



An Oshkosh Corporation Company

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# Service and Maintenance Manual

## ***Model*** **600A** **600AJ**

**S/N 0300177361\***  
**to Present**

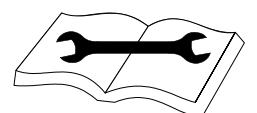
*\*See inside front cover for exceptions*

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**ANSI**

**CE**



This manual also covers Serial Number 0300176207.

## SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

### A GENERAL

This section contains general safety precautions which must be observed during aerial platform maintenance. 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 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 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 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 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.



### 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.
- ALWAYS DISCONNECT BATTERY 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

Maximum Work Load (Capacity) - ANSI Unrestricted: Restricted:	500 lb (227 kg) 1000 lb (454 kg)
Maximum Work Load (Capacity) - CE & Australia Unrestricted:	500 lb (230 kg)
Maximum Travel Grade (Gradeability) 2WD 4WD	30% 45%
Maximum Travel Grade (Side Slope)	5°
Turning Radius - (Outside) 2WS 4WS	17 ft. 7 in. (5.36 m) 9 ft. 6 in. (2.9 m)
Turning Radius - (Outside) Narrow chassis 2WS 4WS	16 ft. 6 in. (5.03 m) 11 ft. 2 in. (3.4 m)
Turning Radius - (Inside) 2WS 4WS	10 ft. 11 in. (3.33 m) 4 ft. 7 in. (1.41 m)
Turning Radius - (Inside) Narrow chassis 2WS 4WS	12 ft. 2 in. (3.71 m) 5 ft. 7 in. (1.7 m)
Maximum Tire Load:	11,700 lbs. (5307 kg)
Ground Bearing Pressure 600A 600AJ 600A - Narrow Chassis 600AJ - Narrow Chassis	77 psi (5.5 kg/cm <sup>2</sup> ) 77 psi (5.5 kg/cm <sup>2</sup> ) 94 psi (6.6 kg/cm <sup>2</sup> ) 94 psi (6.6 kg/cm <sup>2</sup> )
Maximum Drive Speed	4.25 MPH (6.25KPH)
Gross Machine Weight - 600A (Approximate) 2WS 4WS Narrow Chassis	21,640 lbs. (9,816 kg) 22,040 lbs. (9,997 kg) 23,900 lbs. (10,841 kg)
Gross Machine Weight - 600AJ (Approximate) 2WS 4WS Narrow Chassis	22,240 lbs. (10,088 kg) 22,740 lbs. (10,315 kg) 24,000 lbs. (10,886 kg)

## 1.2 DIMENSIONAL DATA

Table 1-2. Dimensional Data

Machine Height (Stowed) 600A 600AJ	8 ft. 4 in. (2.54 m) 8 ft. 5 in. (2.57 m)
Machine Length (Stowed) 600A 600AJ	26 ft. 5 in. (8.05 m) 29 ft. (8.80 m)
Machine Width (by tire size) 355/55D-625 41/18LLx22.5X625 (turf)	98 in. (2.49 m) 100 in. (2.54 m)
Wheelbase	8 ft. 2 in. (2.49 m)
Ground Clearance	11.7 in. (0.29 m)
Platform Height 600A 600AJ	60 ft. 5 in. (18.42 m) 60 ft. 7 in. (18.47 m)
Horizontal Reach 600A 600AJ	39 ft. 7 in. (12.07 m) 39 ft. 9 in. (12.10 m)
Tail Swing	0 in. (0 m)

## SECTION 1 - SPECIFICATIONS

### 1.3 CAPACITIES

**Table 1-3. Capacities**

Fuel Tank	30 Gallons (113.6 L)
Hydraulic Oil Tank	30.6 Gallons (115.8 L)
Hydraulic System (Including Tank)	40 Gallons (151.4 L)
Torque Hub, Drive*	20 ounces (0.6 L)
Engine Crankcase	
Deutz D2011L04	11 qt (10.5 L)
Deutz 2.9L4	2.4 Gallons (8.9 L) w/Filter
GM 3.0	4.5 qt (4.25 L) w/Filter
*Drive hubs should be one half full of lubricant.	

### 1.4 ENGINE DATA

**Table 1-4. 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 (2.46 LPH)

**Table 1-5. Deutz D2011L04**

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

**Table 1-6. 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 qt (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	1.27 GPH (4.81 LPH)
LP	7.25 lb./h (3.29 Kg/h)

**Table 1-7. Ford DF 2.5L, MSG 425**

Fuel	Gasoline/LP Gas
Oil Capacity	7 qt (6.6 L)
Coolant Capacity	0.63 Gallon (2.4 L)
Low RPM	1000 ±50 rpm
High RPM	3200 ±50 rpm
Alternator	150 Amp
Starter	64.4 Amp @ 3574 rpm
Fan Ratio	1:3
Fuel Consumption	
Gasoline	1 GPH (3.79 LPH)
LP	5.34 lb./h (2.42 Kg/h)
Max Output (Power)	
Gasoline	84HP @ 3200
LP	80HP @ 3200
Max Output (Torque)	
Gasoline	142 ft. lbs. (192 Nm) @ 2400 RPM
LP	145 ft. lbs. (197 Nm) @ 2400 RPM



## 1.5 TIRES

Table 1-8. Tire Specifications

Size	IN355/55D 625
Load Range	G
Ply Rating	14
Foam Fill (Optional)	Foam/Crumb
Diameter	36.9 in. (937.26 mm)
Width	13.95 in. (354.33 mm)
Rim Size	11.75 x 24.5 in. (298.5 X 622.3 mm)
Max Tire Load	11,700 lb (5307 kg) @ 90 psi (6 bar)
Size	14x17.5 Airboss
Load Range	G
Diameter	35.6
Width	14
Max Tire Load	11,800 lb (5443 kg)
Size	41/18LLx22.5 Turf/Sand
Load Range	G
Ply Rating	N/A
Foam Fill	Soft
Diameter	41
Width	18.4
Rim Size	14 x 22.5
Max Tire Load	15,500 lb @ 70 psi/5 bar
Size	36x12-20FA Solidboss
Load Range	G
Ply Rating	N/A
Diameter	36
Width	12
Max Tire Load	11,800 lb (5443 kg)

## 1.6 TORQUE REQUIREMENTS

Table 1-9. Torque Requirements

Description	Torque Value (Dry)	Interval Hours
Bearing To Chassis	190 ft-lb (260 Nm)	50/600*
Bearing To Turntable	190 ft-lb (260 Nm)	50/600*
Wire Rope	15 ft-lb (20 Nm)	150
Wheel Lugs	170 ft-lb (231 Nm)	150
Engine Mounting Bolts	165 ft-lb (231 Nm)	A/R
Engine Manifold Mounting Bolts	30 ft-lb (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 1-10. 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. If hydraulic oil other than Mobil 424 is desired, contact JLG Industries for proper recommendations.

Table 1-11. Mobilfluid 424

SAE Grade	10W-30
ISO	55
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 1-12. Mobile DTE 10 Excel 32

ISO Viscosity Grade	#32
Pour Point, Max	-65°F (-54°C)
Flash Point, Min.	482°F (250°C)
Viscosity	
at 40°C	32.7 cSt
at 100°C	6.63 cSt
at 100°F	32.7 cSt
at 212°F	6.63 cSt
Viscosity Index	164
Density (Kg/l) at 15°C	0.8468
Density (Kg/l) at 60°F	0.0305

Table 1-13. Quintolubric 888-46 Specs

Type	Synthetic Fire Resistant Biodegradable
Density	0.91 @ 15°C (59°F)
Pour Point	<-20°C (<-4°F)
Flash Point	275°C (527°F)
Fire Point	325°C (617°F)
Auto Ignition Temperature	450°C (842°F)
Viscosity	
at 0°C (32°F)	360 cSt
at 20°C (68°F)	102 cSt
at 40°C (104°F)	46 cSt
at 100°C (212°F)	10 cSt
Viscosity Index	220

Table 1-14. Mobil EAL 224

Type	Synthetic Biodegradable
ISO Viscosity Grade	46
Specific Gravity	.922
Pour Point	-25°F (-32°C)
Flash Point	428°F (220°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	37 cSt
at 100°C	8.4 cSt
Viscosity Index	213

Table 1-15. Mobil EAL EnviroSyn H 46 Specs

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.	-29 to 93°C (-20 to 200°F)
Viscosity	
at 40°C	48.8 cSt
at 100°C	7.8 cSt
Viscosity Index	145

**Table 1-16. 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)
<b>Viscosity</b>	
at 40°C	43.3 cSt
at 100°C	7.7 cSt
Viscosity Index	149

**Table 1-17. Exxon Unavis HVI 26 (Arctic)**

Specific Gravity	32.1
Pour Point	-76°F (-60°C)
Flash Point	217°F (103°C)
<b>Viscosity</b>	
at 40°C	25.8 cSt
at 100°C	9.3 cSt
Viscosity Index	376
<b>NOTE:</b>	<i>Mobil/Exxon recommends this oil be checked on a yearly basis for viscosity.</i>

## 1.8 CRITICAL STABILITY 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. Critical Stability Weights**

Components		LBS.	KG.
Tire and Wheel (Pneumatic)	355/55D345	235	107
Tire and Wheel (Foam Filled)	355/55D345	440	200
Engine	Deutz D2011	1222	554
	Deutz TD2.9L	1250	567
	GM	1070	486
	Ford	873	396
Counterweight	600A	5400	2449
	600AJ	6100	2767
	Narrow Frame	8050	3651
	600A w/Soft Touch	6100	2767
Platform	30x48	151	68
	30x60	165	75
	36x72	199	90
	36x96	230	105

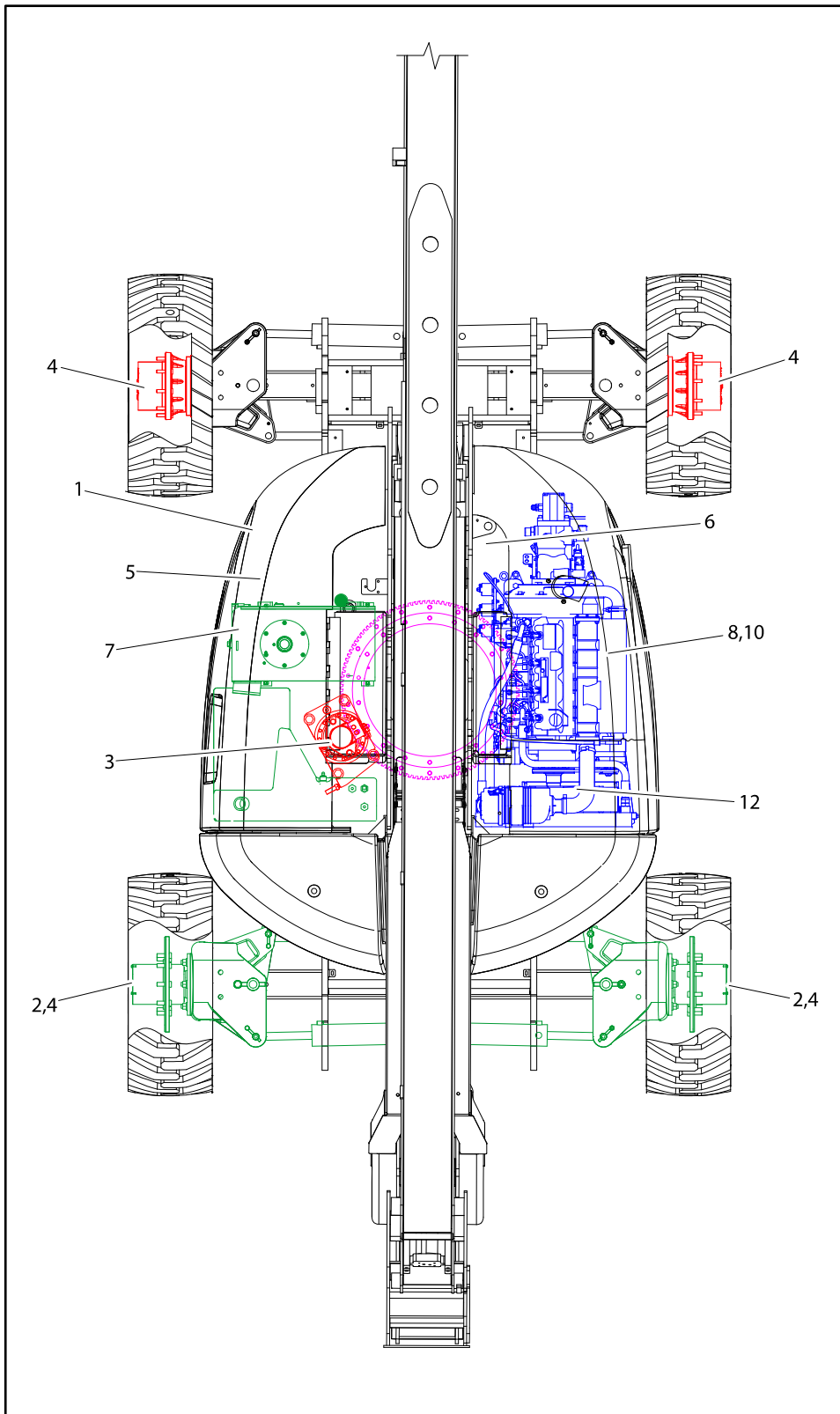


Figure 1-1. Operator Maintenance and Lubrication Diagram - Deutz D2011

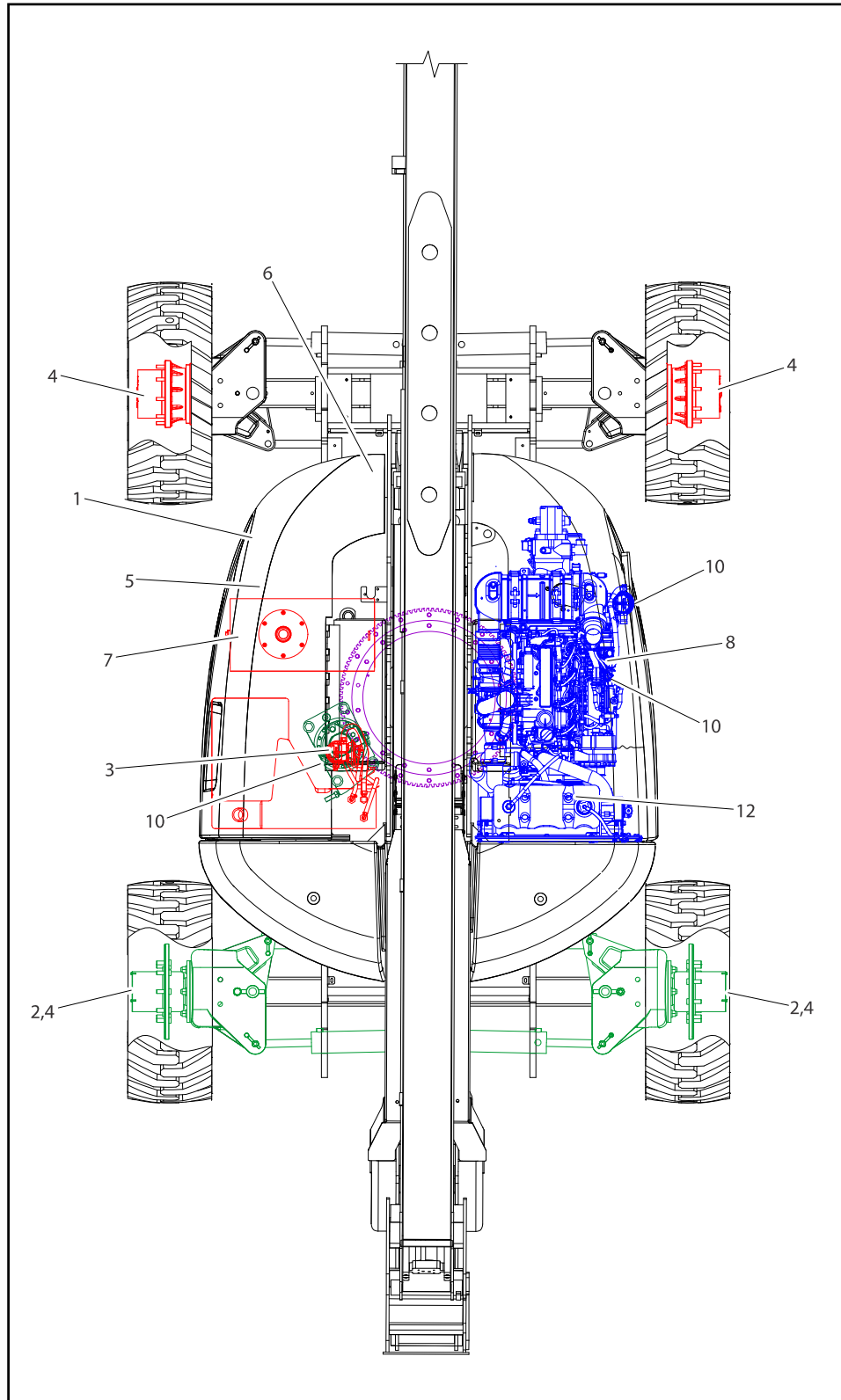


Figure 1-2. Operator Maintenance and Lubrication Diagram - Deutz TD2.9

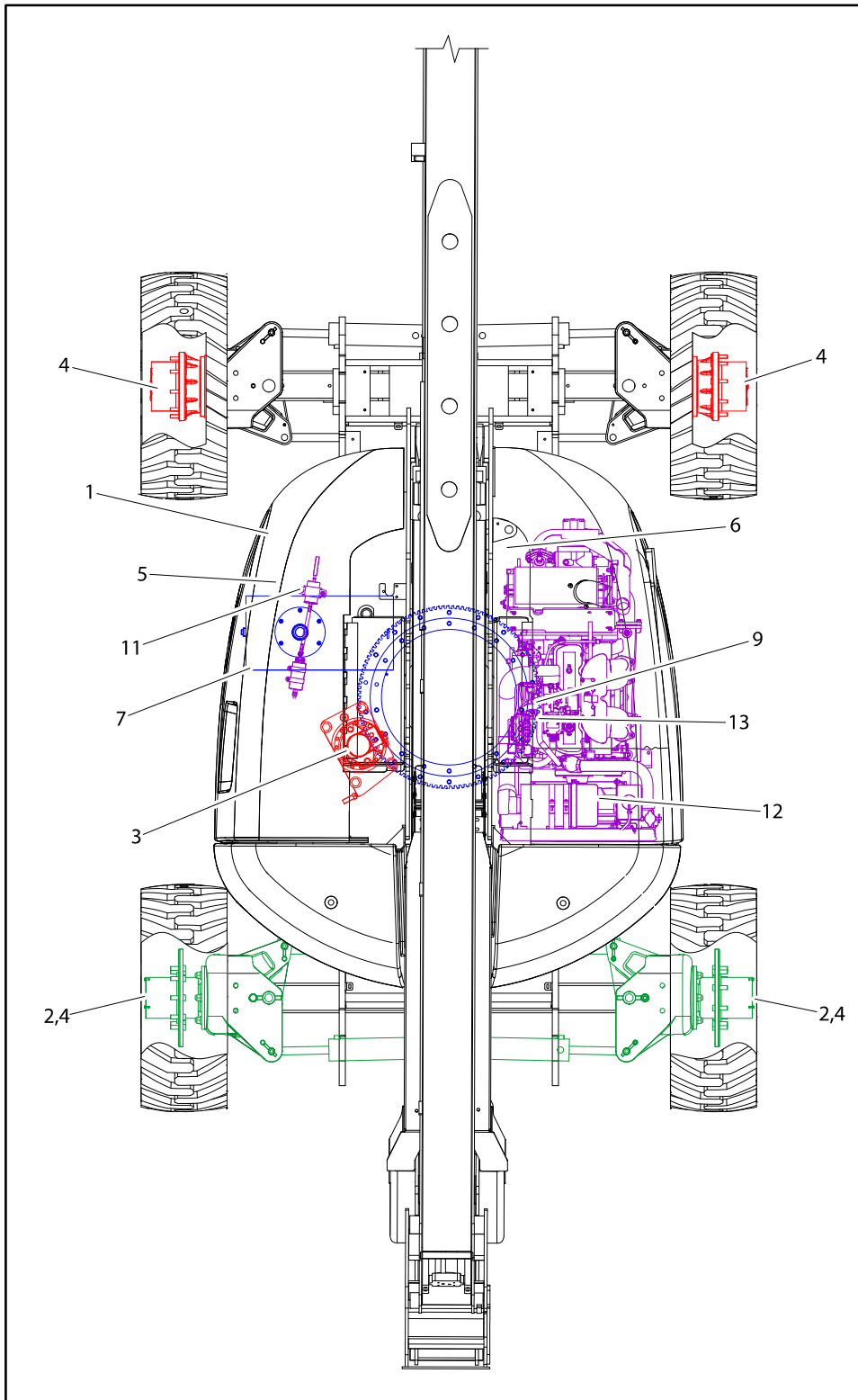


Figure 1-3. Operator Maintenance and Lubrication Diagram - GM 3.0L

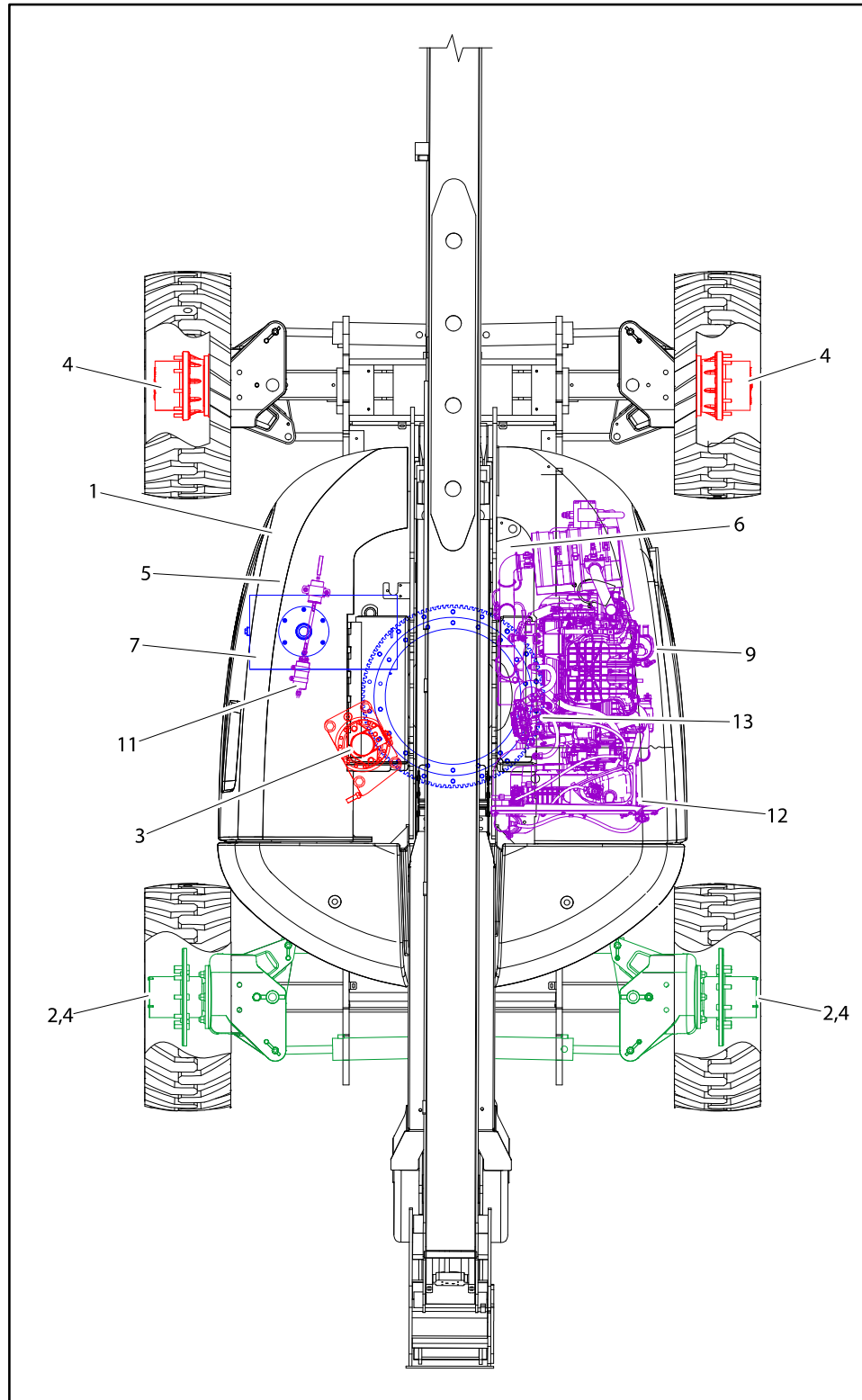


Figure 1-4. Operator Maintenance and Lubrication Diagram - Ford MSG 425

### 1.9 OPERATOR MAINTENANCE

**NOTE:** The following numbers correspond to those in Figure 1-1., Figure 1-2. and Figure 1-3.

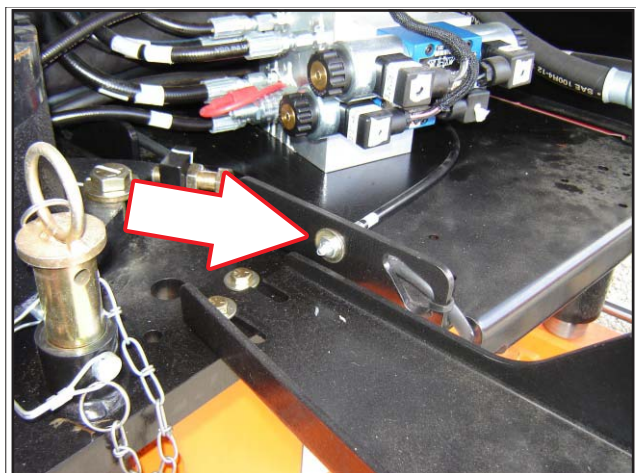
**Table 1-19. Lubrication Specifications.**

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. Refer Section 1.7, Hydraulic Oil.
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**

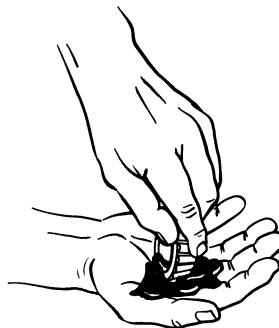
LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

**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

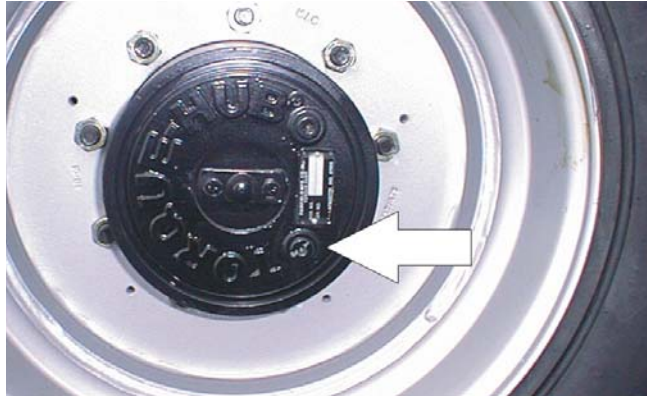
**3. Swing Drive Hub**



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

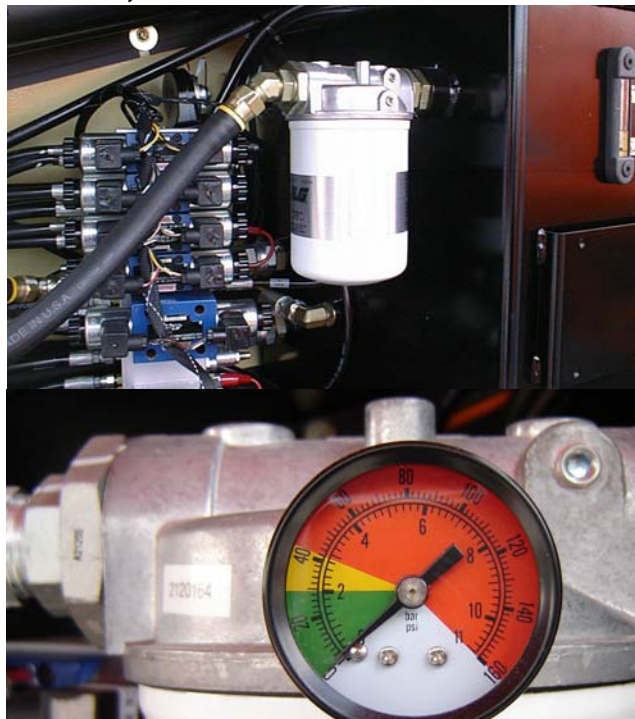


**4. Wheel Drive Hub**



Lube Point(s) - Level/Fill Plug  
 Capacity - 20 oz. (0.6 L)  
 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**



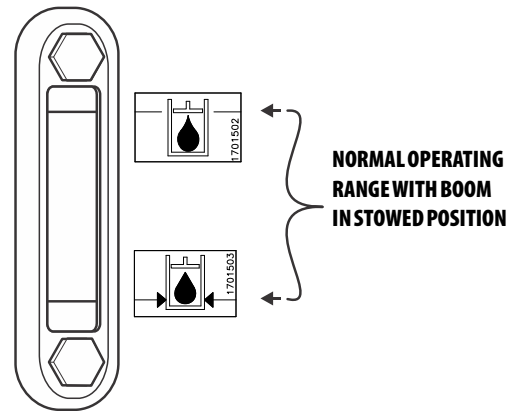
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as shown by Condition Indicator.

**6. Hydraulic Charge Filter**



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

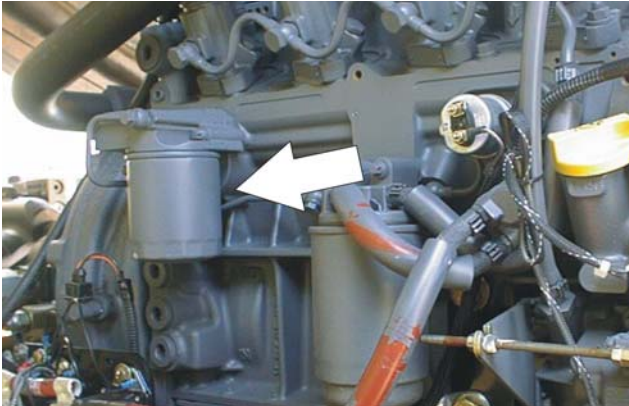
**7. Hydraulic Tank Lube Point(s) - Fill Cap**



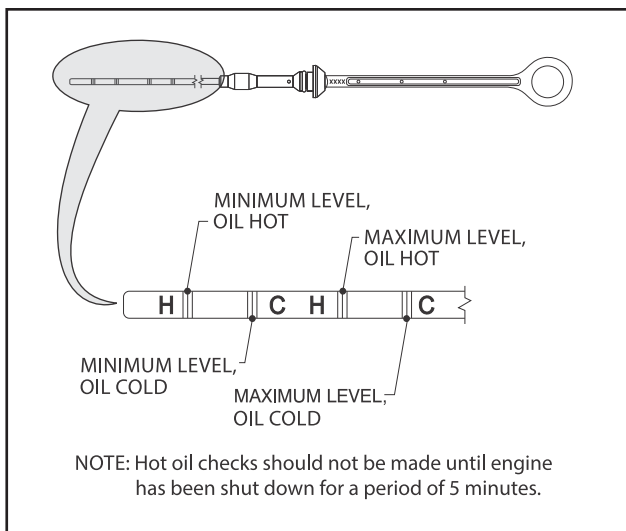
Lube Point (s) - Fill Cap  
 Capacity: Tank - 30.6 gal. (115.8 L);  
 System - 40 gal. (151.4 L);  
 Lube - HO  
 Interval - Check Level daily; Change every 2 years or 1200 hours of operation

**SECTION 1 - SPECIFICATIONS**

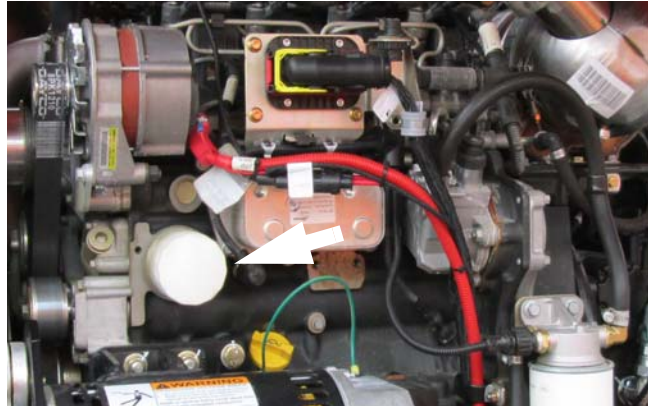
**8. A. Oil Change w/Filter - Deutz 2011**



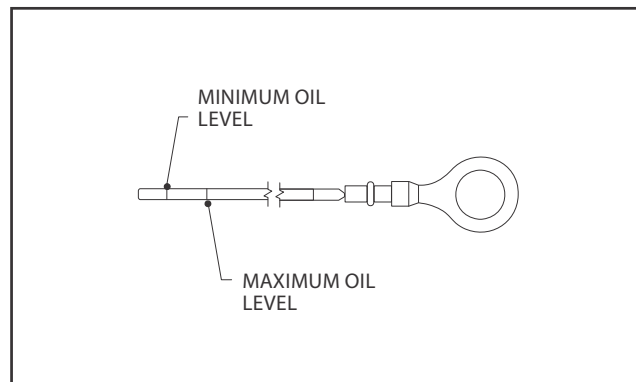
Lube Point(s) - Fill Cap/Spin-on Element  
 Capacity - 11 Quarts Crankcase; 5 Quarts Cooler  
 Lube - EO  
 Interval - Every Year or 1200 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.



**B. Oil Change w/Filter - Deutz D2.9**



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.

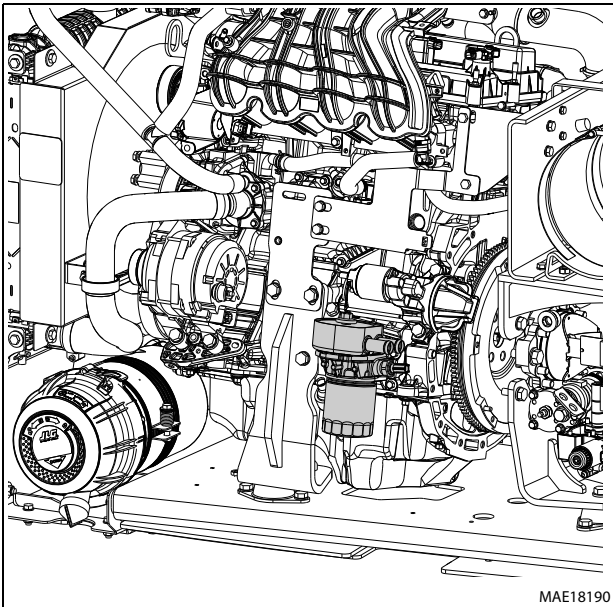


**9. A. Oil Change w/Filter - GM**



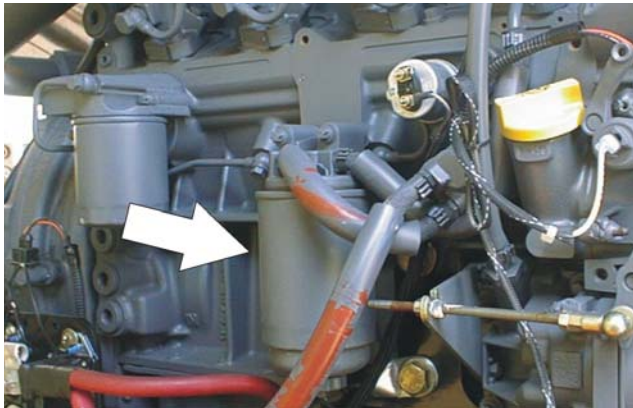
Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7027965)  
 Capacity - 4.5 qt. (4.25 L) w/filter  
 Lube - EO  
 Interval - 3 Months or 150 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.

**B. Oil Change w/Filter - Ford (On Engine)**



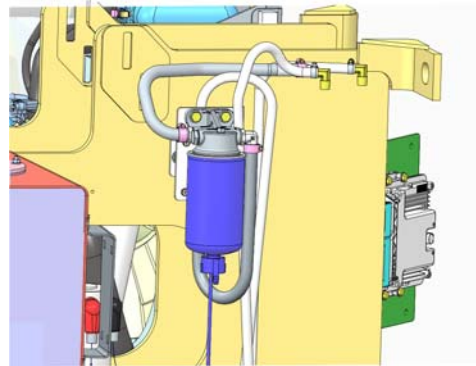
Lube Point(s) - Fill Cap/Spin-on Element  
 Interval - Every 3 months or 300 hours of operation  
 Comments - Check level daily/Change in accordance with engine manual.

**10. A. Fuel Filter - Deutz**



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

**B. Fuel Filter - Deutz TD2.9 (On Turntable)**



Lube Point(s) - Replaceable Element  
 Interval - Change in accordance with engine manual

**C. Fuel Filter - Deutz TD2.9 (On Engine)**



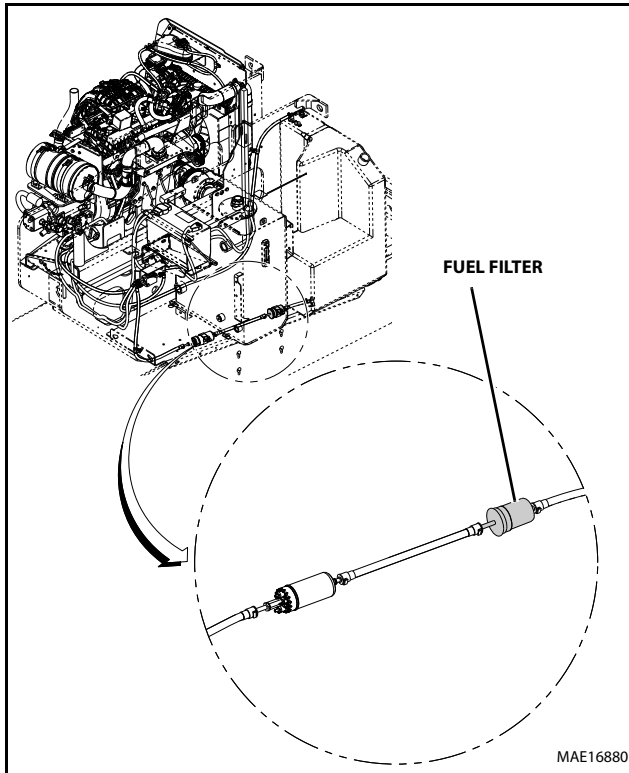
Lube Point(s) - Replaceable Element  
 Interval - Change in accordance with engine manual

## SECTION 1 - SPECIFICATIONS

### 11. A. Fuel Filter (Gasoline) - GM

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

### B. Fuel Filter - Ford (On Engine)



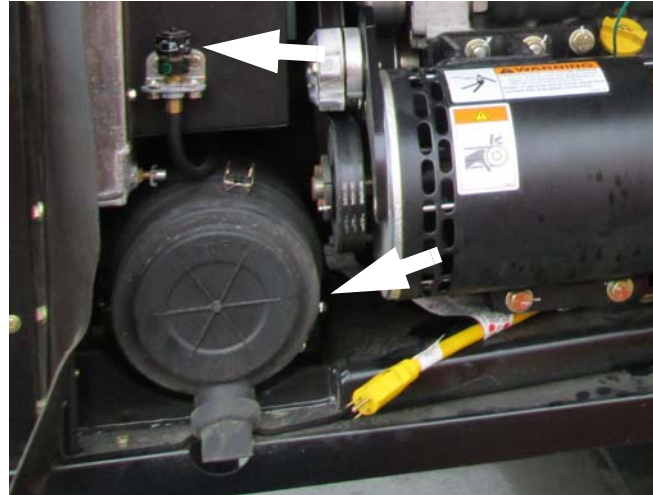
Lube Point(s) - Replaceable Element  
Interval - Every 6 months or 300 hours of operation

### 12. A. Air Filter (Deutz 2011 and GM)



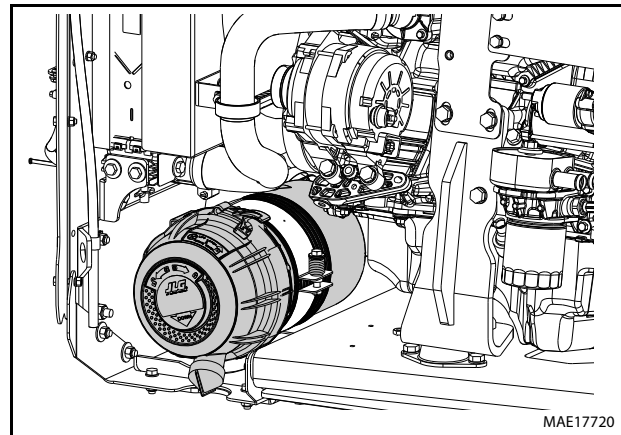
Lube Point(s) - Replaceable Element  
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator

### 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.

### C. Air Filter - Ford



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

### 13. A. Fuel Filter (Propane) - GM Engine



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

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)																			
SAE GRADE 5 BOLTS & GRADE 2 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)		Clamp Load	Torque (Dry or Loctite® 263) K= 0.20		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.15		Torque (Loctite® 262™ or TITE™ 131) K=0.15	
					IN-LB	FT-LB	IN-LB	FT-LB	IN-LB	FT-LB	IN-LB	FT-LB		IN-LB	FT-LB	IN-LB	FT-LB		IN-LB
4	40	0.1120	0.0604	380	8	0.9	6	0.7											
		0.1120	0.0661	420	9	1.0	7	0.8											
6	32	0.1380	0.0909	580	16	1.8	12	1.4											
		0.1380	0.1015	610	18	2.0	13	1.5											
8	32	0.1640	0.1400	900	30	3.4	22	2.5											
		0.1640	0.1474	940	31	3.5	23	2.6											
10	24	0.1900	0.1750	1120	43	4.8	32	3.5											
		0.1900	0.2000	1285	49	5.5	36	4											
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12									
		0.2500	0.0364	2320	120	13.5	86	10	135	15									
5/16	18	0.3125	0.0524	3340	177	23	133	18	19	26									
		0.3125	0.0580	3700	19	26	14	19	21	29									
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48									
		0.3750	0.0878	5600	35	47	25	34	40	54									
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75									
		0.4375	0.1187	7550	55	75	40	54	60	82									
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116									
		0.5000	0.1599	10700	90	122	65	88	100	136									
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163									
		0.5625	0.2030	12850	120	163	90	122	135	184									
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224									
		0.6250	0.2580	16300	170	230	130	176	190	258									
3/4	10	0.7500	0.3340	21300	260	353	200	288	285	398									
		0.7500	0.3730	23800	300	407	220	298	330	449									
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646									
		0.8750	0.5090	32400	470	637	350	470	520	707									
1	8	1.0000	0.6060	38600	640	868	480	651	675	918									
		1.0000	0.6630	42200	700	949	530	719	735	1000									
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142									
		1.1250	0.8560	47500	880	1193	660	895	925	1258									
1 1/4	7	1.2500	0.9630	53800	1120	1518	840	1139	1175	1598									
		1.2500	1.0730	59600	1240	1681	920	1247	1300	1768									
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074									
		1.3750	1.3150	73000	1660	2278	1260	1708	1750	2380									
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754									
		1.5000	1.5860	87700	2200	2983	1640	2224	2300	3128									

NO. 5000059 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

REFERENCE JLG THREAD LOCKING COMPOUND			
JLG P/N	Loctite® P/N	ND Industries P/N	Description
0100011	242™	Vibra-TITE™ 121	Medium Strength (Blue)
0100019	271™	Vibra-TITE™ 140	High Strength (Red)
0100071	262™	Vibra-TITE™ 131	Medium - High Strength (Red)

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

Values for Magni Coating Fasteners (Ref 4150701)																		
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) K=0.17		Torque (Loclote@ 242™ or 271™ OR Vibra-TITE™ K=0.16)		Torque (Loclote@ 262™ or VIBRA-TITE™ 131) K=0.15		Torque (Dry or Loclote@263) K=0.17		Torque (Loclote@242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16		Torque (Loclote@262™ or VIBRA-TITE™ 131) K=0.15			
					IN-LB	LB	IN-LB	LB	IN-LB	LB	IN-LB	LB	IN-LB	LB	IN-LB	LB	IN-LB	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	0.1640	0.01400	900	25	2.8												
	36	0.1640	0.01474	940	26	2.9												
10	24	0.1900	0.01750	1120	36	4.1												
	32	0.1900	0.02000	1285	42	4.7												
1/4	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]	IN-LB	[N.m]	FT-LB	[N.m]	IN-LB	[N.m]	FT-LB	[N.m]	IN-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	15	20	14	19	15	20	4720	20	25	20	25	20	25	25
	24	0.3125	0.0580	3700	15	20	15	21	15	20	5220	25	35	20	25	20	25	25
3/8	16	0.3750	0.0775	4840	25	35	25	34	25	34	7000	35	50	35	50	35	50	50
	24	0.3750	0.0878	5600	30	40	28	38	25	34	7900	40	55	40	55	35	50	50
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48	9550	60	80	55	75	50	70	70
	20	0.4375	0.1187	7550	45	60	44	60	40	54	10700	65	90	60	80	60	80	80
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75	12750	90	120	85	115	80	110	110
	20	0.5000	0.1599	10700	75	100	71	97	65	88	14400	100	135	95	130	90	120	120
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109	16400	130	175	125	170	115	155	155
	18	0.5625	0.2030	12950	105	145	97	132	90	122	18250	145	195	135	185	130	175	175
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156	20350	180	245	170	230	160	220	220
	18	0.6250	0.2560	16300	145	195	136	185	125	170	23000	205	280	190	260	180	245	245
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272	30100	320	435	300	410	280	380	380
	16	0.7500	0.3730	23800	255	345	238	324	225	306	33600	355	485	335	455	315	430	430
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435	41600	515	700	485	660	455	620	620
	14	0.8750	0.5090	32400	400	545	378	514	355	483	45800	570	775	535	730	500	680	680
1	8	1.0000	0.6060	38600	545	740	515	700	480	653	51500	730	995	685	930	645	875	875
	12	1.0000	0.6630	42200	600	815	563	765	530	721	59700	845	1150	795	1080	745	1015	1015
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809	68700	1095	1490	1030	1400	965	1310	1310
	12	1.1250	0.8560	47500	755	1025	713	969	670	911	77000	1225	1665	1155	1570	1085	1475	1475
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142	87200	1545	2100	1455	1980	1365	1855	1855
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265	96600	1710	2325	1610	2190	1510	2055	2055
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496	104000	2025	2755	1905	2590	1785	2430	2430
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707	118100	2300	3130	2165	2945	2030	2780	2780
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992	126500	2690	3660	2530	3440	2370	3225	3225
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237	142200	3020	4105	2845	3870	2665	3625	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

Figure 1-6. Torque Chart (SAE Fasteners - Sheet 2 of 5)

SOCKET HEAD CAP SCREWS													
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Magni Coating (Ref 4150701)*				Zinc Yellow Chromate Fasteners (Ref 4150707)*				
					Torque (Dry) K = .17	Torque (Locitite® 242™ or 271™ OR Vibra-TITE™ 111 or TITE™ 131) K=0.16	Torque (Locitite® 262™ or Vibra-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	FT-LB	[N.m]	IN-LB	FT-LB	[N.m]	IN-LB	FT-LB	[N.m]
4	40	0.1120	0.00604										
4.8	48	0.1120	0.00661										
6	32	0.1380	0.00909										
8	40	0.1380	0.01015										
3/8	32	0.1640	0.01400										
3/8	36	0.1640	0.01474										
10	24	0.1900	0.01750										
3/4	32	0.1900	0.02000										
1/4	20	0.2500	0.0318	2860	122	14	13	114	13	15	143	16	15
3/8	28	0.2500	0.0364	3280	139	16	15	131	15	17	148	19	17
5/16	18	0.3125	0.0524	4720	20	25	25	20	25	20	35	20	25
3/8	24	0.3125	0.0580	5220	25	35	25	20	25	20	35	25	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50	45	60	55
7/16	24	0.3750	0.0878	7900	40	55	40	55	35	50	50	70	65
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70	95	65	90
1/2	20	0.4375	0.1187	10700	65	90	60	80	60	80	110	70	95
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110	145	95	130
9/16	20	0.5000	0.1599	14400	100	135	95	130	90	120	165	110	140
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155	210	140	190
5/8	18	0.5625	0.2030	18250	145	195	135	185	130	175	230	155	210
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220	285	190	260
3/4	18	0.6250	0.2560	23000	205	280	190	260	180	245	325	215	290
3/4	10	0.7500	0.3340	30100	320	435	300	380	260	360	460	280	380
7/8	16	0.7500	0.3730	33600	355	485	335	455	315	430	570	380	515
1	14	0.8750	0.4620	41800	515	700	485	660	455	620	825	545	740
1	8	1.0000	0.5090	45800	570	775	535	730	500	680	910	600	815
1 1/8	12	1.0000	0.6060	51500	730	995	685	930	645	875	1170	775	1055
1 1/8	7	1.0000	0.6630	59700	845	1150	795	1080	745	1015	1355	895	1215
1 1/4	12	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310	1755	1160	1580
1 1/4	7	1.2500	0.8560	77000	1225	1665	1155	1570	1085	1475	1965	1300	1770
1 3/8	12	1.2500	0.9690	87200	1545	2100	1455	1960	1365	1855	2470	1635	2225
1 3/8	6	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055	2740	1810	2460
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430	3245	2145	2915
1 3/8	6	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760	3680	2435	3310
1 1/2	12	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225	4305	2870	3870
1 1/2	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625	4835	3200	4350

NO. 5000059 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 1-7. Torque Chart (SAE Fasteners - Sheet 3 of 5)

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® 242™ or 271™ 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	5665	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 1-8. 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.

NO. 5000059 REV. K

Figure 1-9. Torque Chart (METRIC Fasteners - Sheet 5 of 5)



## SECTION 2. GENERAL

### 2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

#### General

This section provides the necessary information needed by those personnel that are responsible to place the machine in operation readiness and maintain its safe operating condition. For maximum service life and safe operation, ensure that all the necessary inspections and maintenance have been completed before placing the machine into service. With proper care, maintenance, and inspections performed per JLG's recommendations, and with any and all discrepancies corrected, this product will be fit for continued use.

#### 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

When disassembling or reassembling a component, complete the procedural steps in sequence. 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. When pressing a bearing into a retainer or bore, apply pressure to the outer race. If the bearing is to be installed on a shaft, apply pressure to the inner race.

## 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, or other contaminants to enter during 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 first 50 hours of operation and every 300 hours (unless specified otherwise) thereafter. If it is necessary to change the oil, use only oils meeting or exceeding specifications in this manual. If unable to obtain same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Do not mix 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 service container. Always clean filter mesh element and replace cartridge any time oil is changed.

3. Inspect all hydraulic components, lines, fittings, etc. while unit is shut down. Perform 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 any 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

#### Theory

When a hydraulic cylinder is supporting a load, cylinder drift may occur as a result of any of the circumstances below:

- Normal leakage of load holding valves or malfunction of load holding valves. See Cylinder Leakage Test and Table 2- 2, Cylinder Drift below for evaluation.
- Damaged or worn piston seals.
- Normal thermal expansion or contraction of the hydraulic oil within cylinders (See Cylinder Thermal Drift below).

The first two circumstances may result in cylinder movement due to oil leaking out of the cylinder externally or by leaking back to tank or due to oil leaking internally from one cylinder chamber to the other.

Thermal expansion or contraction of oil in hydraulic cylinders is a normal occurrence and does not result in oil leaking out of the cylinder or leaking internally from one cylinder chamber to the other. Thermal expansion or contraction is the tendency for materials to change size in response to a change in temperature.

#### Cylinder Leakage Test

**Cylinder oil must be at stabilized ambient temperature before beginning this test.**

Measure drift at cylinder rod with a calibrated dial indicator.

In an area free of obstructions, cylinder must have load applied and appropriately positioned to detect drift.

Cylinder leakage is acceptable if it passes this test.

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	0.004	0.10
9	228.6	0.003	0.08

**NOTE:** This information is based on 6 drops per minute cylinder leakage.

## Cylinder Thermal Drift

The oil in all hydraulic cylinders will expand or contract due to thermal effects over time and may result in changes to the boom and/or platform position while the machine is stationary. These effects occur as the cylinder oil changes temperature, usually from a higher oil temperature as it cools and approaches the ambient air temperature. Results of these effects are related to several factors including cylinder length and change in temperature over the time the cylinder remains stationary.

## 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. Housing should be blown out to remove all dirt and debris. Bearings and bearing housings must be free of all contamination.
  - b. Bearing / pins should be cleaned with a solvent to remove all grease and oil. Filament wound bearing are a dry joint and should not be lubricated unless otherwise instructed (i.e. sheave pins).
  - c. Pins should be inspected to ensure it is free of burrs, nicks, and scratches which would damage the 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:

- Ground on frame and weld on any other area than chassis.
- Ground on turntable and weld on any other area than turntable.
- Ground on platform/support and weld on any other area than platform/support.
- Ground on a specific boom section and weld on any other area than that specific boom section.
- Allow pins, wear pads, wire ropes, bearings, gearing, seals, valves, electrical wiring, or hoses to be between grounding position and welded area.

### NOTICE

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

**SECTION 2 - GENERAL**

**Table 2-3. Inspection and Preventive Maintenance Schedule**

AREA	INTERVAL		
	Pre-Delivery <sup>2</sup> or Frequent <sup>3</sup> Inspection	Annual <sup>4</sup> (Yearly) Inspection	Every 2 Years
<b>Boom Assembly</b>			
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	
<b>Platform Assembly</b>			
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	
<b>Turntable Assembly</b>			
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	
<b>Chassis Assembly</b>			
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 <sup>2</sup> or Frequent <sup>3</sup> Inspection	Annual <sup>4</sup> (Yearly) Inspection	Every 2 Years
<b>Functions/Controls</b>			
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	
<b>Power System</b>			
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	
<b>Hydraulic/Electric System</b>			
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	
<b>General</b>			
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 <sup>2</sup> or Frequent <sup>3</sup> Inspection	Annual <sup>4</sup> (Yearly) Inspection	Every 2 Years
Annual Machine Inspection Due	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: <sup>1</sup> Prior to use each day; or at each Operator change <sup>2</sup> Prior to each sale, lease, or delivery <sup>3</sup> In service for 3 months or 150 Hours; or Out of service for 3 months or more; or Purchased used <sup>4</sup> 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			

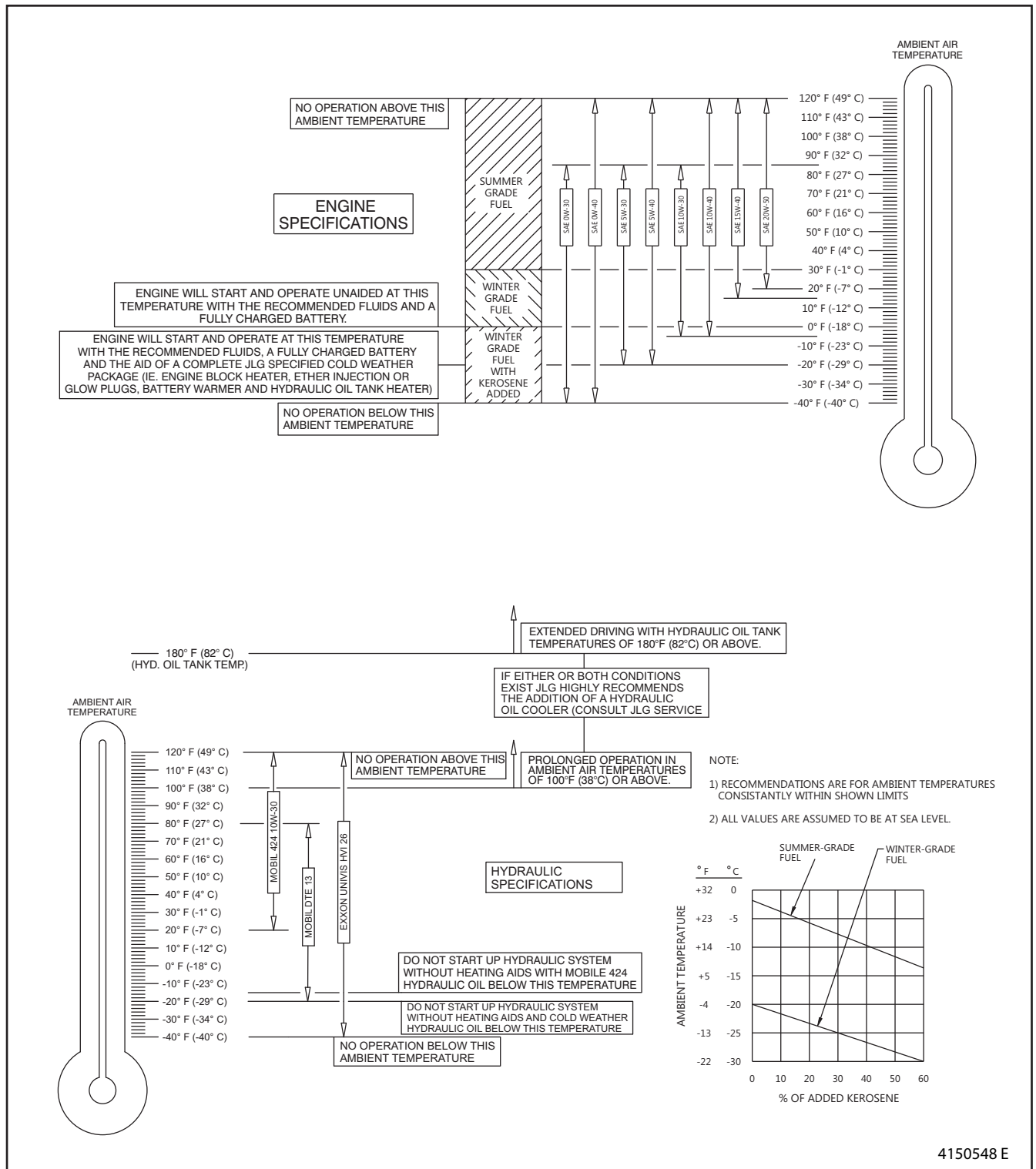
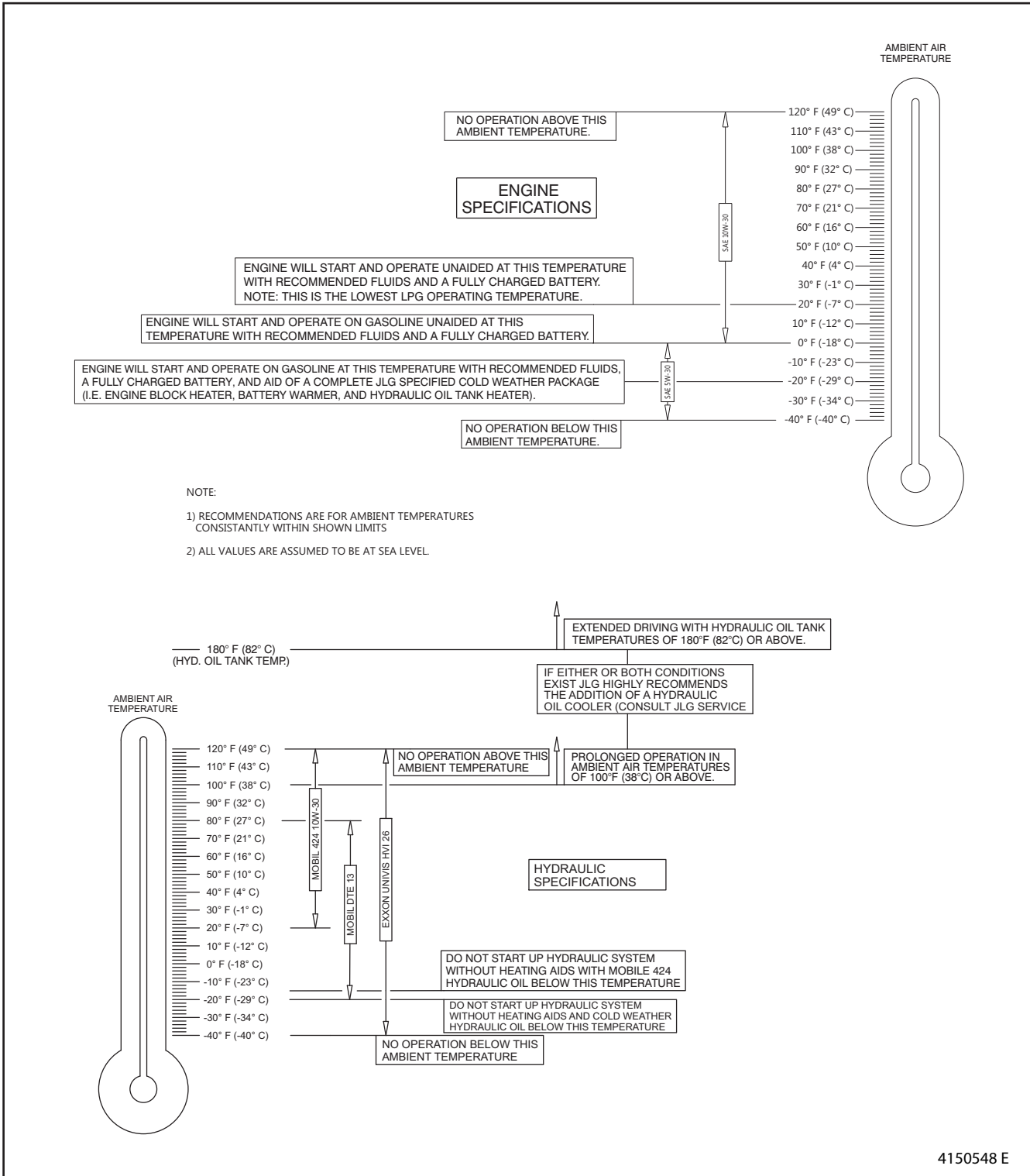


Figure 2-1. Engine and Hydraulic Operating Temperature Specifications - Deutz

**SECTION 2 - GENERAL**



**Figure 2-2. Engine and Hydraulic Operating Temperature Specifications - GM 3.0L**

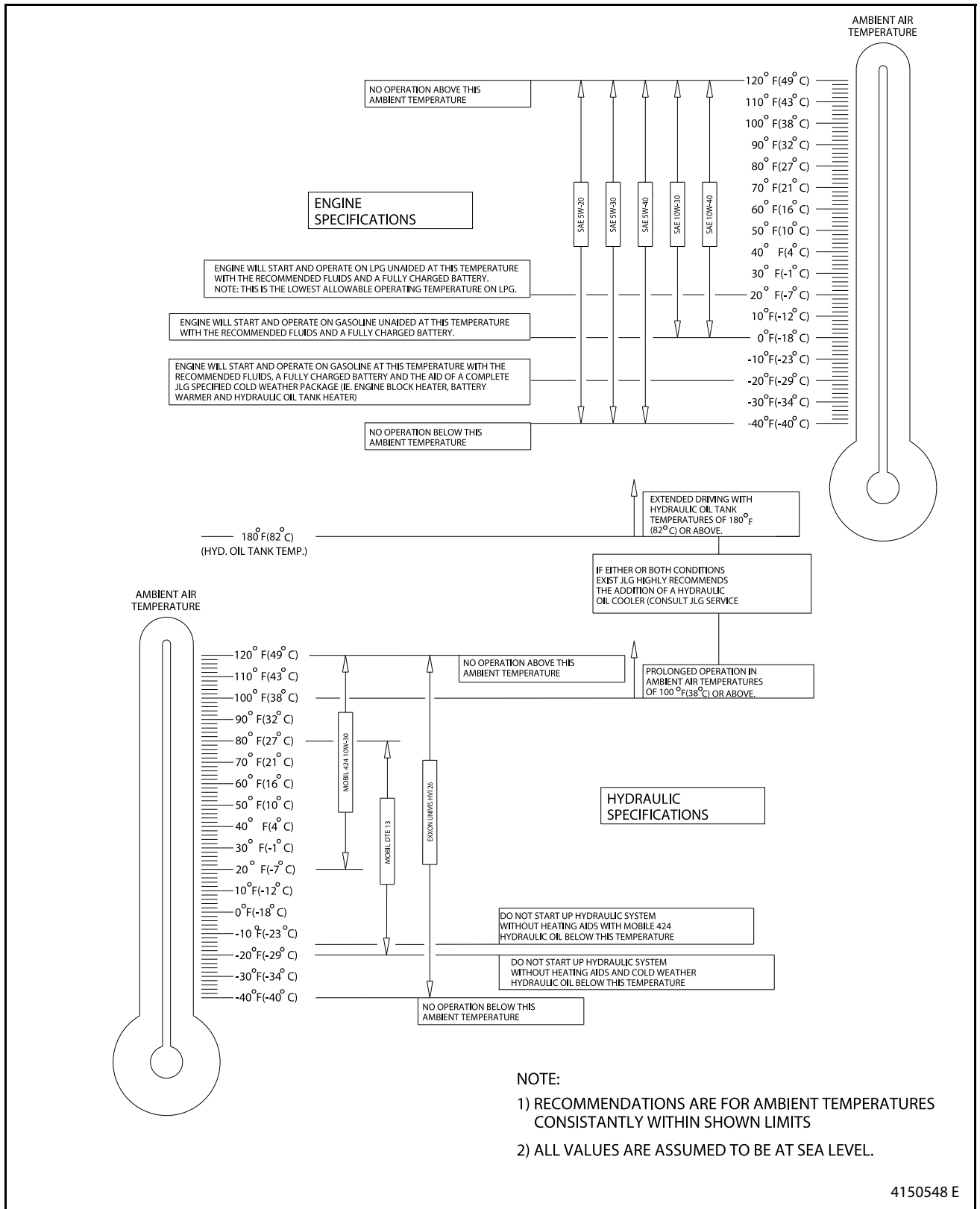


Figure 2-3. Engine and Hydraulic Operating Temperature Specifications - Ford MSG 425



## SECTION 3. CHASSIS & TURNTABLE

### 3.1 TIRES AND 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 operational characteristics.

#### Tire Damage

For 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 and arrangements must be made for replacement of the tire or tire assembly.

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

- Smooth, even cut through cord plies which exceeds 3 inches (7.5 cm) in total length.
- Tears or rips (ragged edges) in cord plies which exceeds 1 inch (2.5 cm) in any direction.
- Any punctures which exceed 1 inch in diameter.
- Any damage to the bead area cords of the tire.

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 that 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 that all tires are inflated to pressure recommended by

JLG. Due to size variations between tire brands, both tires on the same axle should be the same.

#### Wheel Replacement

Rims installed on each product model have been 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

It is extremely important to apply and maintain proper wheel mounting torque.

#### **! WARNING**

**WHEEL NUTS MUST BE INSTALLED AND MAINTAINED AT THE PROPER TORQUE TO PREVENT LOOSE WHEELS, BROKEN STUDS, AND POSSIBLE DANGEROUS SEPARATION OF WHEEL FROM THE AXLE. BE SURE TO USE ONLY THE NUTS MATCHED TO THE CONE ANGLE OF THE 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. The proper procedure for attaching wheels is as follows:

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.

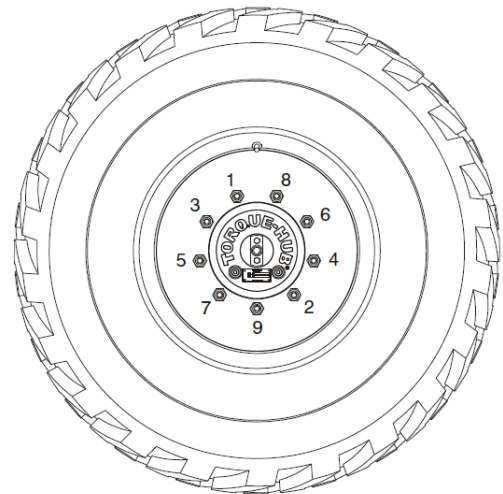


Figure 3-1. Wheel Lug Nut Tightening Sequence

- The tightening of the nuts should be done in stages. Following the recommended sequence, tighten nuts per wheel torque chart.

**Table 3-1. Wheel Torque Chart**

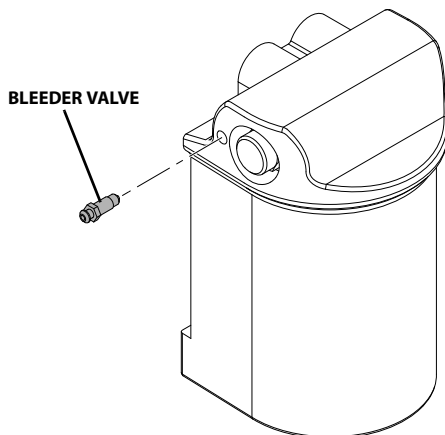
TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
40 ft.-lbs. (55 Nm)	95 ft.-lbs. (130 Nm)	170 ft.-lbs. (230 Nm)

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

### 3.2 OSCILLATING AXLE BLEEDING PROCEDURE AND LOCKOUT TEST

#### Lockout Cylinder Bleeding

- Position the turntable to the normal stowed position. In this position the axle is free oscillate. Drive charge pressure will pass through the lock out valve built into the swivel and down to the pilot section of the hold valves on the cylinders. This will automatically purge the air from the pilot section of the circuit.
- Disconnect the brake wire connector on the brake valve located under the drive pump.
- Locate the bleeder on the lock out cylinders. Use a small hose (gas hose, etc.) to direct the oil to a bucket. Do one cylinder a time. Using a wrench open the bleeder a 1/4 turn. Have the operator in the platform just crake the drive controller in reverse. This will activate the brake valve sending charge pressure to the lock out cylinder. make sure the bleeder is open enough to vent any air for about 10 seconds. Close the bleeder while there is fluid pressure at the bleeder.
- Repeat the procedure for the other lockout cylinder.
- Reconnect the brake wire connector on the brake valve.



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#### 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 prior to beginning lockout cylinder test.*

- Place a 6 inches (15.2 cm) high block with ascension ramp in front of left front wheel.
- From platform control station, start engine.
- Place the Drive control lever to the forward position and carefully drive machine up ascension ramp until left front wheel is on top of block.
- Carefully activate Swing control lever and position boom over right side of machine.
- With boom over right side of machine, place Drive control lever to Reverse and drive machine off of block and ramp.
- Have an assistant check to see that left front wheel remains locked in position off of ground.
- 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 to activate Drive to release cylinders.
- Place the 6 inches (15.2 cm) high block with ascension ramp in front of right front wheel.
- Place Drive control lever to Forward and carefully drive machine up ascension ramp until right front wheel is on top of block.
- With boom over left side of machine, place Drive control lever to Reverse and drive machine off of block and ramp.
- Have an assistant check to see that right front wheel remains locked in position off of ground.
- 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.
- If lockout cylinders do not function properly, have qualified personnel correct the malfunction prior to any further operation.



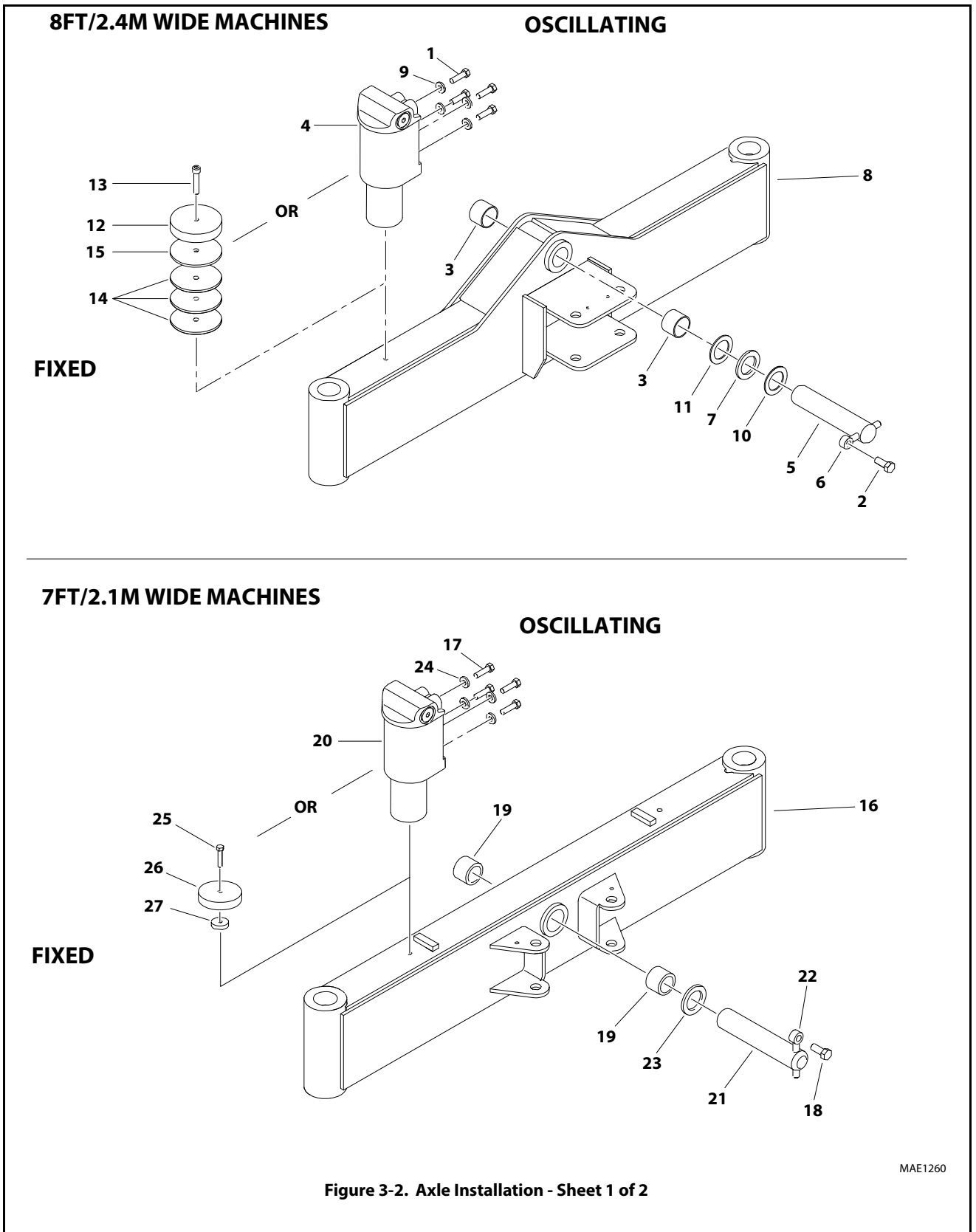
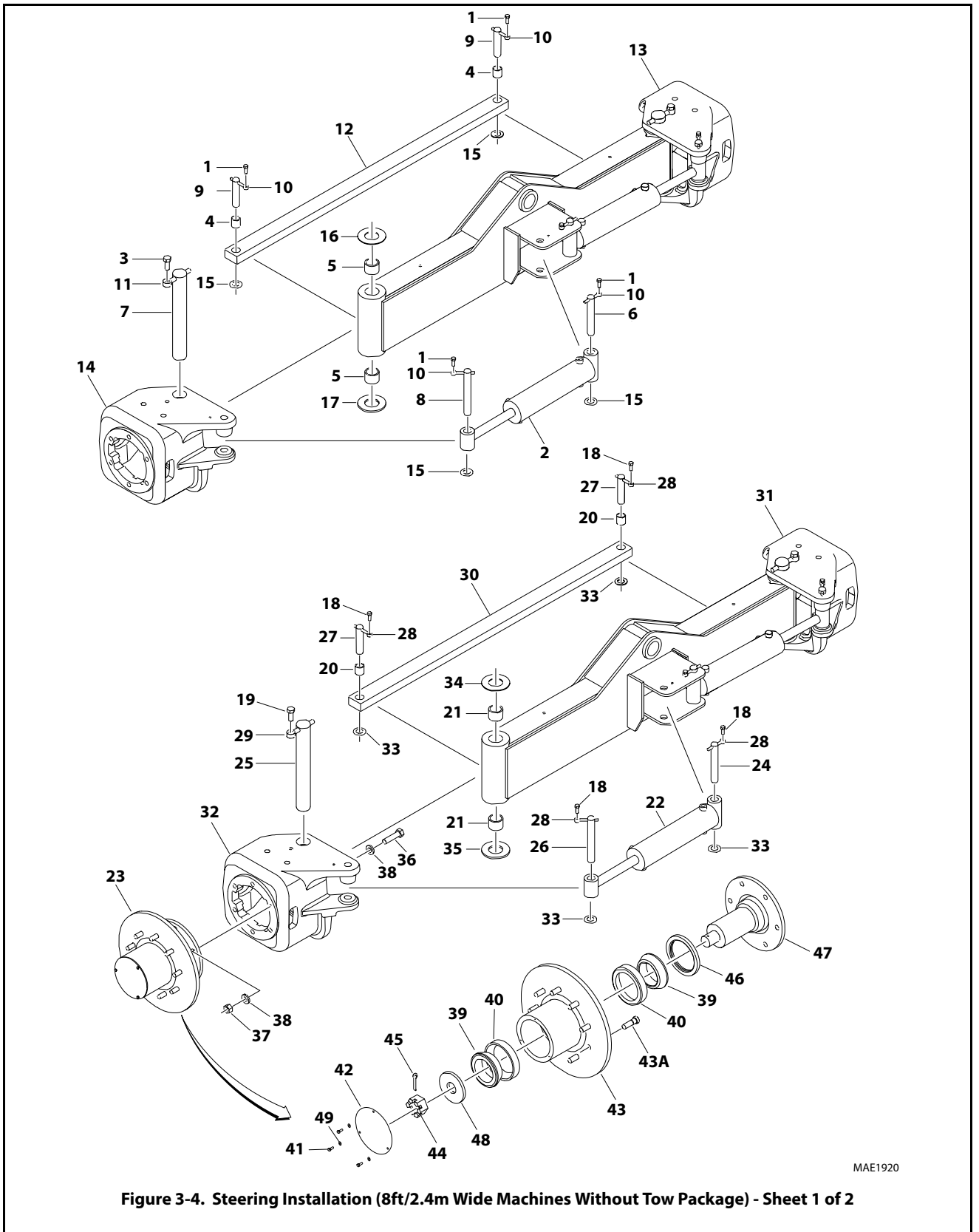


Figure 3-2. Axle Installation - Sheet 1 of 2

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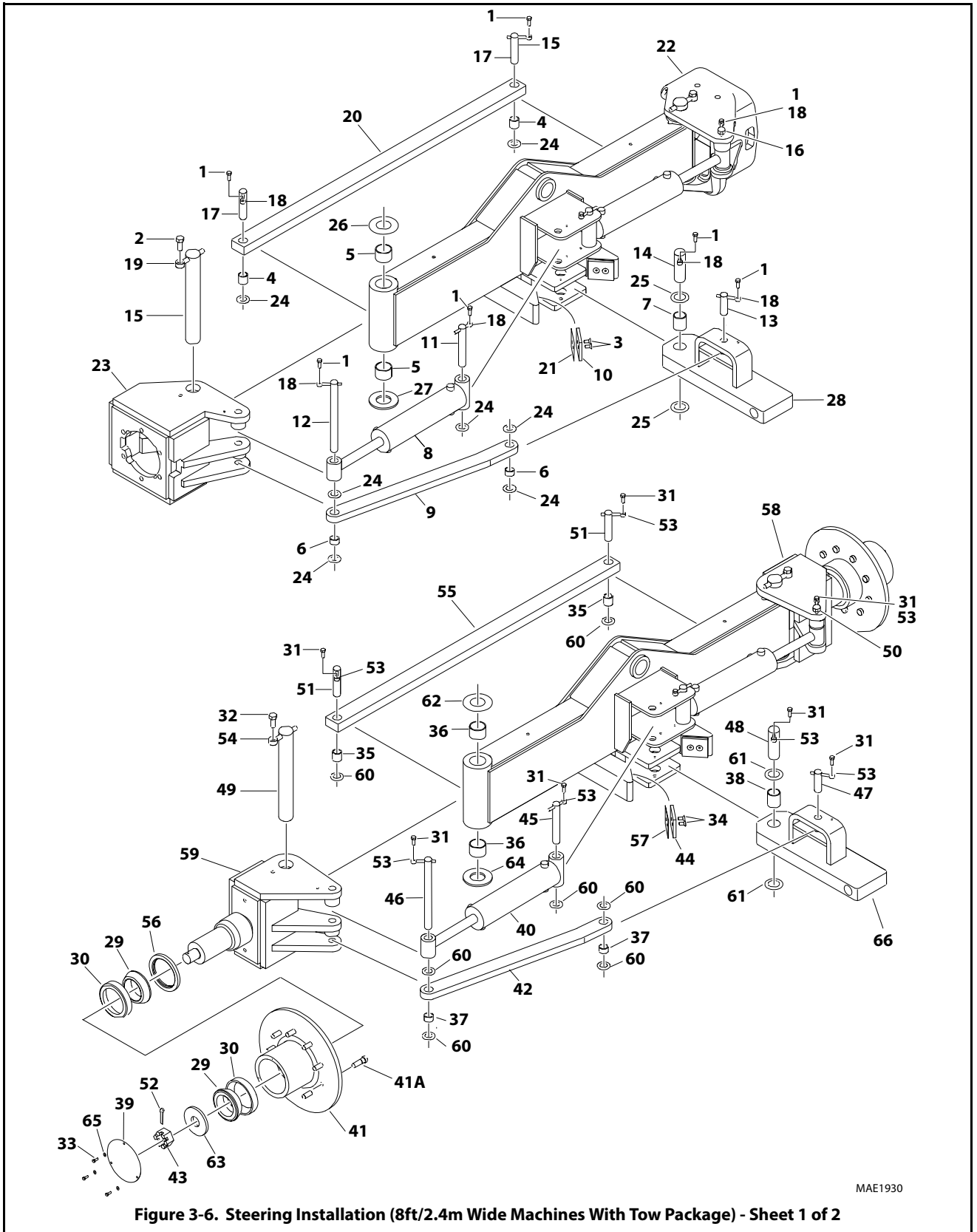
- |                                   |                   |                                    |
|-----------------------------------|-------------------|------------------------------------|
| 1. Bolt                           | 10. Thrust washer | 19. Bearing                        |
| 2. Bolt                           | 11. Shim          | 20. Axle Lockout Cylinder Assembly |
| 3. Bearing                        | 12. Stop Plate    | 21. Pin                            |
| 4. Axle Lockout Cylinder Assembly | 13. Cap Screw     | 22. Keeper Pin                     |
| 5. Pin                            | 14. Shim          | 23. Thrust washer                  |
| 6. Keeper Pin                     | 15. Shim          | 24. Flat washer                    |
| 7. Thrust washer                  | 16. Axle Weldment | 25. Bolt                           |
| 8. Axle Weldment                  | 17. Bolt          | 26. Stop Plate                     |
| 9. Flat washer                    | 18. Bolt          | 27. Spacer                         |

**Figure 3-3. Axle Installation - Sheet 2 of 2**



- |                            |                             |                  |                  |
|----------------------------|-----------------------------|------------------|------------------|
| 1. Bolt                    | 14. Spindle                 | 27. Pin          | 40. Cup Bearing  |
| 2. Steer Cylinder Assembly | 15. Thurstwasher            | 28. Keeper Pin   | 41. Bolt         |
| 3. Bolt                    | 16. Thurstwasher            | 29. Keeper Pin   | 42. Hub Cap      |
| 4. Bushing                 | 17. Thurstwasher            | 30. Tie-Rod      | 43. Hub          |
| 5. Bushing                 | 18. Bolt                    | 31. Spindle      | 43 A. Wheel Stud |
| 6. Pin                     | 19. Bolt                    | 32. Spindle      | 44. Nut          |
| 7. King Pin                | 20. Bushing                 | 33. Thurstwasher | 45. Cotter Pin   |
| 8. Pin                     | 21. Bushing                 | 34. Thurstwasher | 46. Seal         |
| 9. Pin                     | 22. Steer Cylinder Assembly | 35. Thurstwasher | 47. Adapter      |
| 10. Keeper Pin             | 23. Hub assembly            | 36. Bolt         | 48. Flat Washer  |
| 11. Keeper Pin             | 24. Pin                     | 37. Nut          | 49. Lock Washer  |
| 12. Tie-Rod                | 25. King Pin                | 38. Flat Washer  |                  |
| 13. Spindle                | 26. Pin                     | 39. Cone Bearing |                  |

**Figure 3-5. Steering Installation (8ft/2.4m Wide Machines Without Tow Package) - Sheet 2 of 2**



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## SECTION 3 - CHASSIS & TURNTABLE

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1. Bolt	18. Keeper Pin	35. Bushing	51. Pin
2. Bolt	19. Keeper Pin	36. Bushing	52. Cotter Pin
3. Screw	20. Tie-Rod	37. Bushing	53. Keeper Pin
4. Bushing	21. Shim	38. Bushing	54. Keeper Pin
5. Bushing	22. Spindle	39. Cap Hub	55. Tie-Rod
6. Bushing	23. Spindle	40. Steer Cylinder Assembly	56. Seal
7. Bushing	24. Thurstwasher	41. Hub	57. Shim
8. Steer Cylinder Assembly	25. Thurstwasher	41 A. Wheel Stud	58. Spindle
9. Link	26. Thurstwasher	42. Link	59. Spindle
10. Pad	27. Thurstwasher	43. Nut	60. Thurstwasher
11. Pin	28. Pivot	44. Pad	61. Thurstwasher
12. Pin	29. Cone Bearing	45. Pin	62. Thurstwasher
13. Pin	30. Cup Bearing	46. Pin	63. Flatwasher
14. Pin	31. Bolt	47. Pin	64. Thurstwasher
15. Pin	32. Bolt	48. Pin	65. Lock Washer
16. Pin	33. Bolt	49. Pin	66. Pivot
17. Pin	34. Screw	50. Pin	

**Figure 3-7. Steering Installation (8ft/2.4m Wide Machines With Tow Package) - Sheet 2 of 2**

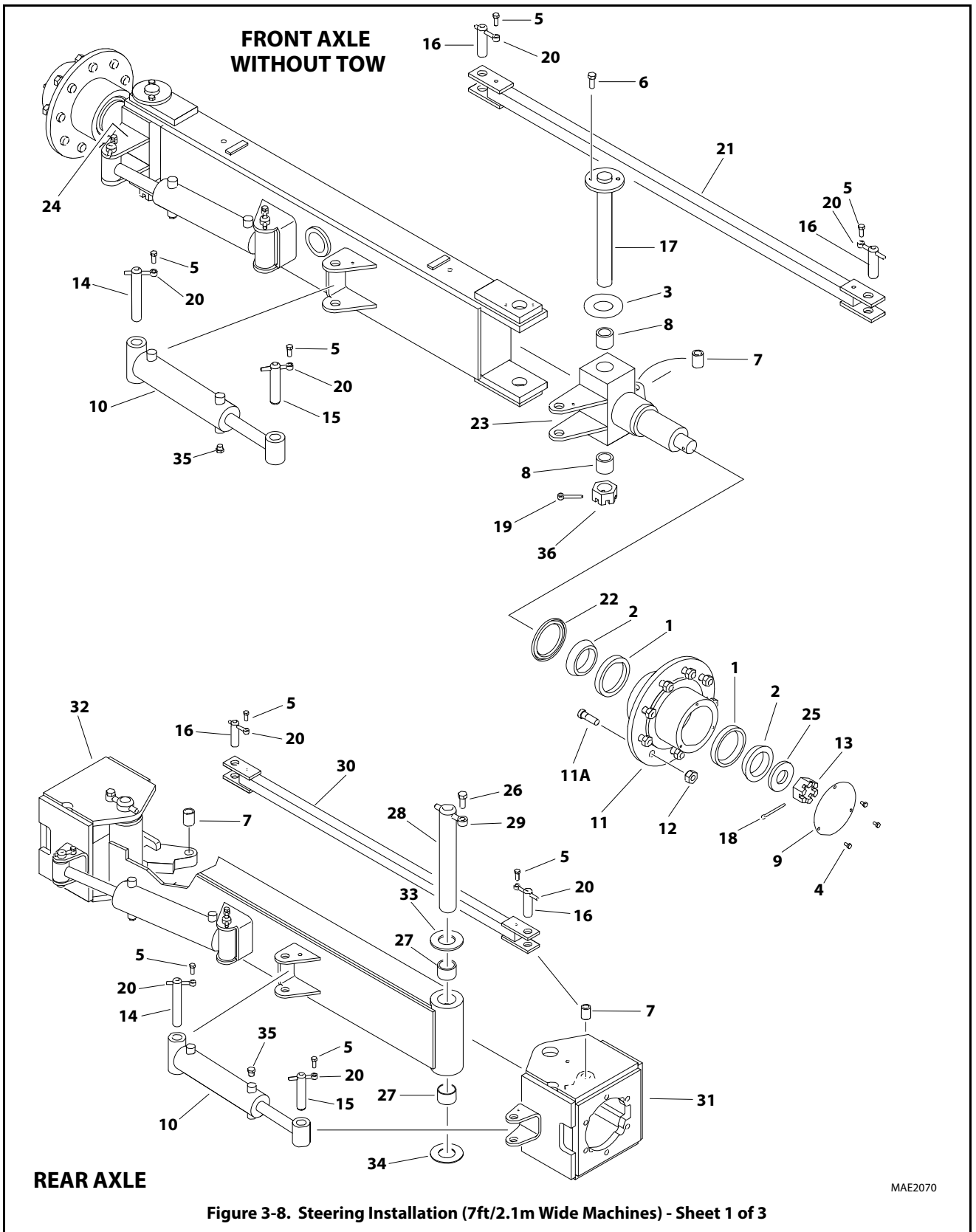


Figure 3-8. Steering Installation (7ft/2.1m Wide Machines) - Sheet 1 of 3

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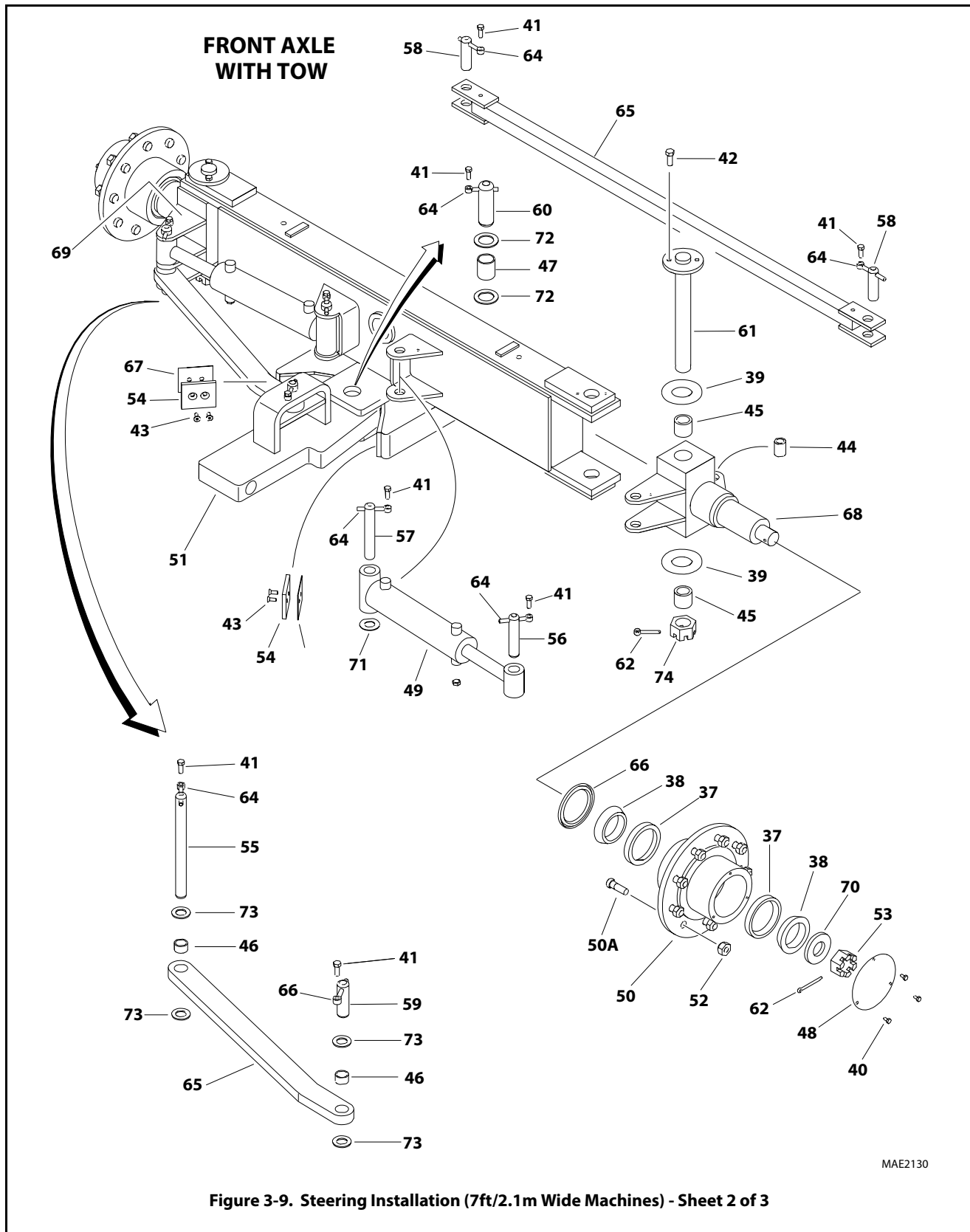


Figure 3-9. Steering Installation (7ft/2.1m Wide Machines) - Sheet 2 of 3



- |                             |                  |                             |                  |
|-----------------------------|------------------|-----------------------------|------------------|
| 1. Cup Bearing              | 19. Cotter Pin   | 38. Cone Bearing            | 56. Pin          |
| 2. Cone Bearing             | 20. Keeper Pin   | 39. Thurstwasher            | 57. Pin          |
| 3. Thurstwasher             | 21. Tie-Rod      | 40. Bolt                    | 58. Pin          |
| 4. Bolt                     | 22. Seal         | 41. Bolt                    | 59. Pin          |
| 5. Bolt                     | 23. Spindle      | 42. Bolt                    | 60. Pin          |
| 6. Bolt                     | 24. Spindle      | 43. Screw                   | 61. King Pin     |
| 7. Bushing                  | 25. Flat Washer  | 44. Bushing                 | 62. Cotter Pin   |
| 8. Bushing                  | 26. Bolt         | 45. Bushing                 | 63. Link         |
| 9. Hub Cap                  | 27. Bearing      | 46. Bushing                 | 64. Keeper Pin   |
| 10. Steer Cylinder Assembly | 28. King Pin     | 47. Bushing                 | 65. Tie-Rod      |
| 11. Hub                     | 29. Keeper       | 48. Hub Cap                 | 66. Seal         |
| 11 A. Wheel Stud            | 30. Tie-Rod      | 49. Steer Cylinder Assembly | 67. Shim         |
| 12. Wheel Nut               | 31. Spindle      | 50. Hub                     | 68. Spindle      |
| 13. Slotted Nut             | 32. Spindle      | 50 A. Wheel Stud            | 69. Spindle      |
| 14. Pin                     | 33. Thurstwasher | 51. Pivot                   | 70. Flat Washer  |
| 15. Pin                     | 34. Thurstwasher | 52. Wheel Nut               | 71. Thurstwasher |
| 16. Pin                     | 35. Plug         | 53. Slotted Nut             | 72. Thurstwasher |
| 17. King Pin                | 36. Slotted Nut  | 54. Pad                     | 73. Flat Washer  |
| 18. Cotter Pin              | 37. Cup Bearing  | 55. Pin                     |                  |

**Figure 3-10. Steering Installation (7ft/2.1m Wide Machines) - Sheet 3 of 3**

### 3.3 TORQUE HUB

#### Oil Information

1. TYPE – EP90  
Use EP90 for normal applications. For applications where lubricant must meet special requirements, the O.E.M can recommend a suitable substitute.
2. OIL TEMPERATURE  
Continuous – 160° F (70° C) Intermittent – 200° F (95° C).
3. 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.

4. 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.

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

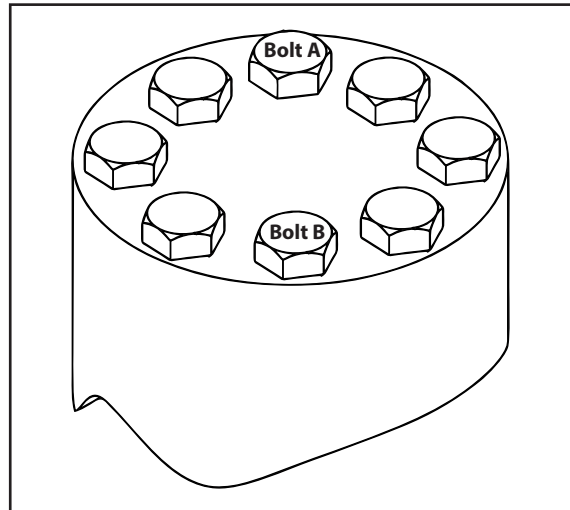
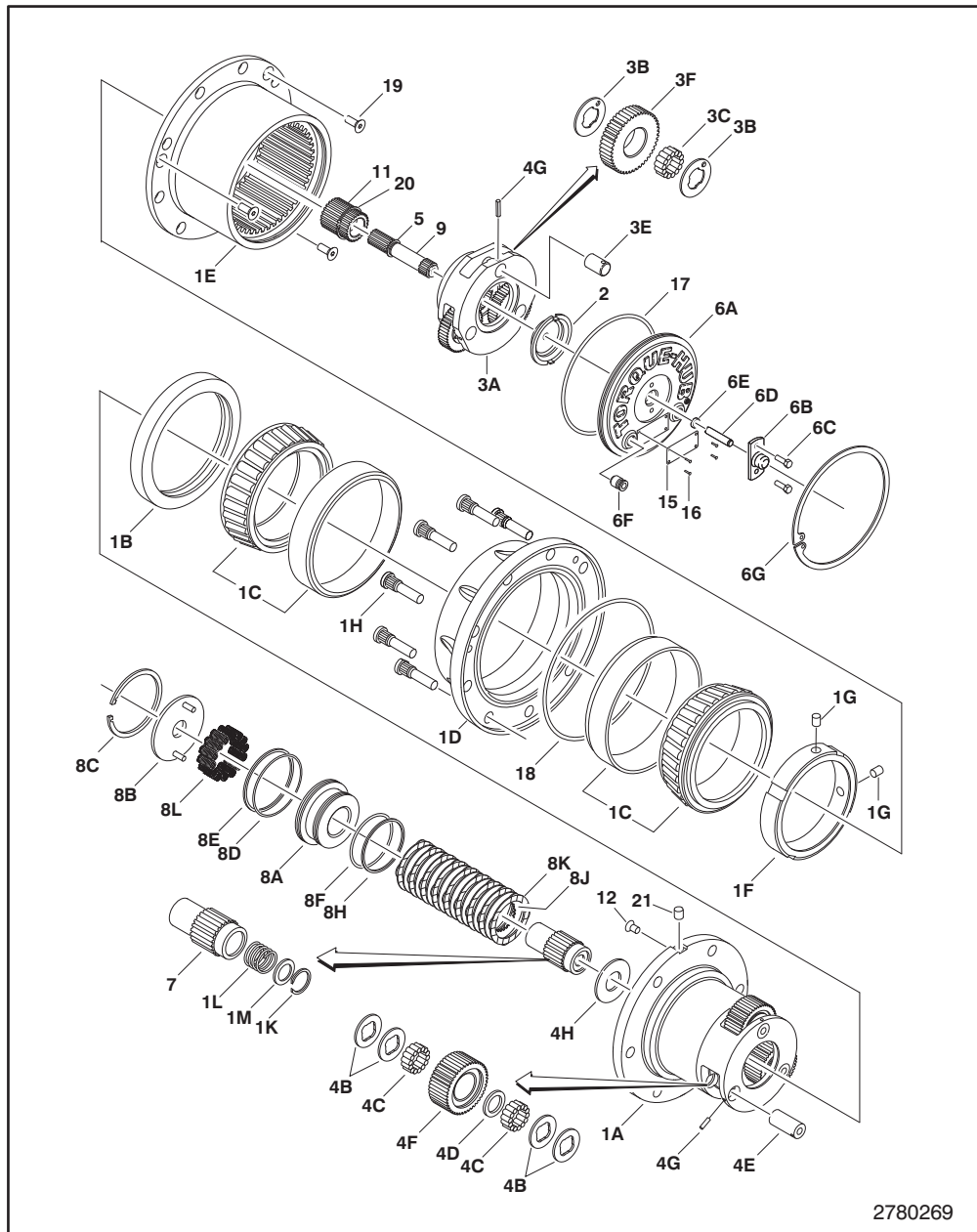


Figure 3-11. Bolt Tightening Sequence



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- |                    |                    |                    |                    |                  |                       |
|--------------------|--------------------|--------------------|--------------------|------------------|-----------------------|
| 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      | 8G. Back-up Ring | 17. O-Ring            |
| 1E. Ring Gear      | 3B. Thrustwasher   | 4G. Roll Pin       | 6G. Retaining Ring | 8H. 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     |                       |

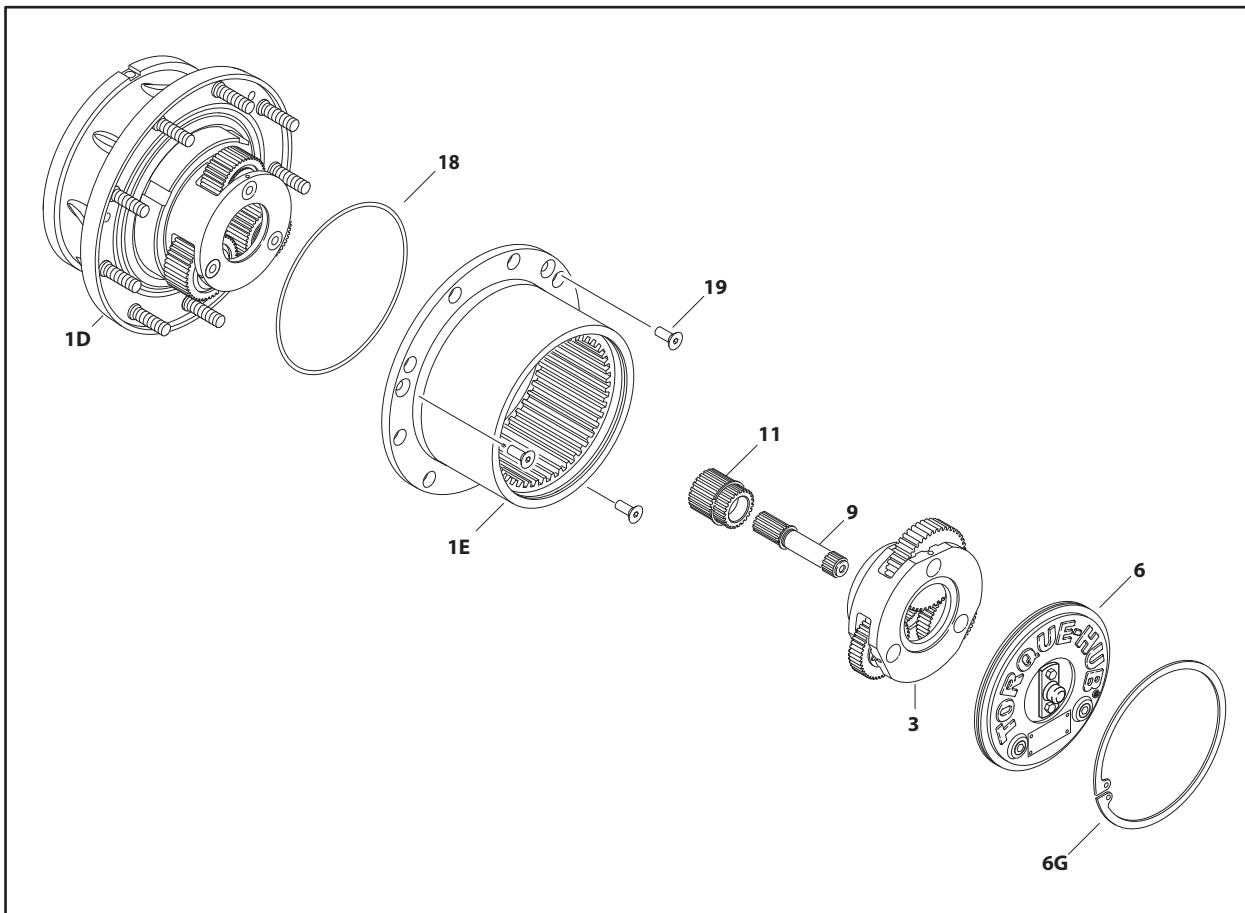
Figure 3-12. Torque Hub

**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).

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

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).



**Figure 3-13. Torque Hub Main Disassembly**

### Output Carrier Disassembly

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

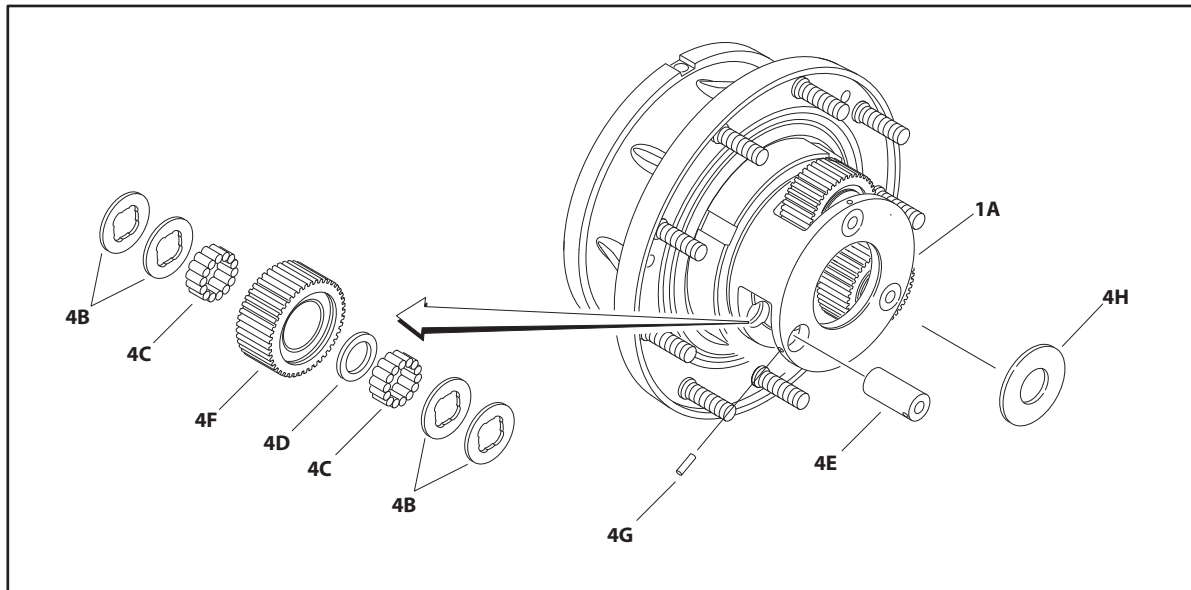


Figure 3-14. Output Carrier Disassembly

### 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.

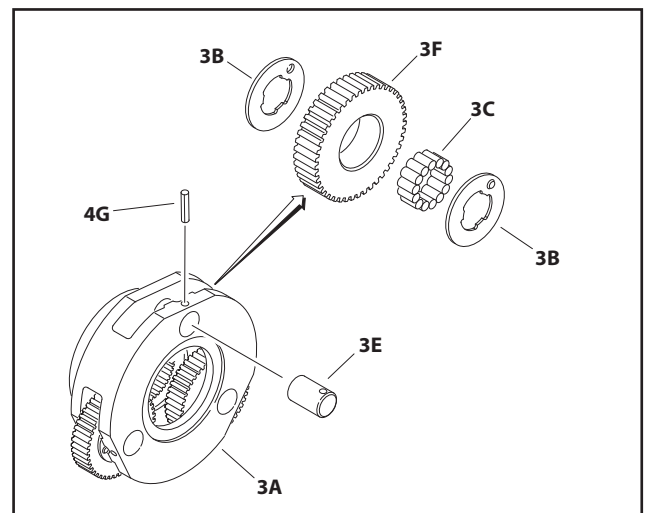
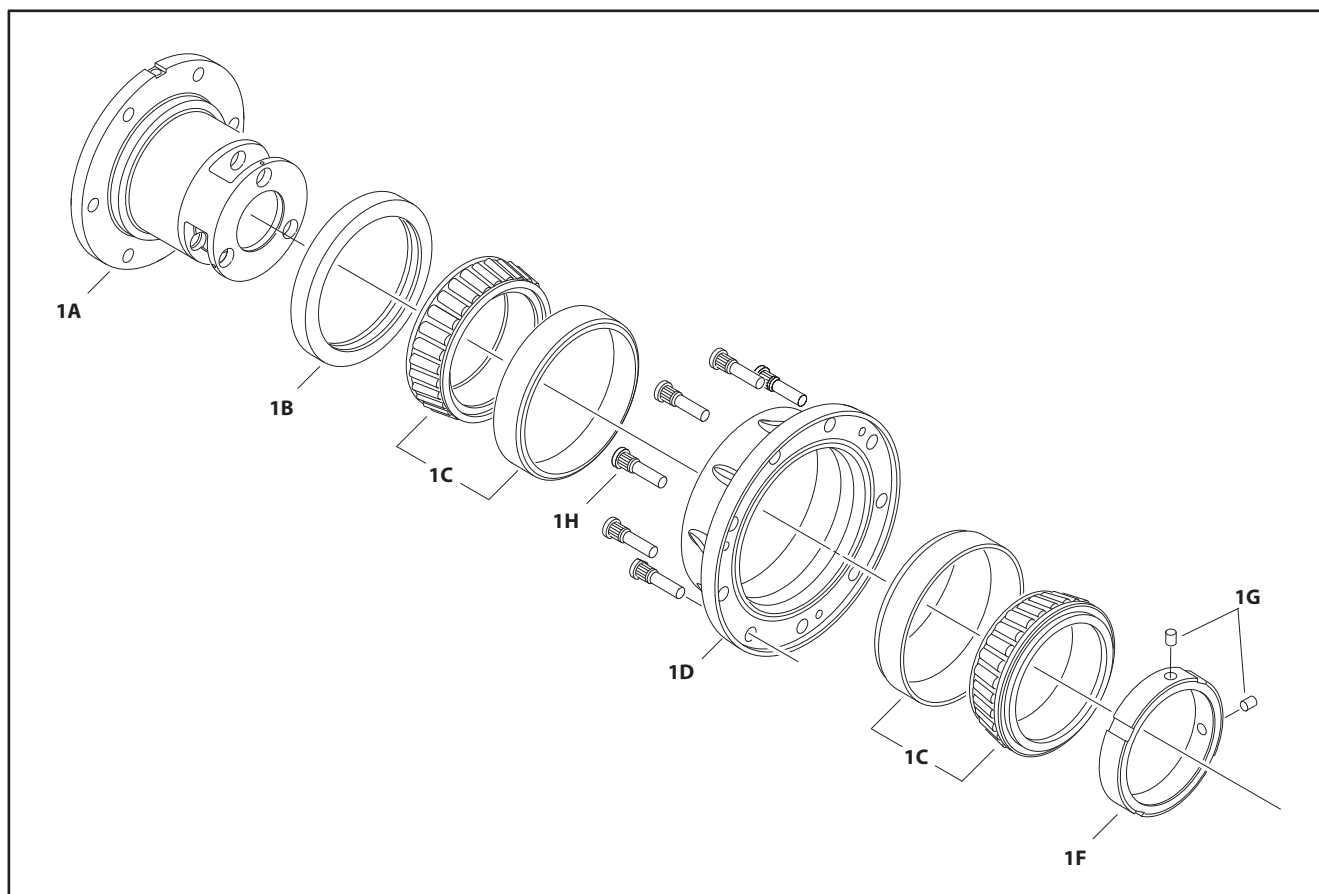


Figure 3-15. Input Carrier Disassembly

**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 3-16. 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.**

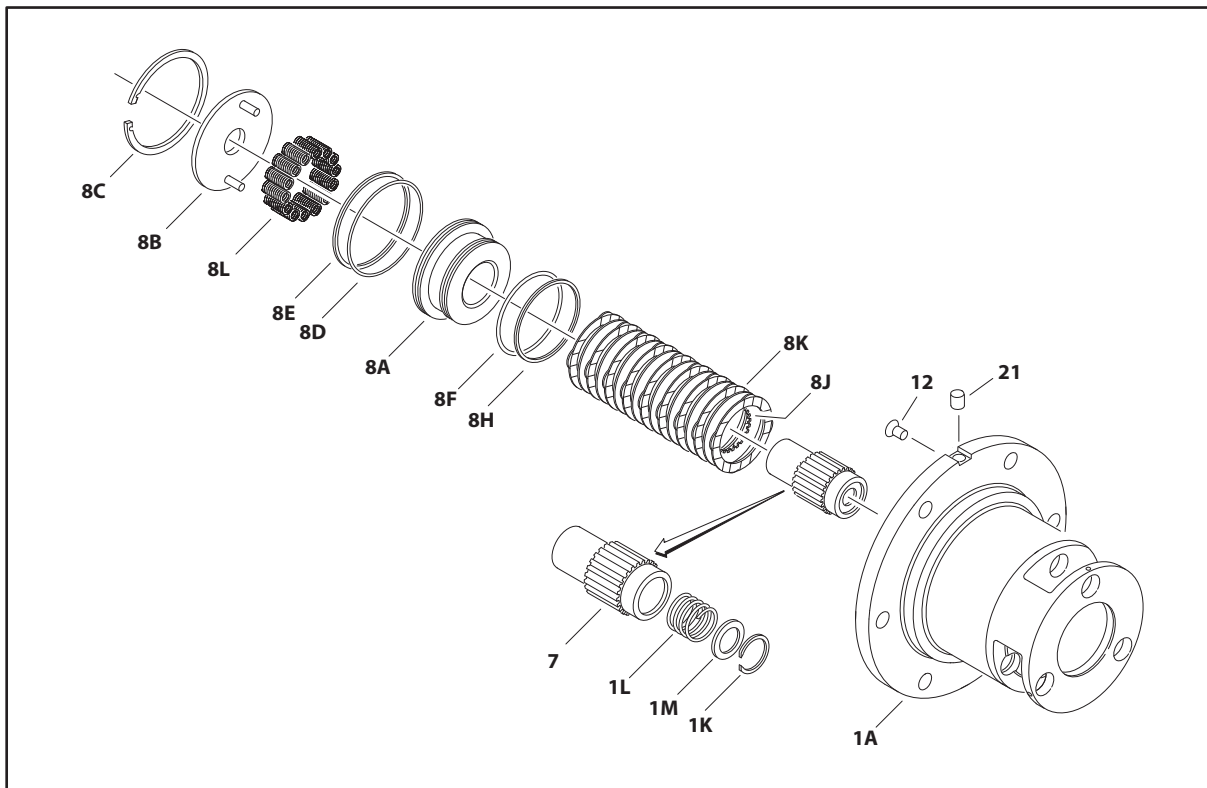
1. Install two 1/4"-20 x 5/8" Flat Head Cap Screws (22) through Pressure Plate (8B) into Piston (8A). Tighten incrementally until spring force is taken off Retaining Ring (8C).

**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 3-17. Spindle Brake Disassembly**

### 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.

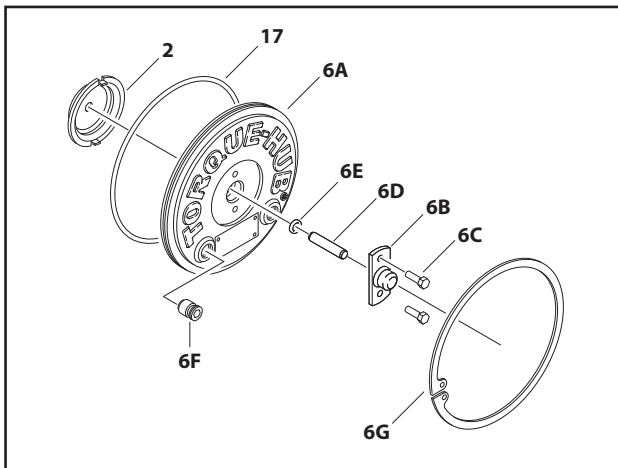


Figure 3-18. Torque Hub Cover

### Input Carrier Sub-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.
4. Insert a Planet Shaft (3E) in planet shaft hole in end of Carrier (3A) opposite splined end. End of planet shaft that does NOT have the roll pin hole should be inserted into carrier FIRST.
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).

**NOTE:** 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 the Thrust Washers (3B) to hold them in place while installing the planet gears.

### Output Planet Gear Sub-Assembly

1. Apply a liberal coat of grease to the bore of one Output Planet Gear (4F).
2. Line inside of the 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. Do the same to the other side.
6. Repeat Steps 1-5 to finish assembly of two remaining Output Planet Gears (4F).

### Spindle - Brake Sub-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 sub-Assembly (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 2 Screws from units when done or brake will not function.

17. Install Pipe Plug (21) if applicable

### Hub-Spindle Sub-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).
5. Place Hub (1D) into pressing base. Press nine Studs (1H) into Hub.

**NOTE:** Use enough pressure to press in studs. Don't use excessively high pressure to press in studs or hub may crack.

6. Set Spindle assembly (1A) on the bench with the flange down. Turn Hub (1D) over and lower onto Spindle (5). Install boot (21) if applicable.
7. Install Bearing Cone of part (1C) into Bearing Cup, position "A".
8. Apply Loctite 243 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 the initial rolling torque with the unit tied down. Then torque Bearing Nut (1F) until rolling torque is 40 to 50 in-lbs greater than initial rolling torque. Using tool T-206569 for the Bearing Nut.

**NOTE:** Final torque is initial rolling torque plus 40-50 in-lb (4.5-5.6 Nm). For example, if initial rolling torque is 30 in-lb (3.3 Nm), final rolling torque is between 70-80 in-lb (7.9-9 Nm). Rotate hub as torque is applied to properly seat bearing. Be sure torque wrench is tangent to the Hub (1D) OD.

9. Using appropriate tool, install two Set Screws (1G) into Bearing Nut (1F) threaded holes. Make sure Set Screw is driven into the spindle thread. Tighten the set screws to damage the thread and stake the edge of the nut around the Set Screws (1G) so the nut will not loosen.
10. Place Thrust Washer (4H) in counterbore of Spindle (1A).
11. Place Planet Gear Sub-assembly (4) into Spindle (1A) through gap between two Studs (1H). Align the planet gear bore with one of the planet shaft holes on the spindle (1A) assembly using T-209919.
12. Insert a Planet Shaft (4E) into the planet shaft hole described in Step (11) on Spindle (1A). Insert end of planet shaft that does NOT have roll pin hole in Spindle FIRST.

## SECTION 3 - CHASSIS & TURNTABLE

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

**NOTE:** Do not hit Planet Gears (4F) when driving in Roll Pins (4G).

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

### Cover Sub-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-lb (7.9- 9 Nm).
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) making sure tangs on washer seat into pockets in cover.
5. Install O-Ring Pipe Plugs (6F) in Cover (6A). Plugs should be hand tight.

### Main Assembly

**NOTE:** All components should receive a generous amount of lubricant oil as they are being assembled.

1. Place Hub-Spindle Sub-Assembly 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 (20-27 Nm).
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 Sub-Assembly.

9. Place Input Carrier Sub-Assembly (3A) on Output Sun Gear (11) splines. Drop Input Sun (10) in mesh with planet gears for specific ratios, if required. (No timing required).
10. Grease O-Ring (17) and insert in groove in Cover Sub-Assembly (6).
11. Install Cover Sub-Assembly (6) in Ring Gear (1E) counter-bore and install Retaining Ring (6G) in groove in Ring Gear (1E).
12. Attach ID Tag (15) on unit using Drive Screws (16).
13. Check disconnect, roll and air check unit, leak check brake, and record release pressure.
14. Insert Plastic Plug (12) if applicable.

### Integral Brake Check

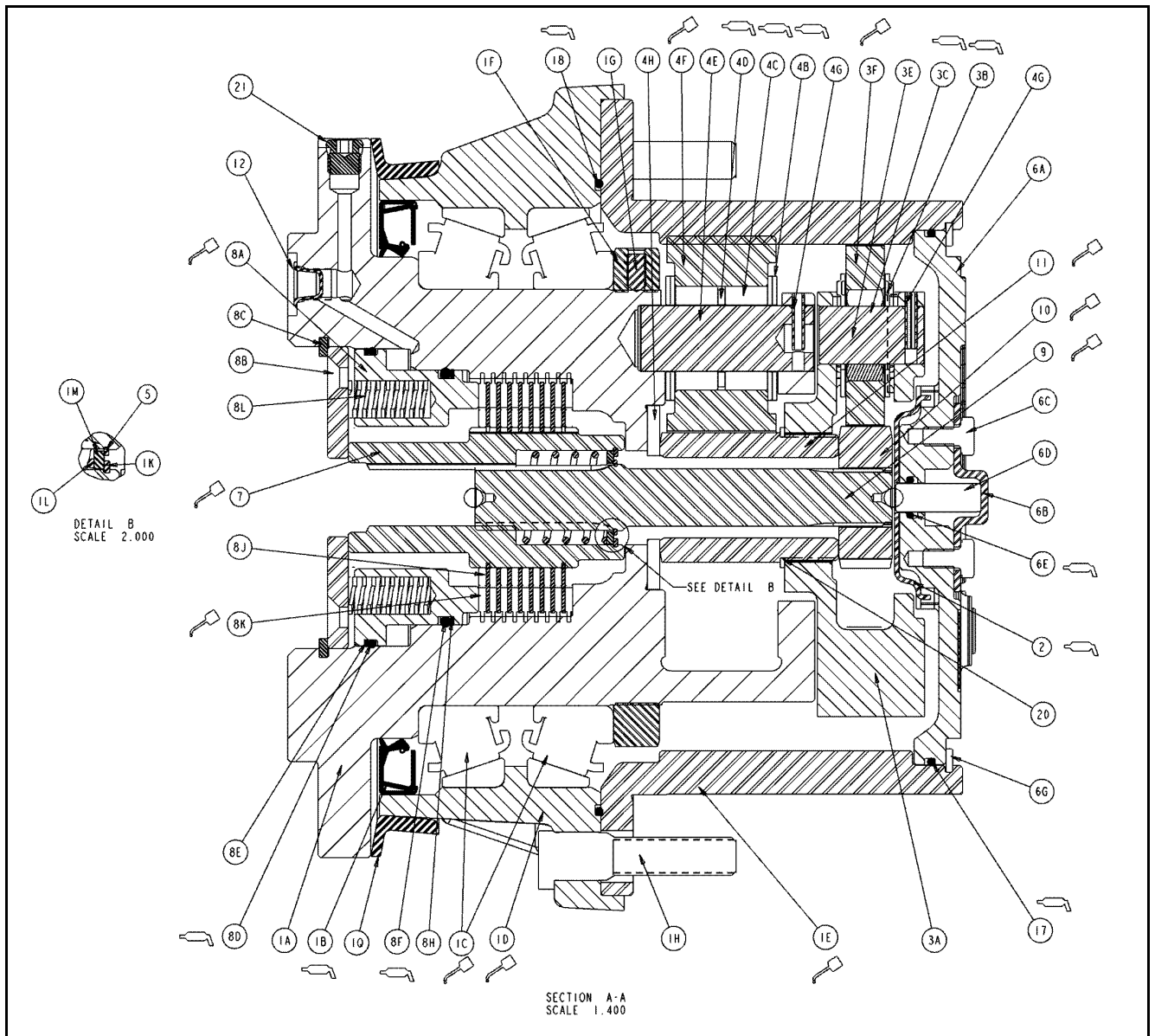
1. Using appropriate fittings, connect hydraulic line from hand pump to brake port.
2. Check brake is set by trying to rotate Input Shaft (9). This can be accomplished by installing an appropriate tool (any tool that can locate on splines of Input Coupling (7), such as a mating splined shaft) into Input Coupling (7).
3. Bleed brake. 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 below.

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.



- |                     |                    |                    |                    |                  |                    |
|---------------------|--------------------|--------------------|--------------------|------------------|--------------------|
| 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 3-19. Hub Assembly

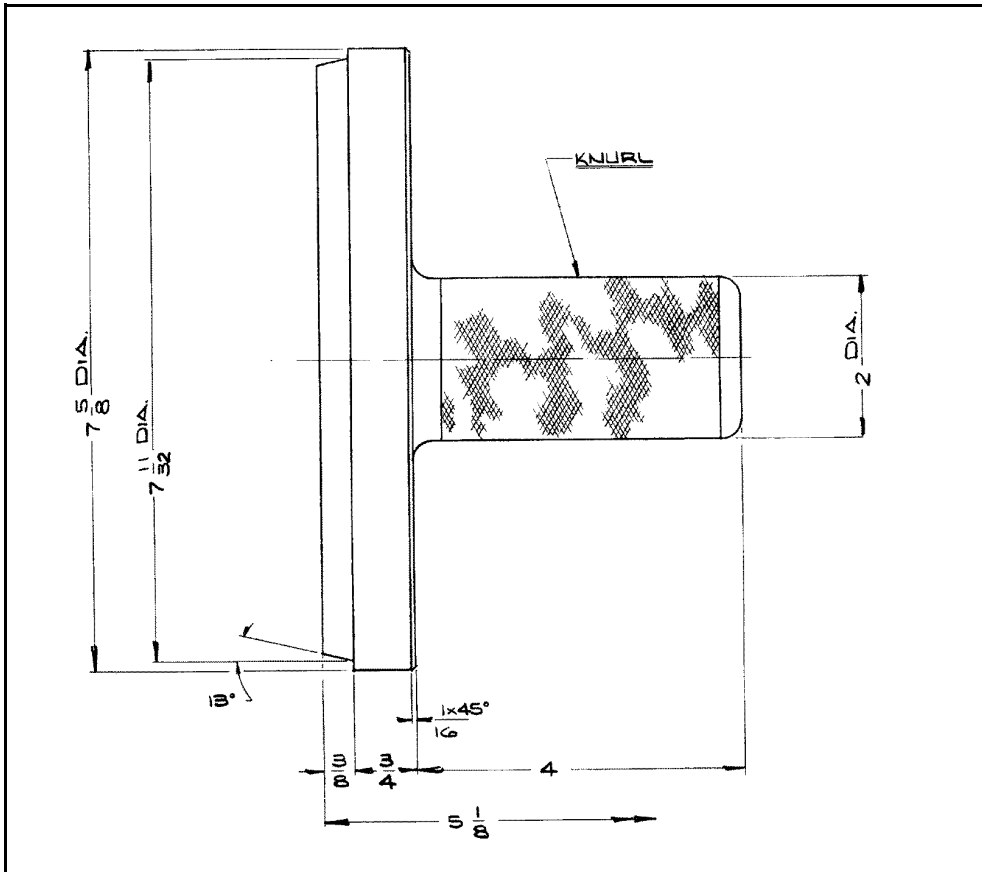


Figure 3-20. Bearing Cup Pressing Tool

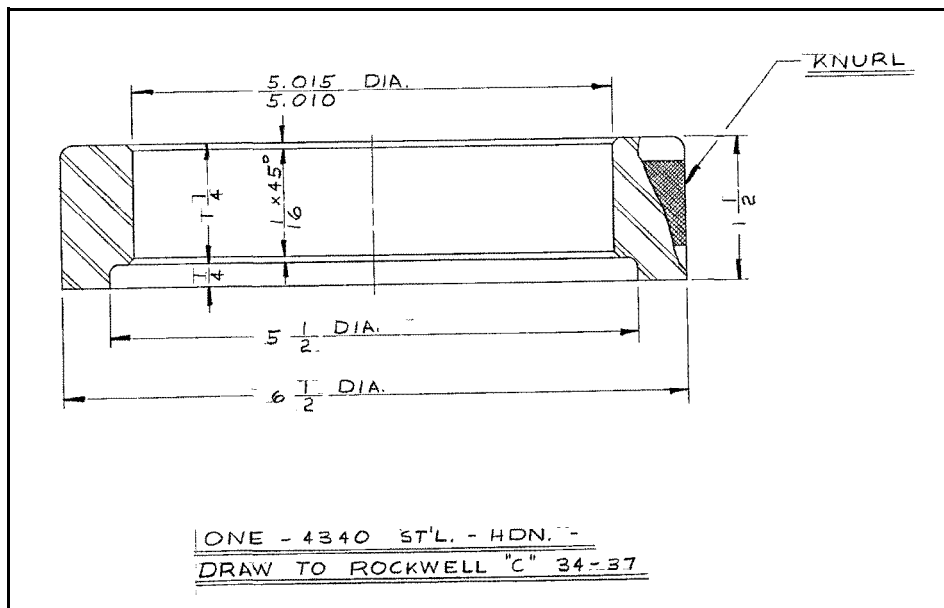


Figure 3-21. Seal Pressing Tool

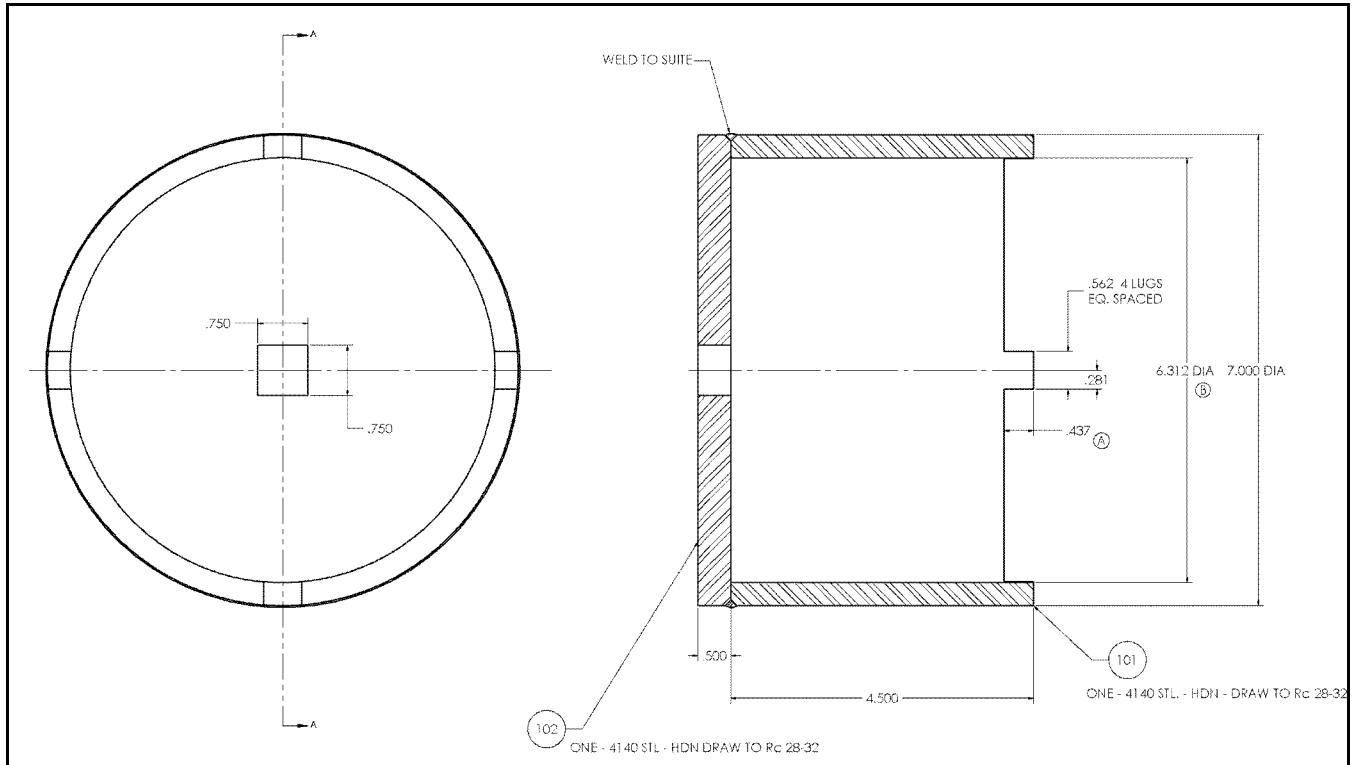


Figure 3-22. Bearing Cup Pressing Tool

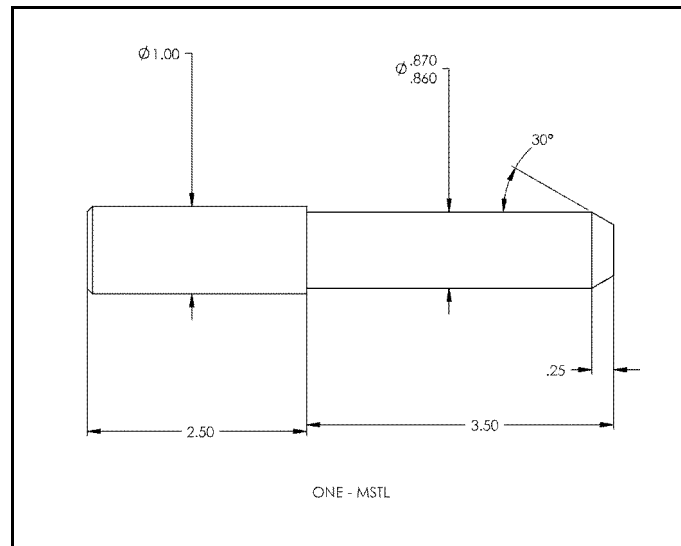


Figure 3-23. Drift Pin for Lining Up Thrust Washers with Output Planet Gear

### 3.4 FREE WHEELING OPTION

#### Disengage Drive Motors and 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 and 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.

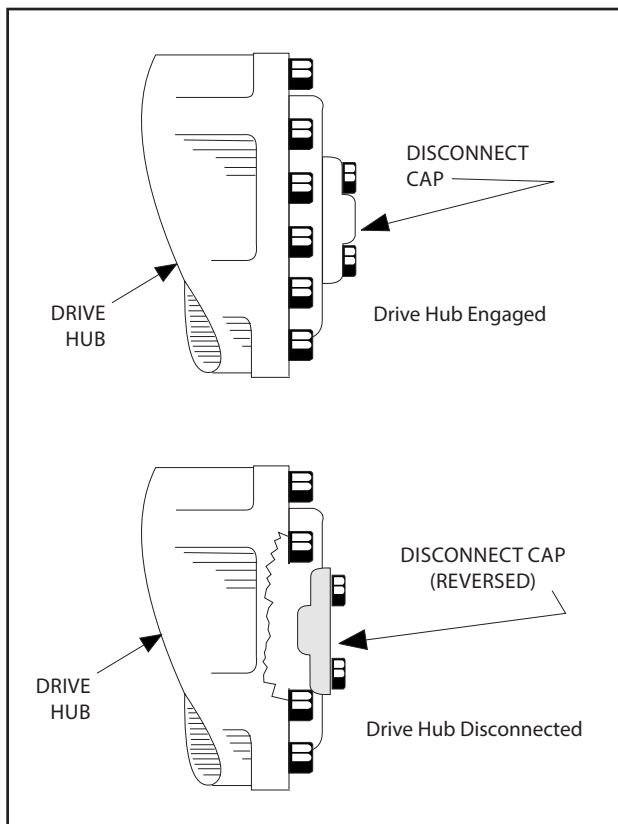


Figure 3-24. Disconnecting Drive Hubs

### 3.5 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.

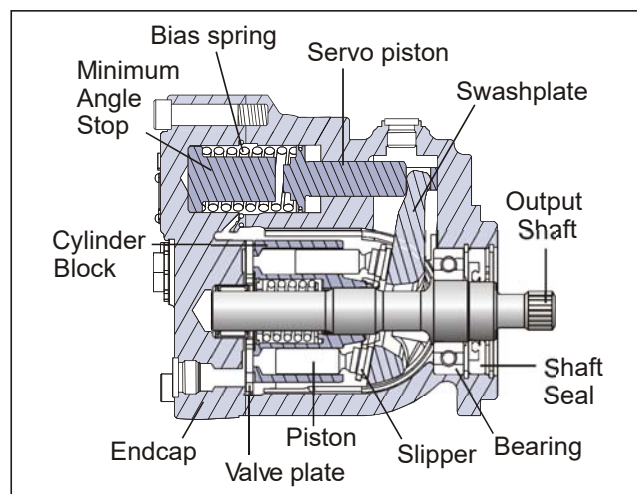
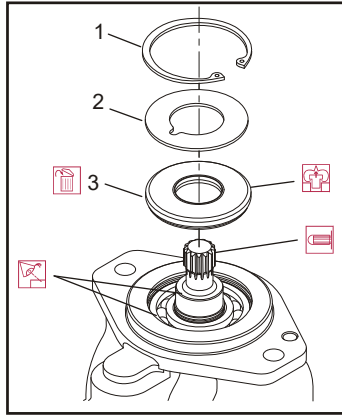


Figure 3-25. Drive Motor Cross Section

## 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 3-26. 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.

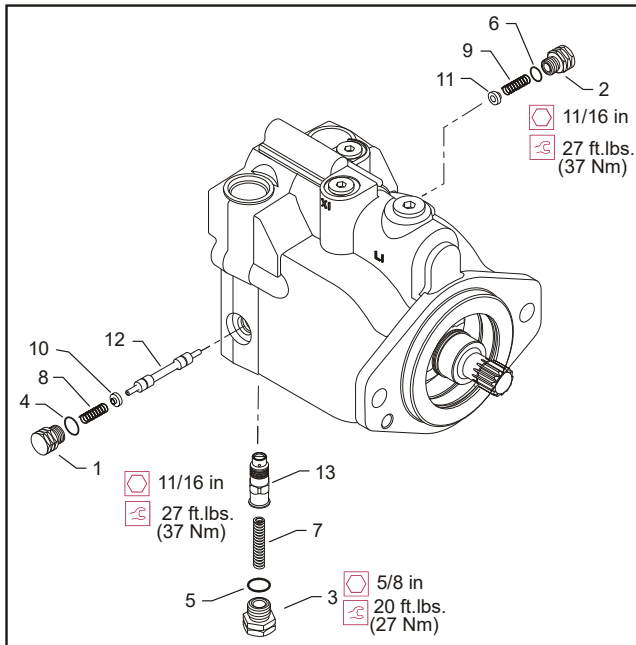
### INSTALLATION

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. Remove plug (1) and (2) using an 11/16 in internal hex wrench.



- |           |            |                    |
|-----------|------------|--------------------|
| 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 3-26. Loop Flushing Spool**

2. Remove plug (3) using a 1/4 in hex wrench.
3. Remove O-rings (4, 5, and 6).
4. Remove centering springs (7, 8, and 9) using pliers.
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. Torque plug (3) to 20 ft-lb (27 Nm) using an 1/4 in hex wrench.
7. Torque plugs (2 and 1) to 27 ft-lb (37 Nm) using an 11/16 in internal hex.



## Troubleshooting

**Table 3-2. 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 3-3. 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 3-4. No 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.

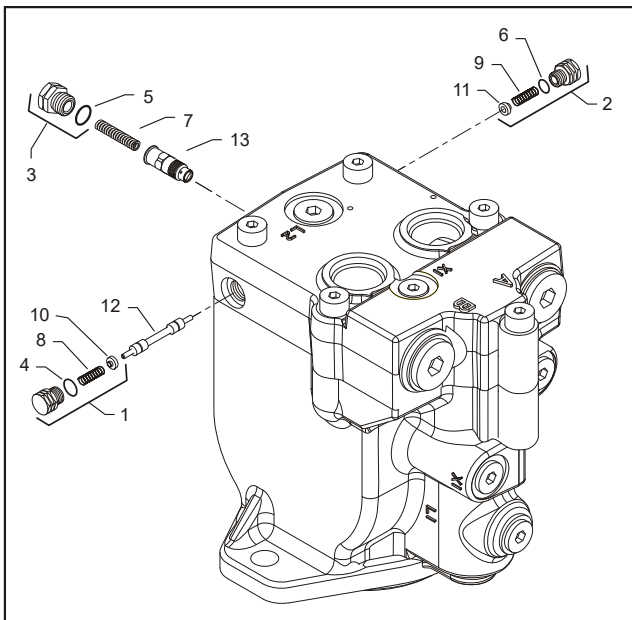
**Disassembly**

**NOTE:** Removal of endcap voids warranty.

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

Replace all O-Rings and gaskets.

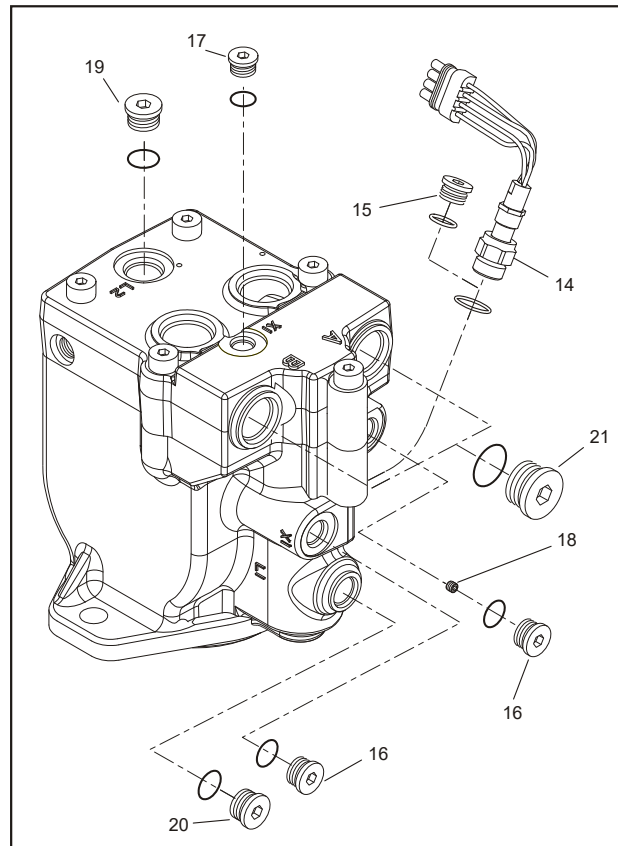
It is recommended to replace all O-rings. Lightly lubricate O-rings with clean petroleum jelly before assembly.



- |           |           |            |                    |
|-----------|-----------|------------|--------------------|
| 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 3-26. Loop Flushing Spool**

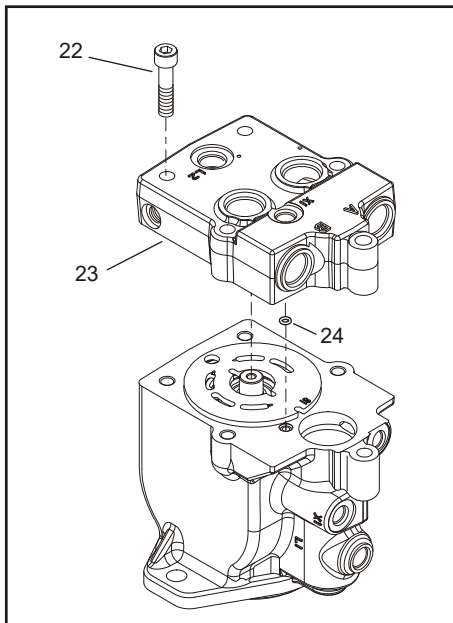
1. Using a 11/16 in wrench remove plug (1) and (2).
2. Using a 5/8 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



- |                       |                    |
|-----------------------|--------------------|
| 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 3-27. Plugs, Fittings, and Speed Sensor**

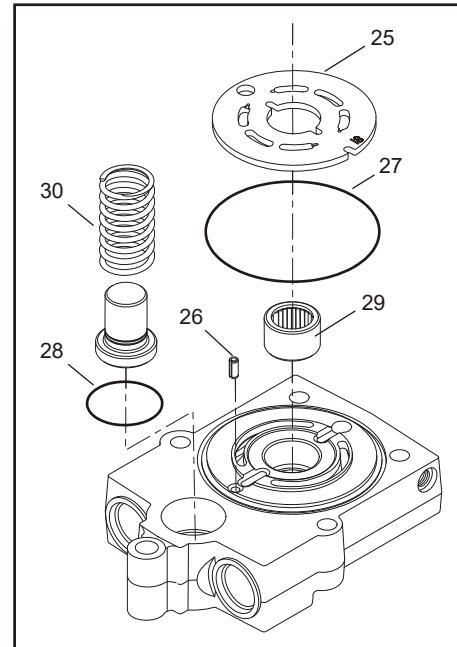
8. Remove all fittings from unit. Discard any O-rings on fittings.
9. Using an 11/16 inch hex wrench, loosen speed sensor lock nut (14) if equipped. Remove speed sensor using a Vi inch hex wrench. Units without speed sensor have an O-ring plug (15) installed in that location; remove it with a Va inch 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 3-28. 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.



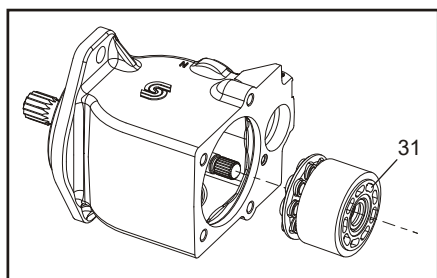
- 25. ValvePlate
- 26. End Cap
- 27. O-ring
- 28. O-ring
- 29. Bearing
- 30. ServoSpring

**Figure 3-29. Valve Plate & Rear Shaft Bearing**

### **NOTICE**

**DO NOT SCRATCH VALVE PLATE SURFACE.**

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 lightly with a soft mallet on the splined end. The grease will force the bearing out. Use caution not to drive bearing past the rear shaft journal as bearing may become trapped on shaft and damaged.
18. Remove minimum angle stop and servo spring (30) from housing.



31. Cylinder Kit Assembly

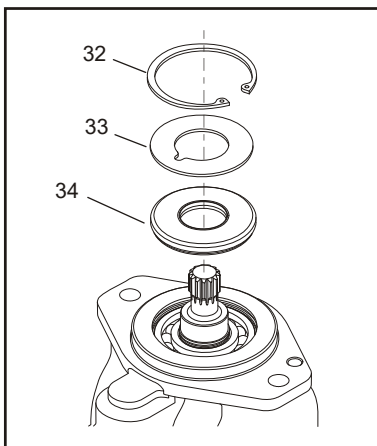
Figure 3-30. Cylinder Kit

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

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

Table 3-5. Displacement Identifiers

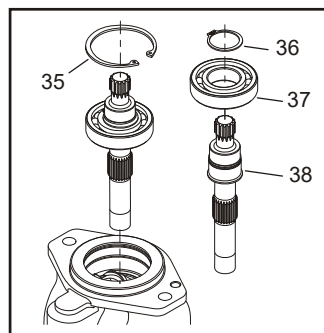
# of Grooves	Frame L	Frame K
1	25	38
2	30	45
3	35	--



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

Figure 3-31. Shaft Seal

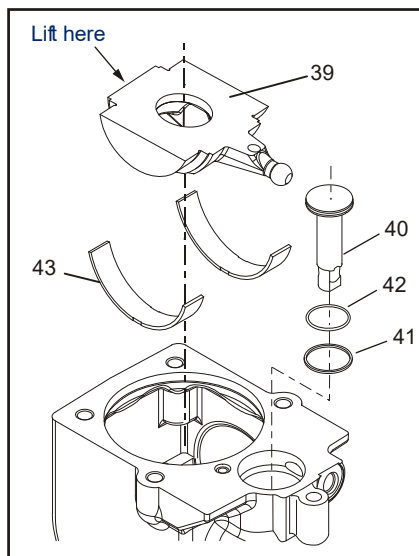
20. Turn housing over and remove snap ring (32) retaining shaft seal and support washer. Remove support washer (33) and carefully pry out shaft seal (34). Discard seal. To avoid damaging shaft during seal removal, install a large sheet metal screw in chuck of slide hammer. Drive screw into seal surface and use slide hammer to pull seal.



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

Figure 3-32. Shaft & Front Bearing

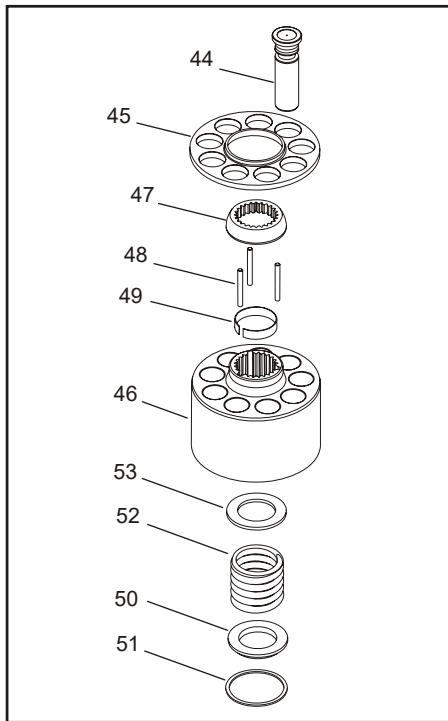
21. Remove inner snap ring (35) and shaft/bearing assembly.
22. Remove snap-ring (36) retaining shaft front bearing. Pull bearing (37) off shaft (38).



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

Figure 3-33. Swash Plate & Servo Piston

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



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

**Figure 3-34. Cylinder Kit Disassembly**

- 26.** Remove pistons (44) and slipper retainer (45) from cylinder block (46).

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.

- 27.** 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 block spring problems.

**⚠ WARNING**

**RISK OF PERSONAL INJURY: COMPRESSING 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 SPRING IS SECURE BEFORE ATTEMPTING TO REMOVE SPIRAL RETAINING RING. RELEASE PRESSURE SLOWLY AFTER RETAINING RING IS REMOVED.**

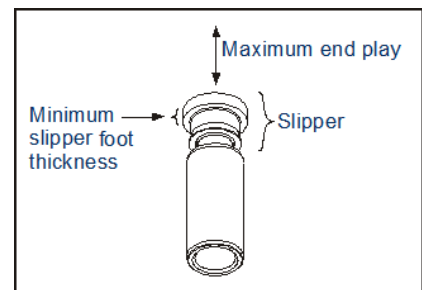
- 28.** Turn block over. Using a press, apply pressure on block spring washer (50) to compress the block spring. Compress spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind the spiral retaining ring (51). Carefully release pressure and remove outer block 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.

Minimum slipper foot thickness and maximum axial end-play are given in table below.

**Table 3-6. Slipper Foot Thickness & End Play**

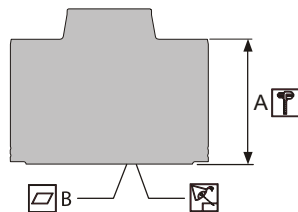
Measurement	L Frame	K Frame
Slipper Foot Thickness	2.71 mm (0.11 in.)	4.07 mm (0.16 in.)
Piston/Slipper End Play	0.15 mm (0.006 in.)	

**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 3-7, Cylinder Block Measurements.

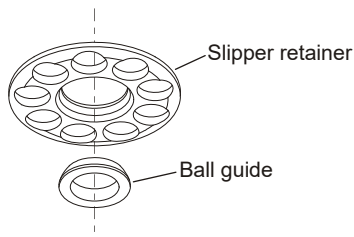
**Table 3-7. Cylinder Block Measurements**

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)



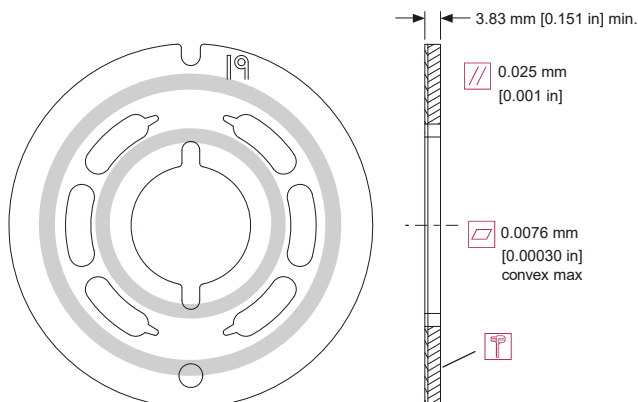
**BALL GUIDE AND SLIPPER RETAINER**

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.



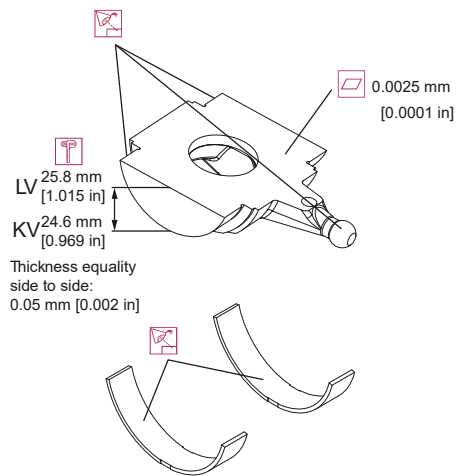
**VALVE PLATE**

Condition of the valve plate 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 to specifications shown in the drawing, provided resurfacing will not reduce thickness below minimum specification.



**SWASHPLATE AND JOURNAL BEARINGS**

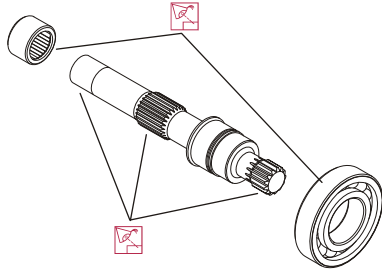
Inspect running face, servo ball-joint, and swashplate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable if surface condition meets specifications shown. Measure swashplate thickness from journals running face. Replace swashplate if damaged 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. The 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.

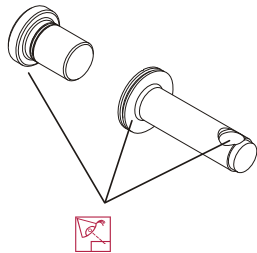


**SHAFT**

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.

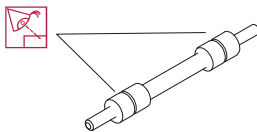
**SERVO PISTON AND MINIMUM ANGLE STOP**

Inspect the minimum angle stop, servo piston head, and servo piston ball-socket for damage or excessive wear. Replace if necessary.



**LOOP FLUSHING SPOOL**

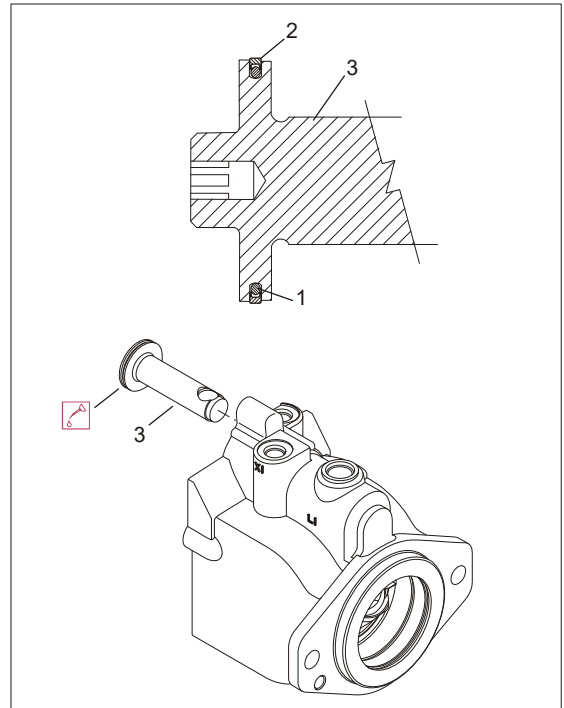
Inspect loop flushing spool for cracks or damage. Replace if necessary.



**Assembly**

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

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 servo cavity in the end-cap and let it stand for at least five minutes.



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

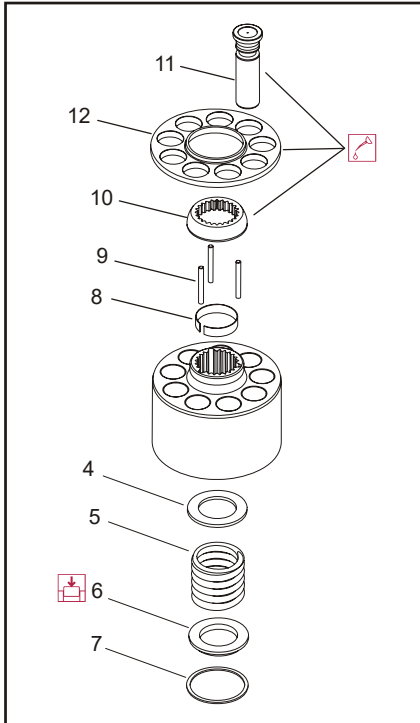
**Figure 3-35. Servo Piston**

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

**⚠ WARNING**

**RISK OF PERSONAL INJURY: COMPRESSING 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 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. Using a press, compress block spring enough to expose retaining ring groove. Wind spiral retaining ring (7) in cylinder block groove.

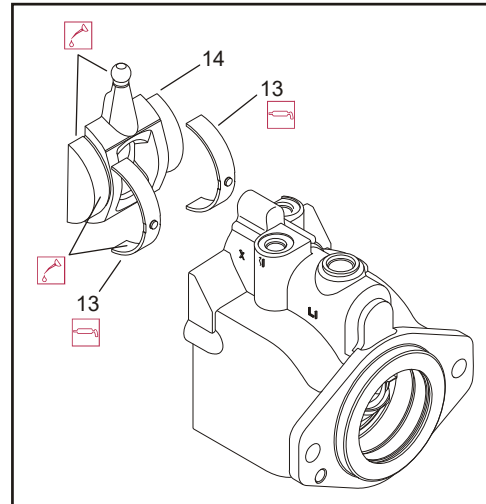


- |                          |                      |
|--------------------------|----------------------|
| 4. Block Spring Washer   | 9. Hold-down Pins    |
| 5. Block Spring          | 10. Ball Guide       |
| 6. Outer Washer          | 11. Piston           |
| 7. Spiral Retaining Ring | 12. Slipper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

**Figure 3-36. Cylinder Kit Assembly**

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.



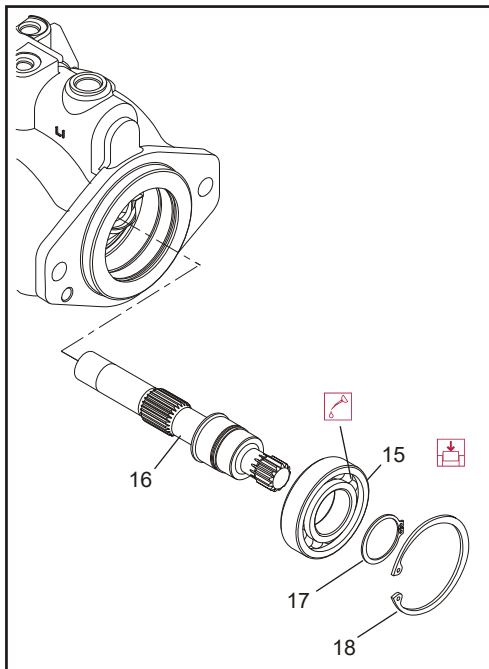
- |                      |
|----------------------|
| 13. Journal Bearings |
| 14. Swash Plate      |

**Figure 3-37. 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.

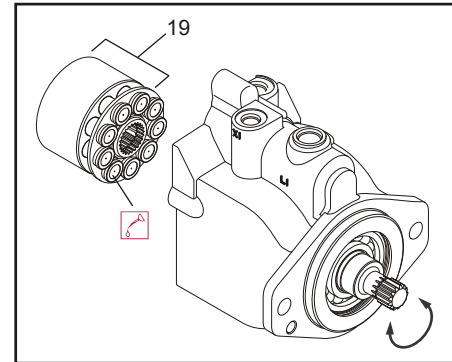


- 15. Front Shaft Bearing
- 16. Shaft
- 17. Snap Ring
- 18. Snap Ring

**Figure 3-38. 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).

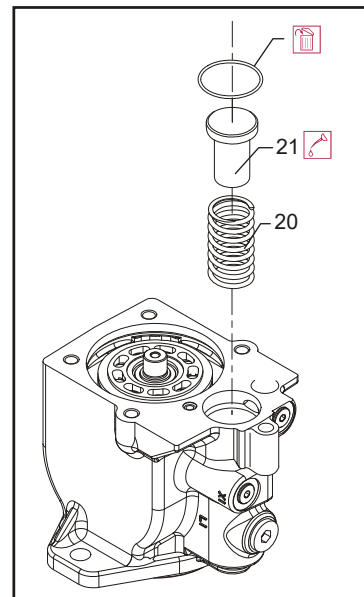
10. Verify swashplate and bearings are properly seated. Install cylinder kit (19) on shaft. Install with slippers facing swashplate. Rock the shaft to align block splines and slide cylinder kit into place. Orient motor with shaft pointing downward and verify cylinder kit, swashplate, journal bearings, and servo piston are secure and properly installed.



- 19. Cylinder Kit

**Figure 3-39. Cylinder Kit Installation**

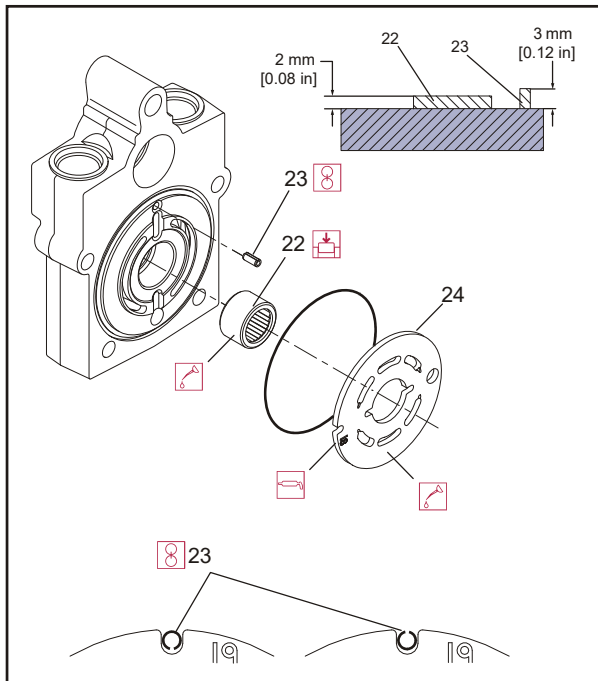
11. Lubricate and install servo spring (20) and minimum angle stop (21) in housing bore.



- 20. Servo Spring
- 21. Minimum Angle Stop

**Figure 3-40. Servo Spring and Minimum Angle Stop**

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

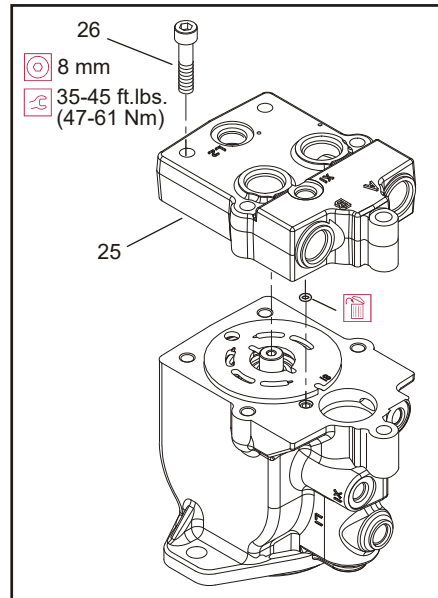


22. Rear Shaft Bearing  
23. Timing Pin  
24. Valve Plate

**Figure 3-41. 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  $0.12 \pm 0.01$  in ( $3 \pm 0.25$  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.

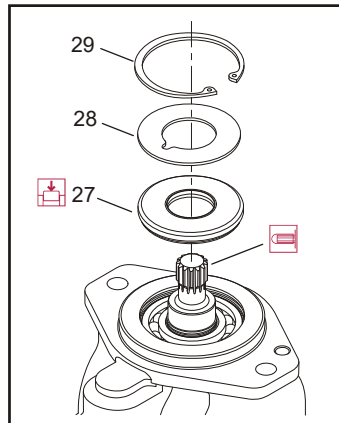
- 15.** Install endcap (25) on housing with endcap screws (26). Ensure endcap will properly seat to housing without interference. Improper assembly of internal components may prevent endcap from seating properly. Ensure O-rings seat properly when installing endcap.



25. End Cap  
26. Screw

**Figure 3-42. End Cap**

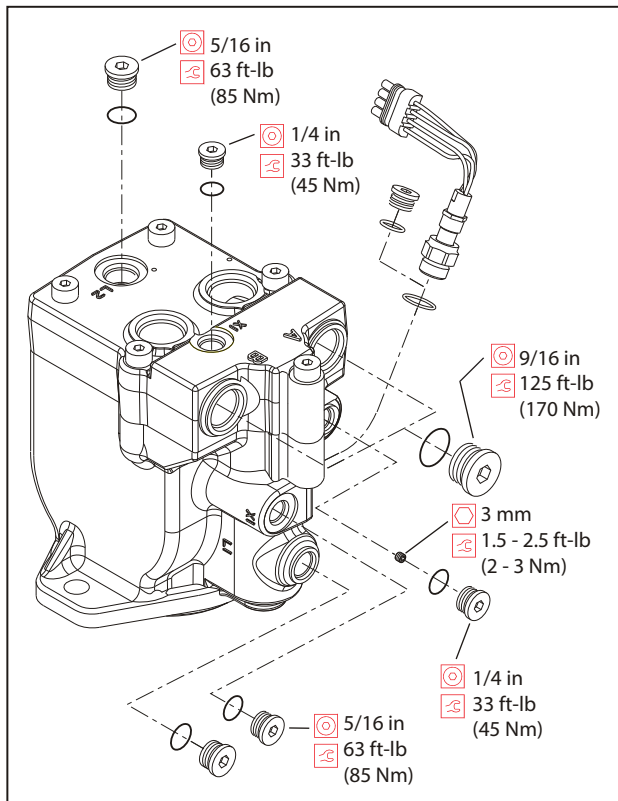
- 16.** Using an 8 mm internal hex wrench, tighten endcap screws. Tighten screws in opposite corners slowly and evenly to compress the servo spring and properly seat the endcap. Torque endcap screws 35-45 ft-lb (47-61 Nm).
- 17.** Before installing shaft seal, ensure shaft turns smoothly with less than 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

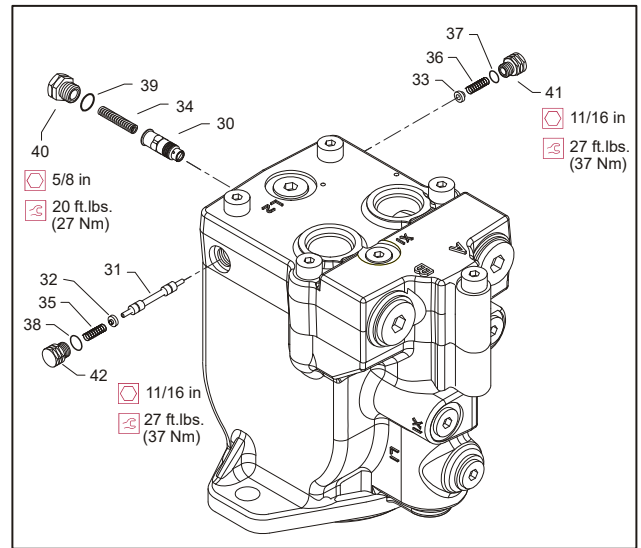
**Figure 3-43. Shaft Seal**

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



**Figure 3-44. 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. Washer         | 36. Spring | 39. O-ring | 42. Plug |
| 33. Washer         |            |            |          |

**Figure 3-45. Loop Flushing Spool**

1. Install shift spool (31).
2. Install spring retaining washers on springs (32 and 33).
3. Carefully install centering springs (34, 35, and 36).
4. Install new O-rings (37, 38, and 39).
5. Using a 5/8 in wrench torque plug (40) to 20 ft-lb (27 Nm).
6. 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.

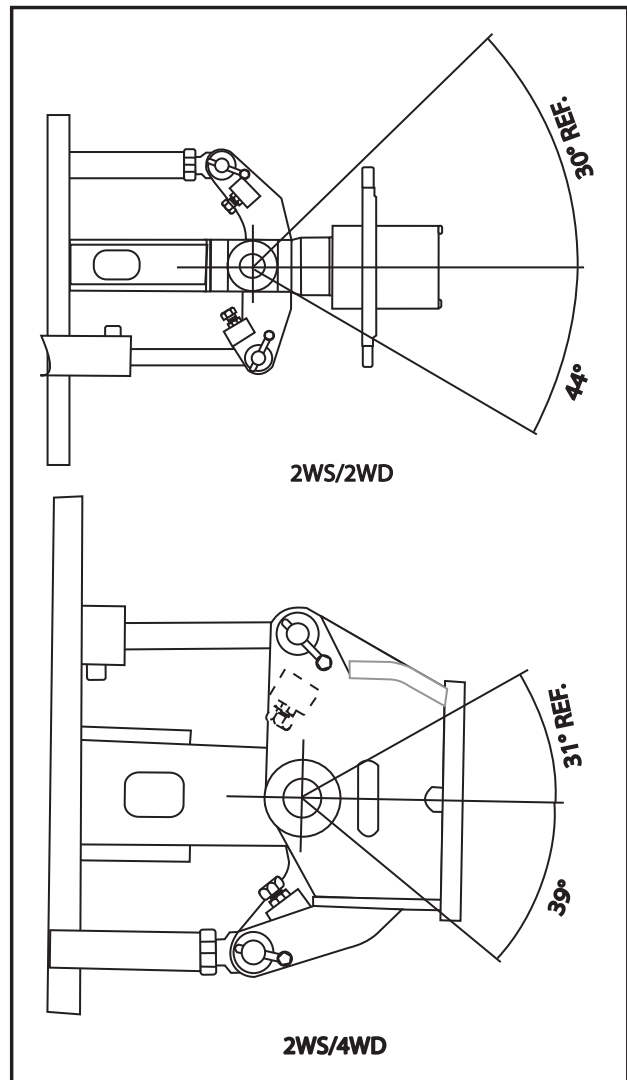
1. Fill reservoir with recommended hydraulic fluid. Always filter fluid through a 10 micron filter when pouring into the reservoir. Never reuse hydraulic fluid.
2. Fill inlet line leading from pump to reservoir. Check inlet line for properly tightened fittings and be certain it is free of restrictions 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. While watching pressure gauge, 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.

### 3.6 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 3-46. Steer Adjustments**

### 3.7 SWING DRIVE

#### Roll, Leak And Brake Testing

Torque-Hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears, bearings and seals are working properly. The following information briefly outlines what to look for when performing these tests.

**NOTE:** *The brake must be released before performing the roll test. This can be accomplished by either pressure testing using the Brake Leak Test procedure below or by tightening the 12 bolts into the piston through the end plate (See Brake Disassembly Procedure).*

**NOTE:** *Bolts must be removed while performing brake release test.*

#### Roll Test

The purpose of the roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and should be examined for improper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency. Release the pressure at the Brake Housing (6) and remove the test fixtures.

#### Leak Test (Main Unit)

The purpose of a leak test is to make sure the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall after the unit has been pressurized and allowed to equalize. Leaks will most likely occur at the pipe plugs, the main seal or wherever o-rings or gaskets are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where the o-rings or gaskets meet on the exterior of the unit, then checking for air bubbles. If a leak is detected in a seal, o-ring or gasket, the part must be replaced, and the unit rechecked. Leak test at 10 psi (0.7 bar) for 20 minutes.

#### Brake Test

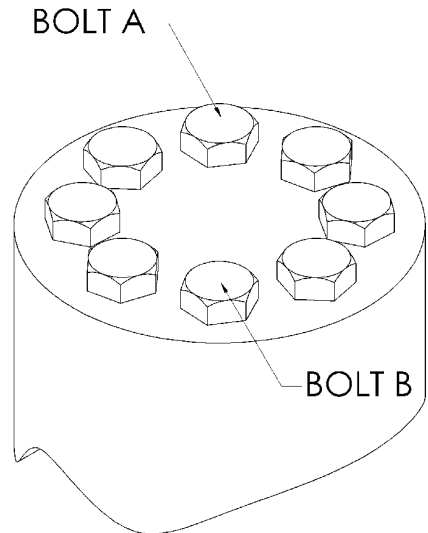
The brake test must be performed with the Motor removed and the Brake Test Plate (T-214404) installed. Install the Hex Bolts through Brake Test Plate and torque to 80 - 100 ft. lbs. (108-135 Nm). Install Roll Checking Tool (T-212731) and apply 210 psi (14 bar) to the o-ring port in the side of the Brake Housing. The roll checking fixture should roll freely. Increase the pressure to 3000 psi (207 bar) and perform the Roll Test.

**NOTE:** *Failure to perform this test may result in damaged or ineffective brake parts.*

#### Tightening and Torquing Bolts

If an air impact wrench is used to tighten bolts, extreme care should be taken to ensure that the bolts are not tightened beyond their specified torque.

The following steps describe how to tighten and torque bolts or socket head cap screws in a bolt circle.

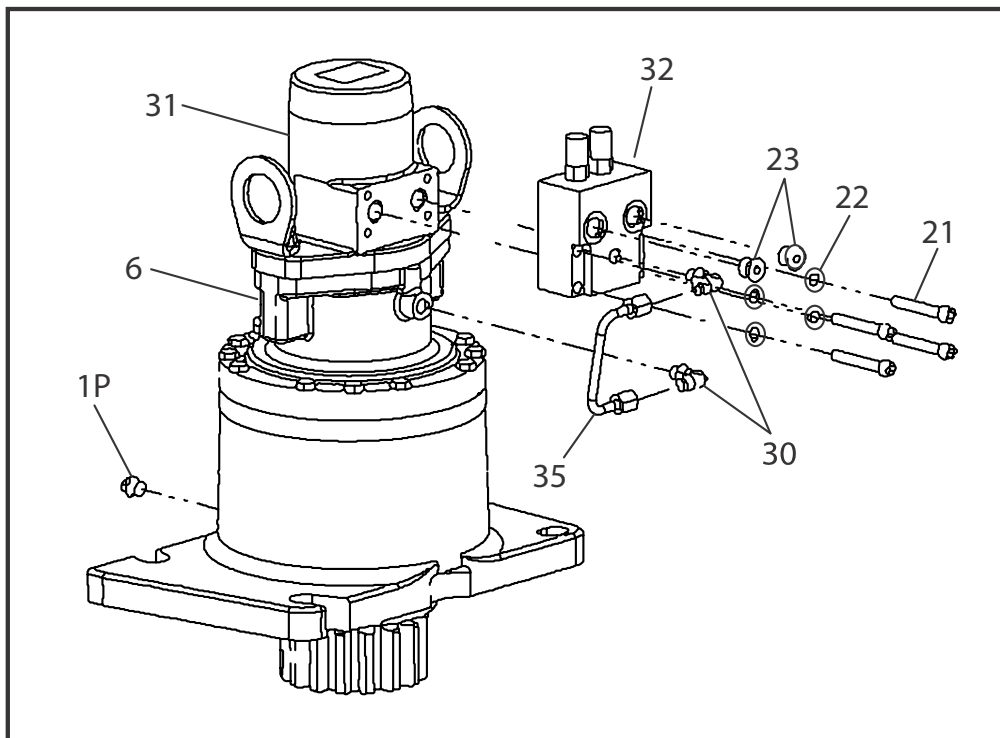


1. Tighten (but do not torque) bolt "A" until snug.
2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.
3. Crisscross around the bolt circle and tighten remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt "A".
5. Using the same sequence, crisscross around the bolt circle and apply an equal torque to the remaining bolts.

### Motor Control Valve Disassembly

**NOTE:** Refer to Figure 3-47.

1. Place unit on bench with the motor end up.
2. Remove O-ring Plug (1P) and drain the oil from the gear-box.
3. Remove Hydraulic Tubing Assembly (35) by loosening fittings on both ends of tube with a wrench.
4. Using a wrench, loosen jam nuts on Elbow Fittings (30) and remove fittings from Brake (6) and Motor Control Valve (32).
5. Remove O-ring Plugs (23) from Motor Control Valve (32).
6. Remove Motor Control Valve (32) from Motor (31) by removing the four Bolts (21) and washers (22).



- |                    |                         |
|--------------------|-------------------------|
| 1P. O-ring Plug    | 30. Elbow Fitting       |
| 6. Hydraulic Brake | 31. Hydraulic Motor     |
| 21. Hex Bolt       | 32. Motor Control Valve |
| 22. Lockwasher     | 35. Hydraulic Tubing    |
| 23. Plug           |                         |

**Figure 3-47. Motor Control Valve**

### Motor and Brake Disassembly

**NOTE:** Refer to Figure 3-48.

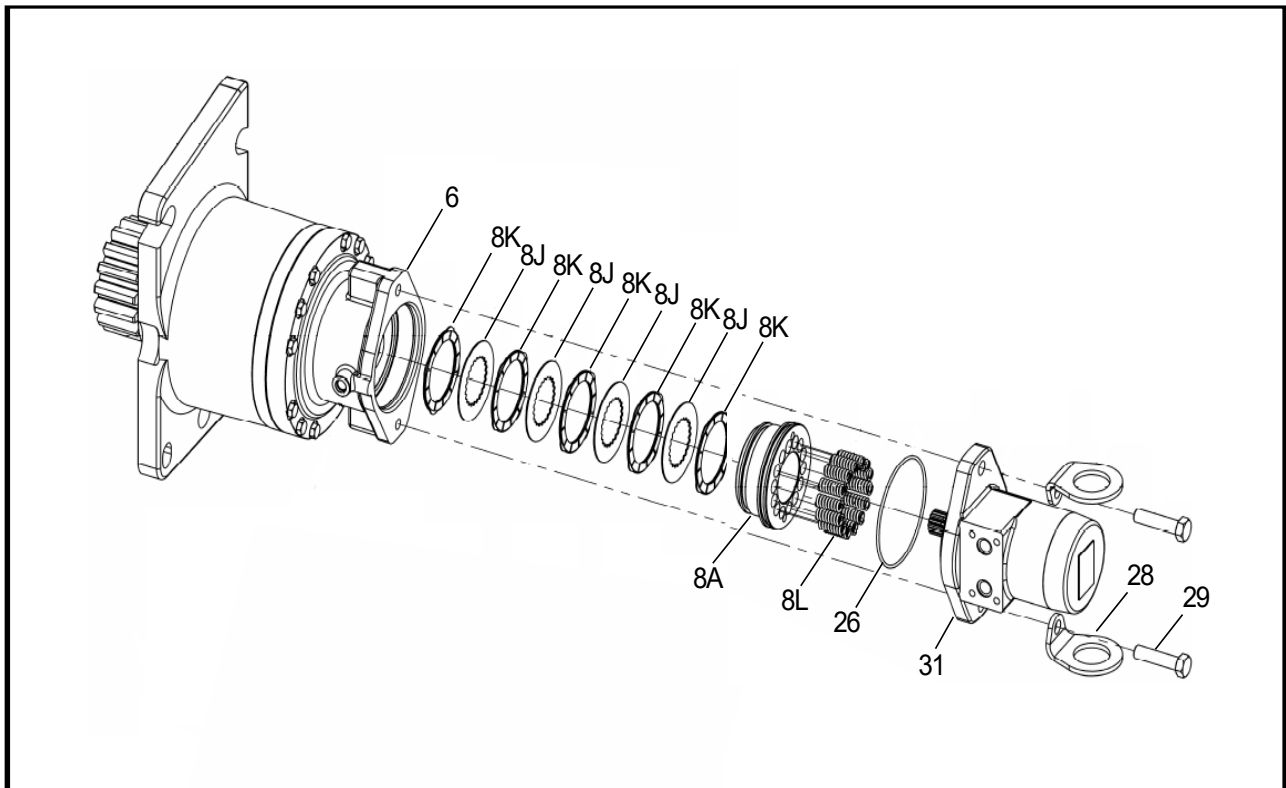
1. With unit resting on bench with Motor (31) end up, loosen Hex Bolts (29) and remove Lift Lugs (28) from the Motor (31).
2. Pull Motor (31) straight up and remove Motor (31) from Brake Housing (6).
3. Remove O-ring (26) from between Motor (31) and Brake Housing (6).

4. Remove the Springs (8L) from the piston.
5. Apply less than 50 psi (3.45 bar) air to the "brake port" to remove Brake Piston (8A).

**⚠ CAUTION**

**THE PISTON MAY MOVE QUICKLY. EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**

6. Remove Rotors (8J) and Stators (8K) from Brake Housing (6).



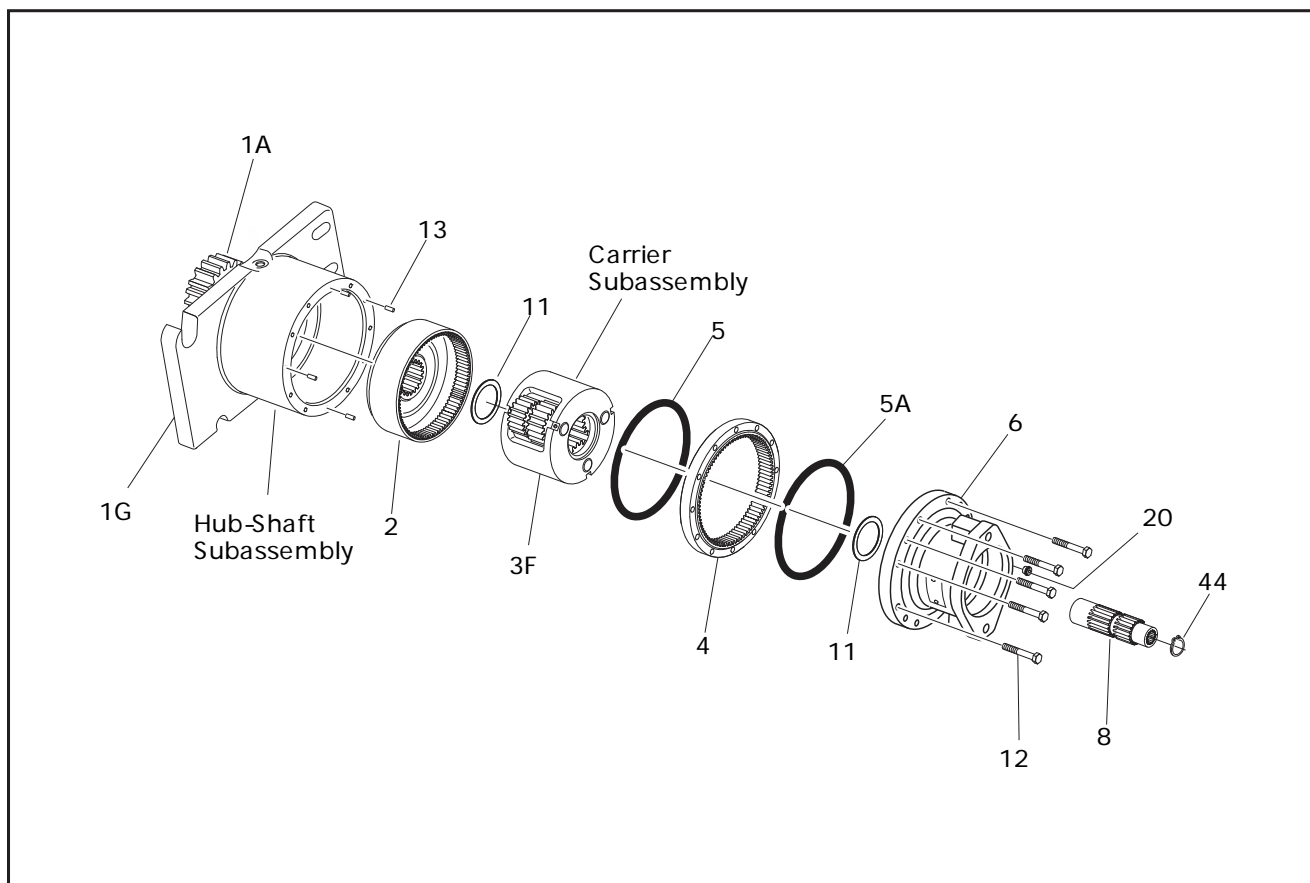
- |                  |              |
|------------------|--------------|
| 6. Brake Housing | 26. O-ring   |
| 8A. Brake Piston | 28. Lift Lug |
| 8L. Spring       | 29. Hex Bolt |
| 8J. Rotors       | 31. Motor    |
| 8K. Stator       |              |

**Figure 3-48. Motor and Brake**

**Main Drive Disassembly**

**NOTE:** Refer to Figure 3-49.

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



- |                           |                   |               |
|---------------------------|-------------------|---------------|
| 1A. Output Shaft (Pinion) | 5. O-ring         | 12. Bolt      |
| 1G. Housing               | 5A. O-ring        | 13. Dowel Pin |
| 2. Internal Gear          | 6. Brake Housing  | 20. Pipe Plug |
| 3F. Carrier subassembly   | 8. Sun Gear       | 44. Ring      |
| 4. Ring Gear              | 11. Thrust Washer |               |

**Figure 3-49. Main Drive Assembly**



## Hub-Shaft Disassembly

**NOTE:** Refer to Figure 3-50.

1. Using retaining ring pliers remove Retaining Ring (1I) from groove in Output Shaft (1A) and discard.

### **CAUTION**

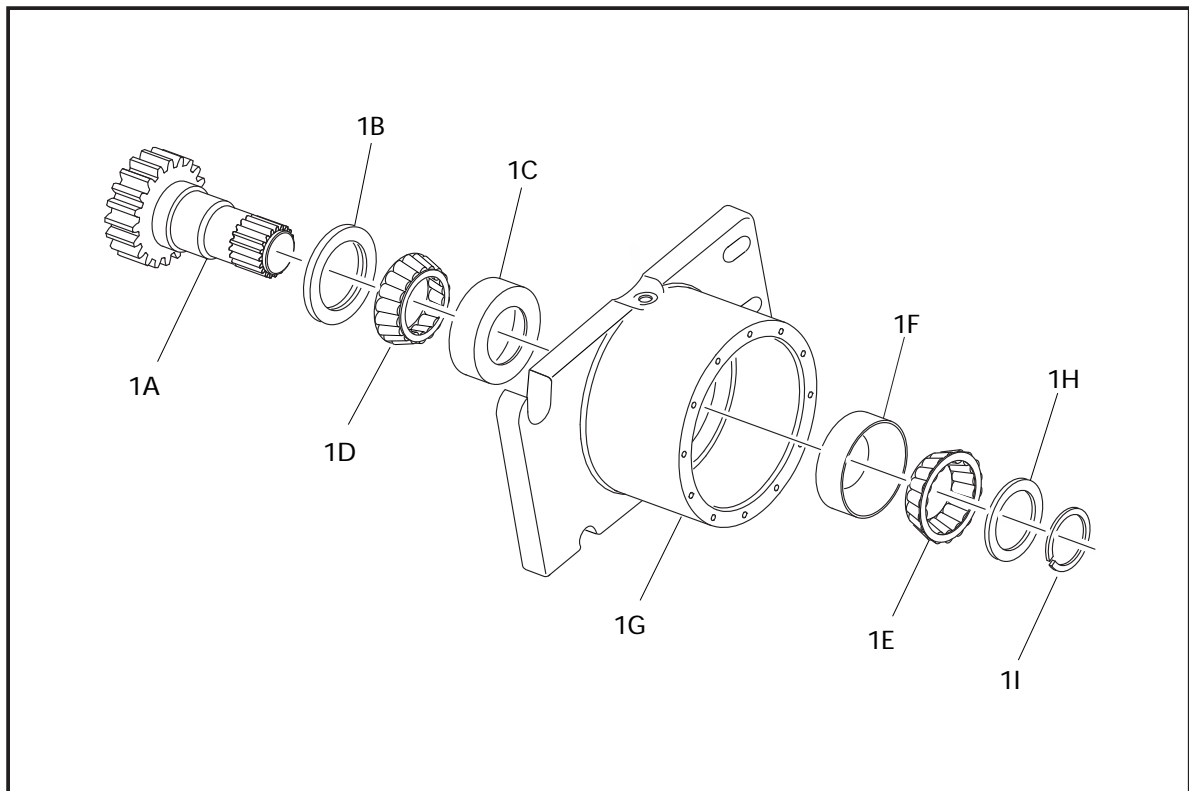
**EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**

2. Remove Thrust Washer (1H).

3. While supporting the Housing (1G) on the Output Shaft (1A) end, press the Output Shaft (1A) out of the Housing (1G).

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

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



- |                  |                    |
|------------------|--------------------|
| 1A. Output Shaft | 1F. Bearing Cup    |
| 1B. Lip Seal     | 1G. Housing        |
| 1C. Bearing Cup  | 1H. Thrust Washer  |
| 1D. Bearing Cone | 1I. Retaining Ring |
| 1E. Bearing Cone |                    |

**Figure 3-50. Hub Shaft**

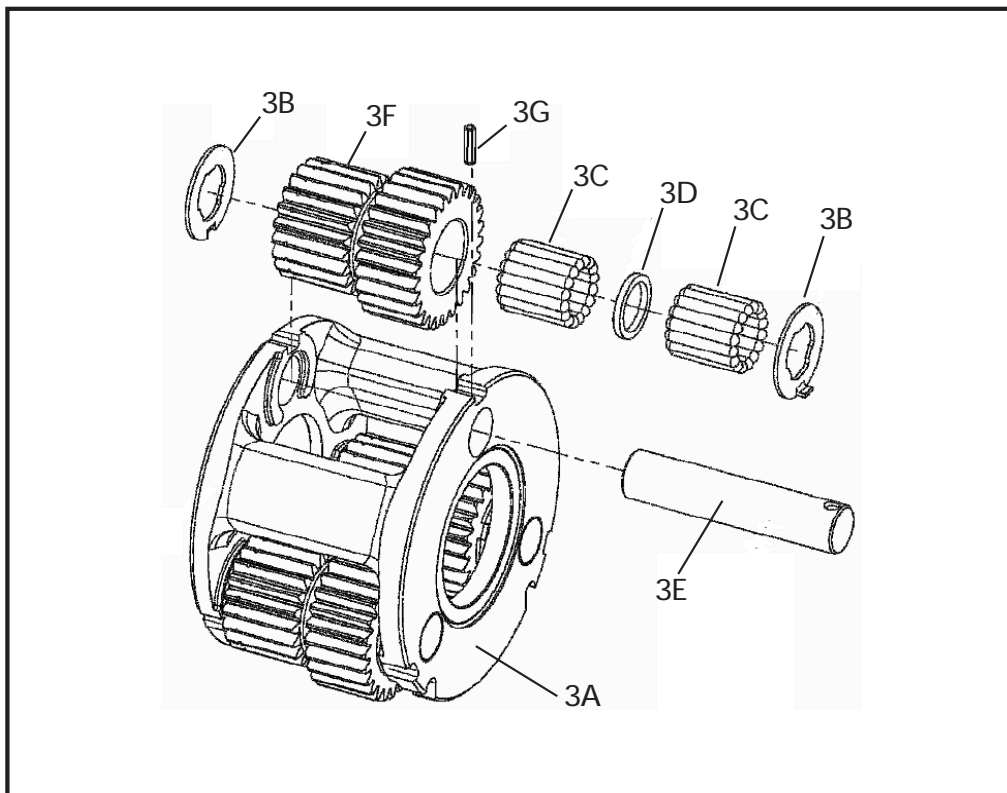
### Carrier Disassembly

**NOTE:** Refer to Figure 3-51.

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

**NOTE:** Make sure that the Roll Pin has bottomed. Otherwise, damage to the carrier could occur when the Planet Shaft is removed.

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



- |                    |                  |
|--------------------|------------------|
| 3A. Carrier        | 3E. Planet Shaft |
| 3B. Thrust Washers | 3F. Cluster Gear |
| 3C. Needle Bearing | 3G. Roll Pin     |
| 3D. Spacer         |                  |

**Figure 3-51. Carrier**

## Hub-Shaft Assembly

**NOTE:** Refer to Figure 3-50.

1. Press Bearing Cup (1C) into Housing (1G) taking care to insure cup starts square with the bore of Hub (1G).
2. Place Bearing Cone (1D) in Bearing Cup (1C) in Housing (1G).
3. Press or tap Seal (1B) Into the counterbore of Housing (1G) to the point where it becomes flush with the Housing (1G) face. Care should be taken to insure Seal (1B) is being correctly installed (smooth face up). Apply grease to the rubber portion of the seal bore.
4. Invert Hub (1G) and press Bearing Cup (1E) into counterbore of Housing (1G).
5. Carefully lower Housing (1G) onto the Output Shaft (1A) until Bearing Cone (1D) contacts the Output Shaft (1A).
6. Press on the small end of the Bearing Cone (1D), being careful not to contact the bearing cage, until the Bearing Cone (1D) seats on the shoulder of the Output Shaft (1A).
7. Start the Bearing Cone (1F) onto the Output Shaft (1A).
8. Press or tap the Bearing Cone (1F) onto the Output Shaft (1A) until it is just seated in the Bearing Cup (1E). while rotating the Housing (G).
9. Install Bearing Spacer (1H) onto Output Shaft (1A) and against Bearing Cone (1F).
10. Install Retaining Ring (1I) into the groove in the Output Shaft (1A). This Retaining Ring (1I) should never be reused in a repair or rebuild.

### **⚠ WARNING**

**EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**

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

### **⚠ WARNING**

**EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.**

12. Install O-ring Plug (1P) and torque to 23 to 24 ft.lbs (31 to 32 Nm).

## Carrier Assembly

**NOTE:** Refer to Figure 3-51.

1. Apply a liberal Coat of grease to the bore of Cluster Gear (3F). This will enable the Needle Rollers (3C) to be held in place during assembly.
2. Install the first row of Needle Rollers (3C) into the bore of Cluster Gear (3F).
3. Insert Spacer (3D) into bore of Cluster Gear (3F) on top of the Needle Rollers (3C).
4. Place second row of Needle Rollers (3C) into bore of Cluster Gear (3F) against Spacer (3D).
5. Place Carrier (3A) so that one of the roll pin holes is straight up.
6. Start Planet Shaft (3E) through the hole in Carrier (3A). Using ample grease to hold it in position, slide one Thrust Washer (3B) over the Planet Shaft (3E) with the tang resting in the cast slot of the Carrier (3A).
7. With large end of Cluster Gear (3F) facing the roll pin hole in the Carrier, place the Cluster Gear into position in carrier (3A) and push Planet Shaft (3E) through the Cluster Gear (3F) without going all the way through.
8. Slide the second Thrust Washer (3B) between the Cluster Gear (3F) and the Carrier (3A) with the tang of the washer located in the cast slot of the Carrier (3A). Finish sliding the Planet Shaft (3E) through the Thrust Washer (3B) and into the Carrier (3A).
9. Position the non-chamfered side on the Planet Shaft (3E) roll pin hole so that it is in line with the hole in the Carrier (3A) using a 1/8" (3 mm) diameter punch.
10. After using a 3/16" (5 mm) punch to align the two roll pin holes. Drive the Roll Pin (3G) through Carrier (3A) and into the Planet Shaft (3E) until the Roll Pin (3G) is flush with the bottom of the cast slot in the Carrier (3A) outside diameter at the thrust washer (3B) tang. Use a 1/4" (6 mm) pin punch to make sure the Roll Pin (3G) is flush in the slot.
11. Repeat Steps 1 thru 10 for the remaining two Cluster Gears(3F).

### Main Drive Assembly

**NOTE:** Refer to Figure 3-49.

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

#### **⚠ WARNING**

**BEWARE OF SHARP EDGES OF THE COUNTER BORE WHILE SEATING THIS O-RING.**

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

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

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

#### **⚠ CAUTION**

**BEWARE OF SHARP EDGES OF THE COUNTER-BORE WHILE SEATING THIS O-RING.**

22. Install the Brake Housing (6), taking care to correctly align Pipe Plug (20) with those in the Hub (1G).
23. Install Bolts (12) through the Brake Housing (6) into the Hub (1G) and torque to 23-27 ft.lbs. (31-37 Nm).
24. With gearbox standing on the pinion end fill gearbox with 43 oz. of ISO VG150/VG220 gear Oil.
25. Install Retaining Ring (44) into the groove in the Sun Gear (8).
26. Install the Sun Gear (8) into mesh with the Planet Gears (3F).
27. Install Pipe Plug (20) into Cover (6) torque to 23 to 24 ft.lbs. (31-32 Nm).

## Motor and Brake Assembly

**NOTE:** Refer to Figure 3-48.

1. Alternate Stators (8K) (O.D. lobes) with Rotors (8J) (I.D. splines) into bore of Brake Housing (6). starting with a Stator (8K) and ending with a Stator (8K).
2. Grease the O-rings (8F) & (8D) and Back-up rings (8H) & (8E). and place them in their respective grooves in the Brake Housing (6) and Piston (8A). Make sure the Back-up rings are correctly positioned.
3. Apply grease sparingly to the Piston O.D. (8A) and the bore of the Brake Housing (6). Insert Piston (8A) into Brake Housing (6) be sure not to damage the O-rings.
4. Install Springs (8L) into the spring pockets of the Piston (8A).
5. Test the brake and perform the roll test. Remove the Brake Test Plate.
6. Install the O-ring (26) onto the pilot of the Motor (31), use grease to keep the O-ring in place.
7. Place Motor (31) into Brake pilot, and line up holes.
8. Assemble Lift Lugs (28) onto Hex Bolts (29). Assemble Hex Bolts (29) with Lift Lugs (28) through the Motor (31) and Brake (6) against Motor flange. Torque to 80-100 ft.lbs. (108-136 Nm).

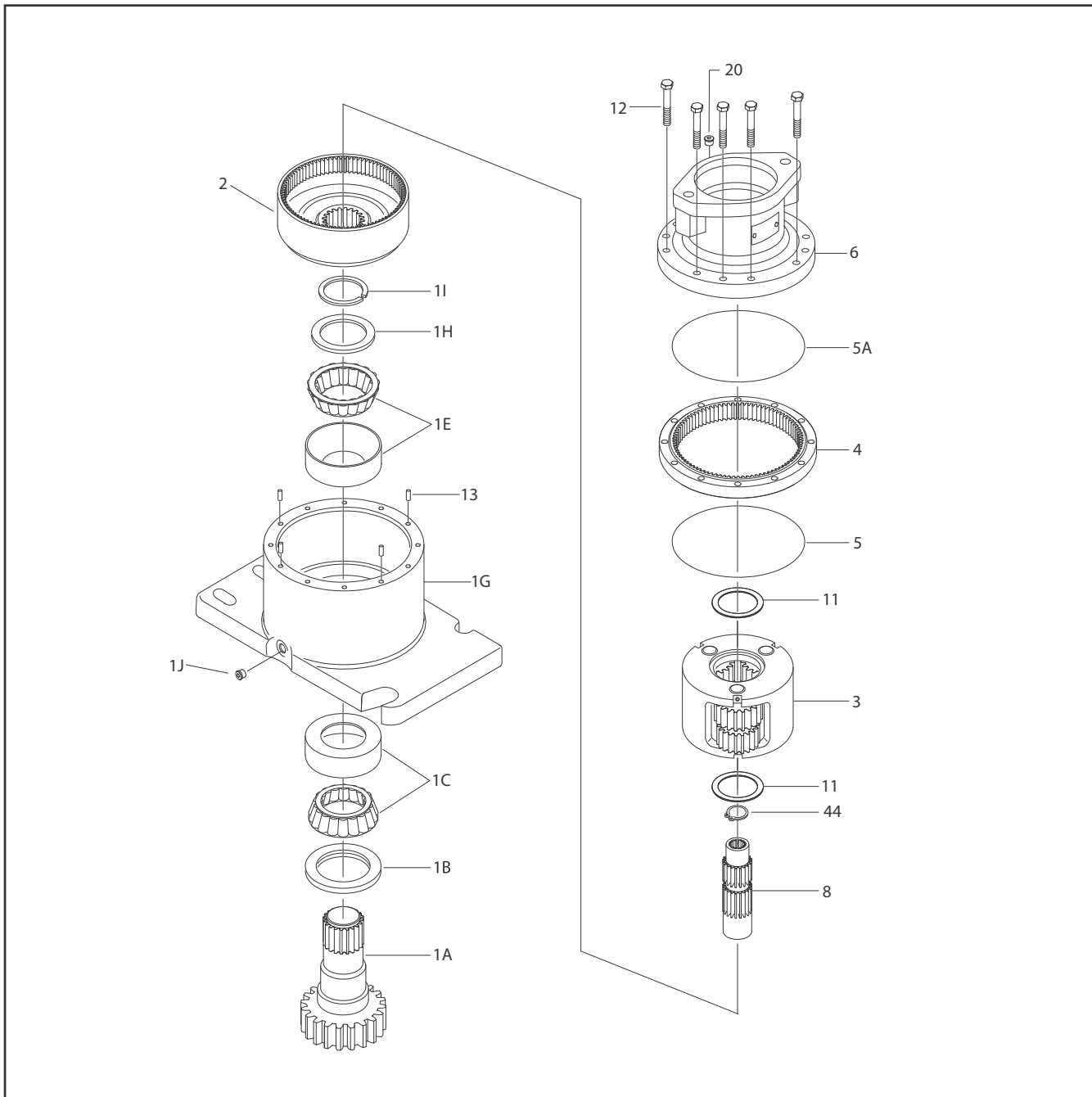
## Motor Control Valve Assembly

**NOTE:** Refer to Figure 3-47.

1. Lay assembly down with motor ports facing up. Remove the two plastic plugs in the motor ports, being careful not to lose the O-ring in each port. Assemble the Motor control Valve (32) onto the Motor (31) with Bolt (21) and Lock Washers (22). Torque Bolts (21) to 23-27 ft.lbs. (31-37 Nm).

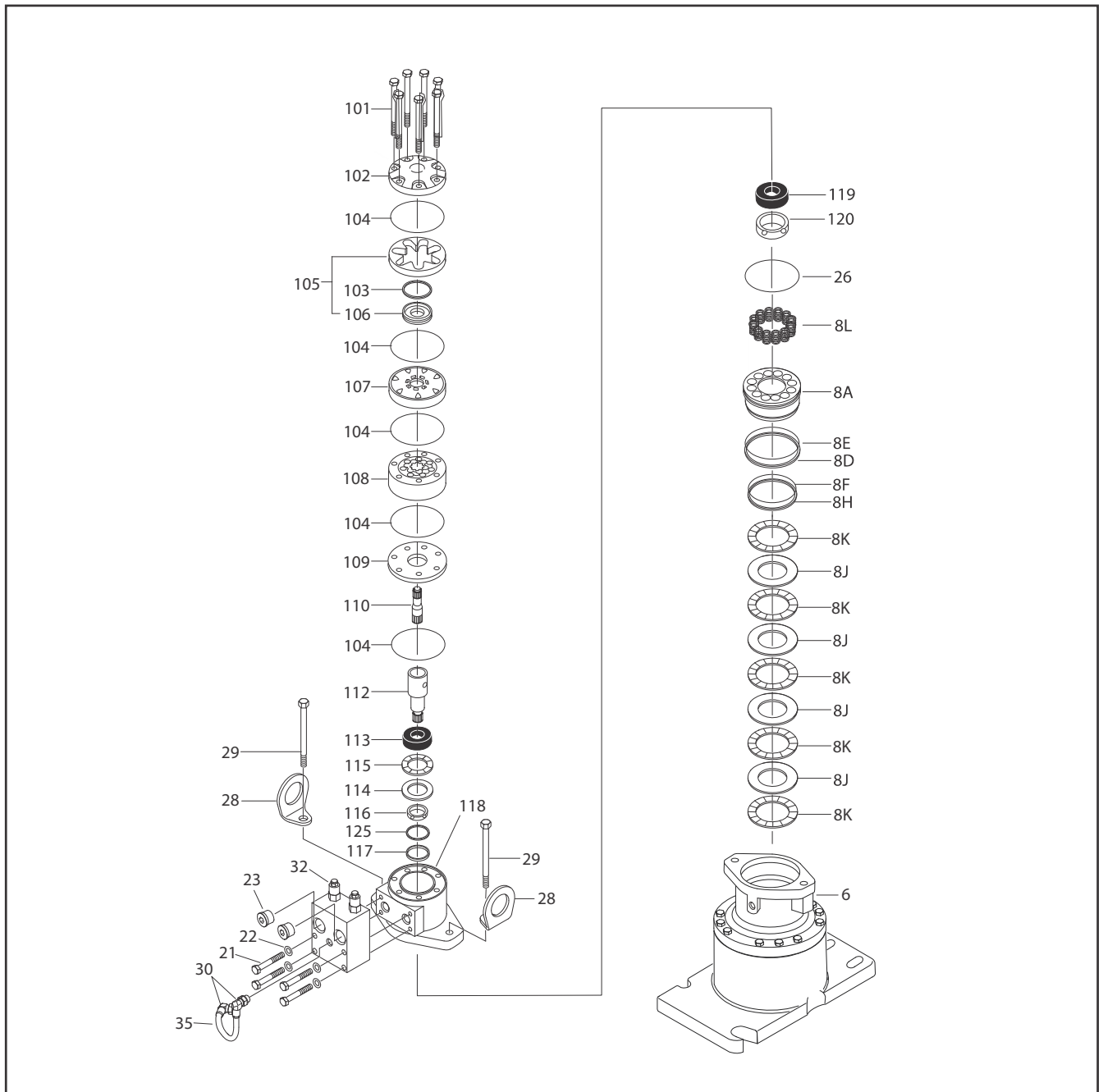
**NOTE:** Be sure to align the holes in the control valve with the motor ports.

2. Install Elbow Fittings (30) into Brake (6). Do not tighten jam nuts.
3. Install Elbow Fittings (30) into Motor Control Valve (32). Do not tighten jam nuts.
4. Assemble Tube (35) into Elbow Fittings (30) and torque to 13-15 ft.lbs (18-20 Nm). Tighten the jam nuts on the Elbow Fittings (30) and torque to 13-15 ft.lbs. (18-20 Nm).
5. Install one O-ring Plug (23) into Motor Control Valve (32) and torque to 30-31 ft.lbs. (41-42 Nm).
6. Pressure test brake, tube and control valve connections by applying 3000 psi (207 bar) pressure to the open port in the Motor Control Valve (32) and holding for 1 minute. Check for leaks at the control-valve-motor interface and the tube connections. Release pressure and install the remaining O-ring Plug (23) into Motor Control Valve (32) and torque to 30-31 ft.lbs. (41-42 Nm).



- |                  |                    |                     |                   |                             |
|------------------|--------------------|---------------------|-------------------|-----------------------------|
| 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 3-52. Swing Drive Assembly

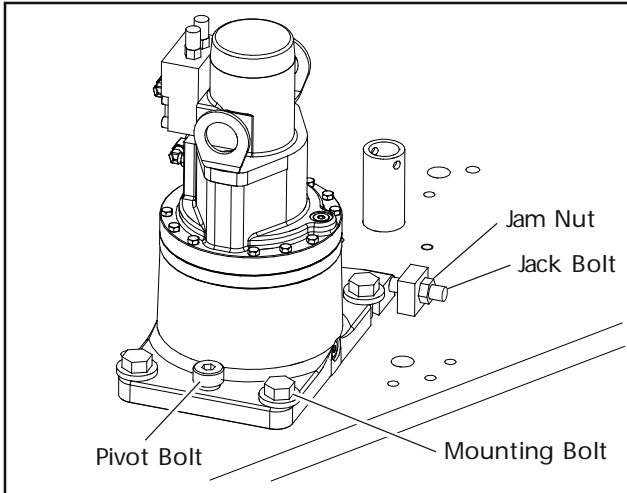


- |                  |                 |                               |                     |                     |
|------------------|-----------------|-------------------------------|---------------------|---------------------|
| 6. Brake Housing | 8L. Spring      | 35. Tube                      | 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 3-53. Swing Motor and Brake Assembly

### 3.8 SWING HUB REMOVAL

1. Disconnect all wiring harness terminals connected to the swing motor.
2. Gently loosen the set screw. Do not remove.
3. Remove the pivot bolt using Allen Wrench.



4. Remove the mounting bolts securing swing drive hub to the turntable.
5. Using the suitable lifting device, remove the swing drive hub from mounting plate without damaging the swing gear.
6. Place swing drive hub in the clean area.
7. Refer to Section 3.7, Swing Drive, for swing drive maintenance.

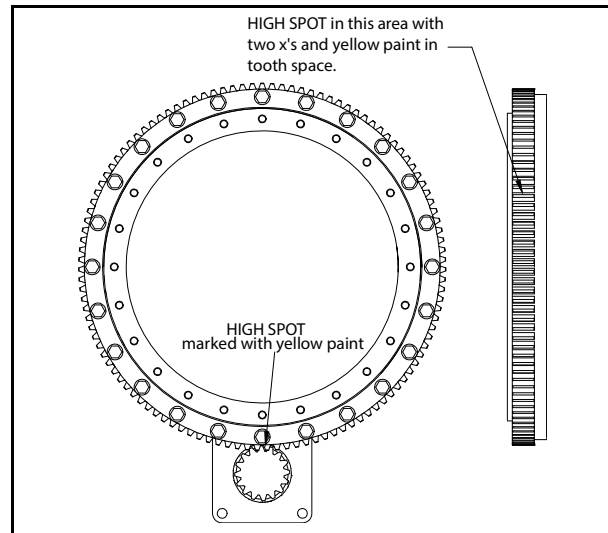
### 3.9 SWING HUB INSTALLATION

Ensure mounting plate and mounting location of the base plate are clean and painted with a uniform coating of minimum thickness (no runs, drips, etc.).

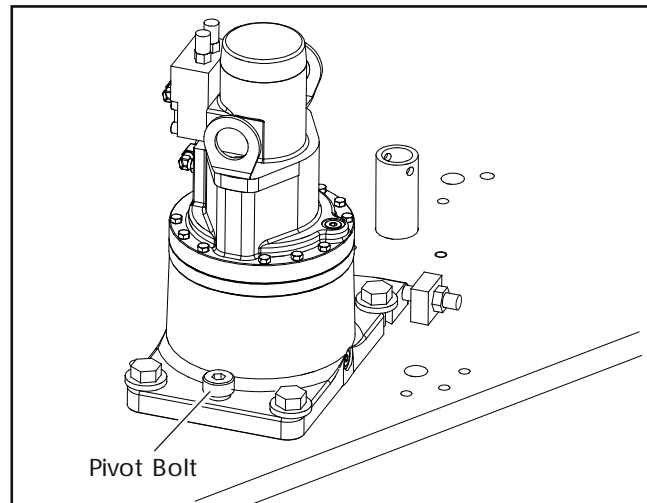
#### Procedure For Setting Swing Gear Backlash

Set backlash to 0.010 in. to 0.015 in. (0.254 mm - 0.381 mm) using the following procedure:

1. Place the machine on firm, level ground.
2. Place shim between pinion and bearing at bearing high spot (shown below).



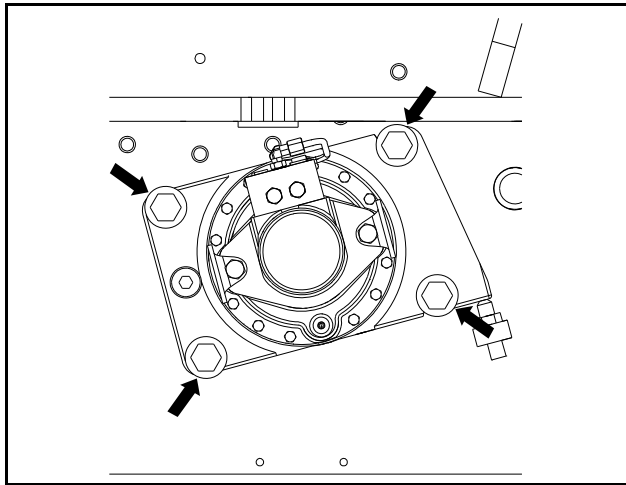
3. Apply JLG Threadlocker P/N 0100019 and torque pivot bolt to 205 ft. lbs. (280 Nm) (shown below).



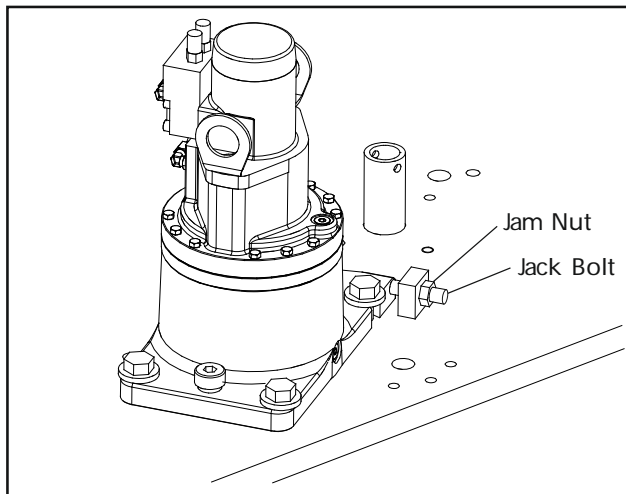
**NOTE:** Make sure the turntable is properly supported during the following step. The turntable can swing a few degrees when the turntable lock is removed if the turntable is not balanced properly.



4. Remove turntable lock pin.
5. Apply JLG Threadlocker P/N 0100019 and pre-torque swing drive mounting bolts to 30 ft. lbs. (40 Nm).

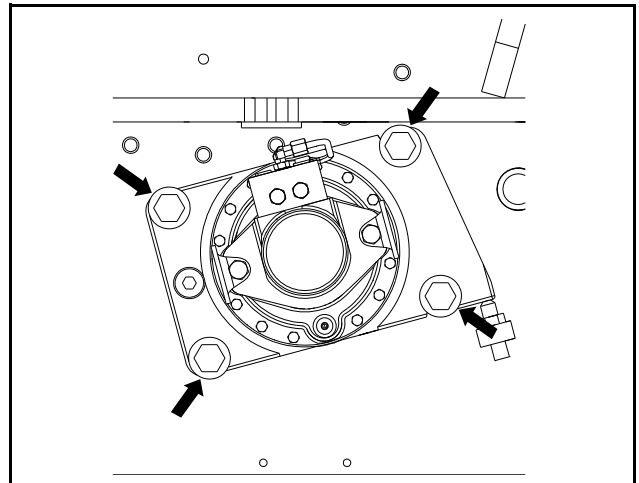


6. Tighten jack bolt until pinion is completely snug against shim and bearing then loosen jack bolt.

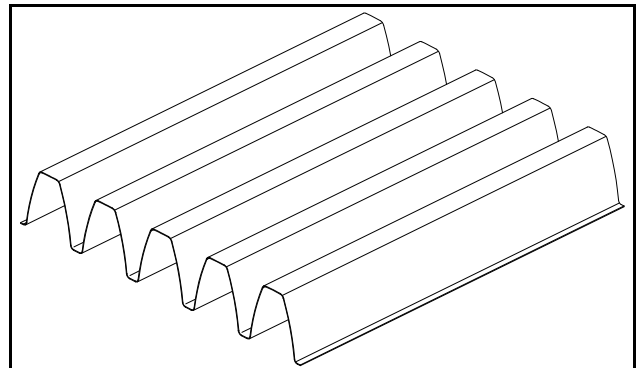


7. Apply JLG Threadlocker P/N 0100019 and torque jack bolt 50 ft. lbs. (68 Nm).
8. Apply JLG Threadlocker P/N 0100019 and tighten jam nut.

9. Torque mounting bolts to 340 ft. lbs. (Nm).

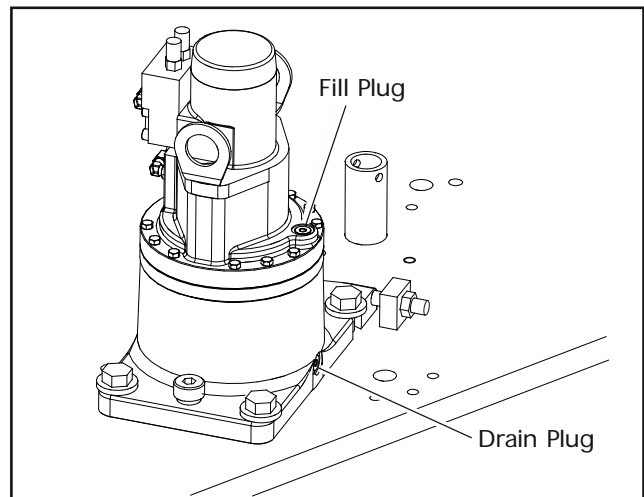


10. Remove shim and discard..



### Swing Drive Lubrication

Fill Swing Drive Gearbox with 43 oz (1.27 L) 90w80gear oil with EP additives. Oil should cover the ring gear. Torque pipe plug to 23-25 ft.lbs (31- 33 Nm).



### 3.10 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 during this check any bolts are found to be missing or loose, replace missing or loose bolts with new bolts and torque to the value specified in the torque chart, after lubricating the bolt threads with JLG Threadlocker P/N 0100019. After replacing and retorquing bolt or bolts recheck all existing bolts for looseness.

1. Check frame to bearing. Attach bolts as follows:
  - a. Elevate fully retracted main boom to 70 degrees (full elevation).
  - b. At the positions indicated on Figure 3-54.. try and insert the 0.0015 in. (0.0381 mm) feeler gauge between the bolt head and hardened washer at the arrow indicated position.
  - c. Assure that the 0.0015 in. (0.0381 mm) feeler gauge will not penetrate under the bolt head to the bolt shank.
  - d. Swing turntable 90 degrees and check some selected bolts are at the new position.
  - e. Continue rotating turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.
2. Check the turntable to bearing. Attach bolts as follows:
  - a. Elevate the fully retracted boom to 70 degrees (full elevation).
  - b. Try and insert the 0.0015" feeler gauge between bolt head and hardened washer at position shown in Figure 3-54.
  - c. Lower the boom to horizontal and fully extend the boom.
  - d. Try and insert the 0.0015" feeler gauge between bolt head and hardened washer at position shown in Figure 3-54.

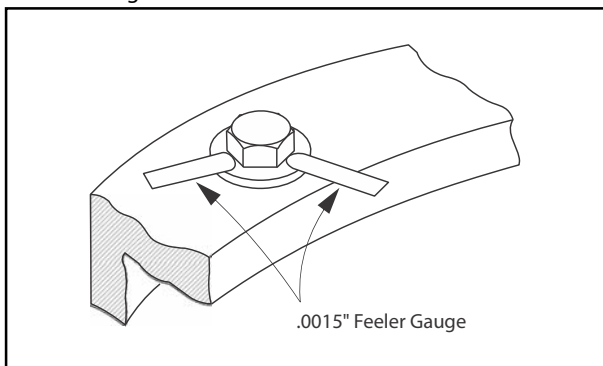


Figure 3-54. Swing Bearing Bolt Feeler Gauge Check

#### Wear Tolerance

1. From underside of the machine, at rear center, with the tower boom fully elevated and fully retracted, as shown in Figure 3-56. 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 3-55. Swing Bearing Tolerance Measuring Point.
2. At the same point, with the main boom horizontal and fully extended, and the tower boom fully elevated as shown in the Figure 3-56. 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 3-55. Swing Bearing Tolerance Measuring Point.
3. If difference is greater than 0.079 in. (2.00 mm), is determined, the swing bearing should be replaced.
4. If a difference less than 0.079 in. (2.00 mm) is determined, and any of the following conditions exist, the bearing should be removed, disassembled, and inspected for the following:
  - a. Metal particles in grease.
  - b. Increased drive power required.
  - c. Noise.
  - d. Rough rotation.
5. If bearing inspection shows no defects, reassemble and return to service.

#### NOTICE

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

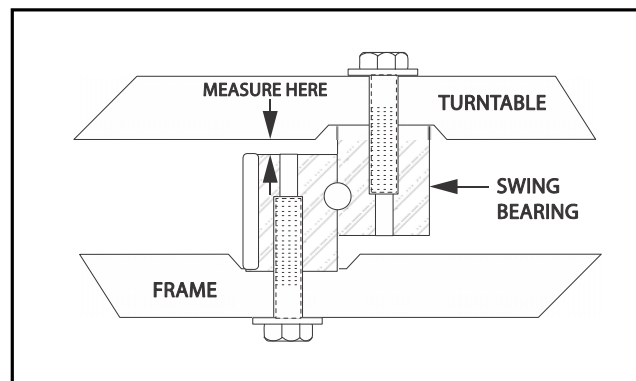


Figure 3-55. Swing Bearing Tolerance Measuring Point

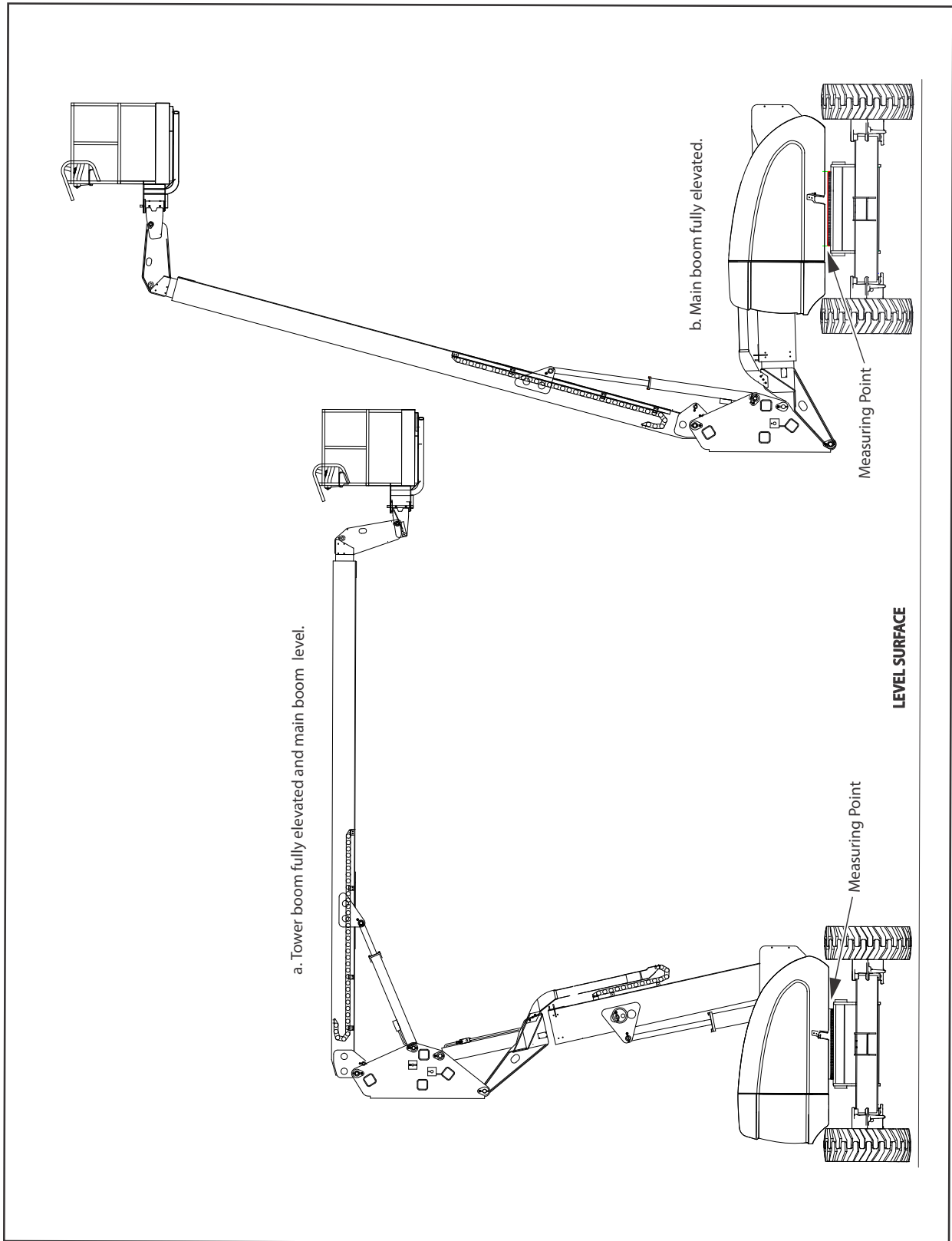


Figure 3-56. Swing Bearing Tolerance Measurement Location & Boom Placement

### Swing Bearing Replacement

#### REMOVAL

1. From Ground Control station, operate the boom adequately to provide access to frame opening or, if equipped, to 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 the fittings on the top of the 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 the turntable weldment.
6. Use a suitable tool to scribe a line on the inner race of the swing bearing and on the underside of the turntable. This will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the turntable to the bearing inner race. Discard the bolts.
7. Use the lifting equipment to carefully lift the complete turntable assembly from the bearing. Ensure that no damage occurs to the turntable, bearing or frame-mounted components.
8. Carefully place the turntable on a suitably supported trestle.
9. Use a suitable tool to scribe a line on the outer race of the swing bearing and the frame. This line will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the outer race of the bearing to the frame. Discard the bolts. Use suitable lifting equipment to remove the bearing from the frame, then move the bearing to a clean, suitably supported work area.

#### INSTALLATION

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

2. Apply a light coating of JLG Threadlocker P/N 0100019 to the new bearing bolts, and loosely install the bolts and washers through the frame and outer race of bearing.

#### **⚠ CAUTION**

**IF COMPRESSED AIR OR ELECTRICALLY OPERATED IMPACT WRENCH IS USED FOR TIGHTENING THE BEARING ATTACHMENT BOLTS, THE TORQUE SETTING ACCURACY OF THE TOOL SHOULD BE CHECKED PRIOR TO USE.**

3. Refer to the Torque Sequence diagram as shown in Figure 3-58., Swing Bearing Torque Sequence Clean any residue off the new bearing bolts, then apply a light coating of JLG Threadlocker P/N 0100019 and install the bolts and washers through the frame and outer race of the bearing. Tighten the bolts to an initial torque of 190 ft. lbs. (260 Nm) w/Loctite.
4. Remove the lifting equipment from the bearing.

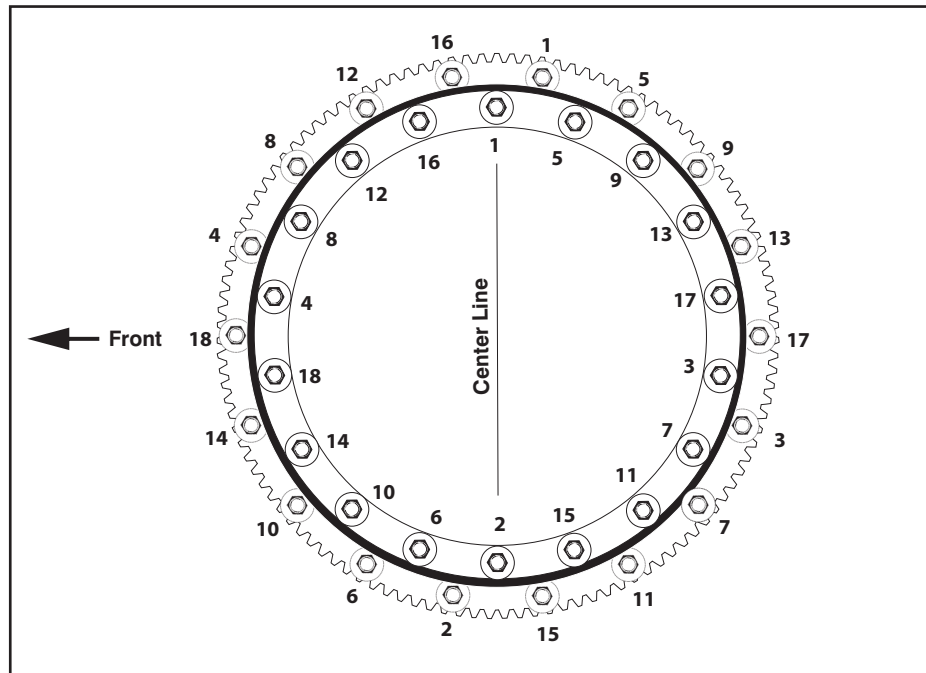


Figure 3-57. Swing Bearing Torque Sequence

5. Using suitable lifting equipment, carefully position the turntable assembly above the machine frame.
6. Carefully lower the turntable onto the swing bearing, ensuring that the scribed line of the inner race of the bearing aligns with scribed line on the turntable. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft center line of the turntable.
7. Clean any residue off the new bearing bolts, then apply a light coating of JLG Threadlocker P/N 0100019 and install the bolts and washers through the turntable and inner race of the bearing.
8. Following the Torque Sequence diagram shown in Figure 3-58., Swing Bearing Torque Sequence, tighten the bolts to a torque of 190 ft. lbs. (260 Nm) w/Loctite.
9. Remove the lifting equipment.
10. Install the rotary coupling retaining yoke brackets, apply a light coating of JLG Threadlocker P/N 0100011 to the attaching bolts and secure the yoke to the turntable with the mounting hardware.
11. Connect the hydraulic lines to the rotary coupling as tagged prior to removal.
12. At ground control station, use boom lift control to lower boom to stowed position.
13. Using all applicable safety precautions, activate the hydraulic system and check the 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 3-57. Swing Bearing Torque Sequence.

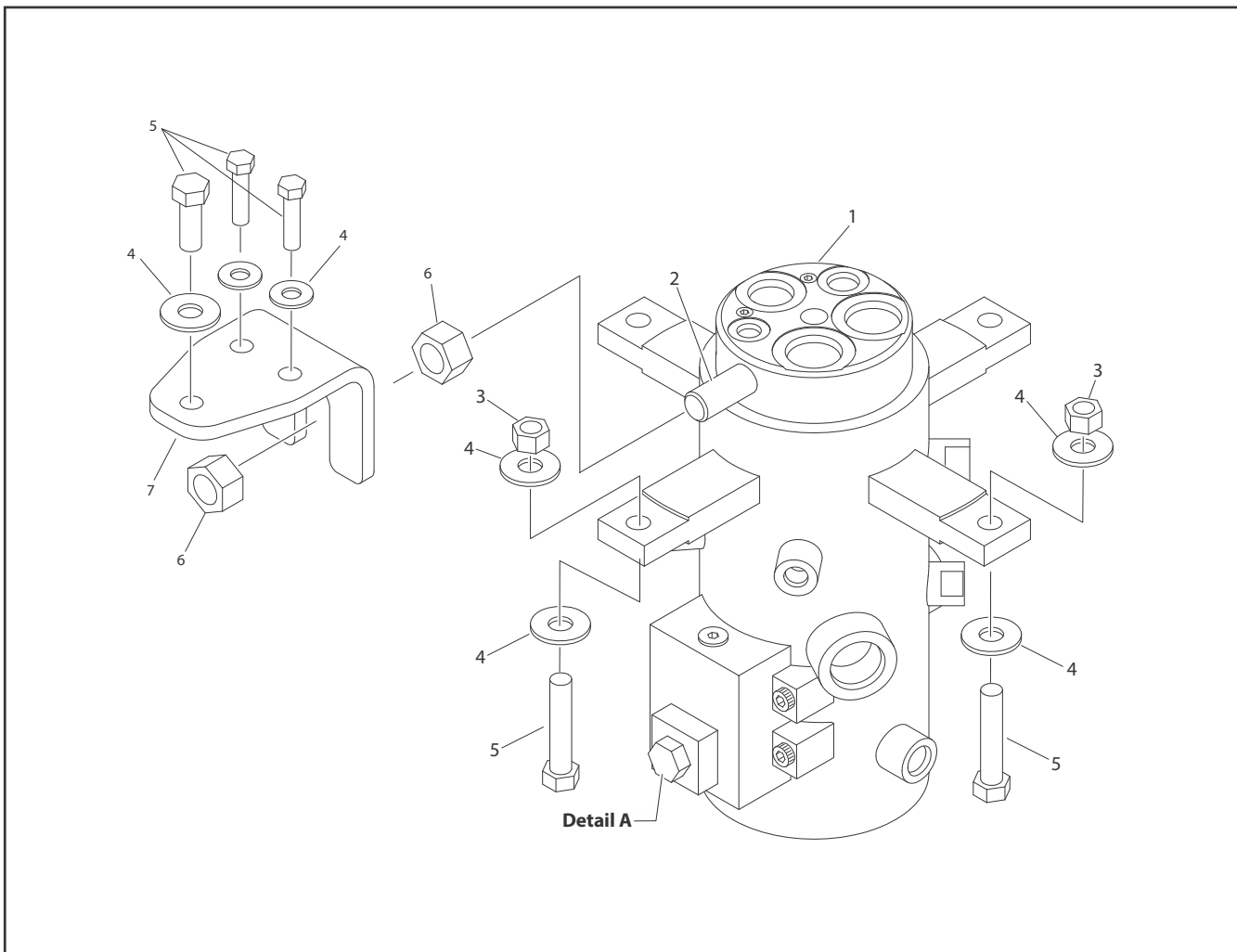
### **⚠ WARNING**

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

**3.11 ROTARY COUPLING**

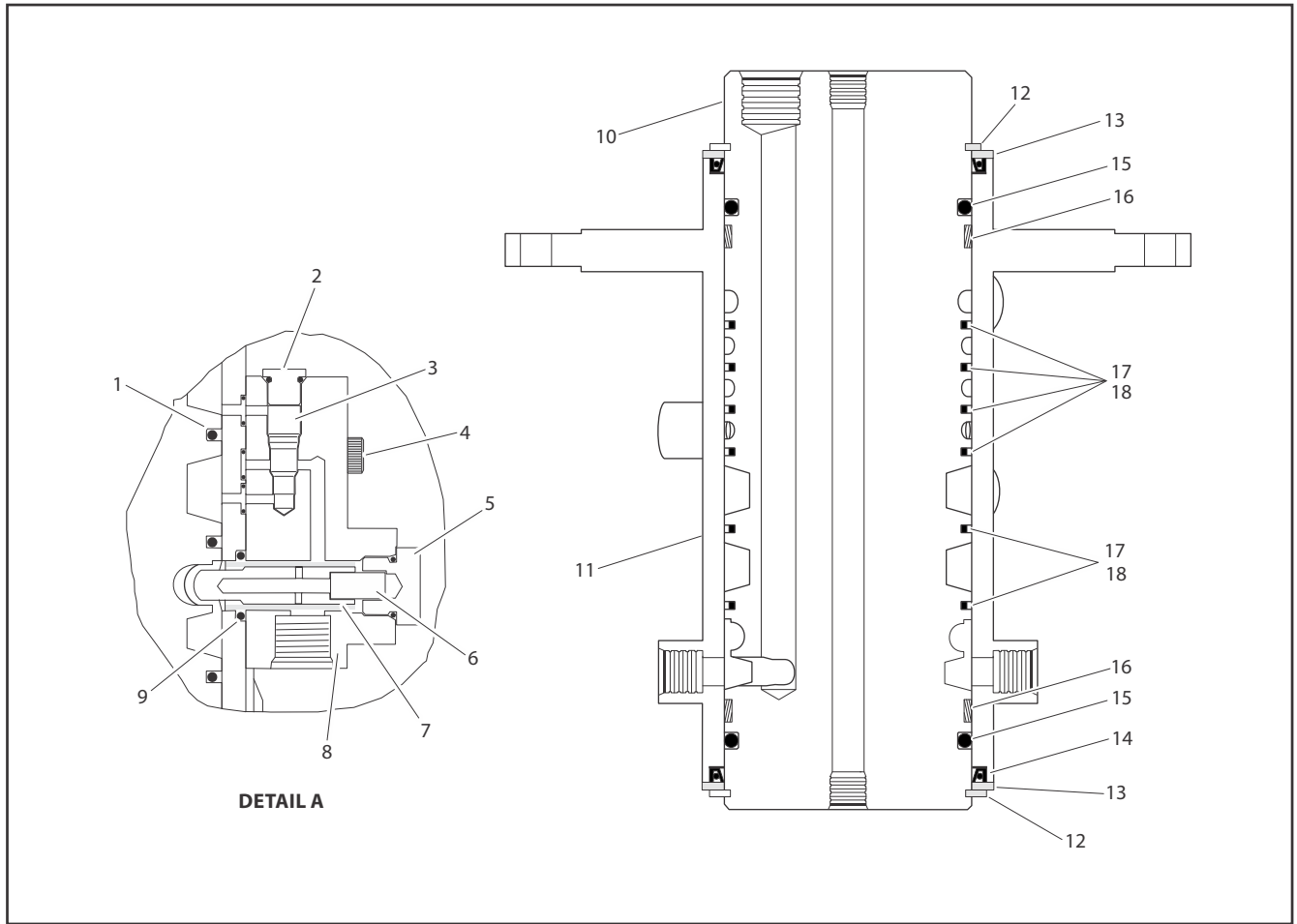
Use the following procedure to install the seal kit.

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 3-59. 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 | 7. Bracket |
| 2. Torque Lug      | 4. Flatwasher | 6. Nut  |            |

**Figure 3-58. 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 3-59. Rotary Coupling - Sheet 2 of 2

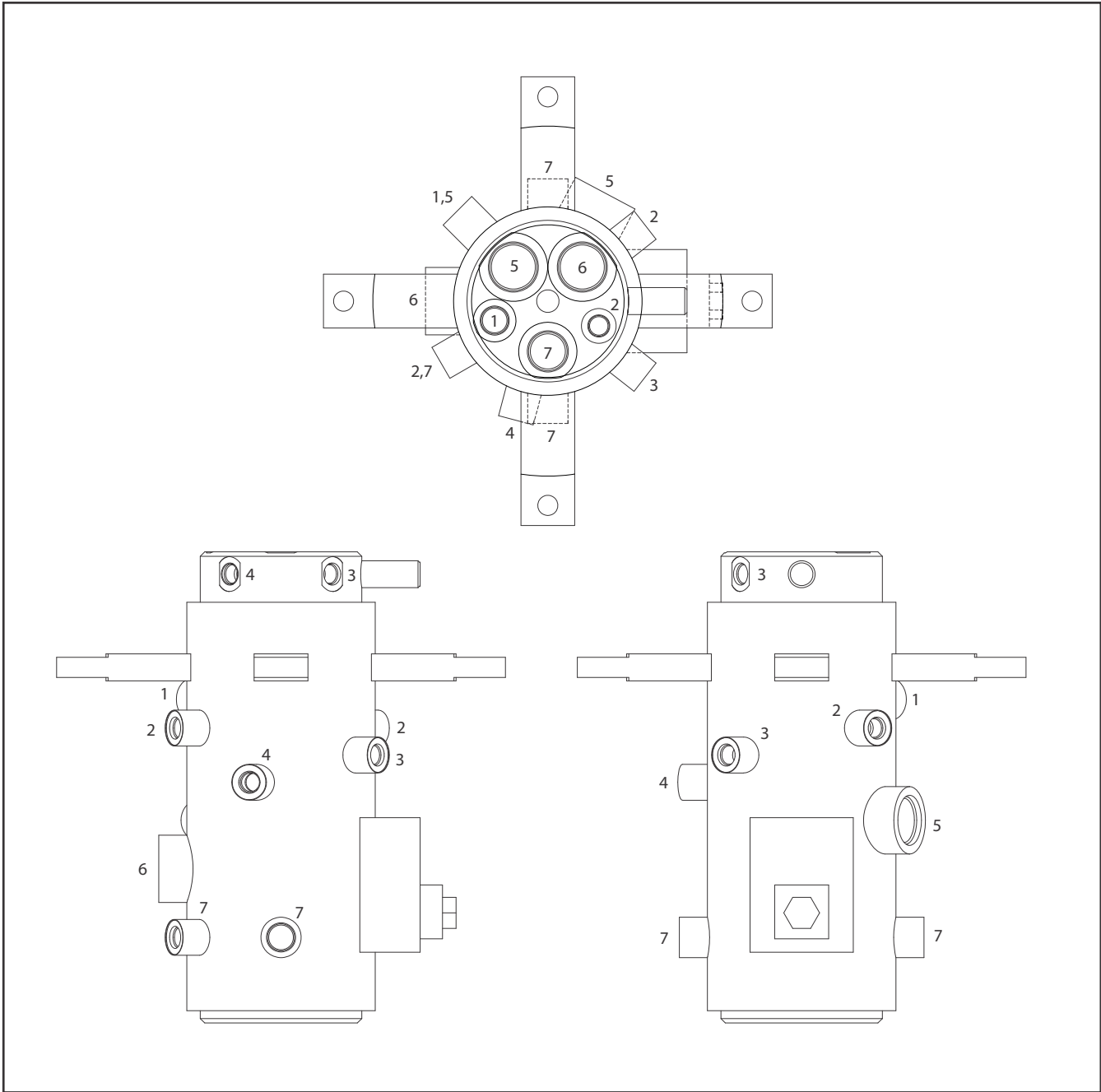


Figure 3-60. Rotary Coupling Port Location - 2WS



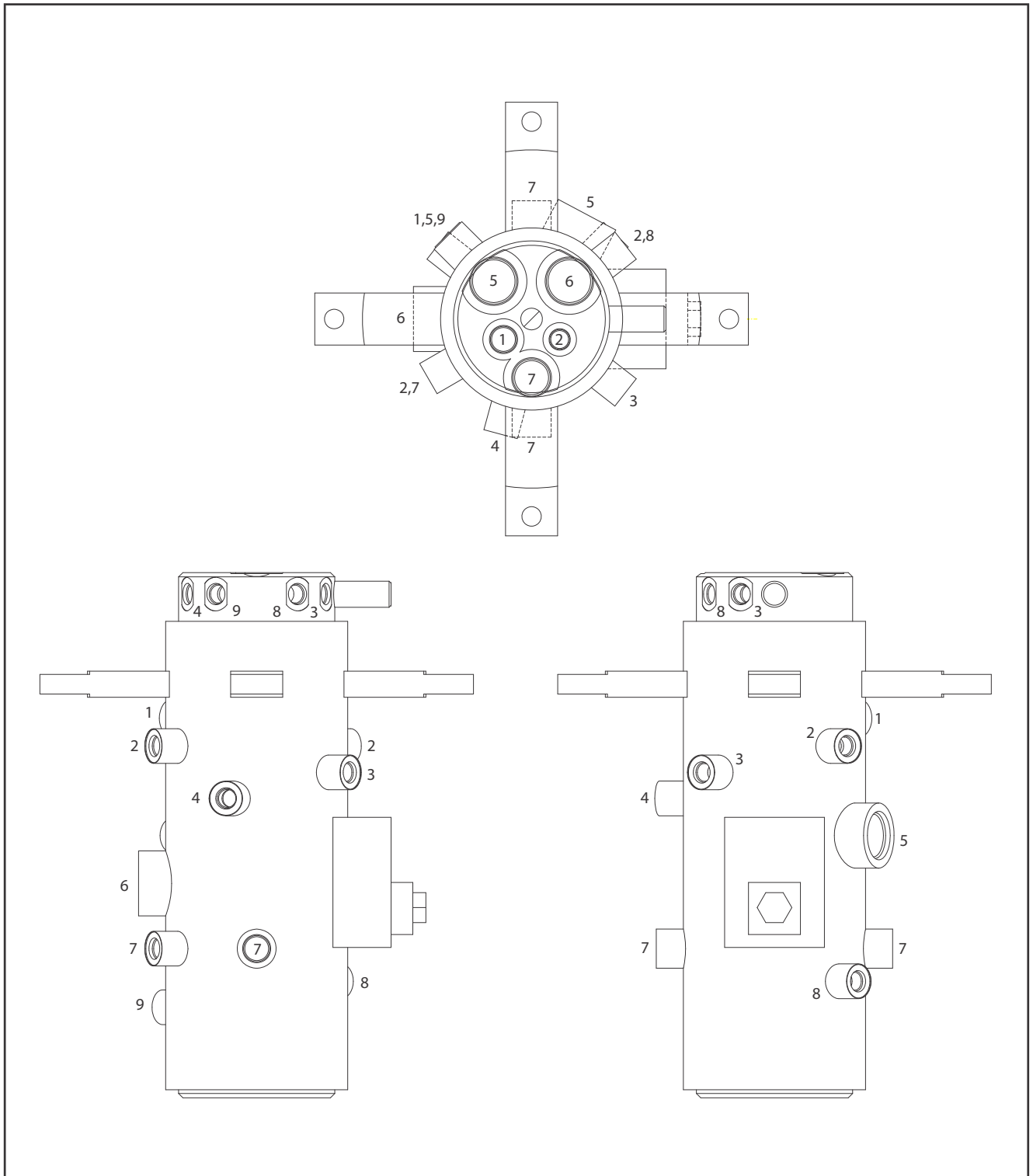


Figure 3-61. Rotary Coupling Port Location - 4WS

Table 3-8. Coupling Port Information Table - 2WS

Port No.	Out-let	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (47)
2	2	-6	2 Speed	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 3-9. Coupling Port Information Table - 4WS

Port No.	Out-let	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (47)
2	2	-6	2 Speed	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)

### 3.12 GENERATOR

#### Every 250 hours

Check drive belt tension every 250 hours of operation,.

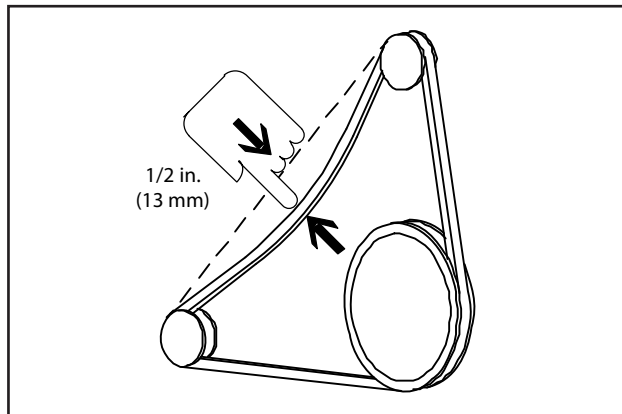


Figure 3-62. Generator Belt Tension

#### Every 500 hours

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

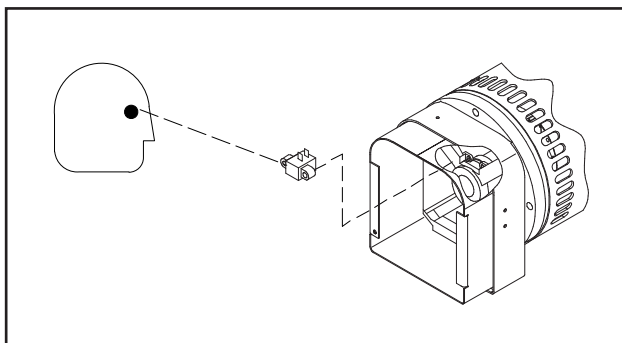


Figure 3-63. Generator Brushes and Slip Rings

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

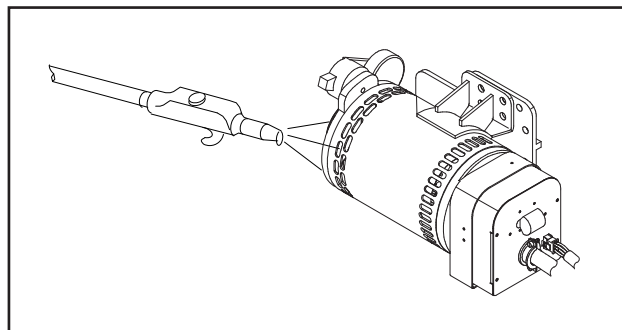


Figure 3-64. Blow Out Generator

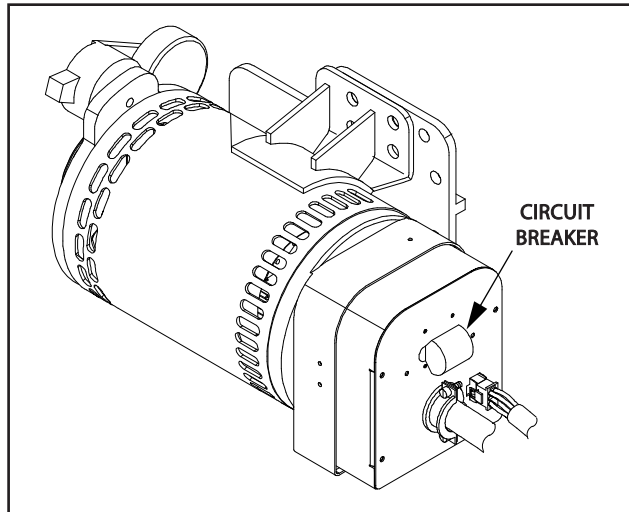
## Overload Protection

### **⚠ 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 3-65. Generator Circuit Breaker Location**

## Inspecting Brushes, Replacing Brushes, and Cleaning Slip Rings

*Refer to Figure 3-66. 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.

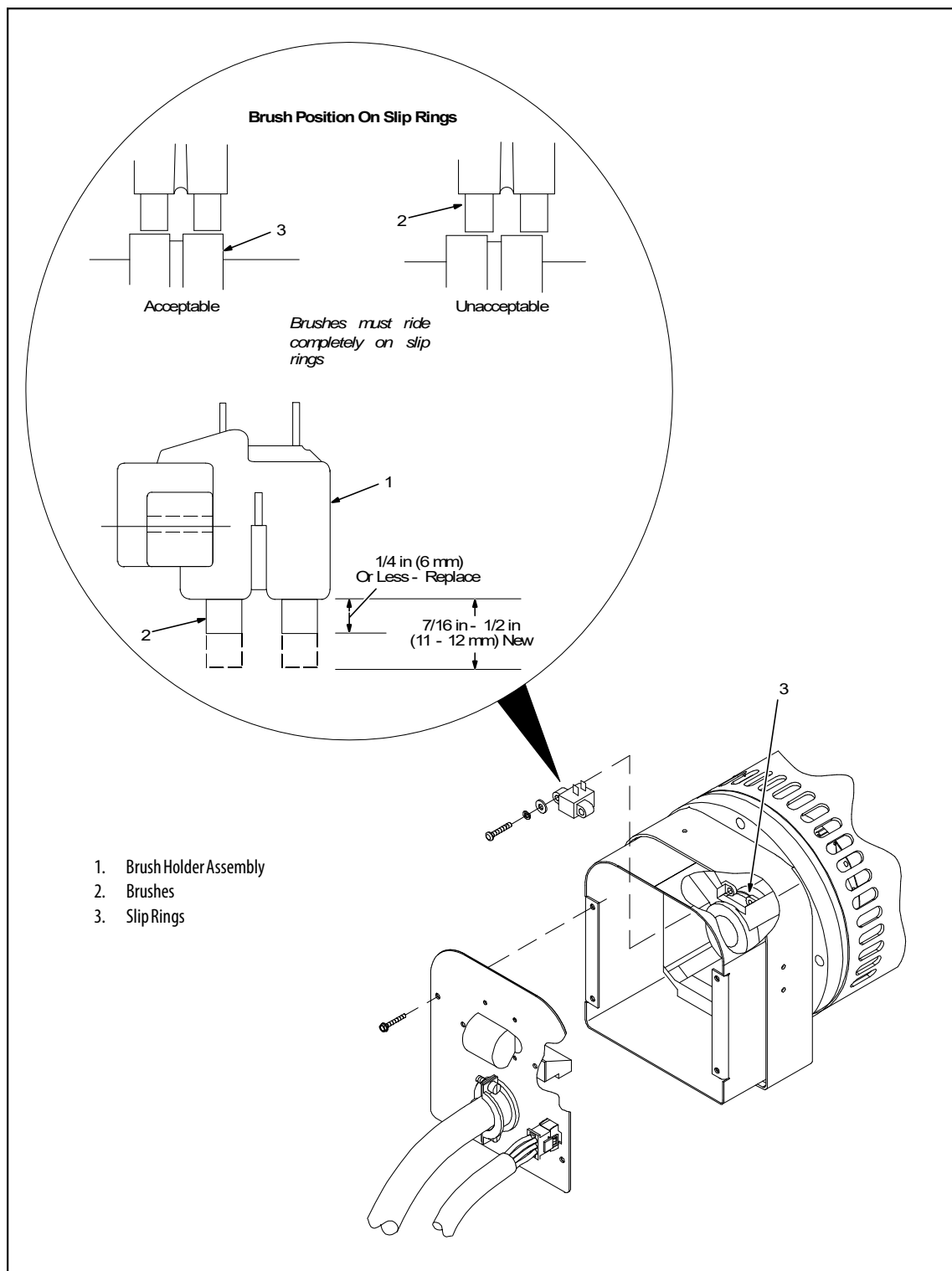
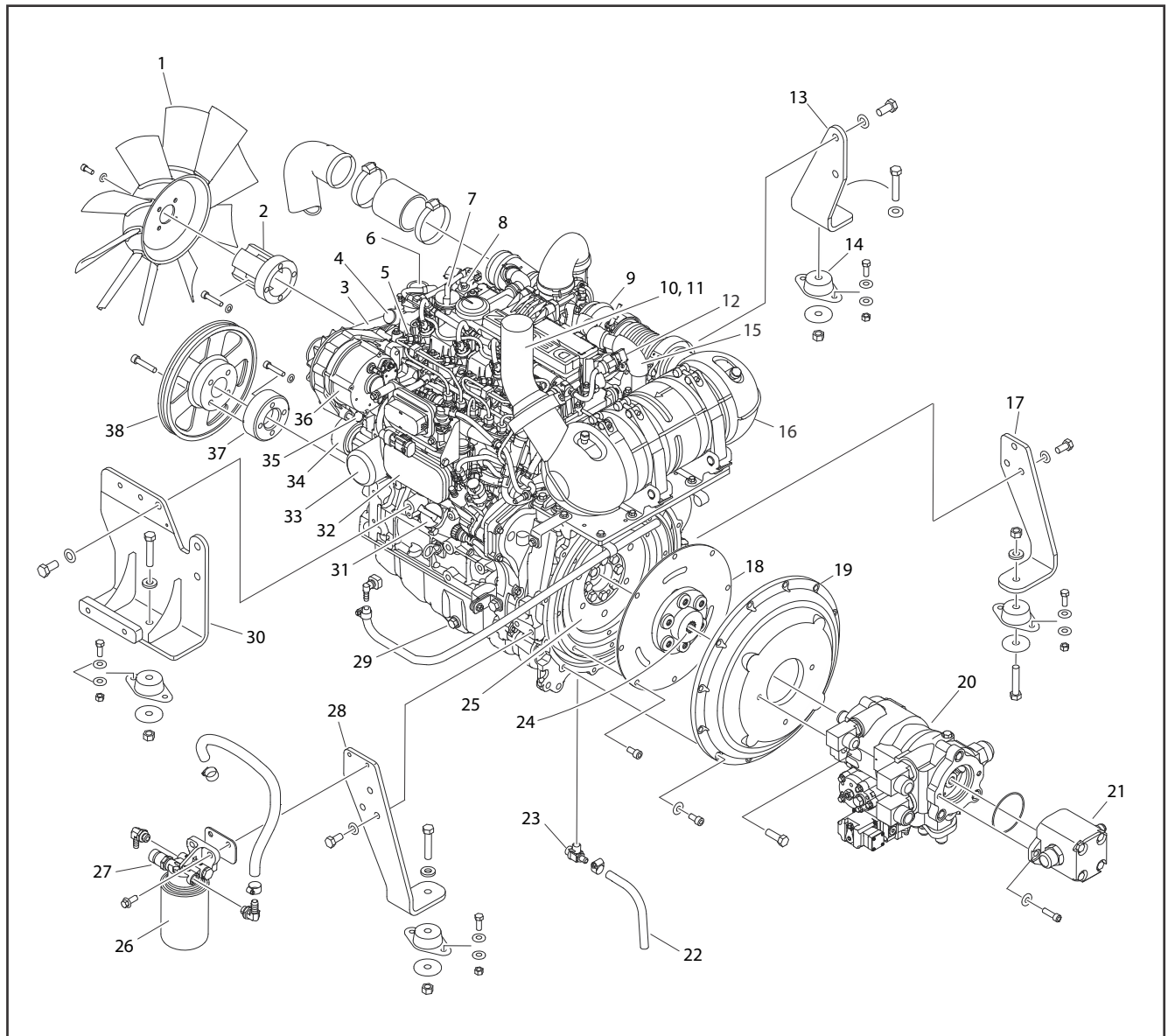


Figure 3-66. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

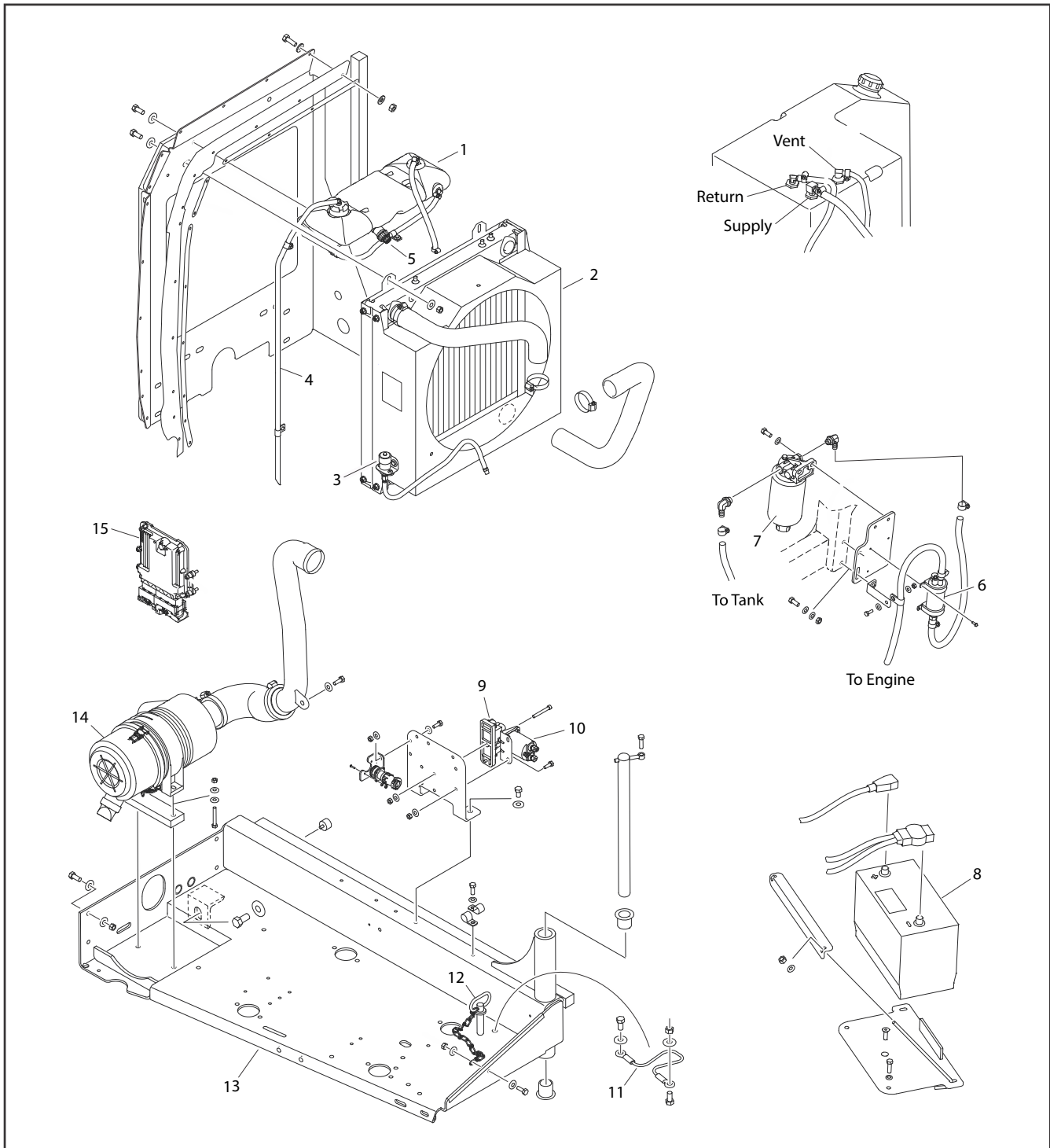
3.13 DEUTZ D2.9 L4 (T4F) ENGINE



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

Figure 3-67. Deutz D2.9 L4 (T4F) Engine Installation - Sheet 1 of 2

**SECTION 3 - CHASSIS & TURNTABLE**



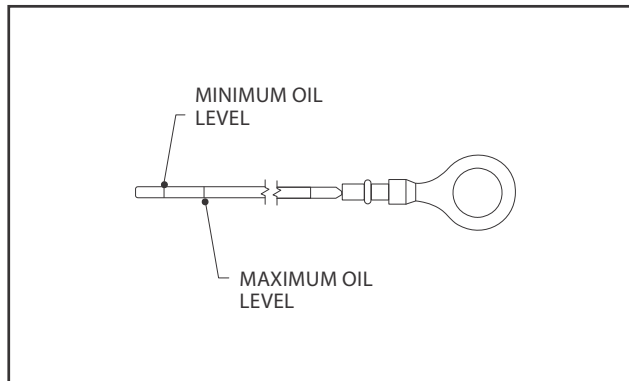
- |                                 |                          |                       |               |                               |
|---------------------------------|--------------------------|-----------------------|---------------|-------------------------------|
| 1. Coolant Recovery Tank        | 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 3-68. Deutz D2.9 L4 (T4F) 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 3-69. 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.

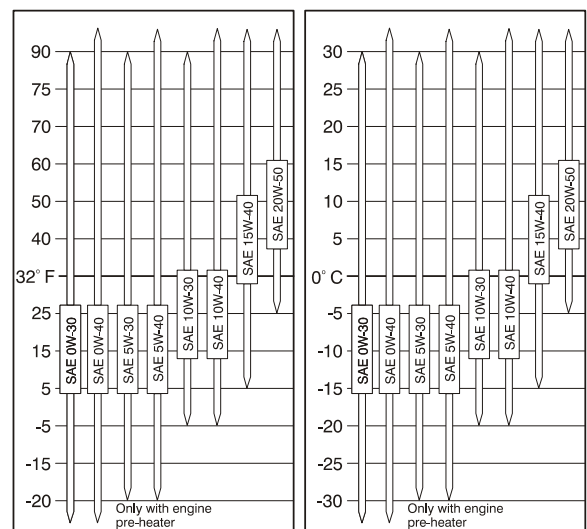
#### **CAUTION**

**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.**

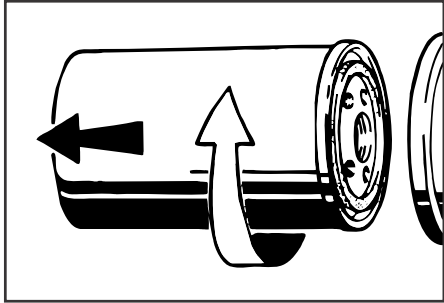
4. Open oil drain valve and drain oil.
5. Close oil drain valve.
6. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-70. Engine Oil Viscosity.



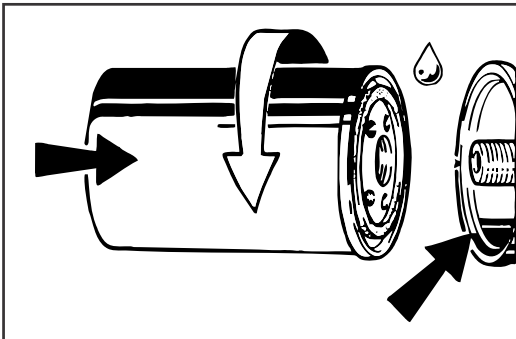
**Figure 3-70. Engine Oil Viscosity**

### 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.



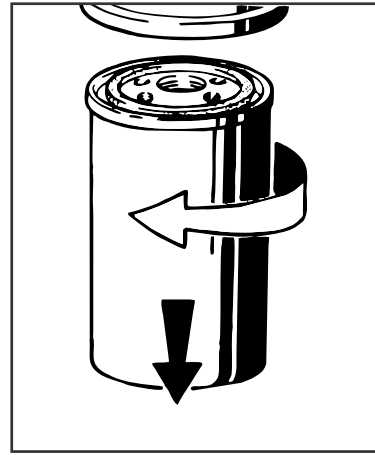
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

### Change Fuel Filters

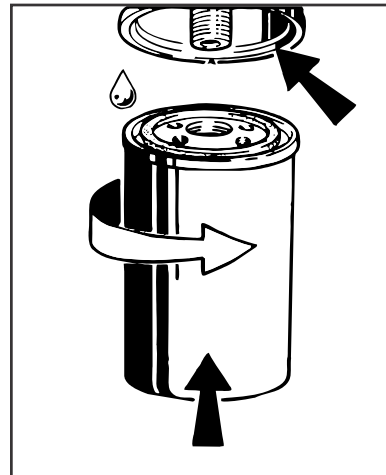
**⚠ WARNING**

**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.



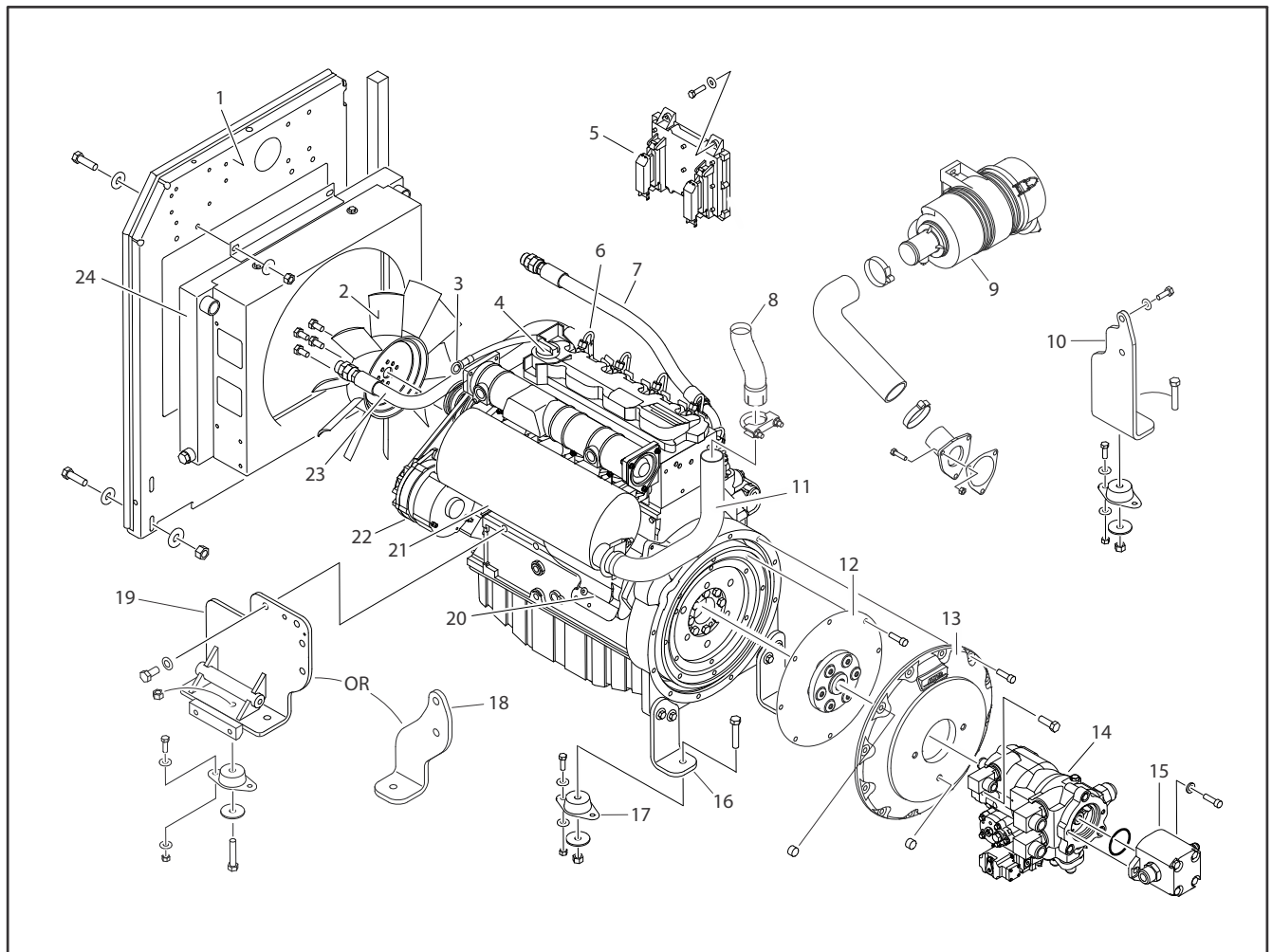
4. Clean dirt from filter carrier sealing surface.
5. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.
6. Screw in new filter by hand until gasket is flush. Hand-tighten filter another half-turn.



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

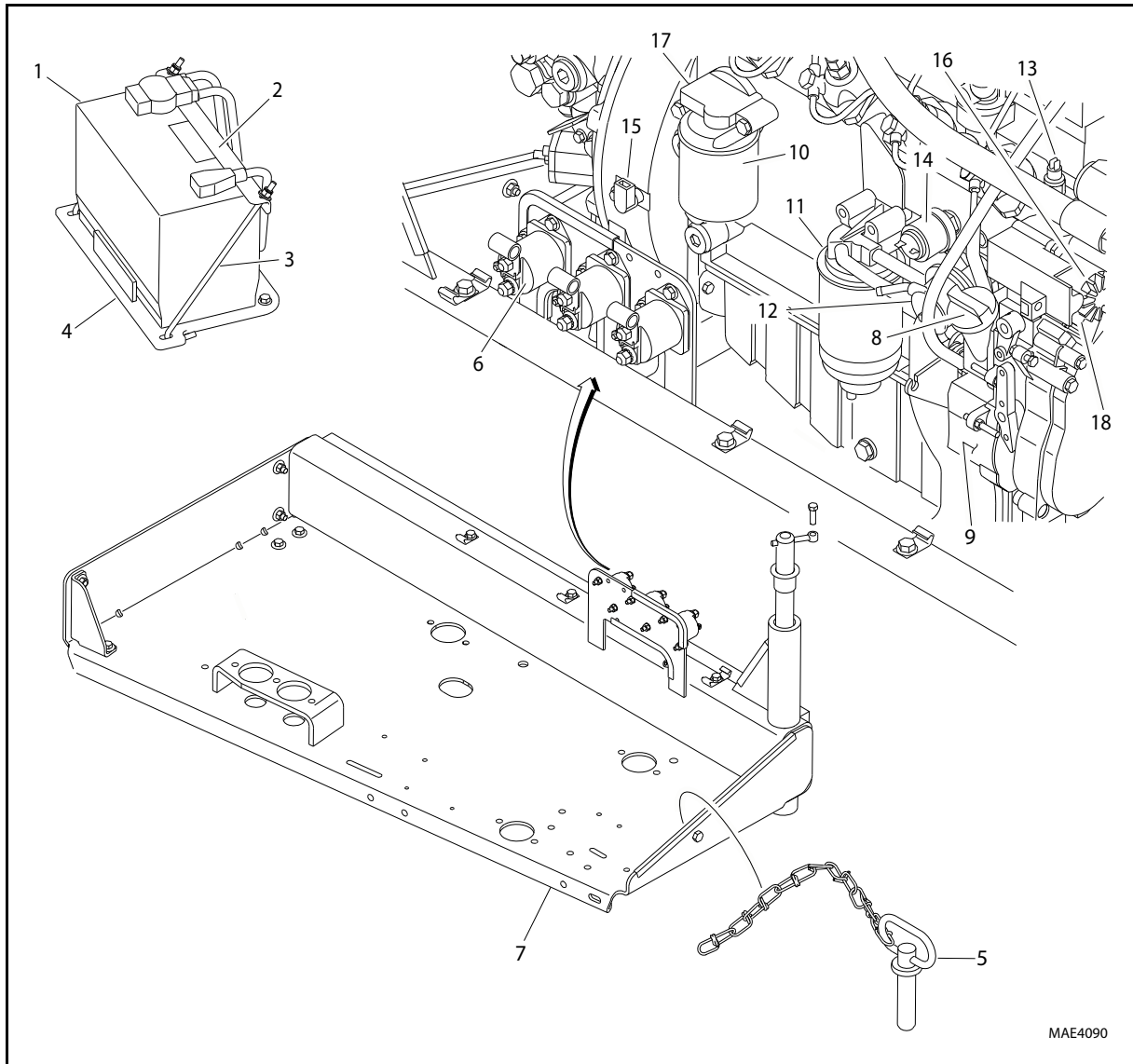


3.14 DEUTZ D2011 (T4I) ENGINE



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

Figure 3-71. Deutz D2011 (T4i) Engine Installation - Sheet 1 of 2



MAE4090

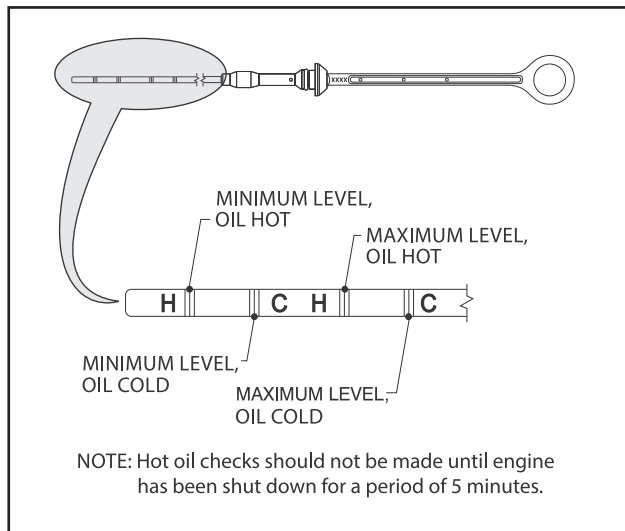
- |                            |                      |                         |
|----------------------------|----------------------|-------------------------|
| 1. Battery                 | 7. Engine Tray       | 13. Temperature Sensor  |
| 2. Battery Hold-Down       | 8. Filler Cap        | 14. Oil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

Figure 3-72. Deutz D2011 (T4i) Engine Installation - Sheet 2 of 2

**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 3-73. 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.

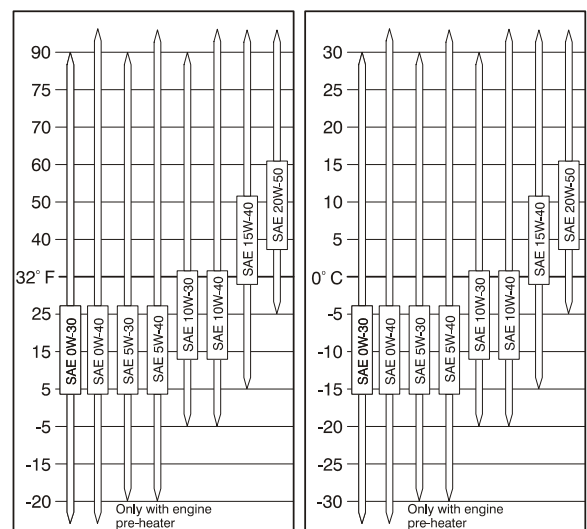
#### **CAUTION**

**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.**

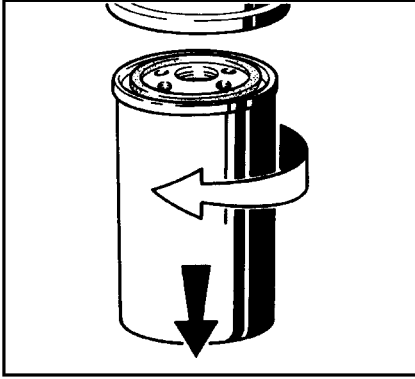
4. Open oil drain valve and drain oil.
5. Close oil drain valve.
6. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-74. Engine Oil Viscosity.



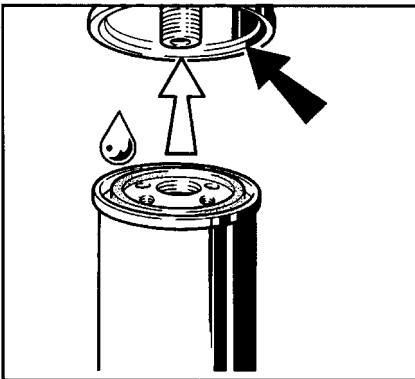
**Figure 3-74. Engine Oil Viscosity**

## Changing Oil Filter

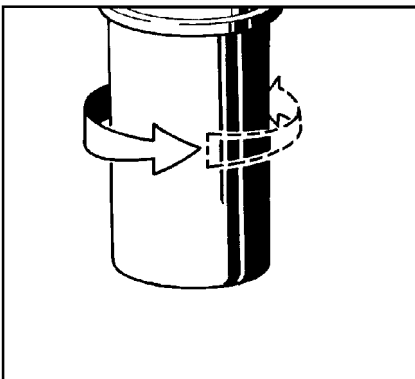
1. Wipe area around filter to clean any dirt from area.
2. Using a suitable oil filter removal tool, loosen lube oil filter cartridge and spin off.



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.**

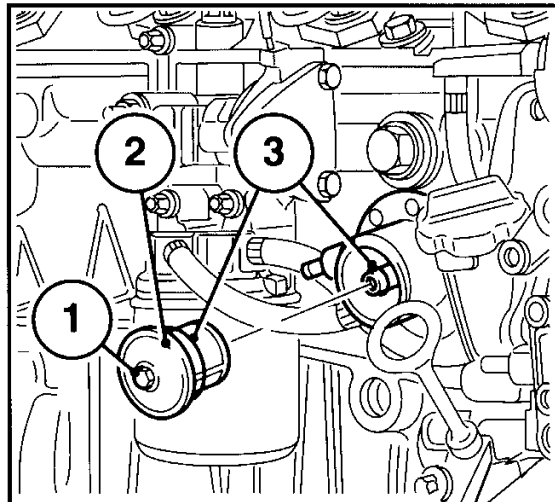
1. Wipe area around filter to clean any dirt from area.
2. Remove fuel filter cartridge. Catch any escaping fuel.
3. Clean dirt from filter carrier sealing surface.
4. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.
5. Screw in new filter by hand until gasket is flush. 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.

### **3.15 SPARK ARRESTER CLEANING INSTRUCTIONS**

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

### **3.16 GLOW PLUGS**

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

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

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

### 3.17 DEUTZ EMR 2

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

The sensors attached to the engine provide the electronics in the control unit with all the relevant physical parameters. In accordance with the information of the current condition of the engine and the 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.

The 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 in order 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 the programming, that is carried out over the ISO9141 interface, the EMR2 possesses a motor-specific data set and this is then fixedly 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.

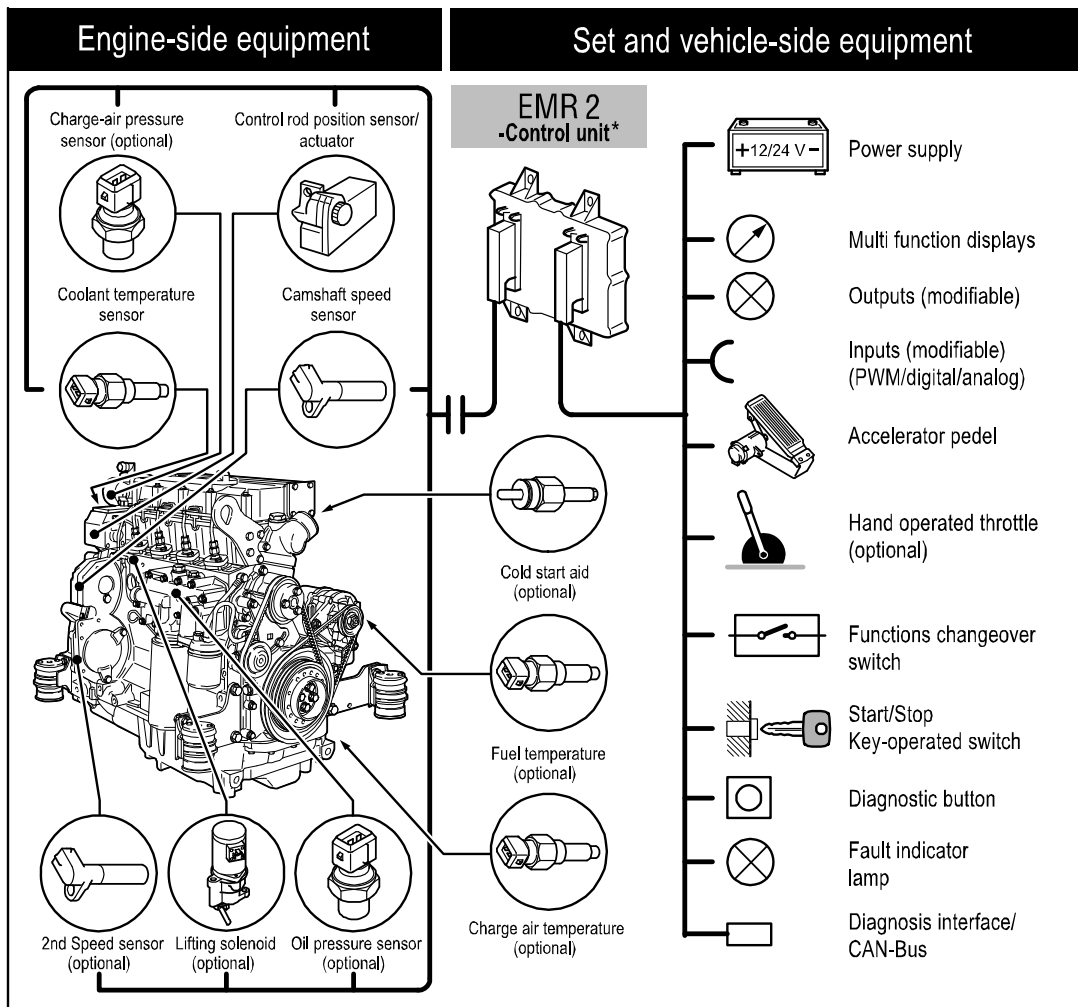


Figure 3-75. EMR 2 Engine Side Equipment

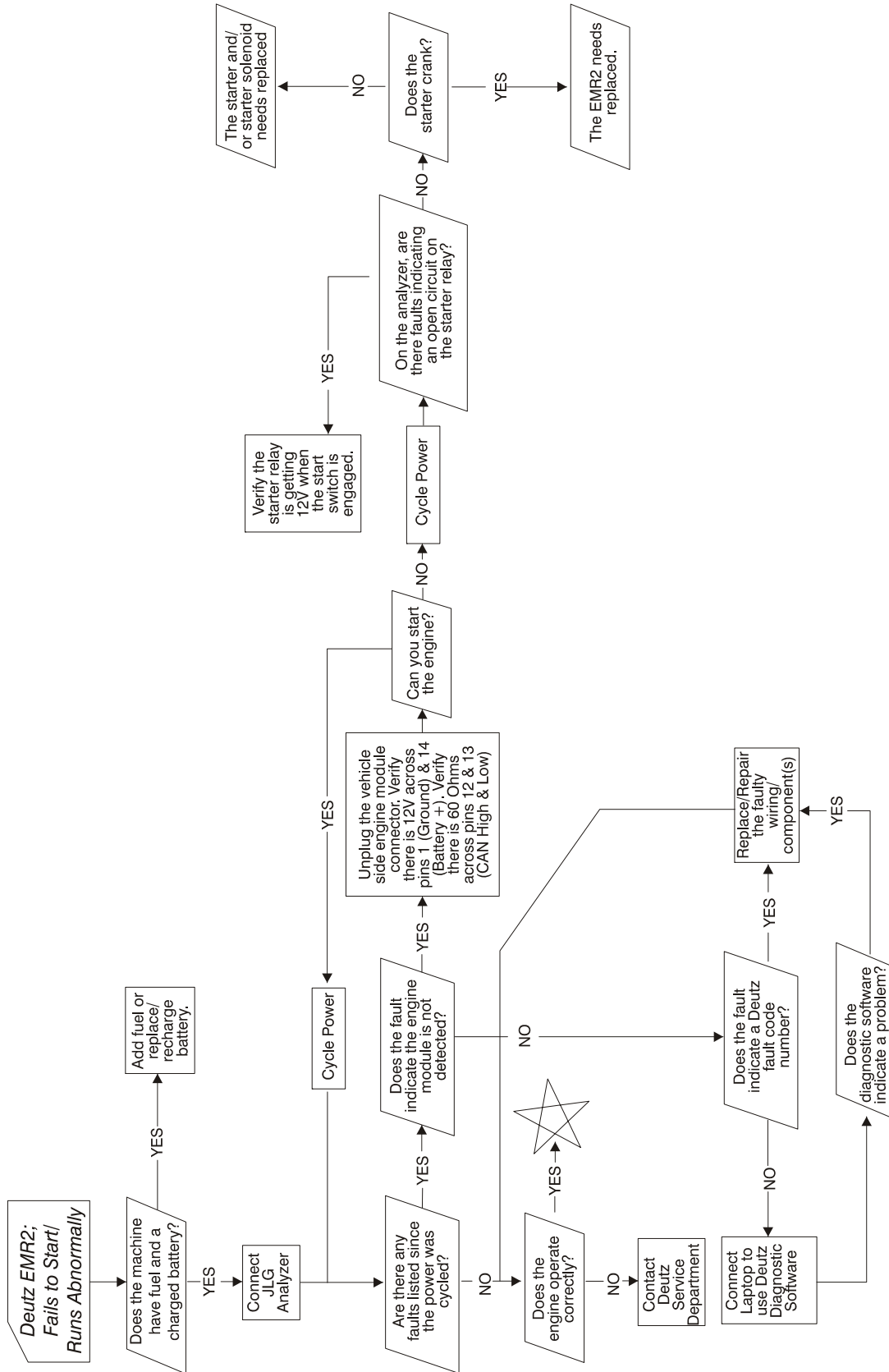


Figure 3-76. Deutz EMR 2 Troubleshooting Flow Chart

- Notes: (N ...)
- equipment declaration according to H52989, part 1, e.g.
  - bus terminal resistance for CAN-internals SAE J 1939 to H52989, part 1, e.g.
  - to be installed permanently, see page 043 2807/00
  - max. permissible length: 3 lines: 13 m
  - max. permissible line section: 5,5 m
  - control unit EHR → actuator: 5,5 m
  - control unit EHR → display: 10 m
  - equipment plug → control- and display elements: 5 m
  - max. permissible current: 30 mA
  - not supplied by IUTIZ
  - don't connect CAN-signal to chassis
  - don't connect additional power-consumers behind fuse F75
  - place connection points near ECU

- Notes: (N ...)
- Gerätebezeichnung nach H52990 Teil 1, z.B. extern Beschalter, siehe Anmerkung SAE J 1939
  - mit technischer Leistungsangabe über 1,5 mA
  - Steuergerät EHR → Aktuator: 5,5 m
  - Steuergerät EHR → Anzeige: 10 m
  - Gerätebezeichner → Bediener- und Anzeigenelemente: 5 m
  - Max. zulässige Stromstärke: 30 mA
  - Kein IUTIZ Lieferant
  - IMO nicht mit Motormasse verbinden
  - Hoch-Sicherung keine zusätzlichen Verbraucher anschließen
  - Anschlussspunkte nahe am Steuergerät montieren

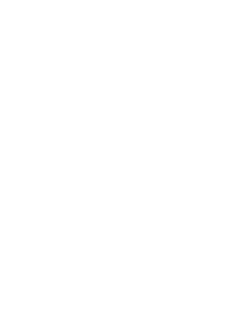
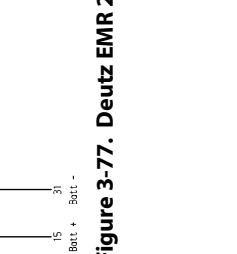
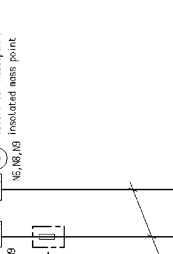
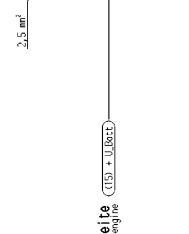
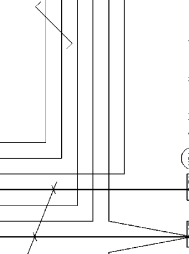
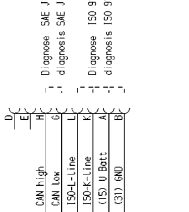
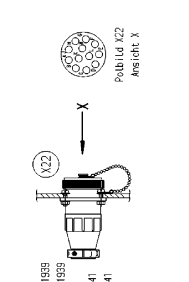
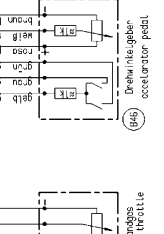
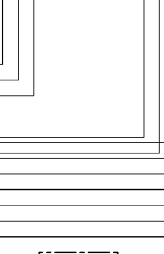
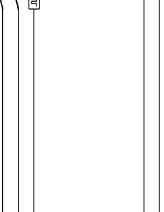
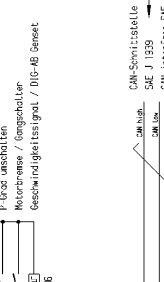
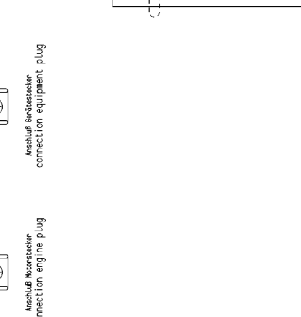
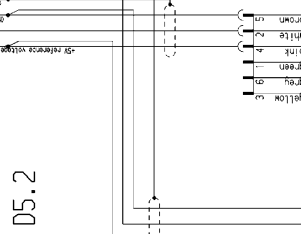
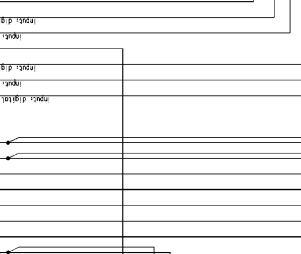
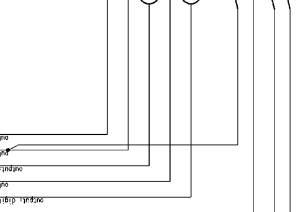
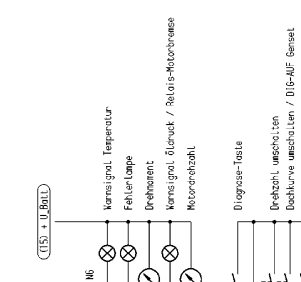
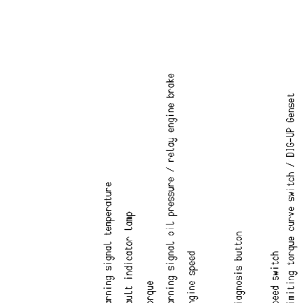
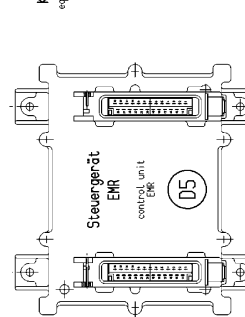
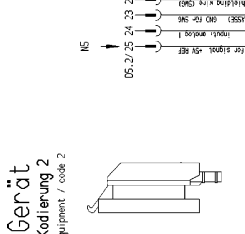
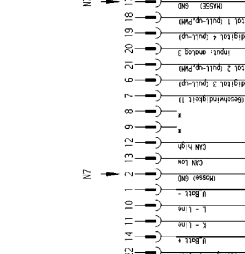
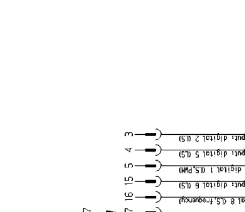


Figure 3-77. Deutz EMR 2 Vehicle Side Connection Diagram



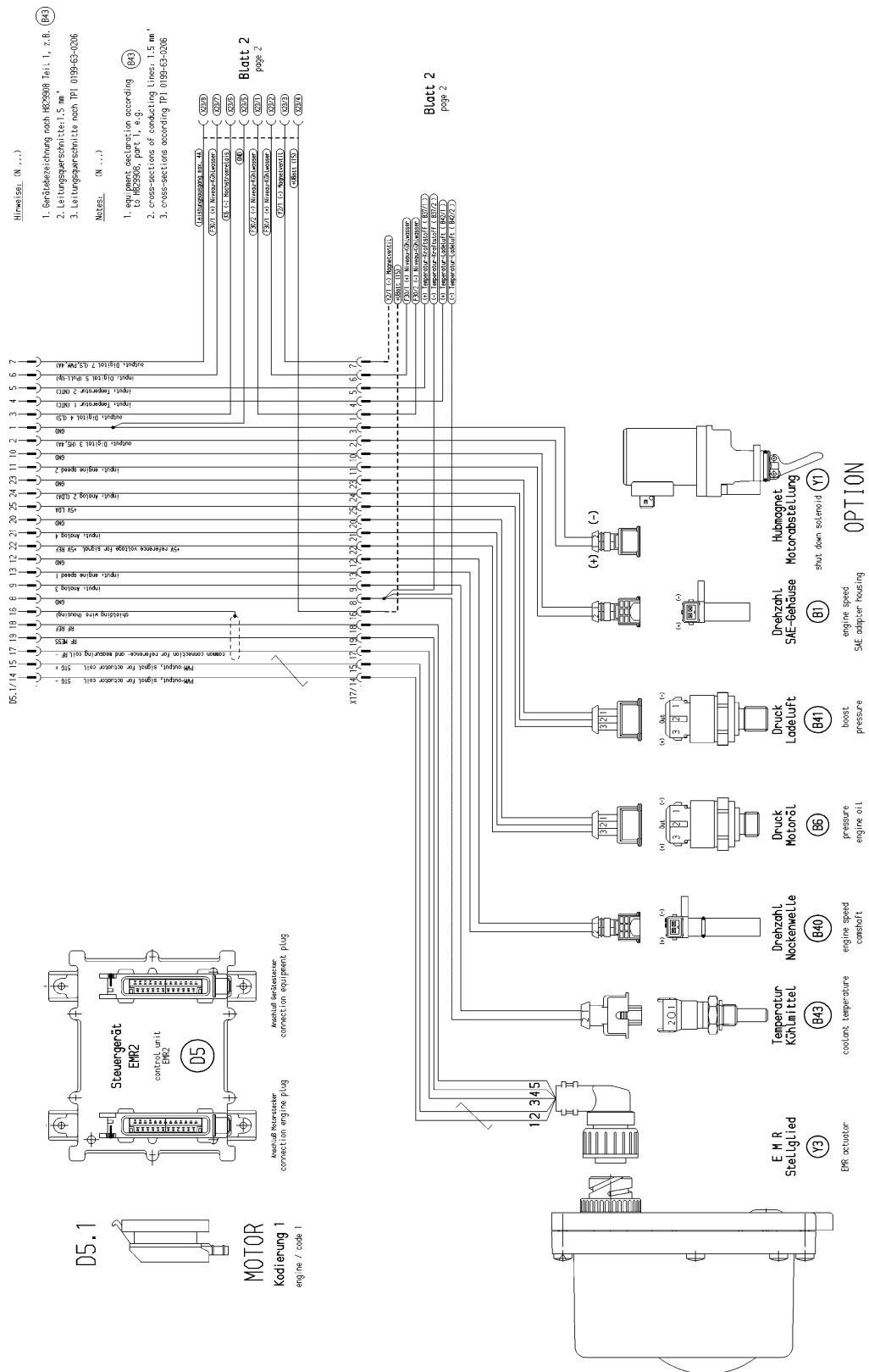


Figure 3-78. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

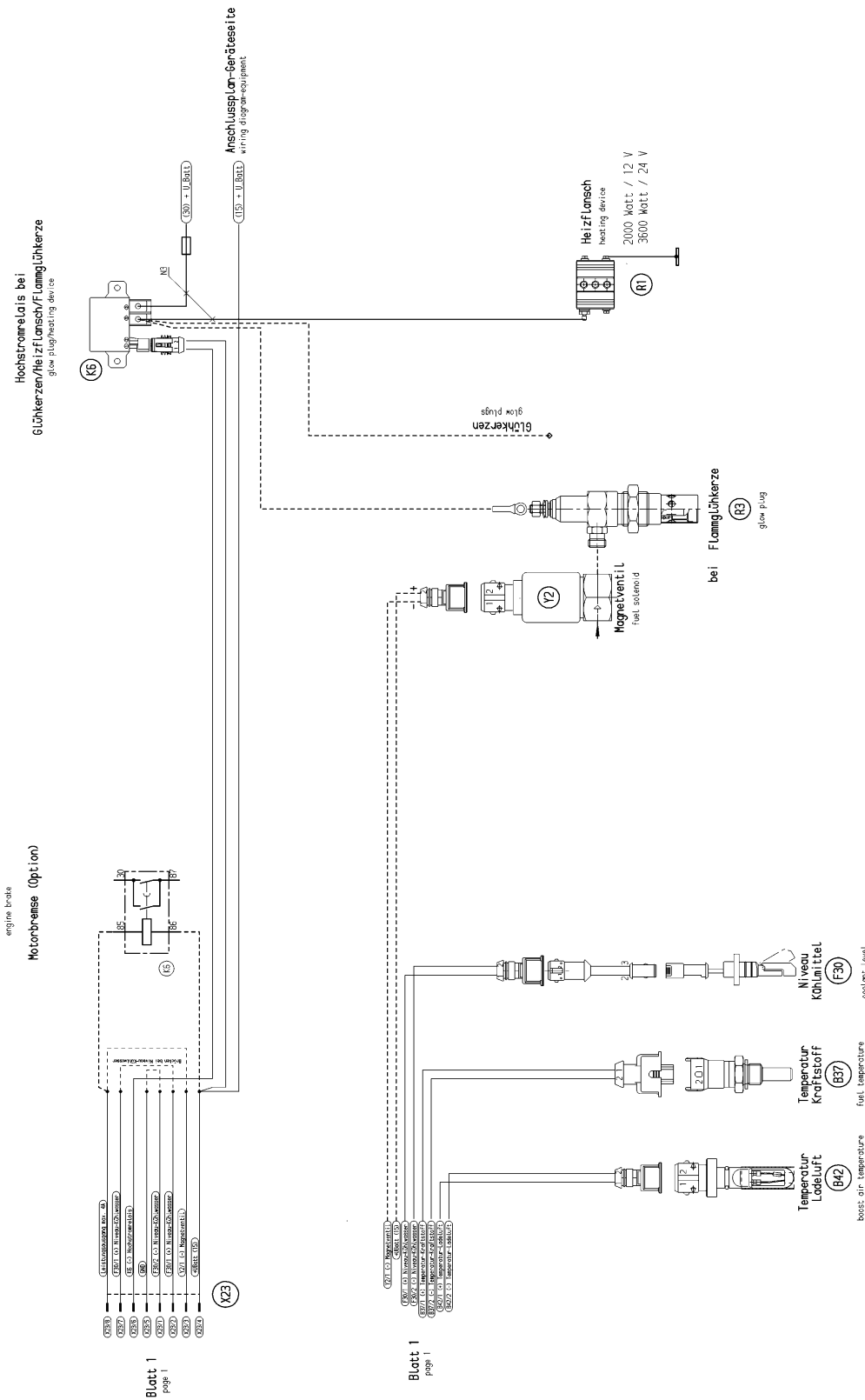
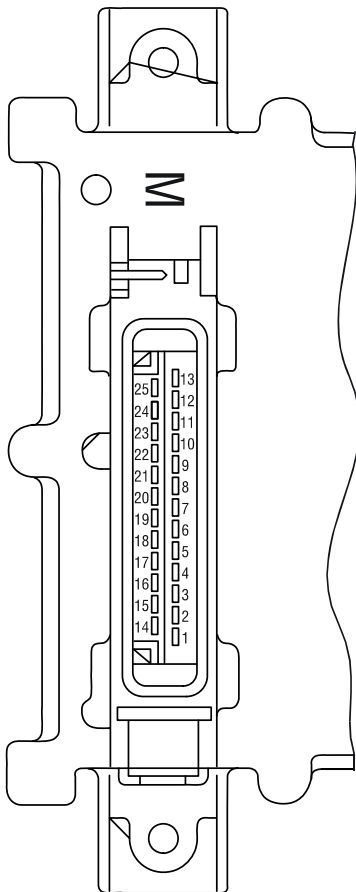


Figure 3-79. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2

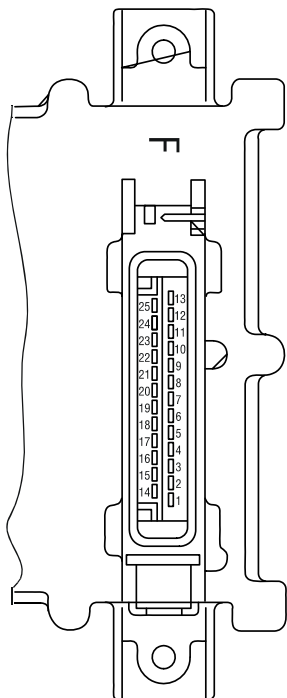


Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid <sup>1)</sup>
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature <sup>2)</sup>
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) 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 3-80. 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 3-81. EMR 2 Vehicle Plug Pin Identification

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.	Engine stop.	Check parameter (21). Check speed settings.
					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.		
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 3-82. 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 again 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.
	36	Fuel temperature warning	174	0	Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator. Check speed sensor (impulses on incorrect speed). 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 3-83. EMR2 Fault Codes - Sheet 2 of 5

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 3-84. EMR2 Fault Codes - Sheet 3 of 5

**SECTION 3 - CHASSIS & TURNTABLE**

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.
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.	Emergency switch-off: engine cannot be started.	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").		
	78	Cyclic RAM test	SID 254	2	Constant monitoring of working memory shows error.		

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 3-85. EMR2 Fault Codes - Sheet 4 of 5**



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.	
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 3-86. EMR2 Fault Codes - Sheet 5 of 5

### **3.18 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. The 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 the white smoke behavior is unacceptable when using a very low cetane number, the use of ignition improvers is to be recommended as a later remedial measure.

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

#### **Bio Fuel**

##### **PERMITTED BIO-DIESEL FUELS**

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**

The 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 the 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 the fuel injector is not allowed.
- The lubricating oil quality must correspond to TR 0199-99-3002. The 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 the engine must be started and stopped with diesel fuel.
- Bio-diesels can be mixed with normal diesel fuel but the 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.
- Approx. 30-50 hours after changing over 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 approx. 30 to 50 hours because the dissolving of dirt takes a certain amount of time.

**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, 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 that a fuel tank is contaminated by micro-organisms:

- Internal tank corrosion,
- Filter blockage and the 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 the water in the air. Water does not dissolve in fuel so that the penetrating water collects at the bottom of the tank. The bacteria and fungi grow in the watery phase, at the phase boundary to the fuel phase, from which they draw their nutrition. There is an increased risk especially with biodiesel (FAME).

**PREVENTIVE MEASURES**

- Keep the storage tank clean, 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.

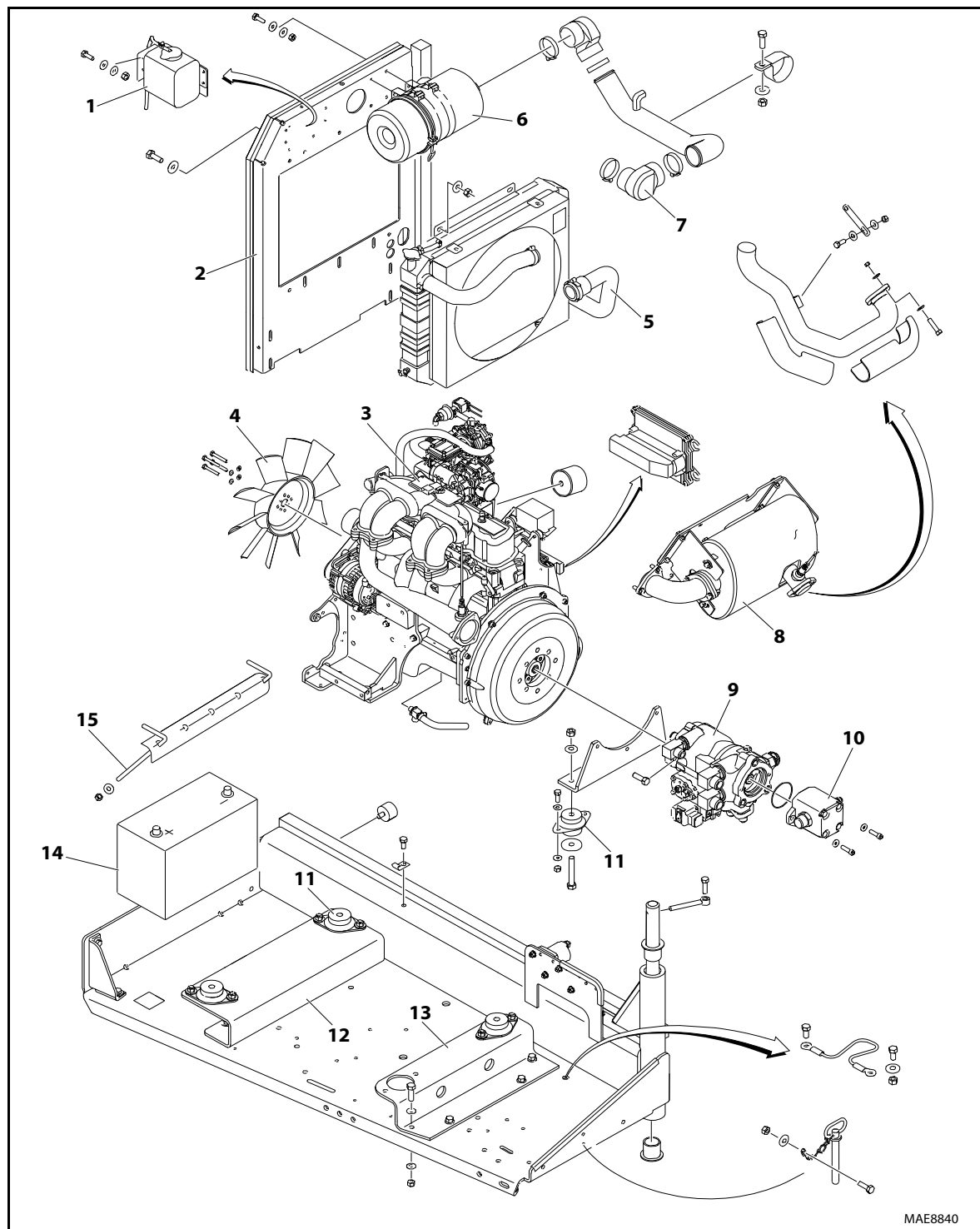
If the fuel system and storage tank have already been attacked by micro-organisms. The biocide must be dosed according to the manufacturer's specifications.

- 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.

3.19 GM ENGINE



MAE8840

- |                            |                         |                          |                        |
|----------------------------|-------------------------|--------------------------|------------------------|
| 1. Container               | 5. Radiator Hose        | 9. Piston Pump           | 13. Engine Mount Plate |
| 2. Radiator Mounting Plate | 6. Air Cleaner Assembly | 10. Gear Pump            | 14. Battery            |
| 3. Oil Filter              | 7. Fitting              | 11. Engine Mount         | 15. Battery Hold Down  |
| 4. Fan                     | 8. Muffler              | 12. Engine Mount (front) |                        |

Figure 3-87. GM Engine Installation Sheet 1 of 2

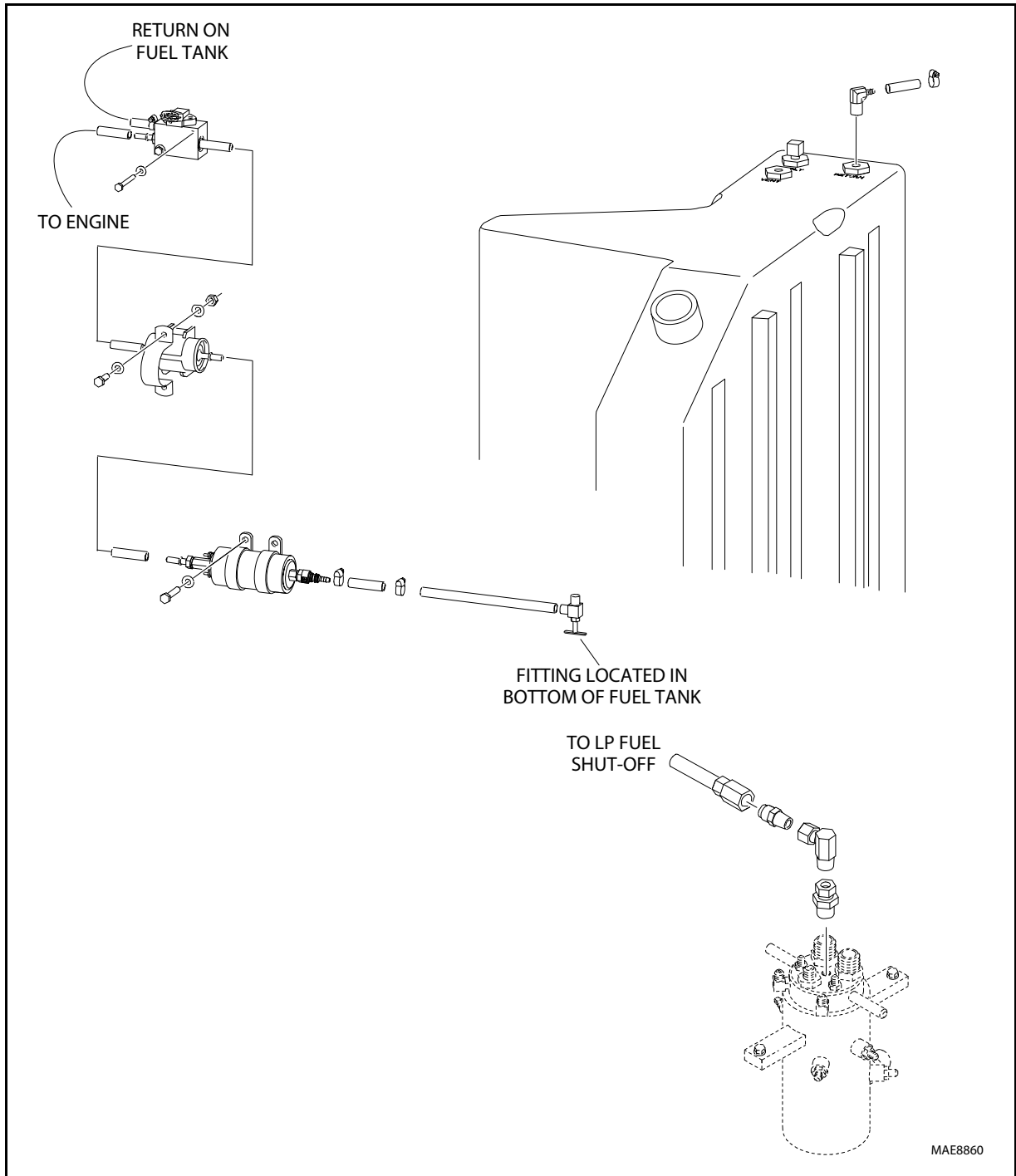


Figure 3-88. GM Engine Installation Sheet 2 of 2

## 3.20 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 proper 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

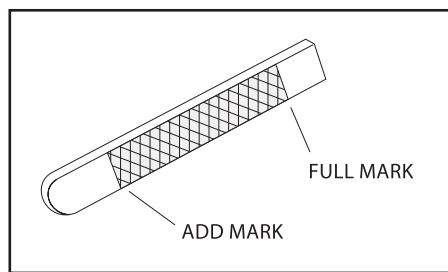
**AN OVERFILLED CRANKCASE (OIL LEVEL OVER THE SPECIFIED FULL MARK) CAN CAUSE AN OIL LEAK, FLUCTUATION OR DROP IN OIL PRESSURE, AND ROCKER ARM "CLATTER".**

#### 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 3-89. 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.



## 3.21 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).

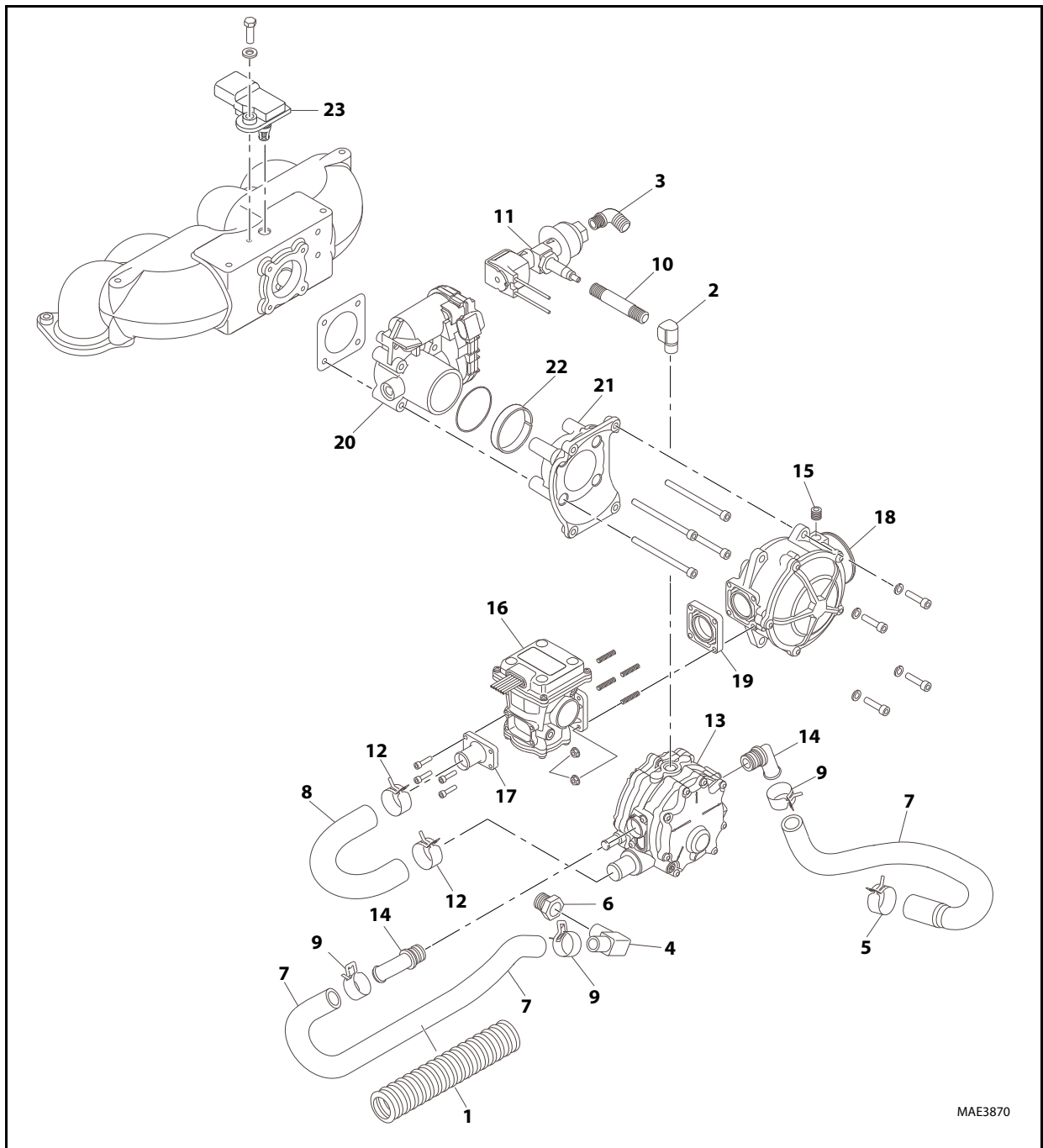
Components shared by both systems include the Electronic Throttle Control and ECM. The ECM contains a dual calibration; one controls the gasoline fuel system during gasoline operation and one controls the LPG fuel system during LPG operation.

### 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.





MAE3870

- |                      |                    |                    |                         |                  |
|----------------------|--------------------|--------------------|-------------------------|------------------|
| 1. 1 inch Split Loom | 6. Adapter Fitting | 11. Lock-Off Valve | 16. Electronic Pressure | 21. Adapter      |
| 2. 90° Fitting       | 7. Hose            | 12. Clamp          | 17. Adapter             | 22. Spacer       |
| 3. 90° Fitting       | 8. Hose            | 13. Regulator      | 18. Mixer               | 23. T-MAP Sensor |
| 4. 90° Fitting       | 9. Clamp           | 14. 45° Fitting    | 19. Spacer (600A Only)  |                  |
| 5. Clamp             | 10. Nipple         | 15. Plug           | 20. Throttle Body       |                  |

Figure 3-90. GM 3.0 Duel 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.

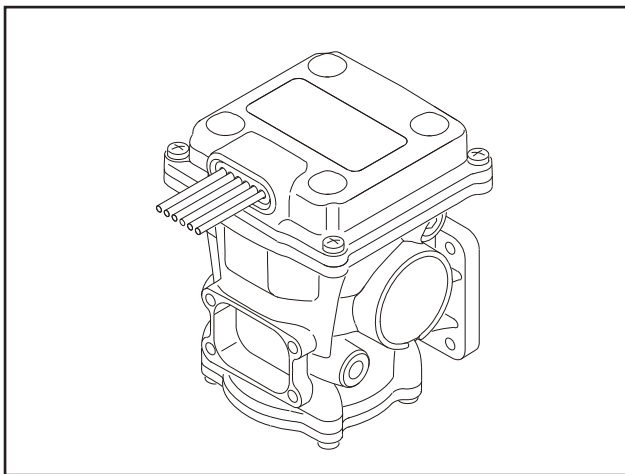


Figure 3-91. Direct Electronic Pressure Regulator

## 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.

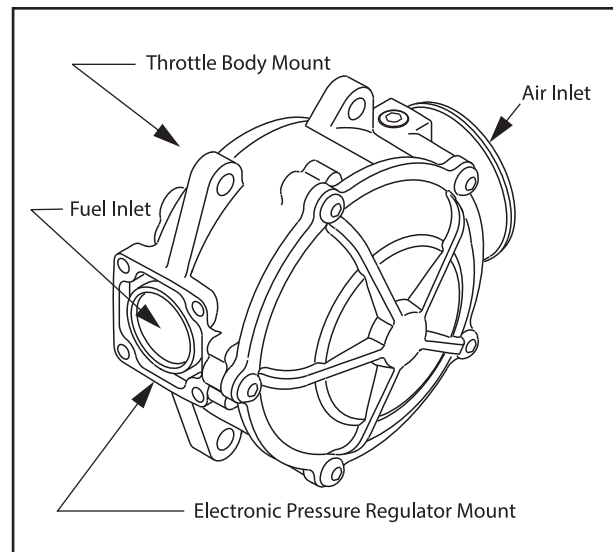


Figure 3-92. Air Fuel Mixer

### 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.

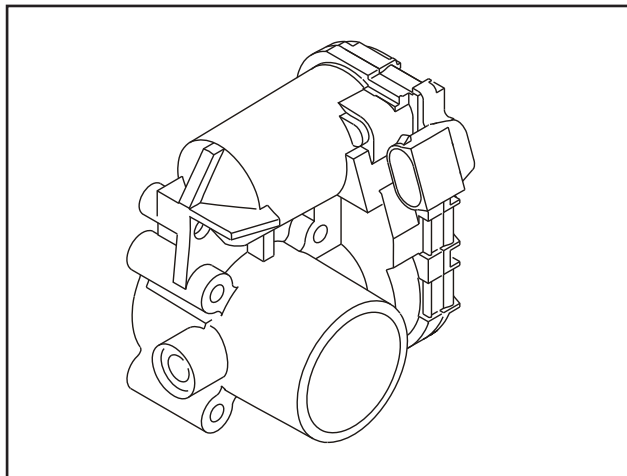


Figure 3-93. Electronic Throttle Control Device

### 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).

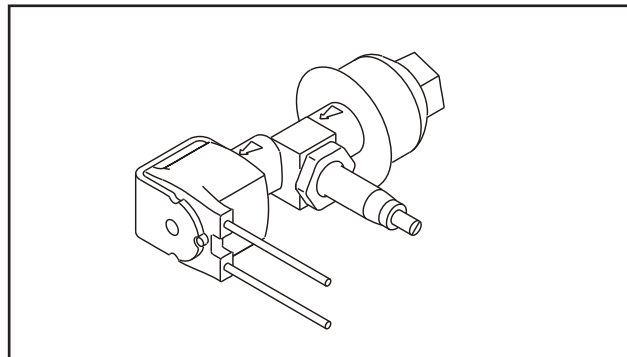


Figure 3-94. Electric Lock Off Assembly

### 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.

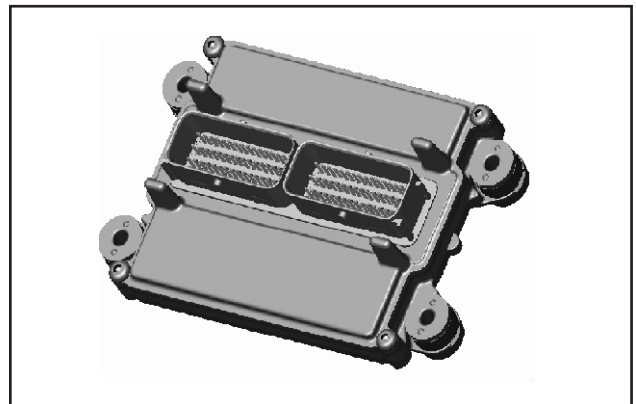


Figure 3-95. ECM Assembly

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.

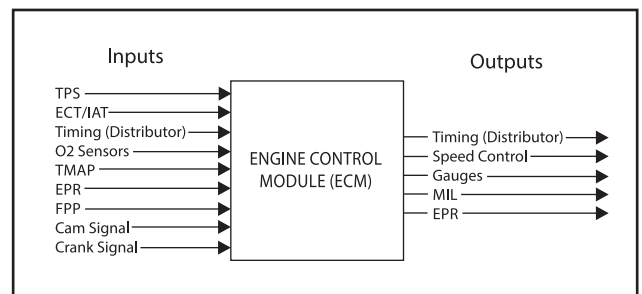


Figure 3-96. ECM Input-Output Diagram

### 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 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.

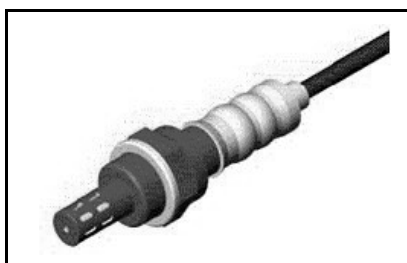


Figure 3-97. Heated Exhaust Gas Oxygen Sensor (HEGO)

### 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 2 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 receive 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.

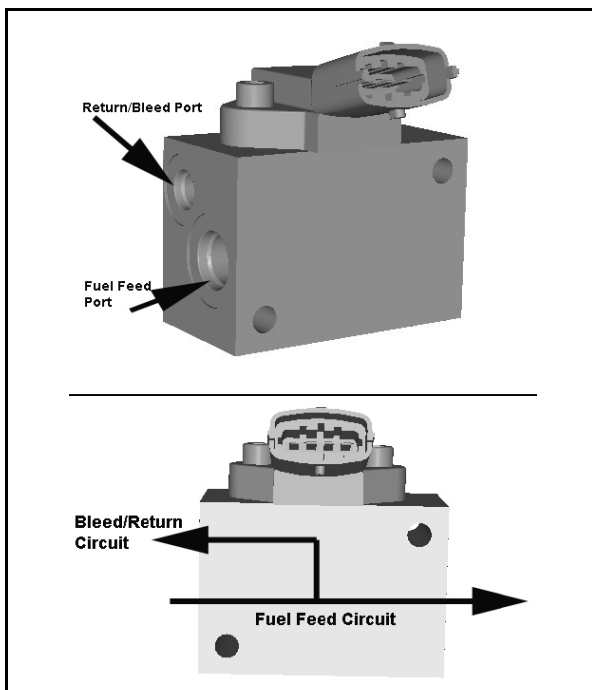


Figure 3-98. Gasoline Fuel Pressure and Temperature Manifold Assembly

## 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.

## 3.22 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.**

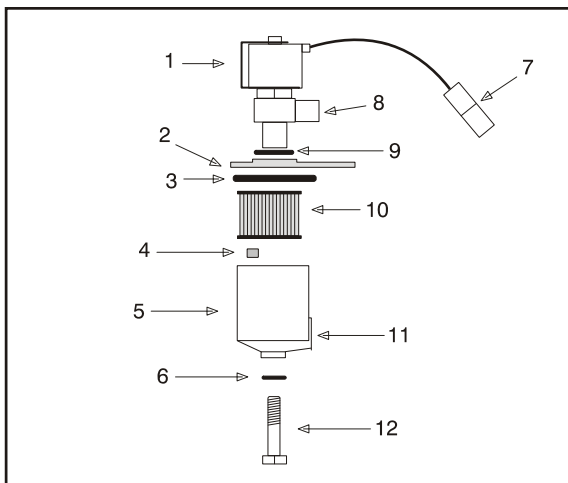
### Propane Fuel System Leak Test

#### 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 3-99. 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

**NOTE:** Refer to Figure 3-90. GM 3.0 Duel 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

**NOTE:** Refer to Figure 3-90. GM 3.0 Duel 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

**NOTE:** Refer to Figure 3-90. GM 3.0 Duel 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

**NOTE:** Refer to Figure 3-90. GM 3.0 Duel 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

**NOTE:** Refer to Figure 3-90. GM 3.0 Duel Fuel System Components.

### REMOVAL

1. Disconnect negative battery cable.
2. Remove Mixer (See "Mixer Replacement" on page 98).
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 98).

## Mixer Replacement

**NOTE:** Refer to Figure 3-90. GM 3.0 Duel Fuel System Components.

### REMOVAL

1. Remove EPR. (See "Electronic Pressure Regulator (EPR) Replacement" on page 99)
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 (EPR) Replacement" on page 99).
3. Reinstall Air Intake Hose.
4. Start engine and leak check all fittings and connections.



## Electronic Pressure Regulator (EPR) Replacement

### REMOVAL

**NOTE:** Refer to Figure 3-90. GM 3.0 Duel 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

**NOTE:** Refer to Figure 3-90. GM 3.0 Duel 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**

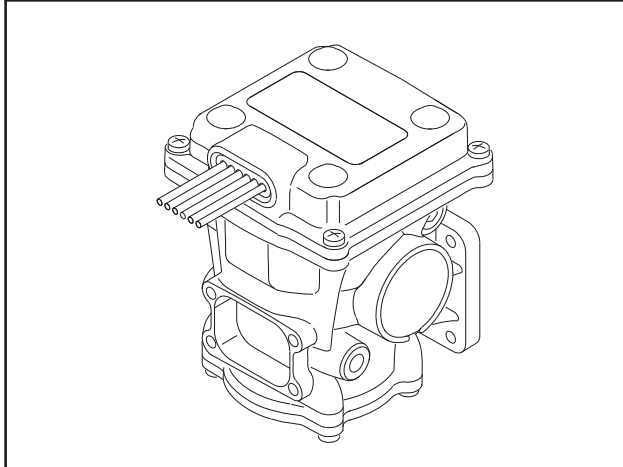
**NOTICE**

**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.

### 3.23 GM ENGINE LPG FUEL SYSTEM DIAGNOSIS

#### Fuel System Description



**Figure 3-100. 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.

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-10. 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 LPR 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

Table 3-10. 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	--

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-11. Symptom Diagnosis**

Checks	Action
<b>Important Preliminary Checks</b>	
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"> <li>1. The Control Module and MIL (Malfunction Indicator Lamp) are operating correctly.</li> <li>2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL.</li> </ol> <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"> <li>1. Verify the customer complaint.</li> <li>2. Locate the correct symptom table.</li> <li>3. Check the items indicated under that symptom.</li> <li>4. Operate the vehicle under the conditions the symptom occurs. Verify HEGO switching between lean and rich.</li> </ol> <p><b>IMPORTANT! Normal HEGO switching indicates the LPG fuel system is in closed loop and operating correctly at that time.</b></p>
Visual and Physical Checks	<ol style="list-style-type: none"> <li><sup>2</sup> Check all ECM system fuses and circuit breakers.</li> <li><sup>2</sup> Check the ECM ground for being clean, tight and in its proper location.</li> <li><sup>2</sup> Check the vacuum hoses for splits, kinks and proper connections.</li> <li><sup>2</sup> Check thoroughly for any type of leak or restriction.</li> <li><sup>2</sup> Check for air leaks at all the mounting areas of the intake manifold sealing surfaces.</li> <li><sup>2</sup> Check for proper installation of the mixer module assembly.</li> <li><sup>2</sup> Check for air leaks at the mixer assembly.</li> <li><sup>2</sup> Check the ignition wires for the following conditions: <ul style="list-style-type: none"> <li>- Cracking</li> <li>- Hardness</li> <li>- Proper routing</li> <li>- Carbon tracking</li> </ul> </li> <li><sup>2</sup> Check the wiring for the following items: <ul style="list-style-type: none"> <li>- Proper connections, pinches or cuts.</li> </ul> </li> <li><sup>2</sup> 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.</li> </ol>
<b>Intermittent</b>	
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"> <li><sup>2</sup> Refer to Important Preliminary Checks.</li> <li><sup>2</sup> 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.</li> </ol>
Faulty Electrical Connections or Wiring	<ol style="list-style-type: none"> <li><sup>2</sup> Faulty electrical connections or wiring can cause most intermittent problems.</li> <li><sup>2</sup> Check the suspected circuit for the following conditions: <ul style="list-style-type: none"> <li>- Faulty fuse or circuit breaker</li> <li>- Connectors poorly mated</li> <li>- Terminals not fully seated in the connector (backed out)</li> <li>- Terminals not properly formed or damaged</li> <li>- Terminal to wires poorly connected</li> <li>- Terminal tension insufficient.</li> </ul> </li> <li><sup>2</sup> 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.</li> <li><sup>2</sup> Checking for poor terminal to wire connections requires removing the terminal from the connector body.</li> </ol>
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.

Table 3-11. Symptom Diagnosis

Checks	Action
Intermittent Malfunction Indicator Lamp (MIL)	The following components can cause intermittent MIL and no DTC(s): <sup>2</sup> 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. <sup>2</sup> The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc. <sup>2</sup> The ignition secondary voltage shorted to a ground. <sup>2</sup> The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground. <sup>2</sup> The Control Module grounds.
Loss of DTC Memory	To check for the loss of the DTC Memory: 1. Disconnect the TMAP sensor. 2. Idle the engine until the Malfunction Indicator Lamp illuminates.  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
Additional Checks	
No Start	
DEFINITION: The engine cranks OK <sup>22</sup> but does not start.	
Preliminary Checks	Refer to Important Preliminary Checks.
Control Module Checks	If a scan tool is available: <sup>2</sup> Check for proper communication with both the ECM <sup>2</sup> Check the fuse in the ECM battery power circuit. Refer to Engine Controls Schematics. <sup>2</sup> 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	<sup>2</sup> Check the TMAP sensor. <sup>2</sup> Check the Magnetic pickup sensor (RPM).
Fuel System Checks	<b>Important:</b> A closed LPG manual fuel shut off valve will create a no start condition. <sup>2</sup> Check for air intake system leakage between the mixer and the throttle body. <sup>2</sup> Verify proper operation of the low pressure lock-off solenoids. <sup>2</sup> Check the fuel system pressures. Refer to the LPG Fuel System Diagnosis. <sup>2</sup> Check for proper mixer air valve operation.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. <sup>2</sup> Check for the proper ignition voltage output with J 26792 or the equivalent. <sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> Check the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits <sup>2</sup> Check for bare or shorted ignition wires. <sup>2</sup> Check for loose ignition coil connections at the coil.
Engine Mechanical Checks	<b>Important:</b> 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. <sup>2</sup> Check for the following: - Vacuum leaks - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes.

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-11. Symptom Diagnosis**

Checks	Action
Exhaust System Checks	<sup>2</sup> Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> <li>- Inspect the exhaust system for damaged or collapsed pipes</li> <li>- Inspect the muffler for signs of heat distress or for possible internal failure.</li> </ul> <sup>2</sup> Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis
<b>Hard Start</b>	
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	<sup>2</sup> Refer to Important Preliminary Checks. <sup>2</sup> Make sure the vehicle's operator is using the correct starting procedure.
Sensor Checks	<sup>2</sup> 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 <sup>2</sup> Check the Crankshaft Position (CKP) sensor. <sup>2</sup> Check the Throttle position (TPS) sensor.
Fuel System Checks	Important: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition. <sup>2</sup> Verify the excess flow valve in the LPG manual shut-off valve is not tripped. <sup>2</sup> Check mixer module assembly for proper installation and leakage. <sup>2</sup> Verify proper operation of the low pressure lock-off solenoids. <sup>2</sup> Verify proper operation of the EPR <sup>2</sup> Check for air intake system leakage between the mixer and the throttle body. <sup>2</sup> Check the fuel system pressures. Refer to the Fuel System Diagnosis.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. <sup>2</sup> Check for the proper ignition voltage output with J 26792 or the equivalent. <sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> Check the spark plugs for the following conditions: <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> </ul> <sup>2</sup> Check for bare or shorted ignition wires. <sup>2</sup> Check for moisture in the distributor cap if applicable. <sup>2</sup> Check for loose ignition coil connections. <b>Important:</b> 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	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. <sup>2</sup> Check for the following: <ul style="list-style-type: none"> <li>- Vacuum leaks               <ul style="list-style-type: none"> <li>- Improper valve timing</li> <li>- Low compression</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Broken or weak valve springs</li> <li>- Worn camshaft lobes.</li> </ul> </li> </ul> <sup>2</sup> Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	<sup>2</sup> Check the exhaust system for a possible restriction: <ul style="list-style-type: none"> <li>- Inspect the exhaust system for damaged or collapsed pipes</li> <li>- Inspect the muffler for signs of heat distress or for possible internal failure.</li> </ul> <sup>2</sup> Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis or Exhaust System in the GM Base Engine Service Manual



Table 3-11. Symptom Diagnosis

Checks	Action
Additional Checks	<sup>2</sup>
<b>Cuts Out, Misses</b>	
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	<sup>2</sup> Refer to Important Preliminary Checks.
Ignition System Checks	<sup>2</sup> Start the engine. <sup>2</sup> Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. <sup>2</sup> Check for proper ignition output voltage with spark tester J 26792. <sup>2</sup> Check for a cylinder misfire. <sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> Remove the spark plugs in these cylinders and check for the following conditions: <sup>2</sup> Insulation cracks <sup>2</sup> Wear <sup>2</sup> Improper gap <sup>2</sup> Burned electrodes <sup>2</sup> Heavy deposits <sup>2</sup> Visually/Physically inspect the secondary ignition for the following: <sup>2</sup> Ignition wires for arcing, cross-firing and proper routing <sup>2</sup> Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	<sup>2</sup> Perform a cylinder compression check. <sup>2</sup> Check the engine for the following: <ul style="list-style-type: none"> <li>- Improper valve timing</li> <li>- Bent pushrods</li> <li>- Worn rocker arms</li> <li>- Worn camshaft lobes.</li> <li>- Broken or weak valve springs.</li> </ul> <sup>2</sup> Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	<sup>2</sup> Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. <sup>2</sup> Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). <sup>2</sup> EMI on the reference circuit can cause a missing condition. <sup>2</sup> Monitoring the engine RPM with a scan tool can detect an EMI. <sup>2</sup> A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. <sup>2</sup> If the problem exists, check the routing of the secondary wires and the ground circuit.
<b>Hesitation, Sag, Stumble</b>	
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	<sup>2</sup> Check the fuel pressure. Refer to LPG Fuel System Diagnosis. <sup>2</sup> 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. <sup>2</sup> Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. <sup>2</sup> Check LPL electrical connection <sup>2</sup> Check the mixer air valve for sticking or binding. <sup>2</sup> Check the mixer module assembly for proper installation and leakage. <sup>2</sup> Check the EPR electrical connections.

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-11. Symptom Diagnosis**

Checks	Action
Ignition System Checks	<p>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.</p> <p><sup>2</sup> Check for the proper ignition voltage output with J 26792 or the equivalent.</p> <p><sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS)</p> <p><sup>2</sup> Check for faulty spark plug wires</p> <p><sup>2</sup> Check for fouled spark plugs.</p>
Additional Check	<p><sup>2</sup> Check for manifold vacuum or air induction system leaks</p> <p><sup>2</sup> Check the generator output voltage.</p>
<b>Backfire</b>	
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	<sup>2</sup> Refer to Important Preliminary Checks.
Ignition System Checks	<p><b>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.</b></p> <p><sup>2</sup> Check for the proper ignition coil output voltage using the spark tester J26792 or the equivalent.</p> <p><sup>2</sup> 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.</p> <p><sup>2</sup> Check the connection at each ignition coil.</p> <p><sup>2</sup> Check for deteriorated spark plug wire insulation.</p> <p><sup>2</sup> Check the spark plugs. The correct spark plugs for LPG are (R42LTS)</p> <p><sup>2</sup> Remove the plugs and inspect them for the following conditions:</p> <ul style="list-style-type: none"> <li>- Wet plugs</li> <li>- Cracks</li> <li>- Wear</li> <li>- Improper gap</li> <li>- Burned electrodes</li> <li>- Heavy deposits</li> </ul>
Engine Mechanical Check	<p>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.</p> <p><sup>2</sup> Check the engine for the following:</p> <ul style="list-style-type: none"> <li>- Improper valve timing</li> <li>- Engine compression</li> <li>- Manifold vacuum leaks</li> <li>- Intake manifold gaskets</li> <li>- Sticking or leaking valves</li> <li>- Exhaust system leakage</li> </ul> <p><sup>2</sup> Check the intake and exhaust system for casting flash or other restrictions.</p>
Fuel System Checks	<sup>2</sup> Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.
<b>Lack of Power, Sluggishness, or Sponginess</b>	
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	<p><sup>2</sup> Refer to Important Preliminary Checks.</p> <p><sup>2</sup> Refer to the LPG Fuel system OBD System Check</p> <p><sup>2</sup> 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</p> <p><sup>2</sup> Remove the air filter and check for dirt or restriction.</p> <p><sup>2</sup> Check the vehicle transmission Refer to the OEM transmission diagnostics.</p>

Table 3-11. Symptom Diagnosis

Checks	Action
Fuel System Checks	<sup>2</sup> Check for a restricted fuel filter, contaminated fuel, or improper fuel pressure. Refer to LPG Fuel System Diagnosis. <sup>2</sup> Check for the proper ignition output voltage with the spark tester J 26792 or the equivalent. <sup>2</sup> Check for proper installation of the mixer module assembly. <sup>2</sup> Check all air inlet ducts for condition and proper installation. <sup>2</sup> Check for fuel leaks between the LPR and the mixer. <sup>2</sup> Verify that the LPG tank manual shut-off valve is fully open. <sup>2</sup> Verify that liquid fuel (not vapor) is being delivered to the LPR.
Sensor Checks	<sup>2</sup> Check the Heated Exhaust Gas Oxygen Sensor (HEGO) for contamination and performance. Check for proper operation of the MAP sensor. <sup>2</sup> Check for proper operation of the TPS sensor.
Exhaust System Checks	<sup>2</sup> 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: <sup>2</sup> Engine compression <sup>2</sup> Valve timing <sup>2</sup> Improper or worn camshaft. Refer to Engine Mechanical in the Service Manual.
Additional Check	<sup>2</sup> Check the ECM grounds for being clean, tight, and in their proper locations. <sup>2</sup> Check the generator output voltage. <sup>2</sup> If all procedures have been completed and no malfunction has been found, review and inspect the following items: <sup>2</sup> Visually and physically, inspect all electrical connections within the suspected circuit and/or systems. <sup>2</sup> Check the scan tool data.
<b>Poor Fuel Economy</b>	
<b>DEFINITION:</b> 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	<sup>2</sup> Refer to Important Preliminary Checks. <sup>2</sup> Check the air cleaner element (filter) for dirt or being plugged. <sup>2</sup> Visually (Physically) check the vacuum hoses for splits, kinks, and proper connections. <sup>2</sup> 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? <sup>2</sup> Suggest to the owner to fill the fuel tank and to recheck the fuel economy. <sup>2</sup> Suggest that a different operator use the equipment and record the results.
Fuel System Checks	<sup>2</sup> Check the LPR fuel pressure. Refer to LPG Fuel System Diagnosis. <sup>2</sup> Check the fuel system for leakage.
Sensor Checks	<sup>2</sup> Check the Temperature Manifold Absolute Pressure (TMAP) sensor.
Ignition System Checks	<sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits <sup>2</sup> Check the ignition wires for the following items: - Cracking - Hardness - Proper connections
Cooling System Checks	<sup>2</sup> Check the engine thermostat for always being open or for the wrong heat range

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-11. Symptom Diagnosis**

Checks	Action
Additional Check	<sup>2</sup> Check the transmission shift pattern. Refer to the OEM Transmission Controls section the Service Manual. <sup>2</sup> Check for dragging brakes.
<b>Rough, Unstable, or Incorrect Idle, Stalling</b>	
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	<sup>2</sup> 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. <sup>2</sup> Check the Heated Exhaust Gas Oxygen Sensor (HEGO) performance: <sup>2</sup> Check the Temperature Manifold Absolute Pressure (TMAP) sensor response and accuracy.
Fuel System Checks	<sup>2</sup> 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. <sup>2</sup> Check for a sticking mixer air valve. <sup>2</sup> Verify proper operation of the EPR. <sup>2</sup> Perform a cylinder compression test. Refer to Engine Mechanical in the Service Manual. <sup>2</sup> Check the LPR fuel pressure. Refer to the LPG Fuel System Diagnosis. <sup>2</sup> Check mixer module assembly for proper installation and connection.
Ignition System Checks	<sup>2</sup> Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. <sup>2</sup> Verify that the spark plugs are correct for use with LPG (R42LTS) <sup>2</sup> 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 <sup>2</sup> 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	<b>Important:</b> 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. <sup>2</sup> Check for vacuum leaks. Vacuum leaks can cause a higher than normal idle and low throttle angle control command. <sup>2</sup> Check the ECM grounds for being clean, tight, and in their proper locations. <sup>2</sup> 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	<sup>2</sup> Check the engine for the following: - Broken motor mounts - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valves springs - Worn camshaft lobes
<b>Surges/Chuggles</b>	
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	<sup>2</sup> Check Heated Exhaust Gas Oxygen Sensor (HEGO) performance.

Table 3-11. Symptom Diagnosis

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

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-12. 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

Table 3-12. 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

### 3.24 FORD ENGINE

**NOTE:** Detailed Engine service instructions are provided in the following publications: Service Manual 3128849.

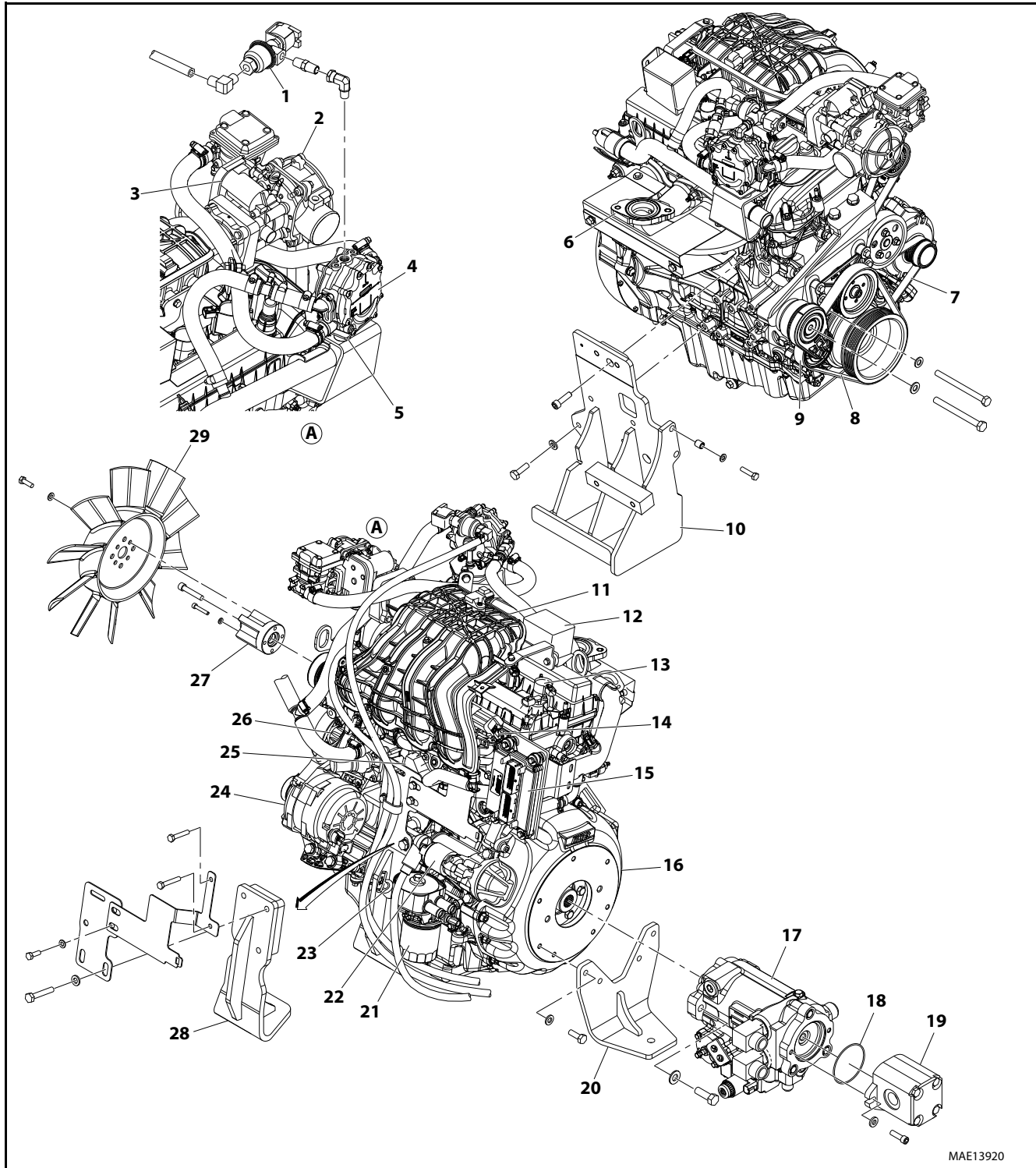


Figure 3-101. Ford Engine Installation Sheet 1 of 4



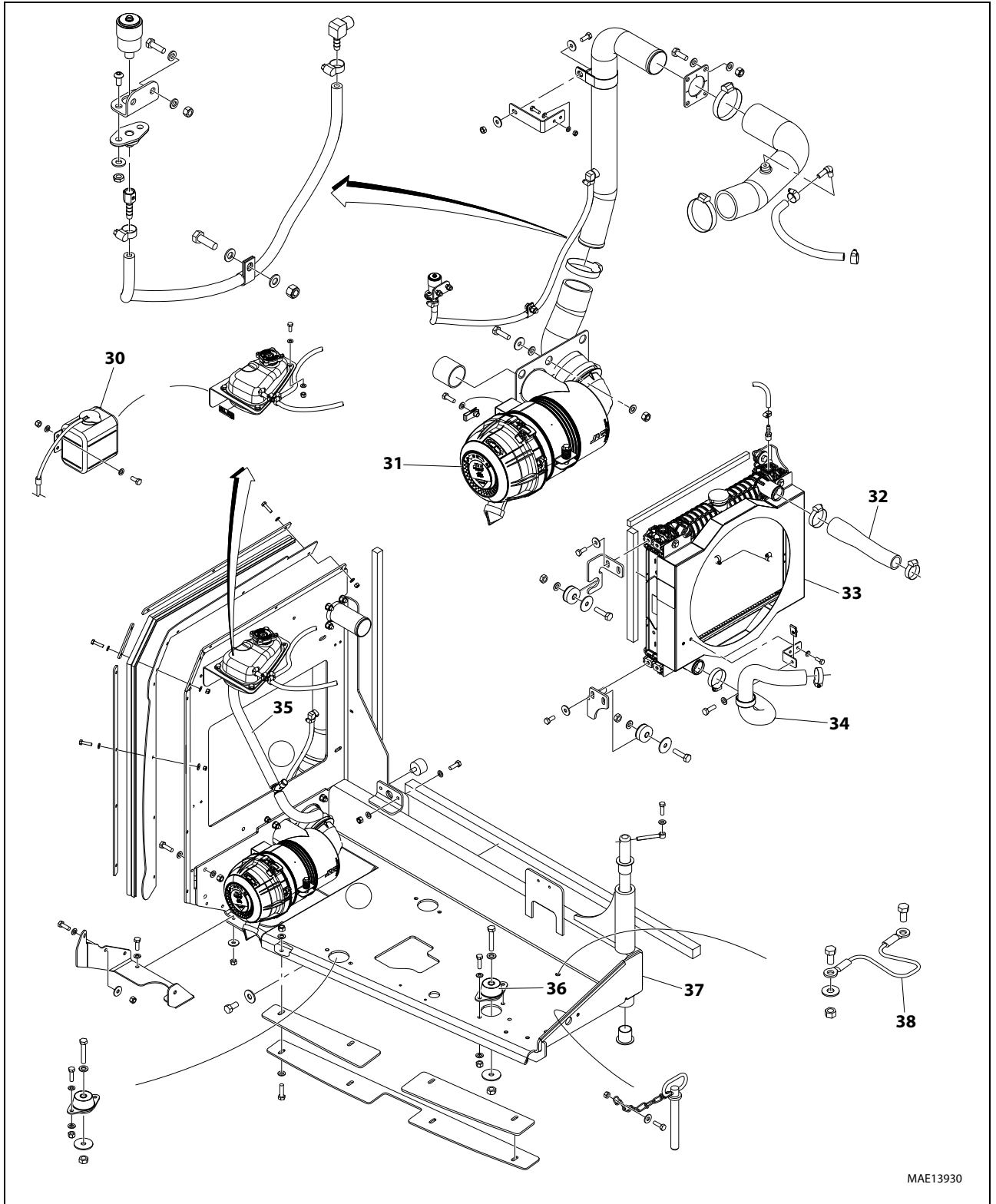
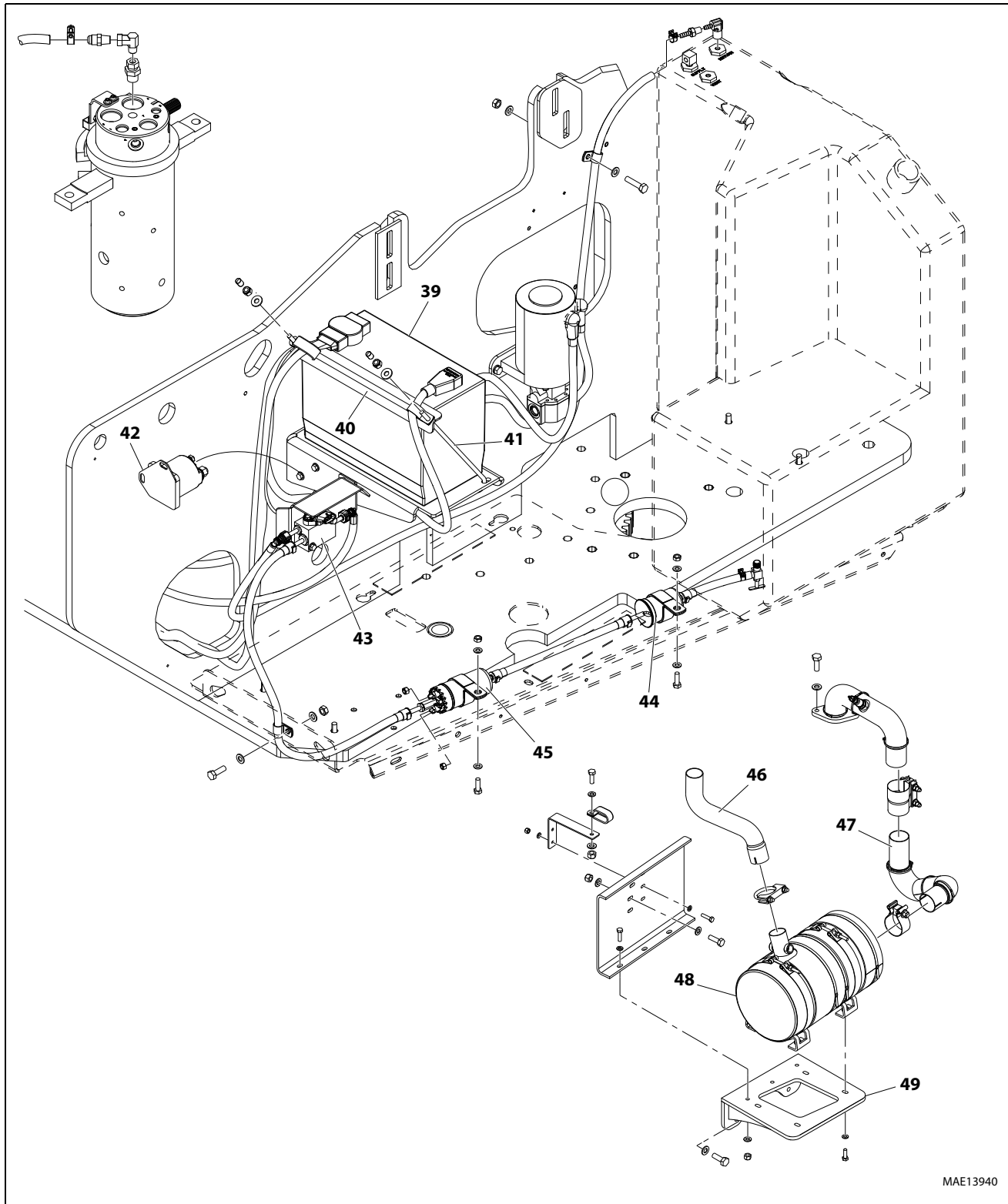


Figure 3-102. Ford Engine Installation Sheet 2 of 4

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**Figure 3-103. Ford Engine Installation Sheet 3 of 4**

- |                                     |                                    |                               |
|-------------------------------------|------------------------------------|-------------------------------|
| 1. Lock-Off Valve                   | 18. O-Ring                         | 35. Radiator Hose             |
| 2. LP Mixer                         | 19. Gear Pump and Fitting Assembly | 36. Motor Mount               |
| 3. Governor                         | 20. Rear Engine Mount              | 37. Tray                      |
| 4. Rubber Isolator                  | 21. Oil Filter                     | 38. Lanyard Cable             |
| 5. Mount Isolator                   | 22. Starter                        | 39. Battery                   |
| 6. Exhaust Manifold                 | 23. Dipstick                       | 40. Battery Hold-Down Bracket |
| 7. Belt                             | 24. Alternator                     | 41. J-Bolt                    |
| 8. V-Belt                           | 25. Thermostat                     | 42. Relay                     |
| 9. Pulley                           | 26. Water Pump                     | 43. Fuel Harness              |
| 10. Front Right Engine Mount        | 27. Fan Spacer                     | 44. Fuel Filter               |
| 11. Engine                          | 28. Front Left Engine Mount        | 45. Fuel Pump                 |
| 12. Relay (Fuel Pump & Power)       | 29. Fan                            | 46. Tail Pipe                 |
| 13. Spark Plug                      | 30. Container                      | 47. Exhaust Pipe              |
| 14. Fuel Injector                   | 31. Air Filter                     | 48. Muffler                   |
| 15. Engine Control Unit (ECU) Mount | 32. Upper Radiator Hose            | 49. Bracket                   |
| 16. Pump Coupling                   | 33. Radiator                       |                               |
| 17. Piston Pump & Fitting Assembly  | 34. Lower Radiator Hose            |                               |

**Figure 3-104. Ford Engine Installation Sheet 4 of 4**

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-13. Fault Code Cross Reference List (Ford Engine)**

Original DTC Number	Fault Name	Corresponding DTC (Current)
11	Intake cam / distributor position	11
24	Exhaust cam position	24
111	CL high LPG	1151
112	EGO open/lazy pre-cat 1	134
113	EGO open/lazy pre-cat 2/post-cat 1	154
114	EGO open/lazy post-cat 1	140
115	EGO open/lazy post-cat 2	160
121	CL high gasoline bank1	1155
122	CL low gasoline bank1	1156
124	CL low LPG	1152
125	CL high NG	1153
126	CL low NG	1154
131	CL high gasoline bank2	1157
132	CL low gasoline bank2	1158
133	Gasoline cat monitor	420
134	LPG cat monitor	1165
135	NG cat monitor	1166
136	Gasoline cat monitor	430
141	AL high gasoline bank1	171
142	AL low gasoline bank1	172
143	AL high LPG	1161
144	AL low LPG	1162
145	AL high NG	1163
146	AL low NG	1164
147	AL high gasoline bank2	174
148	AL low gasoline bank2	175
161	Battery Voltage High	563
162	Battery Voltage Low	562
163	AUX analog PD1 high	1515
164	AUX analog PD1 low	1516
165	AUX analog PU3 high	1517
166	AUX analog PU3 low	1518
167	AUX analog PUD1 high	1541
168	AUX analog PUD1 low	1542
171	AUX analog PUD2 high	1543
172	AUX analog PUD2 low	1544
173	AUX analog PUD3 high	1545
174	AUX analog PUD3 low	1546
181	AUX DIG1 high	1551
182	AUX DIG1 low	1552
183	AUX DIG2 high	1553
184	AUX DIG2 low	1554

Table 3-13. Fault Code Cross Reference List (Ford Engine)

Original DTC Number	Fault Name	Corresponding DTC (Current)
185	AUX DIG3 high	1555
186	AUX DIG3 low	1556
211	IAT high voltage	113
212	IAT low voltage	112
213	IAT higher than expected 1	111
214	IAT higher than expected 2	127
215	Oil pressure low	524
221	ECT/CHT High Voltage	118
222	ECT/CHT Low Voltage	117
223	CHT higher than expected 1	1521
224	CHT higher than expected 2	1522
225	ECT higher than expected 1	116
226	ECT higher than expected 2	217
231	MAP High Pressure	108
232	MAP Low Voltage	107
234	BP high pressure	2229
235	BP low pressure	129
242	Crank sync noise	336
243	Never crank synced at start	16
244	Cam loss	342
245	Cam sync noise	341
246	Crank loss	337
253	Knock 1 sensor Open	327
254	Knock 1 Excessive Signal	326
255	Knock 2 sensor Open	332
256	Knock 2 Excessive Signal	331
261	FP high voltage	92
262	FP low voltage	91
271	FT Gasoline High Voltage	183
272	FT Gasoline Low Voltage	182
273	FT Gaseous fuel high voltage	188
274	FT Gaseous fuel low voltage	187
281	TIP High Voltage	238
282	TIP Low Voltage	237
283	TIP Active	236
301	Emissions/catalyst damaging misfire	301
302	Emissions/catalyst damaging misfire	302
303	Emissions/catalyst damaging misfire	303
304	Emissions/catalyst damaging misfire	304
305	Emissions/catalyst damaging misfire	305
306	Emissions/catalyst damaging misfire	306
307	Emissions/catalyst damaging misfire	307

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**Table 3-13. Fault Code Cross Reference List (Ford Engine)**

Original DTC Number	Fault Name	Corresponding DTC (Current)
308	Emissions/catalyst damaging misfire	308
311	Injector Loop Open or Low-side short to Ground	261
312	Injector Coil Shorted	262
313	Injector Loop Open or Low-side short to Ground	264
314	Injector Coil Shorted	265
315	Injector Loop Open or Low-side short to Ground	267
316	Injector Coil Shorted	268
321	Injector Loop Open or Low-side short to Ground	270
322	Injector Coil Shorted	271
323	Injector Losop Open or Low-side short to Ground	273
324	Injector Coil Shorted	274
325	Injector Loop Open or Low-side short to Ground	276
326	Injector Coil Shorted	277
331	Injector Loop Open or Low-side short to Ground	279
332	Injector Coil Shorted	280
333	Injector Loop Open or Low-side short to Ground	282
334	Injector Coil Shorted	283
335	Injector Loop Open or Low-side short to Ground	285
336	Injector Coil Shorted	286
341	Injector Loop Open or Low-side short to Ground	288
342	Injector Coil Shorted	289
351	FPump motor loop open or high-side shorted to ground	628
352	FPump motor high-side shorted to power	629
353	Megajector delivery pressure higher than expected	1171
354	Megajector delivery pressure lower than expected	1172
355	Megajector comm lost	1173
359	Fuel run-out longer than expected	1181
361	Megajector voltage supply high	1174
362	Megajector voltage supply low	1175
363	Megajector internal actuator fault detection	1176
364	Megajector internal circuitry fault detection	1177
365	Megajector internal comm fault detection	1178
411	Primary Loop Open or Low-side Short to Ground	2300
412	Primary Coil Shorted	2301
413	Primary Loop Open or Low-side Short to Ground	2303
414	Primary Coil Shorted	2304
415	Primary Loop Open or Low-side Short to Ground	2306
416	Primary Coil Shorted	2307
421	Primary Loop Open or Low-side Short to Ground	2309
422	Primary Coil Shorted	2310
423	Primary Loop Open or Low-side Short to Ground	2312
424	Primary Coil Shorted	2313

Table 3-13. Fault Code Cross Reference List (Ford Engine)

Original DTC Number	Fault Name	Corresponding DTC (Current)
425	Primary Loop Open or Low-side Short to Ground	2315
426	Primary Coil Shorted	2316
431	Primary Loop Open or Low-side Short to Ground	2318
432	Primary Coil Shorted	2319
433	Primary Loop Open or Low-side Short to Ground	2321
434	Primary Coil Shorted	2322
435	Primary Loop Open or Low-side Short to Ground	2324
436	Primary Coil Shorted	2325
441	Primary Loop Open or Low-side Short to Ground	2327
442	Primary Coil Shorted	2328
511	FPP1 high voltage	2122
512	FPP1 low voltage	2123
513	FPP1 higher than IVS limit	2115
514	FPP1 lower than IVS limit	2139
515	FPP1 higher than FPP2	2126
516	FPP1 lower than FPP2	2121
517	IVS stuck at-idle, FPP1/2 match	2130
518	IVS stuck off-idle, FPP1/2 match	2131
521	FPP2 high voltage	2128
522	FPP2 low voltage	2127
523	FPP2 higher than IVS limit	2116
524	FPP2 lower than IVS limit	2140
525	FPP1/2 simultaneous voltages out of range	1121
526	FPP1 invalid voltage and FPP2 disagrees with IVS	2120
527	FPP2 invalid voltage and FPP1 disagrees with IVS	2125
528	FPP1/2 do not match each other or the IVS	1122
531	TPS1 high voltage	123
532	TPS1 low voltage	122
533	TPS2 high voltage	223
532	TPS2 low voltage	222
535	TPS1 higher than TPS2	221
536	TPS1 lower than TPS2	121
537	Unable to reach higher TPS	2112
538	Unable to reach lower TPS	2111
539	TPS1/2 simultaneous voltages out of range	2135
541	AUX analog PU1 high	1511
542	AUX analog PU1 low	1512
543	AUX analog PU2 high	1513
544	AUX analog PU2 low	1514
545	IVS/Brake/Trans-Park interlock failure	1531
551	Max govern speed override	219
552	Fuel rev limit	1111

**SECTION 3 - CHASSIS & TURNTABLE**

**Table 3-13. Fault Code Cross Reference List (Ford Engine)**

Original DTC Number	Fault Name	Corresponding DTC (Current)
553	Spark rev limit	1112
611	COP failure	606
612	Invalid interrupt	1616
613	A/D loss	1615
614	RTI 1 loss	1612
615	Flash checksum invalid	601
616	RAM failure	604
631	5VE1 low voltage	642
632	5VE1 high voltage	643
633	5VE2 high voltage	653
634	5VE2 low voltage	652
635	5VE 1/2 simultaneous out-of-range	1611
641	Rx Inactive	1621
642	Rx Noise	1622
643	Invalid Packet Format	1623
644	Shutdown Request	1624/1625
646	CAN Tx failure	1626
647	CAN Rx failure	1627
648	CAN address conflict failure	1628
655	RTI 2 loss	1613
656	RTI 3 loss	1614
711	Relay Control ground short	686
712	Relay Coil Open	685
713	Relay coil short to power	687
714	Fpump relay control ground short	628
715	Fpump relay coil open	627
716	Fpump relay coil short to power	629
721	Start relay control ground short	616
722	Start relay coil open	615
723	Start relay coil short to power	617
724	Buzzer control ground short	1641
725	Buzzer open	1642
726	Buzzer control short to power	1643
731	PWM1-Gauge1 open /ground short	1631
732	PWM1-Gauge1 short to power	1632
733	PWM2-Gauge2 open /ground short	1633
734	PWM2-Gauge2 short to power	1634
735	PWM3-Gauge3 open / ground short	1635
736	PWM3-Gauge3 short to power	1636
741	PWM4 open /ground short	1637
742	PWM4 short to power	1638
743	PWM5 open / ground short	1639



Table 3-13. Fault Code Cross Reference List (Ford Engine)

Original DTC Number	Fault Name	Corresponding DTC (Current)
744	PWM5 short to power	1640
761	MIL control ground short	1644
762	MIL open	650
763	MIL control short to power	1645
771	Tach output ground short	2618
772	Tach output short to power	2619
1182	Fuel impurity level high	1182
1183	Megajector autozero /lockoff failed	1183
1311	Misfire detected	1311
1312	Misfire detected	1312
1313	Misfire detected	1313
1314	Misfire detected	1314
1315	Misfire detected	1315
1316	Misfire detected	1316
1317	Misfire detected	1317
1318	Misfire detected	1318
1547	AUX analog PUD4 high	1547
1548	AUX analog PUD4 low	1548
1561	AUX analog PD2 high	1561
1562	AUX analog PD2 low	1562
1563	AUX analog PD3 high	1563
1564	AUX analog PD3 low	1564
1629	J1939 TSC1 message receipt lost	1629
1630	J1939 ETC message receipt lost	1630
1661	PWM6 open /ground short	1661
1662	PWM6 short to power	1662
1663	PWM7 open /ground short	1663
1664	PWM7 short to power	1664
1665	PWM8 open /ground short	1665
1666	PWM8 short to power	1666
1669	PWM9 open /ground short	1669
1670	PWM9 short to power	1670

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**Table 3-14. CAN to DTC Cross Reference (Ford Engine)**

DTC	DTC and Description	SPN	FMI
108	MAP pressure high	106	16
107	MAP voltage low	106	4
118	ECT voltage high	110	3
117	ECT voltage low	110	4
116	ECT higher than expected stage 1	110	15
113	IAT voltage high	105	3
112	IAT voltage low	105	4
2229	BP pressure high	108	0
129	BP pressure low	108	1
563	Vbat voltage high	168	15
562	Vbat voltage low	168	17
643	Sensor supply voltage 1 high	1079	3
642	Sensor supply voltage 1 low	1079	4
123	TPS1 voltage high	51	3
122	TPS1 voltage low	51	4
223	TPS2 voltage high	3673	3
222	TPS2 voltage low	3673	4
221	TPS1-2 higher than expected	51	0
121	TPS1-2 lower than expected	51	1
2122	FPP1 voltage high	91	3
2123	FPP1 voltage low	91	4
2128	FPP2 voltage high	29	3
2127	FPP2 voltage low	29	4
2115	FPP1 higher than IVS	91	0
2139	FPP1 lower than IVS	91	1
2116	FPP2 higher than IVS	29	0
2140	FPP2 lower than IVS	29	1
2126	FPP1-2 higher than expected	91	16
2121	FPP1-2 lower than expected	91	18
524	Oil pressure low	100	1
171	Adaptive-learn gasoline bank1 high	4237	0
172	Adaptive-learn gasoline bank1 low	4237	1
1155	Closed-loop gasoline bank1 high	4236	0
1156	Closed-loop gasoline bank1 low	4236	1
1157	Closed-loop gasoline bank2 high	4238	0
1158	Closed-loop gasoline bank2 low	4238	1
1151	Closed-loop LPG high	4236	0
1152	Closed-loop LPG low	4236	1
1153	Closed-loop NG high	4236	0
1154	Closed-loop NG low	4236	1
174	Adaptive-learn gasoline bank2 high	4239	0
175	Adaptive-learn gasoline bank2 low	4239	1

Table 3-14. CAN to DTC Cross Reference (Ford Engine)

DTC	DTC and Description	SPN	FMI
1161	Adaptive-learn LPG high	4237	0
1162	Adaptive-learn LPG low	4237	1
1163	Adaptive-learn NG high	4237	0
1164	Adaptive-learn NG low	4237	1
261	Injector 1 open or short to ground	651	5
264	Injector 2 open or short to ground	652	5
267	Injector 3 open or short to ground	653	5
270	Injector 4 open or short to ground	654	5
273	Injector 5 open or short to ground	655	5
276	Injector 6 open or short to ground	656	5
279	Injector 7 open or short to ground	657	5
282	Injector 8 open or short to ground	658	5
285	Injector 9 open or short to ground	659	5
288	Injector 10 open or short to ground	660	5
262	Injector 1 coil shorted	651	6
265	Injector 2 coil shorted	652	6
268	Injector 3 coil shorted	653	6
271	Injector 4 coil shorted	654	6
274	Injector 5 coil shorted	655	6
277	Injector 6 coil shorted	656	6
280	Injector 7 coil shorted	657	6
283	Injector 8 coil shorted	658	6
286	Injector 9 coil shorted	659	6
289	Injector 10 coil shorted	660	6
2300	Spark coil 1 primary open or short to ground	1268	5
2303	Spark coil 2 primary open or short to ground	1269	5
2306	Spark coil 3 primary open or short to ground	1270	5
2309	Spark coil 4 primary open or short to ground	1271	5
2312	Spark coil 5 primary open or short to ground	1272	5
2315	Spark coil 6 primary open or short to ground	1273	5
2318	Spark coil 7 primary open or short to ground	1274	5
2321	Spark coil 8 primary open or short to ground	1275	5
2324	Spark coil 9 primary open or short to ground	1276	5
2327	Spark coil 10 primary open or short to ground	1277	5
2301	Spark coil 1 primary shorted	1268	6
2304	Spark coil 2 primary shorted	1269	6
2307	Spark coil 3 primary shorted	1270	6
2310	Spark coil 4 primary shorted	1271	6
2313	Spark coil 5 primary shorted	1272	6
2316	Spark coil 6 primary shorted	1273	6
2319	Spark coil 7 primary shorted	1274	6
2322	Spark coil 8 primary shorted	1275	6
2325	Spark coil 9 primary shorted	1276	6

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**Table 3-14. CAN to DTC Cross Reference (Ford Engine)**

DTC	DTC and Description	SPN	FMI
2328	Spark coil 10 primary shorted	1277	6
217	ECT higher than expected stage 2	110	0
111	IAT higher than expected stage 1	105	15
127	IAT higher than expected stage 2	105	0
327	Knock1 sensor open or not present	731	4
2112	Unable to reach higher TPS	51	7
2111	Unable to reach lower TPS	51	7
1531	Gov1/2/3 interlock failure	0	31
628	Fuel-pump high-side open or short to ground	1347	5
629	Fuel-pump high-side short to power	1347	6
342	Loss of CAM input signal	723	4
341	CAM input signal noise	723	2
336	CRANK input signal noise	636	2
16	Crank and/or cam could not synchronize during start	636	8
606	Microprocessor failure - COP	629	31
1612	Microprocessor failure - RTI 1	629	31
1613	Microprocessor failure - RTI 2	629	31
1614	Microprocessor failure - RTI 3	629	31
1615	Microprocessor failure - A/D	629	31
1616	Microprocessor failure - Interrupt	629	31
601	Microprocessor failure - FLASH	628	13
604	Microprocessor failure - RAM	630	12
326	Knock1 excessive or erratic signal	731	2
219	RPM higher than max allowed govern speed	515	15
1111	RPM above fuel rev limit level	515	16
1112	RPM above spark rev limit level	515	0
134	EG01 open / lazy	3217	5
154	EG02 open / lazy	3227	5
140	EG03 open / lazy	3256	5
1521	CHT higher than expected stage 1	110	16
1522	CHT higher than expected stage 2	110	0
1515	AUX analog Pull-Down 1 high voltage	710	3
1516	AUX analog Pull-Down 1 low voltage	710	4
1511	AUX analog Pull-Up 1 high voltage	701	3
1512	AUX analog Pull-Up 1 low voltage	701	4
1513	AUX analog Pull-Up 2 high voltage	702	3
1514	AUX analog Pull-Up 2 low voltage	702	4
1621	RS-485 Rx inactive	0	31
1622	RS-485 Rx noise	0	31
1623	RS-485 Rx bad packet format	0	31
1624	RS-485 remote shutdown request	0	31
238	TIP high voltage	102	3
237	TIP low voltage	102	4

Table 3-14. CAN to DTC Cross Reference (Ford Engine)

DTC	DTC and Description	SPN	FMI
92	FP high voltage	94	3
91	FP low voltage	94	4
420	Catalyst inactive on gasoline (Bank 1)	3050	11
1165	Catalyst inactive on LPG	3050	11
1166	Catalyst inactive on NG	3050	11
1171	MegaJector delivery pressure higher than expected	520260	0
1172	MegaJector delivery pressure lower than expected	520260	1
1173	MegaJector comm lost	520260	31
1174	MegaJector voltage supply high	520260	3
1175	MegaJector voltage supply low	520260	4
1176	MegaJector internal actuator fault detection	520260	12
1177	MegaJector internal circuitry fault detection	520260	12
1178	MegaJector internal comm fault detection	520260	12
1131	WGP voltage high	1192	3
1132	WGP voltage low	1192	4
234	Boost control overboost failure	102	0
299	Boost control underboost failure	102	1
236	TIP active	102	2
183	FT high voltage	174	3
182	FT low voltage	174	4
524	Oil pressure sender low pressure	100	1
521	Oil pressure sender high pressure	100	0
523	Oil pressure sender high voltage	100	3
522	Oil pressure sender low voltage	100	4
337	Crank signal loss	636	4
1625	J1939 shutdown request	1110	31
1626	CAN-J1939 Tx fault	639	12
1627	CAN-J1939 Rx fault	639	12
508	IAC ground short	520201	6
509	IAC coil open/short	520201	5
686	Power relay ground short	1485	4
685	Power relay coil open	1485	5
687	Power relay coil short to power	1485	3
616	Start relay ground short	1321	4
615	Start relay coil open	1321	5
617	Start relay coil short to power	1321	3
1641	Buzzer control ground short	920	4
1642	Buzzer open	920	5
1643	Buzzer control short to power	920	3
628	Fuel pump relay control ground short	1348	4
627	Fuel pump relay coil open	1348	5
629	Fuel pump relay coil short to power	1348	3
1644	MIL control ground short	1213	4

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**Table 3-14. CAN to DTC Cross Reference (Ford Engine)**

DTC	DTC and Description	SPN	FMI
650	MIL open	1213	5
1645	MIL control short to power	1213	3
2618	Tach output ground short	645	4
2619	Tach output short to power	645	3
2130	IVS stuck at-idle, FPP1/2 match	558	5
2131	IVS stuck off-idle, FPP1/2 match	558	6
1121	FPP1/2 simultaneous voltages out-of-range (redundancy lost)	91	31
2120	FPP1 invalid voltage and FPP2 disagrees with IVS (redundancy lost)	520199	11
2125	FPP1/2 do not match each other or IVS (redundancy lost)	520199	11
1122	FPP1/2 do not match each other or IVS (redundancy lost)	520199	11
653	Sensor supply voltage 2 high	1080	3
652	Sensor supply voltage 2 low	1080	4
1611	Sensor supply voltage 1 and 2 out-of-range	1079	31
332	Knock2 sensor open or not present	520197	4
331	Knock2 excessive or erratic signal	520197	2
2135	TPS1/2 simultaneous voltages out-of-range	51	31
2428	EGT temperature high	173	0
1628	J1939 CAN address / engine-number conflict	639	13
1631	PWM1-Gauge1 open / ground short	697	5
1632	PWM1-Gauge1 short to power	697	3
1633	PWM2-Gauge2 open / ground short	698	5
1634	PWM2-Gauge2 short to power	698	3
1635	PWM3-Gauge3 open / ground short	699	5
1636	PWM3-Gauge3 short to power	699	3
1637	PWM4 open / ground short	700	5
1638	PWM4 short to power	700	3
1639	PWM5 open / ground short	924	5
1640	PWM5 short to power	924	3
430	Catalyst inactive on gasoline (Bank 2)	3051	11
160	EGO4 open / lazy	3266	5
1517	AUX analog Pull-Up 3 high voltage	703	3
1518	AUX analog Pull-Up 3 low voltage	703	4
1541	AUX analog Pull-Up/Down 1 high voltage	704	3
1542	AUX analog Pull-Up/Down 1 low voltage	704	4
1543	AUX analog Pull-Up/Down 2 high voltage	705	3
1544	AUX analog Pull-Up/Down 2 low voltage	705	4
1545	AUX analog Pull-Up/Down 3 high voltage	706	3
1546	AUX analog Pull-Up/Down 3 low voltage	706	4
1551	AUX digital 1 high voltage	707	3
1552	AUX digital 1 low voltage	707	4
1553	AUX digital 2 high voltage	708	3
1554	AUX digital 2 low voltage	708	4
1555	AUX digital 3 high voltage	709	3

Table 3-14. CAN to DTC Cross Reference (Ford Engine)

DTC	DTC and Description	SPN	FMI
1556	AUX digital 3 low voltage	709	4
188	Gaseous fuel temperature sender high voltage	3468	3
187	Gaseous fuel temperature sender low voltage	3468	4
1629	J1939 TSC1 message receipt loss	695	9
359	Fuel run-out longer than expected	632	31
1630	J1939 ETC message receipt loss	91	19
502	Roadspeed input loss of signal	84	8
1411	EMWT1 voltage high	441	3
1412	EMWT2 voltage high	442	3
1413	EMWT1 voltage low	441	4
1414	EMWT2 voltage low	442	4
1415	EMWT1 higher than expected stage 1	441	15
1416	EMWT2 higher than expected stage 1	442	15
1417	EMWT1 higher than expected stage 2	441	0
1418	EMWT2 higher than expected stage 2	442	0
1561	AUX analog Pull-Down 2 high voltage	711	3
1561	AUX analog Pull-Down 2 low voltage	711	4
1561	AUX analog Pull-Down 3 high voltage	712	3
1561	AUX analog Pull-Down 3 low voltage	712	4
1419	ERWT1 voltage high	1385	3
1420	ERWT2 voltage high	1386	3
1421	ERWT1 voltage low	1385	4
1422	ERWT2 voltage low	1386	4
1423	ERWT1 higher than expected stage 1	1385	15
1424	ERWT2 higher than expected stage 1	1386	15
1425	ERWT1 higher than expected stage 2	1385	0
1426	ERWT2 higher than expected stage 2	1386	0
8901	UEGO microprocessor internal fault	3221	31
8902	UEGO heater supply high voltage	3222	3
8903	UEGO heater supply low voltage	3222	4
8904	UEGO cal resistor voltage high	3221	3
8905	UEGO cal resistor voltage low	3221	4
8906	UEGO return voltage shorted high	3056	3
8907	UEGO return voltage shorted low	3056	4
8908	UEGO pump voltage shorted high	3218	3
8909	UEGO pump voltage shorted low	3218	4
8910	UEGO sense cell voltage high	3217	3
8911	UEGO sense cell voltage low	3217	4
8912	UEGO pump voltage at high drive limit	3225	3
8913	UEGO pump voltage at low drive limit	3225	4
8914	UEGO sense cell slow to warm up	3222	10
8915	UEGO pump cell slow to warm up	3225	10
8916	UEGO sense cell impedance high	3222	0

## SECTION 3 - CHASSIS & TURNTABLE

**Table 3-14. CAN to DTC Cross Reference (Ford Engine)**

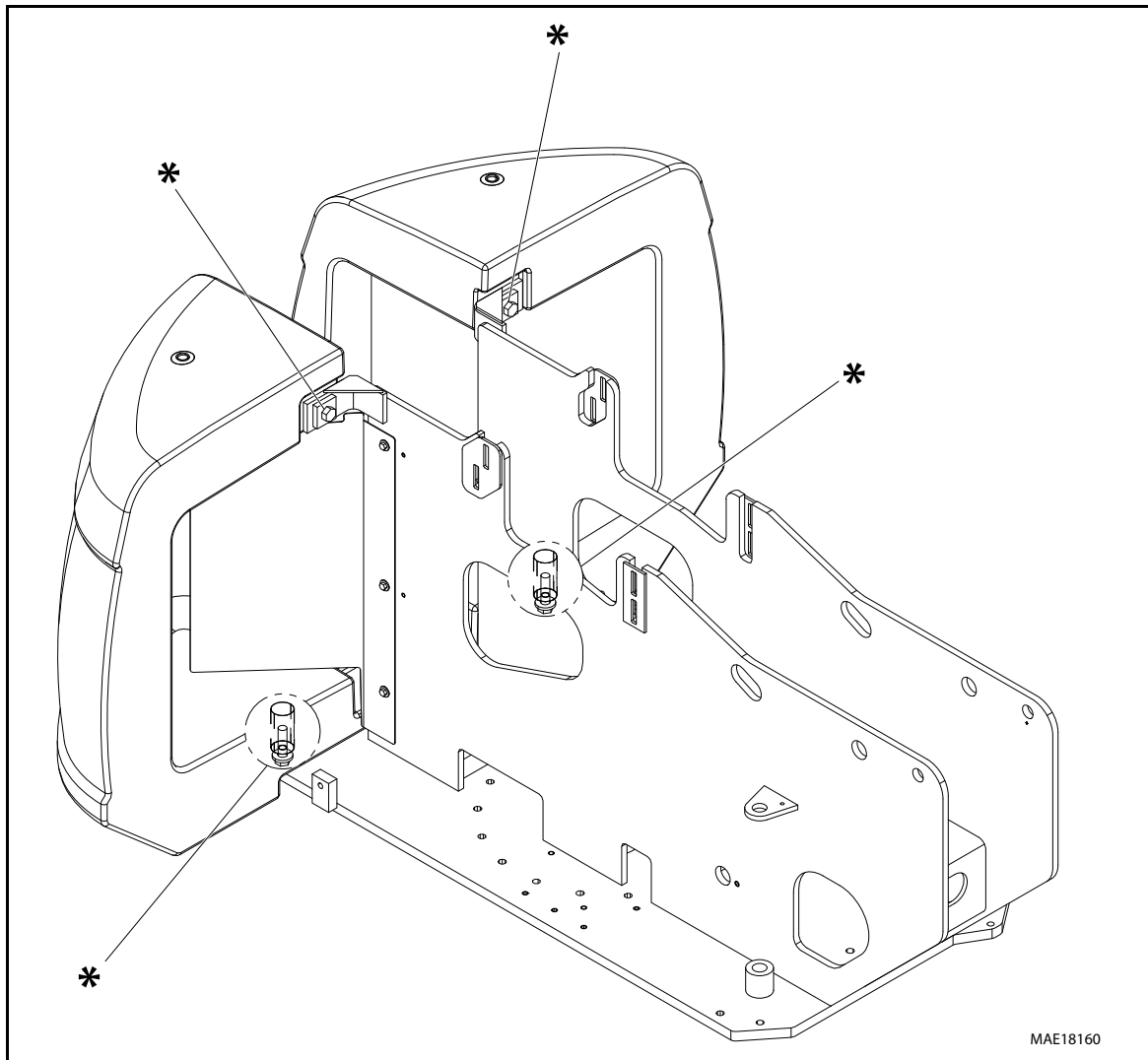
DTC	DTC and Description	SPN	FMI
8917	UEGO pump cell impedance high	3225	0
8918	UEGO pump cell impedance low	3225	1
1311	Cylinder 1 misfire detected	1323	11
1312	Cylinder 2 misfire detected	1324	11
1313	Cylinder 3 misfire detected	1325	11
1314	Cylinder 4 misfire detected	1326	11
1315	Cylinder 5 misfire detected	1327	11
1316	Cylinder 6 misfire detected	1328	11
1317	Cylinder 7 misfire detected	1329	11
1318	Cylinder 8 misfire detected	1330	11
301	Cylinder 1 emissions/catalyst damaging misfire	1323	31
302	Cylinder 2 emissions/catalyst damaging misfire	1324	31
303	Cylinder 3 emissions/catalyst damaging misfire	1325	31
304	Cylinder 4 emissions/catalyst damaging misfire	1326	31
305	Cylinder 5 emissions/catalyst damaging misfire	1327	31
306	Cylinder 6 emissions/catalyst damaging misfire	1328	31
307	Cylinder 7 emissions/catalyst damaging misfire	1329	31
308	Cylinder 8 emissions/catalyst damaging misfire	1330	31
1651	J1939 ETC message receipt loss while in-gear	91	9
1661	PWM6 open / ground short	925	5
1662	PWM6 short to power	925	3
1663	PWM7 open / ground short	926	5
1664	PWM7 short to power	926	3
1547	AUX analog Pull-Up/Down 4 high voltage	713	3
1548	AUX analog Pull-Up/Down 4 low voltage	713	4
1182	Fuel impurity level high	520401	0
1665	PWM8 open / ground short	2646	5
1666	PWM8 short to power	2646	3
1669	PWM9 open / ground short	2647	5
1670	PWM9 short to power	2647	3
1183	MegaJector autozero / lockoff failure	520803	31
11	Intake cam / distributor position error	520800	7
24	Exhaust cam position error	520801	7
88	Fuel pressure higher than expected	94	0
87	Fuel pressure lower than expected	94	1
1555	Water Intrusion Detection	709	3
520	Oil pressure sender low pressure stage 1	100	18
916	Shift actuator feedback out-of-range	520226	3
919	Shift unable to reach desired gear	520226	7
920	Shift actuator or drive circuit failed	520226	31

**NOTE:** For detail Diagnostic Trouble Code of Ford Engine refer DTC manual (PN 3128850).



### 3.25 COUNTERWEIGHT

If the counterweight has been removed, ensure the retaining bolts are torqued to the proper value as shown in Figure 3-105. Counterweight Bolt Torque.



\* Torque to 320 ft-lb (435 Nm)

**Figure 3-105. Counterweight Bolt Torque**

**SECTION 3 - CHASSIS & TURNTABLE**

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**NOTES:**

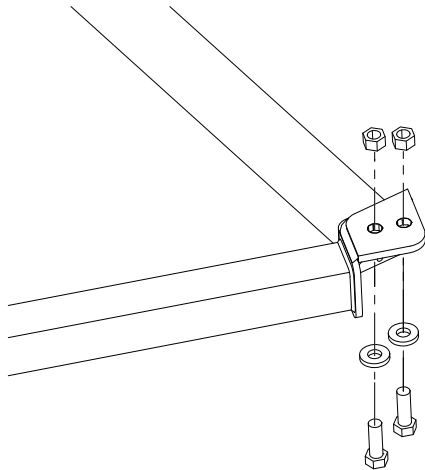
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## SECTION 4. BOOM &amp; PLATFORM

## 4.1 PLATFORM

## Support Removal

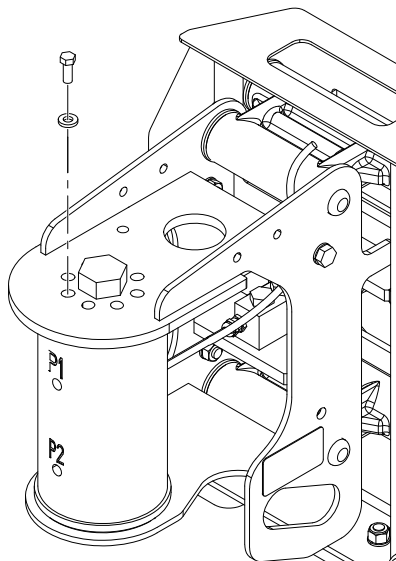
1. Disconnect electrical cables from control console.
2. Tag and disconnect the hydraulic lines from the rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove the bolts securing the platform to the platform support, then remove the platform.



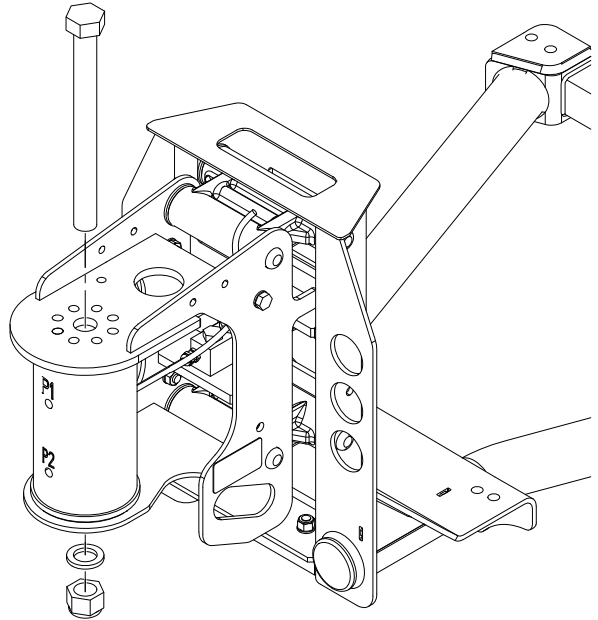
4. Using a suitable lifting device, support the platform support.

**NOTE:** The platform support weighs approximately 125 lbs. (56.8 kg).

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.

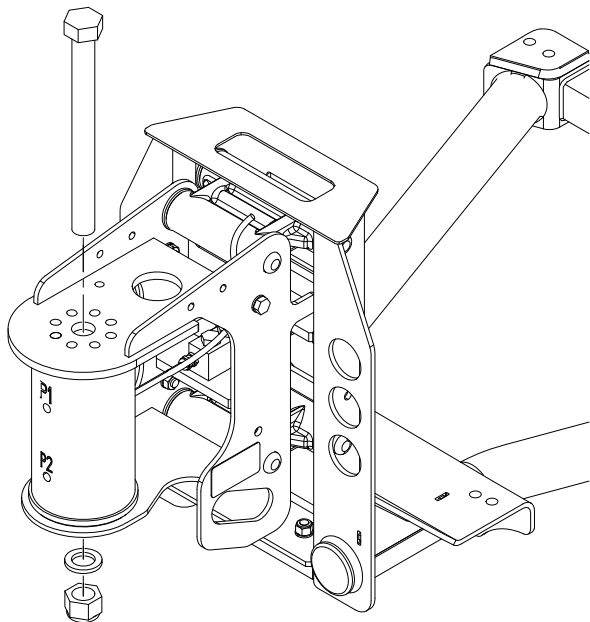


### Support Installation

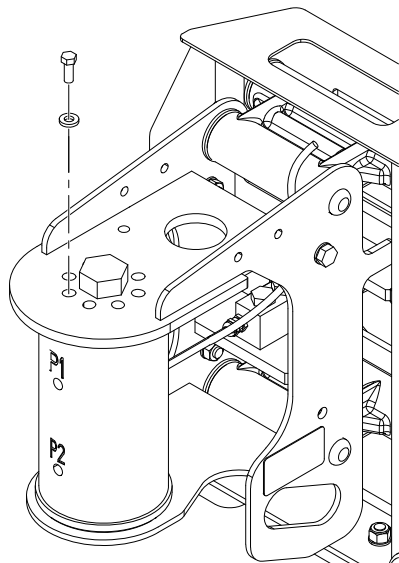
1. Using a suitable lifting device, support the platform support and position it on the rotator.

**NOTE:** The platform support weighs approximately 125 lbs. (56.8 kg).

2. Install the rotator center bolt.

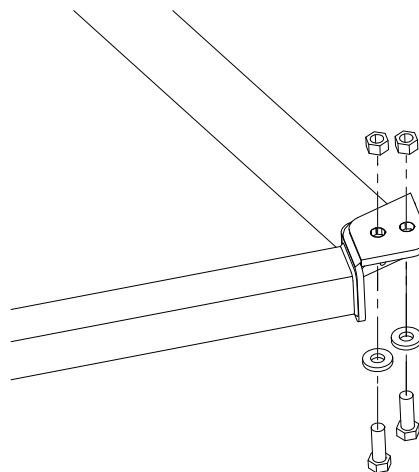


3. Apply JLG Threadlocker P/N 0100011 to the bolts and washers securing the support to the rotator and install the bolts and washers.

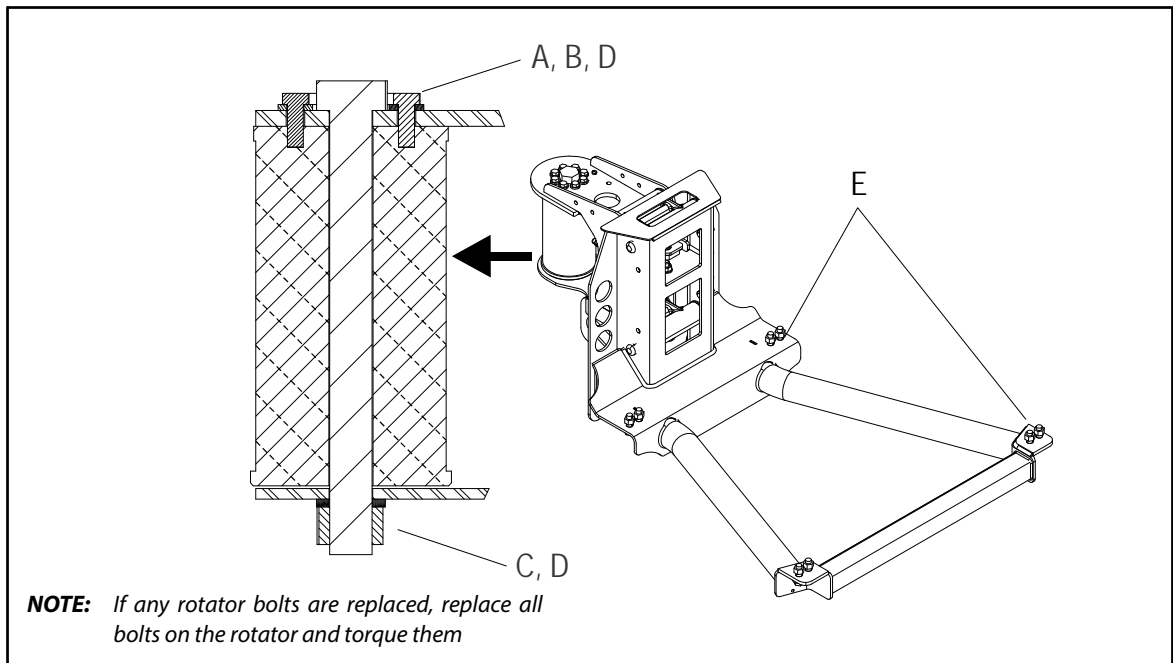


4. Torque the nut on the rotator center bolt to 586 ft. lbs. (795 Nm). Torque the retaining bolts to 40 ft. lbs. (55 Nm).

5. Position the platform on the platform support and install the bolts securing the platform to the platform support. Torque the bolts to 105 ft. lbs. (145 Nm).



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



- A Torque to 40 ft.lbs. (55 Nm)
- B JLG Threadlocker P/N 0100011
- C Torque 586ft. lbs. (795 Nm)
- D Check torque every 150 hours of operation
- E Torque 105 ft. lbs. (145 Nm)

**Figure 4-1. Platform Support Torque Values**

## 4.2 ROTATOR AND SLAVE CYLINDER

### Removal

#### 600A

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.
5. Tag and disconnect hydraulic lines from the slave leveling cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the slave cylinder.

#### 600AJ

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 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. Remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the jib assembly.
6. Supporting the slave cylinder, remove the hardware from pin #4. Using a suitable brass drift and hammer remove pin #4 from the fly boom.
7. Tag and disconnect hydraulic lines from the slave leveling cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the slave cylinder.

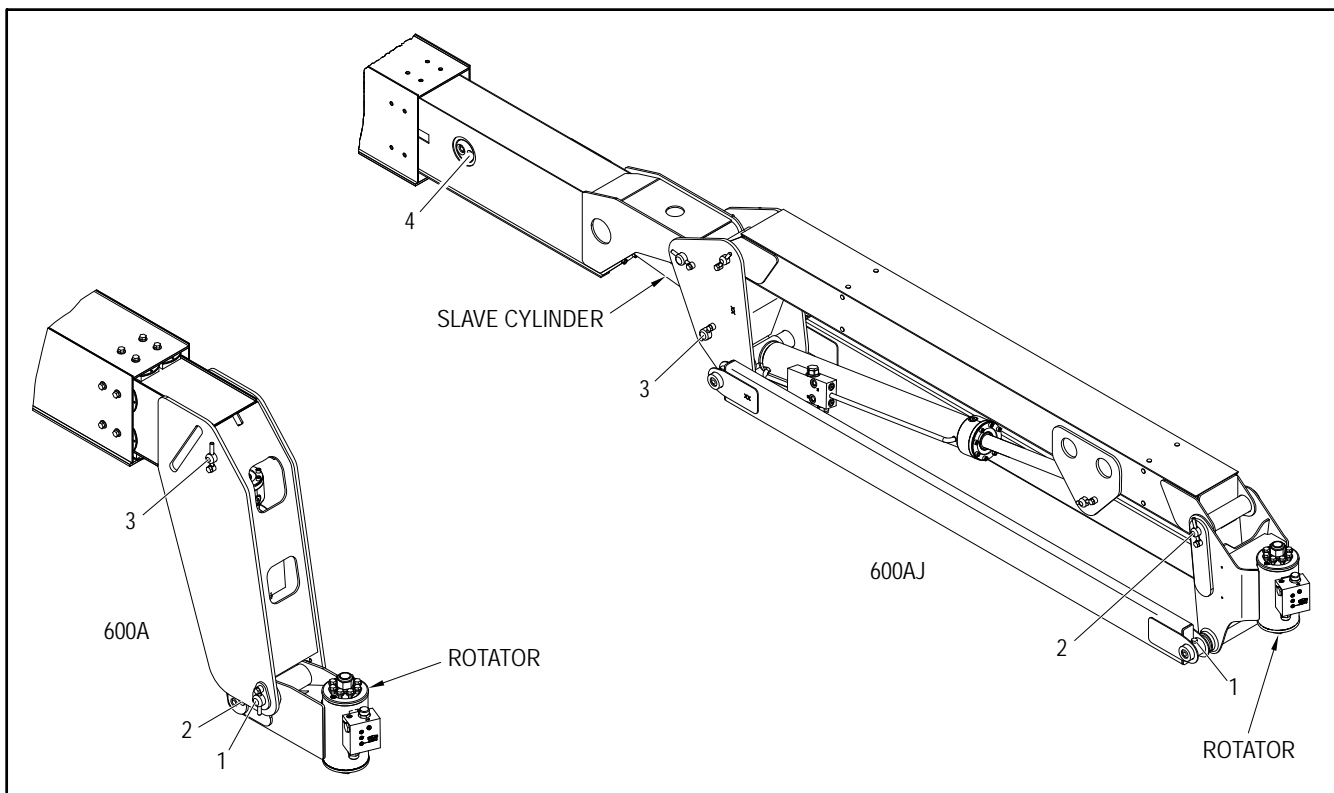


Figure 4-2. Rotator and Leveling Cylinder Components

**Installation**

**600A**

1. Support the slave cylinder. Using a suitable brass drift and hammer, install pin #3 to the fly boom.
2. Support the rotator. Using a suitable brass drift and hammer, install pin #2 to the fly boom and install the rotator.
3. Using a suitable brass drift and hammer, install pin #1 to the rotator.
4. Remove tag and reconnect the hydraulic lines to the rotator and the slave cylinder.

**600AJ**

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 fly boom.
3. Using a suitable brass drift and hammer, install pin #3 to the jib assembly.
4. Support the rotator. Using a suitable brass drift and hammer, install pin #2 to the fly boom and install the rotator.
5. Using a suitable brass drift and hammer, install pin #1 to the rotator.
6. Remove tag and reconnect the hydraulic lines to the rotator and the slave cylinder.

### 4.3 MAIN BOOM POWERTRACK

#### Removal

1. Disconnect wiring harness connectors located in tower upright.

**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 connectors at boom assembly. Use suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Disconnect dual capacity indicator limit switch from side of boom section (600A only).
4. Remove hydraulic lines and electrical cables from powertrack.
5. Using suitable lifting equipment, adequately support powertrack weight along entire length.
6. Remove bolt #1 securing the push tube on the fly boom section.
7. Remove bolt #2 securing the push tube on the mid section of the boom.
8. With powertrack supported and using all applicable safety precautions, remove bolts #3, #4, and #5 securing rail to the base boom section. Remove powertrack from boom section.

#### Installation

1. Using suitable lifting equipment, adequately support the powertrack weight along entire length.
2. With powertrack supported and using all applicable safety precautions, install bolts #3 securing rail to the base boom.
3. Install bolts #2 that attaches rail to the push tube on the main boom section.
4. Install bolts #1 securing the push tube on the fly boom section.
5. Remove tag and reconnect all hydraulic lines and electrical cable from powertrack.
6. Reconnect dual capacity indicator limit switch from side of boom section (600A only).
7. Remove tag and reconnect hydraulic lines from connectors at boom assembly.

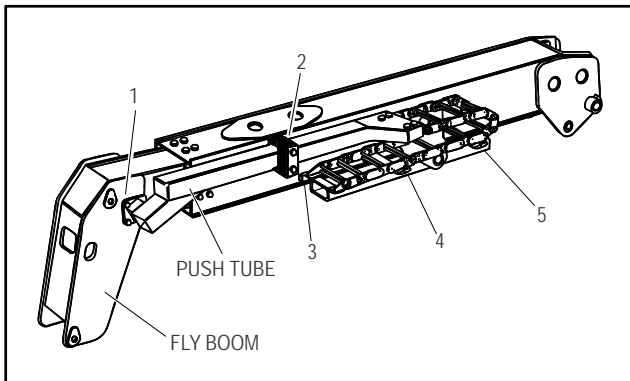


Figure 4-3. Main Boom Powertrack Components



#### 4.4 POWERTRACK MAINTENANCE

##### Remove Link

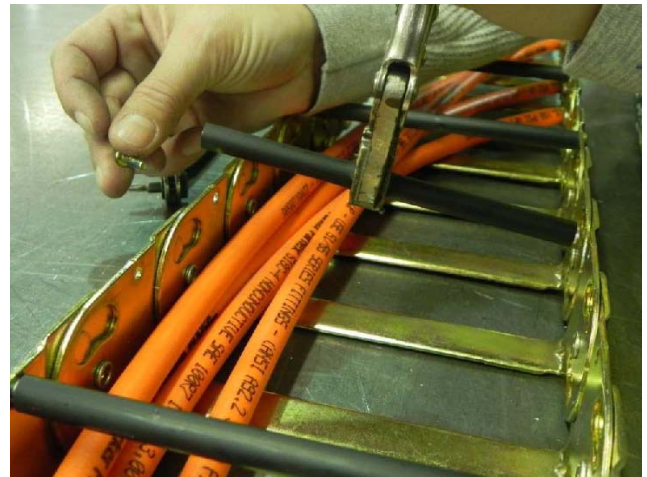
**NOTE:** Hoses shown in powertrack are for example only. Actual hose and cable arrangements are different.



1. Clamp bar and poly roller tightly so they do not spin when removing screw. With a small ¼" 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.

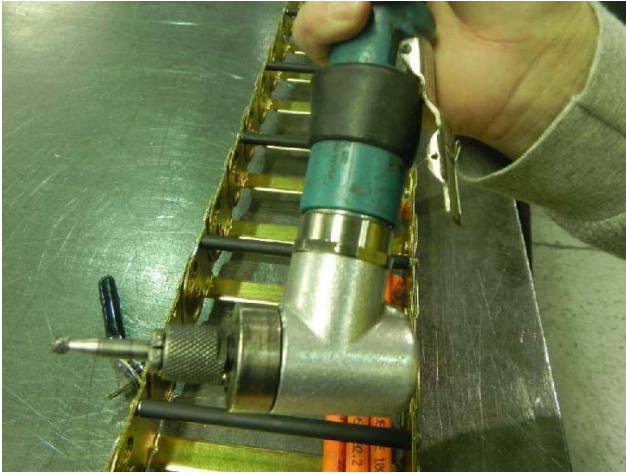


##### **NOTICE**

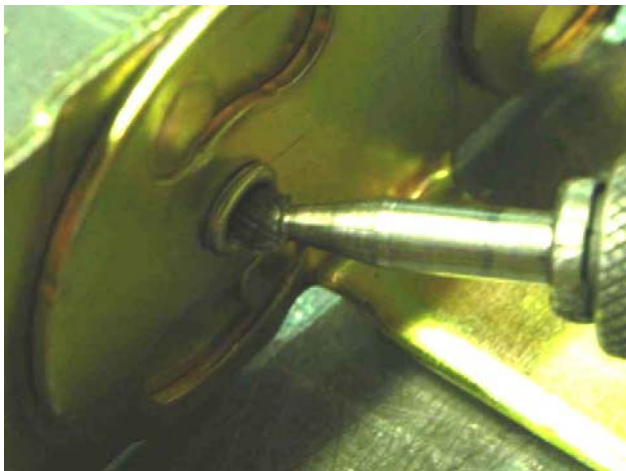
**REPOSITION CABLES/HOSES. KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.**

## SECTION 4 - BOOM & PLATFORM

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.

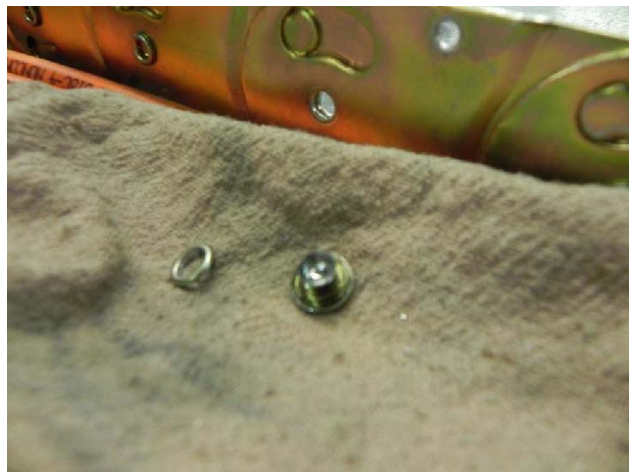


4. insert tool into rolled over end of rivet. Grind out middle of rivet until rolled over part of rivet falls off. Repeat for all rivets to be removed.

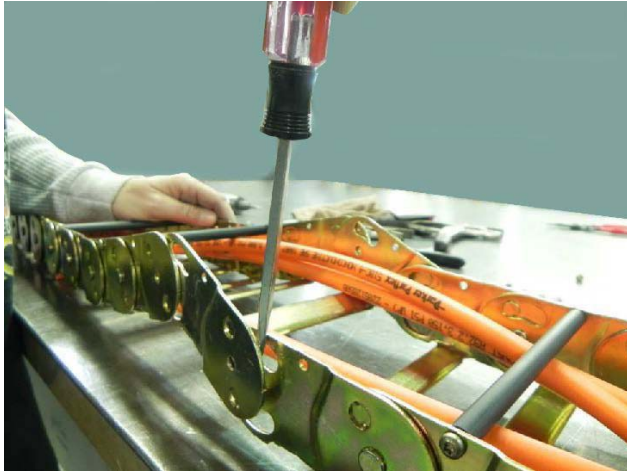


5. After grinding it may be necessary to use a center punch with a hammer to remove rivet.

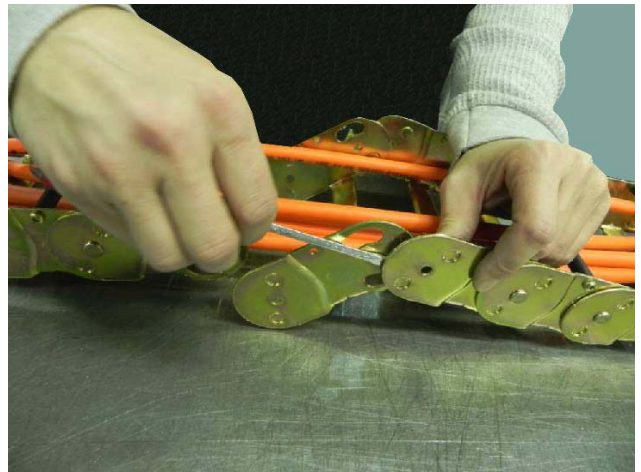
**NOTE:** It may be necessary to loosen fixed end brackets from machine to move track section enough to disconnect links.



6. Insert flat head screwdriver between links. Twist and pull links apart.

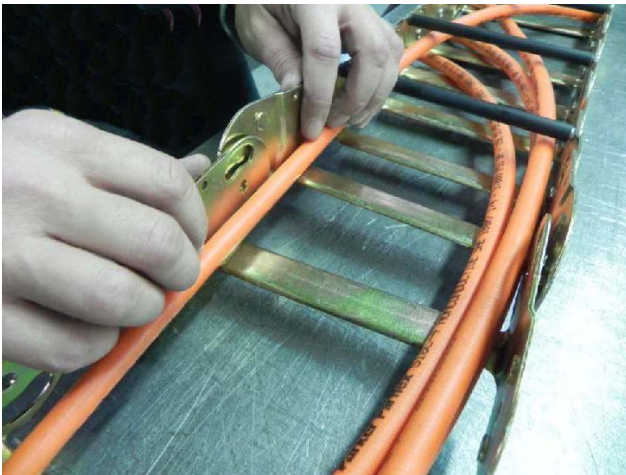


7. Remove link from other section of powertrack using screwdriver.

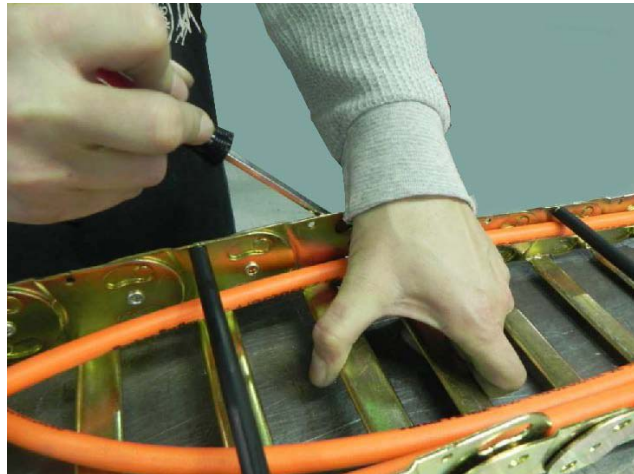
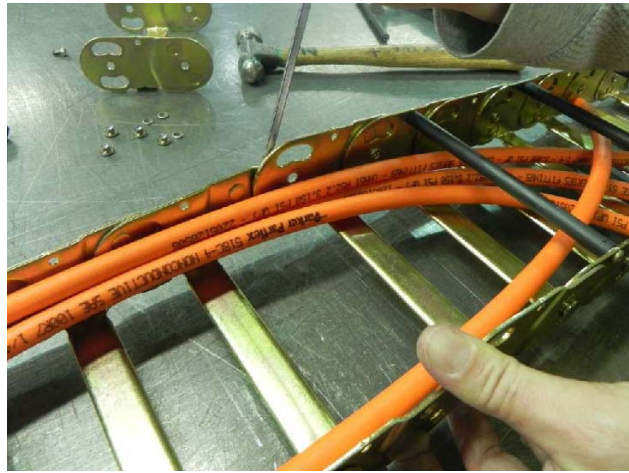


**Install New Link**

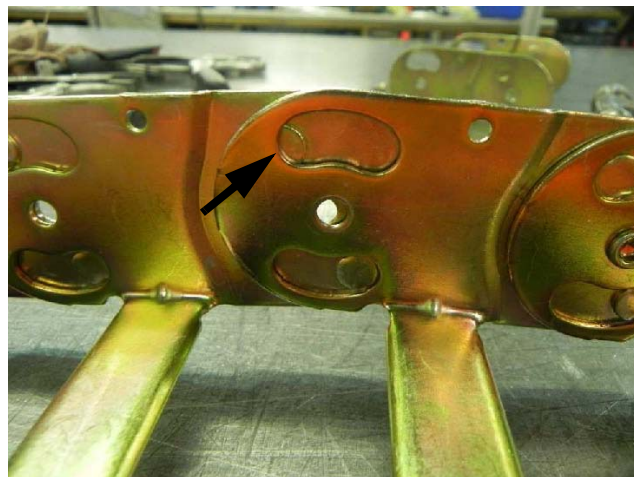
1. Squeeze cut-out end of new link into half-shear (female) end of track section.



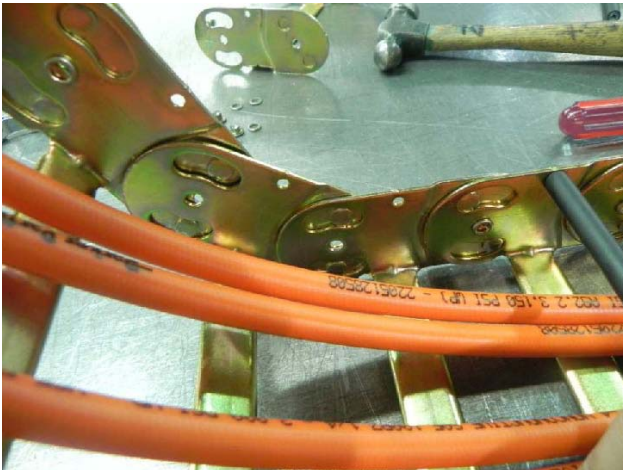
2. Spread half-shear (female) end of new link and slide cut-out end of track section into it. Use screwdriver if necessary.



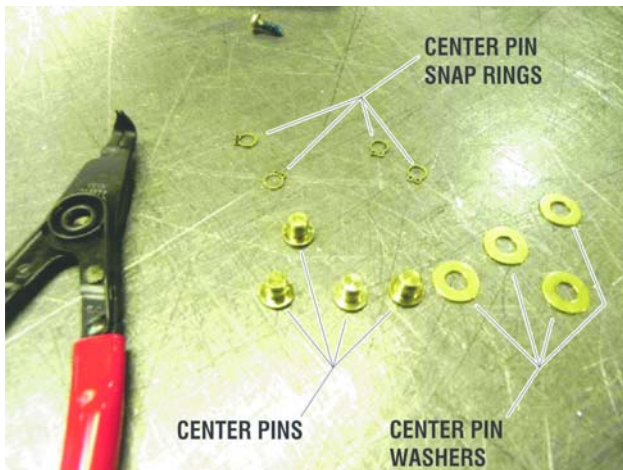
3. Round half-shears will not fit properly in cut-outs after new link is installed.



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.

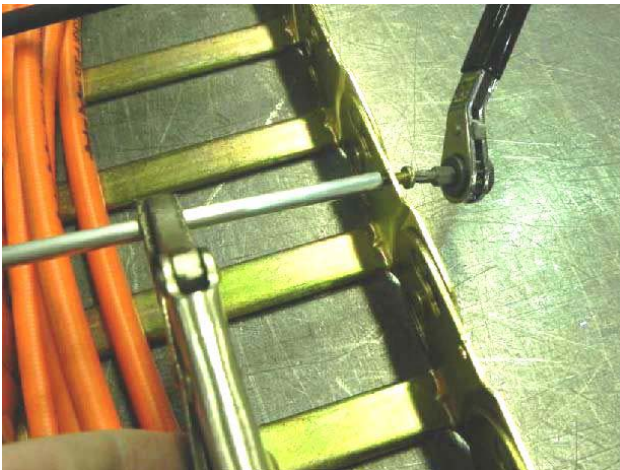


## SECTION 4 - BOOM & PLATFORM

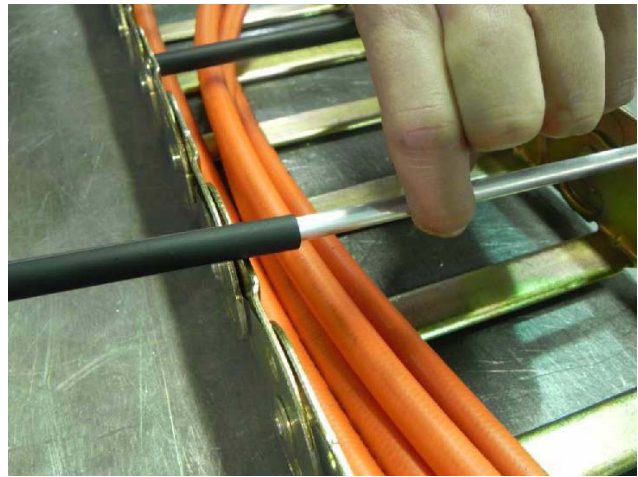
**NOTE:** Make sure snap rings are seated in pin groove and closed properly.



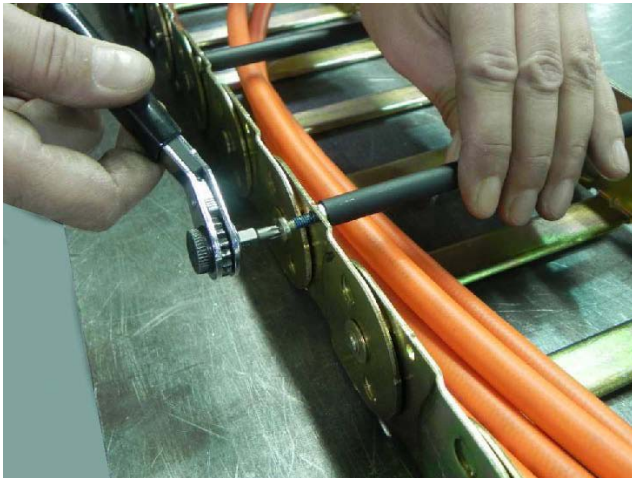
8. Install new 8-32 x 0.500 self-threading Torx head screw in end of new aluminum round bar. Torque to 18-20 in-lb (2-2.25 Nm).



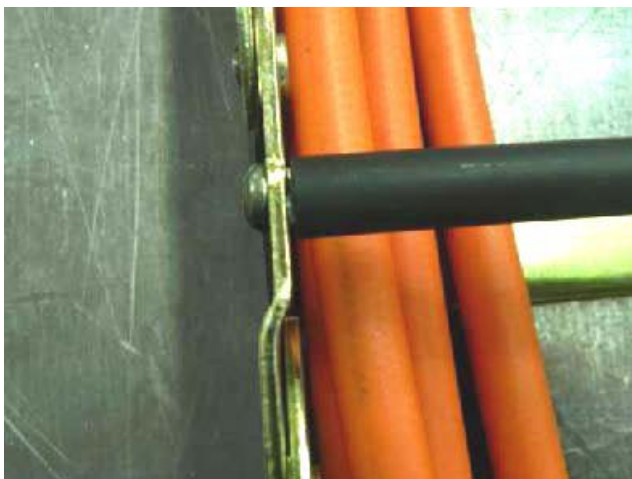
9. Pull up on other end of round bar. Slide new poly roller on bar.



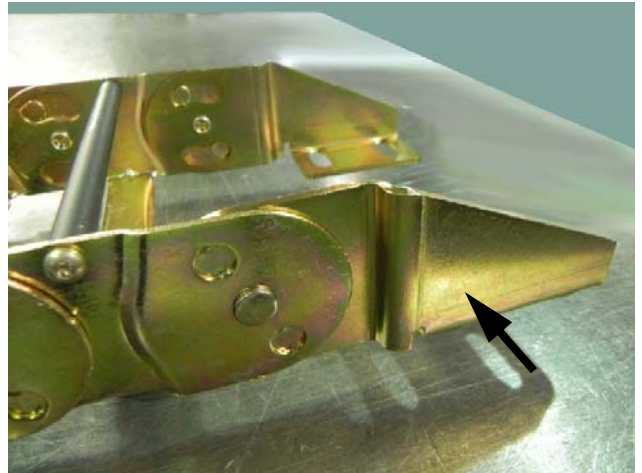
10. Install new 8-32 x 0.500 self threading screw on other side. Torque to 18-20 in-lb (2-2.25 Nm).



**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.



2. Parts used: Bracket Center Pin and Center Pin Snap Ring.



## SECTION 4 - BOOM & PLATFORM

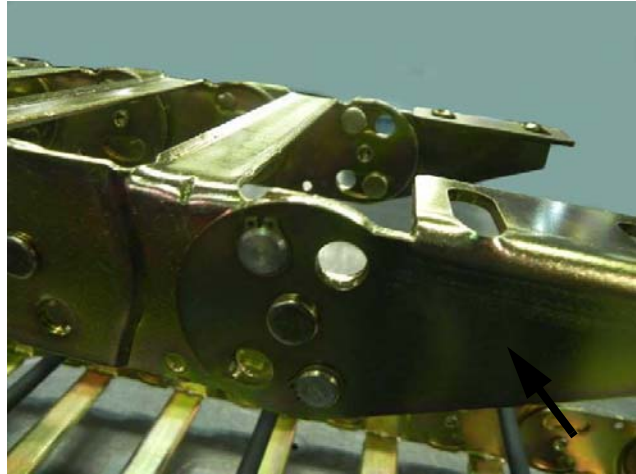
3. Take new bracket and install bracket center pin and snap ring. Repeat on other bracket if replacing it.



**NOTE:** Ensure snap rings are seated in pin groove and closed properly.



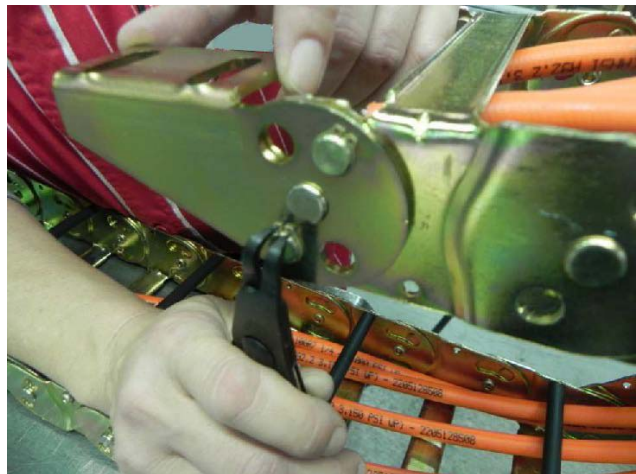
## Replace Moving End Brackets



### NOTICE

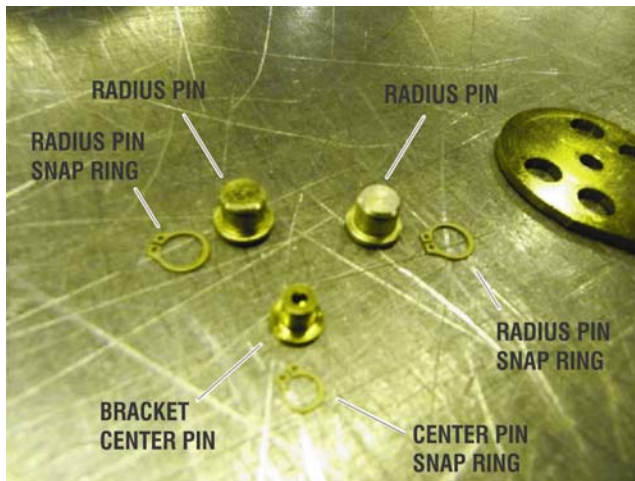
**REPOSITION CABLES AND HOSES. KEEP COVERED DURING GRINDING TO PREVENT DAMAGE.**

1. Remove existing pins and center rivet. Remove rivet as shown in link removal instructions on page 4-20. Repeat on other bracket if replaced.

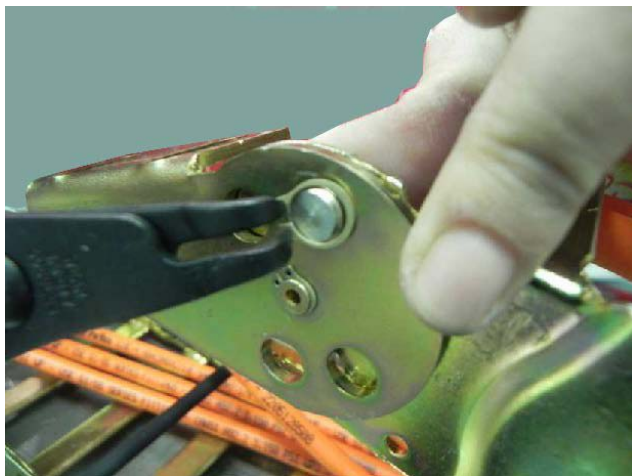




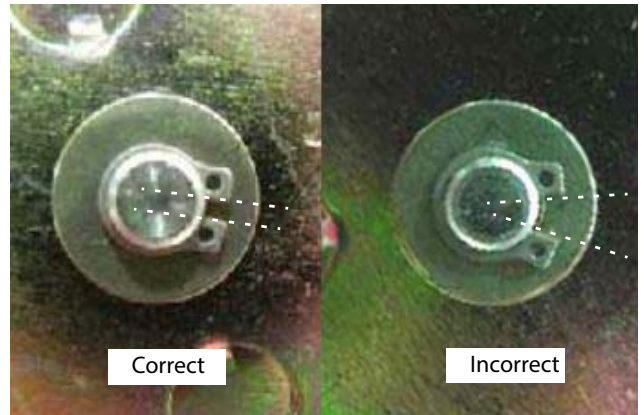
2. Install center pin with snap ring in new bracket.



3. Install radius pins and snap rings in original locations. Repeat with other moving end if replaced.



**NOTE:** Ensure snap rings are seated in pin groove and closed properly.



4. Make sure both brackets rotate correctly.



## 4.5 MAIN BOOM ASSEMBLY

Refer to Figure 4-4., Main Boom Assembly Components.

### Removal

1. Support boom assembly weight along entire length using suitable lifting equipment.

### NOTICE

**CAP HYDRAULIC LINES AND PORTS IMMEDIATELY AFTER DISCONNECTING LINES TO PREVENT SYSTEM CONTAMINATION.**

2. Tag and disconnect hydraulic lines from telescope cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove hardware securing lift cylinder rod end to base boom section.

4. Remove lift cylinder pin from base boom using a suitable brass drift and hammer.
5. Remove hardware securing master cylinder rod end to base boom section.
6. Remove master cylinder pin from base boom using a suitable brass drift and hammer.
7. Remove hardware securing boom pivot pin to turntable upright.
8. Using a suitable brass drift and hammer, remove pivot pin from turntable upright.
9. Using all applicable safety precautions, carefully lift boom assembly clear of upright. Lower to ground or suitably supported work surface.

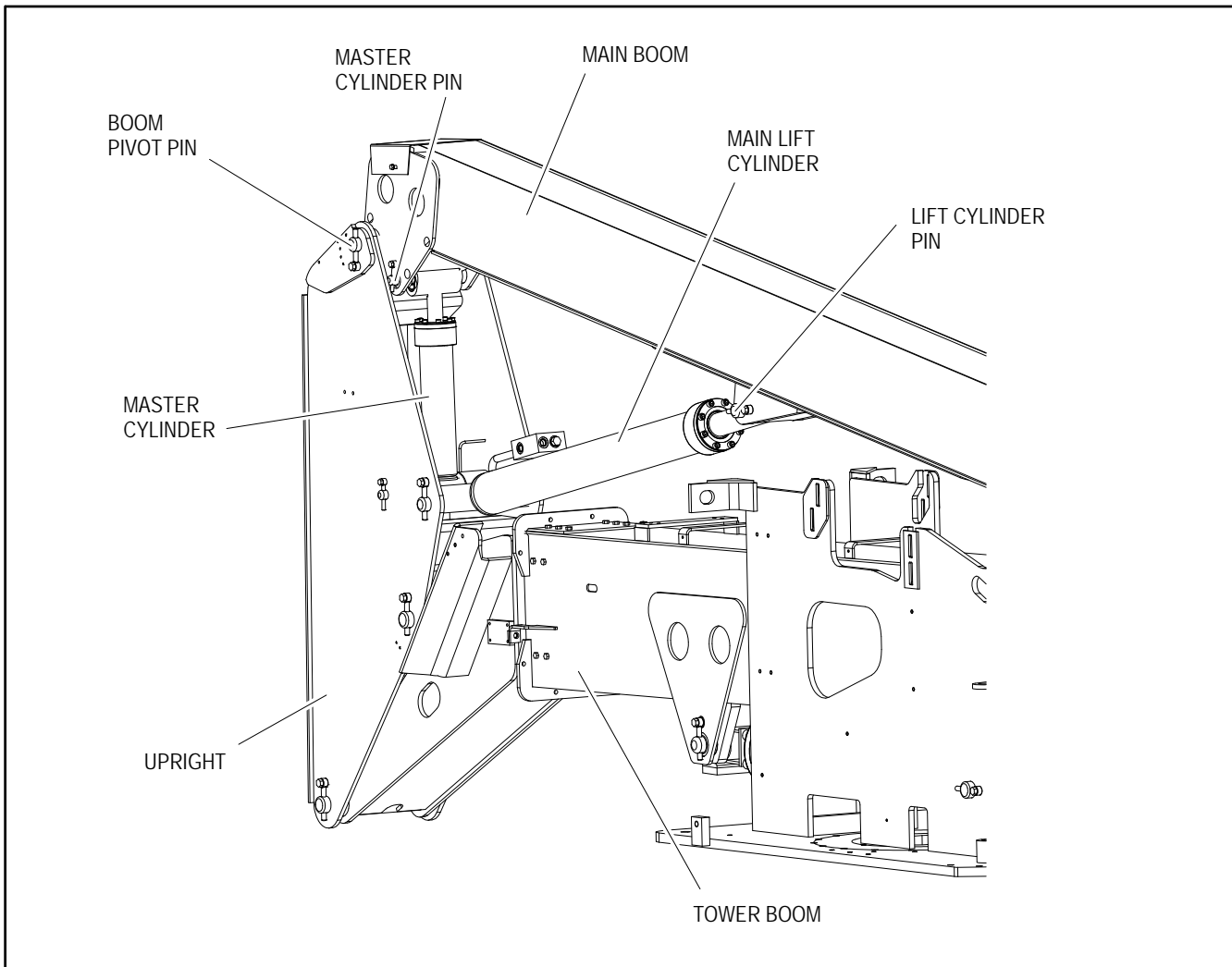


Figure 4-4. Main Boom Assembly Components

## Disassembly

1. Remove hardware securing telescope cylinder to aft end of main boom section.
2. Remove hardware and wear pads from top, sides, and bottom of main boom section.
3. Remove fly boom assembly from main boom using overhead crane or suitable lifting device.
4. Remove hardware from telescope cylinder pin. Remove cylinder pin from fly boom section using a suitable brass drift and hammer.
5. Pull telescope cylinder partially from aft end of fly boom. Secure cylinder with a suitable sling and lifting device at center of gravity.
6. Carefully remove telescope cylinder and place on a suitable trestle.

**NOTE:** *The Main Boom Telescope Cylinder can be removed without disassembling the main boom by disconnecting hydraulic lines, top attaching pin of main boom lift cylinder and telescope cylinders as directed above, and pulling out the telescope cylinder through the access plate opening of the upright.*

7. Remove hardware and wear pads from top, sides, and bottom of fly boom section.

## Inspection

**NOTE:** *Replace worn or damage components as needed.*

1. Inspect main boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins if necessary.
2. Inspect telescope cylinder attach point for scoring, tapering and ovality. Replace pins if necessary.
3. Inspect main lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Protect pin surfaces before installation. Replace pins if necessary.
4. Inspect inner diameter of boom pivot bearing for scoring, distortion, wear, or other damage. Replace bearing if necessary.
5. Inspect all wear pads for excessive wear or other damage.
6. Inspect threaded components for stretching, thread deformation, twisting, or other damage. Replace if necessary.
7. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections if necessary.

### Assembly

**NOTE:** When installing fly section wear pads, install same number and thickness of shims as were removed during disassembly.

1. Measure inside dimensions of base section to determine number of shims required for proper lift.
2. Install side, top, and bottom wear pads to aft end of fly section. Shim evenly to inside measurements of base boom section.

### **NOTICE**

**ENSURE BOOM SLIDING AREAS ARE CLEAR OF CHAINS, TOOLS, AND OTHER OBJECTS WHEN ASSEMBLING BOOM SECTIONS.**

3. Secure sling and lifting device at telescope cylinder center of gravity. Lift cylinder to aft end of fly boom section.
4. Slide telescope cylinder in aft end of fly boom section. Align attachment holes in fly boom section with hole in rod end of telescope cylinder.
5. Install telescope cylinder pin. Secure with mounting hardware.
6. Secure sling and lifting device at fly boom center of gravity.
7. Slide fly boom assembly in base boom section. Check for 1/16 in. (1.57 mm) clearance. Shim if needed.
8. Install wear pads in forward position of base boom section. Check for 2/10 in. (5.08 mm) clearance. Shim if needed.
9. Align cylinder with slots at aft end of base boom section. Secure cylinder with mounting hardware.

### Installation

1. Use a suitable lifting device to position boom assembly on upright. Align pivot holes in boom and upright.
2. Install boom pivot pin. Ensure location of hole in pin is aligned with attach point with upright.
3. Gently tap pin in position with soft headed mallet. Install pin mounting hardware.
4. Align holes in boom structure with hole in master cylinder. Insert master cylinder pin. Ensure location of hole in pin is aligned with attach point on boom.
5. Using all applicable safety precautions, operate lifting device and position boom lift cylinder so holes in cylinder rod end and boom structure are aligned. Insert lift cylinder pin. Ensure location of hole in pin is aligned with attach point on boom.
6. Connect all wiring connectors.
7. Connect all hydraulic lines running along side of boom assembly.
8. Using all applicable safety precautions, operate machine systems and raise and extend boom fully. Note extension cycle performance.
9. Retract and lower boom. Note retraction cycle performance.

## 4.6 UPRIGHT

### Removal

#### NOTICE

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

1. Tag and disconnect hydraulic lines to main lift cylinder (1). Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Support main lift cylinder using suitable lifting device.
3. Remove bolt and keeper pin from main lift cylinder barrel end pin (2). Remove pin using a suitable brass drift and hammer.
4. Tag and disconnect hydraulic lines to master cylinder (3). Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
5. Remove bolt and keeper pin from master cylinder barrel end pin (4). Remove pin using a suitable brass drift and hammer.
6. Disconnect wiring harness to two horizontal limit switches (5) and dual capacity limit switch (6).
7. Support tower upright (7) with suitable lifting device.
8. Remove mounting hardware and hose bracket (8) from tower upright.
9. Remove bolt and keeper pin from upright level cylinder (9) barrel end pin (10). Remove pin using a suitable brass drift and hammer.
10. Remove bolt and keeper pin from upright pivot pin (11). Remove pin using a suitable brass drift and hammer. Remove upright from tower boom assembly.

### Installation

1. Using suitable lifting device, position upright on tower boom assembly so pivot holes in upright and tower boom are aligned.
2. Install upright pivot pin (11) into the tower boom assembly and secure it with the mounting hardware.
3. Using all applicable safety precautions, operate lifting device and position upright leveling cylinder (9) so holes in cylinder barrel end and upright structure are aligned. Insert level cylinder pin (10), ensuring that location of hole in pin is aligned with attach point on upright.
4. Align main lift cylinder (1) with attach holes in upright. Using a soft head mallet, install cylinder pin (2) and secure with mounting hardware.
5. Align master cylinder (3) with attach holes in upright. Using a soft head mallet, install cylinder pin (4) and secure with mounting hardware.
6. Install mounting hardware and hose bracket (8) to tower upright.
7. Connect wiring harness to horizontal limit switch (5) and dual capacity limit switch (6).
8. Connect the hydraulic lines to the main boom lift cylinder as tagged during removal.

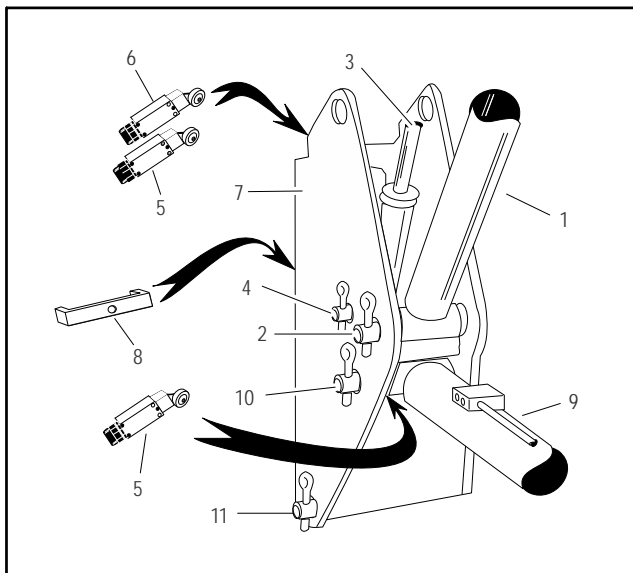


Figure 4-5. Tower Upright Components

## 4.7 TOWER BOOM ASSEMBLY

### Removal

**NOTICE**

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

1. Using an overhead crane or suitable lifting device, support the entire Tower Boom Assembly and separately support the tower lift cylinder.
2. Tag and disconnect all hydraulic lines from tower boom assembly to turntable components. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Disconnect wiring harness from ground control box.
4. Remove mounting hardware from tower lift cylinder rod end. Using a suitable brass drift and hammer, remove the tower lift cylinder pin #1 from the tower boom assembly.
5. Remove mounting hardware from tower boom pivot pin. Using a suitable brass drift and hammer, remove pin #2 from turntable assembly.
6. Using all applicable safety precautions, carefully lift the Tower Boom Assembly clear of turntable and lower to ground or a suitable supported work surface.

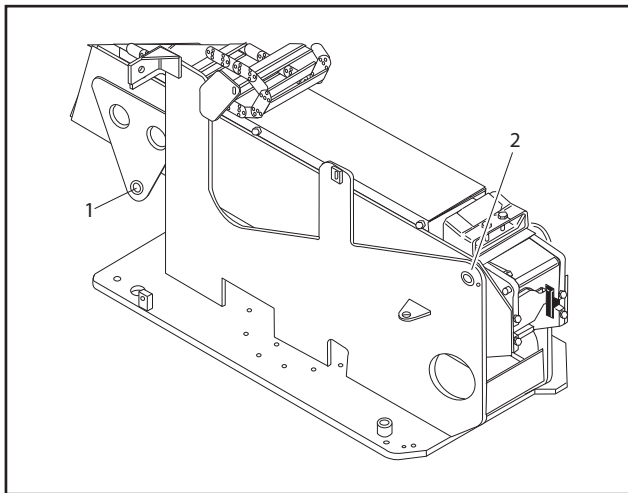


Figure 4-6. Tower Boom Components

### Disassembly

1. Remove brackets securing hoses and wiring harnesses to push tubes and top of tower boom assembly.
2. Mark all hoses and wiring harnesses at bracket on rear end of tower base boom section for future assembly.

Remove hoses and wiring harness from tower boom powertrack.

3. Remove mounting hardware which secures the push tubes to the tower fly boom section.
4. Remove mounting hardware which secures push tubes to the powertrack. Remove push tubes.
5. Remove mounting hardware which secures the powertrack to the cover plate, then remove powertrack.
6. Remove mounting hardware which secures the cover plate to the top of the tower base section, then remove cover plate.
7. Remove mounting hardware from tower boom telescope cylinder barrel end.
8. Remove mounting hardware which secures the wear pads to front of tower base boom section; remove the wear pads from the top, sides and bottom of the tower base boom.
9. Remove fly assembly from base section using an overhead crane or suitable lifting device.
10. Remove mounting hardware which secures tower telescope cylinder to the fly section. Remove pin from fly boom section using a suitable brass drift and hammer.
11. Remove mounting hardware which secures wear pads to aft end of tower fly boom section; remove the wear pads from the top, sides and bottom of the fly boom.
12. Remove mounting hardware which secures upright leveling cylinder to fly section. Remove pin from fly boom section using a suitable brass drift and hammer.
13. Remove hardware and wear pads from top, sides, and bottom of fly boom aft section.

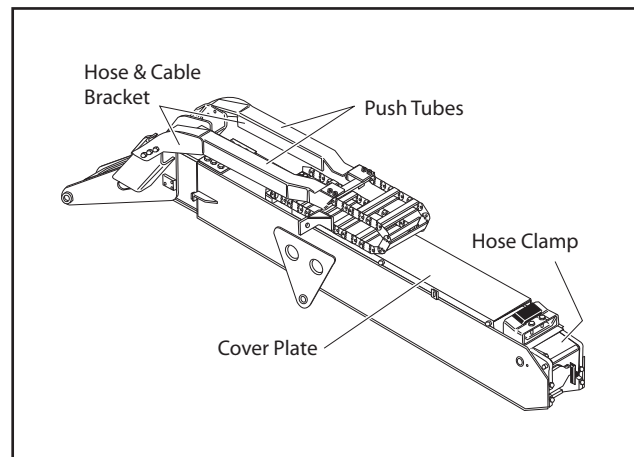


Figure 4-7. Tower Boom Powertrack Components

## Inspection

**NOTE:** Replace worn or damage components as needed.

1. Inspect tower boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins if necessary.
2. Inspect tower boom pivot attach points for scoring, tapering and ovality, or other damage. Replace pins if necessary.
3. Inspect inner diameter of tower boom pivot bearings for scoring, distortion, wear, or other damage. Replace pins if 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 if necessary.
5. Inspect inner diameter of upright attach point bearings for scoring, distortion, wear, or other damage. Replace bearing if necessary.
6. Inspect all threaded components for stretching, thread deformation, twisting, or other damage. Replace if necessary.
7. Inspect structural units of tower boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections if necessary.
8. Inspect powertrack for cracking, wear, or other damage. Replace links or assembly, if necessary.

## Assembly

**NOTE:** When installing fly section wear pads, install same number and thickness of shims as were removed during disassembly.

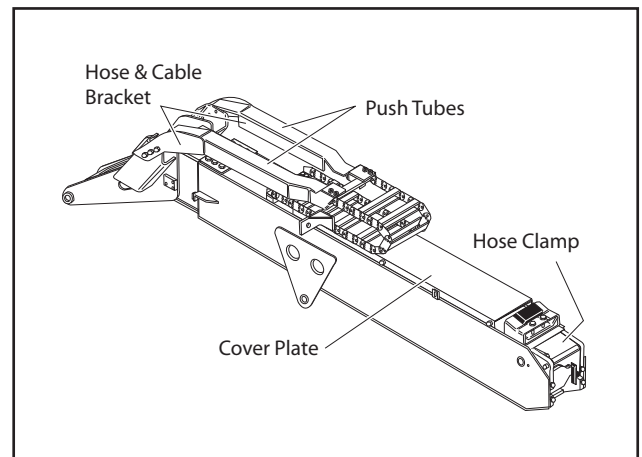
1. Measure inside dimensions of tower base section to determine number of shims required for proper lift.
2. Install side, top and bottom wear pads to front end of tower fly section. Shim evenly to measurements of the inside of base boom section.

### NOTICE

**ENSURE BOOM SLIDING AREAS ARE CLEAR OF CHAINS, TOOLS, AND OTHER OBJECTS WHEN ASSEMBLING BOOM SECTIONS.**

3. Align upright leveling cylinder with attach holes in tower fly boom. Using a soft head mallet, install the cylinder pin into tower fly boom and secure with mounting hardware.
4. Install side, top, and bottom wear pads to the aft end of tower fly section; shim evenly to the measurements of the inside of the base boom section.

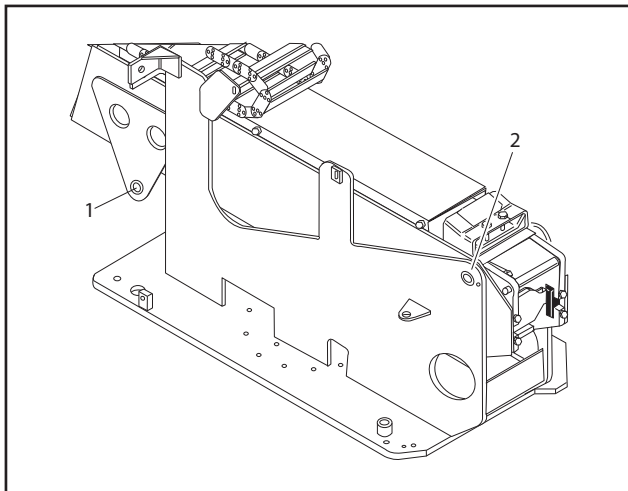
5. Align tower telescope cylinder with attach holes in tower fly boom. Install cylinder pin in tower fly boom using a soft head mallet. Secure with mounting hardware.
6. Secure the sling and lifting device at the tower fly boom assembly's approximate center of gravity.
7. Slide tower fly boom assembly into the tower base boom section. Shim boom, if necessary, for a total of 1/16 in. (0.062) clearance.
8. Install wear pads in forward position of the tower base boom section. Shim boom, if necessary, for a total of 2/10 in. (0.20) clearance.
9. Align telescope cylinder with slots at aft end of tower base boom section. Secure cylinder with mounting hardware.
10. Install cover plate to attach point on the tower base boom section, then secure with mounting hardware.
11. Install powertrack to attach point on the tower base boom section, then secure with mounting hardware.
12. Attach push tubes to the powertrack and attach point on the tower fly boom section with mounting hardware.
13. Properly route hoses and wiring harnesses through bracket at aft end of tower base boom section.
14. Pull hoses and wiring harnesses through hose bracket to mark on hoses and harnesses from disassembly. Clamp for proper length.
15. Route hoses and harnesses through powertrack. Push tubes through holes in side of tower fly boom nose. Secure hoses and harnesses with hoses brackets.



**Figure 4-8. Tower Boom Powertrack Components**

**Installation**

1. Position tower boom assembly on turntable using a suitable lifting device. Align pivot holes in boom and turntable.
2. Install tower boom pivot pin #1. Ensure 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 all applicable safety precautions, operate lifting device and position lower boom lift cylinder so holes in cylinder rod end and tower boom structure are aligned. Insert lift cylinder pin #2, ensuring that location of hole in pin is aligned with attach point on tower boom.
5. Connect all wiring connections at ground controls.
6. Connect all hydraulic lines running from aft end of tower boom assembly to ground controls.



**Figure 4-9. Tower Boom Components**

**4.8 JIB ASSEMBLY - 600AJ**

*Refer to Figure 4-10., Jib Assembly.*

**Removal**

**NOTE:** Support the jib using a suitable lifting device.

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 jib 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 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.

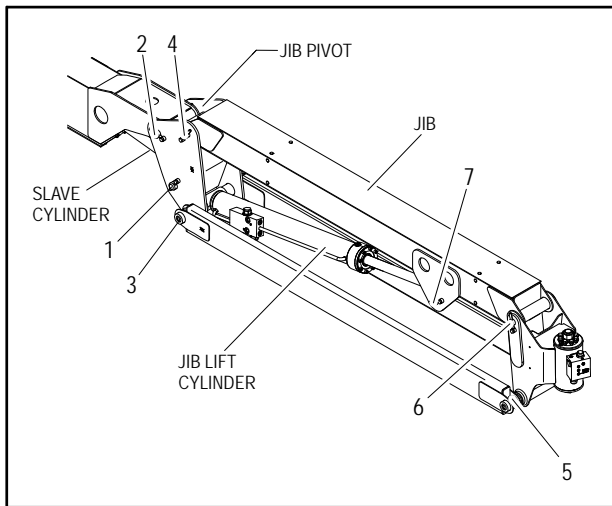


Figure 4-10. Jib Assembly

### 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 BOOM CLEANLINESS GUIDELINES

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

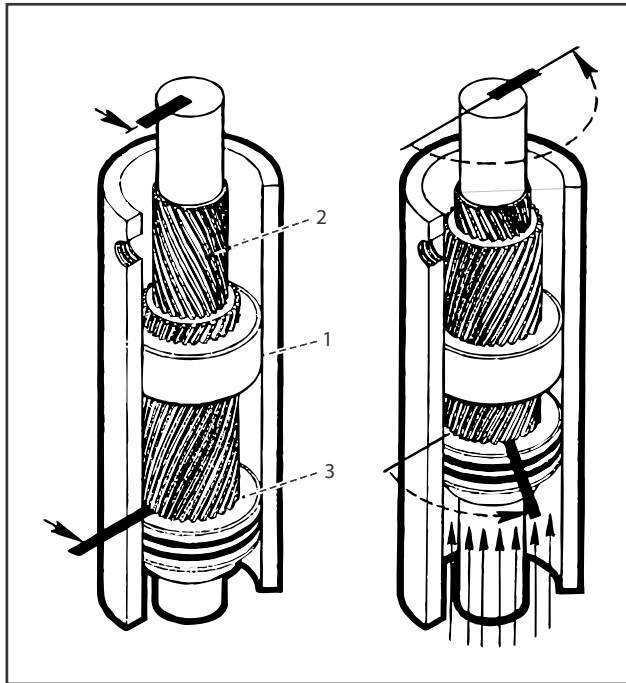
1. JLG recommends the use of the JLG Hostile Environment Package if available to keep the internal portions of a boom cleaner and to help prevent dirt and debris from entering the boom. This package reduces the amount of contamination which can enter the boom but does not eliminate the need for more frequent inspections and maintenance when used in these types of environments.
2. JLG recommends that you follow all guidelines for servicing your equipment in accordance with the instructions outlined in the JLG Service & Maintenance Manual for your machine. Periodic maintenance and inspection is vital to the proper operation of the machine. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.
3. Debris and foreign matter inside of 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 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 the debris, then water with mild solvents applied via a pressure washer can be used. Again the method is to wash the debris toward the nearest exiting point from the boom. Make sure that all debris is removed, that no "puddling" of water has occurred, and that the boom internal components are dry prior to operating the machine. Make sure you comply with all federal and local laws for disposing of the wash water and debris.
6. If neither pressurized air nor washing of the boom dislodges and removes the debris, then disassemble the boom in accordance to the instructions outlined in the JLG Service & Maintenance Manual to remove the debris.

## 4.10 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 (1) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (2), and the annular piston sleeve (3). 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.



Bars indicate starting positions of piston and shaft. Arrows indicate direction of rotation. The housing with integral ring gear remains stationary. As fluid pressure is applied, the piston is displaced axially while helical gearing causes the piston and shaft to rotate simultaneously. The double helix design compounds rotation: shaft rotation is about twice of the piston.

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 shaft in position. The shaft is supported radially by the large upper radial bearing and lower radial bearing.

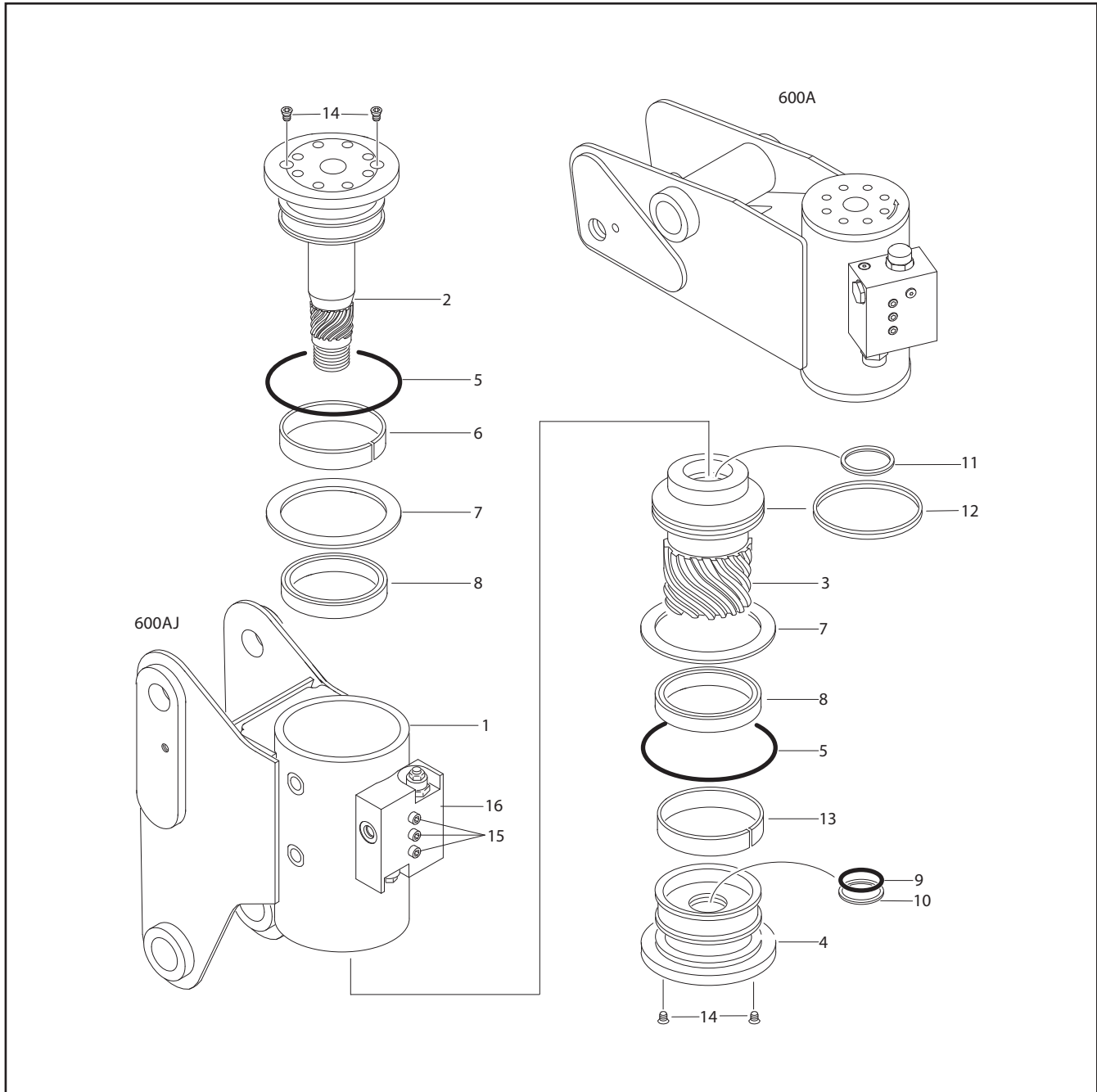
### Required Tools



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.



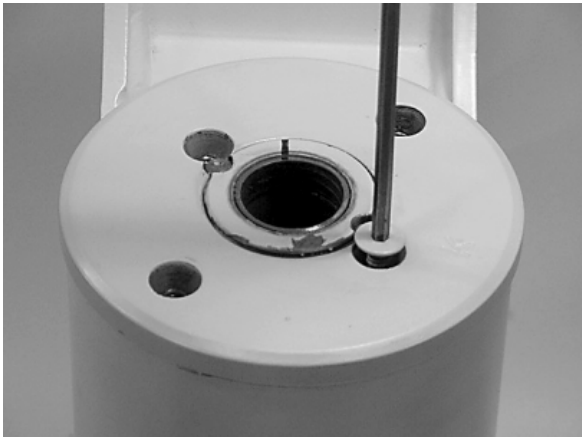


- |            |                    |                  |                 |
|------------|--------------------|------------------|-----------------|
| 1. Housing | 5. O-Ring          | 9. Cap Seal      | 13. Cap Bearing |
| 2. Shaft   | 6. Shaft Bearing   | 10. Back-Up Ring | 14. Capscrew    |
| 3. Piston  | 7. Thrustwasher    | 11. Rod Seal     | 15. Bolt        |
| 4. End Cap | 8. Bearing Packing | 12. Piston Seal  | 16. Valve Block |

**Figure 4-11. Rotary Actuator - Exploded View**

**Disassembly**

1. Remove capscrews (113) over end cap lock pins (109).

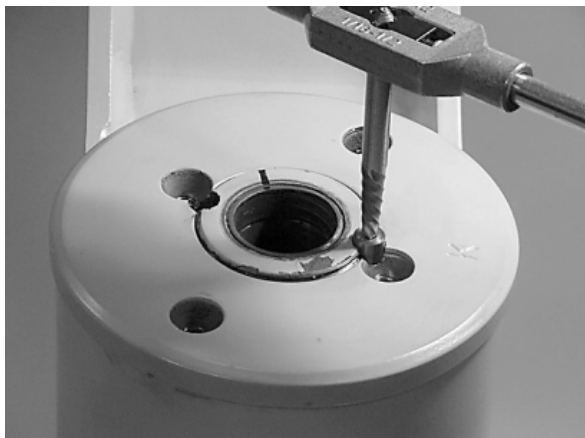


2. Using a 1/8" (3.18mm) drill bit, drill a hole in center of each lock pin approximately 3/16" (4.76mm) deep.

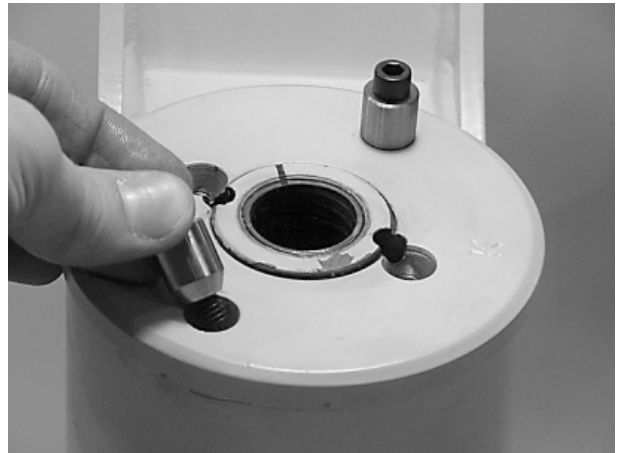


3. Remove lock pins using an "Easy Out" (Size #2 shown). If pin will not come out, use 5/16" drill bit 1/2" (12.7mm) deep to drill out entire pin.

**NOTE:** If the pin will not come out with the "Easy Out", use 5/16 in. drill bit to a depth of 1/2 in. (12.7 mm) to drill out the entire pin. Do not drill deeper than 1/2 in. (12.7 mm).



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.

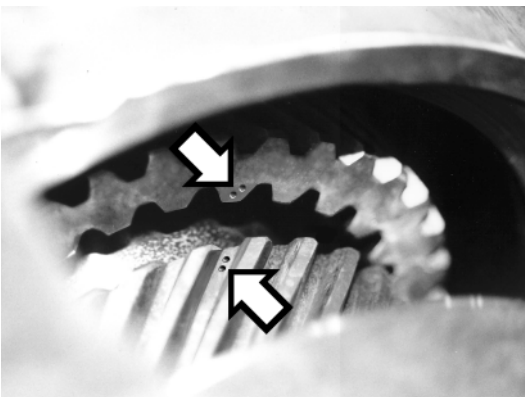
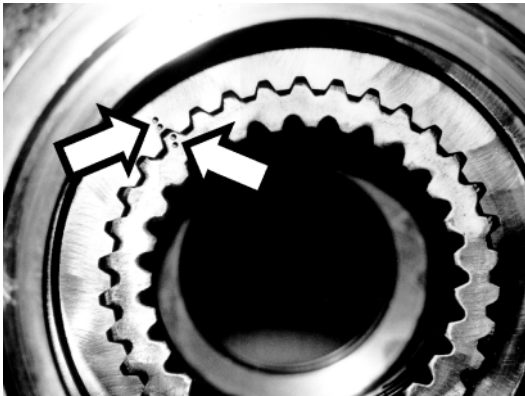


## SECTION 4 - BOOM & PLATFORM

7. Remove stop tube if installed.



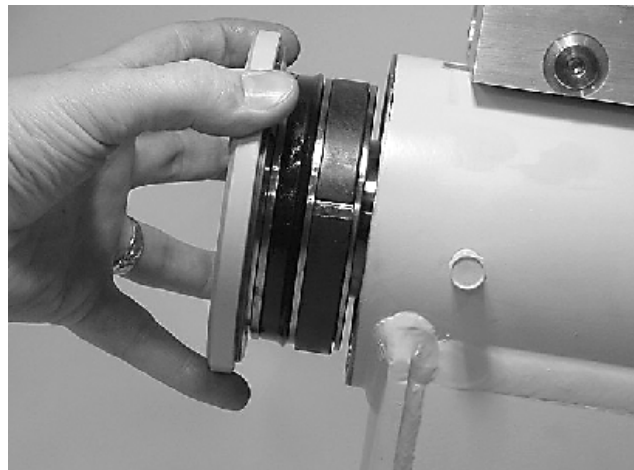
8. Actuator has timing marks for proper engagement.



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.



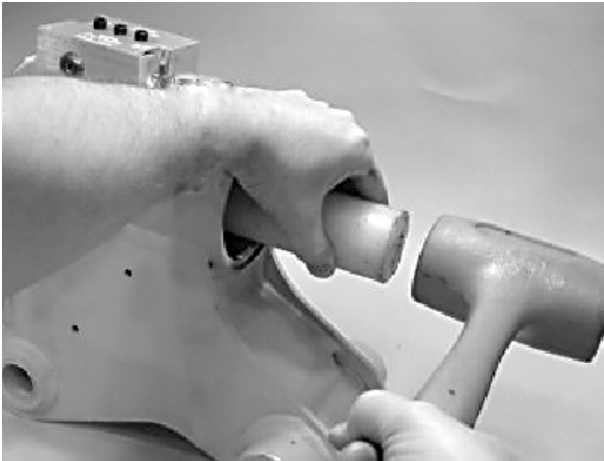
- 11.** Before removing piston (3), mark housing (1) ring gear in relation to piston O.D. gear. There should be timing marks on housing (1) ring gear, piston (3), and shaft (2).



- 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.



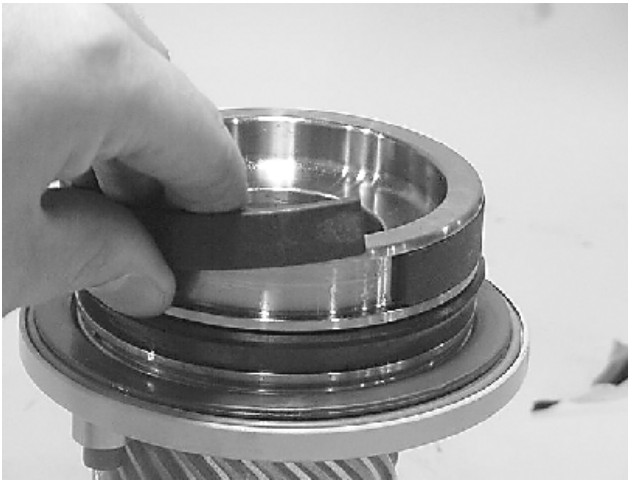
- 14.** Remove O-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.



## SECTION 4 - BOOM & PLATFORM

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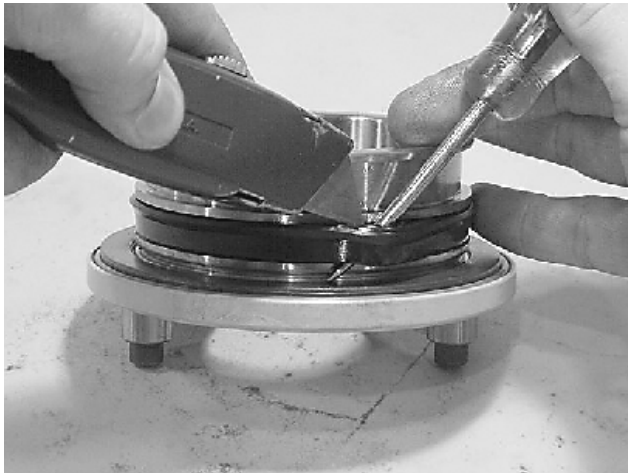
15. Remove wear guides (302) from end cap (4) and shaft (2).



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).





20. Remove piston I.D. seal (200).

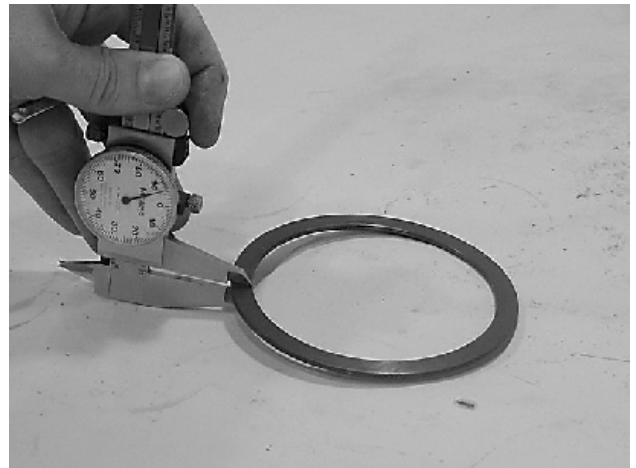


**Inspection**

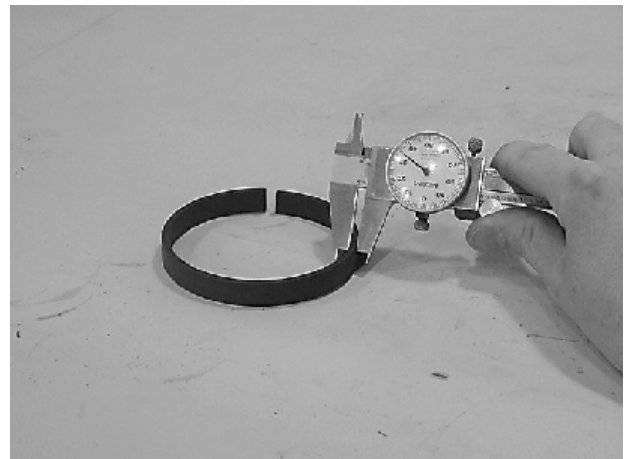
1. Clean all parts in a solvent tank and dry with compressed air before inspecting. Carefully inspect all critical areas for any surface finish abnormalities: Seal grooves, bearing grooves, thrust surfaces, rod surface, housing bore, and gear teeth.



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.



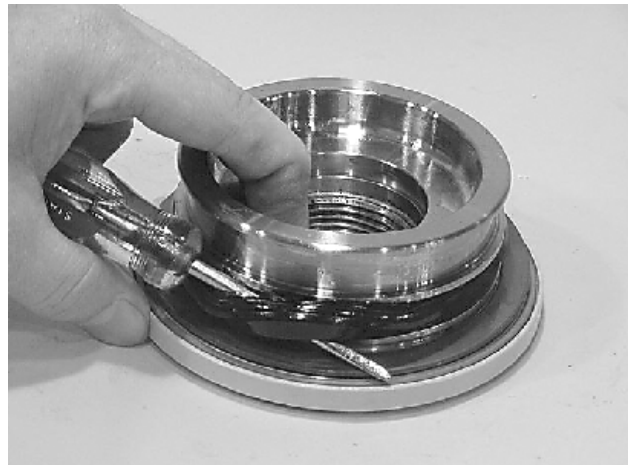
2. Install thrust washer (304) on shaft (2) and end cap (4).



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).



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).

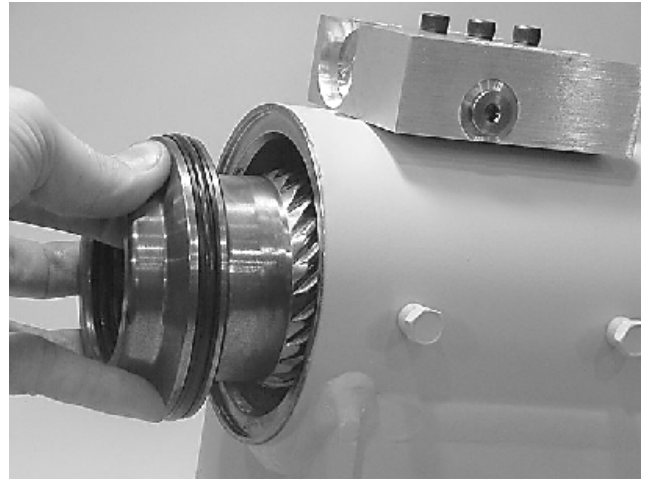


7. Beginning with inner seal (200) insert one end of b/u ring in lower groove and feed the rest in using a circular motion. Make sure wedged ends overlap correctly.

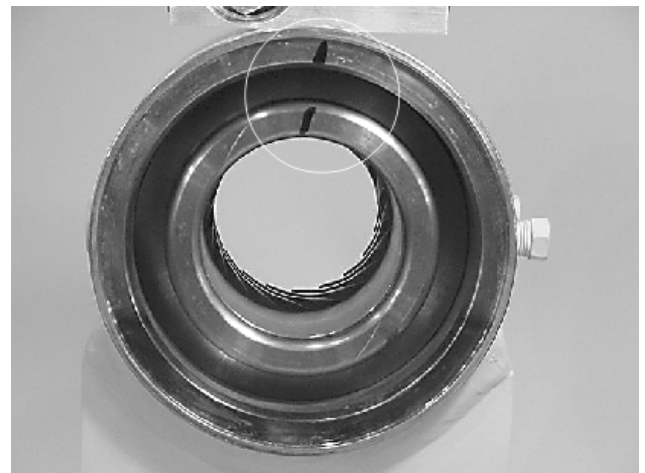
Repeat for outer seal (202).



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.

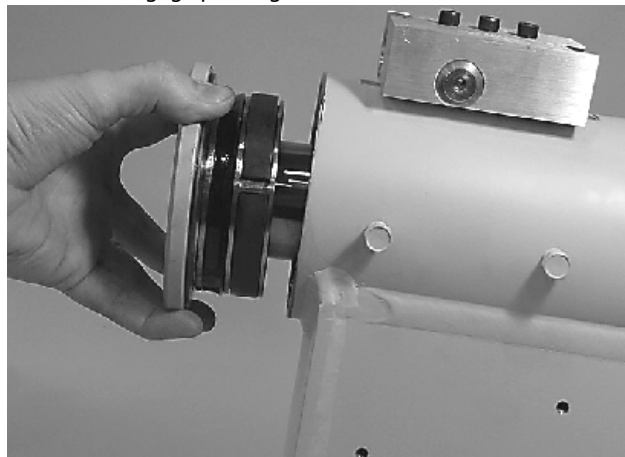


## SECTION 4 - BOOM & PLATFORM

- 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.



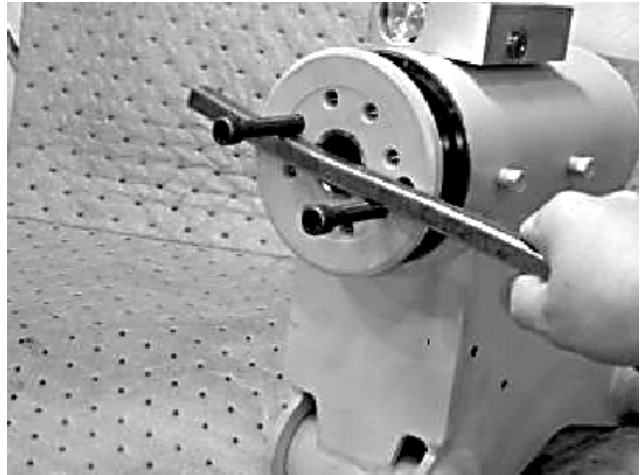
- 11.** Install shaft (2) in piston (3). Do not damage seals. Do not engage piston gear teeth.



- 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.

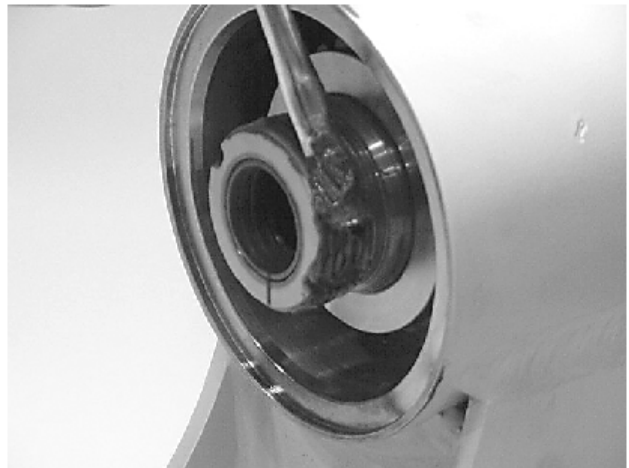


- 13.** Install 2 bolts in threaded holes in flange. Using a bar, rotate shaft clockwise until wear guides are seated in housing bore.



- 14.** Install stop tube on shaft end. Stop tube is an available option to limit actuator rotation.

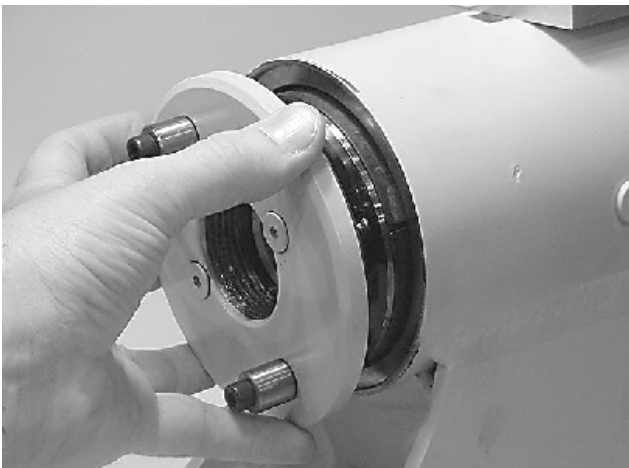
- 15.** Coat threads on end of shaft with anti-seize grease to prevent galling.



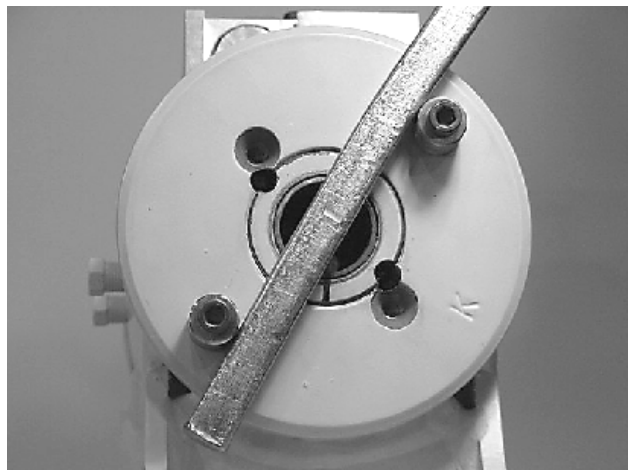
- 16.** Install O-ring (204) and back-up ring (207) in inner seal groove on end cap (4).



- 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).



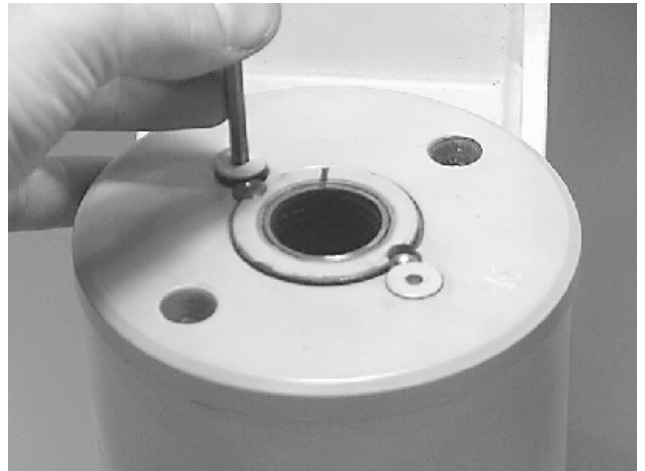
- 18.** Tighten end cap (4). Ensure holes for lock pins line up.



- 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.



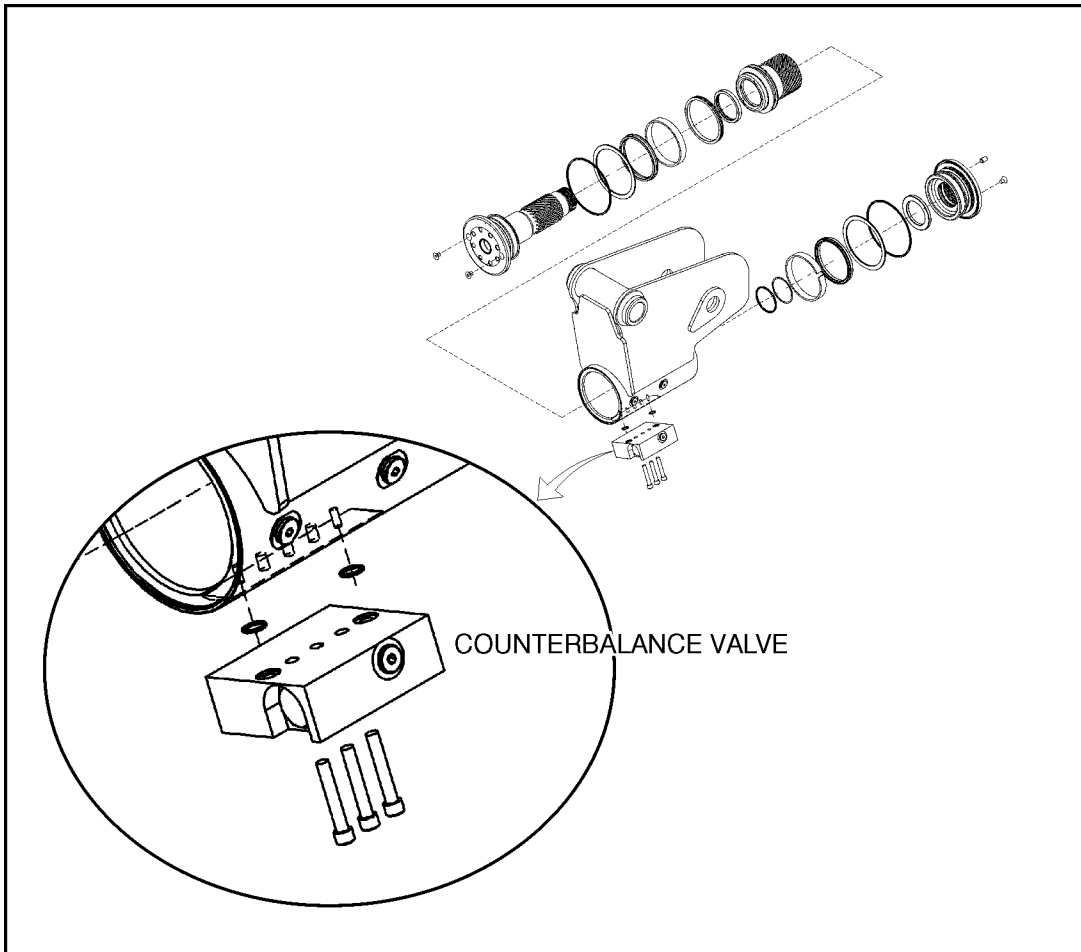
- 20.** Insert set screws (113) over lock pins. Tighten to 25 in-lb (2.825 Nm).



**Installing Counterbalance Valve**

Refer to Figure 4-12., 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 4-12. 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

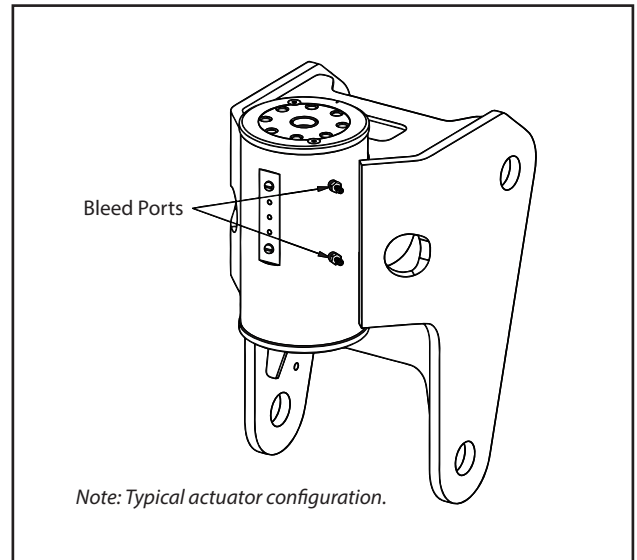
#### **⚠ WARNING**

**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 4-13. 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.

## Troubleshooting

**Table 4-1. Troubleshooting**

Problem	Cause	Solution
1. Shaft rotates slowly or not at all	<p>a. Insufficient torque output</p> <p>b. Low rate of fluid flow</p> <p>c. Control or counterbalance valve has internal leak</p> <p>d. Piston and/or shaft seal leak</p> <p>e. Corrosion build-up on the thrust surfaces</p> <p>f. Swollen seals and composite bearings caused by incompatible hydraulic fluid</p>	<p>a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.</p> <p>b. Inspect ports for obstructions and hydraulic lines for restrictions and leaks.</p> <p>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.</p> <p>d. Remove plug and housing's valve ports. Operate actuator through housing ports. Conduct internal leakage test.</p> <p>e. Rebuild actuator. Remove all rust then polish. Replacement parts may be needed.</p> <p>f. Rebuild actuator. Use fluid compatible with all seals and bearings.</p>
2. Operation is erratic or not responsive	a. Air in actuator	a. Purge air from actuator. See bleeding procedures.
3. Shaft will not fully rotate	<p>a. Twisted or chipped gear teeth</p> <p>b. Port fittings are obstructing the piston</p>	<p>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.</p> <p>b. Check thread length of port fittings. Fittings should during stroke not reach inside housing bore.</p>
4. Selected position cannot be maintained	<p>a. Control or counterbalance valve has internal leak</p> <p>b. Piston and/or shaft seal leak</p> <p>c. Air in actuator</p>	<p>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.</p> <p>b. Remove plug and housing's valve ports. Operate actuator through housing ports. Conduct internal leakage test.</p> <p>c. Purge air from actuator. See bleeding procedures</p>



## 4.11 FOOT SWITCH ADJUSTMENT

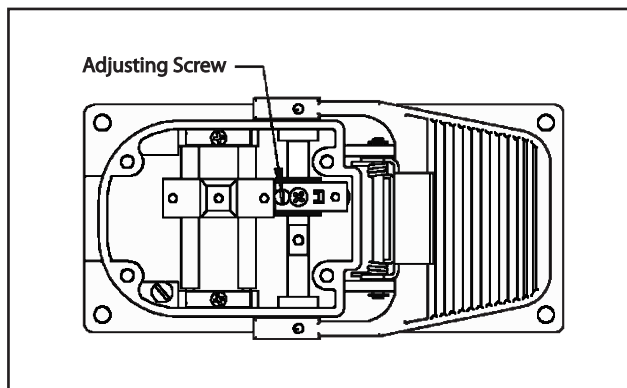
Adjust foot switch to operate functions when pedal is at center of travel. Adjust if switch operates within last 1/2 in. (6.35 mm) of top or bottom travel.

### **⚠ 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 4-14. Foot Switch Adjustment**

4. Install cover and secure with four socket head cap screws. Torque to 18-22 in-lb (2-3 Nm).

## 4.12 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 41 for functions.

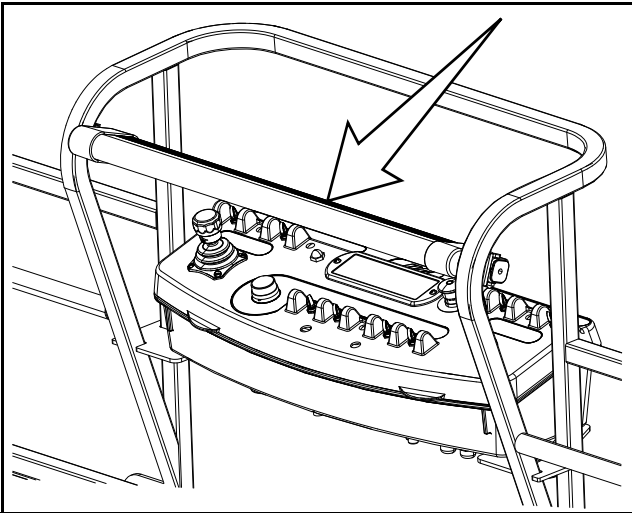


Figure 4-15. Skyguard

### 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 → 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.										

### 4.13 BOLT ON FALL ARREST

The bolt on fall arrest system is designed to provide a lanyard attach point while allowing the operator to access areas outside the platform. Exit/Enter the platform through the gate area only. The system is designed for use by one person.

Personnel must use fall protection at all times. A full body harness is required with lanyard not to exceed 6 ft. (1.8 M) in length, that limits the maximum arrest force to 900 lbs. (408 kg).

External Fall Arrest System capacity is 310 lb (140 kg) - one (1) person maximum.

Do not move the platform during use of the external fall arrest system.

**⚠ WARNING**

**DO NOT OPERATE ANY MACHINE FUNCTIONS WHILE OUTSIDE OF PLATFORM. BE CAREFUL WHEN ENTERING/EXITING THE PLATFORM AT ELEVATION.**

**⚠ WARNING**

**IF THE EXTERNAL FALL ARREST SYSTEM IS USED TO ARREST A FALL OR IS OTHERWISE DAMAGED, THE ENTIRE SYSTEM MUST BE REPLACED AND THE PLATFORM FULLY INSPECTED BEFORE RETURNING TO SERVICE. REFER TO THE SERVICE MANUAL FOR REMOVAL AND INSTALLATION PROCEDURES.**

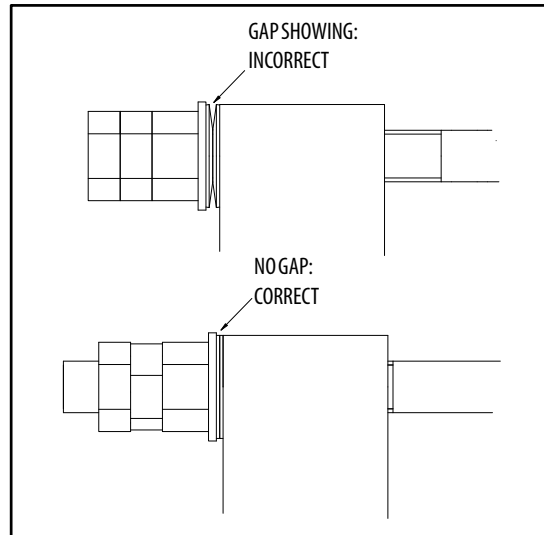
**THE EXTERNAL FALL ARREST SYSTEM REQUIRES AN ANNUAL INSPECTION AND CERTIFICATION. THE ANNUAL INSPECTION AND CERTIFICATION MUST BE PERFORMED BY A QUALIFIED PERSON OTHER THAN THE USER.**

#### Inspection Before Use

The external fall arrest system must be inspected before each use of the aerial work platform. Replace components if there are any signs of wear or damage.

Before each use, perform a visual inspection of the following components:

- Cable: Inspect cable for proper tension, broken strands, kinks, or any signs of corrosion.

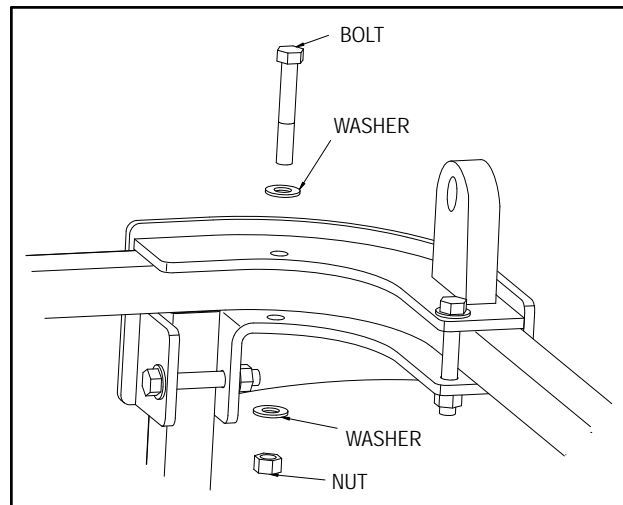


**Figure 4-16. Bolt On Fall Arrest Cable Tension**

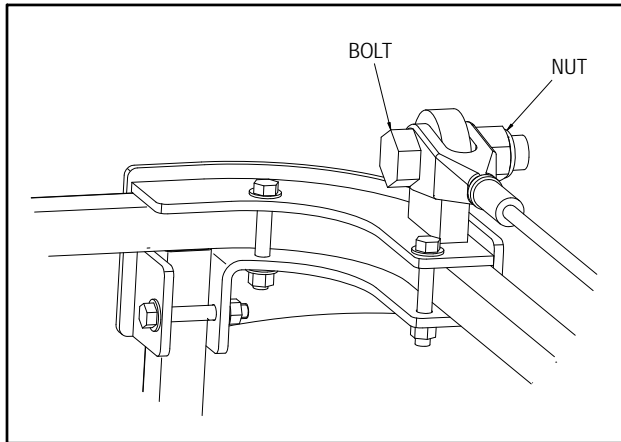
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are no missing components and hardware is properly tightened.
- Platform Rails: No visible damage is acceptable.

#### Installation

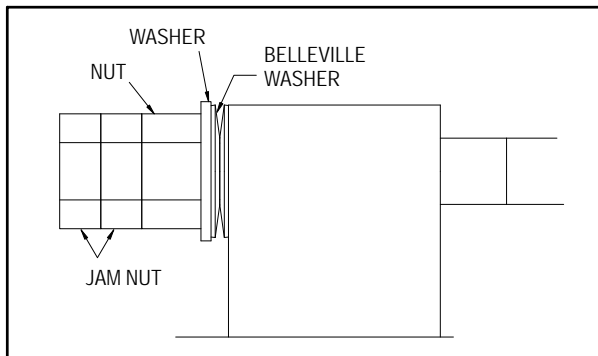
1. Install the retaining hardware (bolts, nuts, and washers) and secure the brackets to the platform rail. Tighten the nuts but do not torque them yet.



2. Attach the fall arrest cable to the right hand bracket Using the attaching bolt and nut. Orient the bolt as shown below. Do not tighten the nut so cable can still rotate.

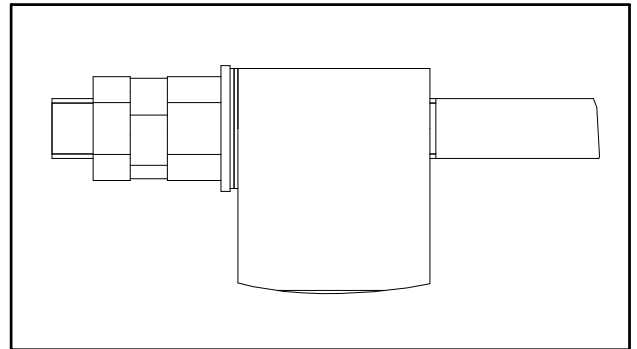


3. Install the Attachment Ring onto the cable.
4. Without twisting the fall arrest cable, pull it thru the left hand bracket and mark the top of the swaged cable end. Install the fall arrest cable through the left hand bracket and secure it using the belleville washers, washer, retaining nut, and jam nuts. Orient the hardware as shown below and with the belleville washers so the gap is present at the outside diameter of the washers. install the nuts onto the cable finger tight so the mark on the cable does not move.



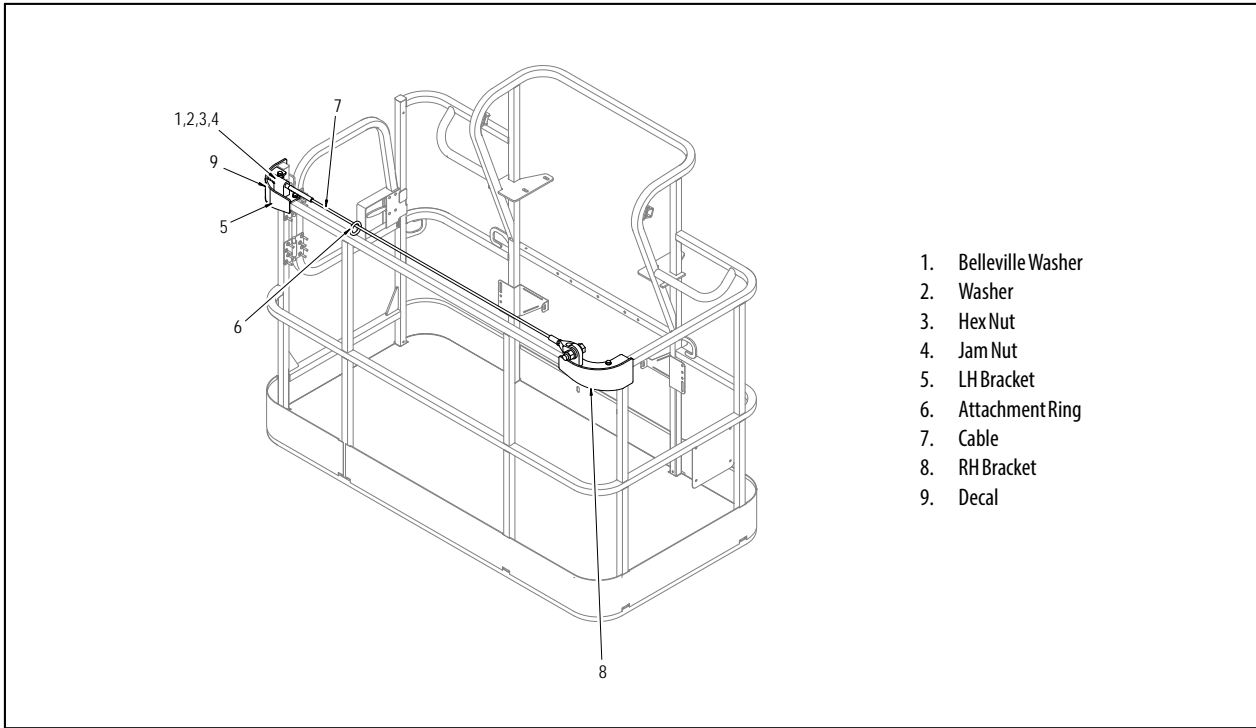
5. Use the two jam nuts to prevent the cable from rotating while the nut is tightened. Tighten the nut until the belleville washers are fully compressed and no gap is pres-

ent at the outside diameter of the washers. Ensure the cable has not rotated during tightening.



6. Tighten the first jam nut against the retaining nut to keep the nut from loosening. Tighten the remaining jam nut against the first jam nut.
7. Torque the nuts and bolts securing the brackets to 15 ft.lbs. (20 Nm).

## SECTION 4 - BOOM & PLATFORM



**Figure 4-17. Bolt On Fall Arrest System**

## SECTION 5. BASIC HYDRAULICS INFORMATION & SCHEMATICS

### 5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

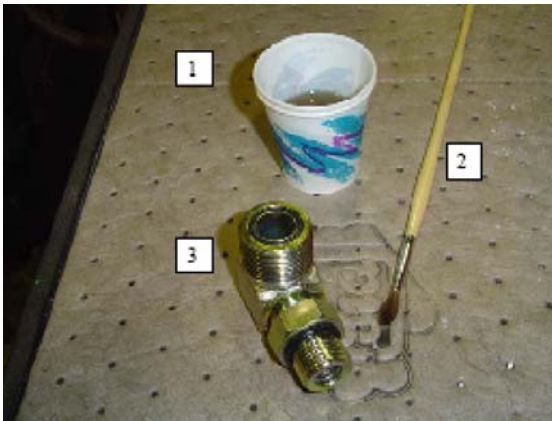
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

**NOTE:** All O-ring fittings must be pre-lubricated with hydraulic oil prior to assembly.

#### Cup and Brush

The following is needed to correctly oil the o-ring in this manner:

- Small container for hydraulic oil
- Small paint brush



1. Hold the fitting in one hand while using the brush with the other hand to dip into the container. Remove excess hydraulic oil from the brush so an even film of oil is applied on the o-ring.



2. Holding the fitting over the hydraulic oil container, brush an even film of oil around the entire o-ring in the fitting, making sure the entire o-ring is completely saturated.



3. Turn the o-ring on the other side of the fitting and repeat the previous step, ensuring the entire o-ring is coated with hydraulic oil.



### Dip Method

**NOTE:** This method works best with Face Seal o-rings, but will work for all o-ring fitting types.

The following is needed to correctly oil the o-ring in this manner:

- A small leak proof container
  - Sponge cut to fit inside container
  - A small amount of hydraulic oil to saturate sponge.
1. Place sponge inside container and add hydraulic oil to the sponge until fully saturated.
  2. Dip the fitting into the sponge using firm pressure. Upon lifting the fitting, a small droplet will form and drip from the bottom of the fitting. This should signify an even coating of oil on the fitting.



3. O-ring Boss type fittings will require more pressure in able to immerse more of the fitting into the saturated sponge. This will also cause more oil to be dispersed from the sponge.



### Spray Method

This method requires a pump or trigger spray bottle.

1. Fill the spray bottle with hydraulic oil.
2. Hold the fitting over suitable catch can.
3. Spray entire o-ring surface with a medium coat of oil.



### Brush-on Method

This method requires a sealed bottle brush.

1. Fill the bottle with hydraulic oil.
2. Using slight pressure to the body of the spray bottle, invert the bottle so the brush end is in the downward position.
3. Brush hydraulic oil on the entire o-ring, applying an even coat of oil.





## 5.2 CYLINDERS - THEORY OF OPERATION

### Systems With Double Acting Cylinders

Systems with double acting cylinders are the Slave Level, Master Level, 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 Lift, Telescope, Lockout, 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 any time 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.

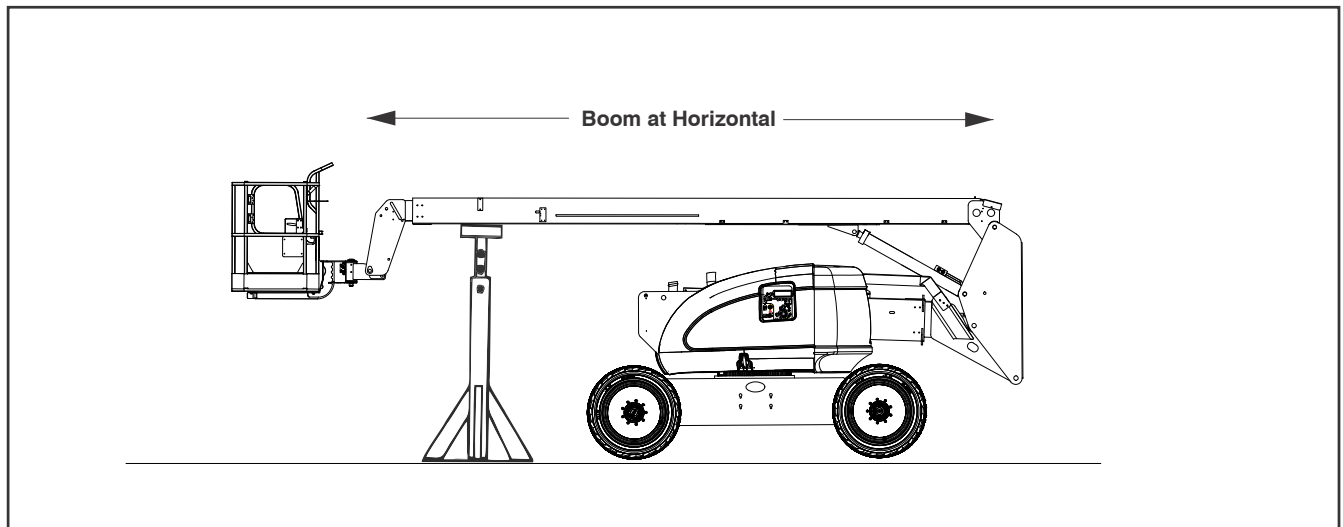


Figure 5-1. Boom Positioning and Support, Cylinder Repair

### 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**

**IMPROPERLY SUPPORTED BOOM CAN FALL AND CAUSE DEATH, SERIOUS INJURY, OR DAMAGE TO PROPERTY AND EQUIPMENT. DO NOT WORK ON CYLINDER WITHOUT A SUITABLE PROP IN PLACE. 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.**

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, and Slave), Slave Level, Lower Lift, Upright level, Main Telescope and Tower Telescope)

#### **⚠ WARNING**

**OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.**

1. Using all applicable safety precautions, activate hydraulic system.

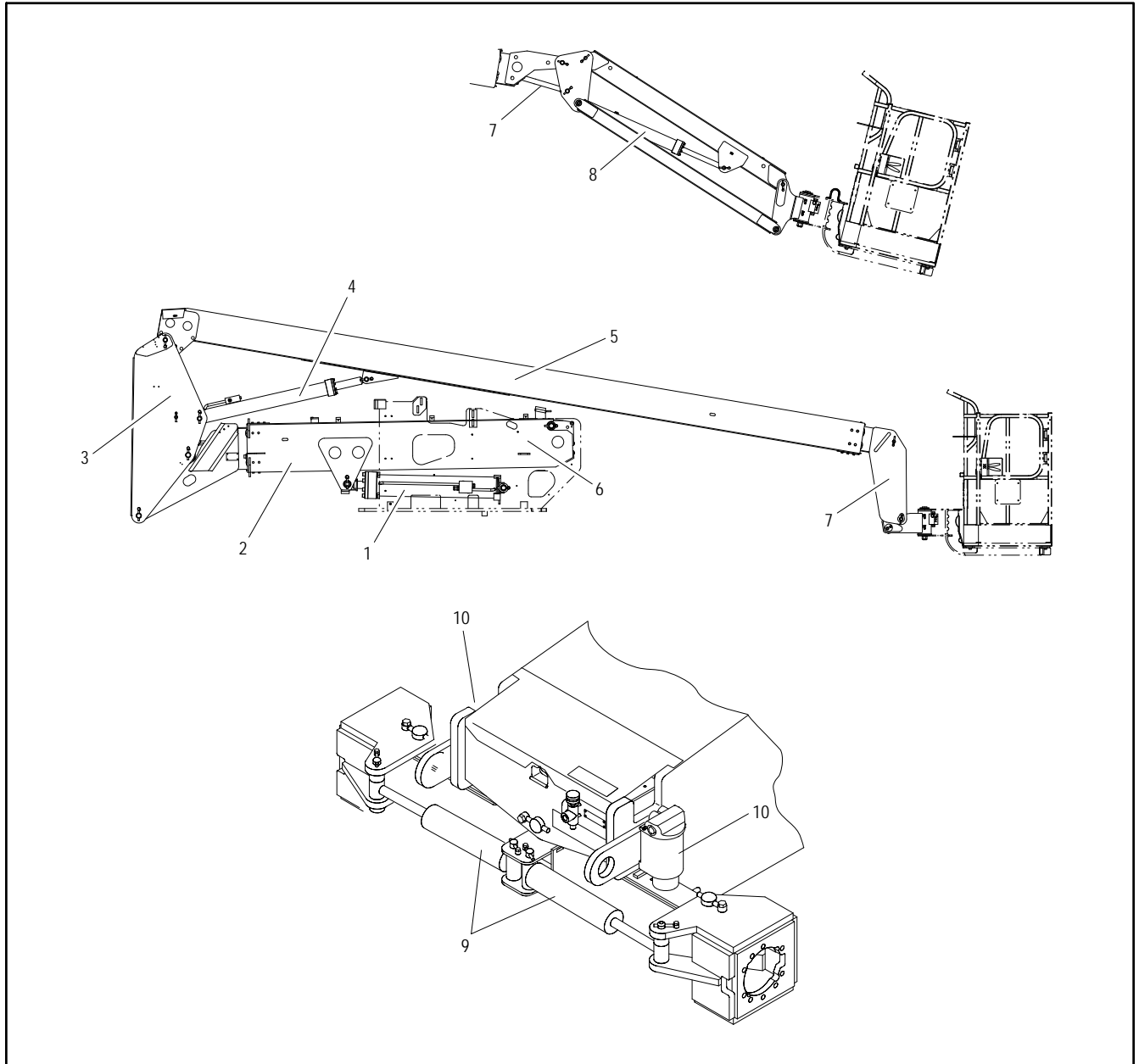
#### **⚠ WARNING**

**IF WORKING ON TOWER BOOM LIFT CYLINDER, RAISE TOWER BOOM HALFWAY, FULLY ELEVATE MAIN BOOM WITH TELESCOPE CYLINDER FULLY RETRACTED. ATTACH AN OVERHEAD CRANE TO THE UPRIGHT FOR SUPPORT, LEAVING APPROXIMATELY 1 INCH (2.54 CM) OF SLACK IN CHAIN OR SLING FOR TEST PURPOSES. IF WORKING ON THE UPRIGHT LEVEL, RAISE TOWER BOOM HALFWAY, THEN RAISE MAIN BOOM TO HORIZONTAL AND POSITION A SUITABLE BOOM PROP APPROXIMATELY 1 INCH (2.54 CM) BELOW MAIN BOOM. IF WORKING ON PLATFORM LEVEL CYLINDER, STROKE PLATFORM LEVEL CYLINDER FORWARD UNTIL PLATFORM SITS AT A 45 DEGREE 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. Catch initial weeping of hydraulic fluid in a suitable container. After initial discharge, there should be no further leakage from 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 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 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 HYDRAULIC CYLINDERS

### Cylinder Locations



Item	Cylinder	Item	Cylinder
1	Tower Boom Lift	6	Tower Boom Telescope
2	Upright Level	7	Platform Level Slave
3	Master	8	Jib Lift
4	Main Boom Lift	9	Steer
5	Main Boom Telescope	10	Axle Lockout

Figure 5-2. Hydraulic Cylinder Locations

## Main Boom Telescope Cylinder Removal

1. Place machine on flat and level surface with main boom horizontal. Extend telescope for access to cylinder rod pin (1).
2. Shut down engine. Support main boom basket end with a prop (2). See Figure 5-1., Boom Positioning and Support, Cylinder Repair.

### NOTICE

**CAP HYDRAULIC LINES AND PORTS IMMEDIATELY AFTER DISCONNECTING LINES TO PREVENT SYSTEM CONTAMINATION.**

3. Tag and disconnect hydraulic lines to telescope cylinder (1). Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
4. Remove bolt and keeper pin from cylinder rod pin (3).
5. Carefully drive telescope cylinder rod pin from fly boom using a suitable brass drift.
6. Remove four bolts (4), two blocks (5), and shims (6) from telescope cylinder barrel end support.
7. Attach a suitable sling to telescope cylinder. Attach suitable lifting device to sling and pull cylinder partially from boom assembly.
8. Secure cylinder with a suitable sling and lifting device at approximate center of gravity.
9. Lift cylinder clear of boom assembly. Lower to ground or suitably supported work area.

## Main Boom Telescope Cylinder Installation

1. Attach hydraulic power supply to telescope cylinder ports. Using suitable supports or lifting devices at each end of cylinder, extend rod so cylinder pin holes are same distance apart as boom pin attach holes.
2. Using suitable lifting equipment, carefully lower cylinder to boom assembly.
3. Install cylinder in boom assembly.
4. Remove lifting devices from telescope cylinder (1).
5. Install telescope cylinder rod pin (3) in fly boom. Install keeper pin and bolt.
6. Install telescope cylinder barrel end support in slots in base boom. Apply JLG Thread Locking Compound P/N 0100011 to bolts (4) and install with shims (6) and blocks (5).
7. Remove hydraulic line and port caps. Correctly route and connect hydraulic lines as tagged to the telescope cylinder.
8. Remove boom prop and overhead crane. Activate hydraulic system.
9. Operate boom functions following all applicable safety precautions. Check for correct operation and hydraulic leaks. Secure as necessary.
11. Check fluid level of hydraulic tank. Adjust as needed.

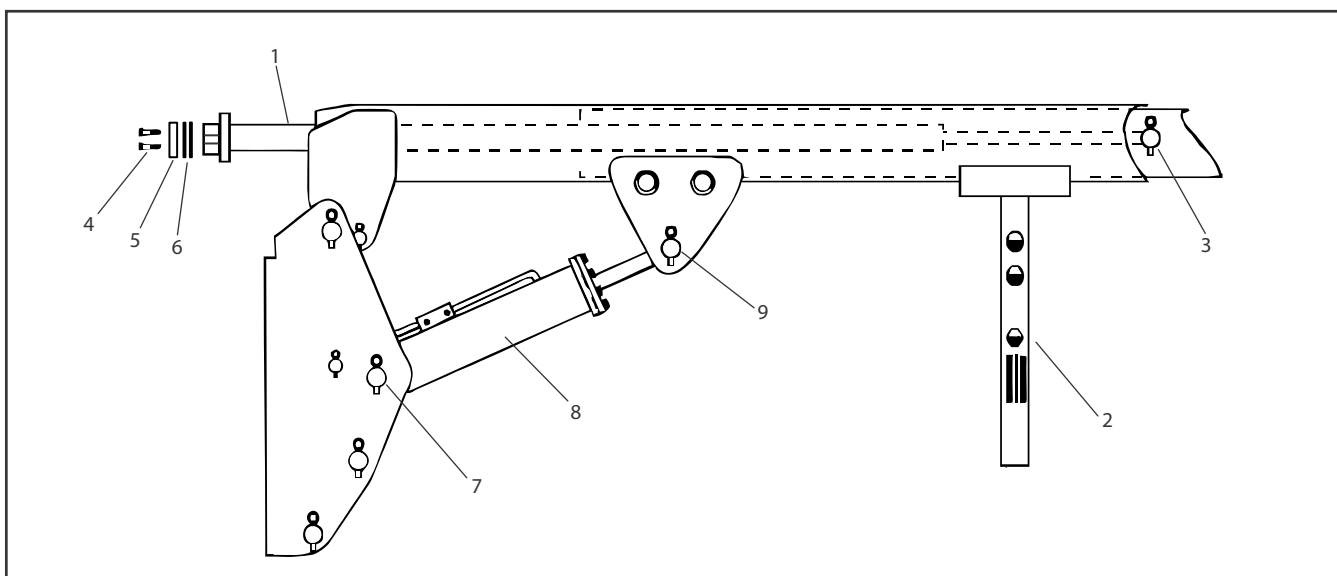


Figure 5-3. Telescope and Lift Cylinder Installation

### Main Boom Lift Cylinder Removal

1. Place machine on flat and level surface. Start engine and place main boom horizontal. Shut down engine and prop boom. (See Figure 5-1., Boom Positioning and Support, Cylinder Repair.
2. Remove bolt and keeper pin from cylinder rod pin (7). Drive out pin using a suitable brass drift.
3. Fully retract lift cylinder rod using auxiliary power,
4. Disconnect, cap, and tag main boom lift cylinder (8) hydraulic lines and ports.
5. Remove barrel end attach pin (9) keeper pin and bolt. Drive out barrel end attach pin from upright using a suitable brass drift.
6. Remove cylinder from boom and place in a suitable work area.

### Main Boom Lift Cylinder Installation

1. Install lift cylinder in place using suitable slings or supports. Align attach pin mounting holes on upright.
2. Using a suitable drift, drive barrel end attach pin (3) through mounting holes in lift cylinder and upright. Install keeper pin and bolt.
3. Remove cylinder port plugs and hydraulic line caps. Connect previously tagged lines to cylinder ports.
4. Using auxiliary power extend cylinder rod until attach pin hole aligns with those in the boom. Using a suitable drift drive cylinder rod attach pin (2) through aligned holes, taking care to align the grooved pin holes. Install keeper pin and bolt.
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 needed.

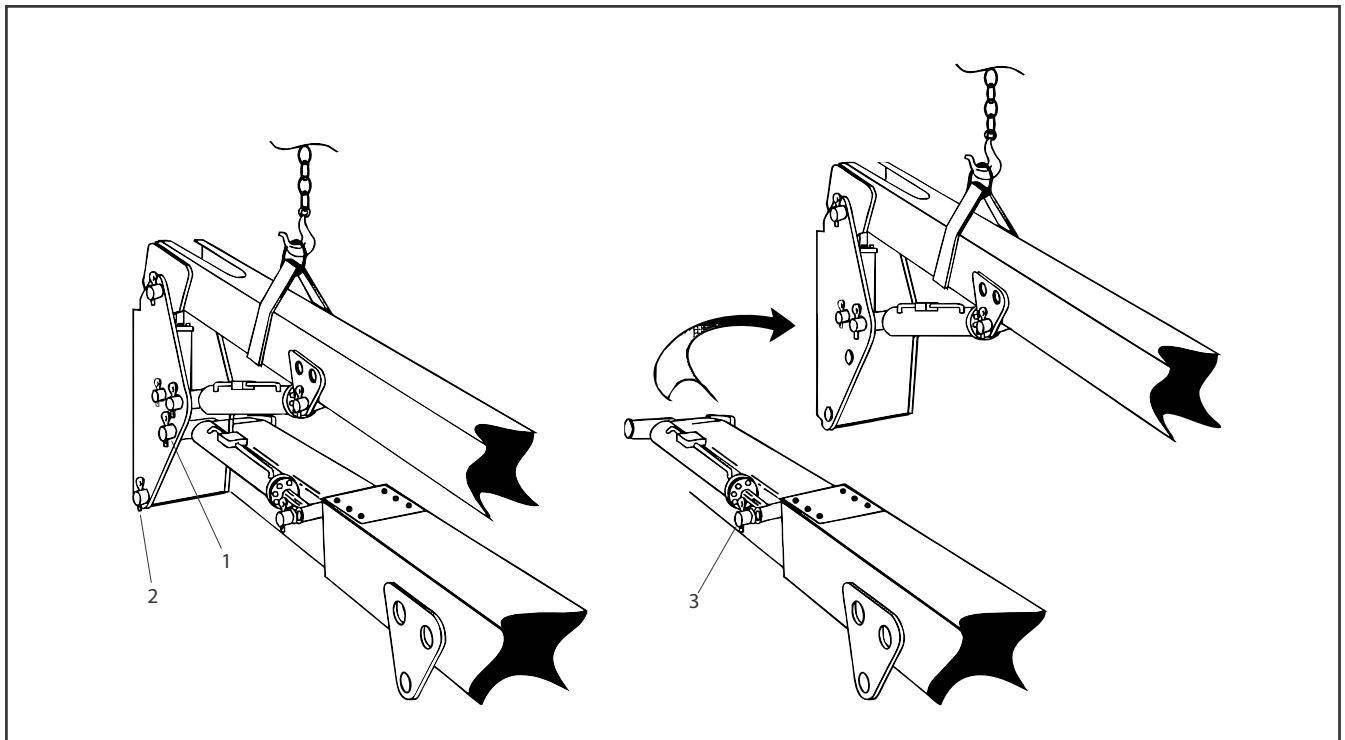
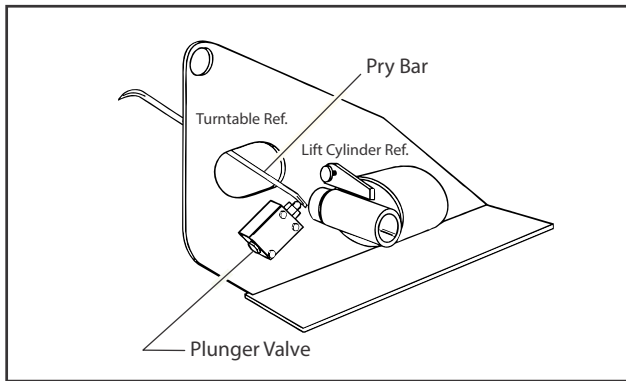


Figure 5-4. Leveling Cylinder Removal

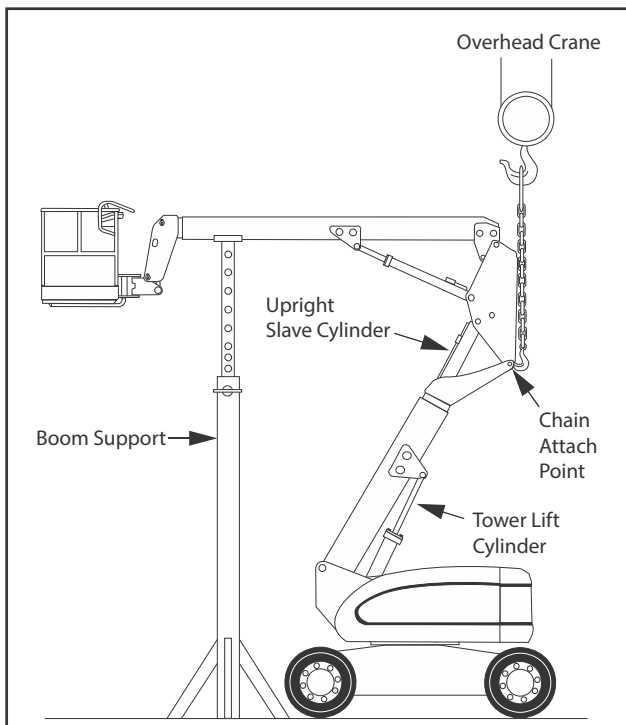
### Upright Level Cylinder Removal

1. With aid of an assistant, manually override Plunger Valve with a pry bar. From Ground Control, use auxiliary power and extend tower telescope to access leveling cylinder rod end pin (3).



**Figure 5-5. Plunger Valve Override**

2. Position and support main boom as shown in Figure 5-6., Boom Positioning and Support, Cylinder Repair.
3. Remove bolt and retaining pin from leveling cylinder to upright pin (1).
4. Support upper boom assembly with overhead crane. Raise boom until tension is released from cylinder pin (1).



**Figure 5-6. Boom Positioning and Support, Cylinder Repair**

5. Drive barrel end attach pin (1) through mounting holes in upright and leveling cylinder using a suitable drift.
6. Remove mounting hardware from upright to tower boom assembly pivot pin (2).
7. Drive pivot pin (2) through mounting holes in upright and tower boom assembly using a suitable drift.
8. Using all applicable safety precautions, operate overhead crane to move upright and upper boom assembly forward to clear tower boom.
9. After moving assemblies forward, operate overhead crane left far enough to remove leveling cylinder.
10. Tag, disconnect, and cap level cylinder hydraulic lines.
11. Remove mounting hardware from leveling cylinder to tower boom fly assembly rod end pin (3).
12. Drive leveling cylinder pin (3) through mounting holes in tower boom fly and leveling cylinder using a suitable drift. Remove leveling cylinder.

### Upright Level Cylinder Installation

1. Place leveling cylinder in position in tower boom. Align holes in tower boom and leveling cylinder. Install leveling cylinder attach pin (3) using a suitable rubber mallet.
2. Secure pin to tower boom with mounting hardware.
3. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.
4. Using all applicable safety precautions, operate the overhead crane to move upright and upper boom assembly in proper position with tower boom.
5. Align holes in upright and tower boom assembly and install upright pivot pin (2) using a suitable rubber mallet. Secure pin with mounting hardware.
6. Align holes in upright and leveling cylinder barrel end. Install leveling cylinder pin (1) using a suitable rubber mallet. Install keeper pin and bolt.
7. Remove overhead crane from upper boom. Activate hydraulic system.
8. Using all applicable safety precautions, operate the boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
9. Check fluid level of hydraulic tank Adjust as needed.

## Tower Boom Lift Cylinder Removal

Refer to Figure 5-6., *Boom Positioning and Support, Cylinder Repair*.

1. Place machine on a flat and level surface. Place main boom in a horizontal position with telescope cylinder fully retracted. Place tower boom in a fully elevated and fully retracted position.
2. Support main boom with a prop. Support upright with an overhead crane.
3. Using slings restrain tower lift cylinder.
4. Remove mounting hardware securing cylinder rod pin to tower boom. Drive out cylinder rod attach pin using a suitable brass drift.
5. Tag, disconnect, and cap tower lift cylinder hydraulic lines and ports.
6. Remove mounting hardware securing cylinder barrel pin to turntable. Drive out cylinder barrel pin using a suitable brass drift.
7. Carefully remove restraining slings. Remove tower lift cylinder from turntable and place in a suitable work area.
8. Fully retract lift cylinder. Use auxiliary power source if necessary.

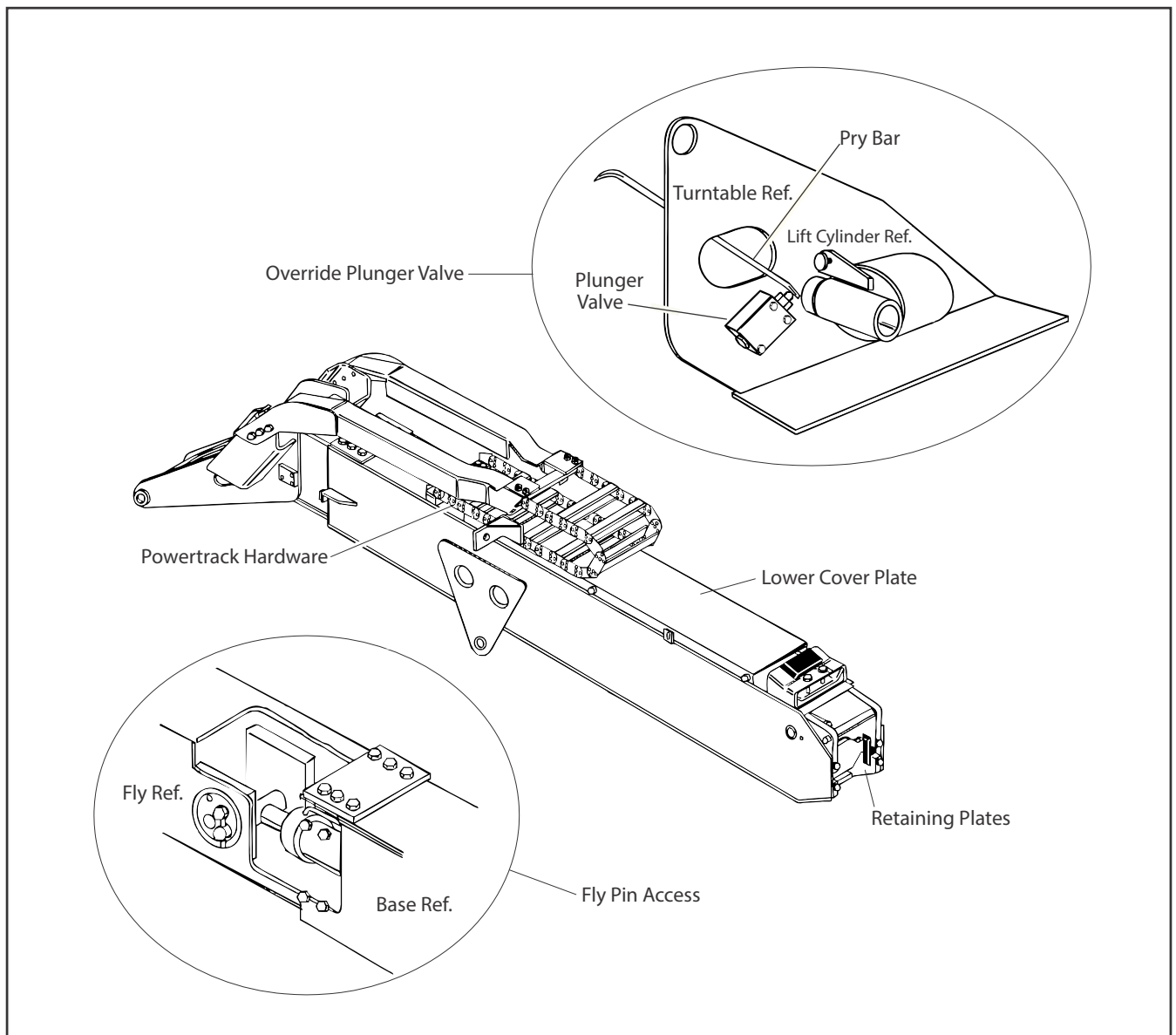


Figure 5-7. Tower Telescope Cylinder Removal

### Tower Lift Cylinder Installation

1. With main boom and tower boom positioned and supported as in Figure 5-1., Boom Positioning and Support, Cylinder Repair, place tower lift cylinder in position on turntable. Secure in place using slings.
2. Align holes in turntable and lift cylinder. Install cylinder barrel pin using a suitable rubber mallet. Install keeper pin and bolt.
3. Connect auxiliary power source to cylinder. Extend cylinder rod until cylinder rod bushing aligns with bushings on boom.
4. Drive rod attach pin through aligned bushings using an appropriate brass drift. Secure pin with attaching hardware.
5. Remove caps from cylinder hydraulic lines. Install lines to cylinder as previously tagged.
6. Remove boom prop and overhead crane. Activate hydraulic system.
7. Operate boom functions following all applicable safety precautions. Check for correct operation and hydraulic leaks. Secure as necessary.
8. Check fluid level of hydraulic tank. Adjust as needed.

### Tower Telescope Cylinder Removal

1. Place machine on a flat and level surface, with main boom horizontal. Shut down engine and prop boom See Figure 5-3., Telescope and Lift Cylinder Installation.
2. With aid of an assistant, manually override Plunger Valve with a pry bar. From Ground Control, using auxiliary power, extend tower telescope to access fly attach pin.
3. Remove lower cover plate.
4. Remove mounting hardware securing powertrack to tower boom assembly. Slide powertrack back to move holes and wiring harness for access to telescope cylinder.
5. Tag, disconnect, and cap hydraulic hoses to Tower Telescope Cylinder. Plug cylinder ports.
6. Remove mounting hardware securing upper cylinder pin to fly boom. Drive out cylinder rod pin using a suitable brass drift.
7. Remove mounting hardware attaching retaining plates to base boom. Remove plate.
8. Carefully slide telescope cylinder from boom. Place cylinder on a suitable work area.

### Tower Telescope Cylinder Installation

1. With boom positioned as in Figure 5-3., Telescope and Lift Cylinder Installation, slide telescope cylinder into boom, aligning cylinder port block end with slotted holes in Base Boom. Secure telescope cylinder with mounting hardware.
2. Remove caps and plugs from hydraulic lines and ports. Connect hydraulic lines to cylinder as tagged during Removal. Reinstall cover plate.
3. Start engine. With aid of an assistant, manually override the plunger valve. Activate Tower telescope out to align attaching pin holes in Fly Boom. Shut down engine.
4. Using a brass drift, drive in attach pin. Secure with mounting hardware.
5. Align holes in base boom and powertrack. Secure powertrack with mounting hardware.
6. Remove boom prop and overhead crane. Activate hydraulic system.
7. Using all applicable safety precautions, operate boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
8. Check hydraulic tank fluid level. Adjust as needed.



## 5.5 HYDRAULIC CYLINDER REPAIR

### Tower Boom Lift Cylinder

#### DISASSEMBLY

Refer to Figure 5-11., Tower Boom Lift 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.

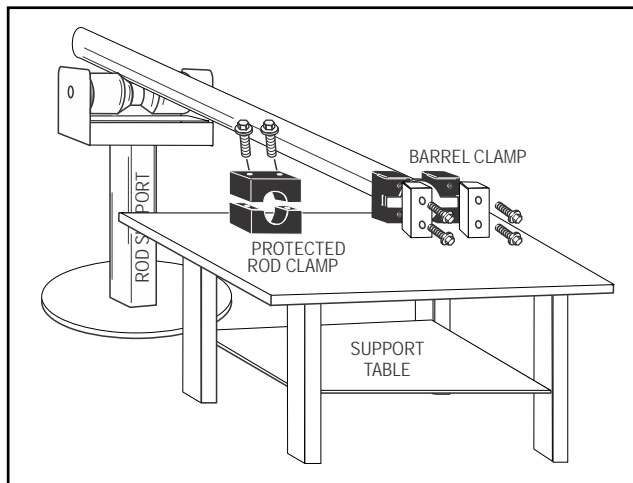


Figure 5-8. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

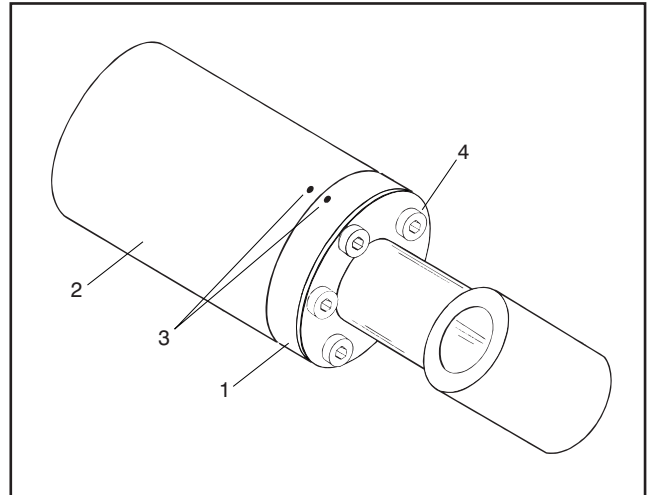


Figure 5-9. Marking Cylinder for Alignment

#### 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.

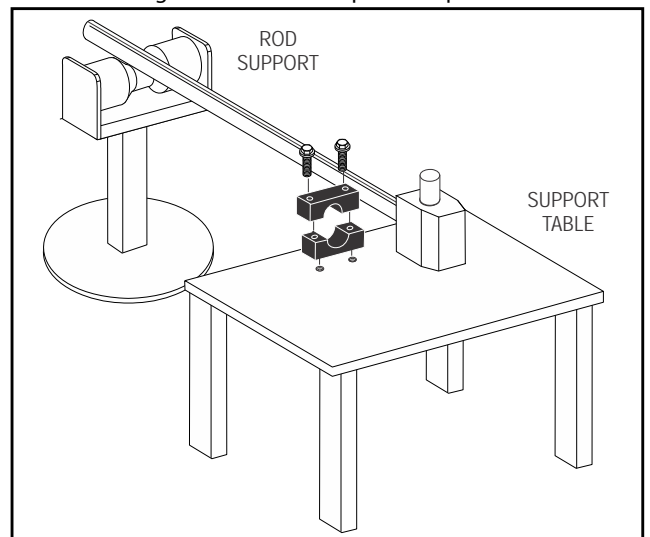
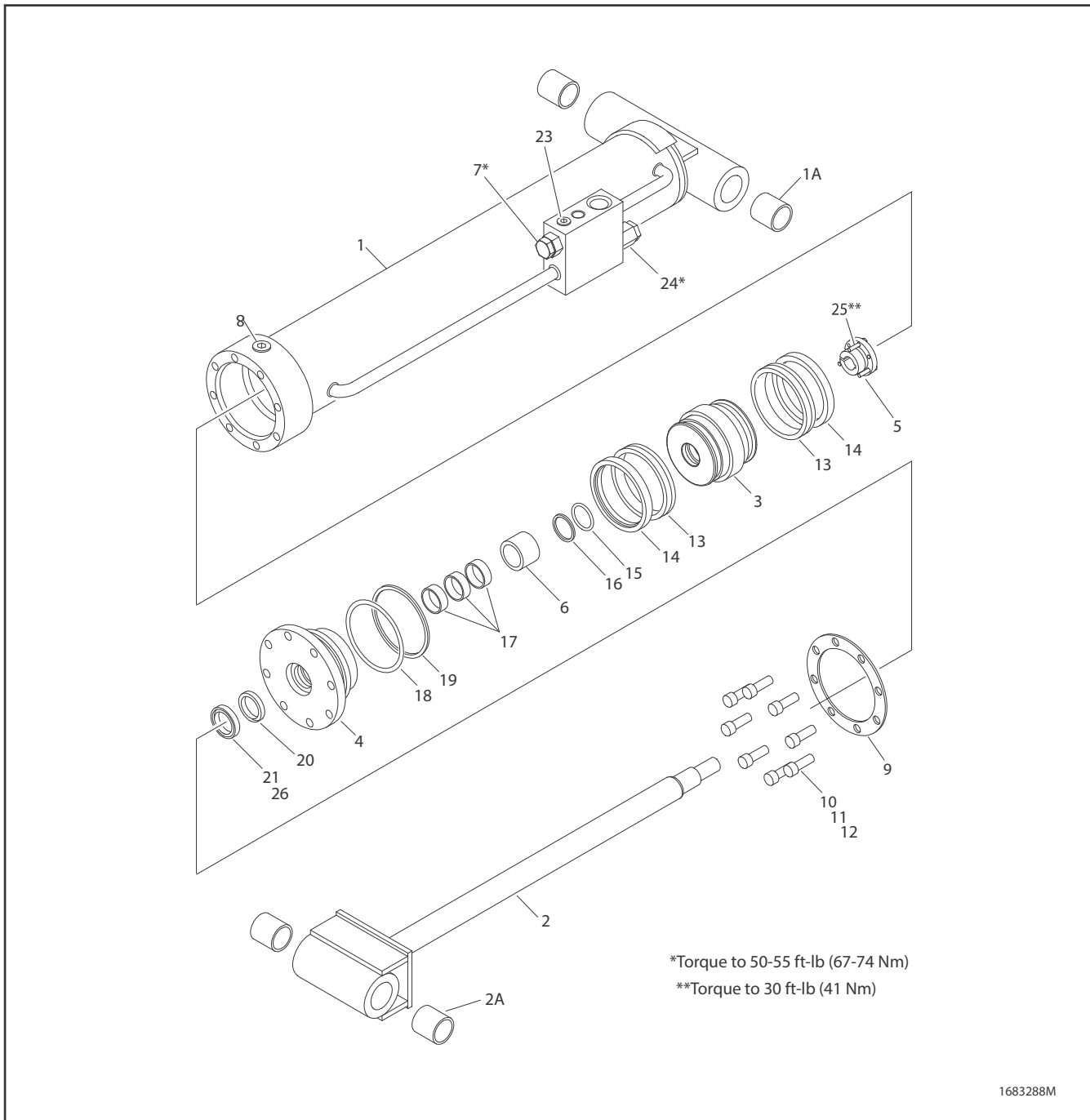


Figure 5-10. Cylinder Rod Support



- |                       |                    |                      |                  |                          |
|-----------------------|--------------------|----------------------|------------------|--------------------------|
| 1. Barrel             | 5. Tapered Bushing | 11. Locking Compound | 17. Wear Ring    | 23. O-Ring Plug          |
| 1a. Composite Bushing | 6. Spacer          | 12. Locking Primer   | 18. O-Ring       | 24. Counterbalance Valve |
| 2. Rod                | 7. Cartridge Valve | 13. Seal             | 19. Back-Up Ring | 25. Bolt                 |
| 2a. Composite Bushing | 8. O-Ring Plug     | 14. Lock Ring        | 20. Rod Seal     |                          |
| 3. Piston             | 9. Ring Washer     | 15. O-Ring           | 21. Wiper        |                          |
| 4. Head               | 10. Capscrew       | 16. Back-Up Ring     | 22. Not Used     |                          |

Figure 5-11. Tower Boom Lift Cylinder

8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Remove cap screws attaching tapered bushing to piston.
10. Insert cap screws in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
11. Remove tapered bushing from piston. Discard cap screws.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

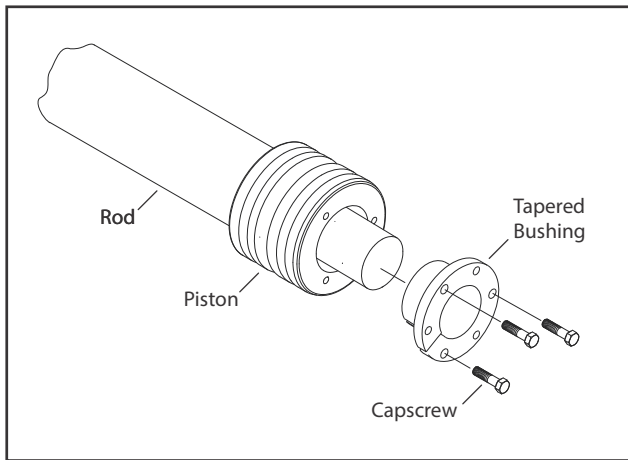


Figure 5-12. Tapered Bushing Removal

**NOTICE**

REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.

13. Remove and discard backup ring (16) and O-ring (15) from inside grooves of piston (3).

14. Remove and discard two lock rings (14) and seals (13) from outside grooves of piston.

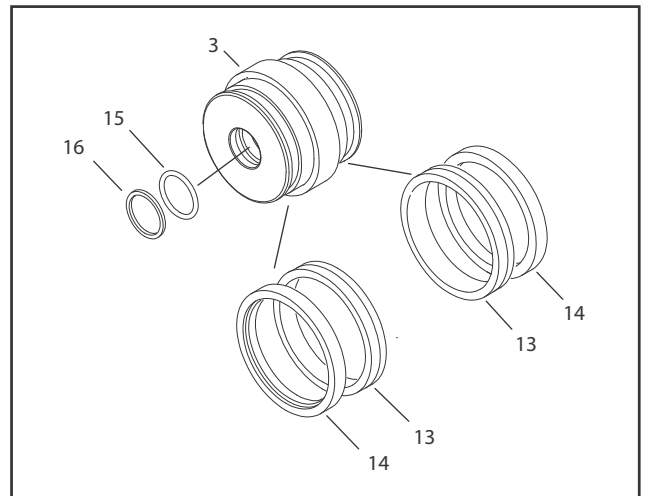


Figure 5-13. Piston Disassembly

15. Remove piston spacer (6) from rod (2).
16. Remove rod from holding fixture. Remove cylinder head (4) and washer ring (9).
17. Remove and discard three wear rings (17), wiper seal (21), and rod seal (20) from inside of cylinder head (4). Remove and discard backup ring (19) and O-ring (18) from outer grooves of cylinder head.

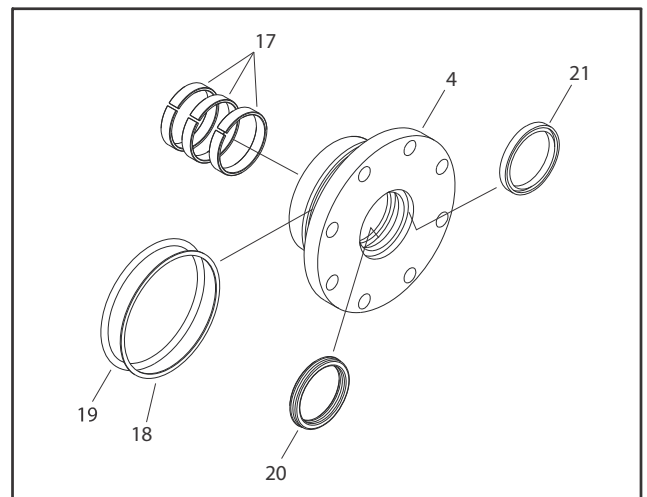


Figure 5-14. Cylinder Head Disassembly

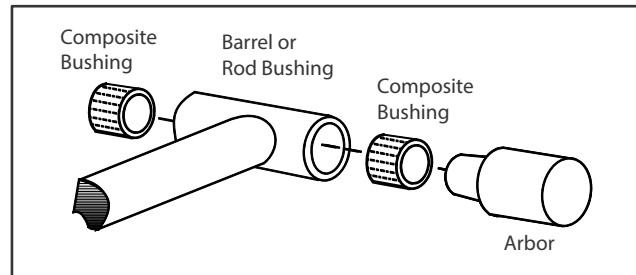
## Cleaning and Inspection

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. Inspect rod and barrel bearings for signs of 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 steel bushing with WD40 before 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 5-15. Composite Bushing Installation**

14. Inspect travel limiting collar or spacer for burrs and sharp edges. Dress inside diameter surface with Scotch Brite or equivalent.
15. Inspect port block fittings and cartridge valves. Replace as necessary.
16. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

**Assembly**

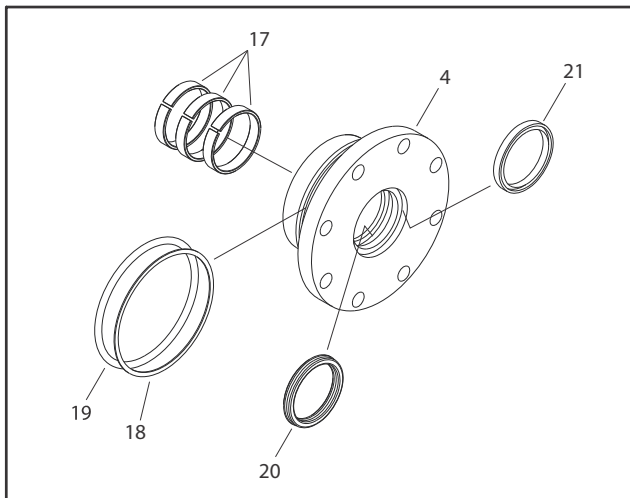
**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

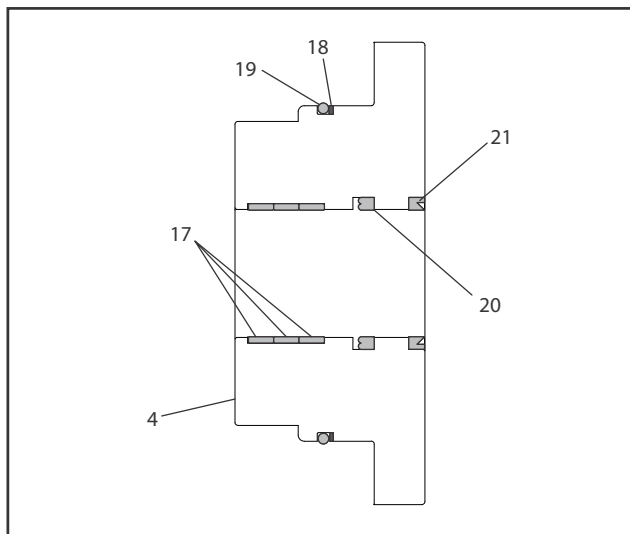
**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Install three wear rings (17), rod seal (20), and wiper (21) in cylinder head (4).
2. Install new backup ring (18) and O-ring (19) in outside diameter groove of cylinder head (3).

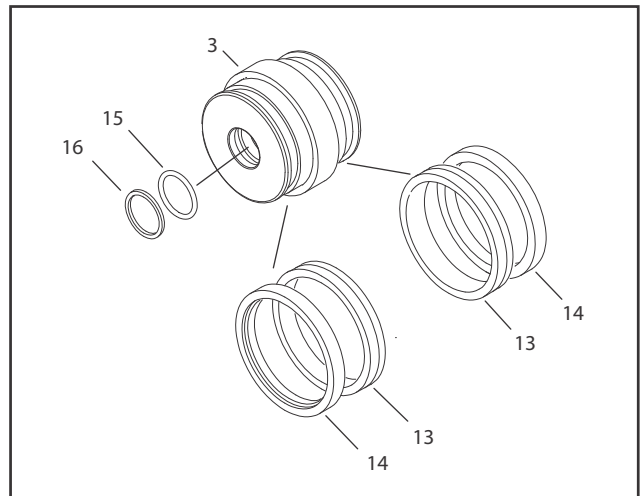


**Figure 5-16. Head Seal Kit Installation**

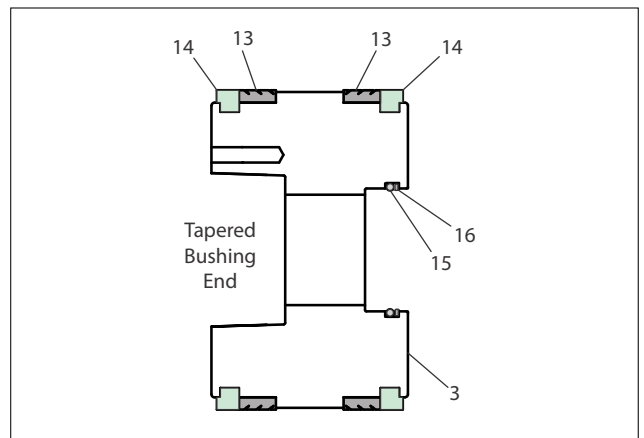


**Figure 5-17. Cylinder Head Seals**

3. Install washer ring (9) on rod (2). Carefully install cylinder head assembly on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Carefully slide piston spacer (6) on rod.
5. Install new O-ring (15) and back-up ring (16) in piston (3).
6. Install two seals (13) and lock rings (14) in outside diameter piston grooves.



**Figure 5-18. Piston Seal Kit Installation**



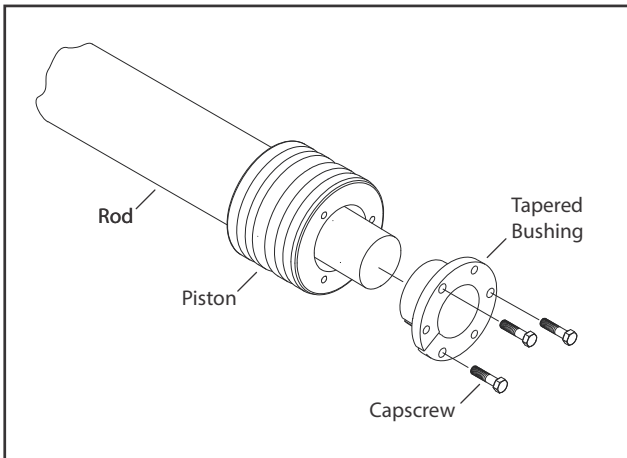
**Figure 5-19. Piston Seals**

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. Do not damaged or dislodge O-ring and back-up rings.

## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

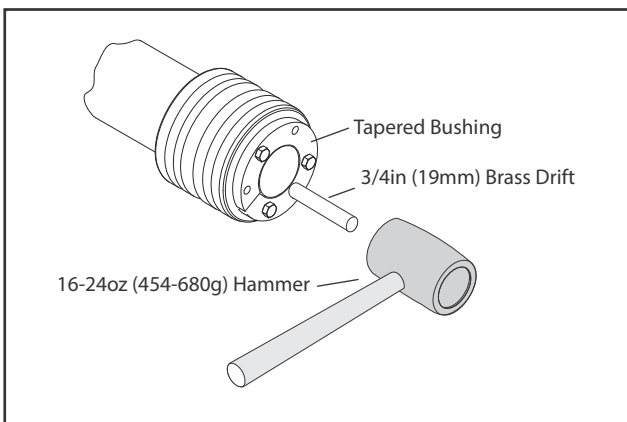
**NOTE:** Piston and mating end of rod must be free of oil when installing tapered bushing.

9. Thread piston on rod until it aligns with spacer end.
10. Apply JLG Medium-Strength (Blue) Thread Locking Compound P/N 010011 or equivalent to new JLG furnished tapered bushing capscrews when rebuilding master, slave, lift, and telescope cylinders.
11. Insert tapered bushing loosely in the piston. Install JLG capscrews (not vendor capscrews) through drilled holes in the bushing and tapped holes in piston.



**Figure 5-20. Tapered Bushing Installation**

12. Tighten capscrews evenly and progressively in rotation to 30 ft-lb (40.6 Nm).
13. Set tapered bushing with a 16-24 oz (454-680g) hammer and 3/4 in (19mm) brass drift. Place drift against bushing between capscrews and tap once. Repeat for remaining two spaces between capscrews.



**Figure 5-21. Seating Tapered Bushing**

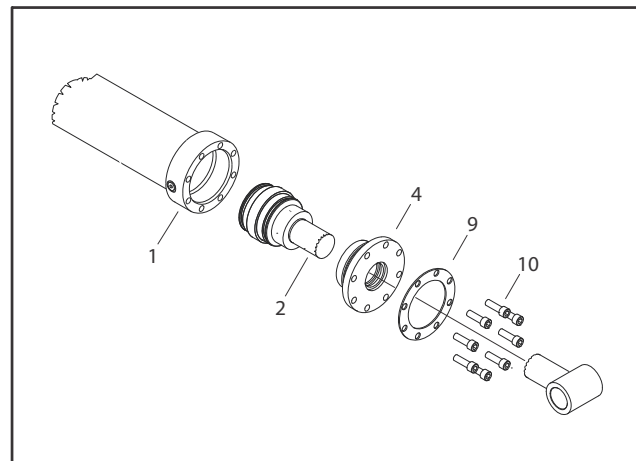
14. Re-torque capscrews evenly and progressively in rotation to 30 ft-lb (40.6 Nm).

15. Remove cylinder rod from holding fixture.
16. 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.**

17. Clamp barrel (1) securely and support rod (2). Insert piston in cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
18. Continue pushing rod into cylinder until cylinder head assembly (4) can be inserted into cylinder.
19. Align marks made during disassembly.
20. Apply locking primer (JLG P/N 0100038) and locking compound (JLG P/N 0100011) to eight socket head bolts (10).
21. Secure cylinder head and washer ring (9) with eight socket head bolts (10).



**Figure 5-22. Rod Assembly Installation**

## Upright Level Cylinder

### DISASSEMBLY

Refer to Figure 5-26., Upright Level 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.

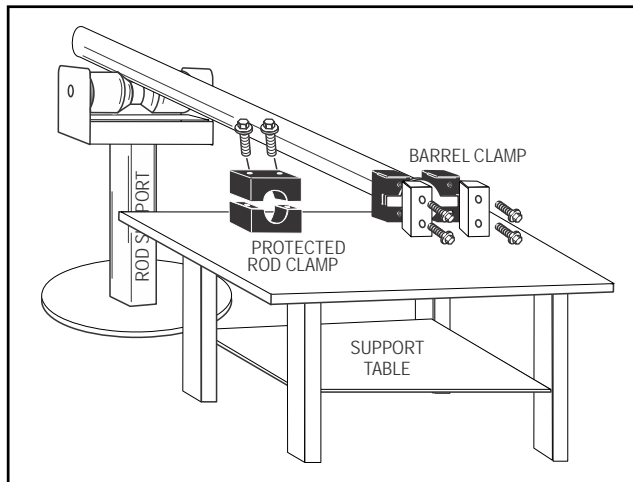


Figure 5-23. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

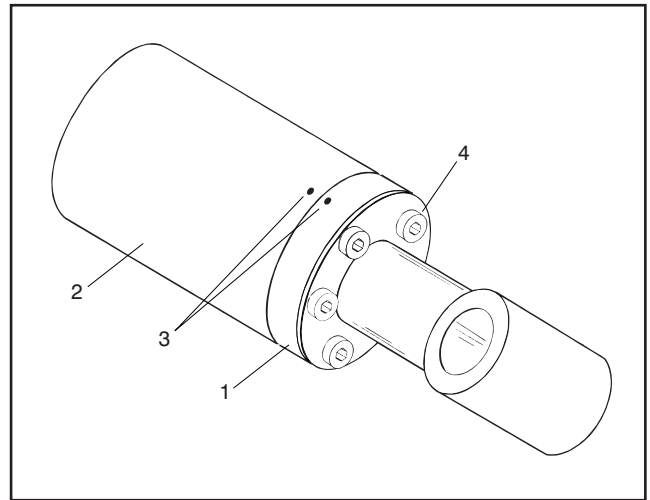


Figure 5-24. Marking Cylinder for Alignment

#### 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.

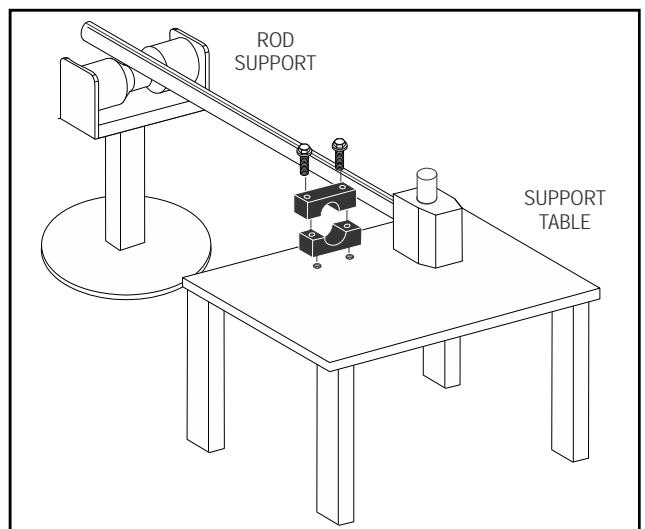
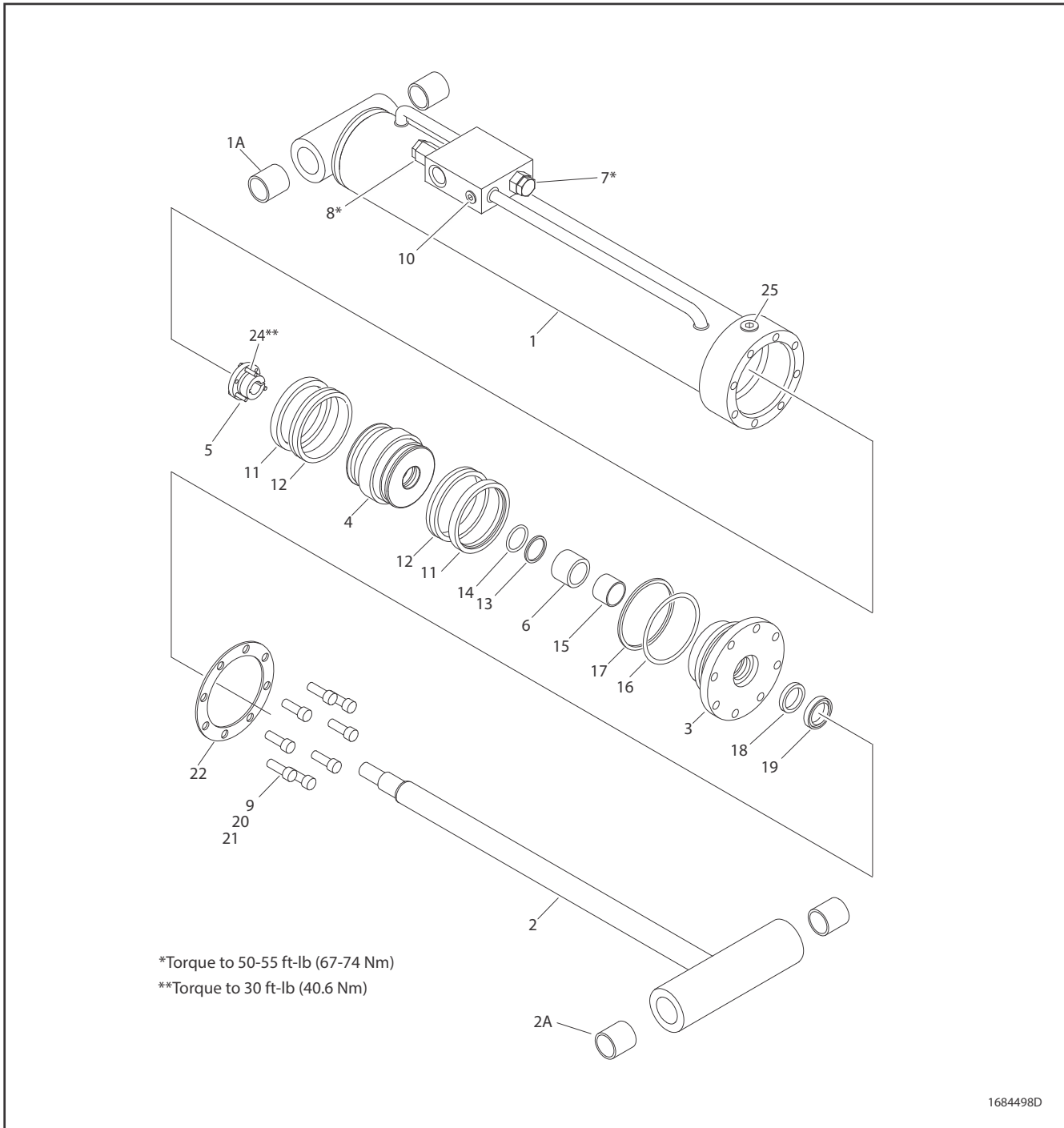


Figure 5-25. Cylinder Rod Support



- |                       |                     |                    |                      |                 |
|-----------------------|---------------------|--------------------|----------------------|-----------------|
| 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. Bolt        |
| 2. Rod                | 7. Cartridge Valve  | 13. O-Ring         | 19. Wiper            | 25. O-Ring Plug |
| 2a. Composite Bushing | 8. Cartridge Valve  | 14. Back-Up Ring   | 20. Locking Compound |                 |
| 3. Head               | 9. Socket Head Bolt | 15. Wear Ring      | 21. Locking Primer   |                 |
| 4. Piston             | 10. O-Ring Plug     | 16. O-Ring         | 22. Ring Washer      |                 |

Figure 5-26. Upright Level Cylinder



8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Remove cap screws attaching tapered bushing to piston.
10. Insert cap screws in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
11. Remove tapered bushing from piston. Discard cap screws.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

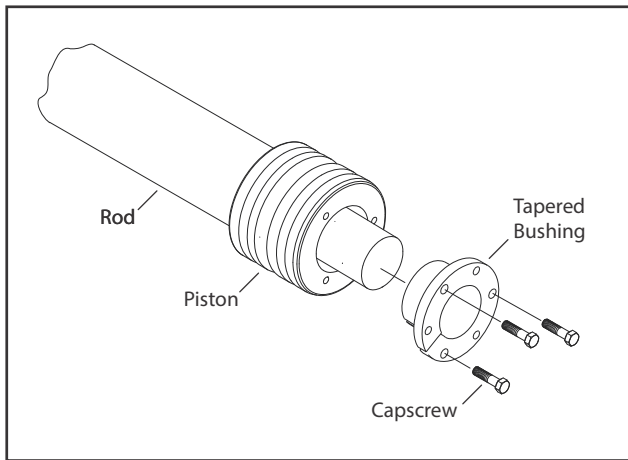


Figure 5-27. Tapered Bushing Removal

**NOTICE**

REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.

13. Remove and discard backup ring (13) and O-ring (14) from inside grooves of piston (4).

14. Remove and discard two lock rings (11) and seals (12) from outside grooves of piston.

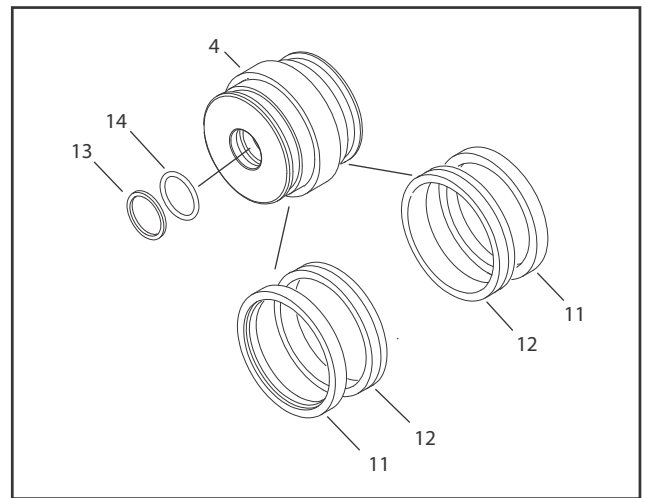


Figure 5-28. Piston Disassembly

15. Remove spacer (6) from rod (2).
16. Remove rod from holding fixture. Remove cylinder head (3) and washer ring (22).
17. Remove and discard wear ring (15), wiper seal (19), and rod seal (18) from inside of cylinder head (3). Remove and discard O-ring (17) and backup ring (16) from outer grooves of cylinder head.

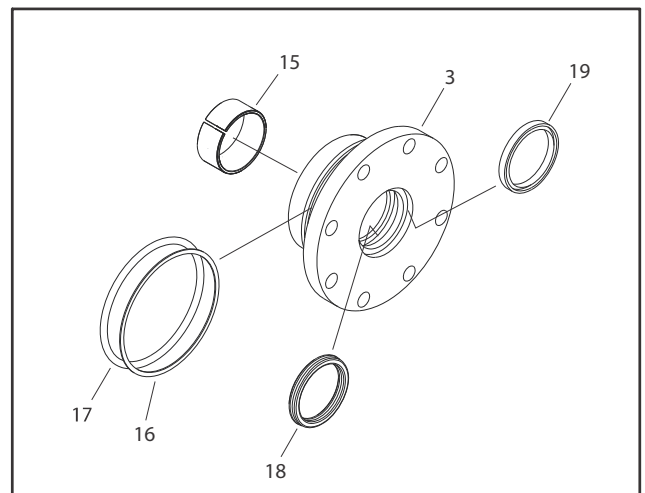


Figure 5-29. Cylinder Head Disassembly

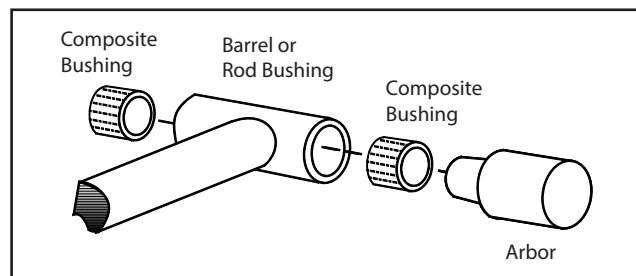
**Cleaning and Inspection**

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. Inspect rod and barrel bearings for signs of 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 steel bushing with WD40 before bearing installation.

**NOTE:** *Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.*

14. Press composite bushing into barrel or rod bushing with correct size arbor.



**Figure 5-30. Composite Bushing Installation**

15. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
16. Inspect port block fittings and cartridge valves. Replace as necessary.
17. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

**Assembly**

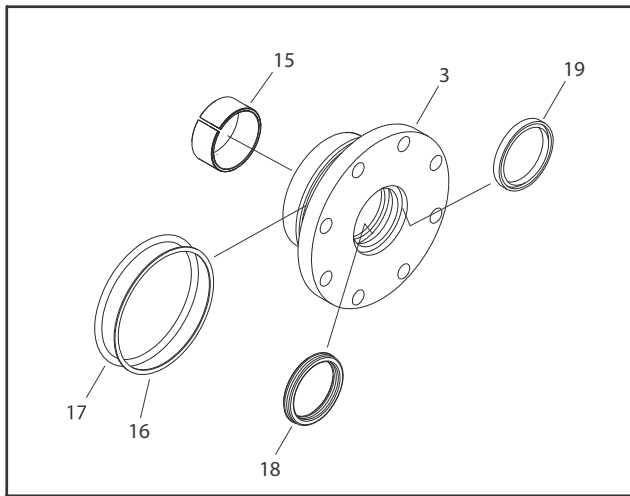
**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

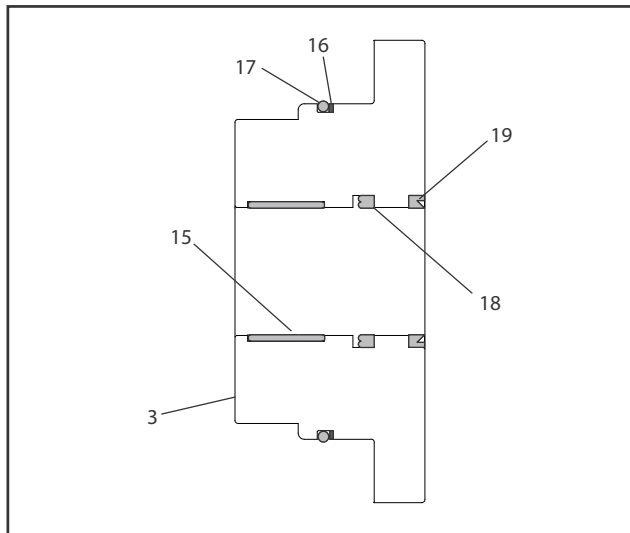
**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Install wear ring (15), rod seal (18), and wiper (19) in cylinder head (3).
2. Install new backup ring (16) and O-ring (17) in outside diameter groove of cylinder head (3).

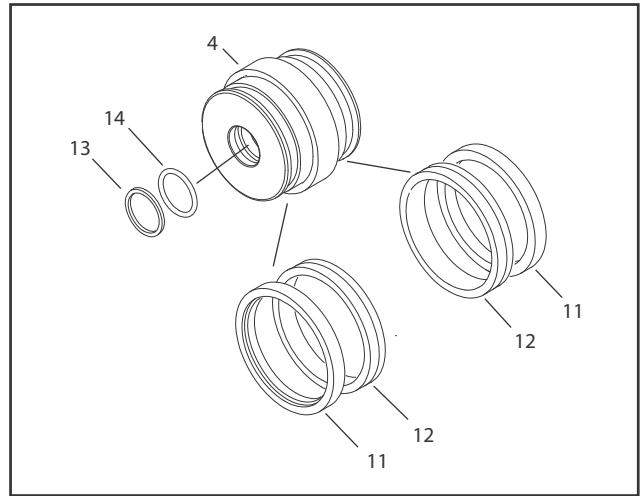


**Figure 5-31. Head Seal Kit Installation**

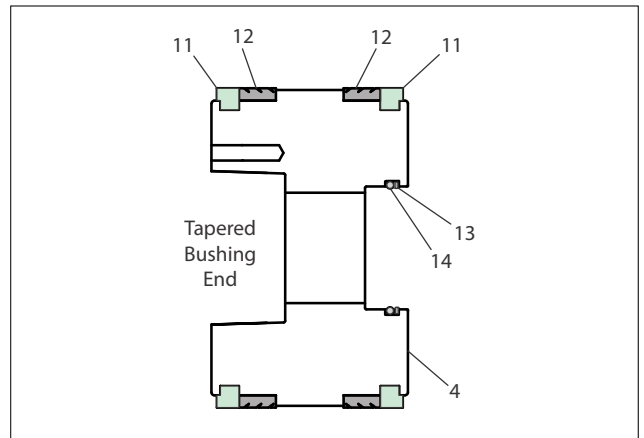


**Figure 5-32. Cylinder Head Seals**

3. Install washer ring (22) on rod (2). Carefully install cylinder head assembly on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Carefully slide spacer (6) on rod.
5. Install O-ring (14) and back-up ring (13) in piston (4).
6. Install two seals (12) and lock rings (11) in outside diameter piston grooves.



**Figure 5-33. Piston Seal Kit Installation**



**Figure 5-34. Piston Seals**

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. Do not damaged or dislodge O-ring and back-up rings.

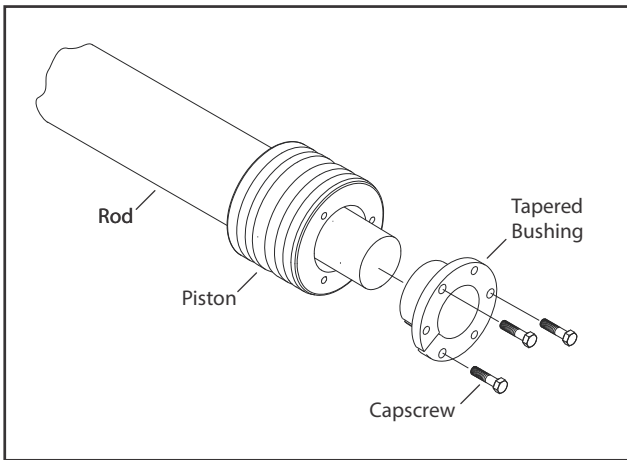
## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Piston and mating end of rod must be free of oil when installing tapered bushing.

9. Thread piston on rod until it aligns with spacer.

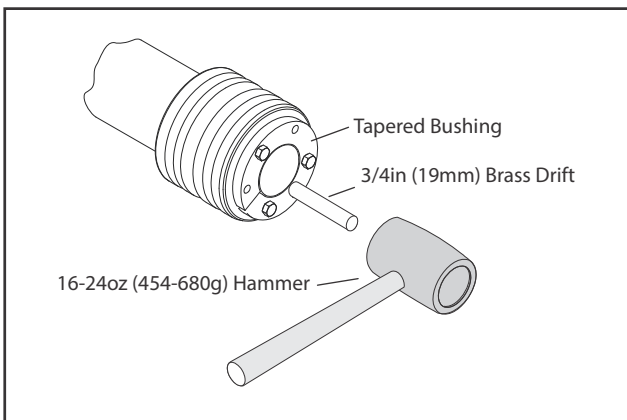
**NOTE:** Apply JLG Medium-Strength (Blue) Thread Locking Compound P/N 010011 or equivalent to new JLG furnished tapered bushing capscrews when rebuilding master, slave, lift, and telescope cylinders.

10. Insert tapered bushing loosely in the piston. Install JLG capscrews (not vendor capscrews) through drilled holes in the bushing and tapped holes in piston.



**Figure 5-35. Tapered Bushing Installation**

11. Tighten capscrews evenly and progressively in rotation to 30 ft-lb (40.6 Nm).
12. Set tapered bushing with a 16-24 oz (454-680g) hammer and 3/4 in (19mm) brass drift. Place drift against bushing between capscrews and tap once. Repeat for remaining two spaces between capscrews.



**Figure 5-36. Seating Tapered Bushing**

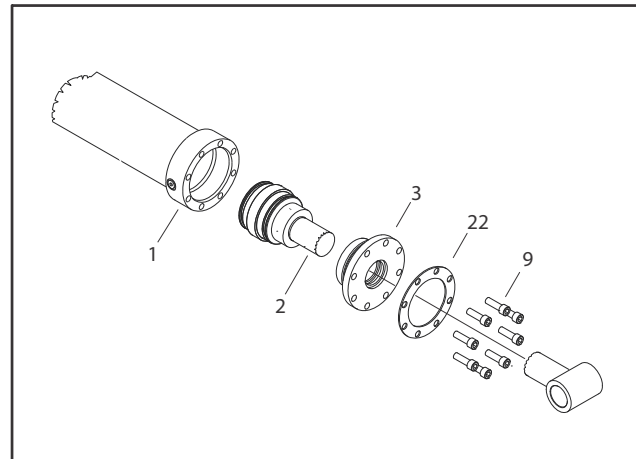
13. Re-torque capscrews evenly and progressively in rotation to 30 ft-lb (40.6 Nm).

14. Remove cylinder rod from holding fixture.
15. 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.**

16. Clamp barrel (1) securely and support rod (2). Insert piston in cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
17. Continue pushing rod into cylinder until cylinder head assembly (3) can be inserted into cylinder.
18. Align marks made during disassembly.
19. Apply locking primer (JLG P/N 0100038) and locking compound (JLG P/N 0100011) to eight socket head bolts (9).
20. Secure cylinder head and washer ring (22) with eight socket head bolts (9).



**Figure 5-37. Rod Assembly Installation**

## Master Cylinder

### DISASSEMBLY

Refer to Figure 5-41. 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.

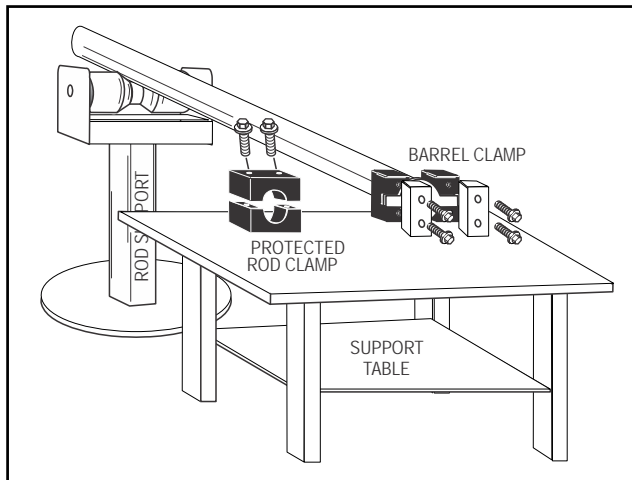


Figure 5-38. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

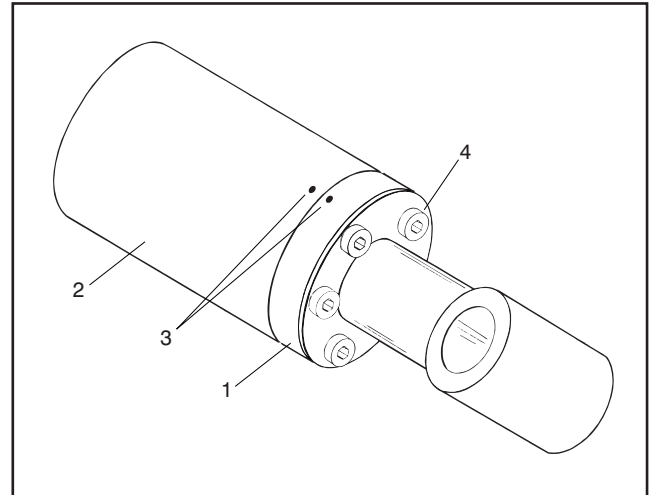


Figure 5-39. Marking Cylinder for Alignment

#### 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.

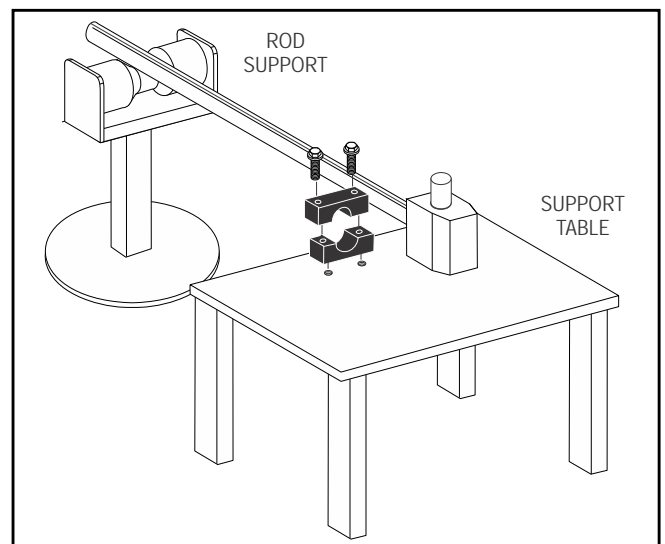
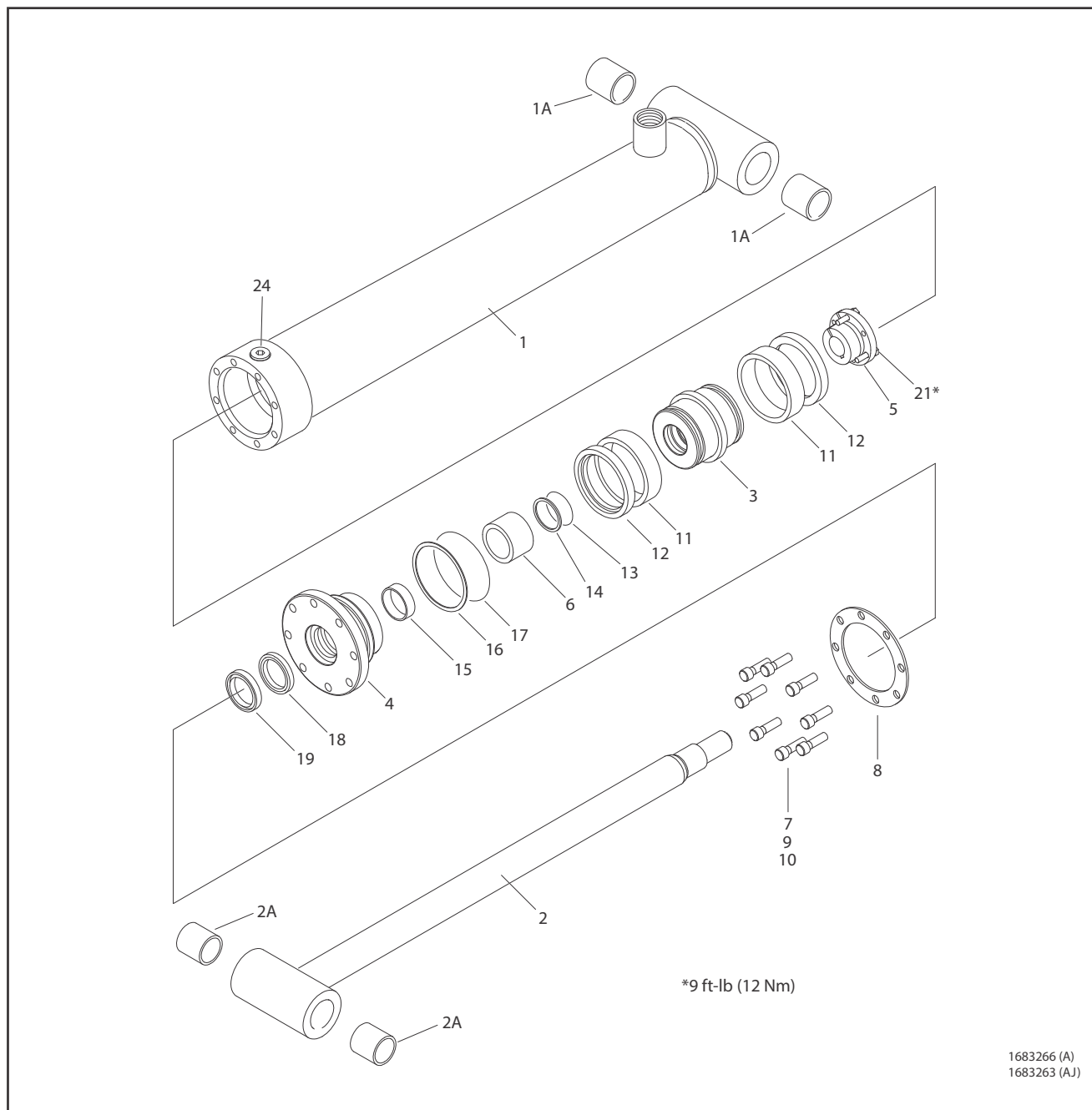


Figure 5-40. Cylinder Rod Support



- |                       |                    |                     |                  |              |
|-----------------------|--------------------|---------------------|------------------|--------------|
| 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 5-41. 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 cap screws attaching tapered bushing to piston.
10. Insert cap screws in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
11. Remove tapered bushing from piston. Discard cap screws.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

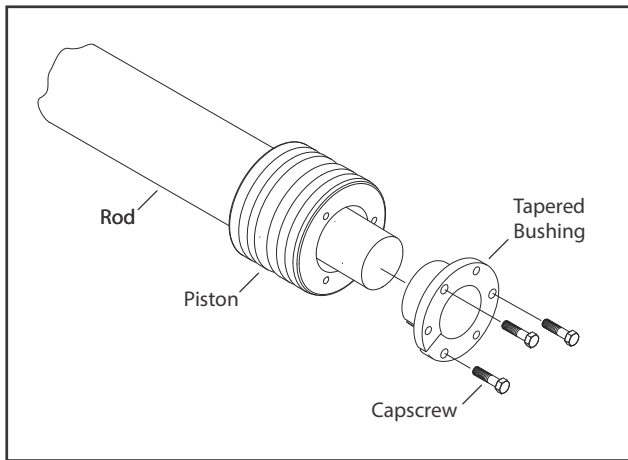


Figure 5-42. Tapered Bushing Removal

**NOTICE**

REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.

13. Remove and discard backup ring (14) and O-ring (13) from inside grooves of piston (3).

14. Remove and discard two lock rings (12) and seals (11) from outside grooves of piston.

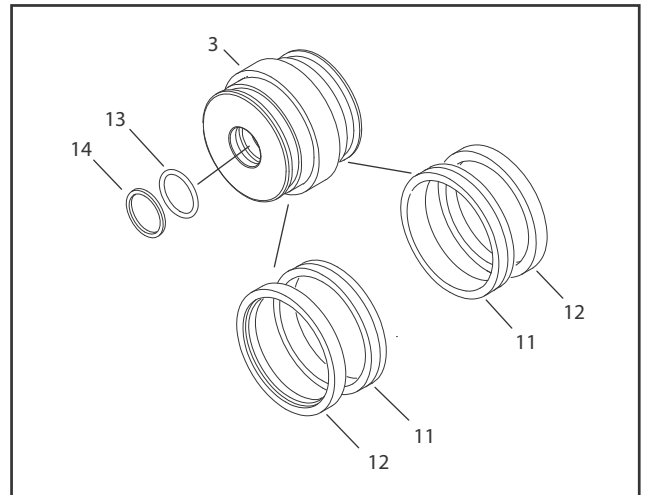


Figure 5-43. Piston Disassembly

15. Remove spacer (6) from rod (2).
16. Remove rod from holding fixture. Remove cylinder head (4) and washer ring (8).
17. Remove and discard wear ring (15), wiper seal (19), and rod seal (18) from inside of cylinder head (4). Remove and discard O-ring (17) and backup ring (16) from outer grooves of cylinder head.

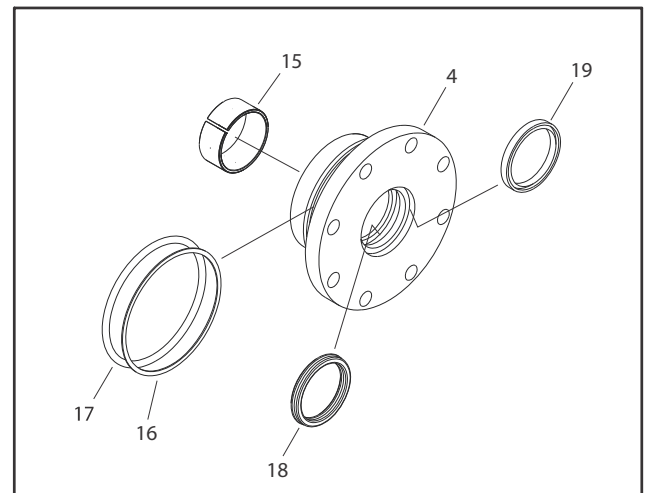


Figure 5-44. Cylinder Head Disassembly

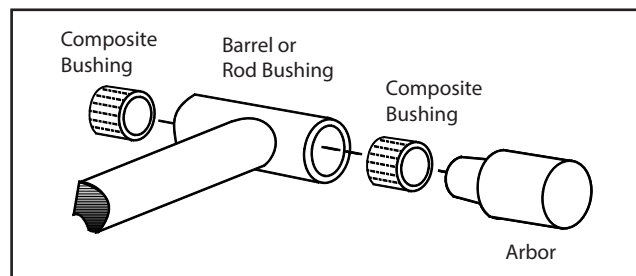
**Cleaning and Inspection**

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. Inspect rod and barrel bearings for signs of 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 steel bushing with WD40 before 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 5-45. 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. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.



**Assembly**

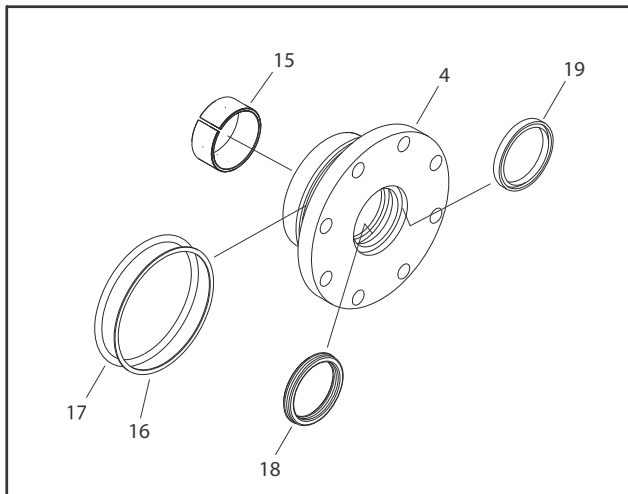
**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

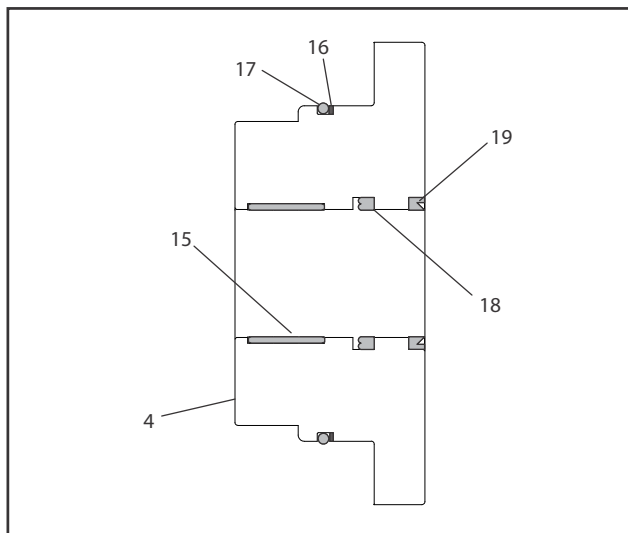
**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Install wear ring (15), rod seal (18), and wiper (19) in cylinder head (4).
2. Install new backup ring (16) and O-ring (17) in outside diameter groove of cylinder head (4).

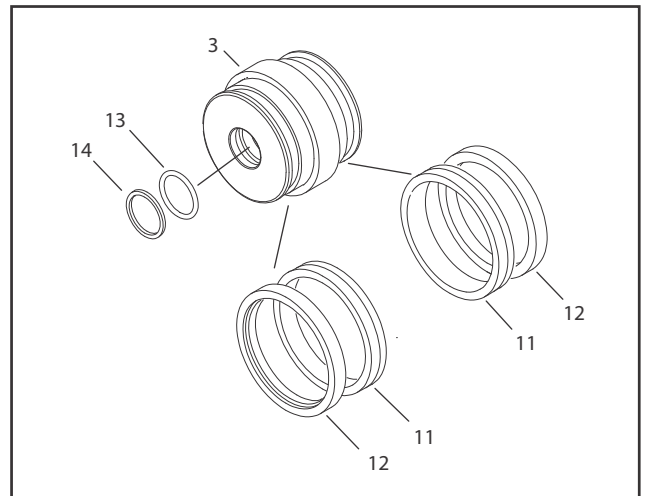


**Figure 5-46. Head Seal Kit Installation**

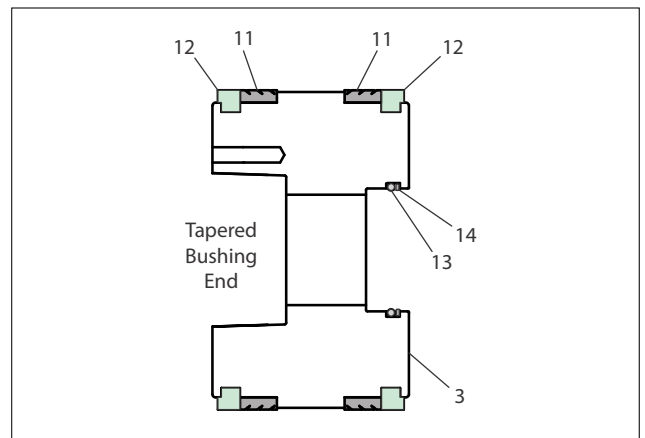


**Figure 5-47. Cylinder Head Seals**

3. Install washer ring (8) on rod (2). Carefully install cylinder head assembly on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Carefully slide spacer (6) on rod.
5. Install O-ring (13) and back-up ring (14) in piston (3).
6. Install two seals (11) and lock rings (12) in outside diameter piston grooves.



**Figure 5-48. Piston Seal Kit Installation**



**Figure 5-49. Piston Seals**

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. Do not damaged or dislodge O-ring and back-up rings.

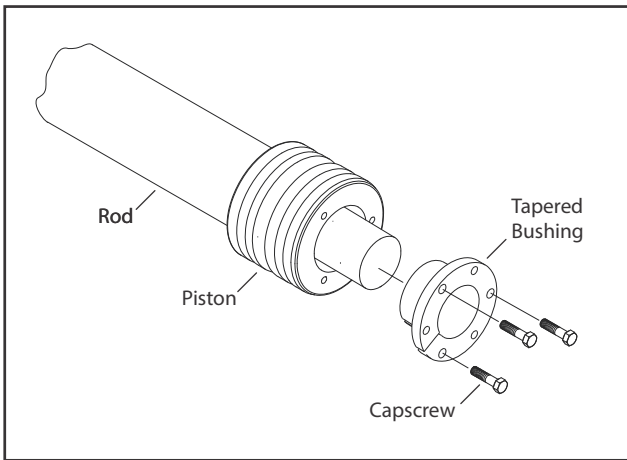
## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Piston and mating end of rod must be free of oil when installing tapered bushing.

9. Thread piston on rod until it aligns with spacer.

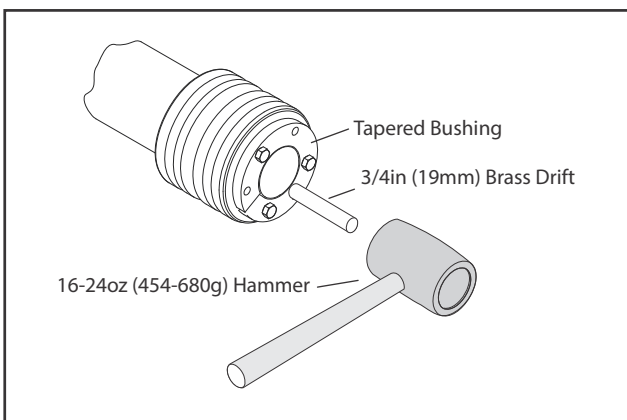
**NOTE:** Apply JLG Medium-Strength (Blue) Thread Locking Compound P/N 010011 or equivalent to new JLG furnished tapered bushing capscrews when rebuilding master, slave, lift, and telescope cylinders.

10. Insert tapered bushing loosely in the piston. Install JLG capscrews (not vendor capscrews) through drilled holes in the bushing and tapped holes in piston.



**Figure 5-50. Tapered Bushing Installation**

11. Tighten capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).
12. Set tapered bushing with a 16-24 oz (454-680g) hammer and 3/4 in (19mm) brass drift. Place drift against bushing between capscrews and tap once. Repeat for remaining two spaces between capscrews.



**Figure 5-51. Seating Tapered Bushing**

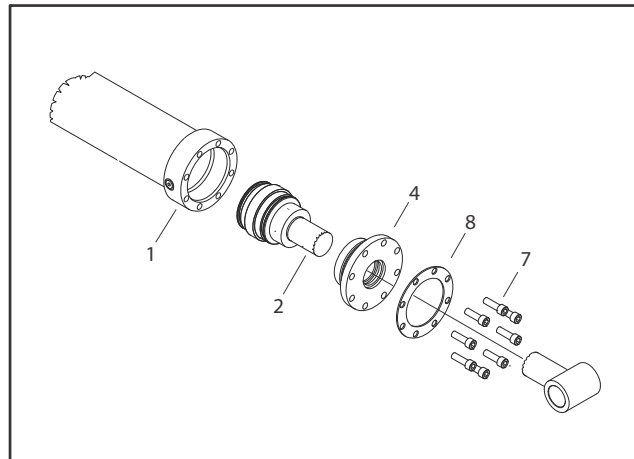
13. Re-torque capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).

14. Remove cylinder rod from holding fixture.
15. 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.**

16. Clamp barrel (1) securely and support rod (2). Insert piston in cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
17. Continue pushing rod into cylinder until cylinder head assembly (4) can be inserted into cylinder.
18. Align marks made during disassembly.
19. Apply locking primer (JLG P/N 0100038) and locking compound (JLG P/N 0100011) to eight socket head bolts (7).
20. Secure cylinder head and washer ring (8) with eight socket head bolts (7).



**Figure 5-52. Rod Assembly Installation**

## Main Boom Lift Cylinder

### DISASSEMBLY

Refer to Figure 5-56., Main Boom Lift Cylinder Assembly.

#### 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.

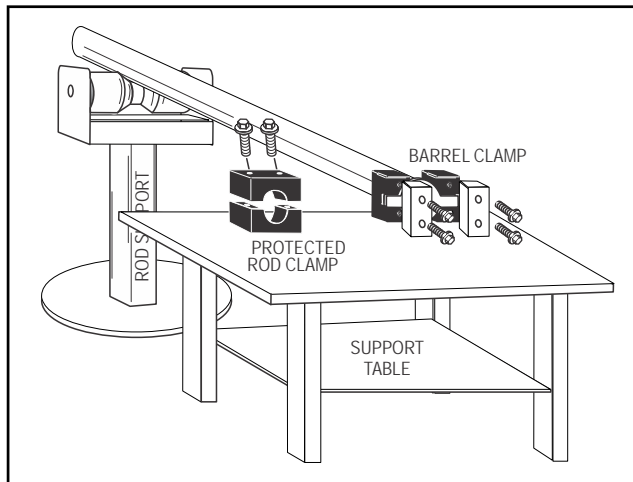


Figure 5-53. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

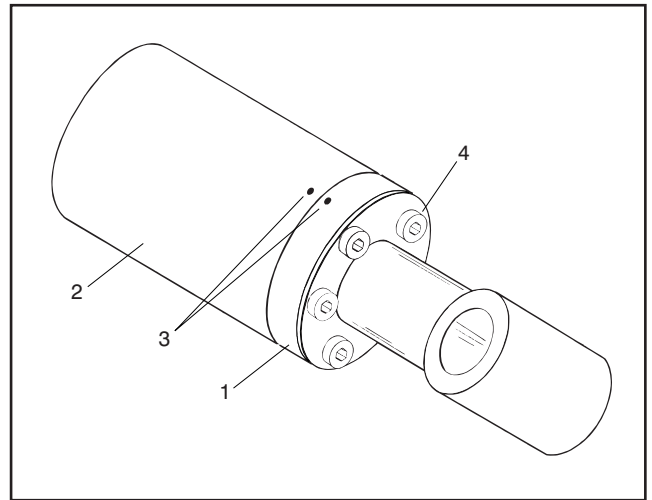


Figure 5-54. Marking Cylinder for Alignment

#### 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.

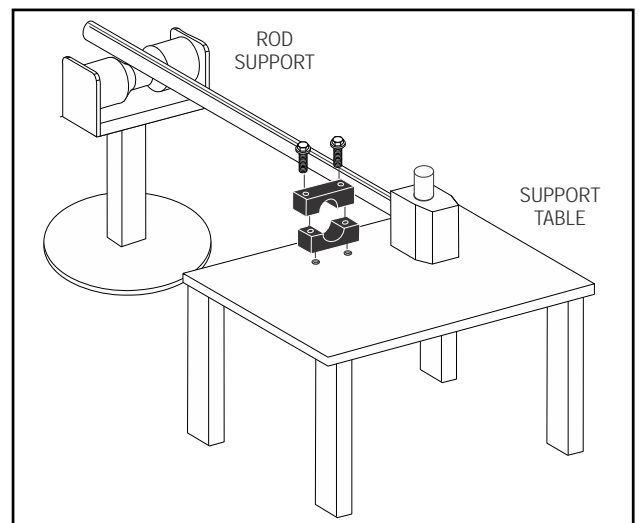
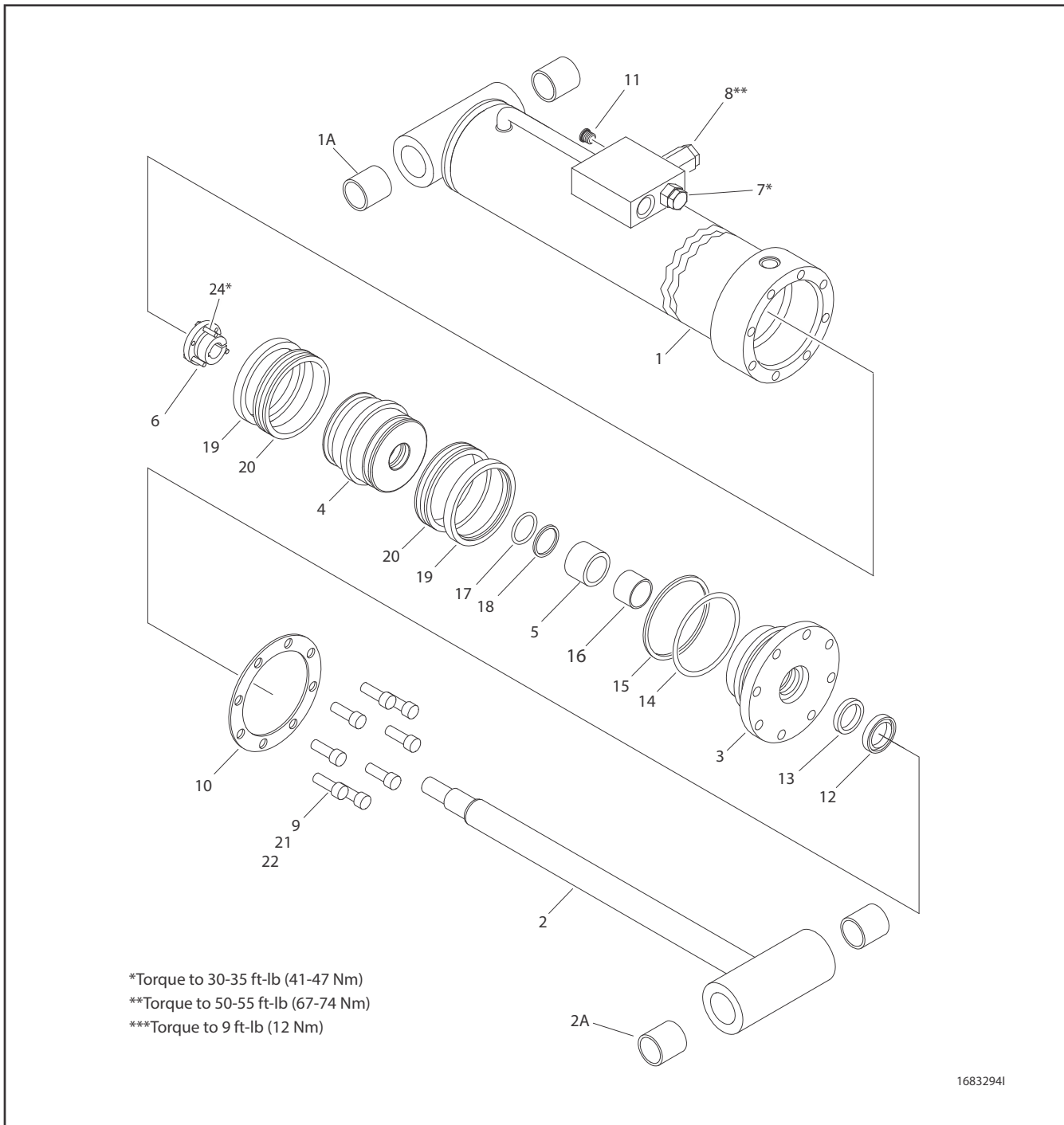


Figure 5-55. Cylinder Rod Support



- |                       |                    |                 |                  |                      |          |
|-----------------------|--------------------|-----------------|------------------|----------------------|----------|
| 1. Barrel             | 4. Piston          | 9. Capscrew     | 14. O-Ring       | 19. Lock Ring        | 24. Bolt |
| 1a. Composite Bushing | 5. Spacer          | 10. Ring Washer | 15. Back-Up Ring | 20. Seal             |          |
| 2. Rod                | 6. Tapered Bushing | 11. O-Ring Plug | 16. Wear Ring    | 21. Locking Compound |          |
| 2a. Composite Bushing | 7. Cartridge Valve | 12. Wiper       | 17. O-Ring       | 22. Locking Primer   |          |
| 3. Head               | 8. Cartridge Valve | 13. Rod Seal    | 18. Back-Up Ring | 23. Not Used         |          |

Figure 5-56. Main Boom Lift Cylinder Assembly

8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Remove cap screws attaching tapered bushing to piston.
10. Insert cap screws in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
11. Remove tapered bushing from piston. Discard cap screws.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

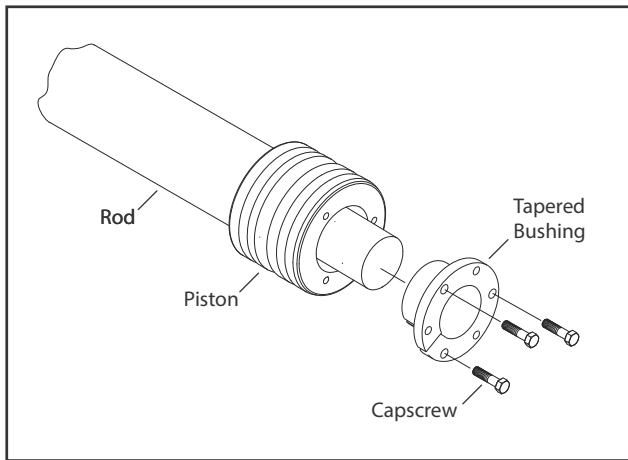


Figure 5-57. Tapered Bushing Removal

**NOTICE**

REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.

13. Remove and discard backup ring (17) and O-ring (18) from inside grooves of piston (4).

14. Remove and discard two lock rings (19) and seals (20) from outside grooves of piston.

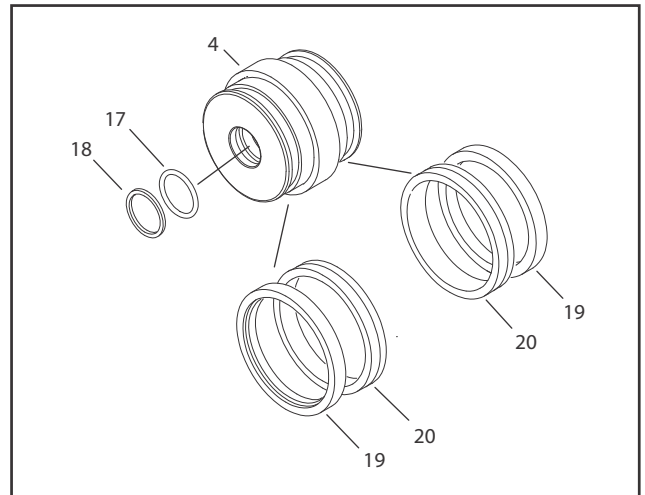


Figure 5-58. Piston Disassembly

15. Remove spacer (5) from rod (2).
16. Remove rod from holding fixture. Remove cylinder head (3) and washer ring (10).
17. Remove and discard wear ring (16), wiper seal (12), and rod seal (13) from inside of cylinder head (3). Remove and discard O-ring (15) and backup ring (14) from outer grooves of cylinder head.

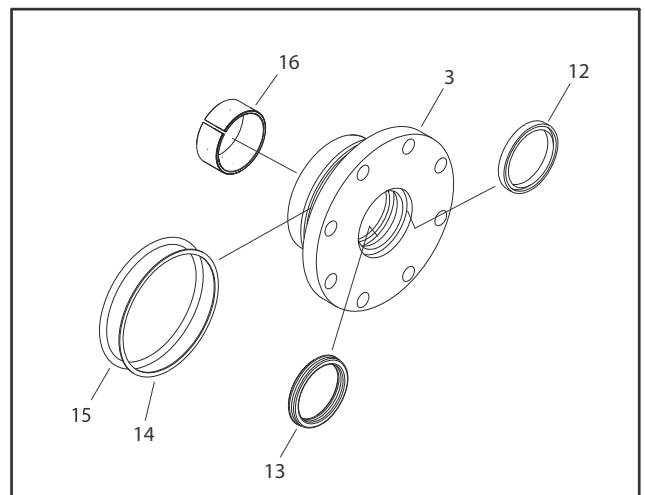


Figure 5-59. Cylinder Head Disassembly

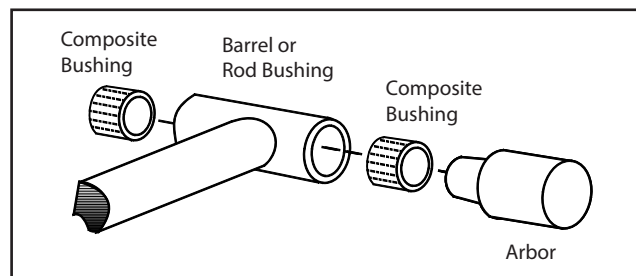
**Cleaning and Inspection**

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. Inspect rod and barrel bearings for signs of 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 steel bushing with WD40 before bearing installation.

**NOTE:** *Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.*

14. Press composite bushing into barrel or rod bushing with correct size arbor.



**Figure 5-60. Composite Bushing Installation**

15. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
16. Inspect port block fittings and cartridge valves. Replace as necessary.
17. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

## Assembly

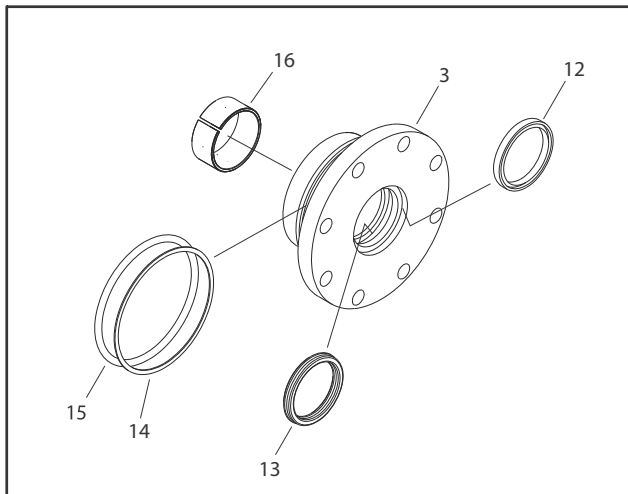
### NOTICE

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

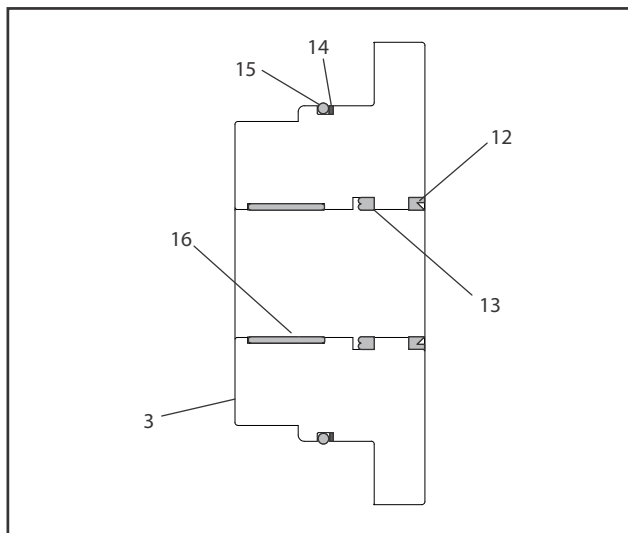
**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Install wear ring (16), rod seal (13), and wiper (12) in cylinder head (3).
2. Install new backup ring (14) and O-ring (15) in outside diameter groove of cylinder head (3).

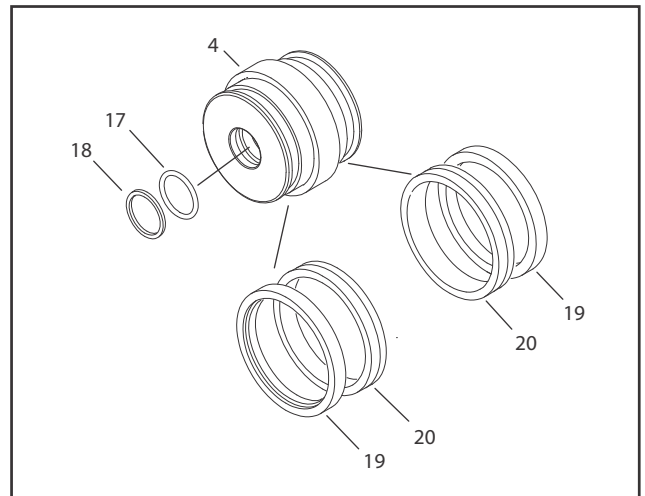


**Figure 5-61. Head Seal Kit Installation**

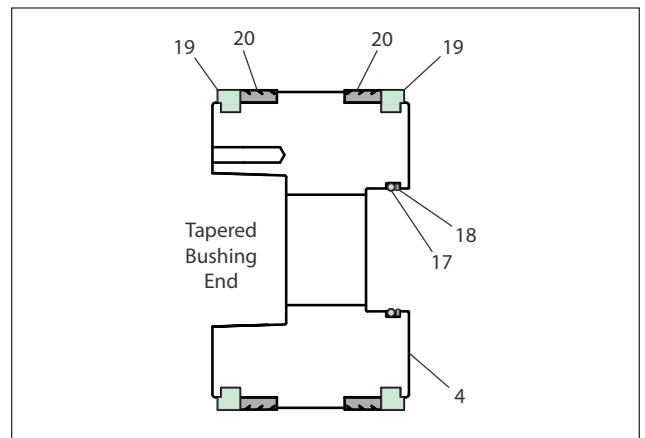


**Figure 5-62. Cylinder Head Seals**

3. Install washer ring (10) on rod (2). Carefully install cylinder head assembly on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Carefully slide spacer (5) on rod.
5. Install O-ring (17) and back-up ring (18) in piston (4).
6. Install two seals (20) and lock rings (19) in outside diameter piston grooves.



**Figure 5-63. Piston Seal Kit Installation**



**Figure 5-64. Piston Seals**

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. Do not damaged or dislodge O-ring and back-up rings.

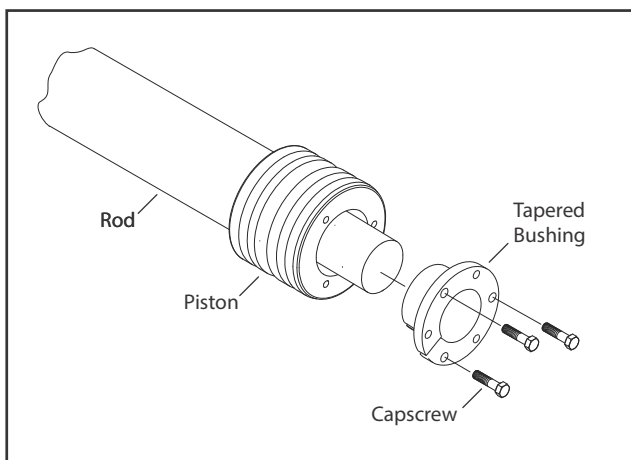
## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Piston and mating end of rod must be free of oil when installing tapered bushing.

9. Thread piston on rod until it aligns with spacer.

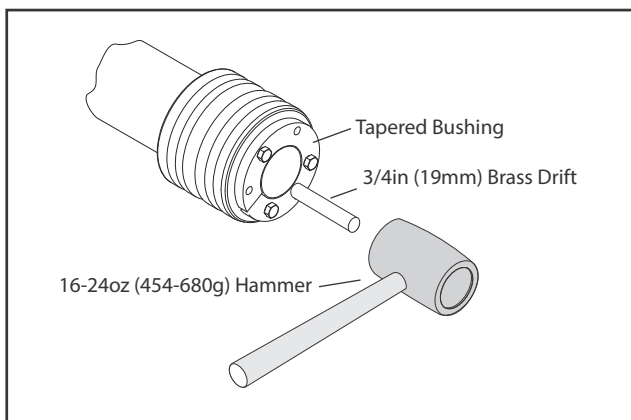
**NOTE:** Apply JLG Medium-Strength (Blue) Thread Locking Compound P/N 010011 or equivalent to new JLG furnished tapered bushing capscrews when rebuilding master, slave, lift, and telescope cylinders.

10. Insert tapered bushing loosely in the piston. Install JLG capscrews (not vendor capscrews) through drilled holes in the bushing and tapped holes in piston.



**Figure 5-65. Tapered Bushing Installation**

11. Tighten capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).
12. Set tapered bushing with a 16-24 oz (454-680g) hammer and 3/4 in (19mm) brass drift. Place drift against bushing between capscrews and tap once. Repeat for remaining two spaces between capscrews.



**Figure 5-66. Seating Tapered Bushing**

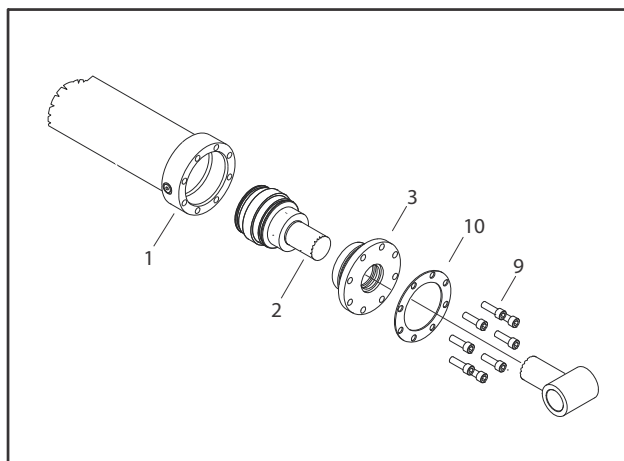
13. Re-torque capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).

14. Remove cylinder rod from holding fixture.
15. 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.**

16. Clamp barrel (1) securely and support rod (2). Insert piston in cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
17. Continue pushing rod into cylinder until cylinder head assembly (3) can be inserted into cylinder.
18. Align marks made during disassembly.
19. Apply locking primer (JLG P/N 0100038) and locking compound (JLG P/N 0100011) to eight socket head bolts (9).
20. Secure cylinder head and washer ring (10) with eight socket head bolts (9).



**Figure 5-67. Rod Assembly Installation**



## Main Boom Telescope Cylinder

Refer to Figure 5-71., Main Boom Telescope Cylinder Assembly.

### 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.

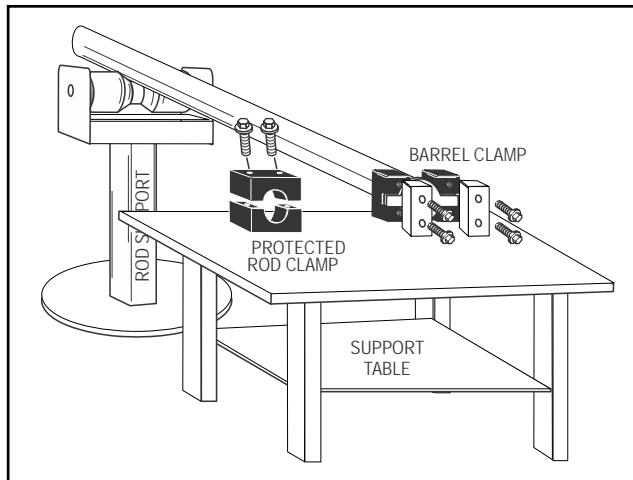


Figure 5-68. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

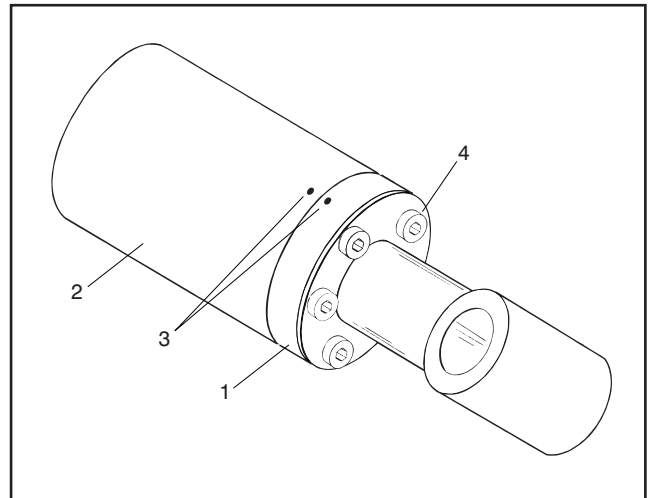


Figure 5-69. Marking Cylinder for Alignment

#### 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.

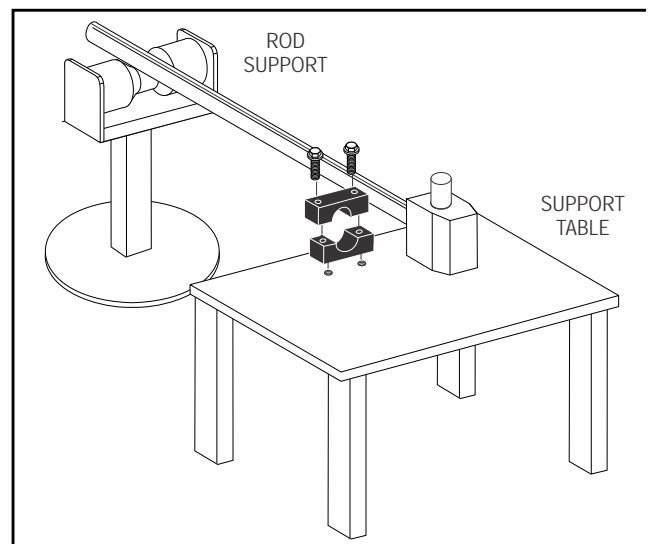
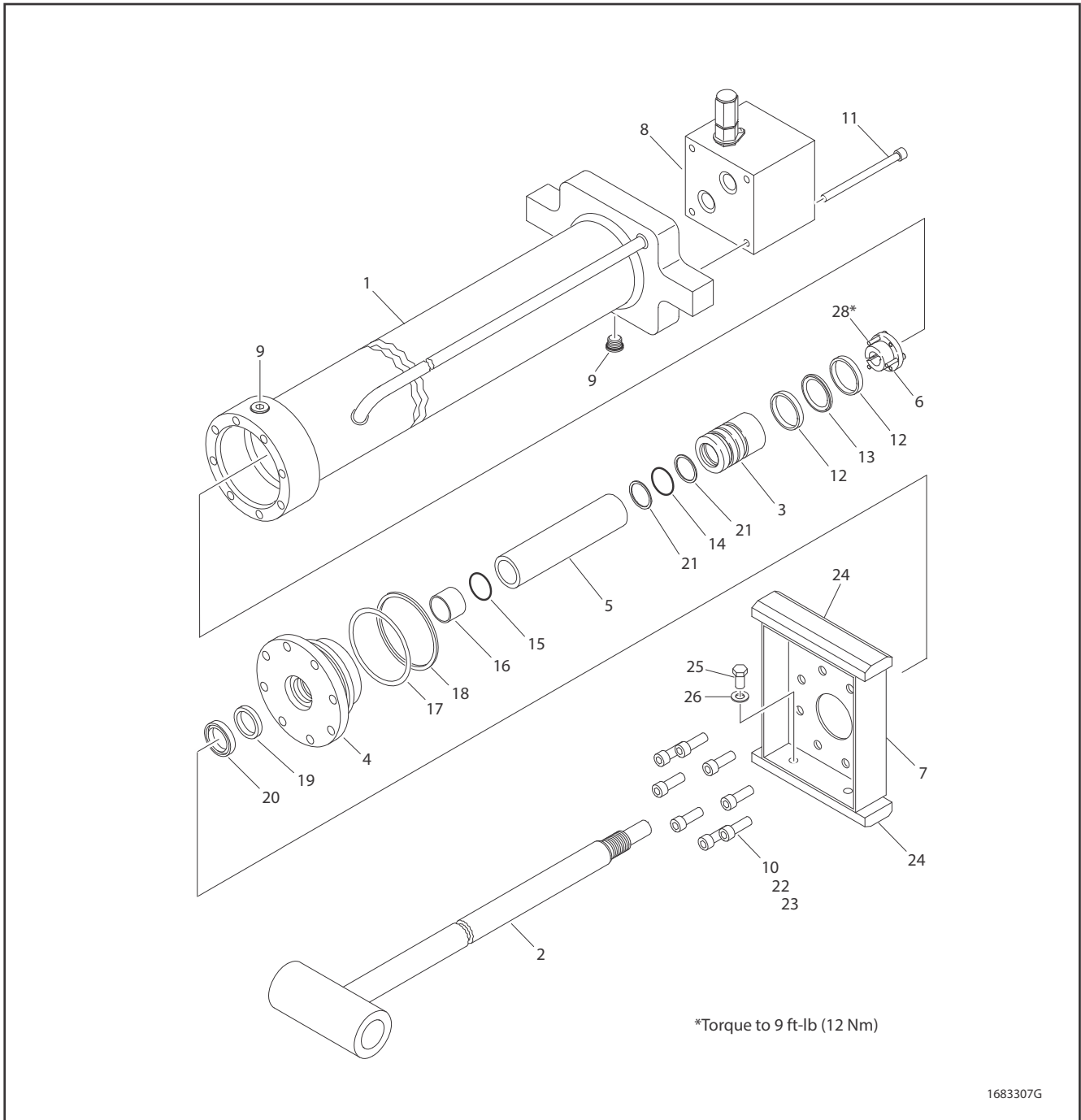


Figure 5-70. Cylinder Rod Support



- |                  |                            |                  |                      |                 |
|------------------|----------------------------|------------------|----------------------|-----------------|
| 1. Barrel        | 7. Wear Pad Mounting Plate | 13. Seal         | 19. Rod Seal         | 25. Bolt        |
| 2. Rod           | 8. Valve Block Assembly    | 14. O-Ring       | 20. Wiper            | 26. Flat Washer |
| 3. Piston        | 9. O-Ring Plug             | 15. O-Ring       | 21. Back-Up Ring     | 27. Not Used    |
| 4. Head          | 10. Capscrew               | 16. Wear Ring    | 22. Locking Primer   | 28. Bolt        |
| 5. Spacer        | 11. Capscrew               | 17. O-Ring       | 23. Locking Compound |                 |
| 6. Taper Bushing | 12. Wear Ring              | 18. Back-Up Ring | 24. Wear Pad         |                 |

**Figure 5-71. Main Boom Telescope Cylinder Assembly**

8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Remove cap screws attaching tapered bushing to piston.
10. Insert cap screws in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
11. Remove tapered bushing from piston. Discard cap screws.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

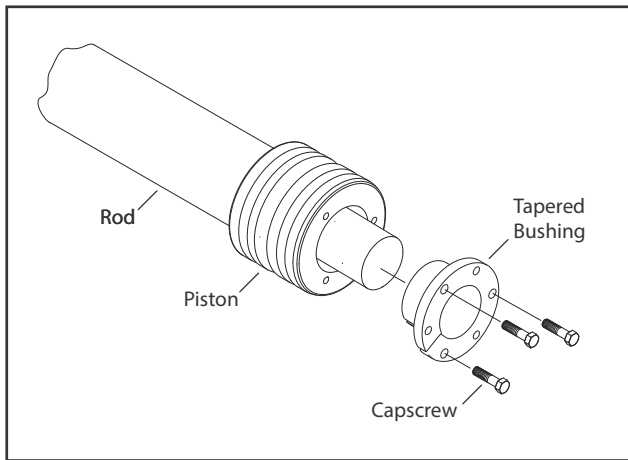


Figure 5-72. Tapered Bushing Removal

**NOTICE**

REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.

13. Remove and discard backup ring (21), O-ring (14), backup ring (21) from inside grooves of piston (3).

14. Remove and discard two lock rings (12) and seal (13) from outside grooves of piston.

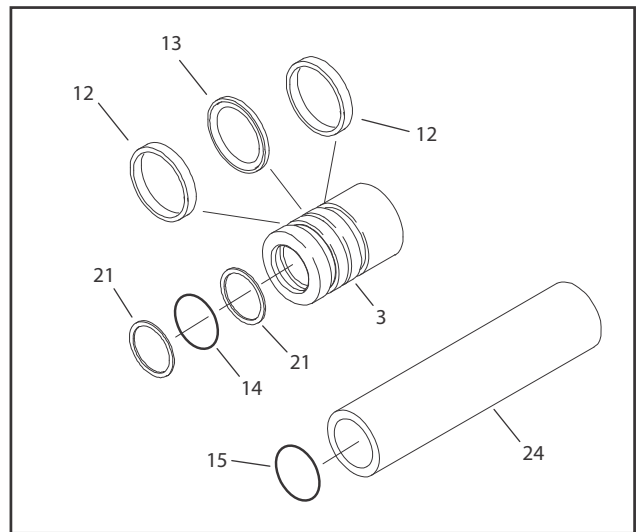


Figure 5-73. Piston Disassembly

15. Remove spacer (24) from rod (2). Remove and discard O-ring (15).
16. Remove rod from holding fixture. Remove cylinder head (4) and wear pad mounting plate (7).
17. Remove and discard wear ring (16), wiper seal (20), and rod seal (19) from inside of cylinder head (4). Remove and discard O-ring (18) and backup ring (17) from outer grooves of cylinder head.

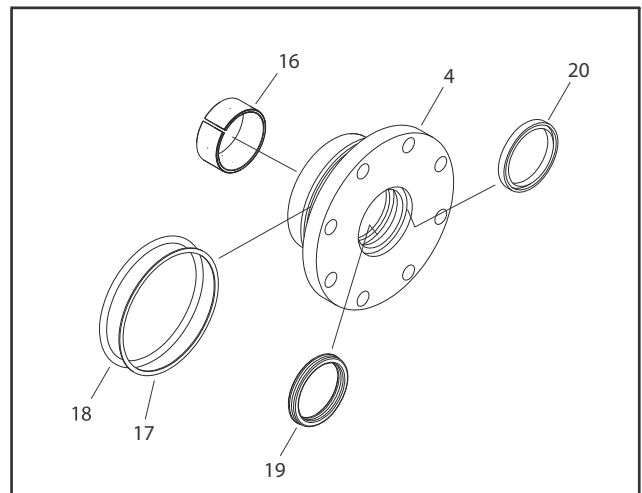


Figure 5-74. Cylinder Head Disassembly

## 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. Inspect wear pad assembly (7) for damage and worn pads (24). Replace parts as required.

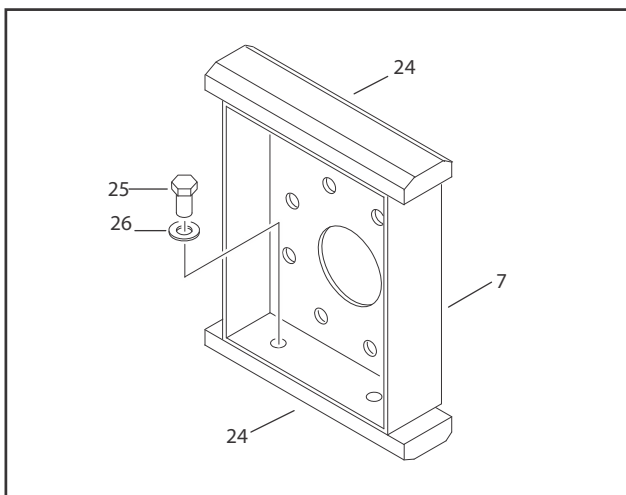


Figure 5-75. Wear Pad Assembly

14. Inspect rod and barrel bearings for signs of 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 steel bushing with WD40 before bearing installation.

**NOTE:** Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

15. Press composite bushing into barrel or rod bushing with correct size arbor.

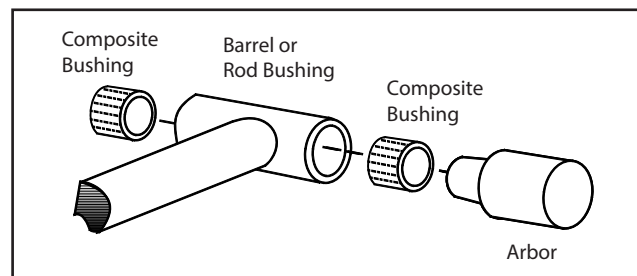


Figure 5-76. Composite Bushing Installation

16. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
17. Inspect port block (8) fittings and cartridge valve. Replace as necessary.
18. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

**Assembly**

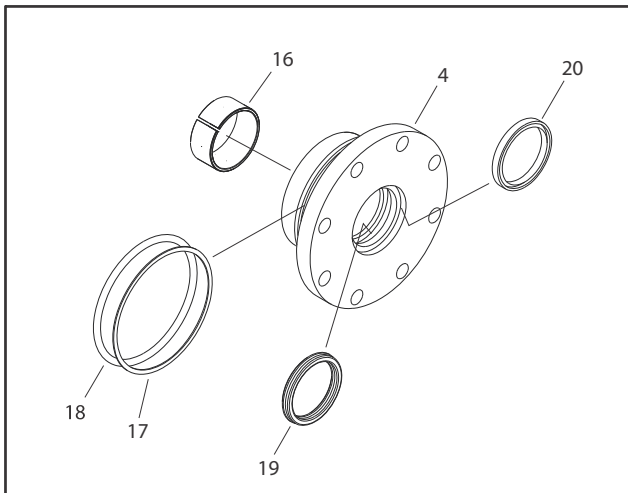
**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

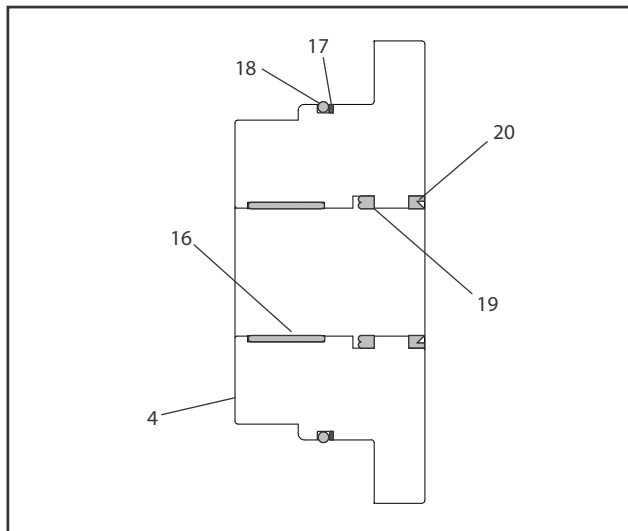
**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Install wear ring (16), rod seal (13), and wiper (12) in cylinder head (3).
2. Install new backup ring (14) and O-ring (15) in outside diameter groove of cylinder head (3).

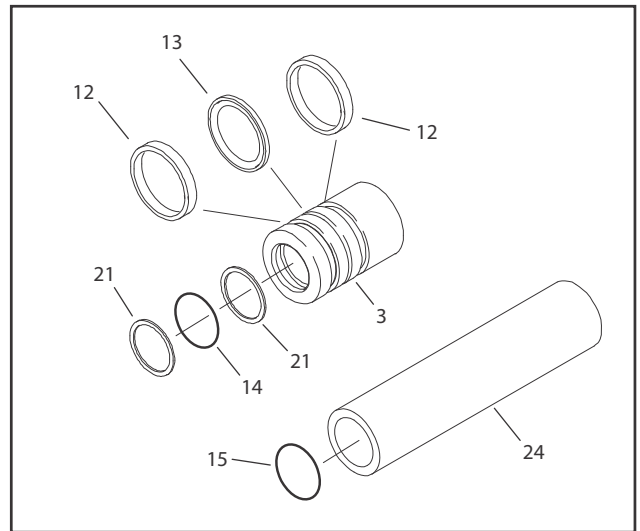


**Figure 5-77. Head Seal Kit Installation**

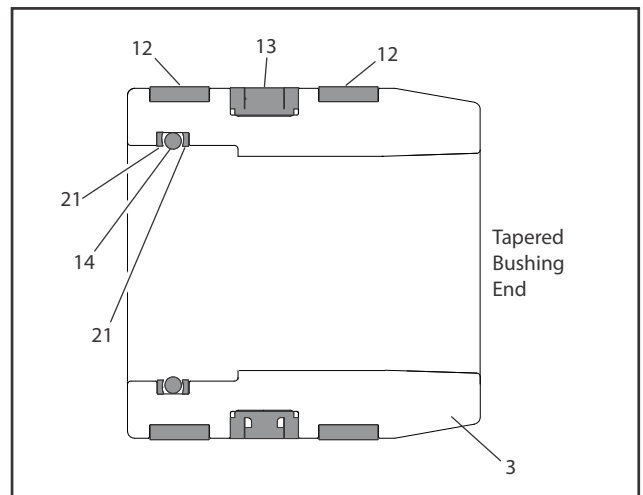


**Figure 5-78. Cylinder Head Seals**

3. Install wear pad assembly (7) on rod (2). Carefully install cylinder head assembly (4) on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Install O-ring (15) in spacer (24). Carefully slide spacer with O-ring end facing cylinder head, on rod.
5. Install backup ring (21), O-ring (14) and back-up ring (21) in piston (3).
6. Install seal (13) and two lock rings (12) in outside diameter piston grooves.



**Figure 5-79. Piston Seal Kit Installation**



**Figure 5-80. Piston Seals**

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. Do not damaged or dislodge O-ring and back-up rings.

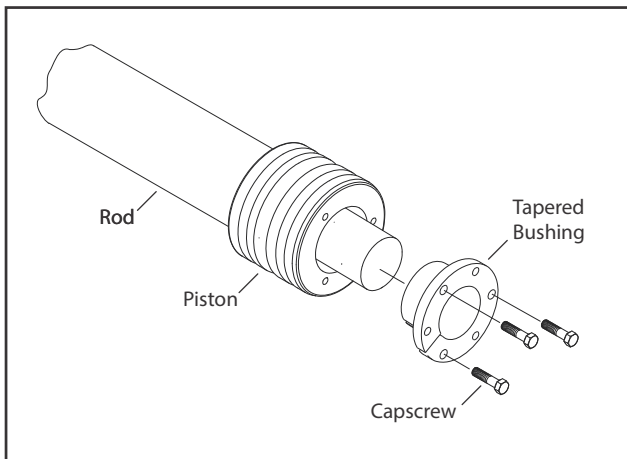
## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Piston and mating end of rod must be free of oil when installing tapered bushing.

9. Thread piston on rod until it aligns with spacer.

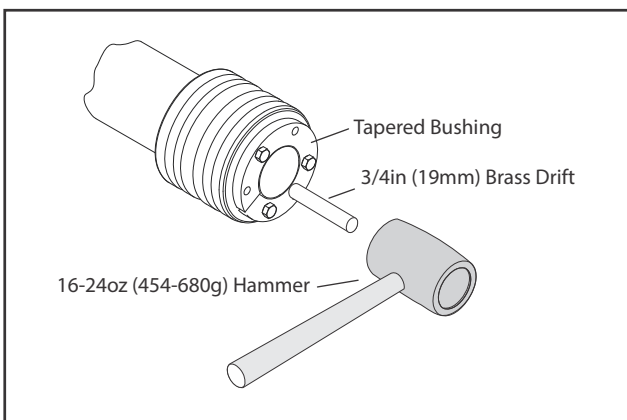
**NOTE:** Apply JLG Medium-Strength (Blue) Thread Locking Compound P/N 010011 or equivalent to new JLG furnished tapered bushing capscrews when rebuilding master, slave, lift, and telescope cylinders.

10. Insert tapered bushing loosely in the piston. Install JLG capscrews (not vendor capscrews) through drilled holes in the bushing and tapped holes in piston.



**Figure 5-81. Tapered Bushing Installation**

11. Tighten capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).
12. Set tapered bushing with a 16-24 oz (454-680g) hammer and 3/4 in (19mm) brass drift. Place drift against bushing between capscrews and tap once. Repeat for remaining two spaces between capscrews.



**Figure 5-82. Seating Tapered Bushing**

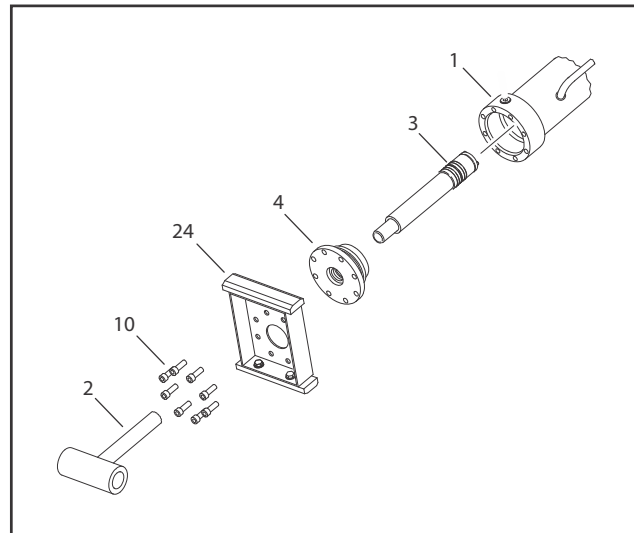
13. Re-torque capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).

14. Remove cylinder rod from holding fixture.
15. 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.**

16. Clamp barrel (1) securely and support rod (2). Insert piston (3) in cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
17. Continue pushing rod into cylinder until cylinder head assembly (4) can be inserted into cylinder.
18. Align marks made during disassembly.
19. Apply locking primer (JLG P/N 0100038) and locking compound (JLG P/N 0100011) to eight socket head bolts (10).
20. Secure cylinder head (4) and wear pad assembly (24) with eight socket head bolts (10).



**Figure 5-83. Rod Assembly Installation**

## Tower Boom Telescope Cylinder

Refer to Figure 5-87., Tower Boom Telescope Cylinder Assembly.

### 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.

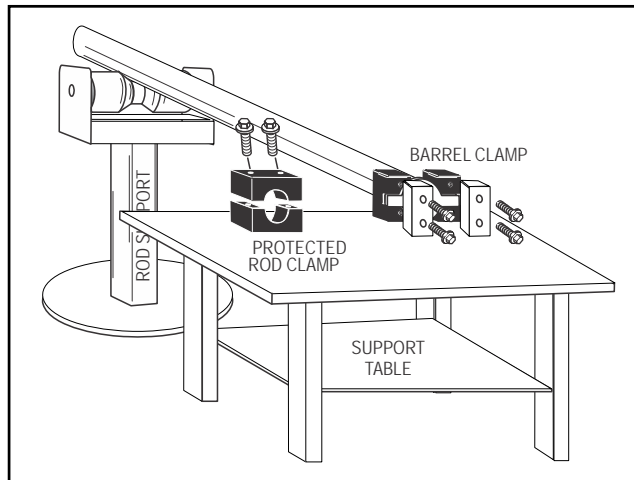


Figure 5-84. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

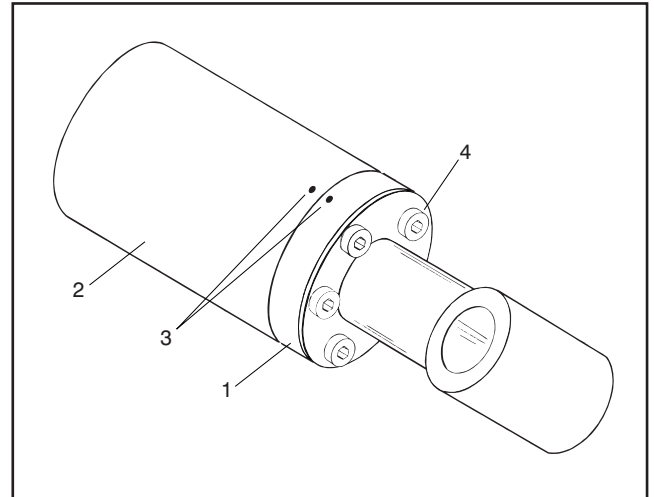


Figure 5-85. Marking Cylinder for Alignment

#### 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.

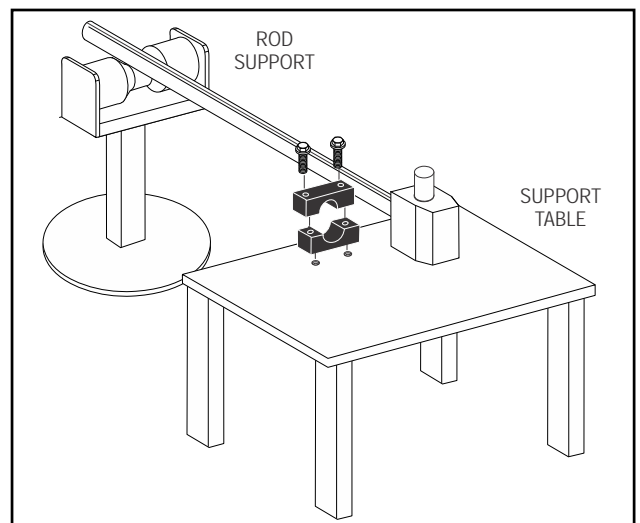
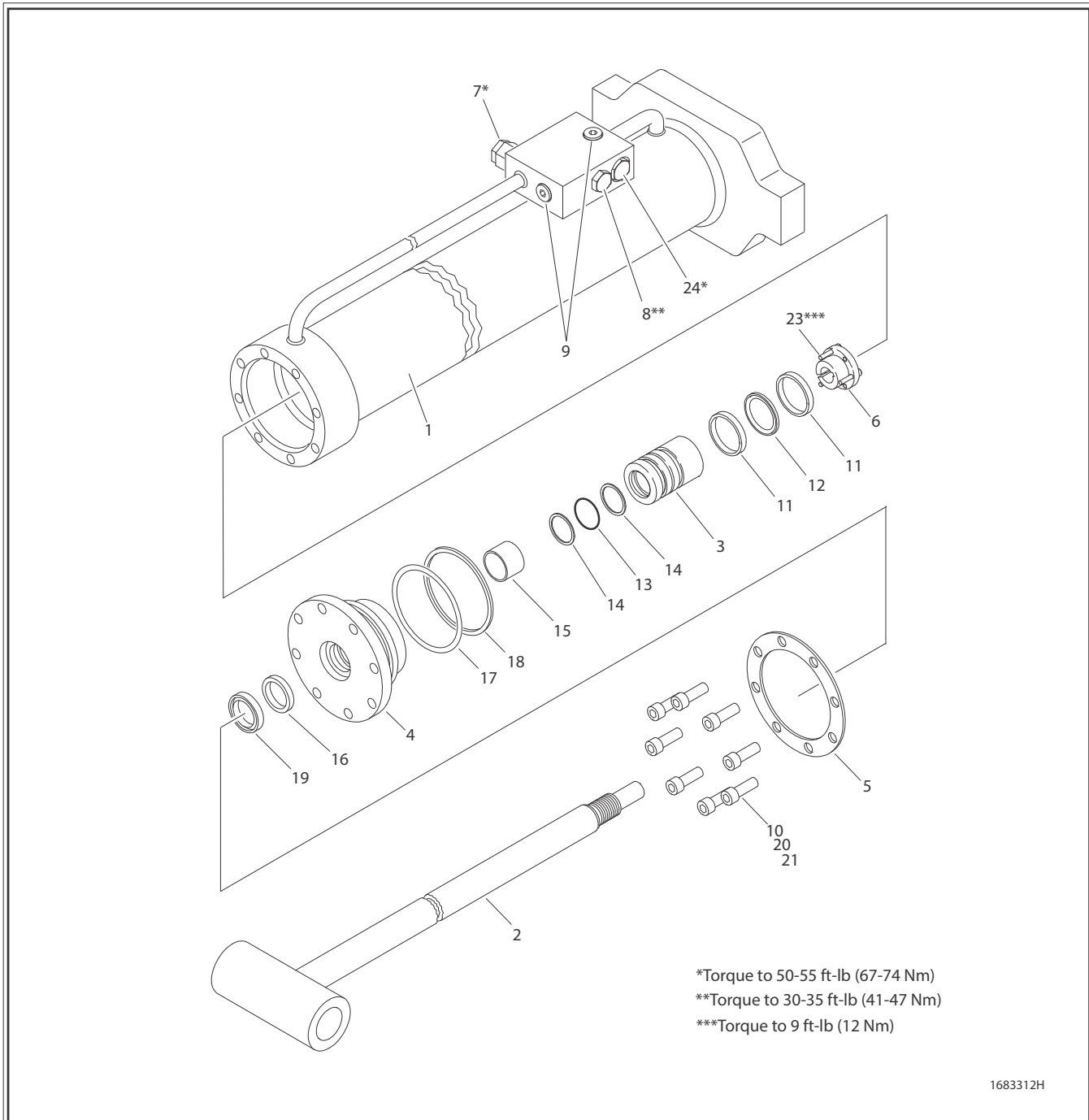


Figure 5-86. Cylinder Rod Support



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- |                |                    |                  |                    |                      |
|----------------|--------------------|------------------|--------------------|----------------------|
| 1. Barrel      | 6. Tapered Bushing | 11. Wear Ring    | 16. Rod Seal       | 21. Locking Compound |
| 2. Rod         | 7. Cartridge Valve | 12. T-Seal       | 17. O-Ring         | 22. Not Used         |
| 3. Piston      | 8. Cartridge Valve | 13. O-Ring       | 18. Back-Up Ring   | 23. Bolt             |
| 4. Head        | 9. O-Ring Plug     | 14. Back-Up Ring | 19. Back-Up Ring   | 24. Cartridge Valve  |
| 5. Ring Washer | 10. Capscrew       | 15. Wear Ring    | 20. Locking Primer |                      |

Figure 5-87. Tower Boom Telescope Cylinder Assembly



8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Remove cap screws attaching tapered bushing to piston.
10. Insert cap screws in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
11. Remove tapered bushing from piston. Discard cap screws.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

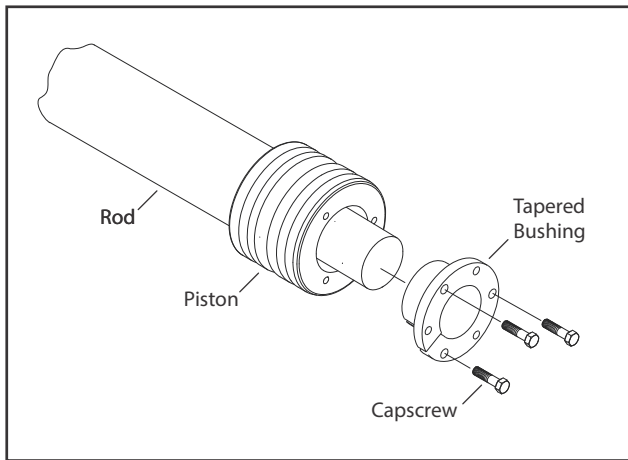


Figure 5-88. Tapered Bushing Removal

**NOTICE**

REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.

13. Remove and discard backup ring (14), O-ring (13), and backup ring (14) from inside grooves of piston (3).

14. Remove and discard two lock rings (11) and seal (12) from outside grooves of piston.

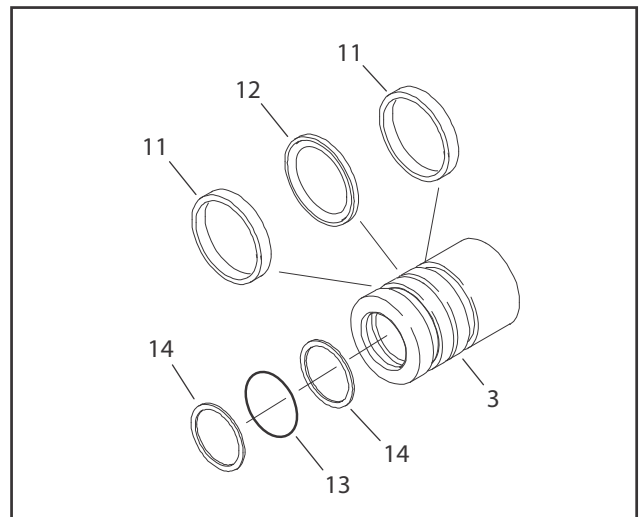


Figure 5-89. Piston Disassembly

15. Remove rod from holding fixture. Remove cylinder head (4) and washer ring (5).
16. Remove and discard wear ring (15), wiper seal (19), and rod seal (16) from inside of cylinder head (4). Remove and discard O-ring (18) and backup ring (17) from outer grooves of cylinder head.

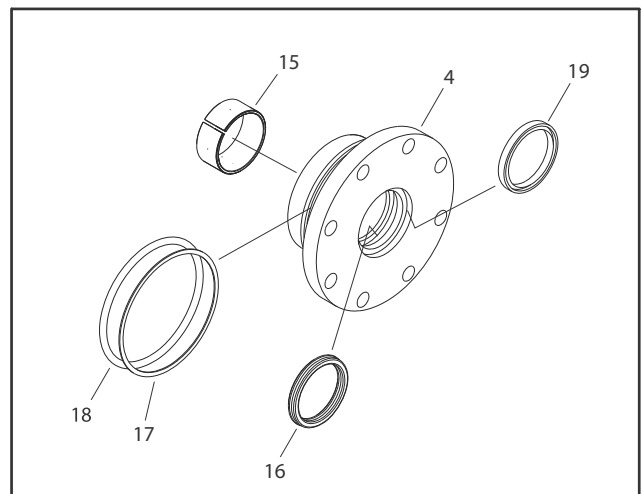


Figure 5-90. Cylinder Head Disassembly

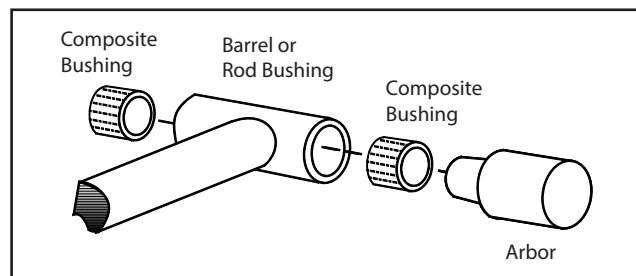
**Cleaning and Inspection**

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. Inspect rod and barrel bearings for signs of 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 steel bushing with WD40 before bearing installation.

**NOTE:** *Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.*

14. Press composite bushing into barrel or rod bushing with correct size arbor.



**Figure 5-91. Composite Bushing Installation**

15. Inspect port block fittings and cartridge valves. Replace as necessary.
16. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

**Assembly**

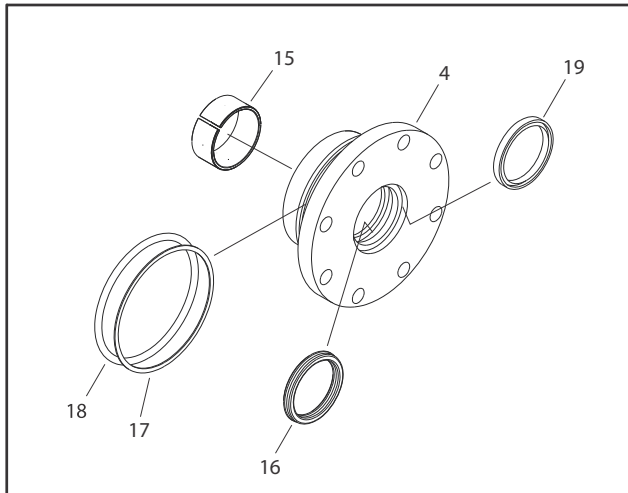
**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

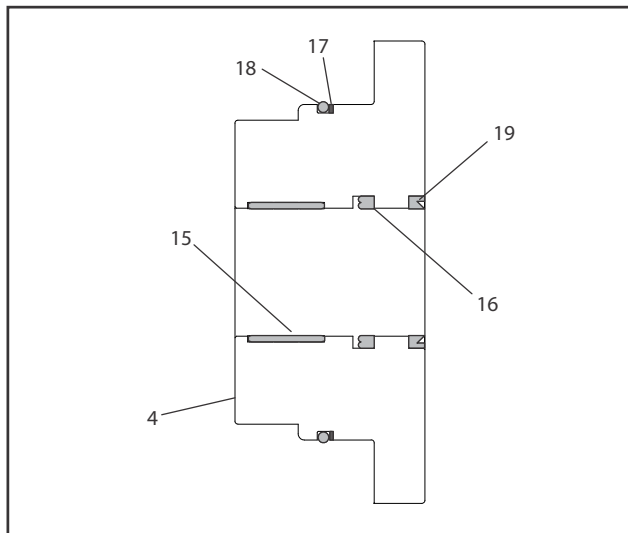
**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Install wear ring (15), rod seal (16), and wiper (19) in cylinder head (4).
2. Install new backup ring (17) and O-ring (18) in outside diameter groove of cylinder head (4).

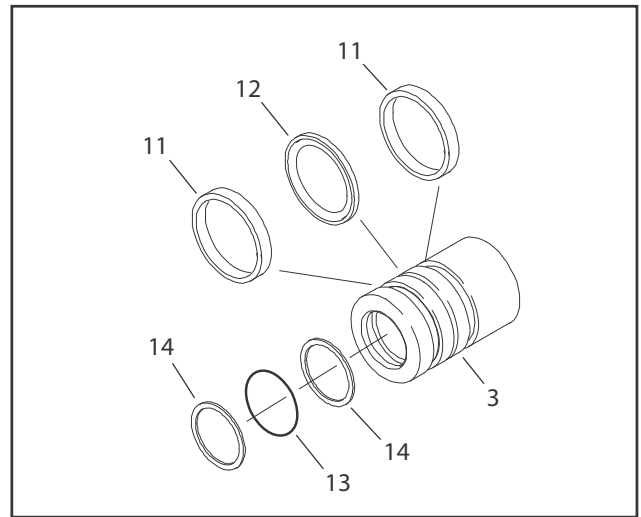


**Figure 5-92. Head Seal Kit Installation**

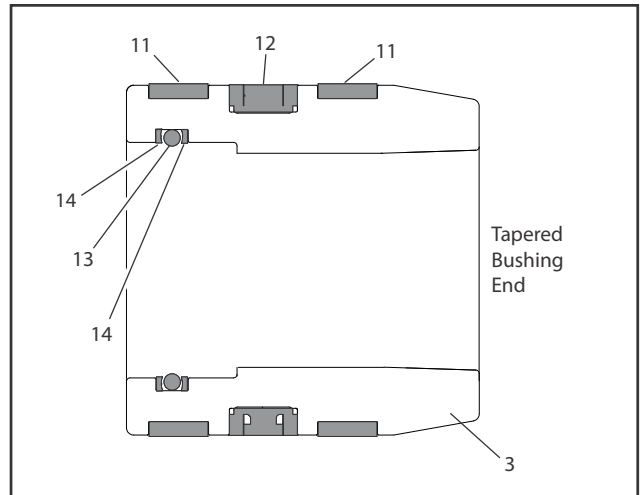


**Figure 5-93. Cylinder Head Seals**

3. Install washer ring (5) on rod (2). Carefully install cylinder head assembly on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Install back-up ring (14), O-ring (13), and back-up ring (14) in piston (3).
5. Install two seal (12) and two lock rings (11) in outside diameter piston grooves.



**Figure 5-94. Piston Seal Kit Installation**



**Figure 5-95. Piston Seals**

6. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
7. Carefully thread piston on cylinder rod hand tight. Do not damaged or dislodge O-ring and back-up rings.

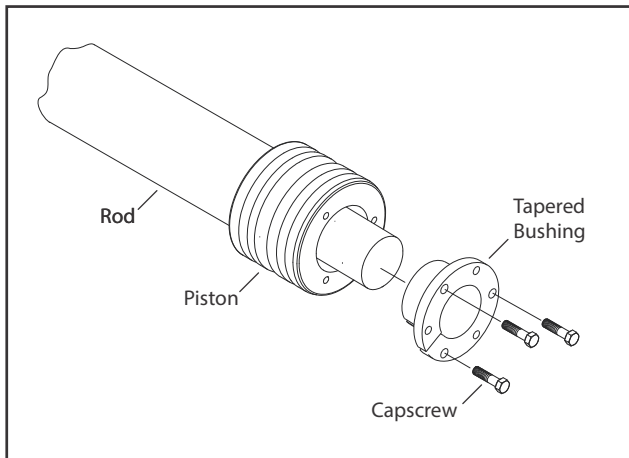
## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Piston and mating end of rod must be free of oil when installing tapered bushing.

8. Thread piston on rod until it aligns with spacer.

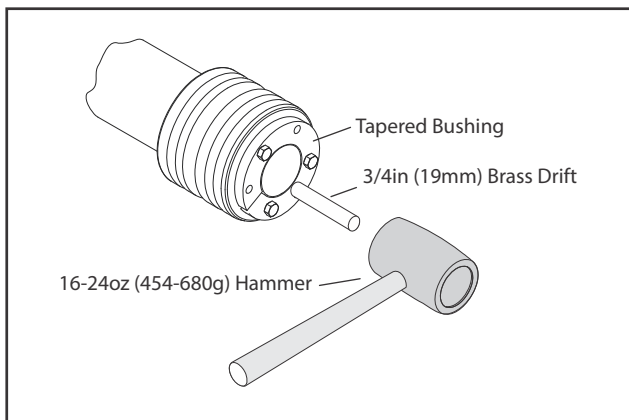
**NOTE:** Apply JLG Medium-Strength (Blue) Thread Locking Compound P/N 010011 or equivalent to new JLG furnished tapered bushing capscrews when rebuilding master, slave, lift, and telescope cylinders.

9. Insert tapered bushing loosely in the piston. Install JLG capscrews (not vendor capscrews) through drilled holes in the bushing and tapped holes in piston.



**Figure 5-96. Tapered Bushing Installation**

10. Tighten capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).
11. Set tapered bushing with a 16-24 oz (454-680g) hammer and 3/4 in (19mm) brass drift. Place drift against bushing between capscrews and tap once. Repeat for remaining two spaces between capscrews.



**Figure 5-97. Seating Tapered Bushing**

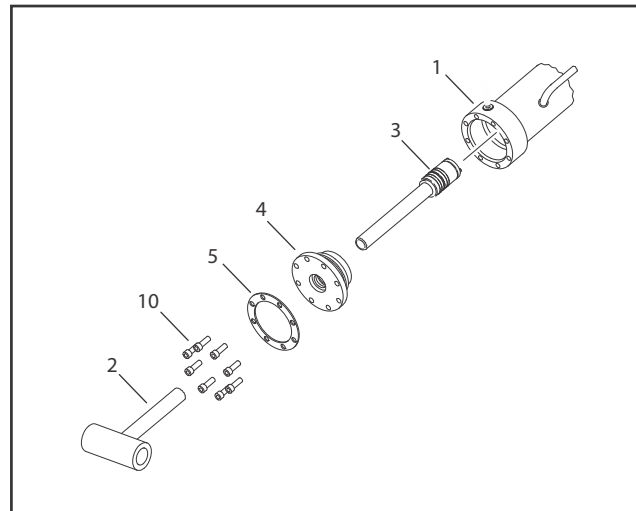
12. Re-torque capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).

13. Remove cylinder rod from holding fixture.
14. 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.**

15. Clamp barrel (1) securely and support rod (2). Insert piston in cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
16. Continue pushing rod into cylinder until cylinder head assembly (4) can be inserted into cylinder.
17. Align marks made during disassembly.
18. Apply locking primer (JLG P/N 0100038) and locking compound (JLG P/N 0100011) to eight socket head bolts (10).
19. Secure cylinder head and washer ring (5) with eight socket head bolts (10).



**Figure 5-98. Rod Assembly Installation**

## Platform Level (Slave) Cylinder

Refer to Figure 5-102., Platform Level (Slave) Cylinder Assembly.

### 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.

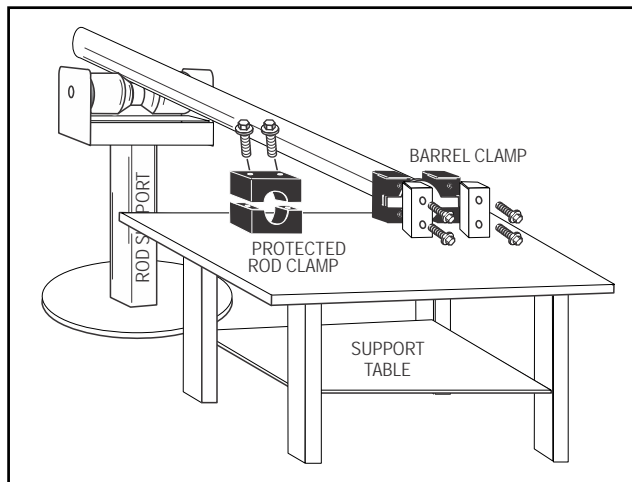


Figure 5-99. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

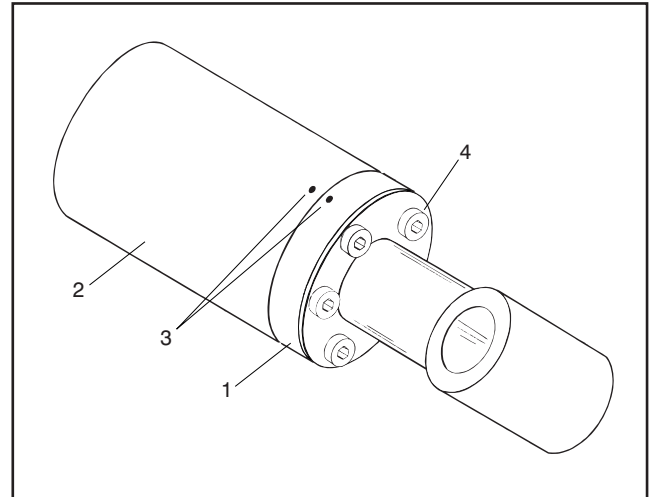


Figure 5-100. Marking Cylinder for Alignment

#### 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.

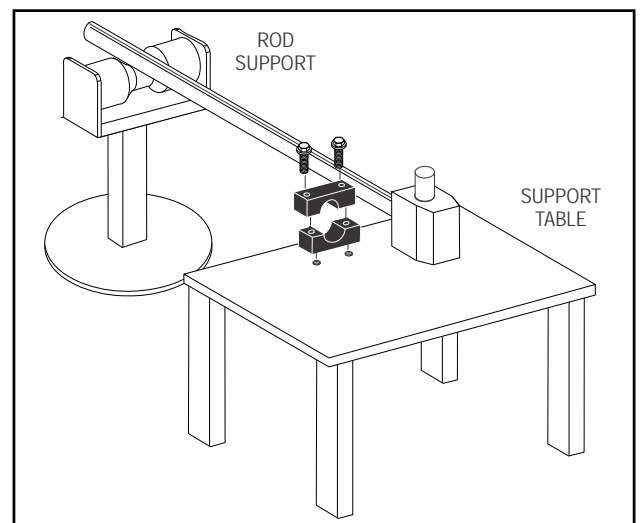
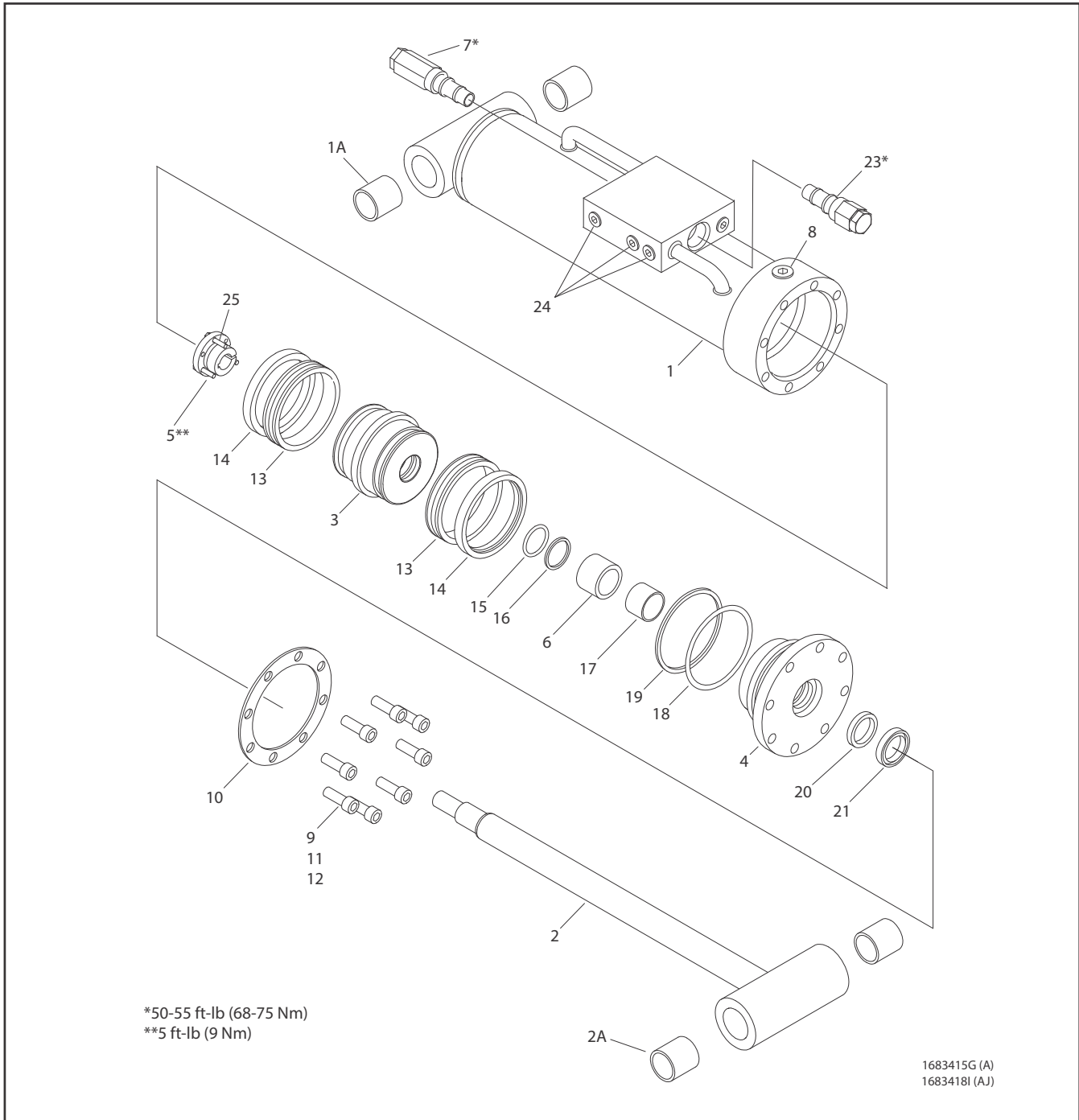


Figure 5-101. Cylinder Rod Support

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



- |                       |                    |                      |                  |                     |
|-----------------------|--------------------|----------------------|------------------|---------------------|
| 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 5-102. 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. Remove cap screws attaching tapered bushing to piston.
10. Insert cap screws in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
11. Remove tapered bushing from piston. Discard cap screws.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

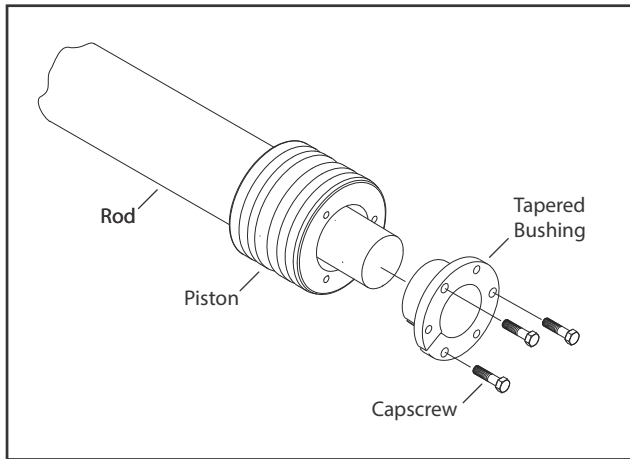


Figure 5-103. Tapered Bushing Removal

**NOTICE**

REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.

13. Remove and discard backup ring (16) and O-ring (15) from inside grooves of piston (3).

14. Remove and discard two lock rings (14) and seals (13) from outside grooves of piston.

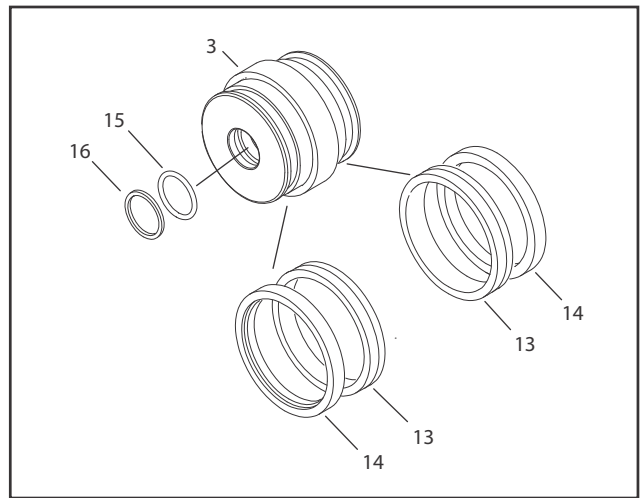


Figure 5-104. Piston Disassembly

15. Remove spacer (6) from rod (2).
16. Remove rod from holding fixture. Remove cylinder head (4) and washer ring (10).
17. Remove and discard wear ring (17), wiper seal (21), and rod seal (20) from inside of cylinder head (3). Remove and discard O-ring (19) and backup ring (18) from outer grooves of cylinder head.

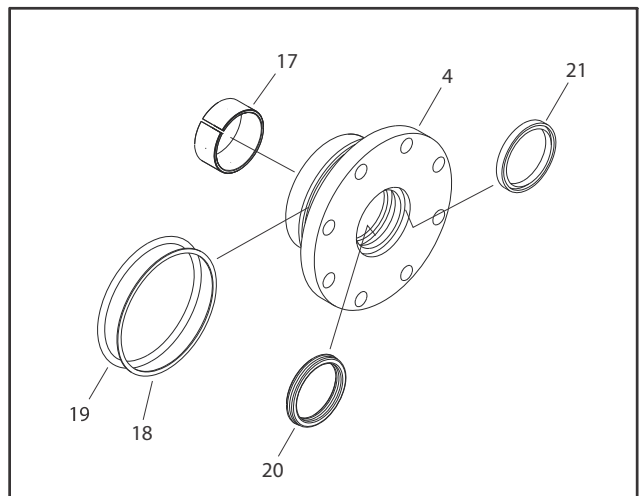


Figure 5-105. Cylinder Head Disassembly

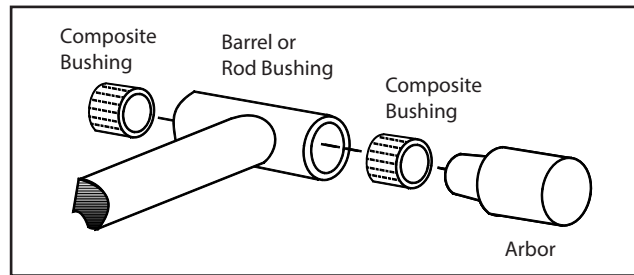
**Cleaning and Inspection**

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. Inspect rod and barrel bearings for signs of 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 steel bushing with WD40 before bearing installation.

**NOTE:** *Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.*

14. Press composite bushing into barrel or rod bushing with correct size arbor.



**Figure 5-106. Composite Bushing Installation**

15. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
16. Inspect port block fittings and cartridge valves. Replace as necessary.
17. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.



**Assembly**

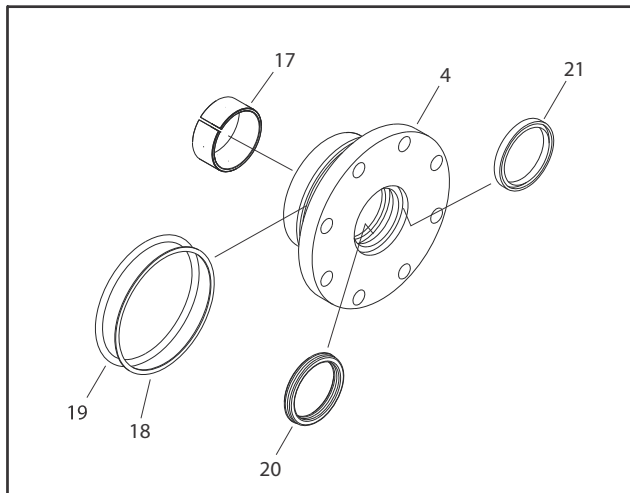
**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

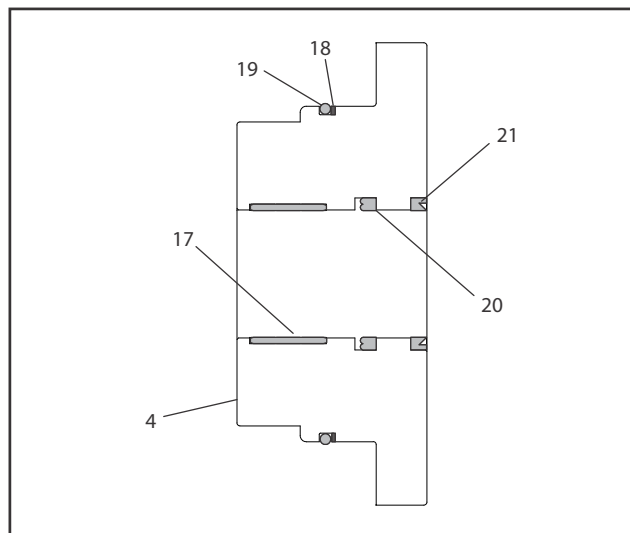
**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Install wear ring (17), rod seal (20), and wiper (21) in cylinder head (4).
2. Install new backup ring (18) and O-ring (19) in outside diameter groove of cylinder head (4).

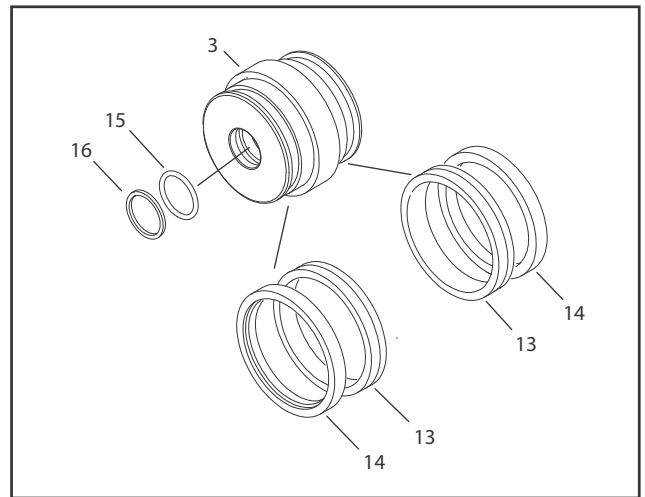


**Figure 5-107. Head Seal Kit Installation**

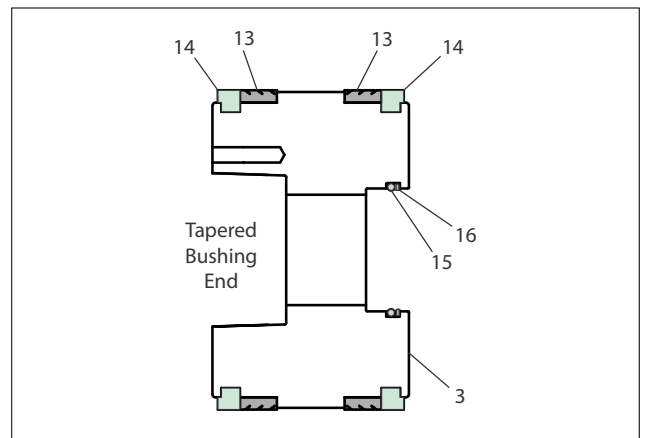


**Figure 5-108. Cylinder Head Seals**

3. Install washer ring (10) on rod (2). Carefully install cylinder head assembly on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Carefully slide spacer (6) on rod.
5. Install O-ring (15) and back-up ring (16) in piston (3).
6. Install two seals (13) and lock rings (14) in outside diameter piston grooves.



**Figure 5-109. Piston Seal Kit Installation**



**Figure 5-110. Piston Seals**

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. Do not damaged or dislodge O-ring and back-up rings.

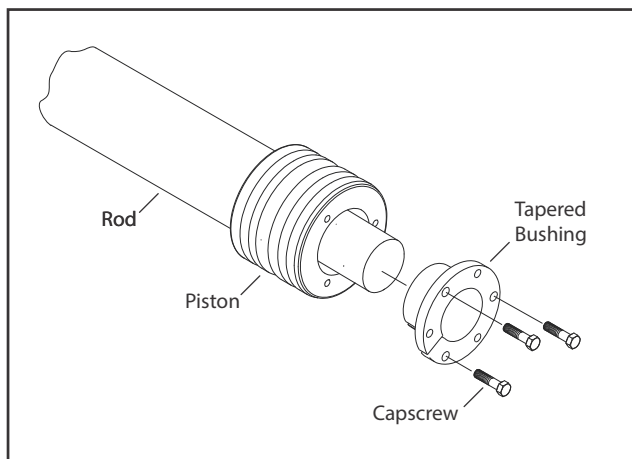
## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Piston and mating end of rod must be free of oil when installing tapered bushing.

9. Thread piston on rod until it aligns with spacer.

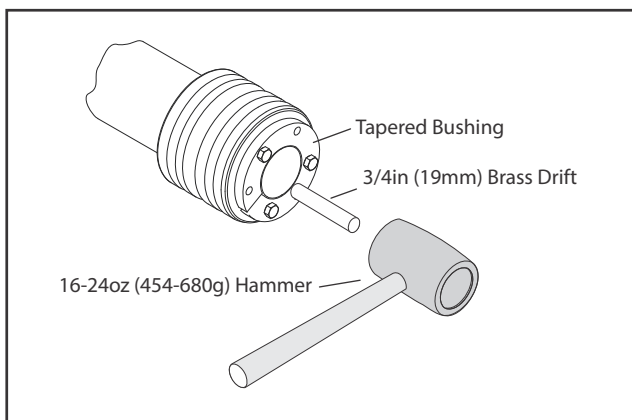
**NOTE:** Apply JLG Medium-Strength (Blue) Thread Locking Compound P/N 010011 or equivalent to new JLG furnished tapered bushing capscrews when rebuilding master, slave, lift, and telescope cylinders.

10. Insert tapered bushing loosely in the piston. Install JLG capscrews (not vendor capscrews) through drilled holes in the bushing and tapped holes in piston.



**Figure 5-111. Tapered Bushing Installation**

11. Tighten capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).
12. Set tapered bushing with a 16-24 oz (454-680g) hammer and 3/4 in (19mm) brass drift. Place drift against bushing between capscrews and tap once. Repeat for remaining two spaces between capscrews.



**Figure 5-112. Seating Tapered Bushing**

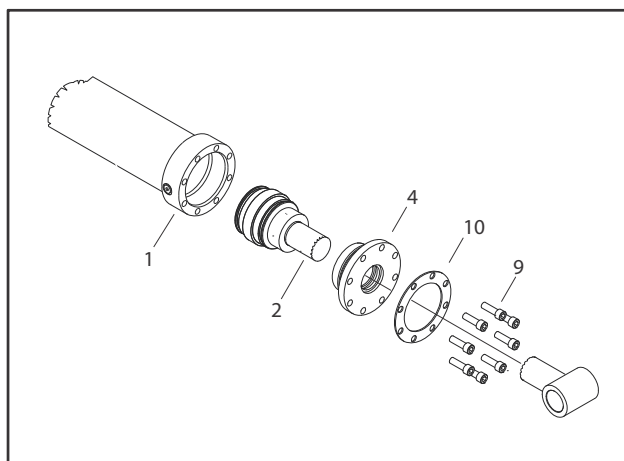
13. Re-torque capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).

14. Remove cylinder rod from holding fixture.
15. 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.**

16. Clamp barrel (1) securely and support rod (2). Insert piston in cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
17. Continue pushing rod into cylinder until cylinder head assembly (3) can be inserted into cylinder.
18. Align marks made during disassembly.
19. Apply locking primer (JLG P/N 0100038) and locking compound (JLG P/N 0100011) to eight socket head bolts (9).
20. Secure cylinder head (4) and washer ring (10) with eight socket head bolts (9).



**Figure 5-113. Rod Assembly Installation**

### Jib Lift Cylinder (600AJ Only)

Refer to Figure 5-117., Jib Lift Cylinder Assembly (600AJ).

#### 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.

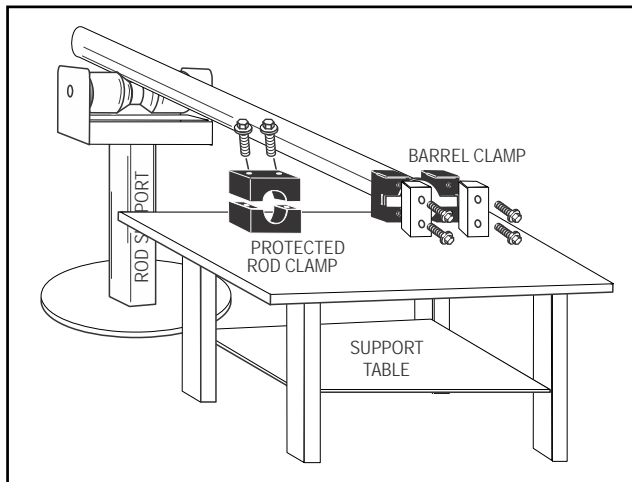


Figure 5-114. Cylinder Barrel Support

5. Mark cylinder head (1) and barrel (2) with center punch marks (3) for later realignment. Remove eight cylinder head cap screws (4).

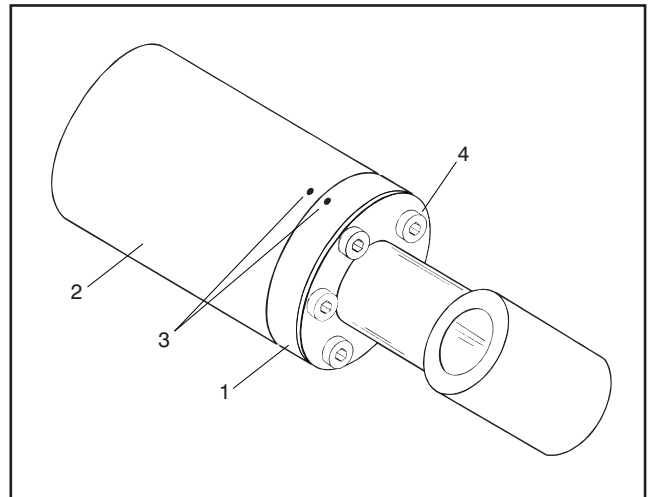


Figure 5-115. Marking Cylinder for Alignment

#### 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.

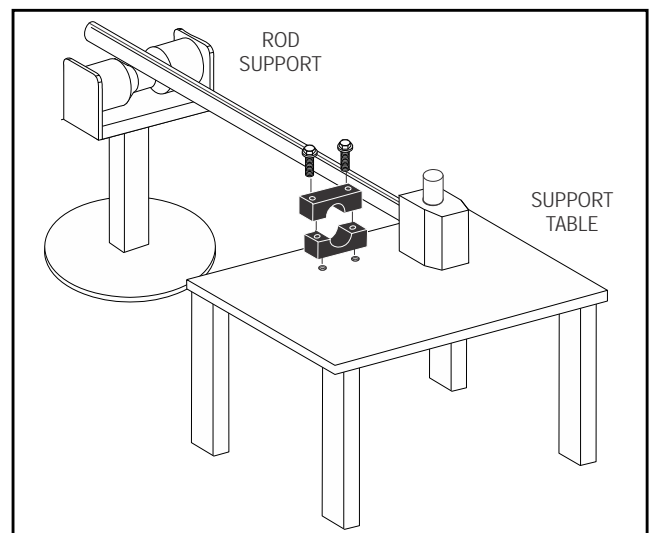
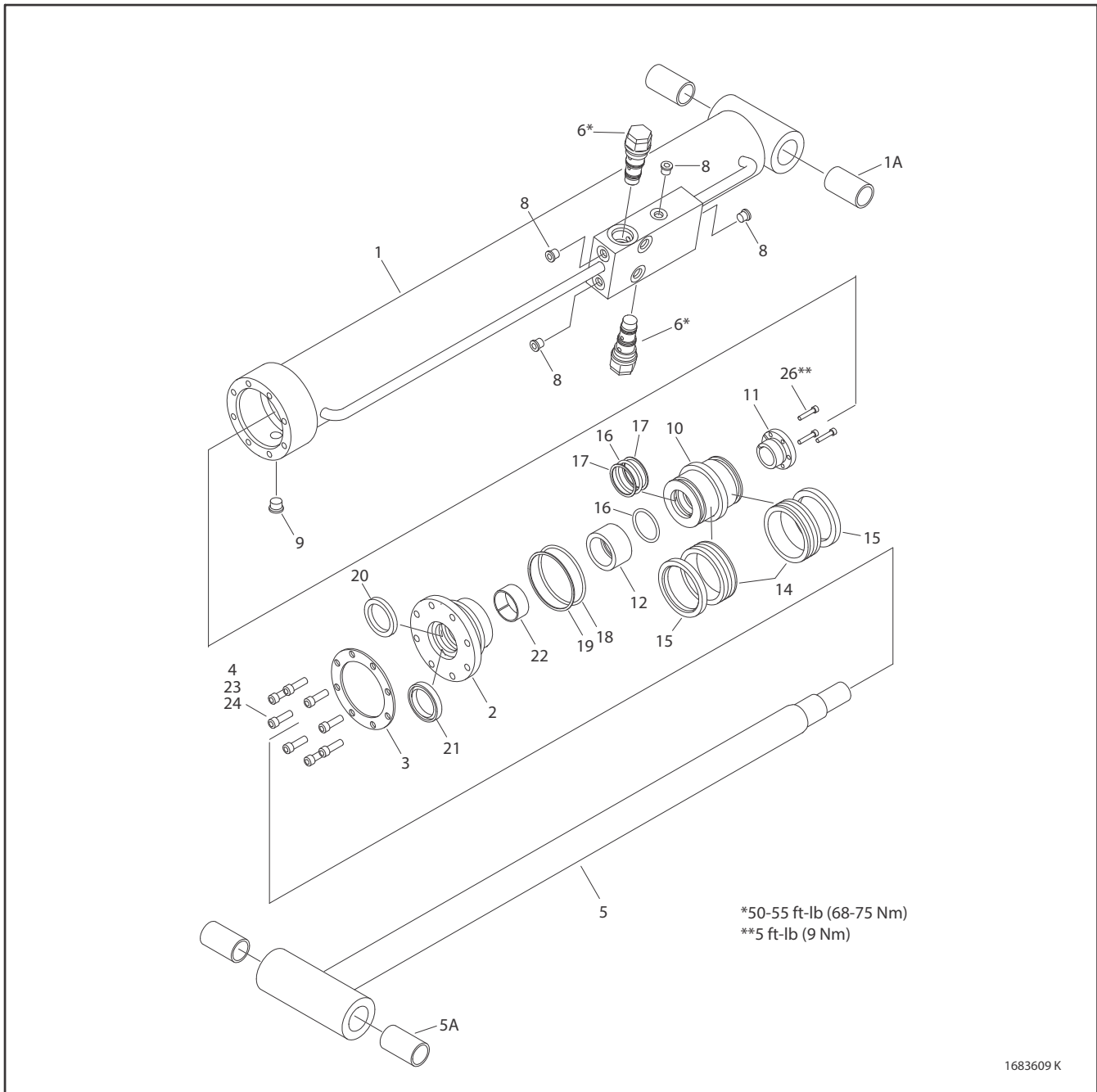


Figure 5-116. Cylinder Rod Support

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



- |                |                    |                     |                  |                      |                    |
|----------------|--------------------|---------------------|------------------|----------------------|--------------------|
| 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 5-117. Jib Lift Cylinder Assembly (600AJ)**

8. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Remove cap screws attaching tapered bushing to piston.
10. Insert cap screws in threaded holes in outer piece of tapered bushing. Progressively tighten cap screw(s) until bushing is loose on piston.
11. Remove tapered bushing from piston. Discard cap screws.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

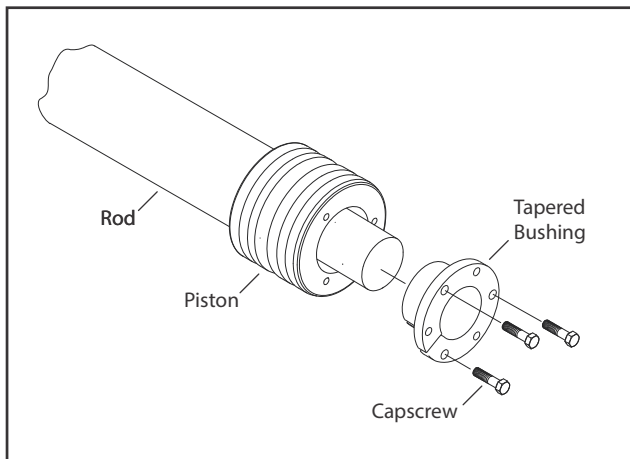


Figure 5-118. Tapered Bushing Removal

**NOTICE**

REMOVE SEALS USING A BRASS OR PLASTIC PICK ONLY. DO NOT USE A KNIFE, SHARP OBJECT, OR SCREW DRIVER. MAKE NOTE OF SEAL ORIENTATION BEFORE REMOVING FOR PROPER INSTALLATION.

13. Remove and discard backup ring (17), O-ring (16), and backup ring (17) from inside grooves of piston (10).
14. Remove and discard two lock rings (15) and seals (14) from outside grooves of piston.

15. Remove spacer (12) from rod (2). Remove and discard O-ring (16) from spacer.

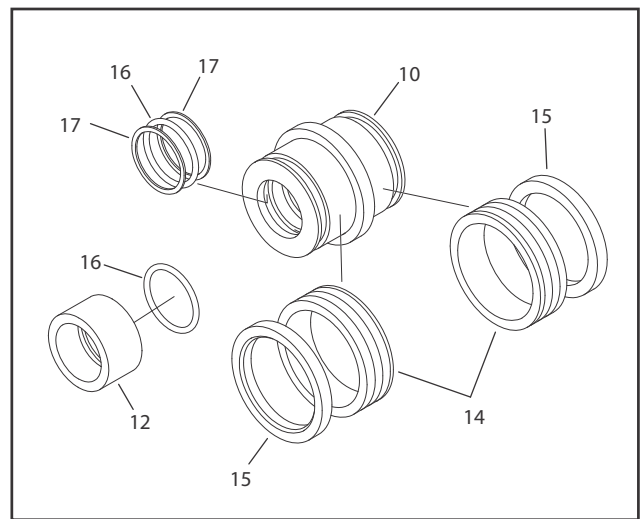


Figure 5-119. Piston And Spacer Disassembly

16. Remove rod from holding fixture. Remove cylinder head (2) and washer ring (3).
17. Remove and discard wear ring (22), wiper seal (20), and rod seal (21) from inside of cylinder head (2). Remove and discard O-ring (18) and backup ring (19) from outer grooves of cylinder head.

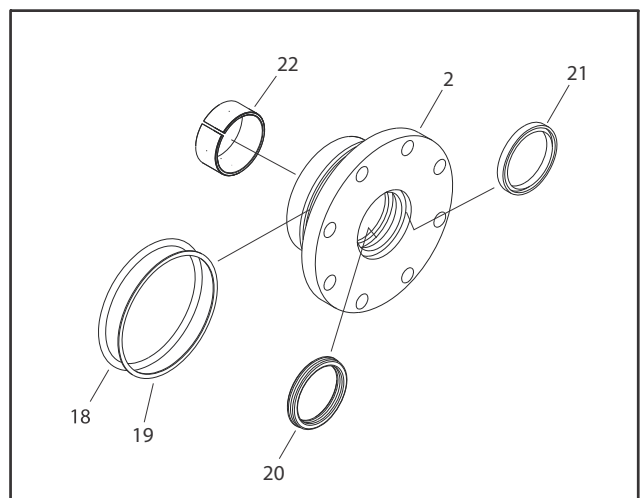


Figure 5-120. Cylinder Head Disassembly

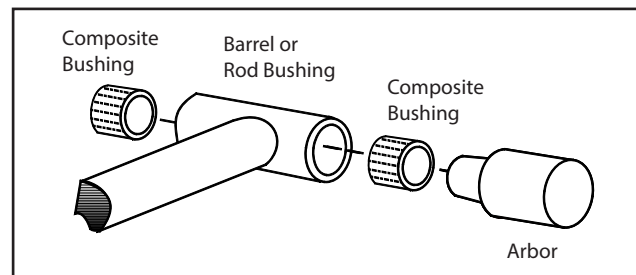
## Cleaning and Inspection

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. Inspect rod and barrel bearings for signs of 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 steel bushing with WD40 before bearing installation.

**NOTE:** Lubrication is not required with nickel plated pins and bearings. Install pin in composite bushing dry.

14. Press composite bushing into barrel or rod bushing with correct size arbor.



**Figure 5-121. Composite Bushing Installation**

15. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
16. Inspect port block fittings and cartridge valves. Replace as necessary.
17. Inspect oil ports for blockage or presence of dirt or other foreign material. Repair as necessary.

**Assembly**

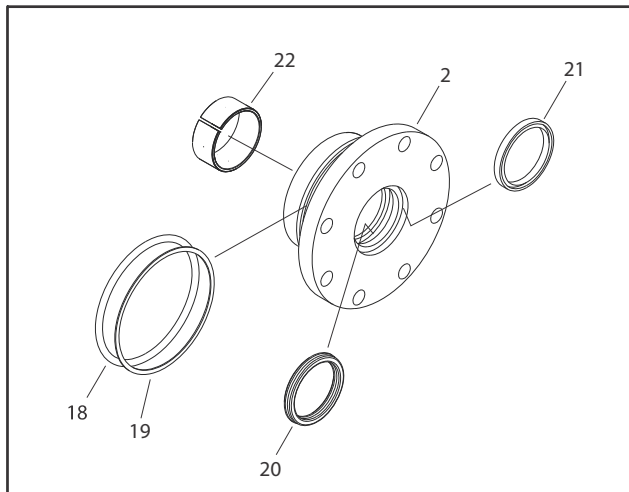
**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

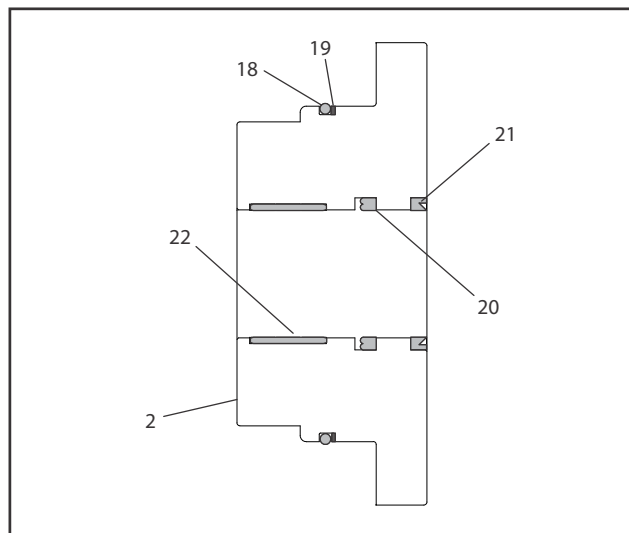
**NOTE:** Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual.

Apply a light film of hydraulic oil to all components before assembly.

1. Install wear ring (22), rod seal (20), and wiper (21) in cylinder head (2).
2. Install backup ring (19) and O-ring (18) in outside diameter groove of cylinder head (2).

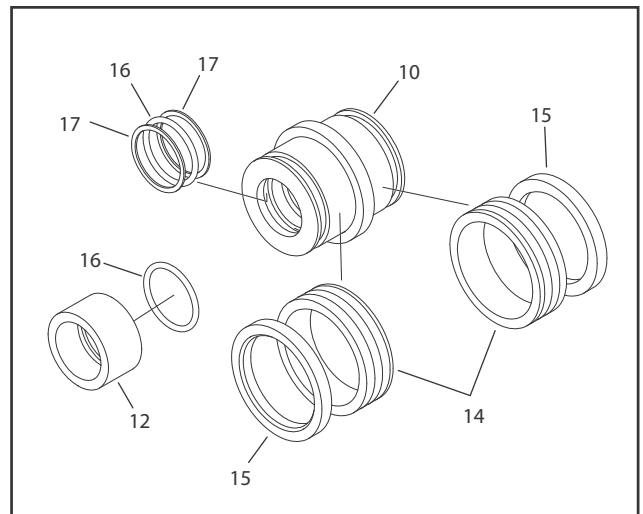


**Figure 5-122. Head Seal Kit Installation**

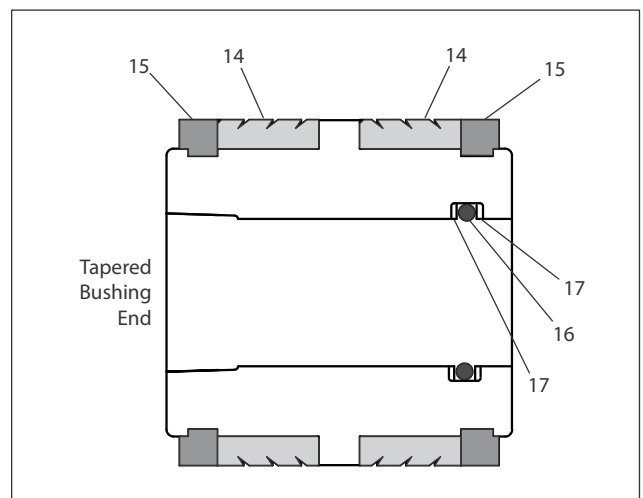


**Figure 5-123. Cylinder Head Seals**

3. Install washer ring (3) on rod (5). Carefully install cylinder head assembly on rod. Do not damage or dislodge wiper and rod seals. Push head along rod to rod end.
4. Install O-ring (16) in spacer (12). Carefully slide spacer on rod.
5. Install back-up ring (17), O-ring (16), and back-up ring (17) in piston (10).
6. Install two seals (14) and lock rings (15) in outside diameter piston grooves.



**Figure 5-124. Piston Seal Kit Installation**



**Figure 5-125. Piston Seals**

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. Do not damaged or dislodge O-ring and back-up rings.

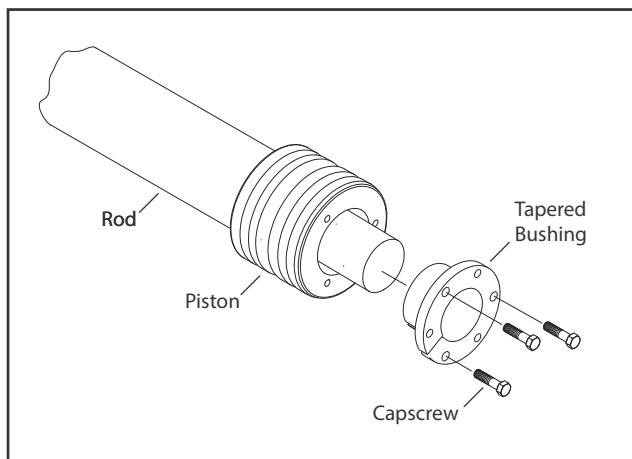
## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

**NOTE:** Piston and mating end of rod must be free of oil when installing tapered bushing.

9. Thread piston on rod until it aligns with spacer.

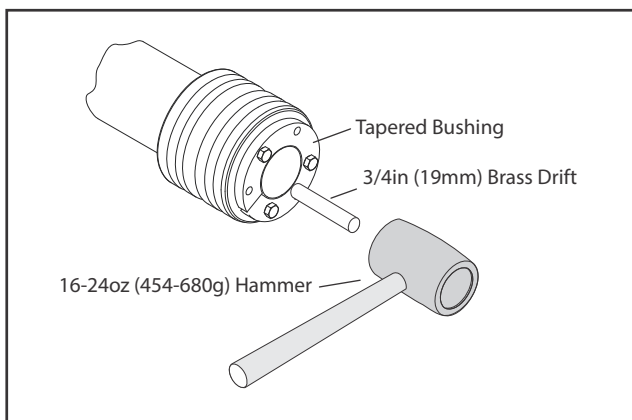
**NOTE:** Apply JLG Medium-Strength (Blue) Thread Locking Compound P/N 010011 or equivalent to new JLG furnished tapered bushing capscrews when rebuilding master, slave, lift, and telescope cylinders.

10. Insert tapered bushing loosely in the piston. Install JLG capscrews (not vendor capscrews) through drilled holes in the bushing and tapped holes in piston.



**Figure 5-126. Tapered Bushing Installation**

11. Tighten capscrews evenly and progressively in rotation to 5 ft-lb (9 Nm).
12. Set tapered bushing with a 16-24 oz (454-680g) hammer and 3/4 in (19mm) brass drift. Place drift against bushing between capscrews and tap once. Repeat for remaining two spaces between capscrews.



**Figure 5-127. Seating Tapered Bushing**

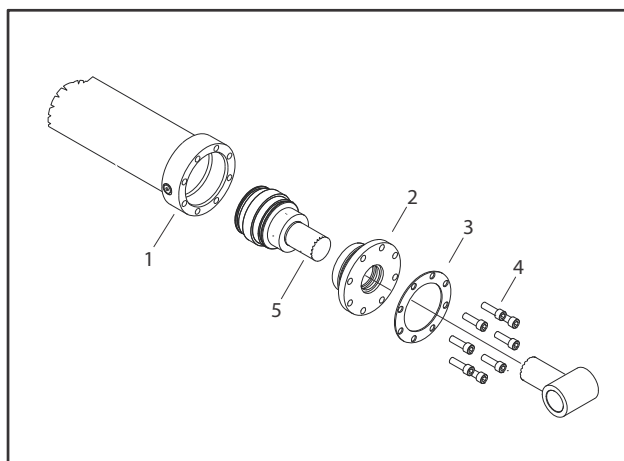
13. Re-torque capscrews evenly and progressively in rotation to 9 ft-lb (12 Nm).

14. Remove cylinder rod from holding fixture.
15. 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.**

16. Clamp barrel (1) securely and support rod (5). Insert piston in cylinder. Do not damage or dislodge piston loading O-ring and seal ring.
17. Continue pushing rod into cylinder until cylinder head assembly (2) can be inserted into cylinder.
18. Align marks made during disassembly.
19. Apply locking primer (JLG P/N 0100038) and locking compound (JLG P/N 0100011) to eight socket head bolts (4).
20. Secure cylinder head (2) and washer ring (3) with eight socket head bolts (4).



**Figure 5-128. Rod Assembly Installation**



## Steer Cylinder

### DISASSEMBLY

Refer to Figure 5-132., Steer Cylinder Assembly.

#### 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.

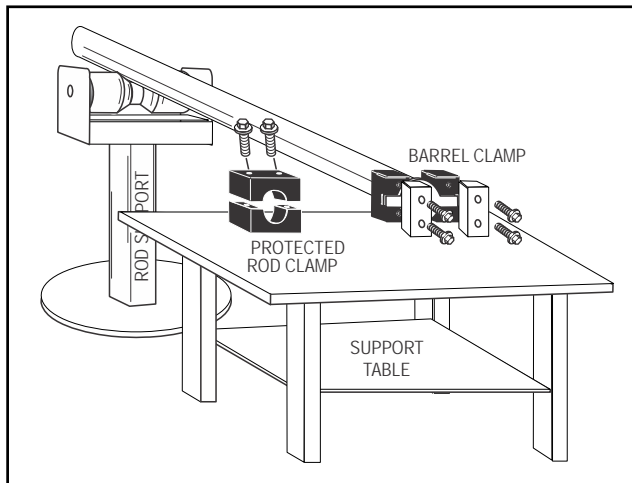


Figure 5-129. Cylinder Barrel Support

4. Remove burrs and contamination from cylinder before disassembly.

5. Unscrew Spanner Nut (13) with hook spanner.

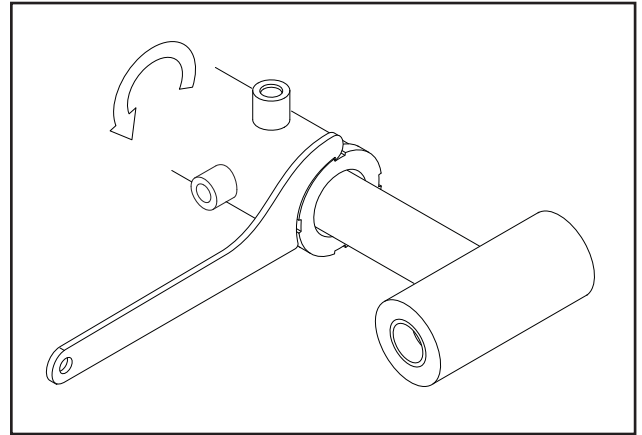


Figure 5-130. Removing Spanner Nut

#### 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.

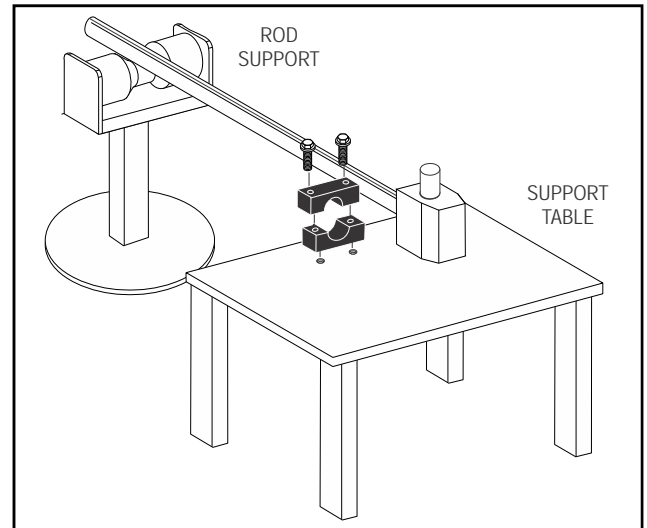
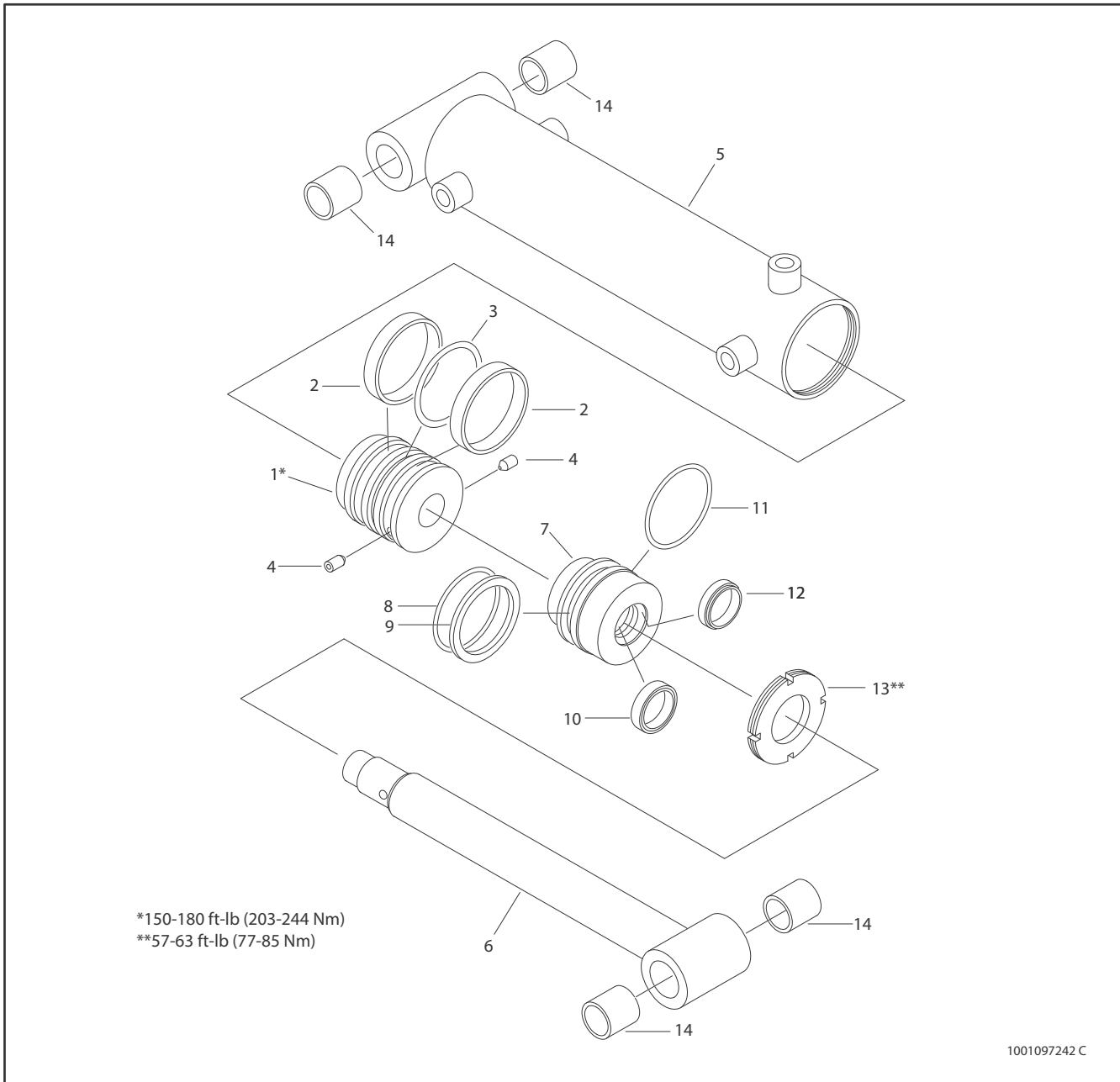


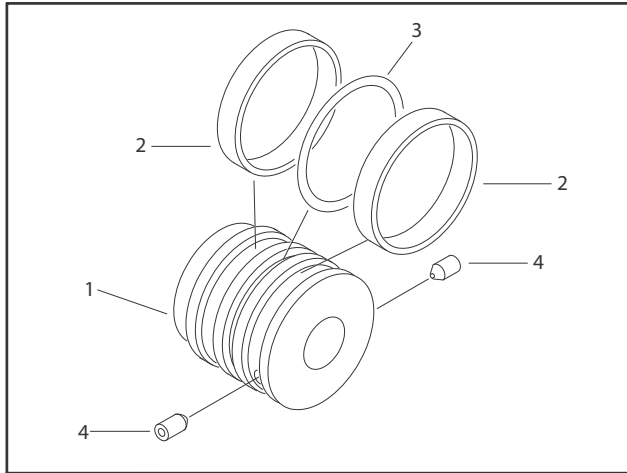
Figure 5-131. Cylinder Rod Support



- |             |           |                 |                       |
|-------------|-----------|-----------------|-----------------------|
| 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 |                 |                       |

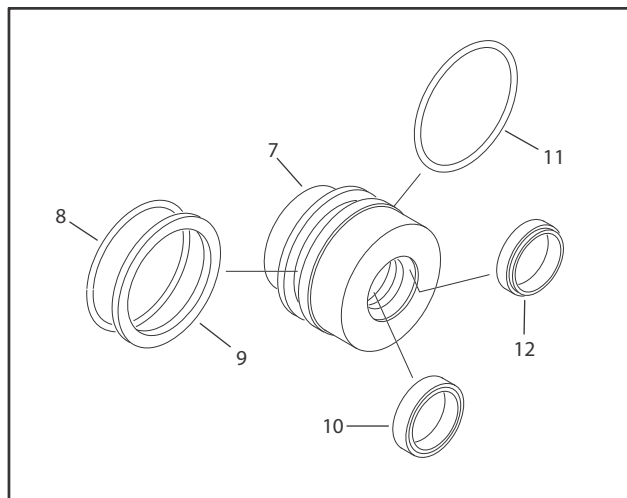
**Figure 5-132. Steer Cylinder Assembly**

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 5-133. Piston Seal and Wear Ring**

9. Remove Cylinder Head (7) from Rod (6).
10. Remove O-Ring (11), O-Ring (8), and Backup Ring (9) 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).

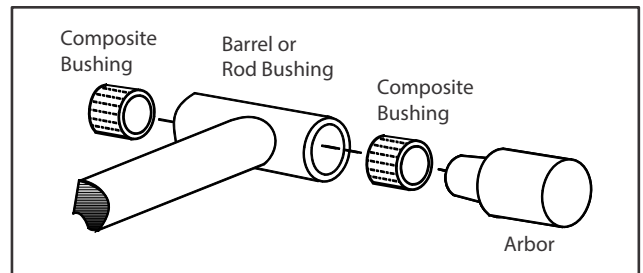


**Figure 5-134. Cylinder Head Disassembly**

### 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 5-135. 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**

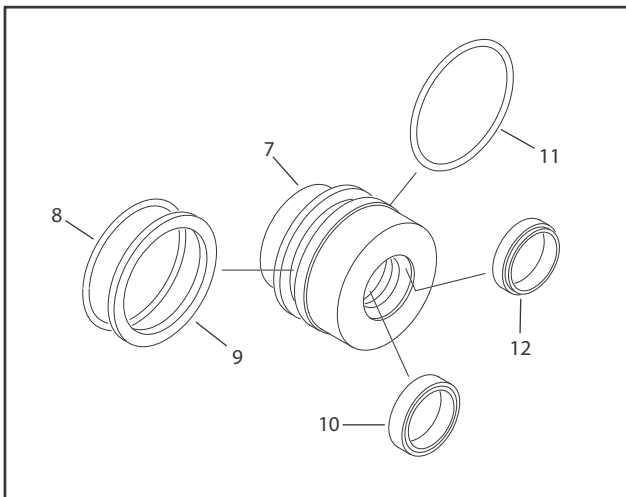
**NOTE:** Apply a light film of hydraulic oil to all components before assembly.

1. Position cylinder barrel in a suitable holding fixture.

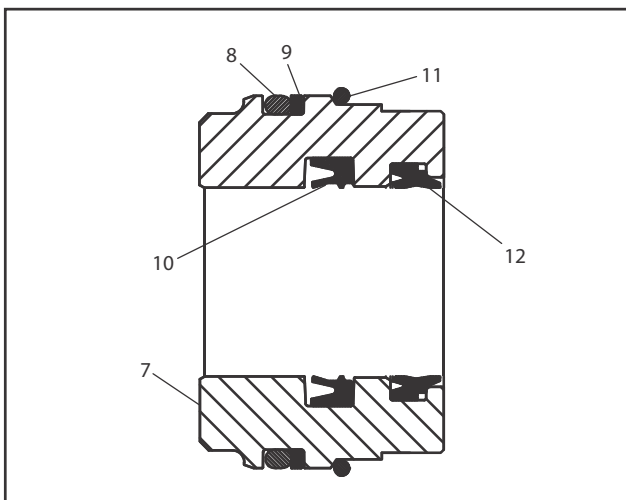
**NOTICE**

**IMPROPER SEAL INSTALLATION CAN CAUSE CYLINDER LEAKS AND IMPROPER CYLINDER OPERATION.**

2. Install Spanner Nut (13) on Rod (6).
3. Install Rod Seal (10) and Wiper (12) in Cylinder Head (7).
4. Install Backup Ring (9), O-Ring (8), and O-Ring (11).

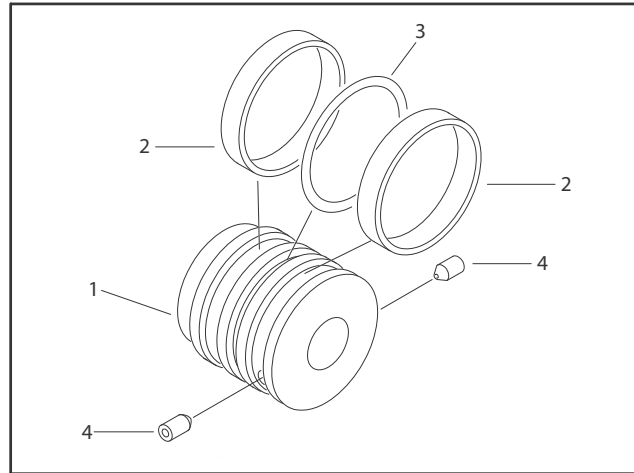


**Figure 5-136. Cylinder Head Assembly**

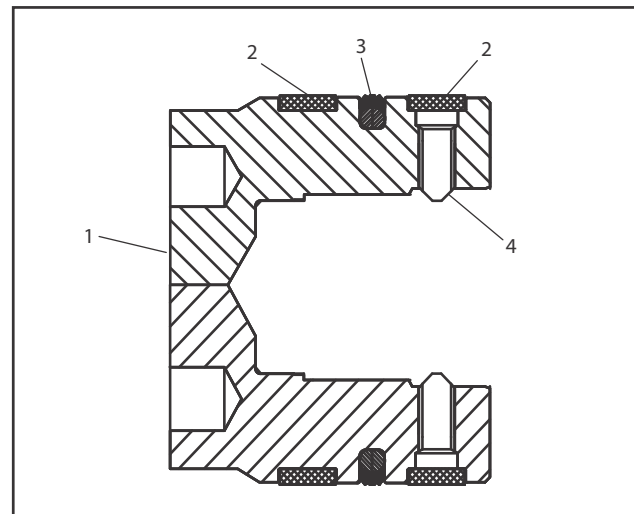


**Figure 5-137. Cylinder Head Seals**

5. Install O-Ring (3) and two seals (2) in piston groove.



**Figure 5-138. Piston Seal and Wear Ring Assembly**



**Figure 5-139. Piston Seals**

**NOTICE**

**INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE INSTALLING CYLINDER ROD AND PISTON.**

6. Insert rod assembly in barrel.
7. Apply locking primer (JLG P/N 0100038) and thread locking compound (JLG P/N 0100011) to spanner nut threads (3).
8. Tighten spanner nut with hook spanner to 57-63 ft-lb (77-85 Nm).

## Axle Lockout Cylinder

**NOTE:** Refer to Figure 5-140., 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.

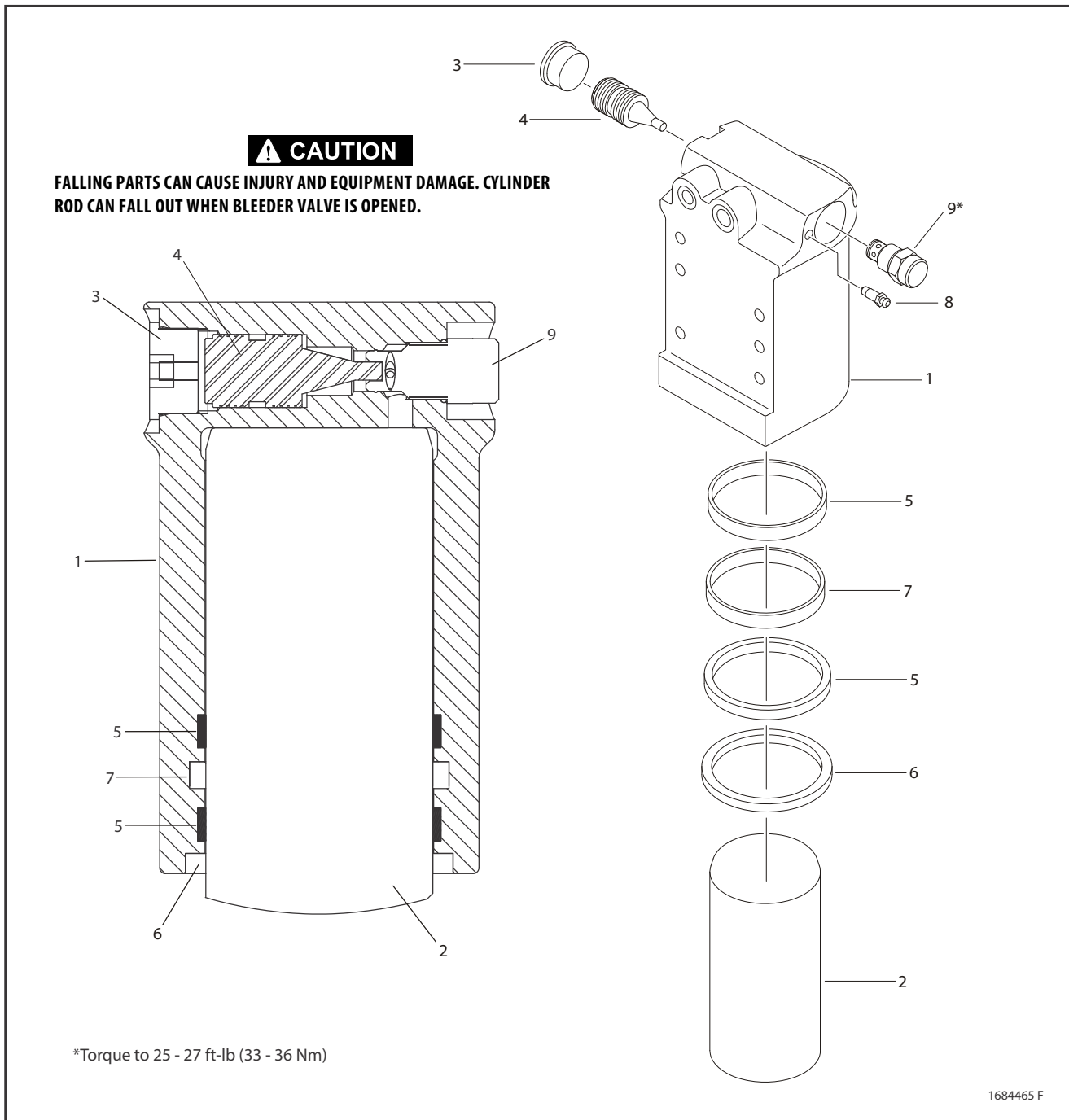
### ASSEMBLY

8. Install two new wear rings (5) and rod seal (7) in piston bore grooves. Make sure they are not twisted.
9. Install new wiper (6) in housing.
10. 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.

11. Install piston (2) in bore and push to top of bore.
12. Install check valve (9). Torque to 25 - 27 ft-lb (33 - 36 Nm).
13. Bleed system.



- |           |                 |                    |
|-----------|-----------------|--------------------|
| 1. Barrel | 4. Pilot Piston | 7. Rod Seal        |
| 2. Rod    | 5. Wear Ring    | 8. Bleeder         |
| 3. Plug   | 6. Wiper        | 9. Cartridge Valve |

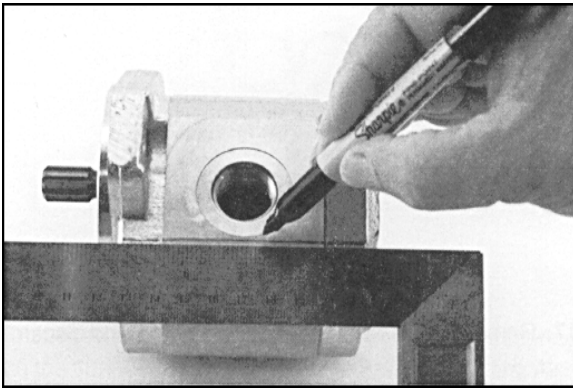
Figure 5-140. Axle Lockout Cylinder

## 5.6 HYDRAULIC PUMP (GEAR)

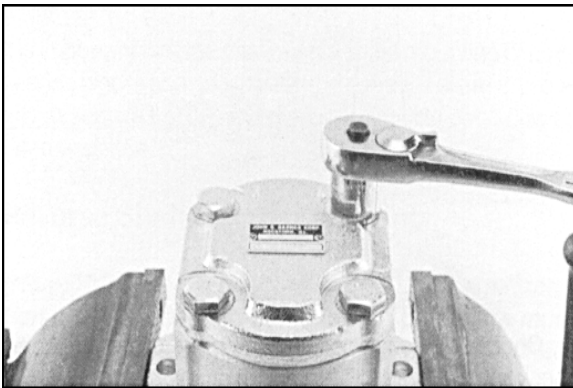
### Disassembly

**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.

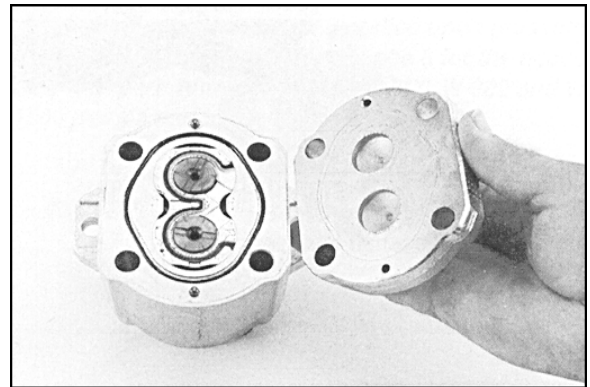


3. Use a permanent marker pen to mark a line across mounting flange, gear housing and end cover. This will assure proper reassembly and rotation of pump.
4. Remove key from drive shaft if applicable.

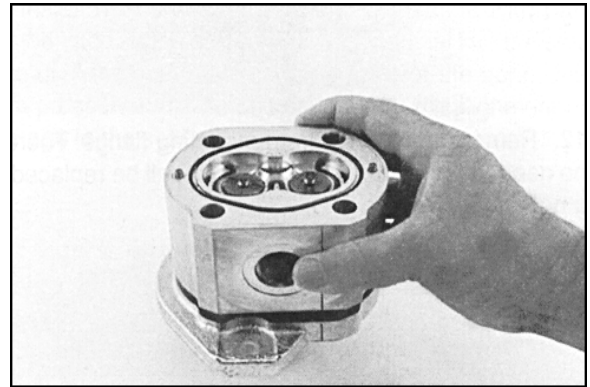


5. Clamp mounting flange in a protected jaw vise with pump shaft facing down.
6. Loosen four metric hex head bolts.

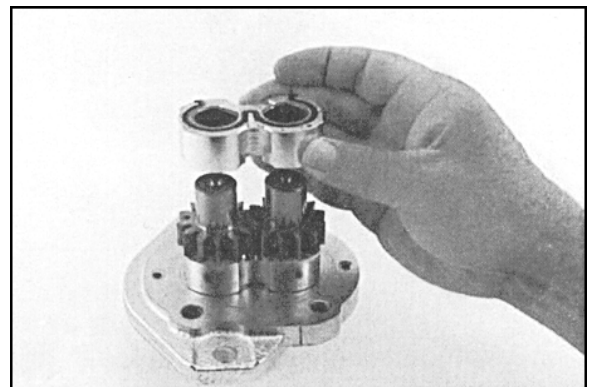
7. Remove pump from vise and place on clean work bench. Remove four hex head bolts and spacers if applicable.



8. Lift and remove end cover.

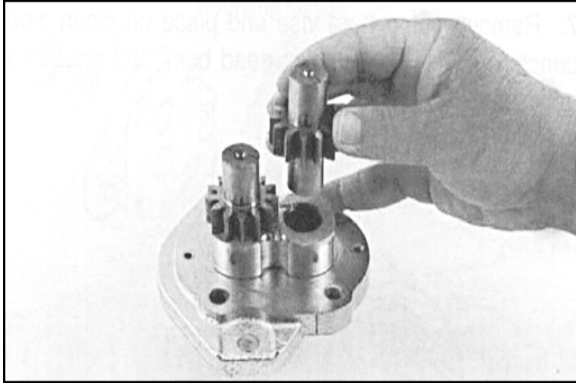


9. Carefully remove gear housing and place on work bench. Make sure rear bearing block remains on drive and idler shafts.

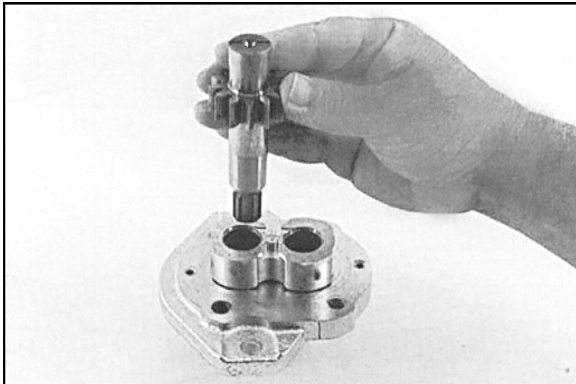


## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

10. Remove rear bearing block from drive and idler shafts.

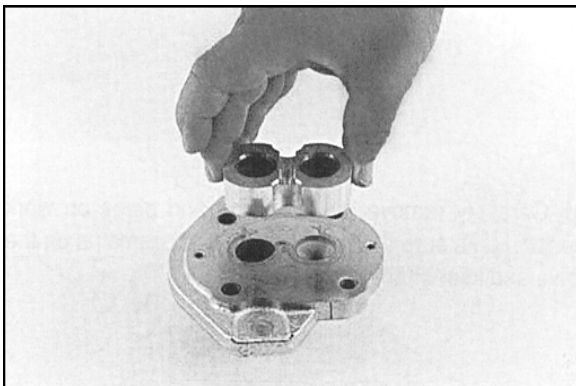


11. Remove idler shaft from bearing block.

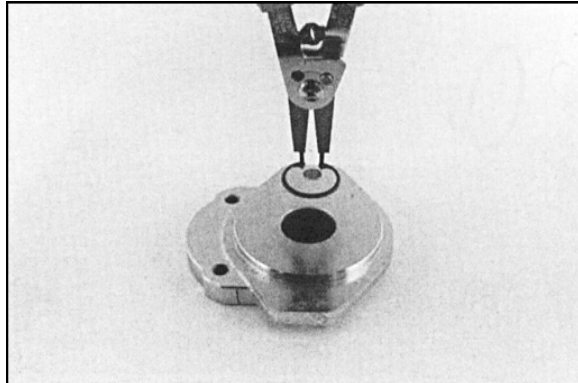


12. Remove drive shaft from mounting flange.

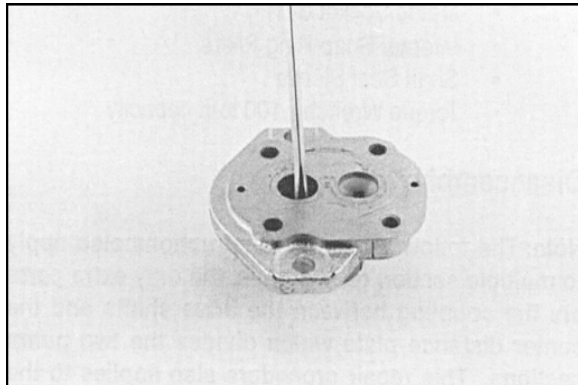
**NOTE:** Shaft seal will be replaced.



13. Remove front bearing block.

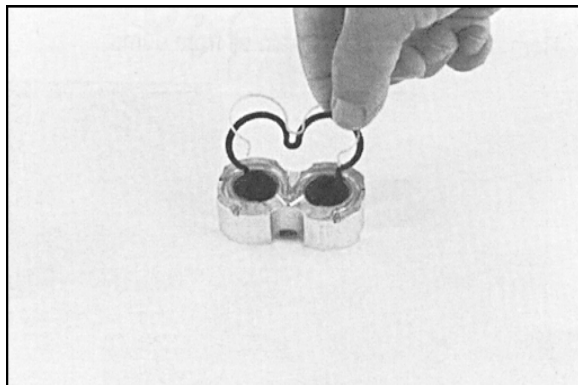


14. Turn mounting flange over, with shaft seal up. Remove retaining ring with snap ring pliers.



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.

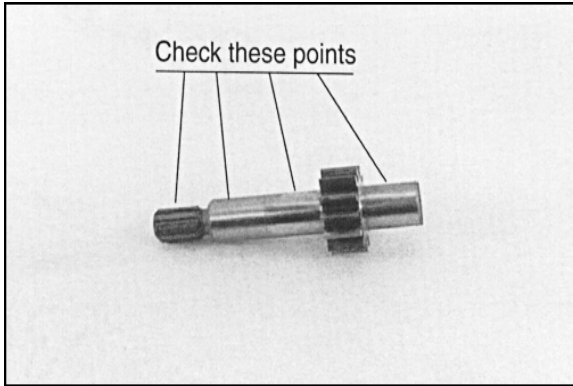


17. Remove and discard seals from both bearing blocks.

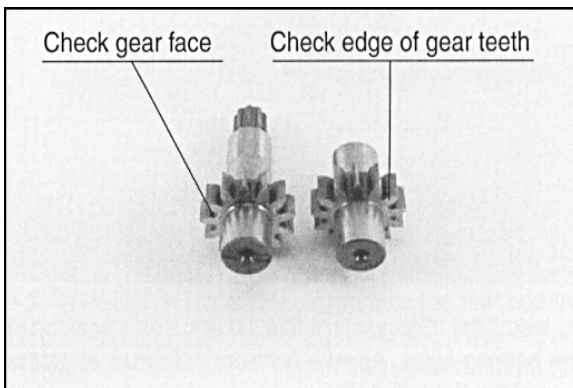


### Inspect Parts For Wear

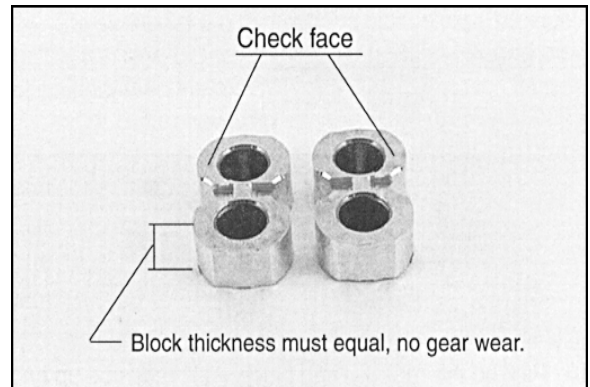
1. Clean and dry all parts thoroughly before inspection. It is not necessary to inspect seals. They will be placed as new items.



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.

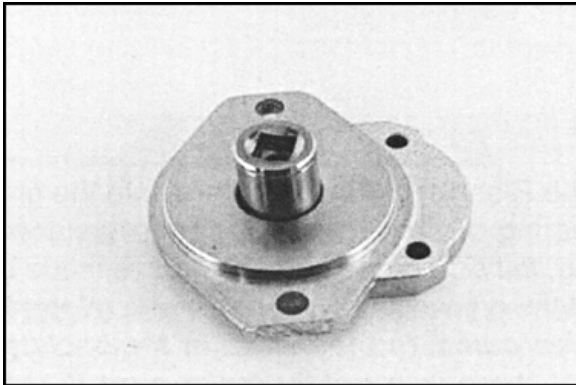
## Reverse Shaft Rotation of Pump

**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.

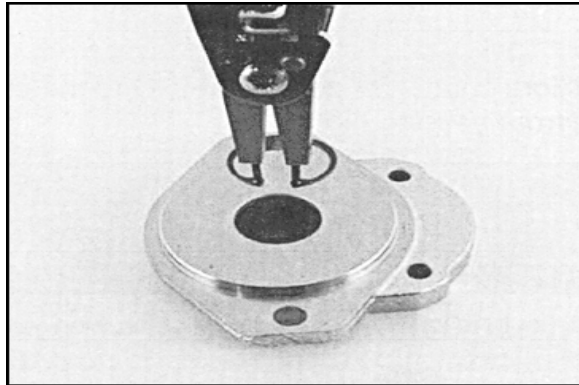
## Assembly

**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.

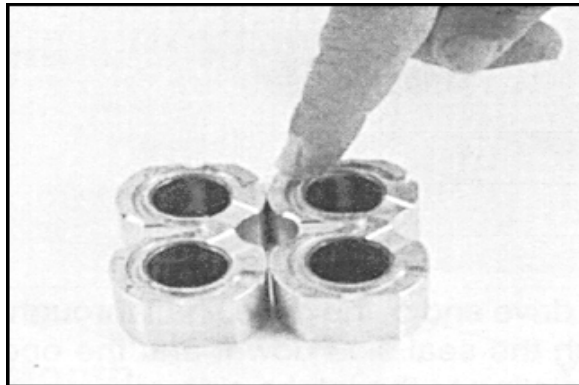


1. Install new shaft seal in mounting flange with part number side facing out. Press seal into seal bore until seal reaches bottom of bore. Use uniform pressure to prevent seal misalignment or damage.

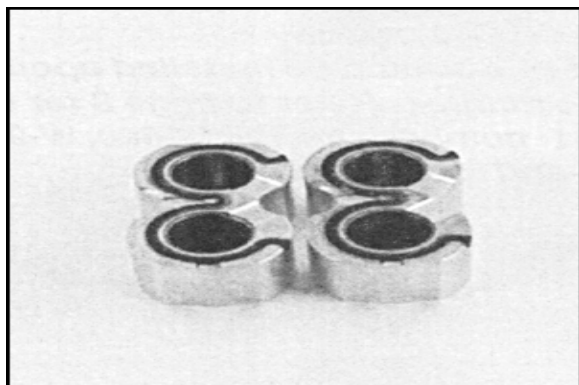
2. Install retaining ring in groove in seal bore of mounting flange.



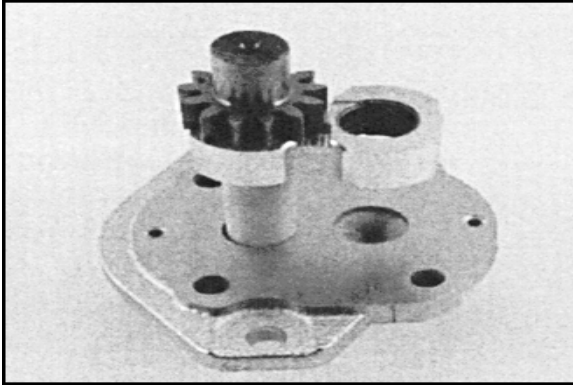
3. Place front and back bearing blocks on a clean surface with E-seal grooves facing up. Apply a light coating of petroleum jelly in the grooves. Coat E-seal and backup with petroleum jelly. This helps keep seals in place during reassembly



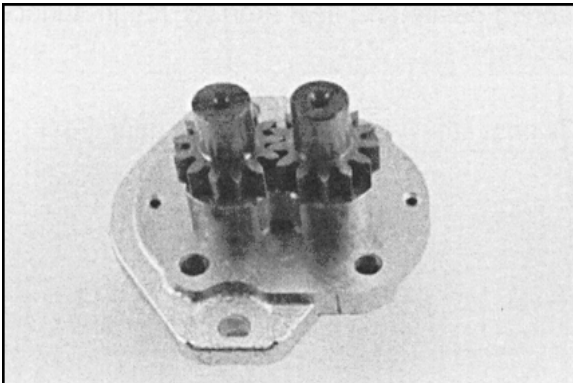
4. Place E-seals, flat side out, into grooves in both bearing blocks. Carefully place backup ring, flat side out, in groove made by E-seal and groove in bearing block. (Note: W900 series pump - In center of backup ring and E-seal there is a notch. Make sure notches line up so backup ring will set flush with E-seal). Backup ring in W1500 pump is symmetrical.



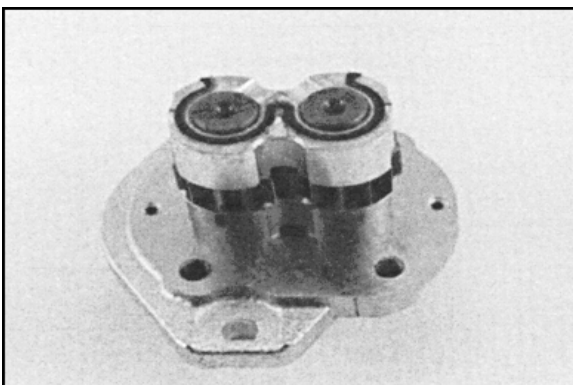
5. Place mounting flange, with shaft seal side down, on a clean flat surface.
6. Apply a light coating of petroleum jelly to exposed face of front bearing block.



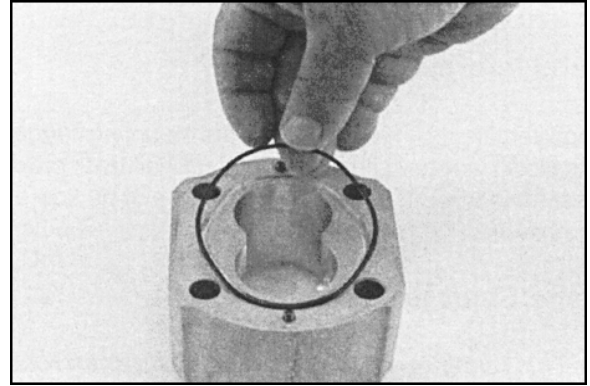
7. Insert drive end of drive shaft through bearing block with seal side down and open side of E-seal pointing to intake side of pump.
8. Install seal sleeve over drive shaft. Carefully slide drive shaft through shaft seal. Remove seal sleeve from shaft.



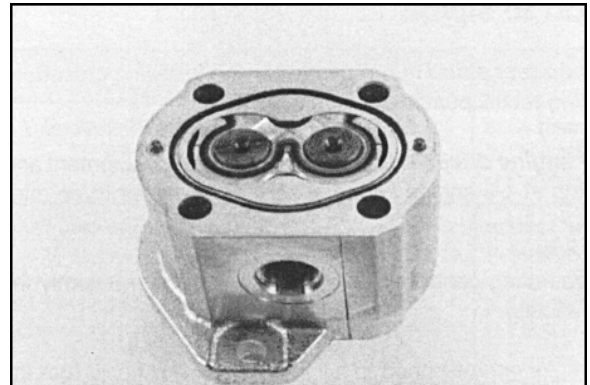
9. Install idler gear shaft in remaining position in bearing block. Apply a light coat of clean oil to face of drive and idler gears.



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.



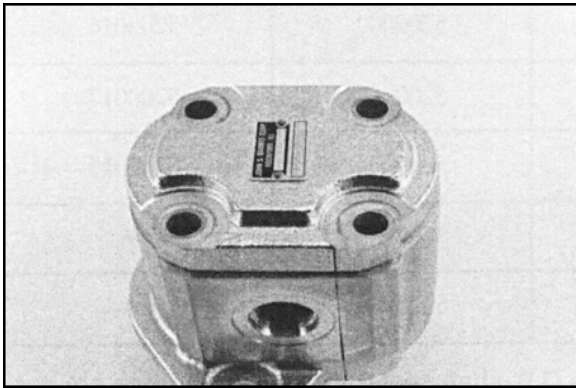
12. Apply a light coating of petroleum jelly in grooves on both sides of gear housing. Coat new O-rings and install in grooves.



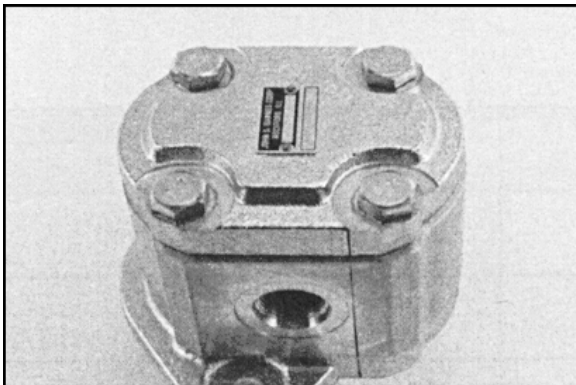
## SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

- 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.

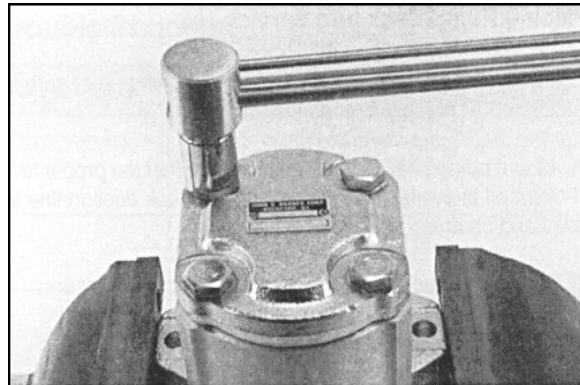
**NOTE:** Rear bearing block surface should be slightly below gear housing face. If bearing block is higher than rear face of gear housing, E-seal or O-ring have shifted out of groove. Remove gear housing and check for proper seal installation.



- 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 (35 bar) for three minutes.
  - d. Intermittently load pump to 1000 psi (60 bar) for three minutes.
  - e. Intermittently load pump to 2000 psi (120 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	600	9/16-18ORF
M3	Charge	1000	60	3/4-16ORF
M4&M5	Servo	1000	60	9/16-18ORF
L1&L2	Case	500	35	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.

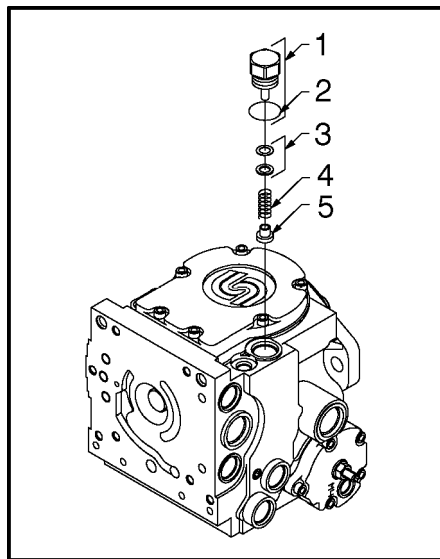
1. Remove servo piston cover.
2. Remove orifice plug (1/8" Int. Hex).
3. Examine orifice and port for cleanliness.
4. Install orifice plug. Torque to 1.5 - 2.5 ft-lb (2.0-3.4 Nm).

### 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

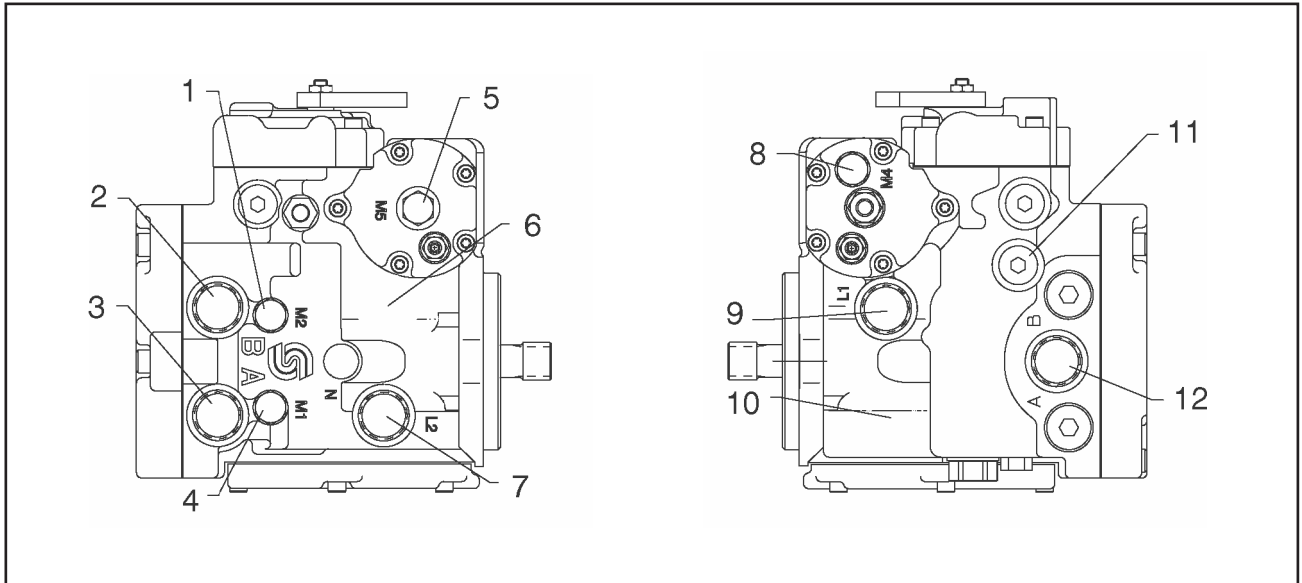


- |           |                  |
|-----------|------------------|
| 1. Plug   | 4. Spring T-Seal |
| 2. O-Ring | 5. Poppet        |
| 3. Shims  |                  |

**Figure 5-141. 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 5-142. Gauge Port Locations

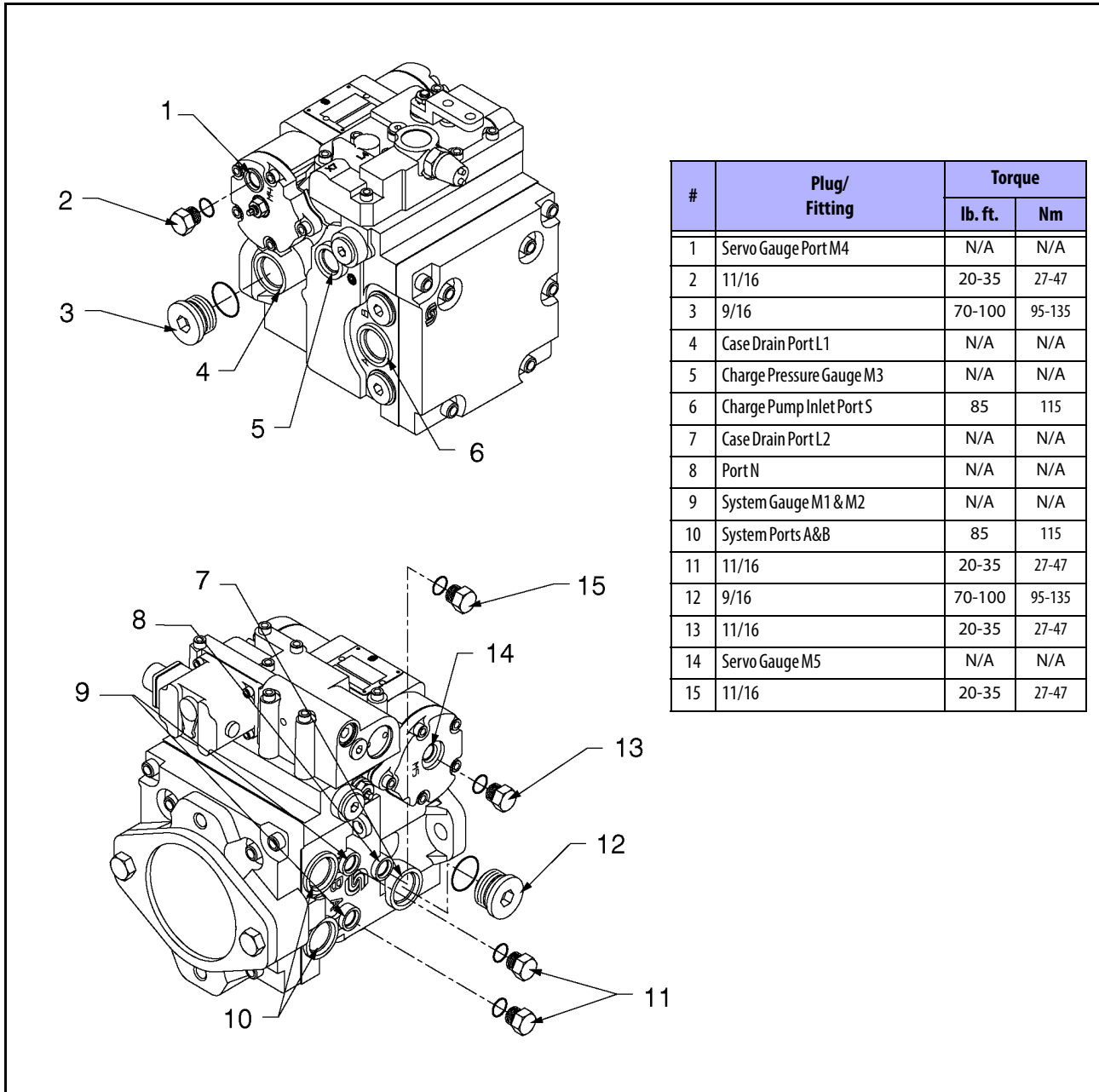
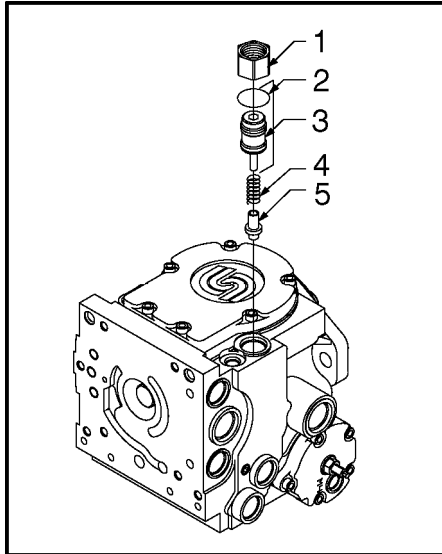


Figure 5-143. Plugs/Fittings Size & Torque



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**

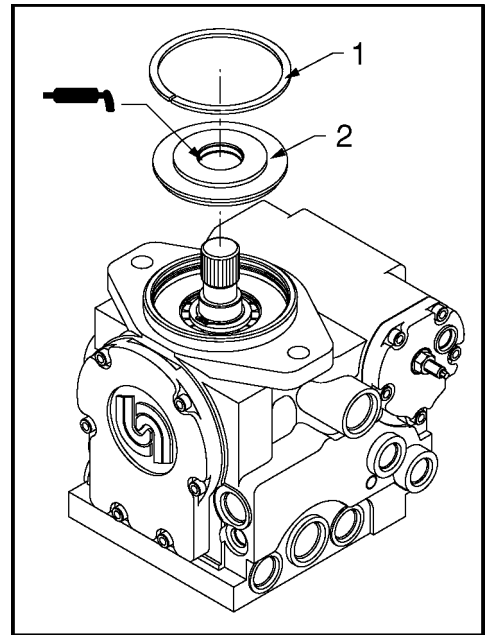


- |             |                  |
|-------------|------------------|
| 1. Lock Nut | 4. Spring-T-Seal |
| 2. O-Ring   | 5. Poppet        |
| 3. Plug     |                  |

**Figure 5-144. 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.

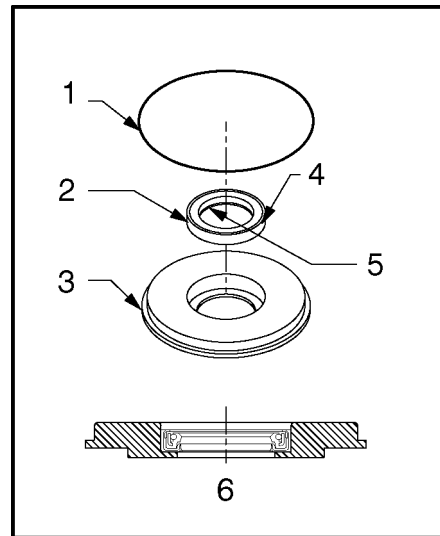
**Shaft Seal and Shaft Replacement**



- |                   |                          |
|-------------------|--------------------------|
| 1. Retaining Ring | 2. Seal Carrier Assembly |
|-------------------|--------------------------|

**Figure 5-145. 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.



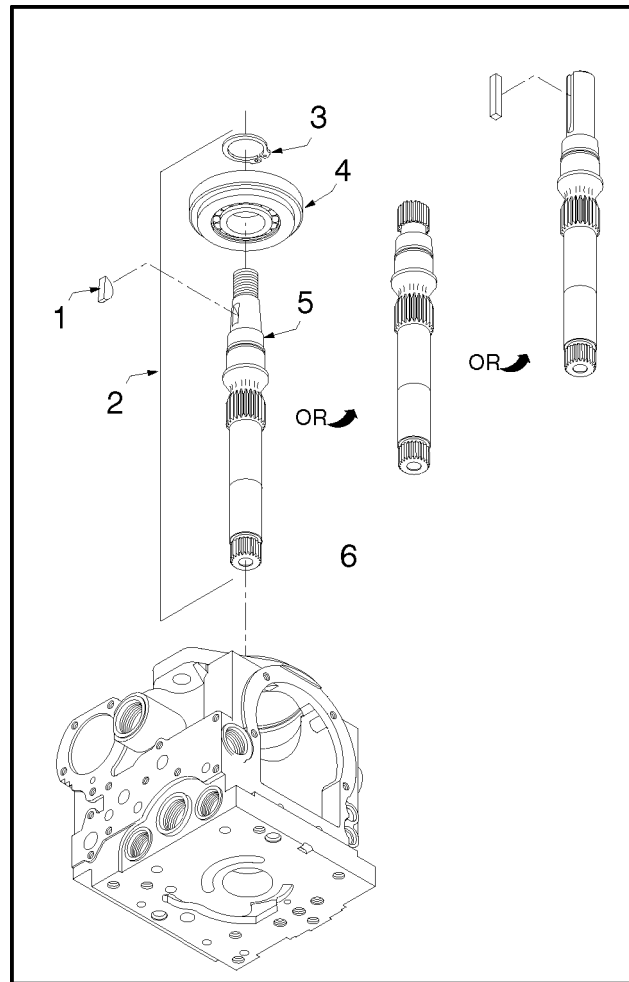
- |                 |  |
|-----------------|--|
| 1. O-Ring       | 4. Sealant may be used on outside diameter |
| 2. Seal         | 5. Inside Lip (face down)                  |
| 3. Seal Carrier | 6. Press Seal to Bottom of Seal Carrier    |

**Figure 5-146. Shaft Seal Installation**

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  
2. Shaft Assembly  
3. Retaining Ring  
4. Roller Bearing  
5. Shaft  
6. Seal Carrier Assembly

**Figure 5-147. 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.

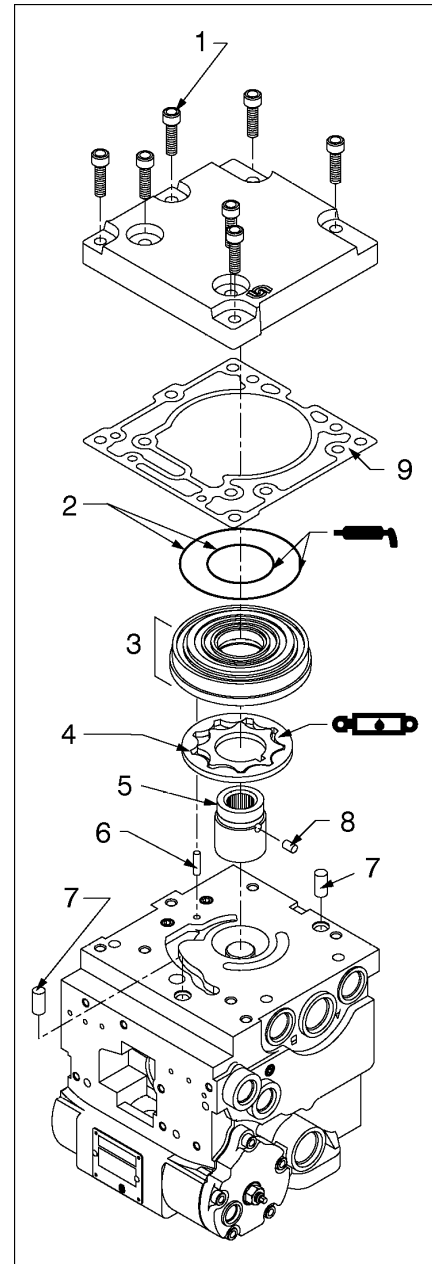
## Charge Pump

**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 5-148. 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 is 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 5-151., Main Control Valve - 4WS (SN 0300181175 to Present).

### NOTICE

**COLD TEMPERATURES HAVE A SIGNIFICANT IMPACT ON PRESSURE READINGS. JLG INDUSTRIES, INC. RECOMMENDS OPERATING MACHINE UNTIL THE HYDRAULIC SYSTEM HAS WARMED TO NORMAL OPERATING TEMPERATURES BEFORE 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 (9).
2. Activate upper telescope in.
3. Adjust main relief valve (16) to 3000 psi (206.85 bar). Turn adjuster clockwise to increase or counterclockwise to decrease pressure.

### Upper (Main) Lift Down

1. Install high pressure gauge in port MP (9).
2. Activate upper lift down.
3. Adjust lift down relief (6) to 1500 psi (103 bar). Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

### Swing

**NOTE:** Left and right swing pressures are set with one adjustment.

1. Install high pressure gauge in port MP (9).
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 (21) 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 (9).
2. Activate steer left and right.
3. Adjust front steer relief valves (14) 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 (9).
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 (14, 24) to 2850 psi (196 bar) in both directions. Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

## 5.10 PLATFORM VALVE BLOCK PRESSURE SETTINGS

Refer to Figure 5-152., Location of Components - Platform Control Valve Block

### Platform Level Extend

1. Install high pressure gauge in port M1 (2).
2. Activate level up to end of stroke.
3. Adjust level up relief (1) to 2800 psi (193 bar). Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

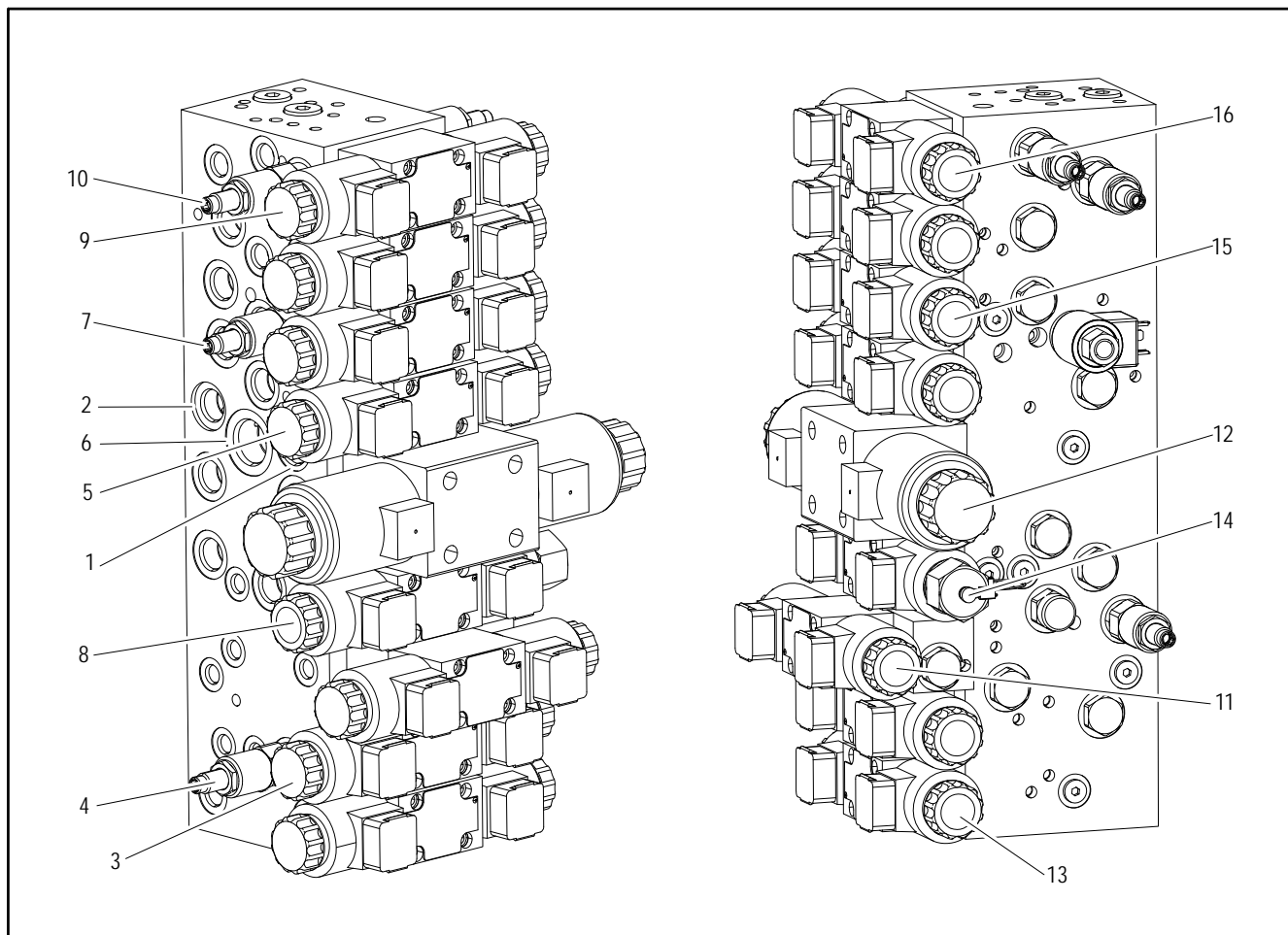
### Platform Level Retract

1. Install high pressure gauge at quick disconnect on port M2 (4).
2. Activate level down to end of stroke.
3. Adjust level down relief (3) to 1800 psi (124 bar). Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.

### Articulating Jib

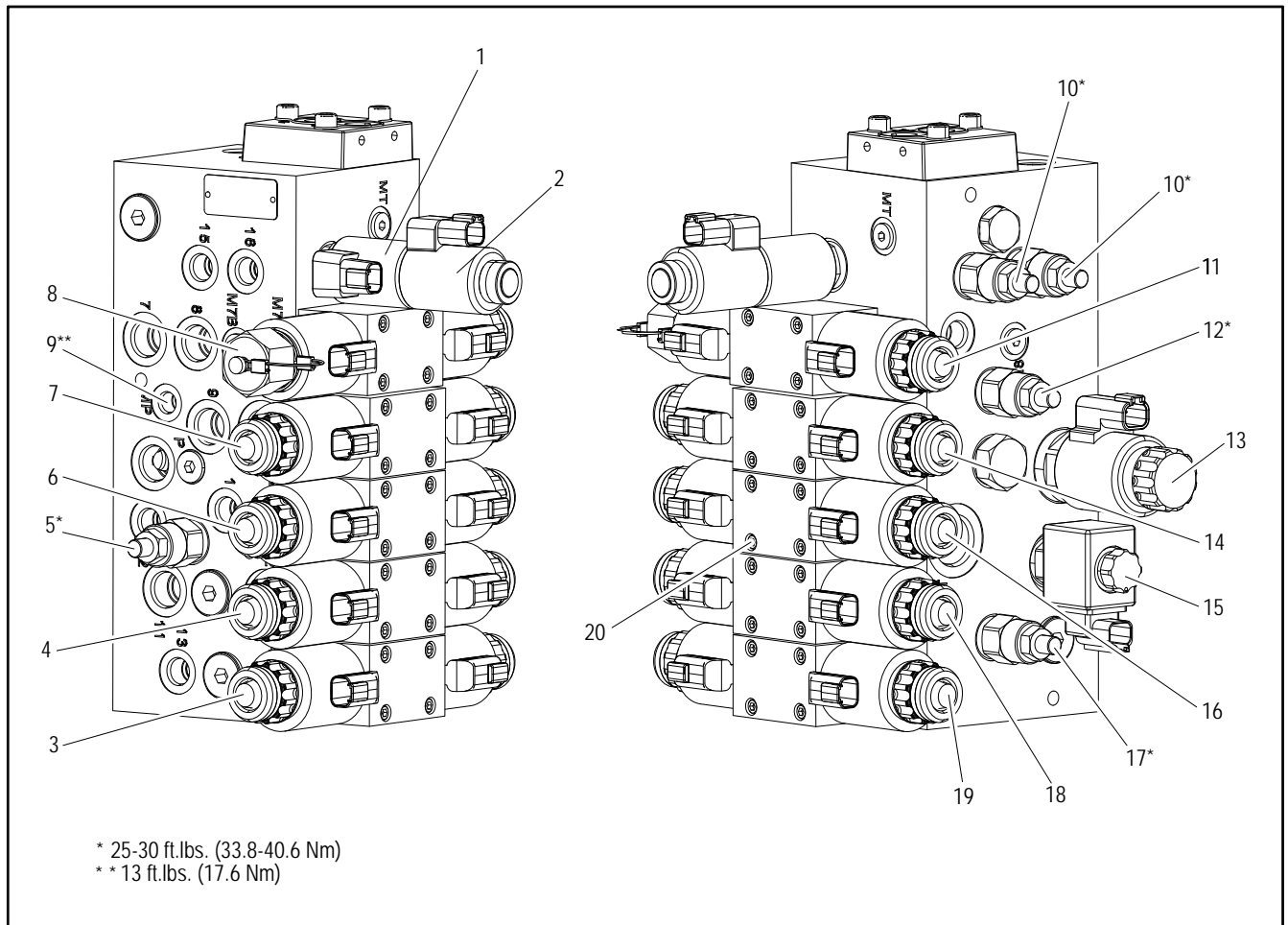
**NOTE:** Relief pressure is bi-directional, but can only be read in one direction.

1. Install high pressure gauge in port M3 (13).
2. Activate jib extend to end of stroke.
3. Adjust jib relief (14) to 1500 psi (103 bar). Turn adjuster clockwise to increase pressure or counterclockwise to decrease pressure.



- |   |  |  |
|---|--|--|
| 1. Pressure Control Load Sense Valve          | 7. Direct Operated Relief Valve                  | 13. Directional Control Valve (Tower Tele) |
| 2. Main Relief Valve Direct Operated          | 8. Directional Control Valve (Upper Lift)        | 14. Rotate Sandwich Check Valve            |
| 3. Directional Control Valve (Platform Level) | 9. Directional Control Valve (Main Lift)         | 15. Directional Control Valve (Main Lift)  |
| 4. Direct Operated Relief Valve               | 10. Directional Control Valve (Steer)            | 16. Directional Control Valve (Steer)      |
| 5. Load Shuttle Valve                         | 11. Directional Control Valve (Platform Rotator) |  |
| 6. Load Shuttle Valve                         | 12. Directional Control Valve (Main Tele)        |  |

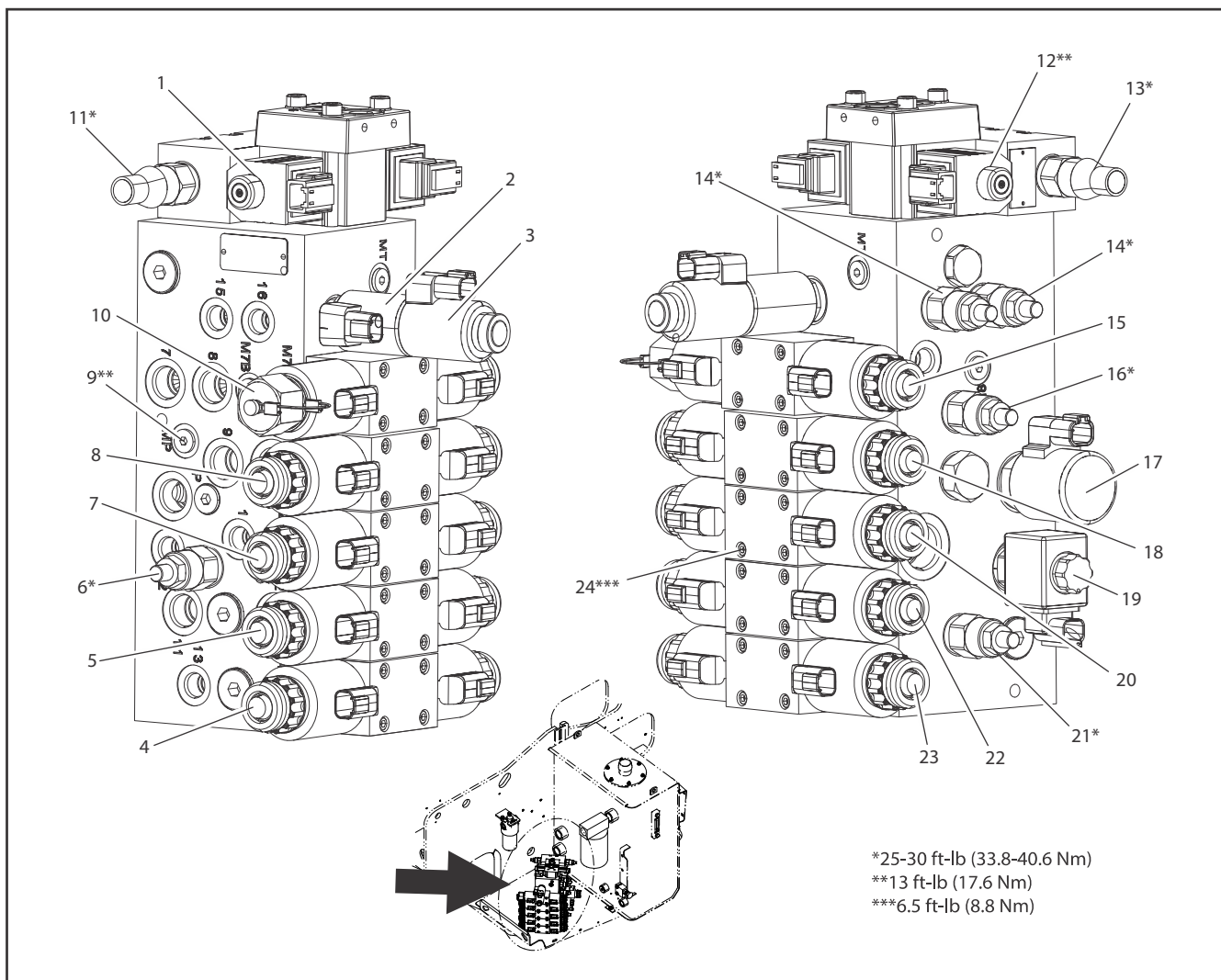
**Figure 5-149. Main Control Valve (SN 0300177361 through 0300181174)**



- |  |                                     |  |
|--|-------------------------------------|--|
| 1. Front Steer Left                      | 8. Tower Lift Down                  | 15. Direct Control Dump Valve                        |
| 2. Front Steer Right                     | 9. Test Port MP                     | 16. Tower Telescope Out                              |
| 3. Swing Right                           | 10. Front Steer Pressure Relief     | 17. Main Upper Boom Pressure Relief                  |
| 4. Main Lift Down                        | 11. Tower Lift Up                   | 18. Main Lift Up                                     |
| 5. Main Upper Boom Pressure Relief Valve | 12. Main Upper Boom Pressure Relief | 19. Swing Left                                       |
| 6. Tower Telescope In                    | 13. Flow Control                    | 20. Front Steer Pressure Relief                      |
| 7. Main Telescope In                     | 14. Main Telescope Out              | 21. Pilot Operated Check Valve (On back - Not Shown) |

**Figure 5-150. Main Control Valve - 2WS (SN 0300181175 to Present)**

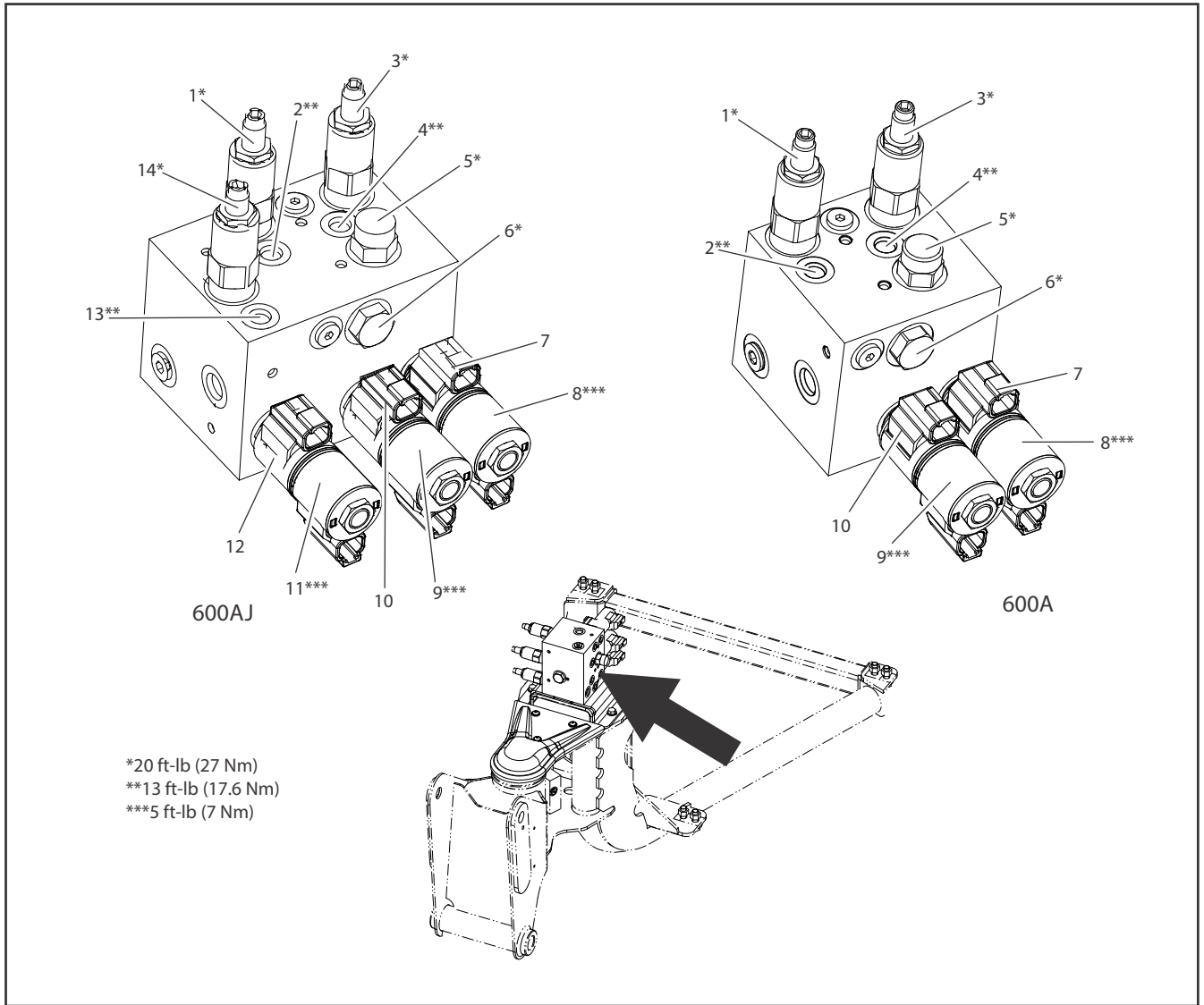
**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



- |  |   |  |
|--|---|--|
| 1. Rear Steer Left (4-Wheel Steer Only)  | 10. Tower Lift Down                                 | 19. Direct Control Dump Valve                        |
| 2. Front Steer Left                      | 11. Rear Steer Pressure Relief (4-Wheel Steer Only) | 20. Tower Telescope Out                              |
| 3. Front Steer Right                     | 12. Rear Steer Right (4-Wheel Steer Only)           | 21. Main Upper Boom Pressure Relief                  |
| 4. Swing Right                           | 13. Rear Steer Pressure Relief (4-Wheel Steer Only) | 22. Main Lift Up                                     |
| 5. Main Lift Down                        | 14. Front Steer Pressure Relief                     | 23. Swing Left                                       |
| 6. Main Upper Boom Pressure Relief Valve | 15. Tower Lift Up                                   | 24. Front Steer Pressure Relief                      |
| 7. Tower Telescope In                    | 16. Main Upper Boom Pressure Relief                 | 25. Socket Head Cap Screw                            |
| 8. Main Telescope In                     | 17. Flow Control                                    | 26. Pilot Operated Check Valve (On back - Not Shown) |
| 9. Test Port MP                          | 18. Main Telescope Out                              |  |

**Figure 5-151. Main Control Valve - 4WS (SN 0300181175 to Present)**





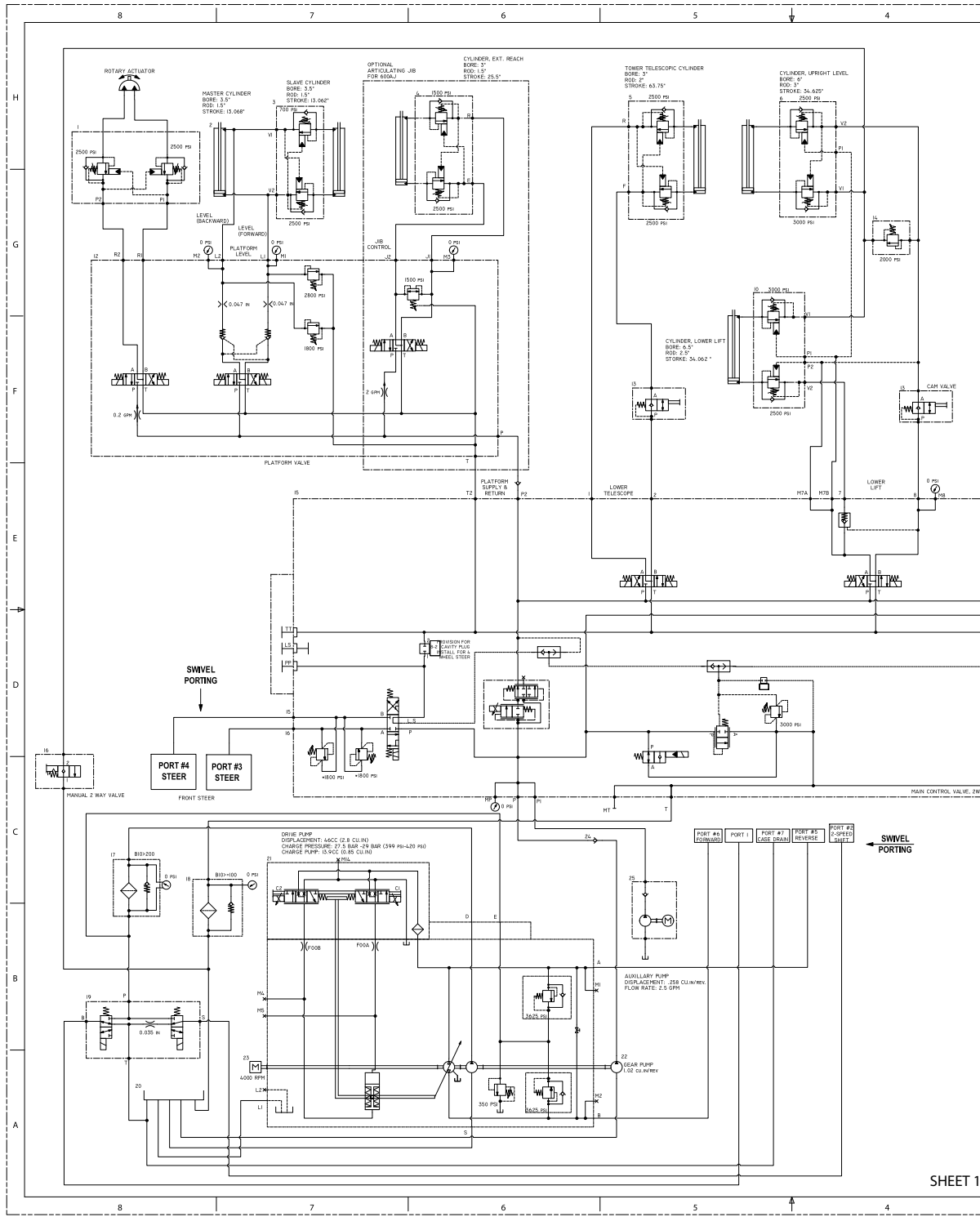
\*20 ft-lb (27 Nm)  
 \*\*13 ft-lb (17.6 Nm)  
 \*\*\*5 ft-lb (7 Nm)

- |                                  |                                  |                            |
|----------------------------------|----------------------------------|----------------------------|
| 1. Level Up Relief Valve (RV2)   | 6. Flow Relief Valve (FR1)       | 11. Jib Up Solenoid        |
| 2. Test Port M1                  | 7. Rotate Left Solenoid          | 12. Jib Down Solenoid      |
| 3. Level Down Relief Valve (RV1) | 8. Rotate Right Solenoid         | 13. Test Port M3           |
| 4. Test Port M2                  | 9. Platform Level Up Solenoid    | 14. Jib Relief valve (CR1) |
| 5. Flow Relief Valve (FR2)       | 10. Platform Level Down Solenoid |                            |

Figure 5-152. Location of Components - Platform Control Valve Block

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**

**5.11 HYDRAULIC SCHEMATICS**



**Figure 5-153. 2-Wheel Steer (2WS) Hydraulic Schematic 1 of 2**

SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

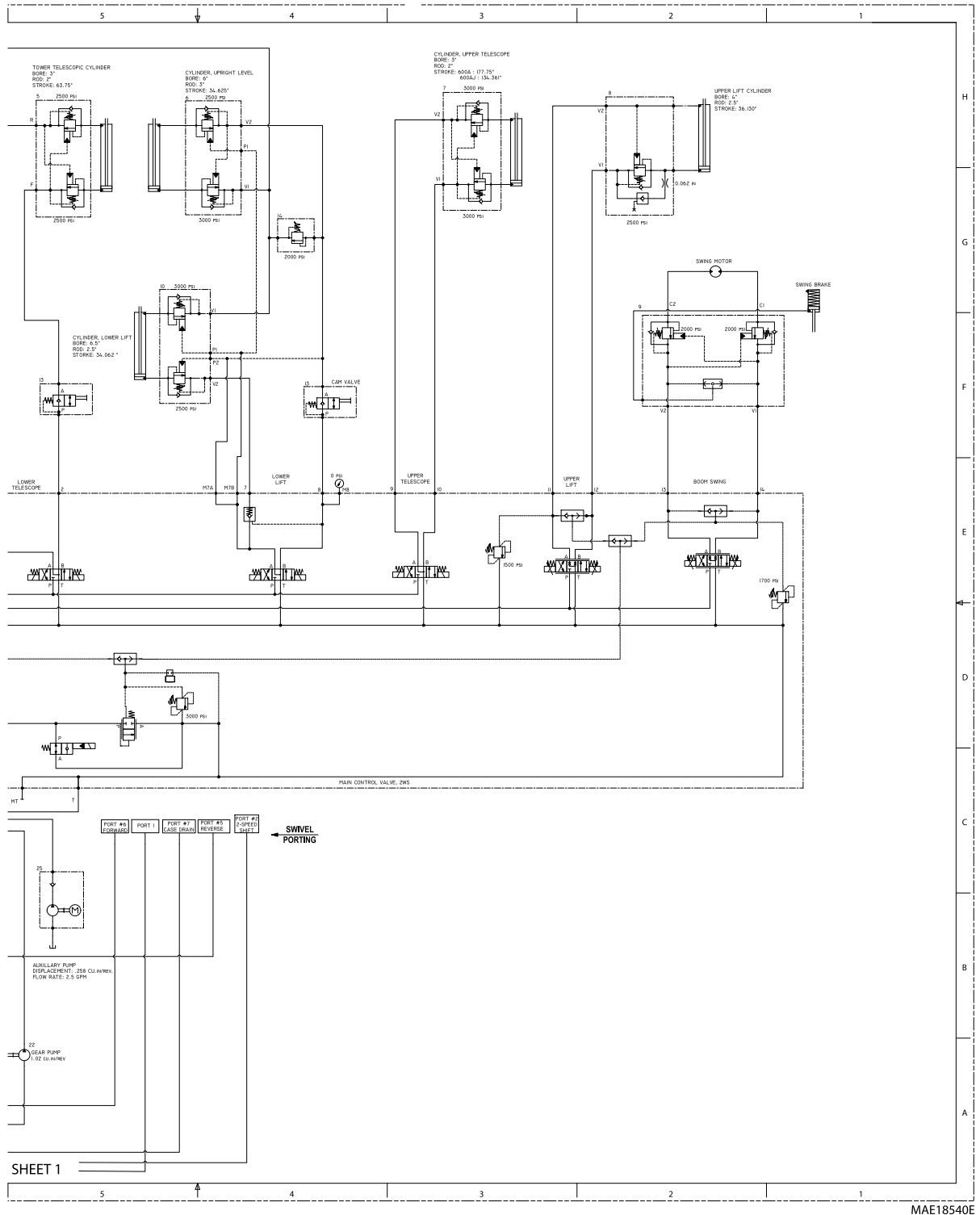
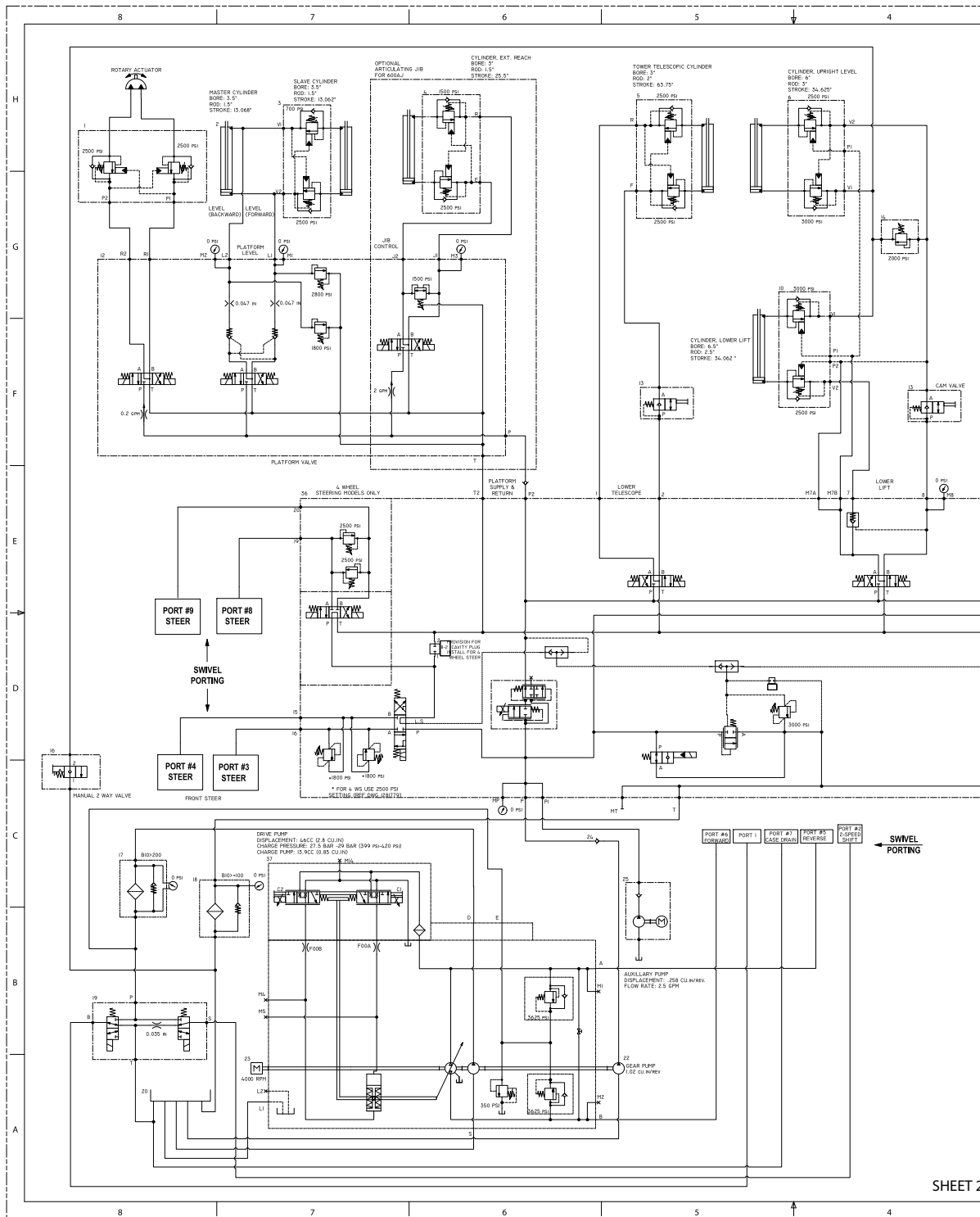


Figure 5-154. 2-Wheel Steer (2WS) Hydraulic Schematic 2 of 2

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



**Figure 5-155. 4-Wheel Steer (4WS) Hydraulic Schematic 1 of 2**

SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

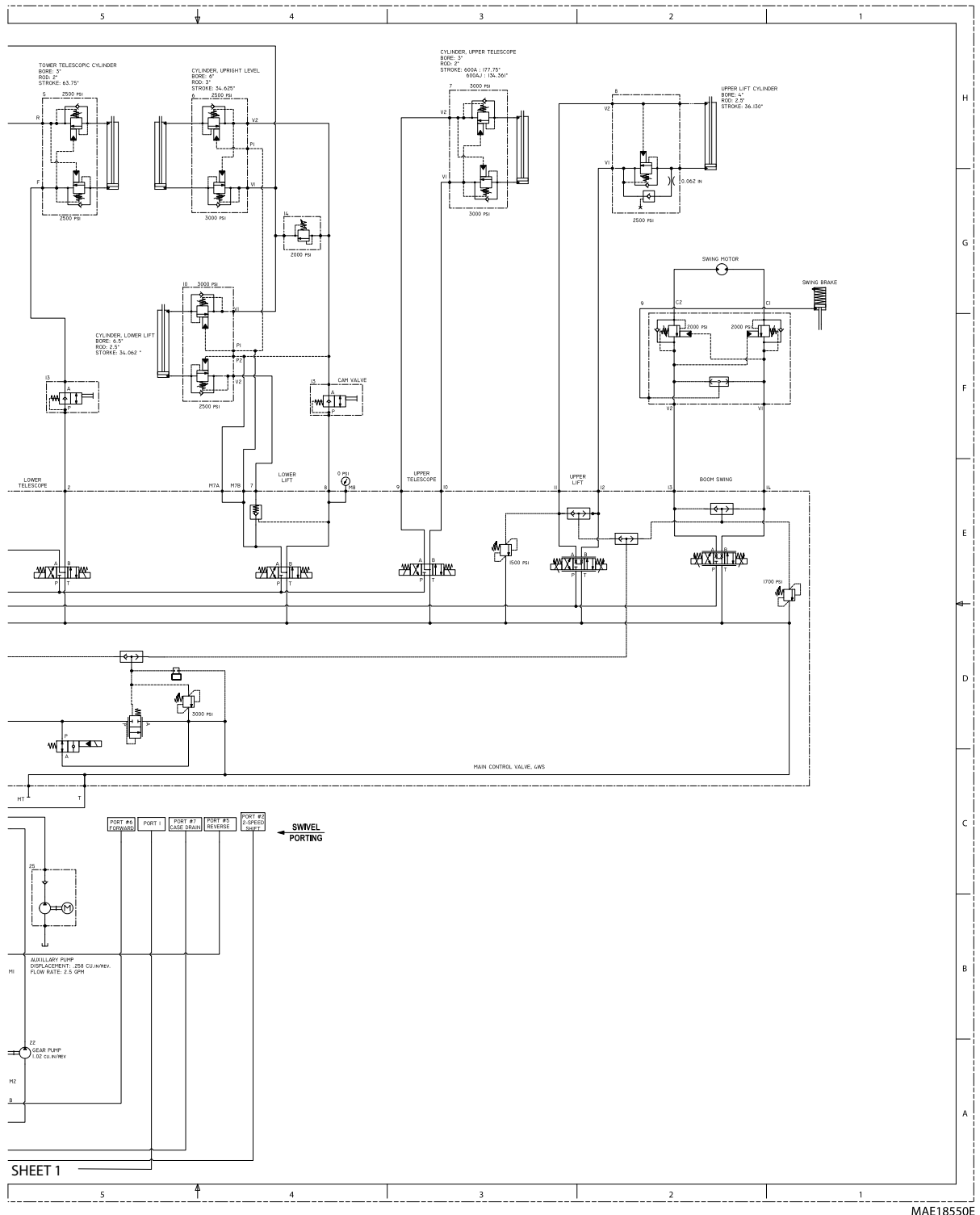
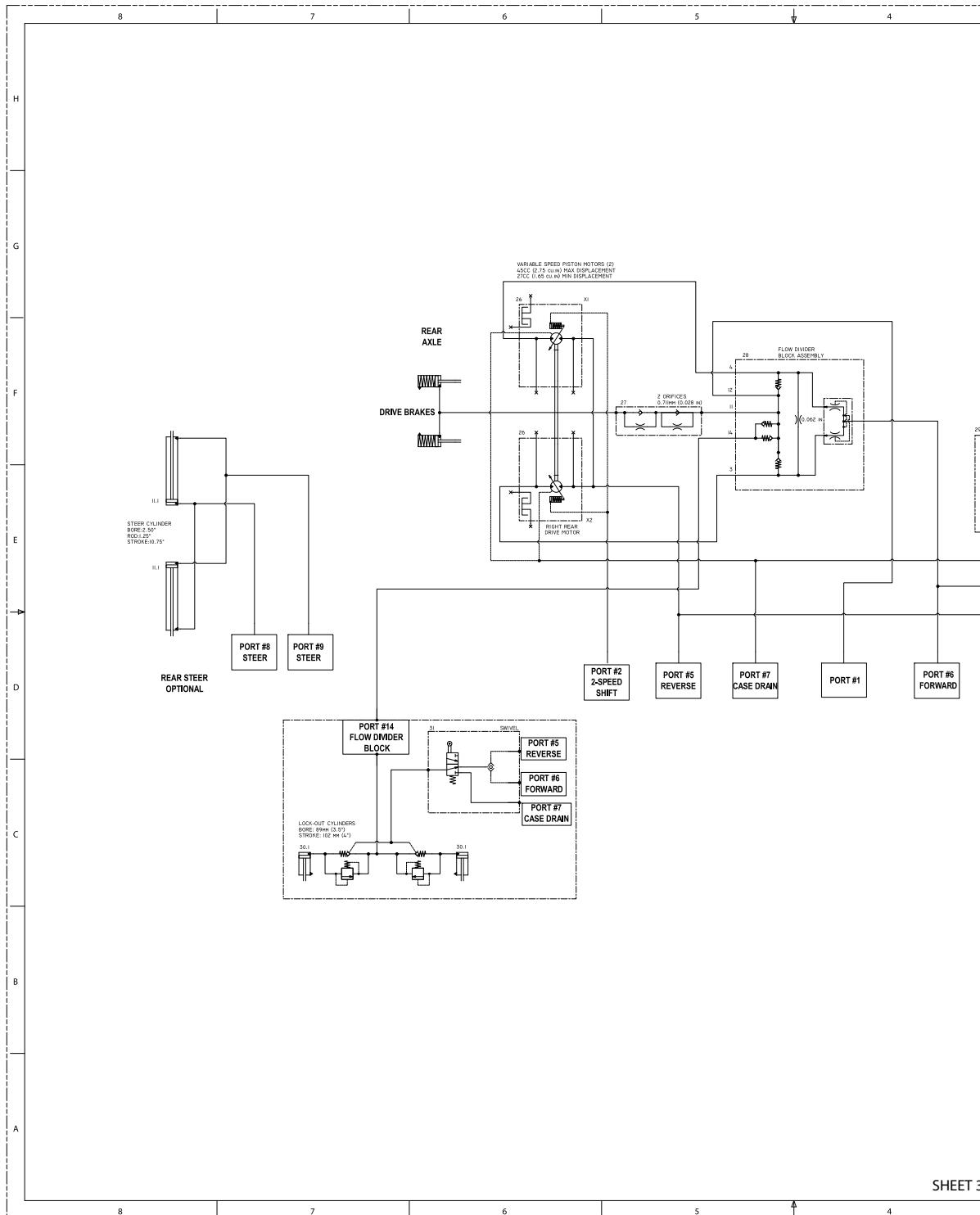


Figure 5-156. 4-Wheel Steer (4WS) Hydraulic Schematic 2 of 2

MAE18550E

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



**Figure 5-157. 2-Wheel Drive (2WD) Hydraulic Schematic 1 of 2**

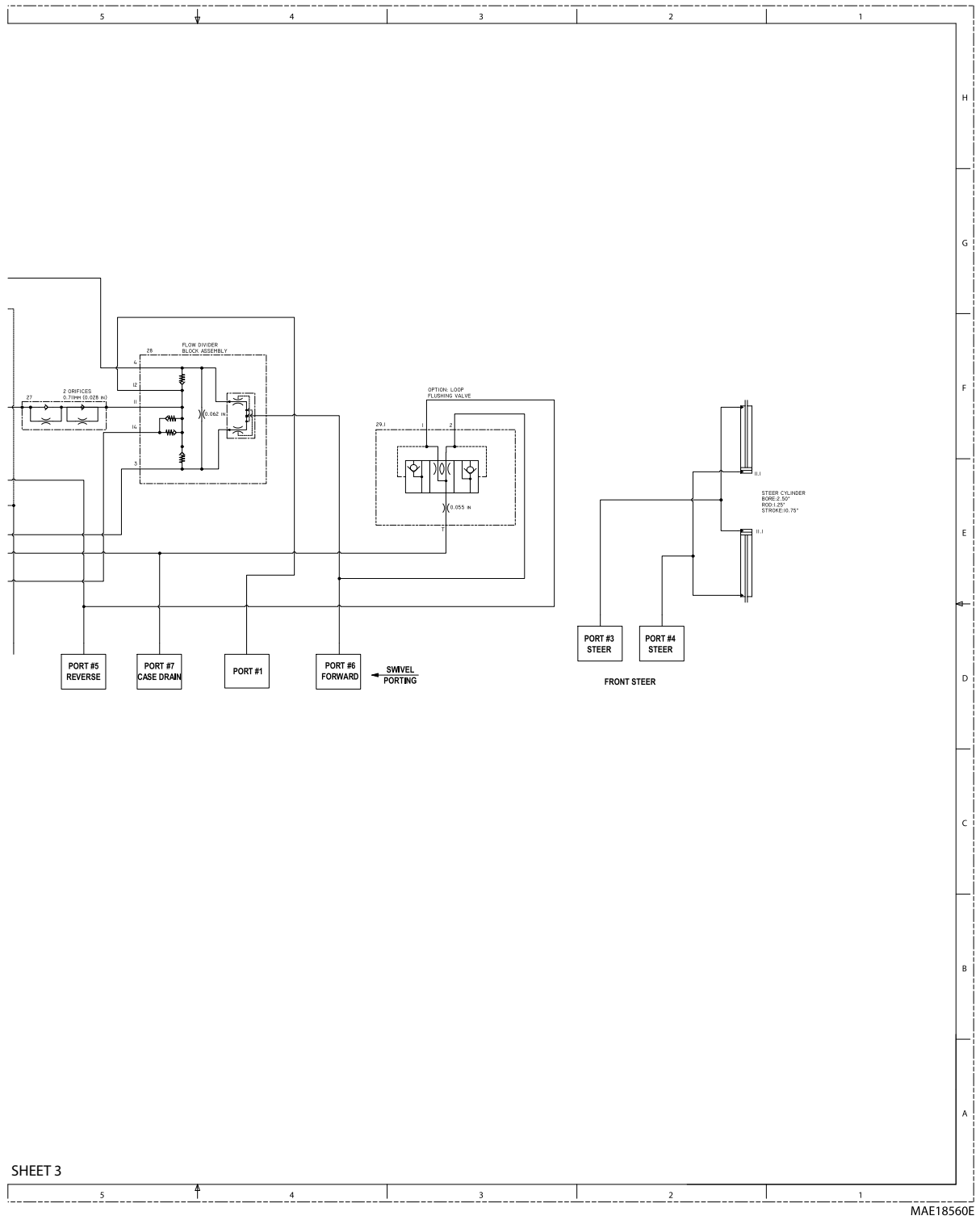
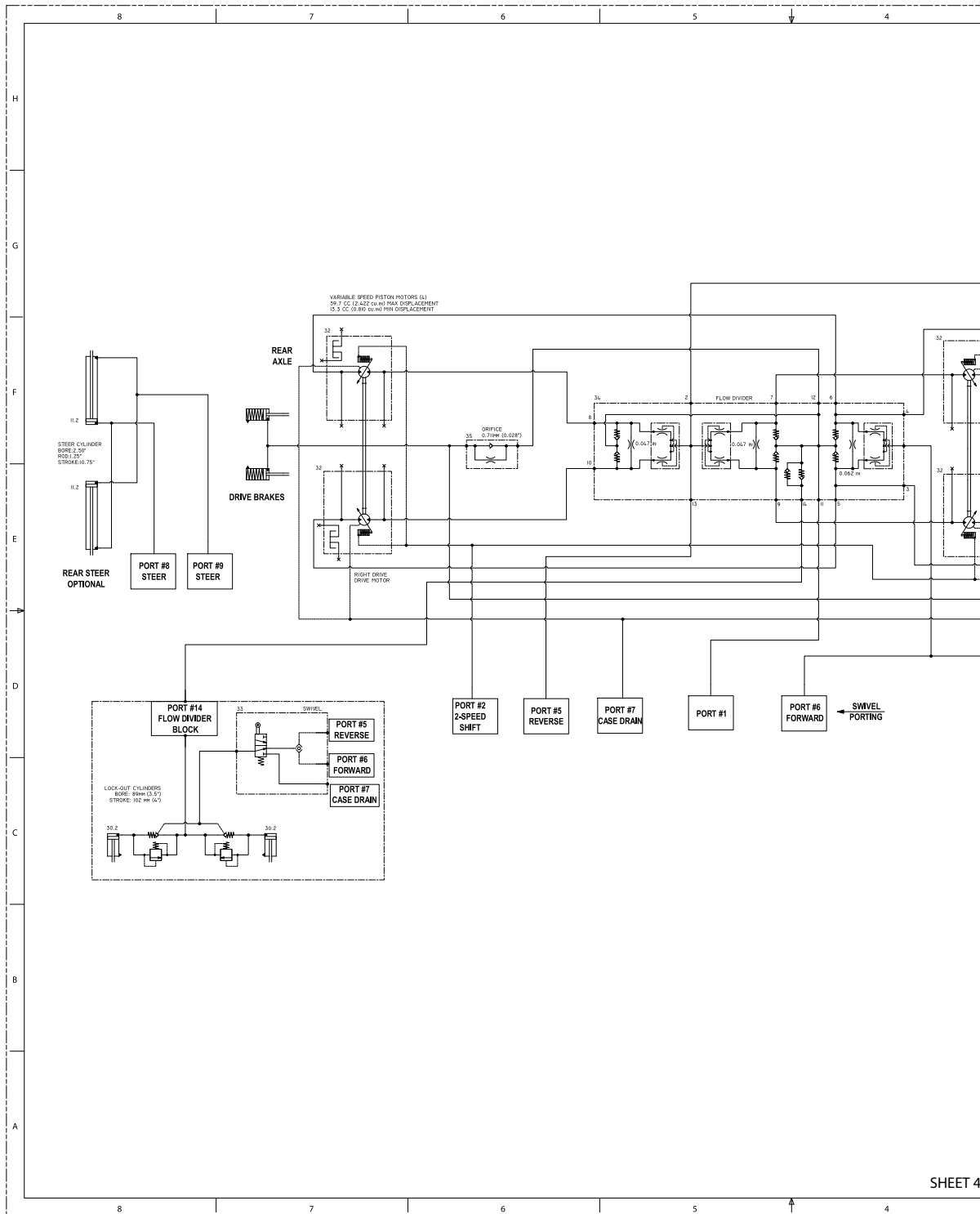


Figure 5-158. 2-Wheel Drive (2WD) Hydraulic Schematic 2 of 2

**SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS**



SHEET 4

**Figure 5-159. 4-Wheel Drive (4WD) Hydraulic Schematic 1 of 2**



SECTION 5 - BASIC HYDRAULICS INFORMATION & SCHEMATICS

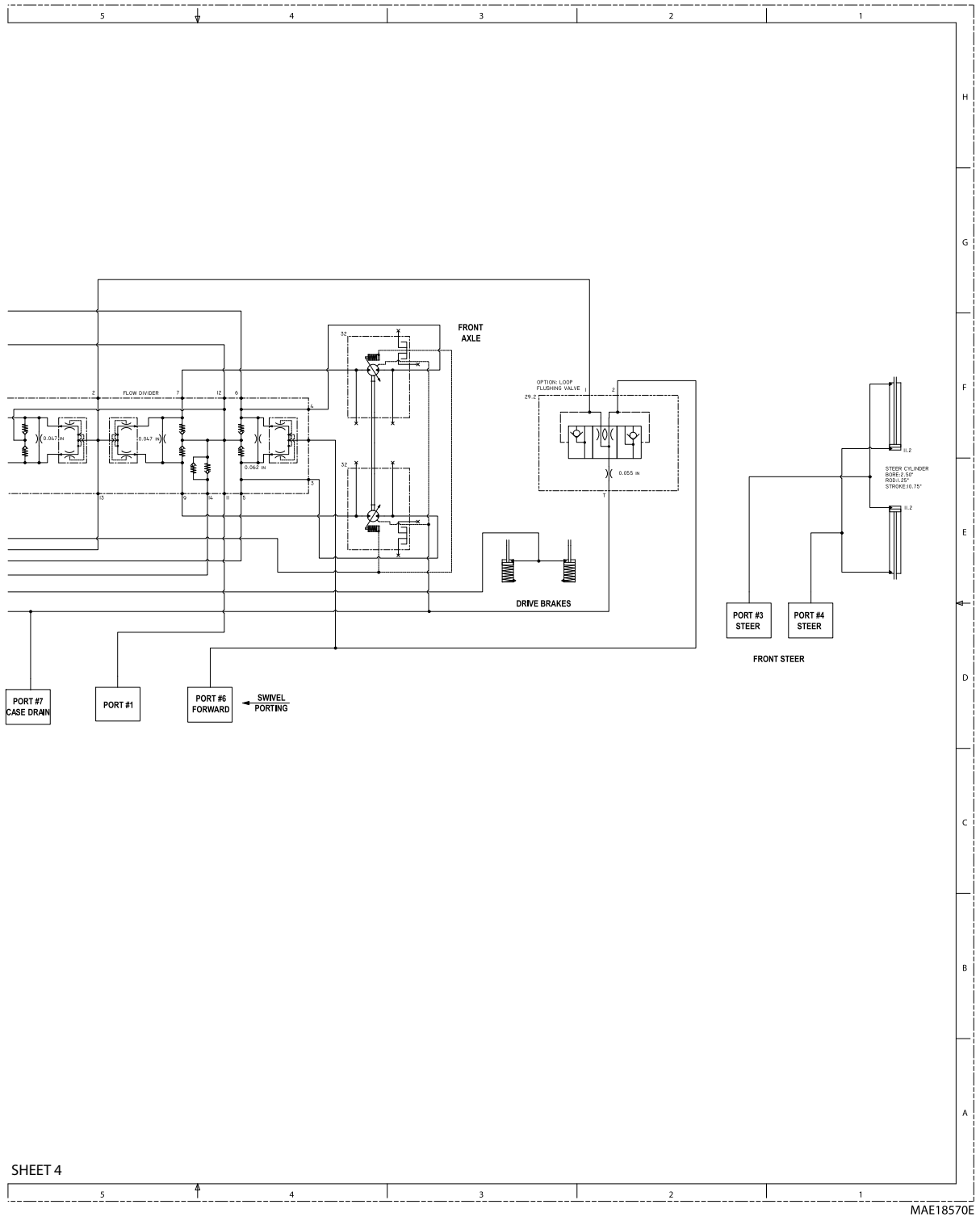


Figure 5-160. 4-Wheel Drive (4WD) Hydraulic Schematic 2 of 2



## SECTION 6. JLG CONTROL SYSTEM

6.1 JLG CONTROL SYSTEM ANALYZER KIT  
INSTRUCTIONS

## Introduction

**NOTICE**

WHEN INSTALLING A NEW POWER MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

**NOTICE**

IT IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED 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) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE 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.

The main 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 utilizing a custom designed, hand held analyzer (Analyzer Kit, JLG part no. 2901443) which will display two lines of information at a time, by scrolling through the program.

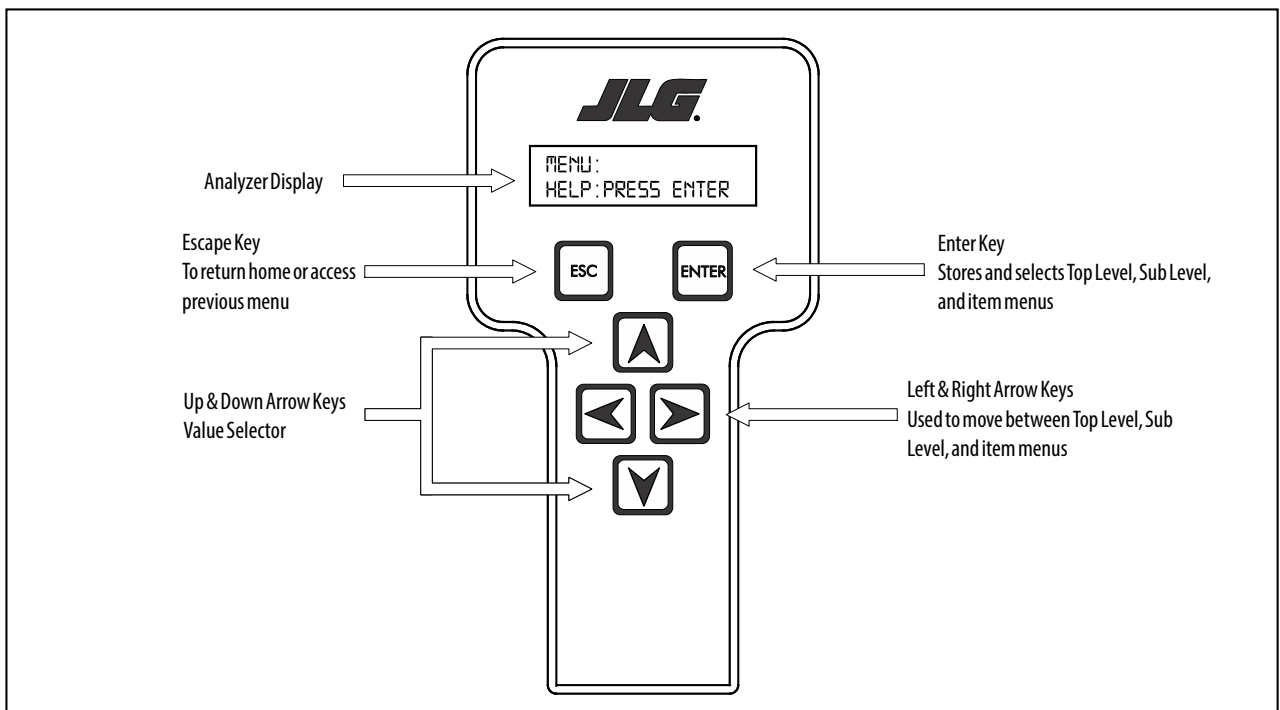


Figure 6-1. Hand Held Analyzer

### Connect JLG Control System Analyzer

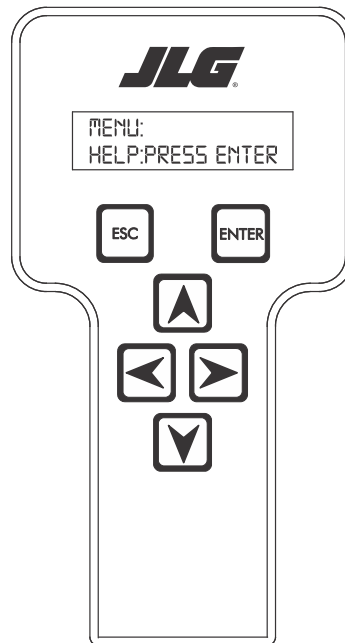
1. Connect four pin end of cable supplied with hand-held or wireless analyzer to controller module on platform box or at controller module inside ground control box. Connect other end of cable to analyzer.

**NOTE:** The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.

2. Power up the Control System by turning the lower key to the platform or ground position and pulling both emergency stop buttons on.


### Using the Analyzer


With the machine power on and the analyzer connected properly, the analyzer will display the following.



**HELP:  
PRESS ENTER**


At this point, using the **RIGHT**  and **LEFT**  arrow keys, you can move between the top level menu items. To


select a displayed menu item, press **ENTER** . To cancel a

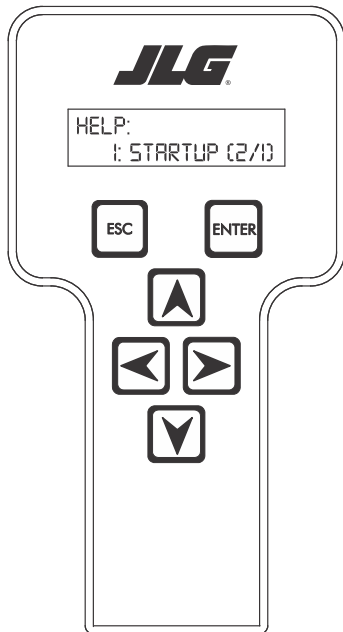
selected menu item, press **ESCAPE** ; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

- HELP
- DIAGNOSTICS
- SYSTEM TEST
- ACCESS LEVEL
- PERSONALITIES
- MACHINE SETUP
- CALIBRATIONS (view only)
- SERVICE MODE

If you press **ENTER** , at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display will scroll the fault across the screen. If there was no fault detected, the display will read: **HELP: EVERYTHING OK**. If powered up at the ground station, the display will read: **GROUND OK**.

If **ENTER**  is pressed again, the display moves to the following display:




**LOGGED HELP**  
**1: STARTUP (2/1)**


At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the

beginning, press **ESCAPE**  two times. **STARTUP (2/1)** indicates a power up.

When a top level menu is selected, a new set of menu items may be offered: for example:

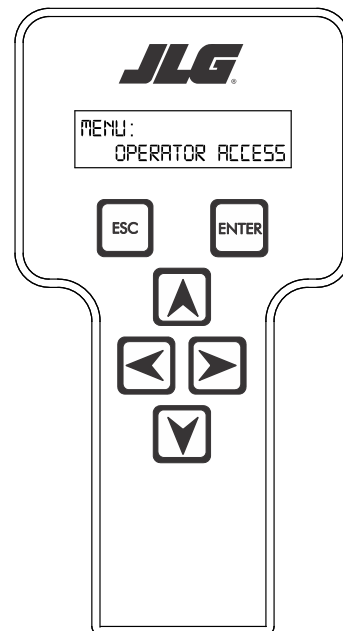
- DRIVE
- BOOM
- SYSTEM
- DATALOG
- VERSIONS

Pressing **ENTER**  with any of the above displayed menus, will display 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 the Access Level of the Hand Held Analyzer

When the 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 the access level, the correct password must be entered. To enter the password, scroll to the **ACCESS LEVEL** menu. For example:




**ACCESS LEVEL:**  
**CODE 00000**

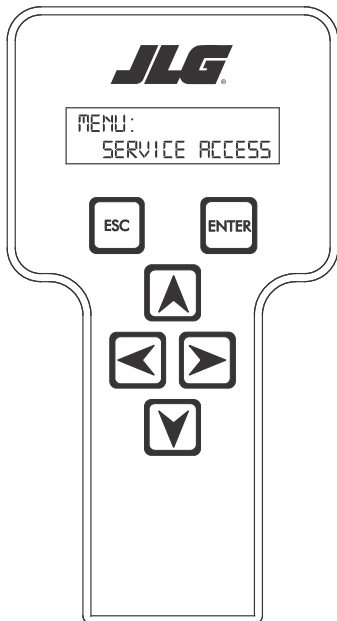
Press **ENTER**  to select the **ACCESS LEVEL** menu.

Using the **UP**  or **DOWN**  arrow keys, enter the first digit of the password, 3.

Then using the **RIGHT**  arrow key, position cursor to the 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:



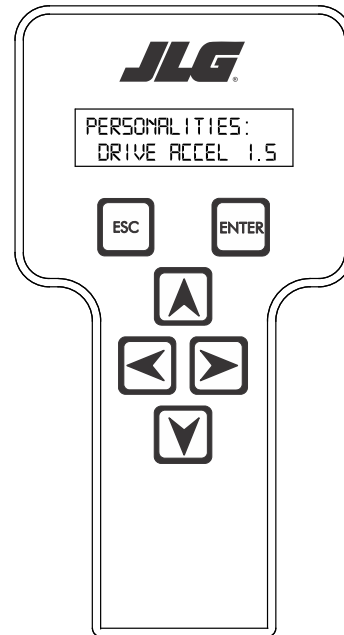
**MENU:  
SERVICE ACCESS**

Repeat the above steps if the correct access level is not displayed or you can not adjust the personality settings.

## Adjusting Parameters Using the Hand Held Analyzer


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:





**PERSONALITIES:  
DRIVE ACCEL 1.5s**

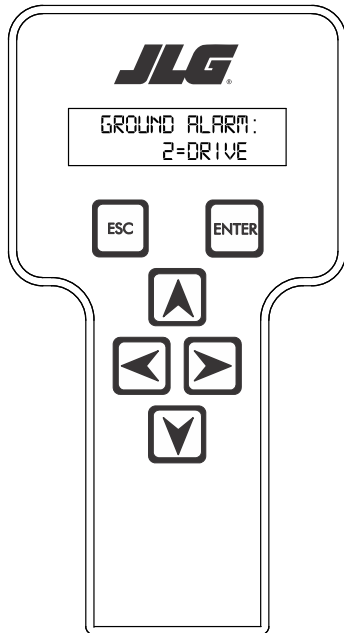
There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP**

 arrow is pressed when at the maximum value nor will

the value decrease if the **DOWN**  arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at service access.

## 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 service access 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.**

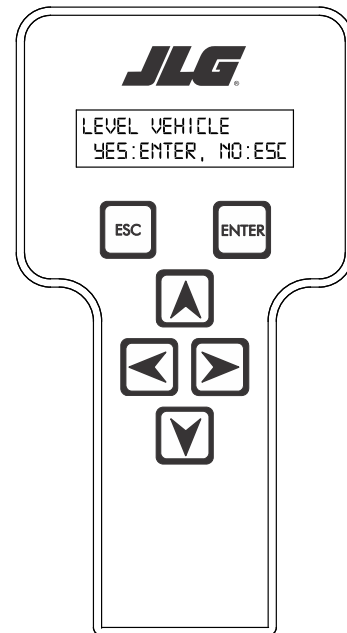
#### **NOTICE**

**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 **ENTER**  confirms that vehicle is currently level, and zeroes the tilt sensor measurements.

## 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	CUT OUT
CONT(S)	CONTRACTOR(S)
COOR	COORDINATED
CRK PT	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**

<b>ABBREVIATION</b>	<b>MEANING</b>
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

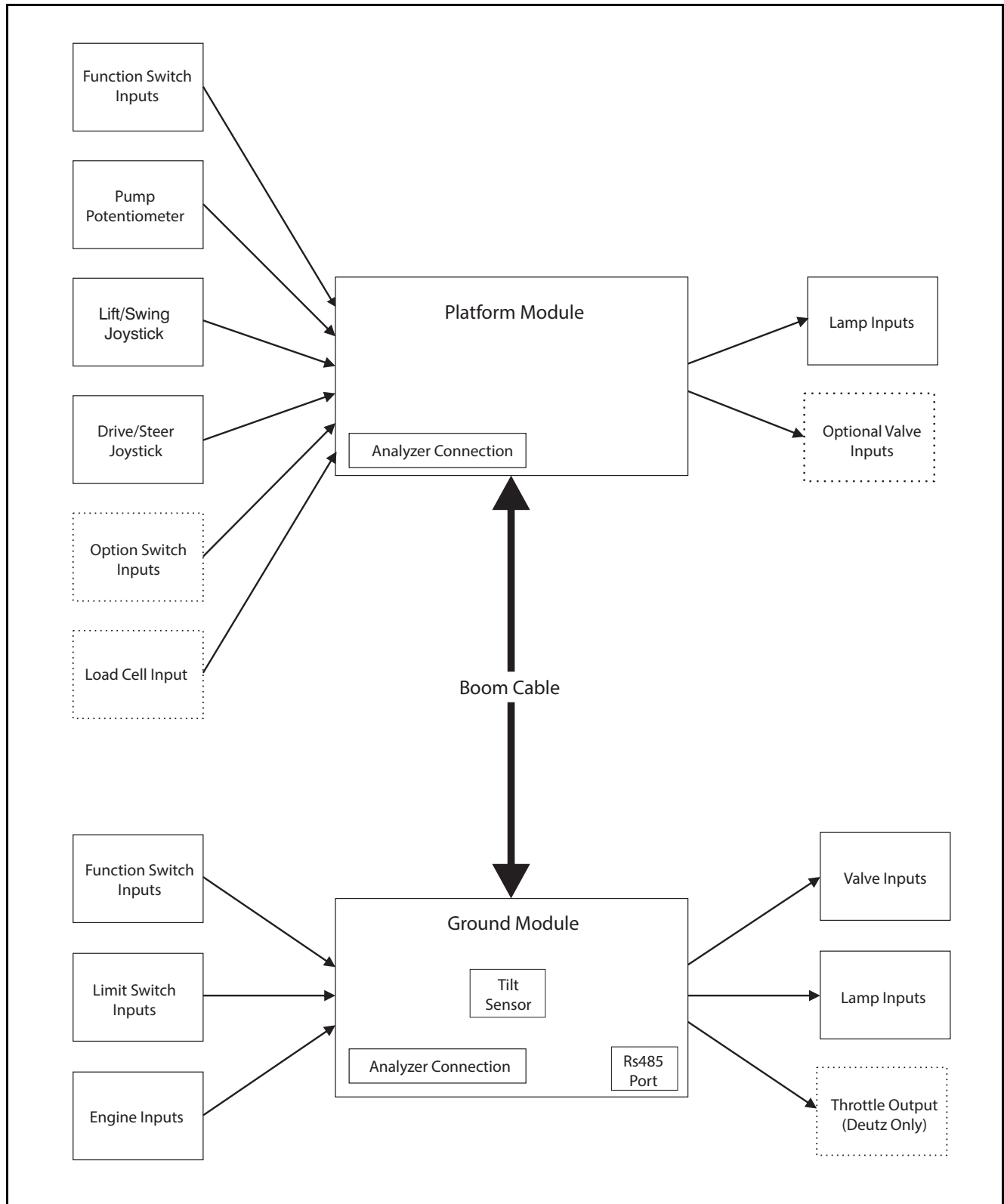
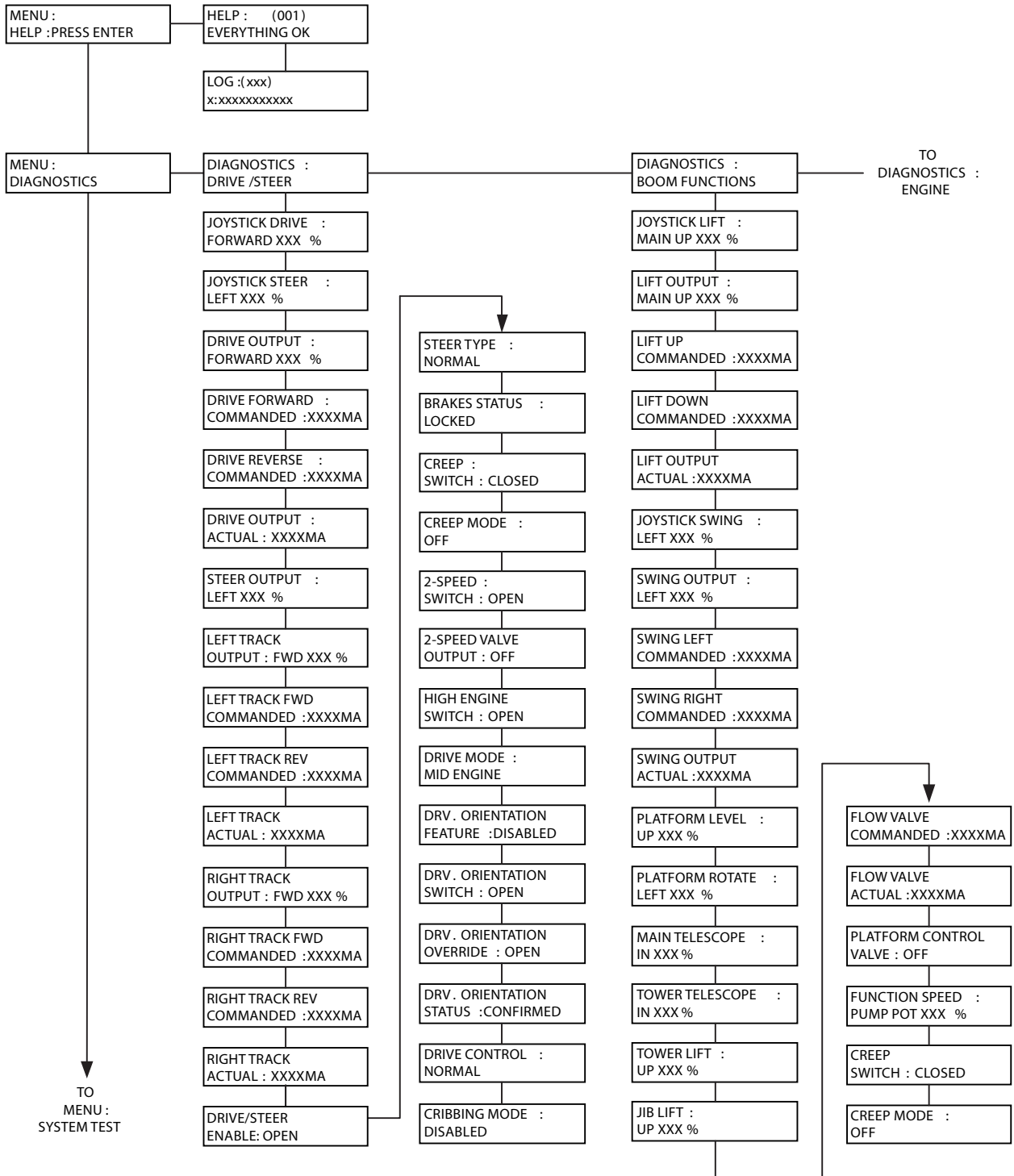


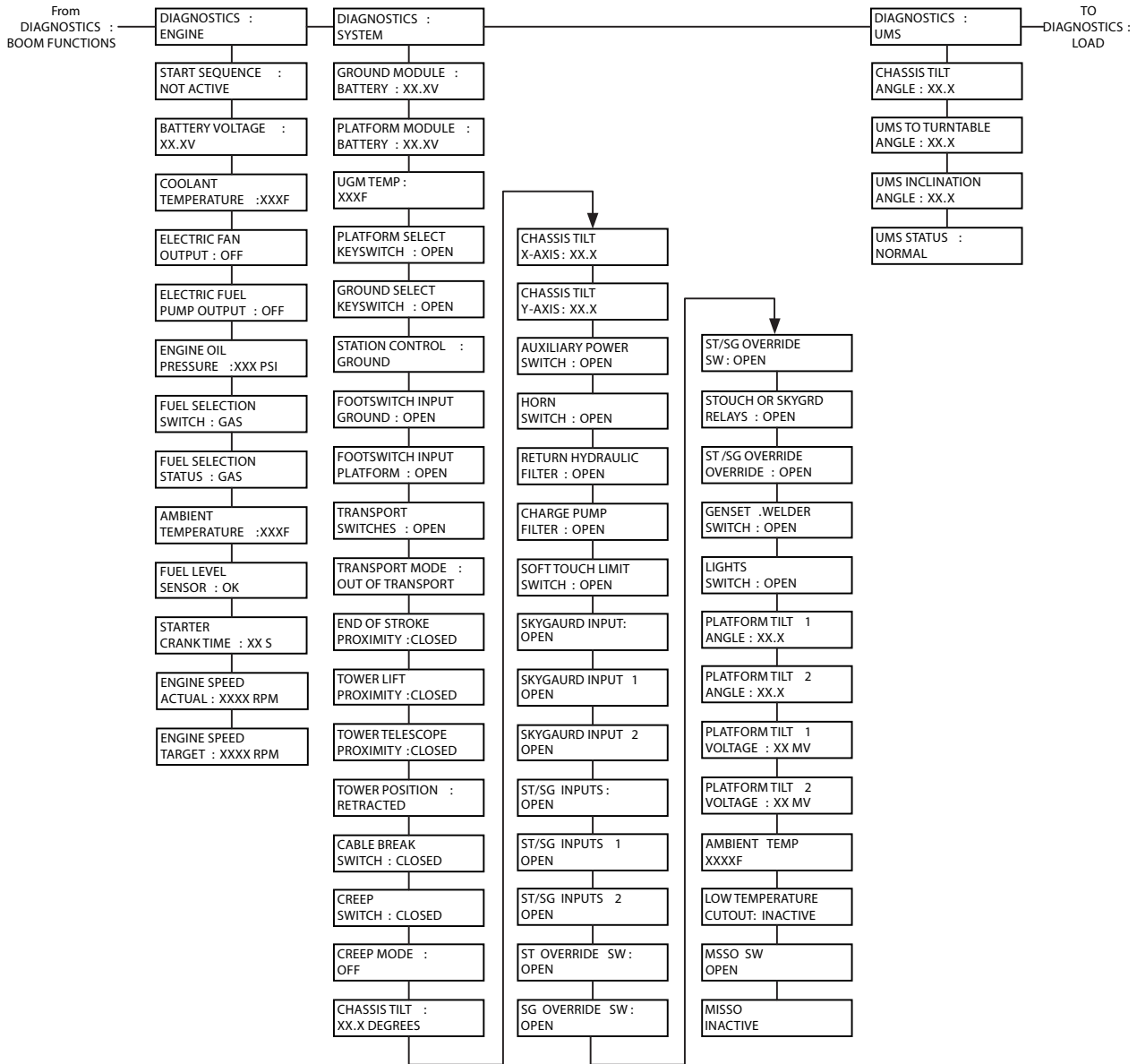
Figure 6-2. ADE Block Diagram



MAE9780N

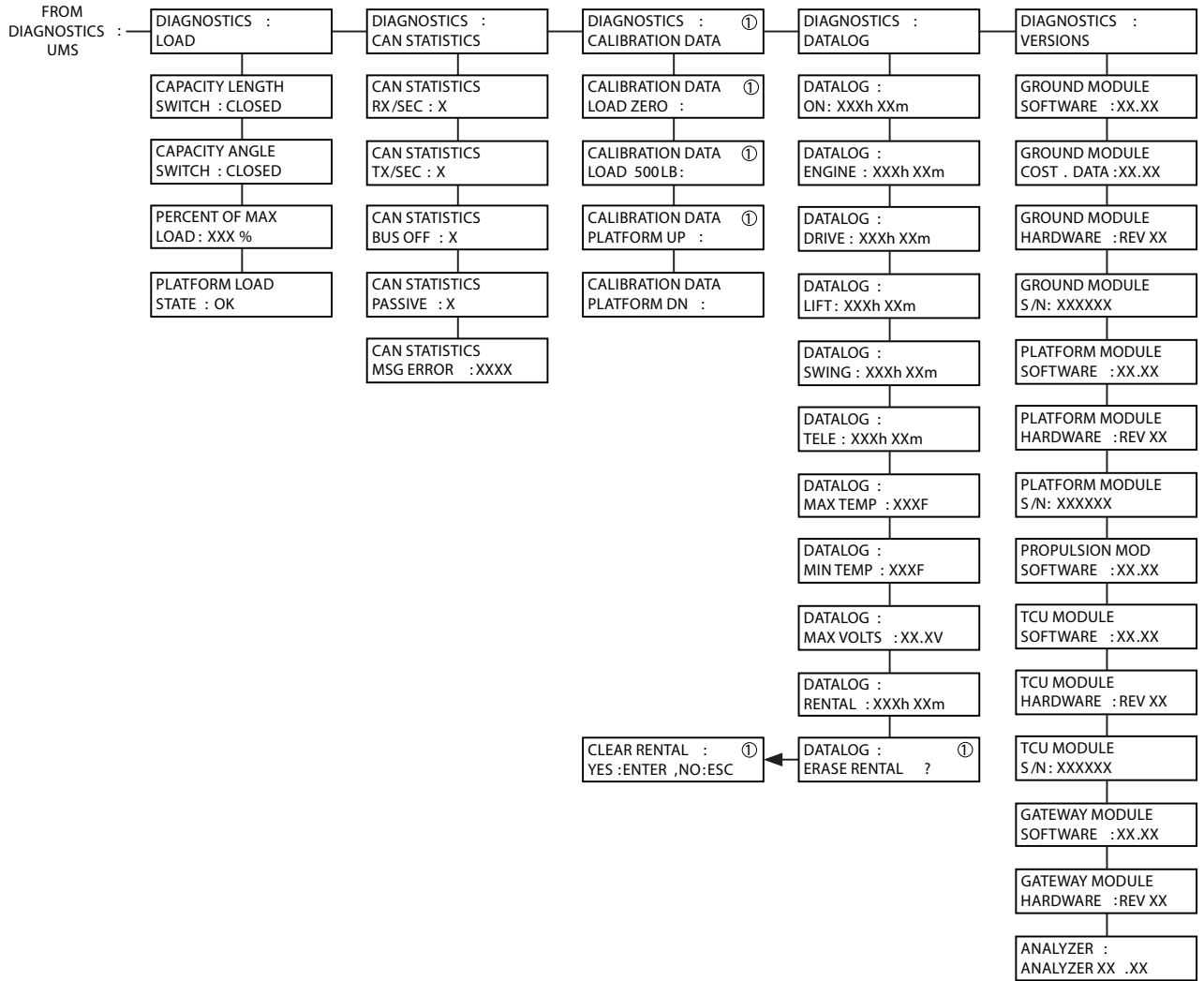
Figure 6-3. Analyzer Software Version 6.8 - Sheet 1 of 6

**SECTION 6 - JLG CONTROL SYSTEM**



MAE8990N

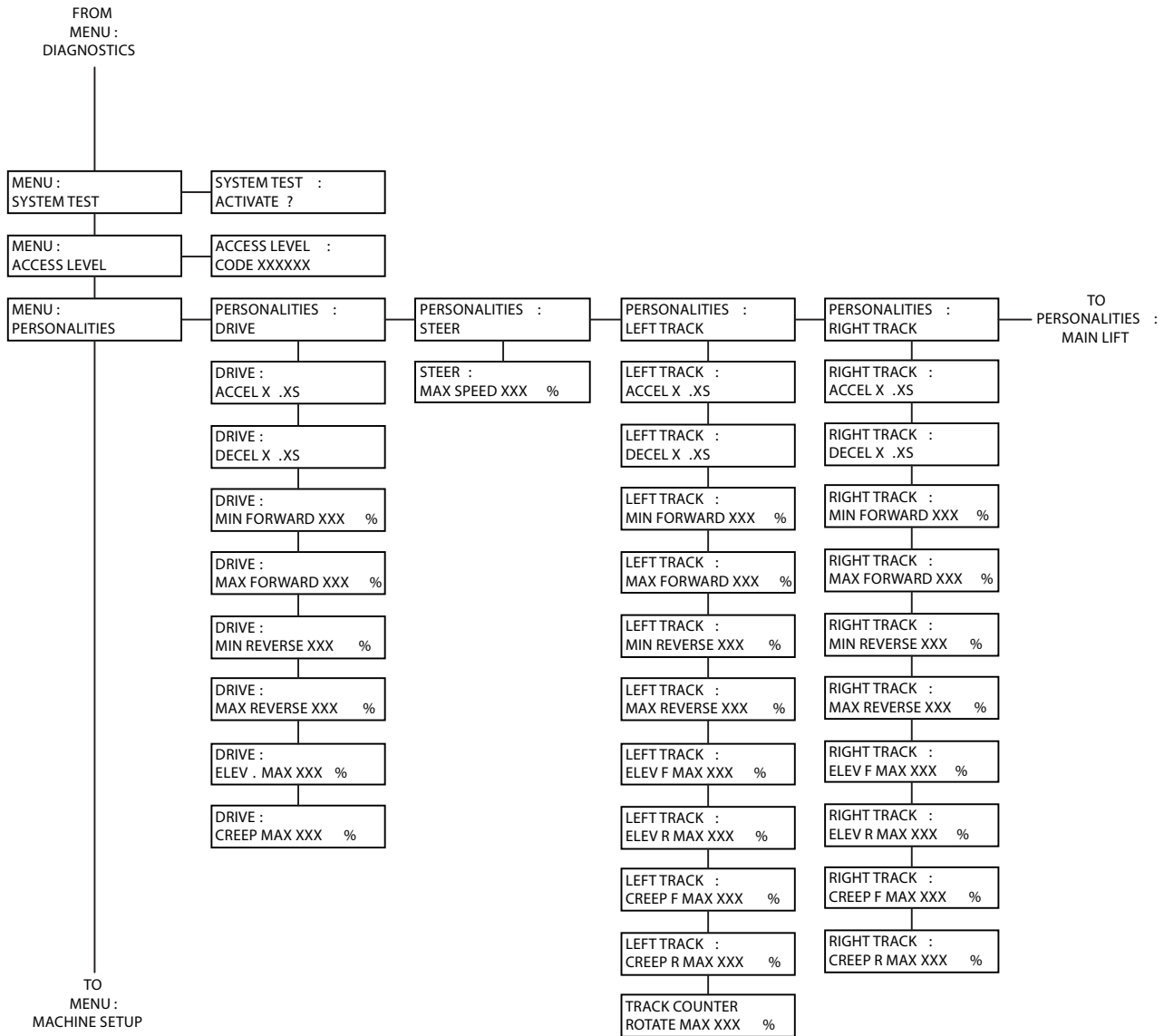
**Figure 6-4. Analyzer Software Version 6.8 - Sheet 2 of 6**



MAE9200N

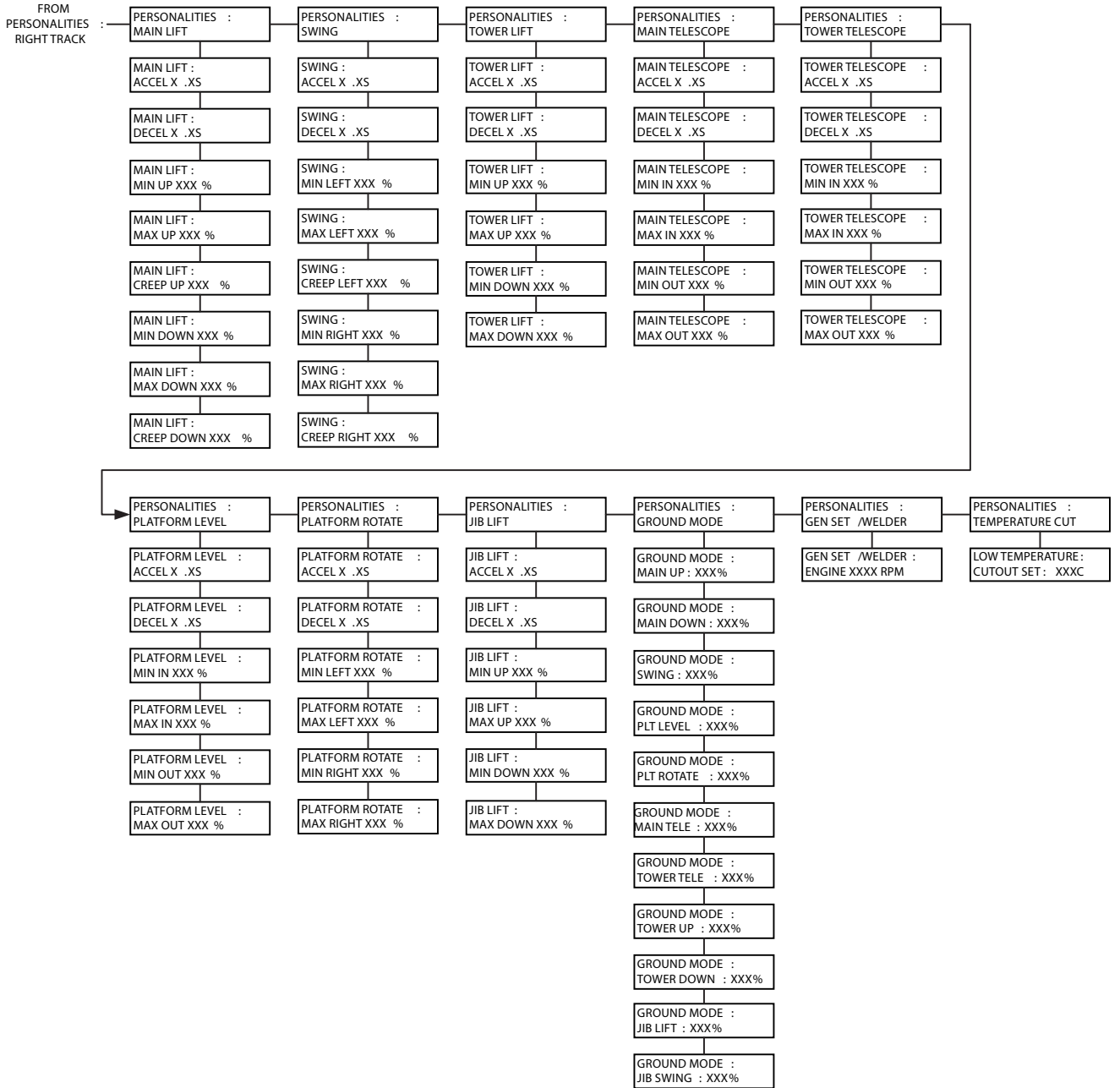
Figure 6-5. Analyzer Software Version 6.8 - Sheet 3 of 6

**SECTION 6 - JLG CONTROL SYSTEM**



MAE9510N

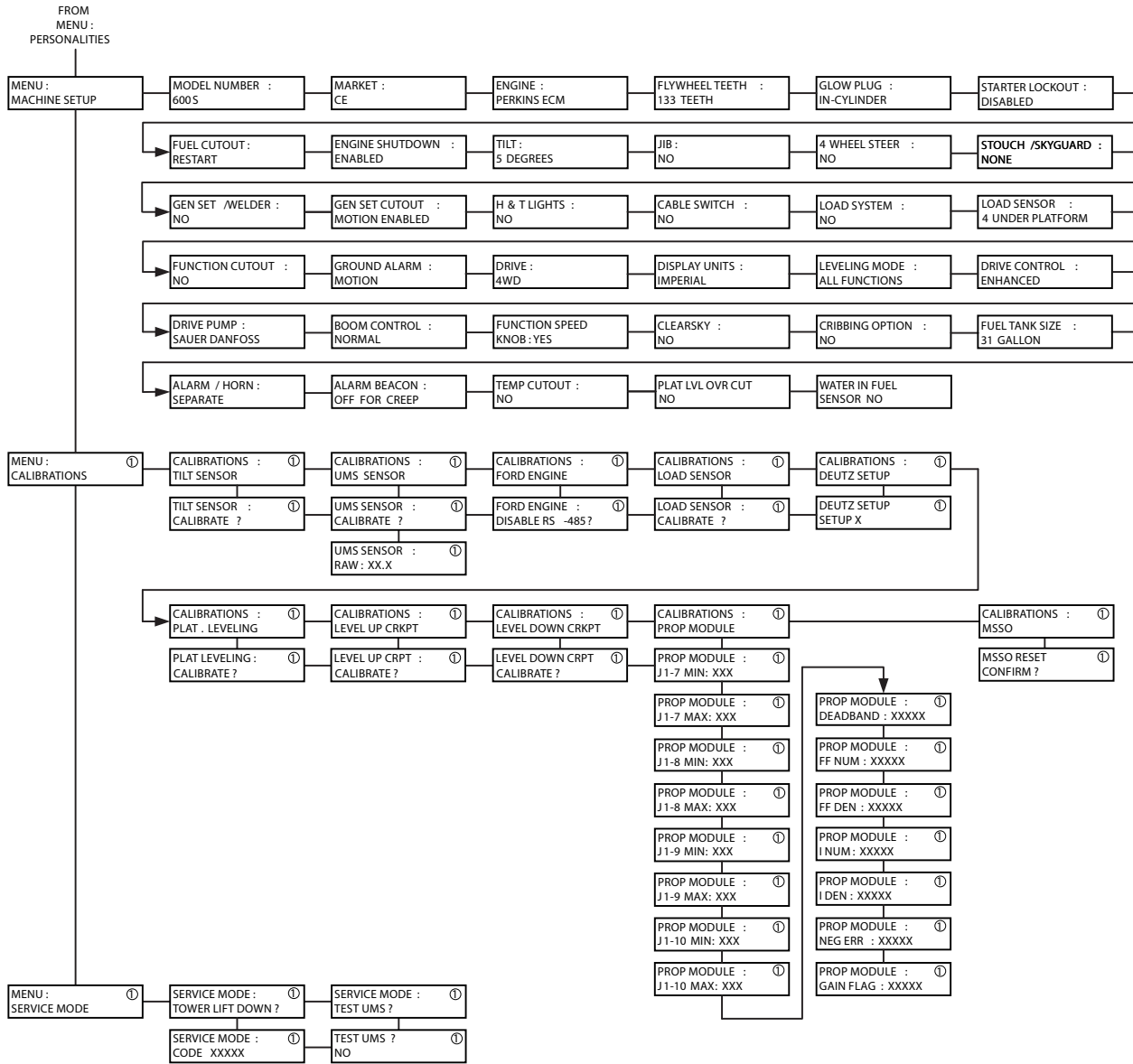
**Figure 6-6. Analyzer Software Version 6.8 - Sheet 4 of 6**



MAE9580N

Figure 6-7. Analyzer Software Version 6.8 - Sheet 5 of 6

**SECTION 6 - JLG CONTROL SYSTEM**



MAE9660N

**Figure 6-8. Analyzer Software Version 6.8 - 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	
			Drive Pump M46-XXX	Drive Pimp 830XXXX
DRIVE	Acceleration	0.0s to 5.0s	2.0	2.0
	Deceleration	0.0s to 3.0s	2.0	2.0
	Forward Minimum Speed	1 to 35%	4	4
	Forward Maximum Speed	1 to 100%	32	97
	Reverse Minimum Speed	1 to 35%	4	4
	Reverse Maximum Speed	1 to 100%	31	97
	Elevated Maximum Speed	1 to 100%	15	62
	Creep Maximum Speed	1 to 90%	20	45
STEER	Maximum Speed	1 to 100%	100	
LEFT TRACK	Acceleration	0.0s to 5.0s	N/A	N/A
	Deceleration	0.0s to 3.0s	N/A	N/A
	Forward Minimum Speed	1 to 35%	N/A	N/A
	Forward Maximum Speed	1 to 100%	N/A	N/A
	Reverse Minimum Speed	1 to 35%	N/A	N/A
	Reverse Maximum Speed	1 to 100%	N/A	N/A
	Elevated Forward Maximum speed	1 to 100%	N/A	N/A
	Elevated Reverse Maximum Speed	1 to 100%	N/A	N/A
	Creep Forward Maximum speed	1 to 90%	N/A	N/A
	Creep Reverse Maximum Speed	1 to 90%	N/A	N/A
	Rotate Maximum Speed	1 to 100%	N/A	N/A

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-2. Personality Ranges/Defaults**

FUNCTION	PERSONALITY	RANGE	DEFAULTS	
			Drive Pump M46-XXX	Drive Pimp 830XXX
RIGHT TRACK	Acceleration	0.0s to 5.0s	N/A	N/A
	Deceleration	0.0s to 3.0s	N/A	N/A
	Forward Minimum Speed	1 to 100%	N/A	N/A
	Forward Maximum Speed	1 to 100%	N/A	N/A
	Reverse Minimum Speed	1 to 100%	N/A	N/A
	Reverse Maximum Speed	1 to 100%	N/A	N/A
	Elevated Forward Maximum speed	1 to 100%	N/A	N/A
	Elevated Reverse Maximum Speed	1 to 100%	N/A	N/A
	Creep Forward Maximum speed	1 to 100%	N/A	N/A
	Creep Reverse Maximum Speed	1 to 100%	N/A	N/A
MAIN LIFT	Acceleration	0.0s to 5.0s	2.0	2.0
	Deceleration	0.0s to 3.0s	0.7	0.7
	Minimum Up Speed	1 to 60%	50	50
	Maximum Up Speed	1 to 100%	73	73
	Creep Up Speed	1 to 65%	59	59
	Maximum Down Speed	1 to 60%	46	46
	Maximum Down Speed	1 to 100%	67	67
	Creep Down Speed	1 to 75%	52	52
TOWER LIFT	Acceleration	0.0s to 5.0s	1.0	1.0
	Deceleration	0.0s to 3.0s	0.5	0.5
	Minimum Up Speed	1 to 60%	30	30
	Maximum Up Speed	1 to 100%	80	80
	Maximum Down Speed	1 to 60%	30	30
	Maximum Down Speed	1 to 100%	75	75
	Medium Speed	0.01 to 1.00	0.30	0.30

Table 6-2. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS	
			Drive Pump M46-XXX	Drive Pimp 830XXXX
SWING	Acceleration	0.0s to 5.0s	2.0	2.0
	Deceleration	0.0s to 3.0s	1.5	1.5
	Minimum Left Speed	1 to 50%	50	50
	Maximum Left Speed	1 to 100%	73	73
	Creep Left Speed	1 to 65%	55	55
	Minimum Right Speed	1 to 50%	48	48
	Maximum Right Speed	1 to 100%	73	73
	Creep Right Speed	1 to 65%	59	59
MAIN TELESCOPE	Acceleration	0.0s to 5.0	3.5	3.5
	Deceleration	0.0s to 3.0	1.2	1.2
	Minimum In Speed	1 to 65%	31	31
	Maximum In Speed	1 to 100%	75	75
	Minimum Out Speed	1 to 65%	35	35
	Maximum Out Speed	1 to 100%	75	75
	Medium Speed	0.01 to 1.00	0.45	0.45
TOWER TELESCOPE	Acceleration	0.0s to 5.0	1.0	1.0
	Deceleration	0.0s to 3.0	0.5	0.5
	Minimum In Speed	1 to 65%	26	26
	Maximum In Speed	1 to 100%	70	70
	Minimum Out Speed	1 to 65%	28	28
	Maximum Out Speed	1 to 100%	75	75
	Medium Speed	0.01 to 1.00	0.40	0.40
PLATFORM LEVEL	Acceleration	0.0 to 5.0	2.5	2.5
	Deceleration	0.0 to 3.0	0.5	0.5
	Minimum Up Speed	1 to 65%	21	21
	Maximum Up Speed	1 to 100%	52	52
	Minimum Down Speed	1 to 65%	22	22
	Maximum Down Speed	1 to 100%	50	50
	Medium Speed	0.01 to 1.00	0.40	0.40

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-2. Personality Ranges/Defaults**

FUNCTION	PERSONALITY	RANGE	DEFAULTS	
			Drive Pump M46-XXX	Drive Pimp 830XXXX
PLATFORM ROTATE	Acceleration	0.0s to 5.0s	1.4	1.4
	Deceleration	0.0s to 3.0s	0.7	0.7
	Minimum Left Speed	1 to 100%	18	18
	Maximum Left Speed	1 to 100%	50	50
	Minimum Right Speed	1 to 100%	17	17
	Maximum Right Speed	1 to 100%	50	50
	Medium Speed	0.01 to 1.00	0.45	0.45
JIB LIFT	Acceleration	0.0s to 5.0s	1.8	1.8
	Deceleration	0.0s to 3.0s	0.8	0.8
	Minimum Up Speed	1 to 65%	17	17
	Maximum Up Speed	1 to 100%	25	25
	Minimum Down Speed	1 to 65%	18	18
	Maximum Down Speed	1 to 100%	25	25
	Medium Speed	0.01 to 1.00	0.35	0.35
GROUND MODE	Tower Lift Up Speed	1 to 100%	79	79
	Tower Lift Down Speed	1 to 100%	74	79
	Main Lift Up	1 to 100%	72	72
	Main Lift Down	1 to 100%	66	66
	Swing Speed	1 to 100%	72	72
	Main Telescope Speed	1 to 100%	70	70
	Tower Telescope Speed	1 to 100%	69	69
	Platform Rotate Speed	1 to 100%	49	49
	Platform Level Speed	1 to 100%	49	51
	Jib Lift Speed	1 to 100%	24	24
	Jib Swing	1 to 100%	N/A	N/A
<b>NOTE:</b> Personality settings can be adjusted anywhere within the adjustment range for optimum machine performance.				
<b>NOTE:</b> GROUND MODE speeds are automatically limited to being lower than platform speed for a given function.				
<b>NOTE:</b> Set personalities in the following order: creep speeds, platform speeds, and then set ground speeds.				
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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		

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		

## 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
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.		11
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		



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	

## 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
	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.		

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	

## 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
	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			

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			

## 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
	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	

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.		

**SECTION 6 - JLG CONTROL SYSTEM**

**Table 6-4. Machine Configuration Programming Information**

Configuration Label/Digit	Number	Description	Default Number
MODEL NUMBER:	1	600S	2
	2	600A	
	3	600SC	
	4	601S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	
	6	GB	



Table 6-4. Machine Configuration Programming Information

Configuration Label/Digit	Number	Description	Default Number
ENGINE: 3*	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	14	PERKINS ECM	
	15	CAT ECM	
	16	DEUTZ EMR4: Deutz Engine Control Module (Tier 4 Final)	
	<b>17</b>	<b>FORD DUAL FUEL</b>	<b>17</b>
* Engine selections vary depending on model selection.			
FLYWHEEL TEETH: 4*	0	133 TEETH: 133 flywheel teeth.	
	<b>1</b>	<b>110 TEETH: 110 flywheel teeth.</b>	<b>1</b>
* This menu item is only visible if Deutz engine selections 3 or 4 are selected.			
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	<b>2</b>	<b>IN-CYLINDER: Glow plugs installed in each cylinder.</b>	<b>2</b>

## SECTION 6 - JLG CONTROL SYSTEM

**Table 6-4. Machine Configuration Programming Information**

Configuration Label/Digit	Number	Description	Default Number
STARTER LOCKOUT: 6	0	<b>DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.</b>	0
	1	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	
FUEL CUTOUT: 7*	0	<b>RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached</b>	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.			
ENGINE SHUTDOWN: 8	0	DISABLED: No engine shutdown.	1
	1	<b>ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. Cor the oil pressure is less than 8 PSI.</b>	
TILT: 9*	1	<b>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.</b>	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	3 DEGREES + 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, tower telescope out, drive, main telescope out and main lift up.	
	6	5 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
* 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	<b>NO: No jib installed.</b>	0
	1	YES: Jib installed which has up and down movements only.	
* Only visible under certain model selections.			
4 WHEEL STEER: 11*	0	<b>NO: No four-wheel steer installed.</b>	0
	1	YES: Four-wheel steer installed.	
* Only visible under certain model selections.			

Table 6-4. Machine Configuration Programming Information

Configuration Label/Digit	Number	Description	Default Number
STOUCH/SKYGUARD: 12	<b>0</b>	<b>None: No soft touch or SkyGuard system installed.</b>	<b>0</b>
	1	SOFT TOUCH - Soft touch only installed	
	2	SKYGUARD - Skyguard only installed	
	3	BOTH(CUTOUT) - Soft touch and Skyguard installed	
GEN SET/WELDER: 13	<b>0</b>	<b>NO: No generator installed.</b>	<b>0</b>
	1	BELT DRIVE: Belt driven setup.	
GEN SET CUTOUT: 14*	<b>0</b>	<b>MOTION ENABLED: Motion enabled when generator is ON.</b>	<b>0</b>
	1	MOTION CUTOUT: Motion cutout in platform mode only.	
* Only visible if Gen Set / Welder Menu selection is not 0.			
H & T LIGHTS: 15*	<b>0</b>	<b>NO: No head and tail lights installed.</b>	<b>0</b>
	1	YES: Head and tail lights installed.	
CABLE SWITCH: 16*	<b>0</b>	<b>NO: No broken cable switch installed.</b>	<b>0</b>
	1	YES: Broken cable switch installed.	
* Only visible under certain model selections.			
* Certain market and model selections will alter the default setting.			
LOAD SYSTEM: 17*	<b>0</b>	<b>NO: No load sensor installed.</b>	<b>0</b>
	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 telescope out & lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	
* 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			
LOAD SENSOR: 18*	0	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	
	<b>1</b>	<b>4 UNDER PLATFORM: Use the EIM for load sensing.</b>	<b>1</b>
* Only visible if Load Sensor Menu selection is not 0 and under certain market selections			
* Certain market selections will limit load sensor options.			

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**Table 6-4. Machine Configuration Programming Information**

Configuration Label/Digit	Number	Description	Default Number
FUNCTION CUTOUT: 19*	0	<b>NO: No drive cutout.</b>	1
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive & steer 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*	0	NO: No ground alarm installed.	3
	1	DRIVE: Travel alarm sounds when the drive function is active.	
	2	DESCENT: Descent alarm sounds when lift down is active.	
	3	<b>MOTION: Motion alarm sounds when any function is active.</b>	
* Certain market selections will alter default setting.			
DRIVE: 21*	0	<b>4WD: 4 wheel drive.</b>	0
	1	2DW: 2 wheel drive	
	2	2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	
* Only visible under certain model selections.			
DISPLAY UNITS: 22*	0	<b>IMPERIAL: DEG F, PSI, LBS.</b>	0
	1	METRIC: DEG C, KPA, KGS	
* Certain market selections will alter default setting.			
LEVELING MODE: 23*	0	<b>ALL FUNCTIONS: Platform level with all functions.</b>	0
	1	LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	
* Only visible on 800S models.			
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	<b>ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.</b>	
DRIVE PUMP: 25*	0	<b>SAUER DANFOSS: Machine equipped with Sauer Danfoss drive pump.</b>	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	

Table 6-4. Machine Configuration Programming Information

Configuration Label/Digit	Number	Description	Default Number
* Only visible on 600A, 600S, and 800S models.			
BOOM CONTROL: 26	0	<b>NORMAL: Boom function coils are energized from the Ground Module</b>	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	<b>YES: Machine is equipped with Function Speed Knob</b>	0
	1	NO: Machine is equipped with Operation Speed Switch	
* Only visible under certain market selections.			
CLEARSKY: 28	0	<b>NO: ClearSky (telematics) options is disabled.</b>	0
	1	YES: ClearSky (telematics) option is enabled.	
CRIBBING OPTION: 29	0	<b>NO: Cribbing Option is disabled.</b>	0
	1	YES: Cribbing Option is enabled.	
FUEL TANK SIZE: 30	0	<b>31 Gallon Tank</b>	0
	1	52 Gallon Tank	
ALARM / HORN: 31	0	<b>SEPARATE: Separate alarm and horn.</b>	0
	1	COMBINED: Combination alarm / horn.	
ALERT BEACON: 32	0	<b>OFF FOR CREEP: Alert beacon will not flash while in Creep</b>	0
	1	20FPS FOR CREEP: Alert beacon will flash at 20FPS while in Creep	
TEMP CUTOUT: 33	0	<b>NO: Temp Cutout is Disabled</b>	0
	1	YES: Temp Cutout is Enabled	
PLAT LVL OVR CUT 34	0	<b>NO: Platform Level Override will always be functional</b>	0
	1	YES: Platform Level Override will only be functional when In Transport	
WATER IN FUEL SENSOR: 35	0	<b>NO: Water in Fuel Sensor Disabled</b>	0
	1	YES: Water in Fuel Sensor Enabled	
* This menu item is only visible if Deutz EMR 4 engine is selected.			
* Only visible under certain market selections.			

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**Table 6-5. Machine Configuration Programming Settings**

600A	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	5	5	5	5	5	5	5
Market	0	1	2	3	4	5	3
Engine	12	12	12	12	12	12	12
Flywheel Teeth	0	0	0	0	0	0	0
	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
Fuel Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Engine Shutdown	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
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
Jib	0	0	0	0	0	0	0
4 WHEEL STEER	0	0	0	0	0	0	0
STOUCH/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
Load System	0	0	0	0	0	0	0
	X	1	X	X	X	1	X
	X	2	X	2	2	2	2
	X	3	X	3	X	3	3
	X	4	X	X	X	4	X

**Table 6-5. Machine Configuration Programming Settings**

600A	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
LOAD SENSOR	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
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
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
	1	1	1	1	1	1	1
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
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
CLEAR SKY	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
	1	1	1	1	1	1	1
ALARM / HORN	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
ALERT BEACON	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
TEMP CUTOUT	X	0	X	0	X	X	0
	X	1	X	1	X	X	1

Table 6-5. Machine Configuration Programming Settings

600A	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
PLAT LVL OVR CUT	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Water in Fuel Sensor	X	0	X	X	X	X	0
	X	1	X	X	X	X	1
<p><b>BOLD BLUE</b> text indicates the default setting. Plain text indicates another available selection. <b>RED ITALIC</b> text indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.</p>							

Table 6-6. Machine Configuration Programming Settings

600AJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	5	5	5	5	5	5	5
Market	0	1	2	3	4	5	3
Engine	12	12	12	12	12	12	12
Flywheel Teeth	0	0	0	0	0	0	0
	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
Fuel Cutout	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
Engine Shutdown	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
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
Jib	1	1	1	1	1	1	1
4 WHEEL STEER	0	0	0	0	0	0	0
STOUCH/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

Table 6-6. Machine Configuration Programming Settings

600AJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
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
Load System	0	0	0	0	0	0	0
	X	1	X	X	X	1	X
	X	2	X	2	2	2	2
	X	3	X	3	X	3	3
	X	4	X	X	X	4	X
LOAD SENSOR	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Function Cutout	0	0	0	0	0	0	0
	X	1	1	1	1	1	1
	2	2	2	X	2	2	2
Ground Alarm	X	3	3	X	3	3	3
	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
Drive Type	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
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
	1	1	1	1	1	1	1
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
BOOM CONTROL	3	3	3	3	3	3	3
	0	0	0	0	0	0	0
FUNCTION SPEED KNOB	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
CLEAR SKY	0	0	0	0	0	0	0
	1	1	1	1	1	1	1

Table 6-6. Machine Configuration Programming Settings

600AJ	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
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
	1	1	1	1	1	1	1
ALARM / HORN	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
ALERT BEACON	0	0	0	0	0	0	0
	1	1	1	1	1	1	1
TEMP CUTOUT	X	0	X	0	X	X	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	X	0	X	X	X	X	0
	X	1	X	X	X	X	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.

### 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, drive reverse, 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.

**LOWER LIFT**, upper boom horizontal, telescope in, lower lift up, record time, lower lift down, record time.

**LOWER TELESCOPE**, lower lift fully elevated, upper boom horizontal, telescoped in, lower tele out, record time, lower tele in, record time.

### Test Notes

1. Stop watch should be started with the function, not with the controller or switch.
2. All speed tests are run from the platform. These speeds do not reflect the ground control operation.
3. The platform speed knob control must be at full speed. (Turned clockwise completely).
4. Function speed may vary due to cold thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).

Table 6-7. Function Speeds (In Seconds)

Function	Speed (Seconds)
Lift Up	26 - 32
Lift Down	26 - 32
Swing Right & Left (No more than 10% difference between swing left and swing right.)	79 - 101
Telescope In	22 - 30
Telescope Out	35 - 50
Platform Rotate Right & Left (No more than 15% difference between rotate left and rotate right.)	16 - 25
Articulating Jib Up	22 - 34
Articulating Jib Down	16 - 26
Lower Lift Up	37 - 50
Lower Lift Down	28 - 38
Lower Telescope Out	15 - 23
Lower Telescope In	09 - 15
Drive (2 - WD & 4 - WD) (Other Engines) (Forward & Reverse)	30 - 34 (4.25 MPH)
Drive (2 - WD & 4 - WD) (Deutz Engines) (Forward & Reverse)	34 - 38 (4.02 MPH)
Drive (2 - WD & 4 - WD) (Above Horizontal) (Forward & Reverse)	46 - 54 (0.68 MPH)

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## 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.

### 6.5 LSS SYSTEM

The JLG-designed Load Sensing System (LSS) measures platform load via a sensor mounted in the platform support structure. If the actual platform load exceeds the selected Rated Load, the following will occur:

1. The Overload Visual Warning Indicator will flash at the selected control position (platform or ground). 
2. The Platform and Ground Alarms will sound 5 seconds On, and 2 seconds Off.
3. All normal movement will be prevented from the platform control position (optional - ground control functions may be prevented).
4. Further movement is permitted by:
  - a. Removing the excess platform load until actual platform load is less than Rated Load.
  - b. Operation of the overriding emergency system (Auxiliary Power Unit).
  - c. By an authorized person at the ground control position (optional - ground control functions may be prevented).

#### **NOTICE**

**THE LOAD SENSING SYSTEM MUST BE CALIBRATED WHEN ONE OR MORE OF THE FOLLOWING CONDITIONS OCCUR:**

- a. LSS Sensor removal or replacement
- b. Addition or removal of certain platform mounted accessories. (Refer to Calibration)
- c. Platform is removed, replaced, repaired or shows evidence of impact.



#### **NOTICE**

**THE LOAD SENSING SYSTEM REQUIRES PERIODIC FUNCTION VERIFICATION NOT TO EXCEED 6 MONTHS FROM PREVIOUS VERIFICATION. REFER TO TESTING & EVALUATION.**

All calibration procedures are menu driven through the use of a JLG Analyzer.

## Diagnostic Menu

The Diagnostic Menu is another troubleshooting tool for the Load Sensing System. Sensor and status information is presented in real-time for the technician. Several sub-menus exist to organize the data.

To access the Diagnostic Menu, use the LEFT  and RIGHT  Arrow keys to select DIAGNOSTICS from the Top Level

Menu. Press the ENTER key  to view the menu.

Press the LEFT and RIGHT Arrow keys to view the displays and select the various sub-menus. To access a sub-menu, press the ENTER key. Once in a sub-menu, press the LEFT and RIGHT Arrow keys to view the various displays (just like a Top Level


menu). To exit a sub-menu, press the ESC key .

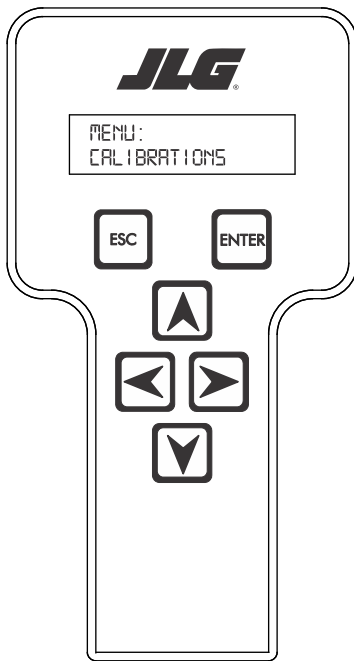
Table 6-8, Diagnostic Menu Descriptions details the structure of the Diagnostic Menu, and describes the meaning of each piece of information presented.

**Table 6-8. Diagnostic Menu Descriptions**


Diagnosics Menu (Displayed on Analyzer 1 <sup>st</sup> Line)	Parameter (Displayed on Analyzer 2 <sup>nd</sup> Line)	Parameter Value (Displayed on Analyzer 2 <sup>nd</sup> Line)	Description
PLATFORM LOAD	STATE:	OK / OVERLOAD	LSS Status.
PLATFORM LOAD	ACTUAL:	XXX.X KG	Calibrated weight of the platform. ??? if Platform Load is Unhealthy**.
PLATFORM LOAD (service*)	GROSS:	XXX.X KG	Gross weight of the platform. ??? if both Cells are Unhealthy**.
PLATFORM LOAD (service*)	OFFSET 1:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	OFFSET 2:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	ACCESSORY	XXX.X KG	Stored accessory weight. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	UNRESTRICT	XXX.X KG	UGM will set Unrestricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RESTRICT	XXX.X KG	UGM will set Restricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RAW 1:	XXX.X KG	Gross value from Cell 1. ??? if Unhealthy**.
PLATFORM LOAD (service*)	RAW 2:	XXX.X KG	Gross value from Cell 2. ??? if Unhealthy**.
* Indicates only visible in service view mode ** Typically indicates a DTC is active			

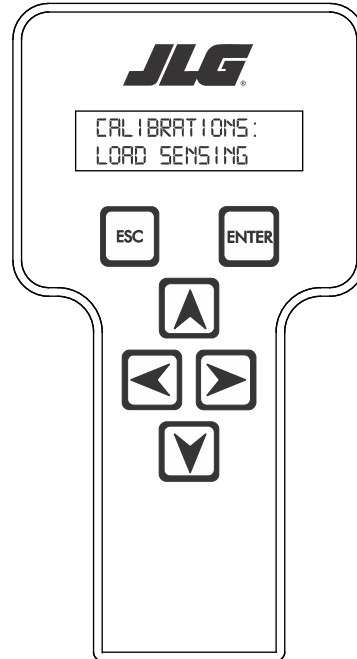
**Calibration Procedure**

1. Remove everything from the platform, except permanently fixed JLG Accessories, to allow the Load Sensing System to record its' weight during calibration. This includes all tools, debris, and customer-installed devices.
2. Plug the JLG Analyzer into the Machine at the Ground Station and enter Service Access Password 33271.
3. The platform should be approximately level for calibration. Level the platform from ground control (if necessary) to within +/- 5°.
4. To access the Calibration Menu, use the LEFT and RIGHT Arrow keys to select CALIBRATION from the Top Level Menu. The screen will read:

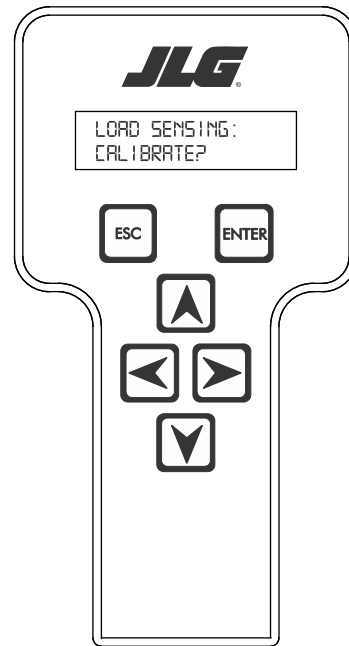


**NOTE:** The Calibration Menu is not available in OPERATOR ACCESS.


5. Press the ENTER key  to view the menu. Upon entry to the Calibration Menu, the JLG Control System will link to the Analyzer and the screen will read:




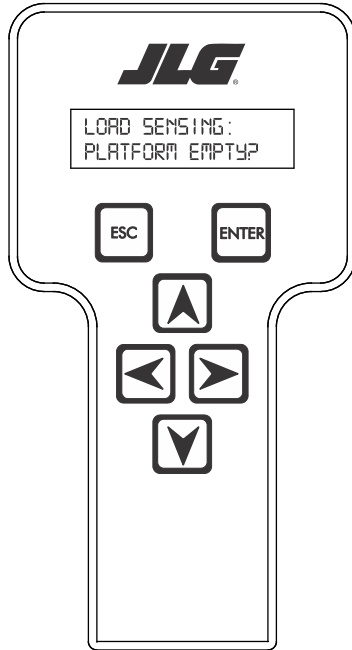
6. Press Enter . The Screen will read:




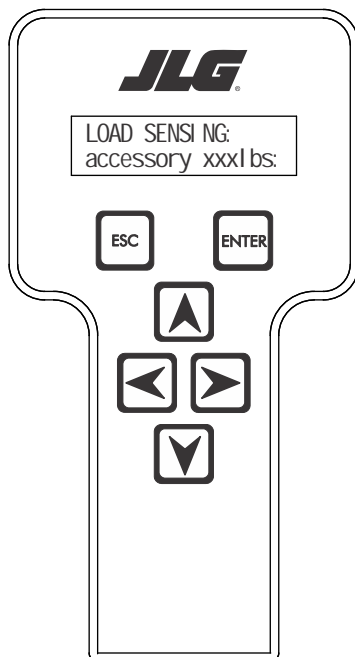
**NOTE:** Calibration will auto fail if LSS DTC's are active (443, 444, 4479, 4480, 663, 821, 822, 823, 824, 8218, 8222 -> 8238, 991, 992, 993, 994 or 99285).

Pressing the ESC key  after starting calibration and before calibration is complete will display the CAL FAILED message. This will not disturb the prior calibration information.

7. Press ENTER . The analyzer screen will read:




8. If the platform is empty, press ENTER . The screen will read:



**NOTE:** Accessory weight will reset to 0 lbs. each time the machine is re-calibrated and will need to be re-entered.

**NOTE:** The Accessory weight will be temporarily stored in the Control System until calibration has been completed successfully.

Refer to Table 6-9, Accessory Weights. Use the up and down analyzer keys to enter the accessory weight(s) (in lbs). When all the accessory weights are entered, press

ENTER . The screen will read:

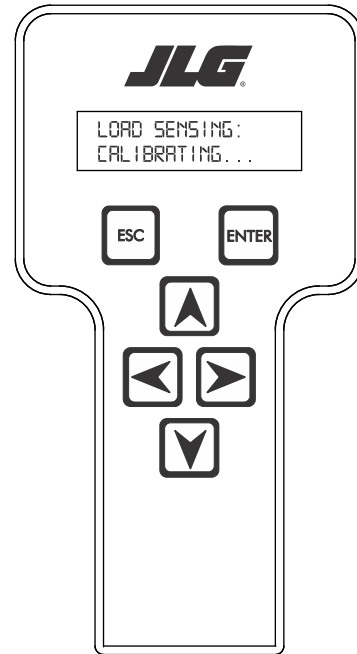


Table 6-9. Accessory Weights

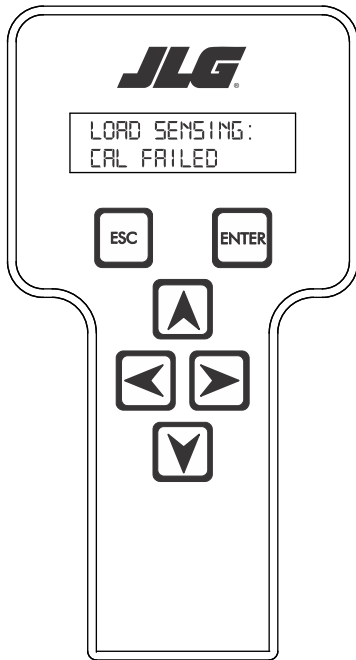
Accessory	Weight
SkyWelder (stick welder)	70 lb (32 kg)
SkyWelder Prep	Prep only = 15 lb (7 kg) Full install = 70 lb (32 kg)
SkyCutter (plasma cutter)	70 lb (32 kg)
SkCutter / SkyWelder Combo	140 lb (64 kg)
Fire Extinguisher	45 lb (20 kg)
Overhead SoftTouch	80 lb (36 kg)
Work Surface	20 lb (9 kg)

**NOTE:** Not all Accessories are available on every JLG model. Some Accessory combinations are prohibited due to excessive weight and/or load restriction. If any installed JLG Accessories are labeled with weight decals but are not listed in the table above, include their weight when entering the ACC WEIGHT value.


## SECTION 6 - JLG CONTROL SYSTEM

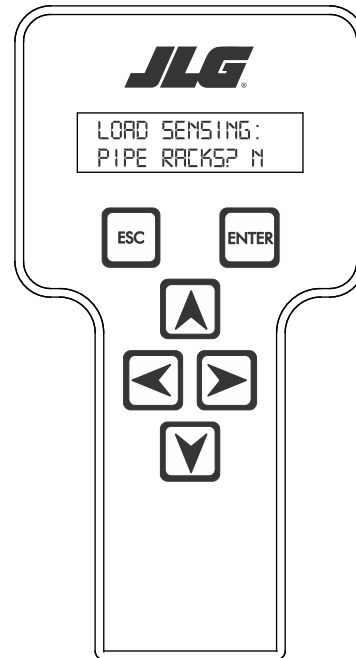
9. The control system will calculate the load cell readings and ensure it is greater than 130 lbs. (59 kg), but less than 575 lbs.(261 kg).


If the platform weight is not within the allowed range, the calibration attempt will be unsuccessful and the Analyzer will show the following:

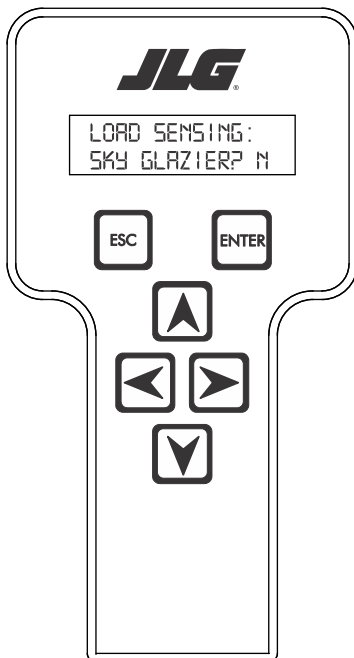


11. Use the analyzer keys to select N for no or Y for yes. Press


ENTER . The screen will read:



10. Press ENTER . The control system will ask for installed accessories. The screen will show the following:



12. Use the analyzer keys to select N for no or Y for yes. Press

ENTER . The control system will default to an estimate of unrestricted capacity, which can be adjusted if necessary. Refer to Table 6-10, SkyGlazier Capacity Reductions and Table 6-11, Pipe Rack Capacity Reductions.

The screen will read:

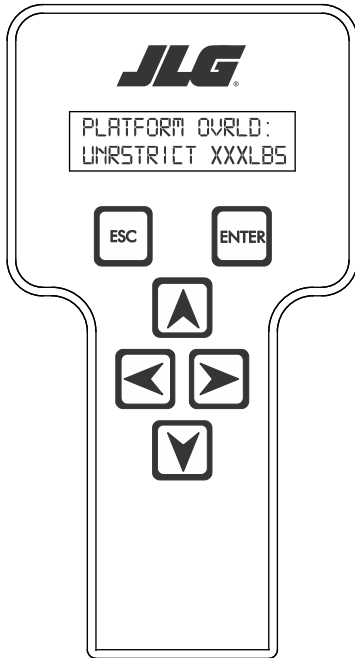


Table 6-10. SkyGlazier Capacity Reductions


Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	400 lb (181 kg)	n/a
600 lb (272 kg)	400 lb (181 kg)	n/a
750 lb (340 kg)	n/a	590 lb (268 kg)
1000 lb (454 kg)	n/a	750 lb (340 kg)

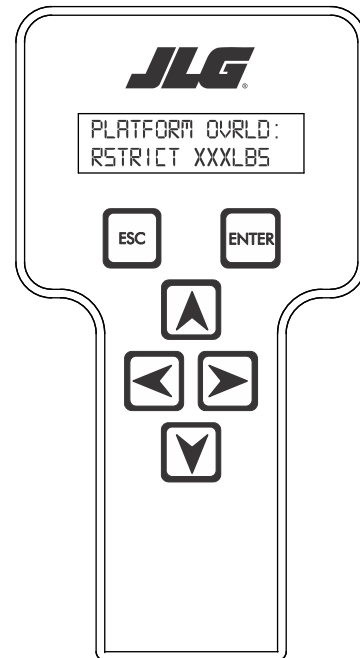
Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.


Table 6-11. Pipe Rack Capacity Reductions

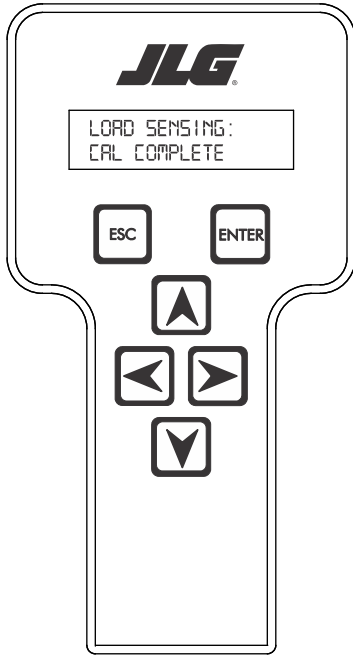
Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	450 lb (204 kg)	n/a
600 lb (272 kg)	500 lb (227 kg)	n/a
750 lb (340 kg)	n/a	650 lb (295 kg)
1000 lb (454 kg)	n/a	900 lb (408 kg)

Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.

13. Press ENTER . The following screen will be displayed for restricted capacity, which can be adjusted if necessary. Refer to Table 6-10, SkyGlazier Capacity Reductions and Table 6-11, Pipe Rack Capacity Reductions.



14. Press ENTER . If calibration is successful, the screen will read:





## Testing & Evaluation

Refer to Troubleshooting if the Load Sensing System fails to meet these guidelines.

1. Connect the JLG Analyzer.
2. Level the Platform. The platform should be approximately level for analysis, or the guidelines below will not be applicable. Level the platform from Ground Control (if necessary) to within  $\pm 5$  degrees.
3. Observe the Empty Platform Weight. Proceed to the DIAGNOSTICS, PLTLOAD sub-menu and observe the measured platform load. All tools, debris, and customer-installed devices shall be removed during evaluation. Ideally, the PLTLOAD should be zero but can vary  $\pm 15$ lbs ( $\pm 7$ kg). Further, the reading should be stable and should not vary by more than  $\pm 2$ lbs ( $\pm 1$ kg) (unless there is heavy influence from wind or vibration).
4. Use the Technician's Weight to Evaluate. The technician should enter the platform and record the PLTLOAD reading while standing in the center of the platform.
5. Confirm Control System Warnings and Interlocks. Using the keyswitch, select Platform Mode and power-up. Start the vehicle's engine and ensure that all controls are functional and the Load Sensing System's Overload Visual and Audible Warnings are not active. Simulate an Overload by unplugging the Shear Beam Load Cell. The Overload Visual Warning should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, and 2 seconds Off. With the engine running, all control should be prevented. Cycle the Platform EMS to stop the engine and then power-up again. The Overload Visual and Audible Warning should continue. Confirm that controls are responsive when using the Auxiliary Power Unit for emergency movement. Reconnect the Load Cell. The Overload Visual and Audible Warnings should cease and normal control function should return. Switch the vehicle's keyswitch to Ground Mode and repeat the above procedure. The Overload Visual Warning at the Ground Controls should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, 2 seconds Off. However, the controls should remain functional when using the engine and the Auxiliary Power Unit (if the Control System's MACHINE SETUP, LOAD is set to "2=CUTOUT PLT". If set to "3=CUTOUT ALL", then Ground Controls will be prevented when using the engine as in the platform).
6. Confirm Control System Capacity Indication (optional for vehicles with Dual Capacity Ratings). For vehicles equipped with a Capacity Select switch on the Platform Console Box, it is necessary to examine an additional interface between the Load Sensing System and the Control System. Using the keyswitch, select Platform Mode and power-up. If necessary, put the boom in the transport position (completely stowed) and center the Jib Plus (if equipped). Place the Capacity Select switch in the unrestricted position and ensure that the proper indicator illuminates on the Platform Console Box. Plug the JLG Analyzer into the Analyzer connection and proceed to the DIAGNOSTICS, SYSTEM submenu. Ensure that the CAPACITY displays indicate OFF. Place the Capacity Select switch in the unrestricted position (if so equipped) and ensure that the proper indicator illuminates on the Platform Console Box (but does not flash). For vehicles with unrestricted capacity, ensure that the unrestricted CAPACITY display indicates ON but the restricted CAPACITY indicates OFF. For vehicles with restricted capacity, ensure that the unrestricted CAPACITY display indicates OFF but the restricted CAPACITY indicates ON.
7. Confirm Load Sensing System Performance with Calibrated Weights. Operate the vehicle from Ground Control and place the boom in the transport position (fully stowed) for safety. Plug the JLG Analyzer into the control system connection and proceed to the DIAGNOSTICS, PLTLOAD display. Place 500lbs (230kg) in the platform and ensure that PLTLOAD is with  $\pm 5\%$  of the actual weight. For Dual Capacity vehicles, do the same for the alternate capacity (unrestricted or restricted).

## Troubleshooting

The following tables are furnished to provide possible resolutions for common difficulties. Difficulties are classified as General, Calibration, Measurement Performance, and Host System Functionality.

**Table 6-12. LSS Troubleshooting Chart**

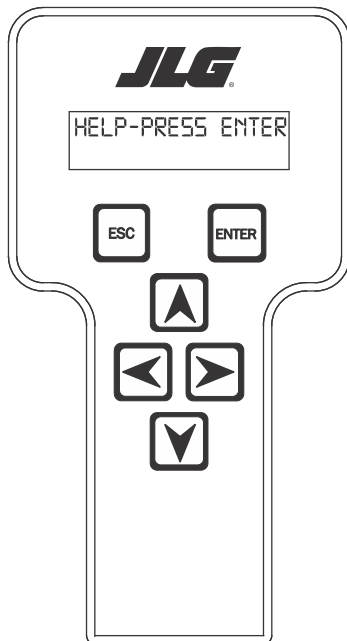
Difficulty	Possible Resolution
<p>Empty Platform Weight (DIAGNOSTICS, PLATFORM LOAD) is not within <math>\pm 15\text{lbs}</math> (<math>\pm 7\text{kg}</math>) of zero.</p> <p>or</p> <p>Platform Load readings (DIAGNOSTICS, PLATFORM LOAD) are unstable by more than <math>\pm 2\text{lbs}</math> (<math>\pm 1\text{kg}</math>) (without the influence of vibration or wind).</p> <p>or</p> <p>There are large variations in Platform Load (DIAGNOSTICS, PLATFORM LOAD) based on the location of the load. Tolerance to variations is 20lbs for an evaluation using the technician's weight, and <math>\pm 5\%</math> of Rated Load when using calibrated weights.</p>	<p>The LSS System is unable to properly measure the platform weight.</p> <ol style="list-style-type: none"> <li>1. The Load Cell is not properly plugged into the LSS Harness. It is possible poor electrical contact is made.</li> <li>2. Wiring leading to the Load Cell is damaged. Carefully inspect sensor wiring where it passes through cable clamps for signs of damage. Inspect wiring where damage to the channel is apparent.</li> <li>3. The Load Cell was not assembled properly during installation. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable. It is often helpful to apply slight downward pressure above the sensor and observe that its output increases (increasing force measurement; decreasing means the sensor is mounted upside-down).</li> <li>4. The Load Cell is contaminated by debris or moisture. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable and stable (not changing by more than <math>\pm 2\text{lbs}</math> (<math>\pm 1\text{kg}</math>) (without the influence of vibration or wind). Lack of measurement stability is a key indication of contamination. Unplug the connector and inspect for dirt or moisture. Look carefully into the female connector on the sensor's cordset for evidence of contamination. Debris should be brushed away with a soft bristle brush (do not introduce any cleaners as they will leave conductive residue). Moisture should be allowed to evaporate or accelerated with a heat-gun (use low heat and be carefully to not melt connector materials). Moisture intrusion into the molded portion of the connector (capillary action into the wire bundle) or the Shear Beam Load Cell itself will require replacement of the sensor.</li> <li>5. The Load Cell has been mechanically damaged. If the Load Cell is physically deformed or has damage to the cover it should be replaced immediately. It is also possible to have invisible mechanical damage resulting from an extreme overload (<math>&gt;6000\text{lbs}</math> [<math>&gt;2722\text{kg}</math>]).</li> </ol>
<p>The Visual and Audible Overload Warnings fail to sound when platform is loaded beyond Rated Load, or when simulated by unplugging the Load Cell. Controls remain functional at Platform and Ground Control positions.</p>	<p>The Control System is failing to regard the overload signal from the LSS System, or the signal is shorted.</p> <ol style="list-style-type: none"> <li>1. The Load Sensing System must be enabled within the Control System. Plug the JLG Analyzer into the Control System, enter the Access Level 1 password (33271), and examine the MACHINE SETUP, LOAD sub-menu. The selection "2=CUTOUT PLT" should be displayed (platform controls prevented during overload, ground controls remain operational). In country- or customer-specific circumstance, the selection "3=CUTOUT ALL" is used (platform and ground controls prevented during overload).</li> </ol>
<p>The Ground Audible Warning fails to sound, but the Platform Audible Warning sounds properly.</p>	<p>The Ground Alarm is missing or improperly installed. Verify that the device is mounted. Verify wiring from the Main Terminal Box and Ground Module.</p>
<p>Controls remain functional at the Ground Control position during an overload, or when simulated by unplugging the Load Cell. The Controls at the Platform Control position are prevented when using the engine, but not when using the Auxiliary Power Unit.</p>	<p>The JLG Control System is configured to prevent platform controls only in the event of overload. Alternately, the Host Control System can be configured to prevent ground and platform controls for country- or customer-specific circumstances.</p> <p>Using the JLG Analyzer, enter the Access Level 1 password (33271). Proceed to the MACHINE SETUP, LOAD sub-menu. Set this parameter to "2=CUTOUT PLT" to prevent platform controls in the event of overload. Set this parameter to "3=CUTOUT ALL" to prevent platform and ground controls in the event of overload.</p>



## 6.6 RESETTING THE MSSO SYSTEM

1. Use the following procedure to reset the MSSO system.
2. Position the Platform/Ground select switch to the desired position.
3. Plug the analyzer into the connector coming from the ground control module or from the platform console.

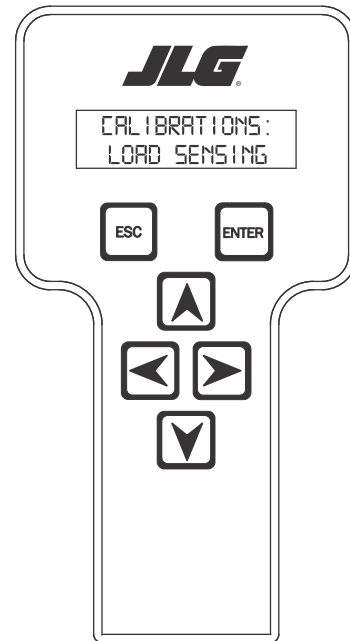
**NOTE:** If performing the procedure from the platform console, the Emergency Stop switch on the ground console must also be pulled out.



4. Pull out the Emergency Stop switch.
5. The analyzer screen should read:



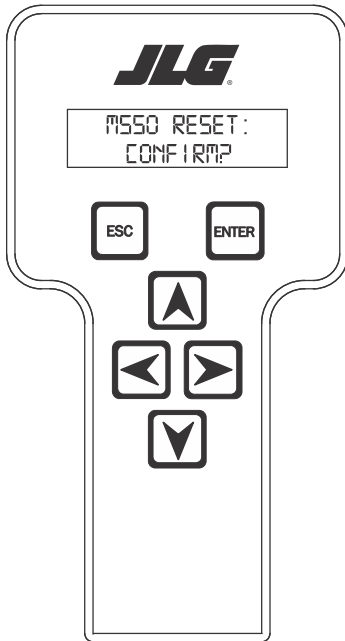
6. Use the arrow button to reach OPERATOR ACCESS. Press  Enter.
7. Enter the Access Code, 33271.
8. Use the right Arrow key to reach MENU: CALIBRATIONS. Press Enter .

9. Use the arrow keys to reach the LOAD SENSING menu. The screen should read:



10. Press ENTER .
11. Use the Down  arrow to reach MSSO RESET.

12. Press Enter . The screen will read:





13. Press Enter . The JLG Control System will reset an active 873 DTC and the MSSO System will be reset. Press Escape  to return to the CALIBRATIONS menu.

Table 6-13. Fault Code List

DTC	Text
001	EVERYTHING OK
002	GROUND MODE 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
0015	LOAD SENSOR READING UNDER WEIGHT
0031	FUEL LEVEL LOW - ENGINE SHUTDOWN
0035	APU ACTIVE
0039	SKYGUARD ACTIVE - FUNCTIONS CUTOUT
0040	RUNNING AT CREEP - CREEP SWITCH CLOSED
211	POWER CYCLE
212	KEYSWITCH FAULTY
213	FSW FAULTY
227	STEER SWITCHES FAULTY
2211	FSW INTERLOCK TRIPPED
2212	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH
2213	STEER LOCKED - SELECTED BEFORE FOOTSWITCH
2214	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE
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
2269	FUNCTION PROBLEM - HIGH SPEED & CREEP ACTIVE TOGETHER
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
23163	FUNCTION PROBLEM - MSSO PERMANENTLY SELECTED
241	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE LOW
242	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE HIGH
259	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS

**Table 6-13. Fault Code List**

<b>DTC</b>	<b>Text</b>
2513	GENERATOR MOTION CUTOUT ACTIVE
2514	BOOM PREVENTED - DRIVE SELECTED
2516	DRIVE PREVENTED - ABOVE ELEVATION
2517	DRIVE PREVENTED - TILTED & ABOVE ELEVATION
2518	DRIVE PREVENTED - BOOM SELECTED
2519	DRIVE PREVENTED - TILTED & EXTENDED OR HIGH ANGLE
2520	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER
2563	SKYGUARD SWITCH - DISAGREEMENT
2568	TEMPERATURE CUTOUT ACTIVE - AMBIENT TEMPERATURE TOO LOW
2576	PLATFORM LEVEL PREVENTED - ABOVE ELEVATION
2577	DRIVE PREVENTED - START BATTERY CONNECTED
331	BRAKE - SHORT TO BATTERY
332	BRAKE - OPEN CIRCUIT
3311	GROUND ALARM - SHORT TO BATTERY
3336	ALTERNATOR POWER - SHORT TO GROUND
3340	AUX POWER - SHORT TO GROUND
3341	AUX POWER - OPEN CIRCUIT
3342	AUX POWER - SHORT TO BATTERY
3346	ELECTRIC FAN - SHORT TO GROUND
3347	ELECTRIC FAN - OPEN CIRCUIT
3348	ELECTRIC FAN - SHORT TO BATTERY
3349	ELECTRIC PUMP - SHORT TO GROUND
3350	ELECTRIC PUMP - OPEN CIRCUIT
3351	ELECTRIC PUMP - 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

Table 6-13. Fault Code List

DTC	Text
3366	STEER DUMP VALVE - OPEN CIRCUIT
3367	STEER DUMP VALVE - SHORT TO BATTERY
3368	TWO SPEED VALVE - SHORT TO GROUND
3369	TWO SPEED VALVE - OPEN CIRCUIT
3370	TWO SPEED VALVE - SHORT TO BATTERY
3371	GROUND ALARM - SHORT TO GROUND
3372	GROUND ALARM - OPEN CIRCUIT
3373	GEN SET/WELDER - SHORT TO GROUND
3374	GEN SET/WELDER - OPEN CIRCUIT
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
33108	TOWER LIFT UP VALVE - SHORT TO BATTERY
33109	TOWER LIFT DOWN VALVE - SHORT TO GROUND
33110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT
33111	TOWER LIFT DOWN VALVE - SHORT TO BATTERY

**Table 6-13. Fault Code List**

<b>DTC</b>	<b>Text</b>
33112	TOWER TELESCOPE IN VALVE - SHORT TO GROUND
33113	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT
33114	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY
33115	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND
33116	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT
33117	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY
33118	SWING RIGHT VALVE - SHORT TO GROUND
33119	SWING RIGHT VALVE - OPEN CIRCUIT
33120	TELESCOPE IN VALVE - SHORT TO BATTERY
33121	SWING RIGHT 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
33170	LIFT DOWN VALVE - OPEN CIRCUIT
33171	LIFT DOWN VALVE - SHORT TO BATTERY
33172	LIFT DOWN VALVE - SHORT TO GROUND
33175	JIB ROTATE LEFT VALVE - OPEN CIRCUIT
33176	JIB ROTATE LEFT VALVE - SHORT TO BATTERY
33177	JIB ROTATE LEFT VALVE - SHORT TO GROUND
33178	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT
33179	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY
33180	JIB ROTATE RIGHT VALVE - SHORT TO GROUND
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
33207	HORN - OPEN CIRCUIT
33208	HORN - SHORT TO BATTERY
33209	HORN - SHORT TO GROUND
33279	GLOWPLUG - OPEN CIRCUIT
33280	GLOWPLUG - SHORT TO BATTERY
33281	GLOWPLUG - SHORT TO GROUND
33287	LIFT - CURRENT FEEDBACK READING TOO LOW
33295	SWING LEFT VALVE - OPEN CIRCUIT
33306	SWING LEFT VALVE - SHORT TO BATTERY



Table 6-13. Fault Code List

DTC	Text
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
33321	DRIVE REVERSE VALVE - SHORT TO BATTERY
33322	DRIVE REVERSE VALVE - SHORT TO GROUND
33323	LIFT UP VALVE - OPEN CIRCUIT
33324	LIFT UP VALVE - SHORT TO BATTERY
33325	LIFT UP VALVE - SHORT TO GROUND
33331	DRIVE - CURRENT FEEDBACK READING TOO LOW
33410	DRIVE - CURRENT FEEDBACK READING LOST
33412	SWING VALVES - SHORT TO BATTERY
33414	SWING - CURRENT FEEDBACK READING TOO LOW
33415	FLOW CONTROL VALVE - CURRENT FEEDBACK READING TOO LOW
33417	LIFT - CURRENT FEEDBACK READING LOST
33418	SWING - CURRENT FEEDBACK READING LOST
33419	FLOW CONTROL VALVE - CURRENT FEEDBACK READING LOST
33488	SWING FLOW CONTROL VALVE - SHORT TO GROUND
33575	ECM PULL DOWN RESISTOR - OPEN CIRCUIT
341	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT
342	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY
343	PLATFORM LEVEL UP VALVE - SHORT TO GROUND
344	PPLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT
345	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT
346	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY
347	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND
348	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT
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

**Table 6-13. Fault Code List**

<b>DTC</b>	<b>Text</b>
3417	JIB LIFT UP VALVE - SHORT TO GROUND
3418	JIB LIFT DOWN VALVE - OPEN CIRCUIT
3419	JIB LIFT DOWN VALVE - SHORT TO BATTERY
3420	JIB LIFT DOWN VALVE - SHORT TO GROUND
3421	JIB ROTATE LEFT VALVE - OPEN CIRCUIT
3422	JIB ROTATE LEFT VALVE - SHORT TO BATTERY
3423	JIB ROTATE LEFT VALVE - SHORT TO GROUND
3424	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT
3425	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY
3426	JIB ROTATE RIGHT VALVE - SHORT TO GROUND
431	FUEL SENSOR - SHORT TO BATTERY OR OPEN CIRCUIT
432	FUEL SENSOR - SHORT TO GROUND
433	OIL PRESSURE - SHORT TO BATTERY
434	OIL PRESSURE - SHORT TO GROUND
435	COOLANT TEMPERATURE - SHORT TO GROUND
436	FORD FAULT CODE ##
437	ENGINE TROUBLE CODE
438	HIGH ENGINE TEMP
439	AIR FILTER BYPASSED
4310	NO ALTERNATOR OUTPUT
4311	LOW OIL PRESSURE
4312	485 COMMUNICATIONS LOST
4313	THROTTLE ACTUATOR FAILURE
4314	WRONG ENGINE SELECTED - ECM DETECTED
4322	LOSS OF ENGINE SPEED SENSOR
4323	SPEED SENSOR READING INVALID SPEED
4331	SOOT LOAD WARNING - LOW
4332	SOOT LOAD WARNING - HIGH
4333	SOOT LOAD WARNING - SEVERE
4334	ENGINE COOLANT - LOW LEVEL
441	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN
442	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN
445	BATTERY VOLTAGE LOW
662	CANBUS FAILURE - PLATFORM MODULE
664	CANBUS FAILURE - ACCESSORY MODULE
6620	CANBUS FAILURE - UMS SENSOR
6622	CANBUS FAILURE - TCU MODULE
6623	CANBUS FAILURE - GATEWAY MODULE

Table 6-13. Fault Code List

DTC	Text
6629	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH
6657	CANBUS FAILURE - TEMPERATURE SENSOR
671	ACCESSORY FAULT
681	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP
813	CHASSIS TILT SENSOR NOT CALIBRATED
815	CHASSIS TILT SENSOR DISAGREEMENT
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
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
8645	REAR LEFT STEER VALVE - OPEN CIRCUIT
8646	REAR LEFT STEER VALVE - SHORT TO BATTERY
8647	REAR LEFT STEER VALVE - SHORT TO GROUND
8648	REAR RIGHT STEER VALVE - OPEN CIRCUIT
8649	REAR RIGHT STEER VALVE - SHORT TO BATTERY
8650	REAR RIGHT STEER VALVE - SHORT TO GROUND
871	RETURN FILTER BYPASSED
872	CHARGE PUMP FILTER BYPASSED
873	MACHINE SAFETY SYSTEM OVERRIDE OCCURRED
998	EEPROM FAILURE - CHECK ALL SETTINGS
9910	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER
9914	PLATFORM MODULE SOFTWARE UPDATE REQUIRED
9915	CHASSIS TILT SENSOR NOT GAIN CALIBRATED
9916	CHASSIS TILT SENSOR GAIN OUT OF RANGE
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
9923	GROUND MODULE FAILURE - HWFS CODE 1
9924	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED
9944	CURRENT FEEDBACK GAINS OUT OF RANGE

**Table 6-13. Fault Code List**

<b>DTC</b>	<b>Text</b>
9945	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT
9979	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER

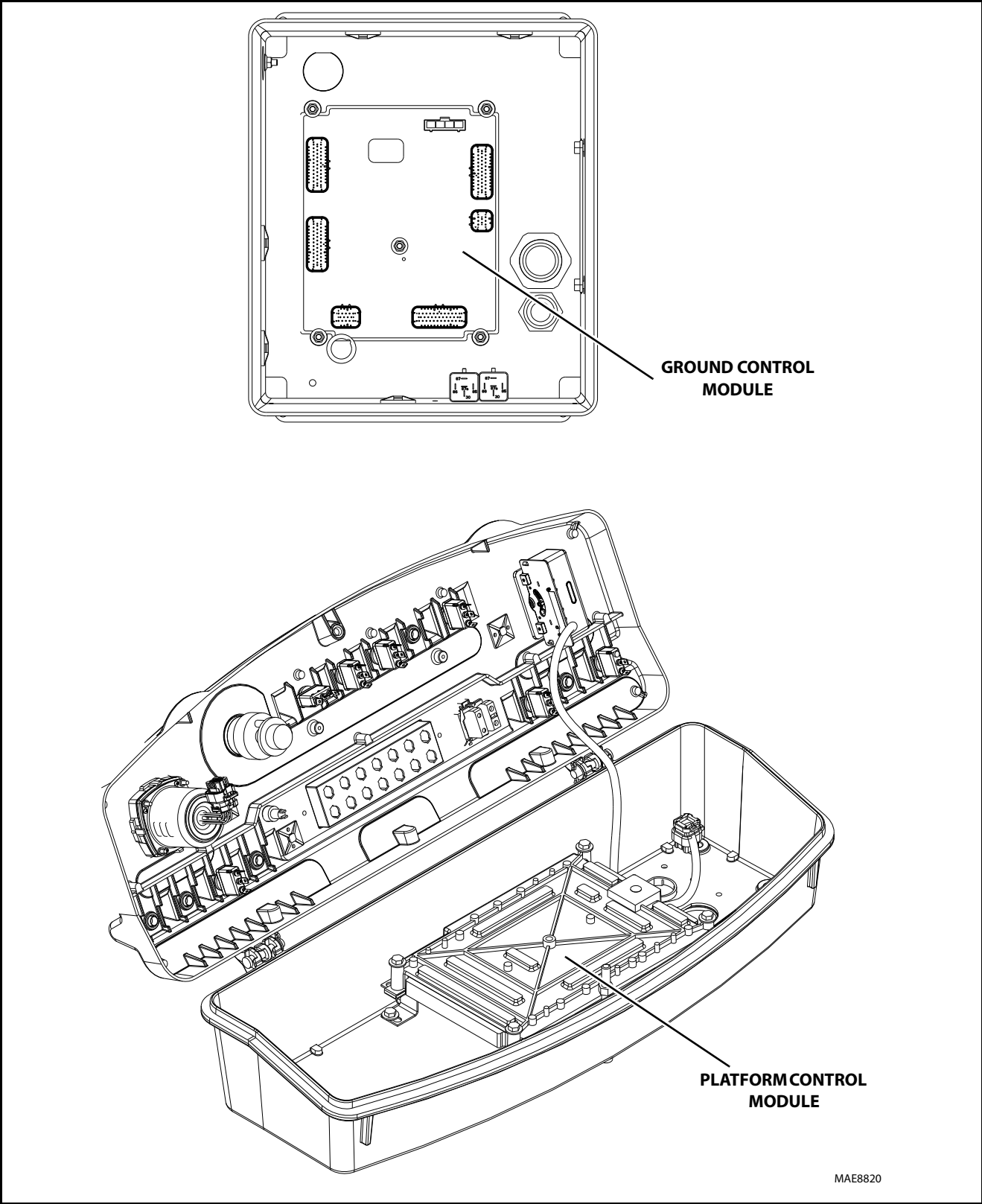
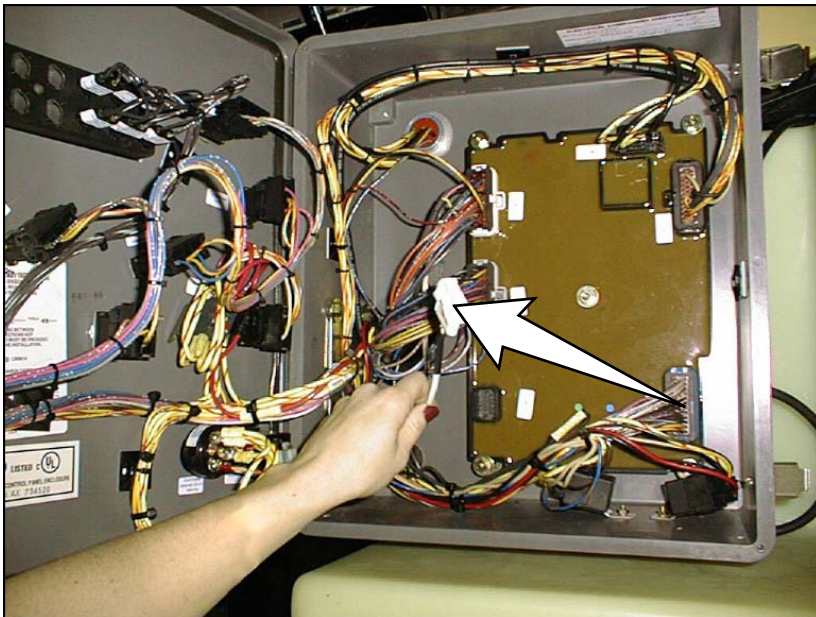


Figure 6-9. Control Module Locations

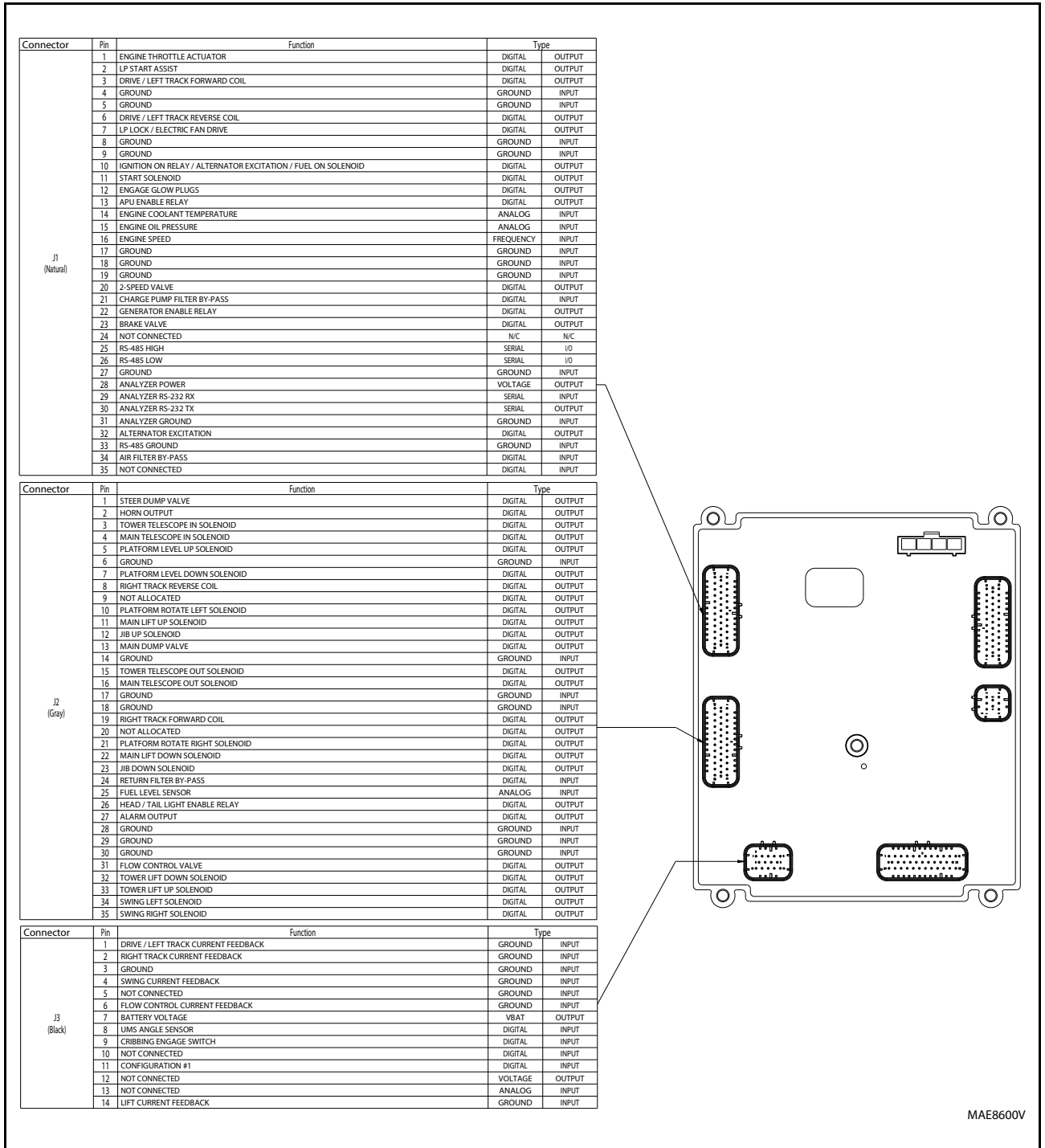


PLATFORM CONNECTION



GROUND CONTROL CONNECTION

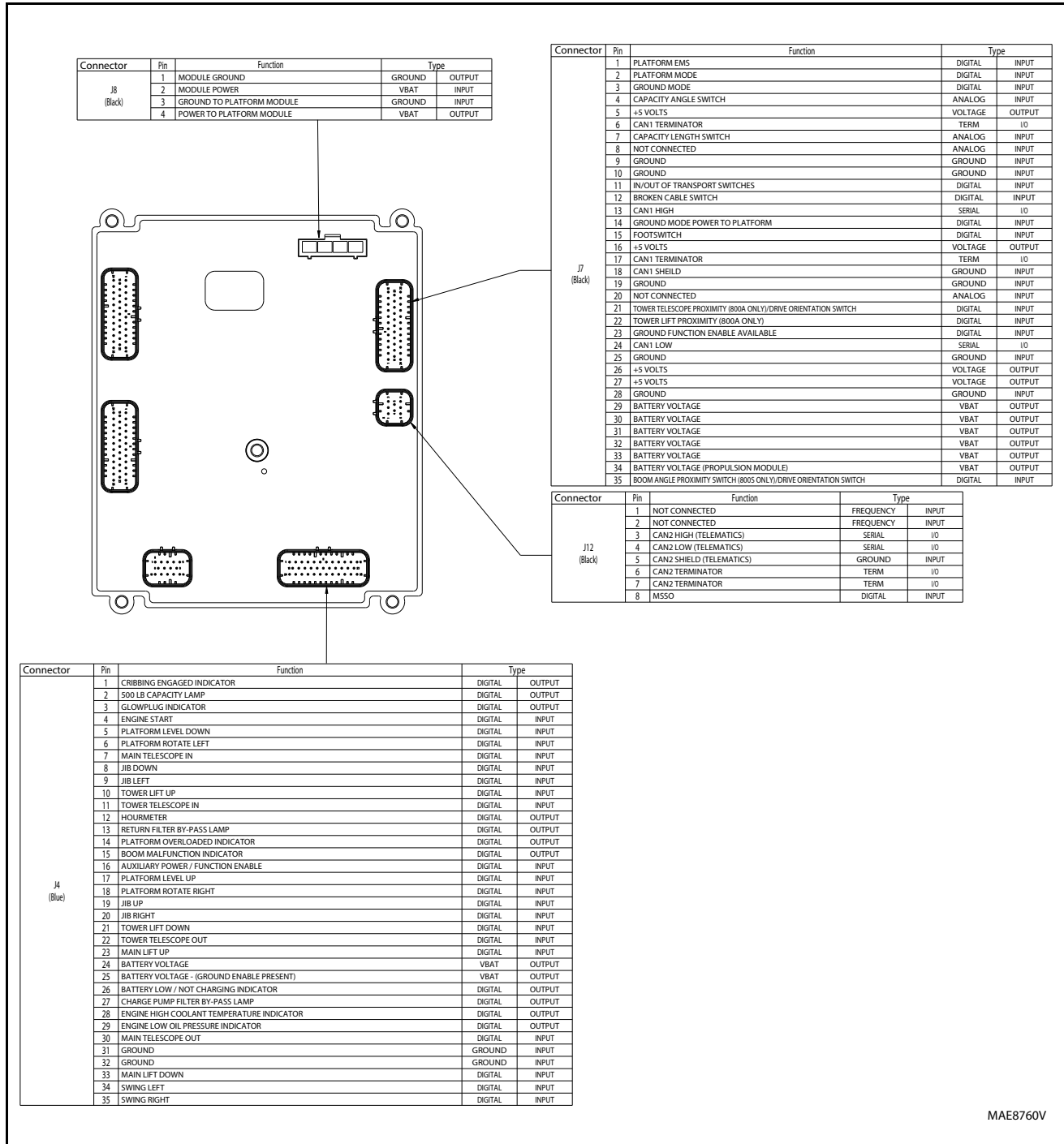
Figure 6-10. Analyzer Connecting Points



MAE8600V

Figure 6-11. Ground Control Module Pin Connections 1 of 2

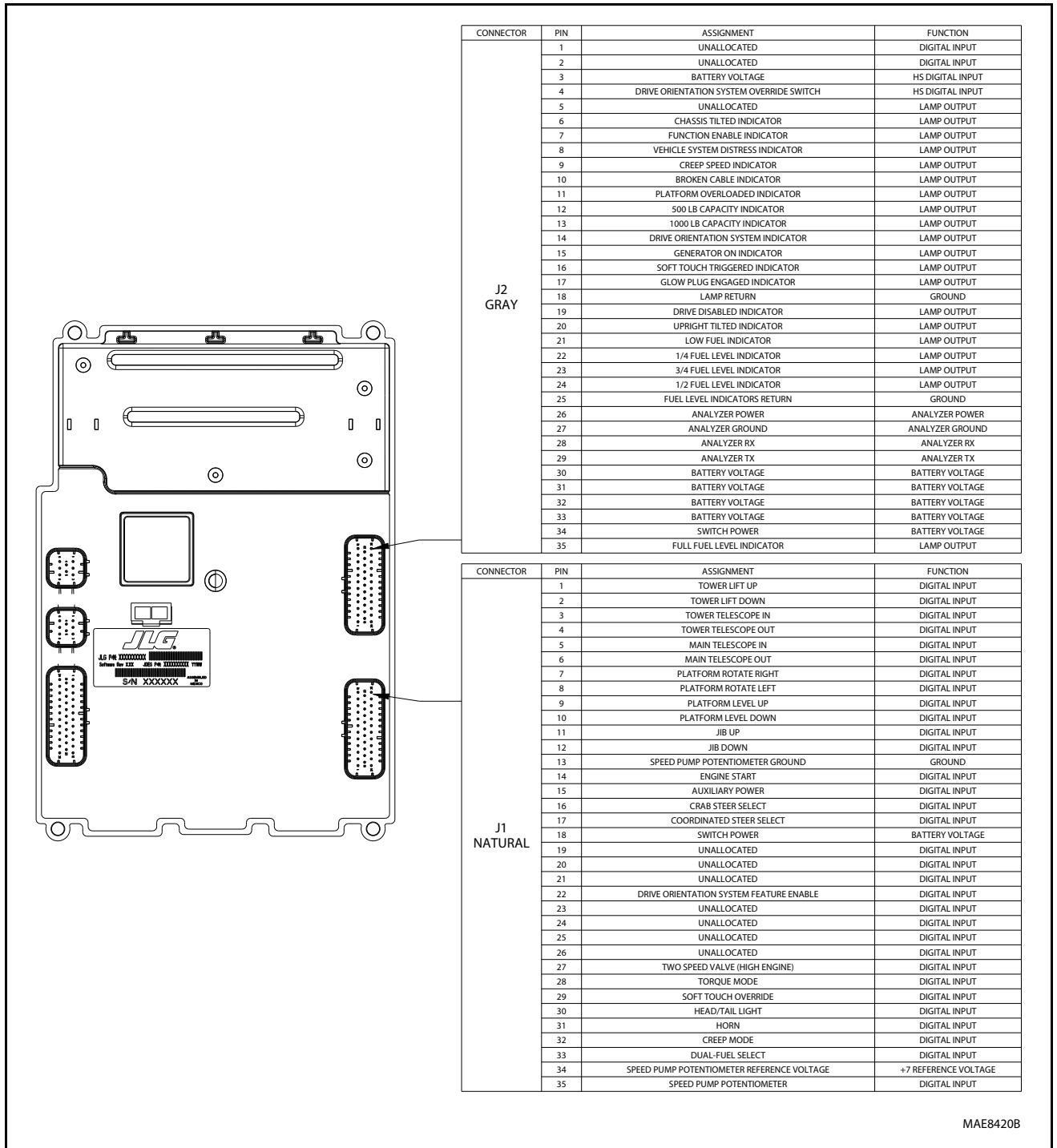
# SECTION 6 - JLG CONTROL SYSTEM



MAE8760V

Figure 6-12. Ground Control Module Pin Connections 2 of 2





MAE8420B

Figure 6-13. Platform Control Module Pin Connections 1 of 2

# SECTION 6 - JLG CONTROL SYSTEM

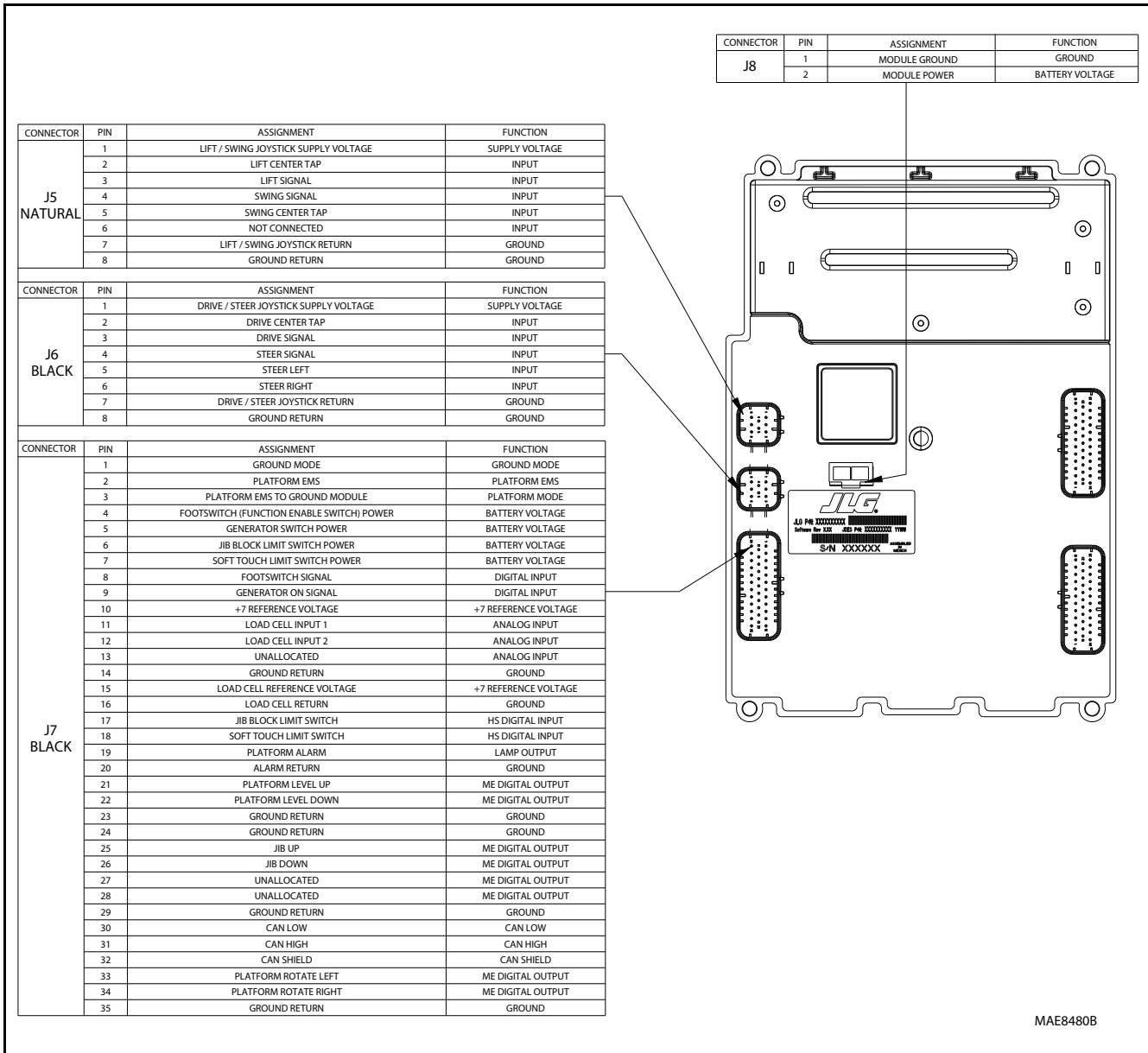


Figure 6-14. Platform Control Module Pin Connections 2 of 2

## SECTION 7. BASIC ELECTRICAL INFORMATION & ELECTRICAL 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

Use of the "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)

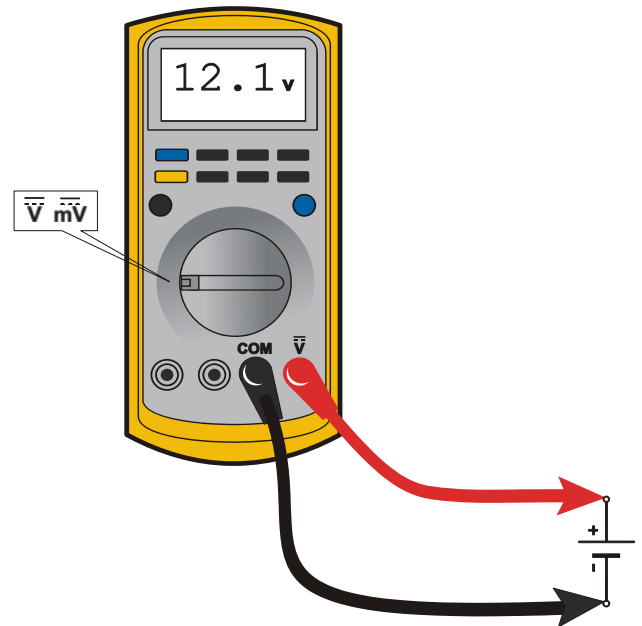
m = milli = (Displayed Number) / 1,000

$\mu$  = micro = (Displayed Number) / 1,000,000

Example: 1.2 kW = 1200 W

Example: 50 mA = 0.05 A

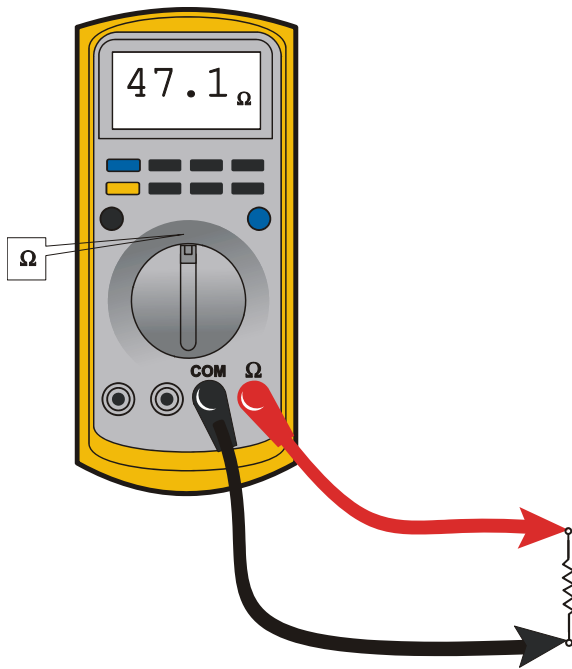
#### Voltage Measurement



**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

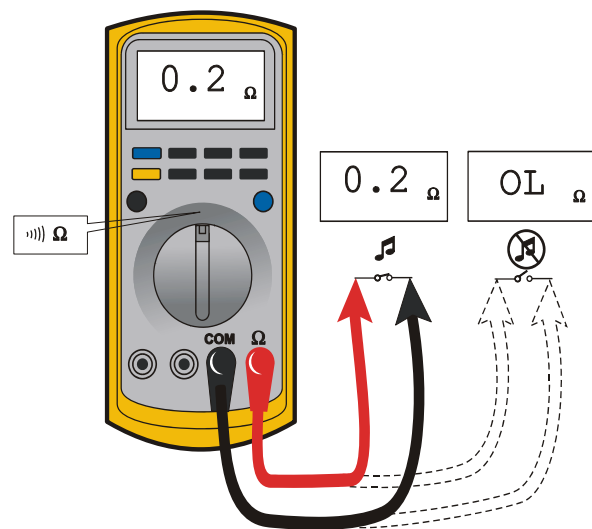
### Resistance Measurement



**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

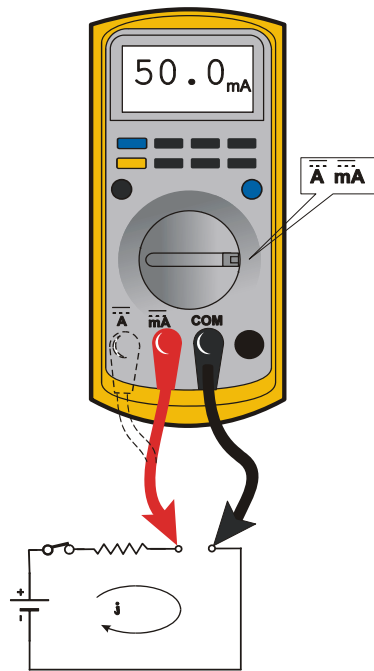
### Continuity Measurement



**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.

- 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.*

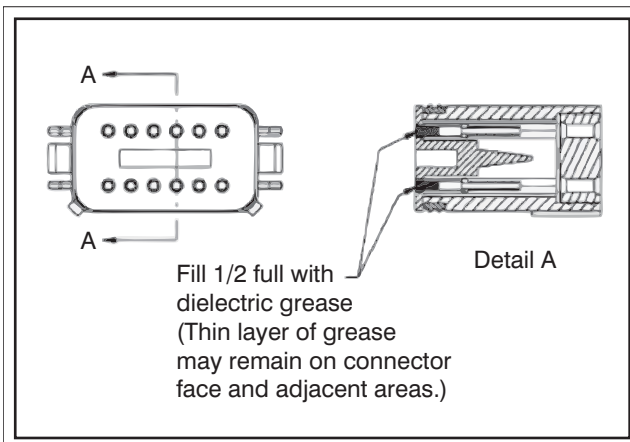
When applied to electrical connections, dielectric grease helps prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from application of dielectric grease.

Dielectric grease shall be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

**Installation of Dielectric Grease**

Before following these instructions, refer to excluded connector types (See Exclusions below).

- Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
- Apply dielectric grease to plug/male connector housing which typically contains sockets contact/female terminals.
- Leave a thin layer of dielectric grease on the face of the connector.
- Assemble connector system immediately to prevent moisture or dust contamination.
- 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 plug/male connector housing which typically contains socket contacts/female terminals. If trapped air prevents the connector from latching, pierce one of the unused wire seals. After assembly, install a seal plug (JLG #4460905) in that location to prevent moisture ingress.

Note that seal plugs may be installed by the wire harness manufacturer if an unused wire seal becomes compromised (wire inserted in the wrong cavity during assembly and the corrected).



**Figure 7-7. Application to plug/male connector housing**

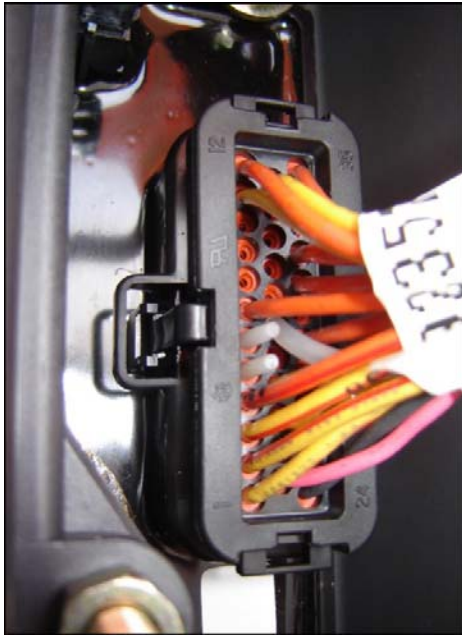


Figure 7-8. Use of Seal Plugs

### AMP Mate-N-Lok

Follow manufacturer installation instructions.

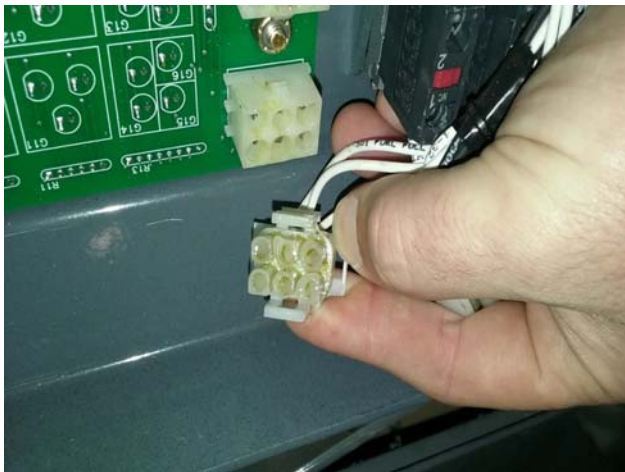


Figure 7-9. AMP Mate-N-Lok Connector

### DIN Connectors

This connector is typically used on hydraulic valves. Follow manufacturer installation instructions.



Figure 7-10. DIN Connector

### Exclusions

A limited number of connectors do not benefit from dielectric grease, or may be permanently damaged by application. Dielectric grease may not be required in properly sealed enclosures.

**BRAD HARRISON/PHOENIX CONTACT M12**

The connector uses gold contact material to resist corrosion and an o-ring seal for moisture integrity. If dielectric grease is mistakenly applied to this connector system, the low-force contacts cannot displace the grease to achieve electrical contact. Once contaminated, there is no practical way to remove the dielectric grease (replacement of female contacts required).



**ENGINE CONTROL UNIT CONNECTORS**

Many times, these types of connectors use back-seals for moisture integrity. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease. The EMR4 engine control module from Deutz employs this connector system (for example).





## 7.4 AMP CONNECTOR

### Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 7-11.). Proceed as follows:

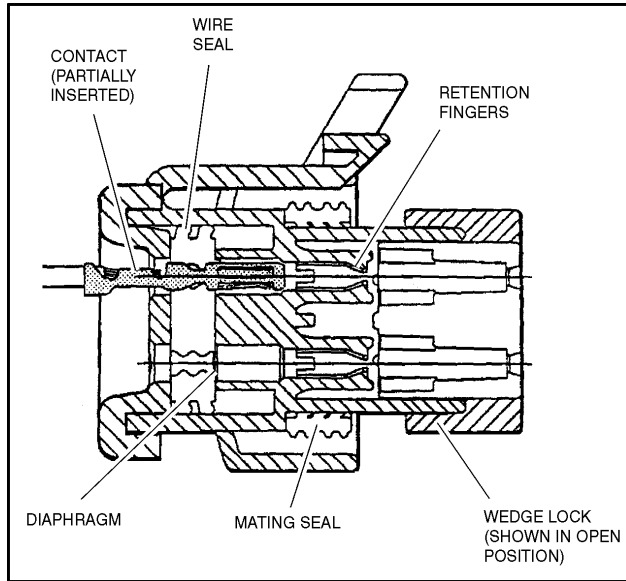


Figure 7-11. Connector Assembly Figure 1

2. Pull back on the contact wire with a force of 1 or 2 lbs. to be sure the retention fingers are holding the contact (See Figure 7-13.).

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-13.).

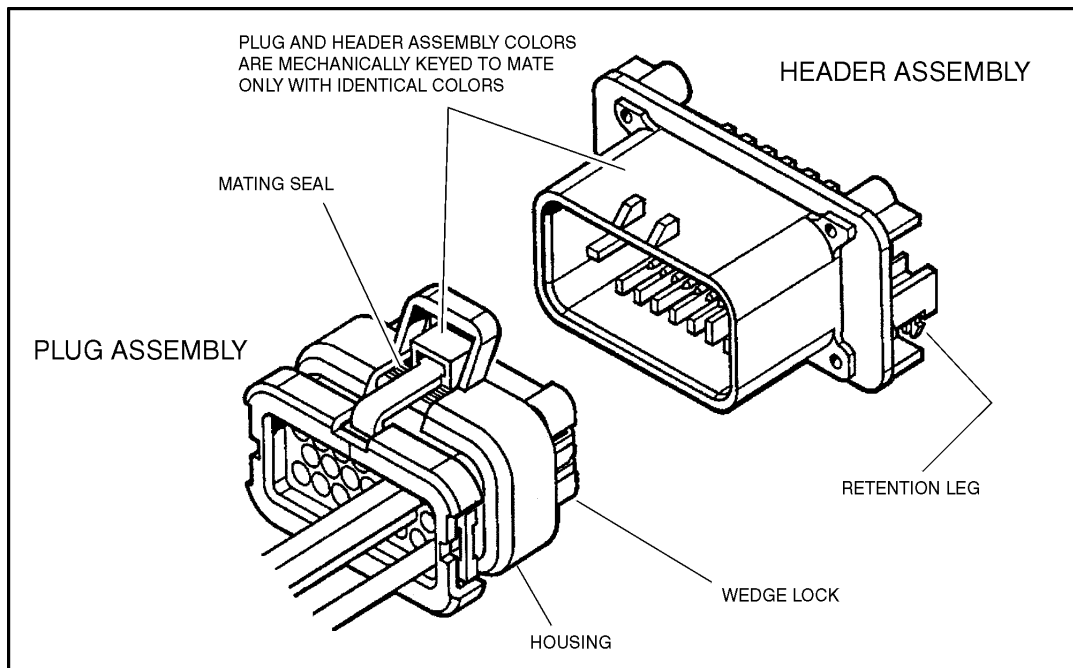


Figure 7-12. AMP Connector

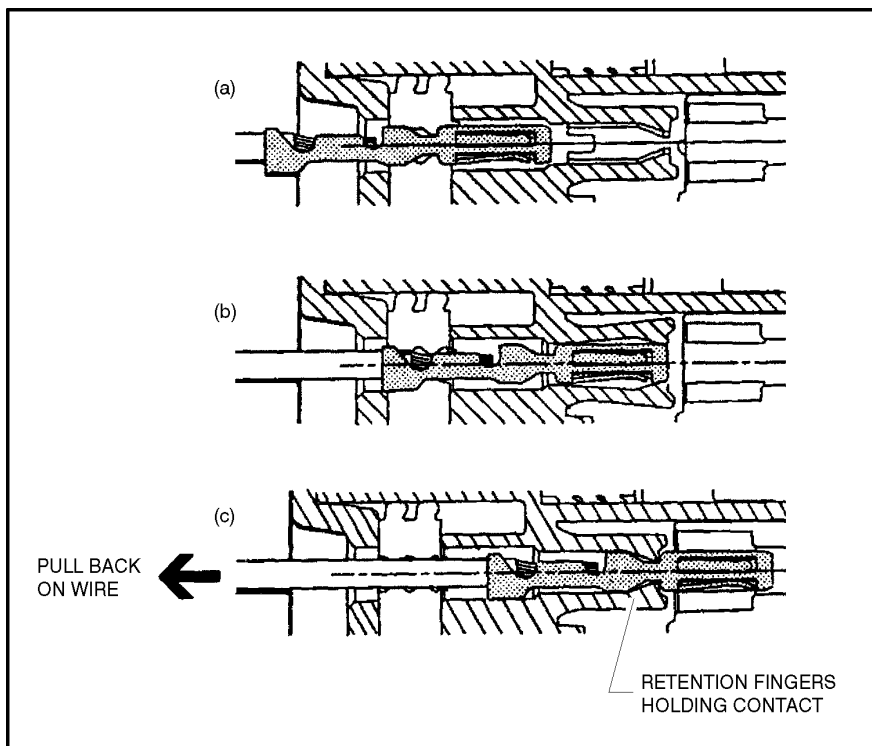


Figure 7-13. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (See Figure 7-14.).

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-15.)

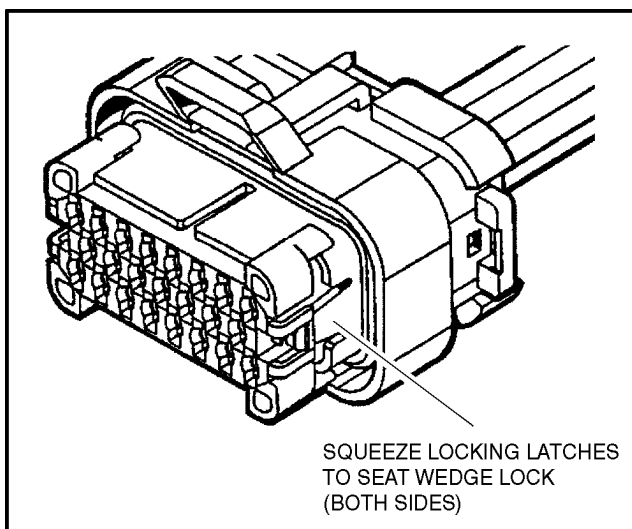


Figure 7-14. Connector Assembly Figure 3

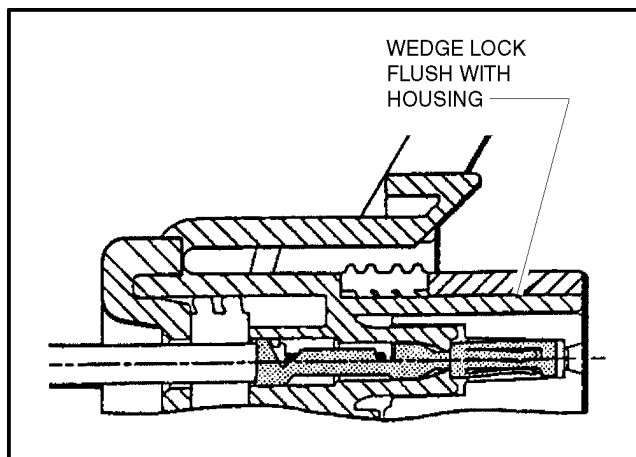


Figure 7-15. Connector Assembly Figure 4

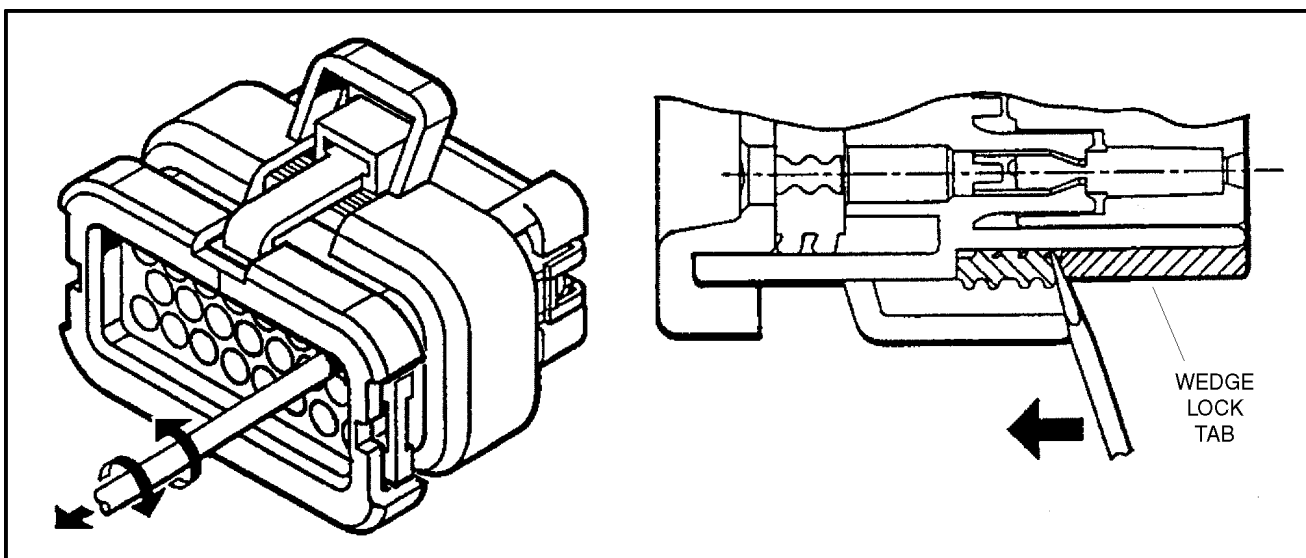


Figure 7-16. Connector Disassembly

### Disassembly

5. Insert a 4.8 mm (3/16") wide screwdriver blade between the mating seal and one of the red wedge lock tabs.
6. Pry open the wedge lock to the open position.
7. While rotating the wire back and forth over a half turn (1/4 turn in each direction), gently pull the wire until the contact is removed.

**NOTE:** The wedge lock should never be removed from the housing for insertion or removal of the contacts.

### 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**

**DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.**

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

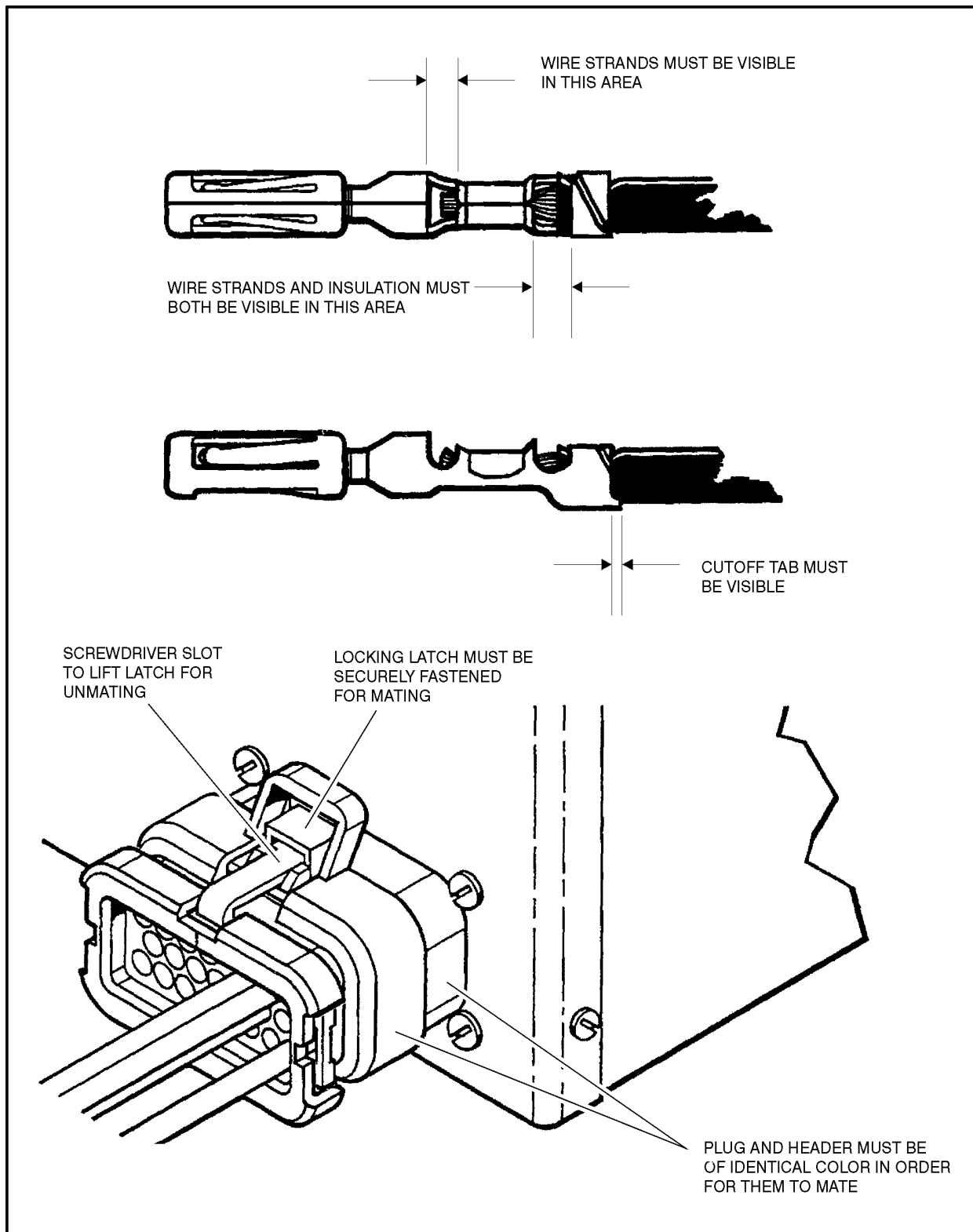


Figure 7-17. Connector Installation

## 7.5 DEUTSCH CONNECTORS

### DT/DTP Series Assembly

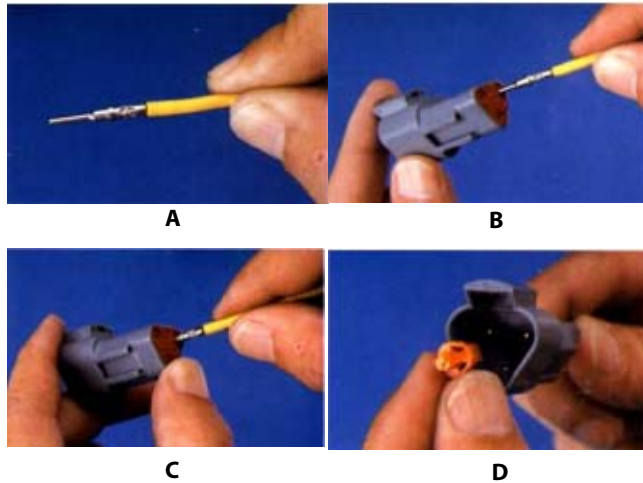


Figure 7-18. DT/DTP Contact Installation

1. Grasp crimped contact about 25mm behind the contact barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that it is properly locked in place.
4. Once all contacts are in place, insert wedgelock 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:** The receptacle is shown - use the same procedure for plug.

### DT/DTP Series Disassembly

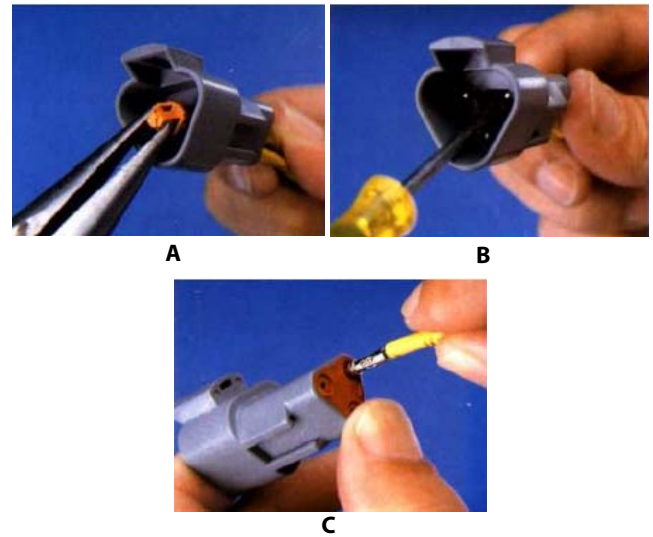
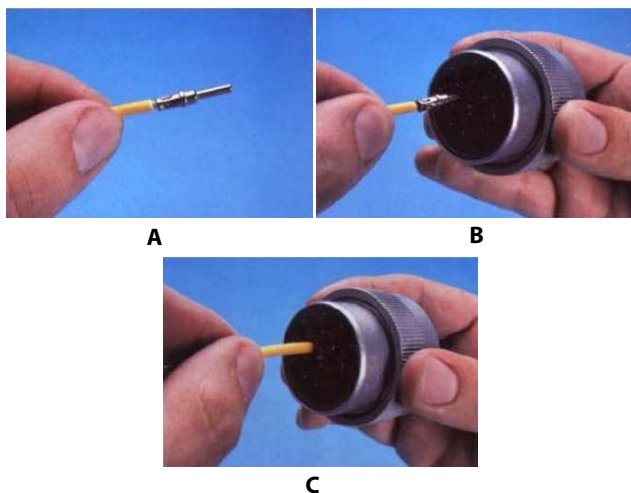


Figure 7-19. DT/DTP Contact Removal

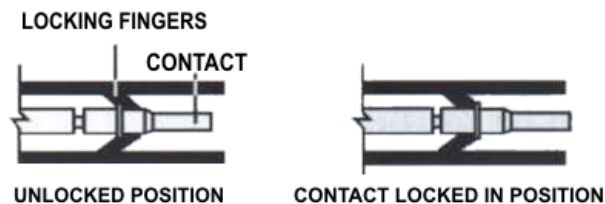
5. Remove wedgelock using needlenose pliers or a hook shaped wire to pull wedge straight out.
6. To remove the contacts, gently pull wire backwards, while at the same time releasing the locking finger by moving it away from the contact with a screwdriver.
7. Hold the rear seal in place, as removing the contact may displace the seal.

**HD30/HDP20 Series Assembly**



**Figure 7-20. HD/HDP Contact Installation**

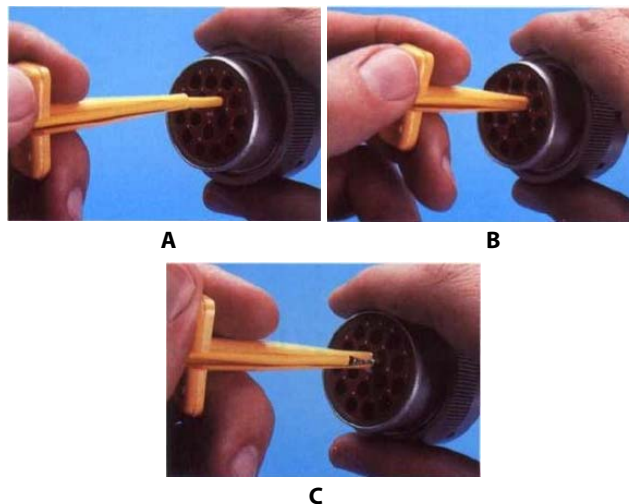
8. Grasp contact about 25mm behind the contact crimp barrel.
9. Hold connector with rear grommet facing you.
10. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm that it is properly locked in place.



**Figure 7-21. HD/HDP Locking Contacts Into Position**

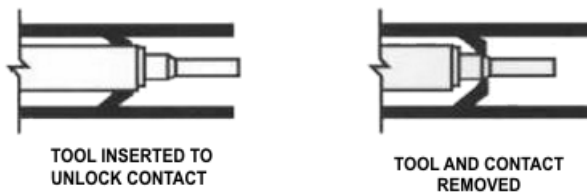
**NOTE:** For unused wire cavities, insert sealing plugs for full environmental sealing.

**HD30/HDP20 Series Disassembly**



**Figure 7-22. HD/HDP Contact Removal**

11. With rear insert toward you, snap appropriate size extractor tool over the wire of contact to be removed.
12. Slide tool along into the insert cavity until it engages contact and resistance is felt.
13. Pull contact-wire assembly out of connector.



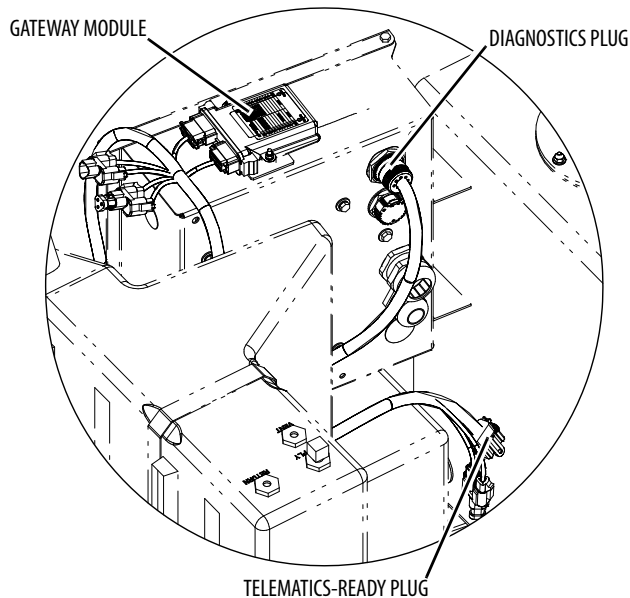
**Figure 7-23. HD/HDP Unlocking Contacts**

**NOTE:** Do Not twist or insert tool at an angle.

## 7.6 TELEMATICS GATEWAY

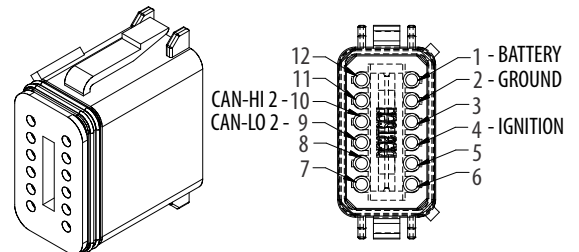
Personnel using machines equipped with an optional telematics gateway will be able to view the following data through their telematics device:

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"> <li>• 0% = Empty</li> <li>• 100% = Full</li> </ul>	Percentage (%)
JLG Machine Faults: Active / Not-Active	<ul style="list-style-type: none"> <li>• 00 - No Machine Faults</li> <li>• 01 - Active Machine Fault</li> <li>• 10 - Error</li> <li>• 11 - Not available</li> </ul>	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:



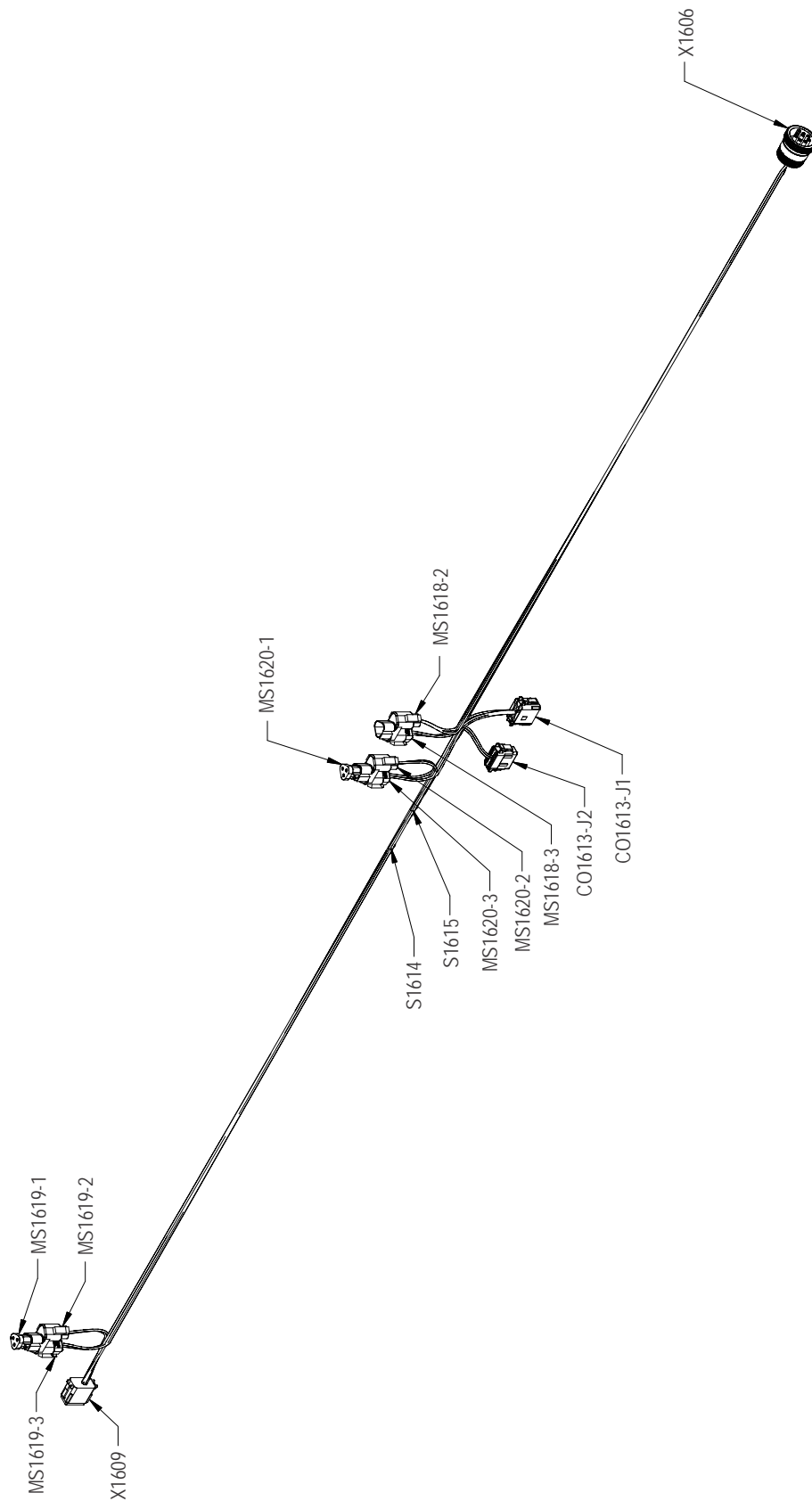


Figure 7-24. Telematics Gateway Harness - Sheet 1 of 3



**SECTION 7 - BASIC ELECTRICAL INFORMATION & ELECTRICAL SCHEMATICS**

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 7-25. Telematics Gateway Harness - Sheet 2 of 3**

**SECTION 7 - BASIC ELECTRICAL INFORMATION & ELECTRICAL SCHEMATICS**

					FROM		TO	
WIRE NO.	COLOR	WIRE GAUGE	LENGTH (mm)	JACKET	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 7-26. Telematics Gateway Harness - Sheet 3 of 3**

## 7.7 WIRING HARNESS

### Connector Labels

Connectors between harnesses are identified by the prefix “X” and a sequentially assigned number. An optional suffix (letters & numbers) may be added when multiple terminations occur at one device or when there are optional connections.

**Examples:**

*X25 connects to X25 in another harness.*

*X65A, X65B connect to different portions of one device*

*X163 connects to X163A in ANSI and X163B in CE machines*

### Component Labels

Every component on the vehicle has a unique identification. A standard prefix letter is assigned according to the table below, followed by a unique sequential number. An optional suffix (letters & numbers) may be added when multiple terminations occur at one device.

Terminals that are not loaded into connectors are considered independent components and labeled in the same fashion.

**Table 7-1. Wiring Harness Connector Labels**

Component	Category	Label
Audible	Alarms	AH
	Horns	
Battery	Batteries	BT
	Battery Terminals	
Control Module	Ground	CO
	LSS	
	Platform	
Engine	Alternator	EC
	Cold Start	
	Controller	
	Coolant Temp	
	Fuel Pump	
	Fuel Solenoid	
	Glow Plugs	
	Oil Pressure	
Fuse & CB Fuse FC	Fuse	FC
	Fusible Link	FC
	Circuit Breaker	CB
Gauge & Display	Board	GD
	Cluster	
	Hour meter	
	LMI	
	Speedometer	
Inline	Resistor	R
	Diode	D
Joystick & Steering	Electronic	JS
	Hydraulic	
Lights	Dome	LB
	Headlights	
	Simple	
	Taillights	
Membrane Panel		MP
Miscellaneous	Radio	MS
	Speakers	
	Splice Blocks	
	T-Connectors	

## SECTION 7 - BASIC ELECTRICAL INFORMATION & ELECTRICAL SCHEMATICS

**Table 7-1. Wiring Harness Connector Labels**

Component	Category	Label
Other Switches	Disconnect	SW
	EMS	
	Foot	
	HVAC	WH
	Key	SW
	Park brake	
	Pump pot	
	Push	
	Shifter	
	Turn signal	
Relay	5 Pin	RL
	4 Pin	
	Contactora	
	Power module	
Rocker Switch		SW
Sensor	Angle	SN
	Fuel	
	Length	
	Limit	
	Load	
	Pressure	
	Proximity	
	Speed	
	Temperature	
	Terminals	
Sockets		
Male Blades		
Female Blades		
Rings		
Forks		
Toggle Switch	DPDT	SW
	DPST	
	SPDT	
	SPST	
	Special	
Valves	Simple	HV
	Suppression	

**Examples:**

*T67 is a ring terminal connected during installation.*

*C01-J3 is the J3 connector for a UGM control module.*

*EC9 is a glow plug supplied with the engine*

7.8 WIRING HARNESS BREAKDOWN

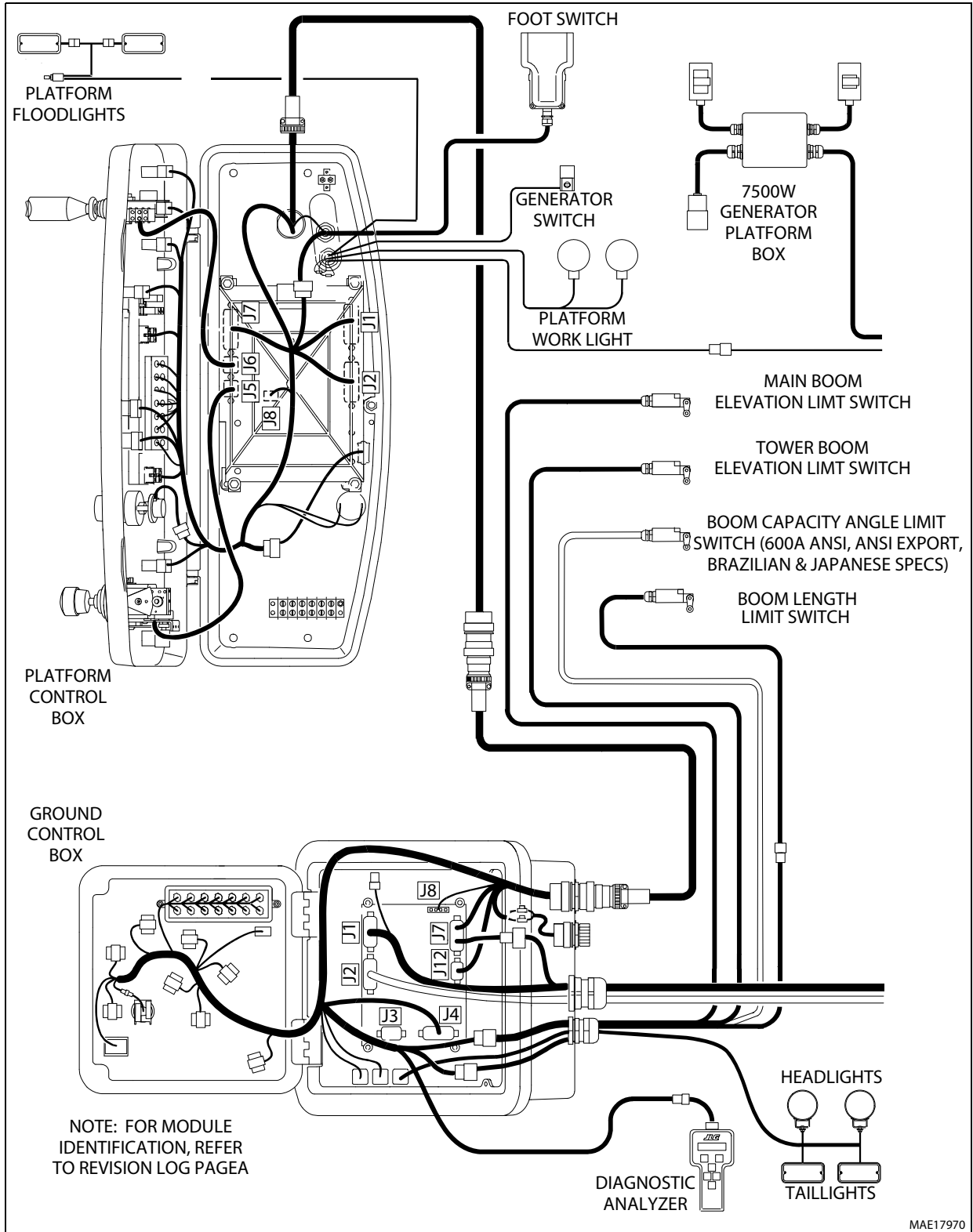


Figure 7-27. Electrical Components 1 of 2 (SN 0300177361 through 0300181174)

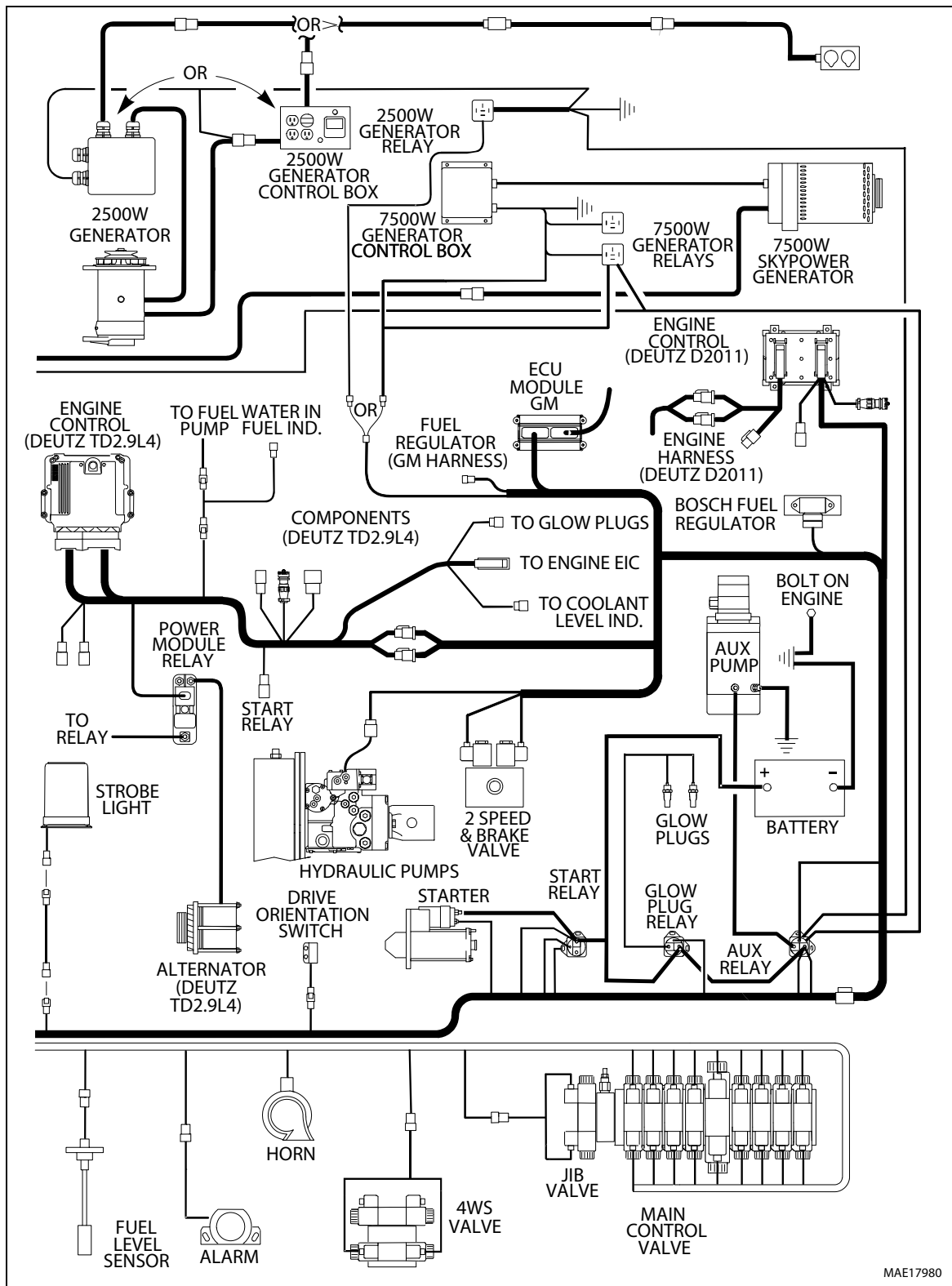


Figure 7-28. Electrical Components 2 of 2 (SN 0300177361 through 0300181174)

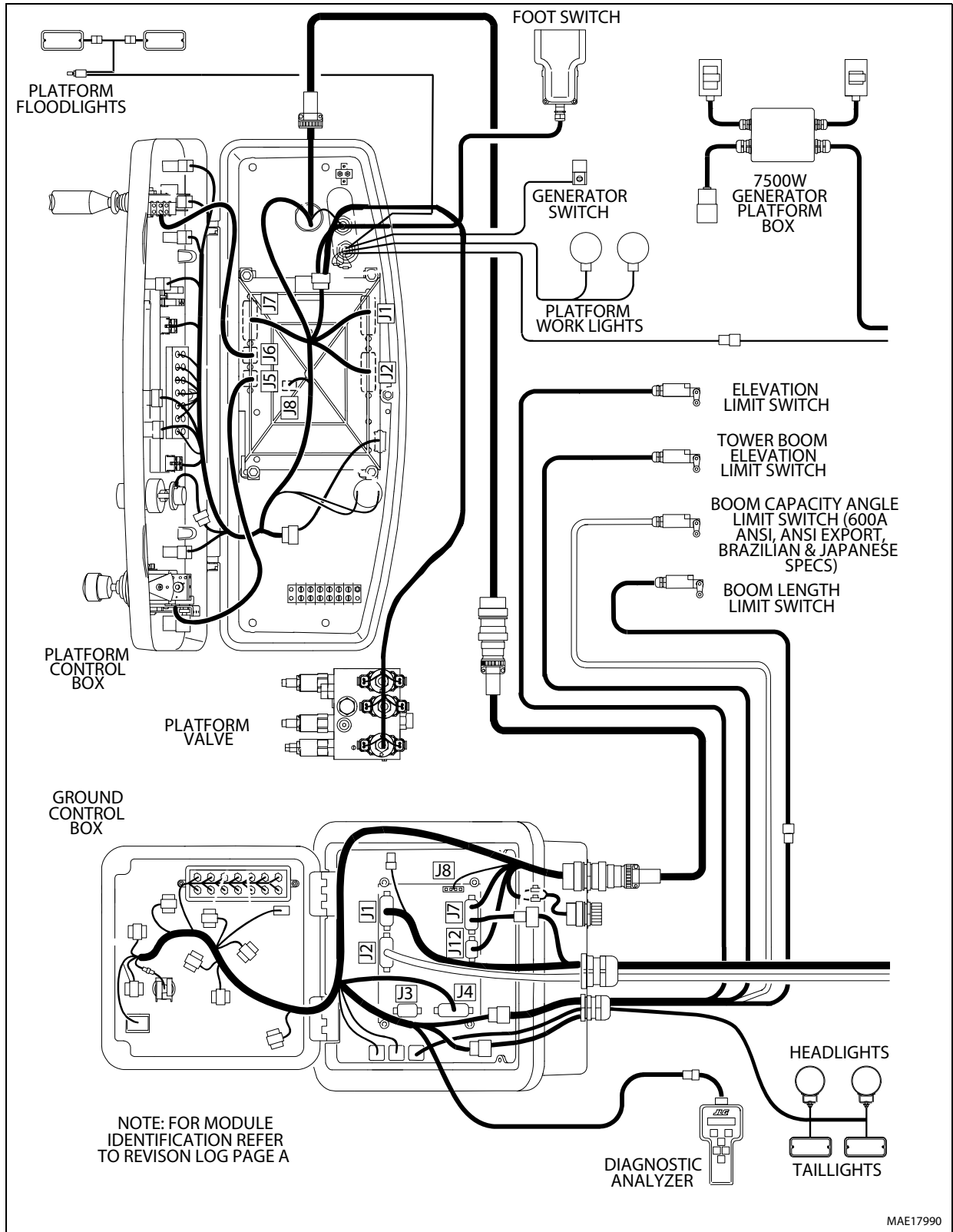
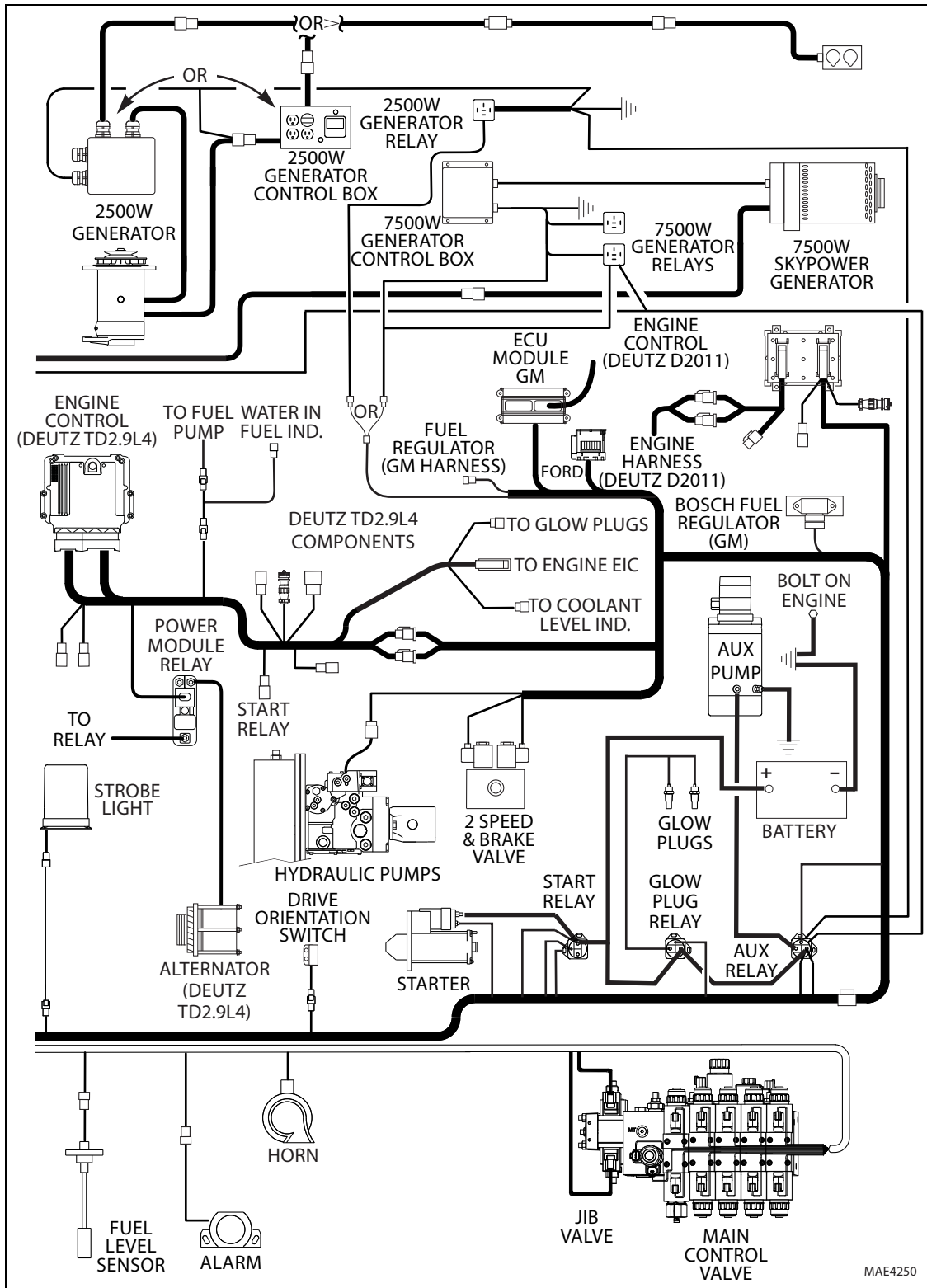


Figure 7-29. Electrical Components 1 of 2 (SN 0300181175 to Present)

**SECTION 7 - BASIC ELECTRICAL INFORMATION & ELECTRICAL SCHEMATICS**



**Figure 7-30. Electrical Components 2 of 2 (SN 0300181175 to Present)**



SECTION 7 - BASIC ELECTRICAL INFORMATION & ELECTRICAL SCHEMATICS

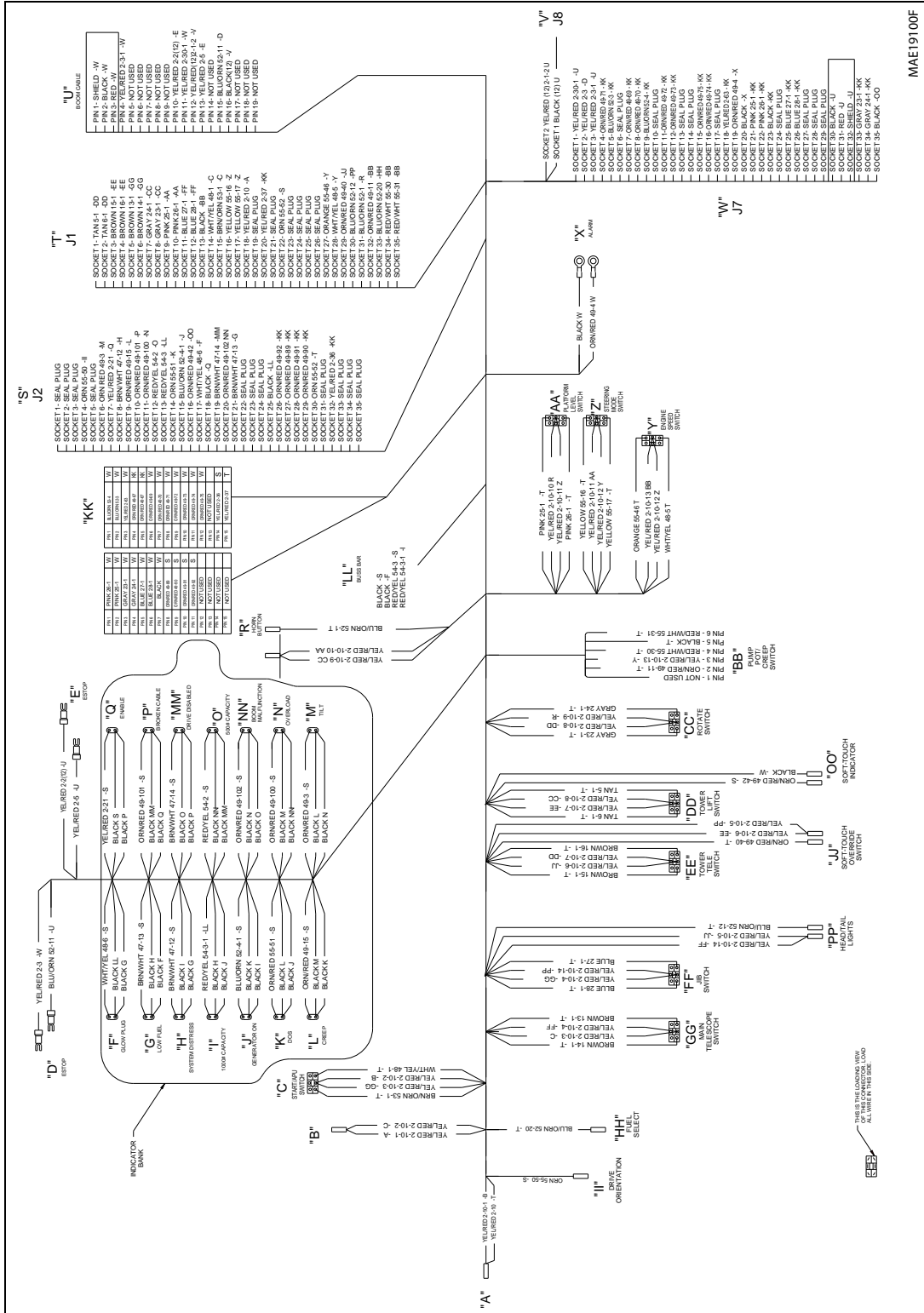


Figure 7-31. Platform Console Box without SkyGuard - Sheet 1 of 2

**SECTION 7 - BASIC ELECTRICAL INFORMATION & ELECTRICAL SCHEMATICS**

**CUT CHART**

REV		
1	BLACK	Q-S 46"
	BLACK	Q-P 11"
	BLACK	P-MM 11"
	BLACK	MM-O 11"
	BLACK	O-NN 11"
	BLACK	NN-N 11"
	BLACK	N-M 11"
	BLACK	M-L 9.5"
	BLACK	L-K 11"
	BLACK	K-J 11"
	BLACK	J-I 11"
	BLACK	I-H 11"
	BLACK	H-G 11"
	BLACK	G-F 11"
	BLACK	LL-S 27.5"
	BLACK	BB-T 38.75"
	BLACK	W-X 28"
	BLACK	W-KK 26.50"
	BLACK	F-LL 38.0"
	BLACK	W-OO 51.0"
2	BLUE 27-1	FF-T 50.5"
	BLUE 28-1	FF-T 50.5"
	BLUE 27-1	W-KK 26.50"
	BLUE 28-1	W-KK 26.50"
3	BLU/ORN 52-3	KK-W 26.5"
	BLU/ORN 52-4-1	J-S 41.5"
	BLU/ORN 52-1	R-T 38"
	BLU/ORN 52-20	HH-T 57.50"
	BLU/ORN 52-11	U-D 56.25"
	BLU/ORN 52-12	A-PP 52"
	BLU/ORN 52-4	KK-W 26.5"
4	BROWN 13-1	GG-T 53.5"
	BROWN 14-1	GG-T 53.5"
	BROWN 15-1	EE-T 48"
	BROWN 16-1	EE-T 48"
5	BRN/ORN 53-1	C-T 59"
6	BRN/WHT 47-12	S-H 43.5"
	BRN/WHT 47-13	S-G 44.5"
	BRN/WHT 47-14	S-MM 43.5"
7	GRAY 23-1	CC-T 43"
	GRAY 24-1	CC-T 43"
	GRAY 23-1	W-KK 26.50"
	GRAY 24-1	W-KK 26.50"
8	ORANGE 55-46	Y-T 41"
	ORANGE 55-50	S-II 56.25"
	ORANGE 55-51	S-K 40.5"
	ORANGE 55-52	S-T 13.5"
9	ORN/RED 49-101	P-S 45"
	ORN/RED 49-100	N-S 43"
	ORN/RED 49-3	M-S 42"
	ORN/RED 49-15	L-S 39.5"
	ORN/RED 49-42	OO-S 51"
	ORN/RED 49-11	BB-Y 38.75"
	ORN/RED 49-4	W-X 28"
	ORN/RED 49-40	JJ-T 49.5"
	ORN/RED 49-67	KK-KK 4"
	ORN/RED 49-69	KK-W 26.5"
	ORN/RED 49-70	KK-W 26.5"
	ORN/RED 49-71	KK-W 26.5"
	ORN/RED 49-72	KK-W 26.5"
	ORN/RED 49-73	KK-W 26.5"
	ORN/RED 49-74	KK-W 26.5"
	ORN/RED 49-75	KK-W 26.5"
	ORN/RED 49-89	KK-S 20"
	ORN/RED 49-90	KK-S 20"
	ORN/RED 49-91	KK-S 20"
	ORN/RED 49-92	KK-S 20"
	ORN/RED 49-102	NN-S 42"

REV		
10	PINK 26-1	T-AA 39"
	PINK 25-1	T-AA 39"
	PINK 26-1	W-KK 26.50"
	PINK 25-1	W-KK 26.50"
11	RED/WHT 55-30	BB-T 38.75"
	RED/WHT 55-31	BB-T 38.75"
12	RED/YEL 54-2	S-O 44"
	RED/YEL 54-3	LL-S 27.5"
	RED/YEL 54-3-1	LL-I 35.0"
13	TAN 5-1	DD-T 45.5"
	TAN 6-1	DD-T 45.5"
14	WHT/YEL 48-6	F-S 45.5"
	WHT/YEL 48-5	Y-T 41"
	WHT/YEL 48-1	T-C 59"
15	YEL/RED 2-21	Q-S 46"
	YEL/RED 2-10-14	PP-FF 12.5"
	YEL/RED 2-10-13	BB-Y 17.75"
	YEL/RED 2-10-12	Y-Z 10.25"
	YEL/RED 2-10-11	Z-AA 11.75"
	YEL/RED 2-10-10	AA-R 15"
	YEL/RED 2-10-9	CC-R 19"
	YEL/RED 2-10-8	CC-DD 13.5"
	YEL/RED 2-10-7	DD-EE 13.5"
	YEL/RED 2-10-5	JJ-PP 16.5"
	YEL/RED 2-10-4	FF-GG 14"
	YEL/RED 2-10-3	GG-C 14.5"
	YEL/RED 2-10-2	C-B 10.75"
	YEL/RED 2-10-1	B-A 9.5"
	YEL/RED 2-10	A-T 59.75"
	YEL/RED 2-5	U-E 52.5"
	YEL/RED 2-3	W-D 54.25"
	YEL/RED 2-3-1	U-W 20"
	YEL/RED 2-30-1	U-W 20"
	YEL/RED 2-10-6	EE-JJ 12.5"
	YEL/RED 2-63	W-KK 26.5"
	YEL/RED 2-37	T-KK 31.0"
	YEL/RED 2-36	KK-L 19"
40	YELLOW 55-16	Z-T 40.75"
	YELLOW 55-17	Z-T 40.75"
16	BLACK(12)	U-V 20"
17	YELLOW/RED(12)2-1-2	U-V 20"
	YELLOW/RED(12)2-2	U-E 57"
18	CANBUS	U-W 20.0

MAE19110F

**Figure 7-32. Platform Console Box without SkyGuard - Sheet 2 of 2**

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MAE18180C

Figure 7-33. Platform Console Box with SkyGuard (SN 0300181175 to Present)

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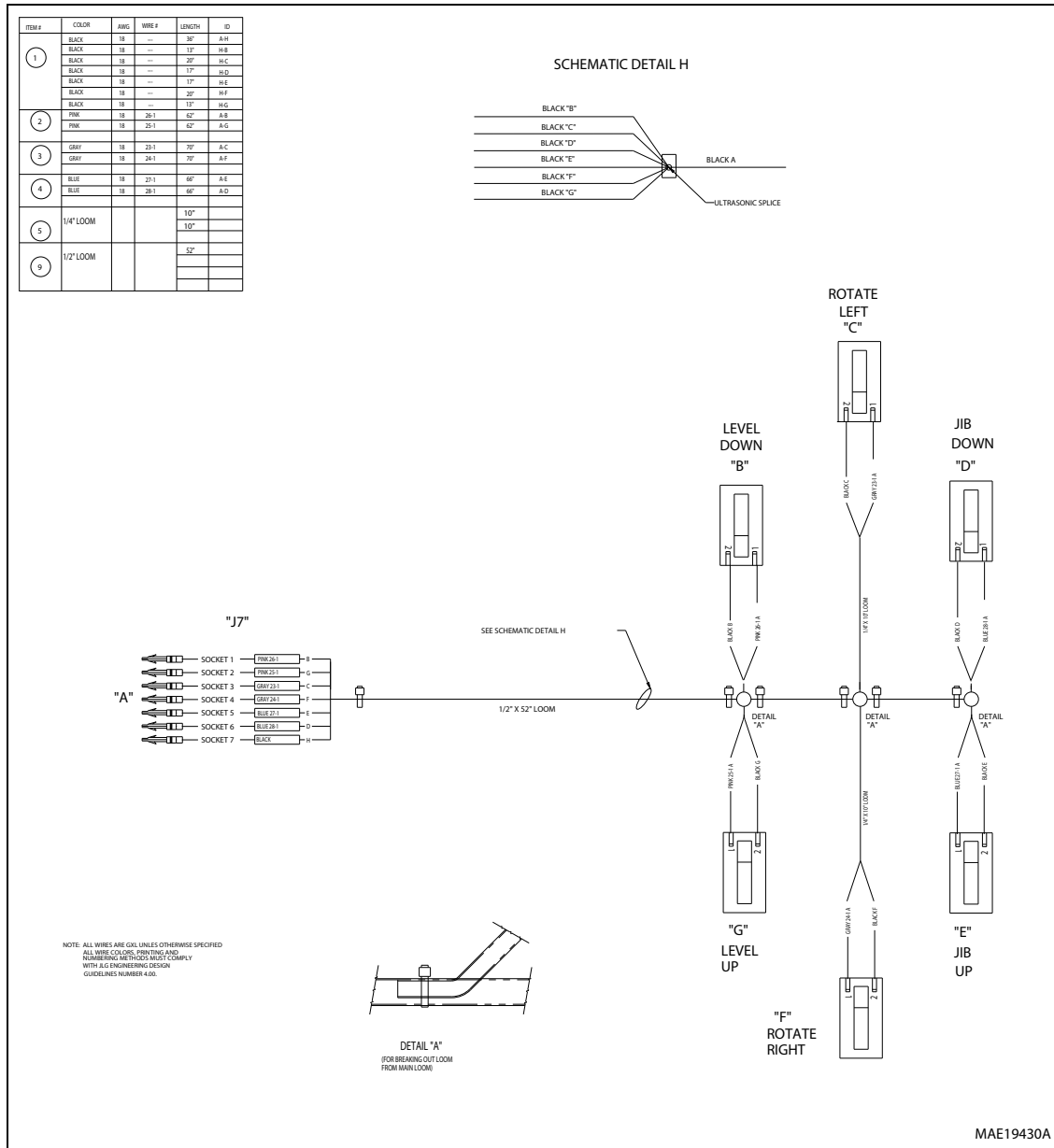


Figure 7-34. Platform Valve Harness Assembly (SN 0300181175 to Present)

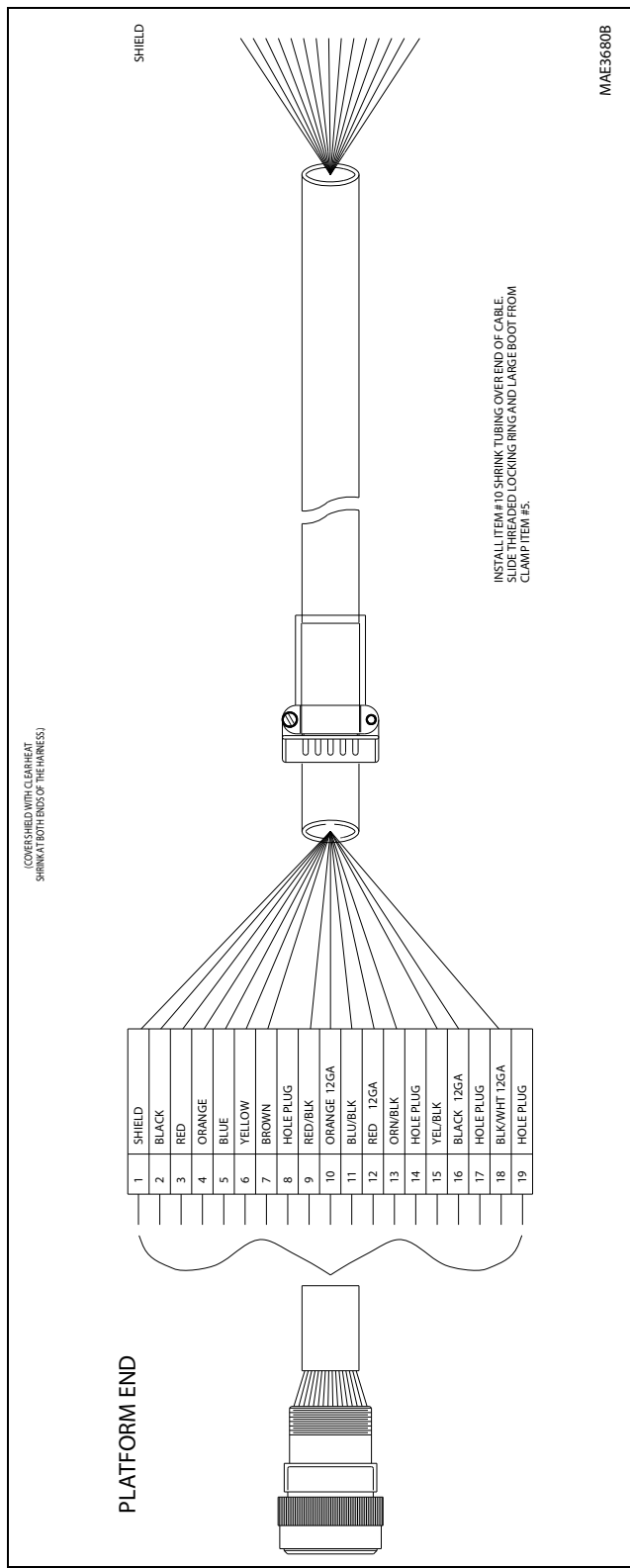


Figure 7-35. Main Boom Harness without Arctic Package

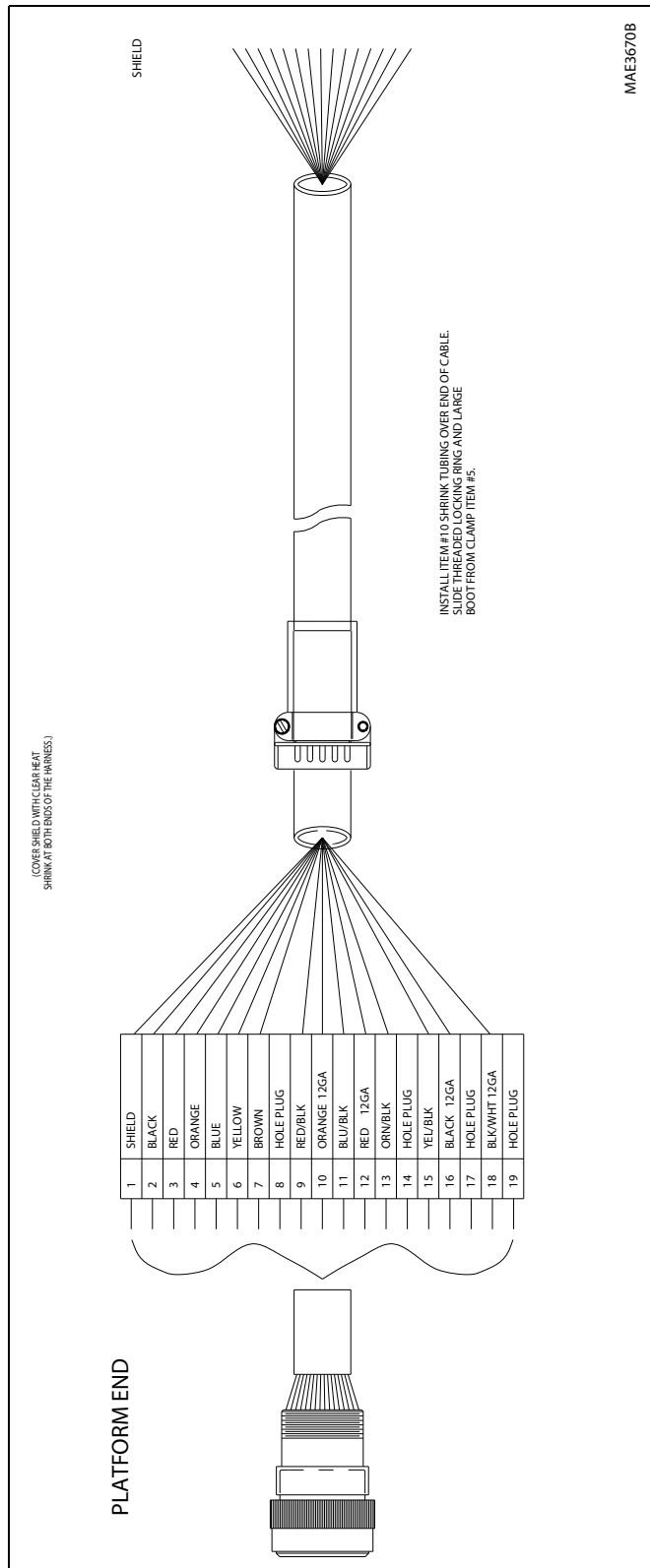


Figure 7-36. Main Boom Harness with Arctic Package

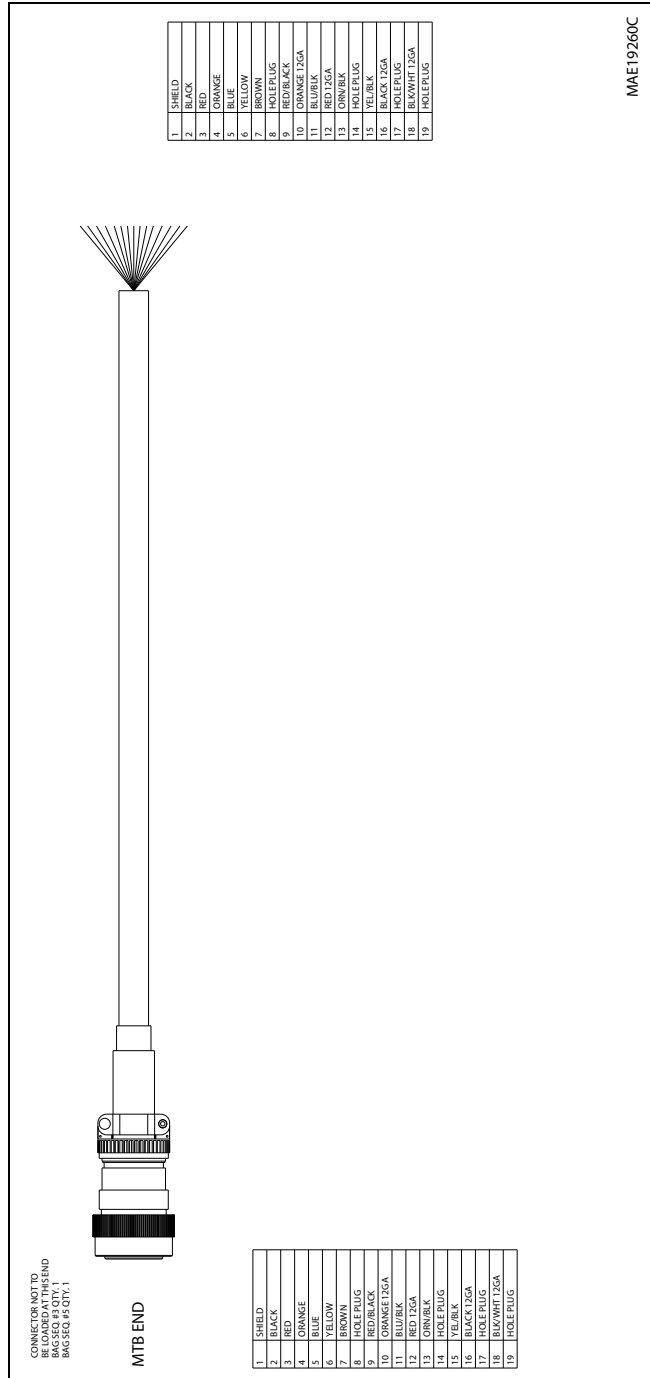


Figure 7-37. Tower Boom Cable Harness without Arctic Package

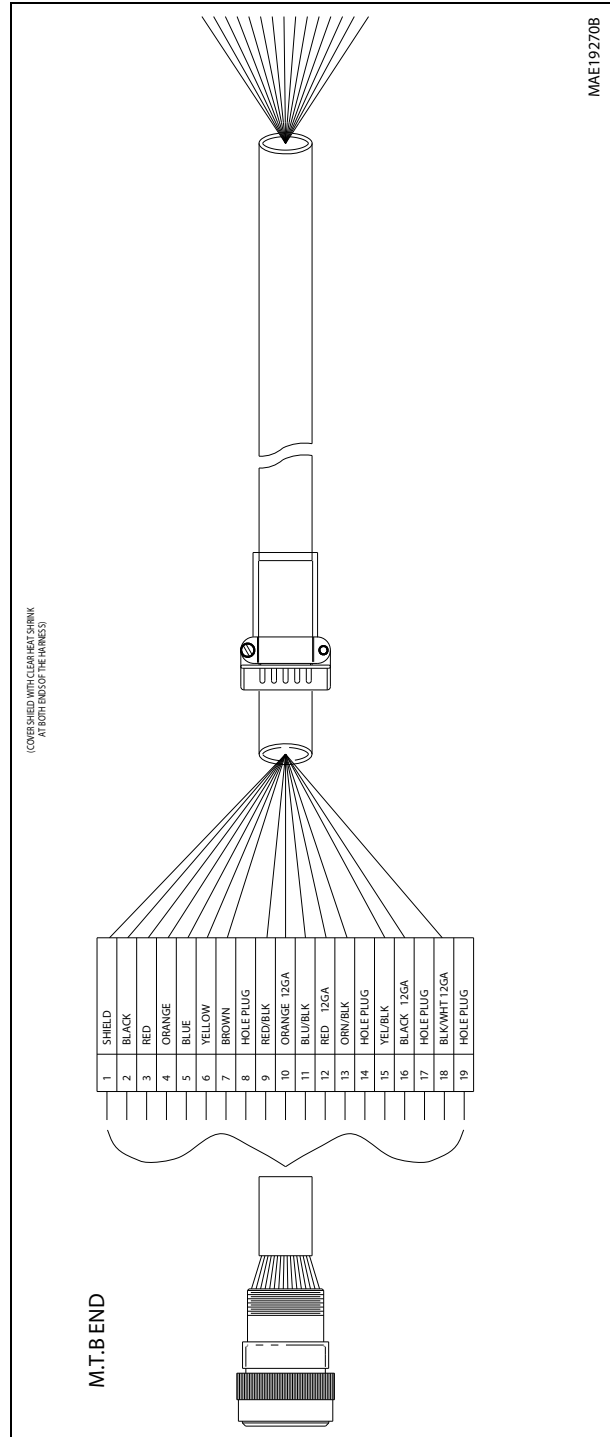


Figure 7-38. Tower Boom Cable Harness with Arctic Package



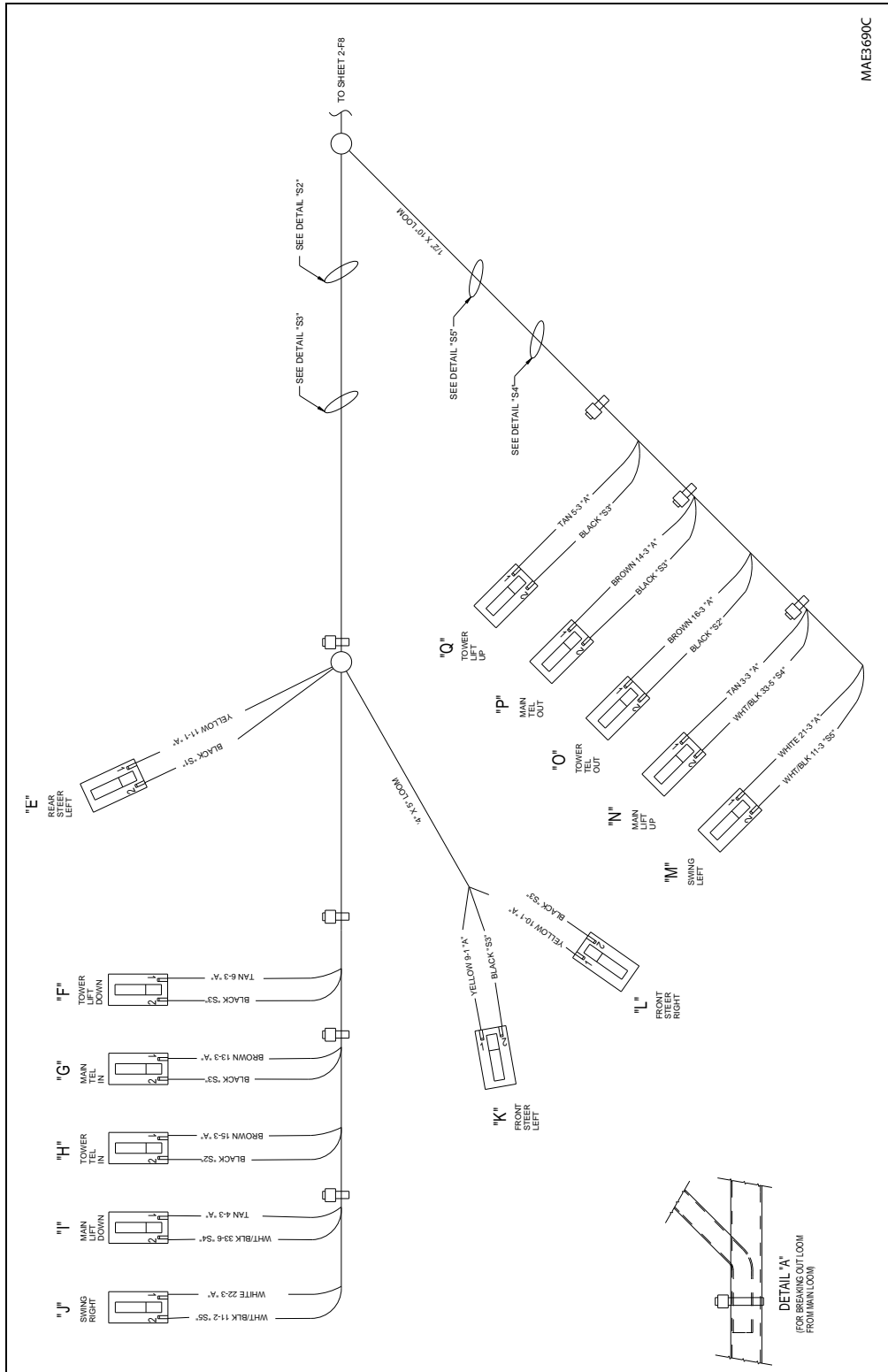


Figure 7-39. Main Valve Harness - Sheet 1 of 2

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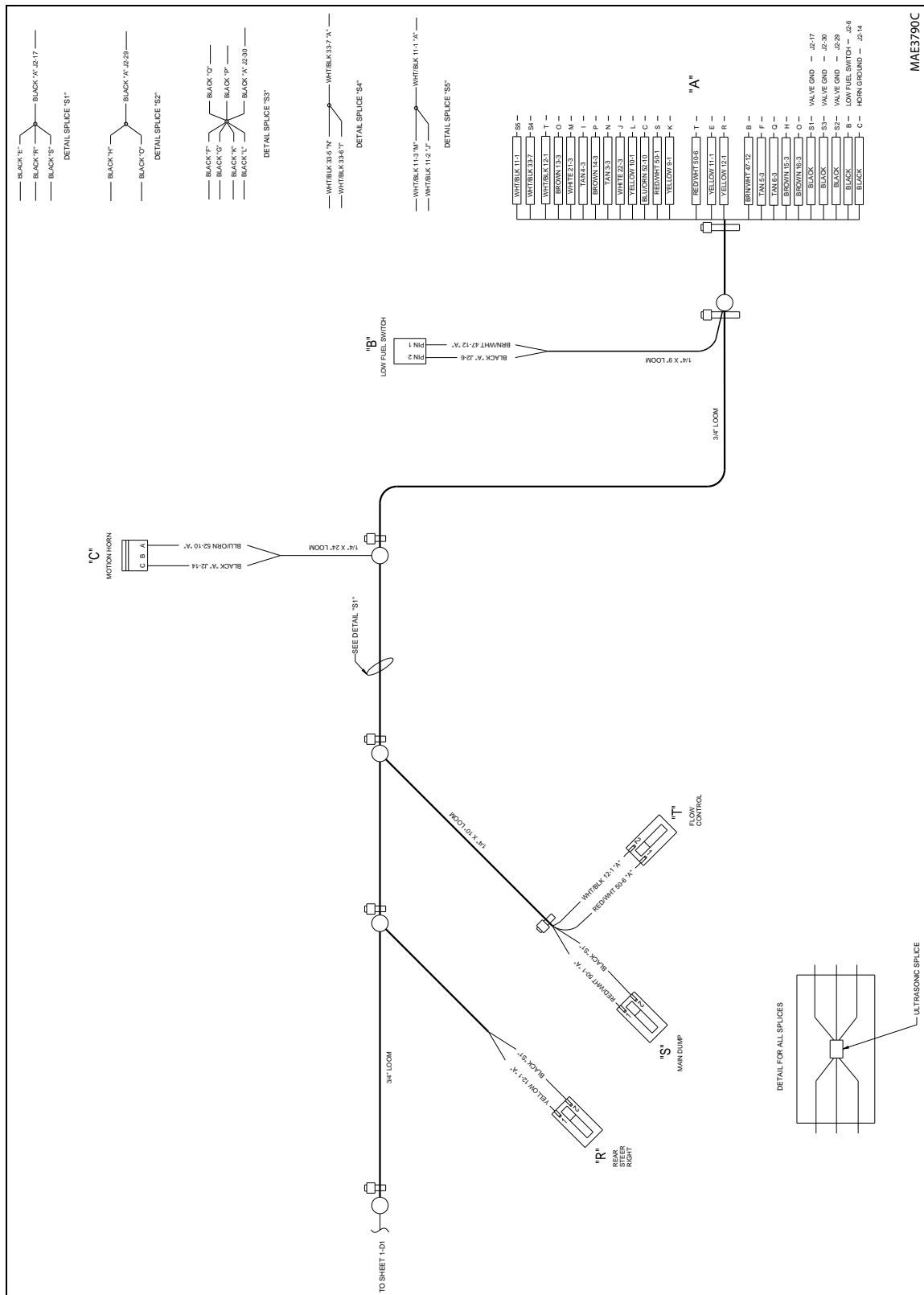
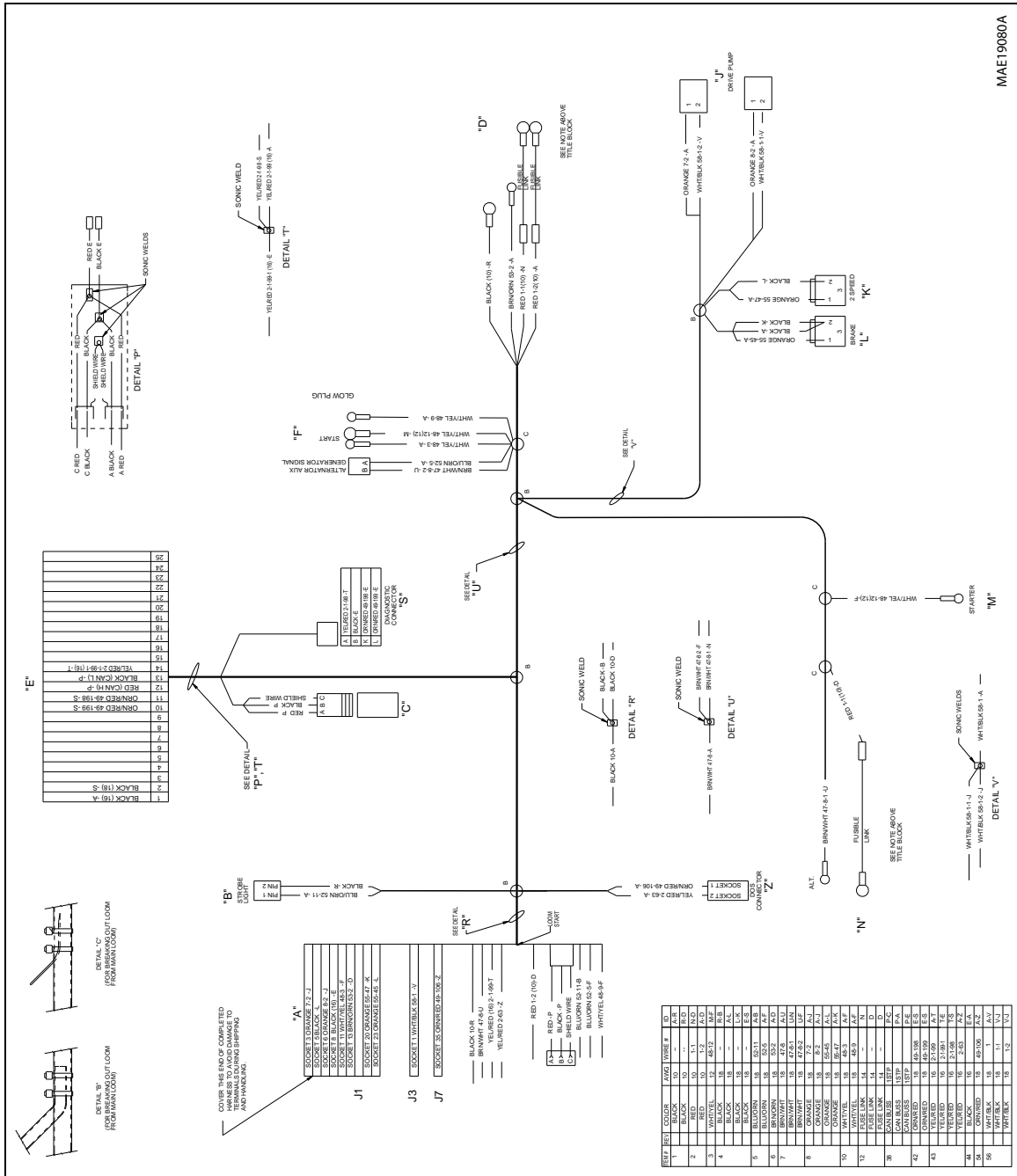


Figure 7-40. Main Valve Harness - Sheet 2 of 2

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Figure 7-41. Deutz D2011 (T4i) Engine Harness

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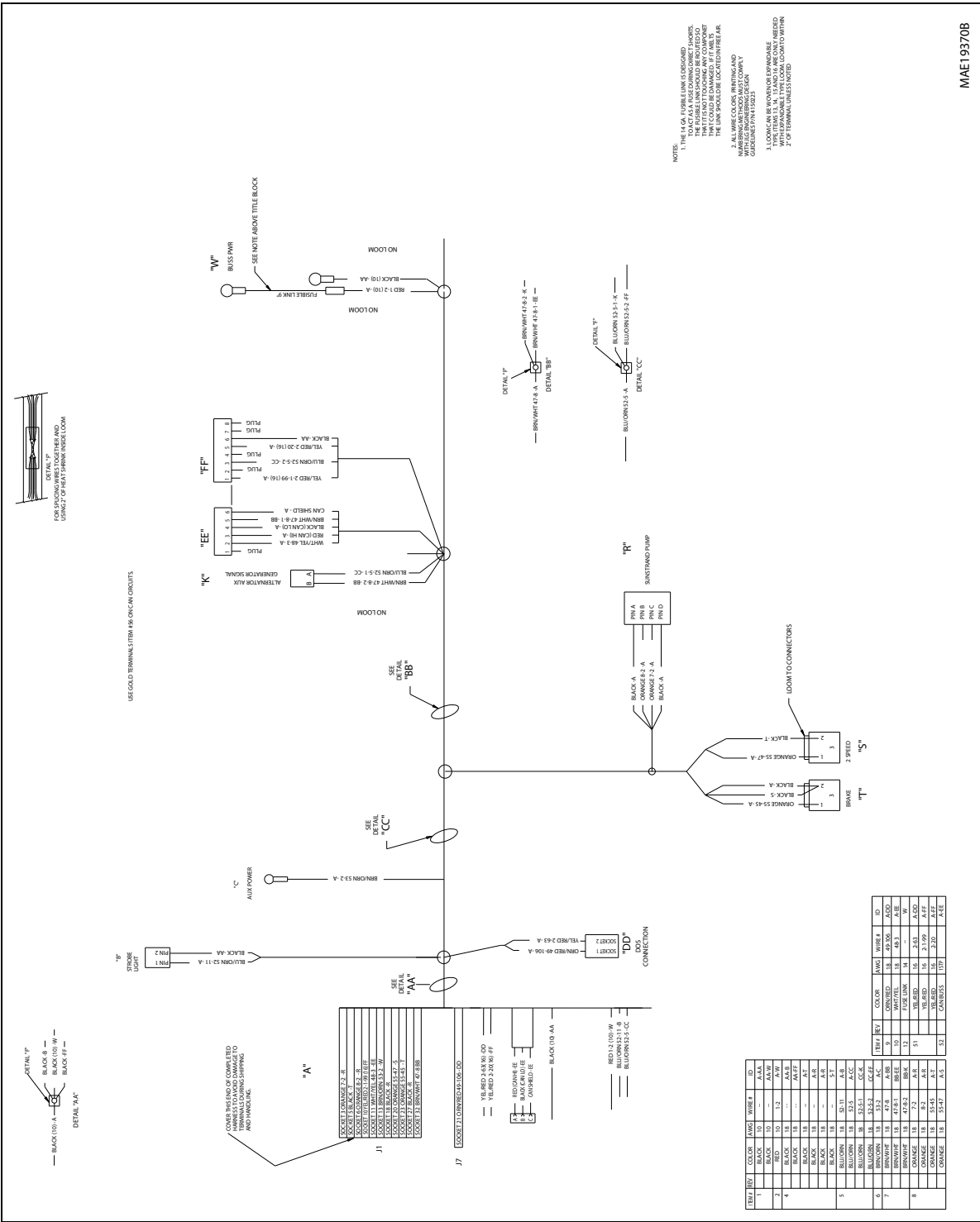


Figure 7-42. Deutz TD2.9L4 (T4F) Engine Harness (SN 0300177361 through 0300181174)

MAE19370B



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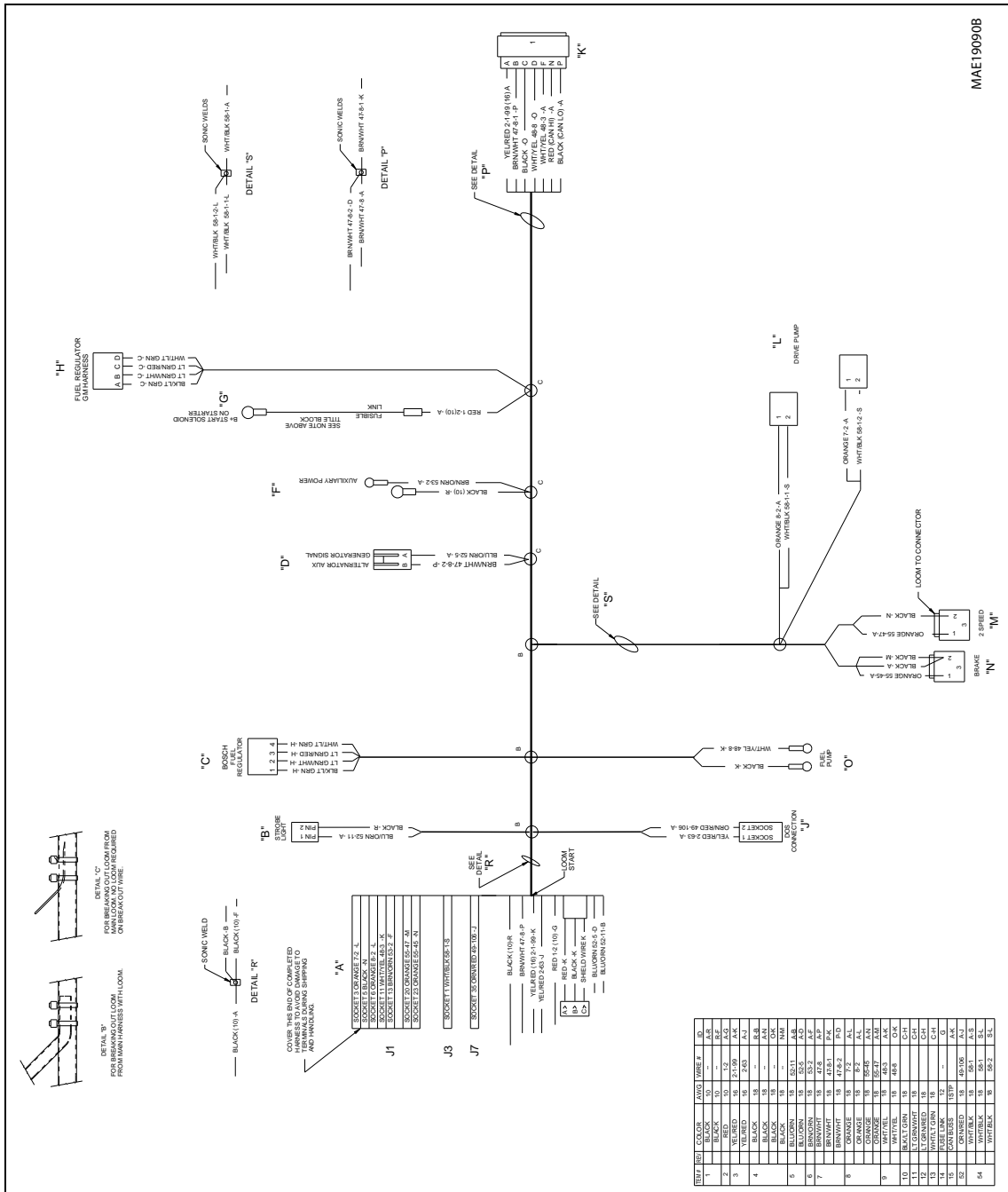


Figure 7-44. GM Engine Harness

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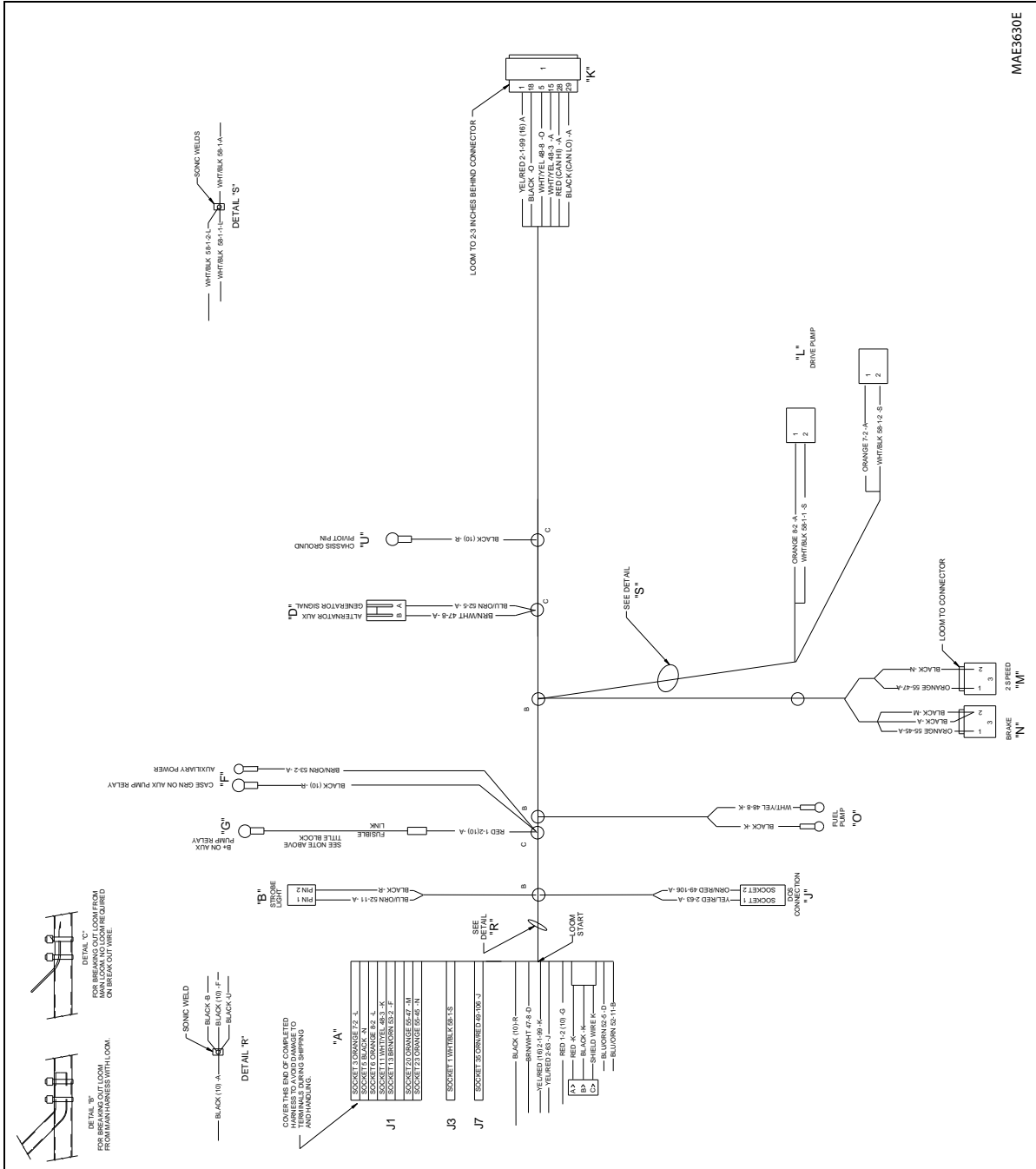


Figure 7-45. Ford Engine Harness (SN 0300181175 to Present)







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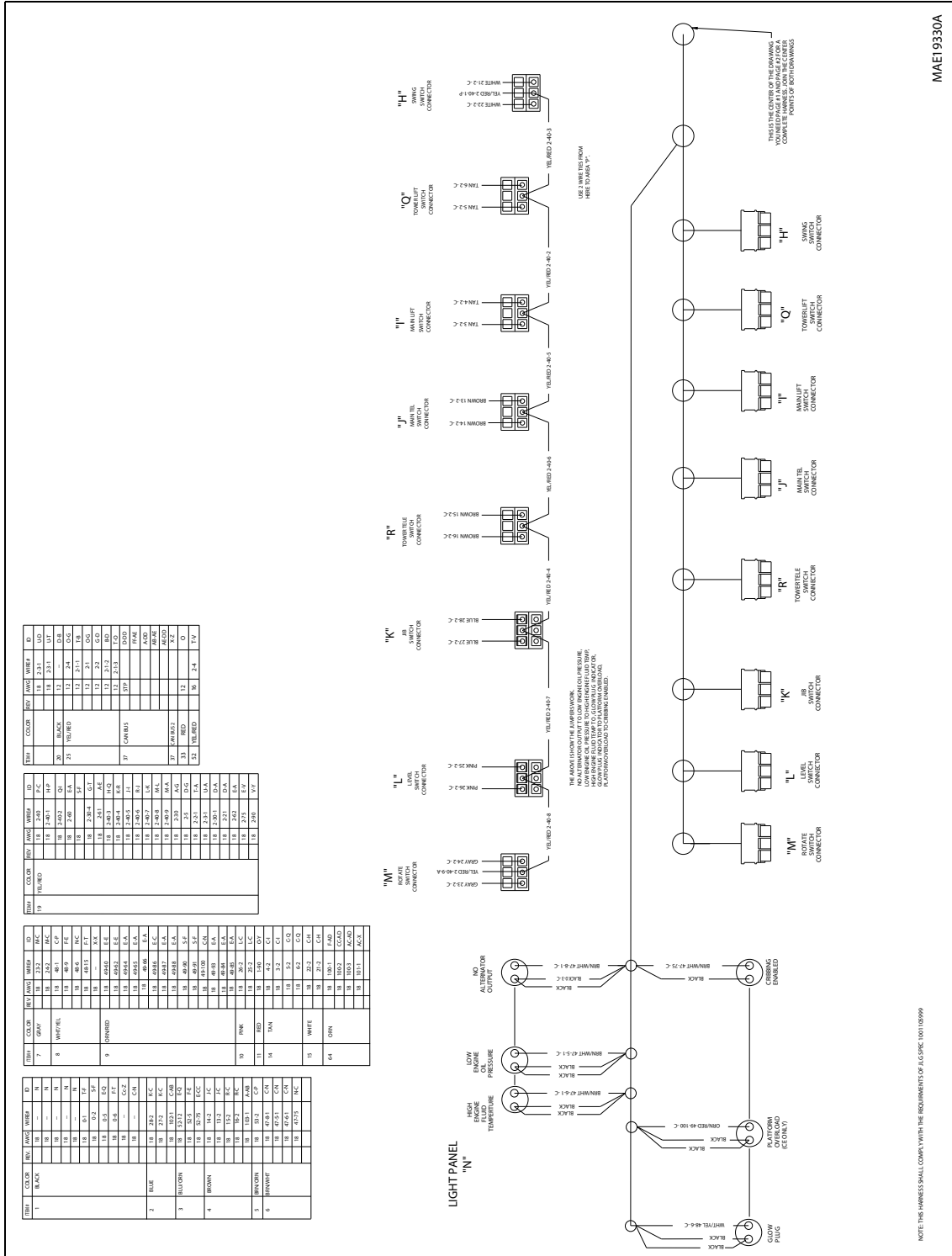


Figure 7-48. Ground Control Box Harness Deutz D2011 (T4i) Engine (SN 0300200809 to Present) - Sheet 1 of 2







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## 7.9 ELECTRICAL SCHEMATICS

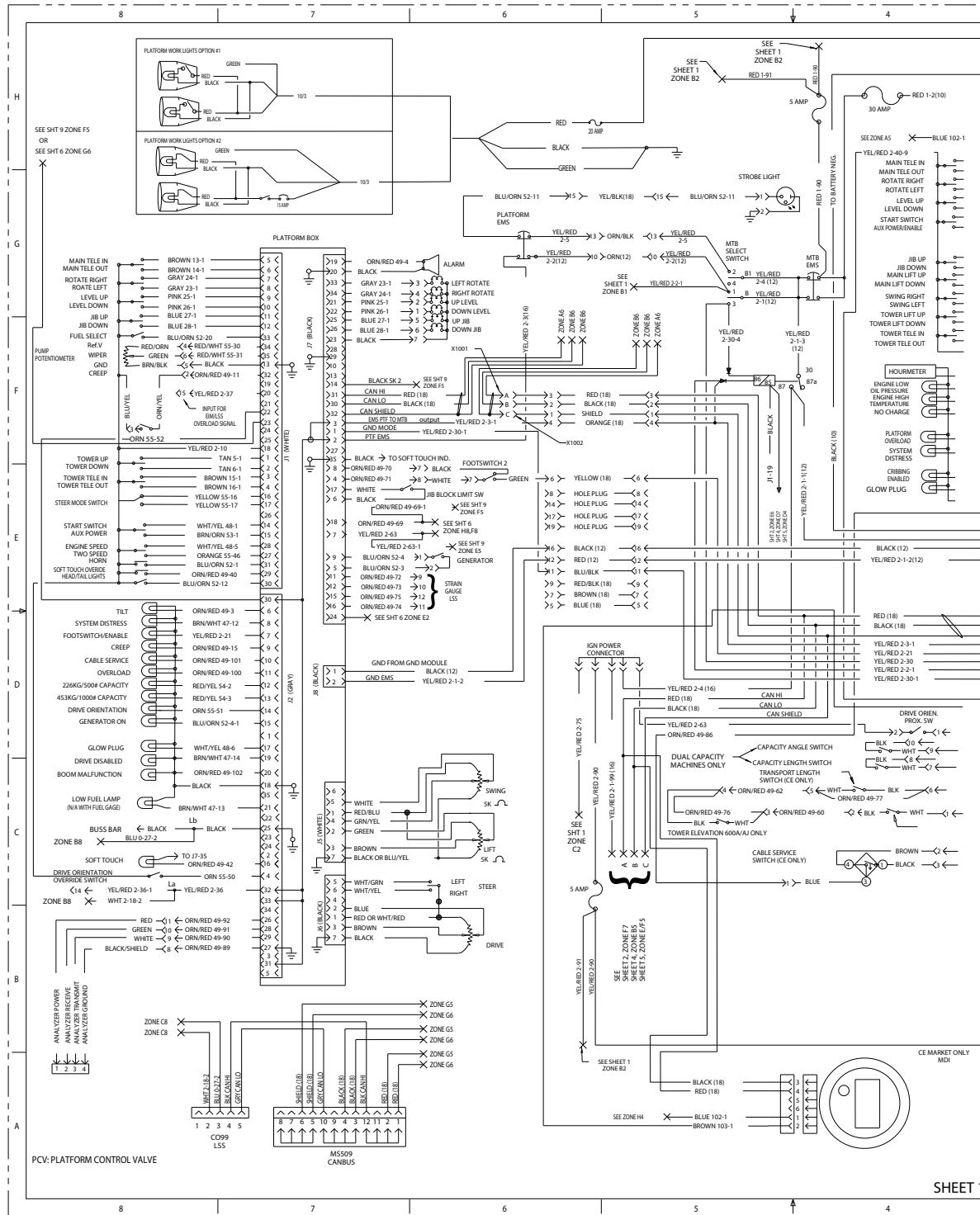


Figure 7-52. Platform and Ground Control Electrical Schematic - 1 of 2

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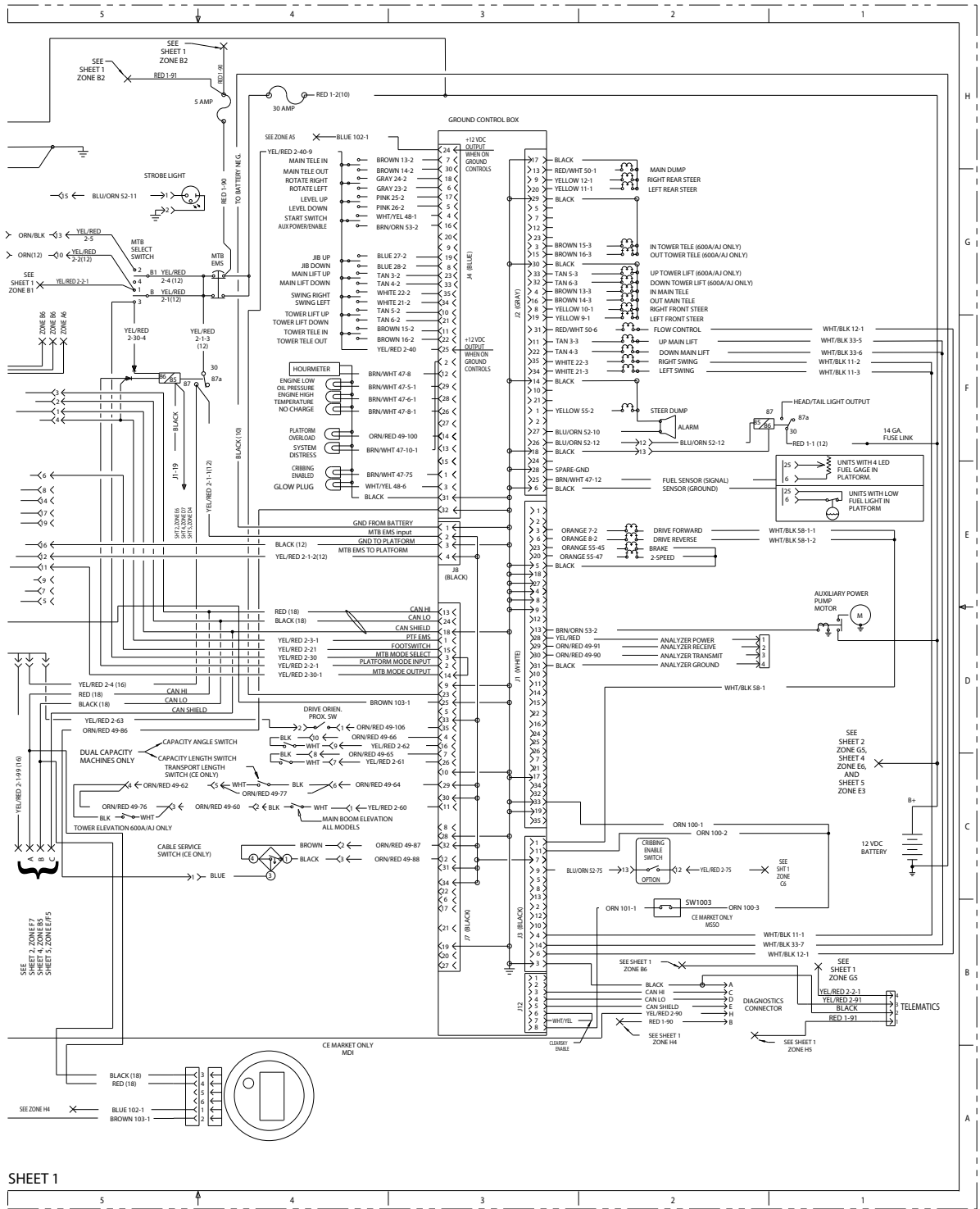
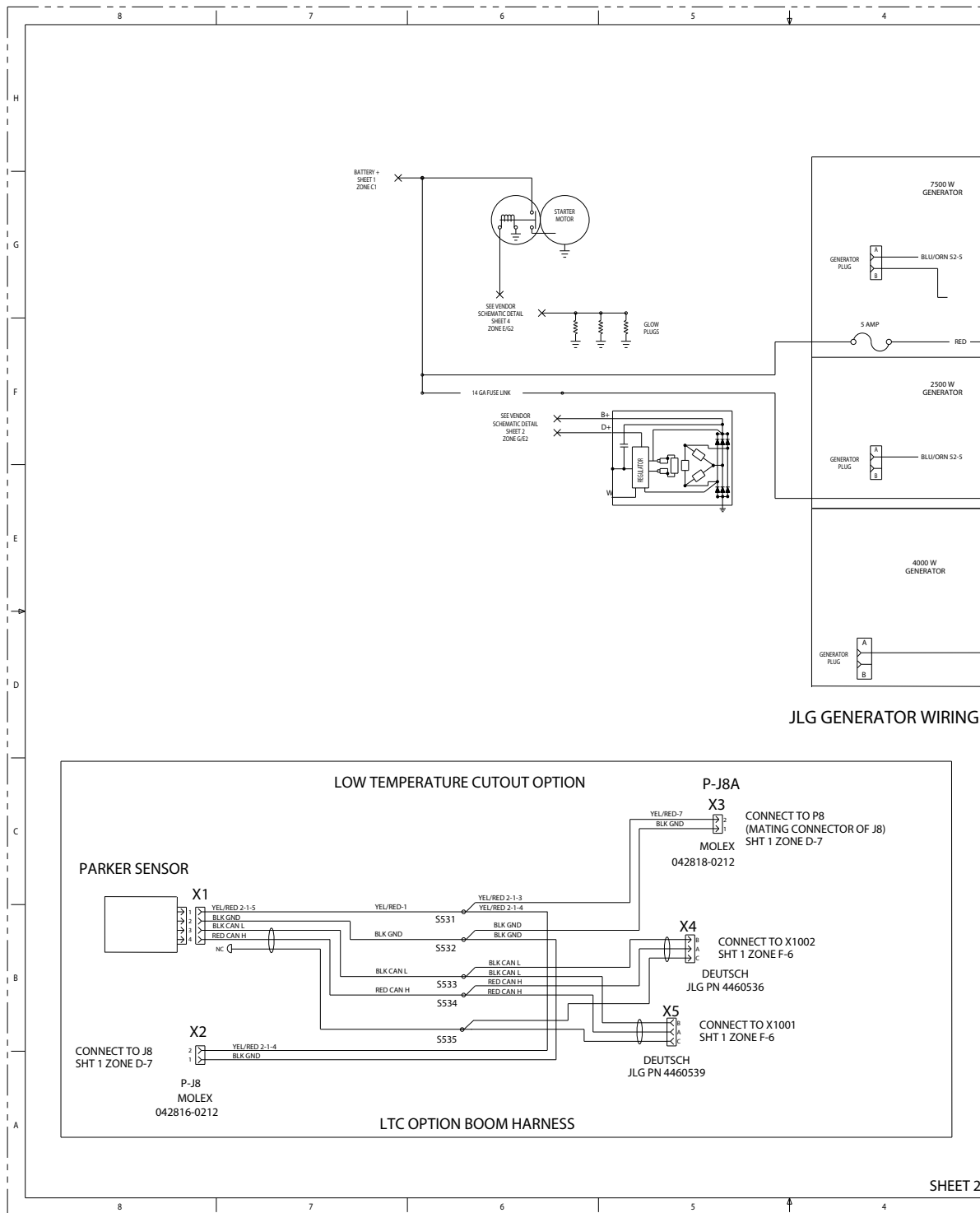


Figure 7-53. Platform and Ground Control Electrical Schematic - 2 of 2

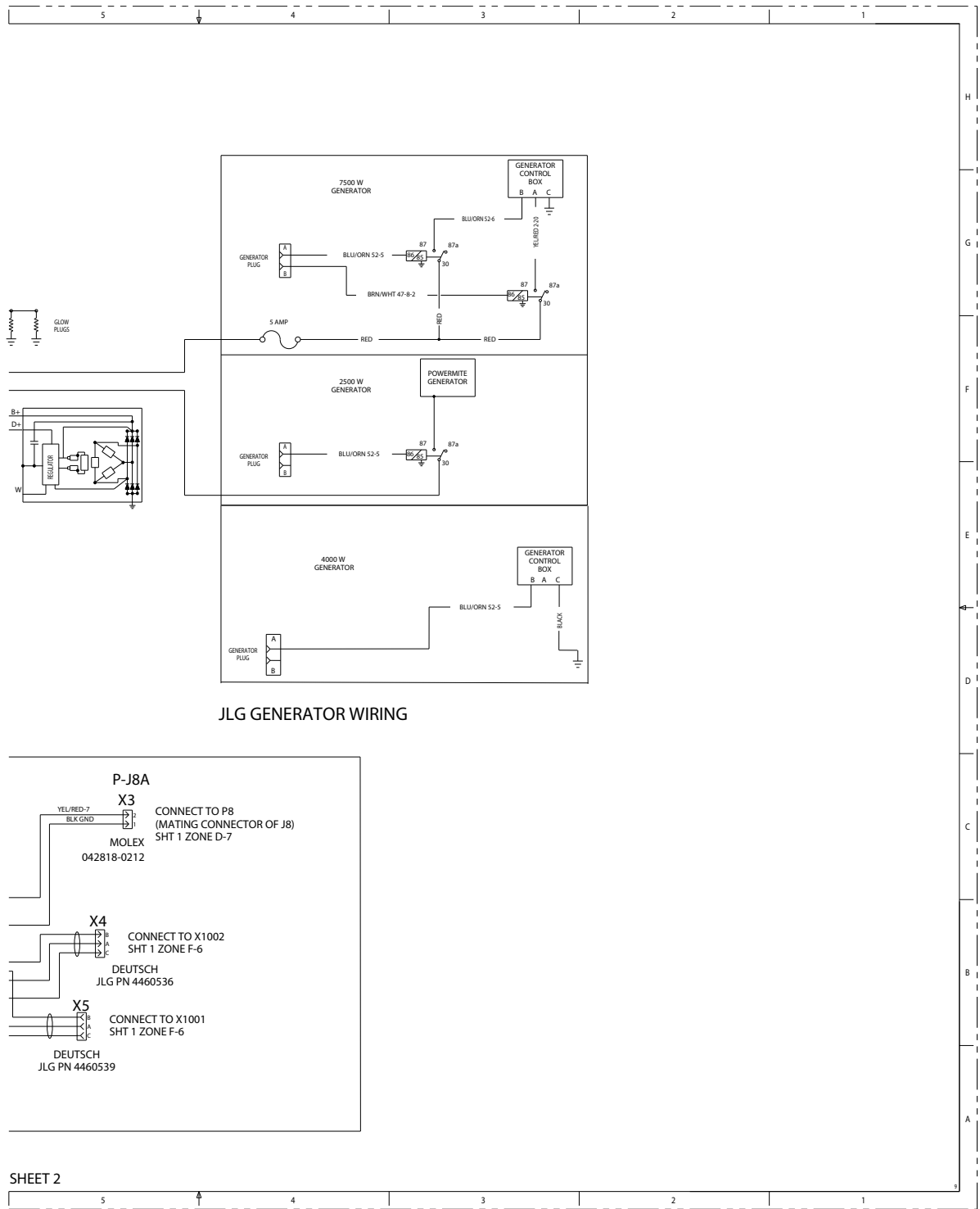
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**Figure 7-54. Generator Wiring Schematic 1 of 2**



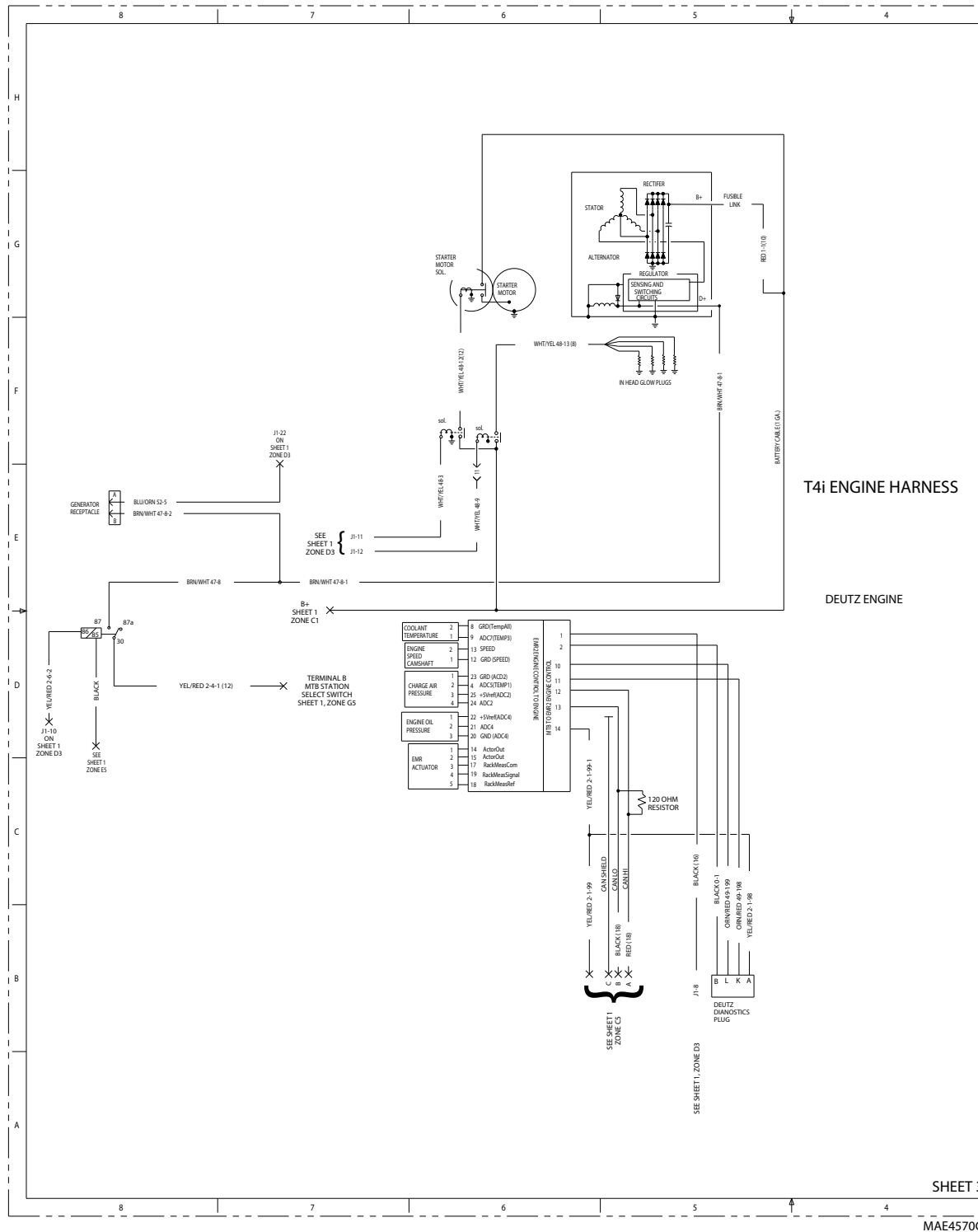
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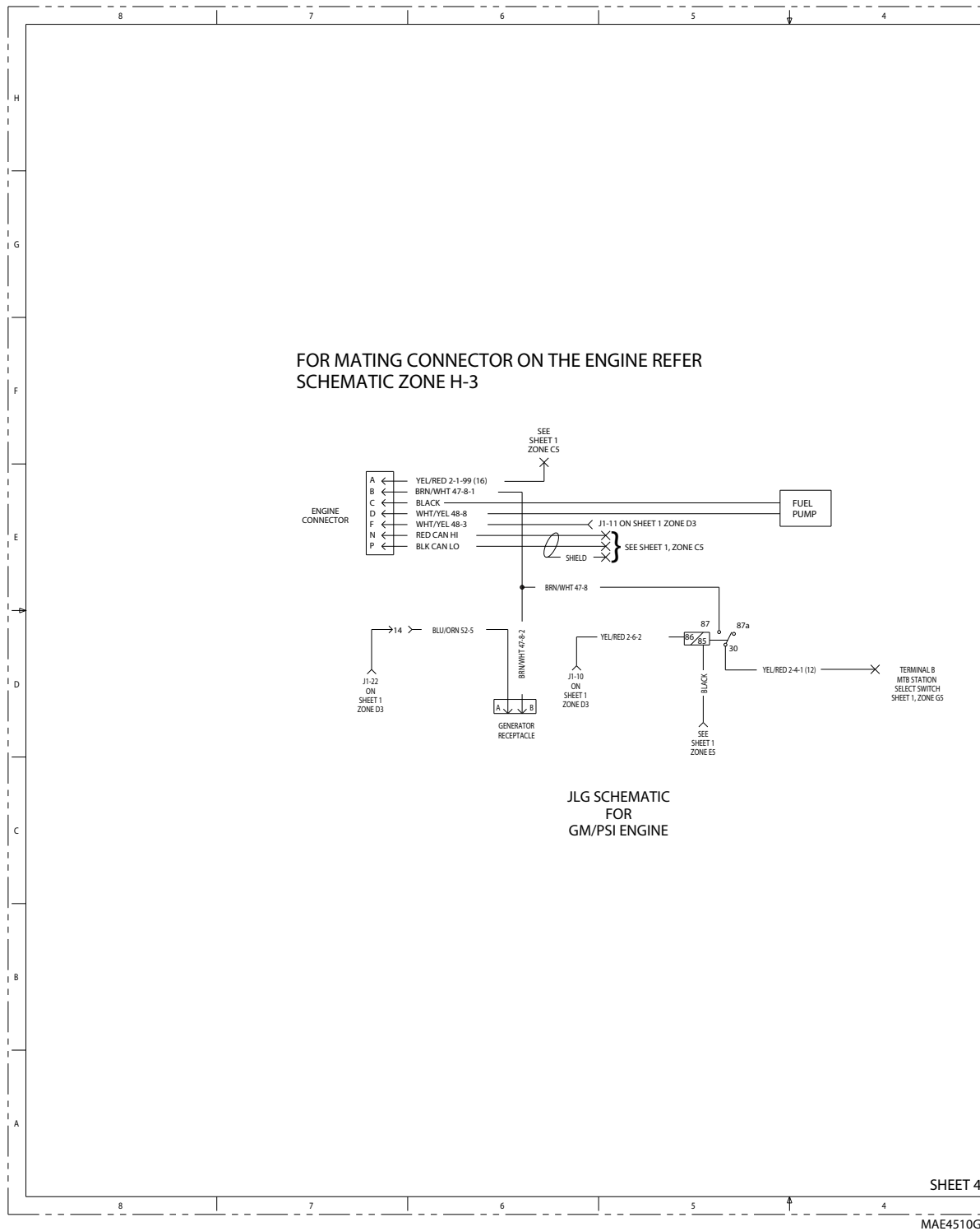
Figure 7-55. Generator Wiring Schematic 2 of 2

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**Figure 7-57. GM/PSI Engine Harness Electrical Schematic**

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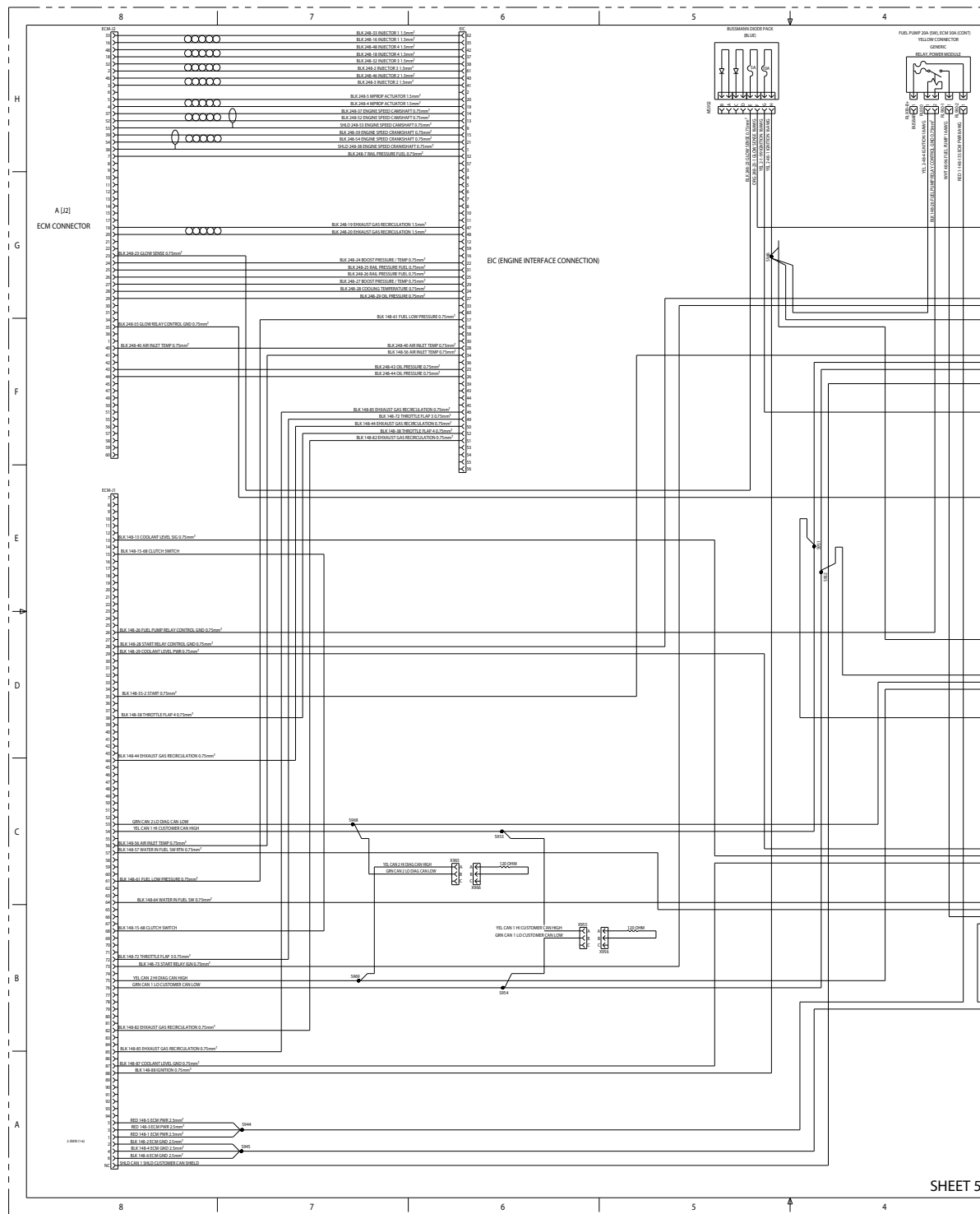
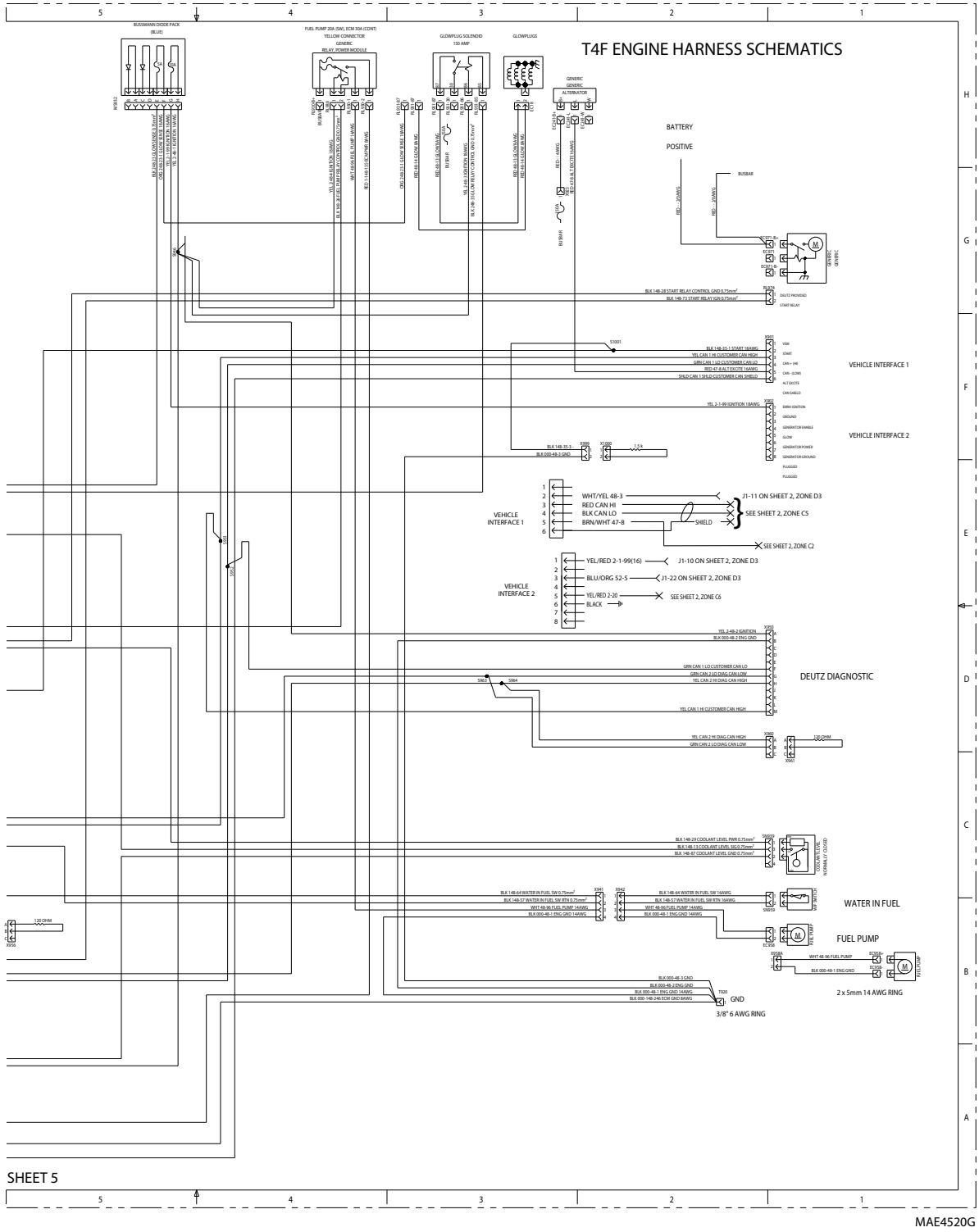


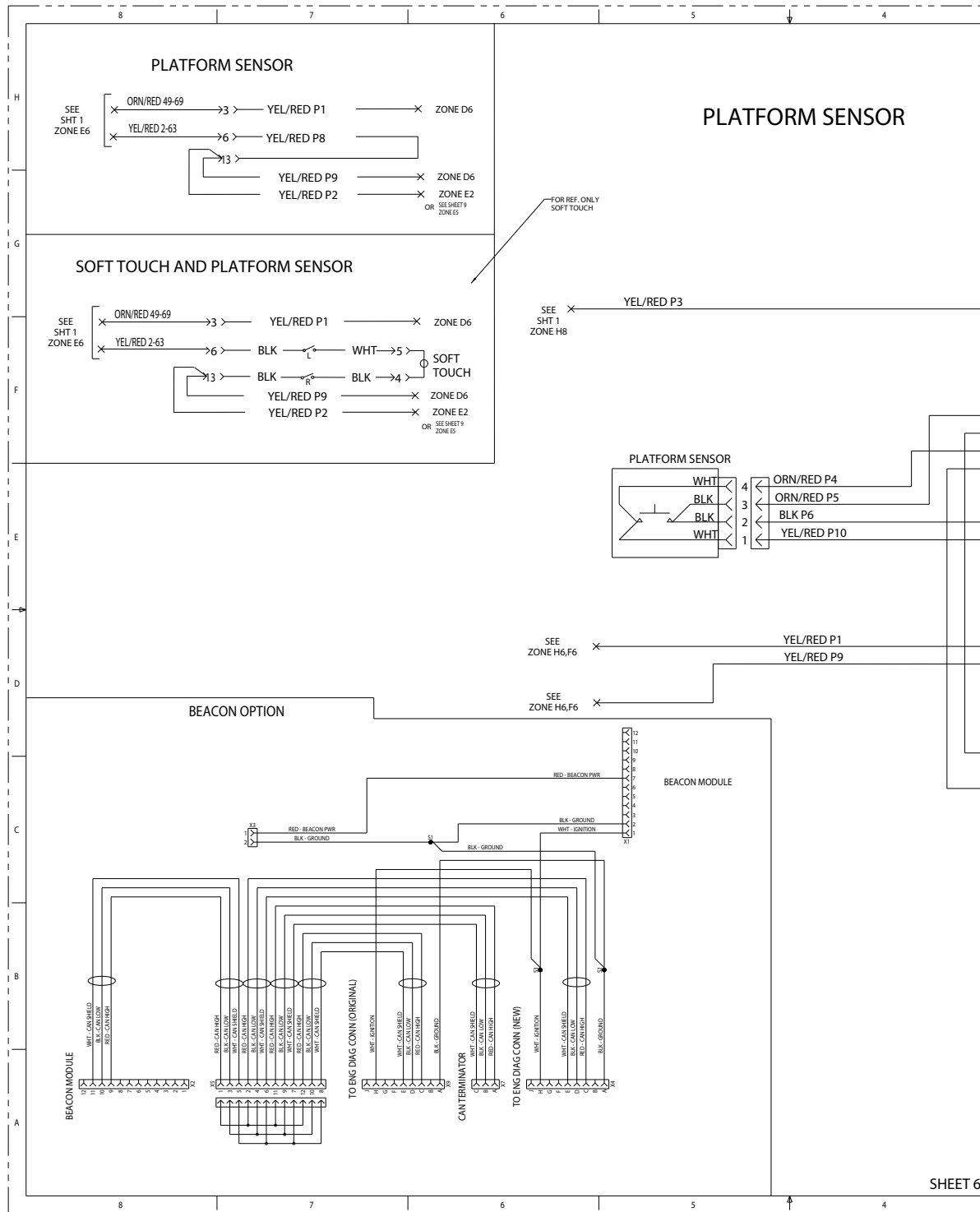
Figure 7-58. Deutz T4F Engine Harness Electrical Schematic 1 of 2

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**Figure 7-59. Deutz T4F Engine Harness Electrical Schematic 2 of 2**

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**Figure 7-60. Platform Sensor Electrical Schematic 1 of 2**



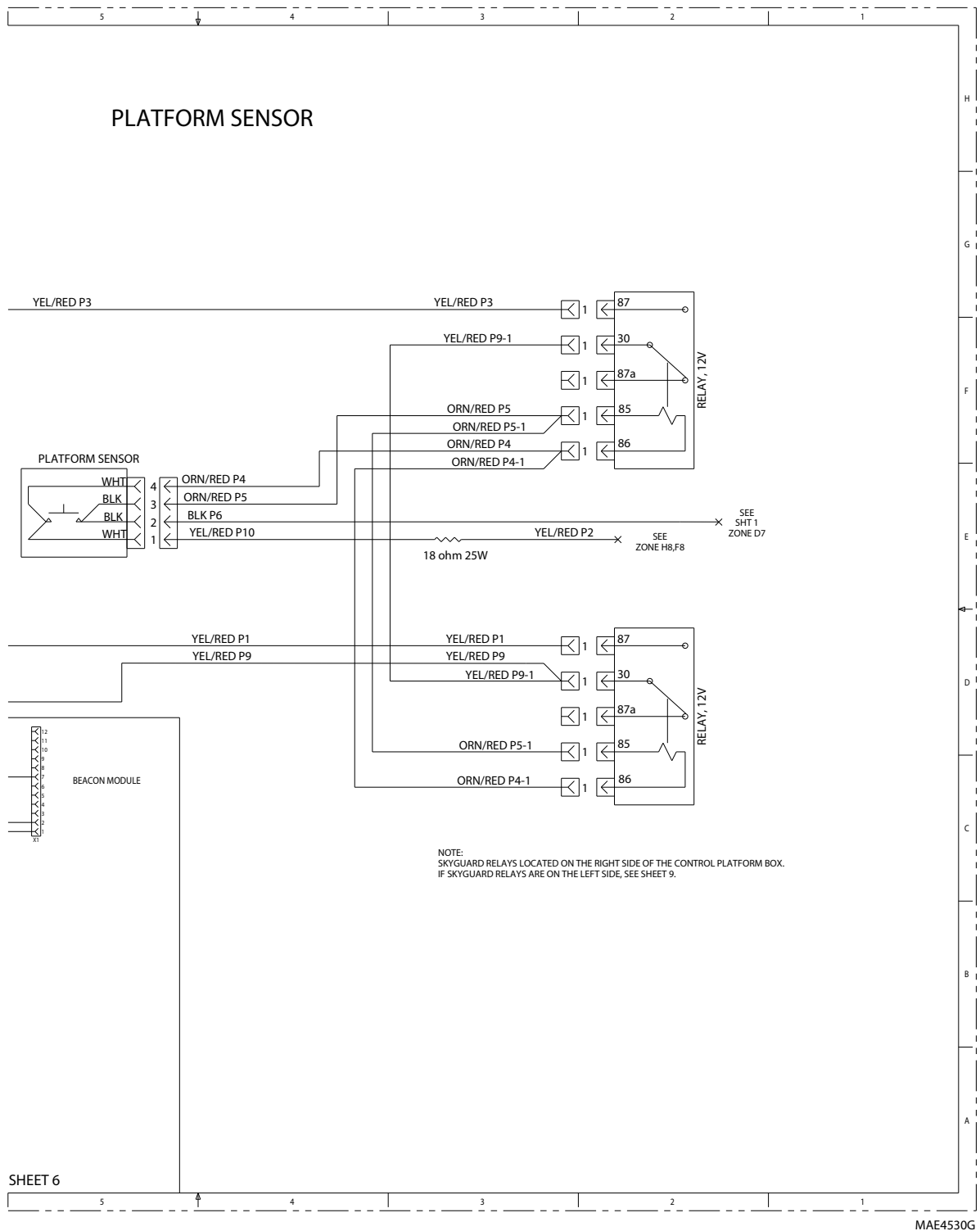
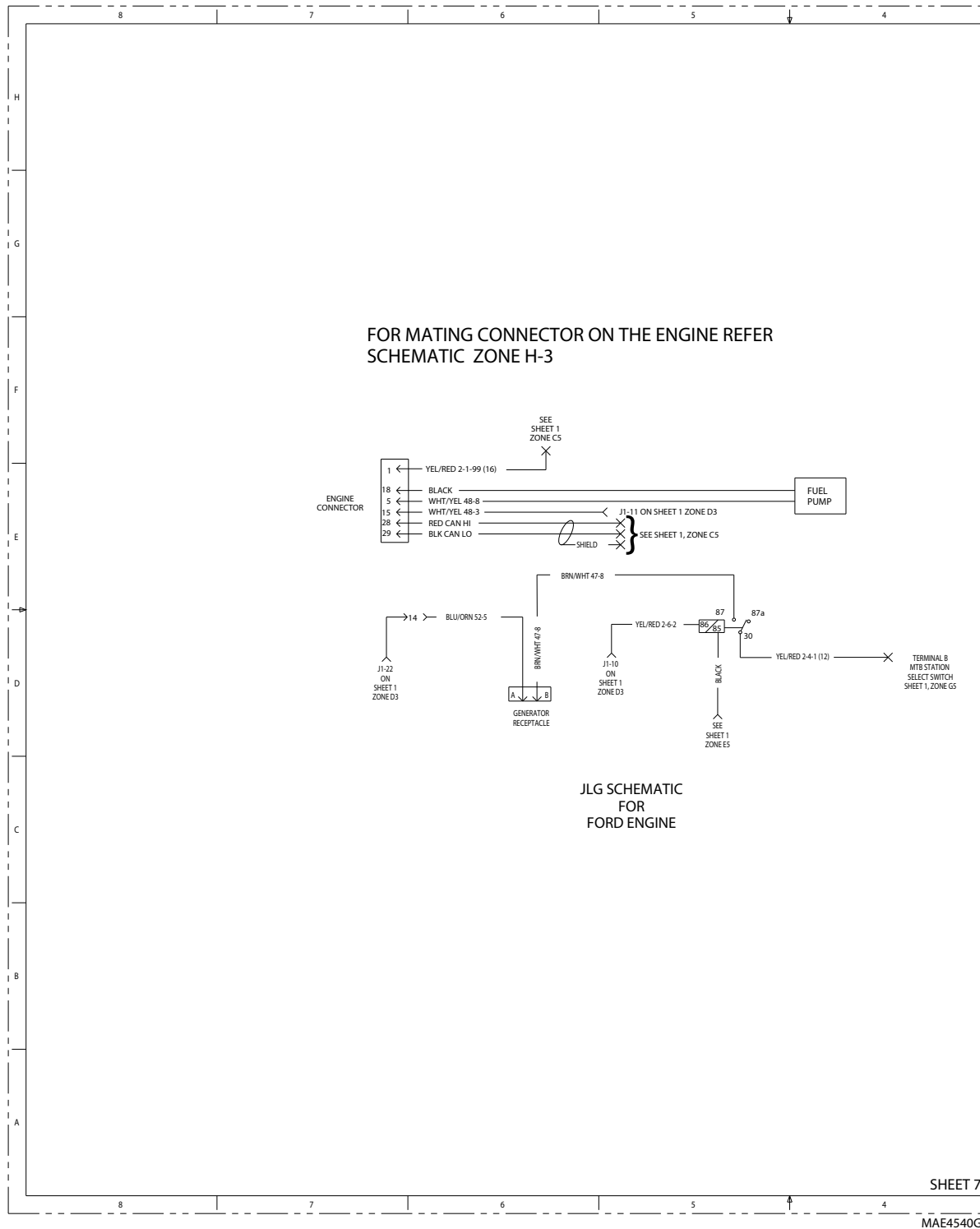


Figure 7-61. Platform Sensor Electrical Schematic 2 of 2

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**Figure 7-62. Ford Engine Electrical Schematic**

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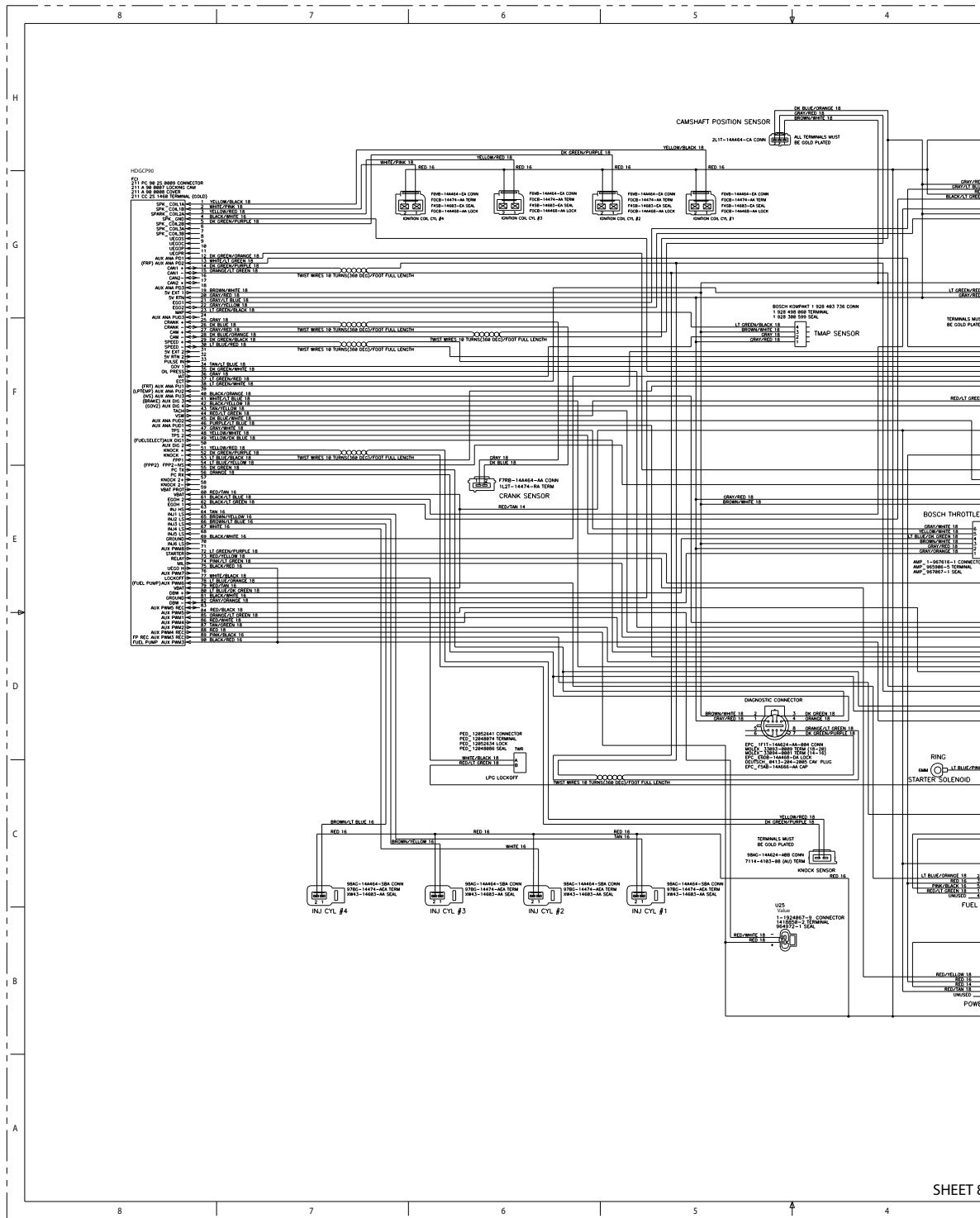


Figure 7-63. Ford Engine Harness Electrical Schematic 1 of 2

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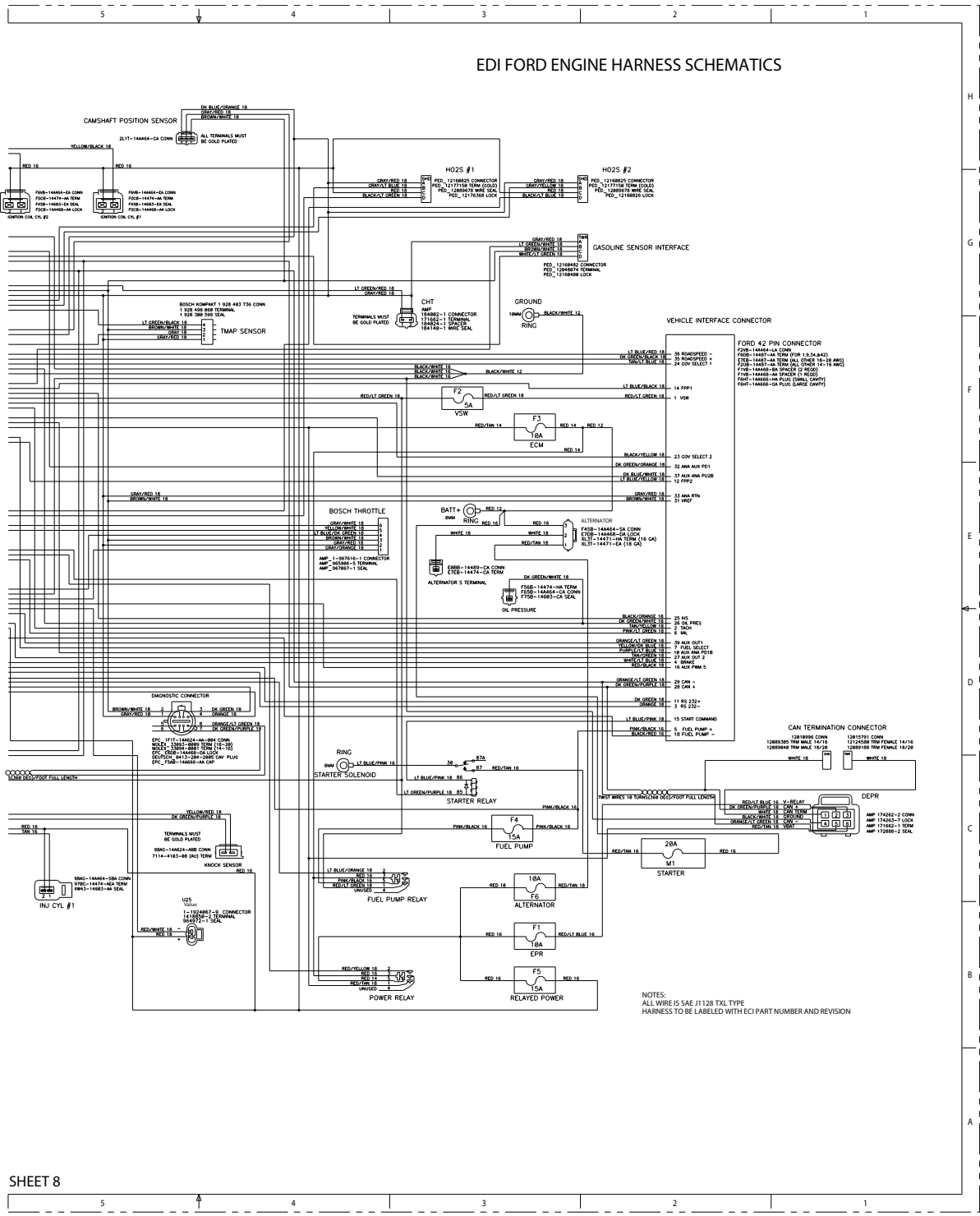
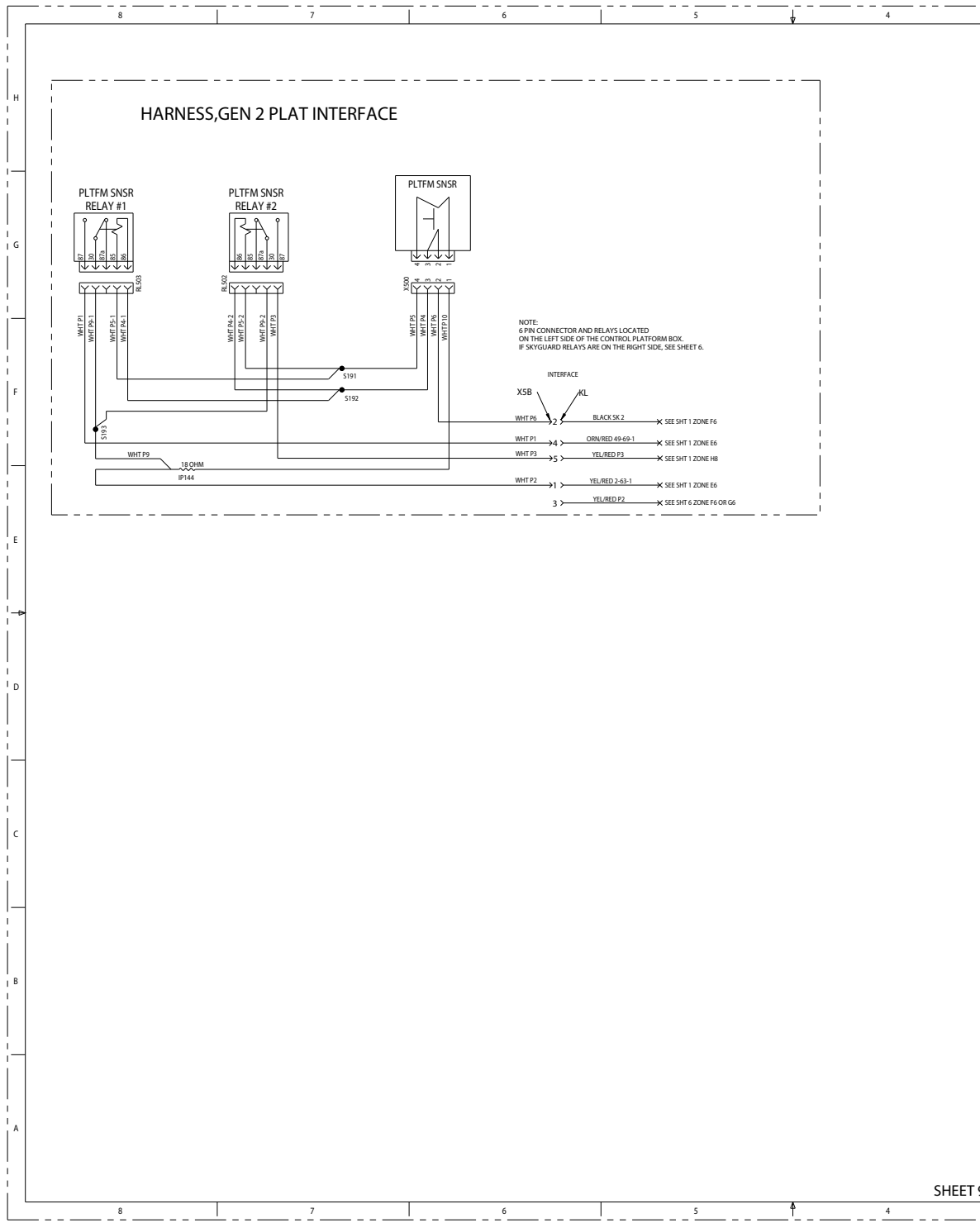


Figure 7-64. Ford Engine Harness Electrical Schematic 2 of 2

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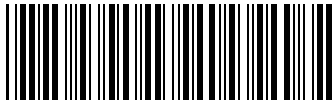
**Figure 7-65. Generator 2 Platform Harness Electrical Schematic**

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