An Oshkosh Corporation Company

Service and Maintenance Manual

Model
510AJ

P/N - 3121181

August, 2014

ANSI

CE

An Oshkosh Corporation Company

SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

A GENERAL

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

⚠ WARNING

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

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

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

⚠ WARNING

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

B HYDRAULIC SYSTEM SAFETY

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

Relieve system pressure by cycling applicable control several times with the engine stopped and ignition on, to direct any line pressure back into the reservoir. Pressure feed lines to system components can then be disconnected with minimal fluid loss.

C MAINTENANCE

⚠ WARNING

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

- ENSURE REPLACEMENT PARTS OR COMPONENTS ARE IDENTICAL OR EQUIVALENT TO ORIGINAL PARTS OR COMPONENTS.
- NO SMOKING IS MANDATORY. NEVER REFUEL DURING ELECTRICAL STORMS. ENSURE THAT FUEL CAP IS CLOSED AND SECURE AT ALL OTHER TIMES.
- REMOVE ALL RINGS, WATCHES AND JEWELRY WHEN PERFORMING ANY MAINTENANCE.
- DO NOT WEAR LONG HAIR UNRESTRAINED, OR LOOSE-FITTING CLOTHING AND NECKTIES WHICH ARE APT TO BECOME CAUGHT ON OR ENTANGLED IN EQUIPMENT.
- OBSERVE AND OBEY ALL WARNINGS AND CAUTIONS ON MACHINE AND IN SERVICE MANUAL.
- KEEP OIL, GREASE, WATER, ETC. WIPED FROM STANDING SURFACES AND HAND HOLDS.
- USE CAUTION WHEN CHECKING A HOT, PRESSURIZED COOLANT SYSTEM.
- NEVER WORK UNDER AN ELEVATED BOOM UNTIL BOOM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR BOOM SAFETY PROP HAS BEEN ENGAGED.
- BEFORE MAKING ADJUSTMENTS, LUBRICATING OR PERFORMING ANY OTHER MAINTENANCE, SHUT OFF ALL POWER CONTROLS.
- BATTERY SHOULD ALWAYS BE DISCONNECTEDDURING 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 24, 2003
Revised	- March 12, 2003
Revised	- September 20, 2005
Revised	- March 16, 2007
Revised	- October 10, 2007
Revised	- January 5, 2011
Revised	- August 20, 2014

SECTION NO.	TITLE	PAGE NO.

SECTION NO.	TITLE	PAGE NO.

SECTION 3 - CHASSIS AND TURNTABLE

SECTION NO.	TITLE	PAGE NO.

FIGURE NO.	TITLE	PAGE NO.

FIGURE NO.	TITLE	PAGE NO.

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SECTION 1. SPECIFICATIONS

1.1 CAPACITIES

Table 1-1. Capacities

Fuel Tank	17 gallons (64.3 liters)
Hydraulic Tank	27 gallons (102 liters) 23.6 gal. (89 liters) to the Full line on the sight gauge

1.2 TIRES

Table 1-2. Tires

Size	Type	Pressure	Weight
12x16.5	Pneumatic	90 psi (6 Bar)	128 lbs. (58 kg)
12x16.5	Foam-Filled	N/A	328 lbs. (149 kg)
33/1550x16.5	Pneumatic	90 psi (6 Bar)	135 lbs. (61 kg)
33/1550x16.5	Foam-Filled	N/A	395 lbs. (179 kg)
14 x 16.1	Pneumatic	40 lbs. (3 bar)	91.5 lbs. (41.5 kg)
14 x 16.1	Foam-Filled	N/A	426 lbs. (193 kg)

1.3 ENGINE

NOTE: *RPM Tolerances are ± 100.*

Table 1-3. Caterpillar 3024/C2.2

Fuel	Diesel
No. of Cylinders	4
BHP	46.5 hp (34 kW)
Bore	3.307 in. (84 mm)
Stroke	3.9370 in. (112 mm)
Displacement	134.3 cu. in. (2.2L)
Oil Capacity	10 qt. (9.4 L)
Compression Ratio	19:1
Firing Order	1-3-4-2
Max. RPM	2800

Table 1-4. Deutz F3M2011F/D2011L03

Fuel	Diesel
No. of Cylinders	3
Bore	3.7 in. (94 mm)
Stroke	4.4 in. (112 mm)
Displacement	142 cu. in. (2331 cm^3)
Oil Capacity crankcase cooler total capacity	 6.3 quarts (6 L) 4.75 quarts (4.5 L) 11 quarts (10.5 L)
Low RPM	1200
Mid RPM Tower Lift, Upper Lift, Tele Swing, Basket Level, Basket Rotate, Jib Lift	 1800 1500
High RPM	2800

Table 1-5. Perkins 404C-22

Fuel	Diesel
No. of Cylinders	4
BHP	50 HP (37.3 kW)
Bore	3.3 in. (84 mm)
Stroke	3.9 in. (100 mm)
Firing Order	1-3-4-2
Displacement	135 cu.in. (2.2 L)
Oil Capacity w/filter	10 qt. (9.4 L)
Compression Ratio	23.3:1

1.4 SPECIFICATIONS AND PERFORMANCE DATA

Dimensional Data

Table 1-6. Dimensional Data

Overall Width	7.4 ft. (2.26 m)
Tailswing	0
Stowed Height	7.4 ft. (2.26 m)
Stowed Length	25.1 ft. (7.68 m)
Wheel base	7.67 ft. (2.34 m)
Turning Radius 6.5 ft. (2.0 m) 16.4 ft. (5.0 m)	 6.5 ft. (2.0 m) 16.4 ft. (5.0 m)
Track Width (12 x 16.5 tire) (33/1550 tire) (14 x 16.1 tire)	 65.3 in. (1.66 m) 66.3 in. (1.69 m) 66.6 in. (1.69 m)
Ground Clearance	1.18 ft. (0.36 m)

Reach Specifications

Table 1-7. Reach Specifications

Max. Platform Height	51.8 ft. (15.81 m)
Max. Horizontal Reach	31.1 ft. (9.48 m)
Up & Over Height	24.08 ft. (7.34 m)
Jib Length	4.5 ft. (1.37 m)
Jib Angle	135° (+70°, -65°)

Chassis

Table 1-8. Chassis Specifications

Swing	357° non-continuous
Platform Capacity	500 lbs. (230 kg)
Rated Gradeability	40%
Max. Tire Load	7900 lb. (3583 kg)
Max. Ground Bearing Pressure Std. Tire Flotation Tire	 48 psi (3.37 kg/cm^{2}) 36 psi (2.53 kg/cm^{2})
Axle Oscillation	8 in. (0.2 m)
Drive Speed	4.5 mph (7.2 kph)
System Voltage	12 Volts
Max. Hydraulic System Operating Pressure	4500 psi (310 bar)
Gross Machine Weight	16,104 lbs. (7305 kg)

1.5 FUNCTION SPEEDS

Table 1-9. Function Speeds (In Seconds)

Function	Speed
Main Lift Up	24-28
Main Lift Down	20-24
Swing Right & Left*	85-95
Telescope Out	18-22
Telescope In	12-16
Platform Rotate Right & Left**	25-32
Jib Up	21-31
Jib Down	19-25
Lower Lift Up	30-38
Lower Lift Down	22-28
Drive (4WD High Engine)	29-31 (4.5 MPH)
Drive above Horizontal (50 ft.)	46-68 (0.75 - 0.50 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 the Turntable to the end stop. Swing the Opposite Direction, Record Time.

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. Drive Select Switch should be set at 2WD High Engine. Start approximately 25 ft. (7.62 m) from starting point so that the unit is at maximum speed when starting the test. Results should be recorded 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 High Engine, High Drive. The Platform Speed Knob should be selected out of the 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 the opposite direction, Record Time. Rotate the other direction, Record Time.

Articulating Jib: Platform level and centered with the boom. Start with the 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.

Test Notes

1. Start Stop watch with function, not controller or switch.
2. Drive test results reflect 12x16.5 tires.
3. All speed tests are run from the platform. Speeds do not reflect ground control operation.
4. Platform speed knob control must be at full speed (turned clockwise completely).
5. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with oil temperature above 100° F (38° C).
6. Some flow control functions may not work with the speed knob clicked into creep position.

1.6 TORQUE REQUIREMENTS

Table 1-10. Torque Specification

Description	Torque Value	Interval Hours
Wheel Lugs	170 ft. lbs. (230 Nm)	150
Swing Bearing (Loctite)	240 ft. lbs. (325 Nm)	50/600*
Starter Solenoid Contacts Coil	 95 in. lbs. (9.5 Nm) 40 in. lbs. (4 Nm)	As required
Drive Hub to Axle	240 ft. lbs. (325 Nm)	As required
Drive Motor to Axle	120 ft. lbs. (163 Nm)	As required
*Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter.		

Table 1-11. Engine Torque Requirements

Description	Torque Value Ft. Lb.s	Torque Value Nm
Cylinder Head Cover	6	8.5
Cyinder Head Cover	6	8.5
Rocker Arm Adjustment Screw	15	21
Intake Manifold	6	8.5
Air Intake Pipe	15	21
Exhaust Manifold (F3M1011)	28.5	40
Exhaust Manifold (F3M2011)	16	22
Pump Coupling (dry)	26.5	37
Pump Coupling (Loctite #242)	28.5	40
Oil Drain Plug	39	55
Oil Pan (sheet metal)	15	21
Oil Pan (cast)	22	31
Injection Line Attachment	21	30
Injection Valve Attachment	15	21
Lube Oil Filter Cartridge	19	27

1.7 LUBRICATION

Hydraulic Oil

Table 1-12. 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 must have anti-wear qualities at least to API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service. JLG Industries recommends Mobilfluid 424 hydraulic oil, with an SAE viscosity index of 152.*

NOTE: *When temperatures remain consistently below 20 degrees F. (-7 degrees C.), JLG Industries recommends the use of Mobil DTE13.*

Aside from JLG recommendations, it is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. If use of hydraulic oil other than Mobilfluid 424 is desired, contact JLG Industries for proper recommendations.

Table 1-13. Mobilfluid 424 Specs

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 1-14. Mobil DTE 13M Specs

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

Table 1-15. UCon Hydrolube HP-5046

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

Table 1-16. Mobil EAL H 46 Specs

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 1-17. 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

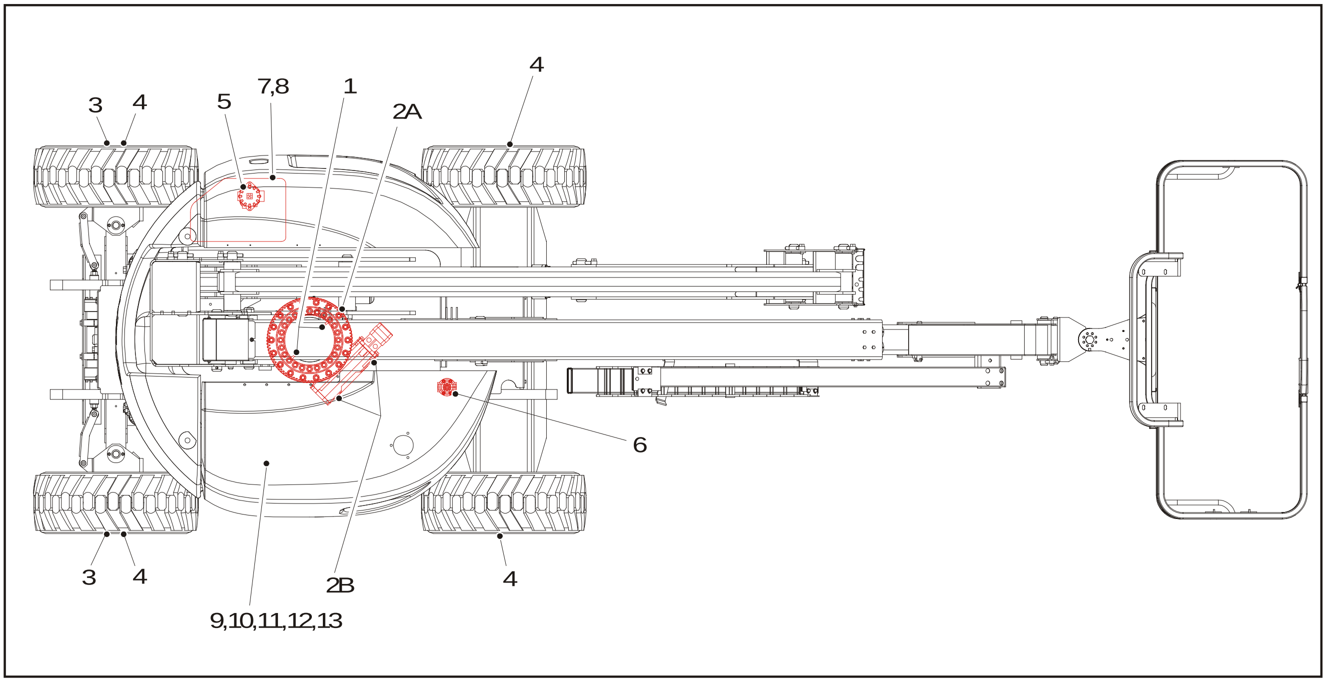


Figure 1-1. Operator Maintenance and Lubrication Diagram

1.8 OPERATOR MAINTENANCE

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

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. Mobilfluid 424.
EO	Engine (crankcase) Oil. Gas - API SF, SH, SG class, MIL-L-2104. Diesel - API CC/CD class, MIL-L-2104B/MIL-L-2104C.
OGL	Open Gear Lubricant - Mobiltac 375 or equivalent.

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.

NOTE: *It is recommended as a good practice to replace all filters at the same time.*

1. Swing Bearing - Internal Ball Bearing

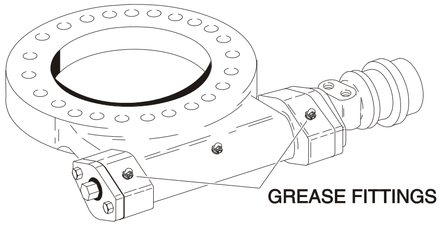
   Lube Point(s) - 2 Grease Fittings
   Capacity - A/R
   Lube - MPG
   Interval - Every 3 months or 150 hrs of operation

2. A. Swing Bearing - Teeth

   Lube Point(s) - Spray On
   Capacity - A/R
   Lube - OGL
   Interval - Every 3 months or 150 hrs of operation
   Comments - More frequent lubrication intervals may be required

   B. End Bearings - Worm Gear*

   Lube Point(s) - 2 Grease Fittings
   Capacity - A/R
   Lube - MPG
   Interval - Every 2 years or 1200 hrs of operation
   Comments - Remove grease fittings and install plugs after greasing

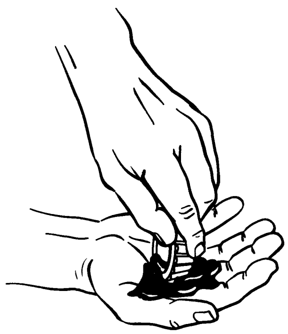


*If necessary install grease fittings into worm gear housing and grease bearings.

CAUTION

DO NOT OVER-GREASE END BEARINGS. OVER-GREASING BEARINGS WILL BLOW OUTER SEAL IN HOUSING.

3. Wheel Bearings (2WD Only)

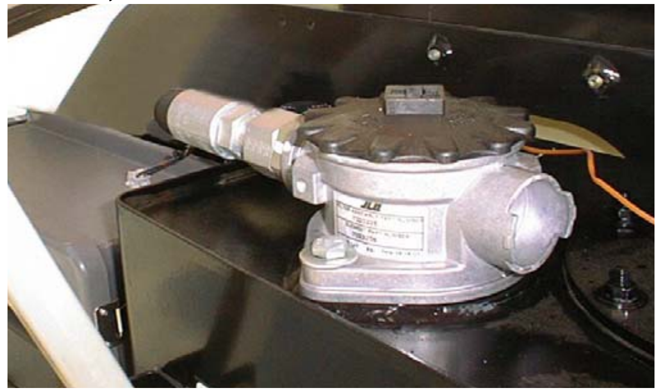


Lube Point(s) - Repack
Capacity - A/R
Lube - MPG
Interval - Every 2 years or 1200 hours of operation

4. Wheel Drive Hub

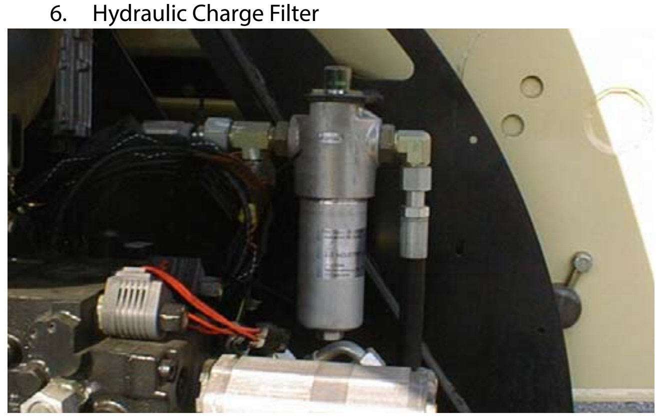
Lube Point(s) - Level/Fill Plug
Capacity - 17 oz. (0.5 L) - 1/2 Full
Lube - EPGL
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation.

5. Hydraulic Return Filter



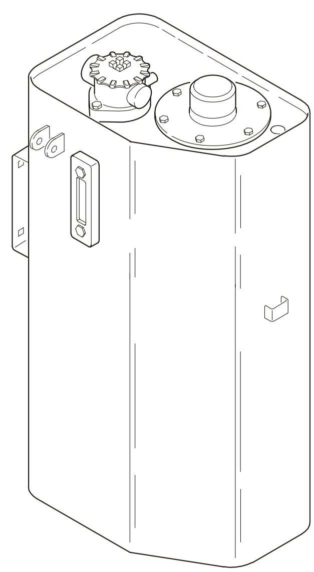
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

6. Hydraulic Charge Filter



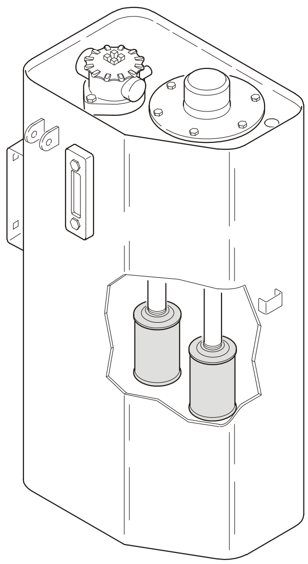
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

7. Hydraulic Tank



Lube Point(s) - Fill Cap
Capacity - 27 gallons (102 liters); 23.6 gal. (89 liters) to the Full line on the sight gauge
Lube - HO
Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

8. Suction Strainers

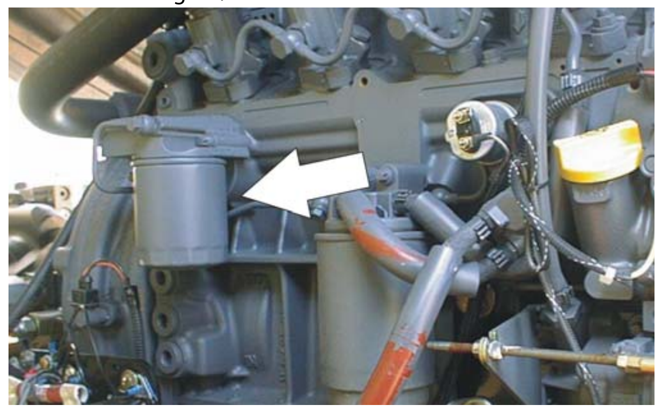


Lube Point(s) - 2
Interval - Every 2 years or 1200 hours of operation, remove and clean at time of hydraulic oil change.

9. Oil Change w/Filter - Caterpillar

Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 10 Quarts (9.4 L)
Lube - EO
Interval - Every Year or 600 hours of operation.
Comments - Check level daily/Change in accordance with engine manual.

10. Oil Change w/Filter - Deutz



Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 11 Quarts(10.5 L) Crankcase; 5 Quarts (4.7 L) Cooler
Lube - EO
Interval - Every Year or 1200 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

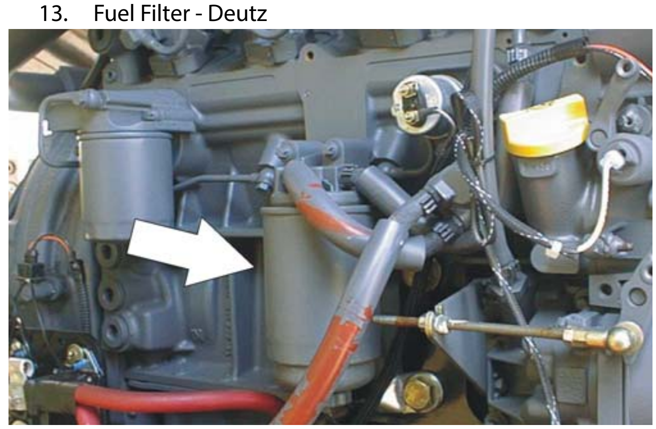
11. Oil Change w/Filter - Perkins

Lube Point(s) - Fill Cap/Spin-on Element (JLG P/N 7026855)
Capacity - 10 Quarts (9.4 L)
Lube - EO
Interval - Every Year or 600 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

12. Fuel Filter - Caterpillar

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

13. Fuel Filter - Deutz

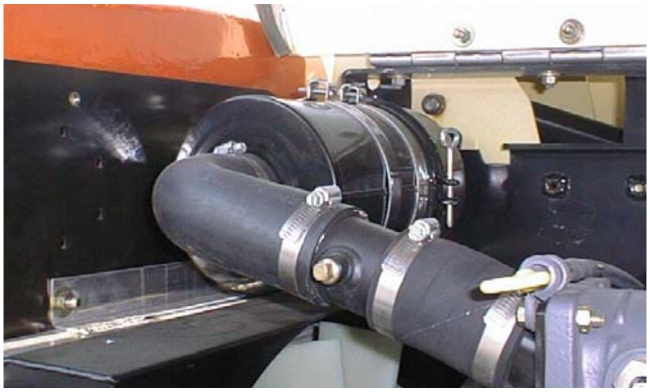


Lube Point(s) - Replaceable Element
Interval - Every Year or 600 hours of operation

14. Fuel Filter - Perkins

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

15. Air Filter



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

1.9 MAJOR COMPONENT WEIGHTS

Table 1-19. Component Weights

Component	Pounds	Kilograms
Engine Only	440	200
Upper Boom	1257	570
Frame (Bare)	2105	955
Turntable (Bare)	1533	695.5

1.10 PRESSURE SETTINGS

Table 1-20. Pressure Settings

SETTING	PSI	BAR
Bang-Bang Main Relief	3300	227.5
Steer	2500	172
Platform Level Up	2800	193
Platform Level Down	1800	124
Articulating Jib	1500	103
Proportional Main Relief	3200	220
Lift Down	1200	83
Swing	1700	117

1.11 SERIAL NUMBER LOCATION

A serial number plate is affixed to the left rear side of the frame. If the serial number plate is damaged or missing, the machine serial number is stamped on the left side of the frame.

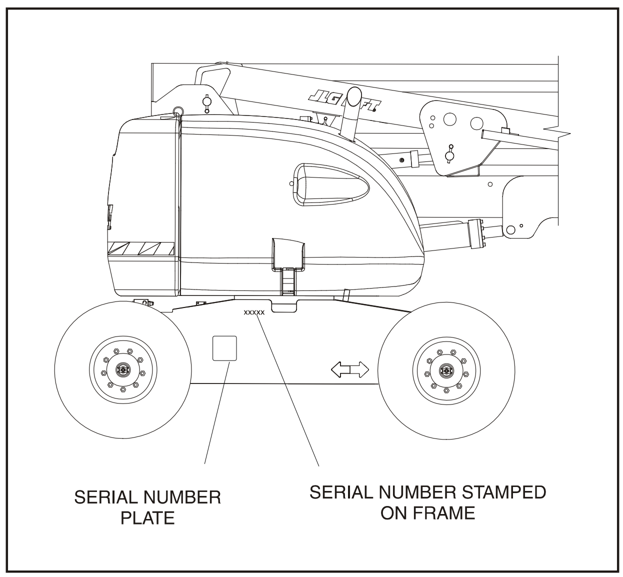


Figure 1-2. Serial Number Locations

				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

NO. 5000059 REV. K

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

				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

Values for Magni Coating Fasteners (Ref 4150701)

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

NO. 5000059 REV. K

Figure 1-4. Torque Chart - Sheet 2 of 5 - (SAE Fasteners)

				SOCKET HEAD CAP SCREWS													
				Magni Coating (Ref 4150701)*							Zinc Yellow Chromate Fasteners (Ref 4150707)*						
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K = .17		Torque (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.

NO. 5000059 REV. K

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

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

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 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 1-7. Torque Chart - Sheet 5 of 5 - (METRIC Fasteners)

NOTES:

SECTION 2. GENERAL

2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

General

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

Preparation, Inspection, and Maintenance

It is important to establish and conform to a comprehensive inspection and preventive maintenance program. The following table outlines the periodic machine inspections and maintenance recommended by JLG Industries, Inc. Consult your national, regional, or local regulations for further requirements for aerial work platforms. The 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 prior to use daily or at each change of operator. Reference the Operator's and Safety Manual for completion procedures for the Pre-Start Inspection. The Operator and Safety Manual must be read in its entirety and understood prior to 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.

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. The 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 the Inspection and Preventative Maintenance Schedule for items requiring inspection during the performance of these inspections. Reference the appropriate areas of this manual for servicing and maintenance procedures.

Annual Machine Inspection

The Annual Machine Inspection must be performed by a Factory-Certified Service Technician on an annual basis, no later than thirteen (13) months from the date of the prior Annual Machine Inspection. JLG Industries, Inc. recognizes a Factory-Certified 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 Preventative Maintenance Schedule for items requiring inspection during performance of this 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 the current machine ownership.

Preventative Maintenance

In conjunction with the 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 Preventative Maintenance Schedule and the appropriate areas of this manual for servicing and maintenance procedures. The 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

Table 2-1. Inspection and Maintenance

Pre-Start Inspection	Prior to use each day; or At each Operator change.	User or Operator	User or Operator	Operator 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 the date of the prior inspection.	Owner, Dealer, or User	Factory-Certified Service Technician	Service and Maintenance Manual and applicable JLG inspection form.
Preventative Maintenance	At intervals as specified in the Service and Maintenance Manual.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual

2.2 SERVICE AND GUIDELINES

General

The following information is provided to assist you in the use and application of servicing and maintenance procedures contained in this book.

Safety and Workmanship

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

Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and foreign materials out of the vital components. Precautions have been taken to safeguard against this. Shields, covers, seals, and filters are provided to keep air, fuel, and oil supplies clean; however, these items must be maintained on a scheduled basis in order to function properly.

2. At any time when air, fuel, or oil lines are disconnected, clear 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 entry of foreign matter.

3. Clean and inspect all parts during servicing or maintenance, and assure that all passages and openings are unobstructed. Cover all parts to keep them clean. Be sure all parts are clean before they are installed. New parts should remain in their containers until they are 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 that the capacity of an eyebolt or similar bracket lessens, as the angle between the supporting structure and the component becomes less than 90 degrees.

3. If a part resists removal, check to see whether all nuts, bolts, cables, brackets, wiring, etc., have been removed and that no adjacent parts are interfering.

Component Disassembly and Reassembly

When disassembling or reassembling a component, complete the procedural steps in sequence. Do not partially disassemble or assemble one part, then start on another. Always recheck your work to assure that nothing has been overlooked. Do not make any adjustments, other than those recommended, without obtaining proper approval.

Pressure-Fit Parts

When assembling pressure-fit parts, use an anti-seize or molybdenum disulfide base compound 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 they are ready to install.

4. Lubricate new or used serviceable bearings before installation. When pressing a bearing into a retainer or bore, apply pressure to the outer race. If the bearing is to be installed on a shaft, apply pressure to the inner race.

Gaskets

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

Bolt Usage and Torque Application

1. 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, standard torque values should be used on heat-treated bolts, studs, and steel nuts, in accordance with recommended shop practices. (See Torque Chart Section 1.)

Hydraulic Lines and Electrical Wiring

Clearly mark or tag hydraulic lines, electrical wiring, and their receptacles when disconnecting or removing them from the unit. This will ensure they are correctly reinstalled.

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 required, to aid assembly.

Lubrication

Service applicable components with amount, type, and grade of lubricant recommended in this manual at 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 enter the system by various means, e.g., using inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting 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, therefore, even the smallest amount of dirt or foreign matter entering a system can cause wear or damage to components and generally results in faulty operation. Every precaution must be taken to keep hydraulic oil clean, including reserve oil in storage. Hydraulic system filters should be checked, cleaned, and/or replaced as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.

3. Cloudy oils indicate a high moisture content which permits organic growth, resulting in oxidation or corrosion. If this condition occurs, system must be drained, flushed, and refilled with clean oil.

4. It is not advisable to mix oils of different brands or types, as 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 the wear-in of meshing components.*

Hydraulic Oil

1. Refer to Section 1 for recommendations for viscosity ranges.
2. JLG recommends Mobilfluid 424 hydraulic oil, which has an SAE viscosity of 10W-30 and a viscosity index of 152.

NOTE: *Start-up of hydraulic system with oil temperatures below -15° F (-26° C) is not recommended. If it is necessary to start the system in a sub-zero environment, it will be necessary to heat oil with a low density, 100 VAC heater to a minimum temperature of -15° F (-26° C).*

3. The only exception to the above is to drain and fill the system with Mobil DTE 13 oil or its equivalent. This will allow start up at temperatures down to -20° F (-29° C). However, use of this oil will give poor performance at temperatures above 120° F (49° C). Systems using DTE 13 oil should not be operated at temperatures above 200° F (94° C) under any condition.

Changing Hydraulic Oil

1. Use of recommended crankcase or hydraulic oils eliminates need for changing oil on a regular basis. However, filter elements must be changed after first 50 hours of operation and every 300 hours thereafter. If it is necessary to change oil, use only oils meeting or exceeding specifications in this manual. If unable to obtain the same type of oil supplied with machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils.
2. Use every precaution to keep hydraulic oil clean. If oil must be poured from original container into another, clean all possible contaminants from service container. Always clean the mesh element of the filter and replace cartridge any time system oil is changed.
3. While unit is shut down, a good preventive maintenance measure is to make a thorough inspection of all hydraulic components, lines, fittings, etc., as well as a functional check of each system, before placing machine back in service.

Lubrication Specifications

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

Cylinder Drift Test

Maximum acceptable cylinder drift is to be measured using the following methods.

Platform Drift

Measure drift of platform to the ground. Lower booms (if equipped) slightly elevated, upper boom fully extended with the rated load in the 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

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

Cylinder must have normal platform load applied.

If cylinder passes this test, it is acceptable.

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

2.4 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 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 (pin should be properly cleaned prior to inspection):
    a. Detectable wear in bearing area.
    b. Flaking, pealing, scoring, or scratches on pin surface.
    c. Rusting of the pin in bearing area.
4. Re-assembly of pinned joints using filament wound bearings.
    a. Blow out housing to remove all dirt and debris. Bearings and bearing housings must be free of all contamination.
    b. Clean bearing and pins with a solvent to remove all grease and oil. Filament wound bearings are a dry joint and should not be lubricated.
    c. Inspect pins to ensure they are free of burrs, nicks, and scratches which would damage bearing during installation and operation.

2.5 WELDING ON JLG EQUIPMENT

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

DO THE FOLLOWING WHEN WELDING ON JLG EQUIPMENT

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

DO NOT DO THE FOLLOWING WHEN WELDING ON JLG EQUIPMENT

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

CAUTION

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

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Boom Assembly	9					
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	
Platform Assembly	9					
Platform	1,2				1,2	
Railing	1,2			1	1,2	
Gate			5	1	1,5	
Floor	1,2			1	1,2	
Rotator		9,5				
Lanyard Anchorage Point	2			1,2,10	1,2,10	
Turntable Assembly	9					
Swing Bearing or Worm Gear				1,2,14	1,2,3,13,14	
Oil Coupling		9				
Swing Drive System						
Turntable Lock				1,2,5	1,2,5	
Hood, Hood Props, Hood Latches				5	1,2,5	
Chassis Assembly	9					
Tires	1	16,17		16,17,18	16,17,18	
Wheel Nuts/Bolts	1	15		15	15	
Wheel Bearings						14,24
Oscillating Axle/Lockout Cylinder Systems					5,8	
Outrigger or Extendable Axle Systems				5,8	5,8	
Steer Components						
Drive Motors						
Torque Hubs				11	11	
Functions/Controls	9					

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Platform Controls	5	5		6	6	
Ground Controls	5	5		6	6	
Function Control Locks, Guards, or Detents	1,5	1,5		5	5	
Footswitch	1,5			5	5	
Emergency Stop Switches (Ground & Platform)	5			5	5	
Function Limit or Cutout Switch Systems				5	5	
Capacity Indicator					5	
Drive Brakes				5		
Swing Brakes				5		
Boom Synchronization/Sequencing Systems					5	
Manual Descent or Auxiliary Power				5	5	
Power System	9					
Engine Idle, Throttle, and RPM				3	3	
Engine Fluids (Oil, Coolant, Fuel)	11	9,11		11	11	
Air/Fuel Filter		1,7		7	7	
Exhaust System			1,9	9	9	
Batteries	5	1,9			19	
Battery Fluid		11		11	11	
Battery Charger		5			5	
Fuel Reservoir, Cap, and Breather	11,9		2	1,5	1,5	
Hydraulic/Electric System	9					
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	11	1,9	2	1,5	1,5	24
Hydraulic Filter		1,9		7	7	
Hydraulic Fluid	11			7,11	7,11	
Electrical Connections		1		20	20	
Instruments, Gauges, Switches, Lights, Horn		1			5,23	
General						
Operators and Safety Manuals in Storage Box	21			21	21	
ANSI and EMI Manuals/Handbooks Installed					21	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years
Capacity Decals Installed, Secure, Legible	21			21	21	
All Decals/Placards Installed, Secure, Legible	21			21	21	
Walk-Around Inspection Performed	21					
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	21, 22	
Paint and Appearance				7	7	
Stamp Inspection Date on Frame					22	
Notify JLG of Machine Ownership					22	

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL					
	Pre-Start[1] Inspection	Weekly Preventive Maintenance	Monthly Preventive Maintenance	Pre-Delivery[2] or Frequent[3] Inspection	Annual[4] (Yearly) Inspection	Every 2 Years

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

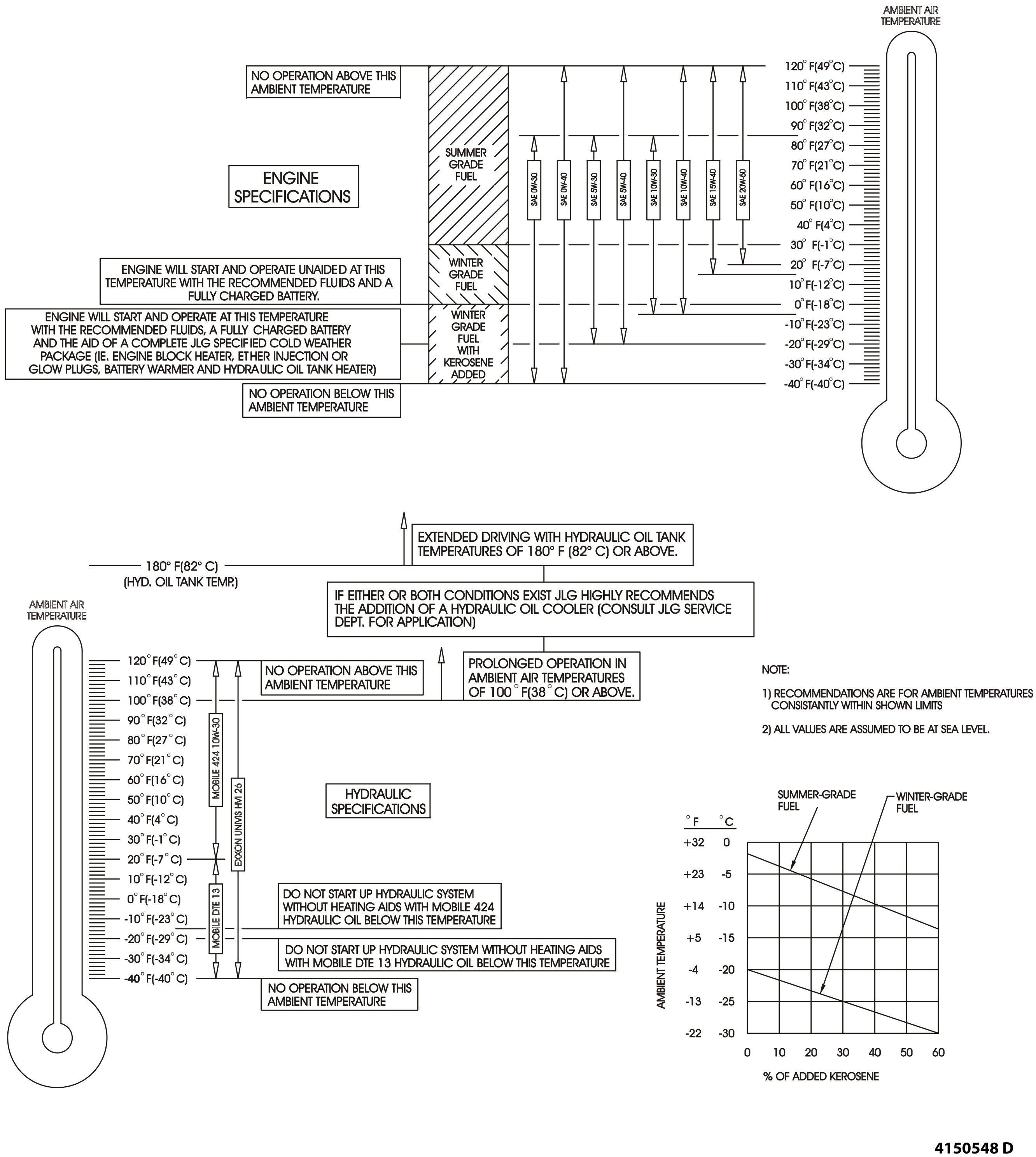


Figure 2-1. Engine Operating Temperature Specifications - Deutz

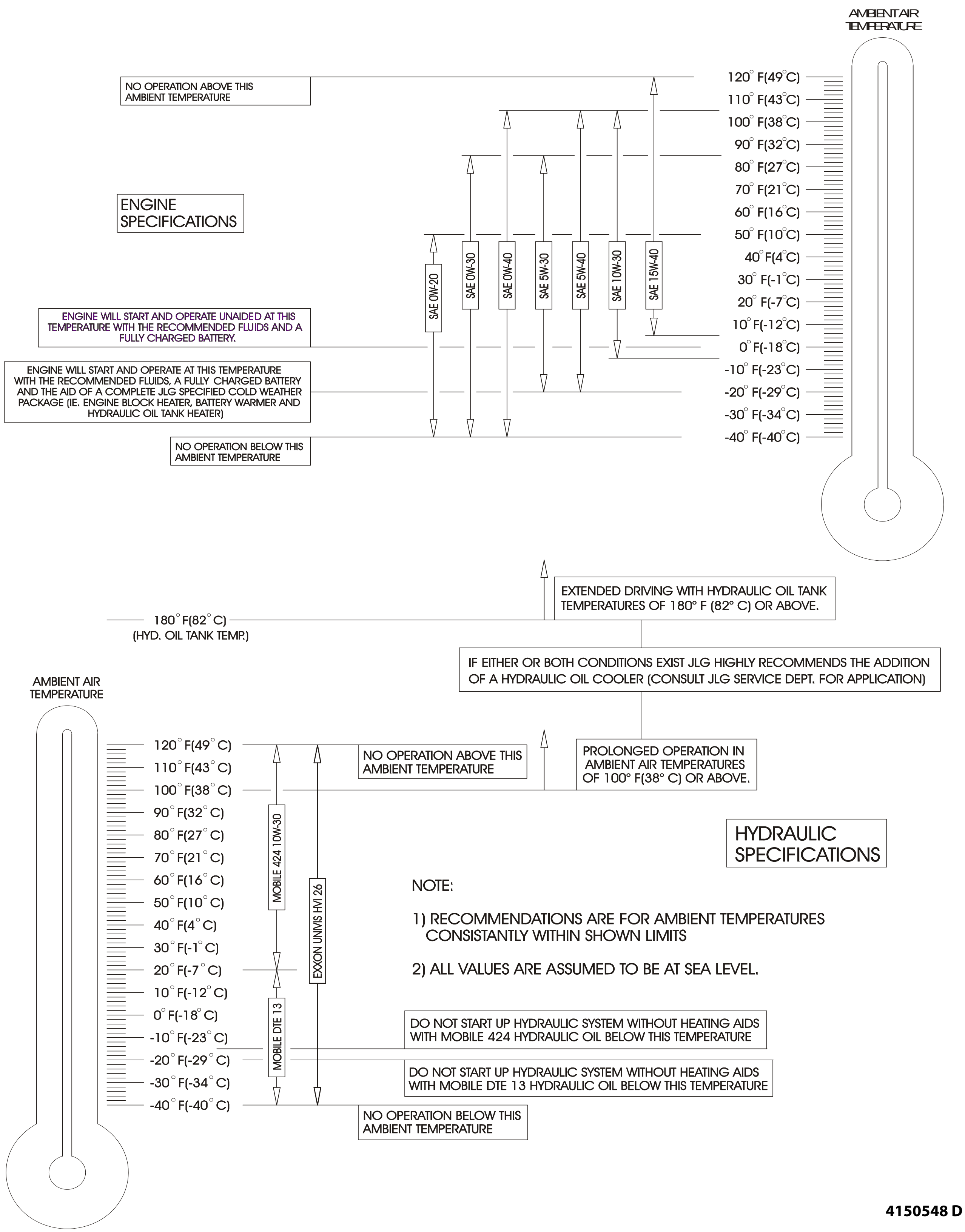


Figure 2-2. Engine Operating Temperature Specifications - Perkins

NOTES:

SECTION 3. CHASSIS AND TURNTABLE

3.1 TIRES & WHEELS

Tire Inflation

The air pressure for pneumatic tires must be equal to the air pressure that is stenciled on the side of the JLG product or rim decal for safe and proper operational characteristics.

Tire Damage

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

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

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

If a tire is damaged but is within the above noted criteria, the tire must be inspected on a daily basis to ensure the damage has not propagated beyond the 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 the part number of the approved tires for a particular machine model. If not using a JLG approved replacement tire, we recommend that replacement tires have the following characteristics:

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

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

Wheel Replacement

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

Wheel Installation

WARNING

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

Tighten lug nuts to proper torque to prevent wheels from coming loose. 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 result in breaking studs or permanently deforming mounting stud holes in the wheels. The proper procedure for attaching wheels is as follows:

1. Start all nuts by hand to prevent cross threading. DO NOT use a lubricant on threads or nuts.
2. Tighten nuts in stages. Following recommended sequence, tighten nuts per wheel torque chart.

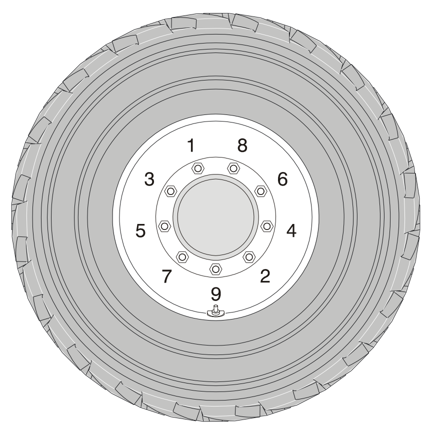


Table 3-1. Wheel Torque Chart

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

3. 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 (MACHINES BUILT BEFORE S/N 1300000064)

Roll, Leak and Brake Testing

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

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

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

ROLL TEST

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

LEAK TEST (MAIN UNIT)

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

BRAKE TEST

Input Brake - 1,850 in-lb (208 Nm) Static,
225 psi (15.5 bar) Full Release
3000 psi (207 bar) maximum o-ring check.

If brake does not release at these pressure values, brake must be inspected, repaired or replaced.

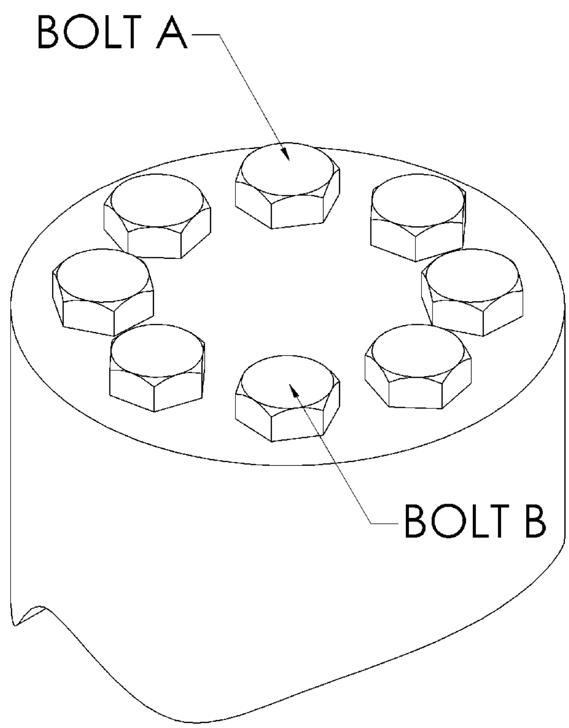
NOTE: *Failure to perform this test may result in damaged or ineffective brake parts.*

Tightening and Torquing Bolts

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

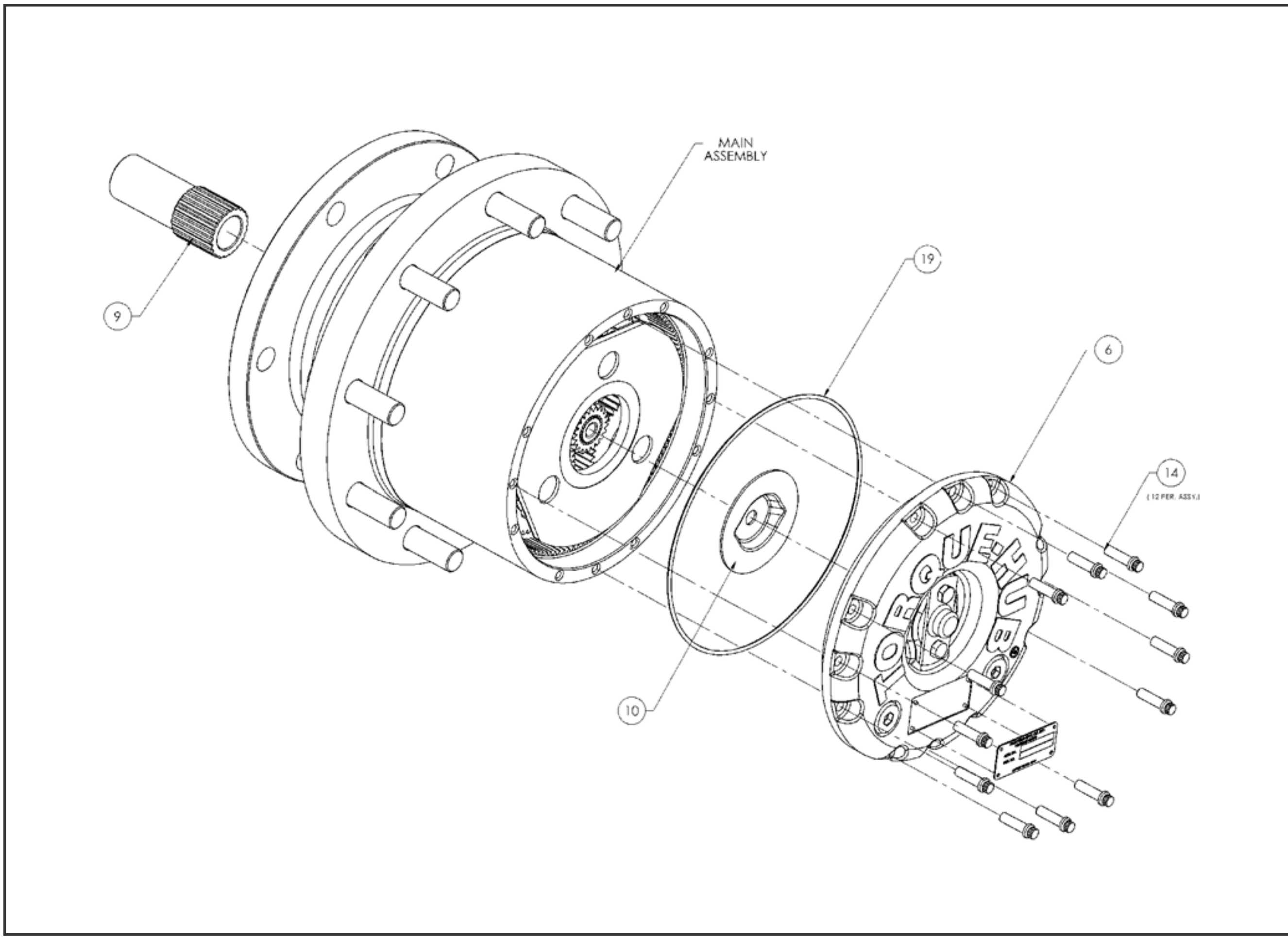
The following steps describe how to tighten and torque bolts or socket head cap screws in a bolt circle.

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



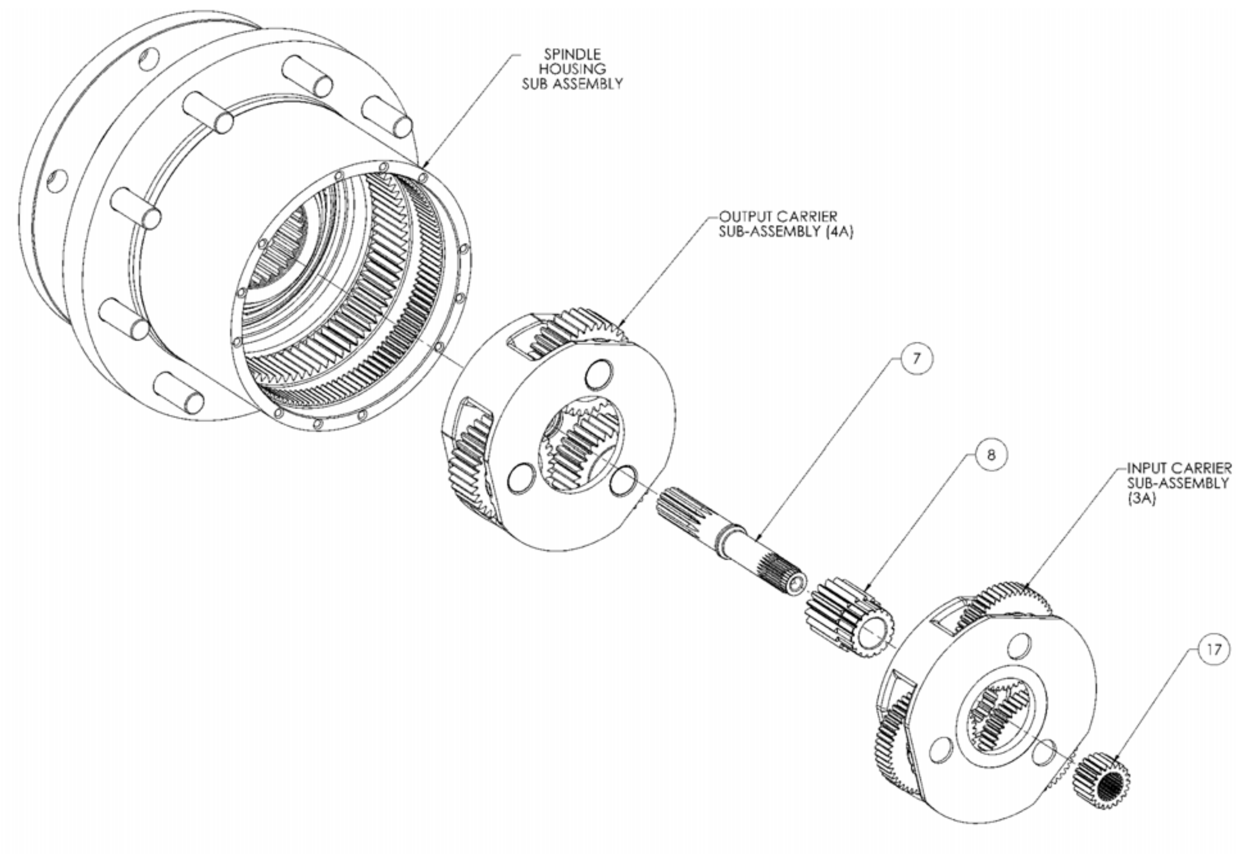
Main Disassembly

1. Perform Roll Check, Leak Check and Brake Check if applicable before disassembling the unit.
2. Drain oil from unit. Note condition and volume of oil.
3. Remove Input Coupling (9) from Spindle (1A) end of unit.
4. Remove Cover Bolts (14) and remove Cover (6).
5. Remove O-ring (19) and Thrust Spacer (10) from Cover (6).
6. Remove Input Sun Gear (17) from Input Carrier Sub-Assembly (3A).
7. Remove Input Carrier Sub-Assembly (3A) from Housing (1E).
8. Remove Output Sun Gear (8) from Output Carrier Sub-Assembly (4A).
9. Remove Input Shaft (7) from Output Carrier Sub-Assembly (4A).
10. Remove Output Carrier Sub-Assembly (4A) from Housing (1E).



6. Cover
9. Input Coupling
10. Thrust Spacer
14. Cover Bolts
19. O-ring

Figure 3-1. Main Disassembly Drawing 1

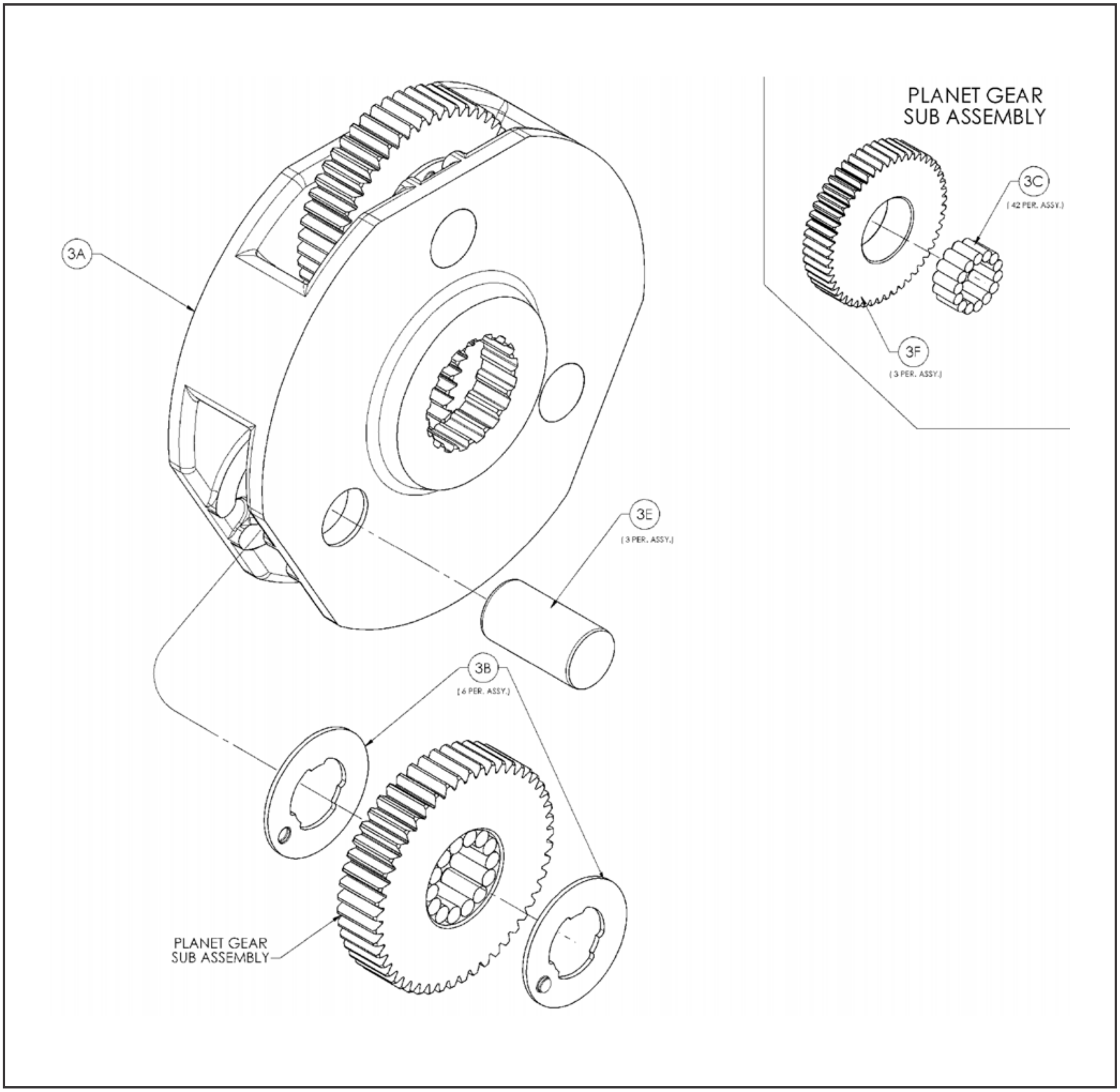


7. Input Shaft
8. Output Sun Gear
17. Input Sun Gear

Figure 3-2. Main Disassembly Drawing 2

Input Carrier Disassembly

1. Place Carrier (3A) on a press with spline end up. Drive Planet Shaft (3E) out of Carrier (3A).
2. Slide Planet Gear (3F) and two Thrust Washers (3B) out of Carrier (3A).
3. Remove 14 needle Bearings (3C) from bore of Planet Gear (3F).
4. Repeat steps 1 through 3 for two remaining planet gears.



3A. Carrier
3B. Thrust Washers
3C. Needle Bearings
3E. Planet Shaft
3F. Planet Gear

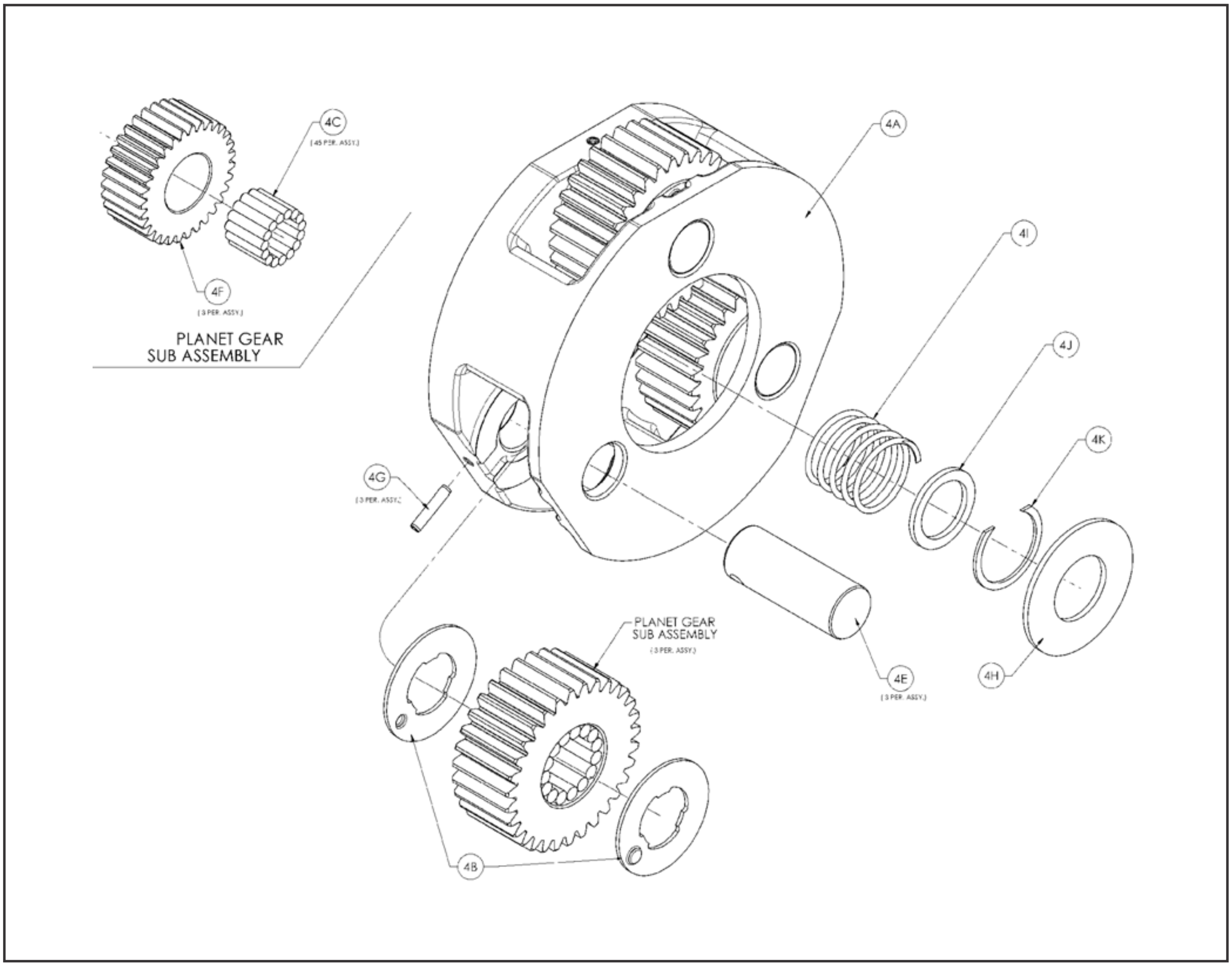
Figure 3-3. Input Carrier Disassembly

Output Carrier Disassembly

1. Using a small diameter punch, Drive Roll Pin (4G) which holds Planet Shaft (4E) in Carrier (4A) into Planet Shaft (4E) until it bottoms.

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

2. Remove Planet Shaft (4E) from Carrier (4A). Use a small punch to remove Roll Pin (4G) from Planet Shaft (4E).
3. Slide Planet Gear (4F) and two Thrust Washers (4B) out of Carrier (4A).
4. Remove 15 needle Bearings (4C) from bore of Planet Gear (4F).
5. Repeat steps 1 through 4 for two remaining planet gears.
6. Remove Thrust Washer (4H) from Carrier (4A).
7. Using retaining ring pliers, remove Retaining Ring (4K) from Carrier (4A). Pull Thrust Washer (4J) and Spring (4I) out of Carrier (4A).



4G. Roll Pin	4J. Thrust Washer	4B. Thrust Washers	4F. Planet Gear
4H. Thrust Washer	4K. Retaining Ring	4C. Needle Bearings	
4I. Spring	4A. Carrier	4E. Planet Shaft	

Figure 3-4. Output Carrier Disassembly

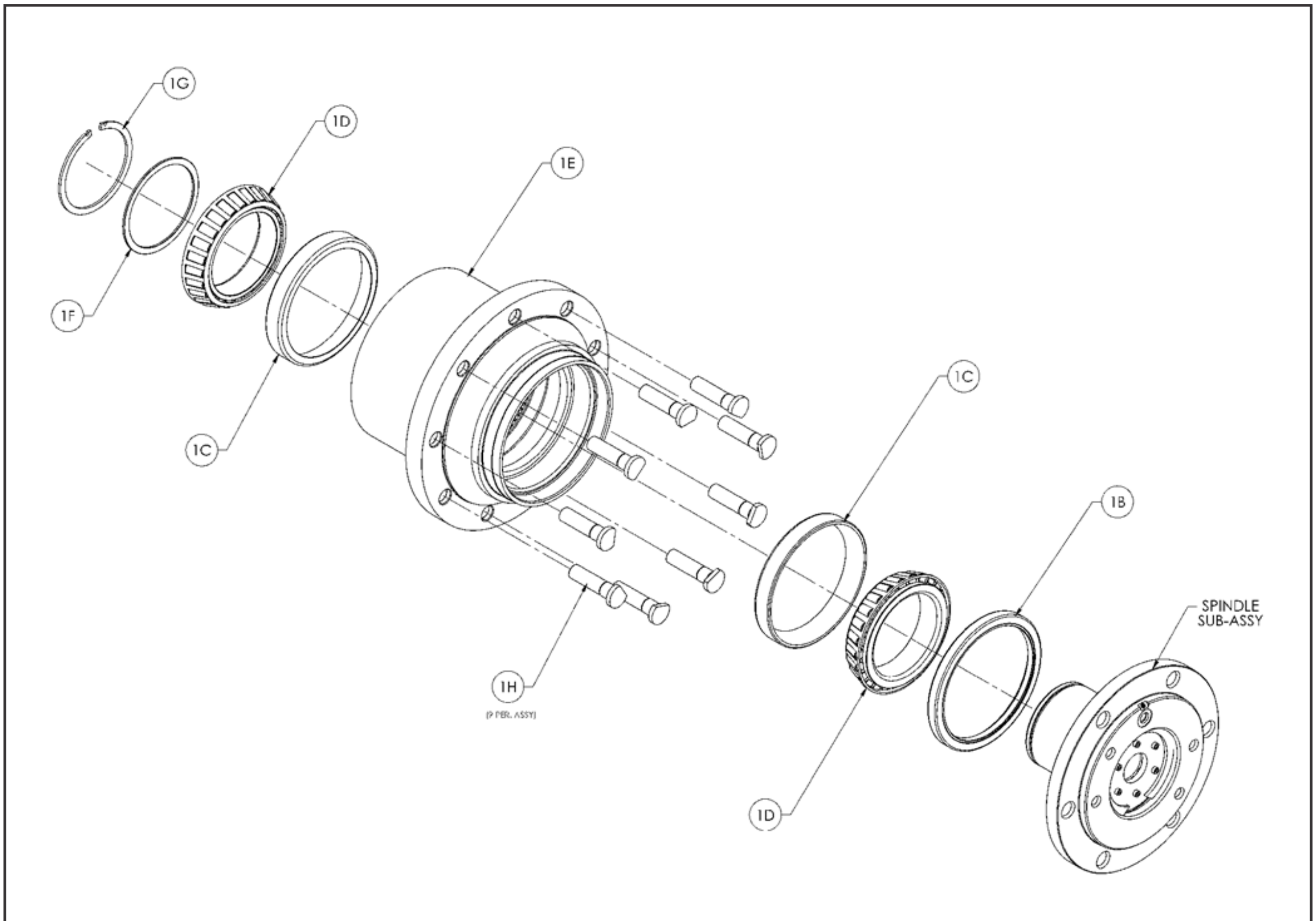
Housing-Spindle Disassembly

1. Place unit on bench with Spindle (1A) end down.

CAUTION

EYE PROTECTION MUST BE WORN WHILE PERFORMING THE NEXT STEP IN THIS PROCEDURE.

2. Using retaining ring pliers, remove Retaining Ring (1G) from groove in Spindle (1A).
3. Remove Bearing Spacer (1F) from top of Bearing Cone (1D).
4. While supporting the unit on Housing (1E) flange, press Spindle (1A) out of Housing (1E). The Seal (1B) and "B" position Bearing Cone (1D) should come out of Housing (1E) with Spindle (1A).
5. Remove "A" position Bearing Cone (1D) from Bearing Cup (1D) in Housing (1E).
6. Lift Housing (1E) off of Spindle (1A).
7. If necessary, press Studs (1N) out of Housing (1E). Locate Housing (1E) on Seal (1B) end.
8. Remove "B" position Bearing Cone (1D) from Spindle (1A).
9. Remove Seal (1B) from the Spindle (1A).
10. Using a soft steel rod, knock both Bearing Cups (1C) out of Housing (1E)



1B. Seal
1C. Bearing Cups
1D. Bearing Cone
1E. Housing
1F. Bearing Spacer
1G. Retaining Ring
1H. Wheel Stud

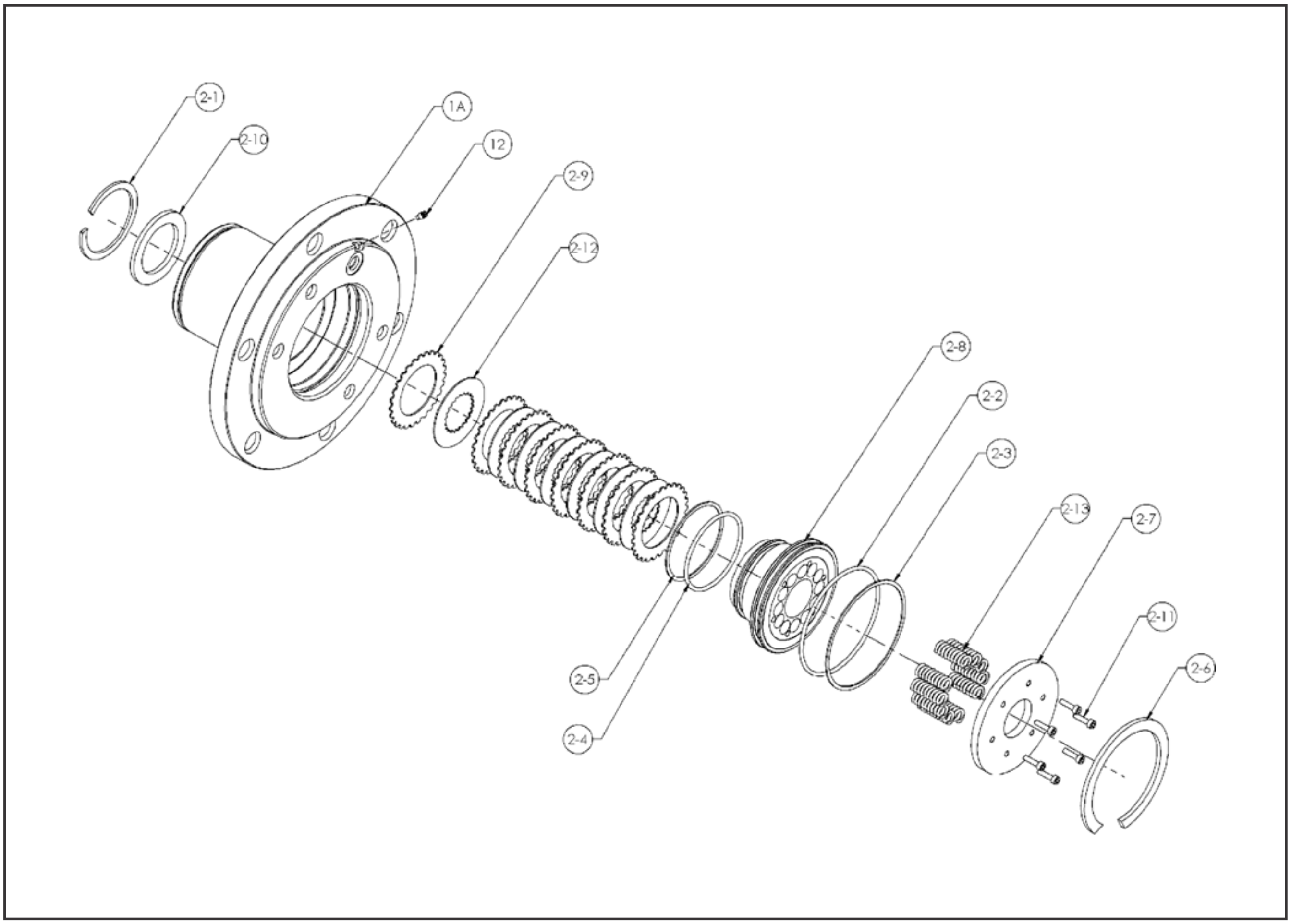
Figure 3-5. Housing-Spindle Disassembly

Spindle-Brake Disassembly

NOTE: *This procedure applies only to units with integral input brake (2).*

NOTE: *For this procedure, use the Brake Assembly Drawing, which will show the proper balloon numbers for the individual brake components. In the following instructions, if the number has a "-" between two numbers, it refers to the Brake Assembly Drawing only and NOT the Torque Hub Assembly Drawing.*

NOTE: *The Pressure Plug (12) requires a special tool for installation. It is not recommended to remove this plug unless it is leaking. The plug is called a Koenig Expander. The installation tool is not supplied by Fairfield manufacturing, but can be supplied by the manufacturer of the Koenig Expander, Sherex Industries, or one of their distributors.*



1-A. Spindle	2-2. O-ring	2-5. Back-up Ring	2-8. Piston	2-11. Capscrew
12. Pressure Plug	2-3. Back-up Ring	2-6. Internal Circlip	2-9. Stator	2-12. Rotor
2-1. Internal Circlip	2-4. O-ring	2-7. End Plate	2-10. Spacer	2-13. Compression Spring

Figure 3-6. Spindle Brake Disassembly

⚠ CAUTION

EYE PROTECTION MUST BE WORN WHILE PERFORMING THE STEPS 1-3 IN THIS PROCEDURE.

1. Compress the Compression Springs (2-13) by installing a minimum of three M4 x 16mm Socket Head Cap Screws (2-11) equally spaced through End Plate (2-7) and into Piston (2-8) and tightening incrementally until spring force has been taken off of the Retaining Ring (2-6).
2. Using a small pry bar or screwdriver, pry one end of the Retaining Ring (2-6) out of the groove in Spindle (1A), then, using pliers, pull Retaining Ring (2-6) the rest of the way out of the groove.
3. Back Socket Head Cap Screws (2-11) incrementally out of Piston (2-8) until spring force is relieved from the End Plate (2-7).
4. Remove Socket Head Cap Screws (2-11) and End Plate (2-7) from brake cavity in Spindle.
5. Remove Compression Springs (2-13) from Piston (2-8).

⚠ CAUTION

EYE PROTECTION MUST BE WORN WHILE PERFORMING THE NEXT STEP IN THIS PROCEDURE.

6. Using an air hose, slowly and carefully pressurize the brake port in the Spindle (1A) until the Piston (2-8) comes out of piston bore of Spindle (1A), Then pull the Piston (2-8) the rest of the way out of the Spindle (1A) by hand.
7. Remove Backup Rings (2-3) & (2-5) and O-rings (2-2) & (2-4) from Piston (2-8).
8. Remove Rotors (2-12) and Stators (2-9) from Spindle (1A).

⚠ CAUTION

EYE PROTECTION MUST BE WORN WHILE PERFORMING THE NEXT STEP IN THIS PROCEDURE.

9. Invert Spindle (1A) and, using retaining ring pliers, remove Retaining Ring (2-1).
10. Remove Spacer (2-10) from Spindle.

Input Carrier Sub-Assembly

1. Apply a liberal coat of grease to the bore of one Input Planet Gear (3F).
2. Line the inside of the 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 the ends of the two rollers that 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) into the planet shaft hole in the end of the Carrier (3A) opposite the splined end.
5. Place one Thrust Washer (3B) onto the end of Planet Shaft (3E). Make sure the flat faces towards the inside of the carrier and make sure the button fits in the pocket inside the Carrier (3A).
6. Place one more Thrust Washer (3B) into the Carrier (3A). Align the Thrust Washer (3B) in the same manner described in Step 5.

NOTE: *Some grease may need to be applied to the Thrust Washers (3B) to hold them in place while installing the planet gear. Instead of using grease, washers can be inserted from the ID of the carrier for buttons to fit in pockets of the carrier.*

7. Following the thrust washers, place Planet Gear (3F) with needle rollers, into the Carrier (3A) between the Thrust Washers (3B).
8. Push the Planet Shaft (3E) through the Planet Gear (3F) and the other Thrust Washer (3B) until it touches the other side of the Carrier (3A).

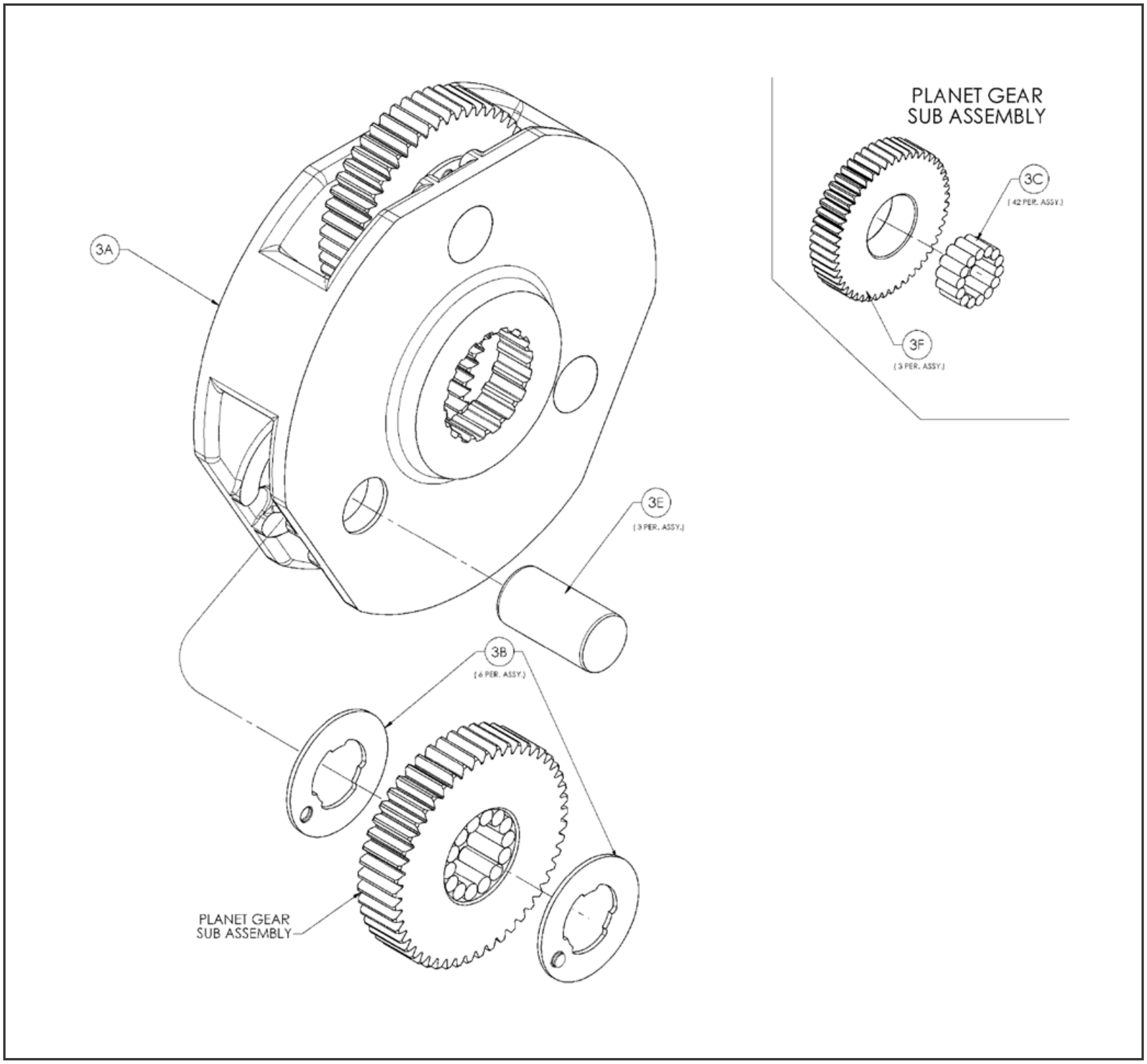
⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

9. Press the Planet Shaft (3E) until it is pressed to the appropriate depth.

NOTE: *If planet shaft locating tooling is not available, press lightly on Planet Shaft (3E) and make sure not to press Planet Shaft (3E) through the small shoulder in Carrier (3A). This shoulder is intended to keep the planet pin from working loose in that direction during proper operation of the unit. It is **NOT** intended to keep the planet pin from being pressed through the carrier.*

10. On the side of the Carrier (3A) where the Planet Shaft (3E) was inserted, stake the Carrier (3A) in 3 places using a punch and a hammer around the Planet Shaft (3E) to assure the shaft stays in place during operation of the unit.
11. Repeat Steps 1 through 10 for the installation of the two remaining Planet Gears (3F).



3A. Carrier
3B. Thrust Washers
3C. Needle Bearings
3E. Planet Shaft
3F. Planet Gear

Figure 3-7. Input Carrier Sub-Assembly

Output Carrier Sub-Assembly

1. Place Spring (4I) into the deep counterbore of the Output Carrier (4A).
2. Place Washer (4J) on top of Spring (4I).

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

3. With Retaining Ring (4K) installed on snap ring pliers, place on top of Washer (4J) and compress Spring (4I) until Retaining Ring (4K) is seated completely in groove.
4. Apply a liberal coat of grease to the bore of one Output Planet Gear (4F).
5. Line the inside of the Planet Gear (4F) with 15 Needle Rollers (4C).

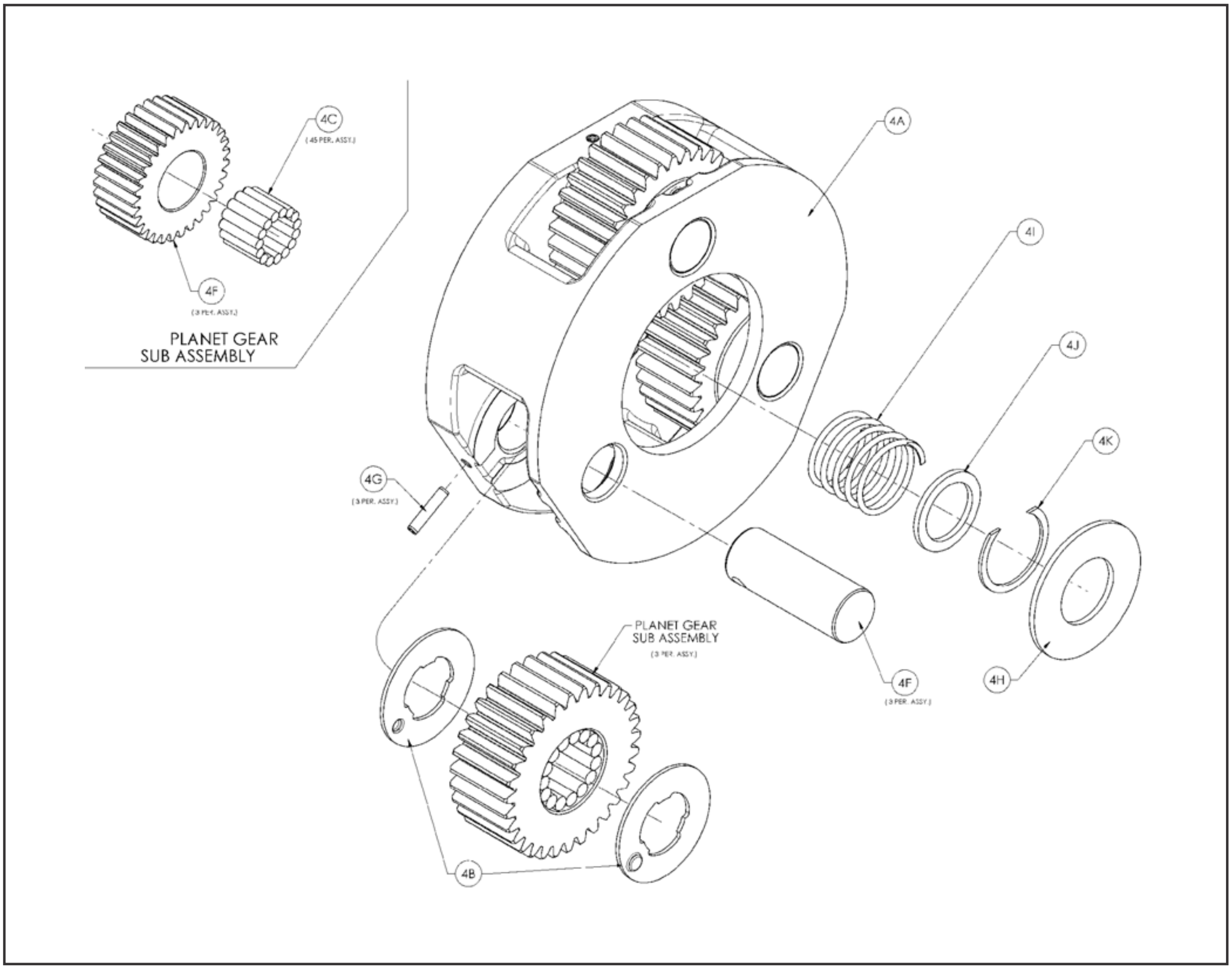
NOTE: *The last roller installed must be installed end wise. That is, the end of the last roller must be placed in between the ends of the two rollers that form the space, and then slid, parallel to the other rollers, into place.*

6. Place Thrust Washer (4H) into the shallow counterbore of the Output Carrier (4A).
7. Set Carrier (4A) in an upright position.
8. Insert a Planet Shaft (4E) into one of the planet shaft holes on the Carrier (4A). The end of the planet shaft that does **NOT** have the roll pin hole should be inserted in the carrier **FIRST**.
9. Place one Thrust Washer (4B) onto the end of Planet Shaft (4E). Make sure the flat faces towards the inside of the carrier and make sure the button fits in the pocket inside the Carrier (4A).
10. Following the thrust washer, place Planet Gear (4F) with needle rollers, onto Planet Shaft (4E).
11. Following the planet gear, place one more Thrust Washer (4B) onto Planet Shaft (4E). Align the Thrust Washer (4B) in the same manner described in Step 6.
12. Now insert Planet Shaft (4E) through the opposite planet shaft hole on Carrier (4A). Use an alignment punch or similar tool to align the roll pin holes on Carrier (4A) and Planet Shaft (4E).

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

13. Drive Roll Pin (4G) down into the aligned roll pin holes. Pin should be flush with OD of carrier.
14. Repeat Steps 4,5, & 8-13 for the installation of the two remaining Planet Gears (4F).



4A. Output Carrier	4E. Planet Shaft	4H. Thrust Washer	4K. Retaining Ring
4B. Thrust Washer	4F. Planet Gear	4I. Spring	
4C. Needle Rollers	4G. Roll Pin	4J. Washer	

Figure 3-8. Input Carrier Sub-Assembly

Spindle-Brake Sub-Assembly

NOTE: *This procedure applies only to units with integral input brake (2).*

NOTE: *For this procedure, use the Brake Assembly Drawing, which will show the proper balloon numbers for individual brake components. In the following instructions, if the number has a "-" between two numbers, it refers to the Brake Assembly Drawing only and NOT the Torque Hub Assembly Drawing.*

NOTE: *The Pressure Plug (12) requires a special tool for installation. It is not recommended to remove this plug unless it is leaking. The plug is called a Koenig Expander. The installation tool is not supplied by Fairfield manufacturing, but can be supplied by the manufacturer of the Koenig Expander, Sherex Industries, or one of their distributors.*

1. Install Pressure Plug (12) into Spindle (1A) using following procedure:

- Clean hole in spindle using appropriate Loctite spray
- Dip collar of plug in Loctite 290 or 680 (keep unplugged portion of hole free of Loctite)
- Using appropriate tool, install plug flush with surface of spindle

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT STEP.

2. Place Spindle (1A) such that the splined end is facing down. Using appropriate tool (See back of manual), install Retaining Ring (2-1) into the spindle groove within the splines.
3. Place Washer (2-10) on top of Retaining Ring (2-1).
4. Place Stator (2-9) on top of Washer (2-10).
5. Place Rotor (2-12) on top of Stator (2-9).
6. Repeat steps 3 & 4 until there are a total of 8 Stators (2-9) and 7 Rotors (2-12) installed.
7. Place Piston (2-8) such that the smaller O.D. end is facing upward.
8. Grease the large Backup Ring (2-3) and install in the large-diameter groove at the bottom of the Piston (2-8).
9. Grease the large O-Ring (2-2) and install in the large-diameter groove at the bottom of the Piston (2-8), on top of the large Backup Ring (2-3).
10. Grease the small O-Ring (2-5) and install in the small-diameter groove near the top of the Piston (2-8). Make sure the O-Ring is seated on the bottom of the groove.
11. Grease the small Backup Ring (2-4) and install in the small-diameter groove near the top of the Piston (2-8), on top of the small O-Ring (2-5).

NOTE: *If piston comes pre-assembled with shipping bolts (2-11), skip to Step 15.*

12. Insert Piston (2-8) into Spindle (1A) until it contacts the Stator (2-9).
13. Insert appropriate number of Springs (2-13) into Piston (2-8) counterbore. Use brake spring chart below and a bill of materials for your particular model number to determine number of springs.

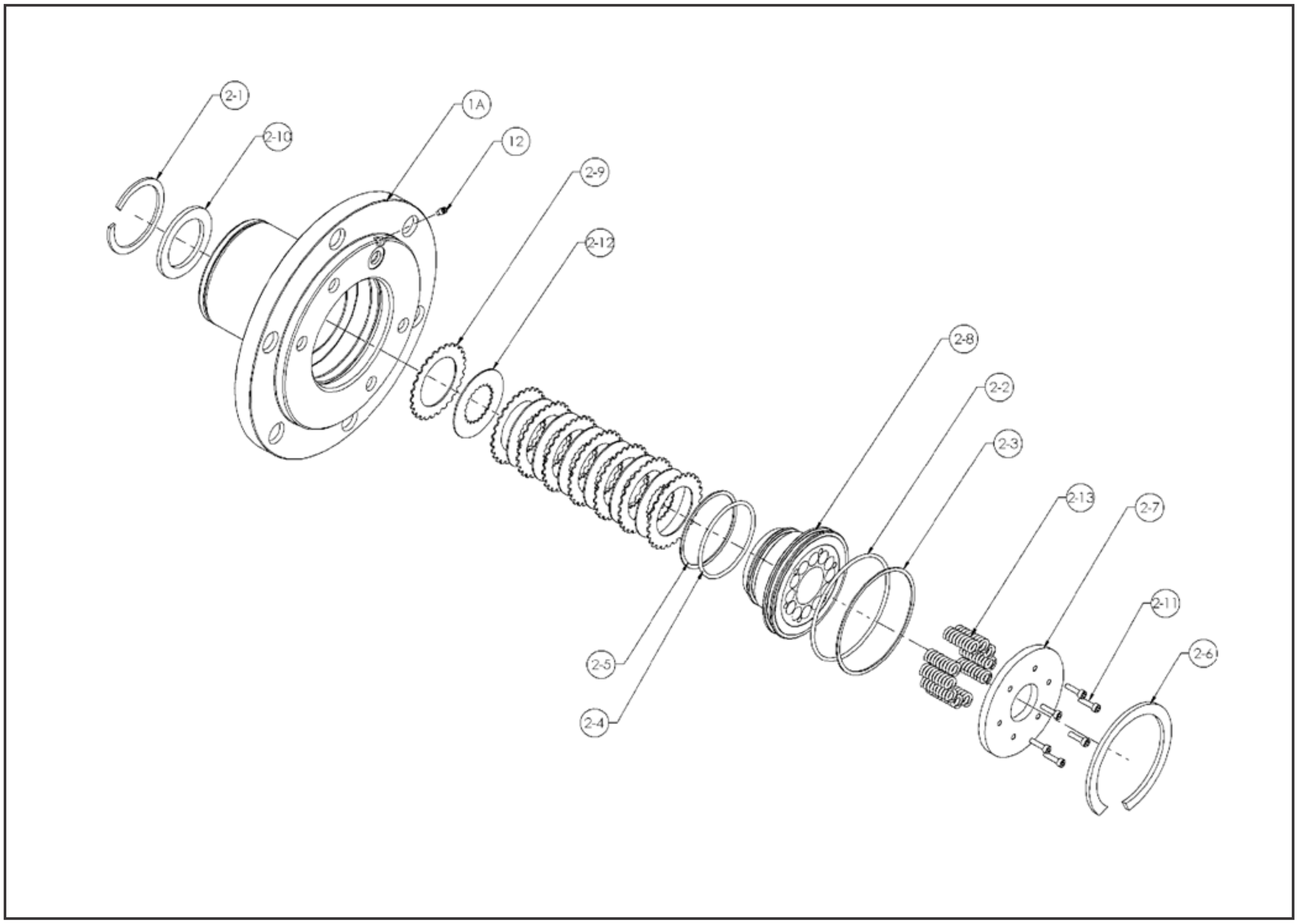
BRAKE CODE	BRAKE P/N	NUMBER OF SPRINGS
A	902337	12
B	902341	10
C	902342	8
D	902343	6
E	902345	9

14. Place Pressure Plate (2-7) on top of Springs (2-13).

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE NEXT TWO STEPS.

15. Using snap ring pliers, install Retaining Ring (2-6) into groove in Spindle (1A) and on top of Pressure Plate (2-7). Make sure that Retaining Ring (2-6) is seated properly in the groove.
16. Remove Shipping Bolts (2-11) in brake pressure plate to release springs in brake. Before removing bolts, use the Coupling (9) (See Assembly Drawing at back of manual) to center and align the Brake Rotors (2-12) with the Spindle (1A).



1-A. Spindle	2-3. Back-up Ring	2-7. End Plate	2-11. Capscrew
12. Pressure Plug	2-4. O-ring	2-8. Piston	2-12. Rotor
2-1. Internal Circlip	2-5. Back-up Ring	2-9. Stator	2-13. Compression Spring
2-2. O-ring	2-6. Internal Circlip	2-10. Spacer	

Figure 3-9. Spindle Brake Sub-Assembly

Housing-Spindle Sub-Assembly

NOTE: *Spray a light film of oil on all component parts during assembly.*

CAUTION

SAFETY GLASSES MUST BE WORN DURING THE ENTIRE HOUSING-SPINDLE SUBASSEMBLY.

1. Press Bearing Cup (1C), position A, into Housing (1E) using appropriate pressing tool (See back of manual).
2. Turn Housing (1E) over and place into pressing base. Press nine Studs (1H) into Housing (1E).

NOTE: *Use enough pressure to press in studs. Don t use excessively high pressure to press in studs or Housing may crack. Make sure head of stud contacts face of flange on Housing.*

NOTE: *Spray a generous amount of oil on bearings during installation.*

3. Press Bearing Cup (1C), position "B", into Housing (1E) using "B" Bearing Cone pressing tool (see back of manual).
4. Place Bearing Cone (1D), into Bearing Cup (1C), position "B".
5. Grease Seal (1B) lip and press seal into Housing (1E) using seal pressing tool (see back of manual) until seal is flush with end of Housing.
6. Turn Housing (1E) over and lower onto Spindle (1A).
7. Install Bearing Cone (1D) into Bearing Cup (1C), position "A". and lightly press on Bearing Cup using the "A" Bearing Cone pressing tool (see back of manual) while rotating Housing (1E) in both directions to seat bearings.
8. Place Bearing Spacer (1F) on top of Bearing Cone (1D).
9. Using retaining ring pliers, install Retaining Ring (1G) into Spindle (1A) groove. Make sure ring is completely seated in groove.

NOTE: *Extra bearing pre-load caused by pressing "A" Bearing Cone (1D) must be removed. This should be done by placing a flat piece of steel or a pressing tool on end of spindle, then lightly striking the tool with a piece of barstock. This should be adequate to remove any additional bearing preload.*

Integral Brake Check

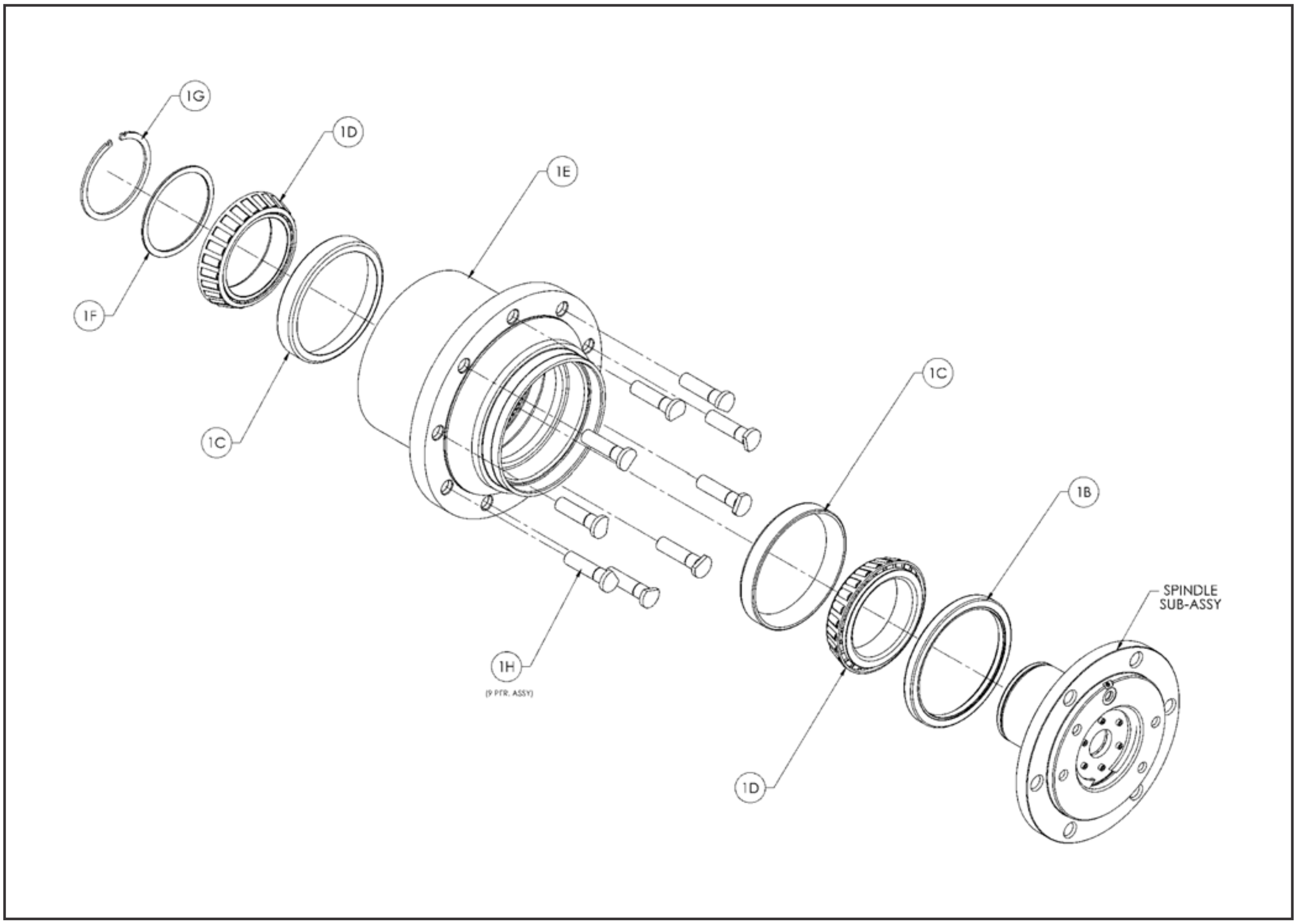
1. Using appropriate fittings, connect hydraulic line from hand pump to brake port.
2. Check brake is set by trying to rotate Input Shaft (7). This can be accomplished by installing an appropriate tool (any tool that can locate on splines of Input Coupling (9), such as a mating splined shaft) into Input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

BRAKE CODE	BRAKE P/N	JUST RELEASE PRESSURE RANGE (psi)
A	902337	185-230
B	902341	155-192
C	902342	125-155
D	902343	93-115
E	902345	132-172

4. Increase pressure to 3,000 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 (9) is centered in Spindle (1A) to make installation of motor possible without release of brake.*



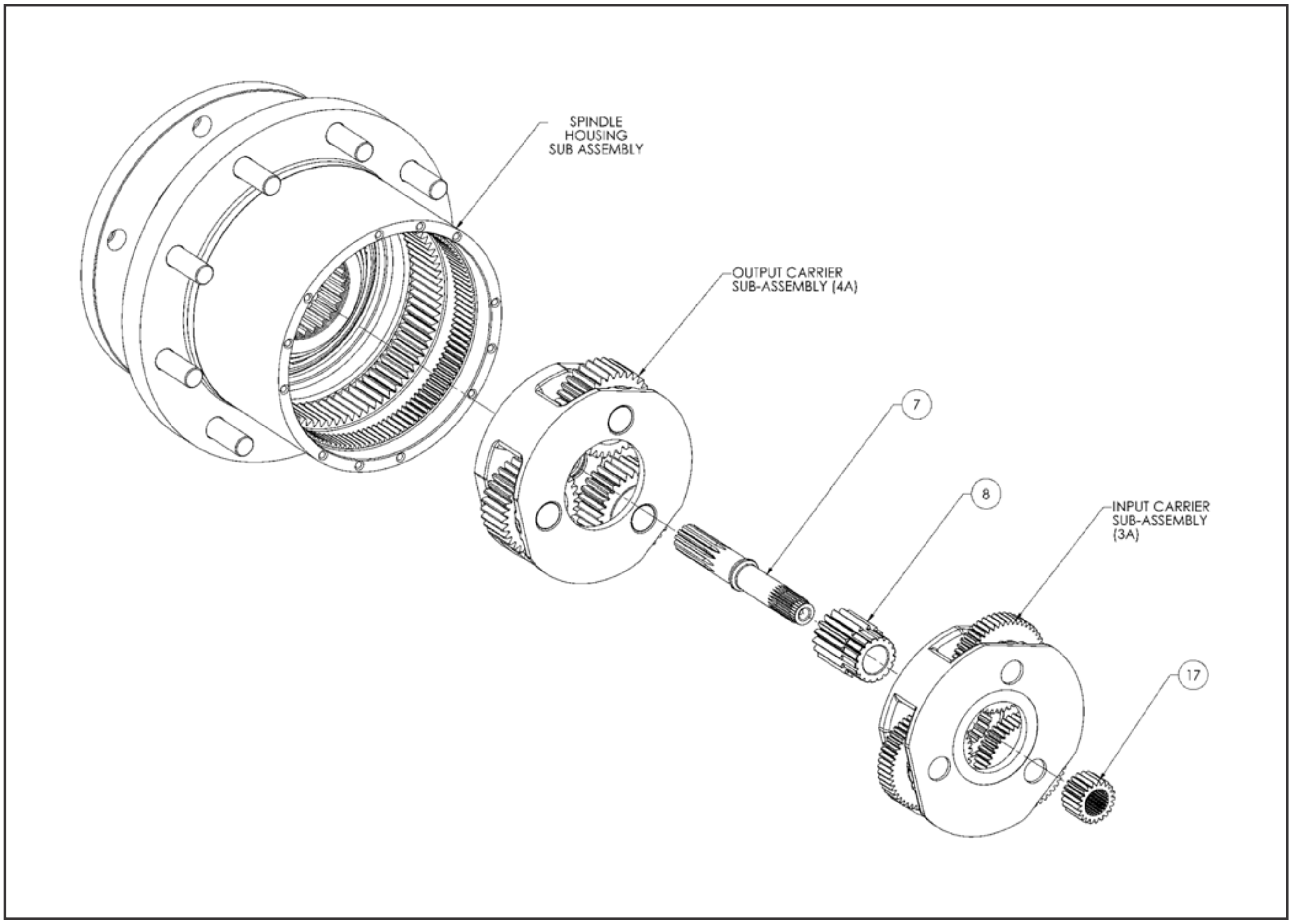
1B. Seal	1D. Bearing Cone	1F. Bearing Spacer	1H. Wheel Stud
1C. Bearing Cups	1E. Housing	1G. Retaining Ring	

Figure 3-10. Housing-Spindle Disassembly

Main Assembly

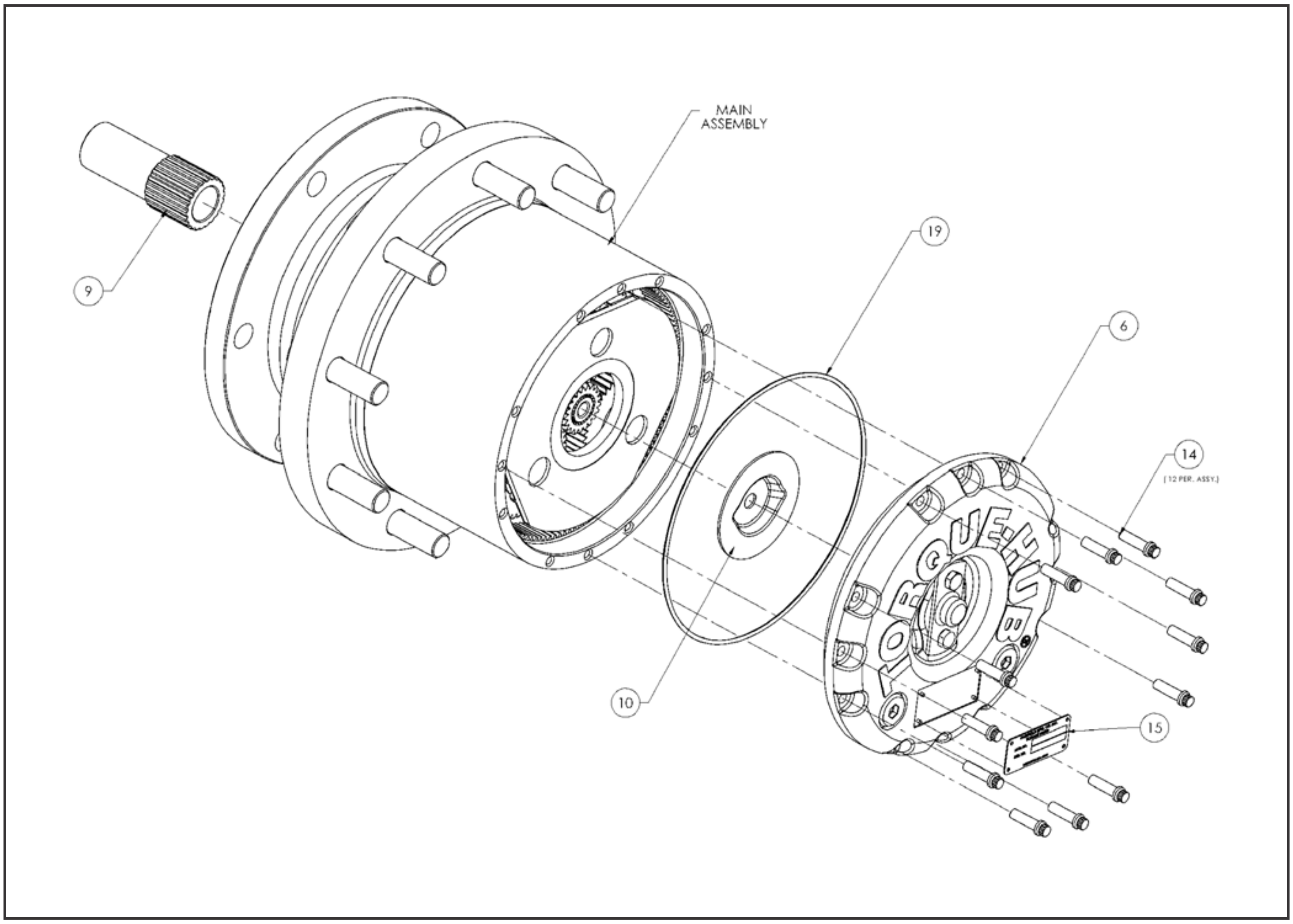
NOTE: *All components should receive a generous amount of lubricant oil as they are being assembled.*

1. Place Housing-Spindle Sub-Assembly on bench with Spindle (1A) side down.
2. Place Output Carrier Sub-Assembly into Housing (1E) and onto Spindle (1A).
3. Insert larger diameter splined end of Input Shaft (7) through bore of Output Carrier Sub Assembly (4A) until shoulder of Input Shaft (7) contacts Thrust Washer (4J) (See assembly drawing at back of manual).
4. With modified spline end facing up, place Output Sun Gear (8) into mesh with planet gears from Output Carrier Sub-Assembly (4A).
5. Place Input Carrier Sub-Assembly (3A) onto Output Sun Gear (8) splines.
6. Grease O-Ring (19) and insert into groove in Cover Sub-Assembly (6).
7. Install Cover Sub-Assembly (6) onto Housing (1E) and install twelve Bolts (14) into Cover (6). Torque bolts to 70-80 in-lbs.
8. Attach ID Tag (15) onto unit. If Cover has knobs as part of the cover, peen top of each knob to form a head to hold on the Tag. If cover has no such knobs, use drive screws.
9. Check disconnect, roll and leak check unit, leak check brake, check brake release pressure.



7. Input Shaft 8. Output Sun Gear 17. Input Sun Gear

Figure 3-11. Main Assembly Drawing 1



6. Cover
10. Thrust Spacer
19. O-ring
9. Input Coupling
14. Cover Bolts

Figure 3-12. Main Assembly Drawing 2

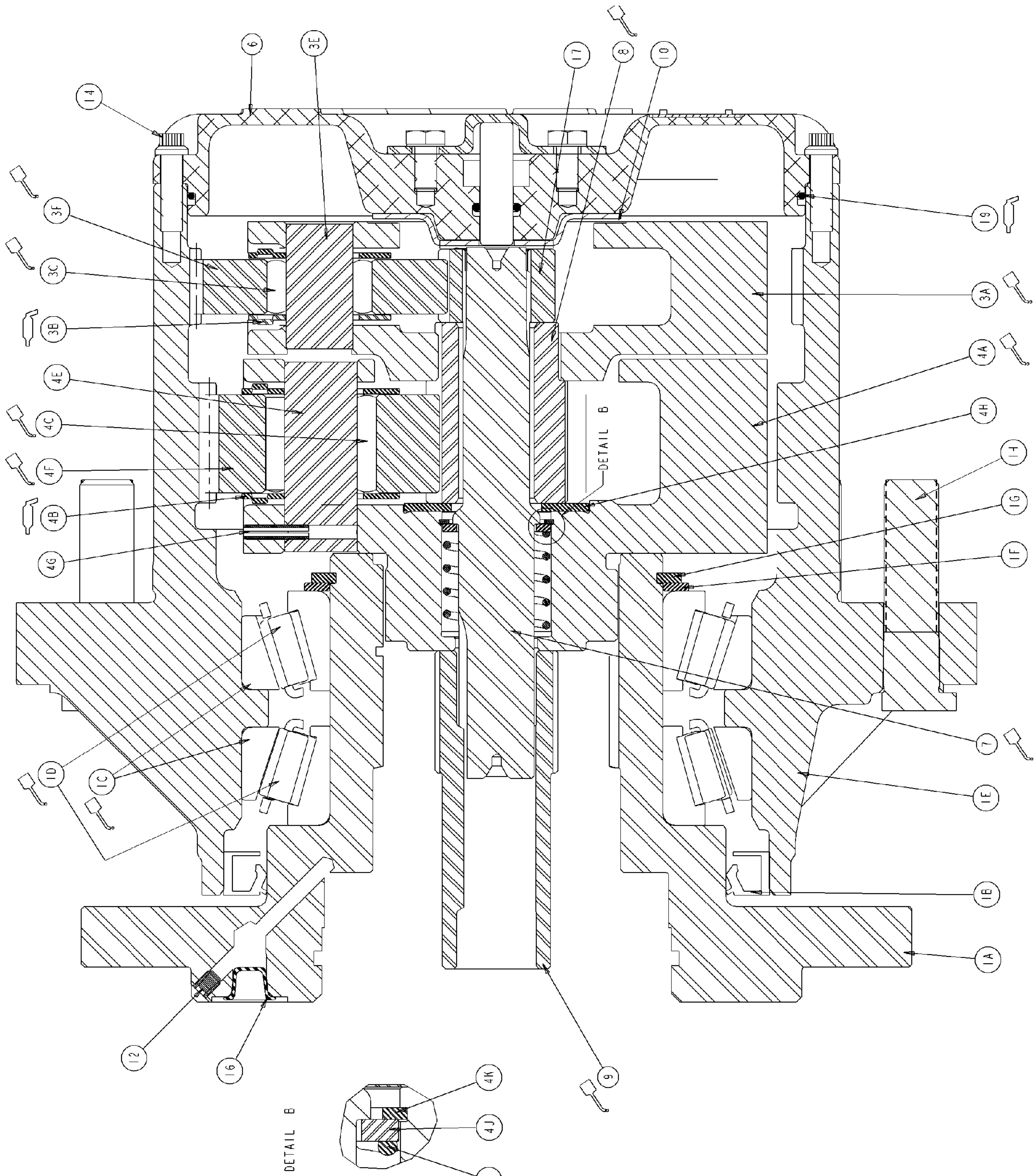


Figure 3-13. Assembly Drawing - Without Integral Input Brake - Sheet 1 of 2

1A	Spindle
1G	Retaining Ring - Ext
12	Pressure Plug
16	O-ring Pipe Plug
1F	Thrust Washer
1E	Housing/Ring Gear
1N	Stud
1C	Tapered Bearing - Cup
1D	Tapered Bearing - Cone
1B	Lip Seal
3A	Carrier
3F	Planet Gear
3E	Planet Shaft
3C	Needle Bearing
3B	Thrust Washer
4A	Carrier
4F	Planet Gear
4E	Planet Shaft
4C	Needle Bearing
4I	Spring
4K	Retaining Ring - Int
4G	Roll Pin
4B	Thrust Washer
4H	Thrust Washer
4J	Thrust Washer
17	Sun Gear
8	Sun Gear
7	Input Shaft
9	Coupling
6	Cover Subassembly
10	Thrust Spacer
15	Id Plate
14	12 Pt Flange Bolt
19	O-ring

Figure 3-14. Assembly Drawing - Without Integral Input Brake - Sheet 2 of 2

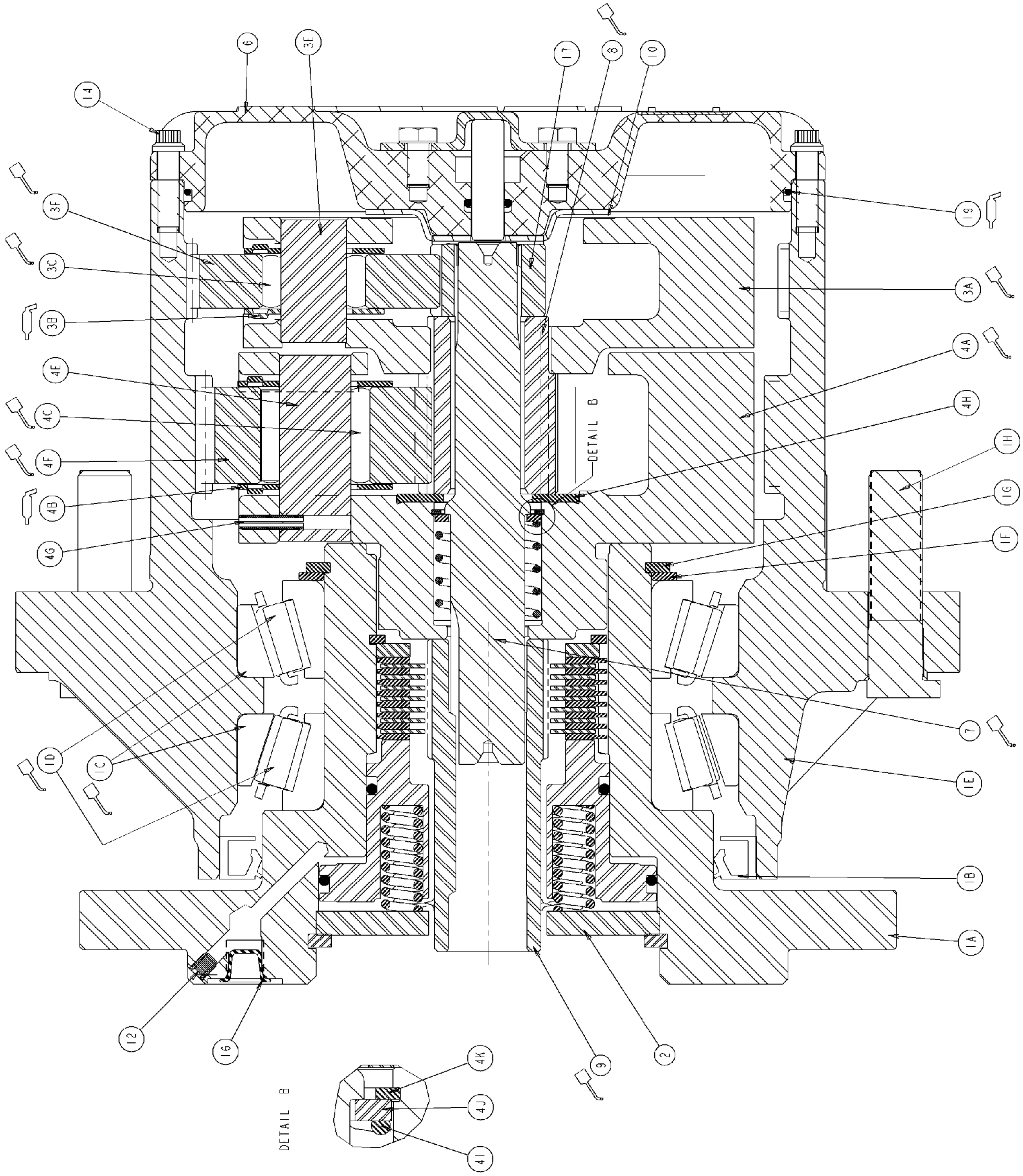


Figure 3-15. Assembly Drawing - With Integral Input Brake - Sheet 1 of 2

1A	Spindle	4K	Retaining Ring - Int
2	Input Brake	4G	Roll Pin
1G	Retaining Ring - Ext	4B	Thrust Washer
12	Pressure Plug	4H	Thrust Washer
16	O-ring Pipe Plug	4J	Thrust Washer
1F	Thrust Washer	17	Sun Gear
1E	Housing/Ring Gear	8	Sun Gear
1N	Stud	7	Input Shaft
1C	Tapered Bearing - Cup	9	Coupling
1D	Tapered Bearing - Cone	6	Cover Subassembly
1B	Lip Seal	10	Thrust Spacer
3A	Carrier	15	Id Plate
3F	Planet Gear	14	12 Pt Flange Bolt
3E	Planet Shaft	19	O-ring
3C	Needle Bearing		
3B	Thrust Washer		
4A	Carrier		
4F	Planet Gear		
4E	Planet Shaft		
4C	Needle Bearing		
4I	Spring		

Figure 3-16. Assembly Drawing - With Integral Input Brake - Sheet 2 of 2

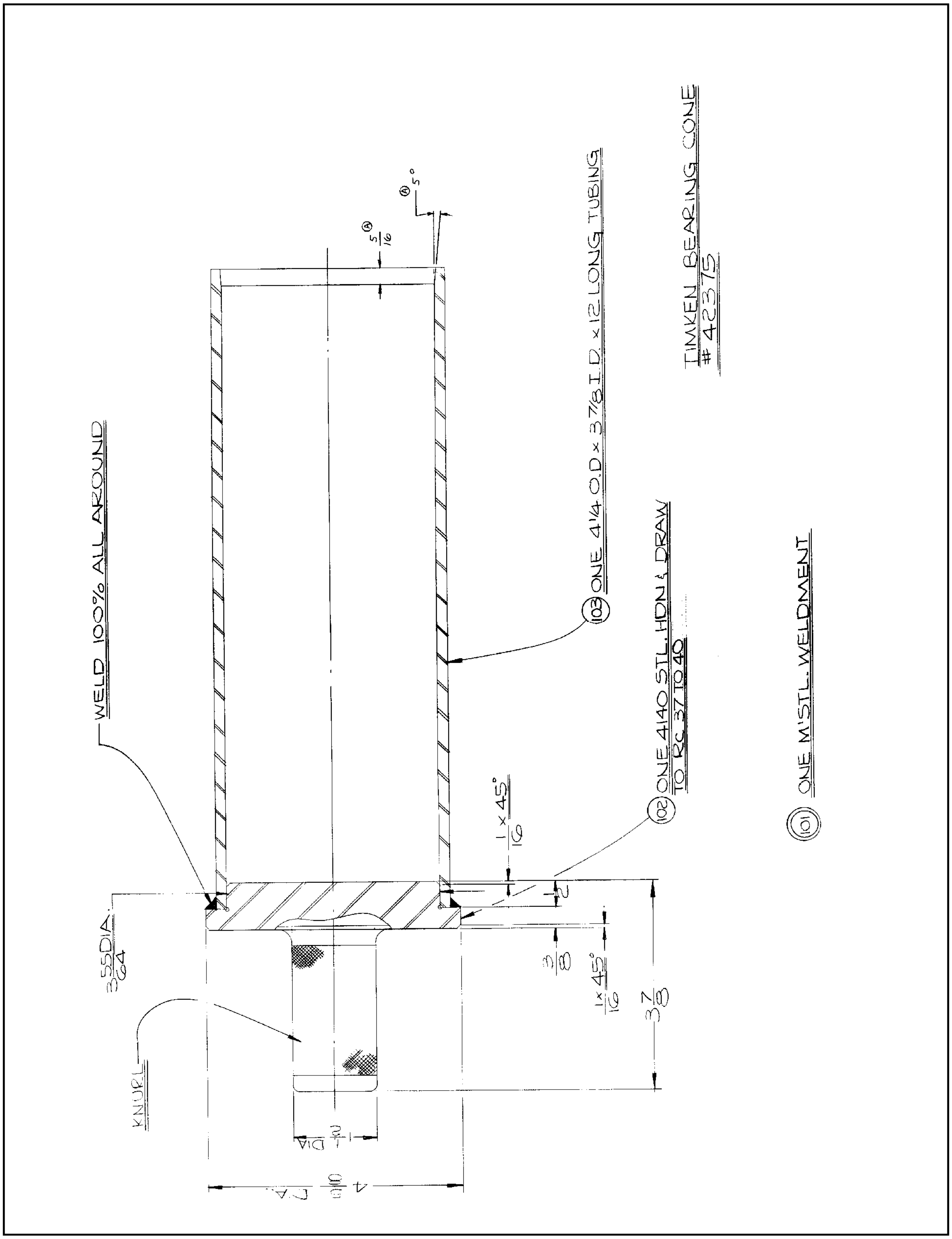


Figure 3-17. Assembly Tools - Bearing Cone Pressing - "B" Bearing

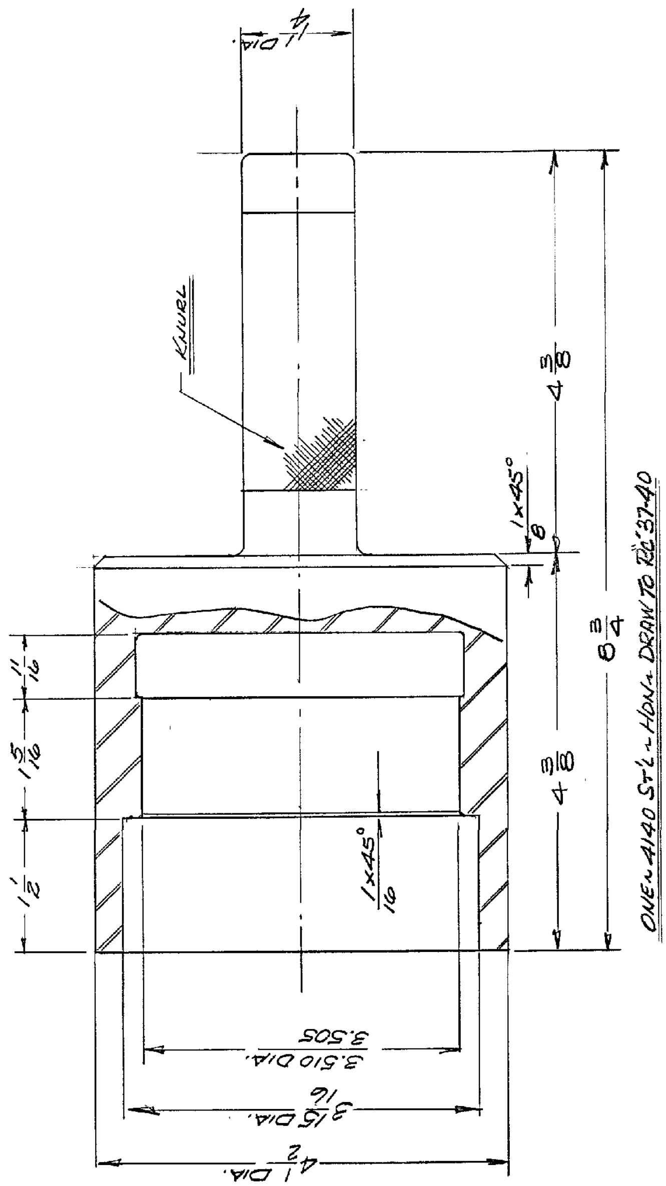


Figure 3-18. Assembly Tools - Bearing Cone Pressing - "A" Bearing

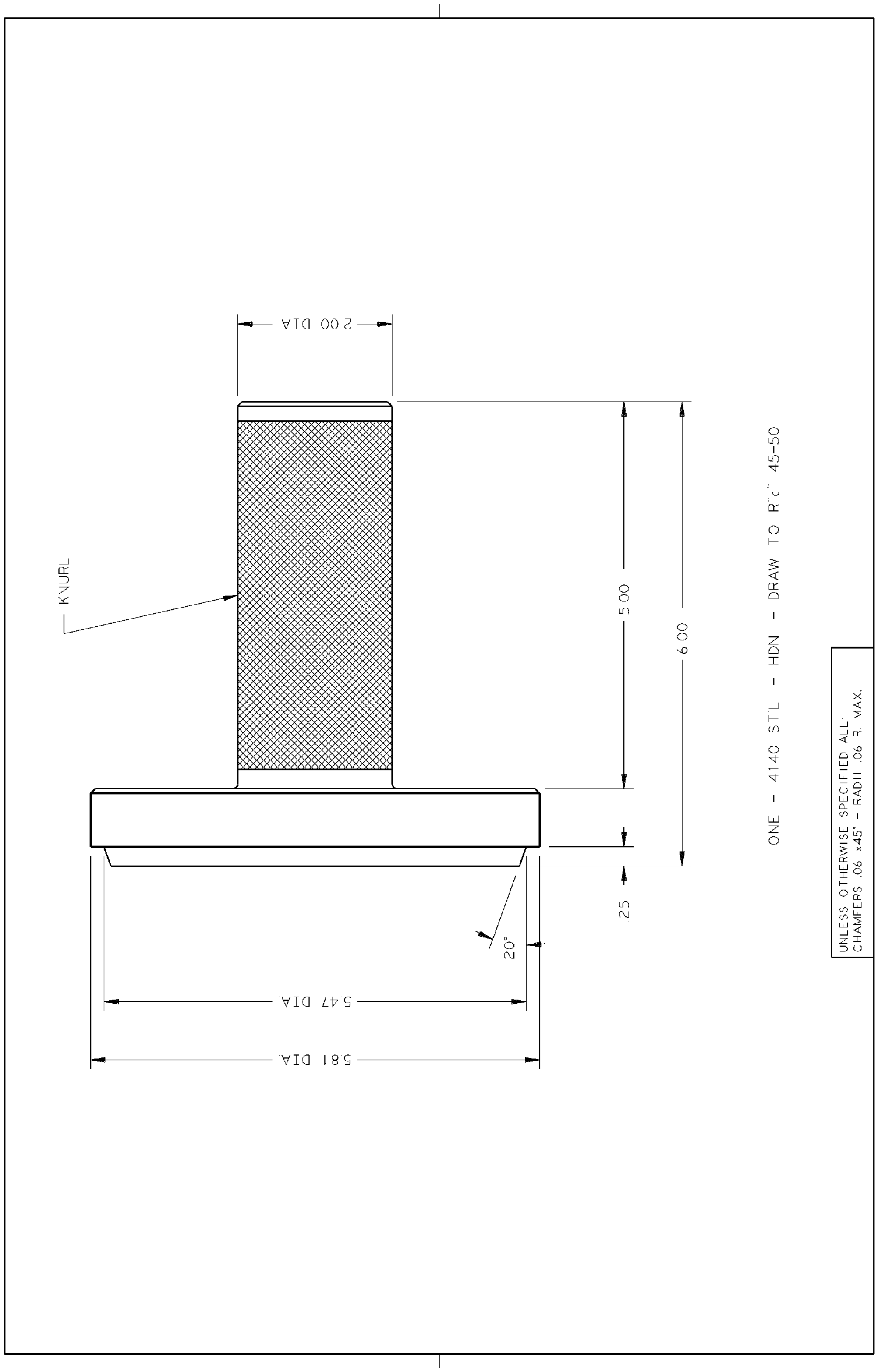


Figure 3-19. Assembly Tools - Bearing Cup Pressing - "A" & "B" Bearings

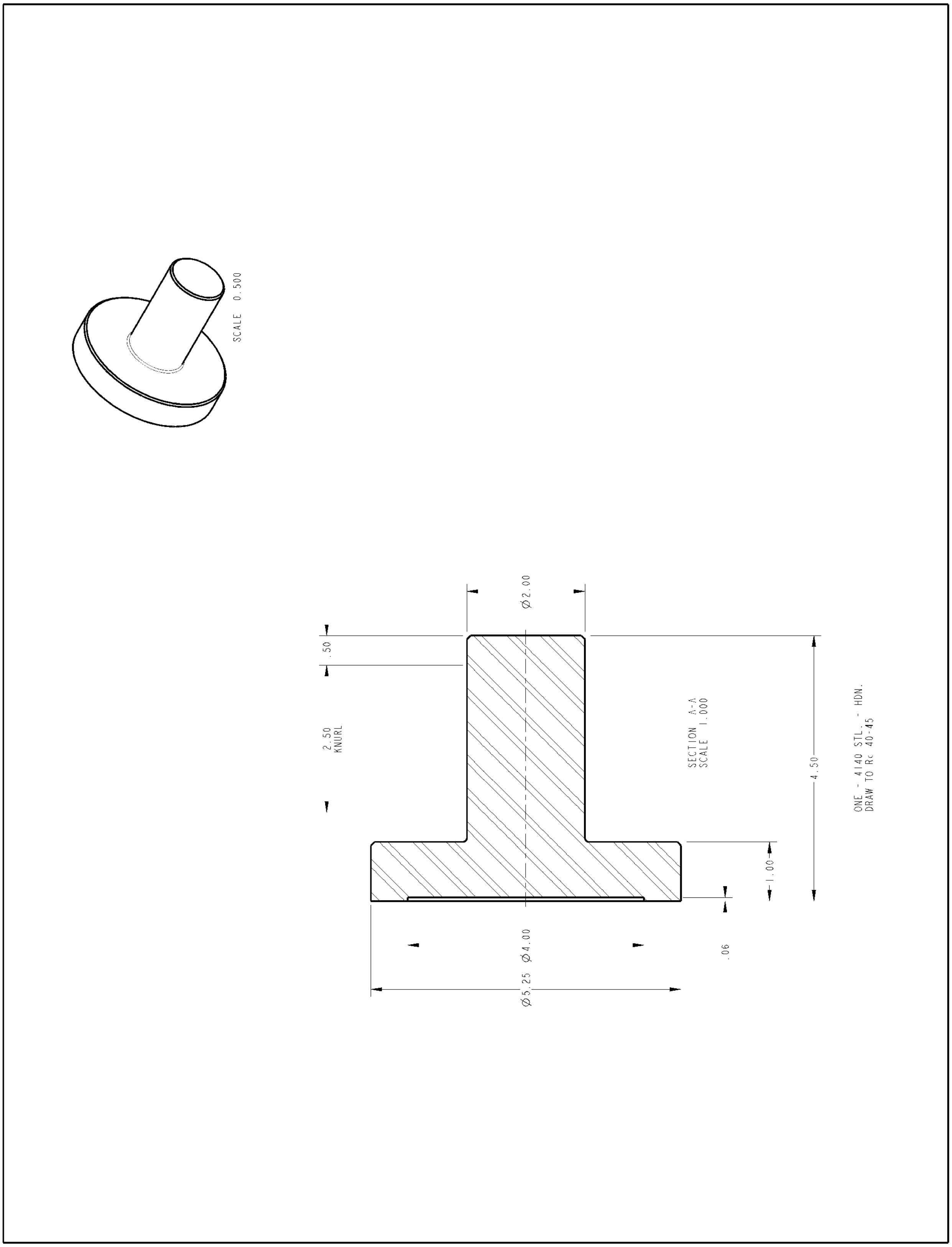


Figure 3-20. Assembly Tools - Seal Pressing

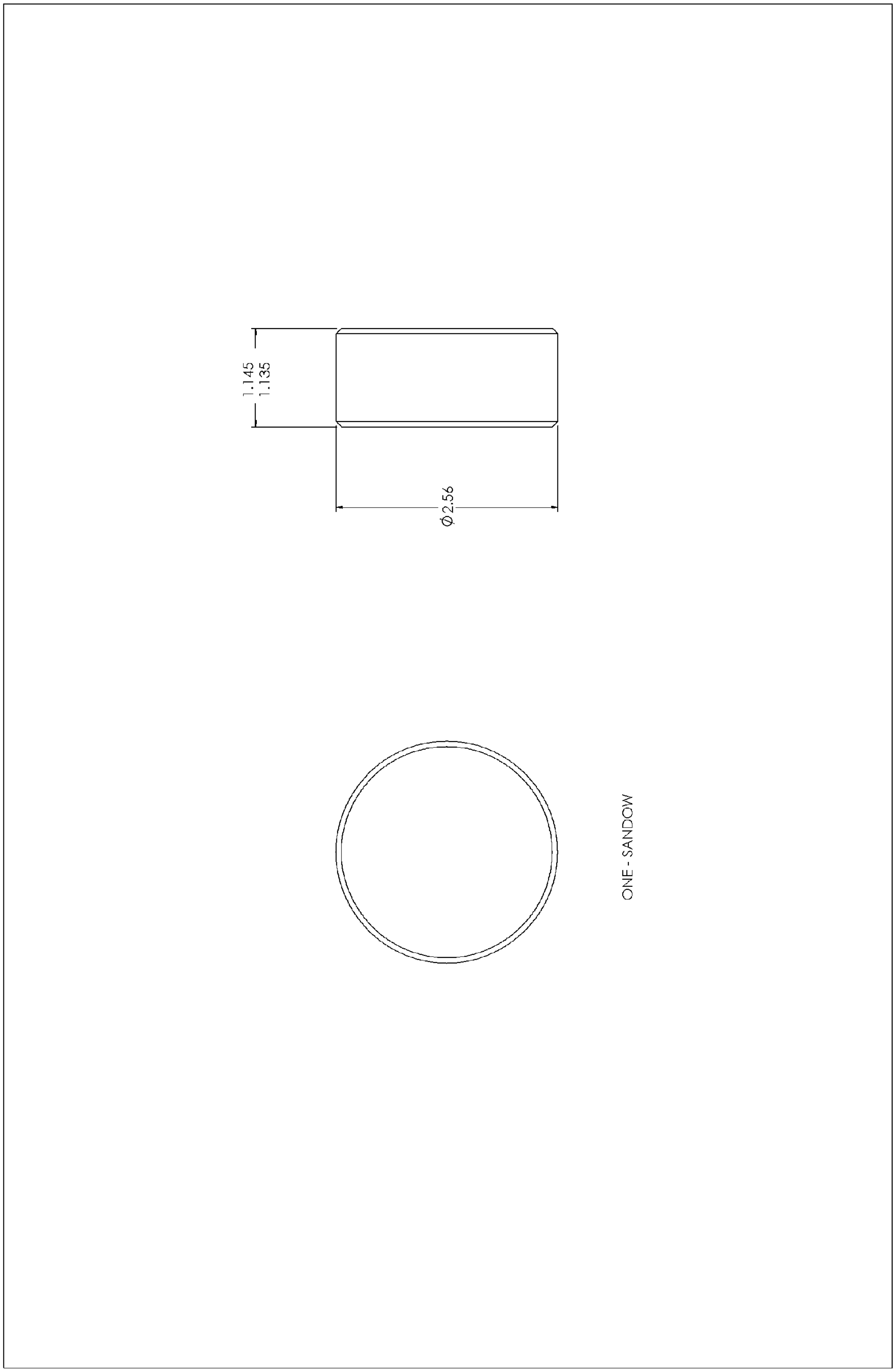


Figure 3-21. Assembly Tools - Spacer - Brake Disc Installation

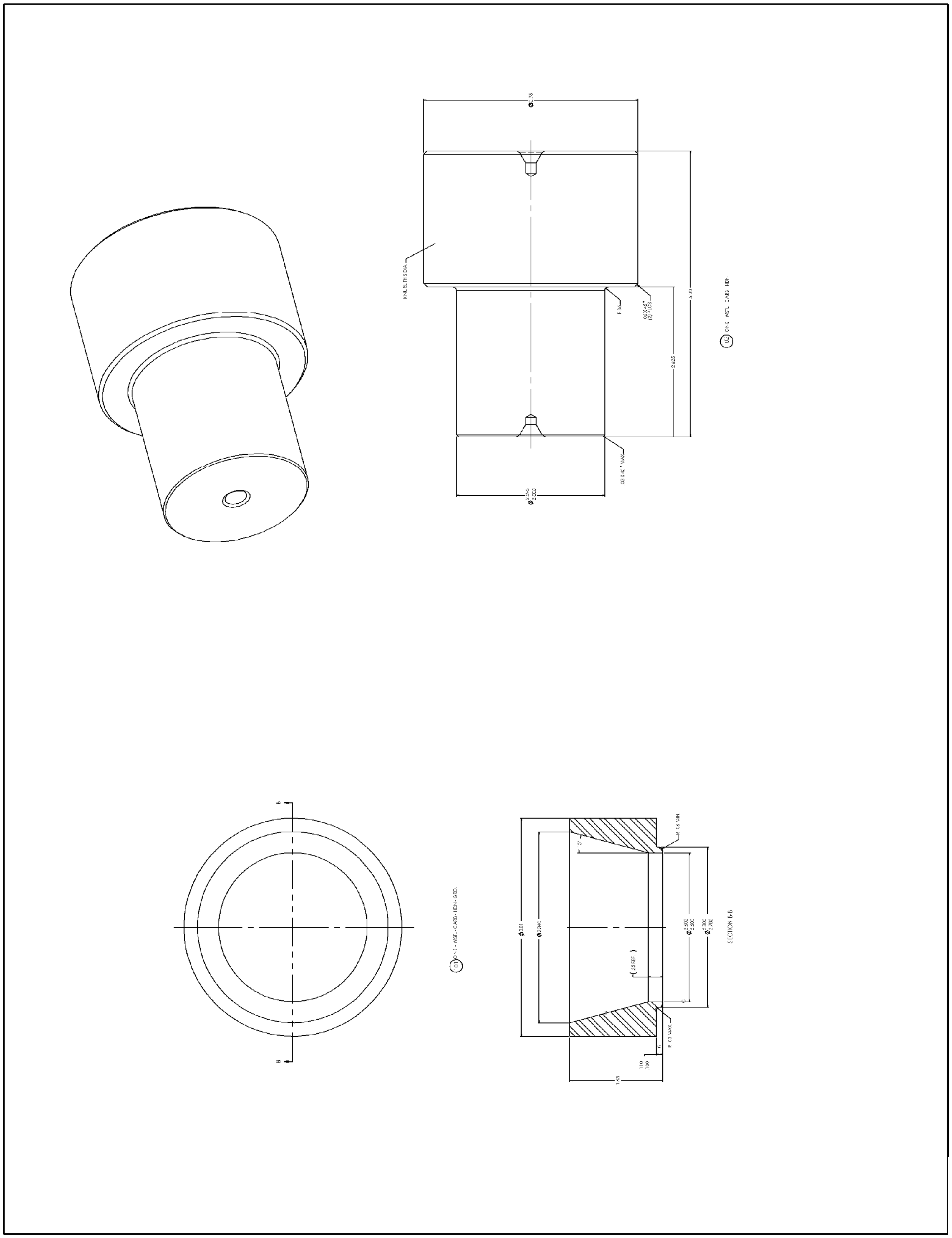


Figure 3-22. Assembly Tools - Brake Retaining Ring Installation

3.3 TORQUE HUB (MACHINES BUILT AFTER S/N 1300000064)

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

LEAK TEST

The purpose of a leak test is to make sure the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall once you have pressurized the unit. Leaks will most likely occur at the main seal or wherever o-rings or gaskets are located. Usually you can detect the exact location of a leak by brushing a soap and water solution around the main seal and where o-rings or gaskets meet the exterior of the unit, then checking for air bubbles. If you detect a leak in a seal, o-ring, or gasket, replace the part immediately.

Tightening and Torquing Bolts

If you use an air impact wrench to tighten bolts, take extreme care to ensure that you do NOT tighten the bolts beyond their indicated torque specification. Never use an impact wrench to tighten shoulder bolts. Always tighten all shoulder bolts by hand.

The following steps describe the proper procedure for tightening and torquing bolts or socket head **capscrews** in a bolt circle.

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

Oil Information

1. 1. TYPE – EP90
   On normal applications, use EP90. On applications where the lubricant must meet special requirements, the O.E.M should be able to 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)

Main Disassembly for "B" Drives

1. 1. Turn hub (1G) over onto its side, Remove coupling (14) from the wide end of spindle (1A).
2. Mark location of shoulder bolt holes on out- side of ring gear and hub for easy re-alignment when rebuilding. Remove the four shoulder bolts (13) and twelve bolts (12) from cover (6).
3. Remove the sixteen flat washers (16) from cover (6).
4. Lift cover sub-assembly (6) off of ring gear (4), and set cover on table, interior side facing up.

⚠ CAUTION

CAUTION: BEWARE OF SHARP EDGES IN THE COUNTERBORE WHEN YOU REMOVE THE O-RING.

5. Remove o-ring (5) from the counterbore around the edge of cover (6A). Discard the o-ring.

NOTE: *If o-ring is not in the cover counter- bore, it is in the ring gear counterbore. Remove it from the hub and discard it.*

6. Remove thrust washer (11) from the counter- bore in top of carrier (3A).
7. Remove input gear (8) from the middle of carrier sub-assembly (3).
8. Lift ring gear (4) off of hub (1G).
9. Lift carrier sub-assembly (3) out of hub (1G).
10. Remove thrust spacer (9) from input shaft (7) in the middle of spindle (1A).
11. Lift input shaft sub-assembly (7) out of middle of spindle (1A), and stand input shaft (7A) on its splined end.

⚠ CAUTION

WEAR SAFETY GLASSES DURING THIS STEP, AND BE AWARE THAT SPRING AND SPACERS COMPRESSED BY RETAINING RING MAY POP SUDDENLY OFF SHAFT WHEN YOU REMOVE THE RETAINING RING.

12. Using retaining ring pliers, remove retaining ring (7B) from the groove on input shaft (7A).
13. Remove one spacer (7D), one spring (7C), and other spacer (7D) from input shaft (7A).
14. Remove thrust washer (11) from around spindle (1A).
15. Lift internal gear (2) out of hub (1G).

⚠ CAUTION

BEWARE OF SHARP EDGES IN COUNTERBORE WHEN YOU REMOVE THE O-RING.

16. Remove o-ring (5) from the counterbore in hub (1G). Discard the o-ring.
17. At this point the main disassembly for "B" drives is complete.

Hub-Spindle Disassembly

NOTE: *Start with large end of hub facing up, large end of spindle facing down.*

⚠ CAUTION

WEAR SAFETY GLASSES DURING THIS STEP.

1. Remove retaining ring (1I) from around spindle (1A) ia hub (1G).
2. Remove spacer (1H) from around spindle (1A) in hub (1G).
3. Set hub (1G), small end/spindle facing down, up on something that will support the hub's flange while it lifts hub up so spindle is not resting on anything. Carefully press or hammer spindle (1A) down out of hub (1G).

NOTE: *If seal (1B) and bearing cone (1D) come out of hub and rest on spindle, remove these parts from the spindle and set them aside. Discard the seal.*

4. If seal and bearing cone did not come out of small end of hub (1G) when you pressed spindle out of hub, remove seal (1B) and bearing cone (1D) from the small end of hub (1G). Discard the seal.
5. Bearing cone (1F) should be lying loose in wide end of hub (1G). Remove bearing cone (1F) from inside hub (1G).

NOTE: *If you use a punch and hammer, make sure you do not strike counterbore with punch when you remove bearing cup.*

6. Remove bearing cup (1C) from the counterbore in the small end of hub (1G).

NOTE: *If you use a punch and hammer, make sure you do not strike the counterbore with the punch when you remove the bearing cup.*

7. Turn hub (1G) over and lift it out of the flange-support. Remove bearing cup (1E) from the counterbore in the wide end of hub (1G).
8. Turn hub (1G) over onto its small end. Remove two pipe plugs (1J) from the two pipe plug holes in the side of hub (1G).

NOTE: *If your unit does not have studs, skip this step:*

9. Press nine studs (1N) out of stud holes in hub (1G).
10. At this point hub-spindle disassembly is complete.

Cover Disassembly

1. Remove two bolts (6C) holding disconnect cap (6D) to cover (6A).
2. Remove disconnect cap (6D) from on top of cover cap (6B) and cover (6A).
3. Remove the two bolts (6C) holding cover cap (6B) to cover (6A).
4. Remove cover cap (6B) from cover (6A).
5. Remove disconnect rod (6K) from cover cap (6B).
6. Pry o-ring (6F) out of the groove inside cover cap (6B). Discard the o-ring.
7. Remove o-ring (6G) from the flange of cover cap (6B). Discard the o-ring.
8. Remove pipe plug (6H) from cover (6A).
9. At this point the cover disassembly is complete.

Carrier Disassembly

NOTE: *When you remove needle rollers from cluster gears, discard old needle rollers and use new ones during re-assembly.*

1. Using a punch and hammer, drive roll pin (3G) into planet shaft (3E).

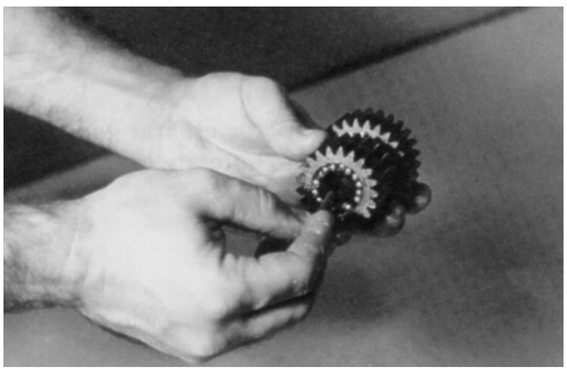
NOTE: *If you don't drive the roll pin all the way into the planet shaft t, you could damage the carrier when you remove the planet shaft from the carrier.*

2. Using a punch and hammer, drive planet shaft (3E) out of the planet shaft t hole in carrier housing (3A).
3. When you remove planet shaft (3E) from carrier housing, one thrust washer (38), one cluster gear (3F), and one more thrust washer (3B) will come off of the planet shaft and come to rest inside the carrier. Remove these parts from inside the carrier.

4. Remove 16 needle rollers (3C) from inside one end of cluster gear (3F). Discard the needle rollers.
5. Remove one spacer (3D) from inside cluster gear (3F).
6. Remove the remaining 16 needle rollers (3C) from the other side of cluster gear (3F). Discard the needle rollers.
7. Repeat steps 1-6 to remove and disassemble the two remaining cluster gears.
8. At this point the carrier disassembly is complete.

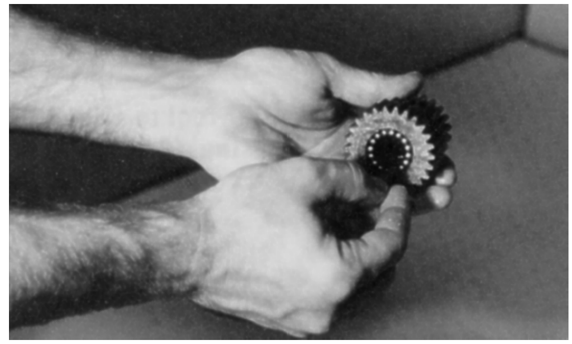
Carrier Assembly

1. Apply grease to inside of one cluster gear (3F) and line one half of cluster gear with 16 needle rollers (3C).

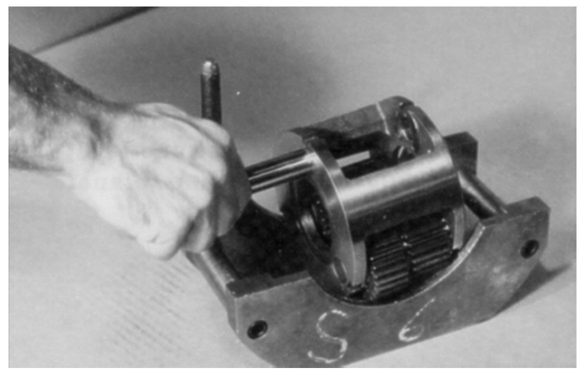


2. Place one spacer (3D) inside cluster gear (3F) so that it rests on top of the needle rollers.

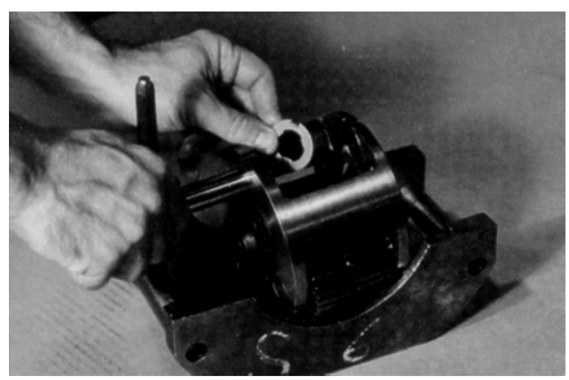
3. Line remaining half of cluster gear (3F) with 16 needle rollers.



4. Set carrier housing (3A) on table, sideways. Insert a planet shaft (3E), roll pin hole last, in one of planet shaft holes from roll-pin-holed side of carrier housing (3A).

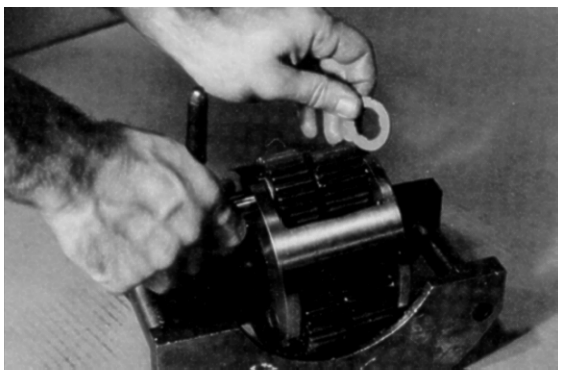


5. Place one thrust washer (3B) onto the end of planet shaft (3E) inside carrier. Fit tang of thrust washer into the slot on the inside edge of the planet shaft hole.

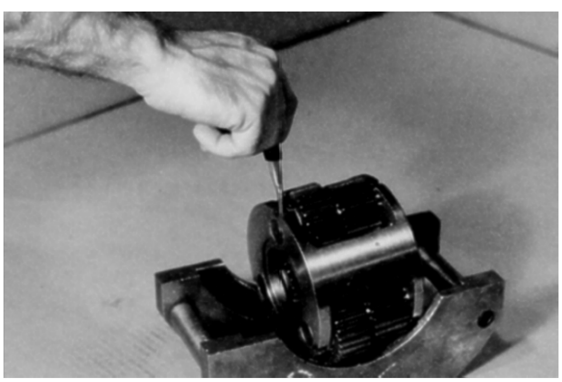


6. Following thrust washer, place cluster gear (3F), large end toward roll pin hole in carrier housing, on planet shaft (3E).

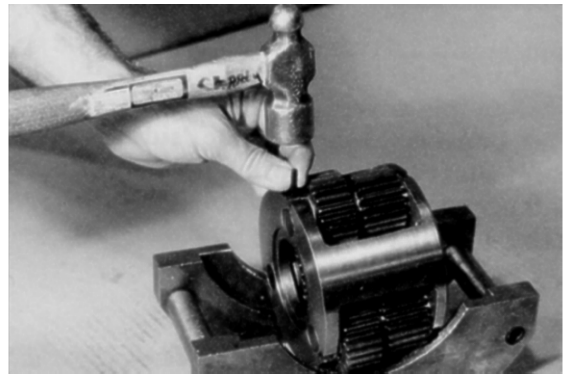
7. Following cluster gear, place one more thrust washer (3B) on planet shaft (3E) through opposite planet shaft hole in carrier housing (3A).



8. Use an alignment punch or similar tool to align roll pin holes in carrier housing (3A) and planet shaft (3E).



9. Drive roll pin (3G) down in aligned roll pin holes in carrier housing (3A) and planet shaft (3E).

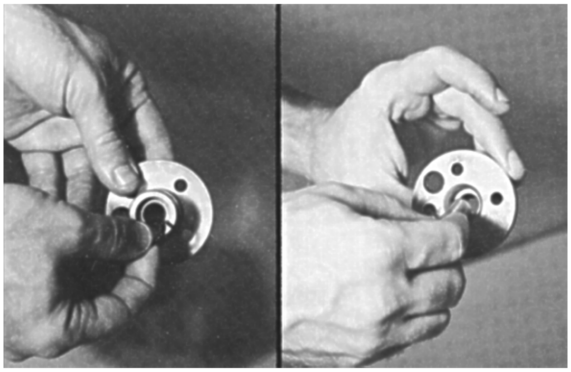


10. Repeat steps 1 thru 9 to assemble and install remaining cluster gears.

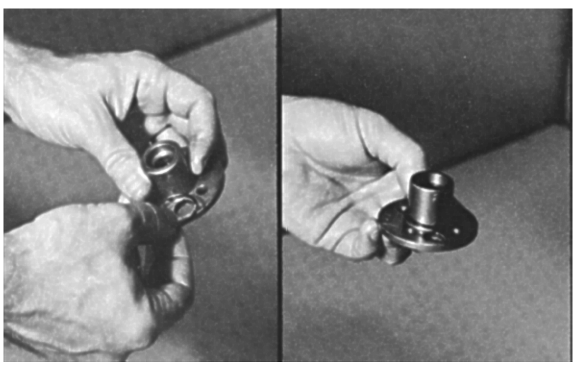
11. At this point carrier sub-assembly is complete.

Cover Sub-Assembly

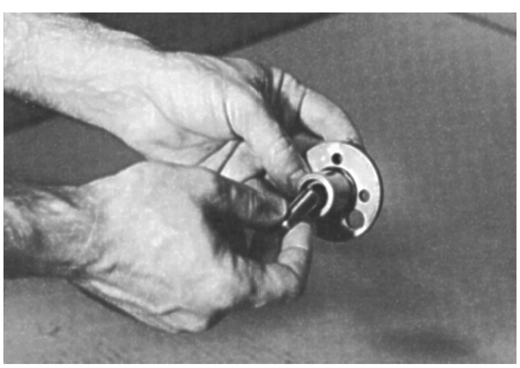
1. Using the disconnect rod, push O-ring (6F) in groove inside cover cap (6B).



2. Place O-ring (6G) on cover cap (6B) so that it rests against flange of cover cap.



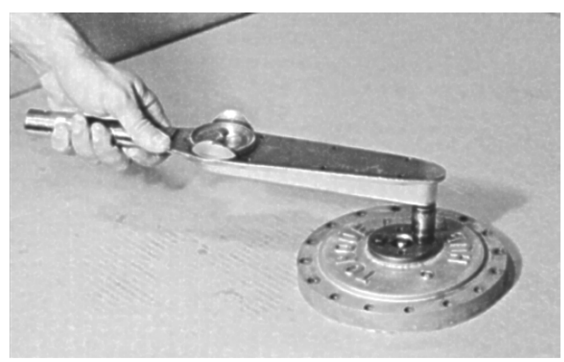
3. Insert disconnect rod (6E) in cover cap (6B).



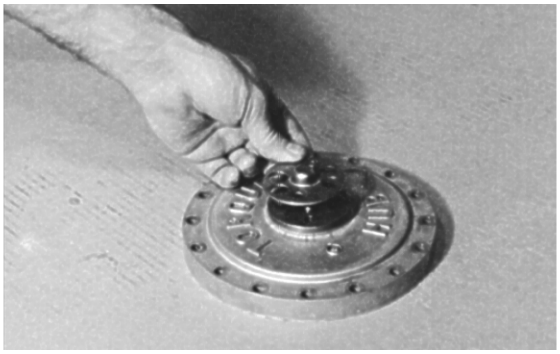
4. Set cover (6A) on table, exterior side up. Place cover cap (6B) on cover (6A), aligning pipe plug hole in cover cap over pipe plug hole in cover.

5. Place two cover cap bolts (6C) in any two bolt hoes that are 180° apart on cover cap (6B) and tighten bolts.

6. Using a torque wrench, apply 36 to 49 in-lb (4 to 5 Nm) of torque to both bolts (6C).

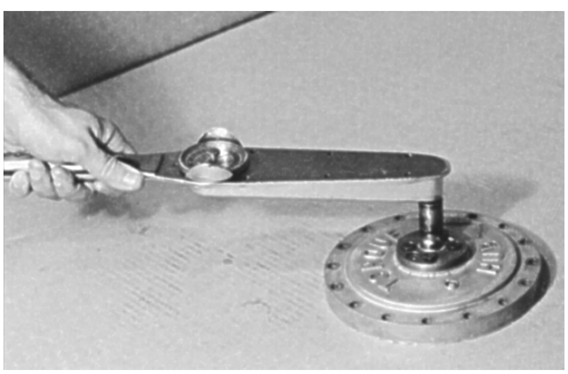


7. With large end down, place disconnect cap (6D) on cover cap (6B), aligning pipe plug hole in disconnect cap over pipe plug hole in cover cap.

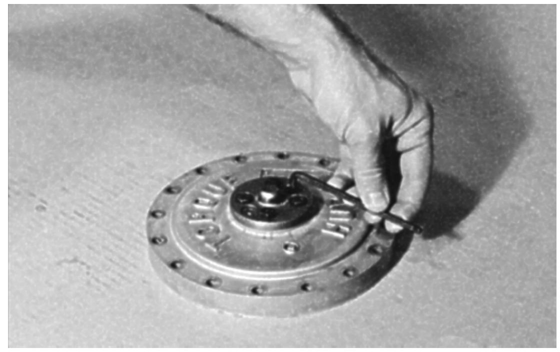


8. Place two remaining bolts (6C) in bolt holes in disconnect cap (6D). Tighten bolts.

9. Using a torque wrench, apply 36 to 49 in-lb (4 to 5 Nm) of torque to both bolts (6C).



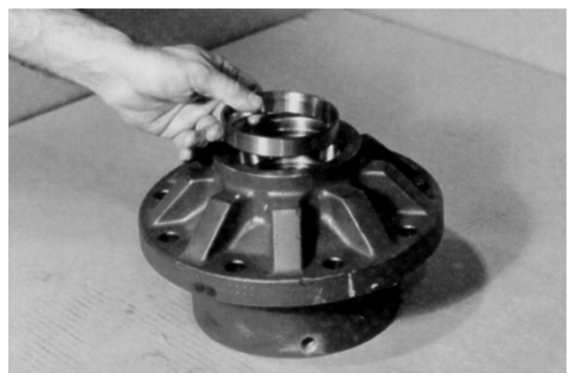
10. Apply a light coat of "Never-Seize" to pipe plug (6H) and tighten it in pipe plug hole in cover (6A).



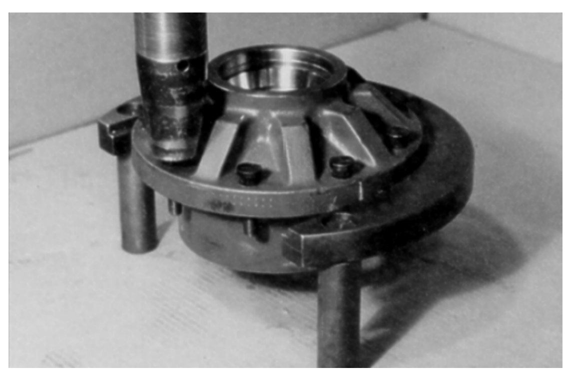
Hub-Spindle Sub-Assembly

NOTE: *Make sure cup is square with counterbore before pressing.*

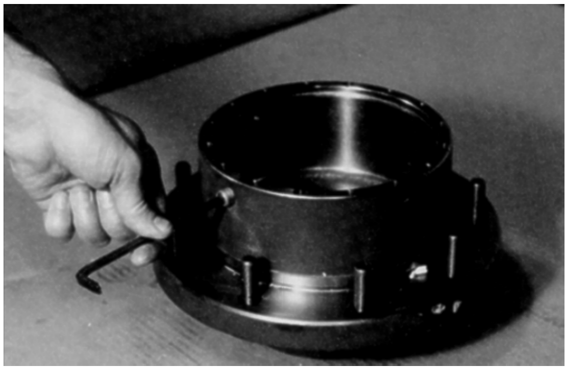
1. Set hub (1G) on large end. Press bearing cup (1C) in counterbore in small end of hub (1G).



2. Press nine studs (1N) in stud holes in hub (1G).

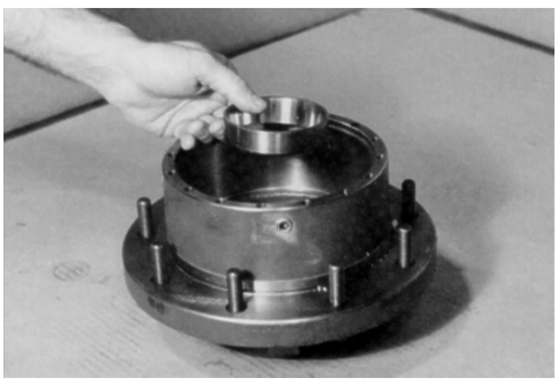


3. Apply a light coat of "Never-Seize" to two pipe plugs (1J) and tighten them into two pipe plug holes in side of hub (1G).

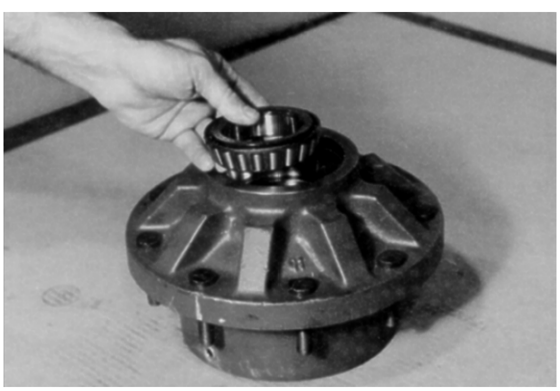


NOTE: *Make sure cup is square with counterbore before pressing.*

4. Turn hub (1G) over onto its small end. Press bearing cup (1E) in counterbore in deep end of hub (1G).



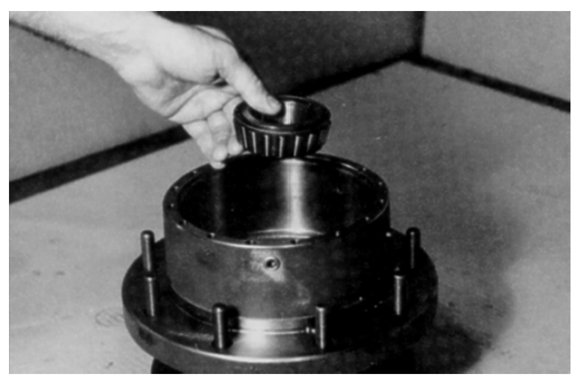
5. Set hub (1G) on its large end. Place bearing cone (1D) in bearing cup (1C).



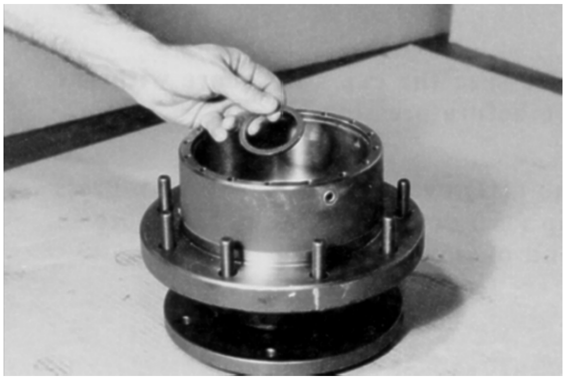
6. Press seal (1B) in small end of hub (1G).

7. Oil spindle, then lower hub (1G), small end down, onto spindle (1A).

8. Press bearing cone (1F) on spindle (1A) in hub (1G).



9. Place spacer (1H) on spindle (1A) in hub (1G).



NOTE: *Make sure retaining ring is securely seated in groove.*

10. Place retaining ring (1I) over spacer onto spindle (1A) in hub (1G).

11. At this point hub-spindle sub-assembly is complete.

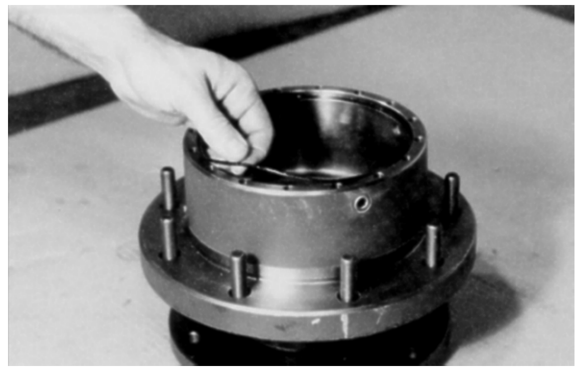
Main Assembly

WARNING

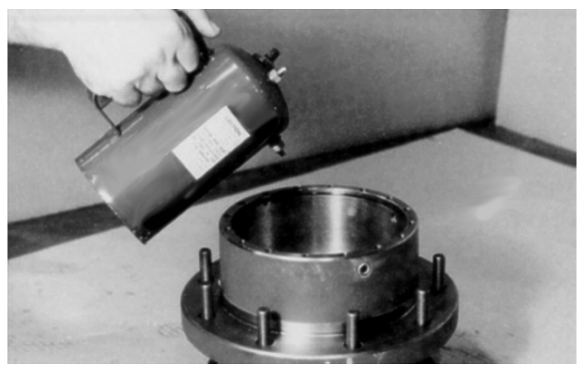
BEWARE OF SHARP EDGES IN COUNTERBORE WHEN INSTALLING THE O-RING

1. Grease O-ring (5) and place it in hub counterbore (1G).

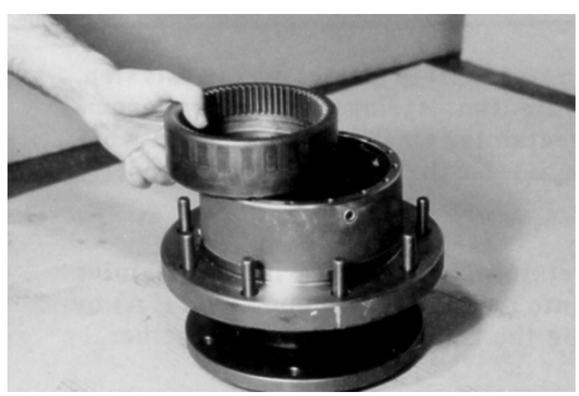
NOTE: *O-ring may be stretched or pinched together to make it fit counterbore.*



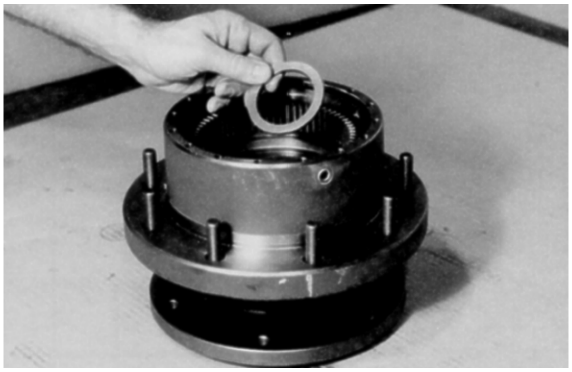
2. Oil all exposed surfaces inside hub (1G).



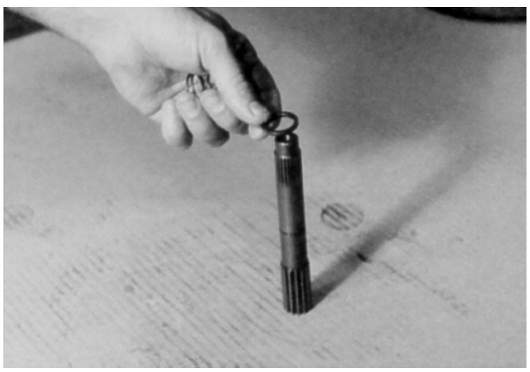
Place internal gear (2) in hub (1G) so its internal splines mesh with external splines of spindle (1A). Oil internal gear (2).



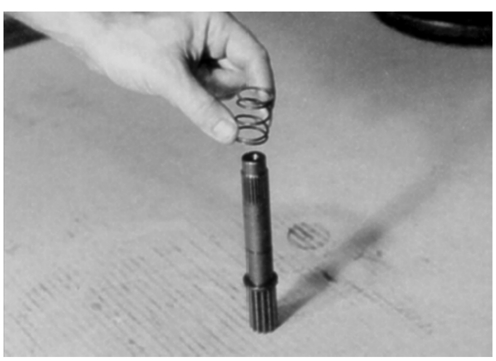
3. Place thrust washer (11) around spindle (1A) so it rests on bottom of internal gear (2).



4. Stand input shaft (7A) on its splined end. Place one spacer (7D) on smooth end of input shaft (7A).



5. Place one spring (7C) on smooth end of input shaft (7A).

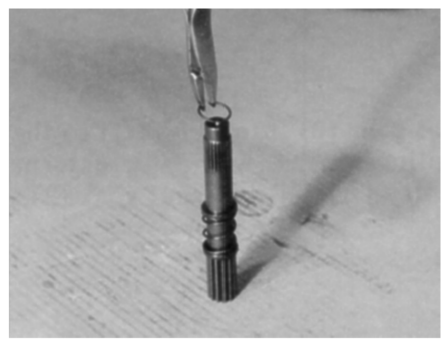


6. Place spacer (7D) on smooth end of input shaft (7A).

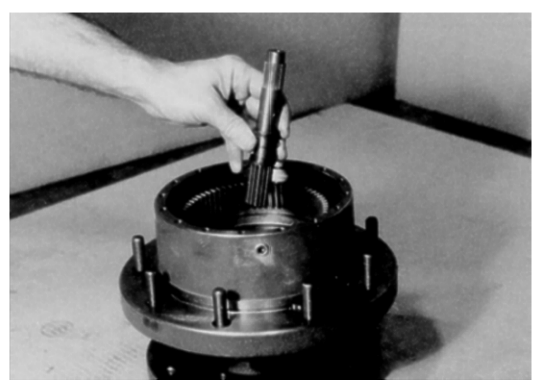
WARNING

WEAR SAFETY GLASSES DURING THIS STEP, AND BE AWARE THAT SPRING AND SPACERS, COMPRESSED BY RETAINING RING, MAY POP SUDDENLY OFF SHAFT IF THE RING IS RELEASED BEFORE IT IS PROPERLY IN PLACE.

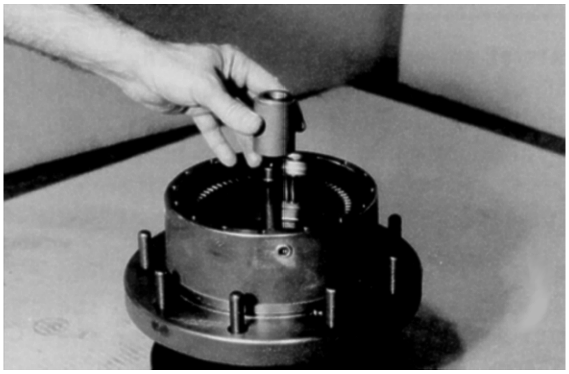
7. Using retaining ring pliers, insert retaining ring (7B) in groove on input shaft (7A) by compressing spring and spacers together.



8. With large splined end down, place input shaft sub-assembly (7) in spindle (1A).



9. Place thrust spacer (9) on input shaft (7).



10. Set carrier sub-assembly (3) on a flat work surface so large ends of cluster gears (3F) face up. Locate punch marks on face of each cluster gear (3F) and position them at 12 o'clock.

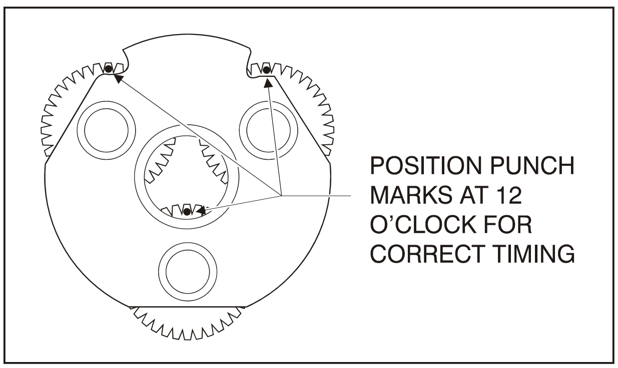
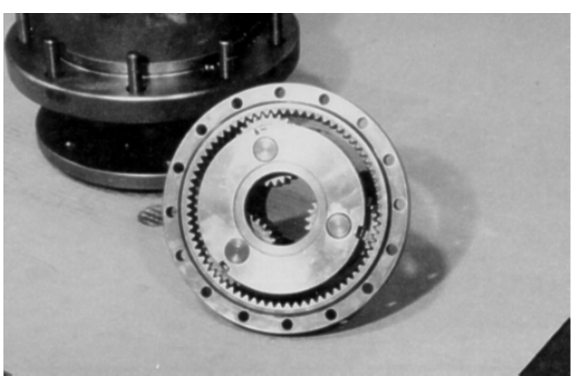


Figure 3-23. Cluster Gear Punch Marks

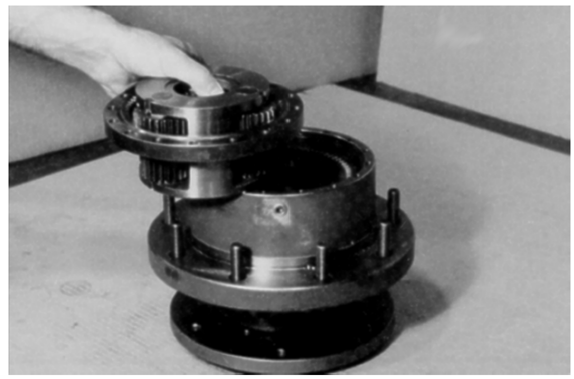
11. With "X" marked side facing up, place ring gear (4) around cluster gears (3F).

NOTE: *This will hold punch marks in position while installing carrier into hub.*

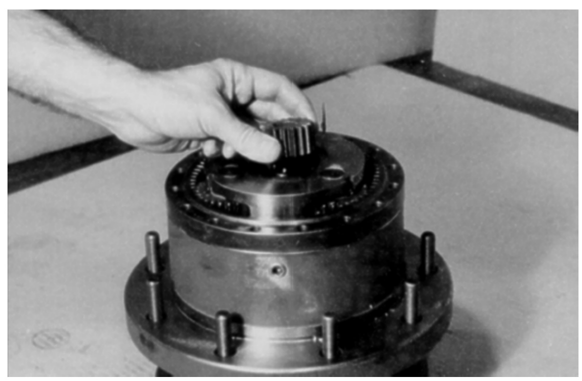


12. Place carrier sub assembly (3) and ring gear (4) together into mesh with internal gear (2). Align "X" marked shoulder bolt hole in ring gear (4) over one of the shoulder bolt holes in the hub. Mark location of shoulder bolt holes on outside of ring gear and hub.

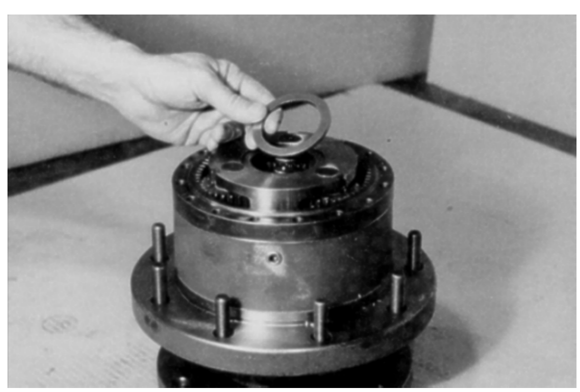
NOTE: *You may lift ring gear off hub to align shoulder bolt holes. Ring gear and carrier are installed together only to keep punch marks on the carrier in place.*



13. With internal splines facing up (counterbore end facing down), place input gear (8) into mesh with carrier sub-assembly (3).



14. Oil all exposed surfaces inside hub (1G). Place thrust washer (11) in counterbore in top of carrier.

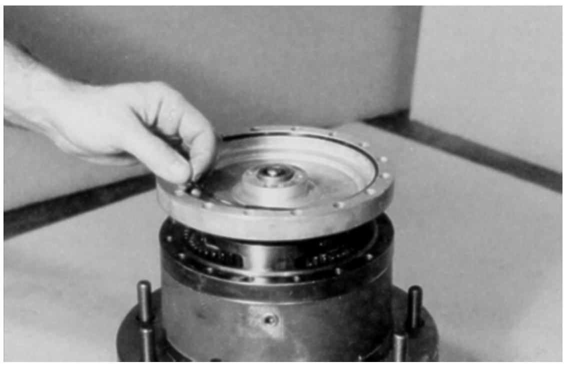


⚠ WARNING

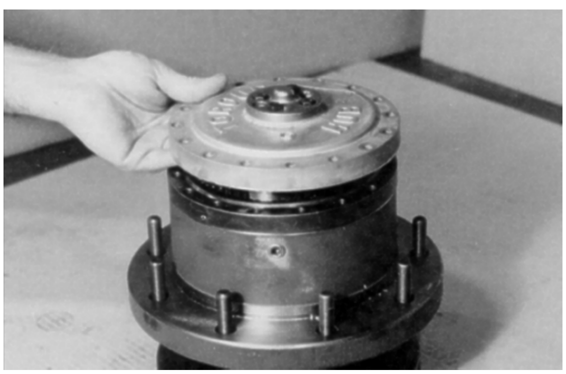
BEWARE OF SHARP EDGES IN COUNTERBORE WHEN INSTALLING O-RING.

15. Set cover (6A) on table, interior side up. Grease O-ring (5) and place it in counterbore around edge of cover (6A).

NOTE: *O-ring may be stretched or pinched together to make it fit counterbore.*

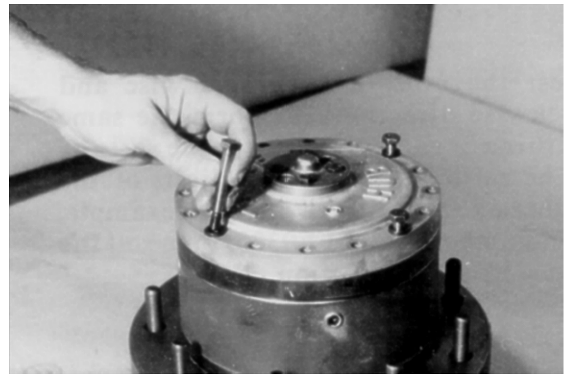


16. Place cover sub-assembly (6) on ring gear (4). Align pipe plug holes according to alignment before disassembly.

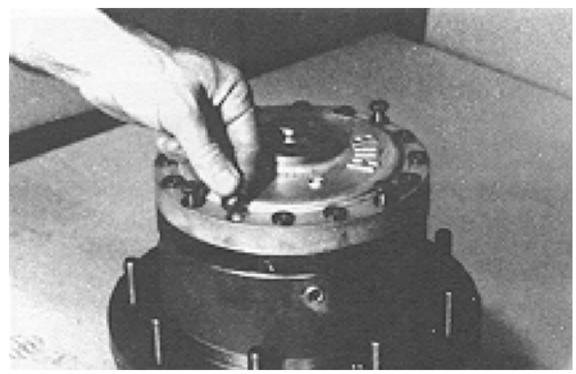


17. Place four flat washers (16) on top of bolt holes in cover sub-assembly.

18. Place shoulder bolts (13) in four shoulder bolt holes in cover (6). Tighten by hand.

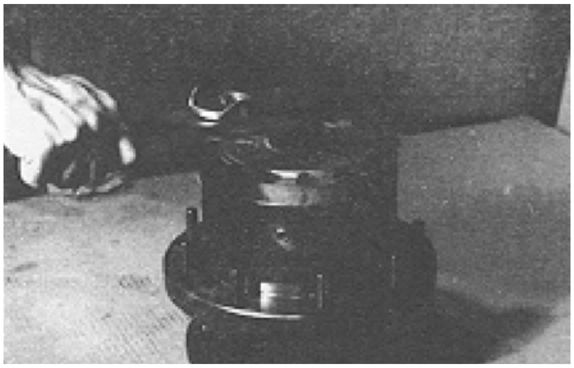


19. Place remaining 12 flat washers (16) on remaining bolt holes in cover (6).

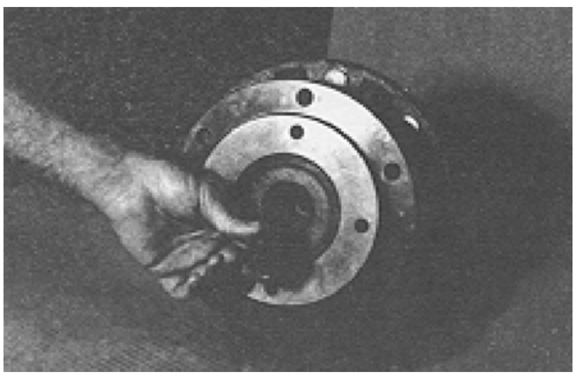


20. Place 12 bolts in remaining bolt holes in cover (6) and tighten.

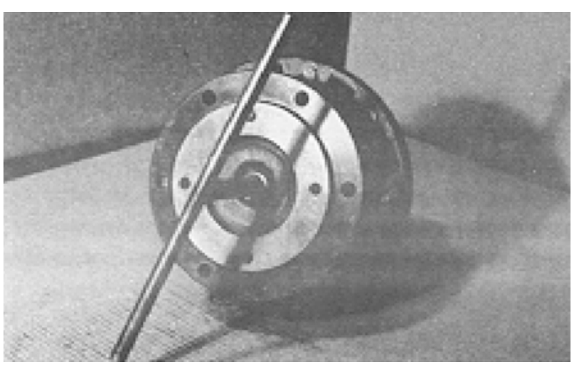
21. Torque shoulder bolts (13) 18 to 25 ft-lb (25 to 34 Nm). Torque bolts (12) 18 to 25 ft-lb (25 to 34 Nm).



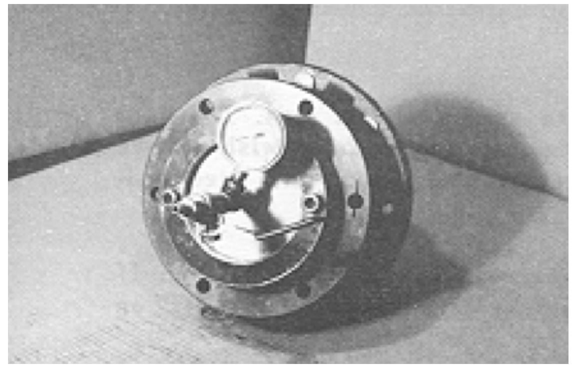
22. Turn hub (1G) over on its side. Insert coupling (14) in the end of spindle (1A).



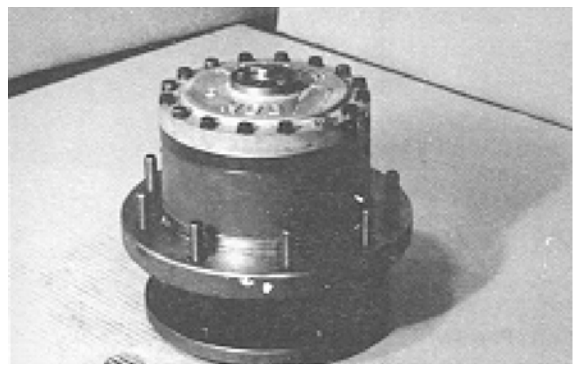
23. Roll test unit in clockwise and counterclockwise directions. Perform same number of turns in each direction as the ratio of the unit. The ratio is last two digits of model number on the unit's ID tag.



24. Leak test unit at a pressure of 5 psi for 2 to 3 minutes.



25. At this point main assembly is complete.

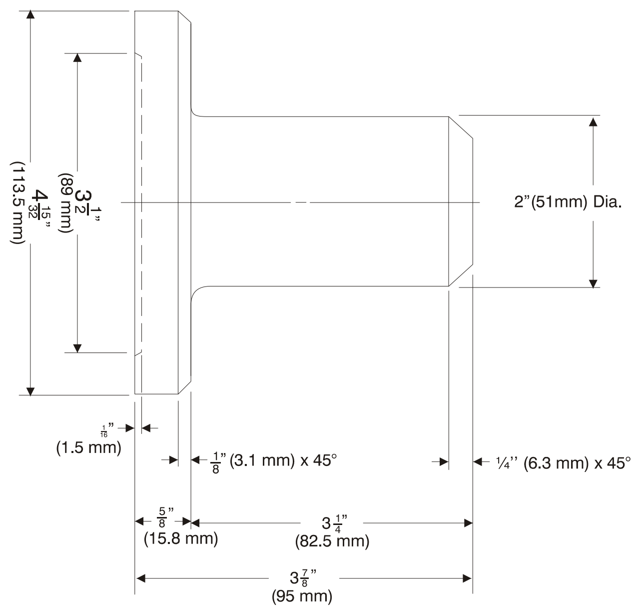


Tool List

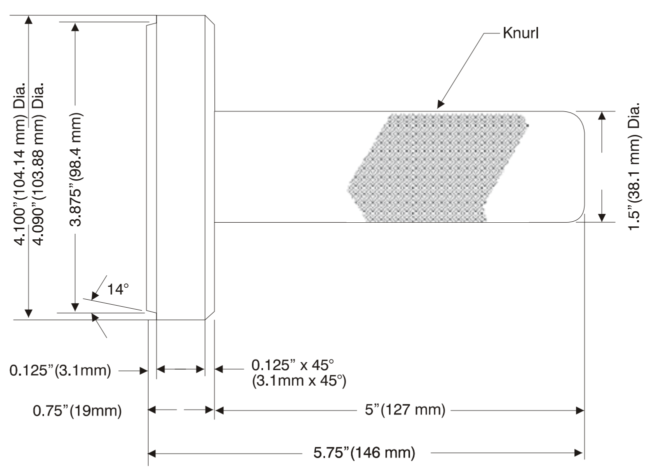
The following specialized tools are used to assemble this unit. Tool diagrams included in this manual are intended for the customer who may wish to have a tool made. All tools exist as one piece and must be made from mild steel All dimensions are given in inches.

NOTE: *To improve tool life, tools may be carburized and hardened. If this is done, tools must be ground on all surfaces labeled with a "G" on the tool diagram.*

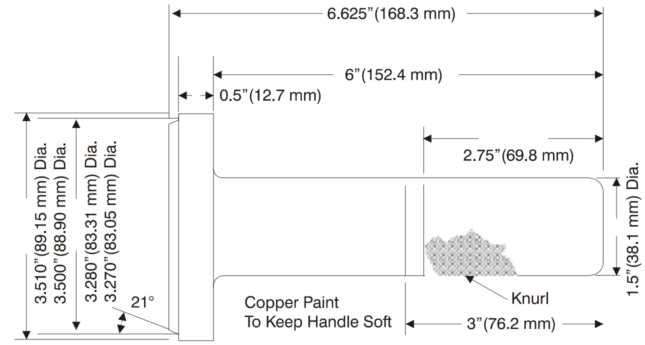
1. T-118126 SEAL PRESSING TOOL for SEAL (1B).



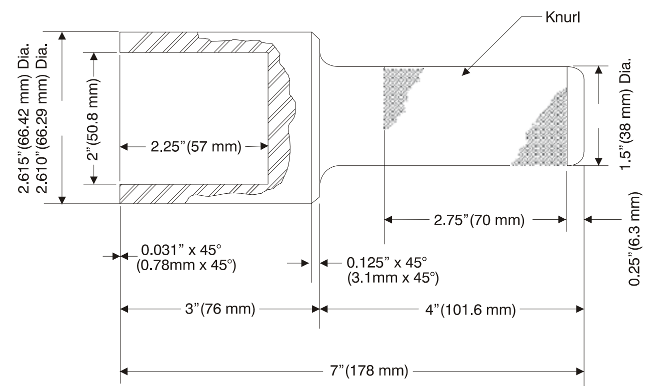
2. T-138903 ASSEMBLY PRESSING TOOL for CUP (1C)



3. T-140433 ASSEMBLY PRESSING TOOL for CUP (1E)



4. T-109691 ASSEMSLY PRESSING TOOL for CONE (1F)



* These tools are for specific seals, cups or cones. There is a specific tool for each cup and cone.

3.4 RE-ALIGNING TORQUE HUB INPUT COUPLING

The following procedure applies to torque hubs with integral brakes.

Equipment Required

1. Hydraulic power supply (hand pump) capable of producing 200 psi (13.8 bar).
2. Hydraulic fittings to adapt hydraulic supply to brake release port on hub.

Procedure

1. Using appropriate fittings, connect a line from hydraulic power supply to brake port.
2. Pressurize brake release port 155 to 200 psi (10.6 to 13.8 bar) to release brake.
3. Verify that the brake is released by rotating the input coupling or hub spindle.
4. Once the brake is released, the input coupling will be free to re-align with the drive motor.
5. Install drive motor on hub, then release hydraulic pressure at brake release port. Coupling will remain in position.
6. Disconnect the hydraulic power supply and reconnect the line going into the brake release port.

3.5 DRIVE MOTOR

Description

Drive motors are low to medium power, two-position axial piston motors incorporating an integral servo piston. They are designed for operation in both 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.

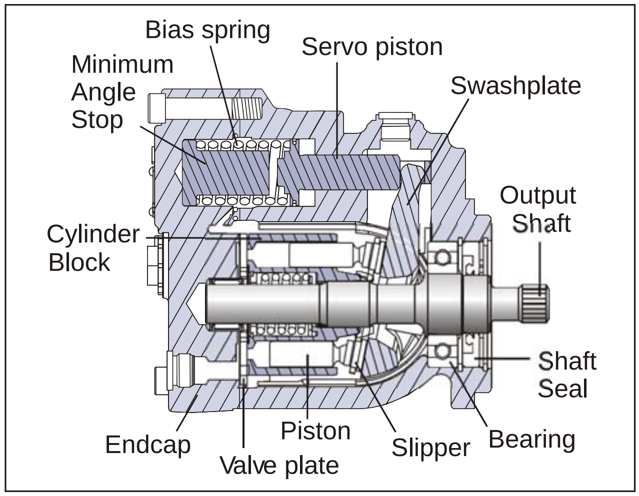
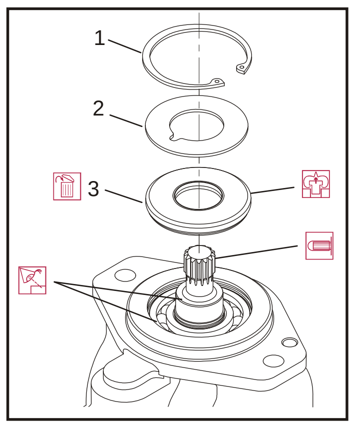


Figure 3-24. Drive Motor Cross Section

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 3-25. Removing Shaft Seal

2. Remove the 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 into seal surface and use slide hammer to pull seal.*

4. Discard seal.

INSPECT COMPONENTS

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

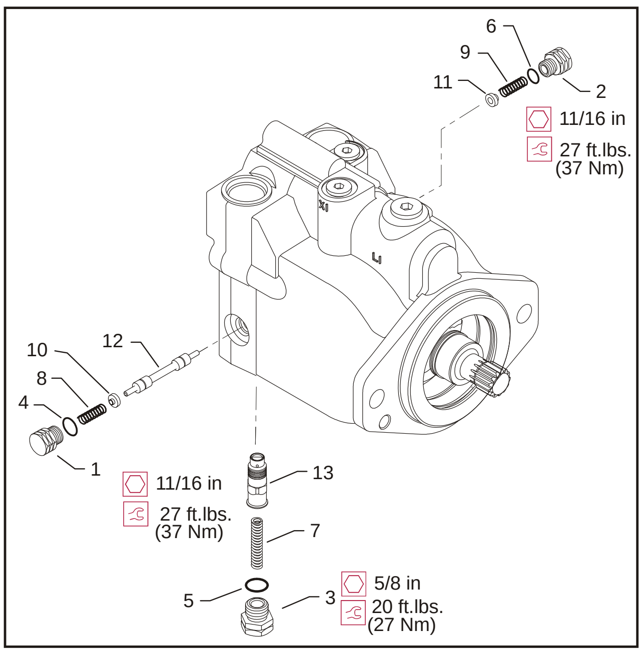
INSTALLATION

1. Cover the shaft splines with an installation sleeve to protect the shaft seal during installation.
2. Install a new shaft seal with the cupped side facing the 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 the installation sleeve.

Loop Flushing Valve

REMOVAL

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



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 3-26. Loop Flushing Spool

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

INSPECT COMPONENTS

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

INSTALLATION

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

Troubleshooting

Table 3-2. Excessive Noise and/or Vibration

Item	Description	Action
Check oil level in reservoir and oil supply to the motor.	Insufficient hydraulic fluid could lead to cavitation that would cause system noise.	Fill the reservoir to the proper level and ensure that oil supply to the motor is adequate and the lines are unobstructed.
Check for air in the system.	Air trapped within the system lines, or the motor itself, could result in cavitation that would cause system noise.	Ensure that all of the system lines and components are purged of air.
Inspect the output shaft couplings.	A loose or incorrect shaft coupling will produce vibrations that could result in system noise.	Ensure that the correct coupling is used and that it fits properly onto the shaft.
Inspect the output shaft alignment.	Misaligned shafts create excessive frictional vibration that could result in system noise.	Ensure that the 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 the pump.	Insufficient amount of hydraulic fluid will not meet the cooling demands of the system.	Fill the reservoir to the proper level.
Inspect the heat exchanger, (if so equipped).	If the heat exchanger fails, or becomes obstructed, it may not meet the cooling demands of the system.	Ensure that heat exchanger is receiving adequate air flow and that the heat exchanger is in good operating condition. Repair or replace as necessary.
Check the system relief valves.	If a system relief valve becomes unseated for an extended period of time or fails for any other reason, the system could become overheated.	Repair or replace any malfunctioning relief valves as applicable and verify that the loads on the machine are not excessive.

Table 3-4. Won't Shift or Slow to Start

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

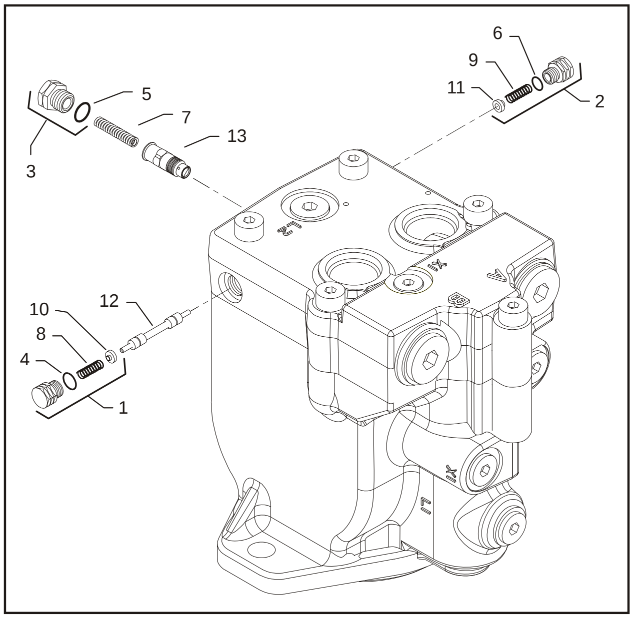
Disassembly

NOTE: *Removal of endcap voids warranty.*

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

Replace all O-Rings and gaskets.

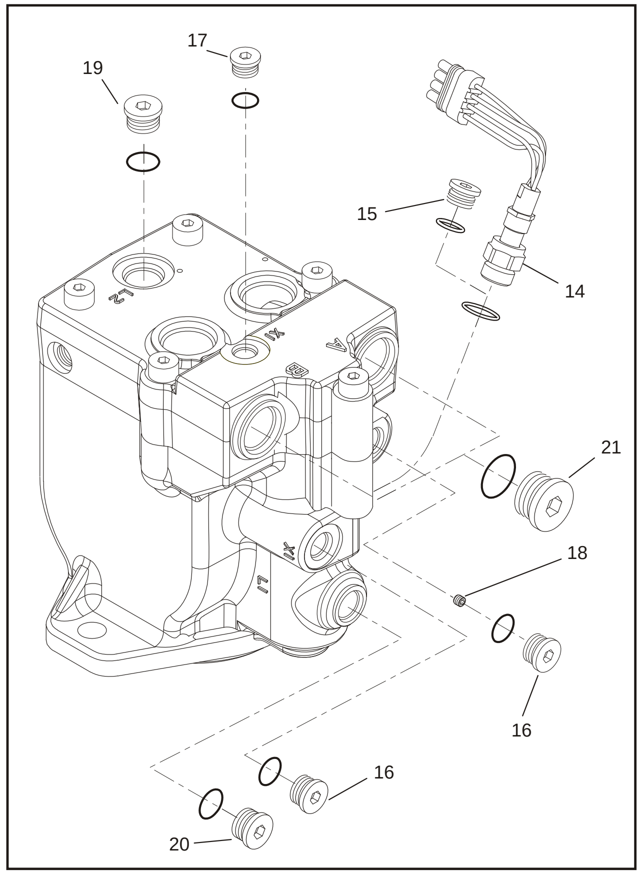
It is recommended that all O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



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

Figure 3-27. Loop Flushing Spool

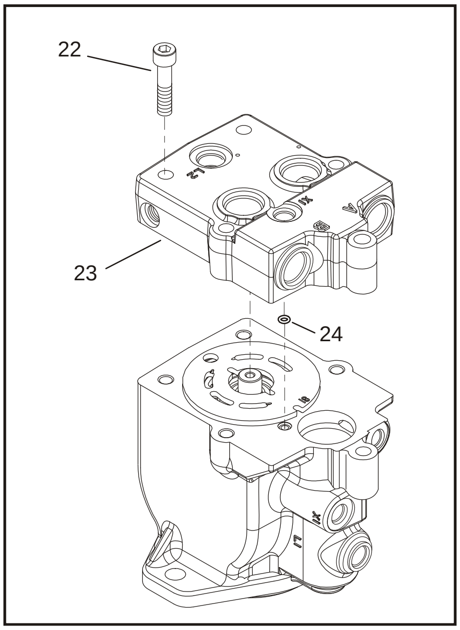
1. Using a 11/16 in wrench remove plug (1) and (2).
2. Using a 5/8 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



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 3-28. Plugs, Fittings, and Speed Sensor

8. Remove all fittings from unit. Discard O-rings on fittings.
9. Using an 11/16 inch hex wrench, loosen the speed sensor lock nut (14) if equipped. Then remove the 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.



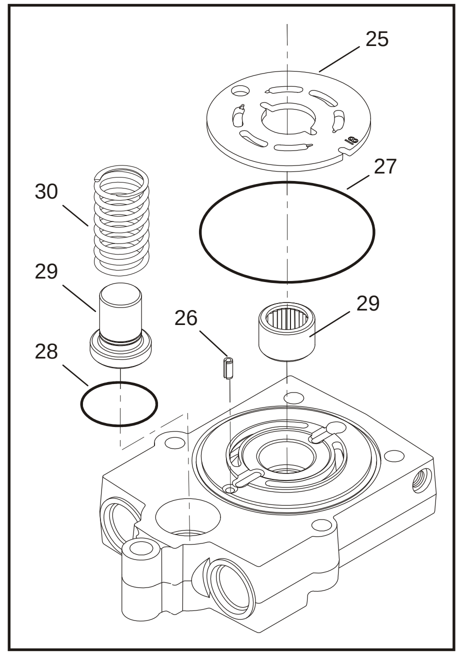
22. Screw
23. End Cap
24. O-ring

Figure 3-29. 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 3-30. Valve Plate & Rear Shaft Bearing

CAUTION

TAKE CARE NOT TO SCRATCH THE SURFACE OF THE VALVE PLATE.

15. Remove valve plate (25) and timing pin (26) from endcap.

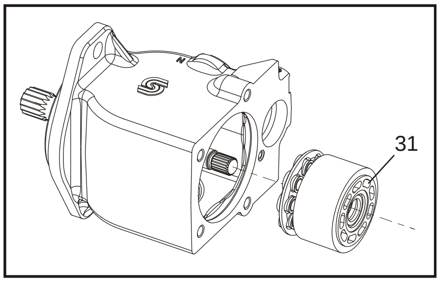
    Each displacement has a unique valve plate. For identification, the last two digits of the valve plate part number are stamped on its surface.

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. Grease will force the bearing out. Use caution not to drive bearing past rear shaft journal as the bearing may become trapped on shaft and damaged.

18. Remove minimum angle stop (29) and servo spring (30) from the housing.



31. Cylinder Kit Assembly

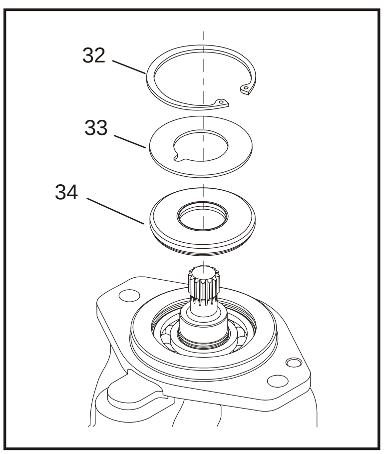
Figure 3-31. Cylinder Kit

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

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

Table 3-5. Displacement Identifiers

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

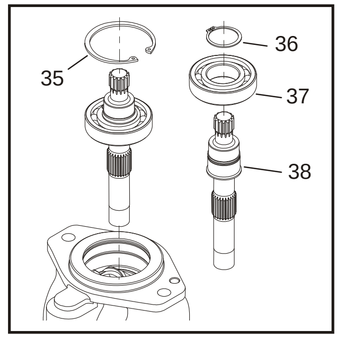


32. Snap Ring
33. Support Washer
34. Shaft Seal

Figure 3-32. 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.

21. To avoid damaging shaft during seal removal. Install a large sheet metal screw into the chuck of a slide hammer. Drive the screw into the seal surface and use the slide hammer to pull the seal.

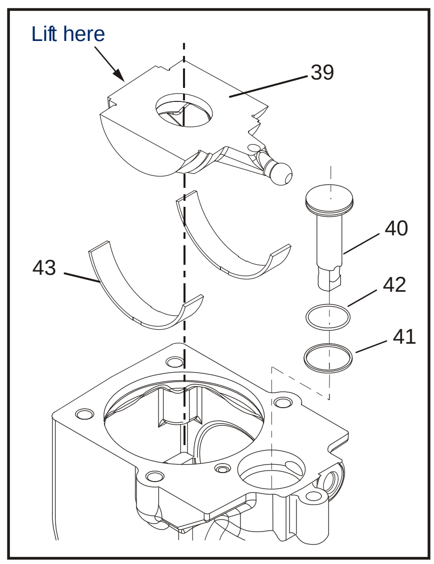


35. Inner Snap Ring
36. Snap Ring
37. Bearing
38. Shaft

Figure 3-33. Shaft & Front Bearing

22. Remove inner snap ring (35) and shaft/bearing assembly.

23. Remove snap-ring (36) retaining the shaft front bearing. Pull bearing (37) off of the shaft (38).



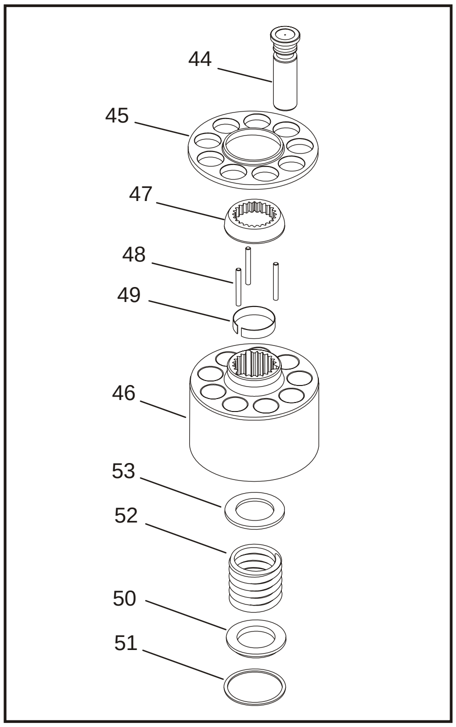
39. Swashplate
40. Servo Piston
41. Piston Seal
42. O-ring
43. Journal Bearings

Figure 3-34. Swash Plate & Servo Piston

24. Turn housing over and remove swashplate (39) by lifting on the end opposite the servo lever.

25. Remove servo piston (40). Remove piston seal (41) and O-ring (42) from servo piston. Discard seal and O-ring.

26. Remove the journal bearings (43) from the housing. If the bearings are to be reused, note the location and orientation of each bearing for reassembly.



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

Figure 3-35. Cylinder Kit Disassembly

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

    The pistons are not selectively fitted, however units with high hourly usage may develop wear patterns. Number the pistons and bores for reassembly if they are to be reused.

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

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

WARNING

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

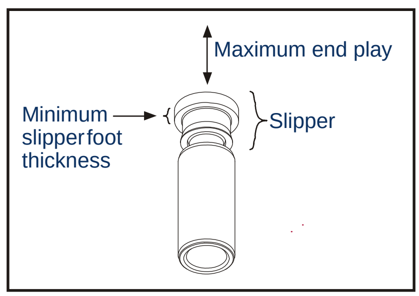
29. Turn block over. Using a press, apply pressure on the block spring washer (50) to compress the block spring. Compress spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind spiral retaining ring (51). Carefully release pressure and remove outer block spring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

Inspection

After disassembly, wash all parts (including the end-cap and housing) thoroughly with clean solvent and allow to air dry. Blow out oil passages in the 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 the pistons for damage and discoloration. Discolored pistons may indicate excessive heat; do not reuse.



SLIPPERS

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

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

Table 3-6. Slipper Foot Thickness & End Play

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

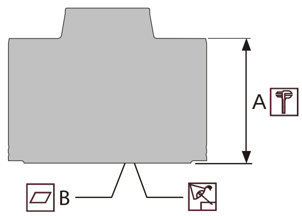
CYLINDER BLOCK

Measure the cylinder block height. Replace blocks worn beyond the minimum height specification. Inspect the running surface of the cylinder block. Replace or resurface worn or scratched blocks.

Blocks may be resurfaced to the specifications shown in the drawing, provided resurfacing will not reduce the block height below the minimum specification. Table 3-7, Cylinder Block Measurements.

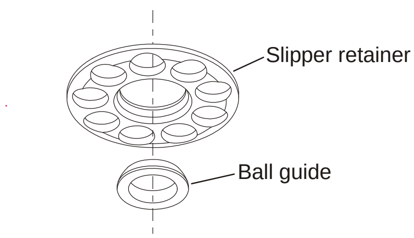
Table 3-7. Cylinder Block Measurements

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)



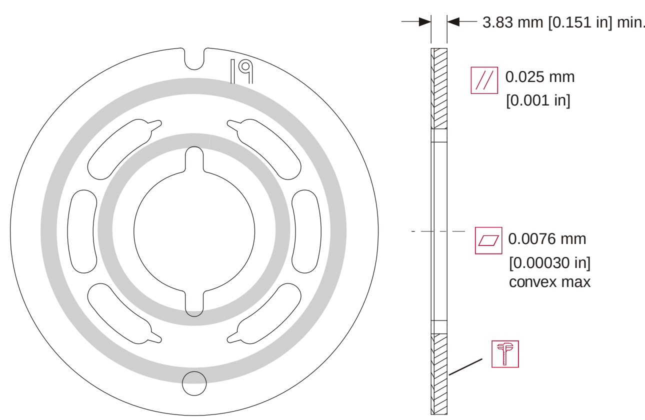
BALL GUIDE AND SLIPPER RETAINER

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



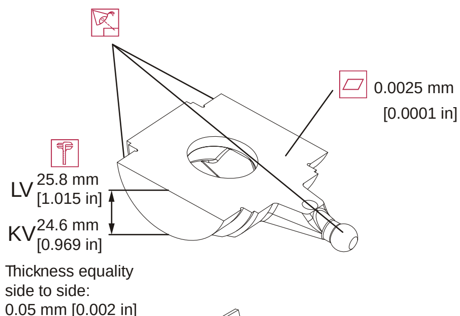
VALVE PLATE

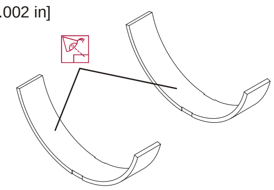
The condition of the valve plate is critical to the efficiency of the motor. Inspect the valve plate surfaces carefully for excessive wear, grooves, or scratches. Replace or resurface grooved or scratched valve plates. Measure the valve plate thickness and replace if worn beyond the minimum specification.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



SWASHPLATE AND JOURNAL BEARINGS

Inspect the 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 providing the surface condition meets specifications shown. Measure the swashplate thickness from the journals to the running face. Replace swashplate if damaged or worn beyond minimum specification. Replace swashplate if the difference in thickness from one side to the other exceeds specification.

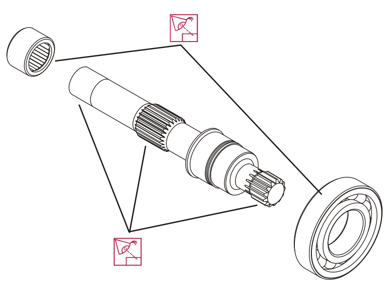




Inspect the journal bearings for damage or excessive wear. Replace journal bearings if scratched, warped, or excessively worn. The polymer wear layer must be smooth and intact.

SHAFT BEARINGS

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

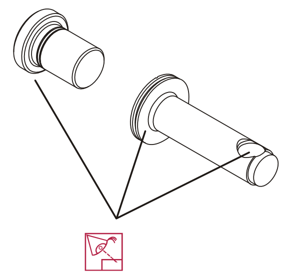


SHAFT

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

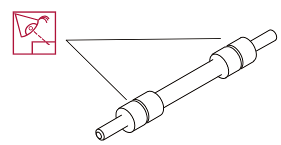
SERVO PISTON AND MINIMUM ANGLE STOP

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



LOOP FLUSHING SPOOL

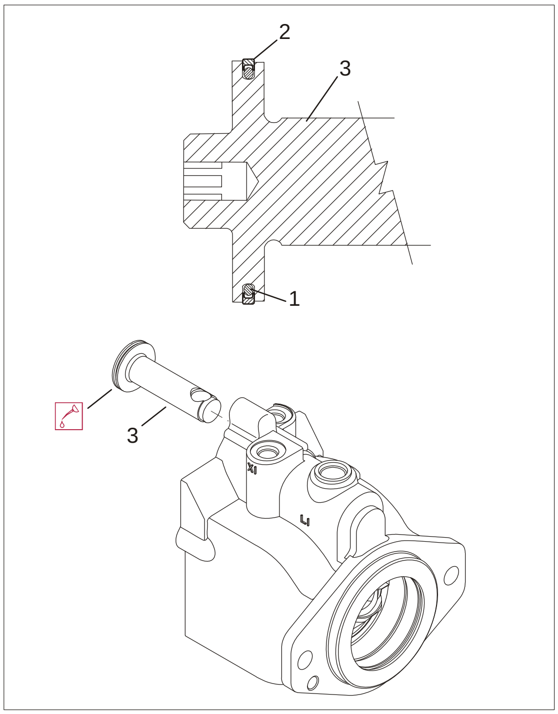
Inspect the loop flushing spool. Check for cracks or damage. Replace if necessary.



Assembly

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

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



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

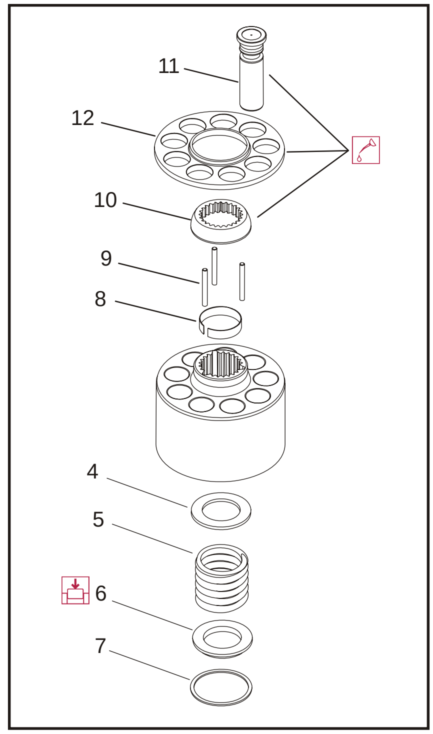
Figure 3-36. Servo Piston

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

⚠ WARNING

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

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

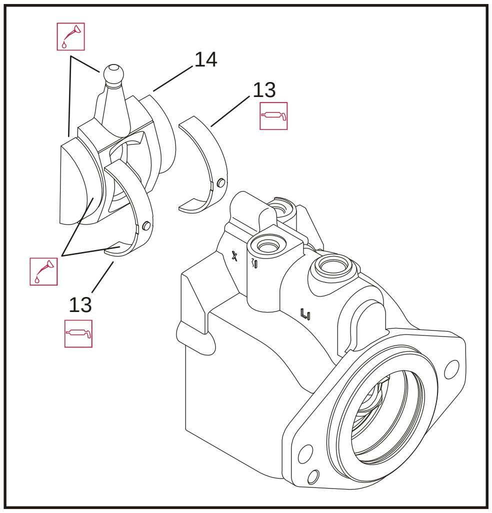


4. Block Spring Washer
5. Block Spring
6. Outer Washer
7. Spiral Retaining Ring
8. Retaining Ring
9. Holddown Pins
10. Ball Guide
11. Piston
12. Slipper Retainer

Figure 3-37. Cylinder Kit Assembly

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

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

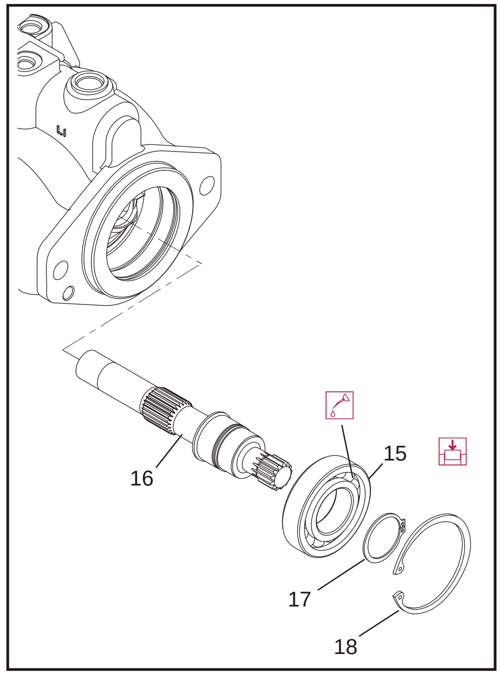


13. Journal Bearings
14. Swash Plate

Figure 3-38. Swash Plate and Journal Bearing

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

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

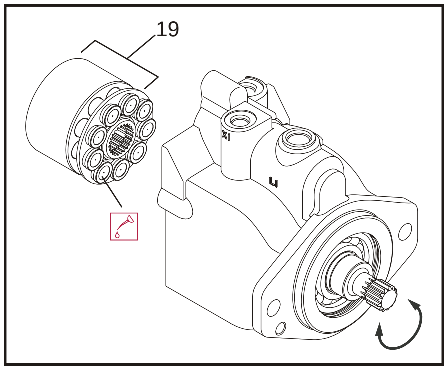


15. Front Shaft Bearing
16. Shaft
17. Snap Ring
18. Snap Ring

Figure 3-39. Shaft and Front Bearing

9. While holding swashplate in place, turn housing on its side. Install shaft/bearing assembly into housing from the flange end. Install snap-ring (18).

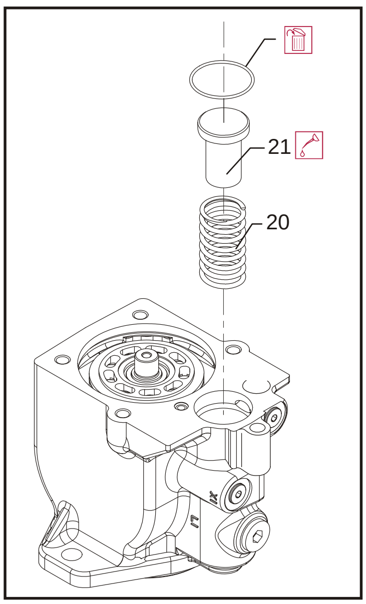
10. Verify swashplate and bearings are properly seated. Install cylinder kit (19) on shaft. Install with slippers facing swashplate. Rock shaft to align block splines and slide cylinder kit into place. Orient motor with shaft pointing downward and verify cylinder kit, swashplate, journal bearings, and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



19. Cylinder Kit

Figure 3-40. Cylinder Kit Installation

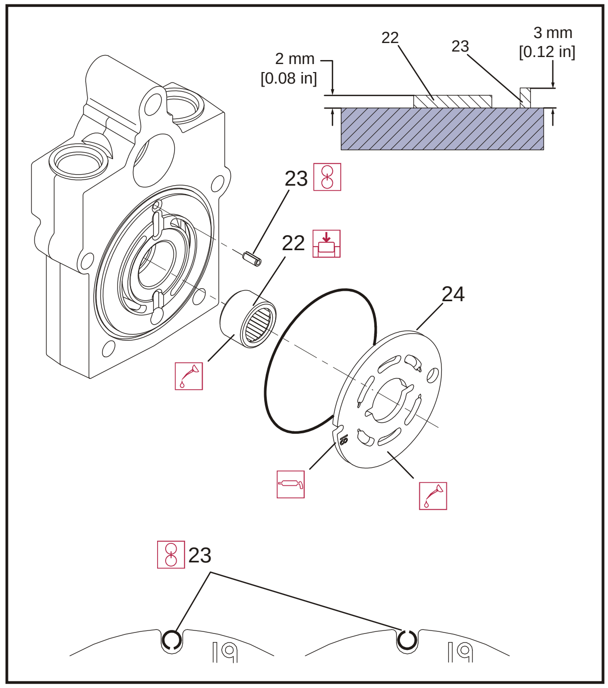
11. Lubricate and install servo spring (20), and minimum angle stop (21) in housing bore.



20. Servo Spring
21. Minimum Angle Stop

Figure 3-41. 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

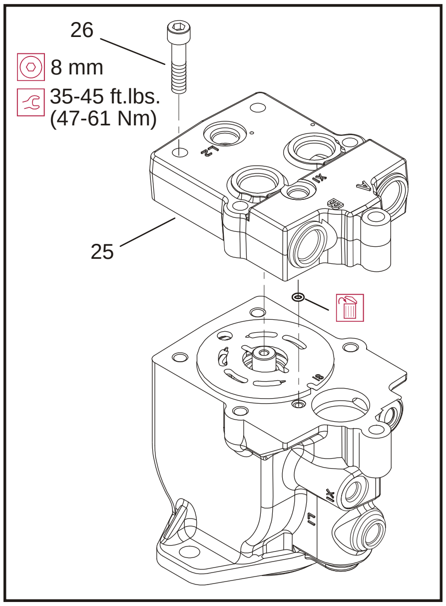
Figure 3-42. Valve Plate and Rear Bearing

13. Install timing pin (23) into its bore in 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.

NOTE: *Improper assembly of internal components may prevent endcap from seating properly.*

15. Install endcap (25) on housing with endcap screws (26). Check endcap will properly seat on housing without interference. Ensure O-rings seat properly when installing endcap.



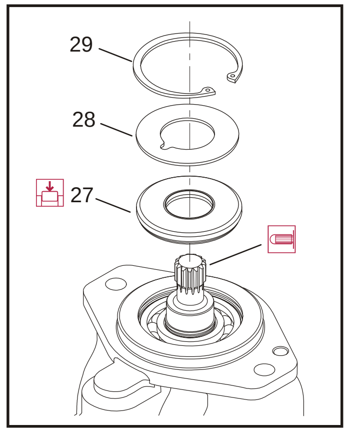
25. End Cap
26. Screw

Figure 3-43. End Cap

16. Using an 8 mm internal hex wrench, tighten endcap screws. Tighten screws in opposite corners slowly and evenly to compress servo spring and properly seat the endcap. Torque endcap screws 35-45 ft.lbs. (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 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 3-44. Shaft Seal

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

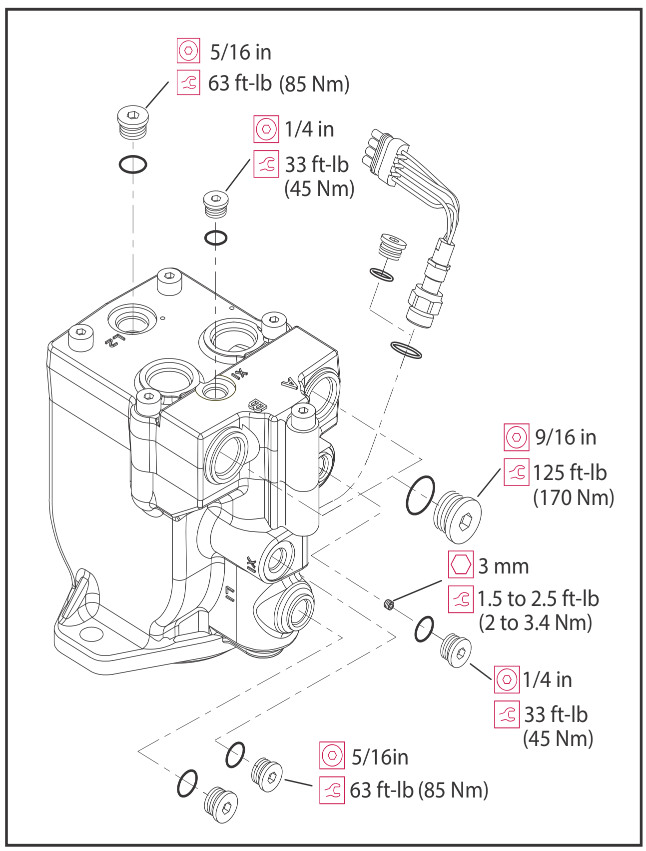
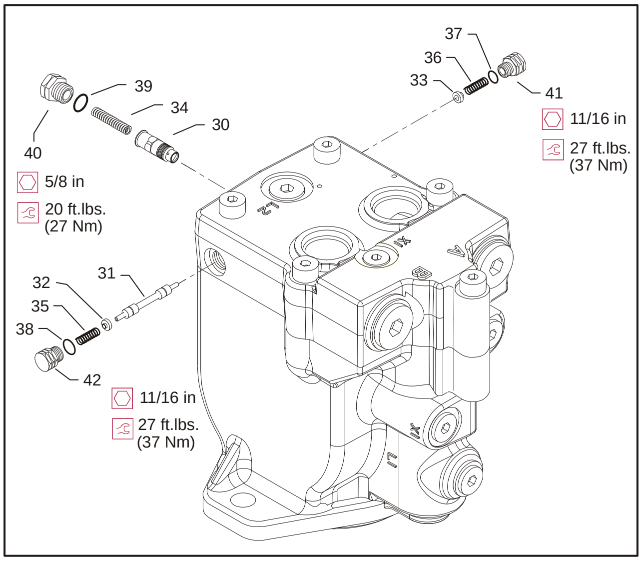


Figure 3-45. Plugs and Fittings Installation

20. Install orifice poppet (30).
21. Install shift spool (31).
22. Install spring retaining washers onto springs (32 and 33).
23. Carefully install centering springs (34, 35, and 36).
24. Install new O-rings (37, 38, and 39).
25. Using 5/8" wrench torque plug (40) to 20 ft-lb (27 Nm).
26. Using 11/16" wrench, torque plugs (41 and 42) to 27 ft-lbs (37 Nm).



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

Figure 3-46. Loop Flushing Spool

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 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 the 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 the prime mover, 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 prime mover and remove pressure gauge. Replace plug at charge pressure gauge port.
10. Check fluid level in reservoir; add clean filtered fluid if necessary. The motor is now ready for operation.

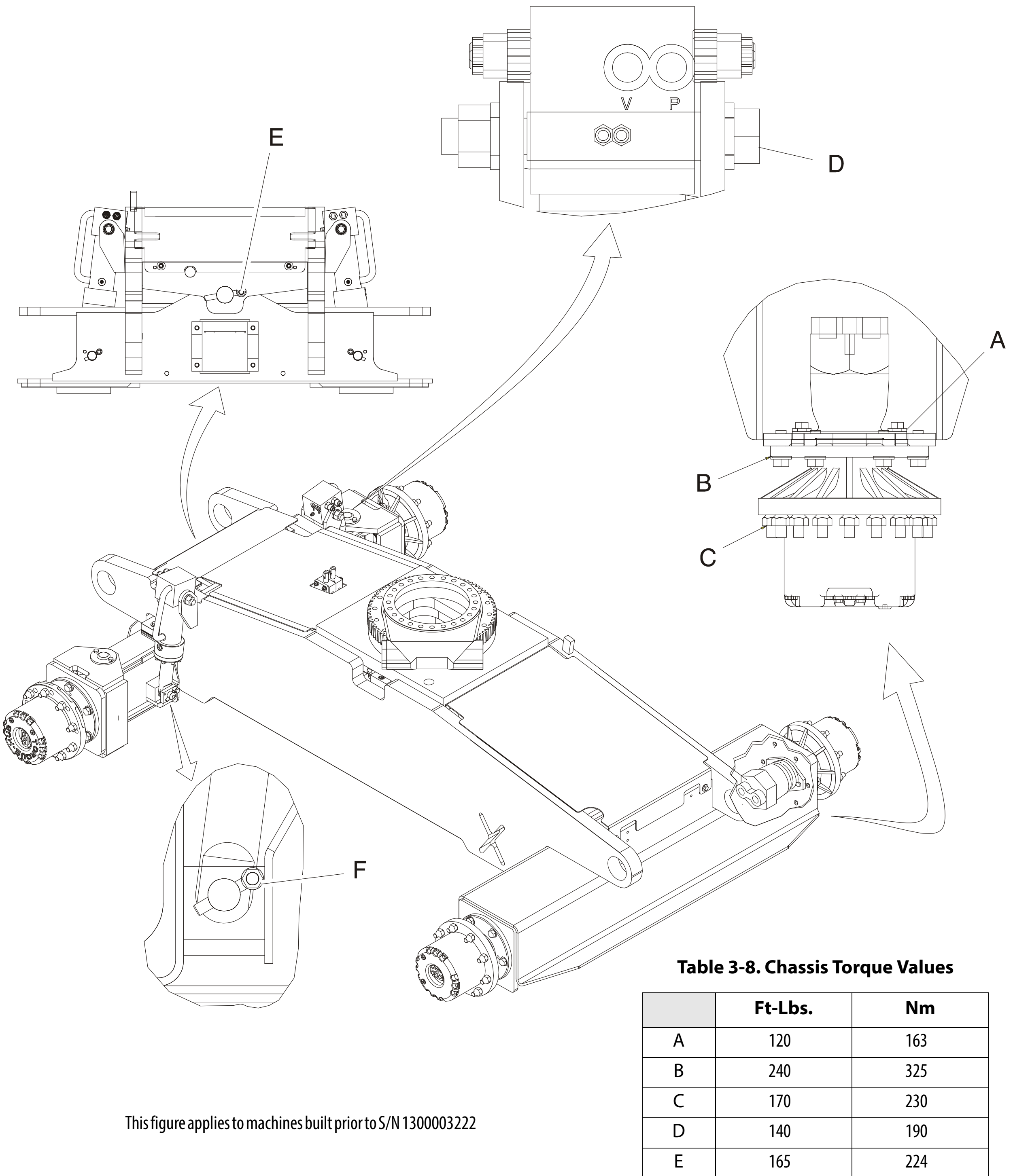


Table 3-8. Chassis Torque Values

	Ft-Lbs.	Nm
A	120	163
B	240	325
C	170	230
D	140	190
E	165	224
F	35	47

Figure 3-47. Chassis Torque Values - Sheet 1 of 2

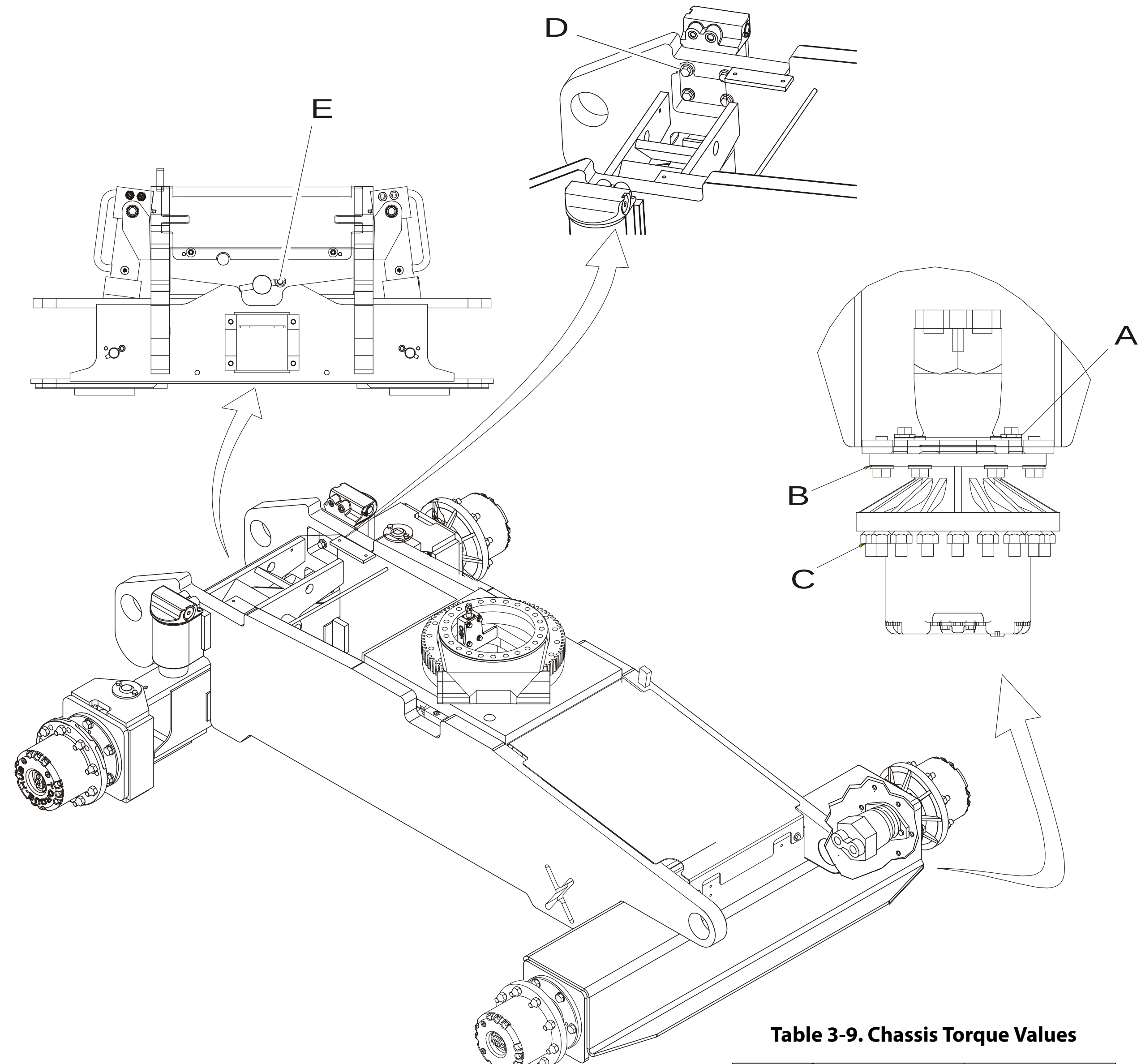


Table 3-9. Chassis Torque Values

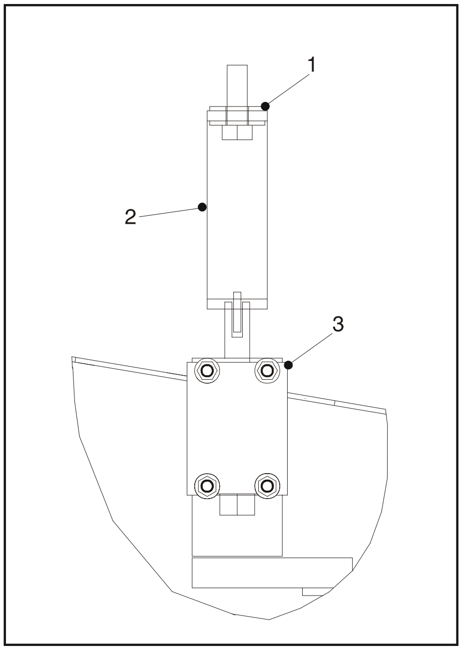
Item	Ft-Lbs.	Nm
A	120	163
B	240	325
C	170	230
D	85	115
E	165	224

This figure applies to machines built S/N 1300003222 to Present

Figure 3-47. Chassis Torque Values - Sheet 2 of 2

3.6 ADJUSTMENT PROCEDURE FOR LOCKOUT VALVE

1. With the turntable centered, adjust the bracket with the washers to push the plunger in 5/16" ± 1/16" (7.9 ± 1.6 mm).



1. Washer
2. Bracket
3. Lockout Valve

Figure 3-47. Valve Adjustment

2. The ideal adjustment is 3/8" (9.5 mm). Do not push the plunger in more that 3/8" (9.5 mm). The extra adjustment is needed for the turntable bearing play.

3.7 OSCILLATING AXLE BLEEDING PROCEDURE AND LOCKOUT TEST

Lockout Cylinder Bleeding (Early Cylinders)

NOTE: *The following procedure is to be used on machines built prior to S/N 1300003222.*

NOTICE

ENSURE PLATFORM IS FULLY LOWERED AND BOOM IS CENTERED OVER REAR AXLE PRIOR TO BEGINNING BLEEDING PROCEDURE.

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

1. Make sure machine is on a level surface.
2. Center boom over rear axle to make sure the cam valve in the rotary coupling is depressed.
3. Place chocks under the tires to ensure the machine does not move. Disable the machine brakes by disconnecting the brake solenoid(s) on the brake valve.
4. Use suitable containers to catch any excess hydraulic fluid. Place the containers under each lockout cylinder.
5. Open one bleeder screw at a time.
6. Start the engine, position drive control lever forward or reverse.
7. Close bleeder screws when all air is dissipated (bled).
8. Reconnect the brake solenoid(s) and remove the wheel chocks.
9. Perform oscillating axle lockout test.
10. If necessary, repeat steps 1 thru 7.

Lockout Cylinder Bleeding (Ram Cylinders)

NOTE: *The following procedure is to be used on machines built S/N 1300003222 to present.*

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

Oscillating Axle Lockout Test

NOTICE

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

NOTE: *Ensure boom is fully retracted, lowered, and centered between drive wheels prior to beginning lockout cylinder test.*

1. Place a 6 inch (15 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 and drive machine off of block and ramp.
7. Have an assistant check to see that 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 the 6 inch (15 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 and drive machine off of block and ramp.
13. Have an assistant check to see that 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 the malfunction prior to any further operation.

3.8 SWING BEARING

Description

The swing bearing has five major components. They are the housing, worm, worm gear, output pinion and gear/pinion cap.

Servicing of these units requires a press, a 3/8" 12 point socket, a 1/2 "socket, a 3/4" socket, torque wrench (80 lb-ft), steel hammer, soft face hammer, bearing puller (external and internal), large flat blade screw driver. Also needed are a shIm and seal kit (refer to the JLG Parts Manual), 3/4" steel rod at least 10" long, silicone sealant, Mobil SHC 007 grease, Mobil SHC 460 grease, Loctite #242 for bolts, and any other parts that may be worn out.

Removal

1. Attach an adequate support sling to the boom and draw all slack from sling. Prop or block the boom if feasible.
2. Tag and disconnect hydraulic lines running through center of turntable and frame. Use a suitable container to retain any residual hydraulic fluid. Cap lines and ports.
3. Attach suitable overhead lifting equipment to the base of turntable weldment.
4. Use a suitable tool to scribe a line on the inner race of the swing bearing and on the underside of the turntable. This will aid in aligning the bearing upon installation. Remove bolts, nuts and washers which attach the turntable to the bearing inner race. Discard nuts and bolts.
5. Use lifting equipment to carefully lift complete turntable assembly from the bearing. Ensure no damage occurs to turntable, bearing, or frame mounted components.
6. Carefully place turntable on a suitably supported trestle.
7. Use a suitable tool to scribe a line on the outer race of the swing bearing and the frame. This line will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the outer race of the bearing to the frame. Discard the bolts. Use suitable lifting equipment to remove the bearing and rotation box assembly from the frame; move to a clean, suitably supported work area.
8. Remove two capscrews securing bearing to the rotation box to separate for inspection.

Disassembly

1. Remove swing bearing assembly from machine.
2. To remove the large turntable bearing (9), remove two 5/16" bolts (6) and washers (7) that hold the turntable bearing to the housing (20).
3. Remove the two #6 machine screws (29) that are located on the cover plate (21) immediately in front of the pinion (18).
4. Remove eight 3/8" 12 point cap screws (3) from gear pinion cap (27). Pry cap from housing. The cover plate (21) wIll come off with the cap. Note where sealant is on the cover and plate so the sealant can be applied in the same place during assembly. Note number and color of shims (31, 32, 33 - 35, 36) between cap and housing. Remove 6 small screws (30) from cover plate. Pry cover plate (21) from cap (27) and discard cover plate. Note number and color of shims between cover plate and cap.

   If there are 5 screws or drive screws holding cover plate to the cap then a new cap (27) should be ordered. This is an older version, the new cover plate has 6 holes.
5. Remove pinon and gear assembly (18,17,13, 14,38,16,19) from housing (20). It lifts directly upward from housing.
6. Disassemble pinion and gear assembly using a press. Support worm gear (17) on press wIth pinion (18) down, allowing room for pinion to be pressed out of the gear. Press pinon out of bearing (16), spacer (19), and worm gear (17) by pressing on the end of pinion.
7. Remove face seal (38) and O-ring (10) from face of the worm gear (17). Note how seal is assembled.

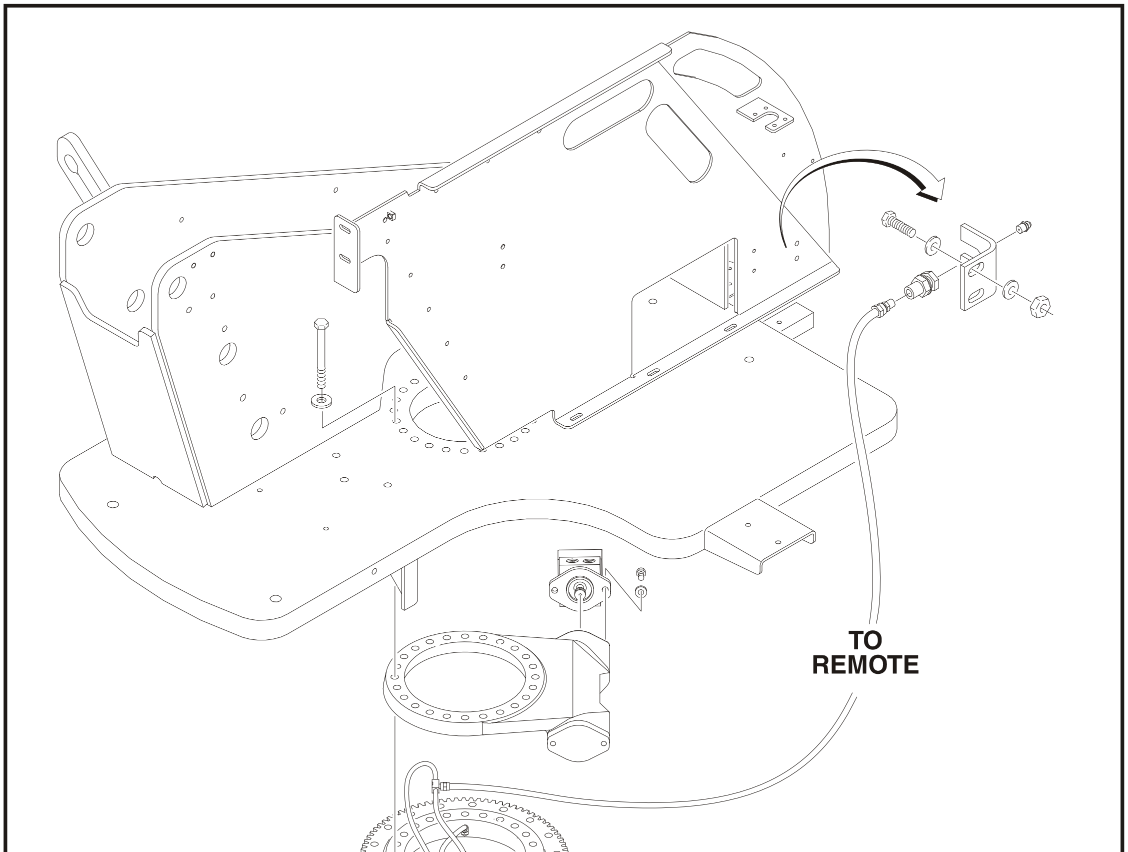
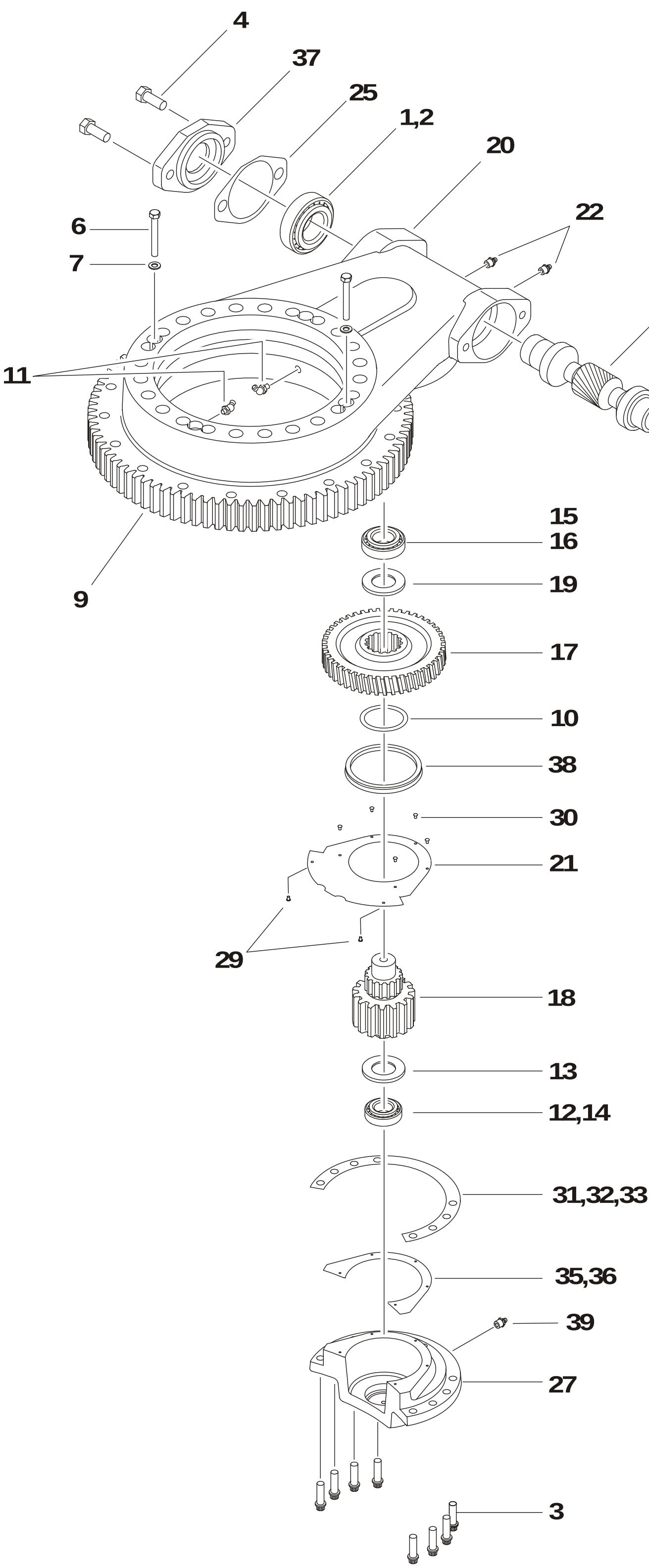


Figure 3-48. Swing Bearing Installation



1. Bearing Cup
2. Bearing
3. Capscrew
4. Bolt
5. Bolt
6. Bolt
7. Washer
8. Seal
9. Turntable Bearing
10. O-ring
11. Grease Fitting
12. Bearing Cup
13. Nilos Ring
14. Bearing
15. Bearing Cup
16. Bearing
17. Worm Gear
18. Pinion
19. Spacer
20. Housing
21. Cover Plate
22. Grease Fitting
23. Shim
24. Shim
25. Shim
26. Shim
27. Gear/Pinion/Cap
28. Worm Cap
29. Screw
30. Screw
31. Shim
32. Shim
33. Shim
34. Worm
35. Shim
36. Shim
37. Motor Adapter
38. Face Seal
39. Grease Fitting

Figure 3-49. Swing Bearing

8. Remove bearing (14) and Nilos Ring (13) from pinon (18) using an external bearing puller or press.
9. Remove two bolts (4) securing motor adapter. Remove motor adapter (37) and shim (25).
10. Remove 1/2" bolts (5) from worm cap (28) using a 3/4" socket. Remove shIms (22, 23, 24, 25, 26) and seal (8) and discard.
11. Remove worm (34) from housing (20) by pushing worm from motor end using a steel rod and hammer. Bearing cup (1) on hex end of the worm will be forced out of housing. Once bearing cup (1) has come out of housing, use a soft hammer to tap worm on hex end to remove other bearing cup (1) from other end of housing.
12. Remove both bearings (2) from worm (34) using an external bearing puller or press.
13. The bearing cup (15) can be removed from the housing (20) by lifting it out (this is not a press fit just a close slip fit).
14. The bearing cup (12) can be removed from the cap (27) using a small pry bar, or by welding a small bead of weld on the internal diameter of the cup, this IS a press fit.

Assembly

1. Press the bearing cup (12) into the cap (27).
2. Place the bearing cup (15) into the housing (20).
3. Put the face seal (38) and O-ring (10) onto the hub of the worm gear (17).
4. Place the worm gear (17) on the press with face seal up and press the pinion (18) into the worm gear. Place the Nilos Ring (13) onto the pinion so that the cup shape is up and press the bearing (14) onto the pinion tight to the Nilos Ring.
5. Turn the assembly over and place the spacer (19) on the pinion against the gear hub so that the hub of the spacer is up. Press the bearing (16) onto the pinion and tIght to the spacer and gear.
6. Place the pinion gear assembly into the housing. Place the gear cap (27) and shims (31, 32, 33) over the gear/ pinion assembly to achieve a slight preload on the pinion bearings. Remove the cap and shims and set the shIms aside. Install a new cover plate (21) onto the cap using 6 screws (30) and shims (35, 36) equal to or close to equal to the total thickness of the shims just set aside. Apply sealant (permatex number 2) to both sides of each of these shims and tighten the screws taking care not to twist these screws off. Set this assembly to the side.
7. Install the bearing (2) on the bore end of the worm (34). This IS almost a slip fit, and may have to be lightly tapped with soft hammer.
8. Install the worm (34) into the housing, hex end first.
9. On the bore end of the worm, install the bearing cup (1) into the worm bore of the housing. Also on bore end of the worm, install the motor adapter (37) and 1 shim (25) to the housing using 1/2" bolts (4) and sealant. Torque to 80 lbs-ft. (108.5 Nm).
10. Install the bearing (2) on the hex end of the worm (34). Place the bearing cup (1) over the bearing and lightly tap the cup into the bore using a soft hammer.
11. Install the worm cap (28) using proper shims (22 thru 26) to achieve 0.000 to 0.001" end play. Use 3/4" bolts (5) and sealant. Torque to 80 lbs-ft. (108.5 Nm).
12. Place the pinion/gear assembly into the housing so the gear teeth mesh with the worm gear teeth.

    You may have to turn the worm or gear set by hand to achieve this.
13. Apply sIlIcone sealant to the surface of the housing where the cap assembly will touch. This includes the vertical surface.
14. Place the gear cap assembly over the pinion assembly and place the shims set aside in step 6.
15. Install the eight 3/8" 12 point screws (3) and torque to 60 lbs-ft. (81 Nm).
16. Install 2 small screws (29).
17. Install the seal (8) in the worm cap (28) at the hex end of worm.
18. Install the turntable bearing using two 5/16" bolts (6) and washers (7).
19. Fill the unit with SHC 007 grease and grease the top bearing with Mobil SHC 460 grease.

Installation

1. Install bearing to rotation box with two capscrews, so that fill plug of bearing is as close to gear as bolt pattern will allow. Do not tighten capscrews.
2. Line up high spot (blue) of bearing with center tooth of worm gear. Set backlash to 0.008 - 0.010 inch (0.20 - 0.25 mm). Tighten capscrews as shown in Figure 3-52., Swing Bearing Torque Sequence.
3. Apply Mobiltac 375 Open Gear Compound or equivalent to bearing and worm gear teeth.
4. Grease bearing. Grease fitting is on inside wall of inner race of bearing.

NOTE: *If Mobiltac 375 Open Gear Compound is not available, Multi-Purpose Grease (MPG) can be substituted, however the service interval will be shorter.*

5. Using suitable lifting equipment, install bearing/rotation box assembly to frame with soft spot (red) 90 degree relative to load axis. If reusing old bearing, ensure that scribed line of outer race of the bearing aligns with the scribed mark on the frame.

⚠ CAUTION

JLG INDUSTRIES RECOMMENDS THAT ALL REMOVED GRADE 8 BEARING NUTS AND BOLTS BE DISCARDED AND REPLACED WITH NEW NUTS AND BOLTS. SINCE THE SWING BEARING IS THE ONLY STRUCTURAL LINK BETWEEN THE FRAME AND TURNTABLE, IT IS IMPERATIVE THAT SUCH REPLACEMENT HARDWARE MEETS JLG SPECIFICATIONS. USE OF GENUINE JLG HARDWARE IS HIGHLY RECOMMENDED.

6. Apply a light coating of Loctite 271 to the new bearing bolts and loosely install the bolts and washers through the frame and outer race of bearing.

⚠ CAUTION

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

7. Following the torque sequence diagram shown in Figure 3-52., Swing Bearing Torque Sequence, tighten the bolts to an initial torque of 175 ft. lbs. (237 Nm). Then following the same sequence, tighten to a final torque of 240 ft. lbs. (326 Nm).
8. Remove lifting equipment from bearing.
9. Use suitable lifting equipment to carefully position the turntable assembly above the machine frame.
10. Carefully lower the turntable onto the swing bearing. Ensure that the scribed line of the inner race of the bearing aligns with the scribed mark on the turntable. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft centerline of the turntable.
11. Apply a light coating of Loctite 271 to the new bearing bolts and install through the turntable and inner race of bearing.
12. Following the torque sequence shown in Figure 3-52., Swing Bearing Torque Sequence, tighten the bolts to an initial torque of 175 ft. lbs. (237 Nm). Then following the same sequence, tighten the bolts to 240 ft. lbs (326 Nm).
13. Remove the lifting equipment.
14. Route hydraulic lines through center of turntable and frame and connect as tagged prior to removal.
15. Using all applicable safety precautions, activate the hydraulic system and functionally check swing system for proper and safe operation.

Turntable Bearing Mounting Bolt Condition Check

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

Check the frame to bearing. Attach bolts as follows:

1. Elevate the fully retracted boom to 70 degrees (full elevation).
2. At the positions indicated on the figure titled Swing Bearing Tolerance Boom Placement. Try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
3. Assure that the 0.0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
4. Swing the turntable 90 degrees, and check some selected bolts at the new position.
5. Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.

Check the turntable to bearing. Attach bolts as follows:

1. Elevate the fully retracted boom to 70 degrees (full elevation).
2. At the positions indicated in the figure below, try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.

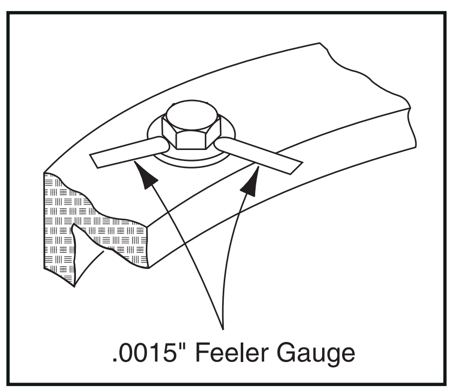


Figure 3-50. Swing Bearing Feeler Gauge Check

3. Lower the boom to horizontal and fully extend boom.
4. At position indicated on Figure 2-30, try and insert a 0.0015" feeler gauge between bolt head and hardened washer at arrow indicated position.

Wear Tolerance

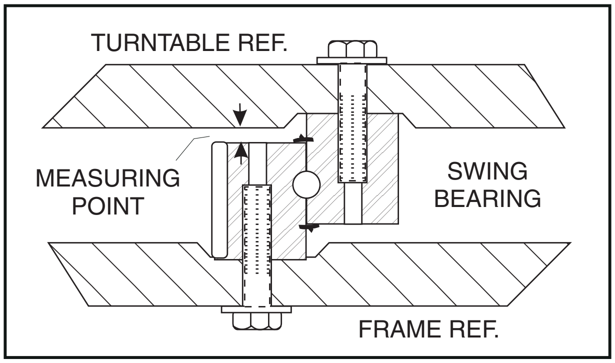


Figure 3-51. Swing Bearing Tolerance Measuring Point

1. With boom positioned over side of machine, the Upper Boom horizontal with telescope fully extended and Mid/Lower Boom stowed, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable.
2. At the same point, with the boom positioned over the side of the machine, the Upper Boom fully elevated and the Mid/Lower Boom fully elevated, using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable.
   If a difference greater than 0.057 in. (1.40 mm) is determined, the swing bearing should be replaced.
3. If a difference less than 0.057 in. (1.40 mm) is determined, and any of the following conditions exist, the bearing should be removed.
   a. Metal particles in the grease.
   b. Increased drive power.
   c. Noise.
   d. Rough rotation.
4. If bearing inspection shows no defects, reassemble bearing and return to service.

Swing Bearing Torque Value

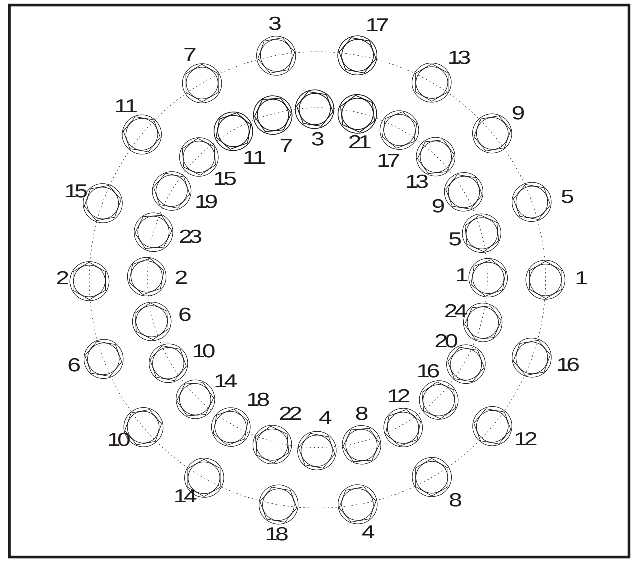


Figure 3-52. Swing Bearing Torque Sequence

Install with Loctite - 240 ft. lbs. (326 Nm).

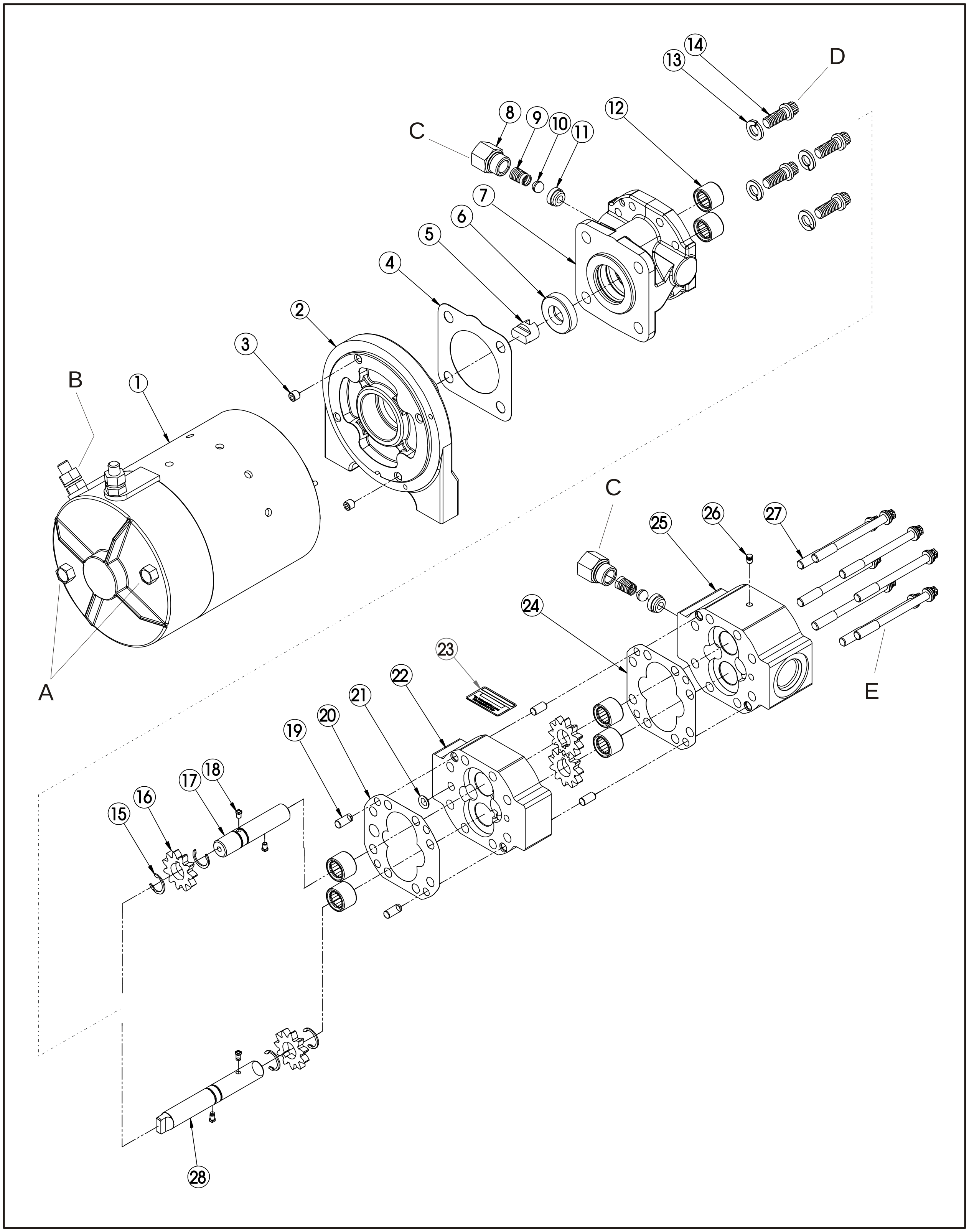


Figure 3-53. Auxiliary Pump - Sheet 1 of 2

1. Motor	11. Seat	21. O-ring
2. Adapter	12. Needle Bearing	22. Gear Housing
3. Setscrew	13. Washer	23. I.D. Label
4. Mounting Gasket	14. Screw	24. Gasket
5. Coupling	15. Retaining Ring	25. Gear Housing
6. Shaft Seal	16. Gear	26. Beta Plug
7. Stator	17. Idler Shaft	27. Screw
8. Cap Assembly	18. Drive Pin	28. Drive Shaft
9. Spring	19. Dowel Pin	29. Plastic Plug
10. Ball	20. Gasket	30. Plastic Plug

A. Torque 96 to 120 in-lb (11 to 13.5 Nm)

B. Torque to 84 in-lb (9.5 Nm)

C. Torque 144 to 180 in-lb (16 to 20 Nm)

D. Torque 180 to 216 in-lb (16 to 24 Nm)

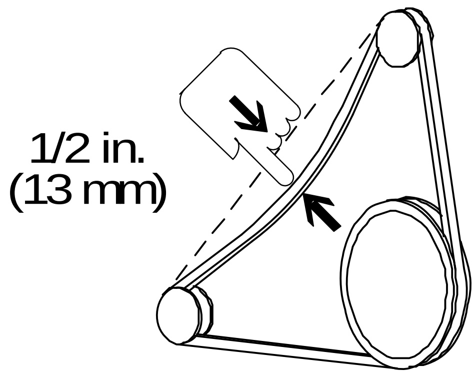
E. Torque 114 to 150 in-lb (12 to 17 Nm)

Figure 3-54. Auxiliary Pump - Sheet 2 of 2

3.9 GENERATOR

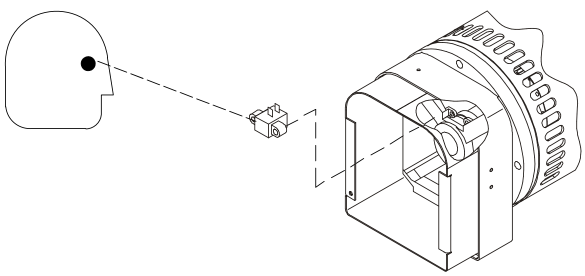
Every 250 hours

Every 250 hours of operation, check the drive belt for proper tension.

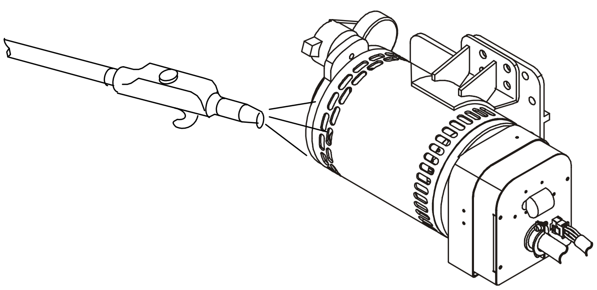


Every 500 hours

Every 500 hours of operation, service the generator brushes and slip rings. Hostile environments may require more frequent service.



Every 500 hours of service, blow out the inside of the generator. If operating in a hostile environment, clean monthly.

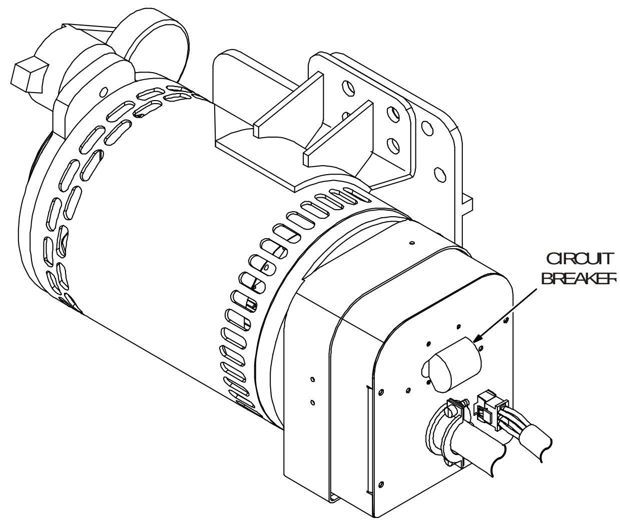


Overload Protection

⚠ CAUTION

STOP ENGINE WHENEVER CHECKING OR INSPECTING THE CIRCUIT BREAKER.

The circuit breaker protects the generator windings from overload. If the circuit breaker opens, generator output stops. If the circuit breaker continues to open, check for faulty equipment connected to the platform receptacles.



Inspecting Brushes, Replacing Brushes, and Cleaning Slip Rings

Refer to Figure 3-54., Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings.

INSPECTING BRUSH POSITION

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

INSPECTING BRUSHES

Remove end panel. Inspect wires. Remove brush holder assembly. Pull brushes from holders.

Replace brushes if damaged, or if brush is at or near minimum length.

CLEANING SLIP RINGS

Visually inspect slip rings. Under normal use, rings turn dark brown.

If slip rings are corroded or their surface is uneven, remove the belt to turn the shaft by hand for cleaning.

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.

Reinstall belt, brush holder assembly, and end panel.

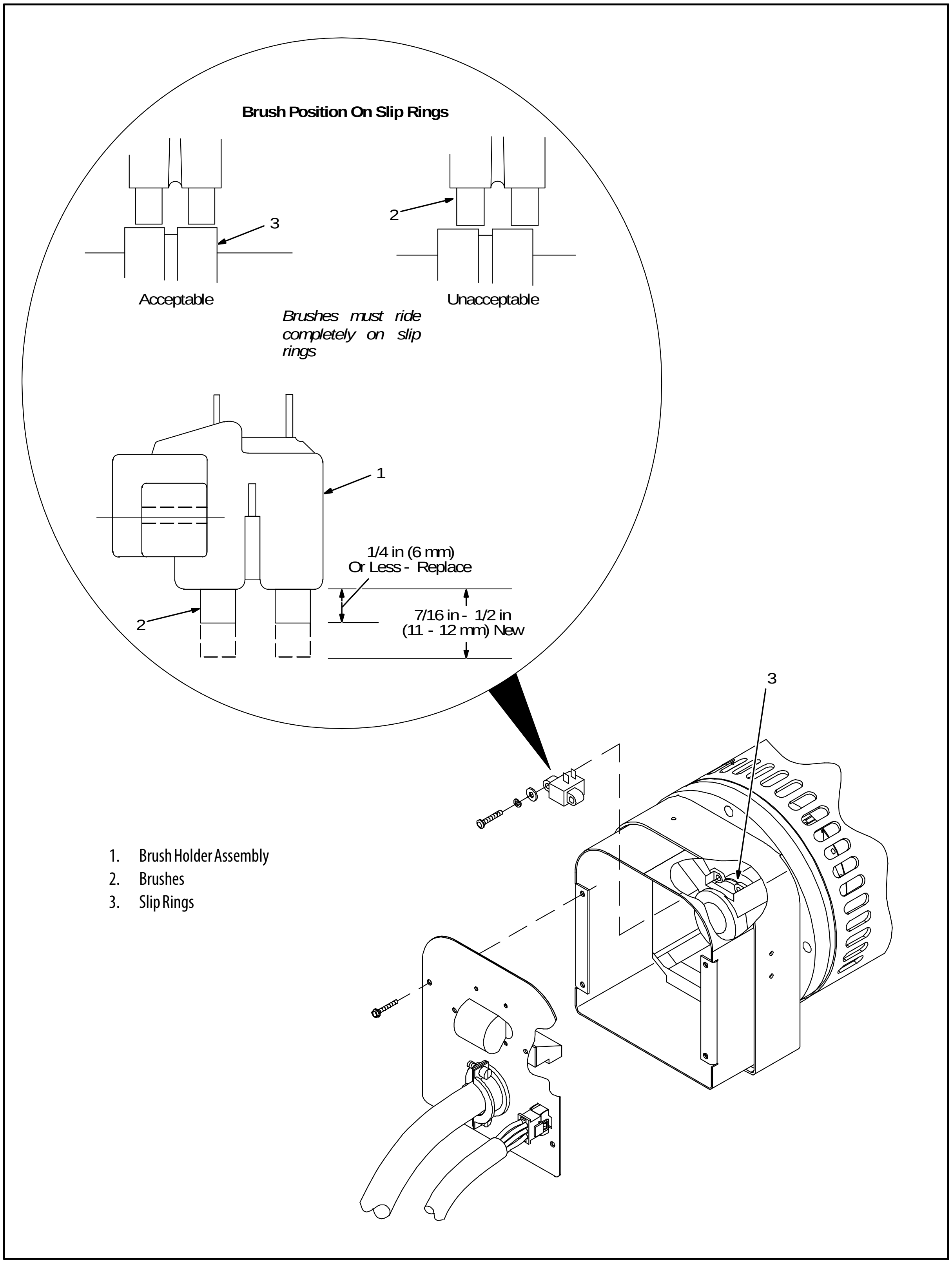


Figure 3-54. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

3.10 DEUTZ ENGINE

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

Checking Oil Level

1. Switch the engine off before checking oil level.
2. Make sure the machine and engine are level.
3. Remove the oil dipstick.
4. Wipe the dipstick with non-fibrous, clean cloth.
5. Insert the dipstick to the stop and remove again.
6. Check the oil level, and if necessary, top the oil level up to the MAX mark with an approved grade and type of oil as outlined in the engine manufacturer's operator's manual.
7. Replace the dipstick making sure that it is fully seated in the dipstick tube to seal off the crankcase.

Changing Engine Oil

1. Allow the engine to warm up. The engine oil should reach approximately 176° F (80° C).
2. Make sure the machine and engine are level.
3. Switch off the engine.
4. Place an oil tray under the engine.
5. Open the oil drain valve.

WARNING

WHEN DRAINING HOT ENGINE OIL THERE IS A RISK OF SCALDING.

CAUTION

DO NOT LET USED OIL RUN INTO THE SOIL; COLLECT THE USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF THE USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.

6. Drain the oil.
7. Close the oil drain valve.
8. Pour in new engine oil. Refer to Section 1 for capacity and refer to Figure 3-55., Engine Oil Viscosity for the proper grade.

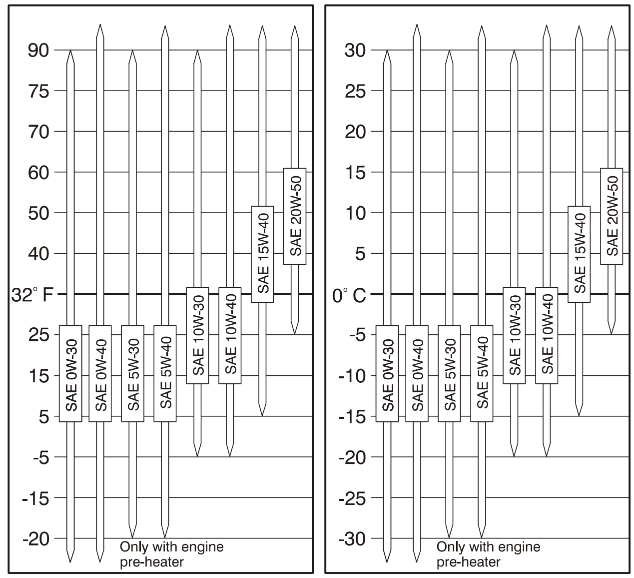
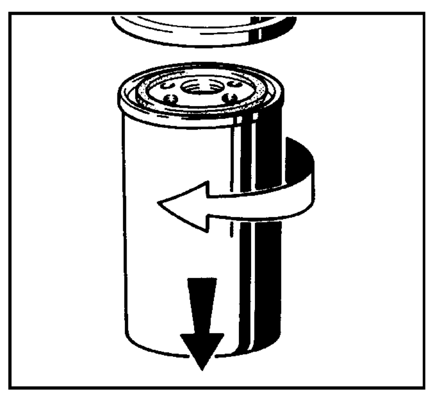


Figure 3-55. Engine Oil Viscosity

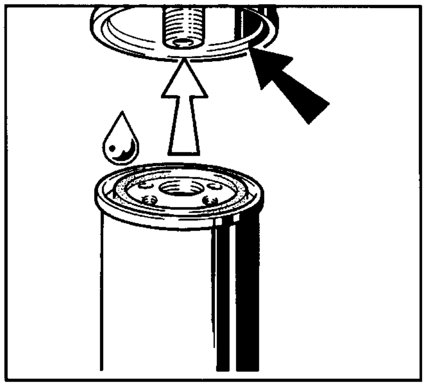
Changing the Oil Filter

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

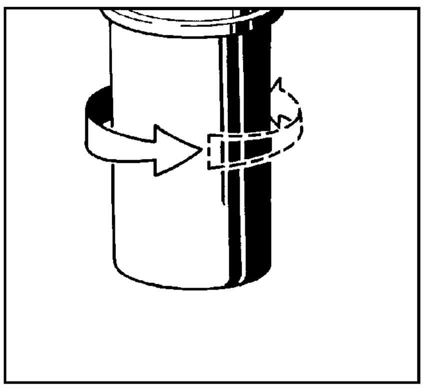


3. Catch any escaping oil.
4. Clean any dirt from the filter carrier sealing surface.

5. Lightly oil the rubber gasket on the new oil filter.



6. Manually screw in the new filter until the gasket is flush.



7. Tighten the filter another half-turn.
8. Check the oil level.
9. Check the oil pressure.
10. Check the oil filter cartridge and make sure there are no leaks.

Replacing Fuel Filter

⚠ WARNING

WHEN WORKING ON THE FUEL SYSTEM, MAKE SURE THERE ARE NO OPEN FLAMES OR SPARKS IN THE AREA. DO NOT SMOKE WHEN WORKING ON THE FUEL SYSTEM.

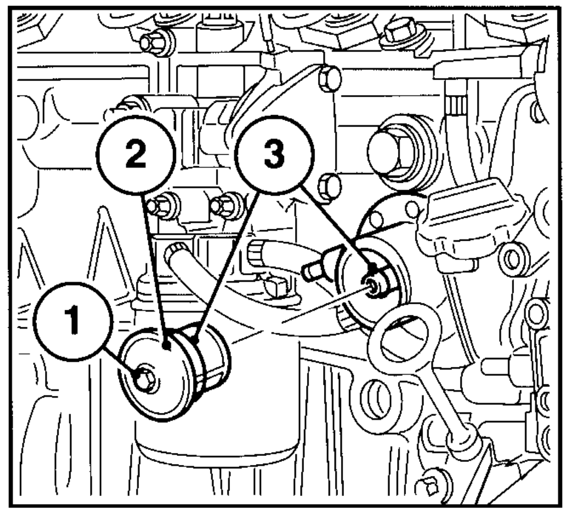
1. Wipe the area around the filter to clean any dirt from the area.
2. Undo the fuel filter cartridge and spin off.
3. Catch any escaping fuel.
4. Clean any dirt from the filter carrier sealing surface.
5. Apply a light film of oil or diesel fuel to the rubber gasket of the new filter cartridge.
6. Manually screw in the new filter until the gasket is flush.
7. Tighten the fuel filter cartridge with a final half-turn.
8. Open the fuel shut-off valve.
9. Check for leaks.

Cleaning Fuel Strainer

⚠ WARNING

WHEN WORKING ON THE FUEL SYSTEM, MAKE SURE THERE ARE NO OPEN FLAMES OR SPARKS IN THE AREA. DO NOT SMOKE WHEN WORKING ON THE FUEL SYSTEM.

1. Unscrew the hexagonal nut (1).



2. Remove the fuel strainer cover (2).
3. Clean the fuel strainer with diesel fuel, replace if necessary.
4. Place the seal (3) in position.
5. Install the fuel strainer cover (2) in position and tighten the hexagonal screw (1).
6. Check for leaks.

3.11 DEUTZ EMR 2 (S/N 1300000981 TO PRESENT)

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

Engine sensors provide the control unit with all relevant physical parameters. In accordance with information of current condition of the engine and preconditions (throttle position etc.), the EMR2 controls an actuator that operates the control rod of the injection pump and adjusts fuel quantity to match performance requirements.

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

The EMR2 is equipped with safety devices and programming to ensure emergency running (Limp home) functions.

To switch engine off, the EMR2 is switched in a de-energized fashion over the ignition switch. A spring in the actuator presses the control rod in the de-energized condition to the zero position. As a redundancy measure, an additional solenoid independently of the actuator, also moves the control rod in the de-energized condition to the zero position.

After programming is done over the ISO9141 interface, the EMR2 possesses a motor-specific data set fixedly assigned to the engine.

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

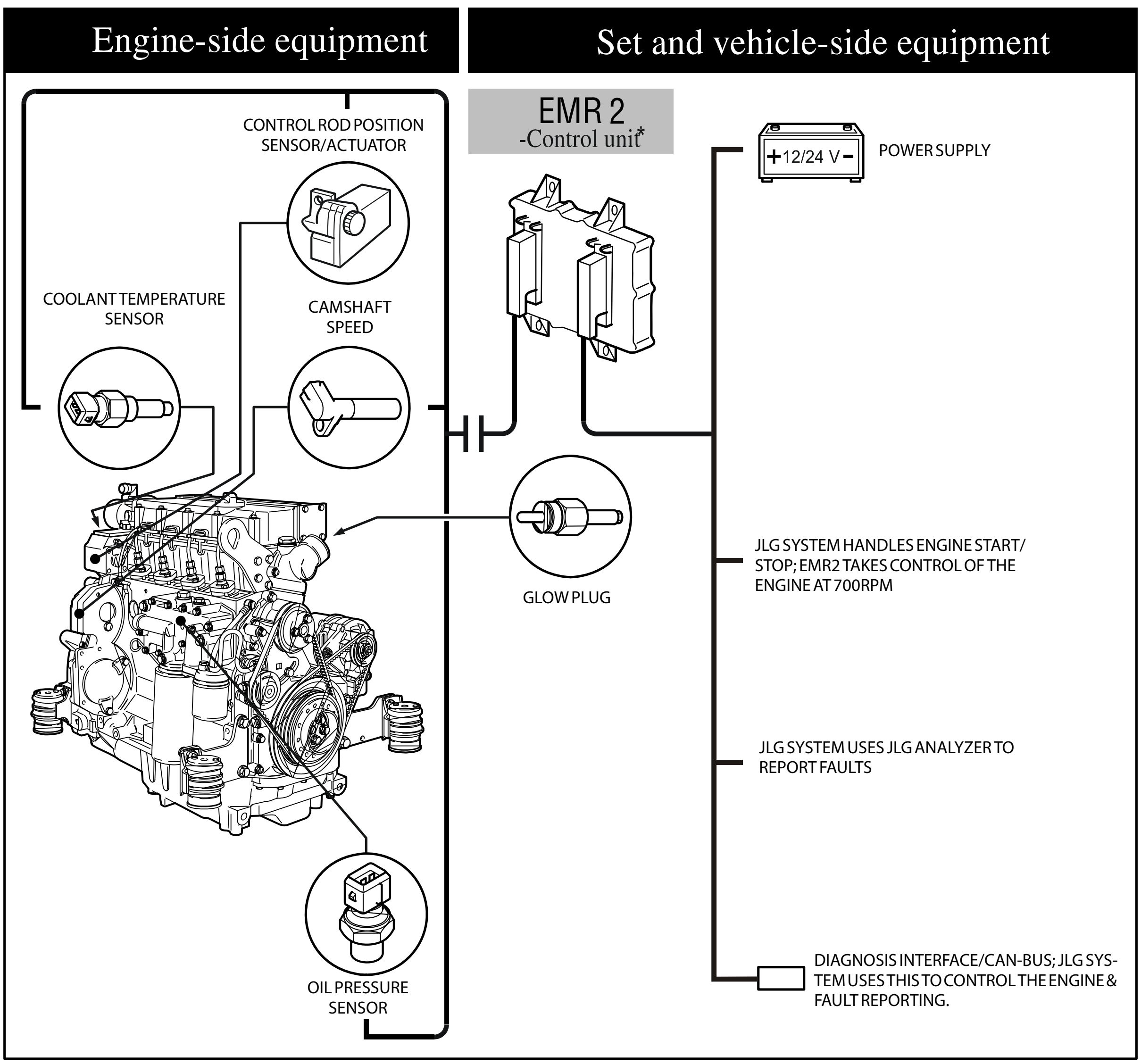


Figure 3-56. EMR 2 Engine Side Equipment

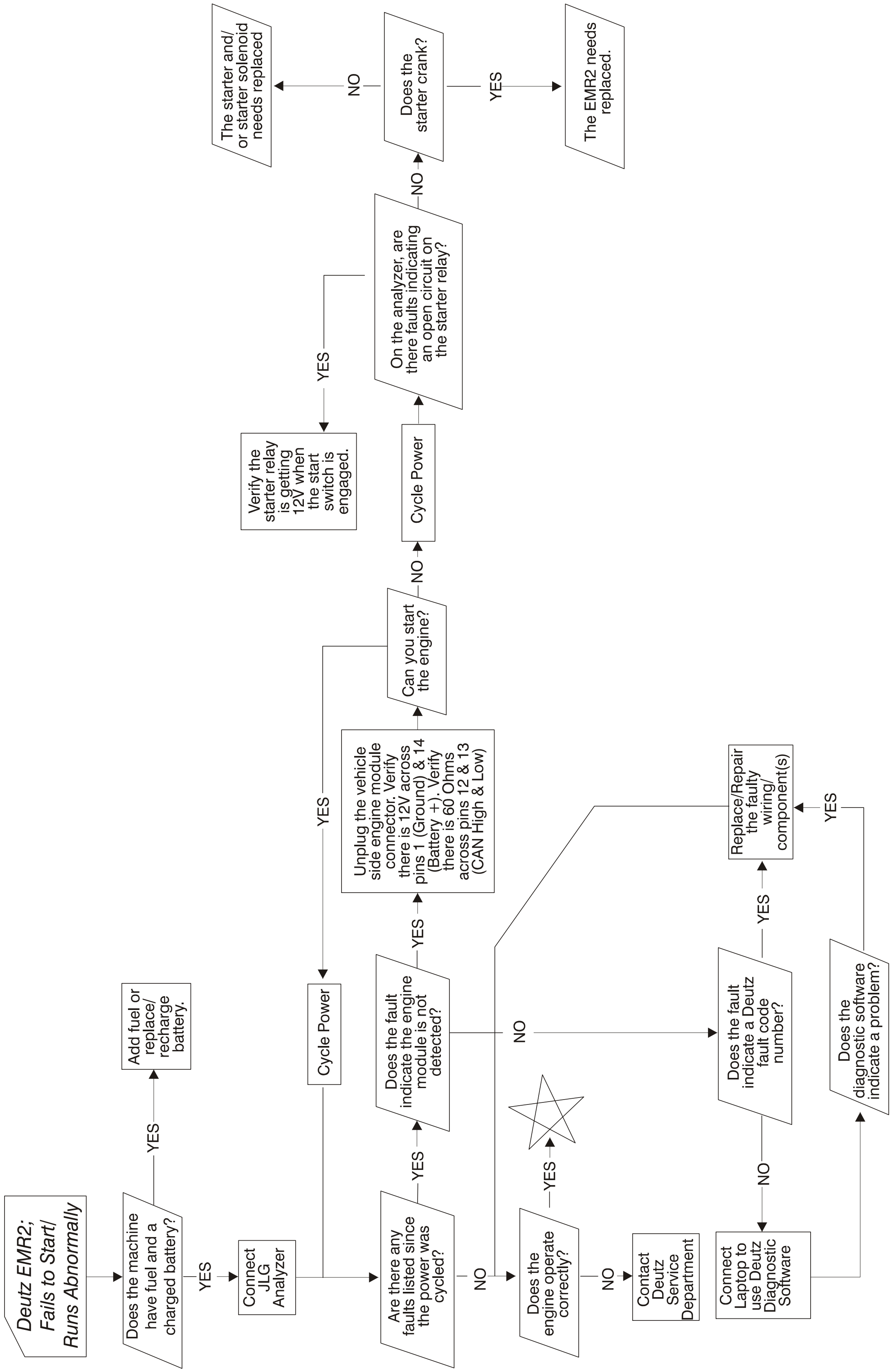


Figure 3-57. Deutz EMR 2 Troubleshooting Flow Chart

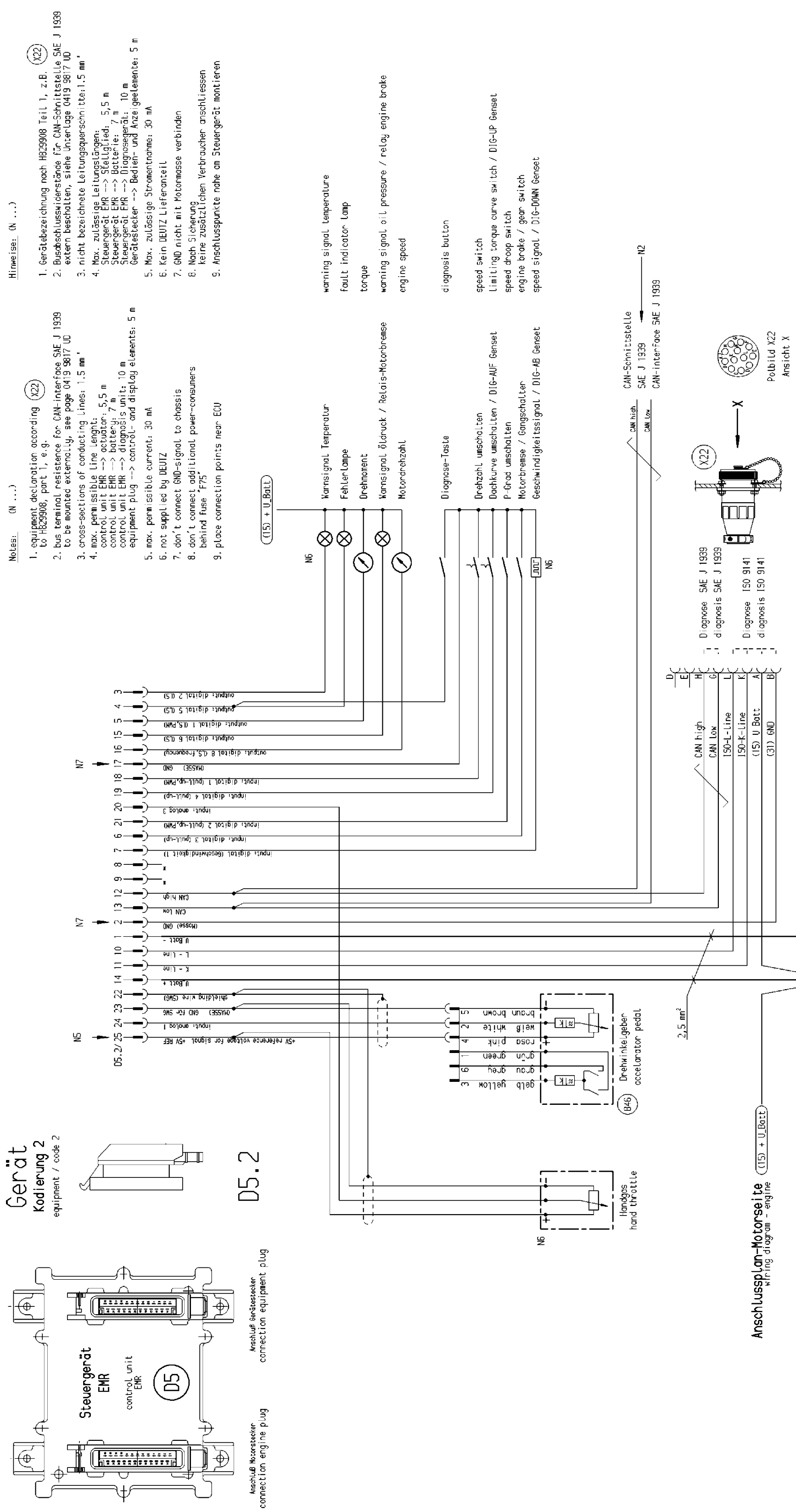


Figure 3-58. Deutz EMR 2 Vehicle Side Connection Diagram

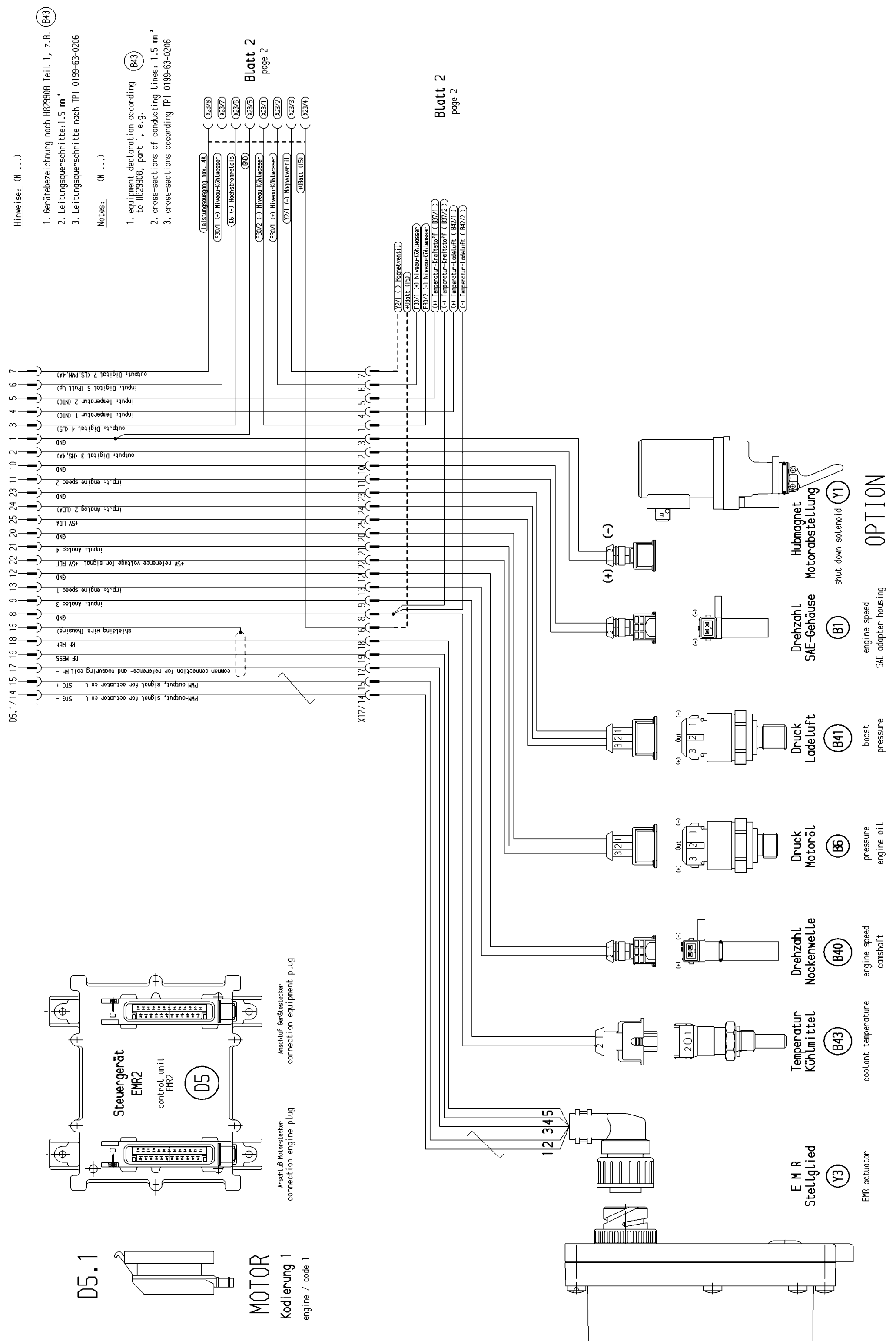


Figure 3-59. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

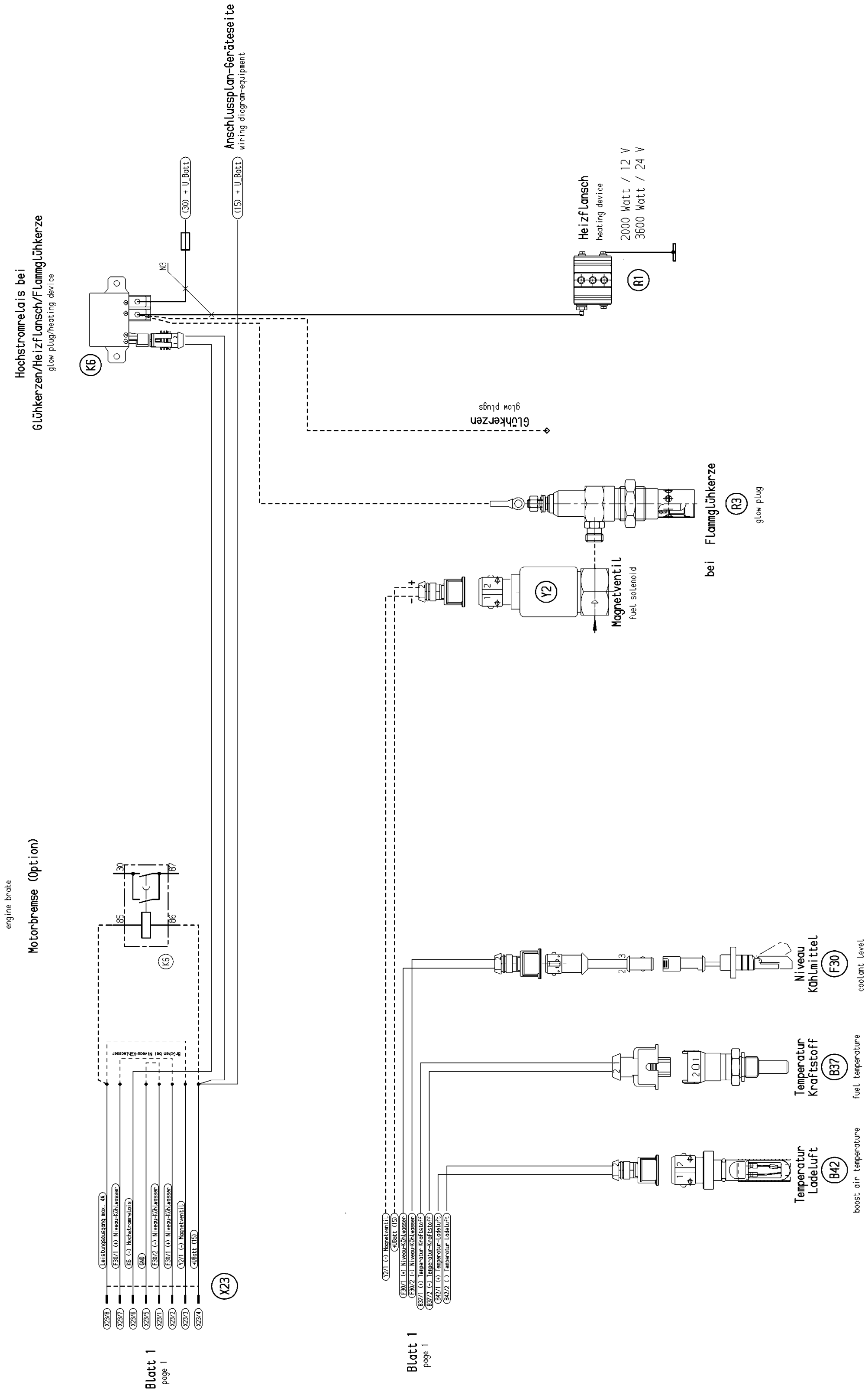
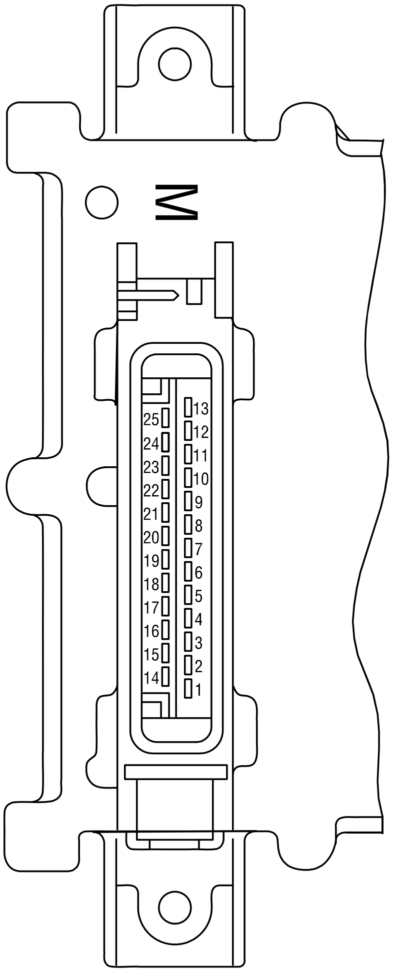


Figure 3-60. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2

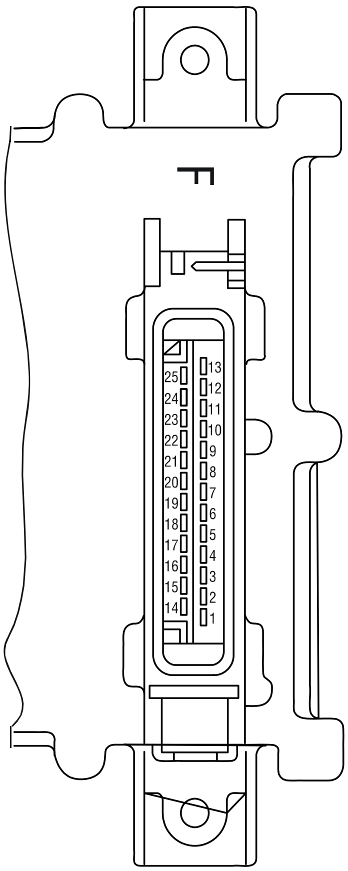


Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid 1)
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature 2)
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) DigIn 5	Coolant 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 3-61. 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 3-62. 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 3-63. 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 3-64. 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 3-65. 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 3-66. 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.

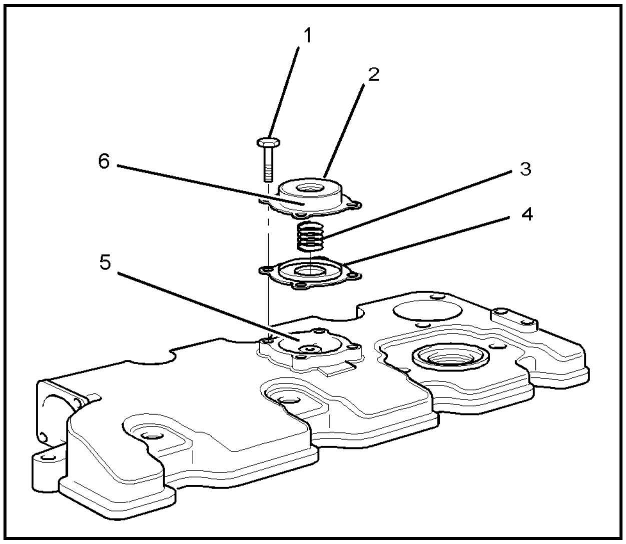
Figure 3-67. EMR2 Fault Codes - Sheet 5 of 5

3.12 PERKINS ENGINE GENERAL MAINTENANCE

Replacing the Engine Crankcase Breather

NOTICE

KEEP ALL PARTS CLEAN FROM CONTAMINANTS. CONTAMINANTS MAY CAUSE RAPID WEAR AND SHORTENED COMPONENT LIFE.



1. Screws for the breather cover
2. Breather cover
3. Spring
4. Diaphragm and plate
5. Cavity
6. Vent hole

Figure 3-68. Crankcase Breather - Perkins

1. Loosen screws (1) and remove breather cover (2) from valve mechanism cover.
2. Remove spring (3). Remove diaphragm and plate (4).
3. Clean vent hole (6) and cavity (5) in valve mechanism cover.

NOTICE

MAKE SURE THAT THE COMPONENTS OF THE BREATHER ASSEMBLY ARE INSTALLED CORRECTLY. ENGINE DAMAGE MAY OCCUR IF THE BREATHER ASSEMBLY IS NOT WORKING CORRECTLY.

4. Install a new diaphragm and plate (4) for the breather assembly into the cavity (5) of valve mechanism cover.
5. Install a new spring (3).
6. Install the breather cover (2) and the four screws (1). Tighten the screws.

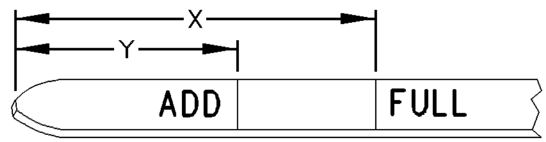
Engine Oil Level - Check

WARNING

HOT OIL AND HOT COMPONENTS CAN CAUSE PERSONAL INJURY. DO NOT ALLOW HOT OIL OR HOT COMPONENTS TO CONTACT THE SKIN.

NOTE: *Perform this maintenance with engine stopped.*

1. Maintain oil level between "ADD" mark (Y) and "FULL" mark (X) on oil level gauge (1). Do not fill the crankcase above "FULL" mark (X).



NOTE: *Operating your engine when oil level is above "FULL" mark could cause your crankshaft to dip into the oil. Air bubbles created from crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in loss of power.*

2. Remove oil filler cap and add oil, if necessary. Clean and install oil filler cap.

Engine Oil and Filter - Change

WARNING

HOT OIL AND HOT COMPONENTS CAN CAUSE PERSONAL INJURY. DO NOT ALLOW HOT OIL OR HOT COMPONENTS TO CONTACT THE SKIN.

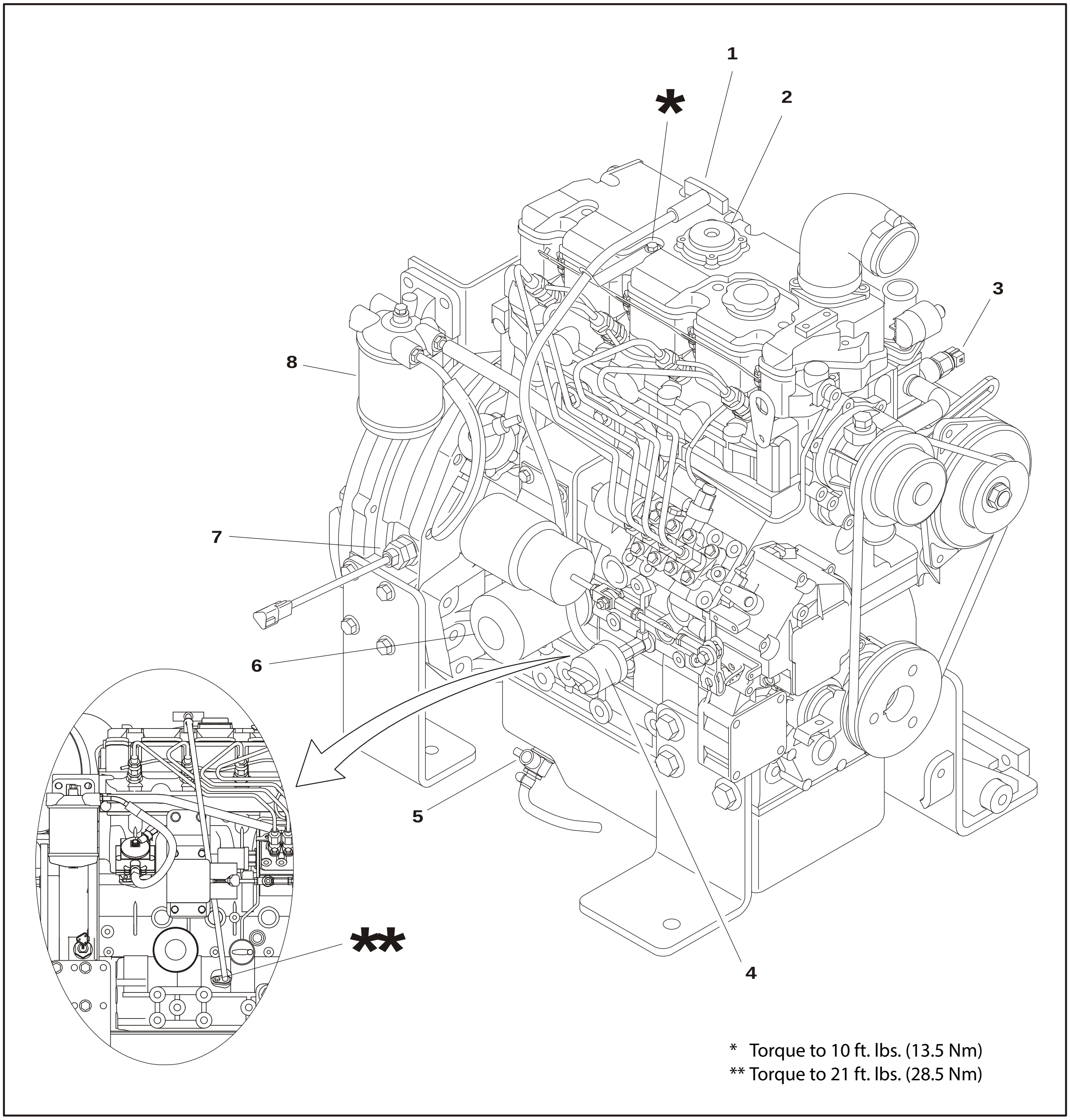
NOTICE

CARE MUST BE TAKEN TO ENSURE THAT FLUIDS ARE CONTAINED DURING PERFORMANCE OF INSPECTION, MAINTENANCE, TESTING, ADJUSTING AND REPAIR OF THE PRODUCT. BE PREPARED TO COLLECT THE FLUID WITH SUITABLE CONTAINERS BEFORE OPENING ANY COMPARTMENT OR DISASSEMBLING ANY COMPONENT CONTAINING FLUIDS.

DISPOSE OF ALL FLUIDS ACCORDING TO LOCAL REGULATIONS AND MANDATES.

NOTE: *Keep all parts clean from contaminants.*

Contaminants may cause rapid wear and shortened component life.



1. Dipstick
2. Crankcase Breather
3. Coolant Sensor
4. Oil Pressure Sensor
5. Oil Drain Valve
6. Oil Filter
7. Speed Sensor
8. Fuel Filter

Figure 3-69. Perkins Engine

NOTE: *Do not drain oil when engine is cold. As oil cools, suspended waste particles settle on bottom of oil pan. The waste particles are not removed with draining cold oil. Drain crankcase with engine stopped. Drain crankcase with oil warm. This draining method allows waste particles that are suspended in oil to be drained correctly. Failure to follow this recommended procedure will cause waste particles to be recirculated through engine lubrication system with new oil.*

DRAINING THE ENGINE OIL

After engine has been run at normal operating temperature, stop engine. Turn drain valve knob counterclockwise to drain the oil. After oil has drained, turn drain valve knob clockwise in to close drain valve.

FILLING THE ENGINE CRANKCASE

1. Remove oil filler cap. Refer to Operation and Maintenance Manual for more information on lubricant specifications. Fill crankcase with correct amount of oil. Refer to Operation and Maintenance Manual for more information on refill capacities.

NOTICE

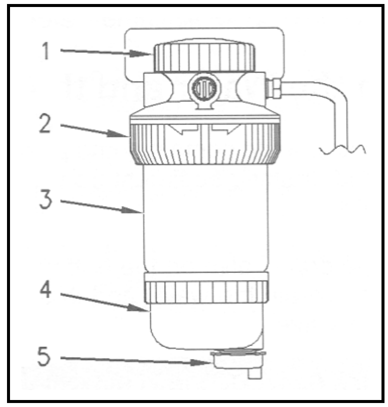
UNDERFILLING OR OVERFILLING THE CRANKCASE WITH OIL CAN CAUSE ENGINE DAMAGE.

NOTICE

TO PREVENT CRANKSHAFT BEARING DAMAGE, CRANK THE ENGINE WITH THE FUEL OFF. THIS WILL FILL THE OIL FILTERS BEFORE STARTING THE ENGINE. DO NOT CRANK THE ENGINE FOR MORE THAN 30 SECONDS.

2. Start engine and run at "LOW IDLE" for two minutes. Perform this procedure to ensure lubrication system has oil and oil filters are filled. Inspect oil filter for oil leaks.
3. Stop engine and allow oil to drain back to sump for a minimum of ten minutes.
4. Remove oil level gauge to check the oil level. Maintain oil level between "MIN" and "MAX" marks on oil level gauge.

Fuel Filter/Water Separator



1. Cap
2. Locking Ring
3. Element
4. Water Separator Bowl
5. Drain

Figure 3-70. Fuel Filter/Water Separator

WARNING

FUEL LEAKED OR SPILLED ONTO HOT SURFACES OR ELECTRICAL COMPONENTS CAN CAUSE A FIRE. TO HELP PREVENT POSSIBLE INJURY, TURN THE START SWITCH OFF WHEN CHANGING FUEL FILTERS OR WATER SEPARATOR ELEMENTS. CLEAN UP FUEL SPILLS IMMEDIATELY.

NOTICE

WATER SEPARATOR IS NOT A FILTER. THE WATER SEPARATOR SEPARATES WATER FROM FUEL. THE ENGINE SHOULD NEVER BE ALLOWED TO RUN WITH WATER SEPARATOR MORE THAN HALF FULL. ENGINE DAMAGE MAY RESULT.

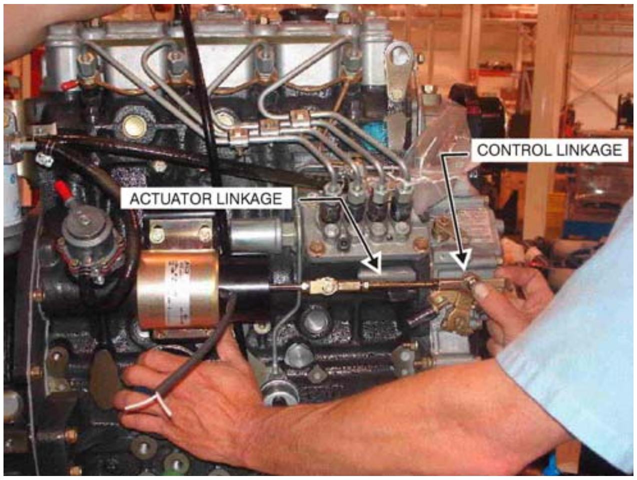
1. Open the drain at the bottom of the separator. Catch the draining water in a suitable container. Properly dispose of the drained water.
2. Close the drain.

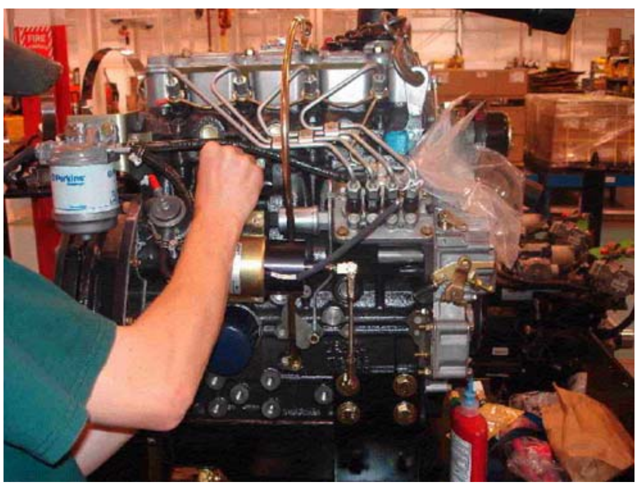
NOTICE

WATER SEPARATOR IS UNDER SUCTION DURING NORMAL ENGINE OPERATION. ENSURE DRAIN VALVE IS SECURELY TIGHTENED TO HELP PREVENT AIR FROM ENTERING THE FUEL SYSTEM.

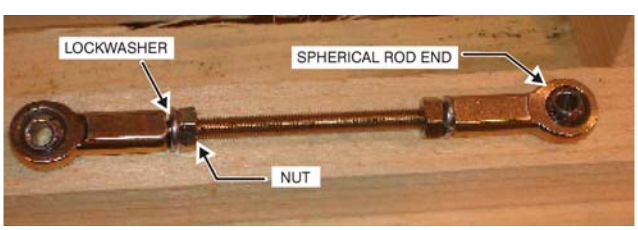
Setting the Actuator

1. Remove bolt from control linkage



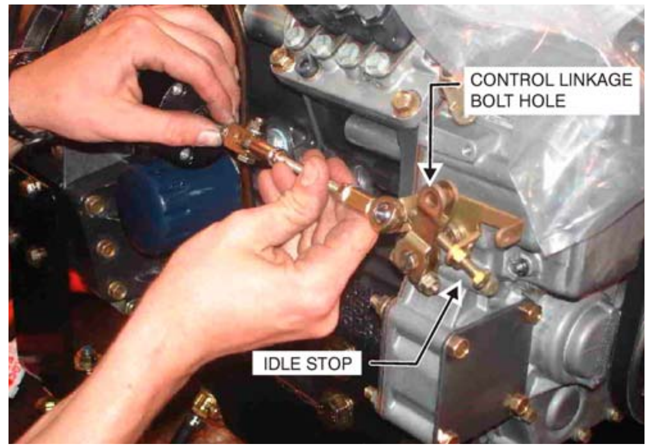


2. With control linkage pushed against idle stop, begin to make adjustments to actuator linkage to align bearing of spherical rod end with control linkage bolt hole. When making linkage adjustments, thread spherical rod end and threaded rod evenly (for every turn of spherical rod end, turn threaded rod.)

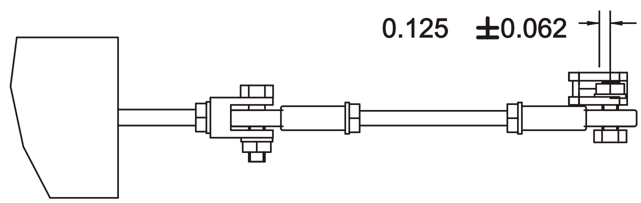


NOTICE

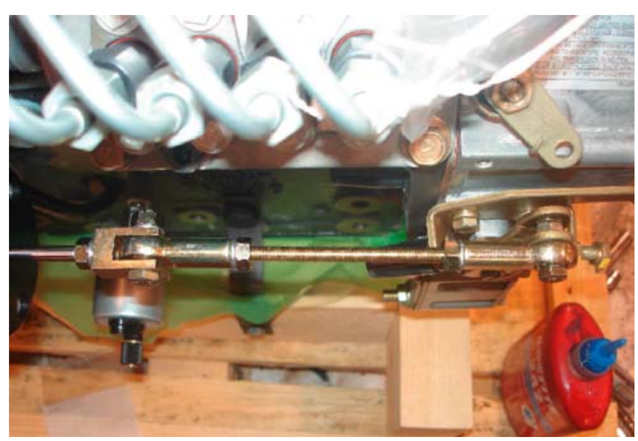
DURING THIS PROCEDURE IT IS VERY IMPORTANT TO KEEP CONTROL LINKAGE PUSHED AGAINST THE STOP.



3. Once the adjustments have been made to align the spherical rod end bearing with the control linkage bolt hole, lengthen the actuator linkage by continuing to turn the spherical rod end and threaded rod 2-2 ½ turns (1-1 ¼ turns of spherical rod end and 1-1 ¼ turns of threaded rod.) This will provide 1/8" (3 mm) preload.



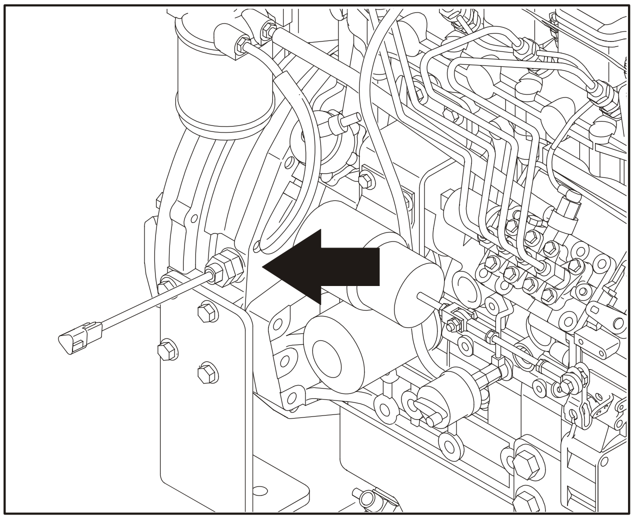
Use a measuring device to ensure the preload is approximately 1/8" (3 mm), then secure the actuator linkage to the control linkage with original bolt and nut. Make sure the spherical ball is seated in the control linkage bolt hole. Tighten two nuts on the threaded rod of the actuator linkage and using two wrenches to prevent binding of clevis heads.



Speed Sensor Installation

NOTE: *A new speed sensor comes with two hex nuts.*

1. Remove one hex nut from the speed sensor and discard it.
2. Install the speed sensor into the housing until it contacts the flywheel.



3. Back off the sensor 1/4 to 3/4 turn and ensure the sensor flats are vertical and tighten the nut.

3.13 ENGINE RADIATOR FILL PROCEDURE - PERKINS & CATERPILLAR

NOTICE

DUE TO THE CONFIGURATION OF THE COOLING SYSTEM, SOME ENGINES REQUIRE A SPECIAL RADIATOR FILL PROCEDURE. FAILURE TO FOLLOW THIS PROCEDURE CAN RESULT IN DAMAGE TO THE ENGINE.

WARNING

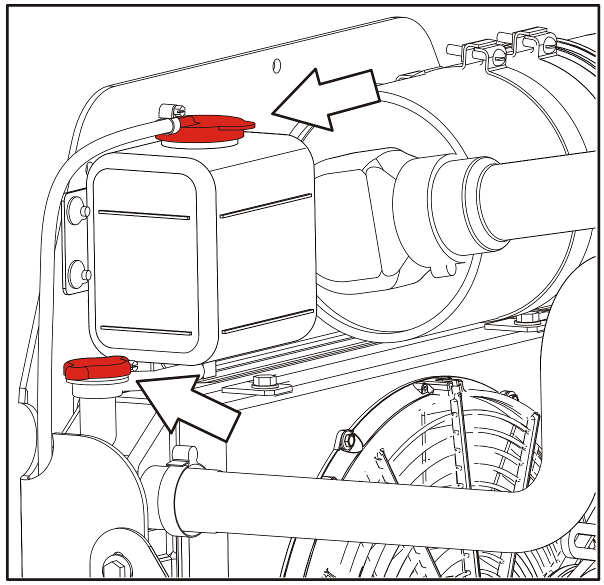
THE FOLLOWING FILL PROCEDURE SHOULD ONLY BE PERFORMED WHEN THE ENGINE IS COLD.

WARNING

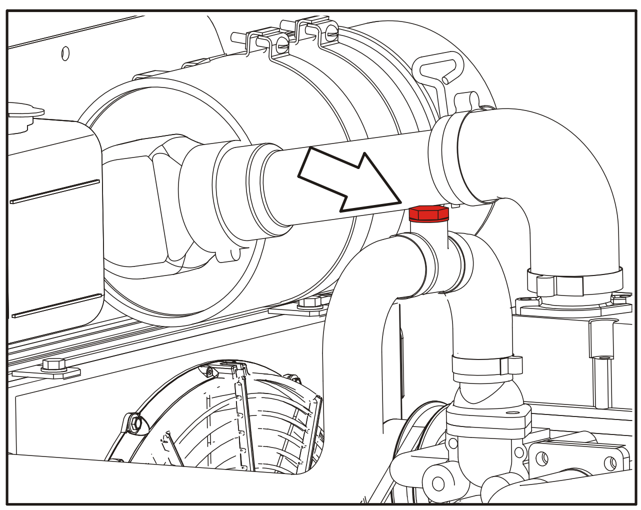
ENGINE COOLANT IS UNDER PRESSURE. DO NOT REMOVE THE RADIATOR CAP WHILE THE ENGINE IS WARM.

NOTE: *If the radiator cap is removed at any time after the following steps are performed, coolant will flow out regardless of whether the engine is cold or hot.*

1. Remove radiator cap and reservoir cap.

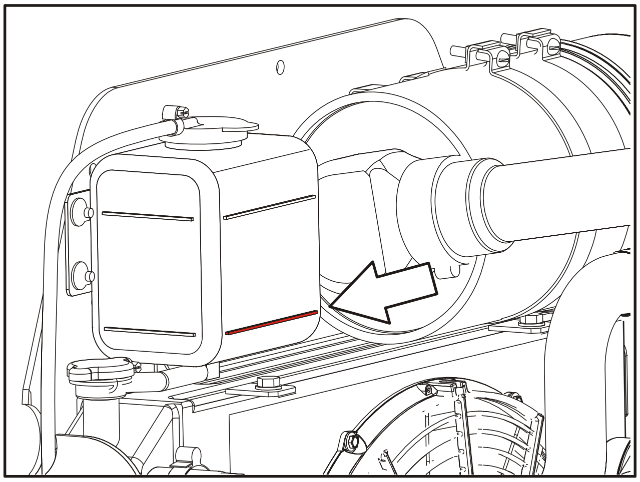


2. Fill radiator to the top. Allow enough time for coolant to properly settle in radiator and add coolant as necessary to top off.
3. Install radiator cap on radiator.
4. Remove plug from adapter and add coolant at this location until radiator hose is full of coolant.



5. Using sealant JLG P/N 0100020 (Loctite #567), install plug back into the adapter.

6. Remove fill cap and fill coolant recovery reservoir to cold level line. Put fill cap back on reservoir when done.

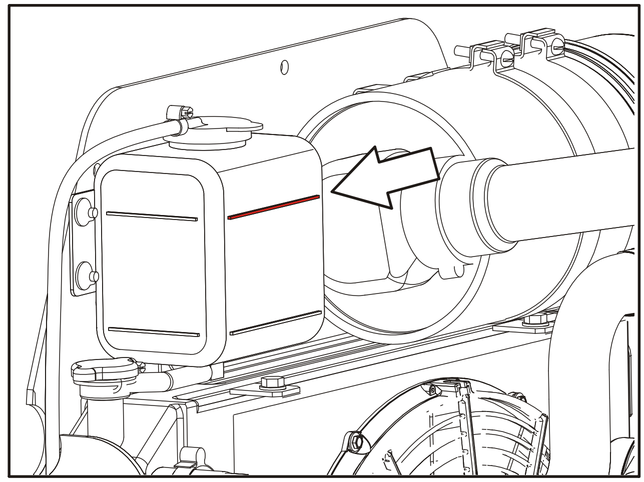


7. Start engine and run it long enough to bring coolant up to operating temperature. Turn off engine.

WARNING

ENGINE COOLANT IS UNDER PRESURE. DO NOT REMOVE THE RADIATOR CAP WHILE THE ENGINE IS WARM.

8. Make sure coolant reaches hot level line on coolant recovery reservoir. Add coolant as needed.



NOTICE

IF RADIATOR CAP IS REMOVED AND COOLANT IS LOST, REPEAT THIS PROCEDURE TO ENSURE COOLING SYSTEM IS FILLED TO PROPER LEVEL.

3.14 DGC DIAGNOSTIC SUPPORT AND TROUBLE CODE DEFINITIONS

This section defines the diagnostics and recommended troubleshooting procedures associated with an EControls Diesel Governor Control (DGC) engine control module (ECM) for use on industrial engines.

Section Layout

This section is organized in the following manner:

DTC XXXX- Diagnostic Condition

Block Diagram of Circuit

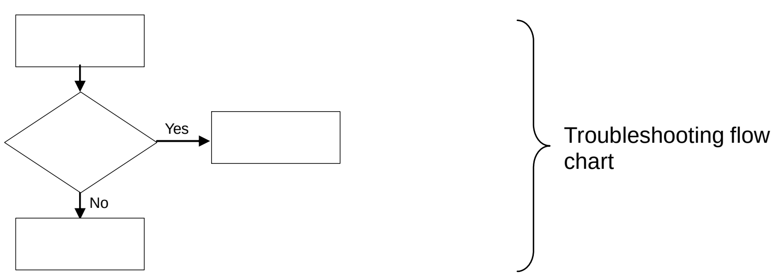
- *External Hardware Input/Output*- This identifies the hardware that either sends an input to the ECM or is driven by and ECM output.
- *Check Condition*- This defines what condition to troubleshoot the fault condition.
- *Fault Condition(s)*- This identifies the condition(s) that set the fault.
- *Corrective Action(s)*- This identifies the *RECOMMENED* corrective action(s) that the ECM is generally programmed to perform. In some instances, the calibration engineer(s) may choose to perform a different action.
- Emissions or Non-emissions related fault

Text to identify the circuit of interest and its use for control.

Text to describe the conditions that cause the fault to set.

DTC XXXX- Diagnostic Condition

Note: Helpful tips used to aid troubleshooting



Diagnostic Aids
- Tip #1
- Tip #2 …

List of Abbreviations in this Section

AL	Adaptive Learn
BP	Barometric Pressure
CAN	Controller Area Network
CCP	CAN Calibration Protocol
CHT	Cylinder Head Temperature
CL	Closed Loop
CNG	Compressed Natural Gas
DBW	Drive-By-Wire
DGC	Diesel Governor Control
DM	Diagnostic Message
DMM	Digital Multi-Meter (high impedance)
DST	Diagnostic Scan Tool
DTC	Diagnostic Trouble Code
DVOM	Digital Voltage and Ohm Meter (high impedance)
ECI	EControls Inc.
ECIPP	EControls Inc. Proprietary Protocol
ECM	Engine Control Module
ECT	Engine Coolant Temperature
ECU	Engine Control Unit
EDIS	EControls Display and Interface Software
EGO	Exhaust Gas Oxygen Sensor, typically heated
EMWT	Exhaust Manifold Water Temperature
EPR	Electronic Pressure Regulator
ERWT	Exhaust Manifold Riser Temperature
ETB	Electronic Throttle Body
ETC	Electronic Throttle Control
FDR	Flight Data Recorder
FMI	Failure Mode Indicator
FO	Firing Order
FP	Fuel Pressure
FPP	Foot Pedal Position
FRP	Fuel Rail Pressure
FRT	Fuel Rail Temperature
FSS	Fault Snapshot
FT	Fuel Temperature
GCP	Global Control Platform
HDGCP	Heavy-Duty Global Control Platform (On-Road Heavy-Duty)
HEGO	Heated Exhaust Gas Oxygen Sensor (same as HO2S)
HO2S	Heated Oxygen Sensor (same as HEGO)
IAC	Idle Air Control
IAT	Intake Air Temperature
ICAV	Instant Crank Angle Velocity
IVS	Idle Validation Switch
LDGCP	Light-Duty Global Control Platform (Industrial, Smart/Logic Coil)
LED	Light Emitting Diode
LPG	Liquefied Propane Gas
MAP	Manifold Absolute Pressure
MGCP	Marine Global Control Platform
µP	Microprocessor
Mfg	Manufacture
MIL	Malfunction Indicator Lamp
NG	Natural Gas
OBD	On-Board Diagnostics
OEM	Original Equipment Manufacture
PC	Personal Computer
PCU	Powertrain Control Unit
PFI	Port Fuel Injection
PGN	Parameter Group Number
PWM	Pulse Width Modulated
RAM	Random Access Memory
RPM	Revolutions Per Minute
Rx	Receive
SAE	Society of Automotive Engineering
SA	Source Address
SPFI	Sequential Port Fuel Injection
SPN	Suspect Parameter Number
Tach	Tachometer
TBI	Throttle Body Injection
TDC	Top Dead Center
TIP	Throttle Inlet Pressure
TPS	Throttle Position Sensor
TSC	Torque/Speed Control
Tx	Transmit
UEGO	Universal Exhaust Gas Oxygen Sensor (also called wide-range EGO)
VDC	Voltage, Direct Current
VR	Variable Reluctance
Vsw	Switched, Ignition Voltage
WGP	Waste-Gate Pressure

Fault Code Broadcast

All diagnostic trouble codes are broadcast through EDIS for display on a PC. EDIS can acquire the data from the ECU via CAN using the EControls Inc. Proprietary Protocol (ECIPP). Faults may also be acquired over the CAN network through CAN J1939-based scan tools or multi-function display units.

Diagnostic Trouble Codes

The numeric diagnostic trouble codes assigned to the faults in this manual are cross-referenced to SAE.s "Recommended Practice for Diagnostic Trouble Code Definitions" (SAE J2012). While these codes are recommended, customers may define their own codes by assigning a new number to the flash code in the diagnostic calibration. This will assign both the DTC as displayed in EDIS as well as the flash code output on the MIL output pin. EDIS may be used to connect to the DGC ECM via CAN.

CAN

The DGC supports SAE J1939 CAN based diagnostic support. This includes:

- DM1: Active Diagnostic Trouble Codes
- DM2: Previously Active Diagnostic Trouble Codes
- DM3: Diagnostic Data Clear/Reset of Previously Active DTCs
- DM4: Freeze Frame Parameters
- DM5: Diagnostic Readiness (bytes 1, 2, and 3 are supported)
- DM11: Diagnostic Data Clear/Reset For Active DTCs
- DM12: Emissions-Related Active Diagnostic Trouble Codes
- DM19: Calibration Information

All diagnostic trouble codes broadcast over CAN will be SAE J1939 DM1 and DM2 formatted messages. DGC ECMs are compliant with J1939 OBD-M, supporting the Diagnostic Messages above as well as user indicators and CAN data defined in the OBD-M protocol. Faults available for broadcast and their respective SPN/FMI numbers are dependent on the application and engine calibration. There are 4 CAN SPN/FMI lists available in the DGC software set, contact EControls Inc. for a list of CAN SPN/FMIs.

Data capture at the occurrence of a fault, known in the ECM as fault snapshot (FSS), is available upon DM4 request. The following bytes are supported for DM4 if configured in the ECM software:

- Byte 1: Freeze Frame Length
- Byte 2-6: SPN, FMI, SPN Conversion Method, and Occurrence
- Byte 7: Manifold Absolute Pressure
- Byte 8-9: Engine Speed
- Byte 10: Engine Load (MAP based estimate)
- Byte 11: Engine Coolant Temperature
- Byte 14: # of starts since fault was last active
- Byte 15: Index into FSS_storage table for Fault Snap Shot retrieval

Resetting active and previously active DTCs is handled through DM11 and DM3, respectively DM1 and DM2 lamp indicators are assigned to each fault based on the fault.s diagnostic action as defined in the calibration. The lamps are assigned based on the configuration outlined in Table 3-10.

Table 3-10. J1939 Diagnostic Lamp Configuration

ECI DIAGNOSTIC ACTION	J1939 LAMP
MIL	MIL
Soft Warning	Amber
Hard Warning, Low Rev Limit, Shutdown	Red Stop
Power Derate 1 & 2	Protect
Forced Idle	None (use in combination with other action)

MIL Output

The MIL output is used to convey fault information to the equipment operator. The MIL is always on (grounded) when the system is in a key-on (Vsw), engine-off state. This provides assurance that the output is functional. If a DTC is logged as previously-active (historic), the MIL will send a single flash for the “Blink on-time” every “Blink off-time.”

Diagnostic Calibration Configuration and Corrective Actions

Each fault within the DGC is capable of being uniquely configured in the engine.s diagnostic calibration to cause one or more corrective actions while a given fault is active. Table 2 identifies the configuration options and corrective actions available for configuration of each fault. The desired action is set by the OEM calibration engineers.

Table 3-11. Diagnostic Corrective Actions

CORRECTIVE ACTION	DESCRIPTION
Enable	Enables the fault for fault detection
Shutdown	Cause an engine shutdown when fault becomes active
Never Forget	Retain fault as historic/previously active until cleared by a technician and does not allow historic fault to be "auto-cleared"
Turn on MIL	Turn on MIL output when fault becomes active
CL Disable	Disable closed-loop while the fault is active
CL Disable Key- Cyc	Disable closed-loop while the fault is active and for the remainder of the key cycle
AL Disable	Disable adaptive learn while the fault is active
AL Disable Key-Cyc	Disable adaptive learn while the fault is active and for the remainder of the key cycle
Power Derate 1	Limit TPS to the Power Derate 1 percent set in the diagnostic calibration while the fault is active. The Power Derate 1 TPS percent should be set higher than Power Derate 2 as Power Derate 2 adds a higher level of protection.
Power Derate 2	Limit TPS to the Power Derate 2 percent set in the diagnostic calibration while the fault is active. If the calibration is set to "Latched for Key-Cycle" Power Derate 2 remains active until engine speed and FPP conditions are satisfied. The Power Derate 2 TPS percent should be set lower than Power Derate 1 as Power Derate 2 adds a higher level of protection.
Low Rev Limit	Limit RPM to the Low Rev Limit speed set in the diagnostic calibration while the fault is active. If the calibration is set to "Latched for Key-Cycle" Low Rev Limit remains active until engine speed and FPP conditions are satisfied.
Forced Idle	Limit RPM to the Forced Idle speed set in the diagnostic calibration while the fault is active and for the remainder of the key cycle
Soft Warning	Turn on the soft warning output when the fault becomes active
Hard Warning	Turn on the hard warning output when the fault becomes active
Stopped Check	Run fault detection/checking while the engine is in a key-on, engine-off condition. NOTE: It is recommended that this feature only be used for general sensor faults (high/low voltage) and some output drivers

Fault/Diagnostic Trouble Code Interaction

All fault and diagnostic information is managed through the Faults page. Interaction includes viewing fault messages, downloading fault data (fault snapshot and flight data recorder), erasing faults from memory, and defining variables for fault data logging.

Faults are separated into two categories, Active and Historic. Active faults are active in real-time and historic faults have been generated at some instance in time that may or may not be active in real-time. Once a fault has become active, it is immediately logged as historic and a snapshot and flight data log is saved. Figure 3-71. shows an example of the fault page when an active fault has been generated. Notice that the fault is present in both the active and historic lists and the malfunction indicator lamp (MIL) has been illuminated. Figure 3-72. shows an example of the fault page with a historic fault stored in memory.

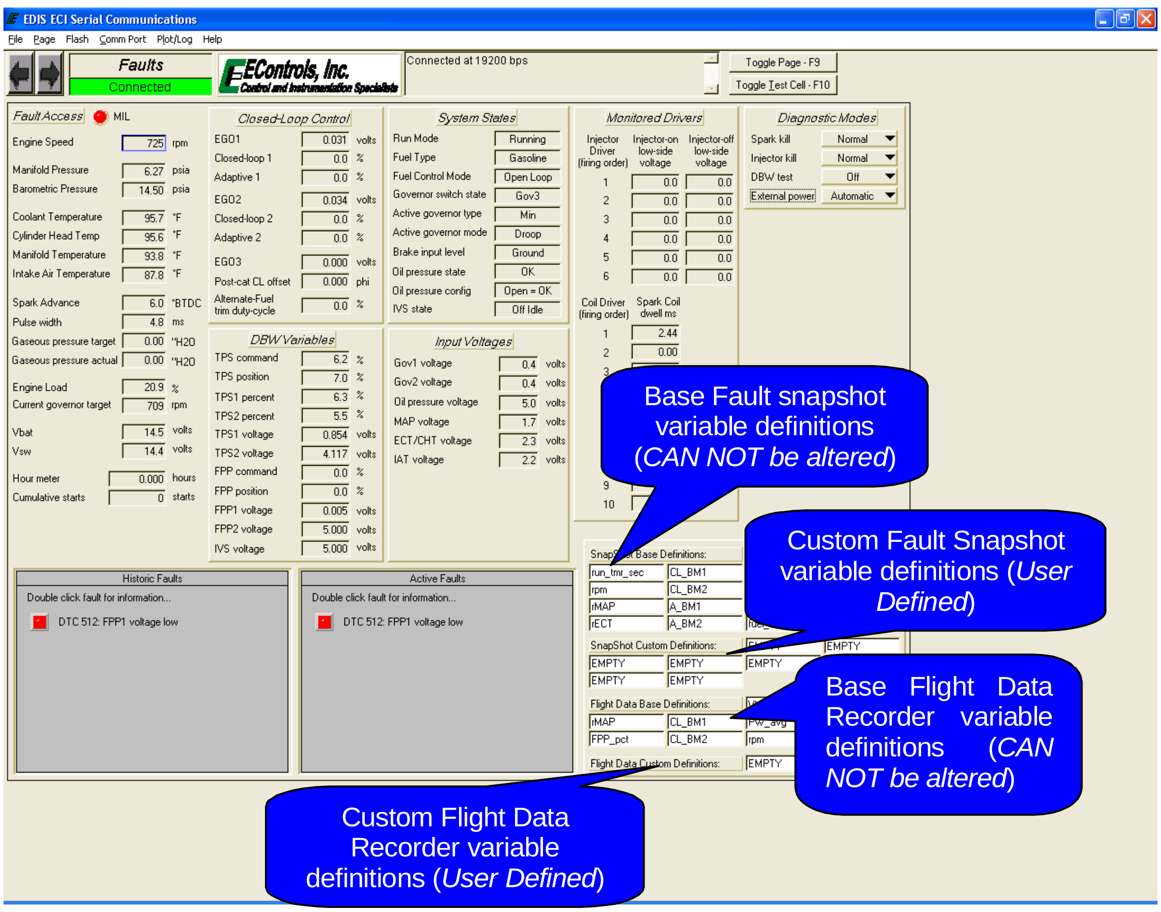


Figure 3-71. Faults Page with Active Fault Message

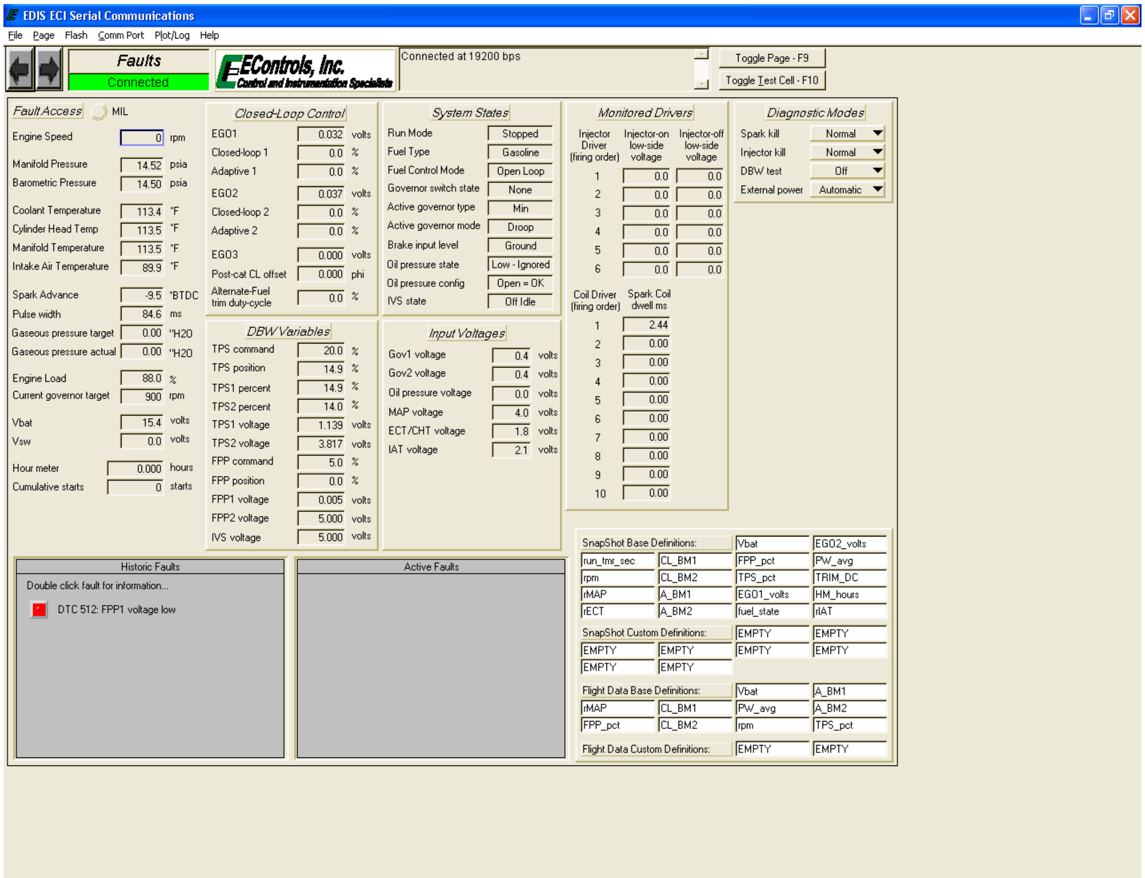


Figure 3-72. Faults Page with Historic Fault Message

Once an active fault has occurred two sets of data are recorded, fault snapshot and flight data recorder. The fault snapshot (FSS) is a sample of data taken at the instance the fault triggered. Variables included in the FSS are defined in the Snapshot Base and Snapshot Custom Definition fields found on the Faults Page. A FSS is saved with each of the first eight (8) faults for the first time the fault becomes active. Conversely, the flight data recorder (FDR) is a ten-second stream of data that includes eight-seconds prior and two-seconds after triggering the fault. An FDR is saved for each of the first two (2) faults for the first time the fault becomes active. Variables included in the FDR are defined in the Flight Data Base and Flight Data Custom Definition fields found on the Faults Page.

The memory location of the FDR is RAM, therefore this data is only available if the ECM has not lost battery power. In addition, if there is a "Dirty Flash Page" in the ECM, the FDR data will not be available. The memory location of the FSS data is EEPROM and is retained when the ECM loses battery power.

Both sets of data are accessed from the Historic Fault Information interface and can be saved to the PC upon retrieval. Base variables for FSS and FDR are generally defined by the OEM to include variables most often referenced during fault diagnosis. The base definitions are not fault dependent. Additional variables may be selected for capture during a fault occurrence through a single, left-click of the custom table and selecting the desired variables from a list. An example of custom fault variable definitions is shown in Figure 3-73.

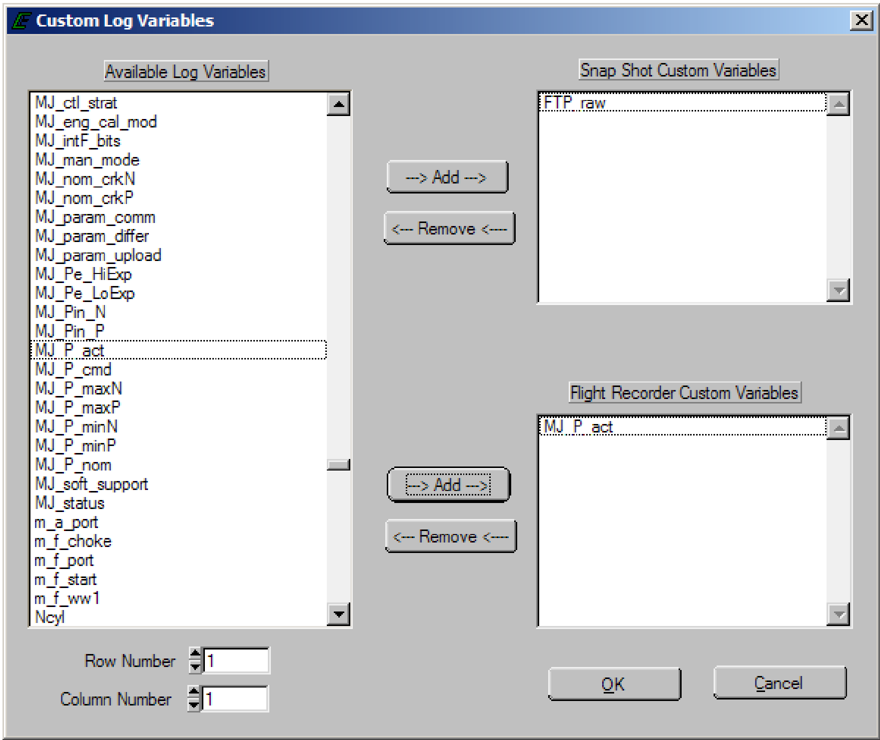


Figure 3-73. Custom Fault Variable Interface

Accessing fault information is accomplished through a double left-click of the fault LED in the historic fault list. This produces the Historic Fault Information interface shown in Figure 3-74. From this interface the user can interpret a diagnostic trouble code (DTC) message, identify whether or not the fault occurred during the current key cycle, identify if the fault caused the engine to shutdown, determine how many key cycles have occurred since the fault was last active, clear selected or all historic faults, and view snapshot and flight data. Table 3-12 outlines the options displayed in the Historic Fault Information screen. Historic faults are not overwritten if the same fault becomes active, storing data from the original active fault.

Figure 3-75. is an example of a fault snapshot after View Fault Snapshot is selected. Data is presented in two columns, base and custom variables. Once retrieved, the FSS data may be saved to the PC in text format with an .fss extension. A FSS saved to a PC may be reviewed in any ASCII based software program.

Figure 3-76. shows the Flight Data Recorder interface after View Flight Data Recorder is selected. The FDR captures a ten second (eight seconds prior and two seconds after generating the fault) strip of data for base and custom variables. FDR data is presented in an interface similar to the Plot interface for a quick graphical presentation. From this interface, the FDR data may be saved to the PC in text, tab-delimited format with an .fdr file extension. Once saved to PC, FDR data may be reviewed using any graphical post-processing software capable of handling tab-delimited formatting.

Fault information may be manually erased using the “Clear” button functions. Once a “Clear” function has been selected, the dialog prompt shown in Figure 3-77. will be displayed. Choosing YES deletes all fault information from the ECM.

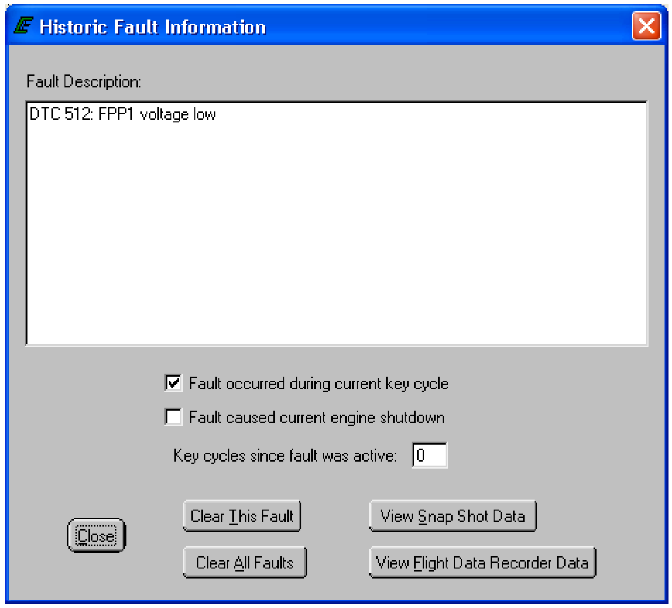


Figure 3-74. Historic Fault Information Interface

Table 3-12. Historic Fault Information Interface Functions

Fault Description Message Box	Customized text that references the DTC flash code and describes the fault.
Fault During Key Cycle Checkbox	Informs that the fault occurred during the current key-on event.
Fault Caused Engine Shutdown Checkbox	Informs that the fault caused the engine to shutdown.
Key Cycles Since Fault Active Indicator	Displays the amount of key-on events since the fault was last active.
Clear This Fault Button*	Erases the selected historic fault from the ECM.
Clear All Faults Button*	Erases all historic faults from the ECM.
View Snap Shot Data Button	Retrieves a data “snap shot” from the ECM for variables defined in the base and custom snapshot variable definition lists. An example of a fault snap shot is shown in Figure 5.
View Flight Data Recorder Data Button	Retrieves a 10-second data strip chart (8 seconds prior, 2seconds after fault trigger) from the ECM for variables defined in the base and custom flight data recorder definition lists. An example of a fault snap shot is shown in Figure 6.
Close Button	Exits the Historic Fault Information interface. DOES NOT cancel or clear any faults.
* Snapshot and flight data recorder data for historic faults is erased after the prompt shown in Figure 3-77. is satisfied	

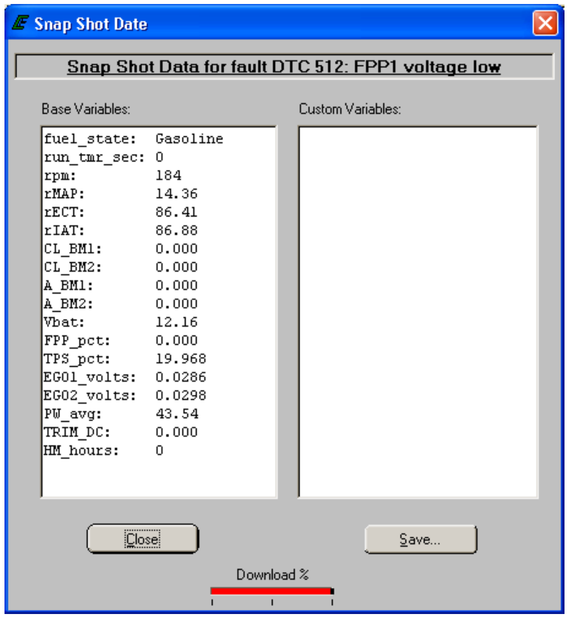


Figure 3-75. Snapshot Data Interface

Figure 3-76. Flight Data Recorder Interface

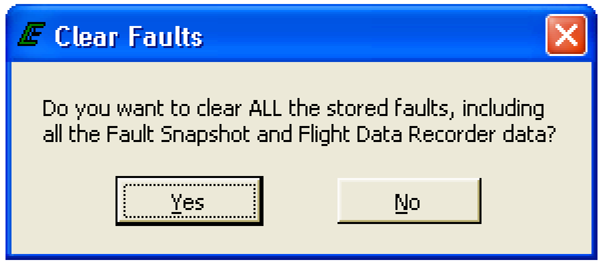


Figure 3-77. Clear Faults Prompt

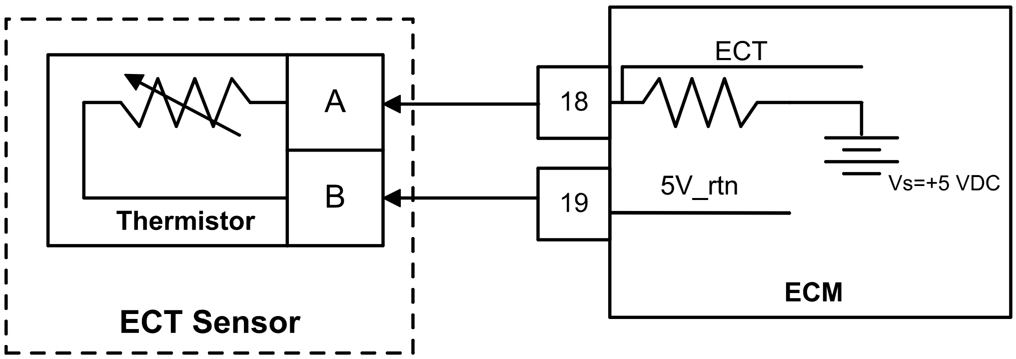
DBW Diagnostic Test

The DGC engine control module incorporates a diagnostic test that may be used to verify proper drive-by-wire throttle actuator operation. This diagnostic test is software selectable through the EDIS using the ECIPP protocol. This test permits full-authority operation of an electronic throttle via the throttle command input while the engine is in the “Stopped” state only. The ECM reverts to normal operation if “Off” state is selected, ignition voltage is lost, or engine speed is sensed.

To enable the test, go to the DBW page of the EDIS. Set “DBW test mode” to “Enabled”. Double-click on the “TPS Command” setting and enter the desired DBW throttle actuator position. Under normal operation, the throttle actuator should move to the position entered. To disable the test, set “DBW test mode” to “Off.”

3.15 DIAGNOSTIC TROUBLE CODE FAULT DESCRIPTIONS

DTC 116- ECT Higher Than Expected Stage 1



- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-Engine Coolant Temperature reading or estimate greater than the stage 1 limit when operating at a speed greater than defined in the diagnostic calibration
- Corrective Action(s): Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during active fault. Recommend a power derate 1/2 and/or a low rev limit to protect engine from possible damage.
- Non-emissions related fault

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. They are used for engine airflow calculation, ignition timing control, to enable certain features, and for engine protection. The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.

This fault will help protect the engine in the event of over temperature. When the coolant exceeds x deg. F and engine RPM exceeds y RPM for the latch time this fault will set.

Diagnostic Aids

If the "ECT High Voltage" fault is also present, follow the troubleshooting procedures for that fault as it may have caused "ECT Higher Than Expected 1."

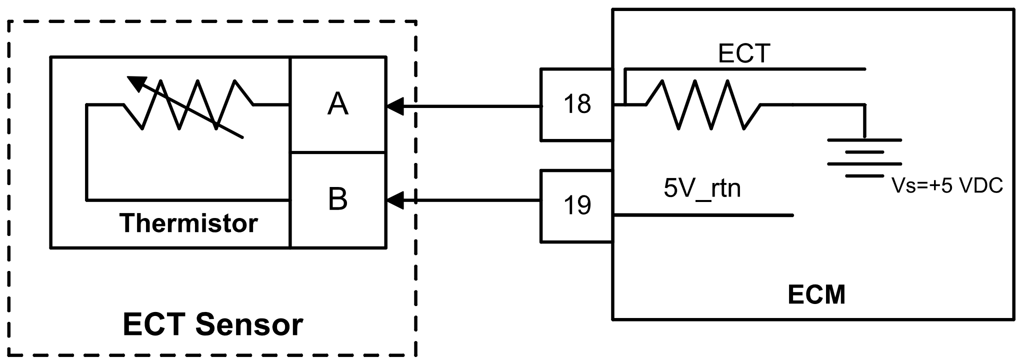
If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:

- Check radiator has a proper amount of ethylene glycol/ water and is not leaking
- Ensure that there is no trapped air in the cooling path
- Inspect cooling system (radiator and hoses) for cracks and ensure connections are leak free
- Check fan is operating properly
- Check thermostat is not stuck closed

If cooling system utilizes a water-to-water heat exchanger:

- Check heat exchanger has a proper amount of ethylene glycol/water and is not leaking
- Ensure there is no trapped air in the cooling path
- Inspect cooling system (radiator and hoses) for cracks and ensure connections are leak free
- Check raw water pickup is not blocked/restricted by debris and hose is tightly connected
- Check thermostat is not stuck closed
- Check raw water pump/impeller is intact and not restricted

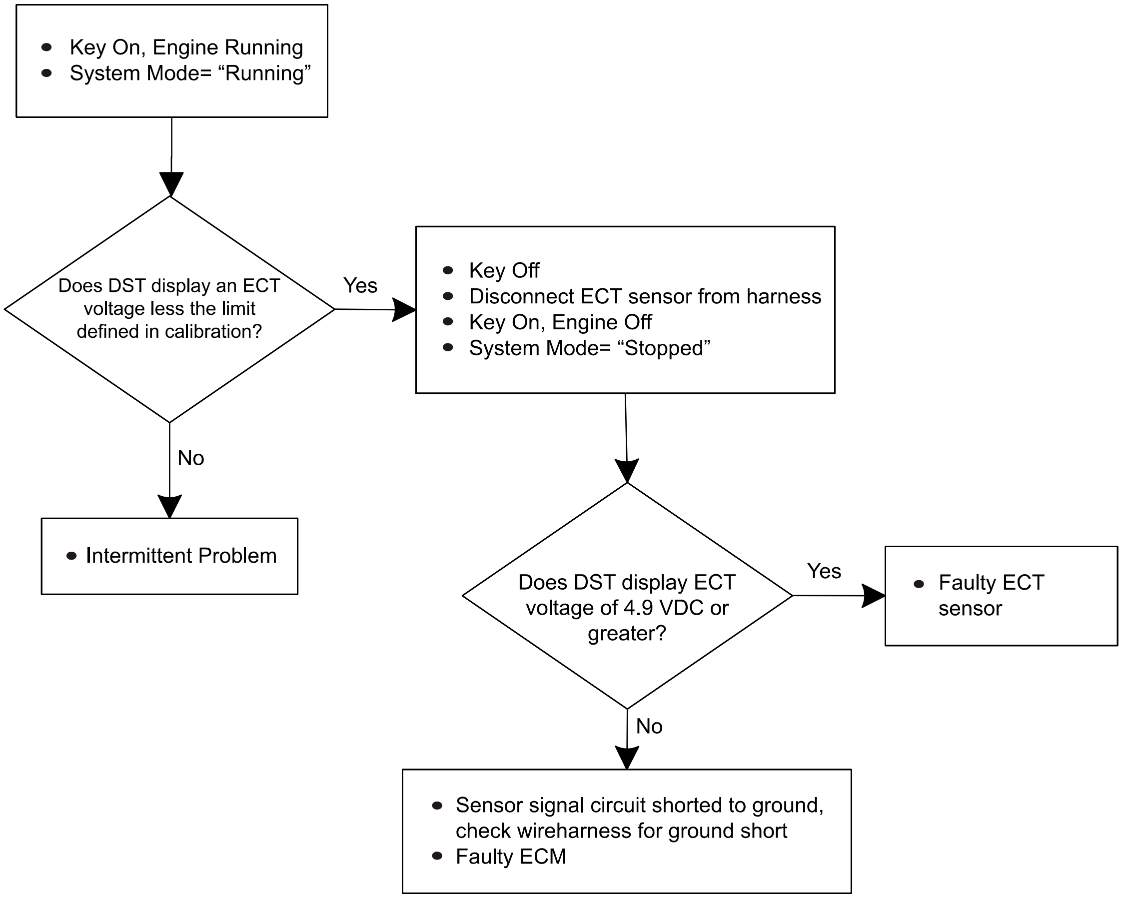
DTC 117- ECT/CHT Low Voltage



- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-CHT/ECT sensor voltage less than the limit defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during active fault, or any combination thereof as defined in calibration. Recommend a power derate 1/2 to reduce the possibility of engine damage due to the inability to sense temperature.
- Non-emissions related fault

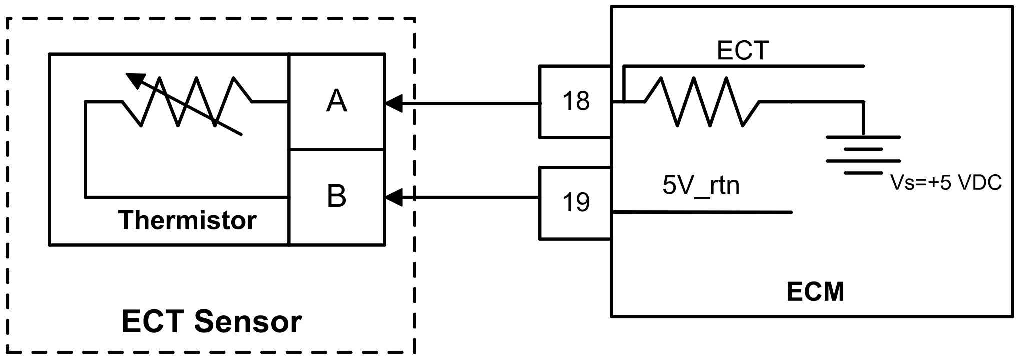
The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use an ECT sensor that is located in the coolant near the thermostat. Some engines use a CHT (Cylinder Head Temperature) sensor that is located in the coolant in the cylinder head. If the engine is equipped with an ECT sensor then the CHT value is estimated. If equipped with a CHT sensor then the ECT value is estimated. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm.

This fault will set if signal voltage is less than the limit defined in the diagnostic calibration any time engine is running. The limit is generally set to 0.10 VDC. The ECM will use a default value for the CHT/ECT sensor in the event of this fault.



Key On, Engine Running
System Mode= "Running"
Does DST display an ECT voltage less the limit defined in calibration?
Yes
No
Key Off
Disconnect ECT sensor from harness
Key On, Engine Off
System Mode= "Stopped"
Intermittent Problem
Does DST display ECT voltage of 4.9 VDC or greater?
Yes
No
Faulty ECT sensor
Sensor signal circuit shorted to ground, check wireharness for ground short
Faulty ECM

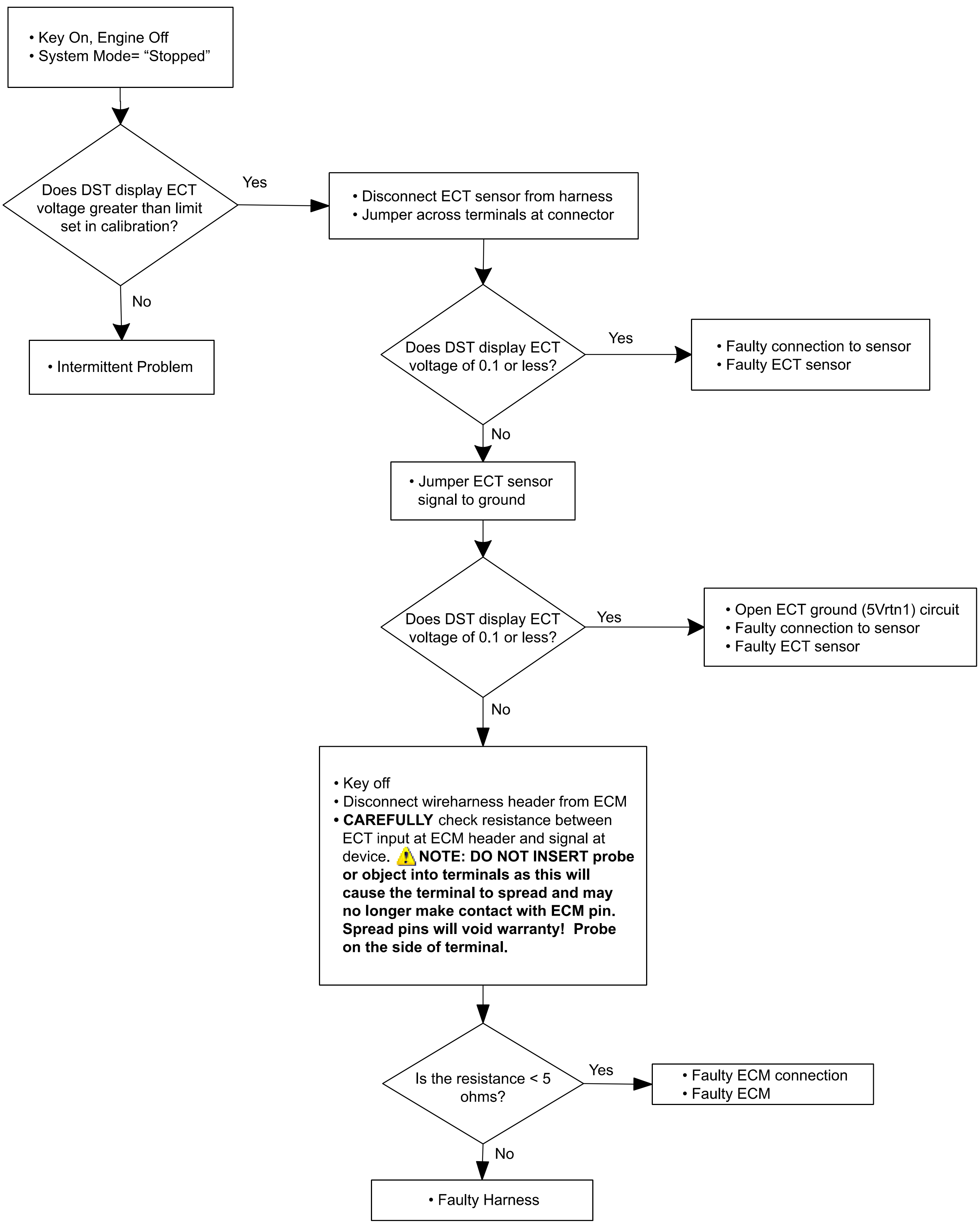
DTC 118- ECT/CHT High Voltage



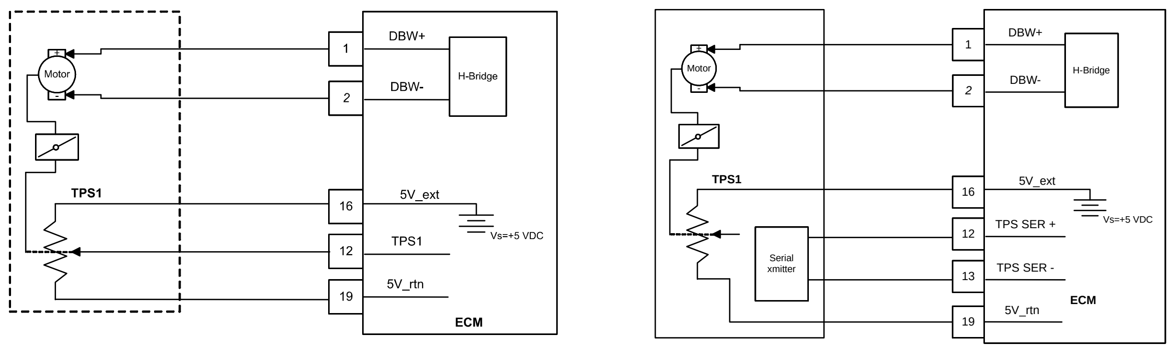
- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-CHT/ECT sensor voltage higher than the limit defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during active fault, or any combination thereof as defined in calibration. Recommend a power derate 1/2 to reduce the possibility of engine damage due to the inability to sense temperature.
- Non-emissions related fault

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use an ECT sensor that is located in the coolant near the thermostat. Some engines use a CHT (Cylinder Head Temperature) sensor that is located in the coolant in the cylinder head. If the engine is equipped with an ECT sensor then the CHT value is estimated. If equipped with a CHT sensor then the ECT value is estimated. The ECM provides a voltage divider circuit so that when the coolant is cool, the signal reads higher voltage, and lower when warm.

This fault will set if signal voltage is higher than high voltage limit as defined in diagnostic calibration anytime the engine is running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the CHT/ECT sensor being disconnected from the engine harness, an open-circuit or short-to-power of the CHT/ECT circuit in the wire harness, or a failure of the sensor. The ECM will use a default value for the CHT/ECT sensor in the event of this fault.


• Key On, Engine Off
• System Mode= “Stopped”
Does DST display ECT voltage greater than limit set in calibration?
Yes
No
• Intermittent Problem
• Disconnect ECT sensor from harness
• Jumper across terminals at connector
Does DST display ECT voltage of 0.1 or less?
Yes
• Faulty connection to sensor
• Faulty ECT sensor
No
• Jumper ECT sensor signal to ground
Does DST display ECT voltage of 0.1 or less?
Yes
• Open ECT ground (5Vrtn1) circuit
• Faulty connection to sensor
• Faulty ECT sensor
No
• Key off
• Disconnect wireharness header from ECM
• CAREFULLY check resistance between ECT input at ECM header and signal at device. NOTE: DO NOT INSERT probe or object into terminals as this will cause the terminal to spread and may no longer make contact with ECM pin. Spread pins will void warranty! Probe on the side of terminal.
Is the resistance < 5 ohms?
Yes
• Faulty ECM connection
• Faulty ECM
No
• Faulty Harness

DTC 122- TPS1 Signal Voltage Low



Electronic Throttle Actuator w/Analog Position Feedback

Electronic Throttle Actuator w/Serial Position Feedback

- Throttle Position Sensor 1
- Check Condition-Key On, Engine Off
- Fault Condition-TPS1 sensor voltage lower than the limit defined in the diagnostic calibration
- Corrective Action(s): Sound audible warning or illuminate secondary warning lamp, shutdown engine
- Non-emissions related fault

In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, references to the throttle and throttle position sensor refer to these fuel injection pump control actuators and their position feedback sensors. When the fuel injection pump is electronically controlled it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either;

1) a variable resistor and voltage divider circuit or

2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

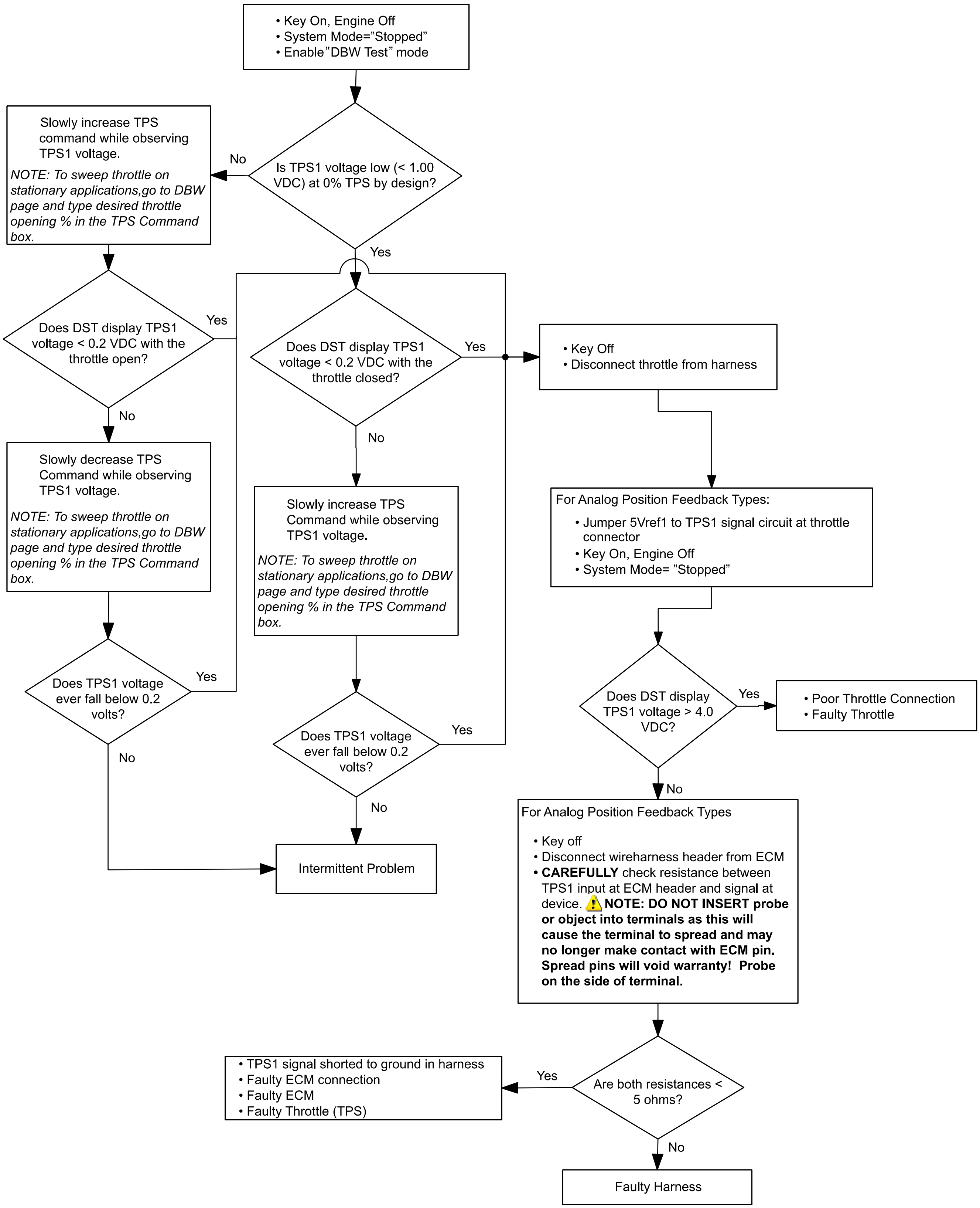
There are two types of throttle actuators;

1) actuator with analog position feedback and

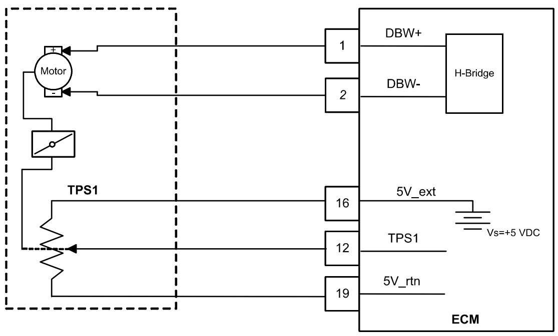
2) actuator with digital position feedback

The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position. The second type, with digital position feedback, provides a serial data signal to the ECM with the throttle actuator position voltage level encoded in the data stream.

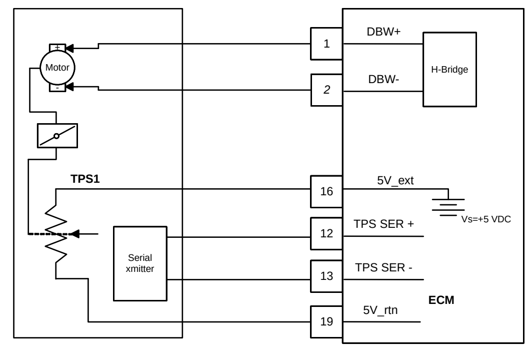
This fault will set if TPS1 voltage is lower than the low voltage limit as defined in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by the TPS sensor being disconnected from the engine harness, an open-circuit or short-to-ground of the TPS circuit in the wire harness, or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.


• Key On, Engine Off
• System Mode="Stopped"
• Enable "DBW Test" mode
Is TPS1 voltage low (< 1.00 VDC) at 0% TPS by design?
No
Yes
Slowly increase TPS command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does DST display TPS1 voltage < 0.2 VDC with the throttle open?
Yes
No
Slowly decrease TPS Command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does TPS1 voltage ever fall below 0.2 volts?
Yes
No
Does DST display TPS1 voltage < 0.2 VDC with the throttle closed?
Yes
No
Slowly increase TPS Command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does TPS1 voltage ever fall below 0.2 volts?
Yes
No
Intermittent Problem
• Key Off
• Disconnect throttle from harness
For Analog Position Feedback Types:
• Jumper 5Vref1 to TPS1 signal circuit at throttle connector
• Key On, Engine Off
• System Mode= "Stopped"
Does DST display TPS1 voltage > 4.0 VDC?
Yes
• Poor Throttle Connection
• Faulty Throttle
No
For Analog Position Feedback Types
• Key off
• Disconnect wireharness header from ECM
• CAREFULLY check resistance between TPS1 input at ECM header and signal at device. NOTE: DO NOT INSERT probe or object into terminals as this will cause the terminal to spread and may no longer make contact with ECM pin. Spread pins will void warranty! Probe on the side of terminal.
Are both resistances < 5 ohms?
Yes
• TPS1 signal shorted to ground in harness
• Faulty ECM connection
• Faulty ECM
• Faulty Throttle (TPS)
No
Faulty Harness

DTC 123- TPS1 Signal Voltage High



Electronic Throttle Actuator w/Analog Position Feedback



Electronic Throttle Actuator w/Serial Position Feedback

- Throttle Position Sensor 1
- Check Condition-Key On, Engine Off
- Fault Condition-TPS1 sensor voltage higher than the limit defined in the diagnostic calibration
- Corrective Action(s): Sound audible warning or illuminate secondary warning lamp, shutdown engine
- Non-emissions related fault

In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, references to the throttle and throttle position sensor refer to these fuel injection pump control actuators and their position feedback sensors. When the fuel injection pump is electronically controlled it can be used to control the idle stability and limit engine speed based on operating conditions.

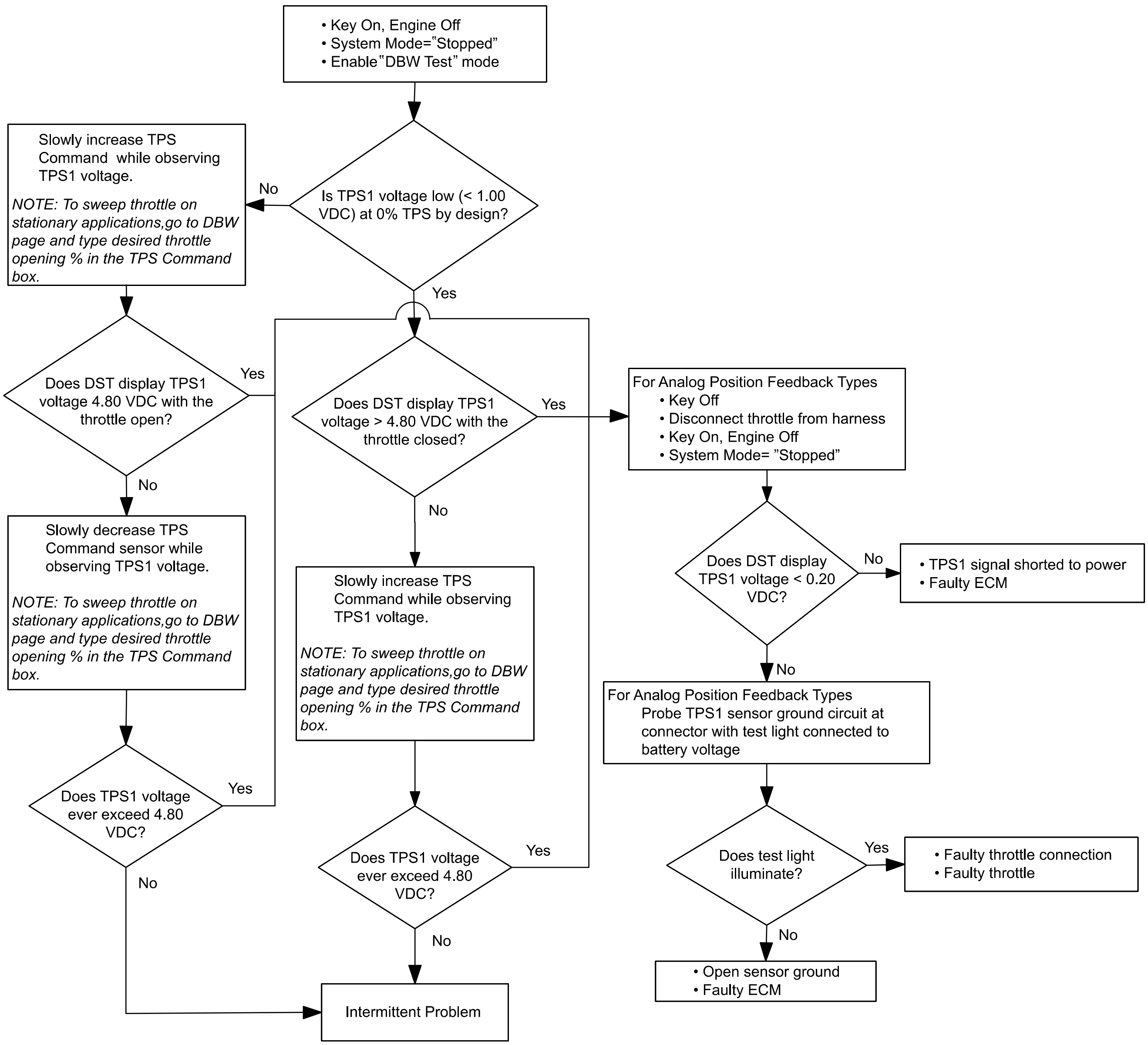
The Throttle Position Sensor uses either;

1) a variable resistor and voltage divider circuit or

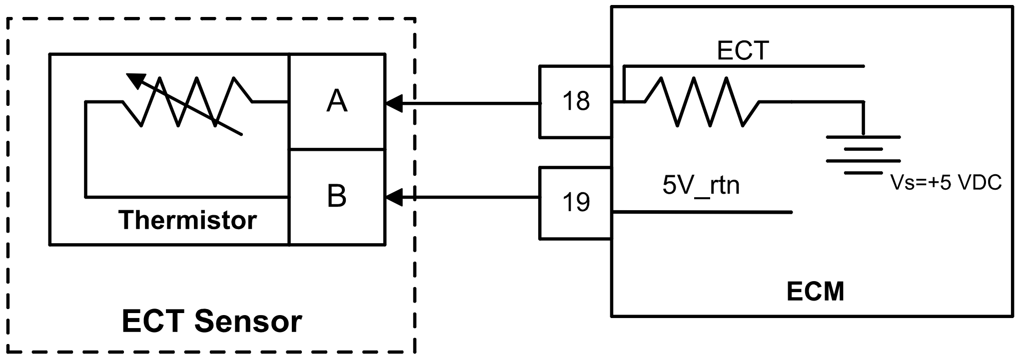
2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

There are two types of throttle actuators, 1) actuator with analog position feedback and 2) actuator with digital position feedback. The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position. The second type, with digital position feedback, provides a serial data signal to the ECM with the throttle actuator position voltage level encoded in the data stream.

This fault will set if TPS1 voltage is higher than the limit set in the diagnostic calibration at any operating condition while the engine is cranking or running. The limit is generally set to 4.90 VDC. In many cases, this condition is caused by a short-to-power of the TPS circuit in the wire harness or a failure of the sensor. This fault should be configured to trigger an engine shutdown and the engine will not start with this fault active.


• Key On, Engine Off
• System Mode="Stopped"
• Enable"DBW Test" mode
Is TPS1 voltage low (< 1.00 VDC) at 0% TPS by design?
No
Yes
Slowly increase TPS Command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does DST display TPS1 voltage 4.80 VDC with the throttle open?
Yes
No
Slowly decrease TPS Command sensor while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does TPS1 voltage ever exceed 4.80 VDC?
Yes
No
Does DST display TPS1 voltage > 4.80 VDC with the throttle closed?
Yes
No
Slowly increase TPS Command while observing TPS1 voltage.
NOTE: To sweep throttle on stationary applications,go to DBW page and type desired throttle opening % in the TPS Command box.
Does TPS1 voltage ever exceed 4.80 VDC?
Yes
No
Intermittent Problem
For Analog Position Feedback Types
• Key Off
• Disconnect throttle from harness
• Key On, Engine Off
• System Mode= "Stopped"
Does DST display TPS1 voltage < 0.20 VDC?
No
• TPS1 signal shorted to power
• Faulty ECM
No
For Analog Position Feedback Types
Probe TPS1 sensor ground circuit at connector with test light connected to battery voltage
Does test light illuminate?
Yes
• Faulty throttle connection
• Faulty throttle
No
• Open sensor ground
• Faulty ECM

DTC 217- ECT Higher Than Expected 2



- Engine Coolant Temperature Sensor
- Check Condition-Engine Running
- Fault Condition-Engine Coolant Temperature reading or estimate greater than the stage 2 limit when operating at a speed greater than defined in the diagnostic calibration
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp, disable adaptive learn fueling correction during active fault. Recommend a power derate 2 and/or a forced idle or engine shutdown to protect engine from possible damage.
- Non-emissions related fault

The Engine Coolant Temperature sensor is a thermistor (temperature sensitive resistor) located in the engine coolant. Some engines use a CHT sensor that is located in the coolant in the cylinder head. Some engines use an ECT (Engine Coolant Temperature) sensor that is located in the coolant near the thermostat. If the engine is equipped with a CHT sensor then the ECT value is estimated. If equipped with an ECT sensor then the CHT value is estimated. The ECM provides a voltage divider circuit so when the sensor reading is cool the sensor reads higher voltage, and lower when warm.

This fault will help protect the engine in the event of over temperature. When the coolant exceeds x deg. F and engine RPM exceeds y RPM for the latch time this fault will set.

Diagnostic Aids

If the "ECT High Voltage" fault is also present, follow the troubleshooting procedures for that fault as it may have caused "ECT Higher Than Expected 2."

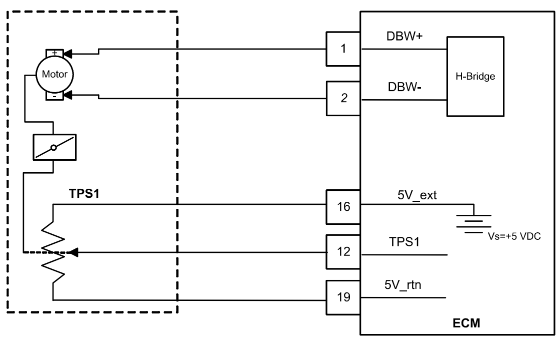
If the cooling system utilizes an air-to-water heat exchanger (radiator) and fan:

- Check that the radiator has a proper amount of ethylene glycol/water and that the radiator is not leaking
- Ensure that there is no trapped air in the cooling path
- Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
- Check that the fan is operating properly
- Check that the thermostat is not stuck closed

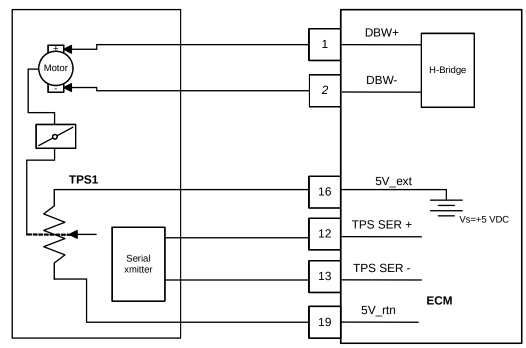
If the cooling system utilizes a water-to-water heat exchanger:

- Check that the heat exchanger has a proper amount of ethylene glycol/water and that the heat exchanger is not leaking
- Ensure that there is no trapped air in the cooling path
- Inspect the cooling system (radiator and hoses) for cracks and ensure connections are leak free
- Check that the raw water pickup is not blocked/restricted by debris and that the hose is tightly connected
- Check that the thermostat is not stuck closed
- Check that the raw water pump/impeller is tact and that it is not restricted

DTC 219- RPM Higher Than Max Allowed Governed Speed



Electronic Throttle Actuator w/Analog Position Feedback



Electronic Throttle Actuator w/Serial Position Feedback

- Max Govern Speed Override- Crankshaft Position Sensor
- Check Condition-Engine Running
- Fault Condition-Engine speed greater than the max governor override speed as defined in the diagnostic calibration
- Corrective Action(s): Sound audible warning or illuminate secondary warning lamp, reduce throttle to limit speed. Recommend closed loop and adaptive learn fueling correction remains active during fault.
- Non-emissions related fault

This fault will set anytime the engine RPM exceeds the limit set in the diagnostic calibration for the latch time or more. This speed overrides any higher max governor speeds programmed by the user. This fault is designed to help prevent engine or equipment damage.

The throttle will be lowered in order to govern the engine to the speed set in the diagnostic calibration.

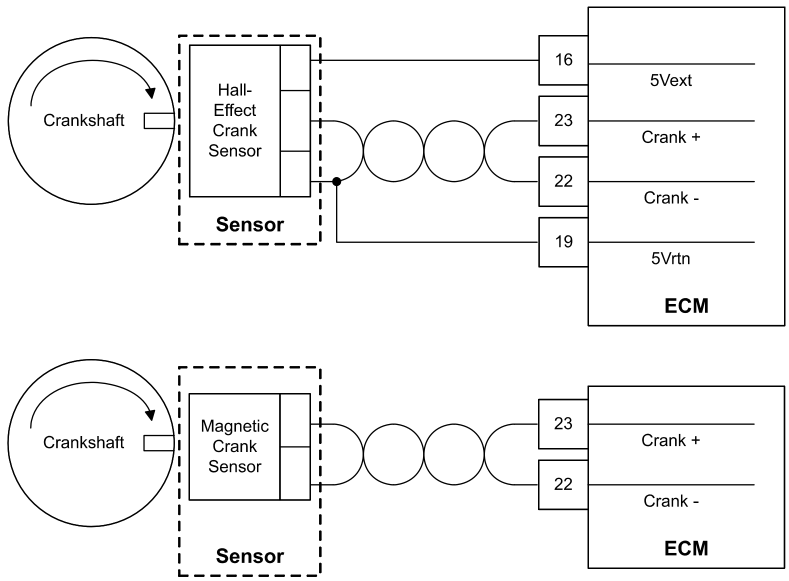
DTC 219- RPM Higher Than Max Allowed Governed Speed (continued)

Diagnostic Aids

NOTE: If any other DTCs are present, diagnose those first.

- Ensure that no programmed governor speeds exceed the limit set in the diagnostic calibration for Max Gov Override Speed
- Check mechanical operation of the throttle actuator

DTC 336- Crank Signal Input Noise

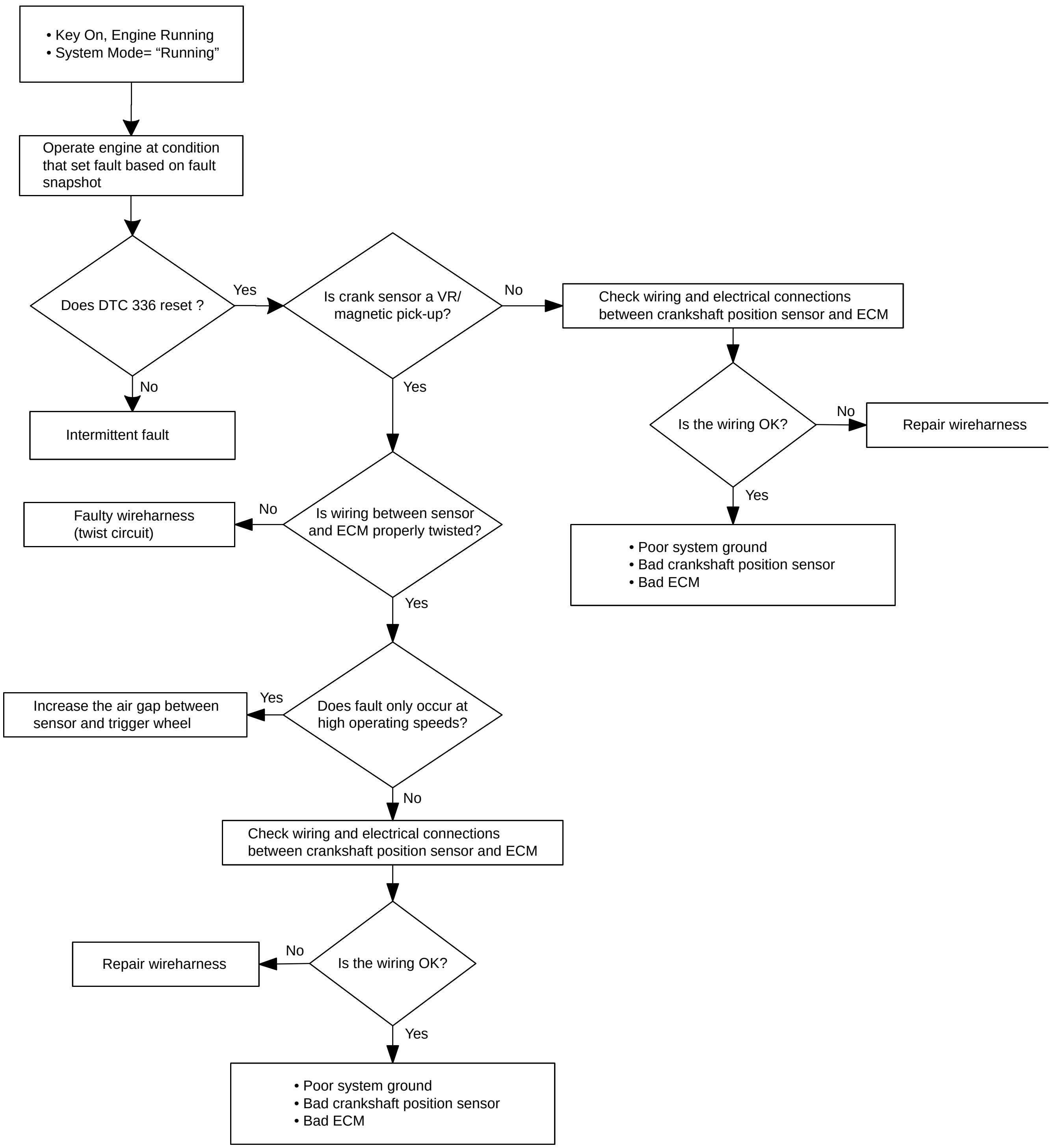


- Crankshaft Position sensor
- Check Condition- Key On, Engine On
- Fault Condition- Electrical noise or irregular crank pattern detected causing x number of crank resynchronization events as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp and disable adaptive fueling correction for remainder of key-cycle.
- Emissions related fault

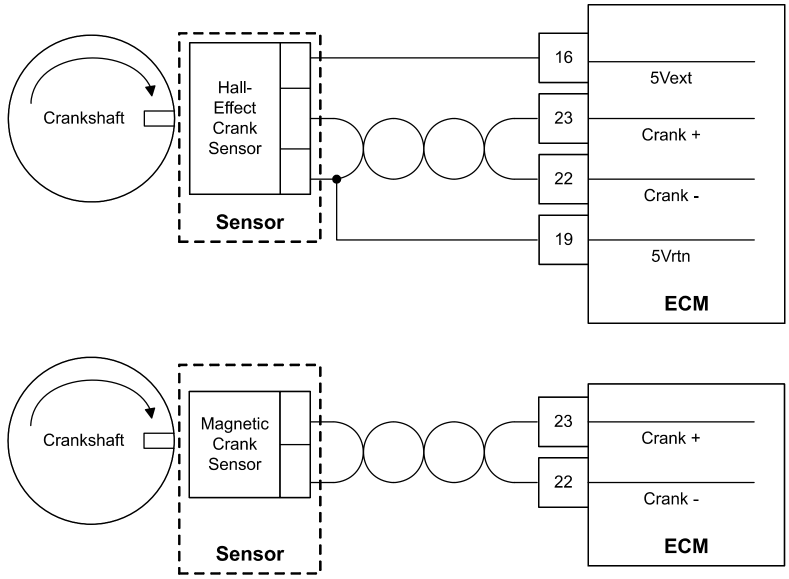
The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or halleffect) installed in the engine block adjacent to a "coded" trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control.

The ECM must see a valid crankshaft position signal while running. If no signal is present, the signal amplitude is too high (due to improper air gap with respect to trigger wheel), or an irregular crank pattern is detected causing the ECM to resynchronize x times for y ms or longer as defined in the diagnostic calibration, this fault will set. Irregular crank patterns can be detected by the ECM due to electrical noise, poor machining of trigger wheel, or trigger wheel runout and/or gear lash.

Ensure crank circuit used with VR/magnetic pick-up sensors are properly twisted.


• Key On, Engine Running
• System Mode= “Running”
Operate engine at condition that set fault based on fault snapshot
Does DTC 336 reset ?
Yes
No
Intermittent fault
Is crank sensor a VR/ magnetic pick-up?
No
Check wiring and electrical connections between crankshaft position sensor and ECM
Is the wiring OK?
No
Repair wireharness
Yes
• Poor system ground
• Bad crankshaft position sensor
• Bad ECM
Yes
Is wiring between sensor and ECM properly twisted?
No
Faulty wireharness (twist circuit)
Yes
Does fault only occur at high operating speeds?
Yes
Increase the air gap between sensor and trigger wheel
No
Check wiring and electrical connections between crankshaft position sensor and ECM
Is the wiring OK?
No
Repair wireharness
Yes
• Poor system ground
• Bad crankshaft position sensor
• Bad ECM

DTC 337- Loss of Crank Input Signal



- Crankshaft Position sensor
- Check Condition- Key On, Engine On
- Fault Condition- Loss of crankshaft position signal while valid camshaft position signals continue for x number of cam pulses as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp
- Emissions related fault

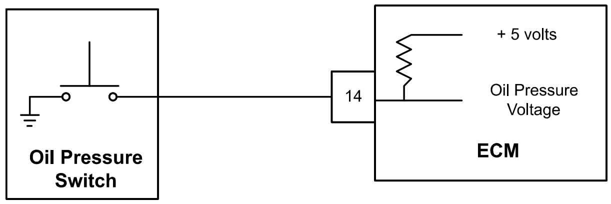
The crankshaft position sensor is a magnetic sensor (variable reluctant/magnetic pick-up or halleffect) installed in the engine block adjacent to a ¡§coded¡¨ trigger wheel located on the crankshaft. The sensor-trigger wheel combination is used to determine crankshaft position (with respect to TDC cylinder #1 compression) and the rotational engine speed. Determination of the crankshaft position and speed is necessary to properly activate the ignition, fuel injection, and throttle governing systems for precise engine control.

The ECM must see a valid crankshaft position signal while running. If no signal is present while x cam pulses continue the fault will set. The engine typically stalls or dies as a result of this fault condition due to the lack of crankshaft speed input resulting in the inability to control ignition timing.

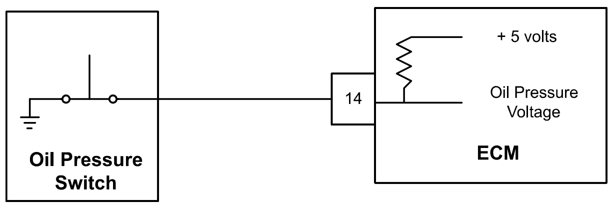
Diagnostic Aids

- Check that crankshaft position sensor is securely connected to harness
- Check that crankshaft position sensor is securely installed into engine block
- Check crankshaft position sensor circuit wiring for open circuit

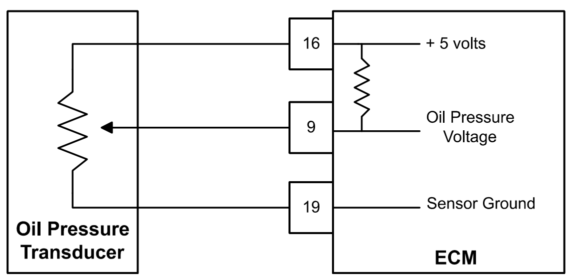
DTC 521- Oil Pressure Sender/Switch High Pressure



Normally-Open Switch-Type



Normally-Closed Switch-Type



Sensor-Type

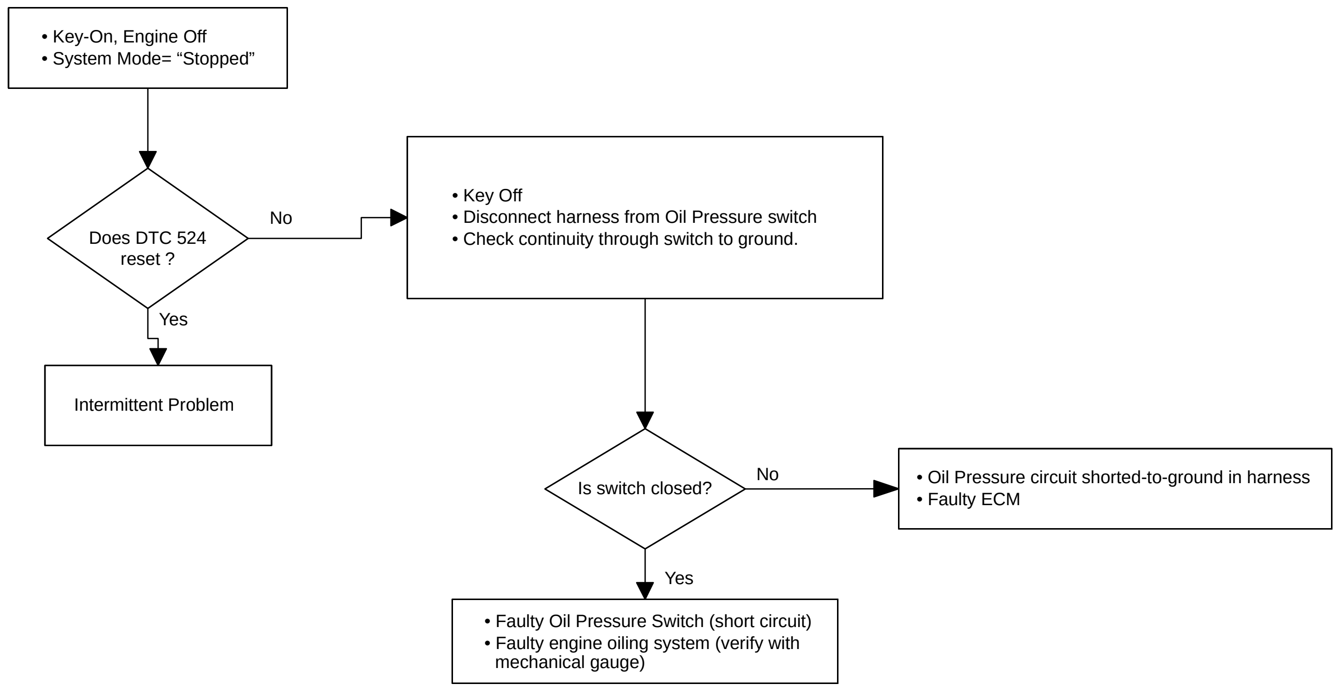
- Engine Oil Pressure
- Check Condition- Key on, Engine on (or Engine off)
- Fault Condition- For sender types, oil pressure higher than x psia while engine speed is greater that y RPM. For switch types, oil pressure is indicating high when the engine has been stopped for more than n seconds.
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, possibly configure for power derate 1 or low rev limit
- Non-emissions related fault

The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

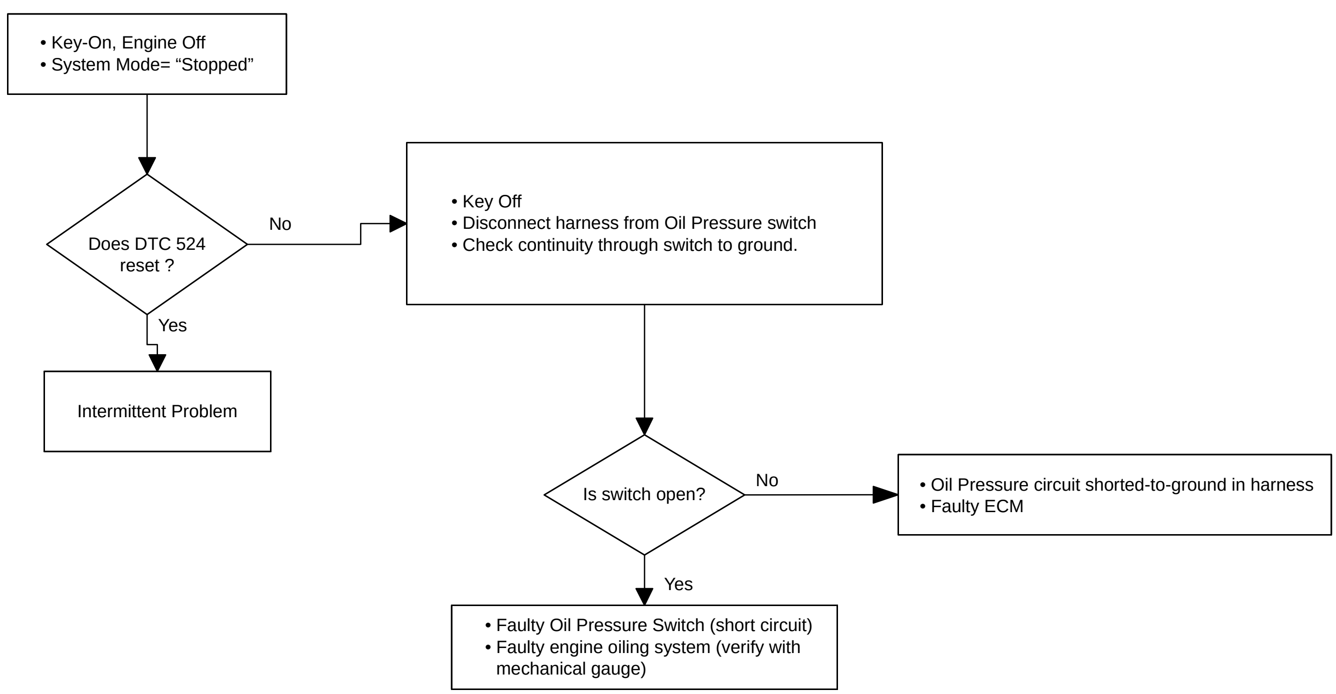
Additionally for normally-open type oil pressure switches, a high pressure indication while the engine is off is a symptom of a failed oil pressure switch. The ECM can monitor oil pressure indication when the engine is stopped for this failure mode.

For sender types, this fault sets if the engine oil pressure is higher than x psia and engine speed greater than y RPM as defined in the diagnostic calibration. For switch types, this fault sets if the engine oil pressure is indicating high when the engine is stopped for more than n seconds. Recommend a power derate and/or low rev limit to help prevent possible engine damage and reduce oil pressure.

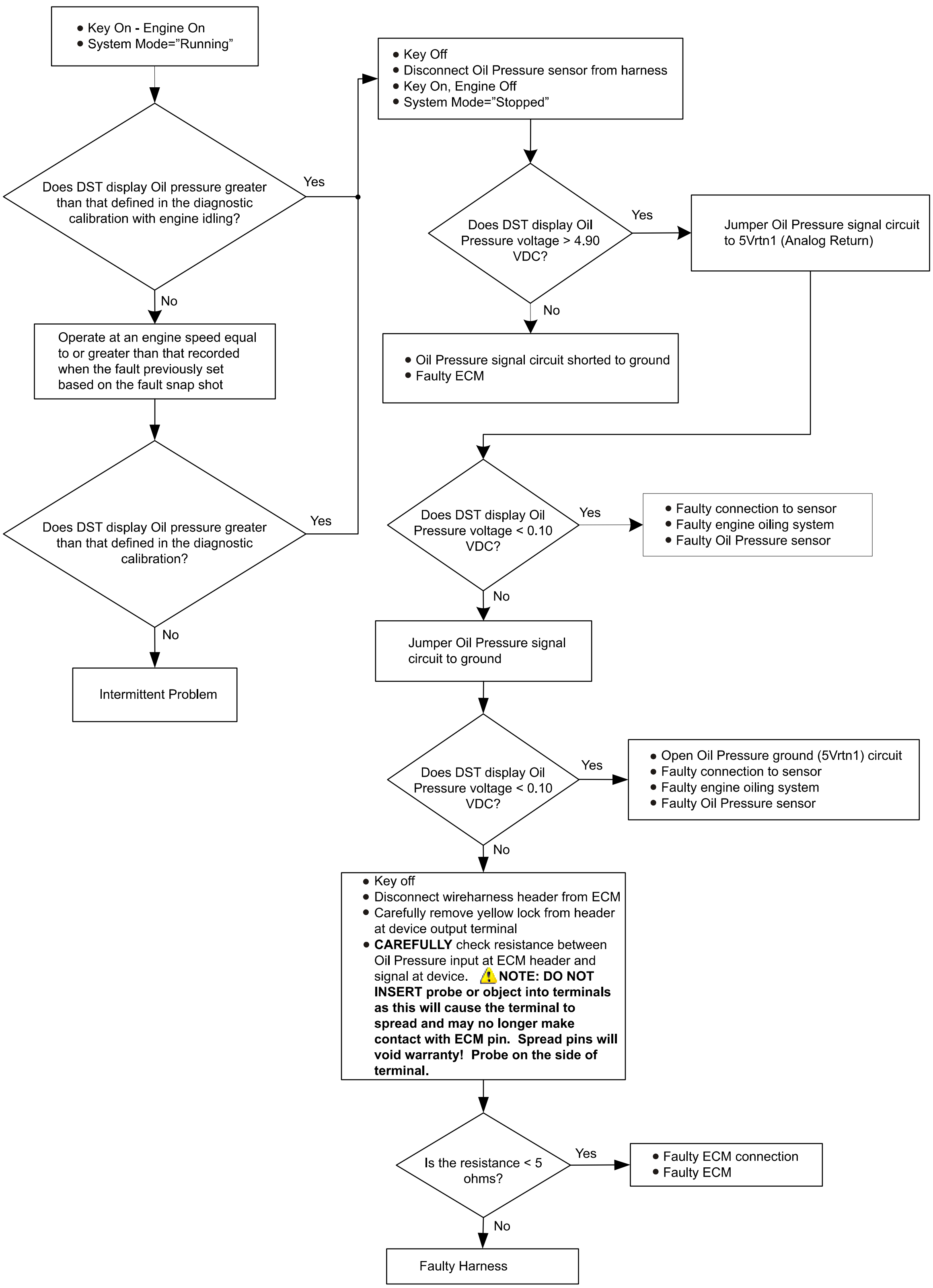
Normally Open Switch



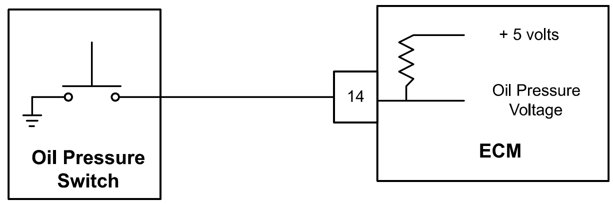
Normally Closed Switch



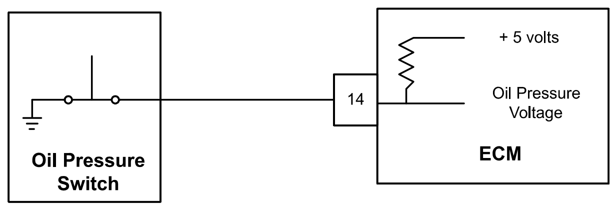
Sensor/Transducer Type



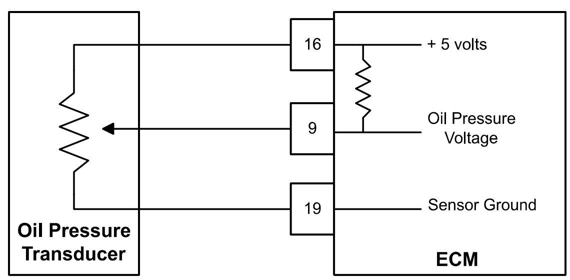
DTC 524- Oil Pressure Low



**Normally-Open
Switch-Type**



**Normally-Closed
Switch-Type**



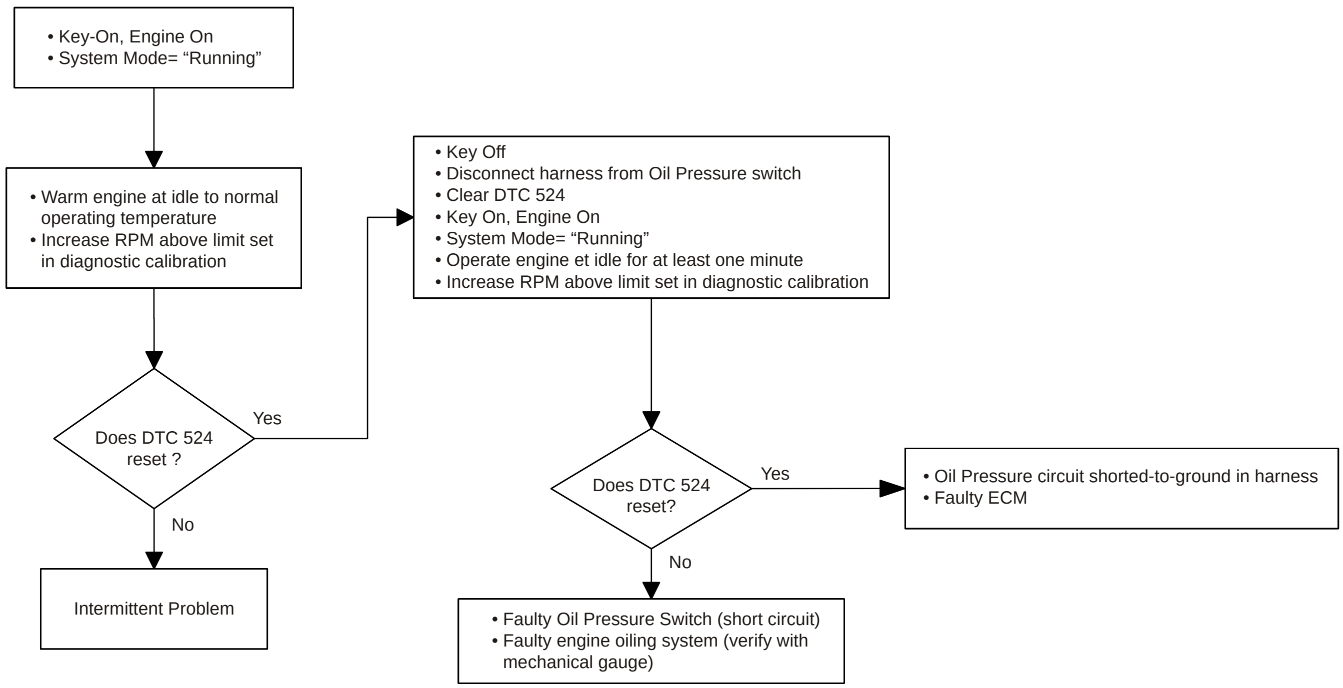
Sensor-Type

- Engine Oil Pressure
- Check Condition- Key on, Engine on
- Fault Condition- Engine oil pressure lower than expected while engine has been running for a minimum amount of time while engine speed is above some limit as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, generally configured to derate the engine and trigger an engine shutdown
- Non-emissions related fault

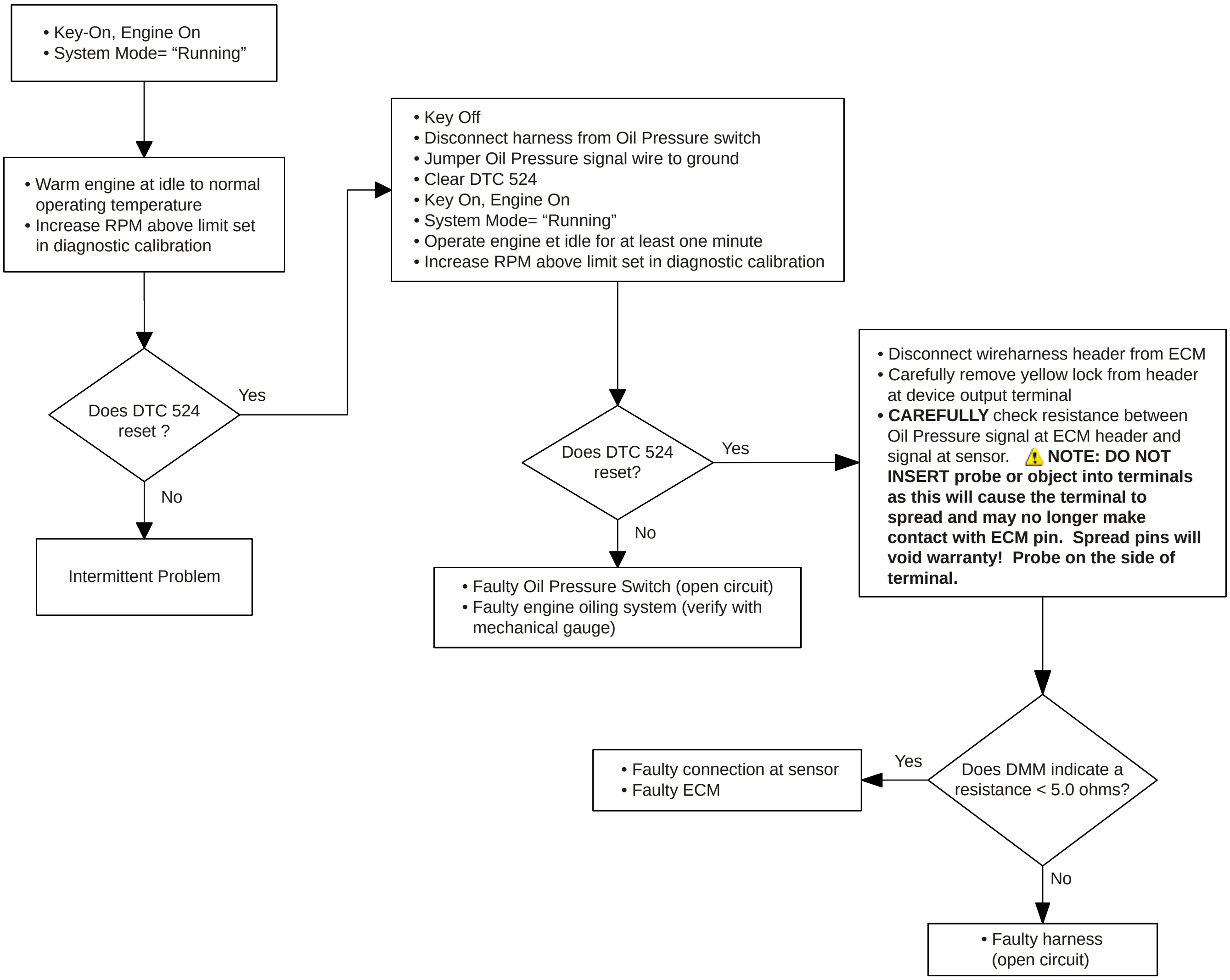
The ECM can be configured to monitor oil pressure through a proportional transducer or through a switch. Oil pressure monitoring is important to prevent engine damage due to low oil pressure resulting in higher friction and lack of lubrication. In addition, high oil pressure can be undesirable because it can cause oil to leak past seals and rings, can be a result of a restriction in the oil flow path, or can be a sign of a malfunctioning oiling system.

For systems that use a transducer, this fault sets if engine oil pressure is less than x psia and engine speed is greater than y RPM after engine has been running for z seconds as defined in the diagnostic calibration. For systems that use a switch this fault can be configured two different ways. It may use a normally closed switch or a normally open switch. If switch is normally open, fault will set if circuit becomes grounded. If switch is normally closed, fault will set if circuit becomes open. Go to Faults page in EDIS to determine how input is configured. ("Open=OK" is normally open and "Ground=OK" is normally closed). The engine will should be configured to derate or force idle and/or shut down in the event of this fault to help prevent possible damage.

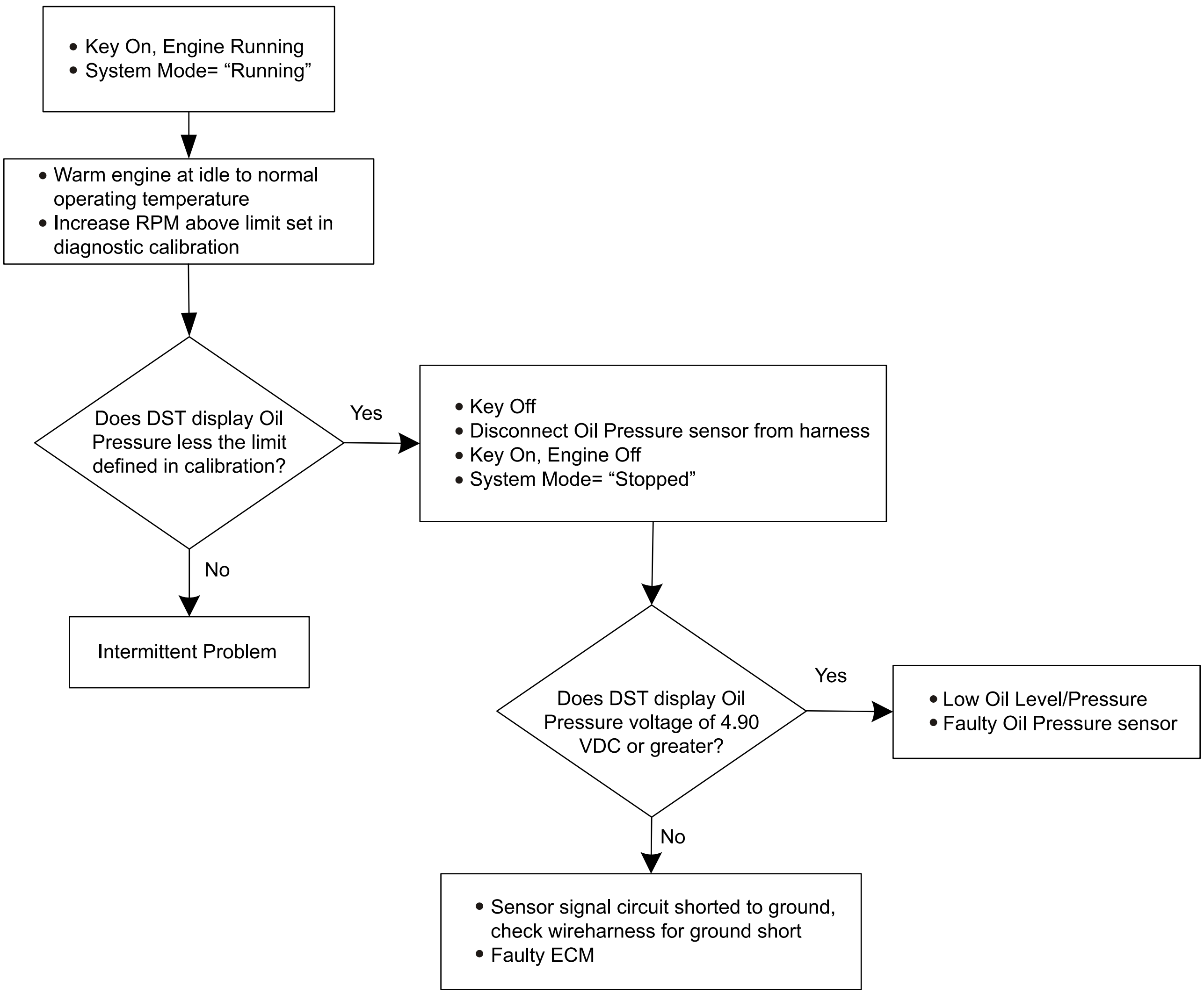
Normally Open Switch



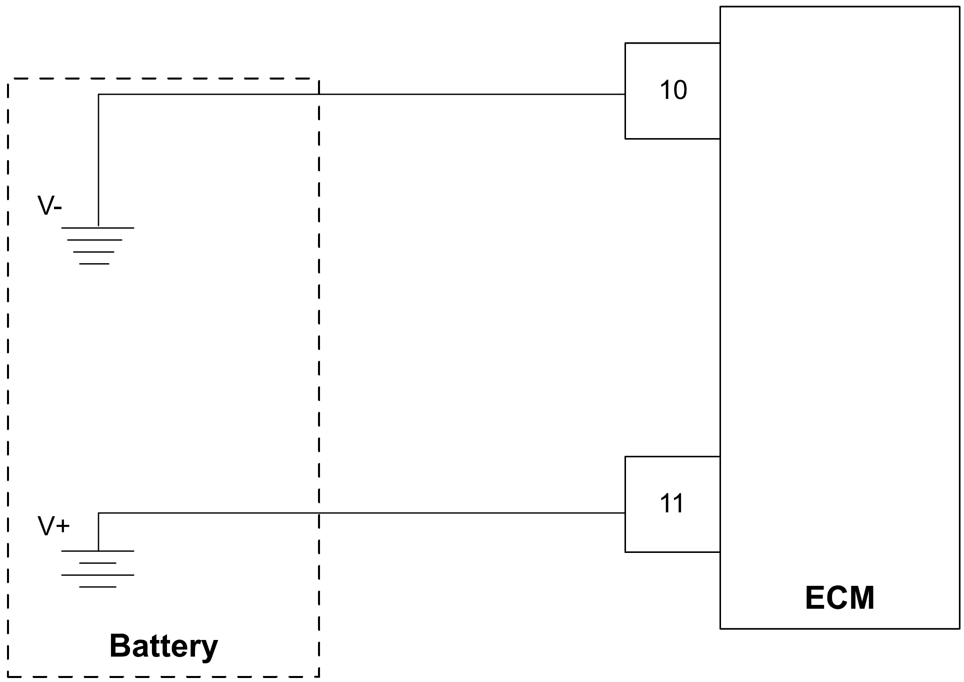
Normally Closed Switch



Sensor/Transducer Type



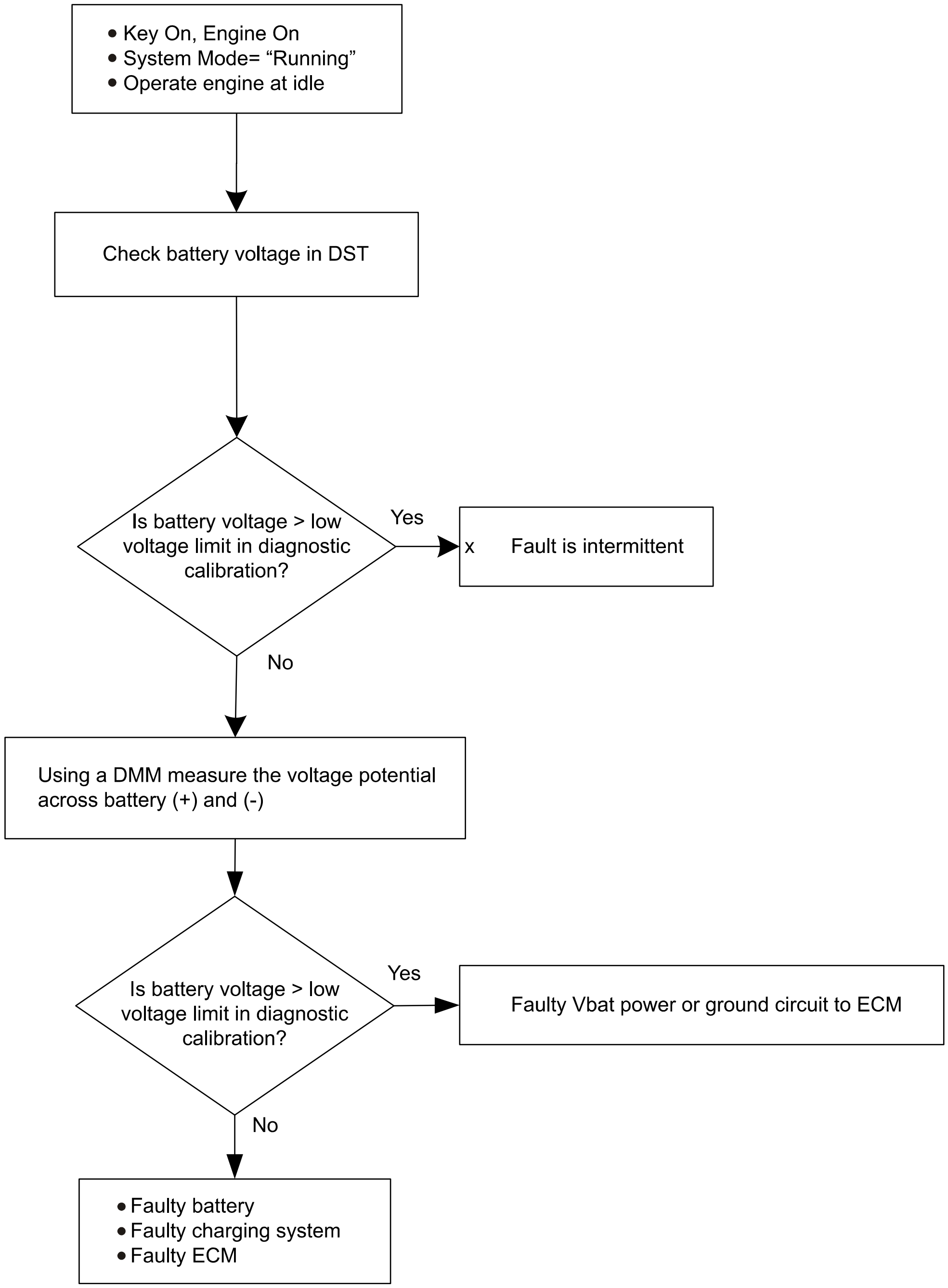
DTC 562- Battery Voltage (VBat) Low



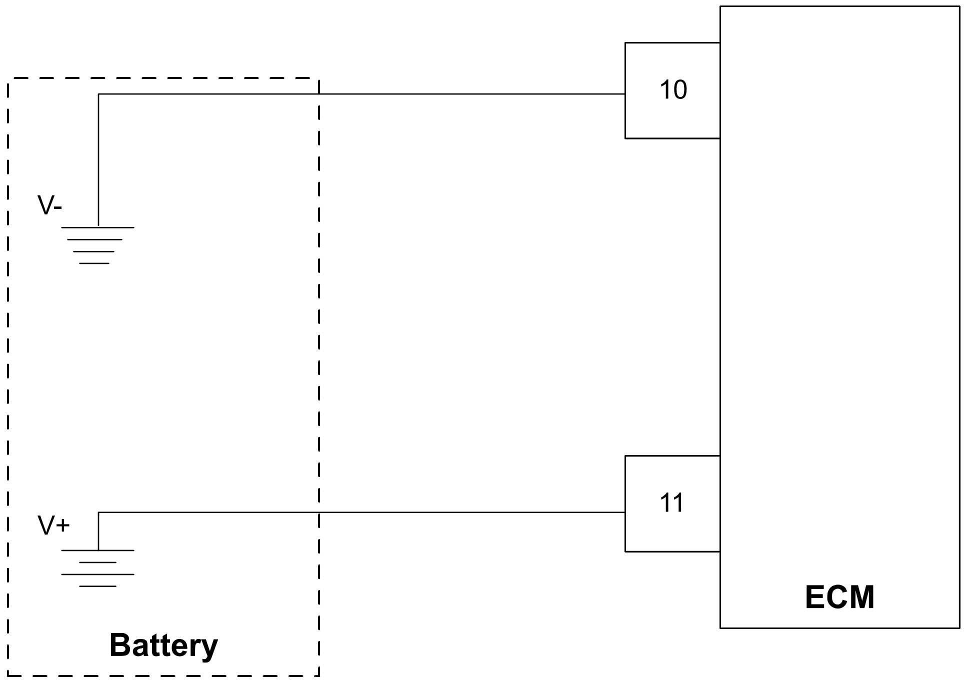
- System voltage to ECM
- Check Condition- Key on, Engine on
- Fault Condition- Battery voltage to ECM less than x volts while the engine is operating at y RPM or greater as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle
- Non-emissions related fault

The battery voltage powers the ECM and must be within limits to correctly operate throttle actuator, power supplies, and other powered devices that the ECM controls.

This fault will set if the ECM detects system voltage less than x volts while the engine is operating at y RPM as defined in the diagnostic calibration as the alternator should be charging the system.


• Key On, Engine On
• System Mode= "Running"
• Operate engine at idle
Check battery voltage in DST
Is battery voltage > low voltage limit in diagnostic calibration?
Yes
x
Fault is intermittent
No
Using a DMM measure the voltage potential across battery (+) and (-)
Is battery voltage > low voltage limit in diagnostic calibration?
Yes
Faulty Vbat power or ground circuit to ECM
No
• Faulty battery
• Faulty charging system
• Faulty ECM

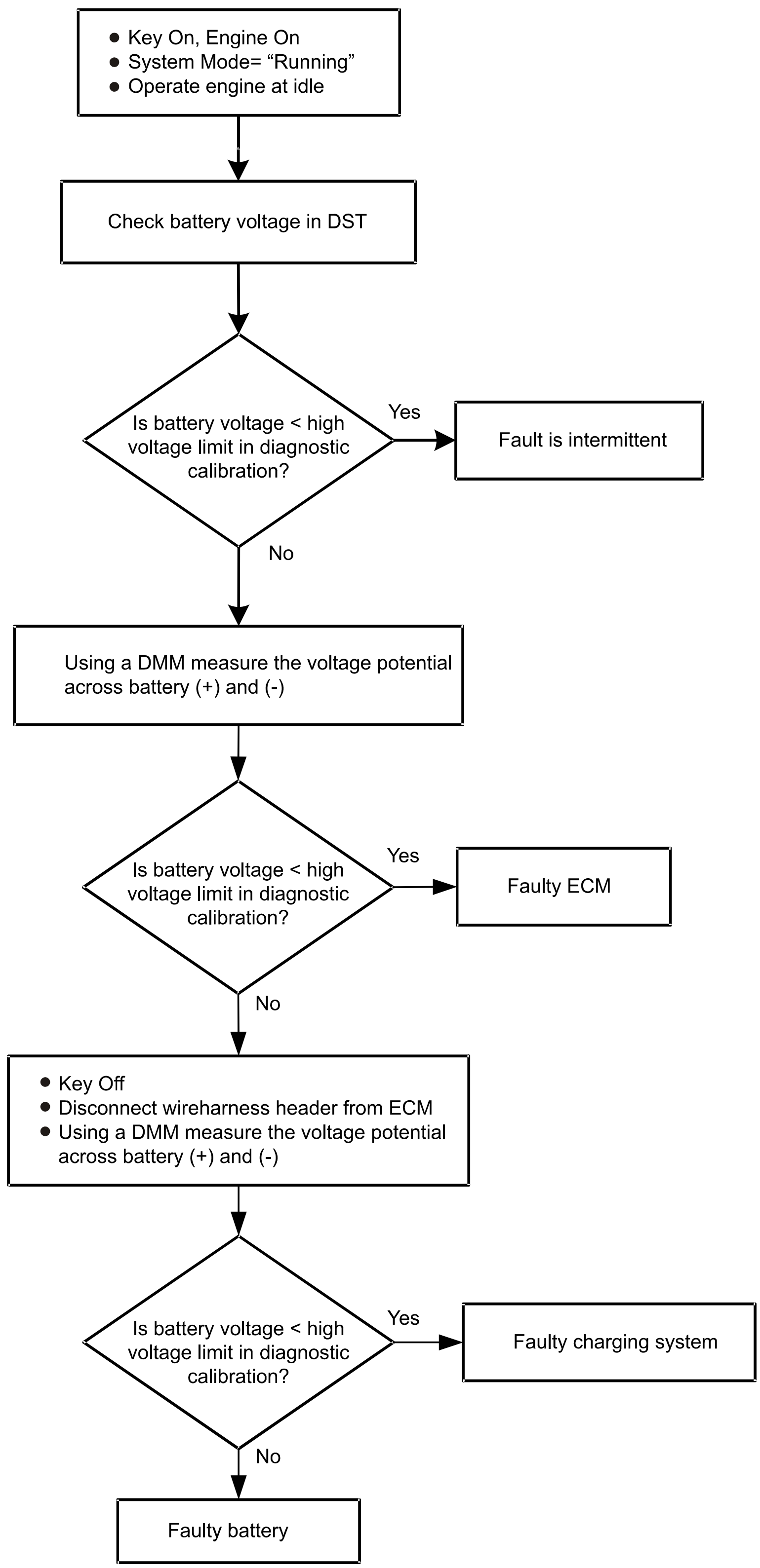
DTC 563- Battery Voltage (VBat) High



- System voltage to ECM
- Check Condition- Key on, Engine Cranking or Running
- Fault Condition- Battery voltage to ECM greater than x volts while the engine is running as defined in the diagnostic calibration
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle
- Non-emissions related fault

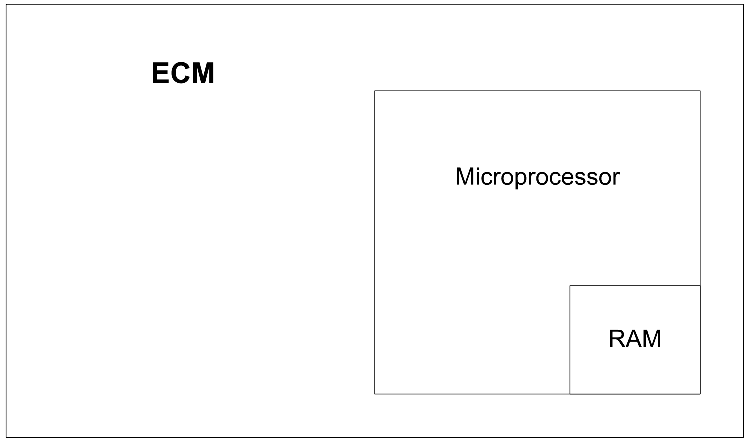
The battery voltage powers the ECM and must be within limits to correctly operate throttle acutator, power supplies, and other powered devices that the ECM controls.

This fault will set if the ECM detects system voltage greater than x volts while the engine is running or cranking as defined in the diagnostic calibration.



• Key On, Engine On
• System Mode= “Running”
• Operate engine at idle
Check battery voltage in DST
Is battery voltage < high voltage limit in diagnostic calibration?
Yes
Fault is intermittent
No
Using a DMM measure the voltage potential across battery (+) and (-)
Is battery voltage < high voltage limit in diagnostic calibration?
Yes
Faulty ECM
No
• Key Off
• Disconnect wireharness header from ECM
• Using a DMM measure the voltage potential across battery (+) and (-)
Is battery voltage < high voltage limit in diagnostic calibration?
Yes
Faulty charging system
No
Faulty battery

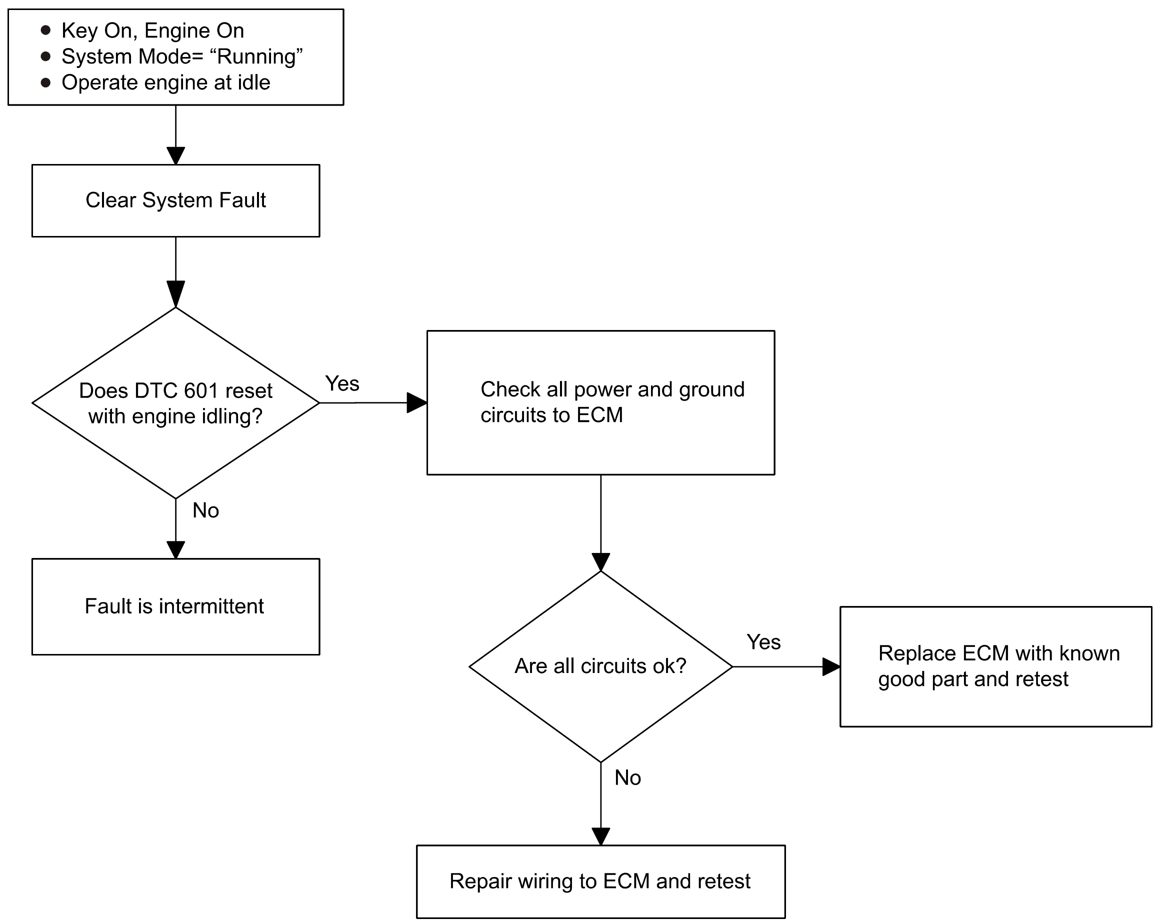
DTC 601- Microprocessor Failure - FLASH



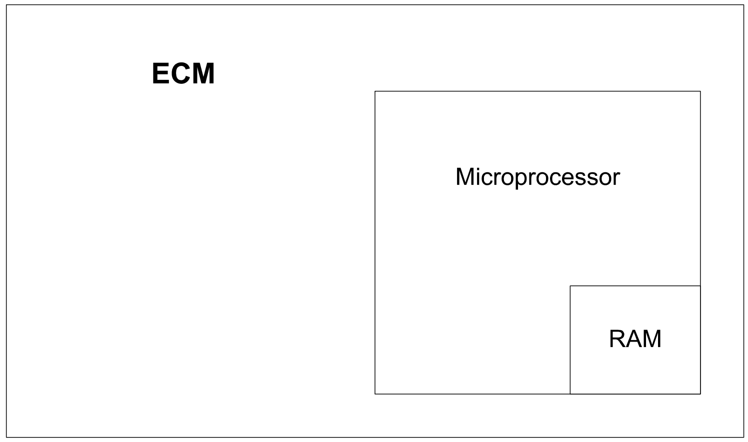
- Engine Control Module- Flash Memory
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle, recommend power derate 2 and low rev limit to reduce possible engine damage and/or overspeed condition
- Non-emissions related fault

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition. A fault of flash memory can occur for any calibration variable set and thus could cause undesirable operation.


Key On, Engine On
System Mode= “Running”
Operate engine at idle
Clear System Fault
Does DTC 601 reset with engine idling?
Yes
Check all power and ground circuits to ECM
No
Fault is intermittent
Are all circuits ok?
Yes
Replace ECM with known good part and retest
No
Repair wiring to ECM and retest

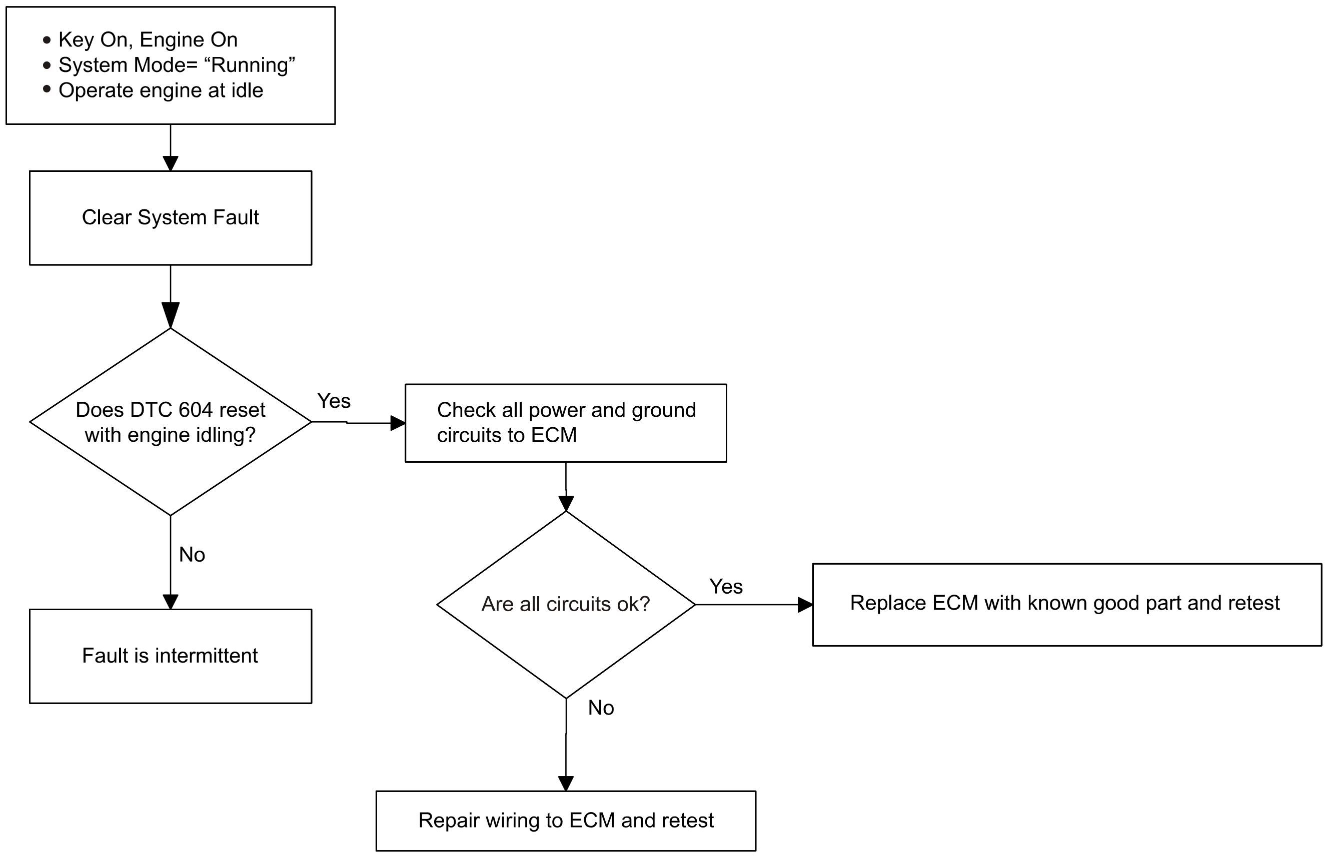
DTC 604- Microprocessor Failure - RAM



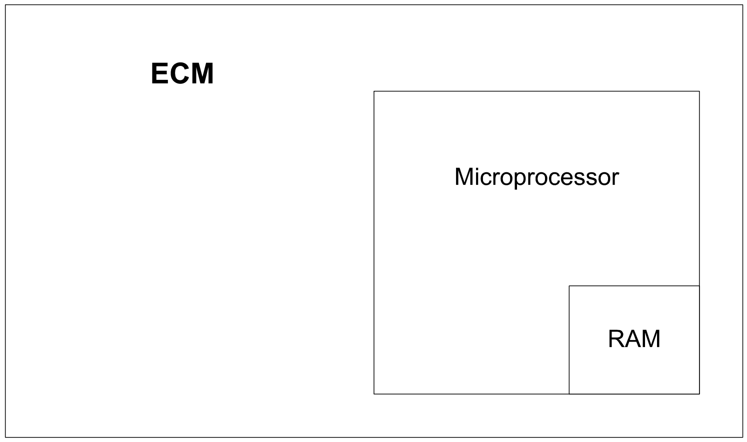
- Engine Control Module- Random Access Memory
- Check Condition- Key on
- Fault Condition- Internal ECM microprocessor memory access failure
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle, recommend power derate 2 and low rev limit to reduce possible engine damage and/or overspeed condition
- Non-emissions related fault

Random Access Memory is located within the microprocessor and can be read from or written to at any time. Data stored in RAM include DTCs (when fault configuration is set to "Battery Power Retained"), adaptive fuel learn tables, octane adaptation table, misfire adaption tables, and closed loop fuel multipliers. The ECM has checks that must be satisfied each time an instruction is executed.

This fault will set if the ECM detects a problem accessing or writing information to RAM and should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition. If this fault sets, the ECM will reset itself and log the code. This fault should be erased by a technician after diagnostics are performed. The fault should be configured to never forget and will not self-erase.


• Key On, Engine On
• System Mode= "Running"
• Operate engine at idle
Clear System Fault
Does DTC 604 reset with engine idling?
Yes
Check all power and ground circuits to ECM
No
Fault is intermittent
Are all circuits ok?
Yes
Replace ECM with known good part and retest
No
Repair wiring to ECM and retest

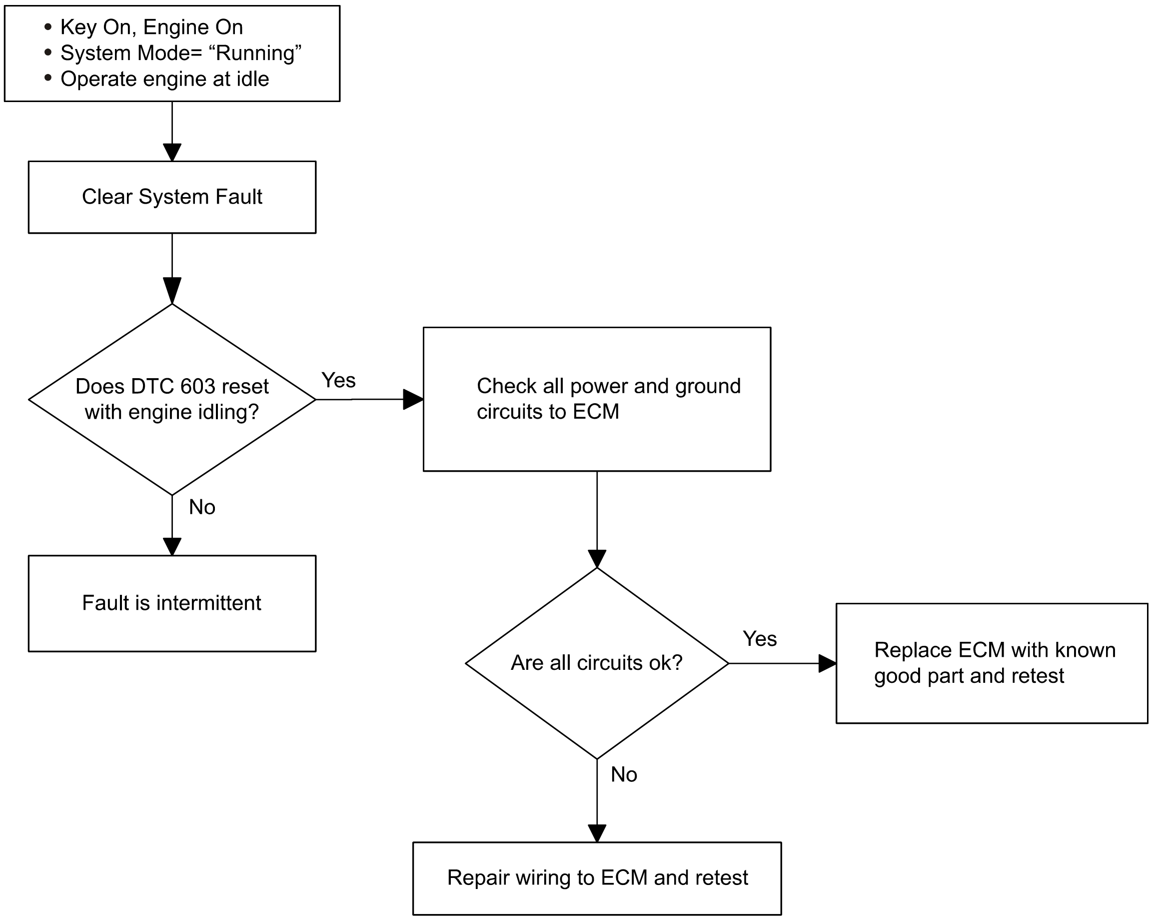
DTC 606- Microprocessor Failure - COP



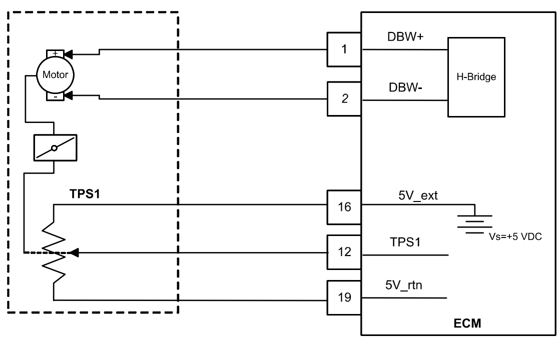
- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- Corrective Action(s) - Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp, disable adaptive fueling correction for remainder of key cycle, recommend power derate 2 and low rev limit to reduce possible engine damage and/or overspeed condition
- Non-emissions related fault

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault.

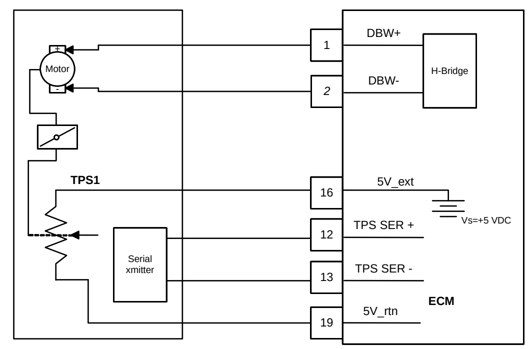
If this fault sets, the ECM will reset itself and log the code. The fault should be configured to never forget and will not self-erase and will not clear until a technician performs diagnostics and manually clears the code. This fault should be configured to set a power derate 2 and low rev limit to reduce possible engine damage and reduce possibility of an overspeed condition.


• Key On, Engine On
• System Mode= "Running"
• Operate engine at idle
Clear System Fault
Does DTC 603 reset with engine idling?
Yes
Check all power and ground circuits to ECM
No
Fault is intermittent
Are all circuits ok?
Yes
Replace ECM with known good part and retest
No
Repair wiring to ECM and retest

DTC 642- 5 Volt External Low Voltage



Electronic Throttle Actuator w/Analog Position Feedback



Electronic Throttle Actuator w/Serial Position Feedback

- Engine Control Module
- Check Condition- Key on
- Fault Condition- ECM 5-volt output is below the acceptable limit
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

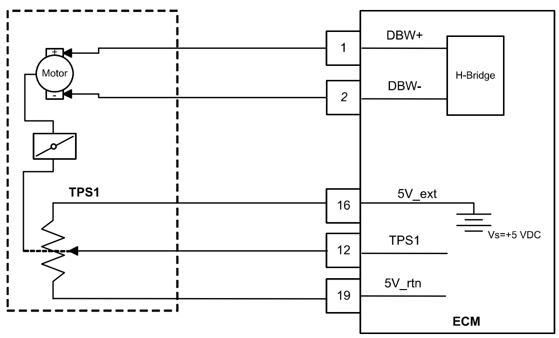
The ECM supplies 5-volt power to sensors, switches, and actuators external to the ECM. By supplying the power to these devices, the ECM can accurately measure their output relative to its own ground reference. The ECM can also control when the devices are active and put the devices in a low or no power state based on the current operating condition of the engine or vehicle.

If this fault sets, something other than the ECM is drawing the 5-volt power output of the ECM below an acceptable threshold. This may be due to a short in the wire harness, malfunctioning device, or failure of the ECM power output circuitry.

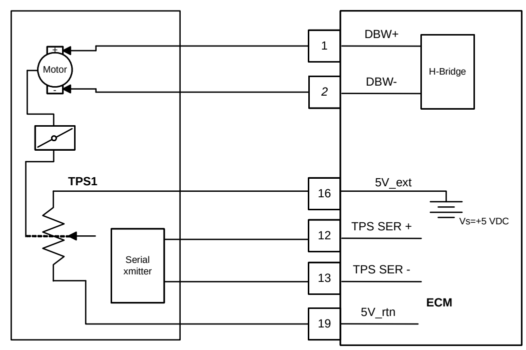
Diagnostic Aids

- Measure the 5-volt output of the ECM while cycling the key on and the engine stopped. Verify that the output is lower than the fault thresholds configured in the diagnostic calibration.
- Inspect the 5-Volt output circuit in the wire harness and look for shorts to ground or other harness circuits.
- Disconnect each device powered by the 5-volt output of the ECM one-at-a-time. Powered devices may include the throttle actuator, smart sensors, smart actuators, etc. After disconnecting device, observe the system fault and determine if the fault has cleared. If the fault clears, troubleshoot the disconnected device for failures.
- With all 5-volt powered devices disconnected, look for a change in the fault state and measure the 5-volt output of the ECM and verify it is within acceptable limits.

DTC 643- 5 Volt External High Voltage



Electronic Throttle Actuator w/Analog Position Feedback



Electronic Throttle Actuator w/Serial Position Feedback

- Engine Control Module
- Check Condition- Key on
- Fault Condition- ECM 5-volt output is above the acceptable limit
- Corrective Action(s)- Illuminate MIL and/or sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

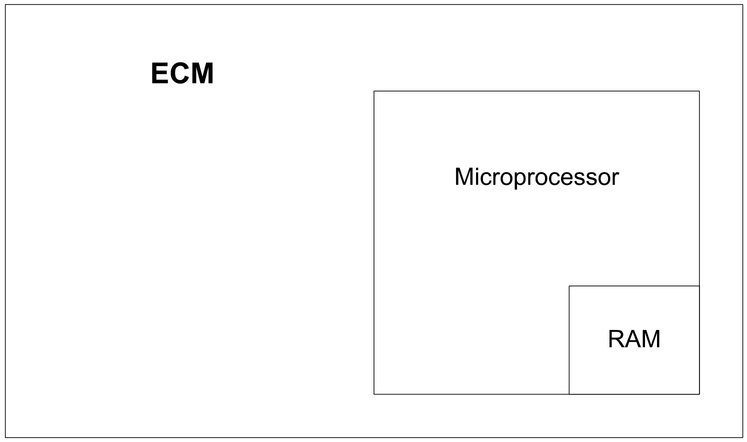
The ECM supplies 5-volt power to sensors, switches, and actuators external to the ECM. By supplying the power to these devices, the ECM can accurately measure their output relative to its own ground reference. The ECM can also control when the devices are active and put the devices in a low or no power state based on the current operating condition of the engine or vehicle.

If this fault sets, something other than the ECM is drawing the 5-volt power output of the ECM above an acceptable threshold. This may be due to a short in the wire harness, malfunctioning device, or failure of the ECM power output circuitry.

Diagnostic Aids

- Measure the 5-volt output of the ECM while cycling the key on and the engine stopped. Verify that the output is lower than the fault thresholds configured in the diagnostic calibration.
- Inspect the 5-Volt output circuit in the wire harness and look for shorts to ground or other harness circuits.
- Disconnect each device powered by the 5-volt output of the ECM one-at-a-time. Powered devices may include the throttle actuator, smart sensors, smart actuators, etc. After disconnecting device, observe the system fault and determine if the fault has cleared. If the fault clears, troubleshoot the disconnected device for failures.
- With all 5-volt powered devices disconnected, look for a change in the fault state and measure the 5-volt output of the ECM and verify it is within acceptable limits.

DTC 1612- Microprocessor Failure - RTI 1

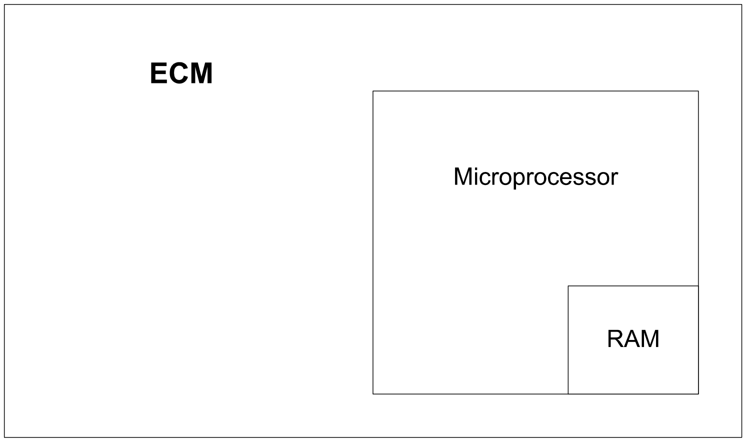


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

DTC 1613- Microprocessor Failure - RTI 2

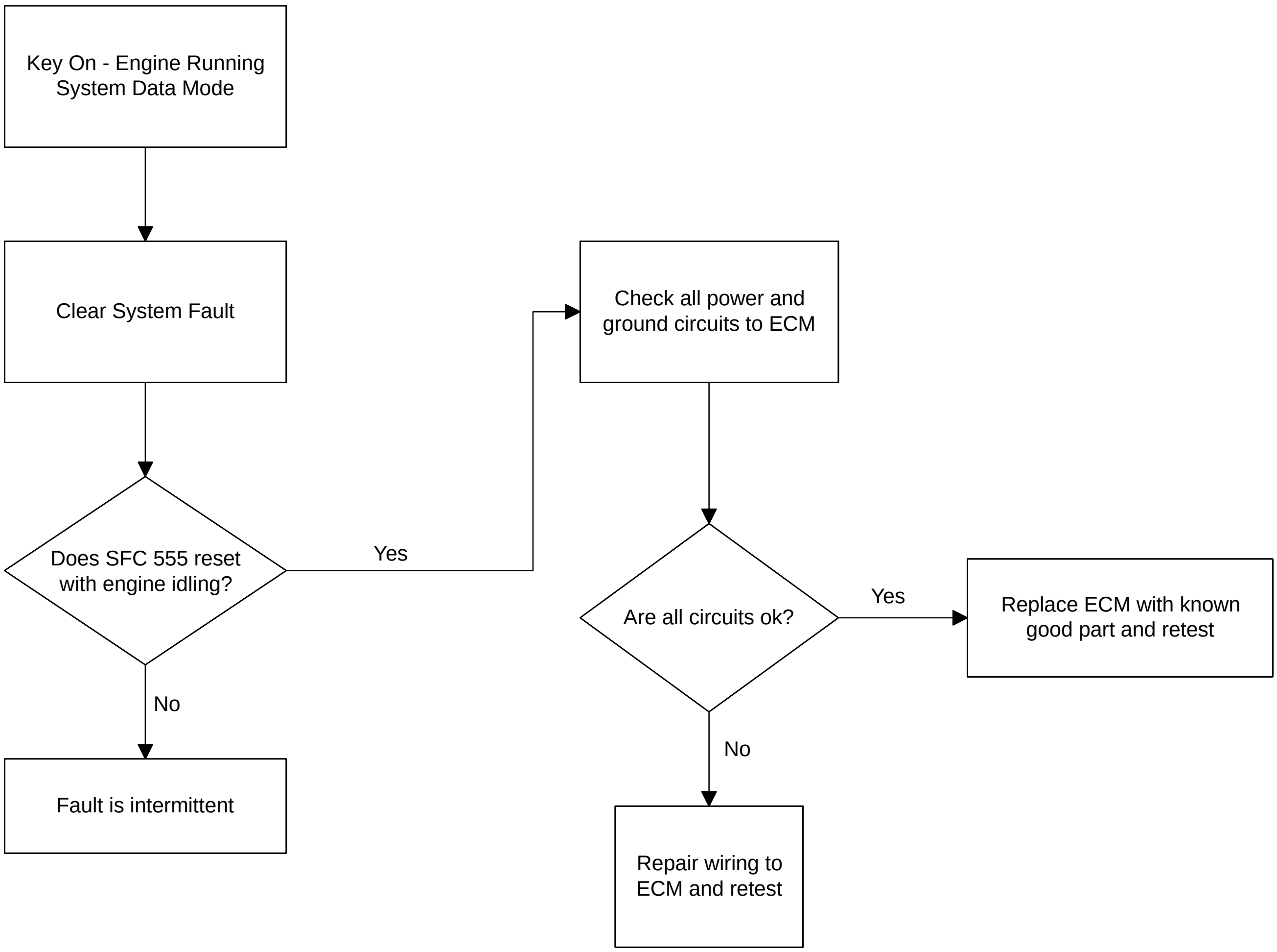


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

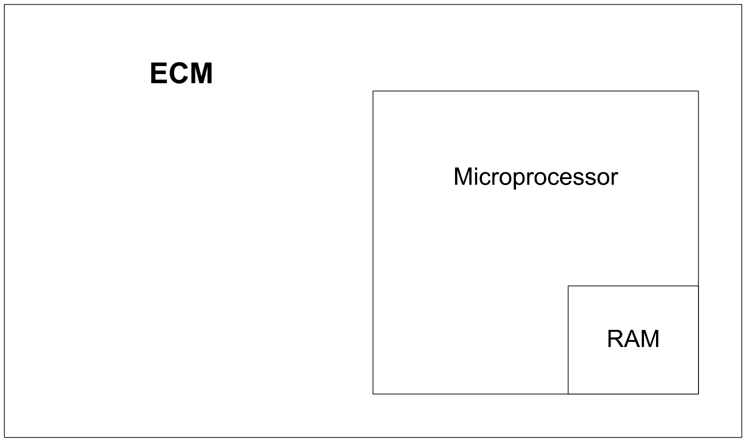
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

SFC 555- RTI 2 Loss



DTC 1614- Microprocessor Failure - RTI 3

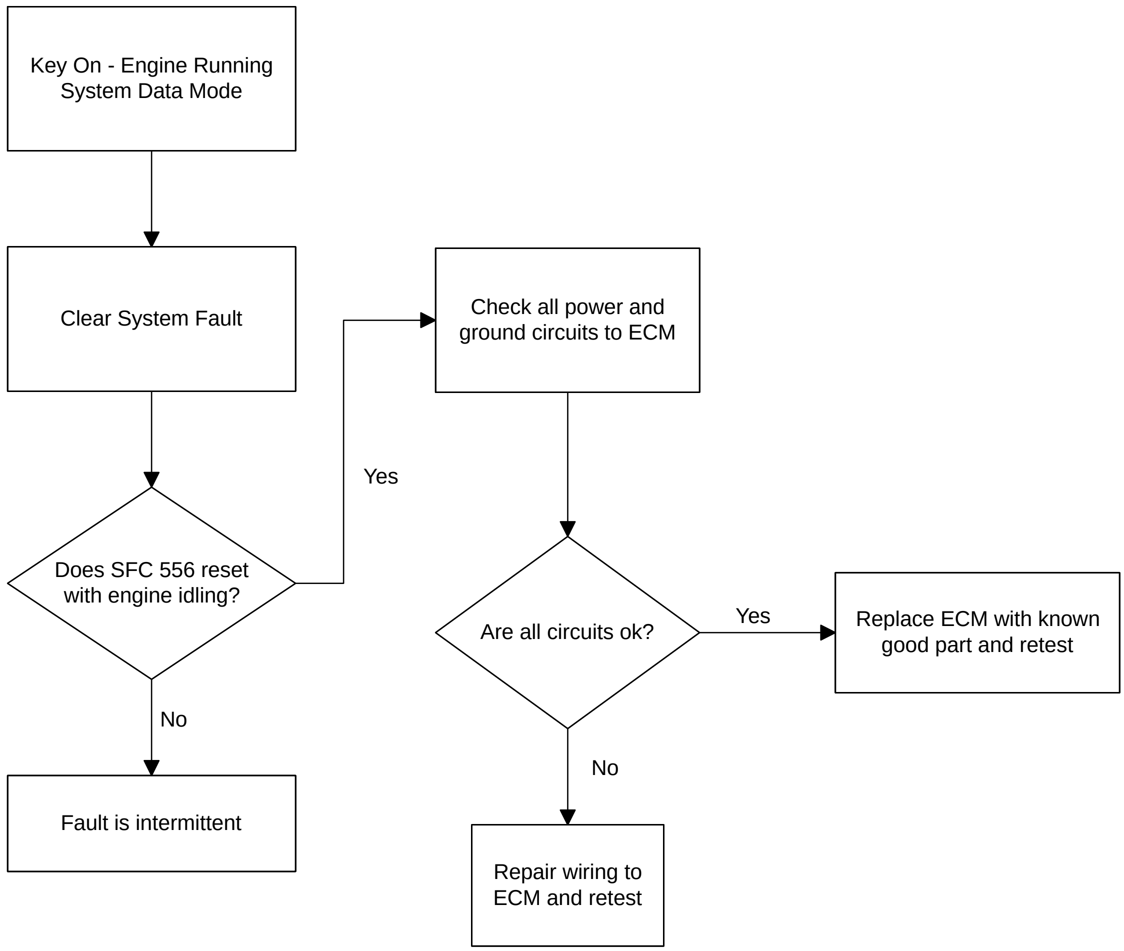


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

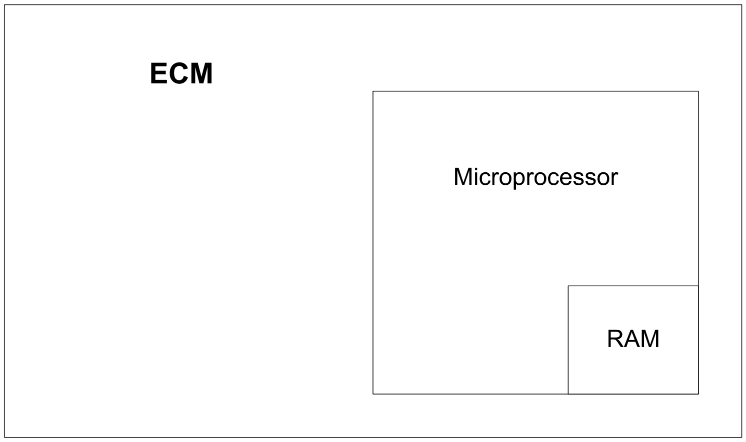
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

SFC 556- RTI 3 Loss



DTC 1615- Microprocessor Failure - A/D

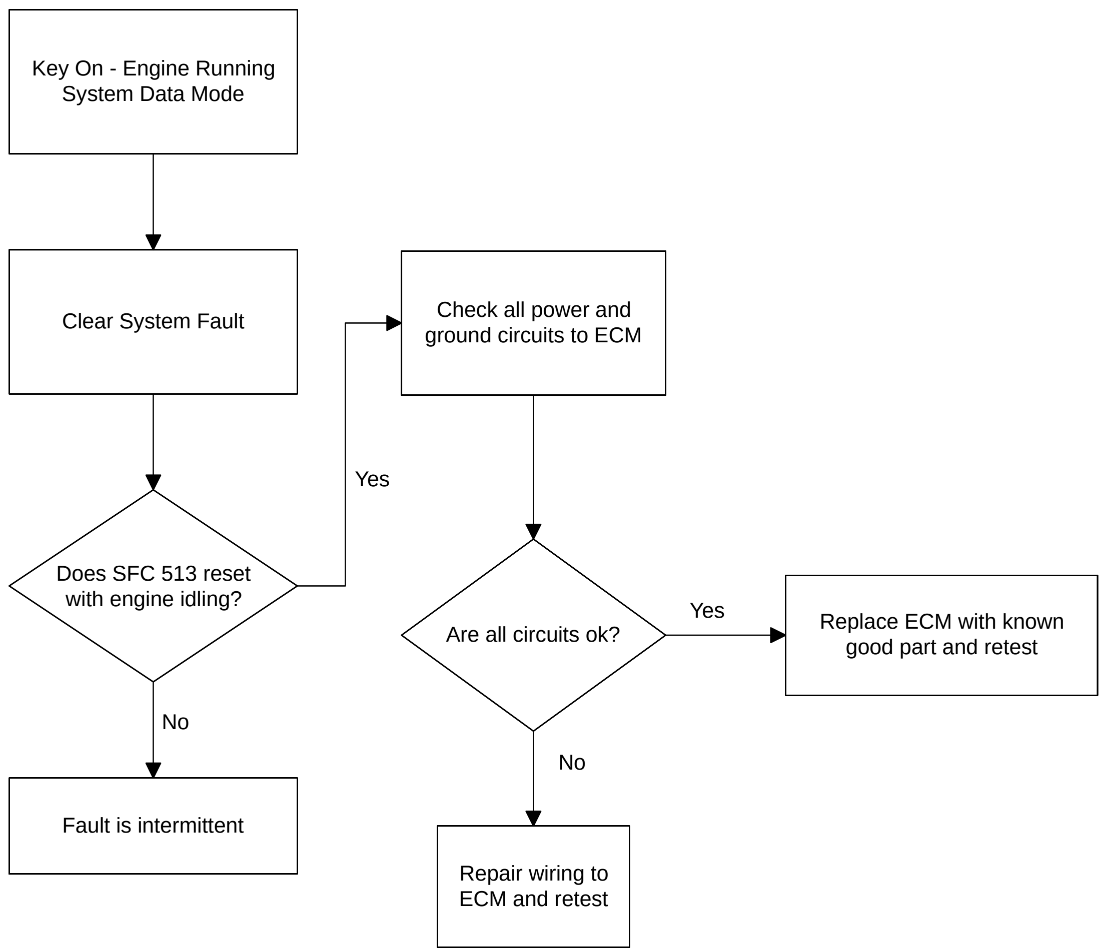


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

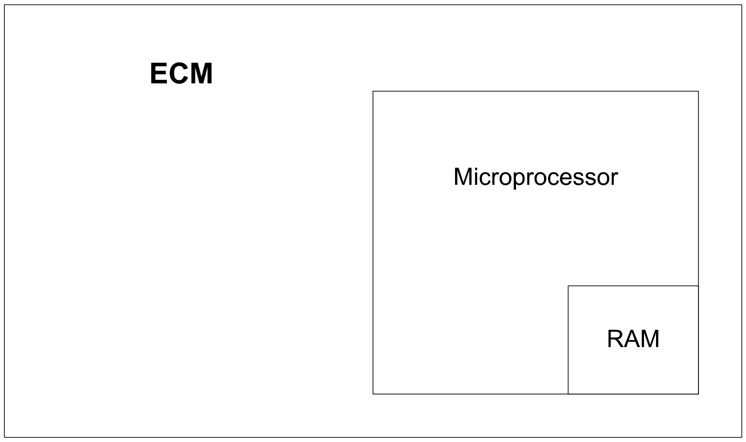
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

SFC 513- A/D Loss



DTC 1616- Microprocessor Failure - interrupt

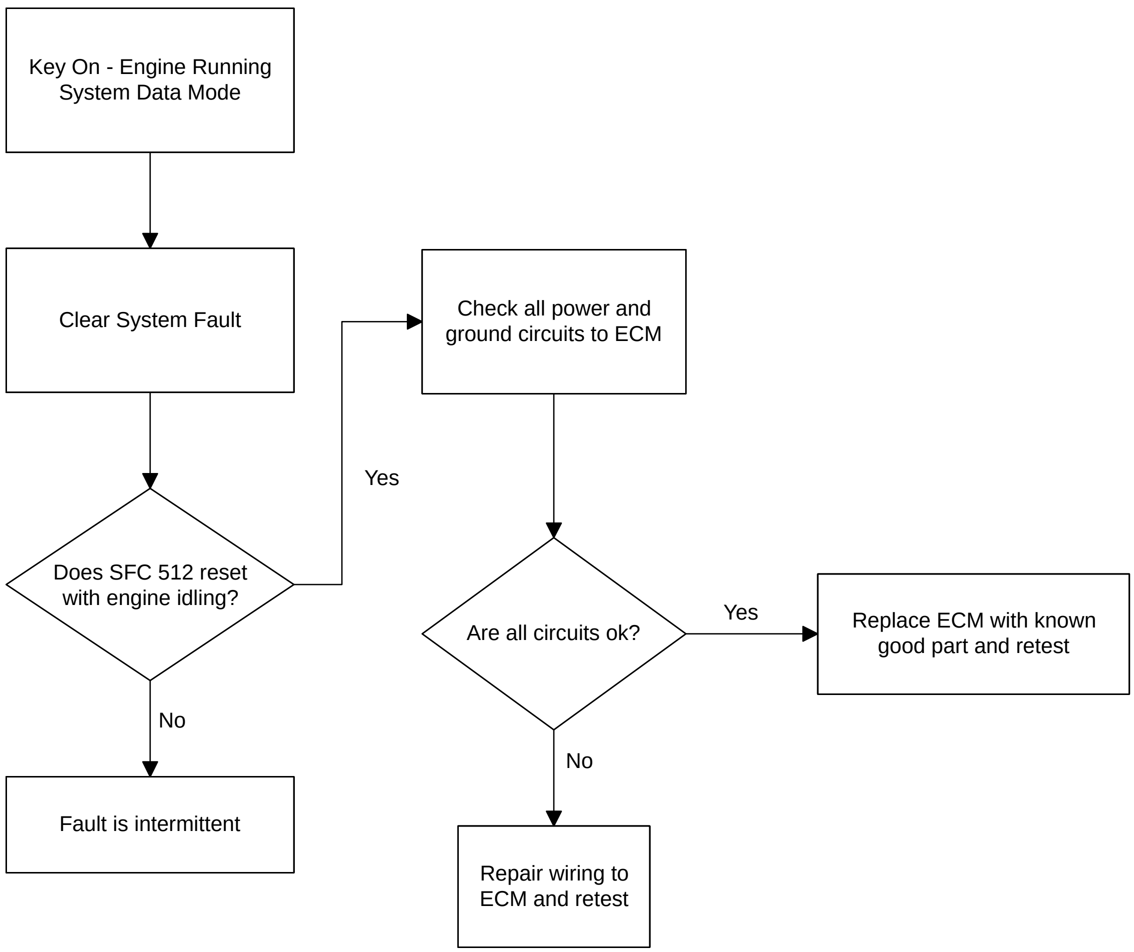


- Engine Control Module
- Check Condition- Key on
- Fault Condition- Internal microprocessor error
- MIL- On until code is cleared by technician
- Adaptive- Disabled for the remainder of the key-on cycle
- Closed Loop- Enabled
- Power Derate (level 2 until fault is cleared manually)

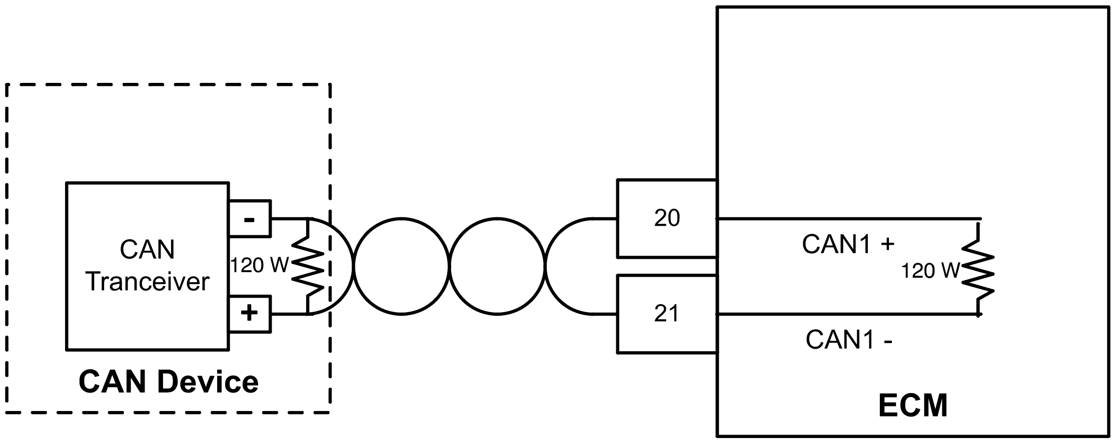
The ECM has checks that must be satisfied each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase.

During this active fault, Power Derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20%. This is enforced until the fault is manually cleared.

SFC 512- Invalid Interrupt



DTC 1625- CAN J1939 Shutdown Request



- Controller Area Network
- Check Condition- Key On, Engine Off and/or Running
- Fault Condition- ECM has received shutdown message from another CAN device and is shutdown on request.
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

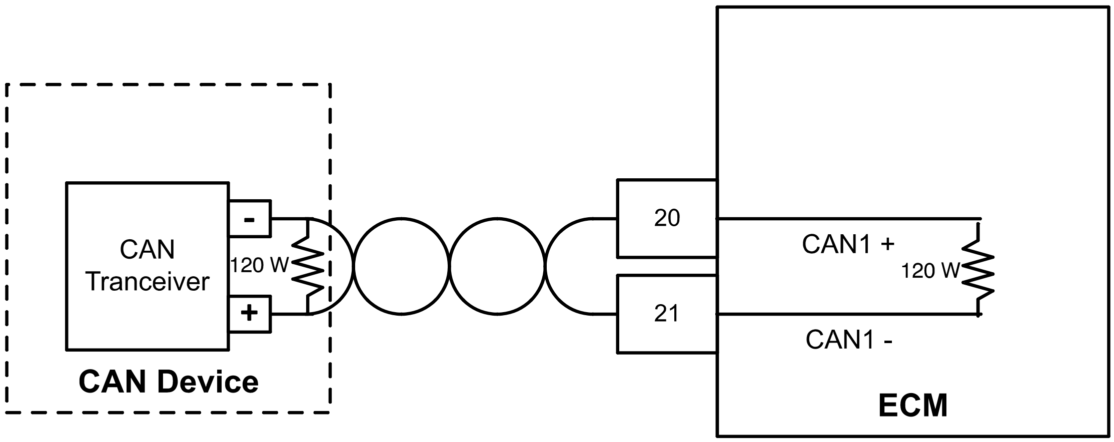
In some situations, external controllers may send a request to the ECM to shutdown engine operation and stop the engine. This request may be sent in response to a safety related condition in the vehicle.

This fault will set if the ECM receives the J1939 shutdown request via the CAN interface. This is the expected behavior.

Diagnostic Aids

- The ECM has shutdown the engine upon command by a external controller. This is the requested and expected behavior.

DTC 1626- CAN J1939 Transmit (Tx) Fault



- Controller Area Network
- Check Condition- Key On, Engine Off and/or Running
- Fault Condition- ECM CAN transceiver transmit error counts greater than the limit defined in the diagnostic calibration (must be < 125 failures)
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

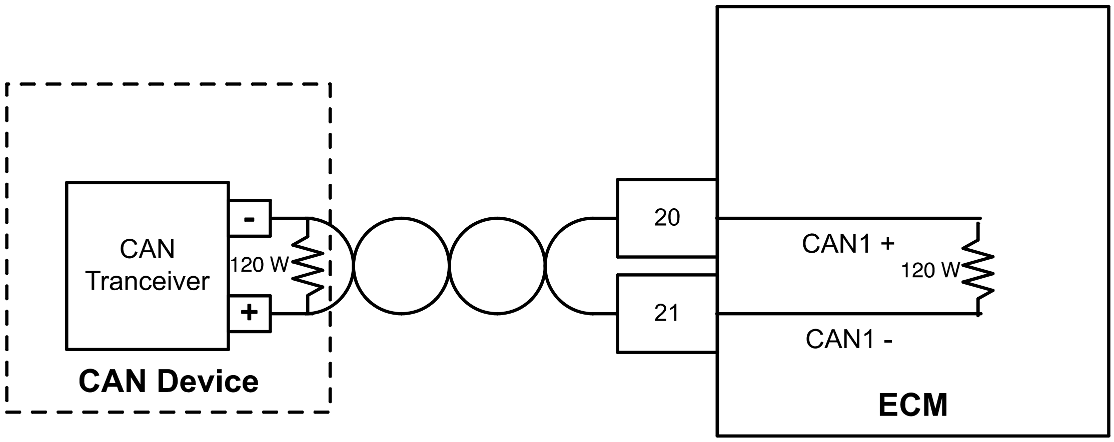
The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators, smart sensors, dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.

This fault will set if CAN communication is enabled and the ECM transceiver broadcasts a number of packets (as defined in the diagnostic calibration, must be set to less than 125 failures) to the network that are not received.

Diagnostic Aids

- Verify that all CAN devices are powered and are properly grounded
- Verify that the CAN network is properly terminated
- Check CAN wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- Check CAN (+) and (-) wires for short circuits

DTC 1627- CAN J1939 Receive (Rx) Fault



- Controller Area Network
- Check Condition- Key On, Engine Off and/or Running
- Fault Condition- ECM CAN transceiver receive error counts greater than the limit defined in the diagnostic calibration (must be < 125 failures)
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

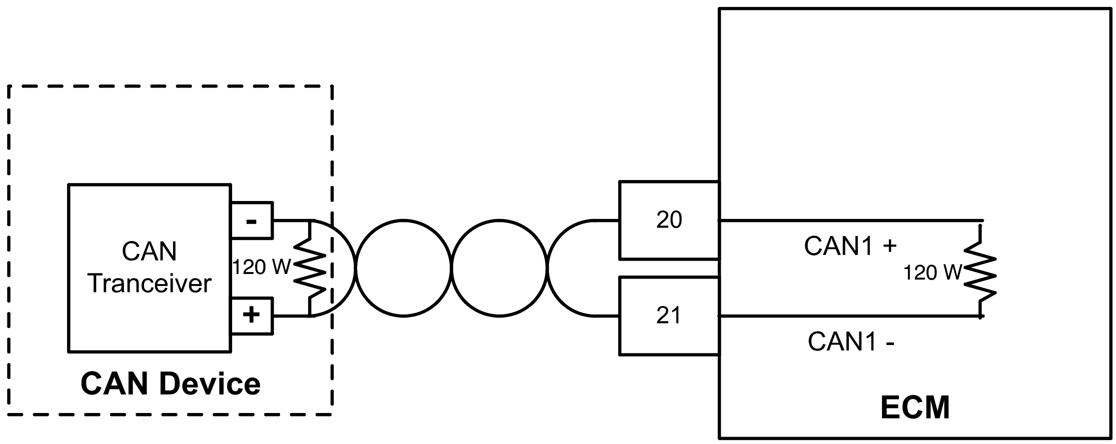
The Controller Area Network (CAN) is a serial communication network used to transmit and receive data between intelligent devices. Systems that utilize CAN communication include smart actuators, smart sensors, dash panels and gauges, and other microcomputers. Each smart sensor, actuator, or controller incorporates a CAN transceiver that interprets logic level signals on the network and translates the information into digital data.

This fault will set if CAN communication is enabled and the ECM transceiver is expecting to see network traffic and either does not see traffic (as defined in the diagnostic calibration, must be set to less than 125 failures).

Diagnostic Aids

- Verify that all CAN devices are powered and are properly grounded
- Verify that the CAN network is properly terminated
- Check CAN wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- Check CAN (+) and (-) wires for short circuits

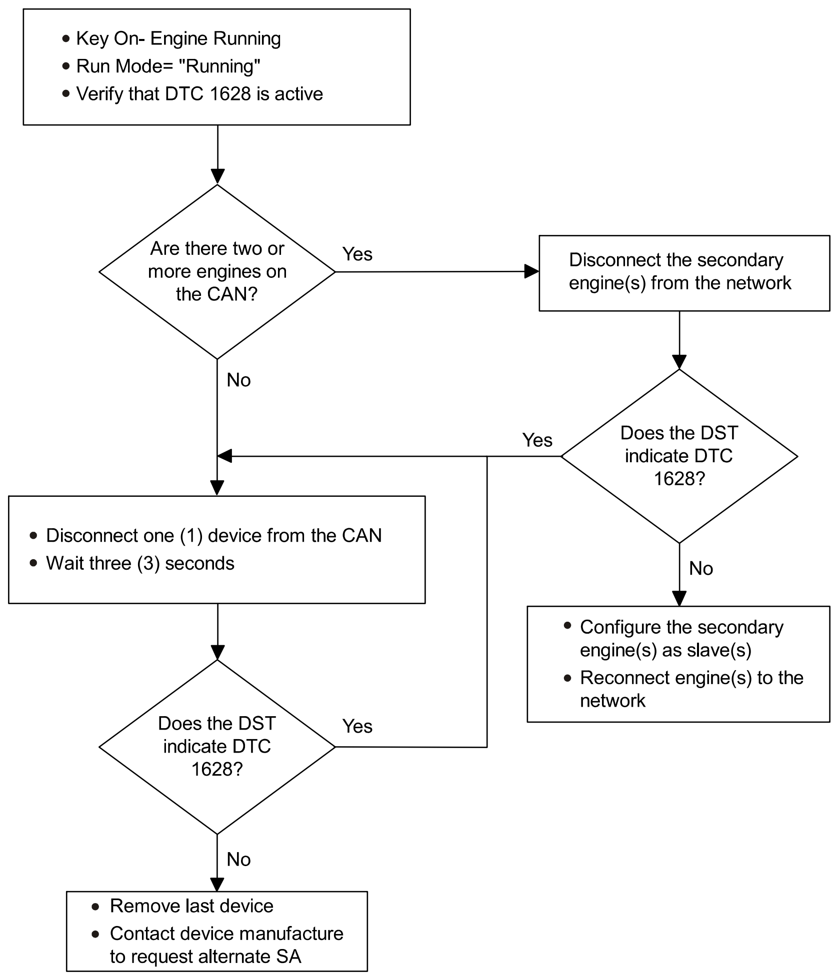
DTC 1628- CAN Address Conflict Failure



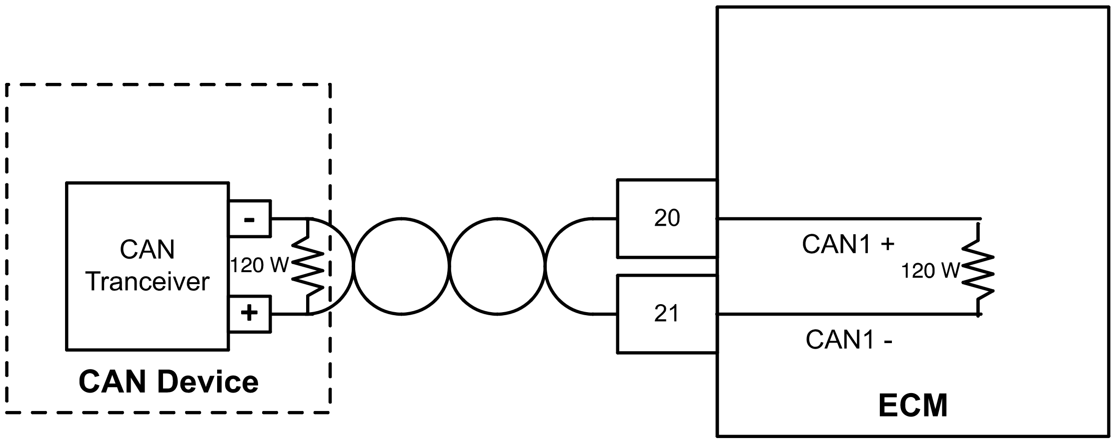
- CAN device(s)
- Check Condition- Key On, Engine on
- Fault Condition- two or more devices on the network that contain the same SA
- Corrective Action(s)- Sound audible warning or illuminate secondary warning lamp
- Non-emissions related fault

The Controller Area Network serves as a communication portal between intelligent devices. These devices may be but are not limited to other engine ECMs (slave), diagnostic tools, "smart" gauges, "smart" sensors, powertrain control units, vehicle controllers, actuators, etc. The network permits several devices to communicate with each other receiving and broadcasting commands as programmed. This type of network allows devices to be added to an entire system through only two conductors and permits all other devices to broadcast and receive commands to and from the device when properly commanded.

This fault indicates that there are two (2) or more devices on the network that use the same source address.


• Key On- Engine Running
• Run Mode= "Running"
• Verify that DTC 1628 is active
Are there two or more engines on the CAN?
Yes
Disconnect the secondary engine(s) from the network
No
Does the DST indicate DTC 1628?
Yes
No
• Disconnect one (1) device from the CAN
• Wait three (3) seconds
• Configure the secondary engine(s) as slave(s)
• Reconnect engine(s) to the network
Does the DST indicate DTC 1628?
Yes
No
• Remove last device
• Contact device manufacture to request alternate SA

DTC 1629- J1939 TSC1 Message Reciept Loss



- Controller Area Network
- Check Condition- Key On, Engine Running
- Fault Condition- ECM is expecting to receive J1939 TSC1 messages and has not received a message for more than n seconds (as defined in the diagnostic calibration).
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp. Govern engine speed at a forced idle.
- Non-emissions related fault

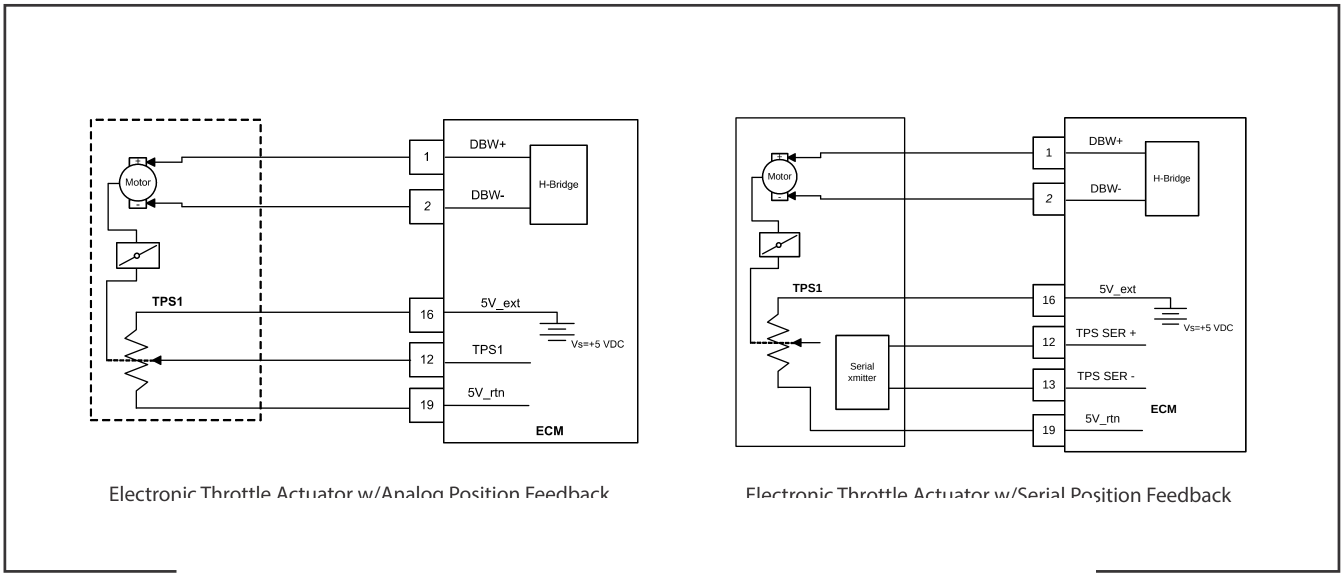
J1939 TSC1 may be used to send a commanded (or desired) engine speed to the ECM. If configured, the ECM will govern the engine speed to this commanded speed if possible. When operating in this mode, the ECM expects to receive TSC1 messages on a regular interval. When this message is not received, the ECM must operate the engine at a default idle speed until commanded to do otherwise.

This fault will set if CAN communication is enabled, the engine is running, and no TSC1 messages are received over the CAN bus for more than n seconds (as determined by the diagnostic calibration).

Diagnostic Aids

- Verify that that the CAN device generating the TSC1 message is powered and properly grounded
- Verify that the CAN network is properly terminated
- Check CAN wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary
- Check CAN (+) and (-) wires for short circuits

DTC 1652- TPS1 Loss of Communications



- Throttle Actuator (with serial/digital position feedback)
- Check Condition- Key On, Engine Running and/or Stopped
- Fault Condition- ECM is expecting to receive throttle position information from the throttle actuator and is not.
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp. Shutdown engine.
- Non-emissions related fault

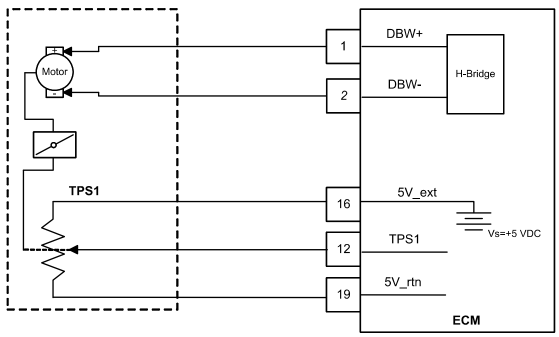
In the case of a throttle actuator with serial/digital position feedback, the ECM receives a constant data stream from the throttle actuator. If the communication is absent or interrupted, the ECM can no longer control the position of the throttle.

This fault will set if the key is on, the throttle actuator is receiving power, and the ECM is not receiving digital information from the actuator.

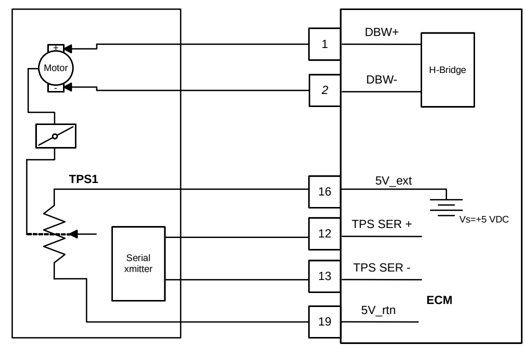
Diagnostic Aids

- Verify that the throttle actuator 5V supply voltage is present at the actuator.
- Check for a all four TPS feedback wires for short circuits.
- Check TPS SER+ and TPS SER- wire routing with respect to noise sources (ignition coils, spark plug coil wires, etc.) and shield if necessary.

DTC 2111- Unable to Reach Lower TPS



Electronic Throttle Actuator w/Analog Position Feedback



Electronic Throttle Actuator w/Serial Position Feedback

- Throttle Position Sensor
- Check Condition-Cranking or Running
- Fault Condition-Throttle command is 20% less than throttle position for 200ms or longer
- MIL-On during active fault
- Engine Shut Down

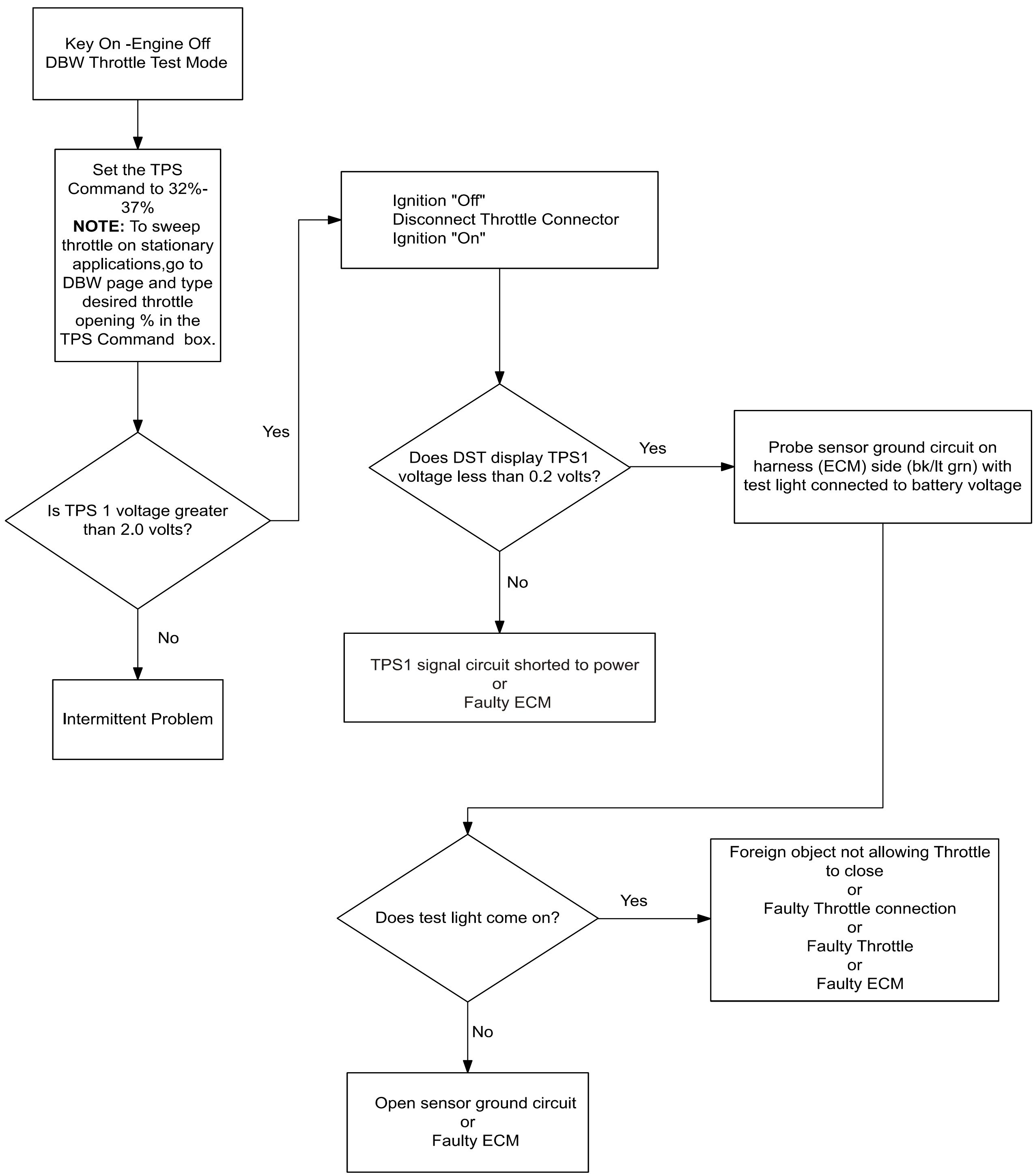
In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, references to the throttle and throttle position sensor refer to these fuel injection pump control actuators and their position feedback sensors. When the fuel injection pump is electronically controlled it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

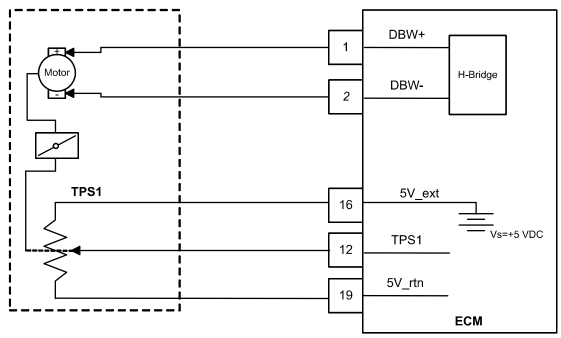
There are two types of throttle actuators, 1) actuator with analog position feedback and 2) actuator with digital position feedback. The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position. The second type, with digital position feedback, provides a serial data signal to the ECM with the throttle actuator position voltage level encoded in the data stream.

This fault will set if the throttle command is 20% less than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.

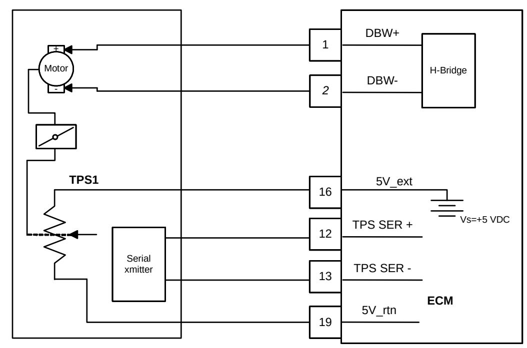
SFC 638-Throttle Unable To Close



DTC 2112- Unable to Reach Higher TPS



Electronic Throttle Actuator w/Analog Position Feedback



Electronic Throttle Actuator w/Serial Position Feedback

- Throttle Position Sensor
- Check Condition-Cranking or Running
- Fault Condition-Throttle command is 20% more than actual throttle position
- MIL-On during active fault
- Engine Shut Down

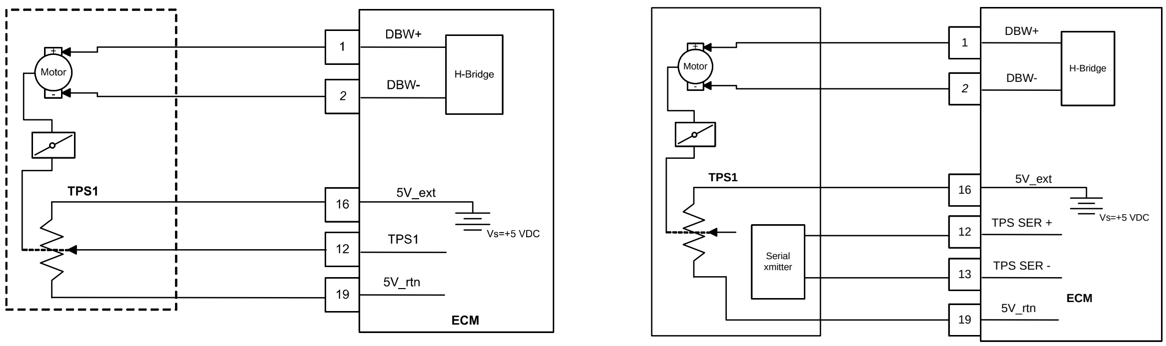
In the case of a diesel engine, an actuator controls a fuel injection pump, directly affecting the fueling level into the cylinders. This may be by direct manipulation of the fuel injection pump rack or by manipulation of the mechanical governor control level or "throttle arm." In the DGC ECM and EDIS, references to the throttle and throttle position sensor refer to these fuel injection pump control actuators and their position feedback sensors. When the fuel injection pump is electronically controlled it can be used to control the idle stability and limit engine speed based on operating conditions.

The Throttle Position Sensor uses either 1) a variable resistor and voltage divider circuit or 2) a non-contact hall-effect sensor to determine throttle actuator position, and is located within the throttle actuator.

There are two types of throttle actuators, 1) actuator with analog position feedback and 2) actuator with digital position feedback. The first type, with analog position feedback, provides an analog return signal between 0 and 5 volts that is proportional to the throttle actuator position. The second type, with digital position feedback, provides a serial data signal to the ECM with the throttle actuator position voltage level encoded in the data stream.

This fault will set if the throttle command is 20% or more than the actual throttle position. During this active fault the MIL light will be on and the engine will shut down.

DTC 9999- Throttle Actuator Failsafe Spring Failure



Electronic Throttle Actuator w/Analog Position Feedback

Electronic Throttle Actuator w/Serial Position Feedback

- Throttle Actuator
- Check Condition- Key Off, Engine Stopped
- Fault Condition- When the key is off (or the actuator is unpowered), the ECM is expecting the failsafe spring in the actuator to return the throttle position to near 0%. If the throttle does not reach this position when the actuator is powered, a fault is generated.
- Corrective Action(s)- Illuminate MIL, sound audible warning or illuminate secondary warning lamp. Govern the engine speed to a forced idle speed.
- Non-emissions related fault

The throttle actuator has a return spring that causes the throttle to move to a near 0% position when powered off. This causes the engine to shutdown following a key off. If the ECM detects the throttle position to be above x volts when the key is off (as determined by the diagnostic calibration), it will power up the actuator and attempt to drive it to a zero position. This should ensure that the engine is stopped.

This fault will set if the throttle does not return to a near 0% position with the key is off.

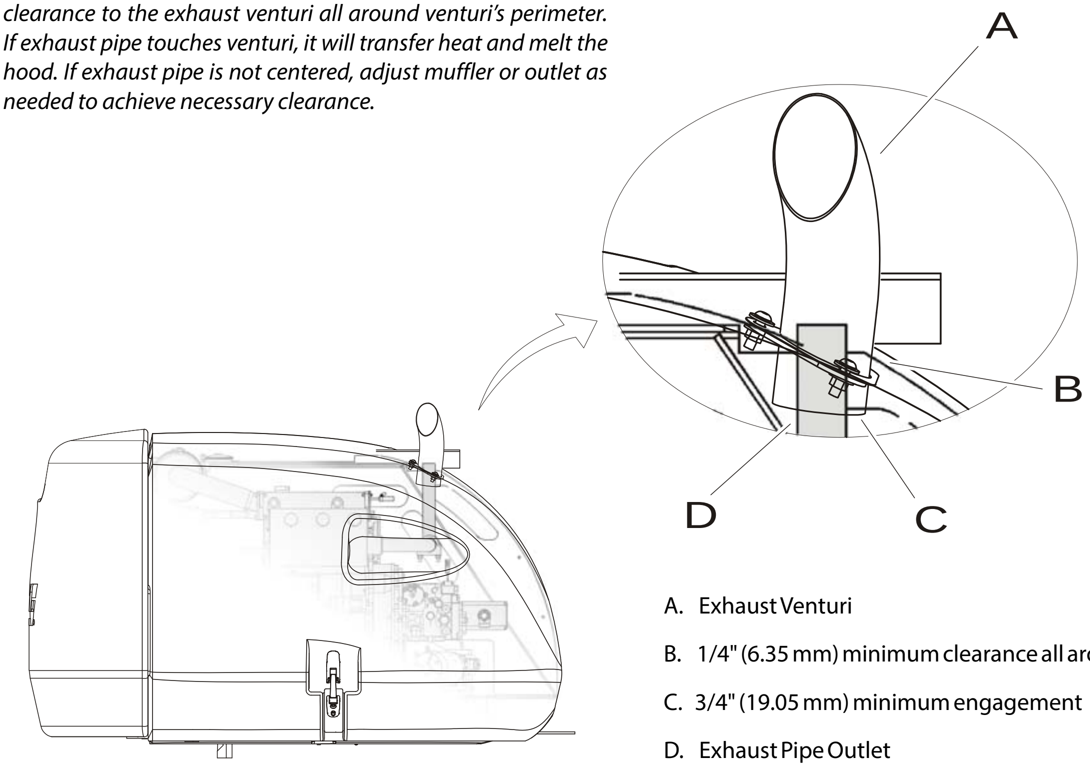
Diagnostic Aids

- Disconnect the throttle actuator from the wire harness. Remove the throttle actuator from the engine and manually move it. Verify that the internal spring forces the throttle back to near 0% position.
- Inspect the throttle arm or fuel rack on the fuel pump. Verify that it is not stuck.

DTC to SPN/FMI Table

FAULT INDEX	DESCRIPTION	DTC SET	
		SPN	FMI
2	DTC 118: ECT voltage high	110	3
3	DTC 117: ECT voltage low	110	4
4	DTC 116: ECT higher than expected stage 1	110	15
9	DTC 563: Vbat voltage high	168	15
10	DTC 562: Vbat voltage low	168	17
11	DTC 643: Sensor supply voltage 1 high	1079	3
12	DTC 642: Sensor supply voltage 1 low	1079	4
13	DTC 123: TPS1 voltage high	51	3
14	DTC 122: TPS1 voltage low	51	4
29	DTC 524: Oil pressure low	100	1
86	DTC 217: ECT higher than expected stage 2	110	0
89	DTC 2112: Unable to reach higher TPS	51	7
90	DTC 2111: Unable to reach lower TPS	51	7
96	DTC 336: CRANK input signal noise	636	2
98	DTC 606: Microprocessor failure - COP	629	31
99	DTC 1612: Microprocessor failure - RTI 1	629	31
100	DTC 1613: Microprocessor failure - RTI 2	629	31
101	DTC 1614: Microprocessor failure - RTI 3	629	31
102	DTC 1615: Microprocessor failure - A/D	629	31
103	DTC 1616: Microprocessor failure - Interrupt	629	31
104	DTC 601: Microprocessor failure - FLASH	628	13
105	DTC 604: Microprocessor failure - RAM	630	12
106	DTC 219: RPM higher than max allowed govern speed	515	15
144	DTC 337: Crank signal loss	636	4
145	DTC 1625: J1939 shutdown request	1384	31
146	DTC 1626: CAN-J1939 Tx fault	639	12
147	DTC 1627: CAN-J1939 Rx fault	639	12
175	DTC 1628: J1939 CAN address / engine-number conflict	639	13
188	DTC 521: Oil pressure high	100	0
189	DTC 1652: TPS1 loss of communications	51	9
190	DTC 1629: CAN-J1939 TSC1 Parameter Rx Fault	695	9
191	DTC 1113: Unable to achieve lower RPM	515	31
192	DTC 9999: TPS1 failsafe spring failure	51	7

NOTE: *Outlet pipe must be centered within 1/4" (6.35 mm) minimum clearance to the exhaust venturi all around venturi's perimeter. If exhaust pipe touches venturi, it will transfer heat and melt the hood. If exhaust pipe is not centered, adjust muffler or outlet as needed to achieve necessary clearance.*



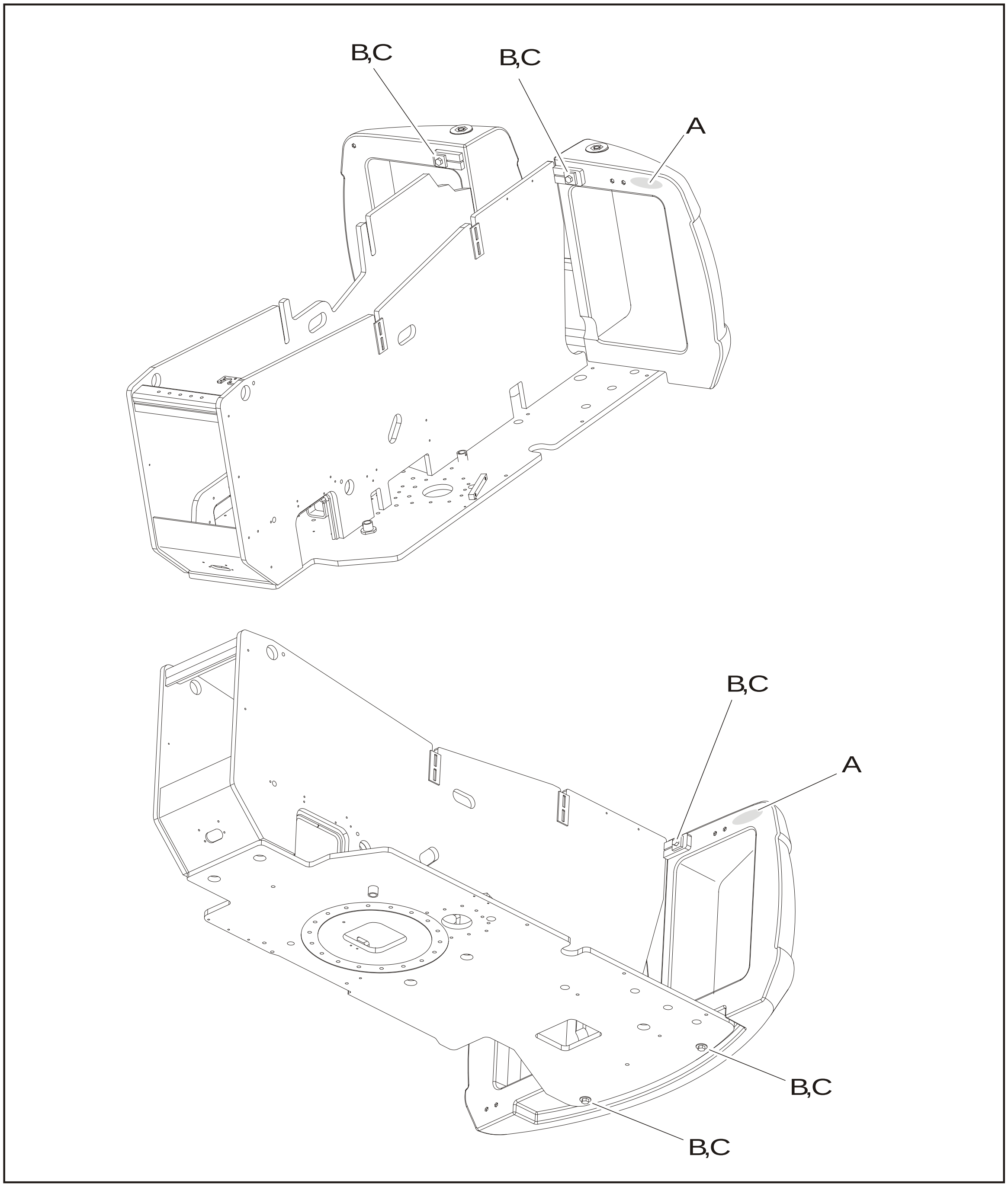
A. Exhaust Venturi

B. 1/4" (6.35 mm) minimum clearance all around.

C. 3/4" (19.05 mm) minimum engagement

D. Exhaust Pipe Outlet

Figure 3-78. Exhaust Venturi Adjustment



A. Part Number\Actual Weight Stamping

B. Apply Loctite #271 to Bolt Threads and to Threads in Counterweight.

C. Torque to 400 ft. lbs. (542 Nm). Typical Four Places.

Figure 3-79. Counterweight

NOTES:

SECTION 4. BOOM AND PLATFORM

4.1 BOOM MAINTENANCE

⚠ CAUTION

DO NOT USE A LIFTING DEVICE TO LIFT BOOMS UNLESS HOLDING VALVES ARE REMOVED FIRST. FAILURE TO DO SO WILL CAUSE SEVERE DAMAGE TO THE BOOM.

Remove Boom Assembly

1. Remove platform and platform support as follows:
   a. Disconnect electrical cable from control console.
   b. Tag and disconnect hydraulic lines to rotate cylinders. Cap hydraulic lines and ports.
   c. Use an overhead crane or suitable lifting device and nylon straps to support platform/support.

NOTE: *When removing retaining pin from rod end of level cylinder, make sure cylinder is properly supported.*

   d. Remove bolts and keeper pins securing retaining pins. Using a suitable brass drift and hammer, remove retaining pins from platform support.
2. Remove boom from turntable as follows:
   a. Disconnect wiring harness from ground control harness connector.

⚠ CAUTION

CAP HYDRAULIC LINES AND PORTS IMMEDIATELY AFTER DISCONNECTING LINES TO PREVENT ENTRY OF CONTAMINANTS INTO SYSTEM.

   b. Tag and disconnect hydraulic lines from boom to control valve. Use suitable container to retain residual hydraulic fluid. Cap all hydraulic lines and ports.
   c. Using suitable lifting equipment, adequately support boom weight along entire length.
   d. Remove bolts and keeper pins securing lift cylinder pivot pin. Using a suitable brass drift and hammer, remove pivot pin from lower boom.

NOTE: *To gain access for removal of pivot pins, it may be necessary to remove ground control box, hydraulic and fuel tanks, and counterweight.*

   e. Remove hardware securing the level link pivot pin. Using a suitable brass drift and hammer, remove the pin from the level link and turntable.
   f. Remove hardware securing lower boom pivot pin. Using a suitable brass drift and hammer, remove pin from turntable.
   g. Using all applicable safety precautions, carefully lift boom assembly clear of turntable and lower to ground or suitable supported work surface.

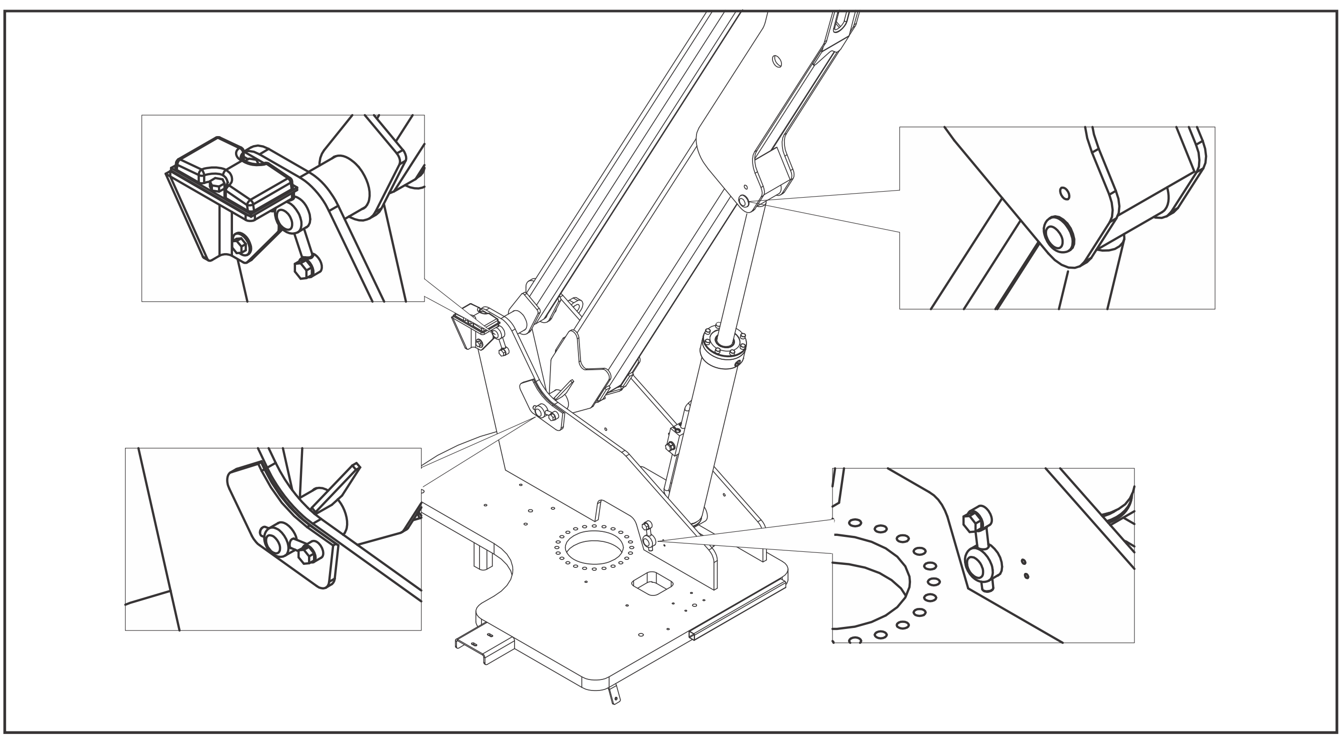


Figure 4-1. Location of Components - Boom Removal

Disassemble Main Boom

1. Loosen jam nuts on aft end of fly boom wear pad adjustment and loosen adjustments.
2. Using a portable power source, attach hose to telescope cylinder port block. Using all applicable safety precautions, activate hydraulic system and extend cylinder to gain access to cylinder rod retaining pin. Shut down hydraulic system.
3. Carefully disconnect hydraulic hose from retract port of cylinder. 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 retract port.
4. Remove hardware securing telescope cylinder to the fly boom section, then remove pin from fly.
5. Remove hardware securing telescope cylinder to the base boom section.

⚠ CAUTION

WHEN REMOVING TELESCOPE CYLINDER FROM BOOM SECTIONS. CARE SHOULD BE TAKEN NOT TO LEAVE CYLINDER REST ON POWERTRACK WHICH COULD CAUSE DAMAGE TO POWERTRACK.

6. Using a suitable lifting device, remove telescope cylinder from boom sections.
7. Using a piece of tape, mark the length of hoses and wires from front of fly boom and bottom of base boom for reassembly.
8. Remove hardware securing the front wear pads on base boom section, remove wear pads.
9. Remove hardware securing the powertrack to the aft end of the fly boom section.
10. Using a suitable lifting device, remove fly boom from boom section.
11. Remove hydraulic lines and electrical cables from powertrack.
12. Remove hardware securing powertrack to base boom section. Remove powertrack.

Inspection

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

Assemble Main Boom

1. Install power track to the attach point on the base boom section. Secure power track with the attaching hardware.
2. Install hydraulic lines and electrical cables into the power track.
3. Install wear pads to the aft end of the fly section.
4. Using suitable lifting equipment, slide fly section into the base section until power track attach point aligns with holes in side of base section.
5. Attach the power track to the aft end of fly boom section. Secure power track with the attaching hardware.
6. Using suitable lifting equipment, slide fly boom section out to gain access to telescope cylinder attach pin hole.
7. Measure the distance between the telescope cylinder port block attach point on base boom section and the attach point on fly boom section.
8. Connect a suitable auxiliary hydraulic power source to the telescope cylinder port block.
9. Extend the telescope cylinder the distance of the two attach points.
10. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the boom assembly.

CAUTION

WHEN INSERTING THE TELESCOPE CYLINDER INTO THE BOOM, CARE MUST BE TAKEN NOT TO DAMAGE THE POWER TRACK ASSEMBLY.

11. Slowly slide the telescope cylinder into boom assembly, align rod end with attach point in fly section. Insert pin and secure with retaining ring.
12. Align bolt holes at aft end of base boom section with telescope cylinder port block. Secure telescope cylinder with hardware.
13. Install wear pads at end of base boom section. Using shims, adjust the adjustable wear pads to zero clearance. Adjust pads alternately side to side, so that fly boom section is centered in base boom section.
14. Retract boom section fully. Using shims, adjust wear pads at aft end of boom section to zero clearance. Adjust pads alternately side to side, so that fly boom section is centered in base boom section.
15. Disconnect auxiliary power source from telescope cylinder.

Install Boom Assembly

1. Using suitable lifting equipment, position boom assembly on turntable so that boom pivot holes in both boom and turntable are aligned.
2. Install boom pivot pin, ensuring that location of the hole in pivot pin aligns with attach point on upright.
3. Using all applicable safety precautions, operate lifting equipment in order to position boom lift cylinder and level link so that holes in cylinder rod end and level link are aligned with the one in the turntable. Insert cylinder pins.
4. If necessary, gently tap pins into position with a soft headed mallet, ensuring that attach holes in pins are aligned with attach holes in boom structure. Secure with hardware.
5. Connect all hosing and wiring.
6. Install the platform to the boom assembly.
7. Connect all hosing and wiring at platform control station.
8. Using all safety precautions, operate machine systems and extend and retract boom for four or five cycles.
9. Shut down machine systems and check for leakage.

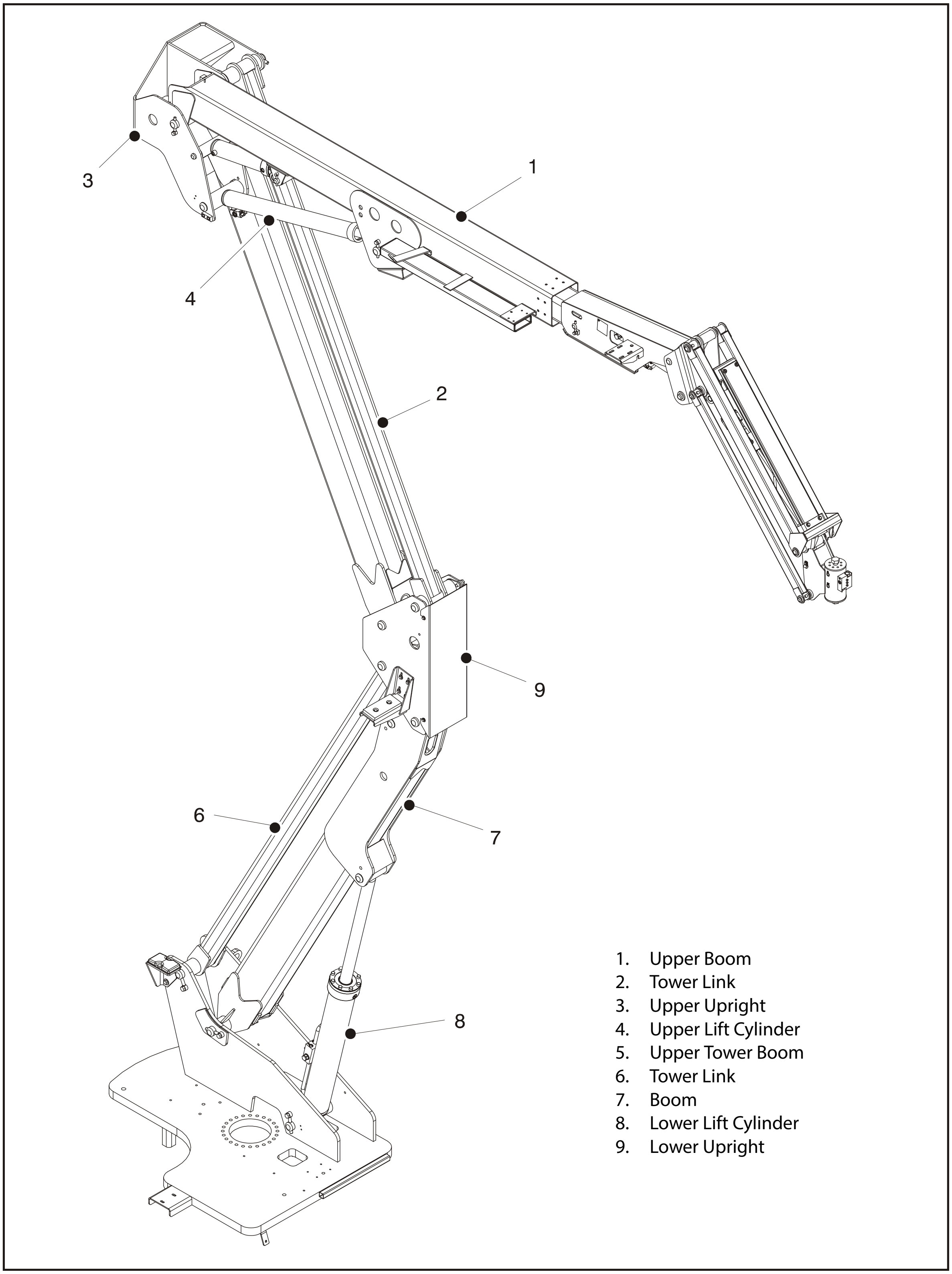


Figure 4-2. Boom Assembly

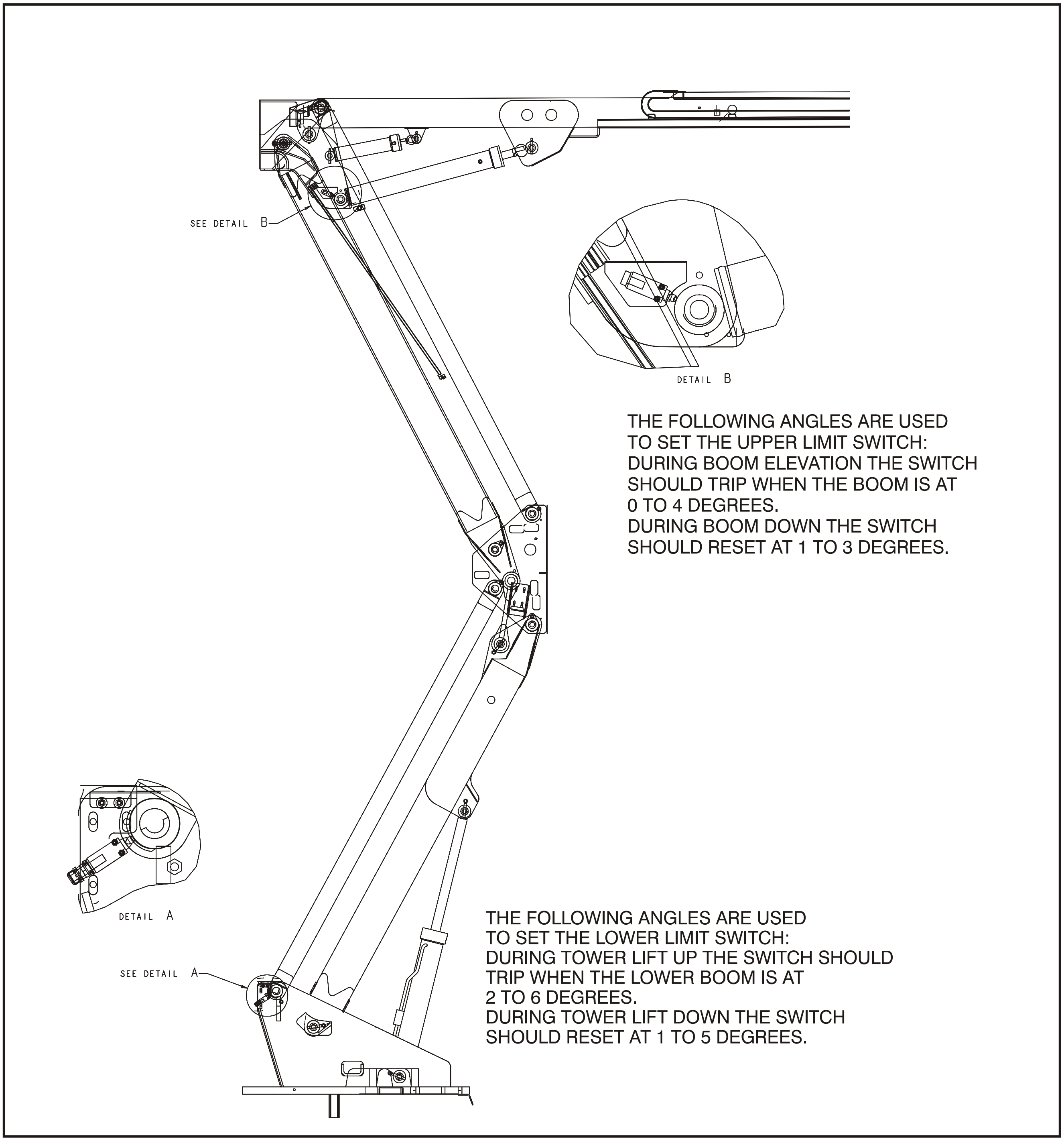


Figure 4-2. Boom Limit Switches

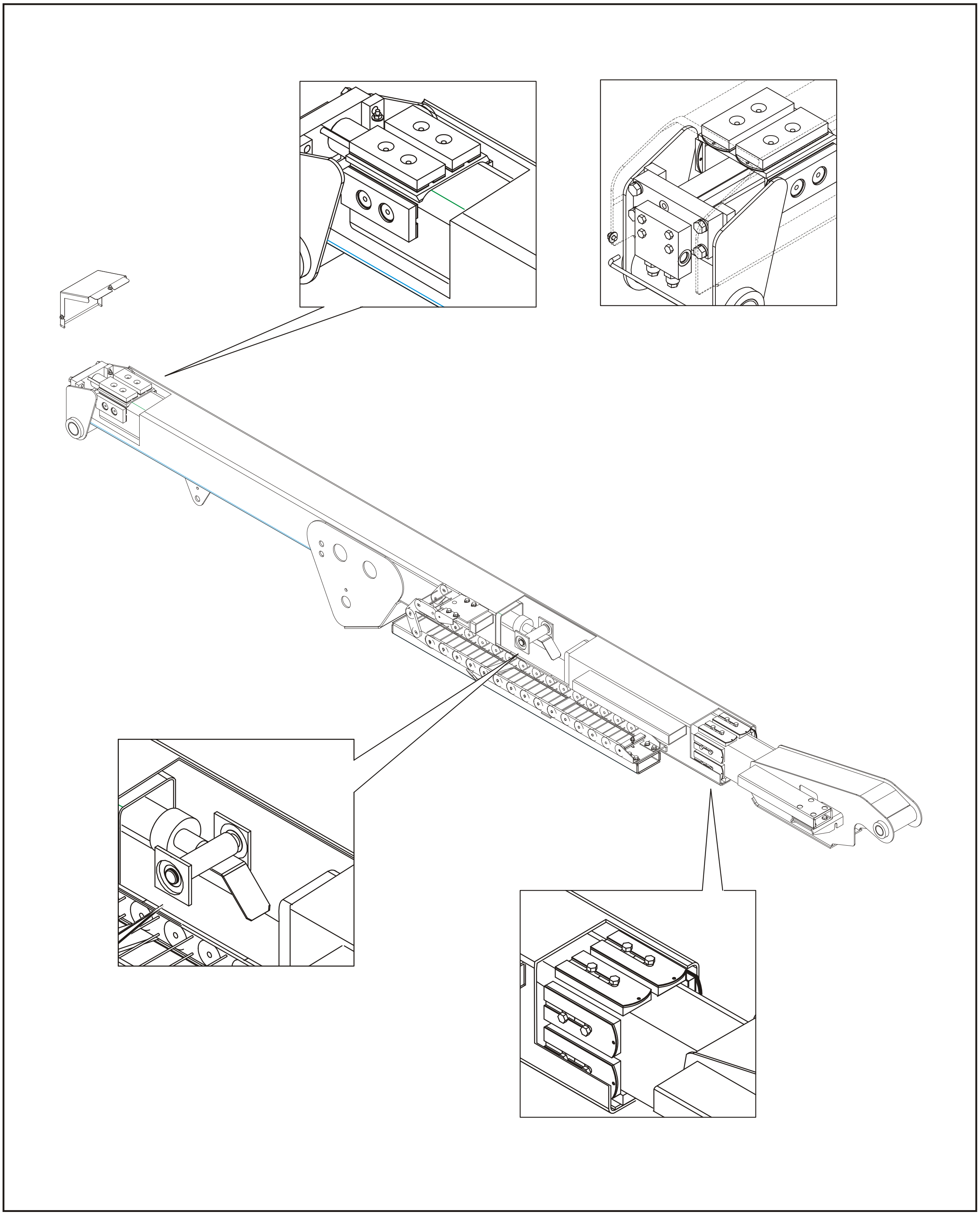


Figure 4-3. Main Boom

4.2 ROTATOR

See Figure 4-5., Rotator Assembly - Cutaway

Disassembly and Inspection

1. Place on a clean workbench with room to place internal parts as they are removed.
2. Remove all hydraulic fittings.
3. Loosen cap screws(7) and unscrew locknut (6) and end cap (5). Shaft is now free to move up and out of engagement with piston sleeve (3).

NOTE: *Note orientation between spline teeth (see Figure 4-4.), as this will greatly simplify actuator timing upon reassembly.*

4. After removing shaft, piston sleeve and piston assembly can be moved down and out of housing.
5. Remove all seals and bearings from their grooves, except static piston seals (9) and (11). These seals generally do not require replacement.
6. Clean all parts thoroughly and inspect for wear.
7. A small amount of wear in spline teeth has little effect on actuator strength. New spline sets are manufactured with a backlash of about 0.005” (0.127 mm) per mating set. After long service, a backlash of about 0.015” (0.381 mm) per set may still be acceptable in most cases, depending on required accuracy of the application.
8. Item (1) is the integral housing and ring gear. Check the ring gear for wear and weld damage to the pins. Inspect the cylinder bore for wear and scratches. The surface finish should be 32 RMS or better; re-hone if necessary.
9. Radial bearings (18) and (19) and piston bearings (17) should have a maximum radial clearance of 0.006” (0.152 mm). A clearance in excess of 0.008” (0.203 mm) requires replacement of bearings.
10. Rough and grooved shaft journals require shaft replacement.

Assembly and Testing

1. Wash parts thoroughly in cleaning solvent and blow dry.
2. Coat all sealing and working surfaces with hydraulic oil.
3. Install seals and bearings in piston sleeve, piston, shaft, and end cap. Lips of exclusion seals (16) face outward. Lips of high pressure seals face inward.
4. Place actuator in a vertical position. Install piston sleeve (3) in timed relation to the housing, applying firm pressure as the new seals and bearings enter the housing and become compressed by the housing chamber.

NOTE: *Do not mis-align sleeve. It will mar cylinder bore. Timing marks must be aligned for proper shaft orientation. Refer to Figure 4-4., Timing Marks.*

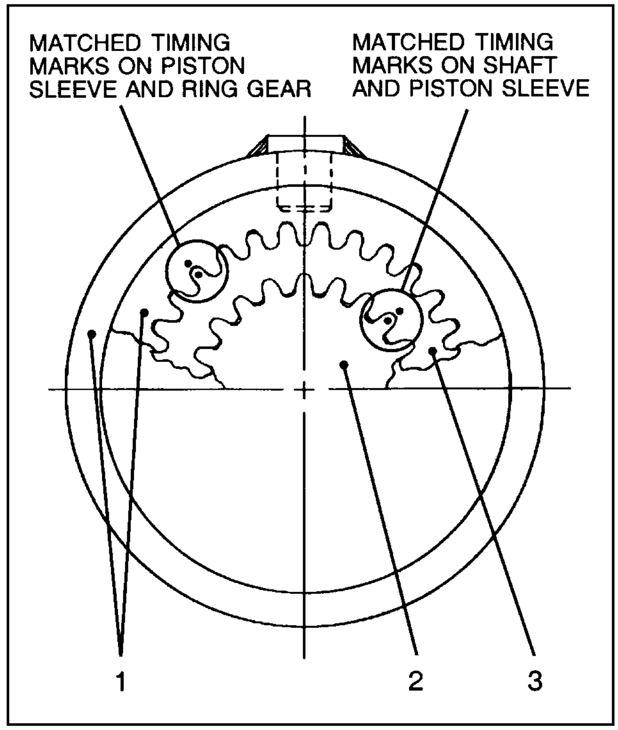
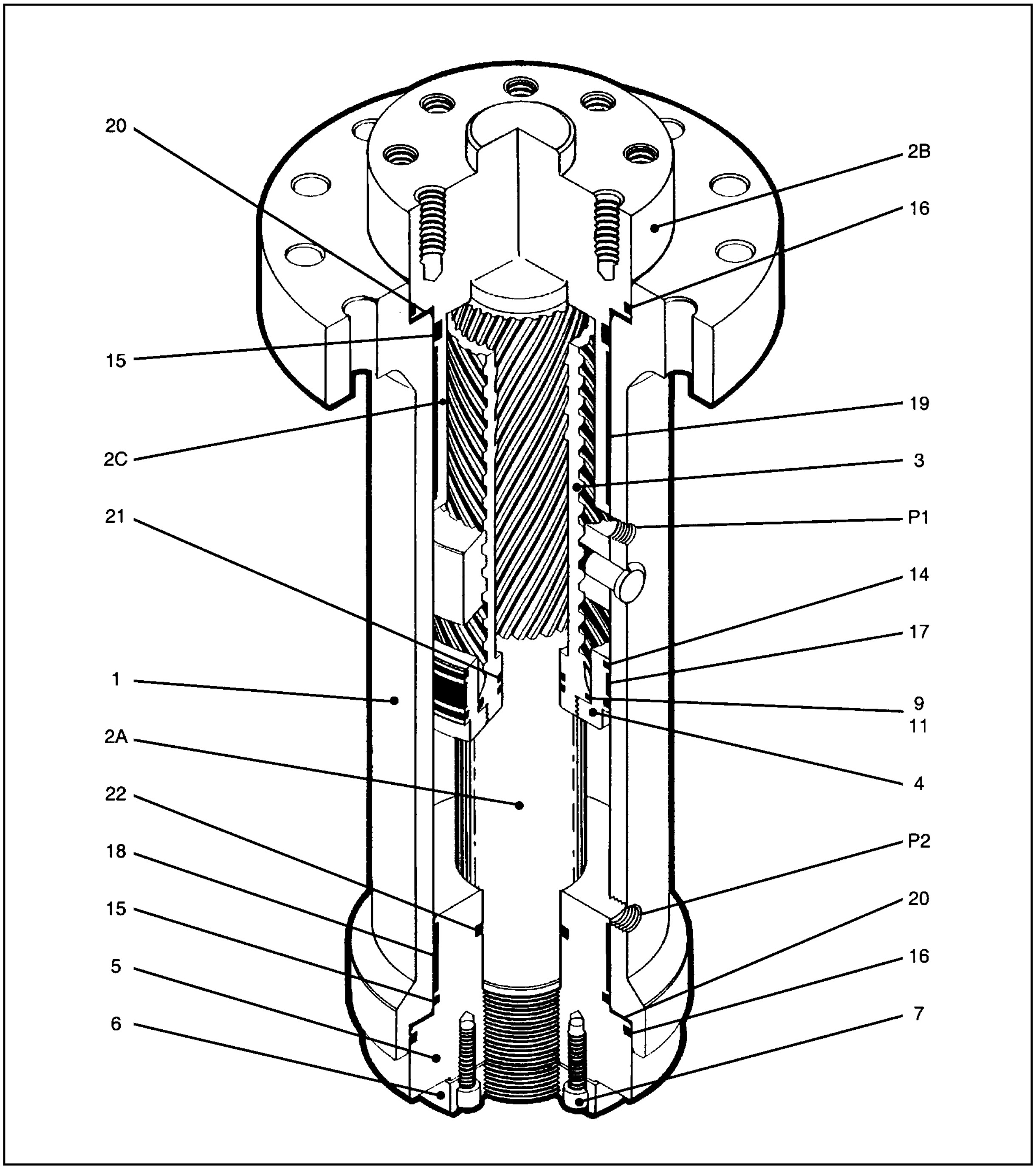


Figure 4-4. Timing Marks

5. If actuator is not equipped with grease fittings, coat thrust bearings (20) with grease before sliding on shaft and end cap.
6. Shaft is installed by aligning punched timing marks. Temporarily taping threaded portion of shaft will help installation past shaft seals (masking tape works well).
7. Apply anti-seize to threaded and surrounding areas of end caps. End cap may need to be installed with actuator in a vertical position.
8. End cap (5) is torqued to 60-400 ft-lb (84-560 Nm) depending on actuator size, so actuator begins rotation at approximately 100 psi (6.9 bar) pressure.
9. Shaft flange cannot be rotated by hand. Combined back drive and friction prevent manual rotation.
10. If end cap is torqued too high, actuator may require as much as 300 psi (20.7 bar) to rotate. If end cap is not torqued high enough, shaft axial motion and radial backlash will result. End cap must be secured against shaft by tightening cap screws (7), or installing axial setscrews, depending on model.
11. Apply hydraulic pressure and check for breakaway pressure and shaft axial motion.
12. To test for leakage, pressurize Port P2 to 3000 psi (206.8 bar). No oil should seep from Port P1 or from end cap (5).
13. Repeat test by pressurizing Port P1 and check for leakage out of Port P2, around shaft flange (2B), and ring gear pin welds.



1. Housing & Ring Gear	5. End Cap	15. O-ring	21. O-ring
2A. Shaft	6. Locknut	16. Exclusion Seals	22. O-ring
2B. Flange	7. Capscrew	17. Piston Bearing	P1 Pressure Port
2C. Bearing Tube	9. Piston Seal	18. Radial Bearing	P2 Pressure Port
3. Piston Sleeve	11. Piston Seal	19. Radial Bearing	
4. Piston	14. O-ring	20. Thrust Bearing	

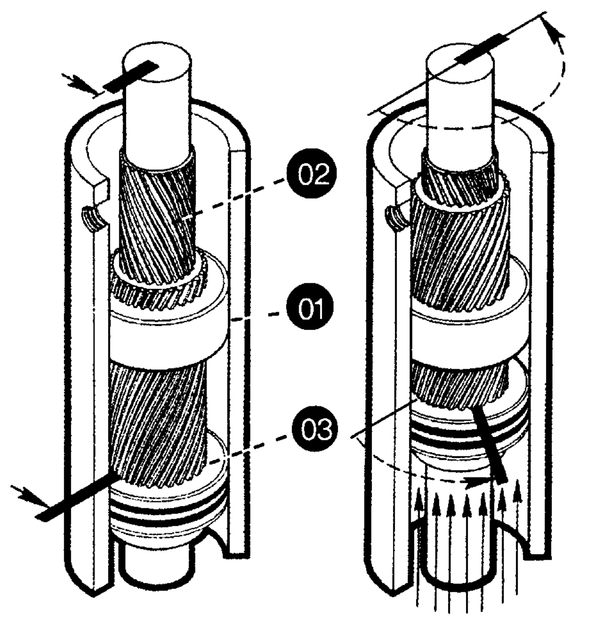
Figure 4-5. Rotator Assembly - Cutaway

4.3 ROTARY ACTUATOR (S/N 1300006433 TO PRESENT)

Theory of Operation

The L20 Series rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert linear piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear teeth (01) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (02), and annular piston sleeve (03). Helical spline teeth machined on the shaft engage matching splines on the in- side diameter of piston.

The outside diameter of piston carries a second set of splines, of opposite hand, which engage with matching splines in the housing. As hydraulic pressure is applied, the piston is displaced axially within the housing - similar to the operation of a hydraulic cylinder - while splines cause shaft to rotate. When control valve is closed, oil is trapped inside the actuator, preventing piston movement and locking the shaft in position.



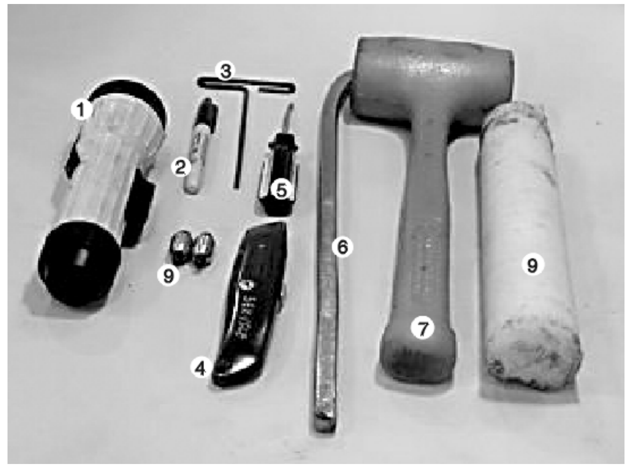
Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.

As fluid pressure is applied, 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 that of piston.

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

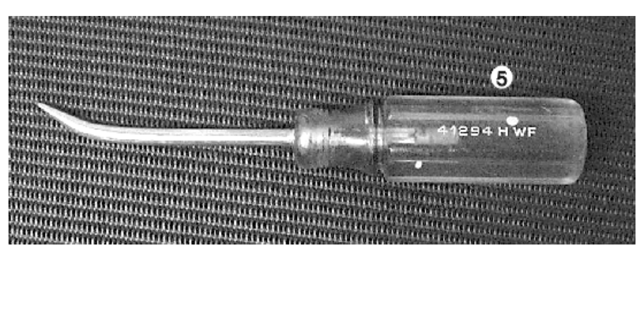
Required Tools

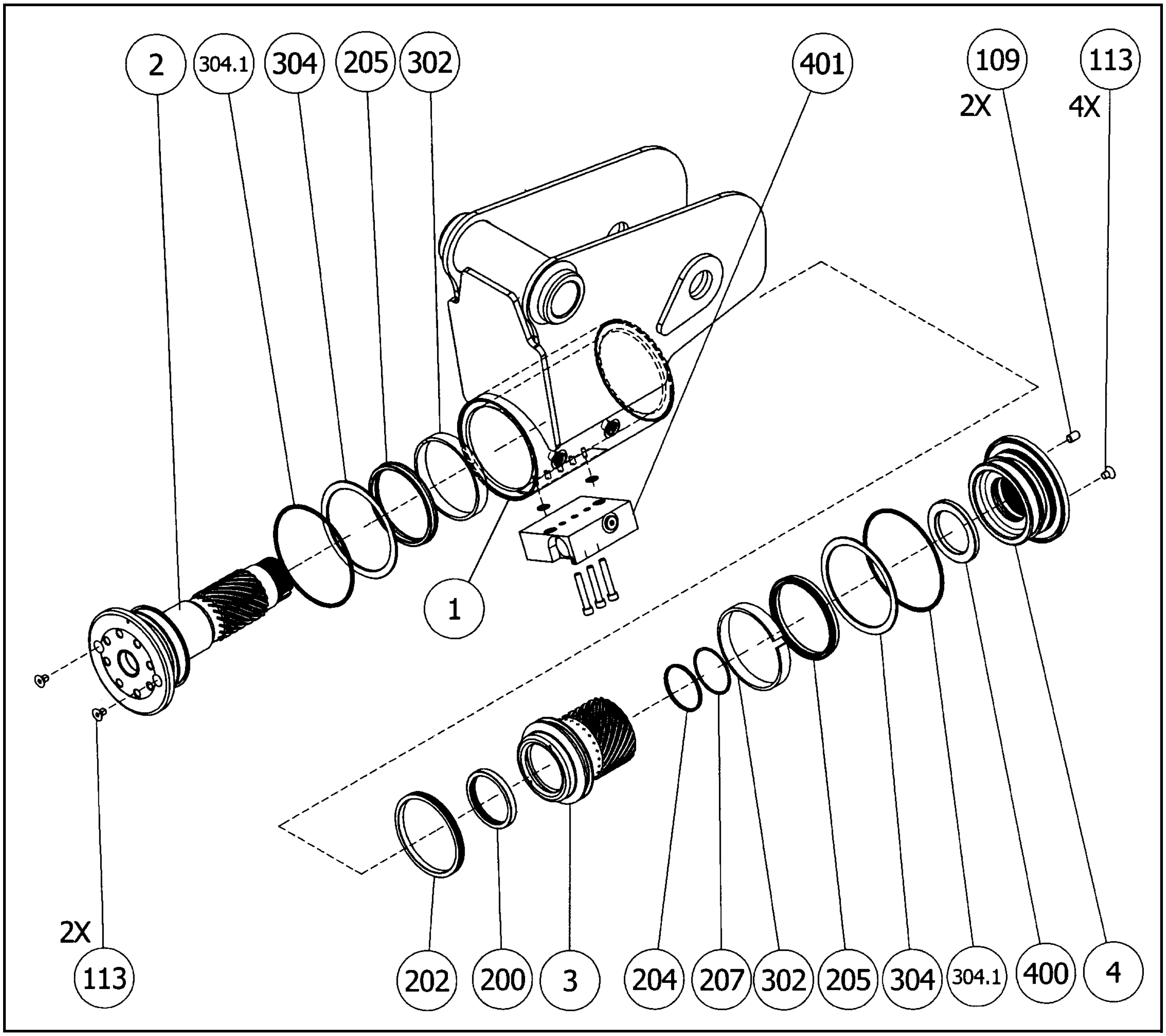
Upon assembly and disassembly of actuator there are basic tools required. The tools and their intended functions are as follows:



1. **Flashlight** - helps examine timing marks, component failure and overall condition.
2. **Felt Marker** - match mark the timing marks and outline troubled areas.
3. **Allen wrench** - removal of 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** - removal of end cap and manual rotation of shaft.
7. **Rubber mallet**- removal and installation of shaft and piston sleeve assembly.
8. **Nylon drift** - installation of piston sleeve
9. **End cap dowel pins** - removal and installation of end cap (sold with Helac seal kit).

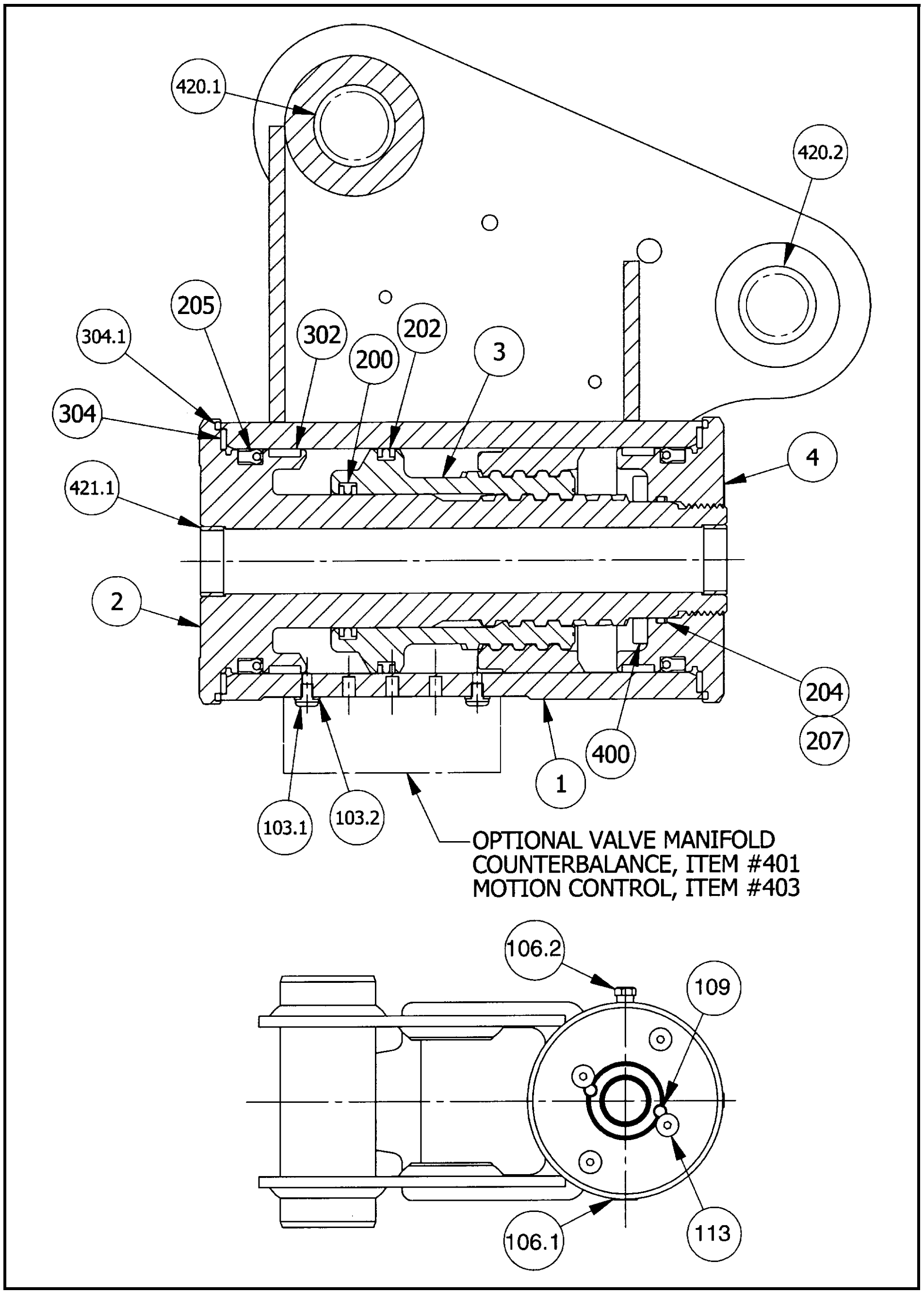
The seal tool is merely a customized standard flat head screwdriver. To make this tool you will need to heat the flat end with a torch. Secure heated end of screwdriver in a vice and physically bend heated end to a slight radius. Once radius is achieved round off all sharp edges of the heated end by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





PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2 . Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109 . Lock Pin	207. Backup Ring		
	113. Capscrew	304.1. Wiper Seal		

Figure 4-6. Rotary Actuator - Exploded View

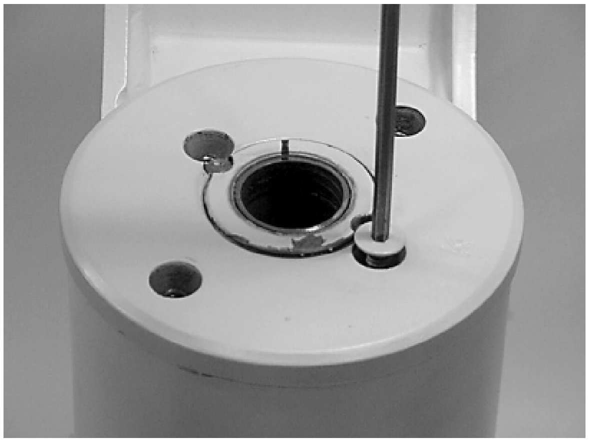


PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
1. Housing	103.1. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
2. Shaft	103.2. Washer	202. T-Seal	304. Thrust Washer	420.1 Bushing
3. Piston Sleeve	106.1. Port Plug	204. O-ring		420.2 Bushing
4. End Cap	106.2. Port Plug	205. Cup Seal		421.1 Bushing
	109. Lock Pin	207. Backup Ring		
	113. Capscrew	304.1. Wiper Seal		

Figure 4-7. Rotary Actuator - Assembly Drawing

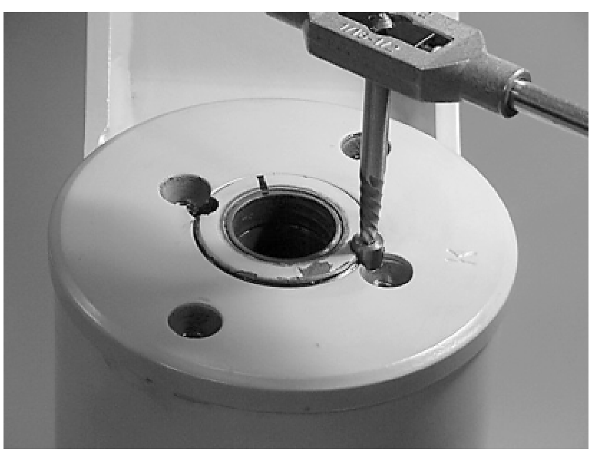
Disassembly

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



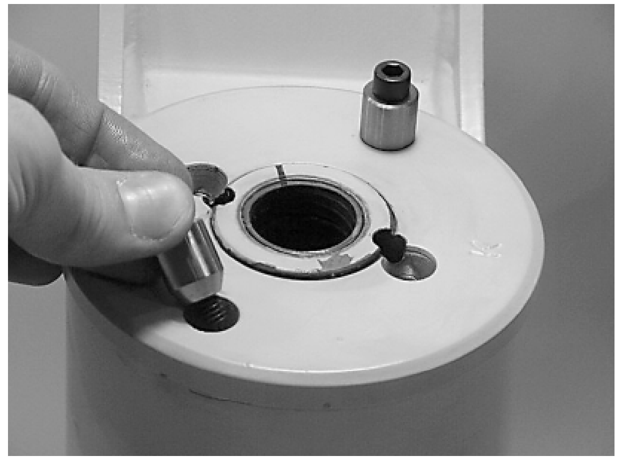
2. Using a 1/8" (3.18mm) drill bit, drill a hole in center of each lock pin to a depth of approximately 3/16" (4.76mm).

3. Remove lock pins using an "Easy Out" (Size #2 is shown).

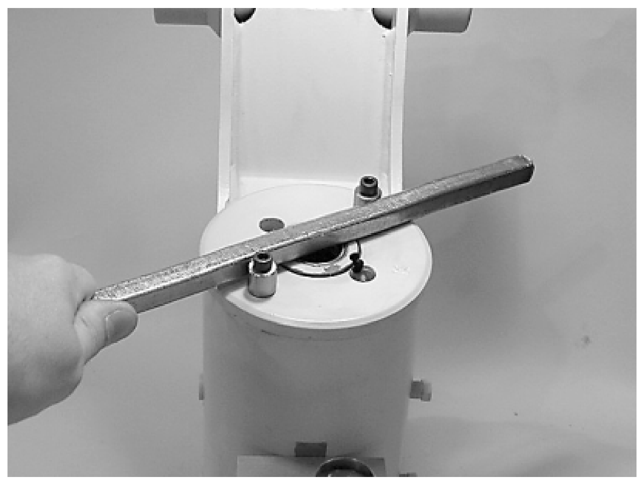


If pin will not come out with "Easy Out", use 5/1 6" drill bit to a depth of 1/2" (12.7mm) to drill out entire pin.

4. Install end cap (4) removal tools provided with Helac seal kit.



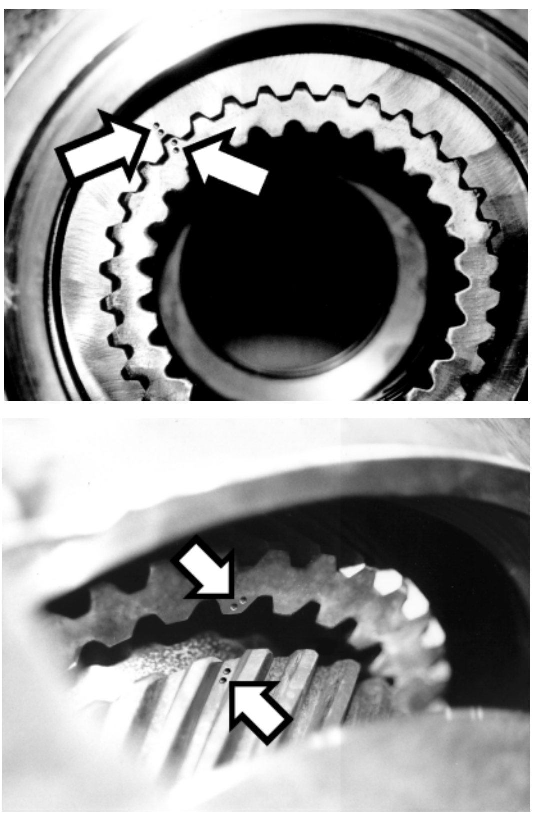
5. Using a metal bar, or something similar, unscrew end cap (4) by turning it counter clockwise.



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

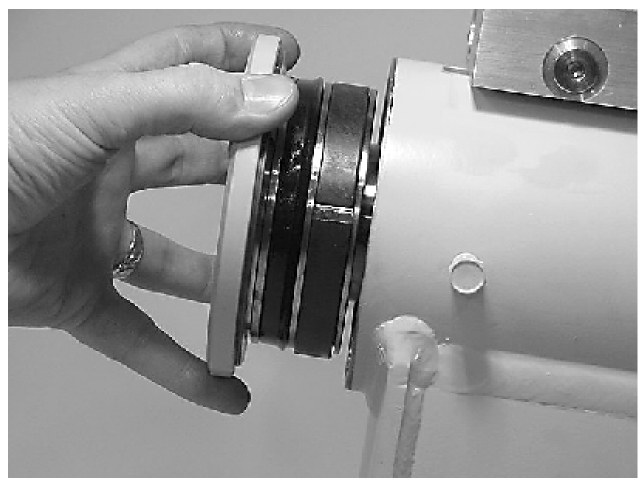
7. Remove stop tube if included. Stop tube is an available option to limit rotation of the actuator.

8. Every actuator has timing marks for proper engagement.



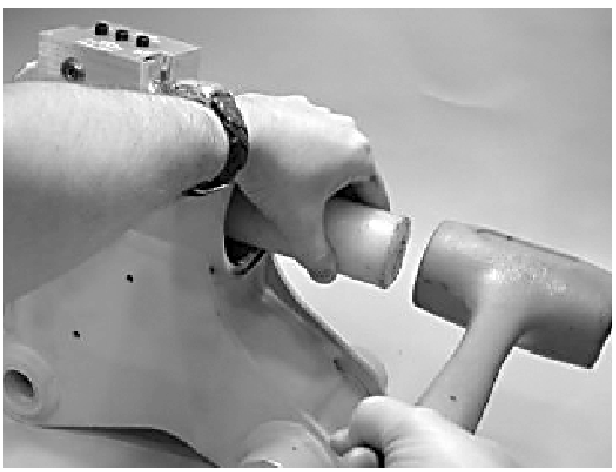
9. Before removing shaft, (2), use a felt marker to clearly indicate timing marks between shaft and piston. This will greatly simplify timing during assembly.

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

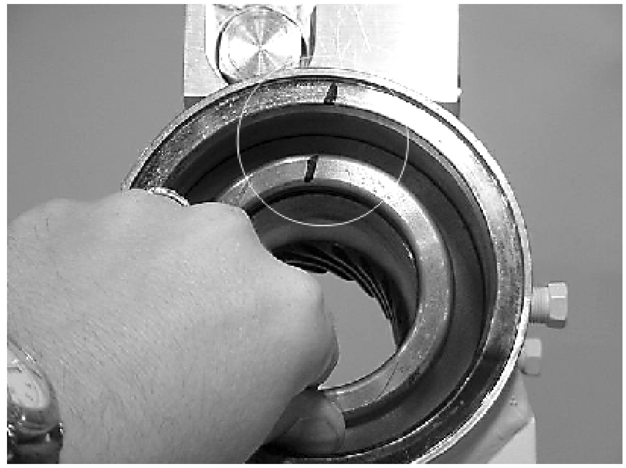


11. Before removing piston (3), mark housing (1) ring gear in relation to piston O.D. gear. There should now be timing marks on housing (1) ring gear, piston (3) and shaft (2).

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

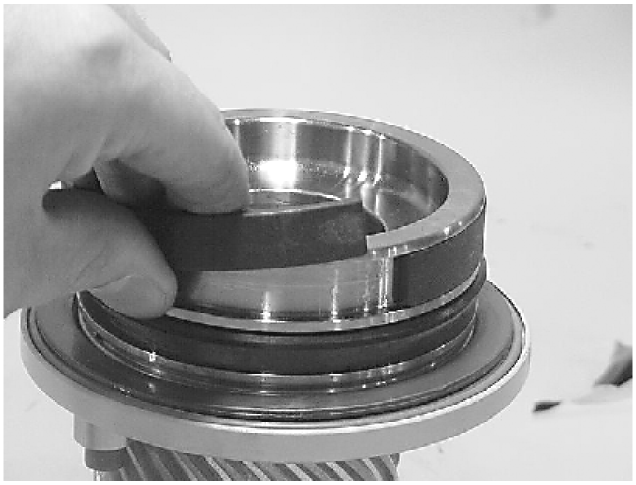


13. At the point when piston gear teeth come out of engagement with housing gear teeth, mark piston and housing with a marker as shown.

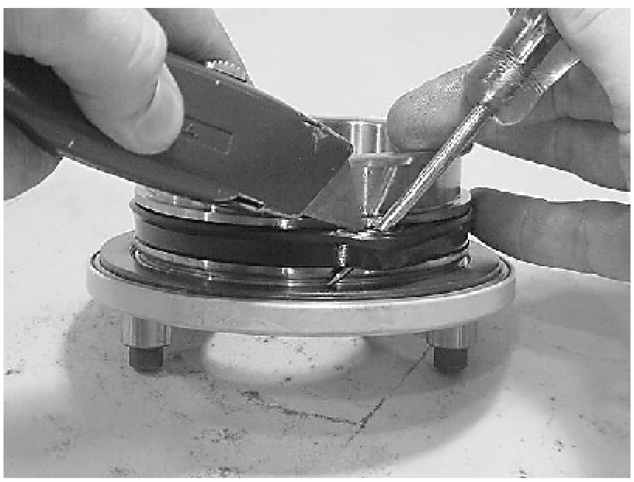


14. Remove O-ring (204) and backup ring (207) from end cap (4). Set aside for inspection.

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



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



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

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

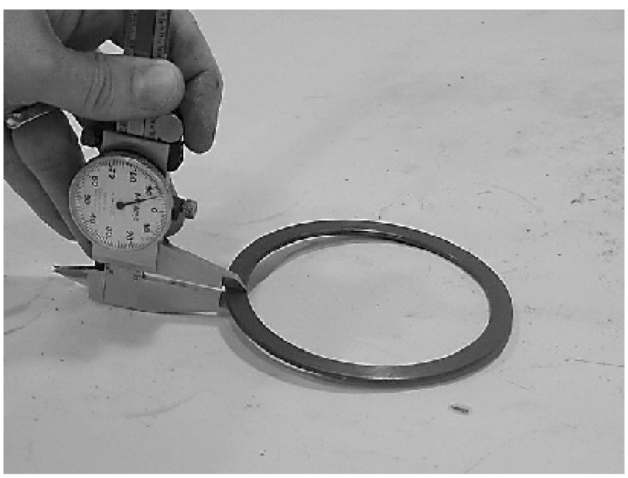
19. Remove piston O.D. seal (202).

20. Remove piston I.D. seal (200). You may now proceed to the inspection process.

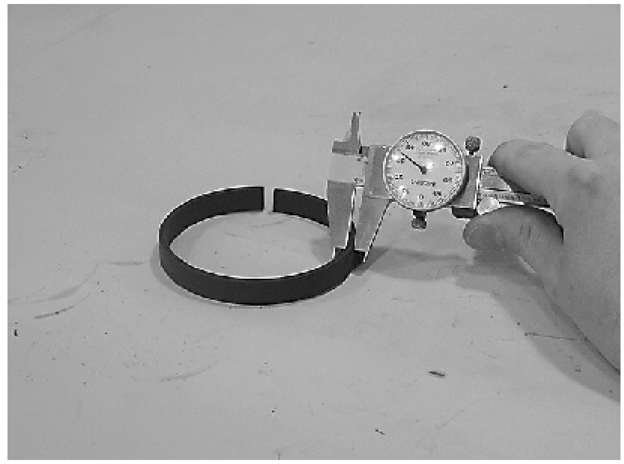
Inspection

1. Clean all parts in a solvent tank and dry with compressed air prior to 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 to make sure it is within specifications (Not less than 0.092" or 2.34 mm).

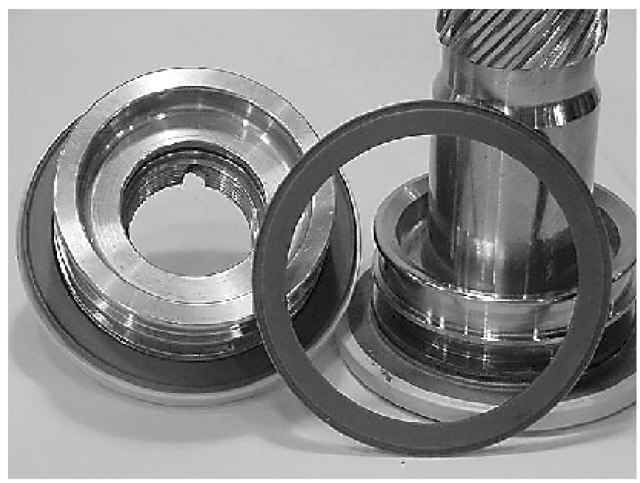


3. Inspect wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).

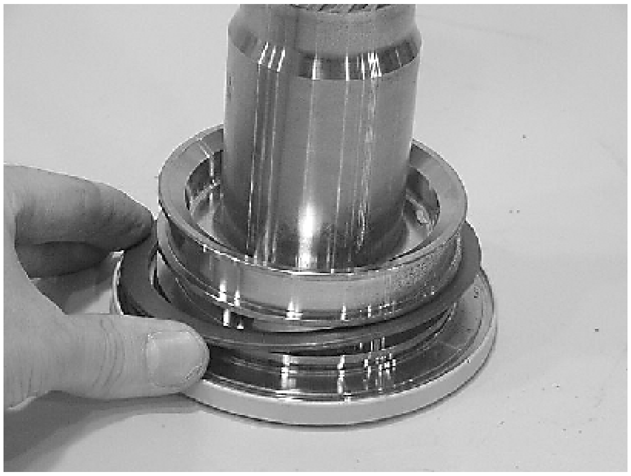


Assembly

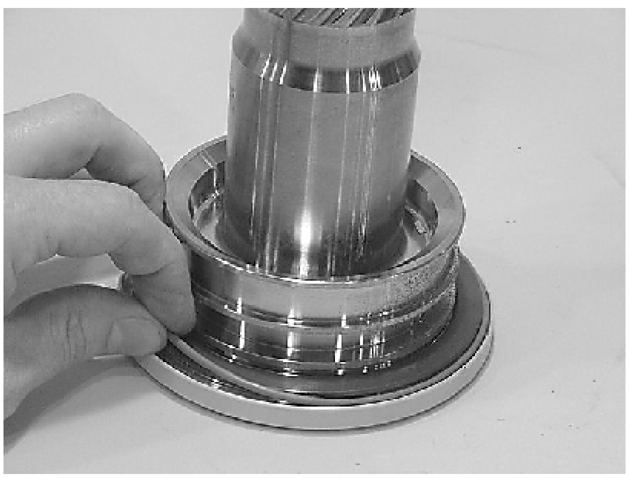
1. Gather all components and tools into one location before re-assembly. Use cut-away drawing to reference seal orientations.



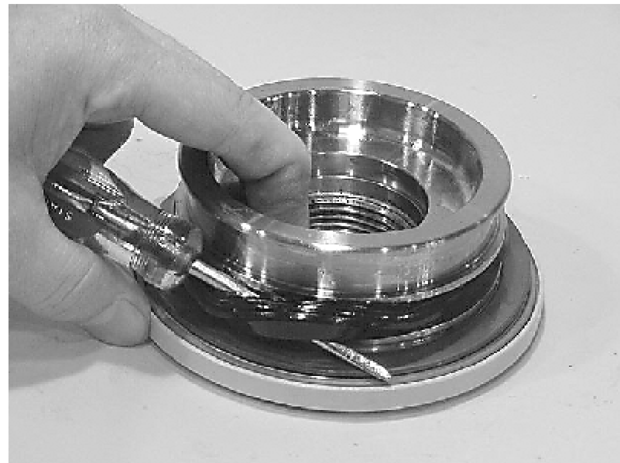
2. Install thrust washer (304) on shaft (2) and end cap (4).



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. Using 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.

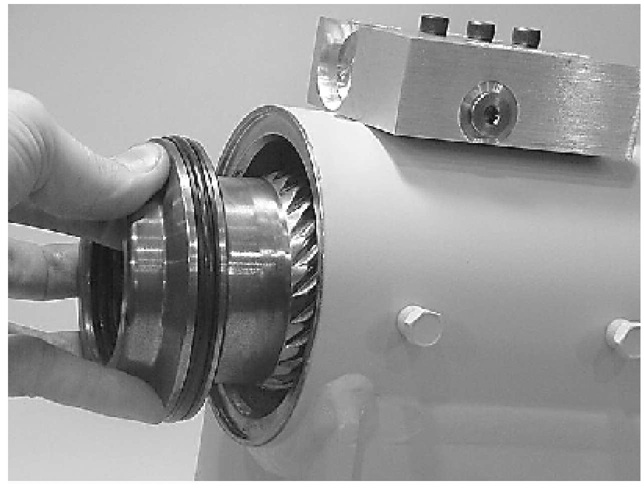
Install outer T-seal (202) by stretching it around the groove in a circular motion.

Each T-seal has two back-up rings (see drawing for orientation).

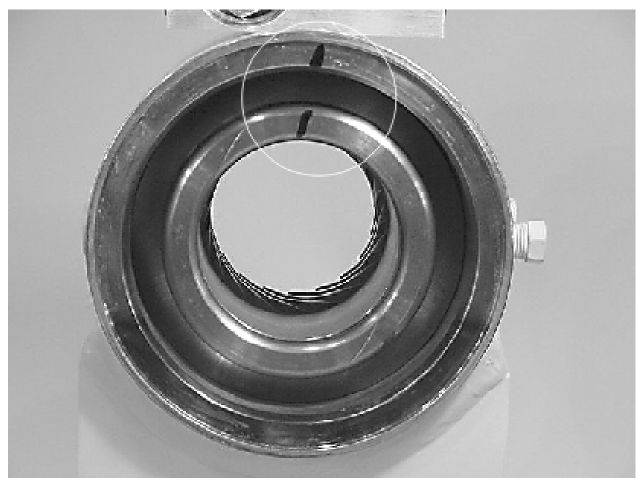
Beginning with inner seal (200) insert one end of backup ring in lower groove and feed the rest in using a circular motion. Make sure wedged ends overlap correctly.

Repeat step for outer seal (202).

7. Insert piston (3) in housing (1) as shown, until outer piston seal (202) is touching inside housing bore.

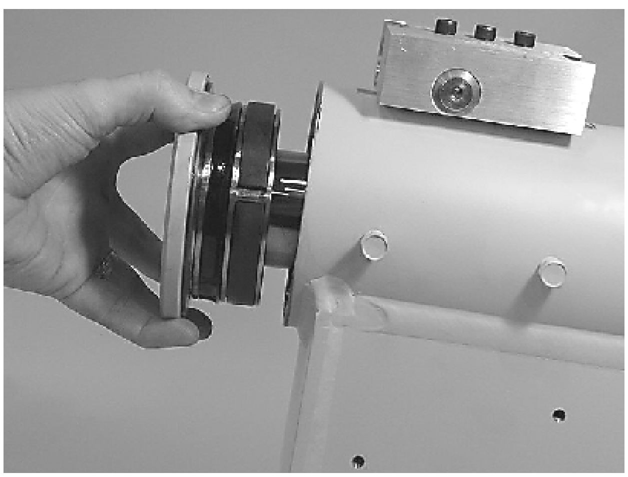


8. Looking from angle shown, rotate piston (3) until marks on piston and housing (1) made during disassembly line up as shown. Using a rubber mallet, tap piston into housing up to the point where gear teeth meet.

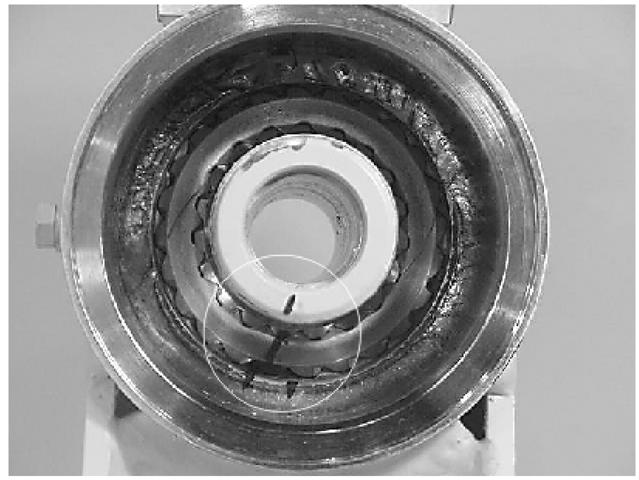


9. Looking from opposite end of housing (1) you can see if timing marks line up. When they do, tap piston (3) in until gear teeth mesh together. Tap piston in housing until it bottoms out.

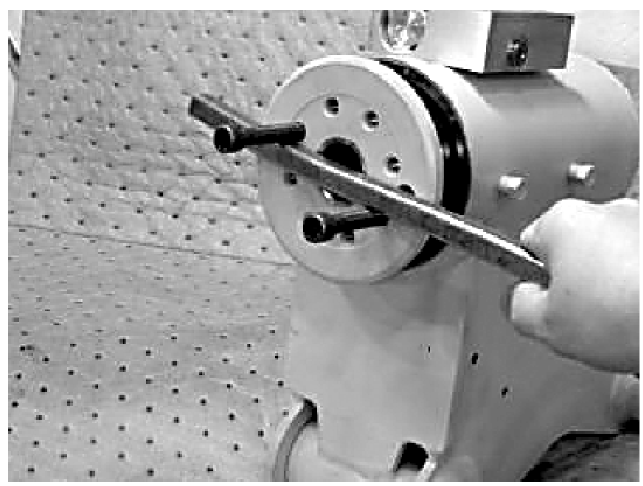
10. Install shaft (2) in piston (3). Dol not damage seals. Do not engage piston gear teeth yet.



11. 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 a rubber mallet until gear teeth engage.

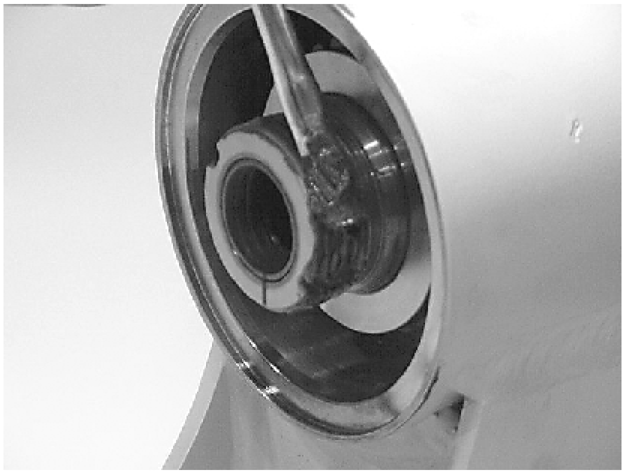


12. Install two bolts in threaded holes of flange. Using a bar, rotate shaft clockwise until wear guides are seated in housing bore.



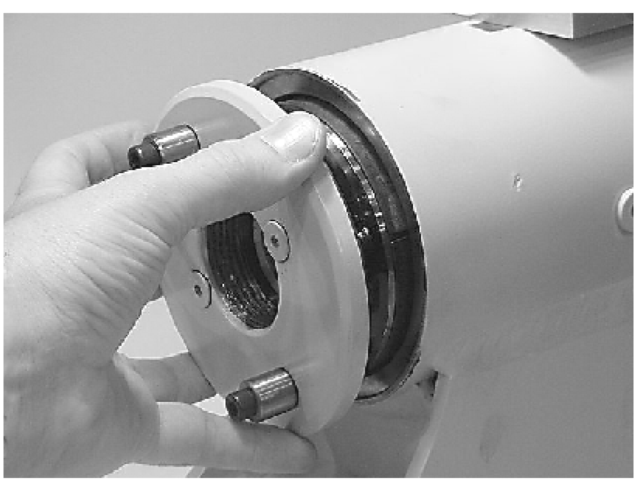
13. Install stop tube on shaft end. Stop tube is an available option to limit rotation of an actuator.

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

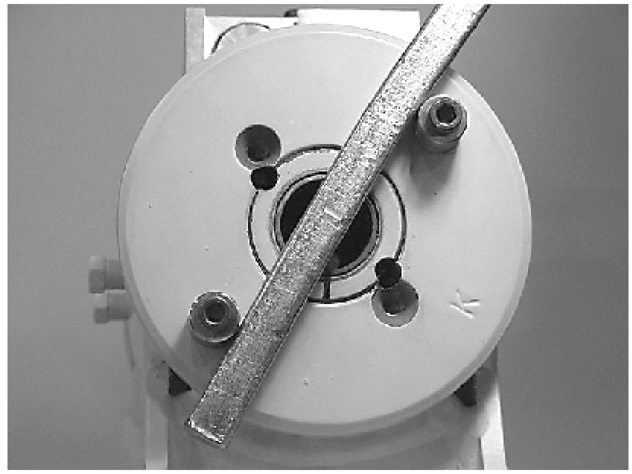


15. Install 0-ring (204) and back-up ring (207) into inner seal groove on end cap (4).

16. Thread end cap (4) on shaft (2) end. Make sure wear guide stays in place on end cap as it is threaded into housing (1).

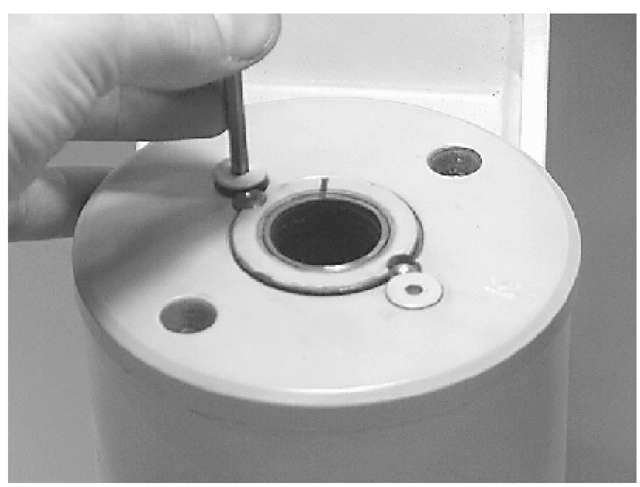


17. Tighten end cap (4). In most cases original holes for lock pins line up.



18. 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.

19. Insert set screws (113) over lock pins. Tighten to 25 in-lb (2.8 Nm).



Installing Counterbalance Valve

Refer to Figure 4-8., Rotator Counterbalance Valve.

1. Make sure actuator surface is clean and free of any contamination and foreign debris - including old Loctite.
2. Make sure new valve has O-rings in counter-bores of valve to seal it to the actuator housing.
3. Bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. Apply Loctite #242 to shank of three bolts at time of installation.
4. Torque 1/4" bolts 110 - 120 in-lb (12.4 to 13.5 Nm). Do not torque over 125 in-lb (14.1 Nm). Torque 5/16" bolts 140 in-lb (15.8 Nm). Do not torque over 145 in-lb (16.3 Nm).

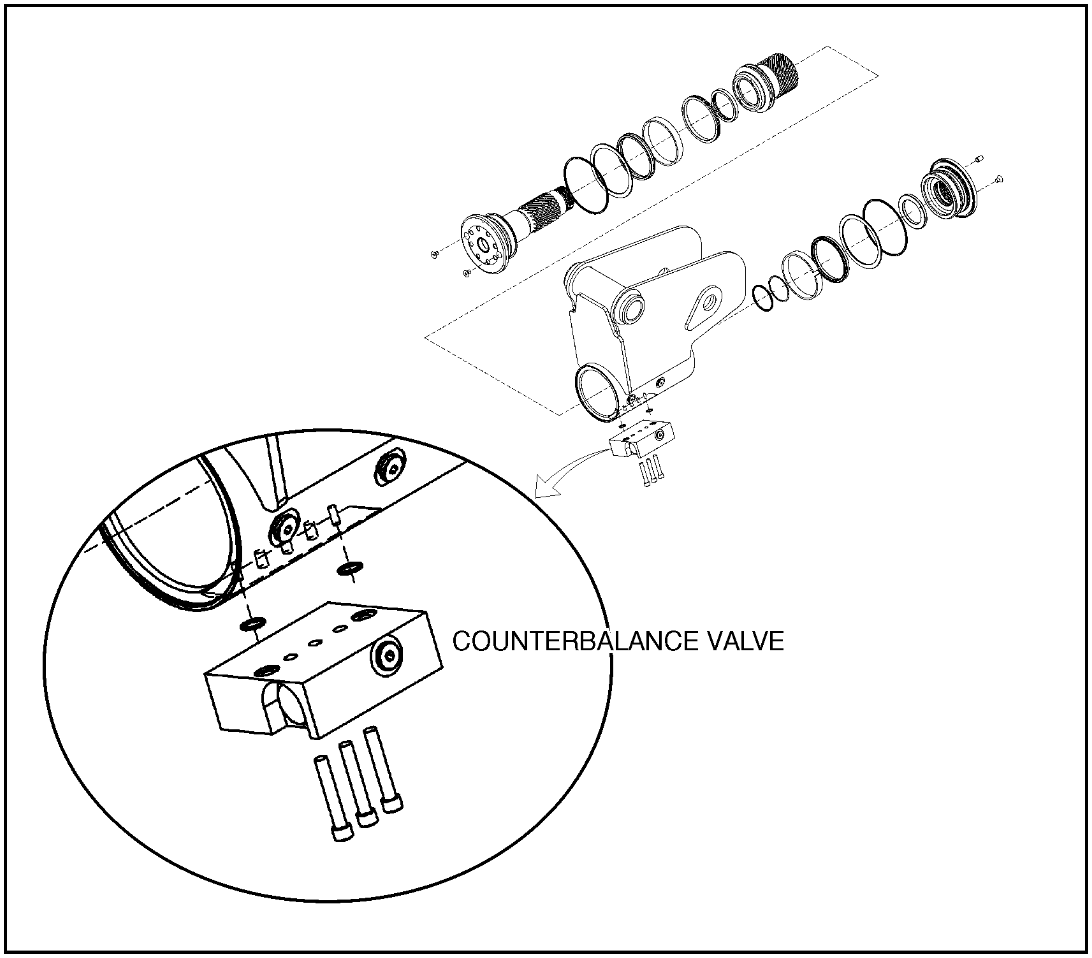
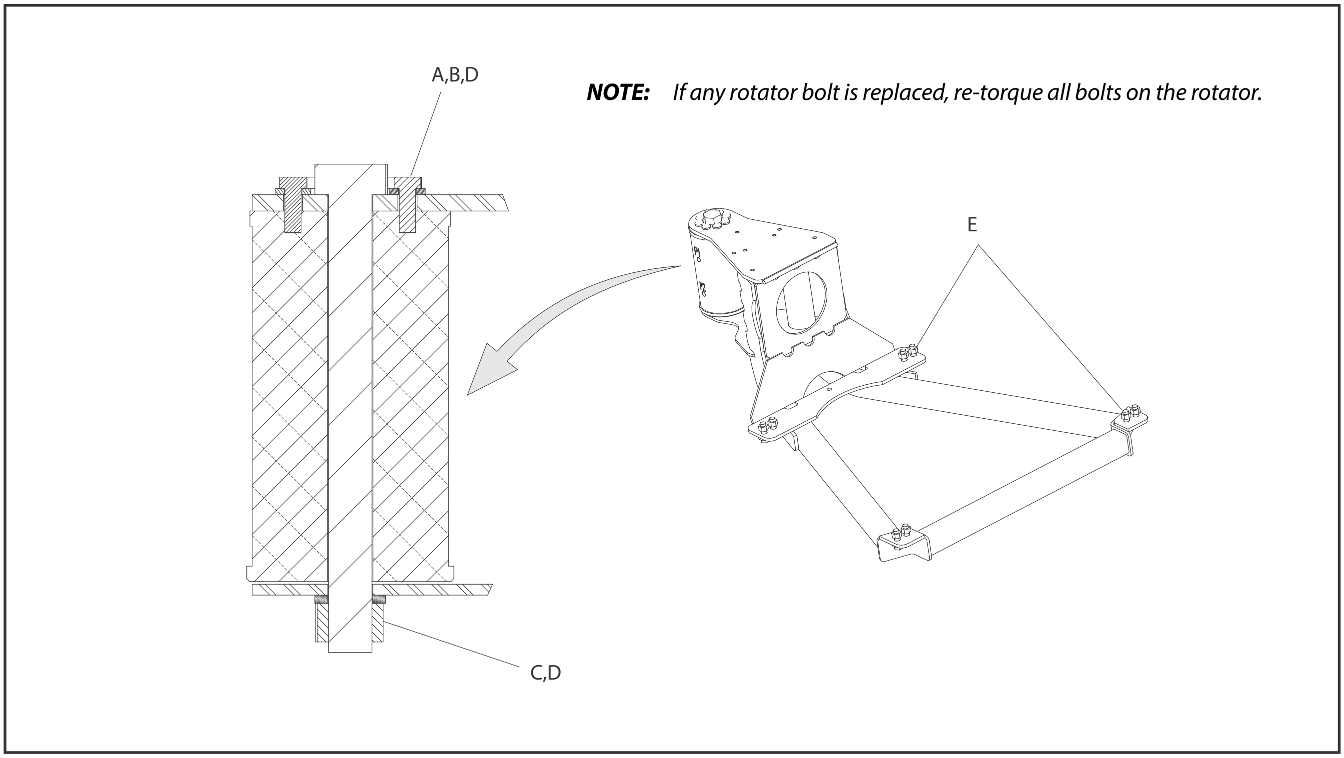


Figure 4-8. Rotator Counterbalance Valve



A Torque to 50 ft-lb (68 Nm)
B Thread Locking Compound - JLG P/N 0100011
C Torque to 480 ft-lb (650 Nm)
D Check torque every 150 hours of operation
E Torque to 85 ft-lb (115 Nm)

Figure 4-9. Platform Support Torque Values

SECTION 5. HYDRAULICS AND HYDRAULIC SCHEMATICS

NOTE: *Hydraulic Schematics located at back of this section.*

5.1 O-RING LUBRICATION

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

1. Cup and Brush

2. Dip

3. Spray

4. Brush-On

Cup and Brush

Tools needed:

- Small container for hydraulic oil
- Small paint brush

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

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

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

Dip

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

Tools needed:

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

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

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

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

Spray

This method requires a pump or trigger spray bottle.

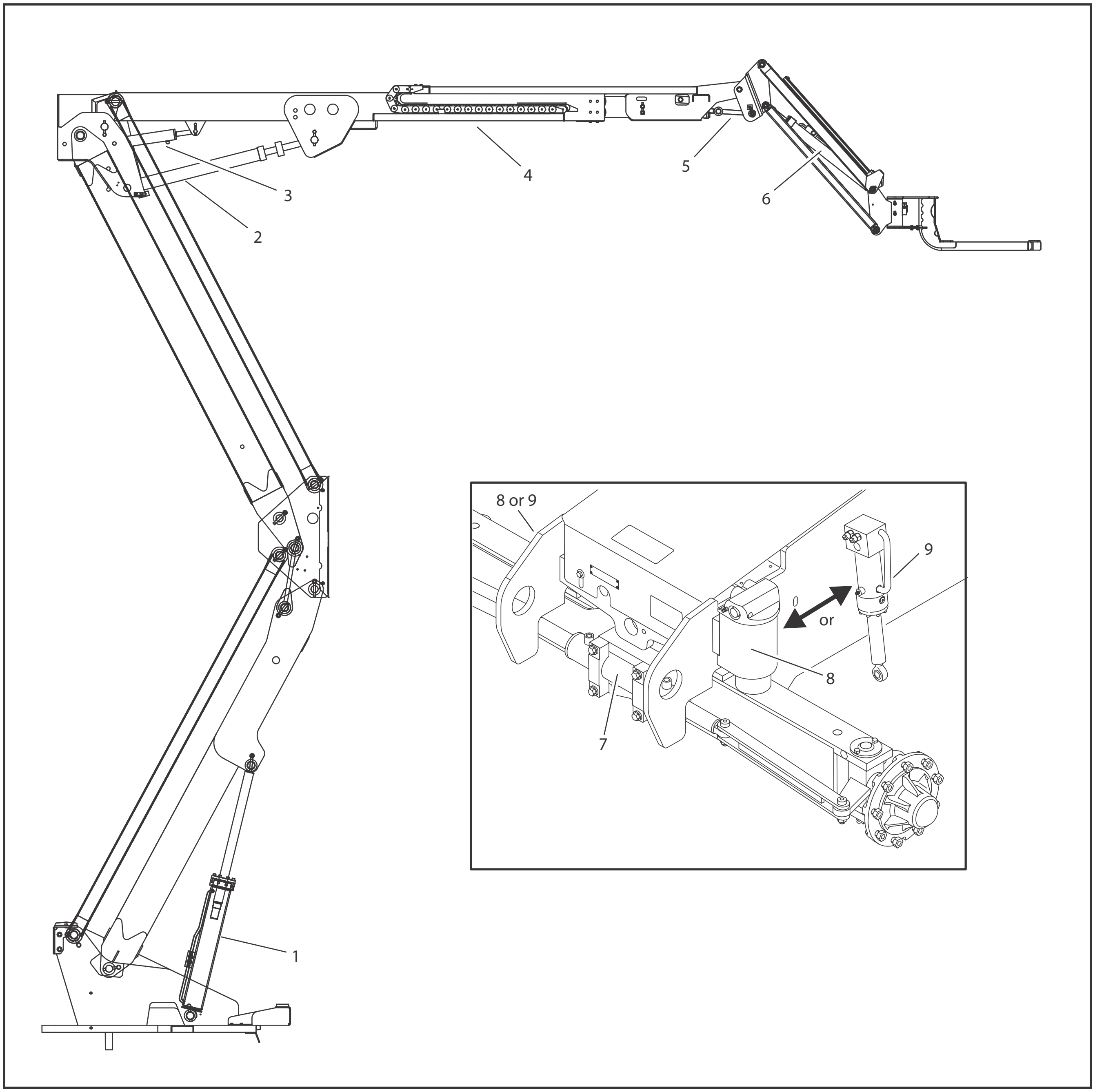
1. Fill spray bottle with hydraulic oil.
2. Hold fitting over suitable catch can.
3. Spray entire O-ring surface with medium coat of oil.

Brush-On

This method requires a sealed bottle brush.

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

5.2 HYDRAULIC CYLINDERS



1. Tower Lift	4. Telescope	7. Steer
2. Main Lift	5. Platform Level (Slave)	8. Axle Lockout (Outside Frame)
3. Master	6. Jib Lift	9. Axle Lockout (Inside Frame)

Figure 5-1. Hydraulic Cylinder Locations

Tower Lift Cylinder

Refer to Figure 5-5.

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. Support cylinder rod as needed.
3. Remove cartridge-type counterbalance valves (2) from valve block. Discard O-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with suitable hammer to break thread-locking compound.

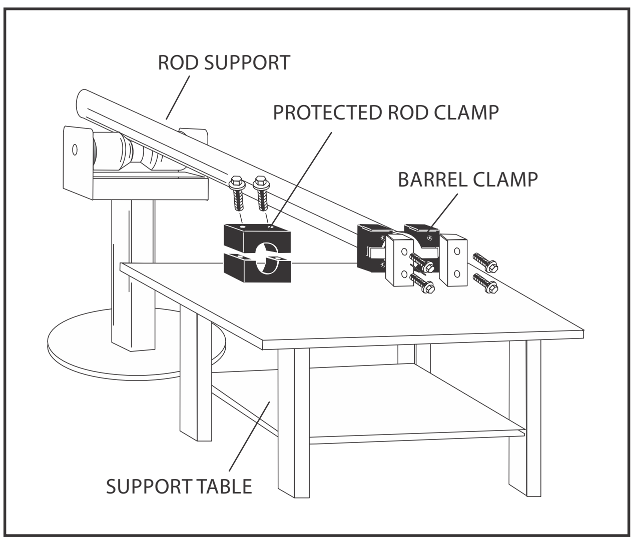


Figure 5-2. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for realignment. Unscrew cylinder head with pin-face spanner wrench.

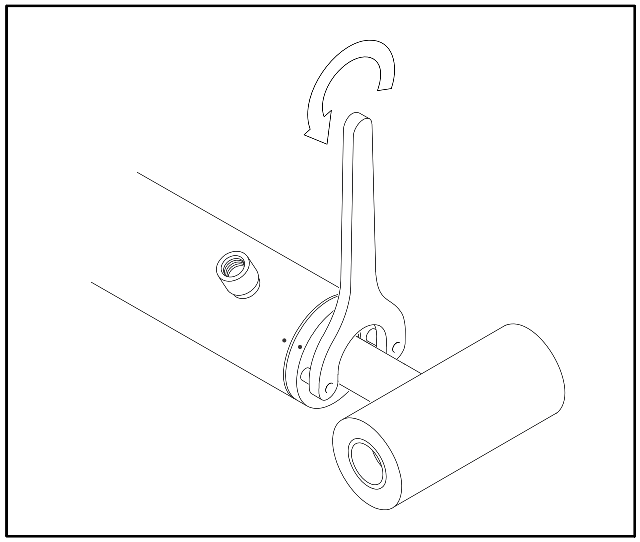


Figure 5-3. Cylinder Head Removal

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 from barrel.

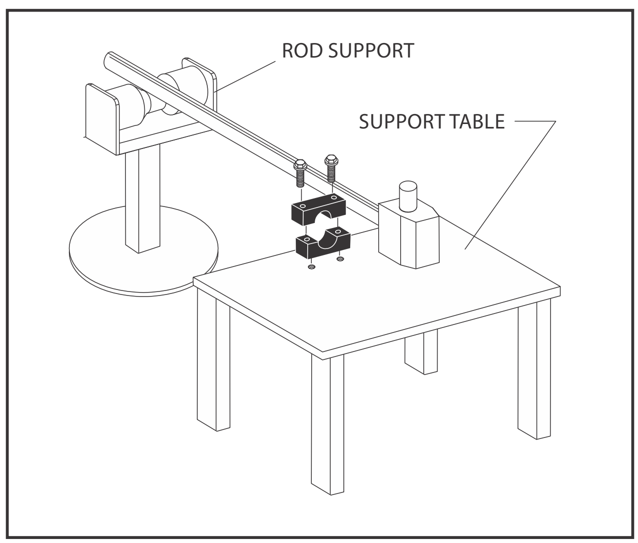
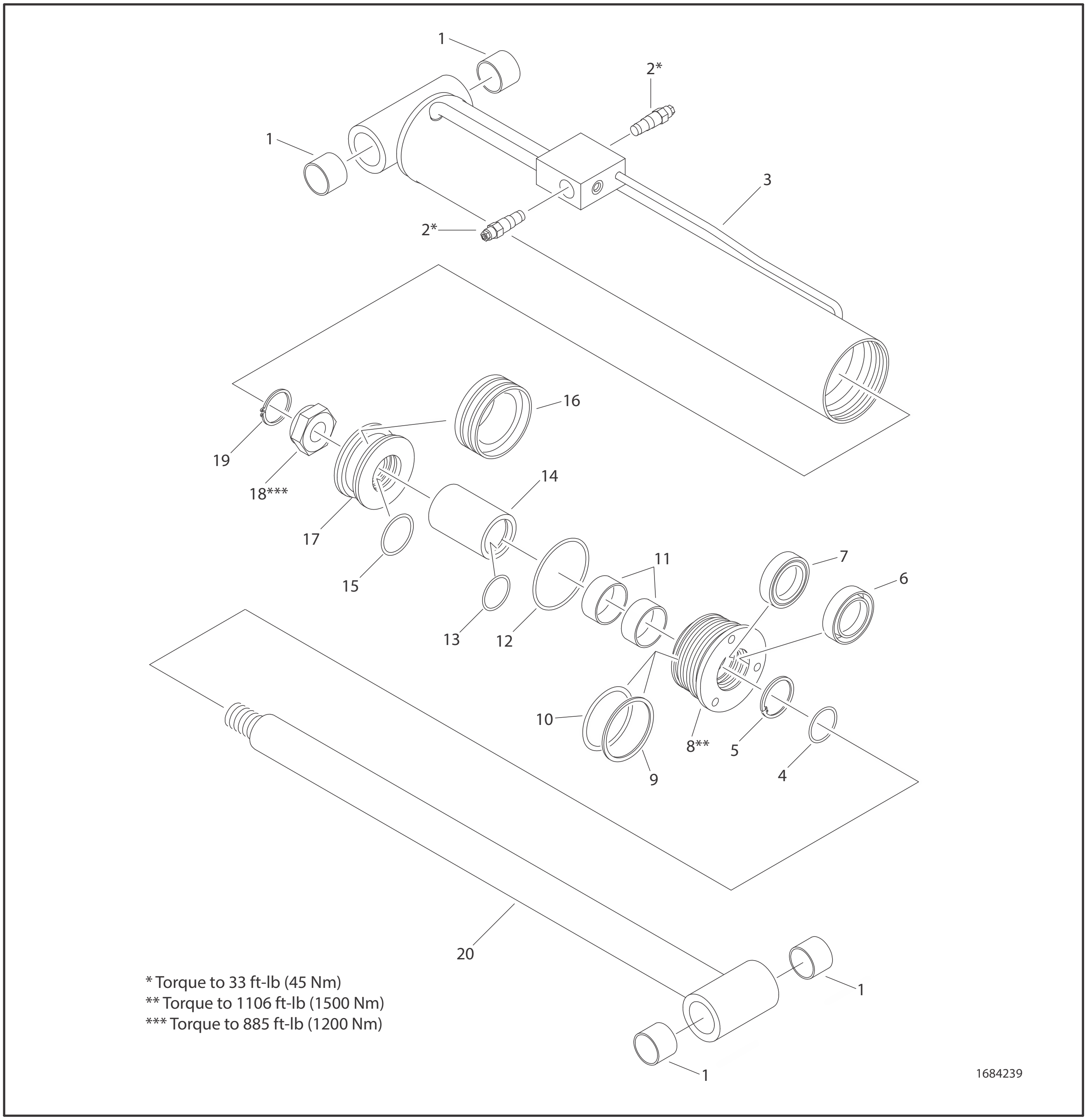


Figure 5-4. Cylinder Rod Support



1. Bushing	5. Retaining Ring	9. Backup Ring	13. O-Ring	17. Piston
2. Cartridge Valve	6. Wiper	10. O-Ring	14. Spacer	18. Nut
3. Barrel	7. Seal	11. Wear Ring	15. O-Ring	19. Retaining Ring
4. O-Ring	8. Head	12. O-Ring	16. Seal	20. Rod

Figure 5-5. Tower Lift Cylinder

7. Using suitable protection, clamp cylinder rod (20) in a vise or similar holding fixture near piston.
8. Remove retaining ring (19) and nut (18).
9. Unscrew and remove piston assembly (17).
10. Remove O-Ring (15) and seal (16) from piston.
11. Remove spacer (14) from rod.
12. Remove O-Ring (13) from spacer.

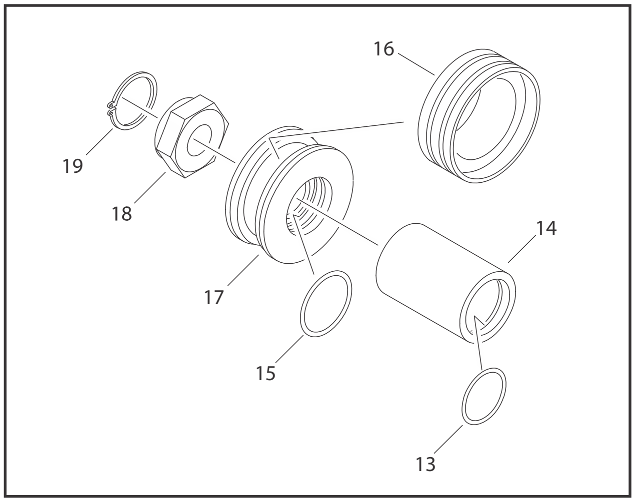


Figure 5-6. Piston And Spacer Disassembly

13. Remove head assembly (8) from rod.
14. Remove O-Ring (10), backup ring (9), and O-Ring (12) from cylinder head.
15. Remove O-Ring (4) and retaining ring (5), wiper (6), and seal (7) from front inside of cylinder head.
16. Remove two wear rings (11) from rear inside of cylinder head.

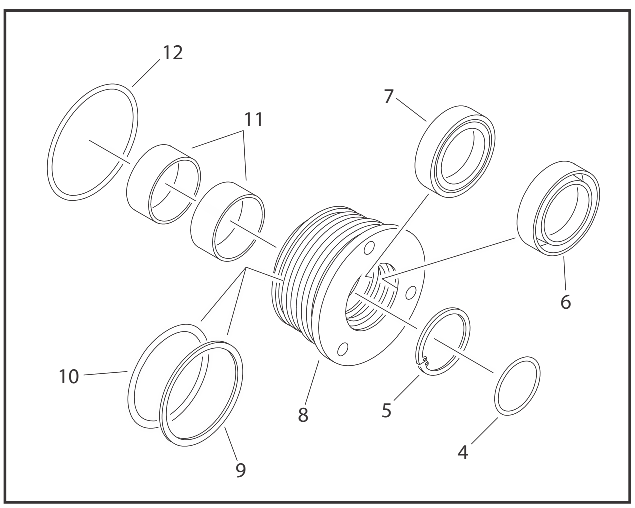


Figure 5-7. Cylinder Head Disassembly

CLEANING AND INSPECTION

1. Clean all parts with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. Dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for 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, and distortion. Dress piston surface or replace piston.
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, ovality, and tapering. Replace as needed.
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 surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage, ovality, and tapering. Replace as needed.
13. Inspect rod and barrel bushings.
    a. Remove burrs, dirt, or other contamination.
    b. Inspect for wear or damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing with WD40 before installing composite bushings. Install new bushings using an arbor.

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

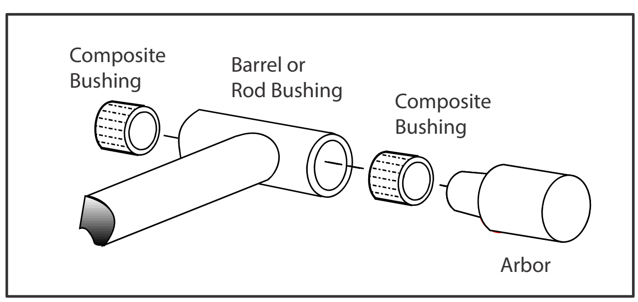


Figure 5-8. Composite Bushing Installation

14. Inspect oil ports for blockage or presence of dirt or other foreign material. Clean or repair as needed.

ASSEMBLY

NOTE: Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual. Apply a light film of hydraulic oil to all components before assembly.

NOTICE

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

1. Install two wear rings (11) in cylinder head grooves.
2. Install seal (7) and wiper (6) in cylinder head grooves.
3. Install retaining ring (5) and O-ring (4) in cylinder head grooves.
4. Install O-ring (12) in outside groove closest to top of cylinder head.
5. Install back-up ring (9) and O-ring (10) in outside diameter cylinder head grooves.

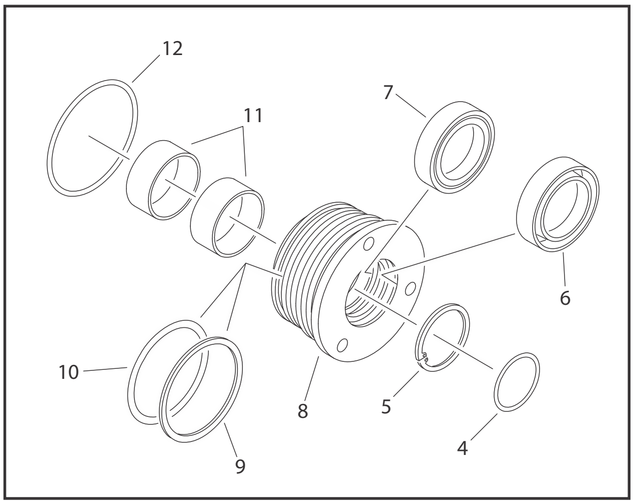


Figure 5-9. Cylinder Head Assembly

6. Carefully install head on rod. Make sure wiper and rod seals are not damaged or dislodged. Push head along rod to rod end.
7. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture near piston location.
8. Install O-ring (13) inside spacer (14). Slide spacer assembly on rod.
9. Install O-ring (15) in piston (17).
10. Apply JLG Thread Locking Compound P/N 0100011 to rod threads. Thread piston on cylinder rod. Do not damage or dislodge O-ring.
11. Install seal (16) in outside groove of piston.
12. Install nut (18) on rod. Torque to 885 ft-lb (1200 Nm). Install retaining ring (19).

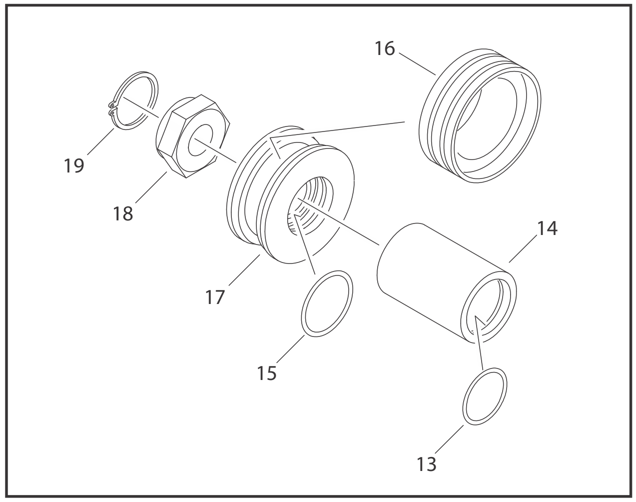


Figure 5-10. Piston And Spacer Assembly

13. Remove cylinder rod from holding fixture.
14. Position cylinder barrel in suitable holding fixture.

NOTICE

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

15. Clamp barrel securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston O-rings and backup ring.
16. Continue pushing rod into barrel. Grease threads on barrel and cylinder head. Screw in cylinder head. Torque to 1106 ft-lb (1500 Nm).

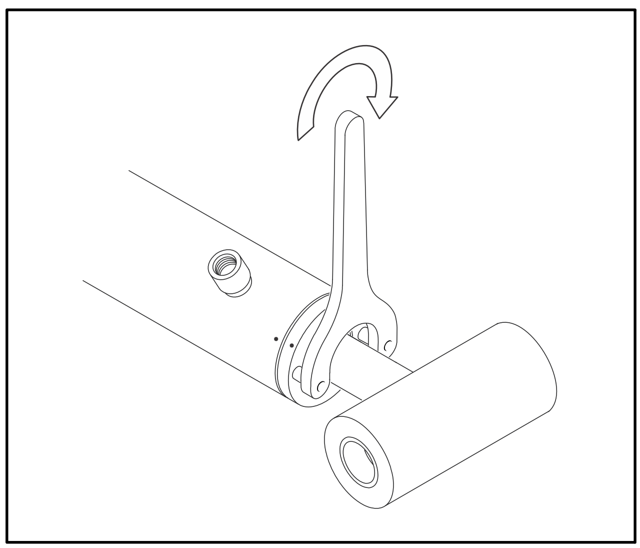


Figure 5-11. Cylinder Head Installation

17. Install two cartridge valves (2) with new O-rings in valve block. Torque to 33 ft-lb (45 Nm).

Main Lift Cylinder

Refer to Figure 5-15.

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. Support cylinder rod as needed.
3. Remove cartridge-type counterbalance valve (3) from valve block. Discard O-ring.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with suitable hammer to break thread-locking compound.

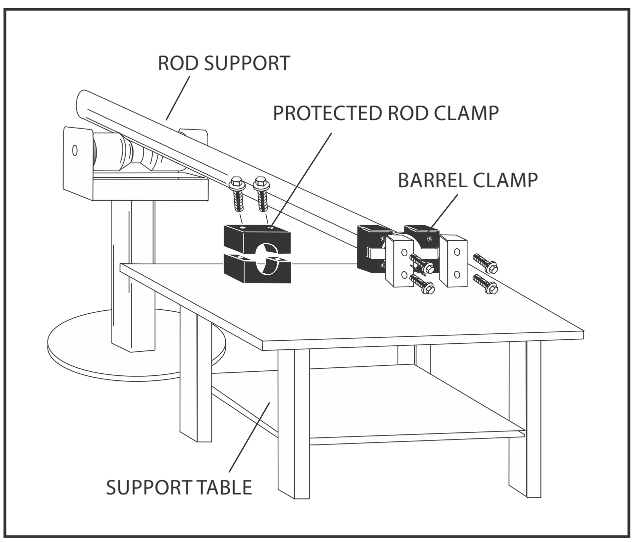


Figure 5-12. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for realignment. Unscrew cylinder head with pin-face spanner wrench.

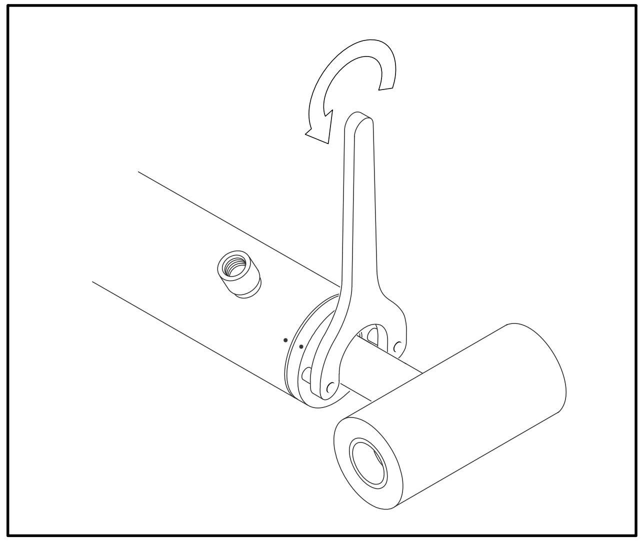


Figure 5-13. Cylinder Head Removal

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 from barrel.

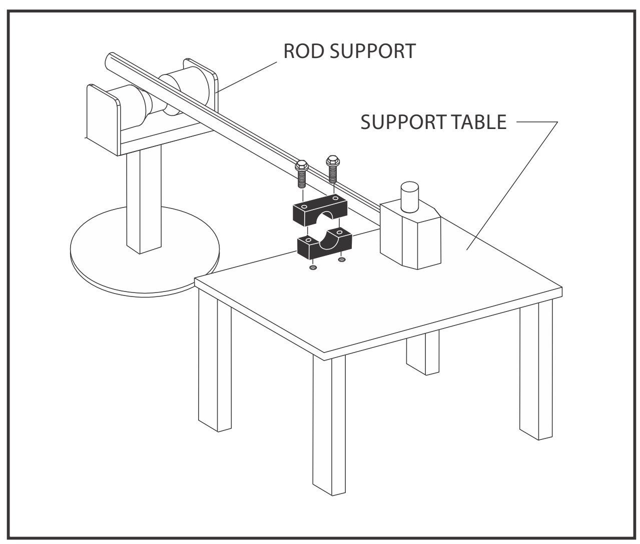
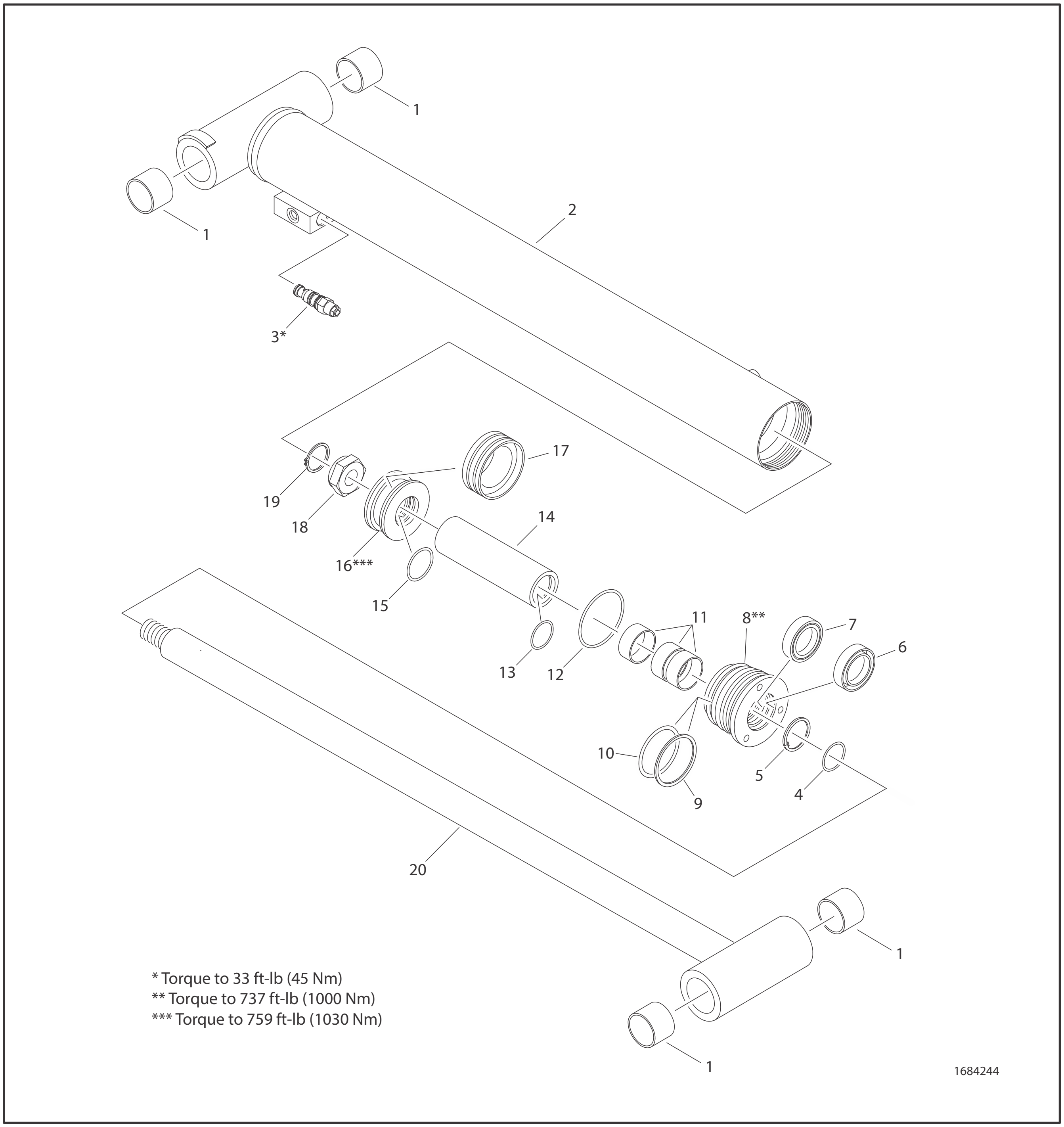


Figure 5-14. Cylinder Rod Support



1. Bushing
2. Barrel
3. Cartridge Valve
4. O-Ring
5. Retaining Ring
6. Wiper
7. Seal
8. Head
9. Backup Ring
10. O-Ring
11. Wear Ring
12. O-Ring
13. O-Ring
14. Spacer
15. O-Ring
16. Piston
17. Seal
18. Nut
19. Retaining Ring
20. Rod

Figure 5-15. Main Lift Cylinder

7. Using suitable protection, clamp cylinder rod (20) in a vise or similar holding fixture near piston.
8. Remove retaining ring (19) and nut (18).
9. Unscrew and remove piston assembly (16).
10. Remove O-Ring (15) and seal (17) from piston.
11. Remove spacer (14) from rod.
12. Remove O-Ring (13) from spacer.

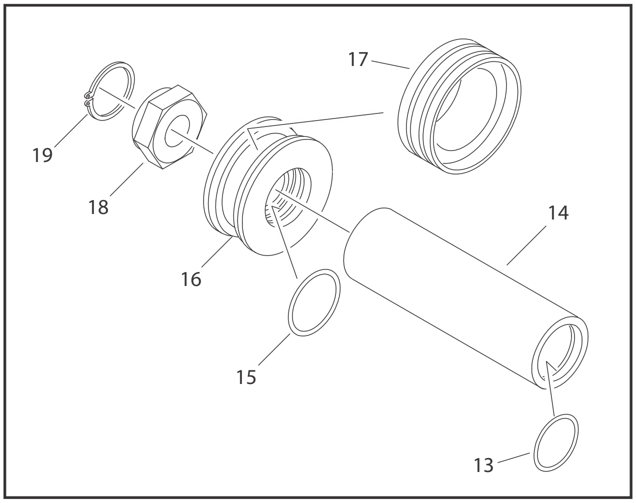


Figure 5-16. Piston And Spacer Disassembly

13. Remove head assembly (8) from rod.
14. Remove O-Ring (10), backup ring (9), and O-Ring (12) from cylinder head.
15. Remove O-Ring (4) and retaining ring (5), wiper (6), and seal (7) from front inside of cylinder head.
16. Remove three wear rings (11) from rear inside of cylinder head.

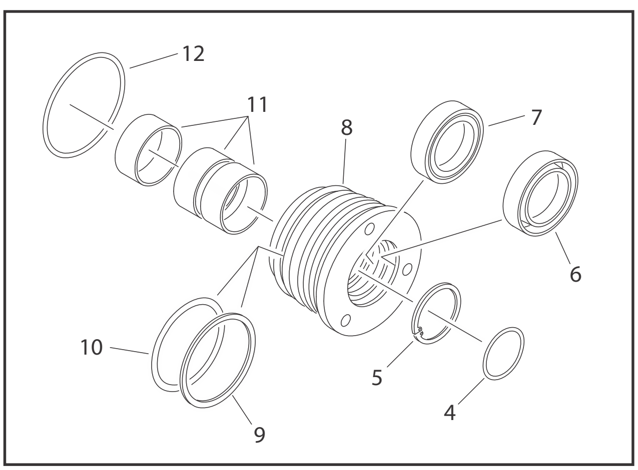


Figure 5-17. Cylinder Head Disassembly

CLEANING AND INSPECTION

1. Clean all parts with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. Dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for 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, and distortion. Dress piston surface or replace piston.
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, ovality, and tapering. Replace as needed.
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 surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage, ovality, and tapering. Replace as needed.
13. Inspect rod and barrel bushings.
    a. Remove burrs, dirt, or other contamination.
    b. Inspect for wear or damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing with WD40 before installing composite bushings. Install new bushings using an arbor.

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

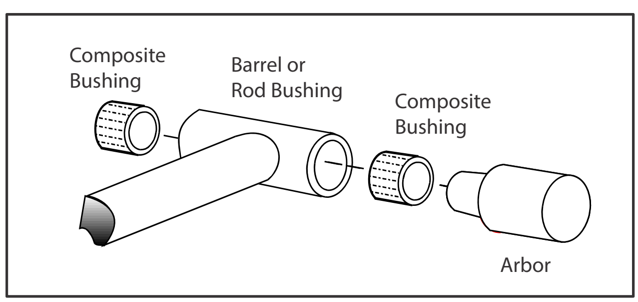


Figure 5-18. Composite Bushing Installation

14. Inspect oil ports for blockage or presence of dirt or other foreign material. Clean or repair as needed.

ASSEMBLY

NOTE: Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual. Apply a light film of hydraulic oil to all components before assembly.

NOTICE

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

1. Install three wear rings (11) in cylinder head grooves.
2. Install seal (7) and wiper (6) in cylinder head grooves.
3. Install retaining ring (5) and O-ring (4) in cylinder head grooves.
4. Install O-ring (12) in outside groove closest to top of cylinder head.
5. Install back-up ring (9) and O-ring (10) in outside diameter cylinder head grooves.

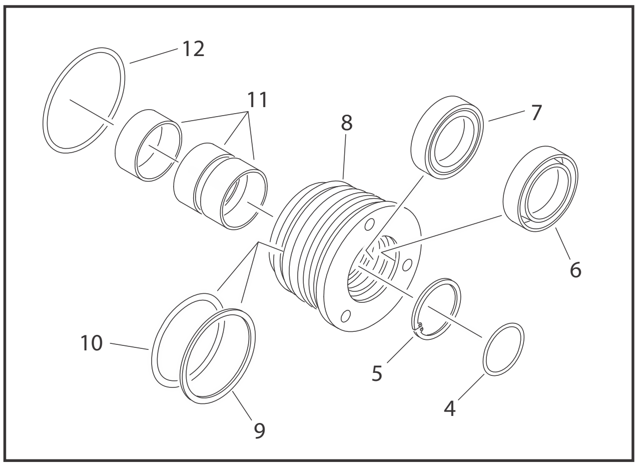


Figure 5-19. Cylinder Head Assembly

6. Carefully install head on rod. Make sure wiper and rod seals are not damaged or dislodged. Push head along rod to rod end.
7. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture near piston location.
8. Install O-ring (13) inside spacer (14). Slide spacer assembly on rod.
9. Install O-ring (15) in piston (16).
10. Apply JLG Thread Locking Compound P/N 0100011 to rod threads. Thread piston on cylinder rod. Do not damage or dislodge O-ring. Torque to 759 ft-lb (1030 Nm).
11. Install seal (17) in outside groove of piston.
12. Install nut (18) on rod.
13. Install retaining ring (19).

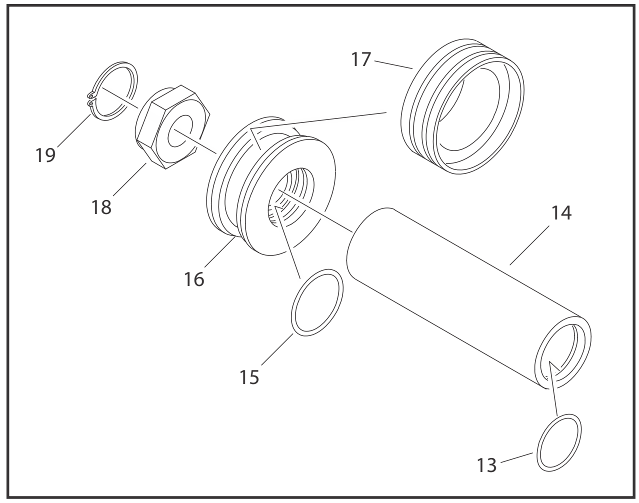


Figure 5-20. Piston And Spacer Assembly

14. Remove cylinder rod from holding fixture.
15. Position cylinder barrel in suitable holding fixture.

NOTICE

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

16. Clamp barrel securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston O-rings and backup ring.
17. Continue pushing rod into barrel. Grease threads on barrel and cylinder head. Screw in cylinder head. Torque to 737 ft-lb (1000 Nm).

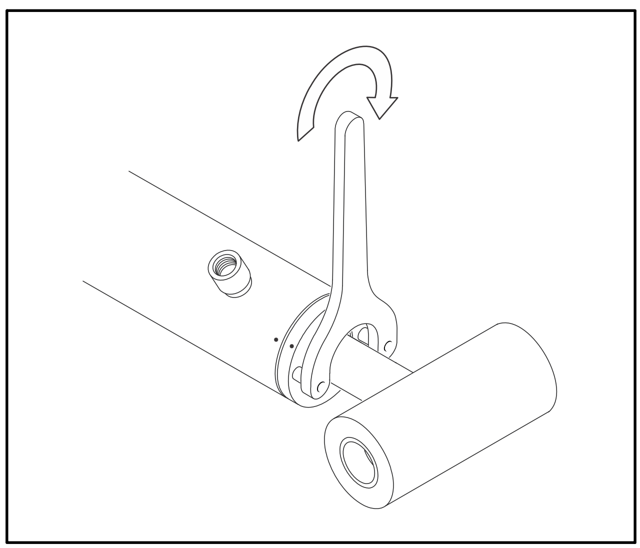


Figure 5-21. Cylinder Head Installation

18. Install cartridge valve (3) with new O-ring in valve block. Torque to 33 ft-lb (45 Nm).

Master Cylinder

Refer to Figure 5-25.

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. Support cylinder rod as needed.
3. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with suitable hammer to break thread-locking compound.

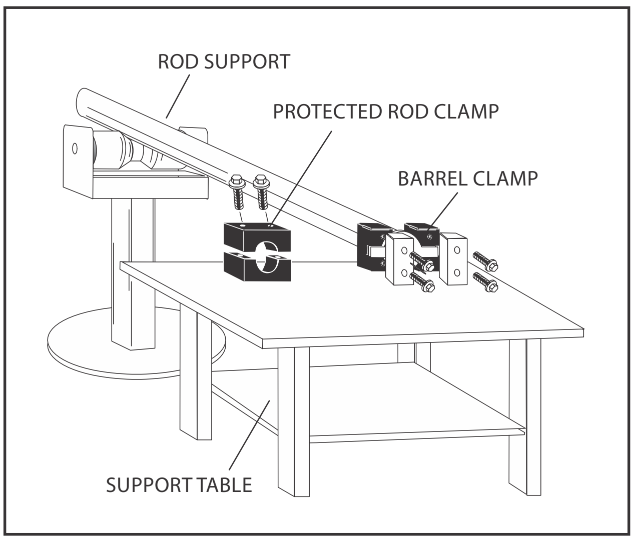


Figure 5-22. Cylinder Barrel Support

4. Mark cylinder head and barrel with a center punch for realignment. Unscrew cylinder head with pin-face spanner wrench.

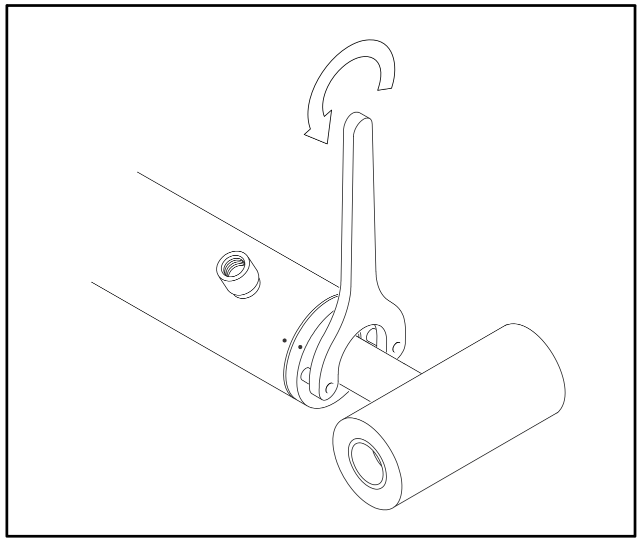


Figure 5-23. Cylinder Head Removal

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.

5. Clamp barrel securely. Pull rod assembly from barrel.

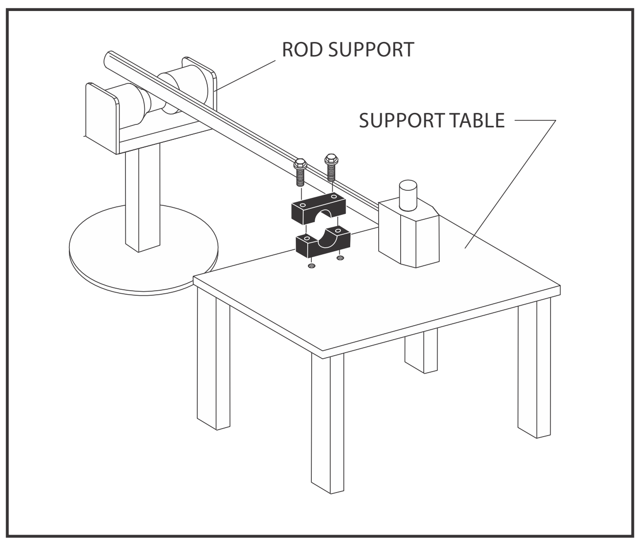
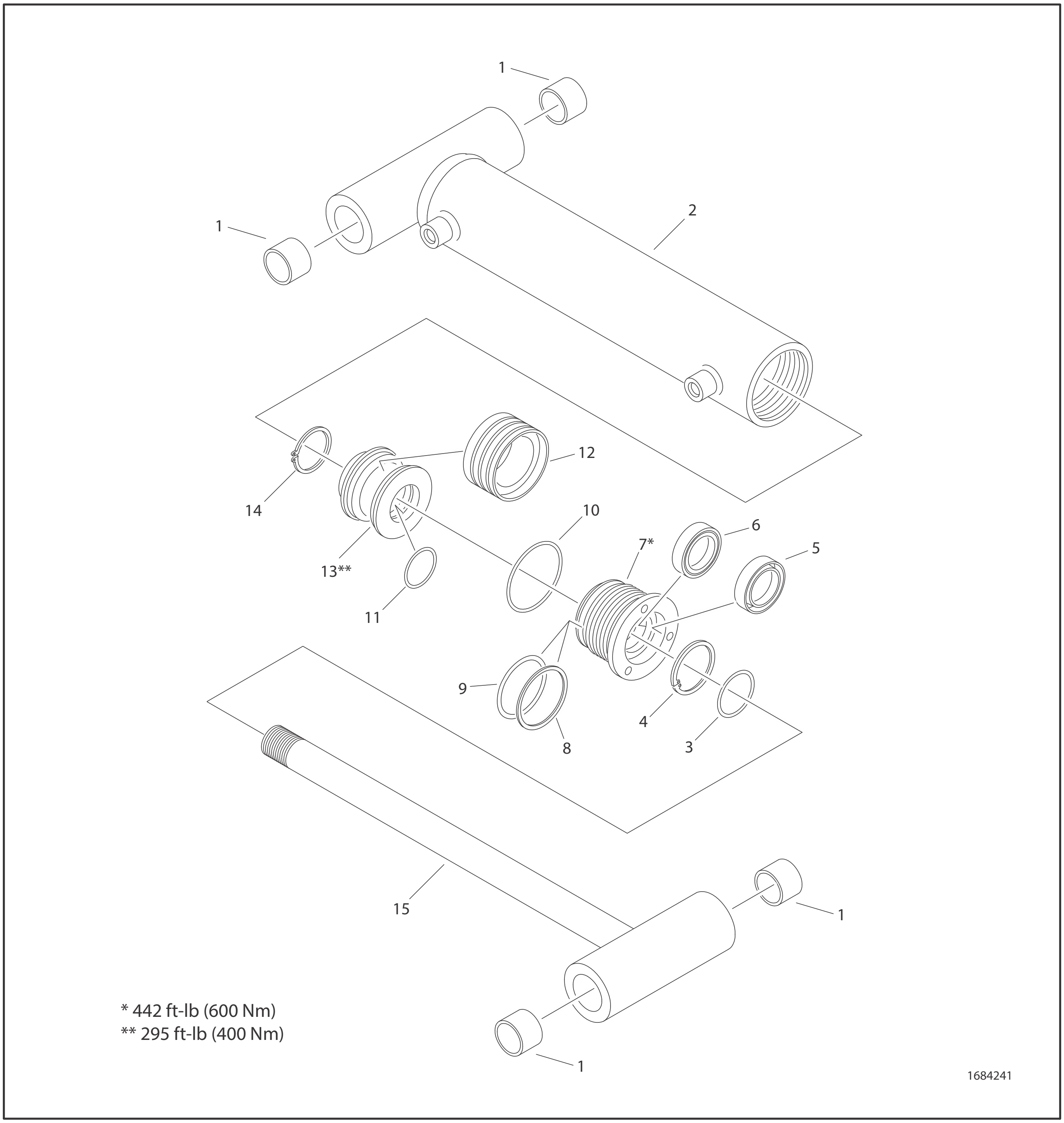


Figure 5-24. Cylinder Rod Support



1. Bushing
2. Barrel
3. O-Ring
4. Retaining Ring
5. Wiper
6. Seal
7. Head
8. Backup Ring
9. O-Ring
10. O-Ring
11. O-Ring
12. Seal
13. Piston
14. Retaining Ring
15. Rod

Figure 5-25. Master Cylinder

6. Using suitable protection, clamp cylinder rod (15) in a vise or similar holding fixture near piston.
7. Remove retaining ring (14).
8. Unscrew and remove piston assembly (13).
9. Remove O-Ring (11) and seal (12) from piston.

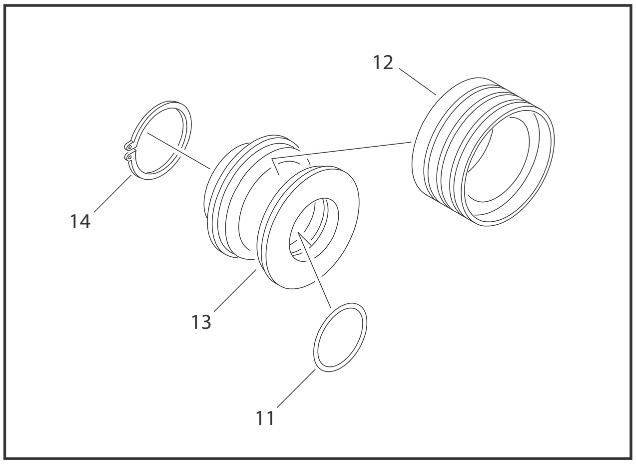


Figure 5-26. Piston Disassembly

10. Remove head assembly (7) from rod.
11. Remove O-Ring (9), backup ring (8), and O-Ring (10) from cylinder head.
12. Remove O-Ring (3), retaining ring (4), wiper (5), and seal (6) from front inside of cylinder head.

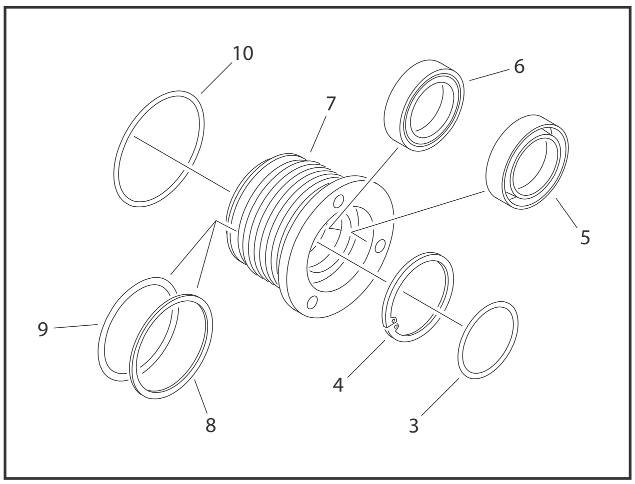


Figure 5-27. Cylinder Head Disassembly

CLEANING AND INSPECTION

1. Clean all parts with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. Dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for 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, and distortion. Dress piston surface or replace piston.
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, ovality, and tapering. Replace as needed.
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 surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage, ovality, and tapering. Replace as needed.
13. Inspect rod and barrel bushings.
    a. Remove burrs, dirt, or other contamination.
    b. Inspect for wear or damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing with WD40 before installing composite bushings. Install new bushings using an arbor.

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

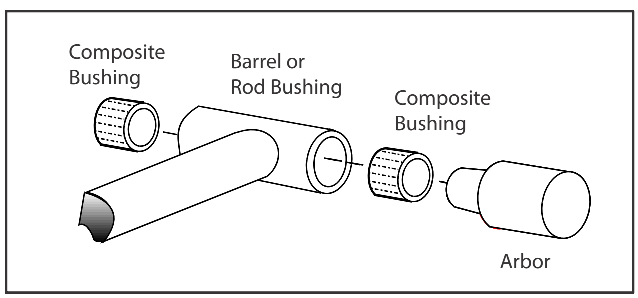


Figure 5-28. Composite Bushing Installation

14. Inspect oil ports for blockage or presence of dirt or other foreign material. Clean or repair as needed.

ASSEMBLY

NOTE: Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual. Apply a light film of hydraulic oil to all components before assembly.

NOTICE

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

1. Install seal (6) and wiper (5) in cylinder head (7).
2. Install retaining ring (4) and O-ring (3).
3. Install O-ring (10) in outside groove closest to top of cylinder head.
4. Install back-up ring (8) and O-ring (9) in outside diameter cylinder head grooves.

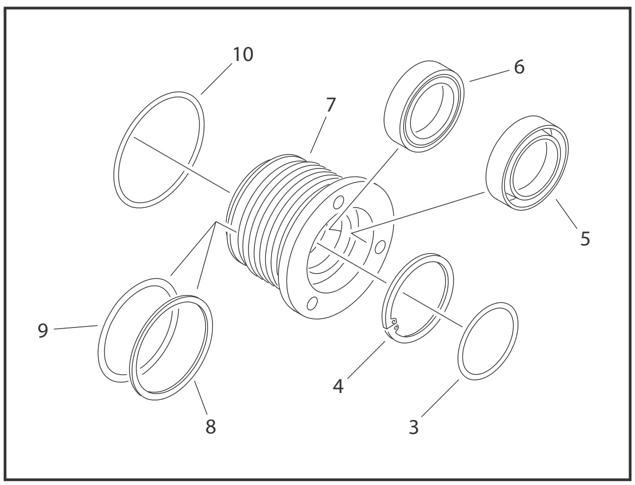


Figure 5-29. Cylinder Head Assembly

5. Carefully install head on rod. Make sure wiper and rod seals are not damaged or dislodged. Push head along rod to rod end.
6. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture near piston location.
7. Install O-ring (11) in piston (13).
8. Apply JLG Thread Locking Compound P/N 0100011 to rod threads. Thread piston on cylinder rod. Do not damage or dislodge O-ring. Torque to 295 ft-lb (400 Nm).
9. Install retaining ring (14).
10. Install seal (12) in outside groove of piston.

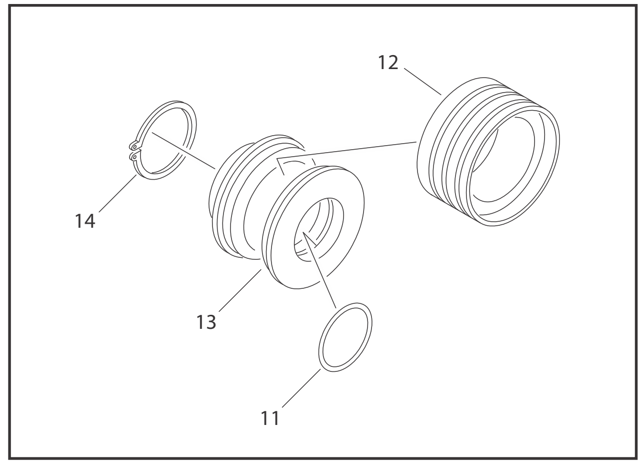


Figure 5-30. Piston Assembly

11. Remove cylinder rod from holding fixture.
12. Position cylinder barrel in suitable holding fixture.

NOTICE

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

13. Clamp barrel securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston O-rings and backup ring.
14. Continue pushing rod into barrel. Grease threads on barrel and cylinder head. Screw in cylinder head. Torque to 442 ft-lb (600 Nm).

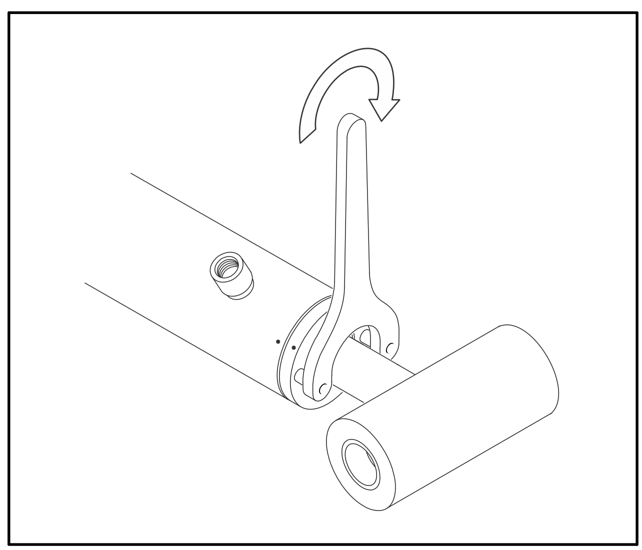


Figure 5-31. Cylinder Head Installation

Telescope Cylinder

Refer to Figure 5-35.

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. Support cylinder rod as needed.
3. Remove cartridge-type counterbalance valves (4) from valve block (1). Discard O-rings.
4. Remove four bolts (2), valve block (1), and two O-rings (3) from valve end of barrel (5).
5. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with suitable hammer to break thread-locking compound.

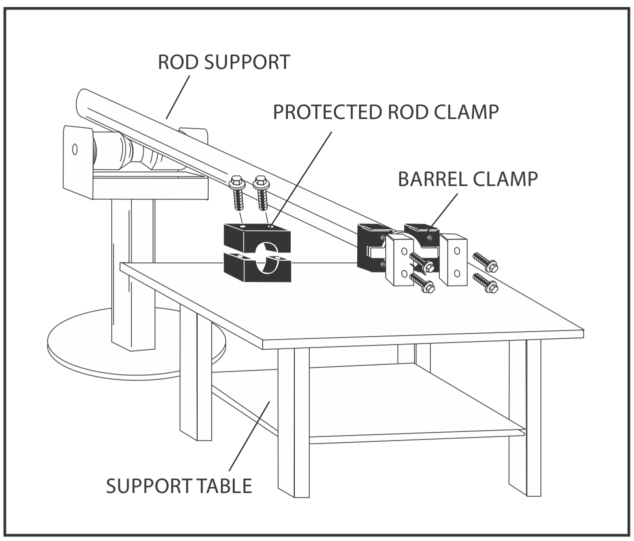


Figure 5-32. Cylinder Barrel Support

6. Mark cylinder head and barrel with a center punch for realignment. Unscrew cylinder head with pin-face spanner wrench.

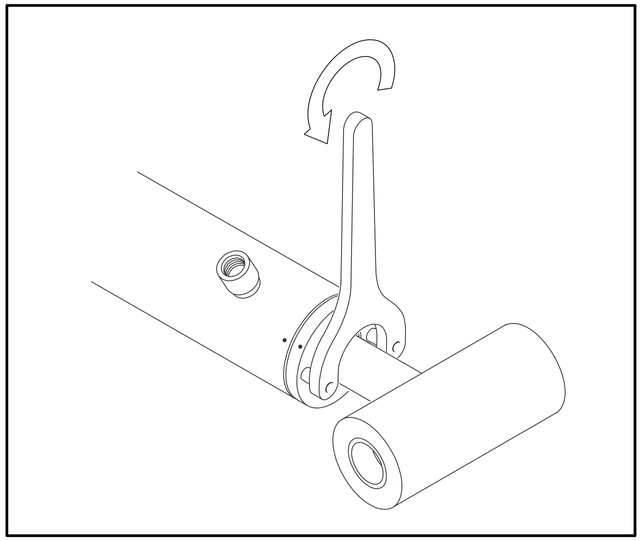


Figure 5-33. Cylinder Head Removal

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.

7. Clamp barrel securely. Pull rod assembly from barrel.
8. Using suitable protection, clamp cylinder rod (21) in a vise or similar holding fixture near piston.

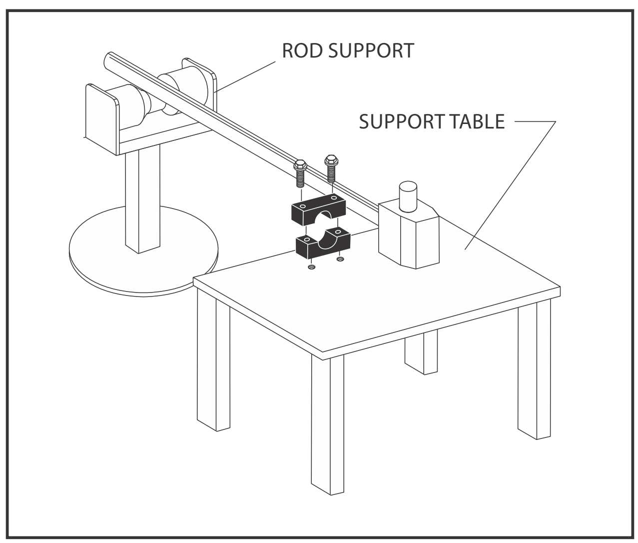
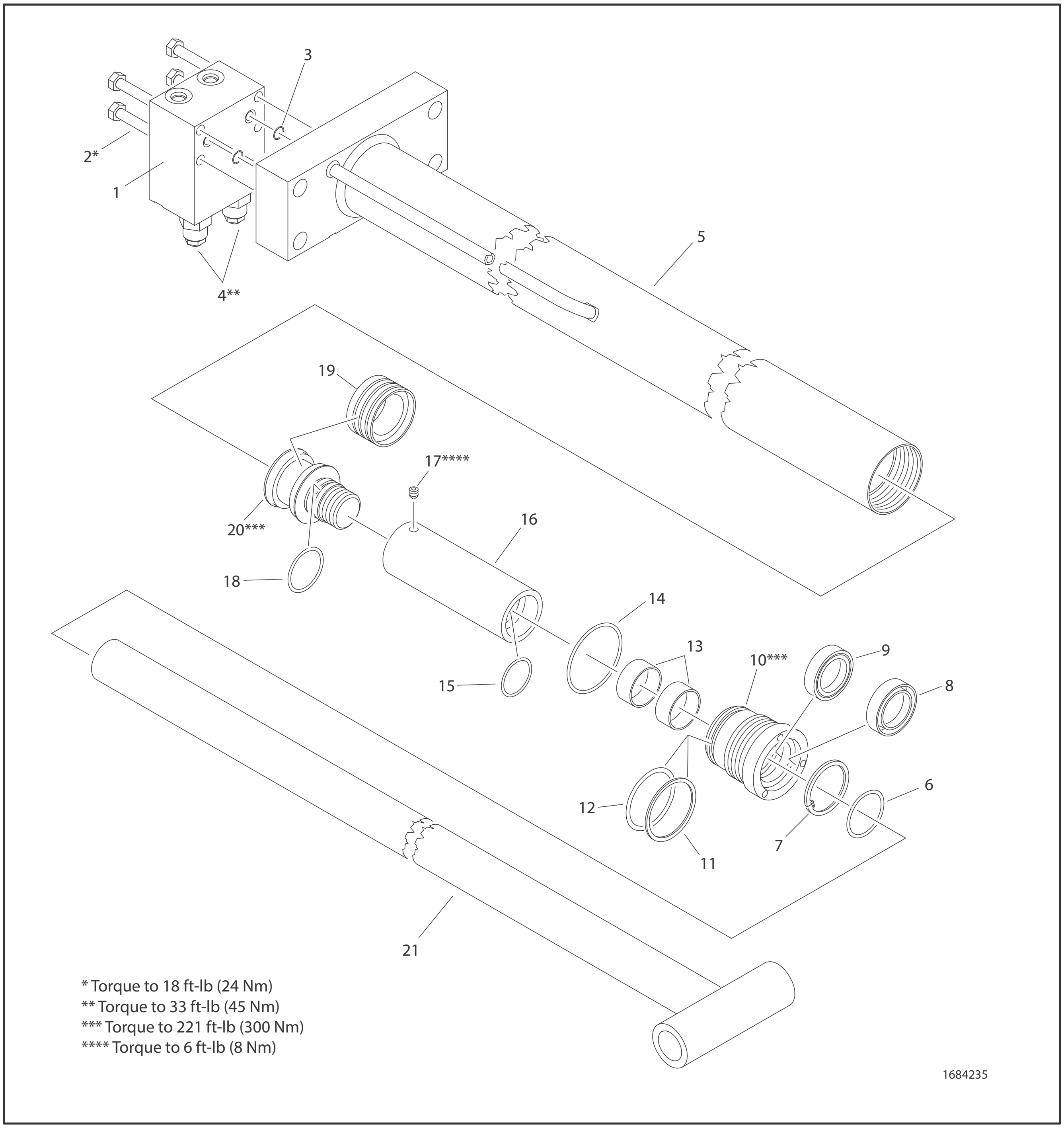


Figure 5-34. Cylinder Rod Support



1. Valve Block Assembly
2. Bolt
3. O-Ring
4. Cartridge Valve
5. Barrel
6. O-Ring
7. Retaining Ring
8. Wiper
9. Seal
10. Head
11. Backup Ring
12. O-Ring
13. Wear Ring
14. O-Ring
15. O-Ring
16. Spacer
17. Setscrew
18. O-Ring
19. Seal
20. Piston
21. Rod

Figure 5-35. Telescope Cylinder

9. Remove seal (19) from piston (20).
10. Unscrew and remove piston assembly.
11. Remove O-Ring (18) from piston.
12. Remove loosen setscrew (17) and remove spacer (16) from rod.
13. Remove O-Ring (15) from spacer.

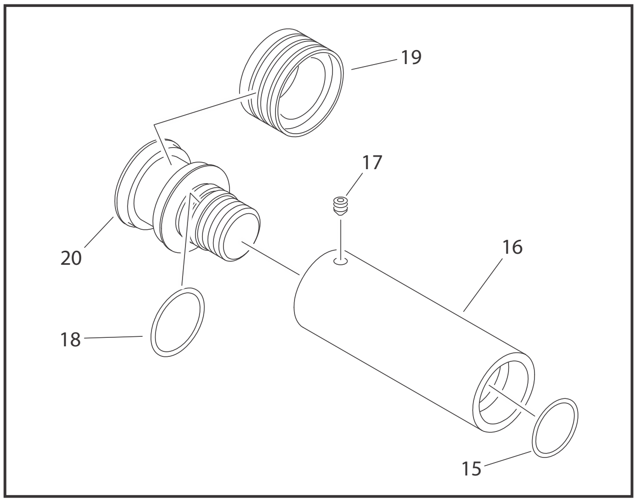


Figure 5-36. Piston And Spacer Disassembly

14. Remove head assembly (10) from rod.
15. Remove O-Ring (12), backup ring (11), and O-Ring (14) from cylinder head.
16. Remove O-Ring (6), retaining ring (7), wiper (8), and seal (9) from front inside of cylinder head.
17. Remove two wear rings (13) from rear inside of cylinder head.

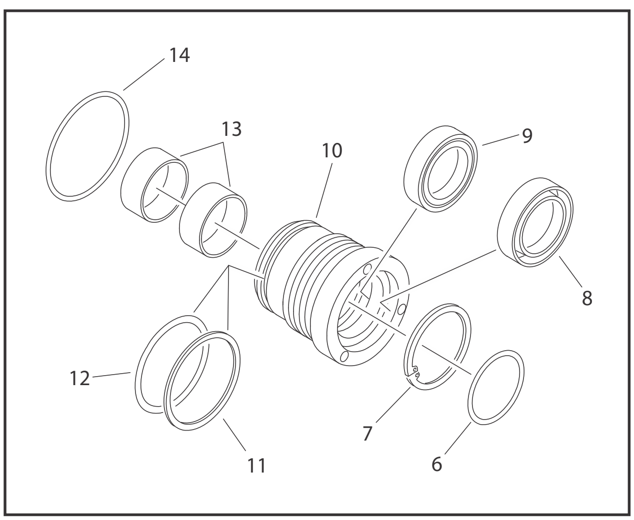


Figure 5-37. Cylinder Head Disassembly

CLEANING AND INSPECTION

1. Clean all parts with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. Dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for 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, and distortion. Dress piston surface or replace piston.
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, ovality, and tapering. Replace as needed.
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 surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage, ovality, and tapering. Replace as needed.
13. Inspect rod bushings. Remove burrs, dirt, or other contamination. Inspect for wear or damage. If steel bushing is worn or damaged, rod must be replaced.
14. Inspect oil ports for blockage or presence of dirt or other foreign material. Clean or repair as needed.

ASSEMBLY

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

NOTICE

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

1. Install two wear rings (13) in cylinder head grooves.
2. Install seal (9) and wiper (8) in cylinder head grooves.
3. Install retaining ring (7) and O-ring (6) in cylinder head grooves.
4. Install O-ring (14), back-up ring (11), and O-ring (12) in outside diameter cylinder head grooves.

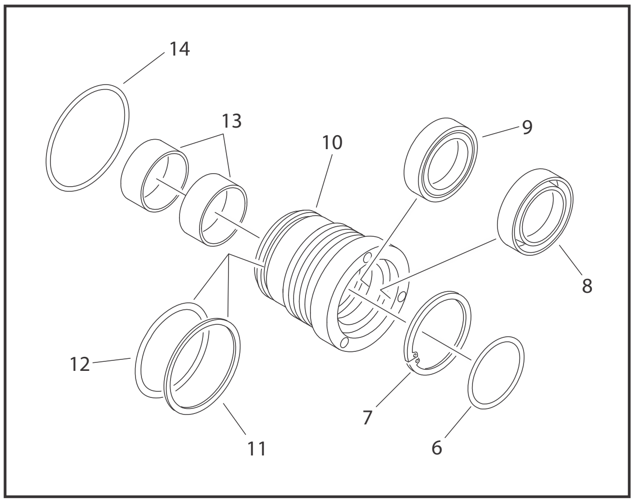


Figure 5-38. Cylinder Head Assembly

5. Carefully install head on rod (21). Make sure wiper and rod seals are not damaged or dislodged. Push head along rod to rod end.
6. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture near piston location.
7. Install O-ring (15) inside spacer (16). Slide spacer assembly on rod.
8. Apply Loctite 222 to setscrew. Install setscrew and torque to 6 ft-lb (8 Nm).
9. Install O-ring (18) to piston (20).
10. Apply JLG Thread Locking Compound P/N 0100011 to rod threads. Thread piston in cylinder rod. Do not damage or dislodge O-ring. Torque to 221 ft-lb (300 Nm).
11. Install seal (19) in outside groove of piston.
12. Install nut (18) on rod.
13. Install retaining ring (19).

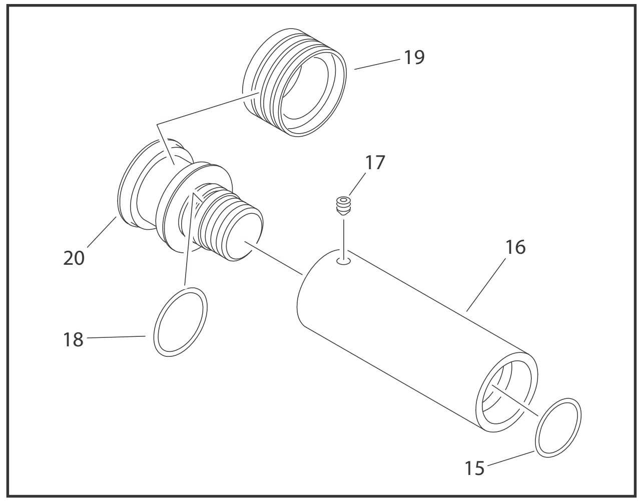


Figure 5-39. Piston And Spacer Assembly

14. Remove cylinder rod from holding fixture.
15. Position cylinder barrel in suitable holding fixture.

NOTICE

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

16. Support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston O-rings and backup ring.
17. Grease threads on barrel and cylinder head. Screw in cylinder head. Torque to 221 ft-lb (300 Nm).

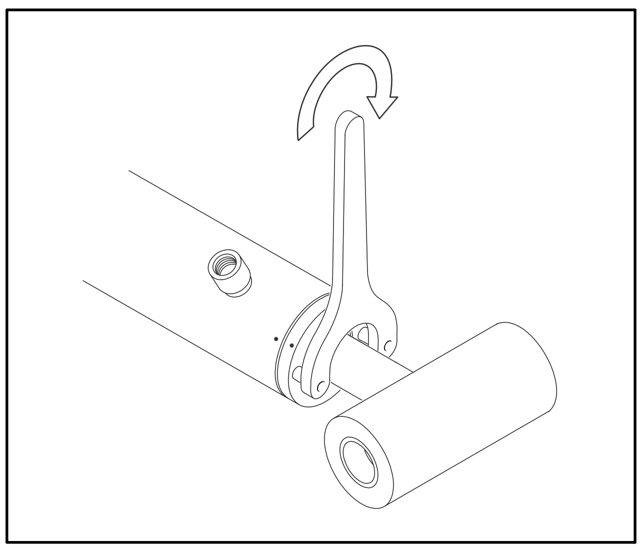


Figure 5-40. Cylinder Head Installation

18. Install two O-rings (3) in valve block (1). Install valve block with four bolts (2). Torque to 18 ft-lb (24 Nm).
19. Install cartridge valves (4) with new O-ring in valve block. Torque to 33 ft-lb (45 Nm).

Platform Level (Slave) Cylinder

Refer to Figure 5-44.

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. Support cylinder rod as needed.
3. Remove cartridge valves (2) from valve block. Discard O-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with suitable hammer to break thread-locking compound.

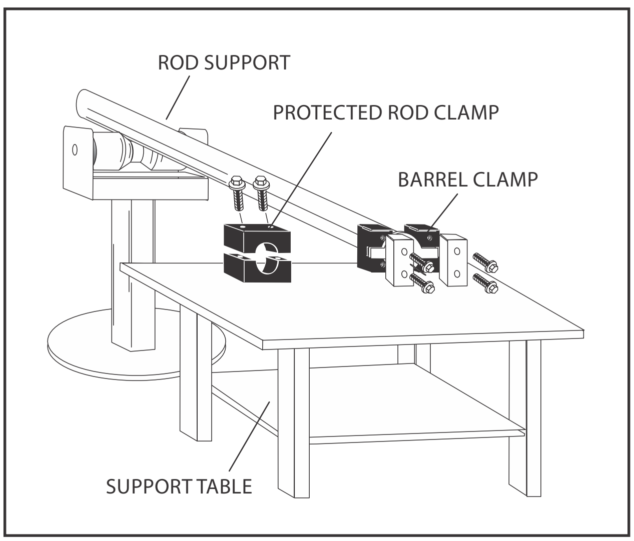


Figure 5-41. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for realignment. Unscrew cylinder head with pin-face spanner wrench.

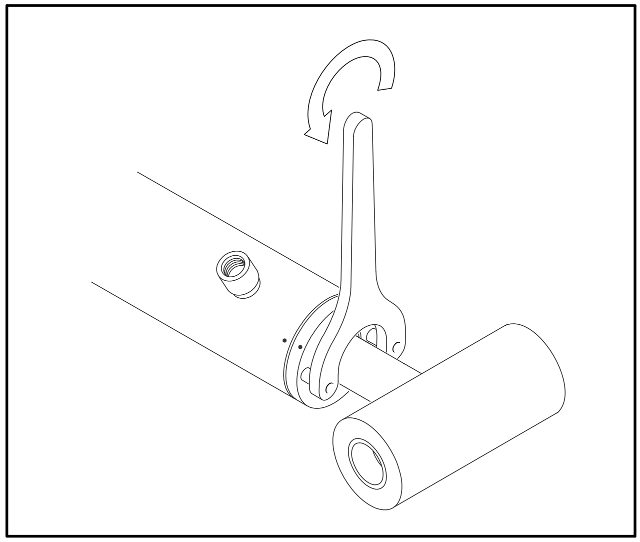


Figure 5-42. Cylinder Head Removal

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 from barrel.

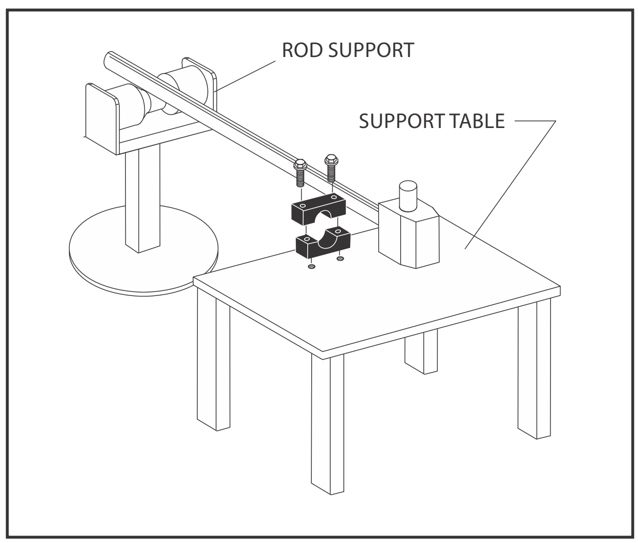
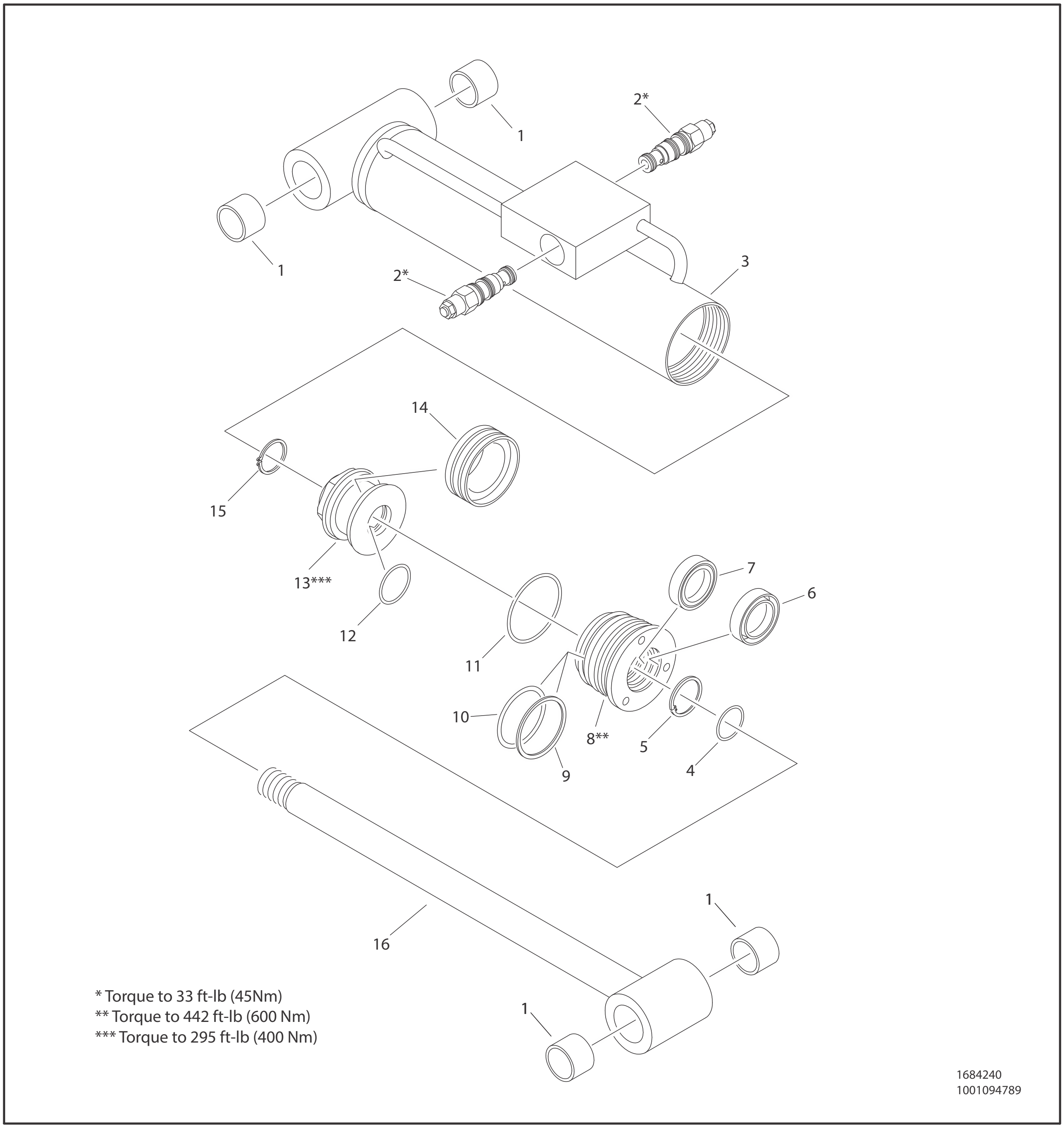


Figure 5-43. Cylinder Rod Support



1. Bushing	5. Retaining Ring	9. Backup Ring	13. Piston
2. Cartridge Valve	6. Wiper	10. O-Ring	14. Seal
3. Barrel	7. Seal	11. O-Ring	15. Retaining Ring
4. O-Ring	8. Head	12. O-Ring	16. Rod

Figure 5-44. Platform Level (Slave) Cylinder

7. Using suitable protection, clamp cylinder rod (20) in a vise or similar holding fixture near piston.
8. Remove retaining ring (15).
9. Unscrew and remove piston assembly (13).
10. Remove O-Ring (12) and seal (14) from piston.

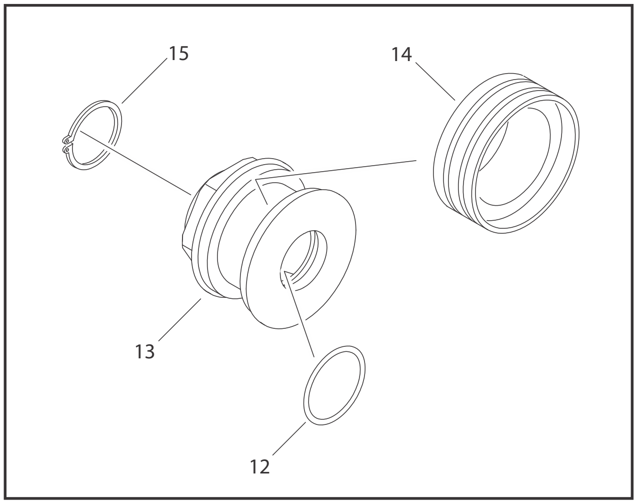


Figure 5-45. Piston Disassembly

11. Remove head assembly (8) from rod (16).
12. Remove O-Ring (10), backup ring (9), and O-Ring (11) from cylinder head.
13. Remove wiper (6), seal (7), O-Ring (4), and retaining ring (5) from front inside of cylinder head.

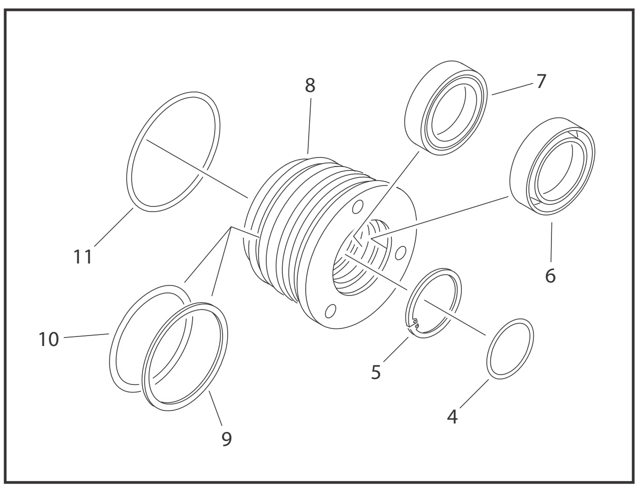


Figure 5-46. Cylinder Head Disassembly

CLEANING AND INSPECTION

1. Clean all parts with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. Dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for 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, and distortion. Dress piston surface or replace piston.
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, ovality, and tapering. Replace as needed.
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 surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage, ovality, and tapering. Replace as needed.
13. Inspect rod and barrel bushings.
    a. Remove burrs, dirt, or other contamination.
    b. Inspect for wear or damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing with WD40 before installing composite bushings. Install new bushings using an arbor.

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

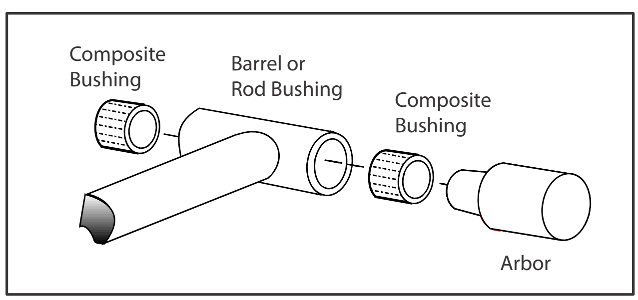


Figure 5-47. Composite Bushing Installation

14. Inspect oil ports for blockage or presence of dirt or other foreign material. Clean or repair as needed.

ASSEMBLY

NOTE: Use proper cylinder seal kit for cylinder assembly. See your JLG Parts Manual. Apply a light film of hydraulic oil to all components before assembly.

NOTICE

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

1. Install retaining ring (5) and O-ring (4) in cylinder head grooves.
2. Install seal (7) and wiper (6) in cylinder head grooves.
3. Install O-ring (11) in outside groove closest to top of cylinder head.
4. Install back-up ring (9) and O-ring (10) in outside diameter cylinder head grooves.

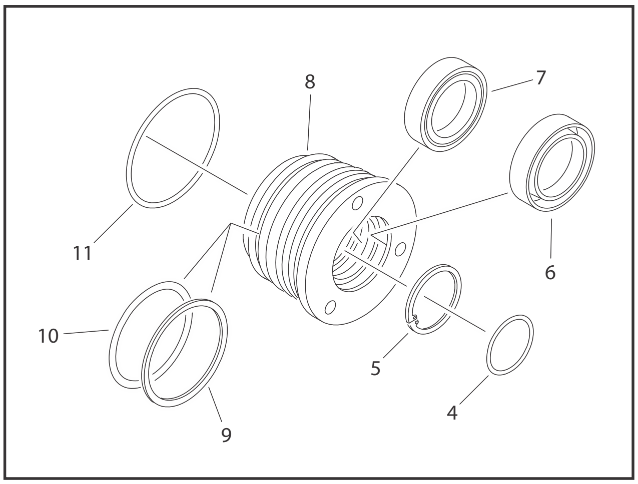


Figure 5-48. Cylinder Head Assembly

5. Carefully install head on rod. Make sure wiper and rod seals are not damaged or dislodged. Push head along rod to rod end.
6. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture near piston location.
7. Install O-ring (12) in piston (13).
8. Apply JLG Thread Locking Compound P/N 0100011 to rod threads. Thread piston on cylinder rod. Do not damage or dislodge O-ring. Torque to 295 ft-lb (400 Nm).
9. Install seal (14) in outside groove of piston.
10. Install retaining ring (15).

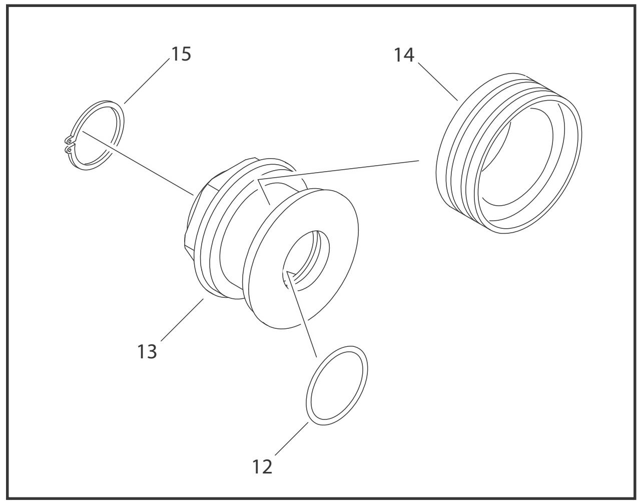


Figure 5-49. Piston And Spacer Assembly

11. Remove cylinder rod from holding fixture.
12. Position cylinder barrel in suitable holding fixture.

NOTICE

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

13. Clamp barrel securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston O-rings and backup ring.
14. Continue pushing rod into barrel. Grease threads on barrel and cylinder head. Screw in cylinder head. Torque to 442 ft-lb (600 Nm).

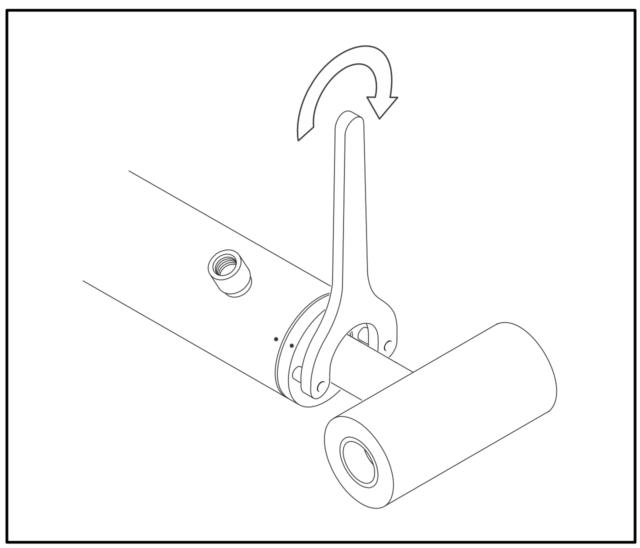


Figure 5-50. Cylinder Head Installation

15. Install cartridge valve (3) with new O-ring in valve block. Torque to 33 ft-lb (45 Nm).

Jib Lift Cylinder

Refer to Figure 5-54.

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. Support cylinder rod as needed.
3. Remove cartridge valves (3) from valve block. Discard O-rings.
4. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with suitable hammer to break thread-locking compound.

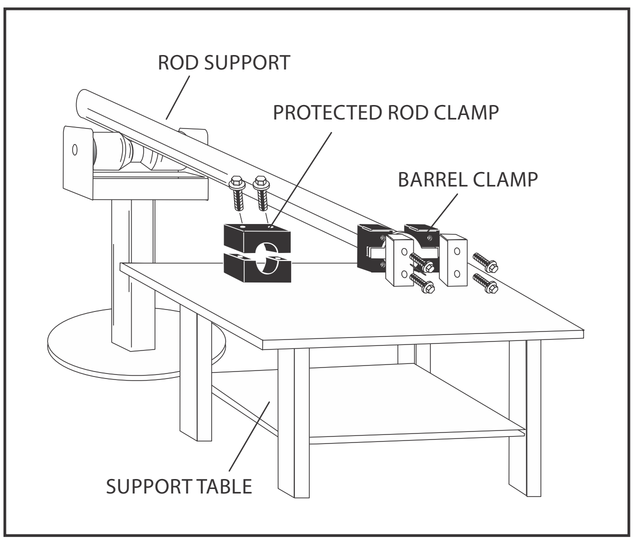


Figure 5-51. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for realignment. Unscrew cylinder head with pin-face spanner wrench.

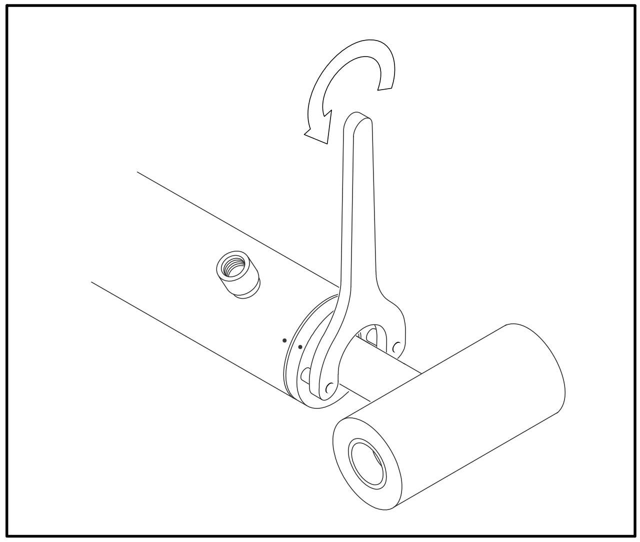


Figure 5-52. Cylinder Head Removal

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 from barrel.

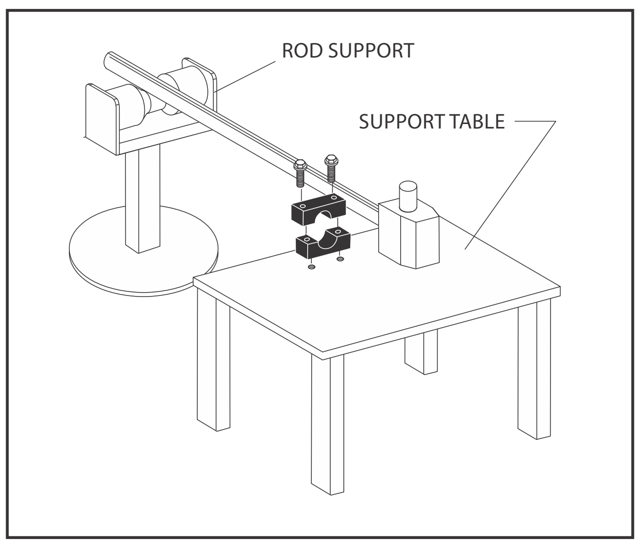
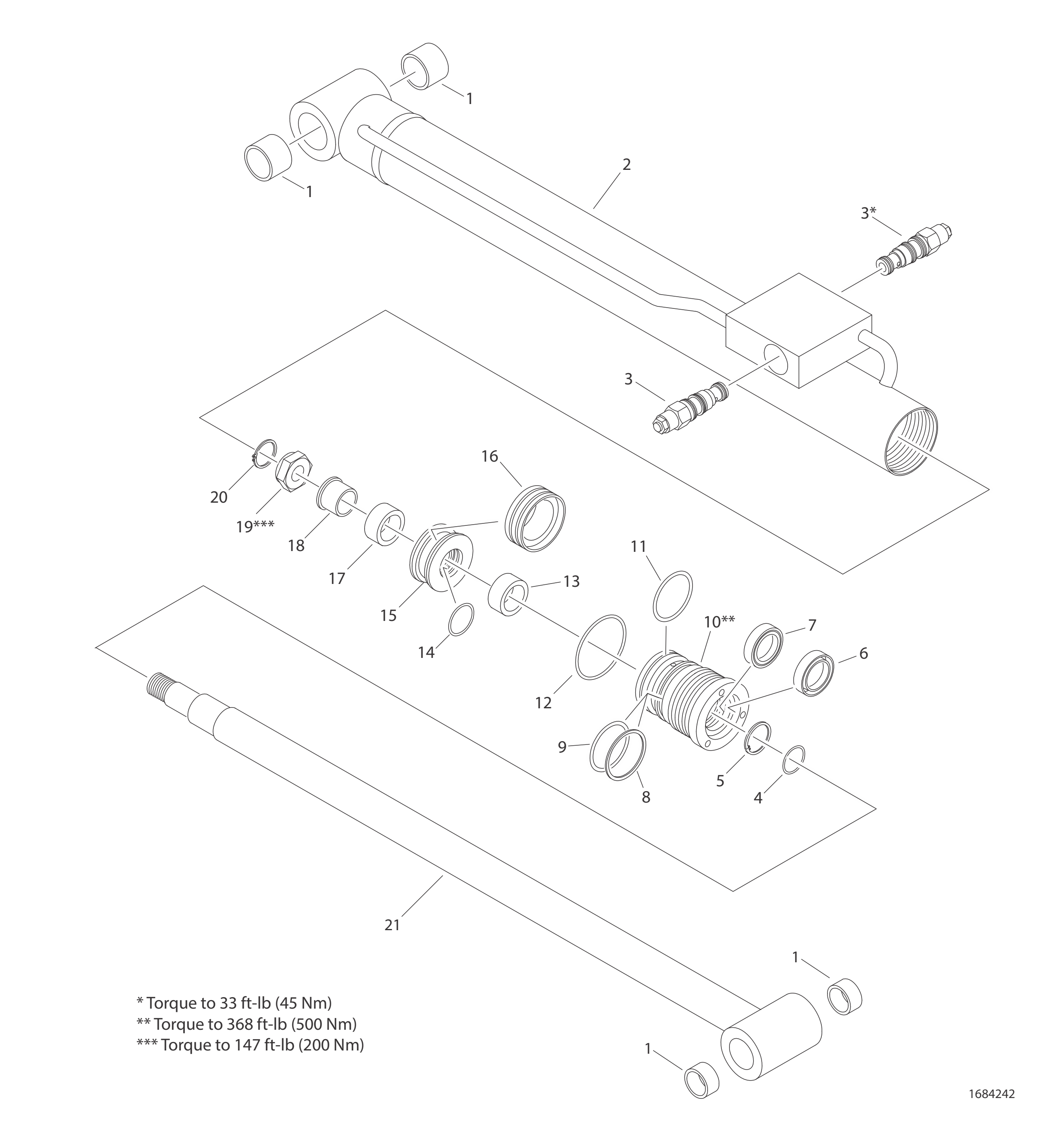


Figure 5-53. Cylinder Rod Support



1. Bushing
2. Barrel
3. Cartridge Valve
4. O-Ring
5. Retaining Ring
6. Wiper
7. Seal
8. Backup Ring
9. O-Ring
10. Head
11. O-Ring
12. O-Ring
13. Bushing
14. O-Ring
15. Piston
16. Seal
17. Bushing
18. Sleeve
19. Nut
20. Retaining Ring
21. Rod

Figure 5-54. Jib Lift Cylinder

7. Using suitable protection, clamp cylinder rod (21) in a vise or similar holding fixture near piston.
8. Remove retaining ring (20), nut (19), sleeve (18), and bushing (17).
9. Unscrew and remove piston assembly (15). Remove bushing (13).
10. Remove O-Ring (14) and seal (16) from piston.

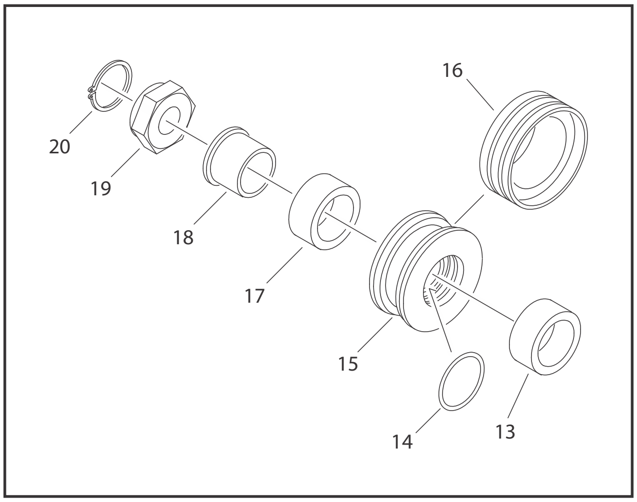


Figure 5-55. Piston And Bushings Disassembly

11. Remove head assembly (10) from rod.
12. Remove O-Ring (11), O-ring (9), backup ring (8), and O-Ring (12) from cylinder head.
13. Remove wiper (6), seal (7), O-Ring (4), and retaining ring (5), from front inside of cylinder head.

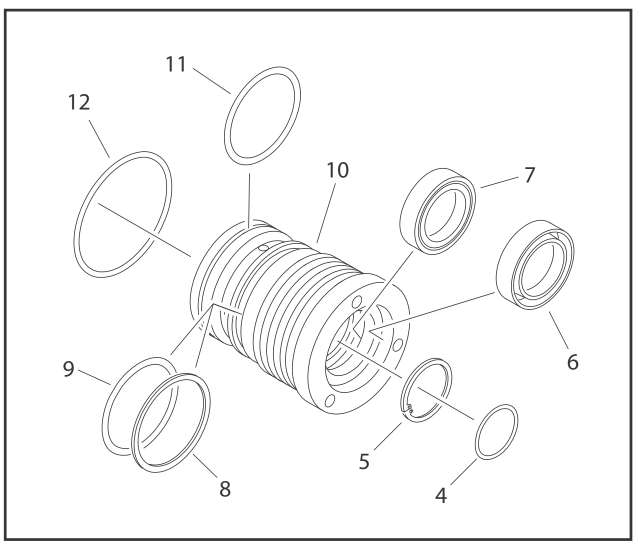


Figure 5-56. Cylinder Head Disassembly

CLEANING AND INSPECTION

1. Clean all parts with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. Dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for 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, and distortion. Dress piston surface or replace piston.
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, ovality, and tapering. Replace as needed.
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 surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage, ovality, and tapering. Replace as needed.
13. Inspect rod and barrel bushings.
    a. Remove burrs, dirt, or other contamination.
    b. Inspect for wear or damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing with WD40 before installing composite bushings. Install new bushings using an arbor.

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

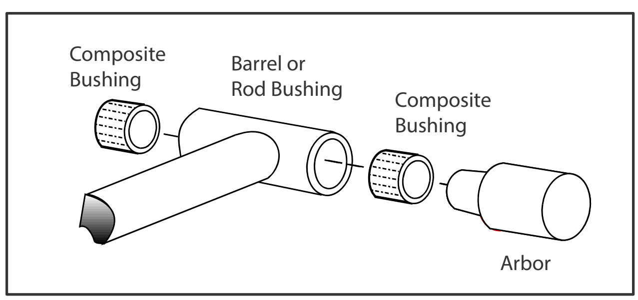


Figure 5-57. Composite Bushing Installation

14. Inspect oil ports for blockage or presence of dirt or other foreign material. Clean or repair as needed.

ASSEMBLY

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

NOTICE

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

1. Install retaining ring (5) and O-ring (4) in cylinder head grooves.
2. Install seal (7) and wiper (6) in cylinder head grooves.
3. Install O-ring (12) in outside groove closest to top of cylinder head.
4. Install back-up ring (8), O-ring (9), and O-ring (11) in outside diameter cylinder head grooves.

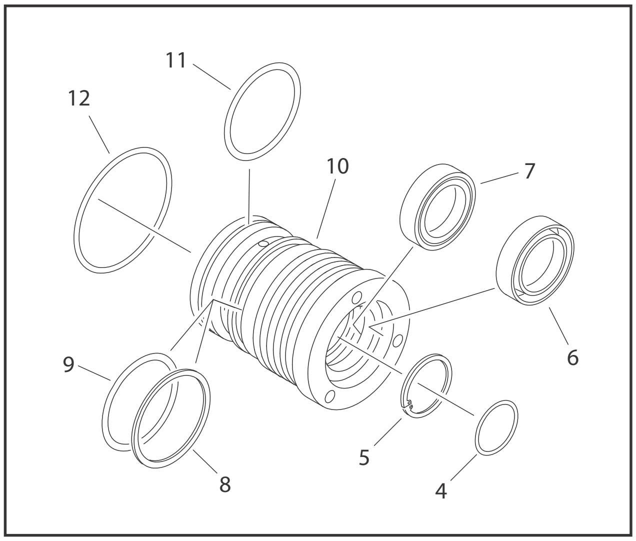


Figure 5-58. Cylinder Head Assembly

5. Carefully install head on rod. Make sure wiper and rod seals are not damaged or dislodged. Push head along rod to rod end.
6. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture near piston location.
7. Slide bushing (13) on rod.
8. Install O-ring (14) in piston (15).
9. Apply JLG Thread Locking Compound P/N 0100011 to rod threads. Thread piston on cylinder rod. Do not damage or dislodge O-ring.
10. Install seal (17) on piston.
11. Install bushing (12) and sleeve (18) on rod.
12. Install nut (19) on rod. Torque to 147 ft-lb (200 Nm)
13. Install retaining ring (20).

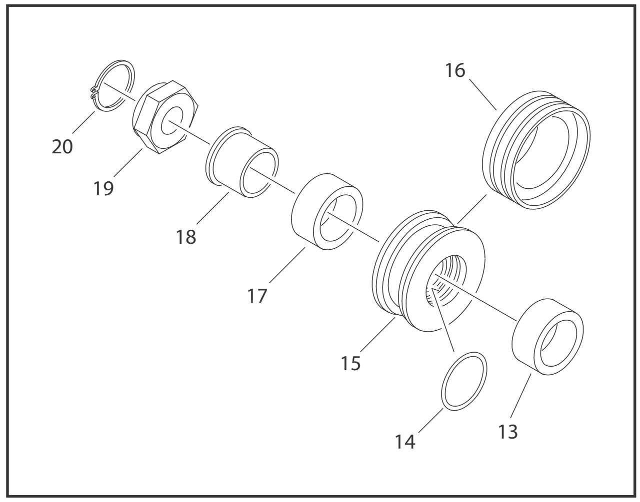


Figure 5-59. Piston And Bushings Assembly

14. Remove cylinder rod from holding fixture.
15. Position cylinder barrel in suitable holding fixture.

NOTICE

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

16. Clamp barrel securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston O-rings and backup ring.
17. Continue pushing rod into barrel. Grease threads on barrel and cylinder head. Screw in cylinder head. Torque to 368 ft-lb (500 Nm).

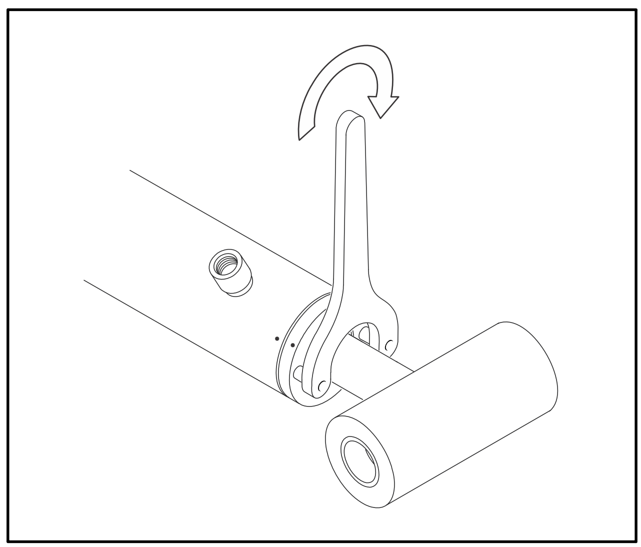


Figure 5-60. Cylinder Head Installation

18. Install two cartridge valves (3) with new O-rings in valve block. Torque to 33 ft-lb (45 Nm).

Steer Cylinder

DISASSEMBLY

Refer to Figure 5-64.

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.
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.

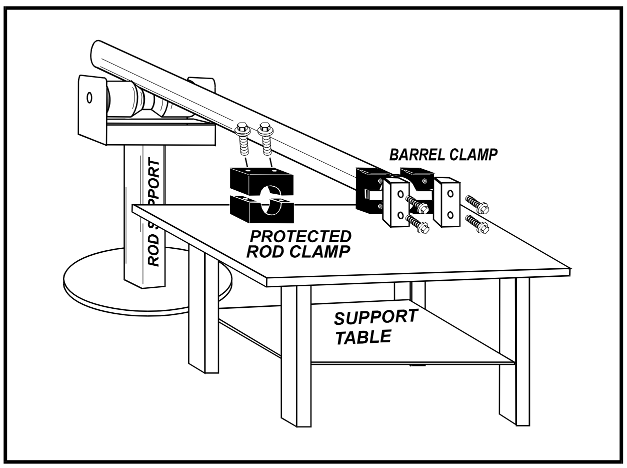


Figure 5-61. Cylinder Barrel Support

4. Remove burrs and contamination from cylinder before disassembly.
5. Unscrew cylinder head with hook spanner on rod end to be pulled.

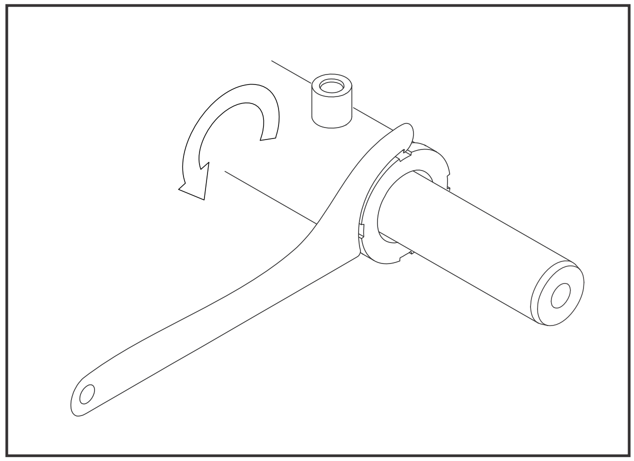


Figure 5-62. Removing Cylinder Head

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD AND PISTON.

6. Clamp securely. Apply pressure to rod pulling device and carefully withdraw complete rod assembly from cylinder barrel.

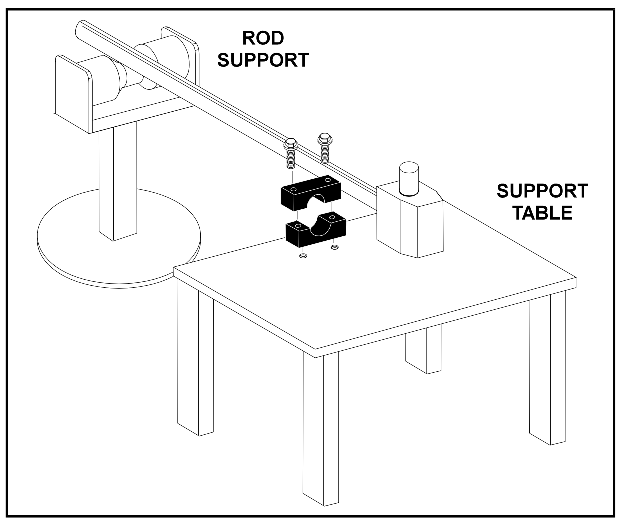
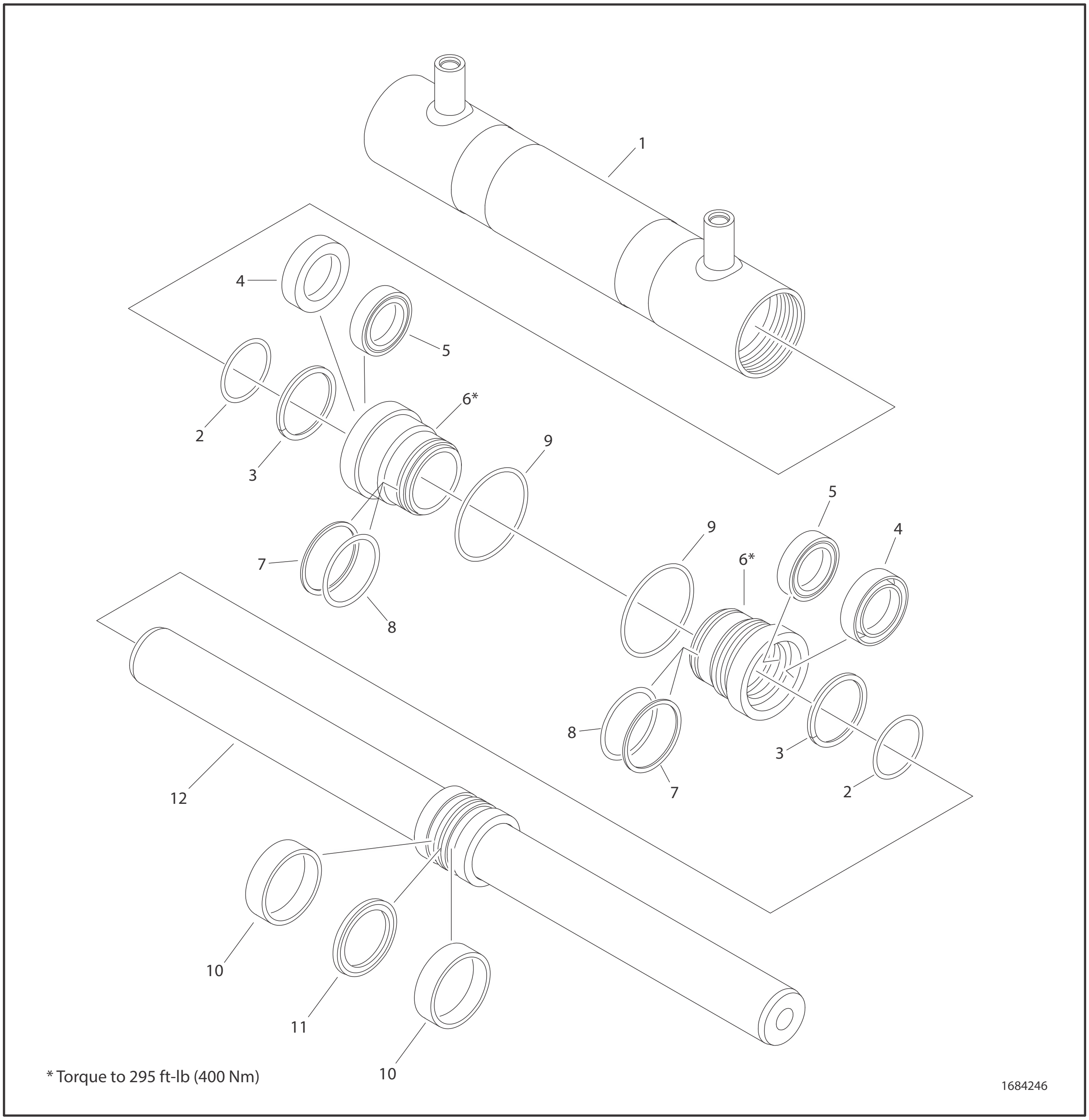


Figure 5-63. Cylinder Rod Support

7. Remove cylinder head from opposite end.



1.	Barrel	4.	Wiper	7.	Backup Ring	10.	Wear Ring
2.	O-Ring	5.	Seal	8.	O-Ring	11.	Seal
3.	Retaining Ring	6.	Head	9.	O-Ring	12.	Piston and Rod Assembly

Figure 5-64. Steer Cylinder Assembly

8. Remove two wear rings (10) from piston/rod assembly (12).

9. Remove seal (11) from piston. Do not damage piston groove.

NOTE: Piston seal is a combination-type seal. If seal separates it cannot be reused.

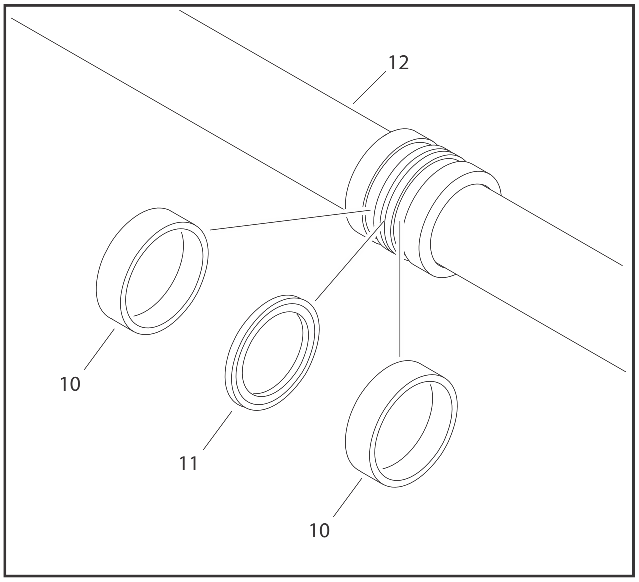


Figure 5-65. Piston Seal and Wear Ring

10. Remove wiper (4), seal (5), O-ring (2) and retaining ring (3) from two cylinder heads (6).

11. Remove O-ring (8), backup ring (7) and O-ring (9).

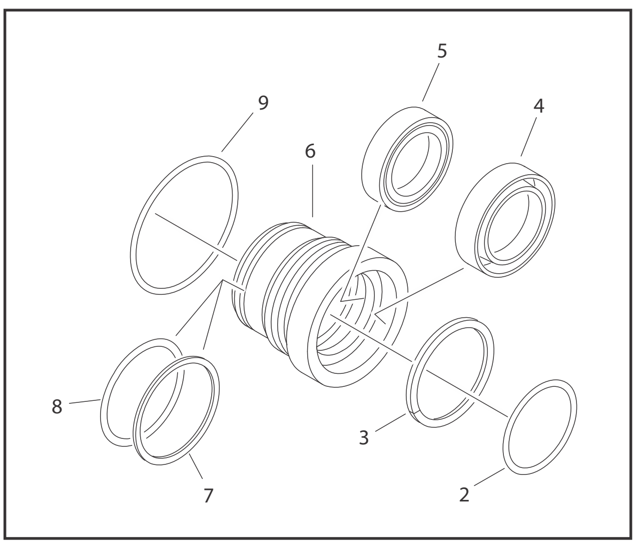


Figure 5-66. Cylinder Head Disassembly

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 cylinder head inside diameter for scoring, tapering, ovality, or other damage. Replace as necessary.

7. Inspect threads, and seal and O-Ring grooves in head for burrs, sharp edges, and other damage. Dress surfaces as necessary.

8. 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 retaining ring (3), O-ring (2), seal (5), and wiper (4) in Cylinder Head (6).
3. Install O-ring (9), backup ring (7) and O-ring (8).
4. Repeat for other cylinder head.

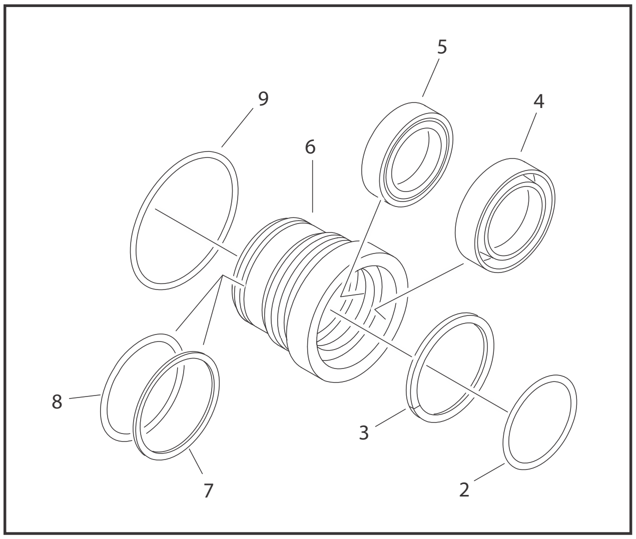


Figure 5-67. Cylinder Head Assembly

5. Install seal (11) in piston groove on rod (12).
6. Install two wear rings (10).

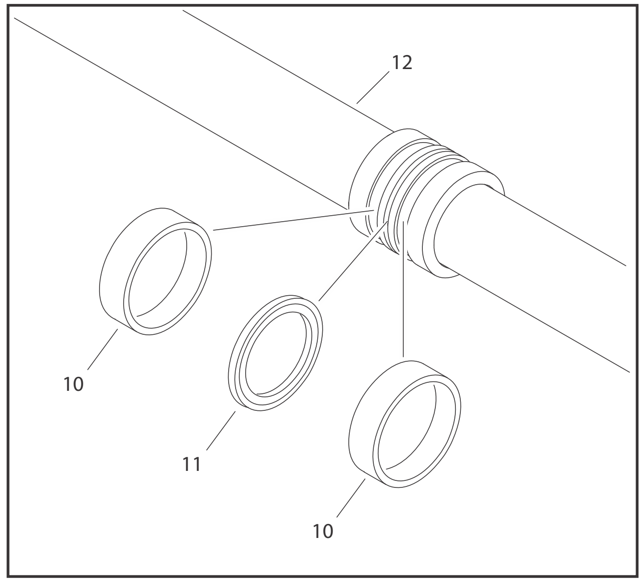


Figure 5-68. Piston Seal and Wear Ring

NOTICE

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

7. Insert rod and piston assembly in barrel until centered.
8. Install two cylinder head assemblies (6) on barrel (1). Torque with hook spanner to 295 ft-lb (400 Nm).

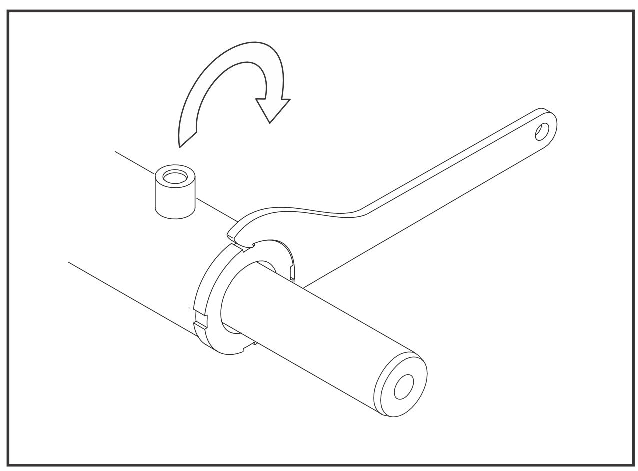


Figure 5-69. Cylinder Head Installation

Axle Lockout Cylinder (Outside Frame)

NOTE: *Refer to Figure 5-70., Axle Lockout Cylinder.*

DISASSEMBLY

NOTICE

CONTAMINATION MAY DAMAGE EQUIPMENT. DISASSEMBLE CYLINDER ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

CAUTION

PISTON CAN FALL OUT OF HOUSING AND CAUSE INJURY OR DAMAGE TO EQUIPMENT. BE CAREFUL WHEN REMOVING AXLE CYLINDER. OPENING BLEED VALVE CAN CAUSE PISTON TO FALL OUT OF HOUSING.

1. Open bleed valve (8). Rotate piston (2) and remove from housing (1).
2. Remove wiper (6). Do not scratch housing bore.
3. Remove two wear rings (5) and rod seal (7) from grooves in piston bore. Do not scratch housing bore.
4. Remove check valve (9), if required.
5. Inspect bore and piston for scoring, pitting, or excessive wear.
6. Remove minor surface blemishes with wet 2000-grit sandpaper. Pitting requires replacement of housing or piston.
7. Clean all parts with approved solvent and dry with compressed air.

ASSEMBLY

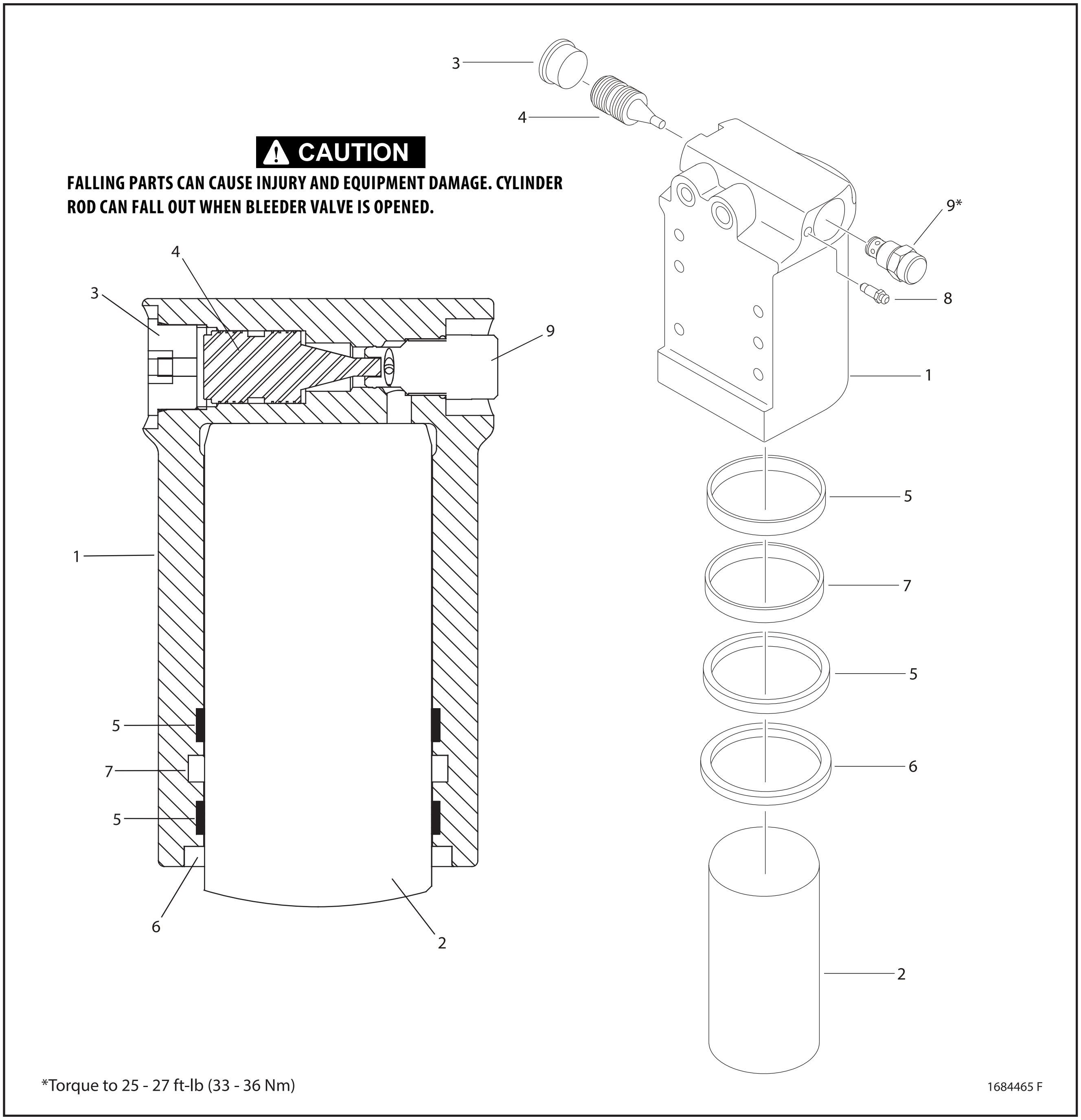
Refer to Figure 5-70., Axle Lockout Cylinder.

1. Install two new wear rings (5) and rod seal (7) in piston bore grooves. Make sure they are not twisted.
2. Install new wiper (6) in housing.
3. Lubricate piston bore with clean hydraulic fluid.

NOTICE

INSERTING PISTON OFF-CENTER CAN DAMAGE PISTON AND PISTON BORE SURFACES. USE EXTREME CARE WHEN INSTALLING PISTON.

4. Install piston (2) in bore and push to top of bore.
5. Install check valve (9). Torque to 25 - 27 ft-lb (33 - 36 Nm).
6. Bleed system.



1. Barrel
2. Rod
3. Plug
4. Pilot Piston
5. Wear Ring
6. Wiper
7. Rod Seal
8. Bleeder
9. Cartridge Valve

Figure 5-70. Axle Lockout Cylinder

Axle Lockout Cylinder (Inside Frame)

Refer to Figure 5-74.

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. Support cylinder rod as needed.
3. Remove cartridge valves (4) from valve block. Discard O-rings.
4. Remove bleeder valves (3) if damaged or leaking.
5. Place cylinder barrel in a suitable holding fixture. Tap around outside of cylinder head retainer with suitable hammer to break thread-locking compound.

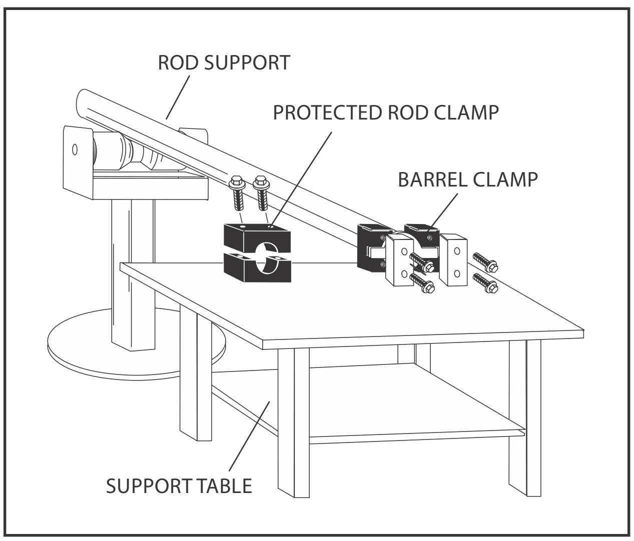


Figure 5-71. Cylinder Barrel Support

6. Unscrew cylinder head with spanner.

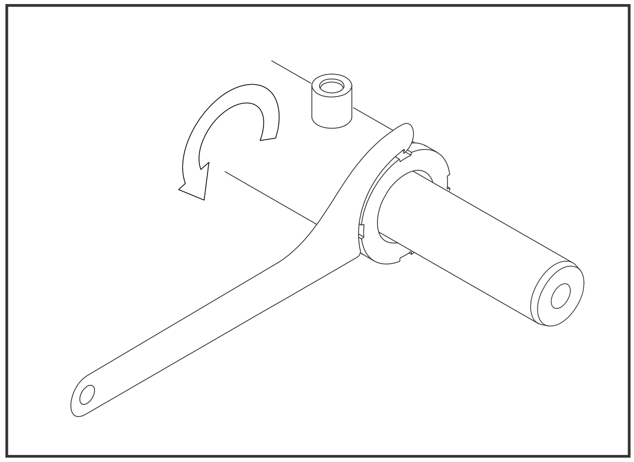


Figure 5-72. Cylinder Head Removal

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.

7. Clamp barrel securely. Pull rod assembly from barrel.

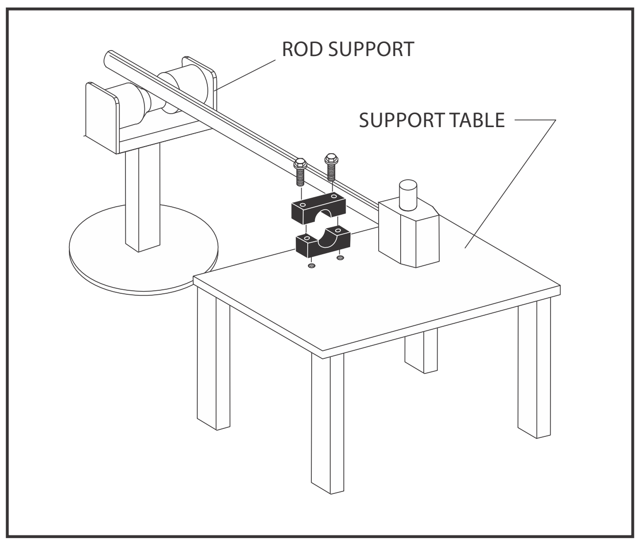
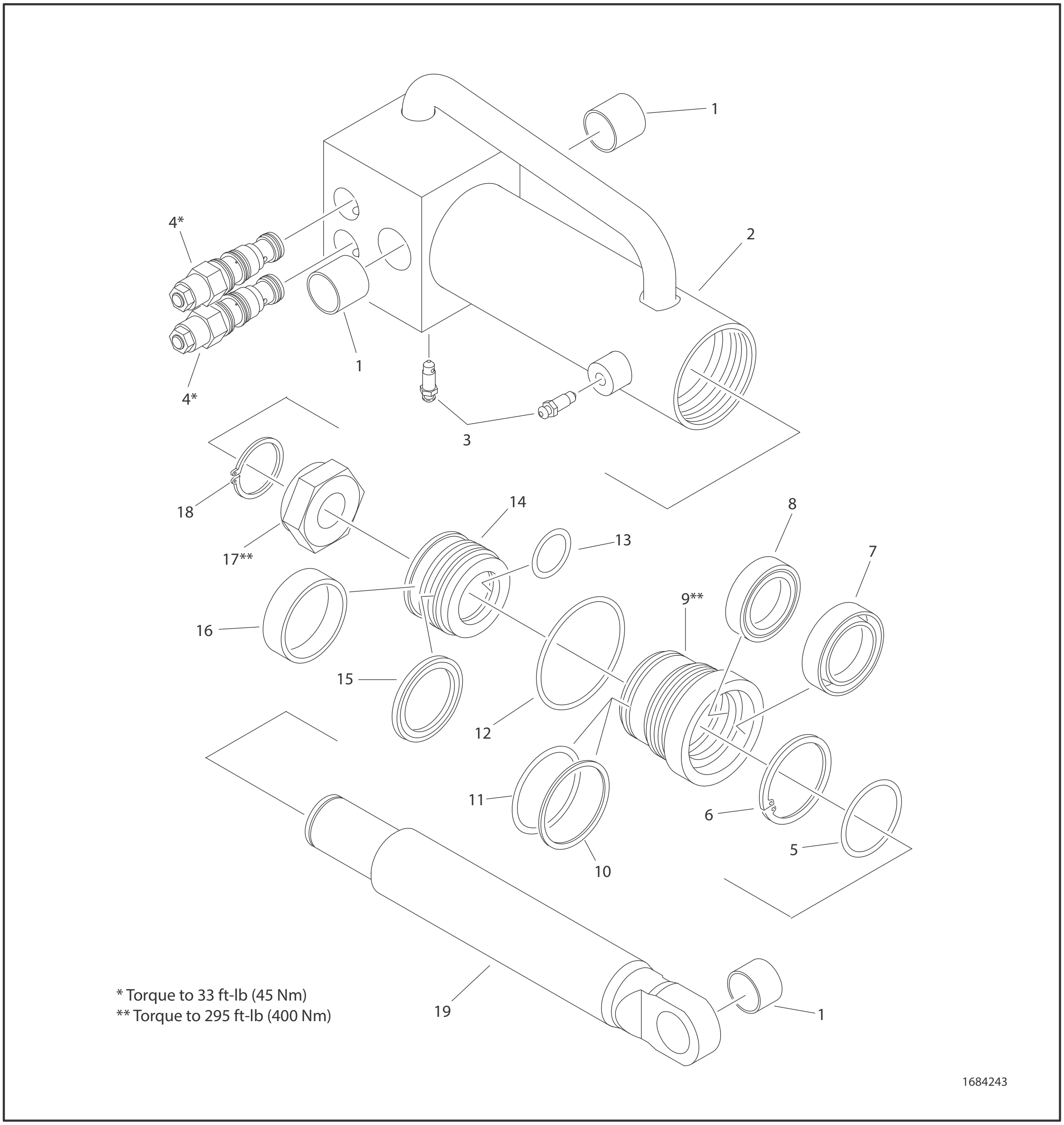


Figure 5-73. Cylinder Rod Support



1. Bushing
2. Barrel
3. Bleeder
4. Cartridge Valve
5. O-Ring
6. Retaining Ring
7. Wiper
8. Seal
9. Head
10. Backup Ring
11. O-Ring
12. O-Ring
13. O-Ring
14. Piston
15. Seal
16. Wear Ring
17. Locknut
18. Retaining Ring
19. Rod

Figure 5-74. Axle Lockout Cylinder (Inside Frame)

8. Using suitable protection, clamp cylinder rod (21) in a vise or similar holding fixture near piston.
9. Remove retaining ring (18) and nut (17).
10. Unscrew and remove piston assembly (14).
11. Remove O-Ring (13), wear ring (16), and seal (15) from piston.

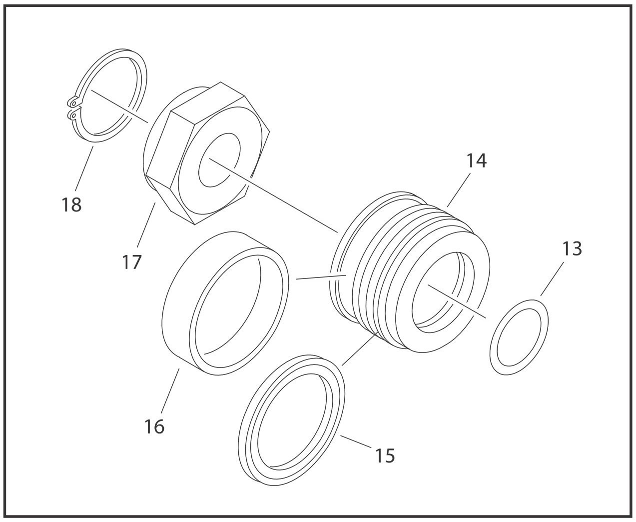


Figure 5-75. Piston Disassembly

12. Remove head assembly (9) from rod (19).
13. Remove O-Ring (11), O-ring (9), backup ring (10), and O-Ring (12) from cylinder head.
14. Remove retaining ring (6), O-ring (5), wiper (7), and seal (6) from front inside of cylinder head.

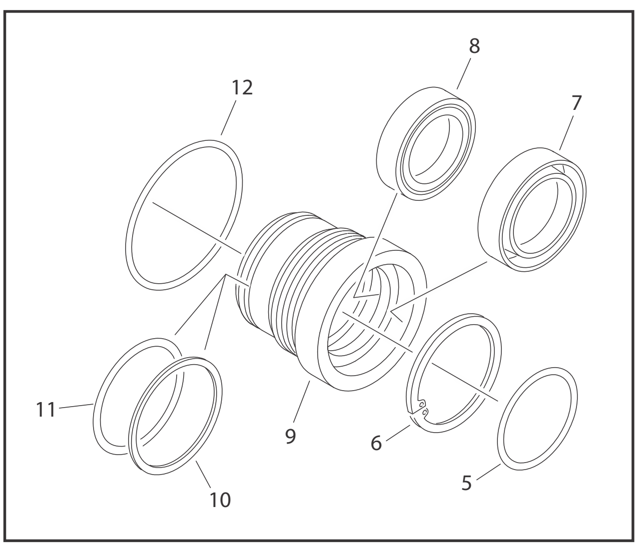


Figure 5-76. Cylinder Head Disassembly

CLEANING AND INSPECTION

1. Clean all parts with approved cleaning solvent.
2. Inspect cylinder rod for scoring, tapering, ovality, or other damage. Dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for 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, and distortion. Dress piston surface or replace piston.
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, ovality, and tapering. Replace as needed.
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 surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage, ovality, and tapering. Replace as needed.
13. Inspect rod and barrel bushings.
    a. Remove burrs, dirt, or other contamination.
    b. Inspect for wear or damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing with WD40 before installing composite bushings. Install new bushings using an arbor.

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

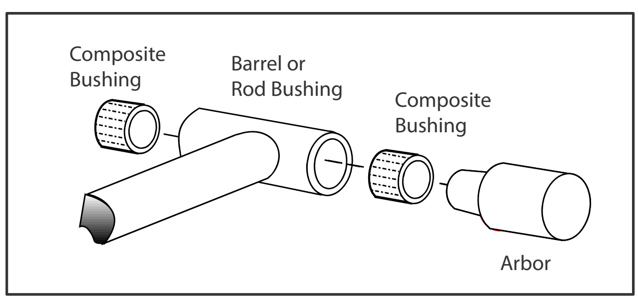


Figure 5-77. Composite Bushing Installation

14. Inspect oil ports for blockage or presence of dirt or other foreign material. Clean or repair as needed.

ASSEMBLY

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

NOTICE

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

1. Install retaining ring (5) and O-ring (4) in cylinder head grooves.
2. Install seal (7) and wiper (6) in cylinder head grooves.
3. Install O-ring (12) in outside groove closest to top of cylinder head.
4. Install back-up ring (8), O-ring (9), and O-ring (11) in outside diameter cylinder head grooves.

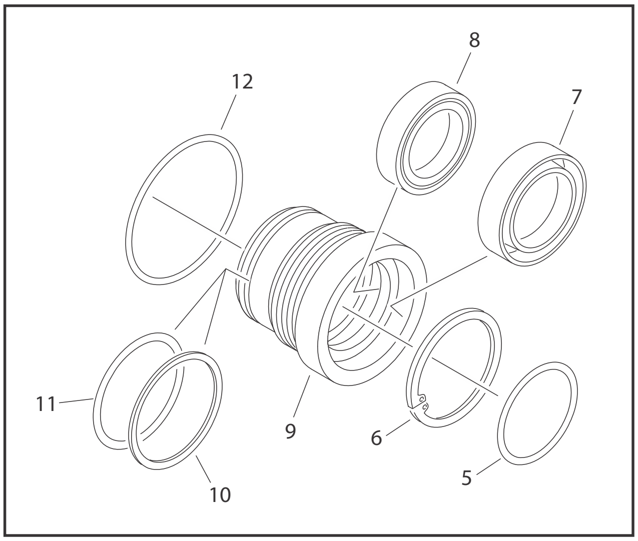


Figure 5-78. Cylinder Head Assembly

5. Carefully install head on rod. Make sure wiper and rod seals are not damaged or dislodged. Push head along rod to rod end.
6. Using suitable protection, clamp cylinder rod in a vise or similar holding fixture near piston location.
7. Install O-ring (13) in piston (14).
8. Apply JLG Thread Locking Compound P/N 0100011 to rod threads. Thread piston on cylinder rod. Do not damage or dislodge O-ring.
9. Install seal (15) and wear ring (16) on piston.
10. Install nut (17) on rod. Torque to 295 ft-lb (400 Nm).
11. Install retaining ring (8).

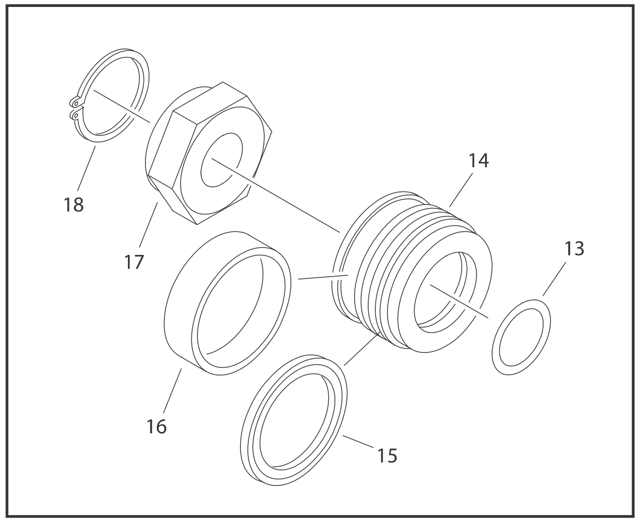


Figure 5-79. Piston And Bushings Assembly

12. Remove cylinder rod from holding fixture.
13. Position cylinder barrel in suitable holding fixture.

NOTICE

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

14. Clamp barrel securely and support rod. Insert piston end into barrel cylinder. Do not damage or dislodge piston O-rings and backup ring.
15. Continue pushing rod into barrel. Grease threads on barrel and cylinder head. Screw in cylinder head. Torque to 295 ft-lb (400 Nm).

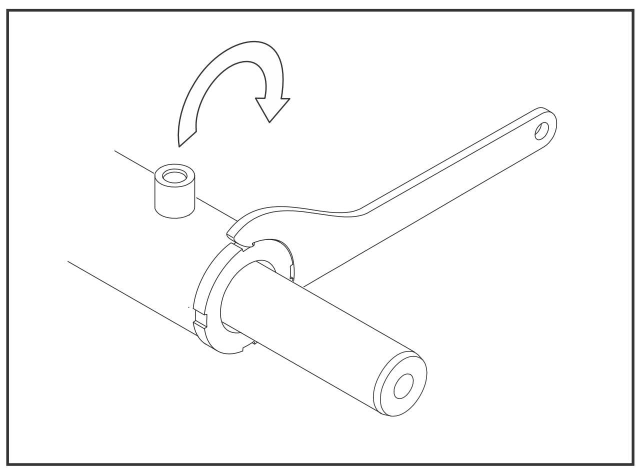


Figure 5-80. Cylinder Head Installation

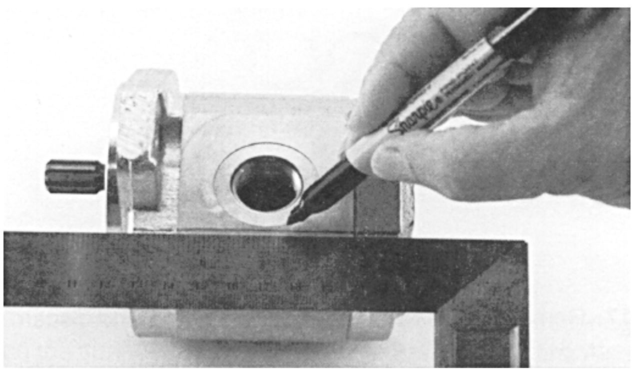
16. Install two cartridge valves (4) with new O-rings in valve block. Torque to 33 ft-lb (45 Nm).
17. Install two bleeder valves (3). Torque to 7 ft-lb (10 Nm).

5.3 HYDRAULIC PUMP (GEAR)

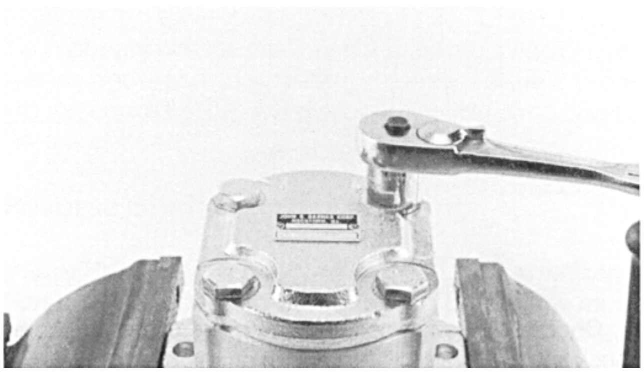
Disassembly

NOTE: *The following general instructions also apply to multiple section gear pumps, the only extra parts are the coupling between the drive shafts and the center distance plate which divides the two pump sections. This repair procedure also applies to the "W" series Gear Motors.*

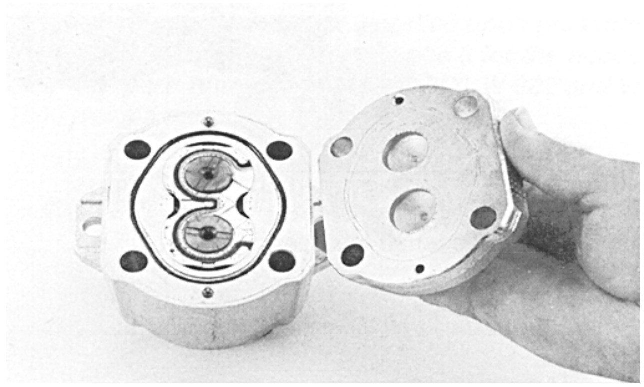
1. It is very important to work in a clean work area when repairing hydraulic products. Plug ports and wash exterior of pump with a proper cleaning solvent before continuing.
2. Remove port plugs and drain oil from pump.



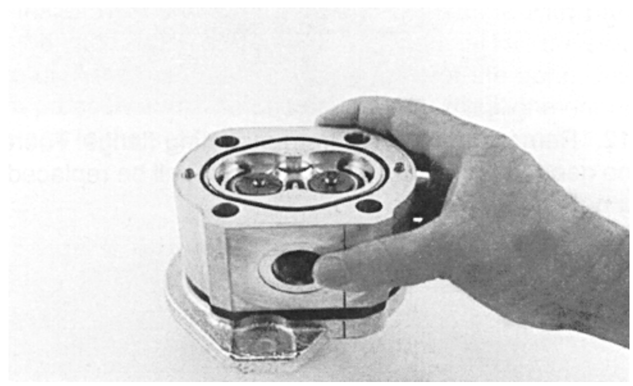
3. Use a permanent marker pen to mark a line across the mounting flange, gear housing and end cover. This will assure proper reassembly and rotation of pump.
4. Remove key from drive shaft if applicable.



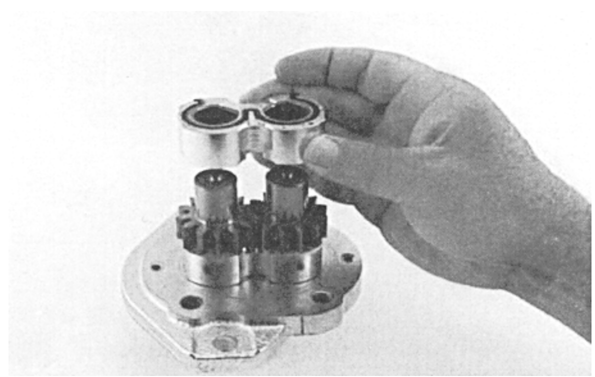
5. Clamp the mounting flange in a protected jaw vise with the pump shaft facing down.
6. Loosen the four metric hex head bolts.
7. Remove pump from vise and place on clean work bench, remove the four hex head bolts and spacers if applicable.



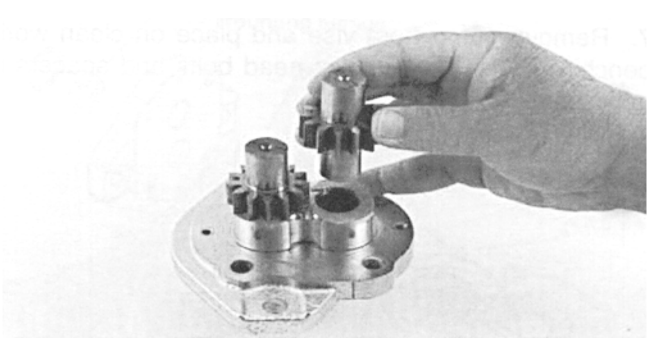
8. Lift and remove end cover.



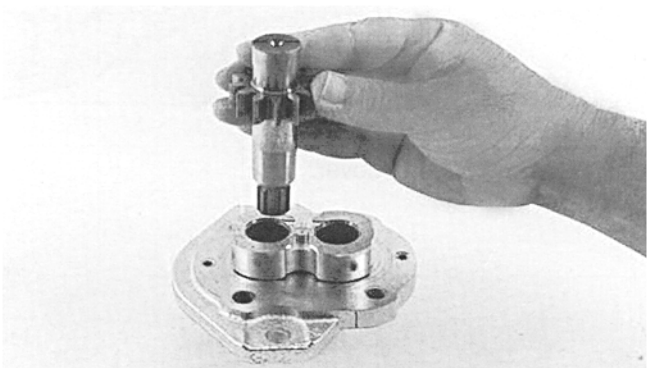
9. Carefully remove gear housing and place on work bench. Make sure the rear bearing block remains on the drive and idler shafts.



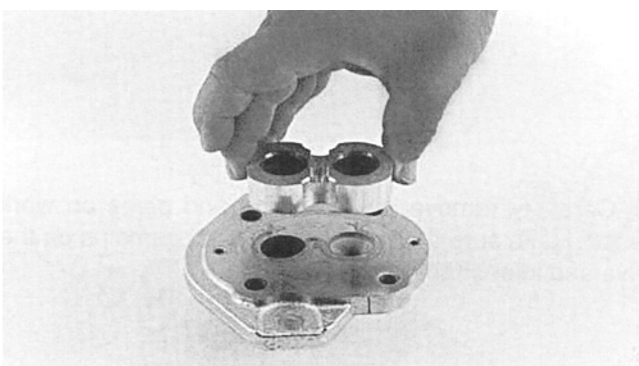
10. Remove rear bearing block from drive and idler shafts.



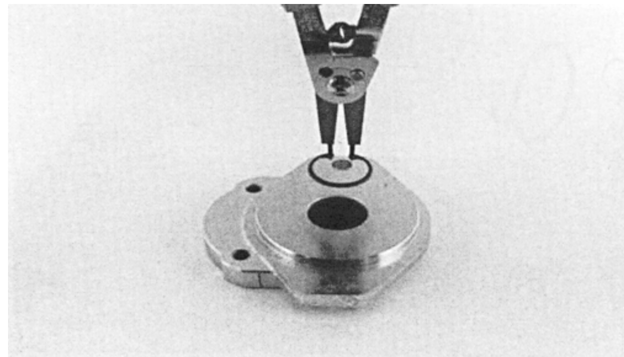
11. Remove idler shaft from bearing block.



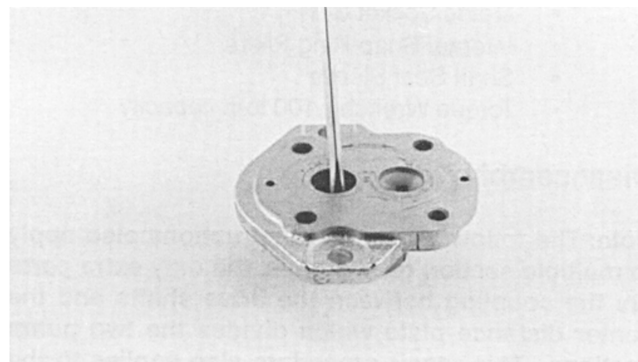
12. Remove drive shaft from mounting flange. There is no need to protect the shaft seal as it will be replaced as a new item.



13. Remove the front bearing block.

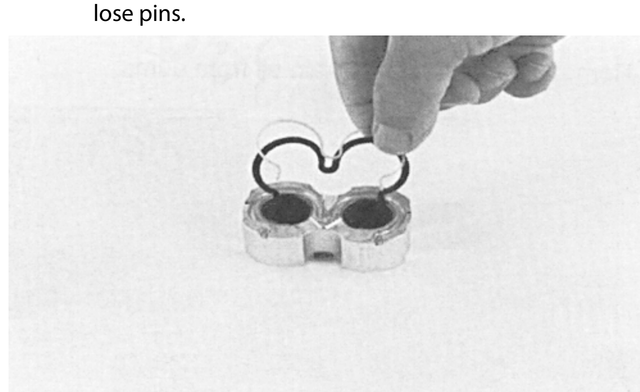


14. Turn the mounting flange over, with the shaft seal up, and remove the retaining ring with proper snap ring pliers.



15. Remove the oil seal from mounting flange, be careful not to mar or scratch the seal bore.

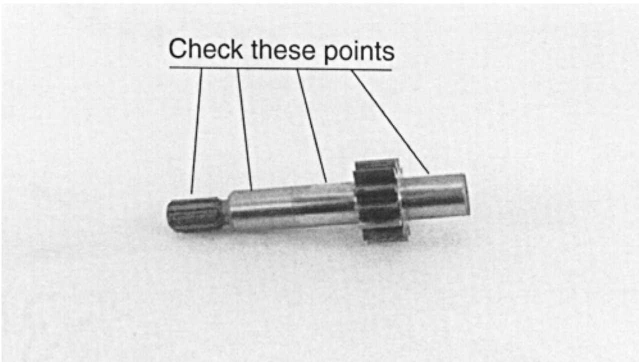
16. Remove the dowel pins from the gear housing. Do not lose pins.



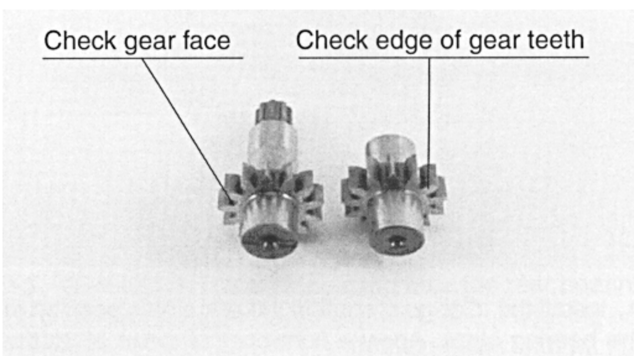
17. Remove seals from both bearing blocks and discard.

Inspect Parts For Wear

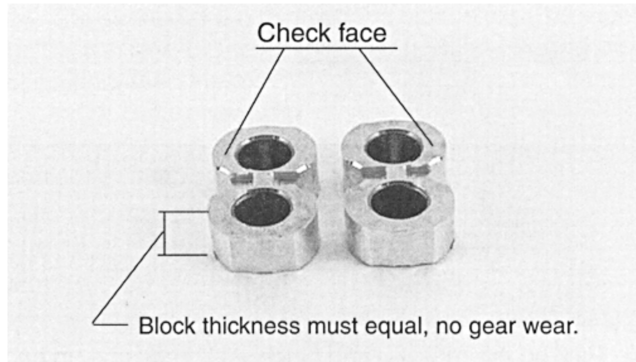
1. Clean and dry all parts thoroughly prior to inspection. It is not necessary to inspect the seals as they will be placed as new items.



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 both the drive gear shaft and idler gear shafts at the bearing points and seal area for rough surfaces and excessive wear.



4. Inspect gear face for scoring or excessive wear. If the face edge of gear teeth are sharp, they will mill into the bearing blocks. If wear has occurred, the parts are unusable.



5. Inspect bearing blocks for excessive wear or scoring on the surfaces which are in contact with the gears. Also inspect the bearings for excessive wear or scoring.
6. Inspect the area inside the gear housing. It is normal for the surface inside the gear housing to show a clean "wipe" on the inside surface on the intake side. There should not be excessive wear or deep scratches and gouges.

General Information

It is important that the relationship of the mounting flange, bearing blocks and gear housing is correct. Failure to properly assemble this pump will result with little or no flow at rated pressure.

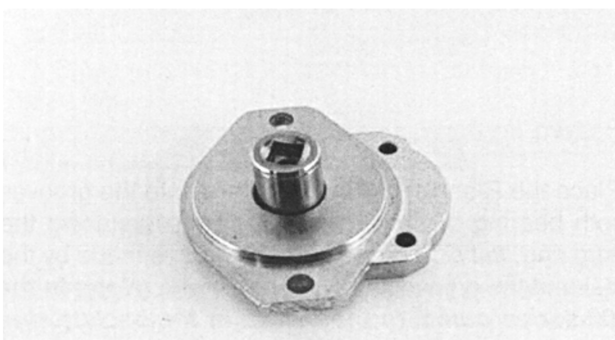
Reverse Shaft Rotation of Pump

NOTE: *This pump is not bi-rotational, if the shaft rotation must be changed the following procedure must be followed.*

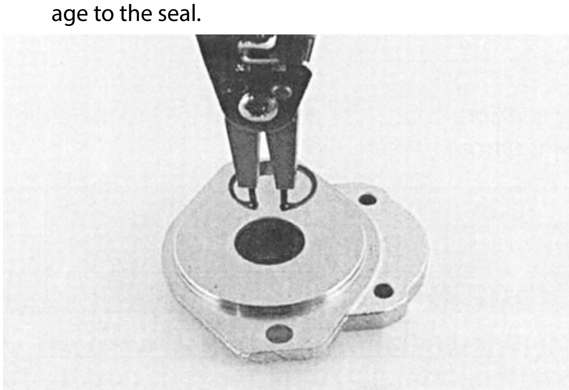
Reversing the shaft rotation of the "W" series gear pump may be accomplished by rotating, as a group, the two bearing blocks and the gear housing 180° in relationship to the remaining parts of the pump. This procedure will place the pressure port on the opposite side of the pump from its original position.

Assembly

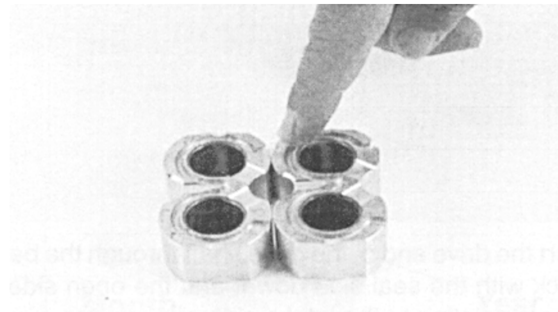
NOTE: *New seals should be installed upon reassembly of pump or motor. deter to page 8 for the necessary kit part numbers for the W-600, W-900 and W-1500 pumps and motors.*



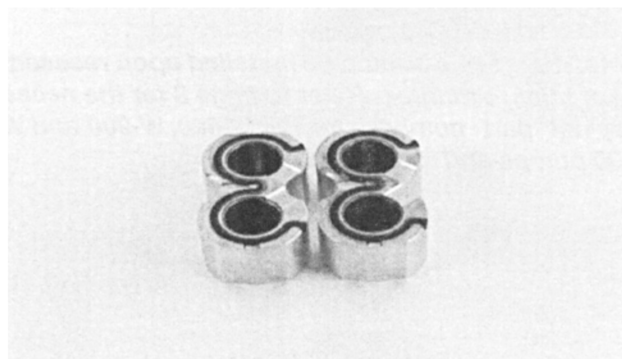
1. Install new shaft seal in mounting flange with part lumber side facing outboard. Press the seal into the seal lore until the seal reaches the bottom of the bore. Uniform pressure must be used to prevent misalignment or damage to the seal.



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

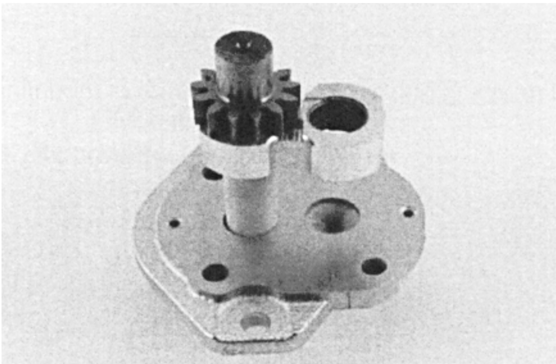


3. Place front and back bearing blocks on a clean surface with the E-seal grooves facing up. Apply a light coating of petroleum jelly in the grooves. Also coat the E-seal and backup with the petroleum jelly, this will help keep the seals in place during reassembly.



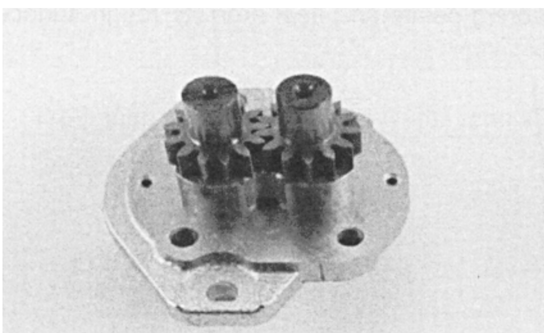
4. Place the E-seals, *flat side outward,* into the grooves in both bearing blocks. Follow by *carefully* placing the backup ring, *flat side outward,* in the groove made by the E-seal and the groove in the bearing block. *(Note: in the W900 series pump, in the center of the backup ring and E-seal there is a notch make sure that these notches line up so the backup ring will set flush with the E-seal).* The backup ring in the 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 the exposed face of the front bearing block.

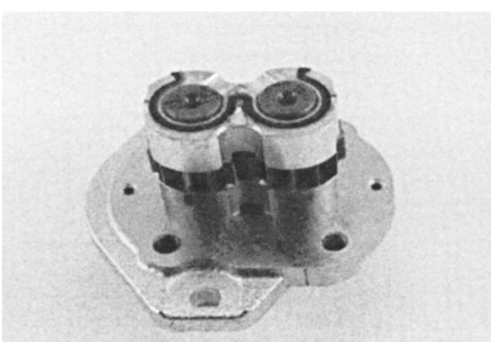


7. Insert the drive end of the drive shaft through the bearing block with the seal side down, and the open side of the E-seal pointing to the intake side of the pump.

8. Install the seal sleeve over the drive shaft and carefully slide the drive shaft through the shaft seal. Remove the seal sleeve from shaft.

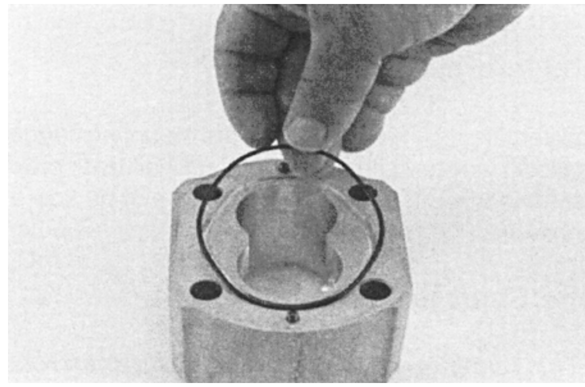


9. Install the idler gear shaft in the remaining position in the bearing block. Apply a light coat of clean oil to the face of the drive and idler gears.

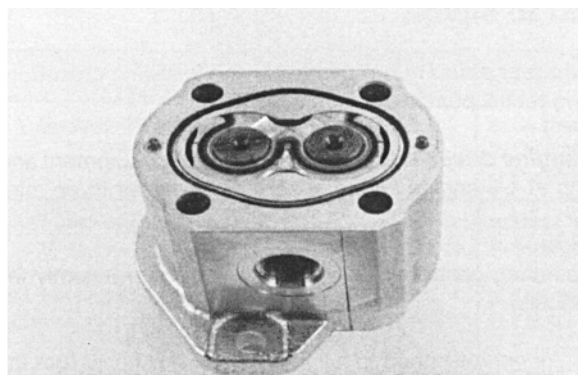


10. Pick up the rear bearing block, with seal side up and with open end of the E-seal facing the intake side of the pump, place over the drive and idler gear shafts.

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



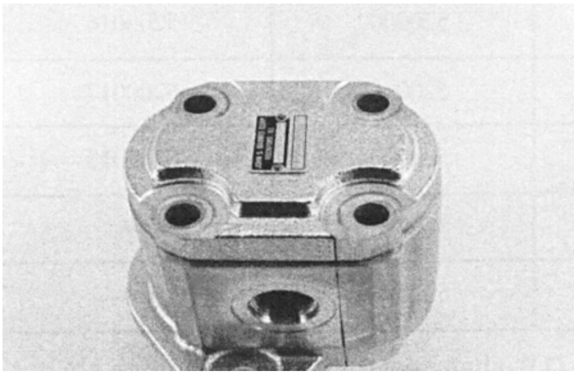
12. To install the O-rings in the gear housing, apply a light coating of petroleum jelly in the grooves on both sides of the gear housing. Also coat the new O-rings and install them in the grooves.



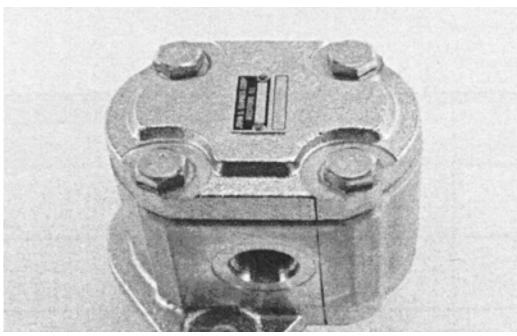
13. Gently slide the gear housing over the rear bearing block assembly, slide housing down until the housing engages the dowel pins. Press firmly in place with hands, do not force or use any tool. Check to make sure the in-take port in the housing is on the same side as the open end of the E-seal and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

14. The surface of the rear bearing block should be slightly below the face of the gear housing. If the bearing block sits higher then the rear face of the gear housing then the E-seal or o-ring have shifted out of the groove. If this

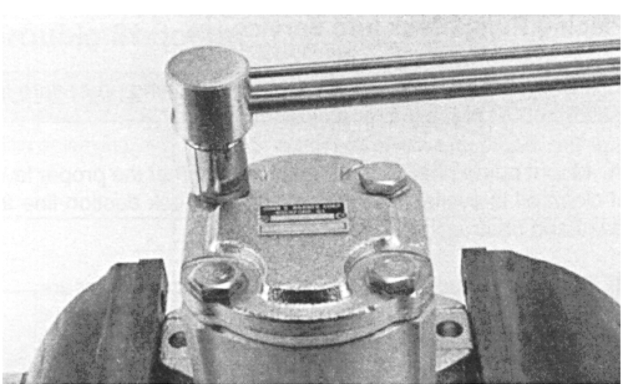
is the case, remove the gear housing and check for proper seal installation.



15. Install the two remaining dowel pins in the rear of the gear housing, if applicable, and place the end cover over the back of the pump.



16. Install the four spacers, if applicable, and hex head bolts through the bolt holes in the end cover, hand tighten.



17. Place mounting flange of the pump back in the protected jawed vise and alternately torque the bolts to the torque specifications in the torque chart. All torque figures are for "dry torque" bolts.

18. Remove pump from vise.

19. Place a small amount of clean oil in the inlet of the pump and rotate the drive shaft away from the inlet one revolution. If the drive shaft binds, disassemble the pump and check for assembly problems, then reassemble the pump.

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

Placing Pump Back Into Service

1. *If shop test stand is available,* the following procedure for testing rebuilt pumps is recommended:
   a. Mount pump on test stand making sure that the proper level of clean oil is available in the 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 P.S.I. for three minutes.
   d. Intermittently load pump to 1000 P.S.I. for three minutes.
   e. Intermittently load pump to 2000 P.S.I. 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,* the following procedure for testing rebuilt pumps is recommended:
   a. *For engine driven pumps,* mount pump on equipment and run pump at 1/2 engine speed at zero pressure for three minutes.
   b. By operating control valve, 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.

5.4 VARIABLE PUMP

Ports and Pressure Gauges

Proper servicing of pumps and motors requires that pressure be measured and monitored at various points in the hydraulic circuit. The Series 42 pump has several locations at which to take these measurements. The following outlines show the locations of the various gauge ports. The following table shows the recommended gauge size and the 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 the electric and hydraulic non-feedback proportional (NFPE and NFPH) controls are non-feedback type controls. The FNR and NFPE controls consist of modules mounted on the pump housing. The hydraulic input for NFPH is received through ports on the top of the pump [9/16–18 SAE O-ring fitting].

The non-feedback controls are set at the factory. The control modules can be removed to clean the ports and change the O-rings.

The orifice plugs for the FNR and NFPE are located inside the servo piston covers. The orifice plugs for the NFPH are located in the NFPH ports. Orifice plugs may be cleaned or replaced.

Removal and Installation of FNR and NFPE Modules

1. Clean pump and module housings.
2. Remove four (4) screws retaining module to housing [4 mm Int. Hex], and remove module from pump 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 [4.7-6.1 Nm (3.5-4.5 ft-lb].

Removal and Installation of FNR and NFPE Control Orifices

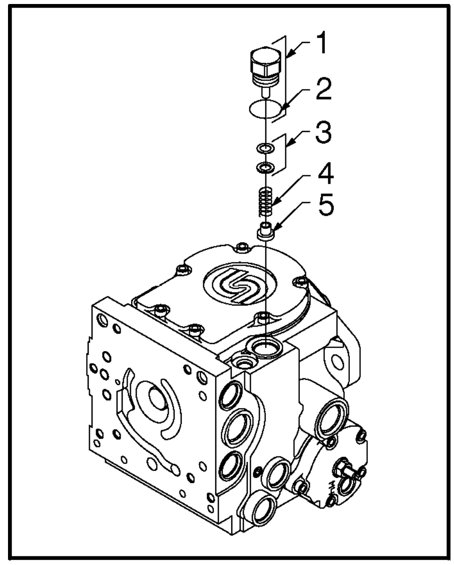
NOTE: *Future models may contain an orifice plate between module and pump housing. This will take the place of the orifice plugs beneath the servo piston cover.*

1. Remove servo piston cover.
2. Remove orifice plug [1/8 in Int. Hex].
3. Examine orifice and port for cleanliness.
4. Install orifice plug [2.0-3.4 Nm (1.5-2.5 ft•lbf)].

Charge Relief Valve

The charge relief valve may be removed for cleaning and installation of fresh O-rings. The pressure setting may be changed. However, note that the setting will vary for different charge flows which depends on charge pump size and pump speed. The factory setting is set relative to case pressure at 1800 rpm. The actual charge pressure will vary at different speeds.

SHIM ADJUSTABLE STYLE

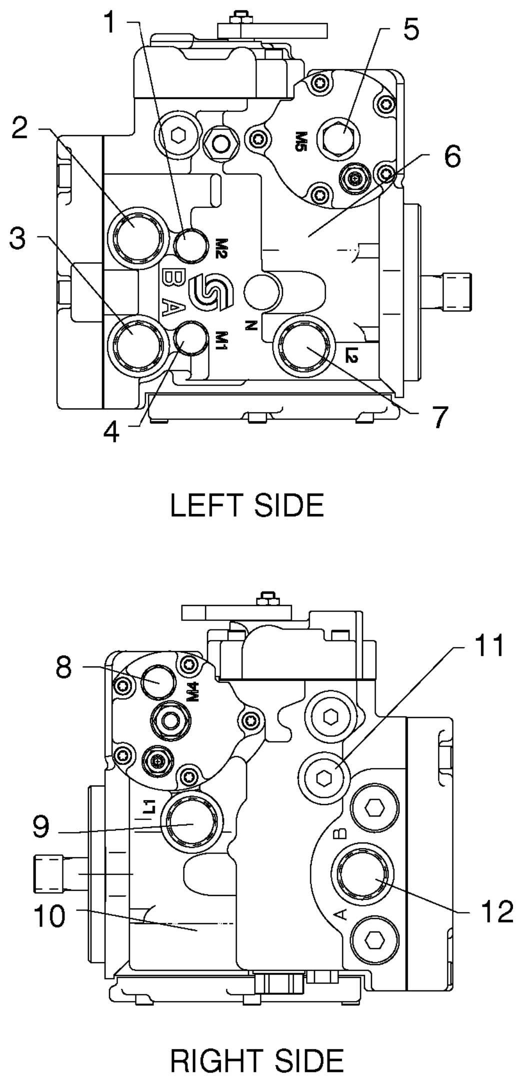


1. Plug
2. O-ring
3. Shims
4. SpringT-Seal
5. Poppet

Figure 5-81. Shim Adjustable Charge Relief Valve Components

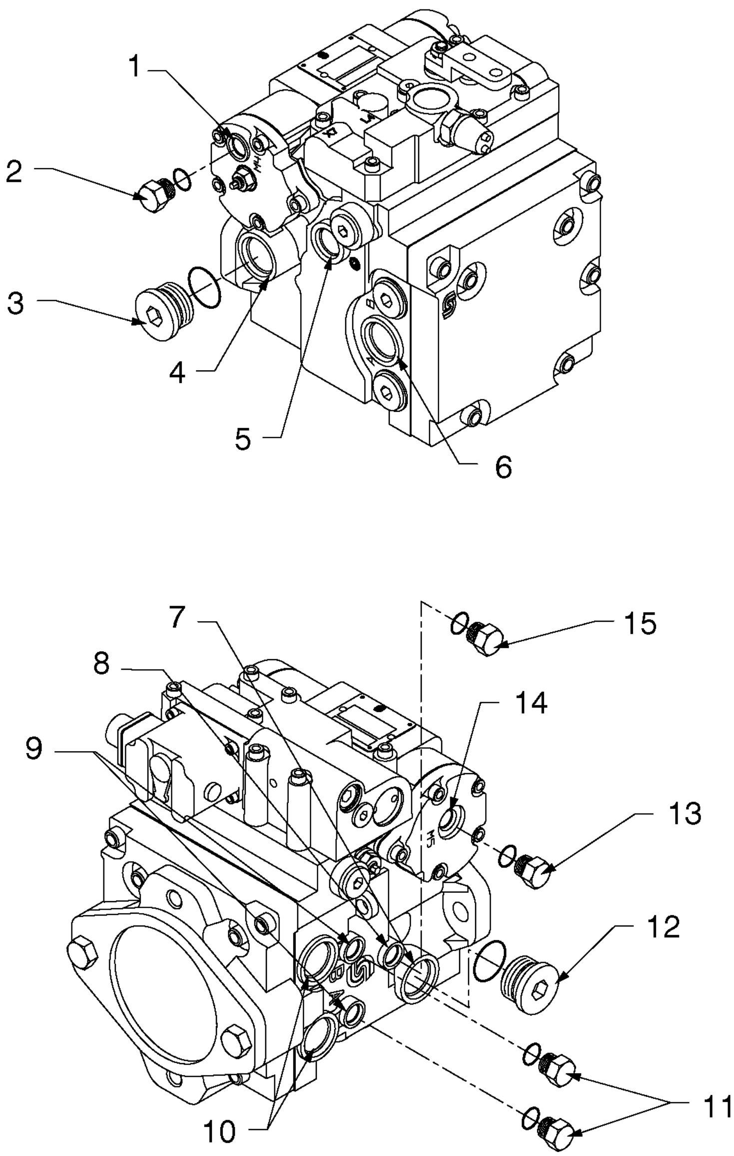
1. Remove the shim adjustable charge relief valve plug [1 in Hex] from the pump housing. Remove the O-ring from the plug.
2. Remove the spring and poppet from the housing.
3. Do not alter the shims which may be installed between the spring and valve plug, or interchange parts with another valve. Inspect the poppet and mating seat in the housing for damage or foreign material.
4. If desired, the charge relief valve setting can be changed. An approximate rule of thumb is 4 bar / 1.25 mm (58 psi / 0.050 in). The effective setting will vary.

   To confirm the charge relief valve setting, measure charge pressure (port M3) with the pump in stroke. The charge pressure should level off when the 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 5-82. Gauge Port Locations

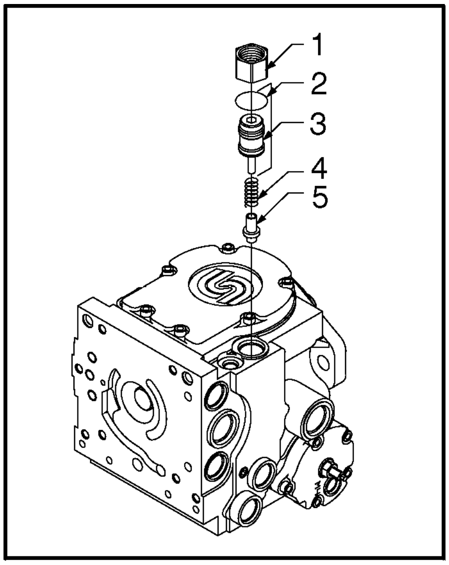


#	Plug/ Fitting	Torque	
		lb. ft.	Nm
1	Servo Gauge Port M4	N/A	N/A
2	11/16	20-35	27-47
3	9/16	70-100	95-135
4	Case Drain Port L1	N/A	N/A
5	Charge Pressure Gauge M3	N/A	N/A
6	Charge Pump Inlet Port S	85	115
7	Case Drain Port L2	N/A	N/A
8	Port N	N/A	N/A
9	System Gauge M1 & M2	N/A	N/A
10	System Ports A&B	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 5-83. Plugs/Fittings Size & Torque

5. Install a new O-ring on the valve plug. Reinstall the poppet, spring, and plug (with shims and O-ring) into the pump housing [55-135 Nm (40-100 ft•lbf)].

SCREW ADJUSTABLE STYLE



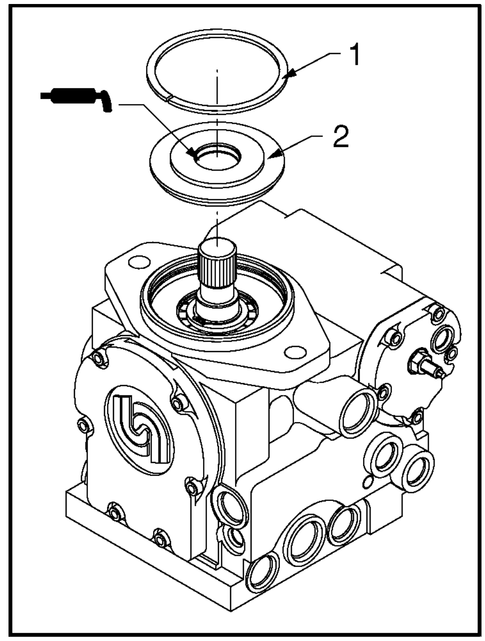
1. Lock Nut
2. O-ring
3. Plug
4. SpringT-Seal
5. Poppet

Figure 5-84. Screw Adjustable Charge Relief Valve Components

1. Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and housing so as to approximately maintain the original adjustment when assembling, Remove the screw adjustable charge relief valve plug by loosening the lock nut [1-1/16 in Hex] and unscrewing the plug [8 mm Int. Hex]. Remove the O-ring from the plug.
2. Remove the spring and poppet from the housing.
3. Inspect the poppet and mating seat in the housing for damage or foreign material.
4. Install a new O-ring on the valve plug. Reinstall the poppet and spring. Reinstall the plug with its lock nut [47-57 Nm (34-42 ft•lbf)], aligning the marks made at disassembly.
5. Check and adjust, if necessary, the charge pressure. For screw adjustable "anti-stall" charge relief valves, an approximate rule of thumb is 2.8 bar / quarter turn (40 psi / quarter turn).

   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.

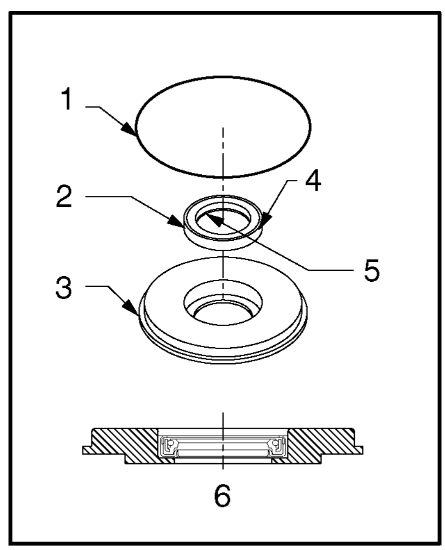
Shaft Seal and Shaft Replacement



1. Retaining Ring
2. Seal Carrier Assembly

Figure 5-85. Shaft Seal Components

A lip type shaft seal is used in Series 42 pumps. This seal and/or the shaft can be replaced without major disassembly of the unit. Replacement generally requires removal of the pump from the 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 5-86. Installation of Shaft Seal

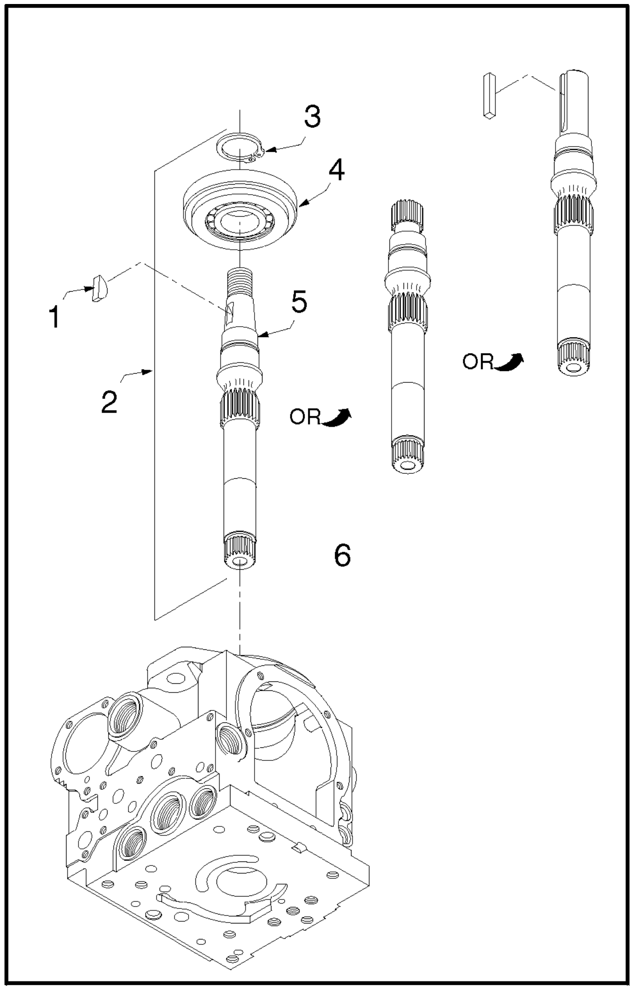
1. Position the pump with shaft facing up.

NOTE: *If the unit is positioned horizontally when the shaft is removed, the 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 new shaft only, proceed to step 8.
5. Place seal carrier in an arbor press with shaft bearing side down. 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.

NOTE: *If shaft is not being replaced go to step 11.*

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 aids in preventing leaks caused by damage to seal bore in seal carrier. Remove shaft and roller bearing assembly from pump or motor. Bearing assembly can be transferred to the new shaft (steps 9 and 10).
8. Remove retaining ring that secures roller bearing assembly with a snap ring pliers. Remove roller bearing assembly. Place roller bearing assembly on new shaft and secure with retaining ring.
9. Place roller bearing assembly on new shaft and secure with retaining ring.
10. Wrap spline or key end of shaft with thin plastic to prevent damage to seal lip during installation. 64 Lubricate inside diameter of shaft seal with petroleum jelly.
11. Place O-ring on shaft bearing and lubricate with petroleum jelly.
12. 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.
13. Install retaining ring.



1. Key
2. Shaft Assembly
3. Retaining Ring
4. Roller Bearing
5. Shaft

Figure 5-87. Shaft Components

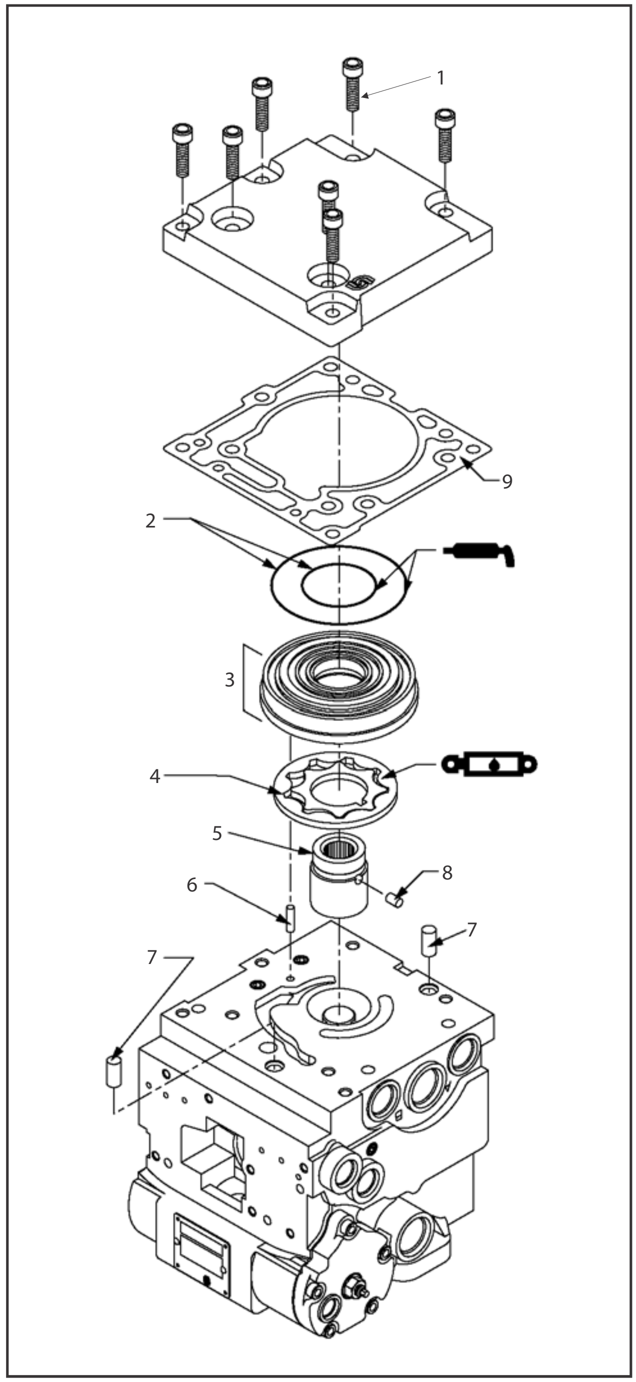
Charge Pump

NOTE: *Charge pump may be disassembled to inspect and clean, or to change the auxiliary shaft drive coupling.*

1. Remove auxiliary pump, if necessary.
2. Remove screws retaining charge pump cover to pump housing. Seven Torx T45 screws are used with the "no pad" or SAE "A" auxiliary mounting pad charge pump cover Six screws are used with the 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 two gerotor cover O-rings.
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. Each part should be inspected separately if they are to be reused. If either of the 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. Prior to assembly, lubricate gerotor assembly with clean hydraulic oil.
8. Install gerotor drive pin into hole in drive coupling, and retain with grease or petroleum jelly.
9. Install drive coupling on pump shaft with smaller outside diameter oriented away from pump shaft. Different couplings are used with different auxiliary pad options.
10. Install gerotor assembly on coupling.
11. Install gerotor cover locating pin in pump housing. Install gerotor cover assembly over gerotor. The 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 onto the gerotor cover and retain with petroleum jelly or grease. (An additional O-ring was used on the gerotor cover of very early production pumps with the SAE "A" pad option.)
13. Install the charge pump cover locating pins and a new charge pump cover gasket.
14. Install charge pump cover. The cover must engage the gerotor cover and locating pins. Install charge pump cover screws. Torque evenly to 26-32 ft-lb (36-43 Nm).
15. If necessary, reinstall auxiliary pump.



1. Cover Retaining Screw
2. O-ring
3. Geroter Cover
4. Geroter Assembly
5. Drive Coupling
6. Geroter Cover Locating Pin
7. Charge Pump Cover Locating Pin
8. Geroter Drive Pin
9. Gasket

Figure 5-88. Charge Pump Components

5.5 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

The goal at system start up is to put the hydrostatic system in operation to preserve the designed system life span. Use the following start-up procedure whenever a new pump or motor is installed, or a system is restarted after a pump or motor has been removed and/or replaced.

WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTIONS DISCONNECTED, ETC.) WHILE PERFORMING THE PROCEDURE TO PREVENT INJURY. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING THE VEHICLE/MACHINE.

Inspect pump and/or motor, unit(s) for damage that may have occurred during shipping and handling. 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 prior to entering the reservoir. Use of contaminated fluid will damage components and may result in unexpected vehicle/machine movement.

NOTE: *If a pump or motor is replaced due to internal damage, inspect remaining units (pump or motors) for damage and contamination. The entire hydraulic system will need to be flushed and fluid replaced. Failure to do so may cause considerable damage to entire system.*

Inlet line leading from reservoir to pump must be filled before start-up. Check inlet line for properly tightened fittings and make sure it is free of restrictions and air leaks.

NOTE: *In most cases, reservoir is above pump inlet so pressure head created by higher oil level helps keep inlet pressures within an acceptable range and prevent high vacuum levels. However, due to hose routing or low reservoir locations, there may be air trapped within this line. It is important to bleed air is from this line. This can be accomplished by loosening hose at fitting closest to pump. When oil begins to flow, line is full, air has been purged, and fitting can be retightened to specified torque. If tank needs to be pressurized to start flow of oil, a vacuum reading should be taken at inlet of pump during operation to verify pump is not being asked to draw an inlet vacuum higher than it is capable of.*

Fill pump and/or motor housing with clean hydraulic fluid before start up. Fill housing by pouring filtered oil in upper case drain port.

NOTE: *It is highly recommended to use the highest possible case drain port, this ensures housing contains as much oil as possible and offers greatest amount of lubrication to internal components.*

NOTE: *In initial start-up conditions, it may be convenient to fill housing before installing case drain line. Component, (especially motor), location may be such that access to the case drain port after installation is not realistic.*

NOTE: *Make certain oil being used to fill component housing is as clean as possible. Store fill container to prevent it from becoming contaminated.*

Install a 60 bar (or 1000 psi) pressure gauge in charge pressure gauge port to monitor charge pressure during start-up.

It is recommended the 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 THE ENGINE UNLESS PUMP IS IN THE NEUTRAL POSITION (0 DEGREES SWASHPLATE 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 the engine and run at the lowest possible RPM until charge pressure has been established. Excess air should be bled from the system lines as close to the motors as possible.

NOTE: *With engine on low idle, "crack", (loosen-don't 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 the line is full, air has been purged, and system hoses should be retightened to specified torque.*

Once charge pressure has been 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 of improper pressure.

WARNING

INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATOR'S ABILITY TO CONTROL THE MACHINE.

Shut down engine and connect external control input signal. Reconnect machine function(s), if disconnected earlier. Start engine, check 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 now ready for operation.

5.6 PRESSURE SETTING PROCEDURE

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within ± 5% of specified pressures.

Telescope Main Relief

1. Install a high pressure gauge at port "M1" located on front face of valve block.
2. Activate telescope in.
3. Adjust relief valve to 3300 psi (227.5 Bar), located on front face of block, 5th relief valve counting left to right. Turn clockwise to increase and counterclockwise to decrease.

Steer

1. Install a high pressure gauge at port "M3".
2. Activate steer and adjust relief valve to 2500 psi (172 Bar). Relief valve is located on front face of block, 3rd relief valve counting left to right. Turn clockwise to increase and counterclockwise to decrease.

Platform Level Up

1. Install a high pressure gauge at port "M2", located on platform valve block.
2. Activate level up to the end of stroke, you should read 2800 psi (193 Bar).
3. Level up relief valve is located right next to the check port. Turn clockwise to increase and counterclockwise to decrease.

Platform Level Down

1. Install a high pressure gauge at the port marked "M1", located on the platform valve block.
2. Activate level down to the end of stroke, reading 1800 psi (124 Bar).
3. The level down relief valve is located right next to the check port. Turn clockwise to increase and counterclockwise to decrease.

Articulating Jib

1. Install a high pressure gauge on the port "M3" on Jib block, located on platform valve block.
2. Activate Jib up or down. Pressure should read 1500 psi (103 Bar).
3. The relief valve is located on the Jib block. Turn clockwise to increase, counterclockwise to decrease.

Proportional Main Relief

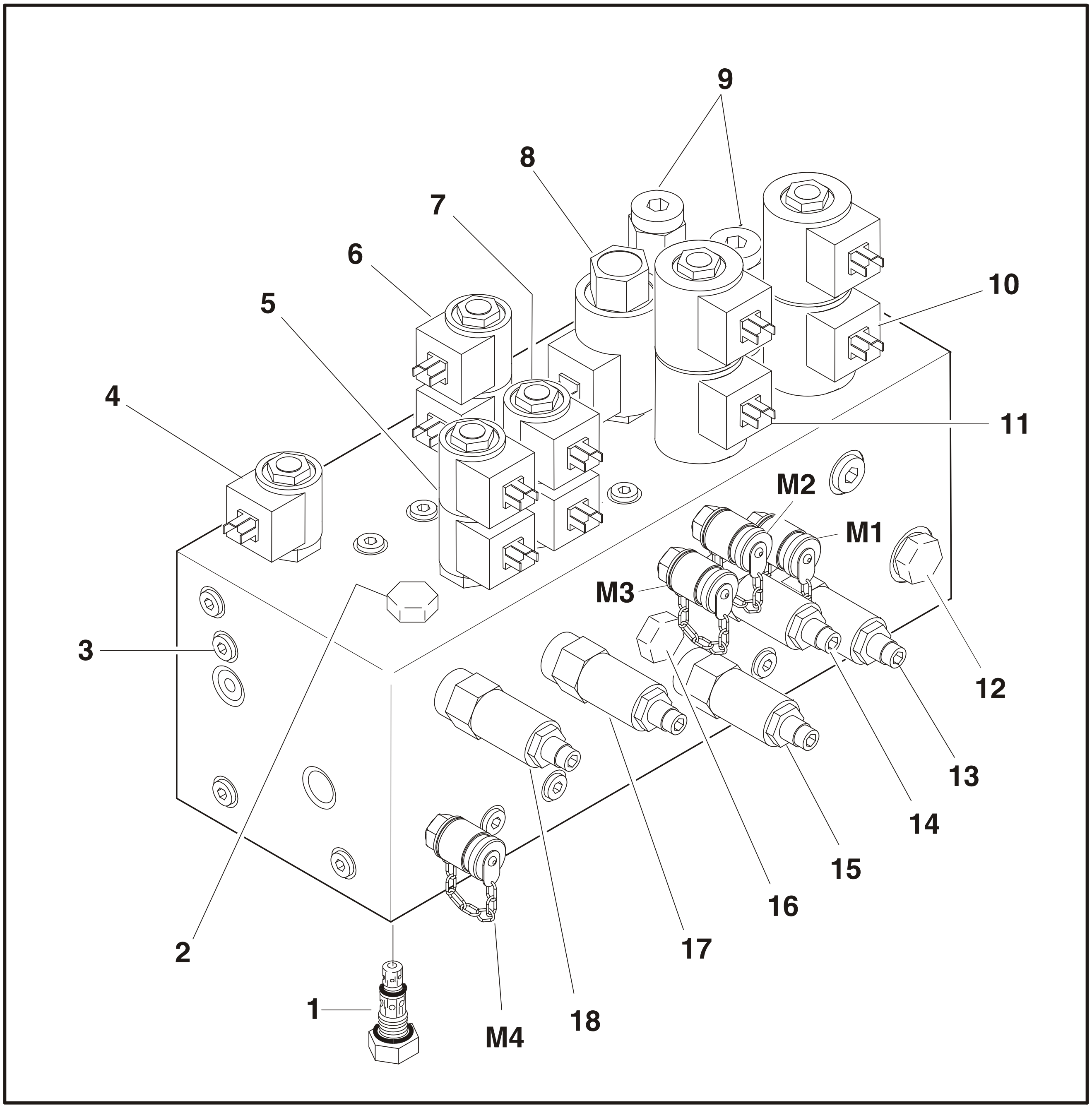
1. Install a high pressure gauge at port "M2", located on front face of the block.
2. Raise the boom up to the end of stroke, or remove the hose from port #10 and plug and cap, then activate lift up.
3. Adjust valve to 3200 psi (220 Bar). This relief valve is located on front face of block and is 4th relief valve counting left to right. Turn clockwise to increase, counterclockwise to decrease.

Lift Down

1. Install a high pressure gauge at port "M2".
2. Activate lift down.
3. Adjust relief valve to 1200 psi. Relief valve is located on the front face of the block, and is 2nd relief valve counting left to right. Turn clockwise to increase, counterclockwise to decrease.

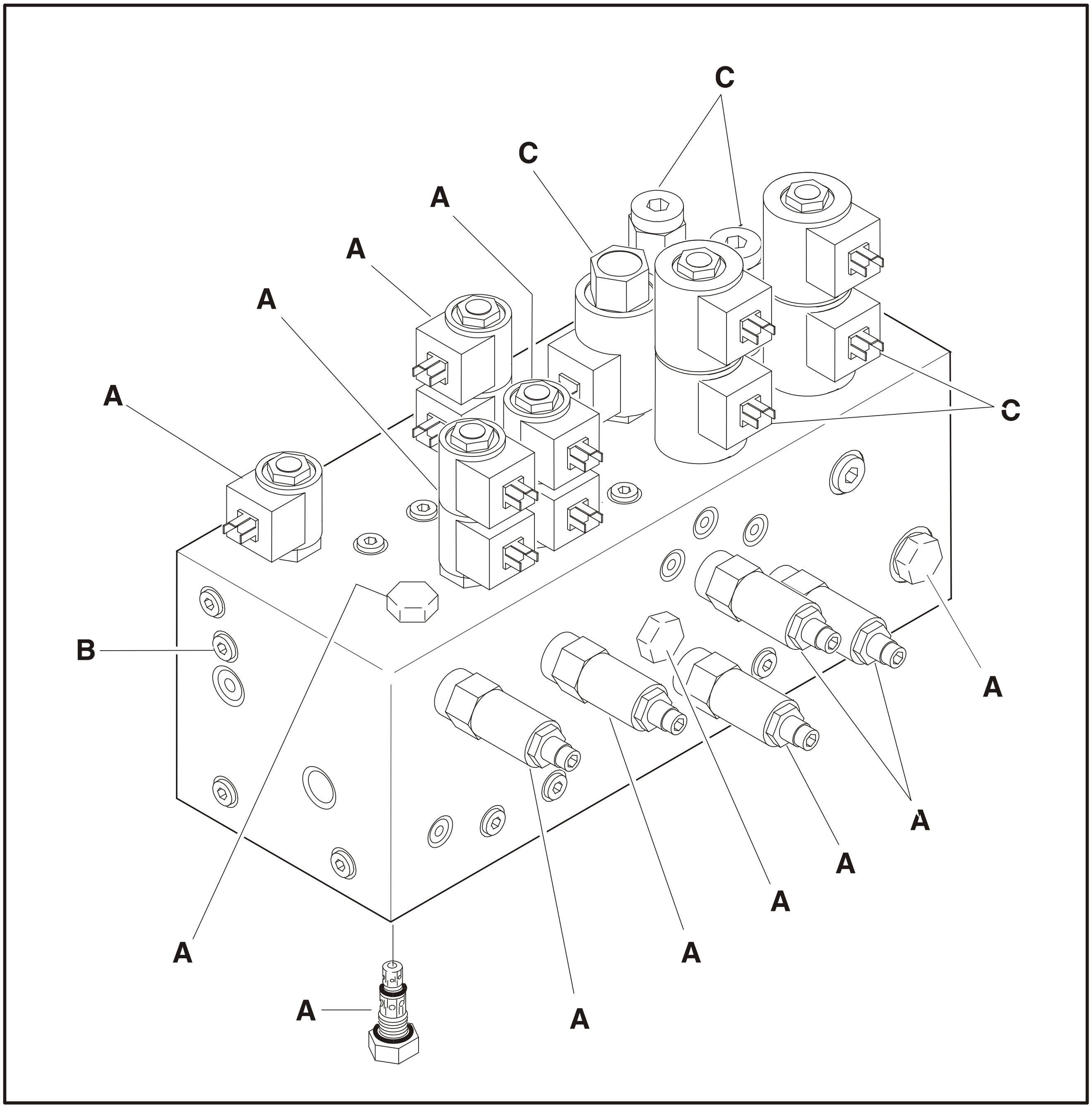
Swing

1. Left and right are done with one adjustment.
2. Install a high pressure gauge at port "M4", located on front face of main valve.
3. Either remove one of the swing hoses, plug and cap or swing turntable around until it hits the stop.
4. Activate swing. Pressure should read 1700 psi. The relief valve is located on front face of the block, first relief valve counting left to right. Turn clockwise to increase, counterclockwise to decrease.



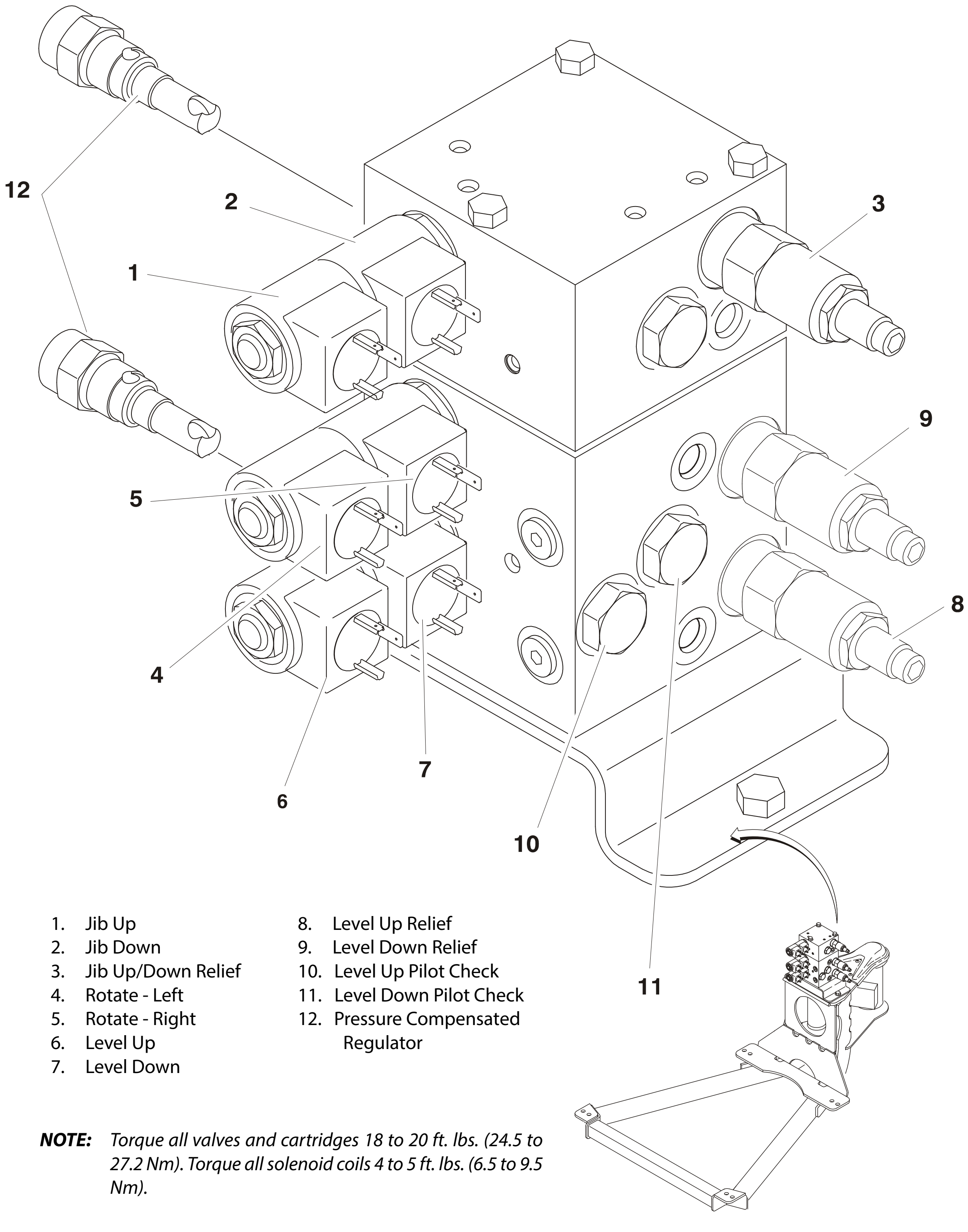
1. Check Valve
2. Load Shuttle
3. Load Shuttle
4. Main Dump
5. Swing
6. Steer
7. Upper Lift
8. Proportional Dump
9. Directional Pilot
10. Telescope
11. Lower Lift
12. Flow Regulator
13. Bang Bang Relief
14. Proportional Main Relief
15. Steer Relief
16. Load Shuttle (Steer)
17. Lift Down Relief
18. Swing Relief

Figure 5-89. Main Control Valve



A	18-20 ft. lbs. (24.5 - 27.2 Nm)
B	4-5 ft. lbs. (5.4 - 6.8 Nm)
C	25-27 ft. lbs. (34 - 36.7 Nm)

Figure 5-90. Main Control Valve Torque Values



1. Jib Up
2. Jib Down
3. Jib Up/Down Relief
4. Rotate - Left
5. Rotate - Right
6. Level Up
7. Level Down
8. Level Up Relief
9. Level Down Relief
10. Level Up Pilot Check
11. Level Down Pilot Check
12. Pressure Compensated Regulator

NOTE: *Torque all valves and cartridges 18 to 20 ft. lbs. (24.5 to 27.2 Nm). Torque all solenoid coils 4 to 5 ft. lbs. (6.5 to 9.5 Nm).*

Figure 5-91. Platform Control Valve

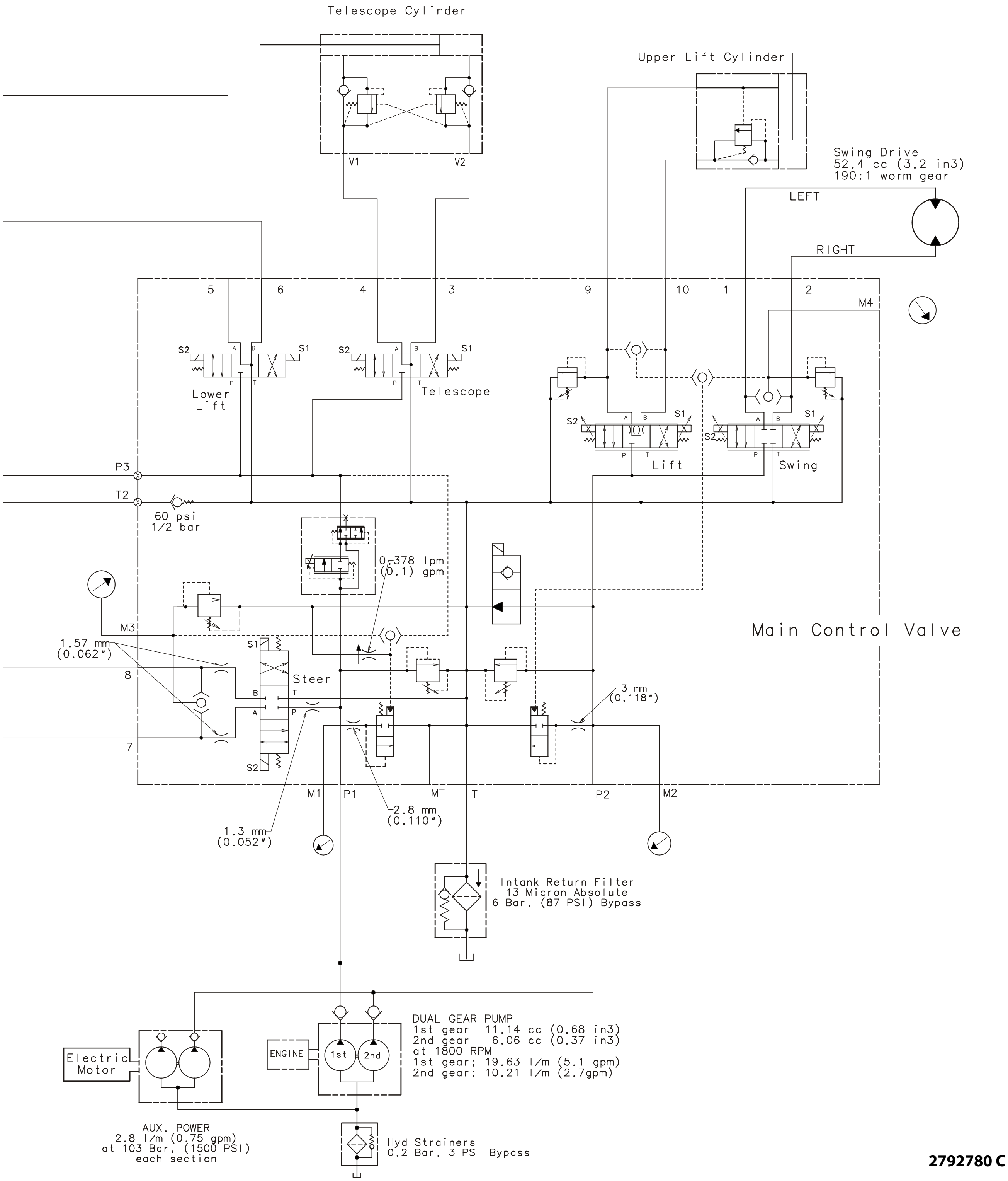


Figure 5-91. Hydraulic Schematic - Sheet 2 of 6

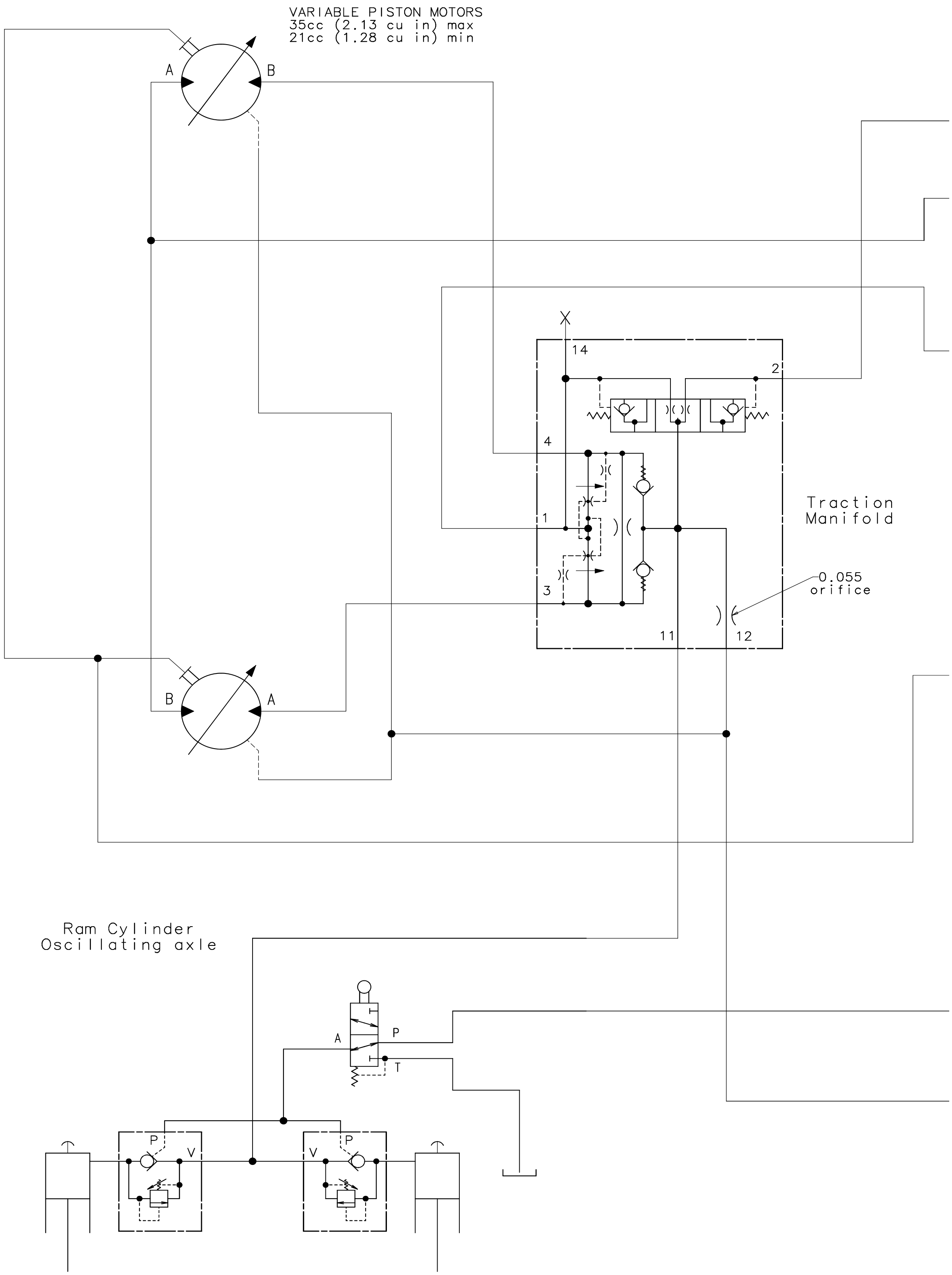
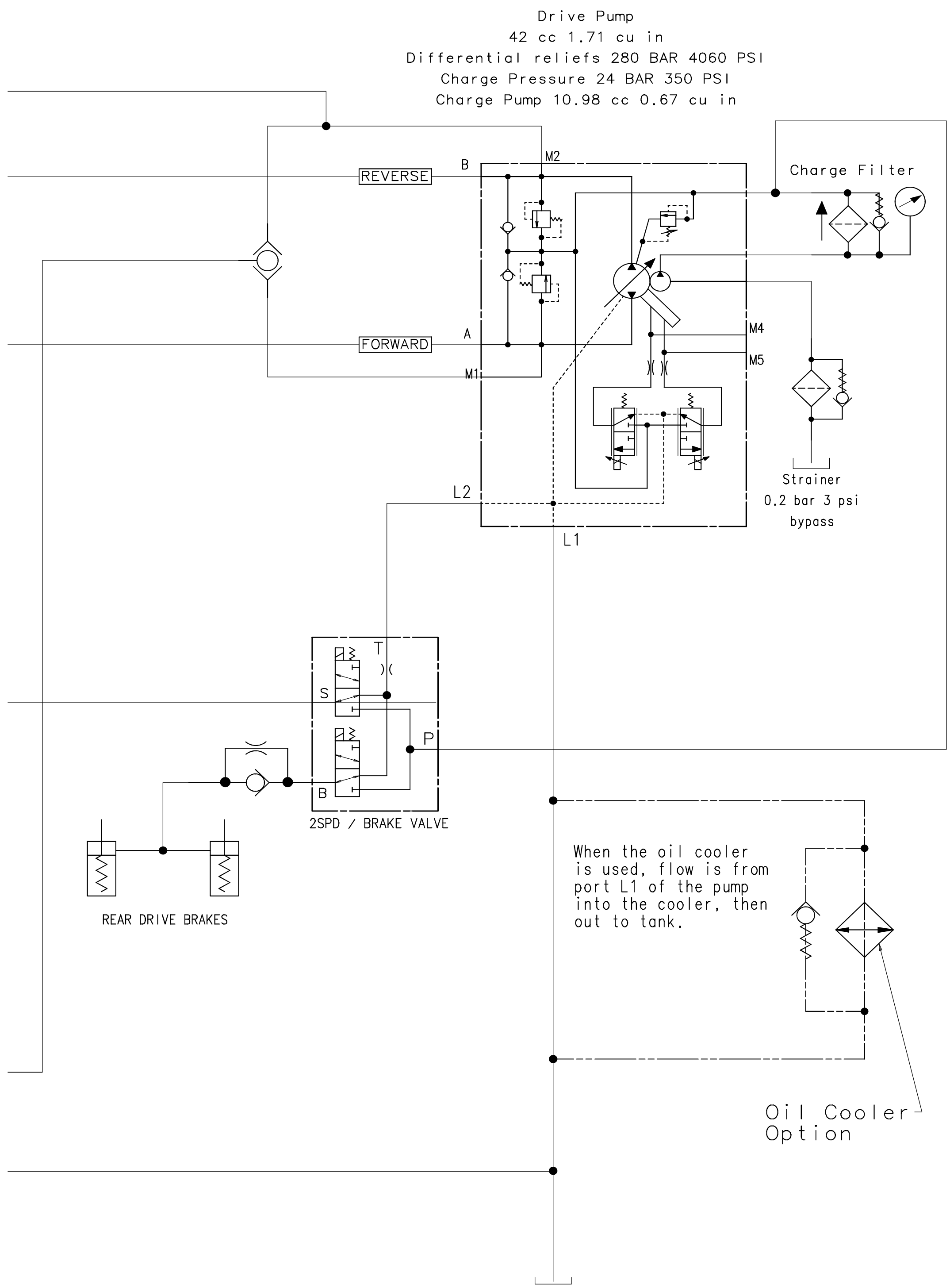


Figure 5-92. Hydraulic Schematic - Sheet 3 of 6



2792780 C

Figure 5-93. Hydraulic Schematic - Sheet 4 of 6

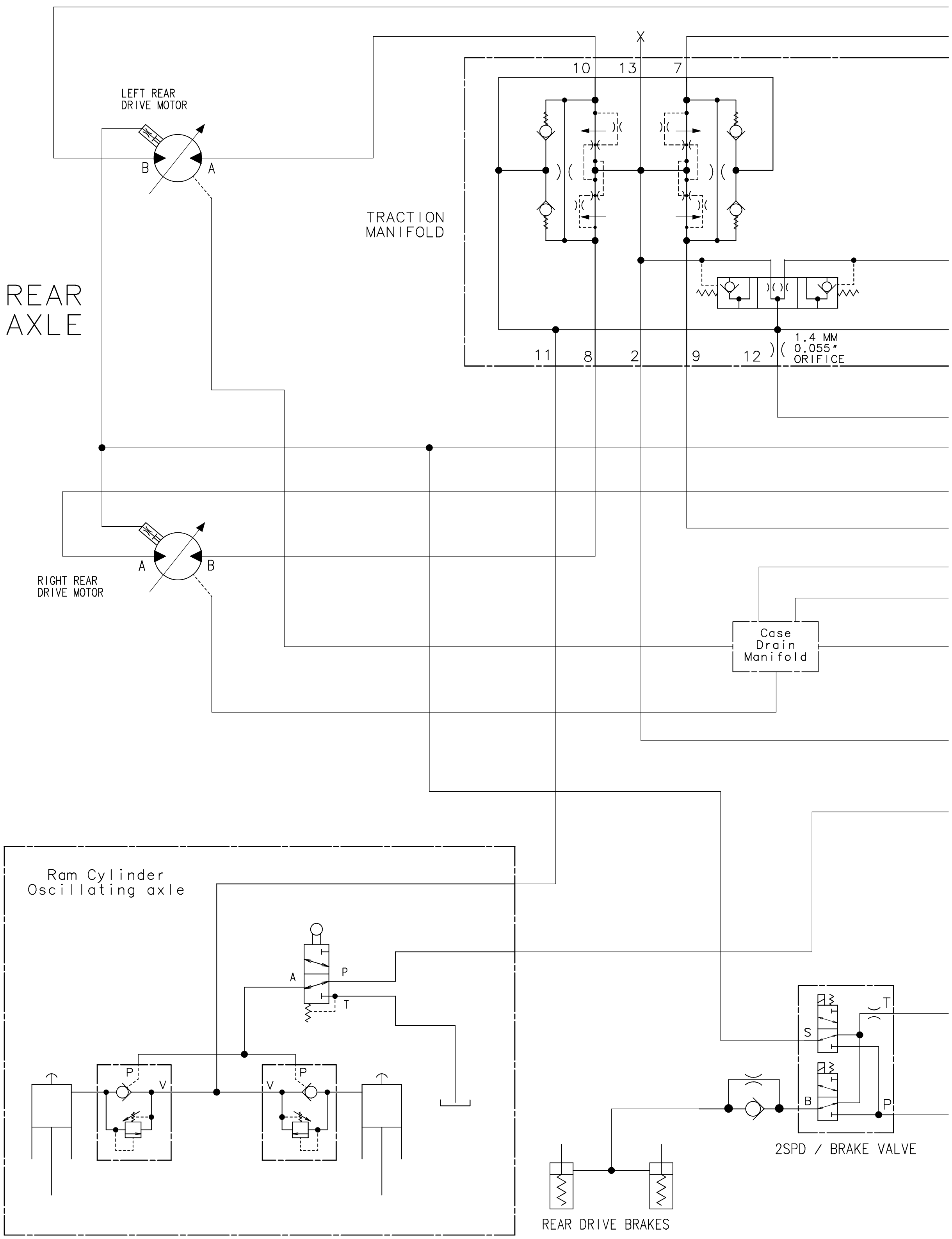


Figure 5-94. Hydraulic Schematic - Sheet 5 of 6

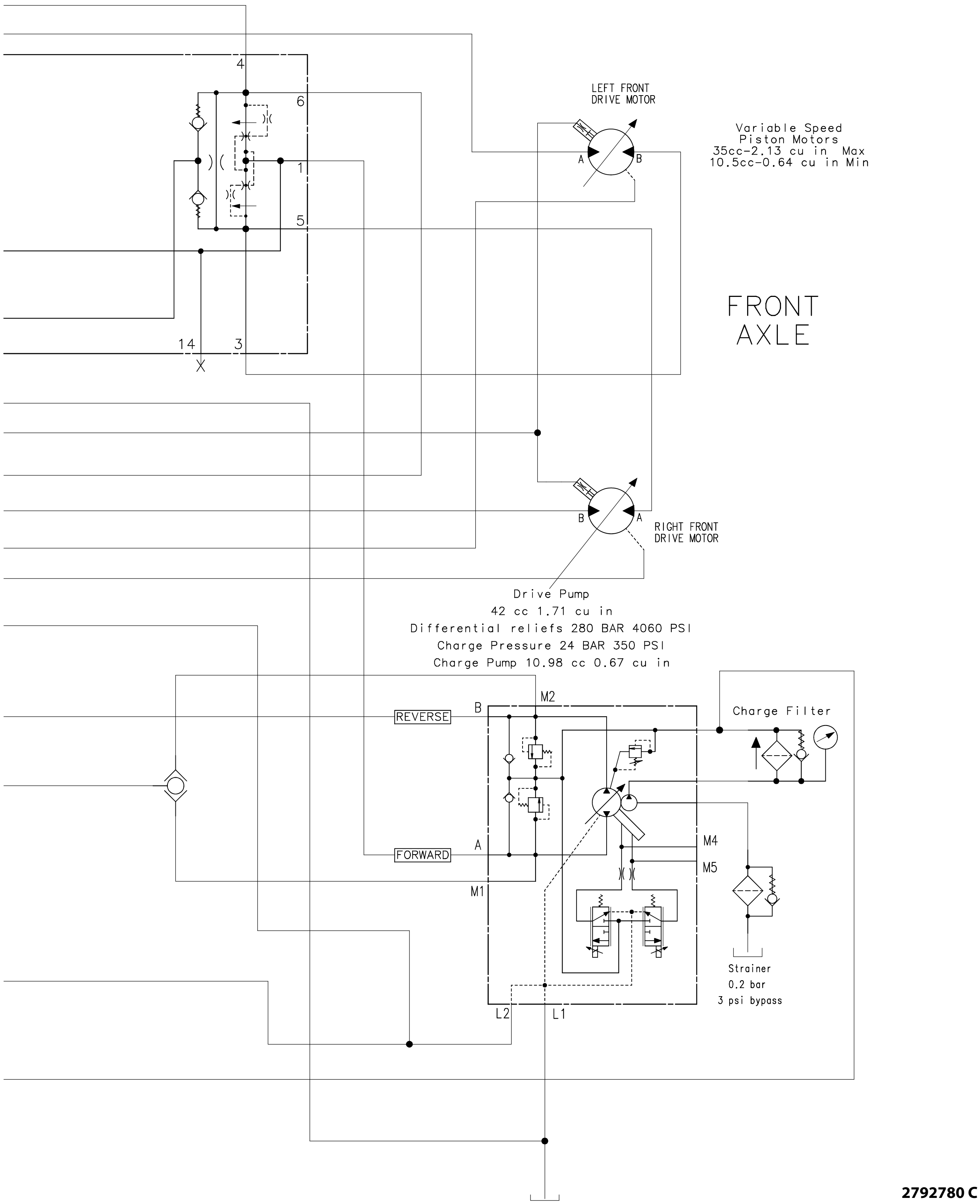


Figure 5-95. Hydraulic Schematic - Sheet 6 of 6

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.

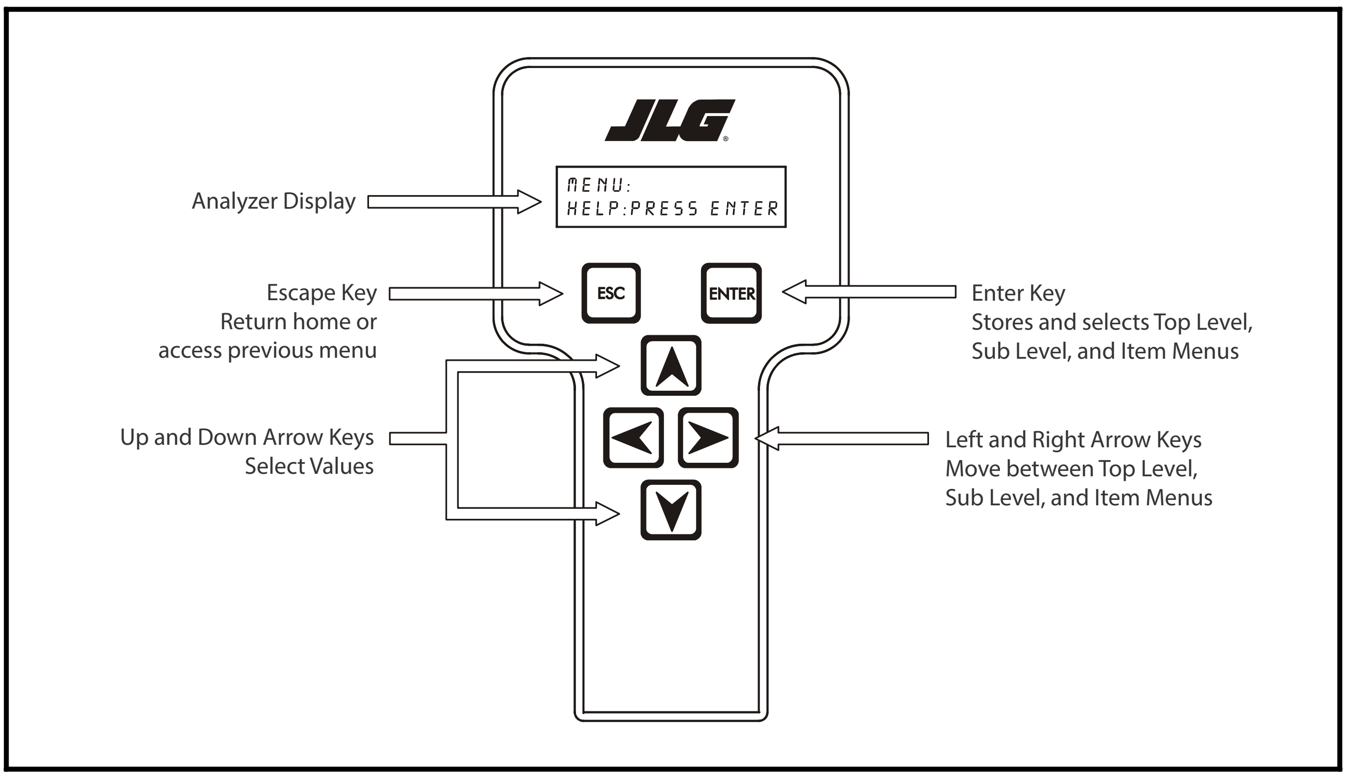
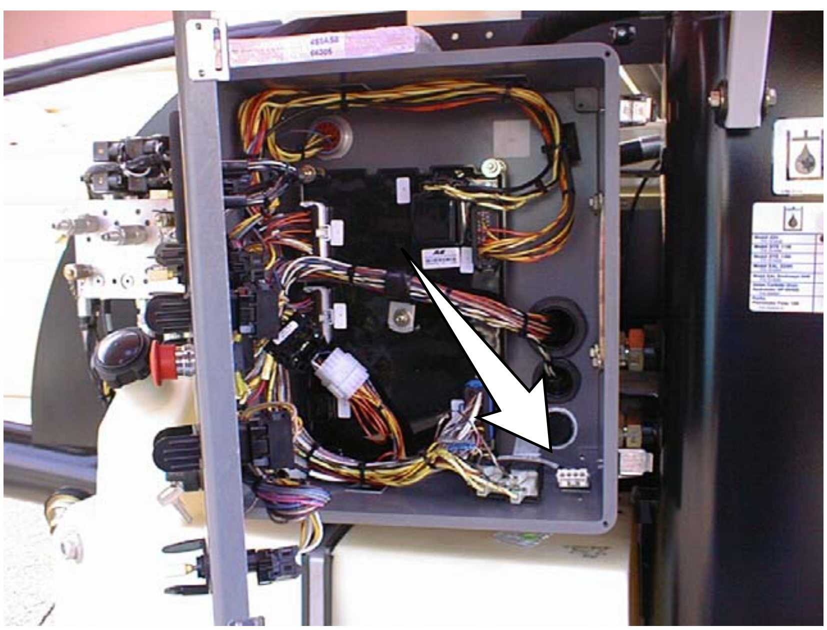


Figure 6-1. Hand-Held Analyzer (WANALYZER Controls and Display Similar)

PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 6-2. Analyzer Connecting Points

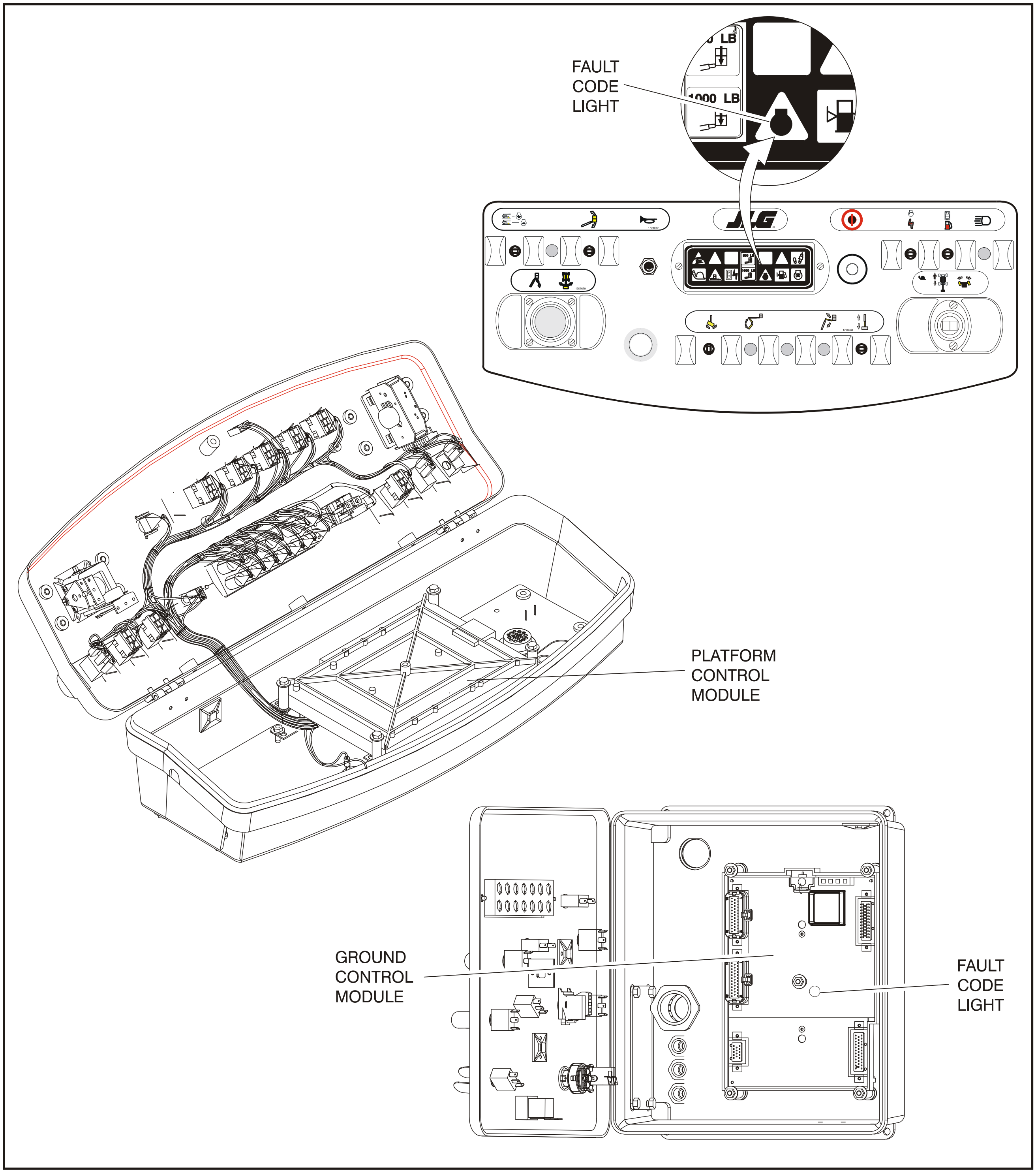


Figure 6-3. Control Module Location

6.4 TO CONNECT THE JLG CONTROL SYSTEM ANALYZER

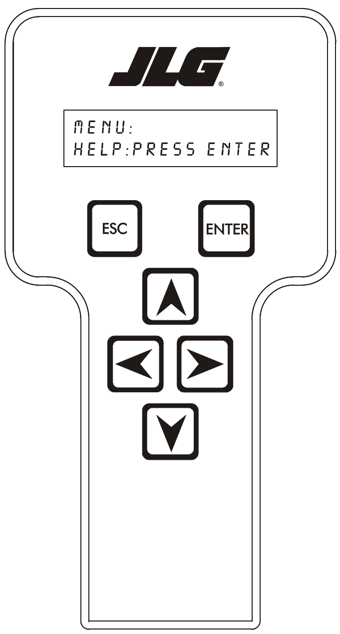
1. Connect the four pin end of the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

NOTE: *The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.*

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

6.5 USING THE ANALYZER

With the machine power on and the analyzer connected properly, the analyzer will display the following:



HELP:
PRESS ENTER

At this point, using the **RIGHT** and **LEFT** arrow keys, you can move between the top level menu items. To select a displayed menu item, press **ENTER**. To cancel a selected menu item, press ESC.; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

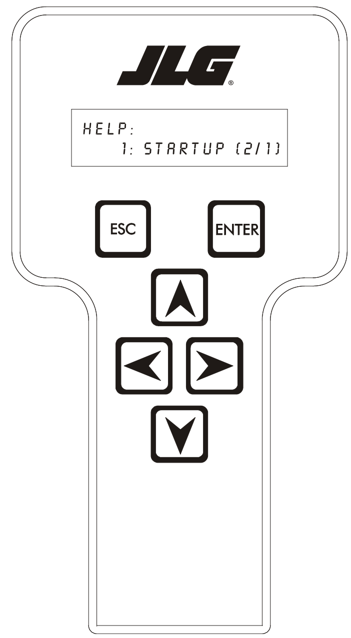
HELP
DIAGNOSTICS
SYSTEM TEST
ACCESS LEVEL
PERSONALITIES

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

MACHINE SETUP
CALIBRATIONS (view only)

If you press **ENTER**, at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display will scroll the fault across the screen. If there was no fault detected, the display will read: **HELP: EVERYTHING OK.** If powered up at the ground station, the display will read: **GROUND OK.**

If **ENTER** is pressed again, the display moves to the following display:



LOGGED HELP
1: POWER CYCLE (0/0)

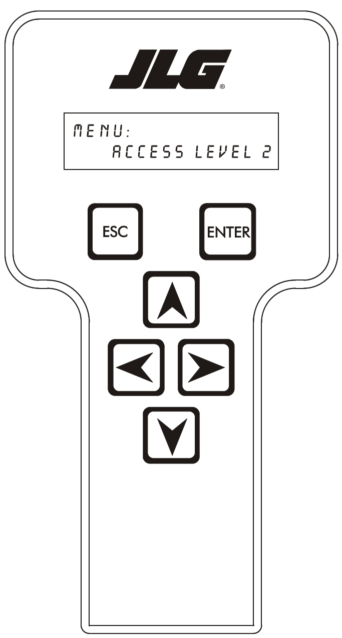
At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESC.** two times. **POWER CYCLE (0/0)** indicates a power up.

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

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

6.6 CHANGING THE ACCESS LEVEL OF THE HAND HELD ANALYZER

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



MENU:
ACCESS LEVEL 2

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

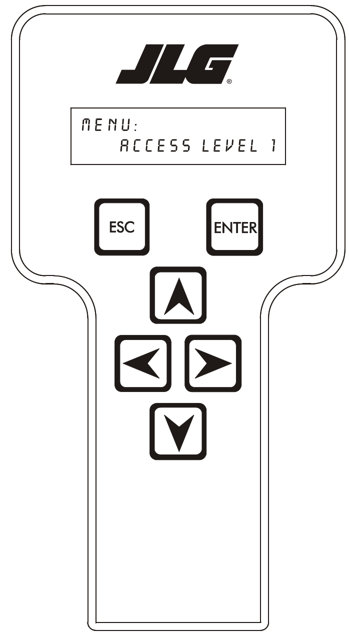
Using the **UP** or **DOWN** arrow keys, enter the first digit of the password, 3.

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

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

Continue using the arrow keys until all the remaining digits of the password is shown.

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:



MENU:
ACCESS LEVEL 1

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

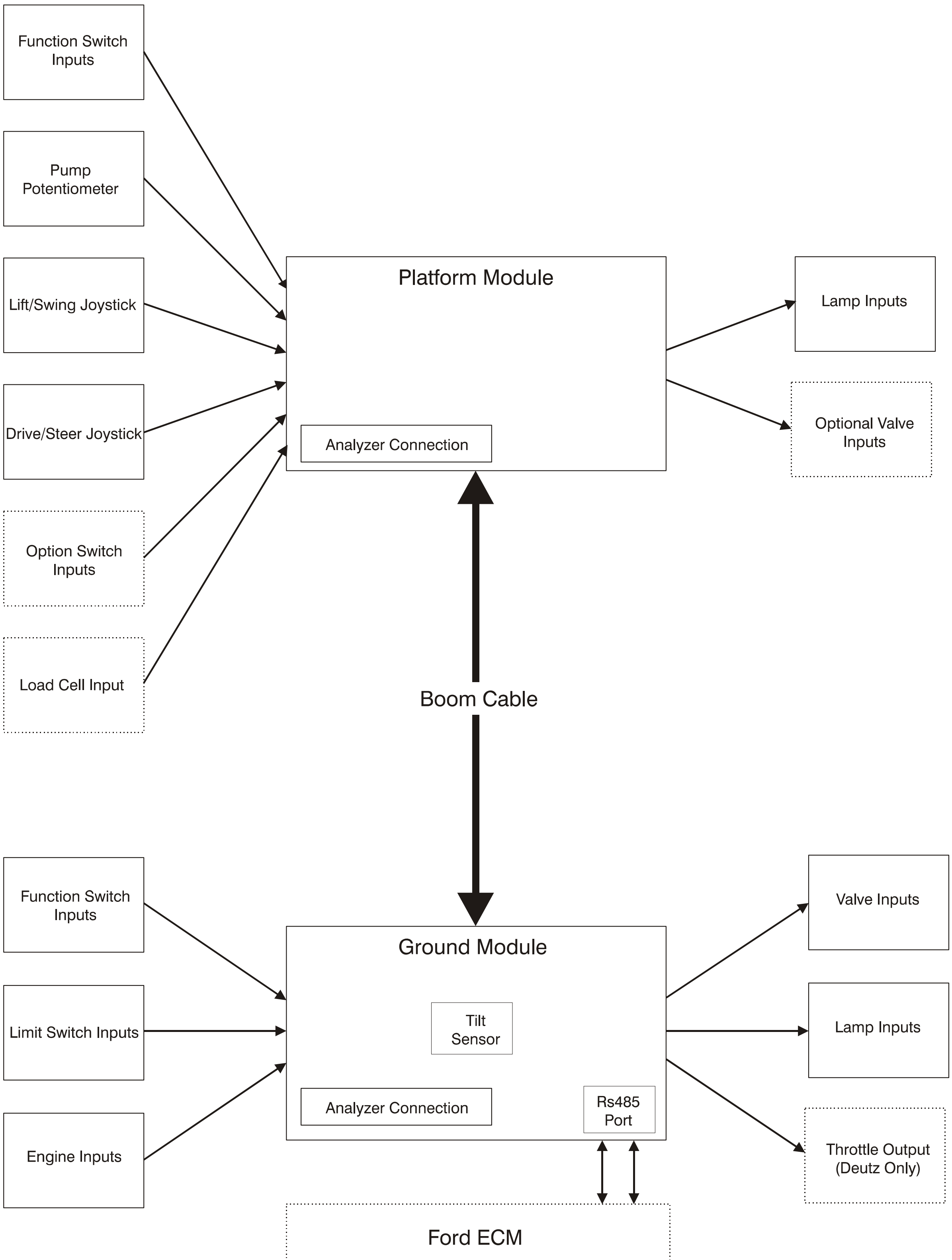
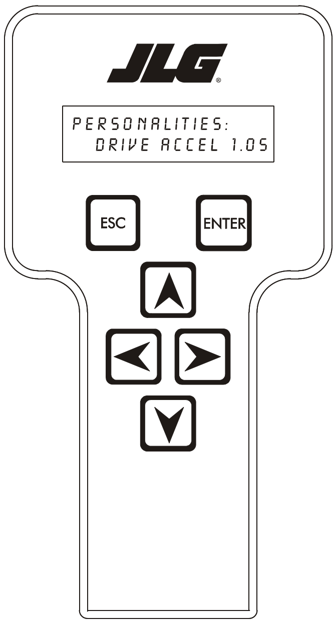


Figure 6-4. ADE Control System Block Diagram

6.7 ADJUSTING PARAMETERS USING THE HAND HELD ANALYZER

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

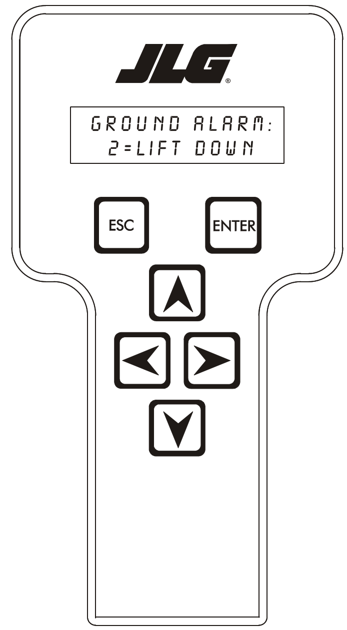


PERSONALITIES:
DRIVE ACCEL 1.0s

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 when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at access level 1.

6.8 MACHINE SETUP

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



GROUND ALARM:
2 = LIFT DOWN

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 lifting down. 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 Table 6-2, Personality Ranges/Defaults, and in this Service Manual for the recommended factory settings.*

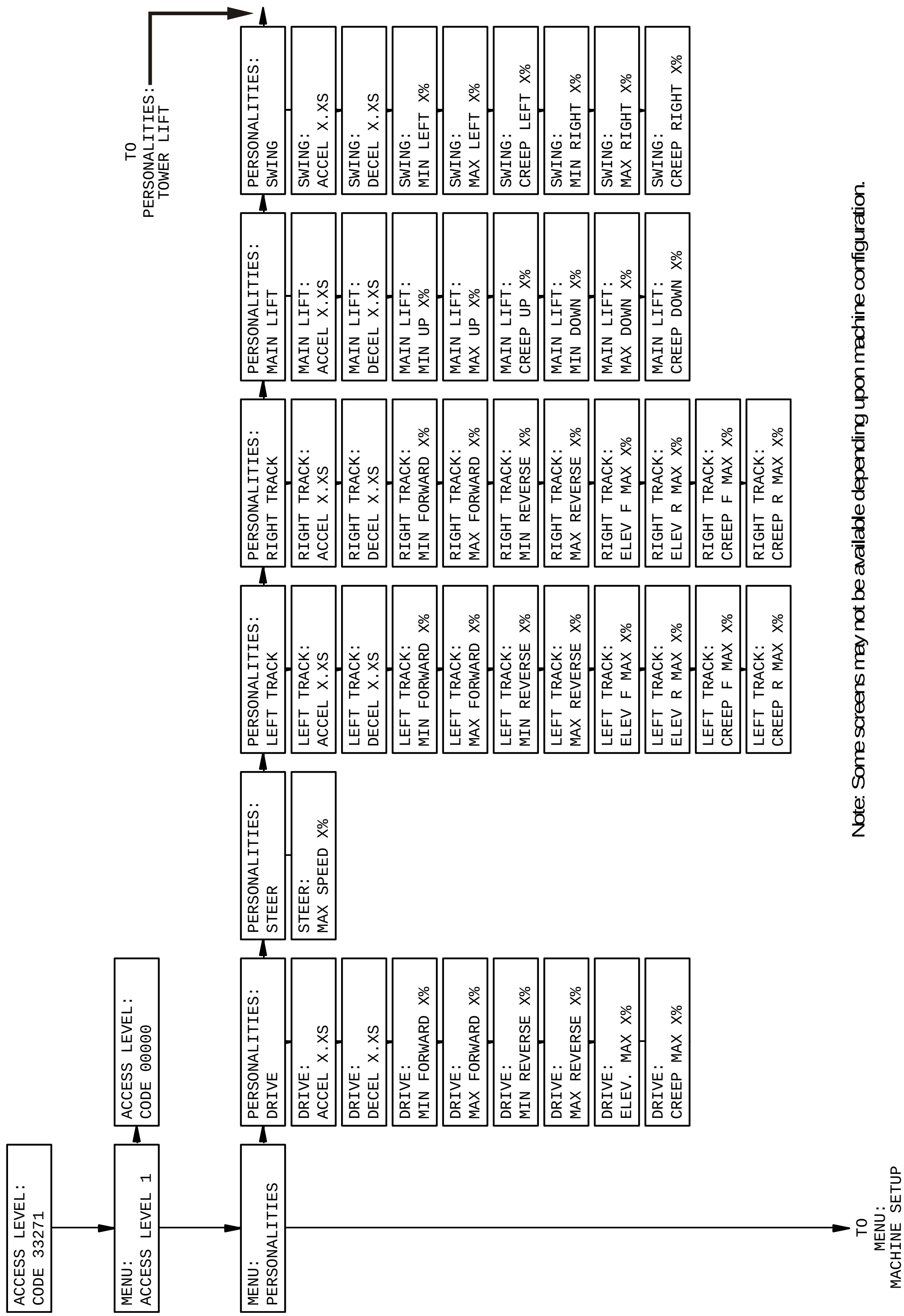
NOTE: *Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.*

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

ELEVATION CUTBACK

⚠ WARNING

CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.



Note: Some screens may not be available depending upon machine configuration.

Figure 6-5. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 1 of 4

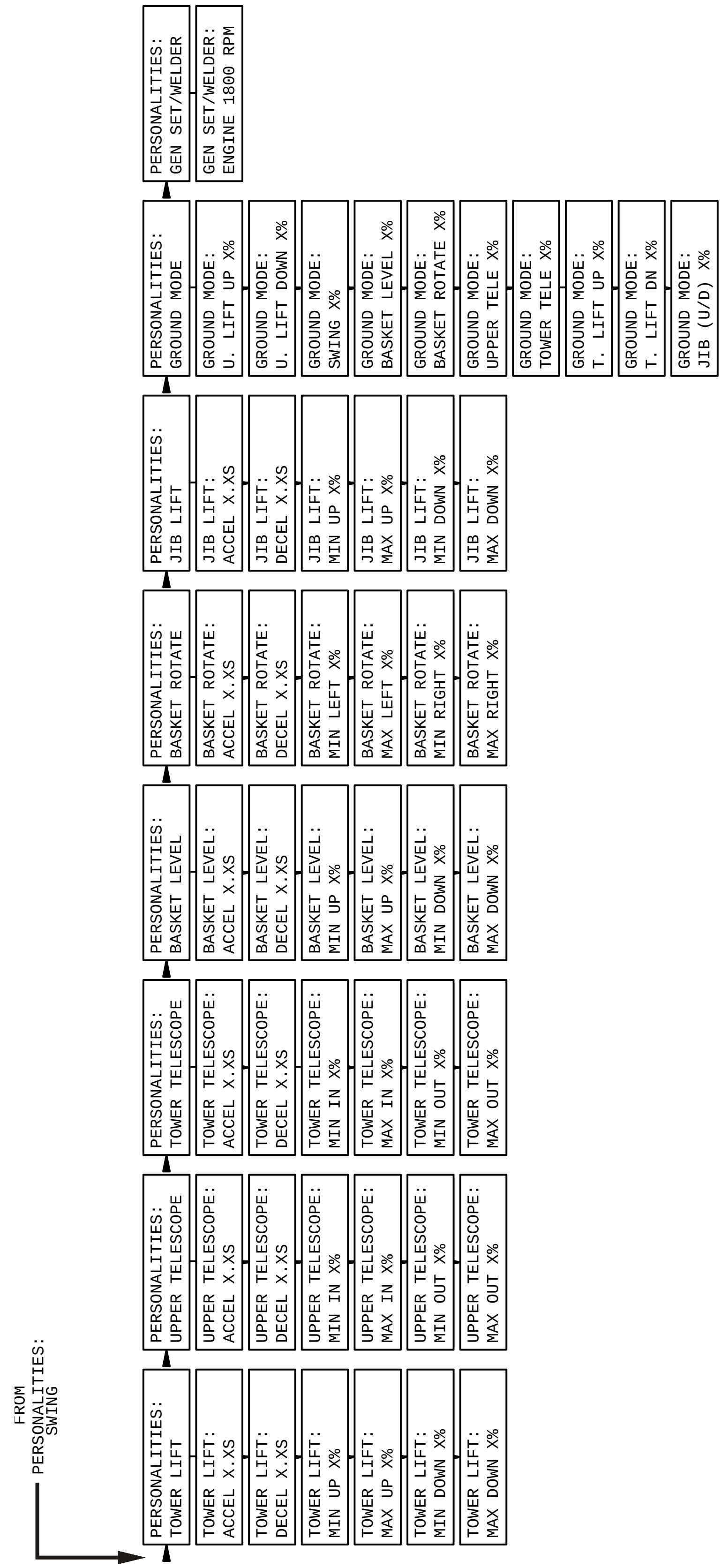


Figure 6-6. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 2 of 4

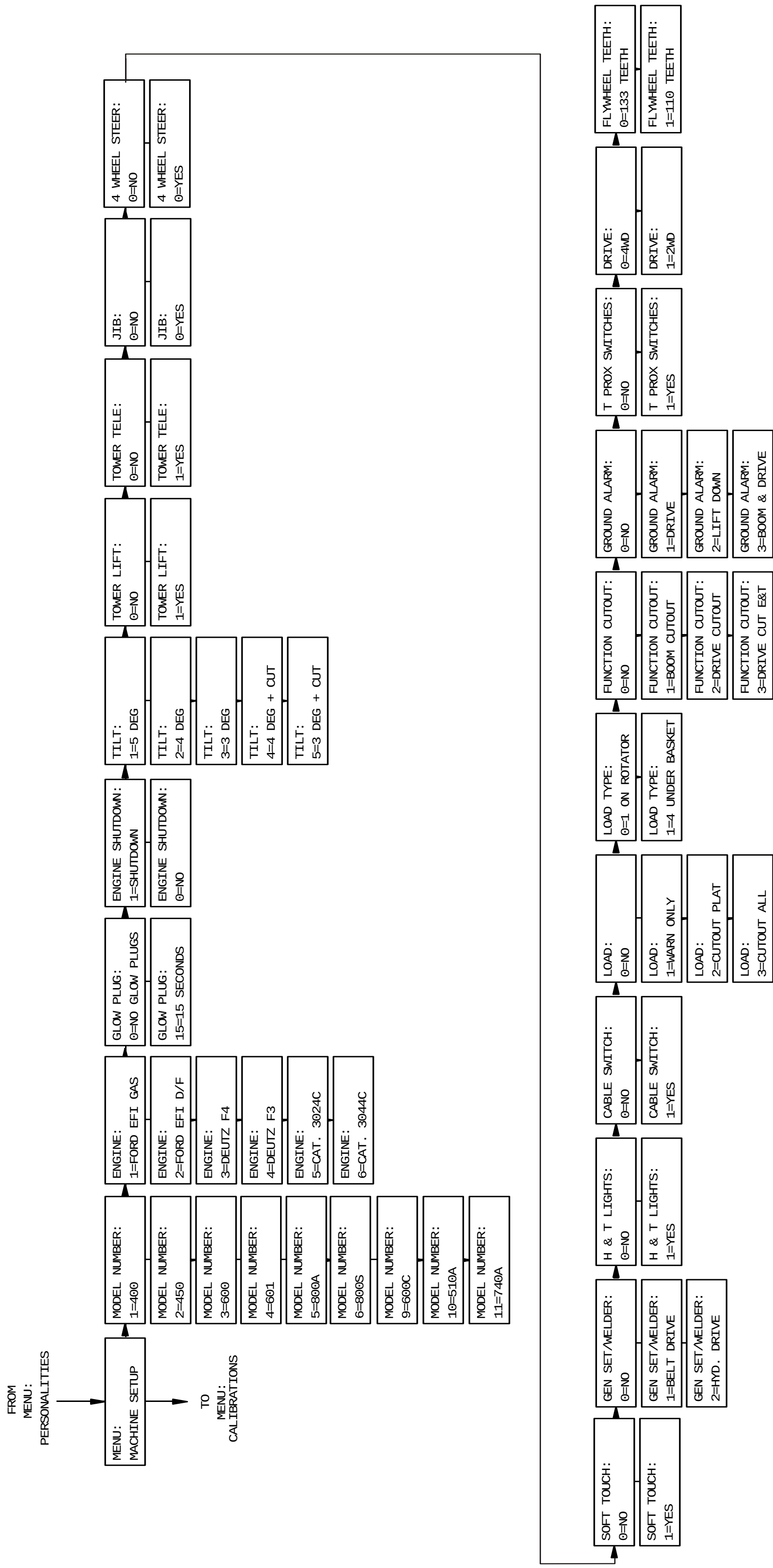


Figure 6-7. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 3 of 4

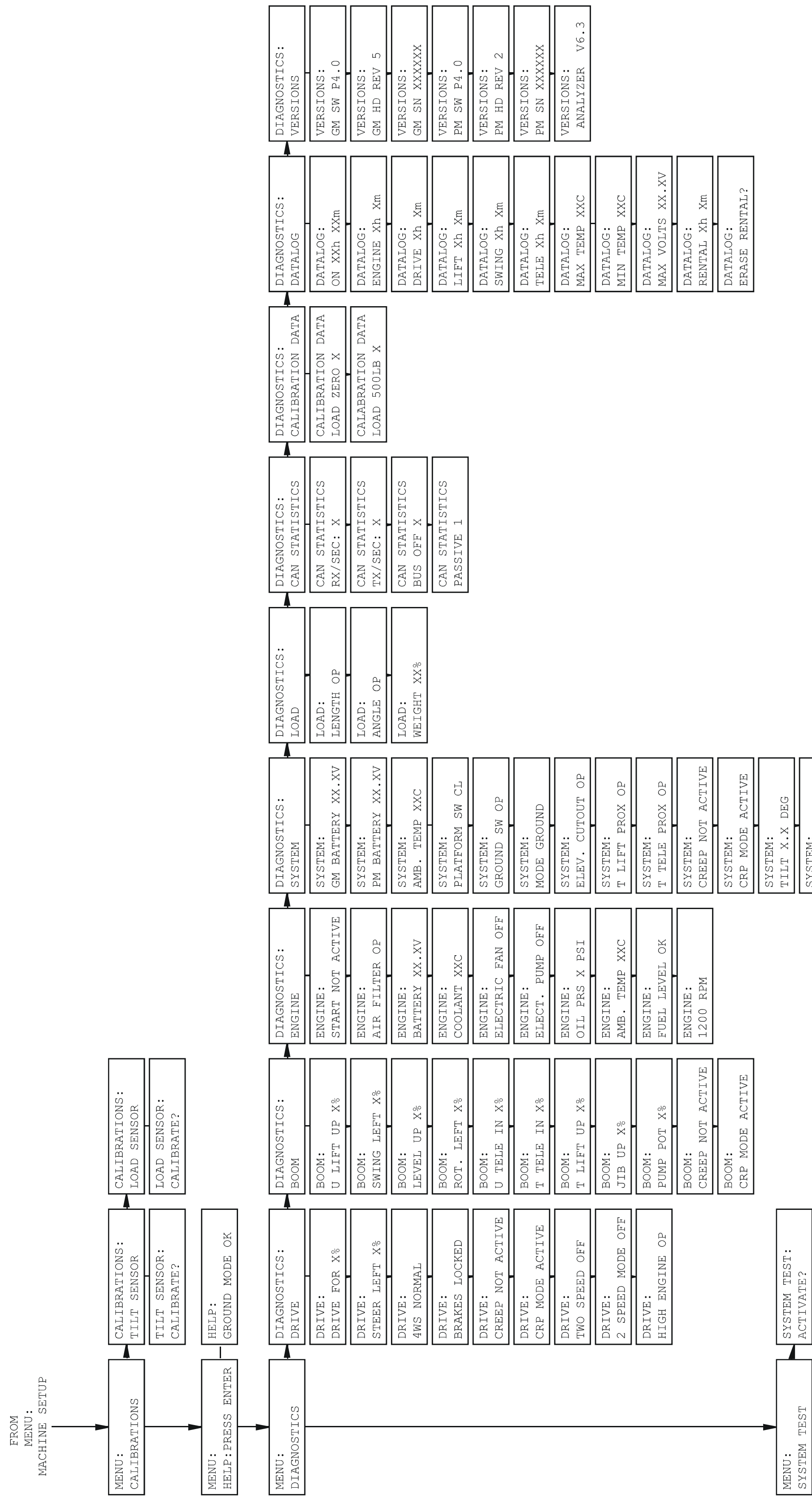
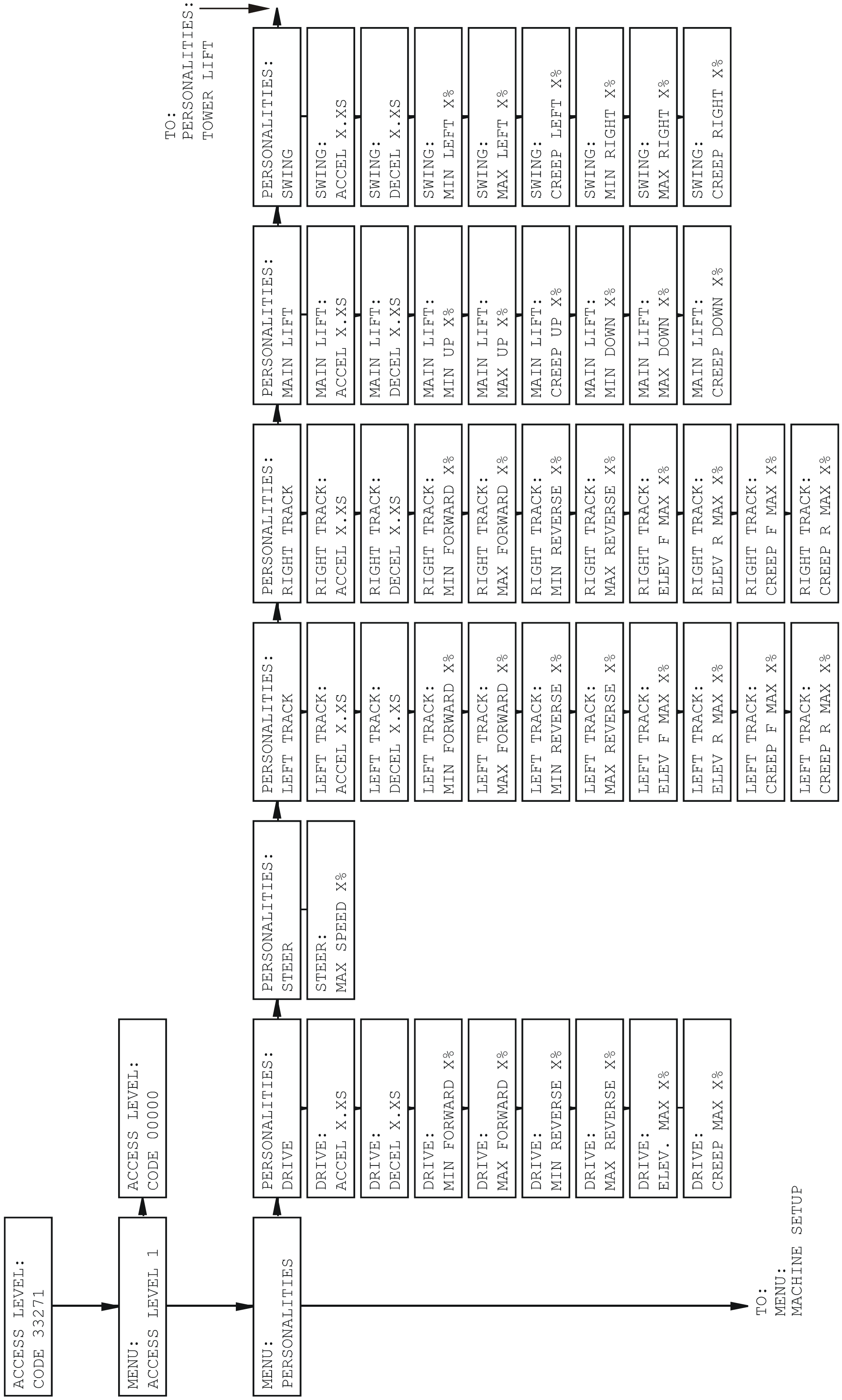


Figure 6-8. Analyzer Flow Chart, Prior to Version 5.X Software - Sheet 4 of 4



NOTE: *Some screens may not be available depending upon machine configuration.*

Figure 6-9. Analyzer Flow Chart, Version 5.X Software - Sheet 1 of 4

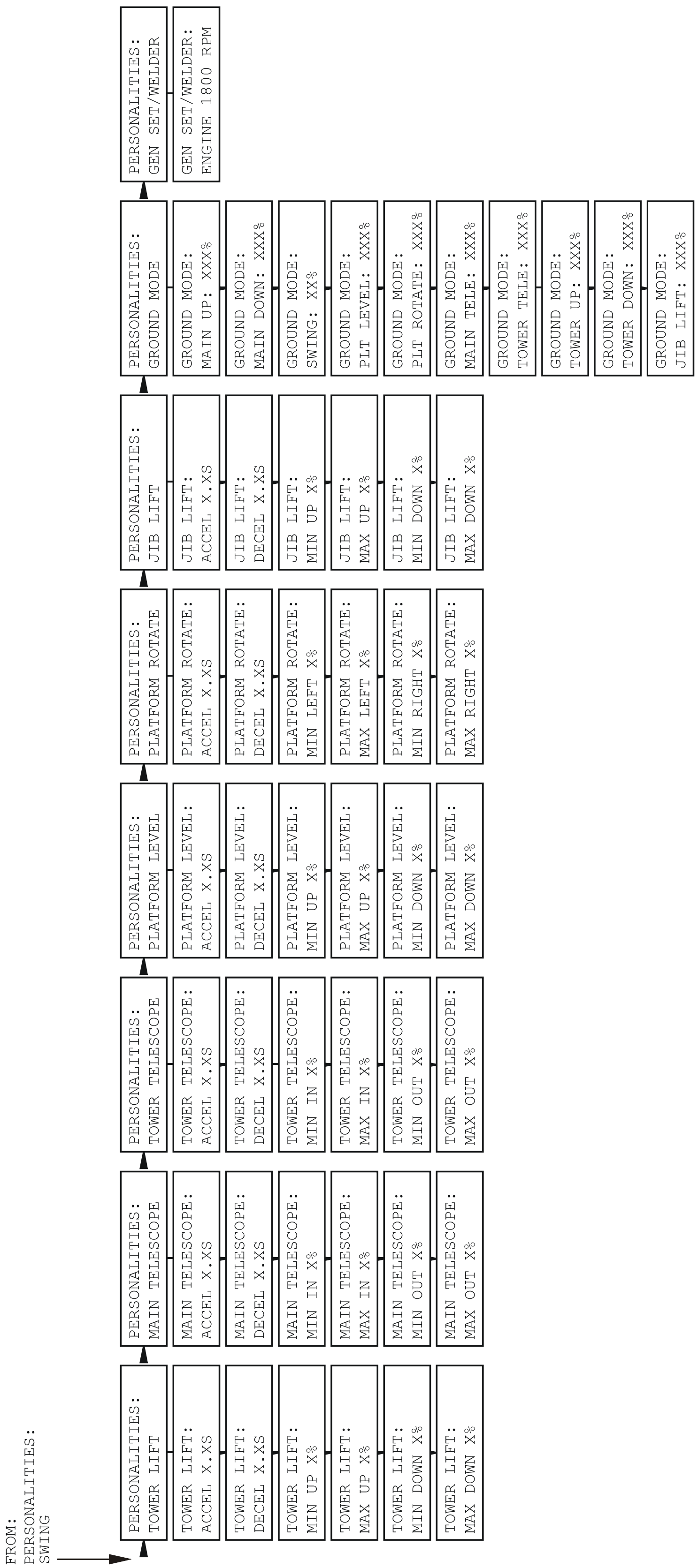


Figure 6-10. Analyzer Flow Chart, Version 5.X Software - Sheet 2 of 4

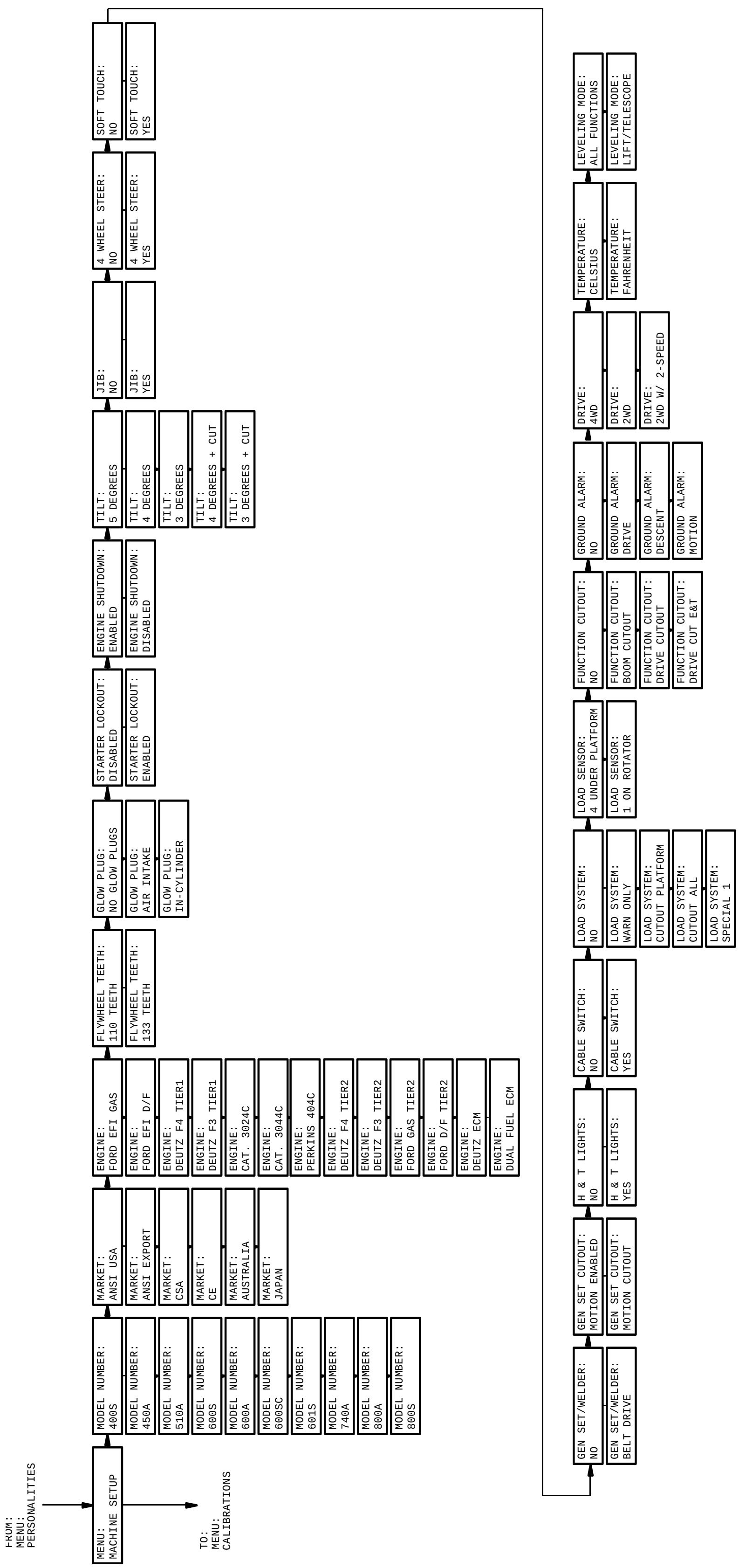


Figure 6-11. Analyzer Flow Chart, Version 5.X Software - Sheet 3 of 4

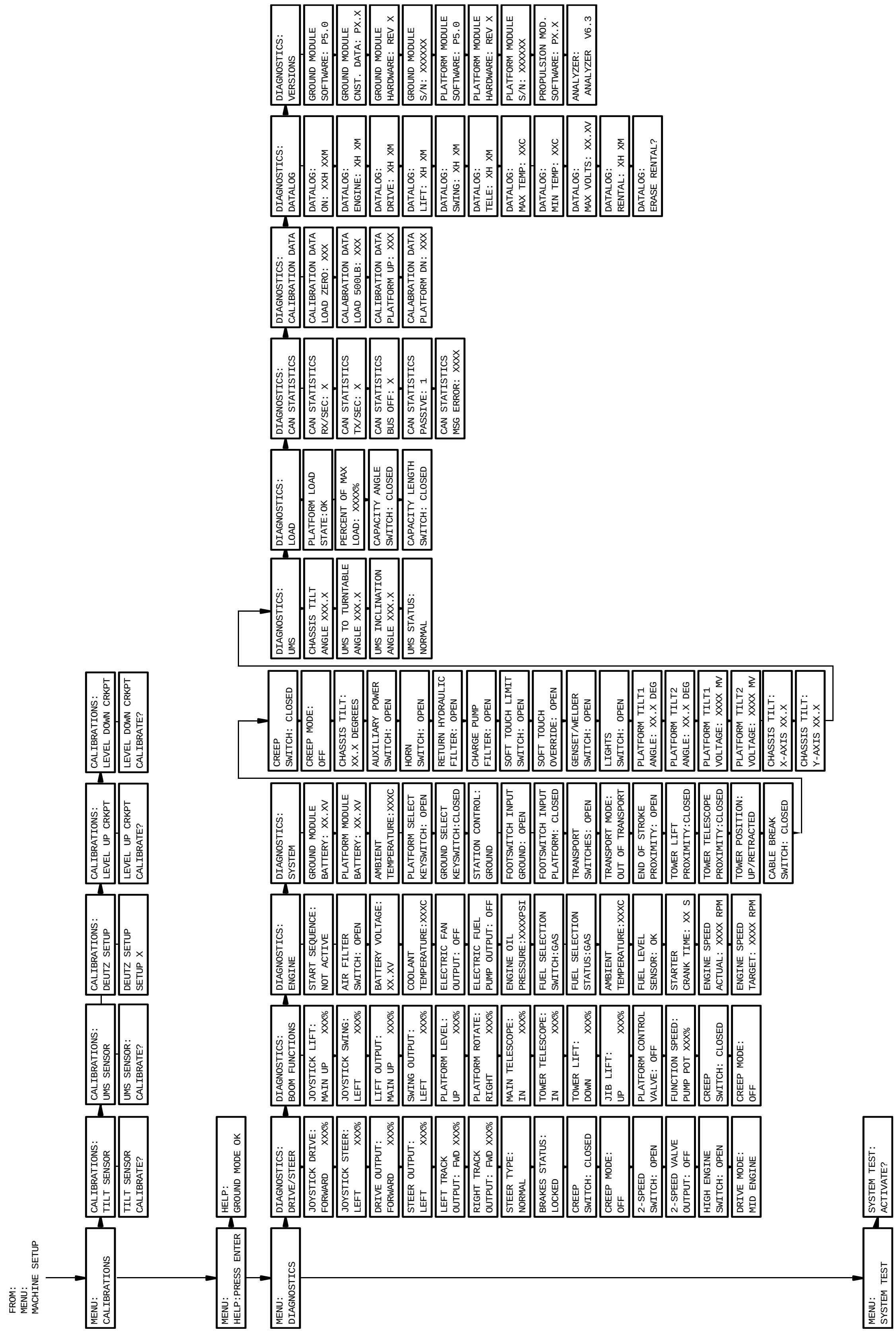


Figure 6-12. Analyzer Flow Chart, Version 5.X Software - Sheet 4 of 4

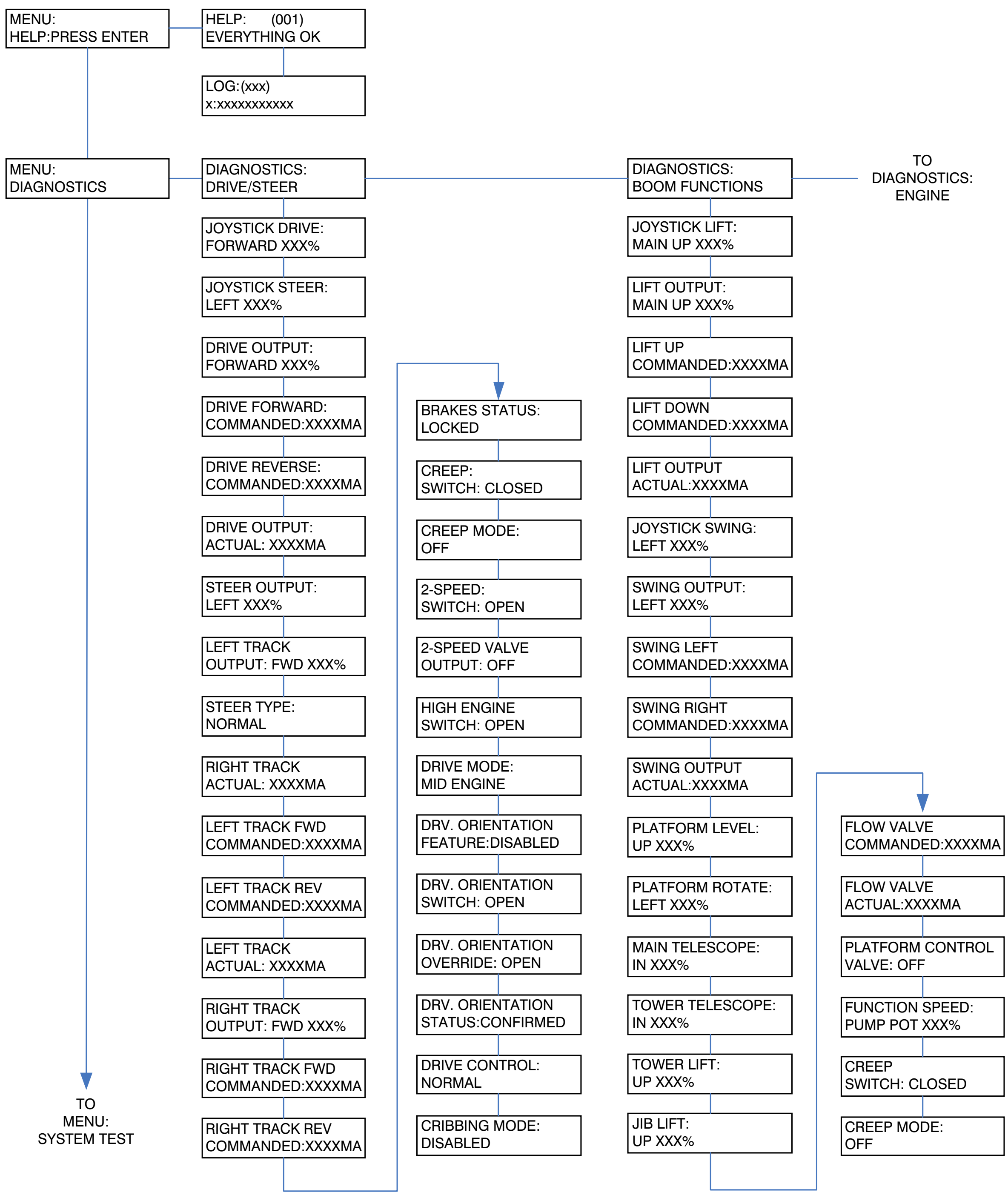


Figure 6-13. Analyzer Flow Chart, Version 6.X Software - Sheet 1of 6

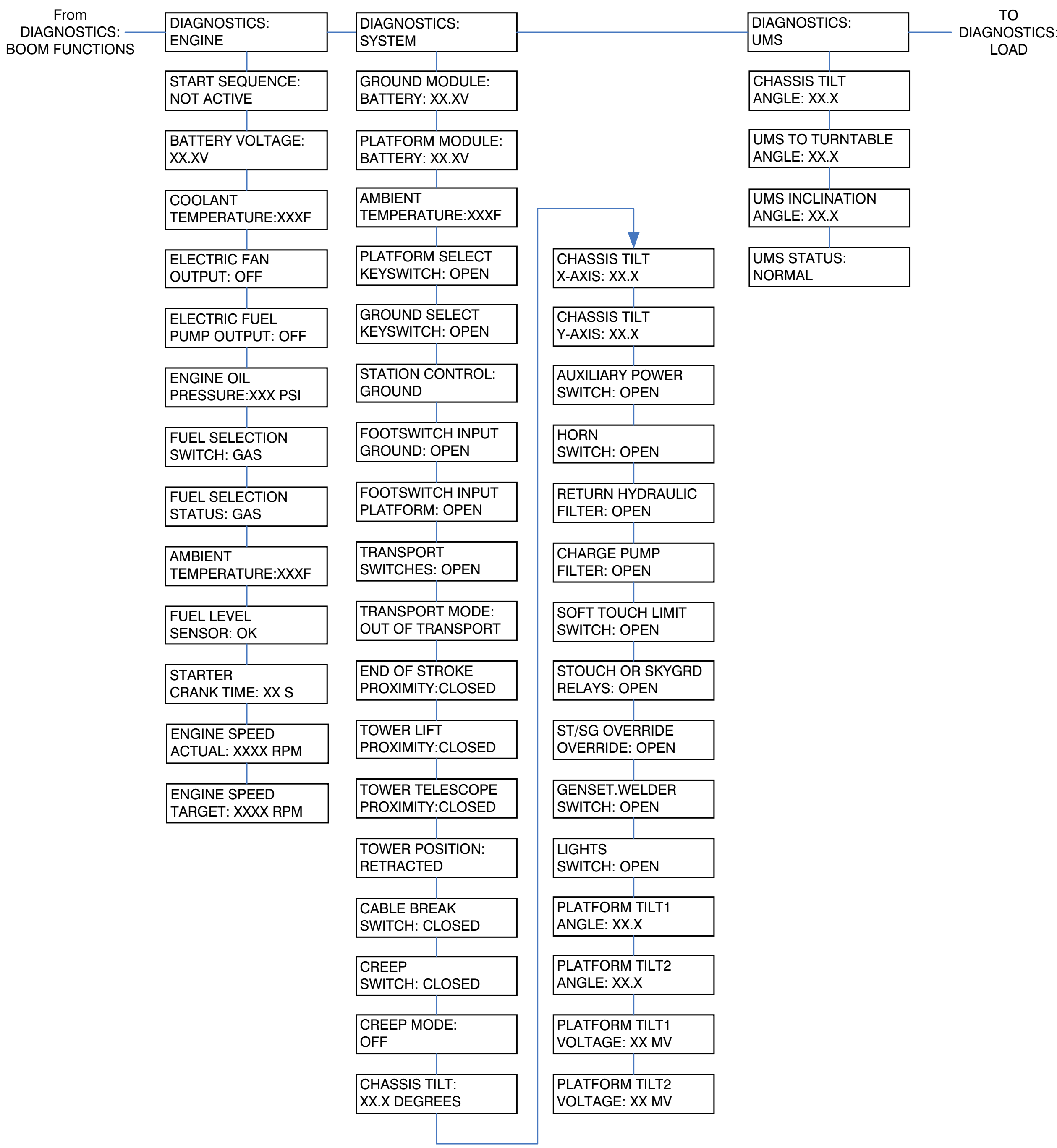


Figure 6-14. Analyzer Flow Chart, Version 6.X Software - Sheet 2 of 6

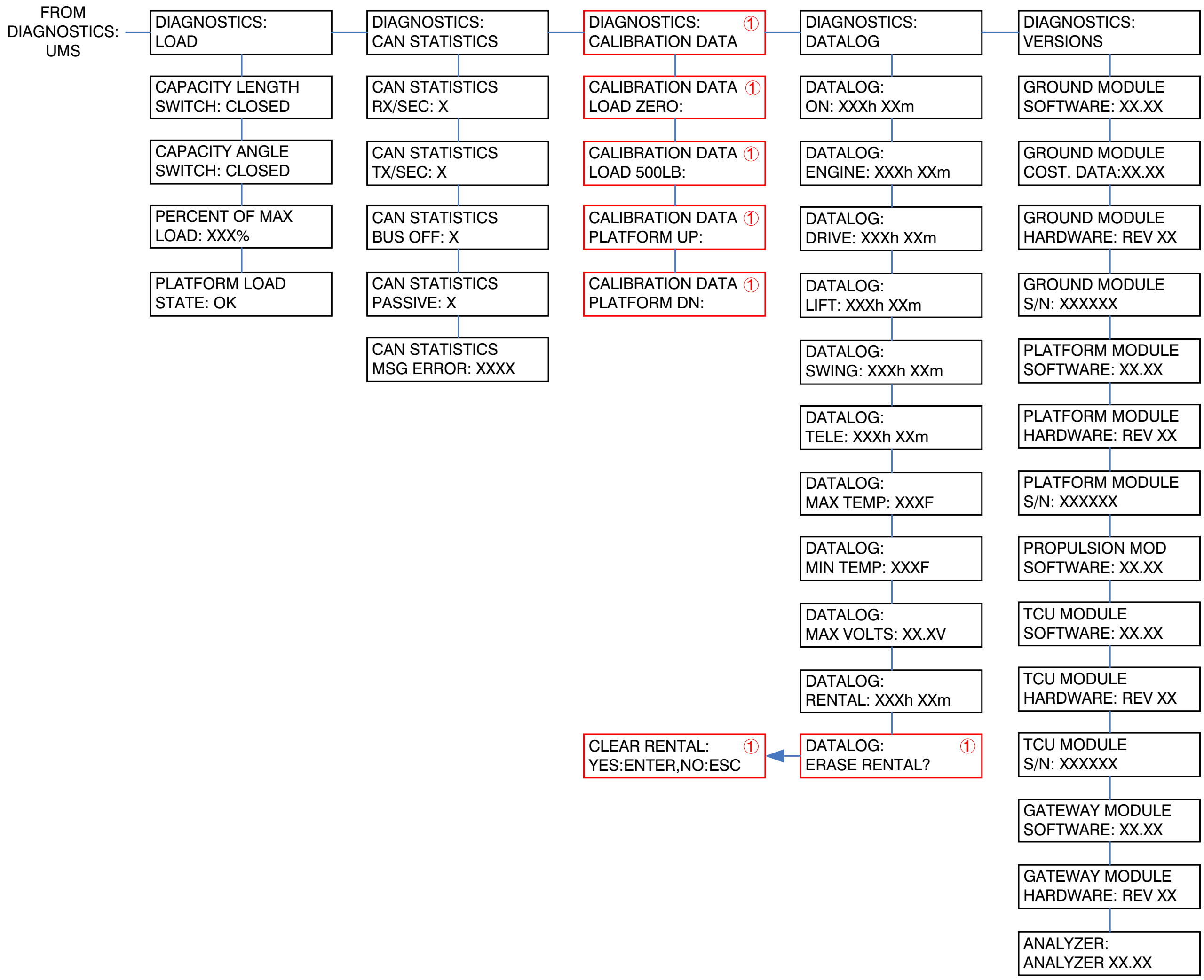


Figure 6-15. Analyzer Flow Chart, Version 6.X Software - Sheet 3 of 6

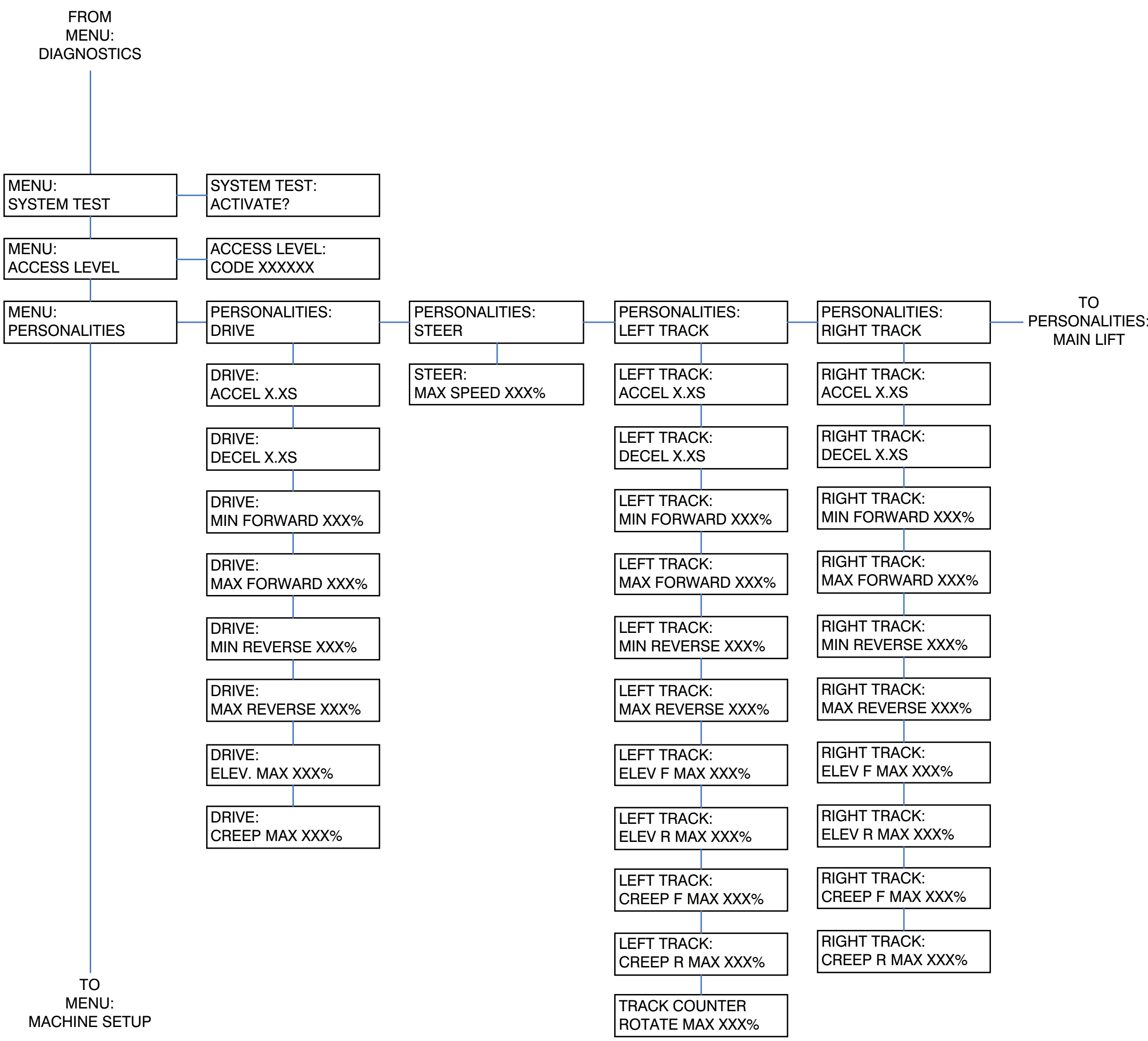


Figure 6-16. Analyzer Flow Chart, Version 6.X Software - Sheet 4of 6

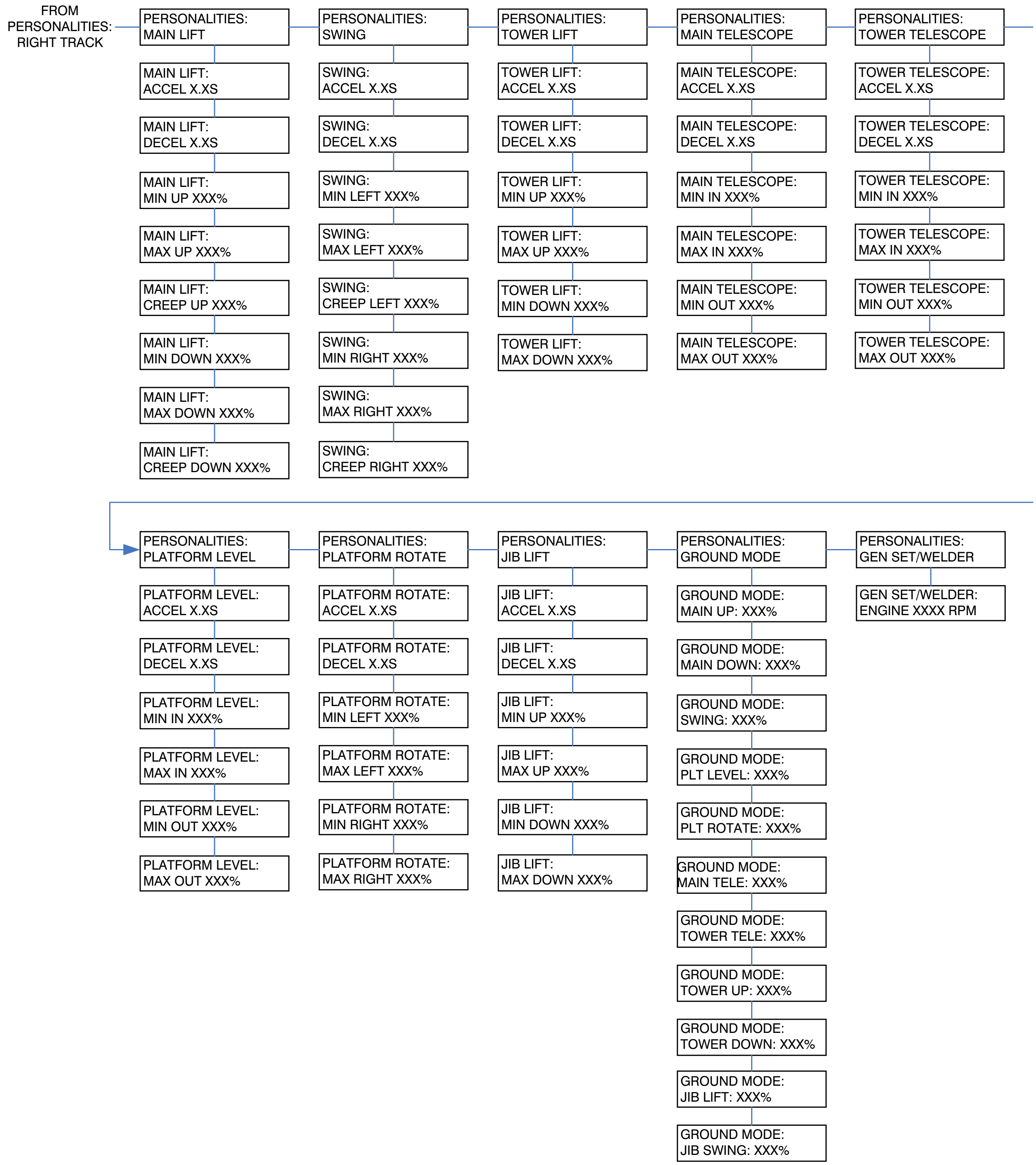


Figure 6-17. Analyzer Flow Chart, Version 6.X Software - Sheet 5of 6

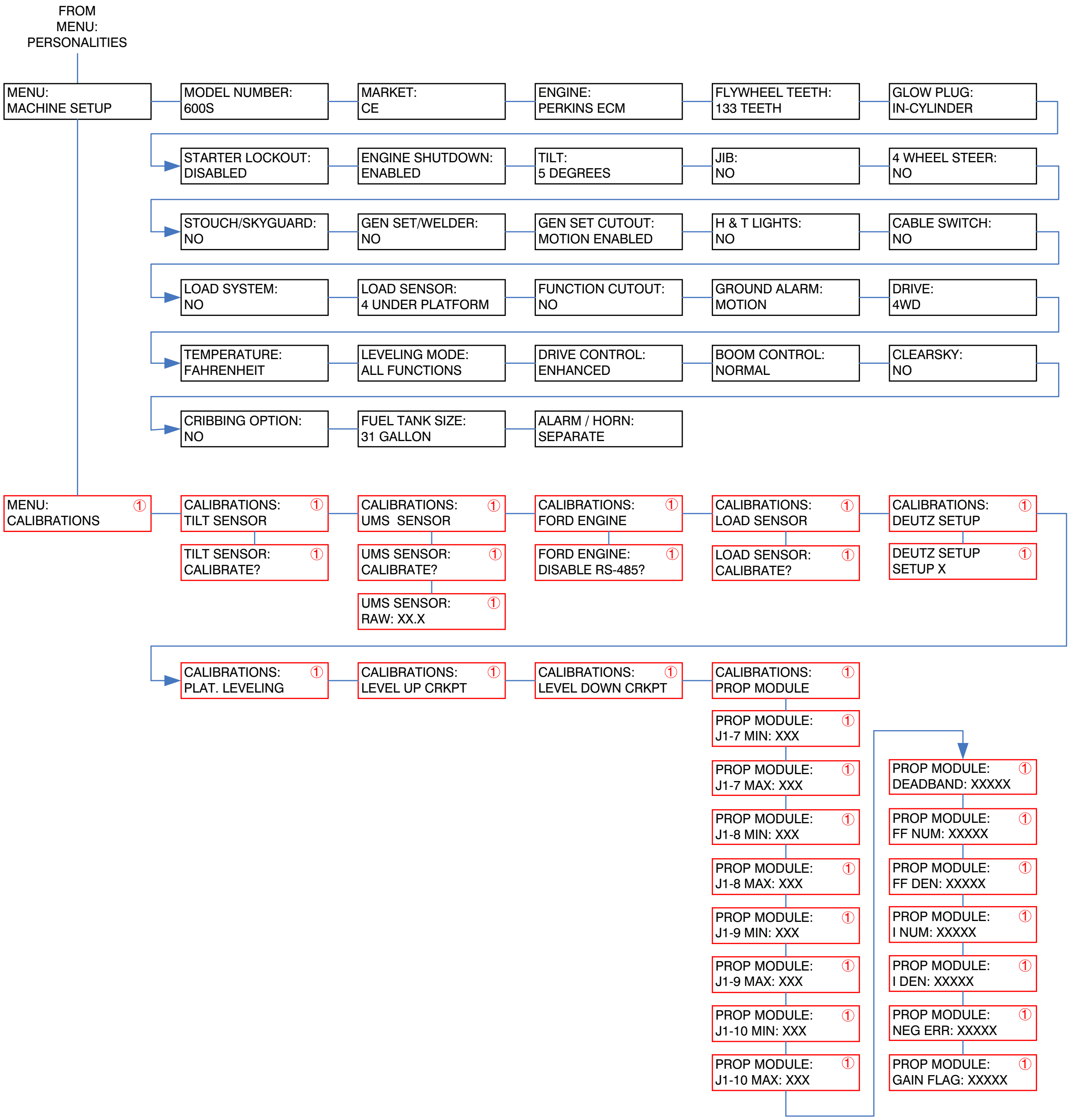


Figure 6-18. Analyzer Flow Chart, Version 6.X Software - Sheet 6 of 6

Table 6-1. Machine Set-Up Parameters

Configuration Digit	Parameter Displayed on Analyzer Line 1	**Description**	**Parameter Value**	Definition	Default Number
1	MODEL NUMBER:	Displays/adjusts machine model	1=400	400	1
			2=450, 510	2=450, 510	
			3=600	3=600	
			4=601	4=601	
			5=800A	5=800A	
			6=800S	6=800S	
			7=1350S	7=1350S	
			8=1200S	8=1200S	
1A	ENVELOPE HEIGHT:	Displays/adjusts envelope height. Only displayed if MODEL NUMBER = 7 or 8.	1=1350S/135'MAX	1350S 135' Envelope (Model 1350 only)	1 or 5, per MODEL NUMBER selection
			2=1350S/125'MAX	1350S 125' Envelope (Model 1350 only)	
			3=1350S/120'MAX	1350S 120' Envelope (Model 1350 only)	
			4=1350S/110'MAX	1350S 110' Envelope (Model 1350 only	
			5=1200S/120'MAX	1200S 120' Envelope (Model 1200 only)	
			6=1200S/110'MAX	1200S 110' Envelope (Model 1200 only)	
2	ENGINE:	Displays/adjusts engine manufacturer/type	1=FORD EFI GAS	Ford LRG425EFI Gas	2
			2=FORD EFI D/F	Ford LRG425EFI Gas with dual fuel	
			3=DEUTZ F4	Deutz F4M1011F, F4M2011, or BF4M2011 Diesel	
			4=DEUTZ F3	Deutz F3M1011F or F3M2011 Diesel	
3	GLOW PLUG:	Display/adjusts glow plug presence and on-time. Only displayed if ENGINE = 3 or 4	0=NO GLOW PLUGS	0 No glow plugs installed	0
			2="XX=XX SECONDS"	1-60Setting this number tells the controller how many seconds after the EMS is pulled to output to the glow plugs before permitting the engine to be started	
4	ENG SHUTDOWN:	Displays/adjusts presence of the engine shutdown feature.	0=NO	No engine shutdown	1
			1=SHUTDOWN	Shutdown engine when coolant temperature is greater than 118° C (for the FORD engine) or the oil pressure is less than 8 psi.	

Table 6-1. Machine Set-Up Parameters

Configuration Digit	Parameter Displayed on Analyzer Line 1	**Description**	**Parameter Value**	Definition	Default Number
5	JOYSTICK TYPE:	Displays/adjusts joystick type	0=LIFT LOCK	LIFT LOCK refers to the OEM controls product with resistive position sensing technology. The Lift/Swing joystick is two axis, and the Drive/Steer is single axis with push buttons for steer. Both joysticks incorporate mechanical locking to prevent inadvertent movement of the vehicle.	0
			1=SPLIT GRIP	SPLIT GRIP refers to the JLG-designed product with inductive position sensing technology and an ergonomic shape. Both joysticks are two axis and incorporate human proximity sensing technology (Q-prox) in place of mechanical locks to prevent inadvertent movement of the vehicle.	
6	TILT**:**	Displays/adjusts tilt sensor function	1=5DEG	5 degree – reduces the maximum speed of all boom functions to creep when tilted and above elevation.	1
			2=4DEG	4 degree – reduces the maximum speed of all boom functions to creep when tilted and above elevation.	
			3=3DEG	3 degree – reduces the maximum speed of all boom functions to creep when titled and above elevation.	
			4=4DEG PLUS CUT	4 degree – reduces the maximum speed of all boom functions to creep when tilted and above elevation and disallows tower lift up, drive, upper telescope out, and upper lift up	
			5=3DEG PLUS CUT	3 degree – reduces the maximum speed of all boom functions to creep when titled and above elevation and disallows tower lift up, drive, upper telescope out, and upper lift up	
7	TOWER LIFT**:**	Displays/adjusts tower lift presence	0=NO	0 No Tower Lift installed	0
			1=YES	1 Yes	
8	TOWER TELE:	Displays/adjusts tower telescope presence	0=NO	No Tower Telescope installed	0
			1=YES	Yes	
9	JIB:	Displays/adjusts jib presence	0=NO	No Jib installed	0
			1=YES	Jib installed which has up and down movements only	
			2=SIDESWING	Jib installed which has up and down movements and side to side movements	

Table 6-1. Machine Set-Up Parameters

Configuration Digit	Parameter Displayed on Analyzer Line 1	**Description**	**Parameter Value**	Definition	Default Number
10	EXT. AXLES:	Displays/adjusts extendable axle presence. NOTE: Not Displayed	0=NO	No Extendable Axles installed	0
			1=YES	1 Yes	
11	4WS:	Displays/adjusts 4 wheel steer presence	0=NO	No 4 wheel steer installed	0
			1=YES	Yes	
12	JIB BLOCK:	Displays presence of jib block limit switch. NOTE: Not Displayed	0=NO	No Jib Block switch	0
			1=YES	1 Yes	
13	SOFT TOUCH:	Displays presence of soft touch system	0=NO	No Soft Touch System installed	0
			1=YES	Yes	
14	GEN SET/ WELDER:	Displays/adjusts presence of generator/welder	0=NO	No Generator/welder installed	0
			1=BELT DRIVE	Belt drive generator/welder installed	
			2=HYD DRIVE	Hydraulic driven generator/welder installed	
15	H & T LIGHTS:	Displays presence of head and tail lights	0=NO	No Head and Tail Lights installed	0
			1=YES	Yes	
16	CABLE SWITCH:	Displays presence of broken cable switch	0=NO	No Broken Cable Switch installed	0
			1=YES	Yes	
17	TURNTABLE POSITION SWITCH:	Displays presence of turntable position switch. NOTE: Not Displayed	0=NO	No Turntable Position Switch installed	0
			1=YES	1 Yes	
18	LOAD:	Displays presence/function of load sensor	0=NO	No load sensor installed.	0
			1=WARN ONLY	Boom and drive function in creep, overload lamp lit, Platform Alarm sounds continuously	
			2=WARN & CUTOUT	All functions cutout, flash overload light (500mS on, 500mS off), Platform Alarm beeps (5 sec on, 55 sec off, 5 sec on)	
			3=SPECIAL 1	As 1=WARN ONLY, but disable upper telescope out and upper lift up	

Table 6-1. Machine Set-Up Parameters

Configuration Digit	Parameter Displayed on Analyzer Line 1	**Description**	**Parameter Value**	Definition	Default Number
19	LOAD TYPE	Selects if we are using the LSS Module, built in load cell or the BPE module (if selected model uses the Gorilla Platform Module) NOTE: Not displayed if LOAD: is 0=NO	0=1 ON ROTATOR	Use the on-board load sensor for all models except those models which use the Gorilla Platform Module, which use the BPE module interface for Platform load sensing	0
			1=4 UNDER BASKET	Use the LSS Module	
20	ANGLE:	Displays presence/function of angle sensor NOTE: 2=ANALOG Not Displayed	1=DIGITAL	1 Limit switches are installed or switches are not present on this model	1
			2=ANALOG	2 An analog sensor is installed	
21	LENGTH:	Displays presence/function of length sensor NOTE: 2=ANALOG Not Displayed	1=DIGITAL	Limit switch installed or switches are not present on this model	1
			2=ANALOG	2 An analog sensor is installed	
22	FUNCTION CUTOUT:	Displays presence/function of drive cutout.	0=NO	No Drive Cutout	0
			1=BOOM CUTOUT	Boom Function Cutout While Driving Above Elevation. (CE)	
			2=DRIVE CUTOUT	Drive Cutout Above Elevation	
			3=DRIVE CUT E & T	Drive Cutout Above Elevation And Tilted	
23	GROUND ALARM:	Displays/adjusts ground alarm presence/function	0=NO	No Ground Alarm installed	0
			1=DRIVE	Travel alarm – sounds when the drive function is active. (Option)	
			2=LIFT DOWN	Descent alarm – sounds when either lift down is active. (Option)	
			3=BOOM & DRIVE	Motion alarm – sounds when any function is active. (Option)	
24	T PROX SWITCHES:	Displays presence/function of Tower Proximity switches.	0=NO	No Tower Prox Switches Installed	0
			1=YES	Tower Prox Switches Installed	

Table 6-1. Machine Set-Up Parameters

Configuration Digit	Parameter Displayed on Analyzer Line 1	**Description**	**Parameter Value**	Definition	Default Number
25	TILT SENSOR:	Displays/adjusts type of tilt sensor NOTE: Only Displayed in Access Level 0	0=EXTERNAL	External tilt sensor	0
			1=INTERNAL	Internal tilt sensor	
26	DRIVE:	Display/adjusts drive wheel configuration. Only displayed if MODEL NUMBER = 2 or 3	0=4WD	4 wheel drive	0
			1=2WD	2 wheel drive	
27	FLYWHEEL TEETH:	Displays/adjusts RPM calculations based on the number of flywheel teeth. Only displayed if ENGINE = 3 or 4. Default value is 1 for 1200S and 1350S models.	0=133 TEETH	133 tooth flywheel	0
			1=110 TEETH	110 tooth flywheel	
28	OSCILLATING AXLE	Displays/adjusts electrically released oscillating axle system presence. Only displayed if MODEL NUMBER = 7 or 8.	0=NO	Fixed axles	1
			1=YES	Electrically released oscillating axles	

6.9 MACHINE PERSONALITY SETTINGS

NOTE: *Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.*

Table 6-2. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS
DRIVE	ACCELeration	0.1s to 5.0s	1.5
	DECELeration	0.1s to 3.0s	1.5
	MINimum speed	0 to 35%	30
	MAXimum speed	0 to 100%	50
	REVerse MINimum speed	0 to 35%	30
	REVerse MAXimum speed	0 to 100%	50
	ELEVATED MAXimum speed	0 to 50%	38
	CREEP MAXimum speed	0 to 50%	40
	Engine RPM	800 to 2900	1800
TOWER LIFT	ACCELeration	0.1 to 5.0	1.0
	DECELeration	0.1 to 3.0	1.0
	MINimum UP speed	0 to 60%	28
	MAXimum UP speed	0 to 100%	45
	MINimum DOWN speed	0 to 60%	27
	MAXimum DOWN speed	0 to 100%	42
	Engine RPM	800 to 2900	1800
UPPER LIFT	ACCELeration	0.1 to 5.0	2.0
	DECELeration	0.1 to 3.0	1.0
	MINimum UP speed	0 to 60%	36
	MAXimum UP speed	0 to 100%	50
	CREEP Maximum UP speed	0 to 65%	40
	MINimum DOWN speed	0 to 60%	29
	MAXimum DOWN speed	0 to 100%	48
	CREEP maximum DOWN speed	0 to 75%	37
	Engine RPM	800 to 2900	1800

Table 6-2. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS
SWING	ACCELeration	0.1 to 5.0s	2.0
	DECELeration	0.1 to 3.0s	1.5
	MINimum LEFT speed	0 to 50%	32
	MAXimum LEFT speed	0 to 100%	58
	CREEP maximum LEFT speed	0 to 65%	40
	MINimum RIGHT speed	0 to 50%	38
	MAXimum RIGHT speed	0 to 100%	58
	CREEP maximum RIGHT speed	0 to 65%	40
	Engine RPM	800 to 2900	1400
TELESCOPE UPPER	ACCELeration	0.1 to 5.0	2.0
	DECELeration	0.1 to 3.0	1.0
	MINimum IN speed	0 to 65%	27
	MAXimum IN speed	0 to 100%	40
	MINimum OUT speed	0 to 65%	27
	MAXimum OUT speed	0 to 100%	37
	Engine RPM	800 to 2900	1800
BASKET LEVEL	ACCELeration	0.1 to 5.0	2.5
	DECELeration	0.1 to 3.0	0.5
	MINimum UP speed	0 to 65%	15
	MAXimum UP speed	0 to 100%	25
	MINimum DOWN speed	0 to 65%	17
	MAXimum DOWN speed	0 to 100%	25
	Engine RPM	800 to 2900	1500
BASKET ROTATE	ACCELeration	0.1 to 5.0	2.0
	DECELeration	0.1 to 3.0	0.5
	MINimum LEFT speed	0 to 65%	15
	MAXimum LEFT speed	0 to 100%	25
	MINimum RIGHT speed	0 to 65%	15
	MAXimum RIGHT speed	0 to 100%	25
	Engine RPM	800 to 2900	1500

Table 6-2. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS
JIB LIFT	ACCELeration	0.1 to 5.0	3.0
	DECELeration	0.1 to 3.0	0.5
	MINimum UP speed	0 to 65%	16
	MAXimum UP speed	0 to 100%	40
	MINimum DOWN speed	0 to 65%	16
	MAXimum DOWN speed	0 to 100%	27
	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%	42
	Tower LIFT DOWN speed	0 to 100%	37
	Upper LIFT UP	0 to 100%	50
	Upper LIFT DOWN	0 to 100%	60
	SWING speed	0 to 100%	60
	Upper TELEscope speed	0 to 100%	43
	BASKET ROTATE speed	0 to 100%	50
	BASKET LEVEL speed	0 to 100%	50
	JIB LIFT speed	0 to 100%	25

4150365-3

Table 6-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Numb er	Description	Default Number
MODEL NUMBER: 1	1 2 3 4 5 6 7 8 9 10	400S 450A 510A 600S 600A 600SC 601S 740A 800A 800S	1
MARKET: 2	0 1 2 3 4 5	ANSI USA ANSI EXPORT CSA CE AUSTRALIA JAPAN	0
ENGINE: 3* *Engine selections vary depending on model selection.	1 2 3 4 5 6 7 8 9 10 11	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1) FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1) DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1) DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1) CAT. 3024C: CAT 3024C Diesel (Tier 2) CAT. 3044C: CAT 3044C Diesel (Tier 2) DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2) DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2) FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2) FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2) DEUTZ ECM: Engine Control Module - ECM	11
FLYWHEEL TEETH: 4* *This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0 1	133 TEETH: 133 flywheel teeth. 110 TEETH: 110 flywheel teeth.	1

Table 6-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0 1 2	NO GLOW PLUGS: No glow plugs installed. W/O STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow. W/ STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	1
ENGINE SHUTDOWN: 6	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 psi.	1
TILT: 7* *Certain market selections will limit tilt options.	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. *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.*	1
JIB: 8* *Only visible under certain model selections	0 1	NO: No jib installed. YES: Jib installed which has up and down movements only.	0
4 WHEEL STEER: 9* *Only visible under certain model selections.	0 1	NO: No four-wheel steer installed. YES: Four-wheel steer installed.	0
SOFT TOUCH: 10* *Only visible under certain model selections.	0 1	NO: No soft touch system installed. YES: Soft touch system installed.	0
GEN SET/WELDER: 11	0 1	NO: No generator installed. BELT DRIVE: Belt driven setup.	0

Table 6-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GEN SET CUTOUT: 12* * Only visible if Gen Set / Welder Menu selection is not 0.	0 1	MOTION ENABLED: Motion enabled when generator is ON. MOTION CUTOUT: Motion cutout in platform mode only.	0
H & T LIGHTS: 13	0 1	NO: No head and tail lights installed. YES: Head and tail lights installed.	0
CABLE SWITCH: 14* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0 1	NO: No broken cable switch installed. YES: Broken cable switch installed.	0
LOAD SYSTEM: 15* * Only visible under certain model selections. * Certain market selections will limit load system options or alter default setting.	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
LOAD SENSOR: 16* * Only visible if Load Sensor Menu selection is not 0. * Market selections will limit certain load sensor options.	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
FUNCTION CUTOUT: 17* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	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

Table 6-3. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GROUND ALARM: 18* * Certain market selections will alter default setting.	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).	0
DRIVE: 19* * Only visible under certain model selections.	0 1 2	4WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	0
TEMPERATURE: 20	0 1	CELSIUS: Celsius unit selection. FAHRENHEIT: Fahrenheit unit selection.	1
LEVELING MODE: 21* * Only visible on 800S models.	0 1	ALL FUNCTIONS: Platform level with all functions. LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	0

4150364-14

Table 6-4. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
MODEL NUMBER: 1	1 2 3 4 5 6 7 8 9 10	400S 450A 510A 600S 600A 600SC 601S 740A 800A 800S	1
MARKET: 2	0 1 2 3 4 5	ANSI USA ANSI EXPORT CSA CE AUSTRALIA JAPAN	0
ENGINE: 3* *Engine selections vary depending on model selection.	1 2 3 4 5 6 7 8 9 10 11	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1) FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1) DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1) DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1) CAT. 3024C: CAT 3024C Diesel (Tier 2) CAT. 3044C: CAT 3044C Diesel (Tier 2) DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2) DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2) FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2) FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2) DEUTZ ECM: Engine Control Module - ECM	11
FLYWHEEL TEETH: 4* *This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0 1	133 TEETH: 133 flywheel teeth. 110 TEETH: 110 flywheel teeth.	1

Table 6-4. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0 1 2	NO GLOW PLUGS: No glow plugs installed. W/O STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow. W/ STARTER LOCK: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	1
ENGINE SHUTDOWN: 6	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 psi.	1
TILT: 7* *Certain market selections will limit tilt options.	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. *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.*	1
JIB: 8* *Only visible under certain model selections	0 1	NO: No jib installed. YES: Jib installed which has up and down movements only.	0
4 WHEEL STEER: 9* *Only visible under certain model selections.	0 1	NO: No four-wheel steer installed. YES: Four-wheel steer installed.	0
SOFT TOUCH: 10* *Only visible under certain model selections.	0 1	NO: No soft touch system installed. YES: Soft touch system installed.	0
GEN SET/WELDER: 11	0 1	NO: No generator installed. BELT DRIVE: Belt driven setup.	0

Table 6-4. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GEN SET CUTOUT: 12* * Only visible if Gen Set / Welder Menu selection is not 0.	0 1	MOTION ENABLED: Motion enabled when generator is ON. MOTION CUTOUT: Motion cutout in platform mode only.	0
H & T LIGHTS: 13	0 1	NO: No head and tail lights installed. YES: Head and tail lights installed.	0
CABLE SWITCH: 14* * Only visible under certain model selections. * Certain market and model selections will alter the default setting.	0 1	NO: No broken cable switch installed. YES: Broken cable switch installed.	0
LOAD SYSTEM: 15* * Only visible under certain model selections. * Certain market selections will limit load system options or alter default setting.	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
LOAD SENSOR: 16* * Only visible if Load Sensor Menu selection is not 0. * Market selections will limit certain load sensor options.	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
FUNCTION CUTOUT: 17* * Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.	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

Table 6-4. Machine Configuration Programming Information Prior to Software Version P5.3

Configuration Digit	Number	Description	Default Number
GROUND ALARM: 18* * Certain market selections will alter default setting.	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).	0
DRIVE: 19* * Only visible under certain model selections.	0 1 2	4WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	0
TEMPERATURE: 20	0 1	CELSIUS: Celsius unit selection. FAHRENHEIT: Fahrenheit unit selection.	1
LEVELING MODE: 21* * Only visible on 800S models.	0 1	ALL FUNCTIONS: Platform level with all functions. LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	0

4150364-14

Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	

Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
ENGINE: 3* *Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	7
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
FLYWHEEL TEETH: 4* *This menu item is only visible if Deutz engine selections 3 or 4 are selected.	0	133 TEETH: 133 flywheel teeth.	1
	1	110 TEETH: 110 flywheel teeth.	
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	IN-CYLINDER: Glow plugs installed in each cylinder.	
STARTER LOCKOUT: 6	0	DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.	0
	1	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	

Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
ENGINE SHUTDOWN: 7	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.	1
TILT: 8* *Certain market selections will limit tilt options and alter default setting. Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.	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
JIB: 9* *Only visible under certain model selections.	0 1	NO: No jib installed. YES: Jib installed which has up and down movements only.	0
4 WHEEL STEER: 10* *Only visible under certain model selections.	0 1	NO: No four-wheel steer installed. YES: Four-wheel steer installed.	0
SOFT TOUCH: 11* *Only visible under certain model selections.	0 1	NO: No soft touch system installed. YES: Soft touch system installed.	0
GEN SET/WELDER: 12	0 1	NO: No generator installed. BELT DRIVE: Belt driven setup.	0

Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
GEN SET CUTOUT: 13* *Only visible if Gen Set / Welder Menu selection is not 0.	0 1	MOTION ENABLED: Motion enabled when generator is ON. MOTION CUTOUT: Motion cutout in platform mode only.	0
H & T LIGHTS: 14	0 1	NO: No head and tail lights installed. YES: Head and tail lights installed.	0
CABLE SWITCH: 15* *Only visible under certain model selections. *Certain market and model selections will alter the default setting.	0 1	NO: No broken cable switch installed. YES: Broken cable switch installed.	0
LOAD SYSTEM: 16* *Only visible under certain market selections. *Certain market selections will limit load system options or alter default setting.	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
LOAD SENSOR: 17* *Only visible if Load Sensor Menu selection is not 0 and under certain market selections. *Certain market selections will limit load sensor options.	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

Table 6-5. Machine Configuration Programming Information Software Version P5.3 to P6.1

Configuration Label/ Digit	Number	Description	Default Number
FUNCTION CUTOUT: 18* *Only visible under certain market selections. *Certain market selections will limit function cutout options or alter default setting.	0 1 2 3	NO: No drive cutout. BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive & steer cutout above elevation. DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	0
GROUND ALARM: 19* *Certain market selections will alter default setting.	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
DRIVE: 20* *Only visible under certain model selections.	0 1 2	4WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	0
TEMPERATURE: 21* *Certain market selections will alter default setting.	0 1	CELSIUS: Celsius unit selection. FAHRENHEIT: Fahrenheit unit selection.	1
LEVELING MODE: 22* *Only visible on 800S models.	0 1	ALL FUNCTIONS: Platform level with all functions. LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	0

4150364-18

Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
MODEL NUMBER: 1	1	400S	1
	2	450A	
	3	510A	
	4	600S	
	5	600A	
	6	600SC	
	7	601S	
	8	740A	
	9	800A	
	10	800S	
MARKET: 2	0	ANSI USA	0
	1	ANSI EXPORT	
	2	CSA	
	3	CE	
	4	AUSTRALIA	
	5	JAPAN	

Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
ENGINE: 3*	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	14
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	14	Perkins ECM	
	15	CAT ECM	
	16	DEUTZ ECM t4F: Deutz Engine Control Module (Tier 4 Final)	
* Engine selections vary depending on model selection.			
FLYWHEEL TEETH: 4*	0	133 TEETH: 133 flywheel teeth.	1
	1	110 TEETH: 110 flywheel teeth.	
* This menu item is only visible if Deutz engine selections 3 or 4 are selected.			
GLOW PLUG: 5	0	NO GLOW PLUGS: No glow plugs installed.	2
	1	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	2	IN-CYLINDER: Glow plugs installed in each cylinder.	

Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
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
Fuel Cutout 7	0 1 2	RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached. ONE RESTART: Engine allowed to be restarted once for 2 minutes when very low fuel level is reached. ENGINE STOP: Engine not able to restart when very low fuel level is reached.	0
*This menu item is only visible if non-dual fuel engines are selected.			
ENGINE SHUTDOWN: 8*	0 1	DISABLED: No engine shutdown. ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.	1
TILT: 9*	1 2 3 4 5 6	5 DEGREES: Reduces 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 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 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 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 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. 5 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	1
* Certain market selections will limit tilt options and alter default setting. *Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.*			

Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
JIB: 10*	0 1	NO: No jib installed. YES: Jib installed which has up and down movements only.	0
* Only visible under certain model selections.			
4 WHEEL STEER: 11*	0 1	NO: No four-wheel steer installed. YES: Four-wheel steer installed.	0
* Only visible under certain model selections.			
SOFT TOUCH/ SKYGUARD: 12*	0 1 2 3	None: 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
* Only visible under certain model selections.			
GEN SET/WELDER: 13	0 1	NO: No generator installed. BELT DRIVE: Belt driven setup.	0
GEN SET CUTOUT: 14*	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.			
H & T LIGHTS: 15	0 1	NO: No head and tail lights installed. YES: Head and tail lights installed.	0
CABLE SWITCH: 16*	0 1	NO: No broken cable switch installed. YES: Broken cable switch installed.	0
* Only visible under certain model selections. * Certain market and model selections will alter the default setting.			

Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
LOAD SYSTEM: 17*	0	NO: No load sensor installed.	0
	1	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	2	CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
	4	SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	
* Only visible under certain market selections. * Certain market selections will limit load system options or alter default setting.			
LOAD SENSOR: 18*	0	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module.	1
	1	4 UNDER PLATFORM: Use the EIM for load sensing.	
* Only visible if Load Sensor Menu selection is not 0 and under certain market selections. * Certain market selections will limit load sensor options.			
FUNCTION CUTOUT: 19*	0	NO: No drive cutout.	0
	1	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	2	DRIVE CUTOUT: Drive & steer cutout above elevation.	
	3	DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	
* Only visible under certain market selections. * Certain market selections will limit function cutout options or alter default setting.			
GROUND ALARM: 20*	0	NO: No ground alarm installed.	3
	1	DRIVE: Travel alarm sounds when the drive function is active (Option).	
	2	DESCENT: Descent alarm sounds when lift down is active (Option).	
	3	MOTION: Motion alarm sounds when any function is active (Option).	
* Certain market selections will alter default setting.			

Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
DRIVE: 21*	0 1 2	4WD: Four wheel drive. 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	0
* Only visible under certain model selections.			
DISPLAY UNITS: 22*	0 1	IMPERIAL: DEG F, PSI, LBS METRIC: DEG C, KPA, KGS	0
* Certain market selections will alter default setting.			
LEVELING MODE: 23*	0 1	ALL FUNCTIONS: Platform level with all functions. LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	0
* Only visible on 800S models.			
DRIVE CONTROL: 24	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
DRIVE PUMP: 25*	0 1	SAUER DANFOSS: Machine equipped with Sauer Danfoss drive pump. EATON: Machine equipped with Eaton drive pump.	0
* Only visible on 800S models.			
BOOM CONTROL: 26	0 1	NORMAL: Boom function coils are energized from the Ground Module. ENHANCED: Boom function are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.	0
FUNCTION SPEED KNOB: 27	0 1	YES: Machine is equipped with Function Speed Knob. NO: Machine is equipped with Operation Speed Switch.	0

Table 6-6. Machine Configuration Programming Information Software Version P6.1 to Present

Configuration Label/ Digit	Number	Description	Default Number
CLEARSKY: 28	0 1	NO: ClearSky (telematics) options is disabled. YES: ClearSky (telematics) option is enabled.	0
CRIBBING OPTION: 29	0 1	NO: Cribbing Option is disabled. YES: Cribbing Option is enabled.	0
FUEL TANK SIZE: 30	0 1	31 Gallon Tank 52 Gallon Tank	0
ALARM / HORN: 31	0 1	SEPARATE: Separate alarm and horn. COMBINED: Combination alarm / horn.	0
ALERT BEACON: 32	0 1	OFF FOR CREEP: Alert beacon will not flash while in Creep. 20FPS FOR CREEP: Alert beacon will flash at 20FPS while in Creep.	0
			4150364-19

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.*

510AJ																								
	MODEL NUMBER	MARKET	ENGINE	GLOW PLUGS			STARTER LOCKOU;T		ENGINE SHUTDOWN		TILT						S TOUCH/SKYGUARD				GEN SET / WELDER		GEN SET CUTOUT	
ANSI USA	***3***	***0***	***14***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	6	***0***	1	2	3	***0***	1	***0***	1
ANSI EXPORT	***3***	***1***	***14***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	6	***0***	1	2	3	***0***	1	***0***	1
CSA	***3***	***2***	***14***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	6	***0***	1	2	3	***0***	1	***0***	1
CE	***3***	***3***	***14***	0	1	***2***	***0***	1	0	***1***	X	***2***	3	4	5	6	***0***	1	2	3	***0***	1	***0***	1
AUSTRALIA	***3***	***4***	***14***	0	1	***2***	***0***	1	0	***1***	X	***2***	3	4	5	6	***0***	1	2	3	***0***	1	***0***	1
JAPAN	***3***	***5***	***14***	0	1	***2***	***0***	1	0	***1***	***1***	2	3	4	5	6	***0***	1	2	3	***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. Shaded cells indicate a hidden menu or selection.*

510AJ	HEAD & TAIL LIGHTS		LOAD SYSTEM					LOAD SENSOR		FUNCTION CUTOUT				GROUND ALARM				DRIVE TYPE			DISPLAY UNITS		DRIVE CONTROL		
ANSI USA	***0***	1	***0***	X	X	X	X	0	***1***	***0***	X	***2***	X	0	1	2	***3***	***0***	1	2	***0***	1	0	1	***2***
ANSI EXPORT	***0***	1	***0***	***1***	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	***0***	1	0	1	***2***
CSA	***0***	1	***0***	X	X	X	X	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	0	***1***	0	1	***2***
CE	***0***	1	0	X	***2***	3	X	0	***1***	0	***1***	X	X	0	1	2	***3***	***0***	1	2	0	***1***	0	1	***2***
AUSTRALIA	***0***	1	***0***	X	***2***	X	X	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	0	***1***	0	1	***2***
JAPAN	***0***	1	0	***1***	2	3	4	0	***1***	***0***	1	2	3	0	1	2	***3***	***0***	1	2	0	***1***	0	1	***2***

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.*

510AJ	BOOM CONTROL		CLEARSKY		CRIBBING OPTION		FUEL TANK SIZE		ALARM/HORN		ALERT BEACON	
ANSI USA	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
ANSI EXPORT	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
CSA	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
CE	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
AUSTRALIA	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1
JAPAN	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1	***0***	1

6.10 SYSTEM TEST

The Control System Incorporates a built-in system test to check the system components and functions. To use this function, use the following procedures.

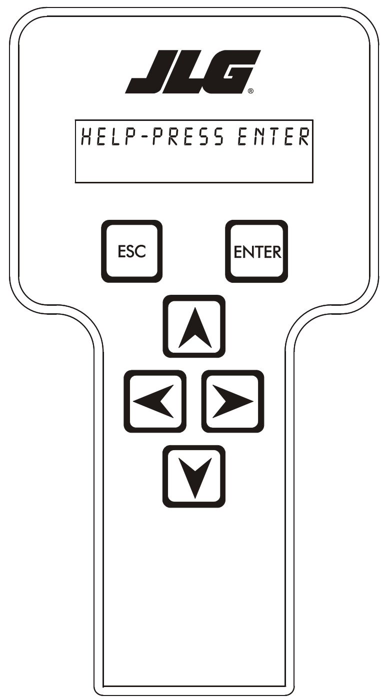
Test from the Platform

1. Position Platform/Ground select switch to Platform position.

2. Plug analyzer in connector at base of platform control box.

3. Pull out Emergency Stop switch and Start engine.

4. The analyzer screen should read:



5. Use arrow button to reach SYSTEM TEST. Hit Enter. The analyzer will prompt if you want to activate system test; hit Enter again to activate.

6. Follow flow path in Figure 6-19., System Test Flow Chart - Platform Tests and go through component tests. Hit ESC key during any part of the test to return to main menu without completing all tests, or wait until all tests are complete.

   During TEST ALL INPUTS sequence, the analyzer allows control switches to be operated and shows if they are closed (CL) or open (OP).

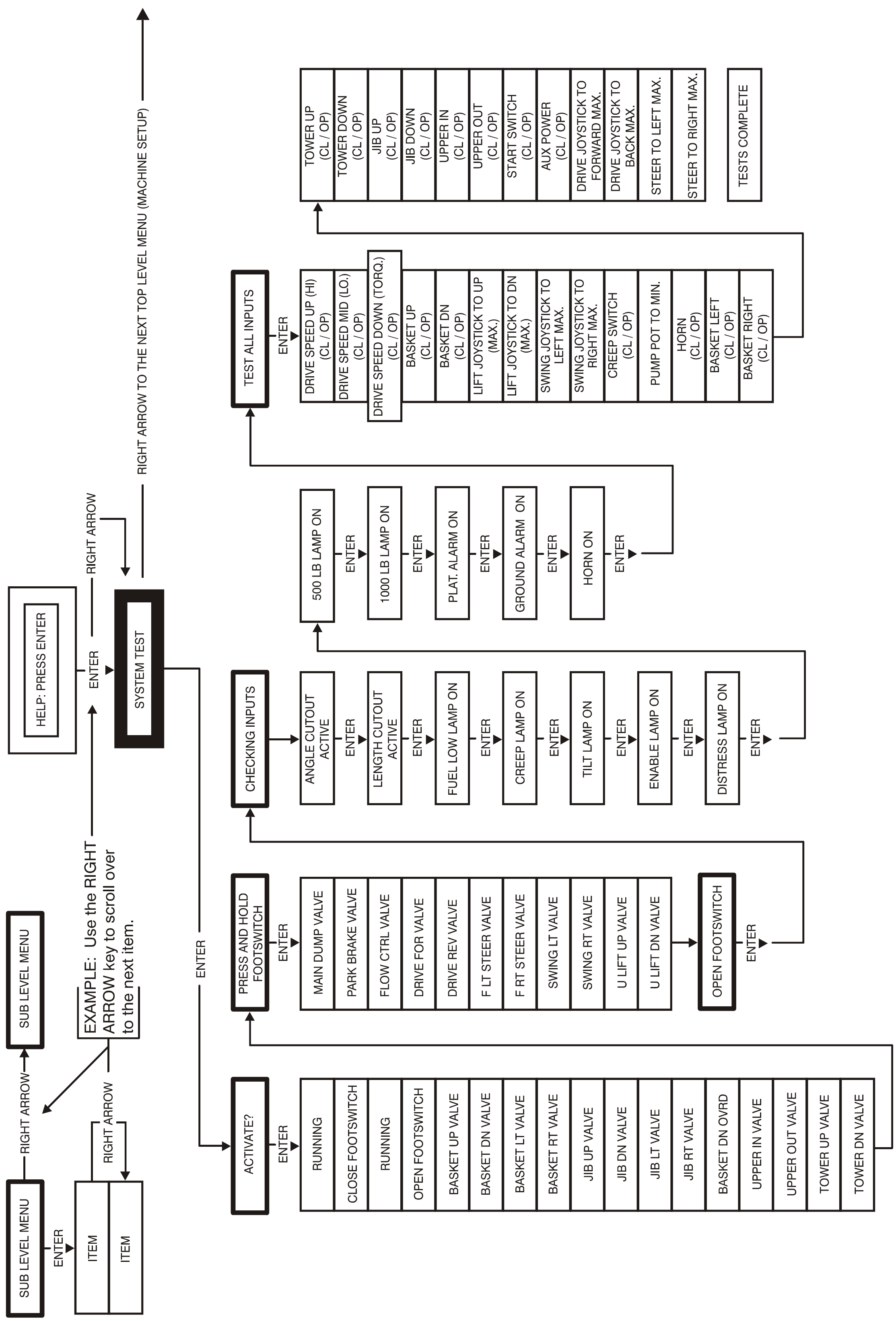
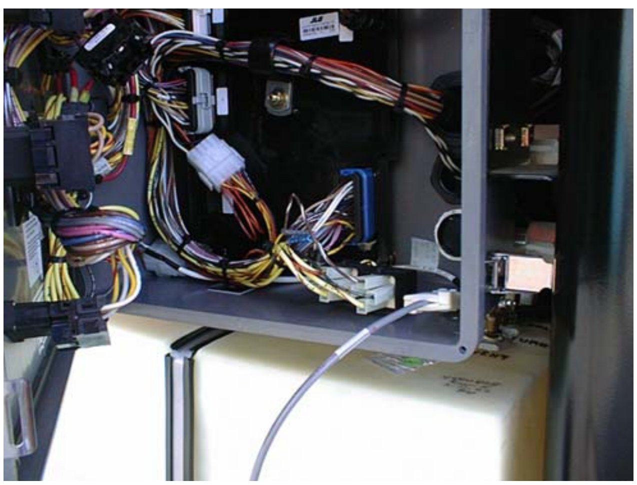


Figure 6-19. System Test Flow Chart - Platform Tests

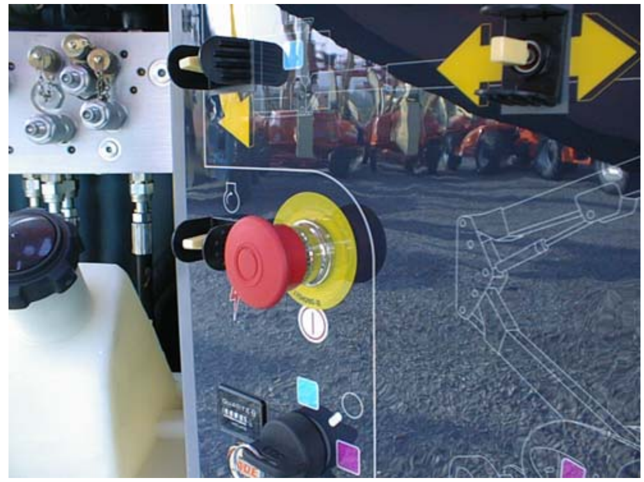
Test from the Ground Station

1. Position the Platform/Ground select switch to the Ground position.

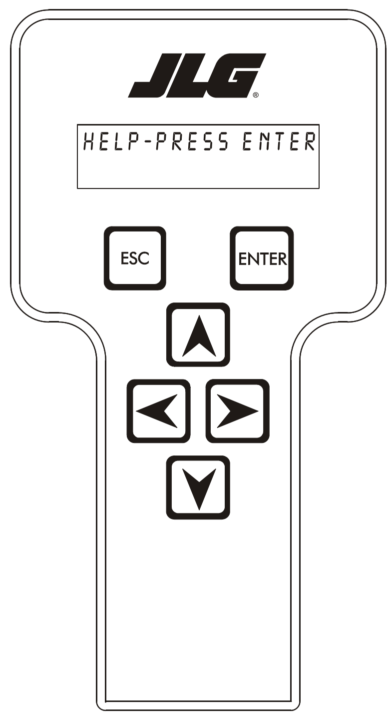
2. Plug the analyzer into the connector inside the Ground control box.



3. Pull out the Emergency Stop switch. and Start the engine.



4. The analyzer screen should read:



5. Use the arrow button to reach SYSTEM TEST. Hit Enter. The analyzer will prompt you asking if you want to activate the system test; hit Enter again to activate.

6. Follow flow path in Figure 6-20., System Test Flow Chart - Ground Station Tests and go through component tests. Hit ESC key during any part of the test to return to the main menu without completing all tests or wait until all tests are complete. During TEST ALL INPUTS sequence, the analyzer allows control switches to be operated and shows if they are closed (CL) or open (OP).

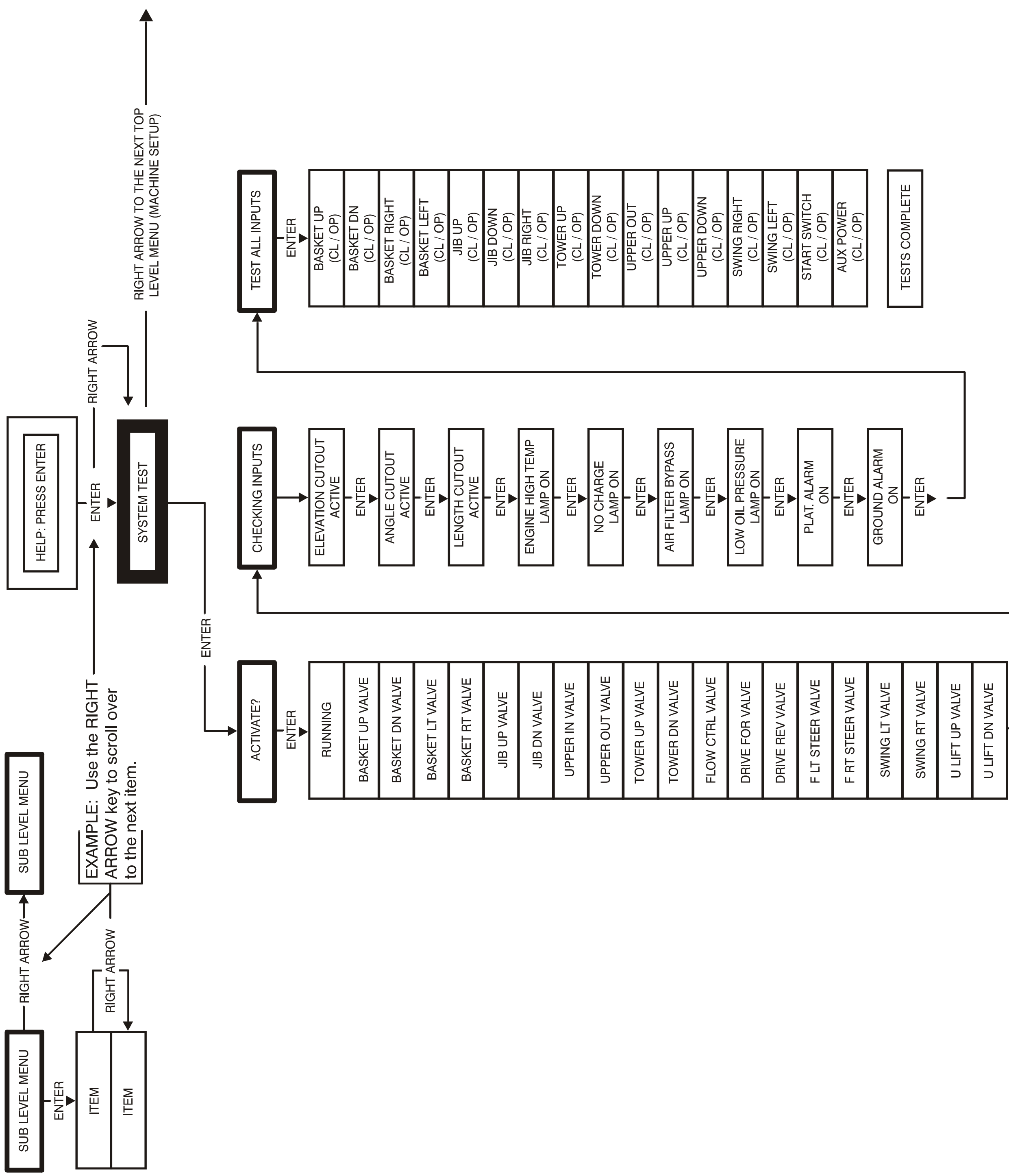


Figure 6-20. System Test Flow Chart - Ground Station Tests

Table 6-7. System Test Messages

Message Displayed on Analyzer	Message Displayed on Analyzer	Description
RUNNING		Initial display when system test is run; certain "critical" checks are made. Problems that can be reported include below messages.
	ONLY 1 ANALYZER!	Do not connect two Analyzers while running the system test.
	BATTERY TOO LOW	The system test cannot run with battery voltage below minimum (9 V).
	BATTERY TOO HIGH	The system test cannot run with battery voltage above maximum. (16 V).
	CHECK CAN WIRING	The system test cannot run in platform mode unless data is being received from the platform and ground modules. The system test cannot run in ground mode unless data is being received from the platform module.
	CHECK SPEED	There is an open- or short- circuit in the speed encoder wiring. Check speed encoder.
	BAD GROUND MODULE	An internal problem was detected in the ground module.
	HIGH TILT ANGLE	The vehicle is very tilted (19.3°), or the tilt sensor has been damaged. Check tilt sensor.
	HOT ENGINE	The engine temperature exceeds 100°C. This is only a warning.
	BAD I/O PORTS	The controller detected a problem with its internal circuits at switch on. If other problems are also detected, the controller may need replacing.
	SUSPECT EEPROM	The controller detected a problem with its EEPROM stored personality settings at switch on. Check and, if necessary correct, all personality settings.
	OPEN FSW	In platform mode, the footswitch must be open at the start of the test.
	CLOSE FSW	In platform mode, the footswitch must be closed when this message is displayed; the footswitch MUST BE KEPT CLOSED during the valve & contactor tests.
	BAD FSW	The two footswitch signals are not changing together, probably because one is open-circuit. One footswitch signal ("FSW1") is routed to the power module, the other ("FSW2") is routed to the platform module. Check footswitch and wiring.
TESTING VALVES		Indicates that the valve test is beginning. Each valve is alternately energized and de-energized; checks are made for open- and short- circuit valve coils. NOTE: In platform mode, the footswitch must be closed. NOTE: Tower lift valves are not tested if TOWER LIFT=NO. Tower telescope valves are not tested if TOWER TELE=NO. Jib valves are not tested if JIB = NO. Extendable axle valves are not tested if EXT AXLES=NO. Four wheel steer valves are not tested if 4WS=NO. NOTE: Left/right jib valves are not tested unless JIB = SIDESWING. Problems that can be reported include below messages.
	CANT TEST VALVES	There is a wiring problem, which prevents the valve test from functioning correctly. Check valve wiring. Check ground alarm & hour meter wiring.
	XXXXXXX S/C	The named valve is drawing too much current so is presumed to be short-circuited. Check valve wiring.
	XXXXXXX O/C	The named valve is drawing too little current so is presumed to be open-circuit. Check valve wiring.

Table 6-7. System Test Messages

Message Displayed on Analyzer	Message Displayed on Analyzer	Description
CHECKING INPUTS		Indicates that the inputs test is beginning. Every input is checked to ensure that it is in its "normal" position; function switches should be open, cutout switches should be closed, joysticks should be in neutral. In platform mode any non-neutral platform switch or joystick is reported; any active cutouts are reported. In ground mode any non-neutral ground switches is reported; any active cutouts are reported. NOTE: Switches, which are not in use (due to the settings of machine digits), are not checked. NOTE: The pump pot is checked only for a wire-off condition; it can be at any demand from creep to maximum. Problems that can be reported include below messages.
	CHECK XXXXXXX	The named switch is not in its "normal" position. Check switch & wiring.
	CHECK XXXXXXX JOY	The named joystick appears to be faulty. Check joystick.
TESTING LAMPS		Indicates that the lamps test is beginning. Each lamp is energized in turn; a prompt asks for confirmation that the lamp is lit. ENTER must be pressed or clicked to continue the test. NOTE: Lamps, which are not in use (due to the settings of machine digits), are not checked. NOTE: Platform Lamps are only tested in platform mode. NOTE: The GM overload lamp and 500# capacity lamp are not tested. NOTE: Head and tail lamps are tested in both platform and ground mode if enabled by a machine digit.
TESTING ALARMS		Indicates that the alarms test is beginning. Each alarm is energized in turn; a prompt asks for confirmation that the alarm is sounding. ENTER must be pressed or clicked to continue the test. NOTE: The platform alarm and the horn are only tested in platform mode. NOTE: The ground alarm is not tested if GROUND ALARM = NO.

Table 6-7. System Test Messages

Message Displayed on Analyzer	Message Displayed on Analyzer	Description
TEST ALL INPUTS?		Prompts whether to check every operator input. If ESC is pressed or clicked, the system test ends. If ENTER is pressed or clicked, each operator input is prompted for in turn. In platform mode every platform switch and joystick is tested. In ground mode every ground switch is tested. NOTE: Tower lift switches are not tested if TOWER LIFT=NO. Tower telescope switches are not tested if TOWER TELE=NO. Jib switches are not tested if JIB = NO. Extendable axle switches are not tested if EXT AXLES=NO. Four wheel steer switches are not tested if 4WS=NO. NOTE: Left/right jib switches are not tested unless JIB = SIDESWING. Prompts displayed during the operator input test below messages.
	CLOSE XXXXXXX	The named switch should be closed.
	OPEN XXXXXXX	The named switch should be opened.
	XXXXXXX XXXXXXX TO MAX	The named joystick should be pushed to its full extent in the named direction.
	XXXXXXX XXXXXXX TO MIN	The named joystick should be returned to neutral from the named direction.
	PUMP POT TO MAX	The pump pot should be turned to maximum.
	PUMP POT TO MIN	The pump pot should be turned to minimum.
	MULTIPLE CLOSURE	More than one operator input is closed; if only one has been operated, there could be a short between two inputs.
TESTS COMPLETE		Indicates that the system test is complete. Any problems reported should have been noted and should now be rectified. Press ESC/CANCEL to return to the RUN SYSTEM TEST Analyzer menu.

Table 6-8. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
DRIVE:			
	DRIVE	FOR/REV XXX%	Displays drive joystick direction & demand
	STEER	RIGHT/LEFT XXX%	Displays steer switch direction & demand
	4WS	NORMAL/COOR/CRAB	Displays status of four wheel steer input (Displayed if 4WS = 1)
	BRAKES	LOCKED/RELEASED	Displays brake control system status
	CREEP	ACTIVE/NOT ACTIVE	Displays pump pot creep switch status
	CRP MODE	ACTIVE/NOT ACT	Displays creep mode status
	QPRX1	ACTIVE/NOT ACTIVE	Displays status of Q-Prox sensor in drive joystick (Displayed if JOYSTICK TYPE = 1)
	QPRX2	ACTIVE/NOT ACTIVE	Displays status of Q-Prox sensor in drive joystick (Displayed if JOYSTICK TYPE = 1)
	TWO SPEED	OP/CL	Displays status of two speed switch input if selected model has two speed.
	2 speed mode	ON/OFF	Displays status of two speed valve if selected model has two speed
	high engine	OP/CL	Displays status of high engine switch
	LT F ANG	XX.X	Displays status of left front steer angle (Displayed if MODEL NUMBER = 7 or 8)
	RT F ANG	XX.X	Displays status of right front steer angle (Displayed if MODEL NUMBER = 7 or 8)
	LT R ANG	XX.X	Displays status of left rear steer angle (Displayed if MODEL NUMBER = 7 or 8)
	RT R ANG	XX.X	Displays status of right rear steer angle (Displayed if MODEL NUMBER = 7 or 8)
	DOS LIM sw	OP/CL	Displays status of Drive Orientation System limit switch. (Displayed if MODEL NUMBER = 7 or 8)
	DOS O/R sw	OP/CL	Displays status of Drive Orientation Limit System override switch. (Displayed if MODEL NUMBER = 7 or 8)

Table 6-8. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
BOOM:			
	U LIFT	UP/DOWN XXX%	Displays upper lift joystick direction & demand
	SWING	RIGHT/LEFT XXX%	Displays swing joystick direction & demand
	QPRX1	ACTIVE/NOT ACTIVE	Displays status of Q-Prox sensor in lift/swing joystick (Displayed if JOYSTICK TYPE = 1)
	QPRX2	ACTIVE/NOT ACTIVE	Displays status of Q-Prox sensor in lift/swing joystick (Displayed if JOYSTICK TYPE = 1)
	LEVEL	UP/DOWN XXX%	Displays basket level switch direction & demand. NOTE: demand is controlled by the pump pot
	ROT.	RIGHT/LEFT XXX%	Displays basket rotate switch direction & demand. NOTE: demand is controlled by the pump pot
	U TELE	IN/OUT XXX%	Displays upper telescope switch direction & demand. NOTE: demand is controlled by the pump pot
	T TELE	IN/OUT XXX%	Displays tower telescope switch direction & demand. NOTE: demand is controlled by the pump pot Not displayed if TOWER TELE=NO (machine digit = 0)
	T LIFT	UP/DOWN XXX%	Displays tower lift switch direction & demand. NOTE: demand is controlled by the pump pot Not displayed if TOWER LIFT=NO (machine digit = 0)
	JIB	UP/DOWN XXX%	Displays jib lift switch direction & demand. NOTE: demand is controlled by the pump pot Not displayed if JIB = NO (machine digit = 0)
	JIB	RIGHT/LEFT XXX%	Displays jib swing switch direction & demand. NOTE: demand is controlled by the pump pot Displayed if JIB = SIDESWING (machine digit = 2)
	JIB INLINE	OP/CL	Displays status of jib inline limit switch. Displayed on models equipped with the Jib Stow System
	JIB LIMIT	OP/CL	Displays status of jib right limit switch. Displayed on models equipped with the Jib Stow System
	JIB LIM OVRD	OP/CL	Displays status of jib limit override switch. Displayed on models equipped with the Jib Stow System
	PCV	ON/OFF	Displays status of Platform Control Valve. Displayed on models equipped with Electronic Platform Leveling.
	PUMP POT	XXX%	Displays pump pot demand. Not displayed if MODEL = 601 (machine digit = 4)
	CREEP	ACTIVE/NOT ACTIVE	Displays pump pot creep switch status
	CRP MODE	ACTIVE/NOT ACT	Displays creep mode status

Table 6-8. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
ENGINE:			
	START	ACTIVE/NOT ACTIVE	Displays status of the engine start circuit
	AIR FILTER	OP/CL	Displays measured status of air filter by-pass switch. (Not displayed if MODEL NUMBER = 7 or 8)
	BATTERY	XX.XV	Displays measured battery voltage
	COOLANT	XXXC	Displays measured coolant temperature
	OIL PRS	LOW / OK or XXPSI	Displays measured oil pressure
	FUEL SELECT	GAS/LP	Displays status of fuel select switch. (Displayed if MODEL NUMBER = 2)
	AMB. TEMP	XXXC	Displays measured ambient air temperature
	FUEL LEVEL	¼ / ½ / ¾ / FULL or LOW / OK	Displays measured fuel level
	XXXX rpm		Engine RPM

Table 6-8. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
SYSTEM:			
	GM BATTERY	XX.XV	Ground module battery voltage
	PM BATTERY	XX.XV	Platform module battery voltage
	AMB. TEMP	XXXC	Ambient temperature
	FSW1	OP/CL	Displays footswitch status. NOTE: FSW1 is wired to the ground module.
	FSW2	OP/CL	Displays footswitch status. NOTE: FSW2 is wired to the platform module.
	ABOVE ELEV.	OP/CL/YES/NO	Displays above elevation cutout switch status or above angle status
	LEN SW 1	OP/CL	Displays status of boom length retracted limit switch (Displayed if MODEL NUMBER = 7 or 8)
	LEN SW 2	OP/CL	Displays status of boom length retracted limit switch (Displayed if MODEL NUMBER = 7 or 8)
	RETRACTED	YES/NO	Displays status of boom length retracted (Displayed if MODEL NUMBER = 7 or 8)
	TRANSPORT	YES/NO	Displays status of transport position
	U LIFT CUTOUT	OP/CL	Displays status of boom length retracted limit switch (Displayed if MODEL NUMBER = 6)
	T LIFT PROX	OP/CL	Displays status of tower lift proximity switch (Displayed if TOWER PROX SWITCHES = 1)
	T TELE PROX	OP/CL	Displays status of tower telescope proximity switch (Displayed if TOWER PROX SWITCHES = 1)
	BR CABLE CUT.	OP/CL	Displays status of broken cable switch (Displayed if BROKEN CABLE SWITCH = 1)
	CREEP	ACTIVE/NOT ACTIVE	Displays pump pot creep switch status. Not displayed if MODEL = 601 (machine digit = 4)
	CRP MODE	ACTIVE/NOT ACT	Displays creep mode status
	SUPER CREEP	ON/OFF	Displays super creep mode status (Displayed if MODEL NUMBER = 7 or 8)
	TILT	XX.X DEG	Displays measured vehicle tilt. (Displayed if internal tilt sensor is configured)
	LO TILTED -	NO/YES	Displays status of lo tilt input. (Displayed if external tilt sensor is configured)

Table 6-8. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
	hi TILTED -	NO/YES	Displays status of hi tilt input. (Displayed if external tilt sensor is configured)
	AUX POWER	OP/CL	Displays the status of the auxiliary power switch input
	HORN	OP/CL	Displays the status of the horn input
	R FILTER	OP/CL	Displays the status of the return hydraulic filter by-pass switch. Displayed ONLY if MODEL = 600 (Configuration digit = 3)
	C FILTER	OP/CL	Displays measured status of charge pump filter bypass switch. Displayed ONLY if MODEL = 600 (Configuration digit = 3)
	JIB BLOCK	OP/CL	Displays jib block limit switch status. Not displayed if associated configuration digit = 0
	BASKET STOWD	YES/NO	Displays status of basket stowed mode. (Displayed if MODEL NUMBER = 7 or 8)
	SOFT LIMIT	OP/CL	Displays status of soft touch limit switch. Not displayed if associated configuration digit = 0
	SOFT O/R	OP/CL	Displays status of soft touch override switch. Not displayed if associated configuration digit = 0
	GEN SET/WELDER	OP/CL	Displays generator/welder switch input status. Not displayed if associated configuration digit = 0
	LIGHTS	OP/CL	Displays head and tail light switch input status. Not displayed if associated configuration digit = 0
	bsk tilt1	XX.X	Displays indicated platform tilt angle. Displayed on models equipped with Electronic Platform Leveling.
	bsk tilt2	XX.X	Displays indicated platform tilt angle. Displayed on models equipped with Electronic Platform Leveling.
	axle RET sw	OP/CL	Displays status of axle extension user switches. (Displayed if MODEL NUMBER = 7 or 8)
	axle EXT sw	OP/CL	Displays status of axle retraction user switches. (Displayed if MODEL NUMBER = 7 or 8)
	axle lim sw	RET/EXT	Displays status of axle extension limit switches. (Displayed if MODEL NUMBER = 7 or 8)
	dos lim sw	OP/CL	Displays status of Drive Orientation System Limit Switch. (Displayed if MODEL NUMBER = 7 or 8)
	dos o/r SW	OP/CL	Displays status of Drive Orientation System Override switch. (Displayed if MODEL NUMBER = 7 or 8)
	CAPACITY SW	500/1000	Displays status of capacity selection switch. (Displayed if MODEL NUMBER = 7 or 8)

Table 6-8. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
	osc axle p sw	OP/CL	Displays status of oscillating axle pressure switch. (Displayed if OSCILLATING AXLE = 1)
	sky welder	YES/NO	Displays the status of Sky Welder selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	sky cutter	YES/NO	Displays the status of Sky Cutter selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	sky glazier	YES/NO	Displays the status of Sky Glazier selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	sky Bright	YES/NO	Displays the status of Sky Bright selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	Pipe Racks	YES/NO	Displays the status of Pipe Racks selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	Camera mount	YES/NO	Displays the status of Camera Mount selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
LOAD:			Not displayed if LOAD=NO, LENGTH=NO, and ANGLE=NO (machine digits = 0)
	LENGTH	OP /CL	Displays measured length, NOTE: Not displayed if MODEL NUMBER = 7 or 8
	ANGLE	OP / CL	Displays measured angle, NOTE: Not displayed if MODEL NUMBER = 7 or 8
	WEIGHT	XXXX%	Percentage of maximum calibrated weight on the platform. An uncalibrated load cell will read 1000% Displayed if LOAD is not 0 and LOAD TYPE is 0.
		OK/OVERLOADED	Displays LSS Module load system status. Displayed if LOAD is not 0 and LOAD TYPE is 1.

Table 6-8. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
MOMENT:			Displayed if MODEL NUMBER = 7 or 8
	(LB-IN) ACTUAL	XXXXXXXX	Displays current moment value
	(LB-IN) OVER	XXXXXXXX	Displays current over moment setpoint.
	(LB-IN) UNDER	XXXXXXXX	Displays current under moment setpoint.
	CAL PT UNDER	XXXXXXXX	Displays the under moment value recorded during boom sensor calibration.
	CAL PT WIT YEL	XXXXXXXX	Displays the yellow witness mark moment value recorded during boom sensor calibration.
	CAL PT WIT GRN	XXXXXXXX	Displays the green witness mark moment value recorded during boom sensor calibration.
	CYL PIN RATIO	X.XXX	Displays the current cylinder moment pin ratio of X and Y forces.
	PIN E FLAGS	0xXXXX	Displays the current error flag status of the cylinder moment pin.
	sky welder	YES/NO	Displays the status of Sky Welder selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	sky cutter	YES/NO	Displays the status of Sky Cutter selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	sky glazier	YES/NO	Displays the status of Sky Glazier selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	sky Bright	YES/NO	Displays the status of Sky Bright selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	Pipe Racks	YES/NO	Displays the status of Pipe Racks selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
	Camera mount	YES/NO	Displays the status of Camera Mount selected during boom sensor calibration. (Displayed if MODEL NUMBER = 7 or 8)
ENVELOPE:			Displayed if MODEL NUMBER = 7 or 8
	LENGTH	XXXX.X	Displays the current indicated boom length in inches.
	ANGLE 1	XX.X	Displays the current indicated boom angle 1 in degrees.
	ANGLE 2	XX.X	Displays the current indicated boom angle 2 in degrees.
	A/D LNGTH	XXXXX	Displays the current indicated boom length in A/D counts.
	A/D ANG1	XXXXX	Displays the current indicated boom angle 1 in A/D counts or raw angle if calibrated.
	A/D ANG2	XXXXX	Displays the current indicated boom angle 2 in A/D counts or raw angel if calibrated.
CAN STATISTICS:			CAN Statistics as detected by the Ground Module
	RX/SEC	XXX	Displays the number of received messages per second
	TX/SEC	XXX	Displays the number of transmitted messages per second
	BUS OFF	XX	Displays the number of bus off occurrences
	PASSIVE	XX	Displays the number of bus passive occurrences

Table 6-8. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
CALIBRATION DATA			
	BASKET UP	XXX	Displays the basket up calibration point
	Basket DOWN	XXX	Displays the basket down calibration point
	L FWD DRIVE	XXX	Displays the left forward drive calibration point
	R FWD DRIVE	XXX	Displays the right forward drive calibration point
	L REV DRIVE	XXX	Displays the left reverse drive calibration point
	R REV DRIVE	XXX	Displays the right reverse drive calibration point
	F LT STEER	XXX	Displays the forward left steer calibration point
	F RT STEER	XXX	Displays the forward right steer calibration point
	R LT STEER	XXX	Displays the reverse left steer calibration point
	R RT STEER	XXX	Displays the reverse right steer calibration point
	U LIFT UP	XXX	Displays the upper lift up calibration point
	U LIFT DOWN	XXX	Displays the upper lift down calibration point
	U TELE IN	XXX	Displays the upper telescope in calibration point
	U TELE OUT	XXX	Displays the upper telescope out calibration point
	BM ANG 1 LO	XXX	Displays the boom angle 1 low calibration point
	BM ANG 1 HI	XXX	Displays the boom angle 1 high calibration point
	BM ANG 2 LO	XXX	Displays the boom angle 2 low calibration point
	BM ANG 2 HI	XXX	Displays the boom angle 2 high calibration point
	LEN RETRACT	XXX	Displays the length sensor retracted calibration point
	LEN EXTEND	XXXXX	Displays the length sensor extended calibration point
	LEN WIT	XXXXX	Displays the witness mark calibration point
	LEN SWITCH	XXXX	Displays the length switch calibration point
DATALOG:			
	ON	XXXXhXXm	Displays total controller on (EMS) time
	ENGINE	XXXXhXXm	Display engine run time
	DRIVE	XXXXhXXm	Displays total controller drive operation time
	LIFT	XXXXhXXm	Displays total controller lift operation time
	SWING	XXXXhXXm	Displays total controller swing operation time
	TELE	XXXXhXXm	Displays total controller telescope operation time
	MAX TEMP	XXC	Displays maximum measured ambient temp.
	MIN TEMP	XXC	Displays minimum measured ambient temp.
	MAX volts	XX.XV	Displays maximum measured battery voltage
	RENTAL	XXXXhXXm	Displays total controller operation time. NOTE: can be reset
	ERASE RENTAL?		Not available at Access Level 2. ENTER resets rental data log time to zero.

Table 6-8. Machine Diagnostics Parameters

Diagnostics Submenu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
VERSIONS:			
	GM SW	PX.X	Displays ground module software version
	GM HW REV	XXXX	Displays ground module hardware revision
	GM SN	XXXXXX	Displays ground module serial number
	PM SW	PX.X	Displays platform module software version
	PM HW REV	XXXX	Displays platform module hardware revision
	PM SN	XXXXXX	Displays platform module serial number
	cm sw	PX.X	Displays chassis module software version
	bm sw	PX.X	Displays BLAM module software version
	c pin SW		Displayed if cylinder moment load pin transmits software version.
	C PIN SN		Displayed if cylinder moment load pin transmits serial number.
	ANALYZER	VX.XXXX	Displays Analyzer software version

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
None		No flash code is indicated for the following help messages. They are intended to hint at a possible problem if the 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 limited to creep. Creep switch is open.	
	RUNNING AT CREEP – TILTED AND ABOVE ELEVATION	All boom function speeds limited to creep. Vehicle is tilted and above elevation.	
	RUNNING AT CUTBACK – OUT OF TRANSPORT POSITION	Drive speed is limited to "ELEVATED MAX" because the vehicle is out of transport position.	
	CHASSIS TILT SENSOR OUT OF RANGE	Chassis 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 the basket is resting on the ground. Not reported during 2 second power-up.	
	ENVELOPE ENCROACHED – HYDRAU-LICS SUSPENDED	Only occurs on machines with envelope control. The system has detected an envelope violation	
	OVER MOMENT – HYDRAULICS SUS-PENDED	Only occurs on machines with moment control. The system has detected an over moment violation.	
	UNDER MOMENT – HYDRAULICS SUS-PENDED	Only occurs on machines with moment control. The system has detected an under moment violation.	
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. An EMS cycle is required.	
	KEYSWITCH FAULTY	Both platform and ground modes are selected simultaneously	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
2/2		**Flash code 2/2 indicates problems with drive & steer selection. Except where noted, these faults are not reported during 2 second power-up sequence.**	**3**
	DRIVE LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Drive was selected before and during footswitch closure. Can be reported during power-up sequence.	
	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 at the same time.	
	D/S JOY. OUT OF RANGE LOW	Resistive joysticks: These faults do not occur.	
	D/S JOY. OUT OF RANGE LOW	Resistive joysticks: These faults do not occur.	
	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.	
	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.	
	WAITING FOR FSW TO BE OPEN	Footswitch was closed when platform mode was selected. Can be reported during power-up sequence.	
	FOOTSWITCH SELECTED BEFORE START	The user attempted to start the machine with the footswitch engaged.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
2/3		**Flash code 2/3 indicates problems with boom function selection.**	**3**
	LIFT/SWING LOCKED – JOYSTICK MOVED BEFORE FOOTSWITCH	Platform upper lift or swing was selected before and during footswitch closure.	
	PUMP SWITCHES FAULTY – CHECK DIAGNOSTICS/BOOM	A boom function (lower lift, telescope, basket level, basket rotate, jib) has both directions selected together.	
	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.	
	l/s joy. out of range low	Resistive joysticks: These faults do not occur.	
	l/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.	
	l/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.	
	PUMP SWITCHES LOCKED – SELECTED BEFORE START SWITCH	This fault occurs when a hydraulic function switch is closed before the start switch is closed.	
	FOOTSWITCH SELECTED BEFORE START	The user attempted to start the machine with the footswitch engaged.	
2/4		**Flash code 2/4 indicates that steering digital inputs are faulty. NOT REQUIRED**	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
2/5		**Flash code 2/5 indicates that 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.	
	JIB SWING PREVENTED – IN 1000# MODE	The user is trying to jib swing in 1000# mode, which is not allowed.	
	CAN DONGLE ATTACHED – HYDRAULICS NOT RESTRICTED	The system allows the user to operate all hydraulics with very limited restrictions.	
	MODEL CHANGED – HYDRAULICS SUSPENDED – CYCLE EMS	User changed the model number using the analyzer. User must cycle power before the hydraulics system will be active again.	**11**
	BACKUP BLAM COMMUNICATIONS ACTIVE	The serial backup communications link to the BLAM module is active	
	DISCONNECT ANALYZER AND CYCLE EMS TO PERFORM BOOM RETRIEVAL	The ground module has detected that it needs to use the RS232 backup communications link to the BLAM module but an analyzer is connected. Remove the analyzer and cycle power	
	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	Reported if the major version of the platform module does not match the major version of the ground module	
	FUNCTIONS LOCKED OUT - CHASSIS MODULE SOFTWARE VERSION IMPROPER	Reported if the major version of the chassis module does not match the major version of the ground module	
	FUNCTIONS LOCKED OUT - BLAM MODULE SOFTWARE VERSION IMPROPER	Reported if the major version of the BLAM module does not match the major version of the ground module	
2/7		**Flash code 2/7 indicates that the 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 that a contactor did not close when energized. NOT REQUIRED**	
3/2		**Flash code 3/2 indicates that a contactor did not open when energized. NOT REQUIRED**	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
3/3		**Flash code 3/3 indicates a driver problem. All driver faults are detected in a similar manner. Open circuit faults are detected when the analog feedback reads too high and the output is commanded off. Short to ground is detected when the analog feedback reads low and the output is commanded on. Short to battery is detected when the analog feedback reads Vbat and the output is commanded off. Not reported during 2 second power-up. An EMS cycle is required.**	**6**
	RIGHT FORWARD DRIVE PUMP SHORT TO GROUND	Only occurs on machines with a chassis module.	
	RIGHT FORWARD DRIVE PUMP SHORT TO BATTERY	Only occurs on machines with a chassis module.	
	RIGHT FORWARD DRIVE PUMP OPEN CIRCUIT	Only occurs on machines with a chassis module.	
	RIGHT REVERSE DRIVE PUMP SHORT TO GROUND	Only occurs on machines with a chassis module.	
	RIGHT REVERSE DRIVE PUMP SHORT TO BATTERY	Only occurs on machines with a chassis module.	
	RIGHT REVERSE DRIVE PUMP OPEN CIRCUIT	Only occurs on machines with a chassis module.	
	LEFT FORWARD DRIVE PUMP SHORT TO GROUND	Only occurs on machines with a chassis module.	
	LEFT FORWARD DRIVE PUMP SHORT TO BATTERY	Only occurs on machines with a chassis module.	
	LEFT FORWARD DRIVE PUMP OPEN CIRCUIT	Only occurs on machines with a chassis module.	
	LEFT REVERSE DRIVE PUMP SHORT TO GROUND	Only occurs on machines with a chassis module.	
	LEFT REVERSE DRIVE PUMP SHORT TO BATTERY	Only occurs on machines with a chassis module.	
	LEFT REVERSE DRIVE PUMP OPEN CIRCUIT	Only occurs on machines with a chassis module.	
	ALTERNATOR/ECM POWER SHORT TO GROUND		
	HOUR METER SHORT TO GROUND		
	HOUR METER SHORT TO BATTERY		
	HORN SHORT TO GROUND		
	HORN OPEN CIRCUIT		
	HORN SHORT TO BATTERY		
	AUX POWER SHORT TO GROUND		
	AUX POWER OPEN CIRCUIT		
	AUX POWER SHORT TO BATTERY		
	GLOW PLUG SHORT TO GROUND	Only occurs on machines with glowplugs configured.	
	GLOW PLUG OPEN CIRCUIT	Only occurs on machines with glowplugs configured.	
	GLOW PLUG SHORT TO BATTERY	Only occurs on machines with glowplugs configured.	
	LP LOCK SHORT TO GROUND	Only occurs on machines with dual-fuel engines.	
	LP LOCK OPEN CIRCUIT	Only occurs on machines with dual-fuel engines.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
	LP LOCK SHORT TO BATTERY	Only occurs on machines with dual-fuel engines.	
	LP START ASSIST SHORT TO GROUND	Only occurs on machines with dual-fuel engines.	
	LP START ASSIST OPEN CIRCUIT	Only occurs on machines with dual-fuel engines.	
	LP START ASSIST SHORT TO BATTERY	Only occurs on machines with dual-fuel engines.	
	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	Only occurs on machines with diesel engines.	
	START SOLENOID OPEN CIRCUIT	Only occurs on machines with diesel engines.	
	START SOLENOID SHORT TO BATTERY	Only occurs on machines with diesel engines.	
	MAIN LIFT APU SHORT TO GROUND	Only occurs on the 1250AJP machine	
	MAIN LIFT APU OPEN CIRCUIT	Only occurs on the 1250AJP machine	
	MAIN LIFT APU SHORT TO BATTERY	Only occurs on the 1250AJP machine	
	MAIN LIFT PILOT PRESSURE FAILURE	Only occurs on the 1250AJP machine	
	NO MAIN LIFT PILOT PRESSURE	Only occurs on the 1250AJP machine	
	MAIN LIFT PILOT PRESSURE SWITCH FAILURE	Only occurs on the 1250AJP machine	
	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	Only occurs on machines with ground alarm configured.	
	GROUND ALARM OPEN CIRCUIT	Only occurs on machines with ground alarm configured.	
	GROUND ALARM SHORT TO BATTERY	Only occurs on machines with ground alarm configured.	
	GEN SET/WELDER SHORT TO GROUND	Only occurs on machines with a generator configured.	
	GEN SET/WELDER OPEN CIRCUIT	Only occurs on machines with a generator configured.	
	GEN SET/WELDER SHORT TO BATTERY	Only occurs on machines with a generator configured.	
	HEAD TAIL LIGHT SHORT TO GROUND	Only occurs on machines with the headlights option configured.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
	HEAD TAIL LIGHT OPEN CIRCUIT	Only occurs on machines with the headlights option configured.	
	HEAD TAIL LIGHT SHORT TO BATTERY	Only occurs on machines with the headlights option configured.	
	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 BATTERY		
	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.	
	TOWER LIFT APU VALVE STUCK OPEN	Only occurs on 1250AJP	
	TOWER LIFT ENABLE STUCK OPEN	Only occurs on 1250AJP	
	TOWER LIFT ENABLE SHORT TO GROUND	Only occurs on 1250AJP	
	TOWER LIFT ENABLE OPEN CIRCUIT	Only occurs on 1250AJP	
	TOWER LIFT ENABLE SHORT TO BATTERY	Only occurs on 1250AJP	
	TOWER TELESCOPE APU SHORT TO GROUND	Only occurs on 1250AJP	
	TOWER TELESCOPE APU OPEN CIRCUIT	Only occurs on 1250AJP	
	TOWER TELESCOPE APU SHORT TO BATTERY	Only occurs on 1250AJP	
	BASKET LEFT OPEN CIRCUIT		
	BASKET LEFT SHORT TO BATTERY		
	BASKET LEFT SHORT TO GROUND		
	BASKET RIGHT SHORT TO GROUND		
	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		

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
	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 BATTERY		
	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		
	MAIN IN SHORT TO GROUND		
	MAIN IN OPEN CIRCUIT		
	MAIN IN SHORT TO BATTERY		
	MAIN OUT SHORT TO GROUND		
	MAIN OUT OPEN CIRCUIT		
	MAIN OUT SHORT TO BATTERY		
	LIFT UP DUMP SHORT TO GROUND		
	LIFT UP DUMP OPEN CIRCUIT		
	LIFT UP DUMP SHORT TO BATTERY		
	LIFT DOWN HOLDING SHORT TO GROUND		
	LIFT DOWN HOLDING OPEN CIRCUIT		
	LIFT DOWN HOLDING SHORT TO BATTERY		
	LIFT PILOT VALVE SHORT TO GROUND	Only occurs on machines with gravity lift down.	
	LIFT PILOT VALVE SHORT TO BATTERY	Only occurs on machines with gravity lift down.	
	LIFT PILOT VALVE OPEN CIRCUIT	Only occurs on machines with gravity lift down.	
	LIFT DOWN AUX VALVE SHORT TO GROUND	Only occurs on machines with gravity lift down.	
	LIFT DOWN AUX VALVE SHORT TO BATTERY	Only occurs on machines with gravity lift down.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
	LIFT DOWN AUX VALVE OPEN CIRCUIT	Only occurs on machines with gravity lift down.	
	TOWER LIFT APU SHORT TO GROUND	Only occurs on 1250AJP	
	TOWER LIFT APU OPEN CIRCUIT	Only occurs on 1250AJP	
	TOWER LIFT APU SHORT TO BATTERY	Only occurs on 1250AJP	
	MAIN LIFT ENABLE SHORT TO GROUND	Only occurs on 1250AJP	
	MAIN LIFT ENABLE OPEN CIRCUIT	Only occurs on 1250AJP	
	MAIN LIFT ENABLE SHORT TO BATTERY	Only occurs on 1250AJP	
	TOWER TELE APU VALVE STUCK OPEN	Only occurs on 1250AJP	
	TOWER TELE ENABLE STUCK OPEN	Only occurs on 1250AJP	
	TOWER TELE APU SHORT TO GROUND	Only occurs on 1250AJP	
	TOWER TELE APU OPEN CIRCUIT	Only occurs on 1250AJP	
	TOWER TELE APU SHORT TO BATTERY	Only occurs on 1250AJP	
	PVG VALVE SHORT TO GROUND	Only occurs on 1250AJP	
	PVG VALVE OPEN CIRCUIT	Only occurs on 1250AJP	
	PVG VALVE SHORT TO BATTERY	Only occurs on 1250AJP	
	FOX SPARE OUTPUT SHORT TO GROUND	Only occurs on Fox machines.	
	FOX SPARE OUTPUT SHORT TO BATTERY	Only occurs on Fox machines.	
	FOX SPARE OUTPUT OPEN CIRCUIT	Only occurs on Fox machines.	
	HOUR METER OPEN CIRCUIT	This fault cannot be detected during normal operation. It may be reported during self test.	
	RESTRICTED TO TRANSPORT – AXLE LOCKOUT VALVE STB OR OC	Only occurs on machines with electrically released oscillating axles configured. A short to battery or open circuit has been detected on the axle lockout valve and the machine is restricted to transport position.	
	RESTRICTED TO TRANSPORT – PARKING BRAKE STB	Only occurs on machines with electrically released oscillating axles configured. A short to battery has been detected on the parking brake valve and the machine is restricted to transport position.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
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 the analog feedback reads too high and output is commanded off. Short to ground is detected when analog feedback reads low and output is commanded on. Short to battery is detected when analog feedback reads Vbat and output is commanded off. Not reported during 2 second power-up. An EMS cycle is required.**	**6**
	BASKET UP SHORT TO BATTERY		
	BASKET UP SHORT TO GROUND		
	BASKET UP OPEN CIRCUIT		
	BASKET UP SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling	
	BASKET DOWN SHORT TO BATTERY		
	BASKET DOWN SHORT TO GROUND		
	bASKET DOWN OPEN CIRCUIT		
	BASKET DOWN SHORT TO BATTERY OR OPEN CIRCUIT	Only occurs on machines with electronic basket leveling.	
	BASKET LEFT SHORT TO BATTERY		
	BASKER LEFT SHORT TO GROUND		
	BASKET LEFT OPEN CIRCUIT		
	BASKET RIGHT SHORT TO BATTERY		
	BASKET RIGHT SHORT TO GROUND		
	BASKET RIGHT OPEN CIRCUIT		
	JIB UP SHORT TO BATTERY		
	JIB UP SHORT TO GROUND		
	JIB UP OPEN CIRCUIT		
	JIB DOWN SHORT TO BATTERY		
	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**	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
4/2		**Flash code 4/2 indicates that the engine is over temperature. NOT REQUIRED**	
4/3		**Flash code 4/3 indicates engine problems. 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 degrees Celsius for Ford engines, and above 130 degrees Celsius for Deutz engines.	
	AIR FILTER BYPASSED	Air filter clogged	
	NO ALTERNATOR OUTPUT	The engine has been running for 15 seconds or more and the battery voltage is still below 11.5 volts.	
	LOW OIL PRESSURE	If a Deutz engine is configured, the oil pressure is below 8 PSI and the engine has been running for at least 10 seconds. If a Ford engine is configured, the Ford ECM has reported a low oil pressure fault.	
	OIL PRESSURE SHORT TO BATTERY	If a Deutz engine is configured, this indicates that the oil pressure sensor is reading above 6.6 volts.	
	OIL PRESSURE SHORT TO GROUND	If a Deutz engine is configured, this indicates that the oil pressure sensor is reading below.1 volts for more than 5 seconds. This fault is not detected during crank.	
	COOLANT TEMPERATURE SHORT TO GROUND	If Deutz engine is configured, this indicates coolant temperature is reading below.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. Can be reported during power-up sequence.	
	ENGINE FAULT CODE : ###(SPN) :###(FMI)	All J1939 CANBUS ECMs report fault messaging in this format. The SPN number represents what is broken and FMI number represents how the component is broken.	
	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 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.	
	FUEL SENSOR SHORT TO GROUND	Indicates fuel sensor is reading below.2 volts.	
	WRONG ENGINE SELECTED – ECM PRESENT	Indicates an Engine Control Module (ECM) has been detected on the CANBUS. This fault will only be applicable when non-CANBUS engine setups are configured.	
	ECM CAN COMMUNICATION LOST	Engine is configured to have a CANBUS controlled engine and the JLG system does not detect an ECM. This fault can be the result of power lost to the ECM or a break in CANBUS communications connection from ECM to JLG system.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
4/4		**Flash code 4/4 indicates problems with the battery supply. Not reported during 2 second power-up.**	**7**
	BATTERY LOW	Battery voltage is below 11V for more than 5 seconds. This fault is not detected during crank. This is a warning – the 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.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
4/5		**Flash code 4/5 indicates problems with the S-D CAN based PVG valves currently used on the 1250AJP only.**	7
	MAIN LIFT PVG COMMUNICATIONS	CAN communications lost with the Main Lift PVG valve.	
	tower lift pvg communications	CAN communications lost with the Tower Lift PVG valve.	
	tOWER TELESCOPE PVG COMUNICA-TIONS	CAN communications lost with the Tower Telescope PVG valve.	
	MAIN LIFT PVG internal fault	Main boom lift pvg valve has an internal fault.	
	tower lift pvg internal fault	Tower boom lift pvg valve has an internal fault.	
	tOWER TELESCOPE PVG internal fault	Tower boom telescope pvg valve has an internal fault.	
	MAIN LIFT PVG VALVE HIGH VOLTAGE	Main boom lift pvg valve has detected high excitation voltage.	
	TOWER LIFT PVG VALVE HIGH VOLTAGE	Tower boom lift pvg valve has detected high excitation voltage.	
	TOWER TELESCOPE PVG VALVE HIGH VOLTAGE	Tower boom telescope pvg valve has detected high excitation voltage.	
	MAIN LIFT PVG VALVE LOW VOLTAGE	Main boom lift pvg valve has detected low excitation voltage.	
	TOWER LIFT PVG VALVE LOW VOLTAGE	Tower boom lift pvg valve has detected low excitation voltage.	
	TOWER TELESCOPE PVG VALVE LOW VOLTAGE	Tower boom telescope pvg valve has detected low excitation voltage.	
	MAIN LIFT PVG VALVE STUCK NEUTRAL	Main boom lift pvg valve detected its' spool is stuck in the neutral position.	
	TOWER LIFT PVG VALVE STUCK NEUTRAL	Tower boom lift pvg valve detected its' spool is stuck in the neutral position.	
	TOWER TELESCOPE PVG VALVE STUCK NEUTRAL	Tower boom telescope pvg valve detected its' spool is stuck in the neutral position.	
	MAIN LIFT PVG VALVE STUCK EXTENDED	Main boom lift pvg valve detected its' spool is stuck in the extended position.	
	TOWER LIFT PVG VALVE STUCK EXTENDED	Tower boom lift pvg valve detected its' spool is stuck in the extended position.	
	TOWER TELESCOPE PVG VALVE STUCK EXTENDED	Tower boom telescope pvg valve detected its' spool is stuck in the extended position.	
	MAIN LIFT PVG VALVE STUCK RETRACTED	Main boom lift pvg valve detected its' spool is stuck in the retracted position.	
	TOWER LIFT PVG VALVE STUCK RETRACTED	Tower boom lift pvg valve detected its' spool is stuck in the retracted position.	
	TOWER TELESCOPE PVG VALVE STUCK RETRACTED	Tower boom telescope pvg valve detected its' spool is stuck in the retracted position.	
	MAIN LIFT PVG VALVE OBSTRUCTED	Main boom lift pvg valve detected its' spool could not achieve command.	
	TOWER LIFT PVG VALVE OBSTRUCTED	Tower boom lift pvg valve detected its' spool could not achieve command.	
	TOWER TELESCOPE PVG VALVE OBSTRUCTED	Tower boom telescope pvg valve detected its' spool could not achieve command.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
	MAIN LIFT PVG VALVE COMMAND IMPROPER	Main boom lift pvg valve received an invalid command from the control system.	
	TOWER LIFT PVG VALVE COMMAND IMPROPER	Tower boom lift pvg valve received an invalid command from the control system.	
	TOWER TELESCOPE PVG VALVE COMMAND IMPROPER	Tower boom telescope pvg valve received an invalid command from the control system.	
	MAIN LIFT PVG VALVE TIMEOUT	Main boom lift pvg valve has not received a position command in 250mS.	
	TOWER TELESCOPE PVG VALVE TIMEOUT	Tower boom lift pvg valve has not received a position command in 250mS.	
	TOWER TELESCOPE PVG VALVE TIMEOUT	Tower boom telescope pvg has not received a position command in 250mS.	
	MAIN LIFT PVG VALVE SETUP FAULT	Main boom lift pvg valve setup data is incorrect. Requires a valve calibration.	
	TOWER LIFT PVG VALVE SETUP FAULT	Tower boom lift pvg valve setup data is incorrect. Requires a valve calibration.	
	TOWER TELESCOPE PVG VALVE SETUP FAULT	Tower boom telescope pvg valve setup data is incorrect. Requires a valve calibration.	
	MAIN LIFT PVG VALVE SENT UNRECOGNIZED FAULT	Main boom lift pvg valve sent an unrecognized fault.	
	TOWER LIFT PVG VALVE SENT UNRECOGNIZED FAULT	Tower boom lift pvg valve sent an unrecognized fault.	
	TOWER TELESCOPE PVG VALVE SENT UNRECOGNIZED FAULT	Tower boom telescope pvg valve sent an unrecognized fault.	
	MAIN LIFT PVG VALVE PARAMETERS INCORRECT	The main lift pvg valves spool data is incorrect. Requires a valve calibration.	
	TOWER LIFT PVG VALVE PARAMETERS INCORRECT	The tower lift pvg valves spool data is incorrect. Requires a valve calibration.	
	TOWER TELESCOPE PVG VALVE PARAMETERS INCORRECT	The tower telescope pvg valves spool data is incorrect. Requires a valve calibration.	
	MAIN LIFT PVG VALVE LOCATION IMPROPER	Main lift pvg valve was hosed wrong or the wiring was incorrect during calibration.	
	TOWER LIFT PVG VALVE LOCATION IMPROPER	Tower lift pvg valve was hosed wrong or the wiring was incorrect during calibration.	
	TOWER TELESCOPE PVG VALVE LOCATION IMPROPER	Tower telescope pvg valve was hosed wrong or the wiring was incorrect during calibration.	
	MAIN LIFT PVG VALVE WIRING INCORRECT	The power wire for the main lift pvg valve is not wired to that valve.	
	TOWER LIFT PVG VALVE WIRING INCORRECT	The power wire for the tower lift pvg valve is not wired to that valve.	
	TOWER TELESCOPE PVG VALVE WIRING INCORRECT	The power wire for the tower telescope pvg valve is not wired to that valve.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
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
	PLATFORM CAN COMMUNICATIONS LOST	The ground module or platform module is not receiving CAN messages. This is probably due to wiring problems between the platform and ground modules.	
	BLAM CAN COMMUNICATIONS LOST	Only occurs on machines with a BLAM. The ground module or BLAM module is not receiving CAN messages. This is probably due to wiring problems between the BLAM and ground modules.	
	CHASSIS CAN COMMUNICATIONS LOST	Only occurs on machines with a chassis module. The ground module or chassis module is not receiving CAN messages. This is probably due to wiring problems between the chassis and ground modules.	
	CYLINDER LOAD PIN CAN COMMUNICATIONS LOST	Only occurs on machines with a cylinder load pin. The ground module or cylinder load pin is not receiving CAN messages. This is probably due to wiring problems between the cylinder load pin and ground module.	
	EXCESSIVE CAN BUS COMMUNICATION ERRORS	More than 500 Bus Off or more than 500 Bus Passive conditions has been detected by the Ground Module in the current power cycle.	
	MAIN ANGL1 CAN COMMUNICATIONS LOST	The control system lost CAN communications with main boom angle sensor #1 (1250AJP only)	
	MAIN ANGL2 CAN COMMUNICATIONS LOST	The control system lost CAN communications with main boom angle sensor #2 (1250AJP only)	
7/7		**Flash code 7/7 indicates problems with a motor.** **NOT REQUIRED**	
8/1		**Flash code 8/1 indicates problems with the Chassis tilt detection system.**	10
	CHASSIS TILT SENSOR NOT CALIBRATED	The leveling (zeroing) calibration has not been performed for the chassis tilt sensor.	
8/2		**Flash code 8/2 indicates problems with the platform load sensing system.**	10
	LOAD SENSOR NOT CALIBRATED	The calibration procedure has not been performed for the load sensor.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
8/3		**Flash code 8/3 indicates problems with the Basket Leveling system.**	10
	BASKET LEVELING CRACKPOINT UP NOT CALIBRATED	Only occurs on machines with electronic leveling systems. Indicates that the basket up valve crackpoint has not been calibrated	
	BASKET LEVELING CRACKPOINT DOWN NOT CALIBRATED	Only occurs on machines with electronic leveling systems. Indicates that the basket down valve crackpoint has not been calibrated	
	BASKET LEVELING SENSOR 1 NOT ZERO CALIBRATED	Only occurs on machines with electronic leveling systems. Indicates that the primary basket leveling tilt sensor has not been calibrated.	
	BASKET LEVELING SENSOR 1 ZERO OUT OF RANGE	Only occurs on machines with electronic leveling systems. Indicates that the primary basket leveling tilt sensor zero is outside of the allowable range	
	BASKET LEVELING SENSOR 1 SHORT TO BATTERY	Only occurs on machines with electronic leveling systems. Indicates that the primary basket leveling tilt sensor is shorted to battery. An EMS cycle is required.	
	BASKET LEVELING SENSOR 1 SHORT TO GROUND OR OPEN CIRCUIT	Only occurs on machines with electronic leveling systems. Indicates that the primary basket leveling tilt sensor is either shorted to ground or is not connected. An EMS cycle is required.	
	BASKET LEVELING SENSOR 2 NOT ZERO CALIBRATED	Only occurs on machines with electronic leveling systems. Indicates that the secondary basket leveling tilt sensor is not zero calibrated.	
	BASKET LEVELING SENSOR 2 ZERO OUT OF RANGE	Only occurs on machines with electronic leveling systems. Indicates that the secondary basket leveling system tilt sensor zero is outside the allowable range.	
	BASKET LEVELING SENSOR 2 SHORT TO BATTERY	Only occurs on machines with electronic leveling systems. Indicates that the secondary basket leveling tilt sensor is shorted to battery. An EMS cycle is required.	
	BASKET LEVELING SENSOR 2 SHORT TO GROUND OR OPEN CIRCUIT	Only occurs on machines with electronic leveling systems. Indicates that the secondary basket leveling tilt sensor is either shorted to ground or not connected. An EMS cycle is required.	
	BASKET LEVELING TILT REFERENCE 1 OUT OF RANGE	Only occurs on machines with electronic leveling systems. Indicates that the reference voltage for the primary basket leveling tilt sensor is outside the expected range (4.9 to 5.1 volts). An EMS cycle is required.	
	BASKET LEVELING TILT REFERENCE 2 OUT OF RANGE	Only occurs on machines with electronic leveling systems. Indicates that the reference voltage for the secondary basket leveling tilt sensor is outside the expected range. (4.9 to 5.1 volts). An EMS cycle is required.	
	BASKET LEVELING TILT SENSOR DIFFERENCE TOO GREAT	Only occurs on machines with electronic leveling systems. Indicates that the basket leveling tilt readings both appear to be good but their measurements do not agree within a specified adjustable tolerance. An EMS cycle is required.	
	BASKET LEVELING SYSTEM TIMEOUT	Only occurs on machines with electronic leveling systems. Indicates that the basket was not able to maintain the desired level within an adjustable range for and adjustable time	
	BASKET LEVELING OVERRIDE ON	User has forced basket leveling on through Access Level 0.	
	BASKET LEVELING OVERRIDE OFF	User has forced basket leveling off through Access Level 0.	
	BASKET LEVELING TILT SENSOR 1 COMMUNICATIONS LOST	Communications have been lost with a serial leveling sensor. Only on 1200S and 1350S models. An EMS cycle is required.	
	BASKET LEVELING TILT SENSOR 2 COMMUNICATIONS LOST	Communications have been lost with a serial leveling sensor. Only on 1200S and 1350S models. An EMS cycle is required.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
8/4		**Flash code 8/4 indicates problems with the envelope system. Only occur on machines with envelope control.**	10
	BOOM ANGLE SENSOR DISAGREEMENT	The boom angle sensors are reporting angles that differ too greatly. An EMS cycle is required.	
	BOOM LENGTH SWITCH FAILED	The boom length switch inputs are reporting the same state. An EMS cycle is required.	
	BOOM LENGTH SWITCH/SENSOR DIS-AGREEMENT	The boom length switch and sensor differ in their reports of extended or retracted. An EMS cycle is required.	
	BOOM LENGTH SENSOR NOT DETECT-ING LENGTH CHANGE	The boom length sensor has not detected a change in length while the user is commanding telescope. An EMS cycle is required.	
	BOOM LENGTH SENSOR OUT OF RANGE HIGH	Indicates that the voltage for the boom length sensor is above the expected range.	
	BOOM LENGTH SENSOR OUT OF RANGE LOW	Indicates that the voltage for the boom length sensor is below the expected range.	
	BOOM LENGTH SENSOR VALUE OUT OF RANGE HIGH	Indicates the length reported for the boom length sensor is above the expected range. An EMS cycle is required.	
	BOOM LENGTH SENSOR VALUE OUT OF RANGE LOW	Indicates the length reported for the boom length sensor is below the expected range. An EMS cycle is required.	
	BOOM ANGLE SENSOR #1 COMMUNI-CATIONS FAULT	Boom angle sensor #1 lost communications with the BLAM. An EMS cycle is required.	
	BOOM ANGLE SENSOR #2 COMMUNI-CATIONS FAULT	Boom angle sensor #2 lost communications with the BLAM. An EMS cycle is required.	
	ANGLE SENSOR #1 INVALID ANGLE	An EMS cycle is required.	
	ANGLE SENSOR #2 INVALID ANGLE	An EMS cycle is required.	
	WRONG TELE RESPONSE	The boom telescope is contrary to the user command	
	WRONG LIFT RESPONSE	The boom lift is contrary to the user command	
	TOWER ANGLE SENSOR DISAGREE-MENT	The tower angle sensors are reporting angles that differ too greatly. An EMS cycle is required.	
	TOWER LENGTH SENSOR DISAGREE-MENT	The tower length sensors are reporting angles that differ too greatly. An EMS cycle is required.	
	MAIN ANGLE SENSOR DISAGREEMENT	The main boom angle sensors are reporting angles that differ too greatly. An EMS cycle is required.	
	BOOM LENGTH SENSOR #1 OUT OF RANGE HIGH	Reported from the BLAM, indicates tower length sensor one value is out of range high.	
	BOOM LENGTH SENSOR #1 OUT OF RANGE LOW	Reported from the BLAM, indicates tower length sensor one value is out of range low.	
	BOOM LENGTH SENSOR #2 OUT OF RANGE HIGH	Reported from the BLAM, indicates tower length sensor two value is out of range high.	
	BOOM LENGTH SENSOR #2 OUT OF RANGE LOW	Reported from the BLAM, indicates tower length sensor two value is out of range low.	
	TWR LENGTH SENSOR NOT DETECTING LENGTH CHANGE	Tower tele is being commanded and the length sensors are not changing value.	
	TWR LENGTH MOVEMENT WITHOUT CMD	Tower length is changing without a tower tele command	
	TWR LENGTH SENSOR ONE VALUE OUT OF RANGE HIGH	This fault is reported by the Ground module when the length sensor value is outside the constant data limit	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
	TWR LENGTH SENSOR ONE VALUE OUT OF RANGE LOW	This fault is reported by the Ground module when the length sensor value is outside the constant data limit	
	TWR LENGTH SENSOR TWO VALUE OUT OF RANGE HIGH	This fault is reported by the Ground module when the length sensor value is outside the constant data limit	
	TWR LENGTH SENSOR TWO VALUE OUT OF RANGE LOW	This fault is reported by the Ground module when the length sensor value is outside the constant data limit	
	TWR ANGL1 INVALID ANGLE	Tower boom angle sensor #1 out of range	
	TWR ANGL2 INVALID ANGLE	Tower boom angle sensor #2 out of range	
	INVALID ANGLE SENSOR #1 MODEL	Wrong tower angle sensor Mfgr. Installed on a 1250AJP (Must be a Rieker, not Spectron)	
	INVALID ANGLE SENSOR #2 MODEL	Wrong tower angle sensor Mfgr. Installed on a 1250AJP (Must be a Rieker, not Spectron)	
	MAIN ANGL1 INVALID ANGLE	Main boom angle sensor #1 out of range	
	MAIN ANGL2 INVALID ANGLE	Main boom angle sensor #2 out of range	
	MAIN ANGLE SENSOR NOT DETECTING ANGLE CHANGE	The main boom is being commanded to move and the main angle sensors are not detecting any movement	
	MAIN ANGLE MOVEMENT WITHOUT CMD	The main boom angle is changing without a main lift command	
	WRONG TWR TELE RESPONSE	The tower telescope is moving in the opposite direction the user is commanding.	
	WRONG TWR LIFT RESPONSE	The tower lift is moving in the opposite direction the user is commanding	
	TWR CYL ANGLE SENSOR OUT OF RANGE LOW	The tower cylinder angle sensor is below 4721 A/D counts	
	TWR CYL ANGLE SENSOR OUT OF RANGE HIGH	The tower cylinder angle sensor is above 29535 A/D counts.	
	TWR CYL ANGLE NOT DETECTING ANGLE CHANGE	The cylinder angle is not changing during a tower lift up/down user command.	
	TWR CYL ANGLE MOVEMENT WITHOUT CMD	The cylinder angle is changing without a tower lift command	
	MAIN TRN ANGLE SW FAILED	The system detected a disagreement of the N.O. vs N.C. contacts on the main boom angle switch.	
	TWR TRN SW DISAGREEMENT	The system detected a disagreement between the tower boom length switch and the tower length sensors.	
	TRN DUAL CAP SWITCHES BAD	The system detected both the Dual capacity and the transport switches are bad.	
	TRN DUAL CAP BAD TRANSITION	The system detected that the Dual capacity or the transport switches changed state out of order.	
	MAIN TRN LEN SW DISAGREEMENT	The system detected a disagreement between the main boom transport length switches.	
	DCAP LEN SW DISAGREEMENT	The system detected a disagreement between the main boom dual capacity length switches.	
	MAIN BOOM TRN ANGLE SW/SENSOR DISAGREEMENT	The system detected a disagreement between main boom transport angle switch and main boom angle sensors.	
	CYL ANGLE SENSOR/SW DISAGREEMENT	The system detected a disagreement of the tower angle input from the BLAM and the tower cylinder angle sensor.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
8/5		**Flash code 8/5 indicates problems with the moment or load pin system. Only occur on machines with moment or load pin control. An EMS cycle is required.**	**10**
	MOMENT PIN HORIZONTAL FORCE OUT OF RANGE	The horizontal force is out of the allowed range.	
	MOMENT PIN VERTICAL FORCE OUT OF RANGE	The vertical force is out of the allowed range.	
	LOAD PIN HORIZONTAL FORCE OUT OF RANGE	The horizontal force is out of the allowed range.	
	LOAD PIN VERTICAL FORCE OUT OF RANGE	The vertical force is out of the allowed range.	
	MOMENT PIN SENSOR FAULT	The moment pin has reported a fault flag.	
	LOAD PIN SENSOR FAULT	The load pin has reported a fault flag.	
	NEW MOMENT PIN DETECTED FAULT	A moment pin was detected on the system different from the one used to calibrate the machine.	
	NEW LOAD PIN DETECTED FAULT	A load pin was detected on the system different from the one used to calibrate the machine.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
8/6		**Flash code 8/6 indicates problems with the steering system. Except as noted, an EMS cycle is required.**	10
	RESTRICTED TO TRANSPORT – OSC AXLE PRESS SW DISAGREEMENT	Only occurs on machines with electrically released oscillating axles configured. The oscillating axle pressure switch indicates pressure while the machine is not driving or does not indicate pressure while the machine is driving and the machine is restricted to transport position.	
	AXLE EXT STB OR OC	A short to battery or open circuit was detected on the axles extension valve.	
	AXLE EXT STG	A short to ground was detected on the axles extension valve.	
	AXLE RET STB OR OC	A short to battery or open circuit was detected on the axles retract valve.	
	AXLE RET STG	A short to ground was detected on the axles retract valve.	
	RT FNT STEER RT STB OR OC	A short to battery or open circuit has been detected on the right front steer right valve.	
	RT FNT STEER RT STG	A short to ground has been detected on the right front steer right valve.	
	RT FNT STEER LT STB OR OC	A short to battery or open circuit has been detected on the right front steer left valve.	
	RT FNT STEER LT STG	A short to ground has been detected on the right front steer left valve.	
	LT FNT STEER RT STB OR OC	A short to battery or open circuit has been detected on the left front steer right valve.	
	LT FNT STEER RT STG	A short to ground has been detected on the left front steer right valve.	
	LT FNT STEER LT STB OR OC	A short to battery or open circuit has been detected on the left front steer left valve.	
	LT FNT STEER LT STG	A short to ground has been detected on the left front steer left valve.	
	RT REAR STEER RT STB OR OC	A short to battery or open circuit has been detected on the right rear steer right valve.	
	RT REAR STEER RT STG	A short to ground has been detected on the right rear steer right valve.	
	RT REAR STEER LT STB OR OC	A short to battery or open circuit has been detected on the right rear steer left valve.	
	RT REAR STEER LT STG	A short to ground has been detected on the right rear steer left valve.	
	LT REAR STEER RT STB OR OC	A short to battery or open circuit has been detected on the left rear steer right valve.	
	LT REAR STEER RT STG	A short to ground has been detected on the left rear steer left valve.	
	LT REAR STEER LT STB OR OC	A short to battery or open circuit has been detected on the left rear steer left valve.	
	LT REAR STEER LT STG	A short to ground has been detected on the left rear steer left valve.	
	FRONT LEFT WHEEL FAULT – CHECK MOUNTING	This indicates that the steering angle sensor has become decoupled.	
	FRONT RIGHT WHEEL FAULT – CHECK MOUNTING	This indicates that the steering angle sensor has become decoupled.	
	REAR LEFT WHEEL FAULT – CHECK MOUNTING	This indicates that the steering angle sensor has become decoupled.	
	REAR RIGHT WHEEL FAULT – CHECK MOUNTING	This indicates that the steering angle sensor has become decoupled.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
	REAR LEFT WHEEL BLOCKED	The wheel is not responding to steer commands. Fault clears when condition clears.	
	REAR RIGHT WHEEL BLOCKED	The wheel is not responding to steer commands. Fault clears when condition clears.	
	FRONT LEFT WHEEL SENSOR OUT OF RANGE LOW	A short to ground or open circuit has been detected on the steering angle sensor.	
	FRONT LEFT WHEEL SENSOR OUT OF RANGE HIGH	A short to battery has been detected on the steering angle sensor.	
	FRONT RIGHT WHEEL SENSOR OUT OF RANGE LOW	A short to ground or open circuit has been detected on the steering angle sensor.	
	FRONT RIGHT WHEEL SENSOR OUT OF RANGE HIGH	A short to battery has been detected on the steering angle sensor.	
	REAR LEFT WHEEL SENSOR OUT OF RANGE LOW	A short to ground or open circuit has been detected on the steering angle sensor.	
	REAR LEFT WHEEL SENSOR OUT OF RANGE HIGH	A short to battery has been detected on the steering angle sensor.	
	REAR RIGHT WHEEL SENSOR OUT OF RANGE LOW	A short to ground or open circuit has been detected on the steering angle sensor.	
	REAR RIGHT WHEEL SENSOR OUT OF RANGE HIGH	A short to battery has been detected on the steering angle sensor.	
8/7		**Flash code 8/7 indicates new main angle sensors**	**10**
	NEW MAIN ANGL1 SENSOR DETECTED	The system detected a different main angle #1 sensor than it was calibrated with. (1250AJP only.)	
	NEW MAIN ANGL2 SENSOR DETECTED	The system detected a different main angle #2 sensor than it was calibrated with. (1250AJP only.)	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
9/9		**Flash code 9/9 indicates problems with the controller or the user disabling safety systems from Access Level 0.**	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.	
	GROUND MODULE CONSTANT DATA UPDATE REQUIRED	The ground module has old constant data that is not compatible with the current ground module software. The GM constant data must be updated to a newer version. An EMS cycle is required.	
	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. An EMS cycle is required.	
	PLATFORM MODULE FAILURE: hwfs CODE 1	Platform module V(Low) FET has failed. An EMS cycle is required.	
	GROUND MODULE FAILURE: hwfs CODE 1	Ground module V(Low) FET has failed. An EMS cycle is required.	
	GROUND 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. An EMS cycle is required.	
	GROUND MODULE FAILURE: hIGH SIDE DRIVER CUTOUT FAULTY	This fault occurs when there is a fault with the hardware based high side driver cutout circuit. An EMS cycle is required.	
	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. An EMS cycle is required.	
	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. An EMS cycle is required.	
	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	Indicates that the chassis tilt sensor calibration information has been lost. Machine will indicate that 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 that the chassis tilt sensor calibration has become corrupted. This calibration data is programmed into the unit at the factory.	
	ENVELOPE CONTROL DISABLED	Only occurs on machines with envelope control. The user has forced envelope control off with the analyzer from Access Level 0.	
	MOMENT CONTROL DISABLED	Only occurs on machines with envelope control. The user has forced moment control off with the analyzer from Access Level 0.	
	STEER SENSORS NOT CALIBRATED	Only occurs on machines with a chassis module. The steer sensors require a calibration that has not yet been performed.	
	BOOM SENSORS NOT CALIBRATED	Only occurs on machines with a BLAM module. The boom sensors require a calibration that has not yet been performed.	
	LIFT CRACKPOINTS NOT CALIBRATED	Only occurs on 1200S and 1350S machines. The lift valves require a calibration that has not yet been performed.	
	TELESCOPE CRACKPOINTS NOT CALIBRATED	Only occurs on 1200S and 1350S machines. The telescope valves require a calibration that has not yet been performed.	
	DRIVE CRACKPOINTS NOT CALIBRATED	Only occurs on 1200S and 1350S machines. The drive valves require a calibration that has not yet been performed.	

Table 6-9. Help Fault Codes, Displayed Faults, and Descriptions

Fault Flash Code	Analyzer Display	Description	Priority
	BLAM SENSOR SUPPLY OUT OF RANGE HIGH	Indicates that the supply voltage for the boom angle sensors is above the expected range. An EMS cycle is required.	
	BLAM SENSOR SUPPLY OUT OF RANGE LOW	Indicates that the supply voltage for the boom angle sensors is below the expected range. An EMS cycle is required.	
	LENGTH SENSOR REF VOLTAGE HIGH	Indicates that the supply voltage for the boom length sensors is above the expected range. An EMS cycle is required.	
	LENGTH SENSOR REF VOLTAGE LOW	Indicates that the supply voltage for the boom length sensors is below the expected range. An EMS cycle is required.	
	BLAM HIGH RES A/D FAILURE	The high resolution Analog to digital converter in the BLAM module has failed. An EMS cycle is required.	
	CHASSIS SENSOR SUPPLY OUT OF RANGE LOW	Indicates that the supply voltage for chassis sensors is below the expected range. An EMS cycle is required.	
	CHASSIS SENSOR SUPPLY OUT OF RANGE HIGH	Indicates that the supply voltage for chassis sensors is above the expected range. An EMS cycle is required.	
	BLAM BACKUP COMMUNICATIONS LINK FAULTY	Reported if the backup communications link to the BLAM failed the test at startup.	
	BLAM BACKUP COMMUNICATIONS LOST - HYDRAULICS SUSPENDED	The backup communications link to the BLAM module was activated but could not establish/maintain communications with the BLAM.	

4150461-E

NOTES:

SECTION 7. BASIC ELECTRICAL INFORMATION AND ELECTRICAL SCHEMATICS

7.1 GENERAL

This section contains basic electrical information and schematics to be used for locating and correcting most of the operating problems which may develop. If a problem should develop which is not presented in this section or which is not corrected by listed corrective actions, technically qualified guidance should be obtained before proceeding with any maintenance.

7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

Min/Max

Use of the "Min/Max" recording feature of some meters can help when taking measurements of intermittent conditions while alone. For example, you can read the 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, the location of the signal and that the leads are connected to the device under test correctly. Also check that the lead on the "COM" port goes to the Ground or negative side of the signal and the 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

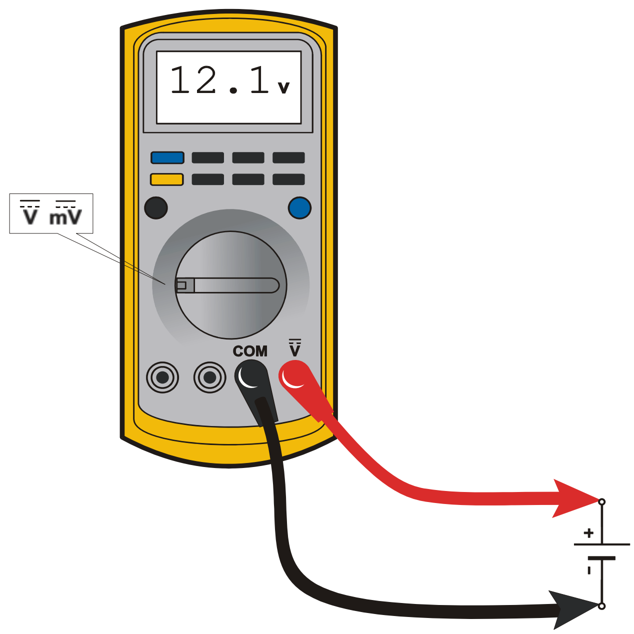


Figure 7-1. Voltage Measurement (DC)

- 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

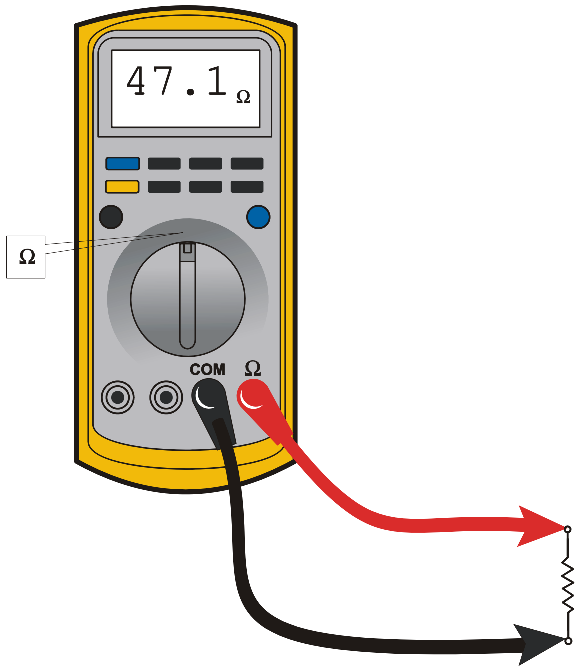


Figure 7-2. Resistance Measurement

- 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

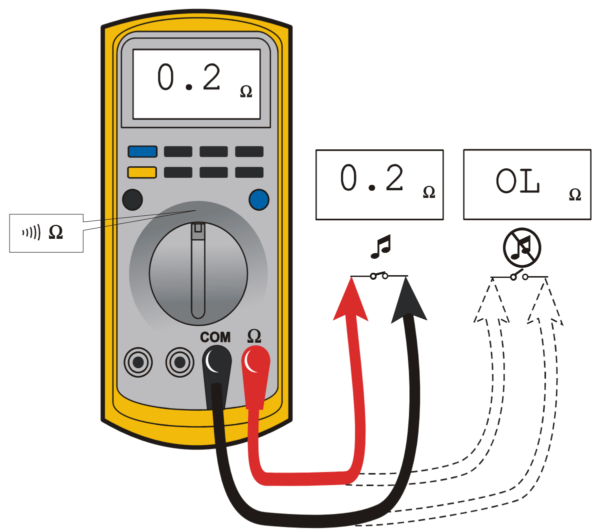


Figure 7-3. Continuity Measurement

- 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

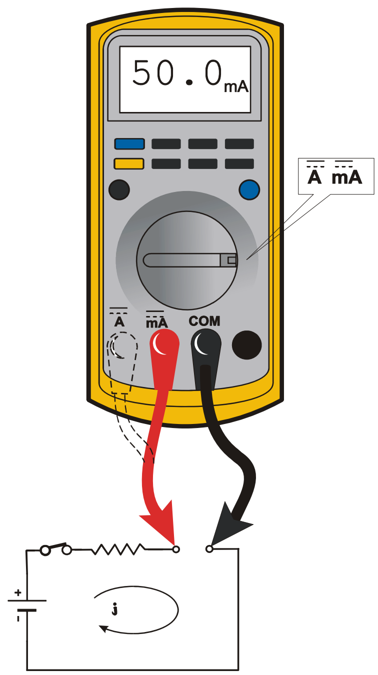


Figure 7-4. Current Measurement (DC)

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

7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

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 the 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 the battery boxes and battery chargers should have silicone grease applied to the contacts only.

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

7.4 AMP CONNECTOR

Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

- To prevent oxidation at the 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.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on inside of connector after mating housing to the header. This is easily achieved by using a syringe to fill header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling housing to the header, it is possible the housing will become air locked, preventing housing latch from engaging.
2. Pierce one of the unused wire seals to allow trapped air inside housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

Assembly

Make sure wedge lock is in the open, or as-shipped, position (See Figure 7-5.). Proceed as follows:

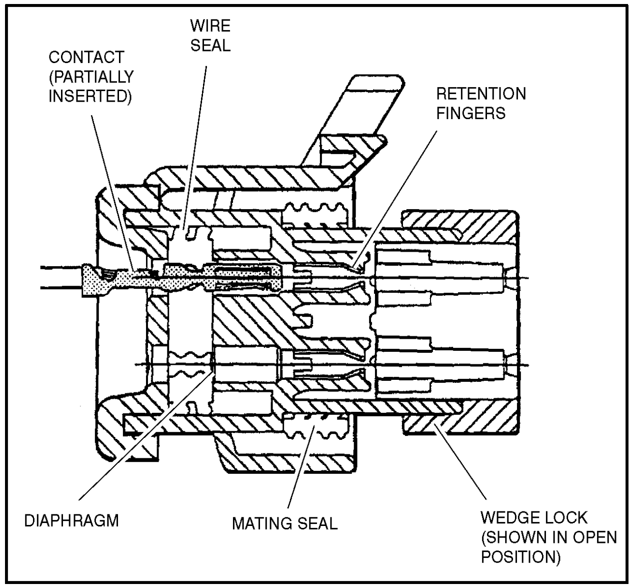


Figure 7-5. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-7.).
2. Pull on contact wire with a force of 1-2 lbs to be sure retention fingers are holding contact (See Figure 7-7.).

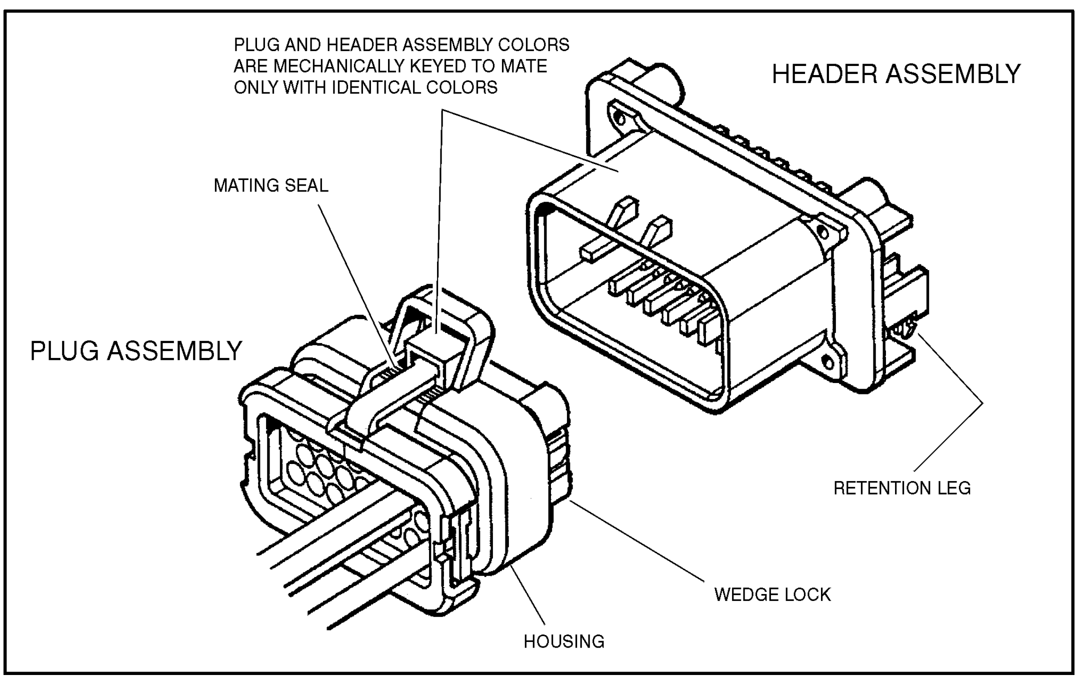


Figure 7-6. AMP Connector

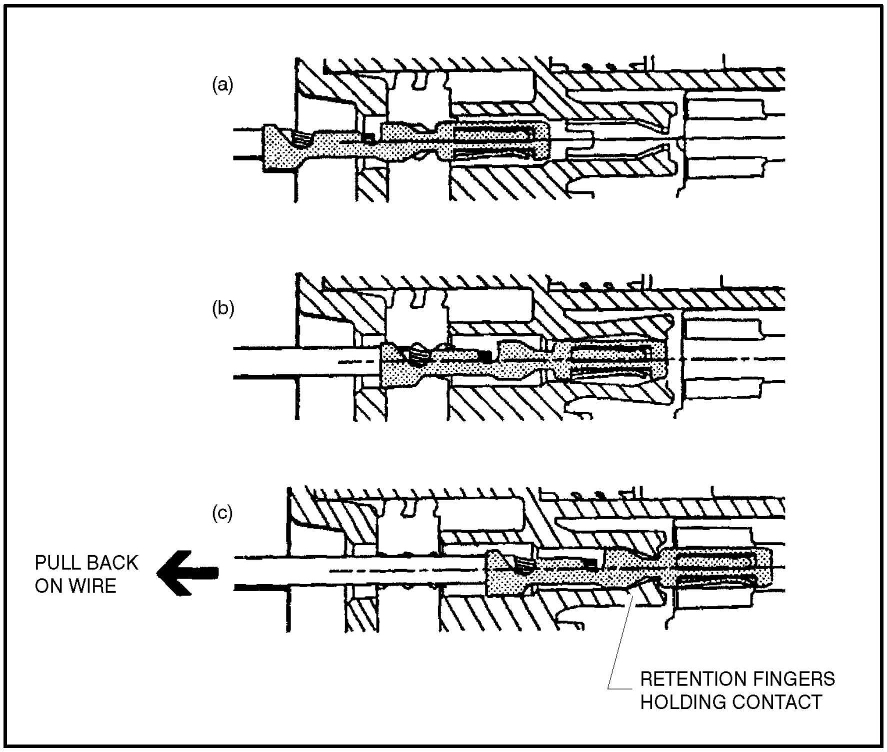


Figure 7-7. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release locking latches by squeezing them inward (See Figure 7-8.).

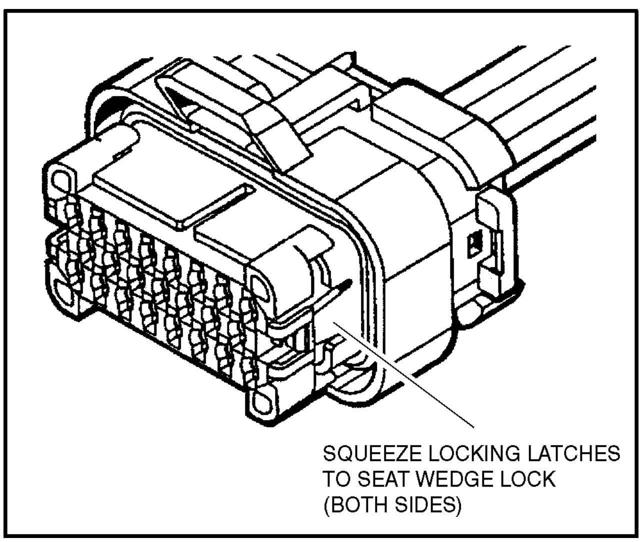


Figure 7-8. Connector Assembly Figure 3

4. Slide wedge lock into housing until it is flush with the housing (See Figure 7-9.).

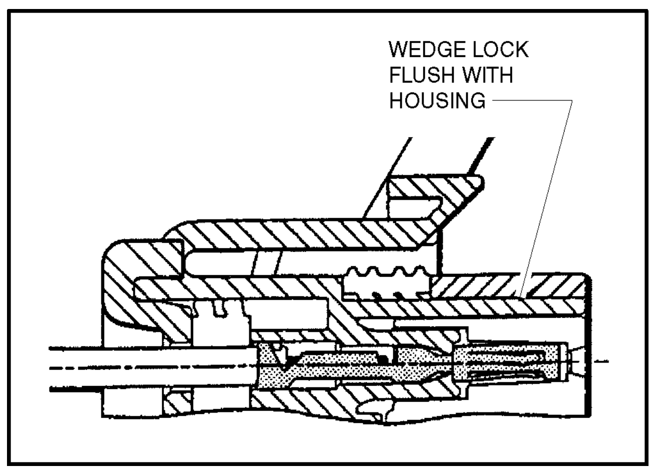


Figure 7-9. Connector Assembly Figure 4

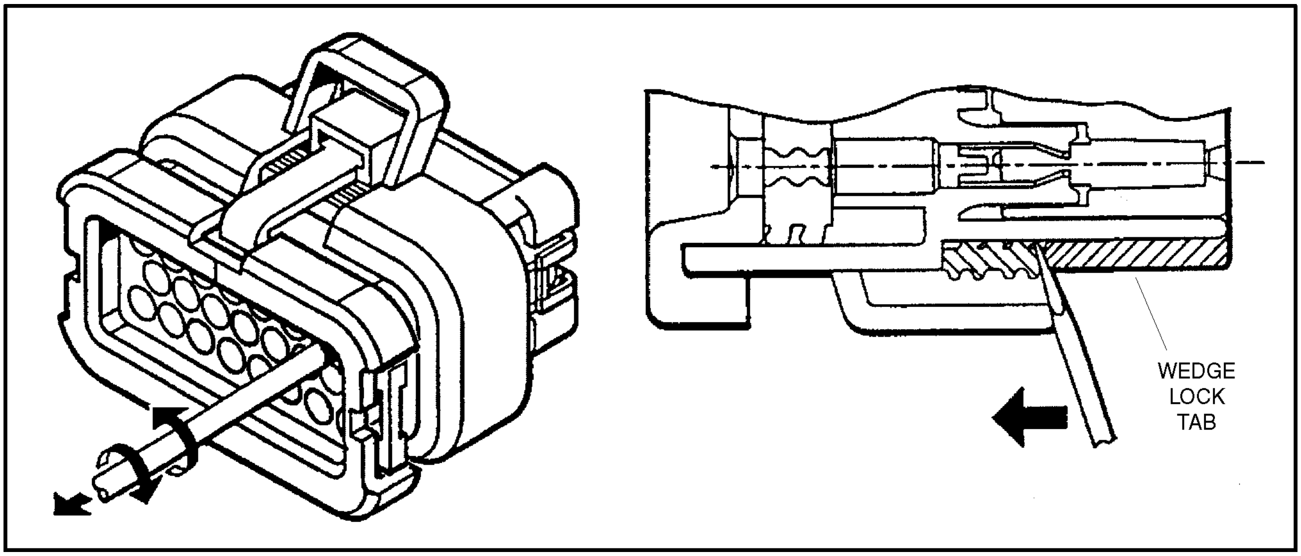


Figure 7-10. Connector Disassembly

Disassembly

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

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

Wedge Lock

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

Service - Voltage Reading

⚠ CAUTION

DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

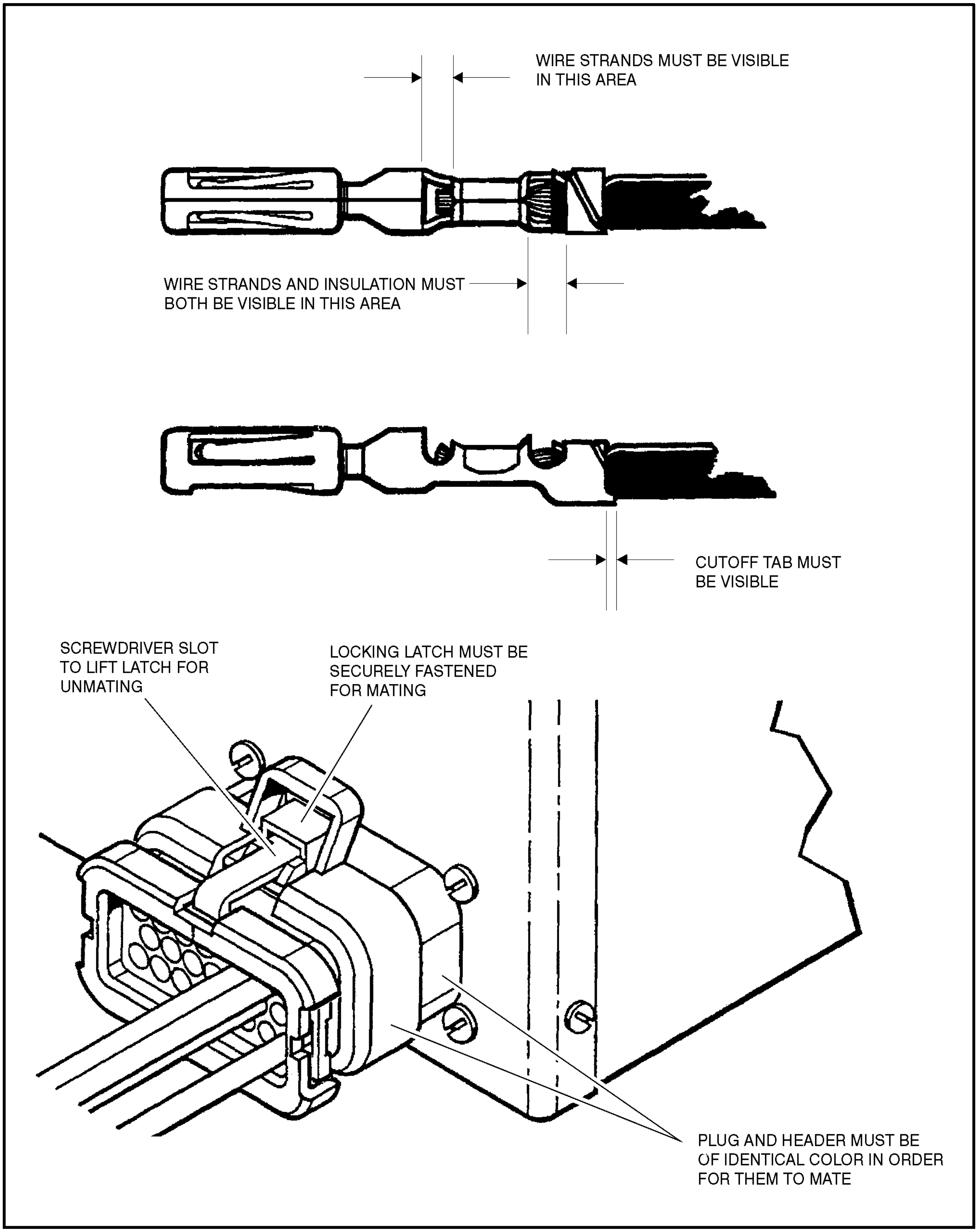


Figure 7-11. Connector Installation

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

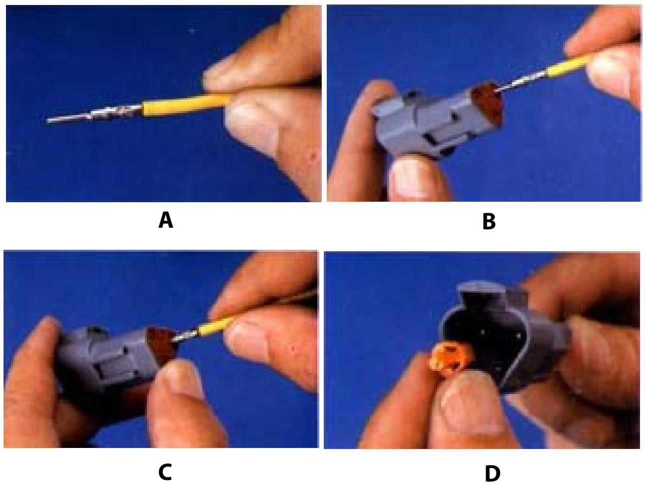


Figure 7-12. DT/DTP Contact Installation

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

NOTE: *The receptacle is shown - use the same procedure for plug.*

DT/DTP Series Disassembly

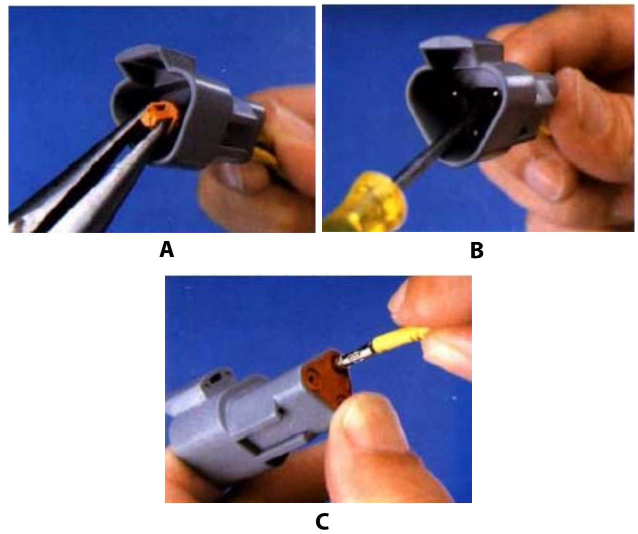


Figure 7-13. DT/DTP Contact Removal

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

HD30/HDP20 Series Assembly

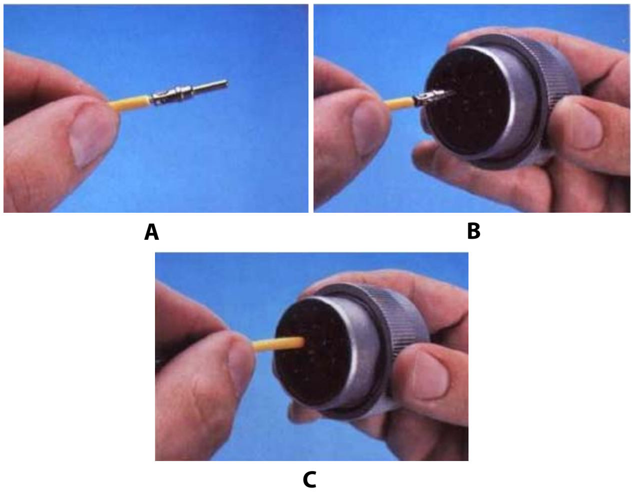


Figure 7-14. HD/HDP Contact Installation

1. Grasp contact about 25mm behind the contact crimp barrel.
2. Hold connector with rear grommet facing you.
3. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm that it is properly locked in place.

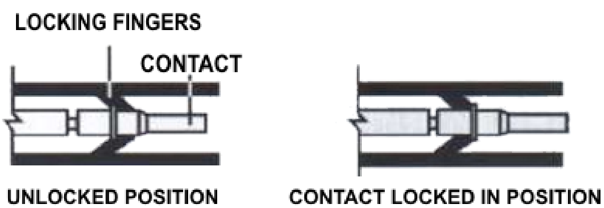


Figure 7-15. HD/HDP Locking Contacts Into Position

NOTE: *For unused wire cavities, insert sealing plugs for full environmental sealing*

HD30/HDP20 Series Disassembly

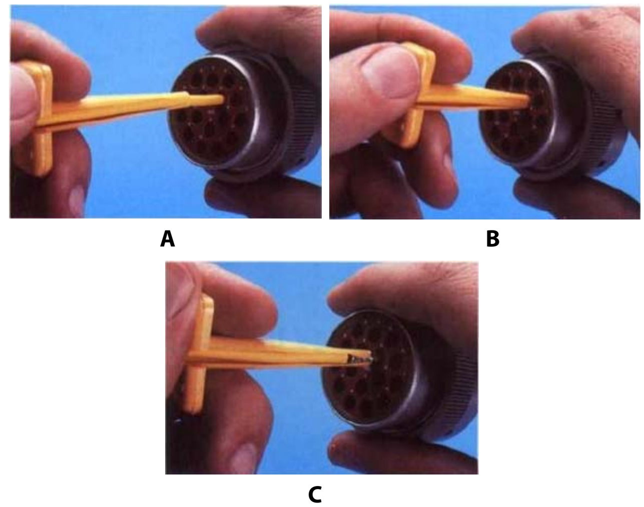


Figure 7-16. HD/HDP Contact Removal

1. With rear insert toward you, snap appropriate size extractor tool over the wire of contact to be removed.
2. Slide tool along into the insert cavity until it engages contact and resistance is felt.
3. Pull contact-wire assembly out of connector.

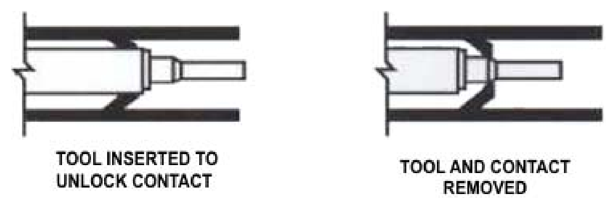


Figure 7-17. HD/HDP Unlocking Contacts

NOTE: *Do Not twist or insert tool at an angle.*

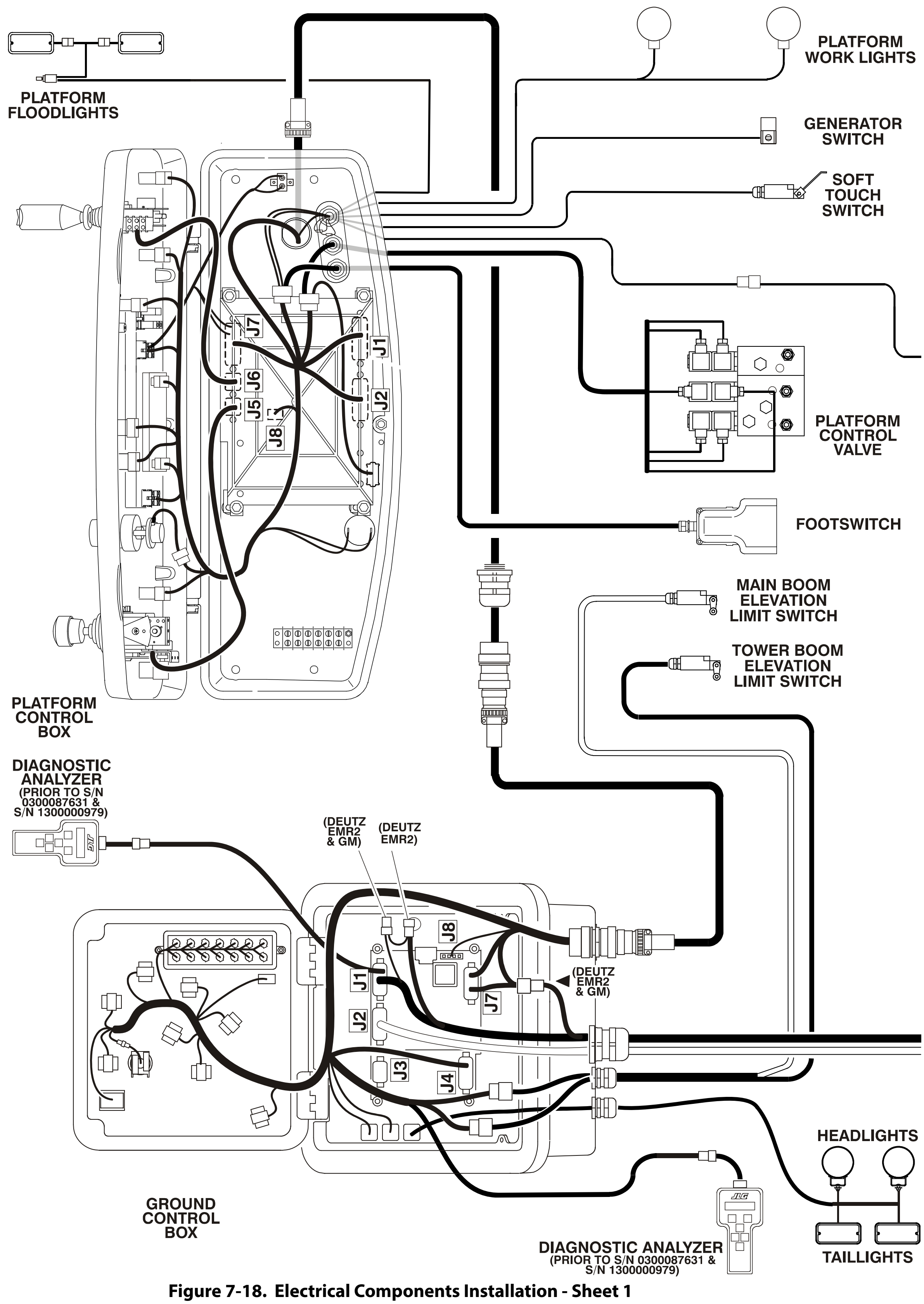


Figure 7-18. Electrical Components Installation - Sheet 1

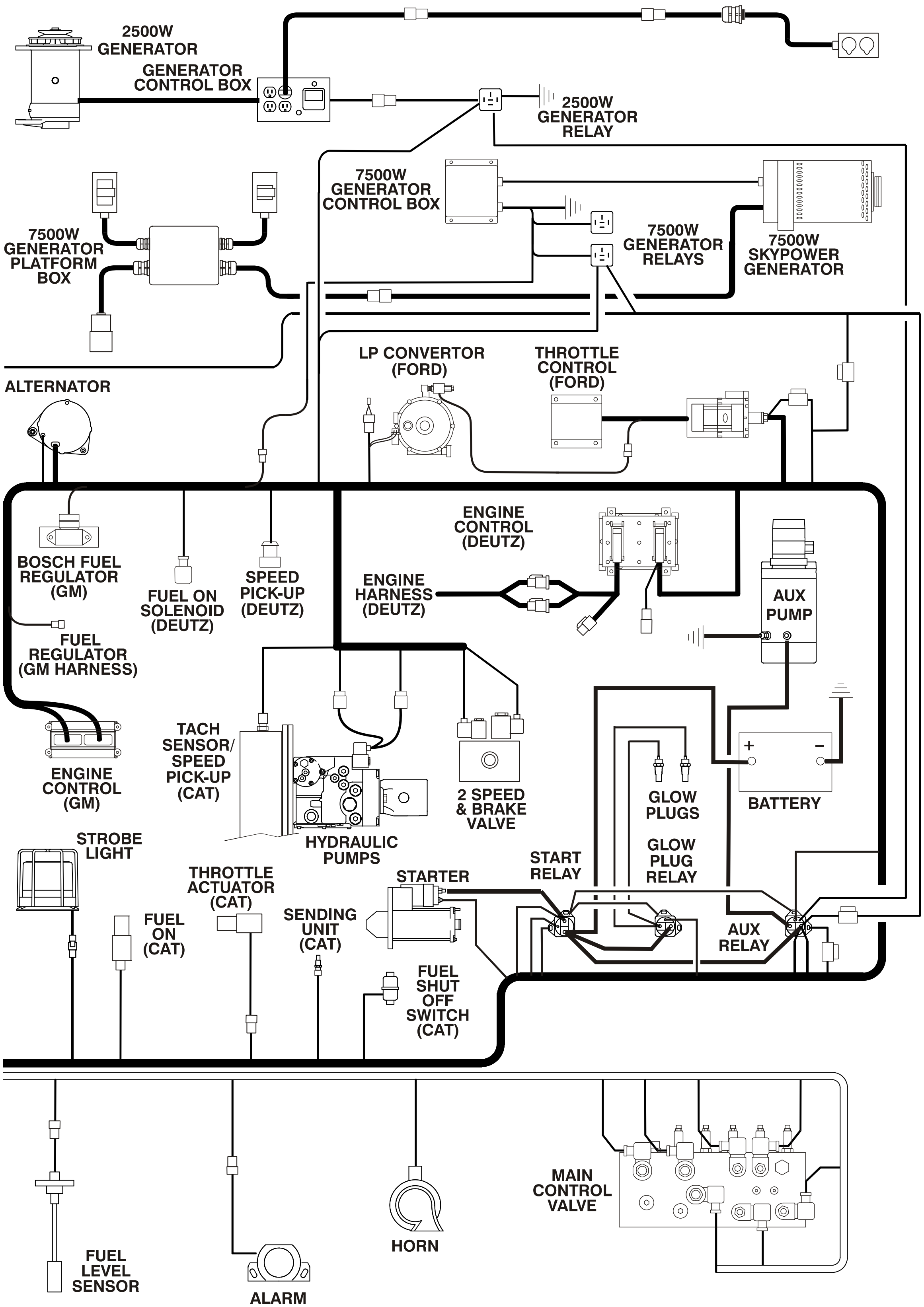
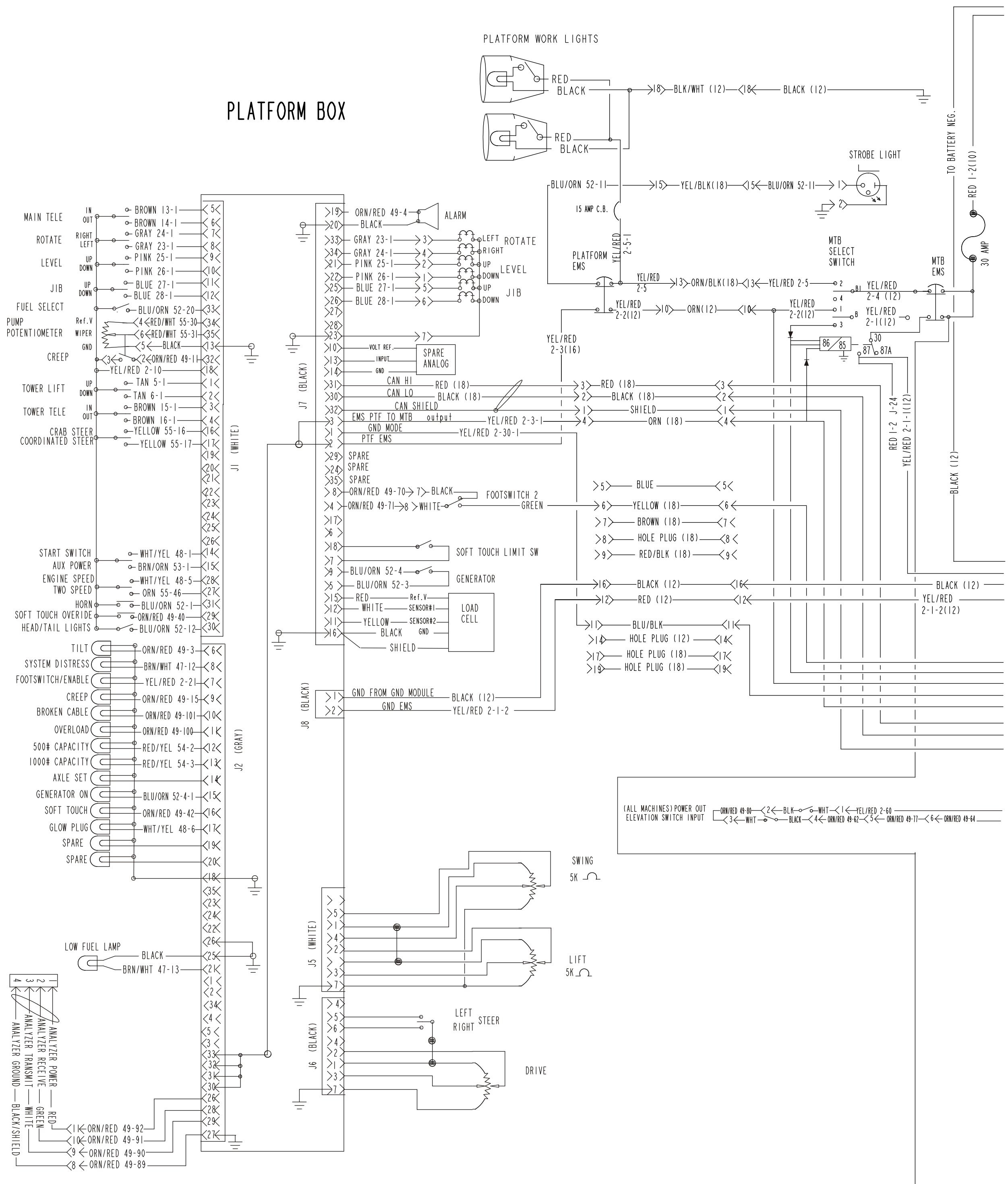


Figure 7-19. Electrical Components Installation - Sheet 2



NOTE: This Schematic covers machines built prior to S/N 1300000979.

Figure 7-20. Electrical Schematic - Sheet 1 of 4

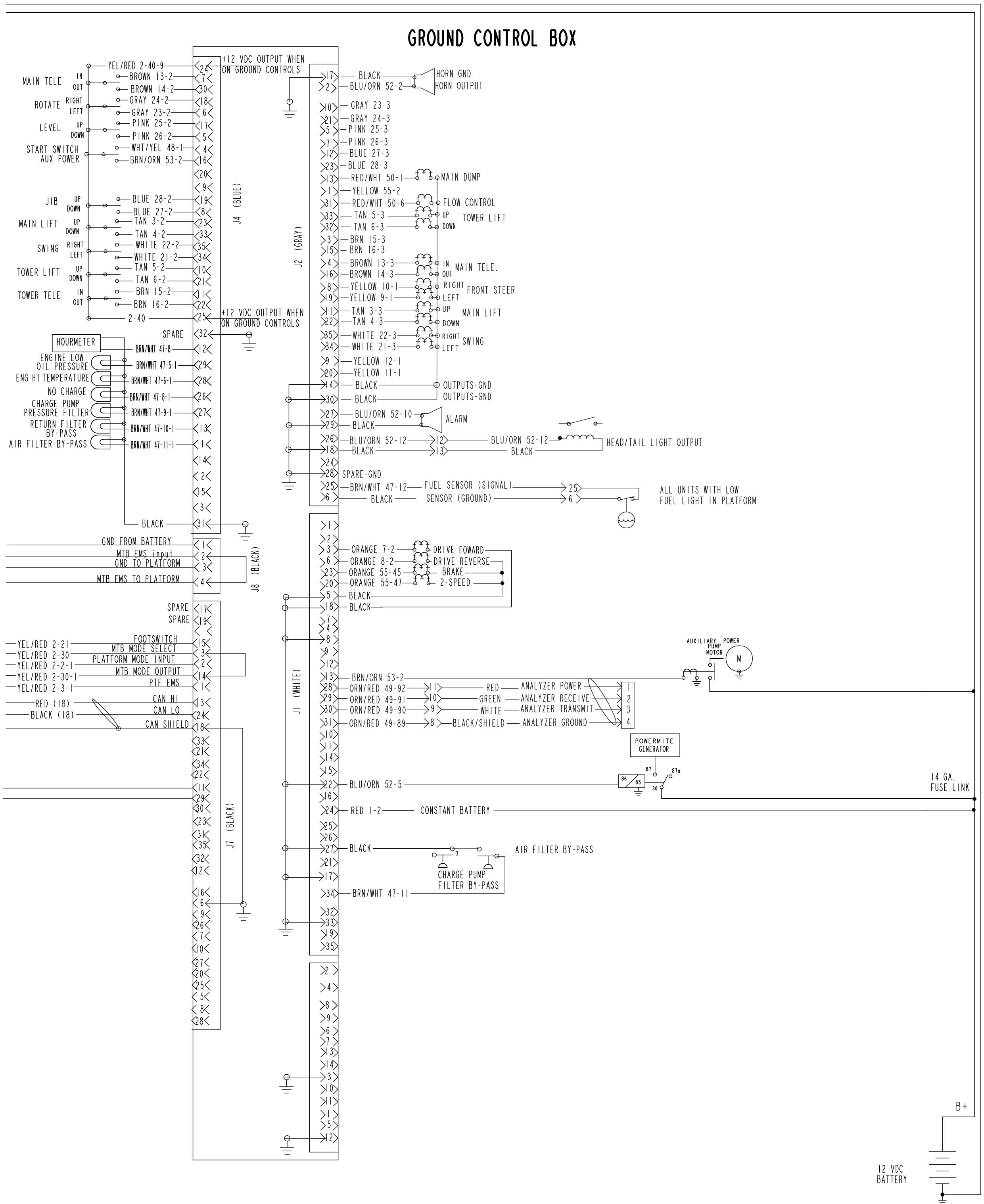


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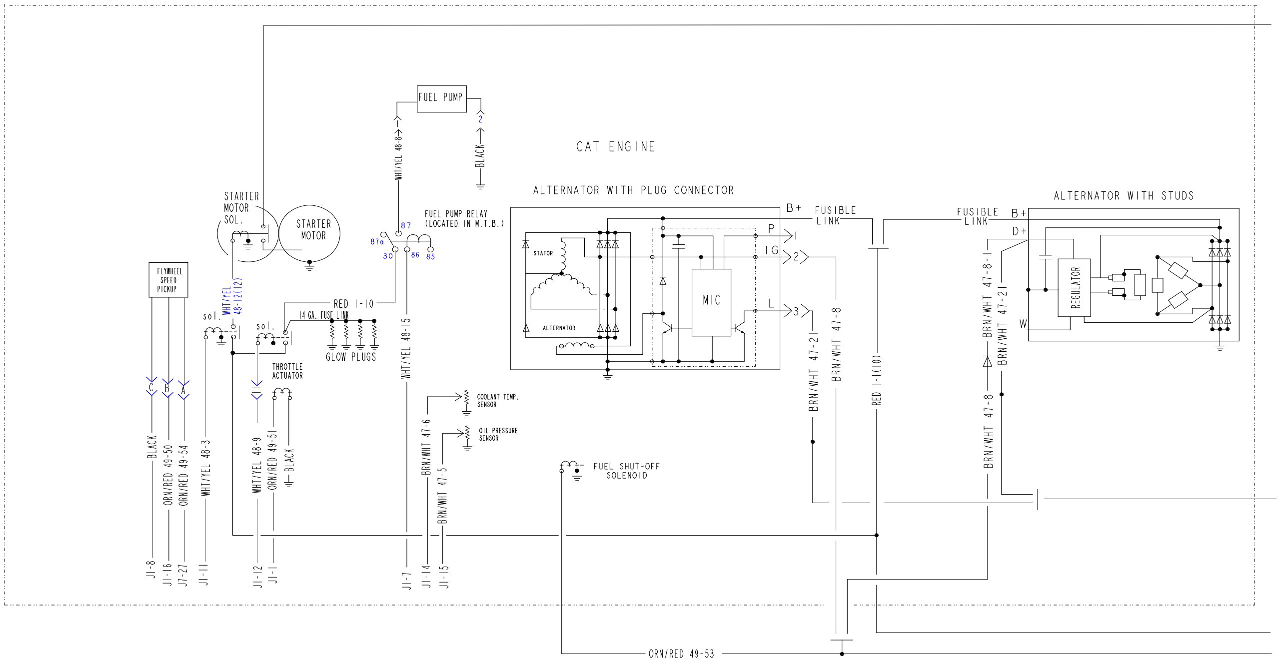
Figure 7-21. Electrical Schematic - Sheet 2 of 4



NOTE: This Schematic covers machines built prior to S/N 1300000979.

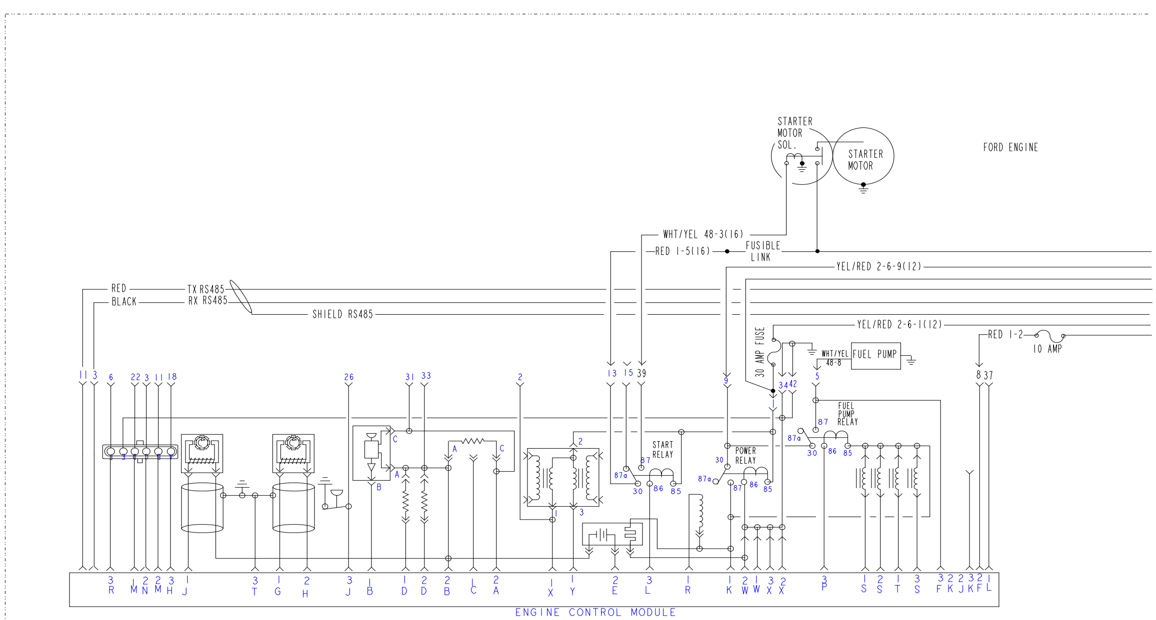


Figure 7-22. Electrical Schematic - Sheet 3 of 4

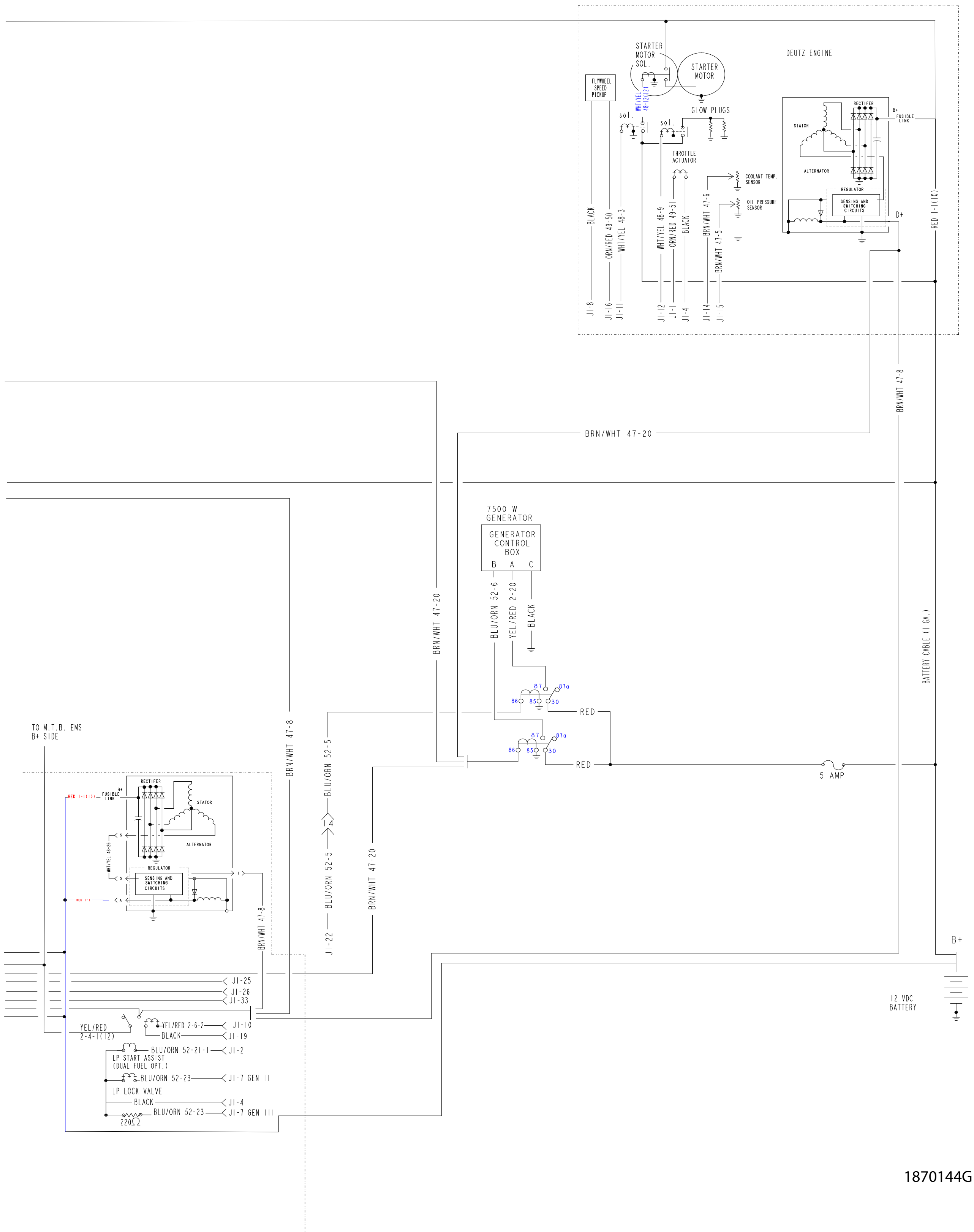
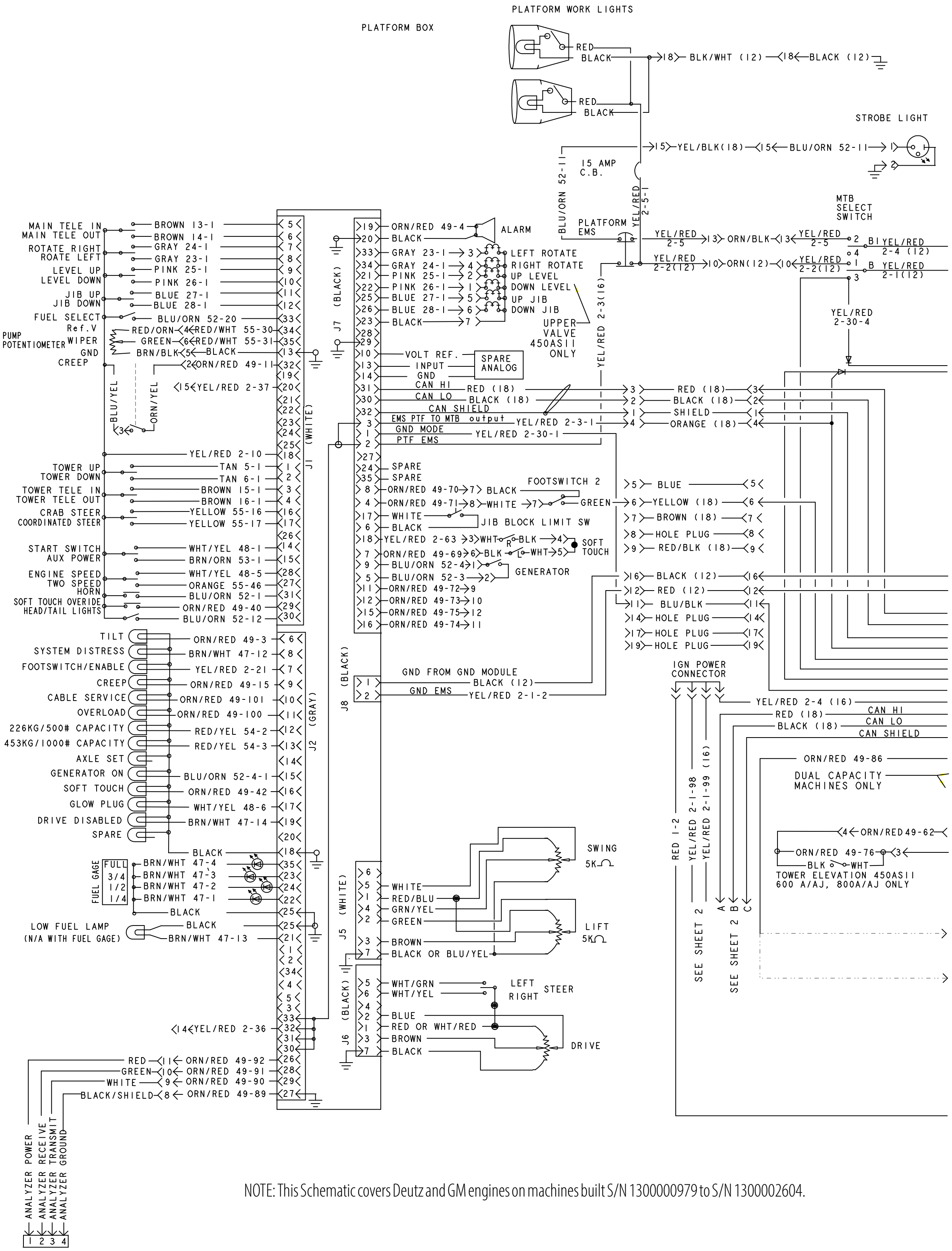


Figure 7-23. Electrical Schematic - Sheet 4 of 4



NOTE: This Schematic covers Deutz and GM engines on machines built S/N 1300000979 to S/N 1300002604.

Figure 7-24. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 1 of 6

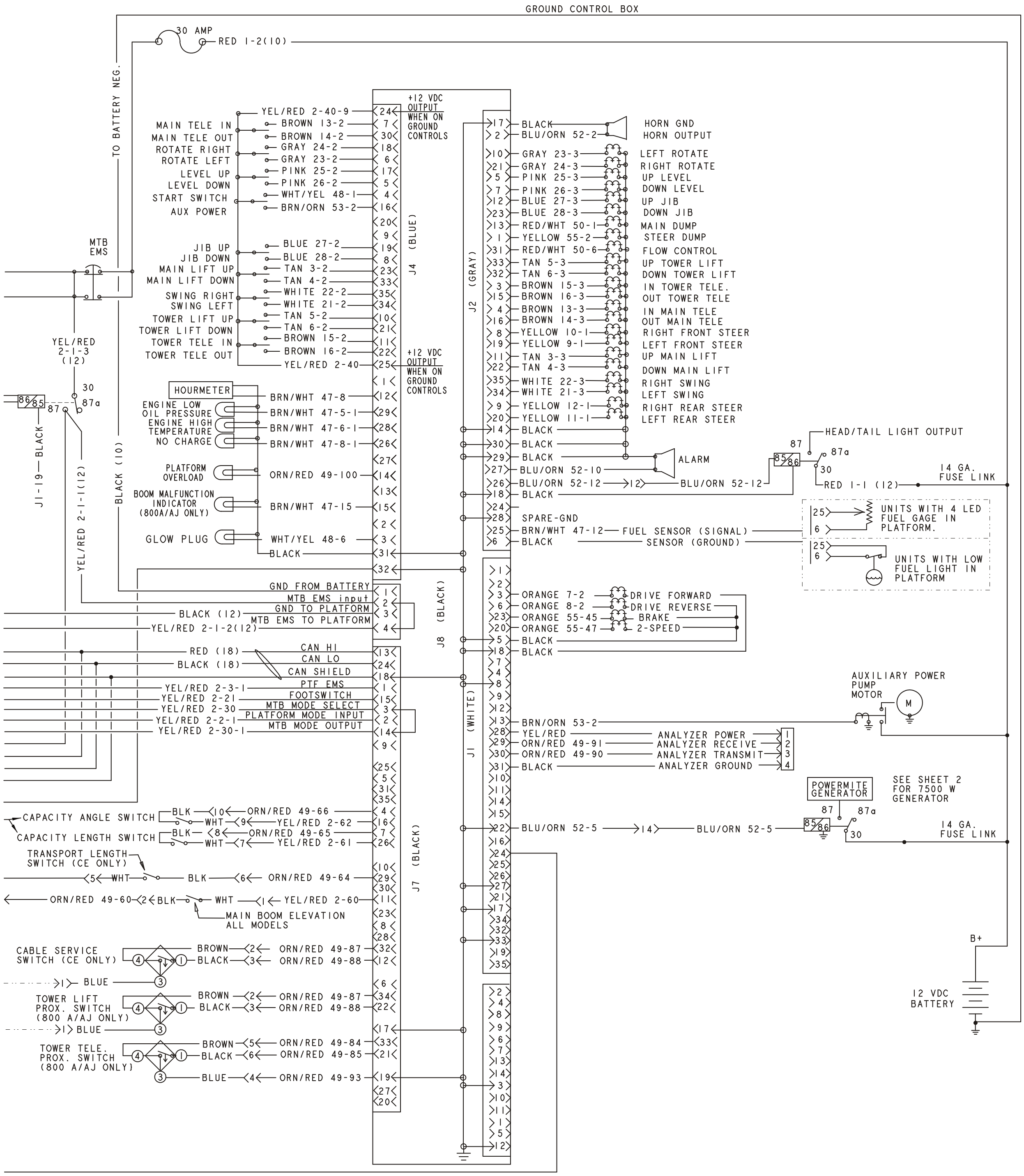


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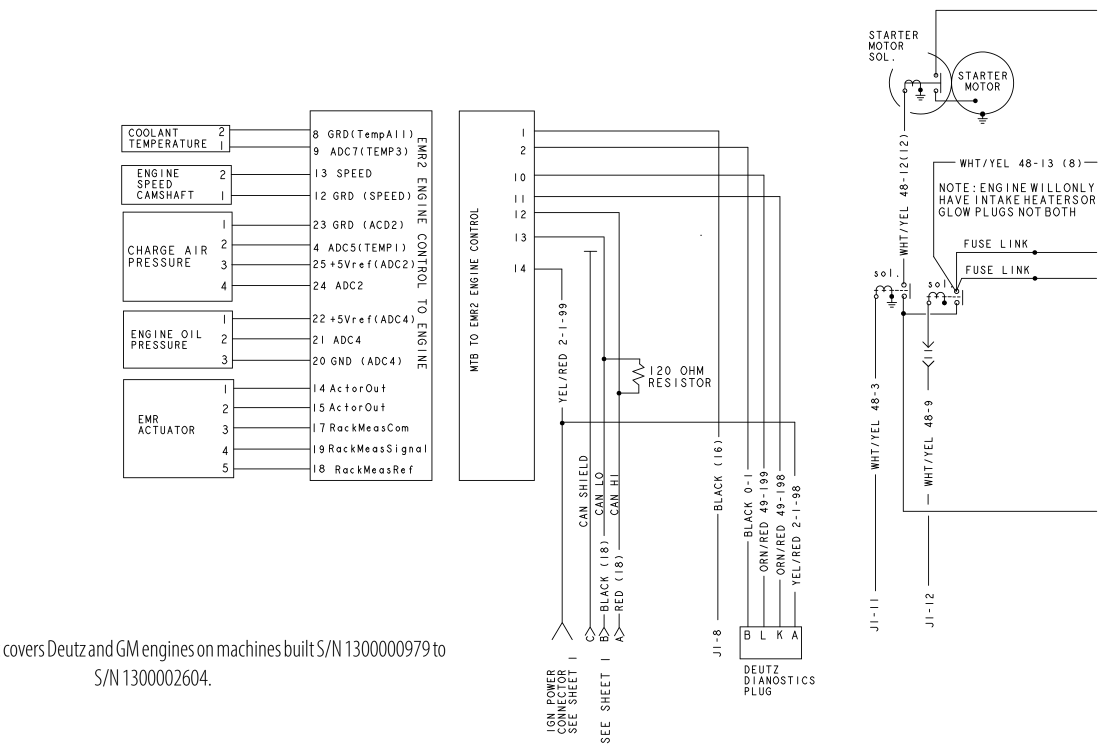
Figure 7-25. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 2 of 6



NOTE: This Schematic covers Deutz and GM engines on machines built S/N 1300000979 to S/N 1300002604.

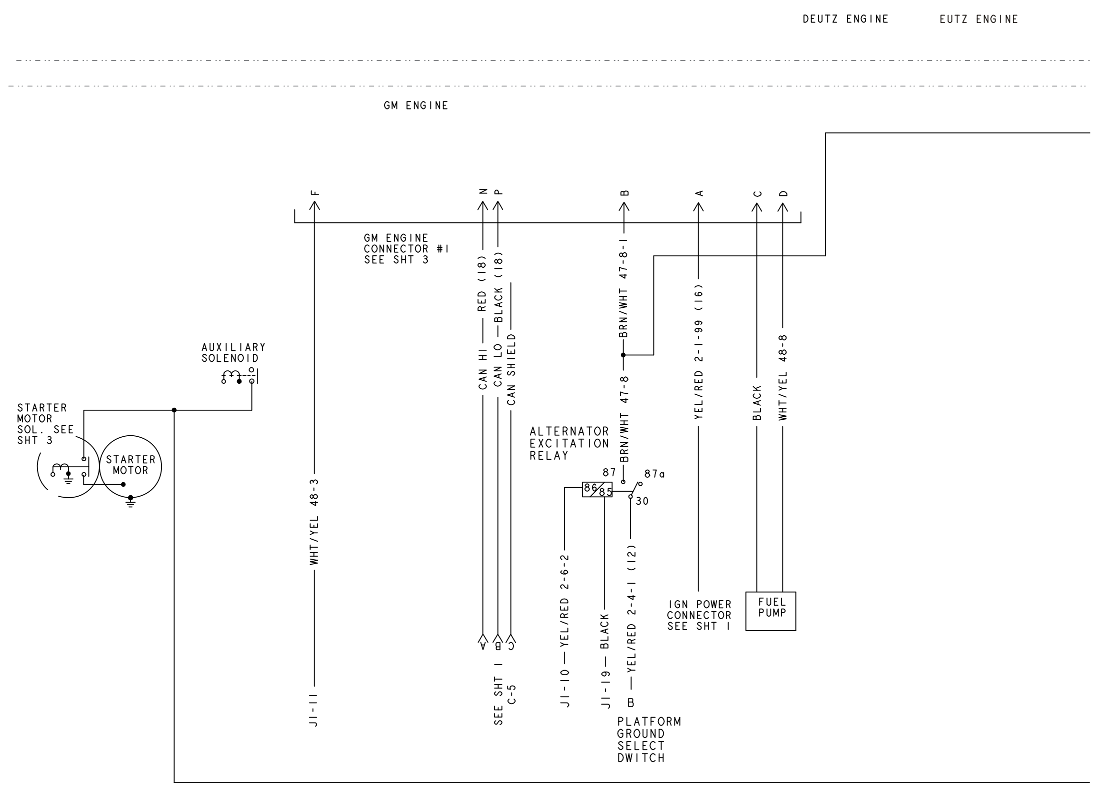


Figure 7-26. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 3 of 6

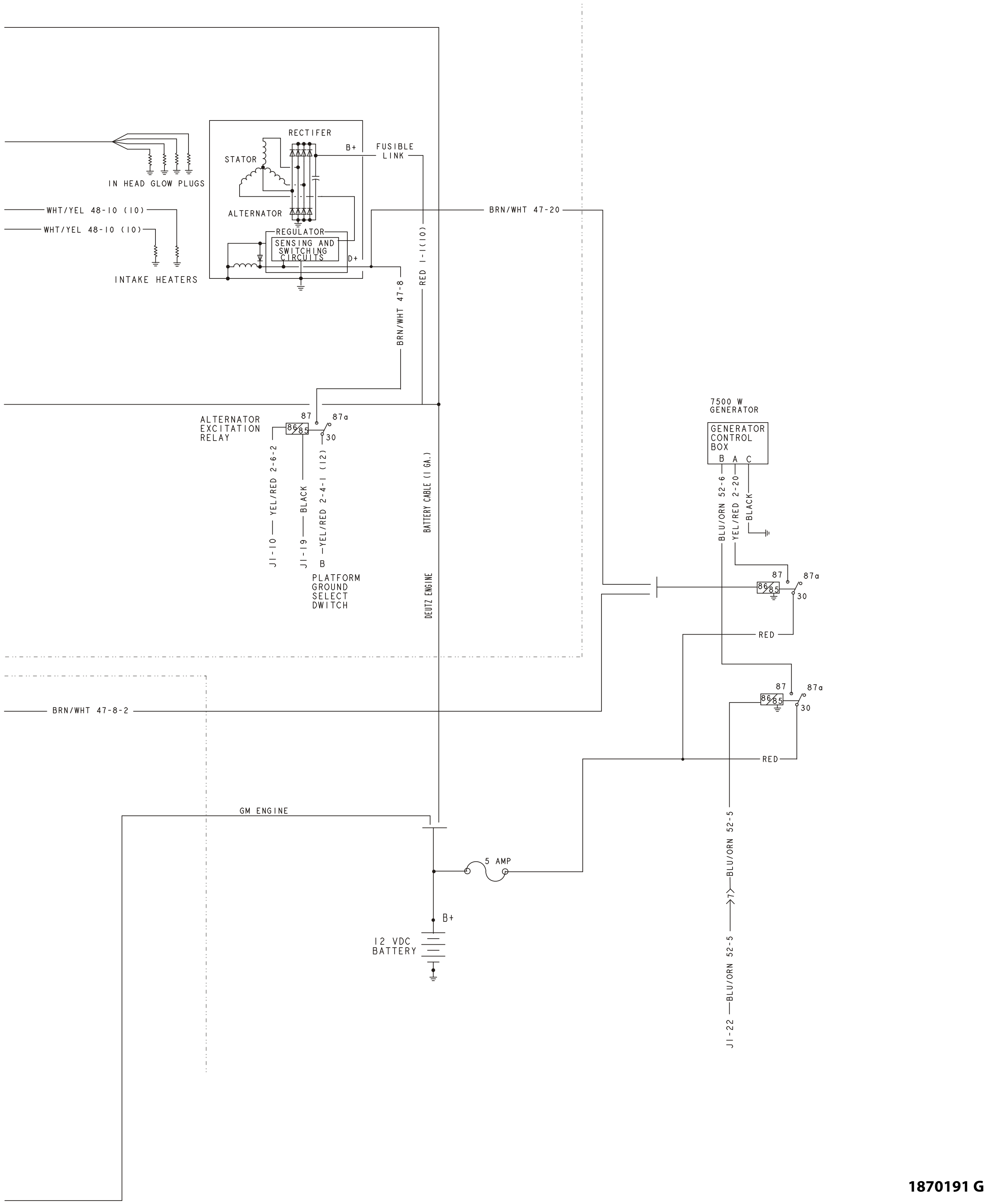
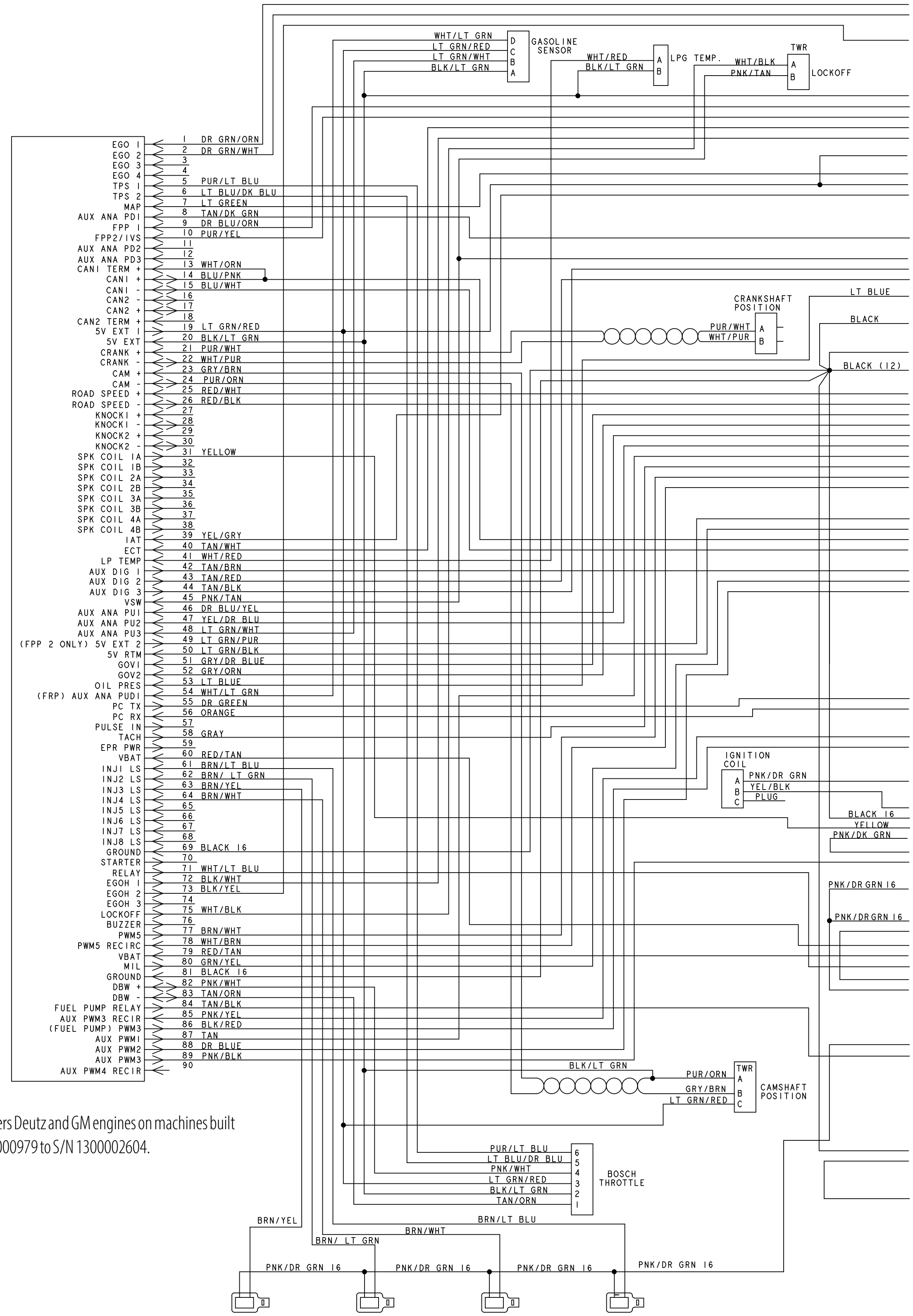


Figure 7-27. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 4 of 6



NOTE: This Schematic covers Deutz and GM engines on machines built S/N 1300000979 to S/N 1300002604.

Figure 7-28. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 5 of 6

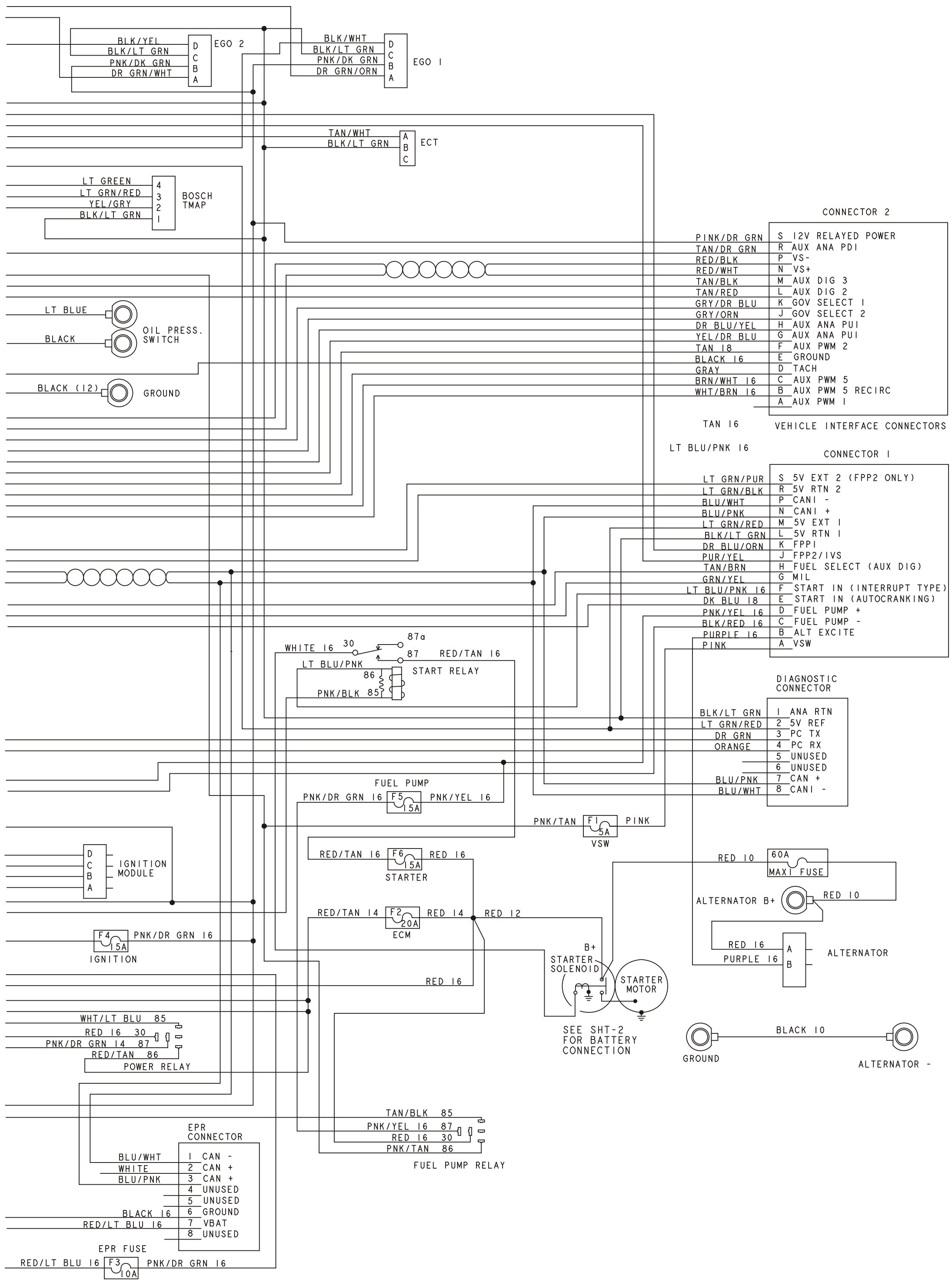


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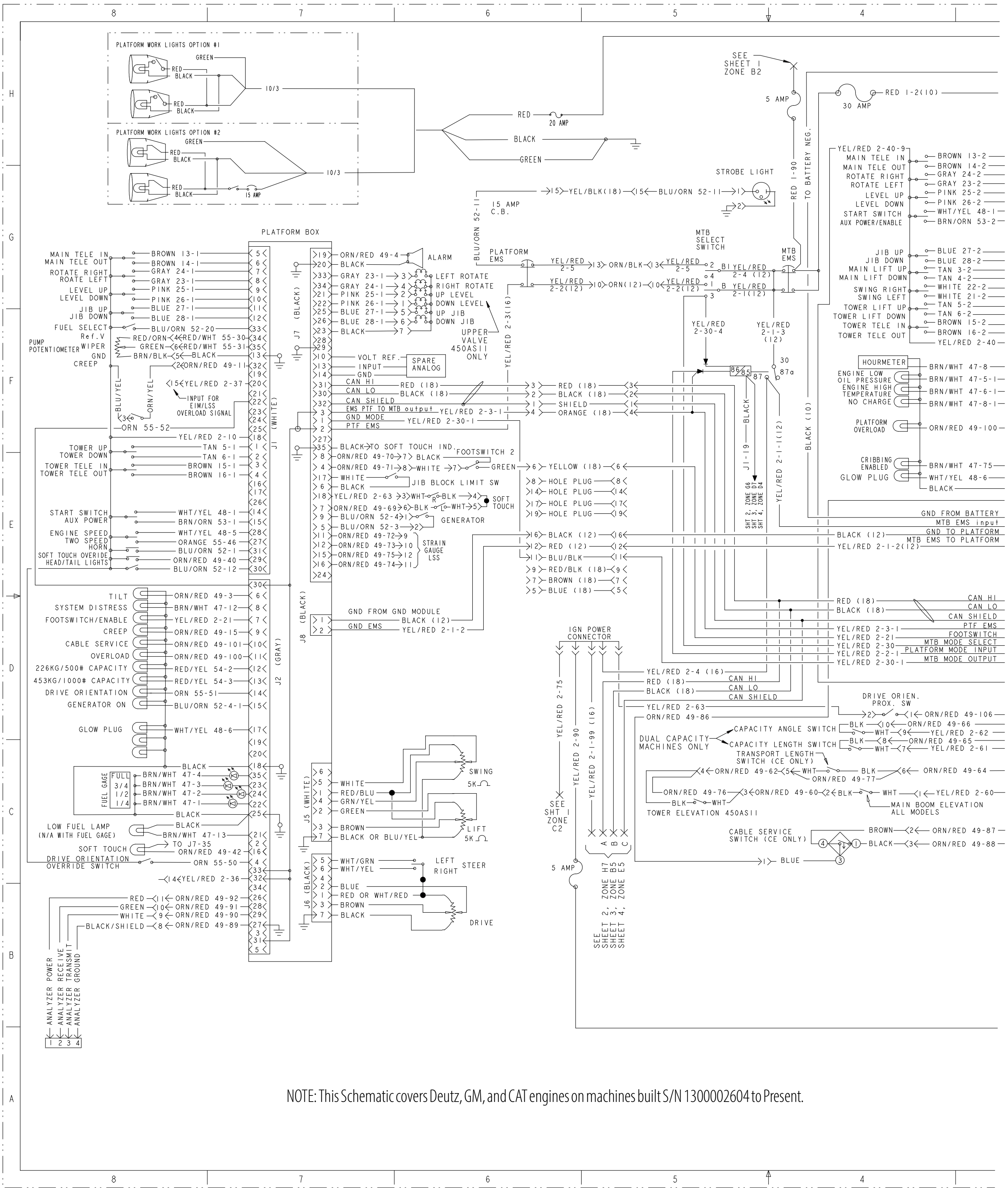
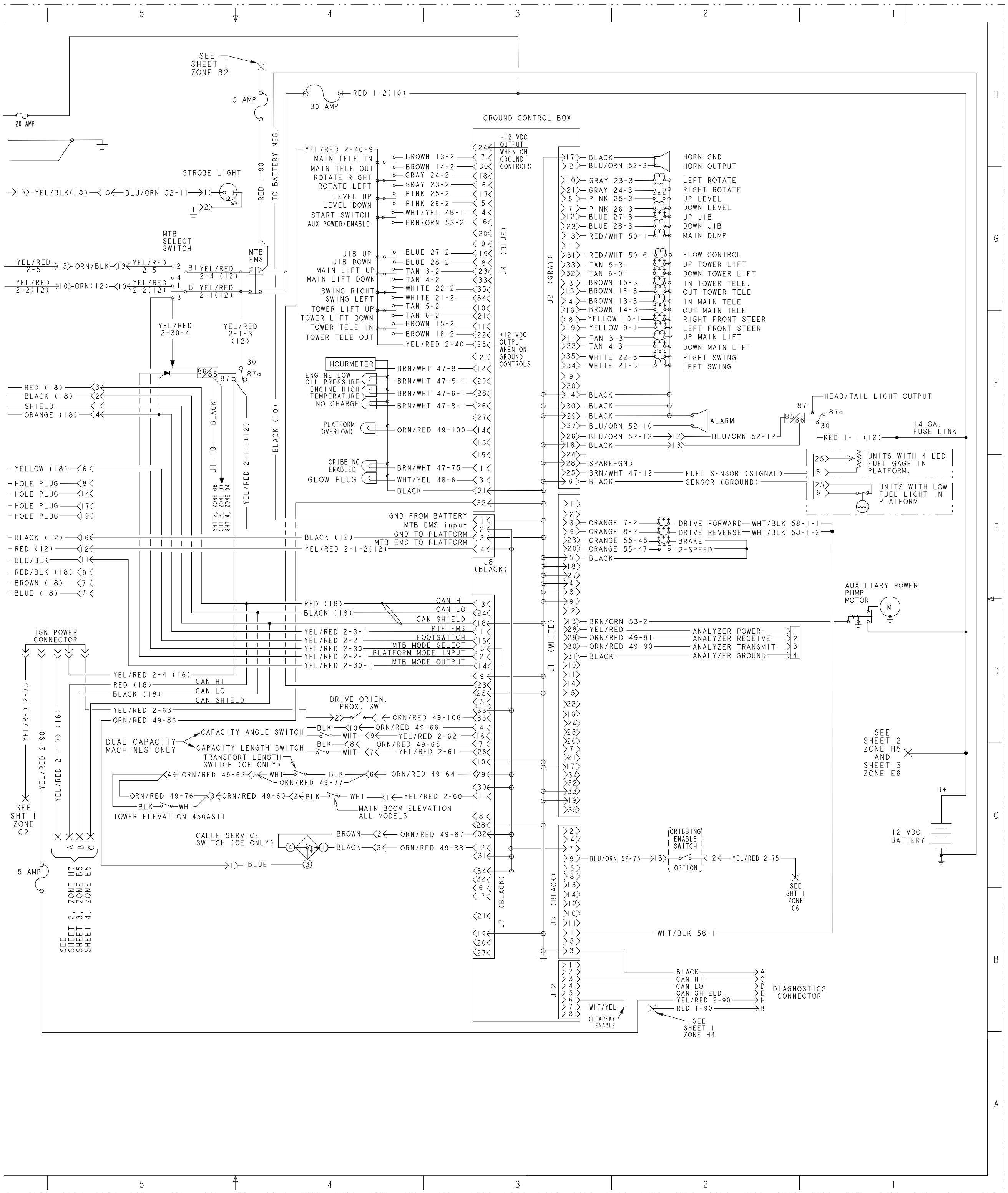
Figure 7-29. Electrical Schematic - Deutz EMR2 & GM Engine - Sheet 6 of 6



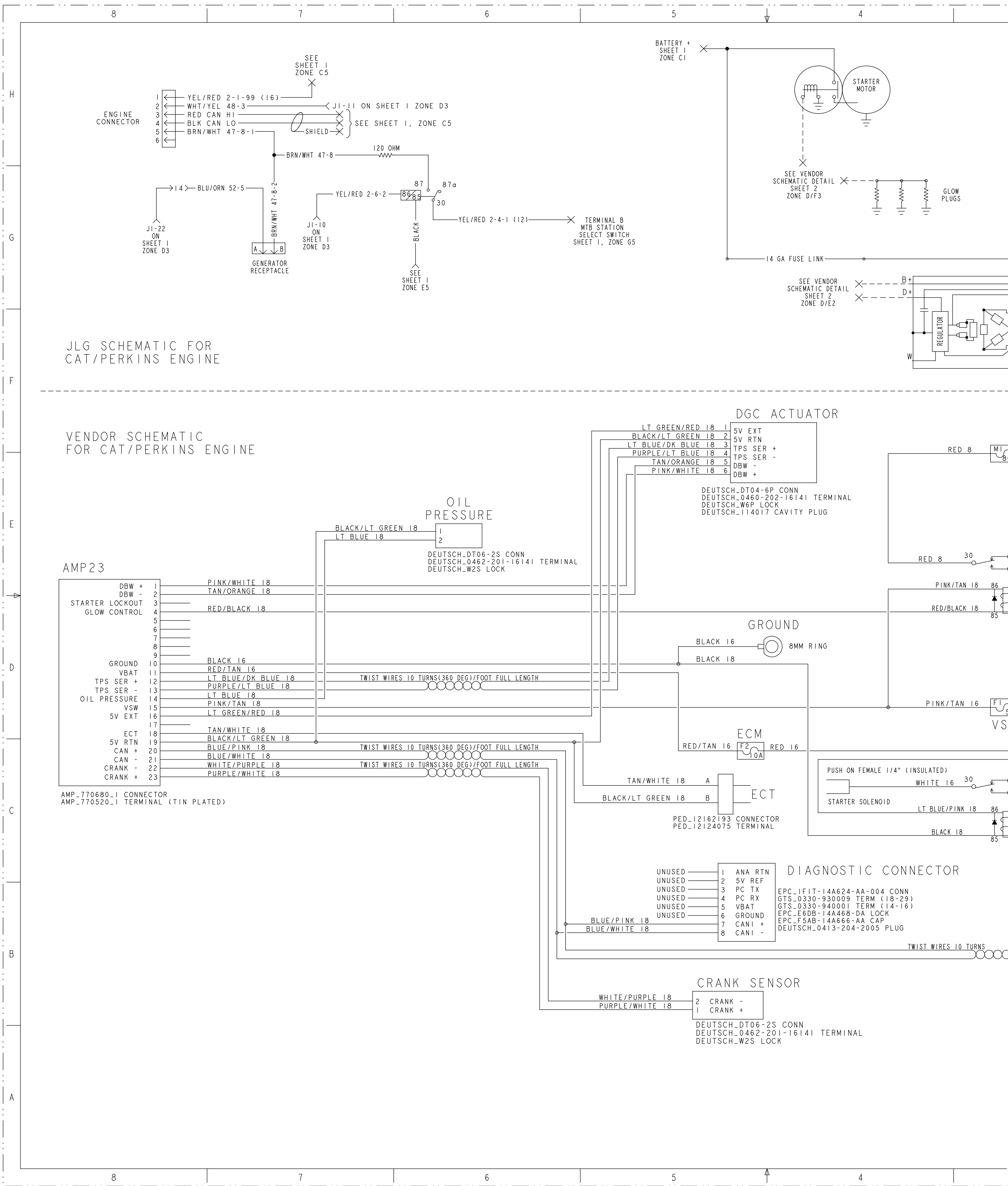
NOTE: This Schematic covers Deutz, GM, and CAT engines on machines built S/N 1300002604 to Present.

Figure 7-30. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 1 of 4 (LH)



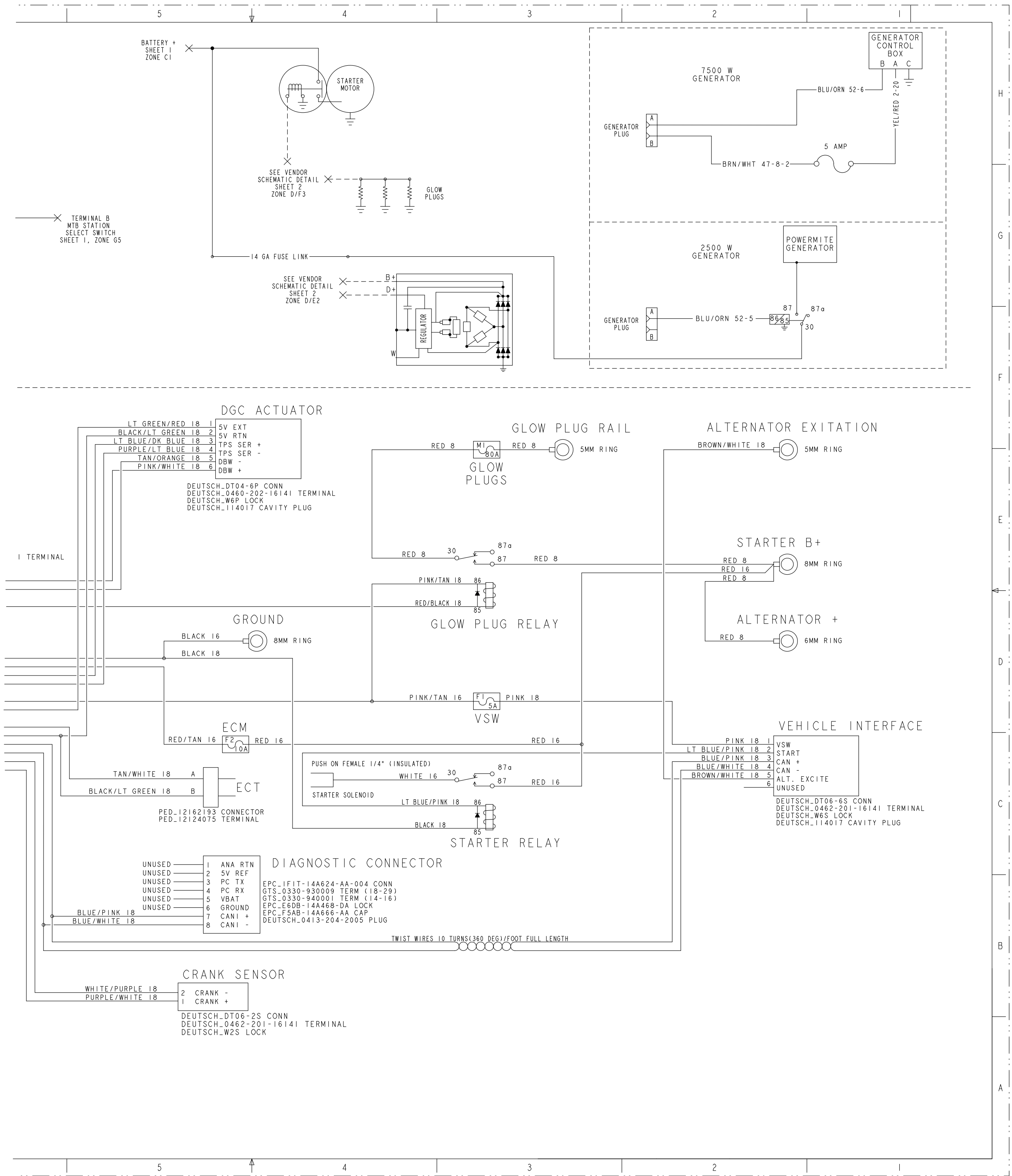
1001108879 F - Sheet 1

Figure 7-31. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 1of 4 (RH)



NOTE: This Schematic covers Deutz, GM, and CAT engines on machines built S/N 1300002604 to Present.

Figure 7-32. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 2 of 4 (LH)



1001108879 F - Sheet 2

Figure 7-33. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 2 of 4 (RH)

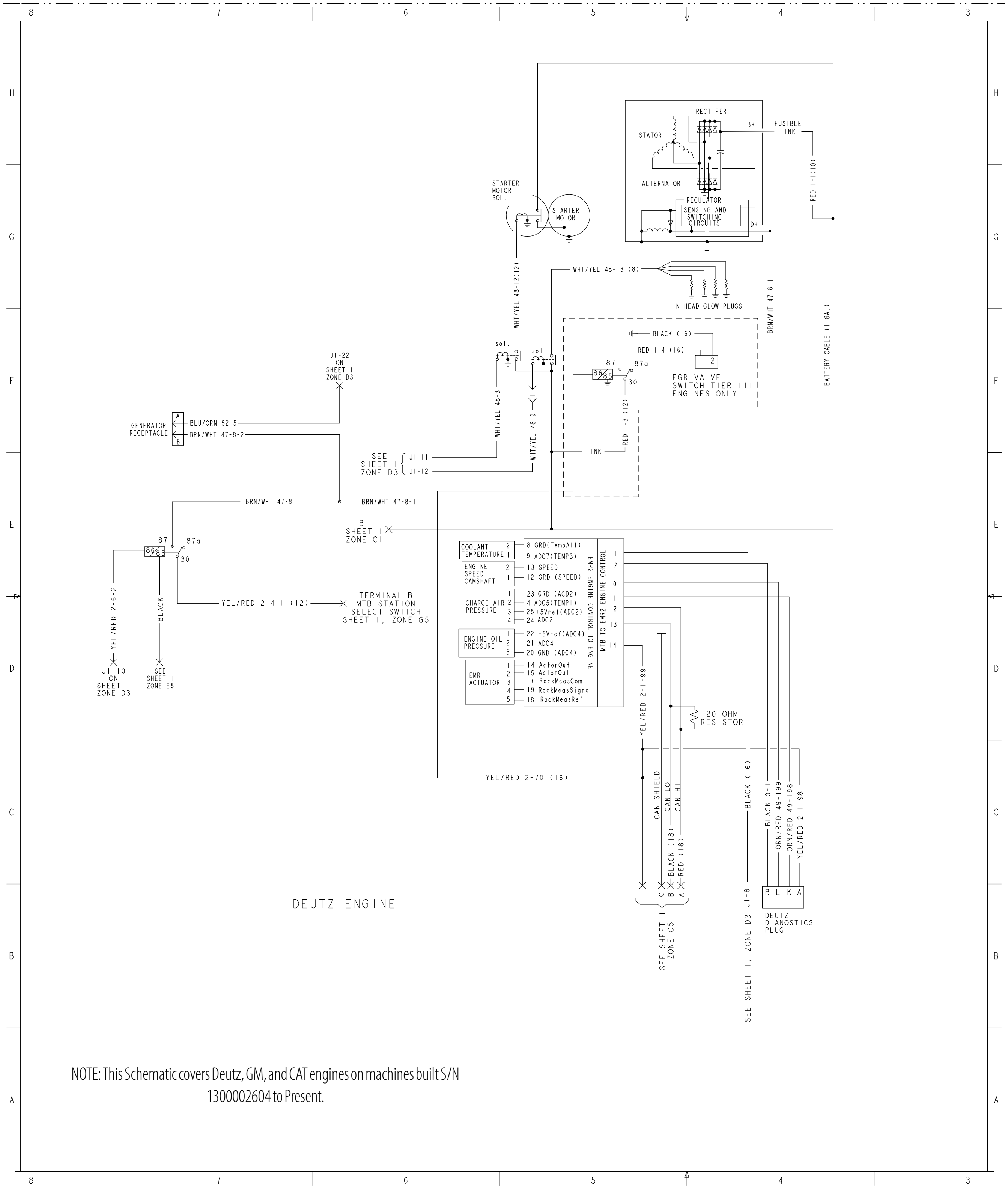


Figure 7-34. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 3 of 4

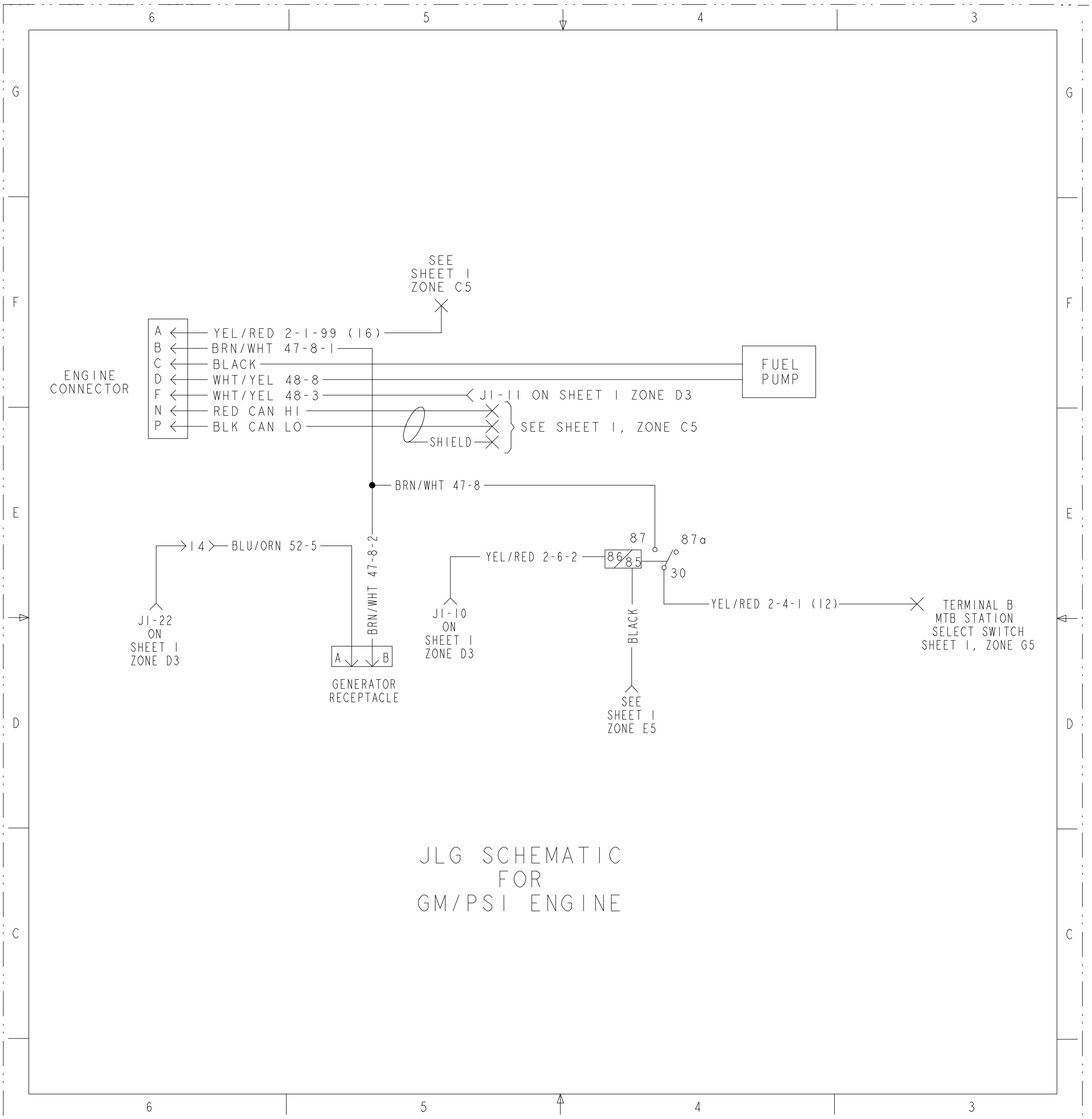


Figure 7-35. Electrical Schematic - Deutz, GM, & CAT Engine - Sheet 4 of 4

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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An Oshkosh Corporation Company

Corporate Office
JLG Industries, Inc.
1 JLG Drive
McConnellsburg PA. 17233-9533
USA
☎ *(717) 485-5161*
(717) 485-6417

JLG Worldwide Locations

JLG Industries (Australia)
P.O. Box 5119
11 Bolwarra Road
Port Macquarie
N.S.W. 2444
Australia
☎ +61 2 65 811111
+61 2 65813058

JLG Latino Americana Ltda.
Rua Eng. Carlos Stevenson,
80-Suite 71
13092-310 Campinas-SP
Brazil
☎ +55 19 3295 0407
+55 19 3295 1025

JLG Industries (UK) Ltd
Bentley House
Bentley Avenue
Middleton
Greater Manchester
M24 2GP - England
☎ +44 (0)161 654 1000
+44 (0)161 654 1001

JLG France SAS
Z.I. de Baulieu
47400 Fauillet
France
☎ +33 (0)5 53 88 31 70
+33 (0)5 53 88 31 79

JLG Deutschland GmbH
Max-Planck-Str. 21
D - 27721 Ritterhude - Ihlpohl
Germany
☎ +49 (0)421 69 350 20
+49 (0)421 69 350 45

JLG Equipment Services Ltd.
Rm 1107 Landmark North
39 Lung Sum Avenue
Sheung Shui N. T.
Hong Kong
☎ (852) 2639 5783
(852) 2639 5797

JLG Industries (Italia) s.r.l.
Via Po. 22
20010 Pregnana Milanese - MI
Italy
☎ +39 029 359 5210
+39 029 359 5845

Oshkosh-JLG Singapore
Technology Equipment Pte Ltd
29 Tuas Ave 4,
Jurong Industrial Estate
Singapore, 639379
☎ +65-6591 9030
+65-6591 9031

Plataformas Elevadoras
JLG Iberica, S.L.
Trapadella, 2
P.I. Castellbisbal Sur
08755 Castellbisbal, Barcelona
Spain
☎ +34 93 772 4700
+34 93 771 1762

JLG Sverige AB
Enkopingsvagen 150
Box 704
SE - 176 27 Jarfalla
Sweden
☎ +46 (0)850 659 500
+46 (0)850 659 534

www.jlg.com