An Oshkosh Corporation Company

Service and Maintenance Manual

Model
600A
660AJ

S/N 0300177361
to Present

P/N - 3121616

February 3, 2015

ANSI

CE

NOTE: This manual also applies to machine with 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.

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.

REVISON LOG

Original Issue	- January 8, 2014
Revision 1	- September 15, 2014
Revision 2	- February 3, 2015

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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: Restricted:	 500 lb (230 kg) 1000 lb (450 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 (5.5kg/cm^2) 77 psi (5.5 kg/cm^2) 94 psi (6.6 kg/cm^2) 94 psi (6.6 kg/cm^2)
Maximum Drive Speed	4.25 MPH (6.25KPH)
Gross Machine Weight --600A 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 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	 26ft. 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. (2.49m)
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)
Maximum Work Load (Capacity) - ANSI Unrestricted: Restricted:	 500 lb (227 kg) 1000 lb (454 kg)
Maximum Work Load (Capacity) - CE & Australia Unrestricted: Restricted:	 500 lb (230 kg) 1000 lb (450 kg)

1.3 CAPACITIES

Table 1-3. Capacities

Fuel Tank	30 gal (113.6 L)
Hydraulic Oil Tank	30.6 gal (115.8 L)
Hydraulic System (Including Tank)	40 gal (121 L)
Torque Hub, Drive*	20 oz (0.6 L)
Engine Crankcase Deutz D2011L04 Deutz 2.9 L 04 GM 3.0	 11 qt (10.5 L) 2.4 gal (8.9 L) w/Filter 4.5 qt (4.25 L) w/Filter
*Fill torque hubs half (1/2) full of lubricant.	

1.4 TIRES

Table 1-4. Tire Specifications

Size	IN355/55D 625
Load Range	G
Ply Rating	14
Foam Fill (Optional)	Foam/Crumb
Diameter	36.9
Width	13.95
Rim Size	11.75 x 24.5
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)

1.5 ENGINE DATA

Table 1-5. Deutz TD 2.9 Specifications

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

Table 1-6. Deutz D2011L04

Fuel	Diesel
Oil Capacity Cooling System Crankcase Total Capacity	 5 qt(4.5 L) 11qt (10.5 L) w/Filter 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 1-7. GM 3.0L

Fuel	Gasoline or Gasoline/LP Gas
No. of Cylinders	4
BHP Gasoline LP	 83 hp @ 3000 rpm 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 Hot	 6 psi (0.4 Bar) @ 1000 rpm 18 psi (1.2 Bar) @ 2000 rpm
Compression Ratio	9.2:1
Firing Order	1-3-4-2
Max. RPM	2800
Fuel Consumption	N/A

1.6 FUNCTION SPEEDS

Table 1-8. Function Speeds (In Seconds)

Function	600A	600AJ
Lift Up	26 - 32	26 - 32
Lift Down	26 - 32	26 - 32
Swing Right & Left*	79 - 101	79 - 101
Telescope In	22 - 30	22 - 30
Telescope Out	35 - 50	35 - 50
Platform Rotate Right & Left**	16 - 25	16 - 25
Jib Up	N/A	22 - 34
Jib Down	N/A	16 - 26
Lower Lift Up	30-38	37-50
Lower Lift Down	22-28	28-38
Drive (2WD & 4WD GM Engine) Forward and Reverse	30-34 (4.25 MPH)	30-34 (4.25 MPH)
Drive (2WD & 4WD Deutz Engine) Forward and Reverse	34 - 38 (4.02 MPH)	34 - 38 (4.02 MPH)
Drive above Horizontal Forward and Reverse	46-54 (0.68 MPH)	46-54 (0.68 MPH)
*Max 10% Difference Between Left & Right **Max 15% Difference Between Left & Right		

Machine Orientation When Doing Speed Tests

Lift: Boom retracted. Telescope retracted. Lift up, record time, Lift down, record time.

Swing: Boom at full elevation. Telescope retracted. Swing turntable off center and stop. Swing opposite direction and start test when turntable is centered. This eliminates controller ramp up and down affecting times.

Telescope: Boom at full elevation; Telescope retracted; Telescope out, record time. Telescope In, record time.

Drive: Test to be done on a smooth level surface. Set Drive Select Switch to 2WD High Engine. Start approximately 25 ft (7.62 m) from starting point so unit is at maximum speed when starting test. Record results for a 200 ft. (60.96 m) course. Drive forward, record time. Drive reverse, record time.

Drive (Above Horizontal): Test should be done on a smooth level surface. Set Drive Select Switch to 2WD High Engine. Select Platform Speed Knob out of creep speed. This verifies switches are working when boom is above horizontal. 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 opposite direction, record time. Rotate other direction, record time.

Articulating Jib: Platform level and centered with boom. Start with Jib down. Jib up, record time. Jib down, record time.

Lower Lift: Upper Boom horizontal. Telescoped In. Lower Lift up, record time. Lower lift down, record time.

Lower Telescope: Lower lift fully elevated, upper boom horizontal, telescoped in. Lower telescope out, record time. Lower telescope in, record time.

Test Notes

1. Start stop watch with function, not with controller or switch.
2. Drive test results reflect 15x19.5 air or foam-filled tires.
3. All speed tests are run from platform. Speeds do not reflect ground control operation.
4. Platform speed knob control must be at full speed (turned clockwise completely).
5. Test with oil temperature above 100° F (38° C). Function speeds vary if hydraulic oil is cold and thick.
6. Some flow control functions may not work with speed knob clicked into creep position.

1.7 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.)		

1.8 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	10W30
Gravity, API	29.0
Density, Lb/Gal. 60°F	7.35
Pour Point, Max	-46°F (-43°C)
Flash Point, Min.	442°F (228°C)
Viscosity	
Brookfield, cP at -18°C	2700
at 40° C	55 cSt
at 100° C	9.3 cSt
Viscosity Index	152

Table 1-12. Mobile DTE 10 Excel 32

ISO Viscosity Grade	#32
Specific Gravity	0.877
Pour Point, Max	-65°F (-54°C)
Flash Point, Min.	482°F (250°C)
Viscosity	
at 40° C	33cSt
at 100° C	6.6 cSt
at 100° F	169 SUS
at 210° F	48 SUS
cp at -20° F	6,200
Viscosity Index	140

Table 1-13. Quintolubric 888-46

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)
Autoignition 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 H46

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

Table 1-16. Exxon Univis HVI 26 (Arctic)

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

1.9 MAJOR COMPONENT WEIGHTS

WARNING

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

Table 1-17. Component Weights

600A Components	LBS.	KG.
Tire and Wheel 355/55D345	235	107
Engine - Deutz	534	242
Counterweight	5400	1315
Platform - 6 ft. (1.83 M)	205	93
Platform - 8 ft. (2.44 M)	230	105

600AJ Components	LBS.	KG.
Tire and Wheel 355/55D345	235	107
Engine - Deutz	534	242
Counterweight	6100	2109
Platform - 6 ft. (1.83 M)	205	93
Platform - 8 ft. (2.44 M)	230	105

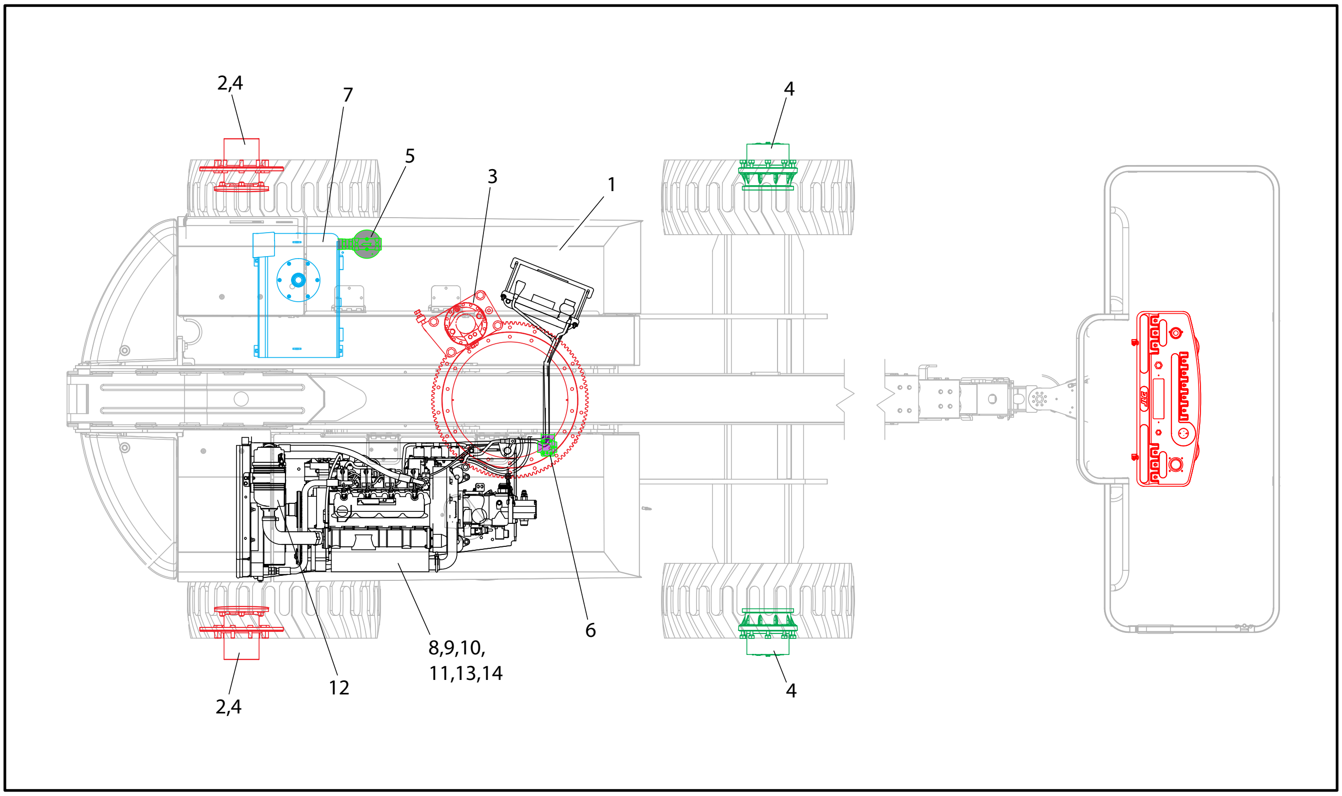


Figure 1-1. Operator Maintenance and Lubrication

1.10 OPERATOR MAINTENANCE

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

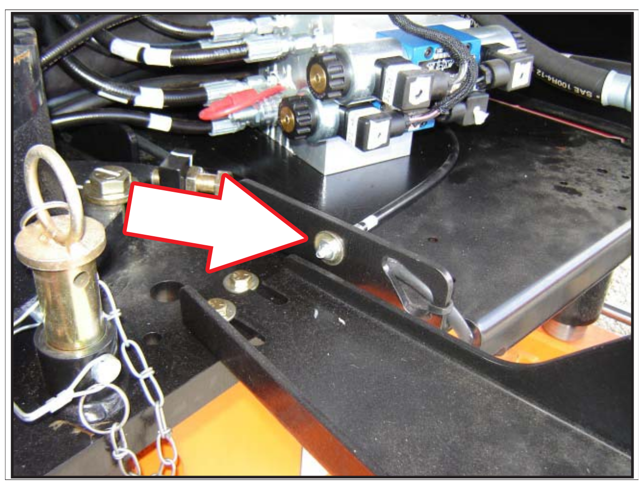
Table 1-18. Lubrication Specifications.

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

NOTICE

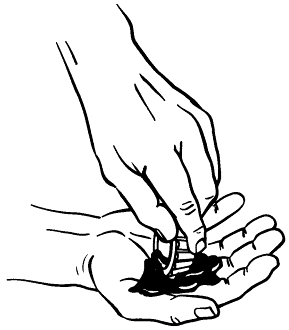
LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

1. Swing Bearing



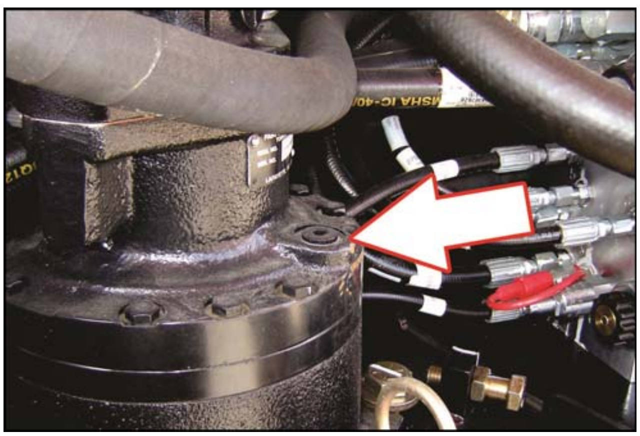
Lube Point(s) - 1 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
Comments - Remote Access. Apply grease and rotate in 90 degree intervals until bearing is completely lubricated.

2. Wheel Bearings (If equipped)



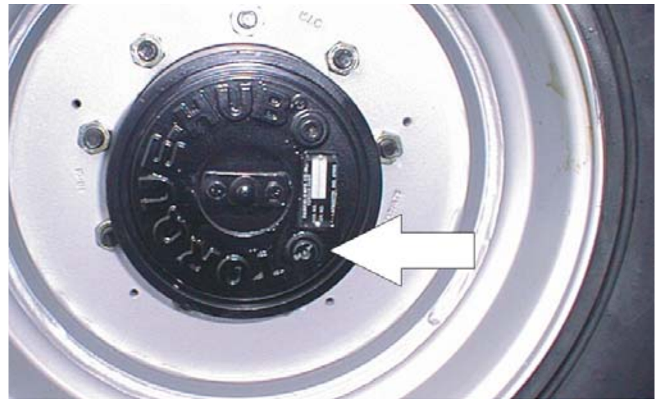
Lube Point(s) - Repack
Capacity - A/R
Lube - MPG
Interval - Every 2 years or 1200 hours of operation

3. Swing Drive Hub



4. 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

5. Wheel Drive Hub



Lube Point(s) - Level/Fill Plug
Capacity - 17 oz. (1/2 Full)
Lube - EPGL
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation

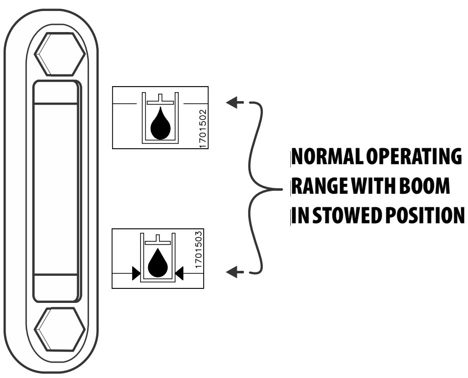
6. Hydraulic Return Filter

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

7. Hydraulic Charge Filter

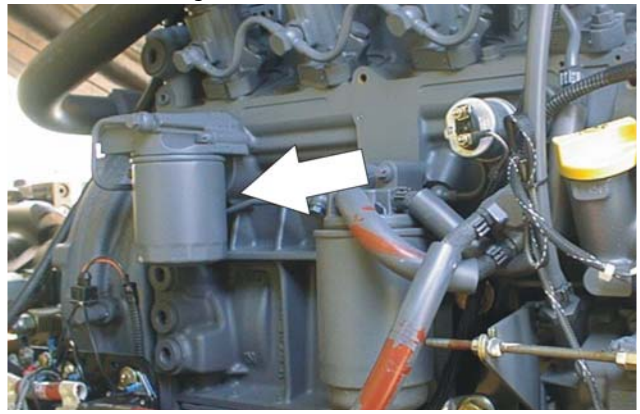
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter, or as shown by Condition Indicator.

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

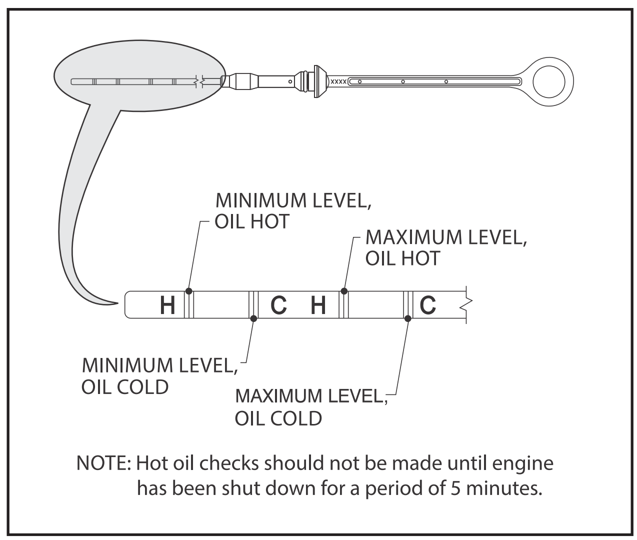


Capacity - 26 gal. Tank; 40 gal. System
Lube - HO
Interval - Check Level daily; Change every 2 years or 1200 hours of operation

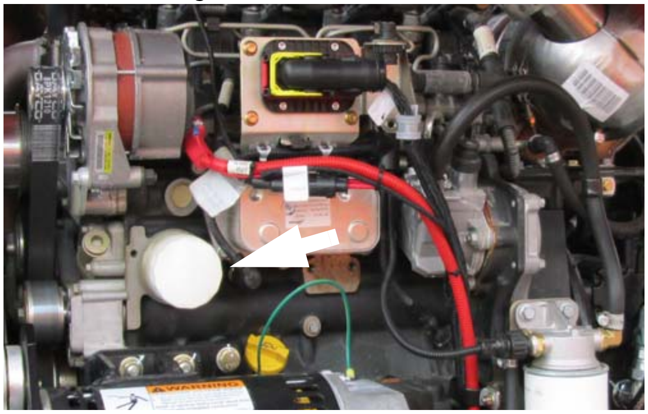
9. Oil Change w/Filter - Deutz 2011



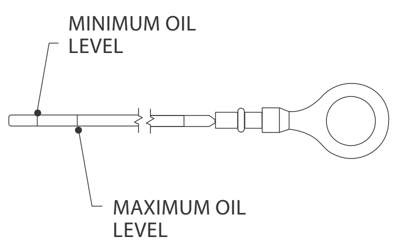
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 11 Quarts Crankcase; 5 Quarts Cooler
Lube - EO
Interval - Every Year or 1200 hours of operation
Comments - Check level daily/Change in accordance with engine manual.



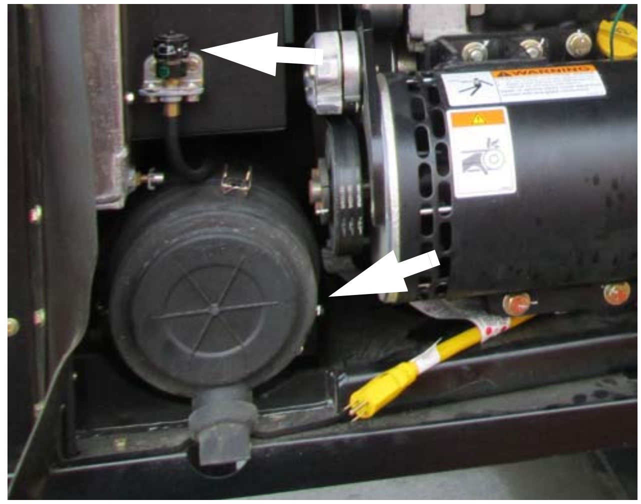
10. Oil Change w/Filter - Deutz D2.9



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.

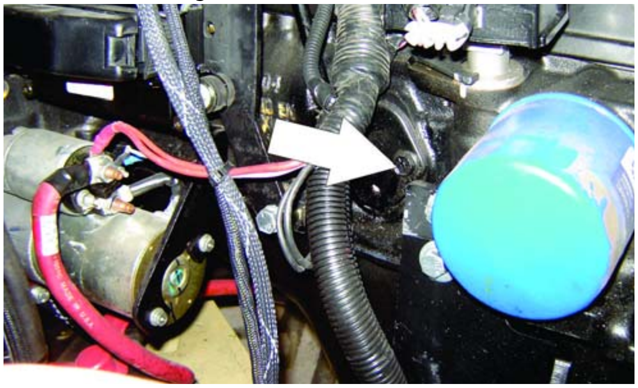


11. Air Filter - Deutz D2.9



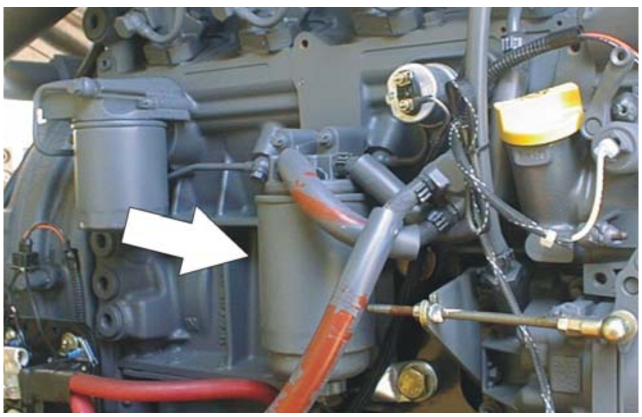
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as shown by condition indicator

1. Oil Change w/Filter - GM



2. 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.

3. Fuel Filter - Deutz

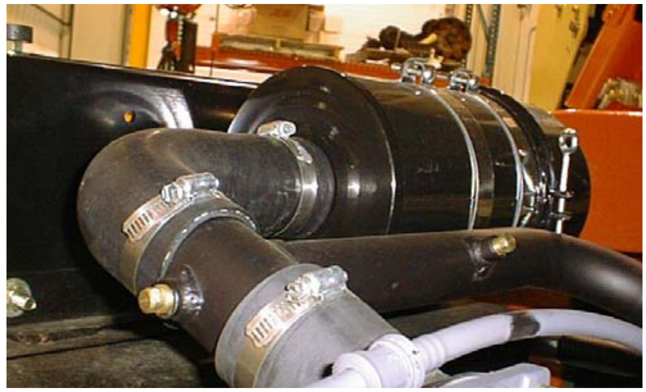


   Lube Point(s) - Replaceable Element
   Interval - Every Year or 600 hours of operation

4. Fuel Filter (Gasoline) - GM

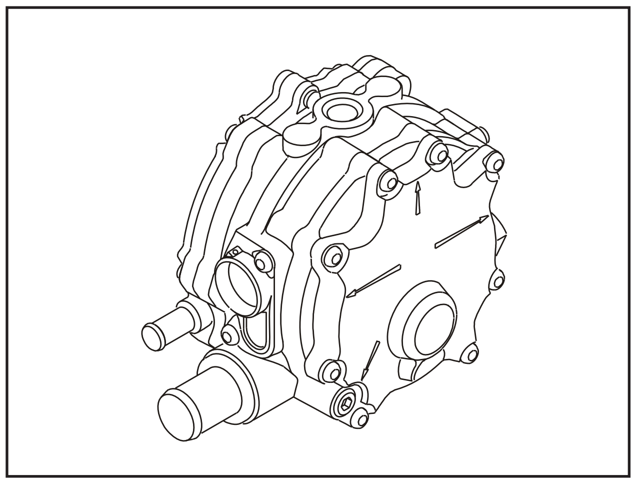
   Lube Point(s) - Replaceable Element
   Interval - Every 6 months or 300 hours of operation

5. Air Filter



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

7. 2-Stage Vaporizer (LP only)



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

8. 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									SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*						
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry)		Torque Lubricated		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or Vibra-TITE™ 131)		Clamp Load	Torque (Dry or Loctite® 263) K= 0.20		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	8	0.9	6	0.7											
	48	0.1120	0.00661	420	9	1.0	7	0.8											
6	32	0.1380	0.00909	580	16	1.8	12	1.4											
	40	0.1380	0.01015	610	18	2.0	13	1.5											
8	32	0.1640	0.01400	900	30	3.4	22	2.5											
	36	0.1640	0.01474	940	31	3.5	23	2.6					1320	43	5				
10	24	0.1900	0.01750	1120	43	4.8	32	3.5					1580	60	7				
	32	0.1900	0.02000	1285	49	5.5	36	4					1800	68	8				
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12			2860	143	16	129	15		
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15			3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	17	23	13	18	19	26	16	22	4720	25	35	20	25	20	25
	24	0.3125	0.0580	3700	19	26	14	19	21	29	17	23	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48	28	38	7000	45	60	40	55	35	50
	24	0.3750	0.0878	5600	35	47	25	34	40	54	32	43	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75	45	61	9550	70	95	65	90	50	70
	20	0.4375	0.1187	7550	55	75	40	54	60	82	50	68	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116	68	92	12750	105	145	95	130	80	110
	20	0.5000	0.1599	10700	90	122	65	88	100	136	80	108	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163	98	133	16400	155	210	140	190	115	155
	18	0.5625	0.2030	12950	120	163	90	122	135	184	109	148	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224	135	183	20350	210	285	190	260	160	220
	18	0.6250	0.2560	16300	170	230	130	176	190	258	153	207	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	21300	260	353	200		285	388	240	325	30100	375	510	340	460	280	380
	16	0.7500	0.3730	23800	300	407	220	298	330	449	268	363	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646	386	523	41600	605	825	545	740	455	620
	14	0.8750	0.5090	32400	470	637	350	475	520	707	425	576	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	38600	640	868	480	651	675	918	579	785	51500	860	1170	770	1045	645	875
	12	1.0000	0.6630	42200	700	949	530	719	735	1000	633	858	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142	714	968	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	47500	880	1193	660	895	925	1258	802	1087	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175	1598	1009	1368	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	59600	1240	1681	920	1247	1300	1768	1118	1516	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074	1322	1792	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750	2380	1506	2042	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754	1755	2379	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300	3128	1974	2676	142200	3555	4835	3200	4350	2665	3625

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

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

				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 (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15		Clamp Load	Torque (Dry or Loctite® 263) K= 0.17		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
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					1320	37	4				
10	24	0.1900	0.01750	1120	36	4.1					1580	51	6				
	32	0.1900	0.02000	1285	42	4.7					1800	58	7				
1/4	20	0.2500	0.0318	2020	86	9.7	80	9			2860	122	14	114	13		
	28	0.2500	0.0364	2320	99	11.1	95	11			3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	FT-LB	[N.m]	FT-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
	24	0.3125	0.0580	3700	15	20	15	21	15	20	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	4940	25	35	25	34	25	34	7000	35	50	35	50	35	50
	24	0.3750	0.0878	5600	30	40	28	38	25	34	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48	9550	60	80	55	75	50	70
	20	0.4375	0.1187	7550	45	60	44	60	40	54	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75	12750	90	120	85	115	80	110
	20	0.5000	0.1599	10700	75	100	71	97	65	88	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109	16400	130	175	125	170	115	155
	18	0.5625	0.2030	12950	105	145	97	132	90	122	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156	20350	180	245	170	230	160	220
	18	0.6250	0.2560	16300	145	195	136	185	125	170	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272	30100	320	435	300	410	280	380
	16	0.7500	0.3730	23800	255	345	238	324	225	306	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435	41600	515	700	485	660	455	620
	14	0.8750	0.5090	32400	400	545	378	514	355	483	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	38600	545	740	515	700	480	653	51500	730	995	685	930	645	875
	12	1.0000	0.6630	42200	600	815	563	765	530	721	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	47500	755	1025	713	969	670	911	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237	142200	3020	4105	2845	3870	2665	3625

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

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

				SOCKET HEAD CAP SCREWS – Magni Coating (Ref 4150701)*							SOCKET HEAD CAP SCREWS – Zinc Yellow Chromate Fasteners (Ref 4150707)*						
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K = .17		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15		Clamp Load See Note 4	Torque (Dry) K = .20		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140 OR Precoat 85®) K=0.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604														
	48	0.1120	0.00661														
6	32	0.1380	0.00909														
	40	0.1380	0.01015														
8	32	0.1640	0.01400														
	36	0.1640	0.01474														
10	24	0.1900	0.01750														
	32	0.1900	0.02000														
1/4	20	0.2500	0.0318	2860	122	14	114	13			2860	143	16	129	15		
	28	0.2500	0.0364	3280	139	16	131	15			3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25	4720	25	35	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50	7000	45	60	40	55	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70	9550	70	95	65	90	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110	12750	105	145	95	130	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155	16400	155	210	140	190	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220	20350	210	285	190	260	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	30100	320	435	300		280	380	30100	375	510	340	460	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620	41600	605	825	545	740	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875	51500	860	1170	775	1055	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625	142200	3555	4835	3200	4350	2665	3625

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

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

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)

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

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

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

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

Figure 1-7. Torque Chart (SAE Fasteners - Sheet 1 of 7)

NOTES:

SECTION 2. GENERAL

2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

General

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

Preparation, Inspection, and Maintenance

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

Pre-Start Inspection

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

Pre-Delivery Inspection and Frequent Inspection

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

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

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

Annual Machine Inspection

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

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

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

Preventive Maintenance

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

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

Table 2-1. Inspection and Maintenance

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

2.2 SERVICE AND GUIDELINES

General

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

Safety and Workmanship

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

Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and contamination out of vital components. Shields, covers, seals, and filters are provided to keep air, fuel, and oil supplies clean; however, these items must be maintained on a schedule to function properly.
2. Any time air, fuel, or oil lines are disconnected, clean adjacent areas as well as the openings and fittings themselves. As soon as a line or component is disconnected, cap or cover all openings to prevent contamination.
3. Clean and inspect all parts during servicing or maintenance. Ensure all passages and openings are unobstructed. Cover all parts to keep them clean. Make sure all parts are clean before they are installed. New parts should remain in their containers until ready to be used.

Components Removal and Installation

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

Component Disassembly and Reassembly

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

Pressure-Fit Parts

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

Bearings

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

Gaskets

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

Bolt Usage and Torque Application

NOTICE

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

1. Always use new replacement hardware when installing locking fasteners. Use bolts of proper length. A bolt which is too long will bottom before the head is tight against its related part. If a bolt is too short, there will not be enough thread area to engage and hold the part properly. When replacing bolts, use only those having the same specifications of the original, or one which is equivalent.
2. Unless specific torque requirements are given within the text, use standard torque values on heat-treated bolts, studs, and steel nuts, in accordance with recommended shop practices. (See Torque Chart in Section 1.)

Hydraulic Lines and Electrical Wiring

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

Hydraulic System

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

Lubrication

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

Battery

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

Lubrication and Servicing

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

2.3 LUBRICATION AND INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants can enter the system by using inadequate hydraulic oil; allowing moisture, grease, filings, 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 questions arise regarding use of greases in maintenance stock, consult your local supplier for evaluation. Refer to Section 1 for an explanation of lubricant key designations in the Lubrication Chart.

2.4 CYLINDER DRIFT TEST

Measure maximum acceptable cylinder drift using the following methods.

Platform Drift

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

Cylinder Drift

Table 2-2. Cylinder Drift

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

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

Cylinder must have normal platform load applied.

Cylinder is acceptable if it passes this test.

2.5 PINS AND COMPOSITE BEARING REPAIR GUIDELINES

Filament wound bearings.

1. Pinned joints should be disassembled and inspected if the following occurs:
   - **a.** Excessive sloppiness in joints.
   - **b.** Noise originating from joint during operation.
2. Filament wound bearings should be replaced if any of the following is observed:
   - **a.** Frayed or separated fibers on the liner surface.
   - **b.** Cracked or damaged liner backing.
   - **c.** Bearings that have moved or spun in their housing.
   - **d.** Debris embedded in liner surface.
3. Pins should be replaced if any of the following is observed (Clean pin before inspection):
   - **a.** Detectable bearing area wear.
   - **b.** Flaking, peeling, scoring, or scratches on pin surface.
   - **c.** Rusting of pin in bearing area.
4. Re-assembly of pinned joints using filament wound bearings:
   - **a.** Blow out housing using compressed air to remove all dirt and debris. Bearings and bearing housings must be free of all contamination.
   - **b.** Clean bearings and pins with solvent to remove all grease and oil.

NOTE: *Filament wound bearings are a dry joint and should not be lubricated unless otherwise instructed (i.e. sheave pins).*

   - **c.** Inspect pin to ensure it is free of burrs, nicks, and scratches which can damage bearing during installation and operation.

2.6 WELDING ON JLG EQUIPMENT

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

Do the Following When Welding on JLG Equipment:

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

Do NOT Do the Following When Welding on JLG Equipment:

NOTICE

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

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

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL				
	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Boom Assembly					
Boom Weldments			1,2,4	1,2,4	
Hose/Cable Carrier Installations			1,2,9,12	1,2,9,12	
Pivot Pins and Pin Retainers			1,2	1,2	
Sheaves, Sheave Pins			1,2	1,2	
Bearings			1,2	1,2	
Wear Pads			1,2	1,2	
Covers or Shields			1,2	1,2	
Extend/Retract Chain or Cable Systems			1,2,3	1,2,3	
Boom Assembly				14	
Platform Assembly					
Platform				1,2	
Railing			1	1,2	
Gate		5	1	1,5	
Floor			1	1,2	
Rotator	9,5		15		
Lanyard Anchorage Point			1,2,10	1,2,10	
Turntable Assembly					
Swing Bearing			1,2,14	1,2,3,13,14	
Oil Coupling	9				
Swing Drive System			11	11	
Turntable Lock			1,2,5	1,2,5	
Hood, Hood Props, Hood Latches			5	1,2,5	
Chassis Assembly					
Tires	16,17		16,17,18	16,17,18	
Wheel Nuts/Bolts	15		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				
	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Functions/Controls					
Platform Controls	5		6	6	
Ground Controls	5		6	6	
Function Control Locks, Guards, or Detents	1,5		5	5	
Footswitch			5	5	
Emergency Stop Switches (Ground & Platform)			5	5	
Function Limit or Cutout Switch Systems			5	5	
Drive Brakes			5		
Swing Brakes			5		
Auxiliary Power			5	5	
Power System					
Engine Idle, Throttle, and RPM			3	3	
Engine Fluids (Oil, Coolant, Fuel)	9,11		11	11	
Air/Fuel Filter	1,7		7	7	
Exhaust System		1,9	9	9	
Batteries	1,9			19	
Battery Fluid	11		11	11	
Battery Charger	5			5	
Fuel Reservoir, Cap, and Breather		2	1,5	1,5	
Hydraulic/Electric System					
Hydraulic Pumps	1,9		1,2,9		
Hydraulic Cylinders	1,9,7	2	1,2,9	1,2,9	
Cylinder Attachment Pins and Pin Retainers	1,9		1,2	1,2	
Hydraulic Hoses, Lines, and Fittings	1,9	12	1,2,9,12	1,2,9,12	
Hydraulic Reservoir, Cap, and Breather	1,9	2	1,5	1,5	24
Hydraulic Filter	1,9		7	7	
Hydraulic Fluid			7,11	7,11	
Electrical Connections	1		20	20	
Instruments, Gauges, Switches, Lights, Horn	1			5,23	
General					
Operation and Safety Manuals in Storage Box			21	21	
ANSI and AEM Manuals/Handbooks Installed (ANSI Markets Only)				21	
Capacity Decals Installed, Secure, Legible			21	21	
All Decals/Placards Installed, Secure, Legible			21	21	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL				
	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (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:

[1] Prior to use each day; or at each Operator change

[2] Prior to each sale, lease, or delivery

[3] In service for 3 months or 150 Hours; or Out of service for 3 months or more; or Purchased used

[4] Annually, no later than 13 months from the date of the prior inspection

Performance Codes:

1 - Check for proper and secure installation
2 - Visual inspection for damage, cracks, distortion or excessive wear
3 - Check for proper adjustment
4 - Check for cracked or broken welds
5 - Operates Properly
6 - Returns to neutral or "off" position when released
7 - Clean and free of debris
8 - Interlocks function properly
9 - Check for signs of leakage
10 - Decals installed and legible
11 - Check for proper fluid level
12 - Check for chafing and proper routing
13 - Check for proper tolerances
14 - Properly lubricated
15 - Torqued to proper specification
16 - No gouges, excessive wear, or cords showing
17 - Properly inflated and seated around rim
18 - Proper and authorized components
19 - Fully charged
20 - No loose connections, corrosion, or abrasions
21 - Verify
22 - Perform
23 - Sealed Properly
24 - Drain, Clean, Refill

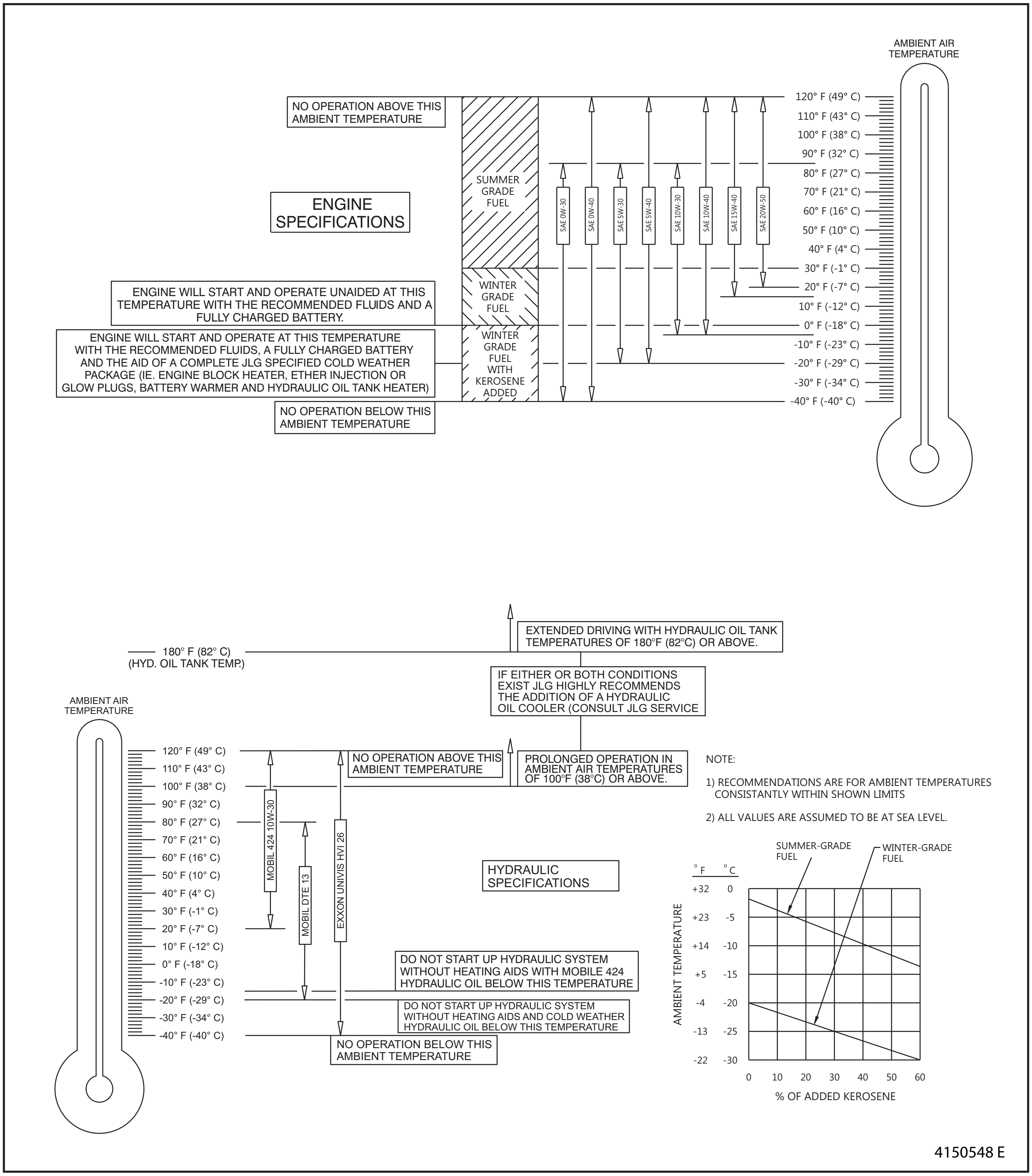


Figure 2-1. Deutz Engine and Hydraulic Operating Temperature Specifications

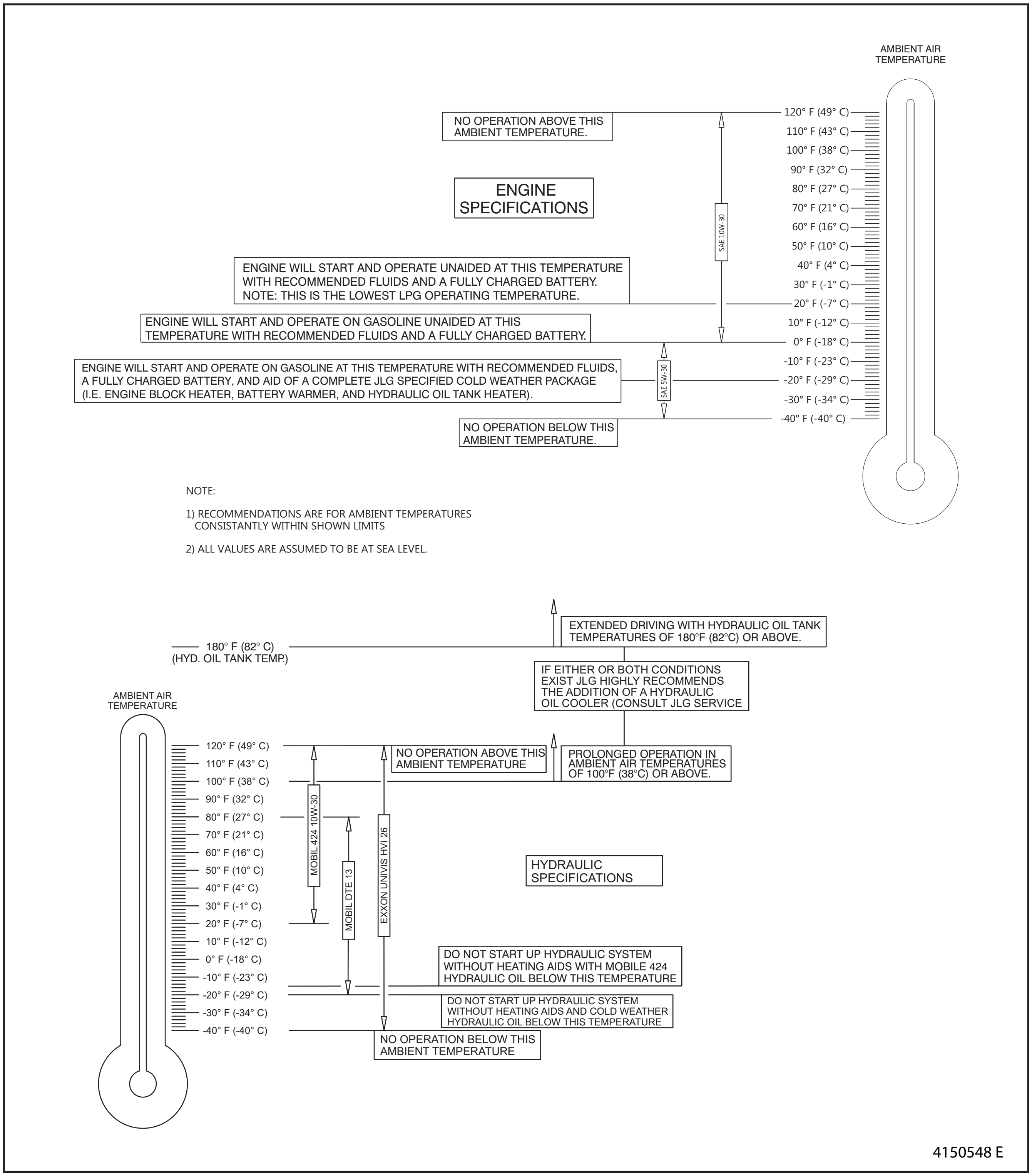


Figure 2-2. GM Engine and Hydraulic Operating Temperature Specifications

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 operation.

Tire Damage

Pneumatic Tires

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

Polyurethane Foam Filled Tires

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

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

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

Tire Replacement

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

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

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

Wheel Replacement

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

Wheel Installation

⚠ WARNING

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

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

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

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

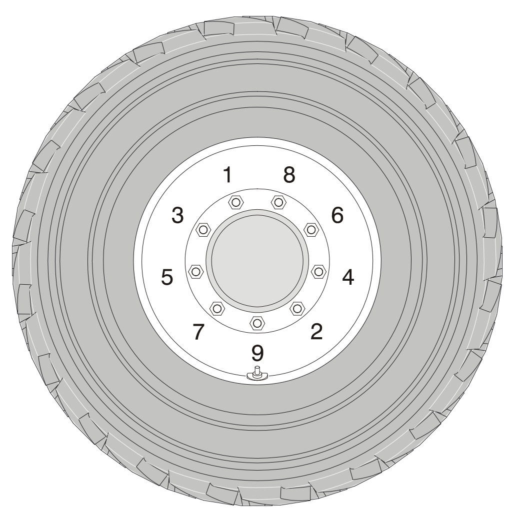


Figure 3-1. Wheel Lug Nut Tightening Sequence

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

Table 3-1. Wheel Torque Chart

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

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

3.2 TORQUE HUB

Oil Information

1. 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 1tr).

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.

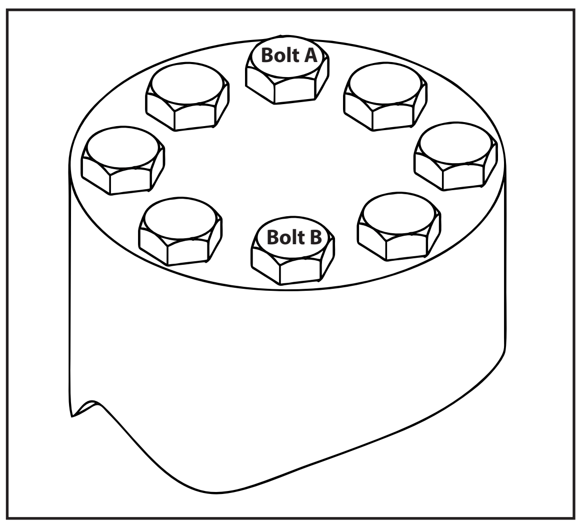
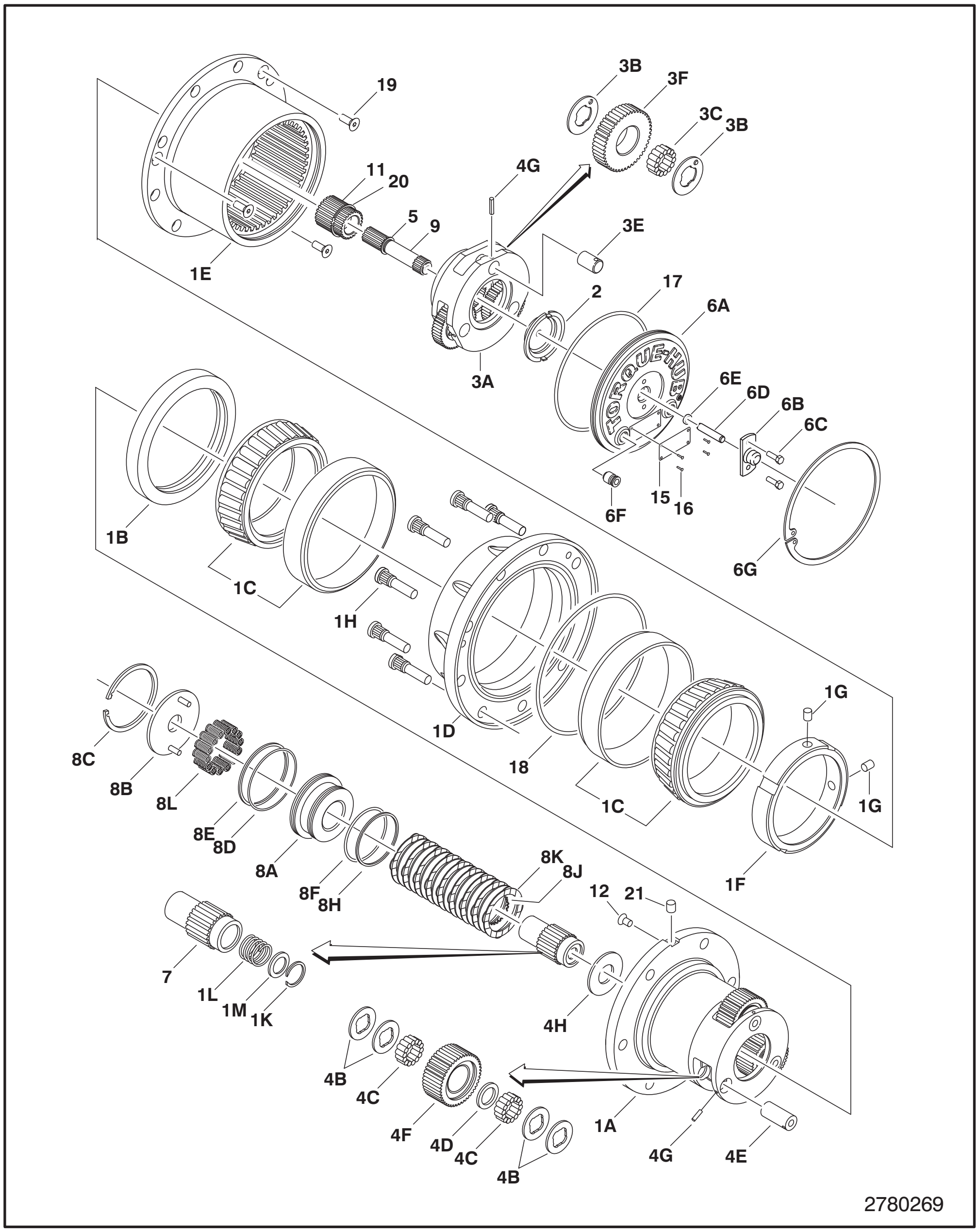


Figure 3-2. Bolt Tightening Sequence



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

Figure 3-3. 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 (1G).
9. Lift Ring Gear (1E) off Housing (1D).
10. Remove O-ring (18) from Housing (1D.

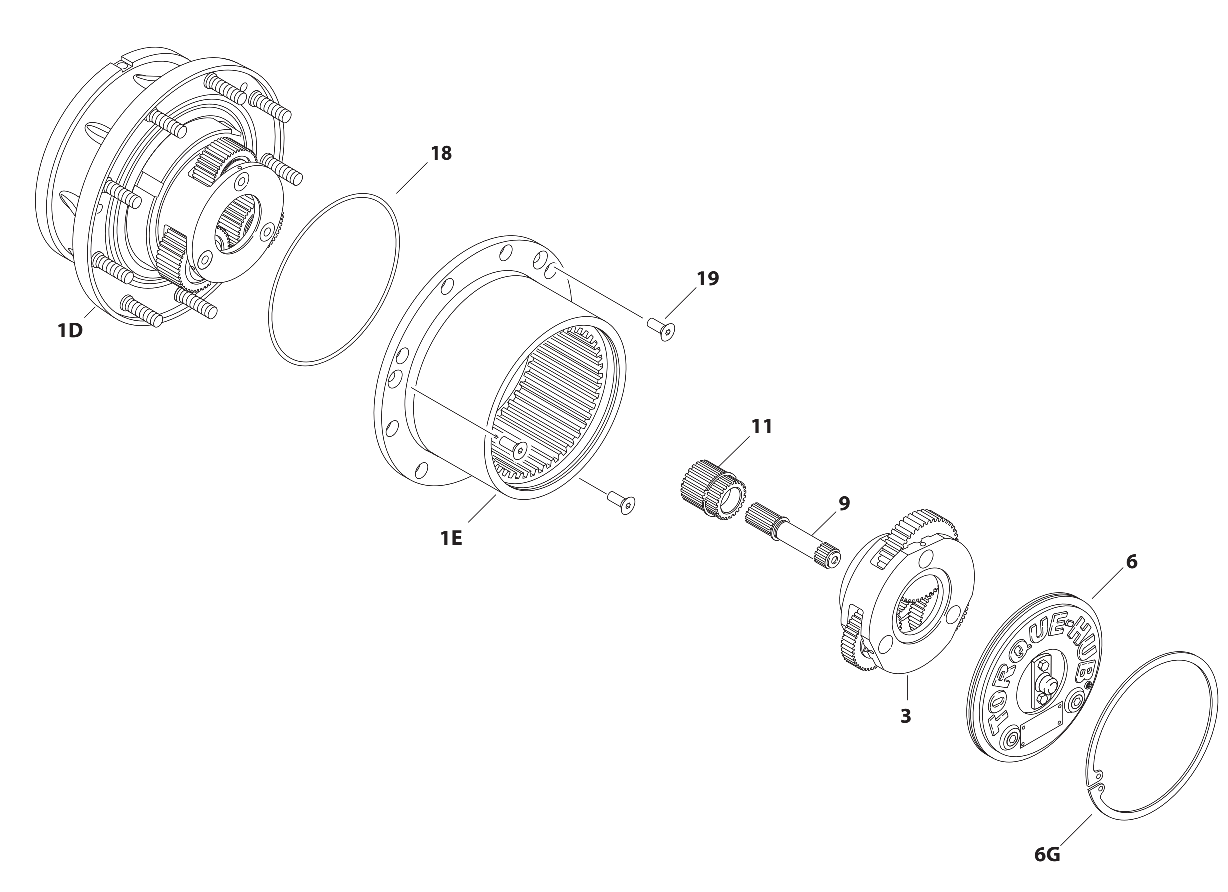


Figure 3-4. Torque Hub Main Disassembly

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-

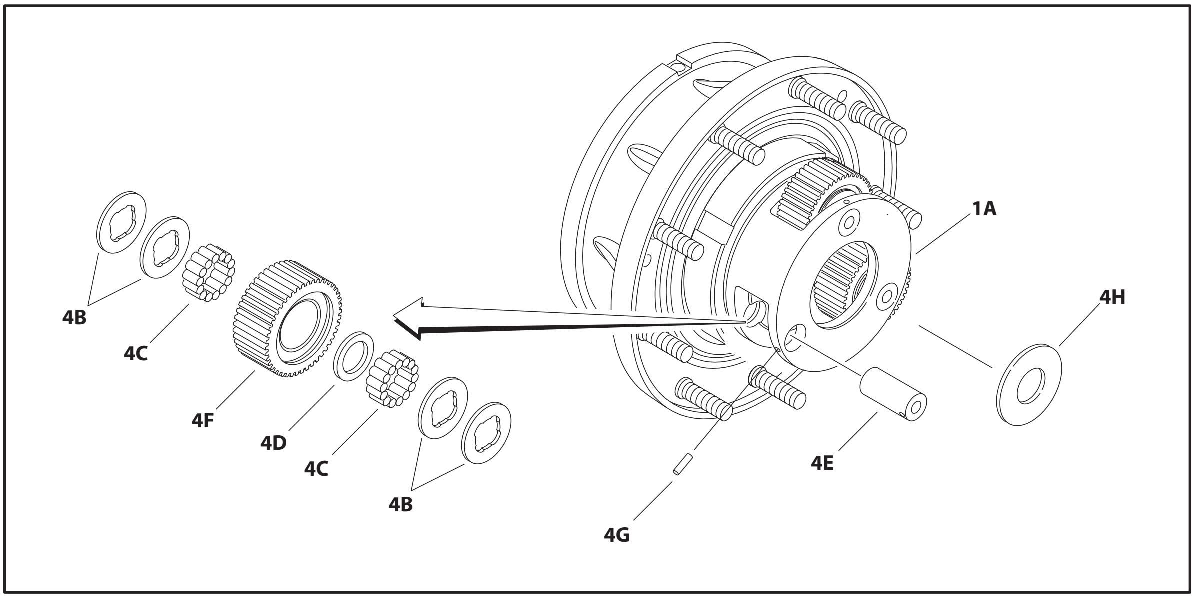


Figure 3-5. Output Carrier Disassembly

Input Carrier Disassembly

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

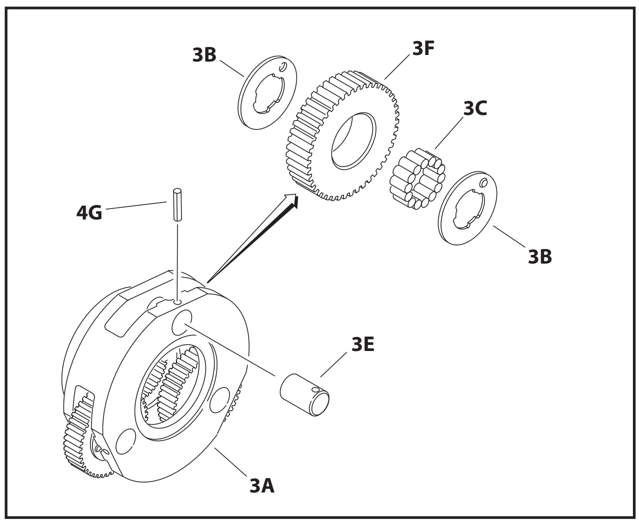


Figure 3-6. Input Carrier Disassembly

Hub-Spindle Disassembly

1. Place unit on bench with Spindle (1A) end down.
2. Remove 2 Set Screws (1G) and Bearing Nut (1F) using T-206569.

NOTE: *Holes in Bearing Nut (1F) for Set Screws (1G) are staked for retention of Set Screws (1G). Clean holes before removing Set Screws.*

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

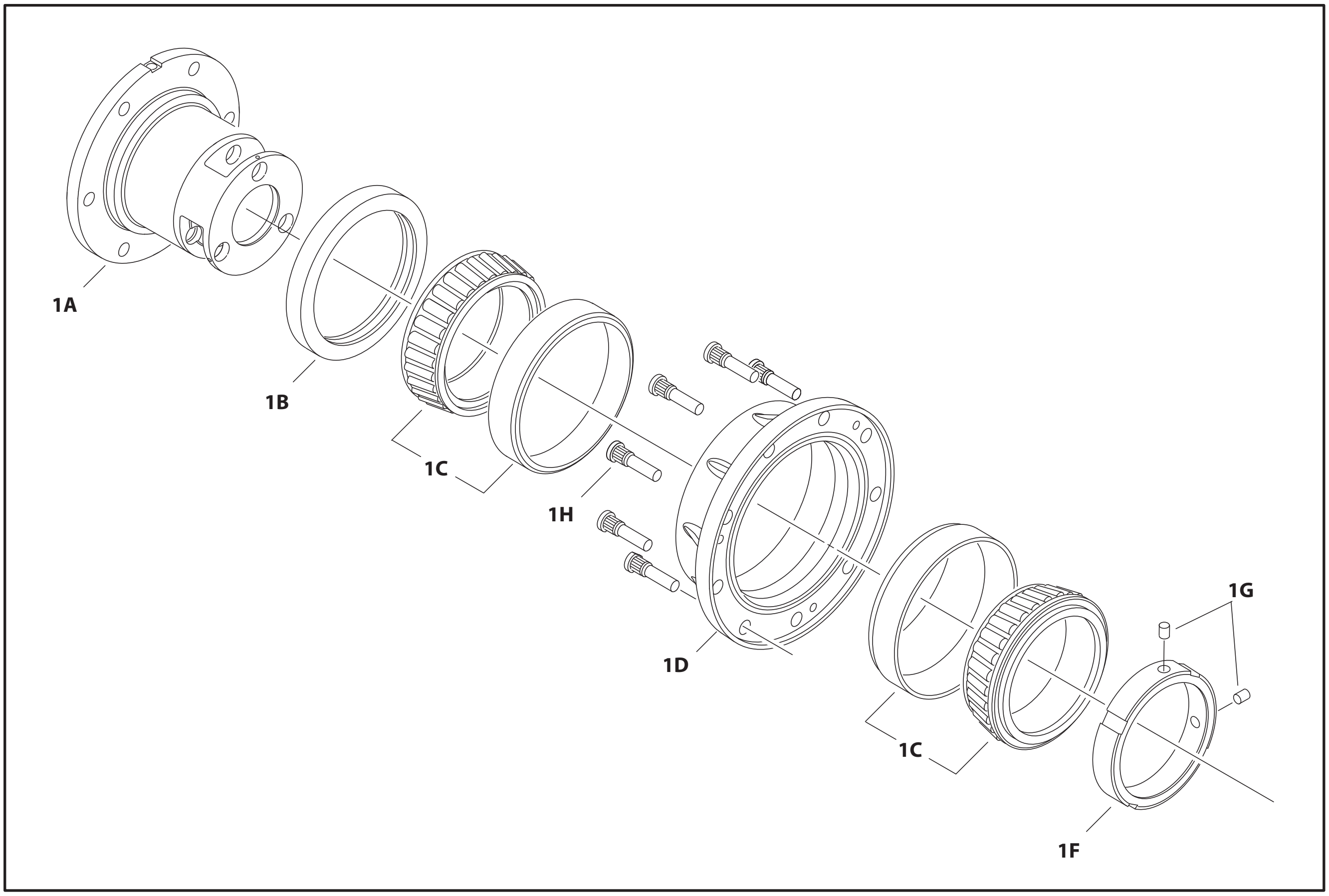


Figure 3-7. Hub Spindle Disassembly

Spindle-Brake Disassembly

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

⚠ CAUTION

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

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

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

2. Using retaining ring pliers, remove Retaining Ring (8C) from groove in Spindle (1A).
3. Back Flat Head Cap Screws (22) incrementally out of Piston (8A) until spring force is relieved from Pressure Plate (8B). Remove Flat Head Cap Screws (22) and Pressure Plate (8B) from brake cavity in Spindle (1A).
4. Remove Compression Springs (8L) from Piston (8A).
5. Using an air hose, slowly and carefully pressurize brake port in Spindle (1A) until Piston (8A) comes out of piston bore of Spindle (1A). Pull Piston (8A) out of Spindle (1A) by hand.
6. Remove Backup Rings (8E and 8H) and O-rings (8D and 8F) from grooves in Piston (8A).
7. Remove Rotors (8J) and Stators (8K) from brake cavity in Spindle (1A).
8. Remove Coupling Subassembly (7) from brake cavity in Spindle (1A).
9. Remove Retaining Ring (1K) from internal groove using appropriate tool.
10. Remove Spacer (1M) and Spring (1L) from bore of Coupling (7).
11. Remove Plastic Plug (12) and Pipe Plug (21) from Spindle (1A) if applicable.

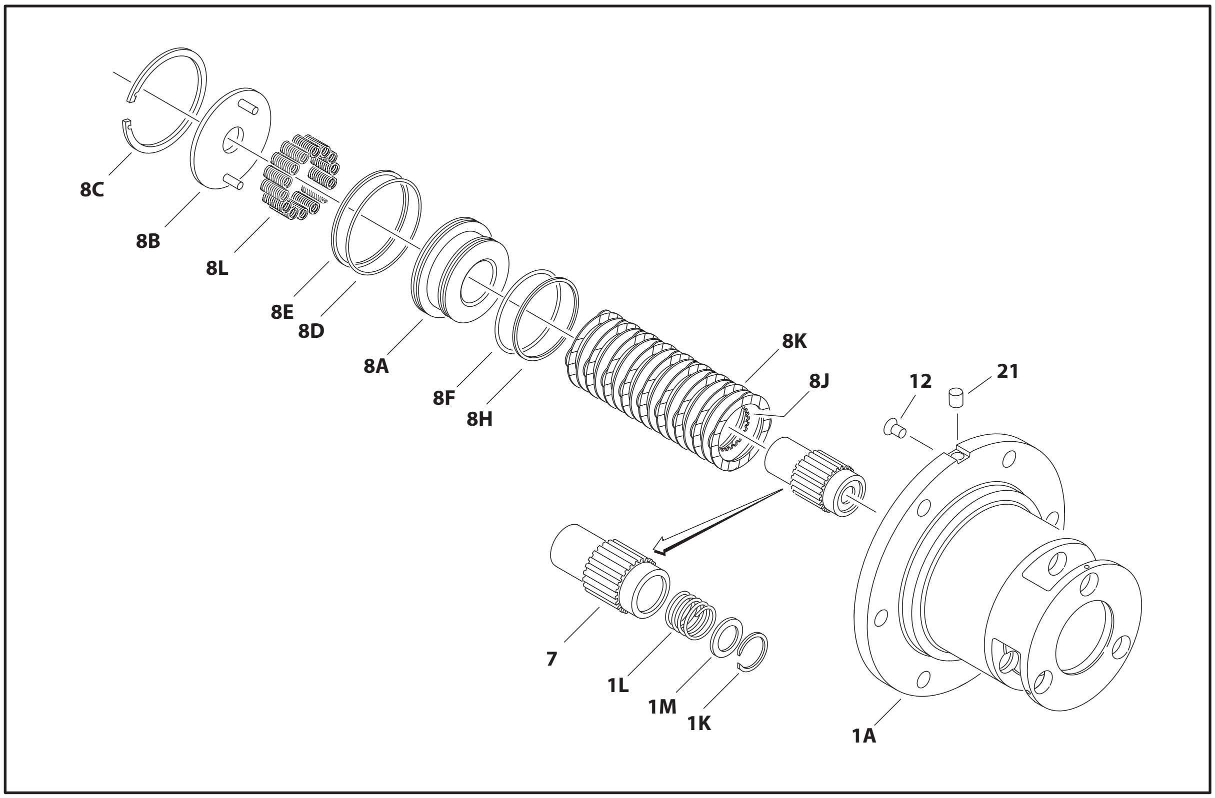


Figure 3-8. Spindle Brake Disassembly

Cover Disassembly

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

Cover Assembly

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

NOTE: *Disengage Rod can be inserted either end first.*

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

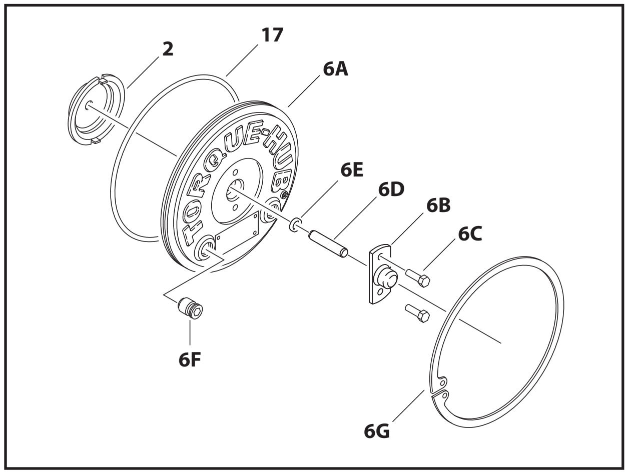


Figure 3-9. Torque Hub Cover

Input Carrier 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.
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) counterbore 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

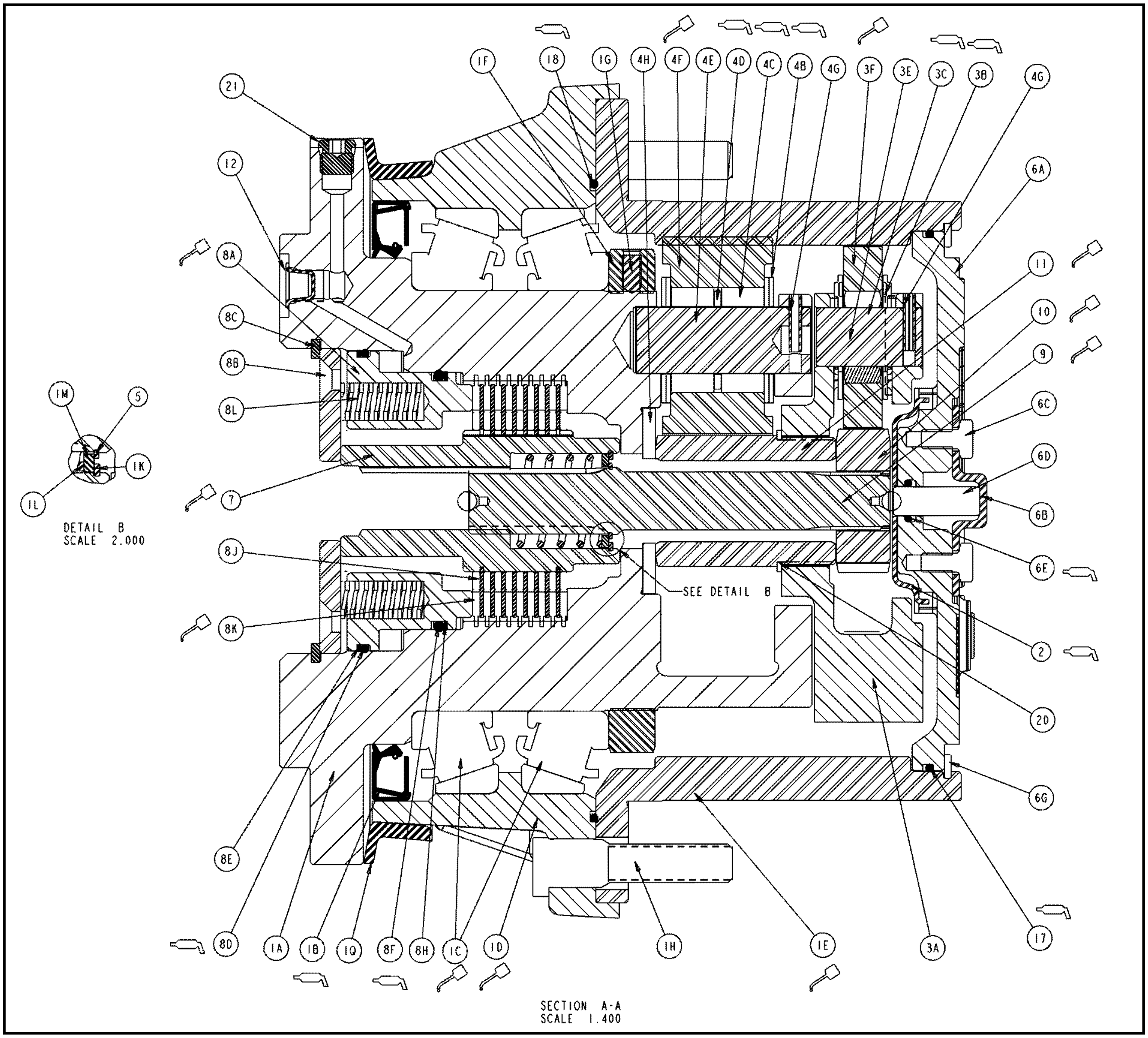
1. Using appropriate fittings, connect hydraulic line from hand pump to brake port.
2. Check brake is set by trying to rotate Input Shaft (9). This can be accomplished by installing an appropriate tool (any tool that can locate on splines of Input Coupling (7), such as a mating splined shaft) into Input 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
1B. Lip Seal
1C. Tapered Bearing
1D. Housing
1E. Ring Gear
1F. Bearing Nut
1G. Setscrew
1H. Stud
1K. Retaining Ring
1L. Spring
1M. Thrust Washer
1Q. Seal Boot
2. Thrust Spacer
3A. Carrier
3B. Thrust Washer
3C. Needle Bearing
3E. Planet Shaft
3F. Planet Gear
4B. Thrust Washer
4C. Needle Bearing
4D. Thrust Spacer
4E. Planet Shaft
4F. Planet Gear
4G. Roll Pin
4H. Thrust Washer
5. Retaining Ring
6A. Cover
6B. Disengage Cap
6C. Bolt
6D. Dowel Pin
6E. O-Ring
6F. Pipe Plug
6G. Retaining Ring
7. Coupling
8A. Brake Piston
8B. Pressure Plate
8C. Retaining Ring
8D. O-Ring
8E. Backup Ring
8F. O-Ring
8H. Backup Ring
8J. Brake Rotor
8K. Brake Stator
8L. Spring
9. Input Shaft
10. Sun Gear
11. Sun Gear
12. Plastic Plug
15. ID Plate
16. Drive Screw
17. O-Ring
18. O-Ring
19. Bolt
20. Retaining Ring
21. O-Ring Plug

Figure 3-10. Hub Assembly

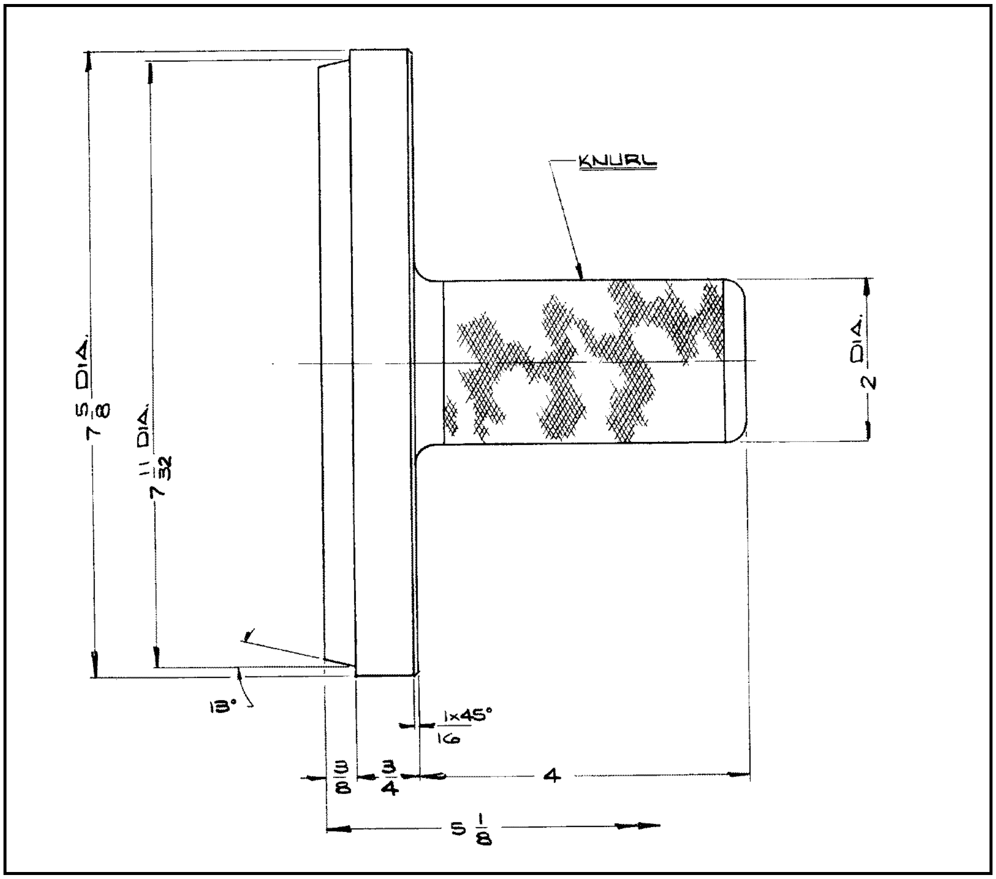


Figure 3-11. Bearing Cup Pressing Tool

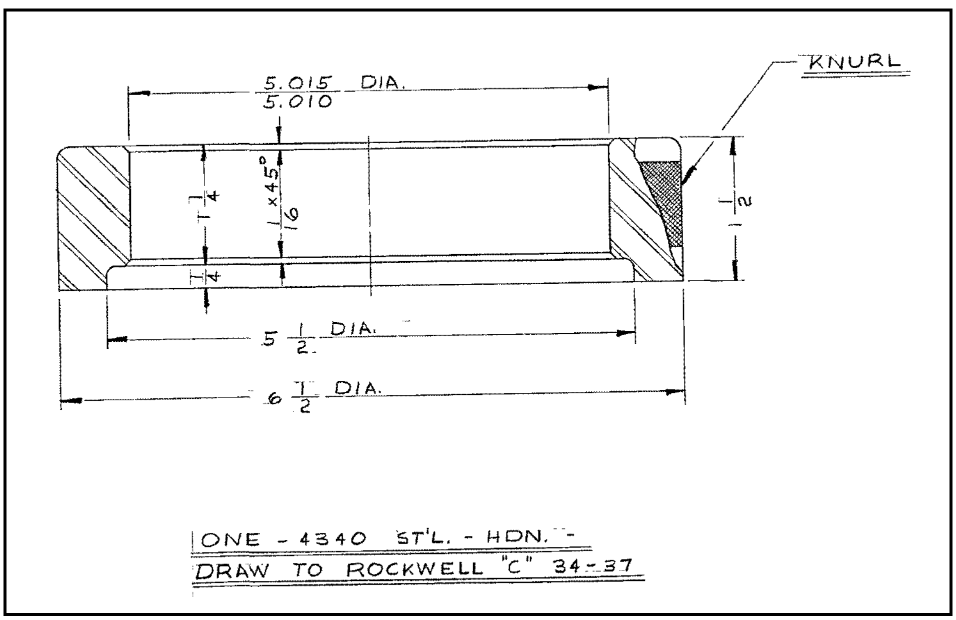


Figure 3-12. Seal Pressing Tool

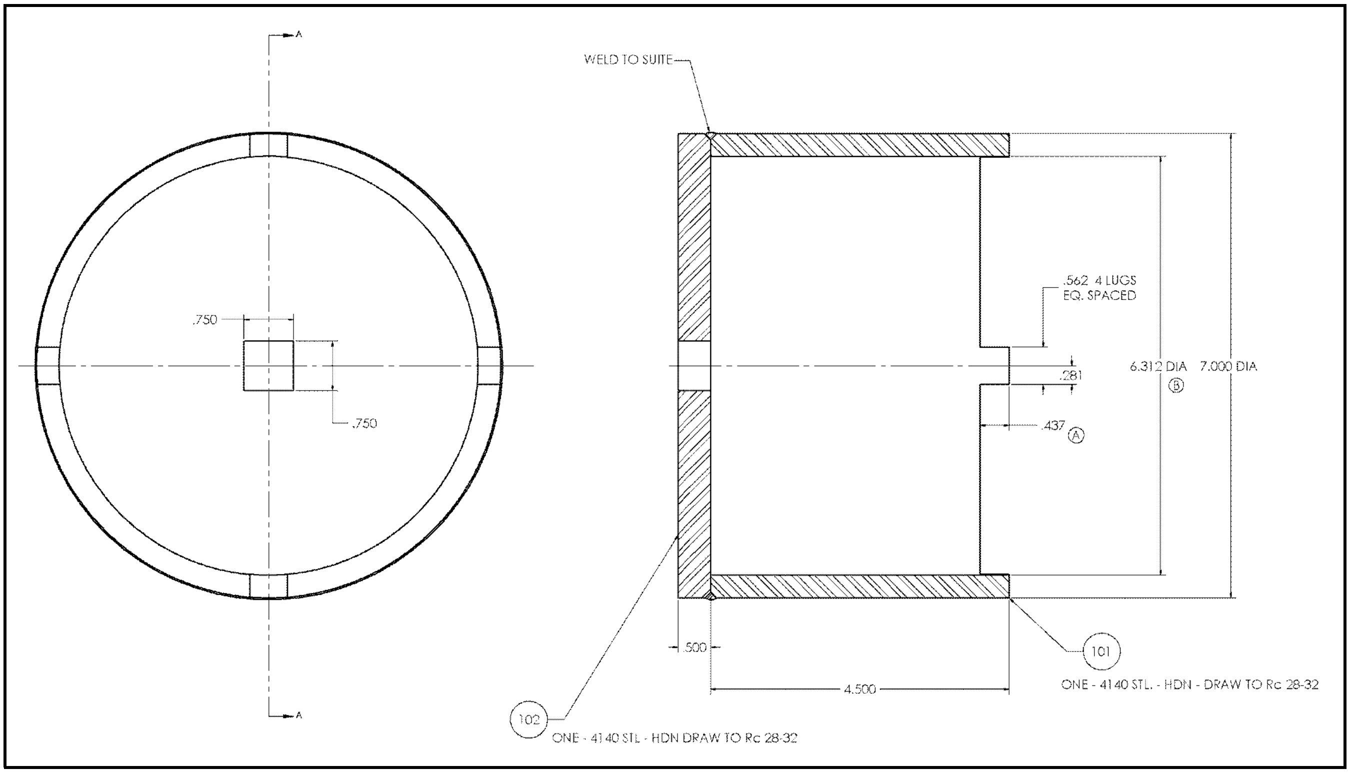


Figure 3-13. Bearing Cup Pressing Tool

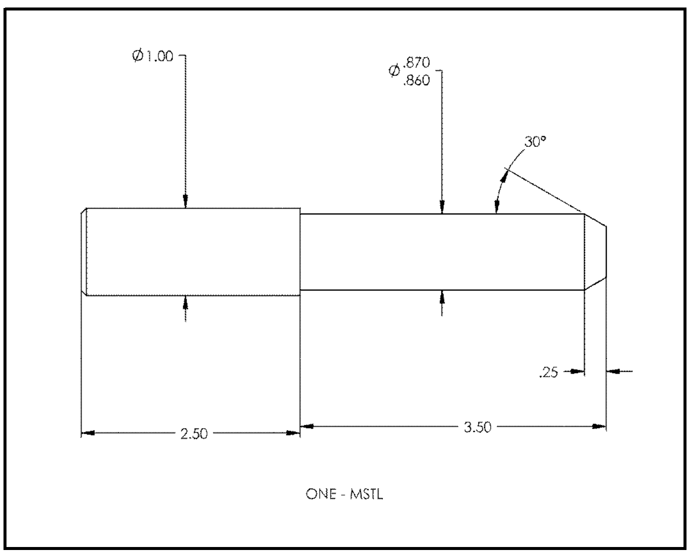


Figure 3-14. Drift Pin for Lining Up Thrust Washers with Output Planet Gear

3.3 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.

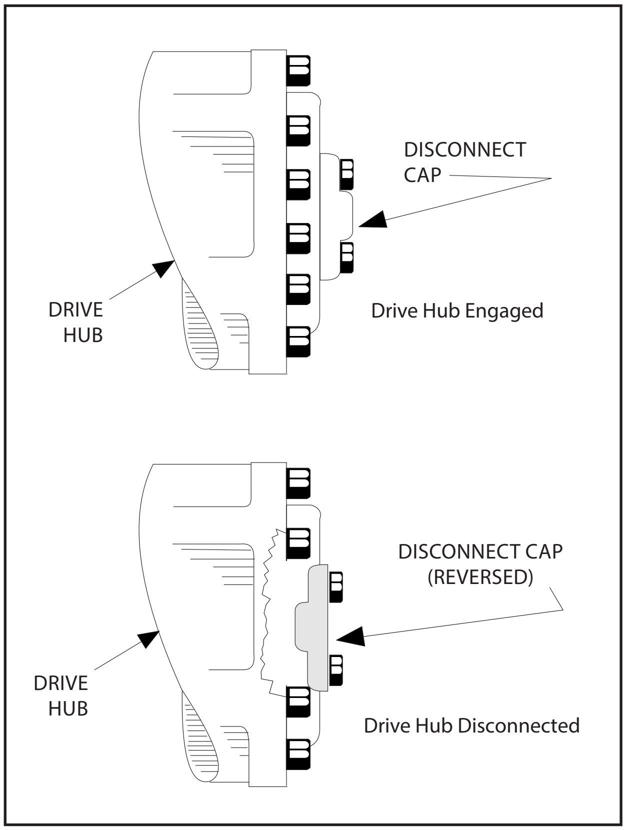


Figure 3-15. Disconnecting Drive Hubs

3.4 DRIVE MOTOR

Description

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

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

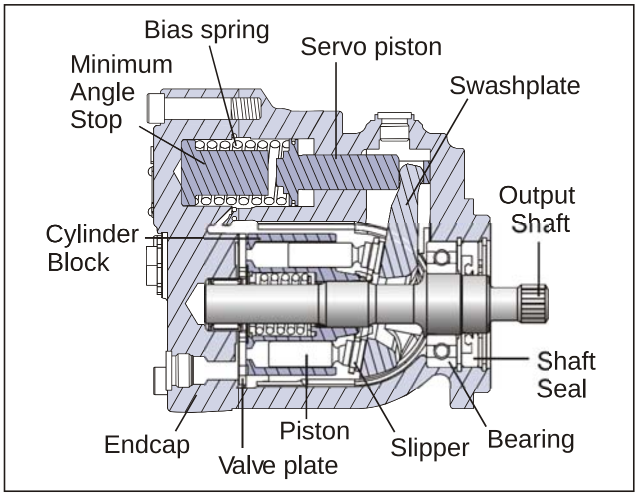
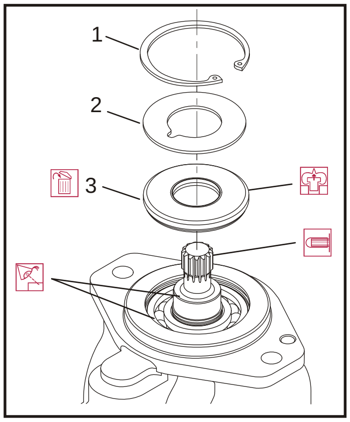


Figure 3-16. Drive Motor Cross Section

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 3-17. 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.

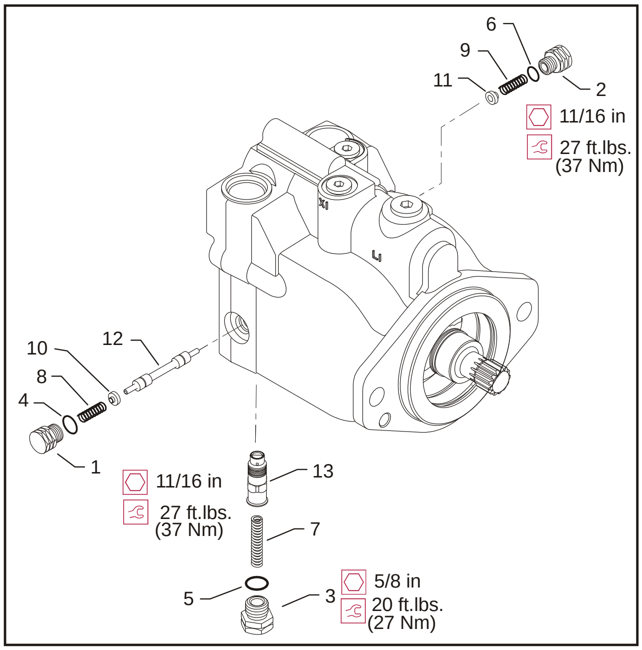
INSTALLATION

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

Figure 3-18. 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.

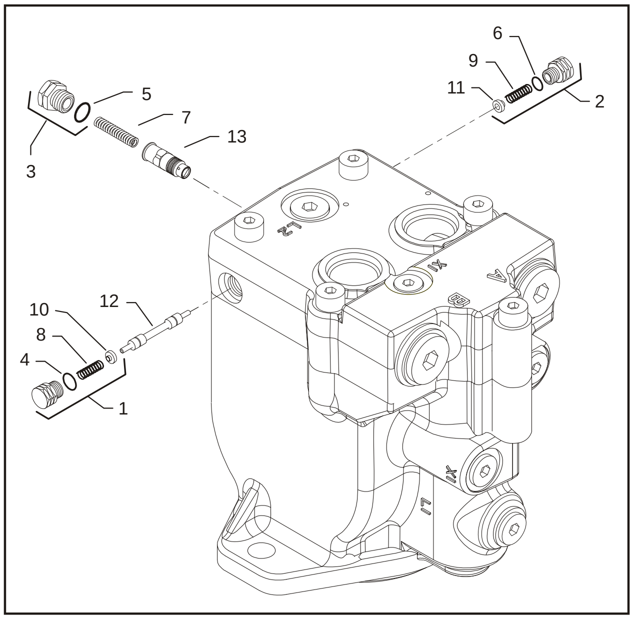
Disassembly

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.

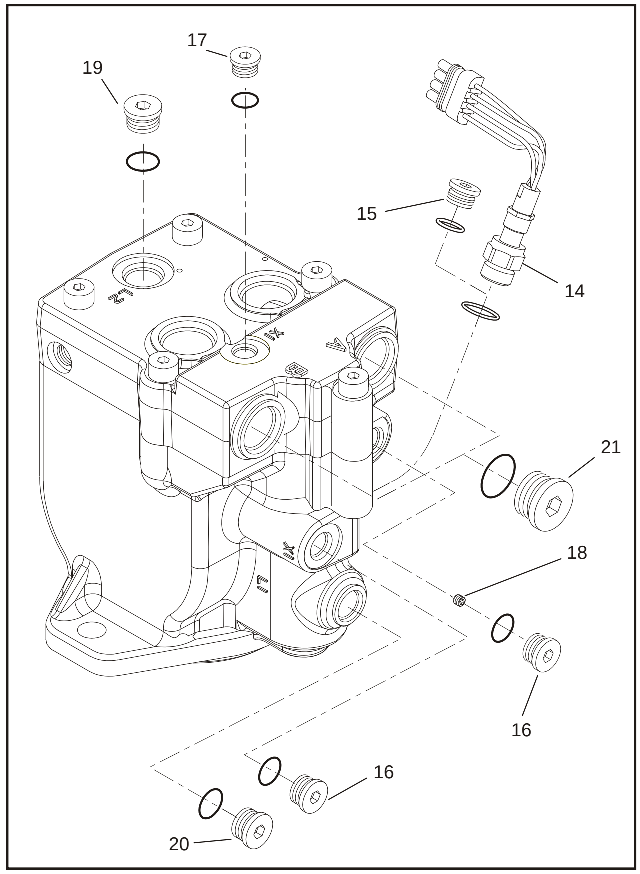
It is recommended to replace all O-rings. Lightly lubricate O-rings with clean petroleum jelly before assembly.



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 3-19. Loop Flushing Spool

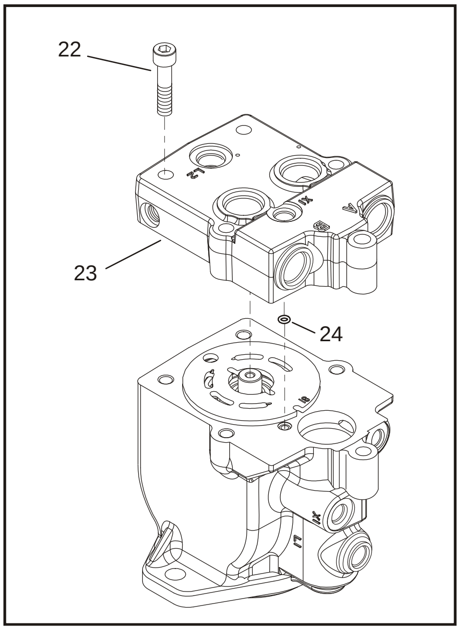
1. Using a 11/16 in wrench remove plug (1) and (2).
2. Using a 5/8 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



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 3-20. 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.

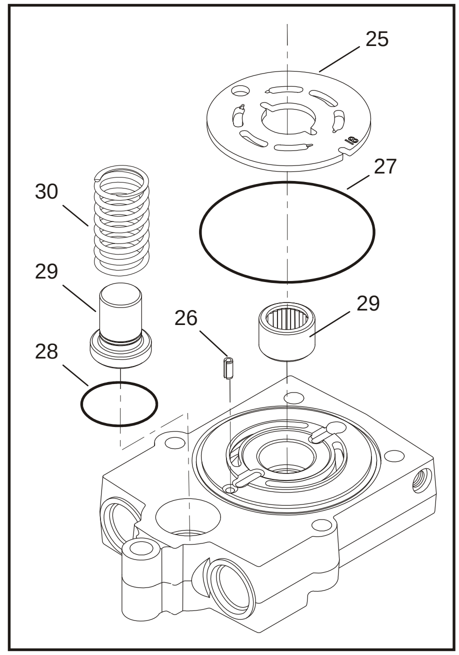


22. Screw
23. End Cap
24. O-ring

Figure 3-21. End Cap

13. Using an 8 mm internal hex wrench, remove endcap screws (22).

14. Remove endcap (23). Remove O-ring (24) from housing or endcap. When endcap screws are removed, pressure from servo spring will cause endcap to bind on shaft. Press down on portion of endcap covering servo piston and hold endcap level while removing.



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

Figure 3-22. Valve Plate & Rear Shaft Bearing

NOTICE

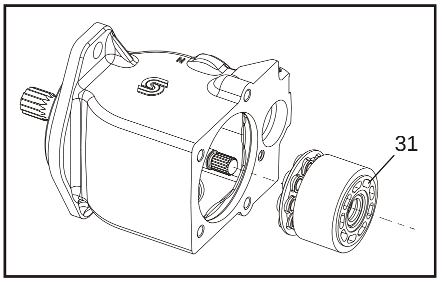
DO NOT SCRATCH VALVE PLATE SURFACE.

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 (29) and servo spring (30) from housing.



31. Cylinder Kit Assembly

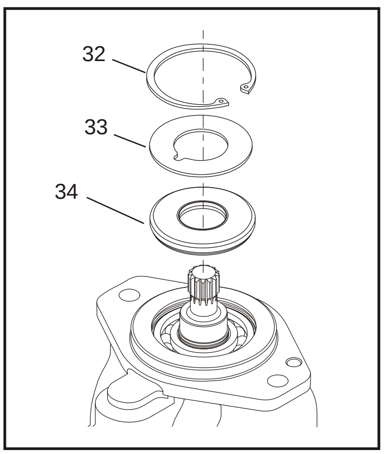
Figure 3-23. Cylinder Kit

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

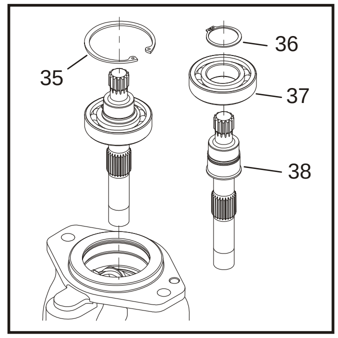
# of Grooves	Frame L	Frame K
1	25	38
2	30	45
3	35	--



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

Figure 3-24. 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.

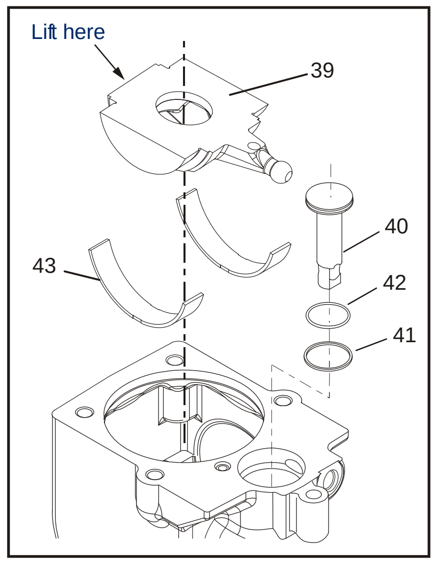


35. Inner Snap Ring
36. Snap Ring
37. Bearing
38. Shaft

Figure 3-25. 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).



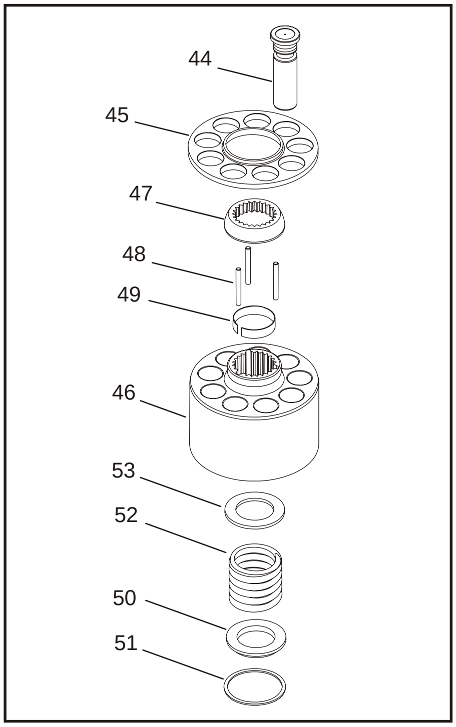
39. Swashplate
40. Servo Piston
41. Piston Seal
42. O-ring
43. Journal Bearings

Figure 3-26. 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
45. Slipper Retainer
46. Cylinder Block
47. Ball Guide
48. Holddown Pins
49. Retaining Ring
50. Block Spring Washer
51. Spiral Retaining Ring
52. Block Spring
53. Inner Block Spring Washer

Figure 3-27. 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.

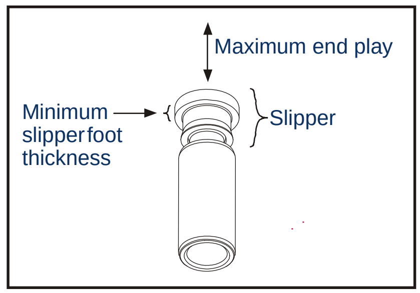
28. Turn block over. Using a press, apply pressure on block spring washer (50) to compress the block spring. Compress spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind the spiral retaining ring (51). Carefully release pressure and remove outer block spring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

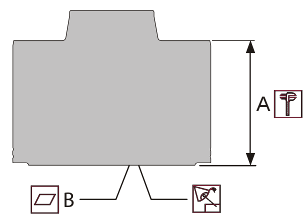
Measurement	L Frame	K Frame
Slipper Foot Thickness	2.71 mm (0.11 in.)	4.07 mm (0.16 in.)
Piston/Slipper End Play	0.15 mm (0.006 in.)	

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.

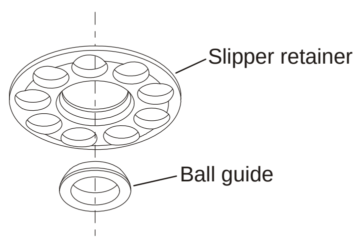
Table 3-7. Cylinder Block Measurements

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)



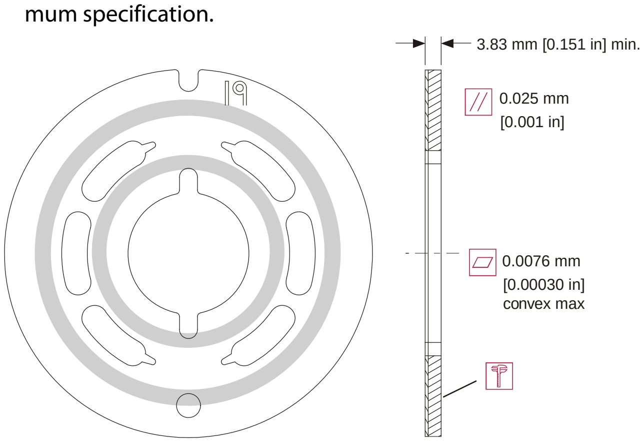
BALL GUIDE AND SLIPPER RETAINER

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.



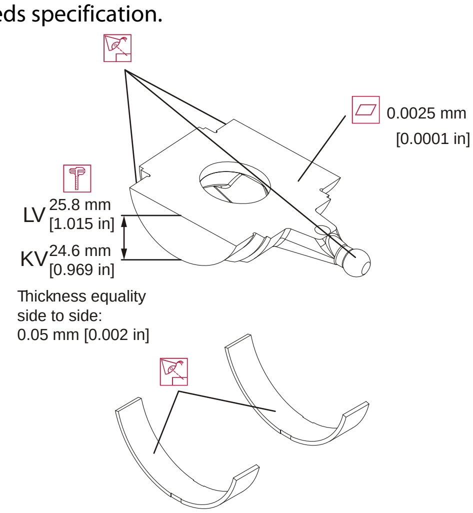
VALVE PLATE

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

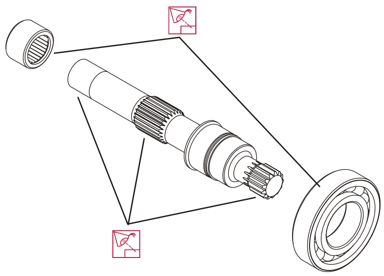
Inspect running face, servo ball-joint, and swashplate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable if surface condition meets specifications shown. Measure swashplate thickness from journals running face. Replace swashplate if damaged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

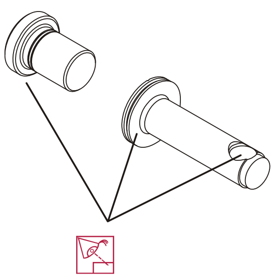


SHAFT

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.

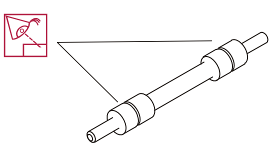
SERVO PISTON AND MINIMUM ANGLE STOP

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



LOOP FLUSHING SPOOL

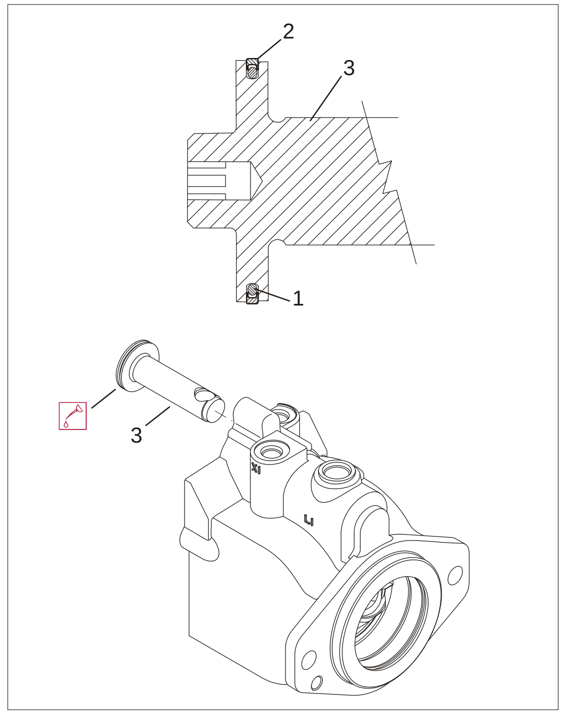
Inspect loop flushing spool for cracks or damage. Replace if necessary.



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

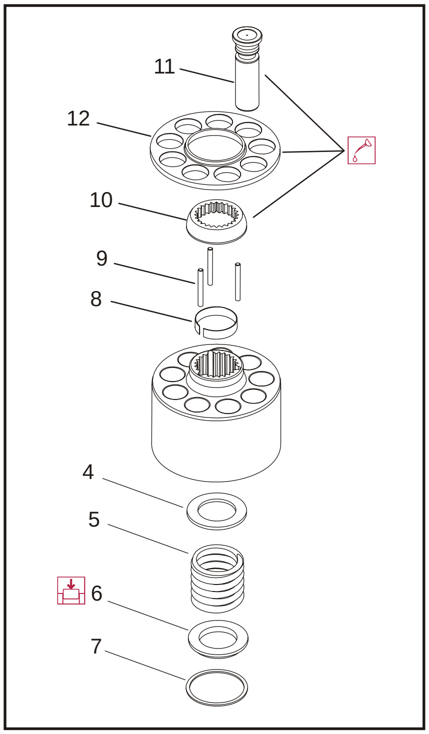
Figure 3-28. Servo Piston

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.



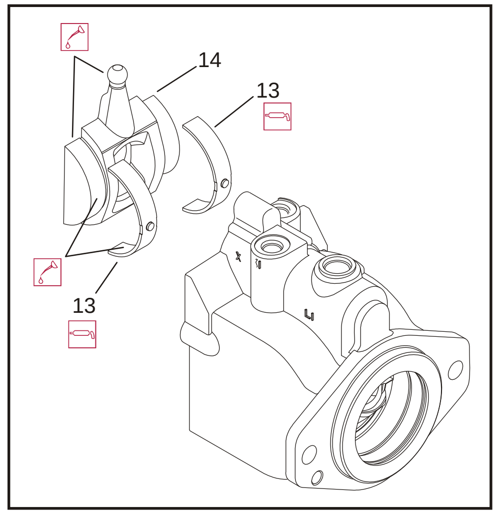
4. Block Spring Washer
5. Block Spring
6. Outer Washer
7. Spiral Retaining Ring
8. Retaining Ring
9. Holddown Pins
10. Ball Guide
11. Piston
12. Slipper Retainer

Figure 3-29. 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.

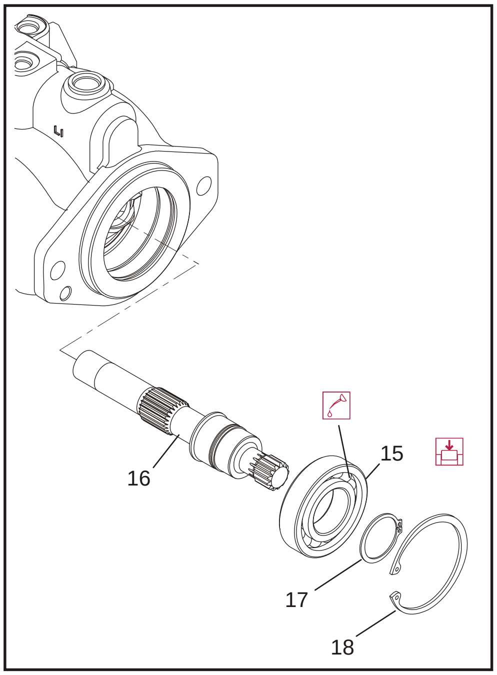


13. Journal Bearings
14. Swash Plate

Figure 3-30. 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.

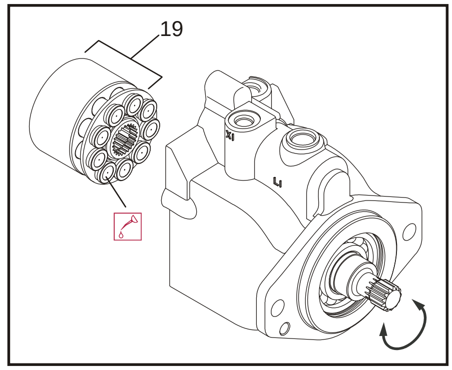


15. Front Shaft Bearing
16. Shaft
17. Snap Ring
18. Snap Ring

Figure 3-31. 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).

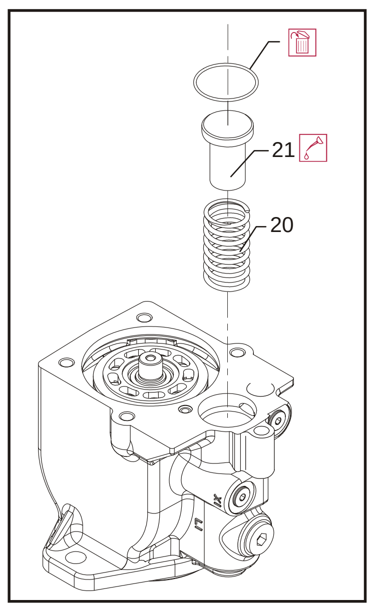
10. Verify swashplate and bearings are properly seated. Install cylinder kit (19) on shaft. Install with slippers facing swashplate. Rock the shaft to align block splines and slide cylinder kit into place. Orient motor with shaft pointing downward and verify cylinder kit, swashplate, journal bearings,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



19. Cylinder Kit

Figure 3-32. Cylinder Kit Installation

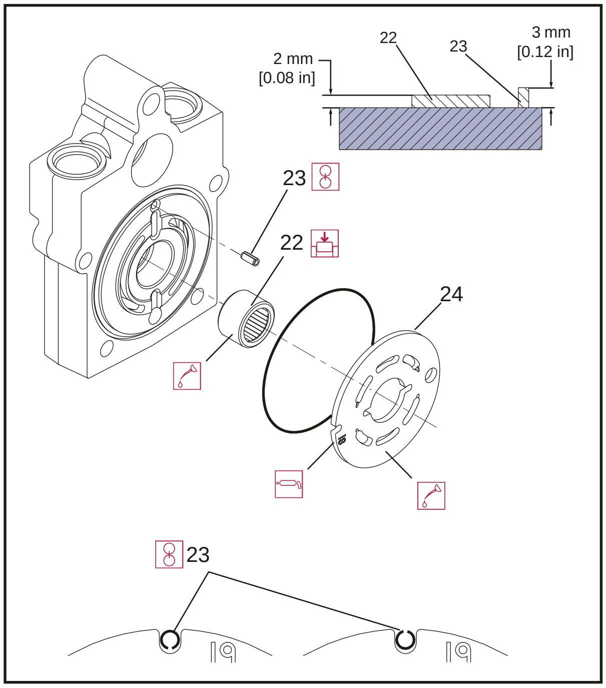
11. Lubricate and install servo spring (20) and minimum angle stop (21) in housing bore.



20. Servo Spring
21. Minimum Angle Stop

Figure 3-33. 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 ±0.01 in (2 ±0.25 mm) above endcap surface.



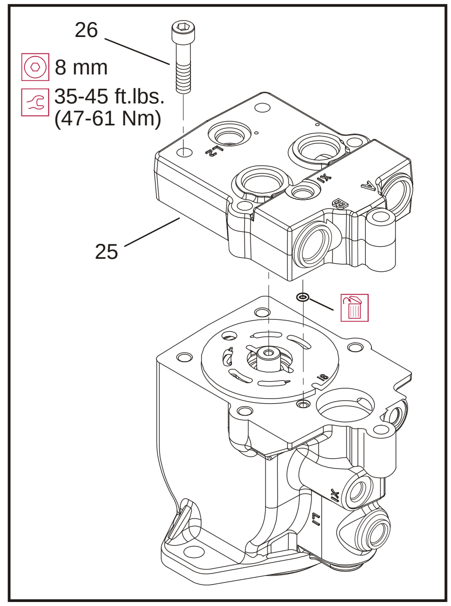
22. Rear Shaft Bearing
23. Timing Pin
24. Valve Plate

Figure 3-34. Valve Plate and Rear Bearing

13. Install timing pin (23) into its bore in the endcap. Install pin with groove facing toward or away from shaft. Press pin until end protrudes 0.12 ±0.01 in (3 ±0.25 mm) above endcap surface.

14. Install valve plate (24) on endcap. Install valve plate with yellow surface toward cylinder block. Align slot in valve plate with timing pin. Apply a liberal coat of assembly grease to endcap side of valve plate to keep it in place during installation.

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



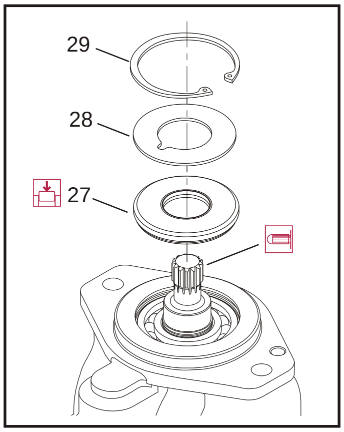
25. End Cap
26. Screw

Figure 3-35. 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 3-36. Shaft Seal

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

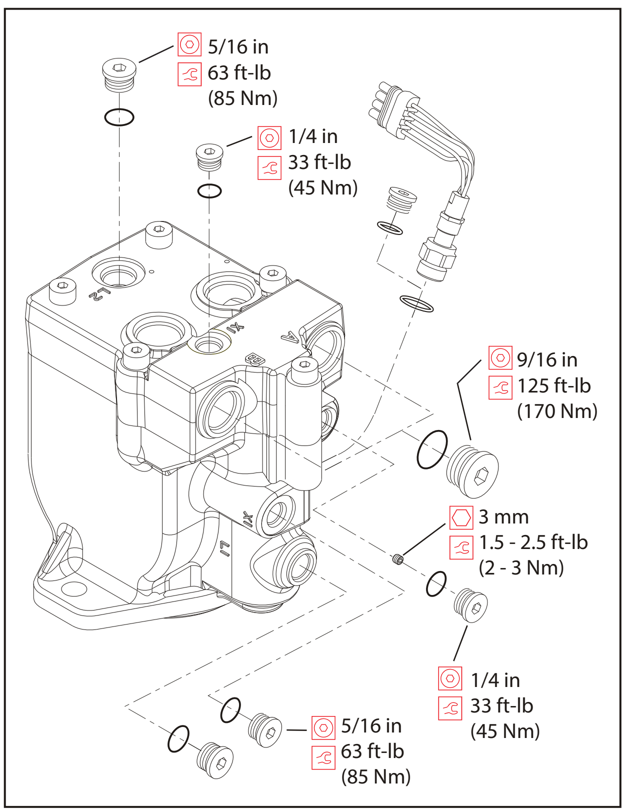
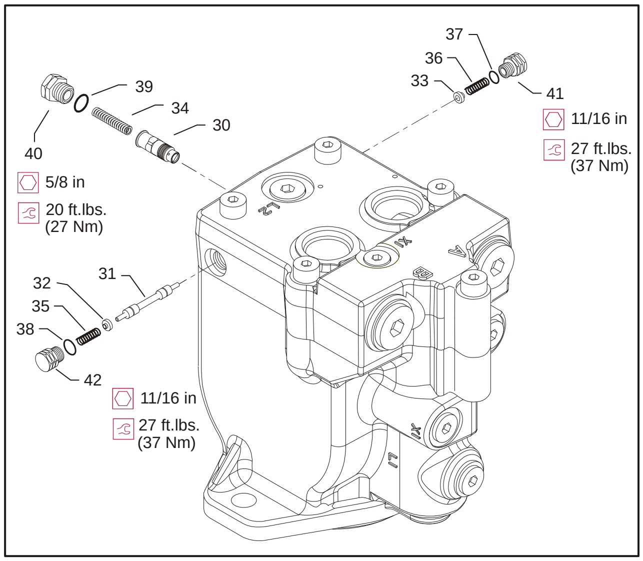


Figure 3-37. Plugs and Fittings Installation

20. Install orifice poppet (30).



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

Figure 3-38. Loop Flushing Spool

21. Install shift spool (31).

22. Install spring retaining washers on springs (32 and 33).

23. Carefully install centering springs (34, 35, and 36).

24. Install new O-rings (37, 38, and 39).

25. Using a 5/8 in wrench torque plug (40) to 20 ft-lb (27 Nm).

26. Using a 11/16 in wrench, torque plugs (41 and 42) to 27 ft-lb (37 Nm).

Initial Start-up Procedures

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

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

1. Fill reservoir with recommended hydraulic fluid. Always filter fluid through a 10 micron filter when pouring into the reservoir. Never reuse hydraulic fluid.

2. Fill inlet line leading from pump to reservoir. Check inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.

3. Fill pump and motor housing with clean hydraulic fluid. Pour filtered oil directly in upper most case drain port.

4. To ensure pump and motor stay filled with oil, install case drain lines in upper most case drain ports.
5. Install a 0 to 500 psi (0 to 35 bar) gauge in charge pressure gauge port of pump to monitor system pressure during start up.
6. 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.

3.5 OSCILLATING AXLE BLEEDING PROCEDURE AND LOCKOUT TEST

Lockout Cylinder Bleeding

NOTICE

ENSURE PLATFORM IS FULLY LOWERED AND BOOM IS CENTERED OVER REAR AXLE BEFORE STARTING BLEED PROCEDURE.

ENSURE MACHINE IS ON A LEVEL SURFACE, REAR WHEELS ARE BLOCKED, AND BRAKE WIRE IS DISCONNECTED.

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

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

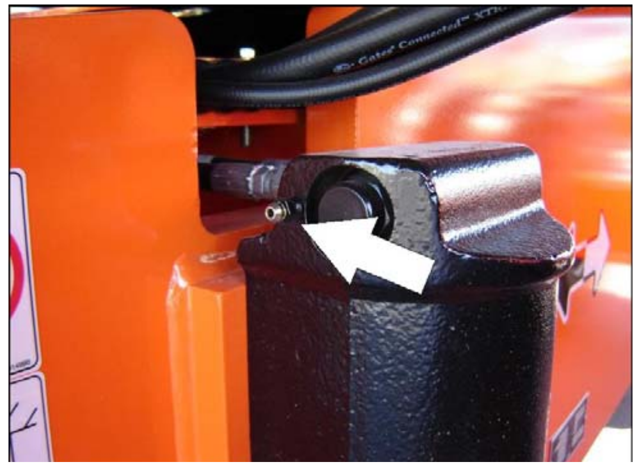


Figure 3-39. Bleeder Valve Location

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

Oscillating Axle Lockout Test

NOTICE

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

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

1. Place a 6 inch (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control station, activate machine hydraulic system.
3. Place FUNCTION SPEED CONTROL and DRIVE SPEED/TORQUE SELECT control switches to their respective LOW positions.
4. Place DRIVE control lever to FORWARD position and carefully drive machine up ascension ramp until left front wheel is on top of block.
5. Carefully activate SWING control lever and position boom over right side of machine.
6. With boom over right side of machine, place DRIVE control lever to REVERSE. Drive machine off block and ramp.
7. Have an assistant check if left front wheel remains locked in position off of ground.
8. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground. It may be necessary activate DRIVE to release cylinders.
9. Place 6 inch (15.2 cm) high block with ascension ramp in front of right front wheel.
10. Place DRIVE control lever to FORWARD and carefully drive machine up ascension ramp until right front wheel is on top of block.
11. Carefully activate SWING control lever and position boom over left side of machine.
12. With boom over left side of machine, place DRIVE control lever to REVERSE. Drive machine off block and ramp.
13. Have an assistant check if right front wheel remains locked in position off of ground.
14. Carefully activate SWING control lever and return boom to stowed position (centered between drive wheels). When boom reaches center, stowed position, lockout cylinders should release and allow wheel to rest on ground. It may be necessary activate DRIVE to release cylinders.
15. If lockout cylinders do not function properly, have qualified personnel correct malfunction before further operation.

3.6 STEER ADJUSTMENTS

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

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

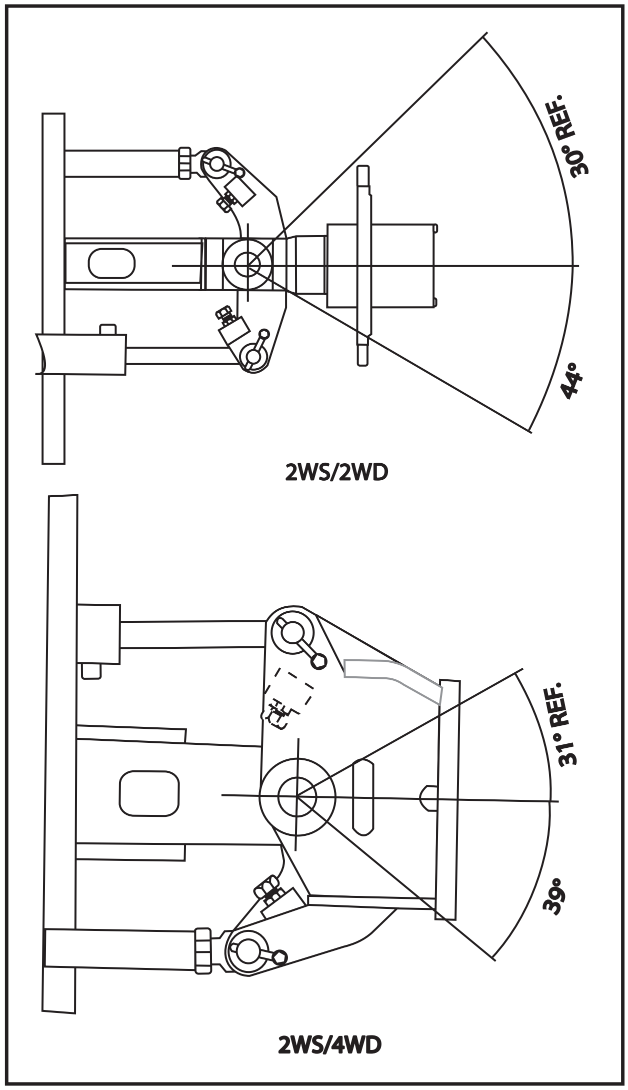
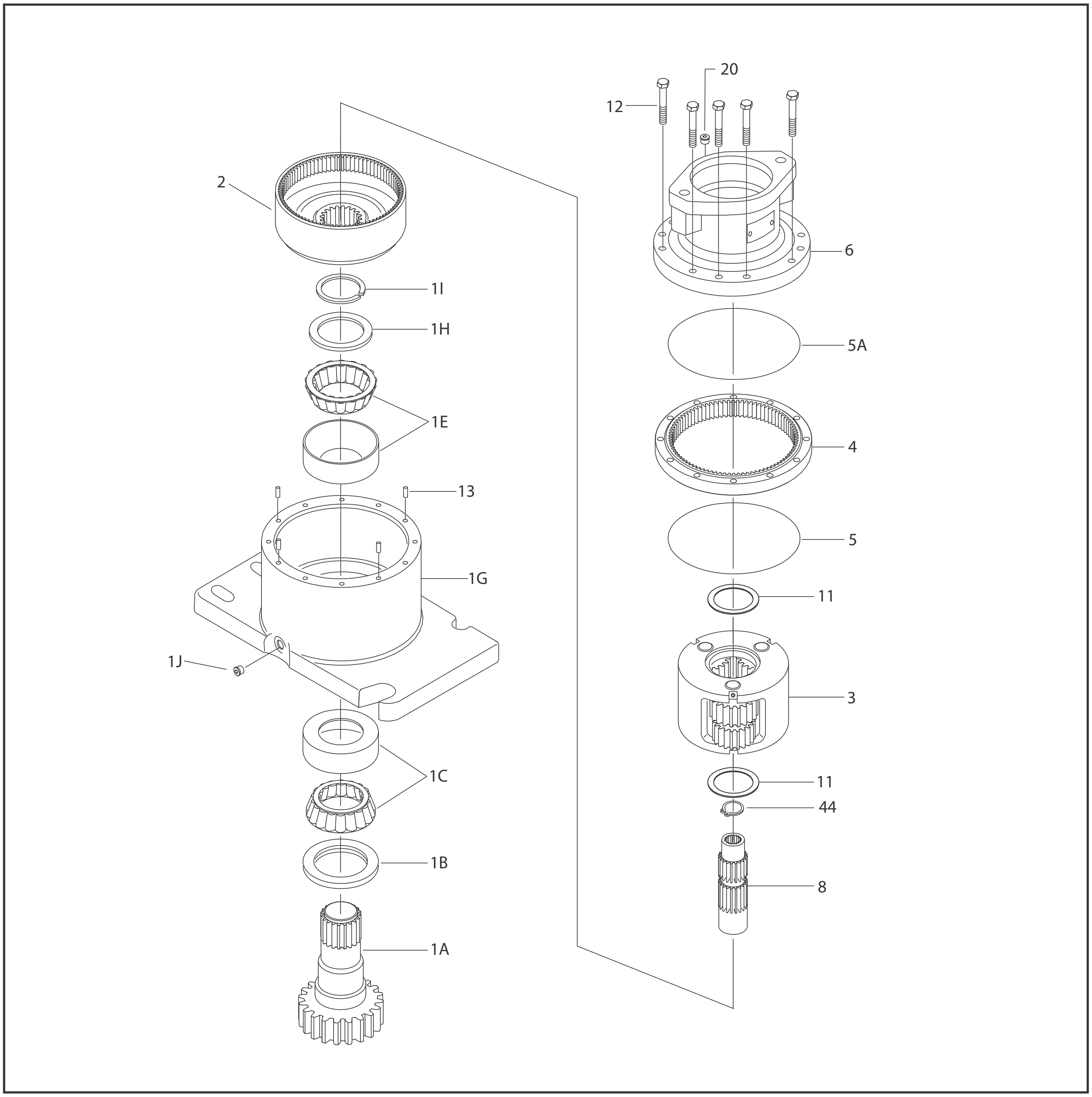


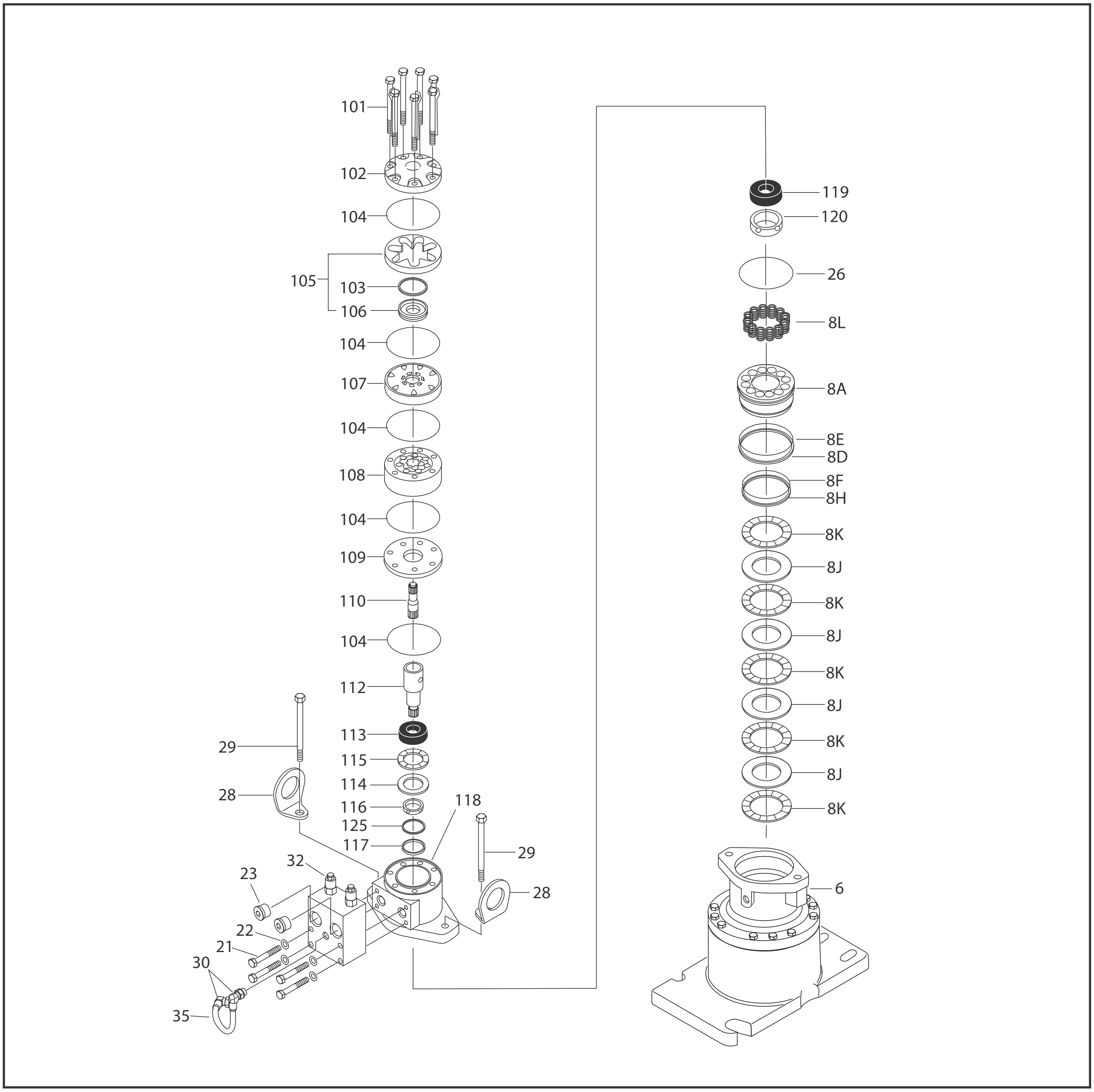
Figure 3-40. Steer Adjustments

3.7 SWING DRIVE



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

Figure 3-41. 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 3-42. Swing Motor and Brake Assembly

Gear Backlash

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

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

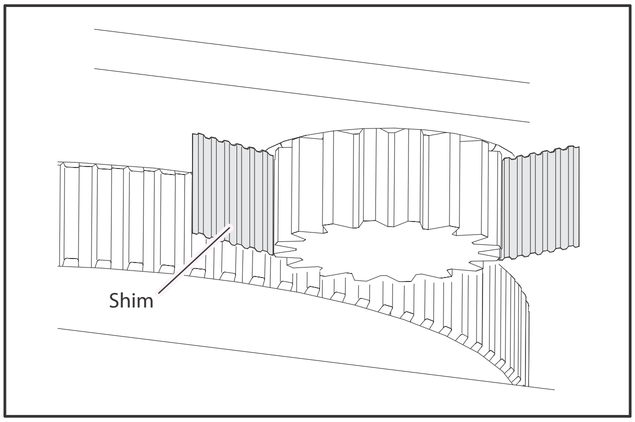


Figure 3-43. Swing Drive Shim Placement

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

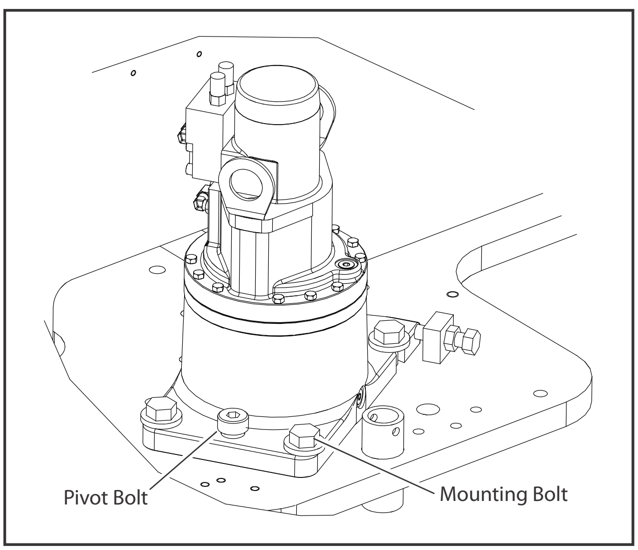


Figure 3-44. Swing Drive Pivot and Mounting Bolts

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

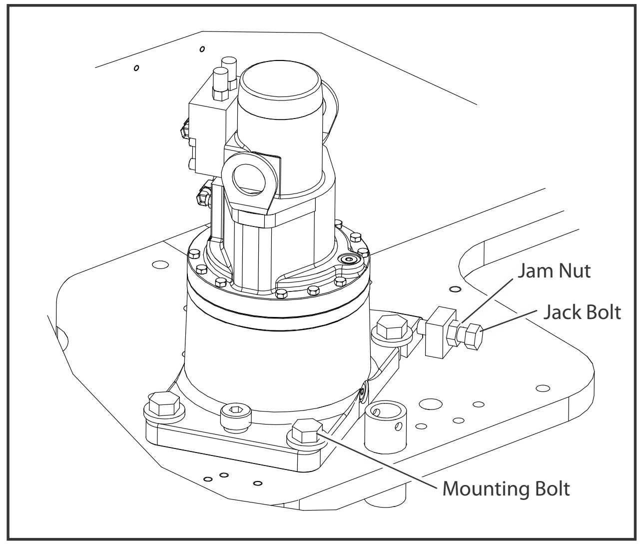


Figure 3-45. Swing Drive Jam Nut and Mounting Bolt

10. Remove and discard swing drive shim.

Swing Drive Lubrication

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

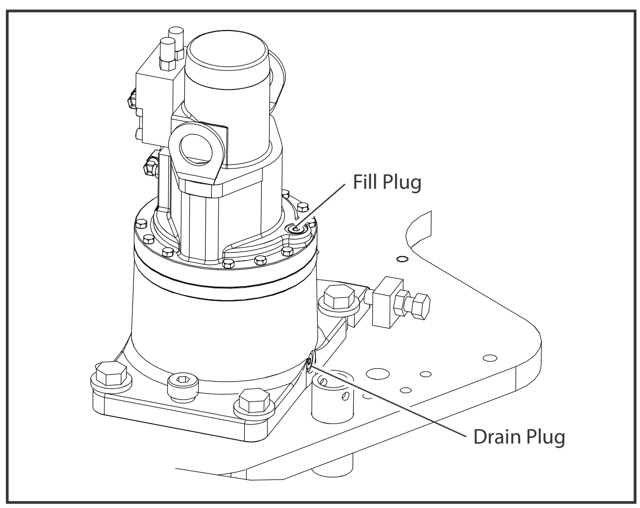


Figure 3-46. Swing Drive Lubrication

Motor Control Valve Disassembly

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

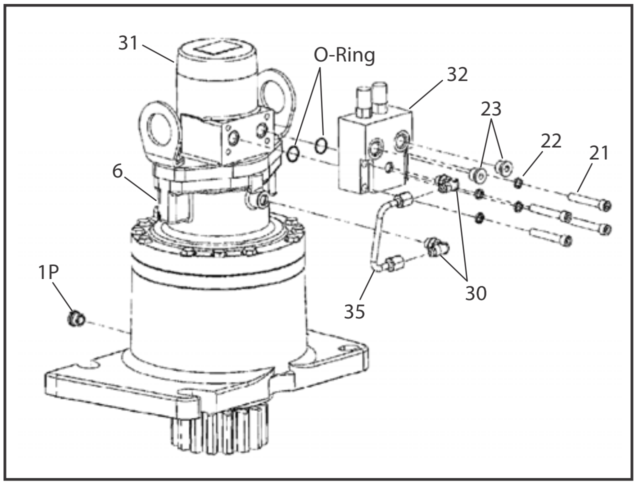


Figure 3-47. Main Control Valve Disassembly

Motor and Brake Disassembly

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

CAUTION

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

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

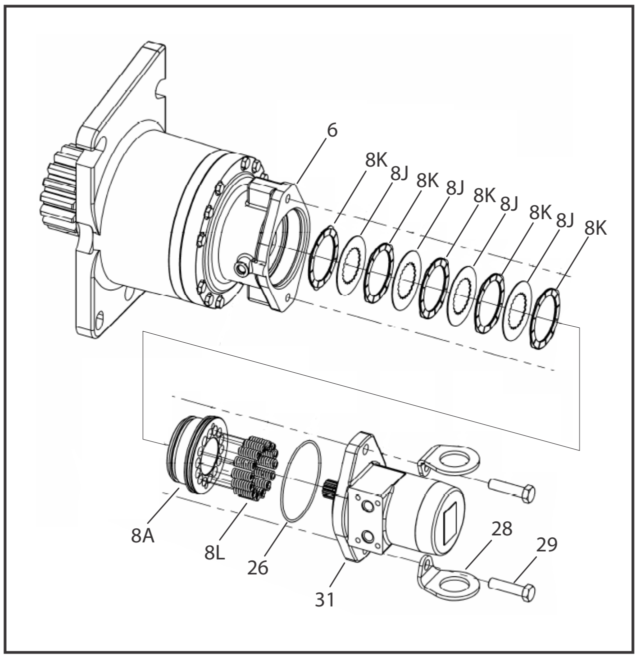


Figure 3-48. Motor and Brake Disassembly

Main Disassembly

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

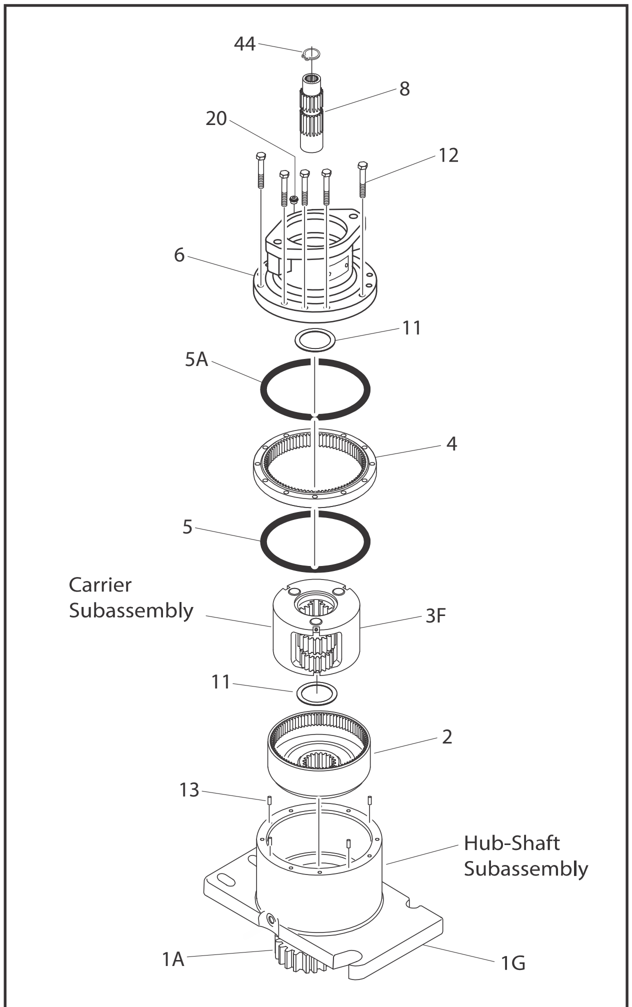


Figure 3-49. Main Disassembly

Hub-Shaft Disassembly

CAUTION

WEAR EYE PROTECTION DURING THIS PROCEDURE.

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

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

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

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

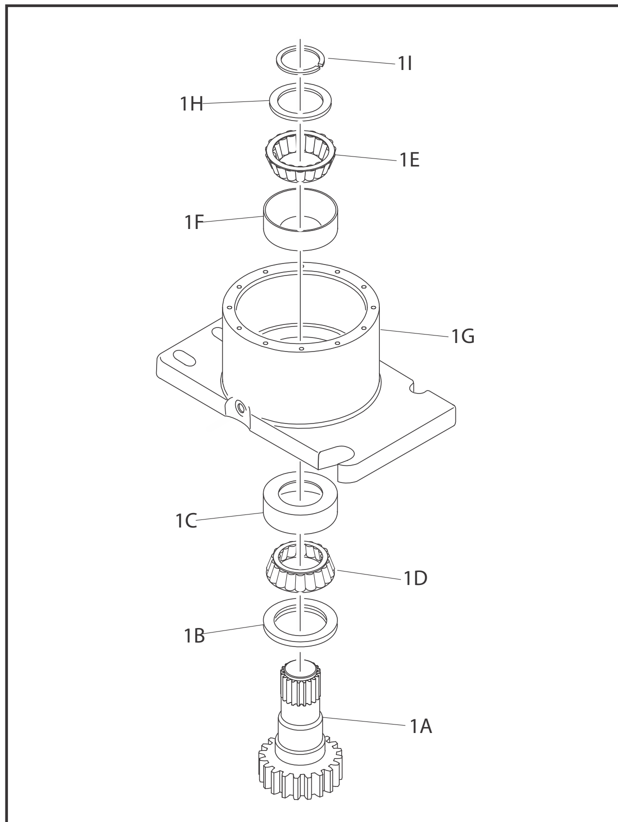


Figure 3-50. Hub-Shaft Disassembly

Carrier Disassembly

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

NOTICE

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

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

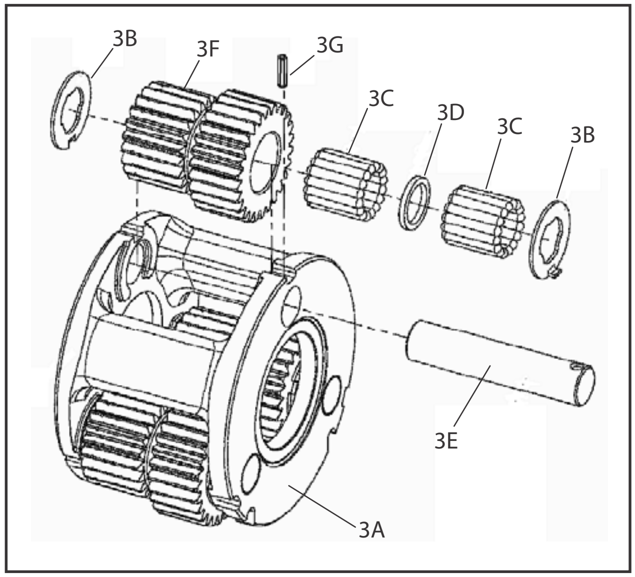


Figure 3-51. Carrier Disassembly

Hub-Shaft Subassembly

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

CAUTION

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

NOTICE

NEVER REUSE A RETAINING RING IN REBUILD OR REPAIR.

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

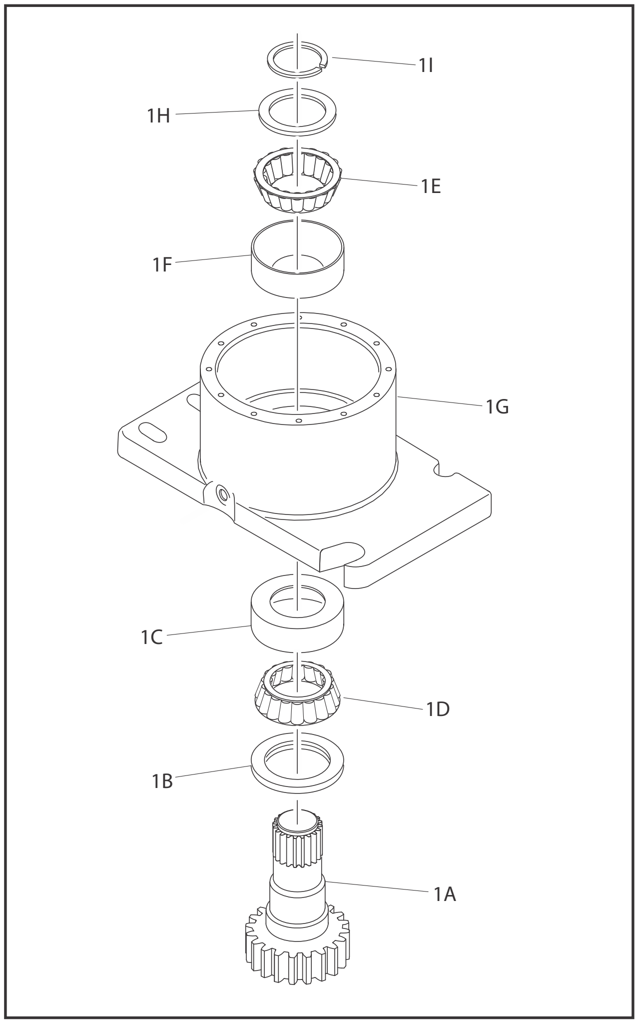


Figure 3-52. Hub-Shaft Subassembly

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

Carrier Subassembly

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

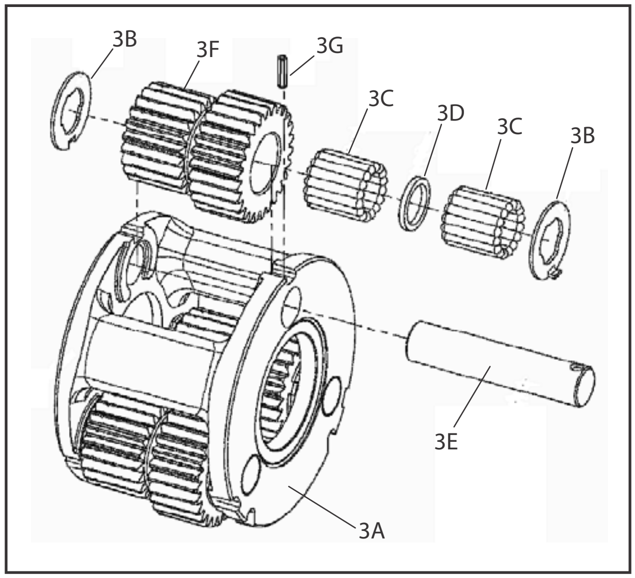


Figure 3-53. Carrier Subassembly

Main Assembly

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

CAUTION

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

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

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

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

CAUTION

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

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

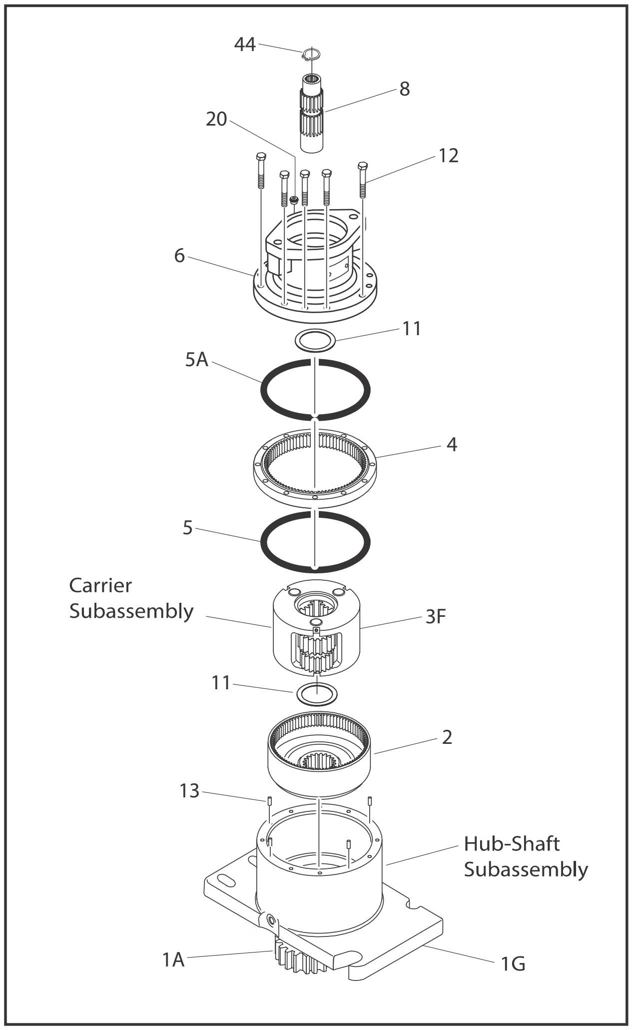


Figure 3-54. Main Assembly

Motor and Brake Assembly

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

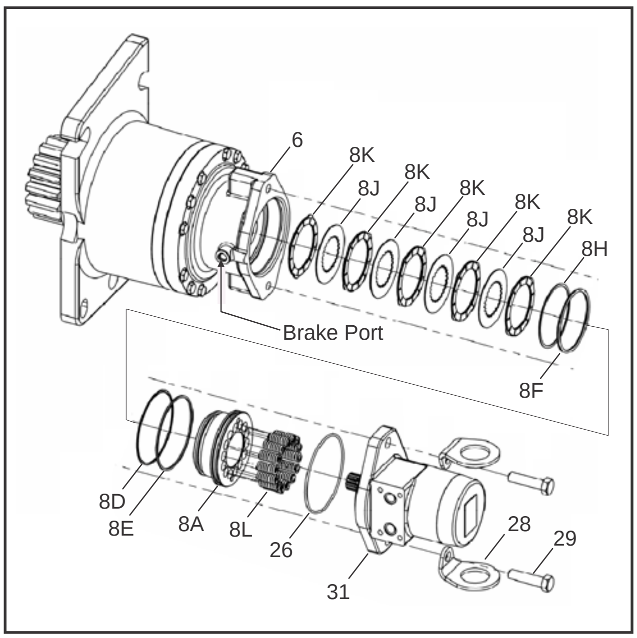


Figure 3-55. Motor and Brake Assembly

Motor Control Valve Assembly

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

NOTE: *Align holes in control valve with motor ports.*

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

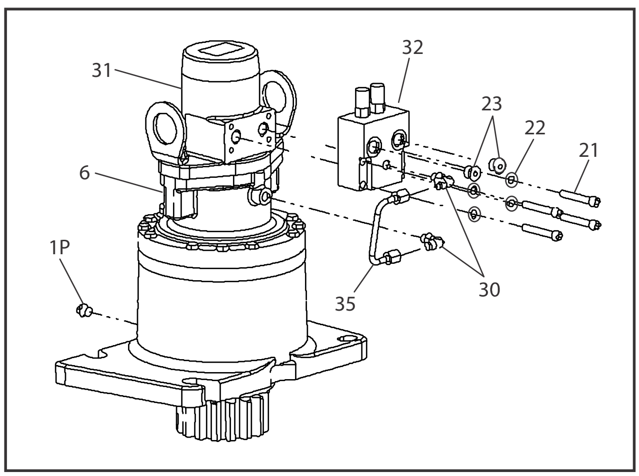


Figure 3-56. Motor Control Valve Assembly

3.8 SWING BEARING

Turntable Bearing Mounting Bolt Condition Check

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

1. Check frame to bearing. Attach bolts as follows:
   - **a.** Elevate fully retracted main boom to full elevation.
   - **b.** Try and insert a 0.0015" feeler gauge between bolt head and hardened washer at position shown in Figure 3-57.
   - **c.** Make sure 0.0015" feeler gauge will not fit under bolt head to bolt shank.
   - **d.** Swing turntable 90° and check some selected bolts at new position.
   - **e.** Continue rotating turntable at 90° intervals until a sampling of bolts are checked in all quadrants.
2. Check turntable to bearing. Attach bolts as follows:
   - **a.** Elevate fully retracted tower boom to full elevation.
   - **b.** try and insert a 0.0015" feeler gauge between bolt head and hardened washer at positions shown in Figure 3-57.
   - **c.** Lower main boom to horizontal.
   - **d.** Try and insert the 0.0015" feeler gauge between bolt head and hardened washer at position shown in Figure 3-57.

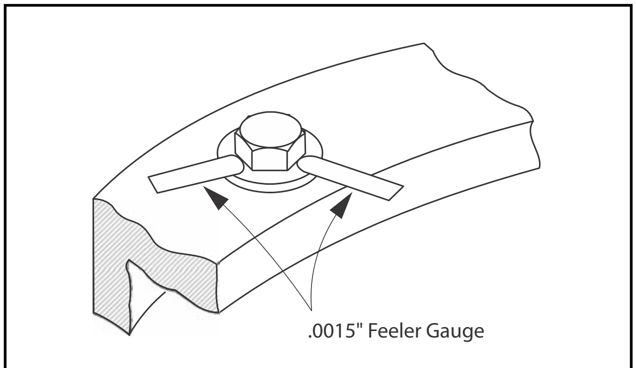


Figure 3-57. Swing Bearing Bolt Feeler Gauge Check

Wear Tolerance

⚠ WARNING

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

1. From underside of machine, at rear center, with main boom fully elevated and fully retracted, as shown in Figure 3-59., 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 3-58., Swing Bearing Tolerance Measuring Point.
2. At the same point, with main boom horizontal and tower boom fully elevated as shown in - Swing Bearing Tolerance Boom Placement A, using a magnetic base dial indicator, measure and record distance between swing bearing and turntable as shown in Figure 3-58., Swing Bearing Tolerance Measuring Point.
3. If difference is greater than 0.079 in. (2.00 mm), replace swing bearing.
4. If difference is less than 0.079 in. (2.00 mm) and any of the following conditions exist:
   - **a.** Metal particles in grease.
   - **b.** Increased drive power required.
   - **c.** Noise.
   - **d.** Rough rotation.
5. Remove, disassemble, and inspect bearing. If bearing inspection shows no defects, reassemble and return to service.

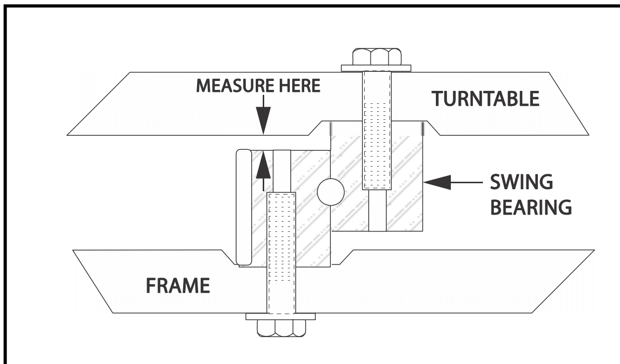


Figure 3-58. Swing Bearing Tolerance Measuring Point

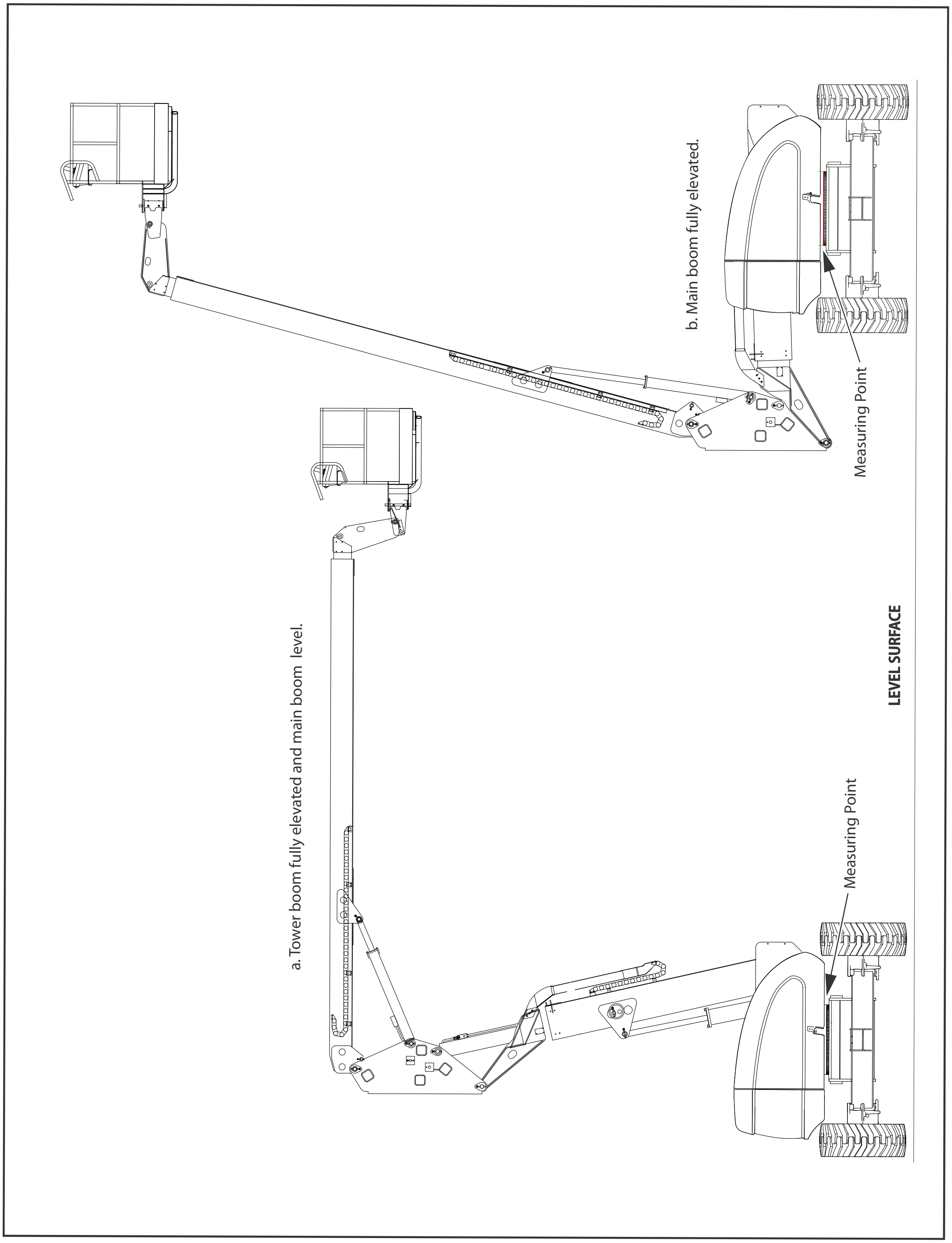


Figure 3-59. Swing Bearing Tolerance Measurement Location & Boom Placement

Swing Bearing Replacement

REMOVAL

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

WARNING

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

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

NOTICE

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

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

INSTALLATION

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

CAUTION

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

2. Apply a light coating of Loctite #271 to new bearing bolts, and loosely install bolts and washers through 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 Torque Sequence diagram as shown in Figure 3-60., Swing Bearing Torque Sequence. Clean residue off new bearing bolts, then apply a light coating of Loctite #271 and install bolts and washers through frame and outer bearing race. Torque bolts to 190 ft-lb (258 Nm). Remove lifting equipment from bearing.
4. Using suitable lifting equipment, carefully position turntable assembly above machine frame.

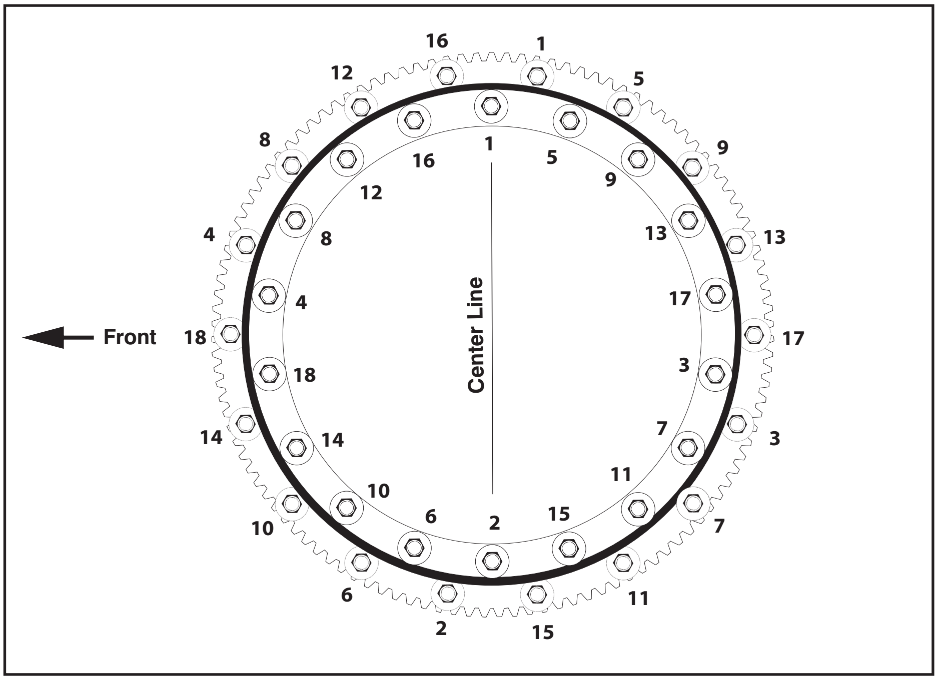


Figure 3-60. Swing Bearing Torque Sequence

a. Carefully lower turntable onto swing bearing. Ensure scribed line of inner bearing race aligns with scribed line on turntable. If a new swing bearing is used, ensure filler plug fitting is 90° fore and aft center line of turntable.

b. Clean residue off new bearing bolts, then apply a light coating of Loctite #271. Install bolts and washers through turntable and bearing inner race.

c. Following Torque Sequence diagram shown in Figure 3-60., Swing Bearing Torque Sequence, torque bolts to 190 ft-lb (258 Nm) w/Loctite.

d. Remove lifting equipment.

e. Install rotary coupling retaining yoke brackets. Apply a light coating of Loctite #242 to attaching bolts and secure yoke to turntable with mounting hardware.

f. Connect hydraulic lines to rotary coupling as tagged prior to removal.

g. At ground control station, use boom lift control to lower boom to stowed position.

h. Using all applicable safety precautions, activate hydraulic system and check swing system for proper and safe operation.

Swing Bearing Torque Values

1. Outer Race - 190 ft-lb (258 Nm) w/Loctite.
2. Inner Race - 190 ft-lb (258 Nm) w/Loctite.
3. See Figure 3-60. 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.

3.9 SWING BRAKE - MICO

Disassembly

1. With shaft protrusion downward, remove end cover (13) by removing capscrews (12).

CAUTION

END COVER IS UNDER SPRING TENSION OF APPROXIMATELY 2000 POUNDS (681 KG). THE FOUR CAPSCREWS SHOULD BE LOOSENED EVENLY TO RELIEVE THIS FORCE. IF A HYDRAULIC PRESS IS AVAILABLE (3000 LBS (1362 KG) MAXIMUM), COVER CAN BE HELD IN POSITION WHILE REMOVING CAPSCREWS AND LOCKWASHERS.

2. Remove case seal (11) from housing (7) then remove bleeder screw (14) from end cover (52).
3. Remove piston (22) from end cover (13).
4. Remove O-ring (17), back-up ring (16), O-ring (19) and back-up ring (18) from piston (22).
5. Remove separators (10) from housing (52).
6. Remove stack assembly consisting of discs (21), return plate (8), and friction discs (20) from housing (52).
7. Remove dowel pins (15), springs (5 & 6) from housing (52).
8. Remove retaining ring (3) from housing (52).
9. Remove shaft by pressing or using a soft mallet on male end of shaft (51).
10. Remove retaining ring (54) bearing (2) from shaft (51).
11. Press rotary seal (1) from housing (51).

Inspection

1. Clean all parts thoroughly.
2. Closely inspect all parts for excessive wear, cracks and chips. Replace parts as necessary.
3. Discard seals and O-rings.
4. Closely inspect bearings and bearing contact surfaces. Replace as necessary.

NOTE: *Bearings may be reused after thorough inspection if they are in good condition.*

Assembly

NOTE: *Lubricate all seals and O-rings with clean hydraulic oil prior to assembly.*

1. Press new rotary seal (1) into housing (52). Note direction of seal.
2. Install new bearing (2) on shaft (51).
3. Install shaft assembly and retaining ring (3) into housing (52).
4. Install dowel pins (15), spring retainer (55), and springs (5 & 6) into housing (52).

NOTE: *Use same number of springs and spring pattern as recorded during disassembly.*

5. Position new large diameter return plate (8) in housing with tabs guided by dowel pins (15) until disc rests on springs (5 & 6).

NOTE: *Discs (21 & 8) and friction discs (20) should remain dry during installation. Oil will contaminate disc surfaces.*

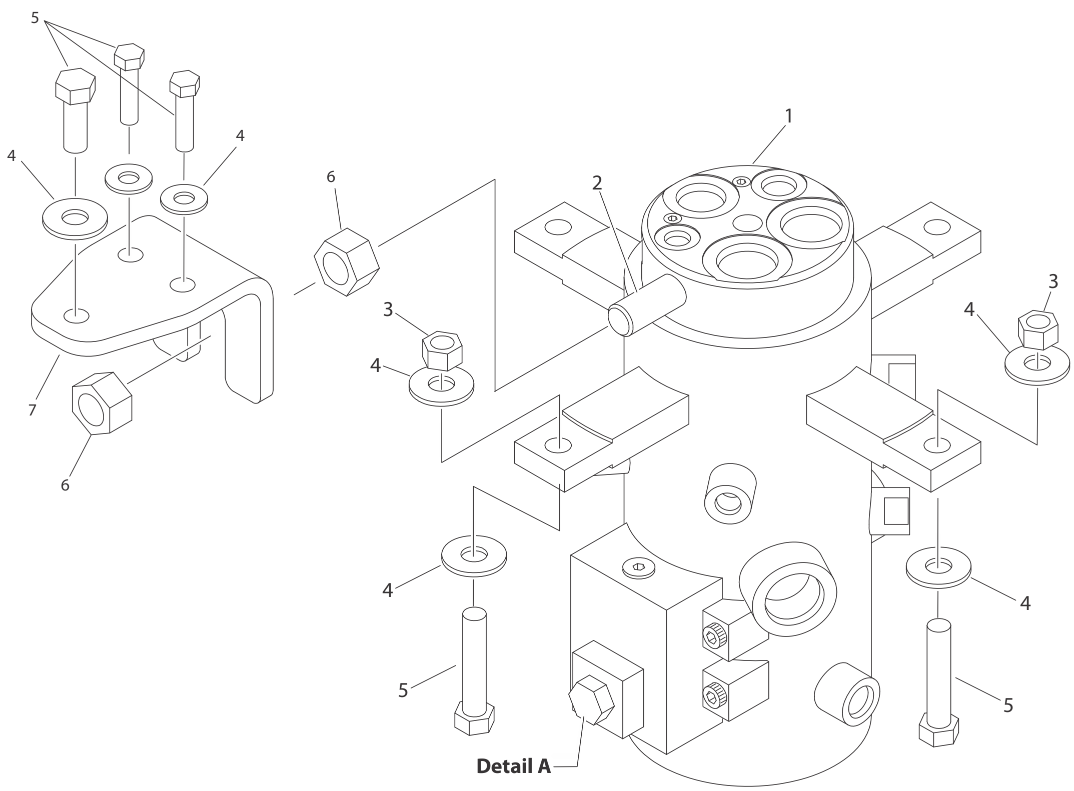
6. Place new disc (20) on shaft (51) until it contacts return plate (8).
7. Add additional discs (21) as required to complete assembly.
8. Insert separators (10) in holes of return plate (8).
9. Install new O-ring (17), new back-up ring (16), new O-ring (19) and new back-up ring (18) on piston (22). Insert piston (22) into end cover (13). Do not shear O-rings or back-up rings.
10. Install new case seal (11) in housing (52). Install bleeder screw (14) in end cover.
11. Position end cover (13) on housing (52). Align dowel pins (15) with holes in end cover.
12. Insert capscrews (12) and tighten evenly to draw end cover (13) to housing (52). Torque capscrews to 55 ft-lb (75 Nm).

3.10 ROTARY COUPLING

Use the following procedure to install the seal kit.

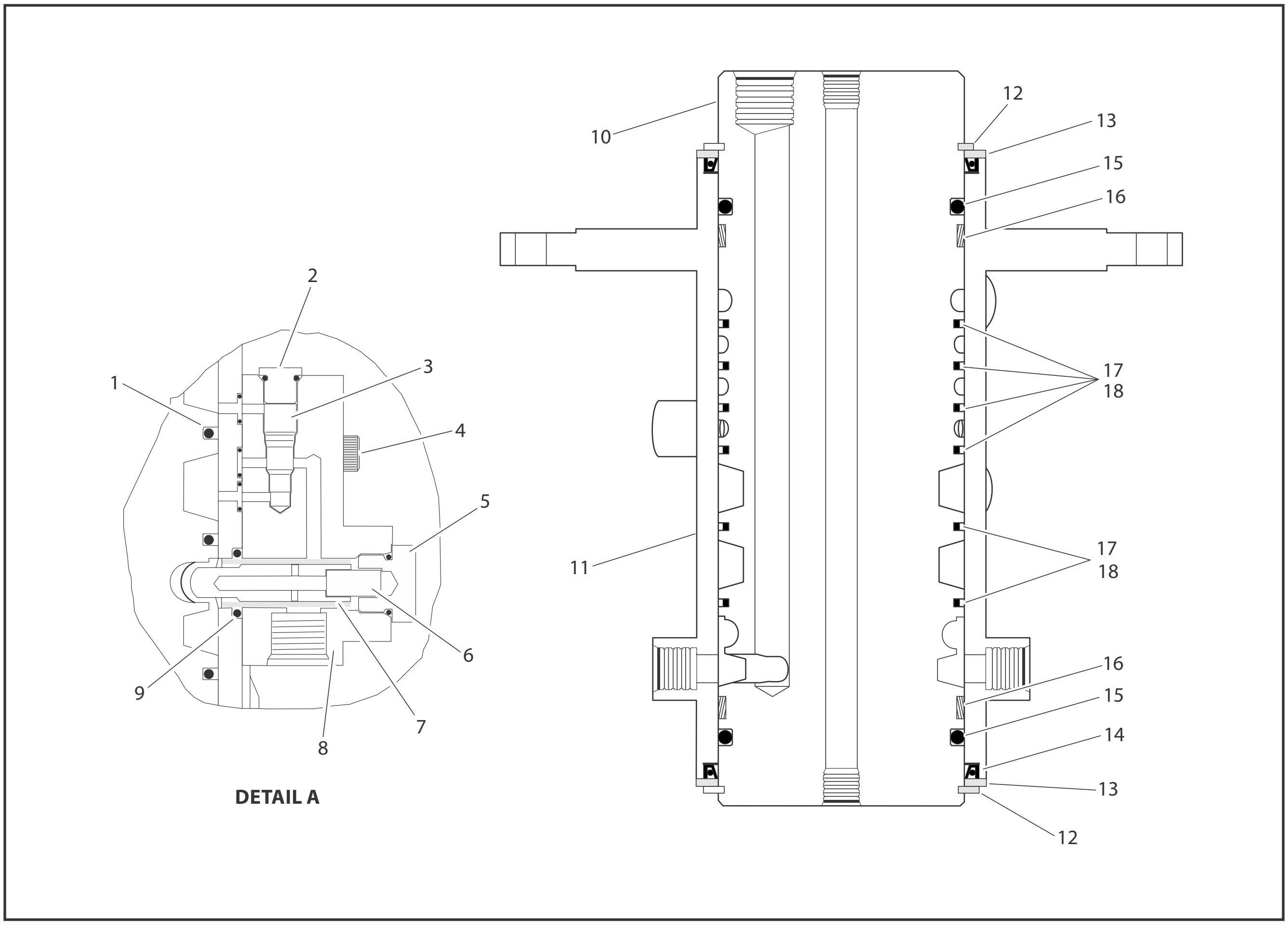
NOTE: *Step 1 applies to machines S/N 75606 to Present.*

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 3-62., 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
2. Torque Lug
3. Locknut
4. Flatwasher
5. Bolt
6. Nut
7. Bracket

Figure 3-61. Rotary Coupling - Sheet 1 of 2



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 3-62. Rotary Coupling - Sheet 2 of 2

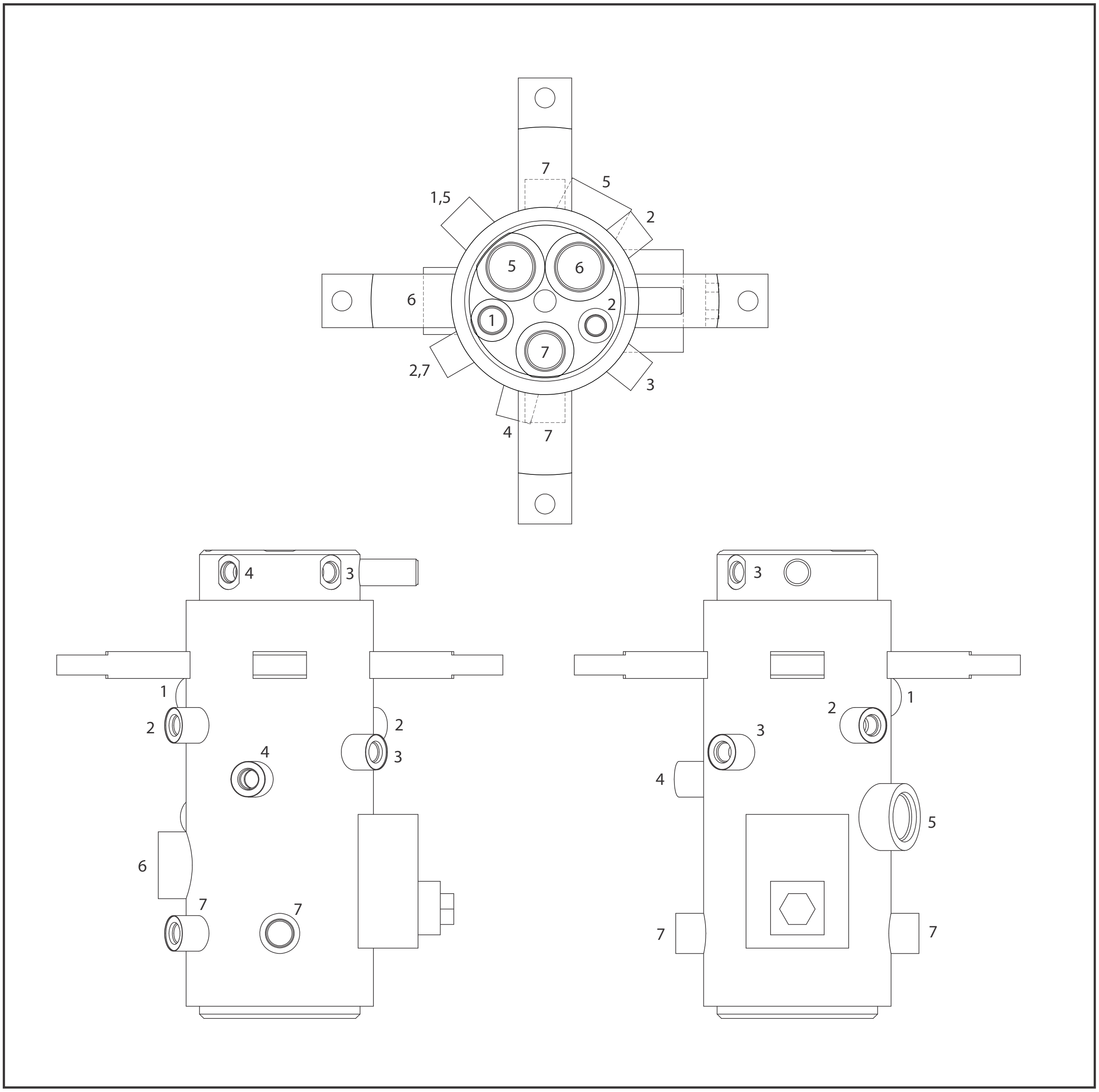


Figure 3-63. Rotary Coupling Port Location - 2WS

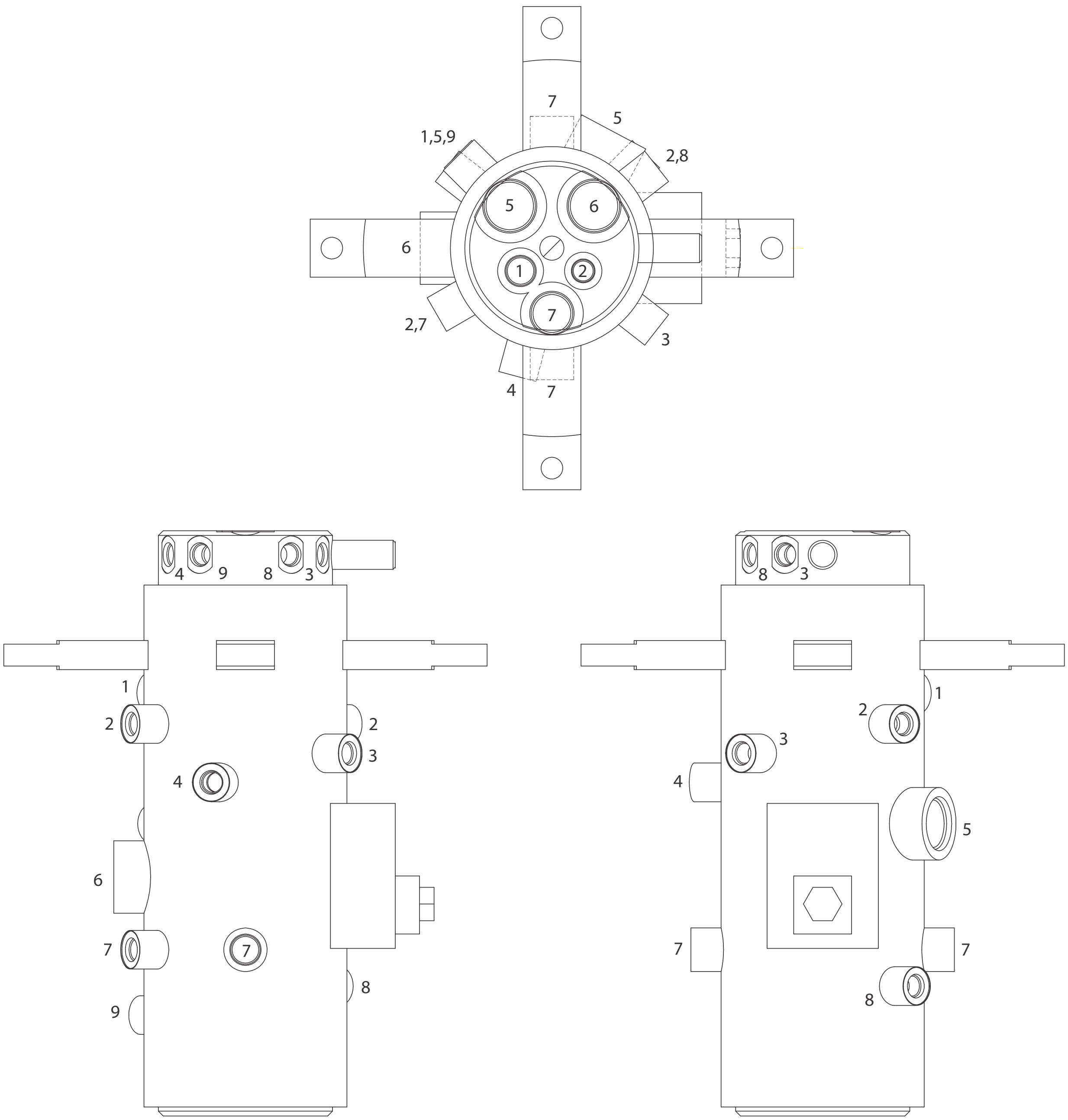


Figure 3-64. Rotary Coupling Port Location - 4WS

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

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

3.11 GENERATOR

Every 250 hours

Check drive belt tension every 250 hours of operation,.

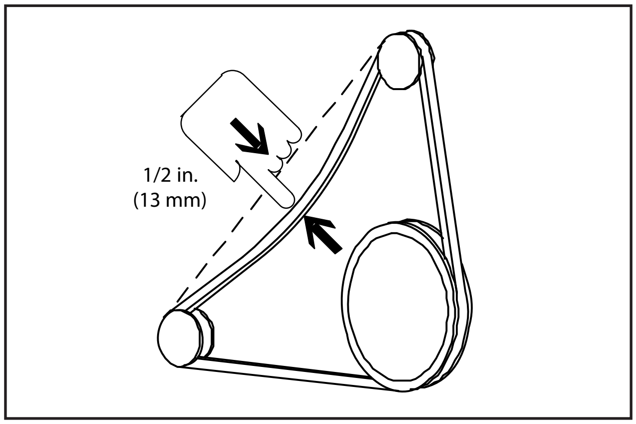


Figure 3-65. Generator Belt Tension

Every 500 hours

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

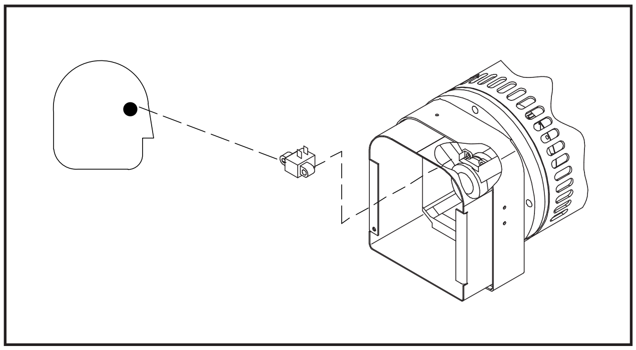


Figure 3-66. Generator Brushes and Slip Rings

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

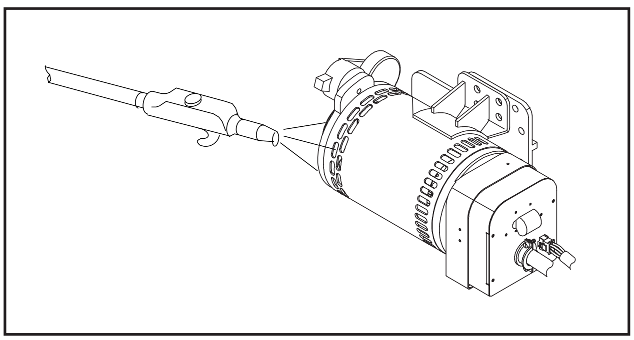


Figure 3-67. Blow Out Generator

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.

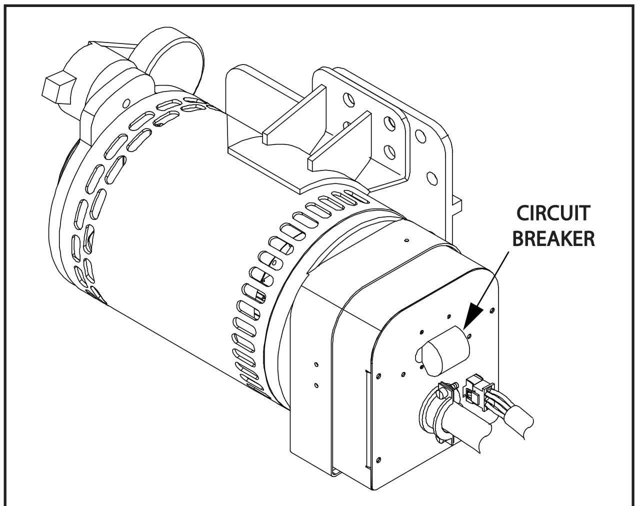


Figure 3-68. Generator Circuit Breaker Location

Inspecting Brushes, Replacing Brushes, and Cleaning Slip Rings

Refer to Figure 3-69., 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.

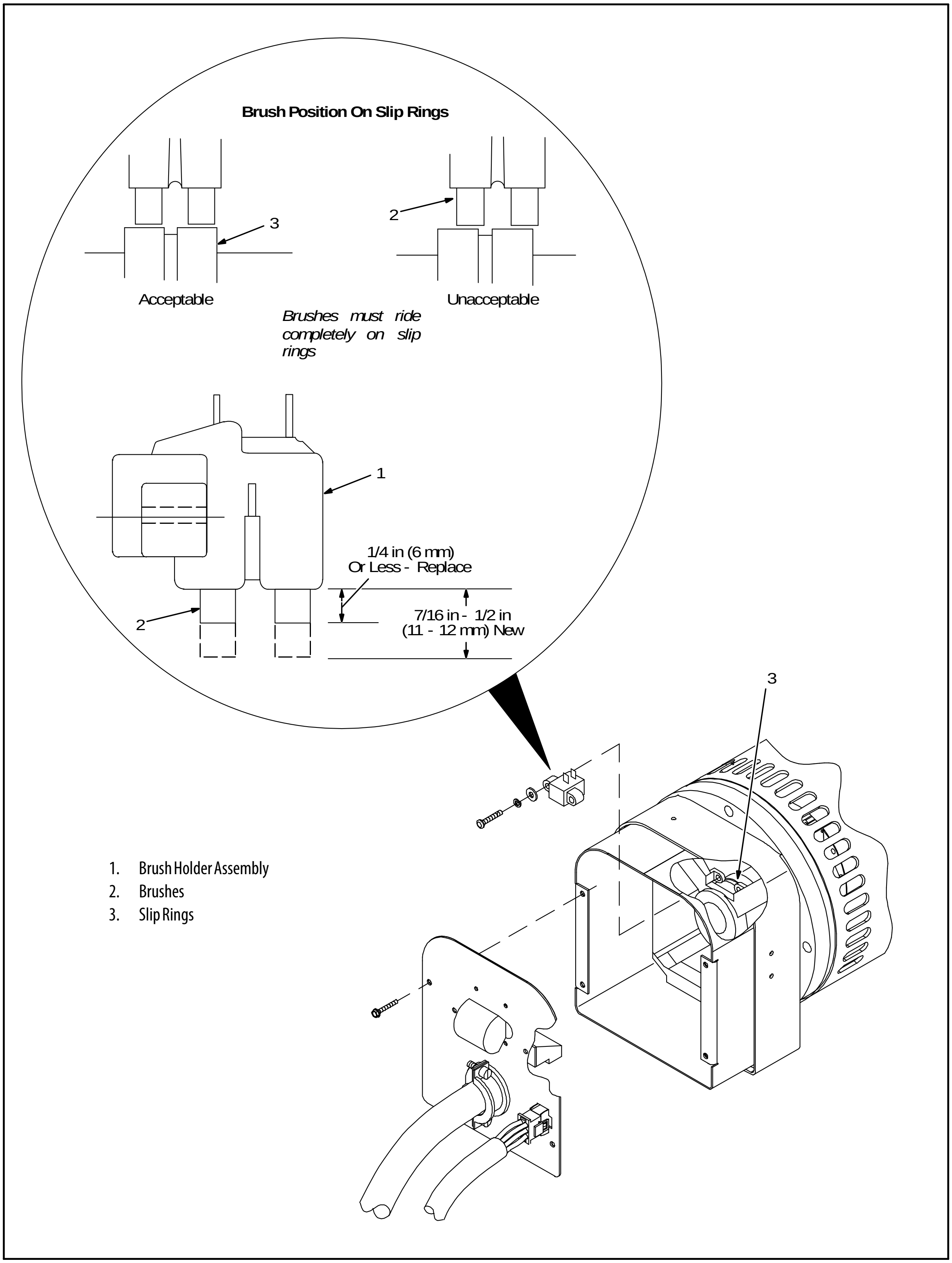
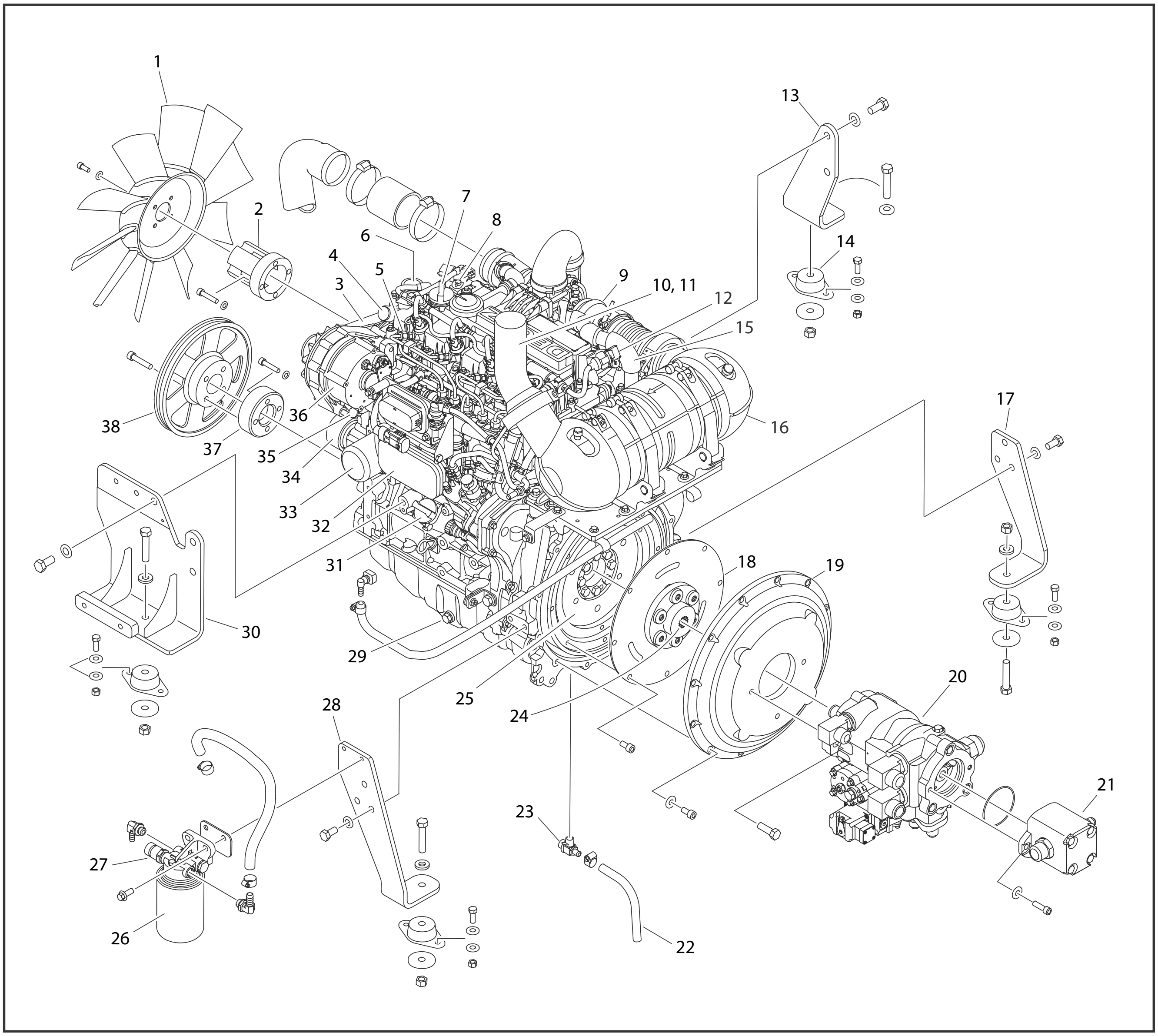


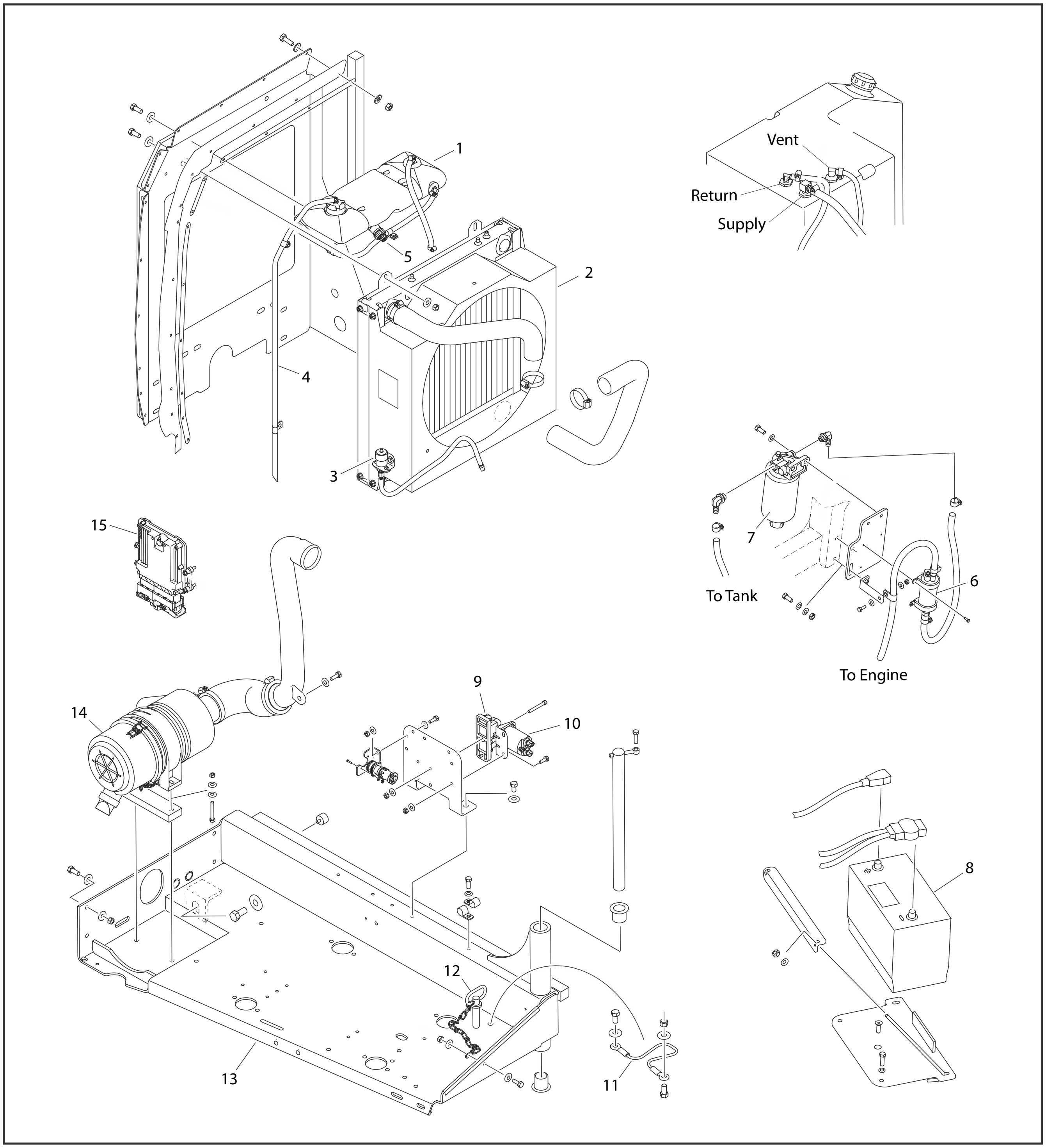
Figure 3-69. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

3.12 DEUTZ D2.9 L4 ENGINE



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

Figure 3-70. Deutz D2.9 L4 Engine Installation - Sheet 1 of 2



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 3-71. Deutz D2.9 L4 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.

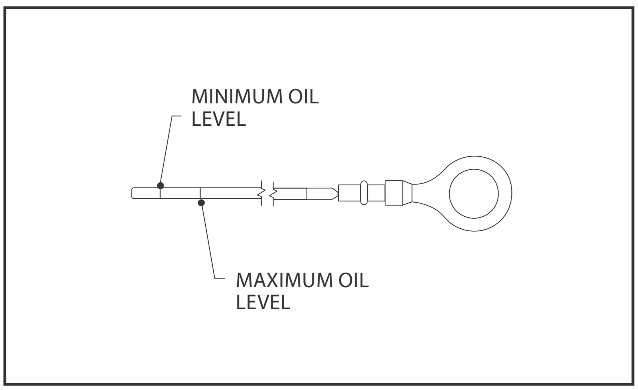


Figure 3-72. Deutz 2.9 T4F Dipstick Markings

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 3-77., Engine Oil Viscosity.

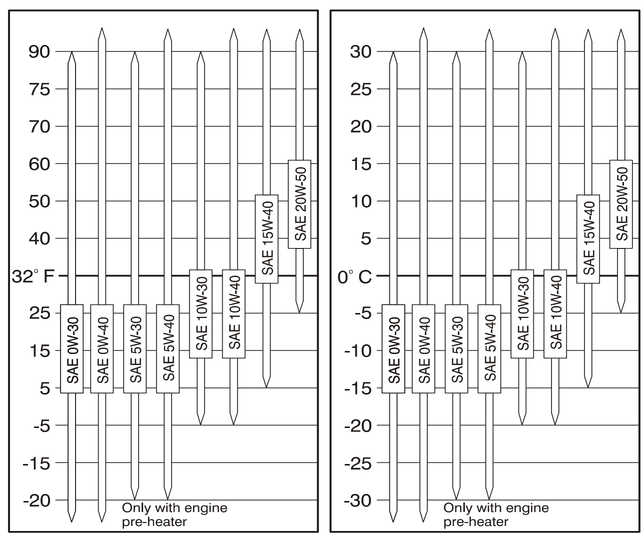
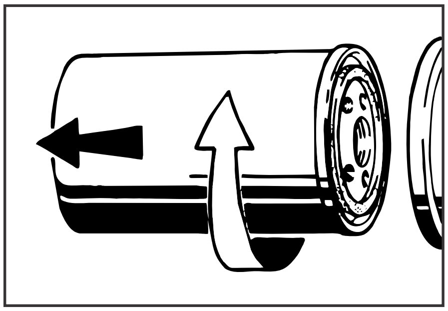


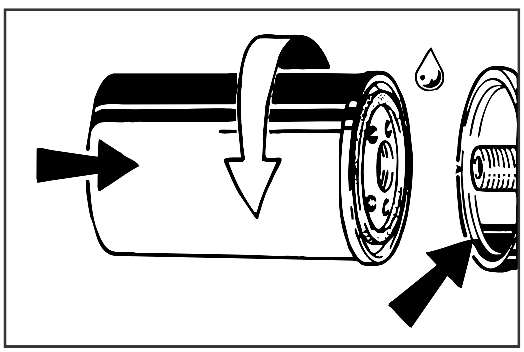
Figure 3-73. Engine Oil Viscosity

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.



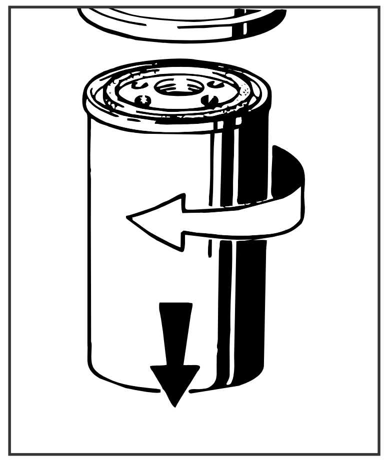
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

Change Fuel Filters

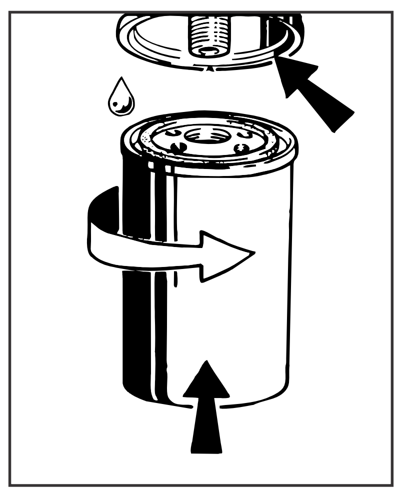
WARNING

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.

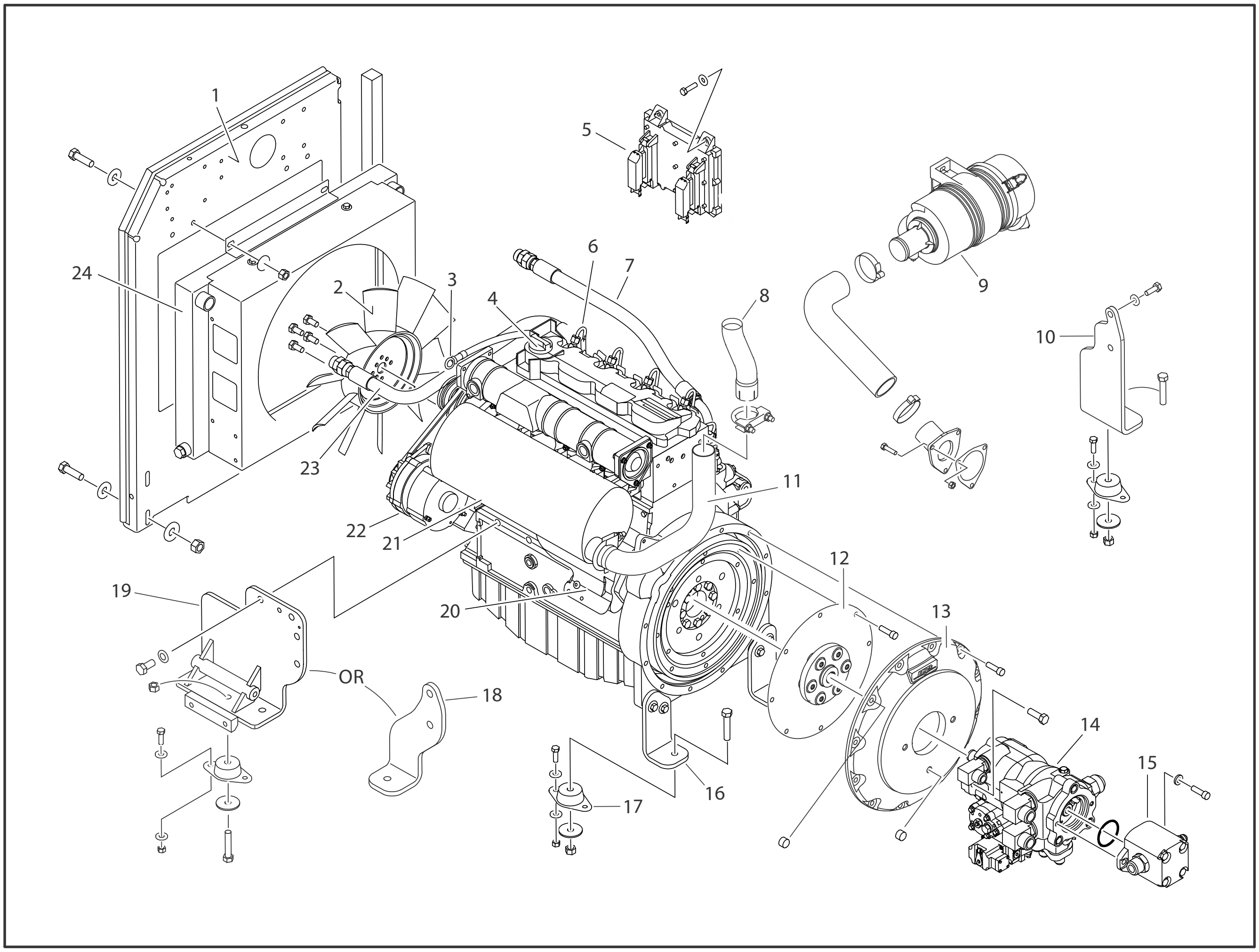


4. Clean dirt from filter carrier sealing surface.
5. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.
6. Screw in new filter by hand until gasket is flush. Hand-tighten filter another half-turn.



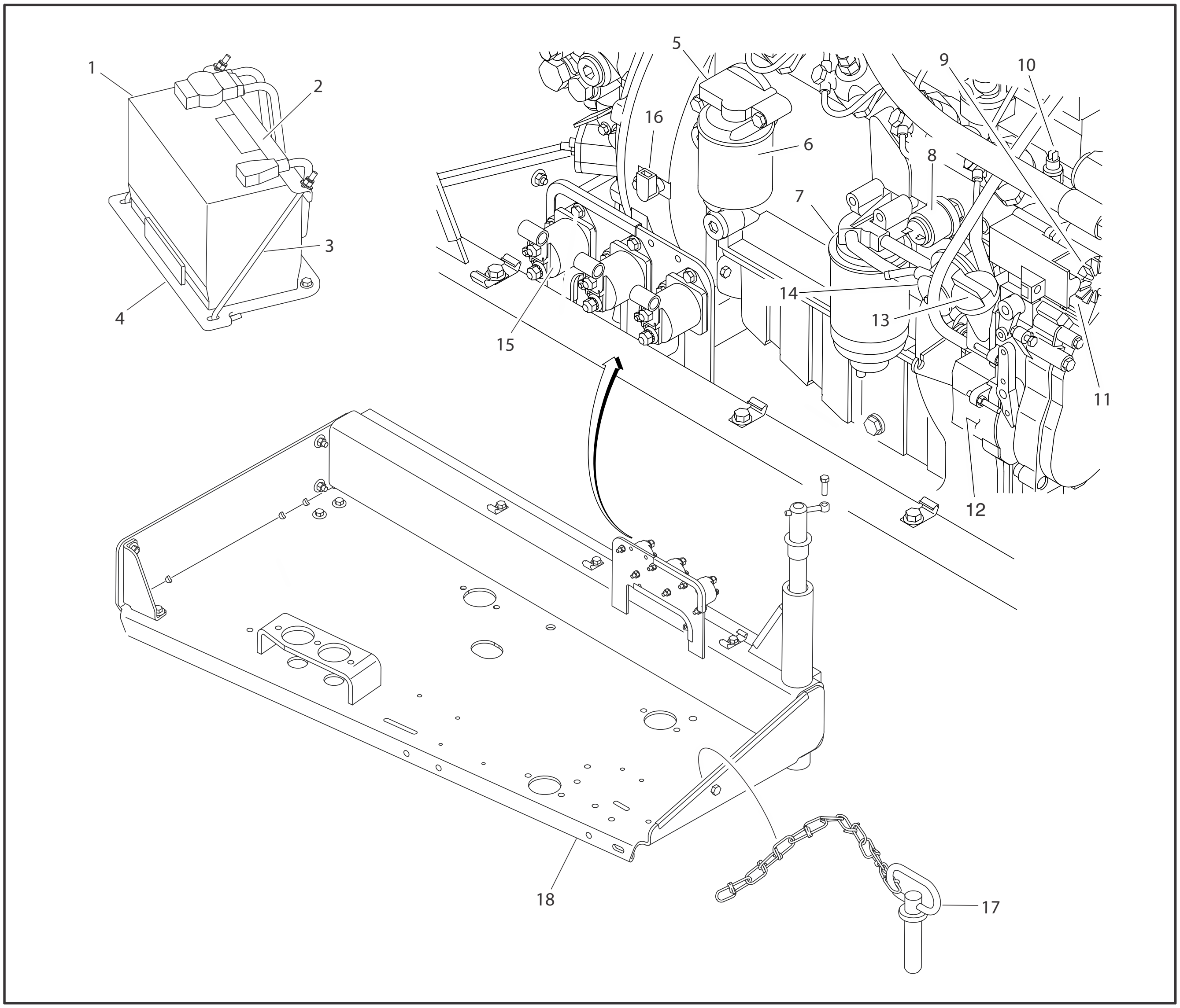
7. Connect water sensor connector (Pre-filter Only).
8. Open fuel shut-off valve.
9. Check for leaks.

3.13 DEUTZ D2011 ENGINE



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

Figure 3-74. Deutz D2011 Engine Installation - Sheet 1 of 2



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

Figure 3-75. Deutz D2011 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.

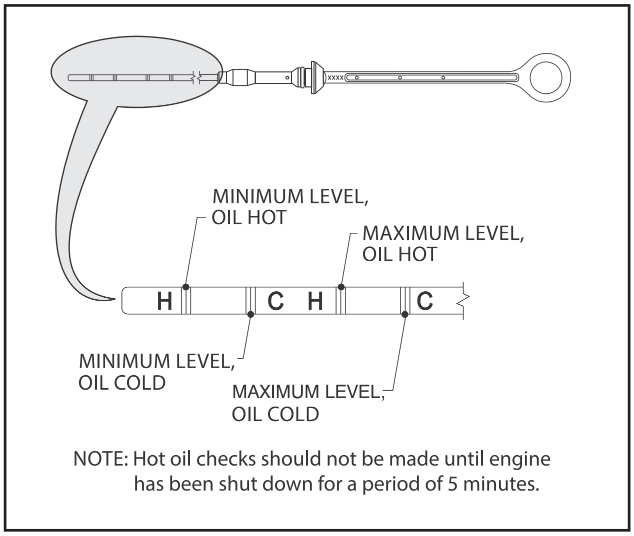


Figure 3-76. Deutz Dipstick Markings

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 3-77., Engine Oil Viscosity.

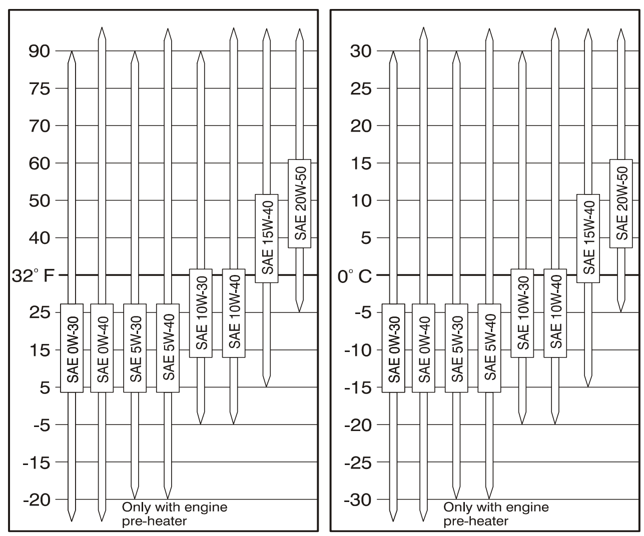
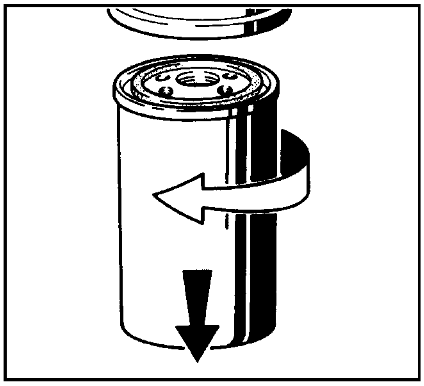


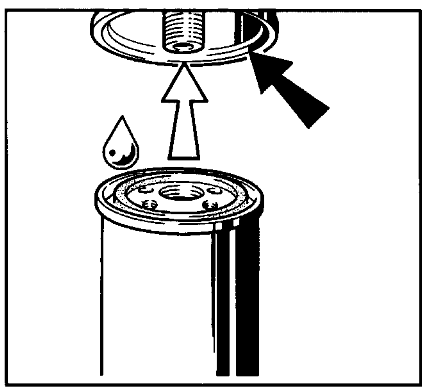
Figure 3-77. Engine Oil Viscosity

Changing Oil Filter

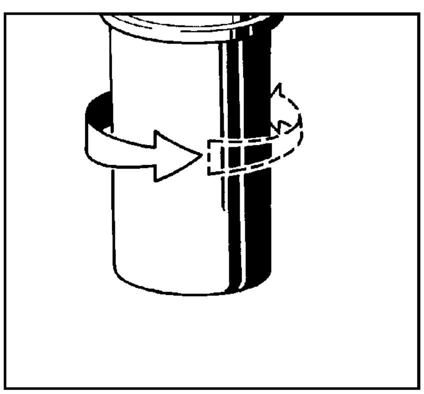
1. Wipe area around filter to clean any dirt from area.
2. Using a suitable oil filter removal tool, loosen lube oil filter cartridge and spin off.



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.

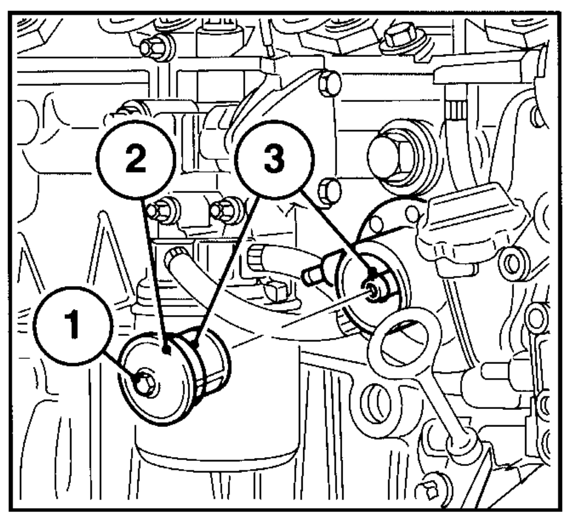
1. Wipe area around filter to clean any dirt from area.
2. Remove fuel filter cartridge. Catch any escaping fuel.
3. Clean dirt from filter carrier sealing surface.
4. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.
5. Screw in new filter by hand until gasket is flush.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

3.14 SPARK ARRESTER CLEANING INSTRUCTIONS

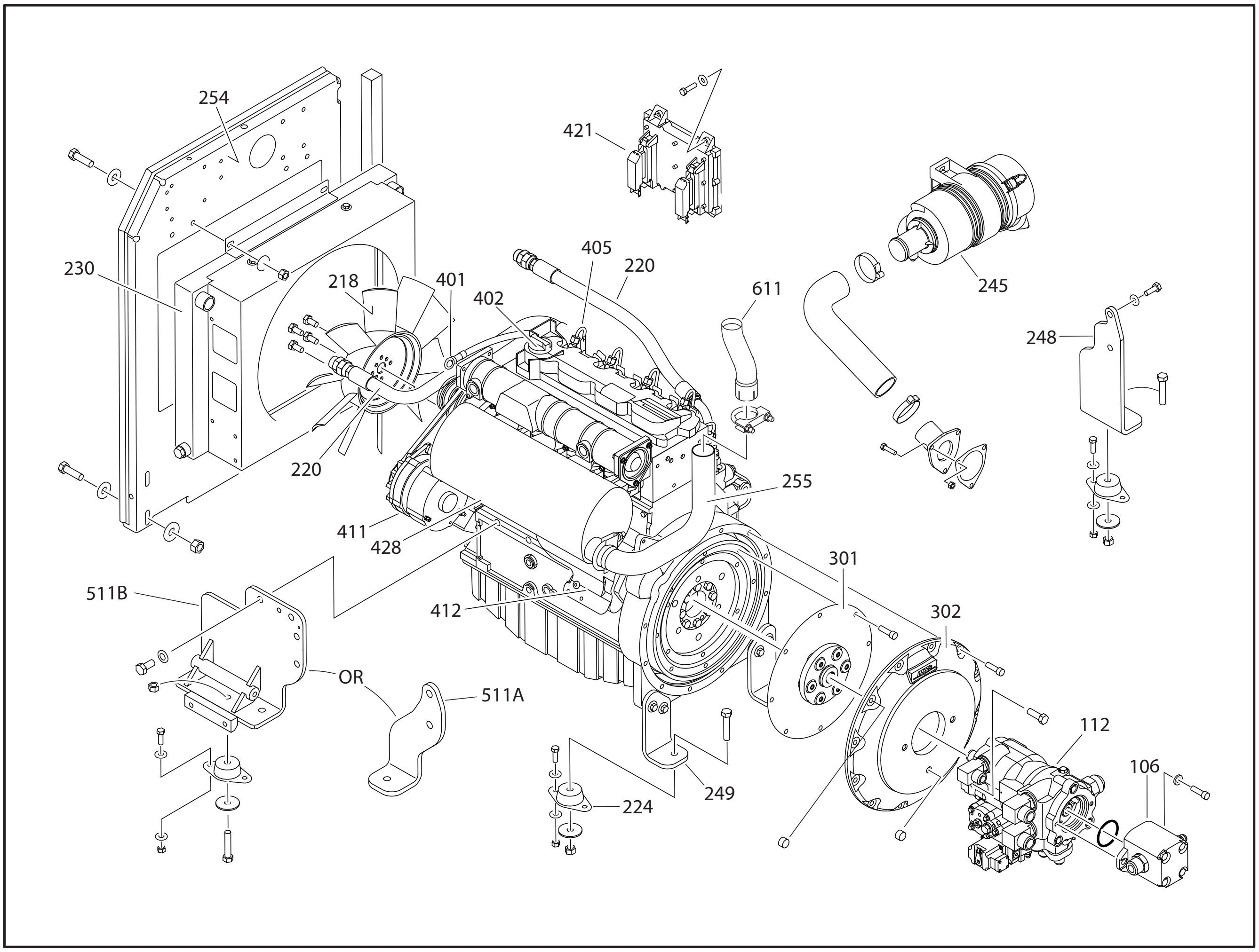
1. Remove cleanout plug in bottom of spark arrester (muffler).
2. Without causing deformation (or any type of damage to spark arrester) repeatedly tap on arrester near cleanout plug. This may be enough to begin spark trap drainage.
3. An industrial vacuum cleaner can do a complete job at this point.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

3.15 GLOW PLUGS

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

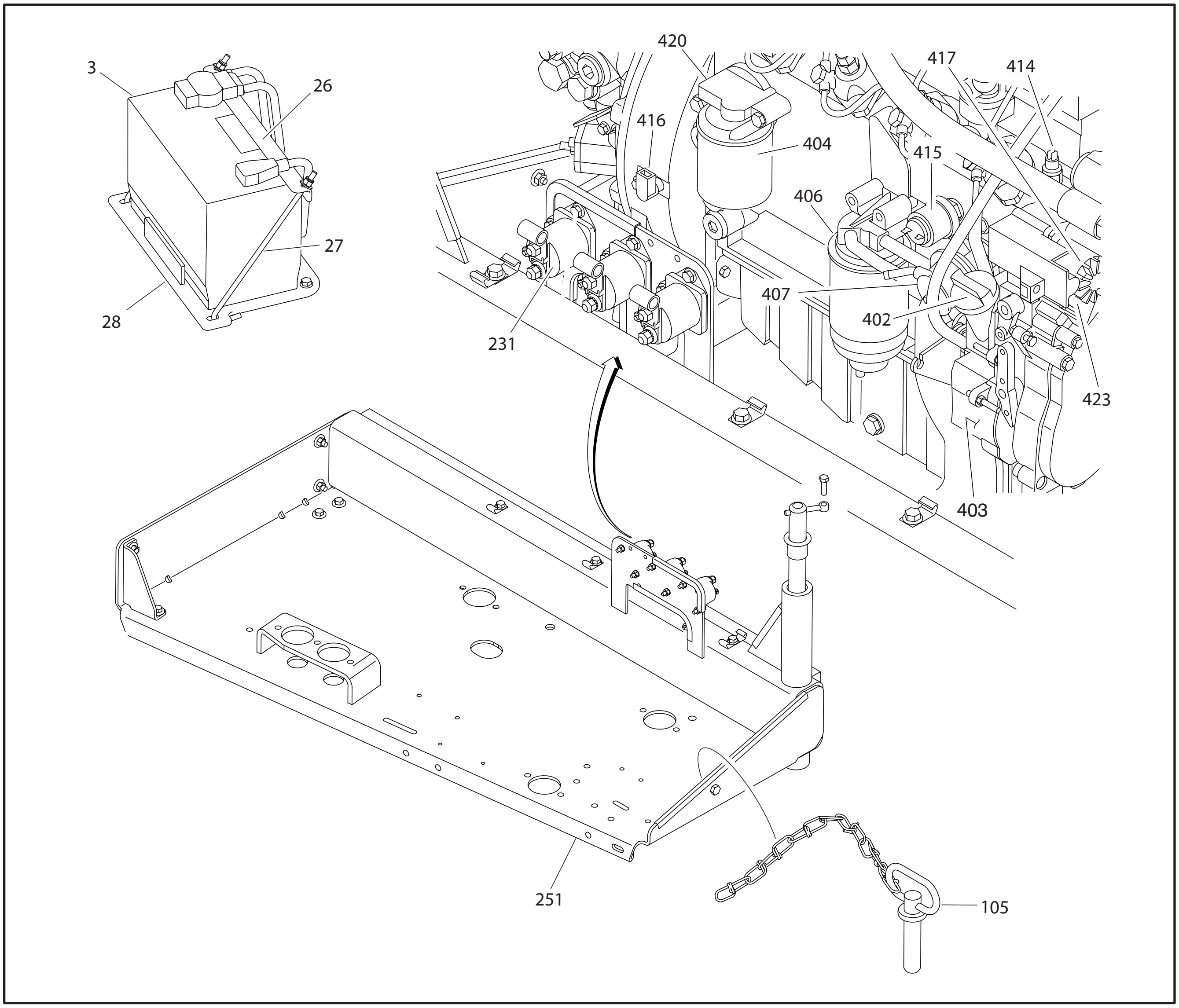
This determination occurs one second after the Power/Emergency Stop switch has been pulled on. Lamp and glow plugs remain energized for period of time specified by setting in the JLG Control System. Engine start is disabled during this period.

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



106. Gear Pump	245. Air Cleaner	302. Pump Adapter Plate	421. Control Module
112. Piston Pump	254. Radiator Mounting Plate	401. Dipstick	428. Muffler
218. Fan	248. Right Rear Engine Mounting Plate	402. Oil Filler Cap	511. Right Front Engine Support
220. Oil Cooler Hose	249. Left Rear Engine Mounting Plate	405. Fuel Injector	611. Exhaust Pipe Extension
224. Engine Mount	255. Exhaust Pipe	411. Alternator	
230. Radiator	301.Coupling	412. Starter	

Figure 3-78. Deutz Engine Installation - Sheet 1 of 2



3. Battery	105. Hitch Pin	403. Oil Lube Pump	414. Temperature Sensor
26. Battery Hold-Down	231. Relay	404. Oil Filter	415. Oil Pressure Sensor
27. J-Bolt	251. Engine Tray	406. Fuel Filter	416. Speed Sensor
28. Battery Hold-Down Plate	402. Filler Cap	407. Fuel Supply Pump	417. Throttle Actuator
			420. Temperature Sensor

Figure 3-79. Deutz Engine Installation - Sheet 2 of 2

3.16 DEUTZ EMR 2

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

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

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

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

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

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

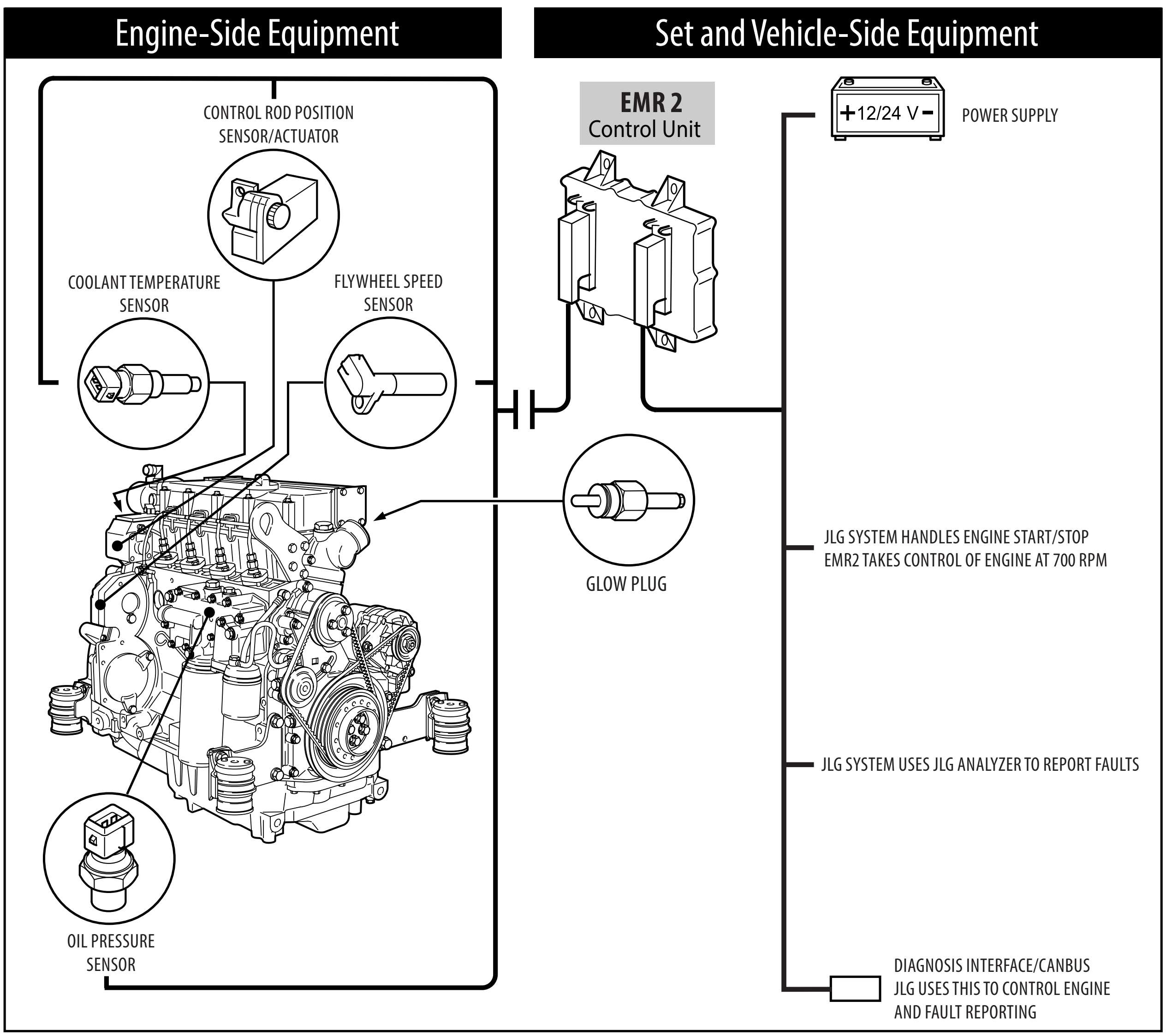


Figure 3-80. EMR 2 Engine Side Equipment

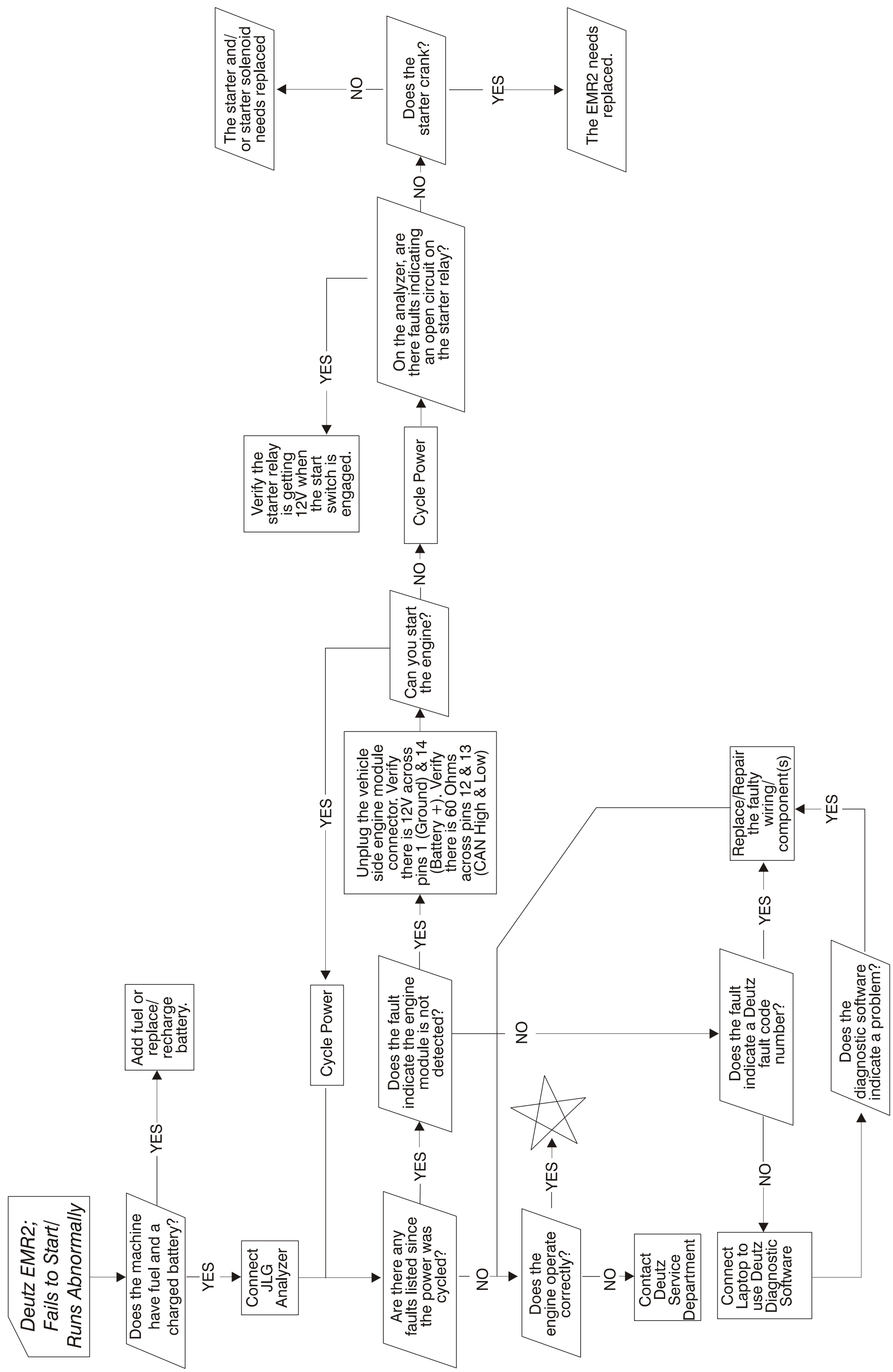


Figure 3-81. Deutz EMR 2 Troubleshooting Flow Chart

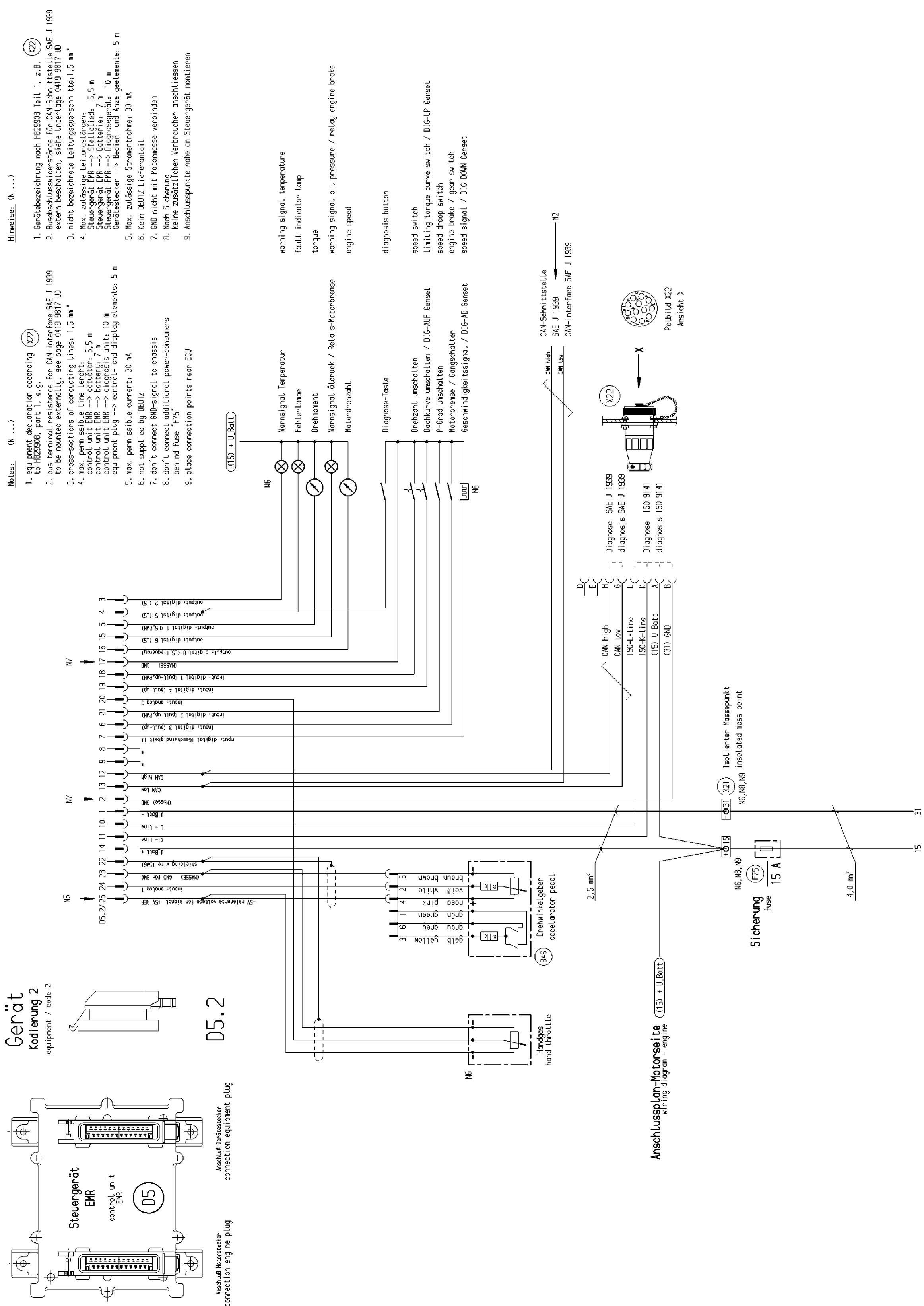


Figure 3-82. Deutz EMR 2 Vehicle Side Connection Diagram

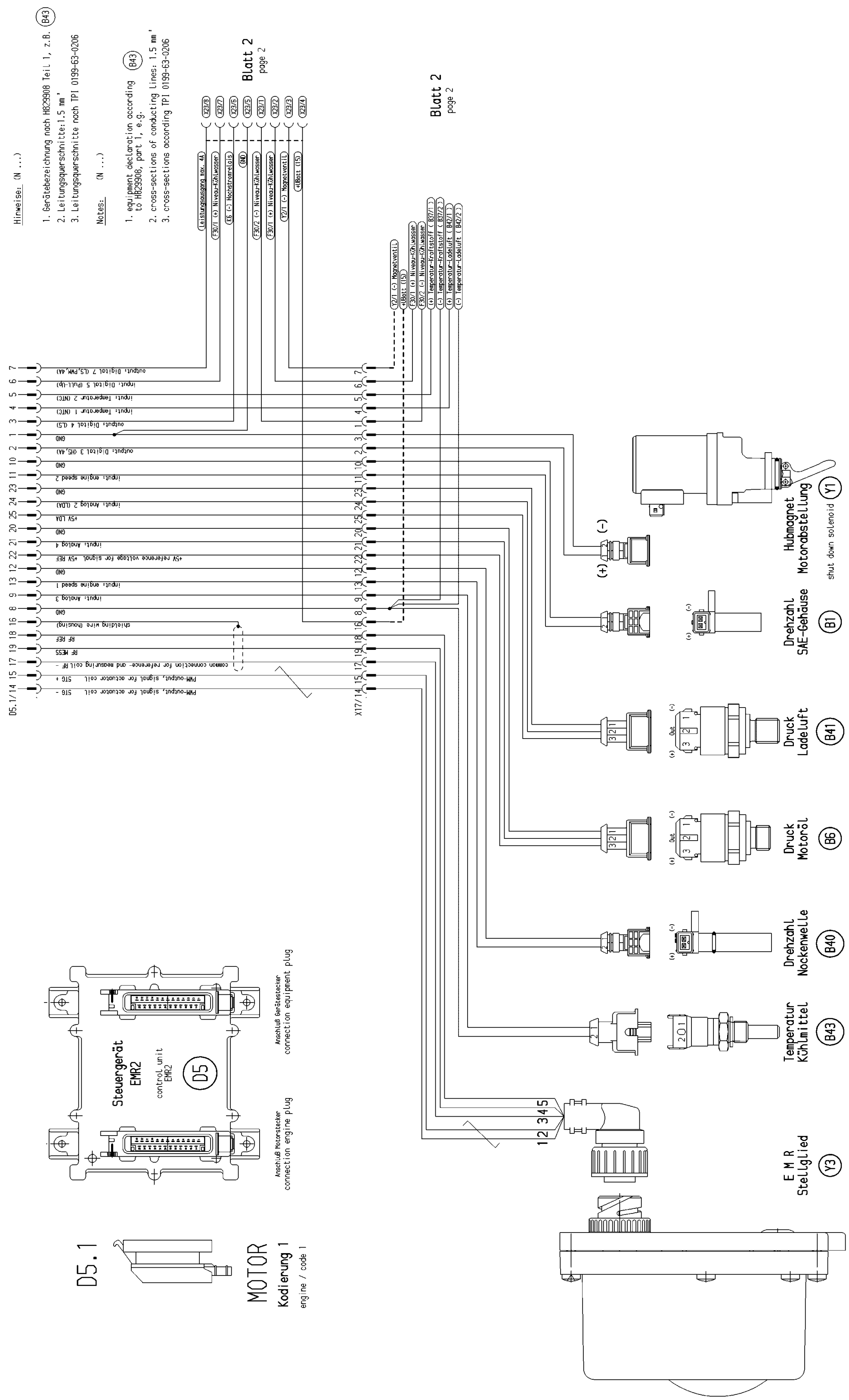


Figure 3-83. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

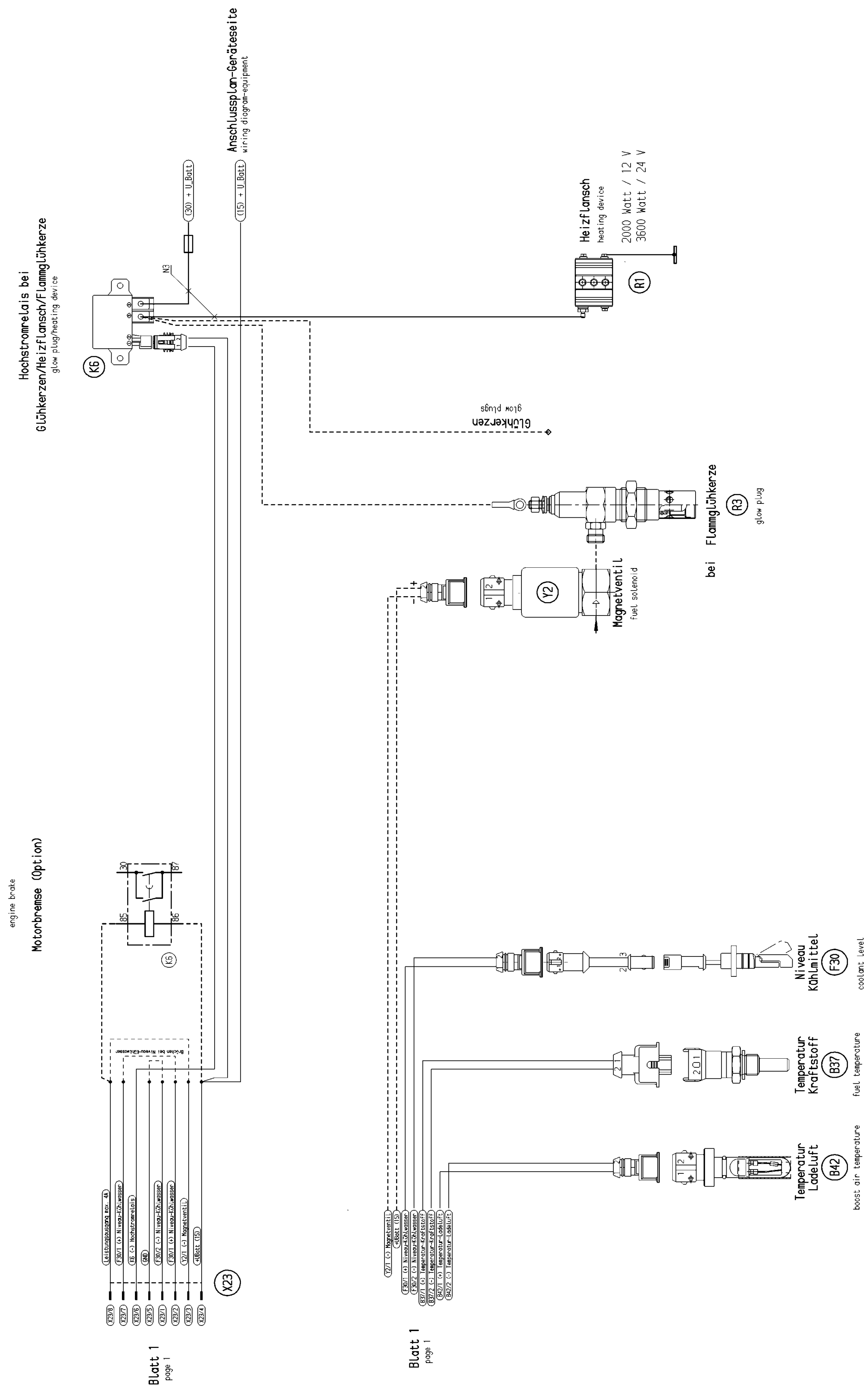
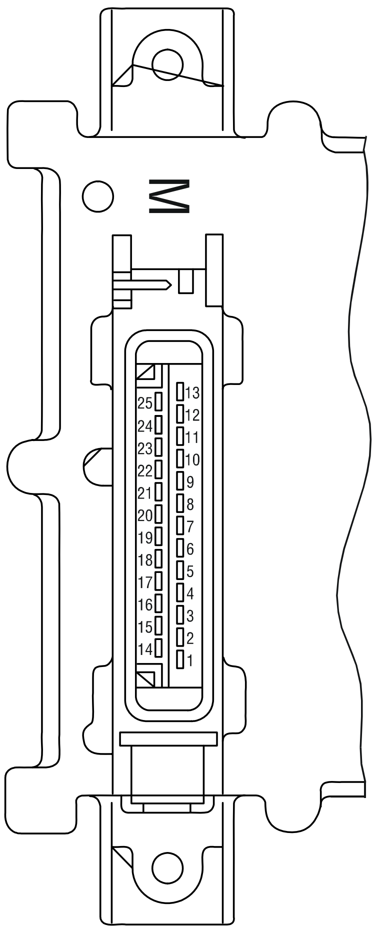


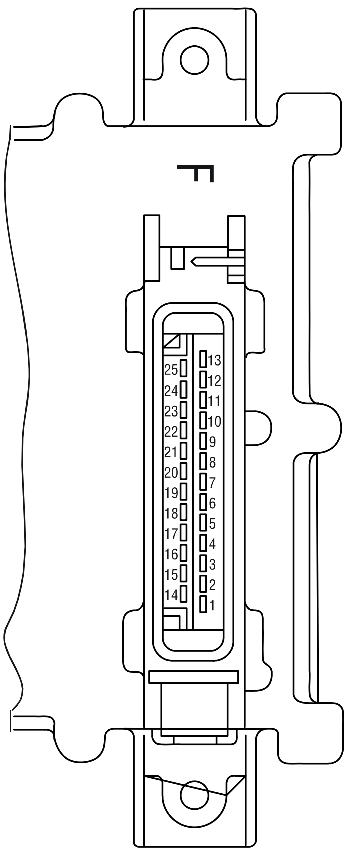
Figure 3-84. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2



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

1) For continuous power: < 4 A
2) Corresponds to special function"fuel temperature compensation at the EMR (0211 2571)

Figure 3-85. 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 3-86. 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. Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator (impulse on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.	Engine stop.	Check parameter (21). Check speed settings.
Sensors	07	Charge air pressure	102	2	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.
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2			
	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 3-87. EMR2 Fault Codes - Sheet 1 of 5

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

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

Figure 3-88. 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 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 3-89. EMR2 Fault Codes - Sheet 3 of 5

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

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

Figure 3-90. 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 3-91. EMR2 Fault Codes - Sheet 5 of 5

3.17 BIO FUEL IN DEUTZ ENGINES

General

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

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

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

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

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

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

Bio Fuel

PERMITTED BIO-DIESEL FUELS

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

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

APPROVED ENGINES

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

BASIC CONDITIONS TO BE OBSERVED

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

PLANT OIL

NOTICE

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

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

Biological Contamination In Fuels

SYMPTOMS

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

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

CAUSE

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

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

PREVENTIVE MEASURES

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

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

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

FUEL ADDITIVES

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

3.18 GM ENGINE GENERAL MAINTENANCE

Drive Belt Maintenance

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

When inspecting belts check for:

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

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

NOTICE

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

Engine Electrical System Maintenance

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

- Check and clean battery terminal connections and ensure connections are tight
- Check battery for any cracks or damage to case
- Check Positive and Negative battery cables for corrosion build up, or rubbing and chafing. Check connections on chassis are tight.
- Check entire engine wire harness for rubbing chafing, cuts or damaged connections. Repair as needed.
- Check all wire harness connectors to ensure they are fully seated and locked.
- Check ignition coil and spark plug cables for hardening, cracking, chafing, separation, split boot covers, and 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.

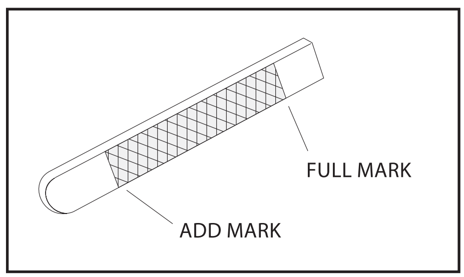


Figure 3-92. GM Engine Oil Dip Stick

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 manufacturers instructions). Do not over tighten.
6. Check sealing ring on drain plug for damage. Replace if necessary. Pipe plug and oil pan sealing surface with a clean rag. Reinstall plug. Do not over tighten.
7. Fill crankcase with oil.
8. Start engine and check for oil leaks.
9. Stop engine and check oil level is at "FULL".
10. Dispose of oil and filter in a safe manner as required by local regulations.

Coolant Fill Procedure - Dual Fuel Engine

CAUTION

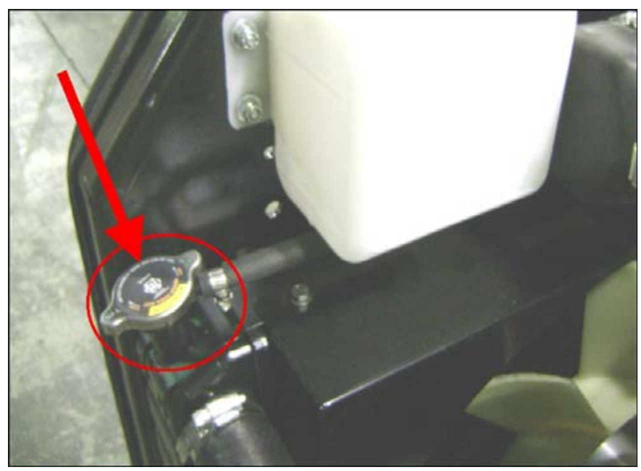
HOT ENGINE AND COMPONENTS CAN CAUSE SEVERE BURNS. MAKE SURE ENGINE IS COOL BEFORE PERFORMING MAINTENANCE.

NOTICE

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

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

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



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

NOTICE

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

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

⚠ CAUTION

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

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

NOTICE

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

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

3.19 GM ENGINE DUAL FUEL SYSTEM

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

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

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

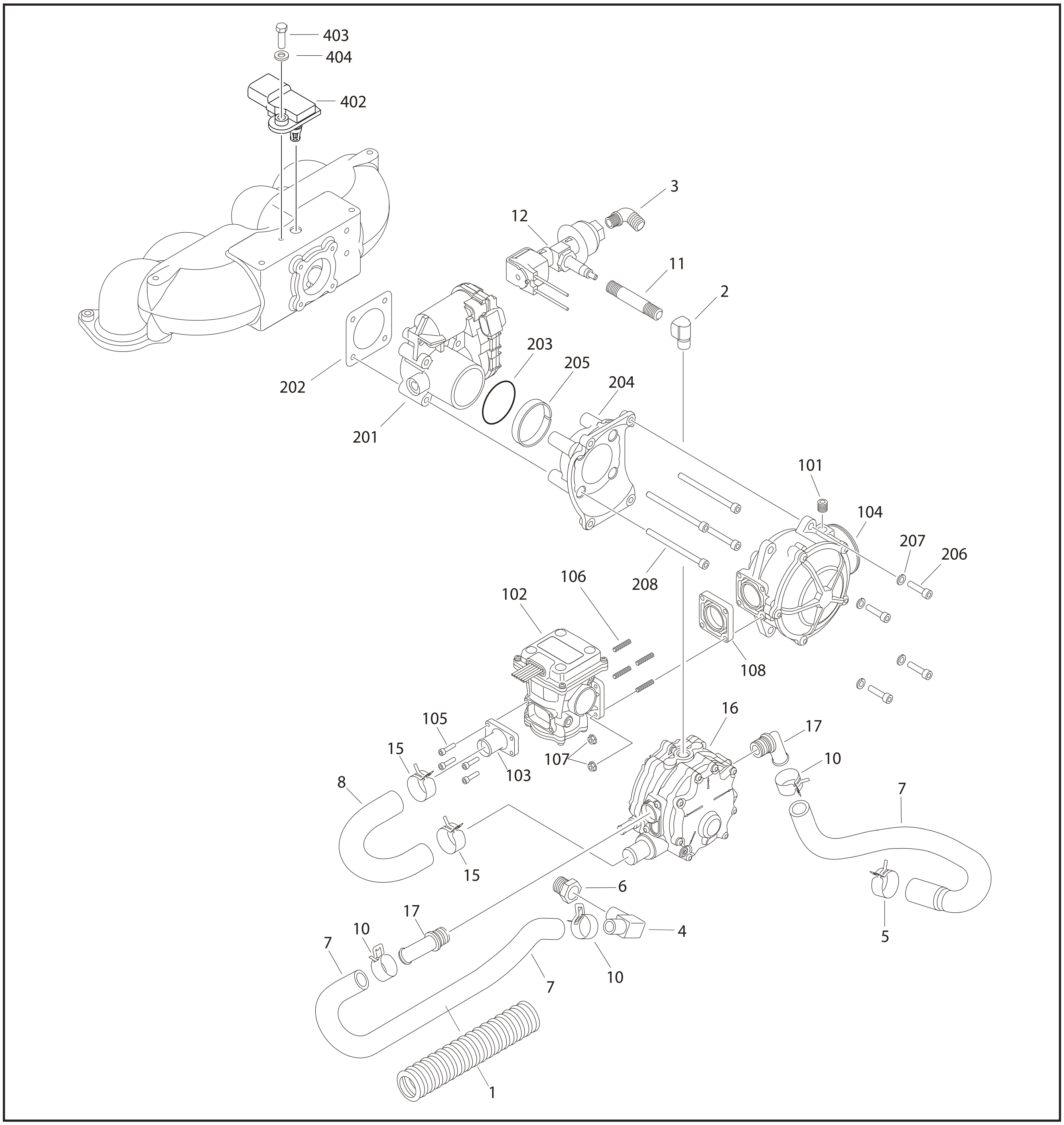
Primary components of the LPG dual fuel system are the LPG fuel tank, in-fuel filter, LPG Low Pressure lock-off, Electronic Pressure Regulator (EPR) and the fuel mixer module. The LPG fuel system operates at pressures which range from 14.0 inches (355.60 mm) of water column up to 312 psi (21.5 BAR).

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

Fuel Filter

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

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



1. 1 inch Split Loom
2. 90° Fitting
3. 90° Fitting
4. 90° Fitting
5. Clamp
6. Adapter Fitting
7. Hose
8. Hose
10. Clamp
11. Nipple
12. Lock-Off Valve
15. Clamp
16. Regulator
17. 45° Fitting
18. Bolt
19. Bolt
20. Nut
101. Plug
102. Electronic Pressure Regulator
103. Adapter
104. Mixer
105. Bolt
106. Stud
107. Nut
108. Spacer (600A Only)
201. Throttle Body
202. Gasket
203. O-Ring
204. Adapter
205. Spacer
206. Bolt
207. Washer
208. Bolt
402. T-MAP Sensor
403. Bolt
404. Flat Washer

Figure 3-93. GM 3.0 Dual Fuel System Components

Direct Electronic Pressure Regulator (DEPR)

NOTICE

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

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

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

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

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

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

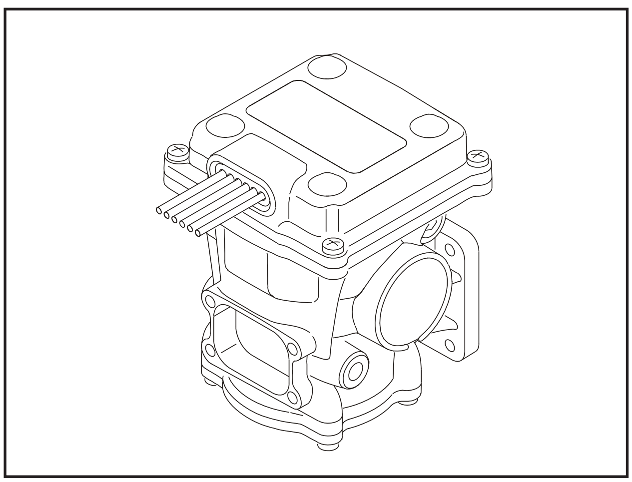


Figure 3-94. Direct Electronic Pressure Regulator

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.

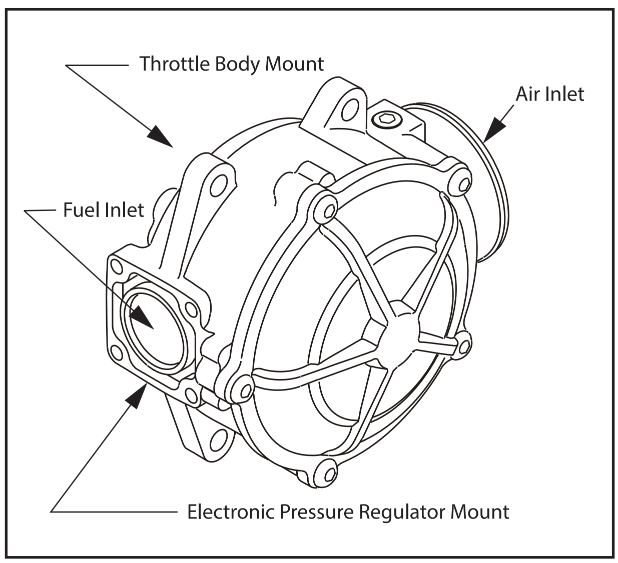


Figure 3-95. Air Fuel Mixer

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.

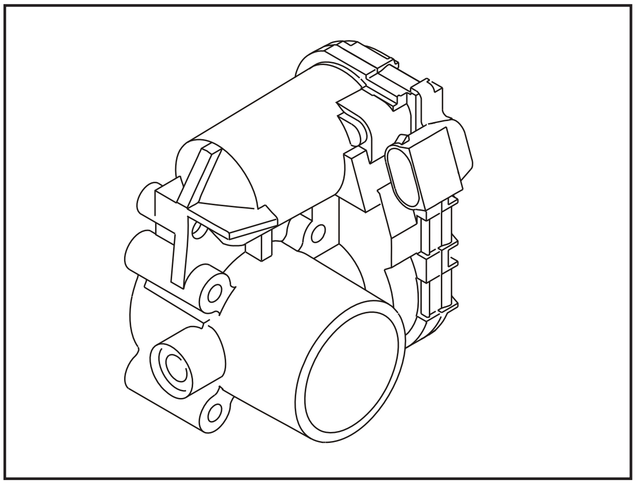


Figure 3-96. ELectronic Throttle Control Device

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).

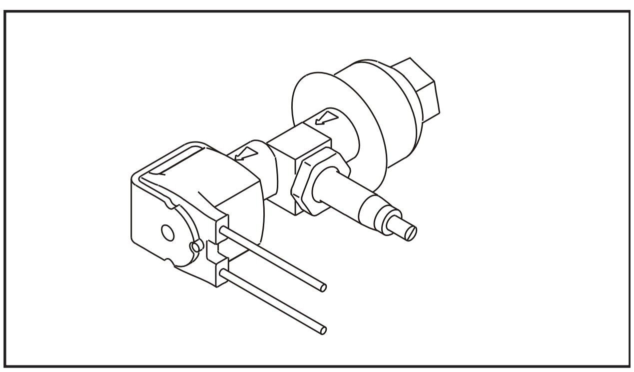


Figure 3-97. Electric Lock Off Assembly

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.

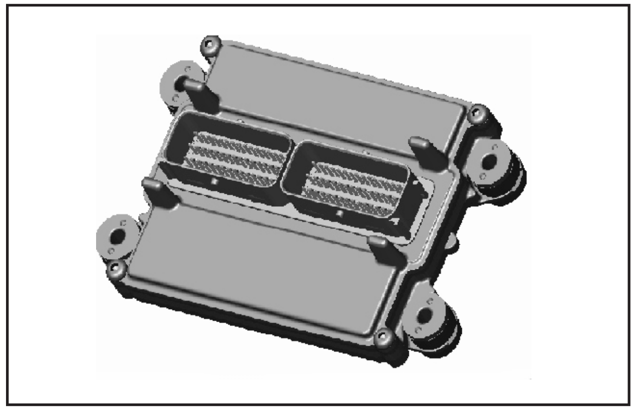


Figure 3-98. ECM Assembly

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.

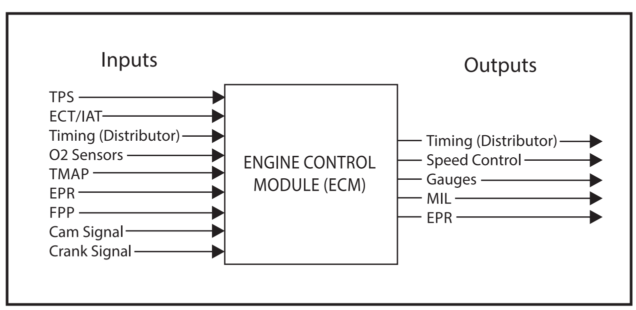


Figure 3-99. ECM Input-Output Diagram

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.

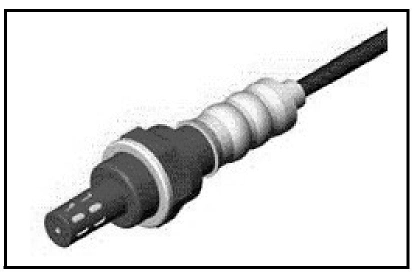


Figure 3-100. Heated Exhaust Gas Oxygen Sensor

Gasoline Multi Point Fuel Injection System (MPFI)

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

Gasoline Fuel Pump

Gasoline is stored as a liquid in the fuel tank and in 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.

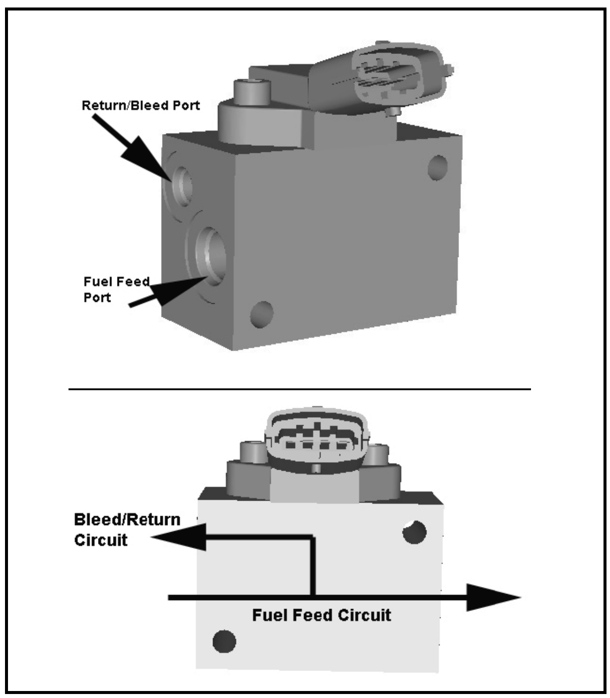


Figure 3-101. Gasoline Fuel Pressure and Temperature Manifold Assembly

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 then when the engine is operating at higher RPMs. The engine has been calibrated to deliver the precise amount of fuel for optimum performance and emission control.

3.20 GM ENGINE FUEL SYSTEM REPAIR

Propane Fuel System Pressure Relief

⚠ CAUTION

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

To relieve propane fuel system pressure:

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

NOTICE

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

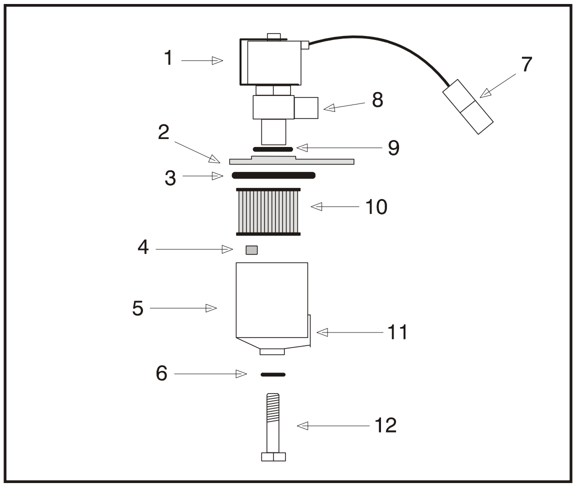
Propane Fuel System Leak Test

⚠ CAUTION

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

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

Propane Fuel Filter Replacement



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

Figure 3-102. 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 3-93. GM 3.0 Dual Fuel System Components.*

NOTICE

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

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

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

NOTE: *Refer to Figure 3-93. GM 3.0 Dual Fuel System Components.*

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

NOTICE

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

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

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

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

CAUTION

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

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

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

NOTICE

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

14. Check for leaks at the inlet and outlet fittings using a soapy solution or an electronic leak detector.
15. Check coolant line connections for leaks.
16. 15. Start engine. Recheck regulator for leaks.
17. 16. 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 3-93. GM 3.0 Dual Fuel System Components.*

NOTICE

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

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

Exhaust System And Catalytic Converter Inspection And Maintenance

NOTICE

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

NOTICE

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

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

Temperature Manifold Absolute Pressure (TMAP) Sensor

NOTE: *Refer to Figure 3-93. GM 3.0 Dual Fuel System Components.*

REMOVAL

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

INSTALLATION

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

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

Throttle Body (ETC) Replacement

NOTE: *Refer to Figure 3-93. GM 3.0 Dual Fuel System Components.*

REMOVAL

1. Disconnect negative battery cable.
2. Remove Mixer (See “Mixer Replacement” on page 88).
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 88).

Mixer Replacement

NOTE: *Refer to Figure 3-93. GM 3.0 Dual Fuel System Components.*

REMOVAL

1. Remove EPR. (See “Electronic Pressure Regulator (EPR) Replacement” on page 89)
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 89).
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 3-93. GM 3.0 Dual Fuel System Components.*

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

INSTALLATION

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

Regulator Replacement

NOTE: *Refer to Figure 3-93. GM 3.0 Dual Fuel System Components.*

REMOVAL

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

INSTALLATION

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

Coolant Hose Replacement

REMOVAL

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

INSTALLATION

NOTE: *Use hose material and lengths specified by JLG.*

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

Vapor Hose Replacement

REMOVAL

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

INSTALLATION

NOTICE

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

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

Engine Control Module Replacement

REMOVAL

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

INSTALLATION

NOTICE

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

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

Heated Exhaust Gas Oxygen Sensor Replacement

REMOVAL

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

INSTALLATION

NOTICE

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

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

3.21 GM ENGINE LPG FUEL SYSTEM DIAGNOSIS

Fuel System Description

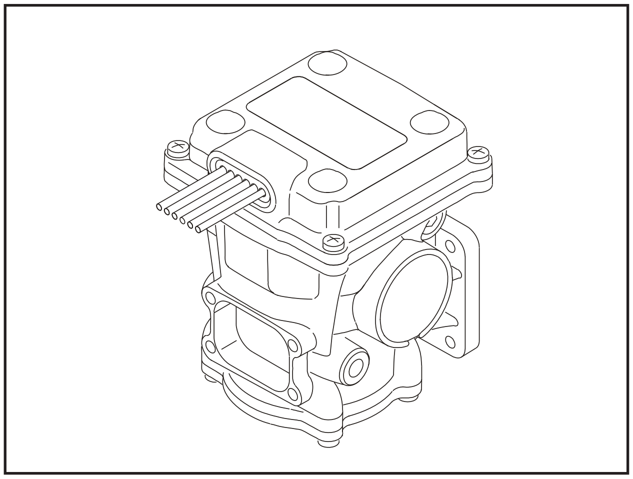


Figure 3-103. DEPR

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

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

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

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

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

Diagnostic Aids

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

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

Tools Required:

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

Diagnostic Scan Tool

- Diagnostic Display tool.

Pressure Gauges

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

Test Description

Numbers below refer to step numbers on the diagnostic table.

5. This step determines if the LPR requires replacement

6. This step determines if the problems are in the mechanical side of the Pressure Regulator or the Electronic Voice Coil

10. This step determines if the Mixer requires replacement

14. This step determines if the Lock Off requires replacement

17. This step determines if the Fuel Filter requires replacement.

Table 3-10. 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 EPR electrical connectors. NOTE: This action will cause a DTC to be set by the ECM 2. With the engine idling observe the pressure reading on the secondary test port. Is the fuel pressure WITHIN the specified range?	-1.0" to -2.0" w.c	Go to Fuel Control System Diagnosis	Go to Step 7
7	1. Inspect the air intake stream between the mixer assembly and the throttle body for leaks. 2. Inspect the fuel hose connection between the LPR and mixer assembly for damage or leakage. 3. Inspect any vacuum hoses for leaks Was a problem found and corrected?	--	Go to Step 26	Go to Step 22
8	1. Connect a water column gauge or a manometer to the secondary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR secondary pressure. Does the fuel pressure indicate a vacuum is present?	--	Go to Step 12	Go to Step 9
9	1. Remove Air induction hose to the mixer 2. Observe the air valve for movement while the engine is cranking. Note: Movement of the air valve will be minimal at cranking speeds. Does the air valve move when the engine is cranked?	--	Go to Step 11	Go to Step 10
10	1. Inspect the air intake stream to the mixer assembly and the throttle body for vacuum leaks. 2. Inspect the vacuum hoses from the mixer for proper connection and condition. Was a problem found and repaired?	--	Go to Step 26	Go to Step 24
11	Inspect the fuel hose connection between the LPR and the mixer assembly for damage or leakage. Was a problem found and repaired?	--	Go to Step 26	Go to Step 12
12	1. Connect a 0-10 psi gauge to the primary test port of the low pressure regulator (LPR). 2. Crank the engine and observe the pressure reading for the LPR primary pressure. Is the fuel pressure ABOVE the specified value?	1- 3 PSI	Go to Step 22	Go to Step 13
13	1. Turn OFF the ignition. 2. Disconnect the LPL connector. 3. Install a test light between the pins of the LPL connector. 4. Crank the engine. The test light should illuminate. Does the test light illuminate?	--	Go to Step 14	Go to Step 16
14	Using a DVOM, check the resistance of the low pressure lock-off (LPL). Is the resistance within the specified range?	12W - 16W	Go to Step 15	Go to Step 23

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	--

Table 3-11. Symptom Diagnosis

Checks	Action
Important Preliminary Checks	
Before Using This Section	Before using this section, you should have performed On Board Diagnostic Check and determined that: 1. The Control Module and MIL (Malfunction Indicator Lamp) are operating correctly. 2. There are no Diagnostic Trouble Codes (DTCs) stored, or a DTC exists but without a MIL. 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.
LPG Fuel System Check	1. Verify the customer complaint. 2. Locate the correct symptom table. 3. Check the items indicated under that symptom. 4. Operate the vehicle under the conditions the symptom occurs. Verify HEGO switching between lean and rich. **IMPORTANT! Normal HEGO switching indicates the LPG fuel system is in closed loop and operating correctly at that time.**
Visual and Physical Checks	[2] Check all ECM system fuses and circuit breakers. [2] Check the ECM ground for being clean, tight and in its proper location. [2] Check the vacuum hoses for splits, kinks and proper connections. [2] Check thoroughly for any type of leak or restriction. [2] Check for air leaks at all the mounting areas of the intake manifold sealing surfaces. [2] Check for proper installation of the mixer module assembly. [2] Check for air leaks at the mixer assembly. [2] Check the ignition wires for the following conditions: - Cracking - Hardness - Proper routing - Carbon tracking [2] Check the wiring for the following items: - Proper connections, pinches or cuts. [2] The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first.
Intermittent	
DEFINITION: The problem may or may not turn ON the Malfunction Indicator Lamp (MIL) or store a Diagnostic Trouble Code (DTC).	
Preliminary Checks	[2] Refer to Important Preliminary Checks. [2] Do not use the DTC tables. If a fault is an intermittent, the use of the DTC tables may result in the replacement of good parts.
Faulty Electrical Connections or Wiring	[2] Faulty electrical connections or wiring can cause most intermittent problems. [2] Check the suspected circuit for the following conditions: - Faulty fuse or circuit breaker - Connectors poorly mated - Terminals not fully seated in the connector (backed out) - Terminals not properly formed or damaged - Terminal to wires poorly connected - Terminal tension insufficient. [2] Carefully remove all the connector terminals in the problem circuit in order to ensure the proper contact tension. If necessary, replace all the connector terminals in the problem circuit in order to ensure the proper contact tension. [2] Checking for poor terminal to wire connections requires removing the terminal from the connector body.
Operational Test	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a scan tool. When the problem occurs, an abnormal voltage or scan reading indicates the problem may be in that circuit.

Table 3-11. Symptom Diagnosis

Checks	Action
Intermittent Malfunction Indicator Lamp (MIL)	The following components can cause intermittent MIL and no DTC(s): [2] A defective relay, Control Module driven solenoid, or a switch that can cause electrical system interference. Normally, the problem will occur when the faulty component is operating. [2] The improper installation of electrical devices, such as lights, 2-way radios, electric motors, etc. [2] The ignition secondary voltage shorted to a ground. [2] The Malfunction Indicator Lamp (MIL) circuit or the Diagnostic Test Terminal intermittently shorted to ground. [2] The Control Module grounds.
Loss of DTC Memory	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[22] but does not start.	
Preliminary Checks	Refer to Important Preliminary Checks.
Control Module Checks	If a scan tool is available: [2] Check for proper communication with both the ECM [2] Check the fuse in the ECM battery power circuit. Refer to Engine Controls Schematics. [2] Check battery power, ignition power and ground circuits to the ECM. Refer to Engine Control Schematics. Verify voltage and/or continuity for each circuit.
Sensor Checks	[2] Check the TMAP sensor. [2] Check the Magnetic pickup sensor (RPM).
Fuel System Checks	**Important:** A closed LPG manual fuel shut off valve will create a no start condition. [2] Check for air intake system leakage between the mixer and the throttle body. [2] Verify proper operation of the low pressure lock-off solenoids. [2] Check the fuel system pressures. Refer to the LPG Fuel System Diagnosis. [2] Check for proper mixer air valve operation.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. [2] Check for the proper ignition voltage output with J 26792 or the equivalent. [2] Verify that the spark plugs are correct for use with LPG (R42LTS) [2] Check the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits [2] Check for bare or shorted ignition wires. [2] Check for loose ignition coil connections at the coil.
Engine Mechanical Checks	**Important:** The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system. [2] Check for the following: - Vacuum leaks - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes.

Table 3-11. Symptom Diagnosis

Checks	Action
Exhaust System Checks	[2] Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes - Inspect the muffler for signs of heat distress or for possible internal failure. [2] Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis
Hard Start	
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	[2] Refer to Important Preliminary Checks. [2] Make sure the vehicle's operator is using the correct starting procedure.
Sensor Checks	[2]Check the Engine Coolant Temperature sensor with the scan tool. Compare the engine coolant temperature with the ambient air temperature on a cold engine. IF the coolant temperature reading is more than 5 degrees greater or less than the ambient air temperature on a cold engine, check for high resistance in the coolant sensor circuit. Refer to DTC 111 [2] Check the Crankshaft Position (CKP) sensor. [2]Check the Throttle position (TPS) sensor.
Fuel System Checks	Important: A closed LPG manual fuel shut off valve will create an extended crank OR no start condition. [2] Verify the excess flow valve in the LPG manual shut-off valve is not tripped. [2] Check mixer module assembly for proper installation and leakage. [2] Verify proper operation of the low pressure lock-off solenoids. [2] Verify proper operation of the EPR [2] Check for air intake system leakage between the mixer and the throttle body. [2] Check the fuel system pressures. Refer to the Fuel System Diagnosis.
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. [2] Check for the proper ignition voltage output with J 26792 or the equivalent. [2] Verify that the spark plugs are correct for use with LPG (R42LTS) [2] Check the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits [2] Check for bare or shorted ignition wires. [2] Check for moisture in the distributor cap if applicable. [2] Check for loose ignition coil connections. **Important:** 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. [2] Check for the following: - Vacuum leaks - Improper valve timing - Low compression - Bent pushrods - Worn rocker arms - Broken or weak valve springs - Worn camshaft lobes. [2] Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	[2] Check the exhaust system for a possible restriction: - Inspect the exhaust system for damaged or collapsed pipes - Inspect the muffler for signs of heat distress or for possible internal failure. [2] Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis or Exhaust System in the GM Base Engine Service Manual

Table 3-11. Symptom Diagnosis

Checks	Action
Additional Checks	[2]
Cuts Out, Misses	
DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 RPM. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	[2] Refer to Important Preliminary Checks.
Ignition System Checks	[2] Start the engine. [2] Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. [2] Check for proper ignition output voltage with spark tester J 26792. [2] Check for a cylinder misfire. [2] Verify that the spark plugs are correct for use with LPG (R42LTS) [2] Remove the spark plugs in these cylinders and check for the following conditions: [2] Insulation cracks [2] Wear [2] Improper gap [2] Burned electrodes [2] Heavy deposits [2] Visually/Physically inspect the secondary ignition for the following: [2] Ignition wires for arcing, cross-firing and proper routing [2] Ignition coils for cracks or carbon tracking
Engine Mechanical Checks	[2] Perform a cylinder compression check. [2] Check the engine for the following: - Improper valve timing - Bent pushrods - Worn rocker arms - Worn camshaft lobes. - Broken or weak valve springs. [2] Check the intake and exhaust manifold passages for casting flash.
Fuel System Checks	[2] Check the fuel system - plugged fuel filter, low fuel pressure, etc. Refer to LPG Fuel System Diagnosis. [2] Check the condition of the wiring to the low pressure lock-off solenoid.
Additional Check	Check for Electromagnetic Interference (EMI). [2] EMI on the reference circuit can cause a missing condition. [2] Monitoring the engine RPM with a scan tool can detect an EMI. [2] A sudden increase in the RPM with little change in the actual engine RPM, indicates EMI is present. [2] If the problem exists, check the routing of the secondary wires and the ground circuit.
Hesitation, Sag, Stumble	
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator. The condition can occur at any vehicle speed. The condition may cause the engine to stall if it's severe enough.	
Preliminary Checks	Refer to Important Preliminary Checks.
Fuel System Checks	[2] Check the fuel pressure. Refer to LPG Fuel System Diagnosis. [2] Check for low fuel pressure during a moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a faulty low pressure regulator or a restriction in the fuel system. [2] Check the Manifold Absolute Pressure (MAP) sensor response and accuracy. [2] Check LPL electrical connection [2] Check the mixer air valve for sticking or binding. [2] Check the mixer module assembly for proper installation and leakage. [2] Check the EPR electrical connections.

Table 3-11. Symptom Diagnosis

Checks	Action
Ignition System Checks	Note: LPG being a gaseous fuel requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. If a problem is reported on LPG and not gasoline, do not discount the possibility of a LPG only ignition system failure and test the system accordingly. [2] Check for the proper ignition voltage output with J 26792 or the equivalent. [2] Verify that the spark plugs are correct for use with LPG (R42LTS) [2] Check for faulty spark plug wires [2] Check for fouled spark plugs.
Additional Check	[2] Check for manifold vacuum or air induction system leaks [2] Check the generator output voltage.
Backfire	
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Check	[2] Refer to Important Preliminary Checks.
Ignition System Checks	**Important! LPG, being a gaseous fuel, requires higher secondary ignition system voltages for the equivalent gasoline operating conditions. The ignition system must be maintained in peak condition to prevent backfire.** [2] Check for the proper ignition coil output voltage using the spark tester J26792 or the equivalent. [2] Check the spark plug wires by connecting an ohmmeter to the ends of each wire in question. If the meter reads over 30,000 ohms, replace the wires. [2] Check the connection at each ignition coil. [2] Check for deteriorated spark plug wire insulation. [2] Check the spark plugs. The correct spark plugs for LPG are (R42LTS) [2] Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits
Engine Mechanical Check	Important! The LPG Fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than a gasoline fuel supply system. [2] Check the engine for the following: - Improper valve timing - Engine compression - Manifold vacuum leaks - Intake manifold gaskets - Sticking or leaking valves - Exhaust system leakage [2] Check the intake and exhaust system for casting flash or other restrictions.
Fuel System Checks	[2] Perform a fuel system diagnosis. Refer to LPG Fuel System Diagnosis.
Lack of Power, Sluggishness, or Sponginess	
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	[2] Refer to Important Preliminary Checks. [2] Refer to the LPG Fuel system OBD System Check [2] Compare the customer's vehicle with a similar unit. Make sure the customer has an actual problem. Do not compare the power output of the vehicle operating on LPG to a vehicle operating on gasoline as the fuels do have different drive feel characteristics [2] Remove the air filter and check for dirt or restriction. [2] Check the vehicle transmission Refer to the OEM transmission diagnostics.

Table 3-11. Symptom Diagnosis

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

Table 3-11. Symptom Diagnosis

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

Table 3-11. Symptom Diagnosis

Checks	Action
Fuel System Checks	[2] Check for Rich or Lean symptom that causes the condition. Drive the vehicle at the speed of the complaint. Monitoring the oxygen sensors will help identify the problem. [2] Check the fuel pressure while the condition exists. Refer to LPG Fuel System Diagnosis. [2] Verify proper fuel control solenoid operation. [2] Verify that the LPG manual shut-off valve is fully open. [2] Check the in-line fuel filter for restrictions.
Ignition System Checks	[2] Check for the proper ignition output voltage using the spark tester J26792 or the equivalent. [2] Verify that the spark plugs are correct for use with LPG (R42LTS) [2] Check the spark plugs. Remove the plugs and inspect them for the following conditions: - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits - Check the Crankshaft Position (CKP) sensor.
Additional Check	[2] Check the ECM grounds for being clean, tight, and in their proper locations. [2] Check the generator output voltage. [2] Check the vacuum hoses for kinks or leaks. [2] Check Transmission

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

NOTES:

SECTION 4. BOOM & PLATFORM

4.1 MAIN BOOM MAINTENANCE

WARNING

UNSECURED COMPONENTS CAN MOVE OR FALL AND CAUSE DEATH, SERIOUS INJURY, OR DAMAGE TO PROPERTY AND EQUIPMENT. PROPERLY SECURE OR SUPPORT ALL COMPONENTS.

NOTICE

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

Remove Rotator

Refer to Figure 4-1., Rotator, Platform Level Cylinder, and Jib Lift Cylinder Installation.

600A

1. Tag and disconnect hydraulic lines to rotator (1). Use suitable container to retain any hydraulic fluid. Cap hydraulic lines and ports.
2. Remove screw and pin (2) from rotator (1) and platform level cylinder (3).
3. Support rotator (1). Remove bolt and keeper pin (4). Remove pin (5) using a suitable brass drift and hammer. Remove rotator.

600AJ

1. Tag and disconnect hydraulic lines to rotator (8). Use suitable container to retain any hydraulic fluid. Cap hydraulic lines and ports.
2. Support left and right bottom tubes (9) to prevent falling when rotator is removed.
3. Remove nut (10) and bolt (11) from left and right bottom tubes (9). Using a suitable brass drift and hammer remove pin (12).
4. Support rotator (8). Remove bolt and keeper pin (13). Remove pin (14) using a suitable brass drift and hammer. Remove rotator.

Remove Platform Level (Slave) Cylinder

Refer to Figure 4-1., Rotator, Platform Level Cylinder, and Jib Lift Cylinder Installation.

600A

1. Support platform or rotator if not removed.
2. Tag and disconnect hydraulic lines to platform level cylinder (3). Use suitable container to retain any hydraulic fluid. Cap hydraulic lines and ports.
3. Remove screw and pin (2) from rotator (1) and platform level cylinder (3).
4. Support platform level cylinder. Remove bolt and keeper pin (6). Remove pin (7) using a suitable brass drift and hammer. Remove cylinder.

600AJ

1. Telescope boom fly section out approximately 20 inches (50.8 cm) for access to platform level cylinder.
2. Support platform, jib, and rotator if not removed.
3. Tag and disconnect hydraulic lines to platform level cylinder (15). Use suitable container to retain any hydraulic fluid.
4. Remove bolt and keeper pin (16). Remove pin (17) using a suitable brass drift and hammer.
5. Remove screw and pin (18) from platform level cylinder. Remove cylinder

Remove Jib Lift Cylinder (600AJ Only)

Refer to Figure 4-1., Rotator, Platform Level Cylinder, and Jib Lift Cylinder Installation.

1. Tag and disconnect hydraulic lines to jib lift cylinder (19). Use suitable container to retain any hydraulic fluid. Cap hydraulic lines and ports.
2. Support left and right bottom tubes (9) to prevent falling when cylinder is removed.
3. Support jib lift cylinder. Remove nut (20) and bolt (21) from left and right bottom tubes (9). Using a suitable brass drift and hammer remove pin (22).
4. Remove bolt and keeper pin (23). Remove pin (24) using a suitable brass drift and hammer. Remove cylinder.

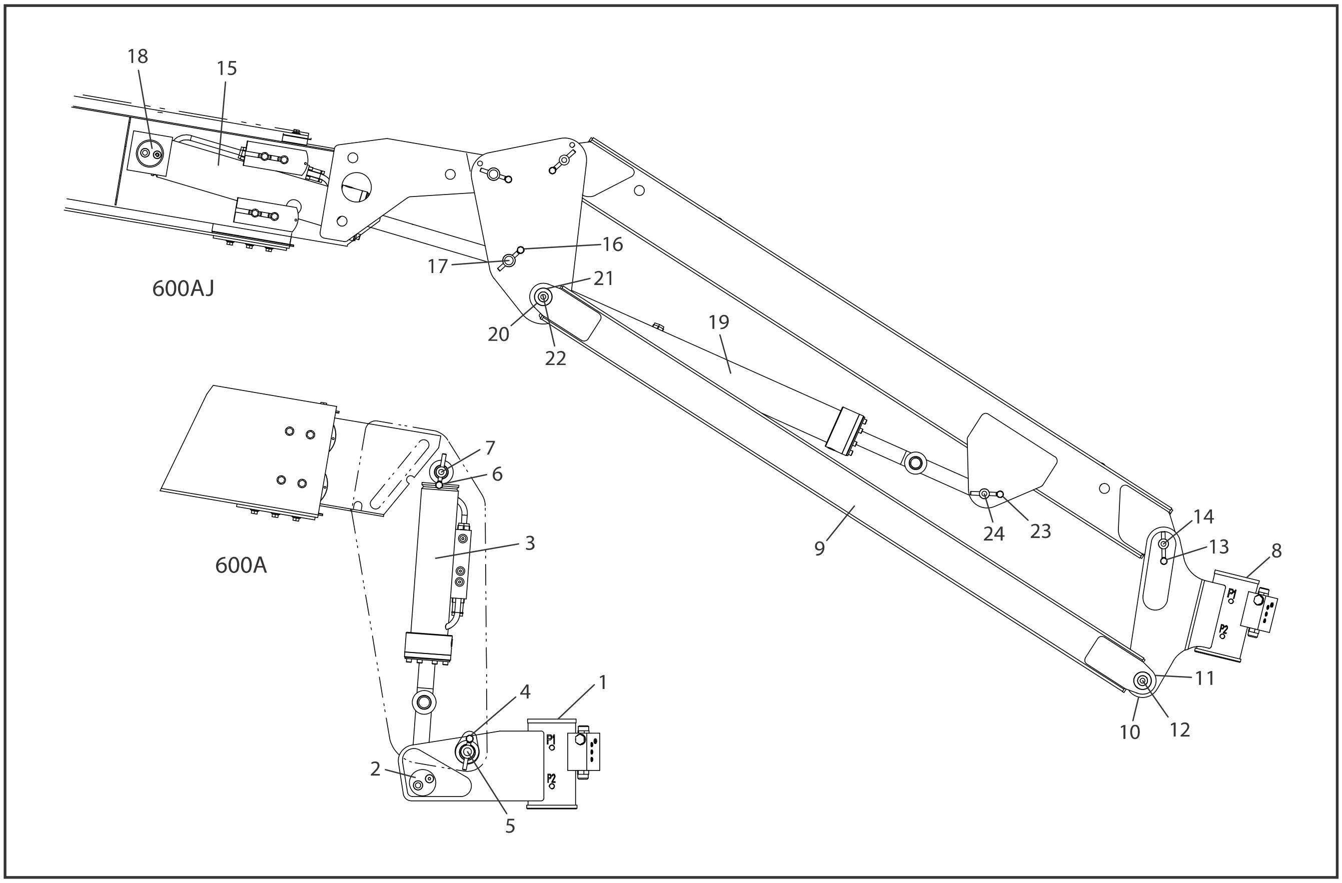


Figure 4-1. Rotator, Platform Level Cylinder, and Jib Lift Cylinder Installation

Remove Main Boom Powertrack

1. Disconnect wiring harness connectors in tower upright.
2. Tag and disconnect hydraulic lines from connectors at boom assembly. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Disconnect dual capacity indicator limit switch from side of boom section.
4. Remove hydraulic lines and electrical cables from powertrack.
5. Support powertrack weight along entire length using suitable lifting equipment.
6. Remove bolt (1) from push tube on fly boom section.
7. Remove bolt (2) from push tube on main boom section.
8. With powertrack supported and using all applicable safety precautions, remove bolts (3), (4), and (5) securing rail to main boom. Remove powertrack.

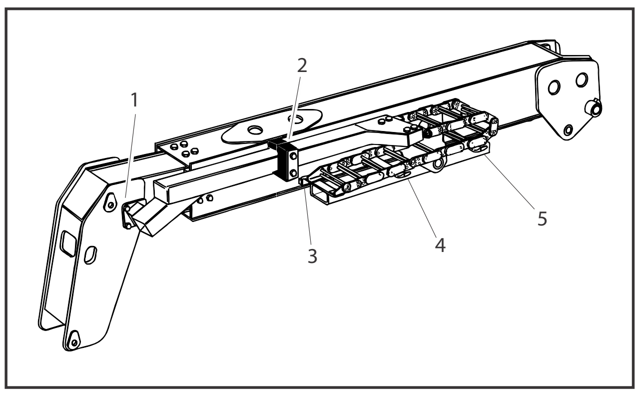


Figure 4-2. Main Boom Powertrack Components

Remove Main Boom

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 turntable. Lower to ground or suitably supported work surface.

DISASSEMBLE

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.
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 boom pivot pin for wear, scoring, tapering and ovality, or other damage.
2. Inspect telescope cylinder attach point for scoring, tapering and ovality.
3. Inspect upper lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Protect pin surfaces before installation.
4. Inspect inner diameter of boom pivot bearing for scoring, distortion, wear, or other damage.
5. Inspect wear pads for excessive wear or other damage. Replace pads when worn to within 1/8 inch (3.2 mm) of threaded insert or damaged.
6. Inspect threaded components for stretching, thread deformation, twisting, or other damage.
7. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage.

ASSEMBLY

NOTE: *Install same number and thickness of shims removed.*

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 inch (0.062) clearance. Shim if needed.
8. Install wear pads in forward position of base boom section. Check for 2/10 inch (0.20) 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 turntable. Align pivot holes in boom and turntable.
2. Install boom pivot pin. Ensure location of hole in pin is aligned with attach point on turntable.
3. Gently tap pin in position with soft headed mallet. Install pin mounting hardware.
4. Connect all wiring connectors.
5. Connect all hydraulic lines running along side of boom assembly.
6. 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.
7. 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.
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.

4.2 TOWER BOOM

Remove Tower Upright

1. Tag and disconnect hydraulic lines to upper lift cylinder (1). Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Support upper lift cylinder using suitable lifting device.
3. Remove bolt and keeper pin from upper 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 hardness 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.

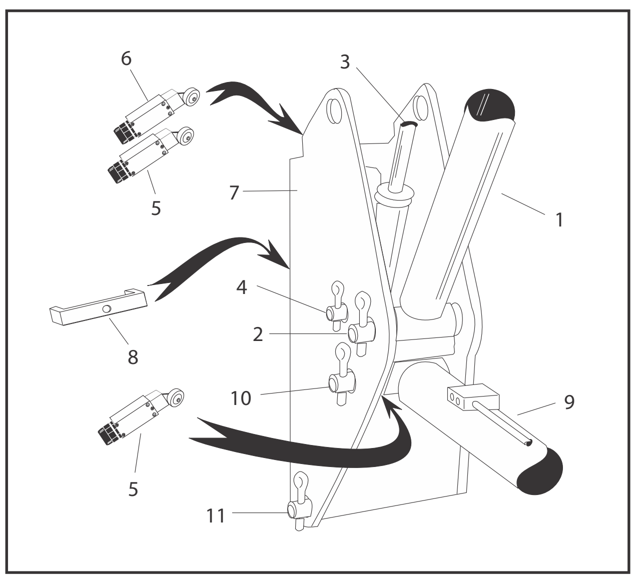


Figure 4-3. Tower Upright Components

Remove Tower Boom

1. 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.
2. Disconnect wiring harness from ground control box.
3. Support tower boom assembly at approximate center of gravity with suitable lifting device.
4. Remove mounting hardware from lower lift cylinder rod end. Using a suitable brass drift and hammer, remove pin #1 from 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. Remove tower boom assembly from turntable upright. Place tower boom assembly on well supported trestles.

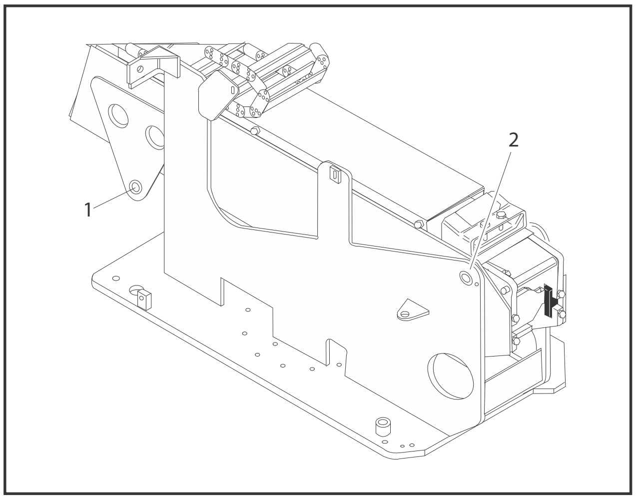


Figure 4-4. Tower Boom Components

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

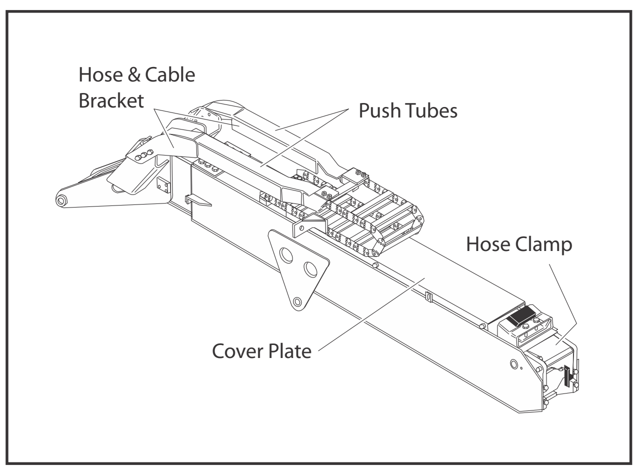


Figure 4-5. Tower Boom Powertrack Components

INSPECTION

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

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

ASSEMBLY

NOTE: *Install same number and thickness of shims as removed.*

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

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. 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, 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.
7. Using suitable lifting device, position upright on tower boom assembly so pivot holes in upright and tower boom are aligned.
8. Using all applicable safety precautions, operate lifting device and position upright leveling cylinder so holes in cylinder barrel end and upright structure are aligned. Insert level cylinder pin, ensuring that location of hole in pin is aligned with attach point on upright.
9. Align upper lift cylinder with attach holes in upright. Using a soft head mallet, install cylinder pin upright and secure with mounting hardware.
10. Align master cylinder with attach holes in upright. Using Install cylinder pin with soft head mallet. Secure with mounting hardware.

4.3 BOOM CLEANLINESS GUIDELINES

Following are guidelines for machines used in excessively dirty environments.

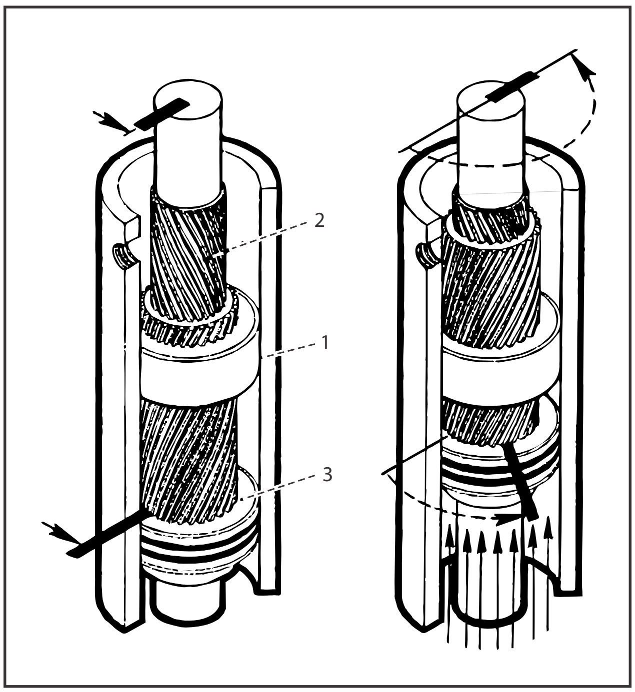
1. JLG recommends use of JLG Hostile Environment Package to keep internal portions of a boom cleaner and prevent dirt and debris from entering the boom. This package reduces the amount of contamination which can enter the boom but does not eliminate the need for more frequent inspections and maintenance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

4.4 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.

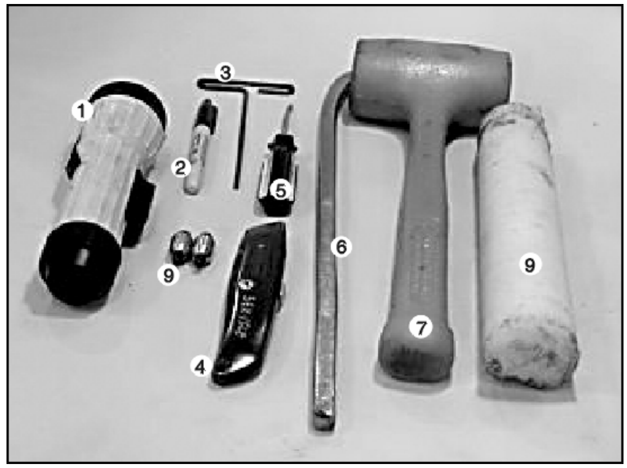
Each actuator is composed of a housing with integrated gear teeth (1) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (2), and the annular piston sleeve (3). Helical spline teeth machined on the shaft engage matching splines on the piston inside diameter. 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.

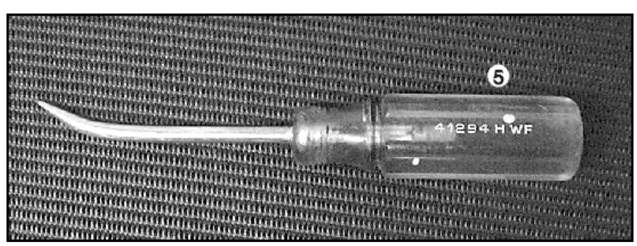
As hydraulic pressure is applied, piston is displaced axially within the housing - similar to operation of a hydraulic cylinder - while splines cause shaft to rotate. When control valve is closed, oil is trapped inside the actuator, preventing piston movement and locking shaft in position. The shaft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

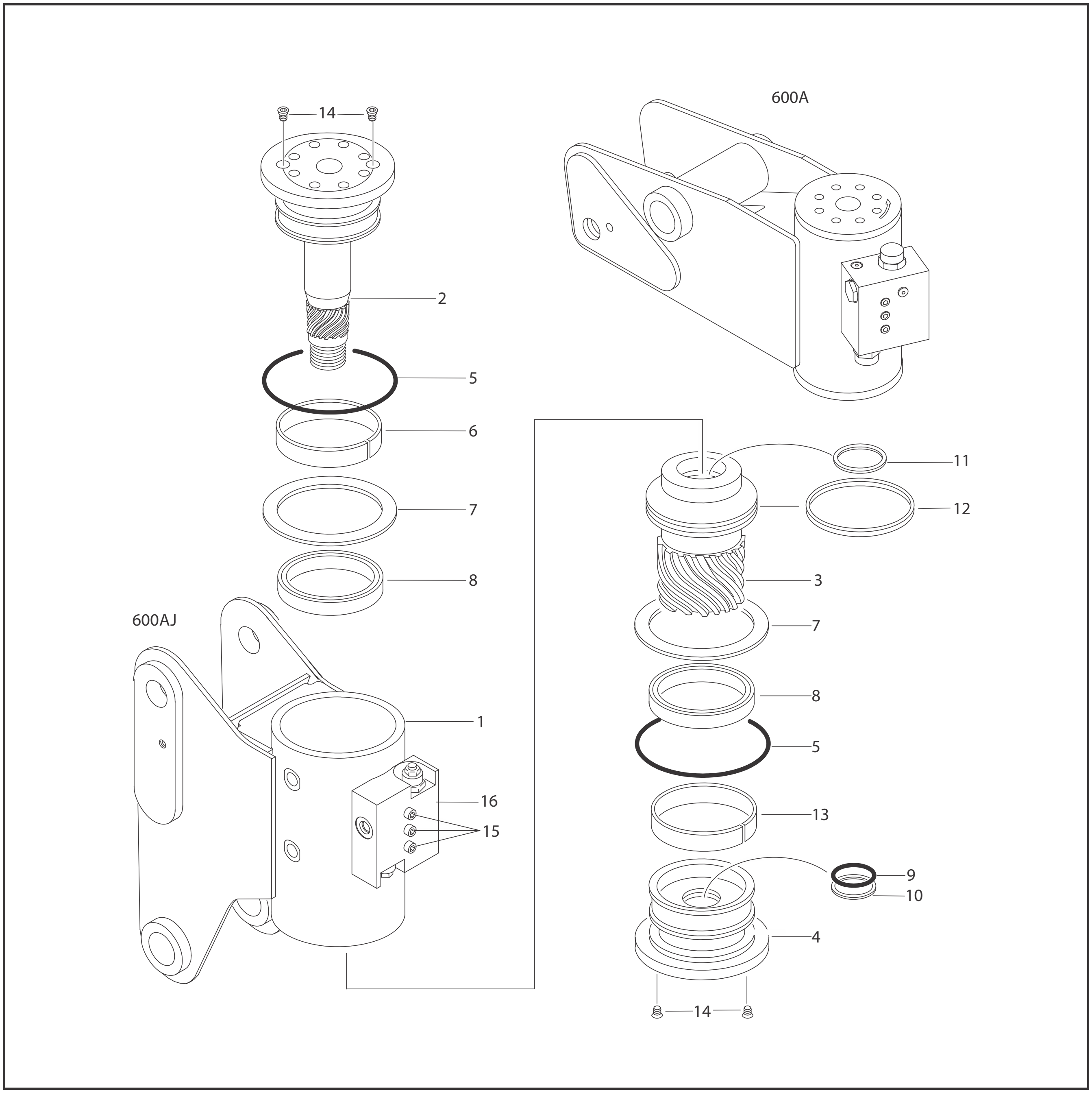
Required Tools



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.



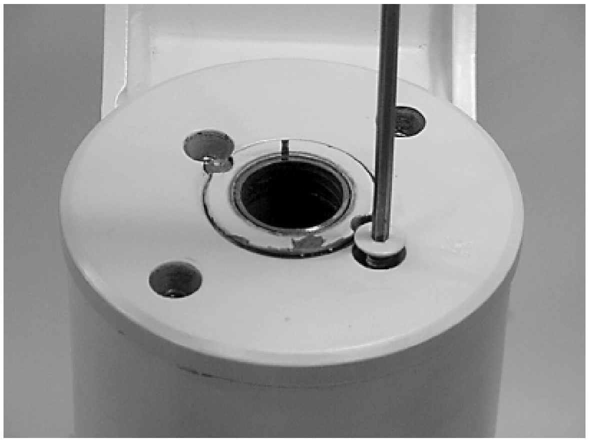


1.	Housing	5.	O-Ring	9.	Cap Seal	13.	Cap Bearing
2.	Shaft	6.	Shaft Bearing	10.	Back-Up Ring	14.	Capscrew
3.	Piston	7.	Thrustwasher	11.	Rod Seal	15.	Bolt
4.	End Cap	8.	Bearing Packing	12.	Piston Seal	16.	Valve Block

Figure 4-6. Rotary Actuator - Exploded View

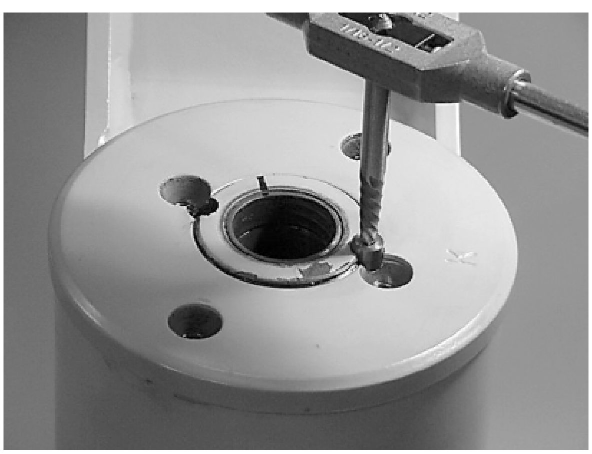
Disassembly

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

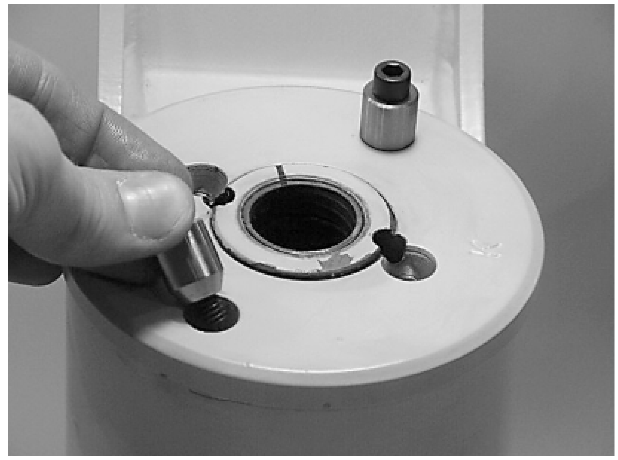


2. Using a 1/8” (3.18mm) drill bit, drill a hole in center of each lock pin approximately 3/16" (4.76mm) deep.

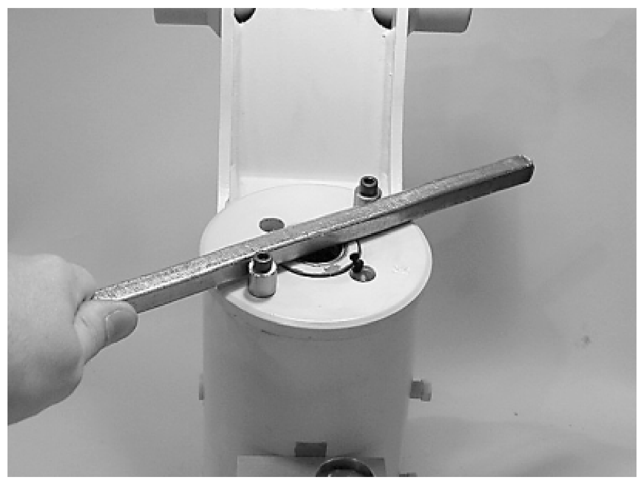
3. Remove lock pins using an ”Easy Out” (Size #2 shown. If pin will not come out, use 5/16" drill bit 1/2" (12.7mm) deep to drill out entire pin.



4. Remove end cap (4) using tools provided with Helac seal kit.



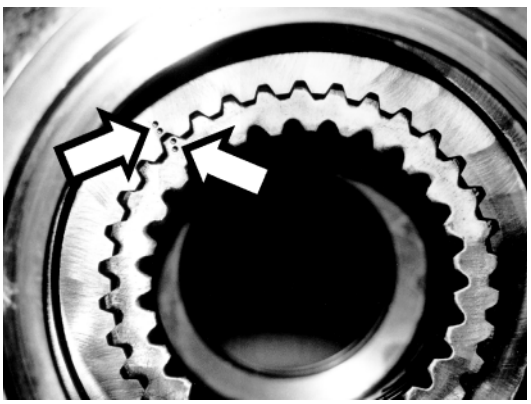
5. Using a metal bar or similar tool, unscrew end cap (4) by turning it counter clockwise.

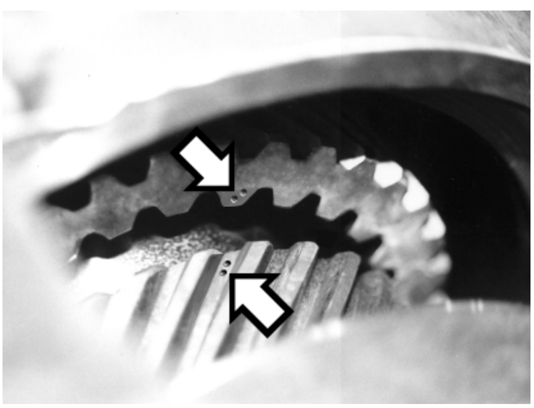


6. Remove end cap (4) and set aside for later inspection.

7. Remove stop tube if installed.

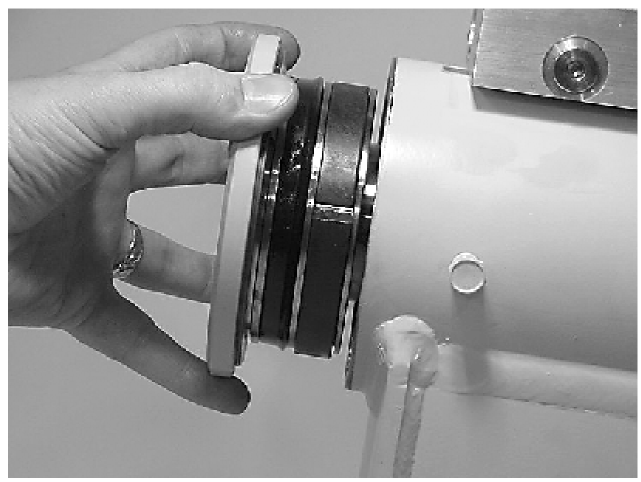
8. Actuator has timing marks for proper engagement.





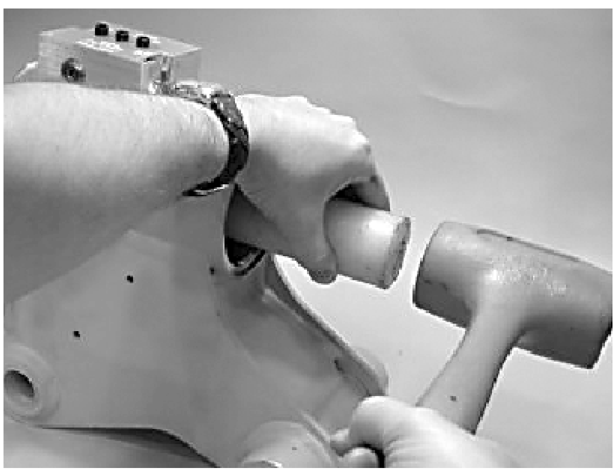
9. Before removing shaft, (2), use a felt marker to clearly indicate timing marks between shaft and piston. This simplifies timing during assembly.

10. Remove shaft (2). It may be necessary to strike threaded end of shaft with a rubber mallet.

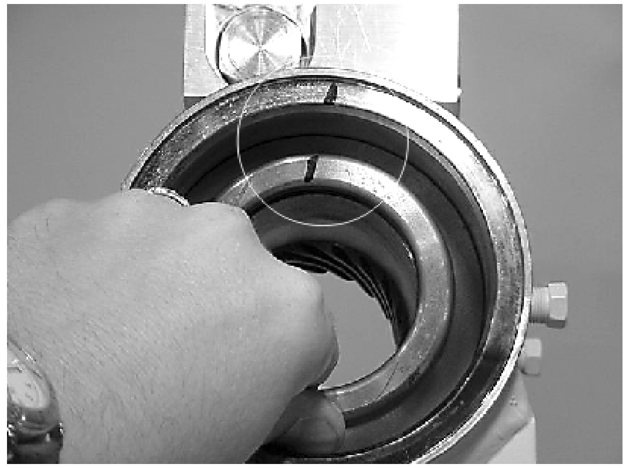


11. Before removing piston (3), mark housing (1) ring gear in relation to piston O.D. gear. There should be timing marks on housing (1) ring gear, piston (3), and shaft (2).

12. To remove piston (3), use a rubber mallet and plastic mandrel so piston is not damaged.

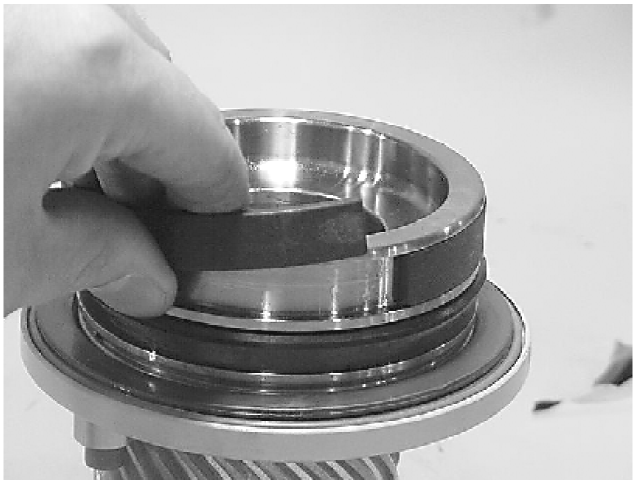


13. At the point when piston gear teeth come out of engagement with housing gear teeth, mark piston and housing with a marker as shown.

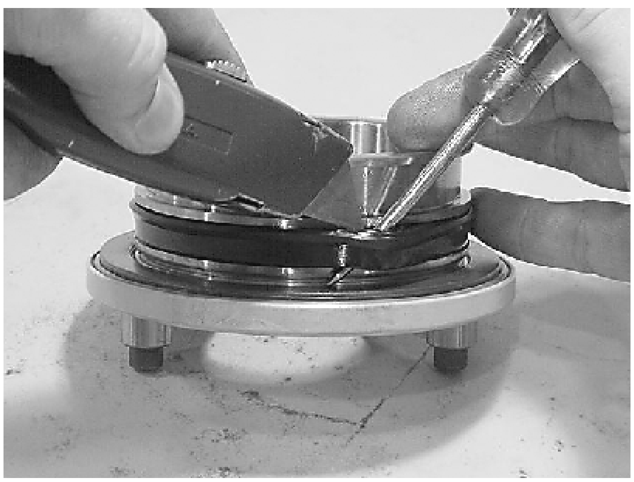


14. Remove O-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.

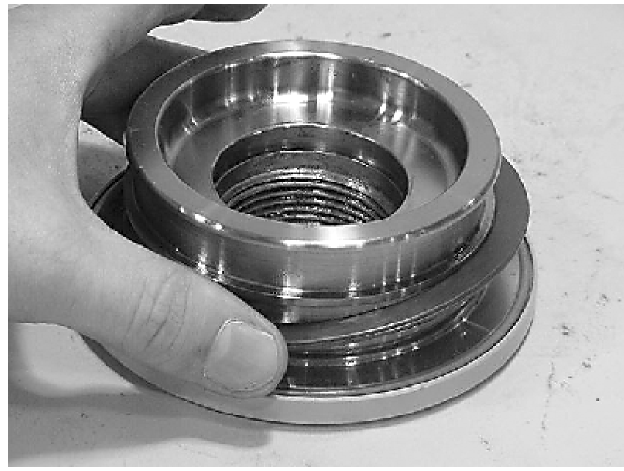
15. Remove wear guides (302) from end cap (4) and shaft (2).



16. To remove main pressure seals (205), cut them with a sharp razor blade. Do not to damage seal groove.



17. Remove thrust washers (304) from end cap (4) and shaft (2).



18. Remove wiper seal (304.1) from end cap (4) and shaft (2).

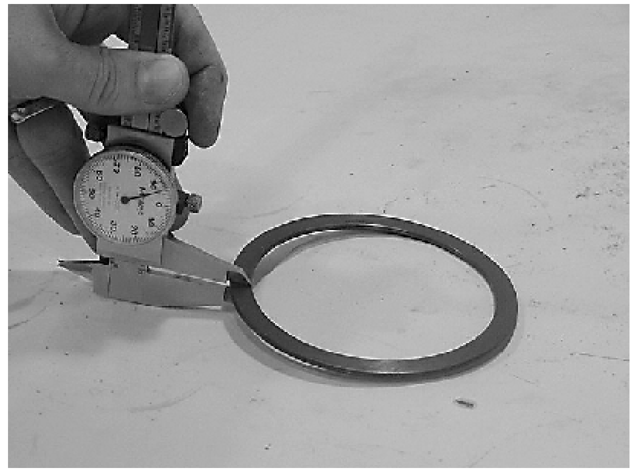
19. Remove piston O.D. seal (202).

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

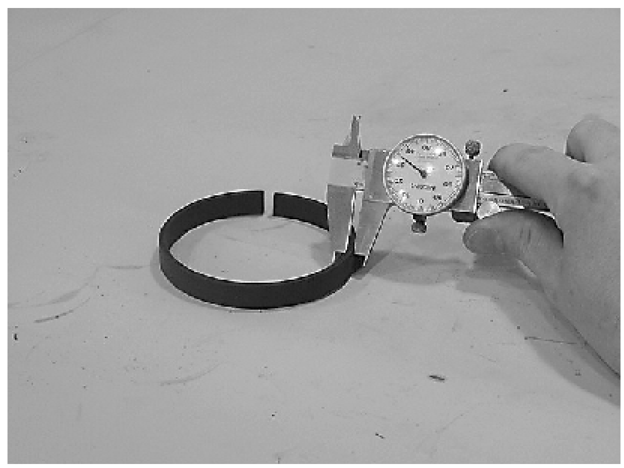
Inspection

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).

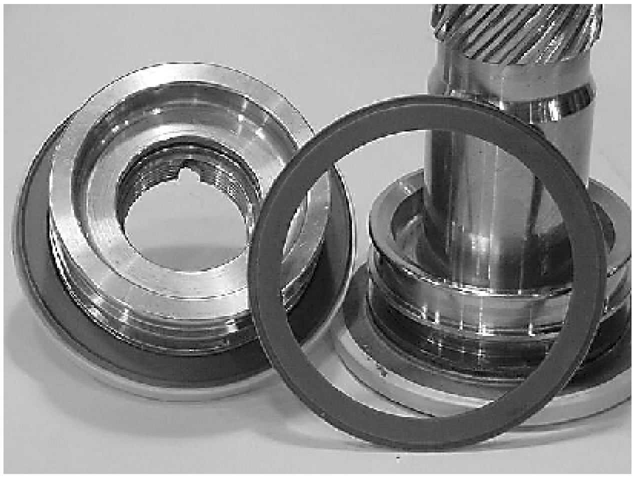


3. Inspect wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).

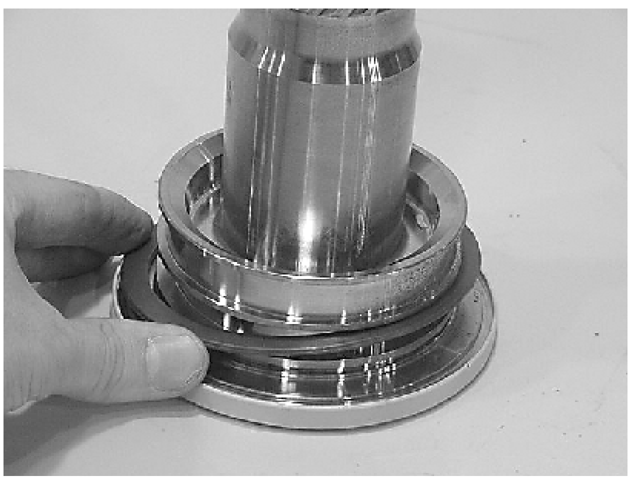


Assembly

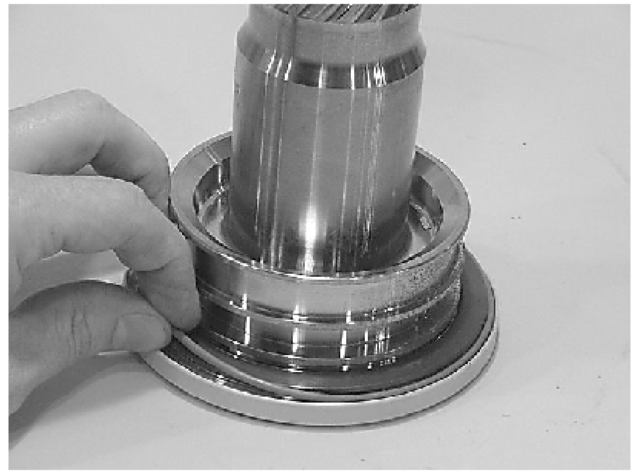
1. Gather all components and tools to one location. Use cut away drawing to reference seal orientations.



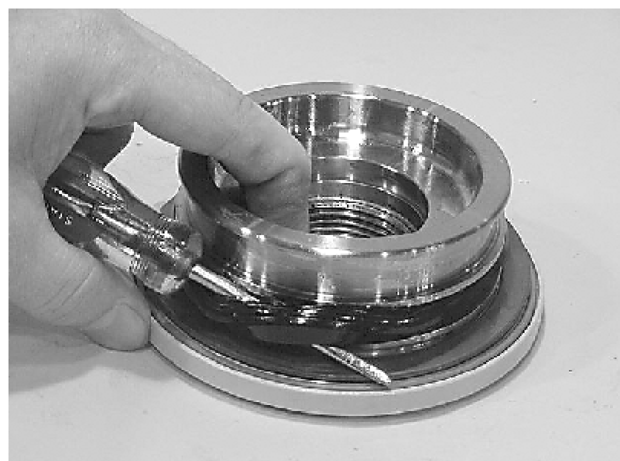
2. Install thrust washer (304) on shaft (2) and end cap (4).



3. Install wiper seal (304.1/green 0-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.



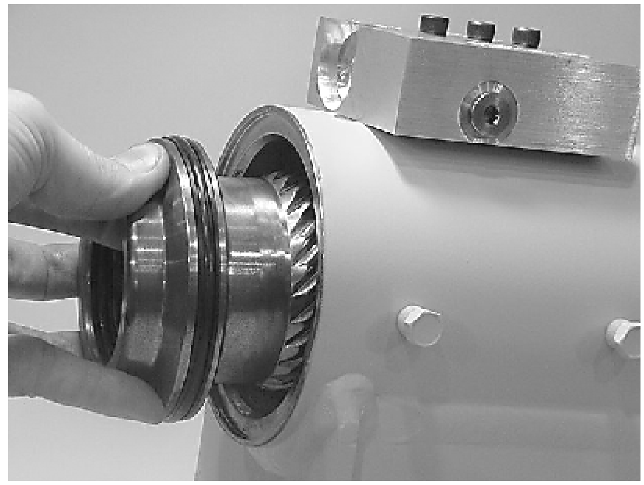
5. Install wear guide (302) on end cap (4) and shaft (2).

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).

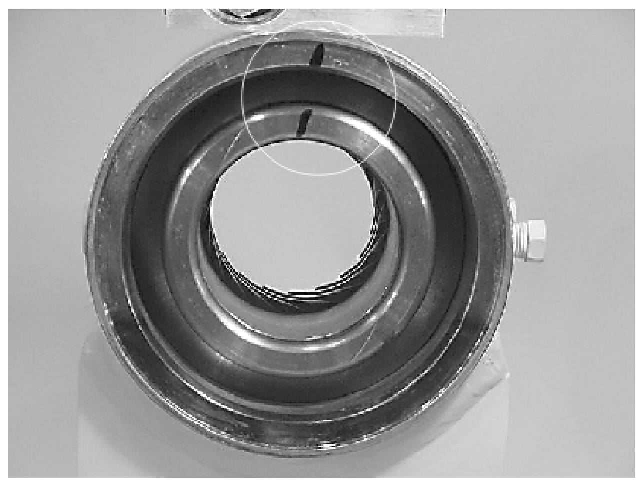
7. Beginning with inner seal (200) insert one end of b/u ring in lower groove and feed the rest in using a circular motion. Make sure wedged ends overlap correctly.

   Repeat for outer seal (202).

8. Insert piston (3) in housing (1) as shown, until outer piston seal (202) touches inside housing bore.

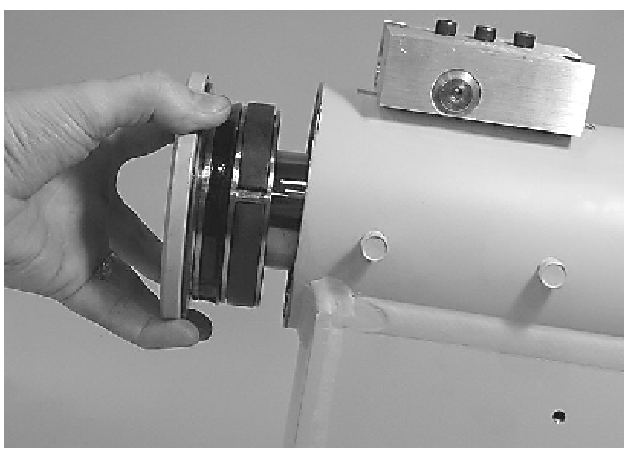


9. Looking from angle shown, rotate piston (3) until marks you put on piston and housing (1) during disassembly line up as shown. Using a rubber mallet, tap piston in housing to point where gear teeth meet.



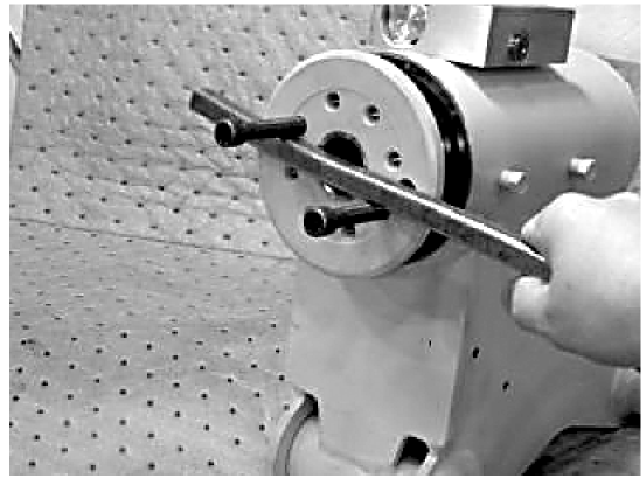
10. Looking from opposite end of housing (1) when timing marks line up, tap piston (3) in until gear teeth mesh together. Tap piston in housing until it bottoms out.

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



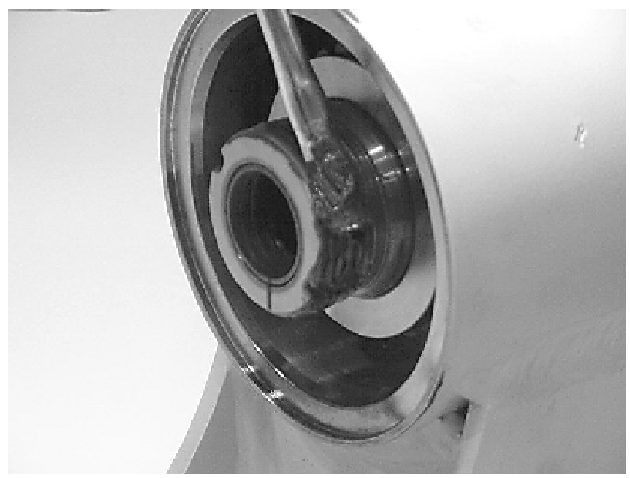
12. Looking from view shown, use existing timing marks to line up gear teeth on shaft (2) with gear teeth on inside of piston (3). Tap flange end of shaft with rubber mallet until gear teeth engage.

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



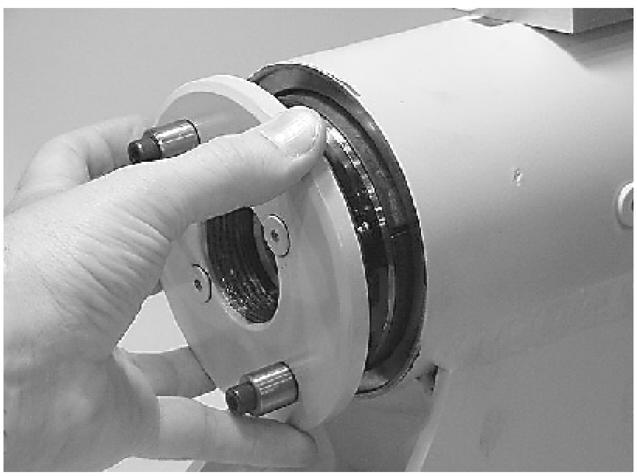
14. Install stop tube on shaft end. Stop tube is an available option to limit actuator rotation.

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

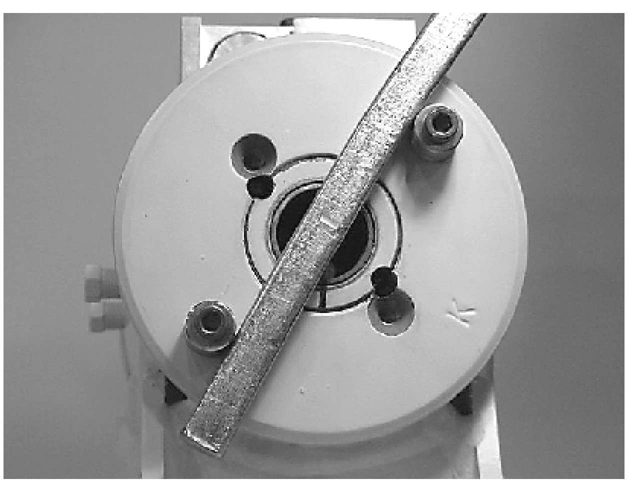


16. Install 0-ring (204) and back-up ring (207) in inner seal groove on end cap (4).

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).

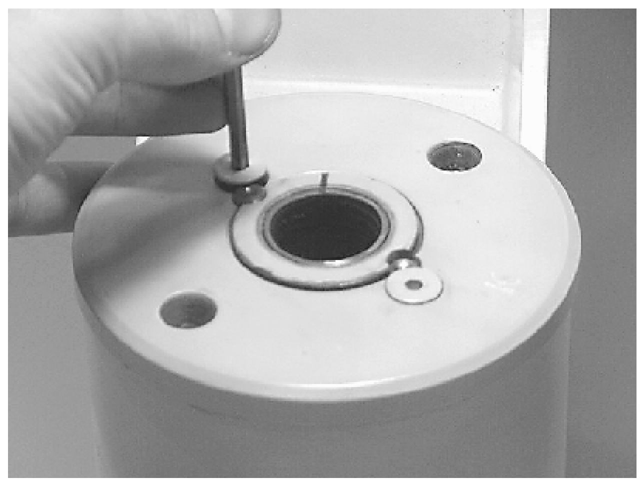


18. Tighten end cap (4). Ensure holes for lock pins line up.



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 4-7., 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).

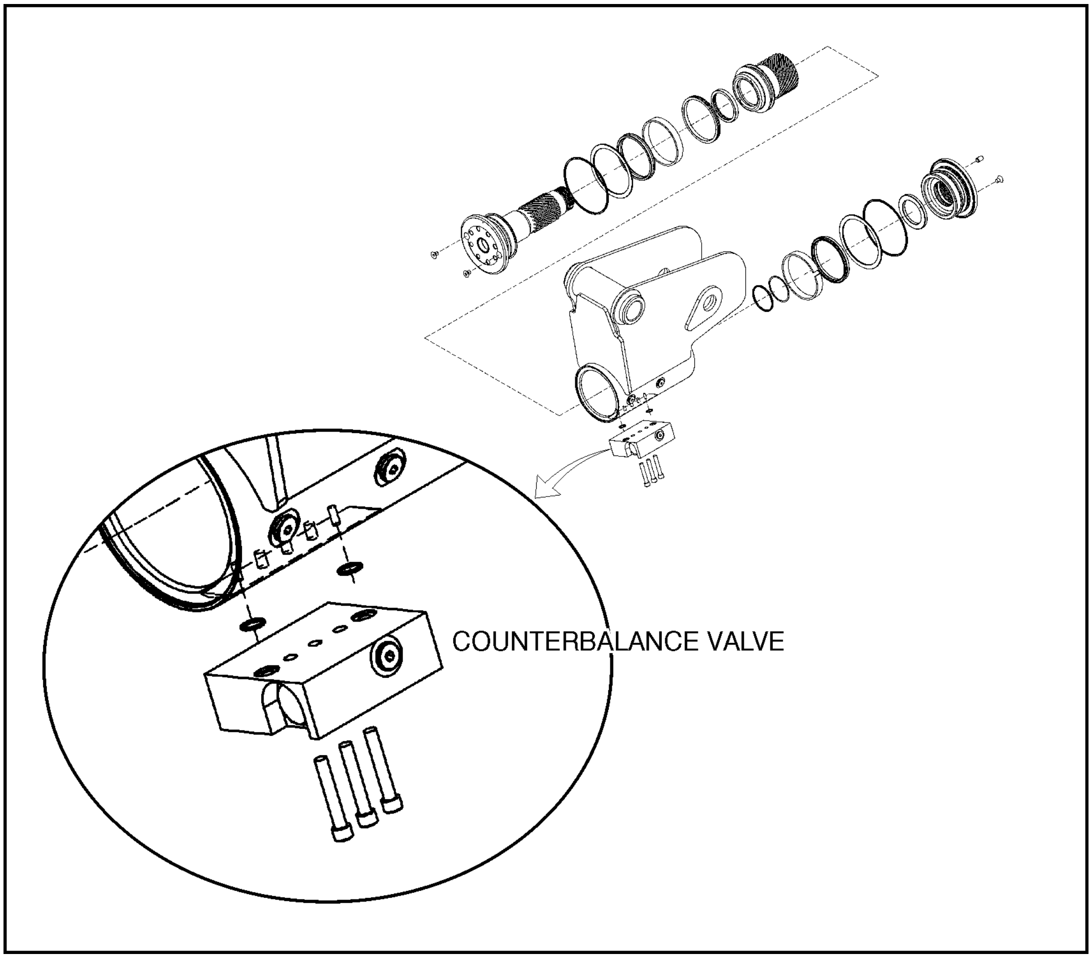


Figure 4-7. Rotator Counterbalance Valve

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

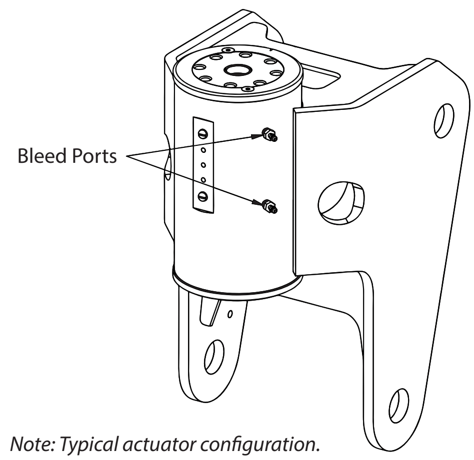
WARNING

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.



Note: Typical actuator configuration.

Figure 4-8. Actuator Bleed Ports

3. With an operator in the platform, open both bleed nipples 1/4 turn. Hydraulically rotate platform to end of rotation (clockwise or counterclockwise), and maintain hydraulic pressure. Oil with small air bubbles will be seen flowing through the tubes. Allow 1/2 gallon of fluid to be purged from actuator.
4. Keep fittings open and rotate platform in opposite direction to end position. Maintain hydraulic pressure until an additional 1/4 gallon of fluid is pumped into the container.
5. Repeat steps 2 & 3. After last 1/2 gallon is purged, close both bleed nipples before rotating away from end position.

Table 4-1. Troubleshooting

Problem	Cause	Solution
1. Shaft rotates slowly or not at all	a. Insufficient torque output	a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.
	b. Low rate of fluid flow	b. Inspect ports for obstructions and hydraulic lines for restrictions and leaks.
	c. Control or counterbalance valve has internal leak	c. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate actuator through housing ports (do not exceed OEM's operating pressure). Valve must be replaced if a steady flow of fluid is seen coming from valve ports.
	d. Piston and/or shaft seal leak	d. Remove plug and housing's valve ports. Operate actuator through housing ports. Conduct internal leakage test.
	e. Corrosion build-up on the thrust surfaces	e. Rebuild actuator. Remove all rust then polish. Replacement parts may be needed.
	f. Swollen seals and composite bearings caused by incompatible hydraulic fluid	f. Rebuild actuator. Use fluid compatible with all seals and bearings.
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	a. Twisted or chipped gear teeth	a. Check for gear binding. Actuator may not be able to be rebuilt and may need to be replaced. Damage could be a result of overload or shock.
	b. Port fittings are obstructing the piston	b. Check thread length of port fittings. Fittings should during stroke not reach inside housing bore.
4. Selected position cannot be maintained	a. Control or counterbalance valve has internal leak	a. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate actuator through housing ports (do not exceed OEM's operating pressure). Valve must be replaced if a steady flow of fluid is seen coming from valve ports.
	b. Piston and/or shaft seal leak	b. Remove plug and housing's valve ports. Operate actuator through housing ports. Conduct internal leakage test.
	c. Air in actuator	c. Purge air from actuator. See bleeding procedures

4.5 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.

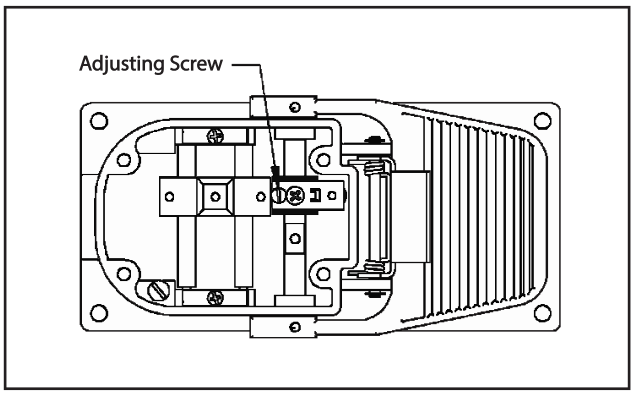


Figure 4-9. Foot Switch Adjustment

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

4.6 PLATFORM

Platform Support Torque Settings

NOTE: *If any rotator bolts are replaced, re-torque all rotator bolts.*

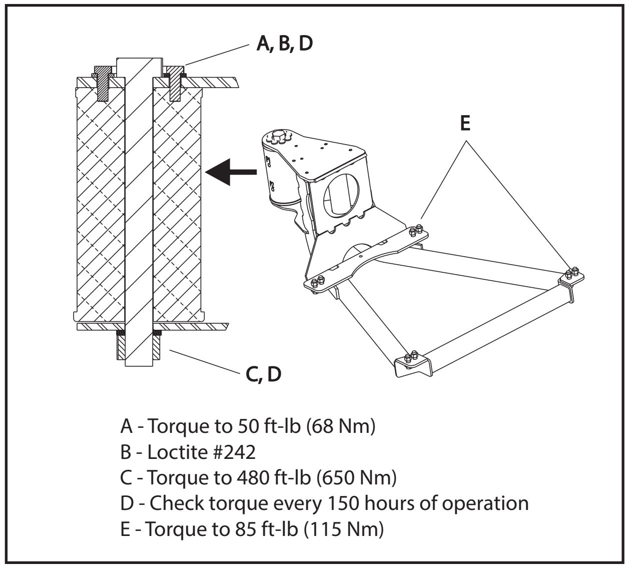


Figure 4-10. Platform Support Torque Values

Replace Platform Sections

The platform is made up of five sections: floor, right side, left side, back (console box mounting.), and gate. Sections are secured with Huck magna grip fastener and collars.

1. Support Huck collar with a suitable support.
2. Using a hammer and chisel, remove collar from fastener.

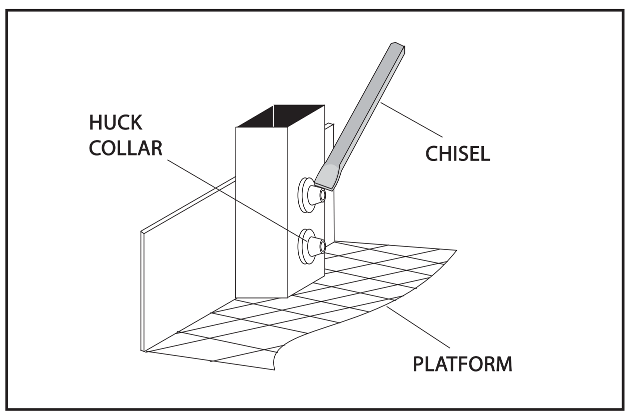


Figure 4-11. Platform Section Replacement

3. Replace Huck fasteners with 1/4 x 20 NC x 2 1/4" grade 5 bolts, flat washers, and locknuts when installing new section of platform.
4. Replace rivets with 1/4 x 20 NC x 2 "grade 5 bolts, flat washers, and locknuts when installing a new gate to platform.

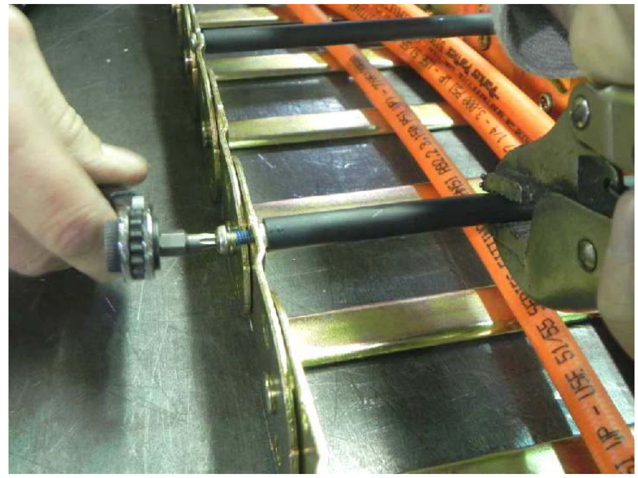
4.7 POWERTRACK MAINTENANCE

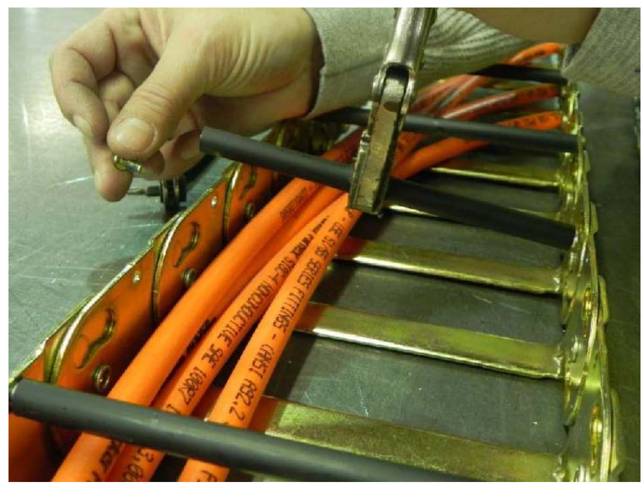
Remove Link

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.

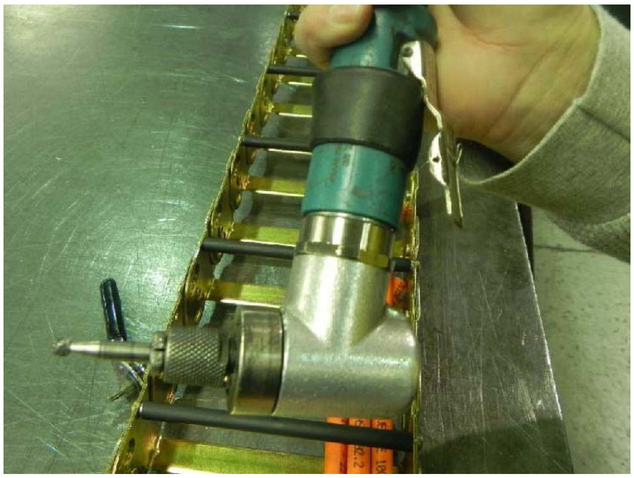




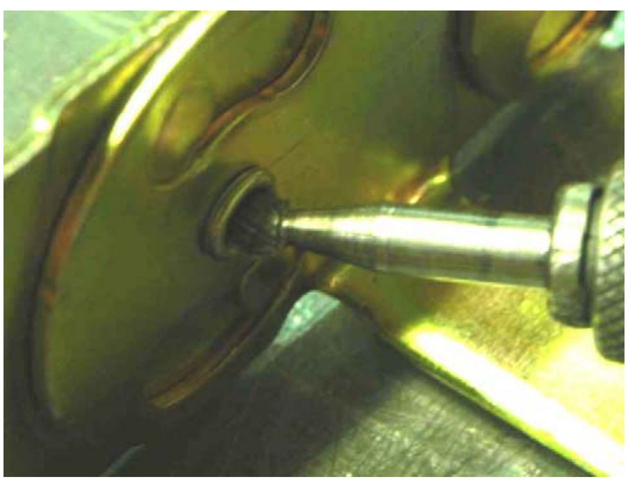
NOTICE

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

3. To remove a link, rivets holding links together must be removed. Use a right-angle pneumatic die grinder with a ¼" ball double cut bur attachment.

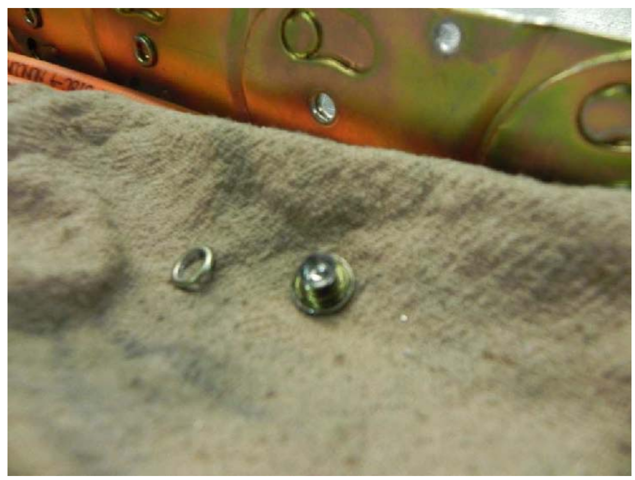


4. insert tool into rolled over end of rivet. Grind out middle of rivet until rolled over part of rivet falls off. Repeat for all rivets to be removed.

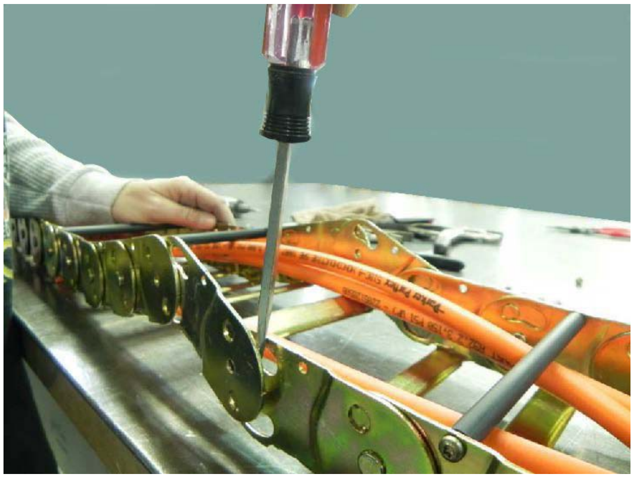


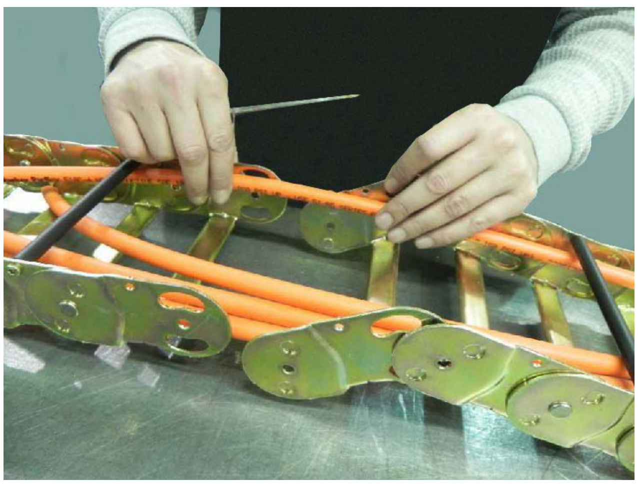
5. After grinding it may be necessary to use a center punch with a hammer to remove rivet.

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.

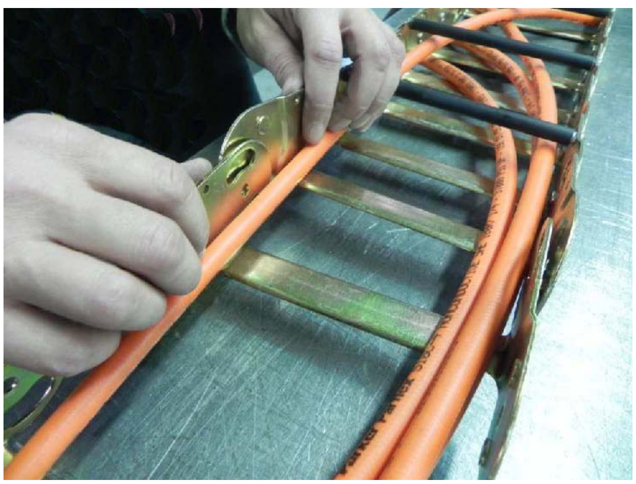




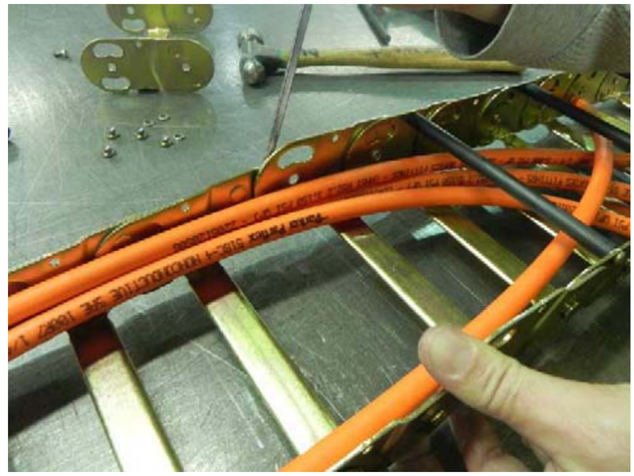
7. Remove link from other section of powertrack using screwdriver.

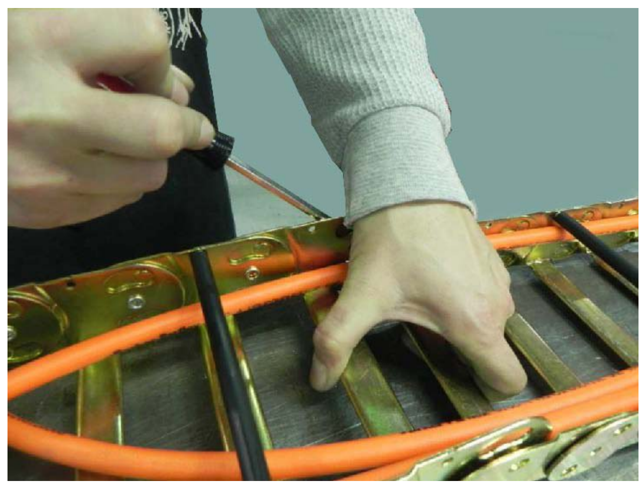
Install New Link

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

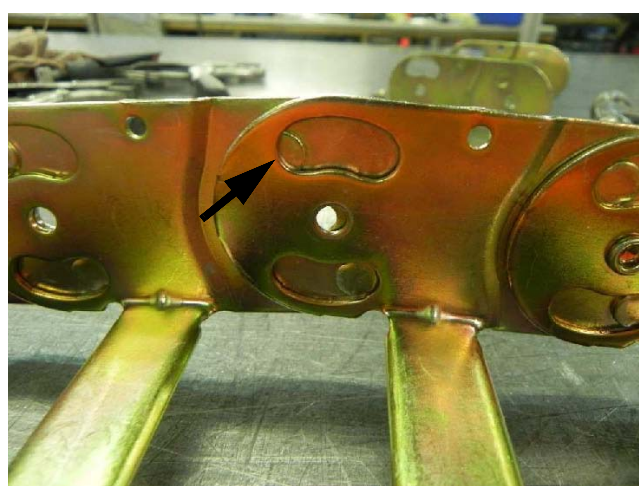


2. Spread half-shear (female) end of new link and slide cut-out end of track section into it. Use screwdriver if necessary.

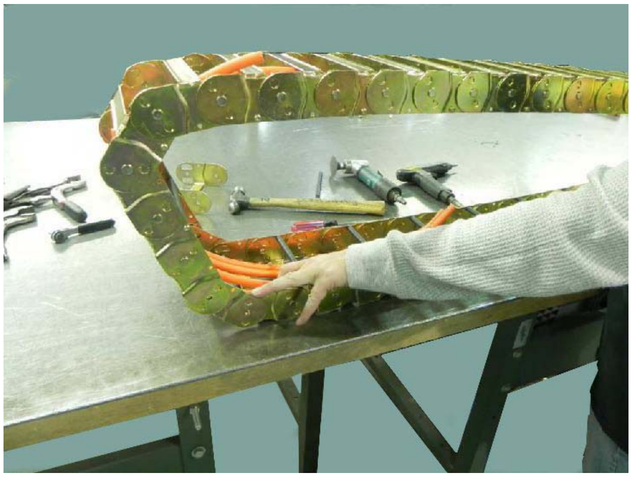


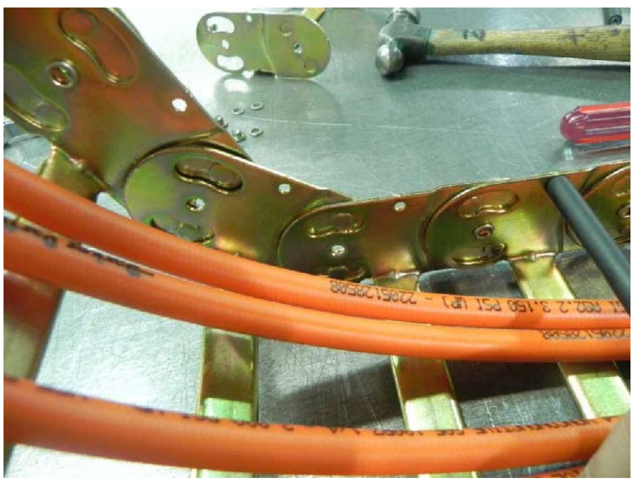


3. Round half-shears will not fit properly in cut-outs after new link is installed.

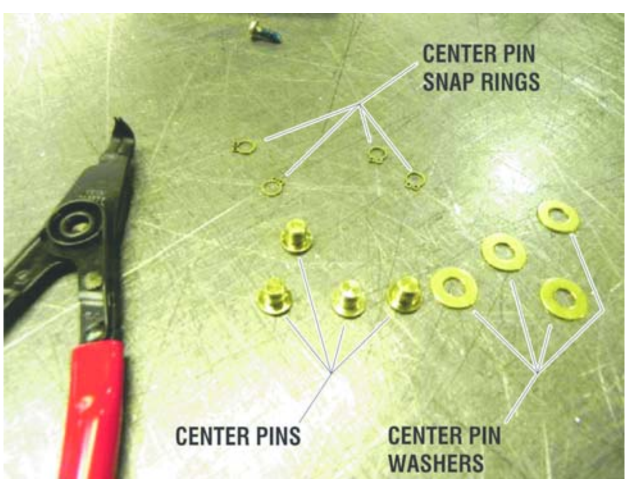


4. Pull moving end over track so new connection is positioned in curve of powertrack. Round half-shears will rotate into cut-outs.





5. Parts shown below connect new link to powertrack.

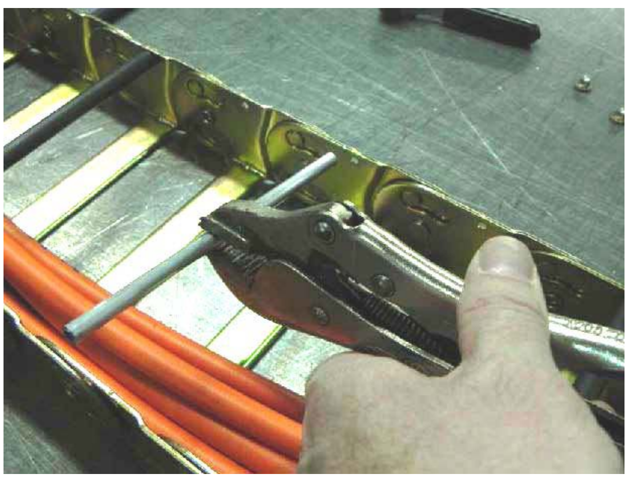


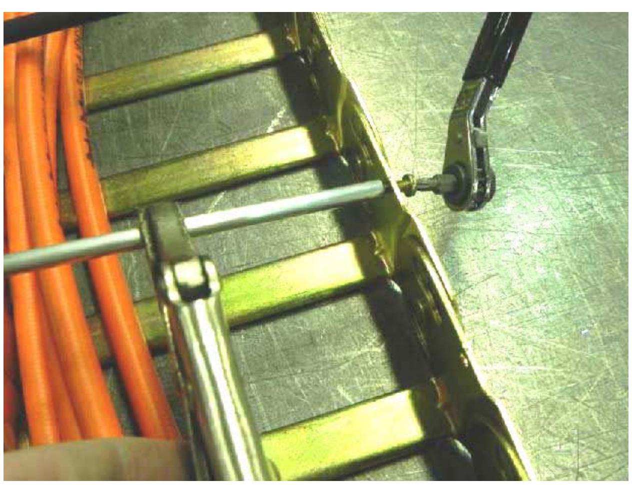
6. Push pin through center hole. Slide washer on pin.

7. Install snap ring in groove on pin. Repeat pin installation steps for all center holes with rivets removed.

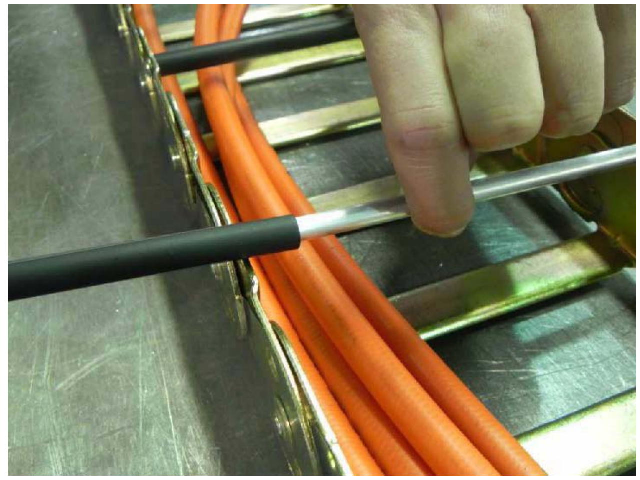
NOTE: *Make sure snap rings are seated in pin groove and closed properly.*

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

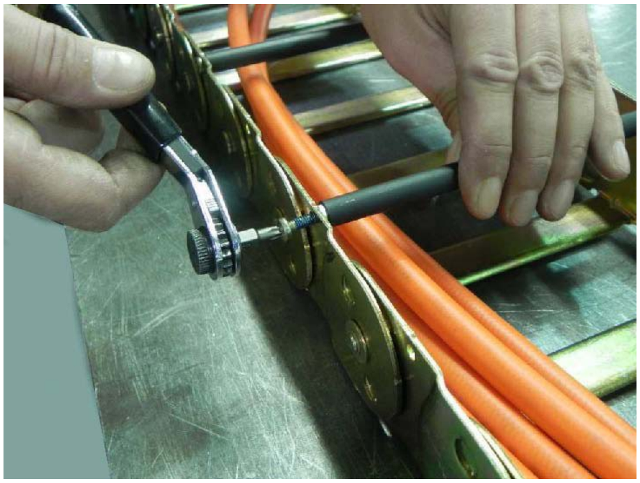




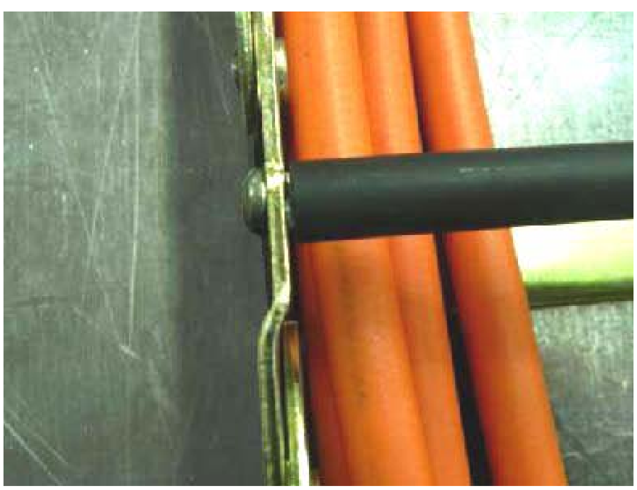
2. Pull up on other end of round bar. Slide new poly roller on bar.



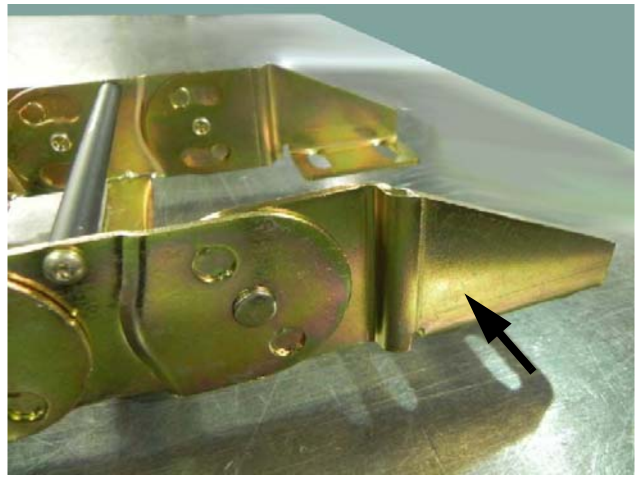
3. Install new 8-32 x 0.500 self threading screw on other side. Torque to 18-20 in-lb (2-2.25 Nm).



NOTE: *When tightening screws make sure screw head is seated against link with no space in between link and underside of screw head.*



Replace Fixed End Brackets



NOTICE

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

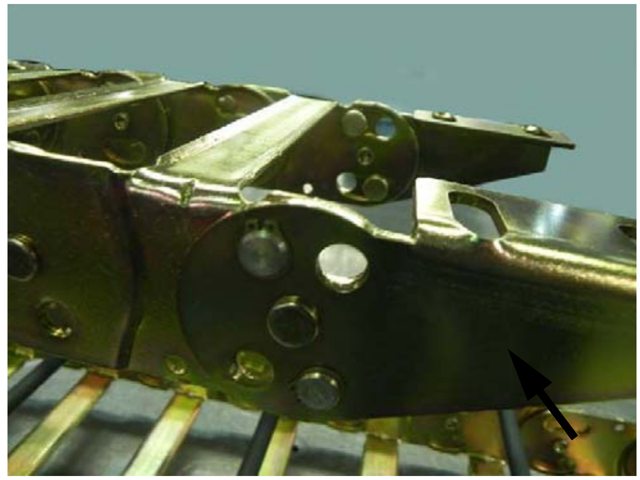
1. Remove rivets as shown in link removal instructions.

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

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.*

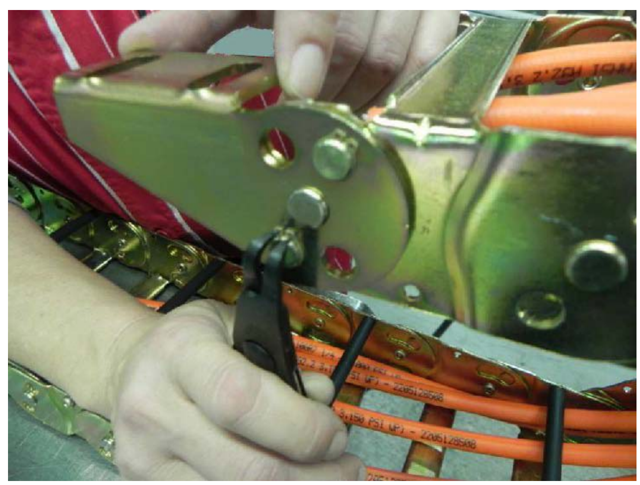
Replace Moving End Brackets



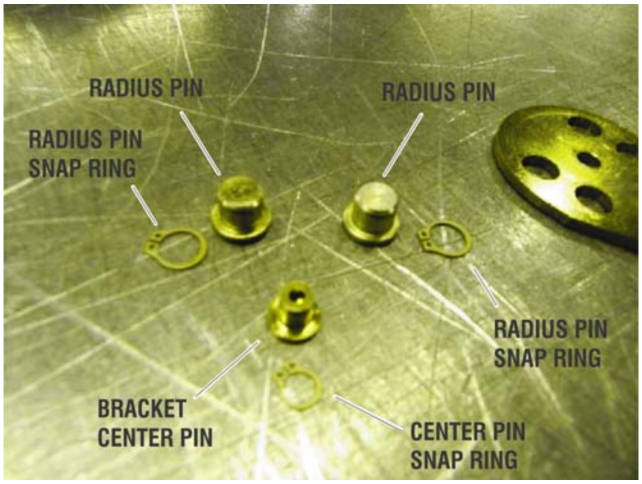
NOTICE

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

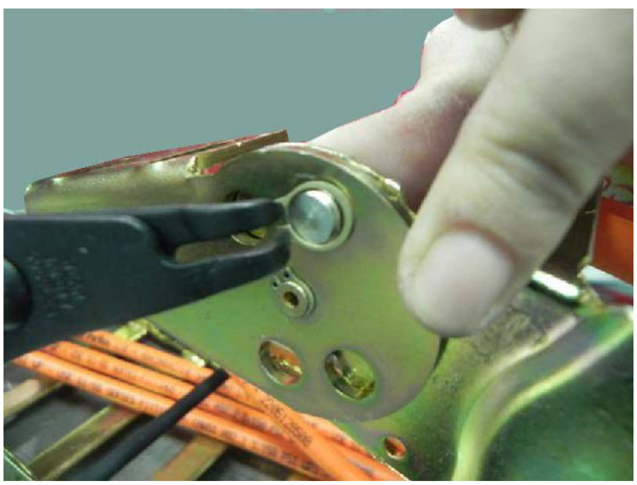
1. Remove existing pins and center rivet. Remove rivet as shown in link removal instructions on page 4-20. Repeat on other bracket if replaced.



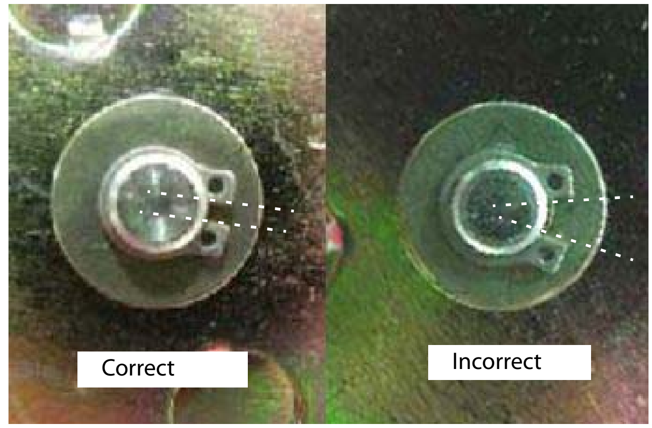
2. Install center pin with snap ring in new bracket.



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.*



1. Make sure both brackets rotate correctly.

NOTES:

SECTION 5. HYDRAULICS AND HYDRAULIC SCHEMATICS

5.1 O-RING LUBRICATION

When assembling connectors, all fittings with O-rings must be lubricated with hydraulic oil before assembly. There are four methods of lubricating O-rings:

1. Cup and Brush

2. Dip

3. Spray

4. Brush-On

Cup and Brush

Tools needed:

- Small container for hydraulic oil
- Small paint brush

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

2. Hold fitting over hydraulic oil container and brush an even film of oil around entire O-ring in fitting. Make sure 8-ring is completely saturated.

3. Turn fitting over and repeat previous step to O-ring on other side of fitting. Make sure entire O-ring is coated with hydraulic oil.

Dip

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

Tools needed:

- Small leak proof container
- Sponge cut to fit inside container
- Small amount of hydraulic oil to saturate sponge.

1. Place sponge inside container and add hydraulic oil to sponge until fully saturated.
2. Dip fitting into sponge using firm pressure.

3. After lifting fitting, a small droplet should form and drip from bottom of fitting. This indicates an even coating of oil.

NOTE: *O-ring boss-type fittings require more pressure to immerse more of fitting into saturated sponge. This also causes more oil to be dispersed from sponge.*

Spray

This method requires a pump or trigger spray bottle.

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

Brush-On

This method requires a sealed bottle brush.

1. Fill bottle with hydraulic oil.
2. Using slight pressure to body of spray bottle, invert bottle so brush end faces down.
3. Brush an even coat of hydraulic oil on entire O-ring.

5.2 CYLINDERS - THEORY OF OPERATION

Systems With Double Acting Cylinders

Systems with double acting cylinders are the 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.

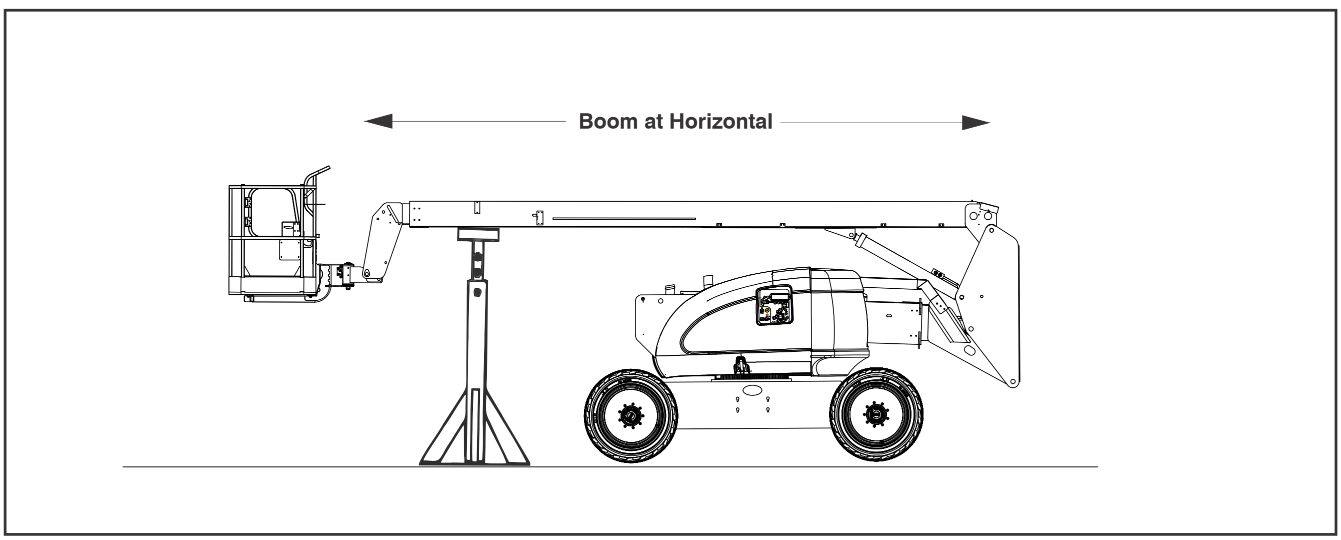


Figure 5-1. Boom Positioning and Support, Cylinder Repair

Cylinders With Single Counterbalance Valve

(Upper 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.

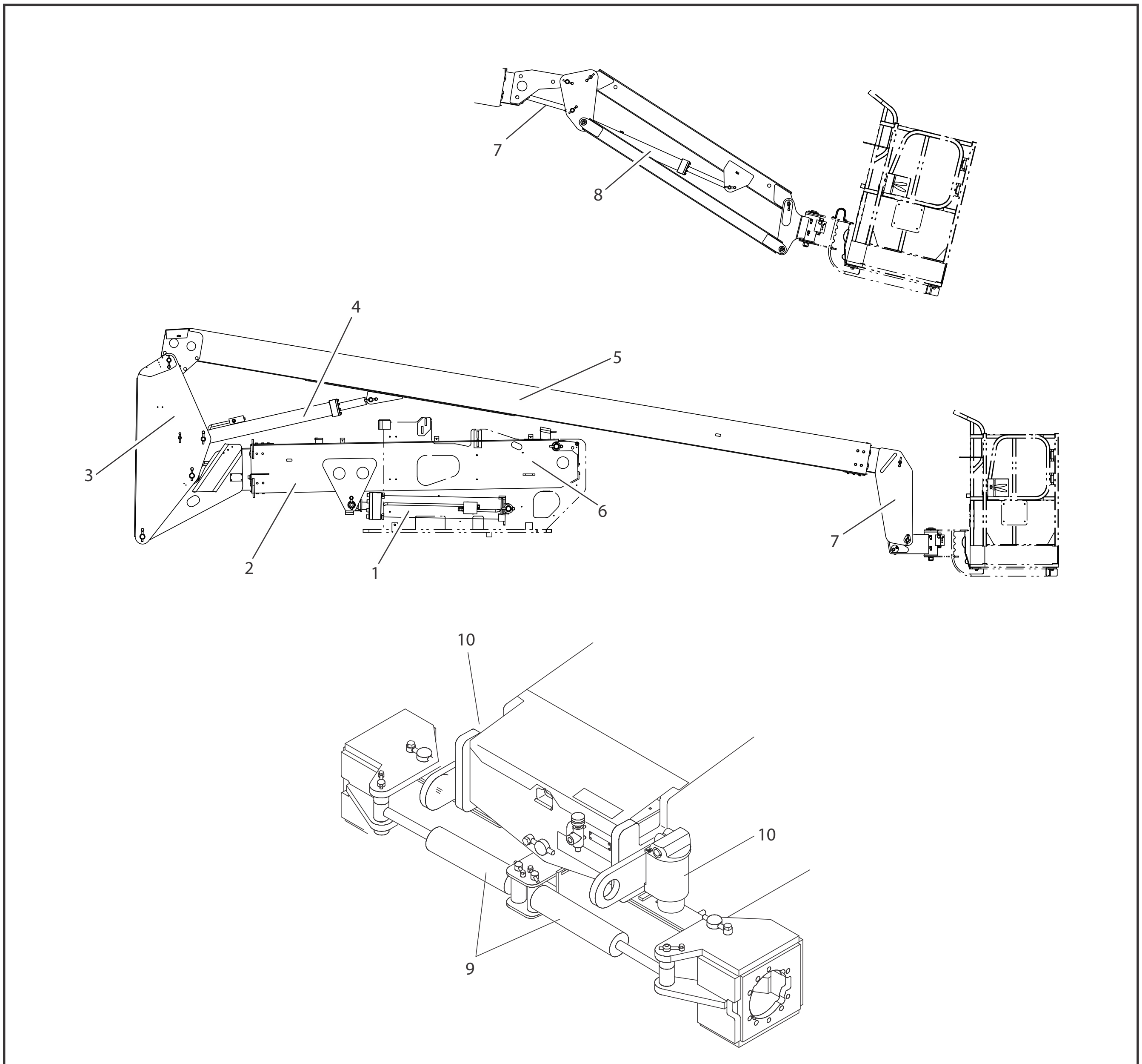
⚠ WARNING

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 CYLINDER REMOVAL AND INSTALLATION

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 (4).
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
10. precautions. Check for correct operation and hydraulic leaks. Secure as necessary.
11. Check fluid level of hydraulic tank. Adjust as needed.

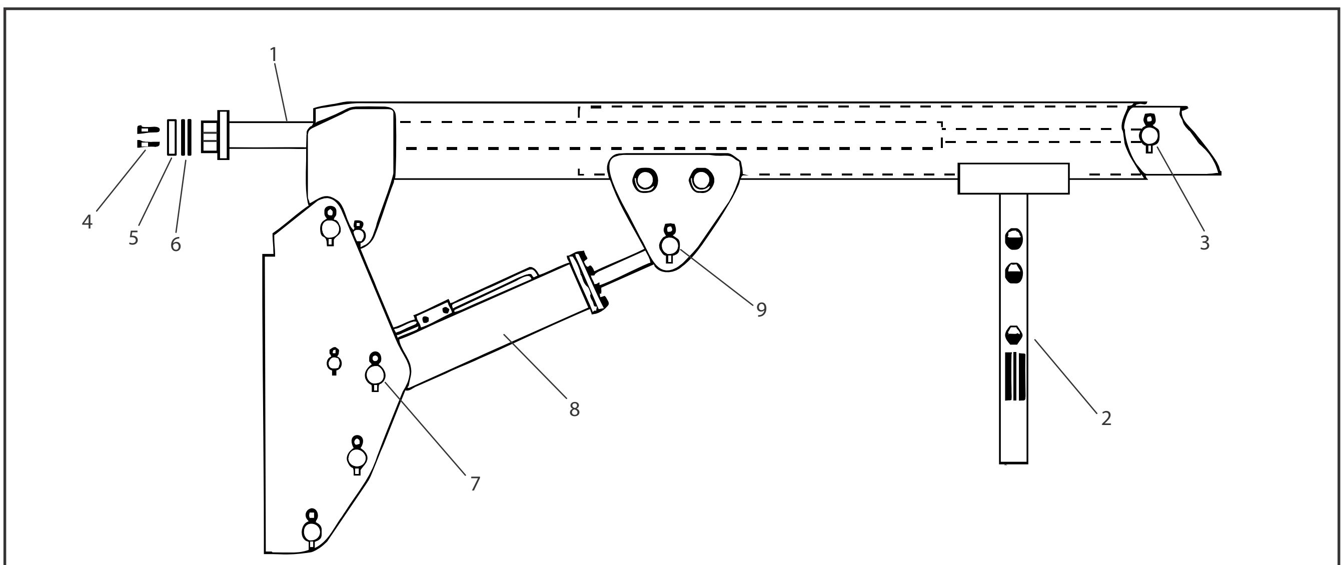


Figure 5-3. Telescope and Lift Cylinder Installation

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.

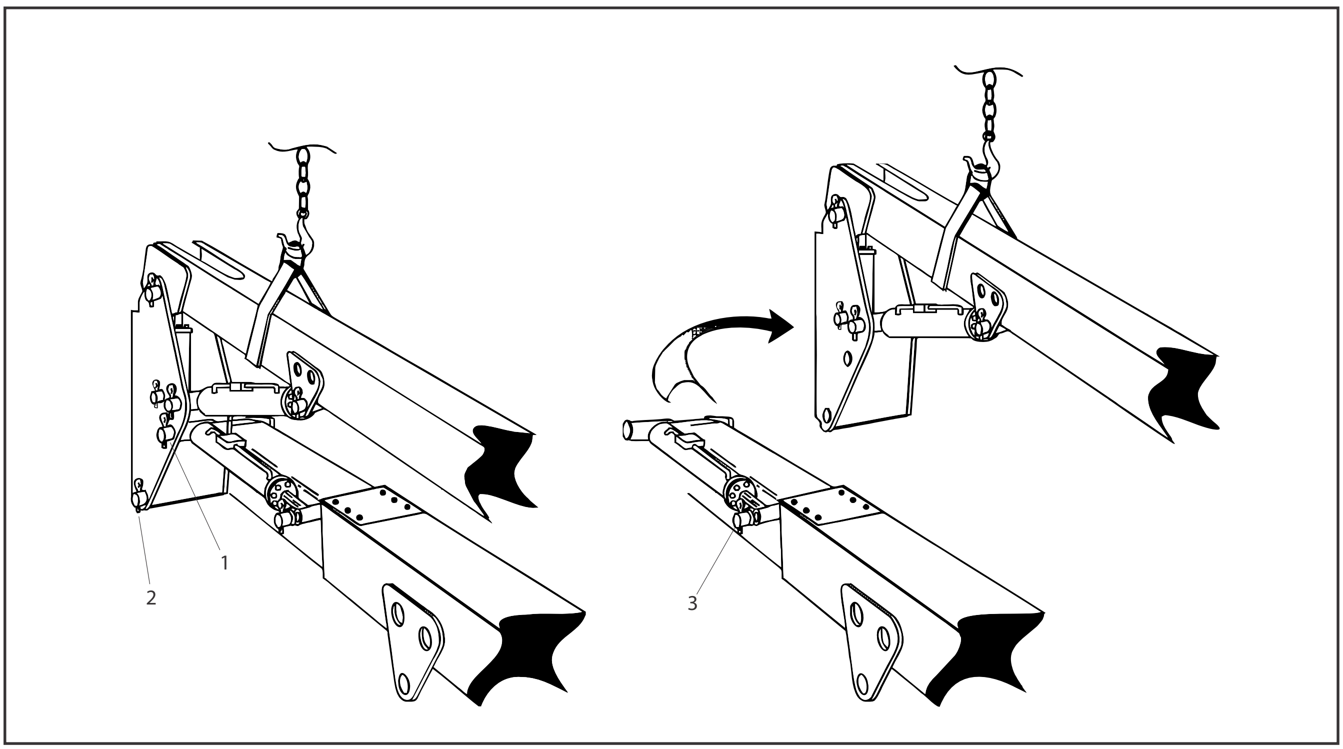


Figure 5-4. Leveling Cylinder Removal

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).

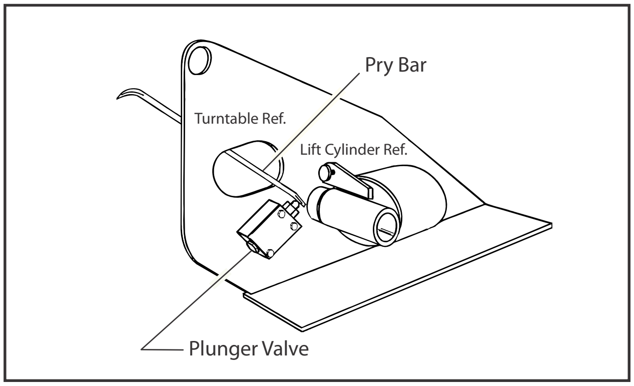


Figure 5-5. Plunger Valve Override

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).

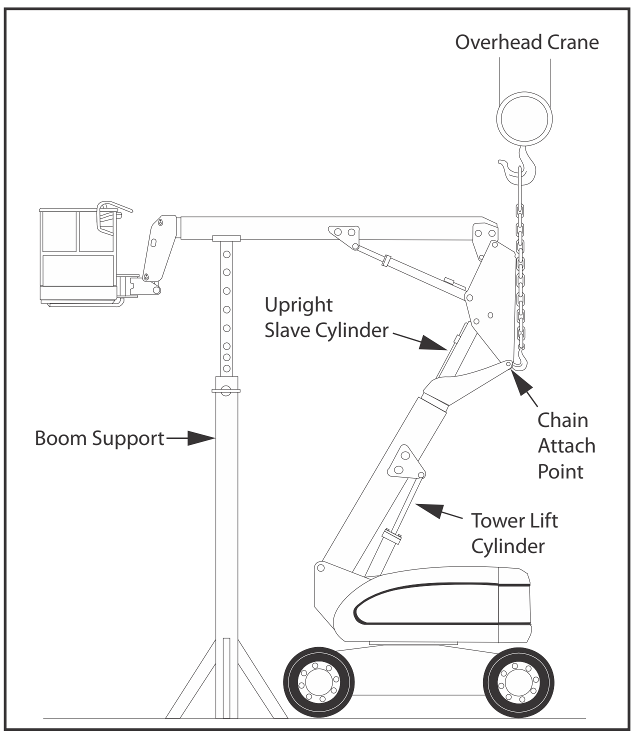


Figure 5-6. Boom Positioning and Support, Cylinder Repair

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.

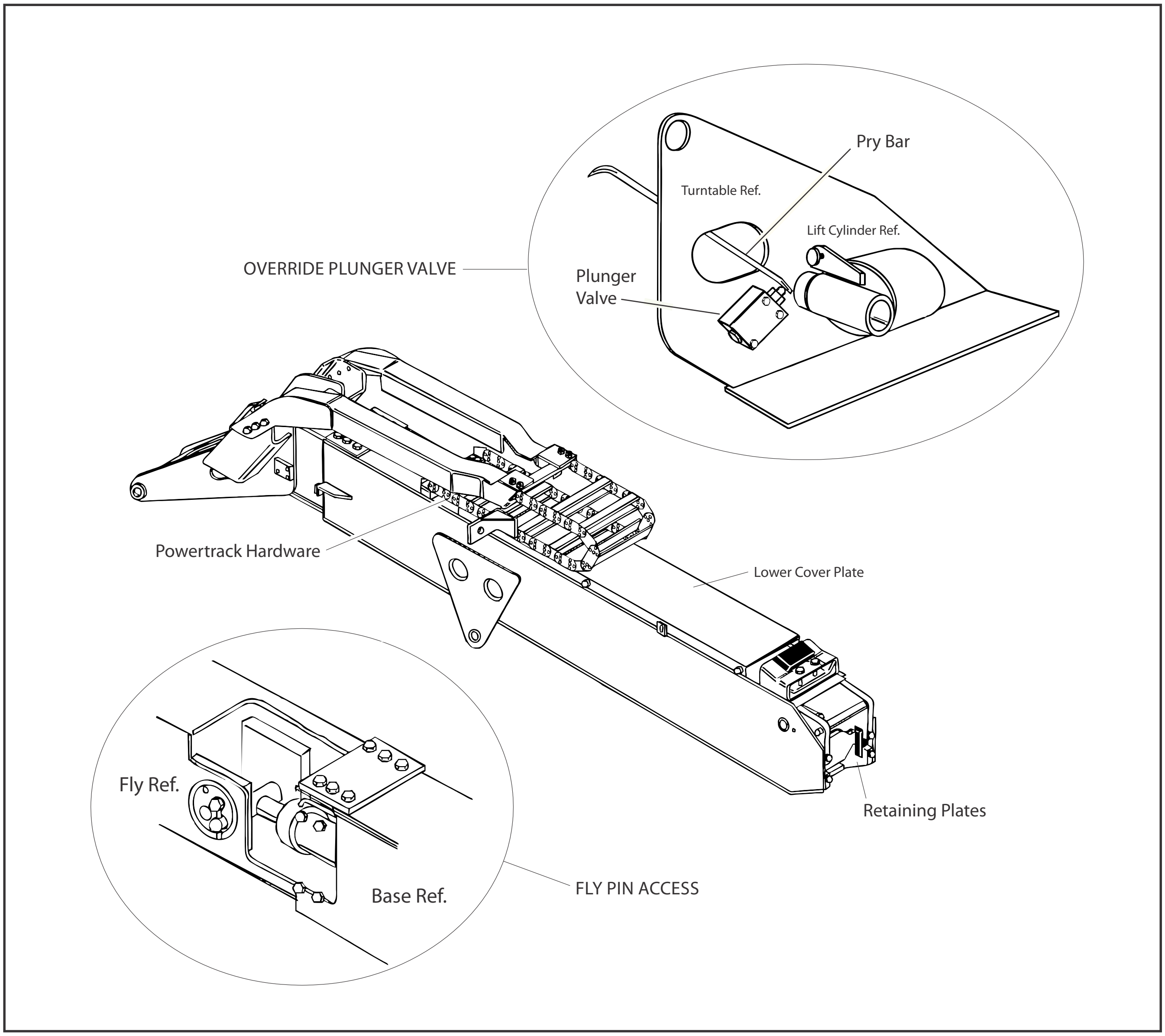


Figure 5-7. Tower Telescope Cylinder Removal

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.

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.

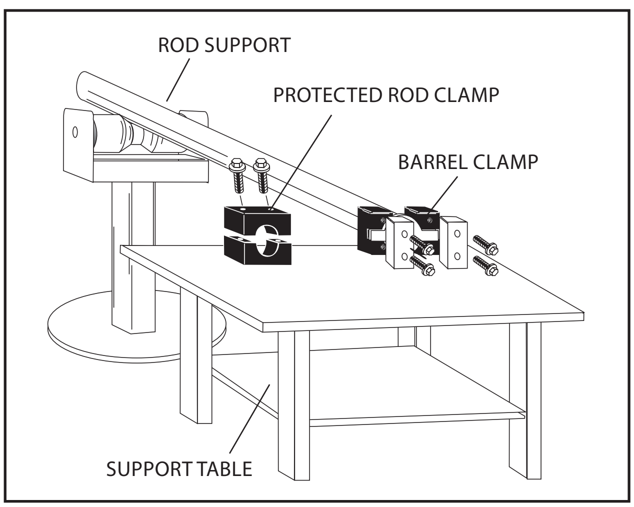


Figure 5-8. Cylinder Barrel Support

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

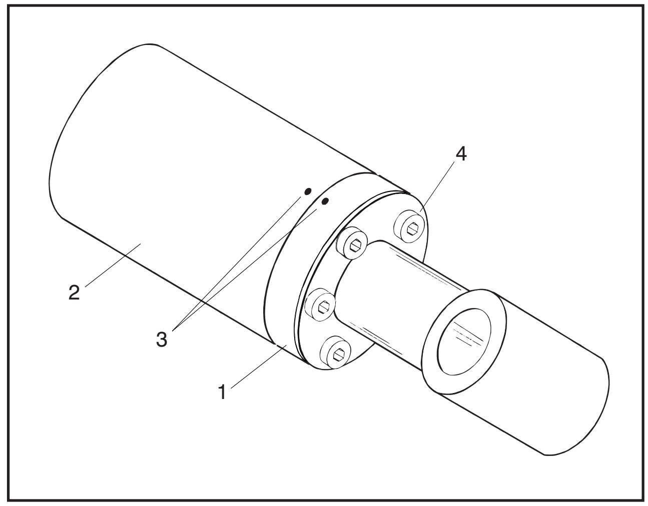


Figure 5-9. Marking Cylinder for Alignment

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.

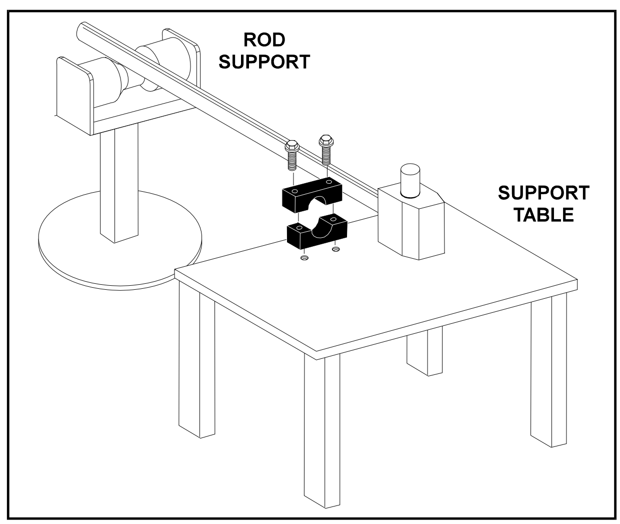
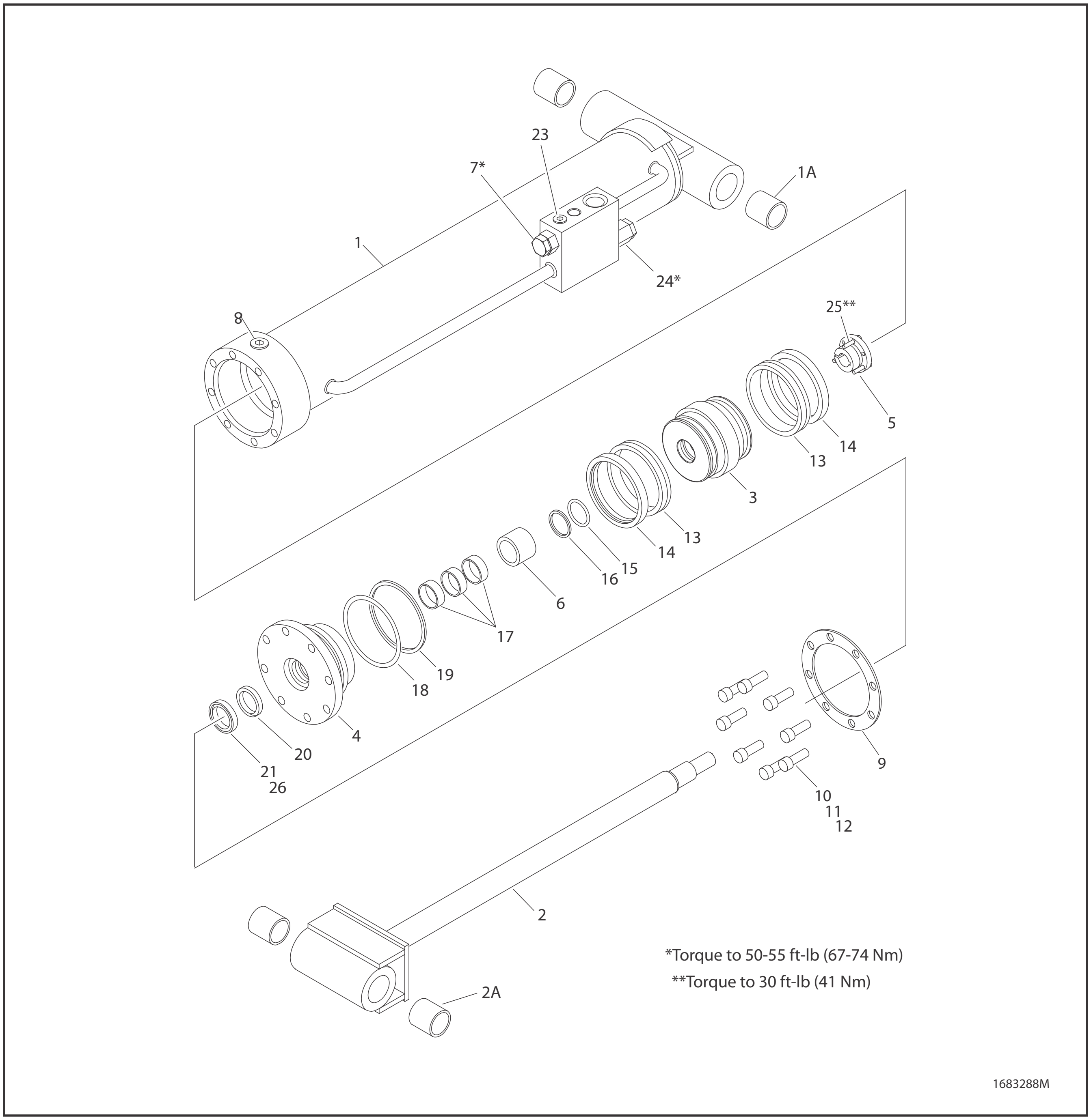


Figure 5-10. Cylinder Rod Support



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

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 capscrews.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

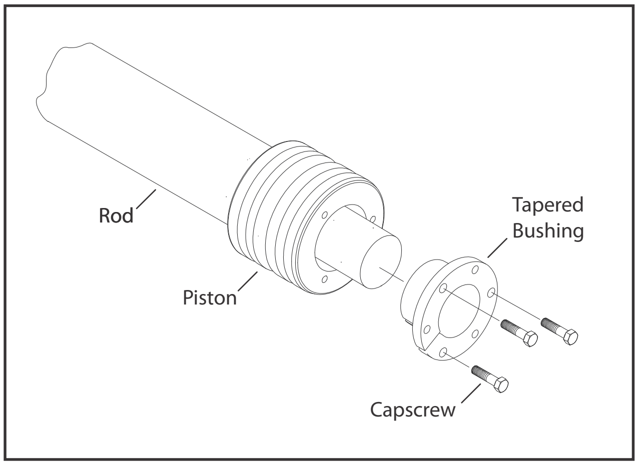


Figure 5-12. Tapered Bushing Removal

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.

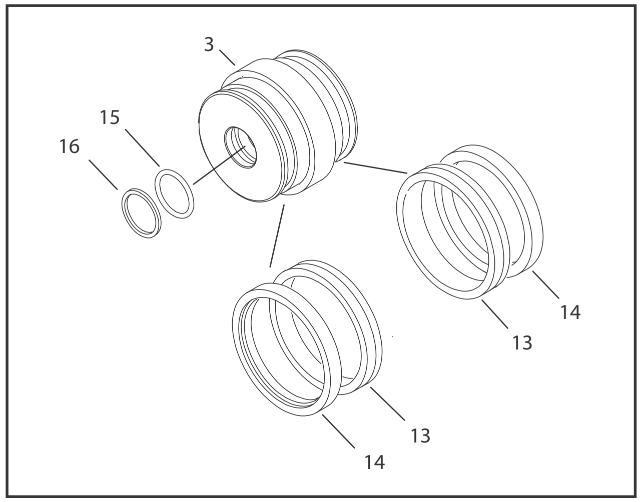


Figure 5-13. Piston Disassembly

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 groves of cylinder head.

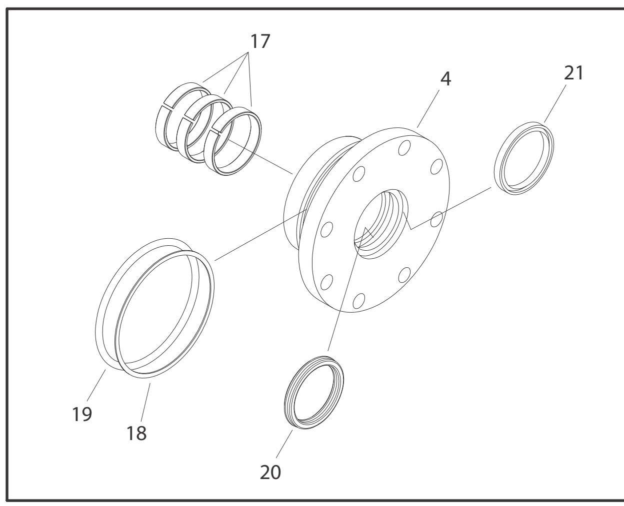


Figure 5-14. Cylinder Head Disassembly

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.

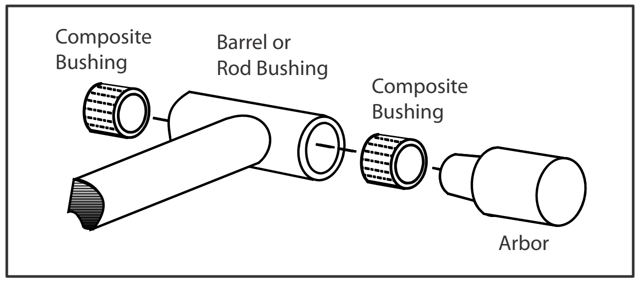


Figure 5-15. Composite Bushing Installation

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).

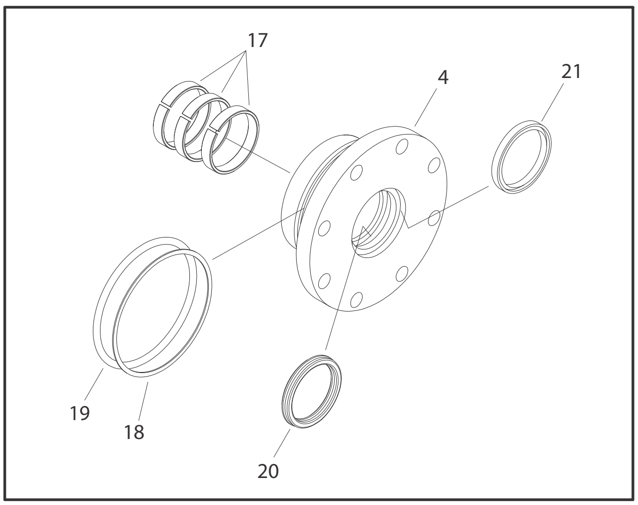


Figure 5-16. Head Seal Kit Installation

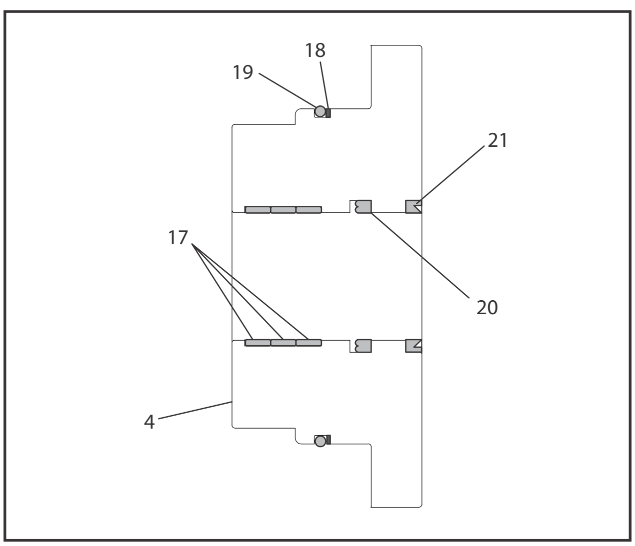


Figure 5-17. Cylinder Head Seals

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.

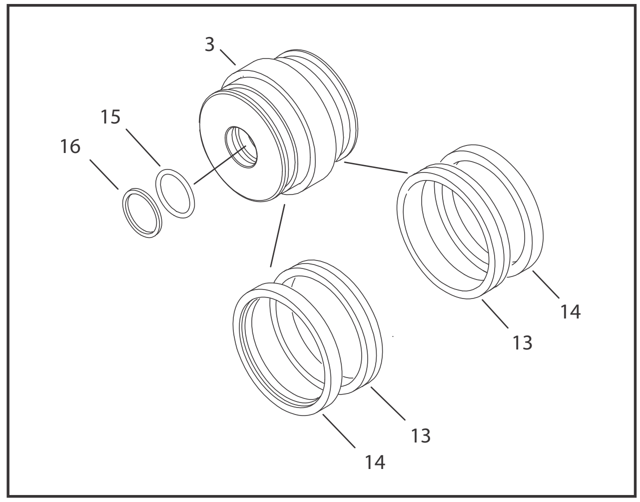


Figure 5-18. Piston Seal Kit Installation

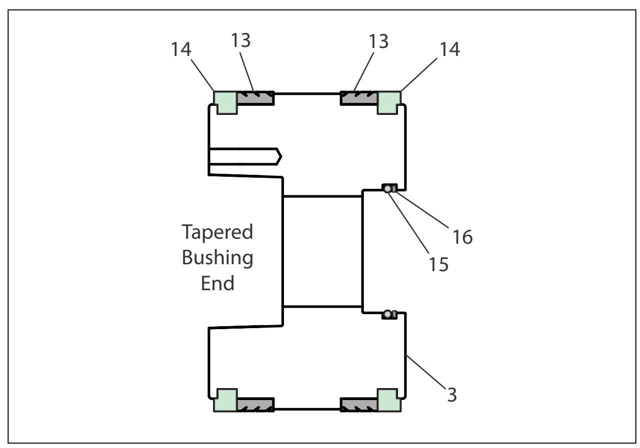


Figure 5-19. Piston Seals

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.

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.

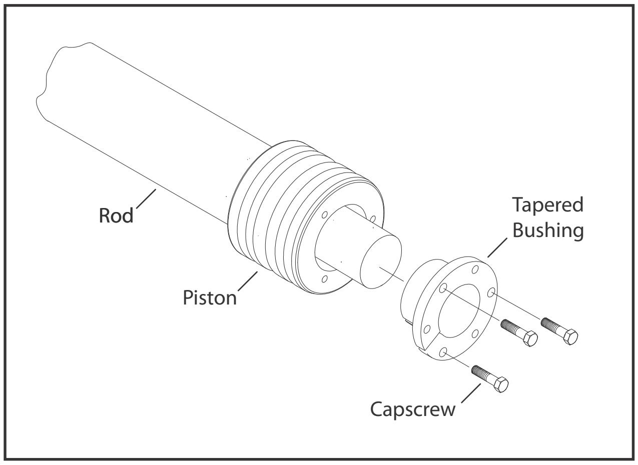


Figure 5-20. Tapered Bushing Installation

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.

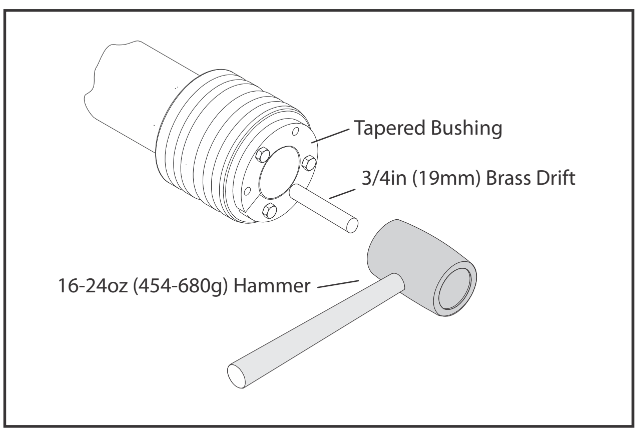


Figure 5-21. Seating Tapered Bushing

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).

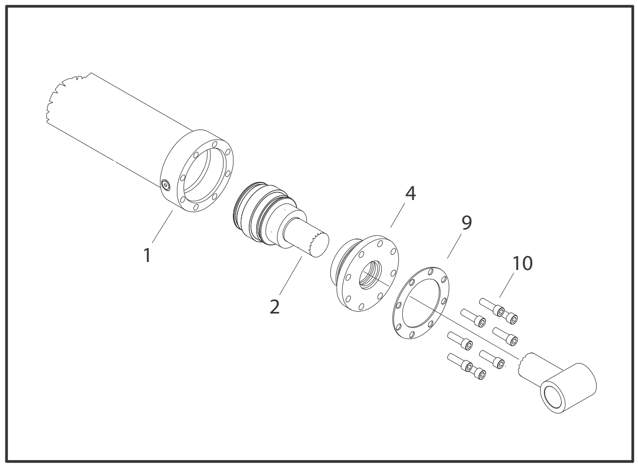


Figure 5-22. Rod Assembly Installation

Upright Level Cylinder

DISASSEMBLY

Refer to Figure 5-26.

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.

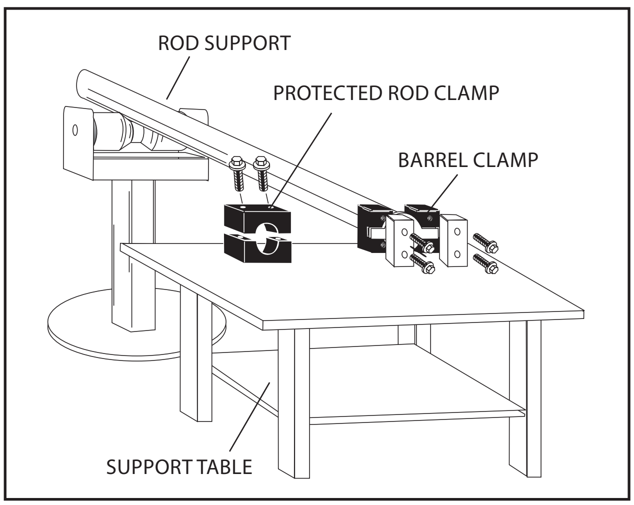


Figure 5-23. Cylinder Barrel Support

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

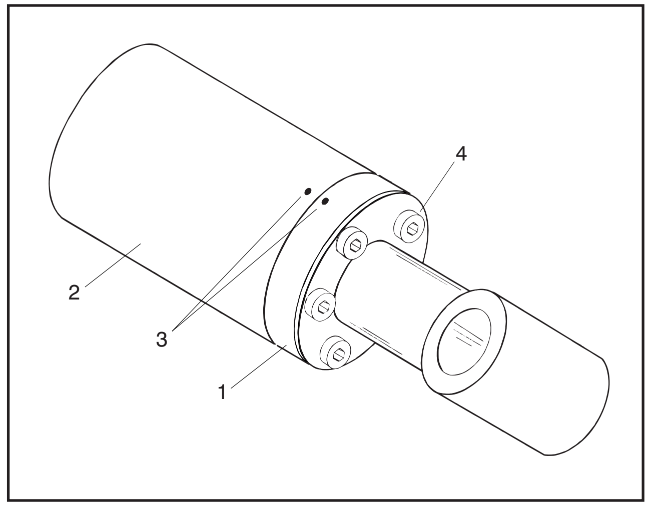


Figure 5-24. Marking Cylinder for Alignment

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.

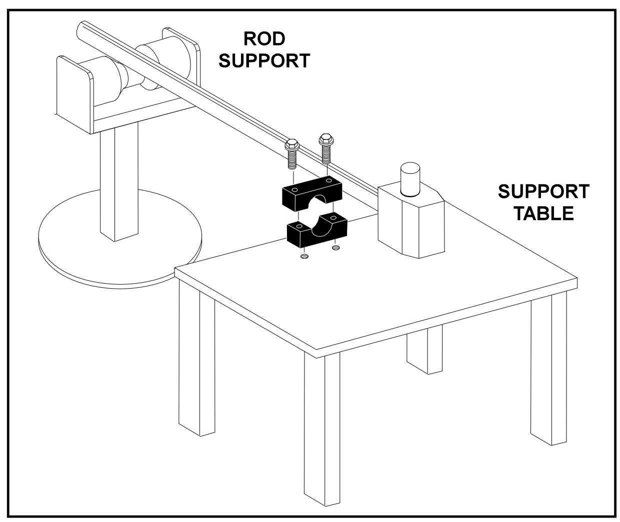
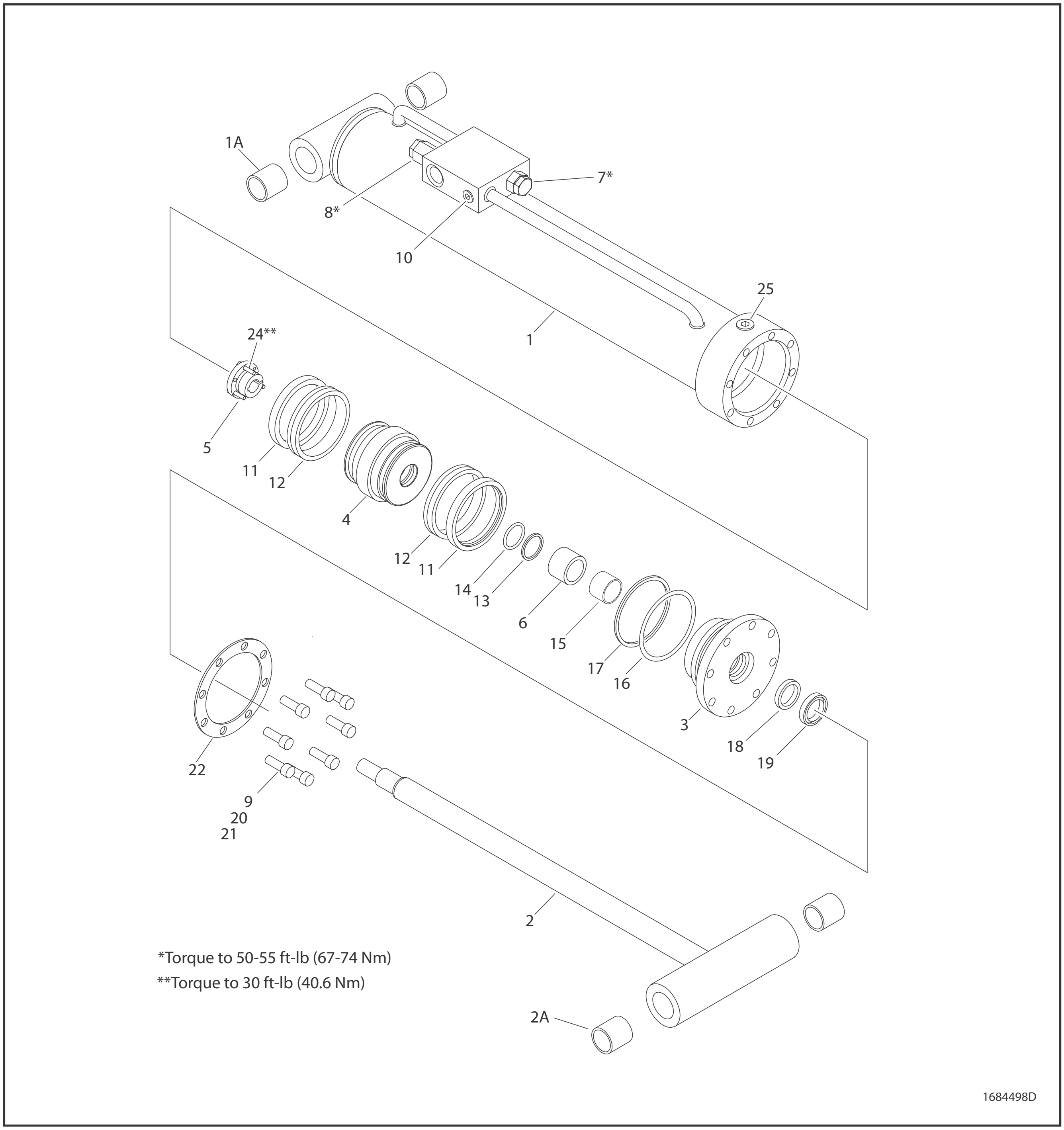


Figure 5-25. Cylinder Rod Support



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 capscrews.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

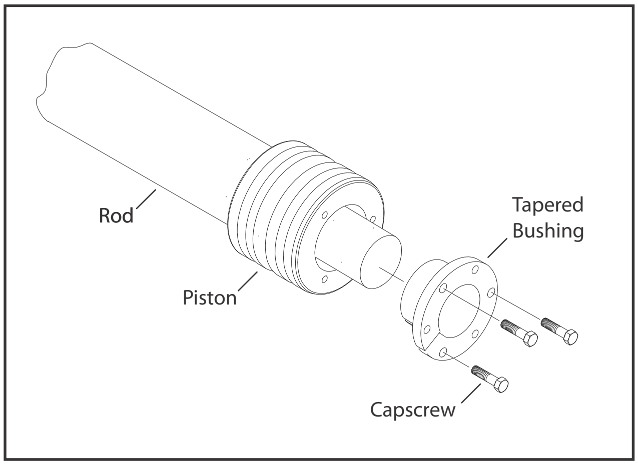


Figure 5-27. Tapered Bushing Removal

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.

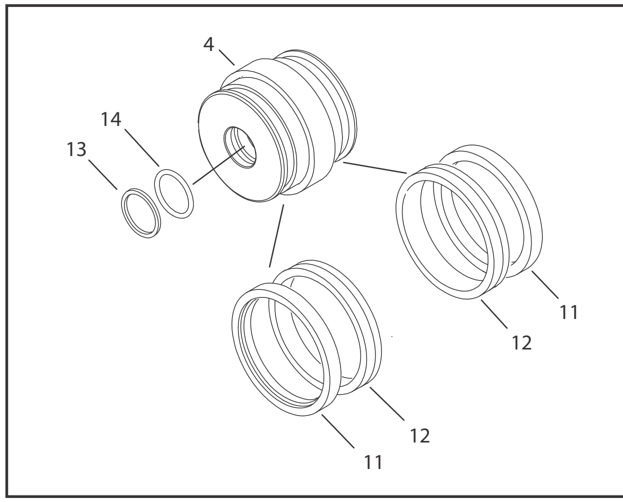


Figure 5-28. Piston Disassembly

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 groves of cylinder head.

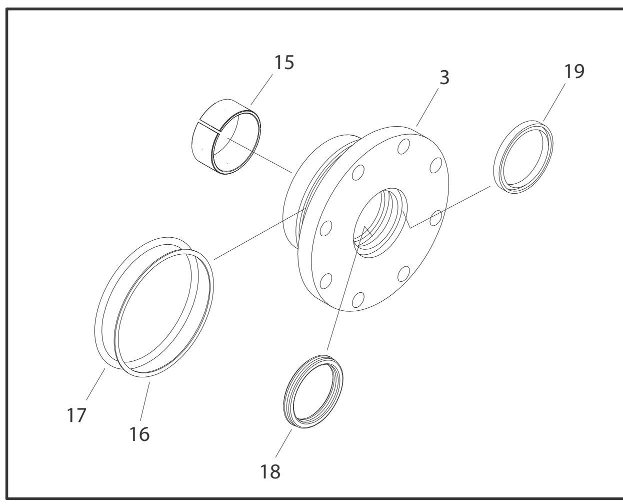


Figure 5-29. Cylinder Head Disassembly

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.

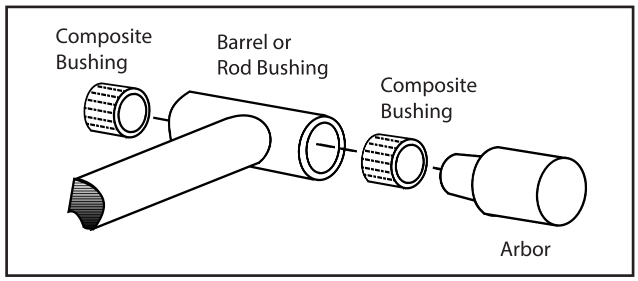


Figure 5-30. Composite Bushing Installation

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).

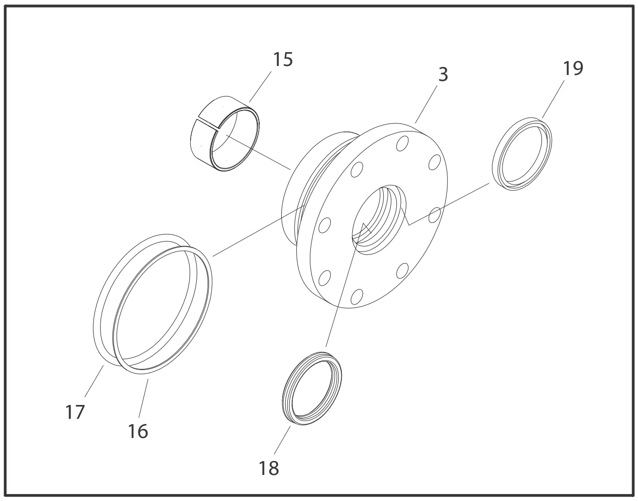


Figure 5-31. Head Seal Kit Installation

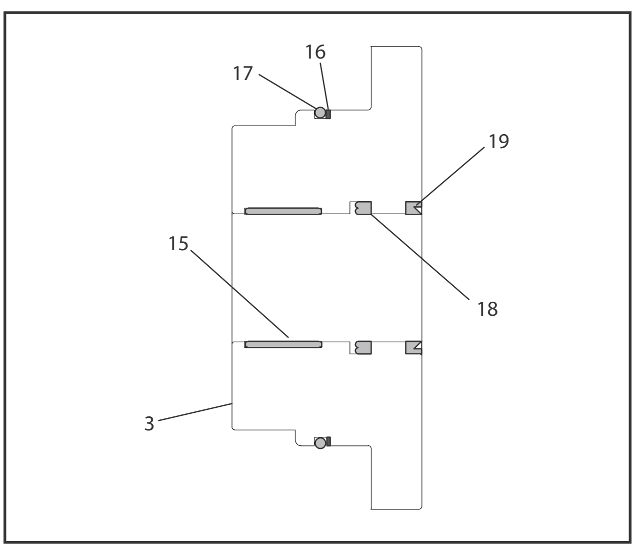


Figure 5-32. Cylinder Head Seals

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.

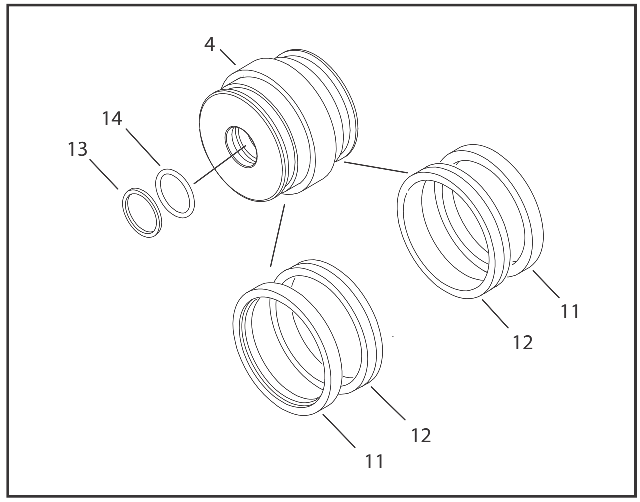


Figure 5-33. Piston Seal Kit Installation

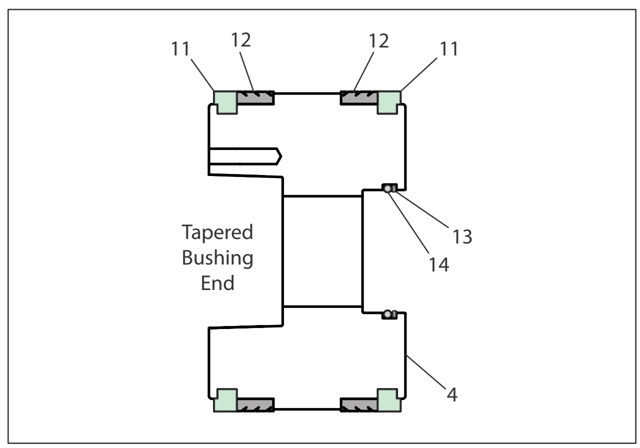


Figure 5-34. Piston Seals

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.

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.

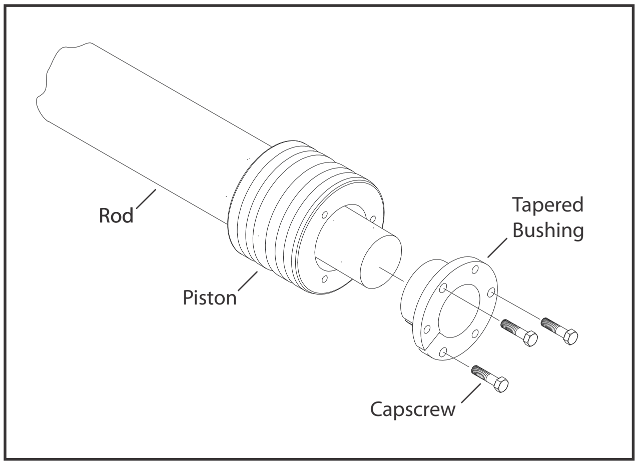


Figure 5-35. Tapered Bushing Installation

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.

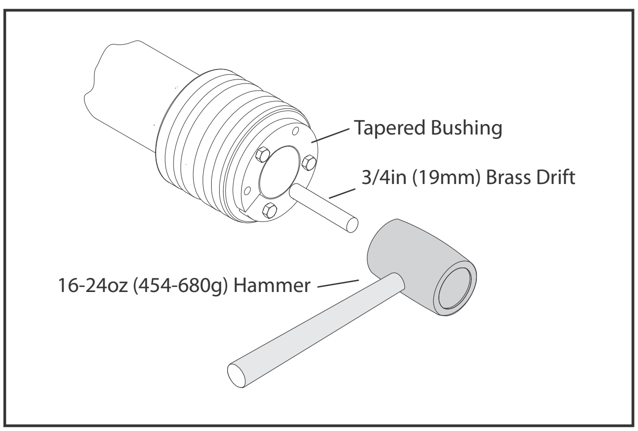


Figure 5-36. Seating Tapered Bushing

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).

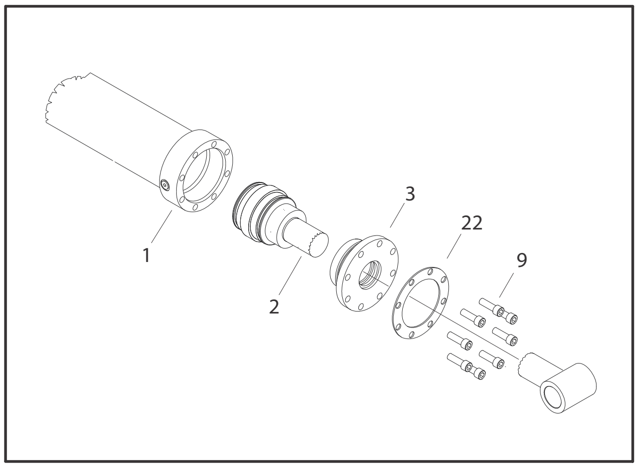


Figure 5-37. Rod Assembly Installation

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.

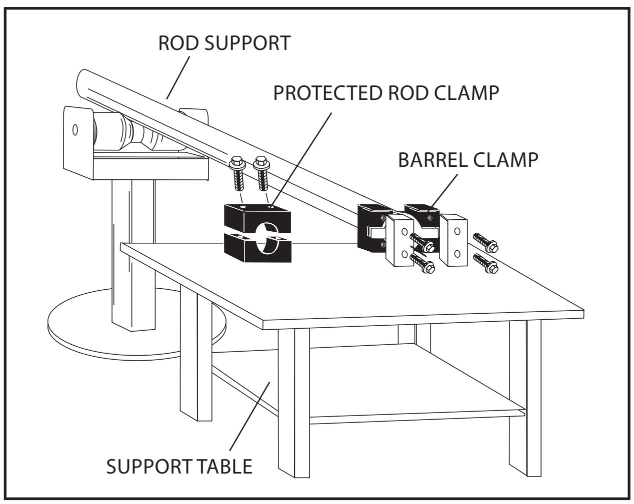


Figure 5-38. Cylinder Barrel Support

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

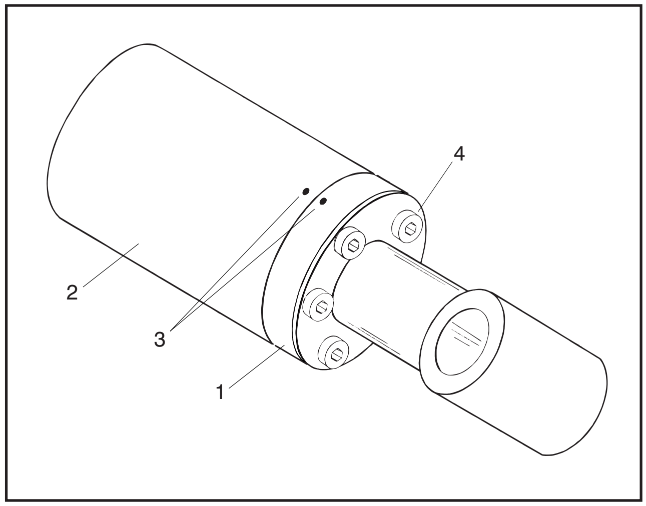


Figure 5-39. Marking Cylinder for Alignment

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.

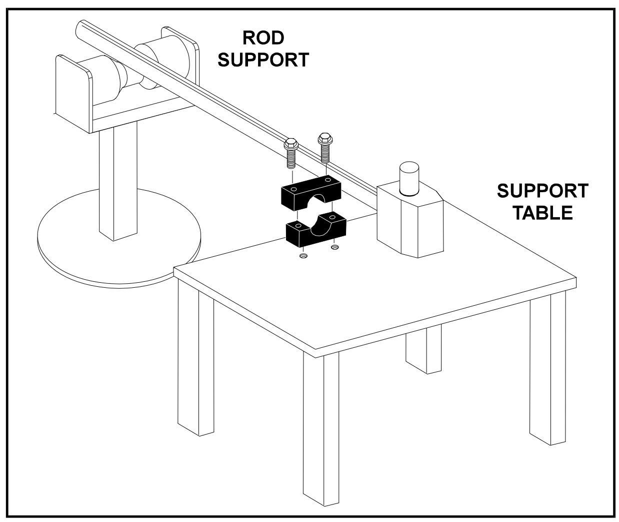
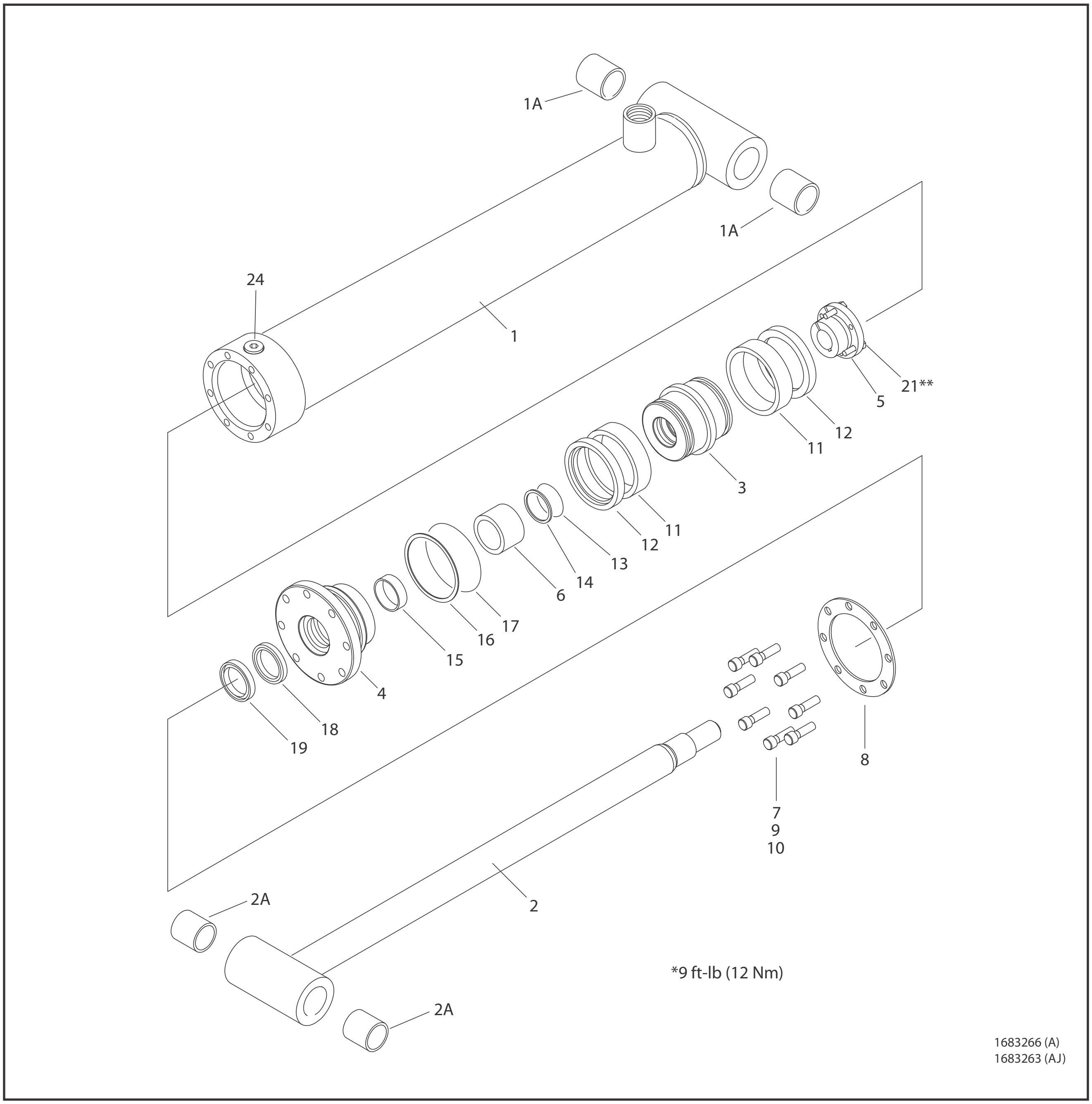


Figure 5-40. Cylinder Rod Support



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

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 capscrews.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

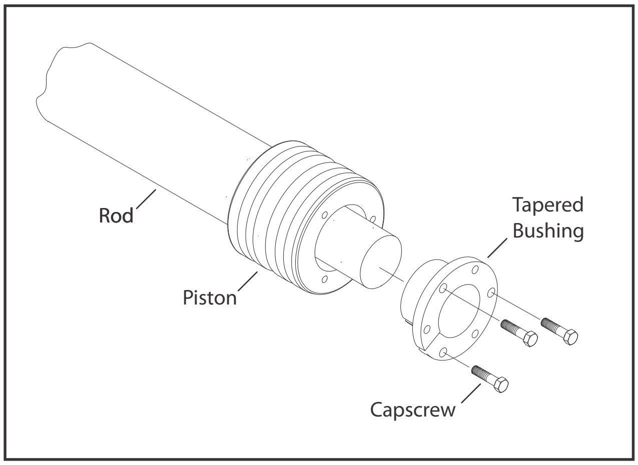


Figure 5-42. Tapered Bushing Removal

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.

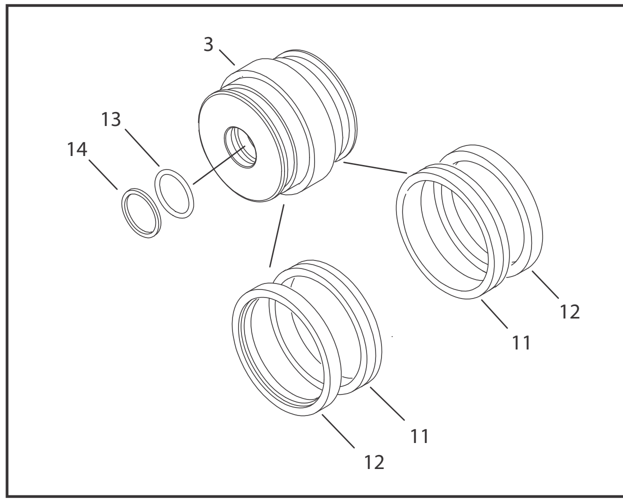


Figure 5-43. Piston Disassembly

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 groves of cylinder head.

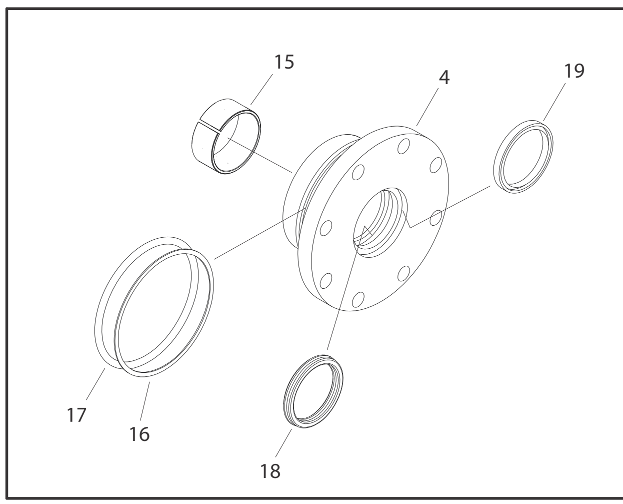


Figure 5-44. Cylinder Head Disassembly

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.

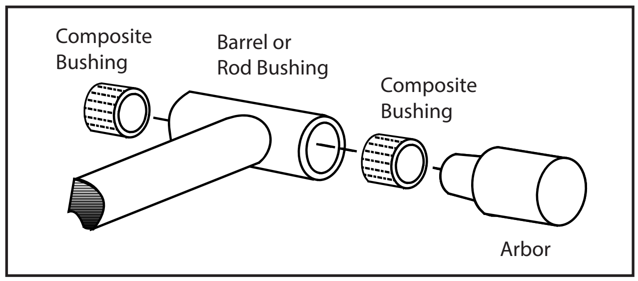


Figure 5-45. Composite Bushing Installation

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).

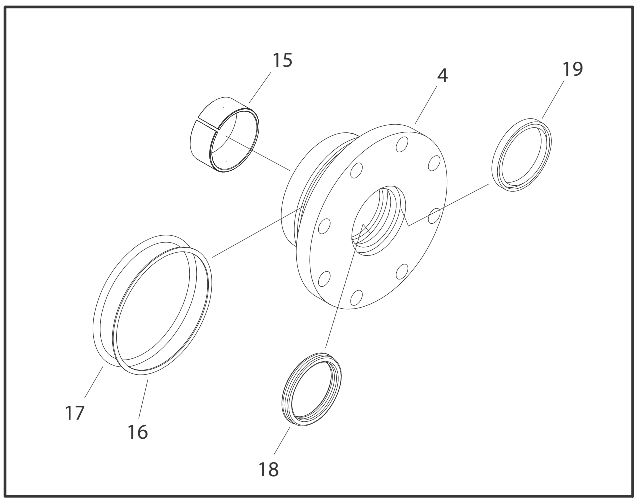


Figure 5-46. Head Seal Kit Installation

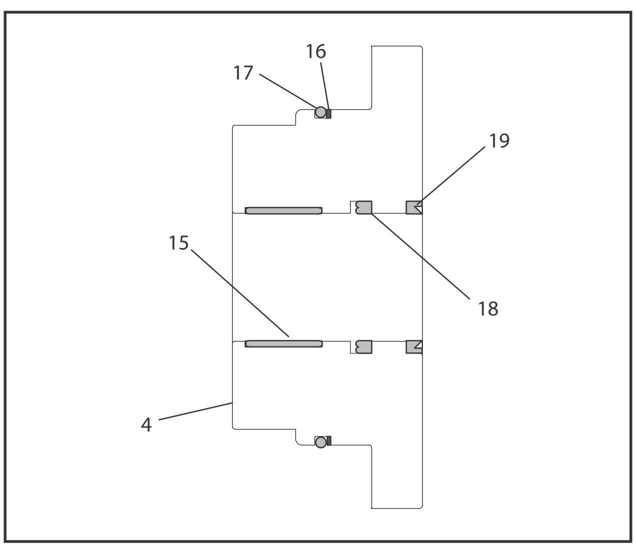


Figure 5-47. Cylinder Head Seals

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.

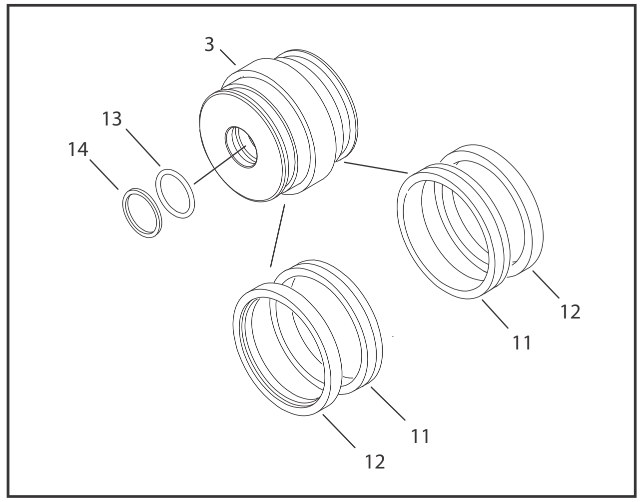


Figure 5-48. Piston Seal Kit Installation

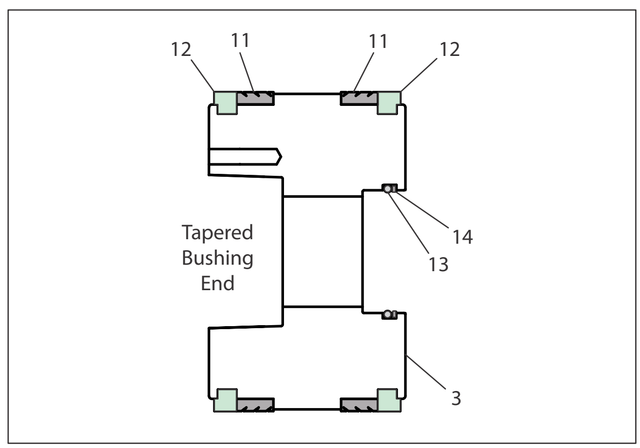


Figure 5-49. Piston Seals

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.

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.

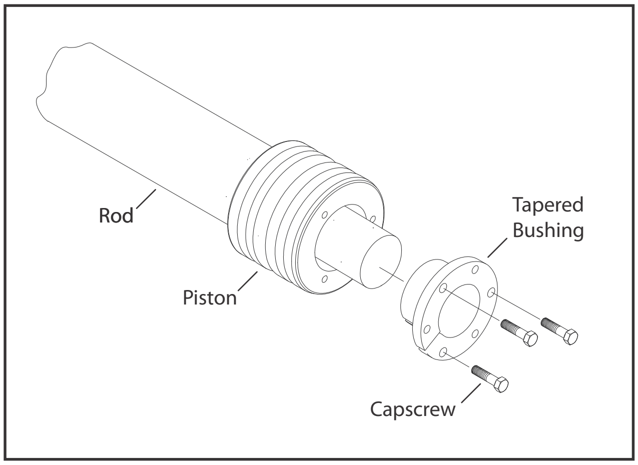


Figure 5-50. Tapered Bushing Installation

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.

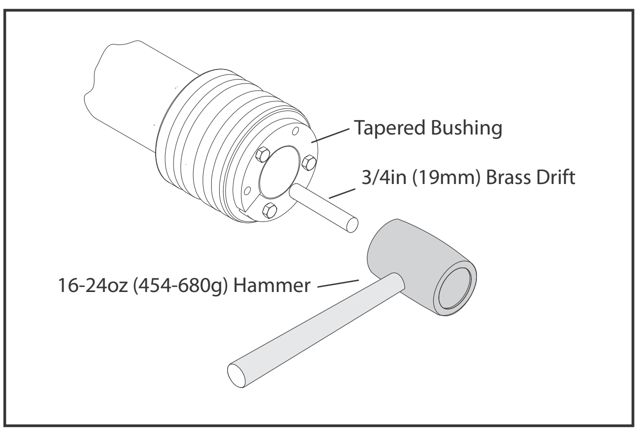


Figure 5-51. Seating Tapered Bushing

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).

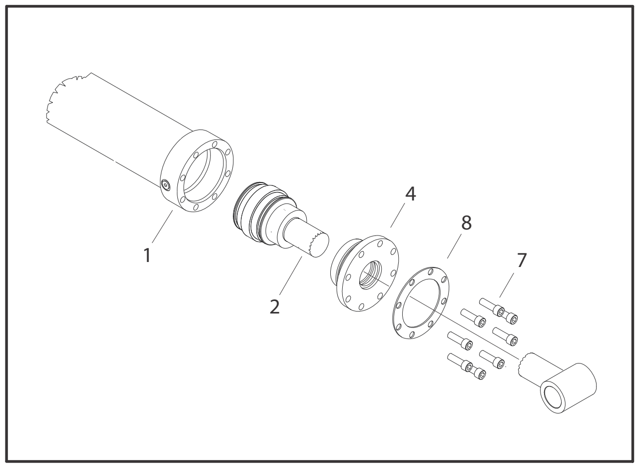


Figure 5-52. Rod Assembly Installation

Main Boom Lift Cylinder

DISASSEMBLY

Refer to Figure 5-56.

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.

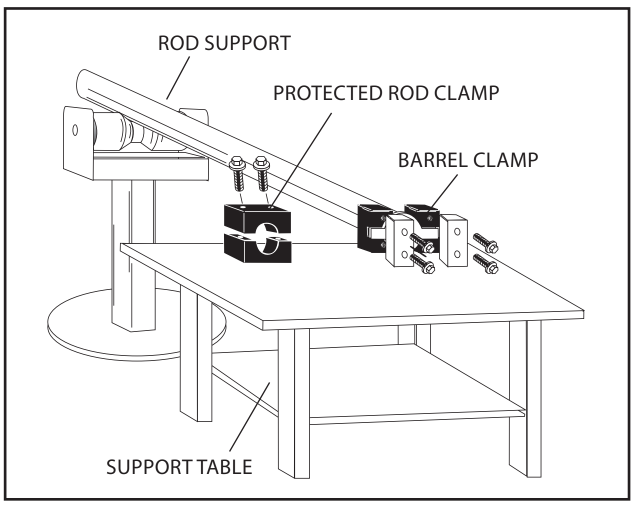


Figure 5-53. Cylinder Barrel Support

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

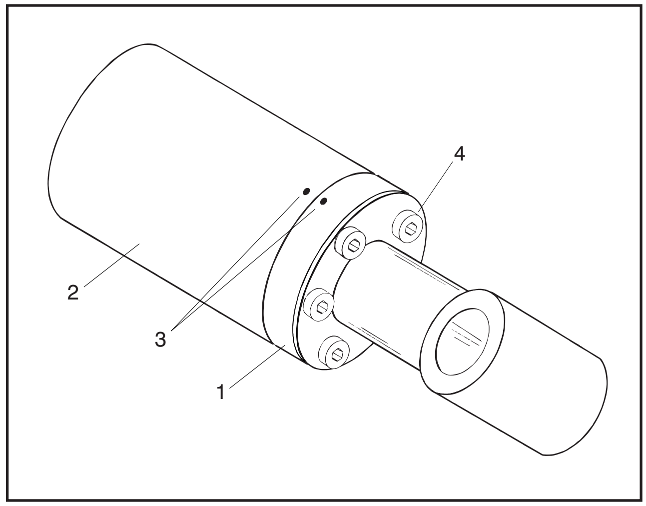


Figure 5-54. Marking Cylinder for Alignment

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.

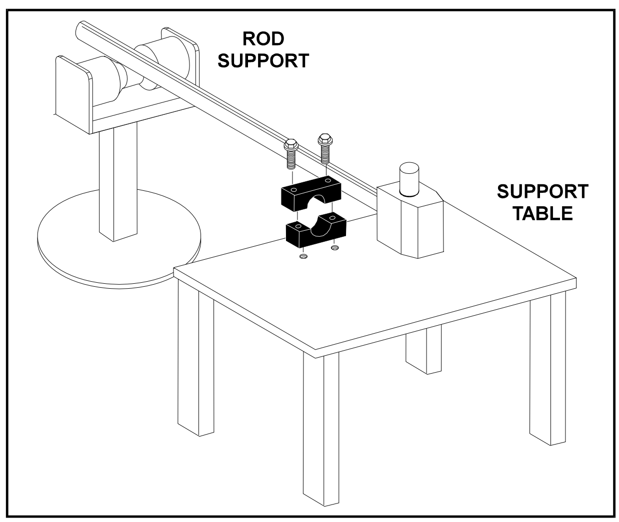
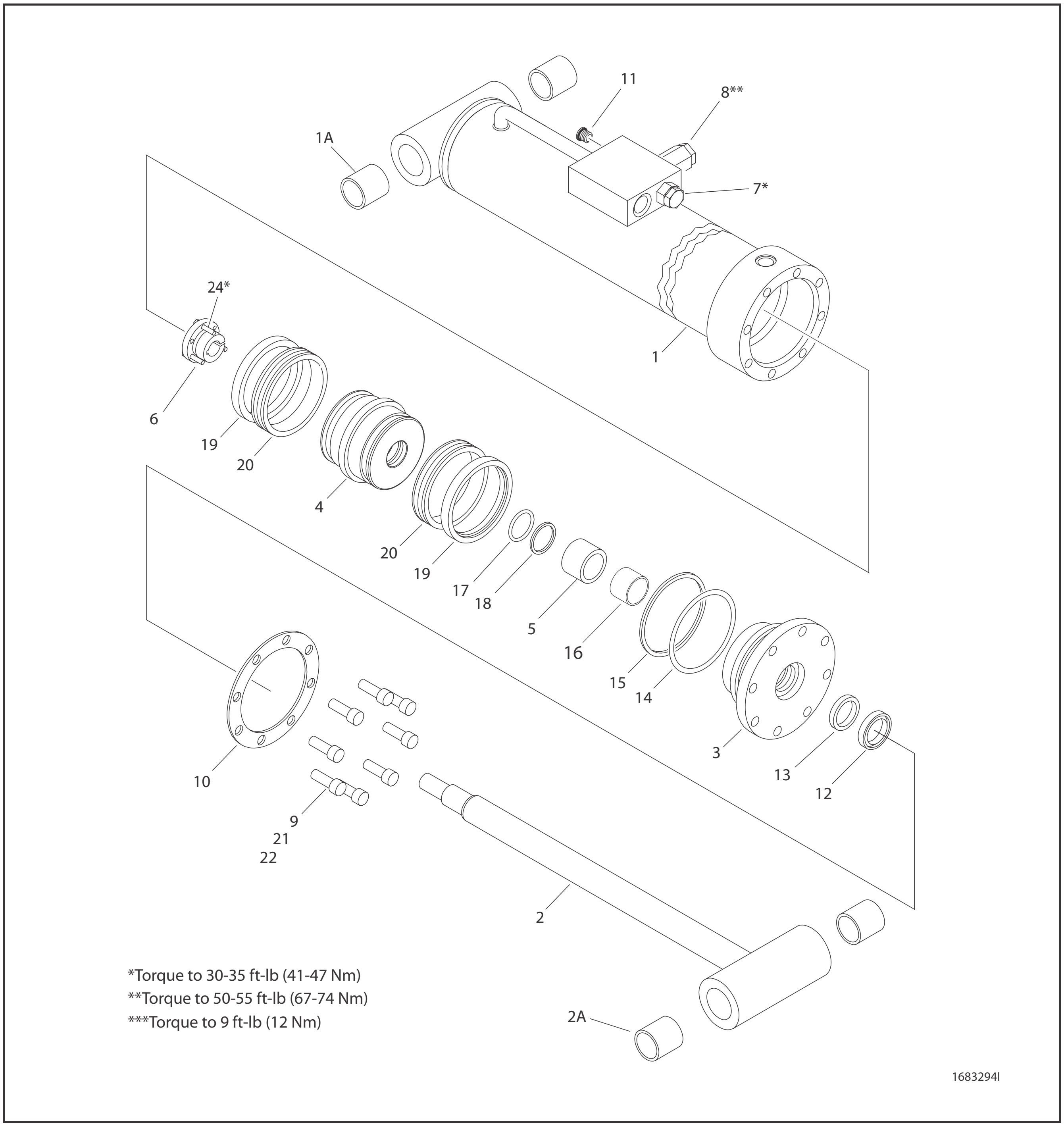


Figure 5-55. Cylinder Rod Support



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

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 capscrews.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

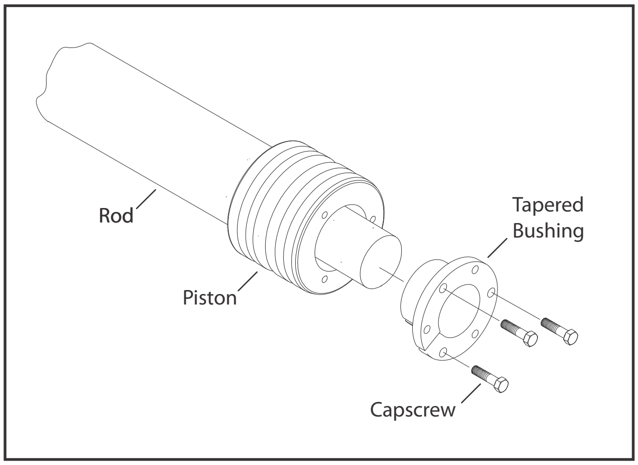


Figure 5-57. Tapered Bushing Removal

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.

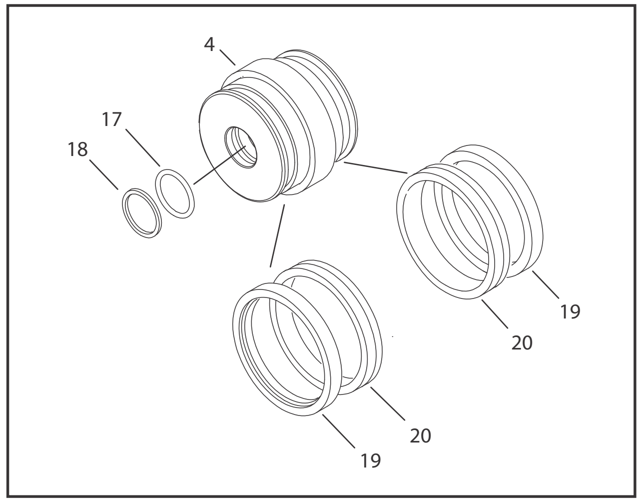


Figure 5-58. Piston Disassembly

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 groves of cylinder head.

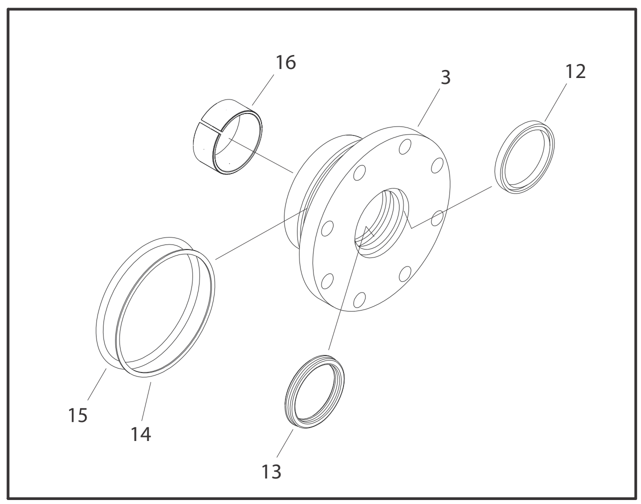


Figure 5-59. Cylinder Head Disassembly

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.

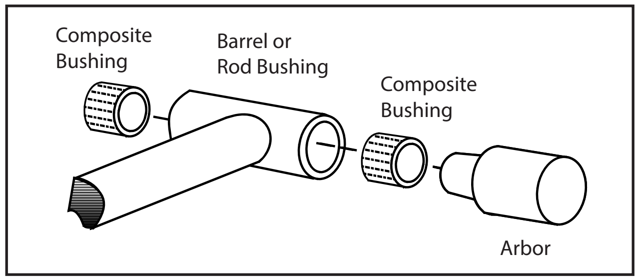


Figure 5-60. Composite Bushing Installation

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).

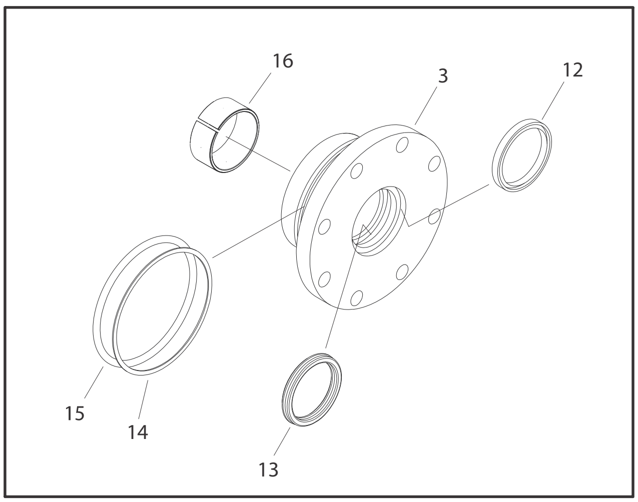


Figure 5-61. Head Seal Kit Installation

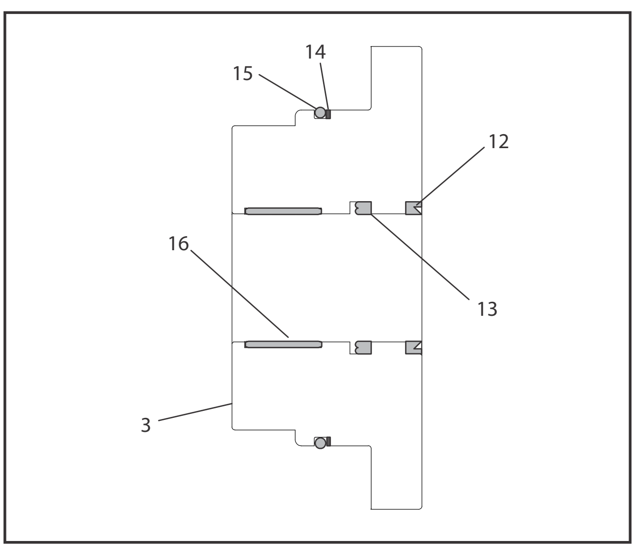


Figure 5-62. Cylinder Head Seals

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.

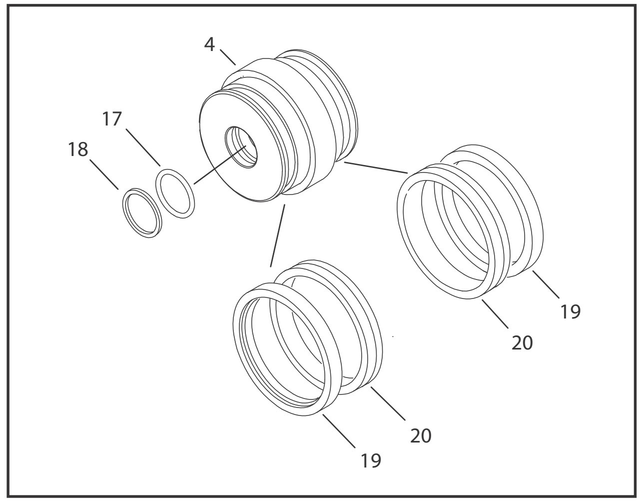


Figure 5-63. Piston Seal Kit Installation

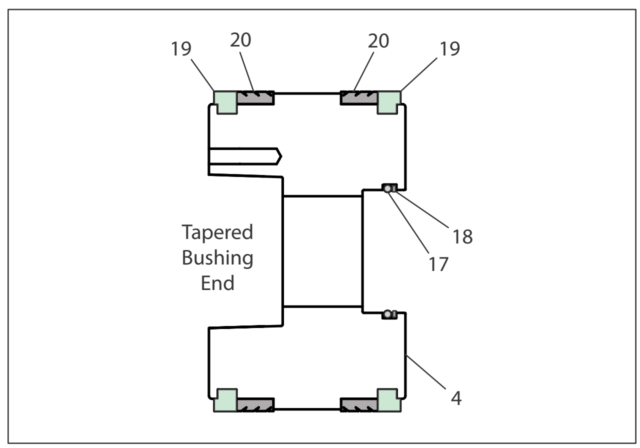


Figure 5-64. Piston Seals

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.

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.

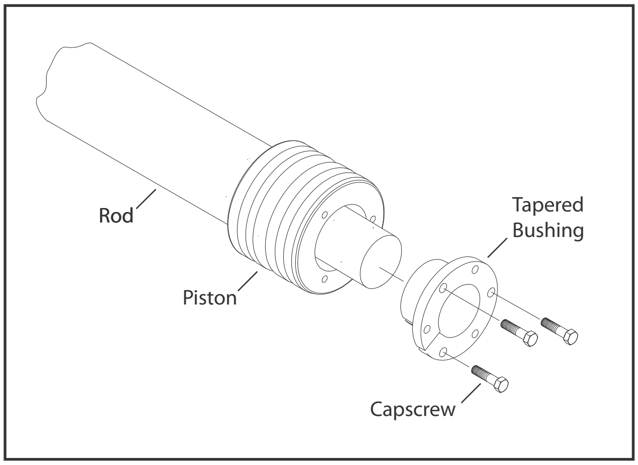


Figure 5-65. Tapered Bushing Installation

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.

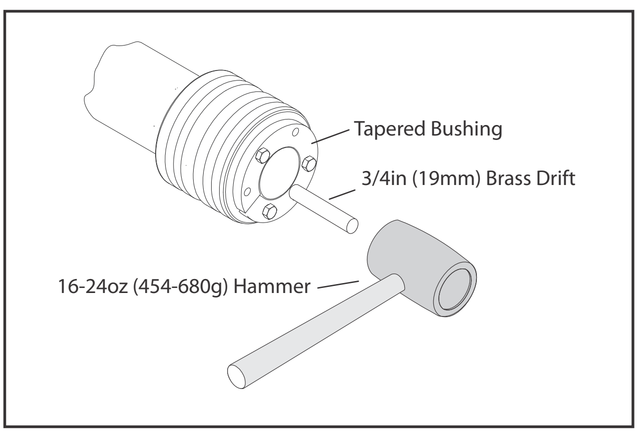


Figure 5-66. Seating Tapered Bushing

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).

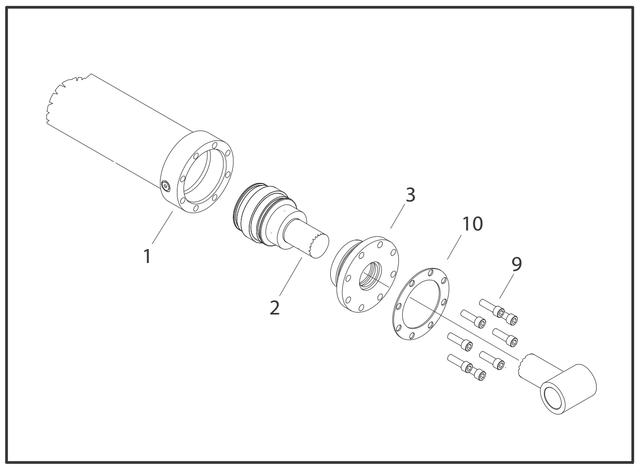


Figure 5-67. Rod Assembly Installation

Main Boom Telescope Cylinder

Refer to Figure 5-71.

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.

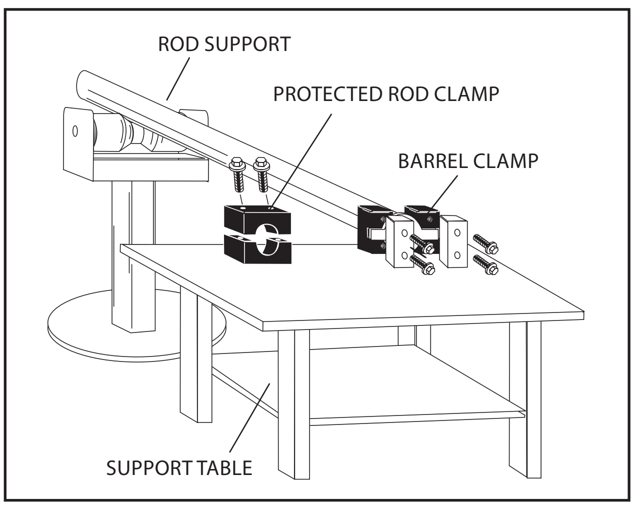


Figure 5-68. Cylinder Barrel Support

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

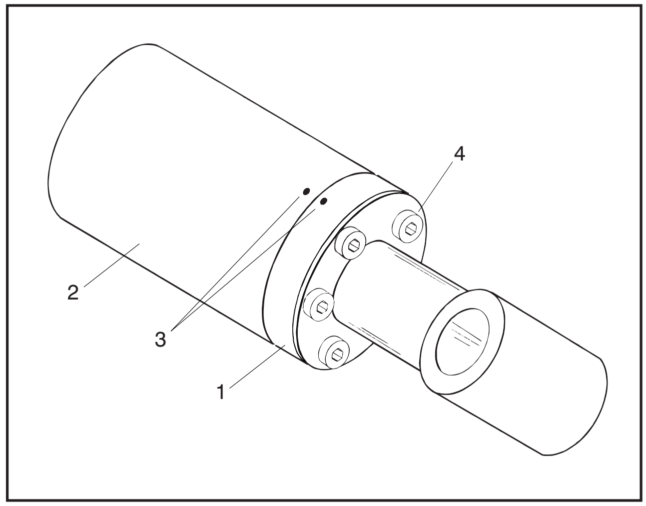


Figure 5-69. Marking Cylinder for Alignment

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.

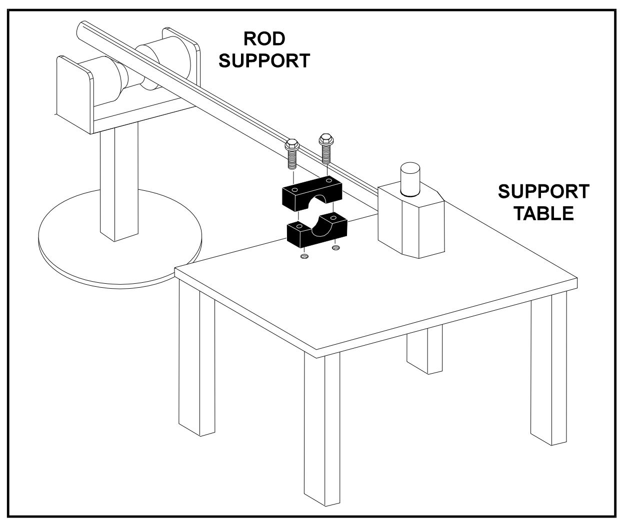
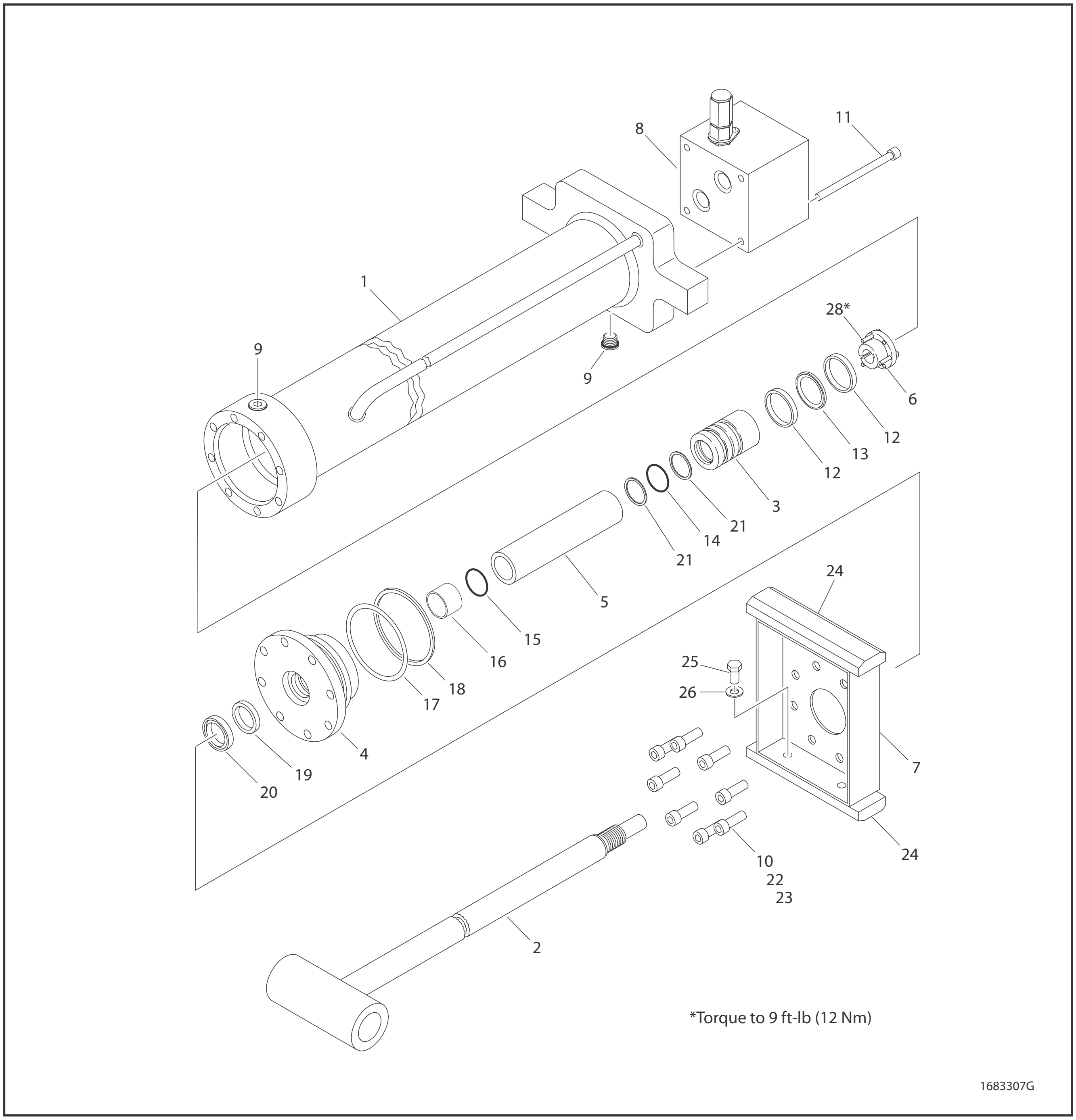


Figure 5-70. Cylinder Rod Support



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

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 capscrews.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

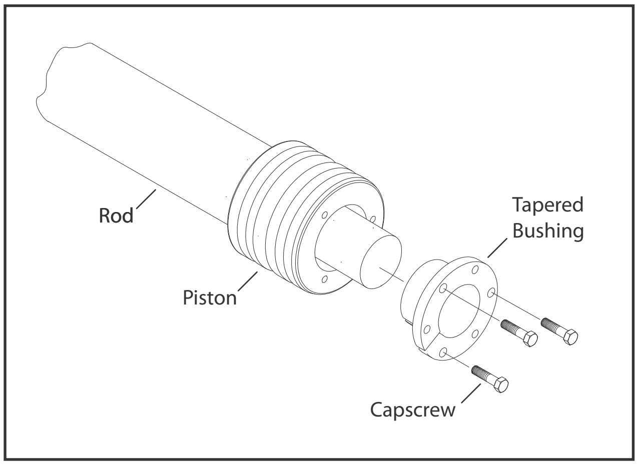


Figure 5-72. Tapered Bushing Removal

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.

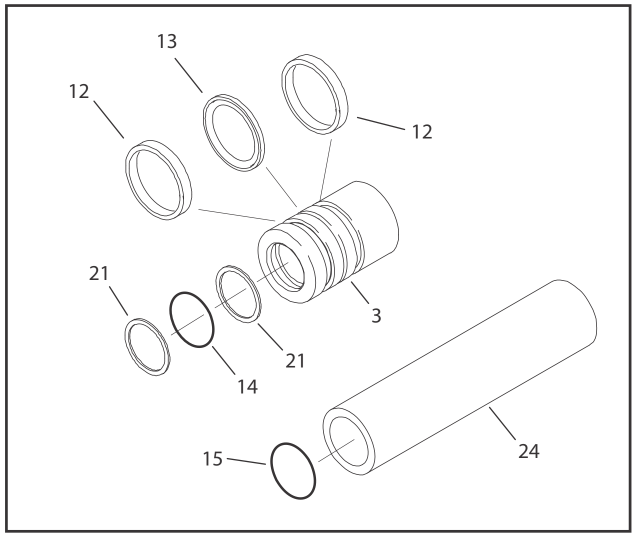


Figure 5-73. Piston Disassembly

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 groves of cylinder head.

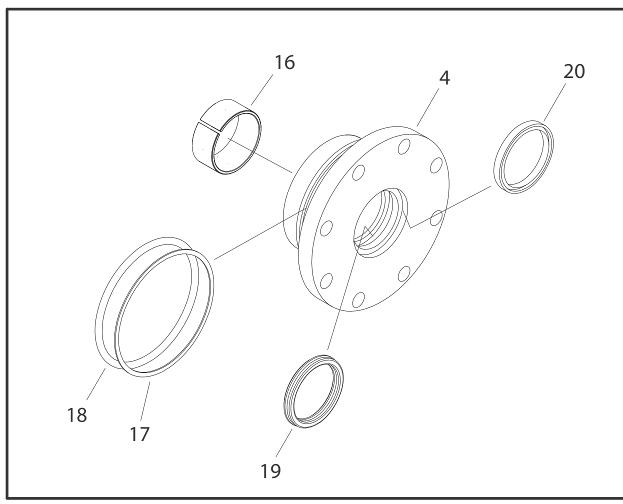


Figure 5-74. Cylinder Head Disassembly

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.

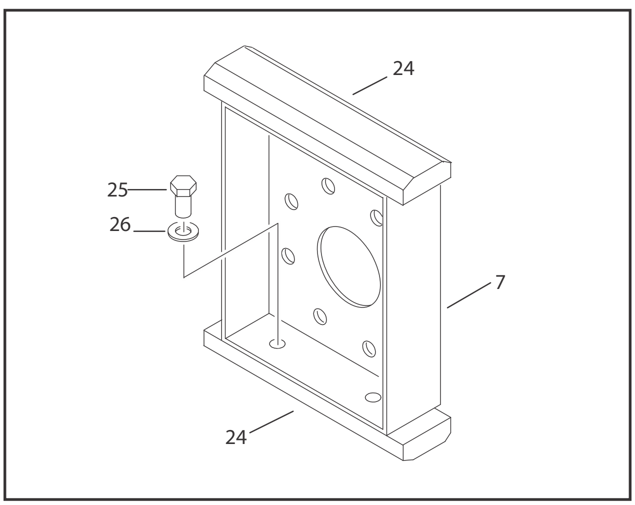


Figure 5-75. Wear Pad Assembly

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.

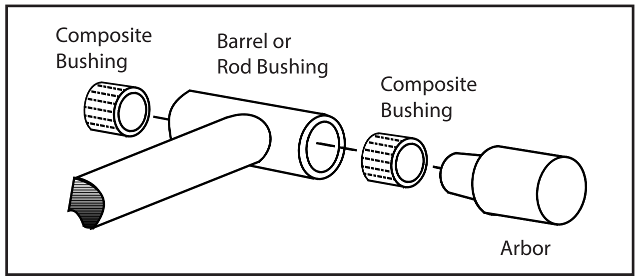


Figure 5-76. Composite Bushing Installation

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).

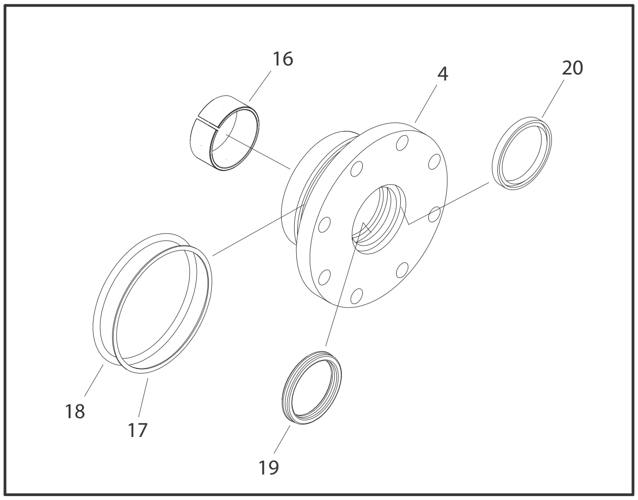


Figure 5-77. Head Seal Kit Installation

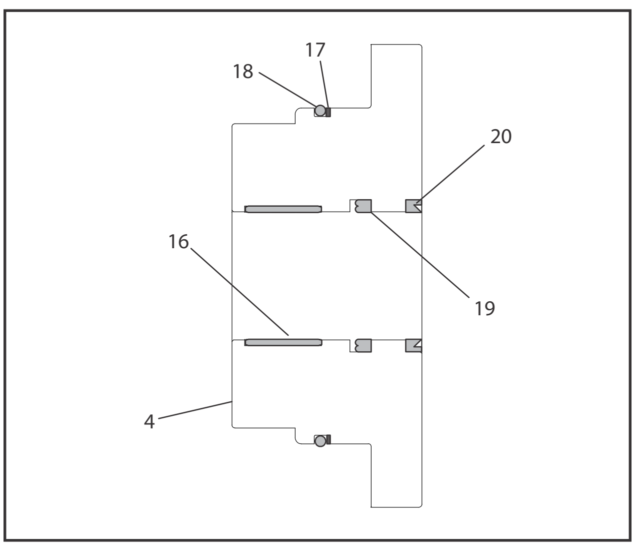


Figure 5-78. Cylinder Head Seals

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.

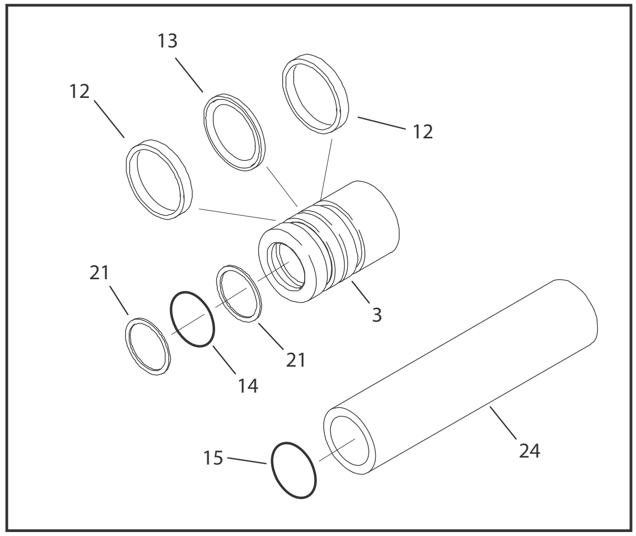


Figure 5-79. Piston Seal Kit Installation

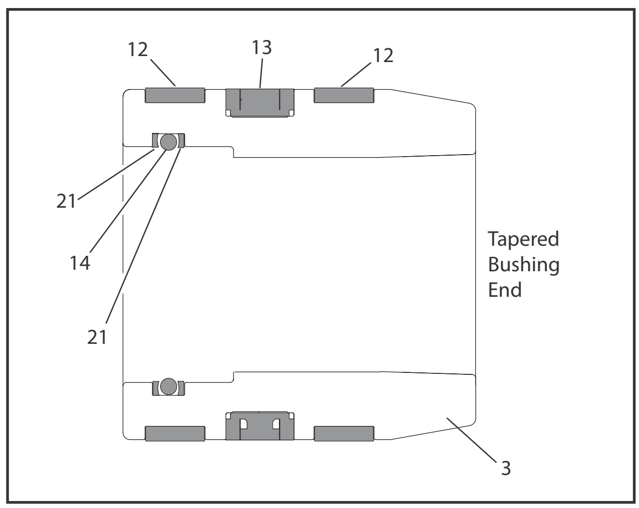


Figure 5-80. Piston Seals

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.

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.

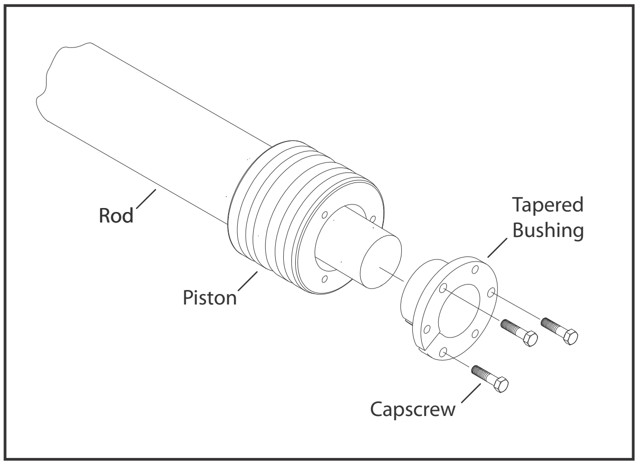


Figure 5-81. Tapered Bushing Installation

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.

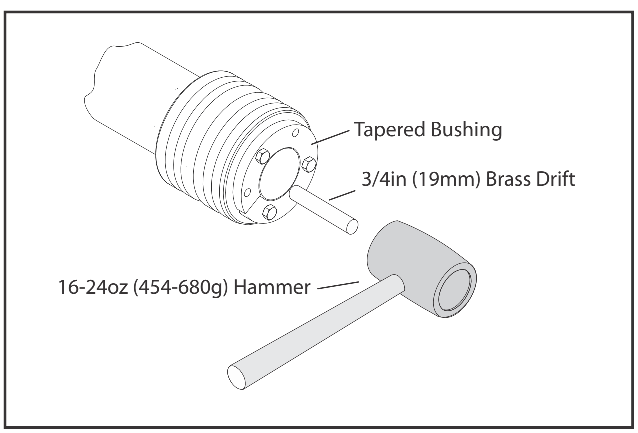


Figure 5-82. Seating Tapered Bushing

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).

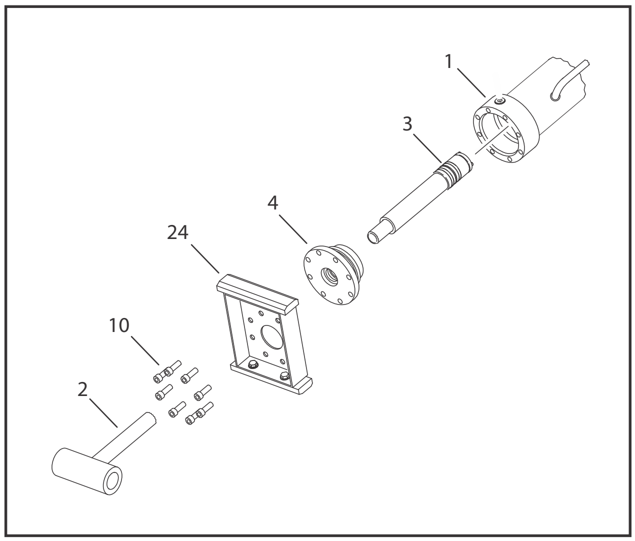


Figure 5-83. Rod Assembly Installation

Tower Boom Telescope Cylinder

Refer to Figure 5-87.

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.

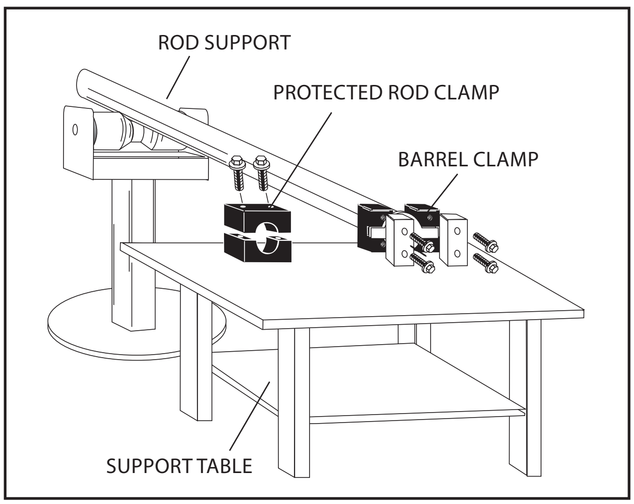


Figure 5-84. Cylinder Barrel Support

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

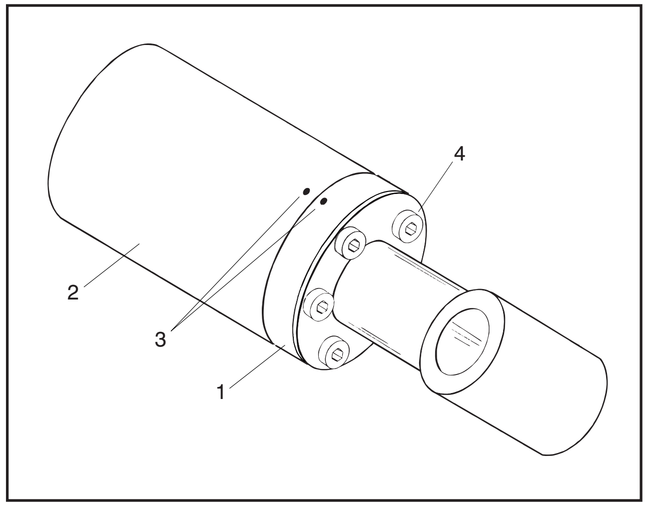


Figure 5-85. Marking Cylinder for Alignment

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.

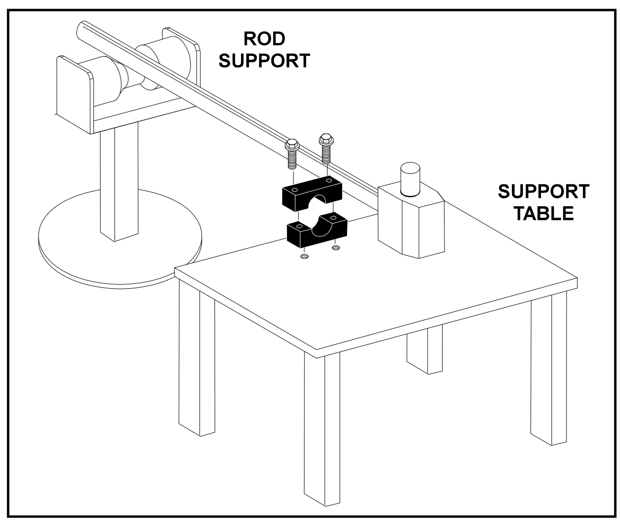
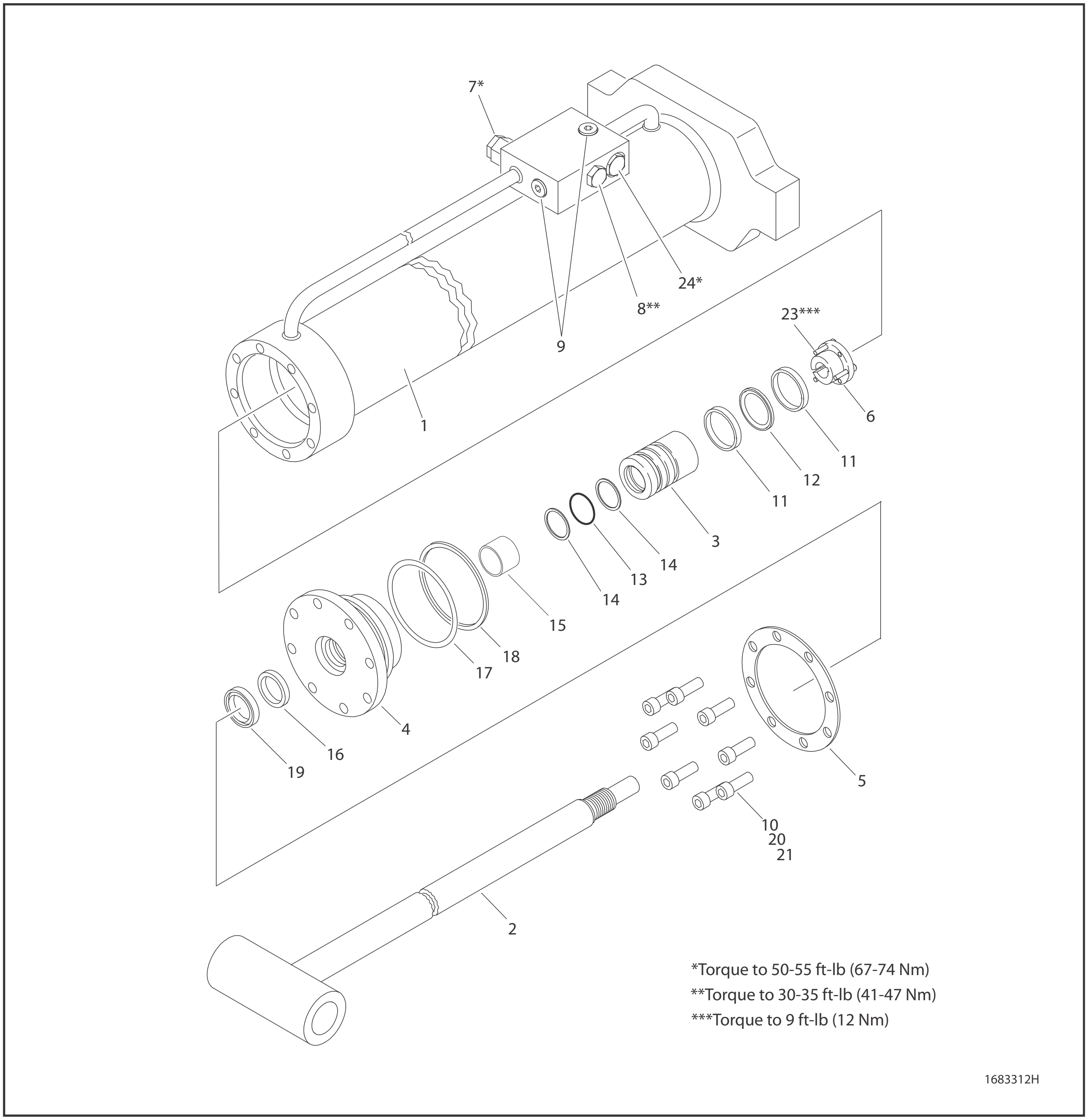


Figure 5-86. Cylinder Rod Support



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

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 capscrews.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

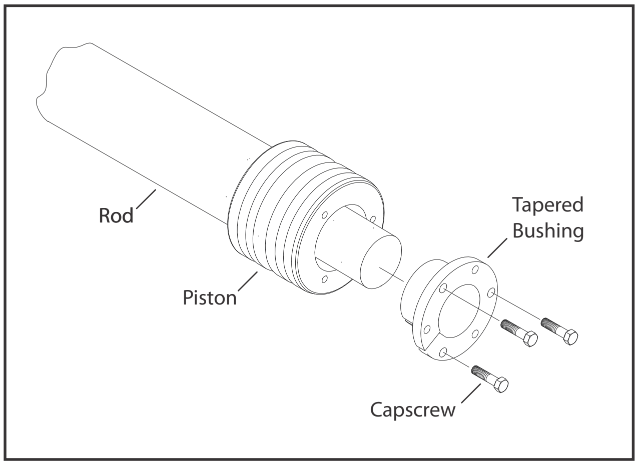


Figure 5-88. Tapered Bushing Removal

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.

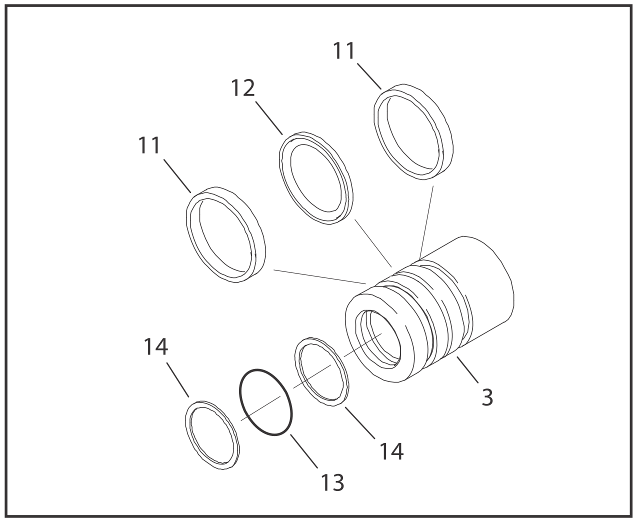


Figure 5-89. Piston Disassembly

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 groves of cylinder head.

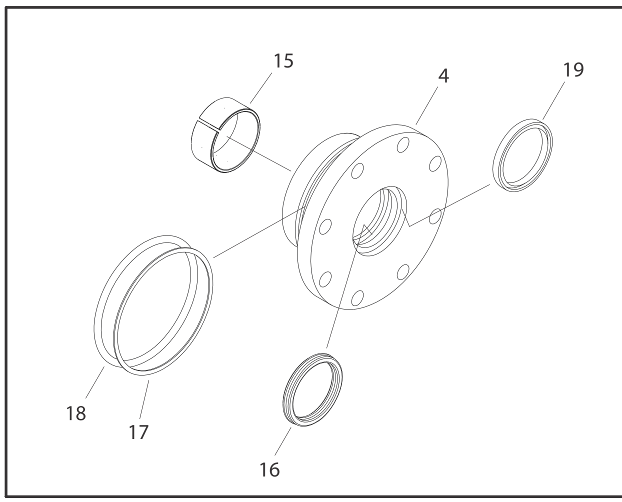


Figure 5-90. Cylinder Head Disassembly

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.

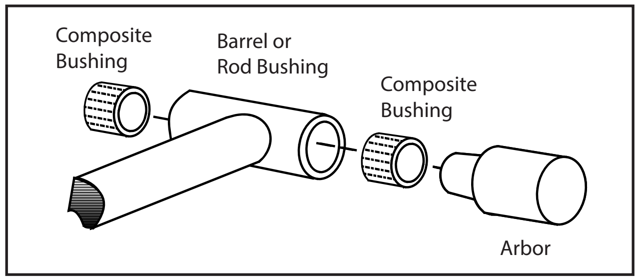


Figure 5-91. Composite Bushing Installation

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).

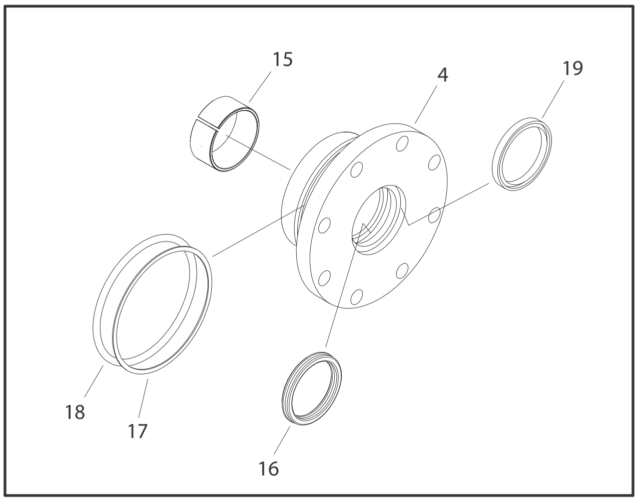


Figure 5-92. Head Seal Kit Installation

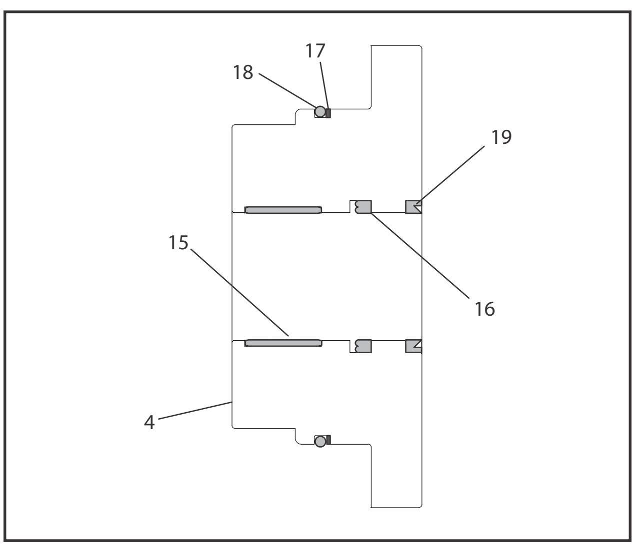


Figure 5-93. Cylinder Head Seals

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.

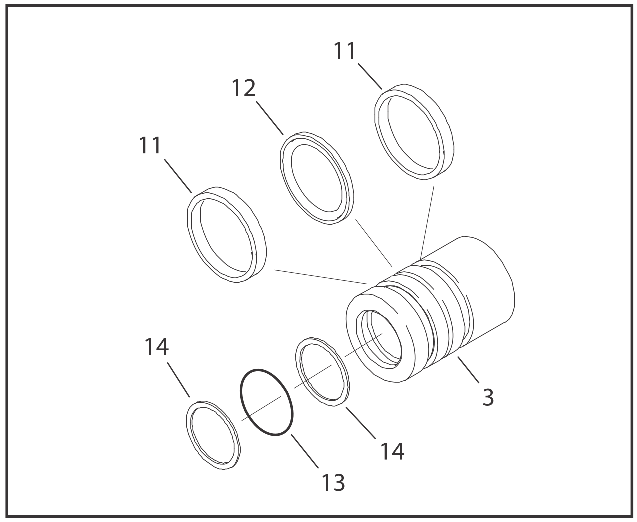


Figure 5-94. Piston Seal Kit Installation

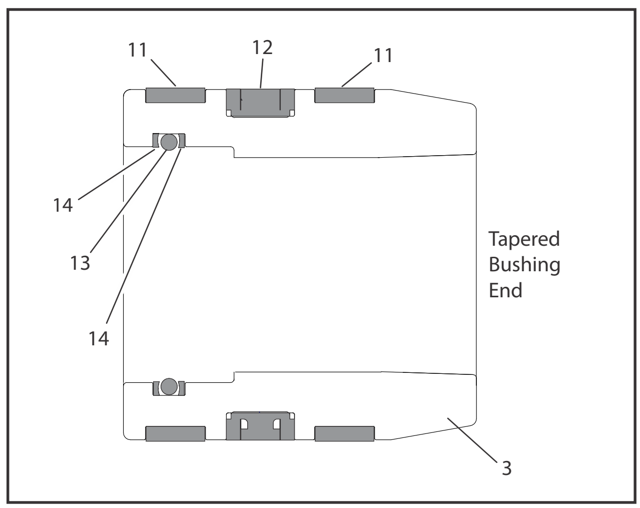


Figure 5-95. Piston Seals

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.

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.

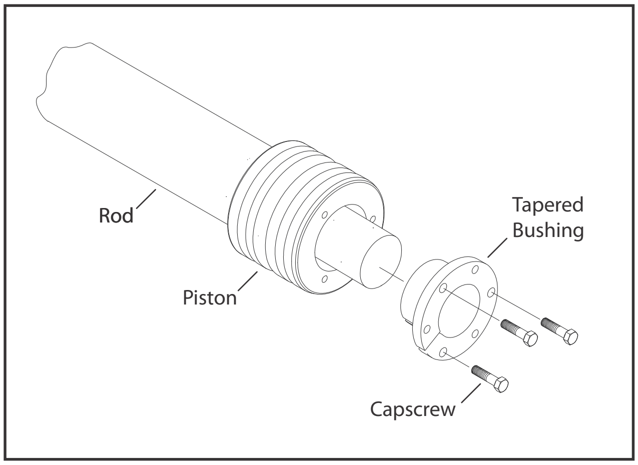


Figure 5-96. Tapered Bushing Installation

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.

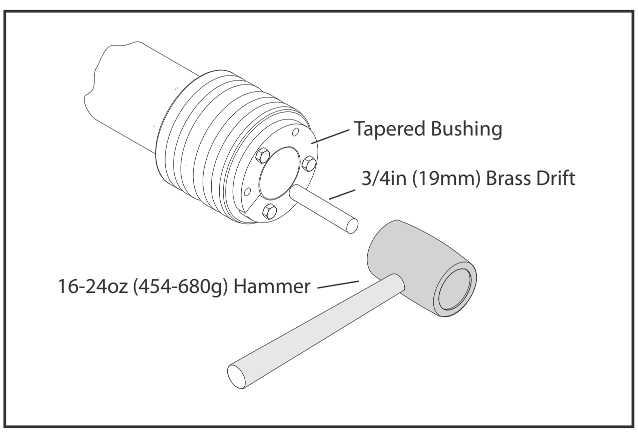


Figure 5-97. Seating Tapered Bushing

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).

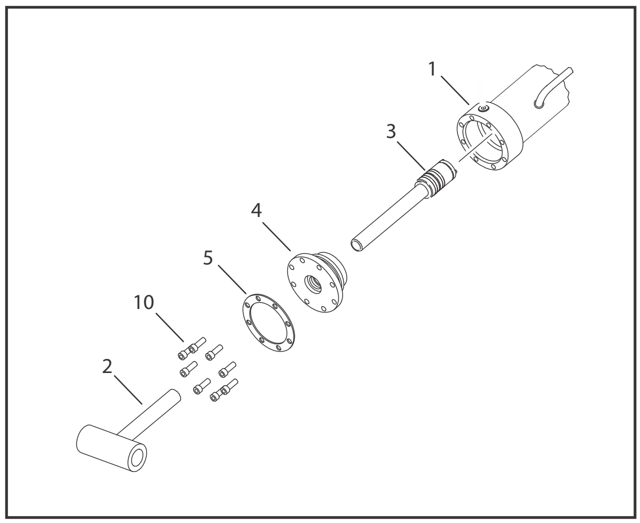


Figure 5-98. Rod Assembly Installation

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.

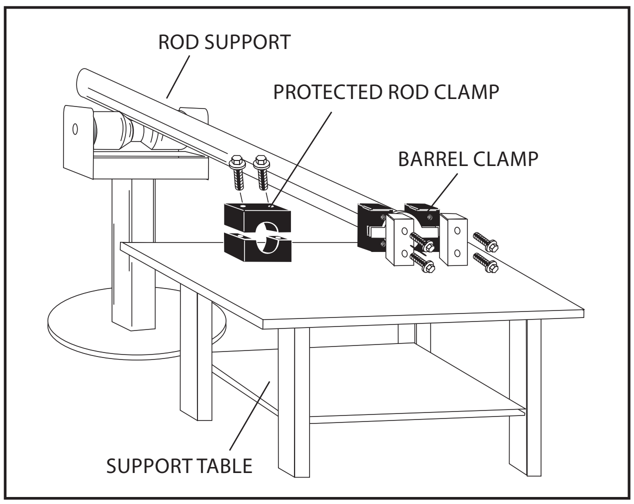


Figure 5-99. Cylinder Barrel Support

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

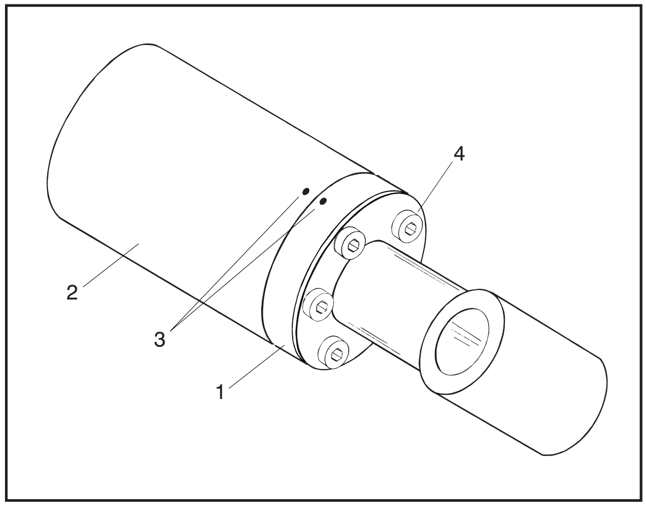


Figure 5-100. Marking Cylinder for Alignment

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.

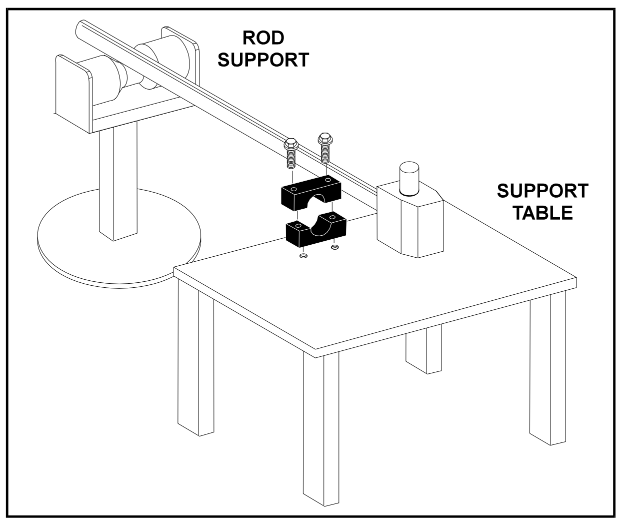
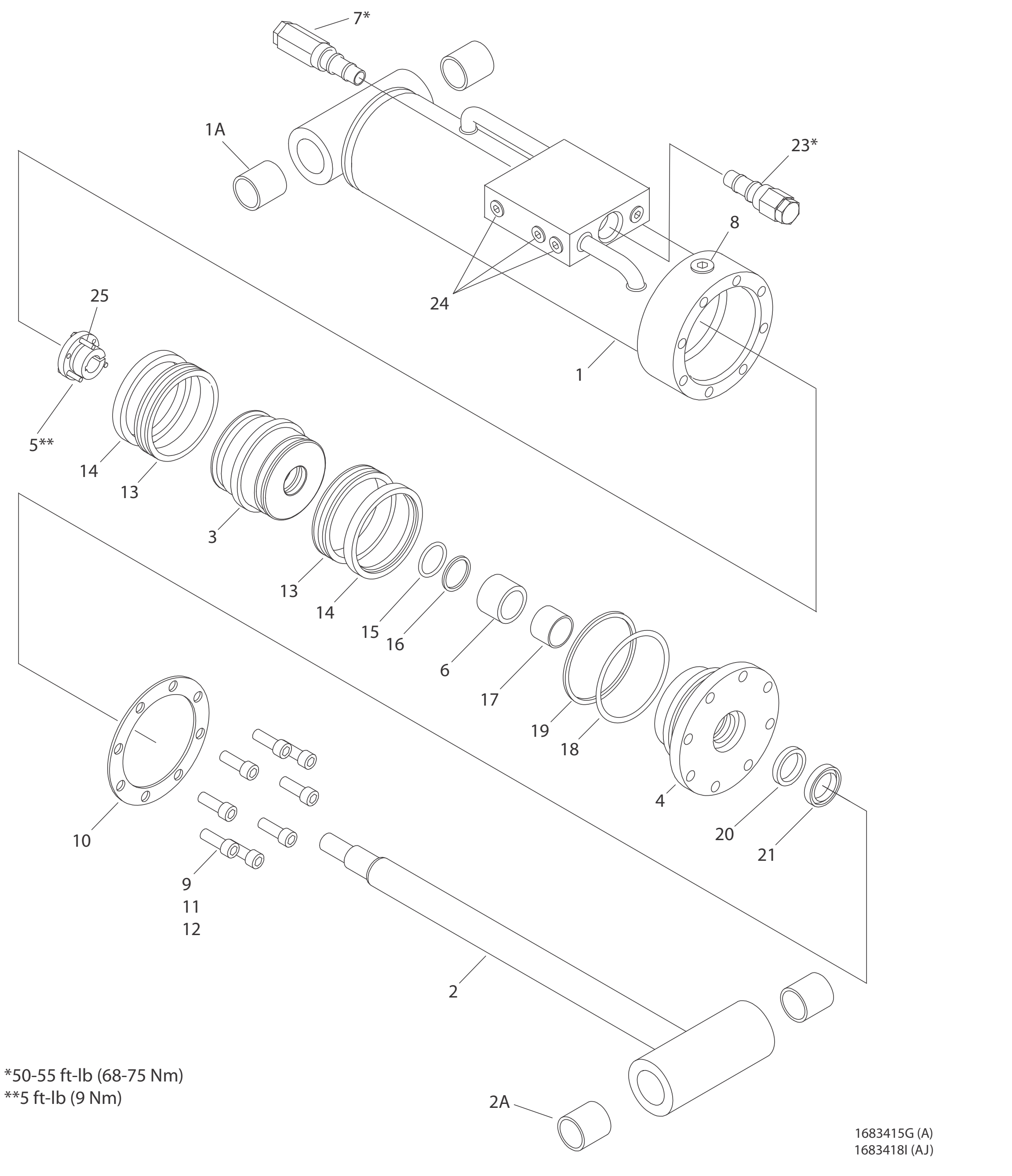


Figure 5-101. Cylinder Rod Support



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

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 capscrews.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

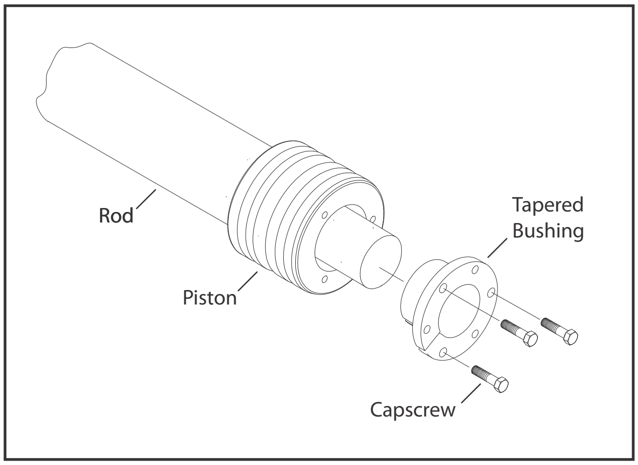


Figure 5-103. Tapered Bushing Removal

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.

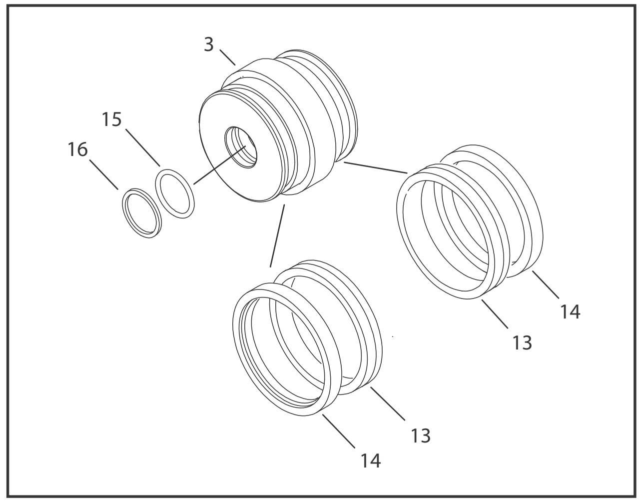


Figure 5-104. Piston Disassembly

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 groves of cylinder head.

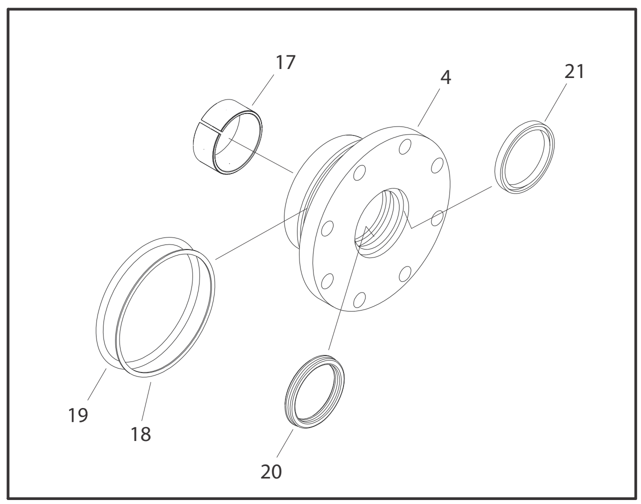


Figure 5-105. Cylinder Head Disassembly

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.

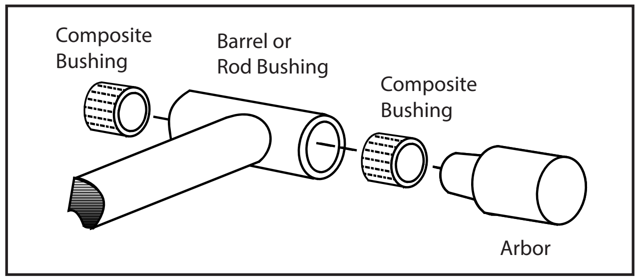


Figure 5-106. Composite Bushing Installation

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).

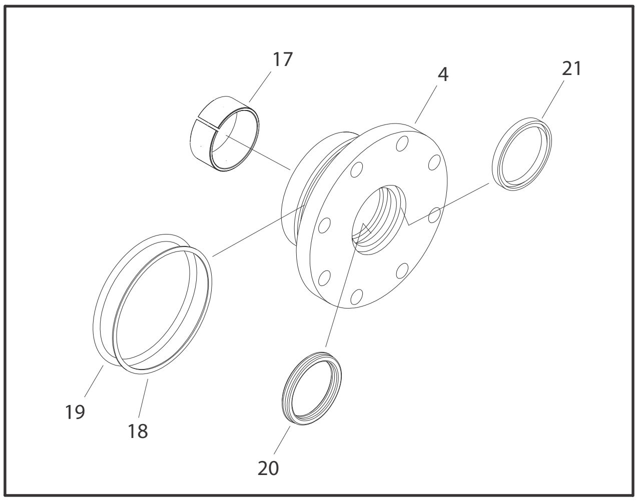


Figure 5-107. Head Seal Kit Installation

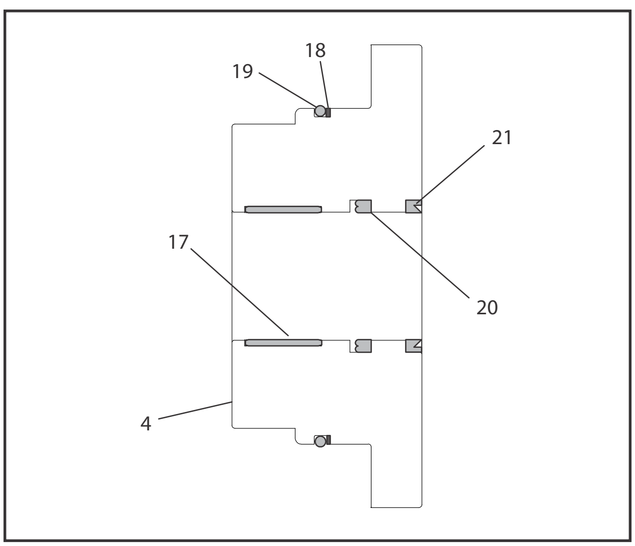


Figure 5-108. Cylinder Head Seals

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.

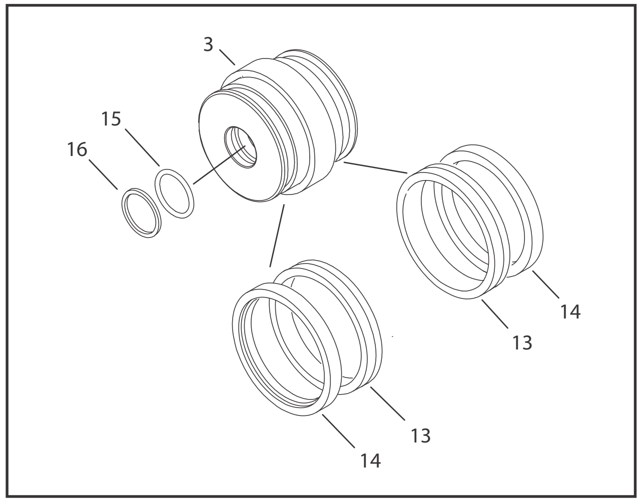


Figure 5-109. Piston Seal Kit Installation

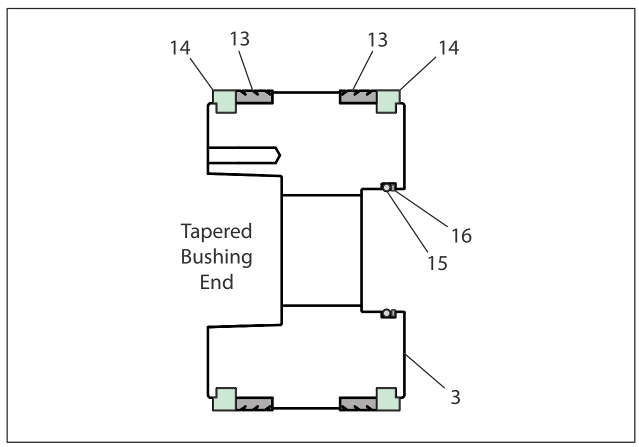


Figure 5-110. Piston Seals

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.

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.

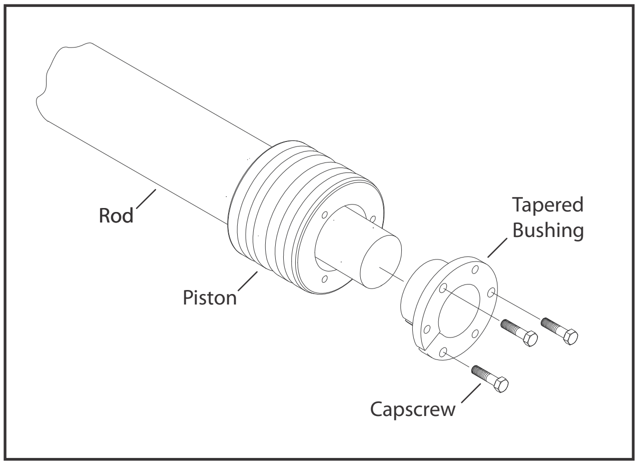


Figure 5-111. Tapered Bushing Installation

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.

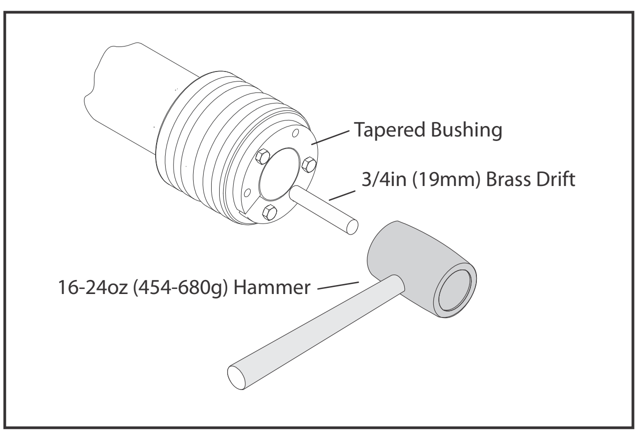


Figure 5-112. Seating Tapered Bushing

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).

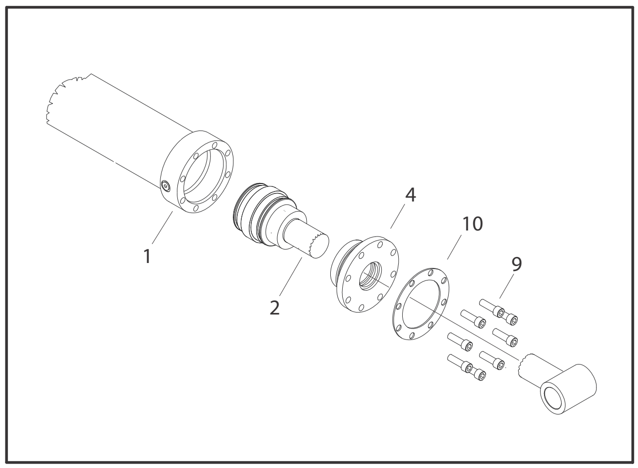


Figure 5-113. Rod Assembly Installation

Jib Lift Cylinder (AJ Only)

Refer to

DISASSEMBLY

NOTICE

CCONTAMINATION 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.

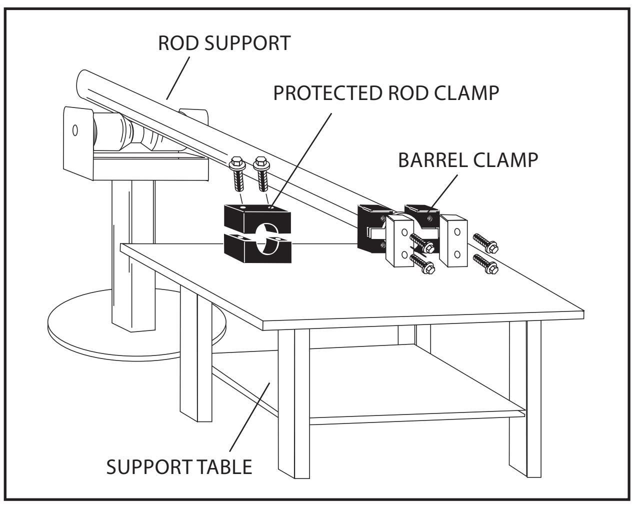


Figure 5-114. Cylinder Barrel Support

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

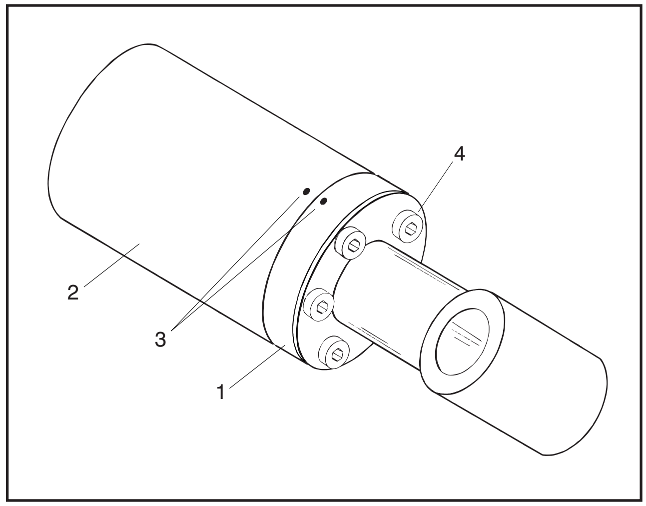


Figure 5-115. Marking Cylinder for Alignment

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.

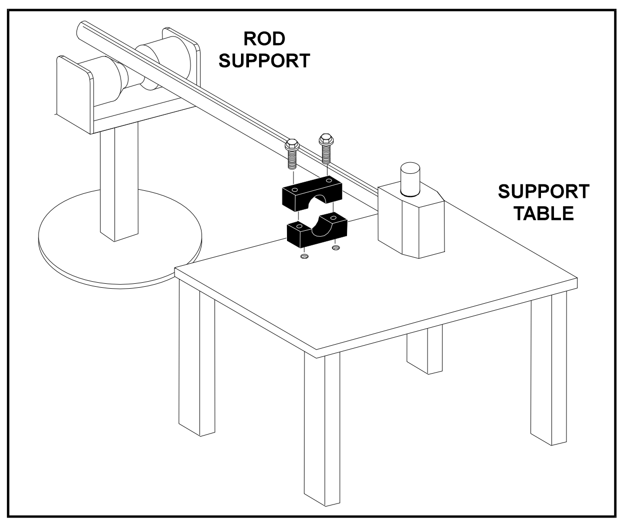
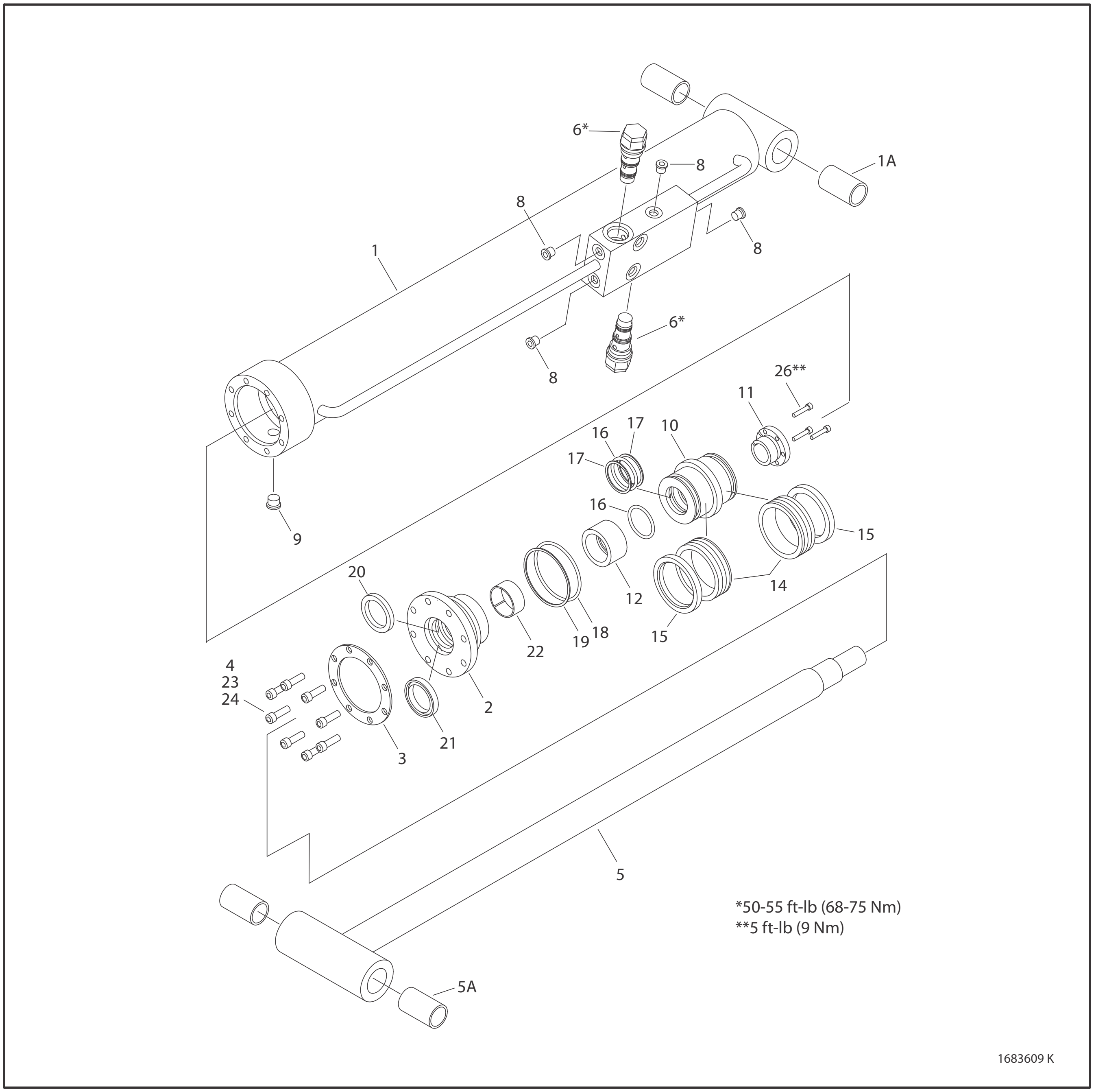


Figure 5-116. Cylinder Rod Support



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 capscrews.
12. Screw piston counter-clockwise by hand and remove from cylinder rod.

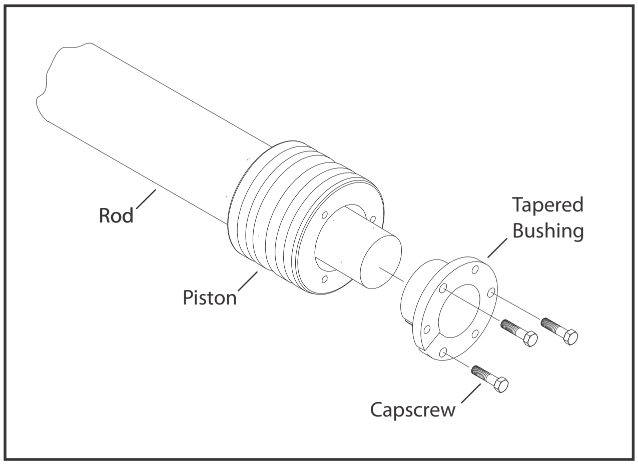


Figure 5-118. Tapered Bushing Removal

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.

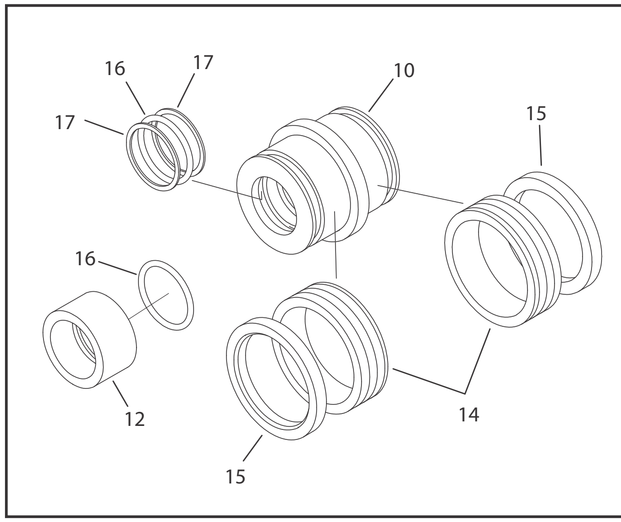


Figure 5-119. Piston And Spacer Disassembly

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.

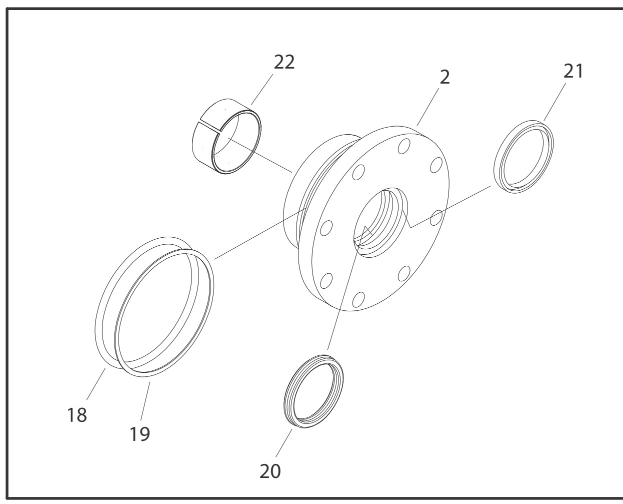


Figure 5-120. Cylinder Head Disassembly

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.

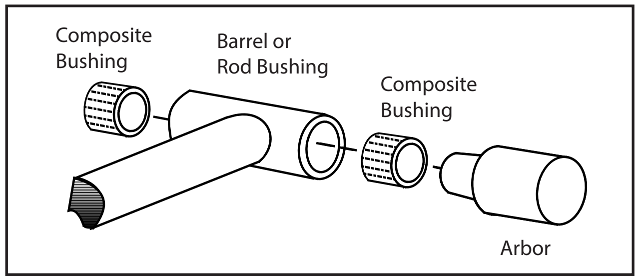


Figure 5-121. Composite Bushing Installation

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).

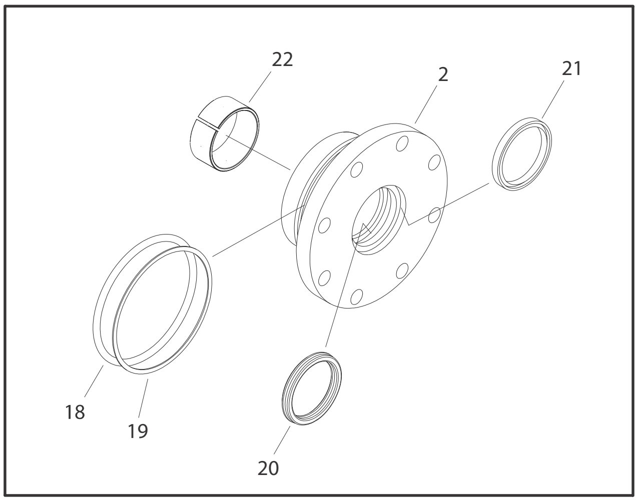


Figure 5-122. Head Seal Kit Installation

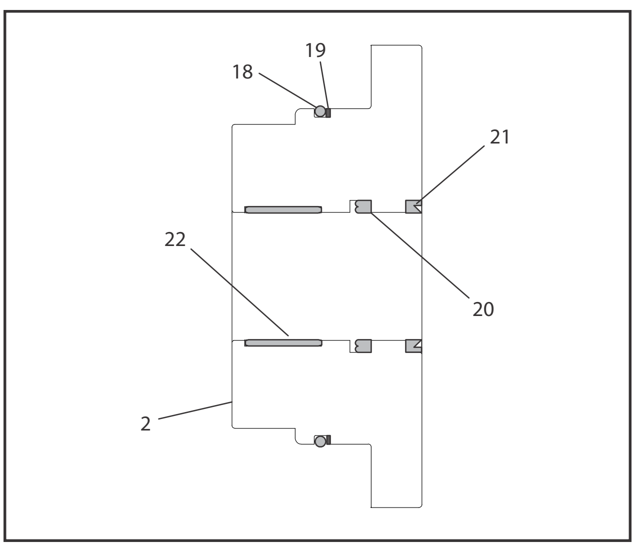


Figure 5-123. Cylinder Head Seals

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.

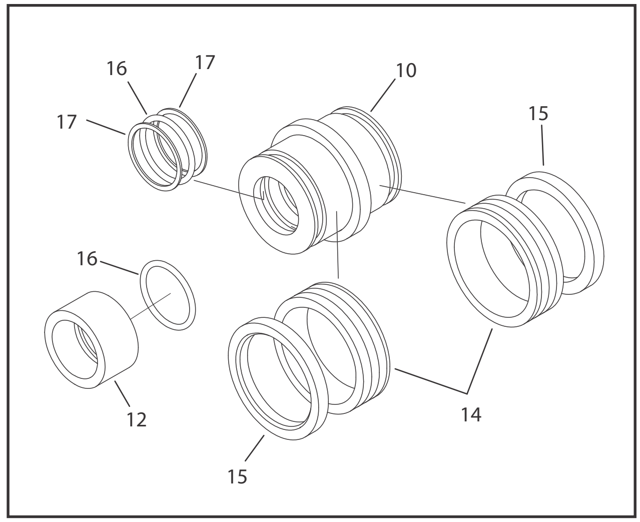


Figure 5-124. Piston Seal Kit Installation

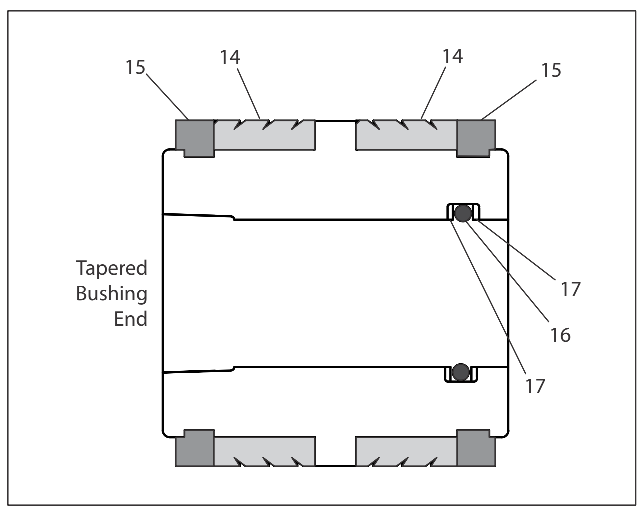


Figure 5-125. Piston Seals

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.

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.

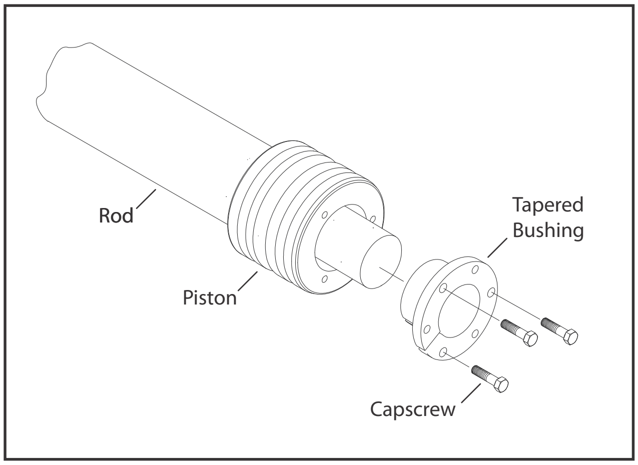


Figure 5-126. Tapered Bushing Installation

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.

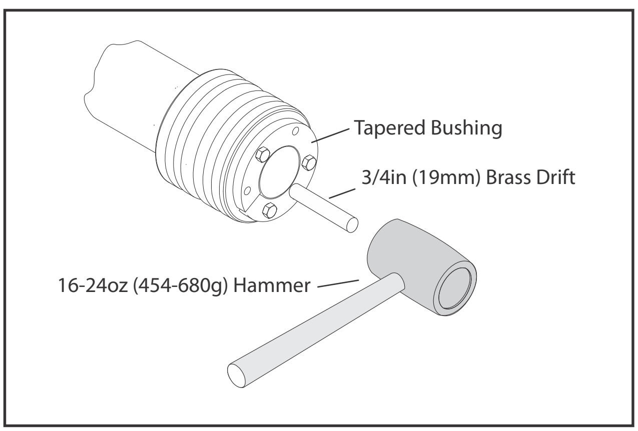


Figure 5-127. Seating Tapered Bushing

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).

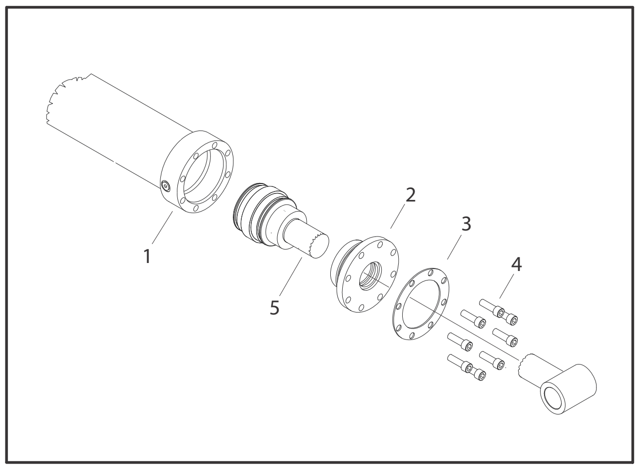


Figure 5-128. Rod Assembly Installation

Steer Cylinder

DISASSEMBLY

Refer to Figure 5-132.

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.

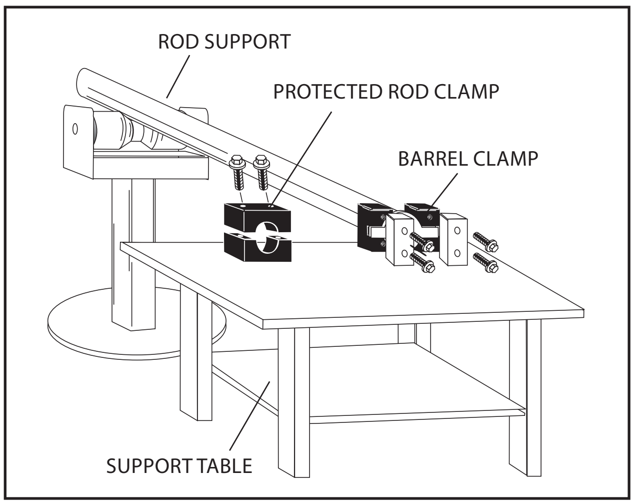


Figure 5-129. Cylinder Barrel Support

4. Remove burrs and contamination from cylinder before disassembly.
5. Unscrew Spanner Nut (13) with hook spanner.

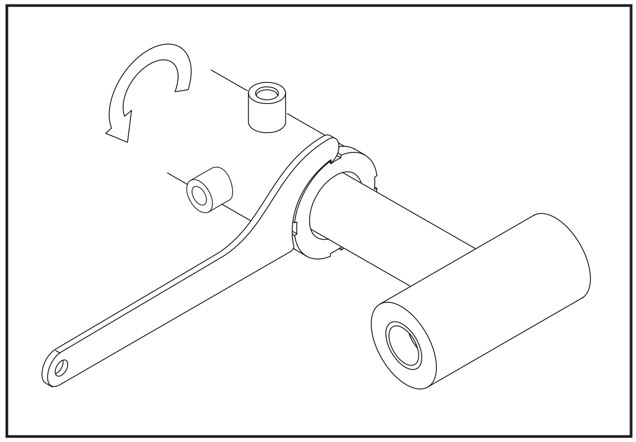


Figure 5-130. Removing Spanner Nut

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.

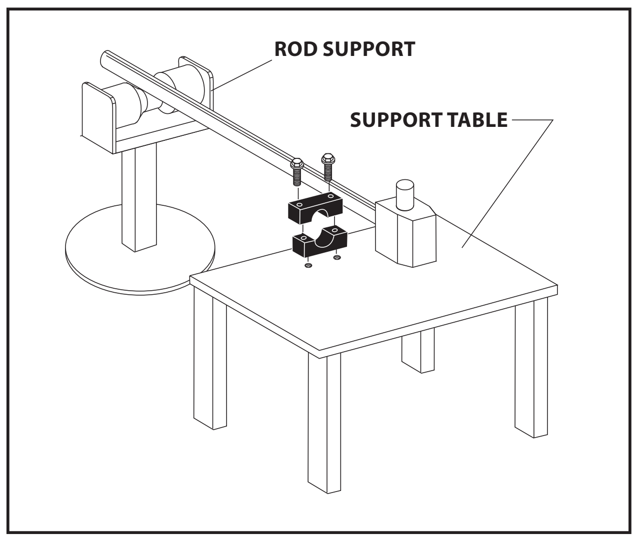
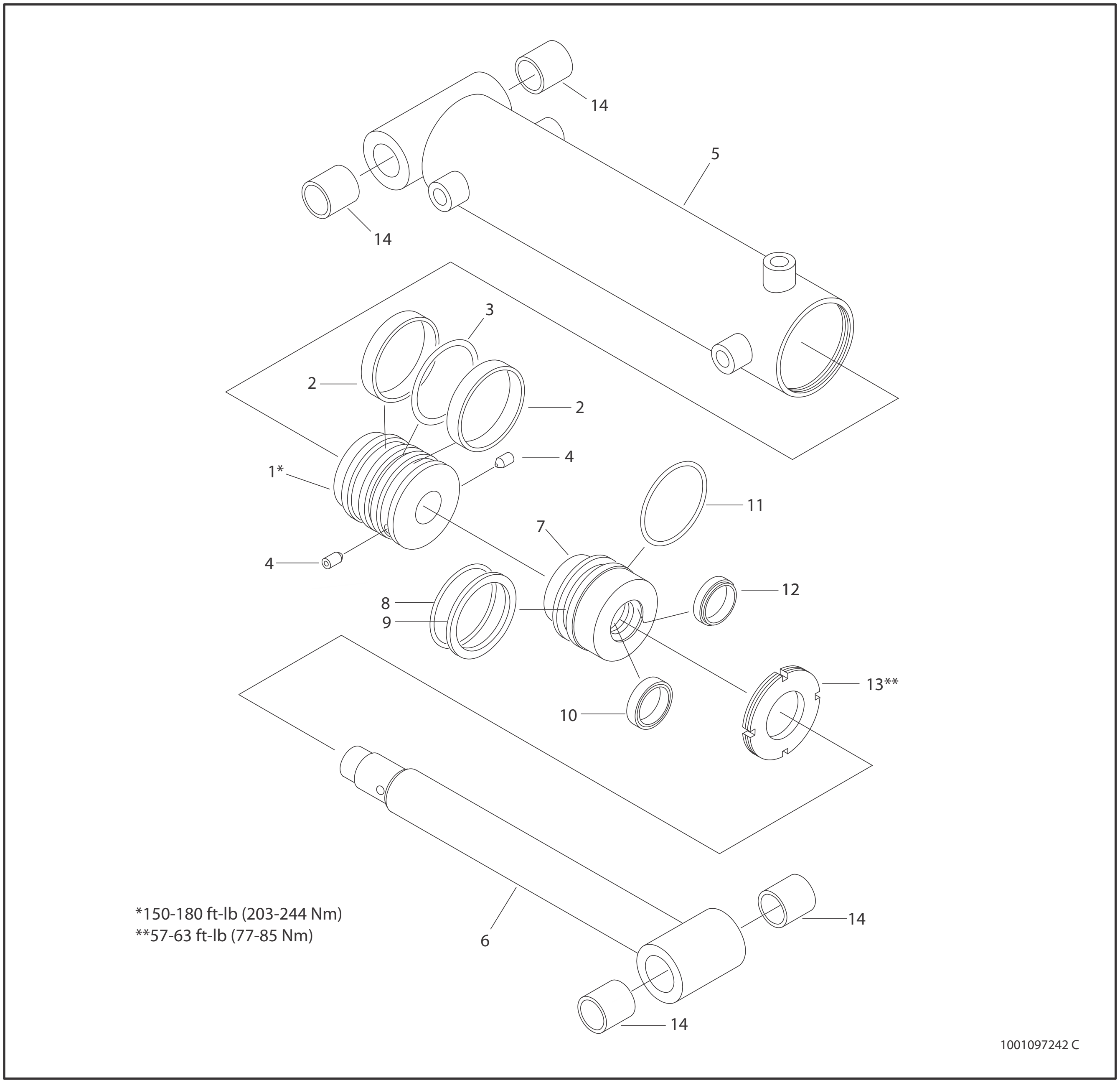


Figure 5-131. Cylinder Rod Support



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.

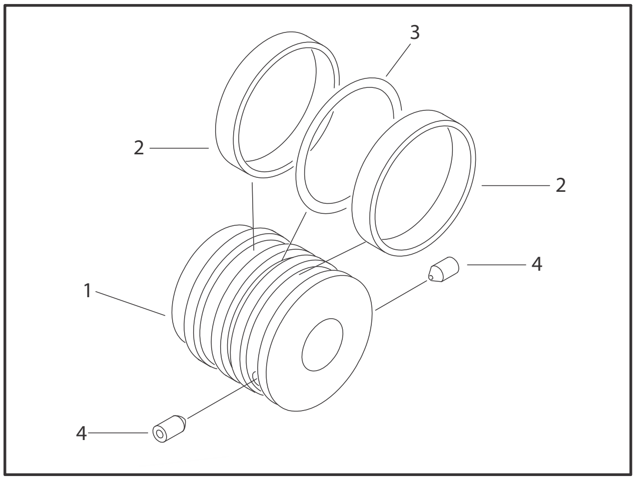


Figure 5-133. Piston Seal and Wear Ring

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).

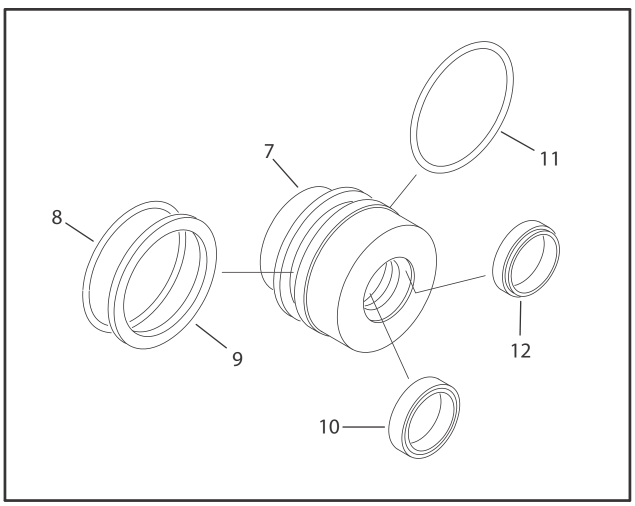


Figure 5-134. Cylinder Head Disassembly

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.*

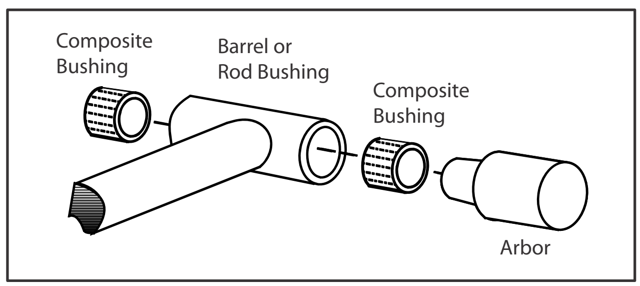


Figure 5-135. Composite Bushing Installation

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).

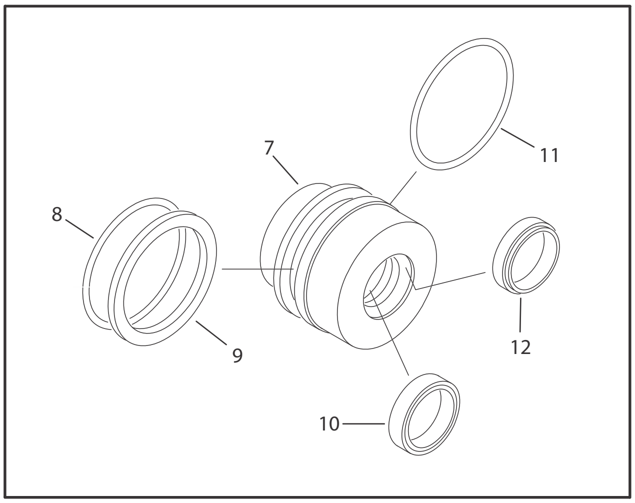


Figure 5-136. Cylinder Head Assembly

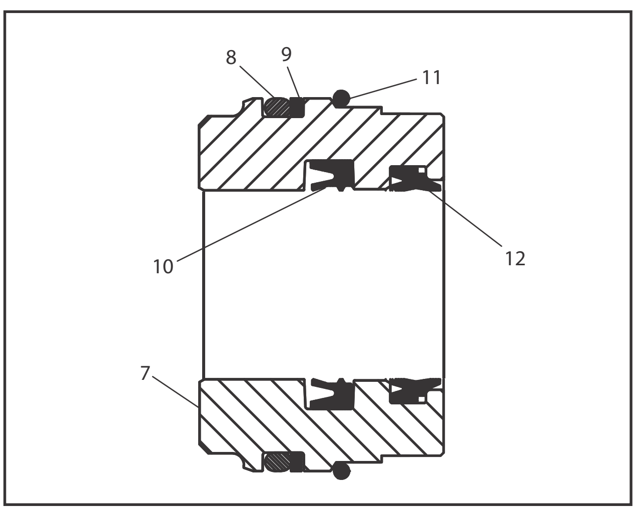


Figure 5-137. Cylinder Head Seals

5. Install O-Ring (3) and two seals (2) in piston groove.

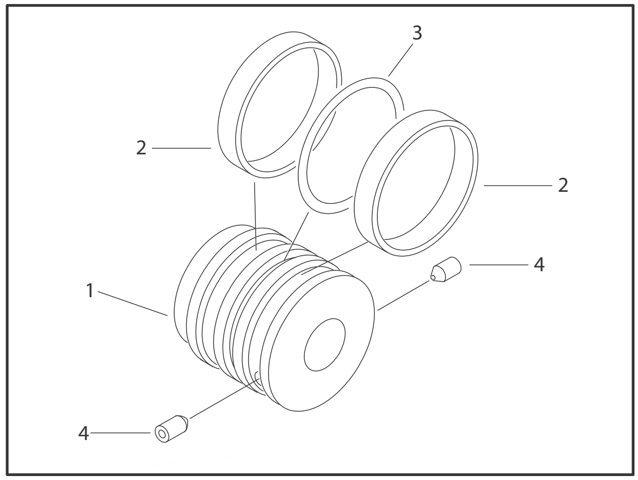


Figure 5-138. Piston Seal and Wear Ring Assembly

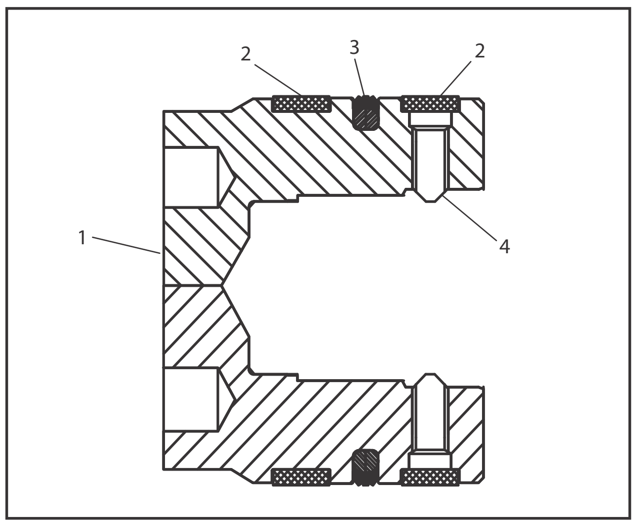


Figure 5-139. Piston Seals

NOTICE

INSERTING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE INSTALLING CYLINDER ROD AND PISTON.

1. Insert rod assembly in barrel.
2. Apply locking primer (JLG P/N 0100038) and thread locking compound (JLG P/N 0100011) to spanner nut threads (3).
3. 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.

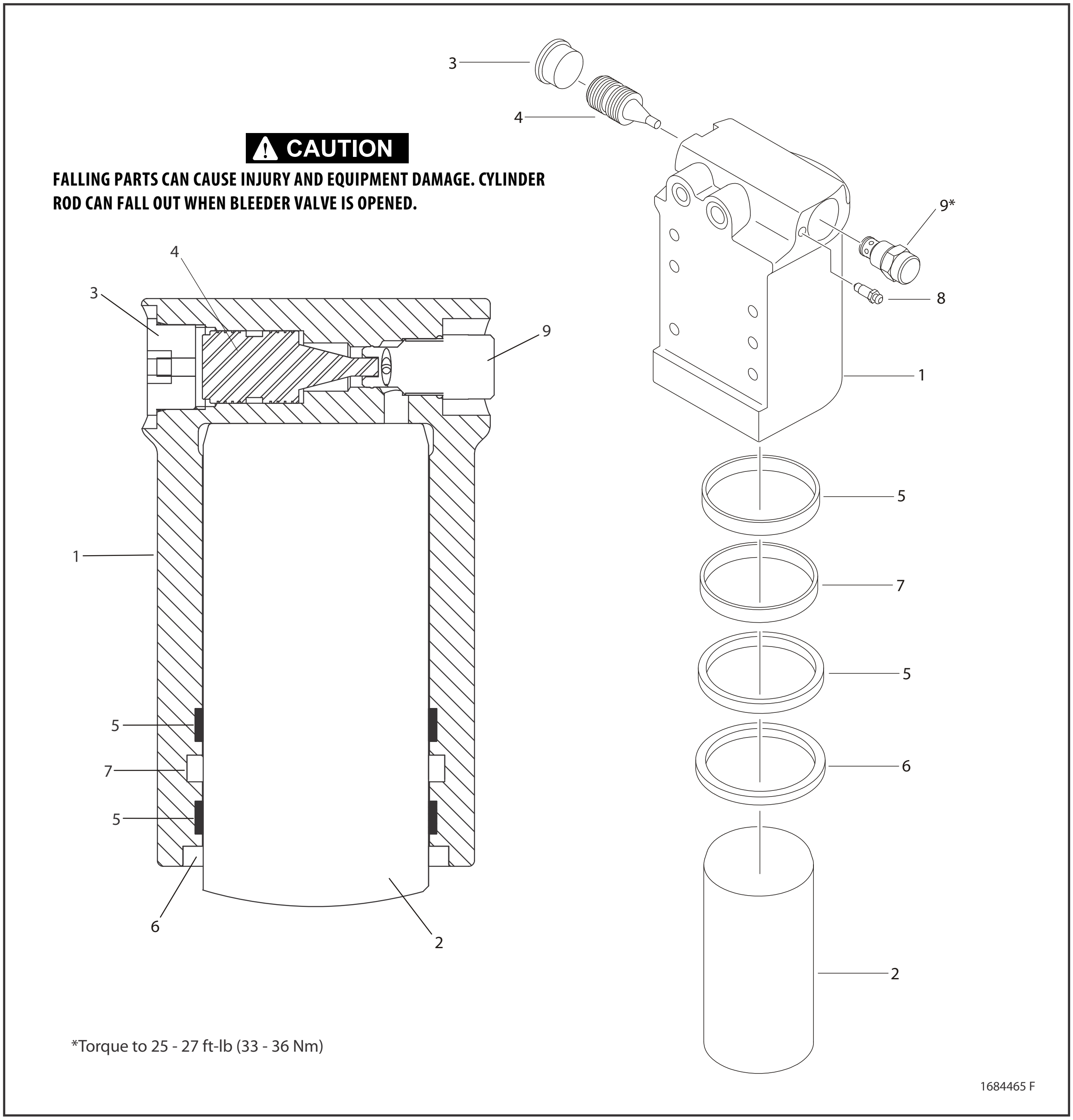
ASSEMBLY

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

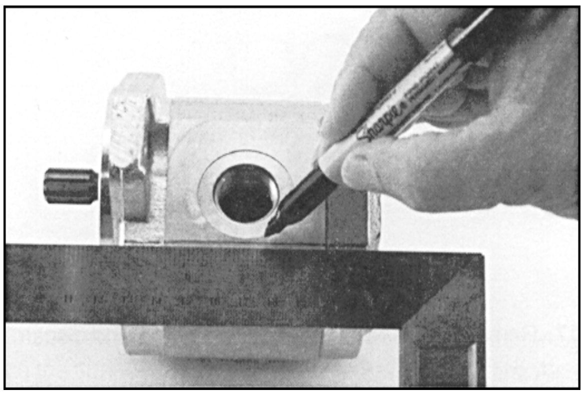
Figure 5-140. Axle Lockout Cylinder

5.6 HYDRAULIC PUMP (GEAR)

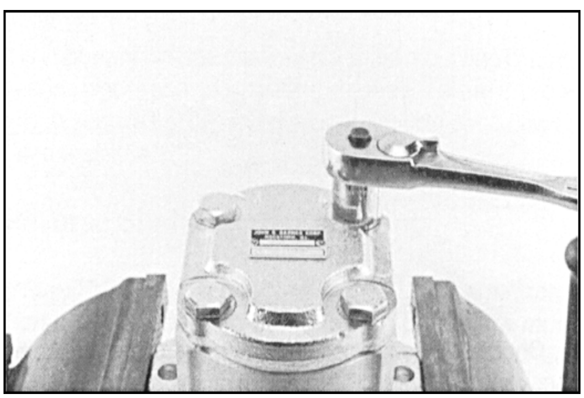
Disassembly

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.*

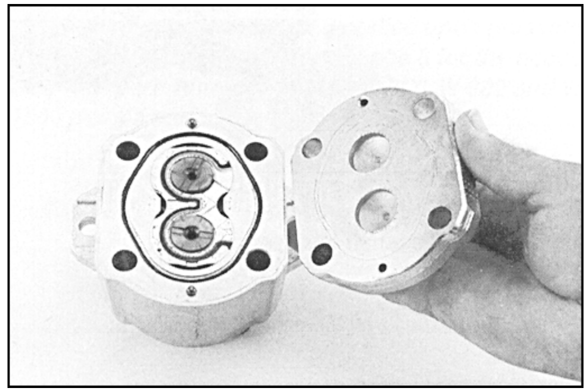
1. Always work in a clean work area when repairing hydraulic products. Plug ports and wash exterior of pump with approved cleaning solvent.
2. Remove port plugs and drain oil from pump.



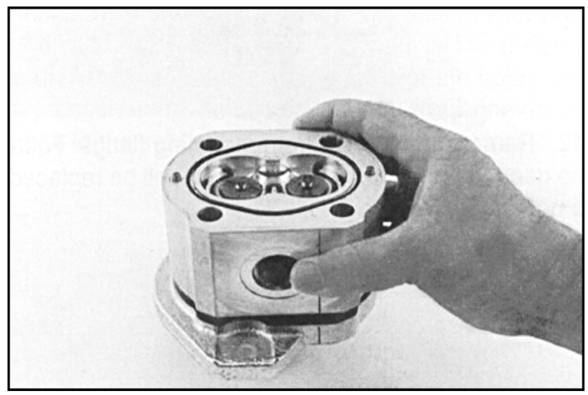
3. Use a permanent marker pen to mark a line across mounting flange, gear housing and end cover. This will assure proper reassembly and rotation of pump.
4. Remove key from drive shaft if applicable.



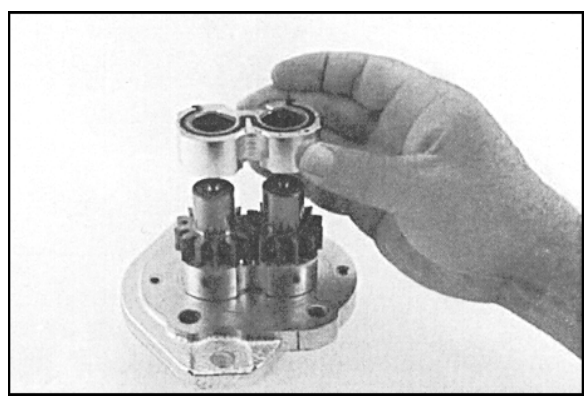
5. Clamp mounting flange in a protected jaw vise with pump shaft facing down.
6. Loosen four metric hex head bolts.
7. Remove pump from vise and place on clean work bench. Remove four hex head bolts and spacers if applicable.



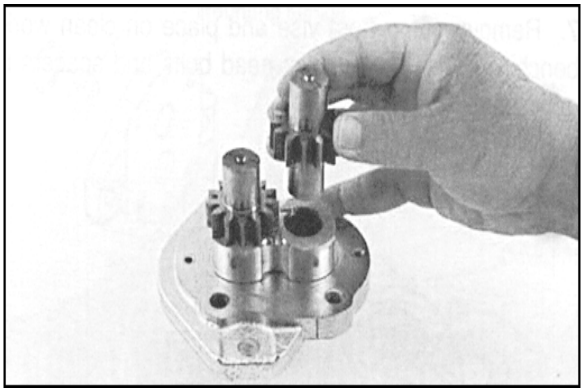
8. Lift and remove end cover.



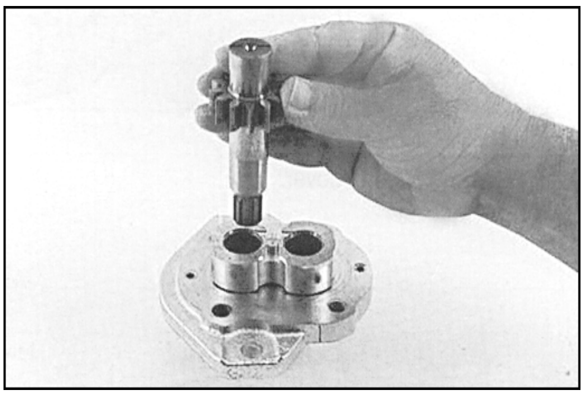
9. Carefully remove gear housing and place on work bench. Make sure rear bearing block remains on drive and idler shafts.



10. Remove rear bearing block from drive and idler shafts.

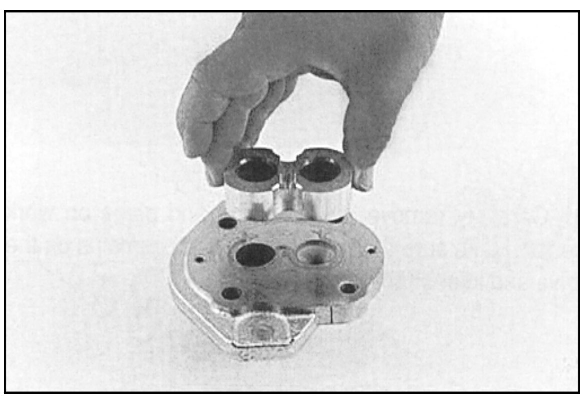


11. Remove idler shaft from bearing block.

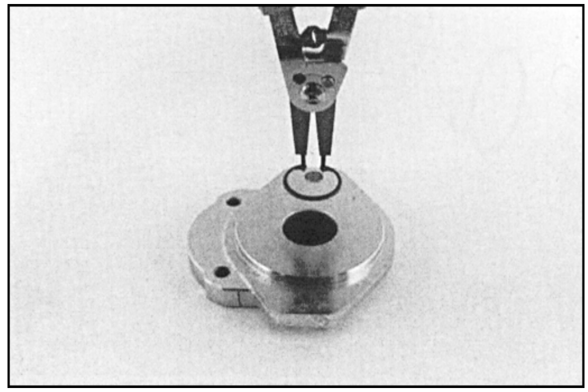


12. Remove drive shaft from mounting flange.

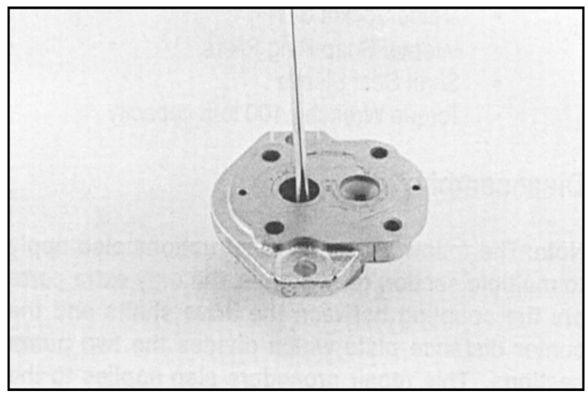
NOTE: *Shaft seal will be replaced.*



13. Remove front bearing block.

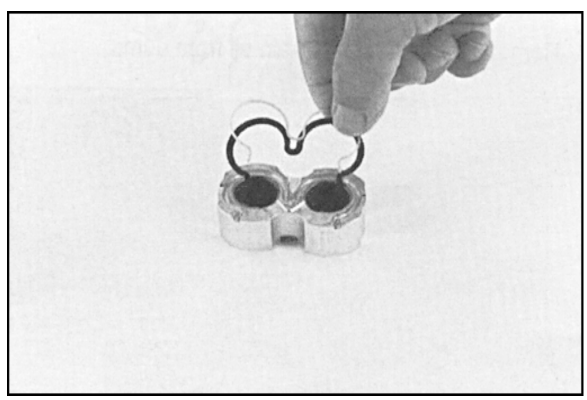


14. Turn mounting flange over, with shaft seal up. Remove retaining ring with snap ring pliers.



15. Remove oil seal from mounting flange. Do not mar or scratch seal bore.

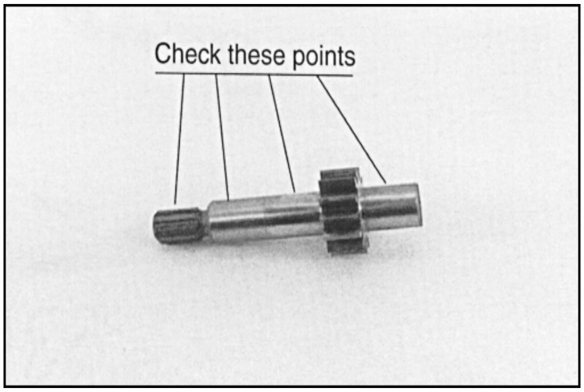
16. Remove dowel pins from gear housing. Do not lose pins.



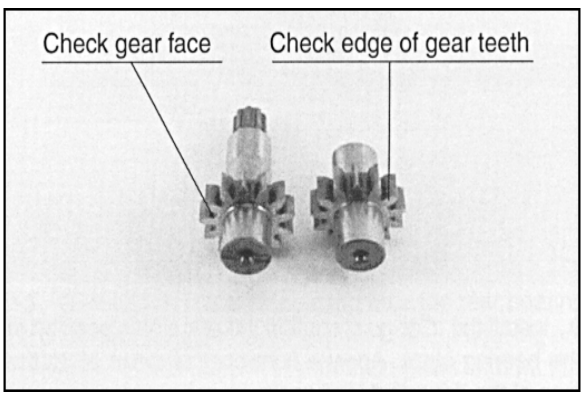
17. Remove and discard seals from both bearing blocks.

Inspect Parts For Wear

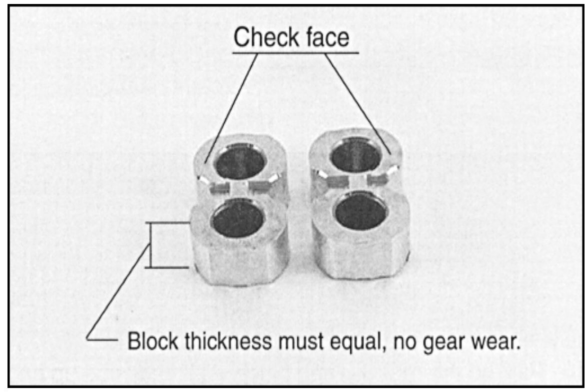
1. Clean and dry all parts thoroughly before inspection. It is not necessary to inspect seals. They will be placed as new items.



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.

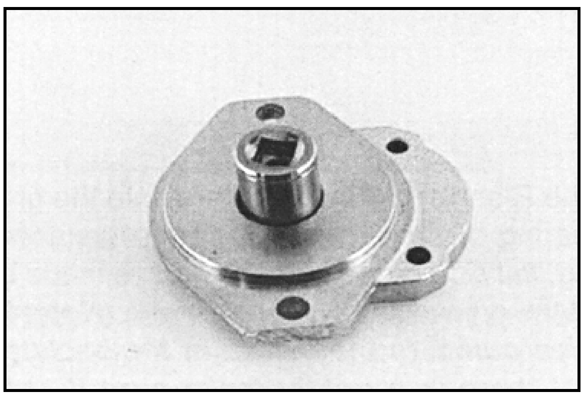
Reverse Shaft Rotation of Pump

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.

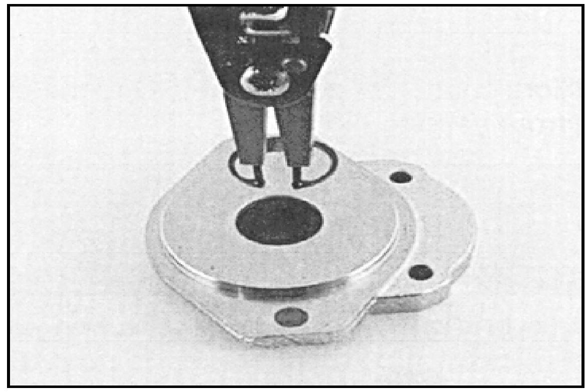
Assembly

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.*

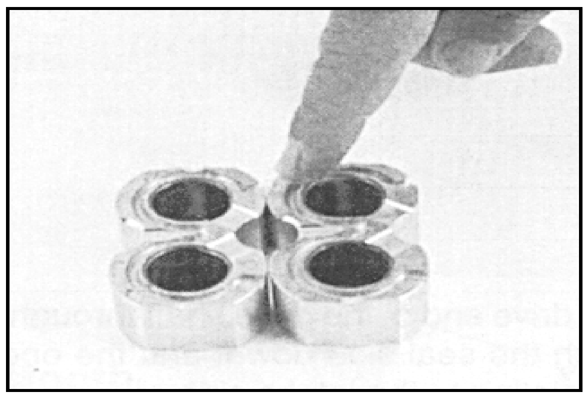


1. Install new shaft seal in mounting flange with part number side facing out. Press seal into seal bore until seal reaches bottom of bore. Use uniform pressure to prevent seal misalignment or damage.

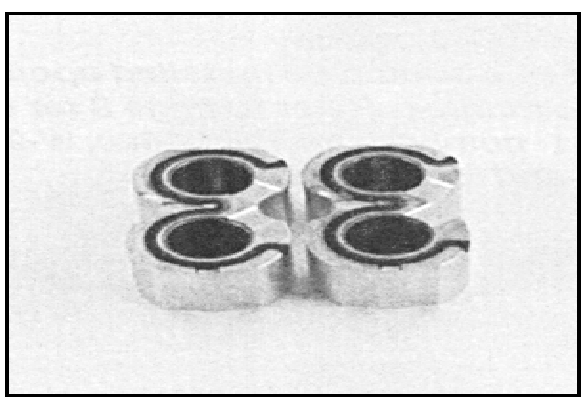
2. Install retaining ring in groove in seal bore of mounting flange.



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

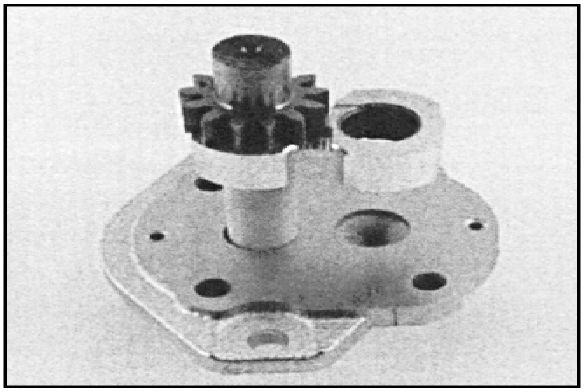


4. Place E-seals, *flat side out,* into grooves in both bearing blocks. *Carefully* place backup ring, *flat side out,* in groove made by E-seal and groove in bearing block. *(Note: W900 series pump - In center of backup ring and E-seal there is a notch. Make sure notches line up so backup ring will set flush with E-seal).* Backup ring in W1500 pump is symmetrical.



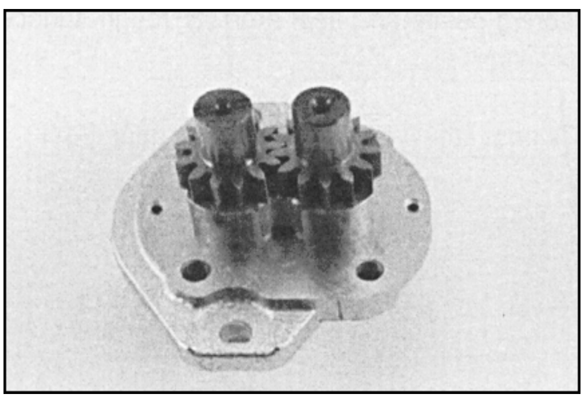
5. Place mounting flange, with shaft seal side down, on a clean flat surface.

6. Apply a light coating of petroleum jelly to exposed face of front bearing block.

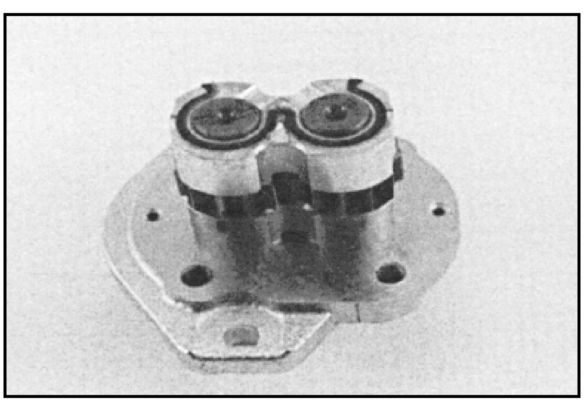


7. Insert drive end of drive shaft through bearing block with seal side down and open side of E-seal pointing to intake side of pump.

8. Install seal sleeve over drive shaft. Carefully slide drive shaft through shaft seal. Remove seal sleeve from shaft.

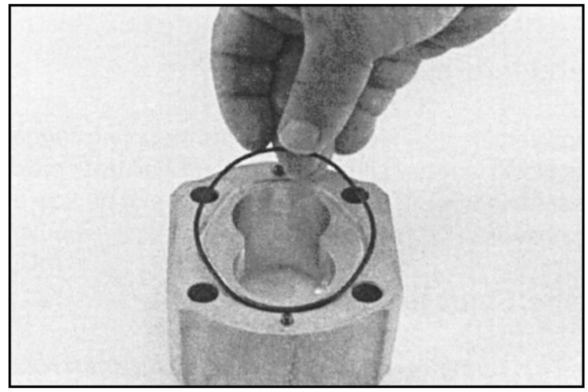


9. Install idler gear shaft in remaining position in bearing block. Apply a light coat of clean oil to face of drive and idler gears.

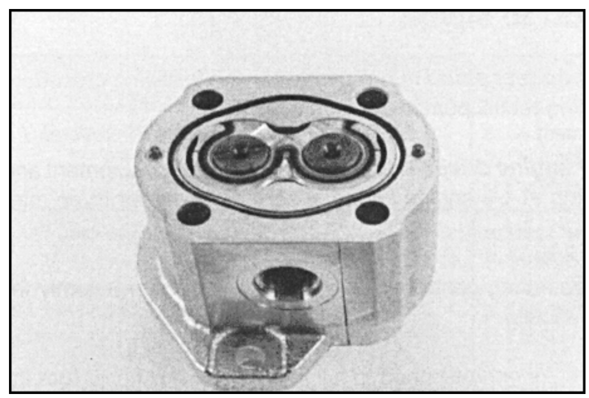


10. Place rear bearing block over drive and idler gear shafts with seal side up and open end of E-seal facing intake side of pump.

11. Install two dowel pins in mounting flange holes or two long dowel pins through gear housing if pump is a multiple section pump.

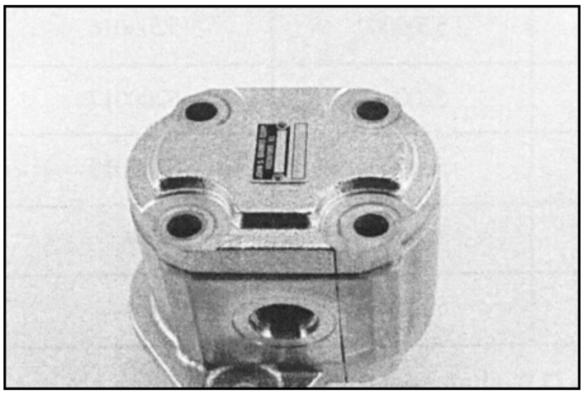


12. Apply a light coating of petroleum jelly in grooves on both sides of gear housing. Coat new O-rings and install in grooves.

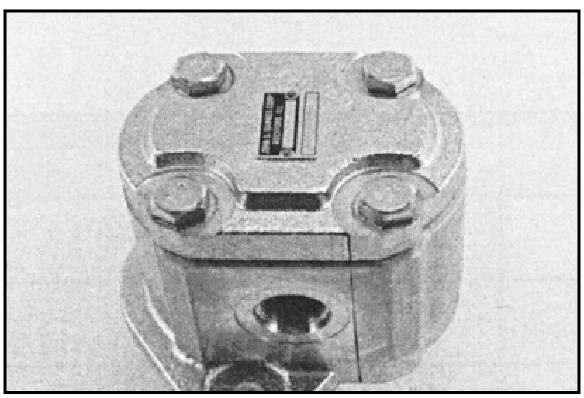


13. Gently slide gear housing over rear bearing block assembly. Slide housing down until it engages dowel pins. Press firmly in place with hands, do not force or use any tool. Check intake port in housing is on same side as open end of E-seal, and marked lines on mounting flange and gear housing are aligned.

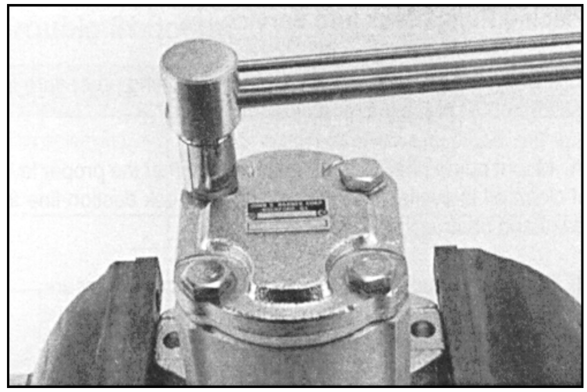
NOTE: *Rear bearing block surface should be slightly below gear housing face. If bearing block is higher than rear face of gear housing, E-seal or O-ring have shifted out of groove. Remove gear housing and check for proper seal installation.*



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	9/16-18 ORF
M3	Charge	1000	60	3/4-16 ORF
M4 & M5	Servo	1000	60	9/16-18 ORF
L1 & L2	Case	500	35	1-1/16-12 ORF
S	Charge Pump Inlet Vacuum	30 in. Hg Vac.	1	1-1/16-12 ORF

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.*

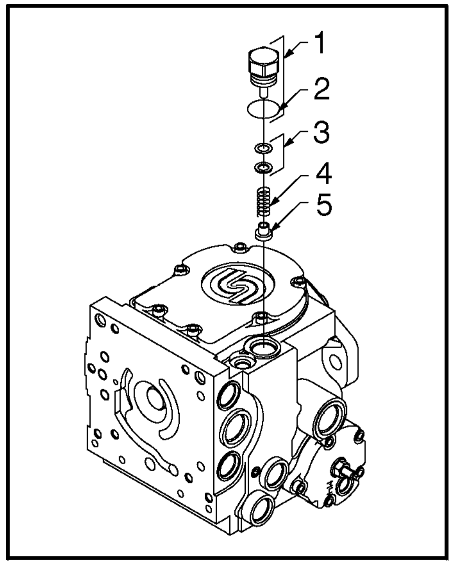
1. Remove servo piston cover.
2. Remove orifice plug (1/8" Int. Hex).
3. Examine orifice and port for cleanliness.
4. Install orifice plug. Torque to 1.5 - 2.5 ft-lb (2.0-3.4 Nm).

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

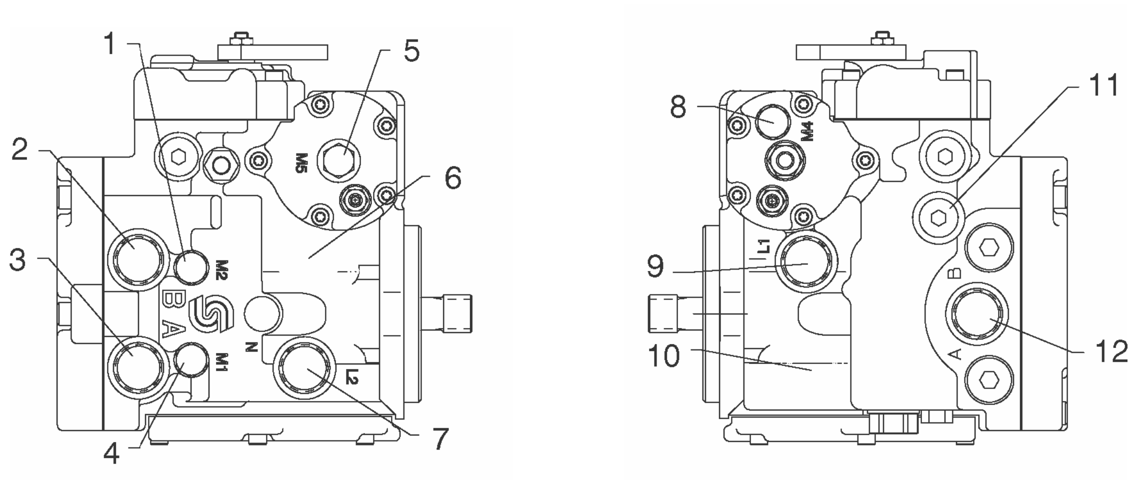


1. Plug
2. O-Ring
3. Shims
4. Spring T-Seal
5. Poppet

Figure 5-141. Shim Adjustable Charge Relief Valve Components

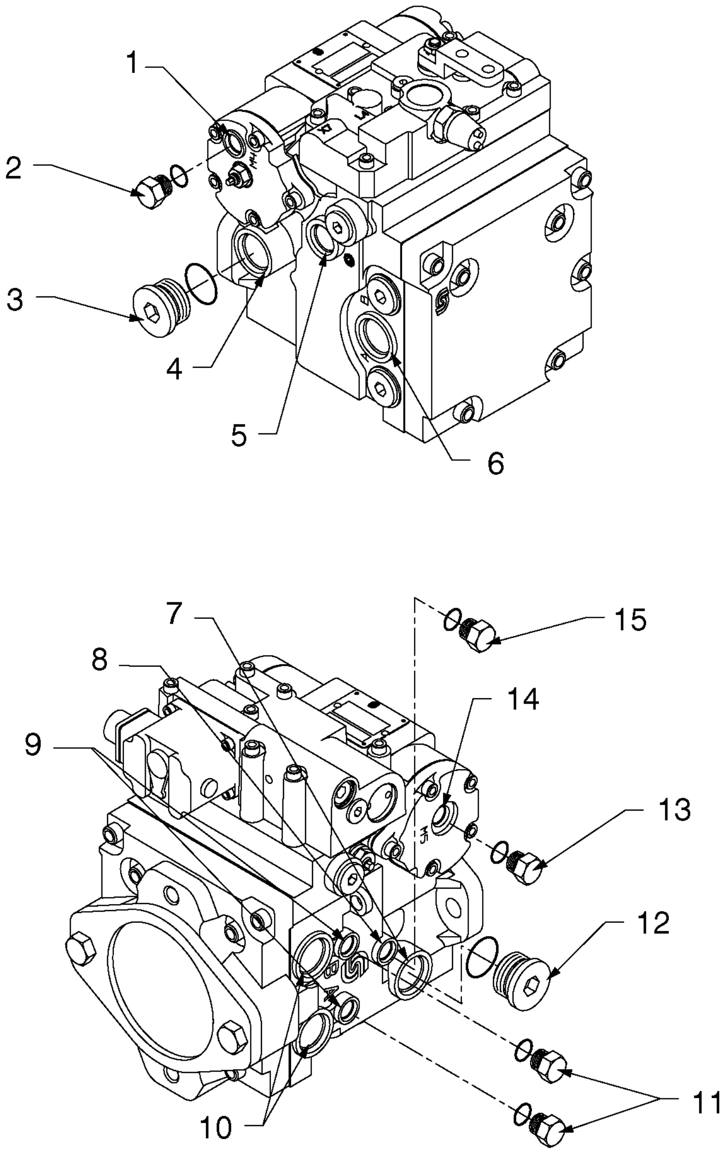
1. Remove shim adjustable charge relief valve plug (1" Hex) from pump housing. Remove O-ring from plug.
2. Remove spring and poppet from housing.
3. Do not alter shims which may be installed between spring and valve plug, or interchange parts with another valve. Inspect poppet and mating seat in housing 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
2. System Pressure Port B
3. System Pressure Port A
4. System Pressure Gauge Port M1
5. Servo Pressure Gauge Port M5
6. Case Drain Port L2 (non-feedback)
7. Case Drain Port L2
8. Servo Pressure Gauge Port L4
9. Case Drain Port L1
10. Case Drain Port L1 (non-feedback)
11. Charge Pressure Gauge
12. Charge Pump Inlet Port S

Figure 5-142. Gauge Port Locations

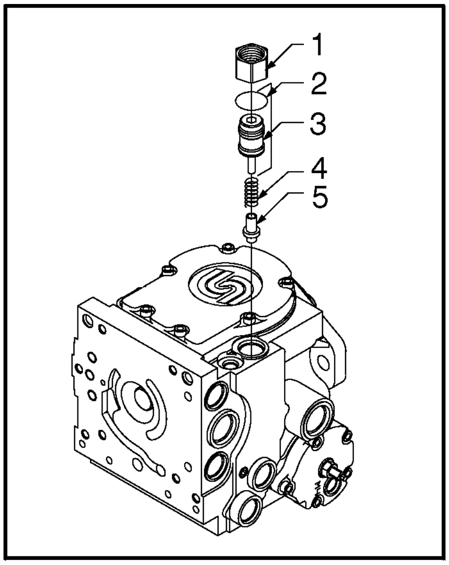


#	Plug/ Fitting	Torque	
		lb. ft.	Nm
1	Servo Gauge Port M4	N/A	N/A
2	11/16	20-35	27-47
3	9/16	70-100	95-135
4	Case Drain Port L1	N/A	N/A
5	Charge Pressure Gauge M3	N/A	N/A
6	Charge Pump Inlet Port S	85	115
7	Case Drain Port L2	N/A	N/A
8	Port N	N/A	N/A
9	System Gauge M1 & M2	N/A	N/A
10	System Ports A&B	85	115
11	11/16	20-35	27-47
12	9/16	70-100	95-135
13	11/16	20-35	27-47
14	Servo Gauge M5	N/A	N/A
15	11/16	20-35	27-47

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

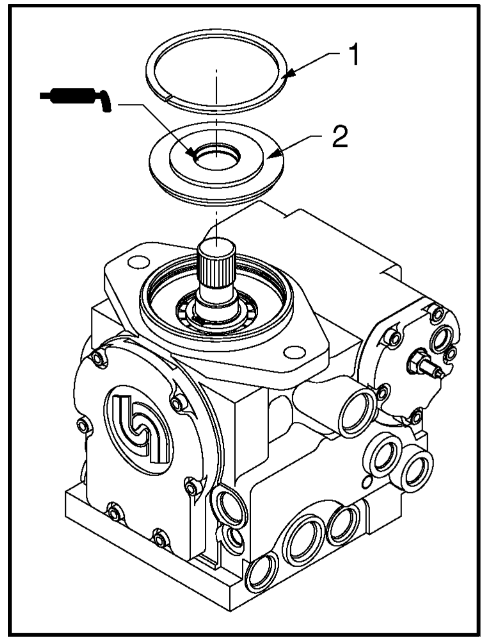


1. Lock Nut
2. O-Ring
3. Plug
4. Spring T-Seal
5. Poppet

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.

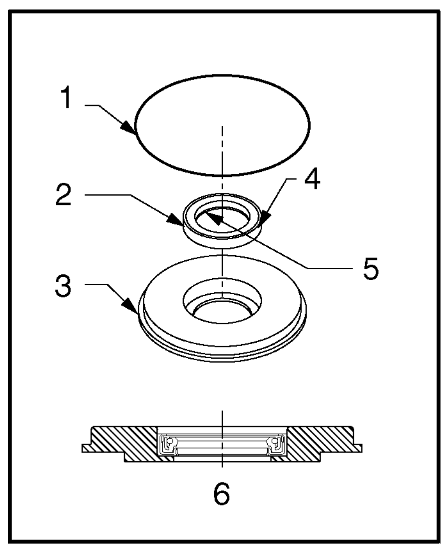
Shaft Seal and Shaft Replacement



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.



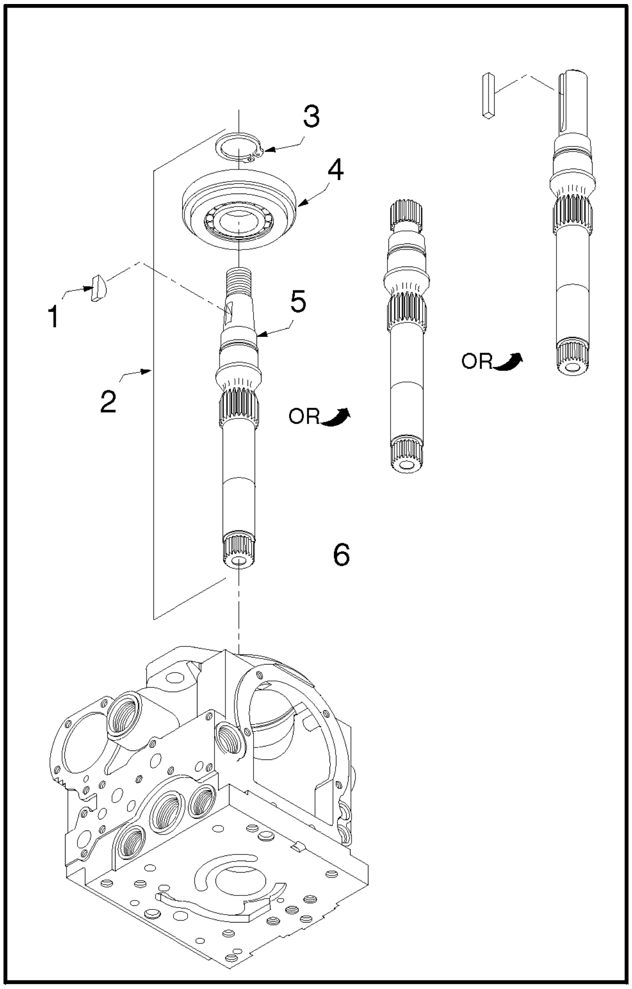
1. O-Ring
2. Seal
3. Seal Carrier
4. Sealant may be used on outside diameter
5. Inside Lip (face down)
6. Press Seal to Bottom of Seal Carrier

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

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.

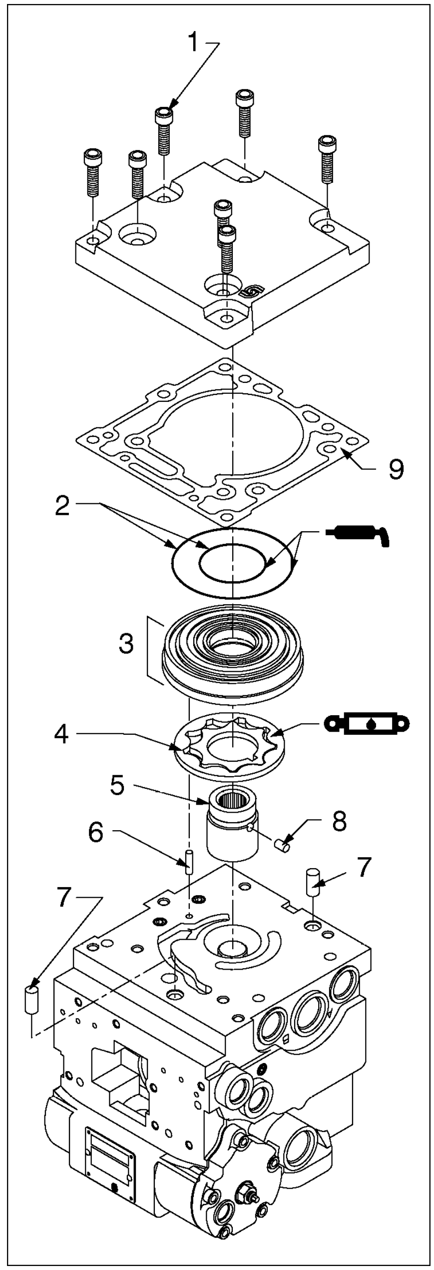
Charge Pump

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
2. O-Ring
3. Gerotor Cover
4. Gerotor Assembly
5. Drive Coupling
6. Gerotor Cover Locating Pin
7. Charge Pump Cover Locating Pin
8. Gerotor Drive Pin
9. Gasket

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 5-149., Location of Components - Main Control Valve Block.

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 5-150., 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.

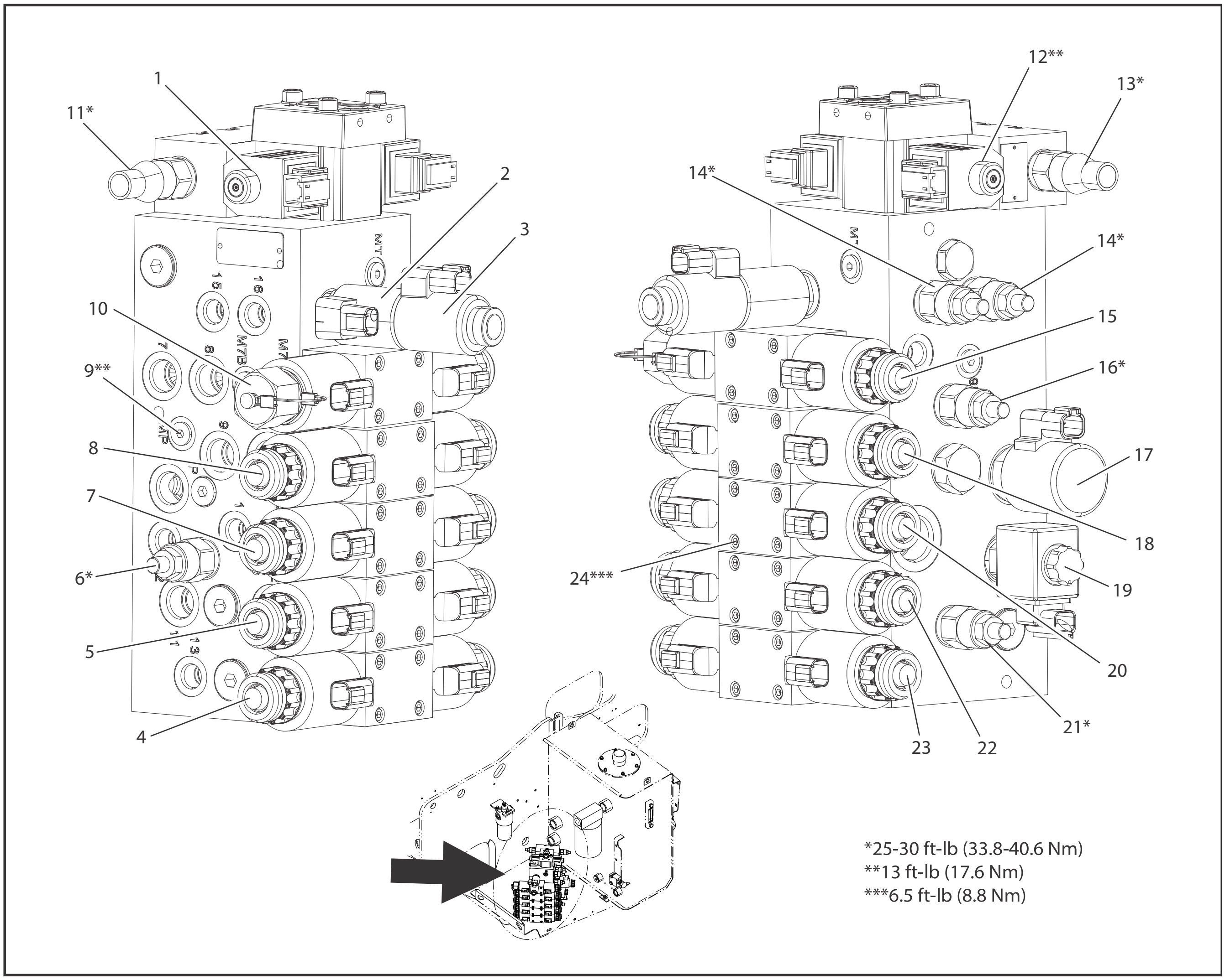
Platform Level Retract

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

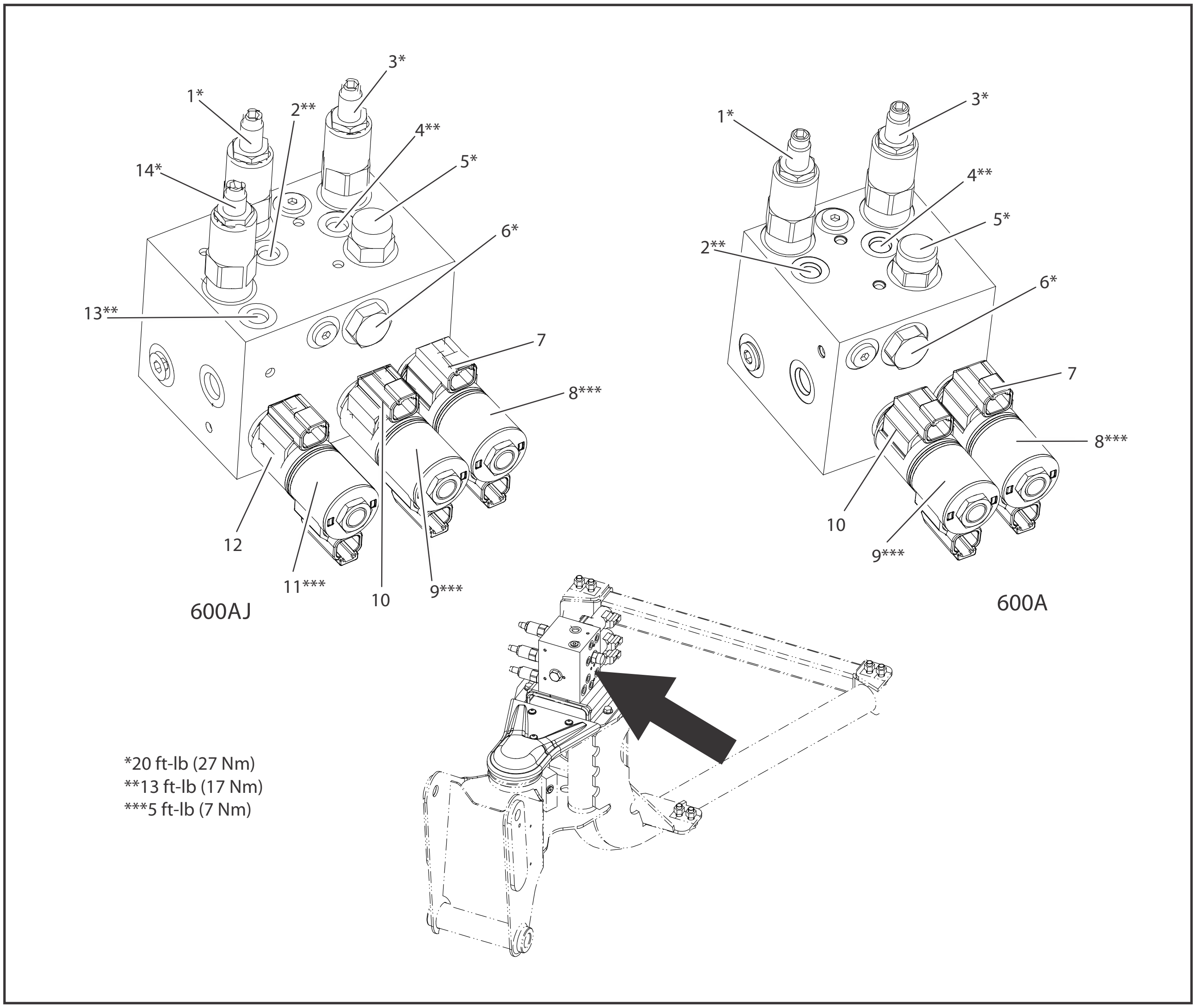
NOTE: *Relief pressure is bi-directional, but can only be read in one direction.*

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. Rear Steer Left (4-Wheel Steer Only)
2. Front Steer Left
3. Front Steer Right
4. Swing Right
5. Main Lift Down
6. Main Upper Boom Pressure Relief Valve
7. Tower Telescope In
8. Main Telescope In
9. Test Port MP
10. Tower Lift Down
11. Rear Steer Pressure Relief (4-Wheel Steer Only)
12. Rear Steer Right (4-Wheel Steer Only)
13. Rear Steer Pressure Relief (4-Wheel Steer Only)
14. Front Steer Pressure Relief
15. Tower Lift Up
16. Main Upper Boom Pressure Relief
17. Flow Control
18. Main Telescope Out
19. Direct Control Dump Valve
20. Tower Telescope Out
21. Main Upper Boom Pressure Relief
22. Main Lift Up
23. Swing Left
24. Front Steer Pressure Relief
25. Socket Head Cap Screw
26. Pilot Operated Check Valve (On back - Not Shown)

Figure 5-149. Location of Components - Main Control Valve Block



1. Level Up Relief Valve (RV2)
2. Test Port M1
3. Level Down Relief Valve (RV1
4. Test Port M2
5. Flow Relief Valve (FR2)
6. Flow Relief Valve (FR1)
7. Rotate Left Solenoid
8. Rotate Right Solenoid
9. Platform Level Up Solenoid
10. Platform Level Down Solenoid
11. Jib Up Solenoid
12. Jib Down Solenoid
13. Test Port M3
14. Jib Relief valve (CR1)

Figure 5-150. Location of Components - Platform Control Valve Block

5.11 HYDRAULIC SCHEMATICS

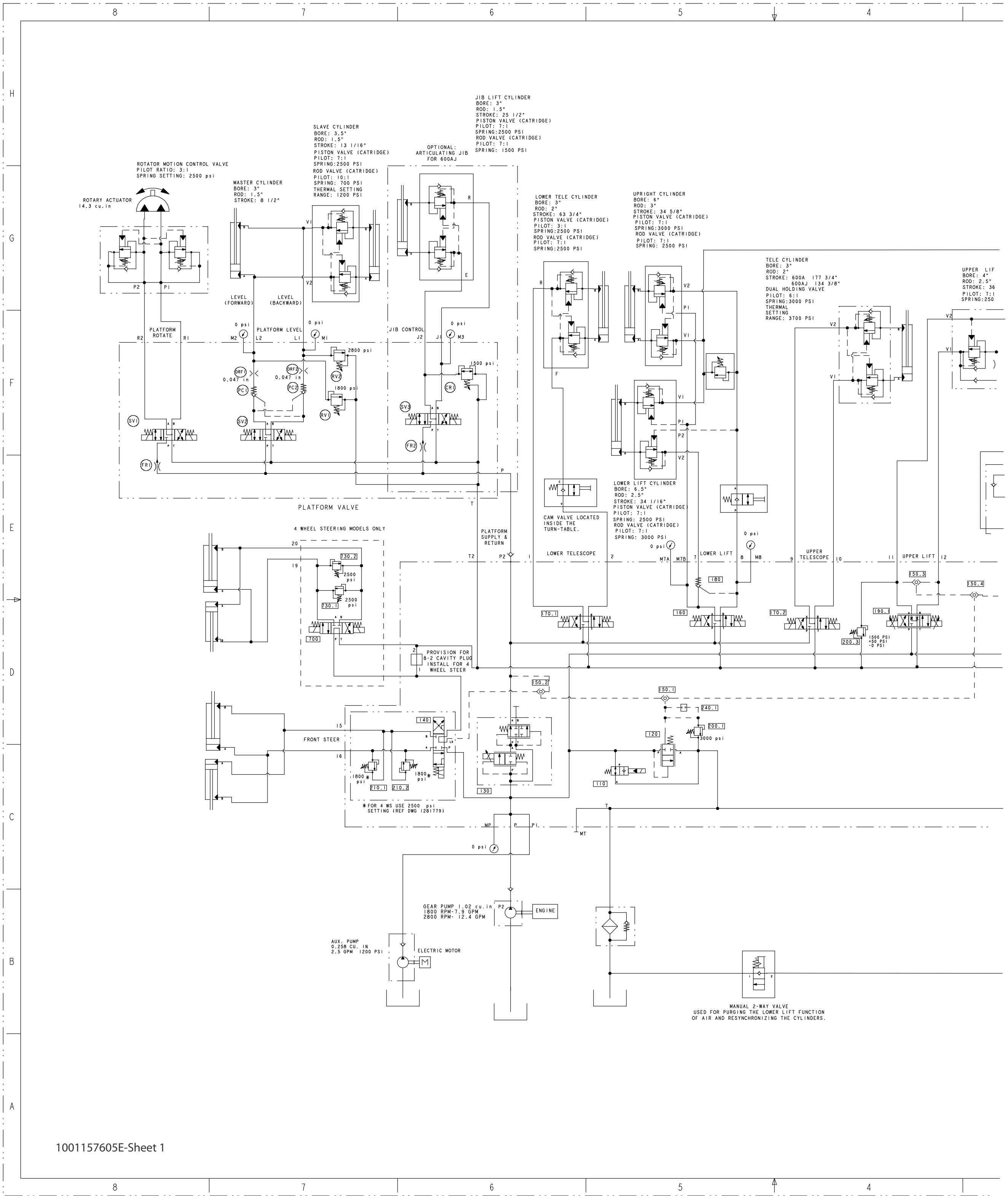


Figure 5-151. Hydraulic Schematic 1 of 2

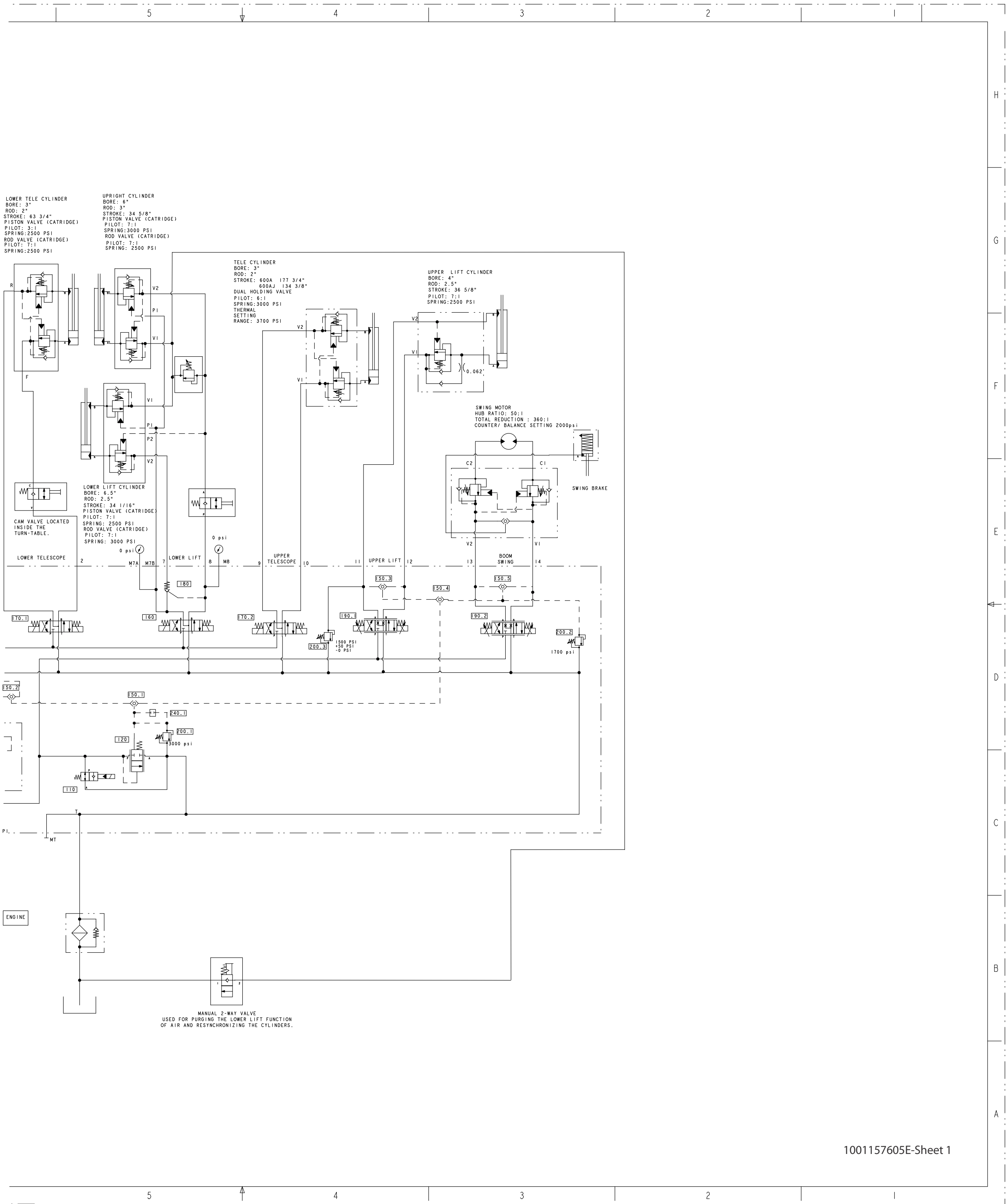


Figure 5-152. Hydraulic Schematic 2 of 2

COMPONENTS OF MAIN AND PLATFORM VALVE			
ITEM IDENTIFIER	QUANTITY	CATALOGUE DESCRIPTION	COMPONENT NAME
110	1	VE18A2B09.36K04.1ANAC220S 0D1504361AS000	2/2 DIRECT CONTROL - DUMP VALVE
120	1	VLST-10A-TF-17 048401008517000	LOAD SENSE CATRIDGE 250psi +/-15%
130	2	KUDSR3C2A/FN9V	PROP.FLOW CONTROL W/PRESS.COMP.15.8 GPM
140	1	VEDS-10A-5310 0D531054KK2000	5/3 DIRECT. CONTROL VALVE - FRONT STEER
150	5	SELB-08A 049405005600000	SHUTTLE VALVE
160	1	4WE 6 J6X/EG12N9K40 S043A-1860	4/3 DIRECT CONT. VALVE LOWER LIFT , 12 VDC
170	2	4WE 6 J6X/EG12N9K40 S043A-1799A	4/3 DIRECT CONT. VALVE TOWER TELESCOPE , 12 VDC
180	1	VSOA-10A-03 043310008503000	PILOT OPERATED CHECK VALVE, LOWER LIFT
190	2	4WRAB 6 W25-10/G12N9K4/MR S043A-1799	4/3 PROP. DIRECT. CONTROL. LIFT 12VDC
200	2	VSBN-08A-S-35 041149735635000	PRESSURE RELIEF VALVE, MAIN, UPPER, BOOM
210	2	VSBN-08A-S-35 041149735635000	PRESSURE RELIEF VALVE, FRONT STEER
700	1	B8008A2010000T0M0	5/3 DIRECT. CONTROL VALVE-FRONT STEER
730	2	VSBN-08A-S-35 041149735635000	PRESSURE RELIEF CATRIDGE, REAR STEER
CR1	1	CR08-38A-0-N-30-15	BI-DIRECTIONAL RELIEF VALVE, VENTED
FR1	1	FR08-20F-0-N-/0.20	REGULATOR, PRESSURE-COMPENSATED
FR2	1	FR08-20F-0-N-/2.00	REGULATOR, PRESSURE-COMPENSATED
PC1,PC2	2	PC08-30-0-N	CHECK, PILOT-TO-OPEN
RV1	1	RV08-22A-0-N-35/18	RELIEF,DIFFERENTIAL AREA POPPET
RV2	1	RV08-22A-0-N-35/28	RELIEF,DIFFERENTIAL AREA POPPET
SV1,SV2,SV3	3	SV08-47D-0-N-00	SPOOL, 4-WAY, 3-POSITION, □MOTOR SPOOL□

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Figure 5-153. Main and Platform Valve Components

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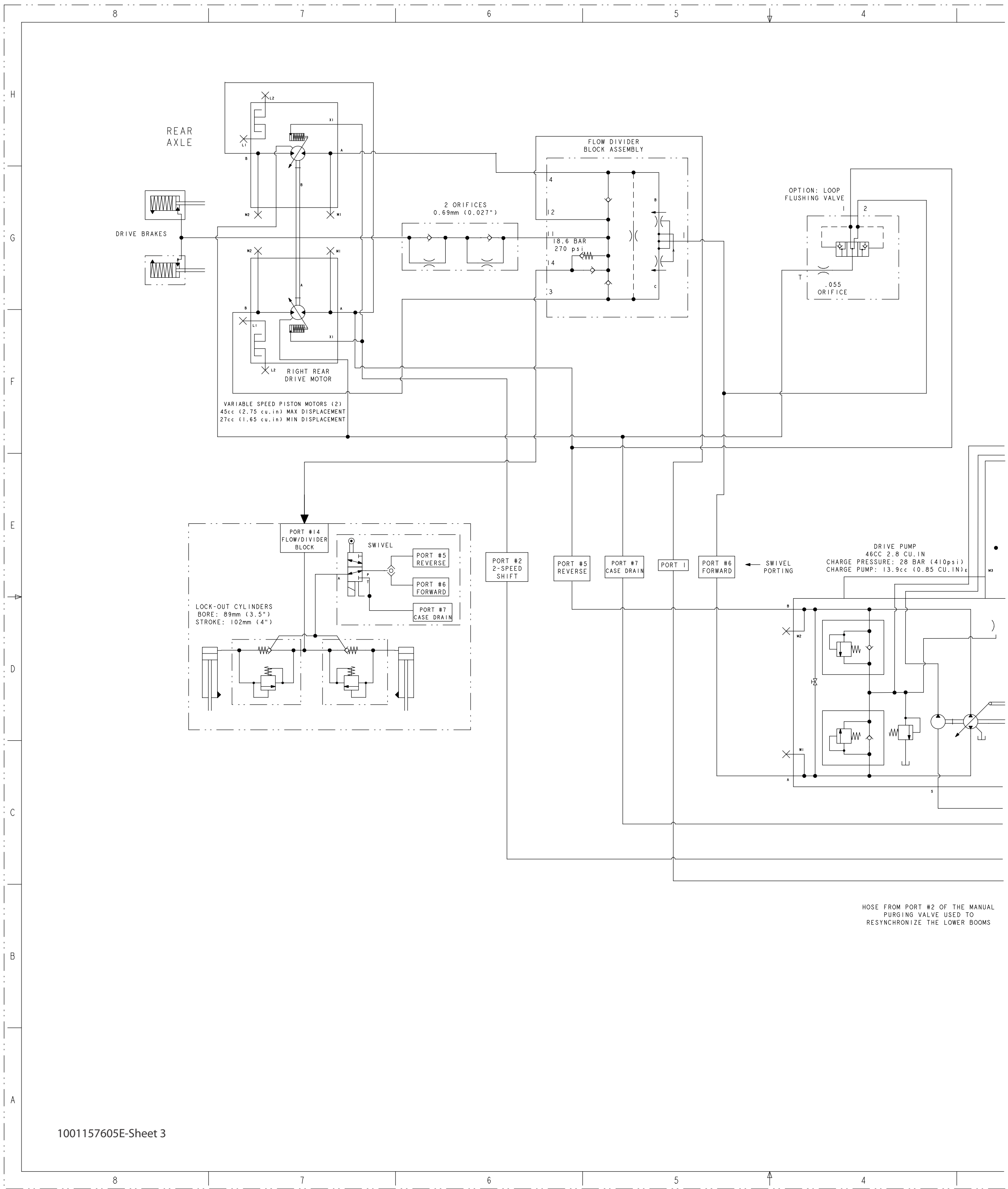


Figure 5-154. 2-Wheel Drive Hydraulic Schematic 1 of 2

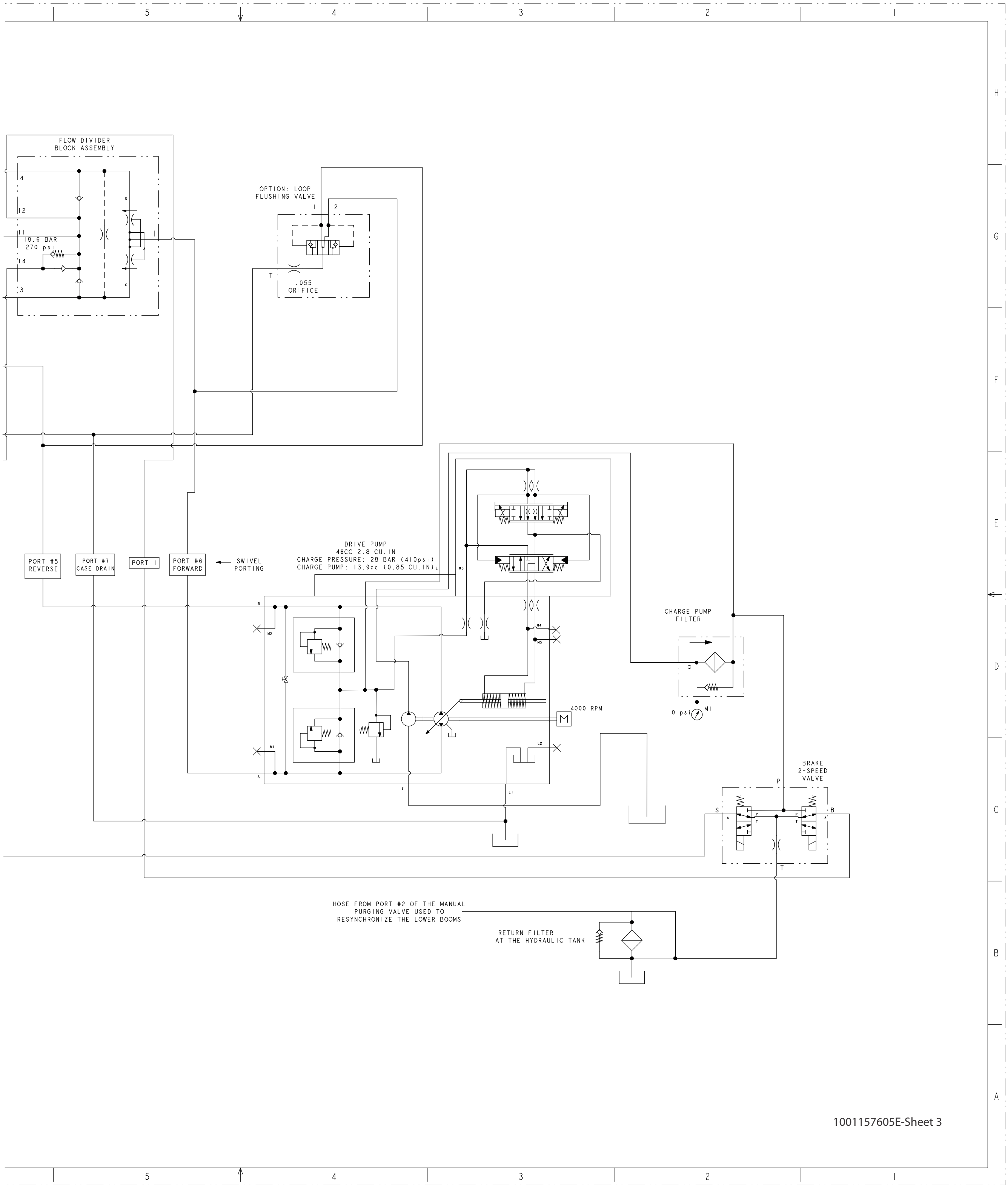


Figure 5-155. 2-Wheel Drive Hydraulic Schematic 2 of 2

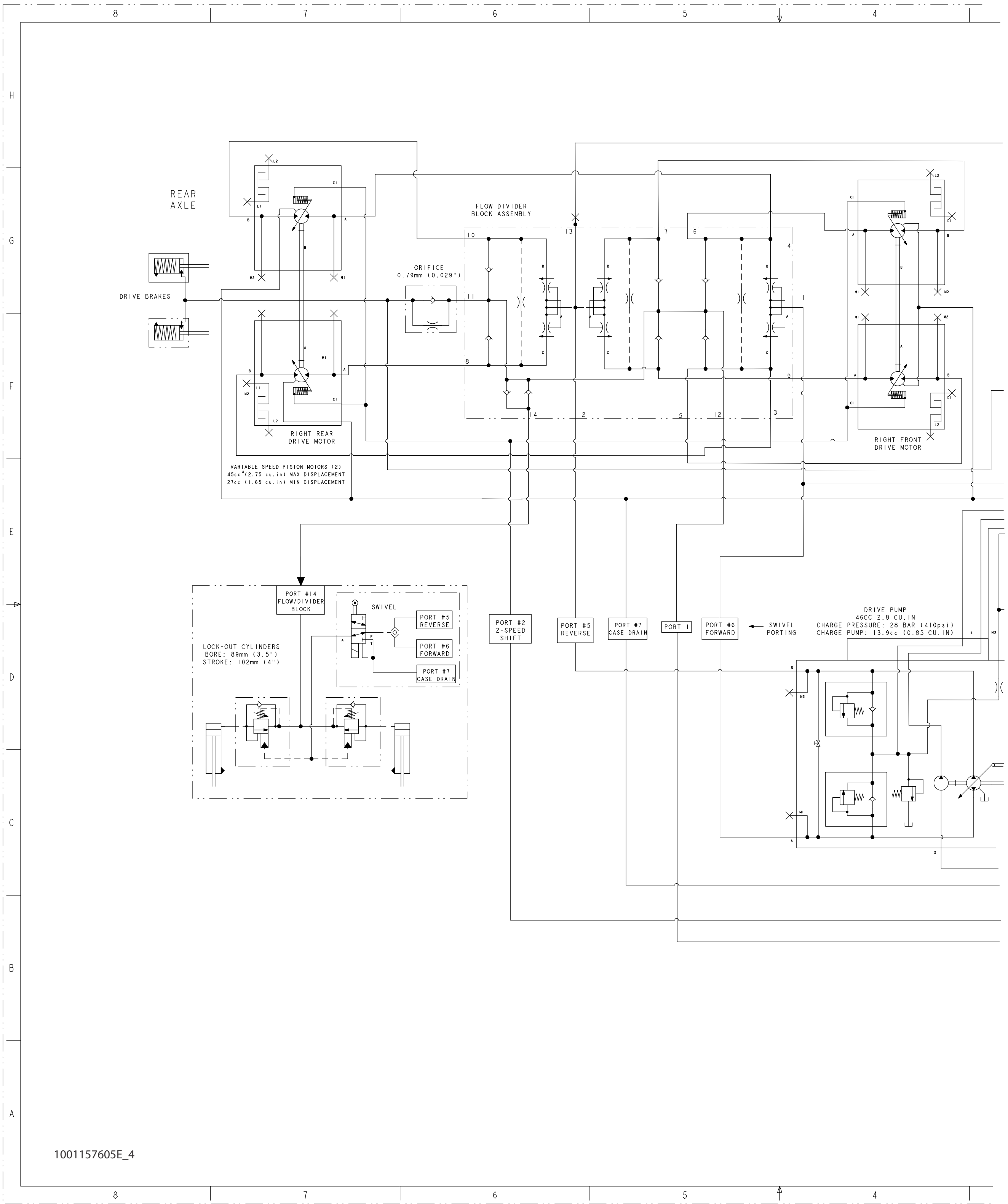


Figure 5-156. 4-Wheel Drive Hydraulic Schematic 1 of 2

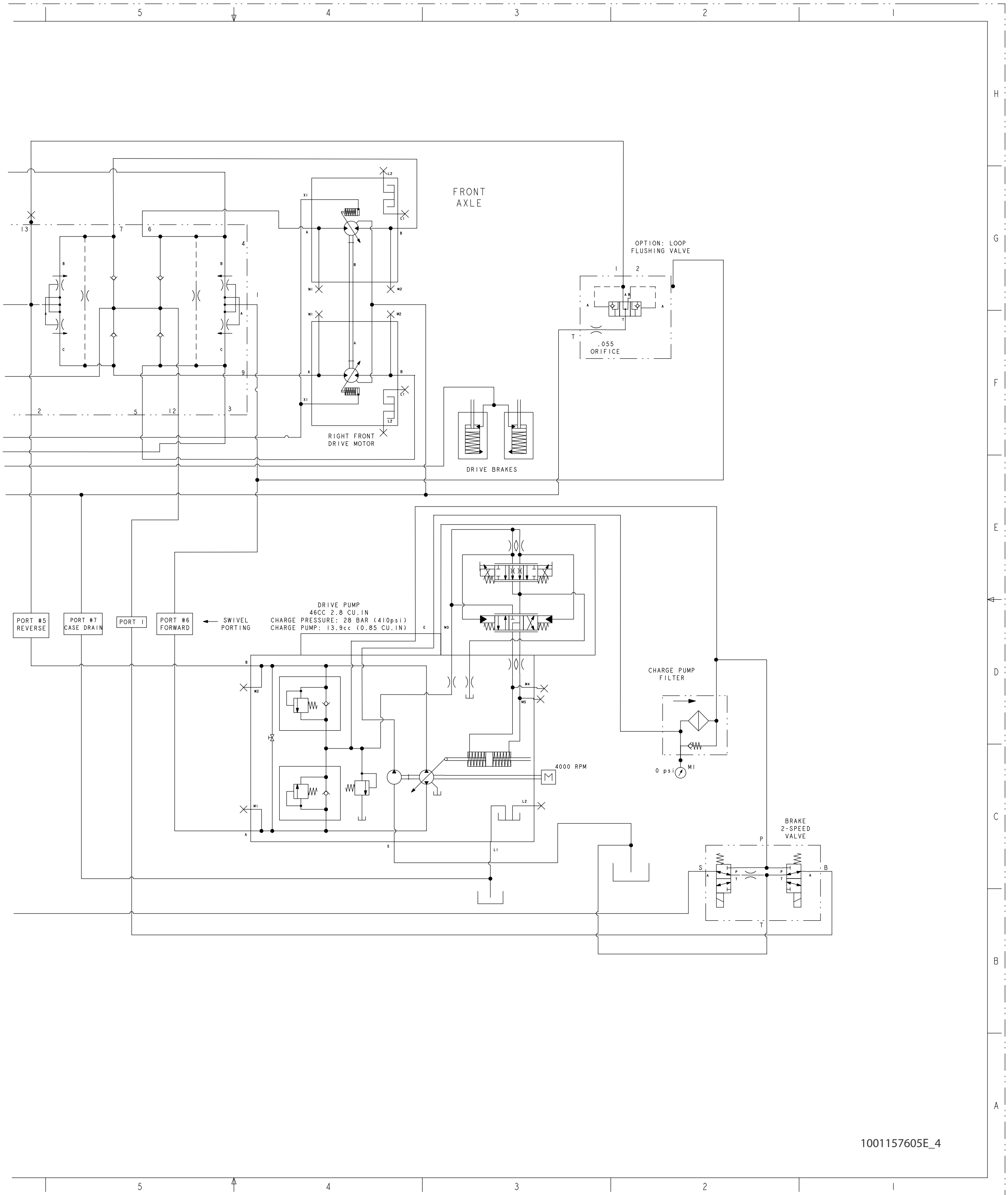


Figure 5-157. 4-Wheel Drive Hydraulic Schematic 2 of 2

NOTES:

SECTION 6. JLG CONTROL SYSTEM

6.1 INTRODUCTION

NOTICE

WHEN INSTALLING A NEW GROUND MODULE CONTROLLER IT IS NECESSARY TO PROGRAM THE CONTROLLER FOR PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

NOTICE

AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. IF PRESSURE-WASHING IS USED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES, INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5 CM) FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 12 volt based motor control unit installed on the boom lift.

The JLG Control System has reduced the need for exposed terminal strips, diodes and trimpots and provides simplicity in viewing and adjusting the various personality settings for smooth control of: acceleration, deceleration, creep, min speed, and max.-speed for all boom, drive, and steering functions.

Upper lift, swing, and drive are controlled by individual joysticks. Steering is controlled by a rocker switch built in the top of the drive joystick. To activate Drive, Lift, and Swing; pull up the slide lock on the joystick and move the handle in the desired direction.

The control system provides voltage output to the valves and pump, as programmed, for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed in the control system.

The JLG Control System controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed with a custom designed, direct connect hand held analyzer or wireless adapter using an app on your Android or iPhone/iPad device. The analyzer or wireless output displays two lines of information at a time, by scrolling through the program.

Each module has a label with JLG part number and a serial number containing a date code.

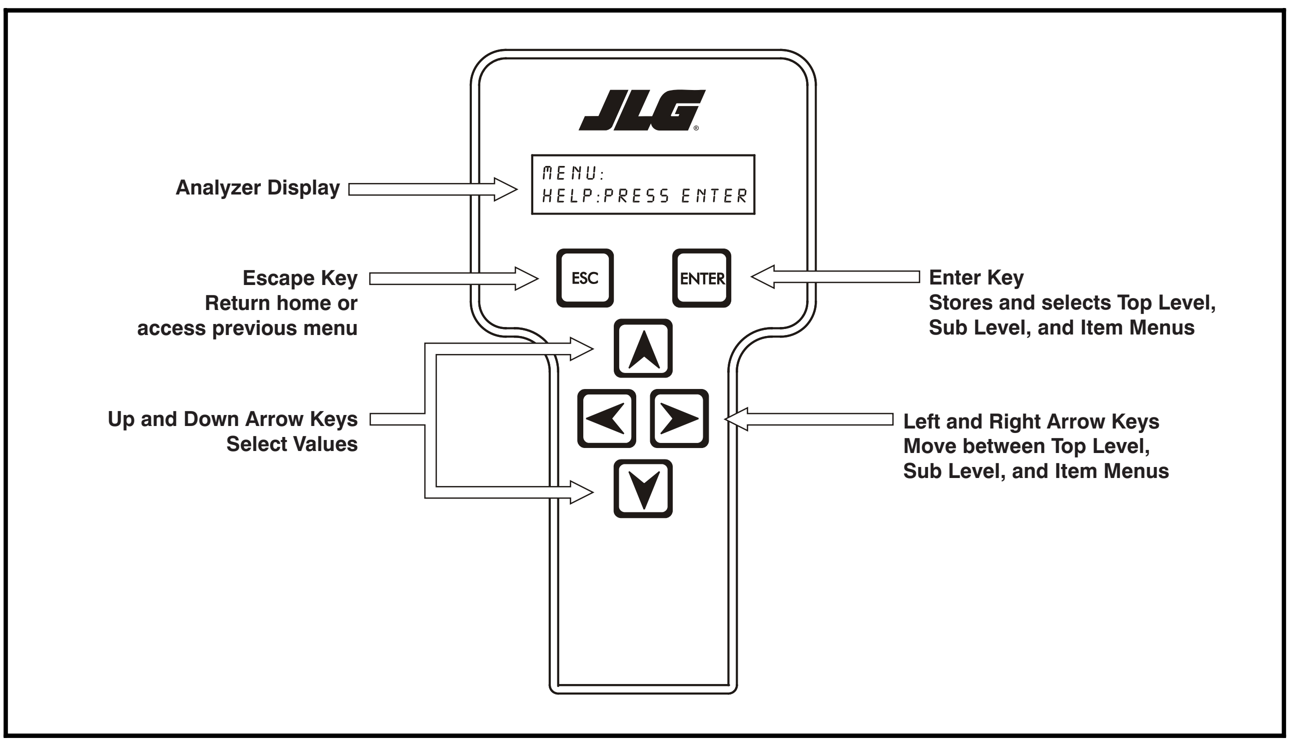


Figure 6-1. Hand-Held Analyzer (WANALYZER Controls and Display Similar)

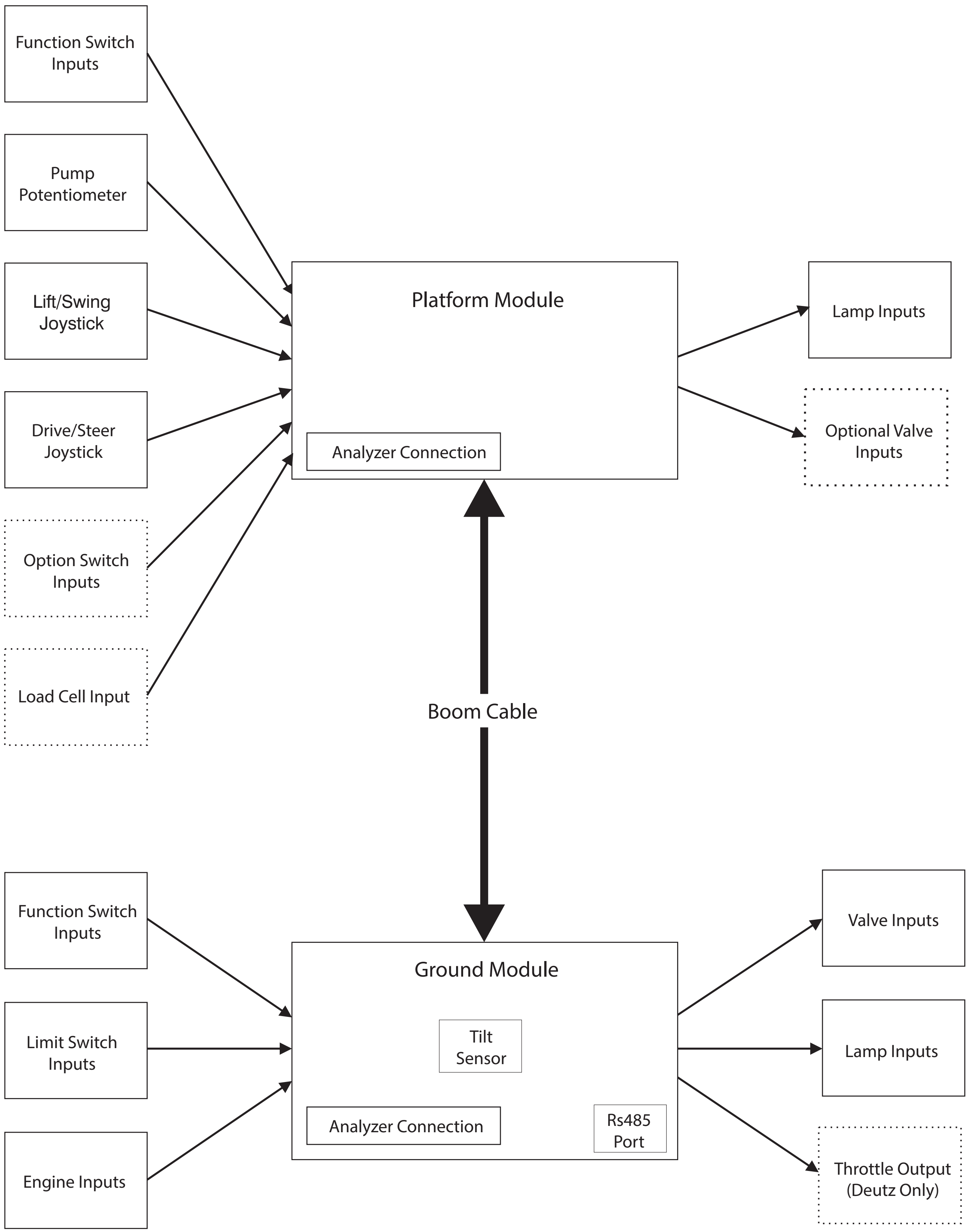


Figure 6-2. Controller Block Diagram

Connect JLG Control System Analyzer

1. Connect four pin end of cable supplied with hand-held or wireless analyzer to controller module on platform box or at controller module inside ground control box. Connect other end of cable to analyzer.

NOTE: *Cable has a keyed four pin connector at each end. It cannot be connected backwards.*

Figure 6-3. Analyzer Platform Connector

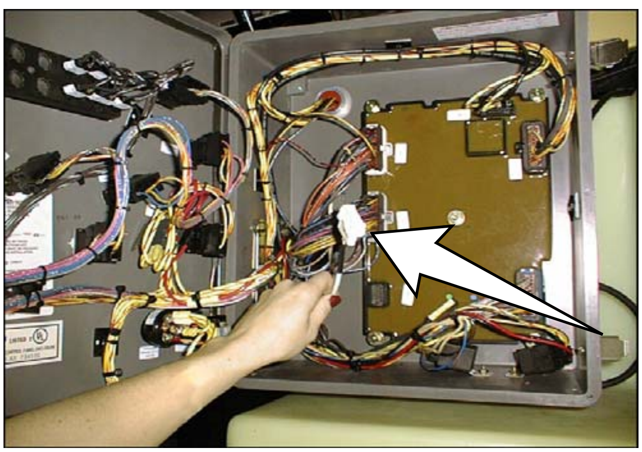


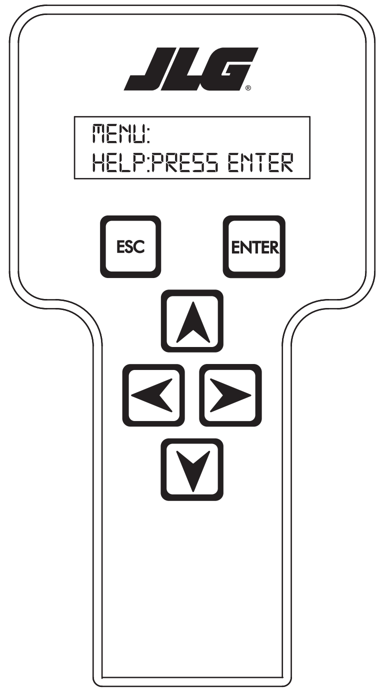
Figure 6-4. Analyzer Ground Control Box Connector

NOTE: *Follow instructions provided with Wireless Analyzer (WANALYZER) kit. JLG Analyzer application must be downloaded and installed to your smartphone or tablet device.*

Using Analyzer

1. Power up Control System by turning lower key to platform or ground position and pulling both emergency stop buttons out.

Analyzer displays the following with machine power on and analyzer connected properly:



MENU:
HELP:PRESS ENTER

Move between top level menu items using

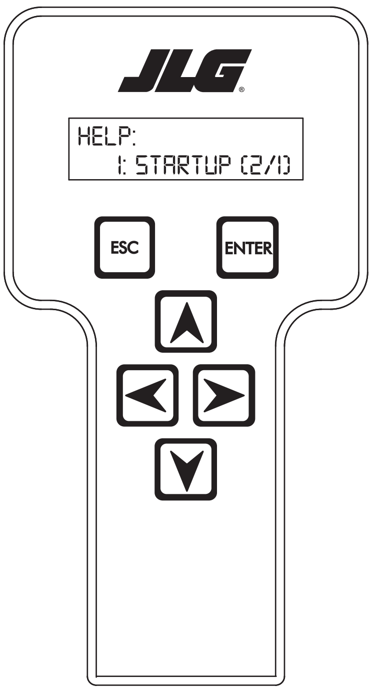
RIGHT  and **LEFT**  arrow keys. To select a displayed menu item, press **ENTER** . To cancel a selected menu item press **ESC** . Scroll using right and left arrow keys to select a different menu item.

Top level menus:

HELP
DIAGNOSTICS
SYSTEM TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
CALIBRATIONS (view only)

If **ENTER** is selected at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display scrolls the fault across the screen. If no fault is detected, the display shows: **HELP: EVERYTHING OK.** If powered up at the ground station, the display shows: **GROUND OK.**

If **ENTER** is pressed again, display shows the following:



LOGGED HELP
1: POWER CYCLE (0/0)

Analyzer displays last system fault if any are present. Use right and left arrow keys to scroll through fault logs and view last 25 faults. Press **ESC** two times to return to MENU screen. **POWER CYCLE (0/0)** indicates a power up.

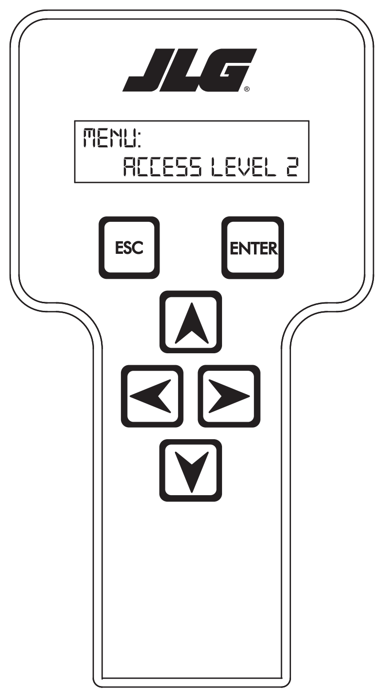
When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

Pressing **ENTER** with any of the above displayed menus, displays additional sub-menus within the selected menu. In some cases, such as **DRIVE**, the next level is the parameter or information to be changed. Refer to the flow chart for what menus are available within the top level menus. You may only view the personality settings for selected menus while in access level 2. Remember, you may always cancel a selected menu item by pressing the **ESCAPE** key.

Changing Access Level

When analyzer is first connected, you will be in access level 2 which enables you to only view most settings which cannot be changed until you enter a password to advance to a lower level. This ensures that a setting cannot be accidentally altered. To change access level, the correct password must be entered. To enter password, scroll to **ACCESS LEVEL** menu. For example:



ACCESS LEVEL:
CODE 00000

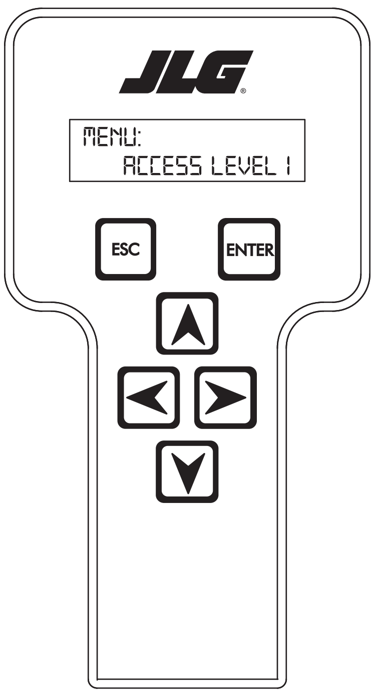
Press **ENTER** to select the **ACCESS LEVEL** menu.

Using the **UP** or **DOWN** arrow keys, enter first digit of the password, 3.

Then using the **RIGHT** arrow key, position cursor right one space to enter the second digit of the password.

Use the **UP** or **DOWN** arrow key to enter the second digit of the password which is 33271.

When correct password is displayed, press **ENTER**. The access level displays the following if password was entered correctly:

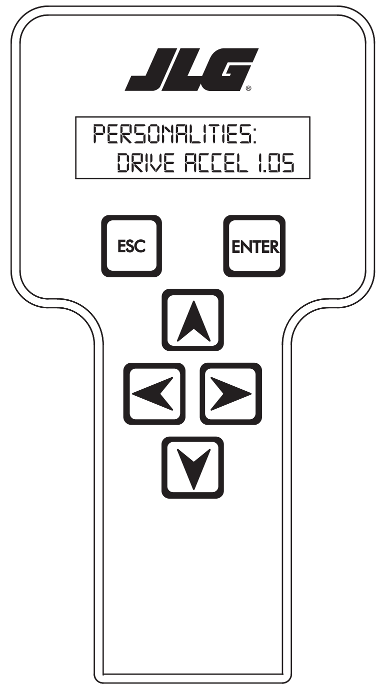


MENU:
ACCESS LEVEL 1

Repeat above steps if correct access level is not displayed or you can not adjust personality settings.

Adjust Parameters

Once you have gained access to level 1, and a personality item is selected, press the **UP** or **DOWN** arrow keys to adjust its value, for example:

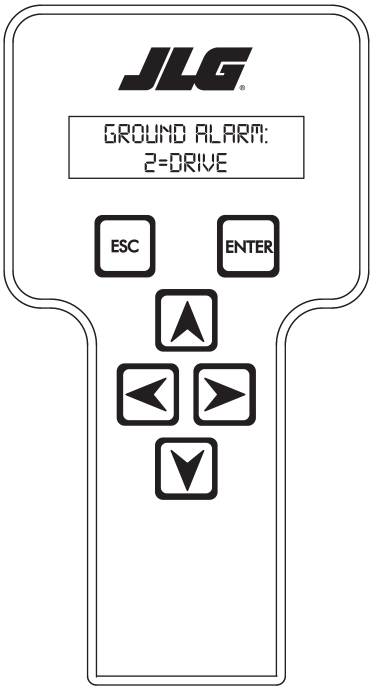


DRIVE:
ACCEL 1.0S

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed at maximum value or decrease if the **DOWN** arrow is pressed at minimum value for any personality. If value does not change when pressing up and down arrows, check access level is at access level 1.

Machine Setup

When a machine digit item is selected, press **UP** or **DOWN** arrow keys to adjust its value, for example:



GROUND ALARM:
2 = DRIVE

The effect of the machine digit value is displayed along with its value. The above display would be selected if the machine was equipped with a ground alarm and you wanted it to sound when driving. There are certain settings allowed to install optional features or select the machine model.

When selection the machine model to match the size of the machine, the personality settings will all default to the factory recommended setting.

NOTE: *Refer to Personality Ranges/Defaults for the recommended factory settings.*

NOTE: *Password 33271 allows access to level 1 to change machine personality settings.*

There is a setting that JLG strongly recommends that you do not change. This setting is so noted below:

ELEVATION CUTBACK

⚠ WARNING

CHANGING ELEVATION CUTBACK SETTING MAY ADVERSELY AFFECT PERFORMANCE OF YOUR MACHINE.

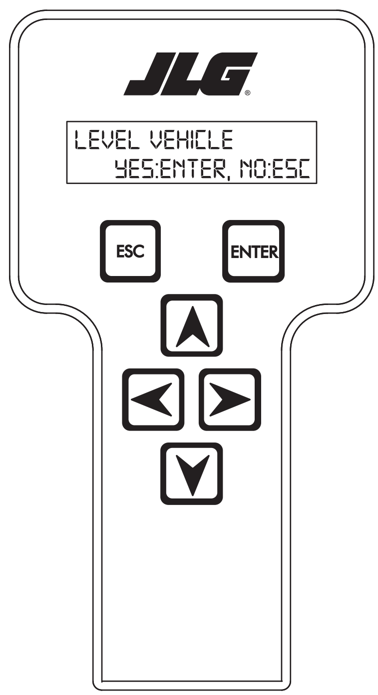
NOTICE

AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. IF PRESSURE-WASHING IS USED TO WASH AREAS CONTAINING ELECTRICAL/ ELECTRONIC COMPONENTS, JLG INDUSTRIES INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5CM) FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

Level Vehicle Description

⚠ WARNING

DO NOT LEVEL VEHICLE EXCEPT ON A LEVEL SURFACE.



LEVEL VEHICLE
YES:ENTER, NO:ESC

Not available at password level 2. ENTER confirms vehicle is current.

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

ABBREVIATION	MEANING
S/C	SHORT CIRCUIT
SEL	SELECTOR
SN	SERIAL NUMBER
SPD	SPEED
STOW	STOWED
STOWD	STOWED
SW	SWITCH or SOFTWARE
TELE	TELESCOPE
TEMP	TEMPERATURE
TORQ.	TORQUE
TRN	TRANSPORT
T/T	TURNTABLE
T	TOWER
TURNTBL	TURNTABLE
TWR	TOWER
U	UPPER or UP
V	VOLT
VER	VERSION
VLV	VALVE
WIT	WITNESS
YEL	YELLOW

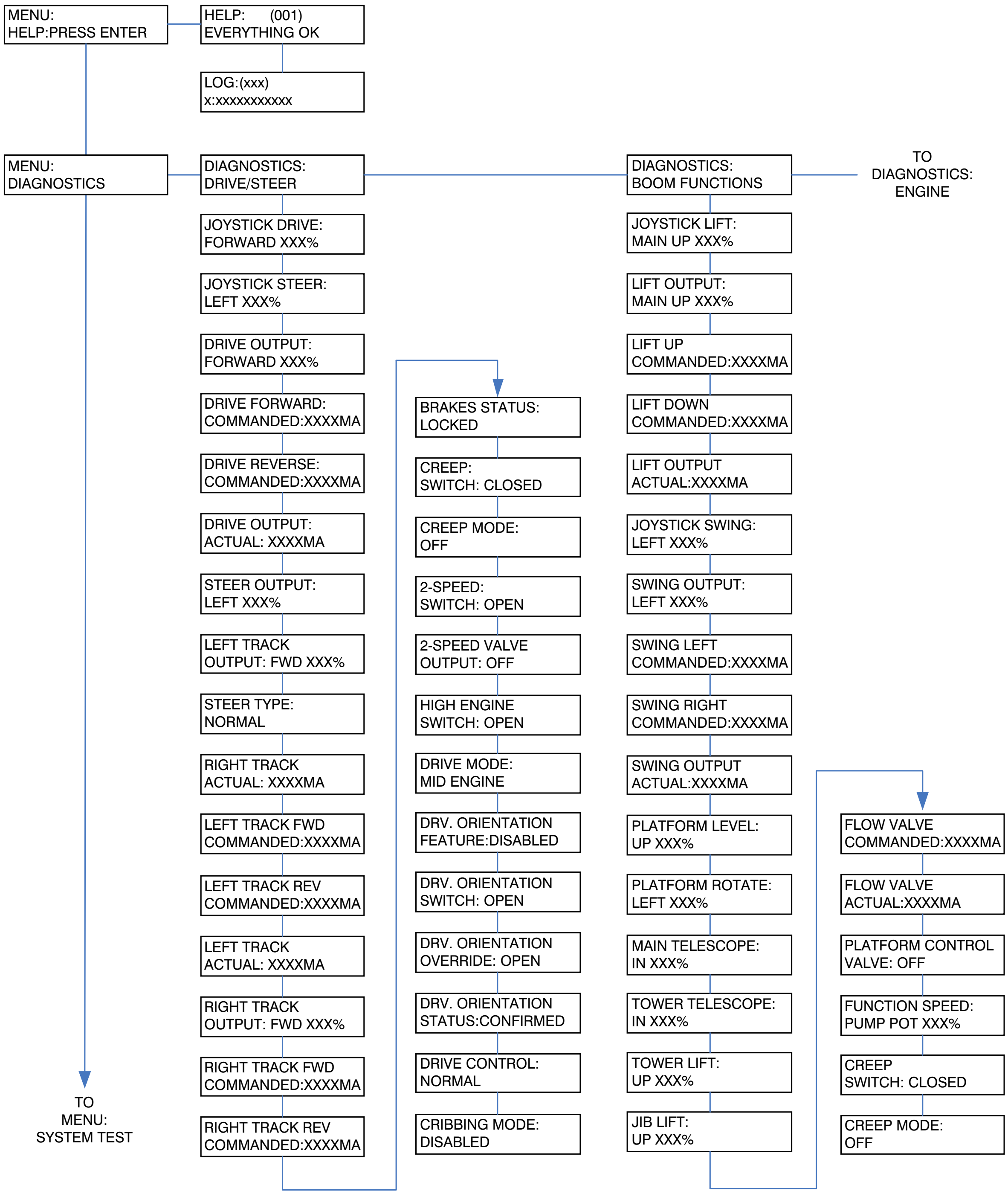


Figure 6-5. Analyzer Software Version 6.8 - Sheet 1 of 6

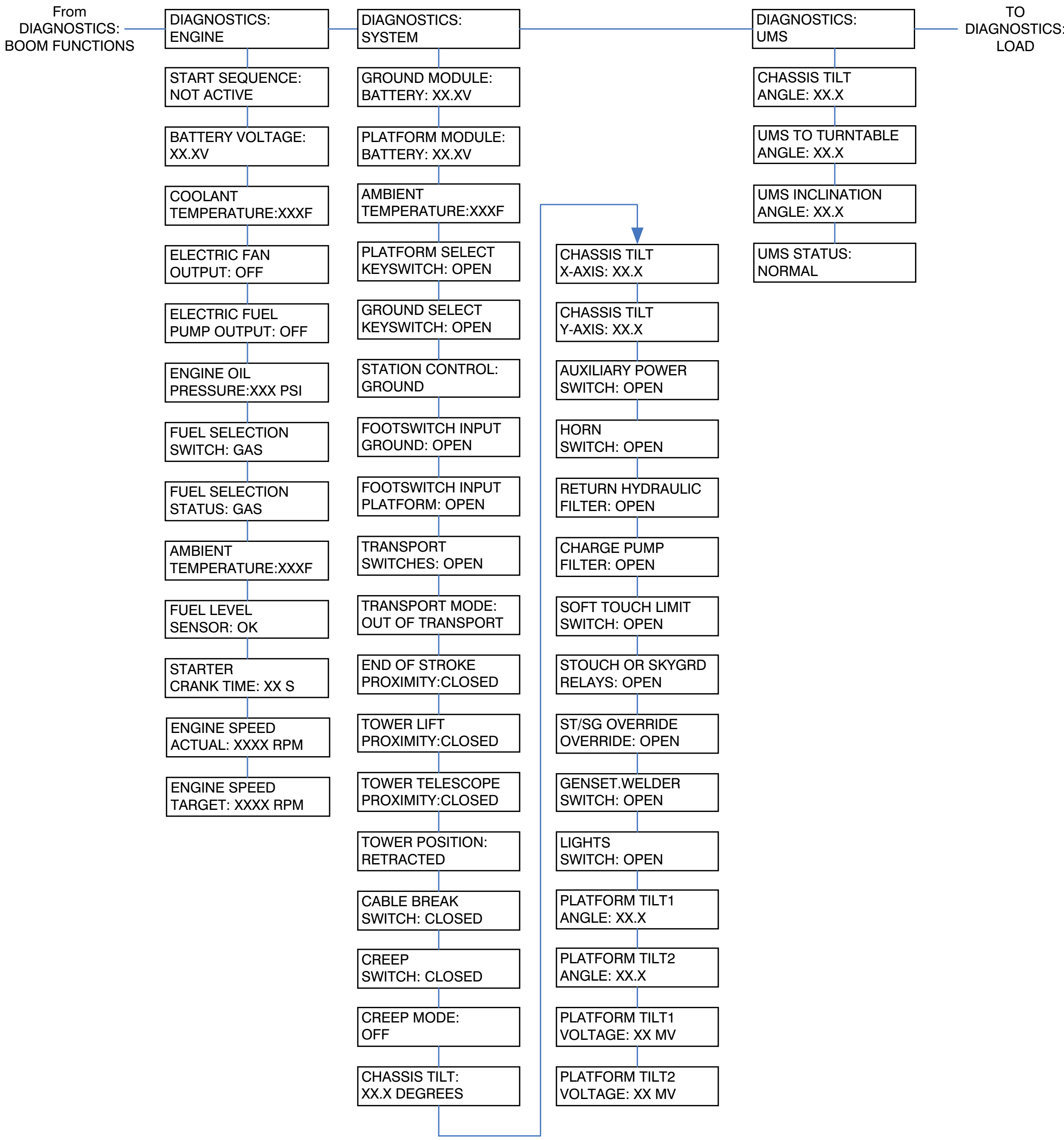


Figure 6-6. Analyzer Software Version 6.8 - Sheet 2 of 6

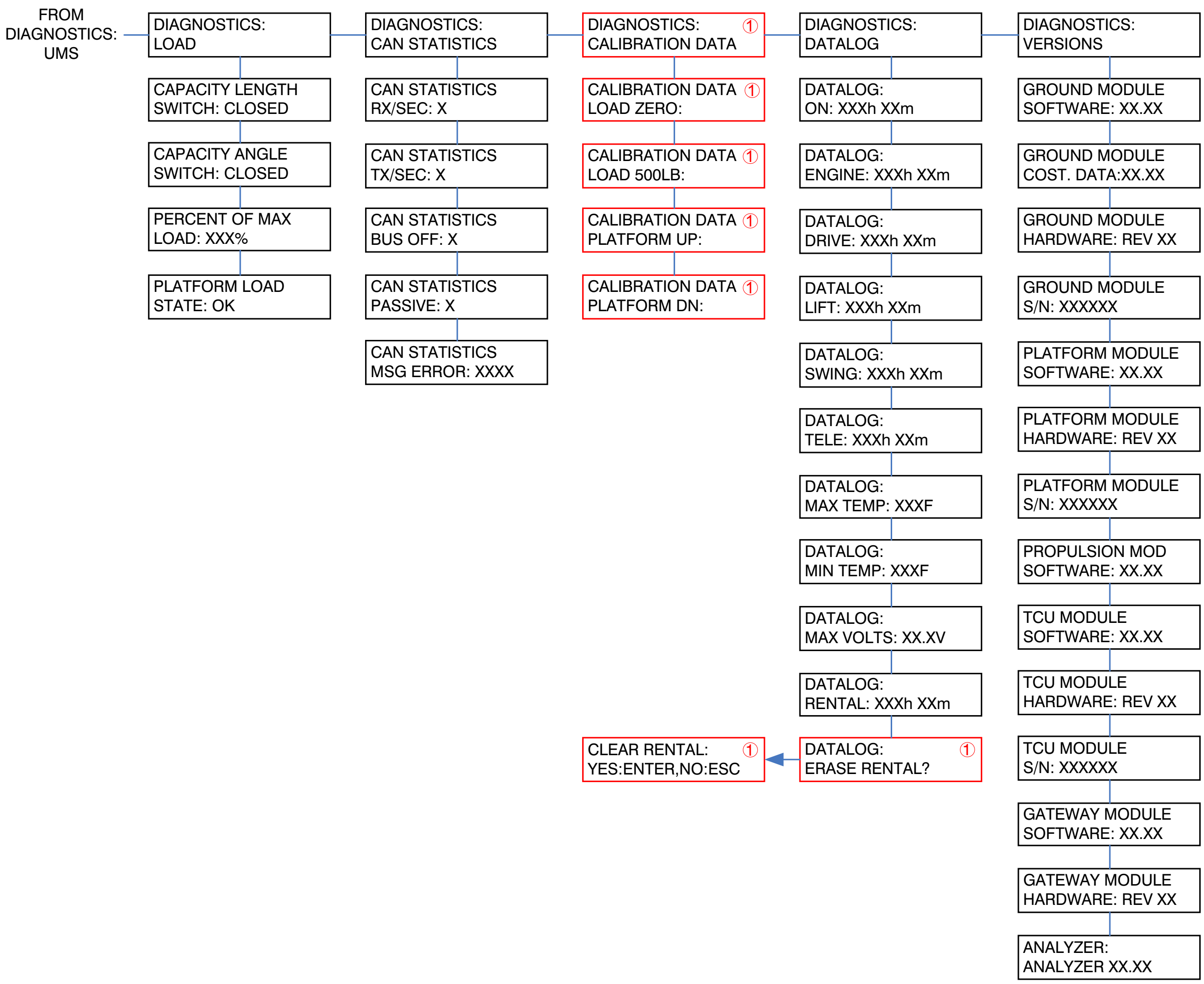


Figure 6-7. Analyzer Software Version 6.8 - Sheet 3 of 6

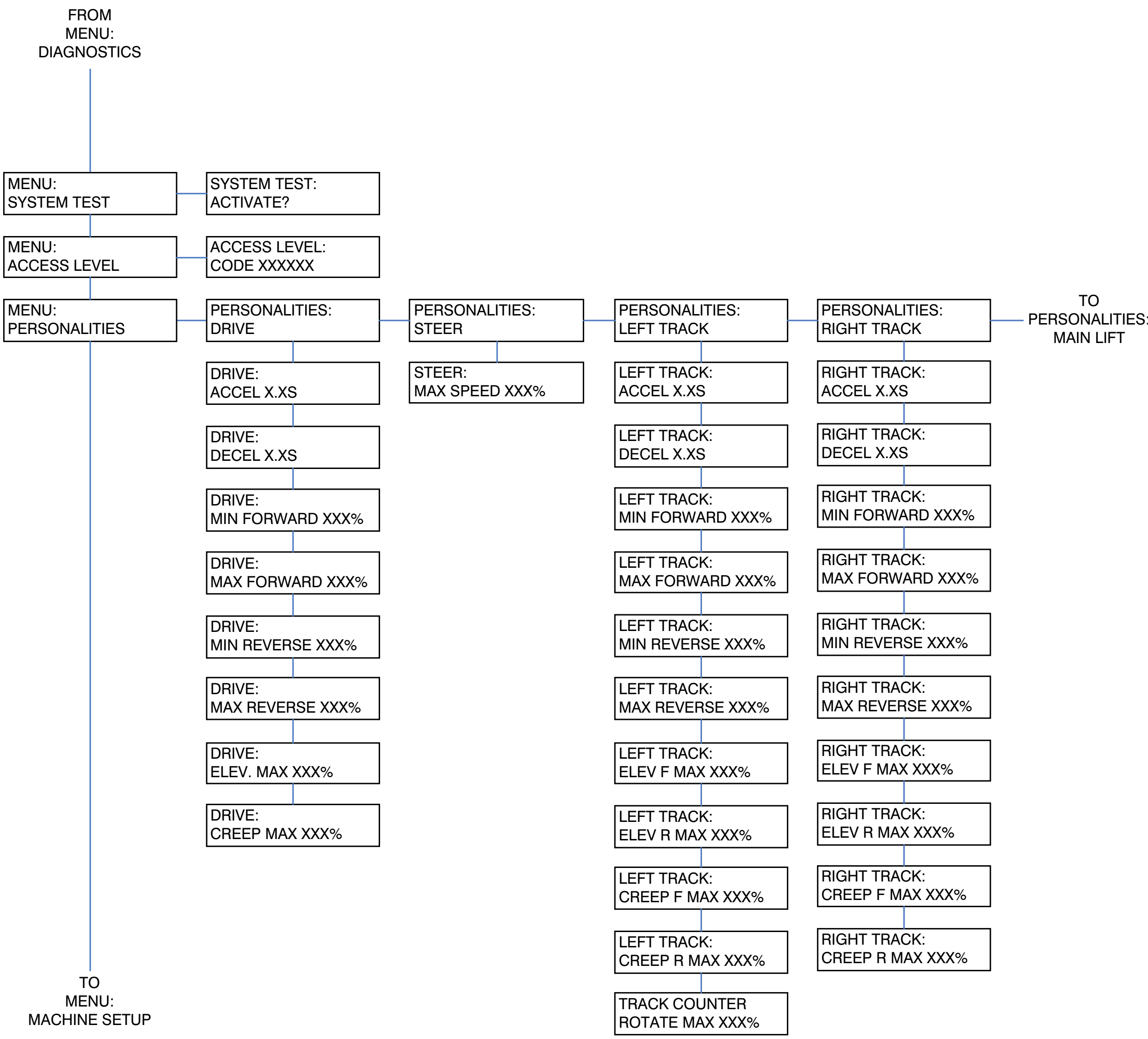


Figure 6-8. Analyzer Software Version 6.8 - Sheet 4 of 6

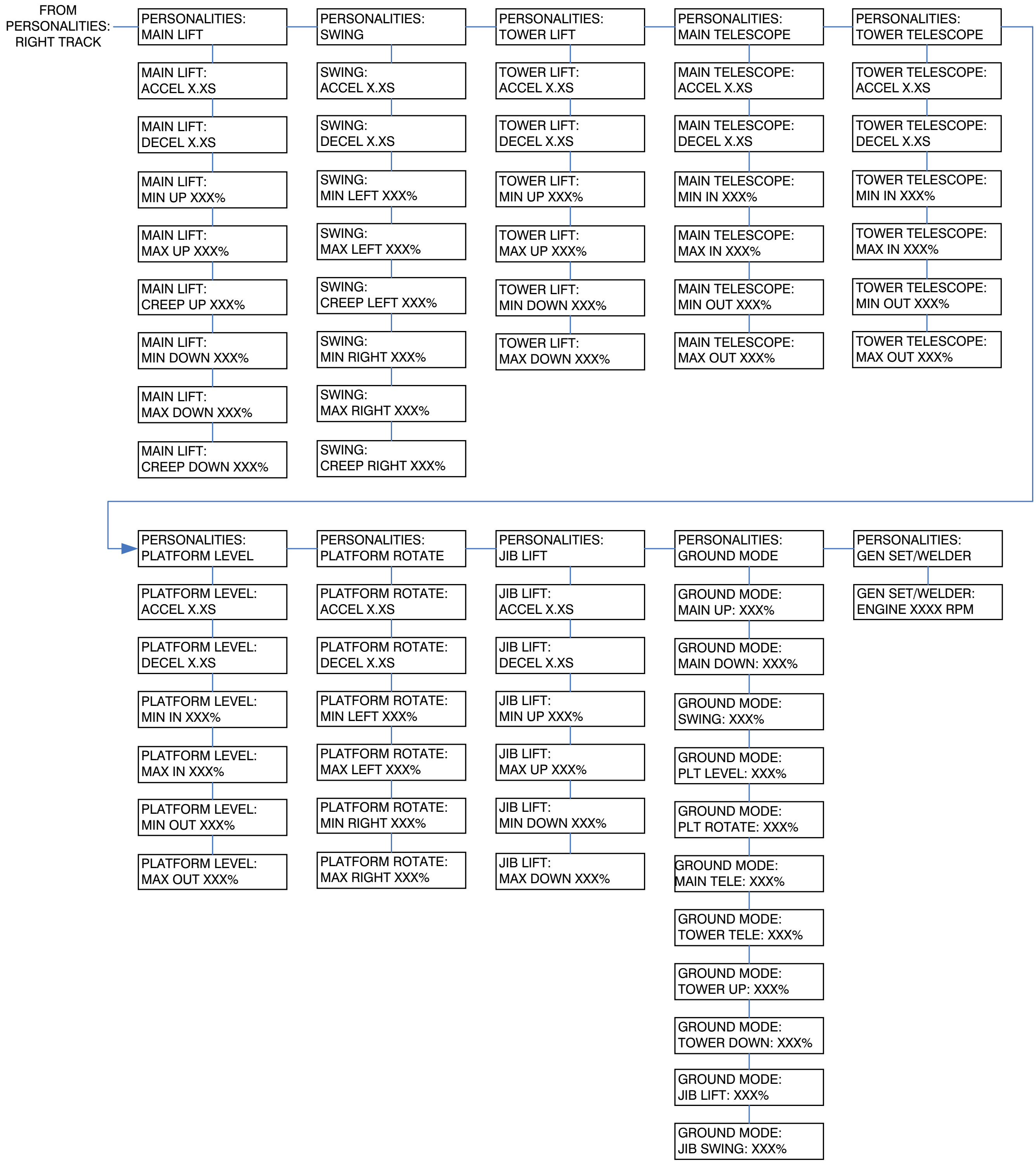


Figure 6-9. Analyzer Software Version 6.8 - Sheet 5 of 6

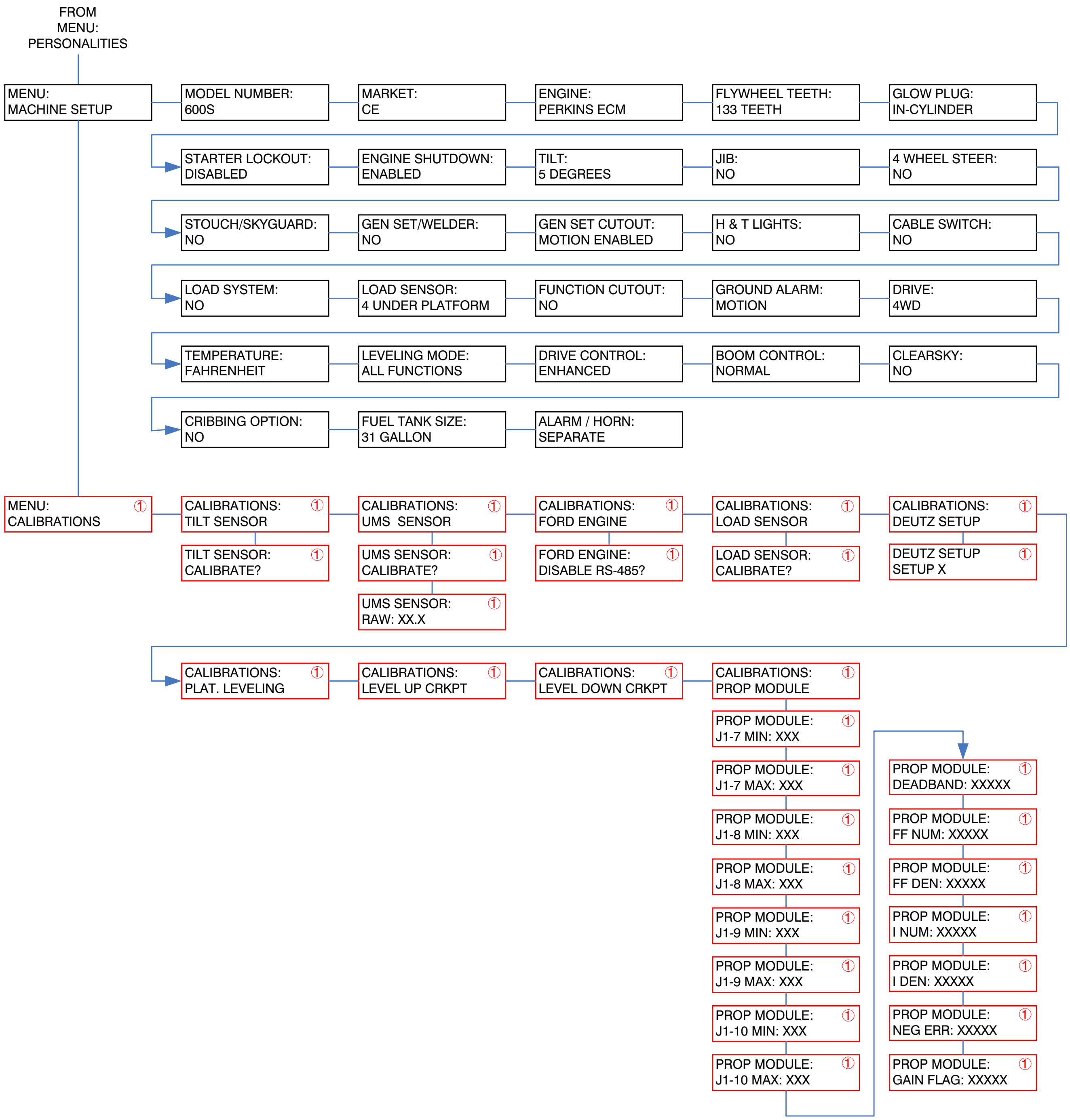


Figure 6-10. Analyzer Software Version 6.8 - Sheet 6 of 6

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 - 600S
DRIVE	ACCELeration	0.1s to 5.0s	2.0
	DECELeration	0.1s to 3.0s	2.0
	Forward MINimum speed	0 to 35%	4
	Forward MAXimum speed	0 to 100%	35
	REVerse MINimum speed	0 to 35%	4
	REVerse MAXimum speed	0 to 100%	35
	ELEVATED MAXimum speed	0 to 50%	15
	CREEP MAXimum speed	0 to 50%	25
	Engine RPM	800 to 2900	1800
TOWER LIFT	ACCELeration	0.1 to 5.0	N/A
	DECELeration	0.1 to 3.0	N/A
	MINimum UP speed	0 to 60%	N/A
	MAXimum UP speed	0 to 100%	N/A
	MINimum DOWN speed	0 to 60%	N/A
	MAXimum DOWN speed	0 to 100%	N/A
	Engine RPM	800 to 2900	N/A
UPPER LIFT	ACCELeration	0.1 to 5.0	2.0
	DECELeration	0.1 to 3.0	0.7
	MINimum UP speed	0 to 60%	40
	MAXimum UP speed	0 to 100%	80
	CREEP Maximum UP speed	0 to 65%	55
	MINimum DOWN speed	0 to 60%	40
	MAXimum DOWN speed	0 to 100%	70
	CREEP maximum DOWN speed	0 to 75%	55
	Engine RPM	800 to 2900	1800

Table 6-2. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 600S
SWING	ACCELeration	0.1 to 5.0s	2.0
	DECELeration	0.1 to 3.0s	1.8
	MINimum LEFT speed	0 to 50%	30
	MAXimum LEFT speed	0 to 100%	65
	CREEP maximum LEFT speed	0 to 65%	45
	MINimum RIGHT speed	0 to 50%	30
	MAXimum RIGHT speed	0 to 100%	65
	CREEP maximum RIGHT speed	0 to 65%	45
	Engine RPM	800 to 2900	1400
TELESCOPE UPPER	ACCELeration	0.1 to 5.0	3.5
	DECELeration	0.1 to 3.0	0.8
	MINimum IN speed	0 to 65%	45
	MAXimum IN speed	0 to 100%	75
	MINimum OUT speed	0 to 65%	45
	MAXimum OUT speed	0 to 100%	70
	Engine RPM	800 to 2900	1800
TELESCOPE TOWER	ACCELeration	0.1 to 5.0	N/A
	DECELeration	0.1 to 3.0	N/A
	MINimum IN speed	0 to 65%	N/A
	MAXimum IN speed	0 to 100%	N/A
	MINimum OUT speed	0 to 65%	N/A
	MAXimum OUT speed	0 to 100%	N/A
	Engine RPM	800 to 2900	N/A
BASKET LEVEL	ACCELeration	0.1 to 5.0	2.5
	DECELeration	0.1 to 3.0	0.5
	MINimum UP speed	0 to 65%	48
	MAXimum UP speed	0 to 100%	52
	MINimum DOWN speed	0 to 65%	45
	MAXimum DOWN speed	0 to 100%	50
	Engine RPM	800 to 2900	1500

Table 6-2. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS - 600S
BASKET ROTATE	ACCELeration	0.1 to 5.0	1.8
	DECELeration	0.1 to 3.0	0.7
	MINimum LEFT speed	0 to 65%	46
	MAXimum LEFT speed	0 to 100%	50
	MINimum RIGHT speed	0 to 65%	46
	MAXimum RIGHT speed	0 to 100%	50
	Engine RPM	800 to 2900	1500
JIB LIFT	ACCELeration	0.1 to 5.0	5.0
	DECELeration	0.1 to 3.0	1.0
	MINimum UP speed	0 to 65%	46
	MAXimum UP speed	0 to 100%	52
	MINimum DOWN speed	0 to 65%	45
	MAXimum DOWN speed	0 to 100%	52
	Engine RPM	800 to 2900	1800
STEER	MAXimum speed	0 to 100%	100
	Engine RPM	800 to 2900	1800
GROUND MODE	Tower LIFT UP speed	0 to 100%	N/A
	Tower LIFT DOWN speed	0 to 100%	N/A
	Upper LIFT UP	0 to 100%	60
	Upper LIFT DOWN	0 to 100%	60
	SWING speed	0 to 100%	60
	Upper TELEscope speed	0 to 100%	70
	Tower TELEscope speed	0 to 100%	N/A
	BASKET ROTATE speed	0 to 100%	50
	BASKET LEVEL speed	0 to 100%	50
	JIB LIFT speed	0 to 100%	50

NOTE: *Personality settings can be adjusted anywhere within the adjustment range for optimum machine performance.*

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Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
None		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	
	GROUND MODE OK	The "normal" help message in ground mode	
	FSW OPEN	A drive or boom function has been selected but footswitch is open.	
	RUNNING AT CREEP – CREEP SWITCH OPEN	All function speeds are limited to creep because creep switch is open.	
	RUNNING AT CREEP – TILTED AND ABOVE ELEVATION	All boom function speeds are limited to creep because vehicle is tilted and above elevation.	
	RUNNING AT CUTBACK – ABOVE ELEVATION	Drive speed is limited to "ELEVATED MAX" because vehicle is above elevation.	
	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.	
	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.	
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.	
	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously	
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.	
	FSW INTERLOCK TRIPPED	Footswitch was closed for seven seconds with no function selected. Can be reported during power-up sequence.	
	STEER LOCKED – SELECTED BEFORE FOOTSWITCH	Steer was selected before and during footswitch closure.	
	STEER SWITCHES FAULTY	Both steer switches are active together.	
	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.	
	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.	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	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.	
	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.	
	WAITING FOR FSW TO BE OPEN	Footswitch was closed when platform mode was selected. Can be reported during power-up sequence.	
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.	
	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.	
	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.	
	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 center tap 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.	
	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.	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	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.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE START SWTICH	This fault occurs when a hydraulic function switch is closed before start switch is closed.	
	FOOTSWITCH SELECTED BEFORE START	User attempted to start machine with footswitch engaged.	
2/4		Flash code 2/4 indicates steering digital inputs are faulty. NOT REQUIRED	
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.	
	DRIVE PREVENTED – ABOVE ELEVATION	Drive is selected while above elevation and drive cutout is configured to prevent drive.	
	DRIVE PREVENTED – BOOM SELECTED	Drive is selected while a boom function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.	
	DRIVE PREVENTED – TILTED & ABOVE ELEVATION	Drive is selected while tilted and above elevation and tilt is configured to cutout drive.	
	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	
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		
	HORN OPEN CIRCUIT		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	HORN SHORT TO BATTERY		
	AUX POWER SHORT TO GROUND		
	AUX POWER OPEN CIRCUIT		
	AUX POWER SHORT TO BATTERY		
	GLOW PLUG SHORT TO GROUND		
	GLOW PLUG OPEN CIRCUIT		
	GLOW PLUG SHORT TO BATTERY		
	LP LOCK SHORT TO GROUND		
	LP LOCK OPEN CIRCUIT		
	LP LOCK SHORT TO BATTERY		
	LP START ASSIST SHORT TO GROUND		
	LP START ASSIST OPEN CIRCUIT		
	LP START ASSIST SHORT TO BATTERY		
	MAIN DUMP SHORT TO GROUND		
	MAIN DUMP OPEN CIRCUIT		
	MAIN DUMP SHORT TO BATTERY		
	PARKING BRAKE SHORT TO GROUND		
	PARKING BRAKE OPEN CIRCUIT		
	PARKING BRAKE SHORT TO BATTERY		
	START SOLENOID SHORT TO GROUND		
	START SOLENOID OPEN CIRCUIT		
	START SOLENOID SHORT TO BATTERY		
	STEER DUMP SHORT TO GROUND		
	STEER DUMP OPEN CIRCUIT		
	STEER DUMP SHORT TO BATTERY		
	TWO SPEED SHORT TO GROUND		
	TWO SPEED OPEN CIRCUIT		
	TWO SPEED SHORT TO BATTERY		
	GROUND ALARM SHORT TO GROUND		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	GROUND ALARM OPEN CIRCUIT		
	GROUND ALARM SHORT TO BATTERY		
	GENERATOR SHORT TO GROUND		
	GENERATOR OPEN CIRCUIT		
	GENERATOR SHORT TO BATTERY		
	WELDER SHORT TO GROUND		
	WELDER OPEN CIRCUIT		
	WELDER SHORT TO BATTERY		
	HEAD TAIL LIGHT SHORT TO GROUND		
	HEAD TAIL LIGHT OPEN CIRCUIT		
	HEAD TAIL LIGHT SHORT TO BATTERY		
	BASKET UP OVERRIDE SHORT TO GROUND	Only occurs on machines with electronic leveling systems.	
	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		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	BASKET DOWN OPEN CIRCUIT		
	BASKET DOWN SHORT TO BAT-TERY		
	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		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	BASKET RIGHT OPEN CIRCUIT		
	BASKET RIGHT SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB DOWN SHORT TO GROUND		
	JIB DOWN OPEN CIRCUIT		
	JIB DOWN SHORT TO BATTERY		
	JIB LEFT SHORT TO GROUND		
	JIB LEFT OPEN CIRCUIT		
	JIB LEFT SHORT TO BATTERY		
	JIB RIGHT SHORT TO GROUND		
	JIB RIGHT OPEN CIRCUIT		
	JIB RIGHT SHORT TO BATTERY		
	TOWER UP SHORT TO GROUND		
	TOWER UP OPEN CIRCUIT		
	TOWER UP SHORT TO BATTERY		
	TOWER DOWN SHORT TO GROUND		
	TOWER DOWN OPEN CIRCUIT		
	TOWER DOWN SHORT TO BAT-TERY		
	TOWER IN SHORT TO GROUND		
	TOWER IN OPEN CIRCUIT		
	TOWER IN SHORT TO BATTERY		
	TOWER OUT SHORT TO GROUND		
	TOWER OUT OPEN CIRCUIT		
	TOWER OUT SHORT TO BATTERY		
	UPPER IN SHORT TO GROUND		
	UPPER IN OPEN CIRCUIT		
	UPPER IN SHORT TO BATTERY		
	UPPER OUT SHORT TO GROUND		
	UPPER OUT OPEN CIRCUIT		
	UPPER OUT SHORT TO BATTERY		
	LIFT UP DUMP SHORT TO GROUND		
	LIFT UP DUMP OPEN CIRCUIT		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	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		

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	JIB DOWN SHORT TO BATTERY		
	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.	
	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.	
	COOLANT TEMPERATURE SHORT TO GROUND	If a Deutz engine is installed, this indicates coolant temperature is reading below 0.1 volts.	
	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.	
	FORD FAULT CODE UNKNOWN	An unrecognized Ford ECM fault code has been received. Can be reported during power-up sequence.	
	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.	
	FUEL SENSOR SHORT TO BATTERY	Indicates fuel sensor is reading above 4.3 volts.	

Table 6-3. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Communicated (Displayed on Analyzer) Fault	Description	Priority
	FUEL SENSOR SHORT TO GROUND	Indicates fuel sensor is reading below 0.2 volts.	
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.	
	BATTERY TOO HIGH – SYSTEM SHUT DOWN	Battery voltage is above 16V. EMS recycle required.	
	BATTERY TOO LOW – SYSTEM SHUT DOWN	Battery voltage is below 9V.	
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.	
	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.	
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.	
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.	
	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	
	GROUND MODULE FAILURE: HWFS CODE 1	Ground module V(Low) FET has failed	
	GROUND SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.	
	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	These faults occur when the seven volt reference voltage used for the joysticks, sensors, etc. goes out of range. Not reported during 2 second power-up.	
	EEPROM FAILURE – CHECK ALL SETTINGS	A critical failure occurred with the EEPROM. Personalities, machine configuration digits, etc. may be reset to default values and should be checked.	
	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	Indicates that chassis tilt sensor calibration information has been lost. Machine will indicate it is tilted at all times. This calibration data is programmed into the unit at the factory.	
	CHASSIS TILT SENSOR GAIN OUT OF RANGE	Indicates chassis tilt sensor calibration is corrupted.	

Table 6-4. Help Message/Fault Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
OK	0	0	CLEARS WHEN FAULT IS REMOVED
DRIVING AT CREEP - TILTED	0	0	CLEARS WHEN FAULT IS REMOVED
FSW OPEN	0	0	CLEARS WHEN FAULT IS REMOVED
RUNNING AT CREEP - CREEP SWITCH OPEN	0	0	CLEARS WHEN FAULT IS REMOVED
RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	0	0	CLEARS WHEN FAULT IS REMOVED
RUNNING AT CUTBACK - ABOVE ELEVATION	0	0	CLEARS WHEN FAULT IS REMOVED
TILT SENSOR OUT OF RANGE	0	0	CLEARS WHEN FAULT IS REMOVED
LOAD SENSOR READING UNDER WEIGHT	0	0	CLEARS WHEN FAULT IS REMOVED
FSW FAULTY	2	1	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
KEYSWITCH FAULTY	2	1	CLEARS WHEN FAULT IS REMOVED
DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	2	2	CLEARS WHEN FAULT IS REMOVED
FSW INTERLOCK TRIPPED	2	2	CLEARS WHEN FAULT IS REMOVED
STEER LOCKED - SELECTED BEFORE FOOTSWITCH	2	2	CLEARS WHEN FAULT IS REMOVED
STEER SWITCHES FAULTY	2	2	CLEARS WHEN FAULT IS REMOVED
D/S JOY. QPROX BAD	2	2	CLEARS WHEN FAULT IS REMOVED
L/S JOY. QPROX BAD	2	3	CLEARS WHEN FAULT IS REMOVED
D/S JOY. OUT OF RANGE LOW	2	2	CLEARS WHEN FAULT IS REMOVED
D/S JOY. OUT OF RANGE HIGH	2	2	CLEARS WHEN FAULT IS REMOVED
L/S JOY. OUT OF RANGE LOW	2	3	CLEARS WHEN FAULT IS REMOVED
L/S JOY. OUT OF RANGE HIGH	2	3	CLEARS WHEN FAULT IS REMOVED
D/S JOY. CENTER TAP BAD	2	2	CLEARS WHEN FAULT IS REMOVED
L/S JOY. CENTER TAP BAD	2	3	CLEARS WHEN FAULT IS REMOVED
WAITING FOR FSW TO BE OPEN	2	2	CLEARS WHEN FAULT IS REMOVED
PUMP POT FAULTY	2	3	CLEARS WHEN FAULT IS REMOVED
PUMP SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	2	3	CLEARS WHEN FAULT IS REMOVED
PUMP SWITCHES LOCKED - SELECTED BEFORE FOOTSWITCH	2	3	CLEARS WHEN FAULT IS REMOVED
PUMP SWITCHES LOCKED - SELECTED BEFORE START SWITCH	2	3	CLEARS WHEN FAULT IS REMOVED
FOOTSWITCH SELECTED BEFORE START	2	3	CLEARS WHEN FAULT IS REMOVED
BOOM PREVENTED - DRIVE SELECTED	2	5	CLEARS WHEN FAULT IS REMOVED
DRIVE PREVENTED - ABOVE ELEVATION	2	5	CLEARS WHEN FAULT IS REMOVED
DRIVE PREVENTED - TILTED & ABOVE ELEVATION	2	5	CLEARS WHEN FAULT IS REMOVED
DRIVE PREVENTED - BOOM SELECTED	2	5	CLEARS WHEN FAULT IS REMOVED

Table 6-4. Help Message/Fault Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
FORD ECM POWER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HORN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
AUX POWER SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GLOW PLUG SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP LOCK SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
LP START ASSIST SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
MAIN DUMP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PARKING BRAKE SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
START SOLENOID SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
STEER DUMP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TWO SPEED SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
ALARM OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 6-4. Help Message/Fault Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
ALARM SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
GENERATOR SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HEAD TAIL LIGHT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HOUR METER SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
HOUR METER SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET UP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET DOWN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET LEFT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BASKET RIGHT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB UP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB DOWN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB LEFT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
JIB RIGHT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT

Table 6-4. Help Message/Fault Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
TOWER UP SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER UP OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER UP SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER DOWN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER IN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
TOWER OUT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER IN SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT SHORT TO GROUND	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT OPEN CIRCUIT	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
UPPER OUT SHORT TO BATTERY	3	3	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
FUEL SENSOR SHORT TO BATTERY	3	3	CLEARS WHEN FAULT IS REMOVED
FUEL SENSOR SHORT TO GROUND	3	3	CLEARS WHEN FAULT IS REMOVED
OIL PRESSURE SHORT TO BATTERY	4	3	CLEARS WHEN FAULT IS REMOVED
OIL PRESSURE SHORT TO GROUND	4	3	CLEARS WHEN FAULT IS REMOVED
COOLANT TEMPERATURE SHORT TO GROUND	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 12	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 13	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 14	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 15	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 21	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 22	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 23	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 24	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 25	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 26	4	3	CLEARS WHEN FAULT IS REMOVED

Table 6-4. Help Message/Fault Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
FORD FAULT CODE 31	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 32	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 33	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 34	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 35	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 36	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 41	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 42	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 43	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 44	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 45	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 46	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 51	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 52	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 53	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 54	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 55	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 56	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 57	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 61	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 62	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 63	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE 64	4	3	CLEARS WHEN FAULT IS REMOVED
FORD FAULT CODE UNKNOWN	4	3	CLEARS WHEN FAULT IS REMOVED
RETURN FILTER BYPASSED	2	8	CLEARS WHEN FAULT IS REMOVED
CHARGE PUMP FILTER BYPASSED	2	8	CLEARS WHEN FAULT IS REMOVED
BATTERY LOW	4	4	CLEARS WHEN FAULT IS REMOVED
BATTERY TOO HIGH - SYSTEM SHUT DOWN	4	4	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
BATTERY TOO LOW - SYSTEM SHUT DOWN	4	4	CLEARS WHEN FAULT IS REMOVED
SPEED SENSOR READING INVALID SPEED	5	5	CLEARS WHEN FAULT IS REMOVED
SPEED INPUT LOST	5	5	CLEARS WHEN FAULT IS REMOVED
ENGINE TEMP HIGH	4	3	CLEARS WHEN FAULT IS REMOVED
AIR FILTER BYPASSED	4	3	CLEARS WHEN FAULT IS REMOVED

Table 6-4. Help Message/Fault Listing

HELP MESSAGE	FAULT		FAULT REMOVAL
NO ALTERNATOR OUTPUT	4	3	CLEARS WHEN FAULT IS REMOVED
OIL PRESSURE LOW	4	3	CLEARS WHEN FAULT IS REMOVED
485 COMMUNICATIONS LOST	4	3	CLEARS WHEN FAULT IS REMOVED
CAN BUS FAILURE	6	6	CLEARS WHEN FAULT IS REMOVED
LOAD SENSOR NOT CALIBRATED	9	9	CLEARS WHEN FAULT IS REMOVED
TILT SENSOR NOT CALIBRATED	9	9	CLEARS WHEN FAULT IS REMOVED
EEPROM FAILURE - CHECK ALL SETTINGS	9	9	REQUIRES EMS TO BE RECYCLED TO CLEAR FAULT
PLATFORM MODULE FAILURE: HWFS CODE 1	9	9	CLEARS WHEN FAULT IS REMOVED
GROUND MODULE FAILURE: HWFS CODE 1	9	9	CLEARS WHEN FAULT IS REMOVED

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
NOTE: *Machine configuration must be completed before any personality settings can be changed. Changing personality settings first and then changing the model number of the machine configuration will cause personality settings to return to default*			
MODEL NUMBER: 1	0 4	No Model 600S	0 1
MARKET: 2	0 1 2 3 4 5	ANSI USA ANSI EXPORT CSA CE AUSTRALIA JAPAN	0
ENGINE: 3	8 9 12 13	DEUTZ F4 TIER1: Deutz BF4M1011 Diesel (Tier 1) DEUTZ F4 TIER2: Deutz BF4M2011 Diesel (Tier 2) DEUTZ ECM: Engine Control Module CAT Engine	14
FLYWHEEL TEETH: 4	0 1	133 TEETH: 133 flywheel teeth. 110 TEETH: 110 flywheel teeth.	1
GLOW PLUG: 5	0 1 2	NO GLOW PLUGS: No glow plugs installed. AIR INTAKE: Glow plugs installed in the air intake on the manifold. IN-CYLINDER: Glow plugs installed in each cylinder.	2
STARTER LOCKOUT: 6	0 1	DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow. ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	0
ENGINE SHUTDOWN: 7	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110°C or oil pressure is less than 8 PSI.	1

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
TILT: 8	1 2 3 4 5	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. 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 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 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. 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.	1
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: 9	0 1	NO: No Jib installed. YES: Jib installed which has up and down movements only.	0
4 WHEEL STEER: 10	0 1	NO: No four-wheel steer installed. YES: Four wheel steer installed	0
STOUCH/SKY-GUARD: 11	0 1 2 3	NO: No soft touch or SkyGuard system installed. SOFT TOUCH: Soft touch only installed. SKYGUARD: SkyGuard only installed. BOTH (CUTOUT) - Soft touch and SkyGuard installed.	0
GEN SET/WELDER: 12	0 1	NO: No generator installed. BELT DRIVE: Belt driven setup	0
GEN SET CUTOUT: 13*	0 1	MOTION ENABLED: Motion enabled when generator is ON. MOTION CUTOUT: Motion cutout in platform mode only.	0
* Only visible if Gen Set / Welder Menu selection is not 0.			

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
H & T LIGHTS: 14	0 1	NO: No head and tail lights installed. YES: Head and tail lights installed.	0
CABLE SWITCH: 15*	0 1	NO: No broken cable switch installed. YES: Broken cable switch installed.	0
* Certain market selections will alter default setting.			
LOAD SYSTEM: 16*	0 1 2 3 4	NO: No load sensor installed. WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF). SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	0
* Only visible under certain market selections.			
* Certain market selections will limit load system options or alter default setting.			
LOAD SENSOR: 17*	0 1	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module. 4 UNDER PLATFORM: Use the EIM for load sensing.	1
* Only visible under certain market selections.			
* Certain market selections will limit load system options or alter default setting.			

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
FUNCTION CUT-OUT: 18*	0 1 2 3	NO: No drive cutout. BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive cutout above elevation. DRIVE CUT E&T: Drive cutout above elevation and tilted.	0
* Only visible under certain market selections.			
* Certain market selections will limit function cutout options or alter default setting.			
GROUND ALARM: 19*	0 1 2 3	NO: No ground alarm installed. DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). MOTION: Motion alarm sounds when any function is active (Option).	3
* Certain market selections will alter default setting.			
DRIVE: 20*	0 1 2	4 WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/2-SPEED: Two wheel drive with two-speed valve.	0
* Only visible under certain market selections.			
DISPLAY UNITS: 21*	0 1	IMPERIAL: DEG F, PSI, LBS METRIC: DEG C, KPA, KGS.	0
* Certain market selections will alter default setting.			
LEVELING MODE: 22*	0 1	ALL: Platform level with all functions. LEVEL LIFT / TELESCOPE: Platform level on lift and telescope only.	0
* Only visible on 800S models.			
DRIVE CONTROL: 23	0 1 2	NORMAL: Drive coils are energized from the Ground Module. PROPULSION: Drive coils are energized from the Propulsion Module. ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.	2
BOOM CONTROL: 24	0 1	NORMAL: Boom control coils are energized from the Ground Module. ENHANCED: Boom control coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.	0

Table 6-5. Machine Configuration Programming Information

Configuration Digit	Number	Description	Default Number
CLEARSKY: 25	0 1	NO: ClearSky Telematics system not installed. YES: ClearSky Telematics system installed.	0
CRIBBING OPTION: 26	0 1	NO: Cribbing Option is disabled. YES: Cribbing Option is enabled.	0
FUEL TANK SIZE: 27	0 1	31 Gallon tank. 52 Gallon tank.	0
ALARM/HORN: 28	0 1	SEPERATE: Separate alarm and horn. COMBINED: combination alarm/horn.	0

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6.3 MACHINE ORIENTATION WHEN SETTING FUNCTION SPEEDS

LIFT UP: from platform control, lowest elevation up to maximum elevation, boom retracted, jib retracted.

LIFT DOWN: from platform control, maximum elevation down to minimum elevation, boom retracted, jib retracted.

JIB LIFT UP: from platform control, lowest jib elevation up to maximum jib elevation, boom retracted, jib retracted.

JIB LIFT DOWN: from platform control, maximum jib elevation down to minimum jib elevation, boom retracted, jib retracted.

SWING RIGHT(Max): 360°, from platform control, boom approximately 45° elevation, boom retracted, jib retracted.

SWING LEFT(Max): 360°, from platform control, boom approximately 45° elevation, boom retracted, jib retracted.

TELESCOPE OUT: from platform control, boom 20°, 500 lb (226 kg) capacity selected.

TELESCOPE IN: from platform control, boom 20°, 500 lb (226 kg) capacity selected.

JIB TELESCOPE IN: from platform control, boom horizontal, jib horizontal, 500 lb (226 kg) capacity selected.

JIB TELESCOPE OUT: from platform control, boom horizontal, jib horizontal, 500 lb (226 kg) capacity selected.

DRIVE FORWARD (Max): high speed - low torque setting, drive 200 ft (61 m) front wheels to front wheels. Timed after machine has obtained maximum speed.

DRIVE REVERSE (Max): high speed - low torque setting, drive 200 ft (61 m) front wheels to front wheels Timed after machine has obtained maximum speed.

DRIVE FORWARD (Creep Max): high torque - low speed setting, platform speed knob at full creep

DRIVE REVERSE (Creep Max): high torque - low speed setting, platform speed knob at full creep

DRIVE FORWARD (Elevated Max - Boom Beyond Transport): high speed - low torque setting, platform speed knob out of creep, Lift boom above transport, drive forward 50 ft (15 m).

DRIVE REVERSE (Elevated Max - Boom Beyond Transport): high speed - low torque setting, platform speed knob out of creep, Lift boom above transport, drive backward 50 ft (15 m).

Test Notes

1. Personality settings can be adjusted anywhere within the adjustment range for optimum machine performance.
2. Stop watch should start when function is activated - not controller or switch.
3. Unless noted, measure function speeds from platform.
4. Platform speed knob must be at full speed (fully clockwise).
5. Perform all tests with oil temperature above 100° F (38° C).

6.4 CANBUS COMMUNICATIONS

CANbus: CAN (Control Area Network) is a two wire differential serial link between the Platform and Ground Modules providing bi-directional communications.

Two-wire: One wire (red) is driven high (5v) and the other low (black) (0v) to send a signal. Both wires "float" (2.5v) when no signal is being sent.

Differential: Any electrical line noise can affect the high or the low wires but never both, so communications is not corrupted.

Serial Link: Messages are being sent bit by bit along the wires; the high bus speed allow all modules to be constantly updated around 20 times per second. Typical traffic is 300 - 500 messages per second.

A complete CANbus circuit is approximately 60 ohms, which can be verified at the "T" fitting inside the ground station. Individual circuits are approximately 120 ohms.

The GROUND MODULE (UGM) is the master system controller. Most functions are dispatched and coordinated from this module. The PLATFORM MODULE handles sub-tasks. All characterized information (values) are stored in the ground module (i.e., Personalities or Calibrations).

Interlocks: Any device that sends an electrical input. (For an example a limit switch, proximity switch, etc;)

Platform Level: The GROUND MODULE stores default values and handles interlocks. The PLATFORM MODULE reads sensors mounted on the platform assembly and controls Level Up / Down valves to maintain setpoint sent from the GROUND MODULE.

Steer: The GROUND MODULE stores crack points, and sends desired drive direction, steering mode, and axle extend/retract commands. The PLATFORM MODULE reports steering switch position to the GROUND MODULE.

Drive: The GROUND MODULE stores crack points and sends commands for each drive pump. (Command is computed from drive joystick input, interlocks, wheel angle, etc).

Lift, Tele, & Swing: The GROUND MODULE stores default values, and handles interlocks and calibration information. Lift, Telescope, and Swing commands depend on interlocks through out the machine. Boom angle, length, and swing are controlled by the GROUND MODULE

.

Table 6-6. Fault Code List

DTC	Text
001	EVERYTHING OK
0010	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION
0011	FSW OPEN
0012	RUNNING AT CREEP - CREEP SWITCH OPEN
0013	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION
0014	CHASSIS TILT SENSOR OUT OF RANGE
0030	RUNNING AT CREEP - PLATFORM STOWED
0031	FUEL LEVEL LOW - ENGINE SHUTDOWN
211	POWER CYCLE
212	KEYSWITCH FAULTY
213	FSW FAULTY
224	FUNCTION PROBLEM - STEER LEFT PERMANENTLY SELECTED
225	FUNCTION PROBLEM - STEER RIGHT PERMANENTLY SELECTED
227	STEER SWITCHES FAULTY
2211	FSW INTERLOCK TRIPPED
2212	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH
2213	STEER LOCKED - SELECTED BEFORE FOOTSWITCH
2216	D/S JOY. OUT OF RANGE HIGH
2217	D/S JOY. CENTER TAP BAD
2219	L/S JOY. OUT OF RANGE HIGH
2220	L/S JOY. CENTER TAP BAD
2221	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH
2222	WAITING FOR FSW TO BE OPEN
2223	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE
2224	FOOTSWITCH SELECTED BEFORE START
2247	FUNCTION PROBLEM - PLATFORM ROTATE LEFT PERMANENTLY SELECTED
2248	FUNCTION PROBLEM - PLATFORM ROTATE RIGHT PERMANENTLY SELECTED
2249	FUNCTION PROBLEM - JIB LIFT UP PERMANENTLY SELECTED
2250	FUNCTION PROBLEM - JIB LIFT DOWN PERMANENTLY SELECTED
2251	FUNCTION PROBLEM - TELESCOPE IN PERMANENTLY SELECTED
2252	FUNCTION PROBLEM - TELESCOPE OUT PERMANENTLY SELECTED
2257	FUNCTION PROBLEM - TOWER LIFT UP PERMANENTLY SELECTED
2258	FUNCTION PROBLEM - TOWER LIFT DOWN PERMANENTLY SELECTED
2262	FUNCTION PROBLEM - PLATFORM LEVEL UP PERMANENTLY SELECTED
2263	FUNCTION PROBLEM - PLATFORM LEVEL DOWN PERMANENTLY SELECTED
234	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM
235	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER
236	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH
237	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH
2310	FUNCTION PROBLEM - GROUND ENABLE PERMANENTLY SELECTED
2370	FUNCTION PROBLEM - JIB LIFT UP PERMANENTLY SELECTED

Table 6-6. Fault Code List

DTC	Text
2371	FUNCTION PROBLEM - JIB LIFT DOWN PERMANENTLY SELECTED
2372	FUNCTION PROBLEM - SWING LEFT PERMANENTLY SELECTED
2373	FUNCTION PROBLEM - SWING RIGHT PERMANENTLY SELECTED
23104	BOOM TRANSPORT SWITCH DISAGREEMENT
23105	FUNCTION PROBLEM - TOWER LIFT UP PERMANENTLY SELECTED
23106	FUNCTION PROBLEM - TOWER LIFT DOWN PERMANENTLY SELECTED
23107	FUNCTION PROBLEM - LIFT UP PERMANENTLY SELECTED
23108	FUNCTION PROBLEM - LIFT DOWN PERMANENTLY SELECTED
23109	FUNCTION PROBLEM - TELESCOPE IN PERMANENTLY SELECTED
23110	FUNCTION PROBLEM - TELESCOPE OUT PERMANENTLY SELECTED
23111	FUNCTION PROBLEM - PLATFORM LEVEL UP PERMANENTLY SELECTED
23112	FUNCTION PROBLEM - PLATFORM LEVEL DOWN PERMANENTLY SELECTED
23113	FUNCTION PROBLEM - PLATFORM ROTATE LEFT PERMANENTLY SELECTED
23114	FUNCTION PROBLEM - PLATFORM ROTATE RIGHT PERMANENTLY SELECTED
259	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS
2513	GENERATOR MOTION CUTOUT ACTIVE
2514	BOOM PREVENTED - DRIVE SELECTED
2516	DRIVE PREVENTED - ABOVE ELEVATION
2517	DRIVE PREVENTED - TILTED & ABOVE ELEVATION
2518	DRIVE PREVENTED - BOOM SELECTED
331	BRAKE - SHORT TO BATTERY
332	BRAKE - OPEN CIRCUIT
334	LIFT UP VALVE - OPEN CIRCUIT
335	LIFT DOWN VALVE - SHORT TO BATTERY
336	LIFT DOWN VALVE - OPEN CIRCUIT
3311	GROUND ALARM - SHORT TO BATTERY
3352	LP LOCK - SHORT TO GROUND
3353	LP LOCK - OPEN CIRCUIT
3354	LP LOCK - SHORT TO BATTERY
3355	LP START ASSIST - SHORT TO GROUND
3356	LP START ASSIST - OPEN CIRCUIT
3357	LP START ASSIST - SHORT TO BATTERY
3358	MAIN DUMP VALVE - SHORT TO GROUND
3359	MAIN DUMP VALVE - OPEN CIRCUIT
3360	MAIN DUMP VALVE - SHORT TO BATTERY
3361	BRAKE - SHORT TO GROUND
3362	START SOLENOID - SHORT TO GROUND
3363	START SOLENOID - OPEN CIRCUIT
3364	START SOLENOID - SHORT TO BATTERY
3365	STEER DUMP VALVE - SHORT TO GROUND
3366	STEER DUMP VALVE - OPEN CIRCUIT
3367	STEER DUMP VALVE - SHORT TO BATTERY
3373	GEN SET/WELDER - SHORT TO GROUND

Table 6-6. Fault Code List

DTC	Text
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
33109	TOWER LIFT DOWN VALVE - SHORT TO GROUND
33110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT
33118	SWING RIGHT VALVE - SHORT TO GROUND
33119	SWING RIGHT VALVE - OPEN CIRCUIT
33120	TELESCOPE IN VALVE - SHORT TO BATTERY
33122	SWING LEFT VALVE - SHORT TO GROUND
33123	TELESCOPE OUT VALVE - SHORT TO BATTERY
33130	THROTTLE ACTUATOR - SHORT TO GROUND
33131	THROTTLE ACTUATOR - OPEN CIRCUIT
33132	THROTTLE ACTUATOR - SHORT TO BATTERY
33182	LIFT VALVES - SHORT TO BATTERY
33186	TELESCOPE OUT VALVE - OPEN CIRCUIT
33188	TELESCOPE OUT VALVE - SHORT TO GROUND
33189	TELESCOPE IN VALVE - OPEN CIRCUIT
33190	TELESCOPE IN VALVE - SHORT TO GROUND
33279	GLOWPLUG - OPEN CIRCUIT
33280	GLOWPLUG - SHORT TO BATTERY

Table 6-6. Fault Code List

DTC	Text
33281	GLOWPLUG - SHORT TO GROUND
33287	LIFT - CURRENT FEEDBACK READING TOO LOW
33295	SWING LEFT VALVE - OPEN CIRCUIT
33314	FLOW CONTROL VALVE - OPEN CIRCUIT
33315	FLOW CONTROL VALVE - SHORT TO BATTERY
33316	FLOW CONTROL VALVE - SHORT TO GROUND
33317	DRIVE FORWARD VALVE - OPEN CIRCUIT
33318	DRIVE FORWARD VALVE - SHORT TO BATTERY
33319	DRIVE FORWARD VALVE - SHORT TO GROUND
33320	DRIVE REVERSE VALVE - OPEN CIRCUIT
33322	DRIVE REVERSE VALVE - SHORT TO GROUND
33331	DRIVE - CURRENT FEEDBACK READING TOO LOW
33406	LIFT UP VALVE - SHORT TO GROUND
33410	DRIVE - CURRENT FEEDBACK READING LOST
33412	SWING VALVES - SHORT TO BATTERY
33413	TOWER LIFT - CURRENT FEEDBACK READING TOO LOW
33414	SWING - CURRENT FEEDBACK READING TOO LOW
33415	FLOW CONTROL VALVE - CURRENT FEEDBACK READING TOO LOW
33416	TOWER LIFT - CURRENT FEEDBACK READING LOST
33417	LIFT - CURRENT FEEDBACK READING LOST
33418	SWING - CURRENT FEEDBACK READING LOST
33419	FLOW CONTROL VALVE - CURRENT FEEDBACK READING LOST
33420	TRACTION LOCK VALVE - SHORT TO BATTERY
33421	TRACTION LOCK VALVE - OPEN CIRCUIT
33422	TRACTION LOCK VALVE - SHORT TO GROUND
33423	OSCILLATING AXLE VALVES - SHORT TO BATTERY
33424	OSCILLATING AXLE VALVES - SHORT TO GROUND
33425	TOWER LIFT VALVES - SHORT TO BATTERY
342	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY
343	PLATFORM LEVEL UP VALVE - SHORT TO GROUND
345	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT
346	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY
347	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND
349	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT
3410	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY
3411	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND
3412	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT
3413	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY
3414	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND
3415	JIB LIFT UP VALVE - OPEN CIRCUIT
3416	JIB LIFT UP VALVE - SHORT TO BATTERY
3417	JIB LIFT UP VALVE - SHORT TO GROUND
3418	JIB LIFT DOWN VALVE - OPEN CIRCUIT

Table 6-6. Fault Code List

DTC	Text
3419	JIB LIFT DOWN VALVE - SHORT TO BATTERY
3420	JIB LIFT DOWN VALVE - SHORT TO GROUND
431	FUEL SENSOR - SHORT TO BATTERY
432	FUEL SENSOR - SHORT TO GROUND
433	OIL PRESSURE - SHORT TO BATTERY
434	OIL PRESSURE - SHORT TO GROUND
435	COOLANT TEMPERATURE - SHORT TO GROUND
437	ENGINE TROUBLE CODE
438	HIGH ENGINE TEMP
4310	NO ALTERNATOR OUTPUT
4311	LOW OIL PRESSURE
4313	THROTTLE ACTUATOR FAILURE
4314	WRONG ENGINE SELECTED - ECM DETECTED
4322	LOSS OF ENGINE SPEED SENSOR
4323	SPEED SENSOR READING INVALID SPEED
4326	FUEL ACTUATOR - SHORT TO GROUND
4327	FUEL ACTUATOR - OPEN CIRCUIT
4328	FUEL ACTUATOR - SHORT TO BATTERY
4329	FUEL ACTUATOR - CURRENT FEEDBACK READING TOO LOW
4330	FUEL ACTUATOR - CURRENT FEEDBACK READING LOST
441	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN
442	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN
443	LSS BATTERY VOLTAGE TOO HIGH
444	LSS BATTERY VOLTAGE TOO LOW
445	BATTERY VOLTAGE LOW
662	CANBUS FAILURE - PLATFORM MODULE
663	CANBUS FAILURE - LOAD SENSING SYSTEM MODULE
666	CANBUS FAILURE - ENGINE CONTROLLER
6613	CANBUS FAILURE - EXCESSIVE CANBUS ERRORS
6622	CANBUS FAILURE - TCU MODULE
6629	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH
681	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP
813	CHASSIS TILT SENSOR NOT CALIBRATED
814	CHASSIS TILT SENSOR OUT OF RANGE
815	CHASSIS TILT SENSOR DISAGREEMENT
821	LSS CELL #1 ERROR
822	LSS CELL #2 ERROR
823	LSS CELL #3 ERROR
824	LSS CELL #4 ERROR
825	LSS HAS NOT BEEN CALIBRATED
826	RUNNING AT CREEP - PLATFORM OVERLOADED
827	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED
828	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED

Table 6-6. Fault Code List

DTC	Text
8211	LSS READING UNDER WEIGHT
8639	FRONT LEFT STEER VALVE - OPEN CIRCUIT
8640	FRONT LEFT STEER VALVE - SHORT TO BATTERY
8641	FRONT LEFT STEER VALVE - SHORT TO GROUND
8642	FRONT RIGHT STEER VALVE - OPEN CIRCUIT
8643	FRONT RIGHT STEER VALVE - SHORT TO BATTERY
8644	FRONT RIGHT STEER VALVE - SHORT TO GROUND
8669	OSCILLATING AXLE SWITCH DISAGREEMENT
991	LSS WATCHDOG RESET
992	LSS EEPROM ERROR
993	LSS INTERNAL ERROR - PIN EXCITATION
994	LSS INTERNAL ERROR - DRDY MISSING FROM A/D
998	EEPROM FAILURE - CHECK ALL SETTINGS
9910	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER
9911	FUNCTIONS LOCKED OUT - LSS MODULE SOFTWARE VERSION IMPROPER
9915	CHASSIS TILT SENSOR NOT GAIN CALIBRATED
9919	GROUND SENSOR REF VOLTAGE OUT OF RANGE
9920	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE
9921	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY
9922	PLATFORM MODULE FAILURE - HWFS CODE 1
9924	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED
9927	GROUND MODULE CONSTANT DATA UPDATE REQUIRED
9944	CURRENT FEEDBACK GAINS OUT OF RANGE
9945	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT
9949	MACHINE CONFIGURATION OUT OF RANGE - CHECK ALL SETTINGS
9977	LSS CORRUPT EEPROM
9979	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER
9986	GROUND MODULE VLOW FET FAILURE

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed.*

600A

	MODEL NUMBER	MARKET	ENGINE	FLYWHEEL TEETH		GLOW PLUG			STARTER LOCKOUT		ENGINE SHUTDOWN		TILT					JIB	4 WHEEL STEER	STOUCH/SKYGUARD			
ANSI USA	***5***	***0***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	***0***	***0***	***0***	1	2	3
ANSI EXPORT	***5***	***1***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	***0***	***0***	***0***	1	2	3
CSA	***5***	***2***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	***0***	***0***	***0***	1	2	3
CE	***5***	***3***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	X	X	***3***	X	5	***0***	***0***	***0***	1	2	3
AUSTRALIA	***5***	***4***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	X	2	***3***	4	5	***0***	***0***	***0***	1	2	3
JAPAN	***5***	***5***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	***0***	***0***	***0***	1	2	3

600A

	GEN SET / WELDER		GEN SET CUTOUT		HEAD & TAIL LIGHTS		CABLE BREAK SWITCH		LOAD SYSTEM					LOAD SENSOR		FUNCTION CUTOUT				GROUND ALARM			
ANSI USA	***0***	1	***0***	1	***0***	1	***0***	1	***0***	X	X	X	X	0	***1***	***0***	X	2	X	0	1	2	***3***
ANSI EXPORT	***0***	1	***0***	1	***0***	1	***0***	1	***0***	<u>***1***</u>	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***
CSA	***0***	1	***0***	1	***0***	1	***0***	1	***0***	X	X	X	X	0	***1***	***0***	1	2	3	0	1	2	***3***
CE	***0***	1	***0***	1	***0***	1	***0***	1	0	X	***2***	3	X	0	***1***	0	***1***	X	X	0	1	2	***3***
AUSTRALIA	***0***	1	***0***	1	***0***	1	***0***	1	***0***	X	<u>***2***</u>	X	X	0	***1***	***0***	1	2	3	0	1	2	***3***
JAPAN	***0***	1	***0***	1	***0***	1	***0***	1	0	***1***	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed.*

600A																						
	DRIVE TYPE			DISPLAY UNITS		LEVELING MODE		DRIVE CONTROL			DRIVE PUMP		BOOM CONTROL		FUNCTION SPEED KNOB		CLEARSKY		CRIBBING OPTION		FUEL TANK SIZE	
ANSI USA	***0***	1	2	***0***	1	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
ANSI EXPORT	***0***	1	2	***0***	1	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
CSA	***0***	1	2	0	***1***	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
CE	***0***	1	2	0	***1***	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
AUSTRALIA	***0***	1	2	0	***1***	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
JAPAN	***0***	1	2	0	***1***	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed.*

600A								
	ALARM/HORN		ALERT BEACON		TEMP CUTOUT		PLT LVL OVR CUT	
ANSI USA	***0***	1	***0***	1	X	X	***0***	1
ANSI EXPORT	***0***	1	***0***	1	***0***	1	***0***	1
CSA	***0***	1	***0***	1	X	X	***0***	1
CE	***0***	1	***0***	1	***0***	1	***0***	1
AUSTRALIA	***0***	1	***0***	1	X	X	***0***	1
JAPAN	***0***	1	***0***	1	X	X	***0***	1

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed.*

600AJ	MODEL NUMBER	MARKET	ENGINE	FLYWHEEL TEETH		GLOW PLUG			STARTER LOCKOUT		ENGINE SHUTDOWN		TILT					JIB	4 WHEEL STEER	STOUCH/SKYGUARD			
ANSI USA	***5***	***0***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	2	3
ANSI EXPORT	***5***	***1***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	2	3
CSA	***5***	***2***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	2	3
CE	***5***	***3***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	X	X	***3***	X	5	***1***	***0***	***0***	1	2	3
AUSTRALIA	***5***	***4***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	X	2	***3***	4	5	***1***	***0***	***0***	1	2	3
JAPAN	***5***	***5***	***12***	0	***1***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	***1***	***0***	***0***	1	2	3

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed.*

600AJ	GEN SET / WELDER		GEN SET CUTOUT		HEAD & TAIL LIGHTS		CABLE BREAK SWITCH		LOAD SYSTEM					LOAD SENSOR		FUNCTION CUTOUT				GROUND ALARM			
ANSI USA	***0***	1	***0***	1	***0***	1	***0***	1	***0***	X	X	X	X	0	***1***	***0***	X	2	X	0	1	2	***3***
ANSI EXPORT	***0***	1	***0***	1	***0***	1	***0***	1	***0***	***1***	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***
CSA	***0***	1	***0***	1	***0***	1	***0***	1	***0***	X	X	X	X	0	***1***	***0***	1	2	3	0	1	2	***3***
CE	***0***	1	***0***	1	***0***	1	***0***	1	0	X	***2***	3	X	0	***1***	0	***1***	X	X	0	1	2	***3***
AUSTRALIA	***0***	1	***0***	1	***0***	1	***0***	1	***0***	X	***2***	X	X	0	***1***	***0***	1	2	3	0	1	2	***3***
JAPAN	***0***	1	***0***	1	***0***	1	***0***	1	0	***1***	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed.*

600AJ																						
	DRIVE TYPE			DISPLAY UNITS		LEVELING MODE		DRIVE CONTROL			DRIVE PUMP		BOOM CONTROL		FUNCTION SPEED KNOB		CLEARSKY		CRIBBING OPTION		FUEL TANK SIZE	
ANSI USA	***0***	1	2	***0***	1	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
ANSI EXPORT	***0***	1	2	***0***	1	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
CSA	***0***	1	2	0	***1***	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
CE	***0***	1	2	0	***1***	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
AUSTRALIA	***0***	1	2	0	***1***	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
JAPAN	***0***	1	2	0	***1***	***0***	1	***0***	1	2	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1

NOTE: *Bold Italic Numbers indicate the default setting. Plain text indicates another available selection. Bold, Italic underlined numbers indicate the default when the option is factory installed.*

600AJ								
	ALARM/HORN		ALERT BEACON		TEMP CUTOUT		PLT LVL OVR CUT	
ANSI USA	***0***	1	***0***	1	X	X	***0***	1
ANSI EXPORT	***0***	1	***0***	1	***0***	1	***0***	1
CSA	***0***	1	***0***	1	X	X	***0***	1
CE	***0***	1	***0***	1	***0***	1	***0***	1
AUSTRALIA	***0***	1	***0***	1	X	X	***0***	1
JAPAN	***0***	1	***0***	1	X	X	***0***	1

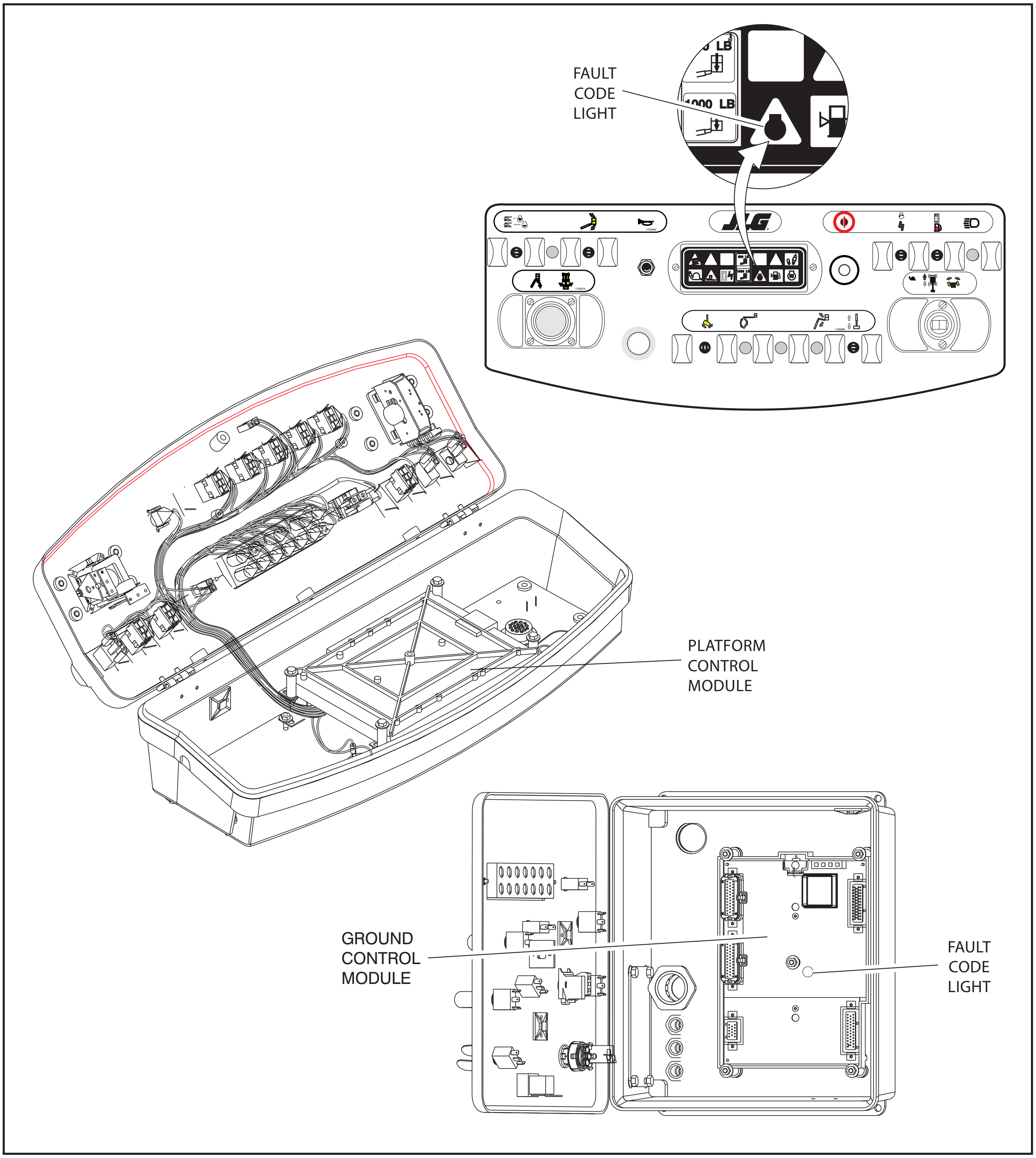

Figure 6-11. Control Module Locations

Connector	Pin	Function	Type	
J1 (Natural)	1	ENGINE THROTTLE ACTUATOR	DIGITAL	OUTPUT
	2	LP START ASSIST	DIGITAL	OUTPUT
	3	DRIVE / LEFT TRACK FORWARD COIL	DIGITAL	OUTPUT
	4	GROUND	GROUND	INPUT
	5	GROUND	GROUND	INPUT
	6	DRIVE / LEFT TRACK REVERSE COIL	DIGITAL	OUTPUT
	7	LP LOCK / ELECTRIC FAN DRIVE	DIGITAL	OUTPUT
	8	GROUND	GROUND	INPUT
	9	GROUND	GROUND	INPUT
	10	IGNITION ON RELAY / ALTERNATOR EXCITATION / FUEL ON SOLENOID	DIGITAL	OUTPUT
	11	START SOLENOID	DIGITAL	OUTPUT
	12	ENGAGE GLOW PLUGS	DIGITAL	OUTPUT
	13	APU ENABLE RELAY	DIGITAL	OUTPUT
	14	ENGINE COOLANT TEMPERATURE	ANALOG	INPUT
	15	ENGINE OIL PRESSURE	ANALOG	INPUT
	16	ENGINE SPEED	FREQUENCY	INPUT
	17	GROUND	GROUND	INPUT
	18	GROUND	GROUND	INPUT
	19	GROUND	GROUND	INPUT
	20	2-SPEED VALVE	DIGITAL	OUTPUT
	21	CHARGE PUMP FILTER BY-PASS	DIGITAL	INPUT
	22	GENERATOR ENABLE RELAY	DIGITAL	OUTPUT
	23	BRAKE VALVE	DIGITAL	OUTPUT
	24	NOT CONNECTED	N/C	N/C
	25	RS-485 HIGH	SERIAL	I/O
	26	RS-485 LOW	SERIAL	I/O
	27	GROUND	GROUND	INPUT
	28	ANALYZER POWER	VOLTAGE	OUTPUT
	29	ANALYZER RS-232 RX	SERIAL	INPUT
	30	ANALYZER RS-232 TX	SERIAL	OUTPUT
	31	ANALYZER GROUND	GROUND	INPUT
	32	ALTERNATOR EXCITATION	DIGITAL	OUTPUT
	33	RS-485 GROUND	GROUND	INPUT
	34	AIR FILTER BY-PASS	DIGITAL	INPUT
	35	NOT CONNECTED	DIGITAL	INPUT

Connector	Pin	Function	Type	
J2 (Gray)	1	STEER DUMP VALVE	DIGITAL	OUTPUT
	2	HORN OUTPUT	DIGITAL	OUTPUT
	3	TOWER TELESCOPE IN SOLENOID	DIGITAL	OUTPUT
	4	MAIN TELESCOPE IN SOLENOID	DIGITAL	OUTPUT
	5	PLATFORM LEVEL UP SOLENOID	DIGITAL	OUTPUT
	6	GROUND	GROUND	INPUT
	7	PLATFORM LEVEL DOWN SOLENOID	DIGITAL	OUTPUT
	8	RIGHT TRACK REVERSE COIL	DIGITAL	OUTPUT
	9	NOT ALLOCATED	DIGITAL	OUTPUT
	10	PLATFORM ROTATE LEFT SOLENOID	DIGITAL	OUTPUT
	11	MAIN LIFT UP SOLENOID	DIGITAL	OUTPUT
	12	JIB UP SOLENOID	DIGITAL	OUTPUT
	13	MAIN DUMP VALVE	DIGITAL	OUTPUT
	14	GROUND	GROUND	INPUT
	15	TOWER TELESCOPE OUT SOLENOID	DIGITAL	OUTPUT
	16	MAIN TELESCOPE OUT SOLENOID	DIGITAL	OUTPUT
	17	GROUND	GROUND	INPUT
	18	GROUND	GROUND	INPUT
	19	RIGHT TRACK FORWARD COIL	DIGITAL	OUTPUT
	20	NOT ALLOCATED	DIGITAL	OUTPUT
	21	PLATFORM ROTATE RIGHT SOLENOID	DIGITAL	OUTPUT
	22	MAIN LIFT DOWN SOLENOID	DIGITAL	OUTPUT
	23	JIB DOWN SOLENOID	DIGITAL	OUTPUT
	24	RETURN FILTER BY-PASS	DIGITAL	INPUT
	25	FUEL LEVEL SENSOR	ANALOG	INPUT
	26	HEAD / TAIL LIGHT ENABLE RELAY	DIGITAL	OUTPUT
	27	ALARM OUTPUT	DIGITAL	OUTPUT
	28	GROUND	GROUND	INPUT
	29	GROUND	GROUND	INPUT
	30	GROUND	GROUND	INPUT
	31	FLOW CONTROL VALVE	DIGITAL	OUTPUT
	32	TOWER LIFT DOWN SOLENOID	DIGITAL	OUTPUT
	33	TOWER LIFT UP SOLENOID	DIGITAL	OUTPUT
	34	SWING LEFT SOLENOID	DIGITAL	OUTPUT
	35	SWING RIGHT SOLENOID	DIGITAL	OUTPUT

Connector	Pin	Function	Type	
J3 (Black)	1	DRIVE / LEFT TRACK CURRENT FEEDBACK	GROUND	INPUT
	2	RIGHT TRACK CURRENT FEEDBACK	GROUND	INPUT
	3	GROUND	GROUND	INPUT
	4	SWING CURRENT FEEDBACK	GROUND	INPUT
	5	NOT CONNECTED	GROUND	INPUT
	6	FLOW CONTROL CURRENT FEEDBACK	GROUND	INPUT
	7	BATTERY VOLTAGE	VBAT	OUTPUT
	8	UMS ANGLE SENSOR	DIGITAL	INPUT
	9	CRIBBING ENGAGE SWITCH	DIGITAL	INPUT
	10	NOT CONNECTED	DIGITAL	INPUT
	11	NOT CONNECTED	DIGITAL	INPUT
	12	NOT CONNECTED	VOLTAGE	OUTPUT
	13	NOT CONNECTED	ANALOG	INPUT
	14	LIFT CURRENT FEEDBACK	GROUND	INPUT

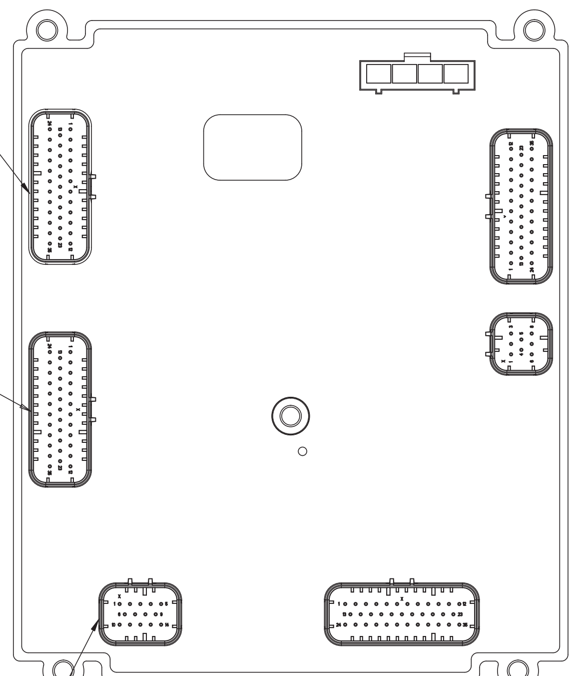

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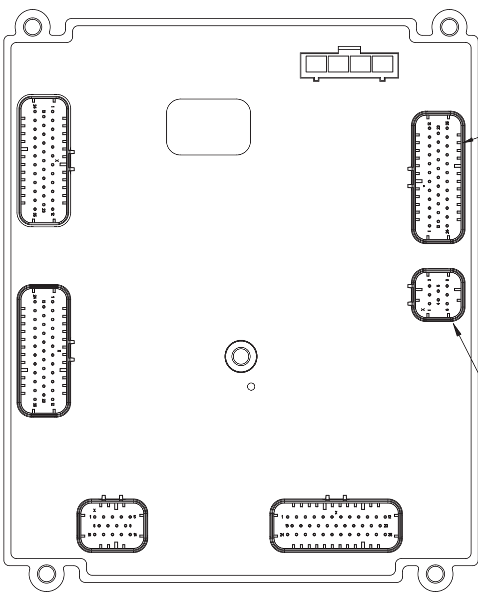
Figure 6-12. Ground Control Module Pin Connections 1 of 3



Connector	Pin	Function	Type	
J7 (Black)	1	PLATFORM EMS	DIGITAL	INPUT
	2	PLATFORM MODE	DIGITAL	INPUT
	3	GROUND MODE	DIGITAL	INPUT
	4	CAPACITY ANGLE SWITCH	ANALOG	INPUT
	5	+5 VOLTS	VOLTAGE	OUTPUT
	6	CAN1 TERMINATOR	TERM	I/O
	7	CAPACITY LENGTH SWITCH	ANALOG	INPUT
	8	NOT CONNECTED	ANALOG	INPUT
	9	GROUND	GROUND	INPUT
	10	GROUND	GROUND	INPUT
	11	IN / OUT OF TRANSPORT SWITCHES	DIGITAL	INPUT
	12	BROKEN CABLE SWITCH	DIGITAL	INPUT
	13	CAN1 HIGH	SERIAL	I/O
	14	GROUND MODE POWER TO PLATFORM	DIGITAL	INPUT
	15	FOOTSWITCH	DIGITAL	INPUT
	16	+5 VOLTS	VOLTAGE	OUTPUT
	17	CAN1 TERMINATOR	TERM	I/O
	18	CAN1 SHIELD	GROUND	INPUT
	19	GROUND	GROUND	INPUT
	20	NOT CONNECTED	ANALOG	INPUT
	21	TOWER TELESCOPE PROXIMITY (800A ONLY) DRIVE ORIENTATION	DIGITAL	INPUT
	22	TOWER LIFT PROXIMITY (800A ONLY)	DIGITAL	INPUT
	23	GROUND FUNCTION ENABLE AVAILABLE	DIGITAL	INPUT
	24	CAN1 LOW	SERIAL	I/O
	25	GROUND	GROUND	INPUT
	26	+5 VOLTS	VOLTAGE	OUTPUT
	27	+5 VOLTS	VOLTAGE	OUTPUT
	28	GROUND	GROUND	INPUT
	29	BATTERY VOLTAGE	VBAT	OUTPUT
	30	BATTERY VOLTAGE	VBAT	OUTPUT
	31	BATTERY VOLTAGE	VBAT	OUTPUT
	32	BATTERY VOLTAGE	VBAT	OUTPUT
	33	BATTERY VOLTAGE	VBAT	OUTPUT
	34	BATTERY VOLTAGE (PROPULSION MODULE)	VBAT	OUTPUT
	35	BOOM ANGLE PROXIMITY (800S ONLY) DRIVE ORIENTATION	DIGITAL	INPUT

Connector	Pin	Function	Type	
J12 (Black)	1	NOT CONNECTED	FREQUENCY	INPUT
	2	NOT CONNECTED	FREQUENCY	INPUT
	3	CAN2 HIGH (TELEMATICS)	SERIAL	I/O
	4	CAN2 LOW (TELEMATICS)	SERIAL	I/O
	5	CAN2 SHIELD (TELEMATICS)	GROUND	INPUT
	6	CAN2 TERMINATOR	TERM	I/O
	7	CAN2 TERMINATOR	TERM	I/O
	8	NOT CONNECTED	DIGITAL	INPUT

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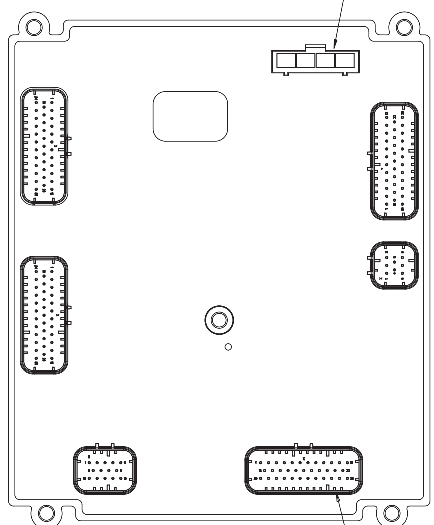
Figure 6-13. Ground Control Module Pin Connections 2 of 3

Connector	Pin	Function	Type	
J8 (Black)	1	MODULE GROUND	GROUND	OUTPUT
	2	MODULE POWER	VBAT	INPUT
	3	GROUND TO PLATFORM MODULE	GROUND	INPUT
	4	POWER TO PLATFORM MODULE	VBAT	OUTPUT



Connector	Pin	Function	Type	
J4 (Blue)	1	CRIBBING ENGAGED INDICATOR	DIGITAL	OUTPUT
	2	500 LB CAPACITY LAMP	DIGITAL	OUTPUT
	3	GLOWPLUG INDICATOR	DIGITAL	OUTPUT
	4	ENGINE START	DIGITAL	INPUT
	5	PLATFORM LEVEL DOWN	DIGITAL	INPUT
	6	PLATFORM ROTATE LEFT	DIGITAL	INPUT
	7	MAIN TELESCOPE IN	DIGITAL	INPUT
	8	JIB BOOM	DIGITAL	INPUT
	9	JIB LEFT	DIGITAL	INPUT
	10	TOWER LIFT UP	DIGITAL	INPUT
	11	TOWER TELESCOPE IN	DIGITAL	INPUT
	12	HOURMETER	DIGITAL	OUTPUT
	13	RETURN FILTER BY-PASS LAMP	DIGITAL	OUTPUT
	14	PLATFORM OVERLOADED INDICATOR	DIGITAL	OUTPUT
	15	BOOM MALFUNCTION INDICATOR	DIGITAL	OUTPUT
	16	AUXILIARY POWER / FUNCTION ENABLE	DIGITAL	INPUT
	17	PLATFORM LEVEL UP	DIGITAL	INPUT
	18	PLATFORM ROTATE RIGHT	DIGITAL	INPUT
	19	JIB UP	DIGITAL	INPUT
	20	JIB RIGHT	DIGITAL	INPUT
	21	TOWER LIFT DOWN	DIGITAL	INPUT
	22	TOWER TELESCOPE OUT	DIGITAL	INPUT
	23	MAIN LIFT UP	DIGITAL	INPUT
	24	BATTERY VOLTAGE	VBAT	OUTPUT
	25	BATTERY VOLTAGE (GROUND ENABLE PRESENT)	VBAT	OUTPUT
	26	BATTERY LOW / NOT CHARGING INDICATOR	DIGITAL	OUTPUT
	27	CHARGE PUMP FILTER BY-PASS LAMP	DIGITAL	OUTPUT
	28	ENGINE HIGH COOLANT TEMPERATURE INDICATOR	DIGITAL	OUTPUT
	29	ENGINE LOW OIL PRESSURE INDICATOR	DIGITAL	OUTPUT
	30	MAIN TELESCOPE OUT	DIGITAL	INPUT
	31	LAMP GROUND	GROUND	INPUT
	32	GROUND	GROUND	INPUT
	33	MAIN LIFT DOWN	DIGITAL	INPUT
	34	SWING LEFT	DIGITAL	INPUT
	35	SWING RIGHT	DIGITAL	INPUT

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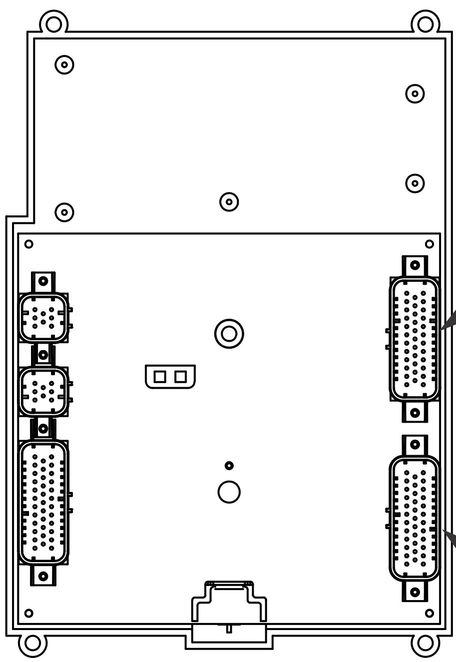
Figure 6-14. Ground Control Module Pin Connections 3 of 3



Connector	Pin	Function	Type	
J2 (Gray)	1	NOT CONNECTED	DIGITAL	INPUT
	2	NOT CONNECTED	DIGITAL	INPUT
	3	BATTERY VOLTAGE	HS DIGITAL	INPUT
	4	DRIVE ORIENTATION SYSTEM OVERRIDE SWITCH	HS DIGITAL	INPUT
	5	NOT CONNECTED	LAMP	OUTPUT
	6	CHASSIS TILTED INDICATOR	LAMP	OUTPUT
	7	FUNCTION ENABLED INDICATOR	LAMP	OUTPUT
	8	VEHICLE SYSTEM DISTRESS INDICATOR	LAMP	OUTPUT
	9	CREEP SPEED INDICATOR	LAMP	OUTPUT
	10	BROKEN CABLE INDICATOR	LAMP	OUTPUT
	11	PLATFORM OVERLOADED INDICATOR	LAMP	OUTPUT
	12	500 LB CAPACITY INDICATOR	LAMP	OUTPUT
	13	1000 LB CAPACITY INDICATOR	LAMP	OUTPUT
	14	DRIVE ORIENTATION SYSTEM INDICATOR	LAMP	OUTPUT
	15	GENERATOR ON INDICATOR	LAMP	OUTPUT
	16	SOFT TOUCH TRIGGERED INDICATOR	LAMP	OUTPUT
	17	GLOW PLUG ENGAGED INDICATOR	LAMP	OUTPUT
	18	LAMP RETURN	GROUND	INPUT
	19	DRIVE DISABLED INDICATOR	LAMP	OUTPUT
	20	UPRIGHT TILTED INDICATOR	LAMP	OUTPUT
	21	LOW FUEL INDICATOR	LAMP	OUTPUT
	22	1/4 FUEL LEVEL INDICATOR	LAMP	OUTPUT
	23	3/4 FUEL LEVEL INDICATOR	LAMP	OUTPUT
	24	1/2 FUEL LEVEL INDICATOR	LAMP	INPUT
	25	FUEL LEVEL INDICATORS RETURN	GROUND	INPUT
	26	ANALYZER POWER	ANALOG	OUTPUT
	27	ANALYZER GROUND	GROUND	INPUT
	28	ANALYZER RX	DIGITAL	INPUT
	29	ANALYZER TX	DIGITAL	OUTPUT
	30	BATTERY VOLTAGE	BATTERY	VOLTAGE
	31	BATTERY VOLTAGE	BATTERY	VOLTAGE
	32	BATTERY VOLTAGE	BATTERY	VOLTAGE
	33	BATTERY VOLTAGE	BATTERY	VOLTAGE
	34	SWITCH POWER	BATTERY	VOLTAGE
	35	FULL FUEL LEVEL INDICATOR	LAMP	OUTPUT

Connector	Pin	Function	Type	
J1 (Natural)	1	TOWER LIFT UP	DIGITAL	INPUT
	2	TOWER LIFT DOWN	DIGITAL	INPUT
	3	TOWER TELESCOPE IN	DIGITAL	INPUT
	4	TOWER TELESCOPE OUT	DIGITAL	INPUT
	5	MAIN TELESCOPE IN	DIGITAL	INPUT
	6	MAIN TELESCOPE OUT	DIGITAL	INPUT
	7	PLATFORM ROTATE RIGHT	DIGITAL	INPUT
	8	PLATFORM ROTATE LEFT	DIGITAL	INPUT
	9	PLATFORM LEVEL UP	DIGITAL	INPUT
	10	PLATFORM LEVEL DOWN	DIGITAL	INPUT
	11	JIB UP	DIGITAL	INPUT
	12	JIB DOWN	DIGITAL	INPUT
	13	SPEED PUMP POTENTIOMETER GROUND	GROUND	INPUT
	14	ENGINE START	DIGITAL	INPUT
	15	AUXILIARY POWER	DIGITAL	INPUT
	16	CRAB STEER SELECT	DIGITAL	INPUT
	17	COORDINATED STEER SELECT	DIGITAL	INPUT
	18	SWITCH POWER	BATTERY	VOLTAGE
	19	NOT CONNECTED	DIGITAL	INPUT
	20	NOT CONNECTED	DIGITAL	INPUT
	21	NOT CONNECTED	DIGITAL	INPUT
	22	DRIVE ORIENTATION SYSTEM FAILURE ENABLE	DIGITAL	INPUT
	23	NOT CONNECTED	DIGITAL	INPUT
	24	NOT CONNECTED	DIGITAL	INPUT
	25	NOT CONNECTED	DIGITAL	INPUT
	26	NOT CONNECTED	DIGITAL	INPUT
	27	TWO SPEED VALVE (HIGH ENGINE)	DIGITAL	INPUT
	28	TORQUE MODE	DIGITAL	INPUT
	29	SOFT TOUCH OVERRIDE	DIGITAL	INPUT
	30	HEAD / TAIL LIGHT	DIGITAL	INPUT
	31	HORN	DIGITAL	INPUT
	32	CREEP MODE	DIGITAL	INPUT
	33	DUAL-FUEL SELECT	DIGITAL	INPUT
	34	SPEED PUMP POTENTIOMETER REFERENCE VOLTAGE	+7	VOLTAGE
	35	SPEED PUMP POTENTIOMETER	DIGITAL	INPUT

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Figure 6-15. Platform Control Module Pin Connections 1 of 2

Connector	Pin	Function	Type	
J8	1	MODULE GROUND	GROUND	OUTPUT
	2	MODULE POWER	VBAT	INPUT

Connector	Pin	Function	Type	
J5 (Natural)	1	LEFT / SWING JOYSTICK SUPPLY VOLTAGE	SUPPLY	VOLTAGE
	2	LIFT CENTER TAP	DIGITAL	INPUT
	3	LIFT SIGNAL	DIGITAL	INPUT
	4	SWING SIGNAL	DIGITAL	INPUT
	5	SWING CENTER TAP	DIGITAL	INPUT
	6	NOT CONNECTED	DIGITAL	INPUT
	7	LIFT / SWING JOYSTICK RETURN	GROUND	INPUT
	8	GROUND RETURN	GROUND	INPUT

Connector	Pin	Function	Type	
J6 (Black)	1	DRIVE / STEER JOYSTICK SUPPLY VOLTAGE	SUPPLY	VOLTAGE
	2	DRIVE CENTER TAP	DIGITAL	INPUT
	3	DRIVE SIGNAL	DIGITAL	INPUT
	4	STEER SIGNAL	DIGITAL	INPUT
	5	STEER LEFT	DIGITAL	INPUT
	6	STEER RIGHT	DIGITAL	INPUT
	7	DRIVE / STEER JOYSTICK RETURN	GROUND	INPUT
	8	GROUND RETURN	GROUND	INPUT

Connector	Pin	Function	Type	
J7 (Black)	1	GROUND MODE	DIGITAL	INPUT
	2	PLATFORM EMS	DIGITAL	OUTPUT
	3	PLATFORM EMS TO GROUND MODULE	DIGITAL	OUTPUT
	4	FOOTSWITCH (FUNCTION ENABLE SWITCH) POWER	BATTERY	VOLTAGE
	5	GENERATOR SWITCH POWER	BATTERY	VOLTAGE
	6	JIB BLOCK LIMIT SWITCH POWER	BATTERY	VOLTAGE
	7	SOFT TOUCH LIMIT SWITCH POWER	BATTERY	VOLTAGE
	8	FOOTSWITCH SIGNAL	DIGITAL	INPUT
	9	GENERATOR ON SIGNAL	DIGITAL	INPUT
	10	+7 REFERENCE VOLTAGE	+7	VOLTAGE
	11	LOAD CELL INPUT 1	ANALOG	INPUT
	12	LOAD CELL INPUT 2	ANALOG	INPUT
	13	NOT CONNECTED	ANALOG	INPUT
	14	GROUND RETURN	GROUND	INPUT
	15	LOAD CELL REFERENCE VOLTAGE	+7	VOLTAGE
	16	LOAD CELL RETURN	GROUND	INPUT
	17	JIB BLOCK LIMIT SWITCH	HS DIGITAL	INPUT
	18	SOFT TOUCH LIMIT SWITCH	HS DIGITAL	INPUT
	19	PLATFORM ALARM	LAMP	OUTPUT
	20	ALARM RETURN	GROUND	INPUT
	21	PLATFORM LEVEL UP	DIGITAL	OUTPUT
	22	PLATFORM LEVEL DOWN	DIGITAL	OUTPUT
	23	GROUND RETURN	GROUND	INPUT
	24	GROUND RETURN	GROUND	INPUT
	25	JIB UP	ME DIGITAL	OUTPUT
	26	JIB DOWN	ME DIGITAL	OUTPUT
	27	NOT CONNECTED	ME DIGITAL	OUTPUT
	28	NOT CONNECTED	ME DIGITAL	OUTPUT
	29	GROUND RETURN	GROUND	INPUT
	30	CAN LOW	DIGITAL	OUPUT
	31	CAN HIGH	DIGITAL	OUTPUT
	32	CAN SHIELD	DIGITAL	OUTPUT
	33	PLATFORM ROTATE LEFT	ME DIGITAL	OUTPUT
	34	PLATFORM ROTATE RIGHT	ME DIGITAL	OUTPUT
	35	GROUND RETURN	GROUND	INPUT

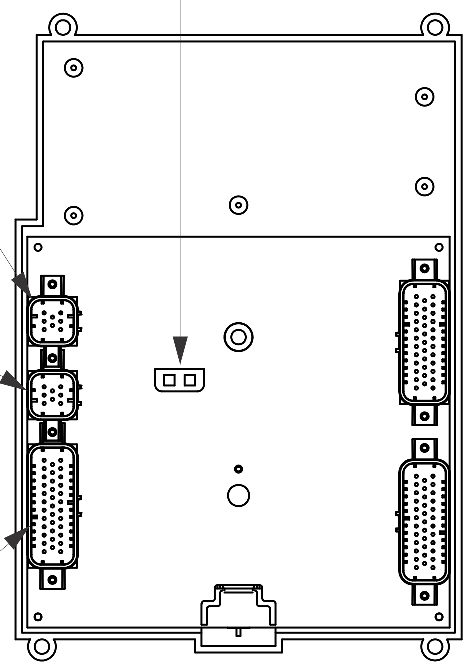

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Figure 6-16. Platform Control Module Pin Connections 2 of 2

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

"Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read voltage applied to a solenoid when it is only operational while a switch, far from the solenoid and meter, is held down.

Polarity

Getting a negative Voltage or current reading when expecting a positive reading frequently means the leads are reversed. Check what reading is expected, location of the signal and leads are correctly connected to the device under test. Also check the lead on the "COM" port goes to the ground or negative side of the signal and lead on the other port goes to the positive side of the signal.

Scale

M = Mega = 1,000,000 * (Displayed Number)

k = kilo = 1,000 * (Displayed Number)

m = milli = (Displayed Number) / 1,000

μ = micro = (Displayed Number) / 1,000,000

Example: 1.2 kΩ = 1200 Ω
Example: 50 mA = 0.05 A

Voltage Measurement

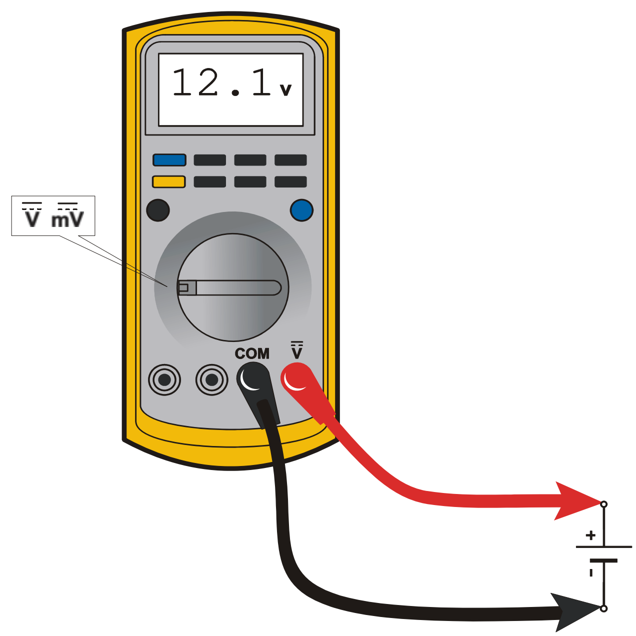


Figure 7-1. Voltage Measurement (DC)

- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)
- Use firm contact with meter leads

Resistance Measurement

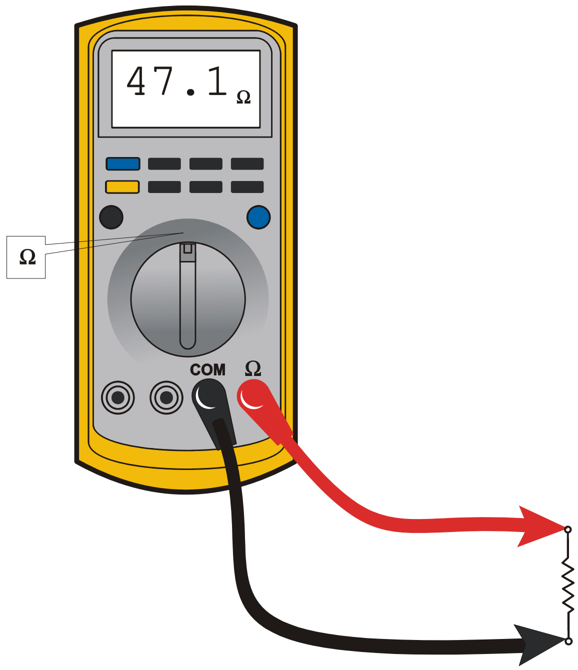


Figure 7-2. Resistance Measurement

- First test meter and leads by touching leads together. Resistance should read a short circuit (very low resistance)
- Circuit power must be turned OFF before testing resistance
- Disconnect component from circuit before testing
- If meter is not auto ranging, set it to the correct range (See multimeter's operation manual)
- Use firm contact with meter leads

Continuity Measurement

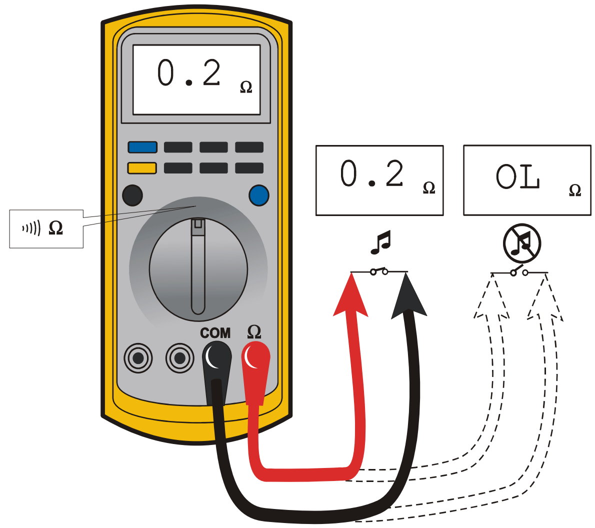


Figure 7-3. Continuity Measurement

- Some meters require a separate button press to enable audible continuity testing
- Circuit power must be turned OFF before testing continuity
- Disconnect component from circuit before testing
- Use firm contact with meter leads
- First test meter and leads by touching leads together. Meter should produce an audible alarm, indicating continuity

Current Measurement

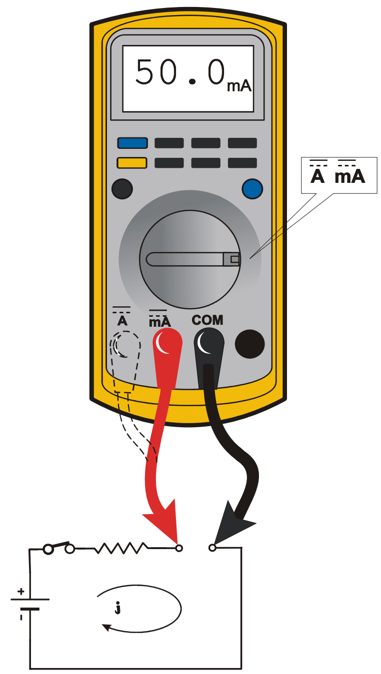


Figure 7-4. Current Measurement (DC)

- Set up meter for expected current range
- Be sure to connect meter leads to correct jacks for selected current range
- If meter is not auto ranging, set it to correct range (See multi meter's operation manual)
- Use firm contact with meter leads

7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

NOTE: *This section is not applicable for battery terminals.*

NOTICE

JLG P/N 0100048 DIELECTRIC GREASE (NOVAGARD G661) IS THE ONLY MATERIAL APPROVED FOR USE AS A DIELECTRIC GREASE.

NOTE: *Do NOT apply dielectric grease to the following connections:*

- Main Boom Rotary sensor connections (on Celesco Sensor),
- LSS Modules connections,
- Deutz EMR 2 ECM connection.

Silicone Dielectric Compound must be used on all electrical connections except for those mentioned above for the following reasons:

- To prevent oxidation at mechanical joint between male and female pins.
- To prevent electrical malfunction caused by low level conductivity between pins when wet.

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors. This procedure applies to all plug connections not enclosed in a box. Silicone grease should not be applied to connectors with external seals.

1. To prevent oxidation, silicone grease must be packed completely around male and female pins on the inside of the connector prior to assembly. This is most easily achieved by using a syringe.

NOTE: *Over a period of time, oxidation increases electrical resistance at the connection, eventually causing circuit failure.*

2. To prevent shorting, silicone grease must be packed around each wire where they enter the outside of the connector housing. Also, silicone grease must be applied at the joint where the male and female connectors come together. Any other joints (around strain reliefs, etc.) where water could enter the connector should also be sealed.

NOTE: *This condition is especially common when machines are pressure washed since the washing solution is much more conductive than water.*

3. Anderson connectors for battery boxes and battery chargers should have silicone grease applied to contacts only.

NOTE: *Curing-type sealants can also be used to prevent shorting and would be less messy, but make future pin removal difficult.*

When applied to electrical connections, dielectric grease helps prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from application of dielectric grease.

Dielectric grease shall be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

Dielectric Grease Application

Before following these instructions, refer to excluded connector types (See Exclusions below).

1. Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
2. Apply dielectric grease to the female contact (fill it approximately ½ full; see example below)
3. Leave a thin layer of dielectric grease on connector face.
4. Assemble connector system immediately to prevent moisture or dust contamination
5. Pierce one of the unused wire seals before assembly if the connector system tends to trap air (i.e. AMP Seal) and then install a seal plug.

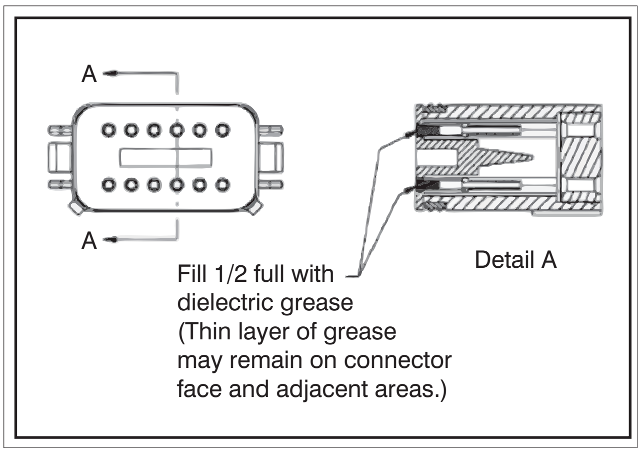


Figure 7-5. Applying Dielectric Grease

Deutsch HD, DT, DTM, DRC Series

The Deutsch connector system is commonly used for harsh environments. Follow installation instructions.

Figure 7-6. Deutsch Connector

AMP Seal

The AMP Seal connector system is used on Control ADE Platform and Ground Modules.

Apply dielectric grease to the female contact. If trapped air prevents connector from latching, pierce one of the unused wire seals.

Figure 7-7. Dielectric Grease On Female Contacts

After assembly, install a seal plug (JLG #4460905) to keep out moisture. Seal plugs may also be installed by the wire harness manufacturer if an unused wire seal was damaged during assembly.

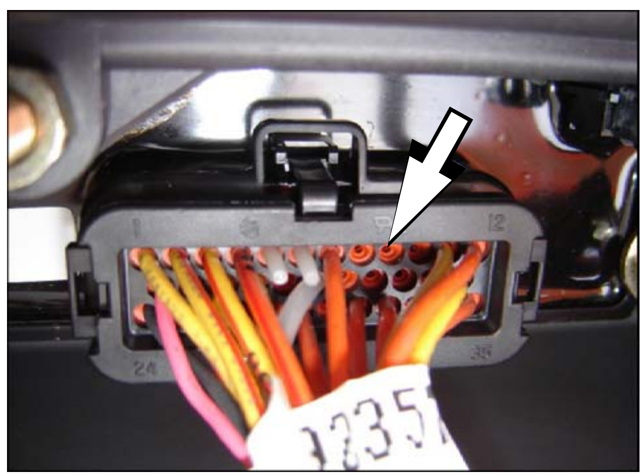


Figure 7-8. Seal Plugs

AMP Mate-N-Lok

Follow manufacturer installation instructions.

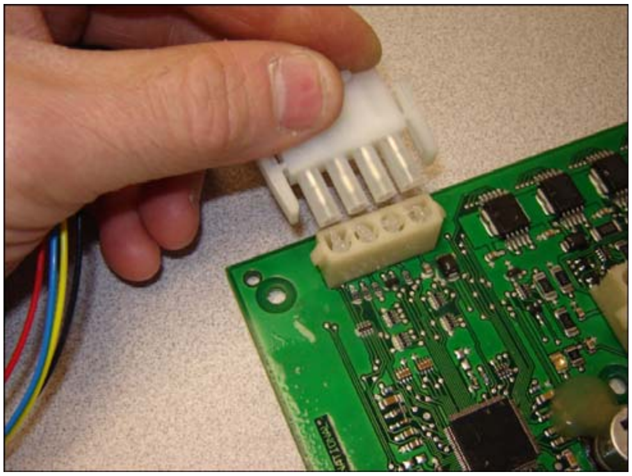


Figure 7-9. AMP Mate-N-Lok Connector

DIN Connectors

This connector is typically used on hydraulic valves. Follow manufacturer installation instructions.

Figure 7-10. DIN Connector

Exclusions

Some connectors do not require or may be permanently damaged by application of dielectric grease. Dielectric grease may not be required in properly sealed enclosures.

NOTICE

DO NOT USE DIELECTRIC GREASE ON BRAD HARRISON/PHOENIX CONTACT M12 OR AMP JUNIOR TIMER CONNECTORS. LOW-FORCE CONTACTS CANNOT DISPLACE DIELECTRIC GREASE AND CREATE ELECTRICAL CONTACT.

BRAD HARRISON/PHOENIX CONTACT M12

This connector uses gold contact material to resist corrosion and an O-ring seal for moisture integrity. Low-force contacts cannot displace dielectric grease to achieve electrical contact. Once contaminated, replacement of female contacts is required. The JLG Load Sensing System and 1250AJP Rotary Angle Sensors are examples of components with the M12 connector system.

Figure 7-11. Brad Harrison/Phoenix Connectors

AMP JUNIOR TIMER

This type of connector uses back-seals to keep out moisture. Low-force contacts cannot displace dielectric grease and create electrical contact. Use solvents (i.e. contact cleaner or mineral spirits) to remove dielectric grease. The Deutz EMR2 engine control module uses this connector.

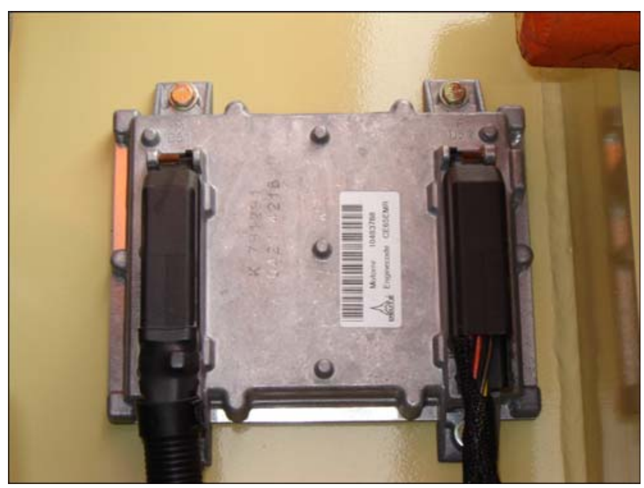


Figure 7-12. AMP Junior Timer

7.4 AMP CONNECTOR

Plug and header assembly colors are mechanically keyed to mate only with identical colors.

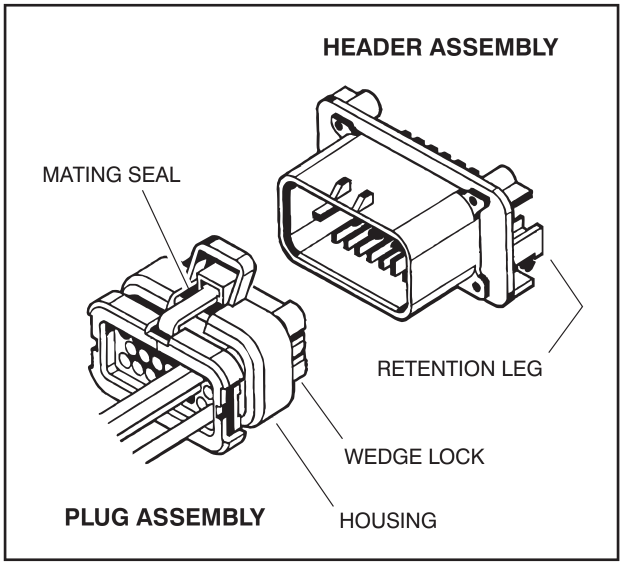


Figure 7-13. AMP Connector

Contact Assembly

1. Strip wire and install in crimp end of connector as shown in Figure 7-14.
2. Crimp connector. Do not damage cutoff tab.

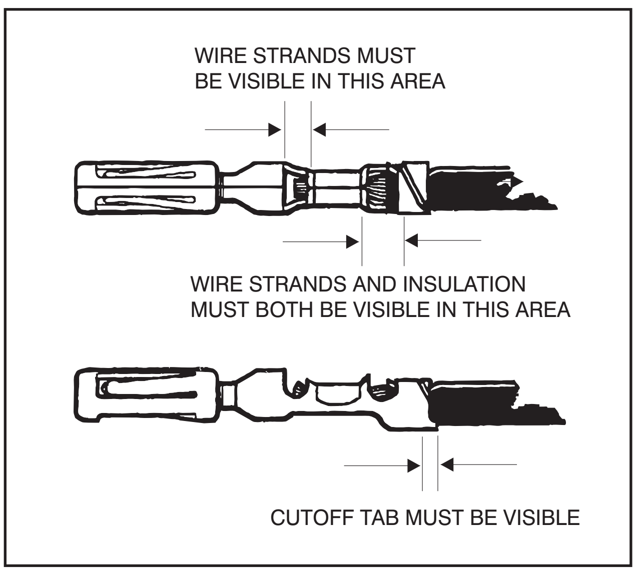


Figure 7-14. AMP Contact Assembly

Connector Assembly

1. Check wedge lock is in the open, or as-shipped, position.

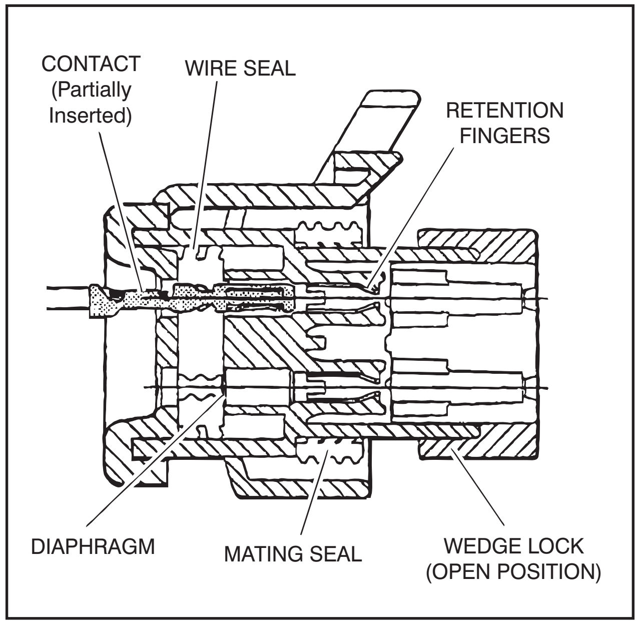


Figure 7-15. AMP Connector Assembly

2. Push contact straight into circuit cavity as far as it will go.
3. Pull on contact wire with a force of 1 - 2 lb to be sure retention fingers are holding contact.

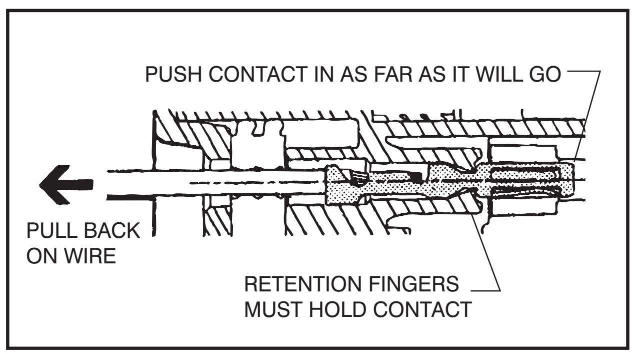


Figure 7-16. AMP Contact Installation

4. After all contacts are inserted, close wedge lock to its locked position. Release locking latches by squeezing them inward.

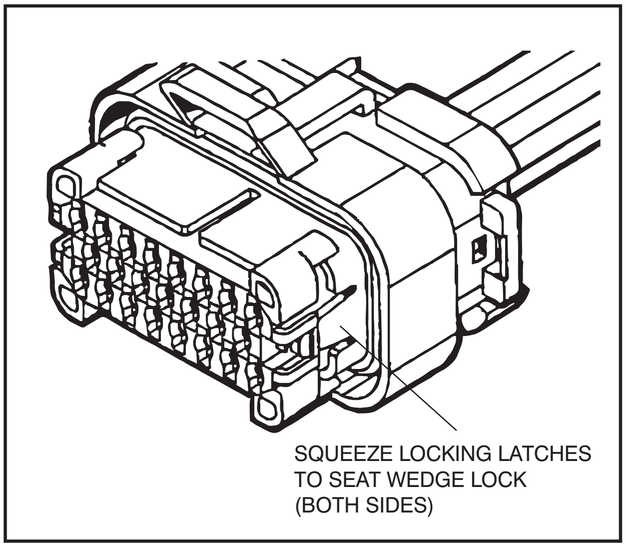


Figure 7-17. Close Wedge Lock

5. Slide wedge lock in housing until flush with housing.

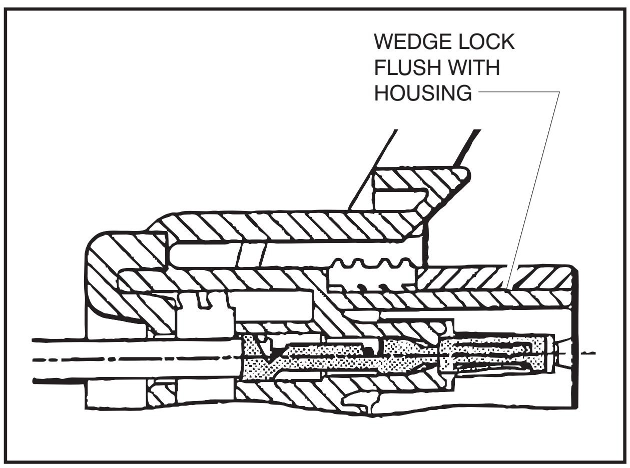


Figure 7-18. Seating Wedge Lock

Disassembly

1. Insert a 4.8 mm (3/16") wide screwdriver blade between mating seal and one of red wedge lock tabs.
2. Pry wedge lock open.
3. While rotating wire back and forth over a half turn (1/4 turn in each direction), gently pull wire until contact is removed.

NOTE: *Wedge lock should never be removed from housing for insertion or removal of contacts.*

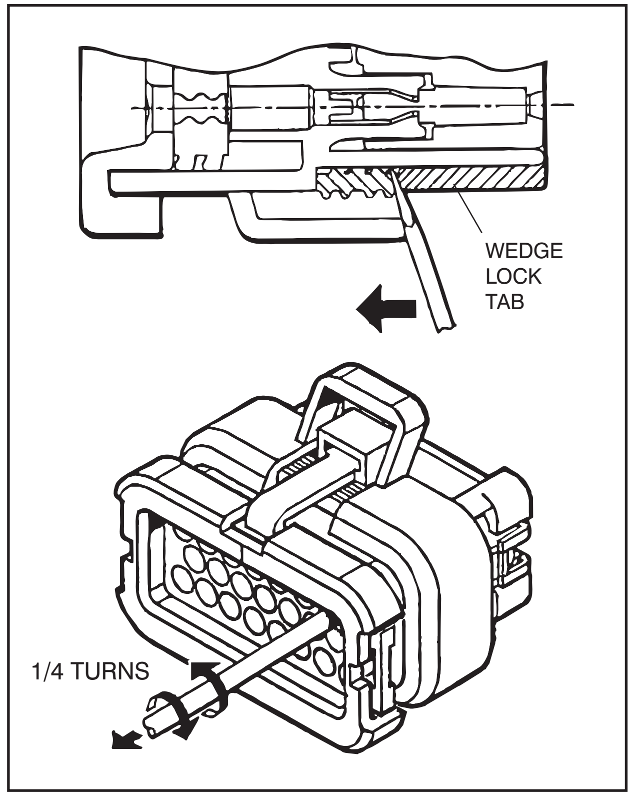


Figure 7-19. AMP Connector Disassembly

Wedge Lock

The wedge lock has slotted openings in the forward, or mating end. These slots accommodate circuit testing in the field by using a flat probe such as a pocket knife. DO NOT use a sharp point such as an ice pick.

Service - Voltage Reading

NOTICE

HOLES IN WIRE INSULATION CAN LET IN MOISTURE AND CAUSE SYSTEM FAILURE. DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing insulation with a sharp point. This practice should be discouraged when dealing with an AMPSEAL plug assembly or any other sealed connector system. Resulting pinholes in the insulation allows moisture to enter by traveling along wire strands and could result in system failure.

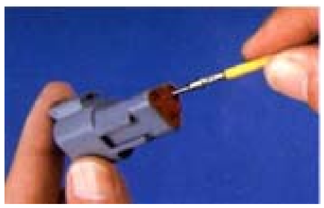
7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

1. Grasp crimped contact (1) about 25mm behind contact barrel.
2. Hold connector with rear grommet (2) facing you.
3. Push contact straight into connector grommet (3) until a click is felt. A slight tug confirms it is locked in place.
4. Once all contacts are in place, insert wedgelock (4) with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. They may go in either way.

NOTE: *Receptacle shown - use same procedure for plug.*


1


2


3


4

Figure 7-20. DT/DTP Contact Installation

DT/DTP Series Disassembly

1. Remove wedgelock (1) using needle-nose pliers or a hook shaped wire to pull wedge straight out.
2. To remove contacts, gently pull wire backwards at the same time releasing the locking finger (2) by moving it away from contact with a screwdriver.
3. Hold rear seal (3) in place. Removing contact may displace seal.


1

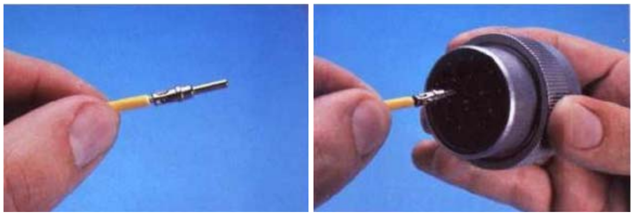

2


3

Figure 7-21. DT/DTP Contact Removal

HD30/HDP20 Series Assembly

1. Grasp contact (1) about 25mm behind contact crimp barrel.
2. Hold connector with rear grommet (2) facing you.



1 2

Figure 7-22. HD/HDP Contact Installation

3. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm it is locked in place.

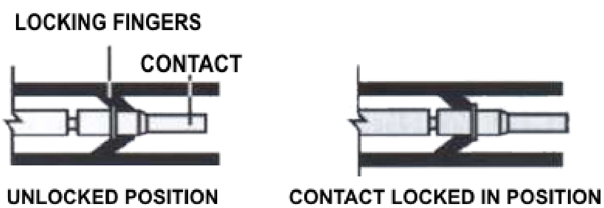


Figure 7-23. HD/HDP Locking Contacts Into Position

NOTE: *Insert sealing plugs in unused wire cavities for full environmental sealing.*

HD30/HDP20 Series Disassembly

1. With rear insert toward you, snap appropriate size extractor tool (1) over wire of contact to be removed.
2. Push tool in the insert cavity (2) until it engages contact and resistance is felt.

1 2

Figure 7-24. HD/HDP Contact Removal

3. Pull contact-wire assembly out of connector

NOTE: *Do Not twist or insert tool at an angle.*

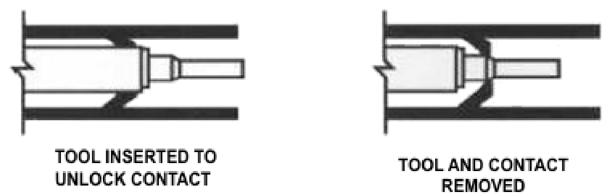


Figure 7-25. HD/HDP Unlocking Contacts

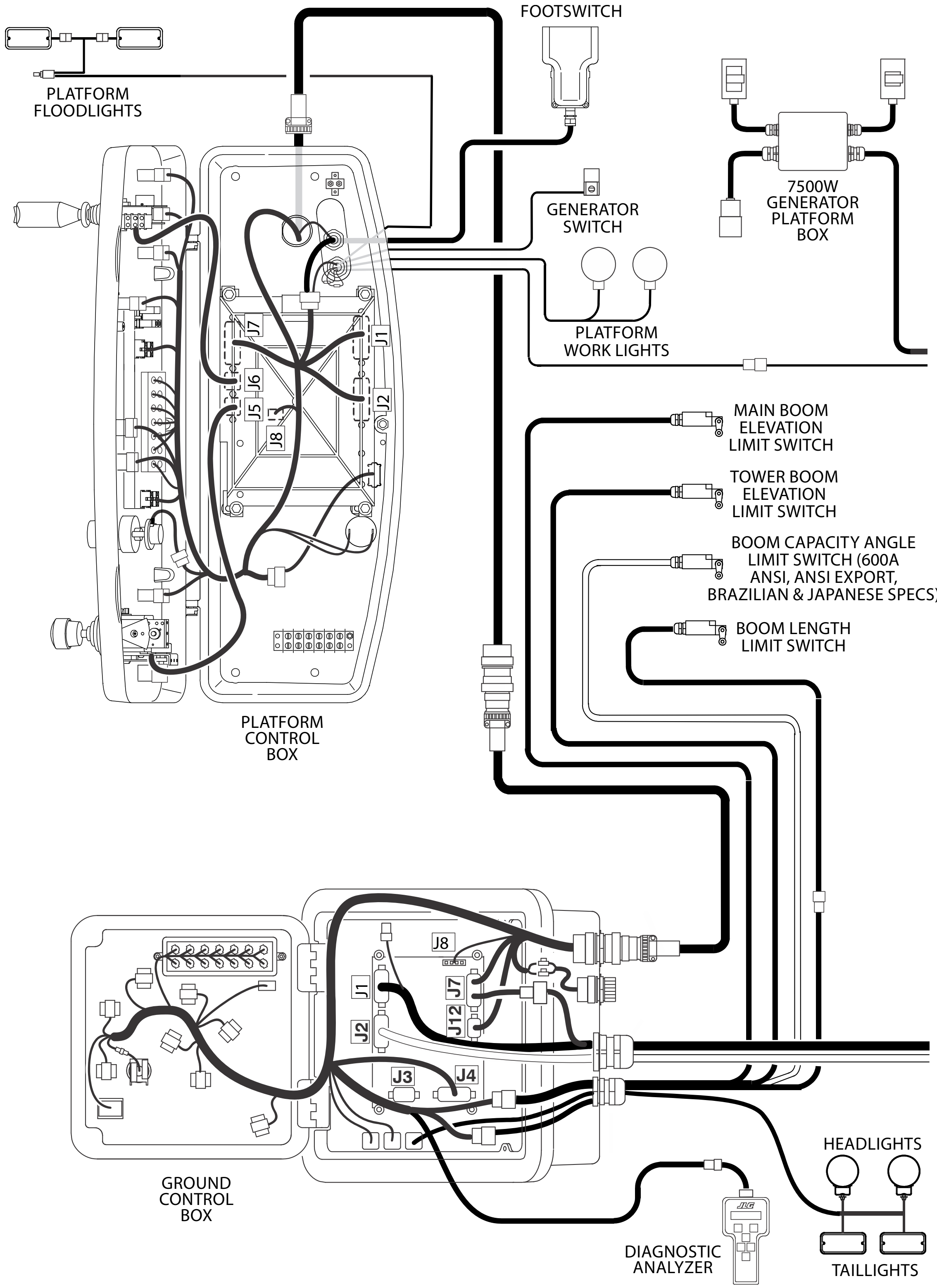


Figure 7-26. Electrical Components 1 of 2

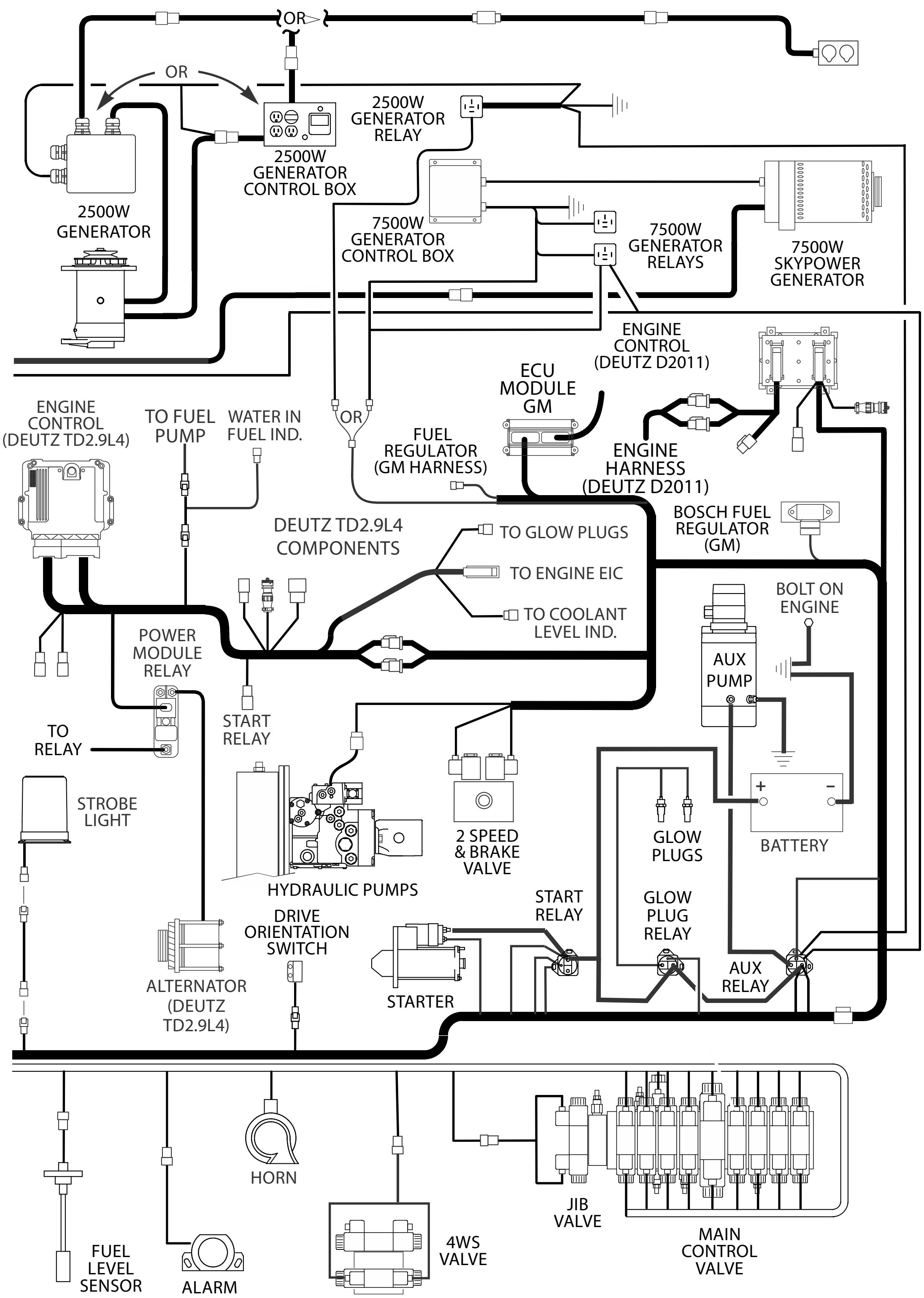


Figure 7-27. Electrical Components 2 of 2

7.6 ELECTRICAL SCHEMATICS

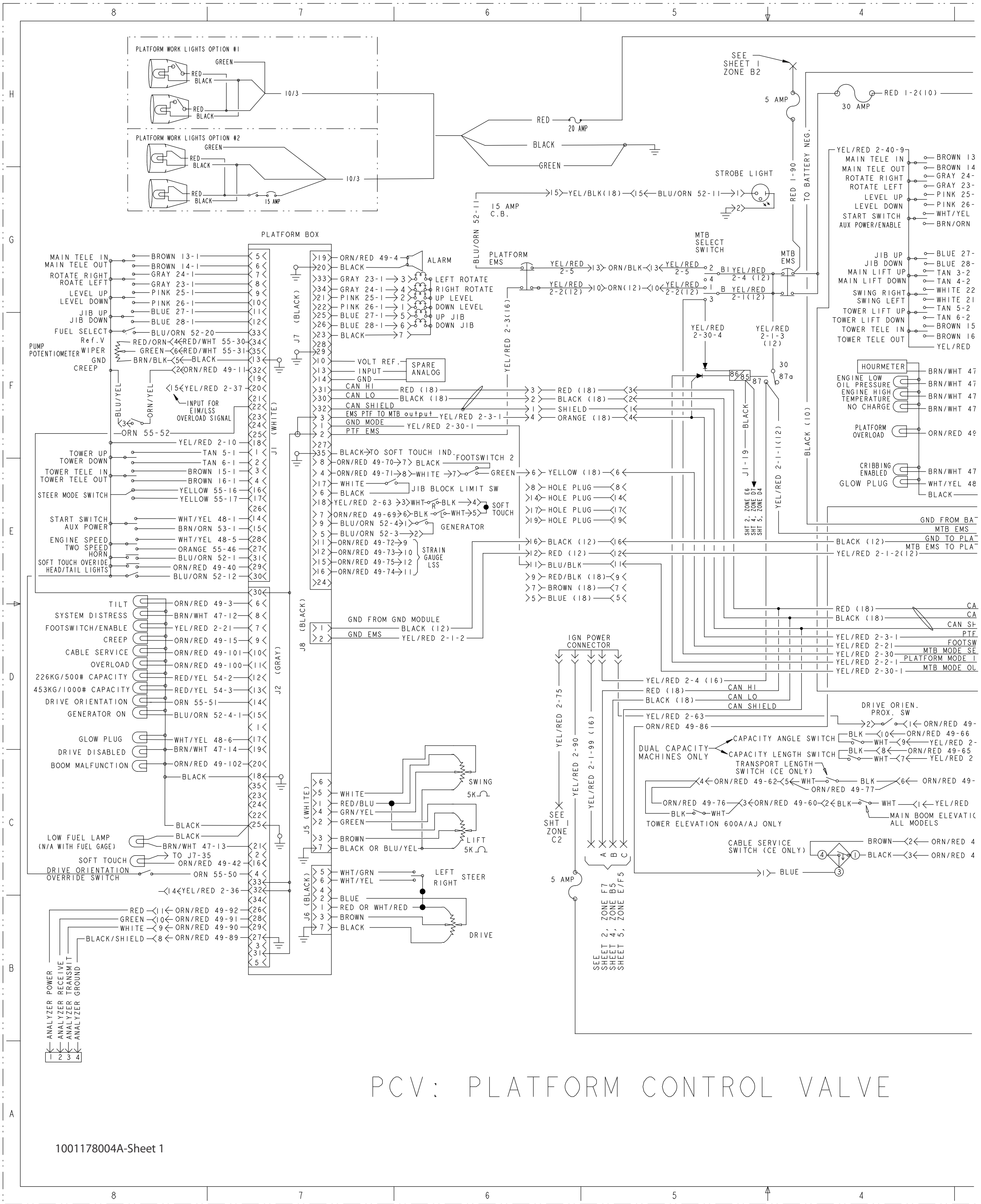


Figure 7-28. Platform and Ground Control Electrical Schematic - 1 of 2

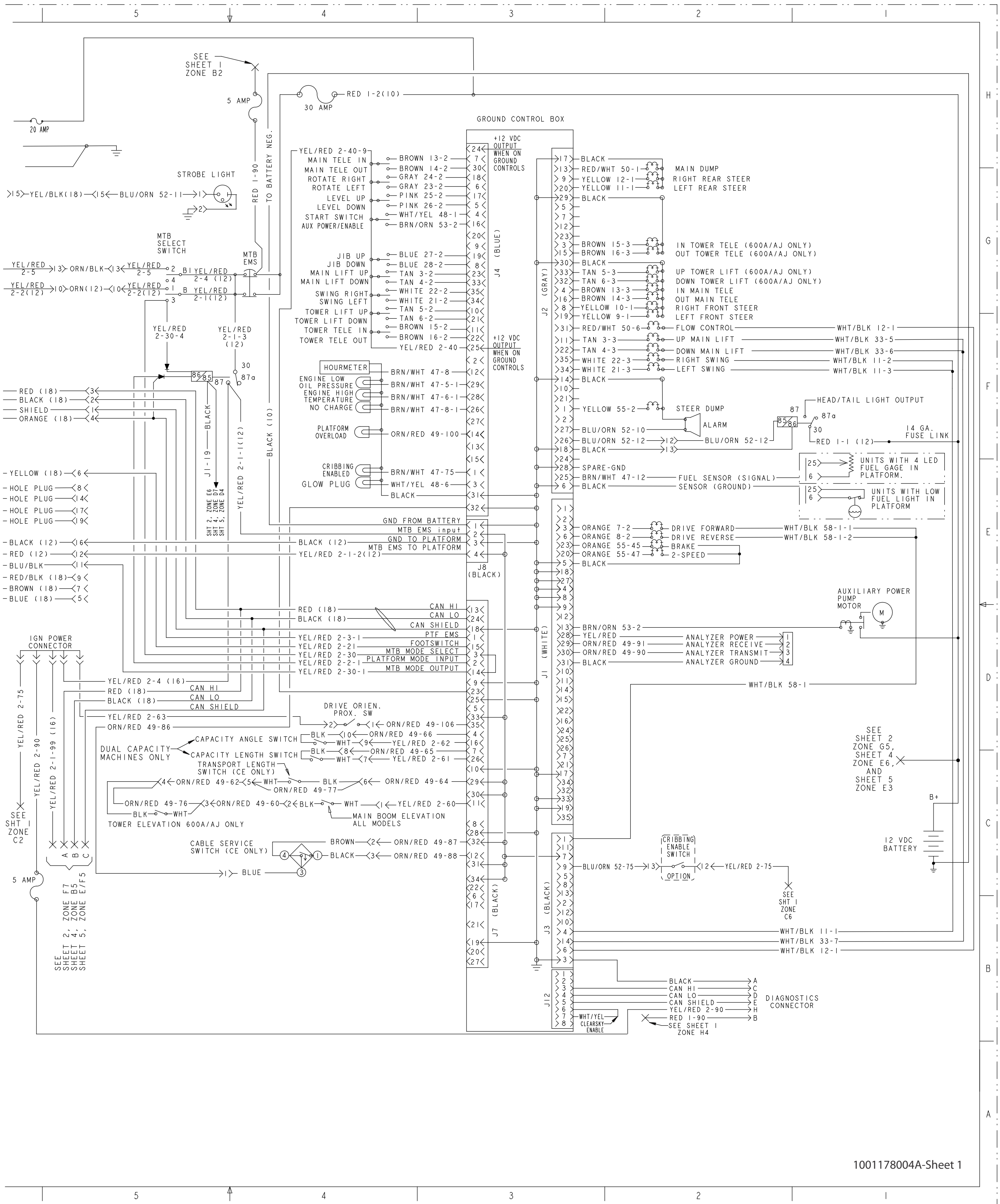


Figure 7-29. Platform and Ground Control Electrical Schematic - 2 of 2

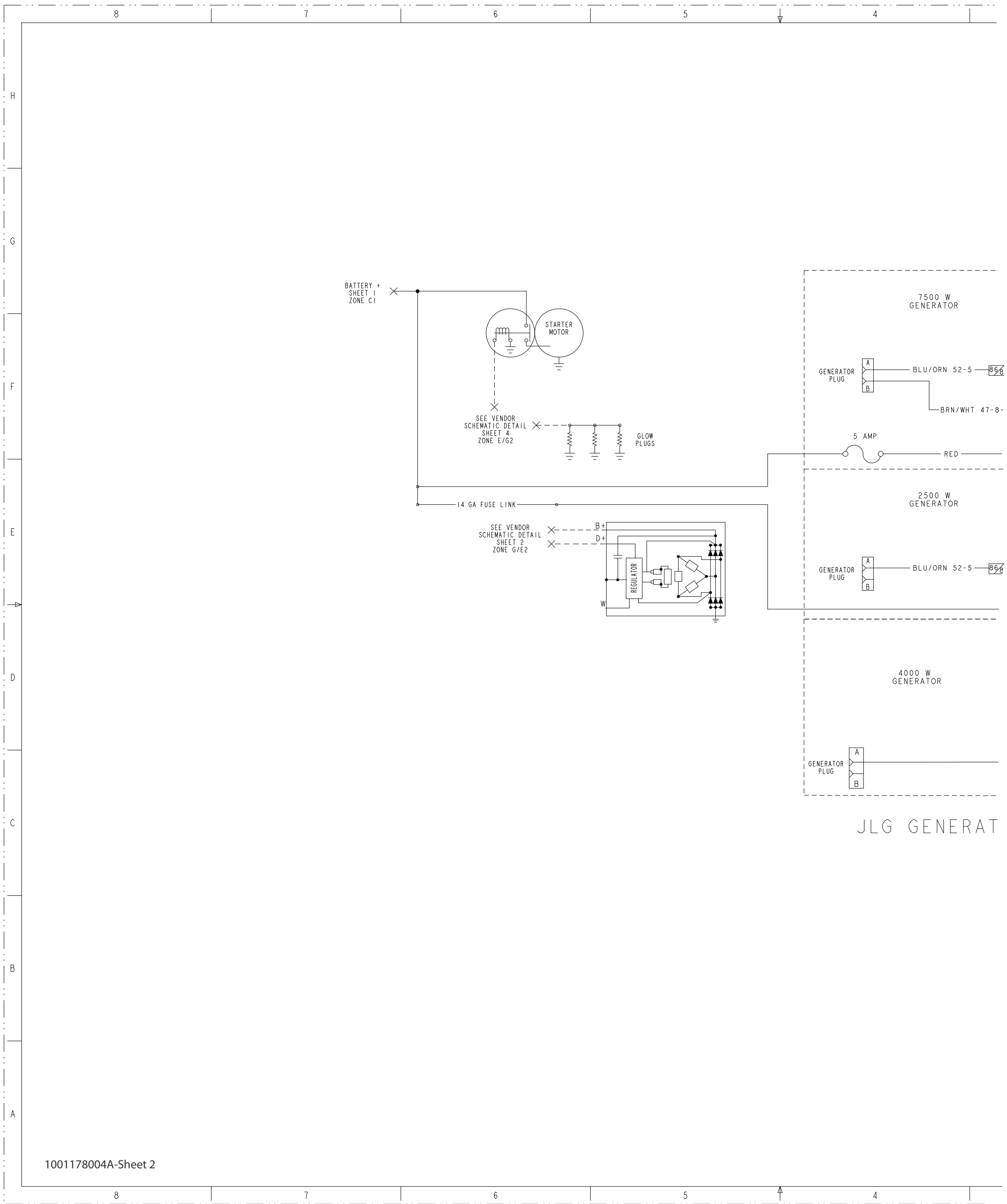


Figure 7-30. Generator Wiring Schematic 1 of 2

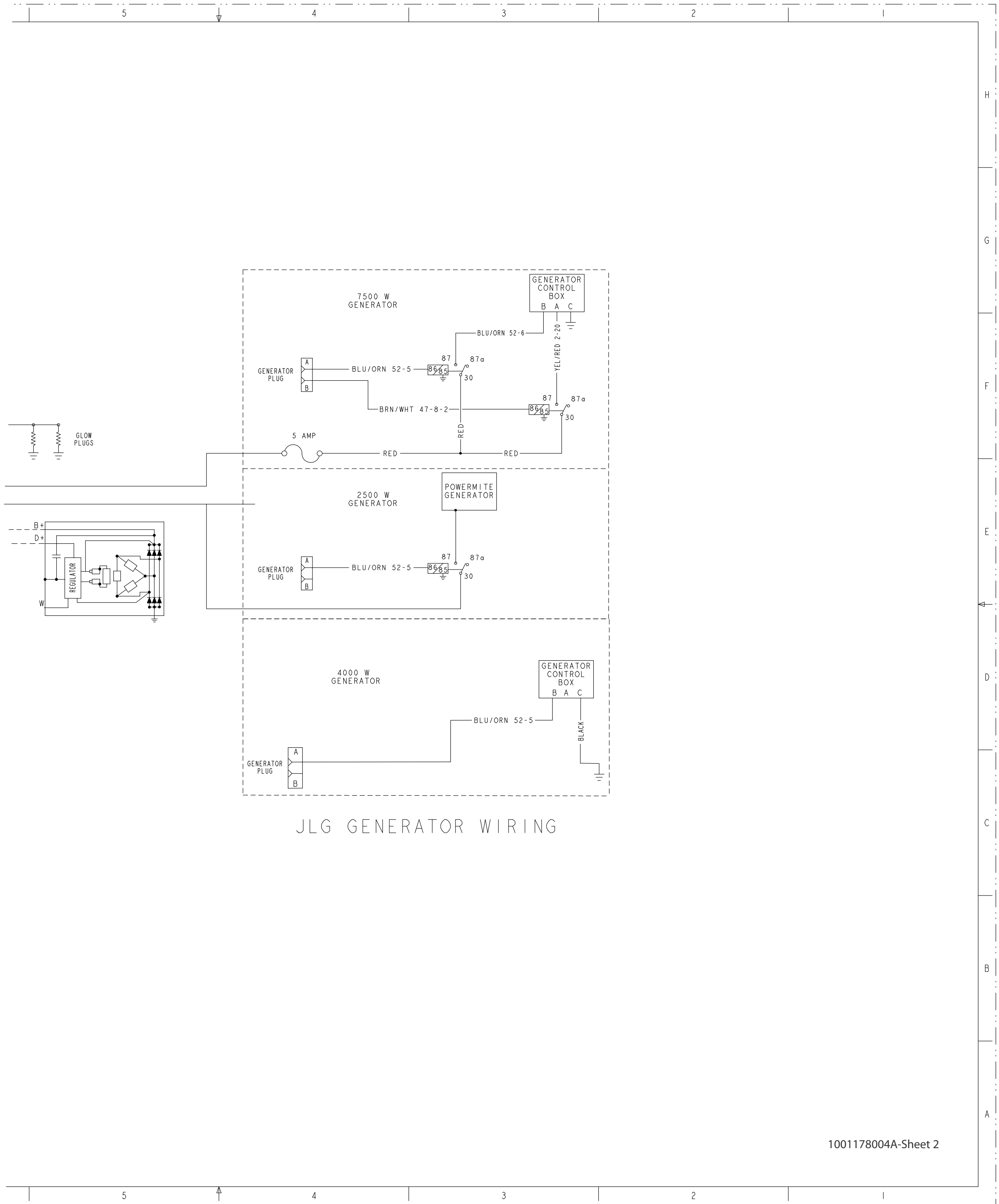


Figure 7-31. Generator Wiring Schematic 2 of 2

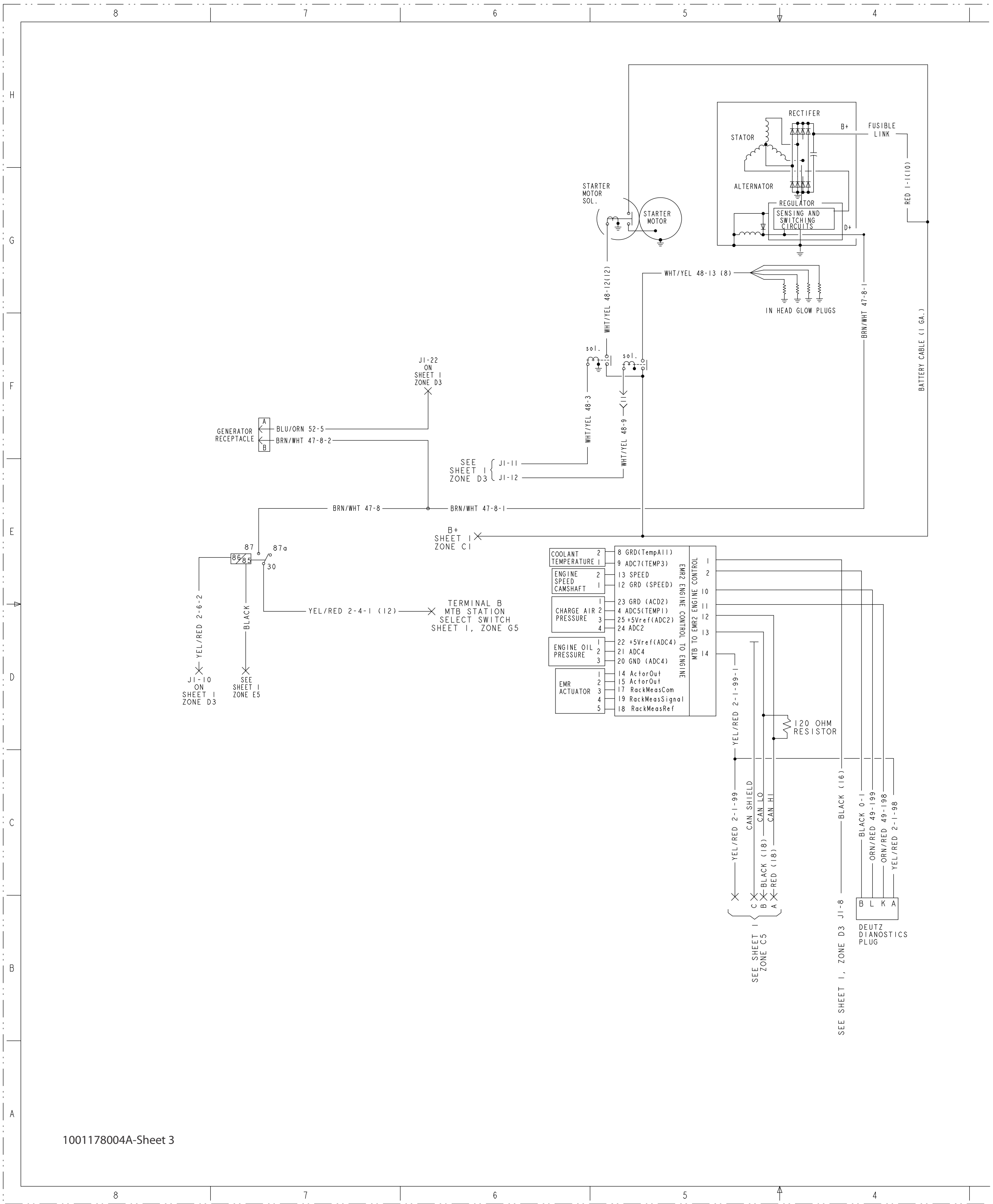


Figure 7-32. Deutz t4i Engine Harness Electrical Schematic

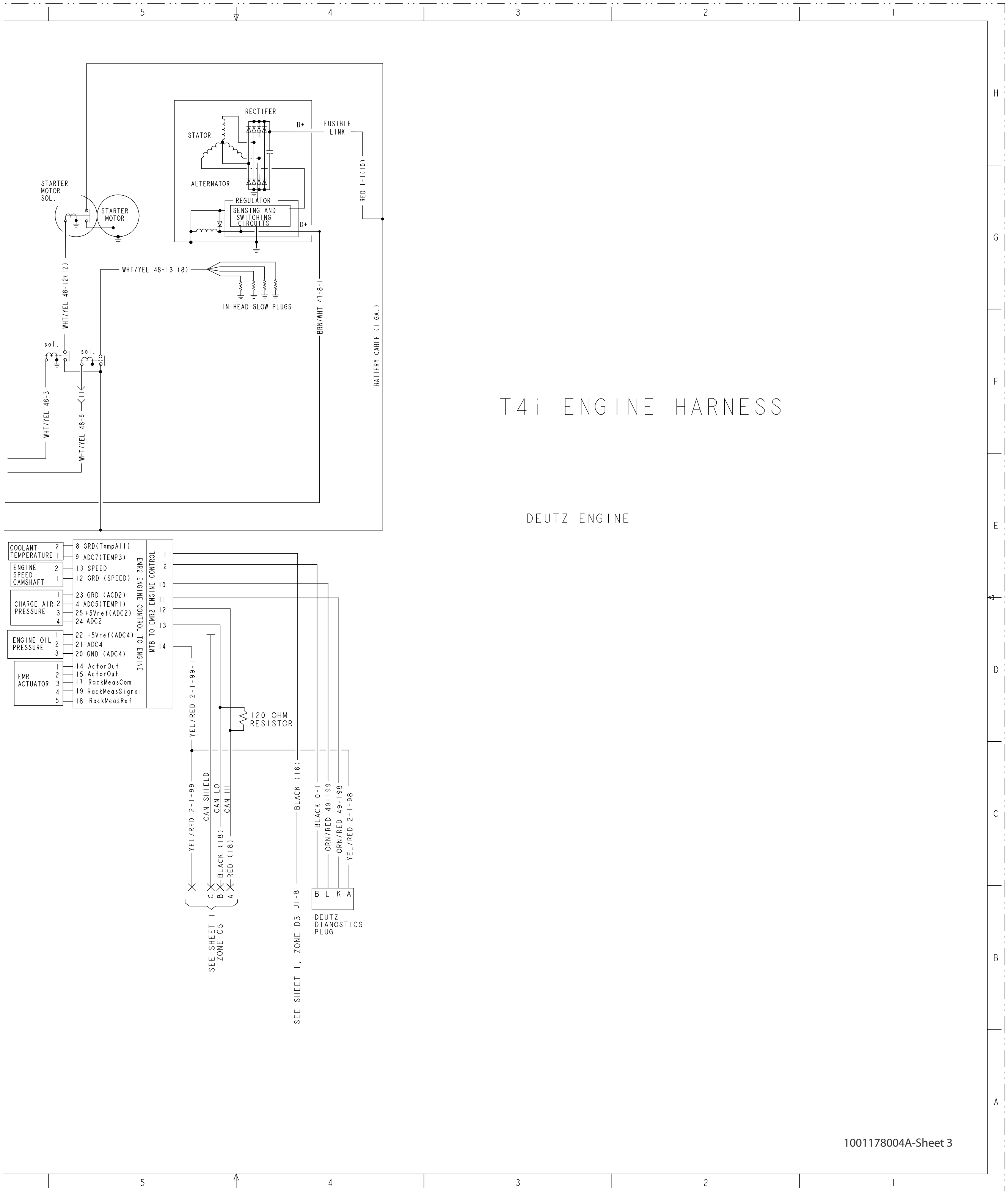


Figure 7-33. Deutz t4i Engine Harness Electrical Schematic

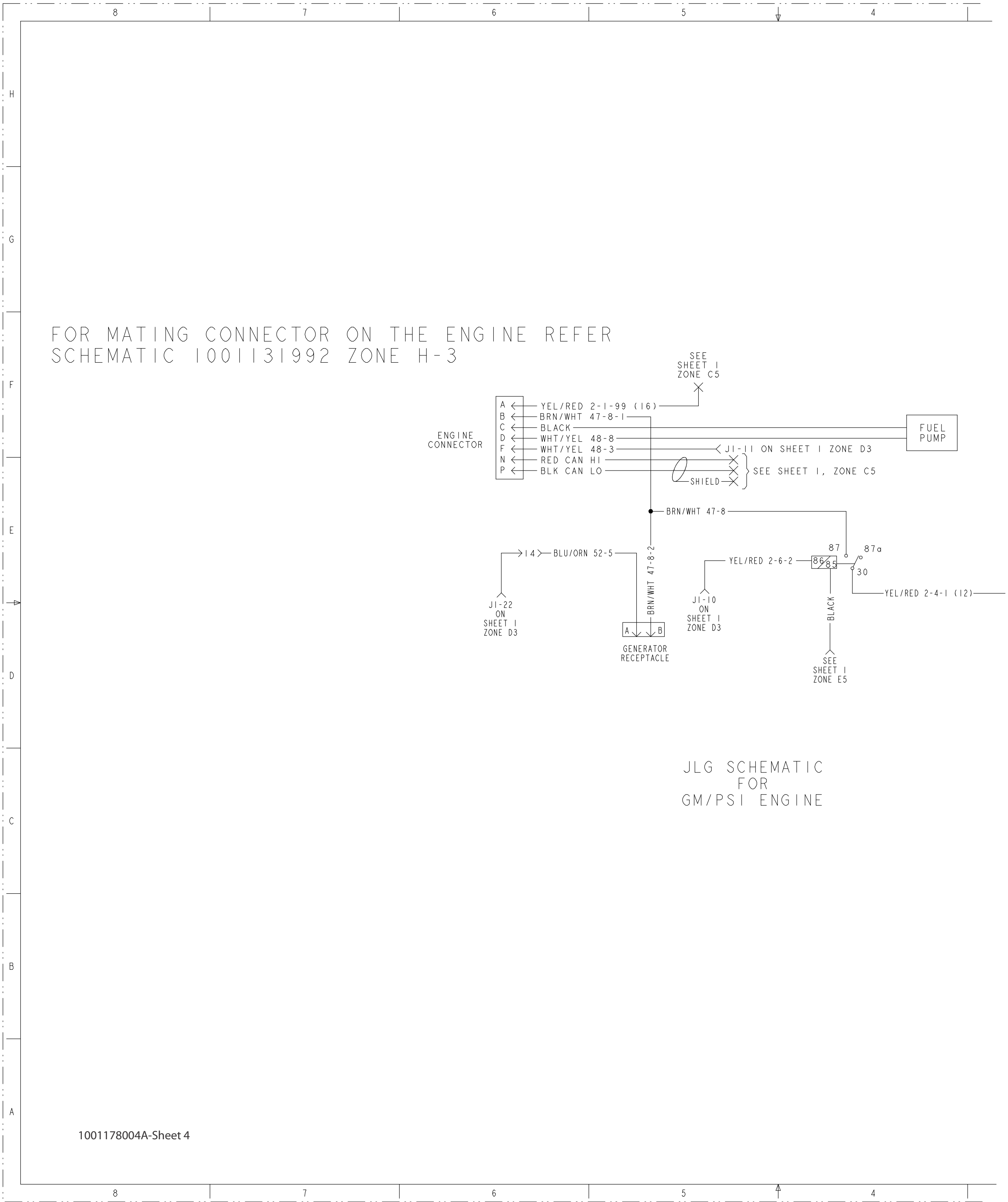


Figure 7-34. GM/PSI Engine Harness Electrical Schematic

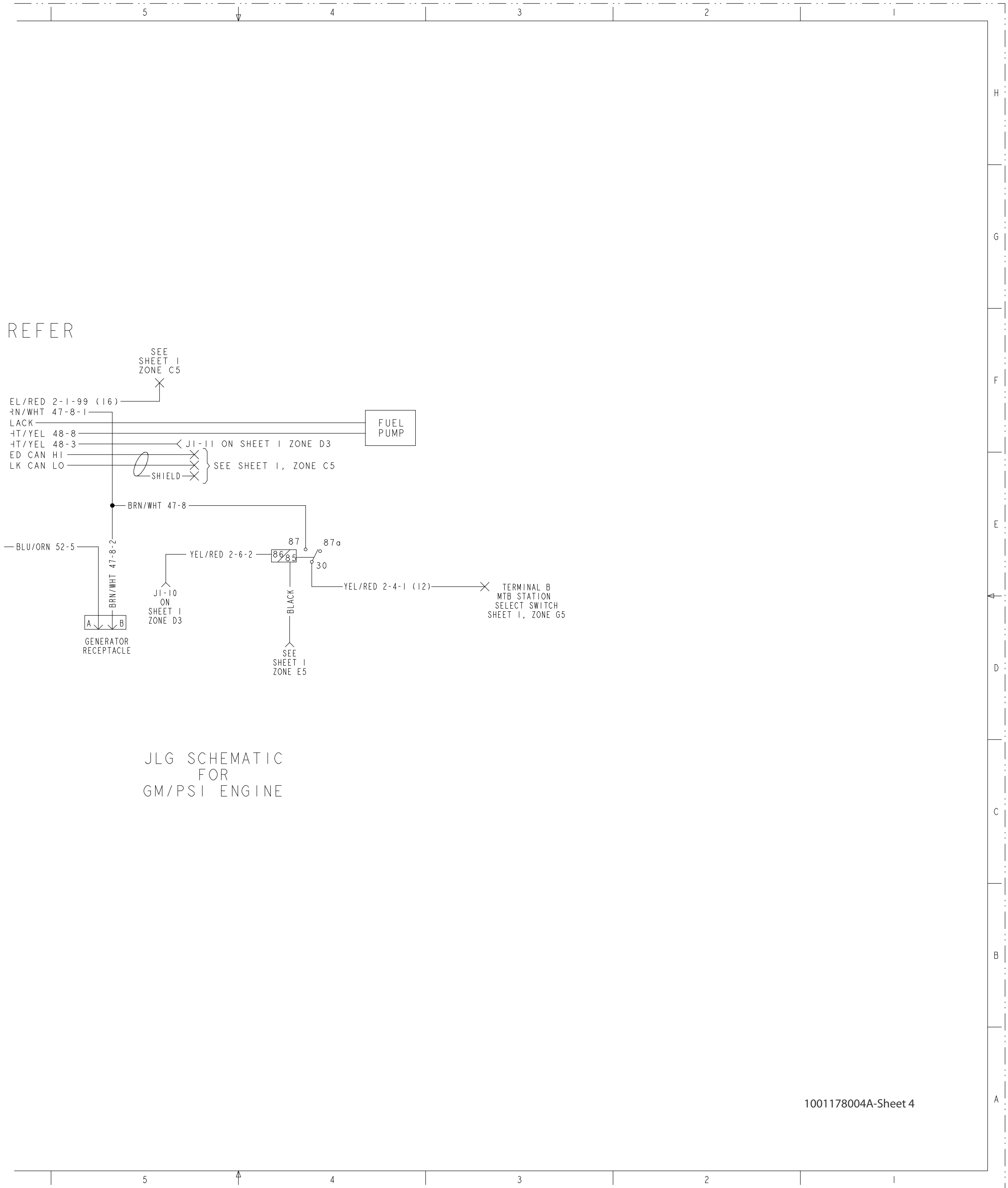


Figure 7-35. GM/PSI Engine Harness Electrical Schematic

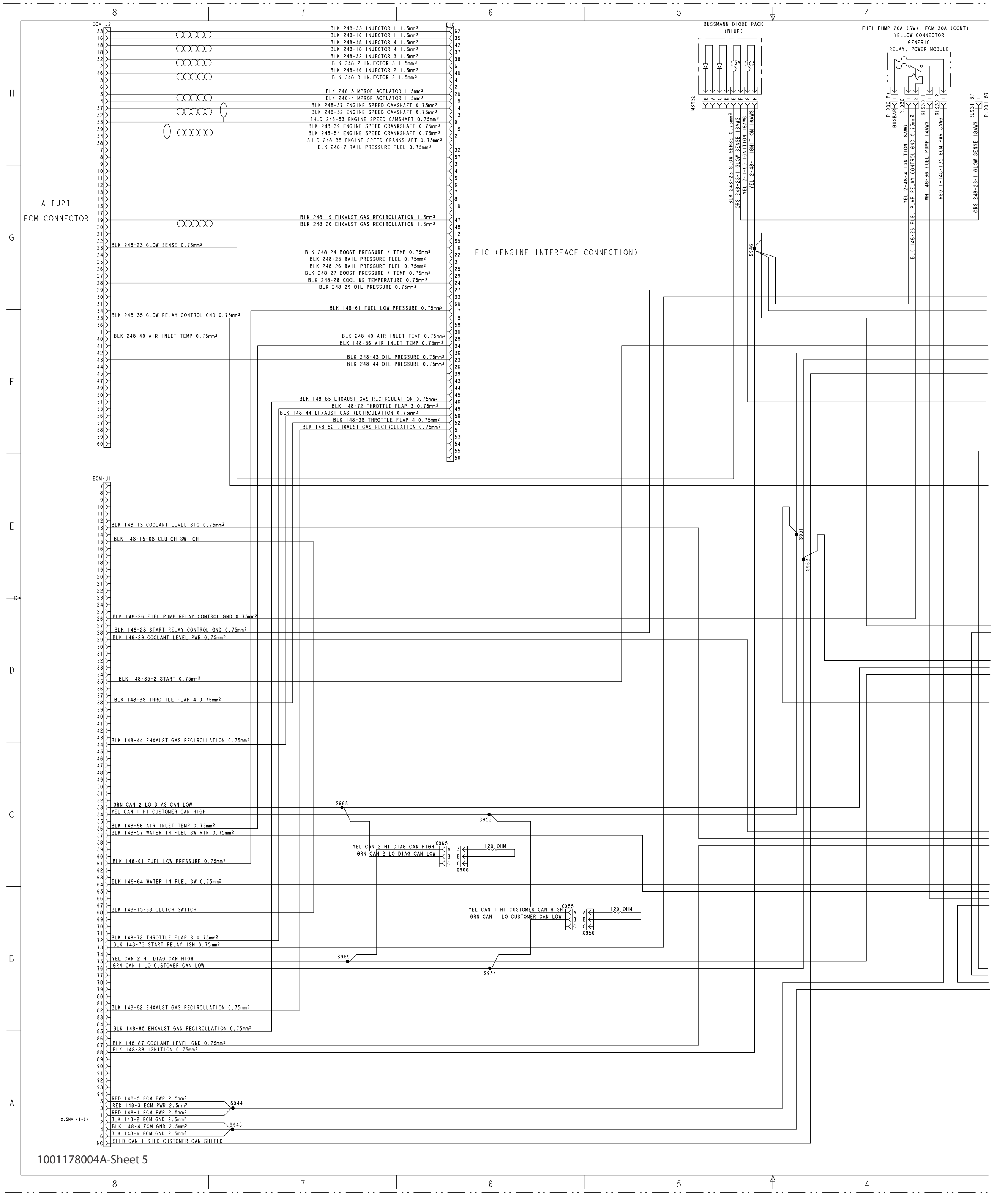


Figure 7-36. Deutz T4F Engine Harness Electrical Schematic

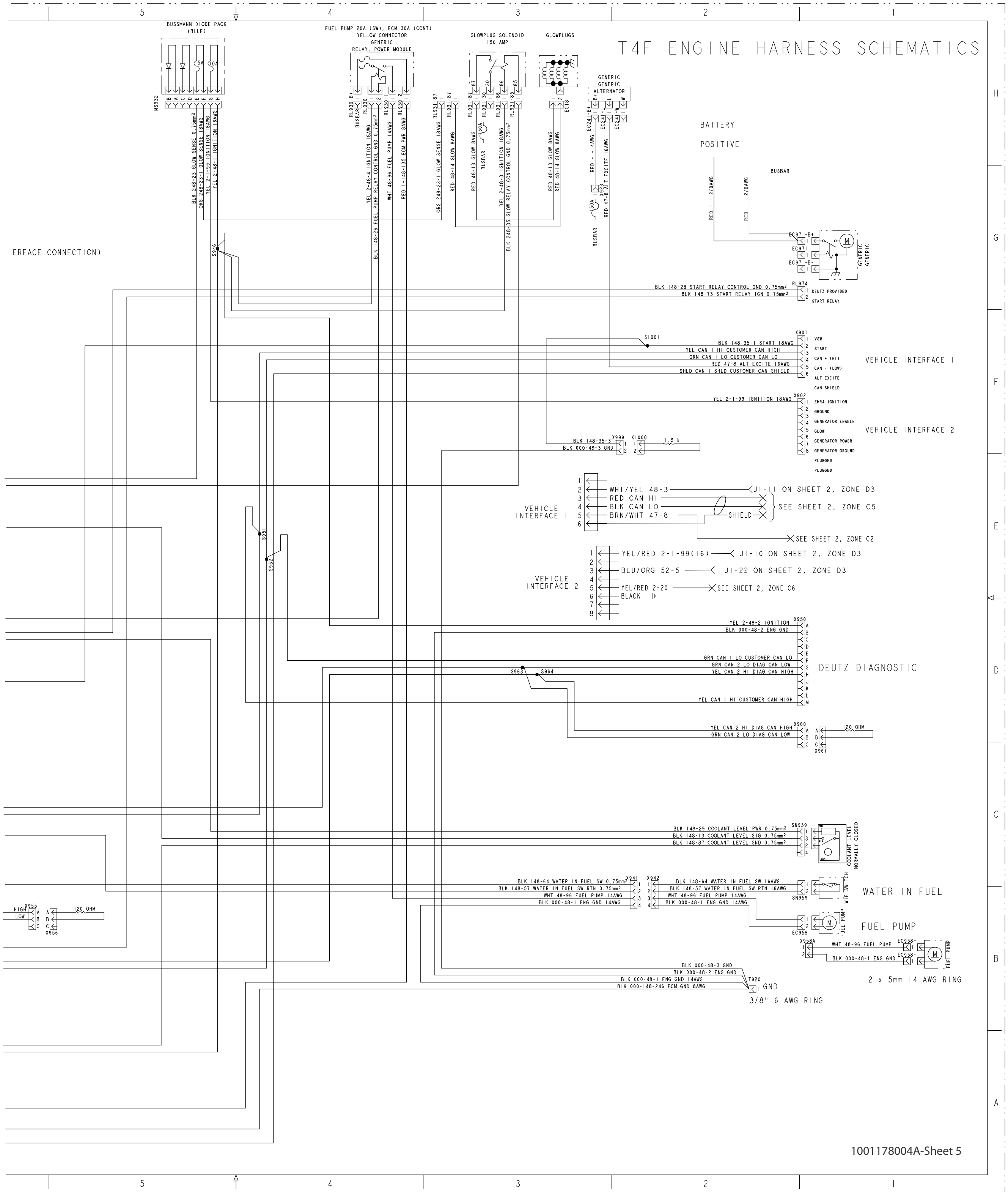


Figure 7-37. Deutz T4F Engine Harness Electrical Schematic

NOTES:

PROPOSITION 65 WARNING

- Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.
- Batteries also contain other chemicals known to the State of California to cause cancer.
- Wash hands after handling.

WARNING:

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

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