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Service and Maintenance Manual

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660SJ

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to S/N 0300235167

P/N - 3121298

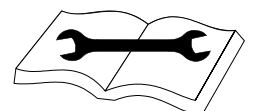
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SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

A GENERAL

This section contains the general safety precautions which must be observed during maintenance of the aerial platform. It is of utmost importance that maintenance personnel pay strict attention to these warnings and precautions to avoid possible injury to themselves or others, or damage to the equipment. A maintenance program must be followed to ensure that the machine is safe to operate.

⚠ WARNING

MODIFICATION OR ALTERATION OF AN AERIAL WORK PLATFORM SHALL BE MADE ONLY WITH WRITTEN PERMISSION FROM THE MANUFACTURER.

The specific precautions to be observed during maintenance are inserted at the appropriate point in the manual. These precautions are, for the most part, those that apply when servicing hydraulic and larger machine component parts.

Your safety, and that of others, is the first consideration when engaging in the maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without the aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. When raising a portion of the equipment, ensure that adequate support is provided.

⚠ WARNING

SINCE THE MACHINE MANUFACTURER HAS NO DIRECT CONTROL OVER THE FIELD INSPECTION AND MAINTENANCE, SAFETY IN THIS AREA RESPONSIBILITY OF THE OWNER/OPERATOR.

B HYDRAULIC SYSTEM SAFETY

It should be noted that the machines hydraulic systems operate at extremely high potentially dangerous pressures. Every effort should be made to relieve any system pressure prior to disconnecting or removing any portion of the system.

Do not use your hand to check for leaks. Use a piece of cardboard or paper to search for leaks. Wear gloves to help protect hands from spraying fluid.



C MAINTENANCE

⚠ WARNING

FAILURE TO COMPLY WITH SAFETY PRECAUTIONS LISTED IN THIS SECTION COULD RESULT IN MACHINE DAMAGE, PERSONNEL INJURY OR DEATH AND IS A SAFETY VIOLATION.

- ENSURE REPLACEMENT PARTS OR COMPONENTS ARE IDENTICAL OR EQUIVALENT TO ORIGINAL PARTS OR COMPONENTS.
- NO SMOKING IS MANDATORY. NEVER REFUEL DURING ELECTRICAL STORMS. ENSURE THAT FUEL CAP IS CLOSED AND SECURE AT ALL OTHER TIMES.
- REMOVE ALL RINGS, WATCHES AND JEWELRY WHEN PERFORMING ANY MAINTENANCE.
- DO NOT WEAR LONG HAIR UNRESTRAINED, OR LOOSE-FITTING CLOTHING AND NECKTIES WHICH ARE APT TO BECOME CAUGHT ON OR ENTANGLED IN EQUIPMENT.
- OBSERVE AND OBEY ALL WARNINGS AND CAUTIONS ON MACHINE AND IN SERVICE MANUAL.
- KEEP OIL, GREASE, WATER, ETC. WIPED FROM STANDING SURFACES AND HAND HOLDS.
- USE CAUTION WHEN CHECKING A HOT, PRESSURIZED COOLANT SYSTEM.
- NEVER WORK UNDER AN ELEVATED BOOM UNTIL BOOM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR BOOM SAFETY PROP HAS BEEN ENGAGED.
- BEFORE MAKING ADJUSTMENTS, LUBRICATING OR PERFORMING ANY OTHER MAINTENANCE, SHUT OFF ALL POWER CONTROLS.
- BATTERY SHOULD ALWAYS BE DISCONNECTED DURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

REVISION LOG

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SECTION 1. SPECIFICATIONS

1.1 OPERATING SPECIFICATIONS

Table 1-1. Operating Specifications

Ground Bearing Pressure 600S 660SJ	67 psi (4.7 kg/cm ²) 75 psi (5.3 kg/cm ²)
Maximum Drive Speed	4.25 MPH (6.8 Km/hr.)
Electrical System	12VDC
Gross Machine Weight (Approximate) 600S - 2WS 600S - 4WS 660SJ - 2WD 660SJ - 4WS	21,425 lbs. (9718 kg) 21,800 lbs. (9888 kg) 26,275 lbs. (11918 kg) 25,910 lbs. (12088 kg)
Ground Bearing Pressure 600S 660SJ	67 psi (4.7 kg/cm ²) 75 psi (5.3 kg/cm ²)
Maximum Drive Speed	4.25 MPH (6.8 Km/hr.)
Electrical System	12VDC
Gross Machine Weight (Approximate) 600S - 2WS 600S - 4WS 660SJ - 2WD 660SJ - 4WS	21,425 lbs. (9718 kg) 21,800 lbs. (9888 kg) 26,275 lbs. (11918 kg) 25,910 lbs. (12088 kg)
Ground Bearing Pressure 600S 660SJ	67 psi (4.7 kg/cm ²) 75 psi (5.3 kg/cm ²)
Maximum Drive Speed	4.25 MPH (6.8 Km/hr.)
Electrical System	12VDC

1.2 DIMENSIONAL DATA

Table 1-2. Dimensional Data

Machine Height (Stowed)	8 ft. 5 in. (2.57 m)
Machine Length (Stowed) 600S 660SJ	28 ft. 4.6 in. (8.65 m) 35 ft. 8 in. (10.88 m)
Machine Width (by tire size) 39x15 - 22.5 15x19.5 tire (non-marking) 41/18LLx22.5X625 (turf)	97 in. (2.46 m) 98 in. (2.49 m) 100 in. (2.54 m)
Wheelbase	8 ft. 1 in. (2.46 m)
Ground Clearance	12 in. (0.3 m)
Platform Height 600S 660SJ	60 ft. 3 in. (18.36 m) 66 ft. 8 in. (20.32 m)
Horizontal Reach 600S 660SJ	49 ft. 6 in. (15.08 m) 56 ft. 9 in. (17.30 m)
Tail Swing	3 ft. 9 in. (1.14 m)
Capacity (Unrestricted)	500 lbs (227 kg)

SECTION 1 - SPECIFICATIONS

1.3 CAPACITIES

Table 1-3. Capacities

Fuel Tank	40 Gallons (151 L)
Hydraulic Oil Tank	32 Gallons (98.4 L)
Hydraulic System (Including Tank)	40 Gallons (121 L)
Torque Hub, Drive*	17 ounces (0.5 L)
Engine Crankcase Deutz D2011L04 GM	11 quarts (10.5 L) 4.5 qts. (4.25 L) w/Filter
*Fill torque hubs half (1/2) full of lubricant.	

1.4 TIRES

Table 1-4. Tire Specifications

Size	39 x 15-22.5
Load Range	G
Ply Rating	14
Foam Fill (Optional)	Foam/Crumb
Diameter	38.5
Width	15.5
Rim Size	11.75 x 22.5
Tire & Wheel Weight	128T, 262FF,
Max Tire Load	16,000 lb (7257 kg) @ 95 psi (6.5 bar)
Size	15 x 19.5 Non-Marking
Load Range	G
Ply Rating	14
Foam Fill	Foam/Crumb
Diameter	40
Width	15.3
Rim Size	11.75 x 19.5
Tire & Wheel Weight	585 lb
Max Tire Load	20,000 lb @ 95 psi (6.5 bar)
Size	41/18LL x 22.5 Turf/Sand
Load Range	H
Ply Rating	16
Foam Fill	Soft
Diameter	41
Width	18.4
Rim Size	14 x 22.5
Tire & Wheel Weight	724 lb (329 kg)
Max Tire Load	15,500 lb @ 70 psi/5 bar

1.5 ENGINE DATA

Table 1-5. Deutz TD 2.9 Specifications

Fuel	Ultra Low Sulfur Diesel (15 ppm)
Output	67 hp (50 kW)
Torque	173 ft.lbs. (234 Nm) @ 1800rpm
Oil Capacity (Crankcase)	2.4 gal (8.9 L) w/Filter
Cooling System	3.3 gal (12.5 L)
Low RPM	1200 ± 50 rpm
High RPM	2600 ± 50 rpm
Alternator	95 Amp
Fuel Consumption	0.65 GPH (2.48 lph)

Table 1-6. Deutz D2011L04

Fuel	Diesel
Oil Capacity	5 Quarts (4.5 L)
Cooling System	11 Quarts (10.5 L) w/Filter
Crankcase	16 Quarts (15 L)
Total Capacity	
Idle RPM	1000
Low RPM	1800
High RPM	2500
Alternator	60 Amp, belt drive
Battery	950 Cold Cranking Amps, 205 Minutes Reserve Capacity, 12 VDC
Fuel Consumption	0.65 GPH (2.46 lph)
Horsepower	49

Table 1-7. GM 3.0L

Fuel	Gasoline or Gasoline/LP Gas
No. of Cylinders	4
BHP	
Gasoline	83 hp @ 3000 rpm
LP	75 hp @ 3000 rpm
Bore	4.0 in. (101.6 mm)
Stroke	3.6 in. (91.44 mm)
Displacement	181 cu.in. (3.0 L, 2966 cc)
Oil Capacity w/filter	4.5 qts. (4.25 L)
Minimum Oil Pressure	
at idle	6 psi (0.4 Bar) @ 1000 rpm
Hot	18 psi (1.2 Bar) @ 2000 rpm
Compression Ratio	9.2:1
Firing Order	1-3-4-2
Max. RPM	2800
Fuel Consumption	
Gasoline	1.43 gph
LPG	8.3 lb/hr

1.6 TORQUE REQUIREMENTS

Table 1-8. Torque Requirements

Description	Torque Value (Dry)	Interval Hours
Bearing To Chassis	190 ft. lbs. (258 Nm)	50/600*
Bearing To Turntable	190 ft. lbs. (258 Nm)	50/600*
Wire Rope	15 ft. lbs (20 Nm)	150
Wheel Lugs	170 ft. lbs (231 Nm)	150
Engine Mounting Bolts	165 ft. lbs. (231 Nm)	A/R
Engine Manifold Mounting Bolts	30 ft. lbs. (42 Nm)	A/R

*Check swing bearing bolts after first 50 hours of operation and every 600 hours thereafter. (See Swing Bearing in Section 3.)

1.7 HYDRAULIC OIL

Table 1-9. Hydraulic Oil

Hydraulic System Operating Temperature Range	S.A.E. Viscosity Grade
+0° to +180°F (-18° to +83°C)	10W
+0° to +210°F (-18° to +99°C)	10W-20, 10W30
+50° to +210°F (+10° to +99°C)	20W-20

NOTE: Hydraulic oils require anti-wear qualities at least API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service.

NOTE: Aside from JLG recommendations, it is not advisable to mix oils of different brands or types. They may not contain required additives or be of comparable viscosities.

Table 1-10. Mobilfluid 424

SAE Grade	10W30
Gravity, API	29.0
Density, Lb/Gal. 60°F	7.35
Pour Point, Max	-46°F (-43°C)
Flash Point, Min.	442°F (228°C)
Viscosity	
Brookfield, cP at -18°C	2700
at 40°C	55 cSt
at 100°C	9.3 cSt
Viscosity Index	152

Table 1-11. Mobil DTE 13M

ISO Viscosity Grade	#32
Specific Gravity	0.877
Pour Point, Max	-40°F (-40°C)
Flash Point, Min.	330°F (166°C)
Viscosity	
at 40°C	33cSt
at 100°C	6.6 cSt
at 100°F	169SUS
at 210°F	48SUS
cp at -20°F	6,200
Viscosity Index	140

Table 1-12. UCon Hydrolube HP-5046

Type	Synthetic Biodegradable
Specific Gravity	1.082
Pour Point, Max	-58°F (-50°C)
pH	9.1
Viscosity	
at 0°C (32°F)	340 cSt (1600SUS)
at 40°C (104°F)	46 cSt (215SUS)
at 65°C (150°F)	22 cSt (106SUS)
Viscosity Index	170

SECTION 1 - SPECIFICATIONS

Table 1-13. Quintolubric 888-46

Density	0.92 @ 15°C (59°F)
Pour Point	<-22°F (<-30°C)
Flash Point	572°F (300°C)
Fire Point	680°F (360°C)
Auto Ignition Temperature	>842°F(>450°C)
Viscosity	
at 0°C (32°F)	320 cSt
at 20°C (68°F)	109 cSt
at 40°C (104°F)	47.5 cSt
at 100°C (212°F)	9.5 cSt
Viscosity Index	190

Table 1-14. Mobil EAL H 46

Type	Synthetic Biodegradable
ISO Viscosity Grade	46
Specific Gravity	.910
Pour Point	-44°F (-42°C)
Flash Point	500°F (260°C)
Operating Temp.	0 to 180°F (-17 to 162°C)
Weight	7.64 lb. per gal. (0.9 kg per liter)
Viscosity	
at 40°C	45 cSt
at 100°C	8.0 cSt
Viscosity Index	153

Table 1-15. Mobil EAL EnviroSyn H 46

Type	Synthetic Biodegradable
ISO Viscosity Grade	46
Density	0.874 @ 15°C (59°F)
Pour Point	-49°F (-45°C)
Flash Point	500°F (260°C)
Operating Temp.	-20 to 200°F (-29 to 93°C)
Viscosity	
at 40°C	48.8 cSt
at 100°C	7.8 cSt
Viscosity Index	145

Table 1-16. Exxon Univis HVI 26

Specific Gravity	32.1
Pour Point	-76°F (-60°C)
Flash Point	217°F (103°C)
Viscosity	
at 40°C	25.8 cSt
at 100°C	9.3 cSt
Viscosity Index	376
NOTE: ExxonMobil recommends checking oil viscosity yearly.	

Table 1-17. Mobil SHC EAL H 46 Specs

Type	Synthetic Biodegradable
ISO Viscosity Grade	46
Density	0.93 @ 15°C (59°F)
Pour Point	-27°F (-33°C)
Flash Point	568°F (298°C)
Operating Temp.	-29 to 93°C (-20 to 200°F)
Viscosity	
at 40°C	43.3 cSt
at 100°C	7.7 cSt
Viscosity Index	149

1.8 MAJOR COMPONENT WEIGHTS

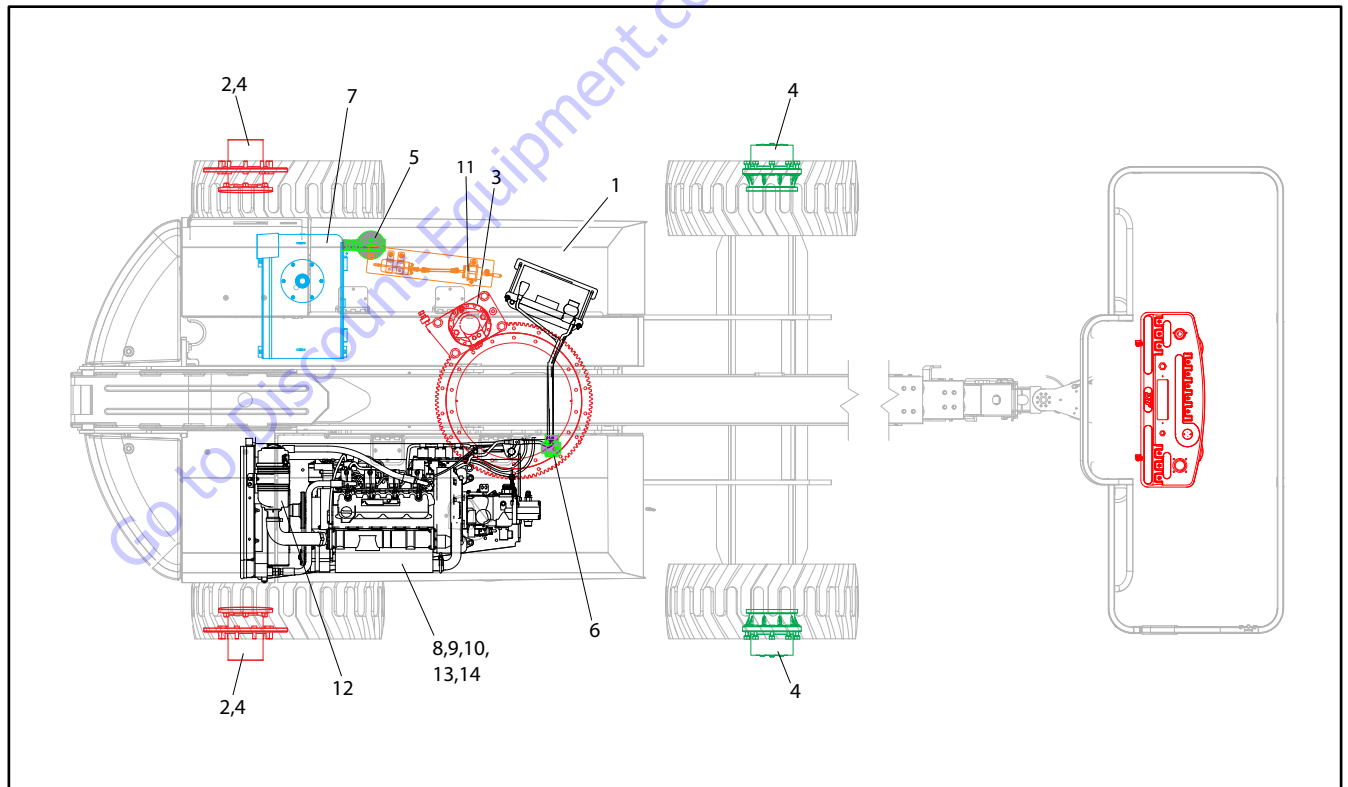
⚠ WARNING

DO NOT REPLACE ITEMS CRITICAL TO STABILITY WITH ITEMS OF DIFFERENT WEIGHT OR SPECIFICATION (FOR EXAMPLE: BATTERIES, FILLED TIRES, PLATFORM) DO NOT MODIFY UNIT IN ANY WAY TO AFFECT STABILITY.

Table 1-18. Component Weights

600S Components	LBS.	KG.
Tire and Wheel (Ballasted Only) 15 - 19.5	253	115
Engine - Deutz	534	242
Counterweight	2900	1315
Platform - 6 ft. (1.83 M)	205	93
Platform - 8 ft. (2.44 M)	230	105

660SJ Components	LBS.	KG.
Tire and Wheel (Ballasted Only) 15 - 19.5	253	115
Engine - Deutz	534	242
Counterweight	4650	2109
Platform - 6 ft. (1.83 M)	205	93
Platform - 8 ft. (2.44 M)	230	105



MAG9540

Figure 1-1. Operator Maintenance and Lubrication

SECTION 1 - SPECIFICATIONS

1.9 OPERATOR MAINTENANCE

NOTE: The following numbers correspond to those in Figure 1-1., Operator Maintenance and Lubrication.

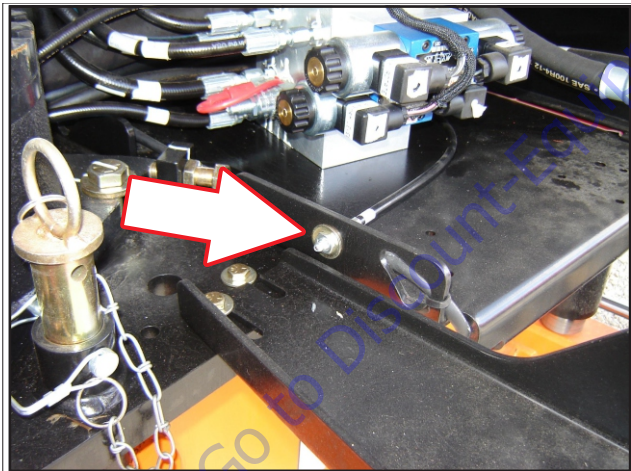
Table 1-19. Lubrication Specifications.

KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350°F (177°C). Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec MIL-L-2105
HO	Hydraulic Oil. API service classification GL-3, e.g. Mobilfluid 424
EO	Engine (crankcase) Oil. Gas - API SF, SH, SG class, MIL-L-2104. Diesel - API CC/CD class, MIL-L-2104B/MIL-L-2104C

NOTICE

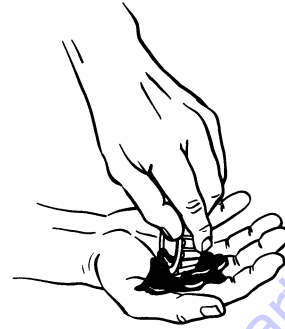
LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

1. Swing Bearing



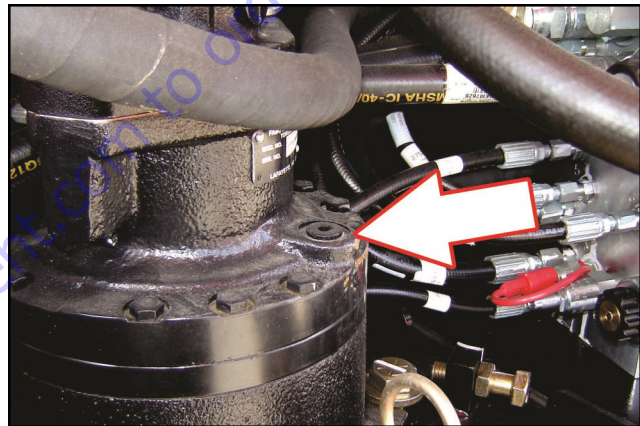
Lube Point(s) - 1 Grease Fittings
 Capacity - A/R
 Lube - MPG
 Interval - Every 3 months or 150 hrs of operation
 Comments - Remote Access. Apply grease and rotate in 90 degree intervals until bearing is completely lubricated.

2. Wheel Bearings (If equipped)



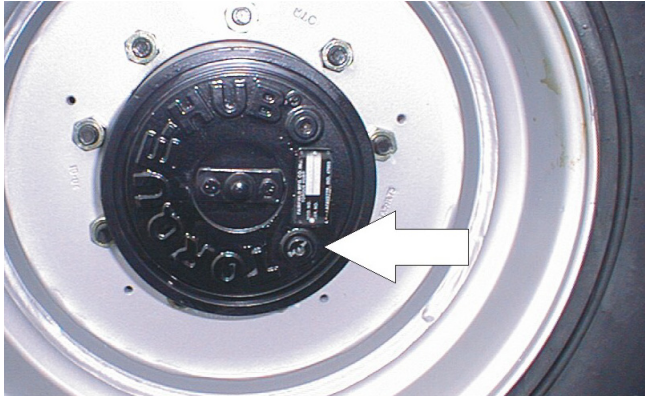
Lube Point(s) - Repack
 Capacity - A/R
 Lube - MPG
 Interval - Every 2 years or 1200 hours of operation.

3. Swing Drive Hub



Lube Point(s) - Level/Fill Plug
 Capacity - 43 oz. (1.3 L)
 Lube - 90w80 Gear Oil
 Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation.

4. Wheel Drive Hub



Lube Point(s) - Level/Fill Plug
Capacity - 17 oz. (1/2 Full)

Lube - EPGL

Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation.

5. Hydraulic Return Filter



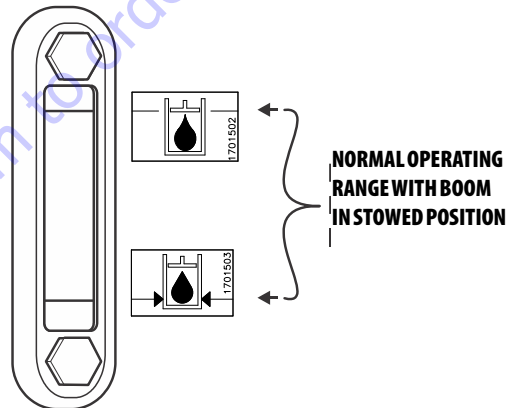
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as shown by Condition Indicator.

6. Hydraulic Charge Filter



Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter, or as shown by Condition Indicator.

7. Hydraulic Tank Lube Point(s) - Fill Cap



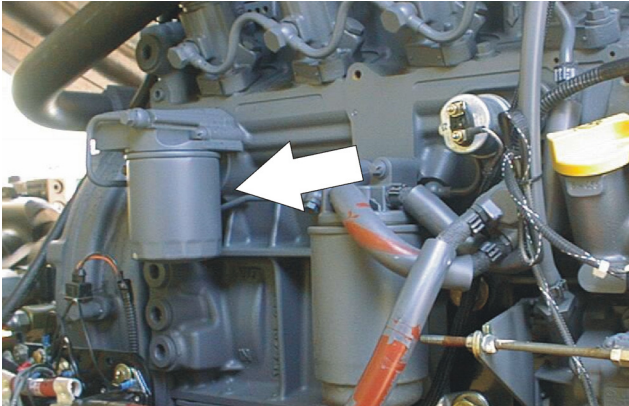
Capacity - 26 gal. Tank; 40 gal. System

Lube - HO

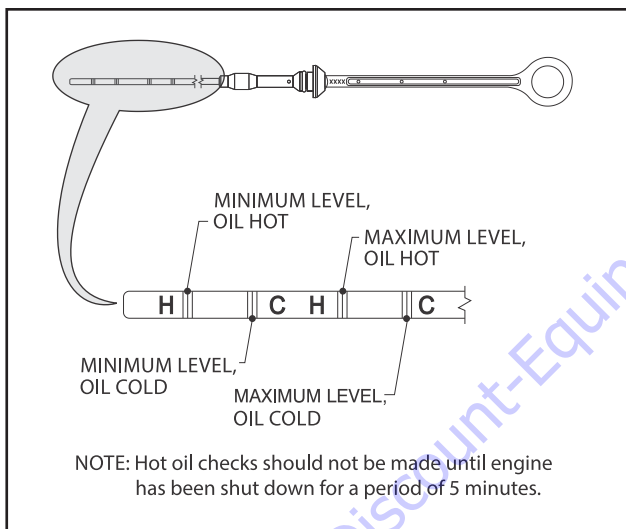
Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

SECTION 1 - SPECIFICATIONS

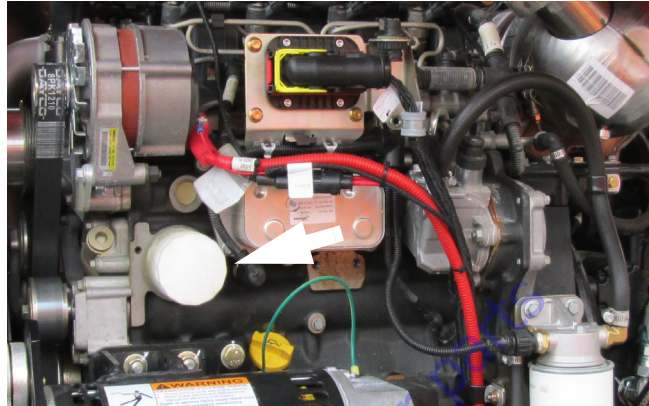
8. A. Oil Change w/Filter - Deutz D2011



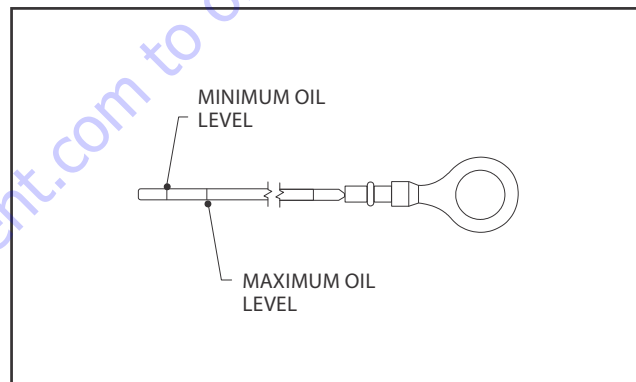
Lube Point(s) - Fill Cap/Spin-on Element
 Capacity - 11 Quarts Crankcase; 5 Quarts Cooler
 Lube - EO
 Interval - Every Year or 1200 hours of operation
 Comments - Check level daily/Change in accordance with engine manual.



B. Oil Change w/Filter - Deutz TD2.9L4



Lube Point(s) - Fill Cap/Spin-on Element
 Capacity - 8.45 Qt (8 L) Crankcase and Filter
 Interval - Every Year or 600 hours of operation
 Comments - Check level daily/Change in accordance with engine manual.

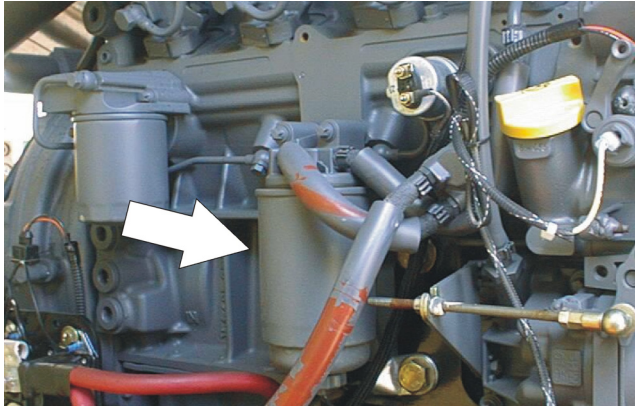


9. Oil Change w/Filter - GM



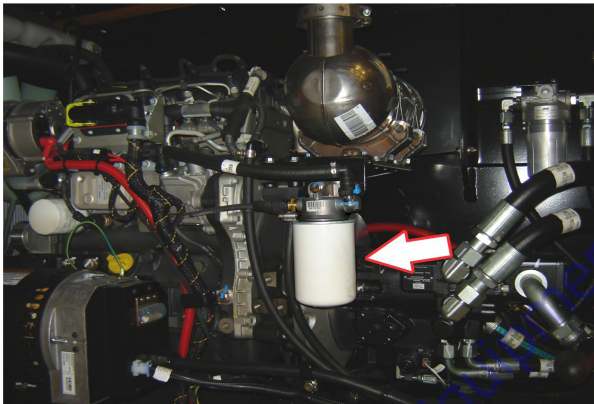
Lube Point(s) - Fill Cap/Spin-on Element
 (JLG P/N 7027965)
 Capacity - 4.5 qt. (4.25 L) w/filter
 Lube - EO
 Interval - 3 Months or 150 hours of operation
 Comments - Check level daily/Change in accordance with engine manual.

10. A. Fuel Filter - Deutz D2011



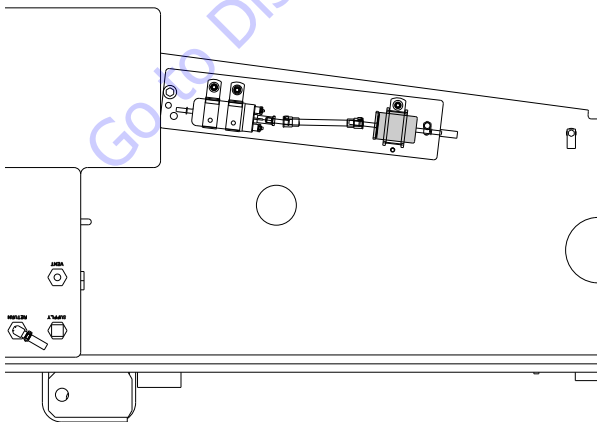
Lube Point(s) - Replaceable Element
Interval - Every Year or 600 hours of operation.

B. Fuel Filter - Deutz TD2.9L4



Lube Point(s) - Replaceable Element
Interval - Every Year or 600 hours of operation.

11. Fuel Filter (Gasoline) - GM



MAG8740

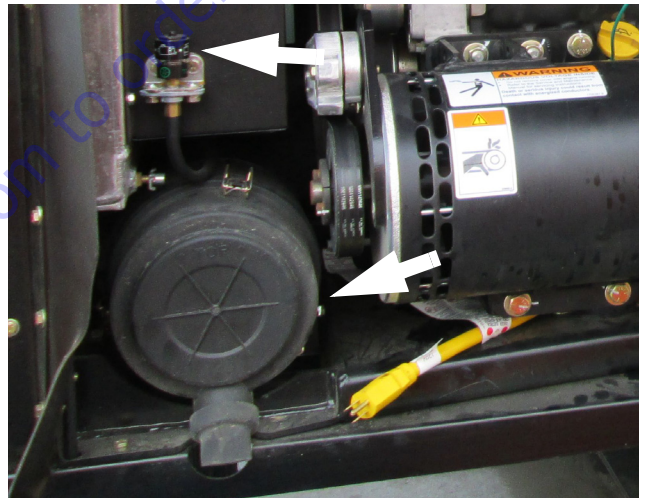
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation.

12. A. Air Filter - Deutz D2011



Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator.

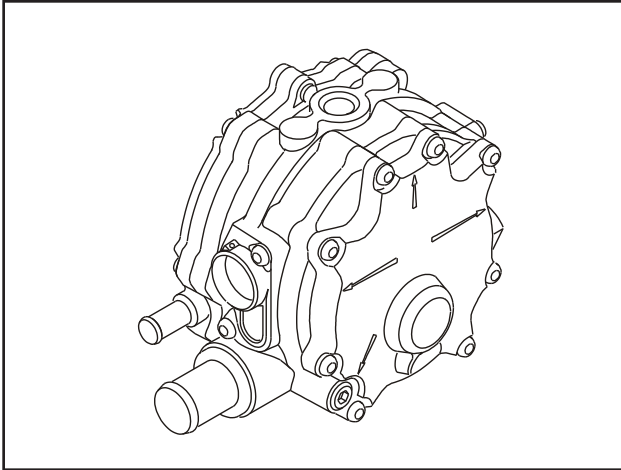
B. Air Filter - Deutz D2.9



Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as shown by condition indicator.

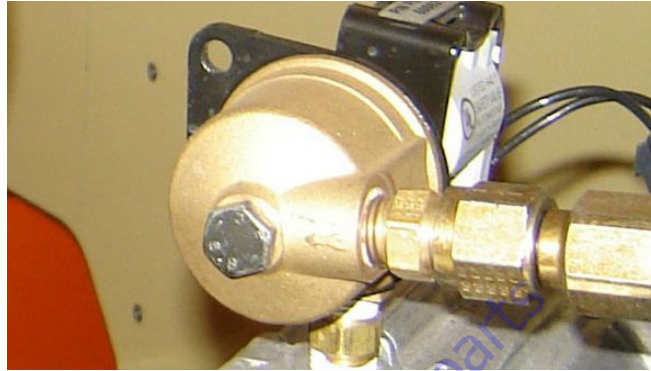
SECTION 1 - SPECIFICATIONS

13. 2-Stage Vaporizer (LP only)



Interval - 3 Months or 150 hours of operation, or whenever fuel is contaminated.
Comments - Drain oil build up or contamination.

14. Fuel Filter (Propane) - GM Engine



Interval - 3 Months or 150 hours of operation
Comments - Replace filter.

Go to Discount-Equipment.com to order your parts

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)																	
SAE GRADE 5 BOLTS & GRADE 2 NUTS							SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry)		Torque Lubricated		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or Vibra-TITE™ 131)		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or TITE™ 131)		
					IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB
4	40	0.1120	0.00604	380	8	0.9	6	0.7									
48	48	0.1120	0.00661	420	9	1.0	7	0.8									
6	32	0.1380	0.00909	580	16	1.8	12	1.4									
40	40	0.1380	0.01015	610	18	2.0	13	1.5									
8	32	0.1640	0.01400	900	30	3.4	22	2.5									
36	36	0.1640	0.01474	940	31	3.5	23	2.6									
10	24	0.1900	0.01750	1120	43	4.8	32	3.5									
32	32	0.1900	0.02000	1285	49	5.5	36	4									
14	20	0.2500	0.0318	2020	96	10.8	75	9									
28	28	0.2500	0.0364	2320	120	13.5	86	10									
5/16	18	0.3125	0.0524	3340	17	23	13	18	16								
24	24	0.3125	0.0580	3700	19	26	14	19	21								
3/8	16	0.3750	0.0775	4940	30	41	23	31	35								
24	24	0.3750	0.0878	5600	35	47	25	34	40								
7/16	14	0.4375	0.1063	6800	50	68	35	47	55								
20	20	0.4375	0.1187	7580	55	75	40	54	60								
12	13	0.5000	0.1419	9050	75	102	55	75	85								
20	20	0.5000	0.1589	10700	90	122	65	88	100								
9/16	12	0.5625	0.1820	11600	110	149	80	108	122								
18	18	0.5625	0.2030	12950	120	163	90	122	135								
5/8	11	0.6250	0.2260	14400	150	203	110	149	165								
18	18	0.6250	0.2560	16300	170	230	130	176	190								
3/4	10	0.7500	0.3340	21300	260	353	200	285	368								
16	16	0.7500	0.3730	23800	300	407	220	298	330								
7/8	9	0.8750	0.4620	29400	430	583	320	434	475								
14	14	0.8750	0.5090	32400	470	637	350	475	520								
1	8	1.0000	0.6060	38600	640	868	480	651	735								
12	12	1.0000	0.6630	42200	700	949	530	719	785								
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840								
12	12	1.1250	0.8560	47500	880	1193	660	895	925								
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175								
12	12	1.2500	1.0730	59600	1240	1681	920	1247	1300								
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525								
12	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750								
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025								
12	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300								

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS.
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%
 3. *ASSEMBLY USES HARDENED WASHER

NO. 5000059 REV. K

REFERENCE JLG THREAD LOCKING COMPOUND		
JLG P/N	Loctite® P/N	Description
0100011	242™	Medium Strength (Blue)
0100019	271™	High Strength (Red)
0100071	262™	Medium - High Strength (Red)

SECTION 1 - SPECIFICATIONS

Values for Magni Coating Fasteners (Ref 4150701)																						
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load		Torque (Dry) K=0.17		Torque (Locite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16		Torque (Locite® 262™ or Vibra-TITE™ 131) K=0.15		Clamp Load		Torque (Dry or Locite® 263) K=0.17		Torque (Locite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16		Torque (Locite® 262™ or Vibra-TITE™ 131) K=0.15				
				LB	Sq In	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB
4	40	0.1120	0.00604	380	7	0.8																
48	0.1120	0.00661	420	8	0.9																	
6	32	0.1380	0.00909	580	14	1.5																
40	0.1380	0.01015	610	14	1.6																	
8	32	0.1840	0.01400	900	25	2.8																
36	0.1840	0.01474	940	26	2.9																	
24	0.1900	0.01750	1120	36	4.1																	
32	0.1900	0.02000	1285	42	4.7																	
20	0.2500	0.0318	2020	86	9.7			80	9													
28	0.2500	0.0364	2320	99	11.1			95	11													
		In	Sq In	LB	FT-LB	[N.m]		FT-LB	[N.m]													
5/16	18	0.3125	0.0524	3340	15	20		14	19													
24	0.3125	0.0580	3700	15	20			15	21													
3/8	16	0.3750	0.0775	4940	25	34		25	34													
24	0.3750	0.0878	5600	30	40			28	38													
7/16	14	0.4375	0.1063	6800	40	55		40	54													
20	0.4375	0.1187	7550	45	60			44	60													
1/2	13	0.5000	0.1419	9050	65	90		60	82													
20	0.5000	0.1599	10700	75	100			71	97													
9/16	12	0.5625	0.1820	11600	90	120		87	118													
18	0.6250	0.2030	12950	105	145			109	130													
5/8	11	0.6250	0.2280	14400	130	175		120	163													
18	0.6250	0.2560	16300	145	195			136	185													
3/4	10	0.7500	0.3340	21300	225	305		213	290													
16	0.7500	0.3730	23800	255	345			225	324													
9	0.8750	0.4620	29400	365	495			343	466													
14	0.8750	0.5090	32400	400	545			378	514													
1	8	1.0000	0.6060	38600	545	740		515	700													
12	1.0000	0.6630	42200	600	815			563	765													
1 1/8	7	1.1250	0.7630	42300	675	920		635	863													
12	1.1250	0.8560	47500	755	1025			713	969													
1 1/4	7	1.2500	0.9690	53800	955	1300		897	1219													
12	1.2500	1.0730	59600	1095	1435			993	1351													
1 3/8	6	1.3750	1.1550	64100	1250	1700		1175	1598													
12	1.3750	1.3150	73000	1420	1930			1338	1820													
1 1/2	6	1.5000	1.4050	78000	1660	2260		1560	2122													
12	1.5000	1.5800	87700	1865	2535			1754	2385													

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%
 3. * ASSEMBLY USES HARDENED WASHER

NO. 5000059 REV. K

Figure 1-3. Torque Chart (SAE Fasteners - Sheet 2 of 5)

SOCKET HEAD CAP SCREWS													
Magni Coating (Ref 4150701)*							Zinc Yellow Chromate Fasteners (Ref 4150707)*						
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K = .17	Torque (Locitite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.16	Torque (Locitite® 262™ or TITE™ 131) K=0.15	Clamp Load See Note 4	Torque (Dry) K = .20	Torque (Locitite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.18	Torque (Locitite® 262™ or Vibra-TITE™ 131) K=0.15		
		In	Sq In	LB	IN-LB [N.m]	FT-LB [N.m]	IN-LB [N.m]	LB	IN-LB [N.m]	FT-LB [N.m]	IN-LB [N.m]	IN-LB [N.m]	FT-LB [N.m]
4	40	0.1120	0.00604										
	48	0.1120	0.00661										
6	32	0.1380	0.00909										
	40	0.1380	0.01015										
8	32	0.1640	0.01400										
	36	0.1640	0.01474										
10	24	0.1900	0.01750										
	32	0.1900	0.02000										
1/4	20	0.2500	0.0318	2860	122	114	13	2860	143	129	15		
	28	0.2500	0.0364	3280	139	131	15	3280	164	148	17		
5/16	18	0.3125	0.0524	4720	20	25	20	4720	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	5220	35	25	35	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	7000	45	60	40	55	35
	24	0.3750	0.0878	7900	40	55	40	7900	50	70	45	60	50
7/16	14	0.4375	0.1063	9550	60	80	55	9550	70	95	65	90	70
	20	0.4375	0.1187	10700	65	90	60	10700	70	100	70	95	80
1/2	13	0.5000	0.1419	12750	90	120	85	12750	105	145	95	130	110
	20	0.5000	0.1599	14400	100	135	95	14400	120	165	110	150	120
9/16	12	0.5625	0.1820	16400	130	175	125	16400	155	210	140	190	115
	18	0.5625	0.2030	18250	145	195	135	18250	170	230	155	210	130
5/8	11	0.6250	0.2260	20350	180	245	170	20350	210	285	190	260	220
	18	0.6250	0.2560	23000	205	280	200	23000	240	325	215	290	245
3/4	10	0.7500	0.3340	30100	320	435	300	30100	375	510	340	460	380
	16	0.7500	0.3730	33600	355	485	335	33600	420	570	380	515	430
7/8	9	0.8750	0.4620	41600	515	700	485	41600	605	825	545	740	620
	14	0.8750	0.5090	45800	570	775	535	45800	670	910	600	815	680
1	8	1.0000	0.6060	51500	730	995	685	51500	860	1170	775	1055	875
	12	1.0000	0.6630	59700	845	1150	795	59700	995	1355	895	1215	1015
1 1/8	7	1.1250	0.7630	68700	1095	1480	1030	68700	1290	1755	1160	1580	1310
	12	1.1250	0.8560	77000	1225	1665	1155	77000	1445	1965	1300	1770	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	87200	1815	2470	1635	2225	1855
	12	1.2500	1.0730	96600	1710	2325	1610	96600	2015	2740	1810	2460	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	104000	2385	3245	2145	2915	2430
	12	1.3750	1.3150	118100	2300	3130	2165	118100	2705	3680	2435	3310	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	126500	3165	4305	2845	3670	3225
	12	1.5000	1.5800	142200	3020	4105	2945	142200	3555	4835	3200	4350	3625

NO. 500059 REV. K

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%

*3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM

4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

Figure 1-4. Torque Chart (SAE Fasteners - Sheet 3 of 5)

SECTION 1 - SPECIFICATIONS

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)											
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS					CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M3 - M5*						
Size	PITCH	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263™)	Torque (Lub)	Torque (Loctite® 262™ OR Vibra-TITE™ 131)	Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)	Clamp Load	Torque (Dry or Loctite® 263™) K=0.20	Torque (Lub OR Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.18	Torque (Loctite® 262™ OR Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]	[N.m]	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.3	1.0	1.2	1.4	3.13			
3.5	0.6	6.78	2.95	2.1	1.6	1.9	2.3	4.22			
4	0.7	8.78	3.82	3.1	2.3	2.8	3.4	5.47			
5	0.8	14.20	6.18	6.2	4.6	5.6	6.8	8.85			
6	1	20.10	8.74	11	7.9	9.4	12	12.5			
7	1	28.90	12.6	18	13	16	19	18.0	25	23	19
8	1.25	36.60	15.9	26	19	23	28	22.8	37	33	27
10	1.5	58.00	25.2	50	38	45	55	36.1	70	65	55
12	1.75	84.30	36.7	88	66	79	97	52.5	125	115	95
14	2	115	50.0	140	105	126	154	71.6	200	180	150
16	2	157	68.3	219	164	197	241	97.8	315	280	235
18	2.5	192	83.5	301	226	271	331	119.5	430	385	325
20	2.5	245	106.5	426	320	383	469	152.5	610	550	460
22	2.5	303	132.0	581	436	523	639	189.0	830	750	625
24	3	353	153.5	737	553	663	811	222.0	1065	960	800
27	3	459	199.5	1080	810	970	1130	286.0	1545	1390	1160
30	3.5	561	244.0	1460	1100	1320	1530	349.5	2095	1885	1575
33	3.5	694	302.0	1990	1490	1790	2090	432.5	2855	2570	2140
36	4	817	355.5	2560	1920	2300	2690	509.0	3665	3300	2750
42	4.5	1120	487.0	4090	3070	3680	4290	698.0	5865	5275	4395

NO. 500059 REV. K

- NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%
 *3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM
 4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

Figure 1-5. Torque Chart (SAE Fasteners - Sheet 4 of 5)

Values for Magni Coated Fasteners (Ref 4150701)										
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS					CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAP SCREWS M6 AND ABOVE*					
Size	PITCH	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263™) K=0.17	Torque (Loctite® 262™ OR Vibra-TITE™ 131) K=0.16	Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.15	Clamp Load	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lub OR Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16	Torque (Loctite® 262™ OR Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.1	1.1	1.0	3.13			
3.5	0.6	6.78	2.95	1.8	1.7	1.5	4.22			
4	0.7	8.78	3.82	2.6	2.4	2.3	5.47			
5	0.8	14.20	6.18	5.3	4.9	4.6	8.85			
6	1	20.10	8.74	9	8.4	7.9	12.5	13	12	11
7	1	28.90	12.6	15	14	13	18.0	21	20	19
8	1.25	36.60	15.9	22	20	19	22.8	31	29	27
10	1.5	58.00	25.2	43	40	38	36.1	61	58	55
12	1.75	84.30	36.7	75	70	66	52.5	105	100	95
14	2	115	50.0	119	110	105	71.6	170	160	150
16	2	157	68.3	186	175	165	97.8	265	250	235
18	2.5	192	83.5	256	240	225	119.5	365	345	325
20	2.5	245	106.5	362	340	320	152.5	520	490	460
22	2.5	303	132.0	494	465	435	189.0	705	665	625
24	3	353	153.5	627	590	555	222.0	905	850	800
27	3	459	199.5	916	860	810	286.0	1315	1235	1160
30	3.5	561	244.0	1245	1170	1100	349.5	1780	1680	1575
33	3.5	694	302.0	1694	1595	1495	432.5	2425	2285	2140
36	4	817	355.5	2176	2050	1920	509.0	3115	2930	2750
42	4.5	1120	487.0	3477	3275	3070	698.0	4985	4690	4395

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS
 2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%
 *3. ASSEMBLY USES HARDENED WASHER OR FASTENER IS PLACED AGAINST PLATED STEEL OR RAW ALUMINUM
 4. CLAMP LOAD LISTED FOR SHCS IS SAME AS GRADE 8 OR CLASS 10.9 AND DOES NOT REPRESENT FULL STRENGTH CAPABILITY OF SHCS. IF HIGHER LOAD IS REQUIRED, ADDITIONAL TESTING IS REQUIRED.

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Figure 1-6. Torque Chart (METRIC Fasteners - Sheet 5 of 5)

PARTS FINDER

**Search Website
by Part Number**



**Search Manual
Library For Parts
Manual & Lookup Part
Numbers – Purchase
or Request Quote**

Search Manuals

Enter your information to search for parts manuals and lookup part numbers.

* Brand:

* Model:

* Serial:

* Part Number:

**Can't Find Part or
Manual? Request Help
by Manufacturer,
Model & Description**

Parts Order Form

Please fill in the following information:

Manufacturer:

Model:

Description:

Discount-Equipment.com is your online resource for quality parts & equipment.

Florida: **561-964-4949** Outside Florida TOLL FREE: **877-690-3101**

Need parts?

Click on this link: <http://www.discount-equipment.com/category/5443-parts/> and choose one of the options to help get the right parts and equipment you are looking for. Please have the machine model and serial number available in order to help us get you the correct parts. If you don't find the part on the website or on one of the online manuals, please fill out the request form and one of our experienced staff members will get back to you with a quote for the right part that your machine needs.

We sell worldwide for the brands: Genie, Terex, JLG, MultiQuip, Mikasa, Essick, Whiteman, Mayco, Toro Stone, Diamond Products, Generac Magnum, Airman, Haulotte, Barreto, Power Blanket, Nifty Lift, Atlas Copco, Chicago Pneumatic, Allmand, Miller Curber, Skyjack, Lull, Skytrak, Tsurumi, Husquvarna Target, , Stow, Wacker, Sakai, Mi-T- M, Sullair, Basic, Dynapac, MBW, Weber, Bartell, Bennar Newman, Haulotte, Ditch Runner, Menegotti, Morrison, Contec, Buddy, Crown, Edco, Wyco, Bomag, Laymor, Barreto, EZ Trench, Bil-Jax, F.S. Curtis, Gehl Pavers, Heli, Honda, ICS/PowerGrit, IHI, Partner, Imer, Clipper, MMD, Koshin, Rice, CH&E, General Equipment, ,AMida, Coleman, NAC, Gradall, Square Shooter, Kent, Stanley, Tamco, Toku, Hatz, Kohler, Robin, Wisconsin, Northrock, Oztec, Toker TK, Rol-Air, Small Line, Wanco, Yanmar

SECTION 2. GENERAL

2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

General

This section provides information needed by personnel responsible to place machine in operation readiness and maintain its safe operating condition. For maximum service life and safe operation, ensure all necessary inspections and maintenance have been completed before placing machine in service.

Preparation, Inspection, and Maintenance

It is important to establish and conform to a comprehensive inspection and preventive maintenance program. The following table outlines periodic machine inspections and maintenance recommended by JLG Industries, Inc. Consult your national, regional, or local regulations for further requirements for aerial work platforms. Frequency of inspections and maintenance must be increased as environment, severity and frequency of usage requires.

Pre-Start Inspection

It is the User's or Operator's primary responsibility to perform a Pre-Start Inspection of the machine before use daily or at each change of operator. Reference the Operator's and Safety Manual for Pre-Start Inspection procedures. The Operator and Safety Manual must be read and understood in its entirety before performing the Pre-Start Inspection.

Pre-Delivery Inspection and Frequent Inspection

The Pre-Delivery Inspection and Frequent Inspection shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

The Pre-Delivery Inspection and Frequent Inspection procedures are performed in the same manner, but at different times. The Pre-Delivery Inspection shall be performed prior to each sale, lease, or rental delivery. The Frequent Inspection shall be accomplished for each machine in service for 3 months or 150 hours (whichever comes first); out of service for a period of more than 3 months; or when purchased used. Frequency of this inspection must be increased as environment, severity and frequency of usage requires.

Reference the JLG Pre-Delivery and Frequent Inspection Form and Inspection and Preventive Maintenance Schedule for items requiring inspection. Reference appropriate areas of this manual for servicing and maintenance procedures.

Annual Machine Inspection

The Annual Machine Inspection must be performed on an annual basis, no later than thirteen (13) months from the date of the prior Annual Machine Inspection. JLG Industries recommends this task be performed by a Factory-Trained Service Technician. JLG Industries, Inc. recognizes a Factory-Trained Service Technician as a person who has successfully completed the JLG Service Training School for the subject JLG product model. Reference the machine Service and Maintenance Manual and appropriate JLG inspection form for performance of this inspection.

Reference the JLG Annual Machine Inspection Form and Inspection and Preventive Maintenance Schedule for items requiring inspection. Reference appropriate areas of this manual for servicing and maintenance procedures.

For the purpose of receiving safety-related bulletins, it is important that JLG Industries, Inc. has updated ownership information for each machine. When performing each Annual Machine Inspection, notify JLG Industries, Inc. of current machine ownership.

Preventive Maintenance

In conjunction with specified inspections, maintenance shall be performed by a qualified JLG equipment mechanic. JLG Industries, Inc. recognizes a qualified JLG equipment mechanic as a person who, by possession of a recognized degree, certificate, extensive knowledge, training, or experience, has successfully demonstrated the ability and proficiency to service, repair, and maintain the subject JLG product model.

Reference the Preventive Maintenance Schedule and appropriate areas of this manual for servicing and maintenance procedures. Frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.

Table 2-1. Inspection and Maintenance

Type	Frequency	Primary Responsibility	Service Qualification	Reference
Pre-Start Inspection	Prior to use each day; or at each Operator change.	User or Operator	User or Operator	Operation and Safety Manual
Pre-Delivery Inspection	Prior to each sale, lease, or rental delivery.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Frequent Inspection	In service for 3 months or 150 hours, whichever comes first; or out of service for a period of more than 3 months; or purchased used.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Annual Machine Inspection	Annually, no later than 13 months from date of prior inspection.	Owner, Dealer, or User	Factory-Trained Service Technician (Recommended)	Service and Maintenance Manual and applicable JLG inspection form.
Preventive Maintenance	At intervals as specified in Service and Maintenance Manual.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual

2.2 SERVICE AND GUIDELINES

General

Following information is provided to assist you in using servicing and maintenance procedures in this manual.

Safety and Workmanship

Your safety, and that of others, is the first consideration in maintenance of equipment. Always be conscious of weight. Never attempt to move heavy parts without aid of a mechanical device. Do not allow heavy objects to rest in an unstable position. Ensure adequate support is provided when raising a portion of the equipment.

Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and contamination out of vital components. Shields, covers, seals, and filters are provided to keep air, fuel, and oil supplies clean; however, these items must be maintained on a schedule to function properly.
2. Any time air, fuel, or oil lines are disconnected, clean adjacent areas as well as the openings and fittings themselves. As soon as a line or component is disconnected, cap or cover all openings to prevent contamination.

3. Clean and inspect all parts during servicing or maintenance. Ensure all passages and openings are unobstructed. Cover all parts to keep them clean. Make sure all parts are clean before they are installed. New parts should remain in their containers until ready to be used.

Components Removal and Installation

1. Use adjustable lifting devices, whenever possible, if mechanical assistance is required. All slings (chains, cables, etc.) should be parallel to each other and as near perpendicular as possible to top of part being lifted.
2. Should it be necessary to remove a component on an angle, keep in mind the capacity of an eyebolt or similar bracket lessens, as the angle between the supporting structure and component becomes less than 90 degrees.
3. If a part resists removal, check to see if all nuts, bolts, cables, brackets, wiring, etc., have been removed and no adjacent parts are interfering.

Component Disassembly and Reassembly

Complete procedural steps in sequence when disassembling or reassembling a component. Do not partially disassemble or assemble one part, then start on another. Always recheck your work to ensure nothing is overlooked. Do not make any adjustments, other than those recommended, without obtaining proper approval.

Pressure-Fit Parts

When assembling pressure-fit parts, use a molybdenum disulfide base compound or equivalent to lubricate the mating surface.

Bearings

1. When a bearing is removed, cover it to keep out dirt and abrasives. Clean bearings in nonflammable cleaning solvent and allow to drip dry. Compressed air can be used, but do not spin the bearing.
2. Discard bearings if races and balls (or rollers) are pitted, scored, or burned.
3. If bearing is found to be serviceable, apply a light coat of oil and wrap it in clean (waxed) paper. Do not unwrap reusable or new bearings until ready to install.
4. Lubricate new or used serviceable bearings before installation. Apply pressure to the outer race when pressing a bearing into a retainer or bore. Apply pressure to the inner race if bearing is installed on a shaft.

Gaskets

Check holes in gaskets align with openings in mating parts. If it is necessary to hand-fabricate a gasket, use gasket material or stock of equivalent material and thickness. Be sure to cut holes in the correct location. Blank gaskets can cause serious system damage.

Bolt Usage and Torque Application

NOTICE

SELF LOCKING FASTENERS, SUCH AS NYLON INSERT AND THREAD DEFORMING LOCKNUTS, ARE NOT INTENDED TO BE REINSTALLED AFTER REMOVAL.

1. Always use new replacement hardware when installing locking fasteners. Use bolts of proper length. A bolt which is too long will bottom before the head is tight against its related part. If a bolt is too short, there will not be enough thread area to engage and hold the part properly. When replacing bolts, use only those having the same specifications of the original, or one which is equivalent.

2. Unless specific torque requirements are given within the text, use standard torque values on heat-treated bolts, studs, and steel nuts, in accordance with recommended shop practices. (See Torque Chart in Section 1.)

Hydraulic Lines and Electrical Wiring

Clearly mark or tag hydraulic lines and electrical wiring, and their receptacles, when disconnecting or removing them from the unit. This ensures correct reinstallation.

Hydraulic System

1. Keep the system clean. If evidence of metal or rubber particles are found in the hydraulic system, drain and flush the entire system.
2. Disassemble and reassemble parts on clean work surface. Clean all metal parts with non-flammable cleaning solvent. Lubricate components as needed to aid assembly.

Lubrication

Service applicable components with the amount, type, and grade of lubricant recommended in this manual at the specified intervals. When recommended lubricants are not available, consult your local supplier for an equivalent that meets or exceeds the specifications listed.

Battery

Clean battery using a non-metallic brush and a solution of baking soda and water. Rinse with clean water. After cleaning, thoroughly dry battery and coat terminals with an anti corrosion compound.

Lubrication and Servicing

Components and assemblies requiring lubrication and servicing are shown in the Lubrication Chart in Section 1.

2.3 LUBRICATION AND INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants can enter the system by using inadequate hydraulic oil; allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance; or allowing the pump to cavitate due to insufficient system warm-up or leaks in pump supply (suction) lines.
2. Design and manufacturing tolerances of component working parts are very close. The smallest amount of dirt or other contamination entering a system can cause wear or damage to components and faulty operation. Take every precaution to keep hydraulic oil clean - including reserve oil in storage. Check, clean, and replace hydraulic system filters as at intervals specified in the Lubrication Chart in Section 1. Always examine filters for metal particles.
3. Cloudy oils indicate high moisture content which permits organic growth and causes oxidation or corrosion. If this condition occurs, the system must be drained, flushed, and refilled with clean oil.
4. It is not advisable to mix oils of different brands or types. They may not contain required additives or be of comparable viscosities. Good grade mineral oils, with viscosities suited to ambient temperatures in which the machine is operating, are recommended for use.

NOTE: *Metal particles may appear in oil or filters of new machines due to wear-in of meshing components.*

Hydraulic Oil

1. Refer to Section 1 for viscosity ranges.

Changing Hydraulic Oil

1. Filter elements must be changed after the first 50 hours of operation and every 300 hours (unless specified otherwise) thereafter. If it is necessary to change the oil, use only those oils meeting or exceeding specifications in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils.
2. Keep hydraulic oil clean. If oil must be poured from original container into another, clean all possible contaminants from the service container. Always clean filter mesh element and replace cartridge any time system oil is changed.
3. While the unit is shut down, a good preventive maintenance measure is to make a thorough inspection of all hydraulic components, lines, fittings, etc., as well as a

functional check of each system, before placing machine back in service.

Lubrication Specifications

Specified lubricants, as recommended by component manufacturers, are always the best choice. However, multi-purpose greases usually have qualities which meet a variety of single purpose grease requirements. Should questions arise regarding use of greases in maintenance stock, consult your local supplier for evaluation. Refer to Section 1 for an explanation of lubricant key designations in the Lubrication Chart.

2.4 CYLINDER DRIFT TEST

Measure maximum acceptable cylinder drift using the following methods.

Platform Drift

Measure platform drift to ground. Lower booms (if equipped) slightly elevated, main boom fully extended with rated load in platform and power off. Maximum allowable drift is 2 inches (5 cm) in 10 minutes. If machine does not pass this test, proceed with the following.

Cylinder Drift

Table 2-2. Cylinder Drift

Cylinder Bore Diameter		Max. Acceptable Drift in 10 Minutes*	
inches	mm	inches	mm
3	76.2	0.026	0.66
3.5	89	0.019	0.48
4	101.6	0.015	0.38
5	127	0.009	0.22
6	152.4	0.006	0.15
7	177.8	0.005	0.13
8	203.2	0.0038	0.10
9	228.6	0.0030	0.08

**Based on 6 drops per minute cylinder leakage.*

Measure drift at cylinder rod with a calibrated dial indicator. Cylinder oil must be at stabilized ambient temperature.

Cylinder must have normal platform load applied.

Cylinder is acceptable if it passes this test.

2.5 PINS AND COMPOSITE BEARING REPAIR GUIDELINES

Filament wound bearings.

1. Pinned joints should be disassembled and inspected if the following occurs:
 - a. Excessive sloppiness in joints.
 - b. Noise originating from joint during operation.
 2. Filament wound bearings should be replaced if any of the following is observed:
 - a. Frayed or separated fibers on the liner surface.
 - b. Cracked or damaged liner backing.
 - c. Bearings that have moved or spun in their housing.
 - d. Debris embedded in liner surface.
 3. Pins should be replaced if any of the following is observed (Clean pin before inspection):
 - a. Detectable bearing area wear.
 - b. Flaking, peeling, scoring, or scratches on pin surface.
 - c. Rusting of pin in bearing area.
 4. Re-assembly of pinned joints using filament wound bearings:
 - a. Blow out housing using compressed air to remove all dirt and debris. Bearings and bearing housings must be free of all contamination.
 - b. Clean bearings and pins with solvent to remove all grease and oil.
- NOTE:** *Filament wound bearings are a dry joint and should not be lubricated unless otherwise instructed (i.e. sheave pins).*
- c. Inspect pin to ensure it is free of burrs, nicks, and scratches which can damage bearing during installation and operation.

2.6 WELDING ON JLG EQUIPMENT

NOTE: *This instruction applies to repairs, or modifications to the machine and to welding performed from the machine on an external structure, or component,*

Do the Following When Welding on JLG Equipment:

- Disconnect battery.
- Disconnect moment pin connection (where fitted)
- Ground only to structure being welded.

Do NOT Do the Following When Welding on JLG Equipment:

NOTICE

FAILURE TO COMPLY WITH THESE INSTRUCTIONS MAY RESULT IN COMPONENT DAMAGE (I.E. ELECTRONIC MODULES, SWING BEARING, COLLECTOR RING, BOOM WIRE ROPES ETC.)

- Do NOT ground on frame and weld on any other area than chassis.
- Do NOT ground on turntable and weld on any other area than turntable.
- Do NOT ground on platform/support and weld on any other area than platform/support.
- Do NOT ground on a specific boom section and weld on any other area than that specific boom section.
- Do NOT allow pins, wear pads, wire ropes, bearings, gearing, seals, valves, electrical wiring, or hoses to be between grounding position and welded area.

SECTION 2 - GENERAL

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL		
	Pre-Delivery ¹ or Frequent ² Inspection	Annual ³ (Yearly) Inspection	Every 2 Years
Boom Assembly			
Boom Weldments	1,2,4	1,2,4	
Hose/Cable Carrier Installations	1,2,9,12	1,2,9,12	
Pivot Pins and Pin Retainers	1,2	1,2	
Sheaves, Sheave Pins	1,2	1,2	
Bearings	1,2	1,2	
Wear Pads	1,2	1,2	
Covers or Shields	1,2	1,2	
Extend/Retract Chain or Cable Systems	1,2,3	1,2,3	
Boom Assembly		14	
Platform Assembly			
Platform		1,2	
Railing	1	1,2	
Gate	1,5	1,5	
Floor	1	1,2	
Rotator	5,9,15		
Lanyard Anchorage Point	1,2,10	1,2,10	
Turntable Assembly			
Swing Bearing	1,2,14	1,2,3,13,14	
Oil Coupling	9		
Swing Drive System	11	11	
Turntable Lock	1,2,5	1,2,5	
Hood, Hood Props, Hood Latches	5	1,2,5	
Chassis Assembly			
Tires	16,17,18	16,17,18	
Wheel Nuts/Bolts	15	15	
Wheel Bearings			14,24
Oscillating Axle/Lockout Cylinder Systems		5,8	
Extendable Axle Systems	5,8	5,8	
Steer Components			
Spindle Thrust Bearing/Washers		1,2	
Drive Hubs	11	11	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL		
	Pre-Delivery ¹ or Frequent ² Inspection	Annual ³ (Yearly) Inspection	Every 2 Years
Functions/Controls			
Platform Controls	5,6	6	
Ground Controls	5,6	6	
Function Control Locks, Guards, or Detents	1,5	5	
Footswitch	5	5	
Emergency Stop Switches (Ground & Platform)	5	5	
Function Limit or Cutout Switch Systems	5	5	
Drive Brakes	5		
Swing Brakes	5		
Auxiliary Power	5	5	
Power System			
Engine Idle, Throttle, and RPM	3	3	
Engine Fluids (Oil, Coolant, Fuel)	9,11	11	
Air/Fuel Filter	1,7	7	
Exhaust System	1,9	9	
Batteries	1,9	19	
Battery Fluid	11	11	
Battery Charger	5	5	
Fuel Reservoir, Cap, and Breather	1,2,5	1,5	
Hydraulic/Electric System			
Hydraulic Pumps	1,2,9		
Hydraulic Cylinders	1,2,7,9	1,2,9	
Cylinder Attachment Pins and Pin Retainers	1,2,9	1,2	
Hydraulic Hoses, Lines, and Fittings	1,2,9,12	1,2,9,12	
Hydraulic Reservoir, Cap, and Breather	1,2,5,9	1,5	24
Hydraulic Filter	1,7,9	7	
Hydraulic Fluid	7,11	7,11	
Electrical Connections	1,20	20	
Instruments, Gauges, Switches, Lights, Horn	1	5,23	
General			
Operation and Safety Manuals in Storage Box	21	21	
ANSI and AEM Manuals/Handbooks Installed (ANSI Markets Only)		21	
Capacity Decals Installed, Secure, Legible	21	21	
All Decals/Placards Installed, Secure, Legible	21	21	

SECTION 2 - GENERAL

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL		
	Pre-Delivery ¹ or Frequent ² Inspection	Annual ³ (Yearly) Inspection	Every 2 Years
Annual Machine Inspection Due	21	21	
No Unauthorized Modifications or Additions	21	21	
All Relevant Safety Publications Incorporated	21	21	
General Structural Condition and Welds	2,4	2,4	
All Fasteners, Pins, Shields, and Covers	1,2	1,2	
Grease and Lubricate to Specifications	22	22	
Function Test of All Systems	21	21,22	
Paint and Appearance	7	7	
Stamp Inspection Date on Frame		22	
Notify JLG of Machine Ownership		22	
Footnotes: ¹ Prior to each sale, lease, or delivery ² In service for 3 months or 150 Hours; or Out of service for 3 months or more; or Purchased used ³ Annually, no later than 13 months from the date of the prior inspection			
Performance Codes: 1 - Check for proper and secure installation 2 - Visual inspection for damage, cracks, distortion or excessive wear 3 - Check for proper adjustment 4 - Check for cracked or broken welds 5 - Operates Properly 6 - Returns to neutral or "off" position when released 7 - Clean and free of debris 8 - Interlocks function properly 9 - Check for signs of leakage 10 - Decals installed and legible 11 - Check for proper fluid level 12 - Check for chafing and proper routing 13 - Check for proper tolerances 14 - Properly lubricated 15 - Torqued to proper specification 16 - No gouges, excessive wear, or cords showing 17 - Properly inflated and seated around rim 18 - Proper and authorized components 19 - Fully charged 20 - No loose connections, corrosion, or abrasions 21 - Verify 22 - Perform 23 - Sealed Properly 24 - Drain, Clean, Refill			

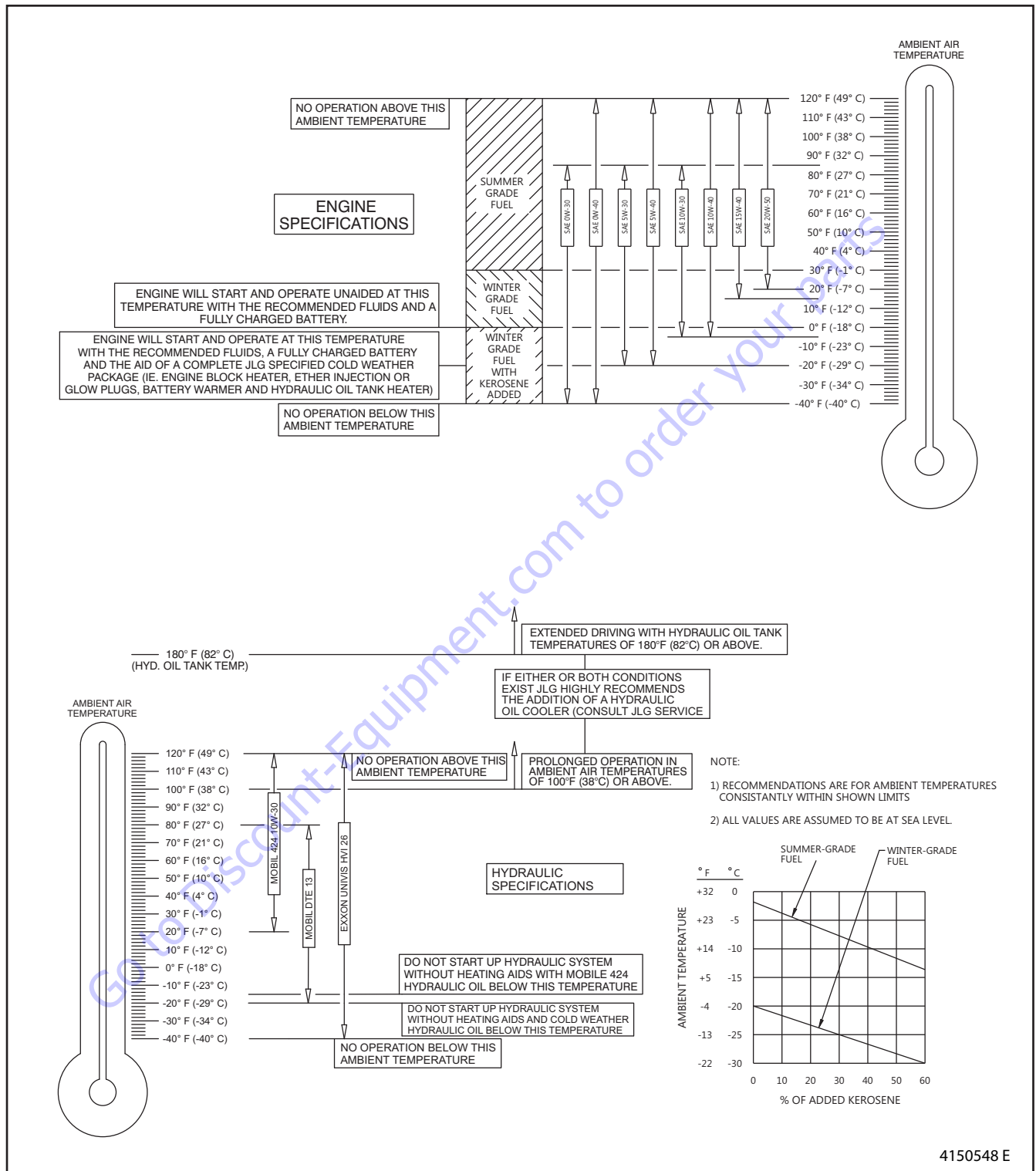


Figure 2-1. Deutz Engine and Hydraulic Operating Temperature Specifications

SECTION 2 - GENERAL

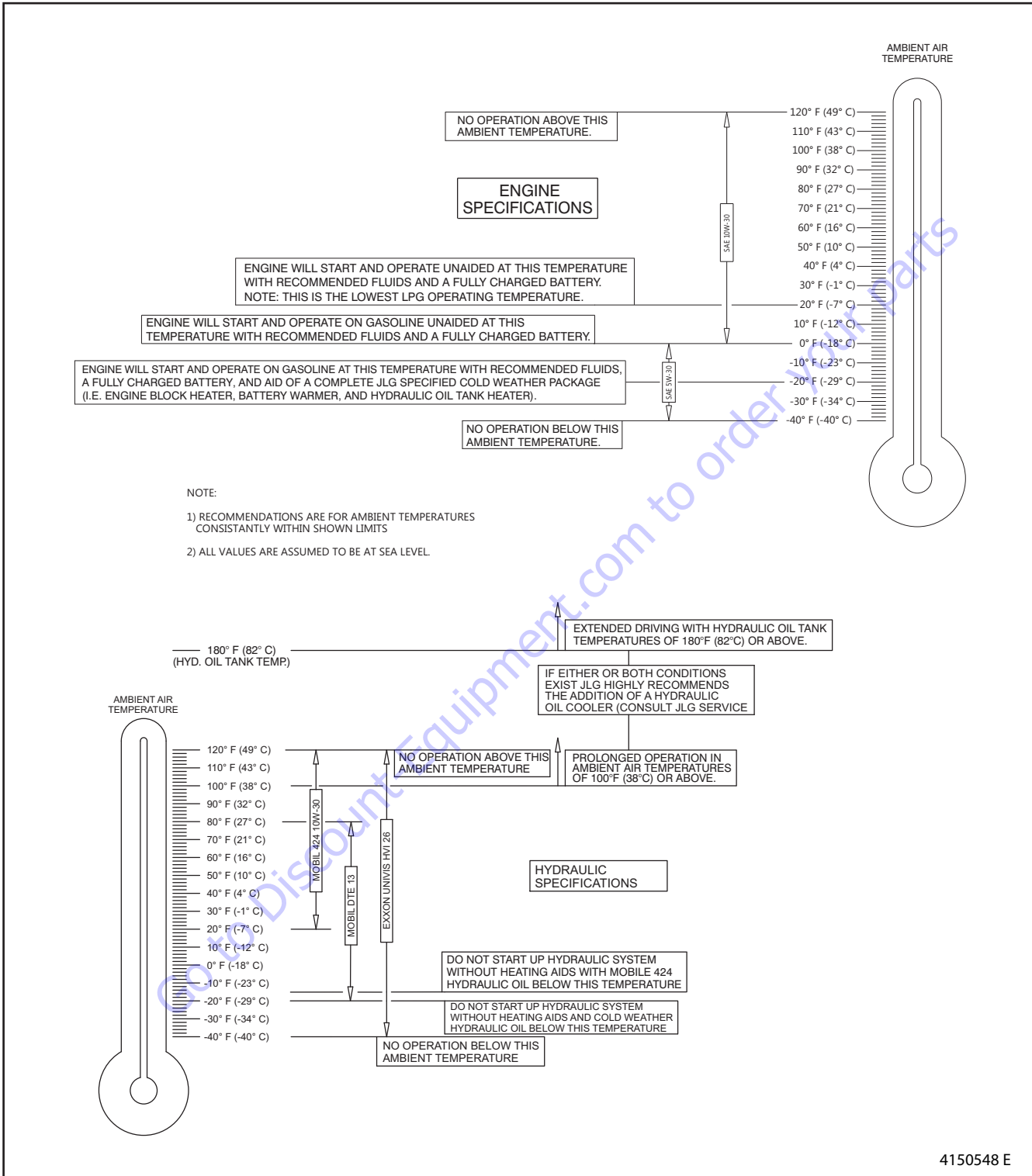


Figure 2-2. GM Engine and Hydraulic Operating Temperature Specifications

PARTS FINDER

**Search Website
by Part Number**



**Search Manual
Library For Parts
Manual & Lookup Part
Numbers – Purchase
or Request Quote**

A screenshot of the "Search Manuals" form on the website. The form has a title "Search Manuals" and a subtitle "Please provide information to help us locate the manual and/or parts you need." It includes several input fields: "Brand" (a dropdown menu), "Serial Number" (a text field), "Model" (a dropdown menu), "Part Number" (a text field), "Part Name" (a text field), and "Comments" (a text area). A "Search" button is located at the bottom of the form.

**Can't Find Part or
Manual? Request Help
by Manufacturer,
Model & Description**

A screenshot of the "Parts Order Form" on the website. The form has a title "Parts Order Form" and a subtitle "Please fill in as much information as possible." It includes several input fields: "Manufacturer" (a dropdown menu), "Model" (a dropdown menu), "Description" (a text field), "Part Number" (a text field), "Part Name" (a text field), "Quantity" (a text field), "Comments" (a text area), and "Requester Name" (a text field). A "Submit" button is located at the bottom of the form.

Discount-Equipment.com is your online resource for quality parts & equipment.

Florida: **561-964-4949** Outside Florida TOLL FREE: **877-690-3101**

Need parts?

Click on this link: <http://www.discount-equipment.com/category/5443-parts/> and choose one of the options to help get the right parts and equipment you are looking for. Please have the machine model and serial number available in order to help us get you the correct parts. If you don't find the part on the website or on once of the online manuals, please fill out the request form and one of our experienced staff members will get back to you with a quote for the right part that your machine needs.

We sell worldwide for the brands: Genie, Terex, JLG, MultiQuip, Mikasa, Essick, Whiteman, Mayco, Toro Stone, Diamond Products, Generac Magnum, Airman, Haulotte, Barreto, Power Blanket, Nifty Lift, Atlas Copco, Chicago Pneumatic, Allmand, Miller Curber, Skyjack, Lull, Skytrak, Tsurumi, Husquvarna Target, , Stow, Wacker, Sakai, Mi-T- M, Sullair, Basic, Dynapac, MBW, Weber, Bartell, Bennar Newman, Haulotte, Ditch Runner, Menegotti, Morrison, Contec, Buddy, Crown, Edco, Wyco, Bomag, Laymor, Barreto, EZ Trench, Bil-Jax, F.S. Curtis, Gehl Pavers, Heli, Honda, ICS/PowerGrit, IHI, Partner, Imer, Clipper, MMD, Koshin, Rice, CH&E, General Equipment, ,AMida, Coleman, NAC, Gradall, Square Shooter, Kent, Stanley, Tamco, Toku, Hatz, Kohler, Robin, Wisconsin, Northrock, Oztec, Toker TK, Rol-Air, Small Line, Wanco, Yanmar

SECTION 3. CHASSIS & TURNTABLE

3.1 TIRES & WHEELS

Tire Inflation

Pneumatic tire air pressure must be equal to air pressure stenciled on side of JLG product or rim decal for safe and proper machine operation.

Tire Damage

PNEUMATIC TIRES

JLG Industries, Inc. recommends when any cut, rip, or tear is discovered that exposes sidewall or tread area cords in the tire, measures must be taken to remove the JLG product from service immediately. Arrangements must be made for replacement of the tire or tire assembly.

POLYURETHANE FOAM FILLED TIRES

JLG Industries, Inc. recommends when any of the following are discovered, measures must be taken to remove the JLG product from service immediately and arrangements made for replacement of tire or tire assembly:

- Smooth, even cut through cord plies which exceeds 3" (7.5 cm) in total length.
- Tears or rips (ragged edges) in cord plies which exceeds 1" (2.5 cm) in any direction.
- Punctures which exceed 1" in diameter.
- Damage to bead area cords.

NOTE: *If a tire is damaged but within above criteria, it must be inspected daily to ensure damage does not exceed allowable criteria.*

Tire Replacement

JLG recommends a replacement tire be the same size, ply, and brand as originally installed on the machine. Please refer to the JLG Parts Manual for part number of approved tires for a particular machine model. If not using a JLG approved replacement tire, we recommend replacement tires have the following characteristics:

- Equal or greater ply/load rating and size of original
- Tire tread contact width equal or greater than original
- Wheel diameter, width, and offset dimensions equal to the original
- Approved for the application by the tire manufacturer (including inflation pressure and maximum tire load)

Unless specifically approved by JLG Industries Inc. do not replace a foam filled or ballast filled tire assembly with a pneumatic tire. When selecting and installing a replacement tire, ensure all tires are inflated to pressure recommended by JLG. Due to size variations between tire brands, both tires on the same axle should be identical.

Wheel Replacement

Rims installed on each product model are designed for stability requirements which consist of track width, tire pressure, and load capacity. Size changes such as rim width, center piece location, larger or smaller diameter, etc., without written factory recommendations, may result in unsafe stability conditions.

Wheel Installation

⚠ WARNING

WHEEL NUTS MUST BE INSTALLED AND MAINTAINED AT PROPER TORQUE TO PREVENT LOOSE WHEELS, BROKEN STUDS, AND DANGEROUS SEPARATION OF WHEEL FROM AXLE. USE ONLY NUTS MATCHED TO CONE ANGLE OF WHEEL.

Tighten lug nuts to proper torque to prevent wheels from coming loose. Use a torque wrench to tighten fasteners. If you do not have a torque wrench, tighten fasteners with a lug wrench, then immediately have a service garage or dealer tighten lug nuts to proper torque.

Over-tightening will break studs or permanently deform mounting stud holes in wheels.

1. Start all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.
2. Tighten nuts in the following sequence:

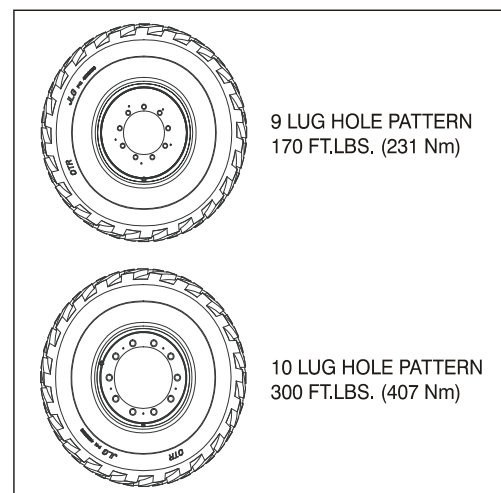


Figure 3-1. Wheel Lug Nut Tightening Sequence

SECTION 3 - CHASSIS & TURNTABLE

- Torque to specifications shown in Table 3-1 below.

Table 3-1. Wheel Torque Chart

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
40 ft-lb (55 Nm)	100 ft-lb (130 Nm)	170 ft-lb (255 Nm)

- Torque wheel nuts after first 50 hours of operation and after each wheel removal. Check torque every 3 months or 150 hours of operation.

3.2 TORQUE HUB

Oil Information

- TYPE – EP90**
Use EP90 for normal applications. For applications where lubricant must meet special requirements, the O.E.M can recommend a suitable substitute.
 - OIL TEMPERATURE**
Continuous – 160° F (70° C) Intermittent – 200° F (95° C).
 - OIL CHANGE**
Initial – After 50 hours or 50,000 revolutions of operation. Subsequent – After 1000 hours or (1) year, whichever comes first.
- NOTE:** Higher temperatures make it necessary to change oil more frequently.
- OIL FILL LEVEL AND VOLUME**
Unit mounted horizontal – half full. (See Diagram A.)
Approximate volume - 17 oz. (0.5 ltr).

Roll and Leak Testing

Always roll and leak test Torque-Hubs after assembly to make sure that the unit's gears and sealants are working properly. The following information briefly outlines what to look for when performing these tests.

ROLL TEST

The roll test determines if the unit's gears rotate freely and properly. You should be able to rotate gears by applying a constant force to the roll checker. If you feel more drag in gears only at certain points, gears are not rolling freely. Examine them for improper installation or defects.

Some gear packages roll with more difficulty than others. Do not be concerned if gears seem to roll hard as long as they roll with consistency.

LEAK TEST

The purpose of a leak test is to make sure unit is air tight. You can tell if your unit has a leak if pressure gauge test reading starts to fall once you have pressurized the unit.

Leaks usually occur at the main seal or wherever O-rings or gaskets are located. You can usually detect location of a leak by brushing a soap and water solution around main seal and where O-rings or gaskets meet unit exterior, then checking for air bubbles. Replace part immediately if you detect a leak in a seal, O-ring, or gasket.

Tightening and Torquing Bolts

NOTICE

USE EXTREME CARE WHEN USING AN AIR IMPACT WRENCH. DO NOT TIGHTEN BOLTS BEYOND THEIR TORQUE SPECIFICATION. NEVER USE AN IMPACT WRENCH TO TIGHTEN SHOULDER BOLTS. TIGHTEN ALL SHOULDER BOLTS BY HAND.

- Tighten (but do not torque) bolt "A" until snug.
- Go to opposite side of bolt circle and tighten bolt "B" until equally snug.
- Continue around bolt circle and tighten remaining bolts.
- Use a torque wrench to apply specified torque to bolt "A".
- Continue around bolt circle and apply equal torque to remaining bolts.

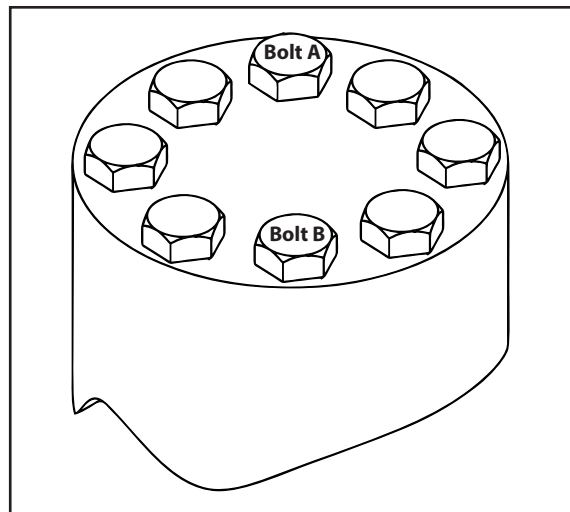
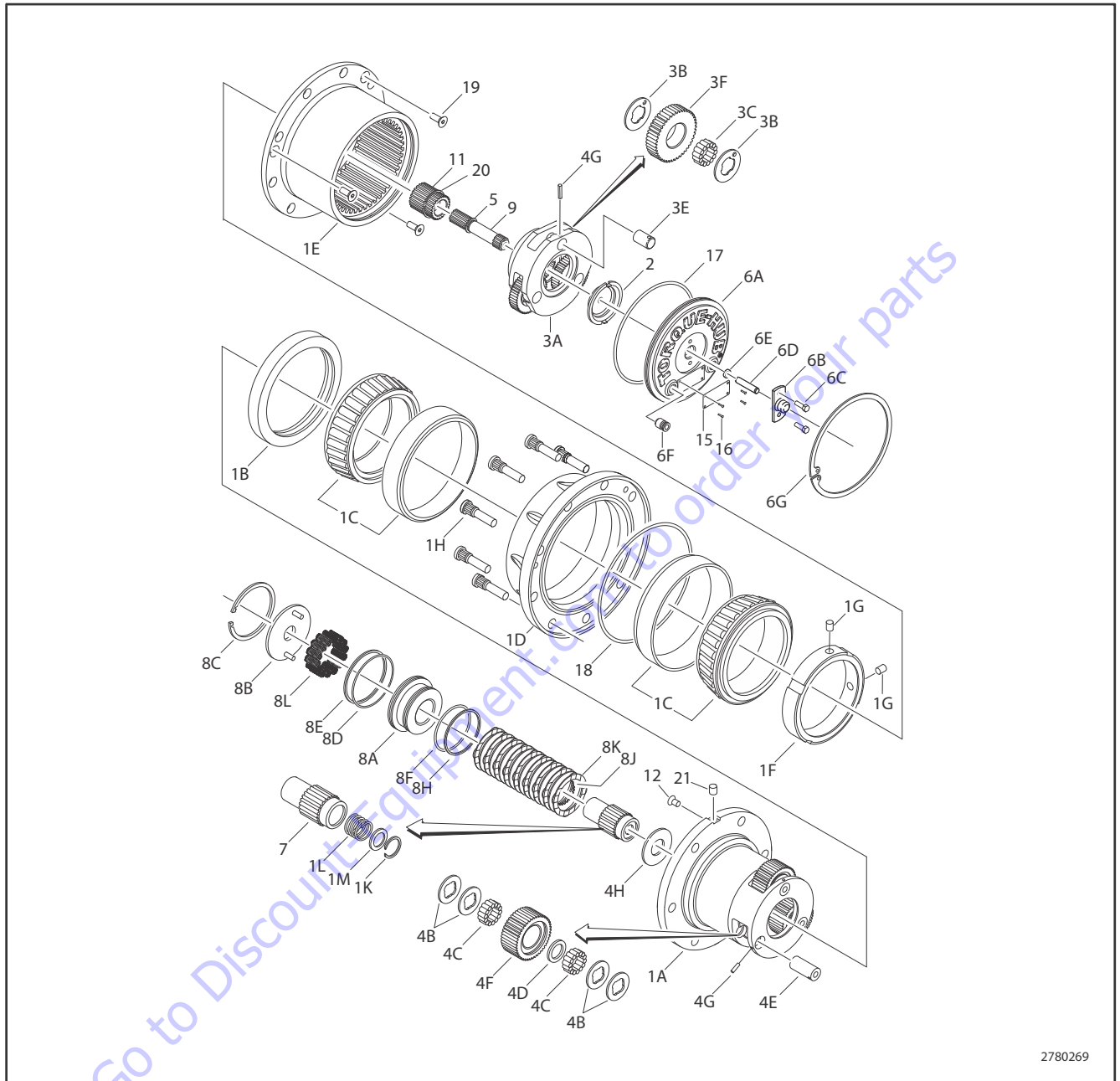


Figure 3-2. Bolt Tightening Sequence



2780269

- | | | | | | |
|--------------------|--------------------|--------------------|--------------------|------------------|-----------------------|
| 1A. Spindle | 1L. Spring | 4C. Needle Bearing | 6C. Bolt | 8D. O-Ring | 12. Plug |
| 1B. Seal | 1M. Thrustwasher | 4D. Thrust Spacer | 6D. Dowel Pin | 8E. Back-up Ring | 15. I.D. Plate |
| 1C. Bearing | 2. Thrustwasher | 4E. Planet Shaft | 6E. O-Ring | 8F. O-Ring | 16. Drive Screw |
| 1D. Housing | 3A. Carrier | 4F. Planet Gear | 6F. Pipe Plug | 8H. Back-up Ring | 17. O-Ring |
| 1E. Ring Gear | 3B. Thrustwasher | 4G. Roll Pin | 6G. Retaining Ring | 8J. Brake Rotor | 18. O-Ring |
| 1F. Bearing Nut | 3C. Needle Bearing | 4H. Thrustwasher | 7. Coupling | 8K. Brake Stator | 19. Countersunk Screw |
| 1G. Setscrew | 3E. Planet Shaft | 5. Retaining Ring | 8A. Brake Piston | 8L. Brake Spring | 20. Retaining Ring |
| 1H. Wheel Stud | 3F. Planet Gear | 6A. Cover Plate | 8B. Pressure Plate | 9. Input Shaft | 21. Plug |
| 1K. Retaining Ring | 4B. Thrustwasher | 6B. Disengage Cap | 8C. Retaining Ring | 11. Sun Gear | |

Figure 3-3. Torque Hub

SECTION 3 - CHASSIS & TURNTABLE

Main Disassembly

1. Perform Roll Check, Leak Check, and Brake Check if applicable before disassembly.
2. Drain oil from unit. Note condition and volume of oil.
3. Remove Retaining Ring (6G) by prying open end of Retaining Ring out of groove in Ring Gear (1E) with a screwdriver. Grasp loose end with pliers and pull out Retaining Ring.
4. Remove Cover Subassembly (6).
5. Remove Input Carrier Subassembly (3).
6. Remove Input Shaft (9).
7. Remove Second Stage Sun Gear (11).
8. Loosen and remove three Flat Head Bolts (19) that retain Ring Gear (1E) to Housing (1D).
9. Lift Ring Gear (1E) off Housing (1D).
10. Remove O-ring (18) from Housing (1D).

NOTE: Carefully pressurize unit with air to pop cover off.

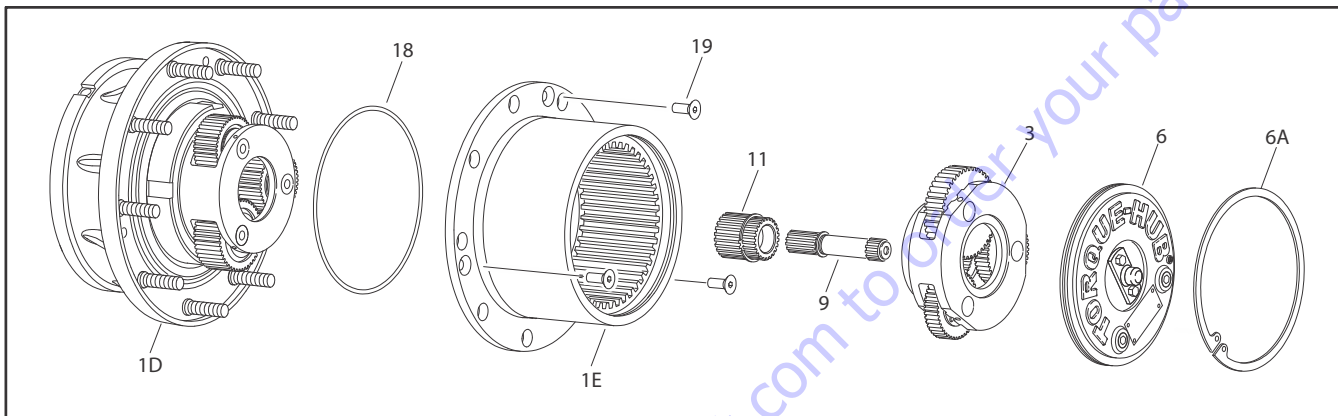


Figure 3-4. Torque Hub Main Disassembly

Output Carrier Disassembly

1. Use a 1/8" diameter punch to drive Roll Pin (4G) in Planet Shaft (4E) until it bottoms against Spindle (1A).
2. Grasp Roll Pin (4G) with needle nosed pliers or a hooked tool and pull Planet Shaft (4E) out of Spindle (1A).
3. Drive Roll Pin (4G) out of Planet Shaft (4E). Discard roll pin.
4. Slide Planet Gear Subassembly (4) out of Spindle (1A). Do not drop Needle Bearings (4C).
5. Remove four Thrust Washers (4B), 28 Needle Rollers (4C), and Thrust Spacer (4D) from Second Stage Planet Gear (4F).
6. Repeat Steps 12-15 for remaining Planet Gears (4F).
7. Remove Thrust Washer (4H) from Spindle (1A) counter-bore.

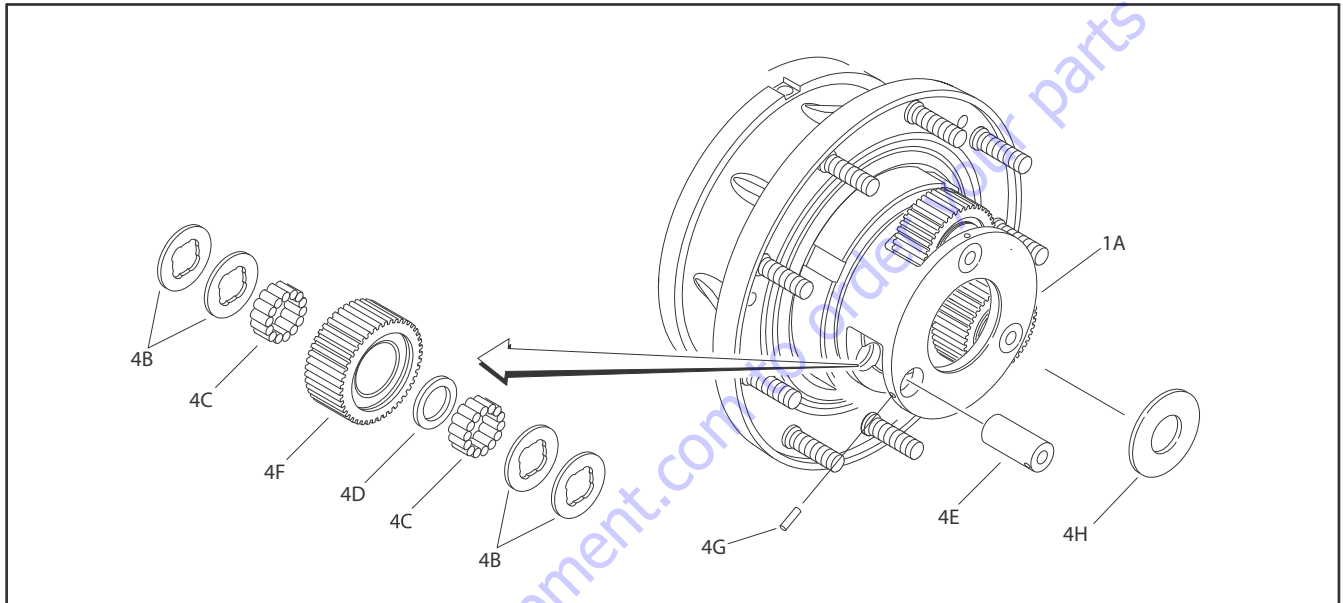


Figure 3-5. Output Carrier Disassembly

Input Carrier Disassembly

1. Using a 1/8" diameter punch, drive Roll Pin (4G) in Planet Shaft (3E) until it bottoms against Carrier (3A).
2. Using a soft face hammer, tap Planet Shaft (3E) out of Carrier (3A).
3. Using a 1/8" diameter punch, drive Roll Pin (4G) out of Planet Shaft (3E). Discard roll pin.
4. Slide Planet Gear (3F) and two Thrust Washers (3B) out of Carrier (3A).
5. Remove 14 needle Bearings (3C) from bore of Planet Gear (3F).
6. Repeat steps 1 through 5 for remaining planet gears.

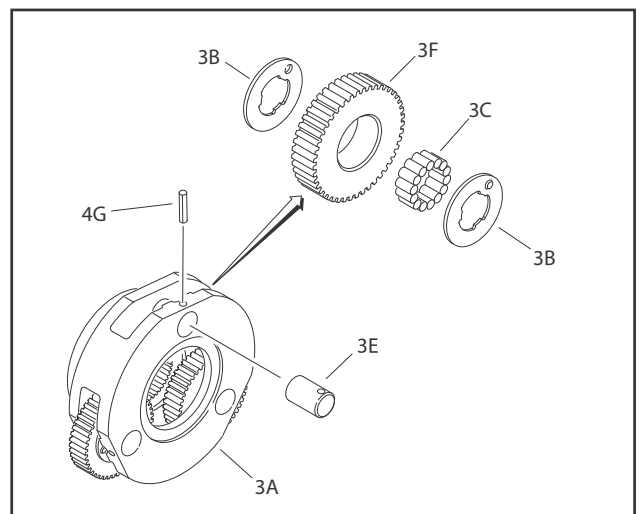


Figure 3-6. Input Carrier Disassembly

Hub-Spindle Disassembly

1. Place unit on bench with Spindle (1A) end down.
 2. Remove 2 Set Screws (1G) and Bearing Nut (1F) using T-206569.
- NOTE:** Holes in Bearing Nut (1F) for Set Screws (1G) are staked for retention of Set Screws (1G). Clean holes before removing Set Screws.
3. Remove "A" position Bearing Cone (1C) from Bearing Cup (1C) in Hub (1D).
 4. While supporting unit on Hub (1D) flange, press Spindle (1A) out of Hub (1D).

5. Lift Hub (1D) off of Spindle (1A). Remove Boot Seal (1Q) from Hub (1D) if applicable.
6. If necessary, press nine Studs (1H) out of Hub (1D). Locate Hub (1D) on Seal (1B) end.
7. Remove Seal (1B) from Hub (1D). Discard seal.
8. Remove "B" position Bearing Cone (1C) from Bearing Cup (1C) in Hub (1D).
9. Remove "B" position Bearing Cone (1C) from Hub (1D).
10. Using a soft steel rod, knock both Bearing Cups (1C) out of Hub (1D).

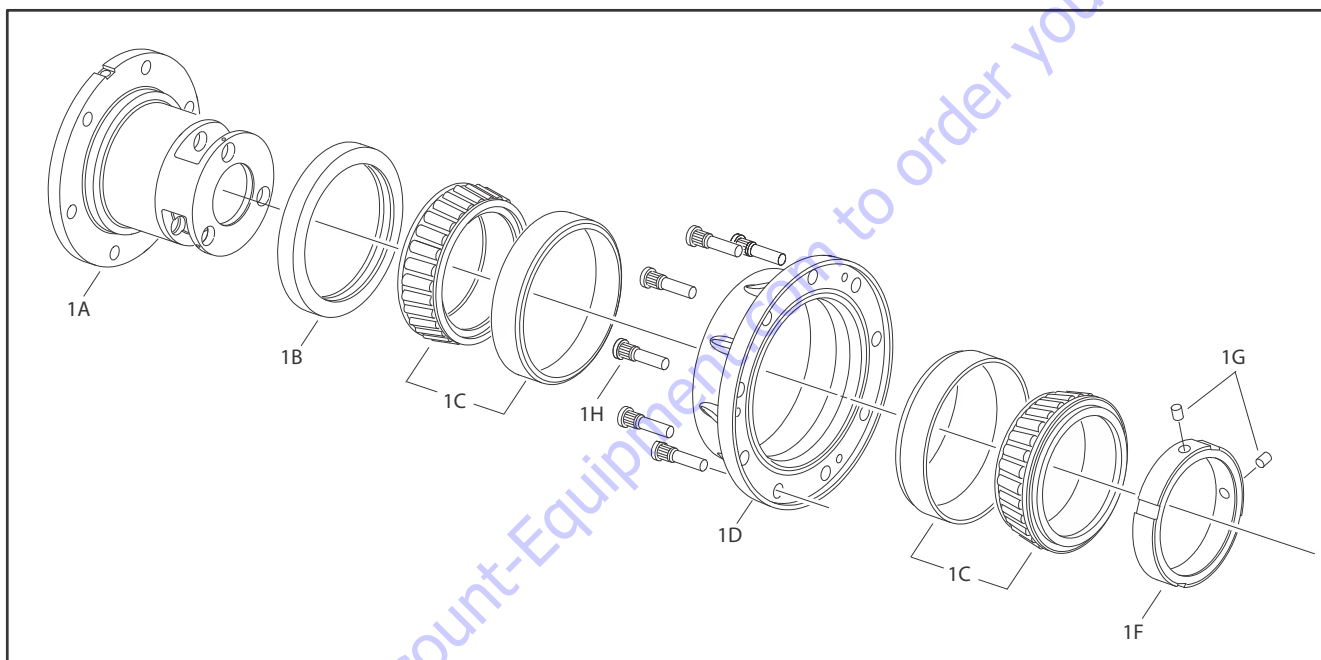


Figure 3-7. Hub Spindle Disassembly

Spindle-Brake Disassembly

NOTE: Units with integral Input Brake (8) only.

CAUTION

COMPRESSED SPRINGS CAN FLY OUT AND CAUSE SEVERE EYE DAMAGE OR OTHER INJURIES. WEAR EYE PROTECTION WHEN PERFORMING THESE PROCEDURES.

1. Install two 1/4"-20 x 5/8" Flat Head Cap Screws (22) through Pressure Plate (8B) into Piston (8A). Tighten incrementally until spring force is taken off Retaining Ring (8C).

NOTE: Flat Head Cap Screws (22) are for transit and service only and are removed before shipping new units. They are included in most brake repair kits.

2. Using retaining ring pliers, remove Retaining Ring (8C) from groove in Spindle (1A).
3. Back Flat Head Cap Screws (22) incrementally out of Piston (8A) until spring force is relieved from Pressure Plate

(8B). Remove Flat Head Cap Screws (22) and Pressure Plate (8B) from brake cavity in Spindle (1A).

4. Remove Compression Springs (8L) from Piston (8A).
5. Using an air hose, slowly and carefully pressurize brake port in Spindle (1A) until Piston (8A) comes out of piston bore of Spindle (1A). Pull Piston (8A) out of Spindle (1A) by hand.
6. Remove Backup Rings (8E and 8H) and O-rings (8D and 8F) from grooves in Piston (8A).
7. Remove Rotors (8J) and Stators (8K) from brake cavity in Spindle (1A).
8. Remove Coupling Subassembly (7) from brake cavity in Spindle (1A).
9. Remove Retaining Ring (1K) from internal groove using appropriate tool.
10. Remove Spacer (1M) and Spring (1L) from bore of Coupling (7).
11. Remove Plastic Plug (12) and Pipe Plug (21) from Spindle (1A) if applicable.

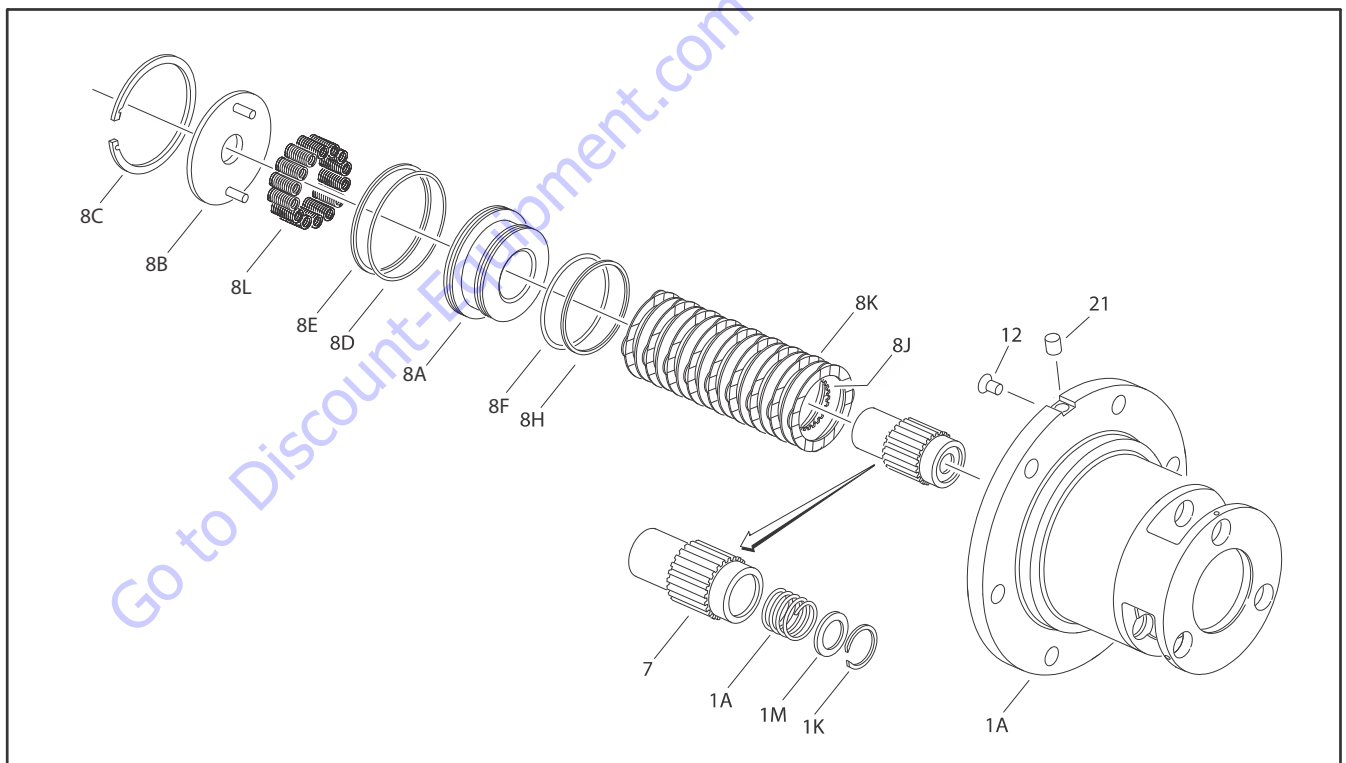


Figure 3-8. Spindle Brake Disassembly

SECTION 3 - CHASSIS & TURNTABLE

Cover Disassembly

1. Remove O-Ring (17) from groove in Cover (6A).
2. Remove Thrust Washer (2) from Cover (6A) pockets.
3. Unscrew two Hex Head Bolts (6C) and remove Disengage Cap (6B) from Cover (6A).
4. Pull Disengage Rod (6D) out from Cover (6A).
5. Use appropriate tool to remove O-ring (6E) from internal groove in Cover (6A).
6. Remove two O-Ring Pipe Plugs (6F) from Cover (6A).

Cover Assembly

1. Grease O-Ring (6E) and insert in internal groove in Cover (6A).
2. Assemble Disengage Cap (6B) on Cover (6A) using two Hex Head Bolts (6C). Torque bolts to 70-80 in-lbs.
3. Insert Disengage Rod (6D) in hole in Cover (6A) until it touches inside of Disengage Cap (6B).

NOTE: Disengage Rod can be inserted either end first.

4. Grease face of Thrust Washer (2) and place in Cover (6A). Make sure tangs on washer seat into pockets in cover.
5. Install O-Ring Pipe Plugs (6F) in Cover (6A). Plugs should be hand tight.

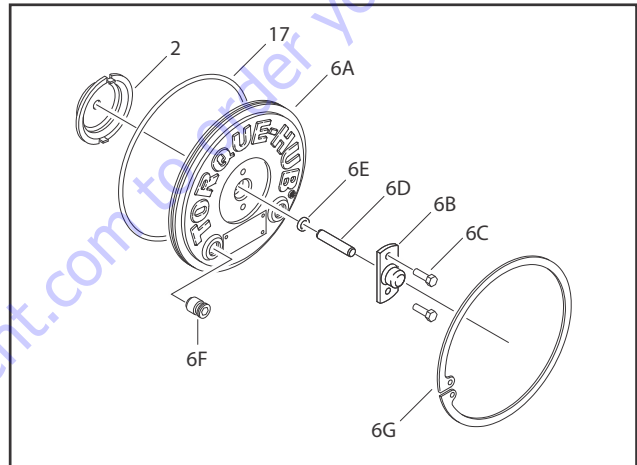


Figure 3-9. Torque Hub Cover

Input Carrier Assembly

1. Apply a liberal coat of grease to bore of one Input Planet Gear (3F).
2. Line inside of Planet Gear (3F) with 14 Needle Rollers (3C).

NOTE: The last roller installed must be installed end wise. That is, the end of the last roller must be placed in between ends of the two rollers which form the space, and then slid, parallel to the other rollers, into place.

3. Set Carrier (3A) in an upright position.

NOTICE

INSERT END OF PLANET SHAFT THAT DOES NOT HAVE ROLL PIN HOLE IN CARRIER FIRST.

4. Insert a Planet Shaft (3E) in planet shaft hole in end of Carrier (3A) opposite splined end.
5. Place one Thrust Washer (3B) on end of Planet Shaft (3E). Make sure the flat faces towards inside of carrier and make sure button fits in the pocket on inside of Carrier (3A) towards the OD.
6. Following the thrust washer, place Planet Gear (3F) with needle rollers, on Planet Shaft (3E).
7. Following the planet gear, place one more Thrust Washer (3B) onto Planet Shaft (3E). Align Thrust Washer (3B) in same manner described in Step 5.

8. Now insert Planet Shaft (3E) through opposite planet shaft hole on Carrier (3A). Use an alignment punch or similar tool to align roll pin holes on Carrier (3A) and Planet Shaft (3E).

NOTICE

DO NOT TO HIT PLANET GEARS (3F) WHEN DRIVING IN ROLL PINS (4G).

9. Drive Roll Pin (4G) down into aligned roll pin holes. Pin should be flush with flat of carrier.
10. Repeat Steps 1-9 for installation of two remaining Planet Gears (3F).

NOTE: Some grease may need to be applied to Thrust Washers (3B) to hold them in place while installing planet gears.

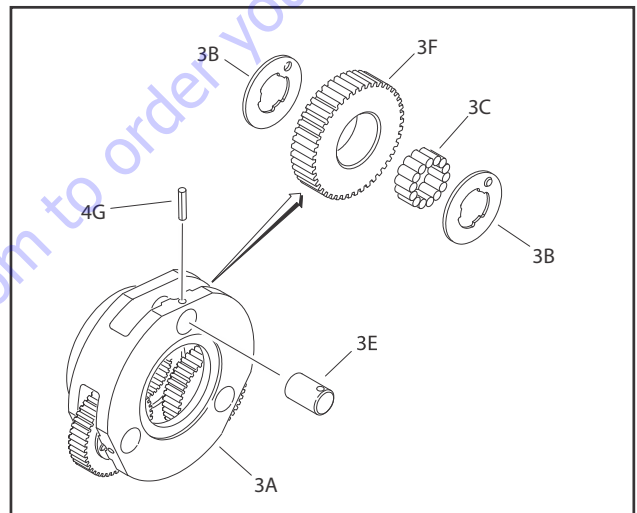


Figure 3-10. Input Carrier Assembly

Spindle - Brake Assembly

1. Place Spindle (1A) with flange side up.
2. Place Stator (8K) in Spindle (1A) scallop cuts.
3. Place Rotor (8J) on top of Stator (8K).
4. Repeat steps 2 & 3 until there are a total of 9 Stators (8K) and 8 Rotors (8J) installed.
5. Place Piston (8A) with smaller O.D. end facing up. Grease two O-Rings and two Backup Rings.
6. Install large Backup Ring (8E) in large-diameter groove at bottom of Piston (8A).
7. Install large O-Ring (8D) in large-diameter groove at bottom of Piston (8A), on top of large Backup Ring (8E).
8. Install small O-Ring (8F) in small-diameter groove near top of Piston (8A). Make sure O-Ring is seated on the bottom of the groove.
9. Install small Backup Ring (8H) in small-diameter groove near top of Piston (8A), on top of small O-Ring (8F).

10. Insert Piston (8A) in Spindle (1A) until it contacts Stator (8K).
11. Insert appropriate number of Springs (8L), based on assembly print, into Piston (8A) counterbore.
12. Place Spring (1L) in Coupling (7) counterbore. Place Pressure plate (1M) on top of Spring (1L).
13. Use appropriate tool to install Retaining Ring (1K) in retaining ring groove in coupling (7) counterbore.
14. Insert Coupling subassembly (7) through Rotors (8J).
15. Place Pressure Plate (8B) on top of Springs (8L).
16. Use two ¼ -20 x 0.625 Flat Head Cap Screws (22) by bolting Pressure Plate (8B) and Piston (8A) together or some other appropriate tools to install Retaining Ring on top of Pressure Plate (8B) until Retaining Ring (8C) is seated.

NOTE: Remove two screws from units when done or brake will not function.

17. Install Pipe Plug (21) if applicable.

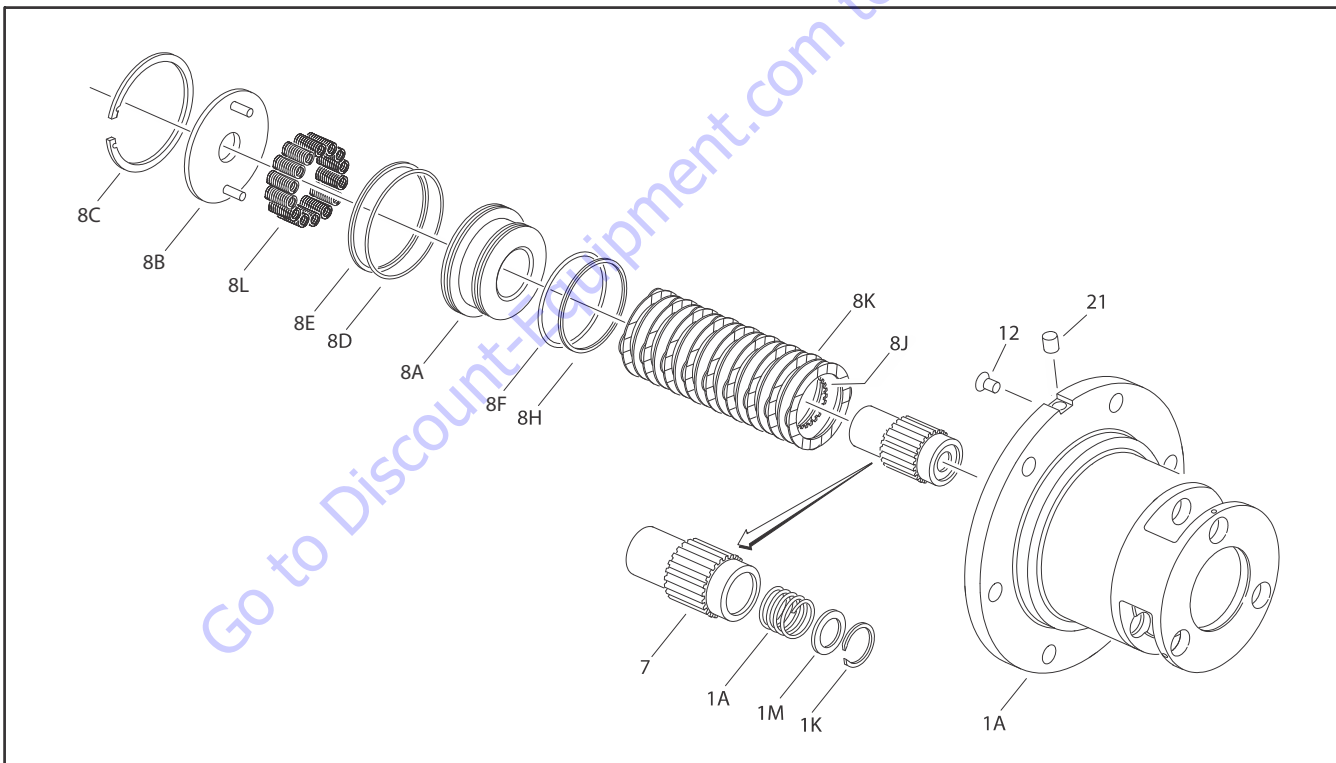


Figure 3-11. Spindle-Brake Assembly

Hub-Spindle Assembly

NOTE: Spray a light film of oil on all component parts during assembly. Spray a generous amount of oil on bearings during installation.

1. Press Bearing Cup of part (1C), position "A", into Hub using T-158422 pressing tool.
2. Turn hub over and press Bearing Cup of part (1C), position "B", into hub using T-158422 pressing tool.(T).
3. Place Bearing Cone of part (1C), into Bearing Cup of part (1C), position "B".
4. Grease Seal (1B) lip and press seal into Hub (1D) using appropriate tool until seal is flush with end of hub.(T).

NOTICE

DO NOT USE EXCESSIVELY HIGH PRESSURE TO PRESS IN STUDS OR HUB MAY CRACK.

5. Place Hub (1D) into pressing base. Press nine Studs (1H) in Hub.

6. Set Spindle assembly (1A) on bench with flange down. Turn Hub (1D) over and lower onto Spindle (5). Install boot (21) if applicable.
7. Install Bearing Cone of part (1C) in Bearing Cup, position "A".
8. Apply Loctite 243 or equivalent on Bearing Nut (1F) thread. Screw Nut (1F) on top of Bearing Cone of part (1C). Leave 0.003-0.005 inches end play to check initial rolling torque with unit tied down. Torque Bearing Nut (1F) until rolling torque is 40 - 50 in-lb (4.5 - 5.6 Nm) greater than initial rolling torque. Using tool T-206569 for Bearing Nut.

NOTE: Final torque is initial rolling torque plus 40-50 in-lb E.g., if initial rolling torque is 30 in-lb, final rolling torque is between 70-80 in-lb. Be sure to rotate hub as torque is applied to properly seat bearing. Be sure torque wrench is tangent to the Hub (1D) OD.

9. Install two Set Screws (1G) in Bearing Nut (1F) threaded holes. Make sure Set Screw is driven in spindle thread. Tighten set screws to damage thread and stake edge of nut around Set Screws (1G) so nut will not loosen.

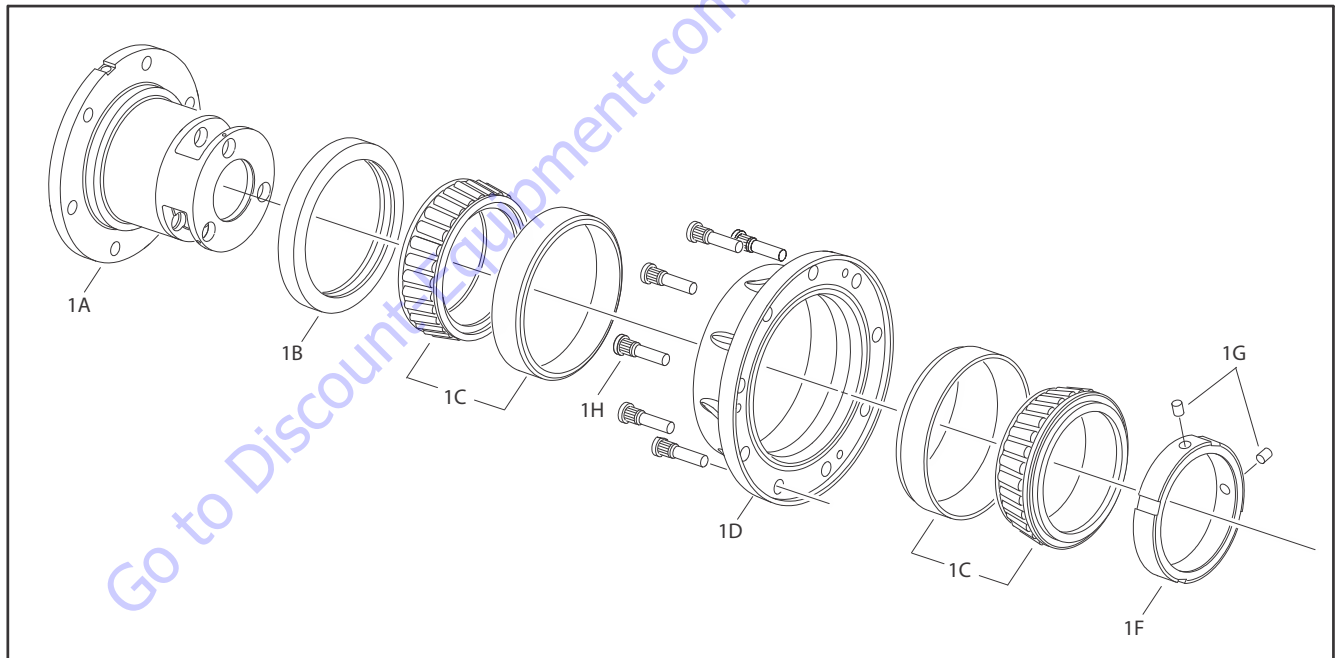


Figure 3-12. Hub Spindle Assembly

SECTION 3 - CHASSIS & TURNTABLE

Output Planet Gear Assembly

1. Apply a liberal coat of grease to the bore of one Output Planet Gear (4F).
2. Line inside of Planet Gear (4F) with 14 Needle Rollers (4C).

NOTE: Last roller installed must be installed end wise. That is, the end of the last roller must be placed in between the ends of the two rollers which form the space, and then slid, parallel to the other rollers, into place.

3. Place Spacer (4D) in bore of Output Planet (4F).
4. Repeat Step 2 to put in second roll of Needle Rollers (4C).
5. Apply grease to hold two Thrust Washers (4B) together and on Output Planet Gear (4F) counterbore. Repeat on other side.
6. Repeat Steps 1-5 for remaining Output Planet Gears (4F).
7. Place Thrust Washer (4H) in counterbore of Spindle (1A).

8. Place Planet Gear Subassembly (4) in Spindle (1A) through gap between two Studs (1H). Align planet gear bore with one of the planet shaft holes on spindle (1A) assembly using special tool T-209919.

NOTICE

INSERT END OF PLANET SHAFT THAT DOES NOT HAVE ROLL PIN HOLE IN SPINDLE FIRST.

9. Insert Planet Shaft (4E) in Spindle (1A) through first set of Thrust Washers (4B), Planet gear, and second set of Washers (4B).
10. Use an alignment punch or similar tool to align roll pin holes on Spindle (1A) and Planet Shaft (4E).

NOTICE

DO NOT HIT PLANET GEARS (4F) WHEN DRIVING IN ROLL PINS (4G).

11. Drive new Roll Pin (4G) in aligned roll pin holes. Pin should be flush with OD of spindle.
12. Repeat Steps (11-14) for remaining Planet Gears (4F).

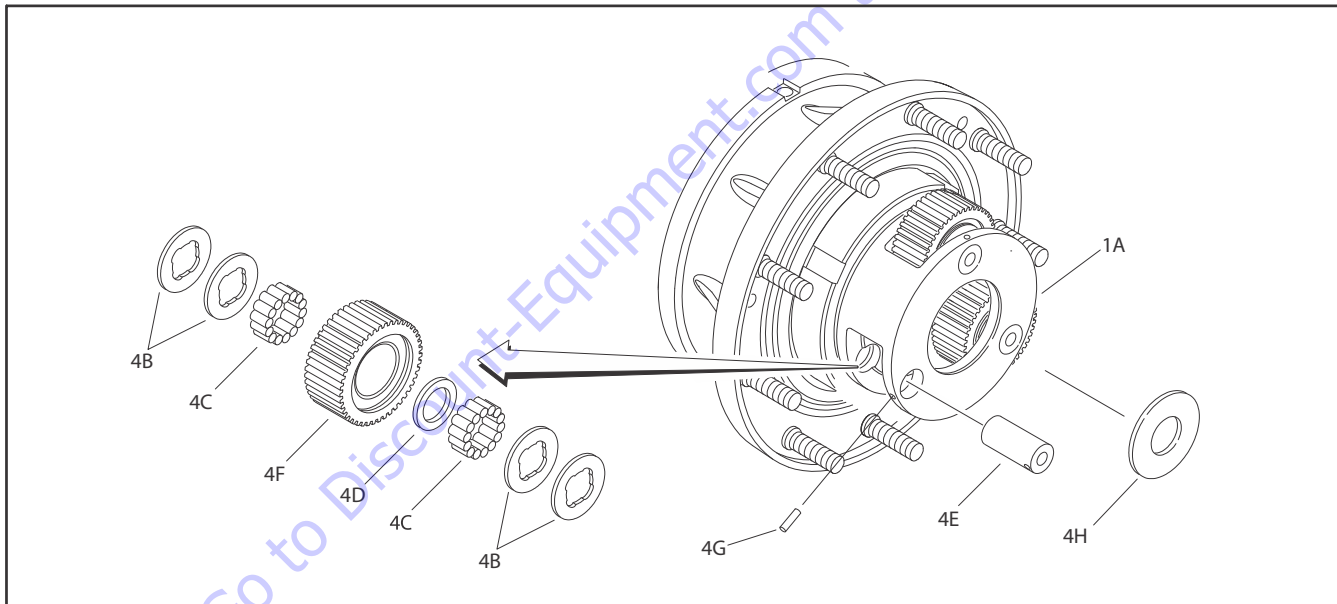


Figure 3-13. Output Planet Gear Assembly

Main Assembly

NOTE: Coat all components with a generous amount of lubricant oil as they are being assembled.

1. Place Hub-Spindle Subassembly on bench.
2. Grease O-Ring (18) and place it in groove of Hub (1D).
3. Place Ring Gear (1E) on Hub (1D). Align three shipping Cap Screw Holes on Hub (1D) and Ring Gear (1E).
4. Install three shipping Cap Screws (19) in ring gear and hub. Torque to 15-20 ft-lb.
5. Place External Retaining Ring (5) over 13T spline to the retaining groove on Input Shaft (9).

NOTE: For ratio 48:1, assemble Output Sun Gear (11) over Input Shaft (9) first, then install External Retaining Ring (5).

6. Using appropriate tool to install Retaining Ring (20) in groove on Output Sun (11).
7. Place Input Shaft (9) spline end into mesh with Internal Coupling (7) splines.
8. With modified spline end facing up, place Output Gear (11) in mesh with planet gears from Hub-Spindle Subassembly.
9. Place Input Carrier Subassembly (3) on Output Sun Gear (11) splines.
10. Grease O-Ring (17) and insert in groove in Cover Subassembly (6).
11. Install Cover Subassembly (6) in Ring Gear (1E) counter-bore and install Retaining Ring (6G) in groove in Ring Gear (1E).
12. Check disconnect, roll and air check unit, leak check brake, and record release pressure.

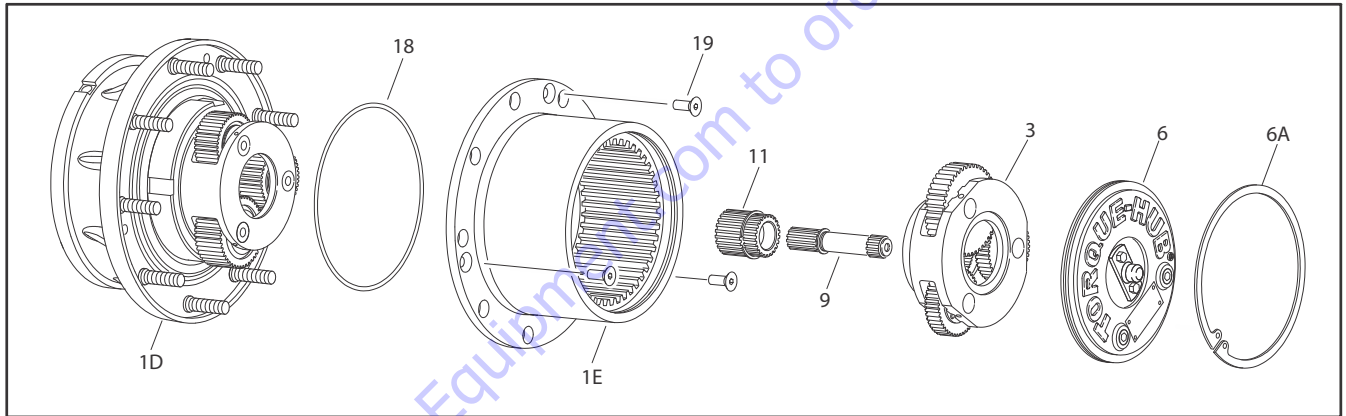


Figure 3-14. Main Assembly

Integral Brake Check

1. Using appropriate fittings, connect hydraulic line from hand pump to brake port.
2. Check brake is set by trying to rotate Input Shaft (9). This can be accomplished by installing an appropriate tool (any tool that can locate on splines of Input Coupling (7), such as a mating splined shaft) into Input Coupling (7). Bleed brake.
3. Increase hydraulic pressure gradually while trying to rotate input until brake just starts to release. Note this pressure. Make sure pressure falls into appropriate range in Table 3-2.

Table 3-2. Torque Hub Brake Release Pressure

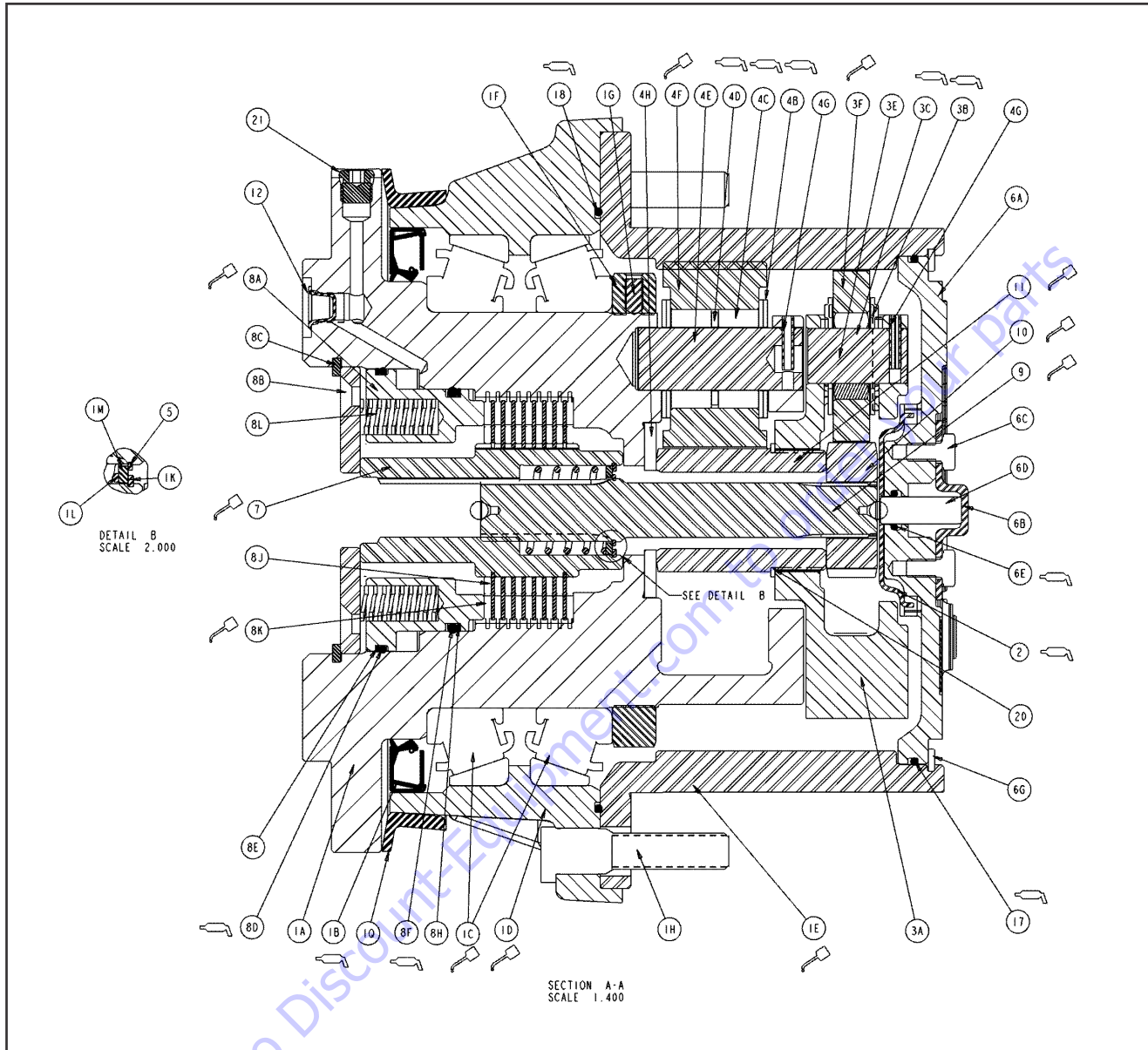
BRAKE CODE	JUST RELEASE PRESSURE RANGE	
	PSI	BAR
A	200-260	13.7-17.9
B	170-220	11.7-15.1
C	140-185	9.6-12.7
D	130-155	8.9-10.6
E	115-145	7.9-9.9

4. Increase pressure to 1,000 psi and hold for 30 seconds to check for leaks. Repair leaks if necessary.

NOTE: Make sure brake re-engages when pressure is released.

NOTE: When done, make sure Input Coupling (7) is centered in Spindle (1A) to make installation of motor possible without release of brake.

SECTION 3 - CHASSIS & TURNTABLE



- | | | | | | |
|---------------------|--------------------|--------------------|--------------------|------------------|--------------------|
| 1A. Spindle | 1M. Thrust Washer | 4C. Needle Bearing | 6C. Bolt | 8D. O-Ring | 11. Sun Gear |
| 1B. Lip Seal | 1Q. Seal Boot | 4D. Thrust Spacer | 6D. Dowel Pin | 8E. Backup Ring | 12. Plastic Plug |
| 1C. Tapered Bearing | 2. Thrust Spacer | 4E. Planet Shaft | 6E. O-Ring | 8F. O-Ring | 15. ID Plate |
| 1D. Housing | 3A. Carrier | 4F. Planet Gear | 6F. Pipe Plug | 8H. Backup Ring | 16. Drive Screw |
| 1E. Ring Gear | 3B. Thrust Washer | 4G. Roll Pin | 6G. Retaining Ring | 8J. Brake Rotor | 17. O-Ring |
| 1F. Bearing Nut | 3C. Needle Bearing | 4H. Thrust Washer | 7. Coupling | 8K. Brake Stator | 18. O-Ring |
| 1G. Setscrew | 3E. Planet Shaft | 5. Retaining Ring | 8A. Brake Piston | 8L. Spring | 19. Bolt |
| 1H. Stud | 3F. Planet Gear | 6A. Cover | 8B. Pressure Plate | 9. Input Shaft | 20. Retaining Ring |
| 1K. Retaining Ring | 4B. Thrust Washer | 6B. Disengage Cap | 8C. Retaining Ring | 10. Sun Gear | 21. O-Ring Plug |
| 1L. Spring | | | | | |

Figure 3-15. Hub Assembly

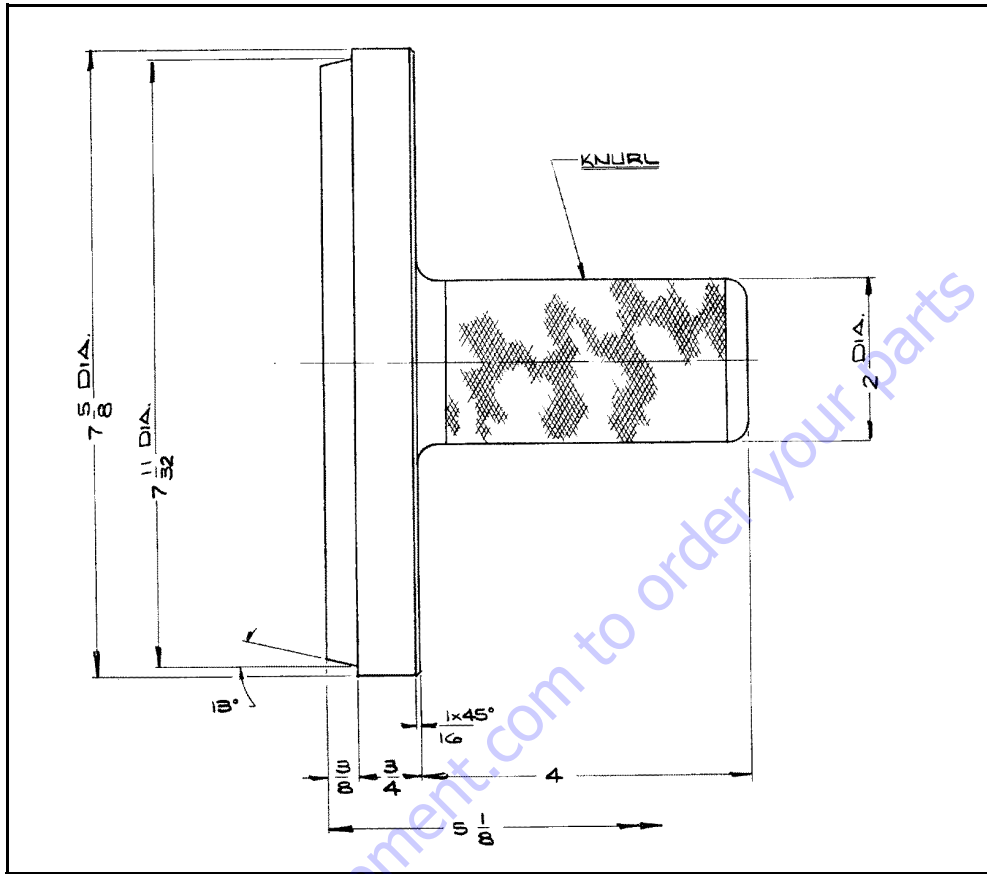


Figure 3-16. Bearing Cup Pressing Tool

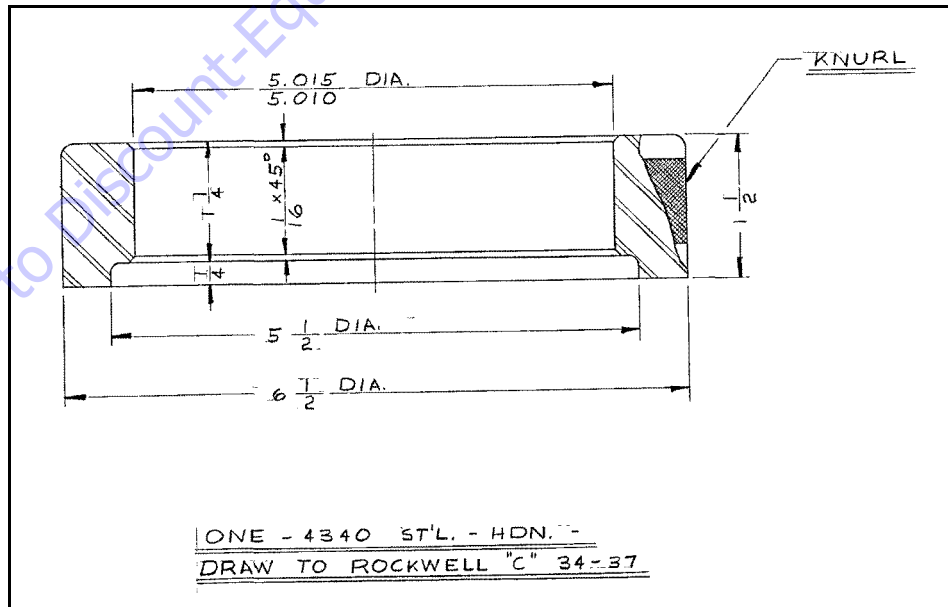


Figure 3-17. Seal Pressing Tool

SECTION 3 - CHASSIS & TURNTABLE

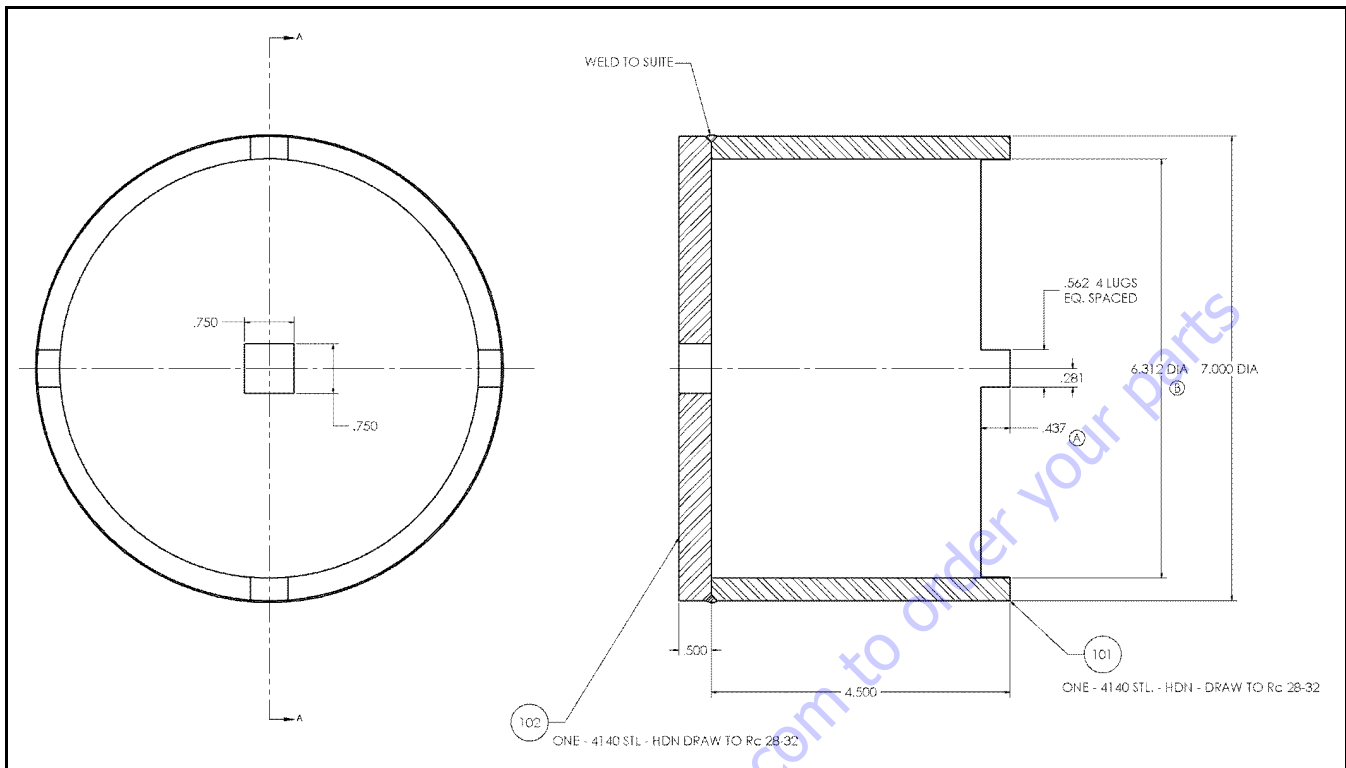


Figure 3-18. Bearing Cup Pressing Tool

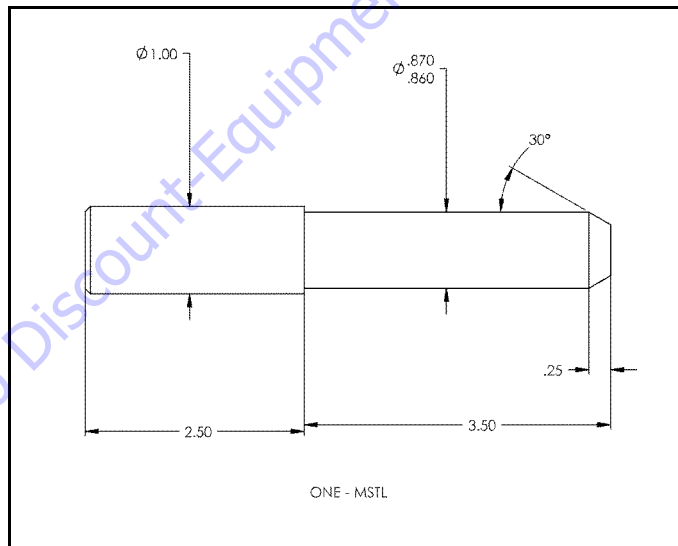


Figure 3-19. Drift Pin for Lining Up Thrust Washers with Output Planet Gear

3.3 FREE WHEELING OPTION

Disengage Drive Motors & Brakes for Towing, etc. (Free Wheel)

1. Chock wheels securely if not on flat level surface.
2. Disconnect both drive hubs by inverting disconnect caps in center of hubs.
3. If equipped, move steer/tow selector valve to float (tow) position by pulling valve knob out.

Engage Drive Motors & Brakes (Normal Operation)

1. If equipped, move steer/tow valve to steer position by pushing valve knob in.
2. Connect both drive hubs by inverting disconnect cap in center of hub.
3. Remove chocks from wheels as required.

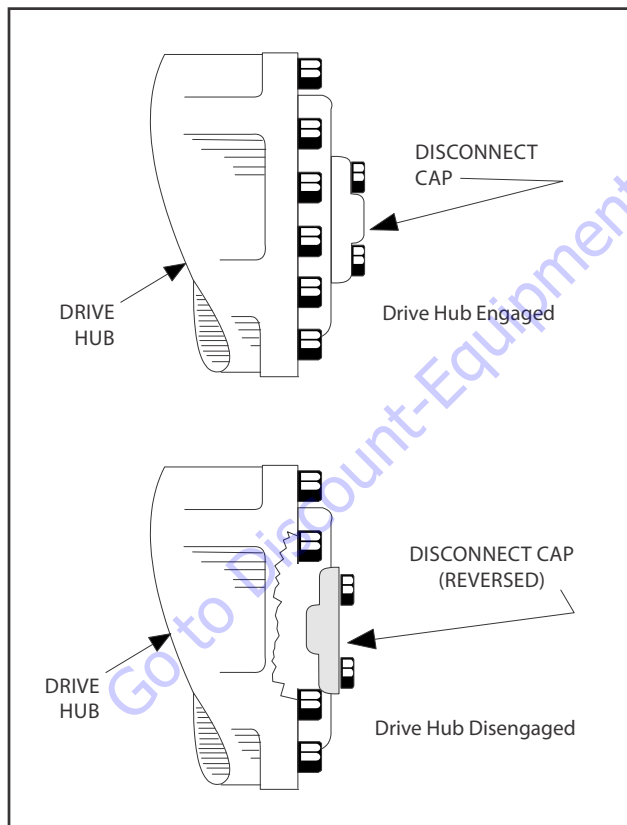


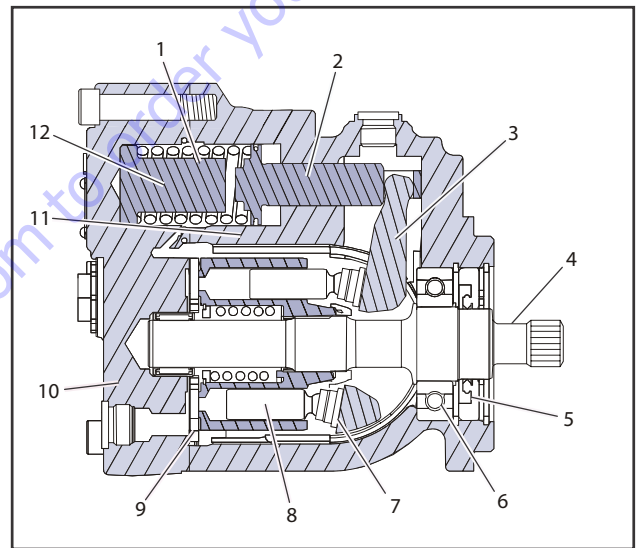
Figure 3-20. Disengaging Drive Hubs

3.4 DRIVE MOTOR

Description

Drive motors are low to medium power, two-position axial piston motors incorporating an integral servo piston. They are designed for operation in open and closed circuit applications. The standard control is a direct acting single line hydraulic control. The integral servo piston controls motor displacement.

Motors are spring biased to maximum displacement and hydraulically shifted to minimum displacement. Minimum and maximum displacement can be set with fixed internal stops. The large diameter servo piston allows smooth acceleration and deceleration with relatively large circuit orificing.



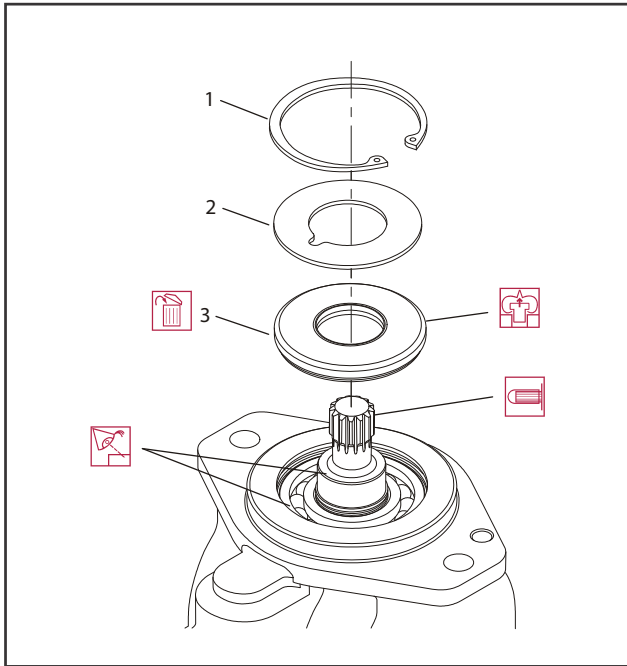
- | | | |
|-----------------|---------------|------------------------|
| 1. Bias Spring | 5. Shaft Seal | 9. Valve Plate |
| 2. ServoPiston | 6. Bearing | 10. End Cap |
| 3. Swashplate | 7. Slipper | 11. Cylinder Block |
| 4. Output Shaft | 8. Piston | 12. Minimum Angle Stop |

Figure 3-21. Drive Motor Cross Section

Shaft Seal Replacement

REMOVAL

1. Remove snap ring (1) retaining shaft seal, and support washer.



1. Snap Ring
2. Support Washer
3. Shaft Seal

Figure 3-22. Removing Shaft Seal

2. Remove support washer (2).
3. Carefully pry out shaft seal (3).

NOTE: To avoid damaging shaft during removal, install a large sheet metal screw in chuck of a slide hammer. Drive screw in seal surface and use slide hammer to pull seal.

4. Discard seal.

INSPECTION

Inspect new seal, motor housing seal bore, and sealing area on shaft for rust, wear, and contamination. Polish shaft and clean housing if necessary.

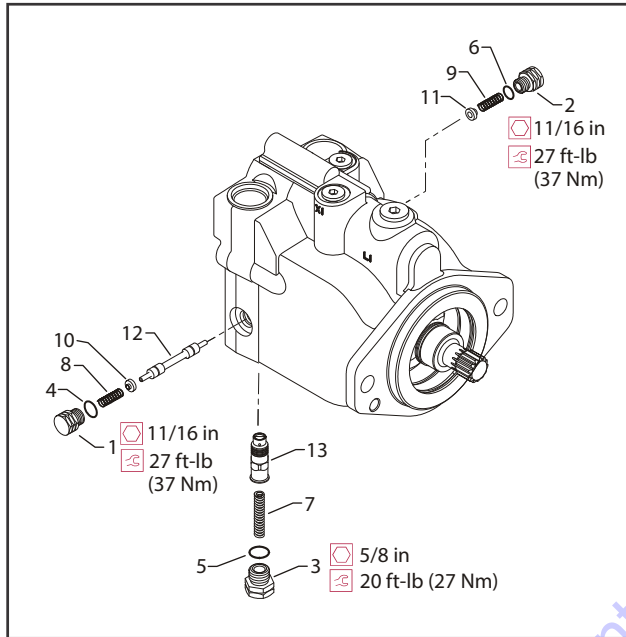
INSTALLATION

1. Cover shaft splines with an installation sleeve to protect shaft seal during installation.
2. Install new shaft seal with cupped side facing motor. Press seal into housing until it bottoms out. Press evenly to avoid binding and damaging the seal.
3. Install seal support washer.
4. Install snap ring.
5. Remove installation sleeve.

Loop Flushing Valve

REMOVAL

1. Using a 11/16 in internal hex wrench remove plug (1) and (2).



- | | | |
|-----------|------------|--------------------|
| 1. Plug | 6. O-ring | 11. Washer |
| 2. Plug | 7. Spring | 12. Shift Spool |
| 3. Plug | 8. Spring | 13. Orifice Poppet |
| 4. O-ring | 9. Spring | |
| 5. O-ring | 10. Washer | |

Figure 3-23. Loop Flushing Spool

2. Using a 1/4 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).

INSPECTION

Inspect new O-rings and the sealing area for rust, wear, or contamination. Check springs and poppet for wear.

INSTALLATION

1. Install orifice poppet (13).
2. Install shift spool (12).
3. Install spring retaining washers on springs (10 and 11).
4. Carefully install centering springs (7, 8, and 9).
5. Install new O-rings (6, 4, and 5).
6. Using a 1/4 in hex wrench torque plug (3) to 20 ft. lbs. (27 Nm).
7. Using a 11/16 in internal hex, torque plugs (2 and 1) to 27 ft.lbs. (37 Nm).

SECTION 3 - CHASSIS & TURNTABLE

Troubleshooting

Table 3-3. Excessive Noise and/or Vibration

Item	Description	Action
Check oil level in reservoir and oil supply to motor.	Insufficient hydraulic fluid could lead to cavitation that would cause system noise.	Fill reservoir to proper level. Ensure oil supply to motor is adequate and lines are unobstructed.
Check for air in system.	Air trapped in system lines or motor could result in cavitation that would cause system noise.	Ensure all system lines and components are purged of air.
Inspect output shaft couplings.	A loose or incorrect shaft coupling will produce vibrations that could result in system noise.	Ensure correct coupling is used and that it fits properly on shaft.
Inspect output shaft alignment.	Misaligned shafts create excessive frictional vibration that could result in system noise.	Ensure shafts are properly aligned.
Hydraulic oil viscosity above limits.	Viscosity above acceptable limits will result in cavitation that would lead to system noise.	Replace hydraulic oil with appropriate fluid for operating conditions.

Table 3-4. System Operating Hot

Item	Description	Action
Check oil level in reservoir and oil supply to pump.	Insufficient amount of hydraulic fluid will not meet system cooling demands.	Fill reservoir to proper level.
Inspect heat exchanger, (if equipped).	If heat exchanger fails, or becomes obstructed, it may not meet system cooling demands.	Ensure heat exchanger is receiving adequate air flow and is in good operating condition. Repair or replace as necessary.
Check system relief valves.	If a system relief valve becomes unseated for an extended period of time or fails for any other reason, system could become overheated.	Repair or replace any malfunctioning relief valves as applicable and verify loads on machine are not excessive.

Table 3-5. Won't Shift or Slow to Start

Item	Description	Action
Check signal line to servo control port.	Obstructed or restricted flow through servo control signal lines could result in slow shift or no shift motor conditions.	Ensure signal lines are not obstructed or restricted and signal pressure is adequate to shift motor.
Check correct supply and drain orifices are properly installed and not obstructed.	Supply and drain orifices determine motor shift. The smaller the orifice, the longer the time it takes to shift the motor. Obstruction also increases shift times.	Ensure proper control orifices are installed in motor and not obstructed. Clean or replace as necessary.

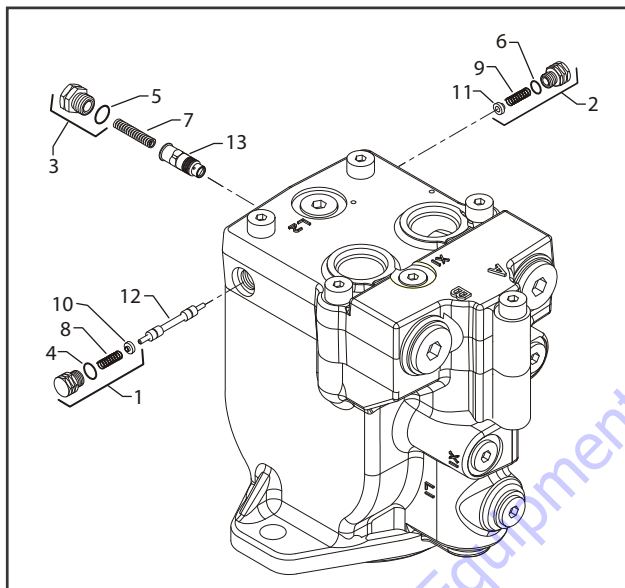
Disassembly

NOTE: Removal of endcap voids warranty.

During assembly, coat all moving parts with a film of clean hydraulic oil. This ensures parts will be lubricated during start-up.

Replace all O-Rings and gaskets.

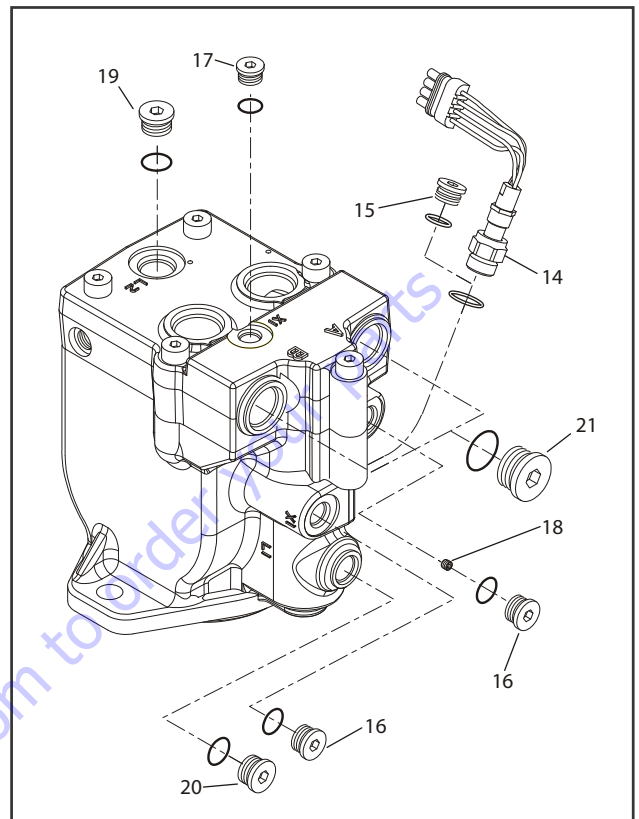
It is recommended that all O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



- | | | | |
|-----------|-----------|------------|--------------------|
| 1. Plug | 5. O-ring | 9. Spring | 12. Shift Spool |
| 2. Plug | 6. O-ring | 10. Washer | 13. Orifice Poppet |
| 3. Plug | 7. Spring | 11. Washer | |
| 4. O-ring | 8. Spring | | |

Figure 3-24. Loop Flushing Spool

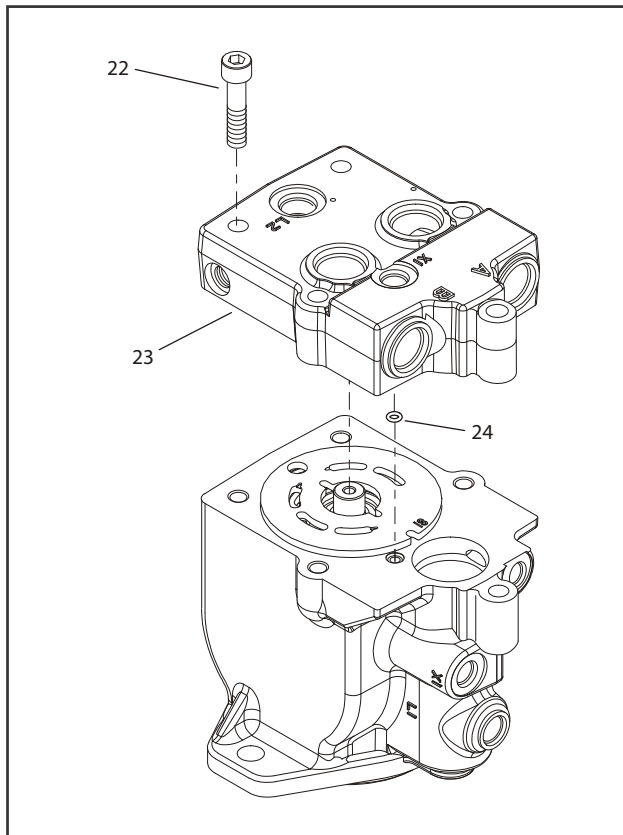
1. Using a 11/16 in wrench remove plug (1) and (2).
2. Using a 5/8 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



- | | |
|-----------------------|--------------------|
| 14. Lock Nut | 18. Cavity Plug |
| 15. O-ring Plug | 19. Drain Plug |
| 16. Control Line Plug | 20. Drain Plug |
| 17. Control Line Plug | 21. Work Port Plug |

Figure 3-25. Plugs, Fittings, and Speed Sensor

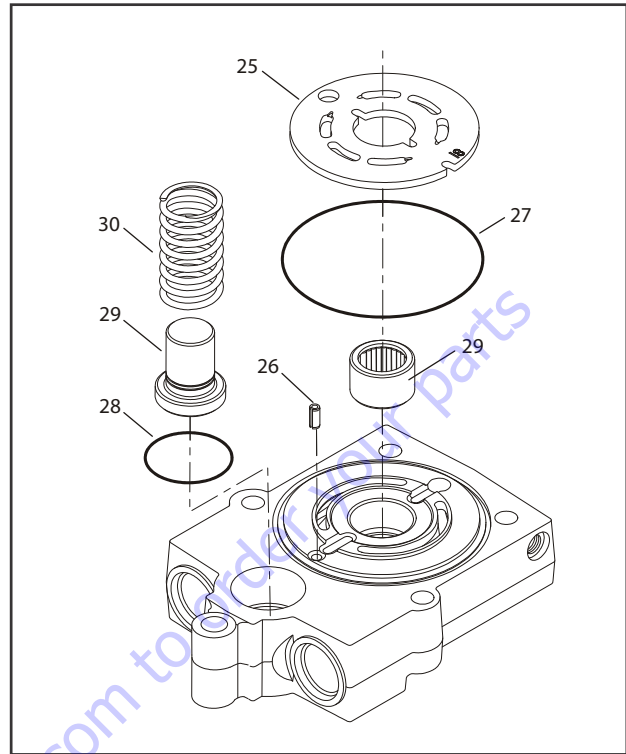
8. Remove all fittings from unit. Discard any O-rings on fittings.
9. Using an 11/16 inch hex wrench, loosen speed sensor lock nut (14) if equipped. Remove speed sensor using a 1/2 inch hex wrench. Units without speed sensor have an O-ring plug (15) installed in that location; remove it with a 3/8 inch internal hex wrench.
10. Using a 1/4 inch internal hex wrench, remove control line plugs (16, 17). Discard O-rings. Using a 3 mm hex wrench, remove cavity plug (18, if equipped with two-line control) from X2 cavity.
11. Using a 5/16 inch internal hex wrench, remove drain plugs (19, 20). Discard O-rings.
12. Using a 9/16 inch internal hex wrench, remove work port plugs (21, if equipped with axial ports). Discard O-rings.



- 22. Screw
- 23. End Cap
- 24. O-ring

Figure 3-26. End Cap

13. Using an 8 mm internal hex wrench, remove endcap screws (22).
14. Remove endcap (23). Remove O-ring (24) from housing or endcap. When endcap screws are removed, pressure from servo spring will cause endcap to bind on shaft. Press down on portion of endcap covering servo piston and hold endcap level while removing.



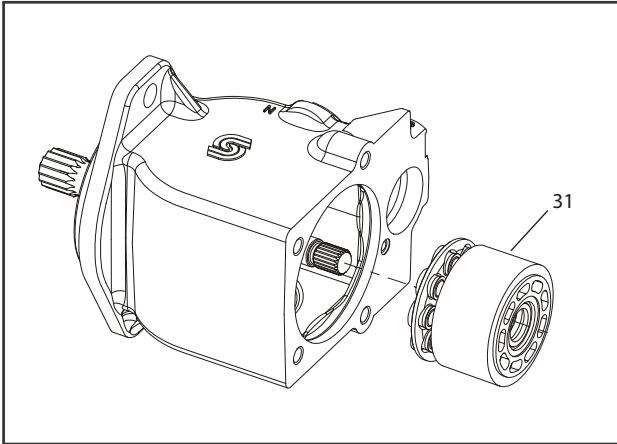
- | | |
|-----------------|------------------|
| 25. Valve Plate | 28. O-ring |
| 26. End Cap | 29. Angle Stop |
| 27. O-ring | 30. Servo Spring |

Figure 3-27. Valve Plate & Rear Shaft Bearing

NOTICE

DO NOT SCRATCH VALVE PLATE SURFACE. DO NOT DRIVE BEARING PAST REAR SHAFT JOURNAL. BEARING MAY BECOME TRAPPED ON SHAFT AND DAMAGED.

15. Remove valve plate (25) and timing pin (26) from endcap. Each displacement has a unique valve plate. For identification, the last two digits of the valve plate part number are stamped on its surface.
16. Remove and discard O-rings (27, 28).
17. Remove rear shaft bearing (29) from endcap with a bearing puller. Bearing may be difficult to remove with a puller. Try this as an alternative: Pack bearing cavity with heavy grease. After shaft is removed, insert it into bearing cavity and tap splined end lightly with a soft mallet. Grease will force the bearing out. Remove minimum angle stop (29) and servo spring (30) from housing.



31. Cylinder Kit Assembly

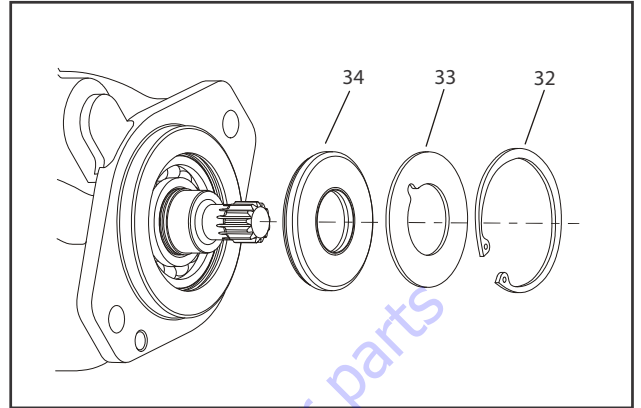
Figure 3-28. Cylinder Kit

18. Turn housing on its side and remove cylinder kit assembly (31). Set assembly aside. Do not scratch running surface.

NOTE: Grooves on surface of cylinder kit identify its displacement:

Table 3-6. Displacement Identifiers

# of Grooves	Frame L	Frame K
1	25	38
2	30	45
3	35	--



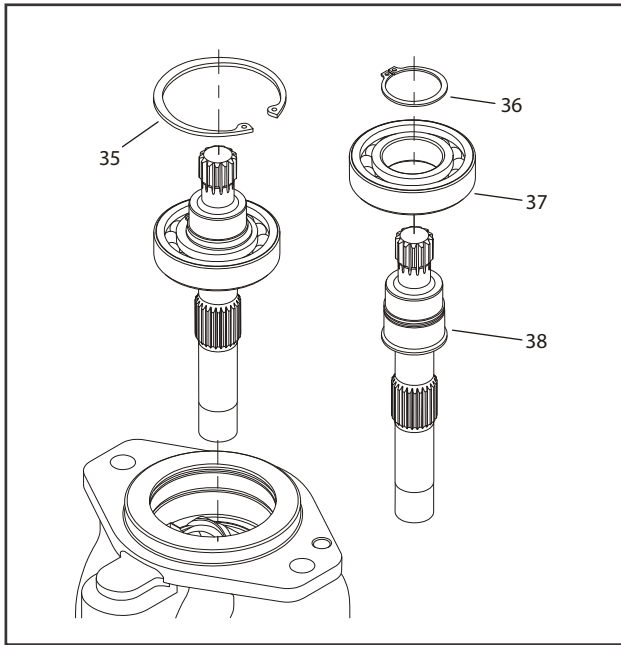
- 32. Snap Ring
- 33. Support Washer
- 34. Shaft Seal

Figure 3-29. Shaft Seal

NOTICE

TO AVOID DAMAGING SHAFT DURING SEAL REMOVAL, INSTALL A LARGE SHEET METAL SCREW IN CHUCK OF SLIDE HAMMER. DRIVE SCREW INTO SEAL SURFACE AND USE SLIDE HAMMER TO PULL SEAL.

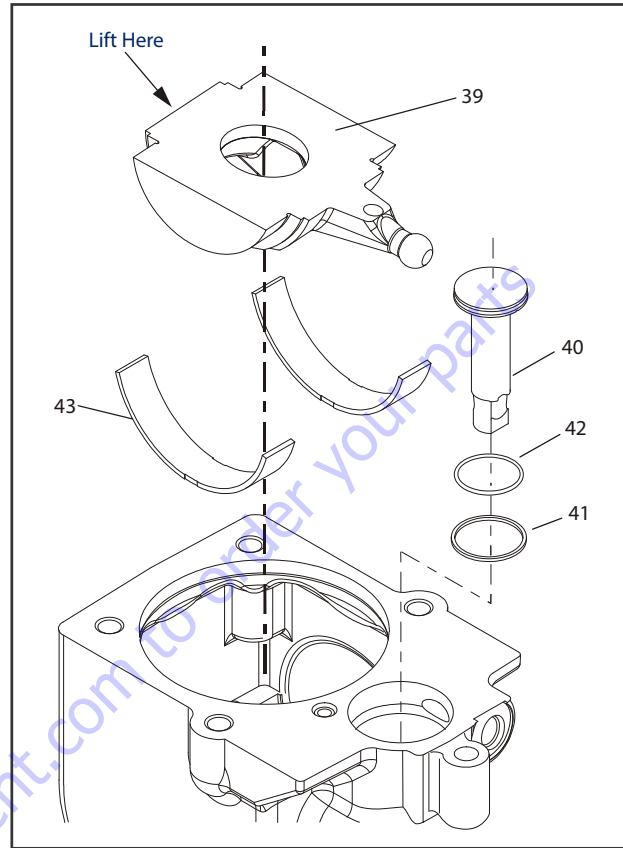
1. Turn housing over and remove snap ring (32) retaining shaft seal and support washer. Remove support washer (33) and carefully pry out shaft seal (34). Discard seal.



- | | |
|---------------------|-------------|
| 35. Inner Snap Ring | 37. Bearing |
| 36. Snap Ring | 38. Shaft |

Figure 3-30. Shaft & Front Bearing

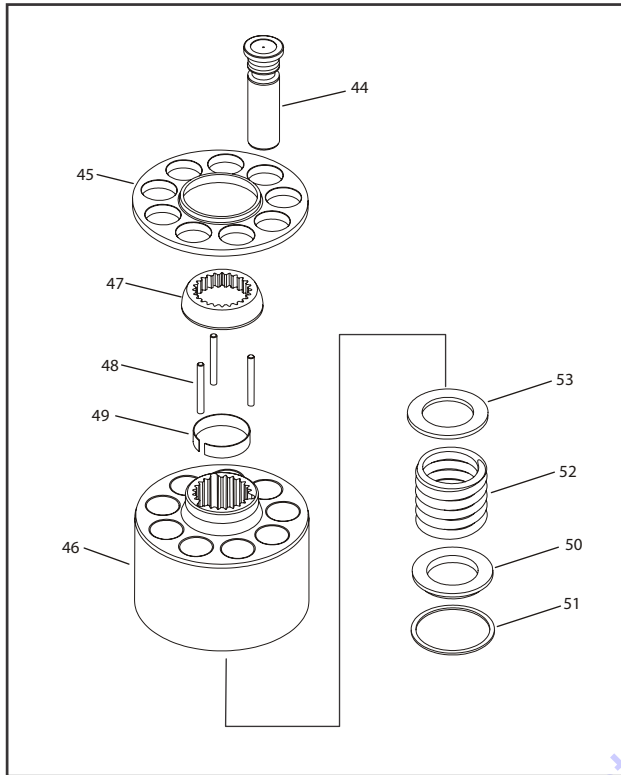
2. Remove inner snap ring (35) and shaft/bearing assembly.
3. Remove snap-ring (36) retaining shaft front bearing. Pull bearing (37) off shaft (38).



- | | |
|------------------|----------------------|
| 39. Swashplate | 42. O-ring |
| 40. Servo Piston | 43. Journal Bearings |
| 41. Piston Seal | |

Figure 3-31. Swash Plate & Servo Piston

4. Turn housing over and remove swashplate (39) by lifting on end opposite servo lever.
5. Remove servo piston (40). Remove piston seal (41) and O-ring (42) from servo piston. Discard seal and O-ring.
6. Remove journal bearings (43) from housing. Note location and orientation of each bearing for reassembly.



- 44. Piston
- 45. Slipper Retainer
- 46. Cylinder Block
- 47. Ball Guide
- 48. Holddown Pins
- 49. Retaining Ring
- 50. Block Spring Washer
- 51. Spiral Retaining Ring
- 52. Block Spring
- 53. Inner Block Spring Washer

Figure 3-32. Cylinder Kit Disassembly

7. Remove pistons (44) and slipper retainer (45) from cylinder block (46).

NOTE: *Pistons are not selectively fitted. However, units with high hourly usage may develop wear patterns. Number pistons and bores for reassembly if they are to be reused.*

8. Remove ball guide (47), hold-down pins (48), and retaining ring (49) from cylinder block.

NOTE: *Most repairs do not require block spring removal. Perform this procedure only if you suspect problems with the block spring.*

⚠ WARNING

RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES FORCE OF ABOUT 80 TO 90 LBF (350 TO 400 N). USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE THE SPRING IS SECURE BEFORE ATTEMPTING TO REMOVE THE SPIRAL RETAINING RING. RELEASE THE PRESSURE SLOWLY AFTER THE RETAINING RING IS REMOVED.

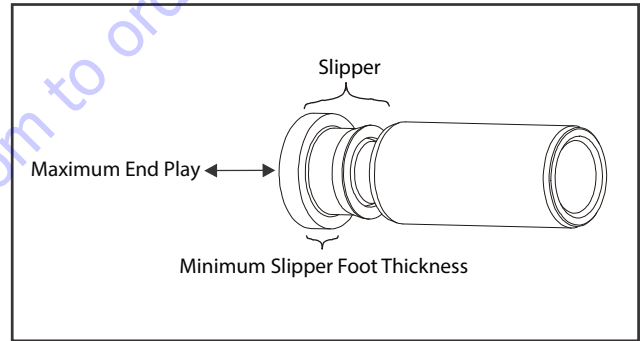
9. Turn block over. Using a press, apply pressure on block spring washer (50) to compress block spring. Compress spring enough to safely remove spiral retaining ring (51). While maintaining pressure, unwind spiral retaining ring (51). Carefully release pressure and remove outer block spring washer (50), block spring (52), and inner block spring washer (53) from cylinder block.

Inspection

After disassembly, wash all parts (including end-cap and housing) thoroughly with clean solvent and allow to air dry. Blow out oil passages in housing and endcap with compressed air. Conduct inspection in a clean area and keep all parts free from contamination. Clean and dry parts again after any rework or resurfacing.

PISTON

Inspect pistons for damage and discoloration. Discolored pistons may indicate excessive heat; do not reuse.



SLIPPERS

Inspect slipper running surfaces. Replace piston assemblies with scored or excessively rounded slipper edges. Measure slipper foot thickness. Replace piston assemblies with excessively worn slippers. Check slipper axial end-play. Replace piston assemblies with excessive end-play.

Table 3-7. Slipper Foot Thickness & End Play

Measurement	L Frame	K Frame
Slipper Foot Thickness	2.71 mm (0.11 in.)	4.07 mm (0.16 in.)
Piston/Slipper End Play	0.15 mm (0.006 in.)	

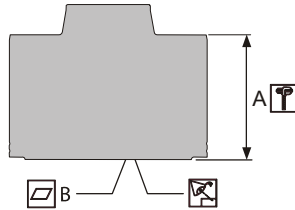
SECTION 3 - CHASSIS & TURNTABLE

CYLINDER BLOCK

Measure cylinder block height. Replace blocks worn beyond minimum height specification. Inspect cylinder block running surface. Replace or resurface worn or scratched blocks. Blocks may be resurfaced to specifications shown in the drawing, provided resurfacing will not reduce block height below minimum specification. Table 3-8, Cylinder Block Measurements.

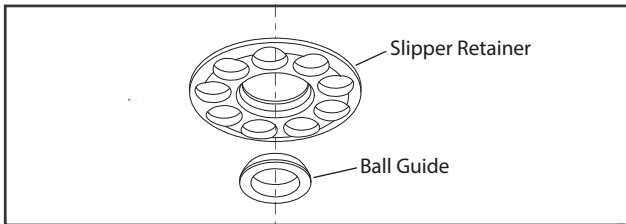
Table 3-8. Cylinder Block Measurements

Measurement	L25	L30	L35	K38	K45
Minimum Cylinder Block Height (A)	50.8 (2.00)	50.8 (2.00)	50.8 (2.00)	54.4 (2.14)	54.4 (2.14)
Cylinder Block Surface Flatness	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)



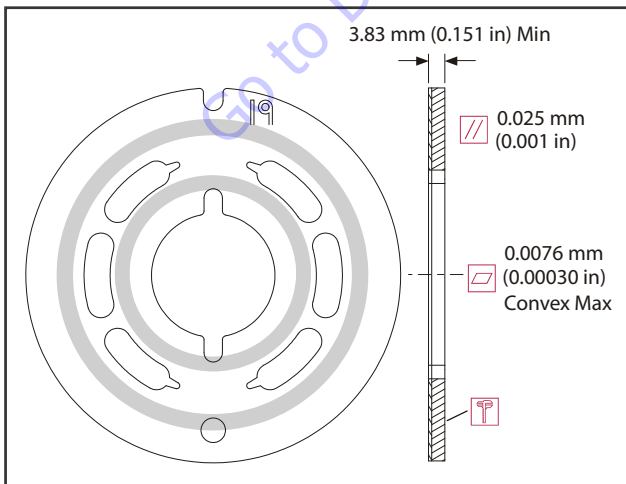
BALL GUIDE AND SLIPPER RETAINER

Inspect ball guide and slipper retainer for damage, discoloration, or excessive wear. A discolored ball guide or slipper retainer indicates excessive heat. Do not reuse.



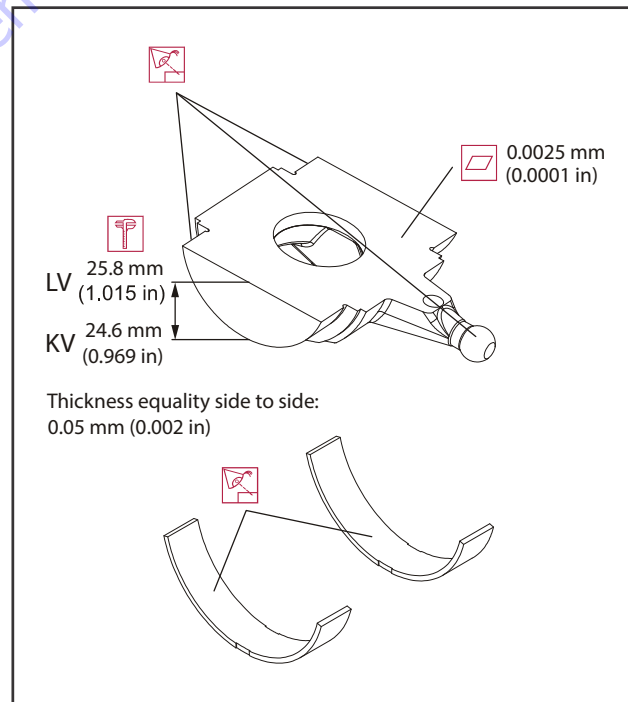
VALVE PLATE

Valve Plate condition is critical to efficiency of the motor. Inspect valve plate surfaces carefully for excessive wear, grooves, or scratches. Replace or resurface grooved or scratched valve plates. Measure valve plate thickness and replace if worn beyond minimum specification. Valve plates may be resurfaced, provided resurfacing will not reduce thickness below minimum specification.



SWASHPLATE AND JOURNAL BEARINGS

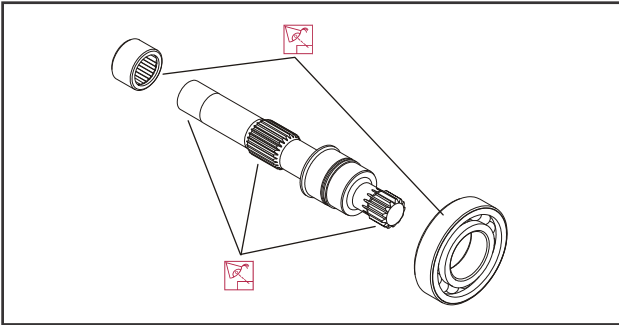
Inspect running face, servo ball-joint, and swashplate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable if surface condition meets specifications shown. Measure swashplate thickness from journals running face. Replace swashplate if damaged or worn beyond minimum specification. Replace swashplate if difference in thickness from one side to the other exceeds specification.



Inspect journal bearings for damage or excessive wear. Replace journal bearings if scratched, warped, or excessively worn. Polymer wear layer must be smooth and intact.

SHAFT BEARINGS

Inspect bearings for excessive wear or contamination. Rotate bearings while feeling for uneven movement. Bearings should spin smoothly and freely. Replace bearings that appear worn or do not rotate smoothly.

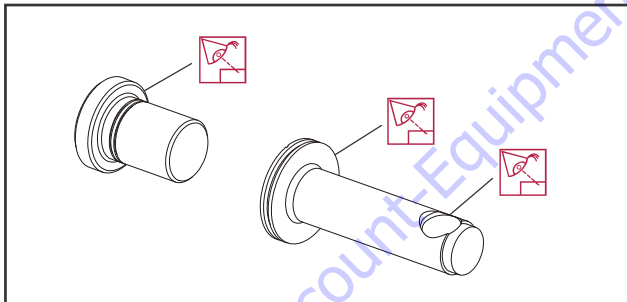


SHAFT

Inspect motor shaft for damage or excessive wear on output and block splines. Inspect bearing surfaces and sealing surface. Replace shafts with damaged or excessively worn splines, bearing surfaces, or sealing surfaces.

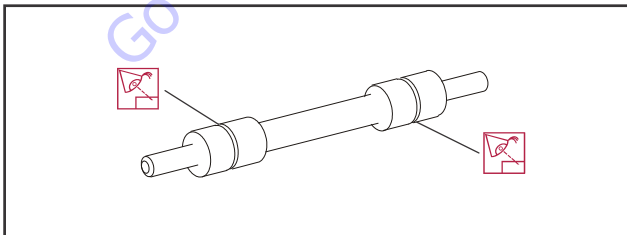
SERVO PISTON AND MINIMUM ANGLE STOP

Inspect minimum angle stop, servo piston head, and servo piston ball-socket for damage or excessive wear. Replace as required.



LOOP FLUSHING SPOOL

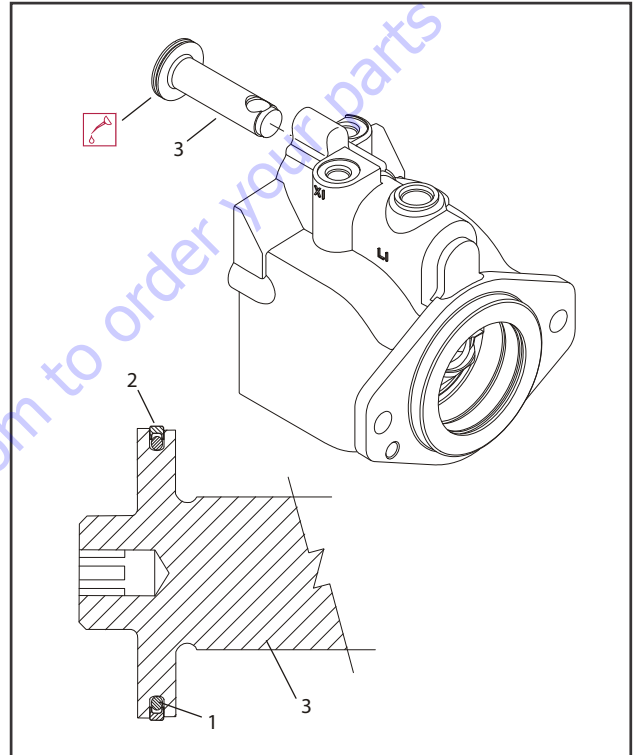
Inspect loop flushing spool for cracks or damage. Replace as required.



Assembly

1. Install new O-ring (1) and piston seal (2) to servo piston (3). Install piston seal over O-ring.

NOTE: Installing piston seal stretches it, making it difficult to install servo piston in its bore. Allow 30 minutes for seal to relax after installation. To speed up seal relaxation, compress seal by installing piston head in end-cap servo cavity and let it stand for at least five minutes.



1. O-ring
2. Piston Seal
3. Servo Piston

Figure 3-33. Servo Piston

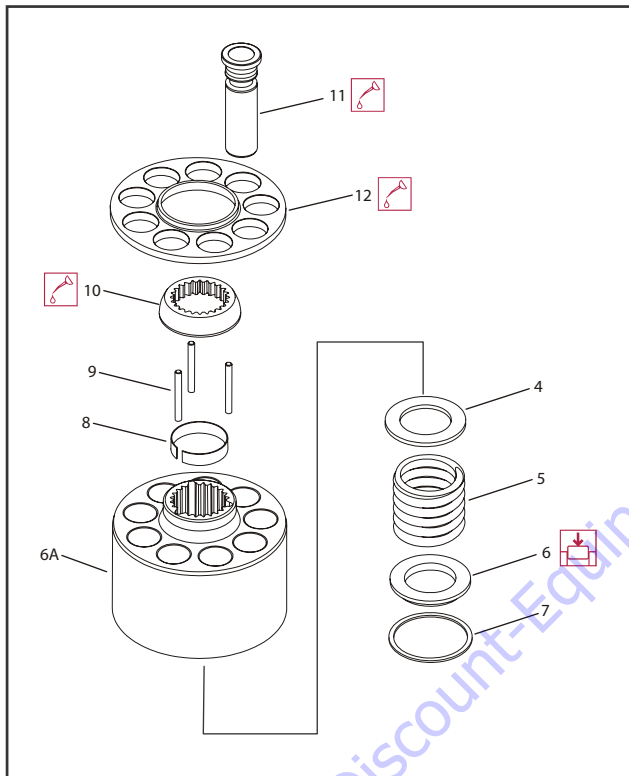
2. After piston seal has relaxed, lubricate and install servo piston in housing bore. Align piston with ball socket facing inside of housing.

SECTION 3 - CHASSIS & TURNTABLE

⚠ CAUTION

RISK OF PERSONAL INJURY: COMPRESSING THE BLOCK SPRING REQUIRES ABOUT 80 TO 90 LBF (350 TO 400 N) OF FORCE. USE A PRESS SUFFICIENT TO MAINTAIN THIS FORCE WITH REASONABLE EFFORT. ENSURE SPRING IS SECURE BEFORE ATTEMPTING TO INSTALL THE SPIRAL RETAINING RING. RELEASE PRESSURE SLOWLY AFTER RETAINING RING IS INSTALLED.

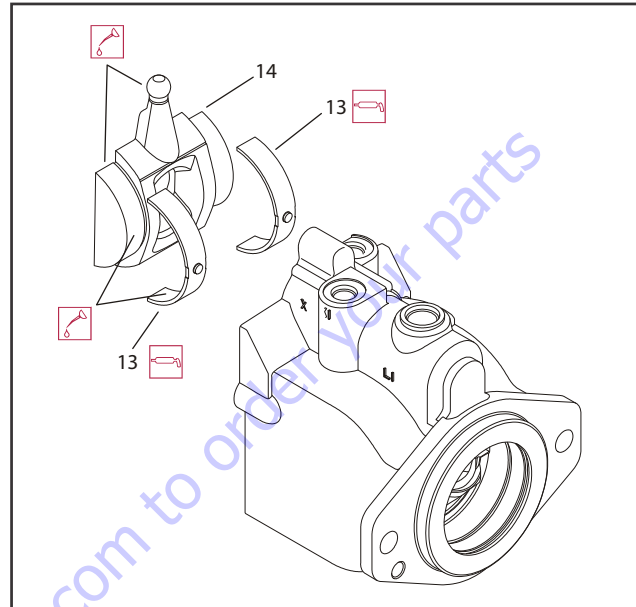
3. Install inner block spring washer (4), block spring (5), and outer washer (6) in cylinder block (6A). Using a press, compress block spring enough to expose retaining ring groove (7). Wind spiral retaining ring (7) in cylinder block groove.



- | | |
|--------------------------|----------------------|
| 4. Block Spring Washer | 8. Retaining Ring |
| 5. Block Spring | 9. Hold-down Pins |
| 6. Outer Washer | 10. Ball Guide |
| 6A. Cylinder Block | 11. Piston |
| 7. Spiral Retaining Ring | 12. Slipper Retainer |

4. Turn block over and install retaining ring (8), hold-down pins (9), and ball guide (10) to cylinder block.
5. Install pistons (11) to slipper retainer (12). Install piston/retainer assembly in cylinder block. Ensure concave surface of retainer seats on ball guide. If reusing pistons, install them in original block bores. Lubricate pistons, slippers, retainer, and ball guide before assembly. Set cylinder kit aside on a clean surface until needed.

6. Install journal bearings (13) in housing seats. Use assembly grease to keep bearings seated during assembly. Ensure locating nubs drop into seat cavities. If reusing bearings, install in original location and orientation. Lubricate journal bearings.

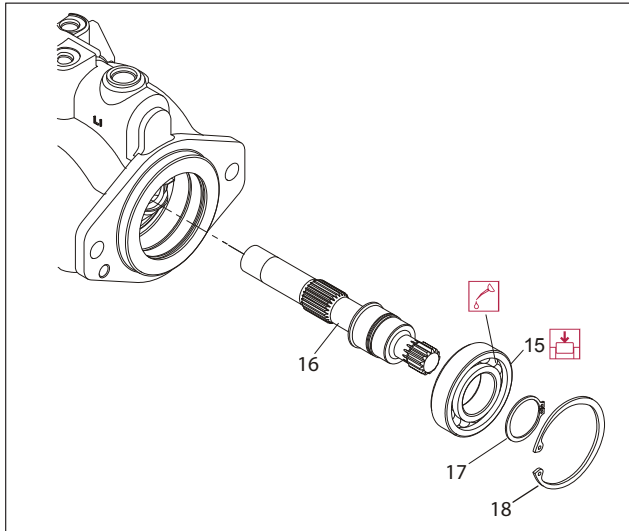


13. Journal Bearings
14. Swash Plate

Figure 3-34. Swash Plate and Journal Bearing

7. Install swashplate (14) in housing. Tilt swashplate and guide servo lever ball into its socket in the servo piston rod. Ensure swashplate seats into journal bearings and moves freely. Lubricate running surface of swashplate.

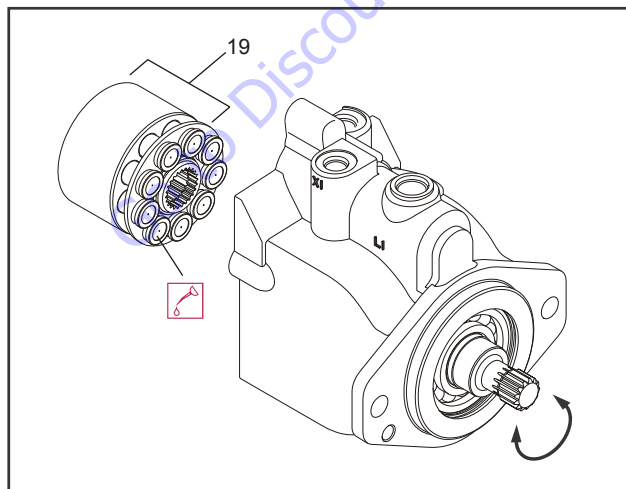
8. Press front shaft bearing (15) on shaft (16). Press bearing on shaft with lettering facing out. Lubricate bearing rollers. Install snap-ring (17) on shaft.



- | | |
|-------------------------|---------------|
| 15. Front Shaft Bearing | 17. Snap Ring |
| 16. Shaft | 18. Snap Ring |

Figure 3-35. Shaft and Front Bearing

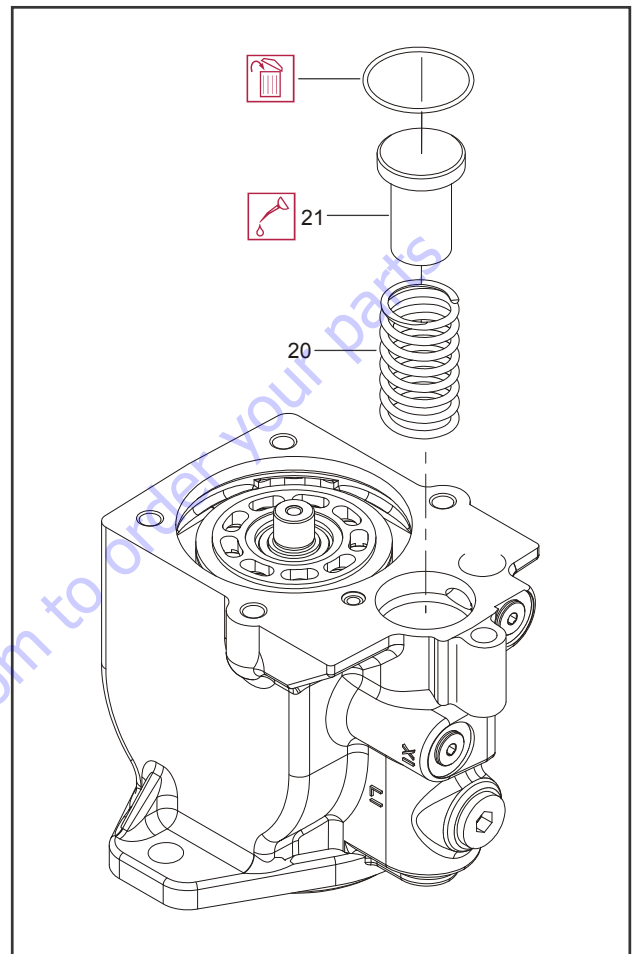
9. While holding swashplate in place, turn housing on its side. Install the install shaft/bearing assembly into housing from flange end. Install snap-ring (18).
10. Verify swashplate and bearings are properly seated. Install cylinder kit (19) on shaft. Install with slippers facing swashplate. Rock the shaft to align block splines and slide cylinder kit into place. Orient motor with shaft pointing downward and verify cylinder kit, swashplate, journal bearings, and servo piston are properly installed.



19. Cylinder Kit

Figure 3-36. Cylinder Kit Installation

11. Lubricate and install servo spring (20) and minimum angle stop (21) in housing bore.

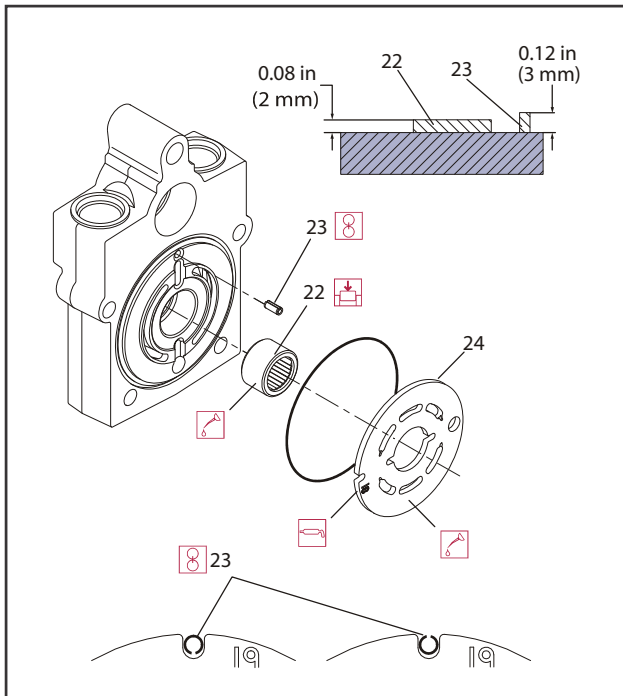


- | |
|------------------------|
| 20. Servo Spring |
| 21. Minimum Angle Stop |

Figure 3-37. Servo Spring and Minimum Angle Stop

SECTION 3 - CHASSIS & TURNTABLE

12. Press rear shaft bearing (22) in endcap. Install bearing with letters facing out. Press until bearing surface is 0.08 ± 0.01 in (2 ± 0.25 mm) above endcap surface.

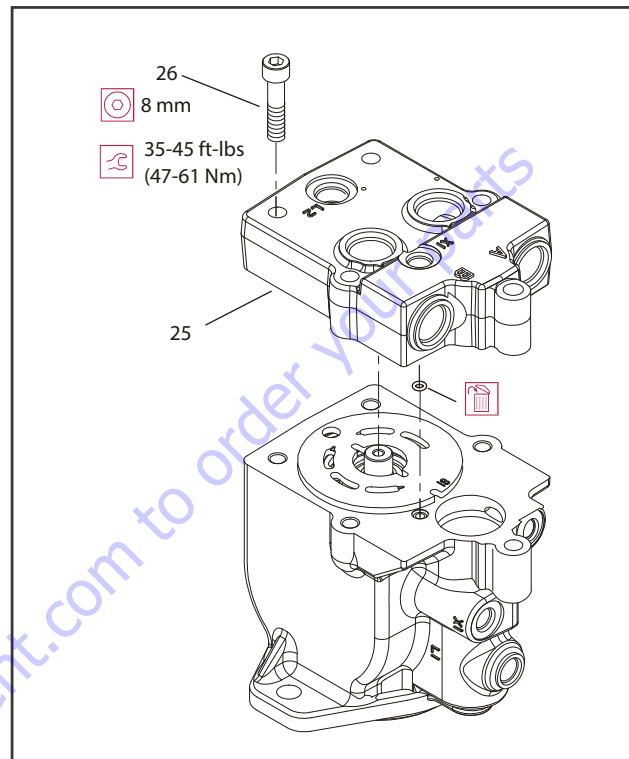


- 22. Rear Shaft Bearing
- 23. Timing Pin
- 24. Valve Plate

Figure 3-38. Valve Plate and Rear Bearing

13. Install timing pin (23) into its bore in the endcap. Install pin with groove facing toward or away from shaft. Press pin until end protrudes 0.12 ± 0.01 in (3 ± 0.25 mm) above endcap surface.
14. Install valve plate (24) on endcap. Install valve plate with yellow surface toward cylinder block. Align slot in valve plate with timing pin. Apply a liberal coat of assembly grease to endcap side of valve plate to keep it in place during installation.

15. Install endcap (25) on housing with endcap screws (26). Ensure endcap will properly seat to housing without interference. Improper assembly of internal components may prevent endcap from seating properly. Ensure O-rings seat properly when installing endcap.

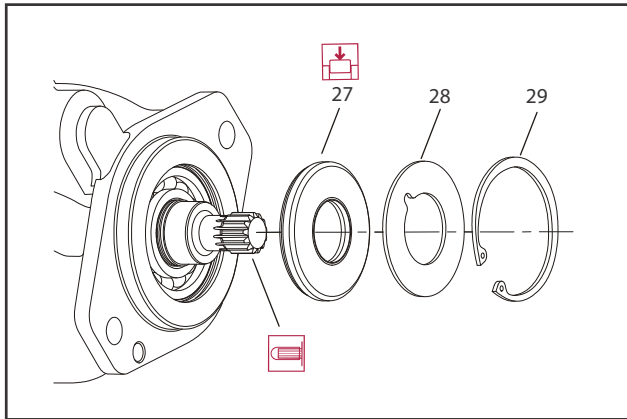


- 25. End Cap
- 26. Screw

Figure 3-39. End Cap

16. Using an 8 mm internal hex wrench, tighten endcap screws. Tighten screws in opposite corners slowly and evenly to compress the servo spring and properly seat the endcap. Torque endcap screws 35-45 ft-lb (47-61 Nm).
17. Before installing shaft seal, ensure shaft turns smoothly with less than 120 in-lb (13.5 Nm) of force. If shaft does not turn smoothly within specified maximum force, disassemble and check unit.

- 18.** Cover shaft splines with an installation sleeve. Install a new shaft seal (27) with cup side facing motor. Press seal in housing until it bottoms out. Press evenly to avoid binding and damaging seal. Install seal support washer (28) and snap ring (29).



- 27. Shaft Seal
- 28. Seal Support Washer
- 29. Snap Ring

Figure 3-40. Shaft Seal

- 19.** Install remaining plugs and fittings to housing. Refer to drawing below for wrench sizes and installation torques.

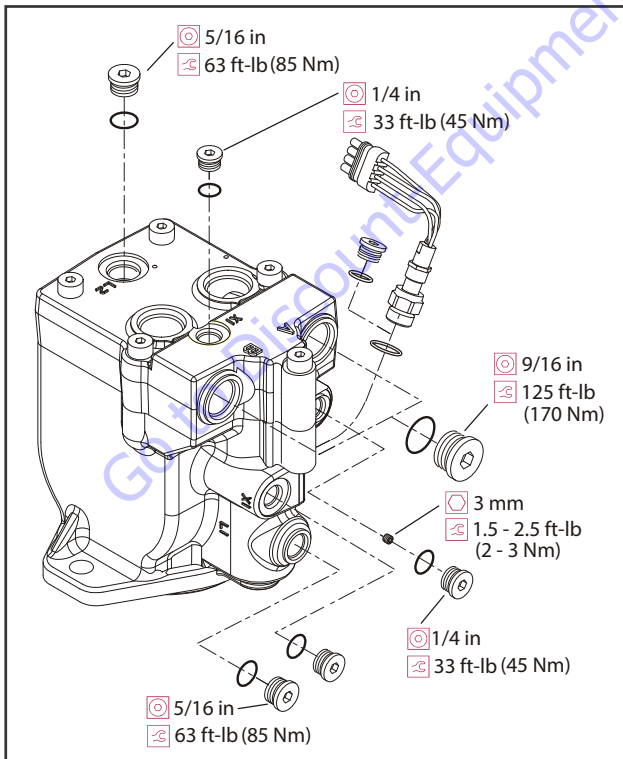
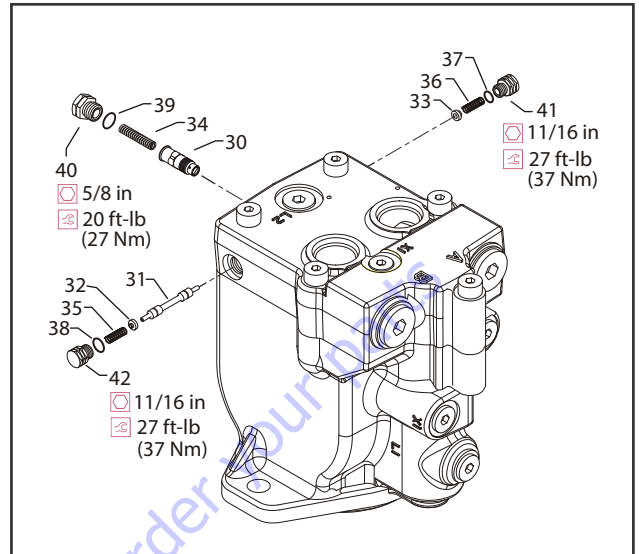


Figure 3-41. Plugs and Fittings Installation

- 20.** Install orifice poppet (30).



- | | | | |
|--------------------|------------|------------|----------|
| 30. Orifice Poppet | 34. Spring | 37. O-ring | 40. Plug |
| 31. Shift Spool | 35. Spring | 38. O-ring | 41. Plug |
| 32. Spring | 36. Spring | 39. O-ring | 42. Plug |
| 33. Spring | | | |

Figure 3-42. Loop Flushing Spool

- 21.** Install shift spool (31).
- 22.** Install spring retaining washers on springs (32 and 33).
- 23.** Carefully install centering springs (34, 35, and 36).
- 24.** Install new O-rings (37, 38, and 39).
- 25.** Using a 5/8 in wrench torque plug (40) to 20 ft-lb (27 Nm).
- 26.** Using a 11/16 in wrench, torque plugs (41 and 42) to 27 ft-lb (37 Nm).

Initial Start-up Procedures

Follow this procedure when starting-up a new motor or when installing a motor that has been removed.

Prior to installing the motor, inspect for damage incurred during shipping. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

1. Fill reservoir with recommended hydraulic fluid. Always filter fluid through a 10 micron filter when pouring into the reservoir. Never reuse hydraulic fluid.
2. Fill inlet line leading from pump to reservoir. Check inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
3. Fill pump and motor housing with clean hydraulic fluid. Pour filtered oil directly in upper most case drain port.
4. To ensure pump and motor stay filled with oil, install case drain lines in upper most case drain ports.
5. Install a 0 to 500 psi (0 to 35 bar) gauge in charge pressure gauge port of pump to monitor system pressure during start up.
6. Watching pressure gauge and run engine at lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shut down engine, determine cause, and take corrective action.
7. Operate hydraulic system for at least fifteen minutes under light load conditions.
8. Check and adjust control settings as necessary after installation.
9. Shut down engine and remove pressure gauge. Replace plug at charge pressure gauge port.
10. Check fluid level in reservoir. Add clean filtered fluid if necessary. Motor is now ready for operation.

3.5 OSCILLATING AXLE BLEED PROCEDURE AND LOCKOUT TEST

Lockout Cylinder Bleeding

NOTICE

ENSURE MACHINE IS ON A LEVEL SURFACE, REAR WHEELS ARE BLOCKED, AND BRAKE WIRE IS DISCONNECTED. ENSURE PLATFORM IS FULLY LOWERED AND BOOM IS CENTERED OVER REAR AXLE BEFORE STARTING BLEED PROCEDURE.

1. Park machine on a level surface and block rear wheels.
2. Center boom over rear axle to make sure oscillation valve in rotary coupling is activated.
3. Place suitable container under flow divider mounted on inside of frame to catch hydraulic fluid.
4. Remove Port 11 tee fitting from flow divider. Cap fitting and plug hose.
5. Place suitable containers under each lockout cylinder to catch hydraulic fluid.
6. Have helper start engine from platform. Turn function control knob speed fully counter-clockwise to Turtle position to set drive creep mode. Activate Low Drive In Reverse creep mode.
7. Open bleeder screw on one lockout cylinder.

NOTE: Open bleeder valve enough to get a fast stream of oil. A fast stream of oil will exhaust air from hose and lockout cylinder better than a slow stream.

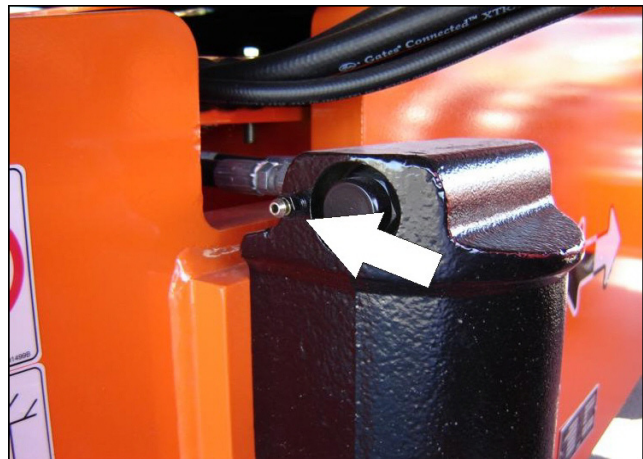


Figure 3-43. Bleeder Valve Location

8. Close bleeder valve when no more air in hydraulic oil.
9. Repeat on opposite lockout cylinder.
10. Shut down engine.
11. Reconnect hose and tee fitting to Port 11 on flow divider.

Oscillating Axle Lockout Test

NOTICE

LOCKOUT SYSTEM TEST MUST BE PERFORMED QUARTERLY, ANY TIME A SYSTEM COMPONENT IS REPLACED, OR WHEN IMPROPER SYSTEM OPERATION IS SUSPECTED.

NOTE: Ensure boom is fully retracted, lowered, and centered between drive wheels before starting lockout cylinder test.

1. Place a 6 inch (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control station, activate machine hydraulic system.
3. Place FUNCTION SPEED CONTROL and DRIVE SPEED/TORQUE SELECT control switches to their respective LOW positions.
4. Place DRIVE control lever to FORWARD position and carefully drive machine up ascension ramp until left front wheel is on top of block.
5. Carefully activate SWING control lever and position boom over right side of machine.
6. With boom over right side of machine, place DRIVE control lever to REVERSE. Drive machine off block and ramp.
7. Have an assistant check if left front wheel remains locked in position off of ground.
8. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground. It may be necessary activate DRIVE to release cylinders.
9. Place 6 inch (15.2 cm) high block with ascension ramp in front of right front wheel.
10. Place DRIVE control lever to FORWARD and carefully drive machine up ascension ramp until right front wheel is on top of block.
11. Carefully activate SWING control lever and position boom over left side of machine.
12. With boom over left side of machine, place DRIVE control lever to REVERSE. Drive machine off block and ramp.
13. Have an assistant check if right front wheel remains locked in position off of ground.
14. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground. It may be necessary activate DRIVE to release cylinders.

15. If lockout cylinders do not function properly, have qualified personnel correct malfunction before further operation.

3.6 STEER ADJUSTMENTS

NOTE: 2 Wheel Steering/2 Wheel Drive: Spindles do not stop on cylinder stroke. Adjust steering stops as follows: Adjust item #1 to achieve 44° inside turn angles. Steer full left and adjust RH item #2 to contact axle. Steer full right and adjust LH item #2 to contact axle.

2 Wheel Steering/Four Wheel Drive: Spindles do not stop on cylinder stroke. Adjust steering stops as follows: Adjust item #1 to achieve 39° inside turn angles. Steer full left and adjust RH item #2 to contact axle. Steer full right and adjust LH item #2 to contact axle.

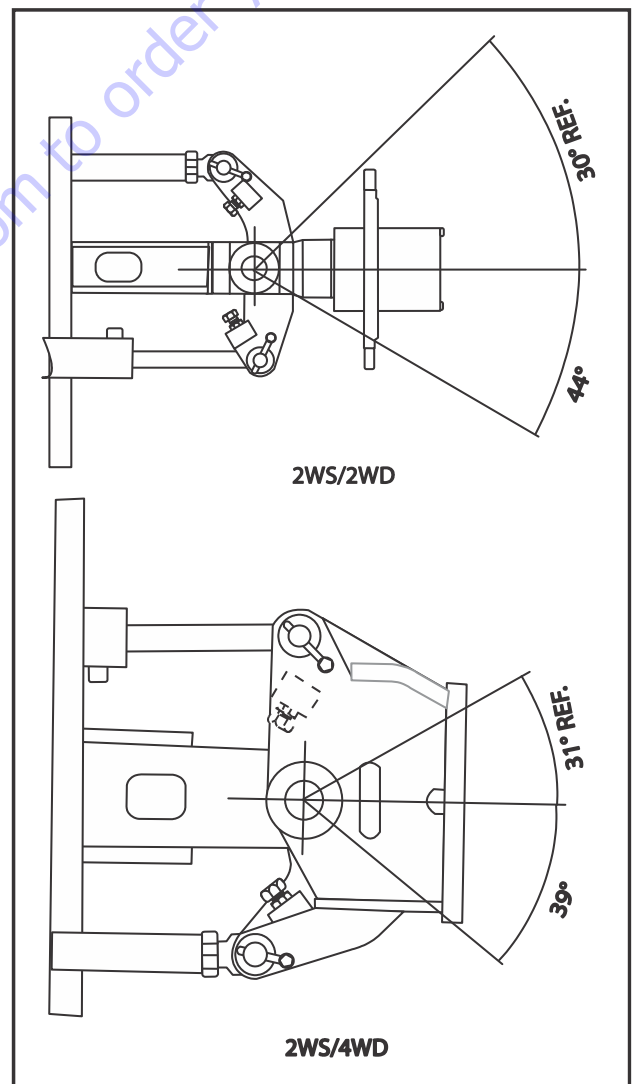
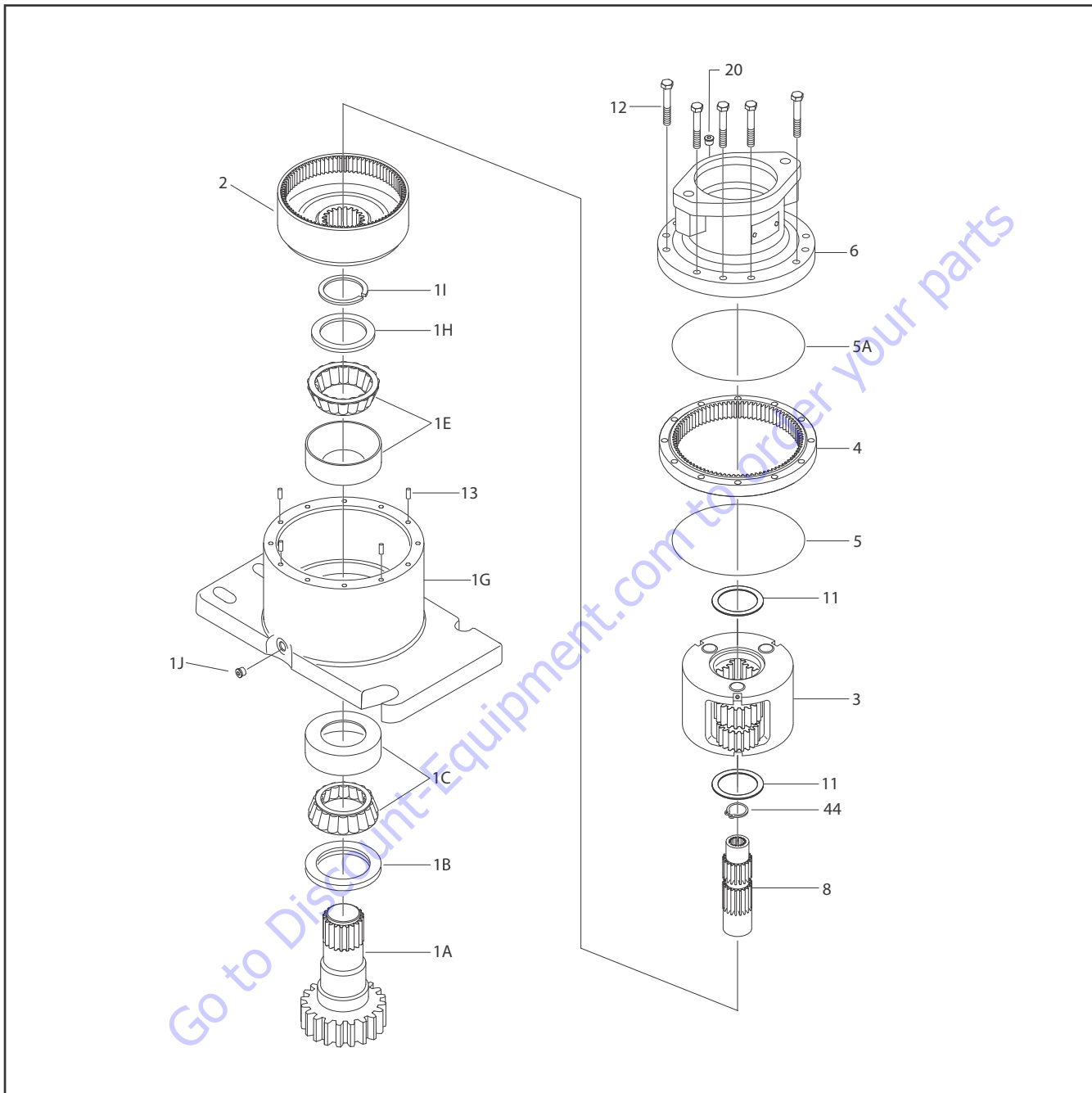


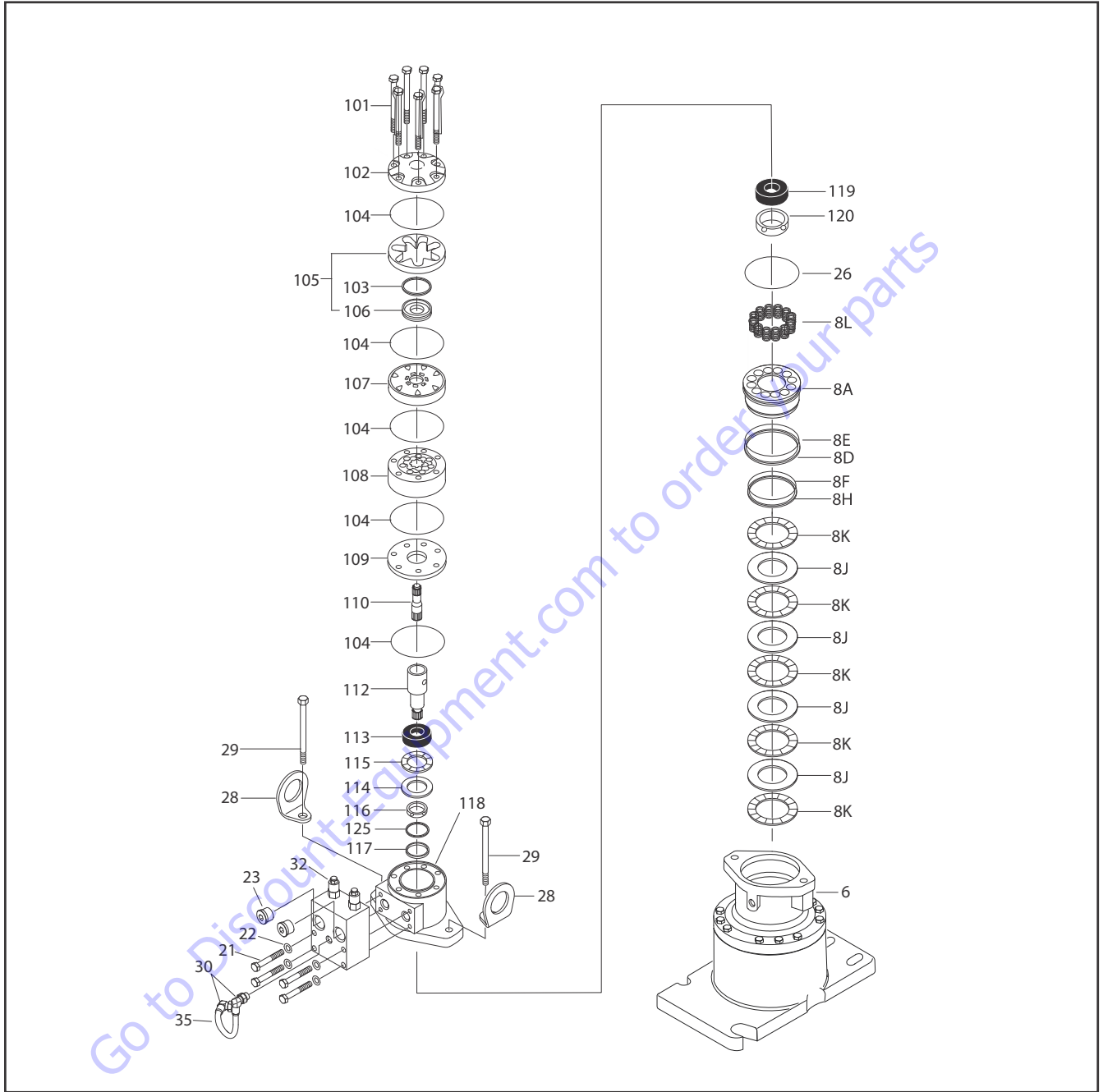
Figure 3-44. Steer Adjustments

3.7 SWING DRIVE



- | | | | | |
|------------------|--------------------|---------------------|-------------------|-----------------------------|
| 1A. Output Shaft | 1G. Housing | 2. Internal Gear | 5A. O-Ring | 12. Bolt |
| 1B. Lip Seal | 1H. Thrust Washer | 3. Carrier Assembly | 6. Brake Housing | 13. Dowel Pin |
| 1C. Bearing | 1I. Retaining Ring | 4. Ring Gear | 8. Sun Gear | 20. Pipe Plug |
| 1E. Bearing | 1J. Pipe Plug | 5. O-Ring | 11. Thrust Washer | 44. Internal Retaining Ring |

Figure 3-45. Swing Drive Assembly



- | | | | | |
|------------------|-----------------|-------------------------------|---------------------|---------------------|
| 6. Brake Housing | 8L. Spring | 35. Tube | 108. Rotor Set | 117. Back-up Washer |
| 8A. Piston | 21. Bolt | 101. Bolt | 109. Wear Plate | 118. Housing |
| 8D. O-Ring | 22. Lockwasher | 102. End Cover | 110. Drive Link | 119. Outer Bearing |
| 8E. Back-Up Ring | 23. Pipe Plug | 103. Commutator Seal | 112. Coupling Shaft | 120. Seal |
| 8F. O-Ring | 26. O-Ring | 104. Ring Seal | 113. Inner Bearing | 125. Back-up Washer |
| 8H. Back-up Ring | 28. Lifting Lug | 105. Commutator and Ring Assy | 114. Thrust Washer | |
| 8J. Rotor Disc | 29. Bolt | 106. Ring | 115. Thrust Bearing | |
| 8K. Stator Disc | 30. Elbow | 107. Manifold | 116. Inner Seal | |

Figure 3-46. Swing Motor and Brake Assembly

Gear Backlash

Set backlash to .010 - .015 in (0.254 to 0.381mm).

1. Insert shim (JLG P/N 4071009) between pinion and bearing on the bearing high spot. The bearing high spot should be stamped with an "X" on the surface below the teeth and marked with yellow paint in the tooth space.

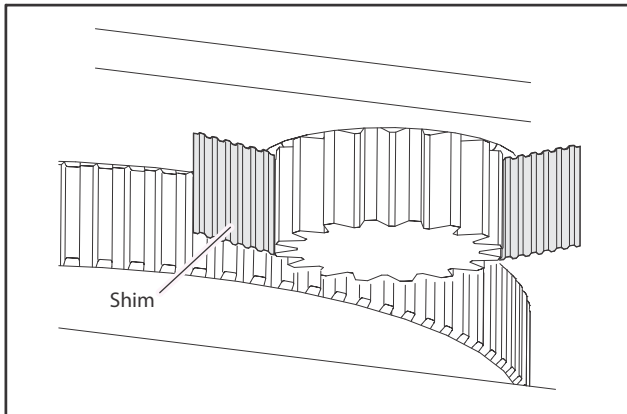


Figure 3-47. Swing Drive Shim Placement

2. Apply JLG Thread locking compound P/N 0100019 to pivot bolt. Torque pivot bolt to 205 ft-lb (280 Nm).
3. Remove turntable lock pin.
4. Apply JLG Thread locking compound P/N 0100019 to four mounting bolts. Torque mounting bolts to 30 ft-lb (40 Nm).

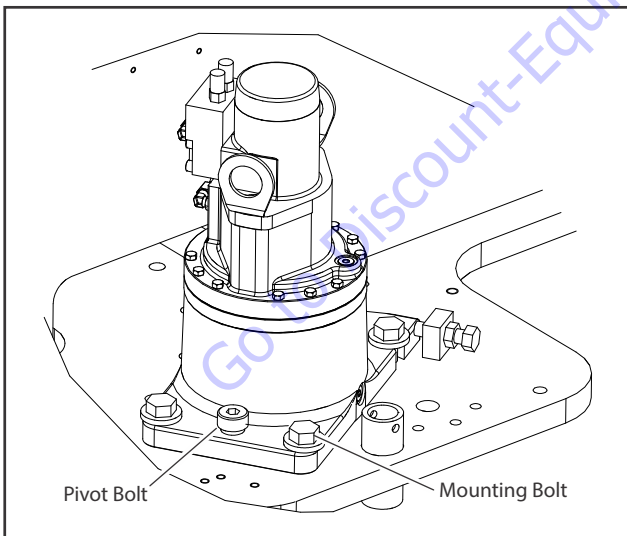


Figure 3-48. Swing Drive Pivot and Mounting Bolts

5. Loosen jam nut.
6. Tighten jack bolt until pinion is snug against shim and bearing, then loosen jack bolt.
7. Apply JLG Thread locking compound P/N 0100019 to jack bolt threads. Torque jack bolt to 50 ft-lb (68 Nm).
8. Tighten jam nut.
9. Torque four mounting bolts to 340 ft-lb (461 Nm).

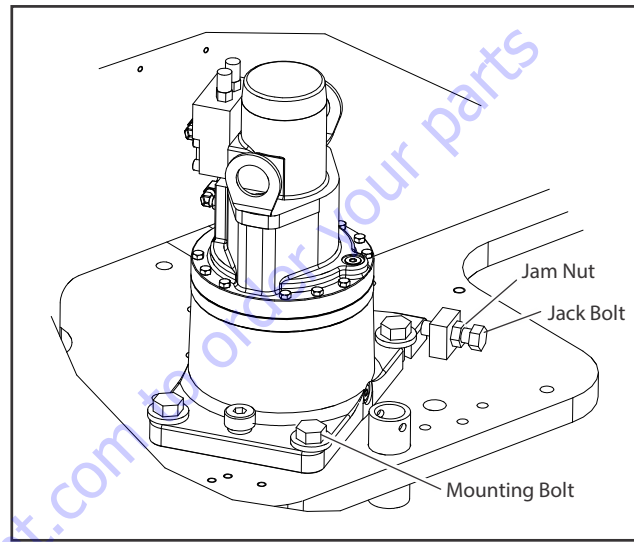


Figure 3-49. Swing Drive Jam Nut and Mounting Bolt

10. Remove and discard swing drive shim.

Swing Drive Lubrication

Fill Swing Drive Gearbox with 43 oz (1.27L) 90w80 gear oil with EP additives. Oil should cover the ring gear. Torque pipe plug 23 - 24 ft-lb (31 - 32.5 Nm).

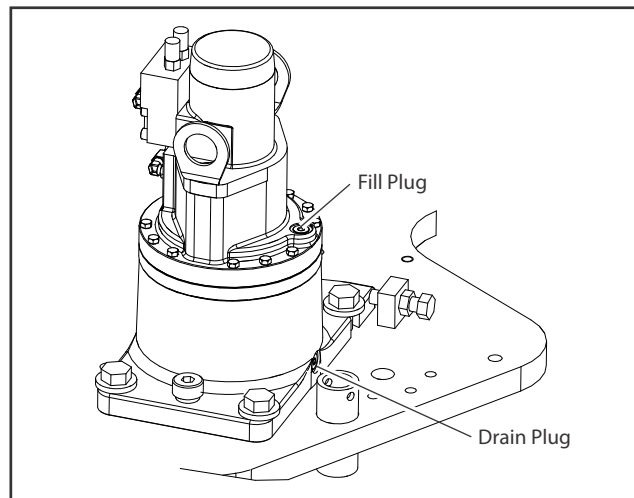


Figure 3-50. Swing Drive Lubrication

Motor Control Valve Disassembly

1. Place unit on bench with motor end up.
2. Remove Drain Plug (1P) and drain oil from gearbox.
3. Remove Hydraulic Tubing Assembly (35).
4. Loosen jam nuts on Elbow Fittings (30). Remove fittings from Brake (6) and Motor Control Valve (32).
5. Remove O-ring Plugs (23) from Motor Control Valve (32).
6. Remove four bolts (21), washers (22), and Motor Control Valve (32) from Motor (31).
7. Reinstall Drain Plug (1P). Torque to 23 - 24 ft-lb (31 - 32.5 Nm).

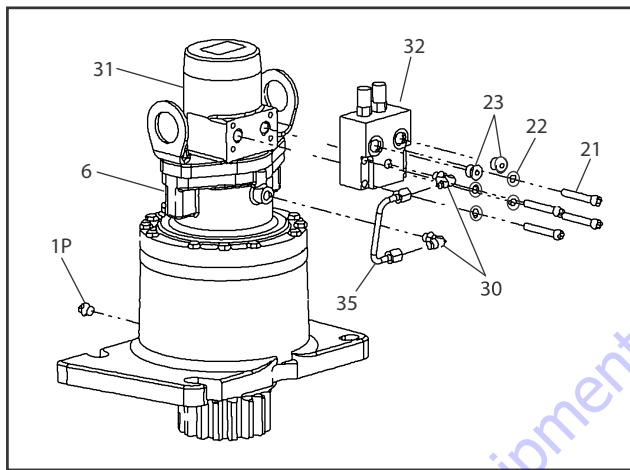


Figure 3-51. Main Control Valve Disassembly

Motor and Brake Disassembly

1. With unit resting on bench with Motor (31) end up, remove Hex Bolts (29) and Lift Lugs (28) from Motor (31).
2. Pull Motor (31) straight up and remove Motor (31) from Brake Housing (6).
3. Remove O-ring (26) between Motor (31) and Brake Housing (6).
4. Remove Springs (8L) from piston.

CAUTION

PISTON (8A) MAY MOVE QUICKLY. WEAR EYE PROTECTION.

5. Apply less than 50 psi air to brake port to remove Brake Piston (8A).
6. Remove Rotors (8J) and Stators (8K) from Brake Housing (6).

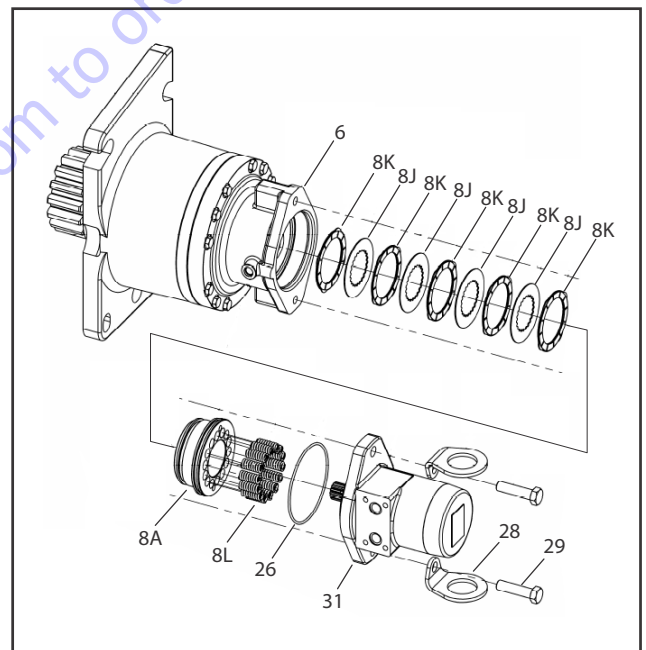


Figure 3-52. Motor and Brake Disassembly

Main Disassembly

1. Remove Sun Gear (8) with Retaining Ring (44) inside.
2. With unit resting on Output Shaft (Pinion) (1A), remove Bolts (12) from Brake Housing (6).
3. Remove Brake Housing (6) from main assembly.
4. Remove O-ring (5A) from Brake Housing (6) and Ring Gear (4).
5. Remove Thrust Washer (11) from Brake Housing (6) and Carrier Subassembly.
6. Remove Ring Gear (4) from Housing (1G).
7. Remove O-ring (5) from Ring Gear (4) and Housing (1G).
8. Remove Carrier Subassembly.
9. Remove Thrust Washer (11) between Carrier Subassembly and Internal Gear (2).
10. Remove Internal Gear (2).

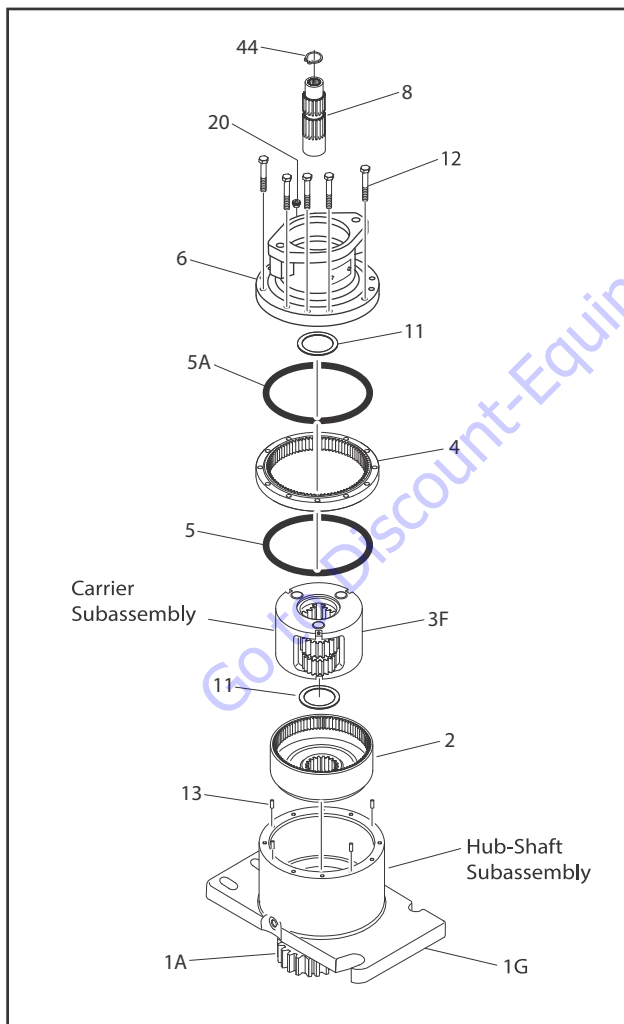


Figure 3-53. Main Disassembly

Hub-Shaft Disassembly

CAUTION

WEAR EYE PROTECTION DURING THIS PROCEDURE.

11. Using retaining ring pliers, remove and discard Retaining Ring (11) from groove in Output Shaft (1A).
12. Remove Thrust Washer (1H).
13. Support Housing (1G) on Output Shaft (1A) end. Press Output Shaft (1A) out of Housing (1G).

NOTE: Lip Seal (1B) will be pressed out of Housing (1G) by Bearing Cone (1D) during this step.

14. Remove Bearing Cone (1E) from Housing (1G).
15. Use a bearing puller to remove Bearing Cone (1D) from Shaft (1A). Bearing Cups (1C & 1F) will remain in Housing (1G).

NOTE: If bearing replacement is necessary, Bearing Cups (1C & 1F) can be removed with a slide hammer puller or driven out with a punch.

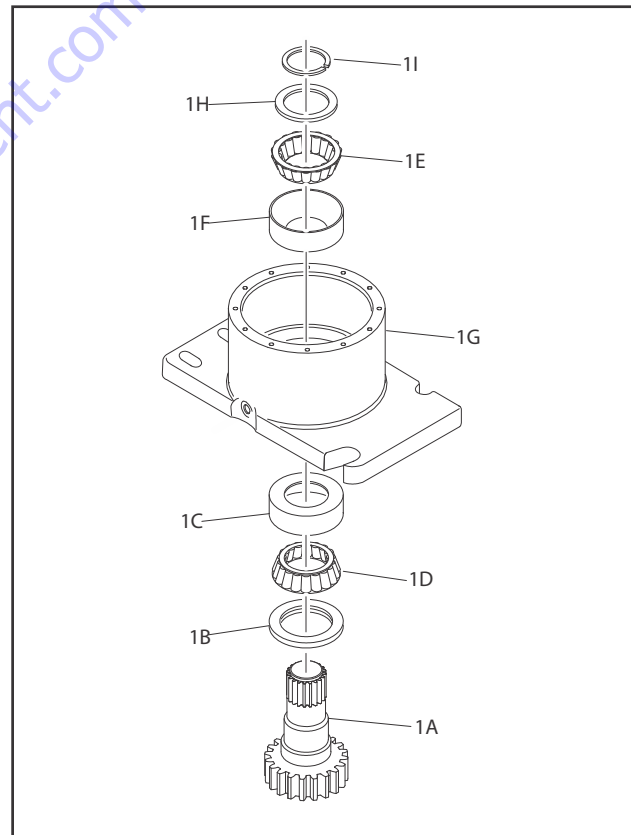


Figure 3-54. Hub-Shaft Disassembly

Carrier Disassembly

1. Using a 3/16" punch drive Roll Pin (3G) holding Planet Shaft (3E) in Carrier (3A) in Planet Shaft (3E) until it bottoms.

NOTICE

MAKE SURE ROLL PIN HAS BOTTOMED OR CARRIER MAY BE DAMAGED WHEN PLANET SHAFT IS REMOVED.

2. Remove Planet Shaft (3E) from Carrier (3A). Use a small punch to remove Roll Pin (3G) from Planet Shaft (3E).
3. Slide Planet Gear (3F) and two Thrust Washers (3B) out of Carrier (3A).
4. Remove both rows of Needle Bearings (3C) and Spacer (3D) from bore of Planet Gear (3F).
5. Repeat Steps 1 thru 4 for remaining Cluster Gears (3F).

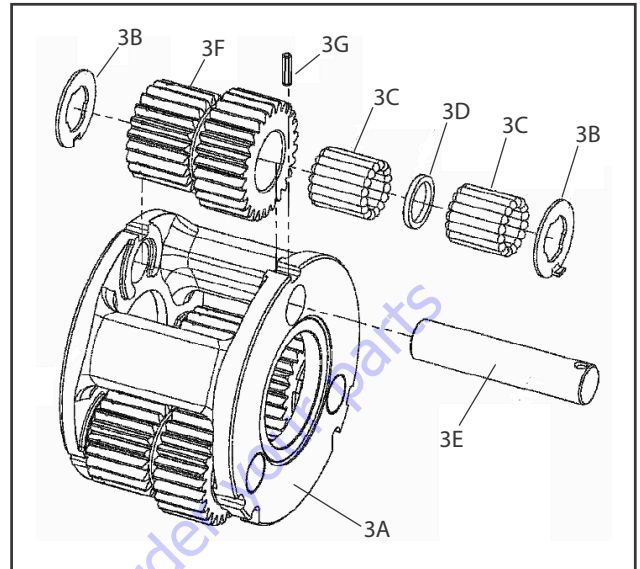


Figure 3-55. Carrier Disassembly

Hub-Shaft Subassembly

1. Press Bearing Cup (1C) in Housing (1G). Make sure cup starts square with bore of Hub (1G).
2. Place Bearing Cone (1D) in Bearing Cup (1C) in Housing (1G).
3. Apply grease to rubber portion of Seal (1B). Press or tap Seal (1B) with smooth face up, in counterbore of Housing (1G) until it is flush with Housing (1G) face bore.
4. Invert Hub (1G) and press Bearing Cup (1E) in counterbore of Housing (1G).
5. Carefully lower Housing (1G) on Output Shaft (1A) until Bearing Cone (1D) contacts Output Shaft (1A).
6. Press on small end of Bearing Cone (1D), being careful not to contact the bearing cage, until Bearing Cone (1D) seats on Output Shaft (1A) shoulder.
7. Start Bearing Cone (1F) on Output Shaft (1A).
8. Press or tap Bearing Cone (1F) on Output Shaft (1A) until it is just seated in Bearing Cup (1E), while rotating the Housing (1G).
9. Install Bearing Spacer (1H) on Output Shaft (1A) against Bearing Cone (1F).

CAUTION

RINGS UNDER TENSION CAN FLY OUT AND CAUSE SERIOUS INJURY. WEAR EYE PROTECTION WHEN INSTALLING RINGS.

NOTICE

NEVER REUSE A RETAINING RING IN REBUILD OR REPAIR.

10. Install new Retaining Ring (1I) in groove of Output Shaft (1A).
11. Tap Retaining Ring (1I) with a soft metal punch to ensure it is completely seated in groove of Output Shaft (1A).

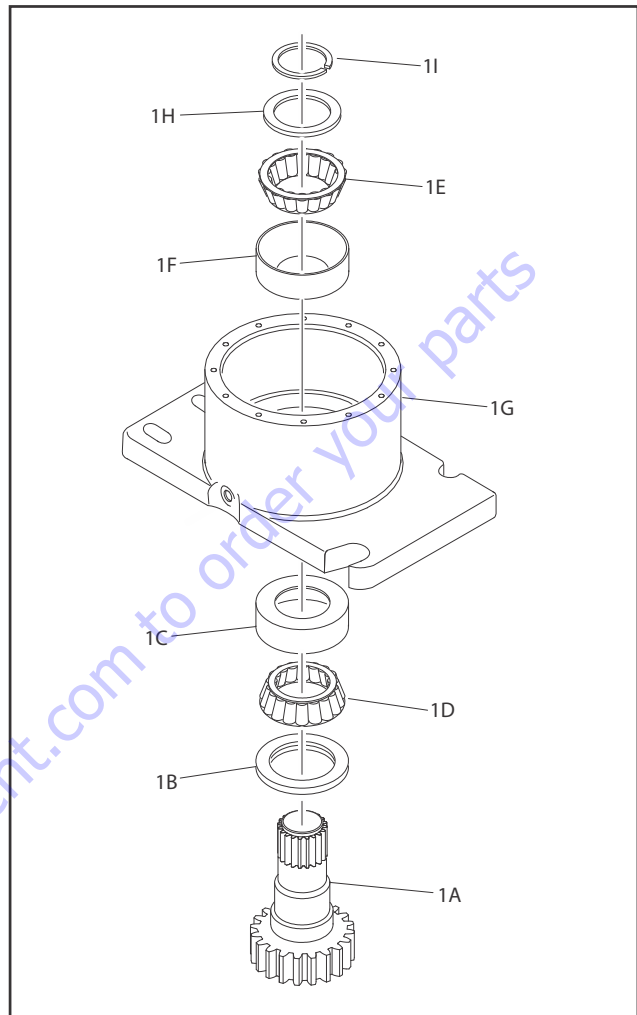


Figure 3-56. Hub-Shaft Subassembly

12. Reinstall Drain Plug if not already installed (1P from Fig. 3-45). Torque to 23 - 24 ft-lb (31 - 32 Nm).

Carrier Subassembly

1. Apply a liberal coat of grease to bore of Cluster Gear (3F). This holds Needle Rollers (3C) in place during assembly.
2. Install first row of Needle Rollers (3C) in bore of Cluster Gear (3F).
3. Insert Spacer (3D) in bore of Cluster Gear (3F) on top of Needle Rollers (3C).
4. Place second row of Needle Rollers (3C) in bore of Cluster Gear (3F) against Spacer(3D).
5. Place Carrier (3A) with one roll pin hole straight up.
6. Start Planet Shaft (3E) through hole in Carrier (3A). Using ample grease to hold it in position, slide one Thrust Washer (3B) over Planet Shaft (3E) with tang resting in cast slot of Carrier (3A).
7. With large end of Cluster Gear (3F) facing roll pin hole in Carrier, place Cluster Gear in position in Carrier (3A). Push Planet Shaft (3E) through Cluster Gear (3F) without going all the way through.
8. Slide second Thrust Washer (3B) between Cluster Gear (3F) and Carrier (3A) with washer tang located in cast slot of Carrier (3A). Finish sliding Planet Shaft (3E) through Thrust Washer (3B) into Carrier (3A).
9. Position non-chamfered side on Planet Shaft (3E) Roll Pin hole in line with hole in Carrier (3A) using a 1/8 inch diameter punch.

10. Use a 3/16" punch to align two roll pin holes. Drive roll pin (3G) through Carrier (3A) and into Planet Shaft (3E) until Roll Pin (3G) is flush with bottom of cast slot in Carrier (3A) outside diameter at Thrust Washer (3B) tang. Use a 1/4" pin punch to make sure roll pin (3G) is flush in slot.
11. Repeat Steps 1 thru 10 for remaining Cluster Gears (3F).

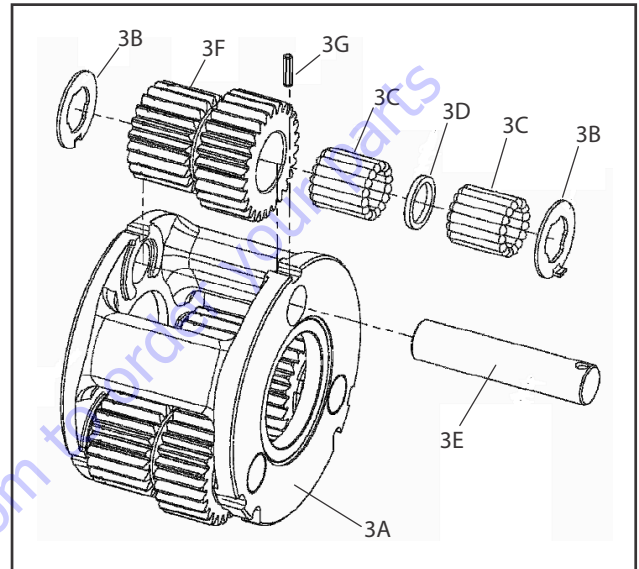


Figure 3-57. Carrier Subassembly

Main Assembly

1. With Hub Shaft Subassembly resting on Shaft (1A) install Internal Gear (2). The spline of Internal Gear (2) bore will mesh with spline of Output Shaft (1A). This will be a tight fit.
2. Inspect location of Internal Gear (2) on Output Shaft (1A). A portion of Output Shaft (1A) should protrude through Internal Gear (2) bore.
3. Install 4 Dowel Pins (13) into counter bore holes in Hub (1G).
4. Install Thrust Washer (11) in counter bore of Carrier Subassembly (Small Cluster-Gear end) Use grease to hold in place.
5. Place O-ring (5) into Hub counter-bore. Use grease to hold O-ring in place.

CAUTION

SHARP EDGES OF COUNTER-BORE CAN CAUSE SERIOUS INJURY. BE CAREFUL WHEN SEATING O-RING.

6. Place Carrier Subassembly on bench with large end of Cluster Gears (3F) facing up with one at 12 o'clock position. Find punch marked tooth on each gear at large end and locate at 12 o'clock (straight up) from each planet pin. Marked tooth will be located just under Carrier on upper two gears. Check timing through slots in carrier. (See Carrier Subassembly)
7. With longer shoulder side of Ring Gear (4) facing down, place Ring Gear (4) over (into mesh with) cluster gears (3F). Be sure cluster gear timing marks (punch marks) remain in correct location during Ring Gear (4) installation. Ring Gear (4) side with an "X" or punch mark stamped on it should be up.
8. While holding Ring Gear (4) and Cluster Gears (3F) in mesh, place small end of Cluster Gears (3F) into mesh with Internal Gear (2). On Ring Gear (4), locate hole marked "X" or punch marked over one of the marked counter-bored holes (Step 5) in Hub (1G). Check timing through slots in carrier. Rotate carrier in assembly to check freedom of rotation.

NOTE: *If gears do not mesh easily or Carrier Assembly does not rotate freely, remove Carrier and Ring Gear. Check Cluster Gear timing.*

9. Install Thrust Washer (11) in counter bore on face of carrier. Use grease to hold in place.
10. Place O-ring (5A) into counter bore of Brake Housing (6). Use grease to hold O-Ring in place.

CAUTION

SHARP EDGES OF COUNTER-BORE CAN CAUSE SERIOUS INJURY. BE CAREFUL WHEN SEATING O-RING.

11. Install Brake Housing (6). Align Pipe Plug hole (20) with those in the Hub (1G).
12. Install Bolts (12) through Brake Housing (6) into Hub (1G). Torque to 23 - 27 ft-lb (31-36 Nm).
13. With gearbox standing on pinion end, fill gearbox with 43 oz of ISO VG150 / VG220 gear oil.
14. Install Retaining Ring (44) in groove of Sun Gear (8).
15. Install Sun Gear (8) into mesh with Planet Gears (3F).
16. Install Pipe Plug (20) in Cover (6). Torque to 23 to 24 ft-lb (31 - 32 Nm).

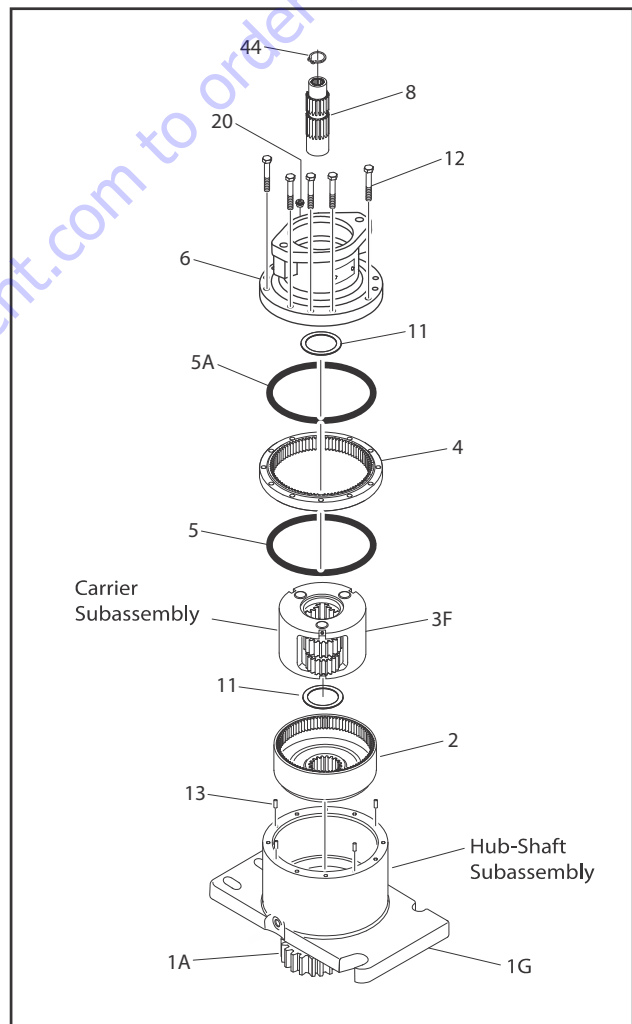


Figure 3-58. Main Assembly

Motor and Brake Assembly

1. Insert Stator (8K) (O.D. lobes) in bore of Brake Housing (6). Alternate Rotors (8J) (I.D. splines) and Stators, ending with a Stator (8K).
2. Grease O-rings (8F) & (8D) and Back-up rings (8H) & (8E). Place them in their respective grooves in Brake Housing (6) and Piston (8A). Make sure Back-up rings are correctly positioned.
3. Apply grease sparingly to Piston O.D. (8A) and bore of Brake Housing (6). Insert Piston (8A) in Brake Housing (6). Do not damage O-rings.
4. Install Springs (8L) in Piston (8A) spring pockets.
5. Test brake and perform roll test. Remove Brake Test Plate.
6. Install O-ring (26) on pilot of Motor (31). Use grease to keep O-ring in place.
7. Place Motor (31) in Brake pilot and line up holes. Check timing sheet.
8. Assemble Lift Lugs (28) on Hex Bolts (29). Assemble Hex Bolts (29) with Lift Lugs (28) through Motor (31) and Brake (6) against Motor flange. Torque to 80-100 ft-lb (108-135 Nm).

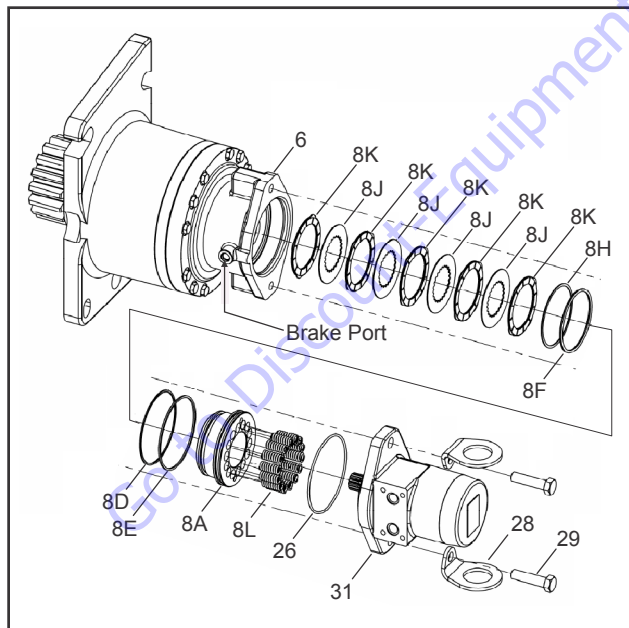


Figure 3-59. Motor and Brake Assembly

Motor Control Valve Assembly

1. Lay assembly down with motor ports facing up. Remove two plastic plugs in the motor ports. Do not lose O-ring in each port. Assemble Motor control Valve (32) on Motor (31) with Bolt (21) and Lock Washers (22). Torque Bolts (21) to 23-27 ft-lb (31-36 Nm).

NOTE: Align holes in control valve with motor ports.

2. Install Elbow Fittings (30) in Brake (6). Do not tighten jam nuts.
3. Install Elbow Fittings (30) in Motor Control Valve (32). Do not tighten jam nuts.
4. Assemble Tube (35) in Elbow Fittings (30). Torque jam nuts to 13-15 ft-lb (17-20 Nm).
5. Install one O-ring Plug (23) in Motor Control Valve (32). Torque to 30-31 ft-lb (40-42 Nm).
6. Pressure test brake, tube, and control valve connections by applying 3000 psi (207 bar) pressure to open port in Motor Control Valve (32) and holding for one minute. Check for leaks at control-valve-motor interface and tube connections. Release pressure and install remaining O-ring Plug (23) in Motor Control Valve (32). Torque to 30-31 ft-lb (40-42 Nm).

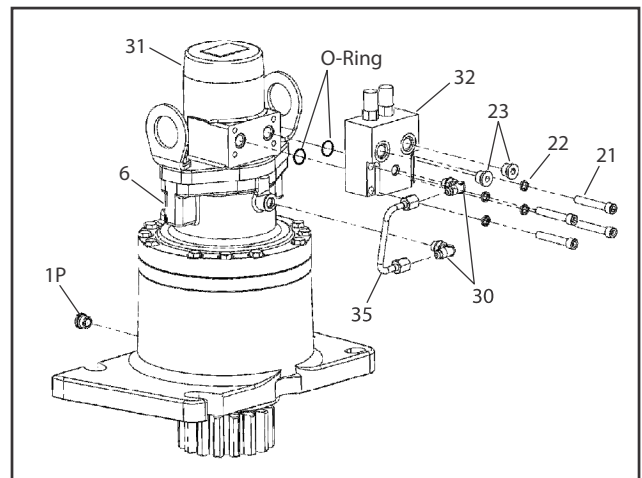


Figure 3-60. Motor Control Valve Assembly

3.8 SWING BEARING

Turntable Bearing Mounting Bolt Condition Check

NOTE: This check is designed to replace existing bearing bolt torque checks on JLG Lifts in service. This check must be performed after first 50 hours of machine operation and every 600 hours of machine operation thereafter. If any bolts are missing or loose, replace missing or loose bolts with new bolts and torque to value specified in torque chart after lubricating bolt threads with loctite #271. After replacing and retorquing bolt or bolts, recheck all bolts for looseness.

1. Check frame to bearing. Attach bolts as follows:
 - a. Elevate fully retracted boom to 70° (full elevation).
 - b. Try and insert a 0.0015" feeler gauge between bolt head and hardened washer at position shown in Figure 3-61.
 - c. Make sure 0.0015" feeler gauge will not fit under bolt head to bolt shank.
 - d. Swing turntable 90° and check some selected bolts at new position.
 - e. Continue rotating turntable at 90° intervals until a sampling of bolts are checked in all quadrants.
2. Check turntable to bearing. Attach bolts as follows:
 - a. Elevate fully retracted boom to 70° (full elevation).
 - b. try and insert a 0.0015" feeler gauge between bolt head and hardened washer at positions shown in Figure 3-61.
 - c. Lower boom to horizontal and fully extend boom.
 - d. Try and insert the 0.0015" feeler gauge between bolt head and hardened washer at position shown in Figure 3-61.

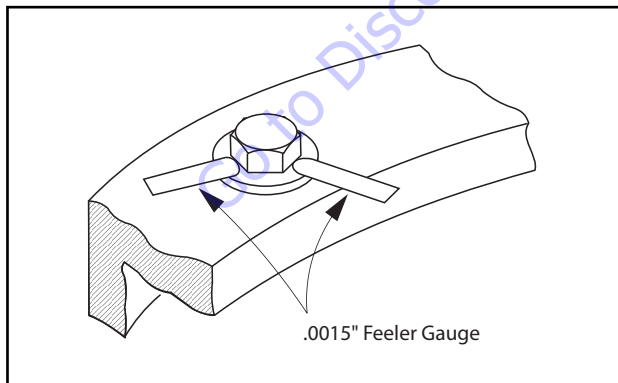


Figure 3-61. Swing Bearing Bolt Feeler Gauge Check

Wear Tolerance

⚠ WARNING

SWING BEARING IS ONE OF THE MOST CRITICAL POINTS ON AN AERIAL LIFT. IT IS HERE STRESSES OF LIFTING ARE CONCENTRATED, AT CENTER OF ROTATION. BECAUSE OF THIS, PROPER MAINTENANCE OF SWING BEARING BOLTS IS A MUST FOR SAFE OPERATION.

1. From underside of machine, at rear center, with in boom fully elevated and fully retracted, as shown in Figure 3-63., Swing Bearing Tolerance Measurement Location & Boom Placement A, using a magnetic base dial indicator, measure and record distance between swing bearing and turntable as shown in Figure 3-62., Swing Bearing Tolerance Measuring Point.
2. At the same point, with boom horizontal and fully extended as shown in Figure 3-63., Swing Bearing Tolerance Measurement Location & Boom Placement B, using a magnetic base dial indicator, measure and record distance between swing bearing and turntable as shown in Figure 3-62., Swing Bearing Tolerance Measuring Point.
3. If difference is greater than 0.079 in. (2.00 mm), replace swing bearing.
4. If difference is less than 0.079 in. (2.00 mm) and any of the following conditions exist:
 - a. Metal particles in grease.
 - b. Increased drive power required.
 - c. Noise.
 - d. Rough rotation.
5. Remove, disassemble, and inspect bearing. If bearing inspection shows no defects, reassemble and return to service.

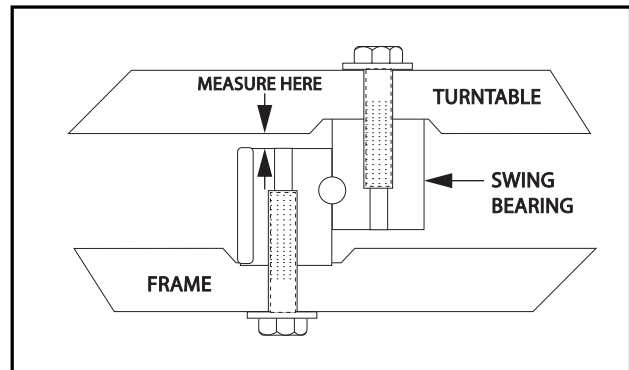


Figure 3-62. Swing Bearing Tolerance Measuring Point

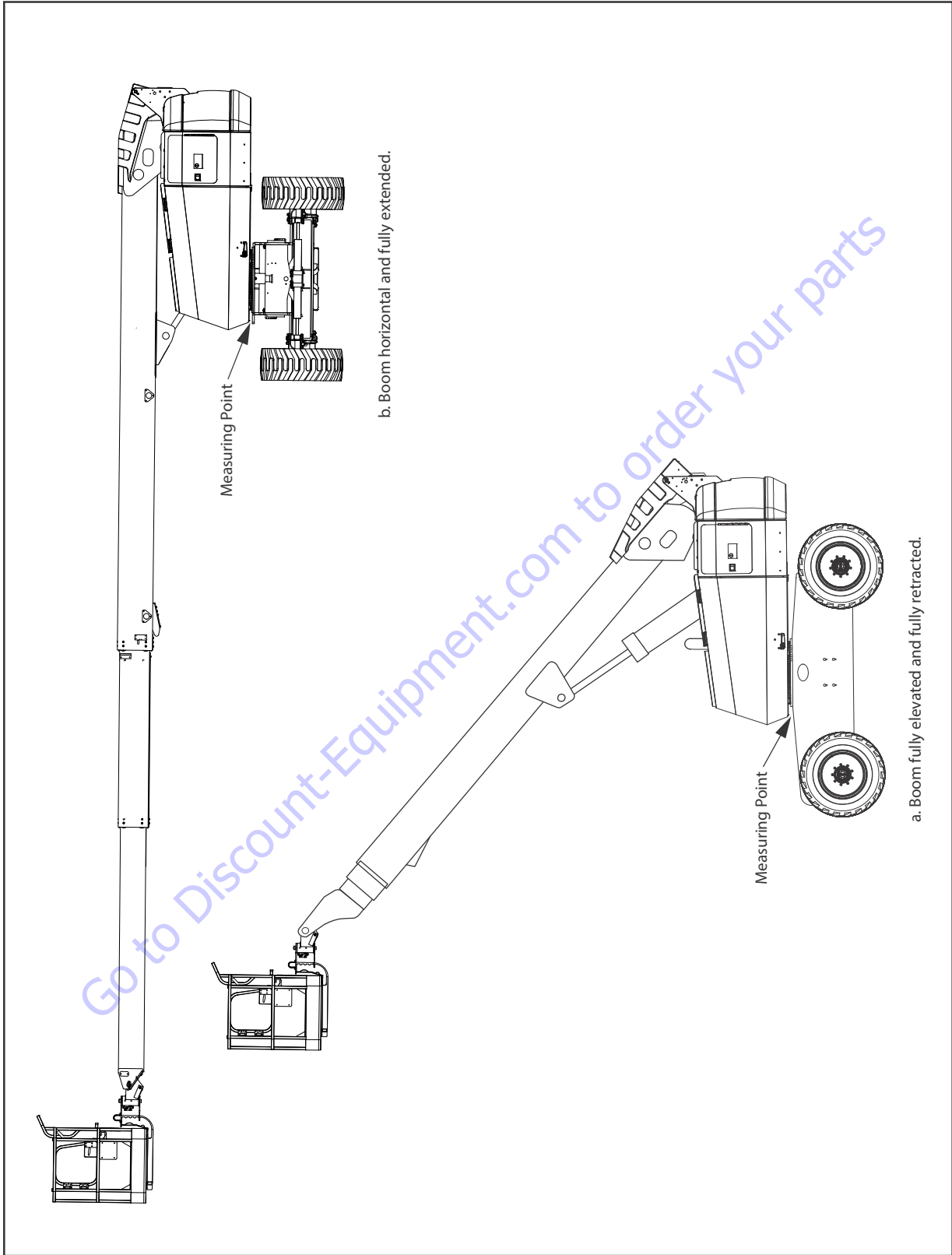


Figure 3-63. Swing Bearing Tolerance Measurement Location & Boom Placement

Swing Bearing Replacement

REMOVAL

1. Operate boom from Ground Control station to provide access to frame opening or rotary coupling.

⚠ WARNING

NEVER WORK BENEATH THE BOOM WITHOUT FIRST ENGAGING BOOM SAFETY PROP OR PROVIDING ADEQUATE OVERHEAD SLING SUPPORT AND/OR BLOCKING.

2. Attach an adequate support sling to boom and draw all slack from sling. Prop or block boom if feasible.
3. From inside turntable, remove mounting hardware attaching rotary coupling retaining yoke brackets to turntable.

NOTICE

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID THE ENTRY OF CONTAMINANTS INTO THE SYSTEM.

4. Tag and disconnect hydraulic lines from fittings on top of rotary coupling. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.
5. Attach suitable overhead lifting equipment to base of turntable weldment.
6. Use a suitable tool to scribe a line on swing bearing inner race an underside of turntable. This will aid in aligning bearing upon installation. Remove bolts and washers which attach turntable to bearing inner race. Discard bolts.
7. Use lifting equipment to carefully lift complete turntable assembly from bearing. Ensure no damage occurs to turntable, bearing, or frame-mounted components.
8. Carefully place turntable on a suitably supported trestle.
9. Use a suitable tool to scribe a line on outer swing bearing race and frame. This line will aid in aligning bearing upon installation. Remove bolts and washers which attach outer race of bearing to frame. Discard bolts. Use suitable lifting equipment to remove bearing from frame, then move bearing to a clean, suitably supported work area.

INSTALLATION

1. Using suitable lifting equipment, carefully lower swing bearing in position on frame. Ensure scribed line of outer bearing race aligns with scribed line on frame. If a new swing bearing is used, ensure filler plug fitting is 90° from fore and aft center line of frame.

⚠ CAUTION

JLG INDUSTRIES RECOMMENDS ALL REMOVED BEARING BOLTS BE DISCARDED AND REPLACED WITH NEW BOLTS. SINCE THE SWING BEARING IS THE ONLY STRUCTURAL LINK BETWEEN THE FRAME AND TURNTABLE, IT IS IMPERATIVE SUCH REPLACEMENT HARDWARE MEETS JLG SPECIFICATIONS. USE OF GENUINE JLG HARDWARE IS HIGHLY RECOMMENDED.

⚠ CAUTION

CHECK TORQUE SETTING ACCURACY OF TOOL IF COMPRESSED AIR OR ELECTRICALLY OPERATED IMPACT WRENCH IS USED TO TIGHTEN BEARING ATTACHMENT BOLTS.

2. Refer to Torque Sequence diagram as shown in Figure 3-64., Swing Bearing Torque Sequence. Clean residue off new bearing bolts and apply a light coating of JLG Threadlocker P/N 0100019 and install bolts and washers through frame and outer bearing race. Torque bolts to 190 ft-lb (258 Nm). Remove lifting equipment from bearing.
3. Using suitable lifting equipment, carefully position turntable assembly above machine frame.
4. Carefully lower turntable onto swing bearing. Ensure scribed line of inner bearing race aligns with scribed line on turntable. If a new swing bearing is used, ensure filler plug fitting is 90° fore and aft center line of turntable.
5. Clean residue off new bearing bolts and apply a light coating of JLG Threadlocker P/N 0100019 and install bolts and washers through turntable and bearing inner race.

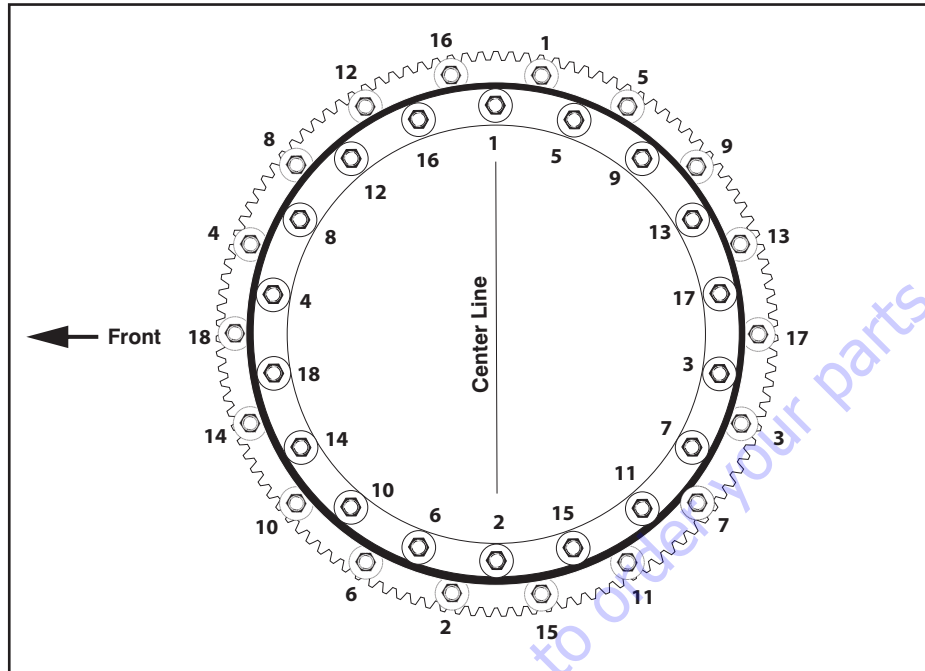


Figure 3-64. Swing Bearing Torque Sequence

6. Following Torque Sequence diagram shown in Figure 3-64., Swing Bearing Torque Sequence, torque bolts to 190 ft-lb (258 Nm) w/Loctite.
7. Remove lifting equipment.
8. Install rotary coupling retaining yoke brackets. Apply a light coating of Thread Locking Compound, JLG P/N 0100011 to attaching bolts. Secure yoke to turntable with mounting hardware.
9. Connect hydraulic lines to rotary coupling as tagged prior to removal.
10. At ground control station, use boom lift control to lower boom to stowed position.
11. Using all applicable safety precautions, activate hydraulic system and check swing system for proper and safe operation.

Swing Bearing Torque Values

1. Outer Race - 190 ft-lb (258 Nm) w/Loctite.
2. Inner Race - 190 ft-lb (258 Nm) w/Loctite.
3. See Figure 3-64. Swing Bearing Torque Sequence.

⚠ WARNING

CHECK OR MISSING OR LOOSE INNER AND OUTER SWING BEARING BOLTS AFTER FIRST 50 HOURS OF OPERATION AND EVERY 600 HOURS THEREAFTER.

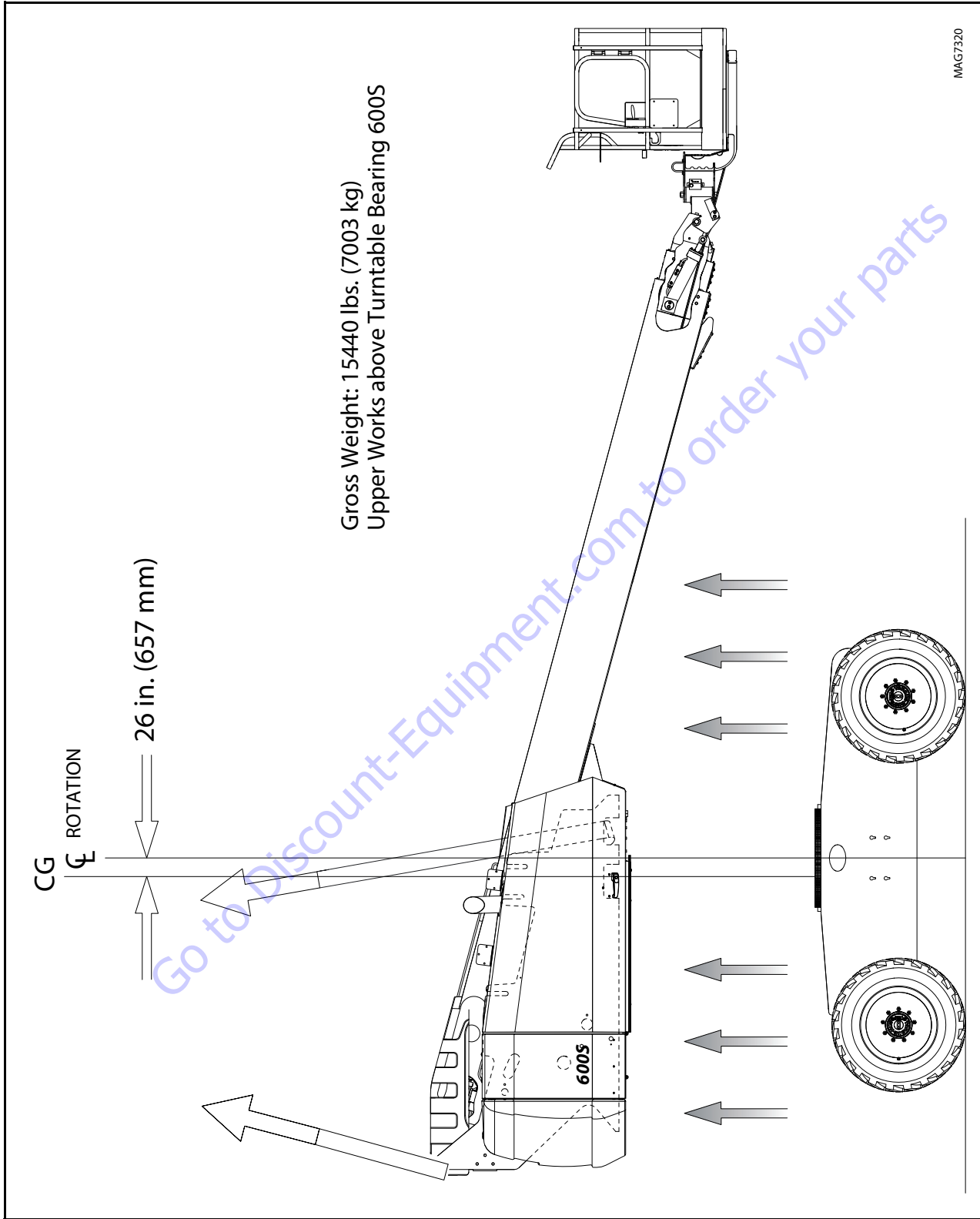


Figure 3-65. Swing Bearing Removal - 600S

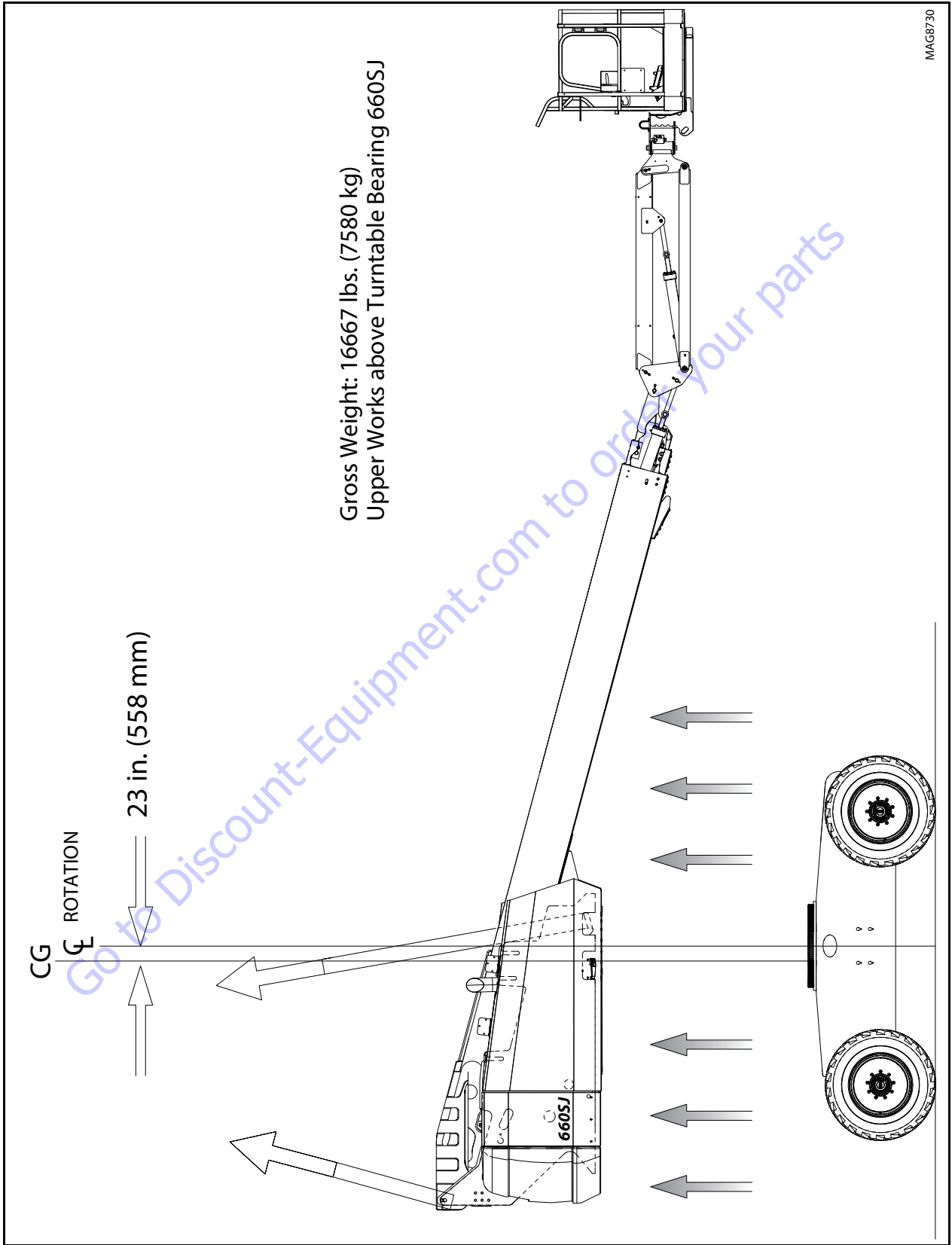
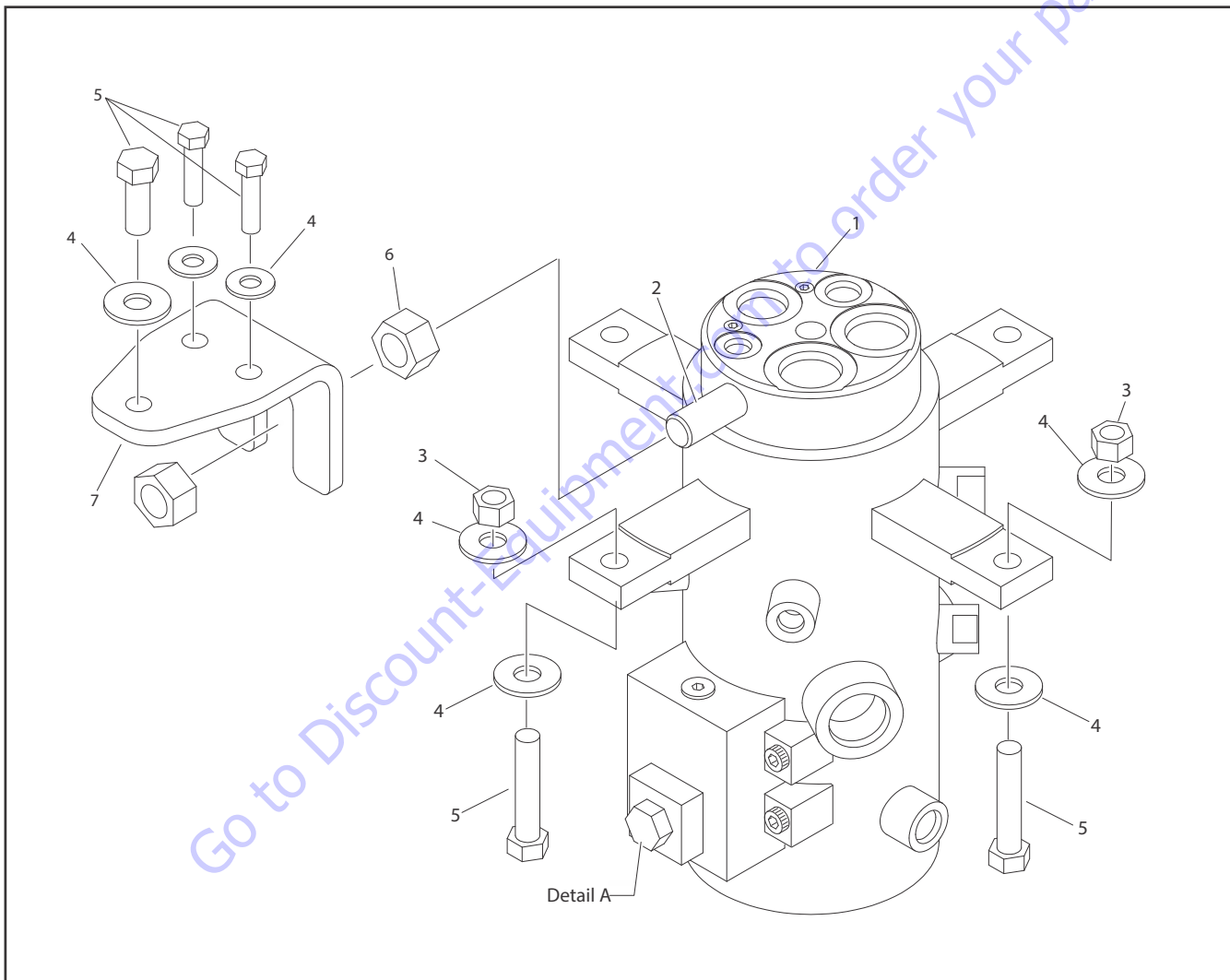


Figure 3-66. Swing Bearing Removal - 660SJ

3.9 ROTARY COUPLING

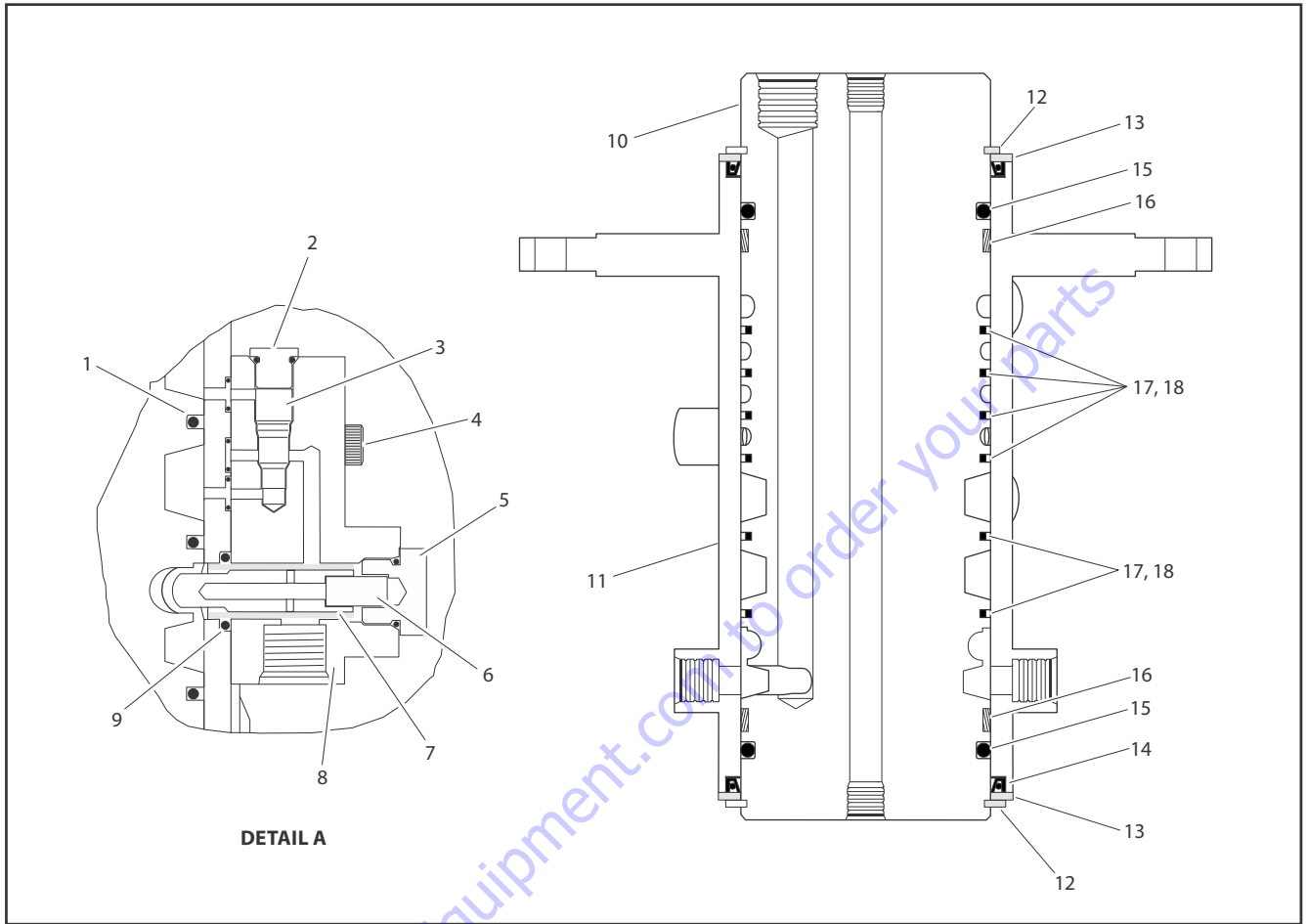
Use the following procedure to install the seal kit.

1. If not already removed, remove axle oscillation valve from cylinder barrel. The valve spool protrudes into the barrel and will damage spool and seals if left in place.
2. Remove snap ring (12) from end.
3. Remove thrust ring (13) from same end.
4. Remove center body (10) from housing (11).
5. Cut off old seals (14,15,17,18).
6. Assemble lip seals (14) in direction shown in Figure 3-68., Rotary Coupling - Sheet 2 of 2.
7. Reassemble O-ring (18).
8. Heat cap seals (17) in hydraulic oil for 5 minutes at 300° F (149° C).
9. Assemble cap seals over O-rings
10. Reinsert center body in housing (lube with hydraulic oil).
11. Replace thrust ring and snap ring.



- | | | |
|--------------------|----------------|------------|
| 1. Rotary Coupling | 3. Locknut | 5. Bolt |
| 2. Torque Lug | 4. Flat Washer | 6. Nut |
| | | 7. Bracket |

Figure 3-67. Rotary Coupling - Sheet 1 of 2



DETAIL A

- | | | | |
|----------------|------------------------|--------------------|--------------|
| 1. O-ring | 6. Spring | 11. Housing | 16. Bearing |
| 2. Plug | 7. Valve Block Plunger | 12. Retaining Ring | 17. Cap Seal |
| 3. Check Valve | 8. Valve Block | 13. Ring | 18. O-ring |
| 4. Screw | 9. O-ring | 14. Oil Seal | |
| 5. Plug | 10. Body | 15. O-ring | |

Figure 3-68. Rotary Coupling - Sheet 2 of 2

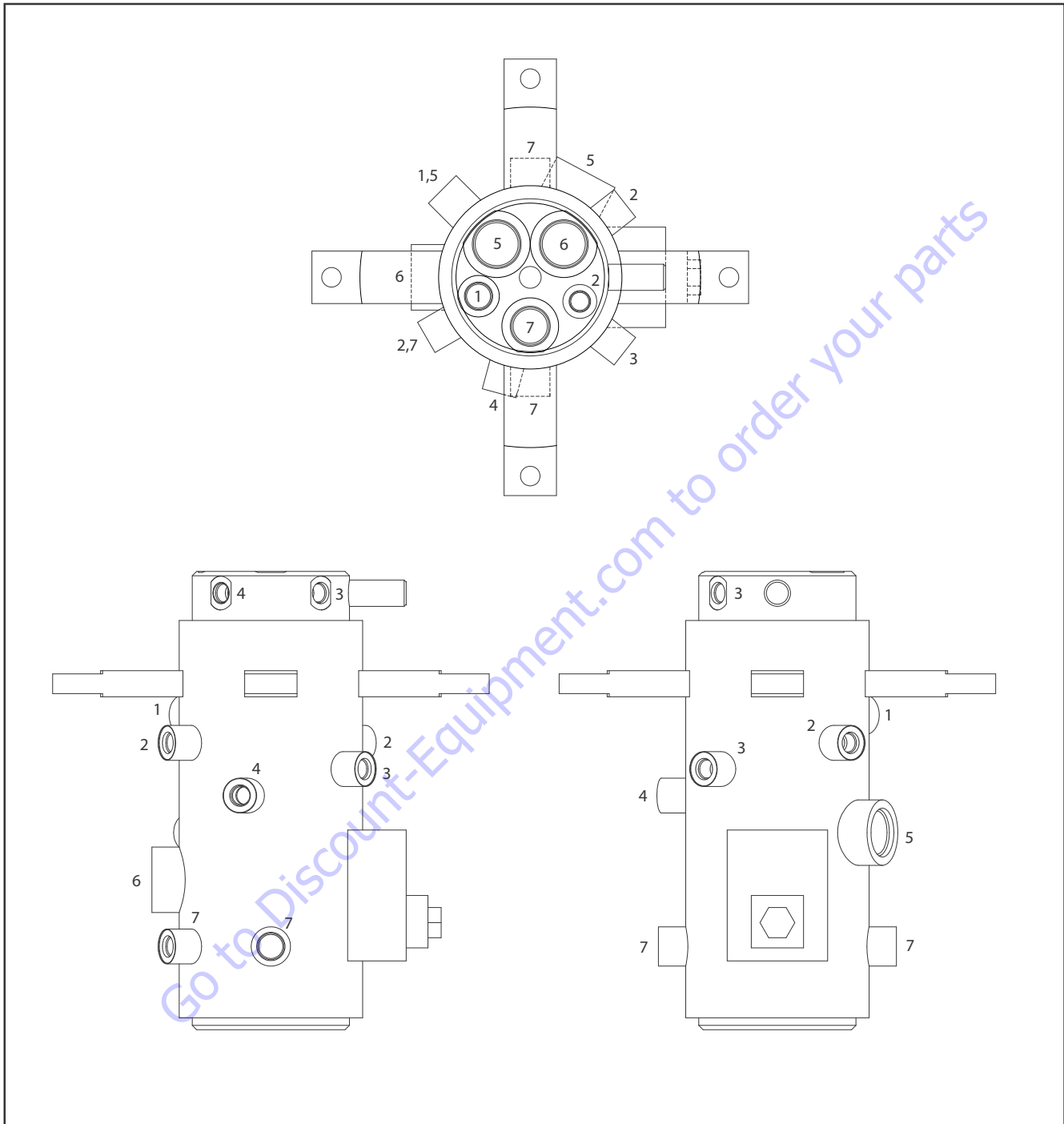


Figure 3-69. Rotary Coupling Port Location - 2WS

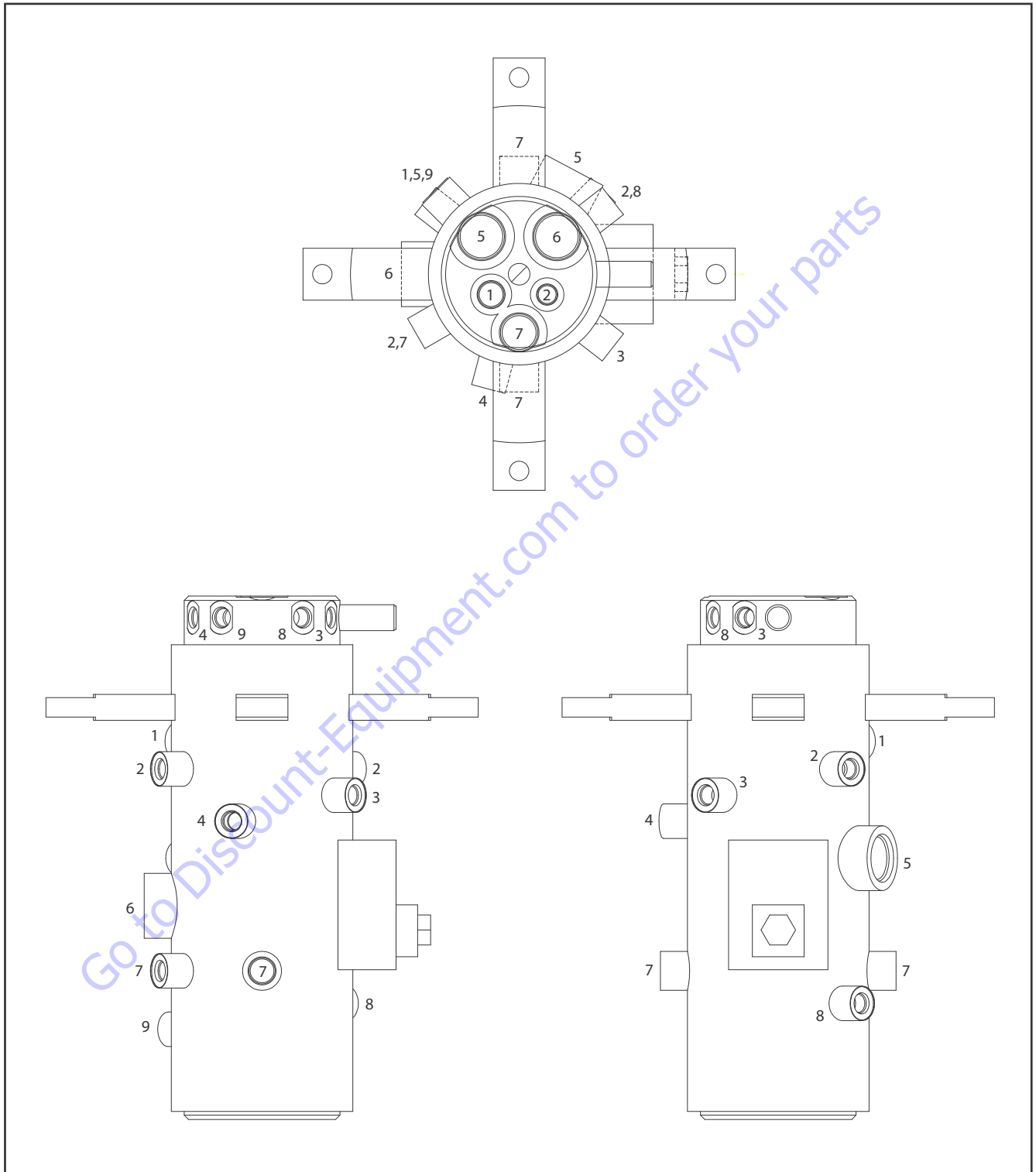


Figure 3-70. Rotary Coupling Port Location - 4WS

SECTION 3 - CHASSIS & TURNTABLE

Table 3-9. Coupling Port Information Table - 2WS

Port No.	Outlet	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (47)
2	2	-6	2Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (259)
4	1	-6	Steer	2500 (172)	3750 (259)
5	2	-6, -16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	-8, -6	Case Drain	250 (17)	375 (26)

Table 3-10. Coupling Port Information Table - 4WS

Port No.	Outlet	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (47)
2	2	-6	2Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (259)
4	1	-6	Steer	2500 (172)	3750 (259)
5	2	-6, -16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	-8, -6	Case Drain	250 (17)	375 (26)
8	1	-6	Steer	2500 (172)	3750 (259)
9	1	-6	Steer	2500 (172)	3750 (259)

3.10 GENERATOR

Every 250 hours

Check drive belt tension every 250 hours of operation.

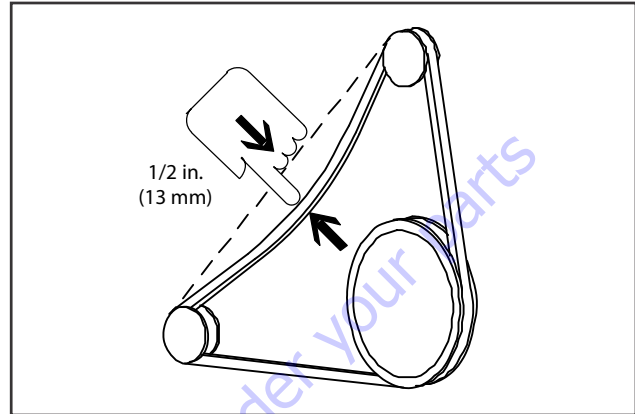


Figure 3-71. Generator Belt Tension

Every 500 hours

Service generator brushes and slip rings every 500 hours of operation. Hostile environments may require more frequent service.

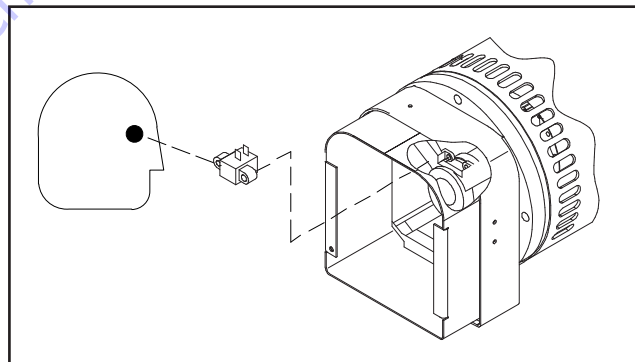


Figure 3-72. Generator Brushes and Slip Rings

Blow out inside of generator every 500 hours of service. If operating in a hostile environment, clean monthly.

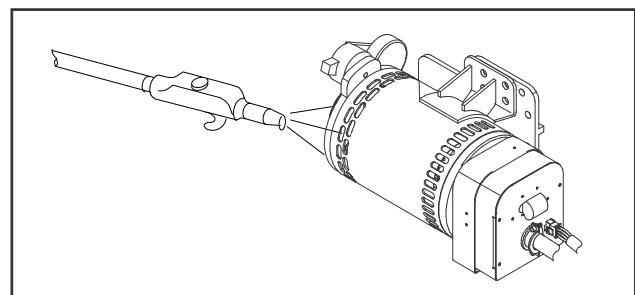


Figure 3-73. Generator Cleaning

Overload Protection

⚠ CAUTION

STOP ENGINE WHENEVER CHECKING OR INSPECTING CIRCUIT BREAKER.

The circuit breaker protects generator windings from overload. Generator output stops if circuit breaker opens.

If circuit breaker continues to open, check for faulty equipment connected to platform receptacles.

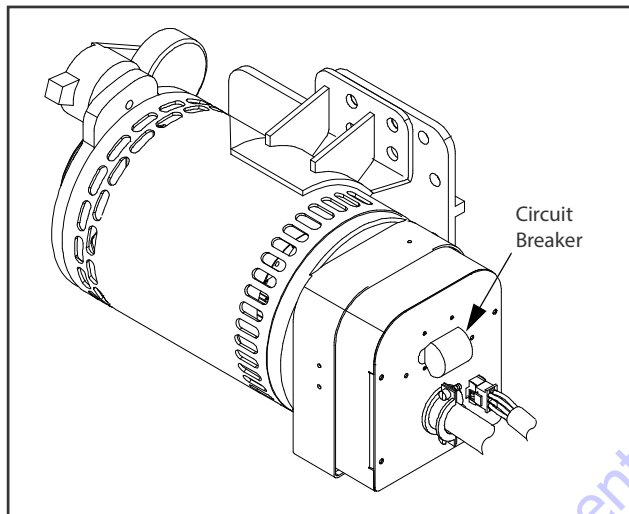


Figure 3-74. Generator Circuit Breaker Location

Inspecting Brushes, Replacing Brushes, and Cleaning Slip Rings

Refer to Figure 3-75., *Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings.*

INSPECTING BRUSH POSITION

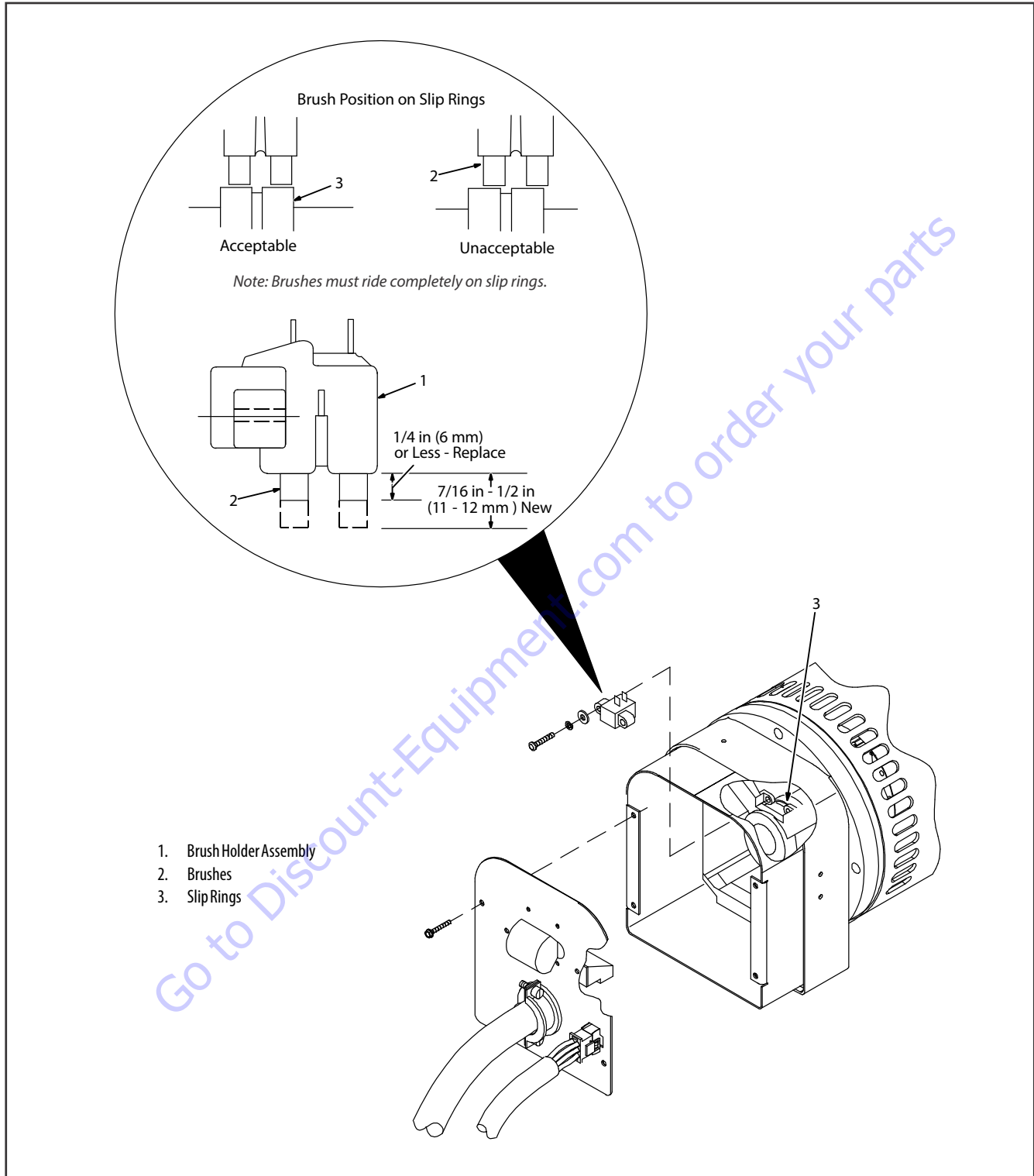
Inspect brush alignment with slip rings. View alignment through air vents in stator barrel. Brushes must ride completely on slip rings.

INSPECTING BRUSHES

1. Remove end panel. Inspect wires.
2. Remove brush holder assembly. Pull brushes from holders.
3. Replace brushes if damaged, or if brush is at or near minimum length.

CLEANING SLIP RINGS

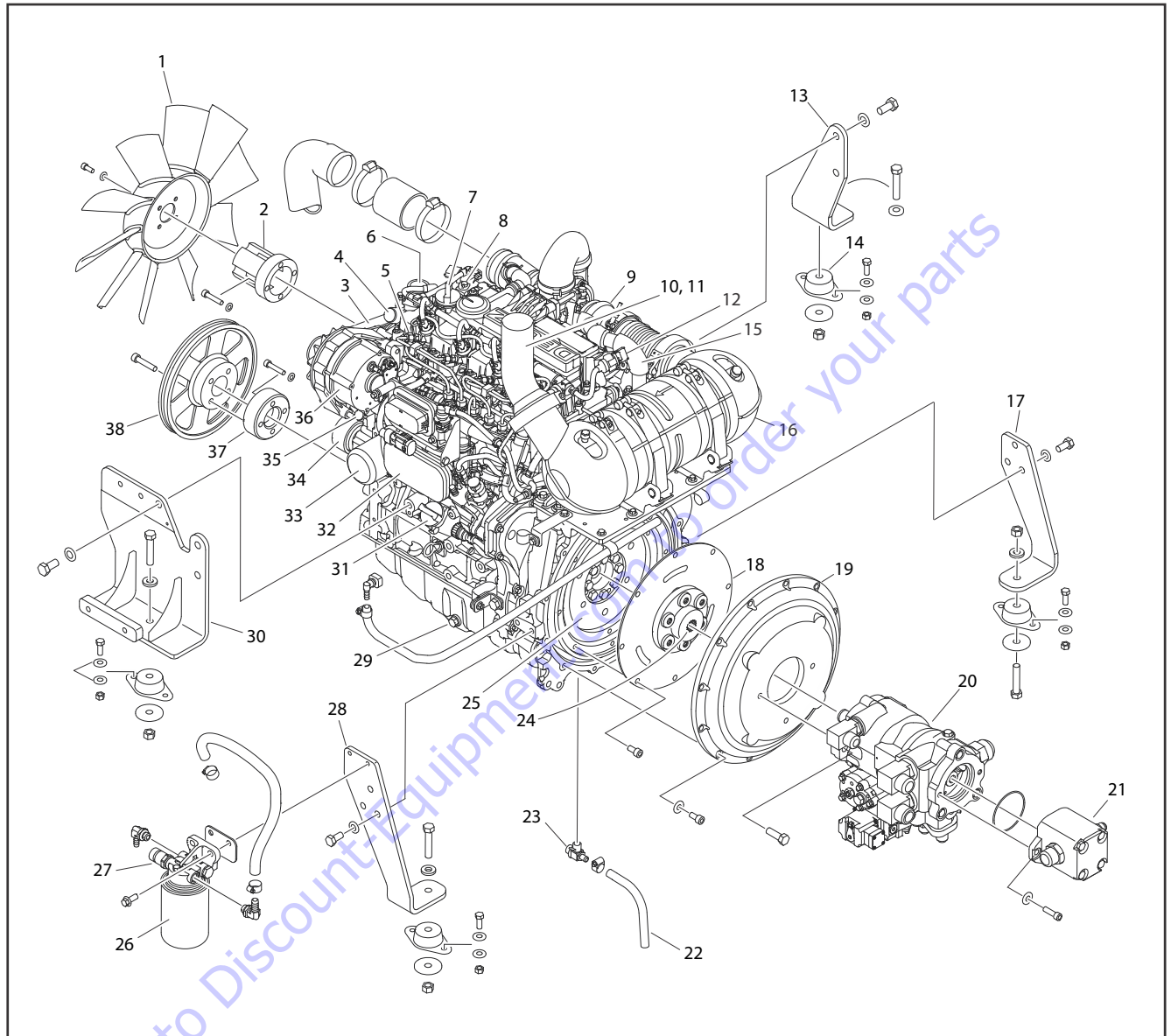
1. Visually inspect the slip rings. Under normal use, the rings turn dark brown.
2. If slip rings are corroded or their surface is uneven, remove belt to turn shaft by hand for cleaning.
3. Clean rings with 220 grit emery paper. Remove as little material as possible. If rings are deeply pitted and do not clean up, consult generator factory service.
4. Reinstall belt, brush holder assembly, and end panel.



Go to Discount-Equipment.com to order your parts

Figure 3-75. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

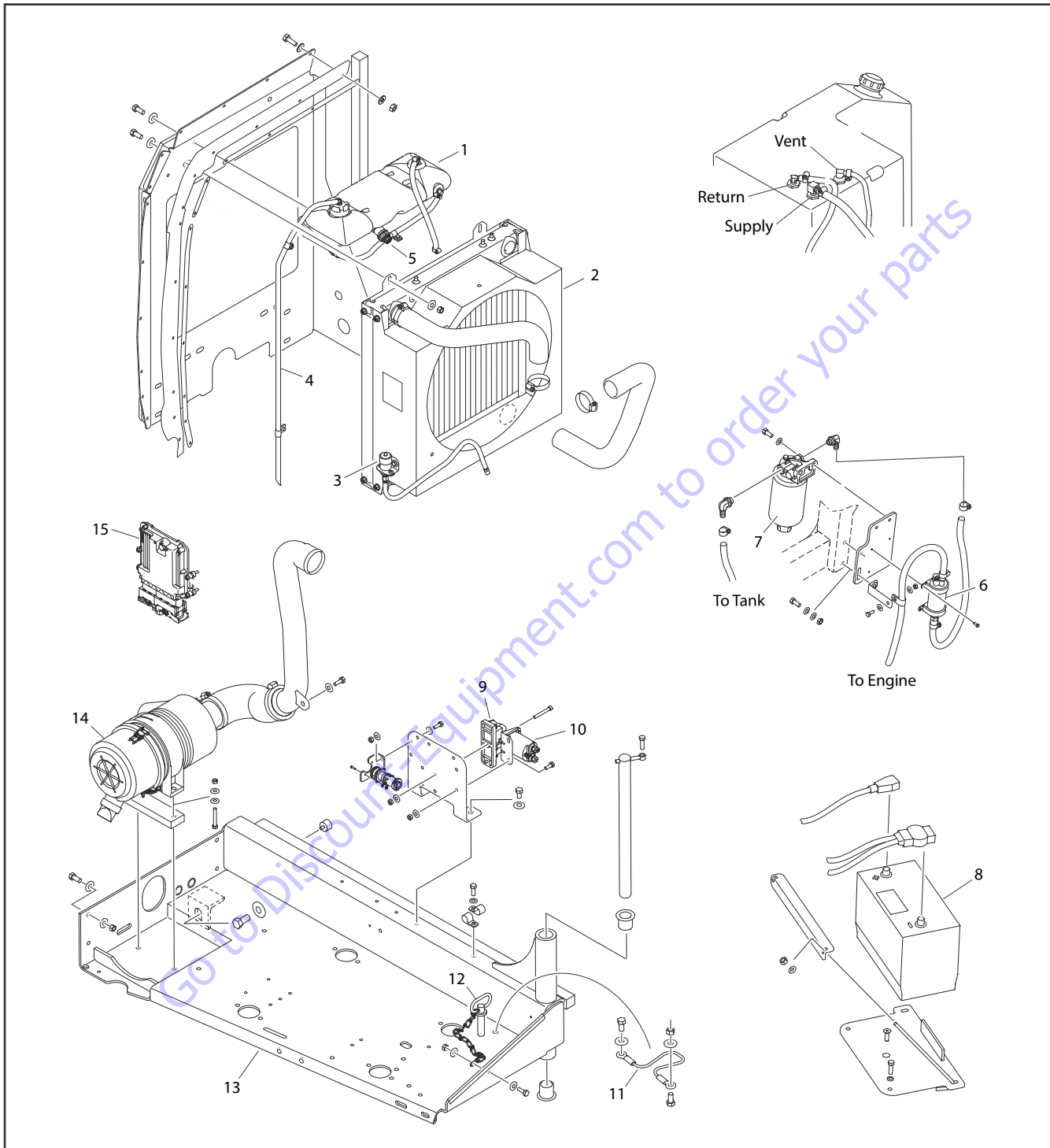
3.11 DEUTZ TD2.9L4 ENGINE



- | | | | | |
|-----------------------|---------------------------------|------------------------|----------------------------------|--------------------|
| 1. Fan | 9. Turbocharger | 17. Rear Engine Mount | 25. Flywheel | 33. Oil Filter |
| 2. Adapter | 10. Exhaust Pipe | 18. Coupling | 26. Fuel Filter | 34. Belt Tensioner |
| 3. Drive Belt | 11. Spark Arrester | 19. Pump Adapter Plate | 27. Pressure Sensor | 35. Plug |
| 4. Water Pump | 12. Pressure Sensor | 20. Pump Assembly | 28. Rear Engine Mount | 36. Alternator |
| 5. Fuel Injector | 13. Front Engine Mount | 21. Gear Pump Assembly | 29. Oil Pan Drain Plug | 37. Adapter |
| 6. Thermostat | 14. Motor Mount | 22. Oil Drain Hose | 30. Front Engine/Generator Mount | 38. Pulley |
| 7. Oil Fill Cap | 15. Shuttle Valve | 23. Oil Drain Valve | 31. Oil Fill Cap | |
| 8. Temperature Sender | 16. Catalytic Converter/Muffler | 24. Pump Coupler | 32. Oil Cooler | |

Figure 3-76. Deutz TD2.9L4 Engine Installation - Sheet 1 of 2

SECTION 3 - CHASSIS & TURNTABLE



- | | | | | |
|---------------------------------|--------------------------|-----------------------|---------------|-------------------------------|
| 1. Coolant Recovery Tank | 4. Coolant Overflow Hose | 7. Fuel Pre-Filter | 10. Relay | 13. Engine Tray |
| 2. Radiator Assembly | 5. Coolant Level Sensor | 8. Battery | 11. Lanyard | 14. Air Filter Assembly |
| 3. Air Filter Service Indicator | 6. Fuel Pump | 9. Power Module Relay | 12. Hitch Pin | 15. Engine Control Unit (ECU) |

Figure 3-77. Deutz TD2.9L4 Engine Installation - Sheet 2 of 2

NOTE: Refer to engine manufacturer's manual for detailed operating and maintenance instructions.

Check Oil Level

1. Make sure machine and engine are level and switch engine OFF before checking oil level.
2. Remove oil dipstick and wipe with clean cloth.
3. Insert dipstick to the stop and remove again.
4. Check oil level. Top oil level as shown in figure below with an approved grade and type of oil outlined in engine manufacturer's operator's manual.

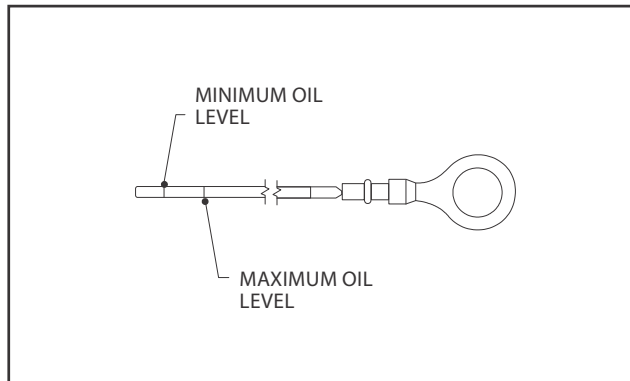


Figure 3-78. Deutz 2.9 T4F Dipstick Markings

5. Replace dipstick until fully seated.

Change Engine Oil

1. Allow engine to warm up. Engine oil should reach approximately 176° F (80° C).
2. Make sure machine and engine are level and switch off engine.
3. Place oil tray under engine.

CAUTION

HOT ENGINE OIL CAN CAUSE BURNS. AVOID CONTACT WITH HOT OIL WHEN DRAINING.

NOTICE

COLLECT USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.

4. Open oil drain valve and drain oil.
5. Close oil drain valve.
6. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-83., Engine Oil Viscosity.

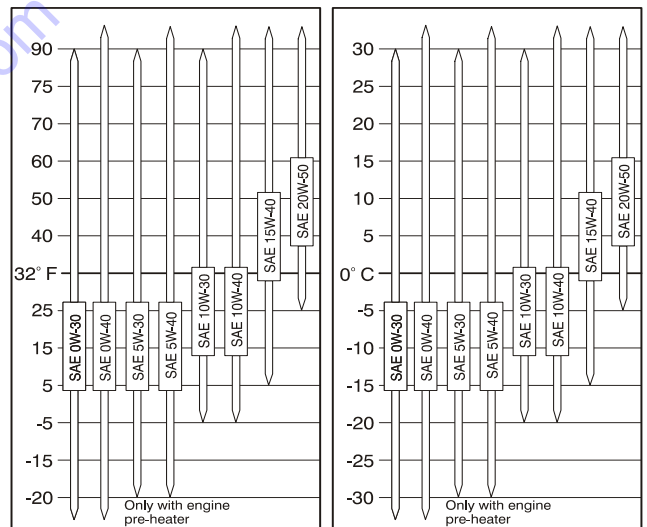
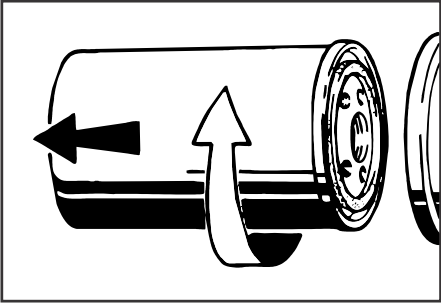


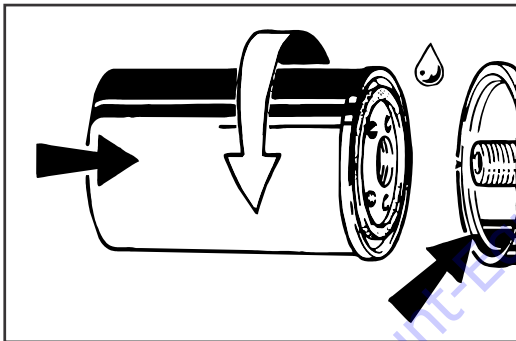
Figure 3-79. Engine Oil Viscosity

Change Oil Filter

1. Wipe area around filter to clean any dirt from area.
2. Using a suitable oil filter removal tool, loosen lube oil filter cartridge and spin off.



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil
6. Screw in new filter by hand until gasket is flush.
7. Hand-tighten filter another half-turn.



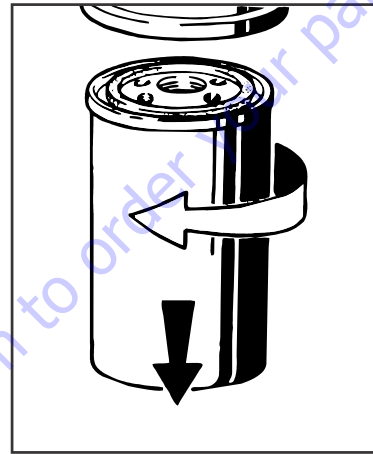
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

Change Fuel Filters

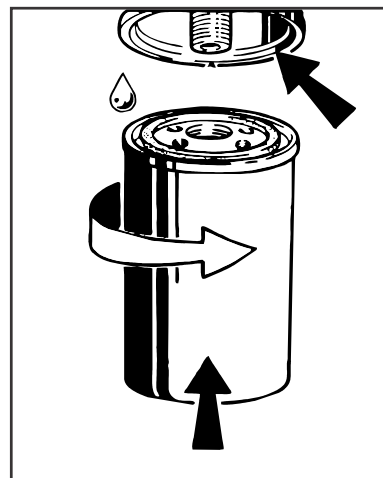
⚠ WARNING

FUEL IS FLAMMABLE AND CAN CAUSE DEATH OR SERIOUS INJURY. MAKE SURE NO OPEN FLAMES OR SPARKS ARE IN THE AREA WHEN WORKING ON FUEL SYSTEM. DO NOT SMOKE WHEN WORKING ON FUEL SYSTEM.

1. Wipe area around filter to clean any dirt from area.
2. Disconnect water sensor connector (Pre-filter Only).
3. Remove fuel filter cartridge. Catch any escaping fuel.



4. Clean dirt from filter carrier sealing surface.
5. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.
6. Screw in new filter by hand until gasket is flush. Hand-tighten filter another half-turn.



7. Connect water sensor connector (Pre-filter Only).
8. Open fuel shut-off valve.
9. Check for leaks.

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
16	0	No detail information
16	0	BusOff error CAN No detail information
29	3	Hand throttle idle validation switch; short circuit to battery
29	4	Hand throttle; short circuit to ground
29	2	Plausibility error between sensor and idle switch, Acceleration Pedal Detection. In case of Hand Throttle with Low Idle Switch, it is the plausibility check between hand throttle and idle switch.
51	5	Intake Throttle Flap, H-Bridge, wiring harness broken at connected actuator
51	6	Intake Throttle Flap, H-Bridge, current above maximum threshold
51	3	Intake Throttle Flap, H-Bridge, short circuit to battery (A02)
51	3	Intake Throttle Flap, H-Bridge, short circuit to battery (A67)
51	4	Intake Throttle Flap, H-Bridge, short circuit to ground (A02)
51	4	Intake Throttle Flap, H-Bridge, short circuit to ground (A67)
51	7	Intake Throttle Flap, H-Bridge, position of actuator not plausible (deviation from set point more than 7%)
51	3	Intake Throttle Flap, H-Bridge, short circuit to battery oder broken wiring harness
51	4	Intake Throttle Flap, H-Bridge, short circuit to ground
91	3	Sensor error accelerator pedal. signal range check high.
91	4	Sensor error accelerator pedal. Signal is below the range.
91	11	Plausibility error between APP1 and APP2 or APP1 and idle switch.
94	3	Sensor error low fuel pressure; signal range check high
94	4	Sensor error low fuel pressure; signal range check low
94	1	Low fuel pressure; warning threshold exceeded
94	1	Low fuel pressure; shut off threshold exceeded
97	3	Sensor error water in fuel; signal range check high
97	4	Sensor error water in fuel; signal range check low.
97	12	Water in fuel level prefilter; maximum value exceeded
98	2	Plausibility Check; No detail information
100	3	Sensor error oil pressure; signal range check high
100	4	Sensor error oil pressure sensor; signal range check low
100	0	High oil pressure; warning threshold exceeded.
100	0	High oil pressure; shut off threshold exceeded
100	1	Low oil pressure; warning threshold exceeded
100	1	Low oil pressure; shut off threshold exceeded
102	2	Charged air pressure above warning threshold.
102	2	Charged air pressure above shut off threshold.
102	2	Pressure downstream charge air cooler, plausibility error
102	1	Pressure downstream charge air cooler, pressure below lower physical threshold
102	3	Pressure downstream charge air cooler, short circuit to battery or open load
102	4	Pressure downstream charge air cooler, short circuit to ground
105	1	Charged Air cooler down stream temperature. Temperature below lower physical threshold.
105	3	Electrical error charged air temperature. Signal range check high.(SRC)
105	4	Electrical error charged air temperature. Signal range check low.

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Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
105	0	Charged air cooler temperature. System reaction initiated. High charged air cooler temperature. Warning threshold exceeded.
105	0	High charged air cooler temperature. Shut off threshold exceeded.
105	11	Diagnostic fault check for charged air cooler downstream temperature sensor No detail information
107	3	Sensor error air filter differential pressure; short circuit to battery
107	0	Sensor error air filter differential pressure; short circuit to ground
107	0	Air filter differential pressure; air filter clogged.
108	11	DFC for CAN message
108	3	Sensor error ambient air pressure; signal range check high
108	4	Sensor error ambient air pressure; signal range check low
110	2	Defect fault check for Absolute plausibility test. No detail information
110	0	Physical Range Check high for Coolant temperature
110	1	Physical Range Check low for Coolant temperature.
110	3	Sensor error coolant temperature; signal range check high
110	4	Sensor error coolant temperature; signal range check low
110	0	High coolant temperature; warning threshold exceeded
110	0	Coolant temperature; system reaction initiated
111	1	Coolant level too low
132	1	The air mass flow AFS_dm is greater than or equal to AFS_PhysRng.Min_C Physical Range Check low for air mass flow sensor. No detail information
157	0	Rail pressure raw value is intermittent. No detail information
157	1	Rail pressure raw value is above maximum offset. No detail information
157	3	Sensor error rail pressure. Sensor voltage above upper limit.
157	4	Sensor error rail pressure. Sensor voltage below lower limit.
164	2	Rail pressure safety function is not executed correctly.
168	3	Sensor error battery voltage; signal range check high.
168	4	Sensor error battery voltage; signal range check low
168	2	High battery voltage; warning threshold exceeded
168	2	High battery voltage; shot off threshold exceeded
168	0	Physical range check high for battery voltage
168	1	Physical range check low for battery voltage
171	0	Environment temperature sensor, temperature above upper physical threshold
171	1	Environment Temperature Physical Range Check low
171	3	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check high
171	4	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check low
172	2	Air inlet filter temperature, plausibility error
172	3	Air flow temperature sensor; short circuit to battery or open load.
172	4	Air flow temperature sensor; short circuit to ground
172	1	Air inlet filter sensor out of physical range check
172	0	air temperature within air filter box above maximum physical value
174	11	DFC for fuel temperature plausibility check function. No detail information

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
175	3	Sensor error oil temperature; signal range check high
175	4	Sensor error oil temperature; signal range check low
175	0	High oil temperature; warning threshold exceeded
175	0	High oil temperature; shut off threshold exceeded
175	2	Customer oil temperature: signal unplausible
190	0	Engine speed above warning threshold Over speed detection in component engine protection
190	0	Engine speed above warning threshold (FOC-Level 1)
190	11	Engine speed above warning threshold (FOC-Level 2)
190	14	Engine speed above warning threshold (Overrun Mode)
190	8	Sensor camshaft speed; disturbed signal
190	12	Sensor camshaft detection; out of range, signal disrupted; no signal
190	2	Offset angle between crank- and camshaft sensor is too large.
190	8	Sensor crankshaft detection; out of range, signal disrupted; disturbed signal
190	12	Speed detection; out of range, signal disrupted Sensor crankshaft speed; no signal
190	14	Camshaft- and Crankshaft speed sensor signal not available on CAN
411	4	Physical range check low for EGR differential pressure
411	0	Delta pressure across venturi in EGR line above physical high limit
411	0	Plausibility Check fault for deviation of desired and actual EGR-mass flow, where the latter is calculated out of EGR Delta Pressure Sensor
411	3	Sensor error differential pressure Venturi unit (EGR), signal range check low.
411	4	Sensor error differential pressure Venturi unit (EGR), signal range check high.
412	3	Electrical error EGR cooler downstream temperature. Signal range check high.
412	4	electrical error EGR cooler downstream temperature. Signal range check low.
520	9	Timeout Error of CAN-Receive-Frame TSC1TR; control signal
598	2	Plausibility check for Clutch. No detail information
624	5	SVS lamp; open load
624	12	SVS lamp: power stage over temperature
624	3	SVS lamp; short circuit to battery
624	4	SVS lamp; short circuit to ground
630	12	Access error EEPROM memory (delete)
630	12	Access error EEPROM memory (read)
630	12	Access error EEPROM memory (write)
639	14	CAN-Bus 0 "BusOff-Status"
651	5	Injector 1 (in firing order); interruption of electric connection
651	3	Injector 1 (in firing order); short circuit
652	5	Injector 2 (in firing order); interruption of electric connection
652	3	Injector 2 (in firing order); short circuit
653	5	Injector 3 (in firing order); interruption of electric connection
653	3	Injector 3 (in firing order); short circuit
654	5	Injector 4 (in firing order); interruption of electric connection
654	3	Injector 4 (in firing order); short circuit
655	5	Injector 5 (in firing order); interruption of electric connection

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Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
655	3	Injector 5 (in firing order); short circuit
655	4	High side to low side short circuit in the injector 5 (in firing order)
656	5	Injector 6 (in firing order); interruption of electric connection
656	3	Injector 6 (in firing order); short circuit
656	4	High side to low side short circuit in the injector 6 (in firing order)
676	11	Cold start device relay error
676	11	Cold start aid relay open load
677	3	Starter relay high side. Short circuit to battery.
677	4	Starter relay high side short circuit to ground.
677	5	Starter relay low side no load error.
677	12	Starter relay power stage over temperature.
677	3	Starter relay low side short circuit to battery.
677	4	Starter relay low side short circuit to ground.
729	5	Cold start aid relay open load
729	12	Cold start aid relay; over temperature error
729	3	Intake Air Heater Device; Short circuit to battery
729	4	Air intake heater; Short circuit to ground error for power stage on CJ945.
898	9	Timeout Error of CAN-Receive-Frame TSC1TE; Set point
975	5	PWM-Signal Fan, Open load or short-circuit ground
975	3	PWM-Signal Fan, short-circuit to plus
975	4	PWM-Signal Fan, open load or short circuit to ground
1079	13	Failure of sensor supply voltage 1.
1080	13	Failure of sensor supply voltage 2.
1109	2	Engine shut off demand ignored
1136	0	Physical range check high for ECU temperature
1176	0	Pressure sensor upstream turbine, Physical Range Check high.
1176	1	Pressure sensor upstream turbine, Physical Range Check low.
1176	3	Pressure sensor upstream turbine, signal range check (SRC) high.
1176	4	Pressure sensor upstream turbine, signal range check (SRC) low.
1180	3	Sensor error exhaust gas temperature upstream turbine; signal range check high
1180	4	Sensor error exhaust gas temperature upstream turbine; signal range check low
1180	0	Physical range check high for exhaust gas temperature upstream turbine
1180	1	Physical range check low for exhaust gas temperature upstream turbine
1188	11	Wastegate actuator; internal error
1188	11	Wastegate actuator; EOL calibration not performed correctly
1188	13	Wastegate actuator calibration deviation too large, re-calibration required
1188	2	Wastegate; status message from ECU missing
1188	7	Wastegate actuator; blocked
1188	11	Wastegate actuator; over temperature (> 135°C)
1188	11	Wastegate actuator; operating voltage error
1188	7	Turbocharger wastegate, mechanical blocking detected.
1188	2	Turbocharger wastegate, CAN Error
1188	13	Turbocharger wastegate, EOL calibration error.

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
1188	12	Turbocharger wastegate, internal electrical error
1188	13	Turbocharger wastegate, learning process aborted.
1188	6	Turbocharger wastegate, current above maximum threshold.
1188	3	Turbocharger wastegate, supply voltage above maximum threshold.
1188	4	Turbocharger wastegate, supply voltage below minimum threshold.
1188	13	Turbocharger wastegate, learning process out of range.
1188	7	Turbocharger wastegate, broken spring detected.
1188	0	Turbocharger wastegate, temperature critical high.
1231	14	CAN-Bus 1 "BusOff-Status"
1235	14	CAN-Bus 2 = CAN_C reports Bus-error (for engines <8L and CV52 it is the engine-CAN@250kbaud) CAN Bus error passive; warning CAN C - engine CAN
1235	14	CAN-Bus 2 = engine bus "BusOff-Status"
1237	2	Override switch; plausibility error.
1322	12	N/A
1323	12	Too many recognized misfires in cylinder 1 (in firing order)
1323	12	N/A
1323	12	N/A
1323	12	N/A
1323	12	N/A
1323	12	N/A
1346	0	Misfire detection monitoring No detail information
1638	2	Hydraulic oil temperature check for Shut off condition
1639	12	Fan speed sensor; electrical error or signal disturbed or very low fan speed
1639	0	Sensor error fan speed; signal range check high or engine speed respective fan speed too high
1639	1	Sensor error fan speed; signal range check low or fan speed too low
1761	14	DEF tank level; warning threshold exceeded
1761	0	DEF tank, DEF level above upper physical threshold
1761	1	DEF tank, DEF level below lower physical threshold
1761	14	Urea Tank Signal to HMI for indicating the Urea Tank-Level (Urea tank volume ratio low threshold 1)
1761	14	DEF tank, DEF level below first warning threshold
1761	14	DEF tank, DEF level below second warning threshold
1761	2	DEF tank level, plausibility error
1761	14	DEF tank, DEF level below third warning threshold
2634	12	Early opening defect of main relay No detail information
2634	12	DFC for stuck main relay error No detail information
2659	2	Exhaust Gas Recirculation AGS Sensor; signal not plausible
2659	0	Exhaust Gas Recirculation AGS Sensor; Sensed exhaust mass value above maximum physical value
2659	1	Exhaust Gas Recirculation AGS Sensor; Sensed exhaust mass value below minimum physical value
2659	12	Exhaust Gas Recirculation AGS Sensor; plausibility error, AGS sensor has not passed the burn off process
2659	2	Exhaust Gas Recirculation AGS Sensor; Temperature of EGR mass not plausible
2791	12	Actuator EGR Valve; power stage over temperature
2791	7	EGR actuator, actuator blocked
2791	2	EGR actuator, CAN error

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Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
2791	13	EGR actuator, EOL calibration error
2791	12	EGR Actuator, internal electrical fault
2791	13	EGR actuator, learning process aborted
2791	6	EGR actuator current is above maximum threshold
2791	3	EGR actuator supply voltage is above the maximum threshold
2791	4	EGR actuator supply voltage is below minimum threshold.
2791	13	EGR actuator, learning process out of range
2791	7	EGR actuator, broken spring detected.
2791	16	EGR actuator, temperature high.
2791	0	EGR actuator, temperature critical high
2797	4	Timeout of Short-Circuit Ground Diagnosis Cyl. Bank 0;_IVDiaShCirGndToutBnk_0
2797	4	Injector diagnostic; Short circuit to ground cylinder bank 0
2798	4	Timeout of Short-Circuit Ground Diagnosis Cyl. Bank 1;_IVDiaShCirGndToutBnk_1
2798	4	Injector diagnostic; Short circuit to ground cylinder bank 1
3031	0	DEF tank, DEF temperature in DEF tank is to high.
3031	1	DEF tank, DEF temperature below lower physical threshold
3031	2	Urea tank temperature outside of plausible thresholds
3219	2	DFCSAE J1939 error No detail information
3224	2	DLC Error of CAN-Receive-Frame AT11G1 NOX Sensor (SCR-system upstream cat; DPF-system downstream cat); length of frame incorrect
3224	9	Timeout Error of CAN-Receive-Frame AT11G1; NOX sensor upstream
3224	2	DLC Error of CAN-Receive-Frame AT11G1Vol NOX sensor.
3224	9	Timeout Error of CAN-Receive-Frame AT11G1Vol; NOX sensor.
3224	1	DFC for plausibility error Max for NOx sensor upstream of SCR Cat
3226	2	Nox feed back fault detection No detail information
3227	2	DFCSAE J1939 error No detail information
3234	2	DLC Error of CAN-Receive-Frame AT101 No detail information
3234	9	Timeout Error of CAN-Receive-Frame AT10G1; NOX sensor (SCR-system downstream cat; DPF-system downstream cat)
3234	2	DLC Error of CAN-Receive-Frame AT101Vol NOX
3234	9	Timeout Error of CAN-Receive-Frame AT10G1Vol.
3234	11	DFC for plausibility error Min for NOx sensor downstream of SCR Cat.
3241	0	Sensor SCR catalyst upstream temperature too high; plausibility error.
3248	4	Sensor error particle filter downstream temperature; signal range check low
3251	0	Differential pressure DPF maximum value is exceeded
3251	0	Differential pressure sensor across DPF exceeds warning high limit
3251	1	Differential pressure DPF, pressure below lower shutoff threshold.
3251	1	Differential pressure DPF, pressure below lower warning threshold.
3253	2	Differential pressure DPF, plausibility error
3253	3	Electrical error differential pressure B58 (DPF). (signal range check high)
3253	4	Electrical error differential pressure (DPF). signal range check low.
3253	2	Sensor differential pressure (DPF); plausibility error
3361	7	DEF dosing valve blocked (SCR)
3361	6	DEF dosing valve; power at the end of injection too high

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
3361	3	DEF dosing valve; short circuit to battery on low side
3361	3	DEF dosing valve; short circuit to battery or open load on high side
3361	4	Urea dosing valve; short circuit to ground or open load on low side
3361	4	DEF dosing valve; short circuit on high side
3519	12	DEF tank temperature, temperature too high
3519	3	DEF quality sensor, internal temperature sensor short circuit to battery or open load
3519	4	DEF quality sensor, internal temperature sensor short circuit to ground
3519	13	Temperature at UQS invalid
3520	3	DEF quality sensor, short circuit to battery or open load
3520	4	DEF quality sensor, short circuit to ground
3520	2	DEF quality sensor, bad DEF quality detected or no DEF measuring possible.
3520	13	Urea quality at UQS invalid
3532	3	Sensor error DEF tank level; signal range check high
3532	4	Sensor error DEF tank level; signal range check low
3532	3	The DEF Level at UQS out of max. physical range
3532	4	Quality at UQS out of min. physical range
3699	2	Passive regeneration of DPF; plausibility error DPF differential pressure sensor and a further sensor or actuator CRT system defective
3699	2	Passive regeneration of DPF; DOC error Temperature sensor us. and ds. DOC simultaneously defect
3699	0	Maximum standstill time reached; oil exchange request ignored
3711	12	Temperature during stand-still main phase too low or too high
3936	14	Standstill request ignored too long.
3936	14	Standstill time based escalation requests Inducement step 2
4171	2	Dynamic temperature check of temp before SCR
4243	11	SCR heater; Pressure line heater error and temperature condition to perform an afterrun (Group error diagnosis heater) SCR system heater diagnostic reports error; shut off SCR-system
4334	0	Supply module DEF, DEF pressure above upper physical threshold
4334	1	Urea supply module pressure sensor; physical range check low (defect pressure sensor)
4334	0	Urea pump pressure sensor; high signal not plausible
4334	1	Urea pump pressure sensor; low signal not plausible
4334	2	DEF supply module pressure, plausibility error
4341	5	SCR heater relay DEF supply line secondary side; open load
4341	5	SCR heater relay DEF supply line primary side; open load
4341	3	SCR-heater DEF supply line; short circuit to battery
4341	4	SCR-heater DEF supply line; short circuit to ground
4343	11	SCR Monitoring; Pressure stabilization error, general pressure check error (SCR)
4343	5	SCR heater relay DEF pressure line secondary side; open load
4343	5	SCR heater relay DEF pressure line primary side; open load
4343	12	Over Temperature error No detail information
4343	3	SCR heater DEF pressure line; short circuit to battery
4343	4	SCR heater DEF pressure line; short circuit to ground
4345	11	Sensor backflow line pressure (SCR); plausibility error
4345	5	SCR heater relay DEF return line secondary side; open load

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Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
4345	5	SCR heater relay DEF return line primary side; open load
4345	12	Over Temperature error No detail information
4345	3	SCR heater DEF return line; short circuit to battery
4345	4	SCR heater DEF return line; short circuit to ground
4360	0	Exhaust temperature upstream SCR-Cat, temperature above upper physical threshold
4360	1	Sensed exhaust temperature before SCR-Cat is < physical low limit
4360	2	Exhaust temperature sensor upstream SCR, plausibility error
4361	2	Signal error for CAN message No detail information
4361	3	Sensor error DEF catalyst exhaust gas temperature upstream; signal range check high
4361	4	Sensor error DEF catalyst exhaust gas temperature upstream; signal range check low
4365	0	DEF tank temperature too high.
4365	2	Tank temperature signal error for CAN message
4365	3	Sensor error urea tank temperature: short circuit to battery
4365	4	Sensor error urea tank temperature; short circuit to ground.
4365	3	DEF quality sensor, tank temperature; Short circuit to battery or open load
4365	4	DEF quality sensor, tank temperature; Short circuit to ground
4366	5	SCR main relay (secondary side): open load
4366	5	SCR main relay (secondary side); Shortcut to battery
4366	5	SCR main relay (secondary side), heat relay (secondary side), heating elements or heating valve short to ground.
4366	5	SCR Tank heating valve secondary side: open load
4366	5	SCR tank heating valve primary side; open load
4366	12	SCR-heater relay urea tank power stage output; over temperature
4366	3	SCR Tank heating valve; short circuit to battery
4366	4	SCR Tank heating valve; short circuit to ground
4374	13	Pressure stabilization error dosing valve (SCR)
4375	5	Urea pump motor; open load
4375	3	Urea pump motor; short circuit to battery
4375	4	Urea pump motor; short circuit to ground
4376	5	SCR reversal valve; open load
4376	12	SCR reversing valve; over temperature
4376	3	SCR reversal valve; short circuit to battery
4376	4	SCR reversing valve; short circuit to ground
4376	5	SCR reverting valve; open load
4376	12	SCR reverting valve; over temperature
4376	4	eSCR reverting valve; short circuit to ground
4765	0	Temperature upstream DOC, temperature above upper shutoff threshold
4765	0	Temperature upstream DOC, temperature above upper warning threshold
4766	0	Temperature downstream DOC, temperature above upper shutoff threshold
4766	0	Temperature downstream DOC, temperature above upper warning threshold
4768	2	Temperature upstream DOC, plausibility error
4768	3	Electrical error exhaust gas temperature upstream (DOC); signal range check high
4768	4	Electrical error exhaust gas temperature upstream (DOC); signal range check low
4768	2	Exhaust gas temperature sensors up and downstream DOC are physically swapped

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
4769	2	Temperature downstream DOC, plausibility error
4769	3	Sensor error exhaust gas temperature downstream (DOC); signal range check high
4769	4	Sensor error exhaust gas temperature downstream (DOC); signal range check low
4769	2	Sensor exhaust gas temperature OxiCat downstream (normal operation); plausibility error
4769	2	Sensor exhaust gas temperature OxiCat downstream (regeneration); plausibility error
5763	6	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8). Signal range check high.
5763	7	Actuator position for EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8) not plausible.
5763	6	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); signal range check high
5763	5	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); signal range check low
5763	3	Position sensor error of actuator EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8). Signal range check high.
5763	4	Position sensor error actuator EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8). Signal range check low.
5763	5	Actuator EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); open load
5763	6	Actuator EGR-Valve (2.9;3.6) or Throttle-Valve (6.1;7.8); over current
5763	3	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to battery
5763	3	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to battery
5763	4	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to ground
5763	4	EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); short circuit to ground
5763	6	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); Overload by short-circuit
5763	11	Power stage over temperature due to high current.
5763	4	Actuator AGR valve (2.9;3.6) throttle valve (4.1;6.1;7.8); Voltage below threshold.
5763	0	Warning threshold for an internal actuator error exceeded, < 4L EGR.actuator und >4L Air Intake Flap
5763	1	Shut off threshold for an internal actuator error exceeded, < 4L EGR.actuator und >4L Air Intake Flap
520521	5	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); signal range check low.
523008	1	Manipulation control was triggered
523008	2	Timeout error in Manipulation control
523009	9	The pressure relief valve (PRV) has reached the number of allowed activations.
523009	10	Open time of Pressure Relief Valve (PRV) for wear out monitoring had exceeded
523090	2	Engine Brake Pre-Selection switch; Plausibility Error
523211	9	Timeout Error of CAN-Receive-Frame EBC1
523212	9	Timeout Error of CAN-Receive-Frame ComEngPrt; Engine Protection
523213	12	Timeout Error of CAN-Transmit-Frame ERC1 No detail information
523216	9	Timeout Error of CAN-Receive-Frame PrHtEnCmd; pre-heat command, engine command
523240	9	Timeout CAN-message FunModCtl; Function Mode Control
523330	14	Immobilizer status; fuel blocked
523330	14	DFC to block the fuel by Sia No detail information
523330	14	DFC to indicate that TEN-code or UC-code received if ECU is learned. No detail information
523330	14	DFC to indicate that no code is received via CAN. No detail information
523330	14	DFC to indicate that wrong code is received. No detail information
523350	4	Injector cylinder-bank 1; short circuit
523352	4	Injector cylinder-bank 2; short circuit

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
523612	12	Diagnosis fault check to report the error to demand for an ICO due to an error in the Pol2 shut-off
523612	12	Diagnosis fault check to report the error to demand for an ICO due to an error in the Pol3 efficiency factor
523612	12	Internal ECU monitoring detection reported error
523612	12	Monitoring of Fuel Quantity Correction
523612	12	Diagnostic fault check to report the plausibility error in rail pressure monitoring
523612	12	Diagnostic fault check to report the error due to torque comparison
523612	12	Diagnosis of curr path limitation forced by ECU monitoring level 2
523612	12	Diagnosis of lead path limitation forced by ECU monitoring level 2
523612	12	Diagnosis of set path limitation forced by ECU monitoring level 2.
523612	3	Reported Over Voltage of Supply
523612	4	Reported Under Voltage of Supply
523612	12	Diagnostic fault check to report WDA active due to errors in query-/response communication
523612	12	Diagnostic fault check to report ABE active due to under voltage detection
523612	12	Diagnostic fault check to report ABE active due to overvoltage detection
523612	12	Diagnostic fault check to report WDA/ABE active due to unknown reason
523612	14	Software reset CPU SWReset_0
523612	14	Software reset CPU SWReset_1
523612	14	Software reset CPU SWReset_2
523612	12	Internal software error ECU
523612	12	Engine starter, plausibility error of starter release condition
523613	0	Rail pressure metering unit, Positive governor deviation.
523613	0	Rail pressure metering unit, Rail pressure disrupted. Maximum positive deviation of rail pressure exceeded.
523613	0	Rail pressure metering unit, Rail pressure disrupted. Maximum positive deviation of rail pressure in metering unit exceeded (RailMeUn1).
523613	0	Rail pressure metering unit, Rail pressure below the target range (RailMeUn2) Rail system leakage detected. (RailMeUn10)
523613	1	Rail pressure metering unit, Minimum rail pressure exceeded (RailMeUn3) Negative deviation of rail pressure second stage (RailMeUn22)
523613	0	Rail pressure metering unit, Maximum rail pressure exceeded.
523613	2	Rail pressure metering unit, Set point of metering unit in overrun mode not plausible.
523613	0	Set point of metering unit in overrun mode not plausible
523615	5	Metering unit (Fuel-System); open load
523615	12	Metering unit (Fuel-System); power stage over temperature
523615	3	Metering unit (Fuel-System); short circuit to battery high side
523615	4	Metering unit (Fuel-System); short circuit to ground high side
523615	3	Metering unit (Fuel-System); short circuit to battery low side
523615	4	Metering Unit (Fuel-System); short circuit to ground low side
523615	3	Metering unit, short circuit to battery
523615	4	Metering unit, short circuit to ground
523618	3	Gearbox oil temperature; Short circuit to battery or broken harness
523618	4	Gearbox oil temperature; Short circuit to ground
523619	2	Physical range check high for exhaust gas temperature up stream (SCR-CAT)
523632	16	Pump pressure SCR metering unit too high.
523632	18	Pump pressure SCR metering unit too low

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Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
523632	0	Pressure overload of SCR-System.
523632	1	Pressure build-up error SCR-System.
523632	11	Pump motor not available for actuation
523632	2	Signal error for CAN message No detail information
523632	3	Sensor error urea pump pressure; signal range check high
523632	4	Sensor error urea pump pressure; signal range check low
523633	11	Long term adoption factor below threshold
523633	11	Nox conversion rate insufficient (SCR-Cat defect, bad DEF quality)
523633	11	Nox conversion rate insufficient (SCR-Cat defect, bad DEF quality); temperature range 1
523698	11	Shut off request from supervisory monitoring function
523699	3	Boost pressure control; negative governor deviation below limit
523699	4	learning value too high No detail information
523704	12	Timeout Error of CAN-Transmit-Frame EEC3
523706	12	Timeout Error of CAN-Transmit-Frame FIEco No detail information
523717	12	Timeout Error of CAN-Transmit-Frame AmbCon; Weather environments
523718	5	tank heating valve; open load
523718	12	SCR main relay (primary side); power stage over temperature
523718	3	SCR main relay (primary side); short circuit to battery
523718	4	SCR main relay (primary side); short circuit to ground
523718	5	SCR main relay; open load (only CV56B)
523718	3	SCR main relay; short circuit to battery (only CV56B)
523718	4	SCR main relay; short circuit to ground (only CV56B)
523719	5	SCR heater relay DEF supply module secondary side; open load
523719	5	SCR heater relay DEF supply module primary side; open load
523719	12	Over Temperature error No detail information
523719	3	SCR heater DEF supply module; short circuit to battery
523719	4	SCR heater DEF supply module; short circuit to ground
523720	2	DEF supply module heater temperature; plausibility error (normal condition).
523720	2	Sensor DEF supply module heater temperature; plausibility error (cold start condition)
523720	8	DEF supply module heater temperature; duty cycle in failure range.
523720	8	DEF supply module heater temperature; duty cycle in invalid range.
523721	2	Sensor DEF supply module temperature; plausibility error (normal condition)
523721	2	Sensor DEF supply module temperature; plausibility error (cold start condition)
523721	11	Urea supply module temperature measurement not available.
523721	8	DEF supply module temperature; duty cycle in failure range.
523721	8	Urea supply module temperature; duty cycle in invalid range.
523722	8	DEF supply module PWM signal; period outside valid range.
523722	8	Detect faulty PWM signal from Supply Module.
523741	14	Engine shut off request through CAN No detail information
523752	0	Plausibility error during Rich to Lean switch over No detail information
523752	0	Monitoring of Nox signal readiness No detail information
523756	14	special pattern for special cases No detail information
523757	14	special pattern for special cases No detail information

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
523758	14	special pattern for special cases No detail information
523759	14	special pattern for special cases No detail information
523760	14	special pattern for special cases No detail information
523766	9	Timeout Error of CAN-Receive-Frame Active TSC1AE
523767	9	Timeout Error of CAN-Receive-Frame Passive TSC1AE
523768	9	Timeout Error of CAN-Receive-Frame Active TSC1AR
523769	9	Timeout Error of CAN-Receive-Frame Passive TSC1AR
523776	9	Timeout Error of CAN-Receive-Frame TSC1TE - active
523777	9	Passive Timeout Error of CAN-Receive-Frame TSC1TE; Set point
523778	9	Timeout Error of CAN-Receive-Frame TSC1TR
523779	9	Passive Timeout Error of CAN-Receive-Frame TSC1TR
523788	12	Timeout Error of CAN-Transmit-Frame TrbCH; Status Waste gate
523788	0	Waste gate plausibility error off CAN transmit message.
523788	0	Timeout Error of CAN-Receive-Frame ComTrbChActr; Wastegate
523793	9	Timeout Error of CAN-Receive-Frame UAA10; AGS sensor service message
523794	9	Timeout Error of CAN-Receive-Frame UAA11; AGS sensor data
523803	9	Timeout error of CAN Receive Message RxEngPres; Status Burner Air Pump
523858	12	Timeout Error of CAN-Transmit-Frame UAA11
523867	12	Timeout Error of CAN-Transmit-Frame UAA1 on CAN 2. Control burner air pump;
523889	3	Over temperature of device driver of pressure control valve No detail information
523891	14	When AirHt_ctDefSRCLoOn_mp is less than AirHt_ctMaxDef_C. DFC to SRC Low error when heater is on No detail information
523895	13	Check of missing injector adjustment value programming (IMA) injector 1 (in firing order).
523896	13	Check of missing injector adjustment value programming (IMA) injector 2 (in firing order).
523897	13	Check of missing injector adjustment value programming (IMA) injector 3 (in firing order).
523898	13	Check of missing injector adjustment value programming (IMA) injector 4 (in firing order).
523899	13	Check of missing injector adjustment value programming (IMA) injector 5 (in firing order).
523900	13	Check of missing injector adjustment value programming (IMA) injector 6 (in firing order).
523906	5	Electrical fuel pre - supply pump; open load
523906	12	Electrical fuel pre - supply pump. ECU powerstage over temperature.
523906	3	Electrical fuel pre - supply pump; short circuit to battery
523906	4	Electrical fuel pre - supply pump. Short circuit to ground.
523910	14	Air pump doesn't achieve air mass flow setpoint Burner Control - burner air pump
523910	9	Burner Control; Air Pump - CAN Lost Air Pump; CAN communication lost
523910	7	Air pump; CAN communication interrupted no purge function available
523910	12	Air Pump; internal error
523910	0	Air Pump; operating voltage error
523910	6	Burner Control Air Pump; over current Air pump electrically overloaded
523911	0	Burner dosing valve (DV2); over current at the end of the injection phase
523911	12	Burner dosing valve (DV2); power stage over temperature
523911	3	Burner dosing valve (DV2); short circuit to battery
523911	4	Burner dosing valve (DV2); short circuit to ground
523911	11	Burner dosing valve (DV2); short circuit high side power stage

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Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
523912	2	Burner dosing valve (DV2) downstream pressure sensor; plausibility error
523912	0	Physical range check high for burner dosing valve (DV2) downstream pressure; shut off regeneration
523912	1	Physical range check low for burner dosing valve (DV2) downstream pressure; shut off regeneration. When burner injector is actuated, the measured pressure does not rise above ca. 1250mbar abs (expected: ca. 2400mbar).
523912	3	Sensor error burner dosing valve (DV2) downstream pressure sensor; signal range check high
523912	4	@ engines < 4l: Throttle valve error, Open Load or Short cut to Battery, blocked valve or wrong control signal for valve. @ engines with Burner T4i: Pressure Sensor error after valve (DV2), lower limit reached
523913	3	Sensor error glow plug control diagnostic line voltage; signal range check high
523913	4	Sensor error glow plug control diagnostic line voltage; signal range check low
523914	5	Glow plug control; open load water pump control (PWM)
523914	12	Glow plug control; power stage over temperature
523914	3	Glow plug control; short circuit to battery water pump control (PWM)
523914	4	Glow plug control; short circuit to ground water pump control (PWM)
523915	0	HCl dosing valve (DV1); over current at the end of the injection phase
523915	12	HCl dosing valve (DV1); power stage over temperature
523915	3	HCl dosing valve (DV1); short circuit to battery
523915	3	HCl dosing valve (DV1); short circuit to battery high side
523915	4	HCl dosing valve (DV1); short circuit to ground
523915	11	HCl dosing valve (DV1); short circuit high side power stage
523915	7	HCl dosing valve (DV1); blocked open
523916	2	Sensor HCl dosing valve (DV1) downstream pressure; plausibility error
523916	0	Physical range check high for HCl dosing valve (DV1) downstream pressure; shut off regeneration
523916	1	Physical range check low for HCl dosing valve (DV1) downstream pressure; shut off regeneration
523916	3	Sensor error HCl dosing valve (DV1) downstream pressure; signal range check high
523916	4	Sensor error HCl dosing valve (DV1) downstream pressure; signal range check low
523917	3	Sensor error DV1 & DV2 upstream pressure; signal range check high
523917	4	Sensor error DV1 & DV2 upstream pressure; signal range check low
523918	3	Sensor error DV1 & DV2 upstream temperature; signal range check high
523918	4	Sensor error DV1 & DV2 upstream temperature; signal range check low
523919	2	DPF burner air pump pressure sensor, plausibility error
523919	0	DPF burner air pump pressure sensor, pressure above upper shutoff threshold
523919	1	DPF burner air pump pressure sensor, pressure below lower shutoff threshold
523919	3	DPF burner air pump pressure sensor, short circuit to battery or open load
523919	4	DPF burner air pump pressure sensor, short circuit to ground
523919	2	Sensor air pump air pressure; plausibility error
523920	2	Exhaust gas pressure upstream burner, plausibility error
523920	0	Exhaust gas pressure upstream burner, pressure above upper shutoff threshold
523920	3	Exhaust gas pressure upstream burner, short circuit to battery or open load
523920	4	Exhaust gas pressure upstream burner, short circuit to ground
523920	2	Sensor exhaust gas back pressure burner; plausibility error
523921	3	Sensor error burner temperature; signal range check high
523921	4	Sensor error burner temperature; signal range check low
523921	0	Burner temperature, temperature above upper shutoff threshold

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
523921	1	Burner temperature, temperature below lower shutoff threshold
523921	2	Burner temperature sensor; Plausibility Check for burner temperature sensor Sensor burner temperature; plausibility error
523922	3	Burner shut of valve; short circuit to battery
523922	7	Burner Control; Shut-off Valve - Blocked closed Burner Shut Off Valve; blocked closed
523922	7	Burner Shut Off Valve; blocked open
523922	5	Burner Shut Off Valve; open load
523922	12	Burner Shut Off Valve; power stage over temperature
523922	4	Burner Shut Off Valve; short circuit to ground
523923	3	UB1; Short circuit to battery error of actuator relay 1
523923	4	Short circuit to ground error No detail information
523924	3	UB2; Short circuit to battery error of actuator relay 2
523924	4	UB2; Short circuit to ground actuator relay 2
523925	3	UB3; Short circuit to battery error of actuator relay 3.
523925	4	UB3; Short circuit to ground actuator relay 3
523926	4	UB4; Short circuit to ground actuator relay 4.
523927	3	UB5; Short circuit to battery error of actuator relay 5.
523935	12	Timeout Error of CAN-Transmit-Frame EEC3VOL1; Engine send messages
523936	12	Timeout Error of CAN-Transmit-Frame EEC3VOL2; Engine send messages
523937	9	Timeout DFC for NOxSensGlbReqTx. No detail information
523938	9	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1IGCVol1.
523939	9	Broadcast Announce Message of the calibration message of the upstream catalytic NOx sensor has failed.
523940	9	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1IGCVol1
523941	9	Timeout Error (BAM to packet) for CAN-Receive-Frame AT10GCVol2.
523942	9	Calibration message 1 of the after catalyst NOx sensor has failed.
523943	9	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT10GCVol2.
523946	0	Zerofuel calibration injector 1 (in firing order); maximum value exceeded
523946	1	Zerofuel calibration injector 1 (in firing order); minimum value exceeded
523947	0	Zerofuel calibration injector 2 (in firing order); maximum value exceeded
523947	1	Zerofuel calibration injector 2 (in firing order); minimum value exceeded
523948	0	Zerofuel calibration injector 3 (in firing order); maximum value exceeded
523948	1	Zerofuel calibration injector 3 (in firing order); minimum value exceeded
523949	0	Zerofuel calibration injector 4 (in firing order); maximum value exceeded
523949	1	Zerofuel calibration injector 4 (in firing order); minimum value exceeded
523950	0	Zerofuel calibration injector 5 (in firing order); maximum value exceeded
523950	1	Zerofuel calibration injector 5 (in firing order); minimum value exceeded
523951	0	Zerofuel calibration injector 6 (in firing order); maximum value exceeded
523953	2	Healing takes place if the condition for error detection is not present. Air temperature monitoring plausibility check array No detail information
523955	2	Healing takes place if the condition for error detection is not present. Air temperature monitoring plausibility check array No detail information
523960	0	Physical range check high for EGR cooler downstream temperature.
523960	1	Physical range check low for EGR cooler downstream temperature.
523960	0	High exhaust gas temperature EGR cooler downstream; warning threshold exceeded.

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Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
523969	11	Fault entry for override control mode. No detail information
523973	14	SCR Tamper detection; derating timer below limit 1
523974	14	SCR Tamper detection; derating timer below limit 2
523975	14	Urea quality; derating timer below limit 1
523976	14	Urea quality; derating timer below limit 2
523977	14	Urea tank level; derating timer below limit 1
523978	14	Urea tank level; derating timer below limit 2
523981	11	SCR plausibility, OBD and diagnosis; Stuck in range check of DEF tank temperature sensor DEF-tank without heating function (heating phase)
523982	0	Power stage diagnosis disabled; high battery voltage
523982	1	Power stage diagnosis disabled; low battery voltage
523984	3	UB7; Short circuit to battery error of actuator relay 7
523986	4	UB6; Short circuit to ground actuator relay 6
523987	4	UB7; Short circuit to ground actuator relay 7
523992	9	N/A
523993	9	N/A
523995	13	Check of missing injector adjustment value programming (IMA) injector 7 (in firing order)
523996	13	check of missing injector adjustment value programming (IMA) injector 8 (in firing order)
523997	4	Injector cylinder bank 1 slave; short circuit
523998	4	Injector cylinder bank 2 slave; short circuit
523999	12	Injector power stage output Slave defect
524000	5	Injector 7 (in firing order); interruption of electric connection
524000	3	Injector 7 (in firing order); short circuit
524001	5	Injector 8 (in firing order); interruption of electric connection
524001	3	Injector 8 (in firing order); short circuit
524013	7	Burner Control; burner Flame; Burner does not start after x trials (burner flame lost detection) Burner flame unintentional deleted
524013	7	Burner Control; Flame lost max Burner operation is interrupted too often
524014	1	Air inlet EPV - pressure too low Air pressure glow plug flush line; below limit
524016	11	Burner Control; HFM - Electrical Fault HFM sensor; electrical fault
524016	2	Burner Control; HFM - Plausibility error1 Amount of air is not plausible to pump speed
524018	14	HMI engine derate service state DPF wasn't regenerated, power reduction phase 1 (manual regeneration request)
524019	11	Burner Control; Air Line - Blocked Air Pump; air lines blocked
524020	14	Burner Control; power reduction due to low lambda. Engine power; Not enough oxygen for regeneration.
524021	11	Burner Control; Fuel line ShutOff downstream - broken Burner fuel line pipe leak behind Shut Off Valve
524022	14	HMI engine derate stop state DPF wasn't regenerated, power reduction phase 2 (manual regeneration request)
524024	11	Deviation of the exhaust gas temperature set point to actual value downstream (DOC) too high
524025	14	Particulate filter regeneration. Regeneration after time X is not successful (The error occurs when the regeneration times (3x) over the max. has been aborted allowed recovery time)

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
524025	5	DPF system; operating voltage error
524025	14	The standstill-regeneration mode time exceeds the long-limit. Vehicle was too long or too often in standstill mode. Make oil change and reset counter.
524025	14	The standstill-regeneration mode time exceeds the short-limit. Vehicle was too long or too often within a short time in standstill mode. Make oil change and reset counter.
524025	8	Max. launch time for stand still exceeded (60min).
524028	2	CAN message PROEGRActr; plausibility error
524029	2	Timeout Error of CAN-Receive-Frame ComEGRActr - exhaust gas recirculation positioner
524030	7	EGR actuator; internal error
524031	13	EGR actuator, calibration error
524032	2	EGR actuator; status message "EGRCust" is missing
524033	7	EGR actuator; due to overload in Save Mode
524034	5	Disc Separator; open load
524034	12	Disc Separator; power stage over temperature
524034	3	Disc separator; short circuit to battery
524034	4	Disc separator; short circuit to ground
524035	12	Injector diagnostics; time out error in the SPI communication
524036	12	Injector diagnostics Slave; time out error in the SPI communication
524038	9	Timeout error of CAN-Receive-Frame ComMS_Sys1TO (error memory Slave); Master-Slave internal CAN message
524039	9	Timeout error of CAN-Receive-Frame ComMS_Sys2TO (error memory Slave); Master-Slave internal CAN message
524040	9	Timeout error of CAN-Receive-Frame ComMS_Sys3TO (error memory Slave); Master-Slave internal CAN message
524041	9	Timeout error of CAN-Receive-Frame ComMS_Sys4TO (error memory Slave); Master-Slave internal CAN message
524042	9	Timeout error of CAN-Receive-Frame ComMS_Sys5TO (error memory Slave); Master-Slave internal CAN message
524043	9	Timeout error of CAN-Receive-Frame ComMS_Sys6TO (error memory Slave); Master-Slave internal CAN message
524044	9	CAN message ComMS_Sys7 not received from slave
524045	9	Master Slave, Error of message counter CAN receive message ComMSMoFOvR; ComMSMoFOvR1CNT
524046	9	Master-Slave CAN; Error Checksum of CAN-Receive Message
524047	9	Master-Slave CAN; Error of message length of CAN receive message ComMSMoFOvR; _ComMSMoFOvR1DLC
524048	9	Timeout error CAN message ComMSMoFOvR1TO error memory Slave
524052	11	Error memory Slave reports FID MSMonFC2 (collective error)
524052	11	Error memory Slave reports FID MSMonFC3 (collective error)
524052	11	Master ECU and Slave ECU data sets or software are not identical
524057	2	Fuel low pressure pump; error pressure build up
524058	2	Particulate filter; regeneration not successful
524063	5	Relay Urea back flow line heater: broken wiring detected (open load) Row engine: SCR-back flow line (K29) V-engine: Master: SCR-suction / back flow line (K32.1) Slave: SCR-suction / back flow line (K32.2)
524063	5	SCR main relay not connected
524063	5	SCR heater pressure line; open load
524063	3	SCR heater main relay; short circuit to battery
524063	4	SCR heater main relay load side (K31) on heating valve (Y31), Short cut to ground.

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Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
524063	5	Relay Urea suction line: broken wiring detected (open load) Row engine: SCR suction line (K28) V-engine: Master: common SCR-suction line (K28) Slave: common SCR back flow line (K29)
524063	5	SCR heater supply module; open load
524063	5	SCR heater tank; open load
524063	12	DEF supply module, time for defrosting too long
524063	12	DEF tank, time for defrosting too long
524065	0	Pressure sensor upstream SCR-CAT, pressure above upper physical threshold
524065	1	Pressure sensor upstream SCR-CAT, pressure below lower physical threshold
524065	3	Pressure sensor upstream SCR-CAT; short circuit battery or open load
524065	4	Pressure sensor upstream SCR-CAT; short circuit ground
524065	2	Pressure sensor upstream SCR-CAT, plausibility error
524066	3	SCR measurement heater output stage; short circuit battery or open load
524067	0	DEF supply module, heater temperature above upper physical threshold
524067	1	DEF supply module, heater temperature below lower physical threshold
524067	0	DEF supply module, temperature above upper physical threshold
524067	1	DEF supply module, temperature below lower physical threshold
524067	2	Supply module heater temperature, plausibility error
524067	2	Supply module temperature, plausibility error
524068	2	Master ECU and Slave ECU have been identified as the same types
524069	9	Timeout Error of CAN-Receive-Frame MSMon_FidFCCTO; Master-Slave CAN communication faulty
524070	2	(Upstream NOx-Sensor) Diagnostic Fault Check for invalid upstream NOx value (Sensor self diagnostic DFC set by Deutz-SW) NOx-Sensor before SCR-Cat: Invalid upstream NOx value
524071	2	(Downstream NOx-Sensor) Diagnostic Fault Check for invalid downstream lambda value (Sensor self diagnostic DFC set by Deutz-SW)
524072	2	(Upstream NOx-Sensor) Diagnostic Fault Check for invalid upstream lambda value (Sensor self diagnostic DFC set by Deutz-SW)
524073	2	(Downstream NOx-Sensor) Diagnostic Fault Check for invalid downstream NOx value (Sensor self diagnostic DFC set by Deutz-SW)
524074	9	NOx sensor downstream SCR-CAT, sensor internally open load
524074	2	NOx-Sensor after SCR-Cat: Nox-Sensor dew point problem or plausibility problem
524075	11	NOx sensor downstream SCR-CAT, sensor internally short circuit
524076	9	NOx sensor upstream SCR-CAT, sensor internally open line
524076	2	NOx-Sensor before SCR-Cat: Nox-Sensor dew point problem or plausibility problem
524077	11	NOx sensor upstream SCR-CAT, sensor internally short circuit
524078	9	NOx sensor downstream SCR-CAT, lambda value above upper physical threshold
524079	9	NOx sensor downstream SCR-CAT, lambda value below lower physical threshold
524080	9	NOx sensor upstream SCR-CAT, lambda value above upper physical threshold
524081	9	NOx sensor upstream SCR-CAT, lambda value below lower physical threshold
524082	9	(Downstream NOx-Sensor) Diagnostic Fault Check for downstream NOx value over maximum limit (DFC set by Deutz-SW)
524083	9	NOx-Sensor downstream SCR-CAT, NOx value below minimum value.
524084	9	NOx-Sensor upstream SCR-CAT, NOx value above maximum value.
524085	9	NOx sensor upstream SCR-CAT, NOx value below lower physical threshold

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
524087	5	Urea Error Lamp; open load
524087	12	Urea Error Lamp; temperature over limit
524087	3	Urea Error Lamp; short circuit battery
524087	4	Urea Error Lamp; short circuit ground
524096	14	Control of the SCR system; If the start stop counter (EPA-Counter) exceeds the threshold SCRctl_ctEngStrtStopThresh_C. This counter will increment only once in each driving cycle in case of an SCR error. If the counter reaches the threshold, the DFC will be set to inhibit the engine start. Engine will not be started, because of EPA-Counter
524097	9	Timeout error of CAN-Transmit-Frame DPFBnAirPmpCtl
524098	9	Timeout error of CAN-Transmit-Frame ComDPFBnPT
524099	9	Timeout error of CAN-Transmit-Frame ComDPFC1
524100	9	Timeout error of CAN-Transmit-Frame ComDPFHisDat.
524101	9	Timeout error of CAN-Transmit-Frame ComDPF1stMon
524102	9	Timeout error of CAN-Receive-Frame ComRxDPFBnAirPmpCtl
524103	9	Timeout error of CAN-Receive-Frame ComRxDPFBnAirPmp
524104	9	Timeout error of CAN-Receive-Frame ComRxDPFC1.
524105	9	Timeout error of CAN-Transmit-Frame ComEGRMsFlw (EGR Steller)
524106	9	Timeout error of CAN-Receive-Frame ComRxEGRMsFlw1 (EGR actuator)
524107	9	Timeout error of CAN-Receive-Frame ComRxEGRMsFlw2 (EGR actuator)
524108	9	Timeout error of CAN-Transmit-Frame ComEGRTVActr (EGR actuator)
524109	9	Timeout error of CAN-Receive-Frame ComRxEGRTVActr (EGR actuator)
524110	9	Timeout error of CAN-Transmit-Frame ComETVActrTO.
524111	9	Timeout error of CAN-Receive-Frame ComRxETVActr
524112	9	Timeout ComIntake Throttle Valve Actr.
524113	9	Timeout error of CAN-Receive-Frame ComRxITVActr
524114	9	Timeout error of CAN-Transmit-Frame A1DOC
524115	9	Timeout error of CAN-Transmit-Frame AT1S
524116	9	Timeout error of CAN-Transmit-Frame SCR2
524117	9	Timeout error of CAN-Transmit-Frame SCR3
524118	9	Timeout error of CAN-Receive-Frame ComRxCM1
524119	9	Timeout error of CAN-Receive-Frame ComRxCustSCR3
524120	9	Timeout error of CAN-Receive-Frame ComRxSCRHtDiag
524121	9	Timeout error of CAN-Receive-Frame ComRxTrbChActr (wastegate actuator)
524122	9	Timeout error of CAN-Receive-Frame ComRxUQSens (Urea quality)
524123	9	Timeout error of CAN-Receive-Frame ComSCRHtCtl
524124	9	Timeout error of CAN-Receive-Frame ComTxAT1IMG
524125	9	Timeout error of CAN-Receive-Frame ComTxTrbChActr (Wastegate actuator)
524132	2	Fuel low pressure upstream fuel low pressure pump not plausible
524132	0	Fuel low pressure upstream fuel low pressure pump, pressure above maximum warning threshold
524132	0	Fuel low pressure upstream fuel low pressure pump, pressure above maximum shut off threshold
524132	1	Fuel low pressure upstream fuel low pressure pump, pressure below minimum shut off threshold
524132	1	Fuel low pressure upstream fuel low pressure pump, pressure below minimum warning threshold
524133	2	HMI system; set if restore button blocked
524134	0	DPF, ash load exceeds the shutoff threshold

SECTION 3 - CHASSIS & TURNTABLE

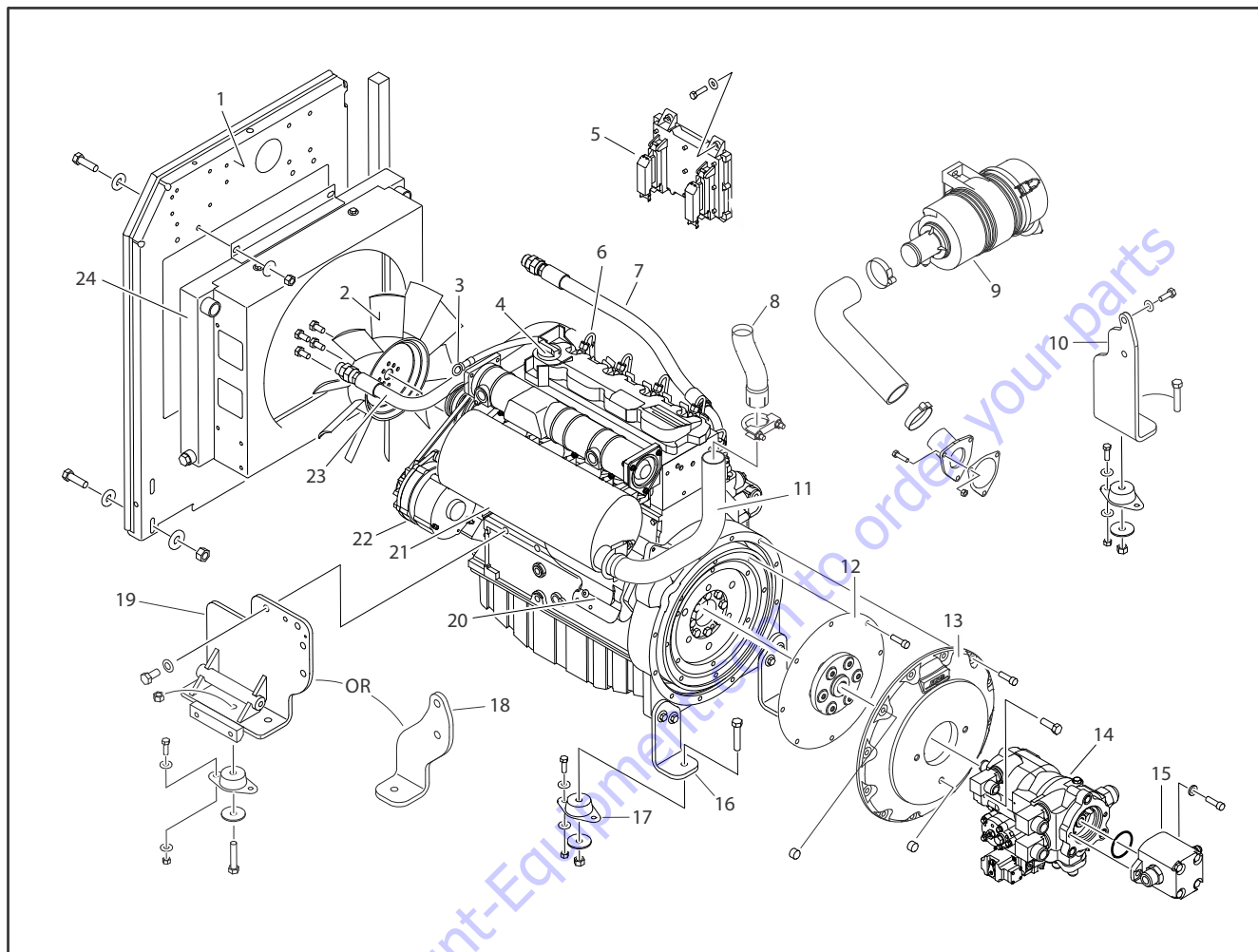
Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

SPN	FMI	Error Identification
524134	0	DPF, ash load exceeds the warning threshold
524135	0	DPF, soot load exceeds the shutoff threshold
524135	14	DPF, soot load exceeds the service request threshold
524135	0	DPF, soot load exceeds the warning threshold
524141	7	DEF dosing valve, dosing valve blocked
524147	13	SCR System, pressure build up not possible
524147	7	SCR-System, reverting valve blocked
524147	13	Set together with DFC_SCRCoBldUpLoPres. DFC_SCRCoBldUpLoPresRst is only used for inducement purposes. It ensures that legal inducement is working correctly.
524149	2	Plausibility error between pressure downstream turbine (PTRbnDs) and ambient air pressure (EnvP)
524149	2	Pressure downstream turbine, plausibility error
524152	2	Urea Quality Sensor; Timeout CAN message
524153	2	Urea tank level & urea tank temperature via CAN bus, timeout of CAN message
524156	9	Timeout error of CAN-Receive-Frame ComRxEBC2.
524157	9	Fan control; time out for fan governing
524159	0	Fan; short circuit battery or open load
524159	1	Fan; short circuit ground
524160	5	Fan; in/outlet valve 1; open load
524160	3	Fan; in/outlet valve 1; short circuit battery
524160	4	Fan; in/outlet valve 1; open load ground
524161	5	Fan; in/outlet valve 2; open load
524161	3	Fan; in/outlet valve 2; short circuit battery
524161	4	Fan; in/outlet valve 2; open load ground
524162	12	Fan; fan control; angle sensor defect
524163	12	Fan; fan control; fan or valve defect
524175	0	SCR-CAT, Nox emissions above maximum threshold
524177	7	SCR System, DEF suction line blocked
524178	7	SCR System, DEF pressure out of range
524189	9	Master / Slave Can disturbed.
524190	14	Inducement level 1 active
524191	14	Inducement level 2 active
524193	8	The standstill-regeneration mode time exceeds the long limit threshold. Vehicle was too long or too often in standstill mode. Change oil and reset counter.
524194	8	The standstill-regeneration mode time exceeds the short-limit. Vehicle was too long or too often within a short time in standstill mode. Change oil and reset counter.
524195	14	Standstill request due to crystallization ignored too long
524196	13	Variant handling, address error
524196	2	Variant handling, Synchronisation error
524202	11	SCR error code in master ECU active.
524203	11	DEF tank level failure is in master ECU active.
524204	11	SCR after run failure is in master ECU active.
524205	11	SCR Co20ff failure is in master ECU active.
524206	11	SCR disable DEF dosing failure is in master ECU active.

Table 3-11. Deutz Trouble Codes (TD2.9 L4 Engine)

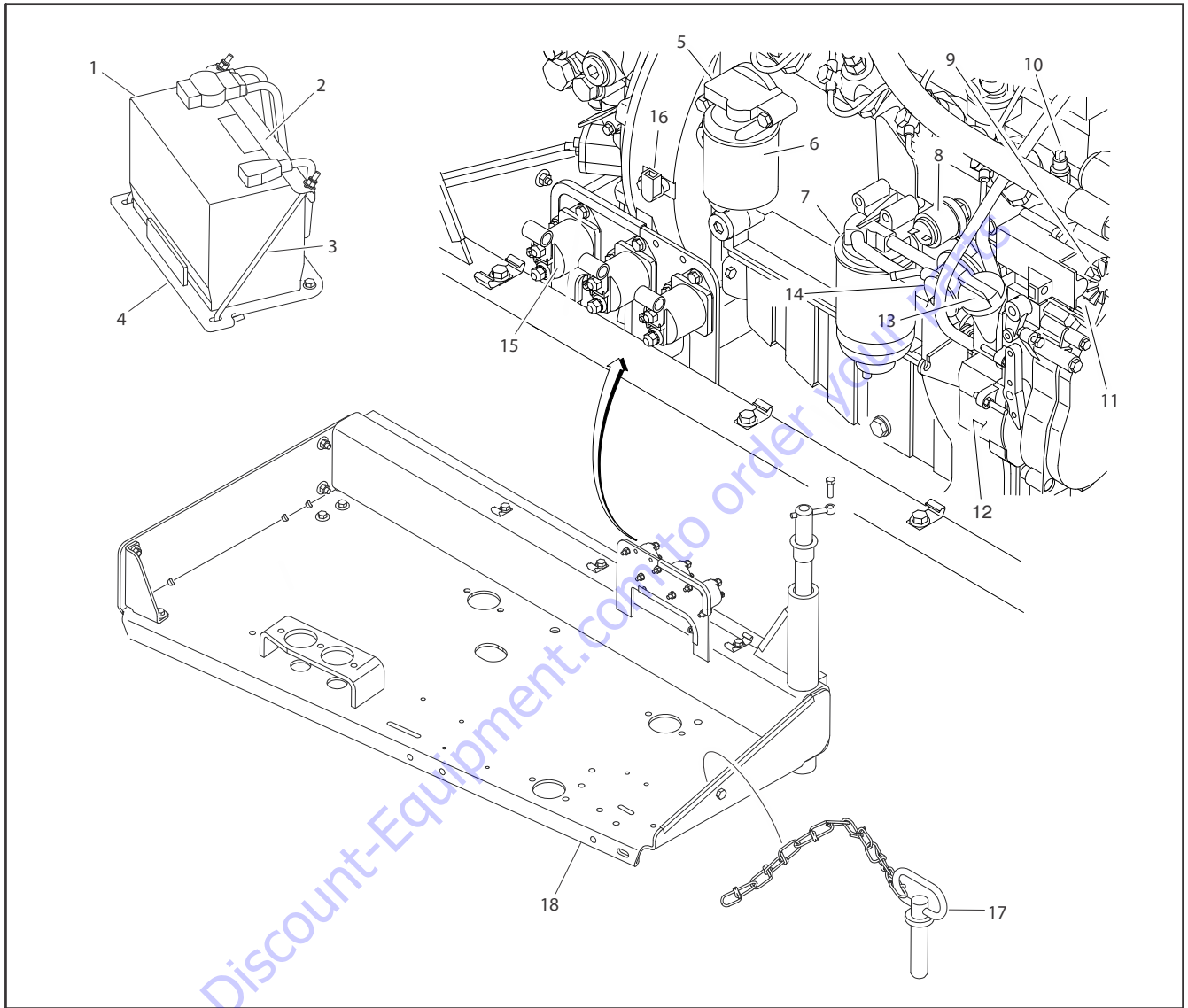
SPN	FMI	Error Identification
524230	11	Inducement HW Failure Slave.
524231	11	Inducement SCR Tamp. Slave
524232	11	Inducement DEF Quality in Slave ECU
524239	11	SCR regeneration failure is in slave ECU active.
524248	11	NOX sensor downstream error in slave ECU
524249	11	DEF dosing valve error in slave ECU
524251	11	DEF pressure problems in slave ECU
524252	11	Reverting valve error in slave ECU
524253	11	DEF back flow line heater error on slave ECU
524254	11	Error NOx-Tailpipe emissions exceeded on Slave ECU
524255	11	DEF suction line heater error on slave ECU
524256	11	DEF supply module heater error on slave ECU
524257	11	Error Exhaust pressure upstream SCR on Slave ECU
524258	11	Error Exhaust temperature upstream SCR on Slave ECU
524259	11	DEF pressure line heater error on slave ECU
524260	11	Error Urea pump temperature on Slave ECU
524261	11	Error DEF heater relays on Slave ECU
524267	14	Announcement triggers the Inducement Level 2

3.12 DEUTZ D2011 ENGINE



- | | | | |
|----------------------------|--------------------------------------|-------------------------------------|---|
| 1. Radiator Mounting Plate | 7. Oil Cooler Hose | 13. Pump Adapter Plate | 19. Left Front Engine/Generator Support |
| 2. Fan | 8. Exhaust Pipe Extension | 14. Piston Pump | 20. Starter |
| 3. Dipstick | 9. Air Cleaner | 15. Gear Pump | 21. Muffler |
| 4. Oil Filler Cap | 10. Right Rear Engine Mounting Plate | 16. Left Rear Engine Mounting Plate | 22. Alternator |
| 5. Control Module | 11. Exhaust Pipe | 17. Engine Mount | 23. Radiator Hose |
| 6. Fuel Injector | 12. Coupling | 18. Left Front Engine Support | 24. Radiator |

Figure 3-80. Deutz D2011 Engine Installation - Sheet 1 of 2



- | | | | | |
|----------------------------|------------------------|------------------------|----------------------|------------------|
| 1. Battery | 5. Temperature Sensor | 9. Throttle Actuator | 13. Oil Filler Cap | 16. Speed Sensor |
| 2. Battery Hold-Down | 6. Oil Filter | 10. Temperature Sensor | 14. Fuel Supply Pump | 17. Hitch Pin |
| 3. J-Bolt | 7. Fuel Filter | 11. Starter | 15. Relay | 18. Engine Tray |
| 4. Battery Hold-Down Plate | 8. Oil Pressure Sensor | 12. Oil Lube Pump | | |

Figure 3-81. Deutz D2011 Engine Installation - Sheet 2 of 2

SECTION 3 - CHASSIS & TURNTABLE

NOTE: Refer to engine manufacturer's manual for detailed operating and maintenance instructions.

Checking Oil Level

1. Make sure machine and engine are level and switch engine OFF before checking oil level.
2. Remove oil dipstick and wipe with clean cloth.
3. Insert dipstick to the stop and remove again.
4. Check oil level. Top oil level as shown in figure below with an approved grade and type of oil outlined in engine manufacturer's operator's manual.

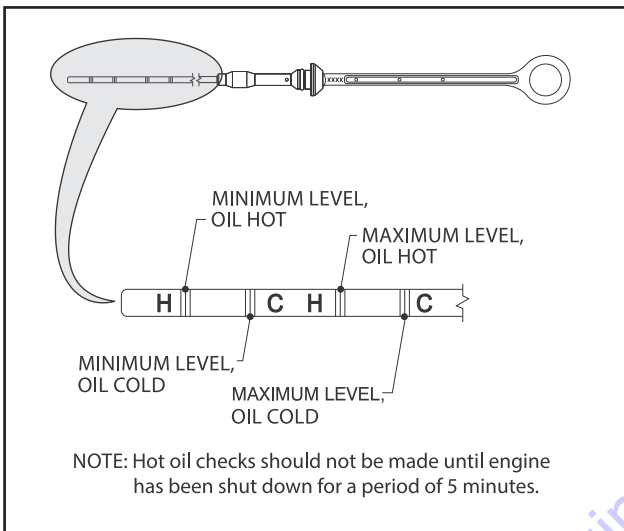


Figure 3-82. Deutz Dipstick Markings

5. Replace dipstick until fully seated.

Changing Engine Oil

1. Allow engine to warm up. Engine oil should reach approximately 176° F (80° C).
2. Make sure machine and engine are level and switch off engine.
3. Place oil tray under engine.

CAUTION

HOT ENGINE OIL CAN CAUSE BURNS. AVOID CONTACT WITH HOT OIL WHEN DRAINING.

NOTICE

COLLECT USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.

4. Open oil drain valve and drain oil.
5. Close oil drain valve.
6. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-83., Engine Oil Viscosity.

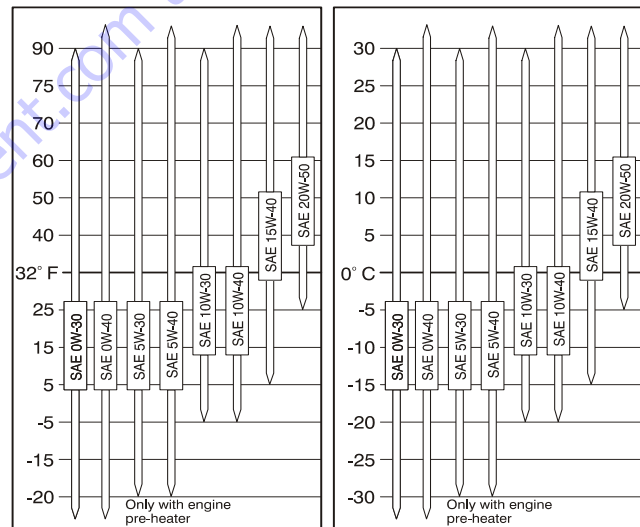
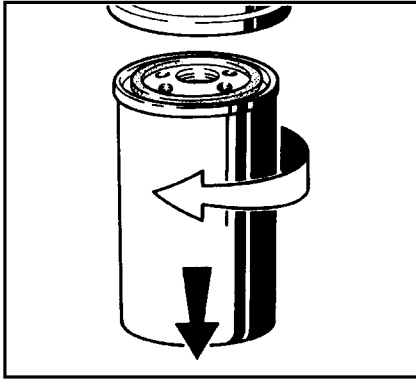


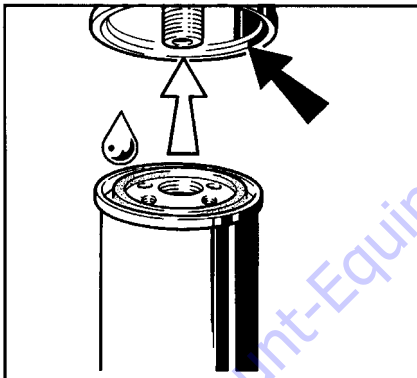
Figure 3-83. Engine Oil Viscosity

Changing Oil Filter

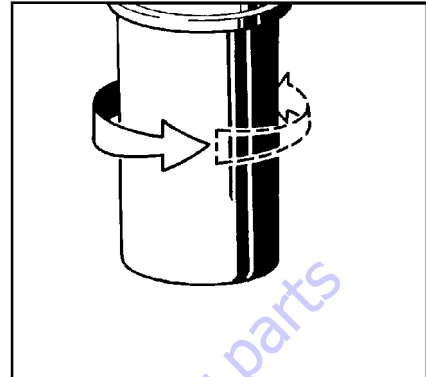
1. Wipe area around filter to clean any dirt from area.
2. Using a suitable oil filter removal tool, loosen lube oil filter cartridge and spin off.



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil.



6. Screw in new filter by hand until gasket is flush.



7. Hand-tighten filter another half-turn.
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

Replace Fuel Filter

⚠ WARNING

FUEL IS FLAMMABLE AND CAN CAUSE DEATH OR SERIOUS INJURY. MAKE SURE NO OPEN FLAMES OR SPARKS ARE IN THE AREA WHEN WORKING ON FUEL SYSTEM. DO NOT SMOKE WHEN WORKING ON FUEL SYSTEM.

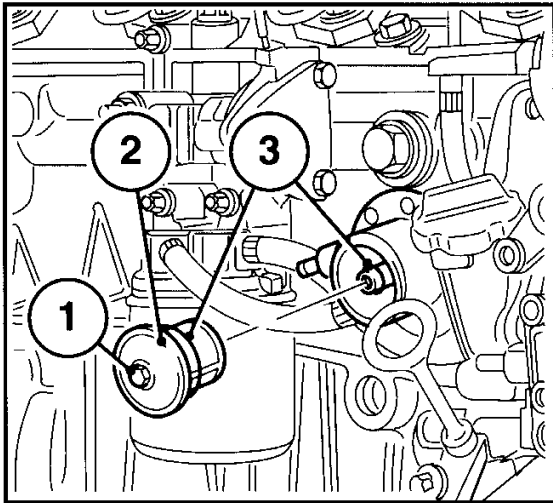
1. Wipe area around filter to clean any dirt from area.
2. Remove fuel filter cartridge. Catch any escaping fuel.
3. Clean dirt from filter carrier sealing surface.
4. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.
5. Screw in new filter by hand until gasket is flush. Hand-tighten filter another half-turn.
6. Open fuel shut-off valve.
7. Check for leaks.

Clean Fuel Strainer

⚠ WARNING

FUEL IS FLAMMABLE AND CAN CAUSE DEATH OR SERIOUS INJURY. MAKE SURE NO OPEN FLAMES OR SPARKS ARE IN THE AREA WHEN WORKING ON FUEL SYSTEM. DO NOT SMOKE WHEN WORKING ON FUEL SYSTEM.

1. Unscrew hexagonal nut (1).



2. Remove fuel strainer cover (2).
3. Clean fuel strainer with diesel fuel and replace as needed.
4. Place seal (3) in position.
5. Install fuel strainer cover (2). Tighten screw (1).
6. Check for leaks.

3.13 SPARK ARRESTER CLEANING INSTRUCTIONS

1. Remove cleanout plug in bottom of spark arrester (muffler).
2. Without causing deformation (or any type of damage to spark arrester) repeatedly tap on arrester near cleanout plug. This may be enough to begin spark trap drainage.
3. An industrial vacuum cleaner can do a complete job at this point.
 - a. Or, IN A SAFE AREA, start engine. Alternate between low idle and high idle for two to three minutes.
 - b. Or, operate engine as required by application for two to three minutes.
4. Install cleanout plug.

3.14 GLOW PLUGS

If glow plug option is enabled in the JLG Control System, glow plug and indicator lamp will be energized when Power/Emergency Stop switch is pulled on if ambient air temperature is less than 50° F (10° C) and engine coolant temperature is less than 140° F (60° C).

This determination occurs one second after the Power/Emergency Stop switch has been pulled on. Lamp and glow plugs remain energized for period of time specified by setting in the JLG Control System. Engine start is disabled during this period.

On Deutz engines, glow plugs continue (post glow) after engine has started three times the machine digit setting.

3.15 DEUTZ EMR 2

The EMR2 consists of sensors, control unit, and actuator. Engine-side controls and the JLG Control System are connected by separate cable harnesses to the EMR control unit.

Sensors attached to the engine provide control unit electronics with all relevant physical parameters. In accordance with information of the current engine conditions and preconditions (throttle position etc.), the EMR2 controls an actuator that operates the control rod of the injection pump and thus doses the fuel quantity in accordance with the performance requirements.

Exact position of the regulating rod is reported back and, if necessary, is corrected, by means of the control rod travel sensor, situated together with the rotation magnets in a housing of the actuator.

The EMR2 is equipped with safety devices and measures in the hardware and software to ensure emergency running (Limp home) functions. In order to switch the engine off, the EMR2 is switched in a de-energized fashion over the ignition switch. A strong spring in the actuator presses the control rod in the de-energized condition into the zero position. As a redundancy measure, an additional solenoid serves for switching off and this, independently of the actuator, also moves the control rod in the de-energized condition into the zero position.

After programming over the ISO9141 interface, the EMR2 possesses a motor-specific data set which is permanently assigned to the engine. Included in this are the various application cases as well as the customer's wishes regarding a particular scope of function.

Each EMR2 module is matched by serial number to the engine. Modules cannot be swapped between engines.

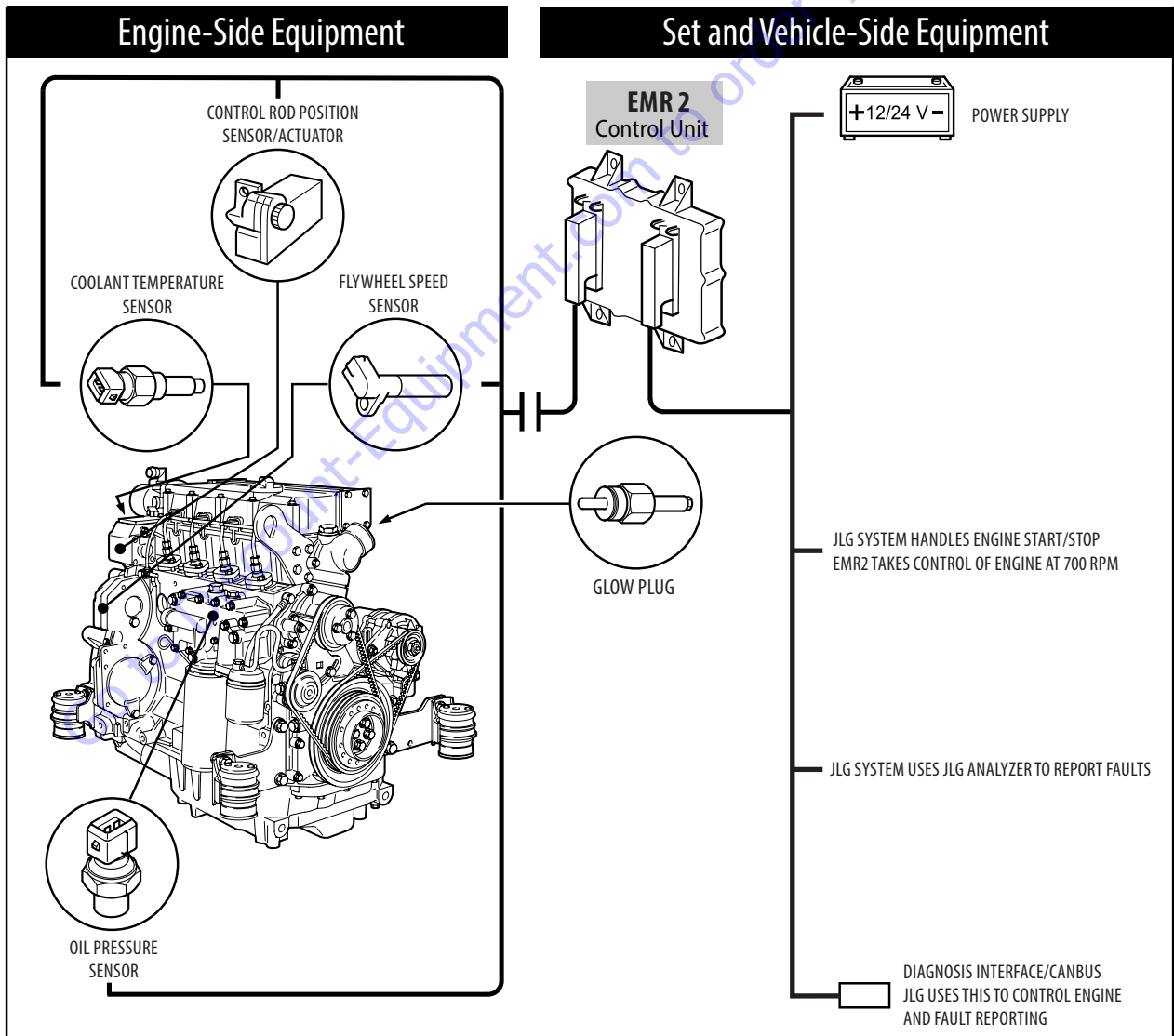


Figure 3-84. EMR 2 Engine Side Equipment

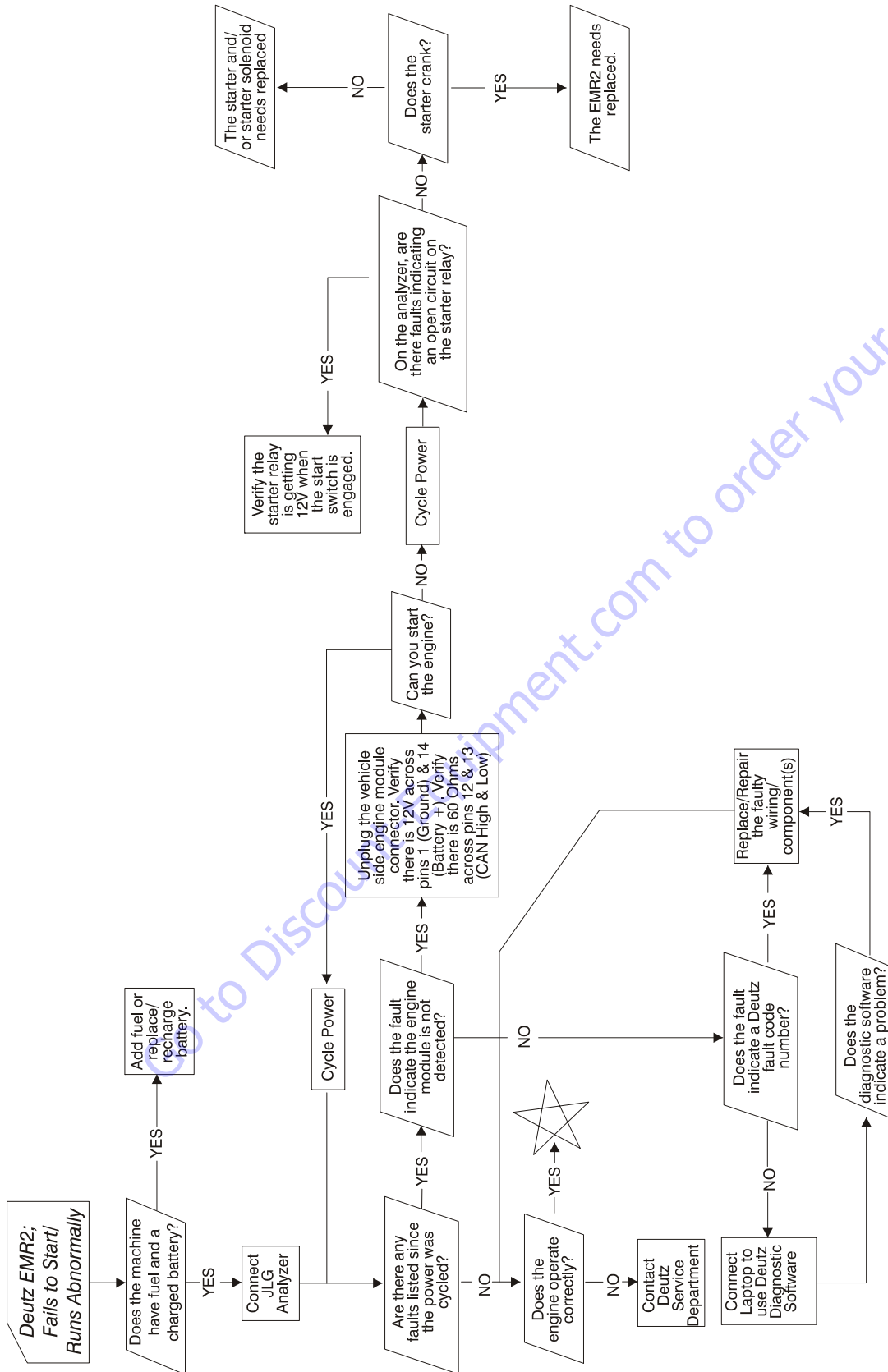


Figure 3-85. Deutz EMR 2 Troubleshooting Flow Chart

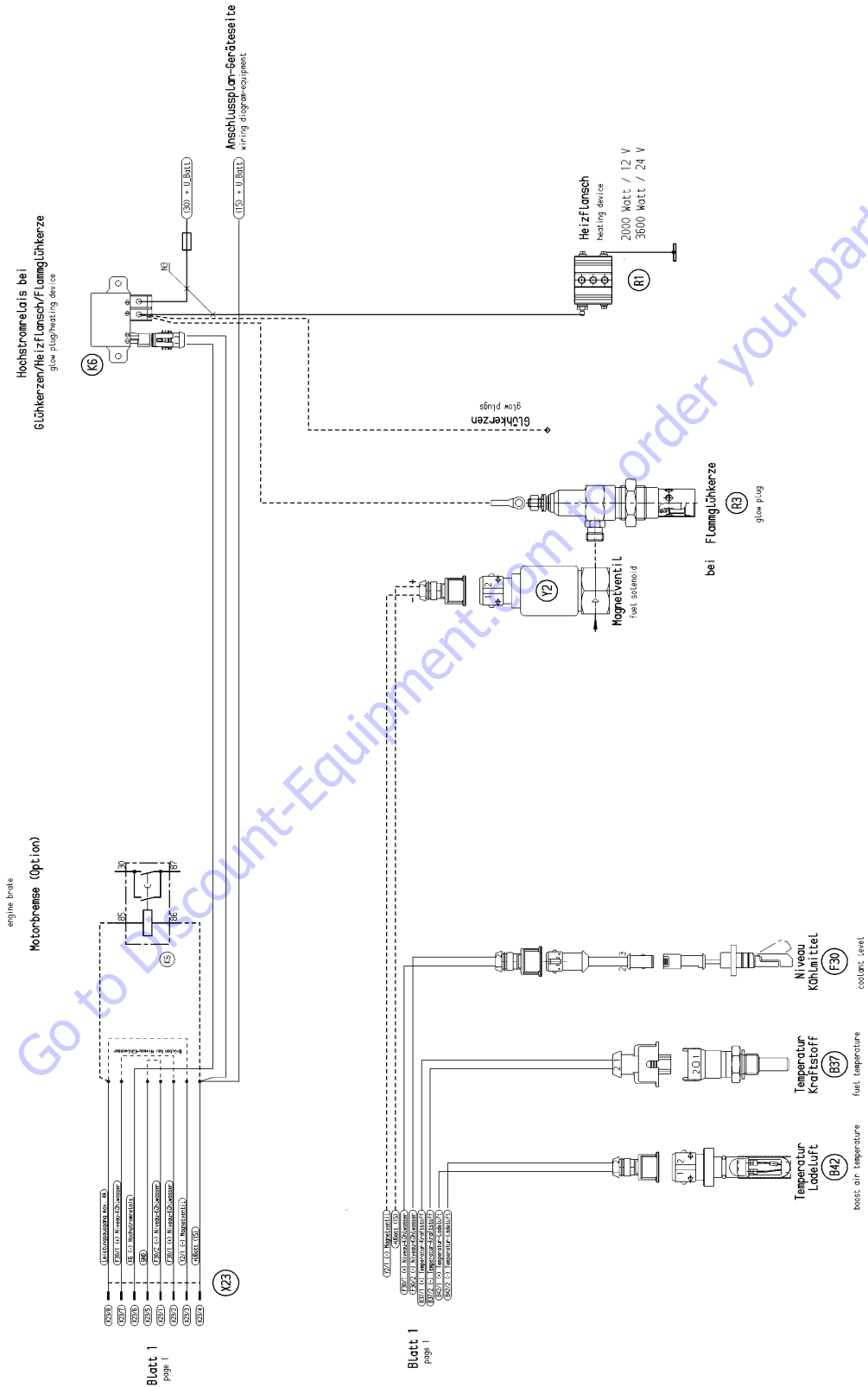
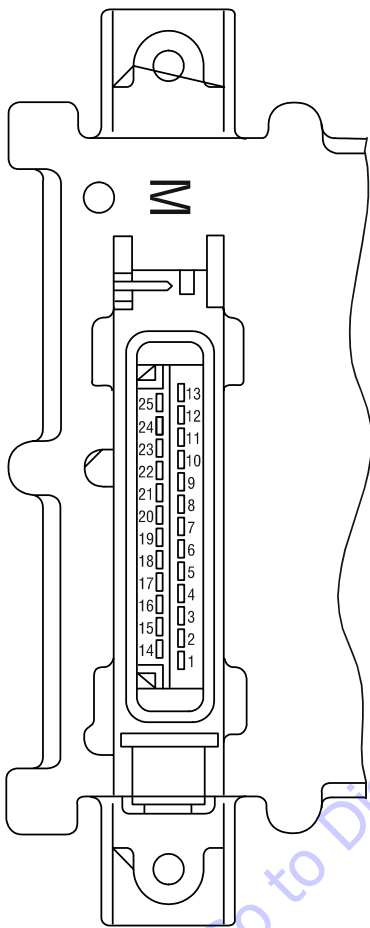


Figure 3-88. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2

SECTION 3 - CHASSIS & TURNTABLE

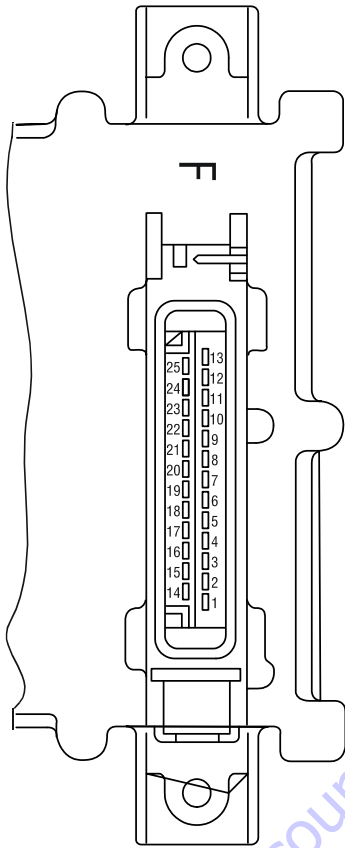


Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid ¹⁾
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature ²⁾
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) DigIn 5	Coolant level / oil level
7	Output: PWM2/digital 6	
8	GND	Reference potential for analog signal at pin 9
9	Input: analog 7	Analog input for Coolant temperature sensor (NTC)
10	GND	Reference potential for analog signal at pin 11
11	Multi-function input: speed 2/DigIn 2	Digital input second engine speed (crankshaft) (optional) and speed signal (optional)
12	GND	Reference potential for analog signal at pin 13
13	Input: speed 1	Digital input first engine speed (camshaft)
14	STG -	PWM output, signal for actuator coil
15	STG +	PWM output, signal for actuator coil
16	Screen	Screening regulating rod travel sensor (for lines 17, 18, 19)
17	RF -	General connection for reference and measuring coil
18	RF REF	Analog input, reference signal of the reference coil
19	RF MESS	Analog input, measuring signal of the measuring coil
20	GND	Reference potential for signal at pin 21
21	Input: analog 4/digital 9	Analog input 4 (sensor signal oil pressure sensor) or digital input 9
22	+5 V REF	+5 V Reference voltage for signal at pin 21 (max. 15 mA)
23	GND	Reference potential for signal at pin 24
24	Input: analog 2/digital 7	Analog input 2 (sensor signal charge air) or digital input 7
25	+5 V LDA	+5 V Reference potential for signal at pin 24 (max. 15 mA)

1) For continuous power: < 4 A

2) Corresponds to special function "fuel temperature compensation at the EMR (0211 2571)

Figure 3-89. EMR 2 Engine Plug Pin Identification



Pin-No.	Designation	Description
1	U Batt -	Negative pole at battery (clamp 31)
2	GND	Reference potential for signal
3	Output: digital 2	PWM or digital output, various functions
4	Input / output: DigInOut	Fault lamp and diagnostic button
5	Output: PWM 1/Dig 1	PWM or digital output, various functions
6	Multi-function input: DigIn 3	Genset applications/gear shift/motor brake
7	Input: digital 10/velocity	Speed signal (tacho input)
8	NC	Not occupied
9	NC	Not occupied
10	L-line	Serial ISO 9141 interface
11	K-line	Serial ISO 9141 interface
12	CAN high	Interface for CAN-Bus
13	CAN low	Interface for CAN-Bus
14	U Batt +	Positive pole for battery (clamp 15)
15	Output: digital 5	Digital output, various functions
16	Output: digital 7/Frequency	Frequency, PWM or digital output, various functions
17	Ground	Reference potential for signal at pins 18, 19 and 21
18	Input: digital 1 / PWM 1	PWM 1 or digital input 1, various functions
19	Multi-function input: DigIn 4	Performance curve switching/genset applications
20	Multi-function input: digital 8 / analog 3	Hand hand throttle/genset applications, Digital (8) or analog input (3)
21	Input: digital 2 / PWM 2	PWM 2 or digital input 2, various functions
22	Screen	Screening (e.g. for lines hand throttle or PWG)
23	GND	Reference potential for signal at pin 24
24	Input: analog 1 / digital 6	Analog input 1 (pedal value sensor, PWG) or digital input 6
25	+5 V REF	+5 V Reference voltage for signal at pin 24

Figure 3-90. EMR 2 Vehicle Plug Pin Identification

SECTION 3 - CHASSIS & TURNTABLE

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Zero error display	-	No faults	524287	31	No active faults present		
Revolutions / speed acquisition	01	Speed sensor 1	190	8	Sensor failure. Distance from gear too far. Additional fault impulses. Cable joint interrupted.	Governor in emergency operation (if sensor 2 available). Emergency switch-off (if sensor 2 not available or failed). Governor in emergency operation (with sensor 1). Emergency switch-off (if sensor 1 not available or failed).	Check distance. Check cable connection. Check sensor and replace if required.
	03	Speed sensor	84	8	Tacho failed. Additional fault impulses. Cable connection interrupted.	Governor in emergency operation.	Check cable connection and Tacho. Replace if required.
	04	Excess speed switch-off	190	0	Speed was/is in excess of limit.e. Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator (impulse on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.	Engine stop.	Check parameter (21). Check speed settings.
Sensors	07	Charge air pressure	102	2			
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2	Fault at corresponding sensor entry (e.g. short circuit or cable break).	With failure of the sensor, the associated monitoring function is de-activated.	Check sensor cable. Check sensor and replace if required. Check fault limits for sensor.
	10	Charge air temperature	105	2			
	11	Fuel temperature	174	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-91. EMR2 Fault Codes - Sheet 1 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault warning	30	Oil pressure warning	100	1	Oil pressure below speed-dependent warning line characteristic	Fault message (disappears when oil pressure is again above recovery limit). After a delay time - fill limitation.	Check engine (oil level, oil pump). Check oil pressure sensor and cable. Check oil pressure warning line characteristic.
	31	Coolant temperature warning	110	0	Coolant temperature has exceeded warning level.	Fault message (disappears when coolant temperature again drops below recovery level). After a delay time - fill limitation.	Check coolant. Check coolant temperature sensor and cable.
	32	Charge air temperature warning	105	0	Charge air temperature has exceeded warning level.	Fault message (disappears when charge air temperature gain drops below recovery level). After a delay time - fill limitation.	Check charge air. Check charge air-temperature sensor and cable.
	34	Coolant level warning	111	1	Switch input "Low coolant level" is active.	Fault message.	Check coolant level. Check coolant level sensor and cable.
	35	Speed warning (with thrust mode operation).	SID 190	14	revolutions was/is above (top) revolution speed limit. "Thrust mode" function is active.		Check parameters. Check speed settings.
						Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator. Check speed sensor (impulses on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.	
	36	Fuel temperature warning	174	0	Fuel-temperature has exceeded warning level.	Fault message (disappears when fuel temperature again drops below recovery level).	Check fuel. Check fuel temperature sensor and cable.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-92. EMR2 Fault Codes - Sheet 2 of 5

SECTION 3 - CHASSIS & TURNTABLE

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault, switch-off	42	Charge air temperature switch-off	105	0	Charge air temperature has exceeded switch-off limit.	Emergency stop	Check charge air. Check charge air-temperature sensor and cable. Check switch-off limit.
	44	Coolant level switch-off	111	1	Switch input "Low coolant level" is active.	Emergency stop. Start lock.	Check coolant level. Check coolant level sensor and cable.
Actuator	50	Feedback	SID 24	12	Actuator not connected. Fault in actuator confirmation.	Emergency switch-off. Actuator cannot be operated.	Check actuator, replace if required. Check cable, check fault limits for "Confirmation".
	52	Reference feedback	SID 24	13			Check actuator, replace if required. Check cable, check fault limits for "Rifeness confirmation".
	53	Control travel difference	SID 23	7	Injection pump/actuator jammed or not connected. Difference between nominal/actual control travel is > 10 % of the overall control path.	Fault message (disappears when difference is < 10 %).	Check actuator/actuator rods / injection pump, replace if required. Check actuator cable.
	59	Auto calibration BOSCH-EDC pumps faulty operation	SID 23	13	No automatic actuator equalization possible. Incorrect input of the actuator reference values.	Engine stop / start lock. Governor cannot be taken into use. EDC actuator calibration required.	Check actuator and replaced if required. Check feedback cable. Check fault limits and reference values of the feedback. Program the fault limits for feedback, save the fault limits for feedback, save values. Switch ignition off and on again. Check again. If faulty, inform DEUTZ-Service and carry out automatic equalization again. Set fault limits again.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-93. EMR2 Fault Codes - Sheet 3 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Hardware inputs/outputs	60	Digital output 3 (Switch-off solenoid, pin M 2)	SID 51	2	Fault (short circuit / cable break) at digital output.	Driver level is switched off.	Check cable of digital output (cable break or short circuit).
	62	Digital output 6, pin M 7	SID 60	2		Fault message.	
	63	Excess voltage switch-off solenoid	SID 51	6			
	67	Error Hand Setp1	91	11			
	68	Error CAN Setp1	898	2			
Communication	70	CAN-Bus controller	SID 231	12	CAN-controller for CAN-bus is faulty. Fault removal despite re-initialising continuously not possible	Application-dependent.	Check CAN connection, terminating resistor (see Chapter 12.4), Check control unit.
	71	CAN interface SAE J 1939	SID 231	9	Overflow in input buffer or a transmission cannot be placed on the bus.		
	74	Cable break, short circuit or bus-error	SID 231	14			Check CAN connection, cable connection. Check sensor and replace if required.
Memory	76	Parameter programming (write EEPROM)	SID 253	12	Fault in parameter programming in the governor fixed value memory.		Switch ignition off and on again. Check again, if faulty inform DEUTZ Service
	77	Cyclic program test	SID 240	12	Constant monitoring of program memory shows error (so-called "Flash-test").	Emergency switch-off, engine cannot be started.	
	78	Cyclic RAM test	SID 254	2	Constant monitoring of working memory shows error.		Note values of parameters (3895 and 3896). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-94. EMR2 Fault Codes - Sheet 4 of 5

SECTION 3 - CHASSIS & TURNTABLE

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Control unit hardware	80	Power supply (Actuator)	SID 254	2	Power supply for actuator not in the permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	83	Reference voltage 1	SID 254	2	Reference voltage for actuator not in the permissible range.	Fault message (disappears when power again in the normal range). Auxiliary value 5 V	Check voltage supply. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	84	Reference voltage 2	SID 254	2			
	85	Reference voltage 4	SID 254	2			
	86	Internal temperature	171	12	Internal temperature for control unit not in permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
87	Atmospheric pressure	108	12	Atmospheric pressure not in permissible range.	Fault message (disappears when power again in normal range). Atmospheric pressure monitoring function de-activated.	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.	
Program logic	90	Parameter fault (EEPROM retrieval or checksum faulty).	SID 253	2	No data found or checksum of data is faulty (note: fault only occurs during setting of parameter / saving or reset).	Engine cannot be started.	Check data for correct settings. Save parameters. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	93	Stack overflow	SID 240	2	Internal calculation fault (so-called "Stack overflow" fault).	Emergency switch-off. Engine cannot be started.	Note parameters (3897 and 3898). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	94	Internal fault	SID 254	2			

NOTE: SID is equal to 512. To get SPN #, add 512 + number. For example, SID 254 would be 512+254 or an SPN of 766.

Figure 3-95. EMR2 Fault Codes - Sheet 5 of 5

3.16 BIO FUEL IN DEUTZ ENGINES

General

Use of bio fuels is permitted for the compact engines made by DEUTZ.

Distillate fuels with residue oil percentages or mixed fuels may not be used in DEUTZ compact engines.

DEUTZ vehicle engines are designed for diesel fuels in accordance with EN 590 with a cetane number of at least 51. DEUTZ engines for mobile machinery are designed for a cetane number of at least 45. When using fuels of a low cetane number, disturbing white smoke and ignition misfires are to be expected under some circumstances.

A cetane number of at least 40 is permissible for the US market, therefore special engine models have been developed to avoid starting difficulties, extreme white smoke or increased hydrocarbon emissions (EPA specification - US EPA REGULATIONS FOR LARGE NONROAD COMPRESSION-IGNITION ENGINES).

If white smoke is unacceptable when using a very low cetane number, use of ignition improvers is to be recommended as a later remedial measure.

Certification measurements for compliance with legal emission limits are carried out with test fuels prescribed by law. These correspond to diesel fuels in accordance with EN 590 and ASTM D 975. No emission values are guaranteed with other fuels described. It is the obligation of the owner to check permission for use of fuels in accordance with regional regulations.

Bio Fuel

PERMITTED BIO-DIESEL FUELS

Originally only rape seed oil methylester (RME) was sold as a bio-diesel fuel in Europe but fatty acid methylester (FAME) based on other oils have come onto the market increasingly in recent years. However, with the latter there is a risk that the limit values of EN 14214 are not kept in the field. Anyone who uses bio-diesel fuel in DEUTZ engines must therefore choose his supplier very carefully and have him guarantee compliance with the EN 14214 limit values. Since experience has shown that rape seed oil methylester (RME) exceeds the limit values less often than other esters, it is expressly recommended to use only rape seed oil methylester. DEUTZ customers in Germany can additionally ensure the quality by buying bio-diesel fuel with an AGQM certificate (Arbeitsgemeinschaft Qualitäts-Management Biodiesel e.V.).

The use of US bio-diesel based on soy oil methylester is only permissible in mixtures with diesel fuel with a bio-diesel part of a max. 20 weight-%. The US bio-diesel used for the mixture must comply with the ASTM D6751-07a (B100) standard.

APPROVED ENGINES

912, 913, 914, 1011, 2011, 1012, 2012, 1013, 2013, 413 and 513 series are approved for bio-diesel from year of manufacture 1993 under compliance with basic conditions specified below.

BASIC CONDITIONS TO BE OBSERVED

- A power loss of 5-9% in relation to diesel fuel in accordance with EN 590 is possible due to the lower heating value. Blocking of fuel injector is not allowed.
- Lubricating oil quality must correspond to TR 0199-99-3002. Lubricating oil change interval must be halved in relation to operation with diesel fuel in accordance with EN 590.
- Standstills of longer than 4 to 6 weeks must be avoided with bio-diesel. Otherwise, engine must be started and stopped with diesel fuel.
- Bio-diesels can be mixed with normal diesel fuel but basic conditions described in this subsection apply for mixtures. Mixtures with up to 5% (m/m) bio-diesel (B5) which have recently been on sale at European fuel stations are excepted. These fuels must be treated like normal diesel fuels because EN 590 expressly permits adding up to 5% (m/m) bio-diesel in accordance with EN 14214.
- Approximately 30-50 hours after changing from diesel fuel to bio-diesel, the fuel filter should be changed as a preventive measure to avoid a drop in performance due to clogged fuel filters. Deposited fuel ageing products are dissolved by bio-diesel and transported into the fuel filter. They should not be changed immediately, but after 30 to 50 hours because that is the time it takes for most dirt to be dissolved.

PLANT OIL

NOTICE

PURE PLANT OILS (E.G. RAPE SEED OIL, SOY OIL, PALM OIL) ARE NOT CLASSIFIED AS BIO-DIESEL AND EXHIBIT PROBLEMATIC PROPERTIES FOR DIESEL ENGINE OPERATION (STRONG TENDENCY TO COKE, RISK OF PISTON SEIZURE, EXTREMELY HIGH VISCOSITY, AND POOR EVAPORATION BEHAVIOR).

The conversion of DEUTZ engines to rape seed oil fuel operation with conversion kits and modified tanks systems of various manufacturers is not allowed and leads to loss of warranty rights.

Biological Contamination In Fuels

SYMPTOMS

The following symptoms may indicate a fuel tank is contaminated by micro-organisms:

- Internal tank corrosion,
- Filter blockage and associated loss of power due to gel-like deposits on the fuel filter (especially after long standstills)

CAUSE

Micro-organisms (bacteria, yeasts, fungi) can form bio-sludge under unfavorable conditions (favoured particularly by heat and water).

Penetration by water is usually caused by condensation of water in the air. Water does not dissolve in fuel so penetrating water collects at bottom of the tank. Bacteria and fungi grow in the watery phase, at phase boundary to the fuel phase, from which they draw their nutrition. There is an increased risk especially with bio-diesel (FAME).

PREVENTIVE MEASURES

- Keep storage tank clean. Perform regular cleaning of the tank by specialist companies
- Installation of fuel pre-filters with water traps, especially in countries with frequently fluctuating fuel qualities and high percentage of water.

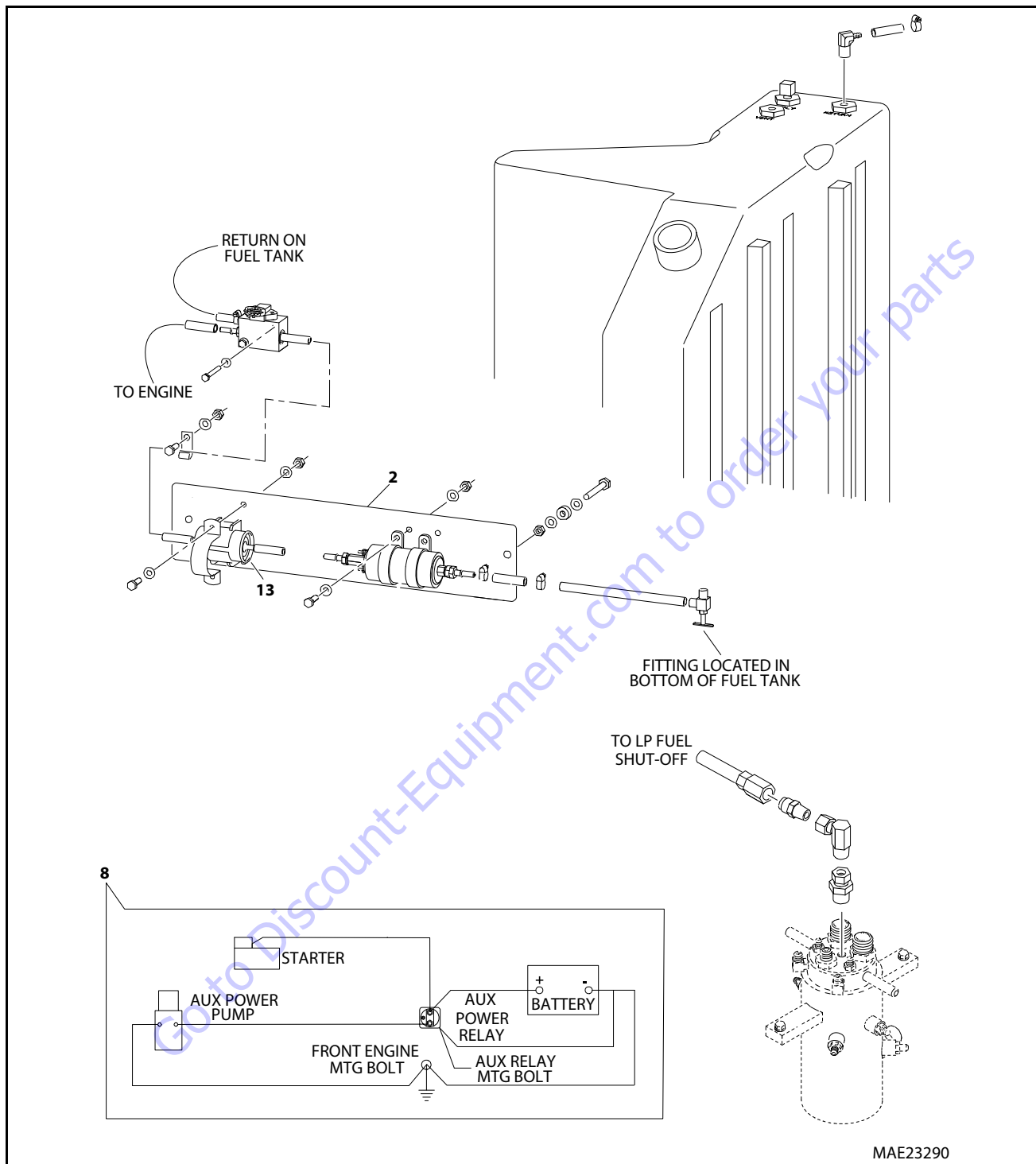
If the fuel system and storage tank have already been attacked by micro-organisms. Biocide must be dosed according to the manufacturer's specifications.

- Avoid direct exposure of the storage tank to sunlight
- Use smaller storage tanks with corresponding low dwell times of the stored fuel

FUEL ADDITIVES

The use of fuel additives is not permitted. The flow improvers mentioned above are an exception. Use of unsuitable additives will result in loss of warranty.

SECTION 3 - CHASSIS & TURNTABLE



- | | | | | |
|-----------------------------|------------------------------|--------------------------|--------------------------------|--------------------------|
| 1. Battery | 6. Baffle Support Bracket | 10. Gear Pump Assembly | 15. Air Cleaner Assembly | 19. Radiator Mount Plate |
| 2. Fuel Pump Filter Bracket | 7. Engine Tray Mount Bracket | 11. Spark Plug | 16. Coolant Overflow Container | 20. Engine Mount Plate |
| 3. Rubber Panel | 8. Battery Cable Kit | 12. Oil Filter | 17. Fan | 21. Radiator |
| 4. Hold Down Plate | 9. Piston Pump Assembly | 13. Fuel Filter | 18. Engine Mount | 22. Engine Tray |
| 5. Battery Hold Down | | 14. Control Module (ECU) | | 23. Engine Mount |

Figure 3-97. GM Engine Installation Sheet 2 of 2

3.18 GM ENGINE GENERAL MAINTENANCE

Drive Belt Maintenance

The serpentine drive belt utilizes a spring loaded tensioner which keeps the belt properly adjusted. The drive belt is an integral part of the cooling and charging systems and should be inspected frequently.

When inspecting belts check for:

- Cracks or breaks
- Chunking of the belt
- Splits
- Material hanging from belt
- Glazing and hardening
- Damaged or improperly aligned pulleys
- Improperly performing tensioner

Check belt tensioner by pressing down on the midway point of the longest stretch between pulleys. The belt should not depress beyond 1/2 inch (13mm). If depression is more than allowable, adjust tension.

NOTICE

ENGINE MANUFACTURER DOES NOT RECOMMEND USE OF "BELT DRESSING" OR "ANTI SLIPPING AGENTS" ON DRIVE BELT.

Engine Electrical System Maintenance

The engine electrical system incorporates computers and microprocessors to control engine ignition, fuel control, and emissions. Periodic inspection of electrical wiring is necessary due to sensitivity of computers to good electrical connections. When inspecting the electrical system use the following:

- Check and clean battery terminal connections and ensure connections are tight
- Check battery for any cracks or damage to case
- Check Positive and Negative battery cables for corrosion build up, or rubbing and chafing. Check connections on chassis are tight.
- Check entire engine wire harness for rubbing chafing, cuts or damaged connections. Repair as needed.
- Check all wire harness connectors to ensure they are fully seated and locked.
- Check ignition coil and spark plug cables for hardening, cracking, chafing, separation, split boot covers, and fit
- Replace spark plugs at the proper intervals as prescribed in the engine manufacturer's manual
- Make sure all electrical components are fitted securely.
- Check ground and platform control stations to ensure all warning indicator lights are functioning.

Checking/Filling Engine Oil Level

NOTICE

AN OVERFILLED CRANKCASE (OIL LEVEL OVER THE SPECIFIED FULL MARK) CAN CAUSE AN OIL LEAK, FLUCTUATION OR DROP IN OIL PRESSURE, AND ROCKER ARM "CLATTER".

NOTICE

CARE MUST BE TAKEN WHEN CHECKING ENGINE OIL LEVEL. OIL LEVEL MUST BE MAINTAINED BETWEEN "ADD" MARK AND "FULL" MARK ON DIPSTICK.

To ensure you are not getting a false reading, make sure the following steps are taken before checking oil level.

1. Stop engine if in use.
2. Allow sufficient time (approximately 5 minutes) for oil to drain back into oil pan.
3. Remove dipstick. Wipe with a clean cloth or paper towel and reinstall. Push dipstick all the way in dipstick tube.
4. Remove dipstick and note oil level.
5. Oil level must be between "FULL" and "ADD" marks.

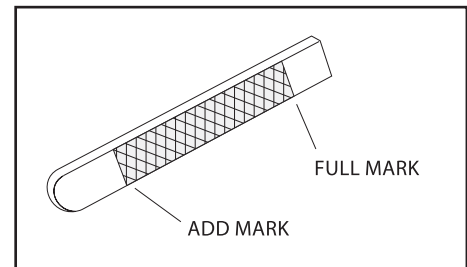


Figure 3-98. GM Engine Oil Dip Stick

6. If oil level is below "ADD" mark, proceed to Step 7 and 8 and reinstall dipstick in dipstick tube.
7. Remove oil filter cap from valve rocker arm cover.
8. Add required amount of oil to bring level up to, but not over, "FULL" mark on dipstick.
9. Reinstall oil fill cap to valve rocker cover and wipe away any excess oil.

Changing Engine Oil

NOTICE

ALWAYS CHANGE OIL FILTER WHEN CHANGING OIL. CHANGE OIL WHEN ENGINE IS WARM FROM OPERATION. OILS WILL FLOW FREELY AND CARRY AWAY MORE IMPURITIES.

To change oil use the following steps:

1. Start engine and run until it reaches normal operating temperature.
2. Stop engine.
3. Remove drain plug and allow oil to drain.
4. Remove and discard oil filter and sealing ring.
5. Coat sealing ring on new filter with clean engine oil and wipe engine filter mounting surface to remove contamination. Tighten filter securely (follow filter manufacturer's instructions). Do not over tighten.
6. Check sealing ring on drain plug for damage. Replace if necessary. Pipe plug and oil pan sealing surface with a clean rag. Reinstall plug. Do not over tighten.
7. Fill crankcase with oil.
8. Start engine and check for oil leaks.
9. Stop engine and check oil level is at "FULL".
10. Dispose of oil and filter in a safe manner as required by local regulations.

Coolant Fill Procedure - Dual Fuel Engine

CAUTION

HOT ENGINE AND COMPONENTS CAN CAUSE SEVERE BURNS. MAKE SURE ENGINE IS COOL BEFORE PERFORMING MAINTENANCE.

NOTICE

DAMAGE TO ENGINE CAN OCCUR IF NOT PROPERLY FILLED WITH COOLANT. LPG FUELED ENGINES ARE MOST PRONE TO CREATING AN AIR LOCK DURING A COOLANT FILL OPERATION DUE TO ELECTRONIC PRESSURE REGULATOR (EPR) BEING THE HIGHEST POINT IN THE COOLING SYSTEM. AN EPR THAT APPEARS TO HAVE FROST FORMING ON IT IS A SIGN THE ENGINE COOLING SYSTEM CONTAINS AIR. APPEARANCE AND TEMPERATURE OF THE EPR SHOULD BE MONITORED DURING COOLANT FILL OPERATION. A WARM EPR IS AN INDICATION THAT THE COOLING SYSTEM IS PROPERLY FILLED AND FUNCTIONING.

1. Loosen worm gear clamp on coolant line running to EPR as shown below. Remove hose from EPR. Place a rag under hose to prevent coolant from running onto engine/machine.



2. Remove radiator cap. Fill radiator with coolant until coolant starts to appear from previously removed hose at the EPR. Reinstall hose back on EPR and continue to fill radiator with coolant.



3. With radiator cap still removed, start engine and run until thermostat opens at 170° F (77° C), which can be checked using the JLG handheld analyzer.

NOTICE

WHILE ENGINE IS RUNNING, AIR AND/OR STEAM MAY BE PRESENT COMING FROM THE RADIATOR. THIS IS NORMAL.

4. Run engine for five minutes after it has reached operating temperature. Shut off engine and continue to step 5.

⚠ CAUTION

WITH ENGINE RUNNING OR WHEN SHUTTING OFF ENGINE, SOME HEATED COOLANT MAY SPILL OUT DUE TO AIR "BURPING" OUT OF THE SYSTEM WITH RADIATOR CAP OFF.

5. Verify the two coolant hoses on the EPR are warm. If they are not warm repeat step 3 and 4, otherwise continue to step 6.

NOTICE

A PROPERLY PURGED COOLING SYSTEM WILL YIELD A WARM UPPER RADIATOR HOSE AND A WARM EPR HOSE. IF UPPER RADIATOR AND EPR HOSES ARE NOT WARM TO THE TOUCH AFTER ENGINE HAS RUN FOR 5-8 MINUTES AFTER REACHING OPERATING TEMPERATURE, THE SYSTEM MAY STILL CONTAIN AIR. IT MAY BE NECESSARY TO REPEAT ABOVE STEPS.

6. Fill radiator with coolant as needed and install radiator cap.
7. Remove coolant recovery bottle cap and fill to just below HOT FULL line. Reinstall cap.

**3.19 GM ENGINE DUAL FUEL SYSTEM**

The fuel system installed on this engine is designed to meet mobile engine emission standards applicable for 2010 and later model years. The Dual Fuel system allows the vehicle to operate on gasoline or LPG by positioning a selector switch in the operator's platform. When the operator places the selector switch in gasoline mode, the gasoline fuel pump is energized. In gasoline mode the LPG fuel lock-off is isolated and will not energize. In addition, the gasoline injector circuit is enabled and injector pulses are provided to each injector. ECM calibration for gasoline is also enabled.

When LPG mode is selected the Low Pressure LPG lock-off is energized and fuel from the LPG tank flows to the Electronic Pressure Regulator (EPR). The EPR receives an electronic signal to position the secondary lever for start or run positions. When the engine begins to crank, the mixer air valve will rise and fuel begins flowing to engine. During this mode the gasoline fuel pump is isolated and is not activated.

Primary components of the gasoline dual fuel system are the gasoline tank, electric fuel pump and filter, fuel supply line, injector rail and injectors and the fuel pressure regulator.

Primary components of the LPG dual fuel system are the LPG fuel tank, in-fuel filter, LPG Low Pressure lock-off, Electronic Pressure Regulator (EPR) and the fuel mixer module. The LPG fuel system operates at pressures which range from 14.0 inches (355.60 mm) of water column up to 312 psi (21.5 BAR).

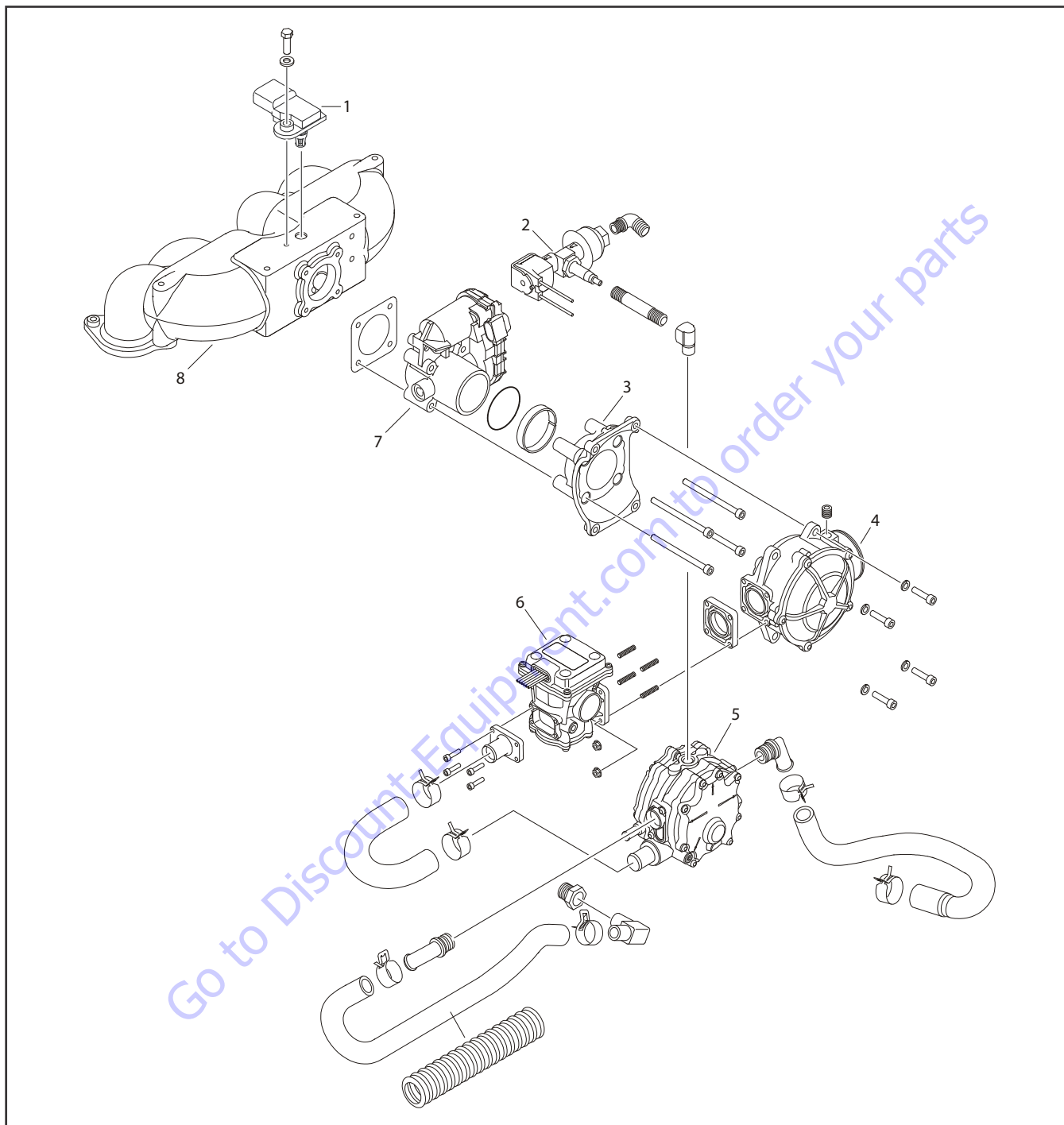
Components shared by both systems include the Electronic Throttle Control and ECM. The ECM contains a dual calibration; one controls the gasoline fuel system during gasoline operation and one controls the LPG fuel system during LPG operation.

Fuel Filter

Propane fuel, like all other motor fuels, is subject to contamination from outside sources. Refueling and removal of the tank from the equipment can contaminate the fuel system. It is necessary to filter fuel before it enters fuel system components downstream of the tank.

An in-line fuel filter is installed in the fuel system to remove fuel contamination. The in-line filter is replaceable as a unit only. Filter maintenance is critical to proper operation of the fuel system and should be replaced as listed in Section 1. More frequent replacement of the filter may be necessary in severe operating conditions.

SECTION 3 - CHASSIS & TURNTABLE



- | | | | |
|-------------------|------------|--|--------------------|
| 1. T-MAP Sensor | 3. Mixer | 5. Regulator | 7. Throttle Body |
| 2. Lock-Off Valve | 4. Adapter | 6. Direct Electronic Pressure Regulator (DEPR) | 8. Intake Manifold |

Figure 3-99. GM 3.0 Dual Fuel System Components

Direct Electronic Pressure Regulator (DEPR)

NOTICE

THE DEPR IS AN EMISSION CONTROL DEVICE AND SHOULD ONLY BE SERVICED BY QUALIFIED TECHNICIANS.

The ECI engine management system uses the DEPR to control fuel delivery for precise fuel metering needed for optimum combustion, fuel economy, and transient response.

The DEPR is a single-stage microprocessor based electromechanical fuel pressure regulator that incorporates a high speed/fast acting actuator. It communicates with the Engine Control Module (ECM) over a Controller Area Network (CAN) link, receiving fuel pressure commands and broadcasting DEPR operating parameters back to the ECM.

The DEPR can regulate fuel pressure from -18 to +13 inches of water column above the Mixer air inlet pressure, providing sufficient control authority to stall an engine either rich or lean.

When the DEPR receives an output pressure command from the ECM, the valve is internally driven to attain targeted fuel pressure, the DEPR then closes the loop internally using a built in fuel pressure sensor to maintain target fuel pressure/fuel flow rate, until another external command from the ECM is received (intervals < 10 ms).

The DEPR has an integral fuel temperature sensor that is used by the ECM to correct for variations in fuel density. This provides an extremely accurate method for open loop fuel control. Then with the addition of the pre- and post-cat oxygen sensors, the pressure command transmitted from the ECM can be further adjusted using closed loop feedback.

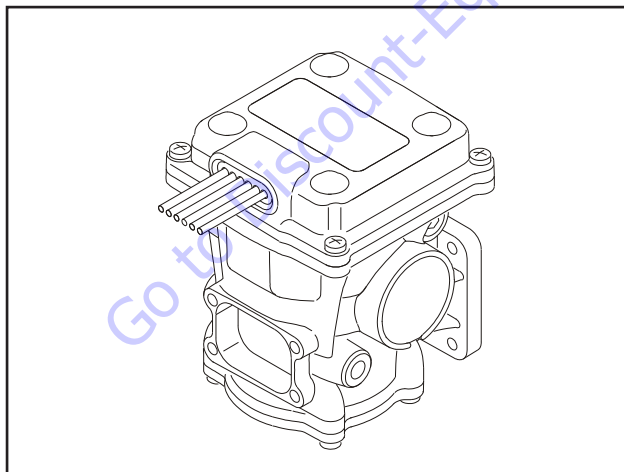


Figure 3-100. Direct Electronic Pressure Regulator

Air Fuel Mixer

NOTICE

THE AIR/FUEL MIXER IS AN EMISSION CONTROL DEVICE. COMPONENTS INSIDE THE MIXER ARE SPECIFICALLY CALIBRATED TO MEET THE ENGINE'S EMISSIONS REQUIREMENTS AND SHOULD NEVER BE DISASSEMBLED OR REBUILT. IF THE MIXER FAILS TO FUNCTION CORRECTLY, REPLACE WITH AN OEM REPLACEMENT PART.

The air valve mixer is a self-contained air-fuel metering device. The mixer is an air valve design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking speeds to full load.

The mixer is mounted in the air stream ahead of the throttle control device. When the engine begins to crank it draws in air with the air valve covering the inlet, and negative pressure begins to build. This negative pressure signal is communicated to the top of the air valve chamber through vacuum ports in the air valve assembly. A pressure/force imbalance begins to build across the air valve diaphragm between the air valve vacuum chamber and the atmospheric pressure below the diaphragm.

The vacuum being created is referred to as Air Valve Vacuum (AVV). As the air valve vacuum reaches the imbalance point, the air valve begins to lift against the air valve spring. The amount of AVV generated is a direct result of throttle position. At low engine speed the air valve vacuum and the air valve position is low, creating a small venturi for the fuel to flow. As engine speed increases, AVV increases and the air valve is lifted higher creating a much larger venturi. Air valve vacuum is communicated from the mixer venturi to the IEPR via the fuel supply hose.

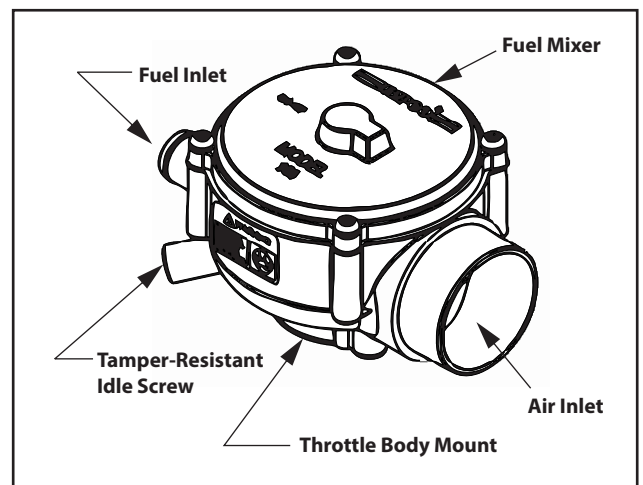


Figure 3-101. Air Fuel Mixer

Electronic Throttle Control (ETC)

The Electronic Throttle Control device or "Throttle Body Assembly" is connected to the intake manifold of the engine. The electronic throttle control device utilizes an electric motor connected to the throttle shaft.

When the engine is running, electrical signals are sent from equipment controls to the engine ECM. The ECM then sends an electrical signal to the motor on the electronic throttle control to increase or decrease the angle of the throttle blade thus increasing or decreasing the air/fuel flow to the engine.

Two internal Throttle Position Sensors (TPS) provide throttle shaft and blade position output signals to the ECM. TPS information is used by the ECM to correct speed and load control, as well as emission control.

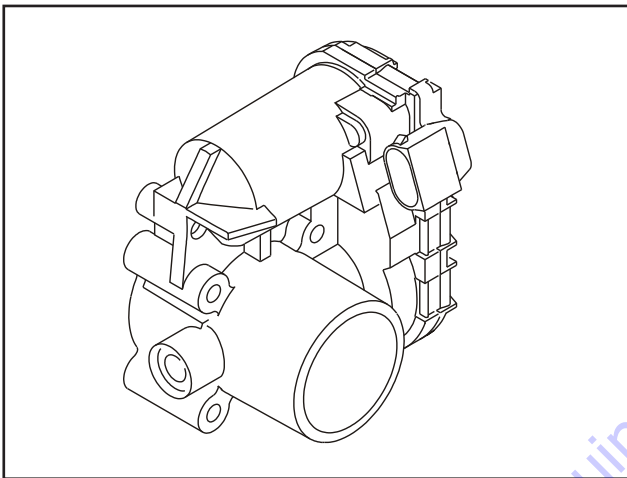


Figure 3-102. Electronic Throttle Control Device

Electric Lock Off

The Electric Lock Off device is an integrated assembly consisting of a 12 volt solenoid and normally closed valve. When energized, the solenoid opens the valve and allows propane fuel to flow through the device. The valve opens during engine cranking and run cycles. Lock Off supply voltage is controlled by the Engine Control Module (ECM).

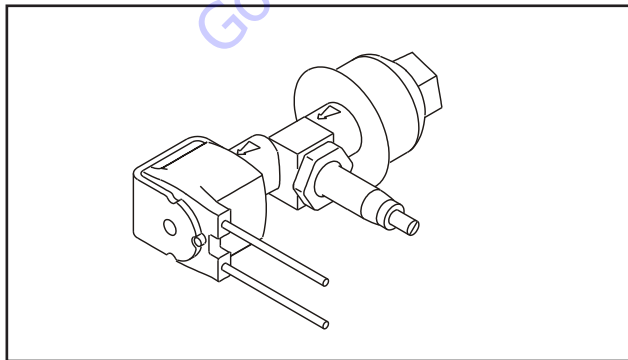


Figure 3-103. Electric Lock Off Assembly

Engine Control Module (ECM)

NOTE: The ECM may also be referred to as the Engine Control Unit (ECU) in some applications.

To obtain maximum effect from the catalyst and accurate control of air fuel ratio, the emission certified engine is equipped with an onboard computer or Engine Control Module (ECM). The ECM is a 32 bit controller which receives input data from sensors fitted to the engine and fuel system and then outputs various signals to control engine operation.

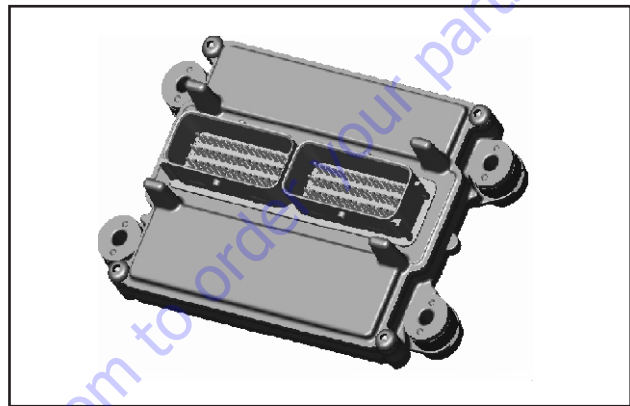


Figure 3-104. ECM Assembly

One specific function of the controller is to maintain "closed loop fuel control". Closed loop fuel control is accomplished when the exhaust gas oxygen sensor (HEGO) mounted in the exhaust system sends a voltage signal to the controller. The controller calculates corrections for the air fuel ratio, and outputs signals to the DEPR to correct the amount of fuel supplied to the mixer. At the same time the ECM may correct throttle blade position to correct engine speed and load.

The controller also performs fuel system diagnostic functions and notifies the operator of malfunctions by turning on a Malfunction Indicator Light (MIL) mounted in the Ground Control Station and Platform Control Station. System malfunctions are identified by a Diagnostic Code number. In addition to notifying the operator of the system malfunction, the controller also stores information about the malfunction in its memory.

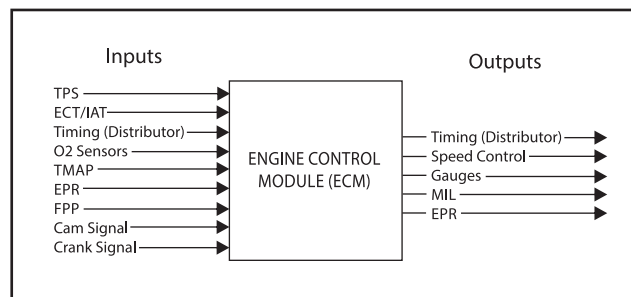


Figure 3-105. ECM Input-Output Diagram

Heated Exhaust Gas Oxygen Sensor

There are two Heated Exhaust Gas Oxygen Sensors (HEGO). The first HEGO is mounted in the exhaust system downstream of the engine. It is used to measure the amount of oxygen present in the exhaust stream and communicate that to the ECM via an electrical signal. The amount of oxygen present in the exhaust stream indicates whether the fuel/air ratio is too rich or too lean. If the HEGO sensor signal indicates exhaust stream is too rich, the ECM will decrease or lean the fuel mixture during engine operation. If mixture is too lean the ECM will richen the mixture. The ECM continuously monitors the HEGO sensor output. If a rich or lean condition is present for an extended period of time, and the ECM cannot correct the condition, the ECM sets a diagnostic code and turns on the MIL light in control box.

The second HEGO is mounted in the exhaust system after the muffler. It measures the amount of oxygen in the exhaust system after the catalyst treatment has been completed in the muffler. If the ECM detects that the catalytic action in the muffler is not sufficient and fuel correction cannot correct the malfunction the MIL light is illuminated in the control box and a DTC code will be stored in the computer.

NOTICE

THE HEATED EXHAUST GAS OXYGEN SENSOR IS AN EMISSION CONTROL DEVICE. IF THE HEGO FAILS TO OPERATE, REPLACE IT WITH AN OEM REPLACEMENT PART. THE HEGO SENSOR IS SENSITIVE TO SILICONE OR SILICONE BASED PRODUCTS AND CAN BECOME CONTAMINATED. AVOID USING SILICONE SEALERS OR HOSES TREATED WITH SILICONE LUBRICANTS IN THE AIR STREAM OR FUEL LINES.



Figure 3-106. Heated Exhaust Gas Oxygen Sensor

Gasoline Multi Point Fuel Injection System (MPFI)

The primary components of the Gasoline Multi Point Fuel Injection (MPFI) fuel system are the fuel tank, electric fuel pump, fuel pressure and temperature sensor manifold, fuel filter, and fuel rail.

Gasoline Fuel Pump

Gasoline is stored as a liquid in the fuel tank and is drawn into the fuel system by an electric fuel pump. The fuel pump receives a signal from the ECM to prime the fuel system for approximately two seconds before start. Priming the fuel system provides for a quicker start when engine begins to crank.

Gasoline Pressure And Temperature Sensor Manifold

This engine is equipped with a fuel injector rail that does not have a pressure regulator or a return circuit to the fuel tank. Fuel pressure for this engine is regulated by the engine's ECM. The ECM receives fuel pressure and temperature feedback from the gasoline fuel sensor manifold and uses this information to control the ground side of the fuel pump. Fuel pressure is regulated by the ECM pulse width modulating (PWM) the fuel pump. The fuel pressure and temperature sensor manifold has a return or "bleed" circuit that connects back to the fuel tank. This circuit is used to bleed off any vapor that develops in the line and return a small amount of fuel to the tank.

Fuel comes from the fuel tank and passes through the fuel pump. Fuel exits the fuel pump, passes through the filter and then enters the fuel pressure and temperature manifold assembly. Fuel flows through the feed circuit and is delivered to the fuel injector rail. Fuel that enters the bleed circuits through the bypass valve in the manifold is returned to the fuel tank.

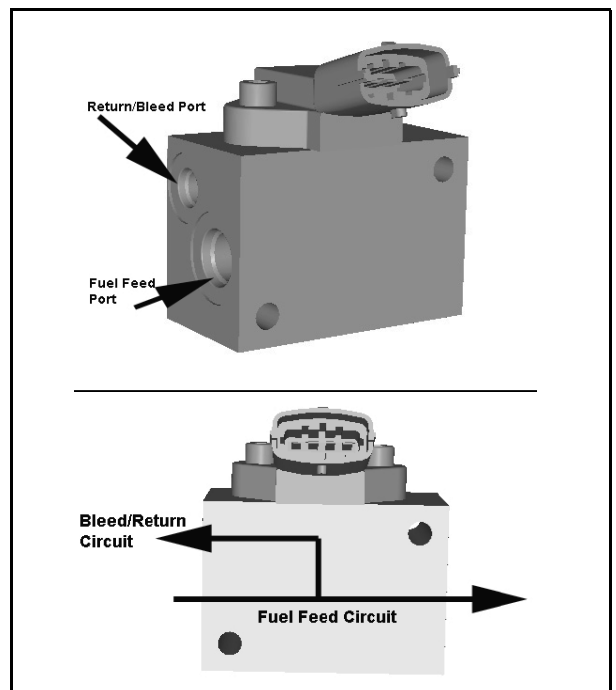


Figure 3-107. Gasoline Fuel Pressure and Temperature Manifold Assembly

Fuel Filter

After fuel is drawn into the fuel pump, the fuel flows through the gasoline fuel filter. The fuel filter traps small particles as fuel passes through the filter to remove debris and prevents fuel pressure and temperature manifold and fuel injectors from becoming damaged. Fuel filter maintenance is required as shown in Section 1.

Fuel Injector Rail

Fuel flows from the fuel pressure and temperature manifold assembly to the fuel rails where fuel is delivered to the fuel injectors. The fuel rail also contains a Schrader valve which is used to test regulated pressure of the fuel system.

Fuel Injector

The fuel supply is maintained on the top of the injector from the injector rail. The injector is fed a "pulse" signal through the wire harness which causes the injector to open. During regular operating conditions the ECM controls the opening and duration of opening of the injector. During lower RPM operation the injector signals or "pulses" are less frequent than when the engine is operating at higher RPMs. The engine has been calibrated to deliver the precise amount of fuel for optimum performance and emission control.

3.20 GM ENGINE FUEL SYSTEM REPAIR

Propane Fuel System Pressure Relief

⚠ CAUTION

THE PROPANE FUEL SYSTEM OPERATES AT PRESSURES UP TO 312 PSI (21.5 BAR). TO MINIMIZE THE RISK OF FIRE AND PERSONAL INJURY, RELIEVE THE PROPANE FUEL SYSTEM PRESSURE (WHERE APPLICABLE) BEFORE SERVICING THE PROPANE FUEL SYSTEM COMPONENTS.

To relieve propane fuel system pressure:

1. Close manual shut-off valve on propane fuel tank.
2. Start and run vehicle until engine stalls.
3. Turn ignition switch OFF.

NOTICE

RESIDUAL VAPOR PRESSURE WILL BE PRESENT IN THE FUEL SYSTEM. ENSURE WORK AREA IS WELL VENTILATED BEFORE DISCONNECTING ANY FUEL LINE.

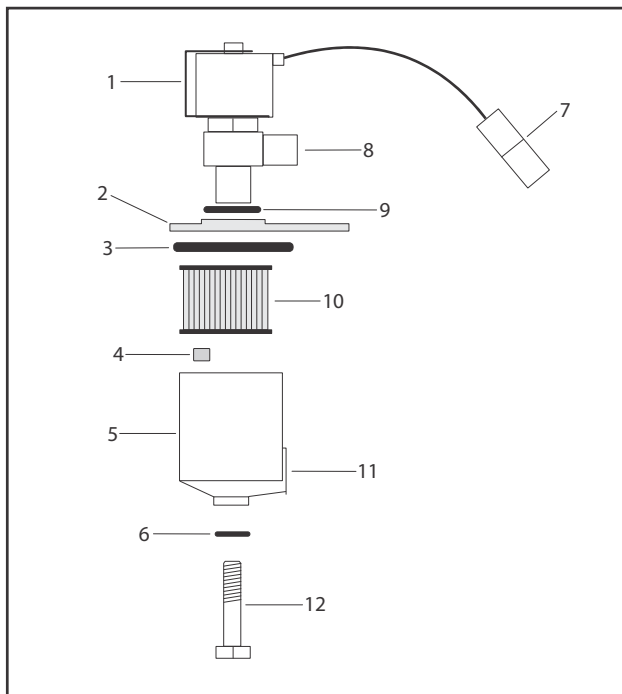
Propane Fuel System Leak Test

⚠ CAUTION

PROPANE IS HIGHLY FLAMMABLE AND CAN EASILY IGNITE AND CAUSE BURNS AND SERIOUS INJURIES. NEVER USE AN OPEN FLAME OF ANY TYPE TO CHECK FOR PROPANE FUEL SYSTEM LEAKS.

Always inspect propane fuel system for leaks after performing service. Check for leaks at fittings of the serviced or replaced component. Use a commercially available liquid leak detector or an electronic leak detector. When using both methods, use electronic leak detector first to avoid contamination by liquid leak detector.

Propane Fuel Filter Replacement



- | | |
|-------------------------------|-------------------------|
| 1. Electric Lock Off Solenoid | 7. Electrical Connector |
| 2. Mounting Plate | 8. Fuel Outlet |
| 3. Housing Seal | 9. O-ring |
| 4. Filter Magnet | 10. Filter |
| 5. Filter Housing | 11. Fuel Inlet |
| 6. Seal | 12. Retaining Bolt |

Figure 3-108. Filter Lock Assembly

REMOVAL

1. Relieve propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slowly loosen the filter housing retaining bolt and remove it.
4. Pull filter housing from electric lock off assembly.
5. Locate and remove filter magnet.
6. Remove the filter from housing.
7. Remove and discard housing seal.
8. Remove and discard retaining bolt seal.
9. Remove and discard mounting plate to lock off O-ring seal.

INSTALLATION

NOTICE

REINSTALL FILTER MAGNET IN HOUSING BEFORE INSTALLING NEW SEAL.

1. Install mounting plate to lock off O-ring seal.
2. Install retaining bolt seal.
3. Install housing seal.
4. Drop magnet in bottom of filter housing.
5. Install filter in housing.
6. Install retaining bolt in filter housing.
7. Install filter up to bottom of electric lock off.
8. Tighten filter retaining bolt to 106 in-lb (12 Nm).
9. Open manual shut-off valve. Start vehicle and leak check propane fuel system at each serviced fitting. Refer to Propane Fuel System Leak Test.

Direct Electronic Pressure Regulator (DEPR) Maintenance And Inspection

Refer to Figure 3-99. GM 3.0 Dual Fuel System Components.

NOTICE

DEPR COMPONENTS ARE SPECIFICALLY DESIGNED AND CALIBRATED TO MEET FUEL SYSTEM REQUIREMENTS OF THE EMISSION CERTIFIED ENGINE. IF THE DEPR FAILS TO OPERATE OR DEVELOPS A LEAK, IT SHOULD BE REPAIRED OR REPLACED WITH OEM RECOMMENDED REPLACEMENT PARTS.

1. Check for any fuel leaks at inlet and outlet fittings.
2. Check for any fuel leaks in DEPR body.
3. Check inlet and outlet fittings of coolant supply lines for water leaks if applicable.
4. Check DEPR is securely mounted and mounting bolts are tight.
5. Check DEPR for external damage.
6. Check DEPR electrical connections are seated and locked.

Check/Drain Oil Build-Up In 2-Stage Vaporizer

Refer to Figure 3-99. GM 3.0 Dual Fuel System Components.

During normal operation for LPG engines oil or “heavy ends” may build inside the Vaporizer secondary chamber. These oil and heavy ends may be a result of poor fuel quality, fuel contamination, or regional variation of the fuel make up. A significant build up of oil can affect performance of the secondary diaphragm response.

NOTICE

FAILURE TO FOLLOW THIS RECOMMENDATION MAY BE USED TO DENY A WARRANTY CLAIM.

Drain oil periodically to maintain emission warranty. More frequent draining of the Vaporizer Regulator is recommended where substandard fuel may be a problem. Drain Vaporizer Regulator at every engine oil change if contaminated or substandard fuel is suspected or known to be have been used with the emission compliant fuel system.

NOTE: *Draining regulator when engine is warm will help oils to flow freely from the regulator.*

1. Move equipment well ventilated area and ensure no external ignition sources are present.
2. Start engine.
3. With engine running, close manual valve.
4. When engine runs out of fuel and stops, turn key OFF.
5. Disconnect negative battery cable.

CAUTION

A SMALL AMOUNT OF FUEL MAY STILL BE PRESENT IN THE FUEL LINE. USE GLOVES TO PREVENT BURNS AND WEAR PROPER EYE PROTECTION.

NOTE: *If fuel continues to flow from connections when loosened, check manual valve is fully closed.*

6. Loosen hose clamps at inlet and outlet hoses. Remove hoses.
7. Remove regulator mounting bolts.
8. Place a small receptacle in the engine compartment.
9. Rotate regulator to 90° so outlet fitting is pointing down into receptacle. Drain regulator.
10. Inspect secondary chamber for any large dried particles and remove.
11. Remove receptacle and reinstall regulator retaining bolts. Torque to specifications.
12. Reinstall fuel hoses. Reconnect any other hoses removed during this procedure.
13. Slowly open manual service valve.

NOTICE

FUEL CYLINDER MANUAL VALVE CONTAINS AN “EXCESS FLOW CHECK VALVE”. OPEN MANUAL VALVE SLOWLY TO PREVENT ACTIVATING THE “EXCESS FLOW CHECK VALVE.”

14. Check for leaks at the inlet and outlet fittings using a soapy solution or an electronic leak detector.
15. Check coolant line connections for leaks.
16. Start engine. Recheck regulator for leaks.
17. Dispose of any drained material in safe and proper manner according to applicable regulations.

Air Fuel Mixer/Throttle Control Device Maintenance And Inspection

Refer to Figure 3-99. GM 3.0 Dual Fuel System Components.

NOTICE

AIR FUEL MIXER COMPONENTS HAVE BEEN SPECIFICALLY DESIGNED AND CALIBRATED TO MEET FUEL SYSTEM REQUIREMENTS OF THE EMISSION CERTIFIED ENGINE. THE MIXER SHOULD NOT BE DISASSEMBLED OR REBUILT. IF MIXER FAILS TO OPERATE OR DEVELOPS A LEAK, IT SHOULD BE REPLACED WITH OEM RECOMMENDED REPLACEMENT PARTS.

1. Check for leaks at the inlet fitting.
2. Inspect fuel inlet hose for cracking, splitting, or chaffing. Replace if any of these condition exist.
3. Ensure mixer is securely mounted and not leaking vacuum at the mounting gasket or surface.
4. Inspect air inlet hose connection and clamp. Inspect inlet hose for cracking, splitting, or chafing. Replace if any of these conditions exist.
5. Inspect air cleaner element.
6. Check fuel lines for cracking, splitting, or chafing. Replace if any of these conditions exist.
7. Check for leaks at the throttle body and intake manifold.

Exhaust System And Catalytic Converter Inspection And Maintenance

NOTICE

EXHAUST SYSTEM ON THIS EMISSION CERTIFIED ENGINE CONTAINS A HEATED EXHAUST GAS OXYGEN SENSOR (HEGO) WHICH PROVIDES FEEDBACK TO THE ECM ON AMOUNT OF OXYGEN PRESENT IN THE EXHAUST STREAM AFTER COMBUSTION. OXYGEN IN THE EXHAUST STREAM IS MEASURED IN VOLTAGE AND SENT TO THE ECM. THE ECM THEN MAKES CORRECTIONS TO THE FUEL AIR RATIO TO ENSURE PROPER FUEL CHARGE AND OPTIMUM CATALYTIC PERFORMANCE. EXHAUST CONNECTIONS MUST REMAIN SECURE AND AIR TIGHT.

NOTICE

THE HEGO SENSOR IS SENSITIVE TO SILICONE BASED PRODUCTS. DO NOT USE SILICONE SPRAYS OR HOSES WHICH ARE ASSEMBLED USING SILICONE LUBRICANTS. SILICONE CONTAMINATION CAN CAUSE SEVERE DAMAGE TO THE HEGO.

1. Check exhaust manifold at cylinder head for leaks and all retaining bolts and shields (if used) are in place.
2. Check manifold to exhaust pipe fasteners are tight and there are no exhaust leaks. Repair if necessary.
3. Inspect HEGO electrical connector is seated and locked. Check wires for cracking, splits, chafing or "burn through." Repair if necessary.
4. Check exhaust pipe extension connector for leaks. Tighten if necessary.
5. Check catalyst muffler is securely mounted. Check for leaks at inlet and outlet.

Temperature Manifold Absolute Pressure (TMAP) Sensor

Refer to Figure 3-99. GM 3.0 Dual Fuel System Components.

REMOVAL

1. Disconnect TMAP (402) electrical connector.
2. Remove retaining bolt (403), washer (404), and TMAP (402).

INSTALLATION

NOTE: Apply a small amount of O-ring lubricant before installation.

1. Install TMAP (402). Secure with washer (404) and bolt (403).
2. Torque retaining bolt to 62 in-lb (7 Nm).
3. Start vehicle and check for proper operation.

Throttle Body (ETC) Replacement

Refer to Figure 3-99. GM 3.0 Dual Fuel System Components.

REMOVAL

1. Disconnect negative battery cable.
2. Remove Mixer (See "Mixer Replacement" on page 113).
3. Disconnect TMAP electrical connector.
4. Disconnect electronic throttle control connector.
5. Remove bolts (208), adapter (204), and throttle body (201) from manifold.
6. Remove spacer (205).
7. Remove and discard gasket (202) and O-ring (203).

INSTALLATION

NOTE: Lightly lubricate O-ring.

1. Install O-ring (203) and spacer (205) on throttle body (201).
2. Align new gasket (202) and throttle body on manifold.
3. Slide adapter (204) on throttle body and secure with four bolts (208).
4. Reinstall Mixer (See "Mixer Replacement" on page 113).

Mixer Replacement

Refer to Figure 3-99. GM 3.0 Dual Fuel System Components.

REMOVAL

1. Remove EPR. (See Electronic Pressure Regulator Replacement on next page).
2. Remove Air Intake hose from Mixer.
3. Remove four bolts (206) and washers (207) securing mixer (104) to adapter (204). Remove Mixer.

INSTALLATION

NOTICE

COVER THROTTLE BODY ADAPTER OPENING TO PREVENT DEBRIS FROM ENTERING ENGINE.

1. Install Mixer (104) to Adapter (204). Secure with four washers (207) and bolts (206). Torque to 80 in-lb (9 Nm)
2. Install EPR (See Electronic Pressure Regulator Replacement on next page).
3. Reinstall Air Intake Hose.
4. Start engine and leak check all fittings and connections.

Electronic Pressure Regulator (EPR) Replacement

REMOVAL

Refer to Figure 3-99. GM 3.0 Dual Fuel System Components.

1. Unplug EPR (102) electrical connector.
2. Remove hoses from EPR.
3. Remove four flange nuts (107) and EPR from Mixer (104).
4. If new EPR is being installed, remove and retain hose adapter (103) and four bolts (105).

INSTALLATION

1. If new EPR is being installed, install adapter (103) and four bolts (105) to EPR.
2. Install EPR (102) on Mixer (104). Secure with four flange nuts (107).
3. Reattach all hoses.
4. Start engine and leak check all fittings and connections.

Regulator Replacement

Refer to Figure 3-99. GM 3.0 Dual Fuel System Components.

REMOVAL

1. Disconnect and remove Lock-Off Valve (12) from Regulator (16).
2. Remove hoses from regulator.
3. Remove regulator from engine.

INSTALLATION

1. Install Regulator (16) on engine.
2. Install hoses on regulator.
3. Install Lock-Off Valve (12) to Regulator. Reconnect Lock-Off Valve.
4. Start engine and leak check all fittings and connections.

Coolant Hose Replacement

REMOVAL

1. Drain coolant.
2. Using hose clamp pliers, disconnect both hose clamps on each hose.
3. Remove hose from fittings.

INSTALLATION

NOTE: Use hose material and lengths specified by JLG.

1. Install hose clamps to each hose and set clamp back on each hose to make installation easier.
2. Fit hose to fittings.
3. Secure by positioning each of the clamps.

Vapor Hose Replacement

REMOVAL

1. Disconnect both hose clamps using hose clamp pliers.
2. Remove vapor hose from each fitting.

INSTALLATION

NOTICE

VAPOR SUPPLY HOSE IS SPECIFICALLY DESIGNED FOR THIS EQUIPMENT. DO NOT USE HOSE MATERIAL OR LENGTH OTHER THAN JLG SPECIFIED PARTS.

1. Install hose clamps and set back on each hose.
2. Reinstall vapor hose to each fitting.
3. Reset clamps.
4. Start engine and check for leaks.

Engine Control Module Replacement

REMOVAL

1. Disconnect Negative battery cable.
2. Remove controller from mounting bracket.
3. Push connector lock back to unlock connector.
4. Unplug and remove controller.

INSTALLATION

NOTICE

CONTROLLER IS CALIBRATED FOR EACH ENGINE. VERIFY YOU HAVE CORRECT CONTROLLER.

1. Plug connector into controller.
2. Push lock into place.
3. Mount controller into mounting bracket.
4. Reconnect the battery cable.
5. Start engine.
6. Check and clear any DTC codes.
7. Verify engine is in closed loop and no warning lights are illuminated.

Heated Exhaust Gas Oxygen Sensor Replacement

REMOVAL

1. Disconnect negative (-) battery cable.
2. Disconnect O2 sensor electrical connector.
3. Using an O2 Sensor socket, remove and discard Sensor.

INSTALLATION

NOTICE

LUBRICATE O2 SENSOR THREADS WITH ANTI-SEIZE COMPOUND GM P/N 5613695 OR EQUIVALENT BEFORE INSTALLATION. DO NOT GET COMPOUND ON SENSOR TIP.

1. Install O2 sensor. Tighten to 30 lb-ft (41 Nm).
2. Start engine.
3. Check and clear any DTC codes.
4. Verify engine is in closed loop and no warning lights are illuminated.

3.21 GM ENGINE LPG FUEL SYSTEM DIAGNOSIS

Fuel System Description

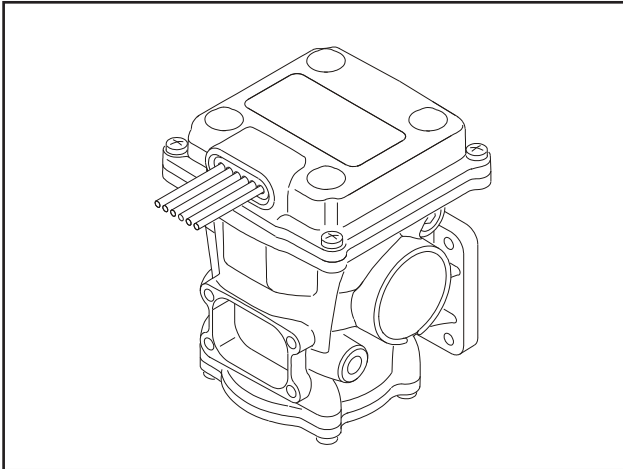


Figure 3-109. DEPR

The Engine Control Module (ECM) receives information from various engine sensors to control the Direct Electronic Pressure Regulator (DEPR) and lock-off Valve.

The lock-off Valve solenoid prevents fuel flow unless the engine is cranking or running.

At Key ON, the DEPR valve receives a two (2) second prime pulse from the ECM, allowing time for the fuel to flow through the fuel filter and fuel lines to the DEPR.

Fuel travels from the lock-off to the light duty 2- stage regulator into the DEPR.

Engine cranking generates vacuum which provided lift for the mixer air valve and is commonly referred to as air valve vacuum. Once in the mixer, fuel is combined with air and drawn into the engine for combustion.

Diagnostic Aids

This procedure is intended to diagnose a vehicle operating on LPG. If vehicle will not continue to run on LPG, refer to Hard Start for preliminary checks.

NOTE: Before proceeding with this procedure, verify vehicle has a sufficient quantity of fuel and that liquid fuel is being delivered to the LPR. Ensure the LPG tank manual shut off valve is fully opened and excess flow valve has not been activated.

Tools Required:

- 7/16 Open end wrench (for test port plugs)
- DVOM (GM J 39200, Fluke 88 or equivalent).
- 12 volt test light

Diagnostic Scan Tool

- Diagnostic Display tool.

Pressure Gauges

- IMPCO ITK-2 Test kit
- Water Column Gauge / Manometer (GM 7333-6 or equivalent).
- 0-10 PSI Gauge

Test Description

Numbers below refer to step numbers on the diagnostic table.

5. This step determines if the LPR requires replacement
6. This step determines if the problems are in the mechanical side of the Pressure Regulator or the Electronic Voice Coil
10. This step determines if the Mixer requires replacement
14. This step determines if the Lock Off requires replacement
17. This step determines if the Fuel Filter requires replacement.

Table 3-12. LP Fuel System Diagnosis

STEP	ACTION	VALUE(S)	YES	NO
1	Were you referred to this procedure by a DTC diagnostic chart?	--	Go to Step 3	Go to Step 2
2	Perform the On Board Diagnostic (OBD) System Check. Are any DTCs present in the ECM?	--	Go to the applicable DTC Table	Go to Step 3
3	Verify that the LPG fuel tank has a minimum of 1/4 tank of fuel, that the manual valve is open and the tank quick connect is fully engaged Does the vehicle have fuel?	--	Go to Step 4	--
4	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Start the engine and allow it to reach operating temperature. Does the engine start and run?	--	Go to Step 5	Go to Step 8
5	With the engine idling, observe the pressure reading for the LPR secondary pressure. Does the fuel pressure fluctuate rhythmically OUTSIDE the specified range?	-1.0" to -2.0" w.c	Go to Step 25	Go to Step 6
6	1. Disconnect the EPR electrical connectors. NOTE: This action will cause a DTC to be set by the ECM 2. With the engine idling observe the pressure reading on the secondary test port. Is the fuel pressure WITHIN the specified range?	-1.0" to -2.0" w.c	Go to Fuel Control System Diagnosis	Go to Step 7
7	1. Inspect the air intake stream between the mixer assembly and the throttle body for leaks. 2. Inspect the fuel hose connection between the LPR and mixer assembly for damage or leakage. 3. Inspect any vacuum hoses for leaks Was a problem found and corrected?	--	Go to Step 26	Go to Step 22
8	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR secondary pressure. Does the fuel pressure indicate a vacuum is present?	--	Go to Step 12	Go to Step 9
9	1. Remove Air induction hose to the mixer 2. Observe the air valve for movement while the engine is cranking. Note: Movement of the air valve will be minimal at cranking speeds. Does the air valve move when the engine is cranked?	--	Go to Step 11	Go to Step 10
10	1. Inspect the air intake stream to the mixer assembly and the throttle body for vacuum leaks. 2. Inspect the vacuum hoses from the mixer for proper connection and condition. Was a problem found and repaired?	--	Go to Step 26	Go to Step 24
11	Inspect the fuel hose connection between the LPR and the mixer assembly for damage or leakage. Was a problem found and repaired?	--	Go to Step 26	Go to Step 12
12	1. Connect a 0-10 psi gauge to the primary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR primary pressure. Is the fuel pressure ABOVE the specified value?	1-3 PSI	Go to Step 22	Go to Step 13
13	1. Turn OFF the ignition. 2. Disconnect the LPL connector. 3. Install a test light between the pins of the LPL connector. 4. Crank the engine. The test light should illuminate. Does the test light illuminate?	--	Go to Step 14	Go to Step 16
14	Using a DVOM, check the resistance of the low pressure lock-off (LPL). Is the resistance within the specified range?	12W - 16W	Go to Step 15	Go to Step 23

SECTION 3 - CHASSIS & TURNTABLE

Table 3-12. LP Fuel System Diagnosis

STEP	ACTION	VALUE(S)	YES	NO
15	1. Turn the ignition OFF. 2. Close the manual shut-off valve on the LPG tank. CAUTION: When disconnecting LPG fuel lines, liquid LPG may be present. Perform this step in a well ventilated area. 3. Loosen the fuel inlet hose fitting at the inlet of the LPL. Was fuel present when the fitting was loosened?	--	Go to Step 23	Go to Step 17
16	1. Turn OFF the ignition. 2. Connect the test light to chassis ground and probe pin A of the LPL connector. 3. Crank the engine. The test light should illuminate. Does the test light illuminate?	--	Go to Step 20	Go to Step 21
17	1. Remove the LPG fuel filter / LPL. 2. Remove the filter from the LPL. 3. Empty the contents of the inlet side of the LPG fuel filter onto a clean surface. 4. Inspect the contents of the LPG fuel filter for an excessive amount of foreign material or water. If necessary, locate and repair the source of contamination. 5. Verify the LPG fuel filter is not restricted or plugged. Was a problem found?	--	Go to Step 19	Go to Step 18
18	The fuel supply system or hoses are plugged or restricted, locate and repair the problem. Is the action complete?	--	Go to Step 26	--
19	Replace the fuel filter. Refer to Fuel Filter Replacement. Is the action complete?	--	Go to Step 26	--
20	Repair the open in the lock-off ground circuit. Is the action complete?	--	Go to Step 26	--
21	Repair the open in the lock-off power circuit. Is the action complete?	--	Go to Step 26	--
22	Replace the low pressure regulator (LPR). Refer to Low Pressure Regulator Replacement. Is the action complete?	--	Go to Step 26	--
23	Replace the lock-off. Refer to Lock-off Replacement. Is the action complete?	--	Go to Step 26	--
24	Replace the mixer assembly. Refer to Fuel Mixer Replacement. Is the action complete?	--	Go to Step 26	--
25	The fuel supply system is operating normally, if a failure of the control solenoids is suspected. Refer to Fuel Control System Diagnosis. 1. Install the test plug in the LPR secondary chamber. 2. If you were sent to this routine by another diagnostic chart, return to the previous diagnostic procedure. Is the action complete?	--	System OK	--
26	1. Disconnect all test equipment 2. Install the primary and secondary test port plugs. 3. Start the engine. 4. Using SNOOP or equivalent, leak check the test port plugs. Is the action complete?	--	System OK	--

Table 3-13. Symptom Diagnosis

Checks	Action
Important Preliminary Checks	
Before Using This Section	<p>Before using this section, you should have performed On Board Diagnostic Check and determined that:</p> <ol style="list-style-type: none"> 1. The Control Module and MIL (Malfunction Indicator Lamp) are operating correctly. 2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL. <p>Several of the following symptom procedures call for a careful visual and physical check. The visual and physical checks are very important. The checks can lead to correcting a problem without further checks that may save valuable time.</p>
LPG Fuel System Check	<ol style="list-style-type: none"> 1. Verify the customer complaint. 2. Locate the correct symptom table. 3. Check the items indicated under that symptom. 4. Operate the vehicle under the conditions the symptom occurs. Verify HEGO switching between lean and rich. <p>IMPORTANT! Normal HEGO switching indicates the LPG fuel system is in closed loop and operating correctly at that time.</p>
Visual and Physical Checks	<ol style="list-style-type: none"> ² Check all ECM system fuses and circuit breakers. ² Check the ECM ground for being clean, tight and in its proper location. ² Check the vacuum hoses for splits, kinks and proper connections. ² Check thoroughly for any type of leak or restriction. ² Check for air leaks at all the mounting areas of the intake manifold sealing surfaces. ² Check for proper installation of the mixer module assembly. ² Check for air leaks at the mixer assembly. ² Check the ignition wires for the following conditions: <ul style="list-style-type: none"> - Cracking - Hardness - Proper routing - Carbon tracking ² Check the wiring for the following items: <ul style="list-style-type: none"> - Proper connections, pinches or cuts. ² The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first.
Intermittent	
DEFINITION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	<ol style="list-style-type: none"> ² Refer to Important Preliminary Checks. ² Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.
Faulty Electrical Connections or Wiring	<ol style="list-style-type: none"> ² Faulty electrical connections or wiring can cause most intermittent problems. ² Check the suspected circuit for the following conditions: <ul style="list-style-type: none"> - Faulty fuse or circuit breaker - Connectors poorly mated - Terminals not fully seated in the connector (backed out) - Terminals not properly formed or damaged - Terminal to wires poorly connected - Terminal tension insufficient. ² Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension. ² Checking for poor terminal to wire connections requires removing the terminal from the connector body.
Operational Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates the problem may be in that circuit.

SECTION 3 - CHASSIS & TURNTABLE

Table 3-13. Symptom Diagnosis

Checks	Action
Intermittent Malfunction Indicator Lamp (MIL)	<p>The following components can cause intermittent MIL and no DTC(s):</p> <ul style="list-style-type: none"> ² A defective relay, Control Module driven solenoid, or a switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating. ² The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc. ² The ignition secondary voltage shorted to a ground. ² The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground. ² The Control Module grounds.
Loss of DTC Memory	<p>To check for the loss of the DTC Memory:</p> <ol style="list-style-type: none"> 1. Disconnect the TMAP sensor. 2. Idle the engine until the Malfunction Indicator Lamp illuminates. <p>The ECM should store a TMAP DTC. The TMAP DTC should remain in the memory when the ignition is turned OFF. If the TMAP DTC does not store and remain, the ECM is faulty</p>
Additional Checks	
No Start	
DEFINITION: The engine cranks OK ²² but does not start.	
Preliminary Checks	Refer to Important Preliminary Checks.
Control Module Checks	<p>If a scan tool is available:</p> <ul style="list-style-type: none"> ² Check for proper communication with both the ECM ² Check the fuse in the ECM battery power circuit. Refer to Engine Controls Schematics. ² Check battery power, ignition power and ground circuits to the ECM. Refer to Engine Control Schematics. Verify voltage and/or continuity for each circuit.
Sensor Checks	<ul style="list-style-type: none"> ² Check the TMAP sensor. ² Check the Magnetic pickup sensor (RPM).
Fuel System Checks	<p>Important: A closed LPG manual fuel shut off valve will create a no start condition.</p> <ul style="list-style-type: none"> ² Check for air intake system leakage between the mixer and the throttle body. ² Verify proper operation of the low pressure lock-off solenoids. ² Check the fuel system pressures. Refer to the LPG Fuel System Diagnosis. ² Check for proper mixer air valve operation.
Ignition System Checks	<p>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions.</p> <ul style="list-style-type: none"> ² Check for the proper ignition voltage output with J 26792 or the equivalent. ² Verify that the spark plugs are correct for use with LPG (R42LTS) ² Check the spark plugs for the following conditions: <ul style="list-style-type: none"> - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits ² Check for bare or shorted ignition wires. ² Check for loose ignition coil connections at the coil.
Engine Mechanical Checks	<p>Important: The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system.</p> <ul style="list-style-type: none"> ² Check for the following: <ul style="list-style-type: none"> - Vacuum leaks - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes.

Table 3-13. Symptom Diagnosis

Checks	Action
Exhaust System Checks	² Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> - Inspect the exhaust system for damaged or collapsed pipes - Inspect the muffler for signs of heat distress or for possible internal failure. ² Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis
Hard Start	
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	² Refer to Important Preliminary Checks. ² Make sure the vehicle's operator is using the correct starting procedure.
Sensor Checks	² Check the Engine Coolant Temperature sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. IF the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Refer to DTC 111 ² Check the Crankshaft Position (CKP) sensor. ² Check the Throttle position (TPS) sensor.
Fuel System Checks	<p>Important: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition.</p> ² Verify the excess flow valve in the LPG manual shut-off valve is not tripped. ² Check mixer module assembly for proper installation and leakage. ² Verify proper operation of the low pressure lock-off solenoids. ² Verify proper operation of the EPR ² Check for air intake system leakage between the mixer and the throttle body. ² Check the fuel system pressures. Refer to the Fuel System Diagnosis.
Ignition System Checks	<p>Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions.</p> ² Check for the proper ignition voltage output with J26792 or the equivalent. ² Verify that the spark plugs are correct for use with LPG (R42LTS) ² Check the spark plugs for the following conditions: <ul style="list-style-type: none"> - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits ² Check for bare or shorted ignition wires. ² Check for moisture in the distributor cap if applicable. ² Check for loose ignition coil connections. <p>Important:</p> <ol style="list-style-type: none"> 1. If the engine starts but then immediately stalls, Check the Crankshaft Position (CKP). 2. Check for improper gap, debris or faulty connections.
Engine Mechanical Checks	<p>Important: The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system.</p> ² Check for the following: <ul style="list-style-type: none"> - Vacuum leaks <ul style="list-style-type: none"> - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes. ² Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	² Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> - Inspect the exhaust system for damaged or collapsed pipes - Inspect the muffler for signs of heat distress or for possible internal failure. ² Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis or Exhaust System in the GM Base Engine Service Manual

SECTION 3 - CHASSIS & TURNTABLE

Table 3-13. Symptom Diagnosis

Checks	Action
Additional Checks	
Cuts Out, Misses	
DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	² Refer to Important Preliminary Checks.
Ignition System Checks	² Start the engine. ² Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. ² Check for proper ignition output voltage with spark tester J 26792. ² Check for a cylinder misfire. ² Verify that the spark plugs are correct for use with LPG (R42LTS) ² Remove the spark plugs in these cylinders and check for the following conditions: ² Insulation cracks ² Wear ² Improper gap ² Burned electrodes ² Heavy deposits ² Visually/Physically inspect the secondary ignition for the following: ² Ignition wires for arcing, cross-firing and proper routing ² Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	² Perform a cylinder compression check. ² Check the engine for the following: <ul style="list-style-type: none"> - Improper valve timing - Bent pushrods - Worn rocker arms - Worn camshaft lobes. - Broken or weak valve springs. ² Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	² Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. ² Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). ² EMI on the reference circuit can cause a missing condition. ² Monitoring the engine RPM with a scan tool can detect an EMI. ² A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. ² If the problem exists, check the routing of the secondary wires and the ground circuit.
Hesitation, Sag, Stumble	
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	Refer to Important Preliminary Checks.
Fuel System Checks	² Check the fuel pressure. Refer to LPG Fuel System Diagnosis. ² Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system. ² Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. ² Check LPL electrical connection ² Check the mixer air valve for sticking or binding. ² Check the mixer module assembly for proper installation and leakage. ² Check the EPR electrical connections.

Table 3-13. Symptom Diagnosis

Checks	Action
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only ignition system failure and test the system accordingly. ² Check for the proper ignition voltage output with J26792 or the equivalent. ² Verify that the spark plugs are correct for use with LPG (R42LTS) ² Check for faulty spark plug wires ² Check for fouled spark plugs.
Additional Check	² Check for manifold vacuum or air induction system leaks ² Check the generator output voltage.
Backfire	
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	² Refer to Important Preliminary Checks.
Ignition System Checks	Important! LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. The ignition system must be maintained in peak condition to prevent backfire. ² Check for the proper ignition coil output voltage using the spark tester J26792 or the equivalent. ² Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires. ² Check the connection at each ignition coil. ² Check for deteriorated spark plug wire insulation. ² Check the spark plugs. The correct spark plugs for LPG are (R42LTS) ² Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits
Engine Mechanical Check	Important! The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than a gasoline fuel supply system. ² Check the engine for the following: - Improper valve timing - Engine compression - Manifold vacuum leaks - Intake manifold gaskets - Sticking or leaking valves - Exhaust system leakage ² Check the intake and exhaust system for casting flash or other restrictions.
Fuel System Checks	² Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.
Lack of Power, Sluggishness, or Sponginess	
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	² Refer to Important Preliminary Checks. ² Refer to the LPG Fuel system OBD System Check ² Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. Do not compare the power output of the vehicle operating on LPG to a vehicle operating on gasoline as the fuels do have different drive feel characteristics ² Remove the air filter and check for dirt or restriction. ² Check the vehicle transmission Refer to the OEM transmission diagnostics.

SECTION 3 - CHASSIS & TURNTABLE

Table 3-13. Symptom Diagnosis

Checks	Action
Fuel System Checks	² Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to LPG Fuel System Diagnosis. ² Check for the proper ignition output voltage with the spark tester J 26792 or the equivalent. ² Check for proper installation of the mixer module assembly. ² Check all air inlet ducts for condition and proper installation. ² Check for fuel leaks between the LPR and the mixer. ² Verify that the LPG tank manual shut-off valve is fully open. ² Verify that liquid fuel (not vapor) is being delivered to the LPR.
Sensor Checks	² Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. Check for proper operation of the MAP sensor. ² Check for proper operation of the TPS sensor.
Exhaust System Checks	² Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes - Inspect the muffler for signs of heat distress or for possible internal failure. - Check for possible plugged catalytic converter.
Engine Mechanical Check	Check the engine for the following: ² Engine compression ² Valve timing ² Improper or worn camshaft. Refer to Engine Mechanical in the Service Manual.
Additional Check	² Check the ECM grounds for being clean, tight, and in their proper locations. ² Check the generator output voltage. ² If all procedures have been completed and no malfunction has been found, review and inspect the following items: ² Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. ² Check the scan tool data.
Poor Fuel Economy	
DEFINITION: Fuel economy, as measured by refueling records, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by an by refueling records.	
Preliminary Checks	² Refer to Important Preliminary Checks. ² Check the air cleaner element (filter) for dirt or being plugged. ² Visually (Physically) check the vacuum hoses for splits, kinks, and proper connections. ² Check the operators driving habits for the following items: - Is there excessive idling or stop and go driving? - Are the tires at the correct air pressure? - Are excessively heavy loads being carried? - Is their often rapid acceleration? ² Suggest to the owner to fill the fuel tank and to recheck the fuel economy. ² Suggest that a different operator use the equipment and record the results.
Fuel System Checks	² Check the LPR fuel pressure. Refer to LPG Fuel System Diagnosis. ² Check the fuel system for leakage.
Sensor Checks	² Check the Temperature Manifold Absolute Pressure (TMAP) sensor.
Ignition System Checks	² Verify that the spark plugs are correct for use with LPG (R42LTS) ² Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits ² Check the ignition wires for the following items: - Cracking - Hardness - Proper connections
Cooling System Checks	² Check the engine thermostat for always being open or for the wrong heat range

Table 3-13. Symptom Diagnosis

Checks	Action
Additional Check	² Check the transmission shift pattern. Refer to the OEM Transmission Controls section the Service Manual. ² Check for dragging brakes.
Rough, Unstable, or Incorrect Idle, Stalling	
DEFINITION: The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Check	Refer to Important Preliminary Checks.
Sensor Checks	² Check for silicon contamination from fuel or improperly used sealant. The sensor will have a white powdery coating. The sensor will result in a high but false signal voltage (rich exhaust indication). The ECM will reduce the amount of fuel delivered to the engine causing a severe drive-ability problem. ² Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance: ² Check the Temperature Manifold Absolute Pressure (TMAP) sensor response and accuracy.
Fuel System Checks	² Check for rich or lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. ² Check for a sticking mixer air valve. ² Verify proper operation of the EPR. ² Perform a cylinder compression test. Refer to Engine Mechanical in the Service Manual. ² Check the LPR fuel pressure. Refer to the LPG Fuel System Diagnosis. ² Check mixer module assembly for proper installation and connection.
Ignition System Checks	² Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. ² Verify that the spark plugs are correct for use with LPG (R42LTS) ² Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Blistered insulators - Heavy deposits ² Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires.
Additional Checks	Important: The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. ² Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. ² Check the ECM grounds for being clean, tight, and in their proper locations. ² Check the battery cables and ground straps. They should be clean and secure. Erratic voltage may cause all sensor readings to be skewed resulting in poor idle quality.
Engine Mechanical Check	² Check the engine for the following: - Broken motor mounts - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes
Surges/Chuggles	
DEFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle feels as if it speeds up and slows down with no change in the accelerator pedal.	
Preliminary Checks	Refer to Important Preliminary Checks.
Sensor Checks	² Check Heated Exhaust Gas Oxygen Sensor (HEGO) performance.

SECTION 3 - CHASSIS & TURNTABLE

Table 3-13. Symptom Diagnosis

Checks	Action
Fuel System Checks	² Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. ² Check the fuel pressure while the condition exists. Refer to LPG Fuel System Diagnosis. ² Verify proper fuel control solenoid operation. ² Verify that the LPG manual shut-off valve is fully open. ² Check the in-line fuel filter for restrictions.
Ignition System Checks	² Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. ² Verify that the spark plugs are correct for use with LPG (R42LTS) ² Check the spark plugs. Remove the plugs and inspect them for the following conditions: <ul style="list-style-type: none"> - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits - Check the Crankshaft Position (CKP) sensor.
Additional Check	² Check the ECM grounds for being clean, tight, and in their proper locations. ² Check the generator output voltage. ² Check the vacuum hoses for kinks or leaks. ² Check Transmission

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Table 3-14. DTC to SPN/FMI Cross Reference Chart

DTC	Description	SPN Code	FMI Code
16	Crank Never Synced at Start	636	8
91	Fuel Pump Low Voltage	94	4
92	Fuel Pump High Voltage	94	3
107	MAP Low Voltage	106	4
108	MAP High Pressure	106	16
111	IAT Higher Than Expected 1	105	15
112	IAT Low Voltage	105	4
113	IAT High Voltage	105	3
116	ECT Higher Than Expected 1	110	15
117	ECT Low Voltage	110	4
118	ECT High Voltage	110	3
121	TPS 1 Lower Than TPS 2	51	1
122	TPS 1 Signal Voltage Low	51	4
123	TPS 1 Signal Voltage High	51	3
127	IAT Higher Than Expected 2	105	0
129	BP Low Pressure	108	1
134	EGO 1 Open/Inactive	724	10
154	EGO 2 Open/Inactive	520208	10
171	Adaptive Learn High Gasoline	520200	0
172	Adaptive Learn Low Gasoline	520200	1
182	Fuel Temp Gasoline Low Voltage	174	4
183	Fuel Temp Gasoline High Voltage	174	3
187	Fuel Temp LPG Low Voltage	520240	4
188	Fuel Temp LPG High Voltage	520240	3
217	ECT Higher Than Expected 2	110	0
219	Max Govern Speed Override	515	15
221	TPS 2 Signal Voltage Low	51	0
222	TPS 2 Signal Low Voltage	520251	4
223	TPS 2 Signal High Voltage	520251	3
261	Injector Driver 1 Open	651	5
262	Injector Driver 1 Shorted	651	6
264	Injector Driver 2 Open	652	5
265	Injector Driver 2 Shorted	652	6
267	Injector Driver 3 Open	653	5
268	Injector Driver 3 Shorted	653	6
270	Injector Driver 4 Open	654	5
271	Injector Driver 4 Shorted	654	6
336	Crank Sync Noise	636	2
337	Crank Loss	636	4
341	Cam Sync Noise	723	2
342	Cam Sensor Loss	723	4
420	Gasoline Cat Monitor	520211	10
524	Oil Pressure Low	100	1

SECTION 3 - CHASSIS & TURNTABLE

Table 3-14. DTC to SPN/FMI Cross Reference Chart

DTC	Description	SPN Code	FMI Code
562	System Voltage Low	168	17
563	System Voltage High	168	15
601	Flash Checksum Invalid	628	13
604	RAM Failure	630	12
606	COP Failure	629	31
642	External 5V Reference Low	1079	4
643	External 5V Reference High	1079	3
685	Power Relay Open	1485	5
686	Power Relay Shorted	1485	4
687	Power Relay Short to Power	1485	3
1111	Fuel Rev Limit	515	16
1112	Spark Rev Limit	515	0
1151	Closed Loop Multiplier High LPG	520206	0
1152	Closed Loop Multiplier Low LPG	520206	1
1155	Closed Loop Multiplier High Gasoline	520204	0
1156	Closed Loop Multiplier Low Gasoline	520204	1
1161	Adaptive Learn High LPG	520202	0
1162	Adaptive Learn Low LPG	520202	1
1165	LPG Cat Monitor	520213	10
1171	LPG Pressure Higher Than Expected	520260	0
1172	LPG Pressure Lower Than Expected	520260	1
1173	EPR Comm Lost	520260	31
1174	EPR Voltage Supply High	520260	3
1175	EPR Voltage Supply Low	520260	4
1176	EPR Internal Actuator Fault	520260	12
1177	EPR Internal Circuitry Fault	520260	12
1178	EPR Internal Comm Fault	520260	12
1612	RTI 1 Loss	629	31
1613	RTI 2 Loss	629	31
1614	RTI 3 Loss	629	31
1615	A/D Loss	629	31
1616	Invalid Interrupt	629	31
1625	Shutdown Request	1384	31
1626	CAN Tx Failure	639	12
1627	CAN Rx Failure	639	12
1628	CAN Address Conflict Failure	639	13
1629	Loss of TSC 1	639	31
2111	Unable to Reach Lower TPS	51	7
2112	Unable to Reach Higher TPS	51	
2135	TPS 1/2 Simultaneous Voltages	51	31
2229	BP Pressure High	108	0

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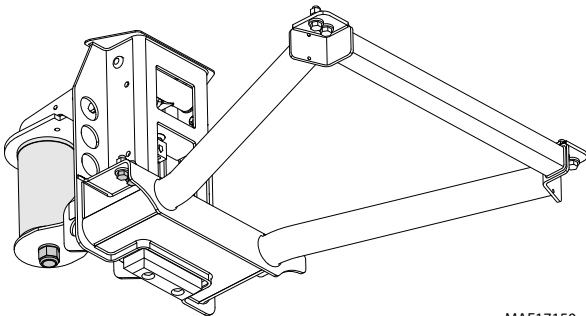
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SECTION 4. BOOM & PLATFORM

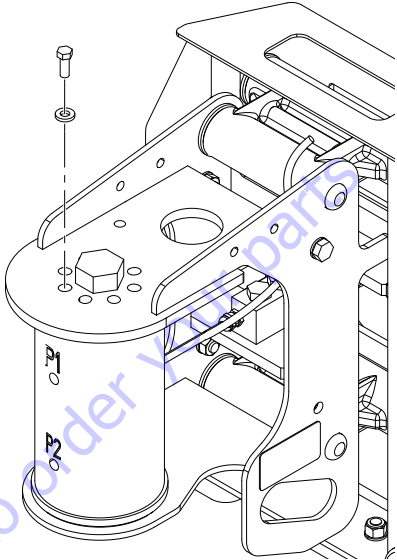
4.1 PLATFORM

Support Removal

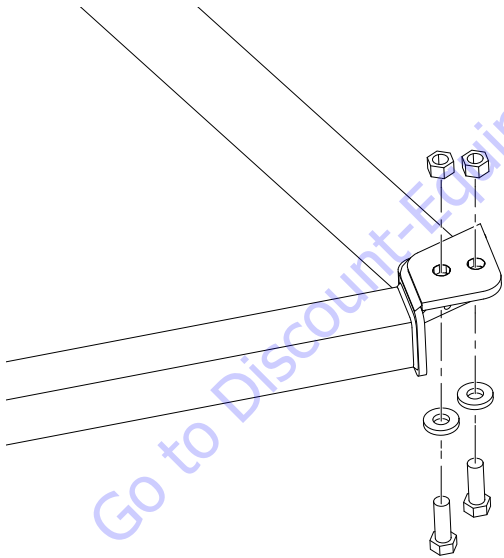


- 1. Disconnect electrical cables from control console.
- 2. Tag and disconnect the hydraulic lines from the rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
- 3. Remove the bolts securing the platform to the platform support, then remove the platform.

- 5. Remove the bolts and washers securing the support to the rotator.

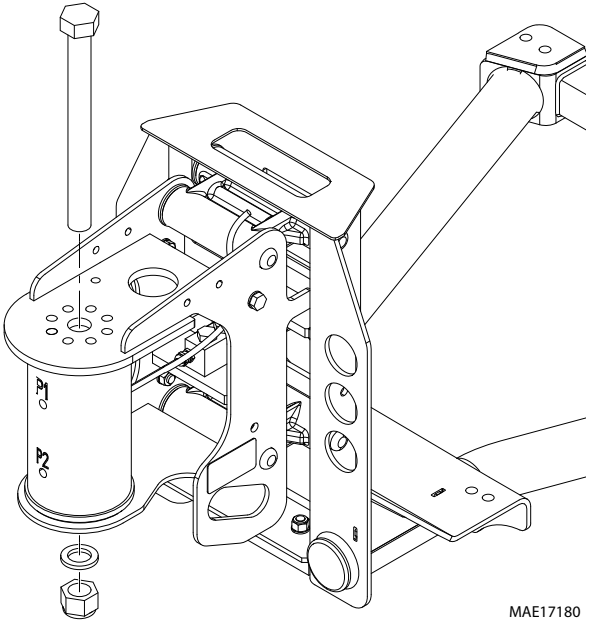


- 6. Using a suitable brass drift and hammer, remove the rotator shaft, then remove the support from the rotator.



- 4. Using a suitable lifting device, support the platform support.

NOTE: The platform support weighs approximately 125 lbs. (56.7 kg).



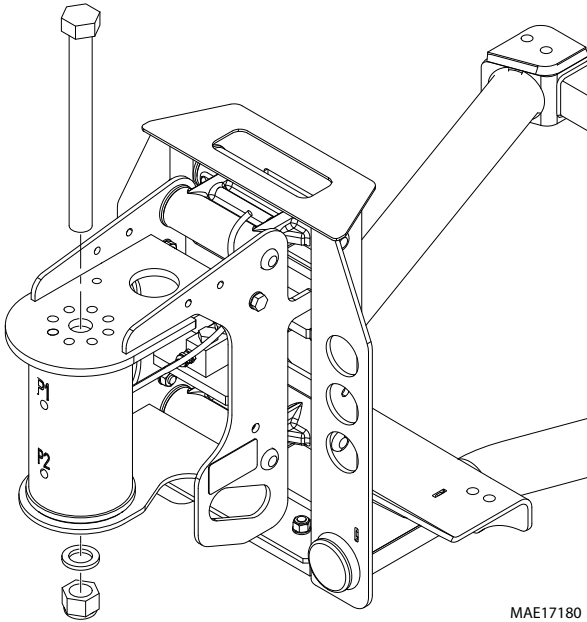
SECTION 4 - BOOM & PLATFORM

Support Installation

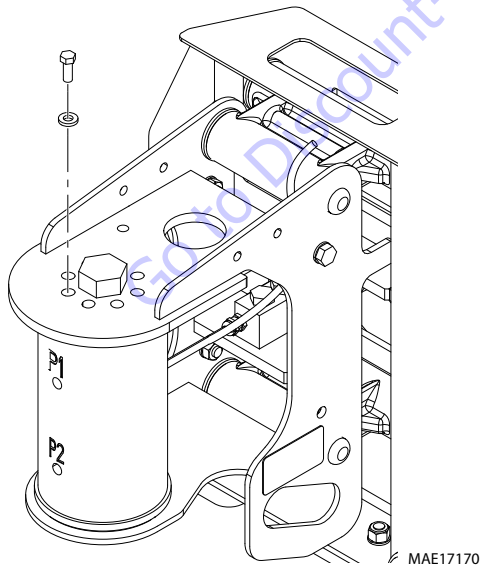
1. Using a suitable lifting device, support the platform support and position it on the rotator.

NOTE: The platform support weighs approximately 125 lbs. (56.7 kg).

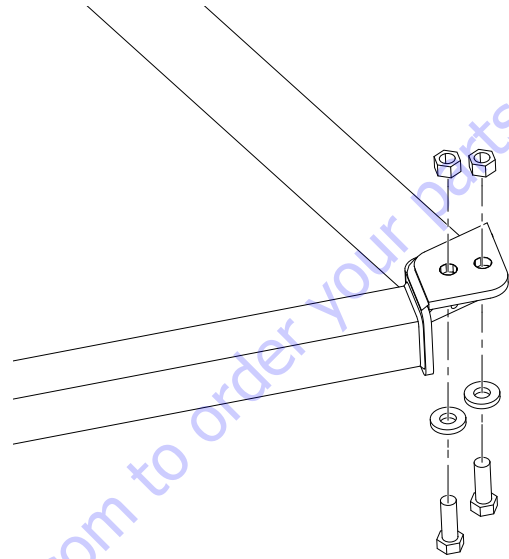
NOTE: Install the rotator center bolt.



2. Apply Loctite 242 to the bolts and washers securing the support to the rotator and install the bolts and washers.



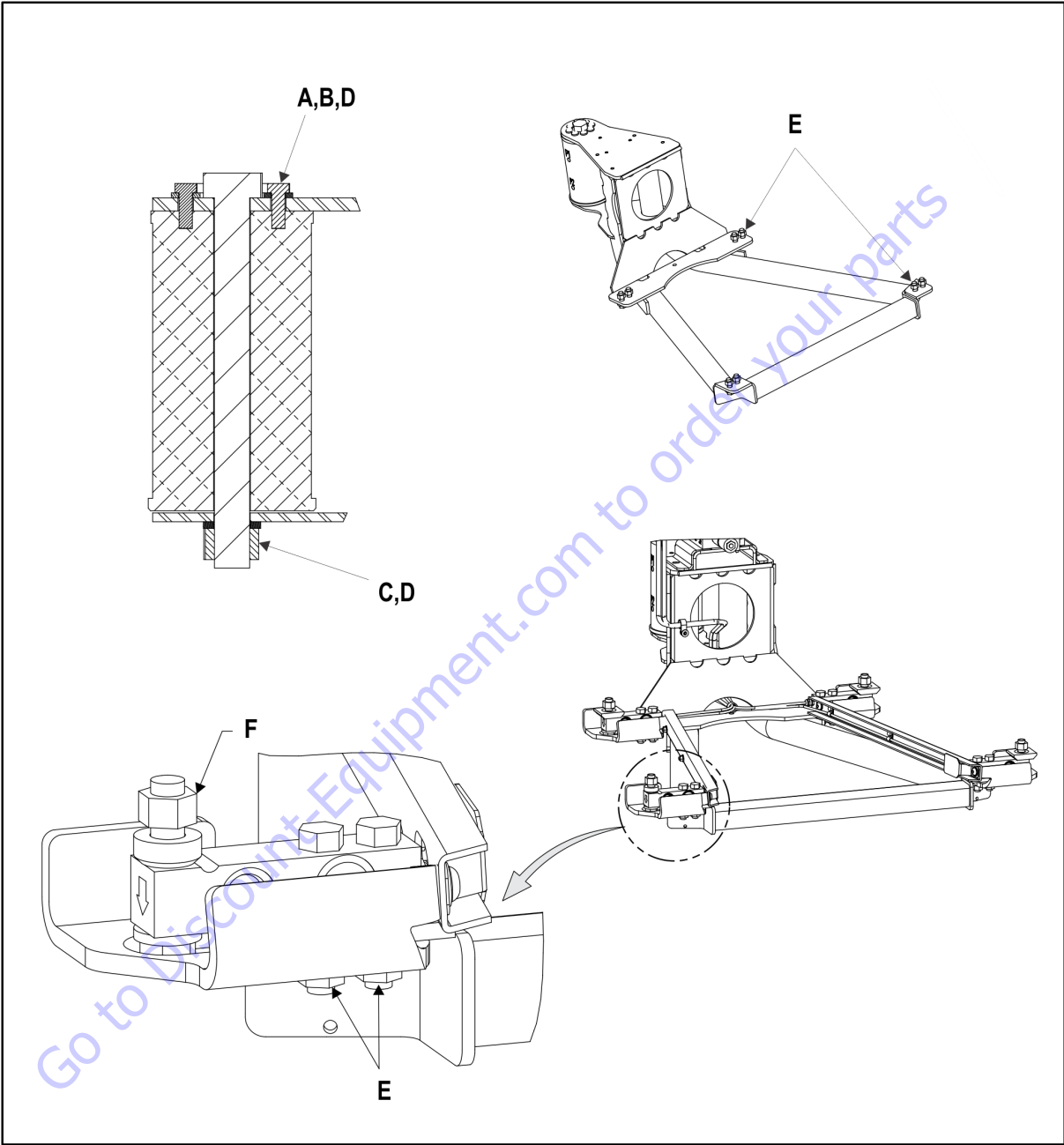
3. Torque the nut on the rotator center bolt to 586 ft. lbs. (795 Nm). Torque the retaining bolts to 40 ft. lbs. (55 Nm).
4. Position the platform on the platform support and install the bolts securing the platform to the platform support.



5. Remove tag and reconnect the hydraulic lines to the rotator.
6. Connect the electrical cables to the platform control console.

Platform Support Torque Settings

NOTE: If any rotator bolts are replaced, replace all bolts on the rotator and torque them.



- A Torque to 55 Nm (40 ft-lb)
- B JLG Threadlocker - PN 0100011
- C Torque to 795 Nm (586 ft-lb)
- D Check torque every 150 hours of operation
- E Torque to 115 Nm (85 ft-lb)
- F Torque to 68 Nm (50 ft-lb)

Figure 4-1. Platform Support Torque Values

4.2 ROTATOR AND SLAVE CYLINDER

Removal

600S

1. Tag and disconnect hydraulic lines from the rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Supporting the rotator, remove hardware from pin (1). Using a suitable brass drift and hammer remove pin (1) from the fly boom.
3. Remove the hardware from pin (2). Using a suitable brass drift and hammer, remove pin (2) from the fly boom and remove the rotator.
4. Supporting the slave cylinder, remove the hardware from pin (3). Using a suitable brass drift and hammer remove pin (3) from the fly boom and remove slave cylinder.

660SJ

1. Tag and disconnect hydraulic lines to rotator and slave cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Supporting the rotator, remove hardware from pin (1). Using a suitable brass drift and hammer remove pin (1) from the jib assembly.
3. Remove the hardware from pin (2). Using a suitable brass drift and hammer, remove pin (2) from the jib assembly and remove the rotator.
4. Telescope the fly section out approximately 20 in. (50.8 cm) to gain access to the slave leveling cylinder.
5. Supporting the slave cylinder, remove the hardware from pin (3). Using a suitable brass drift and hammer remove pin (3) from the jib assembly.
6. Remove the hardware from pin (4). Using a suitable brass drift and hammer remove pin (4) from the fly boom.

Installation

600S

1. Support the slave cylinder. Using a suitable brass drift and hammer, install pin (3) to the fly boom. Install hardware securing pin (3) and torque to 40 ft. lbs. (55 Nm).
2. Support the rotator. Using a suitable brass drift and hammer, install pin (2) to the fly boom. Install hardware securing pin (2) and torque to 40 ft. lbs. (55 Nm).
3. Using a suitable brass drift and hammer, install pin (1) to the rotator. Install hardware securing pin (1) and torque to 40 ft. lbs. (55 Nm).
4. Remove tag and reconnect the hydraulic lines to the rotator and the slave cylinder.

660SJ

1. Telescope the fly section out approximately 20 in. (50.8 cm) to gain access to the slave leveling cylinder.
2. Support the slave cylinder. Using a suitable brass drift and hammer, install pin (4) to the jib assembly. Install hardware securing pin (4) and torque to 40 ft. lbs. (55 Nm).
3. Using brass drift and hammer install pin (3) to jib assembly and install the slave cylinder. Install hardware securing pin (3) and torque to 40 ft. lbs. (55 Nm).
4. Support the rotator. using a suitable brass drift and hammer, install pin (2) to the jib assembly. Install hardware securing pin (2) and torque to 40 ft. lbs. (55 Nm).
5. Using brass drift and hammer install pin (1) to jib assembly and install the rotator. Install hardware securing pin (1) and torque to 40 ft. lbs. (55 Nm).
6. Remove tag and reconnect the hydraulic lines to the rotator and the slave cylinder.

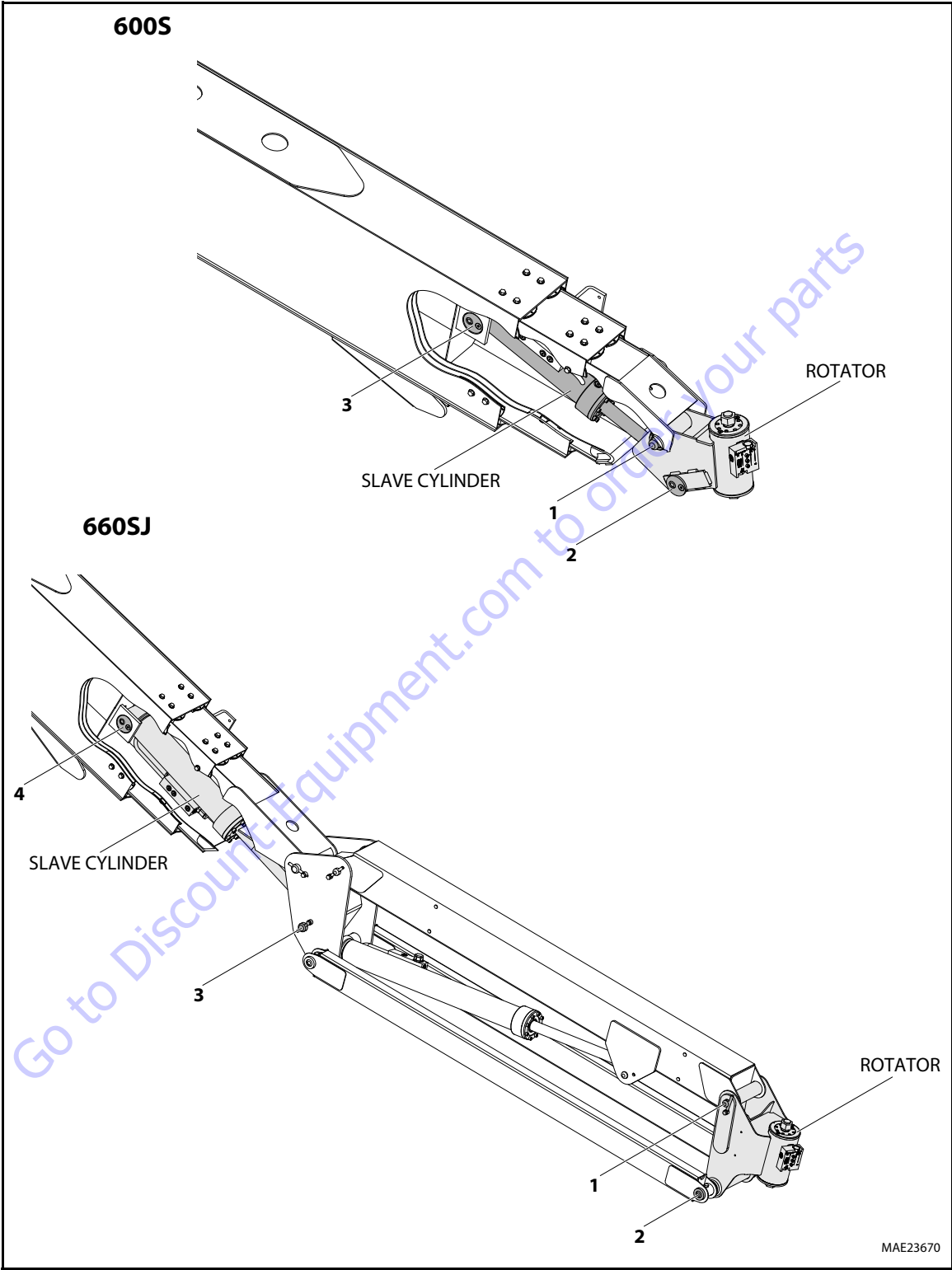


Figure 4-2. Rotator and Slave Cylinder

SECTION 4 - BOOM & PLATFORM

4.3 MAIN BOOM ASSEMBLY

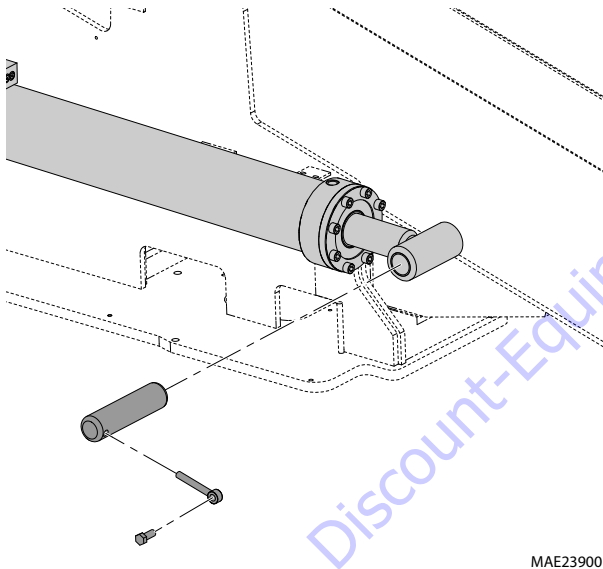
Removal

1. Using suitable lifting equipment, adequately support boom assembly weight along entire length.

NOTICE

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

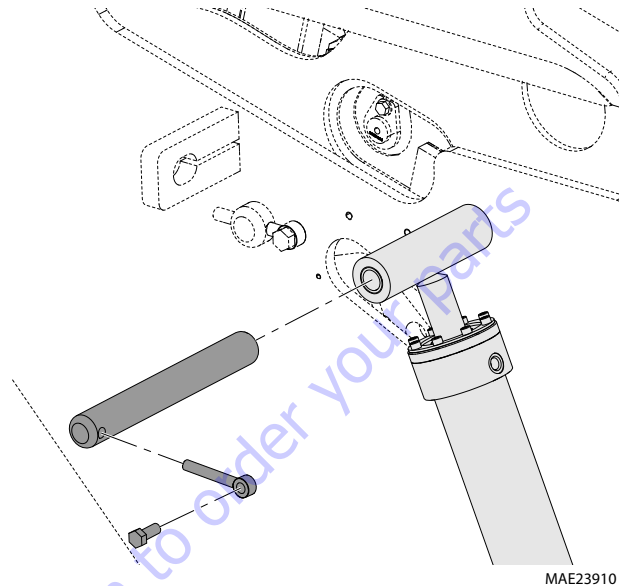
2. Tag and disconnect hydraulic lines from telescope cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Use adequate support for the main boom lift cylinder.
4. Using a suitable brass drift and hammer, remove hardware securing the main boom lift cylinder rod end pin to the base boom section. Remove the main boom lift cylinder pin from base boom. Retract the main boom lift cylinder by using the auxiliary power switch.



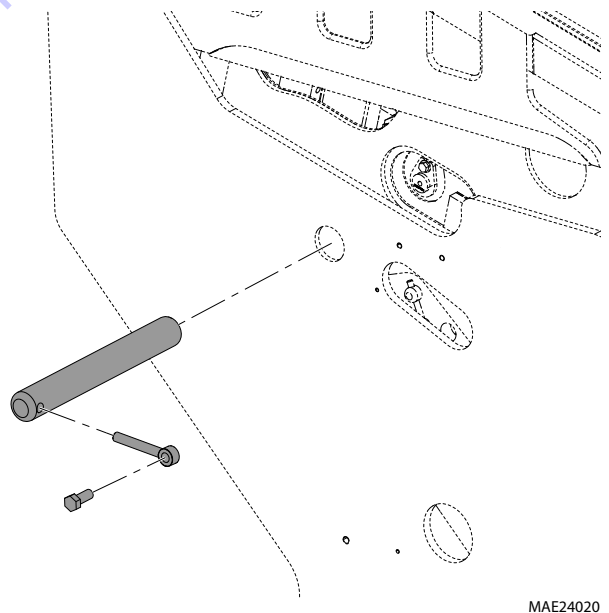
5. Using an adequate supporting device, support the master cylinder so it doesn't fall when the retaining pins are removed.

NOTE: The master cylinder weighs approximately 39.7 lbs. (18 kg).

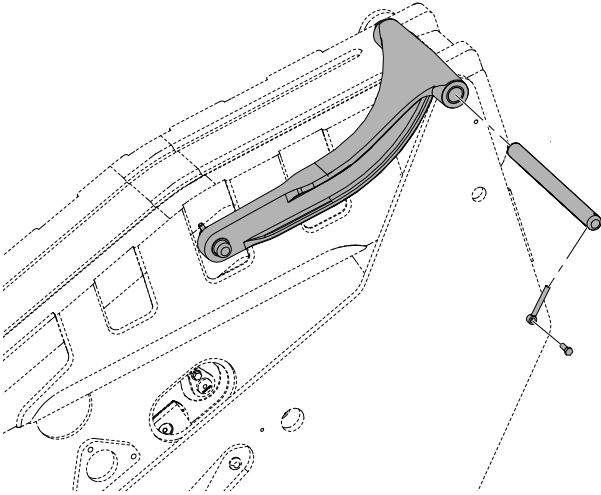
6. Using a suitable brass drift and hammer, remove hardware securing the master cylinder rod end pin to the base boom section. Remove the master cylinder pin from base boom.



7. Using a suitable brass drift and hammer, remove hardware securing the main boom section to the turntable.



- 8. Using a suitable brass drift and hammer, remove hardware securing the push bar and cover pin to the turntable.



MAE24010

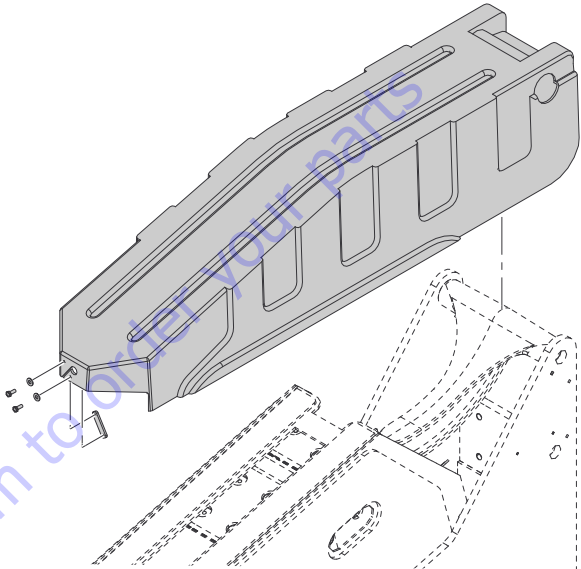
- 9. Using all applicable safety precautions, carefully lift boom assembly clear of turntable and lower to ground or suitably supported work surface.

NOTE: The main boom alone weighs approximately 2687 lbs. (1220 kg)

Boom Disassembly

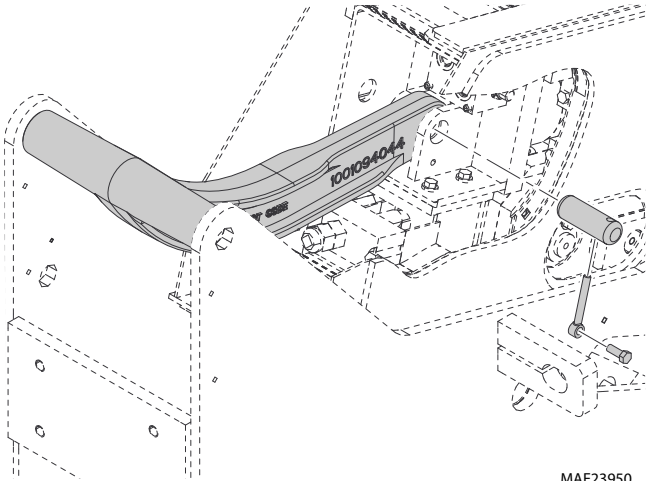
NOTE: The following procedure assumes the boom is removed from the machine.

- 1. Remove hardware securing the cover from the top of main boom..



MAE23940

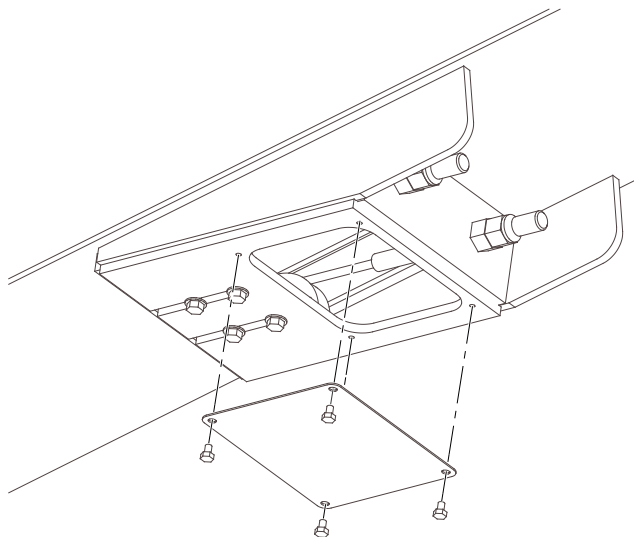
- 2. Remove hardware securing the push bar to aft end of the telescope cylinder, then remove pin from cylinder.



MAE23950

SECTION 4 - BOOM & PLATFORM

3. Remove hardware securing the cover plate on the bottom front of the base boom section.



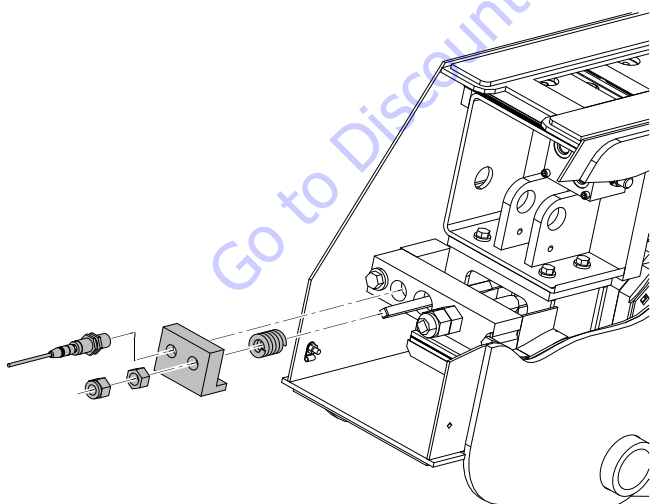
MAE23930

NOTE: Do not allow wire rope to rotate. This may damage the wire rope.

4. Clamp both threaded ends of wire rope to prevent rotation.

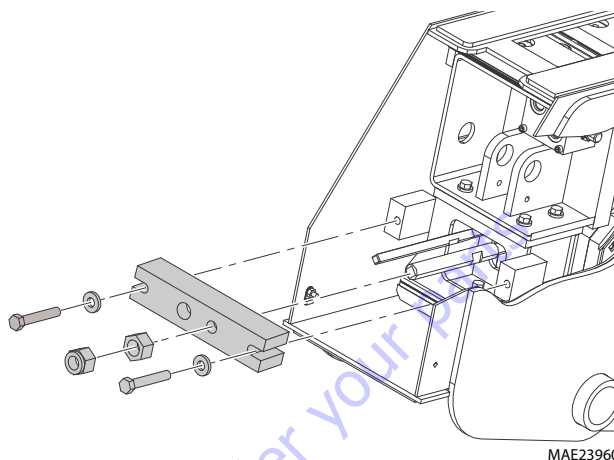
NOTE: Do not clamp on threads. Remove jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.

5. Remove the spring mounting plate, spring, and proximity switch from the aft end of the base section.



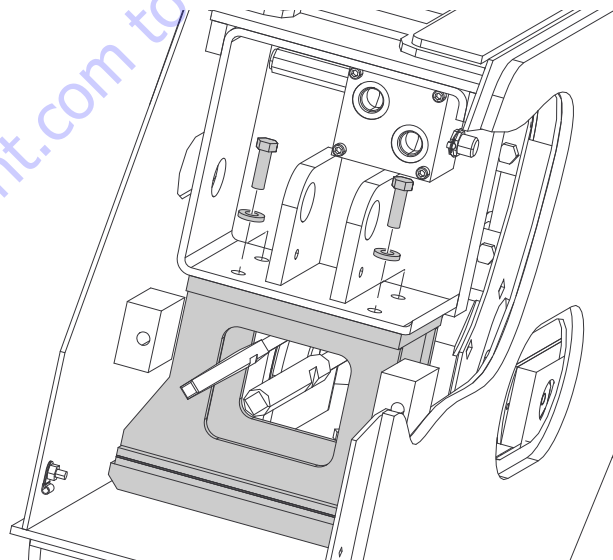
MAE24370

6. Remove hardware securing the wire rope adjustment block to aft end of the base boom section and remove the block.



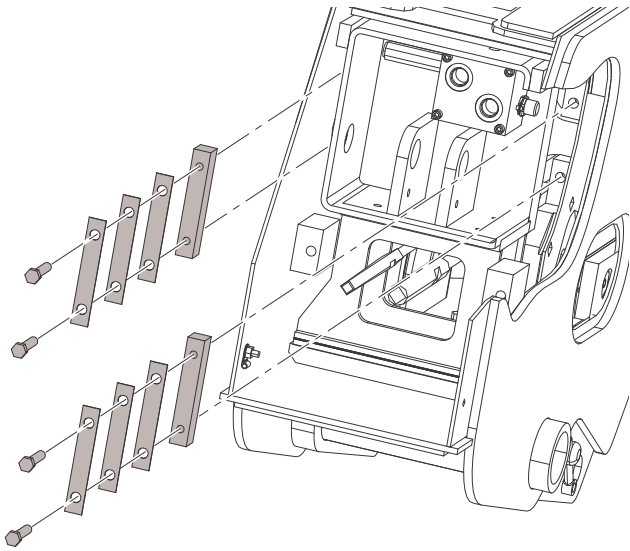
MAE23960

7. Remove hardware securing the telescope cylinder and support wear pad.



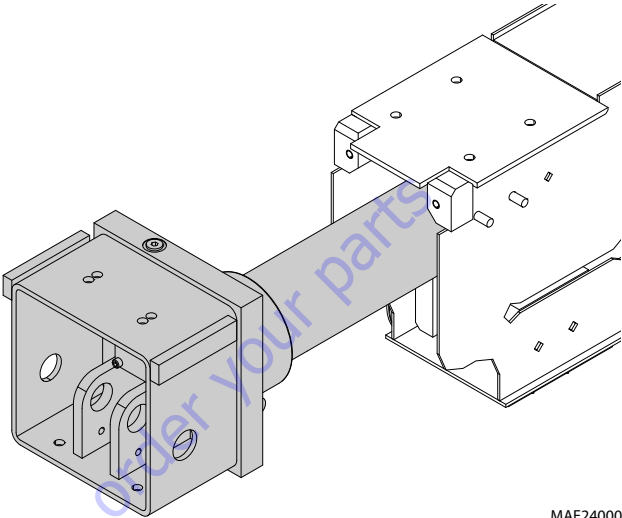
MAE23970

- 8. Remove the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the aft end of mid boom section.



MAE23980

- 10. Pull the telescope cylinder and wire ropes partially from aft end of the base boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.



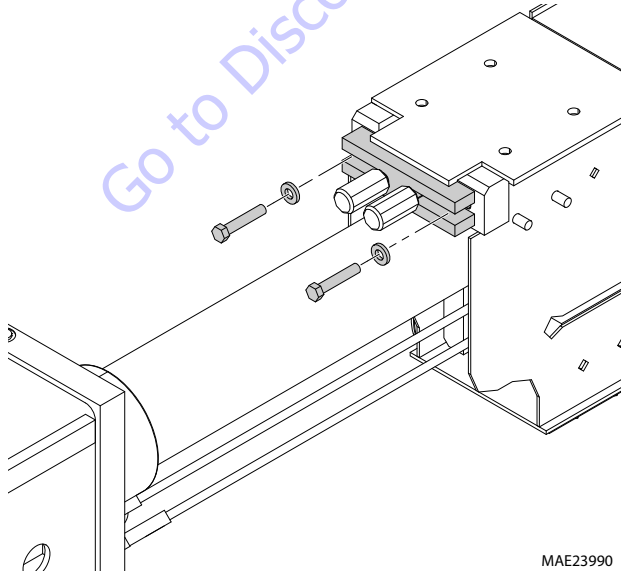
MAE24000

NOTICE

WHEN REMOVING THE TELESCOPE CYLINDER FROM THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY FROM THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

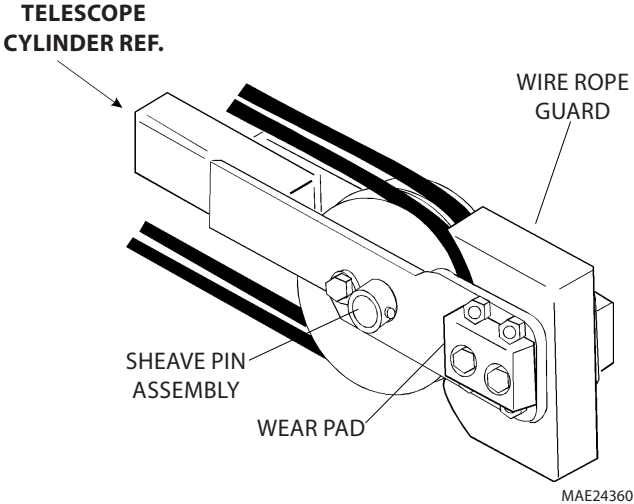
NOTE: The telescope cylinder weighs approximately 421.6 lbs. (191.2 kg).

- 9. Remove bolts securing wire rope attach bar to top of fly boom section.



MAE23990

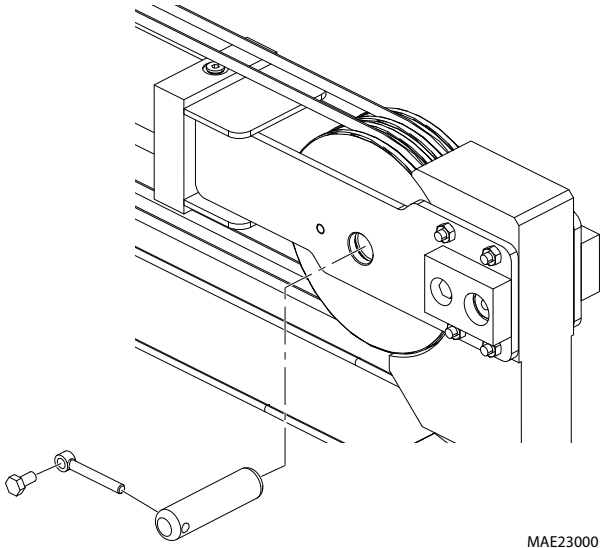
- 11. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.



MAE24360

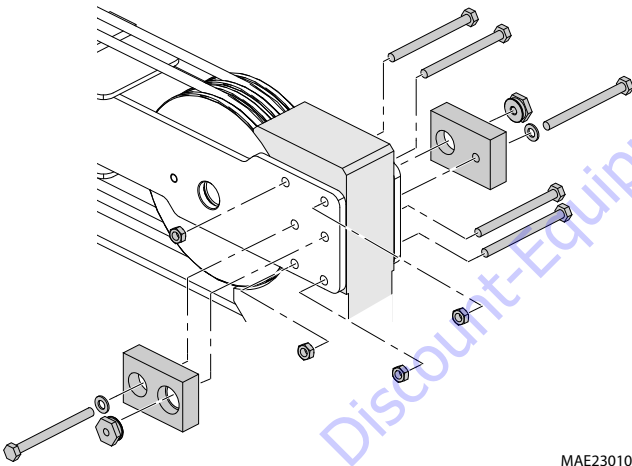
SECTION 4 - BOOM & PLATFORM

12. Remove the pin that secures sheave assembly to telescope cylinder.



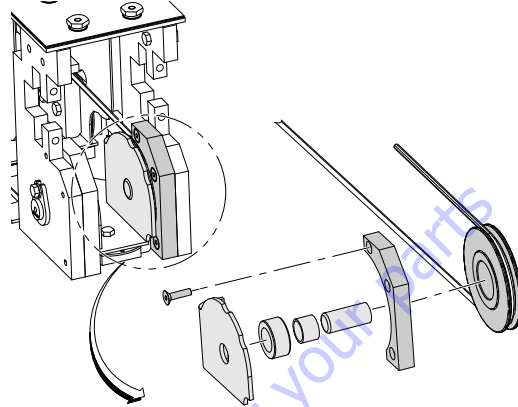
MAE23000

13. Remove spacer and hardware that secure sheave guard to the telescope cylinder.



MAE23010

14. Remove hardware which secures the wear pads to the front of base boom section; remove wear pads from the top, sides and bottom of the base boom section.



MAE23030

15. Using an overhead crane or suitable lifting device, remove mid and fly boom sections from base section.

NOTE: When removing mid and fly boom sections from base boom section, retract wire rope must be dragged along with boom sections.

16. Remove hardware which secures the wear pads to the aft end of mid boom section; remove the wear pads from the top, sides and bottom of the mid boom section.

17. Remove hardware which secures the sheave guards and sheave assemblies to mid boom section, remove sheave assemblies from mid boom section.

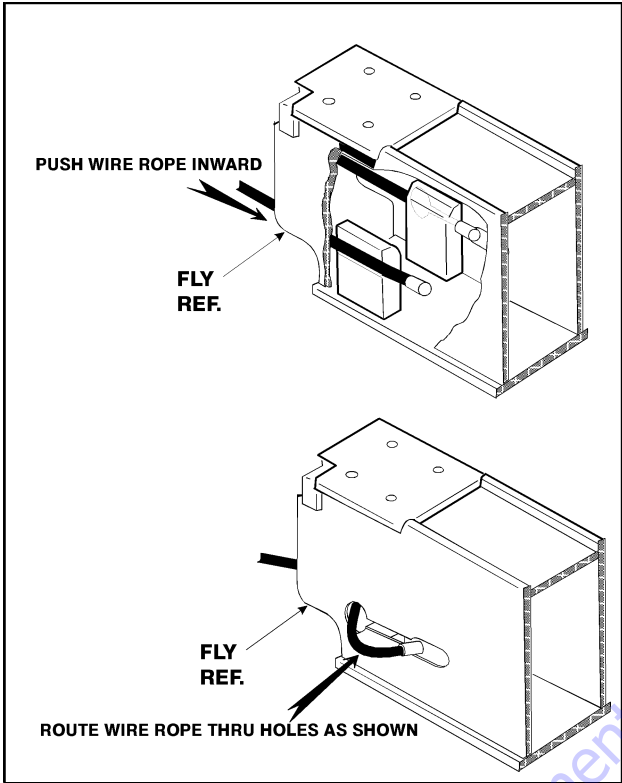
18. Remove hardware which secures the wear pads to the front of mid boom section; remove wear pads from the top, sides and bottom of the mid boom section.

19. Using an overhead crane or suitable lifting device, remove fly boom section from mid section.

NOTE: When removing fly boom section from mid boom section, retract wire rope must be dragged along with fly boom section.

20. Remove hardware which secures the wear pads to the aft end of fly boom section; remove wear pads from the top, sides and bottom of the fly boom section.

- 21. When removing wire rope from fly boom section, push the cable into fly boom. Route wire rope back through holes in the side of the fly boom section.



SECTION 4 - BOOM & PLATFORM

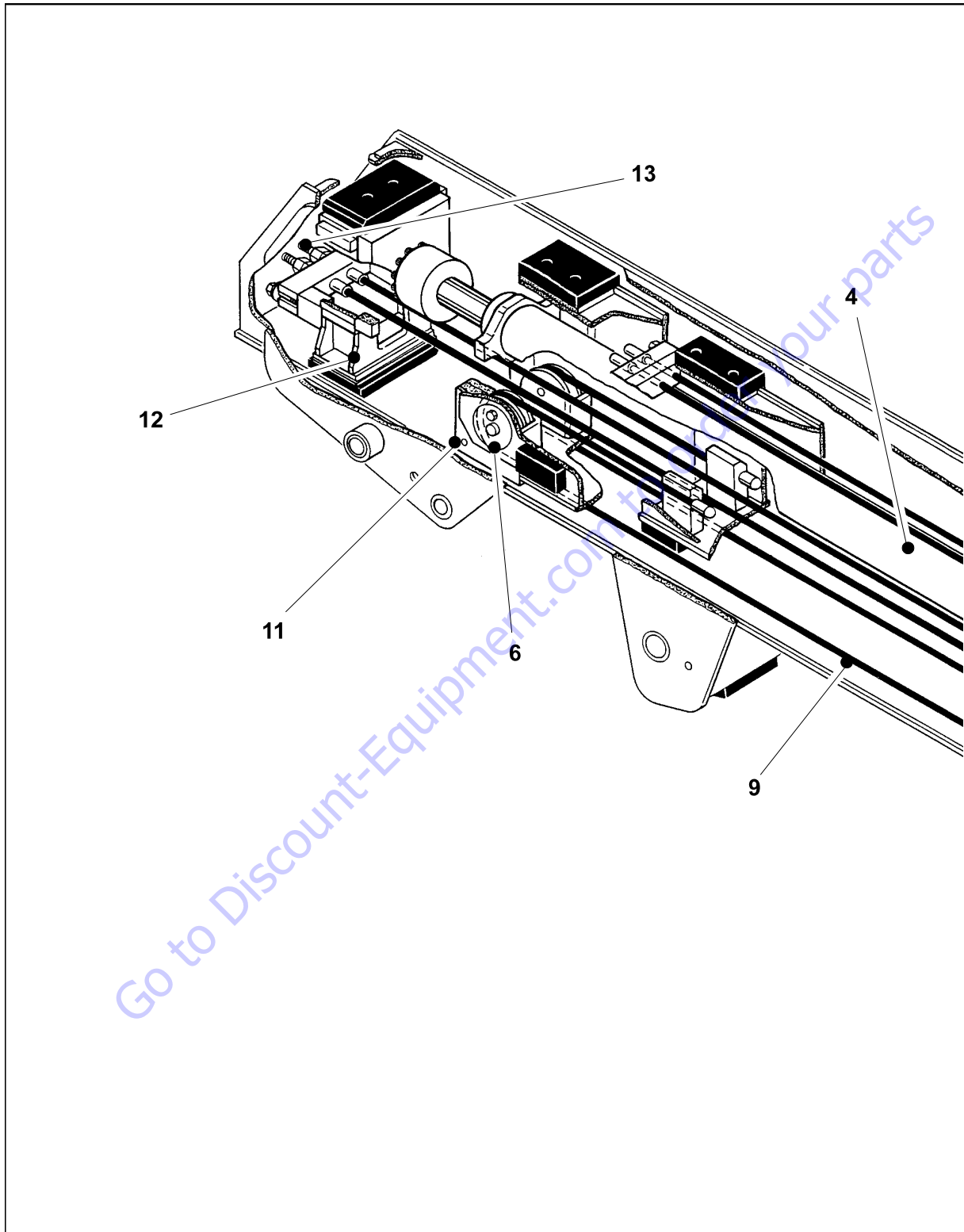


Figure 4-3. Boom Assembly Cutaway - Sheet 1 of 3

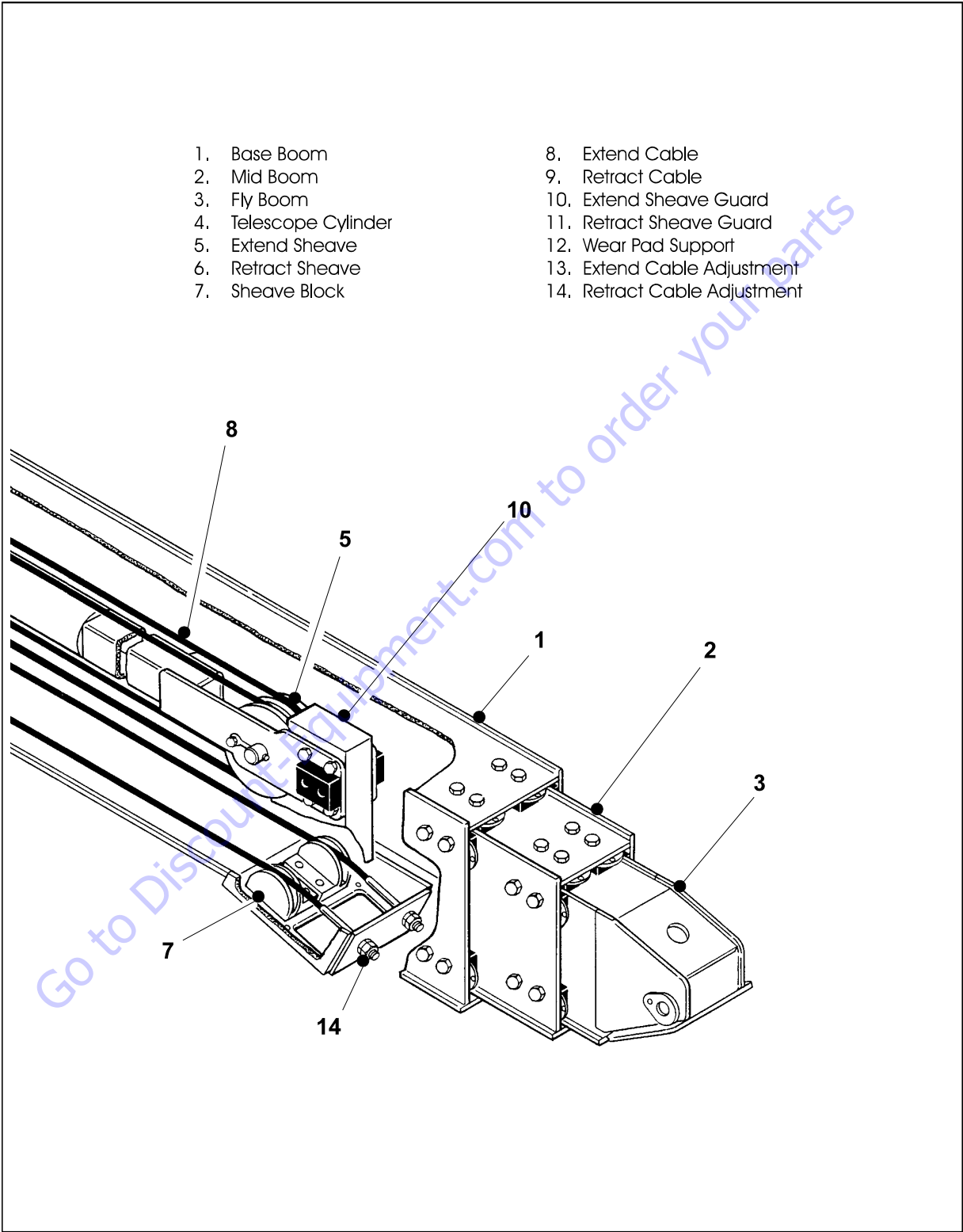


Figure 4-4. Boom Assembly Cutaway - Sheet 2 of 3

SECTION 4 - BOOM & PLATFORM

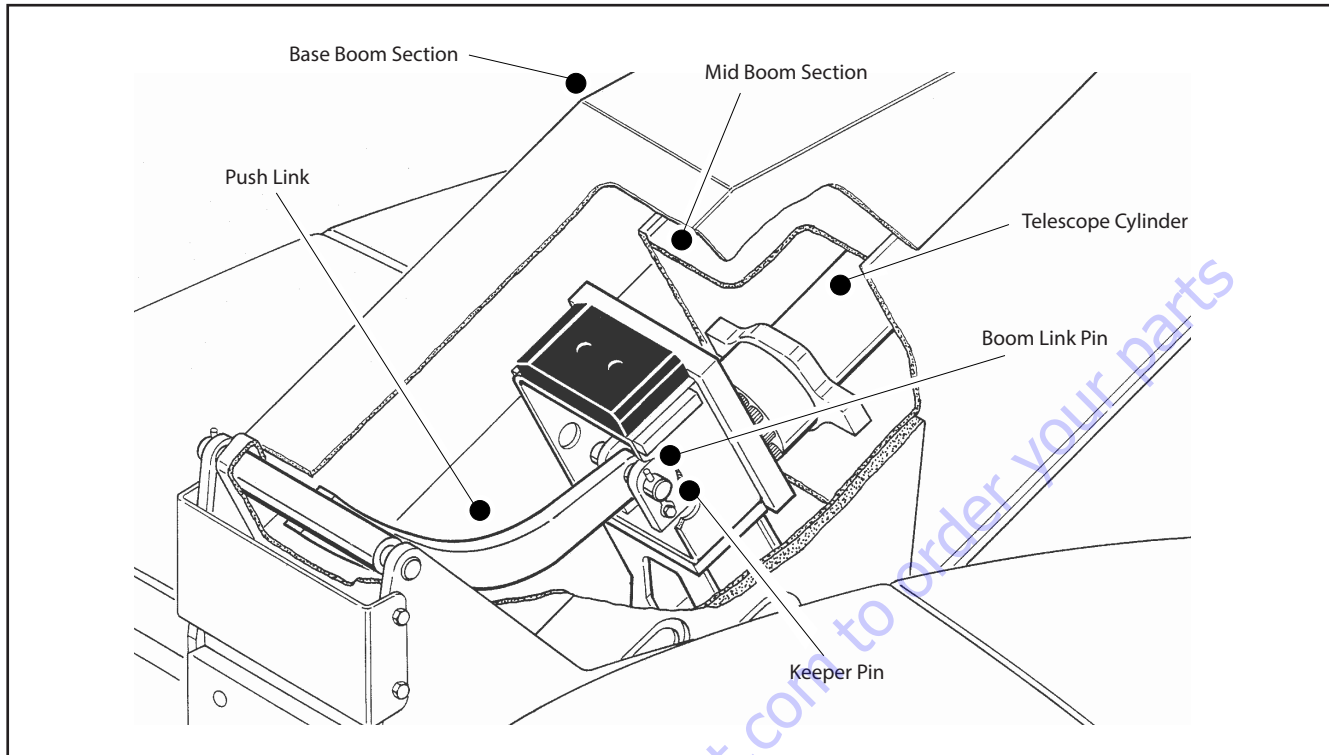


Figure 4-5. Boom Assembly Cutaway - Sheet 3 of 3

Assembly

NOTE: Install same number and thickness of shims removed during disassembly when installing fly section wear pads.

1. Measure inside dimensions of base and mid sections to determine number of shims required for proper lift.
2. Measure inside dimensions of mid section to determine number of shims required for proper lift.
3. Install side, top, and bottom wear pads to aft end of fly section. Shim evenly to inside measurements of mid section.
4. Install retract wire ropes in aft end of fly section. Route wire ropes through holes in side of fly boom section and pull into slot.

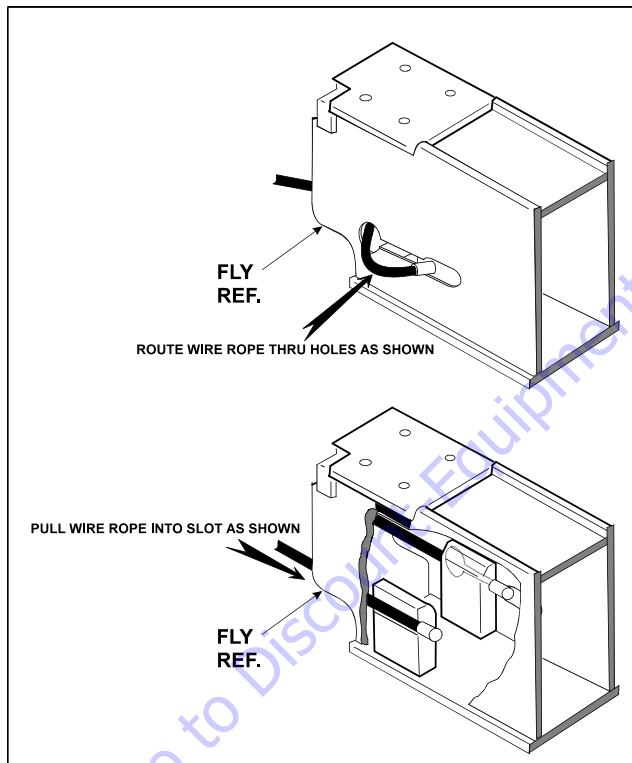


Figure 4-6. Routing Installation of Retract Wire Ropes

5. Install side, top, and bottom wear pads to aft end of mid section. Shim evenly to mid section inside measurements.

NOTICE

WHEN ASSEMBLING BOOM SECTIONS, ENSURE BOOM SLIDING TRAJECTORIES ARE CLEAR OF CHAINS, TOOLS, AND OTHER OBSTRUCTIONS.

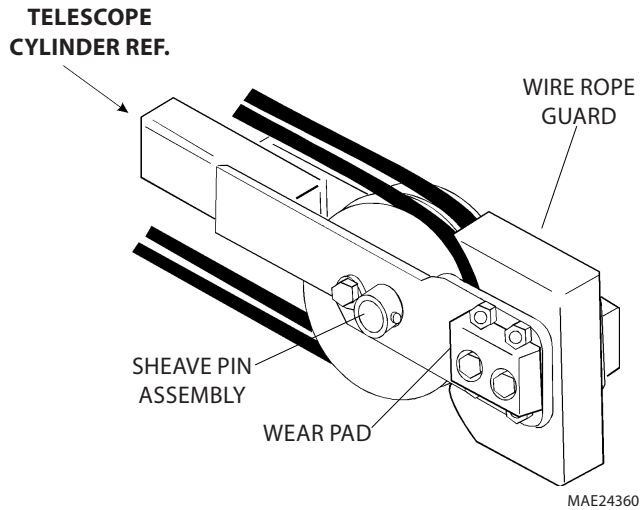
6. Shim insides of boom sections for a total of 1/16 inch (1.58 mm) clearance (if action is centered, there will be 1/32 inch clearance on each side).

7. Slide fly boom section into mid boom section. Shim boom, if necessary, for a total of 1/16 inch (1.58 mm) clearance.
8. Install wear pads in forward position of the mid boom section. Shim boom, if necessary, for a total of 2/10 inch (5.08 mm) clearance.
9. Properly position retraction wire rope sheaves assemblies at aft end of mid boom section. Ensure all sheave-to-mounting block attachment holes align. Install sheave pins and secure them with mounting hardware. Position retract wire ropes onto sheaves.
10. Install sheave guards to aft end of mid boom section and secure with mounting hardware.
11. Slide mid boom section into base boom section. Allow retraction wire ropes to trail between bottom surfaces of boom sections. Shim boom, if necessary, for a total of 1/16 inch (1.58 mm) clearance.
12. Install wear pads into the forward position of base boom section. Shim boom, if necessary, for a total of 2/10 inch (5.08 mm) clearance.
13. Install sheave block to bottom of base boom section and adjust block so that retract wire ropes do not come into contact with boom surfaces.
14. Install wire rope threaded ends thru attachment holes in bottom of base boom section. Loosely install nuts and jam nuts on threaded ends of wire ropes.
15. Align telescope cylinder barrel-to-sheave attachment point. Install extend sheave pin through telescope cylinder barrel and sheave assembly; secure pin with mounting hardware.
16. Route extend wire ropes around extend sheave and secure wire ropes to the telescope cylinder.

SECTION 4 - BOOM & PLATFORM

17. Install extend wire rope mounting blocks to threaded ends of wire ropes. Loosely install nuts and jam nuts on threaded ends of wire ropes.

NOTE: Do not twist or cross wire ropes during installation.



NOTE: For non CE specification machines, skip step 18 and proceed to step 19.

18. Install extend wire rope mounting blocks, proximity mounting plate and spring to threaded ends of wire ropes. Loosely install nuts and jam nuts on threaded ends of wire ropes. Refer to Figure 4-7., Proximity Switch Installation.
19. Secure sling and lifting device at telescope cylinder's approximate center of gravity, and lift cylinder to aft end of boom assembly.

NOTICE

WHEN INSERTING TELESCOPE CYLINDER IN BOOM, IT MAY BE NECESSARY TO TURN CYLINDER SLIGHTLY TO CLEAR ASSEMBLIES MOUNTED IN BOOM. CARE MUST BE TAKEN TO MOVE CYLINDER SLOWLY INTO POSITION. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH ASSEMBLIES.

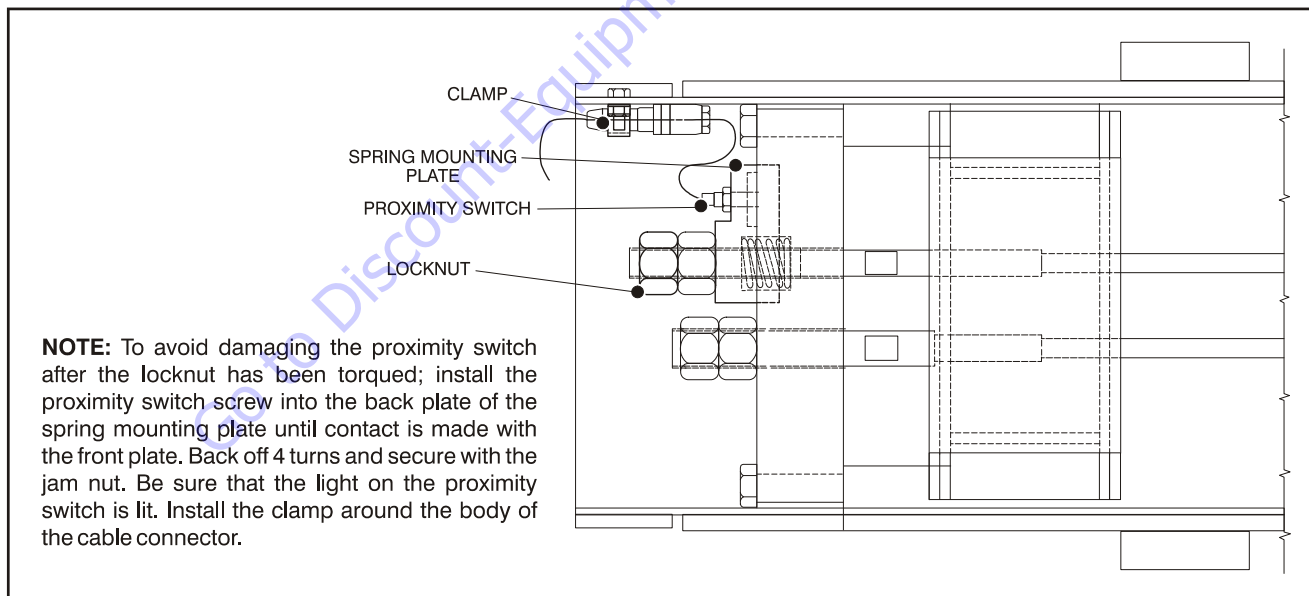
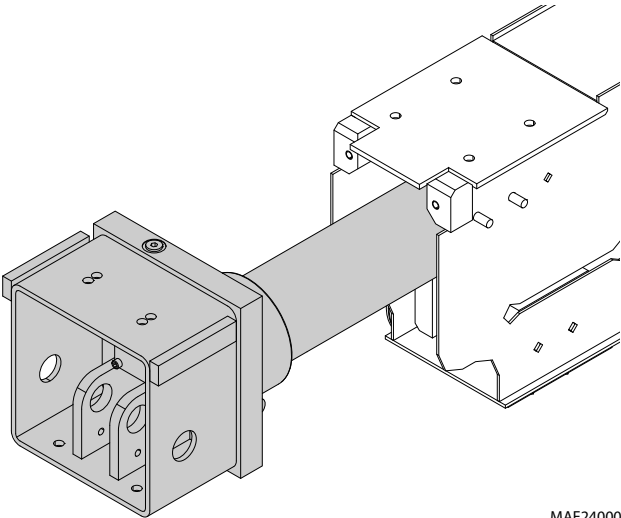


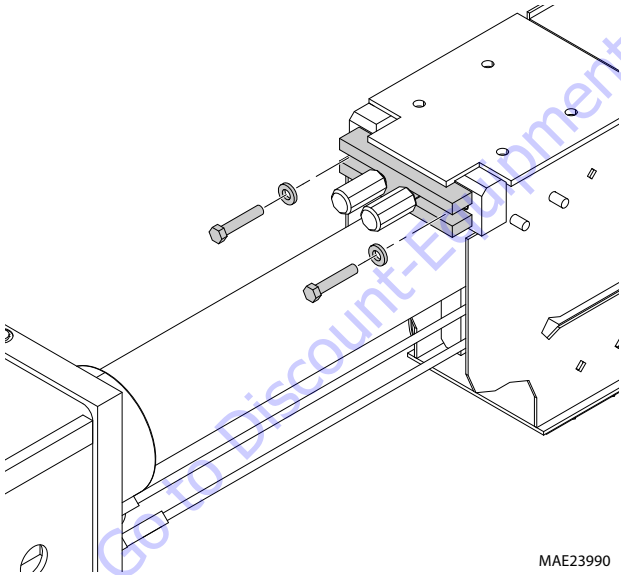
Figure 4-7. Proximity Switch Installation

- 20. Align cylinder with slots at aft end of mid boom section, then secure cylinder with mounting hardware.



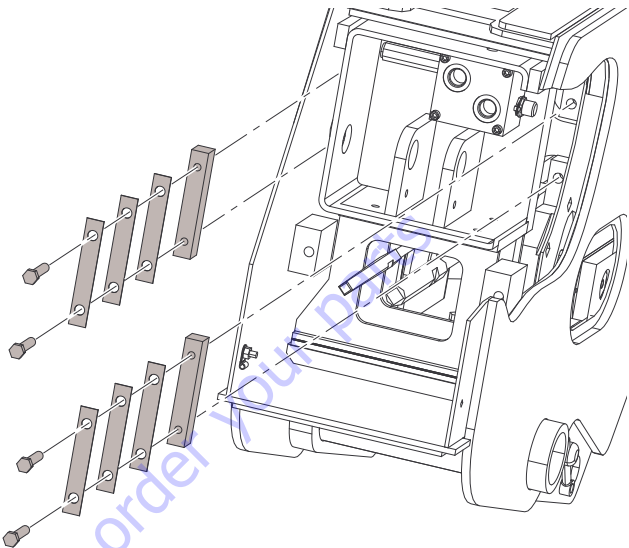
MAE24000

- 21. Align holes in aft end of fly boom section with holes in wire rope mounting block. Secure with mounting hardware.



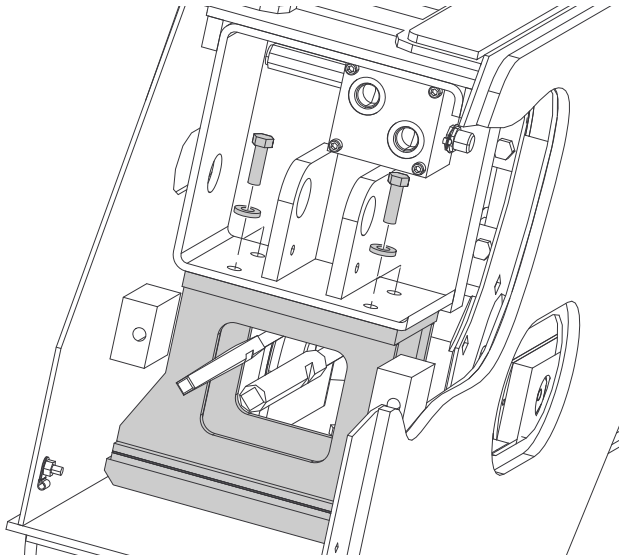
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- 22. Install the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the aft end of mid boom section.



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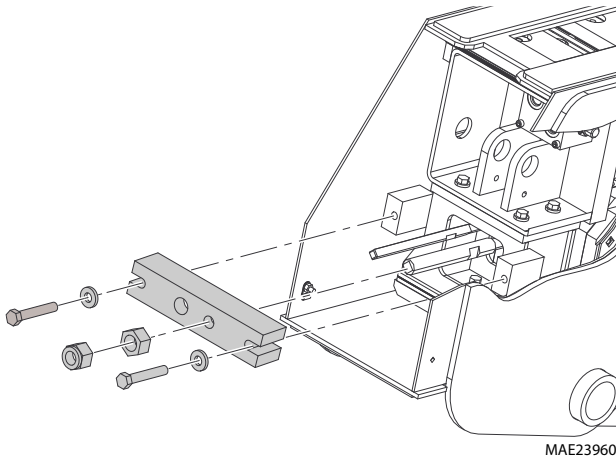
- 23. Install hardware securing the telescope cylinder and support wear pad.



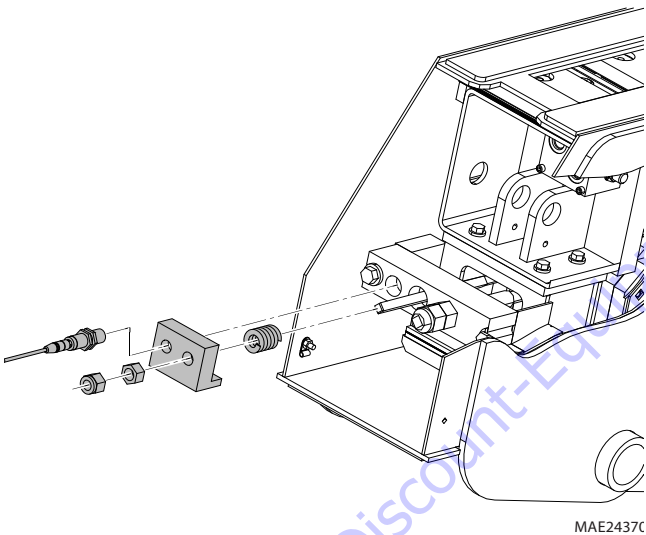
MAE23970

SECTION 4 - BOOM & PLATFORM

24. Install hardware securing the wire rope adjustment block to aft end of the base boom section and remove the block.



25. Install the spring mounting plate, spring, and proximity switch from the aft end of the base section.

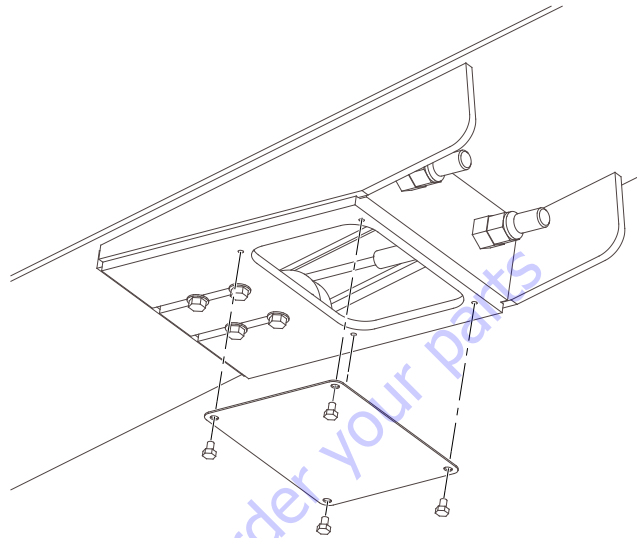


26. Clamp both threaded ends of wire rope to prevent rotation.

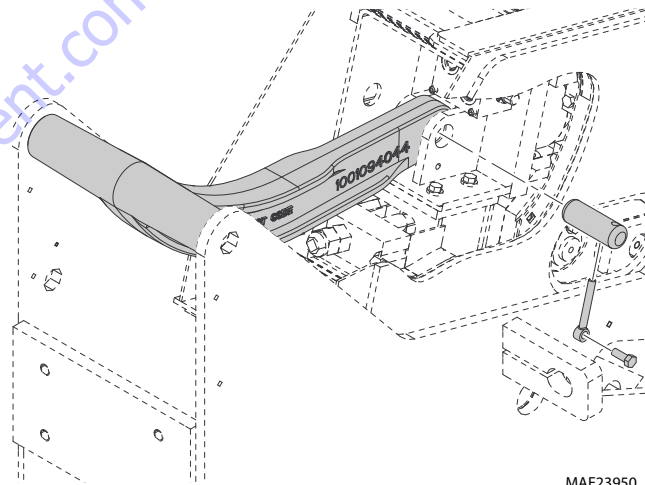
NOTE: Do not clamp on threads. Install jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.

NOTE: Do not allow wire rope to rotate. This may damage the wire rope.

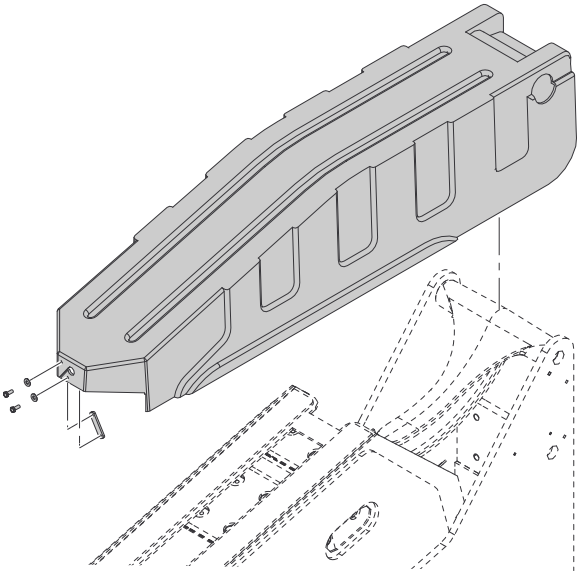
27. Remove hardware securing the cover plate on the bottom front of the base boom section.



28. Align holes in rod end of the telescope cylinder with holes in push bar. Install push bar pin and secure with mounting hardware.

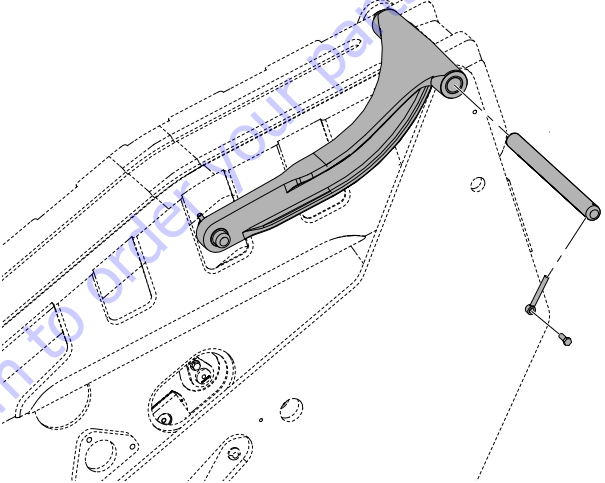


- 29. Install hardware securing the cover from the top of main boom.

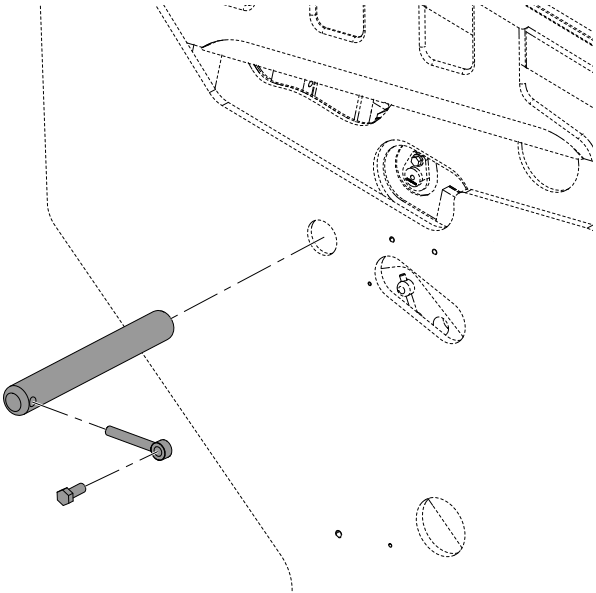


Installation

- 1. Using a suitable lifting device, position boom assembly on turntable so that the pivot holes of boom, push bar, cover, and turntable are aligned.
- 2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on turntable.
- 3. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.



- 4. Using a suitable brass drift and hammer, install hardware securing the main boom section to the turntable.

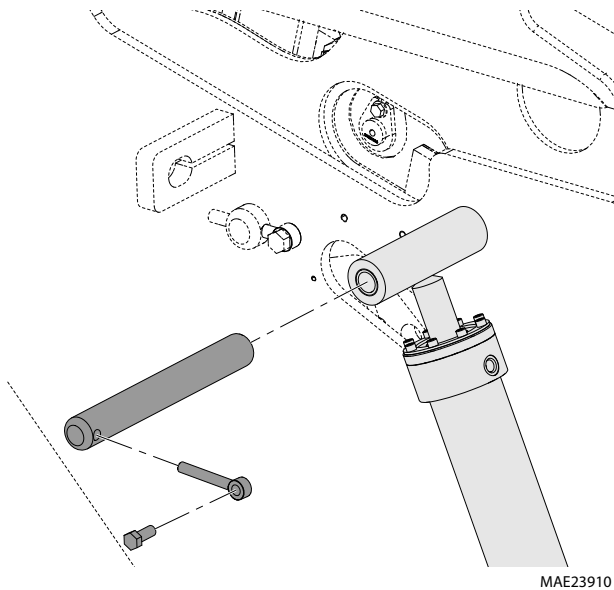


- 5. Using an adequate supporting device, align the master cylinder with the mounting holes on the boom and upright.

SECTION 4 - BOOM & PLATFORM

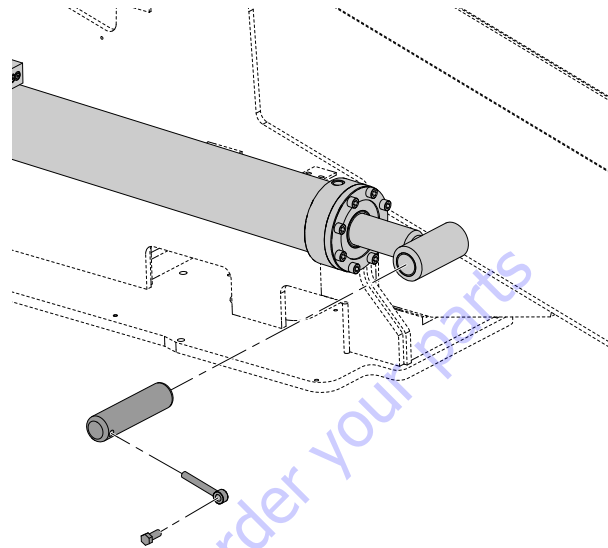
- Using a suitable brass drift and hammer, install hardware securing the master cylinder rod end pin to the base boom section. Install the master cylinder pin into base boom.

NOTE: When installing the master cylinder rod end pin, insert the keeper hardware pin to prevent the pin from inserting too far.



- Connect hydraulic lines to the master cylinder as tagged during removal.
- Using an adequate supporting device, align the main boom lift cylinder with the mounting holes on the boom section.
- Extend the main boom lift cylinder by using the auxiliary power switch. Using a suitable brass drift and hammer,

install hardware secured to the main boom lift cylinder rod end pin into the base boom section.



MAE23900

- Connect all wiring to the ground control box.
- Connect all hydraulic lines running along side of boom assembly
- Adjust retract and extend cables to the proper torque. Refer to Section 4.7, Wire Rope Tensioning Adjustment for boom cable torque procedures.
- Using all applicable safety precautions, operate machine systems and raise and extend boom fully, noting the performance of the extension cycle.
- Retract and lower boom, noting the performance of the retraction cycle.

4.4 MAIN BOOM POWERTRACK

Removal

1. Disconnect wiring harness from ground control box.

NOTICE

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

2. Tag and disconnect hydraulic lines from boom to control valve. Use a suitable container for residual hydraulic fluid. Cap hydraulic lines and ports.
3. Disconnect dual capacity indicator limit switch from side of boom section.
4. Remove hydraulic lines and electrical cables from powertrack.
5. Using a suitable lifting equipment, adequately support powertrack weight along entire length.
6. Remove bolts #1 securing push tube on fly boom section.
7. Remove bolts #2 securing push tube on mid boom section.
8. With powertrack support and using all applicable safety precautions, remove bolts #3 and #4 securing rail to the base boom section. Remove powertrack from boom section.

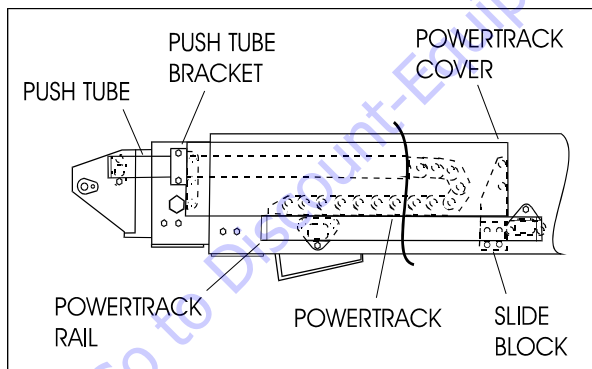


Figure 4-8. Boom Powertrack Components

Installation

1. Align holes in powertrack rail with attachment holes in side of base boom section. Secure rail with mounting hardware.
2. Install powertrack to rail with mounting hardware.
3. Attach push tube bracket to side of mid boom section with mounting hardware.

NOTE: Do not over tighten attach bolt on push tube bracket. It should pivot freely.

4. Install slide block and wear pads to powertrack rail with mounting hardware.
5. Install powertrack to push tube with mounting hardware.
6. Carefully feed hoses and electrical cables through aft end of powertrack rail, powertrack, and push tube.
7. Ensure all hoses and cables are properly routed through powertrack rail, powertrack, and push tube. Tighten or install all clamping or securing apparatus to hoses or cables, as necessary.
8. Install powertrack cover and push tube rods with mounting hardware.

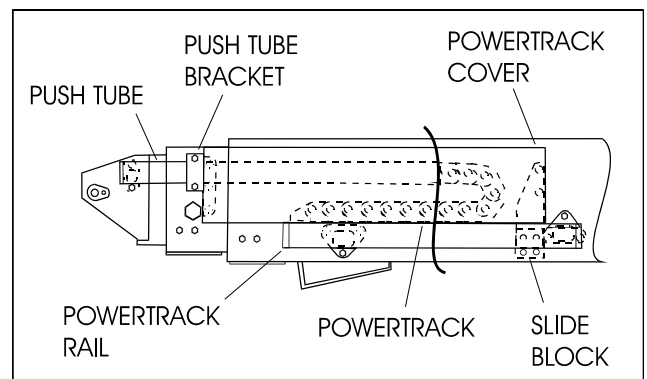


Figure 4-9. Boom Powertrack Assembly

SECTION 4 - BOOM & PLATFORM

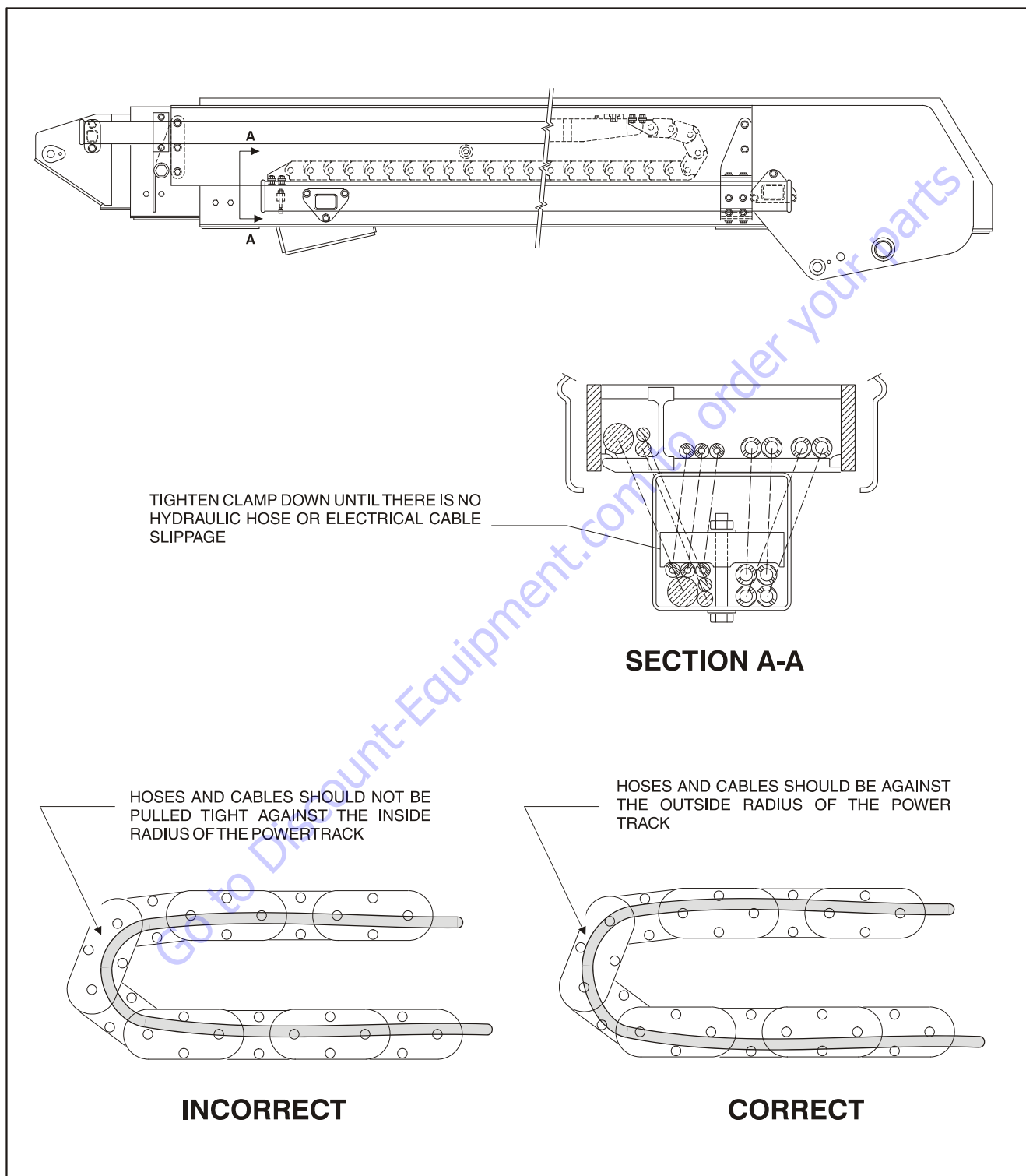
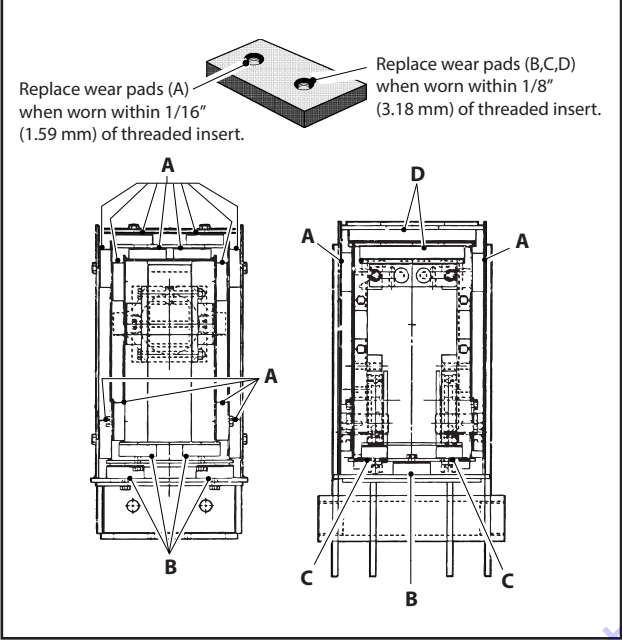


Figure 4-10. Boom Powertrack Installation

4.5 WEAR PADS

Wear pads are made of polyethylene. Pads move on polyurethane painted surfaces. No paint is removed and no lubrication is applied.



PAD	THICKNESS OF NEW PAD	REPLACE WHEN WORN TO:
A	5/8"	9/16"
B, C, D	3/4"	5/8"

Figure 4-11. Location and Thickness of Wear Pads

1. Shim wear pads to within 1/32 inch (.79 mm) tolerance between wear pad and adjacent surface.
2. Replace wear pads when worn within 1/16 inch (1.59 mm) and 1/8 inch (3.18 mm) - B, C, D of threaded insert. See Location and Thickness Of Wear Pads.
3. Bolt length must be changed when adjusting wear pads and removing or adding shims.
 - a. Longer bolts must be used when adding shims to ensure proper thread engagement in insert.
 - b. Shorter bolts must be used when shims are removed so bolt does not protrude from insert and contact boom surface.

SECTION 4 - BOOM & PLATFORM

4.6 WIRE ROPE

CAUTION

WIRE ROPE CAN HAVE SHARP EDGES AND CAUSE SERIOUS INJURY. NEVER HANDLE WIRE ROPE WITH BARE HANDS.

Each day before using machine:

1. Raise main boom approximately horizontal.
2. Extend and retract the boom sections.
3. Check for delayed movement of fly section which indicates loose wire ropes.

Inspection

NOTE: Pictures in this paragraph are samples to show rope replacement criteria.

1. Inspect ropes for broken wires, particularly valley wire breaks and breaks at end terminations.

NOTE: Flexing a wire rope can often expose broken wires hidden in valleys between strands.

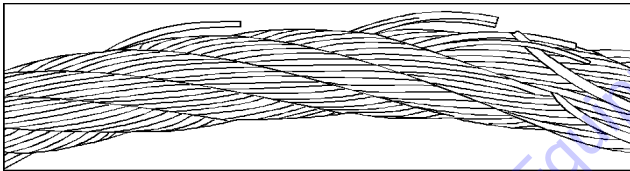


Figure 4-12. Wire Rope Wire Breaks

2. Inspect ropes for corrosion.
3. Inspect ropes for kinks or abuse.

NOTE: A kink is caused by pulling down a loop in a slack line during improper handling, installation, or operation.

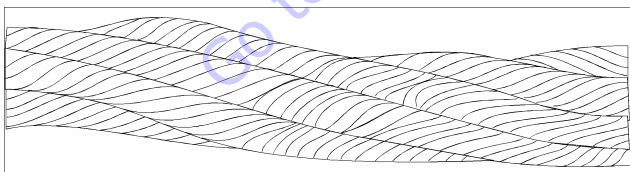


Figure 4-13. Wire Rope Kink

4. Inspect sheaves for condition of bearings/pins. (See Dimension Of Sheaves for proper dimension.) Inspect sheaves for condition of flanges. (See Dimension Of Sheaves for proper dimension.)
5. Inspect sheaves with a groove wearout gage for excessive wear.

NOTE: Check groove so that it may be clearly seen if gauge contour matches sheave groove contour.

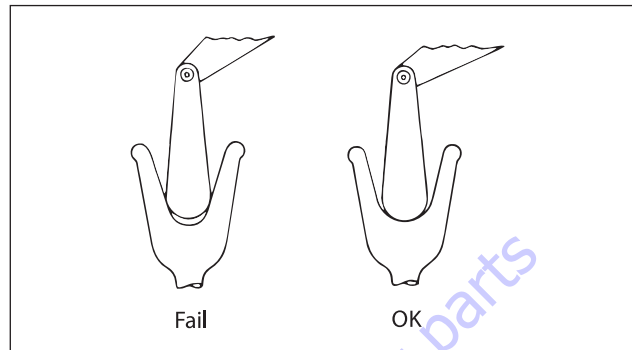


Figure 4-14. Sheave Groove Wear

7. Ropes passing inspection should be lubricated with wire rope lubricant before reassembly.

Three Month Inspection

1. Remove boom covers and visually (with flashlight) inspect the ropes for rust, broken wires, frays, abuse, or any signs of abnormalities.
2. Check wire rope tension by deflecting wire ropes by hand. Properly tensioned ropes should have little or no movement.

12 Year or 7000 Hour Replacement

1. Mandatory wire rope and sheave replacement.

Additional inspection required if:

- a. Machine is exposed to hostile environment or conditions.
- b. Erratic boom operation or unusual noise exists.
- c. Machine is idle for an extended period.
- d. Boom is overloaded or sustained a shock load.
- e. Boom exposed to electrical arc. Wires may be fused internally.

Additional Replacement Criteria

NOTE: Sheaves and wire rope must be replaced as sets.

1. Rusted or corroded wire ropes.
2. Kinked, "bird caged", or crushed ropes.
3. Ropes at end of adjustment range.
4. Sheaves failing wearout gage inspection.
5. Ropes with 6 total broken wires in one rope lay, 3 in one strand in one rope lay, 1 valley break, or 1 break at any end termination.

4.7 WIRE ROPE TENSIONING ADJUSTMENT

Wire Rope Tensioning Procedure

1. Position boom in fully down and retracted position.

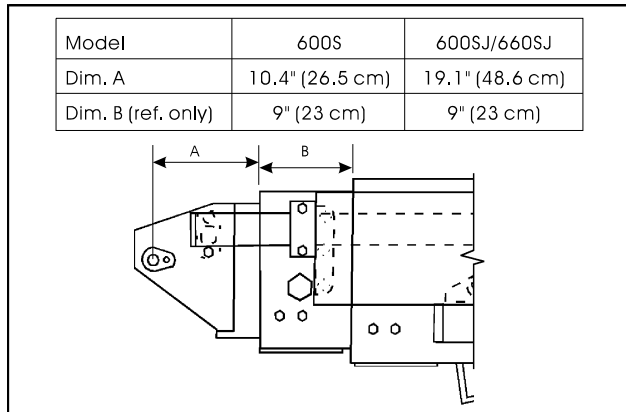


Figure 4-15. Dimensions of Boom Sections

NOTICE

DO NOT CLAMP ON THREADS OR THREADS MAY BE DAMAGED.

DO NOT ALLOW WIRE ROPE TO ROTATE OR WIRE ROPE MAY BE DAMAGED.
CLAMP THREADED ENDS OF WIRE ROPE TO PREVENT ROTATION.

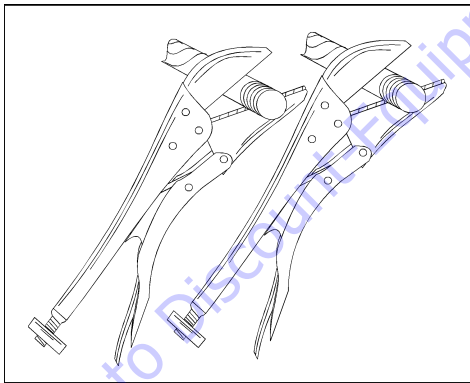


Figure 4-16. Clamping Wire Ropes

2. Install adjusting nuts (or remove nylon collar locknuts if re-adjusting) to both retract and extend wire ropes.
3. Torque retract adjusting nuts (platform end) to 15 ft-lb (20 Nm) alternating between the two wire ropes and keeping approximately the same amount of thread beyond the adjusting nut.
4. Repeat torque procedure in step #4 to extend wire ropes (turntable end).
5. Extend boom 2 - 3 feet using telescope function. Repeat step #4.

6. Retract boom 1 - 2 feet using telescope function. Do not bottom out telescope cylinder. Repeat step #5.

7. Extend boom approximately 2 - 3 feet again and check torque on retract wire ropes.

8. Retract boom without bottoming out telescope cylinder. Check torque on extend wire ropes.

NOTE: Step #8 and #9 may need to be repeated to equalize the torque on all 4 wire ropes.

9. After all wire ropes are properly torqued, install nylon collar locknuts. Remove all clamping devices and install all covers and guards. Check boom for proper function.

SECTION 4 - BOOM & PLATFORM

4.8 JIB - 660SJ

NOTE: Using a suitable lifting device, support the jib.

Removal

1. For platform and support removal see Section 4.1 - Platform.
2. Position the articulating jib boom level with ground.

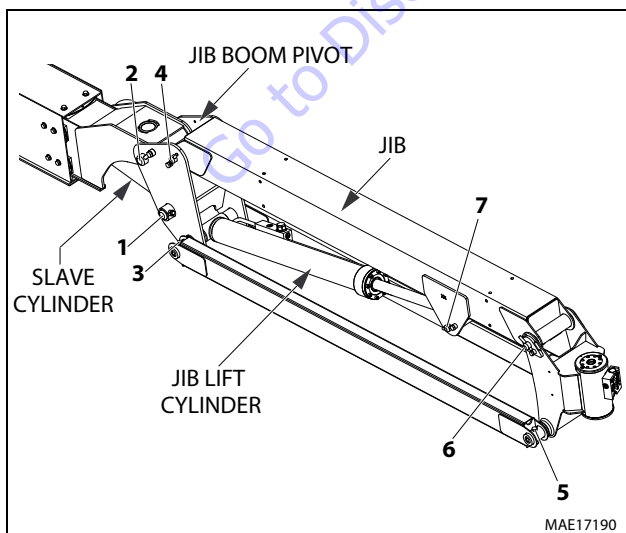
NOTICE

HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

3. Tag and disconnect hydraulic lines from level cylinder and lift cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
4. Remove mounting hardware from slave leveling cylinder pin (1). Using a suitable brass drift and hammer, remove the cylinder pin from jib assembly.
5. Remove mounting hardware from jib assembly boom pivot pin (2). Using a suitable brass drift and hammer, remove the pivot pin from boom assembly.

Disassembly

1. Remove mounting hardware from articulating jib boom pivot pins (3) and (4). Using a suitable brass drift and hammer, remove the pins from articulating jib boom pivot weldment.
2. Remove mounting hardware from rotator support pins (5) and (6). Using a suitable brass drift and hammer, remove the pins from rotator support.
3. Remove mounting hardware from lift cylinder pin (7). Using a suitable brass drift and hammer, remove the cylinder pin from articulating jib boom.



Inspection

NOTE: When inspecting pins and bearings Refer to Section 2.5 - Pins and Composite Bearing Repair Guidelines.

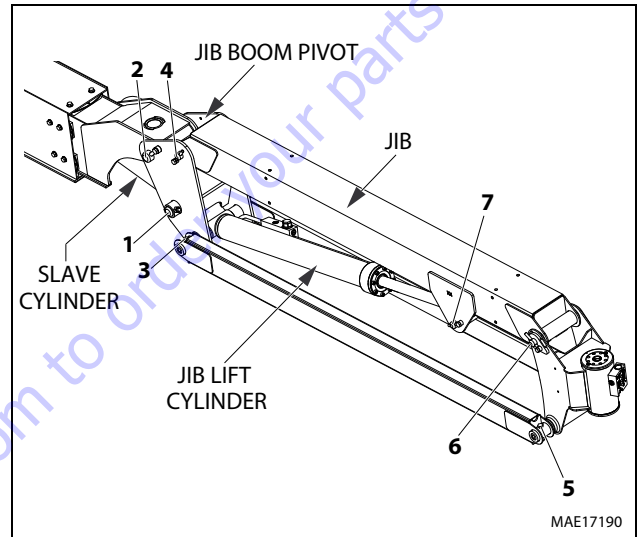
1. Inspect fly boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
2. Inspect fly boom pivot attach points for scoring, tapering and ovality, or other damage. Replace pins as necessary.
3. Inspect inner diameter of fly boom pivot bearings for scoring, distortion, wear, or other damage. Replace bearings as necessary.
4. Inspect lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
5. Inspect inner diameter of rotator attach point bearings for scoring, distortion, wear, or other damage.
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of jib boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Assembly

1. Align lift cylinder with attach holes in jib assembly. Using a soft head mallet, install cylinder pin (7) into jib and secure with mounting hardware.
2. Align rotator support with attach hole in jib assembly. Using a soft head mallet, install rotator support pin (6) into jib and secure with mounting hardware.
3. Align bottom tubes with attach holes in rotator support. Using a soft head mallet, install rotator support pin (5) into jib assembly and secure with mounting hardware.
4. Align jib assembly with attach hole in jib boom pivot weldment. Using a soft head mallet, install rotator support pin (4) into jib assembly and secure with mounting hardware.
5. Align bottom tubes with attach holes in jib boom pivot weldment. Using a soft head mallet, install rotator support pin (3) into jib boom pivot weldment and secure with mounting hardware.

Installation

1. Align jib boom pivot weldment with attach holes in fly boom assembly. Using a soft head mallet, install pivot pin (2) into fly boom assembly and secure with mounting hardware.
2. Align the slave leveling cylinder with attach holes in jib boom pivot weldment. Using a soft head mallet, install slave leveling cylinder pin (1) into articulating jib boom pivot weldment and secure with mounting hardware.



4.9 LIMIT SWITCHES AND CAM VALVE ADJUSTMENT

Adjust switches and cam valve as shown in Figure 4-17., Horizontal Limit and Dual Capacity Limit Switches Adjustments and Figure 4-18., Transport Switch Adjustments - CE Machines Only.

4.10 BOOM CLEANLINESS GUIDELINES

The following are guidelines for internal boom cleanliness for machines used in excessively dirty environments.

1. JLG recommends use of JLG Hostile Environment Package to keep internal portions of a boom cleaner and help prevent dirt and debris from entering the boom. This package reduces the amount of contamination which can enter the boom, but does not eliminate the need for more frequent inspections and maintenance when used in these types of environments.
2. JLG recommends you follow all guidelines for servicing your equipment in accordance with instruction in the JLG Service & Maintenance Manual for your machine. Periodic maintenance and inspection is vital to proper operation of the machine. Frequency of service and maintenance must be increased as environment, severity, and frequency of usage requires.
3. Debris and contamination inside the boom can cause premature failure of components and should be removed. Methods to remove debris should always be done using all applicable safety precautions outlined in the JLG Operation & Safety Manual and the JLG Service & Maintenance Manuals.
4. The first attempt to remove debris from inside the boom must be to utilize pressurized air to blow the debris toward the nearest exiting point from the boom. Make sure that all debris is removed before operating the machine.
5. If pressurized air cannot dislodge debris, then water with mild solvents applied with a pressure washer can be used. Wash debris toward the nearest exiting point from the boom. Make sure all debris is removed, no "puddling" of water has occurred, and boom internal components are dry before operating machine. Make sure you comply with all federal and local laws for disposing of wash water and debris.
6. If pressurized air or washing boom does not dislodge and remove debris, disassemble boom following instructions outlined in the JLG Service & Maintenance Manual to remove debris.

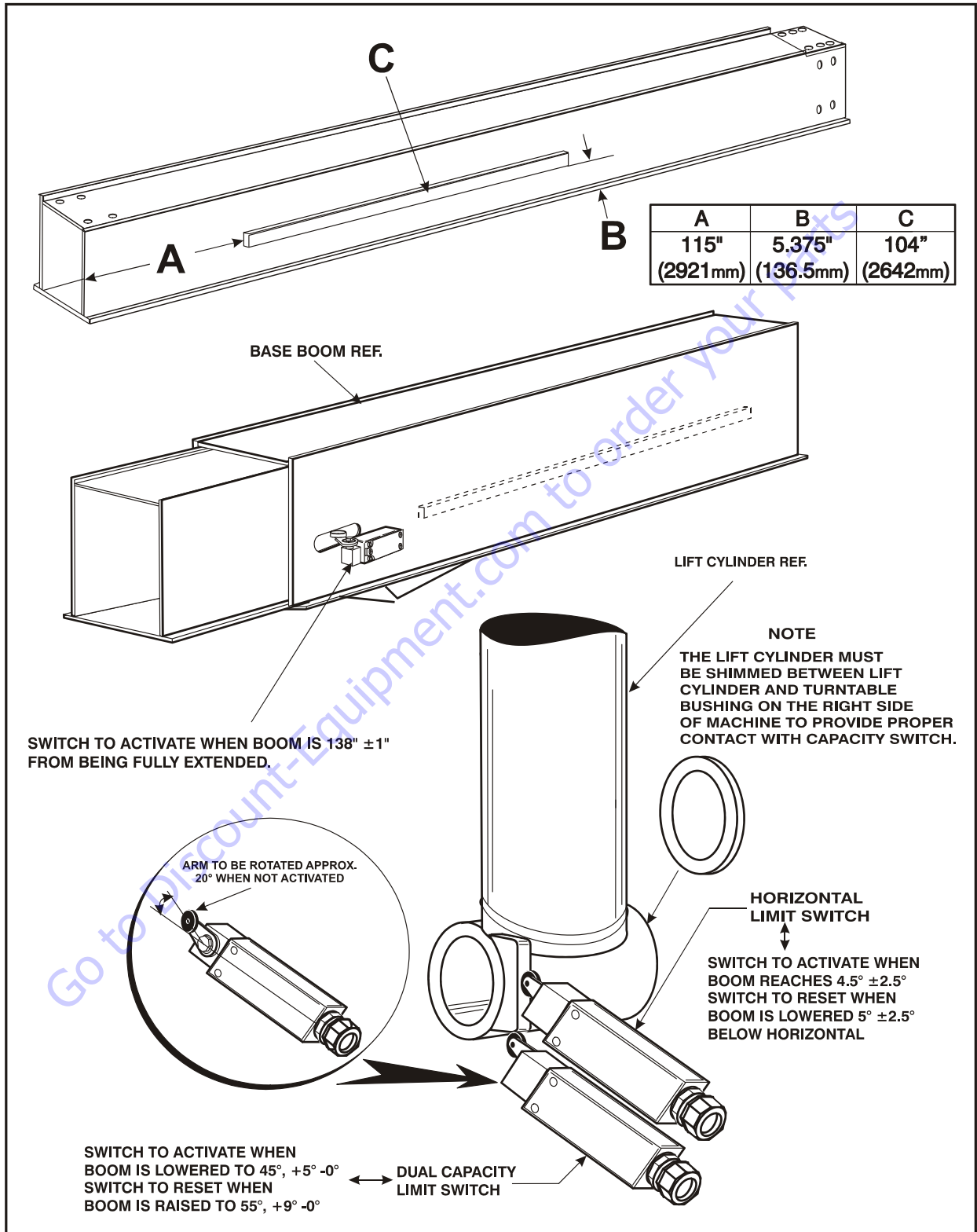


Figure 4-17. Horizontal Limit and Dual Capacity Limit Switches Adjustments

SECTION 4 - BOOM & PLATFORM

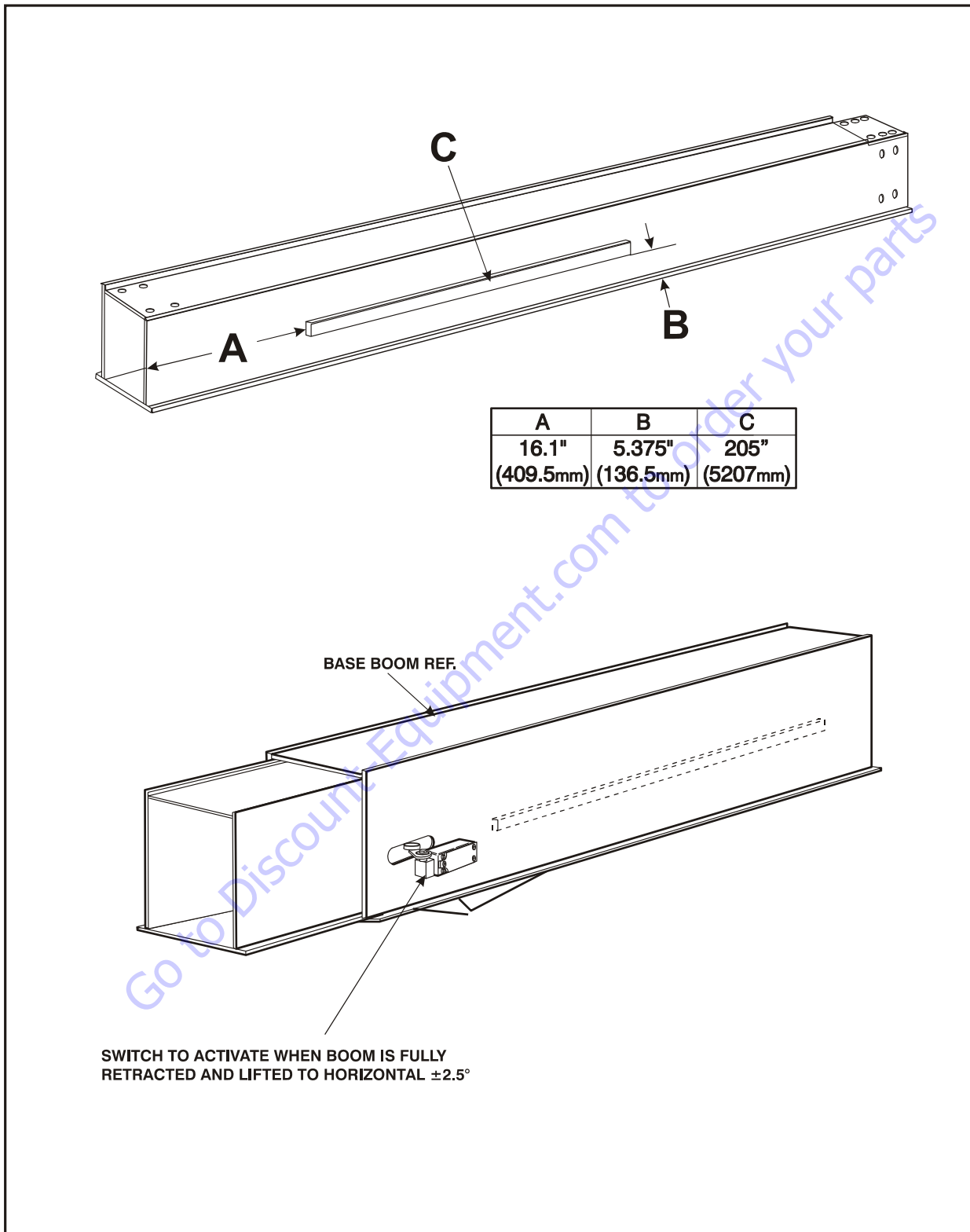


Figure 4-18. Transport Switch Adjustments - CE Machines Only

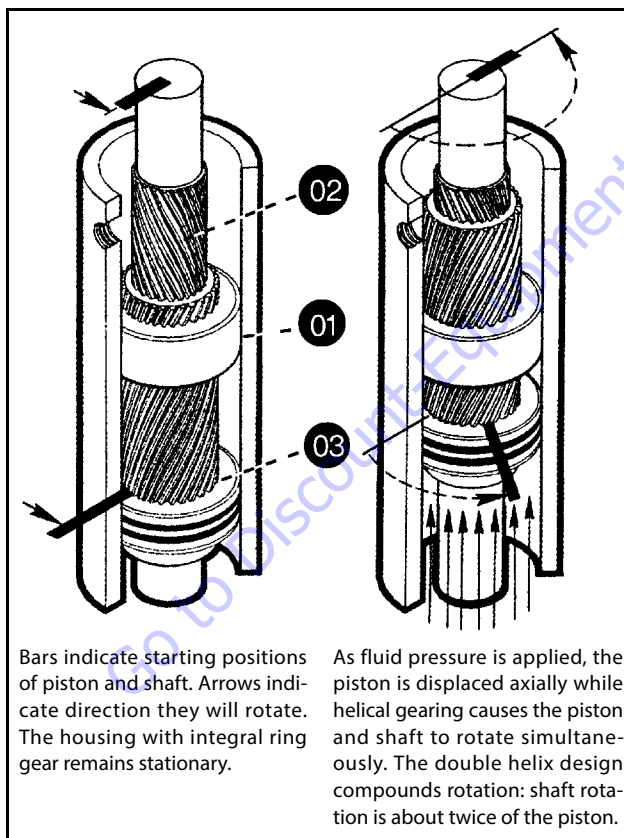
4.11 ROTARY ACTUATOR

Theory of Operation

The L20 Series rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert linear piston motion into powerful shaft rotation.

Each actuator is composed of a housing with integrated gear teeth (01) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (02), and the annular piston sleeve (03). Helical spline teeth machined on the shaft engage matching splines on the piston inside diameter. The piston outside diameter carries a second set of opposite direction splines which engage with matching splines in the housing.

As hydraulic pressure is applied, piston is displaced axially within the housing - similar to operation of a hydraulic cylinder - while splines cause shaft to rotate. When control valve is closed, oil is trapped inside the actuator, preventing piston movement and locking the shaft in position. The shaft is sup-



ported radially by the large upper radial bearing and lower radial bearing. Axially, the shaft is separated from the housing by upper and lower thrust washers. End cap is adjusted for axial clearance and locked in position by set screws or pins.

Required Tools

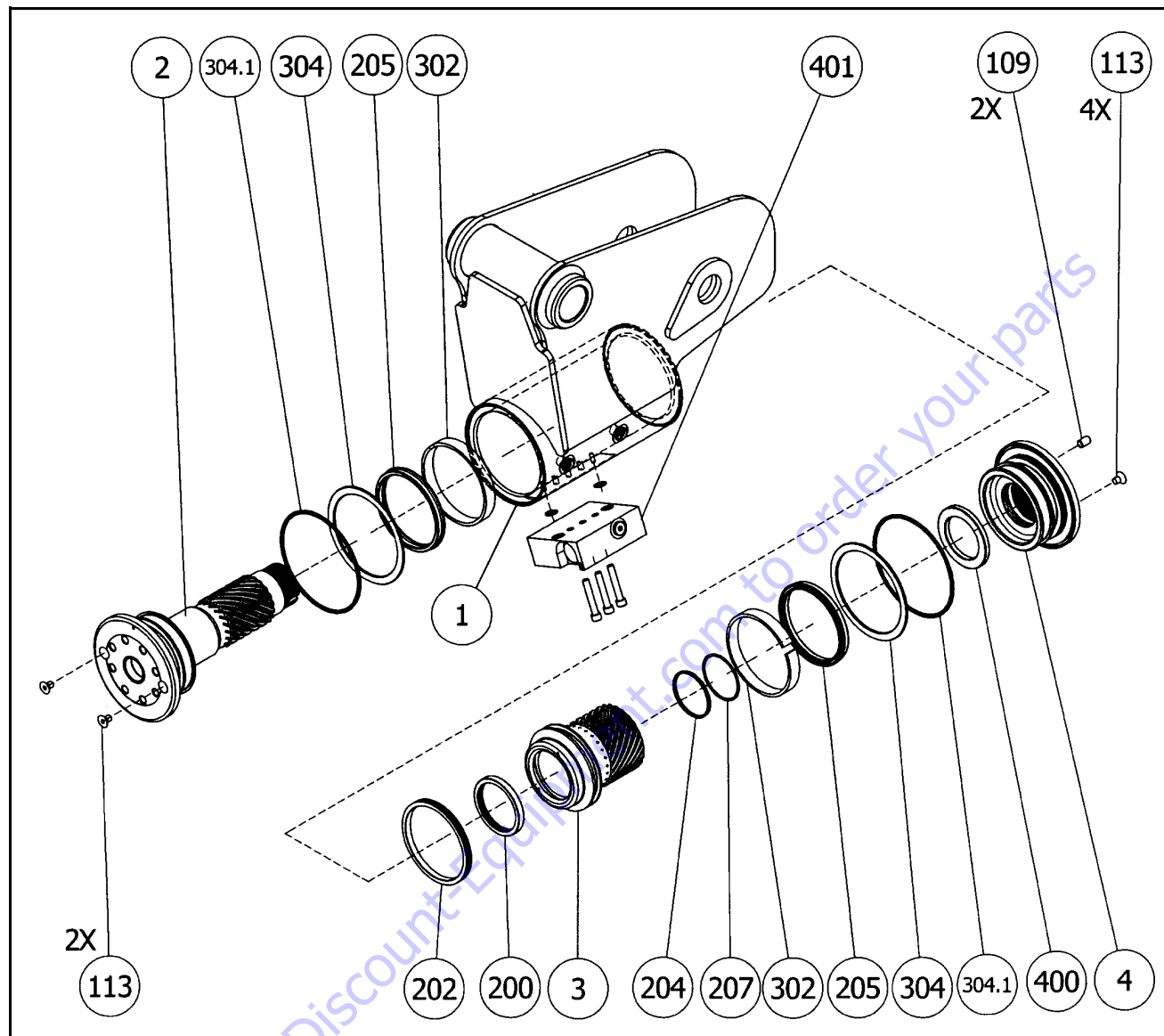


1. Flashlight - Examine timing marks, component failure, and overall condition.
2. Felt Marker - Match mark timing marks and outline troubled areas.
3. Allen wrench - Remove port plugs and set screws.
4. Box knife - removal of seals.
5. Seal tool - assembly and disassembly of seals and wear guides.
6. Pry bar - End cap removal and manual rotation of shaft.
7. Rubber mallet- Removal and installation of shaft and piston sleeve assembly.
8. Nylon drift - Piston sleeve installation.
9. End cap dowel pins - removal and installation of end cap (sold with Helac seal kit).

The seal tool is a customized standard flat head screwdriver. To make this tool, heat flat end with a torch. Secure heated end of screwdriver in a vice and bend to a slight radius. Once radius is achieved, round off all sharp edges using a grinder. There may be some slight modifications for your personal preference.



SECTION 4 - BOOM & PLATFORM



PARTS

- 1. Housing
- 2. Shaft
- 3. Piston Sleeve
- 4. End Cap

HARDWARE

- 103.1. Screw
- 103.2. Washer
- 106.1. Port Plug
- 106.2. Port Plug
- 109. Lock Pin
- 113. Capscrew

SEALS

- 200. T-Seal
- 202. T-Seal
- 204. O-ring
- 205. Cup Seal
- 207. Backup Ring
- 304.1. Wiper Seal

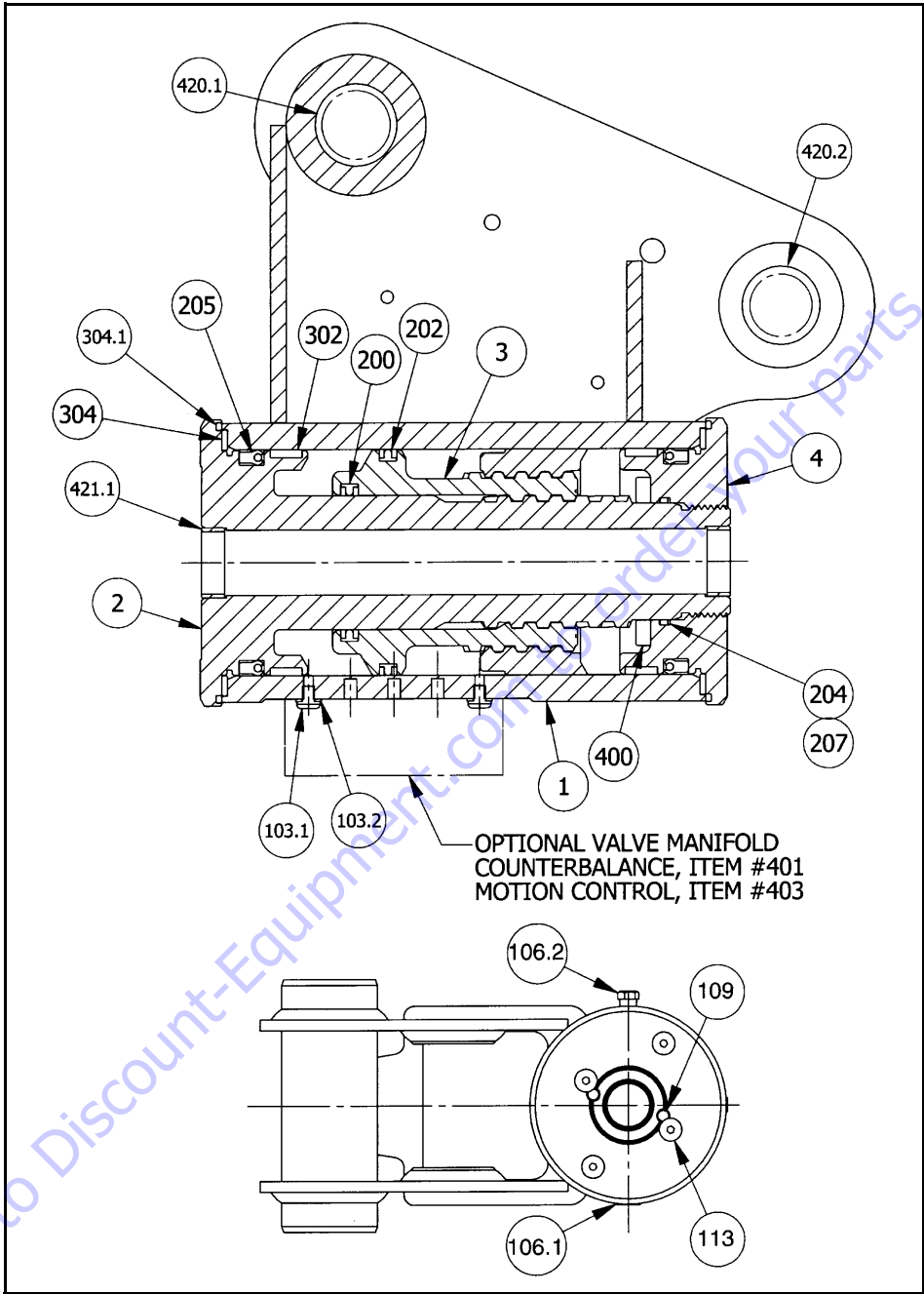
BEARINGS

- 302. Wear Guide
- 304. Thrust Washer

ACCESSORIES

- 400. Stop Tube
- 420.1 Bushing
- 420.2 Bushing
- 421.1 Bushing

Figure 4-19. Rotary Actuator - Exploded View



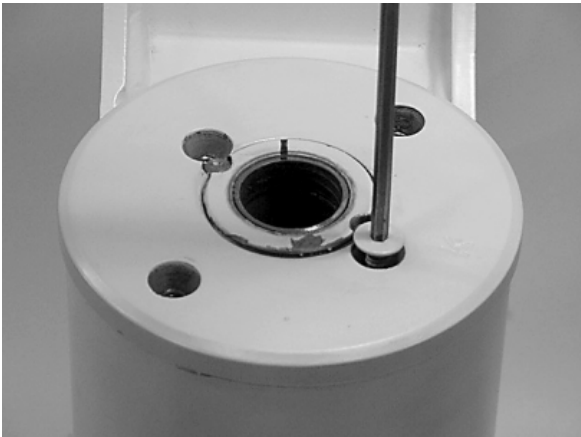
PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109. Lock Pin	207. Backup Ring		
	113. Capscrew	304.1. Wiper Seal		

Figure 4-20. Rotary Actuator - Assembly Drawing

SECTION 4 - BOOM & PLATFORM

Disassembly

1. Remove cap screws (113) over end cap lock pins (109).



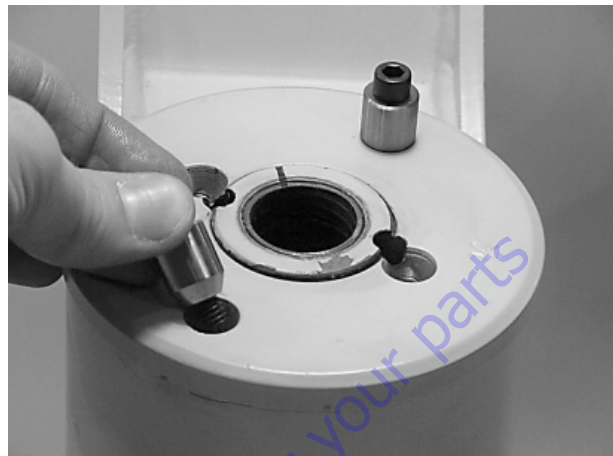
2. Using a 1/8" (3.18mm) drill bit, drill a hole in center of each lock pin approximately 3/16" (4.76mm) deep.



3. Remove lock pins using an "Easy Out" (Size #2 shown. If pin will not come out, use 5/16" drill bit 1/2" (12.7mm) deep to drill out entire pin.



4. Remove end cap (4) using tools provided with Helac seal kit.



5. Using a metal bar or similar tool, unscrew end cap (4) by turning it counter clockwise.



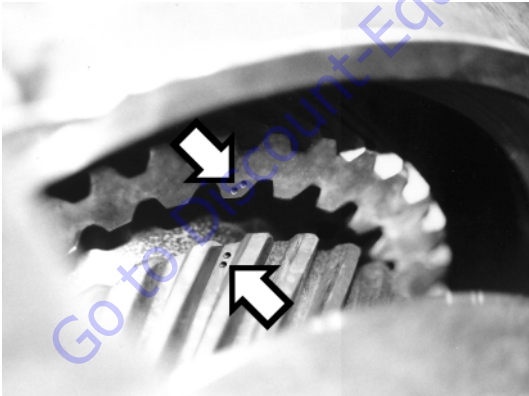
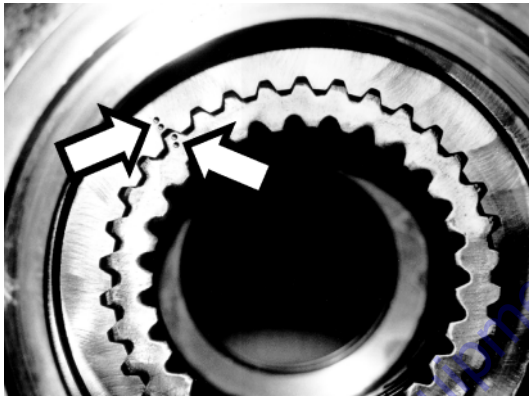
6. Remove end cap (4) and set aside for later inspection.



7. Remove stop tube if installed.



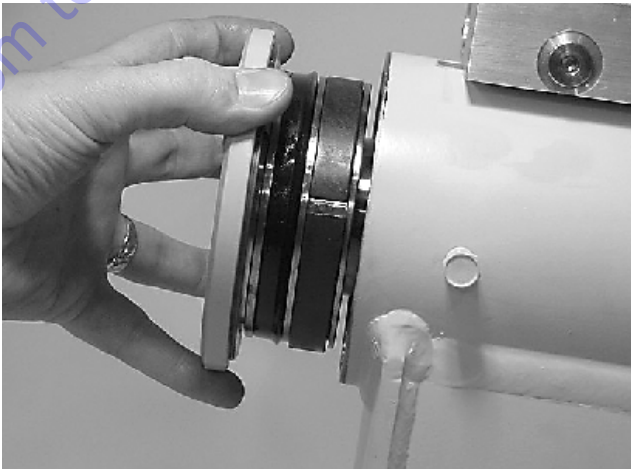
8. Actuator has timing marks for proper engagement.



9. Before removing shaft, (2), use a felt marker to clearly indicate timing marks between shaft and piston. This simplifies timing during assembly.



10. Remove shaft (2). It may be necessary to strike threaded end of shaft with a rubber mallet.

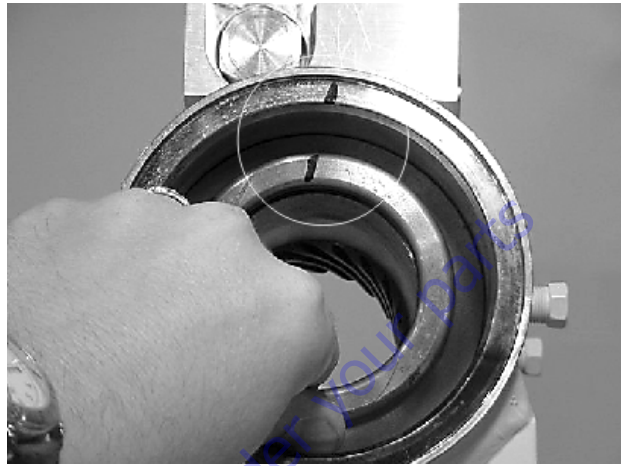


SECTION 4 - BOOM & PLATFORM

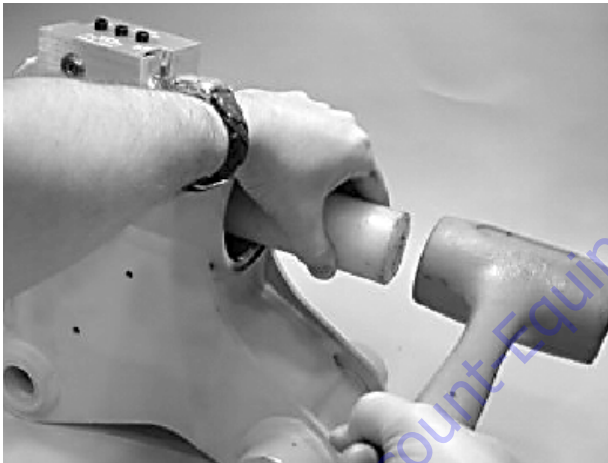
11. Before removing piston (3), mark housing (1) ring gear in relation to piston O.D. gear. There should be timing marks on housing (1) ring gear, piston (3), and shaft (2).



13. At the point when piston gear teeth come out of engagement with housing gear teeth, mark piston and housing with a marker as shown.



12. To remove piston (3), use a rubber mallet and plastic mandrel so piston is not damaged.



14. Remove O-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.



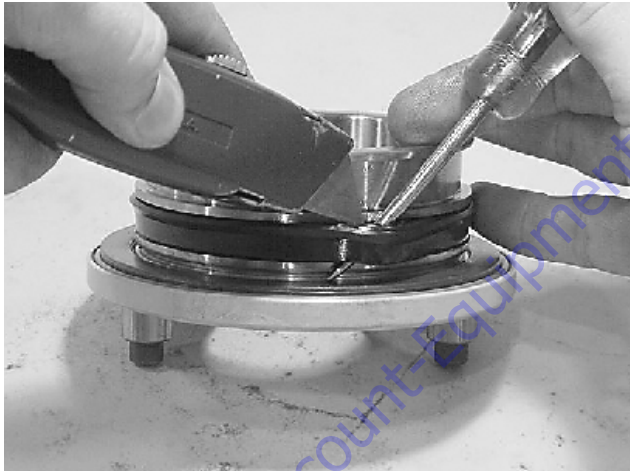
- 15. Remove wear guides (302) from end cap (4) and shaft (2).



- 17. Remove thrust washers (304) from end cap (4) and shaft (2).



- 16. To remove main pressure seals (205), cut them with a sharp razor blade. Do not to damage seal groove.



- 18. Remove wiper seal (304.1) from end cap (4) and shaft (2).



- 19. Remove piston O.D. seal (202).



SECTION 4 - BOOM & PLATFORM

20. Remove piston I.D. seal (200).

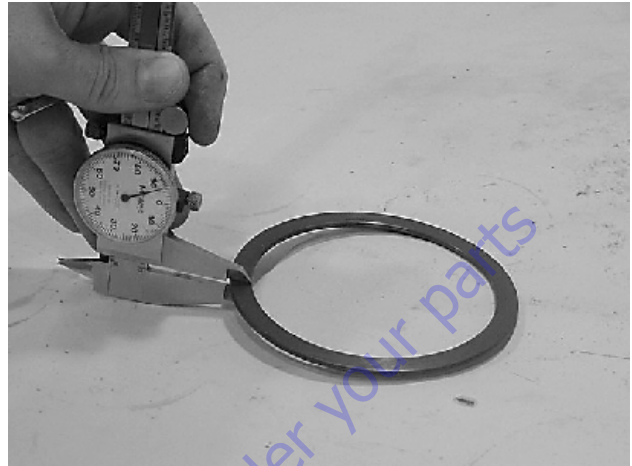


Inspection

1. Clean all parts in a solvent tank and dry with compressed air before inspecting. Carefully inspect all critical areas for any surface finish abnormalities: Seal grooves, bearing grooves, thrust surfaces, rod surface, housing bore, and gear teeth.



2. Inspect thrust washers (304) for rough or worn edges and surfaces. Measure thickness is within specifications (Not less than 0.092" or 2.34 mm).



3. Inspect wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).



Assembly

- 1. Gather all components and tools to one location. Use cut away drawing to reference seal orientations.



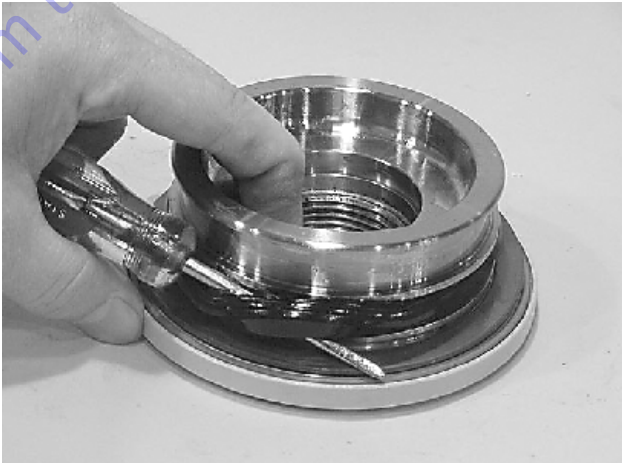
- 2. Install thrust washer (304) on shaft (2) and end cap (4).



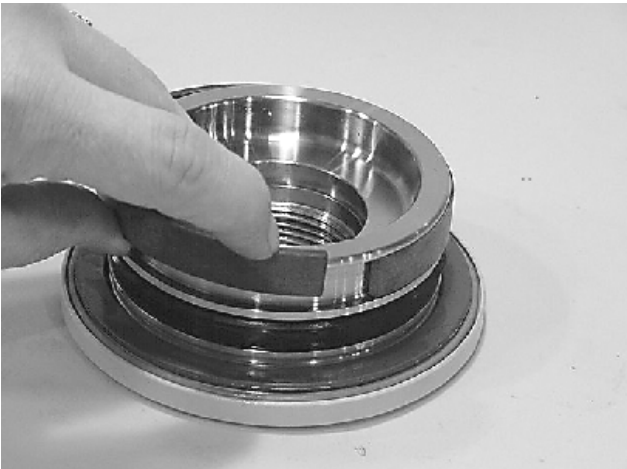
- 3. Install wiper seal (304.1/green O-ring) in groove on shaft (2) and end cap (4) - around outside edge of thrust washer (304).



- 4. Use a seal tool install main pressure seal (205) on shaft (2) and end cap (4). Use seal tool in a circular motion.



- 5. Install wear guide (302) on end cap (4) and shaft (2).



SECTION 4 - BOOM & PLATFORM

6. Install inner T-seal (200) in piston (3) using a circular motion. Install outer T-seal (202) by stretching it around the groove in a circular motion. Each T-seal has two back-up rings (see drawing for orientation).



7. Beginning with inner seal (200) insert one end of b/u ring in lower groove and feed the rest in using a circular motion. Make sure wedged ends overlap correctly.

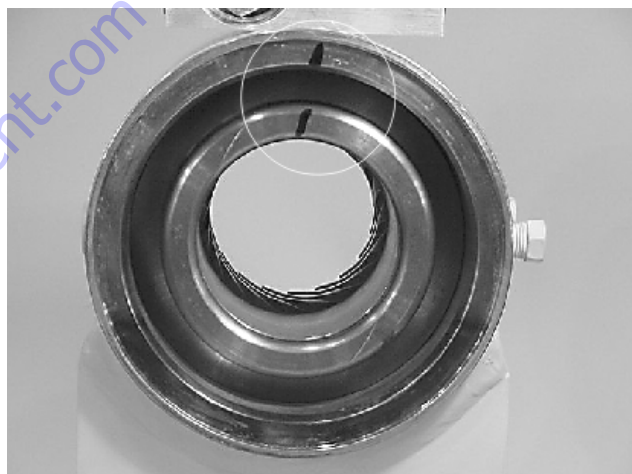
Repeat for outer seal (202).



8. Insert piston (3) in housing (1) as shown, until outer piston seal (202) touches inside housing bore.



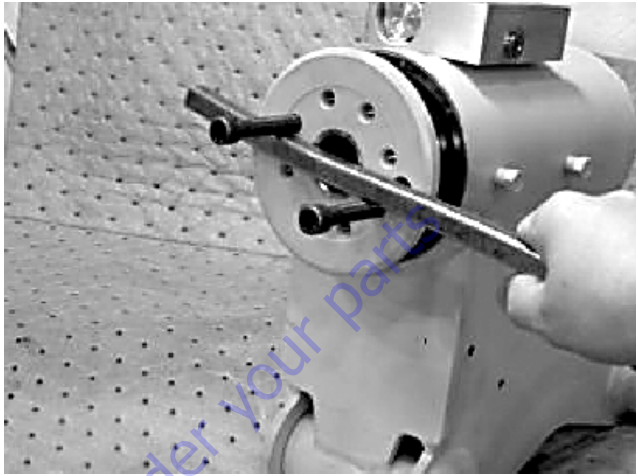
9. Looking from angle shown, rotate piston (3) until marks you put on piston and housing (1) during disassembly line up as shown. Using a rubber mallet, tap piston in housing to point where gear teeth meet.



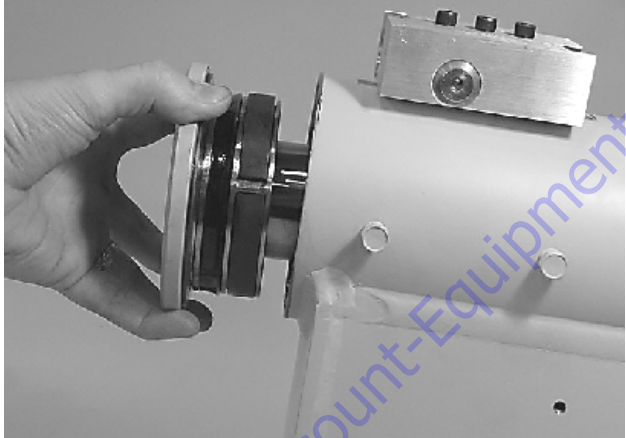
- 10. Looking from opposite end of housing (1) when timing marks line up, tap piston (3) in until gear teeth mesh together. Tap piston in housing until it bottoms out.



- 13. Install 2 bolts in threaded holes in flange. Using a bar, rotate shaft clockwise until wear guides are seated in housing bore.

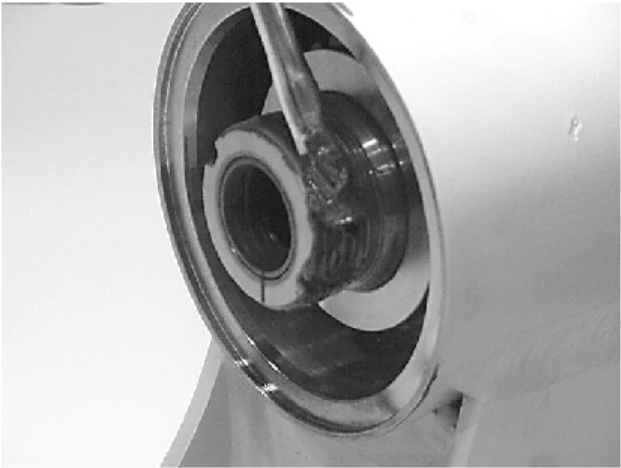


- 11. Install shaft (2) in piston (3). Do not damage seals. Do not engage piston gear teeth.



- 14. Install stop tube on shaft end. Stop tube is an available option to limit actuator rotation.

- 15. Coat threads on end of shaft with anti-seize grease to prevent galling.



- 12. Looking from view shown, use existing timing marks to line up gear teeth on shaft (2) with gear teeth on inside of piston (3). Tap flange end of shaft with rubber mallet until gear teeth engage.

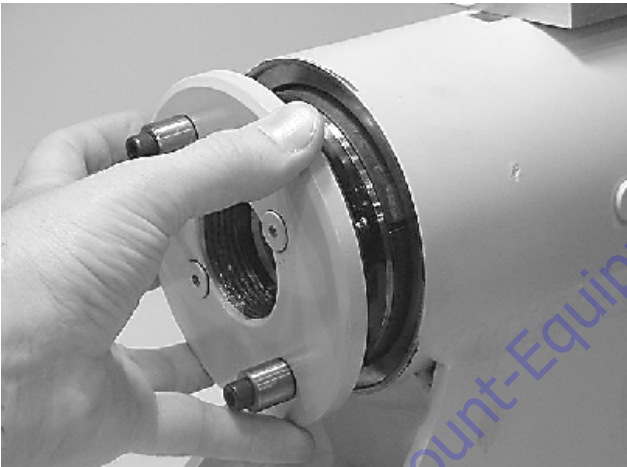


SECTION 4 - BOOM & PLATFORM

16. Install O-ring (204) and back-up ring (207) in inner seal groove on end cap (4).



17. Thread end cap (4) on shaft (2) end. Ensure wear guide stays in place on end cap as it is threaded in housing (1).



18. Tighten end cap (4). Ensure holes for lock pins line up.



19. Place lock pins (109) provided in Helac seal kit in holes with dimple side up. Using a punch, tap lock pins to bottom of hole.



20. Insert set screws (113) over lock pins. Tighten to 25 in-lb (2.825 Nm).



Installing Counterbalance Valve

Refer to Figure 4-21., Rotator Counterbalance Valve.

1. Make sure surface of actuator is clean and free of any contamination and debris, including old Loctite.
2. Make sure new valve has the O-rings in counterbores of valve to seal it to the actuator housing.
3. Bolts that come with valve are Grade 8 bolts. Install new bolts with a new valve. Apply Loctite #242 to shanks of the three bolts at time of installation.
4. Torque 1/4-inch bolts 110-120 in-lb (12.4-13.5 Nm). Do not torque over 125 in-lb (14.1 Nm). Torque 5/16-inch bolts to 140 in-lb (15.8 Nm). Do not torque over 145 in-lb (16.3 Nm).

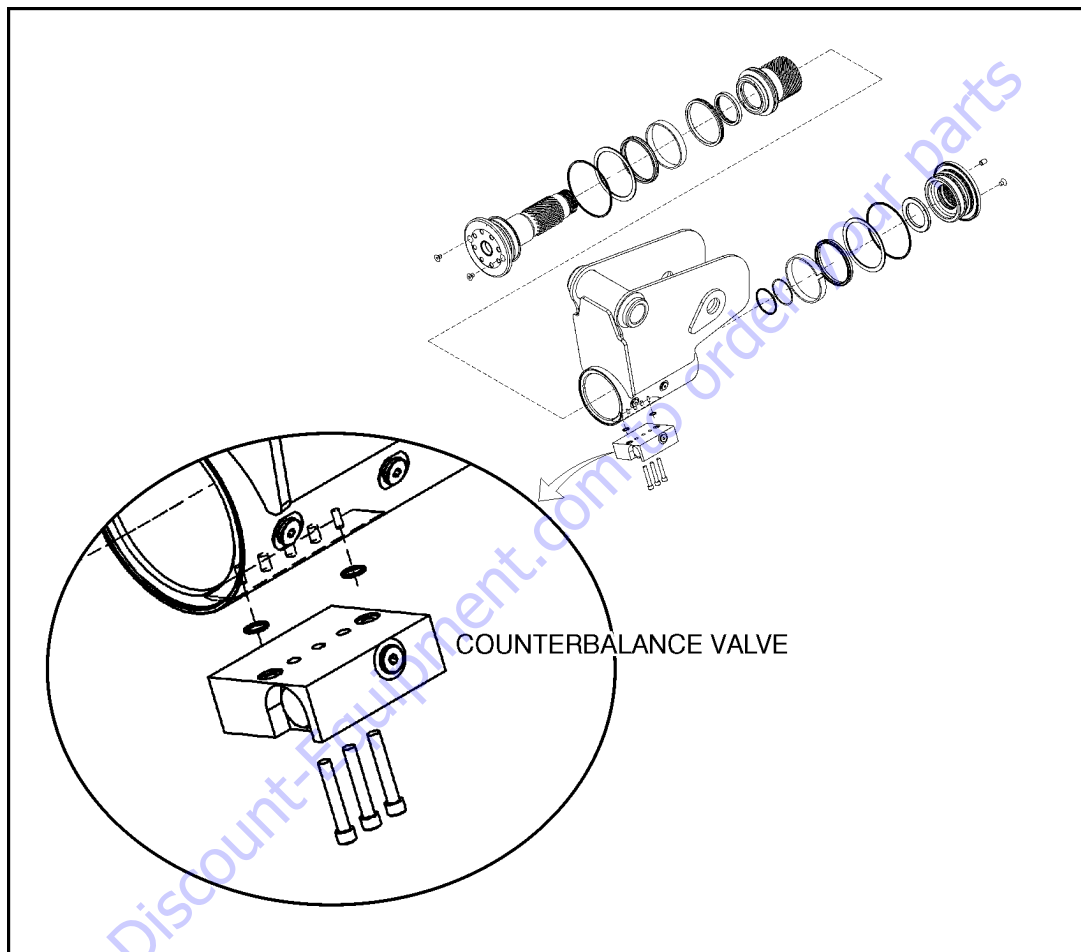


Figure 4-21. Rotator Counterbalance Valve

Testing Actuator

If equipment is available, test actuator on a hydraulic test bench. Breakaway pressure — the pressure at which the shaft begins to rotate — should be approximately 400 psi (28 bar). Cycle actuator at least 25 times at 3000 psi (210 bar) pressure. After 25 rotations, increase pressure to 4500 psi (315 bar). Check for leaks and cracks. Perform test again at end of rotation in the opposite direction.

Testing Actuator for Internal Leaks

If actuator is equipped with a counterbalance valve, plug valve ports, connect hydraulic lines to housing ports. Bleed all air from actuator (see Installation and Bleeding). Rotate shaft to end of rotation at 3000 psi (210 bar) and maintain pressure. Remove hydraulic line from non-pressurized side.

Continuous oil flow from open housing port indicates internal leakage across the piston. Replace line and rotate shaft to end of rotation in opposite direction. Repeat test procedure outlined above for other port. If there is an internal leak, disassemble, inspect, and repair.

Installation and Bleeding

⚠ WARNING

AFTER INSTALLING ACTUATOR, IT IS IMPORTANT THAT ALL SAFETY DEVICES SUCH AS TIE RODS OR SAFETY CABLES ARE PROPERLY REATTACHED.

To purge air from hydraulic lines, connect them together to create a closed loop and pump hydraulic fluid through them. Review hydraulic schematic to determine which hydraulic lines to connect. The linear feet and inside diameter of hydraulic supply lines together with pump capacity determine amount of pumping time required to fully purge the hydraulic system.

Bleeding may be necessary if excessive backlash is exhibited after actuator is connected to hydraulic system. The following steps are recommended when a minimum of two gal (8L) is purged.

1. Connect a 3/16" inside diameter x 5/16" outside diameter x 5 foot clear, vinyl drain tube to each of the two bleed nipples. Secure with hose clamps. Place vinyl tubes in a clean 5-gallon container to collect purged oil.
2. Oil can be returned to reservoir after procedure is completed.

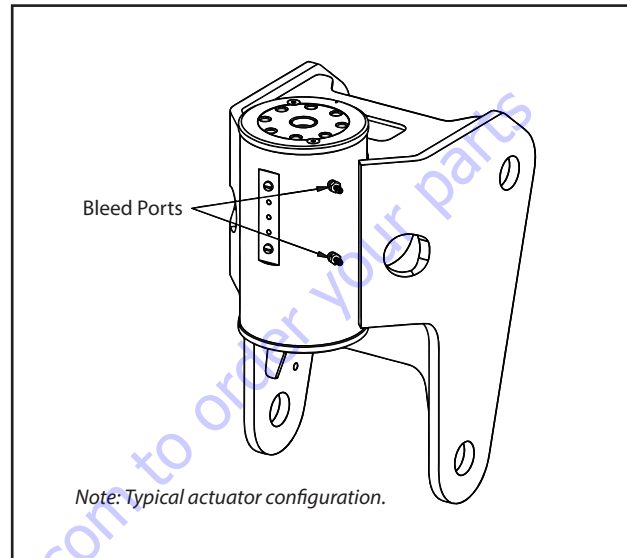


Figure 4-22. Actuator Bleed Ports

3. With an operator in the platform, open both bleed nipples 1/4 turn. Hydraulically rotate platform to end of rotation (clockwise or counterclockwise), and maintain hydraulic pressure. Oil with small air bubbles will be seen flowing through the tubes. Allow 1/2 gallon of fluid to be purged from actuator.
4. Keep fittings open and rotate platform in opposite direction to end position. Maintain hydraulic pressure until an additional 1/4 gallon of fluid is pumped into the container.
5. Repeat steps 2 & 3. After last 1/2 gallon is purged, close both bleed nipples before rotating away from end position.

Table 4-1. Troubleshooting

Problem	Cause	Solution
1. Shaft rotates slowly or not at all	<ul style="list-style-type: none"> a. Insufficient torque output b. Low rate of fluid flow c. Control or counterbalance valve has internal leak d. Piston and/or shaft seal leak e. Corrosion build-up on the thrust surfaces f. Swollen seals and composite bearings caused by incompatible hydraulic fluid 	<ul style="list-style-type: none"> a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator. b. Inspect ports for obstructions and hydraulic lines for restrictions and leaks. c. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate actuator through housing ports (do not exceed OEM's operating pressure). Valve must be replaced if a steady flow of fluid is seen coming from valve ports. d. Remove plug and housing's valve ports. Operate actuator through housing ports. Conduct internal leakage test. e. Rebuild actuator. Remove all rust then polish. Replacement parts may be needed. f. Rebuild actuator. Use fluid compatible with all seals and bearings.
2. Operation is erratic or not responsive	<ul style="list-style-type: none"> a. Air in actuator 	<ul style="list-style-type: none"> a. Purge air from actuator. See bleeding procedures.
3. Shaft will not fully rotate	<ul style="list-style-type: none"> a. Twisted or chipped gear teeth b. Port fittings are obstructing the piston 	<ul style="list-style-type: none"> a. Check for gear binding. Actuator may not be able to be rebuilt and may need to be replaced. Damage could be a result of overload or shock. b. Check thread length of port fittings. Fittings should during stroke not reach inside housing bore.
4. Selected position cannot be maintained	<ul style="list-style-type: none"> a. Control or counterbalance valve has internal leak b. Piston and/or shaft seal leak c. Air in actuator 	<ul style="list-style-type: none"> a. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate actuator through housing ports (do not exceed OEM's operating pressure). Valve must be replaced if a steady flow of fluid is seen coming from valve ports. b. Remove plug and housing's valve ports. Operate actuator through housing ports. Conduct internal leakage test. c. Purge air from actuator. See bleeding procedures

4.12 FOOT SWITCH ADJUSTMENT

Adjust foot switch to operate functions when pedal is at center of travel. Adjust if switch operates within last 1/2 in. (6.35 mm) of top or bottom travel.

⚠ WARNING

ELECTRIC SHOCK OR UNCONTROLLED MACHINE MOVEMENT CAN CAUSE DEATH OR SERIOUS INJURY. DISCONNECT INPUT POWER BEFORE PERFORMING INSTALLATION OR MAINTENANCE.

NOTE: For models with two switches, both switches can be independently adjusted.

1. Remove four socket head cap screws and cover from foot switch assembly.
2. To increase travel before switch is activated, turn Adjustment Screw clockwise.
3. To decrease travel before switch is activated, turn Adjustment Screw counter-clockwise.

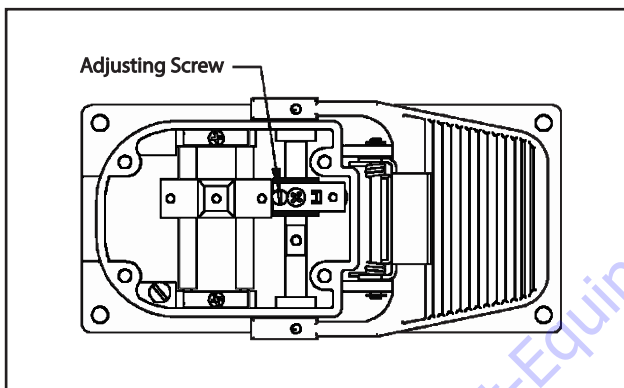


Figure 4-23. Foot Switch Adjustment

4. Install cover and secure with four socket head cap screws. Torque to 18-22 in-lb (2-3 Nm).

4.13 POWERTRACK MAINTENANCE

Remove Link

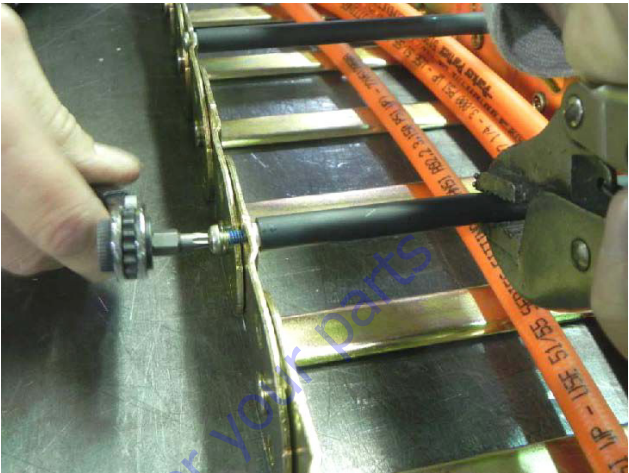
NOTE: Hoses shown in powertrack are for example only. Actual hose and cable arrangements are different.



- 1. Clamp bar and poly roller tightly so they do not spin when removing screw. With a small 1/4" ratchet and a T-20 Torx bit, remove 8-32 x 0.500 screw from one side.



- 2. Repeat step 1 and remove screw from other side of track. Remove bar/poly roller from powertrack.



SECTION 4 - BOOM & PLATFORM

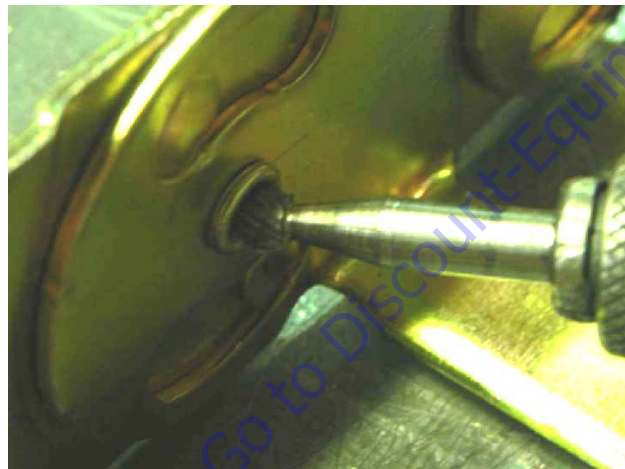
NOTICE

REPOSITION CABLES/HOSES. KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.

3. To remove a link, rivets holding links together must be removed. Use a right-angle pneumatic die grinder with a 1/4" ball double cut bur attachment.

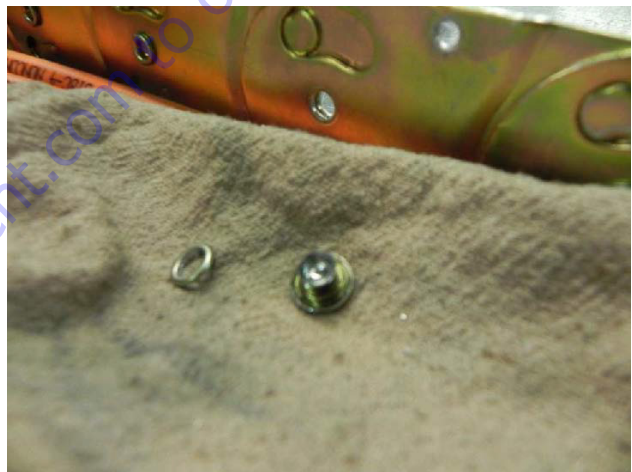


4. insert tool into rolled over end of rivet. Grind out middle of rivet until rolled over part of rivet falls off. Repeat for all rivets to be removed.

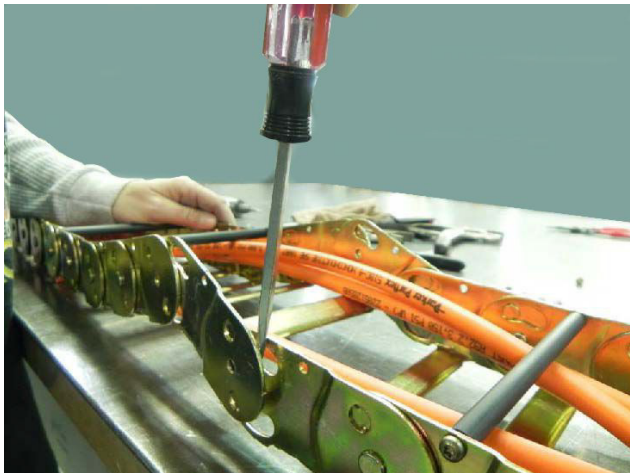


5. After grinding it may be necessary to use a center punch with a hammer to remove rivet.

NOTE: It may be necessary to loosen fixed end brackets from machine to move track section enough to disconnect links.



6. Insert flat head screwdriver between links. Twist and pull links apart.



7. Remove link from other section of powertrack using screwdriver.

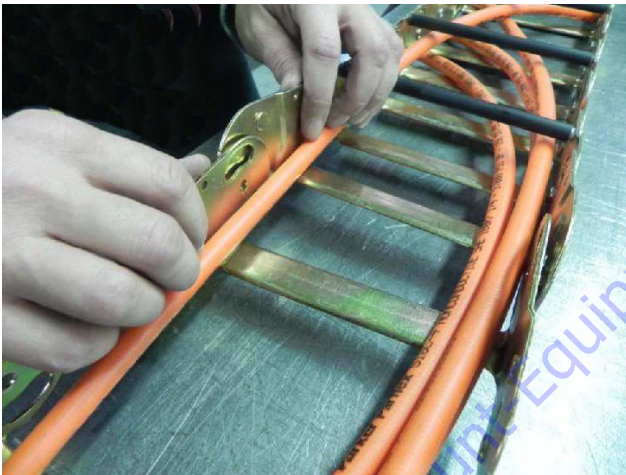


Go to Discount-Equipment.com to order your parts

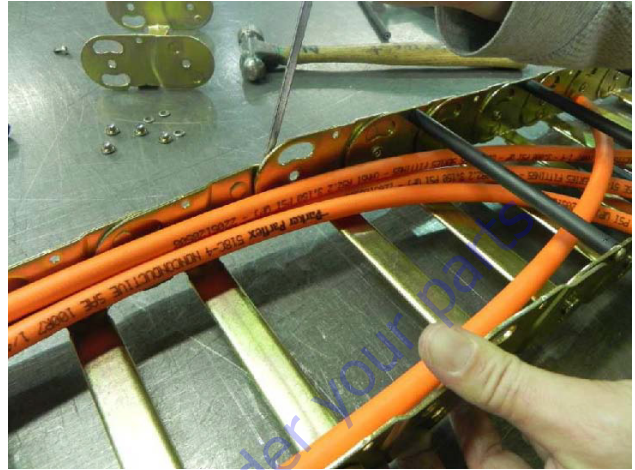
SECTION 4 - BOOM & PLATFORM

Install New Link

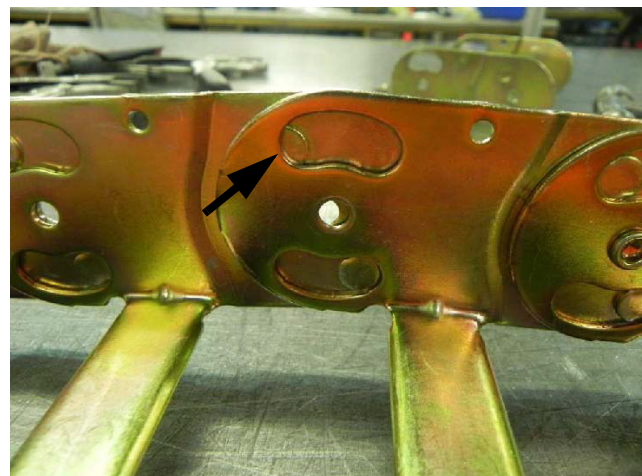
1. Squeeze cut-out end of new link into half-shear (female) end of track section.



2. Spread half-shear (female) end of new link and slide cut-out end of track section into it. Use screwdriver if necessary.



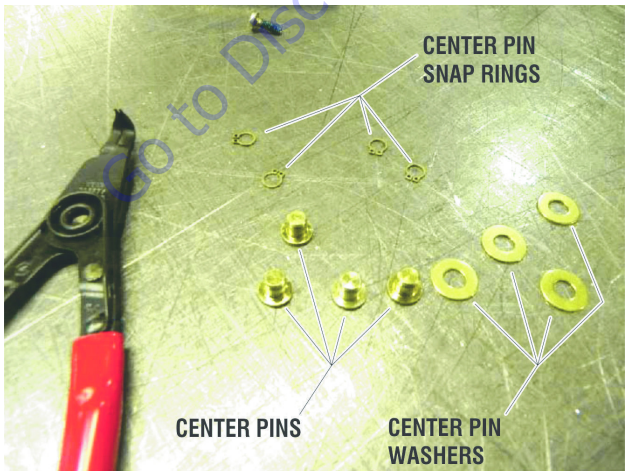
3. Round half-shears will not fit properly in cut-outs after new link is installed .



- 4. Pull moving end over track so new connection is positioned in curve of powertrack. Round half-shears will rotate into cut-outs.



- 5. Parts shown below connect new link to powertrack.



- 6. Push pin through center hole. Slide washer on pin.

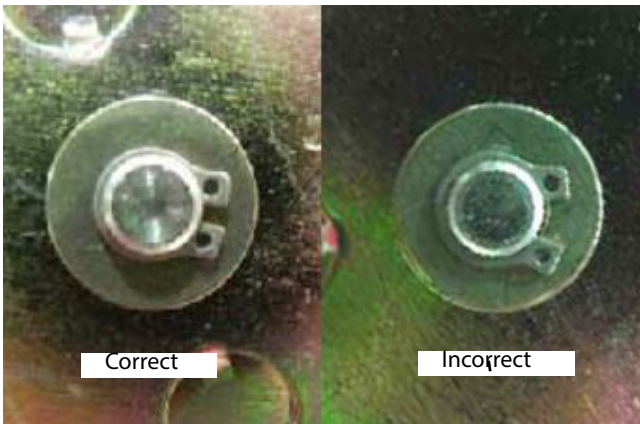


- 7. Install snap ring in groove on pin. Repeat pin installation steps for all center holes with rivets removed.



SECTION 4 - BOOM & PLATFORM

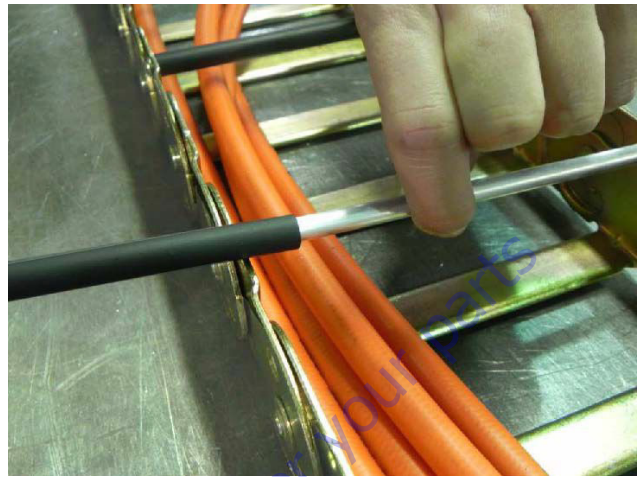
NOTE: Make sure snap rings are seated in pin groove and closed properly.



1. Install new 8-32 x 0.500 self-threading Torx head screw in end of new aluminum round bar. Torque to 18-20 in-lb (2-2.25 Nm).



2. Pull up on other end of round bar. Slide new poly roller on bar.



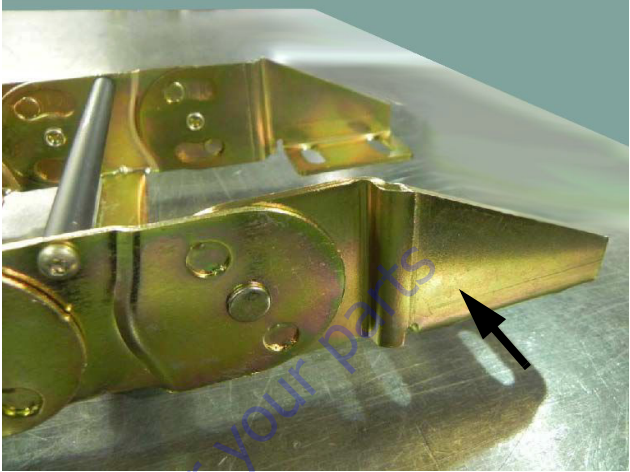
- 3. Install new 8-32 x 0.500 self threading screw on other side. Torque to 18-20 in-lb (2-2.25 Nm).



NOTE: When tightening screws make sure screw head is seated against link with no space in between link and underside of screw head.



Replace Fixed End Brackets



NOTICE

REPOSITION CABLES/HOSES. KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.

- 1. Remove rivets as shown in link removal instructions..



SECTION 4 - BOOM & PLATFORM

- Parts used: Bracket Center Pin and Center Pin Snap Ring.



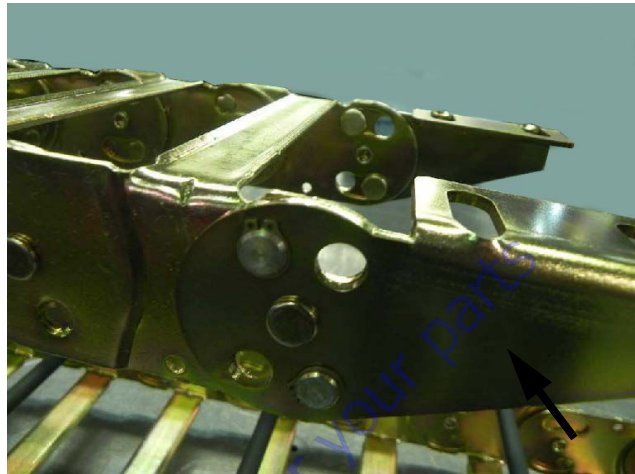
- Take new bracket and install bracket center pin and snap ring. Repeat on other bracket if replacing it.



NOTE: Ensure snap rings are seated in pin groove and closed properly.



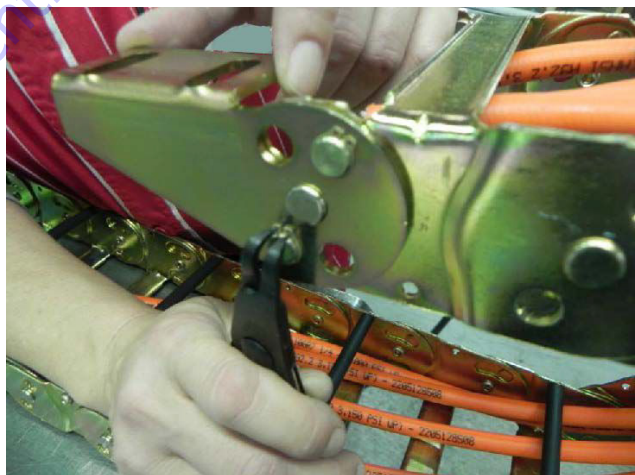
Replace Moving End Brackets



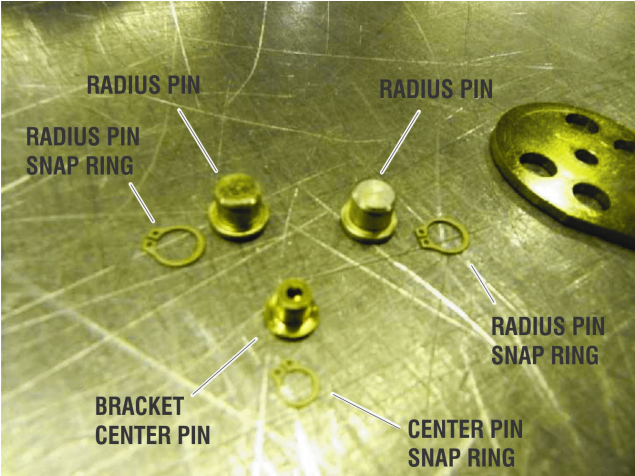
NOTICE

REPOSITION CABLES AND HOSES. KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.

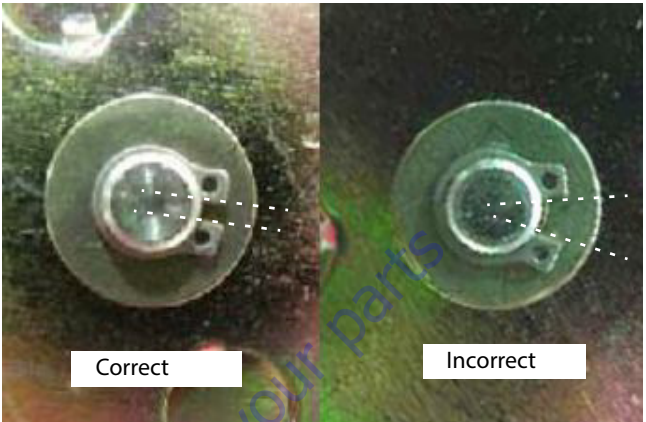
- Remove existing pins and center rivet. Remove rivet as shown in link removal instructions on page 4-20. Repeat on other bracket if replaced.



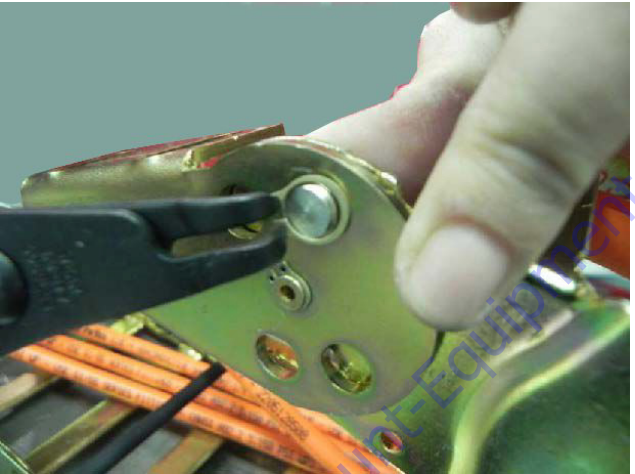
2. Install center pin with snap ring in new bracket.



NOTE: Ensure snap rings are seated in pin groove and closed properly.



3. Install radius pins and snap rings in original locations. Repeat with other moving end if replaced.



1. Make sure both brackets rotate correctly.



4.

4.14 SKYGUARD

Operation

Skyguard is used to provide enhanced control panel protection. When the SkyGuard sensor is activated, functions that were in use at the time of actuation will reverse or cutout. Refer Table 4-2, "SkyGuard Function Table," on page 57 for functions.

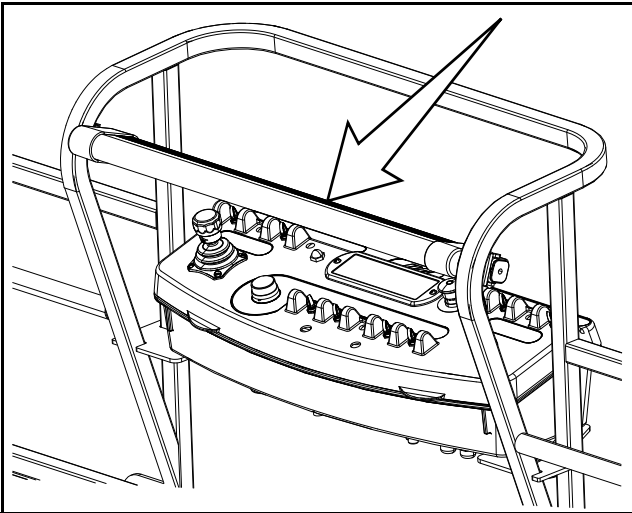


Figure 4-24. Skyguard

Functional Test

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "SKYGUARD" IS SELECTED IN MACHINE SET UP.

In Platform Mode:

1. In an area free of obstructions, from the platform controls test the SkyGuard feature by operating the telescope out functions and engaging (and holding) the SkyGuard sensor. Telescope function will be stopped and telescope in function will be activated for a short duration. Soft touch indicator light will flash at 3HZ, horn will be turned on, until the SkyGuard sensor and footswitch is disengaged.
2. With SkyGuard sensor engaged, press and hold the yellow "Override Soft Touch" button and then operate a function switch or joystick to check if the operation can be resumed.
3. Disengage the SkyGuard sensor, release controls, recycle the foot switch, make sure normal operation available.

In Ground Mode:

Operation will be allowed regardless of SkyGuard sensor activation.

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "BOTH" IS SELECTED.

In Platform Mode:

NOTE: Machine will treat Soft Touch/SkyGuard override switch as if it is a Soft Touch and SkyGuard switch.

1. In an area free of obstructions, from platform controls test the SkyGuard feature by operating the telescopic out functions and engaging the SkyGuard sensor, telescopic out function will be stopped, soft touch indicator light will flash at 3HZ, the horn will be turned on until the SkyGuard sensor and footswitch is disengaged.
2. With SkyGuard sensor engaged, press and hold the yellow "Override Soft Touch" button and then operate a function switch or joystick to check if the operation can be resumed.
3. Disengage the SkyGuard sensor, release controls, recycle the foot switch, make sure normal operation is available.

In Ground Mode:

Operation will be allowed regardless of SkyGuard switch activation.

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "SOFT TOUCH" IS SELECTED.

Machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch.

IF SKYGUARD SYSTEM IS INSTALLED ON MACHINE & "NONE" IS SELECTED.

Skyguard sensor status will be ignored. No function cutout or reversal will be implemented.

Diagnostic & Troubleshooting

If you are experiencing a problem that is not described here, see your authorized dealer for service.

1. Check the configuration under the menu "MACHINE SETUP à STOUCH/SKYGUARD" according to the actual system installed on machine. Make sure recommended configuration described is selected.

If SkyGuard does Not Function with sensor engaged.



AUTHORIZED TECHNICIAN OR OPERATOR IS REQUIRED TO CONDUCT AN OPERATION CHECK OF SKYGUARD SENSOR DAILY.

Help menu or diagnostics menu is to be used to collect the fault information.

Depending on configurations, diagnostics menu will read:

Diagnostics->System->Skyguard switch

Diagnostics->System->STOUCH OR SG

Pressing to engage the SkyGuard sensor will change the switch or relay to open/close status.

If the switch status stays in "Open" while the actual SkyGuard sensor is pressed, then the SkyGuard sensor may have failed, it needs to be changed immediately.

2. If machine operation is not available:

Help menu or diagnostics menu is to be used to collect the fault information.

Depending on configuration, diagnostics menu will read:

Diagnostics->System->Skyguard switch

Diagnostics->System->STOUCH OR SG

Pressing to engage the SkyGuard sensor will change the switch or relay to open/close status.

If the switch status states "Closed" regardless of sensor activation status:

Power or ground wire is not making good contact and/or may be loose or broken.

Both relays failed (low probability).

If the switch status is in disagreement, then one relay may have failed or one relay isn't inserted into the holder correctly. This may also be noticed since machine will not be able to be operated.

Switch disagreement fault (2563) and SkyGuard switch activation fault (0039) will be shown under Help menu.

Table 4-2. SkyGuard Function Table

Main Lift	Main Tele In	Main Tele Out	Main Swing	Drive Forward		Drive Reverse		Basket Level	Basket Rotate	Jib Lift
				DOS Enabled	DOS Not Enabled	DOS Enabled	DOS Not Enabled			
R	C	R	R	R	C*	R	R	C	C	C
R = Indicates Reversal is Activated										
C = Indicates Cutout is Activated										
* Disregard when boom is in line and driving forward with or without steering and no other function active										
Note: When Soft Touch is enabled with SkyGuard all functions are cut out only.										

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SECTION 5. HYDRAULICS

5.1 O-RING LUBRICATION

When assembling connectors, all fittings with O-rings must be lubricated with hydraulic oil before assembly. There are four methods of lubricating O-rings:

1. Cup and Brush
2. Dip
3. Spray
4. Brush-On

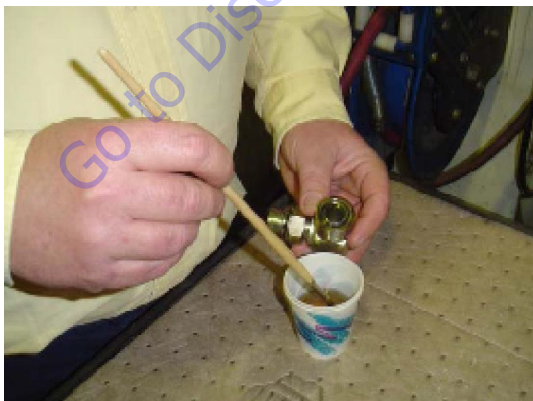
Cup and Brush

Tools needed:

- Small container for hydraulic oil
- Small paint brush



1. Hold fitting in one hand and dip brush into container with other hand. Remove excess hydraulic oil from brush so an even film of oil is applied to O-ring.



2. Hold fitting over hydraulic oil container and brush an even film of oil around entire O-ring in fitting. Make sure O-ring is completely saturated.



3. Turn fitting over and repeat previous step to O-ring on other side of fitting. Make sure entire O-ring is coated with hydraulic oil.



Dip

NOTE: This method works best with Face Seal O-rings, but will work for all O-ring fitting types.

Tools needed:

- Small leak proof container
 - Sponge cut to fit inside container
 - Small amount of hydraulic oil to saturate sponge.
1. Place sponge inside container and add hydraulic oil to sponge until fully saturated.
 2. Dip fitting into sponge using firm pressure.



3. After lifting fitting, a small droplet should form and drip from bottom of fitting. This indicates an even coating of oil.



NOTE: O-ring boss-type fittings require more pressure to immerse more of fitting into saturated sponge. This also causes more oil to be dispersed from sponge.

Spray

This method requires a pump or trigger spray bottle.

1. Fill spray bottle with hydraulic oil.
2. Hold fitting over suitable catch can.
3. Spray entire O-ring surface with medium coat of oil.



Brush-On

This method requires a sealed bottle brush.

1. Fill bottle with hydraulic oil.
2. Using slight pressure to body of spray bottle, invert bottle so brush end faces down.
3. Brush an even coat of hydraulic oil on entire O-ring.



5.2 CYLINDERS - THEORY OF OPERATION

Systems With Double Acting Cylinders

Systems with double acting cylinders are the Platform (Slave) Level, Master Level, Main Lift, Telescope, Articulating Jib Boom Lift, Axle Lockout, and Steer. A double acting cylinder is one that requires oil flow to operate the cylinder rod in both directions. Directing oil (by actuating the corresponding control valve to piston side of cylinder) forces the piston to travel toward the rod end of the barrel, extending the cylinder rod (piston attached to rod). When oil flow is stopped, movement of rod stops. By directing oil to the rod side of the cylinder, the piston is forced in the opposite direction and the cylinder rod retracts.

Systems With Holding Valves

Holding valves are used in the Main Lift, Telescope, Lockout, Platform (Slave) Level, and Articulating Jib Boom Lift circuits to prevent retraction of the cylinder rod should a hydraulic line rupture or a leak develop between the cylinder and its control valve.

5.3 CYLINDER CHECKING PROCEDURE

NOTE: Cylinder check must be performed anytime a system component is replaced or when improper system operation is suspected.

Cylinders Without Counterbalance Valves - Master Cylinder and Steer Cylinder

1. Using all applicable safety precautions, activate engine and fully extend cylinder to be checked. Shut down engine.
2. Carefully disconnect hydraulic hoses from retract port of cylinder. There will be some initial weeping of hydraulic fluid which can be caught in a suitable container. After initial discharge, there should be no further drainage from the retract port.
3. Activate engine and extend cylinder.
4. If cylinder retract port leakage is less than 6-8 drops per minute, carefully reconnect hose to port and retract cylinder. If leakage continues at a rate of 6-8 drops per minute or more, repair cylinder.
5. With cylinder fully retracted, shut down engine and carefully disconnect hydraulic hose from cylinder extend port.
6. Activate engine and retract cylinder. Check extend port for leakage.
7. If extend port leakage is less than 6-8 drops per minute, carefully reconnect hose to extend port, then activate cylinder through one complete cycle and check for leaks. If leakage continues at a rate of 6-8 drops per minute or more, repair cylinder.

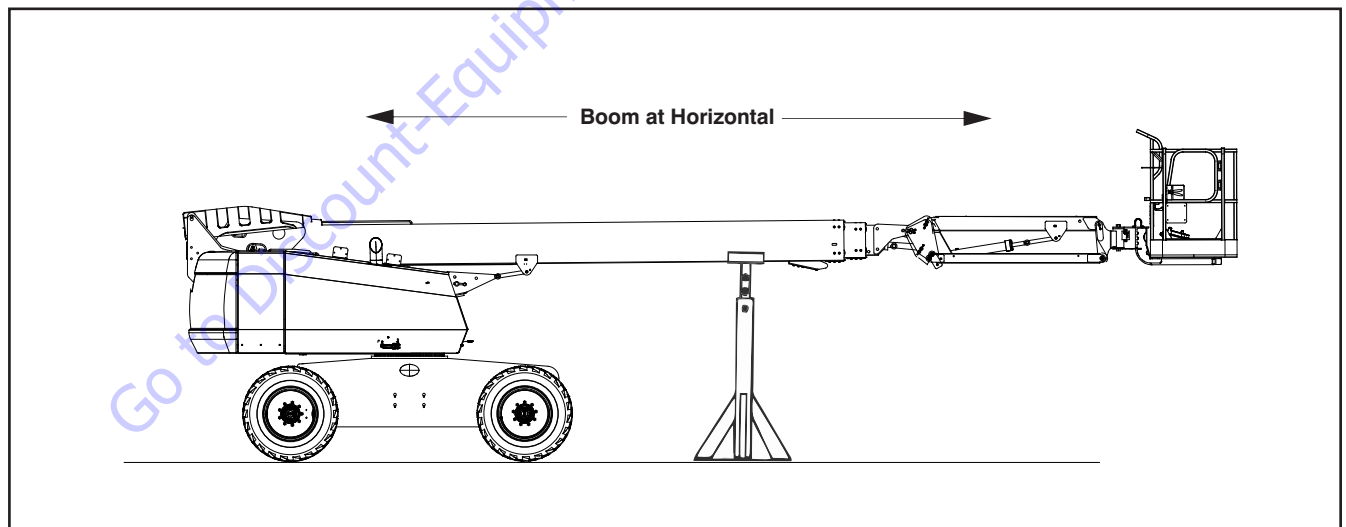


Figure 5-1. Boom Positioning and Support, Cylinder Repair

Cylinders With Single Counterbalance Valve

(Main Lift Cylinder)

⚠ WARNING

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

1. Using all applicable safety precautions, activate hydraulic system.

⚠ WARNING

WHEN WORKING ON MAIN LIFT CYLINDER, RAISE BOOM TO HORIZONTAL AND PLACE A BOOM PROP APPROXIMATELY 1 INCH (2.54 CM) BELOW THE MAIN BOOM. DO NOT WORK ON CYLINDER WITHOUT A SUITABLE PROP IN PLACE.

2. Shut down hydraulic system and allow machine to sit for 10-15 minutes. If machine is equipped with proportional control valves, turn IGNITION SWITCH to ON, move control switch or lever for applicable cylinder in each direction, then turn IGNITION SWITCH to OFF. If machine is equipped with hydraulic control valves, move control lever for applicable cylinder in each direction. This is done to relieve hydraulic line pressure. Carefully remove hydraulic hoses from appropriate cylinder port block.
3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After initial discharge, there should be no further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, counterbalance valve is defective and must be replaced.
4. To check piston seals, carefully remove counterbalance valve from the retract port. After initial discharge, there should be no further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, piston seals are defective and must be replaced.
5. If no repairs are necessary or when repairs have been made, replace counterbalance valve and connect hydraulic hoses to cylinder port block.
6. If used, remove lifting device from upright or remove prop from below main boom. Activate hydraulic system and run cylinder through one complete cycle to check for leaks.

Cylinders With Dual Counterbalance Valves

(Articulating Jib Boom Lift, Platform (Slave) Level, Main Telescope)

⚠ WARNING

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

1. Using all applicable safety precautions, activate hydraulic system.

⚠ WARNING

IF WORKING ON PLATFORM LEVEL CYLINDER, STROKE PLATFORM LEVEL CYLINDER FORWARD UNTIL PLATFORM SITS AT A 45 DEGREES ANGLE.

2. Shut down hydraulic system and allow machine to sit for 10-15 minutes. If machine is equipped with proportional control valves, turn IGNITION SWITCH to ON, move control switch or lever for applicable cylinder in each direction, then turn IGNITION SWITCH to OFF. If machine is equipped with hydraulic control valves, move control lever for applicable cylinder in each direction. This is done to relieve hydraulic line pressure. Carefully remove hydraulic hoses from appropriate cylinder port block.
3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After initial discharge, there should be no further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, counterbalance valve is defective and must be replaced.
4. To check piston seals, carefully remove the counterbalance valve from the retract port. After initial discharge, there should be no further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, the piston seals are defective and must be replaced.
5. If no repairs are necessary or when repairs have been made, replace counterbalance valve and carefully connect hydraulic hoses to cylinder port block.
6. Remove lifting device from upright or remove prop from below main boom. Activate hydraulic system and run cylinder through one complete cycle to check for leaks.

5.4 CYLINDER REMOVAL AND INSTALLATION

Main Boom Telescope Cylinder Removal

1. Place machine on a flat and level surface, with main boom in the horizontal position.
2. Shut down engine. Support main boom basket end with a prop. (See Figure 5-1., Boom Positioning and Support, Cylinder Repair).

NOTICE

CAP HYDRAULIC LINES AND PORTS IMMEDIATELY AFTER DISCONNECTING LINES TO PREVENT ENTRY OF CONTAMINANTS INTO THE SYSTEM.

3. Tag and disconnect hydraulic lines to telescope cylinder. Use a suitable container to retain residual hydraulic fluid. Cap hydraulic lines and ports.
4. Remove hardware securing cover plate on bottom of base boom section and remove cover.

NOTICE

DO NOT ALLOW CABLE TO ROTATE. THIS MAY DAMAGE THE CABLE.

5. Clamp both threaded ends of cable to prevent rotation. Note: Do not clamp on threads. Remove jam nuts and loosen adjustment nuts so there is slack in the cables. (See Section 4 - Boom & Platform).
6. Remove hardware securing push bar to turntable and telescope cylinder.
7. Using a suitable brass drift, carefully drive push bar pins from telescope cylinder rod and turntable.
8. Remove hardware securing cable adjustment block to aft end of the base boom section and remove block.
9. Remove hardware securing telescope cylinder to aft end of mid boom section.

NOTICE

WHEN REMOVING TELESCOPE CYLINDER FROM BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED IN THE BOOM. MOVE CYLINDER SLOWLY INTO POSITION OR DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

10. Remove bolts securing cable attach bar to top of fly boom section.
11. Pull telescope cylinder and cables partially from aft end of base boom section. Secure cylinder with a suitable sling and lifting device at center of gravity.
12. Carefully remove telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.

Main Boom Telescope Cylinder Installation

1. Route extend cables around extend sheave and secure cables to the telescope cylinder.
2. Install extend cables mounting blocks to threaded ends of cables. Loosely install nuts and jam nuts on threaded end of cables.

NOTICE

DO NOT TO TWIST OR CROSS CABLES DURING INSTALLATION.

3. Secure sling and lifting device at telescope cylinder's center of gravity. Lift cylinder to aft end of boom assembly.
4. Install extend cable mounting blocks to threaded ends of cables. Loosely install nuts and jam nuts on threaded ends of cables.

NOTICE

WHEN INSERTING TELESCOPE CYLINDER INTO BOOM, IT MAY BE NECESSARY TO TURN CYLINDER SLIGHTLY TO CLEAR ASSEMBLIES MOUNTED IN THE BOOM. MOVE CYLINDER SLOWLY INTO POSITION OR DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

5. Carefully install telescope cylinder barrel end support into slots in mid boom and secure with blocks and bolts. Use Loctite #242 on bolts.
6. Align holes in aft end of fly boom section with holes in cable mounting block. Secure with mounting hardware.
7. Align holes in aft end of base boom section with holes in cable mounting block. Secure with mounting hardware.
8. Remove cylinder port plugs and hydraulic line caps. Correctly attach lines to cylinder ports.
9. Align holes in rod end of telescope cylinder with holes in push bar. Install push bar pin and secure with mounting hardware.
10. Align holes in push bar with holes in turntable. Install push bar pin and secure with mounting hardware.

NOTE: *Boom cables must be torqued after telescope cylinder installation. (See Section 4.7, Wire Rope Tensioning Adjustment)*

Main Boom Lift Cylinder Removal

1. Place machine on a flat and level surface. Start engine and place main boom in horizontal position. Shut down engine and prop boom. (See Figure 5-1., Boom Positioning and Support, Cylinder Repair)
2. Remove hardware retaining cylinder rod attach pin to boom. Using a suitable brass drift, drive out cylinder rod pin.
3. Using auxiliary power, retract the lift cylinder rod completely.
4. Disconnect, cap and tag the main boom lift cylinder hydraulic lines and ports.
5. Remove barrel end attach pin retaining hardware. Using a suitable brass drift drive out the barrel end attach pin from the turntable.
6. Remove the cylinder from the turntable and place in a suitable work area.

Main Boom Lift Cylinder Installation

1. Install lift cylinder in place using suitable slings or supports, aligning attach pin mounting holes on the turntable.
2. Using a suitable drift, drive barrel end attach pin through mounting holes in lift cylinder and turntable. Secure in place with pin retaining hardware.
3. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.
4. Using auxiliary power, extend cylinder rod until attach pin hole aligns with those in the boom. Using a suitable soft mallet, drive cylinder rod attach pin through the boom and lift cylinder. Secure pin in place with attaching hardware.
5. Remove boom prop and overhead crane. Activate hydraulic system.
6. Using all applicable safety precautions, operate boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
7. Check fluid level of hydraulic tank. Adjust as necessary.

5.5 CYLINDER REPAIR

NOTE: Following are general procedures that apply to all cylinders on this machine. Procedures that apply to a specific cylinder are noted.

Disassembly

NOTICE

CYLINDER DISASSEMBLY SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA TO PREVENT CONTAMINATION.

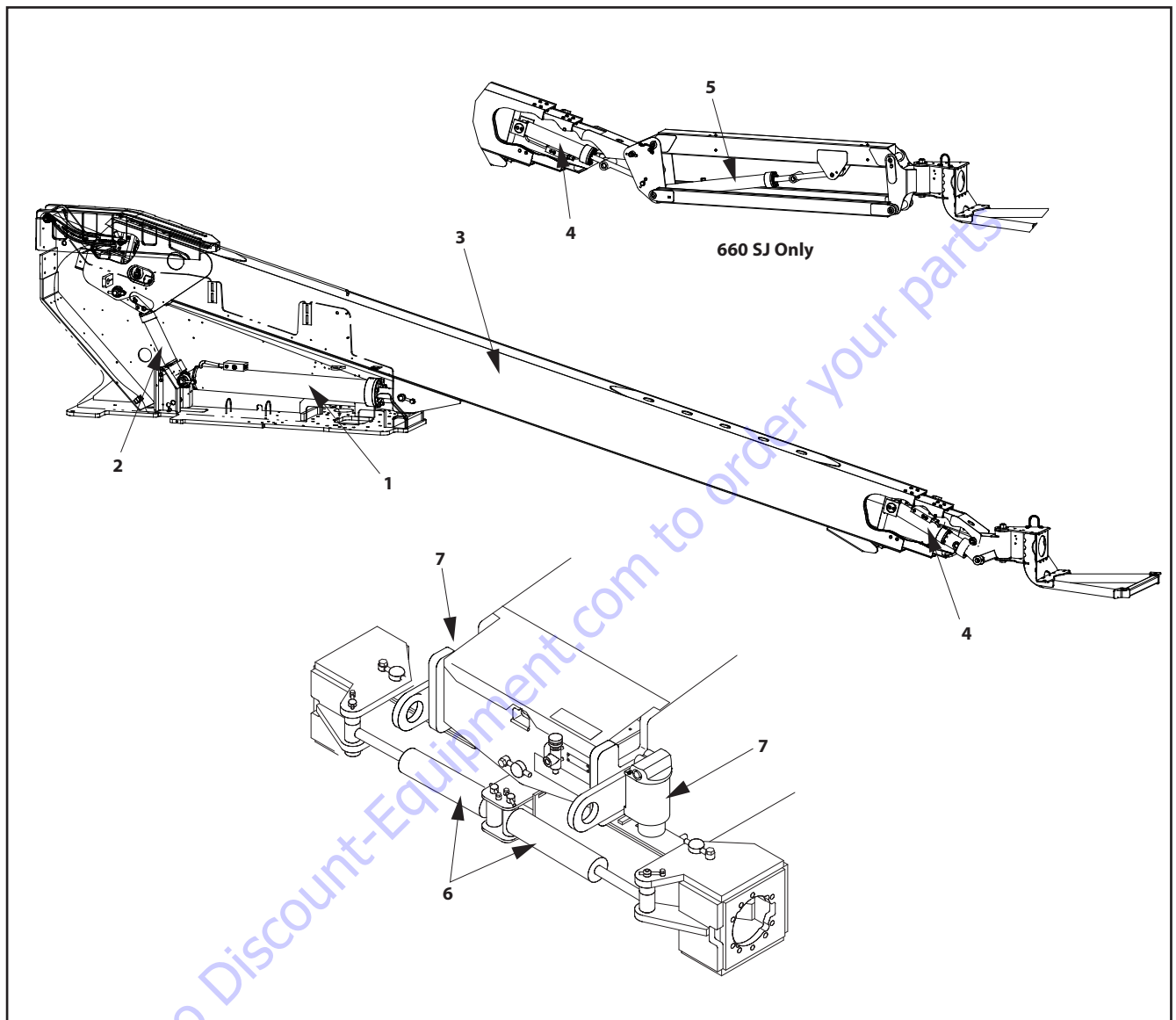
1. Connect a suitable auxiliary hydraulic power source to cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate hydraulic power source and extend the cylinder. Shut down and disconnect power source. Adequately support cylinder rod, if applicable.
3. If applicable, remove cartridge-type holding valve and fittings from cylinder port block. Discard O-rings.

Cylinder Locations



Item	Cylinder
1	Main Lift
2	Master
3	Telescope
4	Platform (Slave Level)
5	Jib Lift
6	Steer
7	Axle Lockout

Figure 5-2. Hydraulic Cylinder Locations

Main Lift Cylinder

DISASSEMBLY

NOTE: Refer to Figure 5-6.

NOTICE

CONTAMINATION MAY DAMAGE EQUIPMENT. DISASSEMBLE CYLINDER ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to cylinder port block fitting.

WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate hydraulic power source and extend cylinder. Shut down and disconnect power source. Adequately support cylinder rod, if applicable.
3. If applicable, remove cartridge-type counterbalance valve and fittings from cylinder port block. Discard O-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

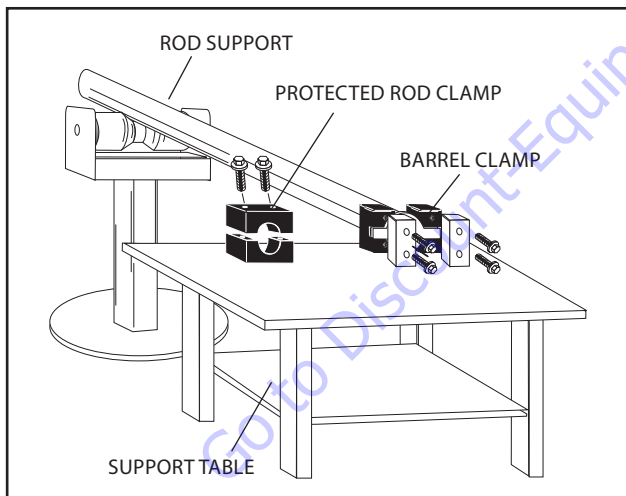


Figure 5-3. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

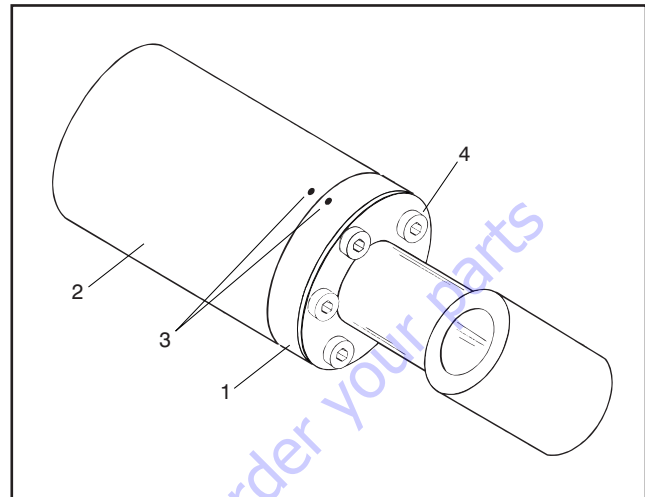


Figure 5-4. Marking Cylinder for Alignment

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.

6. Clamp barrel securely. Pull rod assembly and cylinder head from barrel.
7. Protect cylinder rod from damage and clamp in a vise or holding fixture as close to piston as possible.

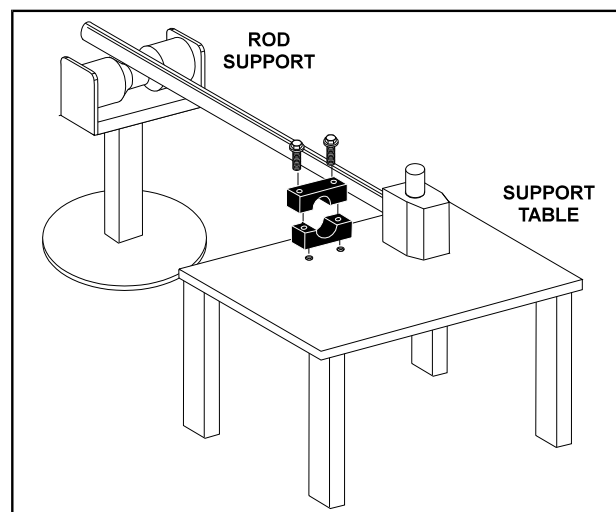
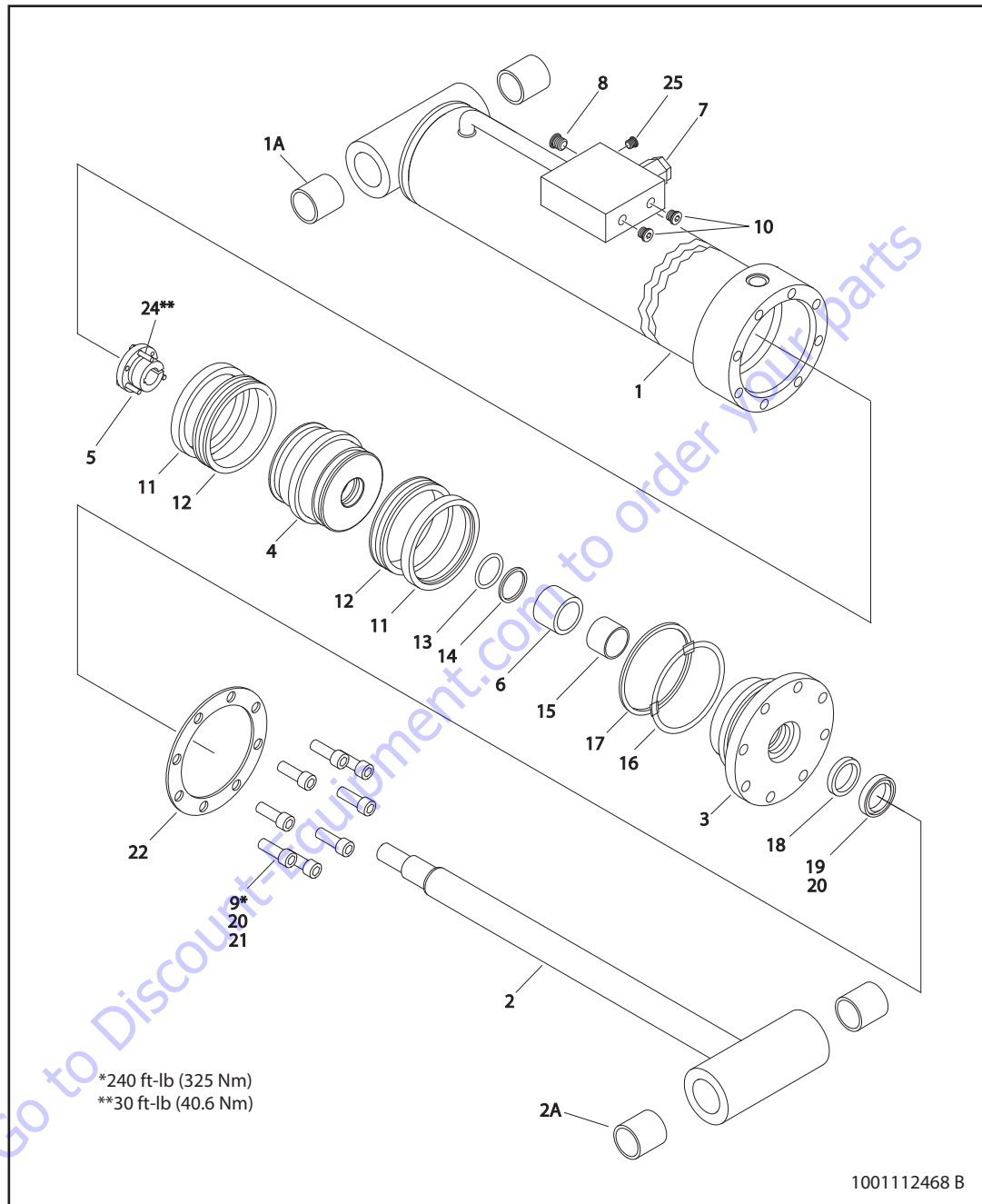


Figure 5-5. Cylinder Rod Support



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*240 ft-lb (325 Nm)
 **30 ft-lb (40.6 Nm)

1001112468 B

- | | | | | |
|-----------------------|--------------------|--------------------|----------------------|-----------------------|
| 1. Barrel | 5. Tapered Bushing | 11. Lock Ring | 17. Back-Up Ring | 23. Not Used |
| 1a. Composite Bushing | 6. Spacer | 12. Hydrolock Seal | 18. Rod Seal | 24. Socket Head Screw |
| 2. Rod | 7. Cartridge Valve | 13. O-Ring | 19. Wiper | 25. O-Ring Plug |
| 2a. Composite Bushing | 8. O-Ring Plug | 14. Back-Up Ring | 20. Locking Compound | |
| 3. Head | 9. 5/16"-11x2 Bolt | 15. Wear Ring | 21. Locking Primer | |
| 4. Piston | 10. O-Ring Plug | 16. O-Ring | 22. Ring Washer | |

Figure 5-6. Main Lift Cylinder Assembly

SECTION 5 - HYDRAULICS

8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Loosen and remove nut attaching piston to rod. Remove piston.
10. Loosen and remove cap screw(s), if applicable, attaching tapered bushing to piston.
11. Insert cap screw(s) in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
12. Remove tapered bushing from piston.
13. Screw piston counter-clockwise by hand and remove from cylinder rod.

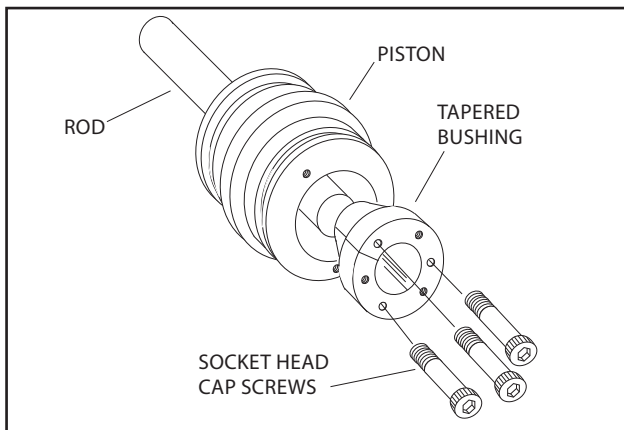


Figure 5-7. Tapered Bushing Removal

14. Remove and discard piston O-rings, seal rings, and backup rings.
15. Remove piston spacer, if applicable, from rod.
16. Remove rod from holding fixture. Remove cylinder head gland and retainer plate, if applicable. Discard O-rings, back-up rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean parts thoroughly with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage, scoring, or distortion. Dress piston surface or replace piston as necessary.

7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and O-ring grooves in piston for burrs and sharp edges. Dress surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage, and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and O-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring, damage, ovality, and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
 - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
 - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
 - c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.

NOTE: Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

- d. Press composite bushing into barrel or rod bushing with correct size arbor.

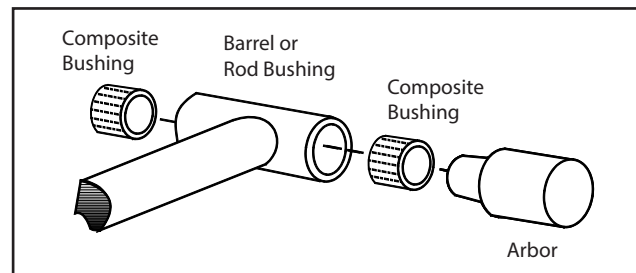


Figure 5-8. Composite Bushing Installation

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Use seal tool to install new rod seal into applicable cylinder head gland groove.

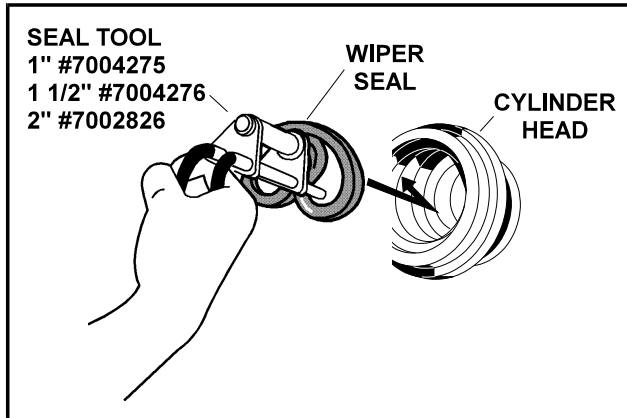


Figure 5-9. Rod Seal Installation

NOTICE

IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION. ENSURE 'POLY-PAK' PISTON SEALS ARE PROPERLY INSTALLED. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION.

2. Use a soft mallet to tap new wiper seal into applicable cylinder head gland groove. Install new wear ring in applicable cylinder head gland groove.

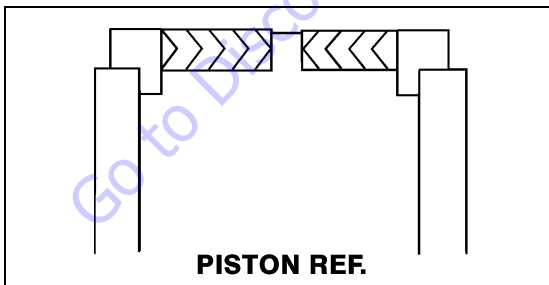


Figure 5-10. Poly-Pak Piston Seal Installation

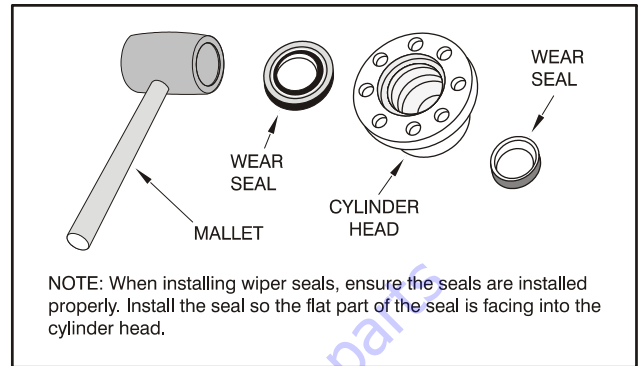


Figure 5-11. Wiper Seal Installation

3. Place new O-ring and back-up seal in applicable outside diameter groove of cylinder head.

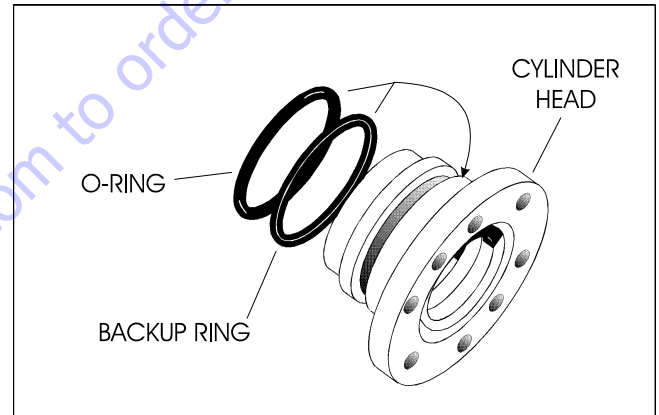


Figure 5-12. Head Seal Kit Installation

4. Install washer ring on rod. Carefully install head gland on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end, as applicable.
5. Carefully slide piston spacer on rod.

SECTION 5 - HYDRAULICS

- If applicable, place new O-ring and back-up rings in inner piston diameter groove.

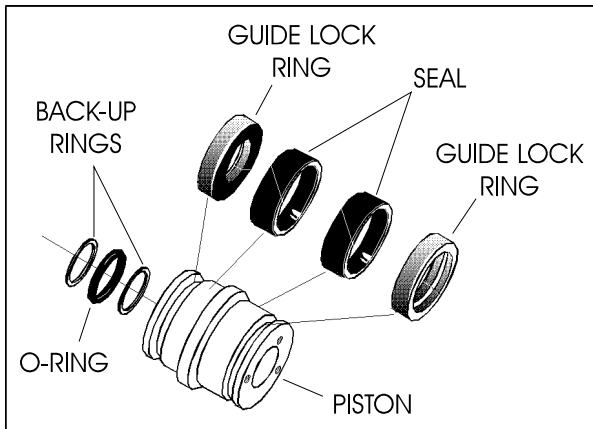


Figure 5-13. Piston Seal Kit Installation

- Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
- Carefully thread piston on cylinder rod hand tight, Ensure O-ring and back-up rings are not damaged or dislodged.

NOTE: Piston and mating end of rod must be free of oil when installing tapered bushing.

- Thread piston onto rod until it aligns with spacer end and install tapered bushing.

NOTE: Apply LOCTITE #242 or equivalent to tapered bushing bolts when rebuilding master, slave, lift, and telescope cylinders.

- Install bolts in tapered bushing using loctite #242

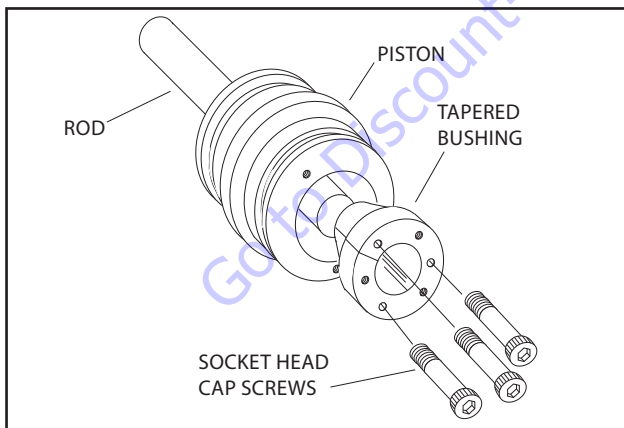


Figure 5-14. Tapered Bushing Installation

- Remove cylinder rod from holding fixture.
- Place new guide locks and seals in applicable outside diameter grooves of cylinder piston. (See Figure 2-28. Piston Seal Kit Installation.)
- Position cylinder barrel in a suitable holding fixture.

NOTICE

INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN INSTALLING CYLINDER ROD, HEAD, AND PISTON.

- Clamp barrel clamped securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
- Continue pushing rod into barrel until cylinder head gland can be inserted into barrel cylinder.
- Secure cylinder head gland using washer ring and socket head bolts.

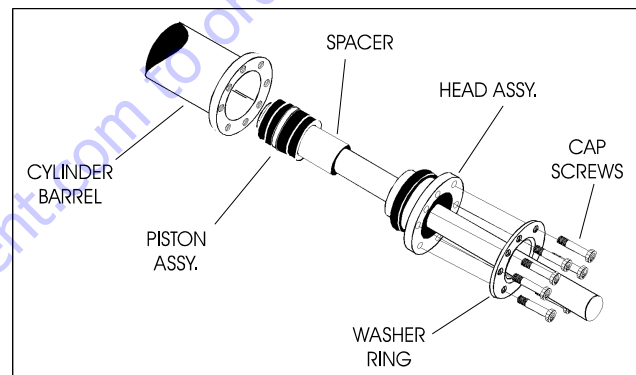


Figure 5-15. Rod Assembly Installation

Master Cylinder

DISASSEMBLY

NOTE: Refer to Figure 5-19. Master Cylinder.

NOTICE

CONTAMINATION MAY DAMAGE EQUIPMENT. DISASSEMBLE CYLINDER ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to cylinder port block fitting.

WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate hydraulic power source and extend cylinder. Shut down and disconnect power source. Adequately support cylinder rod, if applicable.
3. If applicable, remove cartridge-type counterbalance valve and fittings from cylinder port block. Discard O-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

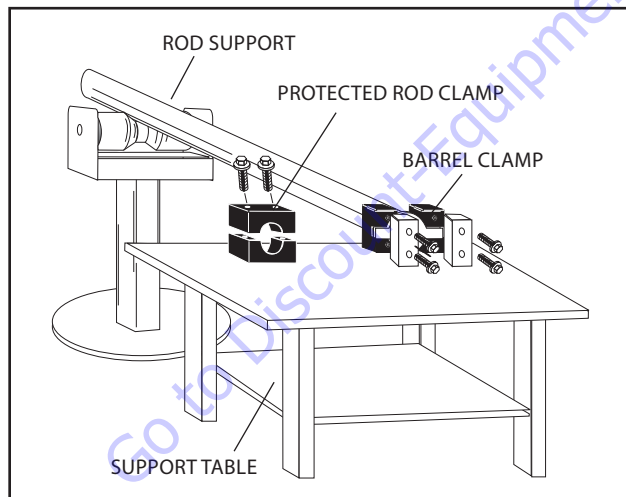


Figure 5-16. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

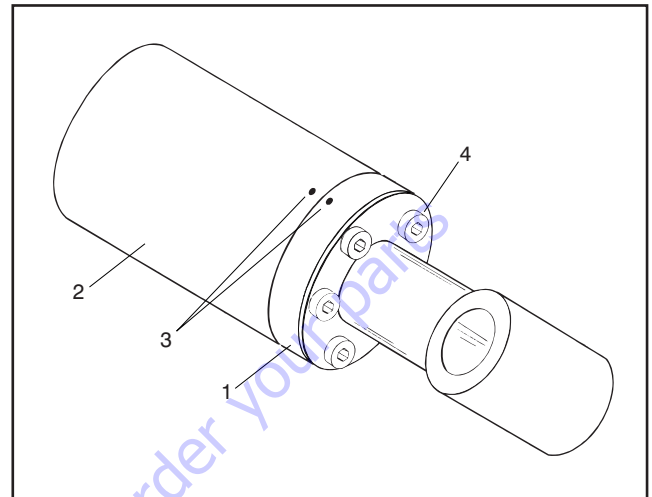


Figure 5-17. Marking Cylinder for Alignment

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.

6. Clamp barrel securely. Pull rod assembly and cylinder head from barrel.
7. Protect cylinder rod from damage and clamp in a vise or holding fixture as close to piston as possible.

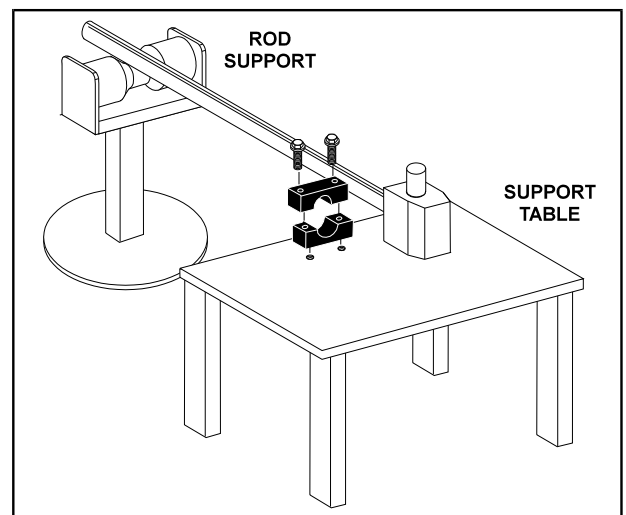
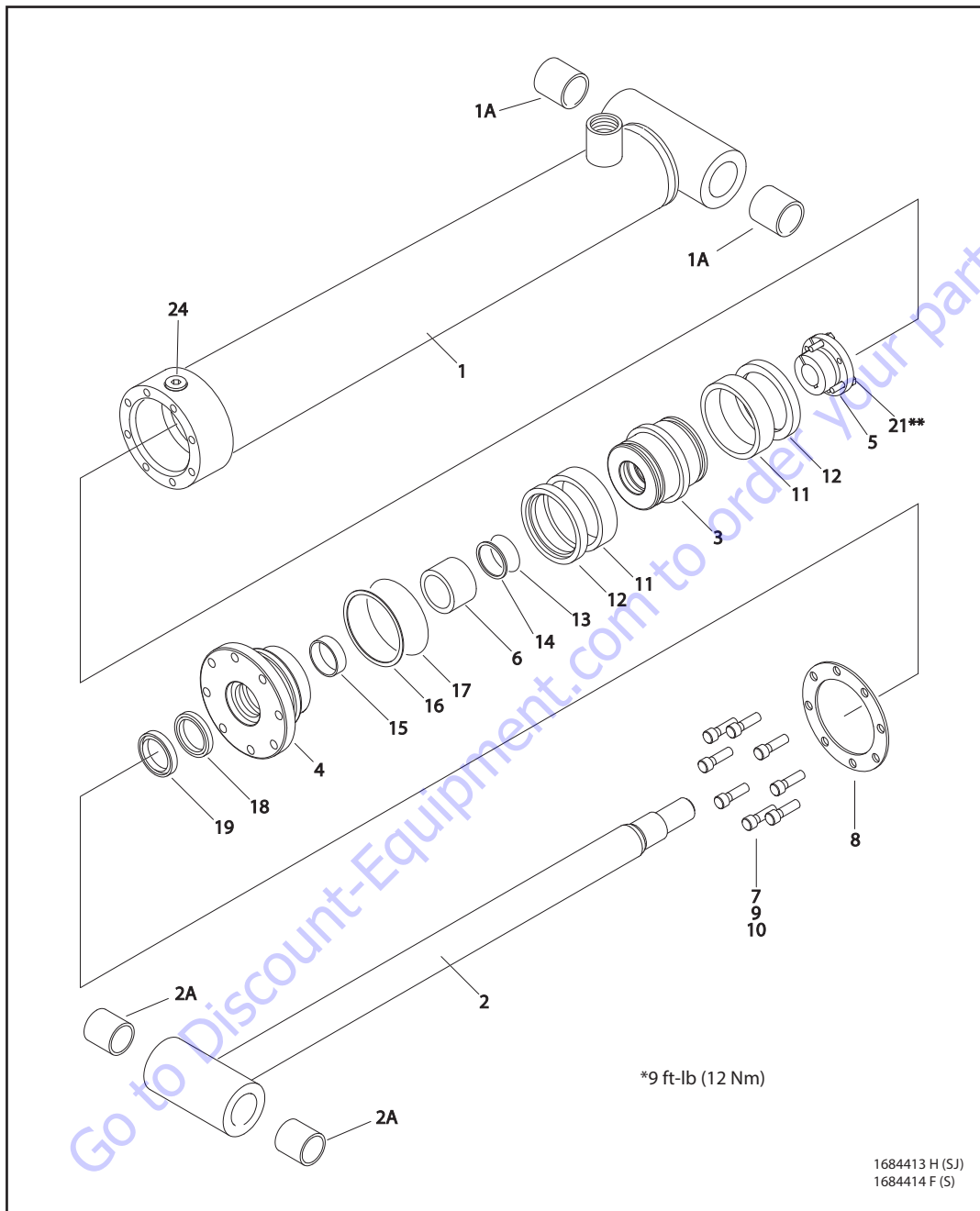


Figure 5-18. Cylinder Rod Support

SECTION 5 - HYDRAULICS



- | | | | | |
|-----------------------|--------------------|---------------------|------------------|--------------|
| 1. Barrel | 4. Head | 9. Locking Compound | 14. Back-Up Ring | 19. Wiper |
| 1a. Composite Bushing | 5. Tapered Bushing | 10. Locking Primer | 15. Wear Ring | 20. Not Used |
| 2. Rod | 6. Spacer | 11. Seal | 16. O-Ring | 21. Capscrew |
| 2a. Composite Bushing | 7. Capscrew | 12. Lock Ring | 17. Back-Up Ring | |
| 3. Piston | 8. Ring Washer | 13. O-Ring | 18. Rod Seal | |

Figure 5-19. Master Cylinder Assembly

8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Loosen and remove nut attaching piston to rod. Remove piston.
10. Loosen and remove cap screw(s), if applicable, attaching tapered bushing to piston.
11. Insert cap screw(s) in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
12. Remove tapered bushing from piston.
13. Screw piston counter-clockwise by hand and remove from cylinder rod.

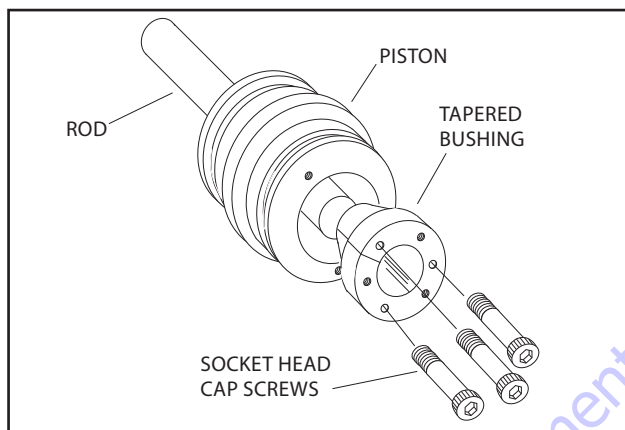


Figure 5-20. Tapered Bushing Removal

14. Remove and discard piston O-rings, seal rings, and backup rings.
15. Remove piston spacer, if applicable, from rod.
16. Remove rod from holding fixture. Remove cylinder head gland and retainer plate, if applicable. Discard O-rings, back-up rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean parts thoroughly with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage, scoring, or distortion. Dress piston surface or replace piston as necessary.

7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and O-ring grooves in piston for burrs and sharp edges. Dress surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage, and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and O-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring, damage, ovality, and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
 - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
 - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
 - c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.

NOTE: Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

- d. Press composite bushing into barrel or rod bushing with correct size arbor.

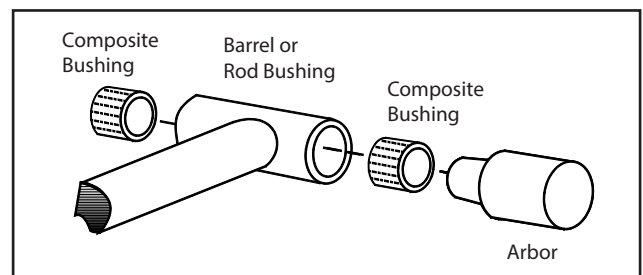


Figure 5-21. Composite Bushing Installation

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Use seal tool to install new rod seal into applicable cylinder head gland groove.

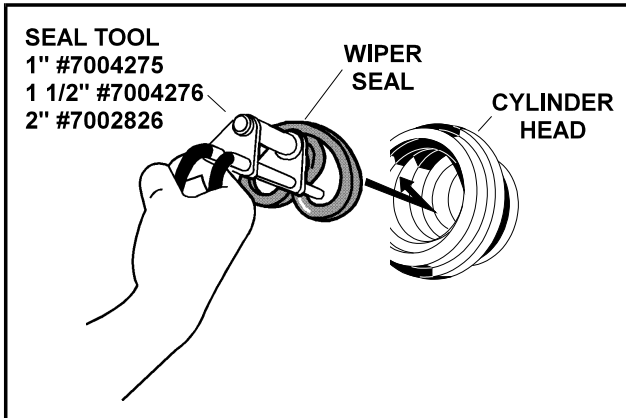


Figure 5-22. Rod Seal Installation

NOTICE

IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION. ENSURE 'POLY-PAK' PISTON SEALS ARE PROPERLY INSTALLED. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION.

2. Use a soft mallet to tap new wiper seal into applicable cylinder head gland groove. Install new wear ring in applicable cylinder head gland groove.

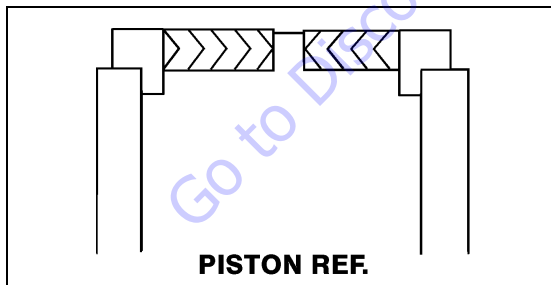
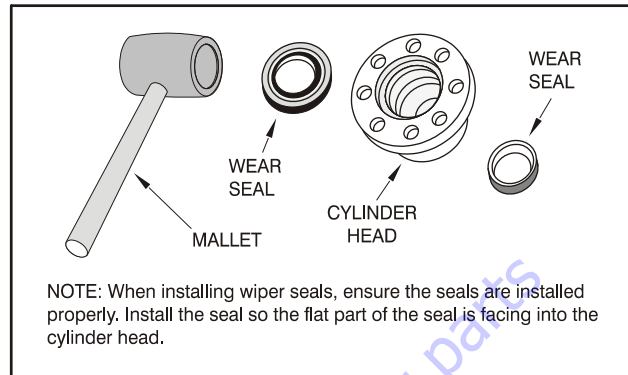


Figure 5-23. Poly-Pak Piston Seal Installation



NOTE: When installing wiper seals, ensure the seals are installed properly. Install the seal so the flat part of the seal is facing into the cylinder head.

Figure 5-24. Wiper Seal Installation

3. Place new O-ring and back-up seal in applicable outside diameter groove of cylinder head.

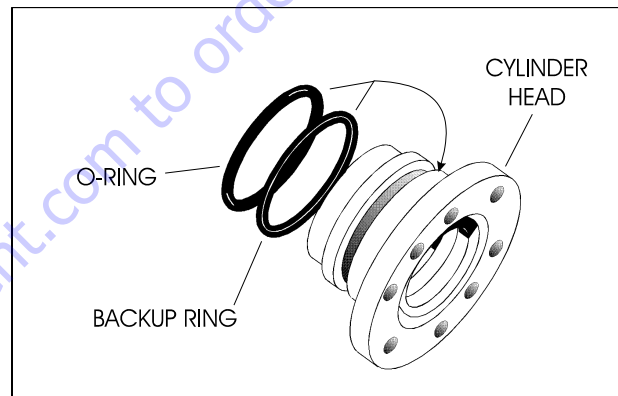


Figure 5-25. Head Seal Kit Installation

4. Install washer ring on rod. Carefully install head gland on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end, as applicable.
5. Carefully slide piston spacer on rod.

6. If applicable, place new O-ring and back-up rings in inner piston diameter groove.

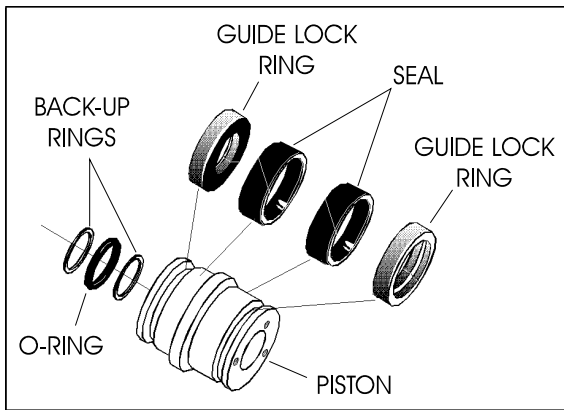


Figure 5-26. Piston Seal Kit Installation

7. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
8. Carefully thread piston on cylinder rod hand tight, Ensure O-ring and back-up rings are not damaged or dislodged.

NOTE: Piston and mating end of rod must be free of oil when installing tapered bushing.

9. Thread piston onto rod until it aligns with spacer end and install tapered bushing.

NOTE: Apply LOCTITE #242 or equivalent to tapered bushing bolts when rebuilding master, slave, lift, and telescope cylinders.

10. Install bolts in tapered bushing using loctite #242

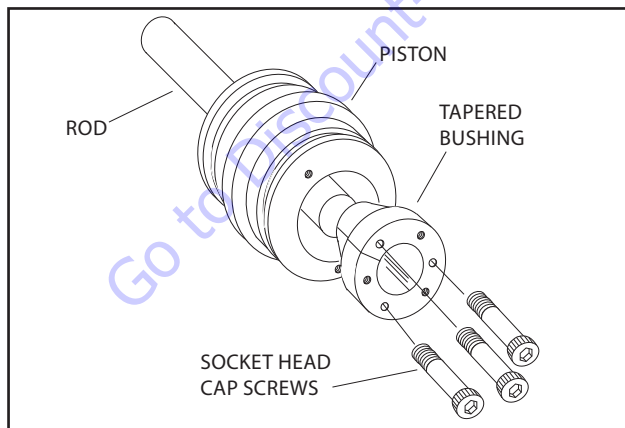


Figure 5-27. Tapered Bushing Installation

11. Remove cylinder rod from holding fixture.
12. Place new guide locks and seals in applicable outside diameter grooves of cylinder piston. (See Figure 2-28. Piston Seal Kit Installation.)
13. Position cylinder barrel in a suitable holding fixture.

NOTICE

INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN INSTALLING CYLINDER ROD, HEAD, AND PISTON.

14. Clamp barrel clamped securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
15. Continue pushing rod into barrel until cylinder head gland can be inserted into barrel cylinder.
16. Secure cylinder head gland using washer ring and socket head bolts.

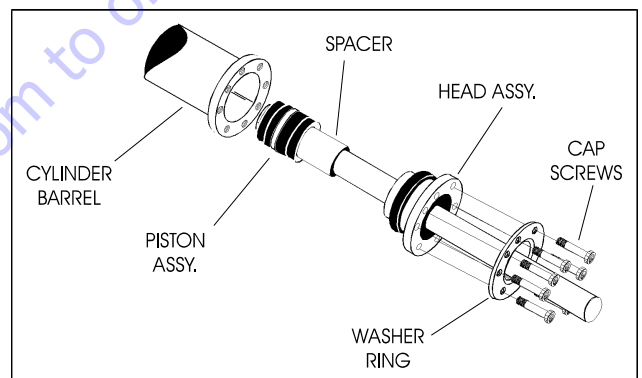


Figure 5-28. Rod Assembly Installation

Telescope Cylinder

DISASSEMBLY

NOTICE

CONTAMINATION MAY DAMAGE EQUIPMENT. DISASSEMBLE CYLINDER ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to cylinder port block fitting.

WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate hydraulic power source and extend cylinder. Shut down and disconnect power source. Adequately support cylinder rod, if applicable.
3. If applicable, remove cartridge-type counterbalance valve and fittings from cylinder port block. Discard O-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

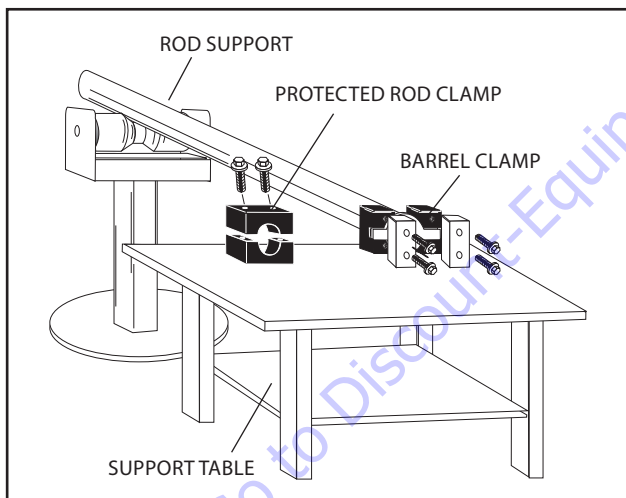


Figure 5-29. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

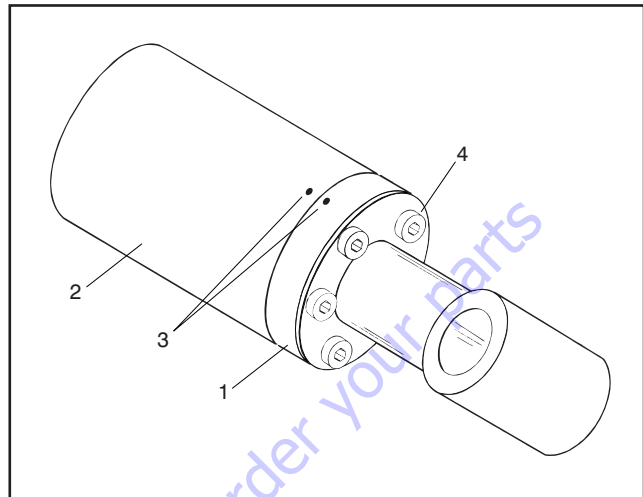


Figure 5-30. Marking Cylinder for Alignment

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.

6. Clamp barrel securely. Pull rod assembly and cylinder head from barrel.
7. Protect cylinder rod from damage and clamp in a vise or holding fixture as close to piston as possible.

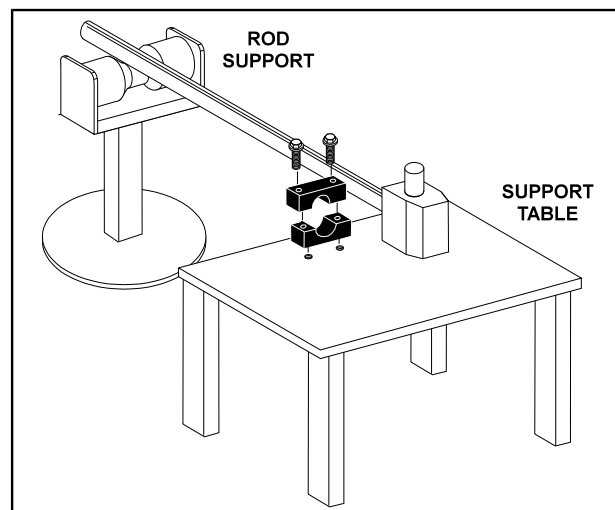
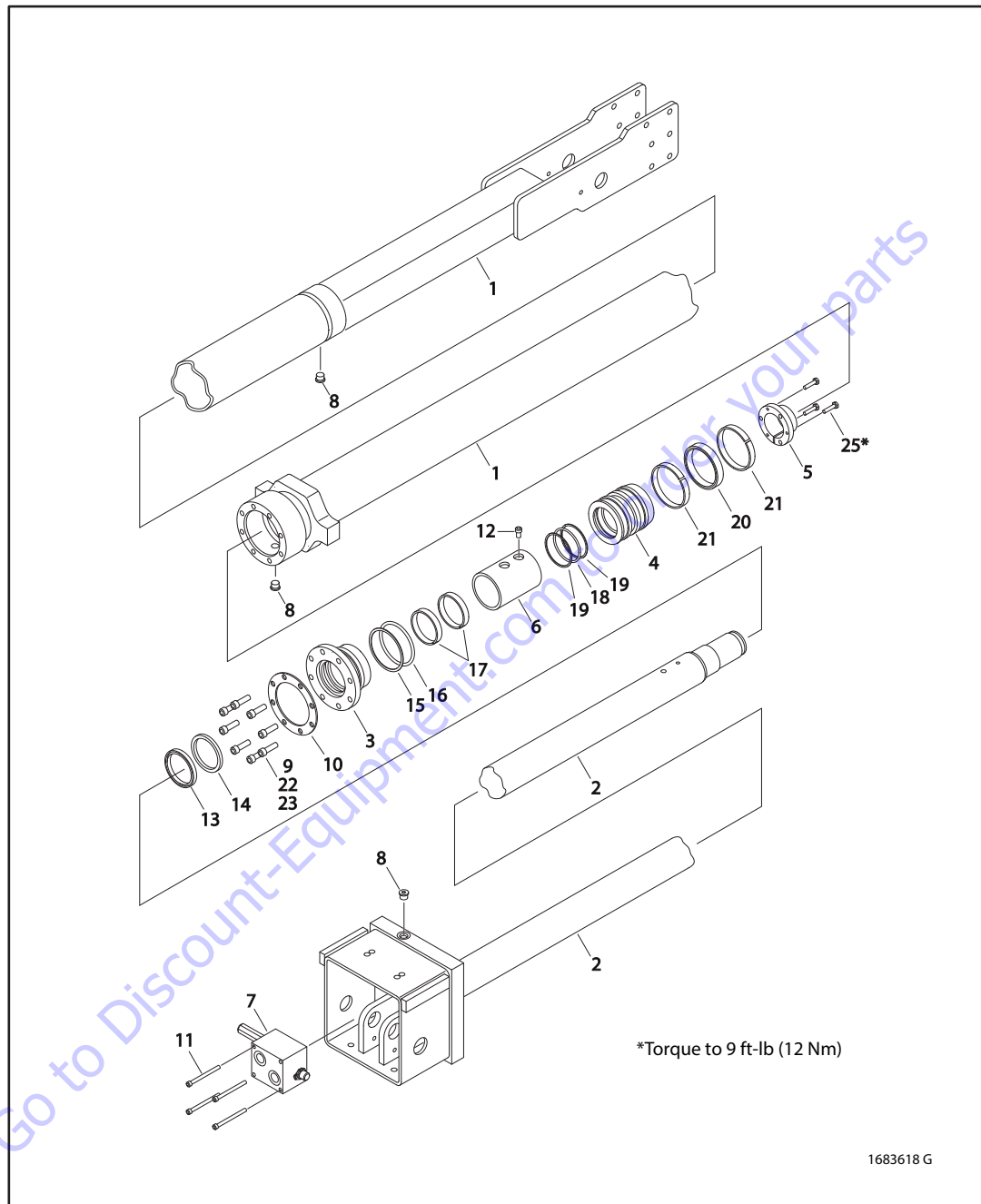


Figure 5-31. Cylinder Rod Support



- | | | | | |
|--------------------|-------------------|--------------|------------------|----------------------|
| 1. Barrel | 6. Spacer | 11. Capscrew | 16. Back-Up Ring | 21. Wear Ring |
| 2. Rod | 7. Valve Assembly | 12. Capscrew | 17. Wear Ring | 22. Locking Compound |
| 3. Head | 8. O-Ring Plug | 13. Wiper | 18. O-Ring | 23. Locking primer |
| 4. Piston | 9. Capscrew | 14. Rod Seal | 19. Back-Up Ring | 24. Not Used |
| 5. Tapered Bushing | 10. Ring Washer | 15. O-Ring | 20. T-Seal | 25. Bolt |

Figure 5-32. Telescope Cylinder Assembly

SECTION 5 - HYDRAULICS

- Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
- Loosen and remove nut attaching piston to rod. Remove piston.
- Loosen and remove cap screw(s), if applicable, attaching tapered bushing to piston.
- Insert cap screw(s) in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
- Remove tapered bushing from piston.
- Screw piston counter-clockwise by hand and remove from cylinder rod.

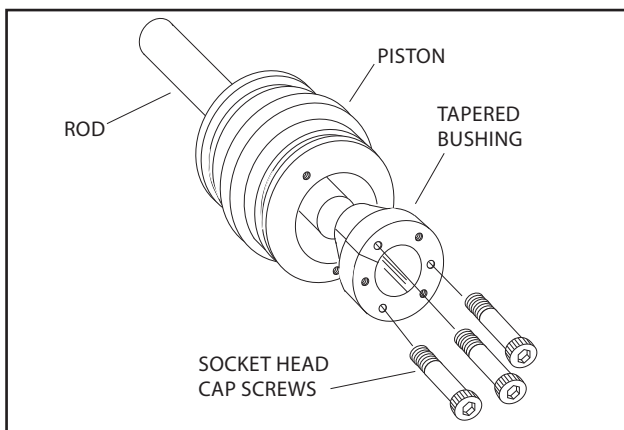


Figure 5-33. Tapered Bushing Removal

- Remove and discard piston O-rings, seal rings, and backup rings.
- Remove piston spacer, if applicable, from rod.
- Remove rod from holding fixture. Remove cylinder head gland and retainer plate, if applicable. Discard O-rings, back-up rings, rod seals, and wiper seals.

Cleaning and Inspection

- Clean parts thoroughly with approved cleaning solvent.
- Inspect cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
- Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
- Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
- Inspect threaded portion of barrel for damage. Dress threads as necessary.
- Inspect piston surface for damage, scoring, or distortion. Dress piston surface or replace piston as necessary.

- Inspect threaded portion of piston for damage. Dress threads as necessary.
- Inspect seal and O-ring grooves in piston for burrs and sharp edges. Dress surfaces as necessary.
- Inspect cylinder head inside diameter for scoring or other damage, and for ovality and tapering. Replace as necessary.
- Inspect threaded portion of head for damage. Dress threads as necessary.
- Inspect seal and O-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
- Inspect cylinder head outside diameter for scoring, damage, ovality, and tapering. Replace as necessary.
- If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
 - Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
 - Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
 - Lubricate inside of the steel bushing with WD40 prior to bearing installation.

NOTE: Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

- Press composite bushing into barrel or rod bushing with correct size arbor.

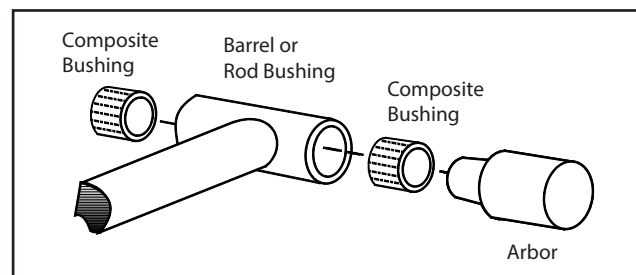


Figure 5-34. Composite Bushing Installation

- Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
- If applicable, inspect port block fittings and holding valve. Replace as necessary.
- Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.
- If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Use seal tool to install new rod seal into applicable cylinder head gland groove.

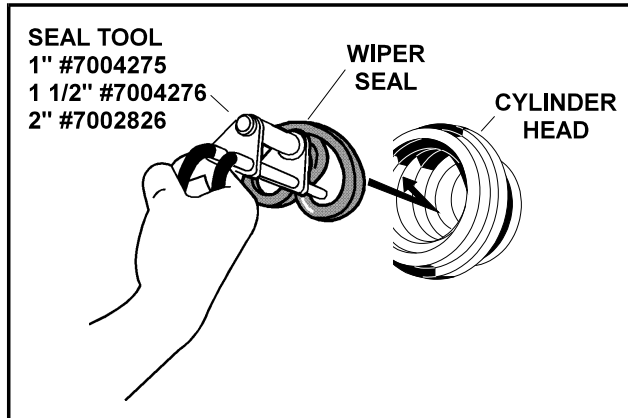


Figure 5-35. Rod Seal Installation

NOTICE

IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION. ENSURE 'POLY-PAK' PISTON SEALS ARE PROPERLY INSTALLED. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION.

2. Use a soft mallet to tap new wiper seal into applicable cylinder head gland groove. Install new wear ring in applicable cylinder head gland groove.

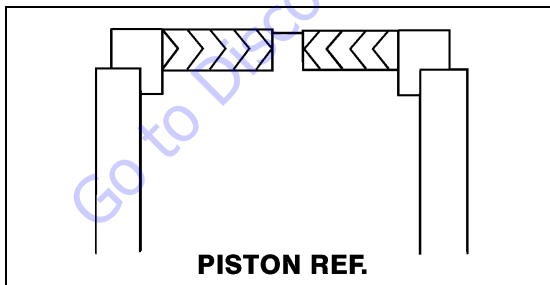


Figure 5-36. Poly-Pak Piston Seal Installation

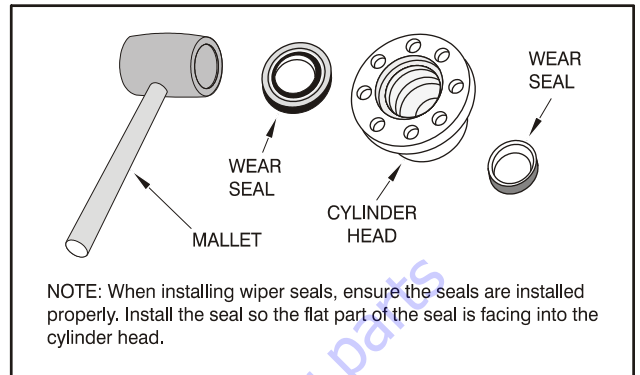


Figure 5-37. Wiper Seal Installation

3. Place new O-ring and back-up seal in applicable outside diameter groove of cylinder head.

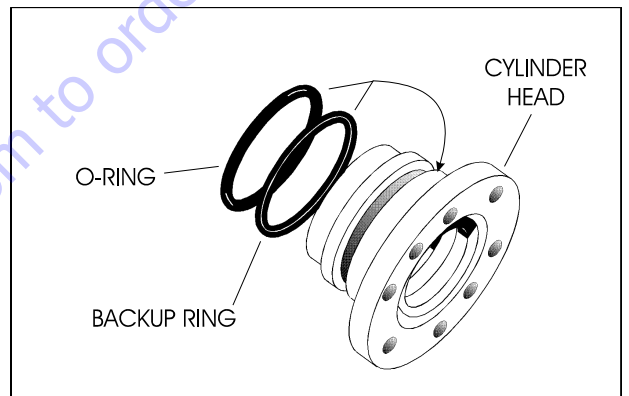


Figure 5-38. Head Seal Kit Installation

4. Install washer ring on rod. Carefully install head gland on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end, as applicable.
5. Carefully slide piston spacer on rod.

SECTION 5 - HYDRAULICS

- If applicable, place new O-ring and back-up rings in inner piston diameter groove.

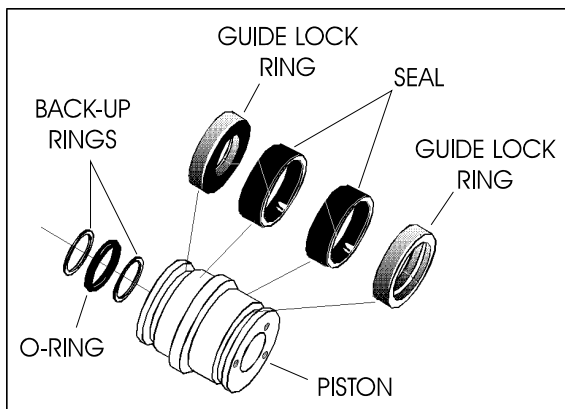


Figure 5-39. Piston Seal Kit Installation

- Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
- Carefully thread piston on cylinder rod hand tight, Ensure O-ring and back-up rings are not damaged or dislodged.

NOTE: Piston and mating end of rod must be free of oil when installing tapered bushing.

- Thread piston onto rod until it aligns with spacer end and install tapered bushing.

NOTE: Apply LOCTITE #242 or equivalent to tapered bushing bolts when rebuilding master, slave, lift, and telescope cylinders.

- Install bolts in tapered bushing using loctite #242

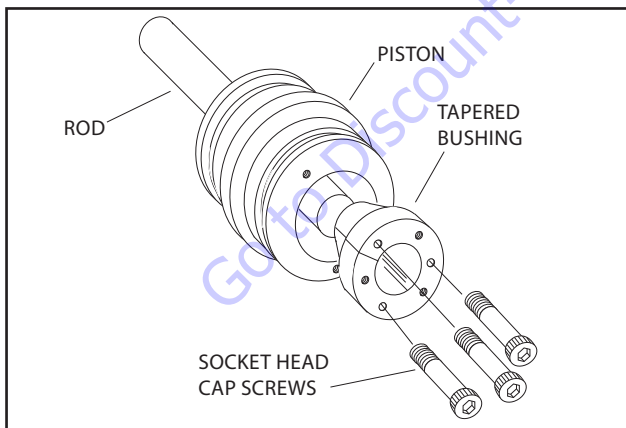


Figure 5-40. Tapered Bushing Installation

- Remove cylinder rod from holding fixture.
- Place new guide locks and seals in applicable outside diameter grooves of cylinder piston. (See Figure 2-28. Piston Seal Kit Installation.)
- Position cylinder barrel in a suitable holding fixture.

NOTICE

INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN INSTALLING CYLINDER ROD, HEAD, AND PISTON.

- Clamp barrel clamped securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
- Continue pushing rod into barrel until cylinder head gland can be inserted into barrel cylinder.
- Secure cylinder head gland using washer ring and socket head bolts.

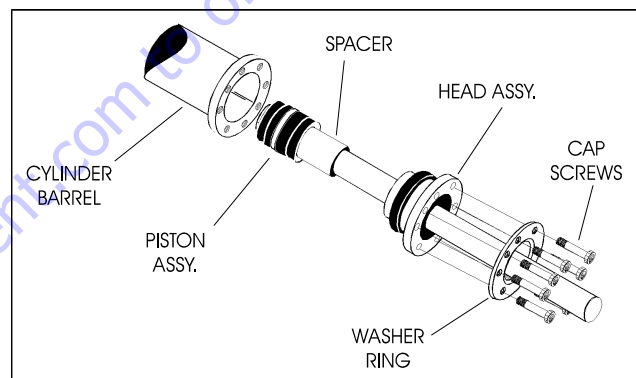


Figure 5-41. Rod Assembly Installation

Platform Level (Slave) Cylinder

DISASSEMBLY

NOTICE

CONTAMINATION MAY DAMAGE EQUIPMENT. DISASSEMBLE CYLINDER ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to cylinder port block fitting.

WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate hydraulic power source and extend cylinder. Shut down and disconnect power source. Adequately support cylinder rod, if applicable.
3. If applicable, remove cartridge-type counterbalance valve and fittings from cylinder port block. Discard O-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

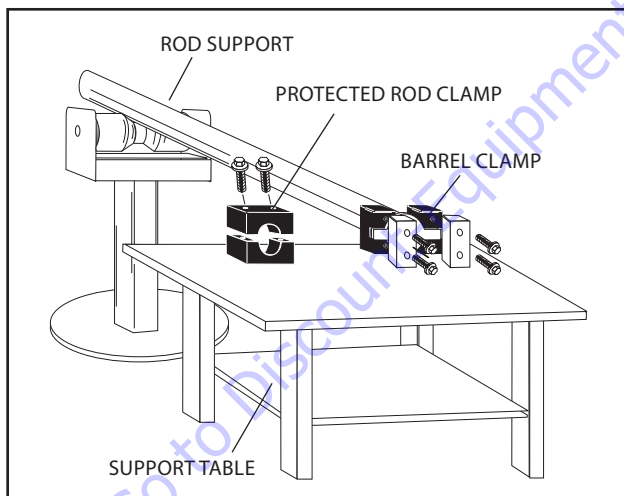


Figure 5-42. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

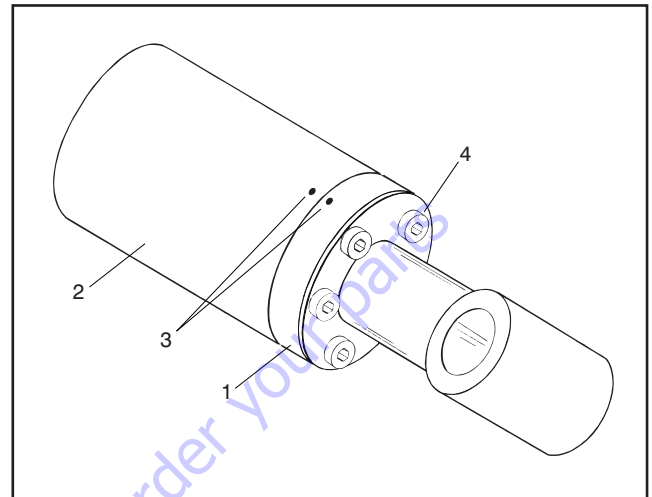


Figure 5-43. Marking Cylinder for Alignment

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.

6. Clamp barrel securely. Pull rod assembly and cylinder head from barrel.
7. Protect cylinder rod from damage and clamp in a vise or holding fixture as close to piston as possible.

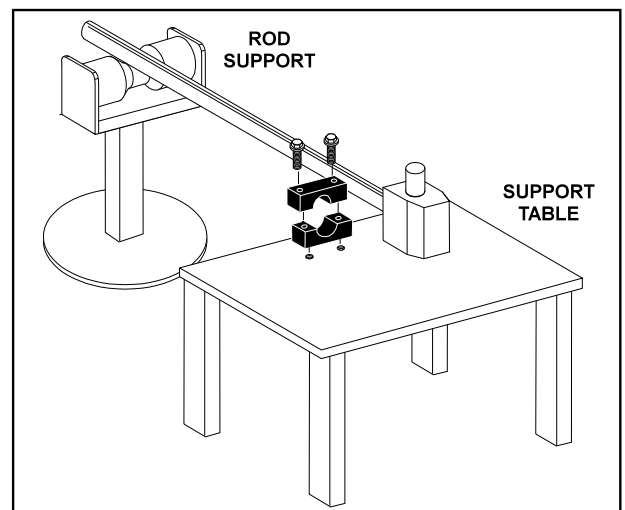
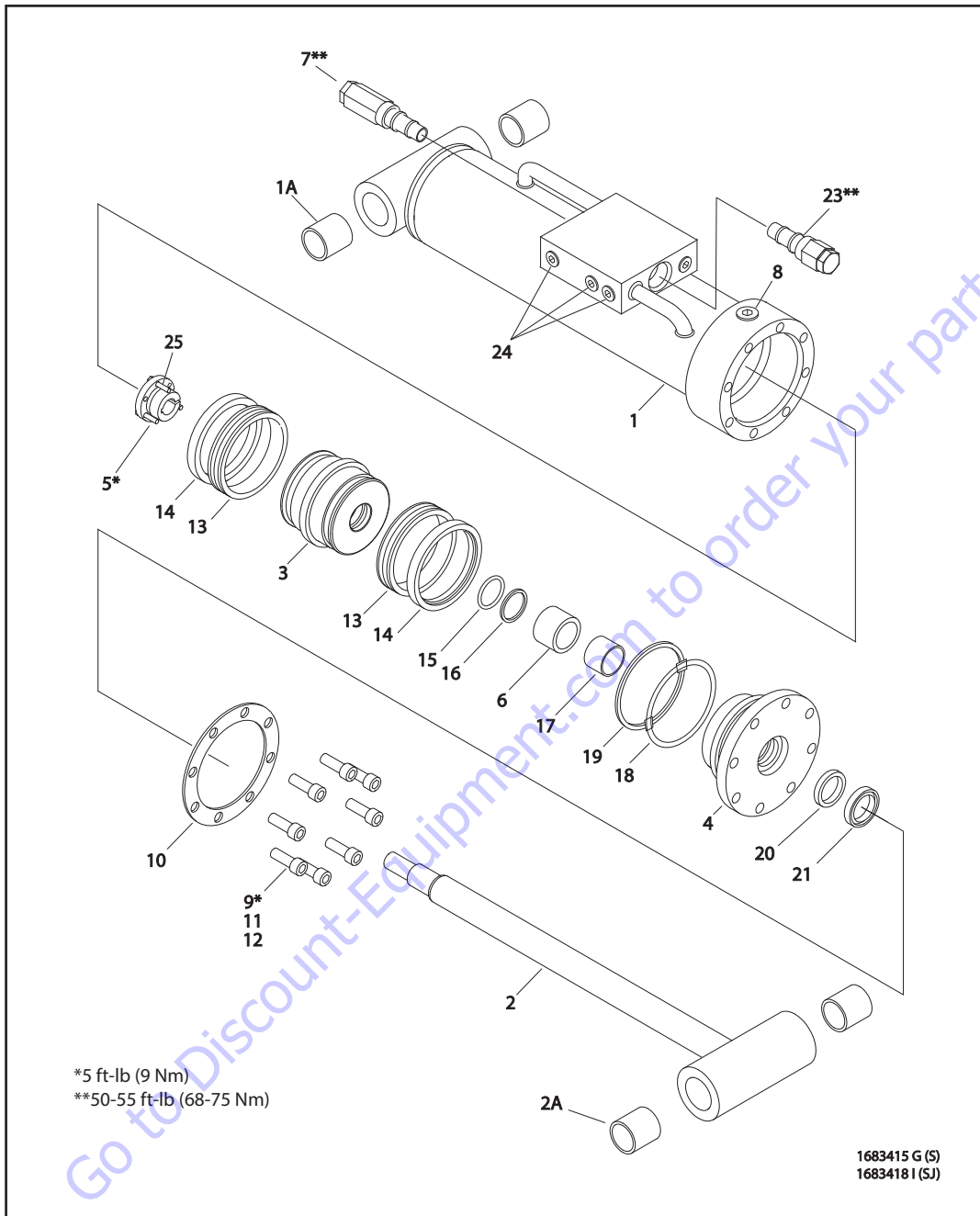


Figure 5-44. Cylinder Rod Support

SECTION 5 - HYDRAULICS



- | | | | | |
|-----------------------|--------------------|----------------------|------------------|---------------------|
| 1. Barrel | 5. Tapered Bushing | 11. Locking Compound | 17. Wear Ring | 22. Not Used |
| 1a. Composite Bushing | 6. Spacer | 12. Locking Primer | 18. O-Ring | 23. Cartridge Valve |
| 2. Rod | 7. Cartridge Valve | 13. Seal | 19. Back-Up Ring | 24. O-Ring Plug |
| 2a. Composite Bushing | 8. O-Ring Plug | 14. Ring Lock | 20. Rod Seal | 25. Bolt |
| 3. Piston | 9. Capscrew | 15. O-Ring | 21. Wiper | |
| 4. Head | 10. Ring Washer | 16. Back-Up Ring | | |

Figure 5-45. Platform Level (Slave) Cylinder Assembly

8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Loosen and remove nut attaching piston to rod. Remove piston.
10. Loosen and remove cap screw(s), if applicable, attaching tapered bushing to piston.
11. Insert cap screw(s) in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
12. Remove tapered bushing from piston.
13. Screw piston counter-clockwise by hand and remove from cylinder rod.

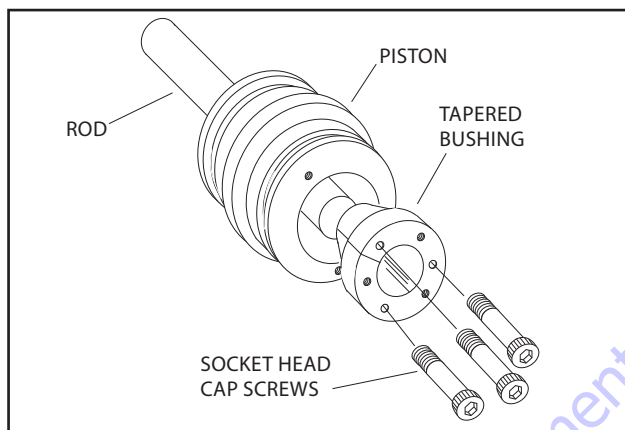


Figure 5-46. Tapered Bushing Removal

14. Remove and discard piston O-rings, seal rings, and backup rings.
15. Remove piston spacer, if applicable, from rod.
16. Remove rod from holding fixture. Remove cylinder head gland and retainer plate, if applicable. Discard O-rings, back-up rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean parts thoroughly with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage, scoring, or distortion. Dress piston surface or replace piston as necessary.

7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and O-ring grooves in piston for burrs and sharp edges. Dress surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage, and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and O-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring, damage, ovality, and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
 - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
 - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
 - c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.

NOTE: Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

- d. Press composite bushing into barrel or rod bushing with correct size arbor.

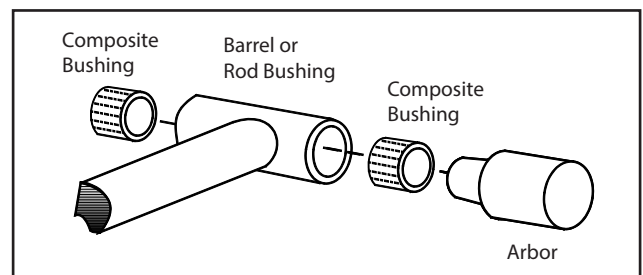


Figure 5-47. Composite Bushing Installation

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Use seal tool to install new rod seal into applicable cylinder head gland groove.

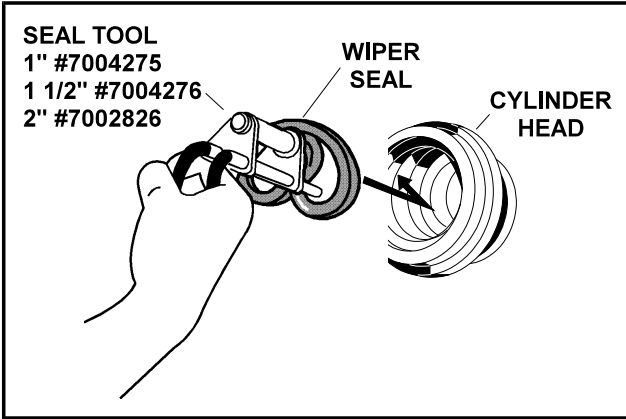


Figure 5-48. Rod Seal Installation

NOTICE

IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION. ENSURE 'POLY-PAK' PISTON SEALS ARE PROPERLY INSTALLED. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION.

2. Use a soft mallet to tap new wiper seal into applicable cylinder head gland groove. Install new wear ring in applicable cylinder head gland groove.

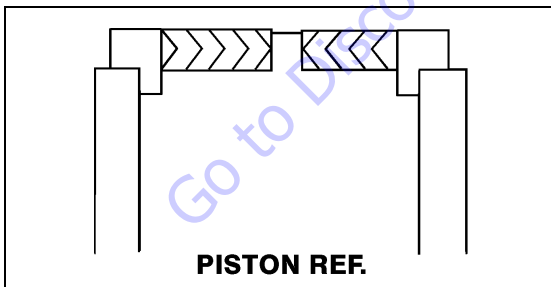
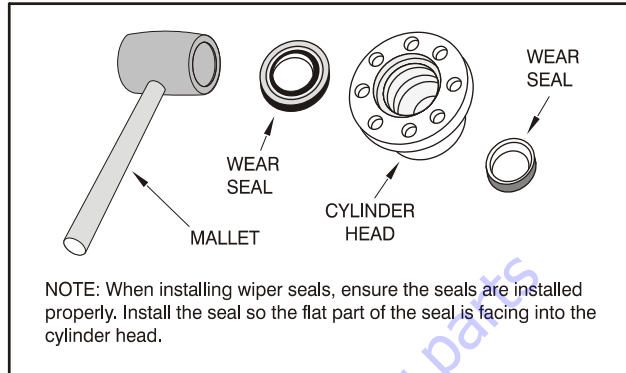


Figure 5-49. Poly-Pak Piston Seal Installation



NOTE: When installing wiper seals, ensure the seals are installed properly. Install the seal so the flat part of the seal is facing into the cylinder head.

Figure 5-50. Wiper Seal Installation

3. Place new O-ring and back-up seal in applicable outside diameter groove of cylinder head.

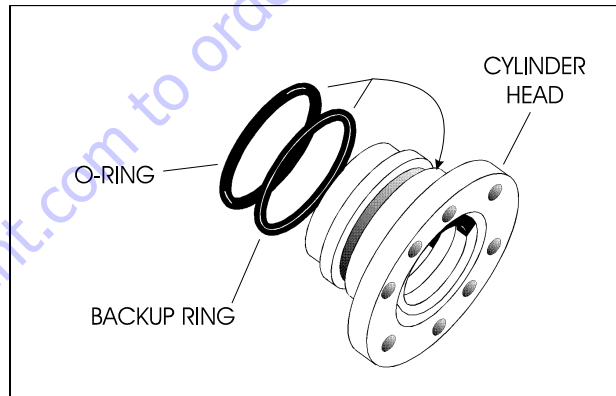


Figure 5-51. Head Seal Kit Installation

4. Install washer ring on rod. Carefully install head gland on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end, as applicable.
5. Carefully slide piston spacer on rod.

6. If applicable, place new O-ring and back-up rings in inner piston diameter groove.

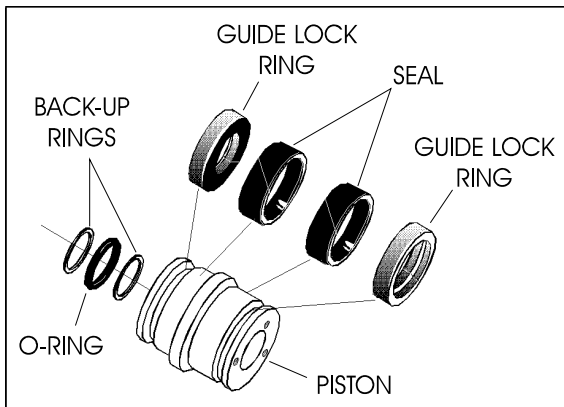


Figure 5-52. Piston Seal Kit Installation

7. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
8. Carefully thread piston on cylinder rod hand tight, Ensure O-ring and back-up rings are not damaged or dislodged.

NOTE: Piston and mating end of rod must be free of oil when installing tapered bushing.

9. Thread piston onto rod until it aligns with spacer end and install tapered bushing.

NOTE: Apply LOCTITE #242 or equivalent to tapered bushing bolts when rebuilding master, slave, lift, and telescope cylinders.

10. Install bolts in tapered bushing using loctite #242

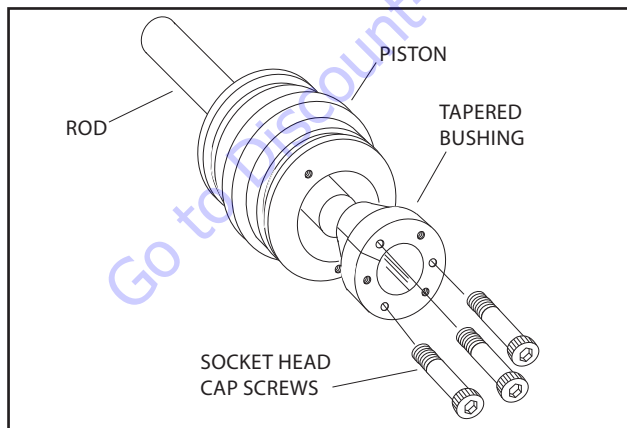


Figure 5-53. Tapered Bushing Installation

11. Remove cylinder rod from holding fixture.
12. Place new guide locks and seals in applicable outside diameter grooves of cylinder piston. (See Figure 2-28. Piston Seal Kit Installation.)
13. Position cylinder barrel in a suitable holding fixture.

NOTICE

INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN INSTALLING CYLINDER ROD, HEAD, AND PISTON.

14. Clamp barrel clamped securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
15. Continue pushing rod into barrel until cylinder head gland can be inserted into barrel cylinder.
16. Secure cylinder head gland using washer ring and socket head bolts.

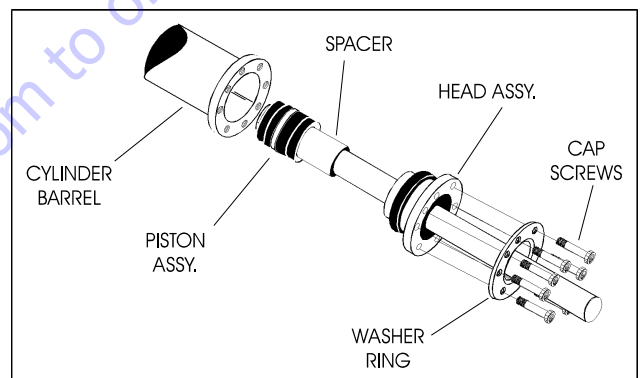


Figure 5-54. Rod Assembly Installation

Jib Lift Cylinder (SJ Only)

DISASSEMBLY

NOTICE

CONTAMINATION MAY DAMAGE EQUIPMENT. DISASSEMBLE CYLINDER ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to cylinder port block fitting.

WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate hydraulic power source and extend cylinder. Shut down and disconnect power source. Adequately support cylinder rod, if applicable.
3. If applicable, remove cartridge-type counterbalance valve and fittings from cylinder port block. Discard O-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

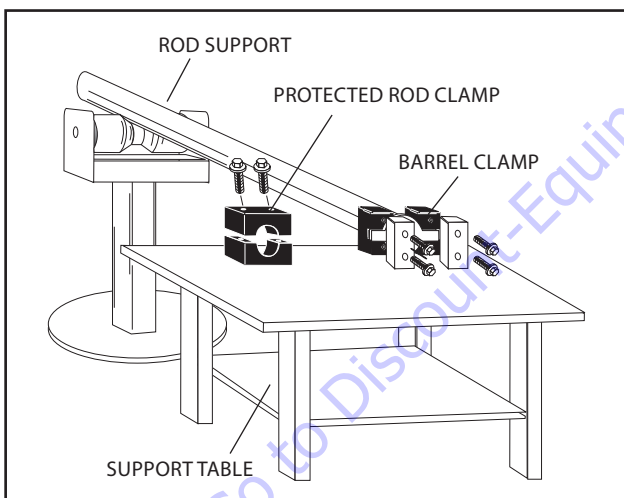


Figure 5-55. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

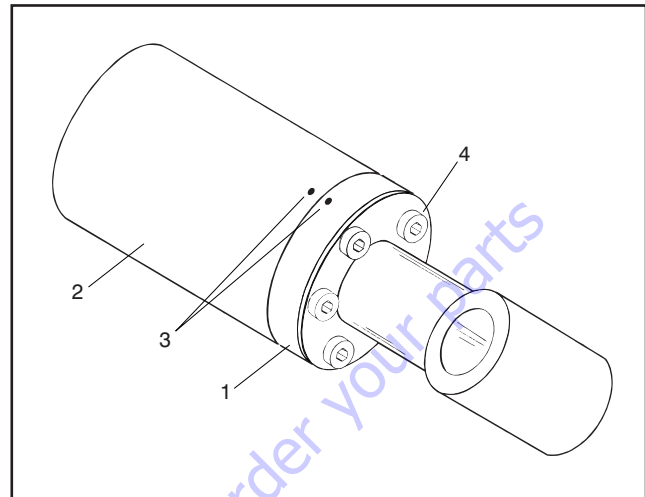


Figure 5-56. Marking Cylinder for Alignment

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.

6. Clamp barrel securely. Pull rod assembly and cylinder head from barrel.
7. Protect cylinder rod from damage and clamp in a vise or holding fixture as close to piston as possible.

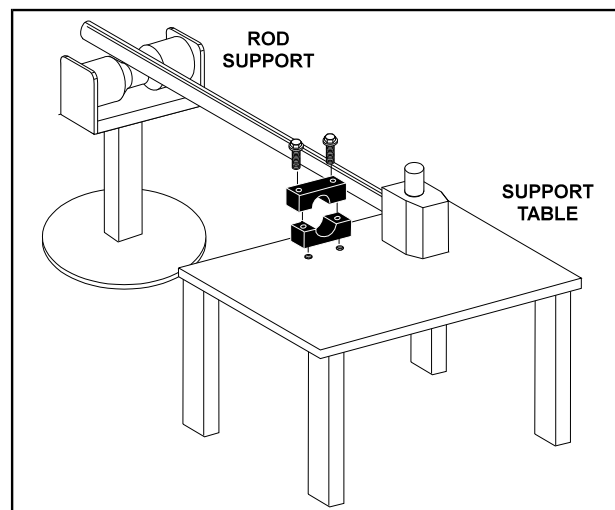
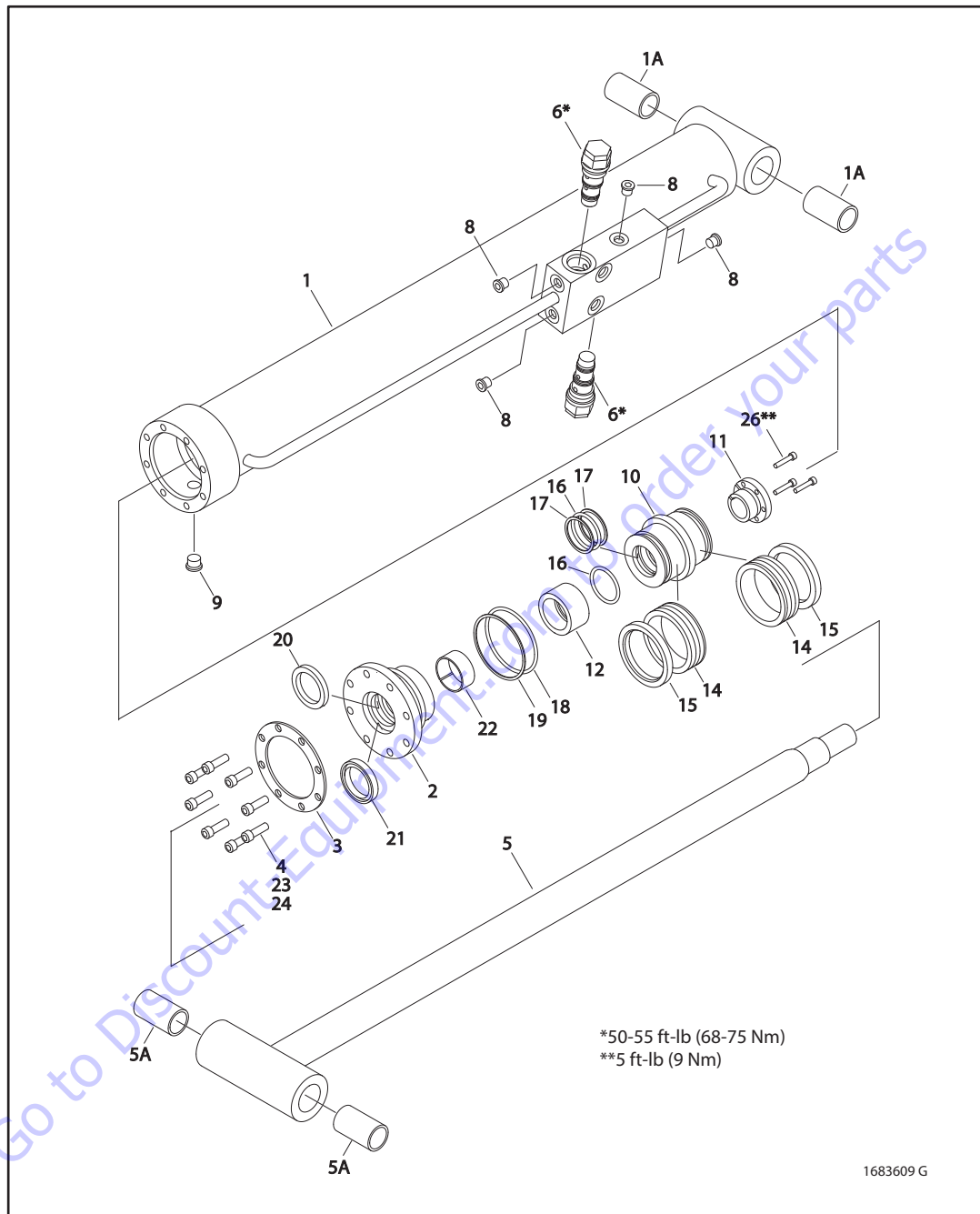


Figure 5-57. Cylinder Rod Support



- | | | | | | |
|----------------|--------------------|---------------------|------------------|----------------------|--------------------|
| 1. Barrel | 5. Rod | 9. O-Ring Plug | 14. Seal | 19. Wiper | 24. Locking Primer |
| 1a. Bushing | 5a. Bushing | 10. Piston | 15. Lock Ring | 20. Wear Ring | 25. Not Used |
| 2. Head | 6. Cartridge Valve | 11. Tapered Bushing | 16. O-Ring | 21. Wiper | 26. Bolt |
| 3. Ring Washer | 7. Not Used | 12. Spacer | 17. Back-Up Ring | 22. Wear Ring | |
| 4. Capscrew | 8. O-Ring Plug | 13. Not Used | 18. Rod Seal | 23. Locking Compound | |

Figure 5-58. Jib Lift Cylinder Assembly(660SJ)

SECTION 5 - HYDRAULICS

8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Loosen and remove nut attaching piston to rod. Remove piston.
10. Loosen and remove cap screw(s), if applicable, attaching tapered bushing to piston.
11. Insert cap screw(s) in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
12. Remove tapered bushing from piston.
13. Screw piston counter-clockwise by hand and remove from cylinder rod.

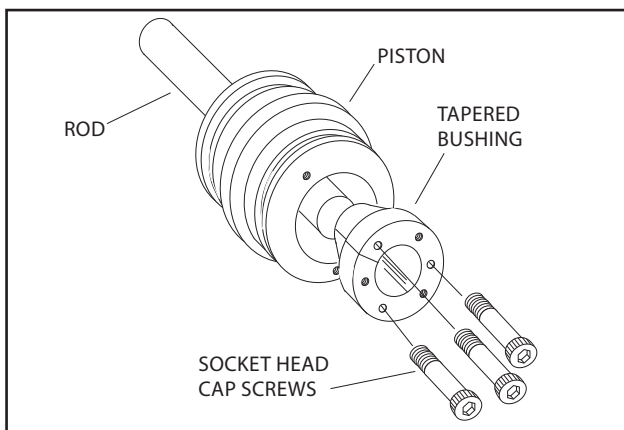


Figure 5-59. Tapered Bushing Removal

14. Remove and discard piston O-rings, seal rings, and backup rings.
15. Remove piston spacer, if applicable, from rod.
16. Remove rod from holding fixture. Remove cylinder head gland and retainer plate, if applicable. Discard O-rings, back-up rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean parts thoroughly with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage, scoring, or distortion. Dress piston surface or replace piston as necessary.

7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and O-ring grooves in piston for burrs and sharp edges. Dress surfaces as necessary.
9. Inspect cylinder head inside diameter for scoring or other damage, and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and O-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring, damage, ovality, and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
 - a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
 - b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
 - c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.

NOTE: Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

- d. Press composite bushing into barrel or rod bushing with correct size arbor.

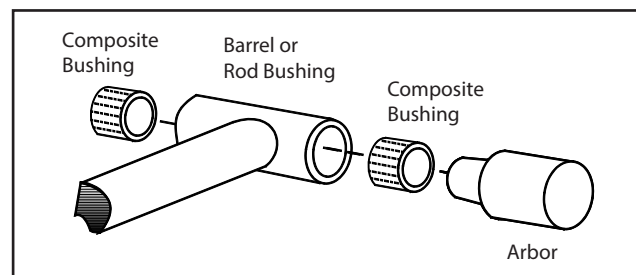


Figure 5-60. Composite Bushing Installation

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Use seal tool to install new rod seal into applicable cylinder head gland groove.

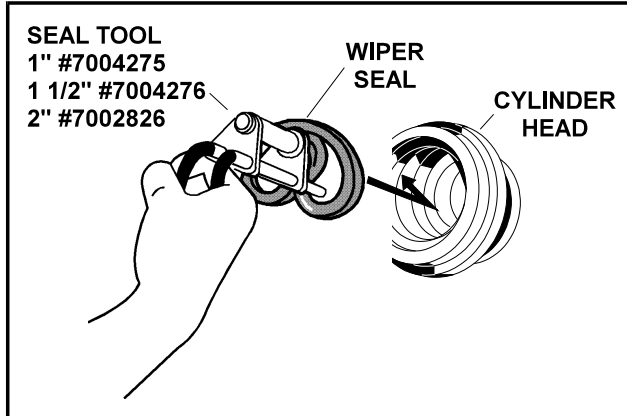


Figure 5-61. Rod Seal Installation

NOTICE

IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION. ENSURE 'POLY-PAK' PISTON SEALS ARE PROPERLY INSTALLED. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION.

2. Use a soft mallet to tap new wiper seal into applicable cylinder head gland groove. Install new wear ring in applicable cylinder head gland groove.

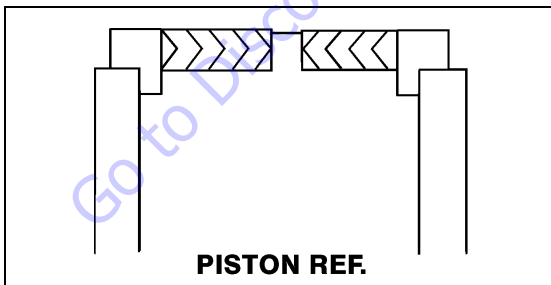


Figure 5-62. Poly-Pak Piston Seal Installation

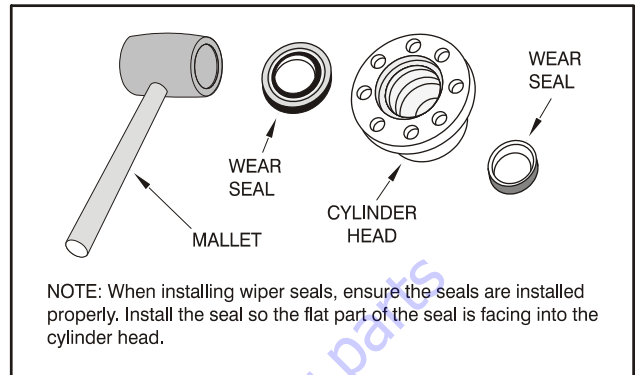


Figure 5-63. Wiper Seal Installation

3. Place new O-ring and back-up seal in applicable outside diameter groove of cylinder head.

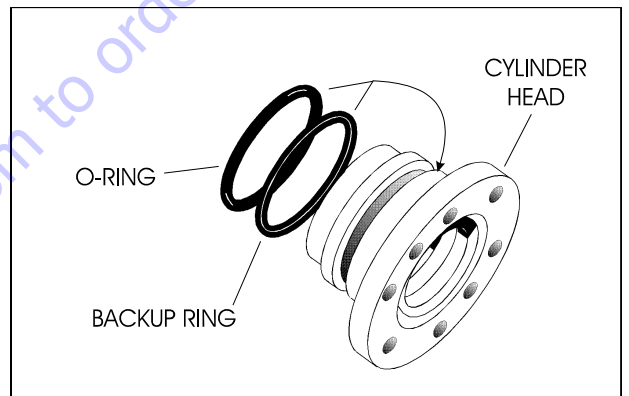


Figure 5-64. Head Seal Kit Installation

4. Install washer ring on rod. Carefully install head gland on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end, as applicable.
5. Carefully slide piston spacer on rod.

SECTION 5 - HYDRAULICS

- If applicable, place new O-ring and back-up rings in inner piston diameter groove.

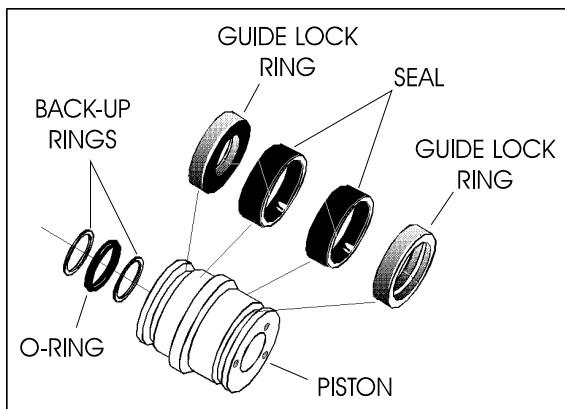


Figure 5-65. Piston Seal Kit Installation

- Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
- Carefully thread piston on cylinder rod hand tight, Ensure O-ring and back-up rings are not damaged or dislodged.

NOTE: Piston and mating end of rod must be free of oil when installing tapered bushing.

- Thread piston onto rod until it aligns with spacer end and install tapered bushing.

NOTE: Apply LOCTITE #242 or equivalent to tapered bushing bolts when rebuilding master, slave, lift, and telescope cylinders.

- Install bolts in tapered bushing using loctite #242

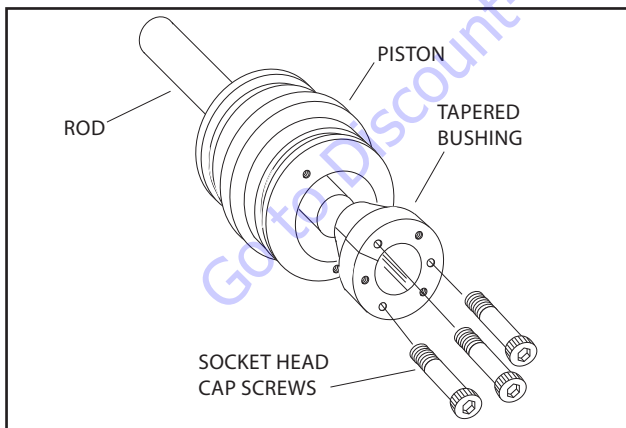


Figure 5-66. Tapered Bushing Installation

- Remove cylinder rod from holding fixture.
- Place new guide locks and seals in applicable outside diameter grooves of cylinder piston. (See Figure 2-28. Piston Seal Kit Installation.)
- Position cylinder barrel in a suitable holding fixture.

NOTICE

INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN INSTALLING CYLINDER ROD, HEAD, AND PISTON.

- Clamp barrel clamped securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
- Continue pushing rod into barrel until cylinder head gland can be inserted into barrel cylinder.
- Secure cylinder head gland using washer ring and socket head bolts.

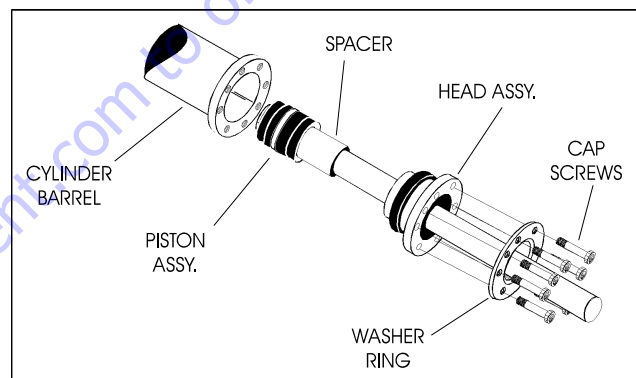


Figure 5-67. Rod Assembly Installation

Steer Cylinder

DISASSEMBLY

NOTE: Refer to Figure 5-71.

NOTICE

CONTAMINATION MAY DAMAGE EQUIPMENT. DISASSEMBLE CYLINDER ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to cylinder port block fitting.

WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate hydraulic power source and extend cylinder. Shut down and disconnect power source. Adequately support cylinder rod, if applicable.
3. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

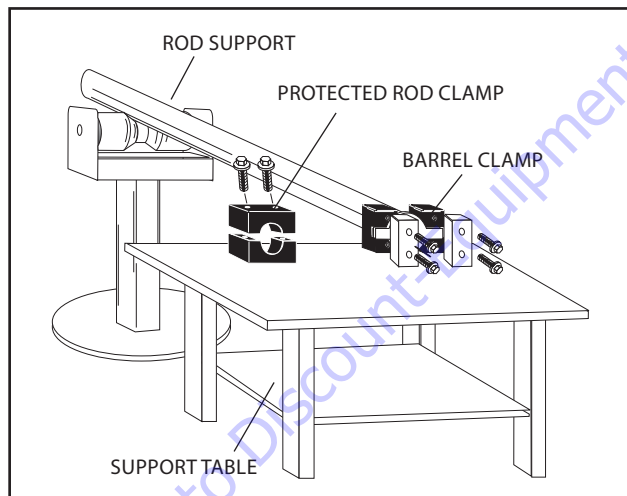


Figure 5-68. Cylinder Barrel Support

4. Remove burrs and contamination from cylinder before disassembly.

5. Unscrew Spanner Nut (13) with hook spanner.

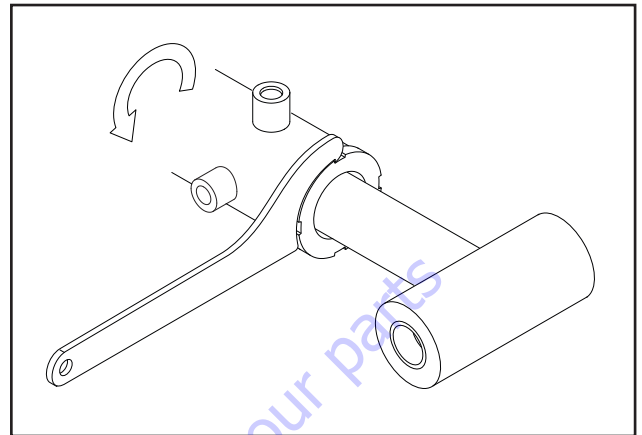


Figure 5-69. Removing Spanner Nut

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD AND PISTON.

6. Clamp barrel securely. Apply pressure to rod pulling device and carefully withdraw complete rod assembly from cylinder barrel.

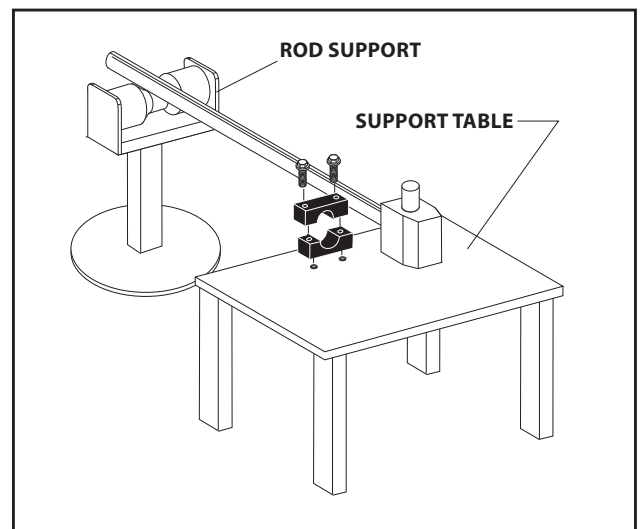
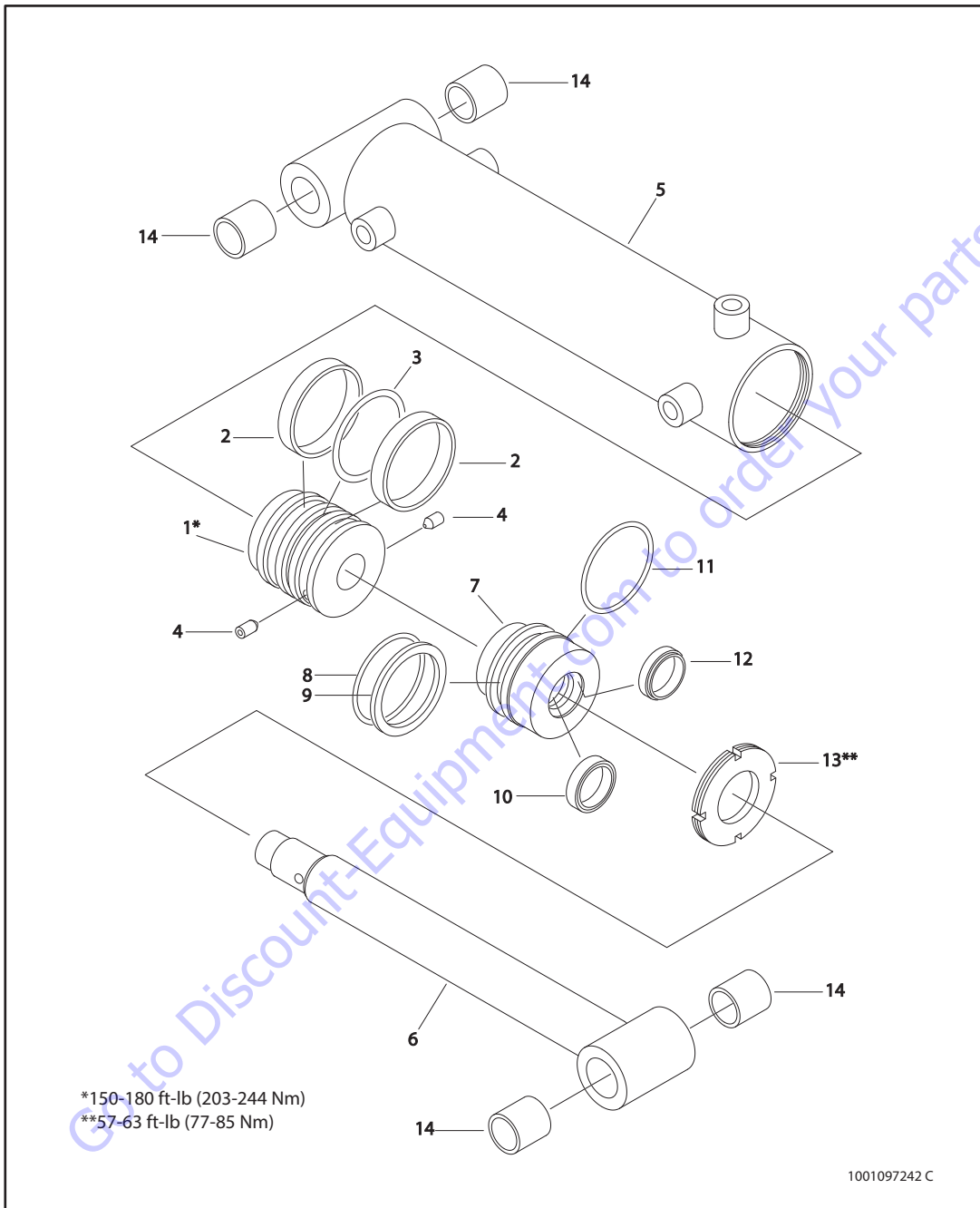


Figure 5-70. Cylinder Rod Support



- | | | | |
|-------------|-----------|-----------------|-----------------------|
| 1. Piston | 5. Barrel | 9. Back-Up Ring | 12. Wiper |
| 2. Seal | 6. Rod | 10. Seal | 13. Spanner Nut |
| 3. O-Ring | 7. Head | 11. O-Ring | 14. Composite Bushing |
| 4. Setscrew | 8. O-Ring | | |

Figure 5-71. Steer Cylinder Assembly

7. Remove two Seals (2) and O-Ring (3) from Piston (1).
8. Loosen two Setscrews (4) in Piston (1). Unscrew and remove Piston (1) from Rod (6) with strap wrench.

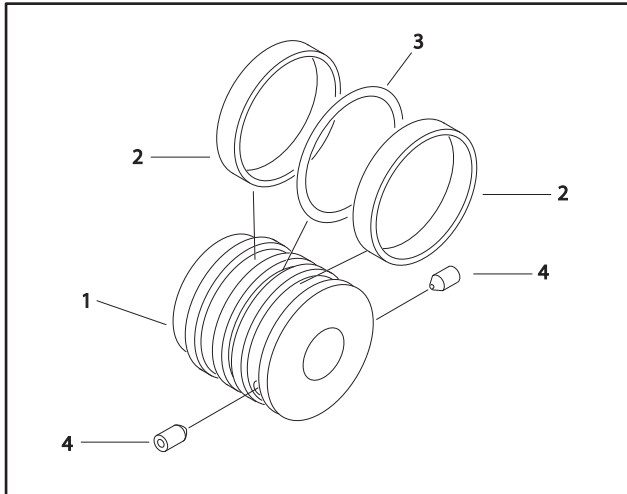


Figure 5-72. Piston Seal and Wear Ring

9. Remove Cylinder Head (7) from Rod (6).
10. Remove O-Ring (11), O-Ring (9), and Backup Ring (8) from Cylinder Head (7).
11. Remove Wiper (12) and Rod Seal (10). Do not damage cylinder head groove.
12. Remove Spanner Nut (13) from Rod (6).

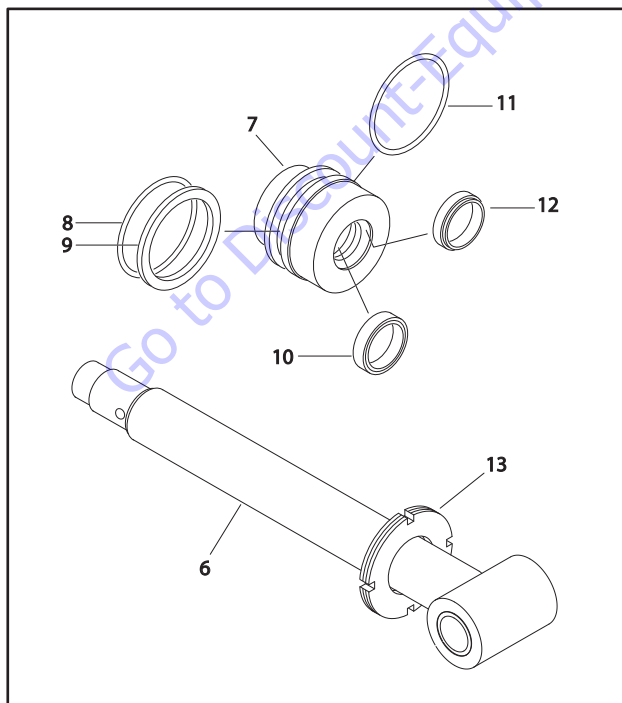


Figure 5-73. Cylinder Head Disassembly

Cleaning and Inspection

1. Clean all parts in an approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite™ or equivalent. Replace rod if necessary.
3. Inspect inner surface of cylinder barrel tube for scoring, tapering, ovality, or other damage. Replace if necessary.
4. Inspect threaded portion of barrel for damage. Dress threads as necessary.
5. Inspect piston surface for damage and scoring and for distortion. Inspect seal and O-ring grooves in piston for burrs and sharp edges. Dress piston surfaces or replace rod assembly as necessary.
6. Inspect rod bushings for excessive wear or damage. Replace as necessary.
 - a. Thoroughly clean rod bushing of burrs, dirt, etc.
 - b. Inspect rod bushing for wear or other damage. If rod bushing is worn or damaged, rod must be replaced.
 - c. Lubricate inside of rod bushing with WD40 before installing composite bushing.
 - d. Press composite bushing in rod bushing using correct size arbor.

NOTE: Pin is installed in composite bushing dry. Lubrication is not required with nickel plated pins and bearings.

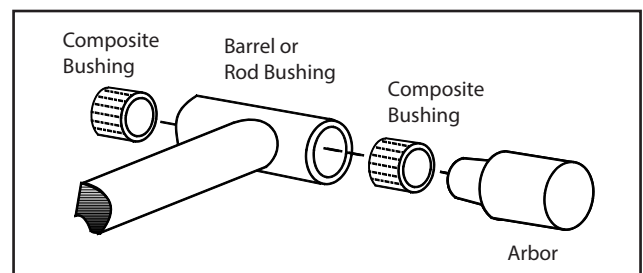


Figure 5-74. Composite Bushing Installation

7. Inspect cylinder head inside diameter for scoring, tapering, ovality, or other damage. Replace as necessary.
8. Inspect threads, and seal and O-Ring grooves in head for burrs, sharp edges, and other damage. Dress surfaces as necessary.
9. Inspect oil ports for blockage or contamination. Repair as necessary.

Assembly

NOTE: Apply a light film of hydraulic oil to all components before assembly.

1. Position cylinder barrel in a suitable holding fixture.

NOTICE

IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.

2. Install Spanner Nut (3) on Rod (6).
3. Install Rod Seal (5) and Wiper () in Cylinder Head (3).
4. Install O-Ring (7), Backup Ring (8), and O-Ring (9).

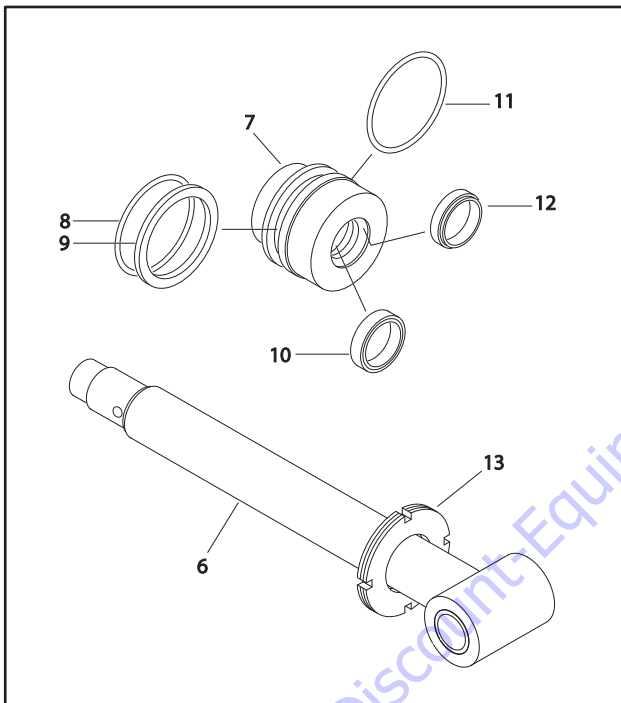


Figure 5-75. Cylinder Head Assembly

5. Install wear ring (11) in piston groove.
6. Install seal (10) in piston groove.

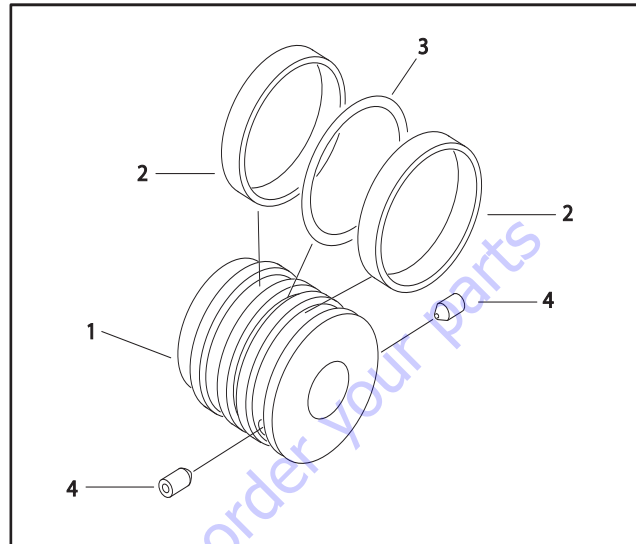


Figure 5-76. Piston Seal and Wear Ring

NOTICE

INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE INSTALLING CYLINDER ROD AND PISTON.

7. Insert Rod Assembly in Barrel (1).
8. Apply Locking Primer and Loctite 242 (or equivalent) to threads of Spanner Nut (3). Tighten spanner nut (3) with hook spanner to 57-63 ft-lb (77-85 Nm).

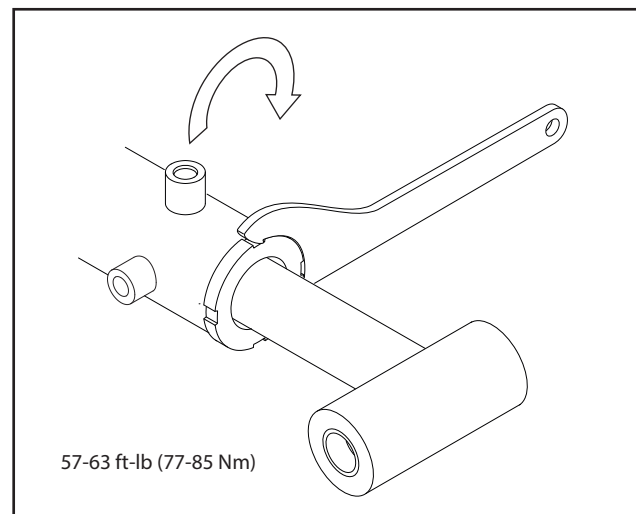


Figure 5-77. Spanner Nut Torque

Axle Lockout Cylinder

NOTE: Refer to Figure 5-78., Axle Lockout Cylinder.

DISASSEMBLY

NOTICE

CONTAMINATION MAY DAMAGE EQUIPMENT. DISASSEMBLE CYLINDER ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

CAUTION

PISTON CAN FALL OUT OF HOUSING AND CAUSE INJURY OR DAMAGE TO EQUIPMENT. BE CAREFUL WHEN REMOVING AXLE CYLINDER. OPENING BLEED VALVE CAN CAUSE PISTON TO FALL OUT OF HOUSING.

1. Open bleed valve (8). Rotate piston (2) and remove from housing (1).
2. Remove wiper (6). Do not scratch housing bore.
3. Remove two wear rings (5) and rod seal (7) from grooves in piston bore. Do not scratch housing bore.
4. Remove check valve (9), if required.
5. Inspect bore and piston for scoring, pitting, or excessive wear.
6. Remove minor surface blemishes with wet 2000-grit sandpaper. Pitting requires replacement of housing or piston.
7. Clean all parts with approved solvent and dry with compressed air.

ASSEMBLY

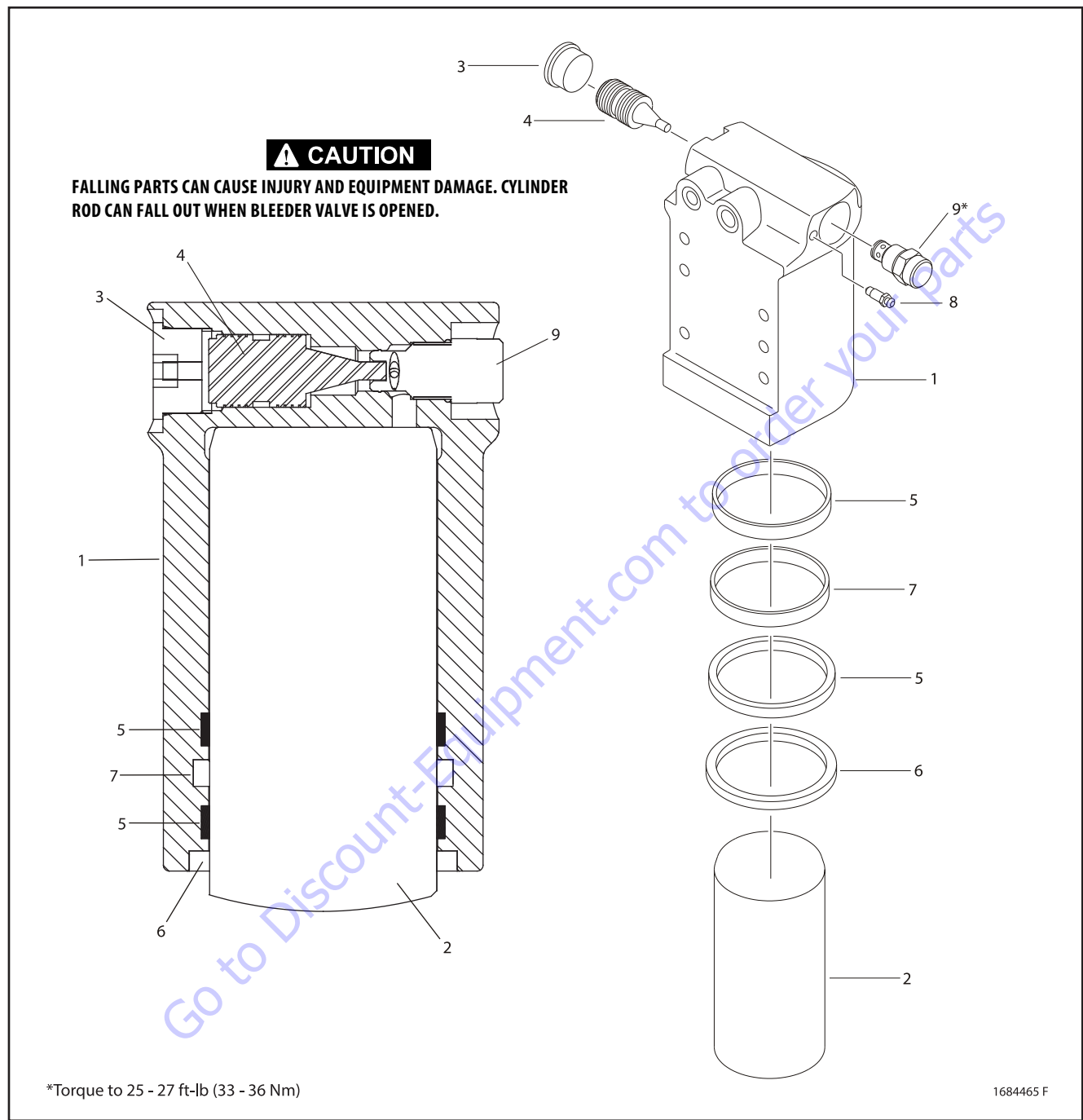
Refer to Figure 5-78., Axle Lockout Cylinder.

1. Install two new wear rings (5) and rod seal (7) in piston bore grooves. Make sure they are not twisted.
2. Install new wiper (6) in housing.
3. Lubricate piston bore with clean hydraulic fluid.

NOTICE

INSERTING PISTON OFF-CENTER CAN DAMAGE PISTON AND PISTON BORE SURFACES. USE EXTREME CARE WHEN INSTALLING PISTON.

4. Install piston (2) in bore and push to top of bore.
5. Install check valve (9). Torque to 25 - 27 ft-lb (33 - 36 Nm).
6. Bleed system.



- | | |
|-----------------|--------------------|
| 1. Barrel | 6. Wiper |
| 2. Rod | 7. Rod Seal |
| 3. Plug | 8. Bleeder |
| 4. Pilot Piston | 9. Cartridge Valve |
| 5. Wear Ring | |

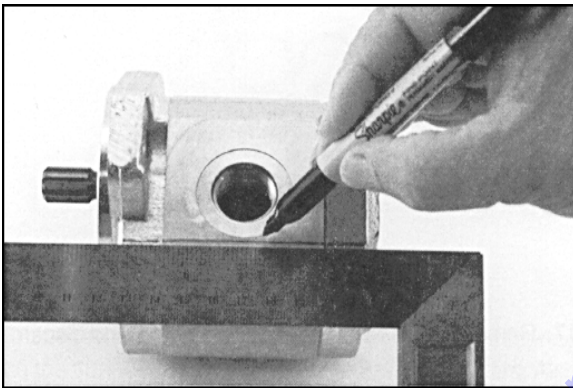
Figure 5-78. Axle Lockout Cylinder

5.6 HYDRAULIC PUMP (GEAR)

Disassembly

NOTE: The following general instructions also apply to multiple section gear pumps. The only extra parts are the coupling between drive shafts and center distance plate which divides the two pump sections. This repair procedure also applies to "W" series Gear Motors.

1. Always work in a clean work area when repairing hydraulic products. Plug ports and wash exterior of pump with approved cleaning solvent.
2. Remove port plugs and drain oil from pump.

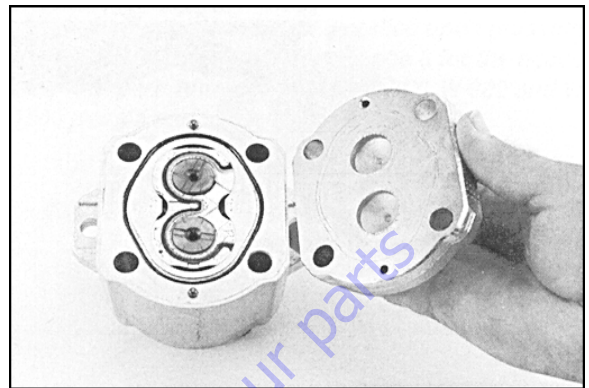


3. Use a permanent marker pen to mark a line across mounting flange, gear housing and end cover. This will assure proper reassembly and rotation of pump.
4. Remove key from drive shaft if applicable.

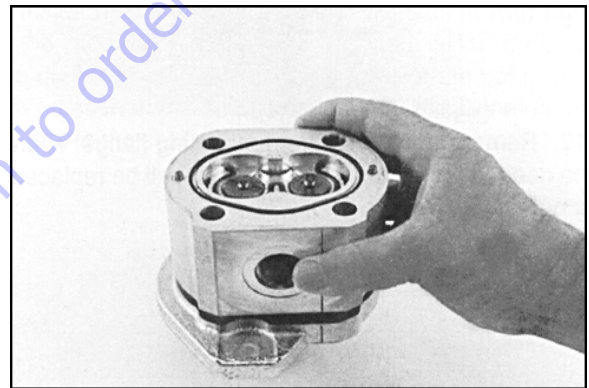


5. Clamp mounting flange in a protected jaw vise with pump shaft facing down.
6. Loosen four metric hex head bolts.

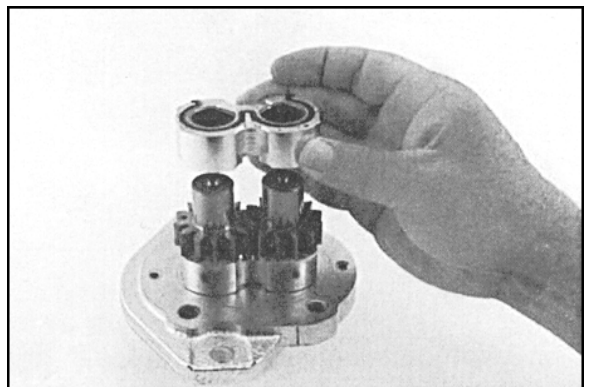
7. Remove pump from vise and place on clean work bench. Remove four hex head bolts and spacers if applicable.



8. Lift and remove end cover.

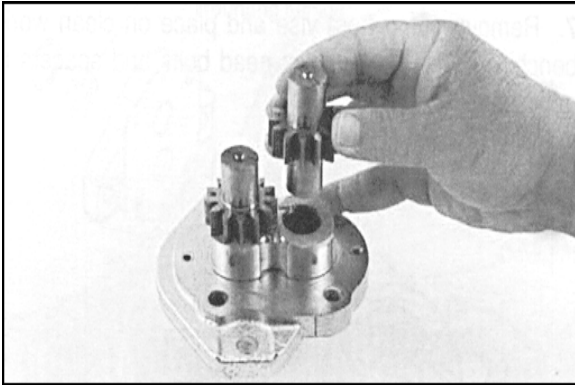


9. Carefully remove gear housing and place on work bench. Make sure rear bearing block remains on drive and idler shafts.

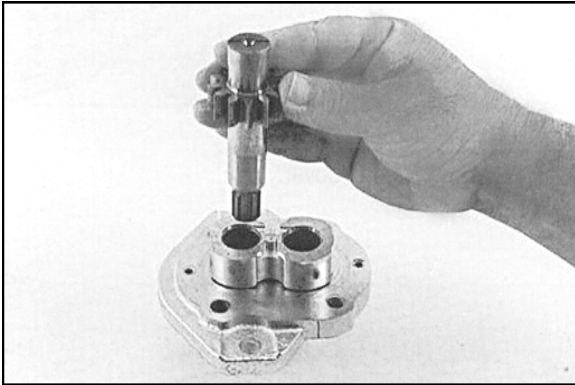


SECTION 5 - HYDRAULICS

10. Remove rear bearing block from drive and idler shafts.

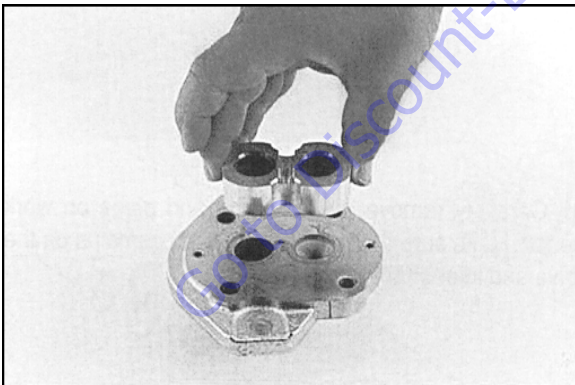


11. Remove idler shaft from bearing block.

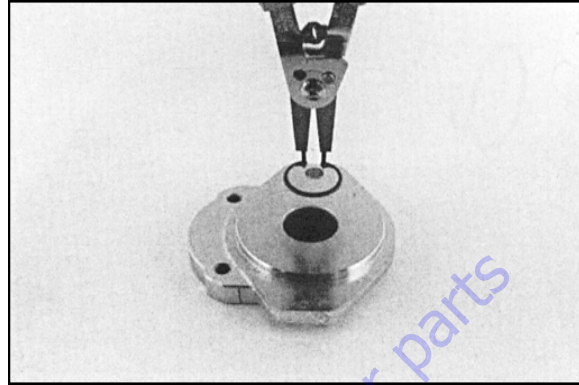


12. Remove drive shaft from mounting flange.

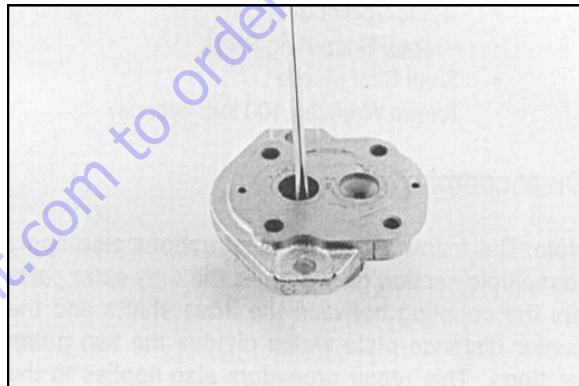
NOTE: Shaft seal will be replaced.



13. Remove front bearing block.

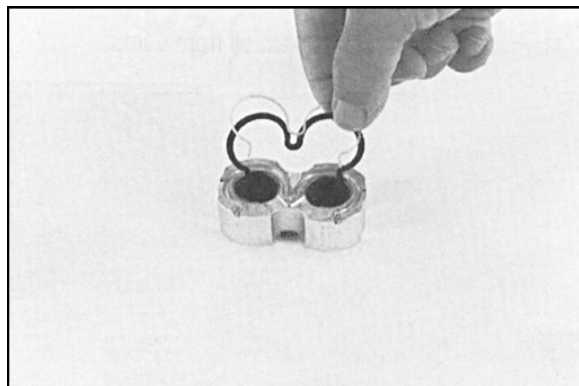


14. Turn mounting flange over, with shaft seal up. Remove retaining ring with snap ring pliers.



15. Remove oil seal from mounting flange. Do not mar or scratch seal bore.

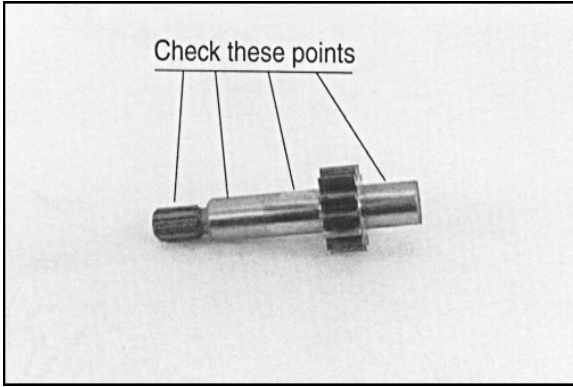
16. Remove dowel pins from gear housing. Do not lose pins.



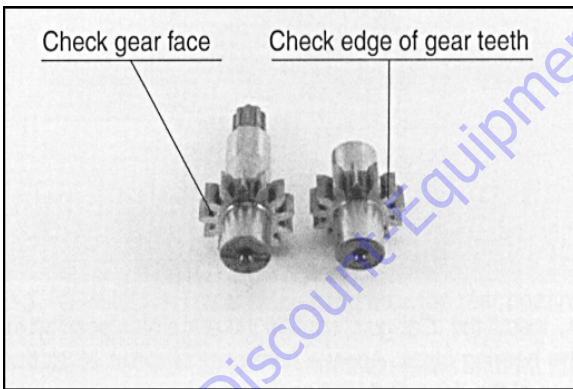
17. Remove and discard seals from both bearing blocks.

Inspect Parts For Wear

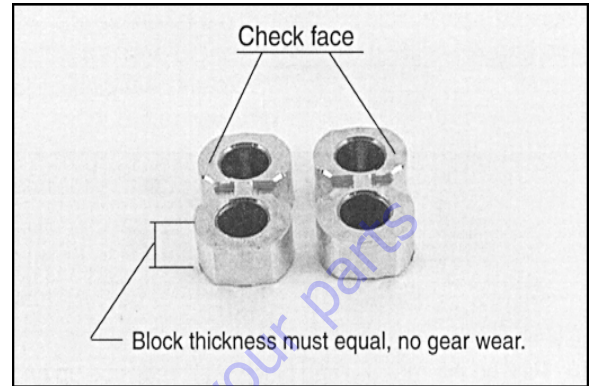
1. Clean and dry all parts thoroughly before inspection. It is not necessary to inspect seals. They will be placed as new items.



2. Check drive shaft spine for twisted or broken teeth, check keyed drive shaft for broken or chipped keyway. No marks or grooves on shaft in seal area, some discoloration of shaft is allowable.
3. Inspect drive gear shaft and idler gear shafts at bearing points and seal area for rough surfaces and excessive wear.



4. Inspect gear face for scoring or excessive wear. If face edge of gear teeth are sharp, they will mill into the bearing blocks. If wear has occurred, parts are unusable.



5. Inspect bearing blocks for excessive wear or scoring on surfaces in contact with gears. Inspect bearings for excessive wear or scoring.
6. Inspect area inside gear housing. A clean "wipe" on inside surface of intake side is normal. There should not be excessive wear, deep scratches, or gouges.

General Information

NOTICE

FAILURE TO PROPERLY ASSEMBLE THIS PUMP WILL RESULT WITH LITTLE OR NO FLOW AT RATED PRESSURE. RELATIONSHIP OF MOUNTING FLANGE, BEARING BLOCKS, AND GEAR HOUSING MUST BE CORRECT.

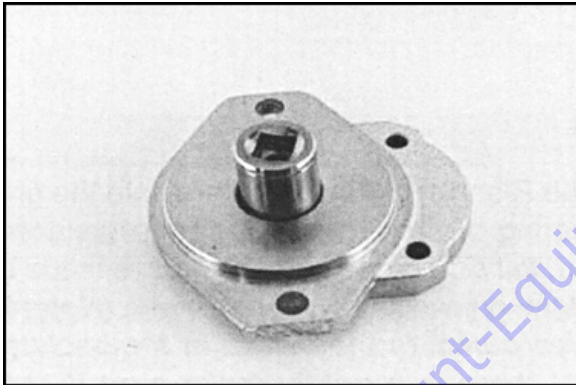
Reverse Shaft Rotation of Pump

NOTE: Pump is not bi-rotational. Use the following procedure if shaft rotation direction is changed.

Reverse shaft rotation of "W" series gear pump by rotating, as a group, two bearing blocks and gear housing 180° in relationship to remaining parts of pump. This places pressure port opposite from original position.

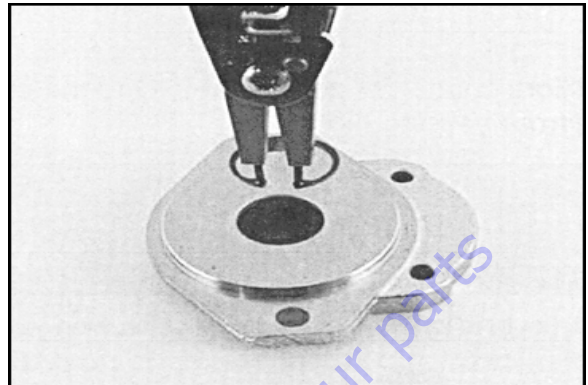
Assembly

NOTE: Install new seals when reassembling pump or motor. Go to page 8 for kit part numbers for W-600, W-900, and W-1500 pumps and motors.

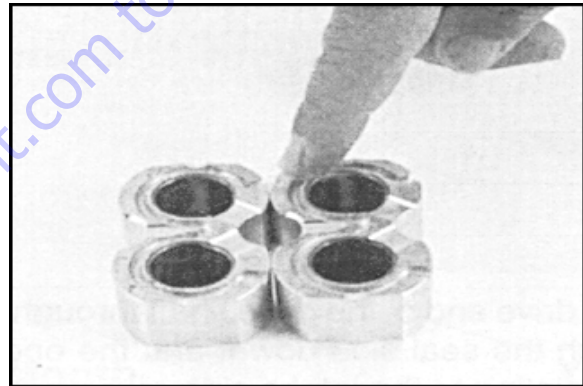


1. Install new shaft seal in mounting flange with part number side facing out. Press seal into seal bore until seal reaches bottom of bore. Use uniform pressure to prevent seal misalignment or damage.

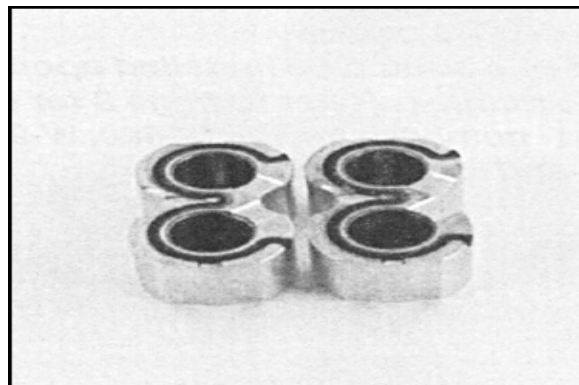
2. Install retaining ring in groove in seal bore of mounting flange.



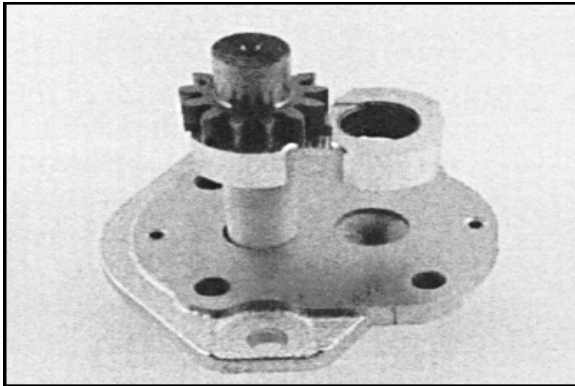
3. Place front and back bearing blocks on a clean surface with E-seal grooves facing up. Apply a light coating of petroleum jelly in the grooves. Coat E-seal and backup with petroleum jelly. This helps keep seals in place during reassembly



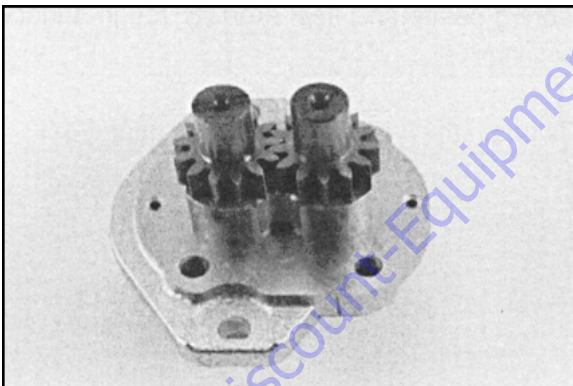
4. Place E-seals, flat side out, into grooves in both bearing blocks. Carefully place backup ring, flat side out, in groove made by E-seal and groove in bearing block. (Note: W900 series pump - In center of backup ring and E-seal there is a notch. Make sure notches line up so backup ring will set flush with E-seal). Backup ring in W1500 pump is symmetrical.



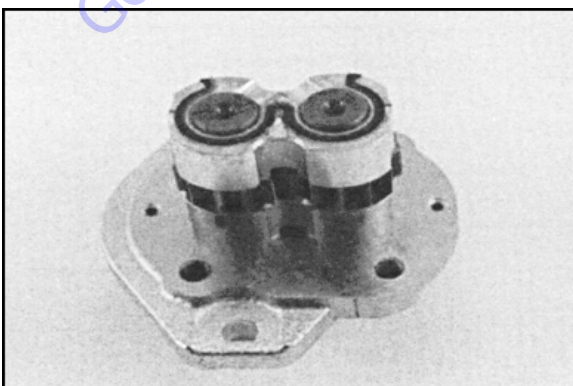
5. Place mounting flange, with shaft seal side down, on a clean flat surface.
6. Apply a light coating of petroleum jelly to exposed face of front bearing block.



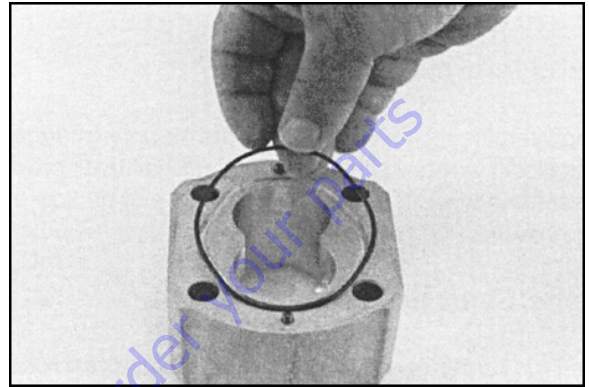
7. Insert drive end of drive shaft through bearing block with seal side down and open side of E-seal pointing to intake side of pump.
8. Install seal sleeve over drive shaft. Carefully slide drive shaft through shaft seal. Remove seal sleeve from shaft.



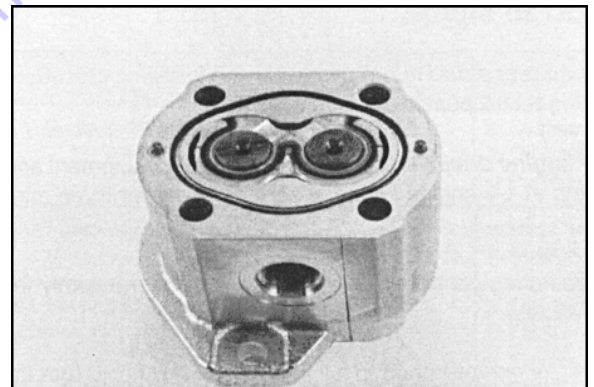
9. Install idler gear shaft in remaining position in bearing block. Apply a light coat of clean oil to face of drive and idler gears.



10. Place rear bearing block over drive and idler gear shafts with seal side up and open end of E-seal facing intake side of pump.
11. Install two dowel pins in mounting flange holes or two long dowel pins through gear housing if pump is a multiple section pump.



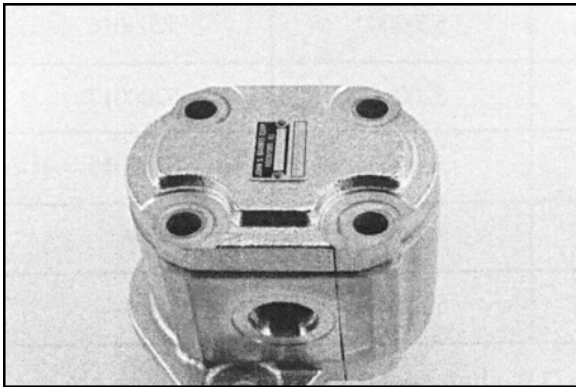
12. Apply a light coating of petroleum jelly in grooves on both sides of gear housing. Coat new O-rings and install in grooves.



SECTION 5 - HYDRAULICS

13. Gently slide gear housing over rear bearing block assembly. Slide housing down until it engages dowel pins. Press firmly in place with hands, do not force or use any tool. Check intake port in housing is on same side as open end of E-seal, and marked lines on mounting flange and gear housing are aligned.

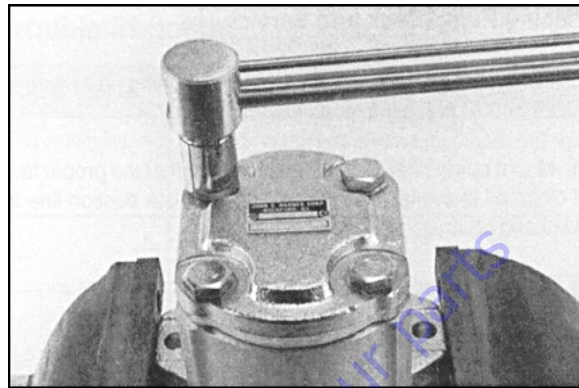
NOTE: Rear bearing block surface should be slightly below gear housing face. If bearing block is higher than rear face of gear housing, E-seal or O-ring have shifted out of groove. Remove gear housing and check for proper seal installation.



14. Install two remaining dowel pins in rear of gear housing, if applicable. Place end cover over back of pump.



15. Install four spacers (if applicable) and hex head bolts through bolt holes in end cover. Hand tighten.



16. Place mounting flange of pump in protected jawed vise and alternately torque bolts to torque chart specifications. All torque figures are for "dry torque" bolts.

Table 5-1. Hydraulic Pump Bolt Torque Chart

Pump Series	Thread Size	Torque Values, Black Oxide End Cover	Torque Values, Zinc Plated End Cover
W-600	M 8 x 1.25	18-21 ft.lb. 24-30 Nm	16-18 ft.lb. 21.7-24.4 Nm
W-900	M 10 x 1.5	50-55 ft.lb. 68-75 Nm	38-43 ft.lb. 51.5-58.3 Nm
W-1500	M 12 x 1.75	80-85 ft.lb. 108-115 Nm	68-73 ft.lb. 92.2-99 Nm

17. Remove pump from vise.
18. Place a small amount of clean oil in pump inlet and rotate drive shaft away from inlet one revolution. If drive shaft binds, disassemble pump and check for assembly problems. Reassemble pump.

Placing Pump Back Into Service

1. *If shop test stand is available, use the following procedure for testing rebuilt pumps:*
 - a. Mount pump on test stand. Make sure proper level of clean oil is available in reservoir. Check suction line for leaks and obstructions.
 - b. Start pump and run for three minutes at zero pressure.
 - c. Intermittently load pump to 500 psi (34 bar) for three minutes.
 - d. Intermittently load pump to 1000 psi (69 bar) for three minutes.
 - e. Intermittently load pump to 2000 psi (138 bar) for three minutes.
 - f. Remove pump from test stand and check for freeness of drive shaft. Check pump for signs of external leakage.
2. *If shop test stand is not available, use the following procedure for testing rebuilt pumps:*
 - a. *For engine driven pumps,* mount pump on equipment and run pump at 1/2 engine speed at zero pressure for three minutes.
 - b. Operate control valve and build pressure intermittently for three minutes.
 - c. Increase engine speed to full throttle and build pressure intermittently for three minutes.
 - d. Stop engine and check pump for external leaks.

5.7 VARIABLE PUMP

Ports and Pressure Gauges

Proper servicing of pumps and motors requires pressure measured and monitored at various hydraulic circuit points. The Series 42 pump has several locations at which to take these measurements. The following outlines show gauge port locations, and gauge and fitting size for each port.

Table 5-2. Recommended Gauge Size

Gauge Port Name	Pressure Measured	Recommended Gauge Size		Fitting
		psi	bar	
M1&M2	System Pressure Ports A & B	10000	689	9/16-18ORF
M3	Charge	1000	69	3/4-16ORF
M4&M5	Servo	1000	69	9/16-18ORF
L1&L2	Case	500	34	1-1/16-12ORF
S	Charge Pump Inlet Vacuum	30 in. Hg Vac.	1	1-1/16-12ORF

NFPE Control

The 3-position FNR control, and electric and hydraulic non-feedback proportional (NFPE and NFPH) controls are non-feedback type controls. FNR and NFPE controls consist of pump housing mounted modules. Hydraulic input for NFPH is received through ports on top of pump [9/16-18 SAE O-ring fitting].

Non-feedback controls are factory set. Control modules can be removed to clean ports and change O-rings.

FNR and NFPE orifice plugs are located inside the servo piston covers. NFPH orifice plugs are located in the NFPH ports. Orifice plugs may be cleaned or replaced.

Remove and Install FNR and NFPE Modules

1. Clean pump and module housings.
2. Remove four screws retaining module to pump housing (4 mm Int. Hex). Remove module from housing.
3. Remove O-rings from the control ports. Examine ports for cleanliness.
4. Clean sealing surfaces.
5. Replace locator pin.
6. Install new O-rings.
7. Replace screws. Torque to 3.5 - 4.5 ft-lb (4.7-6.1 Nm).

Remove and Install FNR and NFPE Control Orifices

NOTE: Future models may contain an orifice plate between module and pump housing. This will take the place of the orifice plugs beneath the servo piston cover.

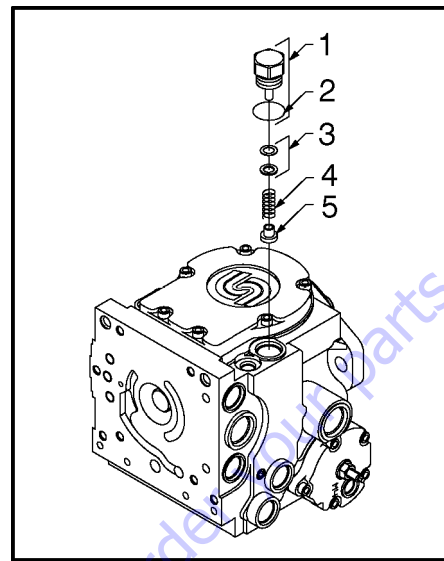
1. Remove servo piston cover.
2. Remove orifice plug (1/8" Int. Hex).
3. Examine orifice and port for cleanliness.
4. Install orifice plug. Torque to 1.5 - 2.5 ft-lb (2.0-3.4 Nm).

Charge Relief Valve

Charge relief valve may be removed for cleaning and installation of new O-rings. Pressure setting may be changed for different charge flows depending on charge pump size and pump speed.

Factory setting is set relative to case pressure at 1800 rpm. Actual charge pressure varies at different speeds.

SHIM ADJUSTABLE STYLE

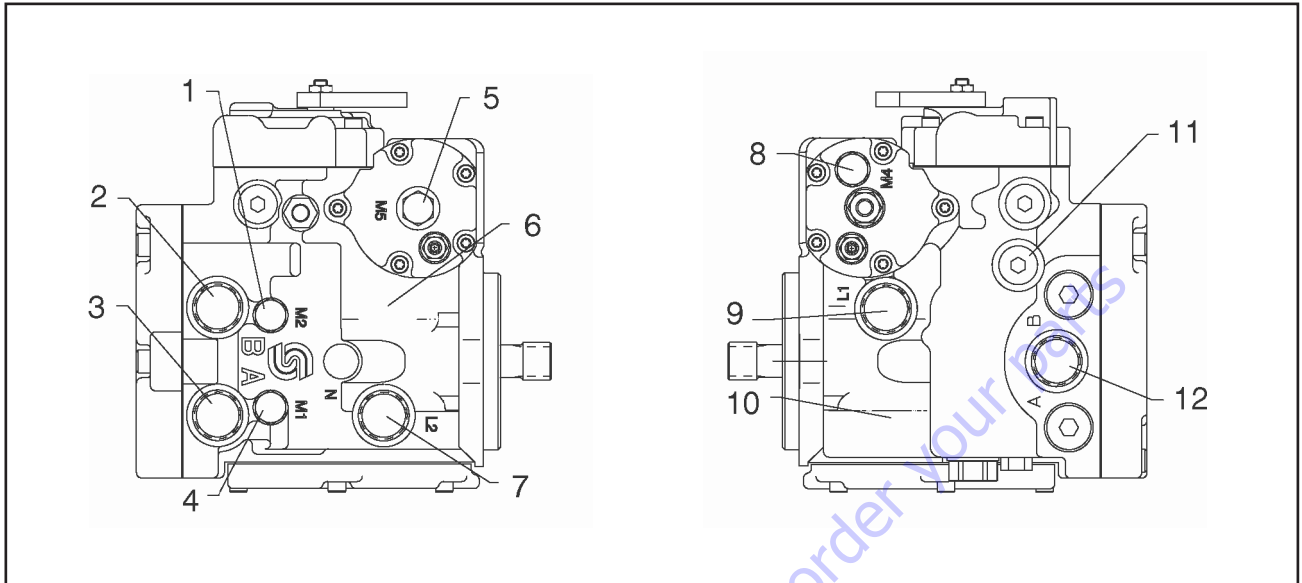


- | | |
|-----------|------------------|
| 1. Plug | 4. Spring T-Seal |
| 2. O-Ring | 5. Poppet |
| 3. Shims | |

Figure 5-79. Shim Adjustable Charge Relief Valve Components

1. Remove shim adjustable charge relief valve plug (1" Hex) from pump housing. Remove O-ring from plug.
2. Remove spring and poppet from housing.
3. Do not alter shims which may be installed between spring and valve plug, or interchange parts with another valve. Inspect poppet and mating seat in housing for damage or foreign material.
4. If desired, change charge relief valve setting. An approximate rule of thumb is 4 bar / 1.25 mm (58 psi / 0.050 in). Effective setting will vary.

To confirm charge relief valve setting, measure charge pressure (port M3) with pump in stroke. Charge pressure should level off when relief setting is reached.



- | | |
|--------------------------------------|---------------------------------------|
| 1. System Pressure Gauge Port M2 | 7. Case Drain Port L2 |
| 2. System Pressure Port B | 8. Servo Pressure Gauge Port L4 |
| 3. System Pressure Port A | 9. Case Drain Port L1 |
| 4. System Pressure Gauge Port M1 | 10. Case Drain Port L1 (non-feedback) |
| 5. Servo Pressure Gauge Port M5 | 11. Charge Pressure Gauge |
| 6. Case Drain Port L2 (non-feedback) | 12. Charge Pump Inlet Port S |

Figure 5-80. Gauge Port Locations

SECTION 5 - HYDRAULICS

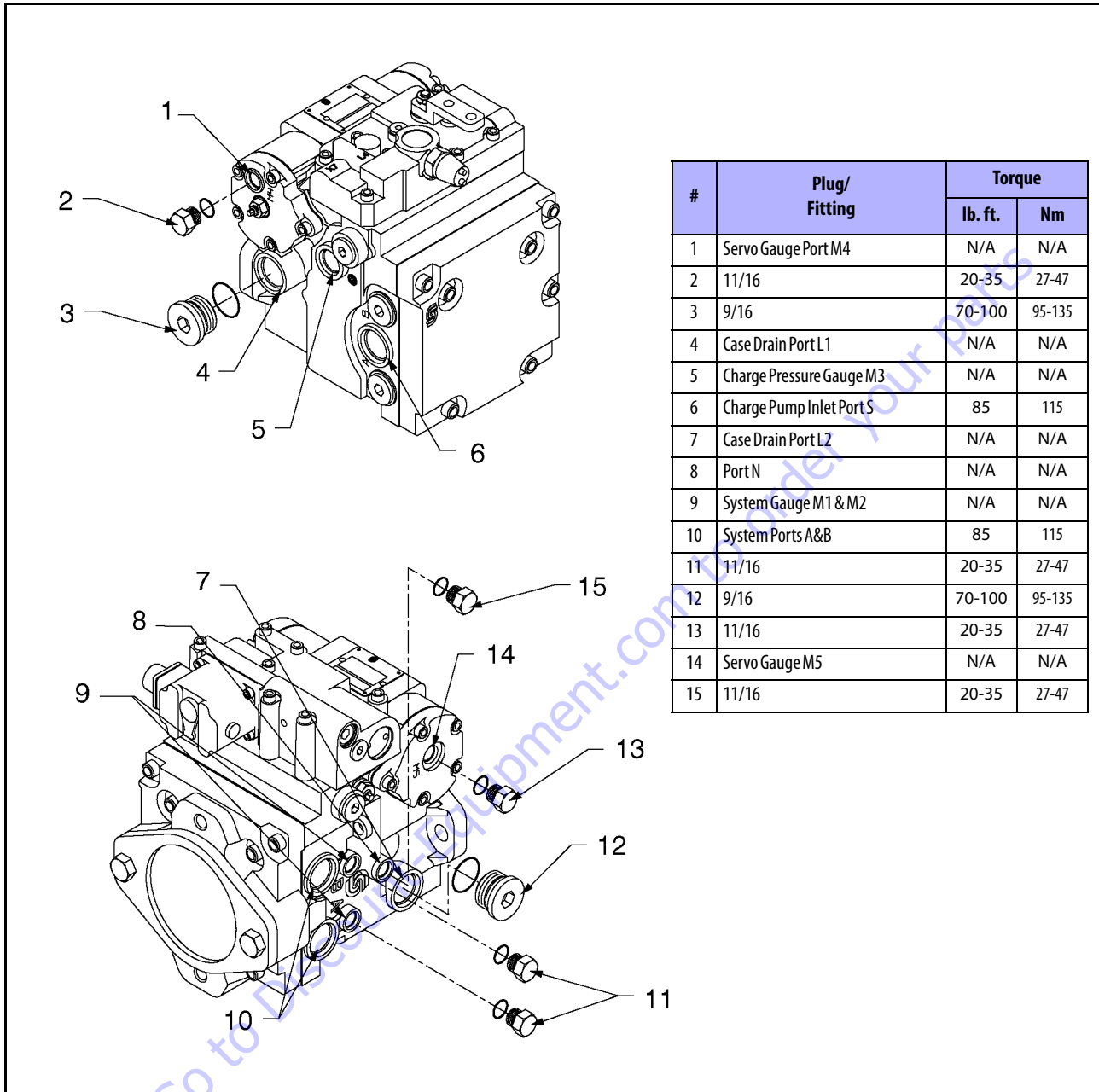
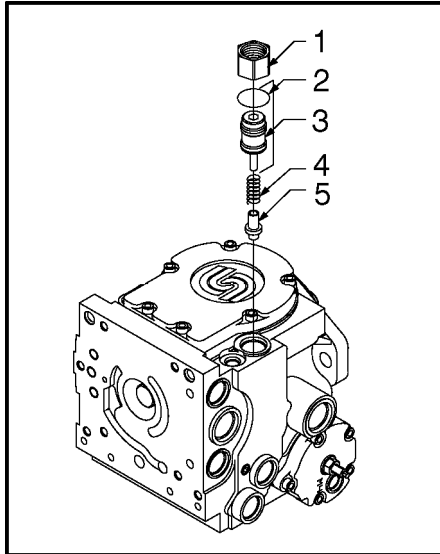


Figure 5-81. Plugs/Fittings Size & Torque

5. Install new O-ring on valve plug. Reinstall poppet, spring, and plug (with shims and O-ring) into pump housing. Torque to 40-100 ft-lb (55-135 Nm).

SCREW ADJUSTABLE STYLE

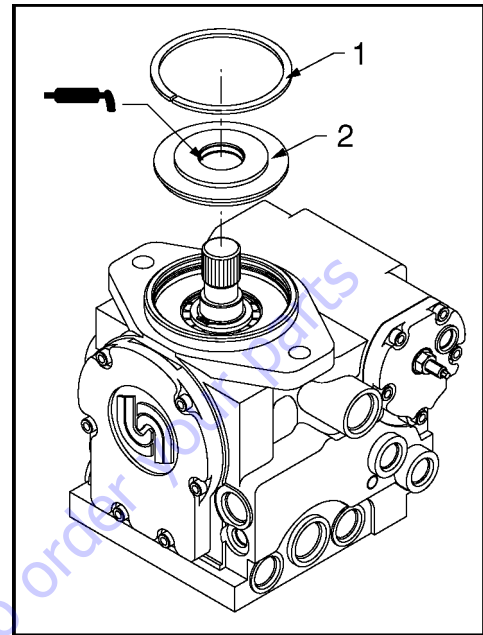


- | | |
|-------------|------------------|
| 1. Lock Nut | 4. Spring-T-Seal |
| 2. O-Ring | 5. Poppet |
| 3. Plug | |

Figure 5-82. Screw Adjustable Charge Relief Valve Components

1. Mark plug, lock nut, and housing to maintain original adjustment before removing screw adjustable relief valve plug. Loosen lock nut (1-1/16" Hex) and remove plug (8 mm Int. Hex). Remove O-ring from plug.
2. Remove spring and poppet from housing.
3. Inspect poppet and mating seat in housing for damage or foreign material.
4. Install new O-ring on valve plug. Reinstall poppet and spring. Reinstall plug and lock nut. Torque to 34 - 42 ft-lb (47-57 Nm), aligning marks made at disassembly.
5. Check and adjust charge pressure if necessary. For screw adjustable "anti-stall" charge relief valves, an approximate rule of thumb is 2.8 bar/quarter turn (40 psi/quarter turn).
6. Measure charge pressure (port M3) with pump in stroke. Charge pressure should level off when relief setting is reached.

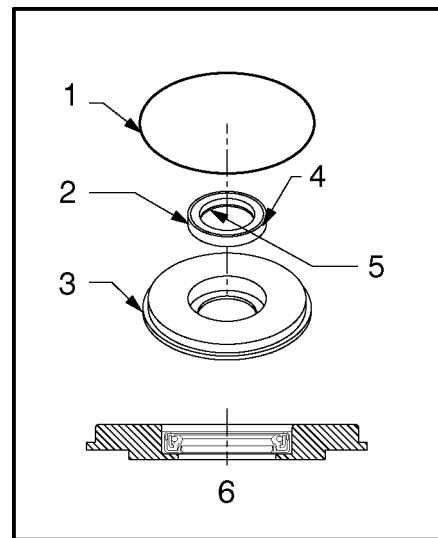
Shaft Seal and Shaft Replacement



- | | |
|-------------------|--------------------------|
| 1. Retaining Ring | 2. Seal Carrier Assembly |
|-------------------|--------------------------|

Figure 5-83. Shaft Seal Components

A lip type shaft seal is used in Series 42 pumps. Seal and shaft can be replaced without major unit disassembly. Replacement generally requires removing pump from machine.



- | | |
|-----------------|--|
| 1. O-Ring | 4. Sealant may be used on outside diameter |
| 2. Seal | 5. Inside Lip (face down) |
| 3. Seal Carrier | 6. Press Seal to Bottom of Seal Carrier |

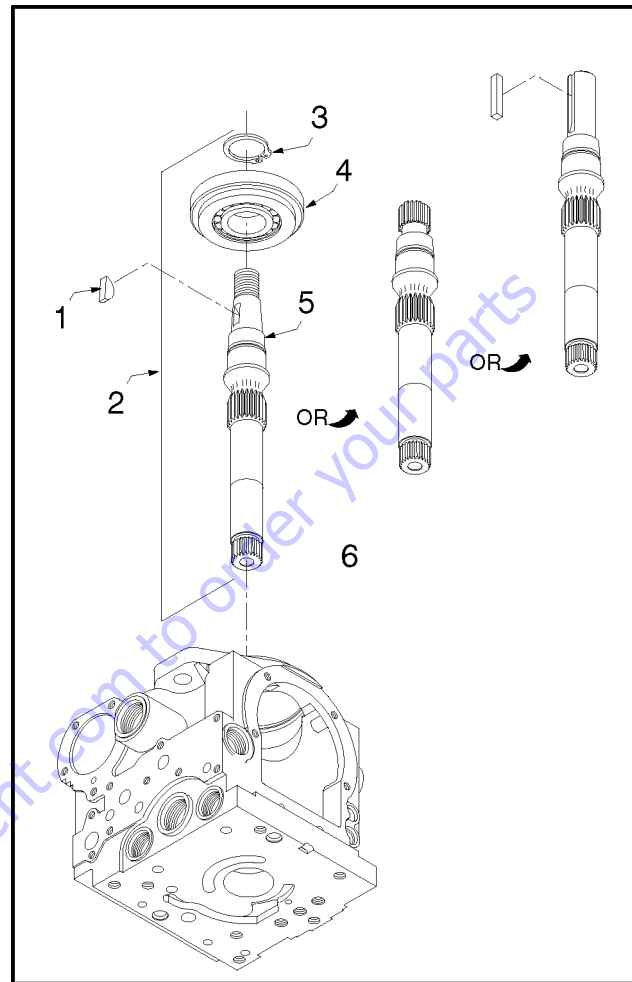
Figure 5-84. Installation of Shaft Seal

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1. Position pump with shaft facing up.

NOTE: If unit is positioned horizontally when shaft is removed, cylinder block could move out of place, making shaft installation difficult.

2. Remove retaining ring from housing.
3. Pull out seal carrier assembly.
4. Remove O-ring from seal carrier. To install a new shaft only, go to step 8.
5. Place seal carrier in an arbor press with shaft bearing side down and press out old seal. An appropriately sized pipe spacer or socket wrench can be used as a press tool. Seal is not reusable.
6. Inspect seal carrier and new seal for damage. Inspect sealing area on shaft for rust, wear, or contamination. Polish sealing area on shaft if necessary.
7. Press new seal in shaft bearing side of seal carrier. Seal lip must face outside of pump. Do not damage seal. Outside diameter of seal may be coated with a sealant (e.g. Loctite High Performance Sealant #59231) before installation. This helps prevent leaks caused by damage to seal bore in seal carrier. If shaft is not being replaced go to step 11.
8. Remove shaft and roller bearing assembly from pump or motor.
9. Remove retaining ring from roller bearing assembly with snap ring pliers. Remove roller bearing assembly.
10. Place roller bearing assembly on new shaft and secure with retaining ring.
11. Wrap spline or key end of shaft with thin plastic to prevent damage to seal lip during installation. Lubricate inside diameter of shaft seal with petroleum jelly.
12. Place O-ring on shaft bearing and lubricate with petroleum jelly.
13. Slide seal carrier assembly over shaft and into housing bore. Press against O-ring. Hold inward pressure against shaft to compress cylinder block spring while pressing seal carrier into place.
14. Install retaining ring.



- | | |
|-------------------|-------------------|
| 1. Key | 4. Roller Bearing |
| 2. Shaft Assembly | 5. Shaft |
| 3. Retaining Ring | |

Figure 5-85. Shaft Components

Hydraulic Pump W/Hayes Pump Drive Coupling Lubrication

Coat pump and drive coupling splines with Lithium Soap Base Grease (TEXACO CODE 1912 OR EQUIVALENT) whenever pump or pump drive coupling is removed. Coupling is greased prior to assembly.

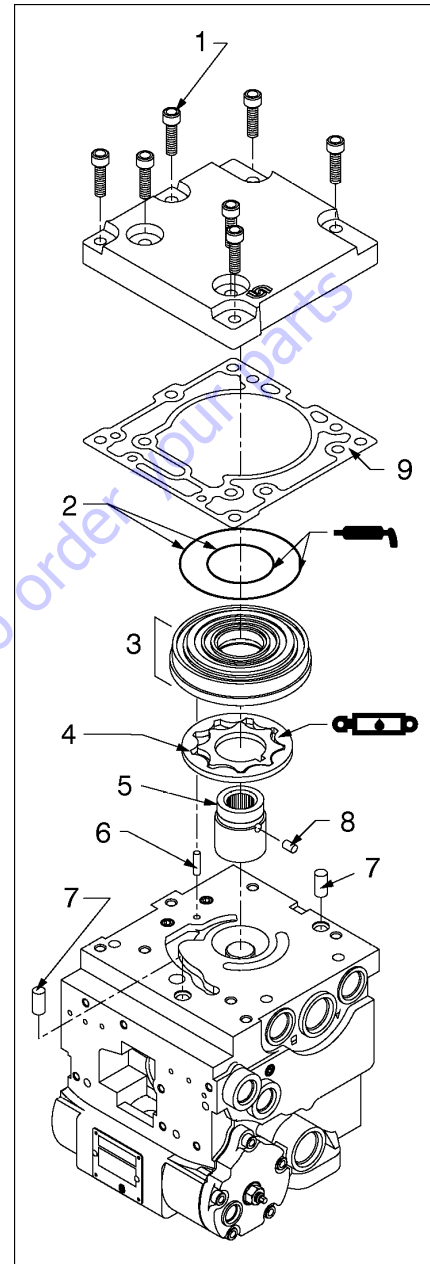
Charge Pump

NOTE: Disassemble charge pump to inspect and clean, or change auxiliary shaft drive coupling.

1. Remove auxiliary pump if necessary.
2. Remove screws retaining charge pump cover to pump housing (Torx T). Seven screws are used with "no pad" or SAE "A" auxiliary mounting pad charge pump cover, and six screws are used with SAE "B" auxiliary mounting pad charge pump cover. Remove charge pump cover, gasket, and cover locating pins.
3. Remove gerotor cover assembly from charge pump cover or back of pump housing. Remove gerotor cover O-rings. Two O-rings are used on gerotor cover of all pumps.
4. Remove gerotor assembly from gerotor cover or pump housing.
5. Remove gerotor drive pin and drive coupling. Remove gerotor cover locating pin from pump housing.
6. Inspect each part if they are to be reused. If either gerotor assembly parts needs to be replaced, they must both be replaced. Always replace O-rings and charge pump cover gasket. Inspect journal bearing in gerotor cover for excessive wear.
7. Lubricate gerotor assembly with clean hydraulic oil before assembly.
8. Install gerotor drive pin into hole in drive coupling. Apply grease or petroleum jelly to keep in place.
9. Install drive coupling on pump shaft with smaller outside diameter facing away from shaft.
10. Install gerotor assembly onto coupling.
11. Install gerotor cover locating pin into pump housing. Install gerotor cover assembly over gerotor. Locating pin must engage slot in gerotor cover.

NOTE: Charge pump rotation is determined by location of gerotor recess and pressure balance hole in gerotor cover. Different gerotor covers are used for clockwise and counterclockwise rotation pumps.

12. Install new pressure balance O-rings to gerotor cover and retain with petroleum jelly or grease.
13. Install charge pump cover locating pins and new charge pump cover gasket.
14. Install charge pump cover. Cover must engage gerotor cover and locating pins. Install charge pump cover screws. Torque evenly to 26 - 32 ft-lb (36-43 Nm).
15. Reinstall auxiliary pump if necessary.



- | | |
|--------------------------|-----------------------------------|
| 1. Cover Retaining Screw | 6. Gerotor Cover Locating Pin |
| 2. O-Ring | 7. Charge Pump Cover Locating Pin |
| 3. Gerotor Cover | 8. Gerotor Drive Pin |
| 4. Gerotor Assembly | 9. Gasket |
| 5. Drive Coupling | |

Figure 5-86. Charge Pump Components

5.8 HYDRAULIC COMPONENT START-UP

The goal at hydrostatic system start up is to preserve the designed life span of the system. Use the following start-up procedure when a new pump or motor is installed or a system is restarted after a pump or motor has been removed and reinstalled.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTIONS DISCONNECTED, ETC.) WHILE PERFORMING PROCEDURE. TO PREVENT INJURY. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING VEHICLE/MACHINE.

Inspect pumps or motors for damage that may have been incurred during shipping and handling before installation. Make sure all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean before filling with fluid.

Fill reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter before entering reservoir. Using contaminated fluid can damage components and may cause unexpected vehicle/machine movement.

NOTICE

INSPECT ALL PUMPS OR MOTORS FOR DAMAGE AND CONTAMINATION IF ANY PUMP OR MOTOR IS REPLACED DUE TO INTERNAL DAMAGE. FLUSH AND REPLACE ALL HYDRAULIC SYSTEM FLUID OR DAMAGE TO ENTIRE SYSTEM MAY RESULT.

Inlet line from reservoir to pump must be filled prior to start-up. Check inlet line for properly tightened fittings, restrictions, and air leaks.

NOTE: *Reservoir is usually above pump inlet. Pressure head created by higher oil level helps keep inlet pressures within acceptable range and prevent high vacuum levels. However, air may be trapped due to hose routing or low reservoir locations. Bleed air by loosening hose at fitting closest to pump. When oil begins to flow, line is full and air has been purged. Tighten fitting to specified torque. If tank needs to be pressurized to start oil flow, take a vacuum reading at pump inlet during operation to verify pump is not trying to draw an inlet vacuum higher than its capability.*

Fill pump and motor housing with clean hydraulic fluid before start up. Fill housing by pouring filtered oil in upper case drain port.

NOTE: *Use highest possible case drain port. This ensures housing contains as much oil as possible and offers the greatest amount of lubrication to internal components.*

NOTE: *It may be easier to fill housing before installing the case drain line. Component (especially motor) location may prevent case drain port access after installation.*

NOTE: *Oil used to fill component housing must be clean. Store fill container properly to prevent contamination.*

Install 1000 psi (60 bar) pressure gauge in charge pressure gauge port to monitor charge pressure during start-up.

It is recommended external control input signal, (electrical connections for EDC), be disconnected at pump control until after initial start-up. This ensures pump remains in its neutral position.

⚠ WARNING

DO NOT START ENGINE UNLESS PUMP IS IN NEUTRAL POSITION (0° SWASH-PLATE ANGLE). TAKE PRECAUTIONS TO PREVENT MACHINE MOVEMENT IN CASE PUMP IS ACTUATED DURING INITIAL START-UP.

"Jog" or slowly rotate engine until charge pressure starts to rise. Start engine and run at lowest possible RPM until charge pressure is established. Excess air should be bled from system lines as close to motors as possible.

NOTE: *With engine on low idle loosen, do not remove, system lines at motor(s). Continue to run engine at low idle and tighten system lines as soon as oil is observed to leak from them. When oil is observed to "leak" at motor, line is full and air is purged. Tighten system hoses to specified torque.*

Once charge pressure is established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code. If charge pressure is inadequate, shut down and determine cause.

⚠ WARNING

INADEQUATE CHARGE PRESSURE WILL AFFECT OPERATOR'S ABILITY TO CONTROL MACHINE.

Shut down engine and connect external control input signal. Reconnect machine function(s), if disconnected earlier. Start engine, checking pump remains in neutral. With engine at normal operating RPM, slowly check forward and reverse machine operation.

Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

Shut down engine, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

Machine is ready for operation.

5.9 MAIN VALVE BLOCK PRESSURE SETTINGS

Refer to Figure 5-88., Main Control Valve Block Assembly - 4WS Deutz D2011 and GM Engines (SN 0300181891 to Present), Deutz TD2.9L4 Engines (SN 0300188199 to Present)

NOTICE

COLD TEMPERATURES HAVE A SIGNIFICANT IMPACT ON PRESSURE READINGS. JLG INDUSTRIES, INC. RECOMMENDS OPERATING THE MACHINE UNTIL THE HYDRAULIC SYSTEM HAS WARMED TO NORMAL OPERATING TEMPERATURES PRIOR TO CHECKING PRESSURES. JLG ALSO RECOMMENDS USING A CALIBRATED GAUGE. PRESSURE READINGS ARE ACCEPTABLE IF WITHIN +/- 5% OF SPECIFIED PRESSURES.

Main Relief

1. Install high pressure gauge in port MP (11).
2. Activate telescope in.
3. Adjust main relief valve (6) to 3000 psi (207 bar). Turn adjuster clockwise to increase or counterclockwise to decrease pressure.

Main Lift Down

1. Install high pressure gauge in port MP (11).
2. Activate Main lift down.
3. Adjust lift down relief (6) to 2000 psi (138 bar). Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

NOTE: *This pressure allows for system pressure drop and should equal 1500 psi (103 bar) at the work port.*

Swing

NOTE: *Left and right swing pressures are set with one adjustment.*

1. Install high pressure gauge in port MP (11).
2. Lock turntable with turntable lock pin.
3. Activate swing left or right
4. Check both directions of swing and adjust lowest pressure reading at swing relief (6) to 1700 psi (117 bar). Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

2-Wheel Steer

1. Install high pressure gauge in port MP (11).
2. Activate steer left and right.
3. Adjust front steer relief valves (7) to 2050 psi (141 bar) in both directions. Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

NOTE: *This pressure allows for system pressure drop and should equal 1800 psi (124 bar) at the work port.*

4-Wheel Steer

1. Install pressure gauge in port MP (11).
2. Activate front wheel steer left and right.

NOTE: *Rear steer relief cartridges are preset and not field adjustable.*

3. Adjust front steer relief valves (7) to 2700 psi (186 bar) in both directions. Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

5.10 PLATFORM (SLAVE) VALVE BLOCK PRESSURE SETTINGS

Refer to Figure 5-90., Location of Components - Main Control Valve Deutz D2011 and GM Engines (SN 0300181891 to Present), Deutz TD2.9L4 Engines (SN 0300188199 to Present)

Platform (Slave) Level Extend

1. Install high pressure gauge in port M1 (1).
2. Activate level up to end of stroke.
3. Adjust level up relief (6) to 2800 psi (193 bar). Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

Platform (Slave) Level Retract

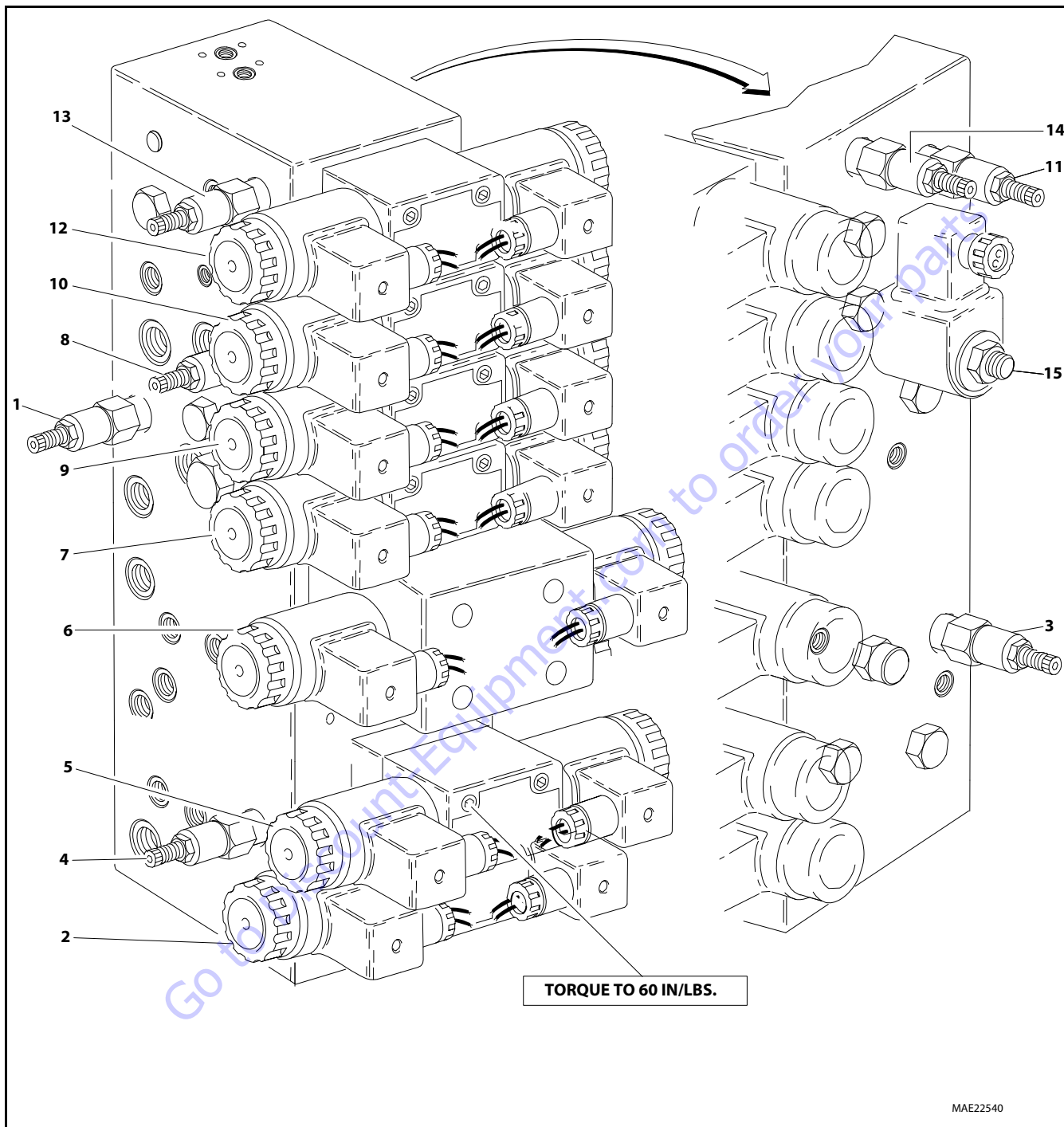
1. Install high pressure gauge at quick disconnect on port M2 (2).
2. Activate level down to end of stroke.
3. Adjust level down relief (5) to 1800 psi (124 bar). Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

Articulating Jib

NOTE: *Relief pressure is bi-directional, but can only be read in one direction.*

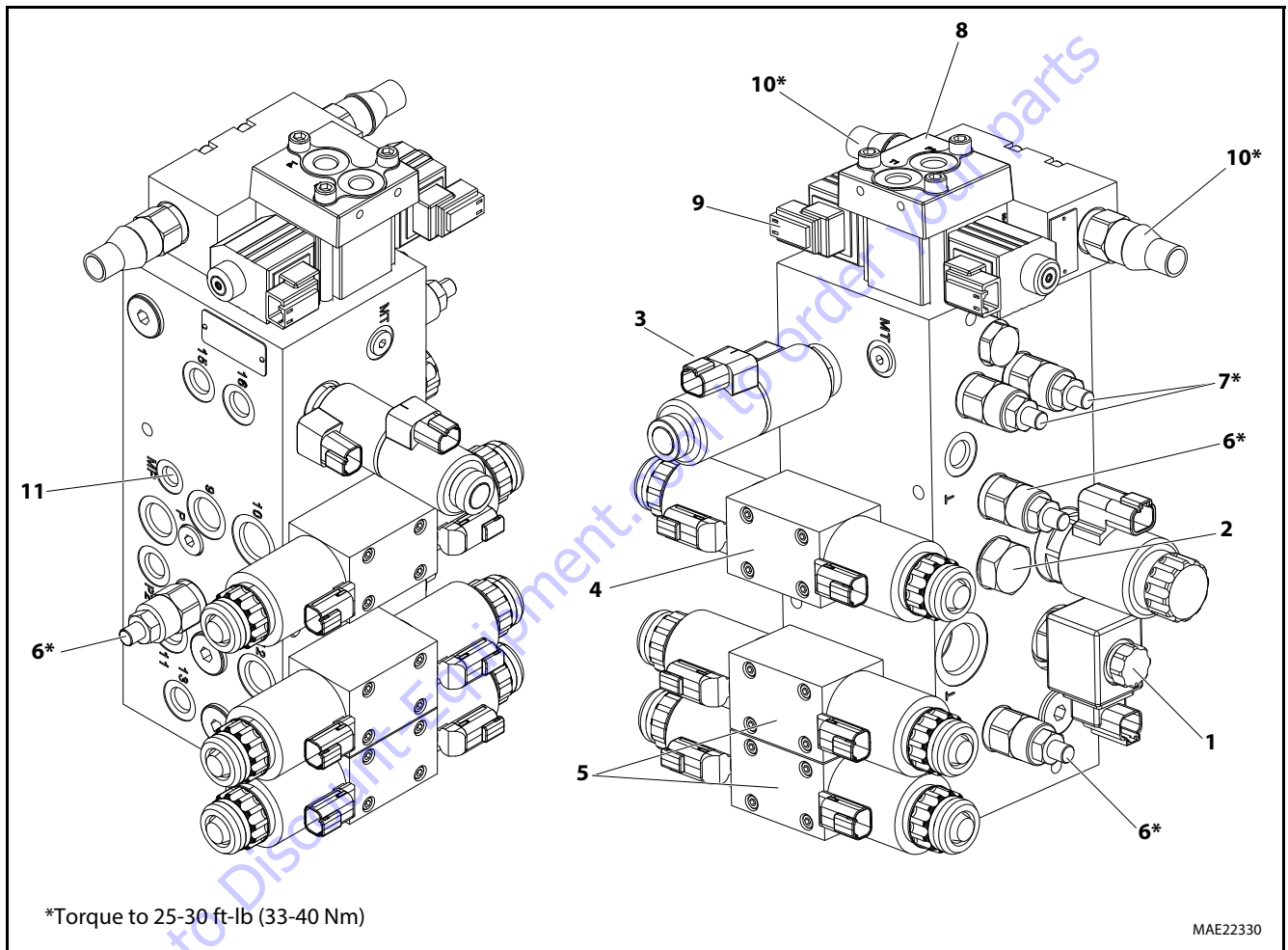
1. Install high pressure gauge in port M3 (12).
2. Activate jib extend to end of stroke.
3. Adjust jib relief (9) to 1500 psi (103 bar). Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

SECTION 5 - HYDRAULICS



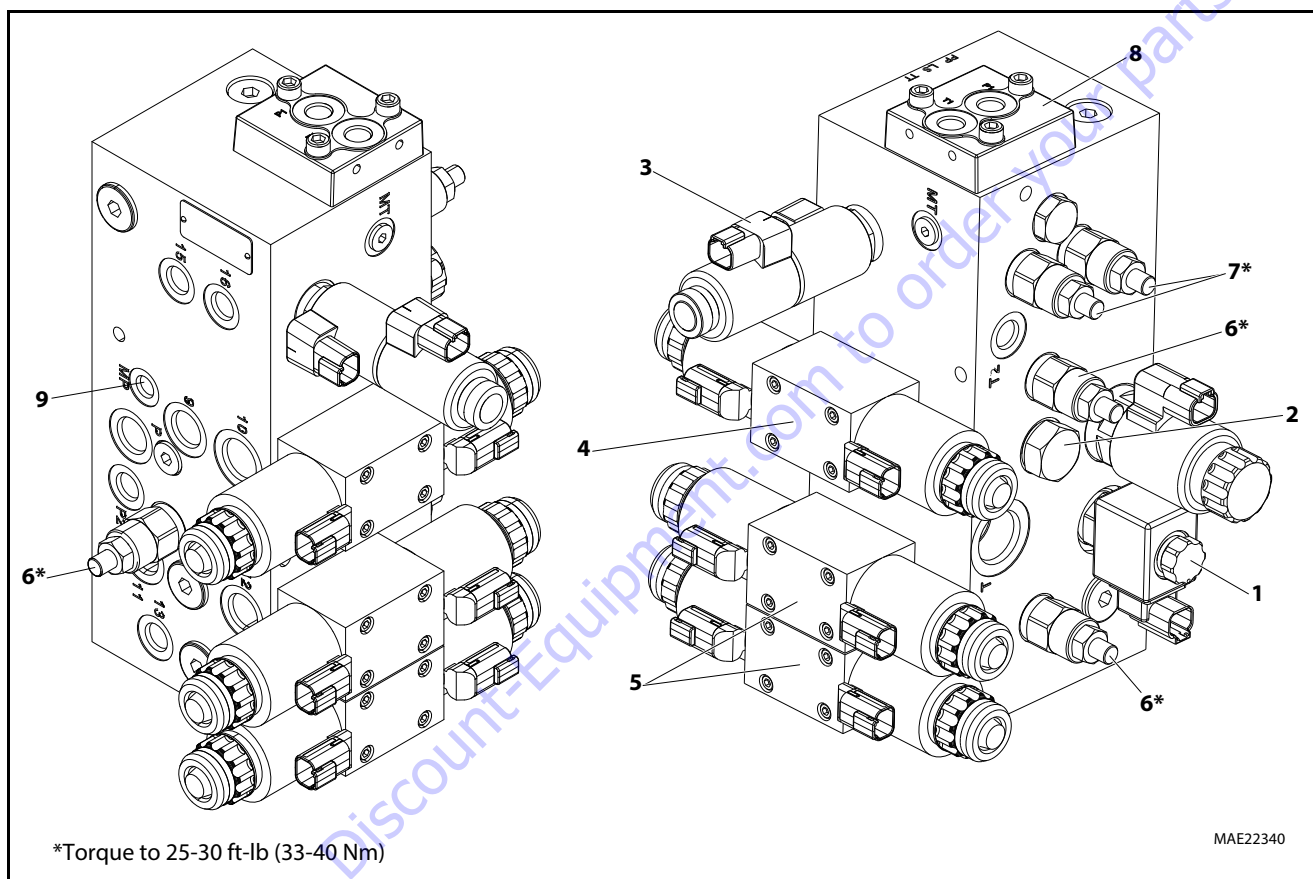
- | | | | |
|---------------------------|---------------------------|----------------------------|----------------------------|
| 1. Main Relief Cartridge | 5. Coil | 9. Coil | 13. Relief Valve Cartridge |
| 2. Coil | 6. Coil | 10. Coil | 14. Relief Valve Cartridge |
| 3. Relief Valve Cartridge | 7. Coil | 11. Relief Valve Cartridge | 15. Cartridge without Coil |
| 4. Relief Valve Cartridge | 8. Relief Valve Cartridge | 12. Coil | |

Figure 5-87. Main Control Valve Block Assembly Deutz D2011 and GM Engines (SN 0300171769 through 0300181890), Deutz TD2.9L4 Engines (SN 0300171769 through 0300188198)



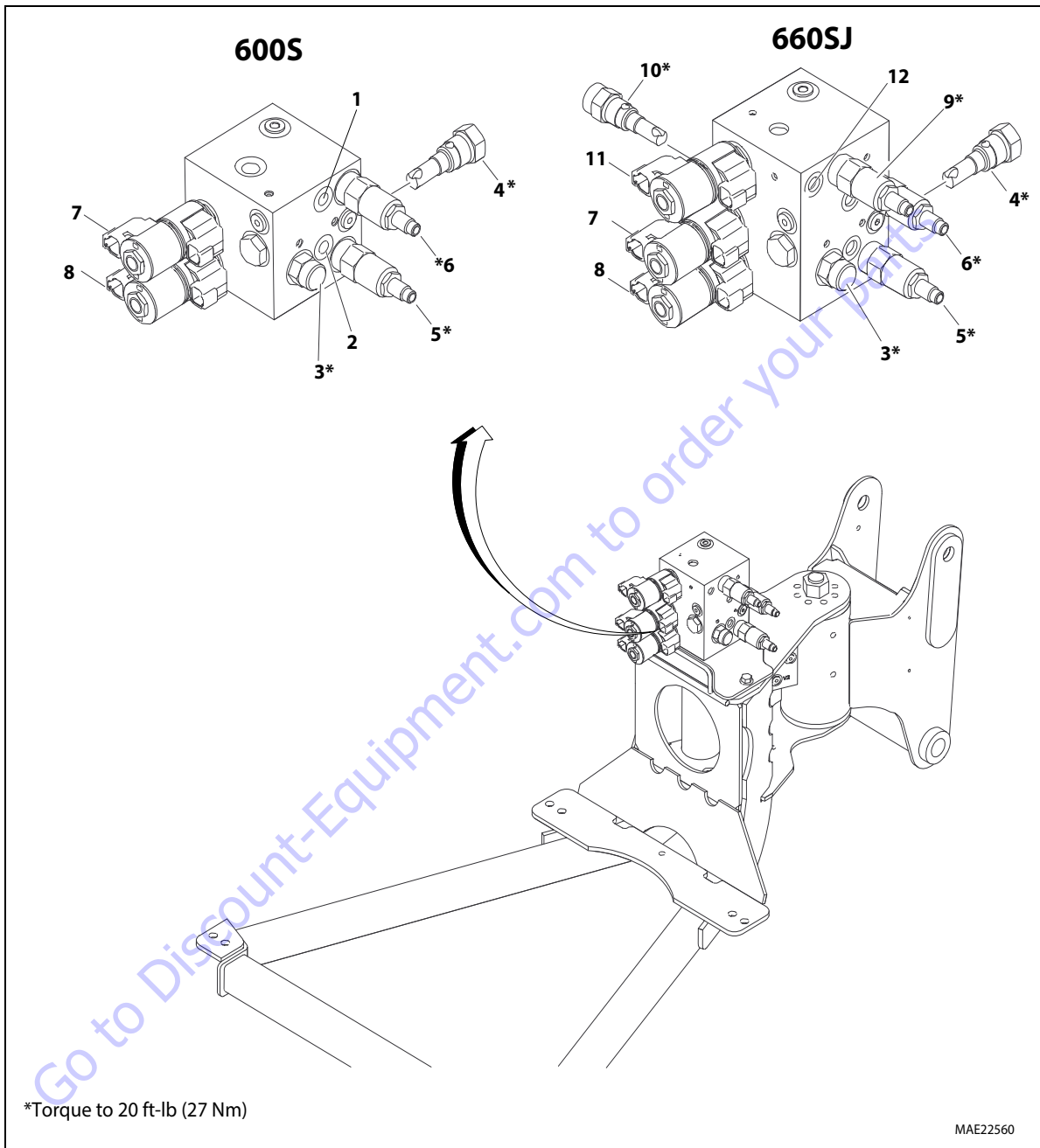
- | | | |
|-------------------------------|--------------------------------------|--------------------------------------|
| 1. Dump Valve | 5. Directional Control Valve | 9. Rear Steer Control Valve |
| 2. Load Sense Cartridge Valve | 6. Main Relief Valve | 10. Rear Steer Pressure Relief Valve |
| 3. Front Steer Control Valve | 7. Front Steer Pressure Relief Valve | 11. Test Port MP |
| 4. Directional Control Valve | 8. Cover Plate | |

Figure 5-88. Main Control Valve Block Assembly - 4WS Deutz D2011 and GM Engines (SN 0300181891 to Present), Deutz TD2.9L4 Engines (SN 0300188199 to Present)



- | | | |
|-------------------------------|------------------------------|--------------------------------------|
| 1. Dump Valve | 4. Directional Control Valve | 7. Front Steer Pressure Relief Valve |
| 2. Load Sense Cartridge Valve | 5. Directional Control Valve | 8. Cover Plate |
| 3. Front Steer Control Valve | 6. Main Relief Valve | 9. Test Port MP |

Figure 5-89. Main Control Valve Block Assembly - 2WS Deutz D2011 and GM Engines (SN 0300181891 to Present), Deutz TD2.9L4 Engines (SN 0300188199 to Present)



*Torque to 20 ft-lb (27 Nm)

MAE22560

- | | | | |
|-----------------|--------------------|-------------------|--------------------|
| 1. Test Port M1 | 4. Cartridge Valve | 7. Solenoid Valve | 10. Flow Valve |
| 2. Test Port M2 | 5. Relief Valve | 8. Solenoid Valve | 11. Solenoid Valve |
| 3. Flow Valve | 6. Relief Valve | 9. Relief Valve | 12. Test Port M3 |

Figure 5-90. Location of Components - Main Control Valve Deutz D2011 and GM Engines (SN 0300181891 to Present), Deutz TD2.9L4 Engines (SN 0300188199 to Present)

SECTION 5 - HYDRAULICS

5.11 HYDRAULIC SCHEMATICS

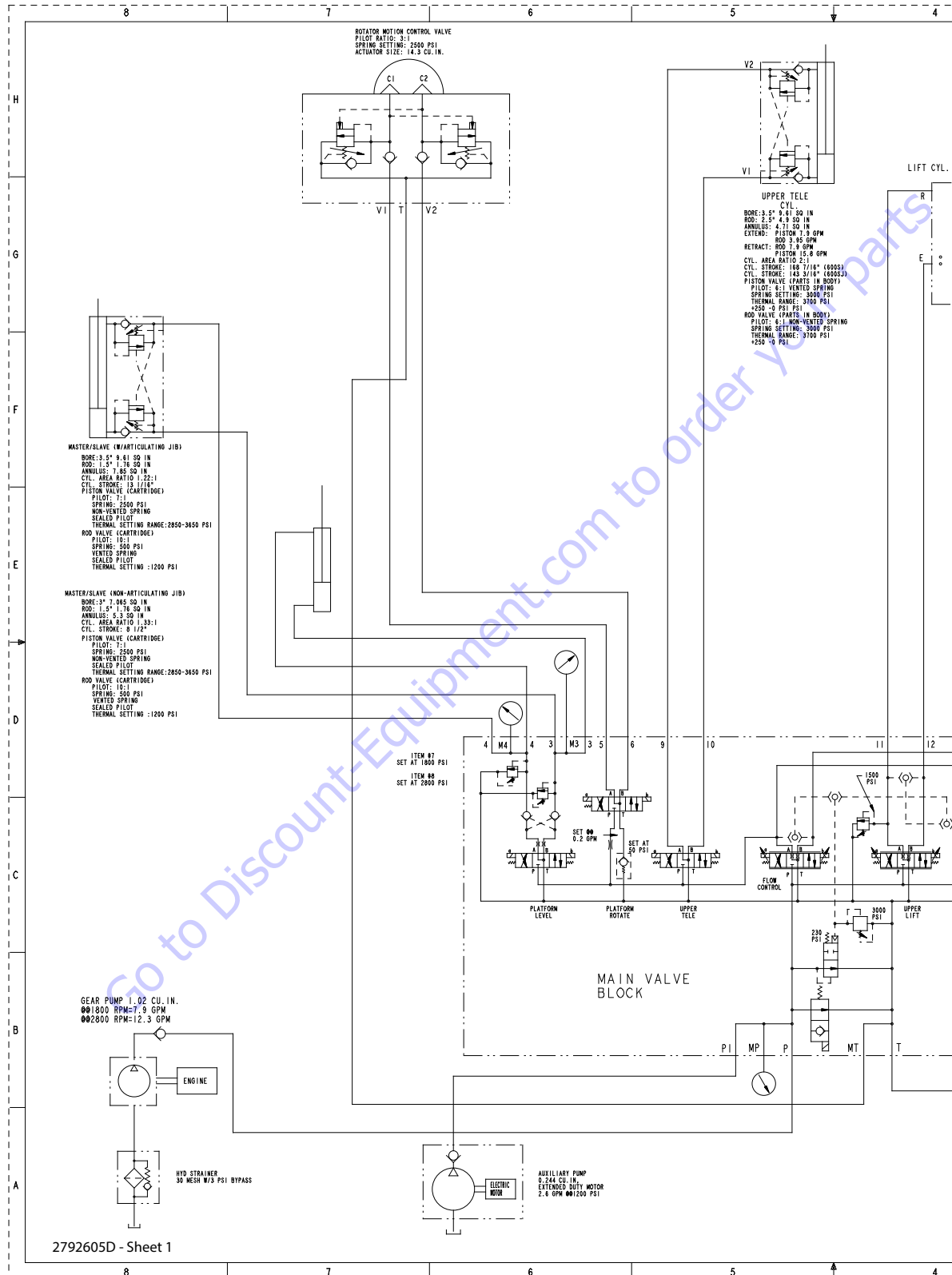


Figure 5-91. Hydraulic Schematic

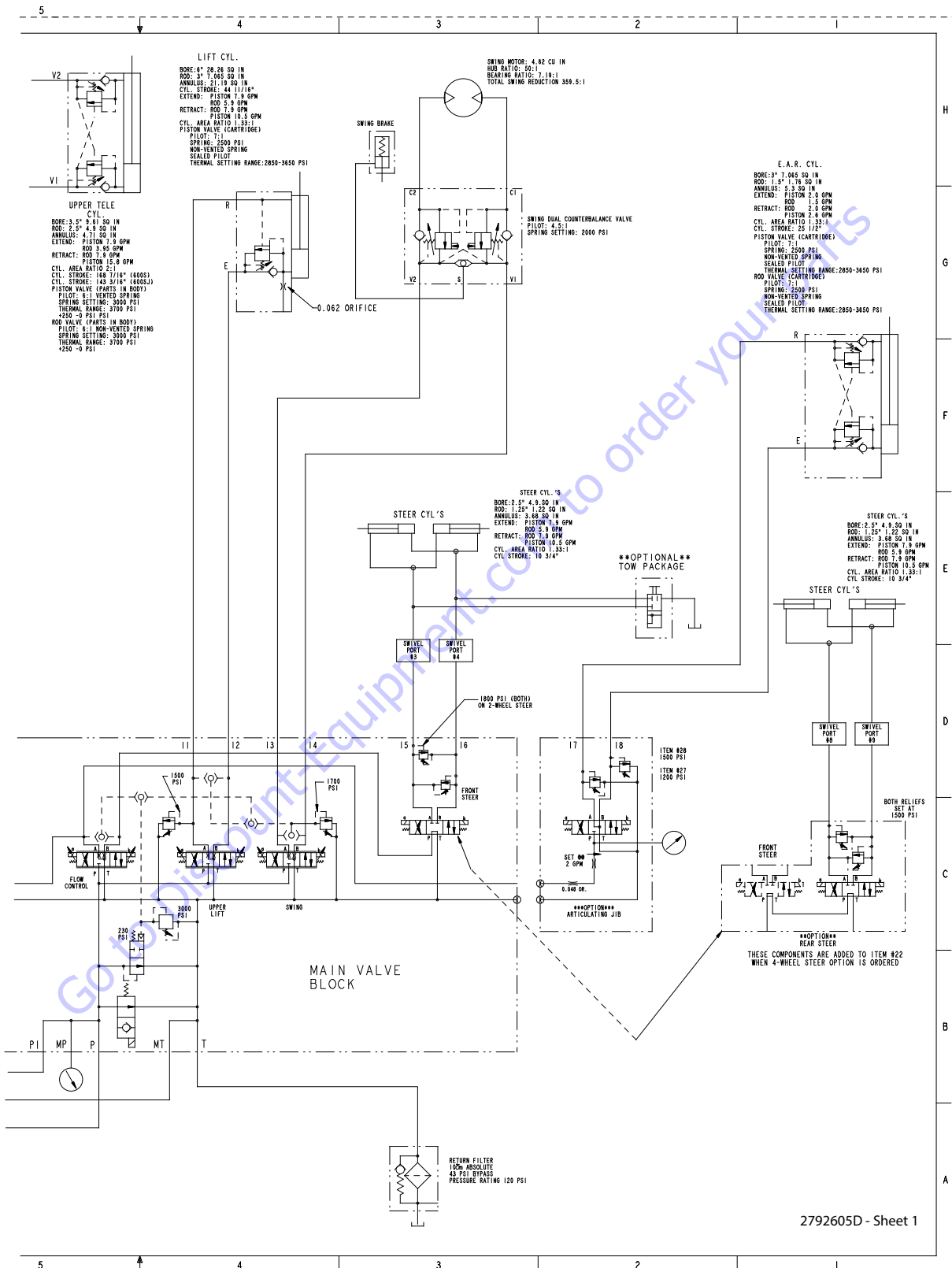


Figure 5-92. Hydraulic Schematic

SECTION 5 - HYDRAULICS

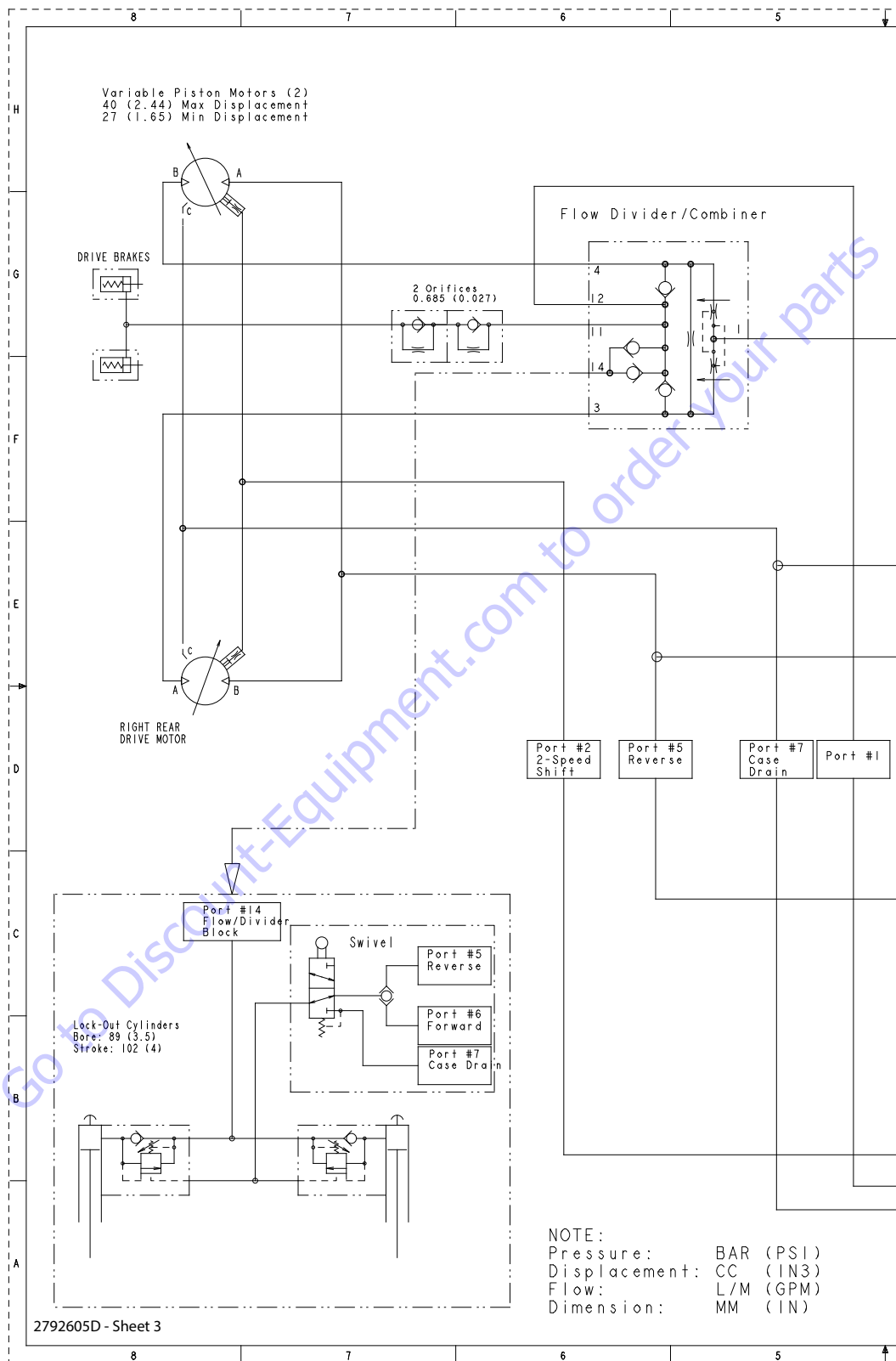
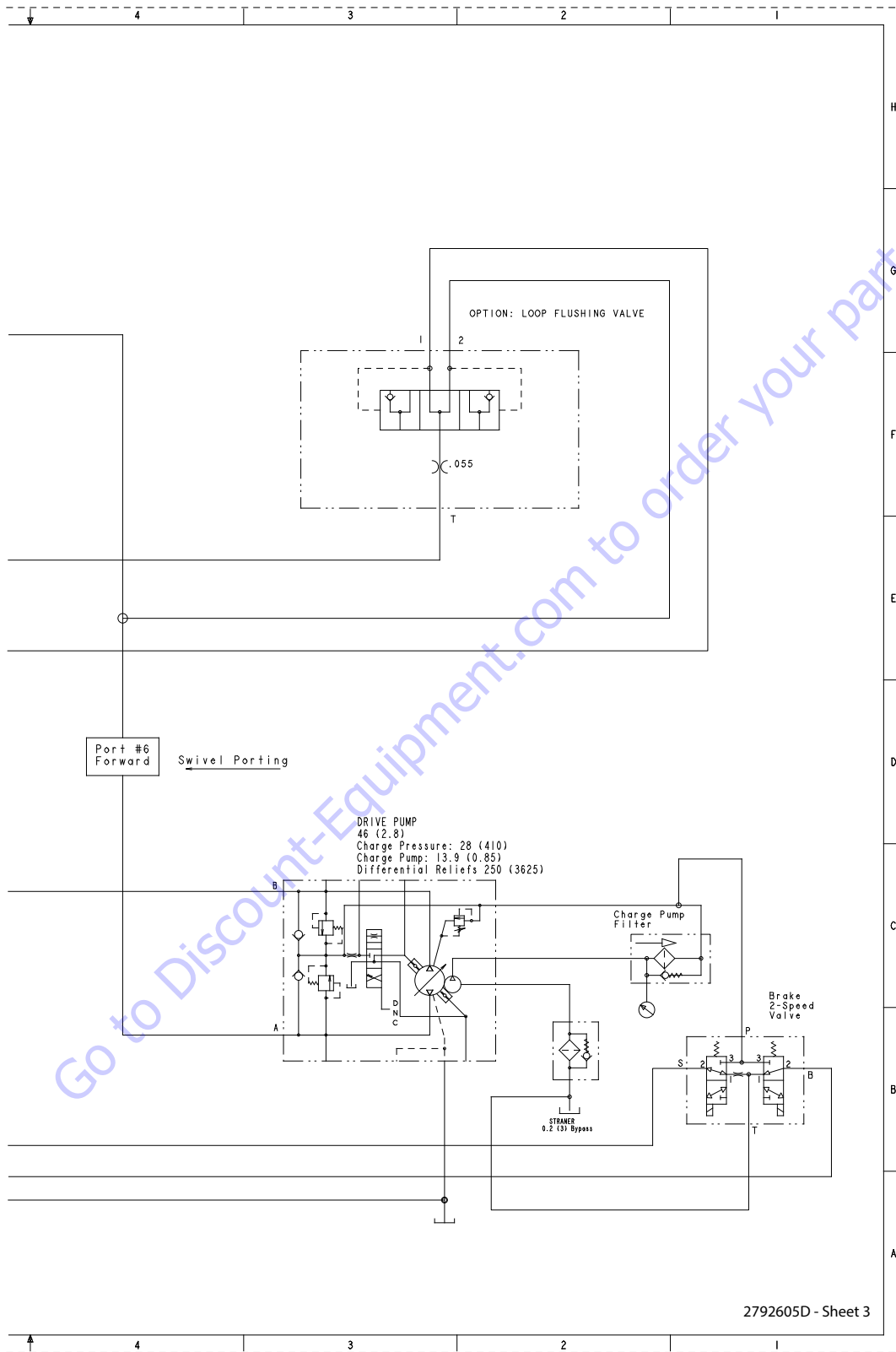


Figure 5-93. Hydraulic Schematic 2-Wheel Drive - 1 of 2



2792605D - Sheet 3

Figure 5-94. Hydraulic Schematic 2-Wheel Drive - 2 of 2

SECTION 5 - HYDRAULICS

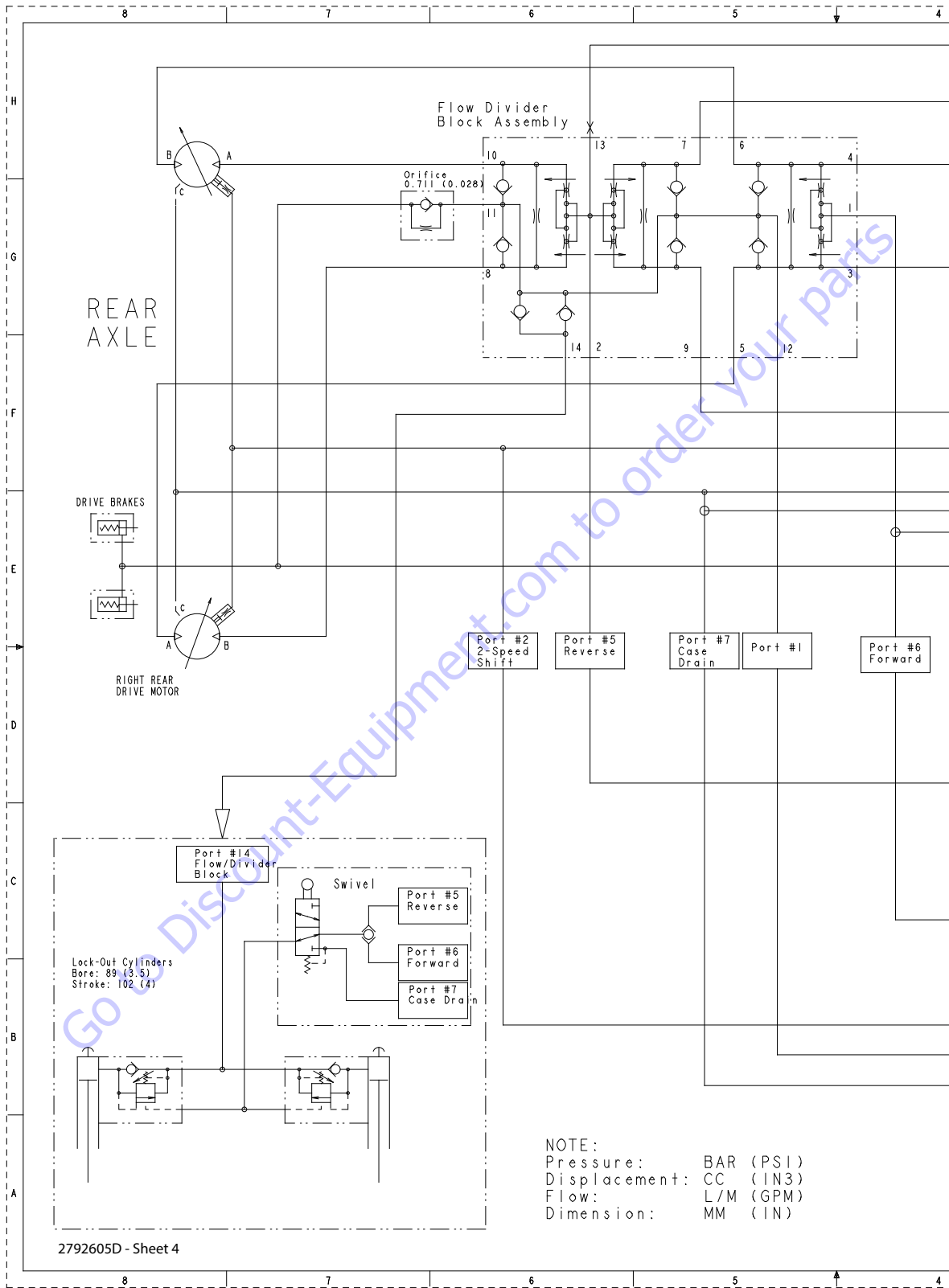


Figure 5-95. Hydraulic Schematic 4-Wheel Drive - 1 of 2

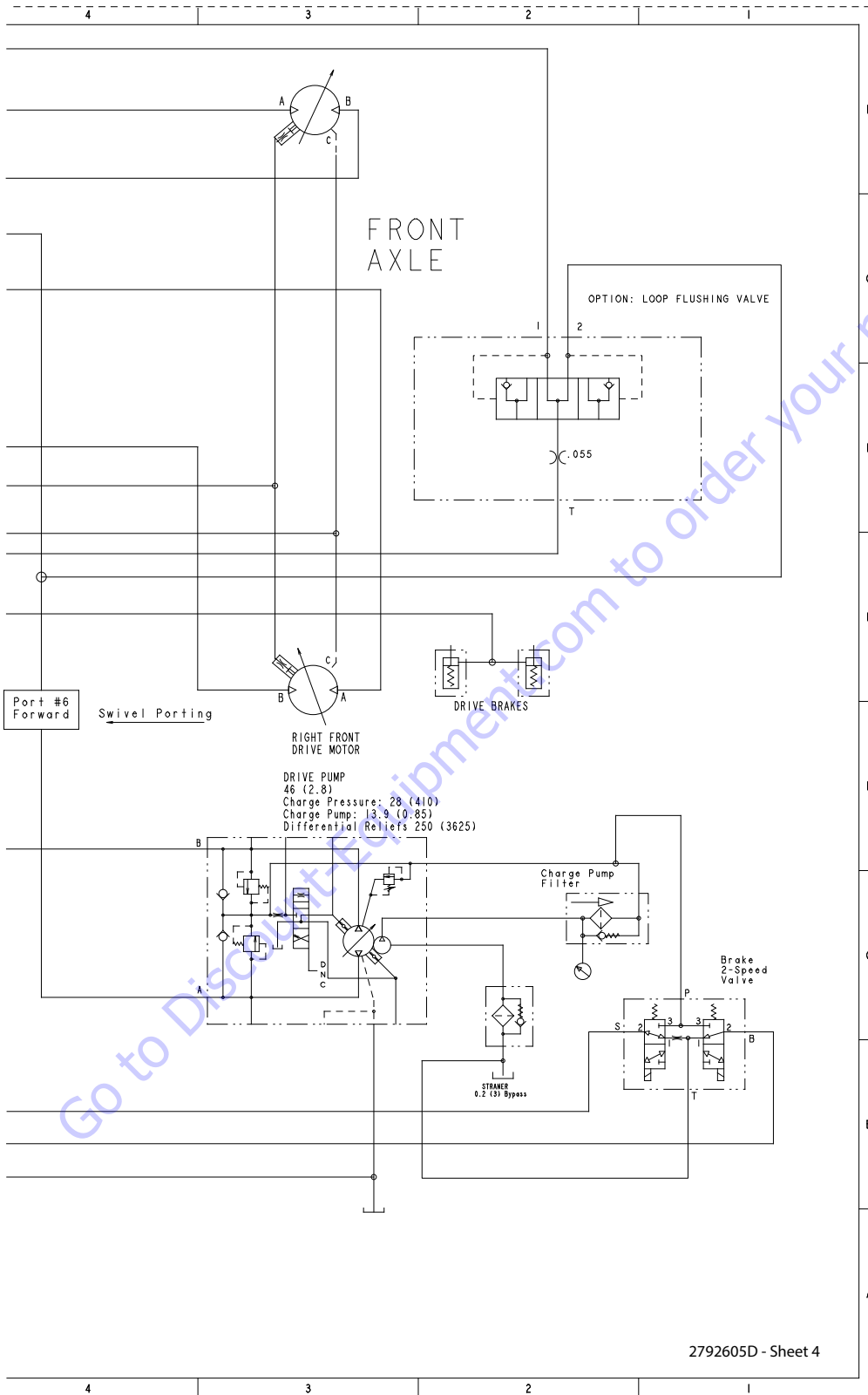


Figure 5-96. Hydraulic Schematic 4-Wheel Drive - 2 of 2

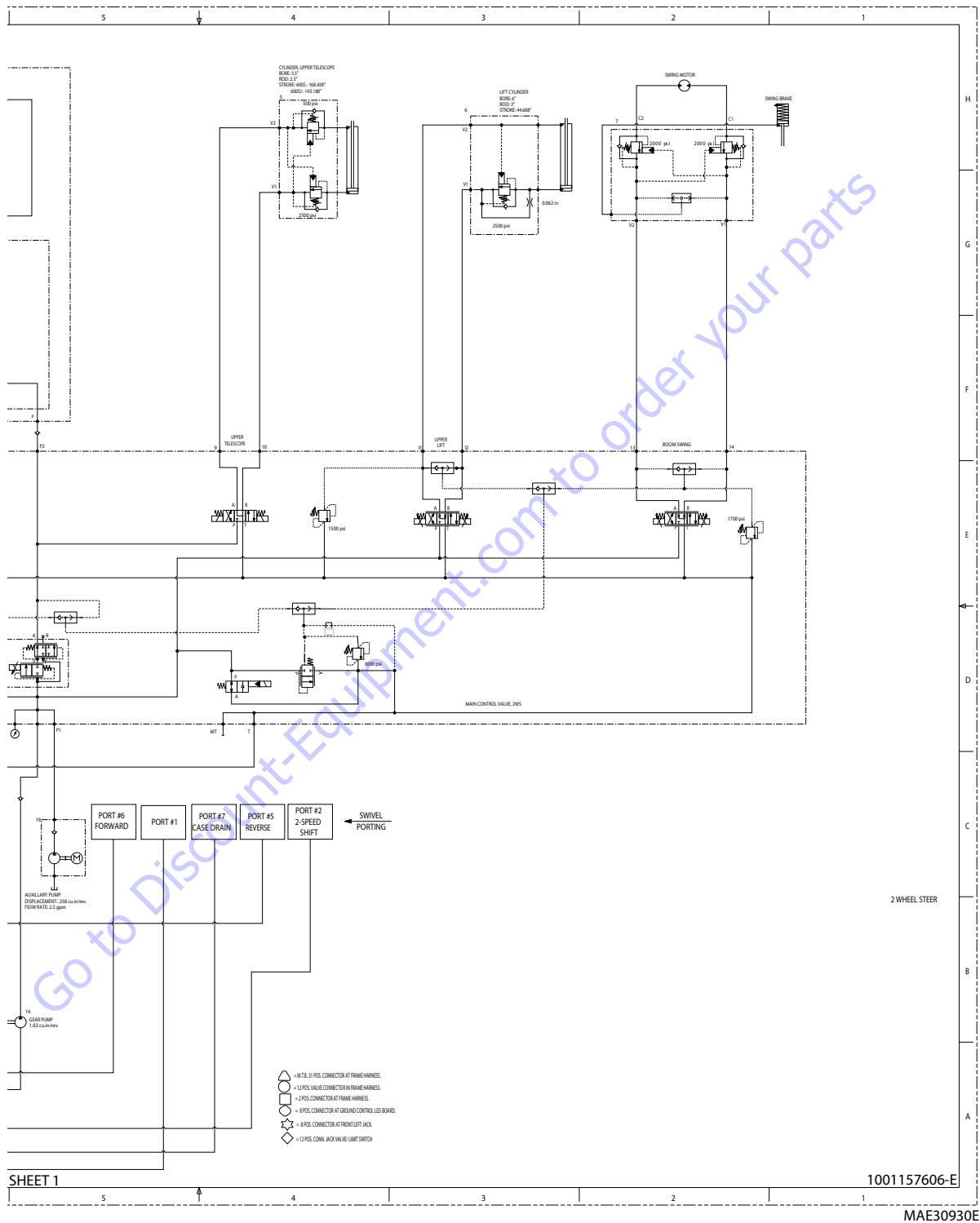


Figure 5-98. Hydraulic Schematic - 2 Wheel Steer - Sheet 2 of 2

SECTION 5 - HYDRAULICS

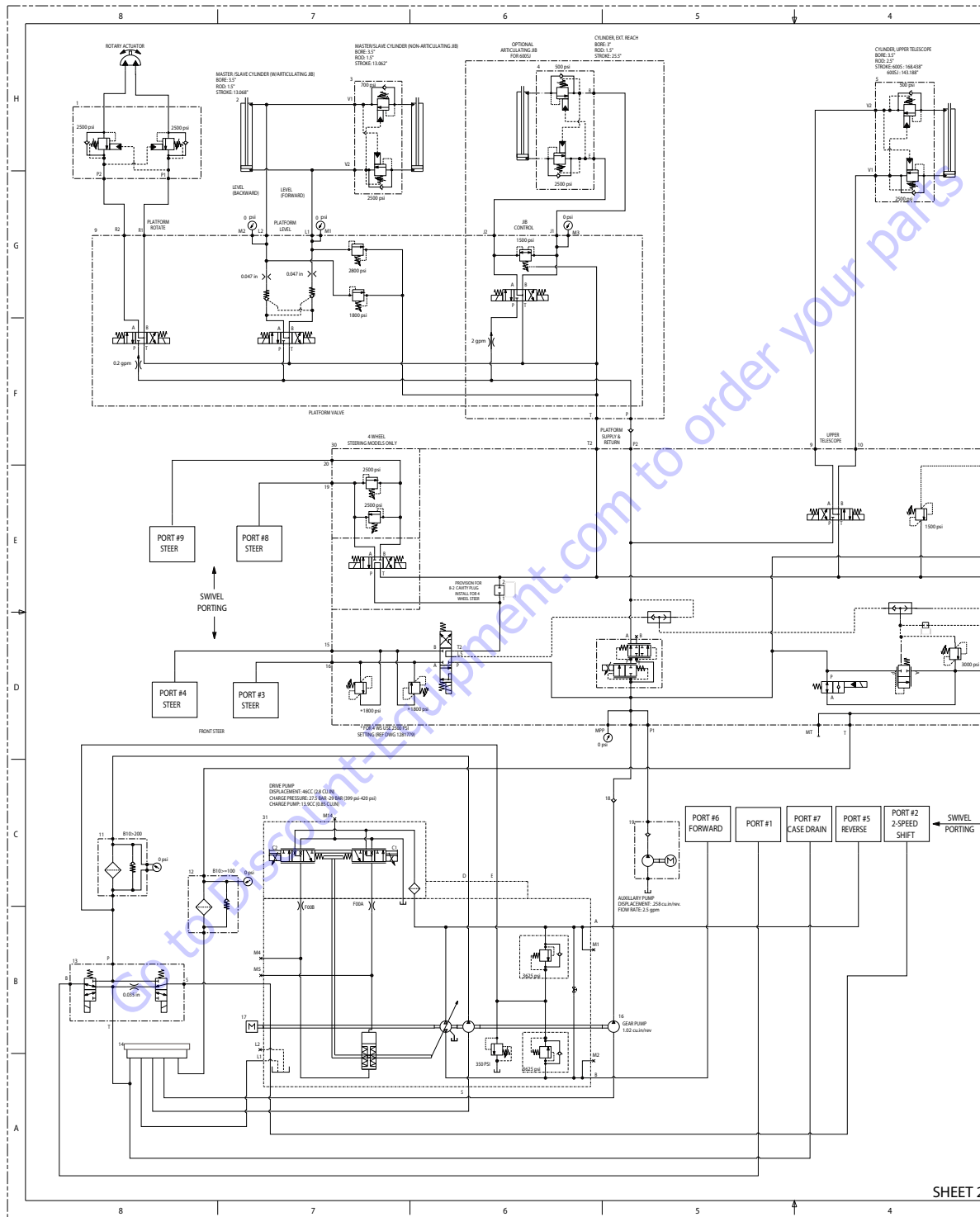


Figure 5-99. Hydraulic Schematic - 4 Wheel Steer - Sheet 1 of 2

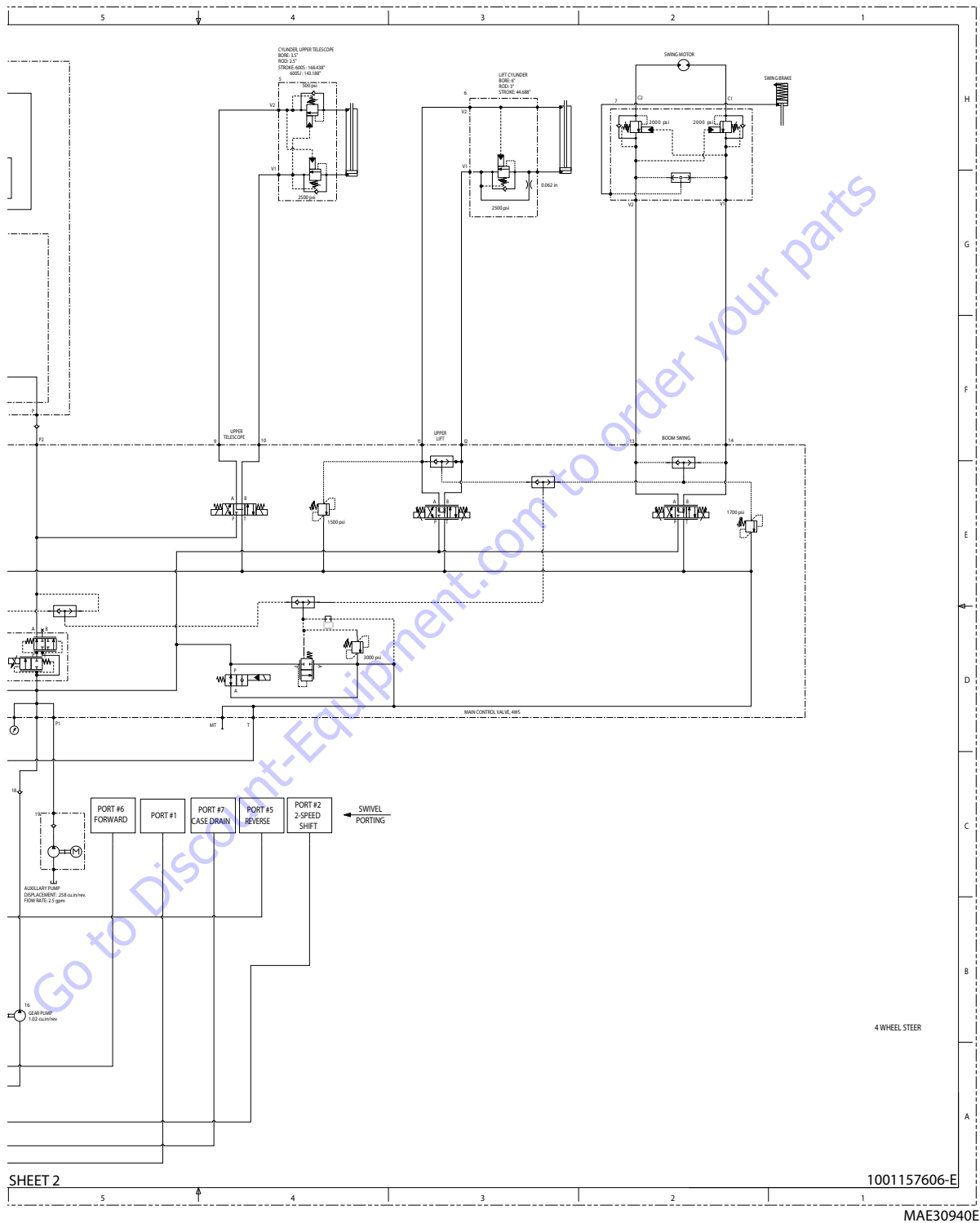


Figure 5-100. Hydraulic Schematic - 4 Wheel Steer - Sheet 2 of 2

SECTION 5 - HYDRAULICS

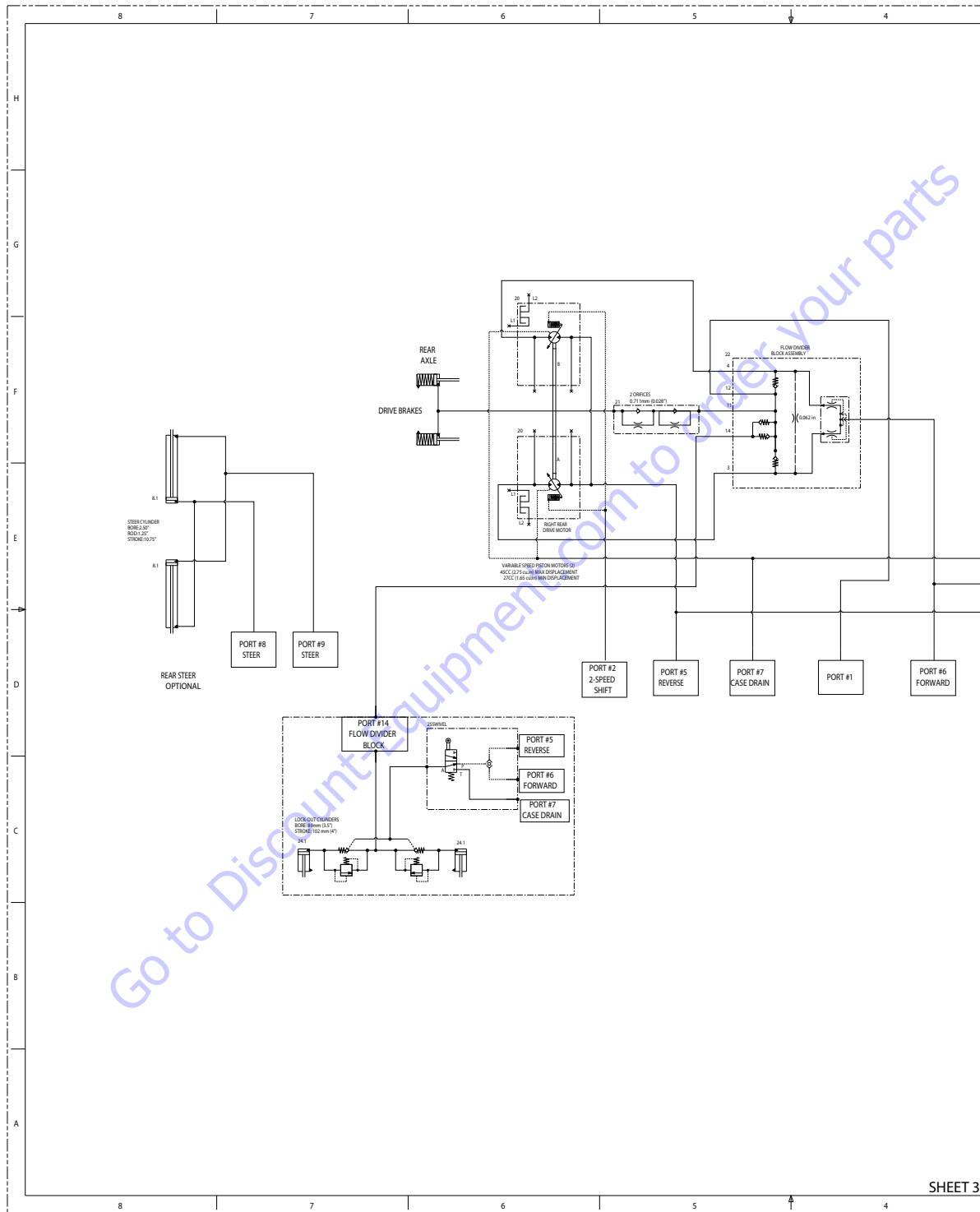


Figure 5-101. Hydraulic Schematic - 2 Wheel Drive - Sheet 1 of 2

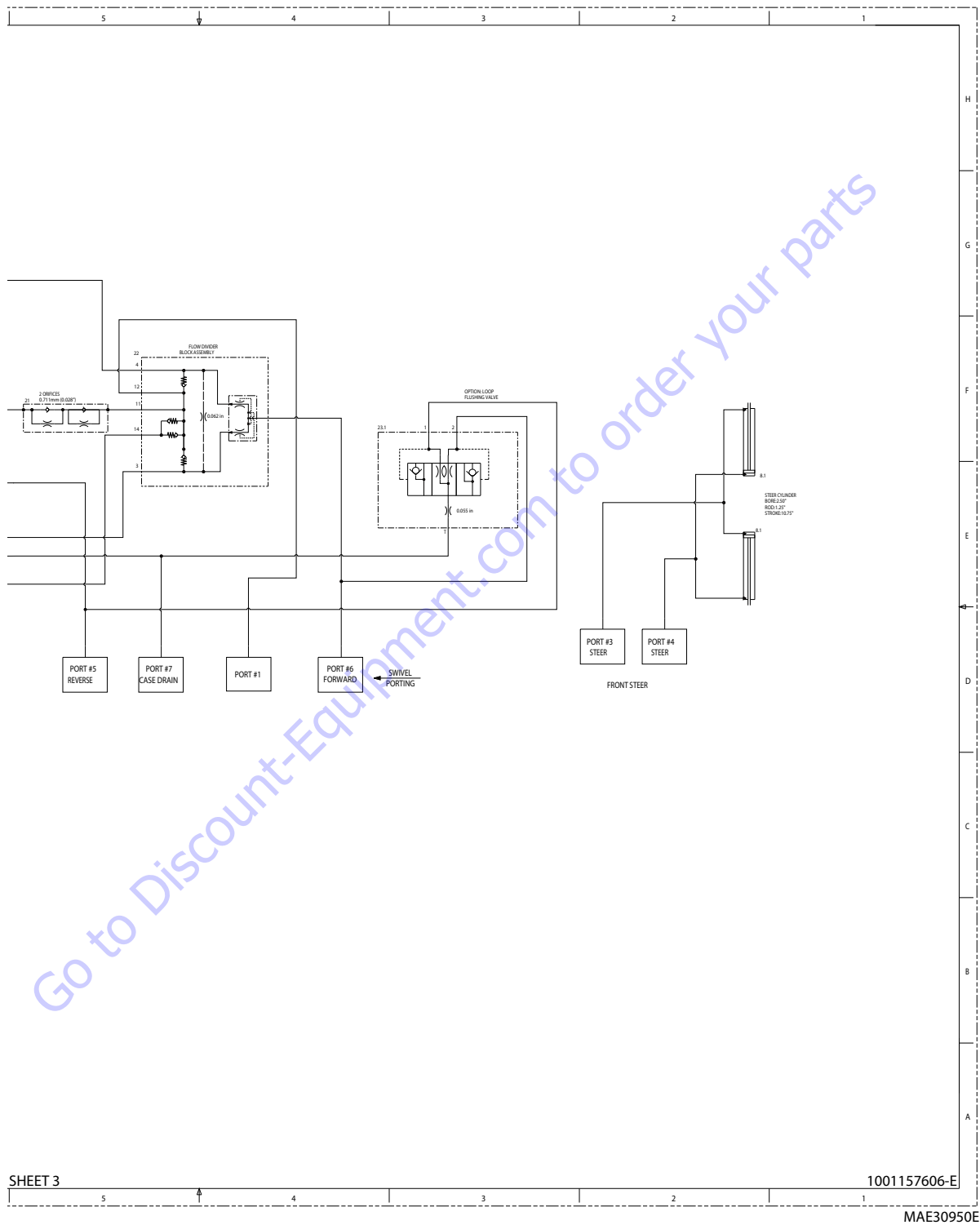


Figure 5-102. Hydraulic Schematic - 2 Wheel Drive - Sheet 2 of 2

SECTION 5 - HYDRAULICS

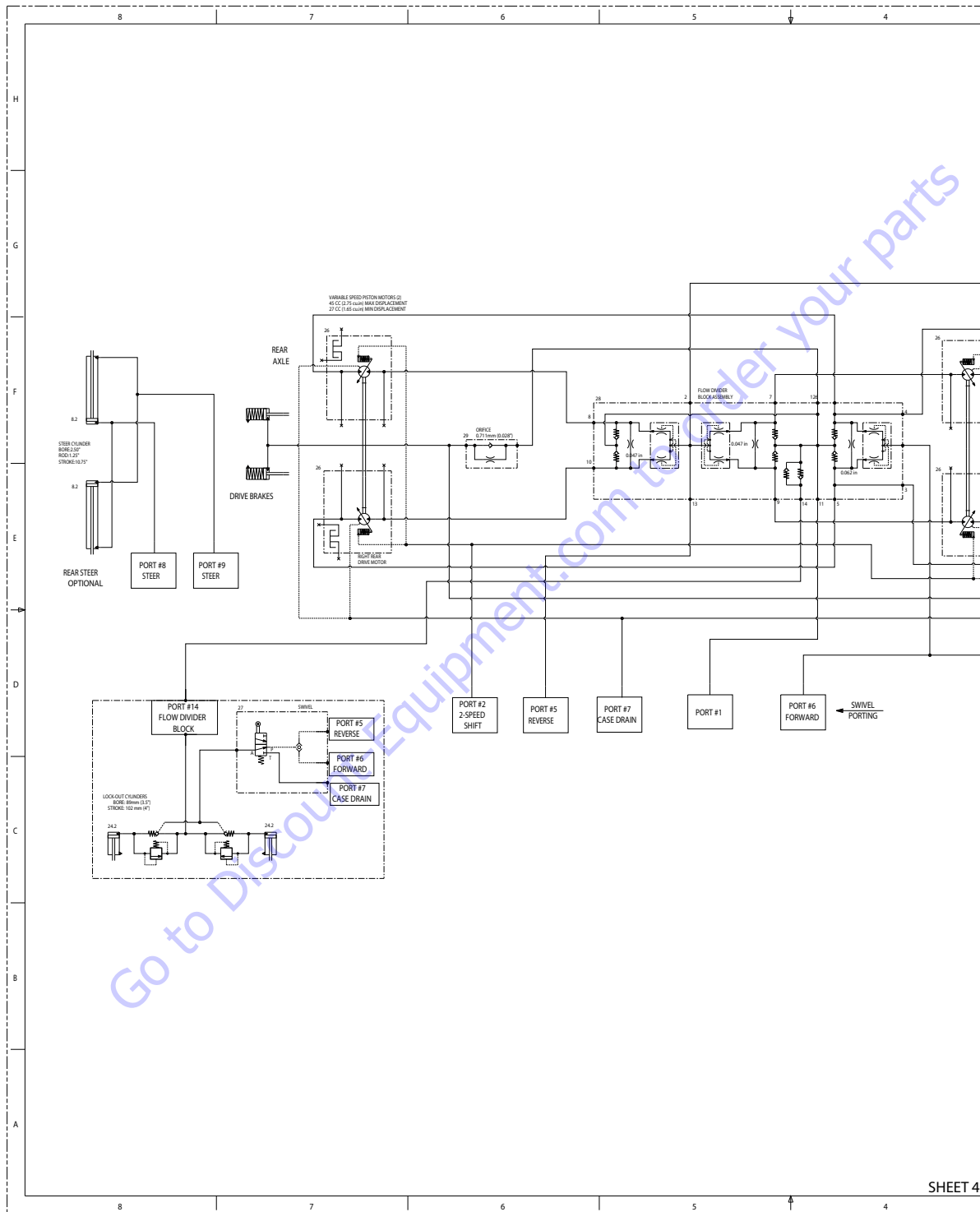
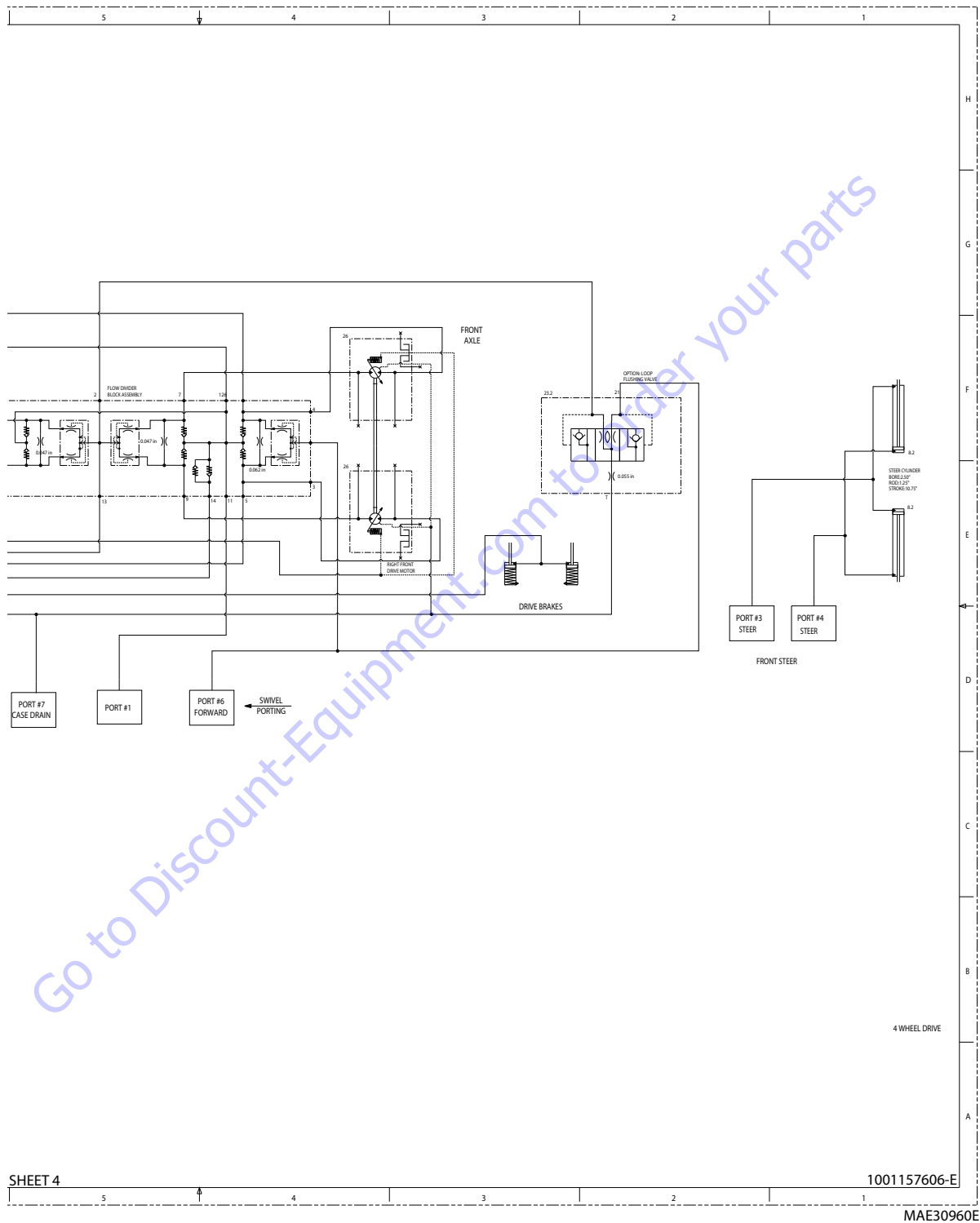


Figure 5-103. Hydraulic Schematic - 4 Wheel Drive - Sheet 1 of 2



SHEET 4

1001157606-E

MAE30960E

Figure 5-104. Hydraulic Schematic - 4 Wheel Drive - Sheet 2 of 2

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Part Status:

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Part Weight:

Part Dimensions:

Part Material:

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SECTION 6. JLG CONTROL SYSTEM

6.1 INTRODUCTION

NOTICE

WHEN INSTALLING A NEW GROUND MODULE CONTROLLER IT IS NECESSARY TO PROGRAM THE CONTROLLER FOR PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

NOTICE

AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. IF PRESSURE-WASHING IS USED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based motor control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min

speed, and max.-speed for all boom, drive, and steering functions.

Upper lift, swing, and drive are controlled by individual joysticks. Steering is controlled by a rocker switch built in the top of the drive joystick. To activate Drive, Lift, and Swing; pull up the slide lock on the joystick and move the handle in the desired direction.

The control system provides voltage output to the valves and pump, as programmed, for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed in the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed with a custom designed, direct connect hand held analyzer or wireless adapter using an app on your Android or iPhone/iPad device. The analyzer or wireless output displays two lines of information at a time, by scrolling through the program.

Each module has a label with JLG part number and a serial number containing a date code.

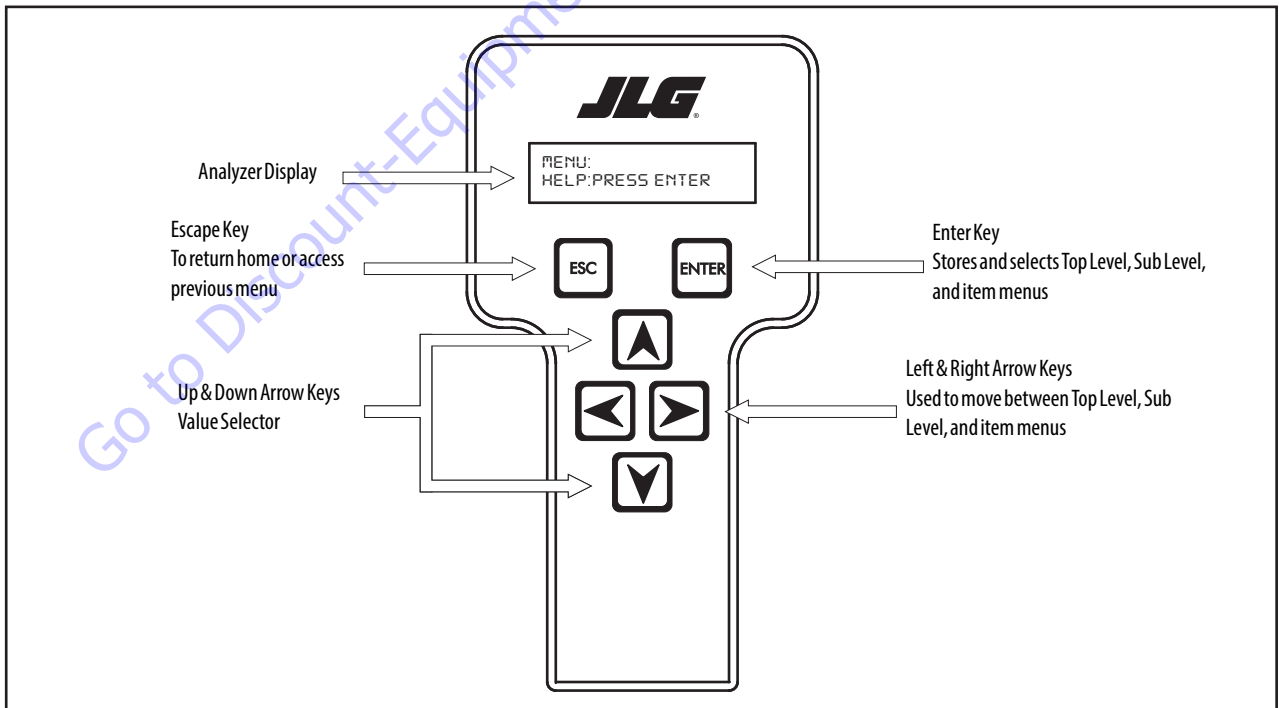


Figure 6-1. Hand-Held Analyzer

Connect JLG Control System Analyzer

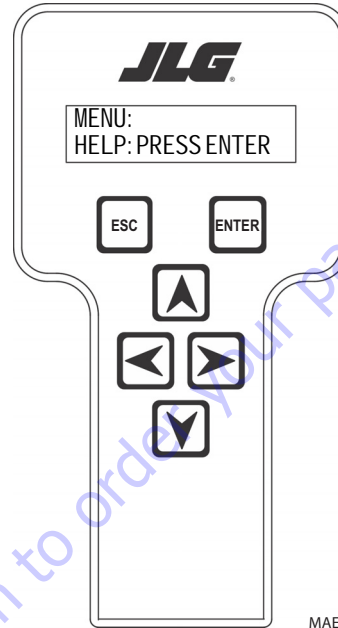
1. Connect four pin end of cable supplied with hand-held or wireless analyzer to controller module on platform box or at controller module inside ground control box. Connect other end of cable to analyzer.

NOTE: Cable has a keyed four pin connector at each end. It cannot be connected backwards.

2. Power up Control System by turning lower key to platform or ground position and pulling both emergency stop buttons on.

Using Analyzer





Analyzer displays the following with machine power on and analyzer connected properly:



MAE19060


**MENU:
HELP:PRESS ENTER**


Move between top level menu items using

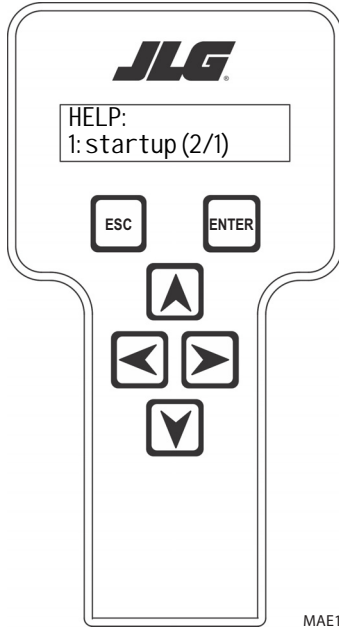
RIGHT  and **LEFT**  arrow keys. To select a displayed menu item, press **ENTER** . To cancel a selected menu item press **ESC** . Scroll using right and left arrow keys to select a different menu item.

Top level menus:

- HELP**
- DIAGNOSTICS**
- SYSTEM TEST**
- ACCESS LEVEL**
- PERSONALITIES**
- MACHINE SETUP**
- CALIBRATIONS (view only)**

If **ENTER**  is selected at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display scrolls the fault across the screen. If no fault is detected, the display shows: **HELP: EVERYTHING OK**. If powered up at the ground station, the display shows: **GROUND OK**.


If **ENTER**  is pressed again, display shows the following:



MAE19060


**LOGGED HELP
1: STARTUP (2/1)**


Analyzer displays last system fault if any are present. Use right and left arrow keys to scroll through fault logs and view last 25

faults. Press **ESC**  two times to return to MENU screen. **POWER CYCLE (0/0)** indicates a power up.

When a top level menu is selected, a new set of menu items may be offered: for example:

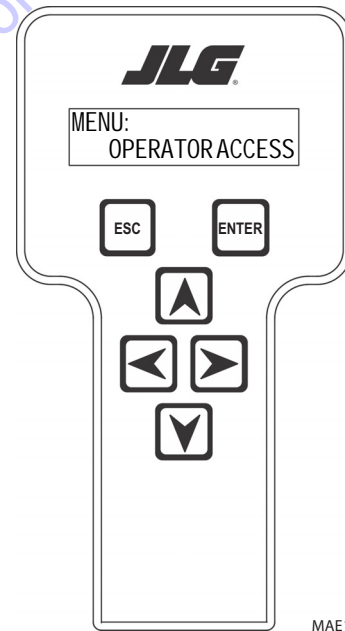
- DRIVE**
- BOOM**
- SYSTEM**
- DATALOG**
- VERSIONS**

Pressing **ENTER**  with any of the above displayed menus, displays additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected

menu item by pressing the **ESCAPE**  key.

Changing Access Level


When analyzer is first connected, you will be in access level 2 which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change access level, the correct password must be entered. To enter password, scroll to **ACCESS LEVEL** menu. For example:



MAE19060



**ACCESS LEVEL:
CODE 00000**


SECTION 6 - JLG CONTROL SYSTEM

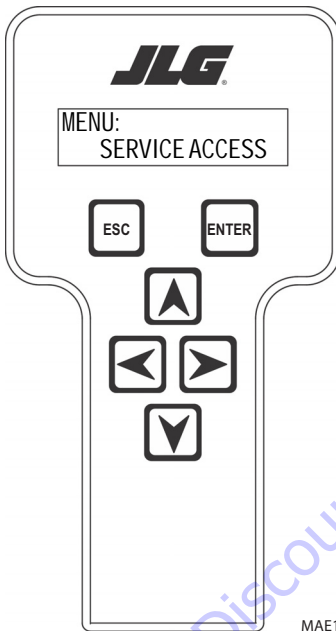
Press **ENTER**  to select the **ACCESS LEVEL** menu.

Using the **UP**  or **DOWN**  arrow keys, enter first digit of the password, 3.

Then using the **RIGHT**  arrow key, position cursor right one space to enter the second digit of the password.

Use the **UP**  or **DOWN**  arrow key to enter the second digit of the password which is 33271.

When correct password is displayed, press **ENTER** . The access level displays the following if password was entered correctly:

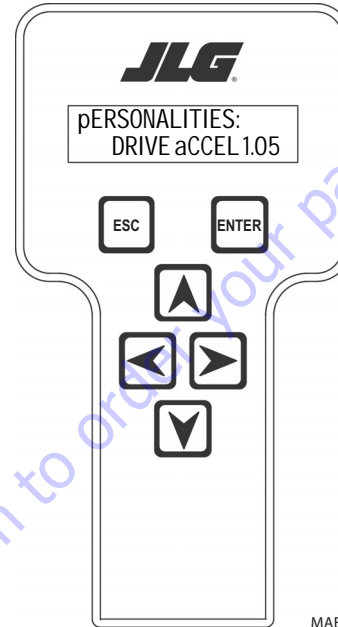


**MENU:
SERVICE ACCESS**

Repeat above steps if correct access level is not displayed or you can not adjust personality settings.


Adjust Parameters


Once you have gained access to level 1, and a personality item is selected, press the **UP**  or **DOWN**  arrow keys to adjust its value, for example:





**DRIVE:
ACCEL 1.05**

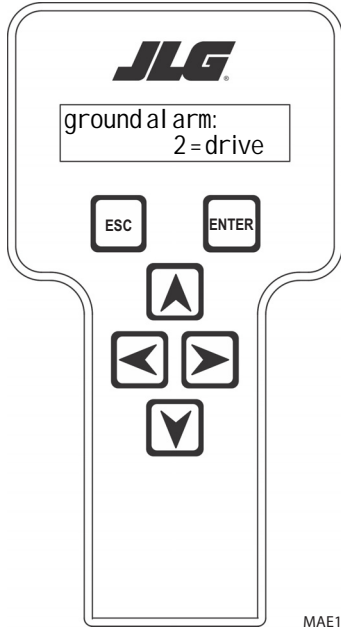
There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP**

 arrow is pressed at maximum value or decrease if the

DOWN  arrow is pressed at minimum value for any personality. If value does not change when pressing up and down arrows, check access level is at access level 1.

Machine Setup

When a machine digit item is selected, press **UP**  or **DOWN**  arrow keys to adjust its value, for example:



**GROUND ALARM:
2 = DRIVE**

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when driving. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

NOTE: Refer to Personality Ranges/Defaults for the recommended factory settings.

NOTE: Password 33271 allows access to level 1 to change machine personality settings.

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

ELEVATION CUTBACK

WARNING

CHANGING ELEVATION CUTBACK SETTING MAY ADVERSELY AFFECT PERFORMANCE OF YOUR MACHINE.

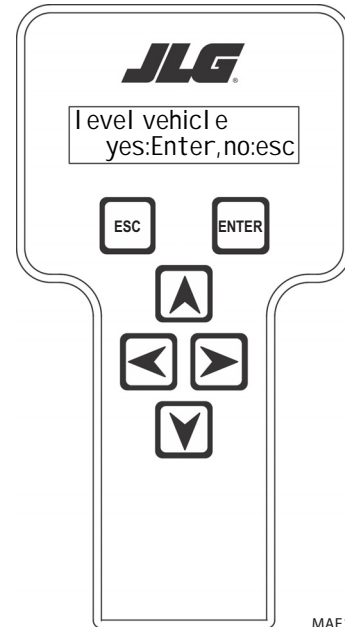
NOTICE

AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. IF PRESSURE-WASHING IS USED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5CM) FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.


Level Vehicle Description

WARNING

DO NOT LEVEL VEHICLE EXCEPT ON A LEVEL SURFACE.



**LEVEL VEHICLE
YES:ENTER, NO:ESC**

Not available at password level 2.  confirms vehicle is current.

SECTION 6 - JLG CONTROL SYSTEM

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
ACCEL	ACCELERATE
ACT	ACTIVE
A/D	ANALOG DIGITAL CONVERTER COUNT
AMB.	AMBIENT
ANG	ANGLE
AUX	AUXILIARY
BCS	BOOM CONTROL SYSTEM
BM	BOOM LENGTH ANGLE MODULE
BLAM	BOOM LENGTH ANGLE MODULE
BR	BROKEN
BSK	BASKET
CAL	CALIBRATION
CL	CLOSED
CM	CHASSIS MODULE
CNTL	CONTROL
CNTRL	CONTROL
C/O	CUTOUT
CONT(S)	CONTRACTOR(S)
COOR	COORDINATED
CRKPT	CRACK POINT
CRP	CREEP
CUT	CUTOUT
CYL	CYLINDER
DECEL	DECELERATE
D	DOWN
DN	DOWN
DWN	DOWN
DEG.	DEGREE
DOS	DRIVE ORIENTATION SYSTEM
DRV	DRIVE
E	ERROR
E&T	ELEVATED & TILTED
ELEV	ELEVATION
ENG	ENGINE
EXT	EXTEND
F	FRONT
FL	FLOW
FNT	FRONT
FOR	FORWARD
FWD	FORWARD
FSW	FOOT SWITCH
FUNC	FUNCTION
G	GROUND

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
GND	GROUND
GRN	GREEN
GM	GROUND MODULE
H	HOURS
HW	HARDWARE
HWFS	HARDWARE FAILSAFE
I	IN or CURRENT
JOY	JOYSTICK
L	LEFT
LB	POUND
LEN	LENGTH
LIM	LIMIT
LT	LEFT
LVL	LEVEL
M	MINUTES
MIN	MINIMUM
MAX	MAXIMUM
M	MAIN
MN	MAIN
NO	NORMALLY OPEN or NO
NC	NORMALLY CLOSED
O	OUT
O/C	OPEN CIRCUIT
OP	OPEN
O/R	OVERRIDE or OUTRIGGER
O//R	OVERRIDE
OSC	OSCILLATING
OVRD	OVERRIDE
P	PLATFORM
P	PRESSURE
PCV	PROPORTIONAL CONTROL VALVE
PLAT	PLATFORM
PLT	PLATFORM
PM	PLATFORM MODULE
POT	POTENTIOMETER
PRES	PRESSURE
PRS	PRESSURE
PT	POINT
R	REAR or RIGHT
REV	REVERSE or REVISION
RET	RETRACT
ROT.	ROTATE
RT	RIGHT

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
S/C	SHORT CIRCUIT
SEL	SELECTOR
SN	SERIAL NUMBER
SPD	SPEED
STOW	STOWED
STOWD	STOWED
SW	SWITCH or SOFTWARE
TELE	TELESCOPE
TEMP	TEMPERATURE
TORQ.	TORQUE
TRN	TRANSPORT
T/T	TURNTABLE
T	TOWER
TURNTBL	TURNTABLE
TWR	TOWER
U	UPPER or UP
V	VOLT
VER	VERSION
VLV	VALVE
WIT	WITNESS
YEL	YELLOW

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SECTION 6 - JLG CONTROL SYSTEM

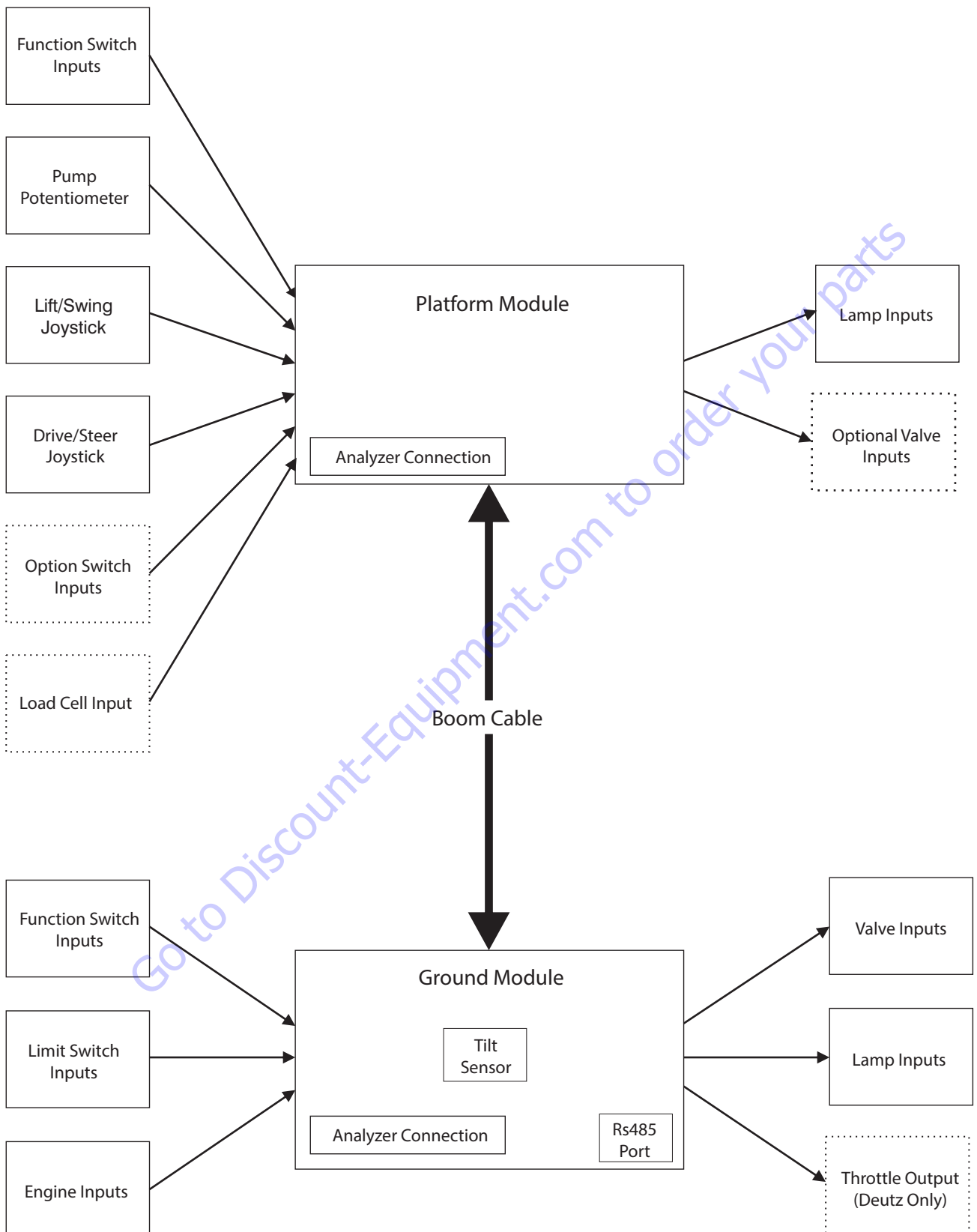
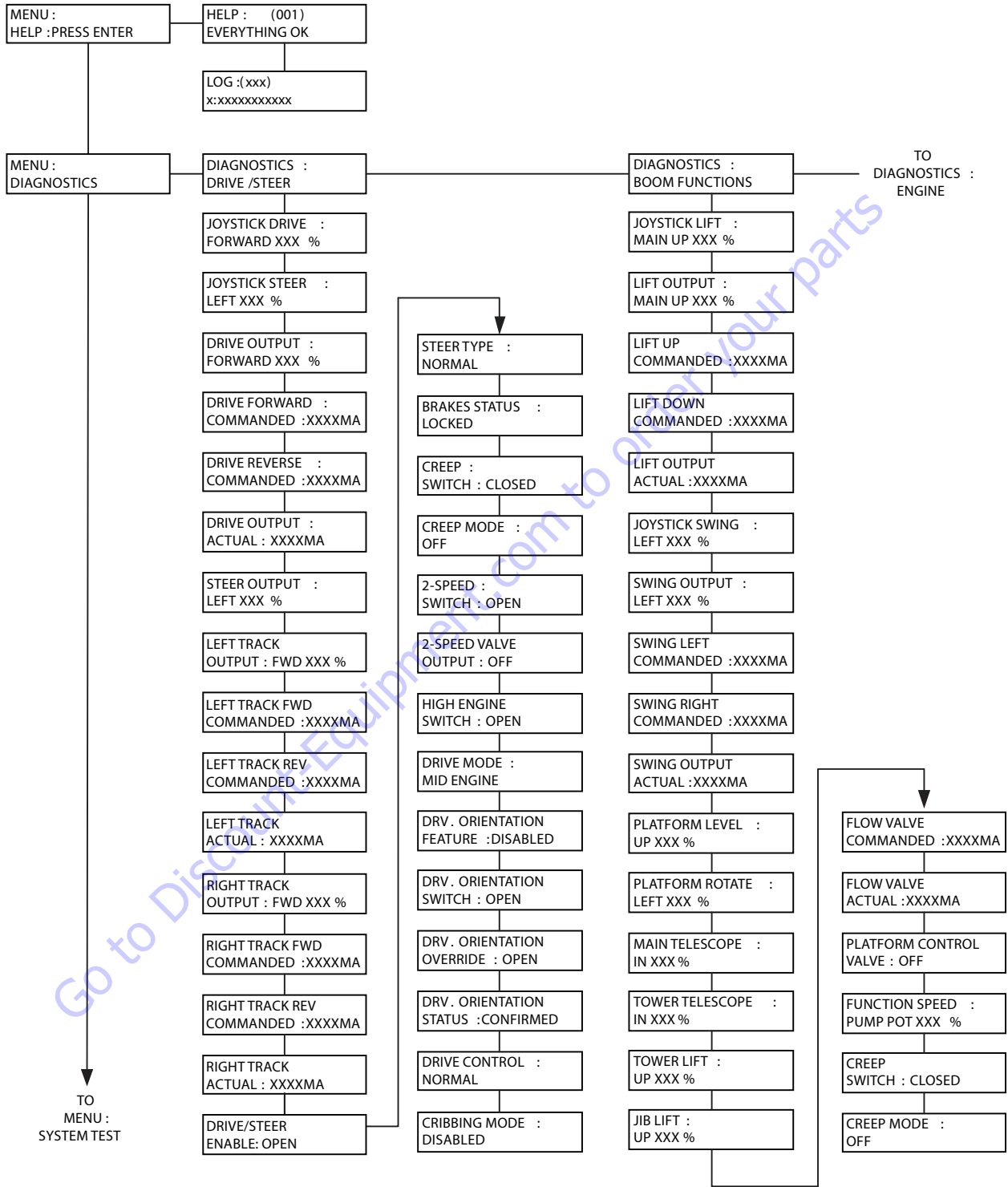


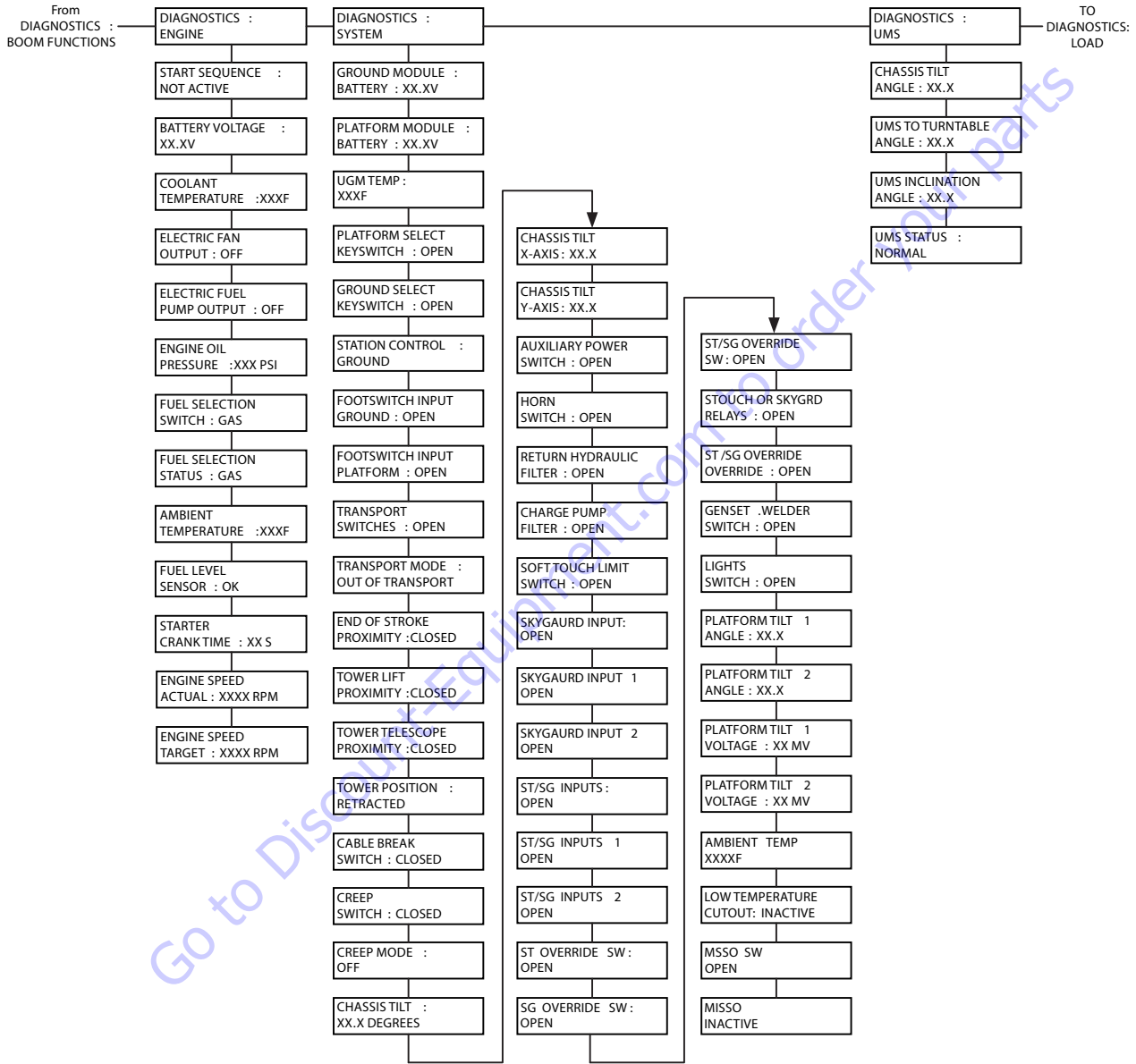
Figure 6-2. ADE Block Diagram



MAE9780R

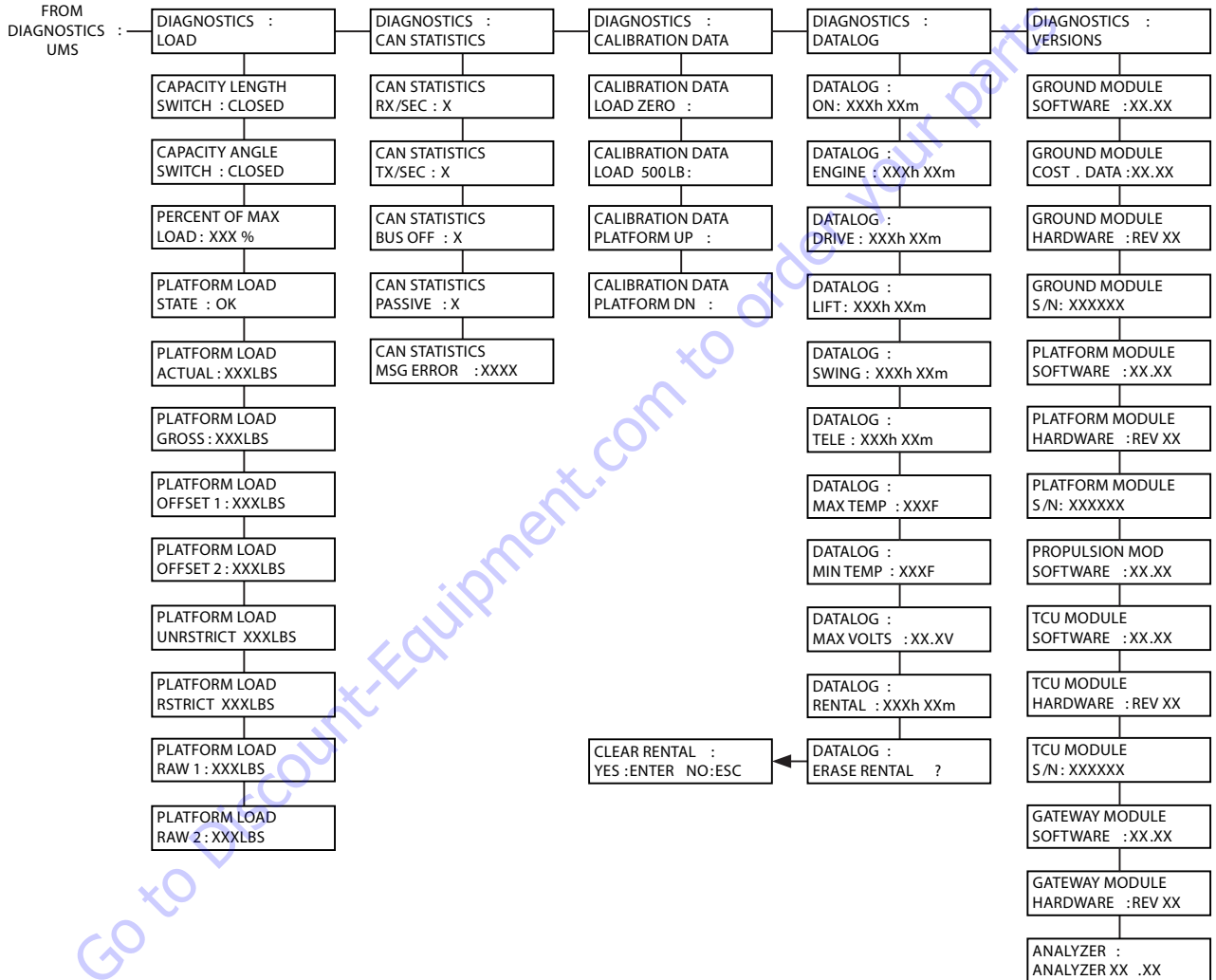
Figure 6-3. Analyzer Software Version 6.24 - Sheet 1 of 6

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MAE8990R

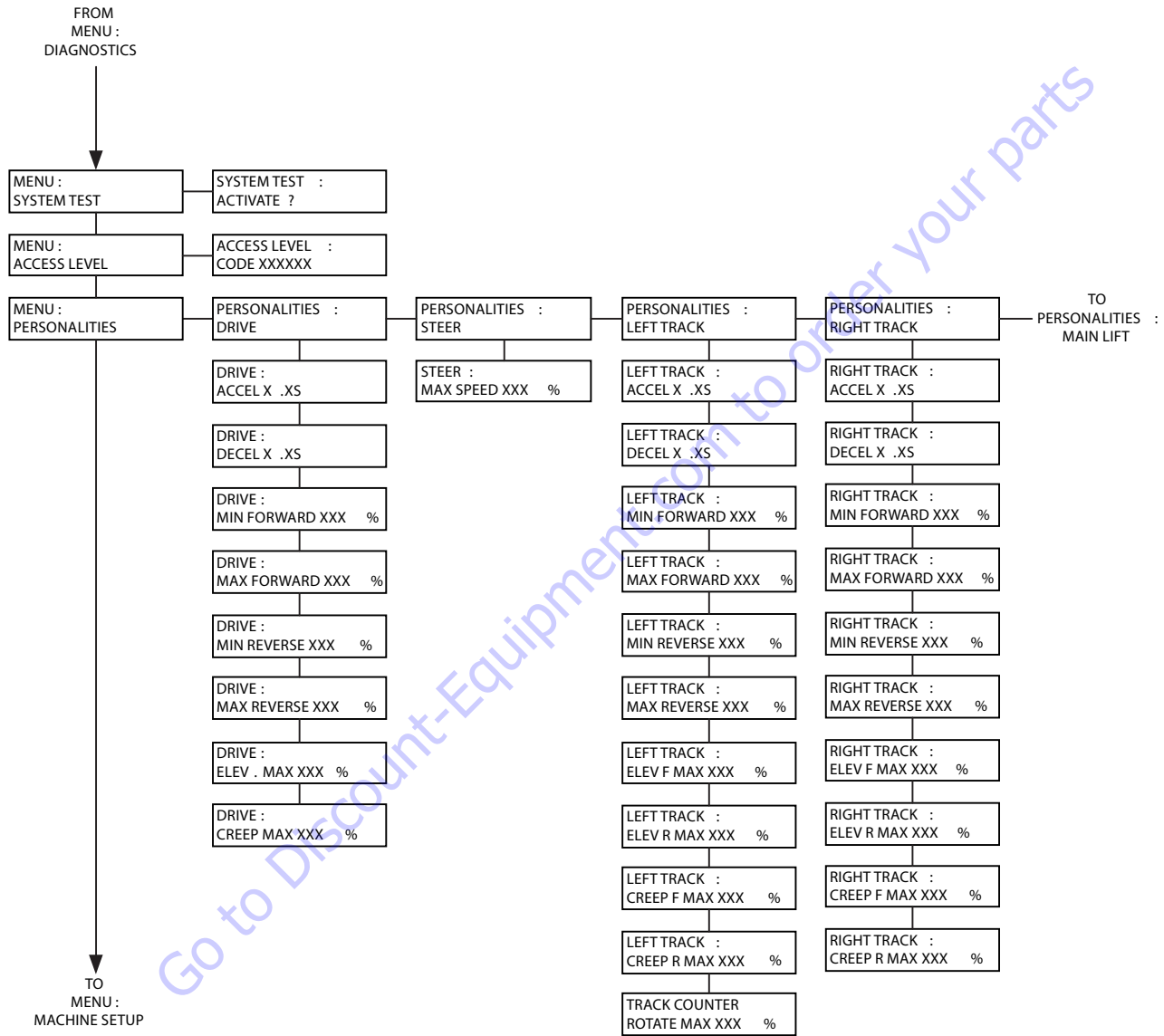
Figure 6-4. Analyzer Software Version 6.24 - Sheet 2 of 6



MAE9200R

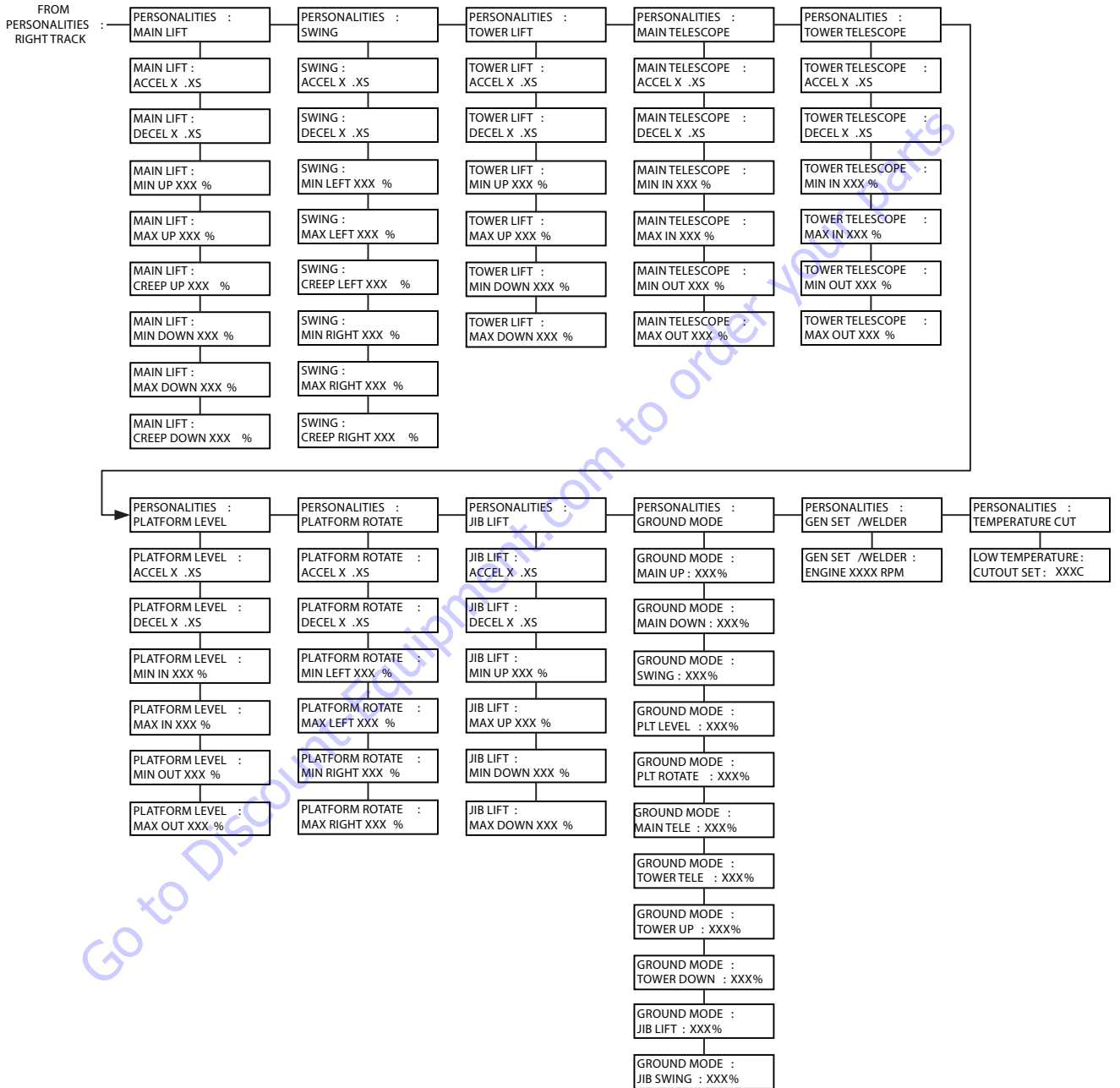
Figure 6-5. Analyzer Software Version 6.24 - Sheet 3 of 6

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MAE9510R

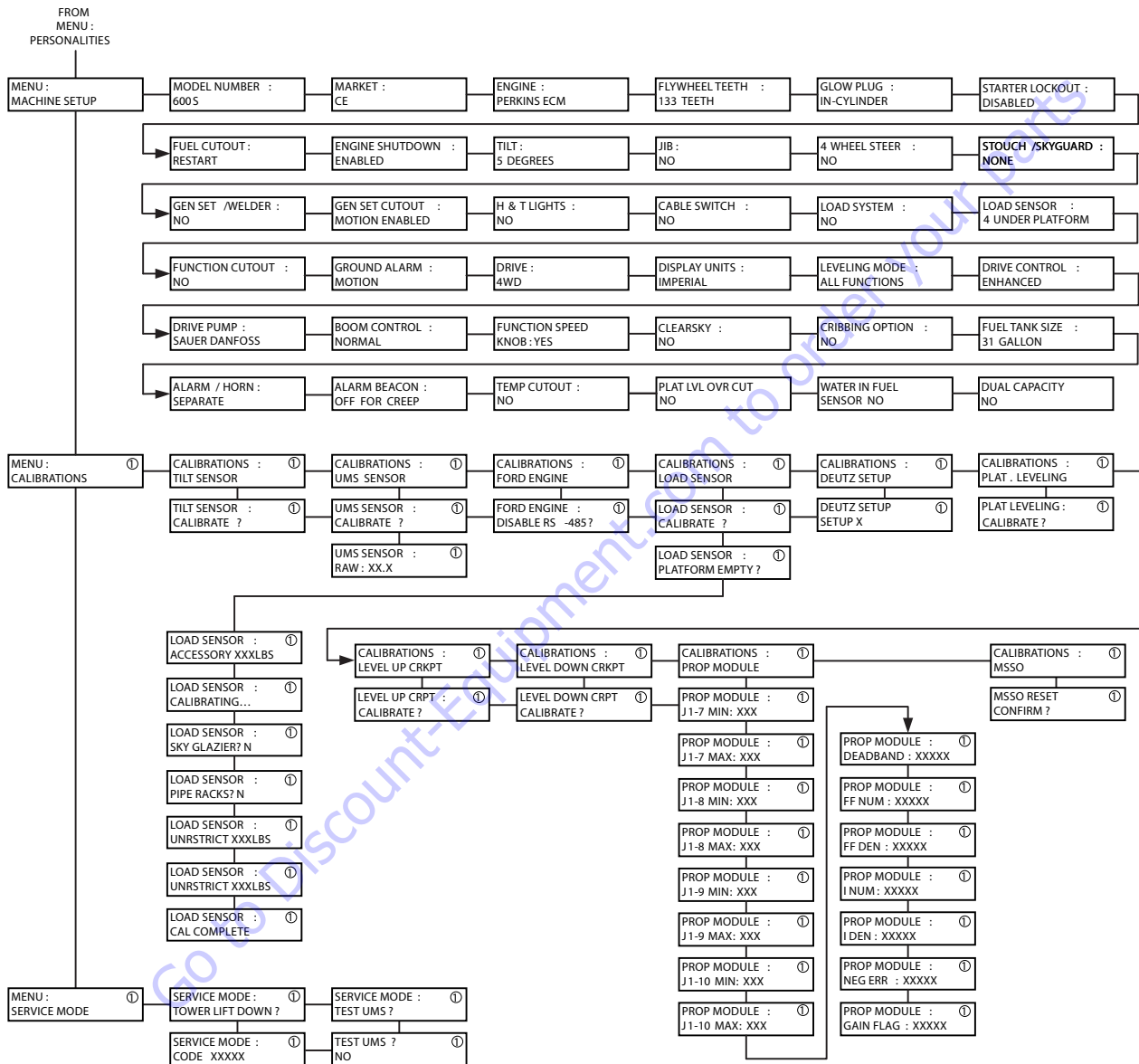
Figure 6-6. Analyzer Software Version 6.24 - Sheet 4 of 6



MAE9580R

Figure 6-7. Analyzer Software Version 6.24 - Sheet 5 of 6

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MAE9660R

Figure 6-8. Analyzer Software Version 6.24 - Sheet 6 of 6

6.2 MACHINE PERSONALITY SETTINGS

NOTE: Personality settings can be adjusted within the adjustment range for optimum machine performance.

Table 6-2. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 600S M46-XXX	DEFAULTS - 600S 830XXX
DRIVE	ACCEL	0.1s to 5.0s	2.5	2.5
	DECEL	0.1s to 3.0s	0.8	0.8
	Forward MIN	1 to 35%	4	4
	Forward MAX	1 to 100%	30	30
	REVERSE MIN	1 to 35%	4	4
	REVERSE MAX	1 to 100%	35	35
	ELEVATED MAX	1 to 100%	18	18
	CREEP MAX	1 to 90%	15	15
STEER	MAXimum speed	1 to 100%	100	100
MAIN LIFT	ACCEL	0.0 to 5.0s	2.5	2.5
	DECEL	0.0 to 3.0s	1	1
	MIN UP	1 to 60%	40	40
	MAX UP	1 to 100%	93	93
	Creep Up	1 to 65%	65	65
	MIN DOWN	1 to 60%	40	40
	MAX DOWN	1 to 100%	100	100
	CREEP DOEWN	1 to 75%	69	69
SWING	ACCEL	0.0 to 5.0s	2.0	2.0
	DECEL	0.0 to 3.0s	1.8	1.8
	MIN LEFT	1 to 50%	45	45
	MAX LEFT	1 to 100%	76	76
	CREEP LEFT	1 to 65%	63	63
	MIN RIGHT	1 to 50%	45	45
	MAX RIGHT	1 to 100%	76	76
	CREEP RIGHT	1 to 65%	63	63

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Table 6-2. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 600S M46-XXX	DEFAULTS - 600S 830XXXX
MAIN TELE	ACCEL	0.0 to 5.0	3.5	3.5
	DECEL	0.0 to 3.0	1.5	1.5
	MIN IN	1 to 65%	48	48
	MAX IN	1 to 100%	80	80
	MIN OUT	1 to 65%	49	49
	MAX OUT	1 to 100%	100	100
	Medium Speed	0.01 to 1.00	0.45	0.45
PLATFORM LEVEL	ACCEL	0.0 to 5.0s	2.5	2.5
	DECEL	0.0 to 3.0s	0.5	0.5
	MIN UP	1 to 65%	30	30
	MAX UP	1 to 100%	75	75
	MIN DOWN	1 to 65%	30	30
	MAX DOWN	1 to 100%	75	75
	Medium Speed	0.01 to 1.00	0.40	0.40
PLATFORM ROTATE	ACCEL	0.0 to 5.0s	1.9	1.9
	DECEL	0.0 to 3.0s	0.8	0.8
	MIN IN	1 to 65%	25	25
	MAX IN	1 to 100%	100	100
	MIN OUT	1 to 65%	25	25
	MAX OUT	1 to 100%	100	100
	MEDIUM SPEED	0.01 to 1.00	0.45	0.45
JIB LIFT	ACCEL	0.0 to 5.0s	1.8	1.8
	DECEL	0.0 to 3.0s	0.8	0.8
	MIN UP	1 to 65%	30	30
	MAX UP	1 to 100%	40	40
	MIN DOWN	1 to 65%	30	30
	MAX DOWN	1 to 100%	43	43
	MEDIUM SPEED	0.1 to 1.00	0.60	0.60

Table 6-2. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 600S M46-XXX	DEFAULTS - 600S 830XXXX
GROUND MODE	MAIN LIFT UP	1 to 100%	85	85
	MAIN LIFT DOWN	1 to 100%	92	92
	SWING	1 to 100%	75	75
	MAINT ELE	1 to 100%	70	70
	PLATFORM ROTATE	1 to 100%	99	99
	PLATFORM LEVEL	1 to 100%	74	74
	JIB LIFT	1 to 100%	39	39
<p>NOTE: Personality settings can be adjusted anywhere within the adjustment range in order to achieve optimum machine performance.</p> <p>NOTE: GROUND MODE speeds are automatically limited to being lower than platform speed for a given function.</p> <p>NOTE: Set personalities in the following order: creep speeds, platform speeds, and then set ground speeds.</p>				
4150365-K				

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Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
0/0		No flash code is indicated for the following help messages. They are intended to hint at a possible problem if vehicle is not behaving as expected.		1
	EVERYTHING OK	The "normal" help message in platform mode	CLEAR WHEN FAULT IS REMOVED	
	GROUND MODE OK	The "normal" help message in ground mode	CLEAR WHEN FAULT IS REMOVED	
	FSW OPEN	A drive or boom function has been selected but footswitch is open.	CLEAR WHEN FAULT IS REMOVED	
	RUNNING AT CREEP – CREEP SWITCH OPEN	All function speeds are limited to creep because creep switch is open.	CLEAR WHEN FAULT IS REMOVED	
	RUNNING AT CREEP – TILTED AND ABOVE ELEVATION	All boom function speeds are limited to creep because vehicle is tilted and above elevation.	CLEAR WHEN FAULT IS REMOVED	
	RUNNING AT CUTBACK – ABOVE ELEVATION	Drive speed is limited to "ELEVATED MAX" because vehicle is above elevation.	CLEAR WHEN FAULT IS REMOVED	
	TILT SENSOR OUT OF RANGE	The tilt sensor has indicated a tilt angle greater than 19 degrees for more than 4 seconds. Not reported during 2 second power-up.	CLEAR WHEN FAULT IS REMOVED	
	LOAD SENSOR READING UNDER WEIGHT	The load sensor is reading 20% or more under the calibrated zero point. This fault may occur if platform is resting on the ground. Not reported during 2 second power-up.	CLEAR WHEN FAULT IS REMOVED	
1/1		Flash code 1/1 indicates a "sleep" mode. NOT REQUIRED		
2/1		Flash code 2/1 indicates problems with footswitch.		2
	FSW FAULTY	The two footswitch inputs have read the same state for more than one second.	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously	CLEAR WHEN FAULT IS REMOVED	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
2/2		Flash code 2/2 indicates problems with drive & steer selection. Except where noted, these faults are not reported during 2 second power-up sequence.		3
	DRIVE LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Drive was selected before and during footswitch closure. Can be reported during power-up sequence.	CLEAR WHEN FAULT IS REMOVED	
	FSW INTERLOCK TRIPPED	Footswitch was closed for seven seconds with no function selected. Can be reported during power-up sequence.	CLEAR WHEN FAULT IS REMOVED	
	STEER LOCKED – SELECTED BEFORE FOOTSWITCH	Steer was selected before and during footswitch closure.	CLEAR WHEN FAULT IS REMOVED	
	STEER SWITCHES FAULTY	Both steer switches are active together.	CLEAR WHEN FAULT IS REMOVED	
	DRIVE / STEER WITH NO QPROX	This fault only occurs with inductive joysticks. It occurs if the joystick is moved out of the neutral position with no Qprox sensors active.		
	D/S JOY. QPROX BAD	These faults only occur with inductive joysticks. They indicate that the Q-Prox sensor is reading above 3.18 volts.	CLEAR WHEN FAULT IS REMOVED	
	D/S JOY. OUT OF RANGE LOW	Resistive joysticks: These faults do not occur. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is less than the centertap voltage minus half the center tap voltage minus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered below 1.05 volts. If the centertap is at the low end of the range, these faults will be triggered below 0.79 volts.	CLEAR WHEN FAULT IS REMOVED	
	D/S JOY. OUT OF RANGE HIGH	Resistive joysticks: These faults do not occur if the Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when the voltage is more than the centertap voltage plus half the centertap voltage plus 0.3 volts. If the centertap is at the high end of the range, these faults will be triggered above 4.35 volts. If the centertap is at the low end of the range, these faults will be triggered above 3.8 volts.	CLEAR WHEN FAULT IS REMOVED	
	D/S JOY. CENTER TAP BAD	Resistive joysticks: These faults occur when the center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated. Inductive joysticks: These faults occur when the center tap voltage is not between 2.18 volts and 2.70 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	CLEAR WHEN FAULT IS REMOVED	
	WAITING FOR FSW TO BE OPEN	Footswitch was closed when platform mode was selected. Can be reported during power-up sequence.	CLEAR WHEN FAULT IS REMOVED	

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Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
2/3		Flash code 2/3 indicates problems with boom function selection.		3
	LIFT/SWING LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Platform upper lift or swing was selected before and during footswitch closure.		
	PUMP SWITCHES FAULTY – CHECK DIAGNOSTICS/BOOM	A boom function (lower lift, telescope, basket level, basket rotate, jib) has both directions selected together.	CLEAR WHEN FAULT IS REMOVED	
	PUMP SWITCHES LOCKED – SELECTED BEFORE FOOTSWITCH	A platform boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before key switch or footswitch closure.	CLEAR WHEN FAULT IS REMOVED	
	PUMP SWITCHES LOCKED – SELECTED BEFORE AUX POWER	A ground boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before aux power.		
	LIFT / SWING WITH NO QPROX	This fault only occurs with inductive joysticks. It occurs if the joystick is moved out of the neutral position with no Qprox sensors active.		
	I/S JOY. QPROX BAD	These faults only occur with inductive joysticks. They indicate the Q-Prox sensor is reading above 3.18 volts.	CLEAR WHEN FAULT IS REMOVED	
	I/S JOY. OUT OF RANGE LOW	Resistive joysticks: These faults do not occur. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when voltage is less than centertap voltage minus half the centertap voltage minus 0.3 volts. If centertap is at high end of the range, these faults will be triggered below 1.05 volts. If centertap is at low end of the range, these faults will be triggered below 0.79 volts.	CLEAR WHEN FAULT IS REMOVED	
	I/S JOY. OUT OF RANGE HIGH	Resistive joysticks: These faults do not occur if Vref voltage is below 8.1 volts. If Vref is above 7.7 volts, Vref is operating out of tolerance or a short to battery has occurred. Inductive joysticks: The trigger points for these faults are dependent on the centertap voltage reading. These faults will be triggered when voltage is more than centertap voltage plus half the centertap voltage plus 0.3 volts. If centertap is at high end of the range, these faults will be triggered above 4.35 volts. If centertap is at low end of the range, these faults will be triggered above 3.8 volts.	CLEAR WHEN FAULT IS REMOVED	
	I/S JOY. CENTER TAP BAD	Resistive joysticks: These faults occur when center tap voltage is not between 3.08 volts and 3.83 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated. Inductive joysticks: These faults occur when center tap voltage is not between 2.18 volts and 2.70 volts. Due to resistor tolerances there is a +/- .1 volt range around these values where the fault may be indicated.	CLEAR WHEN FAULT IS REMOVED	
	PUMP SWITCHES LOCKED – SELECTED BEFORE START SWITCH	This fault occurs when a hydraulic function switch is closed before start switch is closed.	CLEAR WHEN FAULT IS REMOVED	
	FOOTSWITCH SELECTED BEFORE START	User attempted to start machine with footswitch engaged.	CLEAR WHEN FAULT IS REMOVED	
2/4		Flash code 2/4 indicates steering digital inputs are faulty. NOT REQUIRED		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
2/5		Flash code 2/5 indicates a function is prevented due to a cutout.		4
	BOOM PREVENTED – DRIVE SELECTED	A boom function is selected while a drive function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	CLEAR WHEN FAULT IS REMOVED	
	DRIVE PREVENTED – ABOVE ELEVATION	Drive is selected while above elevation and drive cutout is configured to prevent drive.	CLEAR WHEN FAULT IS REMOVED	
	DRIVE PREVENTED – BOOM SELECTED	Drive is selected while a boom function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	CLEAR WHEN FAULT IS REMOVED	
	DRIVE PREVENTED – TILTED & ABOVE ELEVATION	Drive is selected while tilted and above elevation and tilt is configured to cutout drive.	CLEAR WHEN FAULT IS REMOVED	
	MODEL CHANGED – HYDRAULICS SUSPENDED – CYCLE EMS	User changed model number using the analyzer. User must cycle power before hydraulics system will be active again.		
2/7		Flash code 2/7 indicates accelerator input is faulty. NOT REQUIRED		
2/8		Flash code 2/8 indicates a problem with a hydraulic filter. Not reported during 2 second power-up.		5
	RETURN FILTER BYPASSED	Hydraulic return filter clogged		
	CHARGE PUMP FILTER BYPASSED	Charge pump filter clogged		
3/1		Flash code 3/1 indicates a contactor did not close when energized. NOT REQUIRED		
3/2		Flash code 3/2 indicates a contactor did not open when energized. NOT REQUIRED		

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Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
3/3		Flash code 3/3 indicates a driver problem. All driver faults are detected in a similar manner. Open circuit faults are detected when analog feedback reads too high and the output is commanded off. Short to ground is detected when analog feedback reads low and the output is commanded on. Short to battery is detected when analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up.		6
	ALTERNATOR/ECM POWER SHORT TO GROUND			
	HOUR METER SHORT TO GROUND			
	HOUR METER SHORT TO BATTERY			
	HORN SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	HORN OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	HORN SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	AUX POWER SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	AUX POWER OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	AUX POWER SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	GLOW PLUG SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	GLOW PLUG OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	GLOW PLUG SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	LP LOCK SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	LP LOCK OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	LP LOCK SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	LP START ASSIST SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	LP START ASSIST OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	LP START ASSIST SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	MAIN DUMP SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	MAIN DUMP OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	MAIN DUMP SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
	PARKING BRAKE SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	PARKING BRAKE OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	PARKING BRAKE SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	START SOLENOID SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	START SOLENOID OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	START SOLENOID SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	STEER DUMP SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	STEER DUMP OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	STEER DUMP SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TWO SPEED SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TWO SPEED OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TWO SPEED SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	GROUND ALARM SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	GROUND ALARM OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	GROUND ALARM SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	GENERATOR SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	GENERATOR OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	GENERATOR SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	WELDER SHORT TO GROUND			
	WELDER OPEN CIRCUIT			
	WELDER SHORT TO BATTERY			
	HEAD TAIL LIGHT SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	HEAD TAIL LIGHT OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	HEAD TAIL LIGHT SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BASKET UP OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.		

SECTION 6 - JLG CONTROL SYSTEM

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
	BASKET UP OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.		
	BASKET UP OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.		
	BASKET UP SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BASKET UP OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BASKET UP SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BASKET DOWN SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BASKET DOWN OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BASKET DOWN SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BASKET DOWN OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.		
	BASKET DOWN OVERRIDE OPEN CIRCUIT	Only occurs on machines with electronic leveling systems.		
	BASKET DOWN OVERRIDE SHORT TO BATTERY	Only occurs on machines with electronic leveling systems.		
	BASKET LEFT OPEN CIRCUIT			
	BASKET LEFT SHORT TO BATTERY			
	BASKET LEFT SHORT TO GROUND			
	BASKET RIGHT SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BASKET RIGHT OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BASKET RIGHT SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB UP SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB UP OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB UP SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB DOWN SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB DOWN OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB DOWN SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB LEFT SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
	JIB LEFT OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB LEFT SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB RIGHT SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB RIGHT OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	JIB RIGHT SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER UP SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER UP OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER UP SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER DOWN SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER DOWN OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER DOWN SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER IN SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER IN OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER IN SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER OUT SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER OUT OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	TOWER OUT SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	UPPER IN SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	UPPER IN OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	UPPER IN SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	UPPER OUT SHORT TO GROUND		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	UPPER OUT OPEN CIRCUIT		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	UPPER OUT SHORT TO BATTERY		REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	LIFT UP DUMP SHORT TO GROUND			

SECTION 6 - JLG CONTROL SYSTEM

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
	LIFT UP DUMP OPEN CIRCUIT			
	LIFT UP DUMP SHORT TO BATTERY			
	LIFT DOWN HOLDING SHORT TO GROUND			
	LIFT DOWN HOLDING OPEN CIRCUIT			
	LIFT DOWN SHORT TO BATTERY			
	HOUR METER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.		
	FORD ECM POWER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.		
	FORD ECM POWER SHORT TO BATTERY	This fault cannot be detected during normal operation. It may be reported during self test.		
3/4		Flash code 3/4 indicates a driver problem on a platform valve block valve driver. All driver faults are detected in a similar manner. Open circuit faults are detected when analog feedback reads too high and the output is commanded off. Short to ground is detected when analog feedback reads low and the output is commanded on. Short to battery is detected when analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up.		6
	BASKET UP SHORT TO BATTERY			
	BASKET UP SHORT TO GROUND			
	BASKET UP OPEN CIRCUIT			
	BASKET UP SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling		
	BASKET DOWN SHORT TO BATTERY			
	BASKET DOWN SHORT TO GROUND			
	BASKET DOWN OPEN CIRCUIT			
	BASKET DOWN SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling.		
	BASKET LEFT SHORT TO BATTERY			
	BASKER LEFT SHORT TO GROUND			
	BASKET LEFT OPEN CIRCUIT			
	BASKET RIGHT SHORT TO BATTERY			
	BASKET RIGHT SHORT TO GROUND			
	BASKET RIGHT OPEN CIRCUIT			
	JIB UP SHORT TO BATTERY			
	JIB UP SHORT TO GROUND			
	JIB UP OPEN CIRCUIT			
	JIB DOWN SHORT TO BATTERY			

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
	JIB DOWN SHORT TO GROUND			
	JIB DOWN OPEN CIRCUIT			
	JIB LEFT SHORT TO BATTERY			
	JIB LEFT SHORT TO GROUND			
	JIB LEFT OPEN CIRCUIT			
	JIB RIGHT SHORT TO BATTERY			
	JIB RIGHT SHORT TO GROUND			
	JIB RIGHT OPEN CIRCUIT			
	PLATFORM CONTROL VALVE SHORT TO BATTERY	Only occurs on machines with electronic basket leveling		
	PLATFORM CONTROL VALVE SHORT TO GROUND	Only occurs on machines with electronic basket leveling		
	PLATFORM CONTROL VALVE OPEN CIRCUIT	Only occurs on machines with electronic basket leveling		
3/5		Flash code 3/5 indicates a brake pressure problem. NOT REQUIRED		
4/2		Flash code 4/2 indicates engine is over temperature. NOT REQUIRED		
4/3		Flash code 4/3 indicates problems with the engine. Except where noted, these faults are not reported during 2 second power-up sequence.		9
	HIGH ENGINE TEMP	Occurs when engine temperature is above 117° Celsius for Ford engines, and above 130° Celsius for Deutz engines.		
	AIR FILTER BYPASSED	Air filter clogged		
	NO ALTERNATOR OUTPUT	Engine has been running for 15 seconds or more and battery voltage is still below 12.5 volts.		
	LOW OIL PRESSURE	If a Deutz engine is installed, oil pressure is below 8 PSI and the engine has been running for at least 10 seconds. If a Ford engine is installed, the Ford ECM has reported a low oil pressure fault.		
	OIL PRESSURE SHORT TO BATTERY	If a Deutz engine is installed, this indicates oil pressure sensor is reading above 6.6 volts.	CLEAR WHEN FAULT IS REMOVED	
	OIL PRESSURE SHORT TO GROUND	If a Deutz engine is installed, this indicates oil pressure sensor is reading below 0.1 volts for more than 5 seconds. This fault is not detected during crank.	CLEAR WHEN FAULT IS REMOVED	
	COOLANT TEMPERATURE SHORT TO GROUND	If a Deutz engine is installed, this indicates coolant temperature is reading below 0.1 volts.	CLEAR WHEN FAULT IS REMOVED	
	FORD FAULT CODE ##	All Ford fault codes except 63 are simply passed through from the FORD ECM. They only occur if a Ford engine is selected in machine configuration digits. Can be reported during power-up sequence.	CLEAR WHEN FAULT IS REMOVED	
	FORD FAULT CODE UNKNOWN	An unrecognized Ford ECM fault code has been received. Can be reported during power-up sequence.	CLEAR WHEN FAULT IS REMOVED	
	485 COMMUNICATIONS LOST	This fault only occurs with a Ford engine. It occurs when no responses are received from the ECM for 2.5 seconds. Can be reported during power-up sequence.	CLEAR WHEN FAULT IS REMOVED	
	FUEL SENSOR SHORT TO BATTERY	Indicates fuel sensor is reading above 4.3 volts.	CLEAR WHEN FAULT IS REMOVED	
	FUEL SENSOR SHORT TO GROUND	Indicates fuel sensor is reading below 0.2 volts.	CLEAR WHEN FAULT IS REMOVED	

SECTION 6 - JLG CONTROL SYSTEM

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Fault Message	Priority
4/4		Flash code 4/4 indicates problems with the battery supply. Not reported during 2 second power-up.		7
	BATTERY LOW	Battery voltage is below 11V for more than 5 seconds. This fault is not detected during crank. This is a warning – controller does not shut down.	CLEAR WHEN FAULT IS REMOVED	
	BATTERY TOO HIGH – SYSTEM SHUT DOWN	Battery voltage is above 16V. EMS recycle required.	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	BATTERY TOO LOW – SYSTEM SHUT DOWN	Battery voltage is below 9V.	CLEAR WHEN FAULT IS REMOVED	
5/5		Flash code 5/5 indicates problems with vehicle engine RPM or the encoder. Not reported during 2 second power-up.		8
	SPEED SENSOR READING INVALID SPEED	This fault is detected with diesel engines only. The RPM pickup is indicating a speed that greater than 4000 RPM or approximately 8875 Hz.	CLEAR WHEN FAULT IS REMOVED	
	SPEED INPUT LOST	This fault is detected with diesel engines only. It occurs if there is no RPM detected and the oil pressure input is reading above 8 PSI for more than three seconds. This is probably due to wiring problems at the ground module or a faulty speed sensor.	CLEAR WHEN FAULT IS REMOVED	
6/6		Flash code 6/6 indicates problems with the CAN bus.		10
	CAN BUS FAILURE:	Ground module or platform module is not receiving CAN messages. This is probably due to wiring problems between the platform and ground modules.	CLEAR WHEN FAULT IS REMOVED	
7/7		Flash code 7/7 indicates problems with a motor. NOT REQUIRED		
9/9		Flash code 9/9 indicates problems with the controller.		11
	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	Platform module code is too old to support the EIM or BPE load sensor and the machine is configured to use one of these two sensors. The PM code must be updated to a newer version.	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT	
	HIGH RESOLUTION A2D FAILURE – INTERRUPT LOST	The ADS1213 chip in the platform module has stopped asserting its interrupt (DRDY) line for some reason. An EMS cycle is required.		
	HIGH RESOLUTION A2D FAILURE-REINIT LIMIT	The ADS1213 has needed to be reset 3 or more times.		
	PLATFORM MODULE FAILURE: HWFS CODE 1	Platform module V(Low) FET has failed	CLEAR WHEN FAULT IS REMOVED	
	GROUND MODULE FAILURE: HWFS CODE 1	Ground module V(Low) FET has failed	CLEAR WHEN FAULT IS REMOVED	
	GROUND SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.		
	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.		
	EEPROM FAILURE – CHECK ALL SETTINGS	A critical failure occurred with the EEPROM. Personalities, machine configuration digits, etc. may be reset to default values and should be checked.		
	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	Indicates that chassis tilt sensor calibration information has been lost. Machine will indicate it is tilted at all times. This calibration data is programmed into the unit at the factory.		
	CHASSIS TILT SENSOR GAIN OUT OF RANGE	Indicates chassis tilt sensor calibration is corrupted.		

Table 6-4. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
<p>NOTE: Machine configuration must be completed before any personality settings can be changed. Changing personality settings first and then changing the model number of the machine configuration will cause personality settings to return to default</p>			
MODEL NUMBER: 1	1	600S	1
MARKET: 2	1 2 3 4 5 6 7	ANSI USA ANSI EXPORT CSA CE AUSTRALIA JAPAN GB	0
ENGINE: 3*	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1) FORD EFID/F: Ford LRG425 EFI dual fuel (Tier 1) DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1) DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1) CAT. 3024C: CAT 3024C Diesel (Tier 2) CAT. 3044C: CAT 3044C Diesel (Tier 2) PERKINS 404C (Tier 2) DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2) DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2) FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2) FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2) DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3) DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2) PERKINSECM CAT ECM DEUTZ EMR4: Deutz Engine Control Module (Tier 4 Final) FORD DUAL FUEL KUBOTA D1305	14
* Engine selections vary depending on model selection.			
FLYWHEEL TEETH: 4*	0 1	133 TEETH: 133 flywheel teeth. 110 TEETH: 110 flywheel teeth.	1
* This menu item is only visible if Deutz engine selections 3 or 4 are selected.			

SECTION 6 - JLG CONTROL SYSTEM

Table 6-4. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	IN-CYLINDER: Glow plugs installed in each cylinder.	
STARTER LOCKOUT: 6	0	DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.	0
	1	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	
ENGINE SHUTDOWN: 7	0	DISABLED: No engine shutdown.	1
	1	ENABLED: Shutdown engine for high coolant temperature greater than 110 deg. C or the oil pressure is less than 8 PSI.	
FUEL CUTOFF: 8*	0	RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached	0
	1	ONE RESTART: Engine allowed to be restarted once for 2 minutes when very low fuel level is reached	
	2	ENGINE STOP: Engine not able to restart when very low fuel level is reached.	
*This menu item is only visible if non dual fuel engines are selected.			

Table 6-4. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
TILT: 9	1	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.	1
	2	4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep.	
	3	3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep.	
	4	4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	5	4 DEG + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, drive, telescope out and lift up.	
	6	3 DEG + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, drive, telescope out and lift up.	
	7	5 DEG + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
	8	4 DEG + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
	9	3 DEG + DRV CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
* Certain market selections will limit tilt options and alter default setting. Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.			
JIB: 10*	0 1	NO: No Jib installed. YES: Jib installed which has up and down movements only.	0
*Only visible under certain model selections.			
4 WHEEL STEER: 11*	0 1	NO: No four- Wheel Steer not installed. YES: Four Wheel Steer installed.	0
* Only visible under certain model selections.			
SOFT TOUCH/SKYGUARD: 12	0 1	None: No Soft Touch system or SkyGuard system installed. SOFT TOUCH - Soft touch only installed.	0

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Table 6-4. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
SOFT TOUCH/SKYGUARD: 12	2	SKYGUARD - Skyguard only installed.	0
	3	BOTH(CUTOUT) - Soft touch and Skyguard installed.	
GEN SET/WELDER: 13	0	NO: No generator installed.	0
	1	BELT DRIVE: Belt driven setup	
GEN SET CUTOUT: 14*	0	MOTION ENABLED: Motion enabled when generator is ON.	0
	1	MOTION CUTOUT: Motion cutout in platform mode only.	
* Only visible if Gen Set / Welder Menu selection is not 1.			
H & T LIGHTS: 15	0	NO: No load sensor installed.	0
	1	YES: Broken cable switch installed.	
CABLE SWITCH: 16*	0	NO: No head and tail lights installed.	0
	1	YES: Head and tail lights installed.	
* Only visible under certain model selections. * Certain market and model selections will alter the default setting.			
LOAD SYSTEM: 17*	0	NO: No load sensor installed.	0
	1	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	2	CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
	4	SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out.	
* Only visible under certain market selections. * Certain market selections will limit load system options or alter default setting. * LOAD SYSTEM will not be visible in CE and defaulted to CUTOUT ALL for machines equipped with MSSO			

Table 6-4. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
LOAD SENSOR: 18*	0	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	
	2	SINGLE CELL: Single Cell, CANbus based sensor.	
* Only visible if Load Sensor Menu selection is not 0 and under certain market selections. * Certain market selections will limit load sensor options.			
FUNCTION CUTOUT: 19*	0	NO: No drive cutout.	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive cutout above elevation.	
	3	DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	
* Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.			
GROUND ALARM: 20*	1	NO: No ground alarm installed.	3
	2	DRIVE: Travel alarm sounds when the drive function is active (Option).	
	3	DESCENT: Descent alarm sounds when lift down is active (Option).	
	4	MOTION: Motion alarm sounds when any function is active (Option).	
* Certain market selections will alter default setting.			
DRIVETYPE: 21*	0	4 WD: Four wheel drive.	0
	1	2WD: Two wheel drive.	
	2	2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	
* Only visible under certain model selections.			
DISPLAY UNITS: 22*	0	IMPERIAL: DEG F, PSI, LBS	0
	1	METRIC: DEG C, KPA, KGS	
* Certain market selections will alter default setting.			
LEVELING MODE: 23*	0	ALL FUNCTIONS: Platform level with all functions.	0
	1	LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	
* Only visible on 800S models.			

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Table 6-4. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
DRIVE CONTROL: 24	0	NORMAL: Drive coils are energized from the Ground Module.	2
	1	PROPULSION: Drive coils are energized from the Propulsion Module.	
	2	ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.	
DRIVE PUMP: 25*	0	SAUER DANFOSS: Machine equipped with Sauer Danfoss drive pump	0
	1	EATON: Machine equipped with Eaton drive pump	
	2	M46-XXXX: Machine equipped with M46-XXXX drive pump	
	3	830XXXXX: Machine equipped with 830XXXXX: drive pump	
* Only visible on 600A, 600S, and 800S models.			
BOOM CONTROL: 26	0	NORMAL: Boom function coils are energized from the Ground Module	0
	1	ENHANCED: Boom function are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns	
FUNCTION SPEED KNOB: 27	0	YES: Machine is equipped with Function Speed Knob	0
	1	NO: Machine is equipped with Operation Speed Switch	
CLEARSKY: 28	1	NO: ClearSky (telematics) options is disabled.	0
	2	YES: ClearSky (telematics) option is enabled.	
CRIBBING OPTION: 29	1	NO: Cribbing Option is disabled.	0
	2	YES: Cribbing Option is enabled.	
FUEL TANK SIZE: 30	0	31 Gallon Tank	0
	1	52 Gallon Tank	
ALARM / HORN: 31	0	SEPARATE: Separate alarm and horn.	0
	1	COMBINED: Combination alarm / horn.	
ALERT BECON: 32	0	OFF FOR CREEP: Alert beacon will not flash while in Creep	0
	1	20FPS FOR CREEP: Alert beacon will flash at 20FPS while in Creep	
TEMP CUTOUT: 33	0	NO: Temp Cutout is Disabled	0
	1	YES: Temp Cutout is Enabled	

Table 6-4. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
* Certain market selections will temp cutout options.			
PLAT LVL OVR CUT: 34	0 1	NO: Platform Level Override will always be functional YES: Platform Level Override will only be functional when In Transport	0
WATER IN FUEL SENSOR: 35	1 2	NO: Water in Fuel Sensor Disabled YES: Water in Fuel Sensor Enabled	0
* This menu item is only visible if Deutz EMR 4 engine is selected. * Only visible under certain market selections.			
DUAL CAPACITY: 36	0 1	NO: Dual Capacity is disabled. YES: Dual Capacity is enabled.	0

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Table 6-5. Machine Configuration Programming Settings

600S	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	4	4	4	4	4	4	4
Market	0	1	2	3	4	5	3
ENGINE	12	12	12	12	12	12	12
Flywheel Teeth	X	X	X	X	X	X	X
	1	1	1	1	1	1	1
Glow Plug	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Starter Lockout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Engine Shutdown	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Fuel Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Tilt	1	1	1	X	X	1	X
	2	2	2	X	2	2	X
	3	3	3	X	3	3	X
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	6	6	6	X	X	6	X
	7	7	7	X	X	7	X
	8	8	8	8	8	8	8
	9	9	9	9	9	9	9
Jib	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
4 Wheel Steer	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
SOFT TOUCH/SKYGUARD	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Gen Set / Welder	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Gen Set Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Head & Tail lights	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cable Break Switch	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

Table 6-5. Machine Configuration Programming Settings

600S	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Load System	0	0	0	0	0	0	0
	X	1	X	X	X	1	X
	X	2	X	2	2	2	2
	X	4	X	X	X	4	X
LOAD SENSOR	X	0	X	0	0	0	0
	1	1	1	1	1	1	1
	X	2	X	2	2	2	2
Function Cutout	0	0	0	0	0	0	0
	X	1	1	1	1	1	1
	2	2	2	X	2	2	2
	X	3	3	X	3	3	3
Ground Alarm	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
DRIVE TYPE	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Display Units	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Leveling Mode	0	0	0	0	0	0	0
	X	X	X	X	X	X	X
Drive Control	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Drive Pump	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Boom Control	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Function Speed Knob	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Clearsky	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cribbing Option	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Fuel tank size	0	0	0	0	0	0	0
	X	X	X	X	X	X	X
ALARM / HORN	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

Table 6-5. Machine Configuration Programming Settings

600S	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Alert Beacon	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Temp Cutout	0	0	0	0	0	0	0
	X	1	X	1	X	X	1
PLAT LVL OVR CUT	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Water in Fuel Sensor	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Dual Capacity	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

BOLD BLUE text indicates the default setting. Plain text indicates another available selection. **RED ITALIC** text indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

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Table 6-6. Machine Configuration Programming Settings

660SJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	4	4	4	4	4	4	4
Market	0	1	2	3	4	5	3
ENGINE	12	12	12	12	12	12	12
Flywheel Teeth	X	X	X	X	X	X	X
	1	1	1	1	1	1	1
Glow Plug	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Starter Lockout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Engine Shutdown	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Fuel Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Tilt	1	1	1	X	X	1	X
	2	2	2	X	2	2	X
	3	3	3	X	3	3	X
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	6	6	6	X	X	6	X
	7	7	7	X	X	7	X
	8	8	8	8	8	8	8
	9	9	9	9	9	9	9
Jib	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
4 Wheel Steer	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
SOFT TOUCH/SKYGUARD	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Gen Set / Welder	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Gen Set Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Head & Tail lights	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cable Break Switch	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

SECTION 6 - JLG CONTROL SYSTEM

Table 6-6. Machine Configuration Programming Settings

660SJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Load System	0	0	0	0	0	0	0
	X	1	X	X	X	1	X
	X	2	X	2	2	2	2
	X	4	X	X	X	4	X
LOAD SENSOR	X	0	X	0	0	0	0
	1	1	1	1	1	1	1
	X	2	X	2	2	2	2
Function Cutout	0	0	0	0	0	0	0
	X	1	1	1	1	1	1
	2	2	2	X	2	2	2
	X	3	3	X	3	3	3
Ground Alarm	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Drive Type	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Display Units	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Leveling Mode	0	0	0	0	0	0	0
	X	X	X	X	X	X	X
Drive Control	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Drive Pump	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Boom Control	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Function Speed Knob	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Clearsky	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Cribbing Option	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Fuel tank size	0	0	0	0	0	0	0
	X	X	X	X	X	X	X
ALARM/HORN	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

Table 6-6. Machine Configuration Programming Settings

660SJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Alert Beacon	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Temp Cutout	0	0	0	0	0	0	0
	X	1	X	1	X	X	1
PLAT LVL OVR CUT	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Water in Fuel Sensor	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Dual Capacity	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

BOLD BLUE text indicates the default setting. Plain text indicates another available selection. **RED ITALIC** text indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

4150364-X

6.3 MACHINE ORIENTATION WHEN SETTING FUNCTION SPEEDS

LIFT, boom retracted, telescope retracted, lift up, record time, lift down, record time.

SWING, boom at full elevation, telescope retracted, swing the turntable off center and stop, swing the opposite direction and start the test when the turntable is centered up. This eliminates ramp up and down on the controller affecting times.

TELESCOPE, boom at full elevation, telescope retracted, telescope out, record time, telescope in, record time.

DRIVE, test to be done on smooth level surface, drive select switch should be set at high speed, start approximately 25 ft. from starting point so that the unit is at maximum speed when starting the test. Results should be recorded for a 200 ft. course, drive forward, record time, record time.

DRIVE (Above horizontal), test to be done on smooth level surface, drive select switch should be set at high engine, high speed, the boom should be raised above horizontal, the platform speed control knob should be selected out of creep speed, results should be recorded for a 50 ft. course, drive forward, record time, drive reverse, record time.

PLATFORM ROTATE, platform level and completely rotated one direction, rotate the opposite direction, record time, rotate the other direction, record time.

ARTICULATING JIB, platform level and centered with the boom, start with jib down. Jib up, record time. Jib down, record time.

Test Notes

1. Personality settings can be adjusted anywhere within the adjustment range for optimum machine performance.
2. Stop watch should start when function is activated, not controller or switch.
3. Unless noted, measure function speeds from platform.
4. Platform speed knob must be at full speed (fully clockwise).
5. Perform all tests with oil temperature above 100° F (38° C).

Table 6-7. Function Speeds (In Seconds)

Function	600S	660SJ
Lift Up	46-60	46-60
Lift Down	33-43	33-43
Swing Right & Left (No more than 10% difference between swing left and swing right.)	79-101	79-101
Telescope In	25-33	25-33
Telescope Out	50-67	50-67
Platform Rotate Right & Left (No more than 15% difference between rotate left and rotate right.)	16-25	16-25
Articulating Jib Up	N/A	22-34
Articulating Jib Down	N/A	16-26
Drive (2 - WD & 4 - WD) (Other Engines) (Forward)	30-34 (4.25 MPH)	30-34 (4.25 MPH)
Drive (2 - WD & 4 - WD) (Deutz Engines) (Forward)	34-38 (4.02 MPH)	34-38 (4.02 MPH)
Drive (2 - WD & 4 - WD) (Above Horizontal) (Forward & Reverse)	46-54 (0.68 MPH)	46-54 (0.68 MPH)

4150501-F

6.4 CANBUS COMMUNICATIONS

CANbus: CAN (Control Area Network) is a two wire differential serial link between the Platform and Ground Modules providing bi-directional communications.

Two-wire: One wire (red) is driven high (5v) and the other low (black) (0v) to send a signal. Both wires "float" (2.5v) when no signal is being sent.

Differential: Any electrical line noise can affect the high or the low wires but never both, so communications is not corrupted.

Serial Link: Messages are being sent bit by bit along the wires; the high bus speed allow all modules to be constantly updated around 20 times per second. Typical traffic is 300 - 500 messages per second.

A complete CANbus circuit is approximately 60 ohms, which can be verified at the "T" fitting inside the ground station. Individual circuits are approximately 120 ohms.

The GROUND MODULE (UGM) is the master system controller. Most functions are dispatched and coordinated from this module. The PLATFORM MODULE handles sub-tasks. All characterized information (values) are stored in the ground module (i.e., Personalities or Calibrations).

Interlocks: Any device that sends an electrical input. (For an example a limit switch, proximity switch, etc;)

Platform Level: The GROUND MODULE stores default values and handles interlocks. The PLATFORM MODULE reads sensors mounted on the platform assembly and controls Level Up / Down valves to maintain setpoint sent from the GROUND MODULE.

Steer: The GROUND MODULE stores crack points, and sends desired drive direction, steering mode, and axle extend/retract commands. The PLATFORM MODULE reports steering switch position to the GROUND MODULE.

Drive: The GROUND MODULE stores crack points and sends commands for each drive pump. (Command is computed from drive joystick input, interlocks, wheel angle, etc).

Lift, Tele, & Swing: The GROUND MODULE stores default values, and handles interlocks and calibration information. Lift, Telescope, and Swing commands depend on interlocks through out the machine. Boom angle, length, and swing are controlled by the GROUND MODULE

Table 6-8. Fault Code List

DTC	Text
001	EVERYTHING OK
0010	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION
0011	FSW OPEN
0012	RUNNING AT CREEP - CREEP SWITCH OPEN
0013	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION
0014	CHASSIS TILT SENSOR OUT OF RANGE
0030	RUNNING AT CREEP - PLATFORM STOWED
0031	FUEL LEVEL LOW - ENGINE SHUTDOWN
211	POWER CYCLE
212	KEYSWITCH FAULTY
213	FSW FAULTY
224	FUNCTION PROBLEM - STEER LEFT PERMANENTLY SELECTED
225	FUNCTION PROBLEM - STEER RIGHT PERMANENTLY SELECTED
227	STEER SWITCHES FAULTY
2211	FSW INTERLOCK TRIPPED
2212	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH
2213	STEER LOCKED - SELECTED BEFORE FOOTSWITCH
2216	D/S JOY. OUT OF RANGE HIGH
2217	D/S JOY. CENTER TAP BAD
2219	L/S JOY. OUT OF RANGE HIGH
2220	L/S JOY. CENTER TAP BAD
2221	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH
2222	WAITING FOR FSW TO BE OPEN
2223	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE
2224	FOOTSWITCH SELECTED BEFORE START
2247	FUNCTION PROBLEM - PLATFORM ROTATE LEFT PERMANENTLY SELECTED
2248	FUNCTION PROBLEM - PLATFORM ROTATE RIGHT PERMANENTLY SELECTED
2249	FUNCTION PROBLEM - JIB LIFT UP PERMANENTLY SELECTED
2250	FUNCTION PROBLEM - JIB LIFT DOWN PERMANENTLY SELECTED
2251	FUNCTION PROBLEM - TELESCOPE IN PERMANENTLY SELECTED
2252	FUNCTION PROBLEM - TELESCOPE OUT PERMANENTLY SELECTED
2257	FUNCTION PROBLEM - TOWER LIFT UP PERMANENTLY SELECTED
2258	FUNCTION PROBLEM - TOWER LIFT DOWN PERMANENTLY SELECTED
2262	FUNCTION PROBLEM - PLATFORM LEVEL UP PERMANENTLY SELECTED
2263	FUNCTION PROBLEM - PLATFORM LEVEL DOWN PERMANENTLY SELECTED
234	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM
235	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER
236	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH
237	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH
2310	FUNCTION PROBLEM - GROUND ENABLE PERMANENTLY SELECTED
2370	FUNCTION PROBLEM - JIB LIFT UP PERMANENTLY SELECTED
2371	FUNCTION PROBLEM - JIB LIFT DOWN PERMANENTLY SELECTED

SECTION 6 - JLG CONTROL SYSTEM

Table 6-8. Fault Code List

DTC	Text
2372	FUNCTION PROBLEM - SWING LEFT PERMANENTLY SELECTED
2373	FUNCTION PROBLEM - SWING RIGHT PERMANENTLY SELECTED
23104	BOOM TRANSPORT SWITCH DISAGREEMENT
23105	FUNCTION PROBLEM - TOWER LIFT UP PERMANENTLY SELECTED
23106	FUNCTION PROBLEM - TOWER LIFT DOWN PERMANENTLY SELECTED
23107	FUNCTION PROBLEM - LIFT UP PERMANENTLY SELECTED
23108	FUNCTION PROBLEM - LIFT DOWN PERMANENTLY SELECTED
23109	FUNCTION PROBLEM - TELESCOPE IN PERMANENTLY SELECTED
23110	FUNCTION PROBLEM - TELESCOPE OUT PERMANENTLY SELECTED
23111	FUNCTION PROBLEM - PLATFORM LEVEL UP PERMANENTLY SELECTED
23112	FUNCTION PROBLEM - PLATFORM LEVEL DOWN PERMANENTLY SELECTED
23113	FUNCTION PROBLEM - PLATFORM ROTATE LEFT PERMANENTLY SELECTED
23114	FUNCTION PROBLEM - PLATFORM ROTATE RIGHT PERMANENTLY SELECTED
259	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS
2513	GENERATOR MOTION CUTOFF ACTIVE
2514	BOOM PREVENTED - DRIVE SELECTED
2516	DRIVE PREVENTED - ABOVE ELEVATION
2517	DRIVE PREVENTED - TILTED & ABOVE ELEVATION
2518	DRIVE PREVENTED - BOOM SELECTED
331	BRAKE - SHORT TO BATTERY
332	BRAKE - OPEN CIRCUIT
334	LIFT UP VALVE - OPEN CIRCUIT
335	LIFT DOWN VALVE - SHORT TO BATTERY
336	LIFT DOWN VALVE - OPEN CIRCUIT
3311	GROUND ALARM - SHORT TO BATTERY
3352	LP LOCK - SHORT TO GROUND
3353	LP LOCK - OPEN CIRCUIT
3354	LP LOCK - SHORT TO BATTERY
3355	LP START ASSIST - SHORT TO GROUND
3356	LP START ASSIST - OPEN CIRCUIT
3357	LP START ASSIST - SHORT TO BATTERY
3358	MAIN DUMP VALVE - SHORT TO GROUND
3359	MAIN DUMP VALVE - OPEN CIRCUIT
3360	MAIN DUMP VALVE - SHORT TO BATTERY
3361	BRAKE - SHORT TO GROUND
3362	START SOLENOID - SHORT TO GROUND
3363	START SOLENOID - OPEN CIRCUIT
3364	START SOLENOID - SHORT TO BATTERY
3365	STEER DUMP VALVE - SHORT TO GROUND
3366	STEER DUMP VALVE - OPEN CIRCUIT
3367	STEER DUMP VALVE - SHORT TO BATTERY
3373	GEN SET/WELDER - SHORT TO GROUND
3374	GEN SET/WELDER - OPEN CIRCUIT

Table 6-8. Fault Code List

DTC	Text
3375	GEN SET/WELDER - SHORT TO BATTERY
3376	HEAD TAIL LIGHT - SHORT TO GROUND
3377	HEAD TAIL LIGHT - OPEN CIRCUIT
3378	HEAD TAIL LIGHT - SHORT TO BATTERY
3379	HOUR METER - SHORT TO GROUND
3382	PLATFORM LEVEL UP VALVE - SHORT TO GROUND
3383	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT
3384	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY
3388	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND
3389	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT
3390	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY
3394	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND
3395	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT
3396	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY
3397	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND
3398	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT
3399	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY
33100	JIB LIFT UP VALVE - SHORT TO GROUND
33101	JIB LIFT UP VALVE - OPEN CIRCUIT
33102	JIB LIFT UP VALVE - SHORT TO BATTERY
33103	JIB LIFT DOWN VALVE - SHORT TO GROUND
33104	JIB LIFT DOWN VALVE - OPEN CIRCUIT
33105	JIB LIFT DOWN VALVE - SHORT TO BATTERY
33106	TOWER LIFT UP VALVE - SHORT TO GROUND
33107	TOWER LIFT UP VALVE - OPEN CIRCUIT
33109	TOWER LIFT DOWN VALVE - SHORT TO GROUND
33110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT
33118	SWING RIGHT VALVE - SHORT TO GROUND
33119	SWING RIGHT VALVE - OPEN CIRCUIT
33120	TELESCOPE IN VALVE - SHORT TO BATTERY
33122	SWING LEFT VALVE - SHORT TO GROUND
33123	TELESCOPE OUT VALVE - SHORT TO BATTERY
33130	THROTTLE ACTUATOR - SHORT TO GROUND
33131	THROTTLE ACTUATOR - OPEN CIRCUIT
33132	THROTTLE ACTUATOR - SHORT TO BATTERY
33182	LIFT VALVES - SHORT TO BATTERY
33186	TELESCOPE OUT VALVE - OPEN CIRCUIT
33188	TELESCOPE OUT VALVE - SHORT TO GROUND
33189	TELESCOPE IN VALVE - OPEN CIRCUIT
33190	TELESCOPE IN VALVE - SHORT TO GROUND
33279	GLOWPLUG - OPEN CIRCUIT
33280	GLOWPLUG - SHORT TO BATTERY
33281	GLOWPLUG - SHORT TO GROUND

SECTION 6 - JLG CONTROL SYSTEM

Table 6-8. Fault Code List

DTC	Text
33287	LIFT - CURRENT FEEDBACK READING TOO LOW
33295	SWING LEFT VALVE - OPEN CIRCUIT
33314	FLOW CONTROL VALVE - OPEN CIRCUIT
33315	FLOW CONTROL VALVE - SHORT TO BATTERY
33316	FLOW CONTROL VALVE - SHORT TO GROUND
33317	DRIVE FORWARD VALVE - OPEN CIRCUIT
33318	DRIVE FORWARD VALVE - SHORT TO BATTERY
33319	DRIVE FORWARD VALVE - SHORT TO GROUND
33320	DRIVE REVERSE VALVE - OPEN CIRCUIT
33322	DRIVE REVERSE VALVE - SHORT TO GROUND
33331	DRIVE - CURRENT FEEDBACK READING TOO LOW
33406	LIFT UP VALVE - SHORT TO GROUND
33410	DRIVE - CURRENT FEEDBACK READING LOST
33412	SWING VALVES - SHORT TO BATTERY
33413	TOWER LIFT - CURRENT FEEDBACK READING TOO LOW
33414	SWING - CURRENT FEEDBACK READING TOO LOW
33415	FLOW CONTROL VALVE - CURRENT FEEDBACK READING TOO LOW
33416	TOWER LIFT - CURRENT FEEDBACK READING LOST
33417	LIFT - CURRENT FEEDBACK READING LOST
33418	SWING - CURRENT FEEDBACK READING LOST
33419	FLOW CONTROL VALVE - CURRENT FEEDBACK READING LOST
33420	TRACTION LOCK VALVE - SHORT TO BATTERY
33421	TRACTION LOCK VALVE - OPEN CIRCUIT
33422	TRACTION LOCK VALVE - SHORT TO GROUND
33423	OSCILLATING AXLE VALVES - SHORT TO BATTERY
33424	OSCILLATING AXLE VALVES - SHORT TO GROUND
33425	TOWER LIFT VALVES - SHORT TO BATTERY
342	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY
343	PLATFORM LEVEL UP VALVE - SHORT TO GROUND
345	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT
346	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY
347	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND
349	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT
3410	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY
3411	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND
3412	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT
3413	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY
3414	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND
3415	JIB LIFT UP VALVE - OPEN CIRCUIT
3416	JIB LIFT UP VALVE - SHORT TO BATTERY
3417	JIB LIFT UP VALVE - SHORT TO GROUND
3418	JIB LIFT DOWN VALVE - OPEN CIRCUIT
3419	JIB LIFT DOWN VALVE - SHORT TO BATTERY

Table 6-8. Fault Code List

DTC	Text
3420	JIB LIFT DOWN VALVE - SHORT TO GROUND
431	FUEL SENSOR - SHORT TO BATTERY
432	FUEL SENSOR - SHORT TO GROUND
433	OIL PRESSURE - SHORT TO BATTERY
434	OIL PRESSURE - SHORT TO GROUND
435	COOLANT TEMPERATURE - SHORT TO GROUND
437	ENGINE TROUBLE CODE
438	HIGH ENGINE TEMP
4310	NO ALTERNATOR OUTPUT
4311	LOW OIL PRESSURE
4313	THROTTLE ACTUATOR FAILURE
4314	WRONG ENGINE SELECTED - ECM DETECTED
4322	LOSS OF ENGINE SPEED SENSOR
4323	SPEED SENSOR READING INVALID SPEED
4326	FUEL ACTUATOR - SHORT TO GROUND
4327	FUEL ACTUATOR - OPEN CIRCUIT
4328	FUEL ACTUATOR - SHORT TO BATTERY
4329	FUEL ACTUATOR - CURRENT FEEDBACK READING TOO LOW
4330	FUEL ACTUATOR - CURRENT FEEDBACK READING LOST
441	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN
442	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN
443	LSS BATTERY VOLTAGE TOO HIGH
444	LSS BATTERY VOLTAGE TOO LOW
445	BATTERY VOLTAGE LOW
662	CANBUS FAILURE - PLATFORM MODULE
663	CANBUS FAILURE - LOAD SENSING SYSTEM MODULE
666	CANBUS FAILURE - ENGINE CONTROLLER
6613	CANBUS FAILURE - EXCESSIVE CANBUS ERRORS
6622	CANBUS FAILURE - TCU MODULE
6629	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH
681	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP
813	CHASSIS TILT SENSOR NOT CALIBRATED
814	CHASSIS TILT SENSOR OUT OF RANGE
815	CHASSIS TILT SENSOR DISAGREEMENT
821	LSS CELL #1 ERROR
822	LSS CELL #2 ERROR
823	LSS CELL #3 ERROR
824	LSS CELL #4 ERROR
825	LSS HAS NOT BEEN CALIBRATED
826	RUNNING AT CREEP - PLATFORM OVERLOADED
827	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED
828	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED
8211	LSS READING UNDER WEIGHT

SECTION 6 - JLG CONTROL SYSTEM

Table 6-8. Fault Code List

DTC	Text
8639	FRONT LEFT STEER VALVE - OPEN CIRCUIT
8640	FRONT LEFT STEER VALVE - SHORT TO BATTERY
8641	FRONT LEFT STEER VALVE - SHORT TO GROUND
8642	FRONT RIGHT STEER VALVE - OPEN CIRCUIT
8643	FRONT RIGHT STEER VALVE - SHORT TO BATTERY
8644	FRONT RIGHT STEER VALVE - SHORT TO GROUND
8669	OSCILLATING AXLE SWITCH DISAGREEMENT
991	LSS WATCHDOG RESET
992	LSS EEPROM ERROR
993	LSS INTERNAL ERROR - PIN EXCITATION
994	LSS INTERNAL ERROR - DRDY MISSING FROM A/D
998	EEPROM FAILURE - CHECK ALL SETTINGS
9910	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER
9911	FUNCTIONS LOCKED OUT - LSS MODULE SOFTWARE VERSION IMPROPER
9915	CHASSIS TILT SENSOR NOT GAIN CALIBRATED
9919	GROUND SENSOR REF VOLTAGE OUT OF RANGE
9920	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE
9921	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY
9922	PLATFORM MODULE FAILURE - HWFS CODE 1
9924	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED
9927	GROUND MODULE CONSTANT DATA UPDATE REQUIRED
9944	CURRENT FEEDBACK GAINS OUT OF RANGE
9945	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT
9949	MACHINE CONFIGURATION OUT OF RANGE - CHECK ALL SETTINGS
9977	LSS CORRUPT EEPROM
9979	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER
9986	GROUND MODULE VLOW FET FAILURE

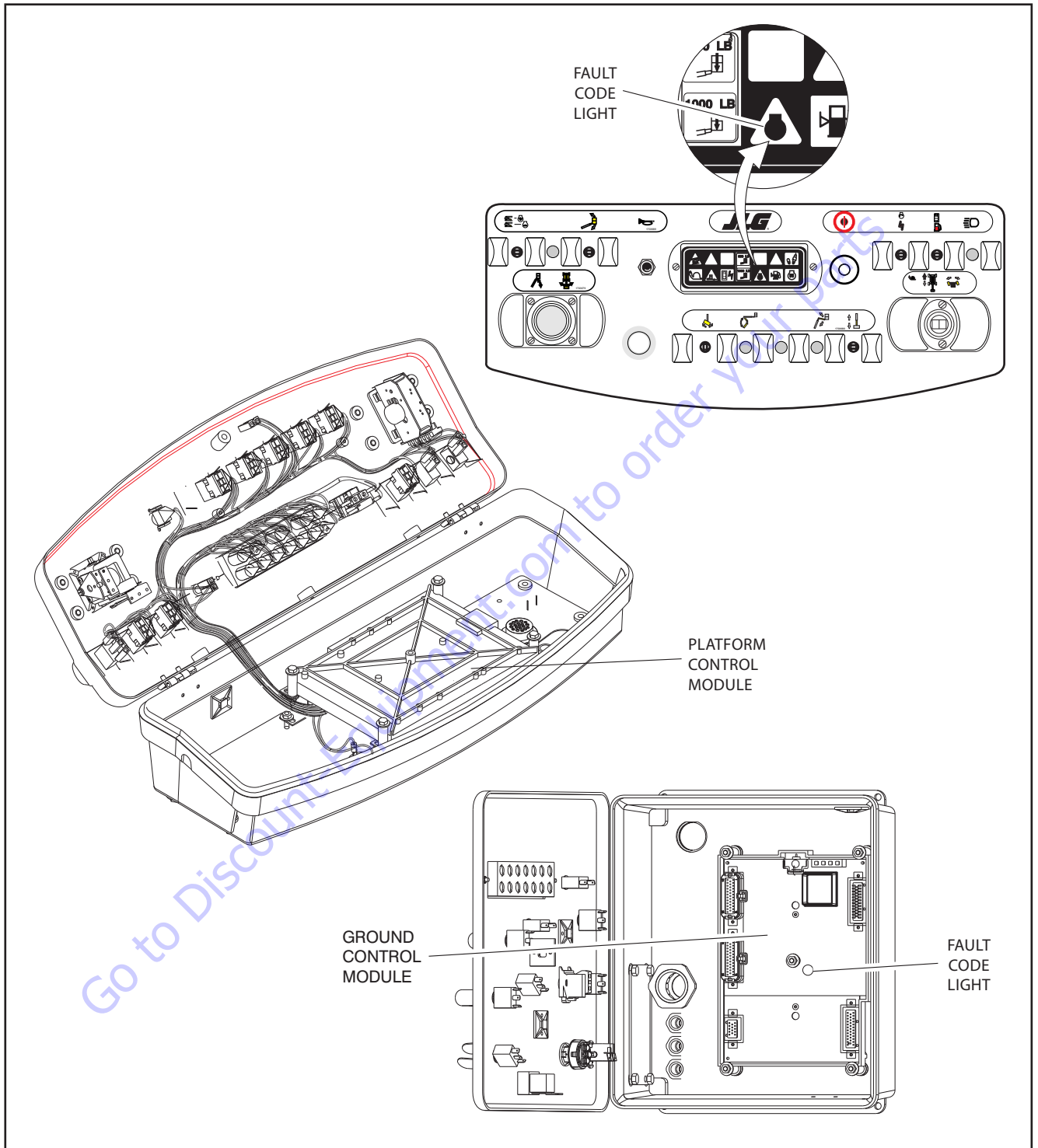


Figure 6-9. Control Module Locations

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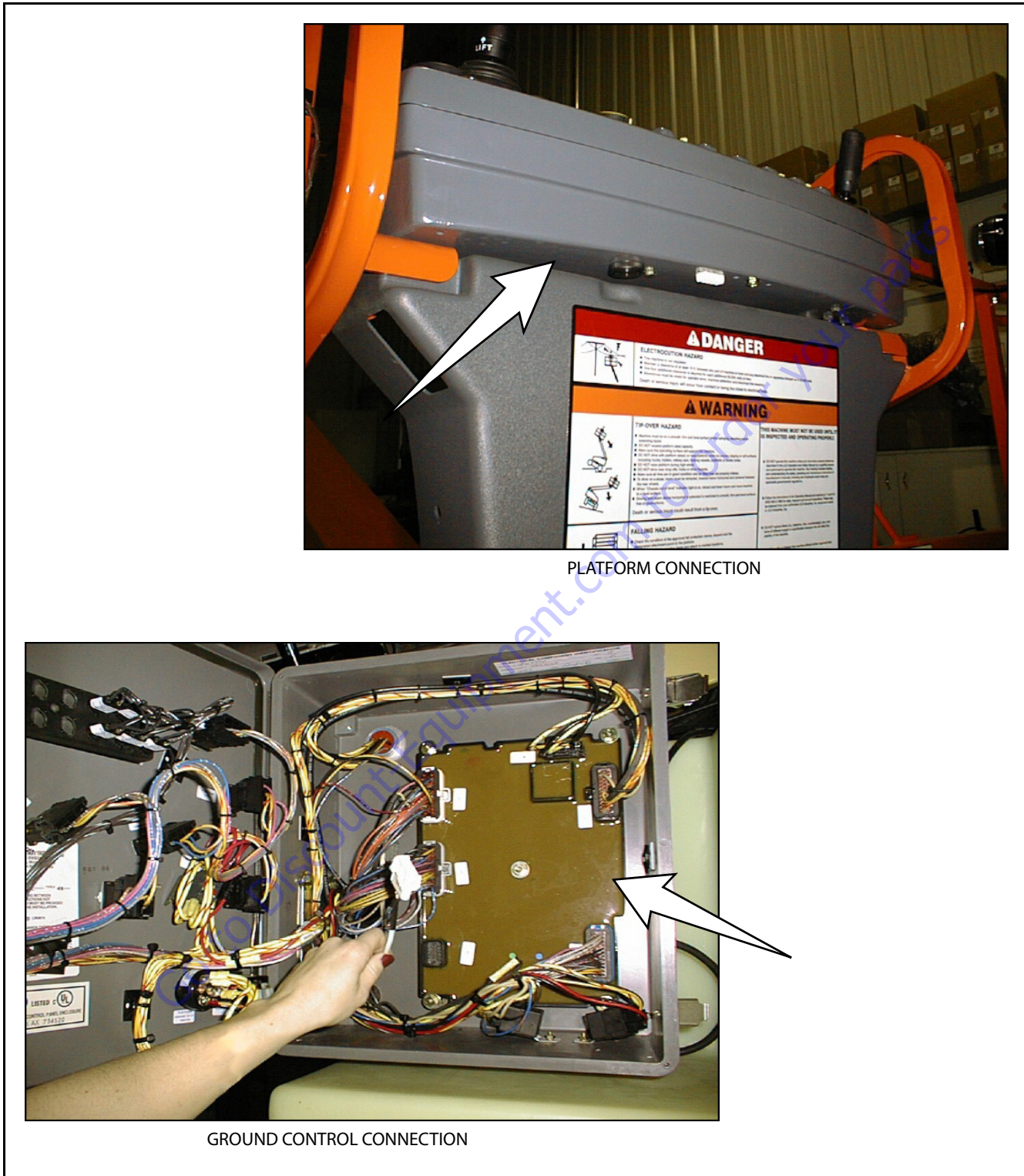


Figure 6-10. Analyzer Connecting Points

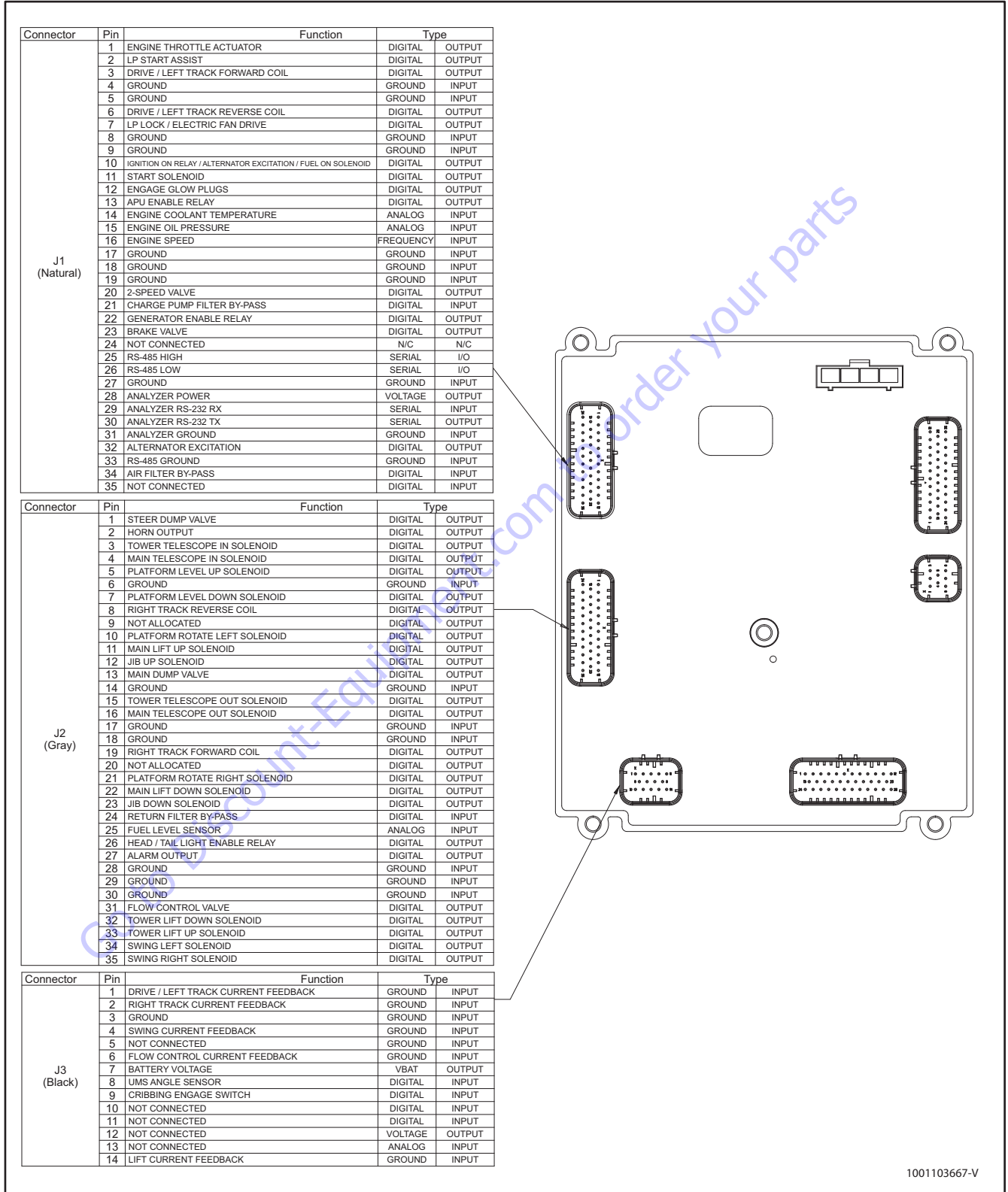


Figure 6-11. Ground Control Module Pin Connections 1 of 3

1001103667-V

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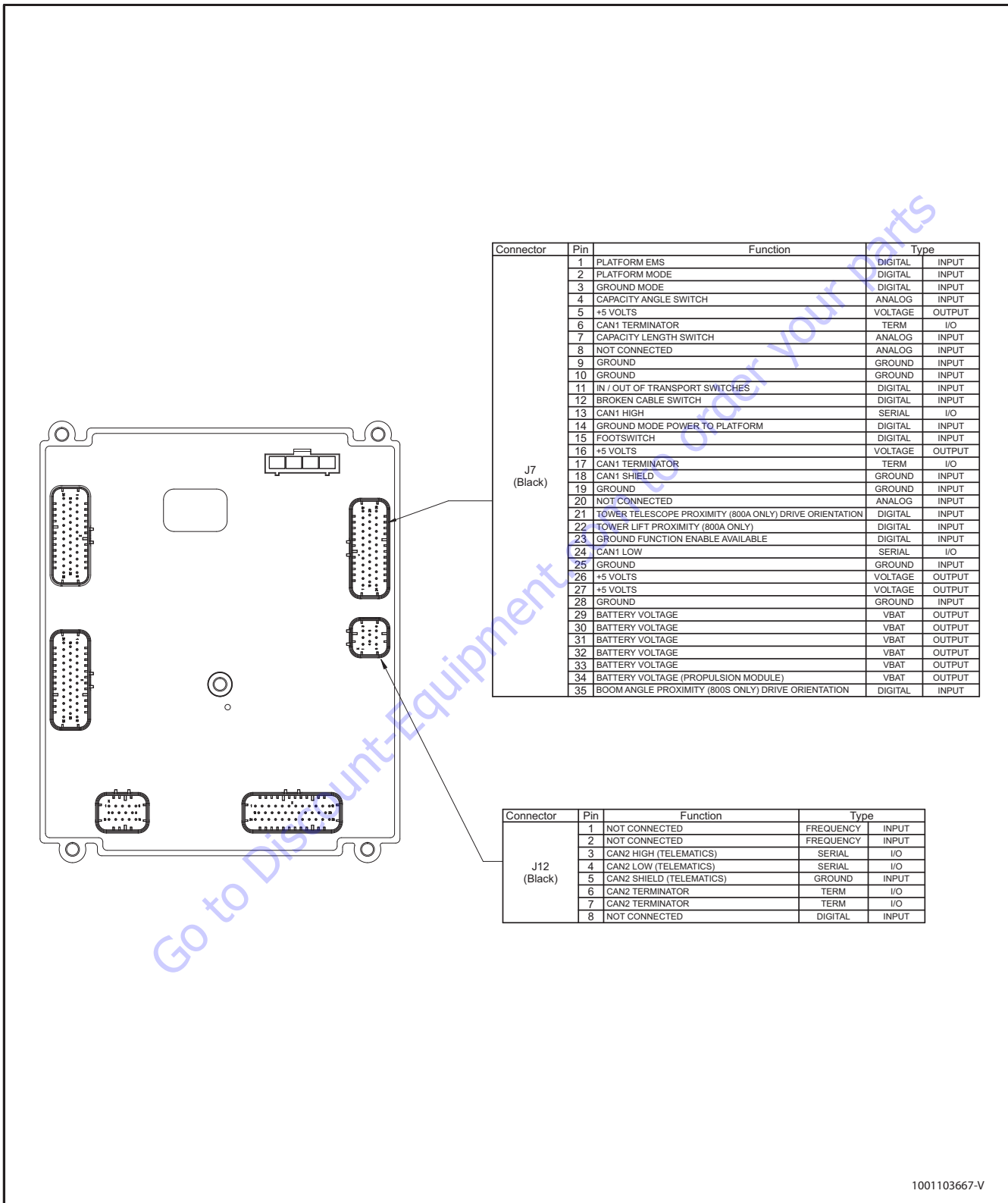
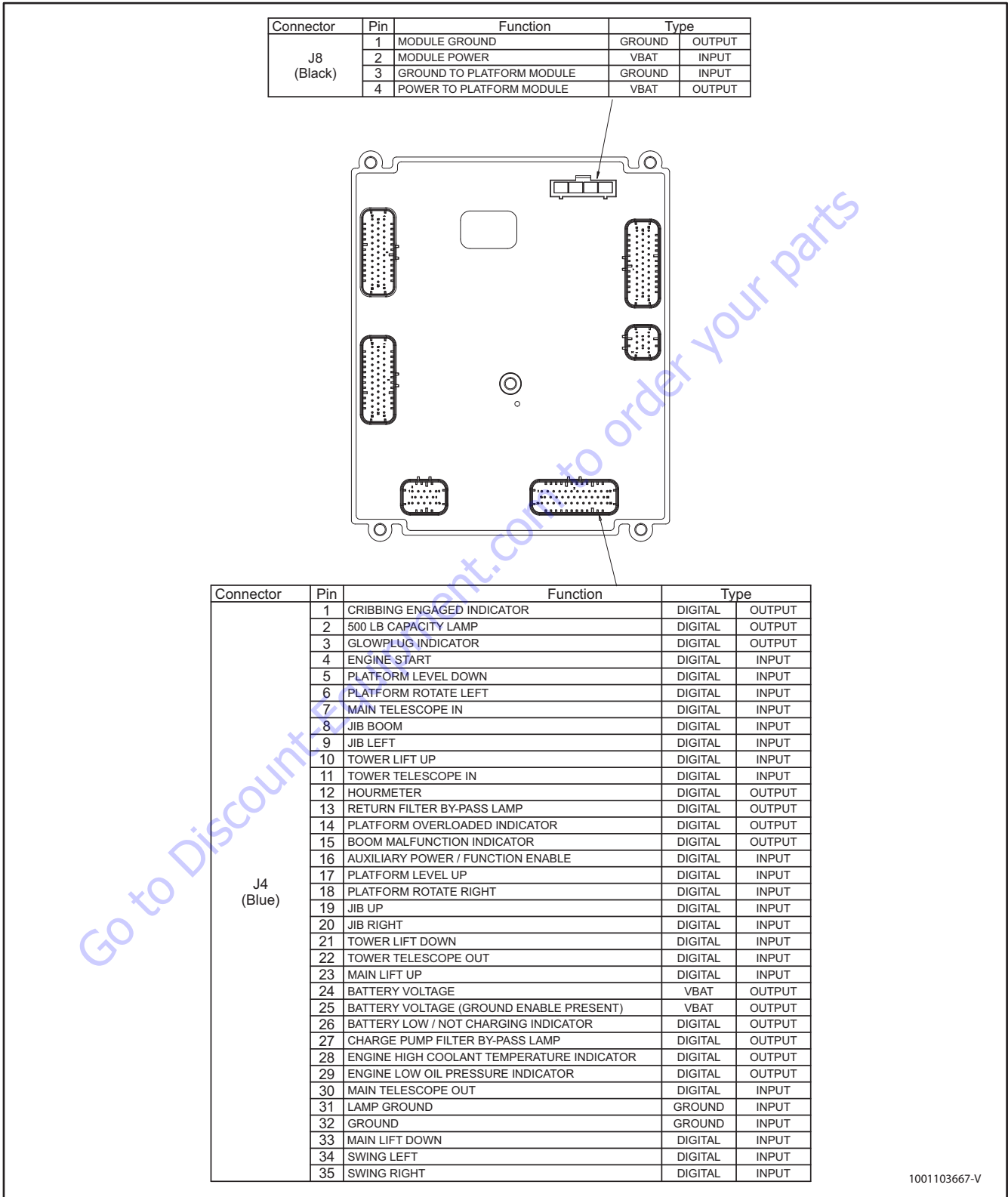


Figure 6-12. Ground Control Module Pin Connections 2 of 3



1001103667-V

Figure 6-13. Ground Control Module Pin Connections 3 of 3

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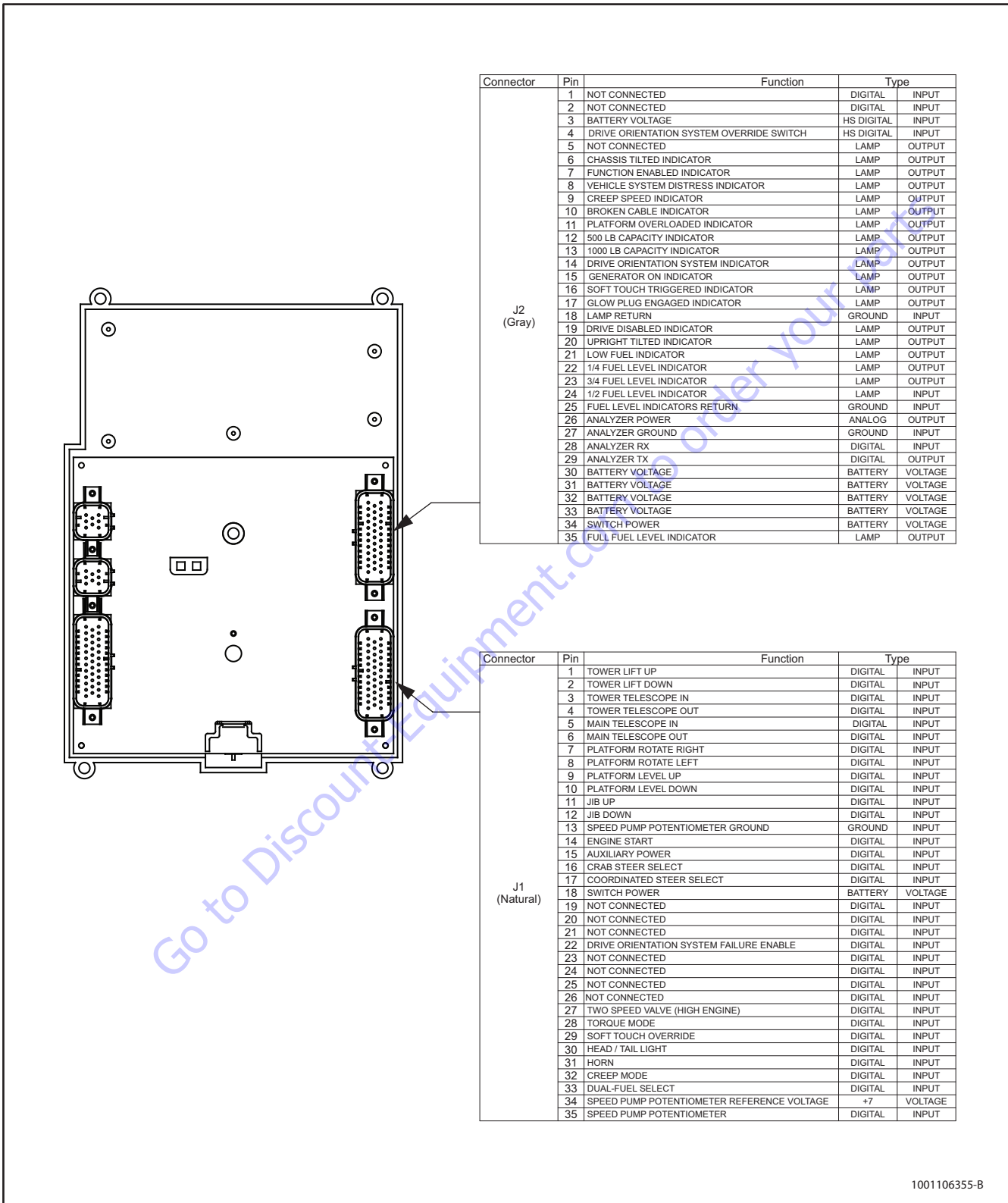


Figure 6-14. Platform Control Module Pin Connections 1 of 2

1001106355-B

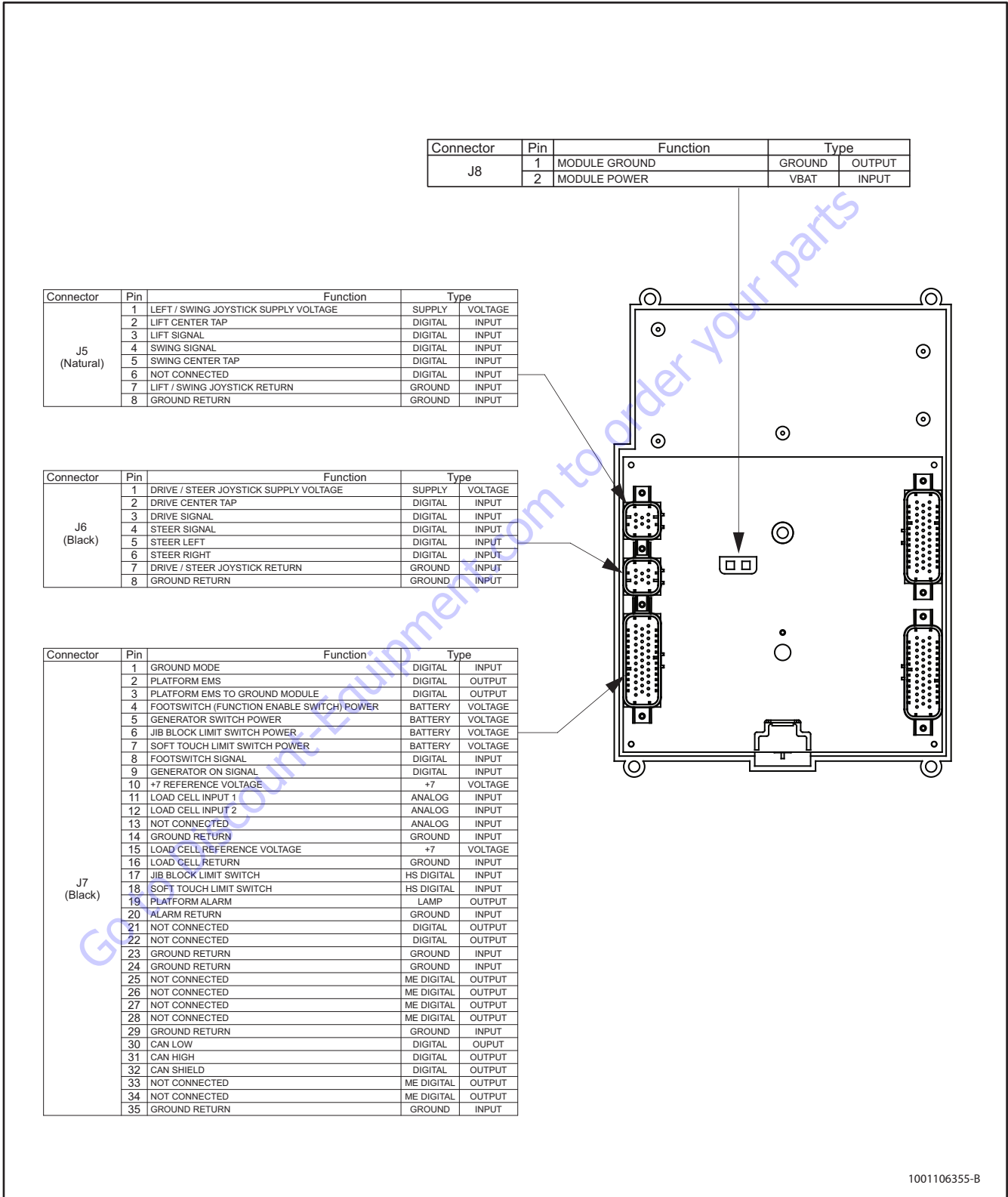


Figure 6-15. Platform Control Module Pin Connections 2 of 2

SECTION 7. BASIC ELECTRICAL INFORMATION & SCHEMATICS

7.1 GENERAL

This section contains basic electrical information and schematics for locating and correcting most electrical problems. If a problem develops which is not presented in this section or corrected by listed corrective actions, obtain technically qualified guidance before proceeding with any additional maintenance.

NOTE: Some procedures/connectors shown in this section may not apply to all models.

7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

Min/Max

"Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read voltage applied to a solenoid when it is only operational while a switch, far from the solenoid and meter, is held down.

Polarity

Getting a negative Voltage or current reading when expecting a positive reading frequently means the leads are reversed. Check what reading is expected, location of the signal and leads are correctly connected to the device under test. Also check the lead on the "COM" port goes to the ground or negative side of the signal and lead on the other port goes to the positive side of the signal.

Scale

M = Mega = 1,000,000 * (Displayed Number)

k = kilo = 1,000 * (Displayed Number)

m = milli = (Displayed Number) / 1,000

μ = micro = (Displayed Number) / 1,000,000

Example: 1.2 k Ω = 1200 Ω

Example: 50 mA = 0.05 A

Voltage Measurement

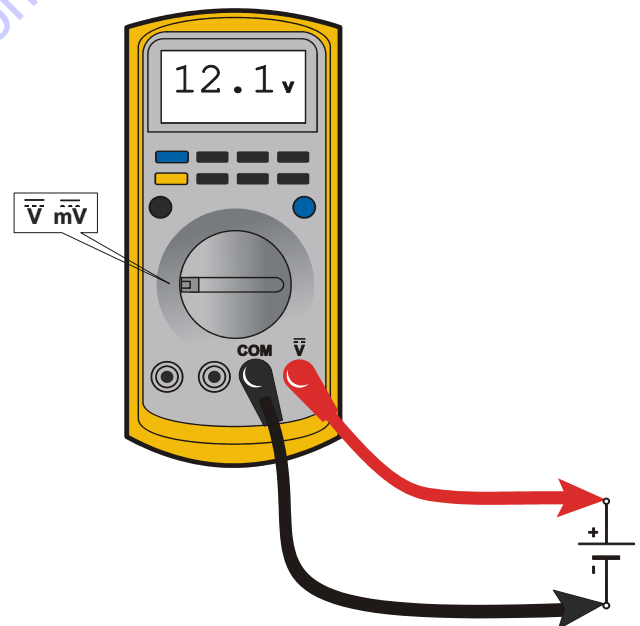


Figure 7-1. Voltage Measurement (DC)

- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)
- Use firm contact with meter leads

Resistance Measurement

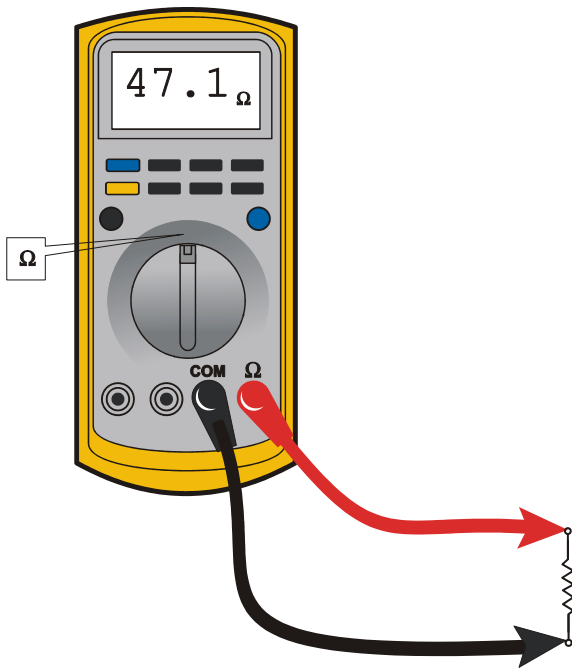


Figure 7-2. Resistance Measurement

- First test meter and leads by touching leads together. Resistance should read a short circuit (very low resistance)
- Circuit power must be turned OFF before testing resistance
- Disconnect component from circuit before testing
- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)
- Use firm contact with meter leads

Continuity Measurement

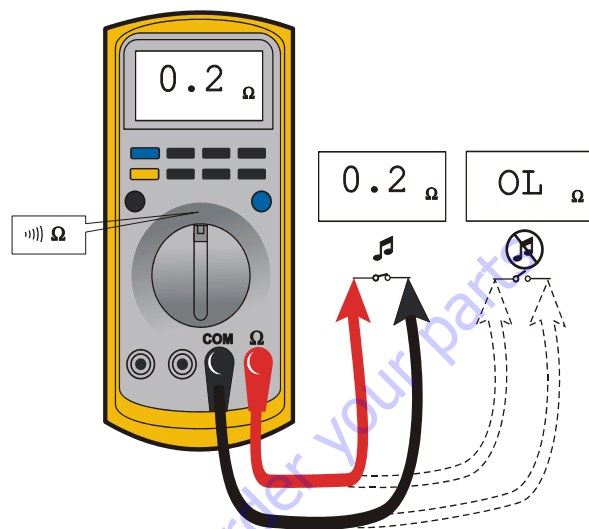


Figure 7-3. Continuity Measurement

- Some meters require a separate button press to enable audible continuity testing
- Circuit power must be turned OFF before testing continuity
- Disconnect component from circuit before testing
- Use firm contact with meter leads
- First test meter and leads by touching leads together. Meter should produce an audible alarm, indicating continuity

Current Measurement

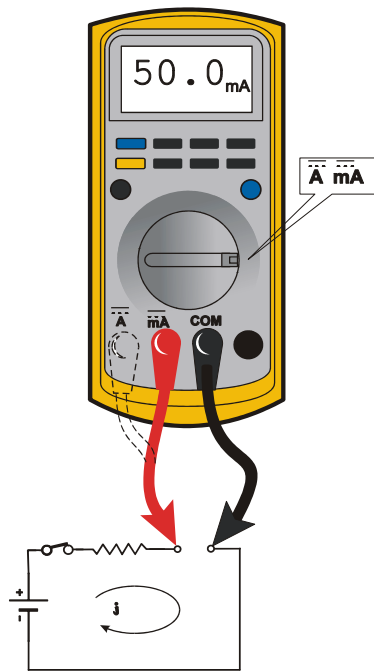


Figure 7-4. Current Measurement (DC)

- Set up meter for expected current range
- Be sure to connect meter leads to correct jacks for selected current range
- If meter is not auto ranging, set it to correct range (See multi meter's operation manual)
- Use firm contact with meter leads

7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

NOTE: This section is not applicable for battery terminals.

NOTICE

JLG P/N 0100048 DIELECTRIC GREASE (NOVAGARD G661) IS THE ONLY MATERIAL APPROVED FOR USE AS A DIELECTRIC GREASE.

NOTE: Do NOT apply dielectric grease to the following connections:

- Main Boom Rotary sensor connections (on Celesco Sensor),
- LSS Modules connections,
- Deutz EMR 2 ECM connection.

Silicone Dielectric Compound must be used on all electrical connections except for those mentioned above for the following reasons:

- To prevent oxidation at mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors. This procedure applies to all plug connections not enclosed in a box. Silicone grease should not be applied to connectors with external seals.

1. To prevent oxidation, silicone grease must be packed completely around male and female pins on the inside of the connector prior to assembly. This is most easily achieved by using a syringe.

NOTE: Over a period of time, oxidation increases electrical resistance at the connection, eventually causing circuit failure.

2. To prevent shorting, silicone grease must be packed around each wire where they enter the outside of the connector housing. Also, silicone grease must be applied at the joint where the male and female connectors come together. Any other joints (around strain reliefs, etc.) where water could enter the connector should also be sealed.

NOTE: This condition is especially common when machines are pressure washed since the washing solution is much more conductive than water.

3. Anderson connectors for battery boxes and battery chargers should have silicone grease applied to contacts only.

NOTE: Curing-type sealants can also be used to prevent shorting and would be less messy, but make future pin removal difficult.

When applied to electrical connections, dielectric grease helps prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from application of dielectric grease.

Dielectric grease shall be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

Dielectric Grease Application

Before following these instructions, refer to excluded connector types (See Exclusions below).

1. Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
2. Apply dielectric grease to the female contact (fill it approximately 1/2 full; see example below)
3. Leave a thin layer of dielectric grease on connector face.
4. Assemble connector system immediately to prevent moisture or dust contamination
5. Pierce one of the unused wire seals before assembly if the connector system tends to trap air (i.e. AMP Seal) and then install a seal plug.

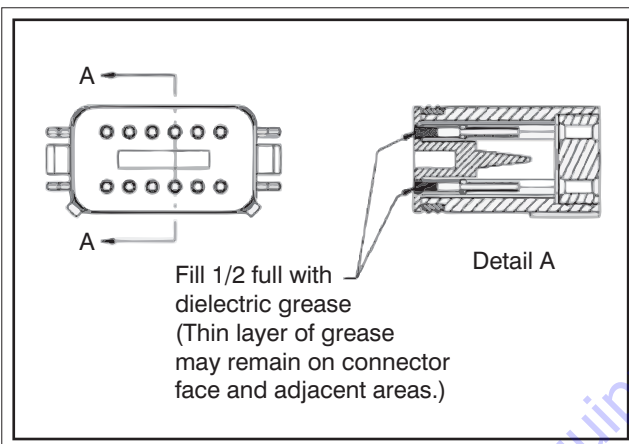


Figure 7-5. Applying Dielectric Grease

Deutsch HD, DT, DTM, DRC Series

The Deutsch connector system is commonly used for harsh environments. Follow installation instructions.



Figure 7-6. Deutsch Connector

AMP Seal

The AMP Seal connector system is used on Control ADE Platform and Ground Modules.

Apply dielectric grease to the female contact. If trapped air prevents connector from latching, pierce one of the unused wire seals.



Figure 7-7. Dielectric Grease On Female Contacts

After assembly, install a seal plug (JLG #4460905) to keep out moisture. Seal plugs may also be installed by the wire harness manufacturer if an unused wire seal was damaged during assembly.

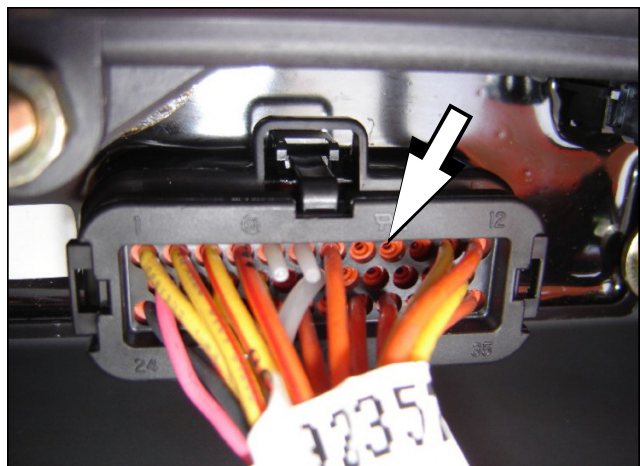


Figure 7-8. Seal Plugs

AMP Mate-N-Lok

Follow manufacturer installation instructions.

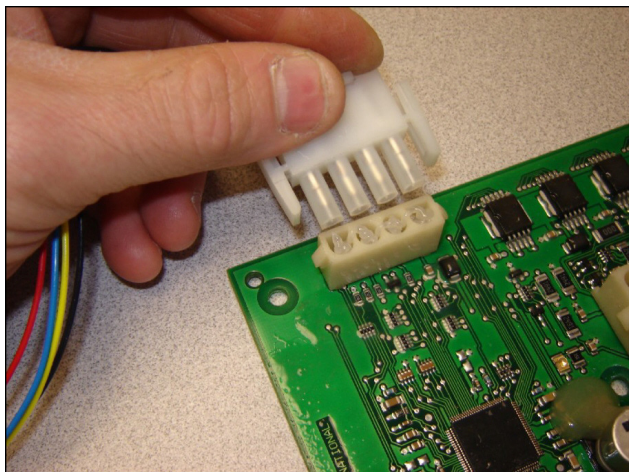


Figure 7-9. AMP Mate-N-Lok Connector

DIN Connectors

This connector is typically used on hydraulic valves. Follow manufacturer installation instructions.



Figure 7-10. DIN Connector

Exclusions

Some connectors do not require or may be permanently damaged by application of dielectric grease. Dielectric grease may not be required in properly sealed enclosures.

NOTICE

DO NOT USE DIELECTRIC GREASE ON BRAD HARRISON/PHOENIX CONTACT M12 OR AMP JUNIOR TIMER CONNECTORS. LOW-FORCE CONTACTS CANNOT DISPLACE DIELECTRIC GREASE AND CREATE ELECTRICAL CONTACT.

BRAD HARRISON/PHOENIX CONTACT M12

This connector uses gold contact material to resist corrosion and an O-ring seal for moisture integrity. Low-force contacts cannot displace dielectric grease to achieve electrical contact. Once contaminated, replacement of female contacts is required. The JLG Load Sensing System and 1250AJP Rotary Angle Sensors are examples of components with the M12 connector system.



Figure 7-11. Brad Harrison/Phoenix Connectors

AMP JUNIOR TIMER

This type of connector uses back-seals to keep out moisture. Low-force contacts cannot displace dielectric grease and create electrical contact. Use solvents (i.e. contact cleaner or mineral spirits) to remove dielectric grease. The Deutz EMR2 engine control module uses this connector.

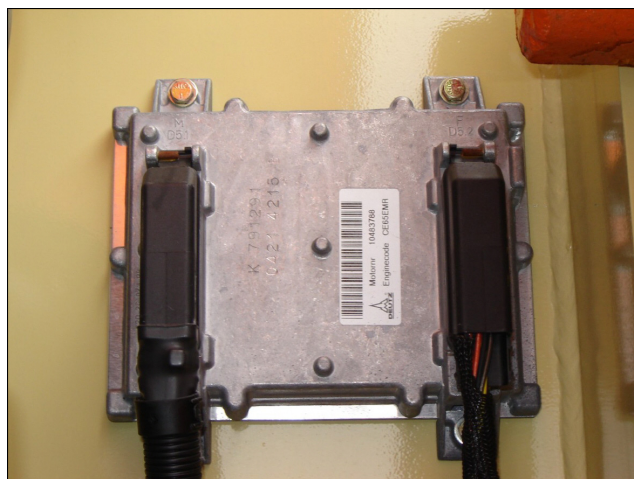


Figure 7-12. AMP Junior Timer

7.4 AMP CONNECTOR

Plug and header assembly colors are mechanically keyed to mate only with identical colors.

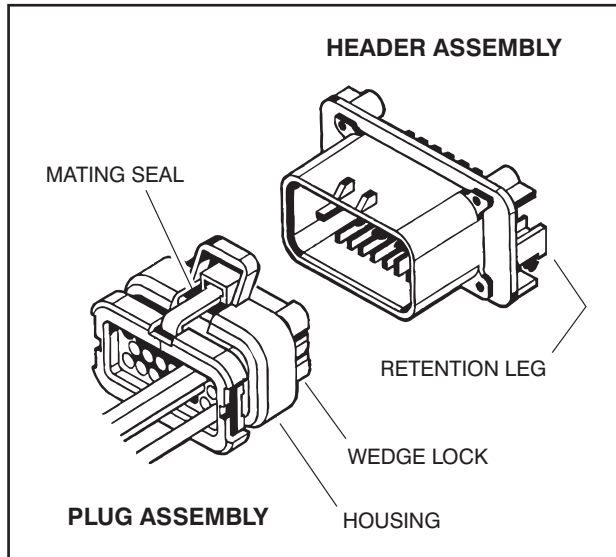


Figure 7-13. AMP Connector

Contact Assembly

1. Strip wire and install in crimp end of connector as shown in Figure 7-14.
2. Crimp connector. Do not damage cutoff tab.

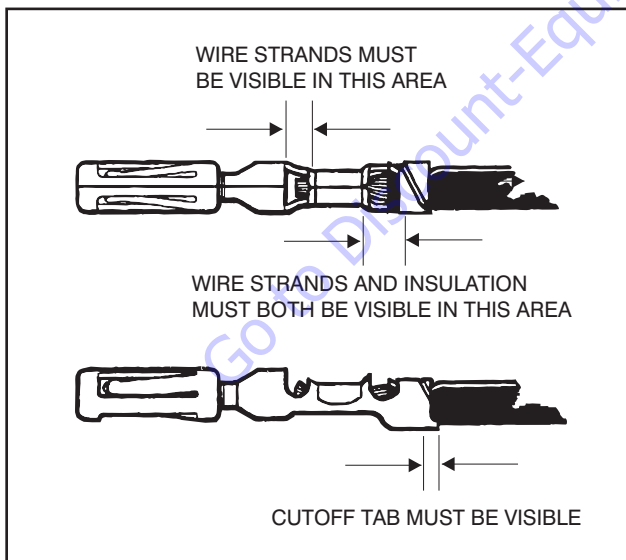


Figure 7-14. AMP Contact Assembly

Connector Assembly

1. Check wedge lock is in the open, or as-shipped, position.

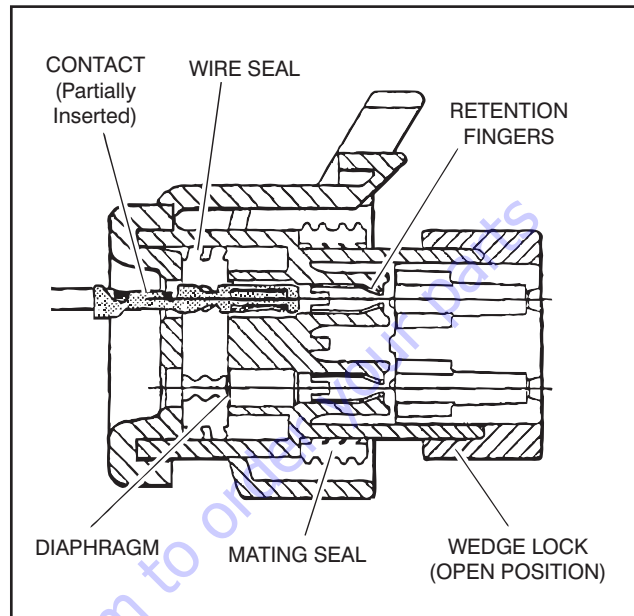


Figure 7-15. AMP Connector Assembly

2. Push contact straight into circuit cavity as far as it will go.
3. Pull on contact wire with a force of 1 - 2 lb to be sure retention fingers are holding contact.

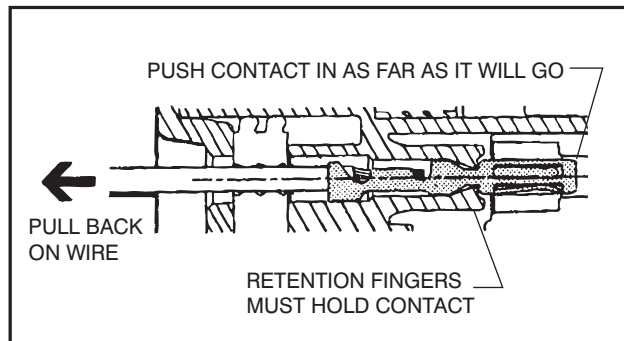


Figure 7-16. AMP Contact Installation

4. After all contacts are inserted, close wedge lock to its locked position. Release locking latches by squeezing them inward.

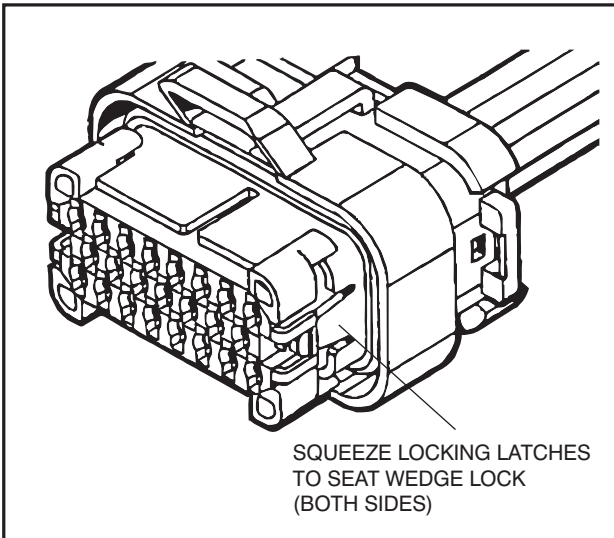


Figure 7-17. Close Wedge Lock

5. Slide wedge lock in housing until flush with housing.

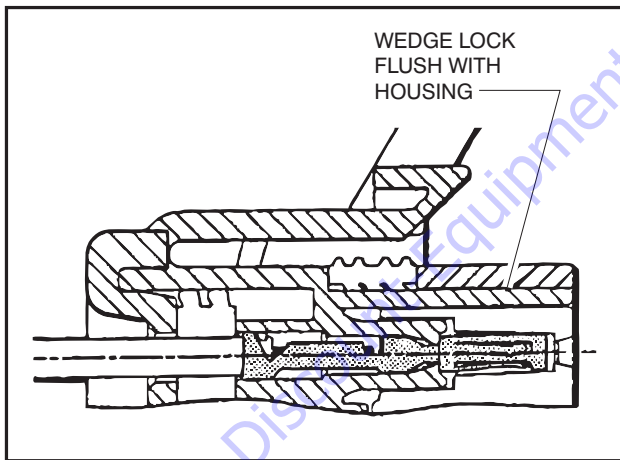


Figure 7-18. Seating Wedge Lock

Disassembly

1. Insert a 4.8 mm (3/16") wide screwdriver blade between mating seal and one of red wedge lock tabs.
2. Pry wedge lock open.
3. While rotating wire back and forth over a half turn (1/4 turn in each direction), gently pull wire until contact is removed.

NOTE: Wedge lock should never be removed from housing for insertion or removal of contacts.

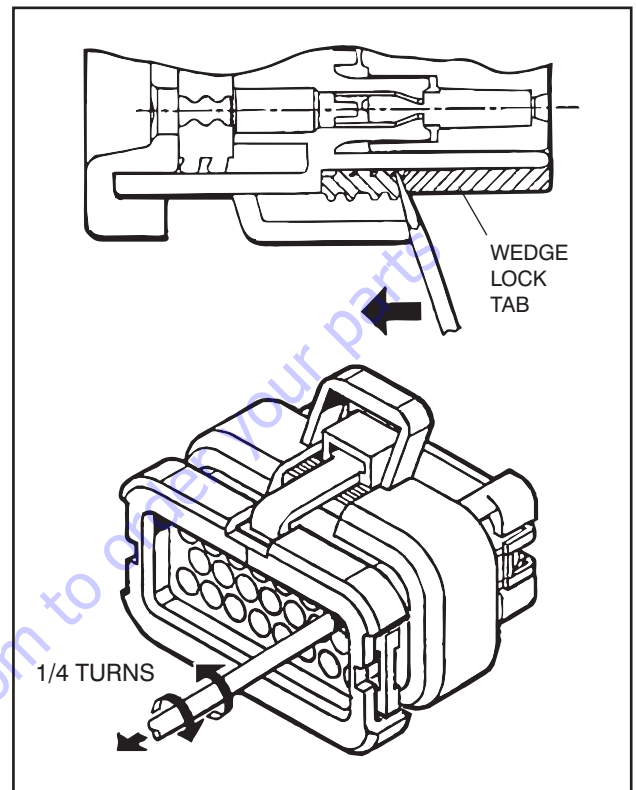


Figure 7-19. AMP Connector Disassembly

Wedge Lock

The wedge lock has slotted openings in the forward, or mating end. These slots accommodate circuit testing in the field by using a flat probe such as a pocket knife. DO NOT use a sharp point such as an ice pick.

Service - Voltage Reading

NOTICE

HOLES IN WIRE INSULATION CAN LET IN MOISTURE AND CAUSE SYSTEM FAILURE. DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing insulation with a sharp point. This practice should be discouraged when dealing with an AMPSEAL plug assembly or any other sealed connector system. Resulting pinholes in the insulation allows moisture to enter by traveling along wire strands and could result in system failure.

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

1. Grasp crimped contact (1) about 25mm behind contact barrel.
2. Hold connector with rear grommet (2) facing you.
3. Push contact straight into connector grommet (3) until a click is felt. A slight tug confirms it is locked in place.
4. Once all contacts are in place, insert wedgelock (4) with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. They may go in either way.

NOTE: Receptacle shown - use same procedure for plug.

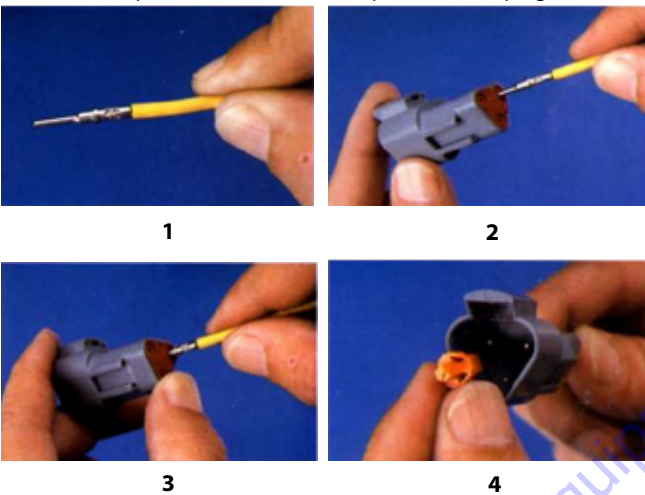


Figure 7-20. DT/DTP Contact Installation

DT/DTP Series Disassembly

1. Remove wedgelock (1) using needle-nose pliers or a hook shaped wire to pull wedge straight out.
2. To remove contacts, gently pull wire backwards at the same time releasing the locking finger (2) by moving it away from contact with a screwdriver.
3. Hold rear seal (3) in place. Removing contact may displace seal.

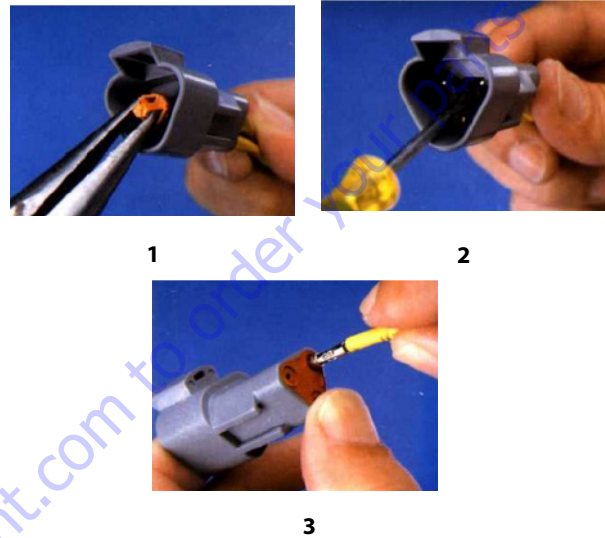


Figure 7-21. DT/DTP Contact Removal

HD30/HDP20 Series Assembly

1. Grasp contact (1) about 25mm behind contact crimp barrel.
2. Hold connector with rear grommet (2) facing you.

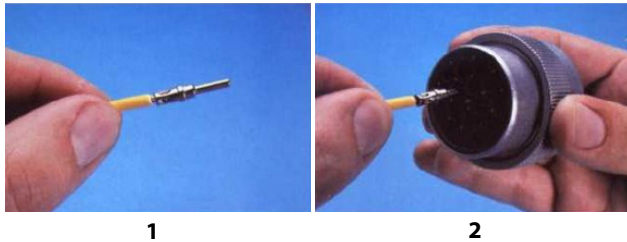


Figure 7-22. HD/HDP Contact Installation

3. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm it is locked in place.

LOCKING FINGERS

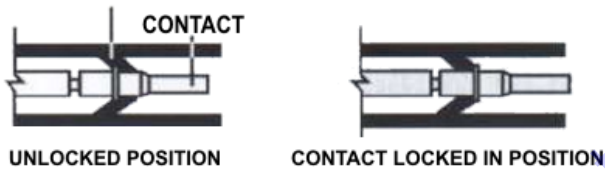


Figure 7-23. HD/HDP Locking Contacts Into Position

NOTE: Insert sealing plugs in unused wire cavities for full environmental sealing.

HD30/HDP20 Series Disassembly

1. With rear insert toward you, snap appropriate size extractor tool (1) over wire of contact to be removed.
2. Push tool in the insert cavity (2) until it engages contact and resistance is felt.

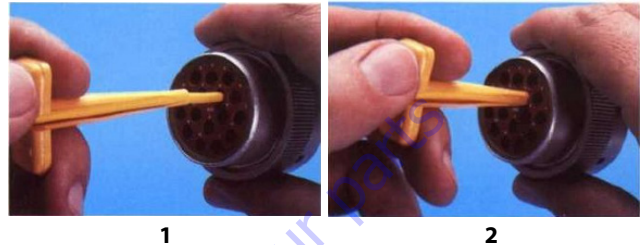


Figure 7-24. HD/HDP Contact Removal

3. Pull contact-wire assembly out of connector

NOTE: Do Not twist or insert tool at an angle.

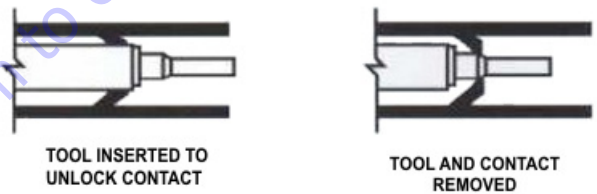


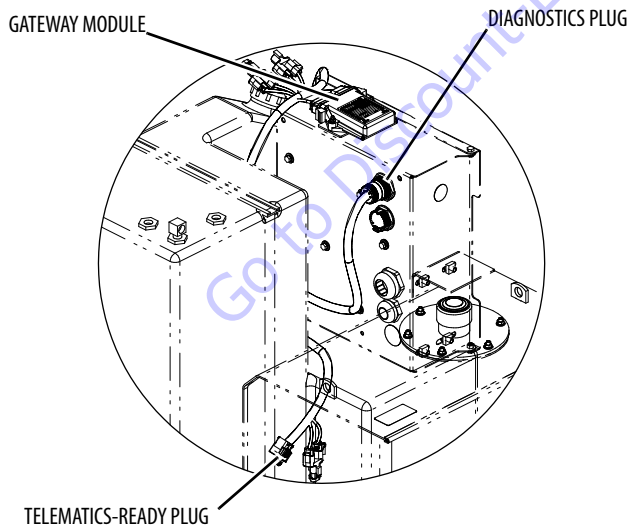
Figure 7-25. HD/HDP Unlocking Contacts

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

7.6 TELEMATICS GATEWAY

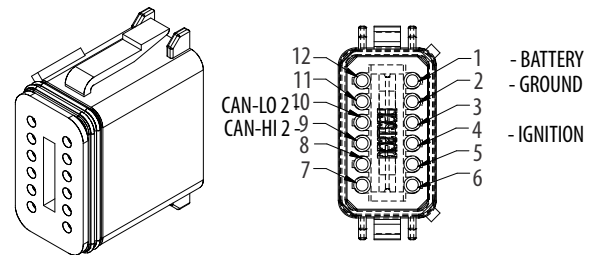
Personnel using machines equipped with an optional telematics gateway will be able to view the following data through their telematics device:

JLG LABEL	DESCRIPTION	UNIT
Engine Speed	Actual engine speed.	RPM
DEF Tank Level (If Equipped)	Indicates the level of DEF (diesel exhaust fluid) within the DEF tank if the machine is equipped with DEF tank. <ul style="list-style-type: none"> • 0% = Empty • 100% = Full 	Percentage (%)
JLG Machine Faults: Active / Not-Active	<ul style="list-style-type: none"> • 00 - No Machine Faults • 01 - Active Machine Fault • 10 - Error • 11 - Not available 	Bit
Total Idle Fuel Used	Total amount of fuel used during vehicle operation during idle conditions.	Liters
Total Idle Hours	Total time of engine operation during idle conditions.	Seconds
Total Engine Hours	Total time of engine operation.	Seconds
Total Fuel Used	Total amount of fuel used during vehicle operation.	Liters
Fuel Rate	Amount of fuel consumed by engine per unit of time.	Liters/Hour
Fuel Level	Ratio of fuel volume to the total volume of the fuel storage container. When a low fuel limit switch is present, the fuel level will indicate "full" until the switch opens, which will then indicate 10% fuel remaining. When Fuel Level 2 (SPN 38) is not used, Fuel Level 1 represents the total fuel in all fuel storage containers. When Fuel Level 2 is used, Fuel Level 1 represents the fuel level in the primary or left side fuel storage container.	Percentage (%)
DM1 Engine Faults	Shows actual engine fault codes.	N/A



Telematics-Ready (TCU) Plug

The telematics-ready (TCU) plug is a standard 12-pin Deutsch connector. Pin-out locations are shown below:



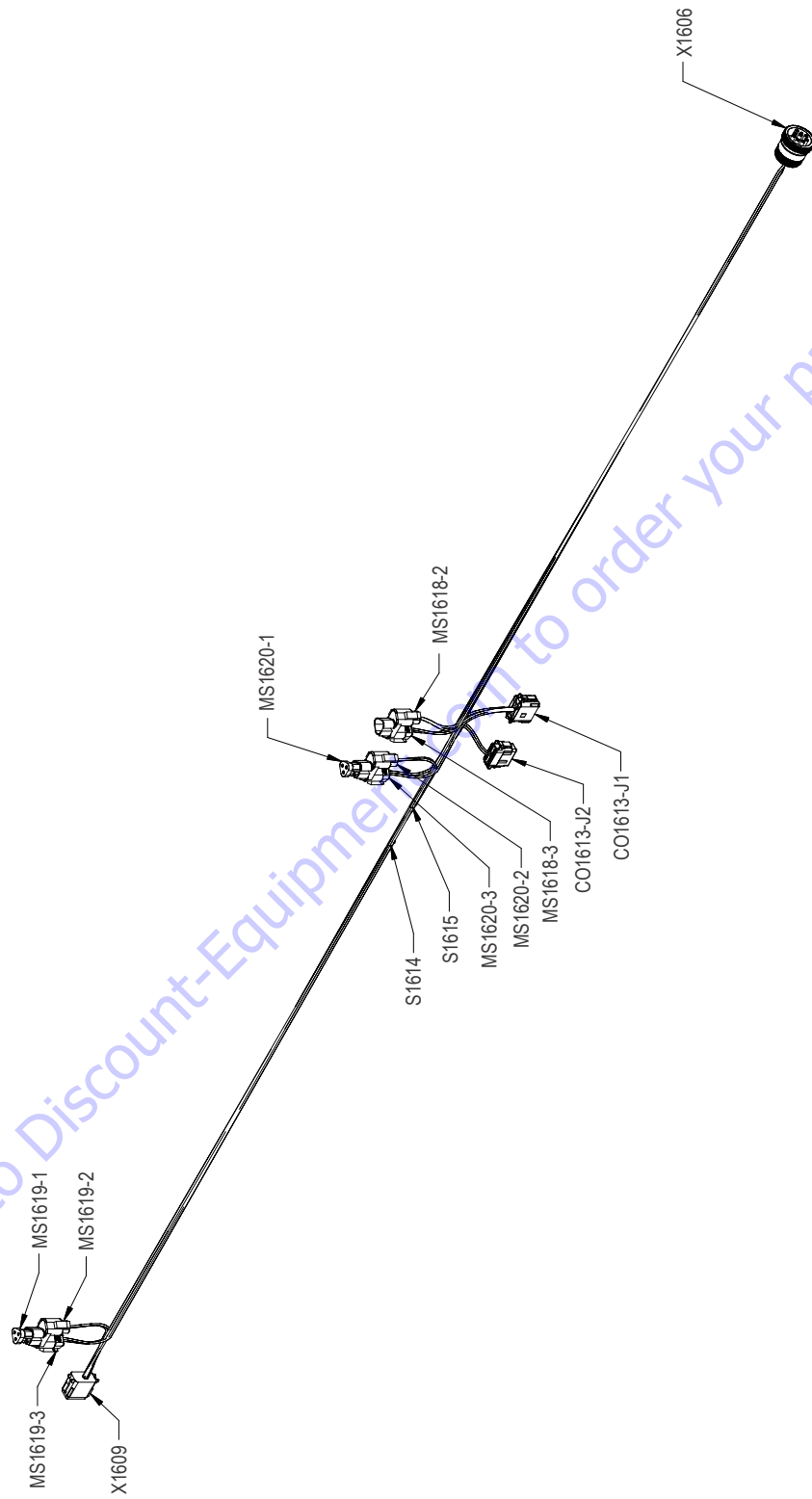


Figure 7-26. Telematics Gateway Harness

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X1609 (TCU)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-0 BAT	16 AWG	GXL	X1606 (B)
2	BLK	0-0 GND	16 AWG	GXL	S1615 (1)
4	ORN	2-0 IGN	16 AWG	GXL	S1614 (1)
9	GRN	CANL2	18 AWG	GXL	MS1619-2 (B)
10	YEL	CANH2	18 AWG	GXL	MS1619-2 (A)

MS1619-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	X1609 (10)
B	GRN	CANL2	18 AWG	GXL	X1609 (9)

MS1619-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1620-2 (A)
B	GRN	CANL2	18 AWG	GXL	MS1620-2 (B)

CO1613-J1 (GATEWAY 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CAN1	18 AWG	GXL	MS1618-2 (B)
10	YEL	CANH1	18 AWG	GXL	MS1618-2 (A)
11	BLK	0-2 GND	16 AWG	GXL	S1615 (2)
12	ORN	2-2 IGN	16 AWG	GXL	S1614 (2)

CO1613-J2 (GATEWAY 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CANL2	18 AWG	GXL	MS1620-3 (B)
10	YEL	CANH2	18 AWG	GXL	MS1620-3 (A)

MS1620-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1619-3 (A)
B	GRN	CANL2	18 AWG	GXL	MS1619-3 (B)

MS1620-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	CO1613-J2 (10)
B	GRN	CANL2	18 AWG	GXL	CO1613-J2 (9)

S1614					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORN	2-0 IGN	16 AWG	GXL	X1609 (4)
2	ORN	2-1 IGN	16 AWG	GXL	X1606 (H)
2	ORN	2-2 IGN	16 AWG	GXL	CO1613-J1 (12)

S1615					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-0 GND	16 AWG	GXL	X1609 (2)
2	BLK	0-1 GND	16 AWG	GXL	X1606 (A)
2	BLK	0-2 GND	16 AWG	GXL	CO1613-J1 (11)

MS1618-2 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	CO1613-J1 (10)
B	GRN	CANL1	18 AWG	GXL	CO1613-J1 (9)

MS1618-3 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	X1606 (C)
B	GRN	CANL1	18 AWG	GXL	X1606 (D)

X1606 (DIAG)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	0-1 GND	16 AWG	GXL	S1615 (2)
B	RED	1-0 BAT	16 AWG	GXL	X1609 (1)
C	YEL	CANH1	18 AWG	GXL	MS1618-3 (A)
D	GRN	CANL1	18 AWG	GXL	MS1618-3 (B)
H	ORN	2-1 IGN	16 AWG	GXL	S1614 (2)

Figure 7-27. Telematics Gateway Harness - Sheet 2 of 3

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WIRE NO.	COLOR	WIRE GAUGE	LENGTH (mm)	JACKET	FROM		TO	
					REFERENCE	PIN	REFERENCE	PIN
CAN L2	GRN	18 AWG	1151	GXL	MS1619-3	B	MS1620-2	B
CAN L2	GRN	18 AWG	151	GXL	X1609	9	MS1619-2	B
CAN L1	GRN	18 AWG	157	GXL	MS1618-2	B	CO1613-J1	9
CAN L2	GRN	18 AWG	225	GXL	MS1620-3	B	CO1613-J2	9
CAN L1	GRN	18 AWG	1076	GXL	MS1618-3	B	X1606	D
CAN H2	YEL	18 AWG	155	GXL	X1609	10	MS1619-2	A
CAN H2	YEL	18 AWG	233	GXL	MS1620-3	A	CO1613-J2	10
CAN H1	YEL	18 AWG	157	GXL	MS1618-2	A	CO1613-J1	10
CAN H2	YEL	18 AWG	1150	GXL	MS1619-3	A	MS1620-2	A
CAN H1	YEL	18 AWG	1079	GXL	MS1618-3	A	X1606	C
0-0 GND	BLK	16 AWG	1006	GXL	X1609	2	S1615	1
0-1 GND	BLK	16 AWG	1145	GXL	X1606	A	S1615	2
0-2 GND	BLK	16 AWG	223	GXL	CO1613-J1	11	S1615	2
1-0 BAT	RED	16 AWG	2150	GXL	X1609	1	X1606	B
2-0 IGN	ORN	16 AWG	939	GXL	X1609	4	S1614	1
2-1 IGN	ORN	16 AWG	1212	GXL	S1614	2	X1606	H
2-2 IGN	ORN	16 AWG	287	GXL	CO1613-J1	12	S1614	2

Figure 7-28. Telematics Gateway Harness - Sheet 3 of 3

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

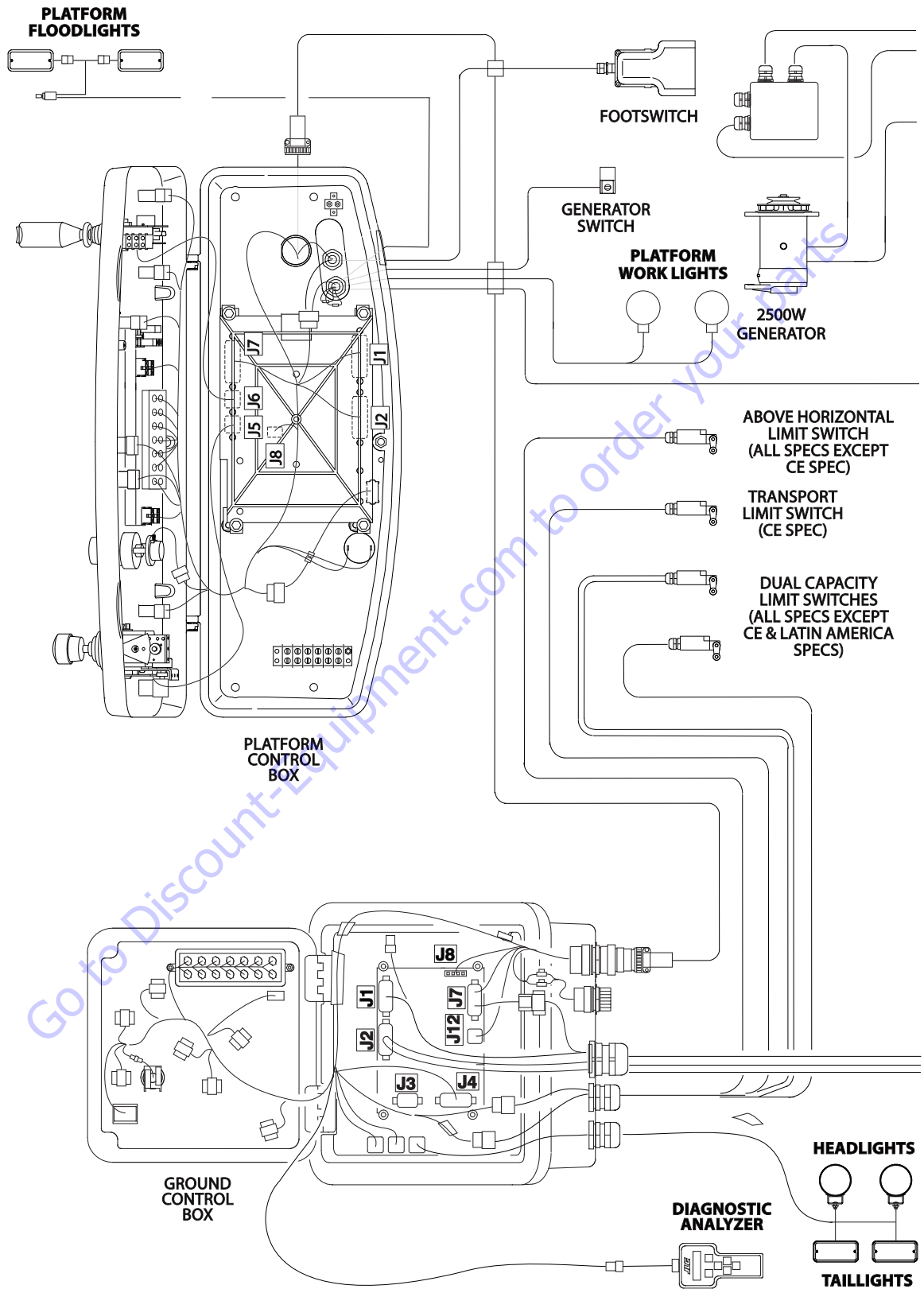


Figure 7-29. Electrical Components 1 of 2

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

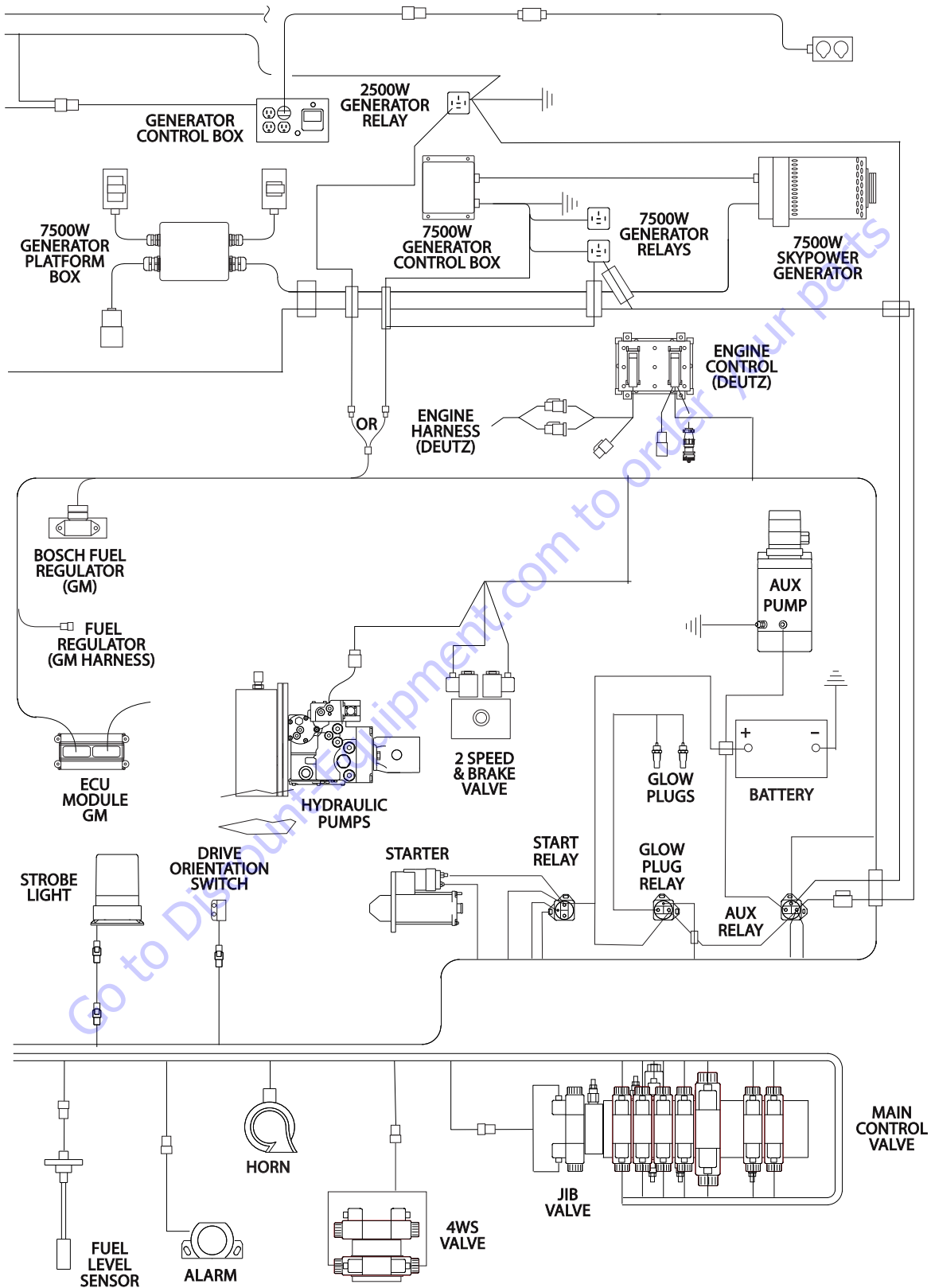


Figure 7-30. Electrical Components 2 of 2

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

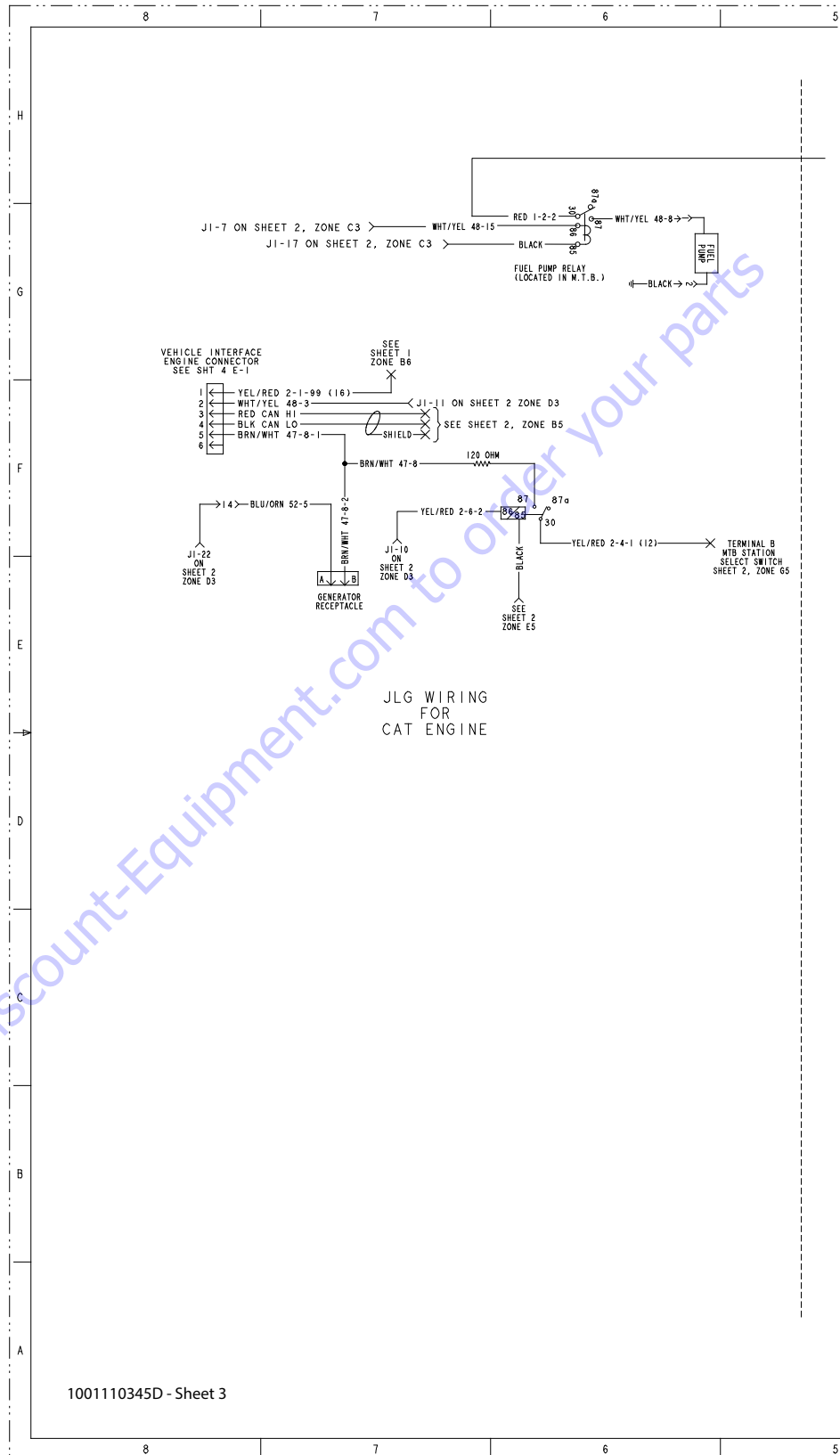
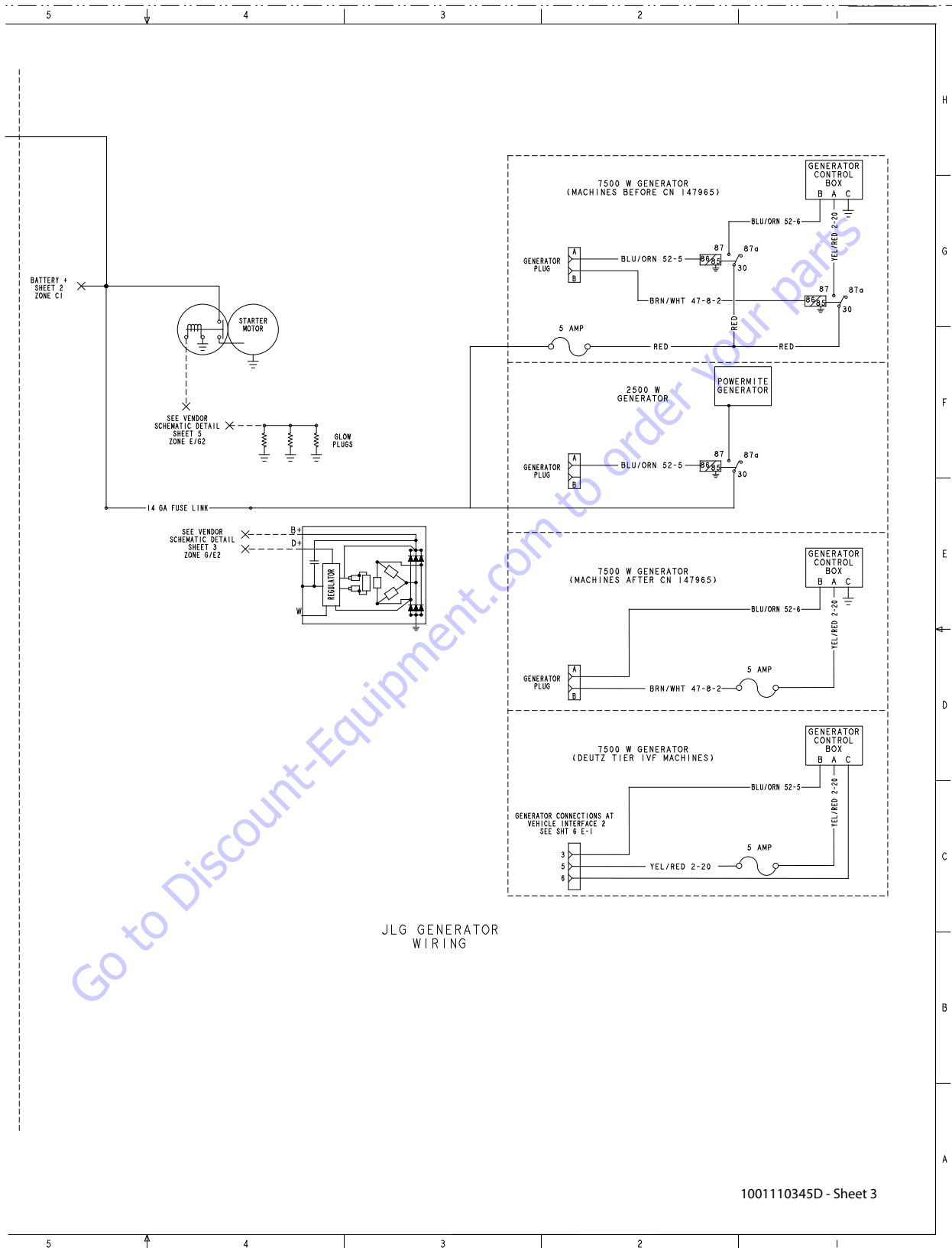


Figure 7-33. Generator Wiring Schematic 1 of 2

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS



JLG GENERATOR WIRING

1001110345D - Sheet 3

Figure 7-34. Generator Wiring Schematic 2 of 2

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

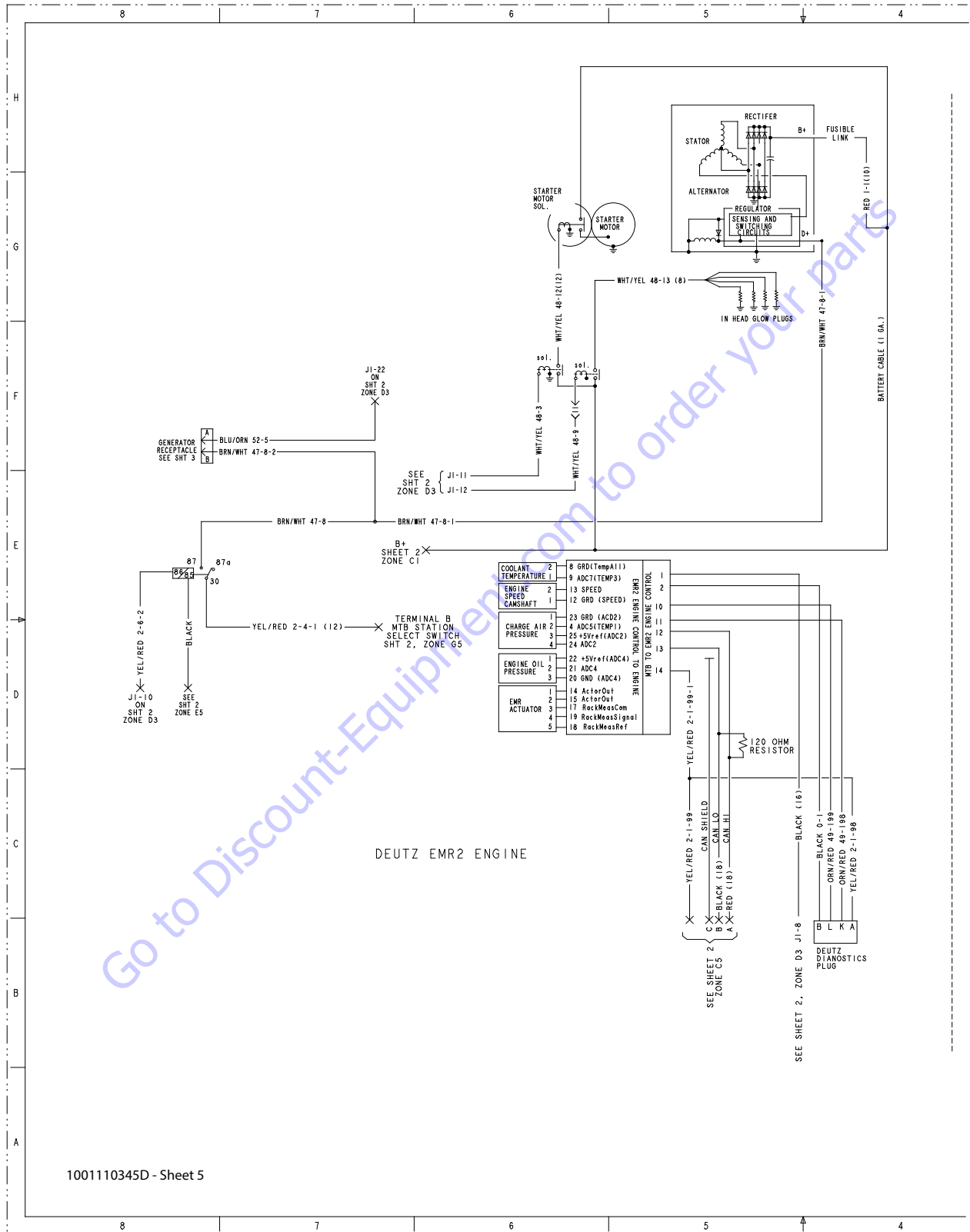


Figure 7-35. Deutz Engine Harness Electrical Schematic

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

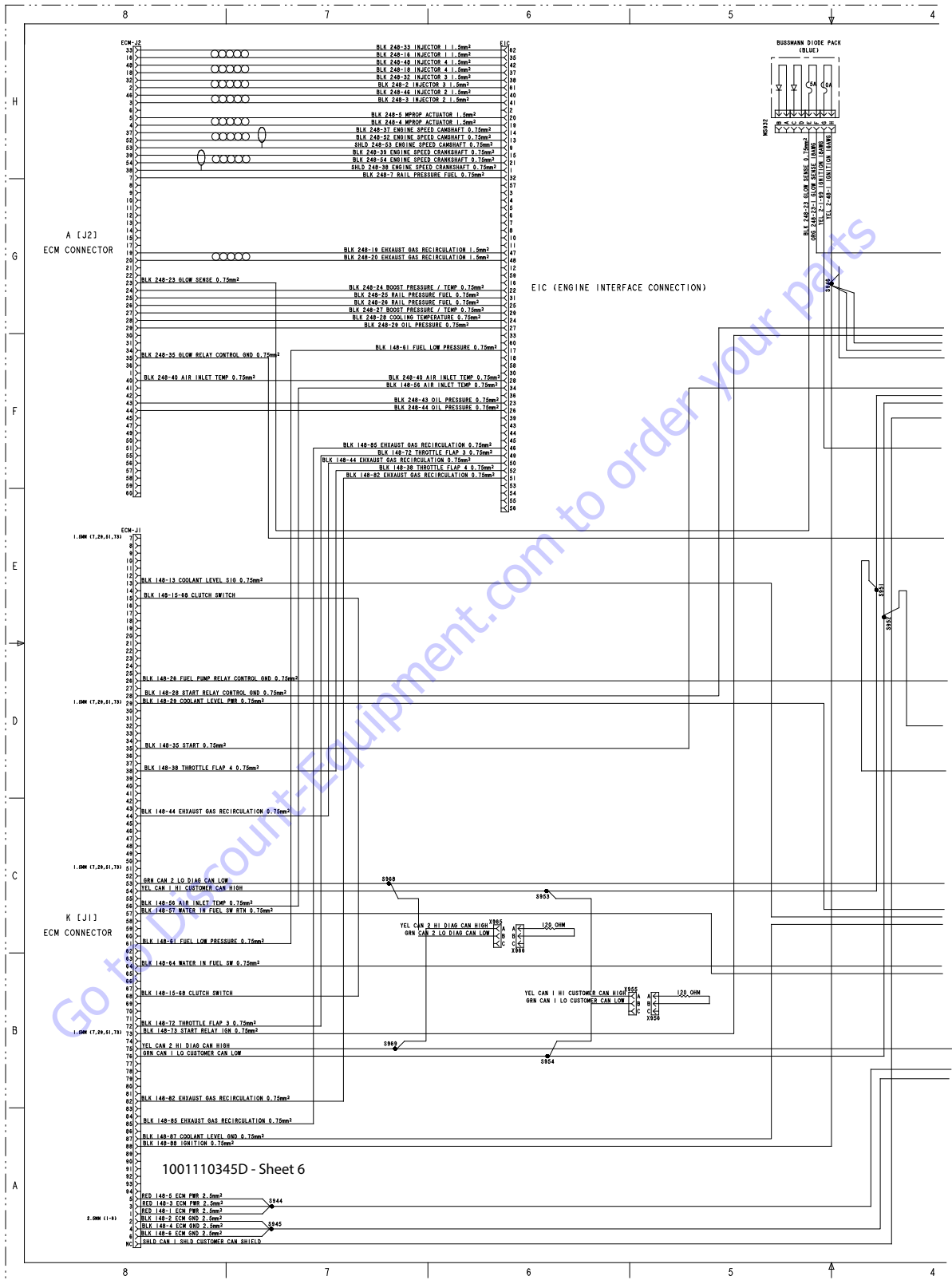


Figure 7-37. Deutz Tier 4 Final Engine Harness Electrical Schematic

SECTION 7 - BASIC ELECTRICAL INFORMATION & SCHEMATICS

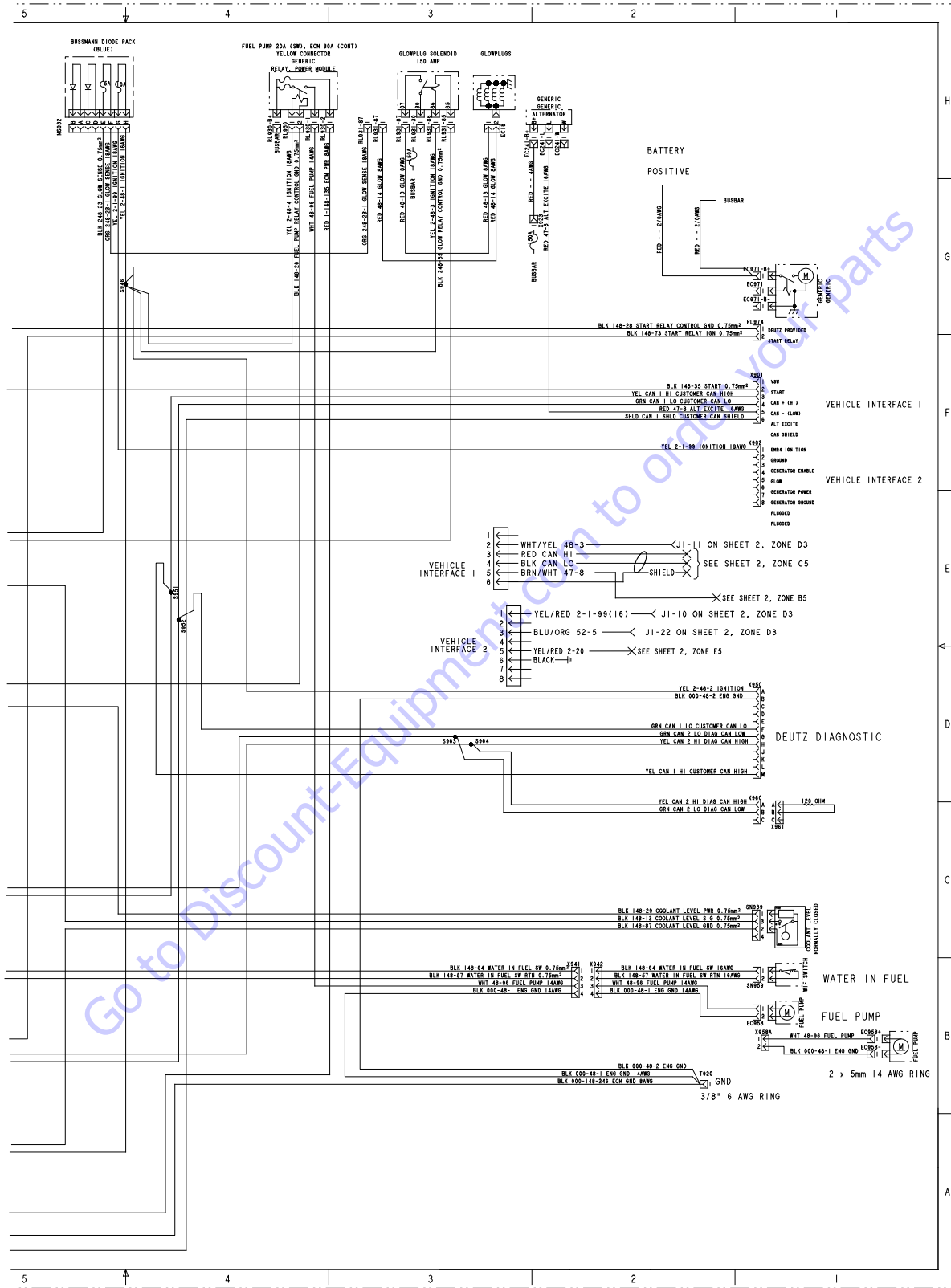


Figure 7-38. Deutz Tier 4 Final Engine Harness Electrical Schematic

PROPOSITION 65 WARNING

- **Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.**
- **Batteries also contain other chemicals known to the State of California to cause cancer.**
- **Wash hands after handling.**



WARNING:



The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

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Part Production:

Part Distribution:

Part Sales:

Part Marketing:

Part Customer Service:

Part Support:

Part Training:

Part Education:

Part Certification:

Part Accreditation:

Part Registration:

Part Licensing:

Part Compliance:

Part Standards:

Part Best Practices:

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