SERVICE & MAINTENANCE

Models
M45A
M45AJ
E45A
E45AJ

3120765
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SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

A GENERAL

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

⚠ WARNING

MODIFICATION OF THE MACHINE WITHOUT CERTIFICATION BY A RESPONSIBLE AUTHORITY THAT THE MACHINE IS AT LEAST AS SAFE AS ORIGINALLY MANUFACTURED, IS A SAFETY VIOLATION.

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 the 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 MAY RESULT IN MACHINE DAMAGE, PERSONNEL INJURY OR DEATH AND IS A SAFETY VIOLATION.

- 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 SERVICEMANUAL.
- KEEP OIL, GREASE, WATER, ETC. WIPED FROM STANDING SURFACES AND HAND HOLDS.
- USE CAUTION WHEN CHECKING A HOT, PRESSURIZED COOLANT SYSTEM.
- NEVER WORK UNDER AN ELEVATED BOOM UNTIL BOOM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR BOOM SAFETY PROP HAS BEEN ENGAGED.
- BEFORE MAKING ADJUSTMENTS, LUBRICATING OR PERFORMING ANY OTHER MAINTENANCE, SHUT OFF ALL POWER CONTROLS.
- BATTERY SHOULD ALWAYS BE DISCONNECTED-DURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

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3-16	- Updated 2-15-00

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SECTION 1. SPECIFICATIONS

1.1 CAPACITIES

Hydraulic Oil Tank

5 gallons (19 liters)

Generator Fuel Tank

4 gallons (15.1 liters)

Drive Axle

Torque Hubs - 19 oz. (0.5 liters)

1.2 COMPONENT DATA

Battery Charger

Input, 110 VAC,60 HZ

Output, 48 VDC (25 Amps)

Batteries (8)

6 Volt, 370 AmpHour (20 hour rate)

Drive System

Drive Motor - 48 VDC, 12.5 H.P. @ 3200 rpm. continuous, rotation - reversible

Drive Brake- spring-applied, hydraulically released

Tires - IN240/55-17.5 pneumatic or foam filled

Tire Pressure - 90 psi (6.2 Bar)

Hydraulic Pump/Electric Motor Assembly

Motor - 48 VDC, 2.14 H.P. @ 2700 rpm.

Pump - 0.098 in.[3]/rev. (1.6 cm[3]/rev.).

Pump Output - 2.96 gpm (11.2 lpm) @ 3200 psi (222 Bar).

Generator

Alternator Output - 58 volts @ 45 Amps

RPM’s under max. load - 3100

Start Battery - 12 volts

Engine Oil - 10W30 (Refer to Engine Manual)

Dynamo - 12 volt, 15 amp DC

Dynamo Output Fuse - 20 amps DC

Control Fuse - 15 amps DC

1.3 PERFORMANCE DATA

Travel Speed

3.2 mph (5.2 kph)

Gradeability

30% (16.7 degrees)

Turning Radius (Inside)

2ft. 0 in. (0.61 m)

Turning Radius (Curb to Curb)

10 ft. 4 in. (3.15 m)

Tail Swing (Any Position)

0

Upper Boom Speed

Lift Up - 27 seconds

Lift Down - 26 seconds

Lower Boom Speed

Lift Up - 30 seconds

Lift Down - 24 seconds.

Swing Speed - 360 Degrees

90 seconds / rev.

Machine Weight

E45A - 12,600 lb. (5,720 kg)
M45A - 12,800 lb. (5,806 kg)
E45AJ - 14,750 lb. (6690 kg)
M45AJ - 14,750 lb. (6690 kg)

Max. Tire Load

M 45A, E45A - 6100 lbs. (2,767 kg)
M45AJ, E45AJ - 6900 lbs. (3,130 kg)

Ground Bearing Pressure

M45A, E45A - 95 psi (6.2 Bar)
M45AJ, E45AJ - 110 psi (7.6 Bar)

Machine Height (stowed)

M45A, E45A - 6 ft. 6.25 in. (1.99 m)

M45AJ, E45AJ - 6ft. 7 in. (2.0 m)

Machine Length (stowed)

M45A, E45A - 18 ft. 8.0 in. (5.69 m)

M45AJ, E45AJ - 21 ft. 2 in. (6.45 m)

Up and Over Platform Height

M45A, E45A - 24 ft. 7 in. (7.49 m)

M45AJ, E45AJ - 25 ft. 3" (7.7 m)

Horizontal Reach @ Maximum Up and Over

M45 A, E45A - 23 ft. 1 in. (7.0 m)

M45AJ, E45AJ - 23 ft. 9 in. (7.24 m)

Machine Width

5 ft. 9 in. (1.75 m)

Wheel Base

6 ft. 7.0 in. (2.00 m)

Working Height

51 ft. 0 in. (15.54 m)

Platform Height

45 ft. 0 in. (13.72 m)

Track Width

5 ft. 0 in. (1.51 m)

Ground Clearance

M45, E45 - 8.5 in. (0.22 m)

M45AJ, E45AJ - 8 in. (0.20 m)

System Voltage

48 volts

Battery Life per Charge

7 hours continuous

Battery Recharge Time

Charger - 17 hours from full discharge

Generator - 6.2 hours

1.4 FUNCTION SPEEDS (M45A/E45A)

Lift Up - 30-24 seconds

Lift Down - 29-23 seconds

Tower Lift Up - 33-27 seconds

Tower Lift Down - 26-22 seconds

Telescope Out - 18-14 seconds

Telescope In - 28-23 seconds

Swing Left 360° - 81-67 seconds*

Swing Right 360° - 81-67 seconds*

Rotate Left 180° - 17-14 seconds

Rotate Right 180° - 18-15 seconds

High Drive - Fwd. & Rev. (200 ft.) - 42-44 seconds**

Drive above Horiz. - Fwd. & Rev. (50 ft.) - 50-53 seconds**

*Swing Left to Swing Right should be within 10% of each other.

**Drive Forward to Drive Reverse should be within 10% of each other.

1.5 FUNCTION SPEEDS (M45AJ/E45AJ)

Lift Up - 30-24 seconds

Lift Down - 29-23 seconds

Tower Lift Up - 33-27 seconds

Tower Lift Down - 26-22 seconds

Jib Up - 25-26 seconds

Jib Down - 24-25 seconds

Telescope Out - 12-9 seconds

Telescope In - 19-15 seconds

Swing Left 360° - 81-67 seconds*

Swing Right 360° - 81-67 seconds*

Rotate Left 180° - 17-14 seconds

Rotate Right 180° - 18-15 seconds

High Drive - Fwd. & Rev. (200 ft.) - 42-44 seconds**

Drive above Horiz. - Fwd. & Rev. (50 ft.) - 50-53 seconds**

*Swing Left to Swing Right should be within 10% of each other.

**Drive Forward to Drive Reverse should be within 10% of each other.

1.6 TORQUE SPECIFICATIONS

Table 1-1.Torque Requirements

Description	Torque Value	Interval Hours
Wheel Lugs	170 ft. lbs. (230 Nm)	150
Swing Bearing (Dry)	220 ft. lbs. (298 Nm)	50/600*
Swing Bearing ((Loctite)	240 ft. lbs. (326 Nm)	50/600*

* Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter.

1.7 LUBRICATION

Hydraulic Oil

Table 1-2.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.*

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 Mobil DTE 11M is desired, contact JLG Industries for proper recommendations.

Lubrication Specifications

Table 1-3.Lubrication Specifications.

KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350 degrees F. 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. Mobil DTE-11M
OG*	Open Gear Lube - Tribol Molub-Alloy 936 Open Gear Compound. (JLG Part No. 3020027)
BG*	Bearing Grease (JLG Part No. 3020029) Mobilith SHA 460.
LL	Synthetic Lithium Lubricant, Gredag 741 Grease. (JLG Part No. 3020022)
EO	Engine (crankcase) Oil. Gas - API SF/SG class, MIL-L-2104. Diesel - API CC/CD class, MIL-L-2104B/MIL-L-2104C.

*MPG may be substituted for these lubricants, if necessary, but service intervals will be reduced.

NOTE: *Refer to Lubrication Chart, Figure1-2, for specific lubrication procedures.*

Table 1-4. Mobil DTE 11M Specs

ISO Viscosity Grade	#15
Gravity API	31.9
Pour Point, Max	-40 F (-40 C)
Flash Point, Min.	330 F (166 C)
Viscosity	
at 40° C	15 cSt
at 100° C	4.1 cSt
at 100° F	80 SUS
at 210° F	43 SUS
cp at -30° F	3.200
Viscosity Index	140

1.8 PRESSURE SETTINGS

Main Valve

Upper Lift Down Relief - 550 psi (38 bar)

Mid/Lower Lift Down Relief - 1700 psi (117 bar)

Telescope In Relief - 2150 psi (148 bar)

Platform Level Up Relief - 2500 psi (172 bar)

Platform Level Down Relief - 1200 psi (83 bar)

Steer/Brake Valve

Steer Relief - 2300 psi (159 bar)

Main Relief - 3200 psi (221 bar)

Jib Valve

Jib Relief (Up and Down) - 1500 psi (103 bar)

1.9 CYLINDER SPECIFICATIONS

NOTE: *All dimensions are given in inches (in.), with the metric equivalent, millimeters (mm), given in parentheses.*

Table 1-5.Cylinder Specifications

Cylinder	Bore	Stroke	Rod Dia.
Upper Lift Cylinder	3.00 (76.2)	28.3125 (719.1)	1.50 (38.1)
Mid Lift Cylinder	3.00 (76.2)	21.25 (539.7)	1.50 (38.1)
Lower Lift Cylinder	4.00 (101.6)	23.25 (590.5)	2.25 (57.1)
Telescope Cylinder	2.00 (50.8)	92 (2337)	1.25 (31.8)
Master Cylinder	2.00 (50.8)	9.375 (238.1)	1.00 (25.4)
Slave Cylinder	2.00 (50.8)	9.375 (238.1)	1.00 (25.4)
Rotator Cylinder	1.875 (47.6)	15.250 (387.3)	1.00 (25.4)
Steer Cylinder (Double Rod)	2.50 (63.5)	4.06 (103.1)	1.75 (44.5)

1.10 MAJOR COMPONENT WEIGHTS

Table 1-6.Major Component Weights

Component	LB.	KG.
Platform and Support	215	97.5
Upper Boom Complete	810	367
Mid Boom Complete	550	249
Lower Boom Complete	550	249
Upper Lift Cylinder	89	40
Mid Lift Cylinder	95	43
Lower Lift Cylinder	110	50
Telescope Cylinder	85	38.5
Upper Upright	225	102
Lower Upright	97	44
Turntable	948	430
Battery Box (incl. batteries)	600	272
Chassis (w/ pneu. tires)	4,295	1948
Chassis (w/ foam-filled tires)	4,695	2130
Counterweight	3850	1746
Machine Complete	11,800	5352

⚠ WARNING

SELECT LIFTING EQUIPMENT WITH CAPACITY CAPABLE OF SAFELY SUPPORTING WEIGHT.

1.11 CRITICAL STABILITY WEIGHTS

Table 1-7.Critical Stability Weights

Component	LB.	KG.
Counterweight	3850	1746
Tire & Wheel (foam-filled)	207	94
Platform (4ft [1.2 m])	90	41
Platform (5 ft [1.5 m])	100	45
Battery (each)	120	54

⚠ WARNING

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

1.12 SERIAL NUMBER LOCATIONS

For machine identification, a serial number plate is affixed to the left rear of frame, in front of left rear wheel. If the serial number plate is damaged or missing, the machine serial number is stamped on the top left side of the frame and the top left side of the turntable. In addition, the serial number is stamped on top of the end of the upper boom, mid boom, and lower boom at the left rear of the booms.

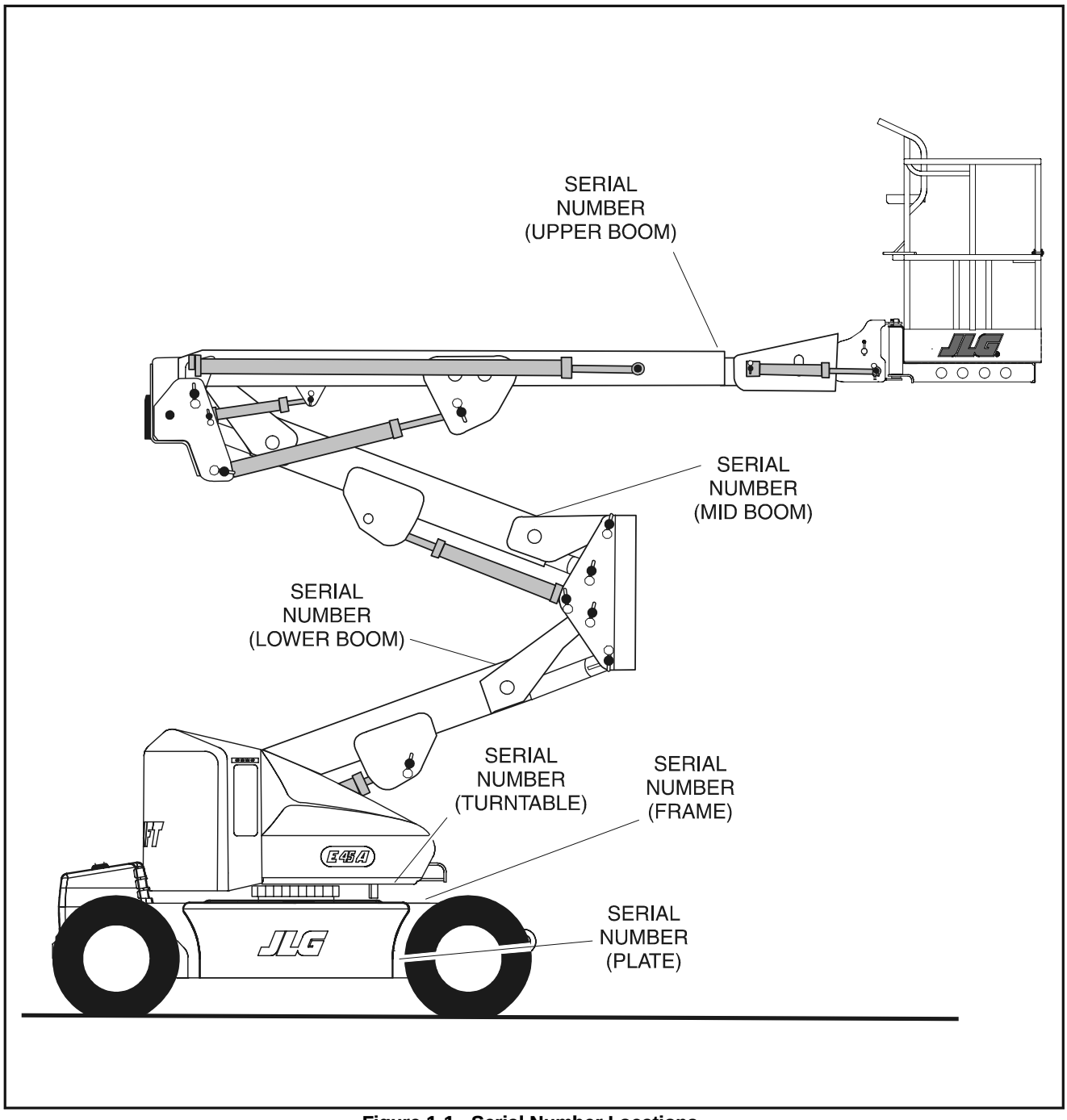


Figure 1-1. Serial Number Locations

VALUES FOR ZINC PLATED BOLTS ONLY													UNPLATED CAP SCREWS	
SIZE	THD	BOLT DIA. (IN.)	THREAD STRESS AREA (SQ. IN.)	SAE GRADE 5 BOLTS & GRADE 2 NUTS					SAE GRADE 8 BOLTS & GRADE 8 NUTS					UNBRAKO 1960 SERIES SOCKET HEAD CAP SCREW WITH LOC-WEL PATCH	
				CLAMP LOAD (LB.)	TORQUE				CLAMP LOAD (LB.)	TORQUE				CLAMP LOAD (LB.)	TORQUE (as received)
					(DRY OR LOC. 263)	(LUB.)	(LOCTITE 262)	(LOCTITE 242 OR 271)		(DRY OR LOC. 263)	(LUB.)	(LOCTITE 262)	(LOCTITE 242 OR 271)		
					LB. IN.	LB. IN.	LB. IN.	LB. IN.		LB. IN.	LB. IN.	LB. IN.	LB. IN.		LB. FT.
4	40	0.1120	0.00604	380	8	6	—	—	540	12	9	—	—	—	—
	48		0.00661	420	9	7	—	—	600	13	10	—	—	—	—
6	32	0.1380	0.00909	580	16	12	—	—	820	23	17	—	—	—	—
	40		0.01015	610	18	13	—	—	920	25	19	—	—	—	—
8	32	0.1640	0.01400	900	30	22	—	—	1260	41	31	—	—	—	—
	36		0.01474	940	31	23	—	—	1320	43	32	—	—	—	—
10	24	0.1900	0.01750	1120	43	32	—	—	1580	60	45	—	—	—	—
	32		0.02000	1285	49	36	—	—	1800	68	51	—	—	—	—
1/4	20	0.2500	0.0318	2020	96	75	—	105	2860	144	108	—	160	3180	13
	28		0.0364	2320	120	86	—	135	3280	168	120	—	185	3640	14
					LB. FT.	LB. FT.	LB. FT.	LB. FT.		LB. FT.	LB. FT.	LB. FT.	LB. FT.		
5/16	18	0.3125	0.0524	3340	17	13	16	19	4720	25	18	22	30	5240	25
	24		0.0580	3700	19	14	17	21	5220	25	20	25	30	5800	27
3/8	16	0.3750	0.0775	4940	30	23	28	35	7000	45	35	40	50	7750	45
	24		0.0878	5600	35	25	32	40	7900	50	35	45	55	8780	50
7/16	14	0.4375	0.1063	6800	50	35	45	55	9550	70	55	63	80	10630	70
	20		0.1187	7550	55	40	50	60	10700	80	60	70	90	11870	75
1/2	13	0.5000	0.1419	9050	75	55	68	85	12750	110	80	96	120	14190	110
	20		0.1599	10700	90	65	80	100	14400	120	90	108	135	15990	115
9/16	12	0.5625	0.1820	11600	110	80	98	120	16400	150	110	139	165	18200	155
	18		0.2030	12950	120	90	109	135	18250	170	130	154	190	20300	165
5/8	11	0.6250	0.2260	14400	150	110	135	165	20350	220	170	180	240	22600	210
	18		0.2560	16300	170	130	153	190	23000	240	180	204	265	25600	220
3/4	10	0.7500	0.3340	21300	260	200	240	285	30100	380	280	301	420	33400	365
	16		0.3730	23800	300	220	268	330	33600	420	320	336	465	37300	400
7/8	9	0.8750	0.4620	29400	430	320	386	475	41600	600	460	485	660	46200	585
	14		0.5090	32400	470	350	425	520	45800	660	500	534	725	50900	635
1	8	1.000	0.6060	38600	640	480	579	675	51500	900	680	687	990	60600	865
	12		0.6630	42200	700	530	633	735	59700	1000	740	796	1100	66300	915
1-1/8	7	1.1250	0.7630	42300	800	600	714	840	68700	1280	960	1030	1400	76300	1240
	12		0.8560	47500	880	660	802	925	77000	1440	1080	1155	1575	85600	1380
1-1/4	7	1.2500	0.9690	53800	1120	840	1009	1175	87200	1820	1360	1453	2000	96900	1750
	12		1.0730	59600	1240	920	1118	1300	96600	2000	1500	1610	2200	107300	1880
1-1/2	6	1.500	1.1550	64100	1460	1100	1322	1525	104000	2380	1780	1907	2625	115500	2320
	12		1.3150	73000	1680	1260	1506	1750	118100	2720	2040	2165	3000	131500	2440
1-1/2	6	1.500	1.4050	78000	1940	1460	1755	2025	126500	3160	2360	2530	3475	140500	3040
	12		1.5800	87700	2200	1640	1974	2300	142200	3560	2660	2844	3925	158000	3270

Note: These torque values do not apply to cadium plated fasteners.

SAE GRADE 5

SAE GRADE 8

Figure 1-2. Torque Chart

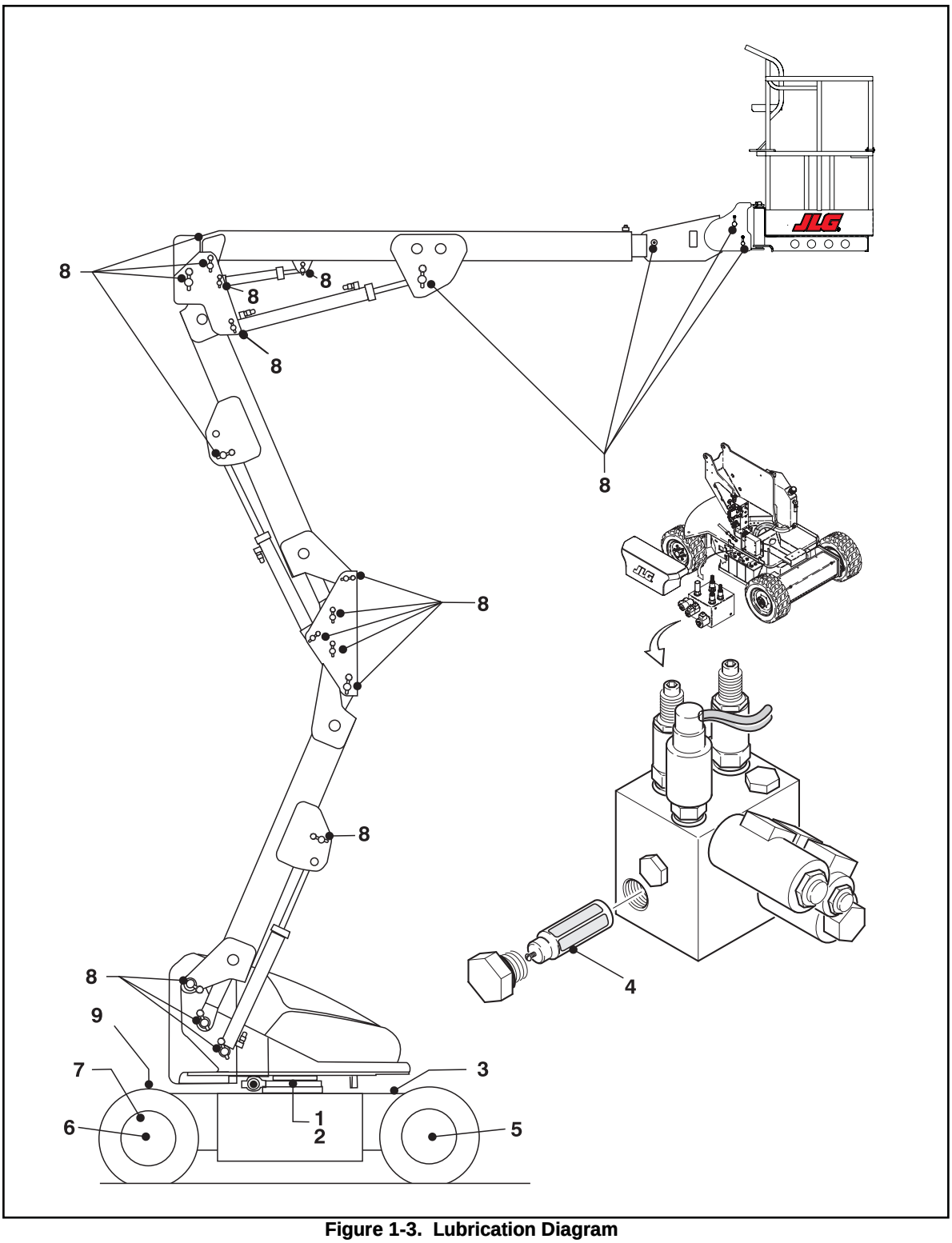


Figure 1-3. Lubrication Diagram

Table 1-8. Lubrication Chart

	Components	Number/Type Lube Points	Capacity	Lube	Interval		Hours		Comments
					3 Months 150 hrs	6 Months 300 hrs	1 Year 600 hrs	2 Years 1200 hrs	
Lubrication									
1	Swing Bearing	1 Grease Fitting or by brush	A/R	MPG	X				More frequent lubrication intervals may be required
2	Swing Bearing / Worm Gear Teeth*	Spray On	A/R	Mobiltac 375NC	X				More frequent lubrication intervals may be required.
3	Hydraulic Fluid (Oil)	Fill Cap	4 Gal. (tank)	HO				X	Check oil every 10 hours of operation. Change oil every 1200 hours of operation.
4	Hydraulic Filter	N/A	N/A	N/A		X			Replace filter element after first 50 hours and every 300 hours thereafter.**
5	Wheel Drive Hub	Fill Plug/Half Full	17 oz. (1/2 Full)	EPGL				X	Check oil level at side plug on hub daily. Change after first 150 hours then every 1200 hours of operation.
6	Wheel Bearing	Repack	A/R	MPG				X	
7	Spindles/Bushing	N/A	A/R	LL	At Spindle/Bushing Replacement				Coat I.D. of bushings prior to installing king pins.
8	Boom Pivot Pins/ Bushing	N/A	A/R	LL	At boom pivot pins/bushing replacement				Coat I.D. of bushings prior to installing pins.
9	Engine	Fill Cap	Refer to Engine Manual	EO					Check daily. Change in accordance with engine manual.

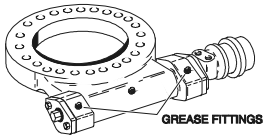
NOTES:

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.

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

⚠ CAUTION

DO NOT OVERGREASE BEARINGS. OVERGREASING BEARINGS WILL RESULT IN BLOWING OUTER SEAL IN HOUSING.



** Under certain conditions, it may be necessary to replace the hydraulic filter on a more frequent basis. A common symptom of a dirty filter is sluggishness experienced in hydraulic functions.

KEY TO LUBRICANTS

EO	Engine Oil
EPGL	Extreme Pressure Gear Lube
HO	Hydraulic Fluid (Mobil DTE-11M)
MPG	Multi-Purpose Grease

SECTION 2. PROCEDURES

2.1 GENERAL

This section provides information necessary to perform maintenance on the aerial platform. Descriptions, techniques and specific procedures are designed to provide the safest and most efficient maintenance for use by personnel responsible for ensuring the correct installation and operation of machine components and systems.

⚠ CAUTION

WHEN AN ABNORMAL CONDITION IS NOTED AND PROCEDURES CONTAINED HEREIN DO NOT SPECIFICALLY RELATE TO THE NOTED IRREGULARITY, WORK SHOULD BE STOPPED AND TECHNICALLY QUALIFIED GUIDANCE OBTAINED BEFORE WORK IS RESUMED.

The maintenance procedures included consist of servicing and component removal and installation, disassembly, and assembly, inspection, lubrication and cleaning. Information on any special tools or test equipment is also provided where applicable.

2.2 SERVICING AND MAINTENANCE GUIDELINES

General

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

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 oil supplies clean; however, these items must be maintained on a scheduled basis in order to function properly.
2. At any time when hydraulic 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.

Component 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 the 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 be installed.
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 that holes in gaskets align with openings in the 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.

Hydraulic Lines and Electrical Wiring

Clearly mark or tag hydraulic lines and electrical wiring, as well as their receptacles, when disconnecting or removing them from the unit. This will assure that 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 the amount, type, and grade of lubricant recommended in this manual, at the specified interval. When recommended lubricants are not available, consult your local supplier for an equivalent that meets or exceeds the specifications listed.

Batteries

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

Lubrication and Servicing

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

2.3 LUBRICATION INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g.; inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc. to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up.
2. The design and manufacturing tolerances of the 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 the 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 at the specified intervals required 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, the 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 the same required additives or be of comparable viscosities. Good grade mineral oils, with viscosities suited to the ambient temperatures in which the machine is operating, are recommended for use.

NOTE: *Metal particles may appear in the 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 Mobil DTE-11 Hydraulic Oil, which has an SAE viscosity of 10W and a viscosity index of 140.

NOTE: *Start-up of hydraulic system with oil temperatures below -20 degrees F. is not recommended. If it is necessary to start the system in a sub-zero environment, it will be necessary to heat the oil with a low density 100VAC heater to a minimum temperature of -20 degrees F.*

Changing Hydraulic Oil

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

Lubrication Specifications

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

2.4 BATTERY MAINTENANCE AND CHARGING

Battery Maintenance, Quarterly

1. Open battery compartment cover to allow access to battery terminals and vent caps.

⚠ CAUTION

WHEN ADDING WATER TO BATTERIES, ADD WATER UNTIL ELECTROLYTE COVERS PLATES. DO NOT CHARGE BATTERIES UNLESS ELECTROLYTE COVERS THE PLATES.

NOTE: *When adding distilled water to batteries, non-metallic containers and/or funnels must be used.*

To avoid electrolyte overflow, add distilled water to batteries after charging.

When adding water to the battery, fill only to level indicated or 3/8" above separators.

2. Remove all vent caps and inspect electrolyte level of each cell. Electrolyte level should be to the ring approximately one inch from top of battery. Fill batteries with distilled water only. Replace and secure all vent caps.
3. Remove battery cables from each battery post one at a time, negative first. Clean cables with acid neutralizing solution (e.g. baking soda and water or ammonia) and wire brush. Replace cables and/or cable clamp bolts as required.
4. Clean battery post with wire brush then re-connect cable to post. Coat non-contact surfaces with mineral grease or petroleum jelly.
5. When all cables and terminal posts have been cleaned, ensure all cables are properly positioned and do not get pinched. Close battery compartment cover.
6. Start hydraulic system and ensure that it functions properly.

Optional On Board Generator

⚠ WARNING

EXHAUST GAS HAZARD. RUN THE GENERATOR IN A WELL VENTILATED AREA ONLY.

⚠ IMPORTANT

WHEN THE GENERATOR ENABLE CONTROL LOCATED IN THE PLATFORM CONTROL BOX IS IN THE ON POSITION AND THE GROUND EMERGENCY STOP SWITCH IS ON (PULLED OUT), THE GENERATOR WILL START AUTOMATICALLY WHEN THE BATTERIES REACH A LOW-CHARGE STATE, AUTOMATICALLY CHARGING THE BATTERIES. THE GENERATOR WILL ALSO AUTOMATICALLY START IF THE GENERATOR START BATTERY IS LOW.

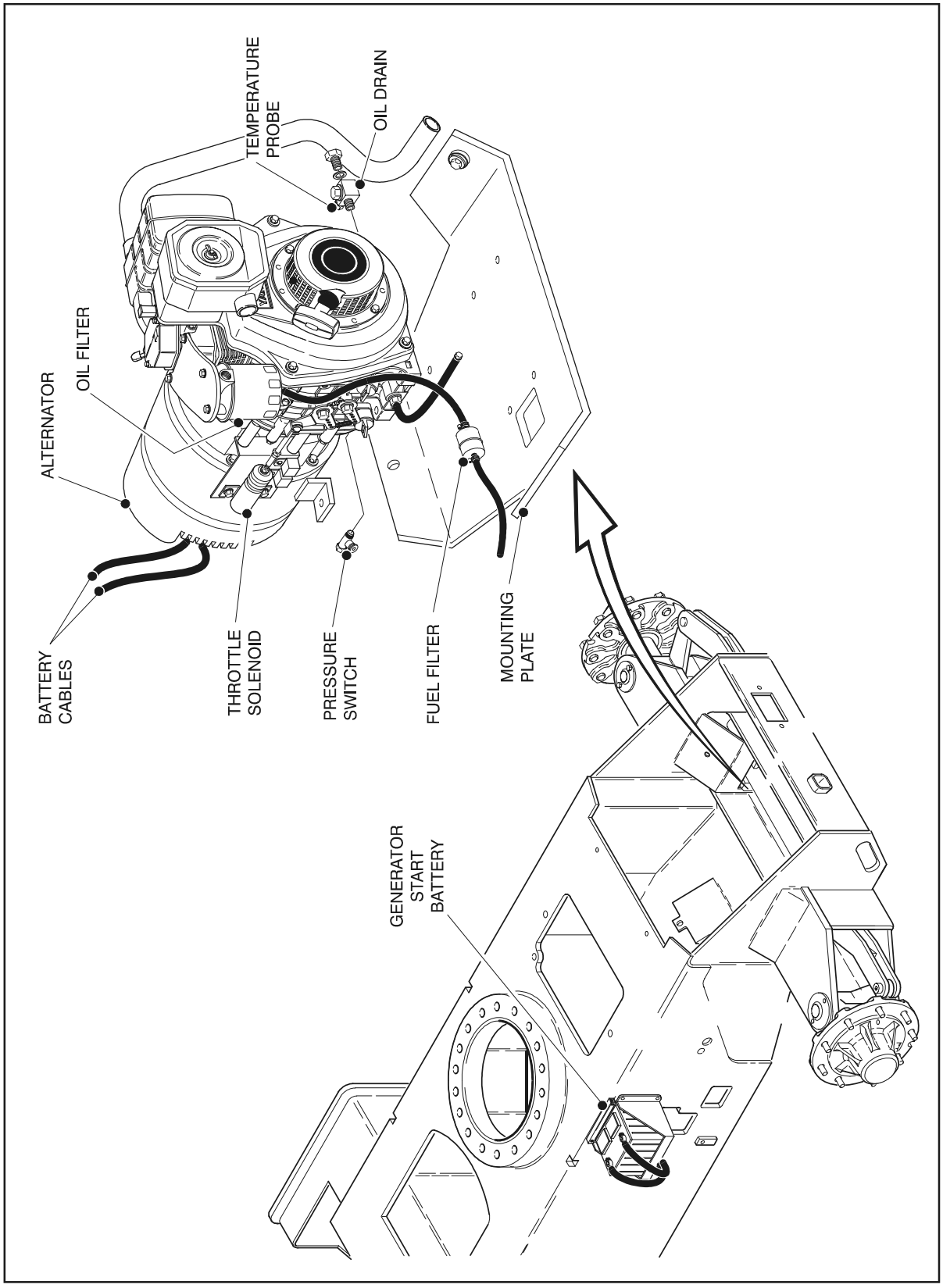


Figure 2-1. On Board Generator

NOTE: *The engine will automatically shut down under the following conditions:*

High Engine Oil Temperature
Low Engine Oil Pressure
Engine Overspeed
Generator Overvoltage
Batteries fully charged

⚠ WARNING

TO AVOID INJURY FROM AN EXPLOSION, DO NOT SMOKE OR ALLOW SPARKS OR A FLAME NEAR BATTERY DURING SERVICING. ALWAYS WEAR EYE AND HAND PROTECTION WHEN SERVICING BATTERIES.

Battery Charging (On Board Charger)

1. For maximum battery life:
   a. Avoid completely discharging the batteries.
   b. Fully charge the batteries each day the machine is used.
   c. Charge the batteries at available times between charging.
   d. Be sure the battery fluid covers the battery plates before charging, but to avoid overflow, do not top off the fluid level until charging.
2. To charge the batteries, connect the charger to a 115 volt source with a 15 amp minimum capacity.
3. The Charger will shut off automatically when the batteries are fully charged.
4. The charge cycle is complete when the ammeter reads 0 amps. Any reading indicates the charge cycle is not complete.
5. Depleted batteries will take approximately 17 hours to charge.

2.5 CYLINDERS - THEORY OF OPERATION

Upper Boom Lift, Mid Boom Lift, Lower Boom Lift, Telescope, Slave, Master, Rotator, and Steer

A double acting cylinder is one that requires oil flow to operate the cylinder rod in both directions. Directing oil (by actuating the corresponding control valve to the piston side of the cylinder) forces the piston to travel toward the rod end of the barrel, extending the cylinder rod (piston attached to rod). When the oil flow is stopped, movement of the rod will stop. By directing oil to the rod side of the cylinder, the piston will be forced in the opposite direction and the cylinder rod will retract.

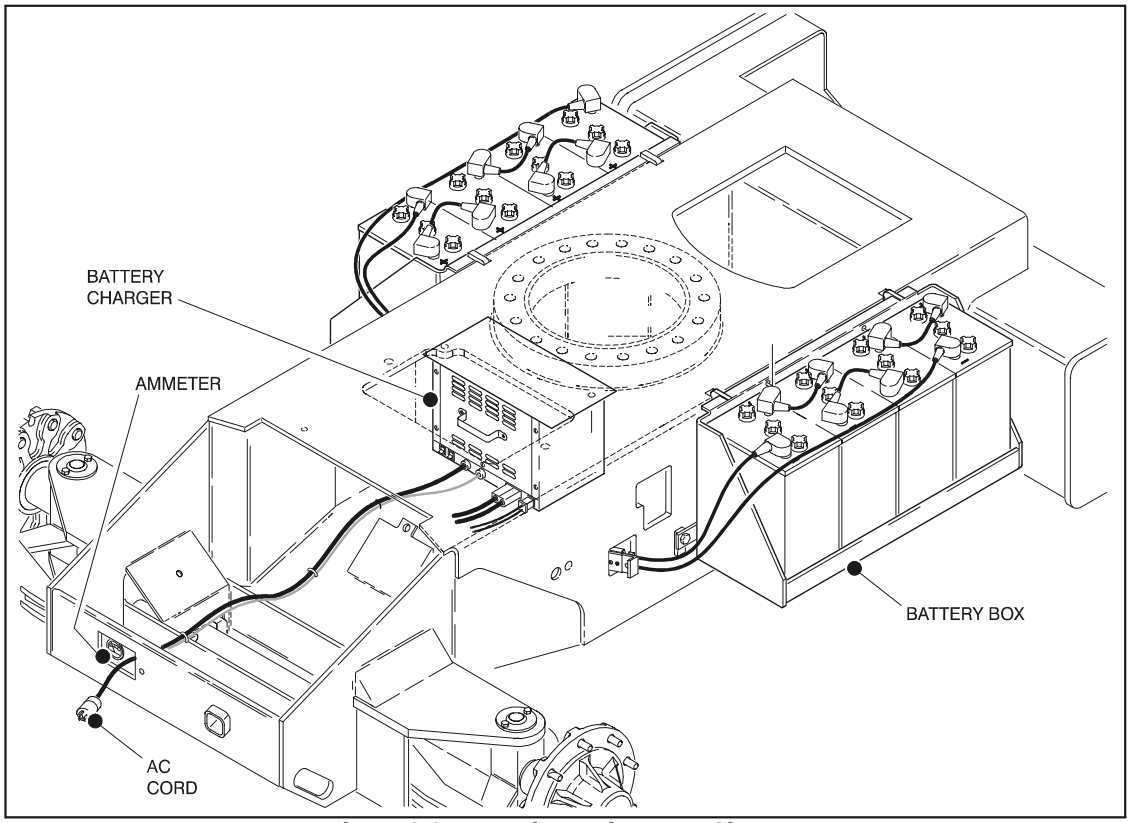


Figure 2-2. Batteries and Battery Charger

Holding valves are used in the Lift circuits to prevent retraction of the cylinder rod should a hydraulic line rupture or leak develop between the cylinder and its related control valve.

2.6 CYLINDER CHECKING PROCEDURES

NOTE: *Cylinder checks must be performed any time a cylinder component is replaced or when improper system operation is suspected.*

Cylinder Without Counterbalance Valves (Steer, Master, and Rotate)

1. Using all applicable safety precautions, activate hydraulic system and fully extend cylinder to be checked. Shut down hydraulic system.
2. 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.
3. Activate hydraulic system, and activate cylinder extend function.
4. If cylinder retract port leakage is less than 6-8 drops per minute, carefully reconnect hose to retract port and retract cylinder. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repairs must be made.
5. With cylinder fully retracted, shut down motor and carefully disconnect hydraulic hose from cylinder extend port.
6. Activate hydraulic system and activate cylinder retract function. Check extend port for leakage.
7. If extend port leakage is less than 6-8 drops per minute, carefully reconnect hose to extend port, then activate cylinder through one complete cycle and check for leaks. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repairs must be made.

Cylinders With Single Counterbalance Valve (Upper Lift Cylinder)

⚠ IMPORTANT

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

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

⚠ WARNING

WHEN WORKING ON THE UPPER BOOM LIFT CYLINDER RAISE THE UPPER BOOM TO HORIZONTAL AND PLACE A BOOM PROP APPROXIMATELY 1 INCH (2.54 CM) BELOW THE MAIN BOOM. IF WORKING ON LOWER BOOM LIFT CYLINDER, RAISE LOWER BOOM HALFWAY, FULLY ELEVATE UPPER BOOM AND ATTACH OVERHEAD CRANE TO THE UPRIGHT FOR SUPPORT, LEAVING APPROXIMATELY 1 INCH (2.54 CM) OF SLACK IN CHAIN OR SLING FOR TEST PURPOSES.

2. After completing the above, shut down hydraulic system and allow machine to sit for 10-15 minutes. This is done to relieve pressure in the hydraulic lines. Carefully remove hydraulic hoses from appropriate cylinder port block.
3. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should not be any further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, the following cylinder repairs must be made. If the retract port is leaking, the piston is leaking, the piston seals are defective and must be replaced. If the extend port is leaking, the counterbalance is defective and must be replaced.
4. If no repairs are necessary or when repairs have been made, carefully reconnect hydraulic hoses to the appropriate ports.
5. Remove boom prop/overhead crane, activate hydraulic system and run cylinder through complete cycle to check for leaks and operation.

Cylinders With Dual Counterbalance Valve (Lower Lift, Mid Lift, Telescope, and Slave Cylinders)

⚠ IMPORTANT

OPERATE ALL FUNCTIONS FROM GROUND CONTROL STATION ONLY.

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

⚠ WARNING

WHEN WORKING ON THE UPPER BOOM LIFT CYLINDER RAISE THE UPPER BOOM TO HORIZONTAL AND PLACE A BOOM PROP APPROXIMATELY 1 INCH (2.54 CM) BELOW THE MAIN BOOM. IF WORKING ON LOWER BOOM LIFT CYLINDER, RAISE LOWER BOOM HALFWAY, FULLY ELEVATE UPPER BOOM AND ATTACH OVERHEAD CRANE TO THE UPRIGHT FOR SUPPORT, LEAVING APPROXIMATELY 1 INCH (2.54 CM) OF SLACK IN CHAIN OR SLING FOR TEST PURPOSES.

2. When working on the platform slave cylinder, stroke platform slave level cylinder forward until platform sits at a 45 degree angle.
3. After completing the above, shut down hydraulic system and allow machine to sit for 10-15 minutes. This is done to relieve pressure in the hydraulic lines. Carefully remove hydraulic hoses from appropriate cylinder port block.
4. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should not be any further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, the following cylinder repairs must be made. If the retract port is leaking, the piston is leaking, the piston seals are defective and must be replaced. If the extend port is leaking, the counterbalance is defective and must be replaced.
5. To check piston seals, carefully remove the counterbalance valve from the retract port. After initial discharge there should not be any further leakage from the ports. If leakage occurs at a rate of 6-8 drops per minute or more, the piston seals are defective and must be replaced.
6. If no repairs are necessary or when repairs have been made, carefully reconnect hydraulic hoses to the appropriate ports.
7. Remove boom prop/overhead crane, activate hydraulic system and run cylinder through complete cycle to check for leaks and operation.

2.7 CYLINDER REPAIR

NOTE: *The following are general procedures that apply to all of the cylinders on this machine. Procedures that apply to a specific cylinder will be so noted.*

Disassembly

⚠ IMPORTANT

DISASSEMBLY OF THE CYLINDER SHOULD BE PERFORMED ON A CLEAN WORK SURFACE IN A DIRT FREE WORK AREA.

1. Connect a suitable auxiliary hydraulic power source to the cylinder port block fitting.

⚠ WARNING

DO NOT FULLY EXTEND CYLINDER TO THE END OF STROKE. RETRACT CYLINDER SLIGHTLY TO AVOID TRAPPING PRESSURE.

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.
3. If applicable, remove the cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

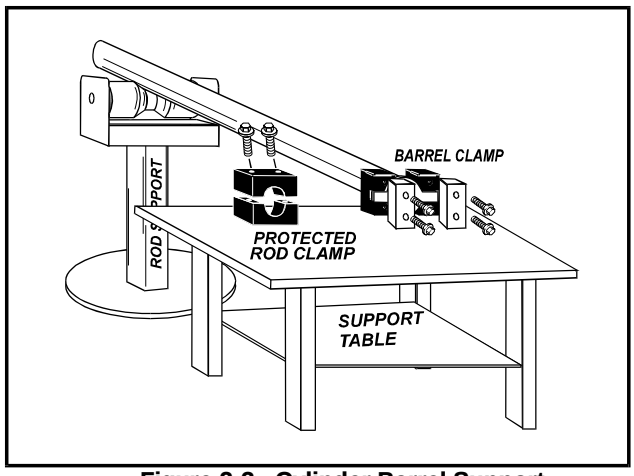


Figure 2-3. Cylinder Barrel Support

5. Mark cylinder head and barrel with a center punch for easy realignment. Using an allen wrench, loosen the cylinder head retainer cap screws, and remove cap screws from cylinder barrel.

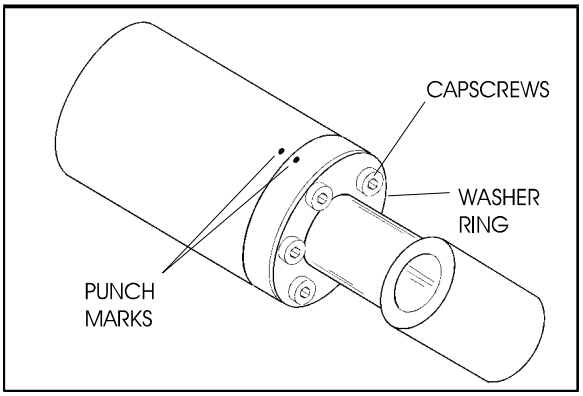


Figure 2-4. Capscrew Removal

NOTE: *Steps 6 applies only to the lower lift and telescope cylinders.*

6. Using a spanner wrench, loosen the end cap or head retainer, and remove from cylinder barrel.
7. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

⚠ IMPORTANT

EXTREME CARE SHOULD BE TAKEN WHEN REMOVING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

8. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.

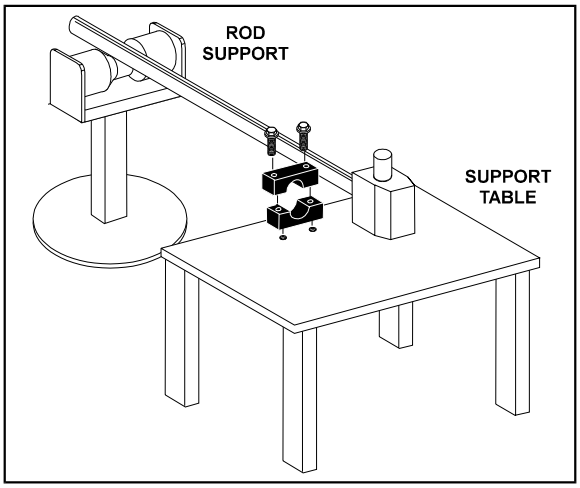


Figure 2-5. Cylinder Rod Support

9. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
10. Loosen and remove the cap screw(s), if applicable, which attach the tapered bushing to the piston.
11. Insert the cap screw(s) in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the cap screw(s) until the bushing is loose on the piston.
12. Remove the bushing from the piston.

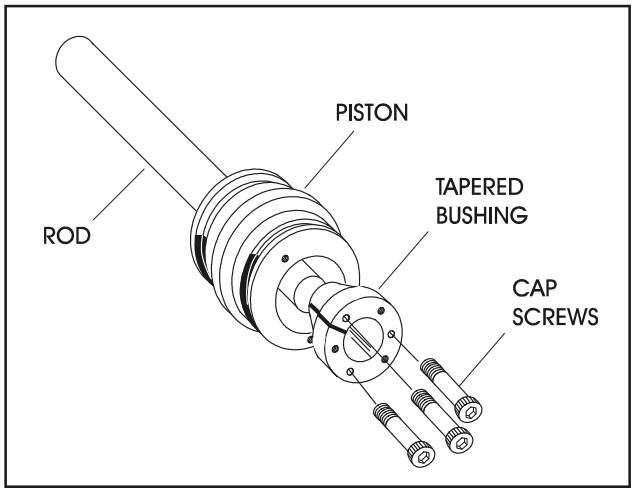


Figure 2-6. Tapered Bushing Removal

13. Screw the piston CCW, by hand, and remove the piston from cylinder rod.
14. Remove and discard the piston o-rings, seal rings, and backup rings.
15. Remove piston spacer, if applicable, from the rod.
16. Remove the rod from the holding fixture. Remove the cylinder head gland and retainer plate, if applicable. Discard the o-rings, back-up rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect threaded portion of piston for damage. Dress threads as necessary.
8. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.

9. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
10. Inspect threaded portion of head for damage. Dress threads as necessary.
11. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
12. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
13. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of the steel bushing with WD40 prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

NOTE: *Install pin into the Gar-Max bearing dry. Lubrication is not required with nickel plated pins and bearings.*

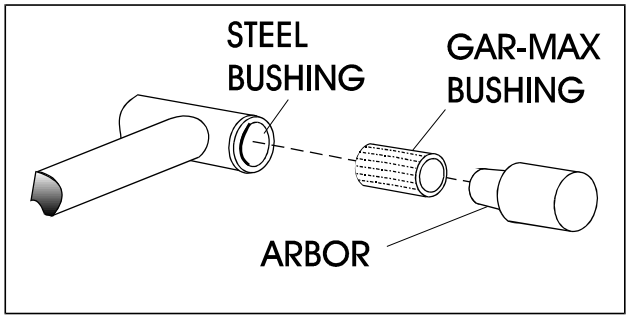


Figure 2-7. Gar-Max Bearing Installation

14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. See your JLG Parts Manual.*

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

1. A special tool is used to install a new rod seal into the applicable cylinder head gland groove.

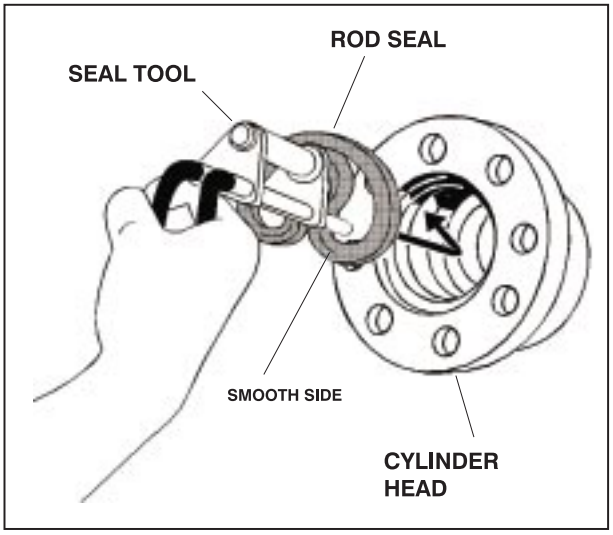


Figure 2-8. Rod Seal Installation

⚠ IMPORTANT

WHEN INSTALLING "POLY-PAK" PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO WIPER SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

2. Use a soft mallet to tap a new wiper seal into the applicable cylinder head gland groove. Install a new wear ring into the applicable cylinder head gland groove.

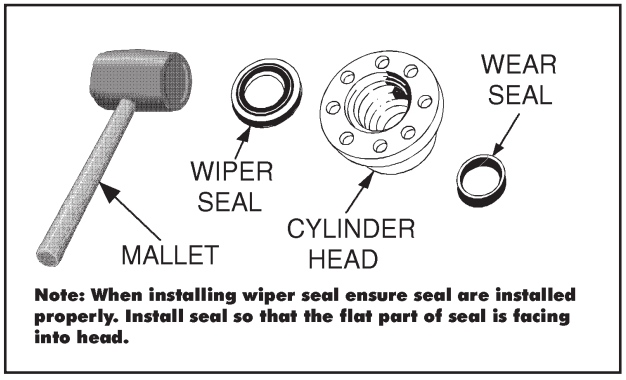


Figure 2-9. Wiper Seal Installation

3. Place a new o-ring and back-up seal in the applicable outside diameter groove of the cylinder head.

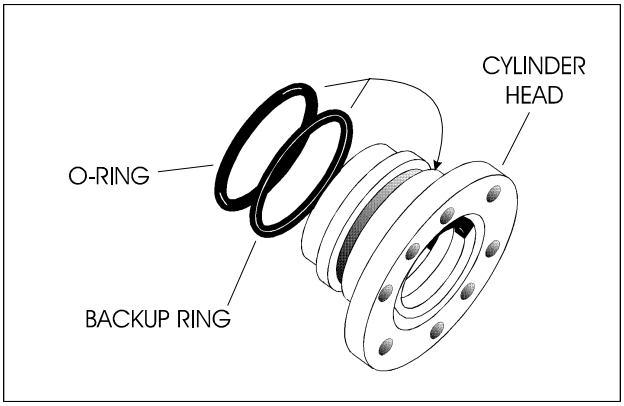


Figure 2-10. Installation of Head Seal Kit

4. Install washer ring onto rod, carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Carefully slide the piston spacer on the rod.
6. If applicable, correctly place new o-ring in the inner piston diameter groove. (The backup ring side facing the O-ring is grooved.)
7. If applicable, correctly place new seals and guide lock rings in the outer piston diameter groove. (A tube, with I.D. slightly larger than the O.D.of the piston is recommended to install the solid seal.)

NOTE: *The backup rings for the solid seal have a radius on one side. This side faces the solid seal.(See magnified insert in Figure 2-11.)The split of seals and backup rings are to be positioned so as not to be in alignment with each other.*

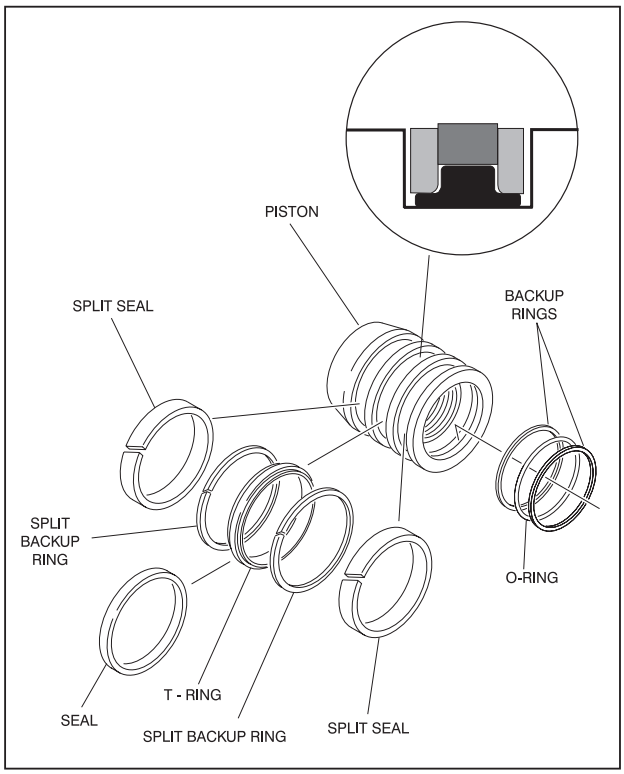


Figure 2-11. Piston Seal Kit Installation

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
9. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and back-up rings are not damaged or dislodged.
10. Thread piston onto rod until it abuts the spacer end and install the tapered bushing.

NOTE: *When installing the tapered bushing, piston and mating end of rod must be free of oil.*

⚠ WARNING

WHEN REBUILDING THE STEER, LOWER LIFT, LEVEL CYLINDER, OR UPPER LIFT CYLINDER, APPLY LOCTITE #242 TO TAPERED BUSHING BOLTS, THEN TIGHTEN SECURELY.

11. Assemble the tapered bushing loosely into the piston and insert JLG capscrews (not vendor capscrews) through the drilled holes in the bushing and into the tapped holes in the piston.

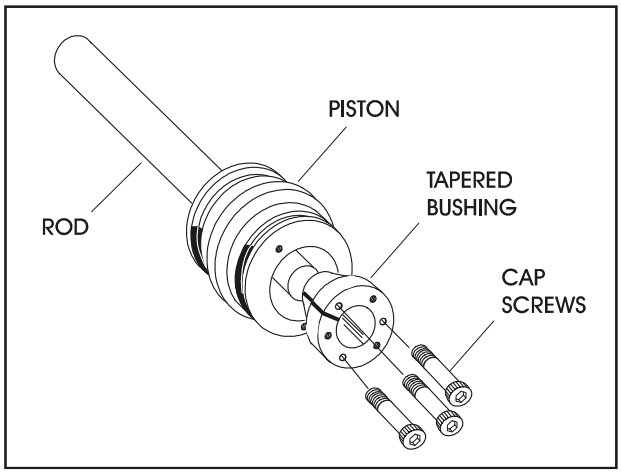


Figure 2-12. Tapered Bushing Installation

12. Tighten the capscrews evenly and progressively in rotation to the specified torque value. (See Table 2-1, Cylinder Head and Tapered Bushing Torque Specifications.)
13. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;
    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.
    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

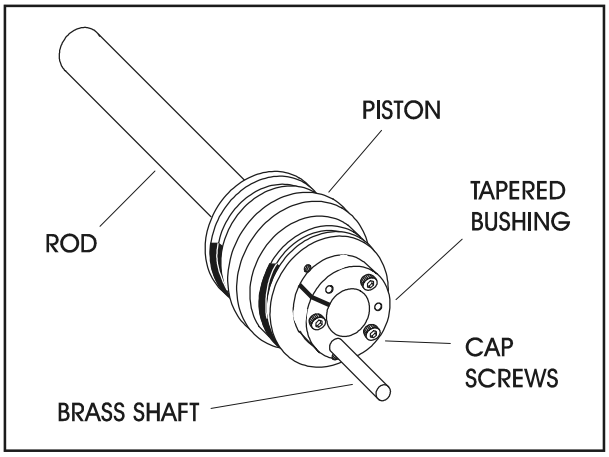


Figure 2-13. Seating the Tapered Bearing

14. Retorque the capscrews evenly and progressively in rotation to the specified torque value. (See Table 2-1, Cylinder Head and Tapered Bushing Torque Specifications.)
15. Remove the cylinder rod from the holding fixture.
16. Place new guide locks and seals in the applicable outside diameter grooves of the cylinder piston. (See Figure 2-11., Piston Seal Kit Installation)

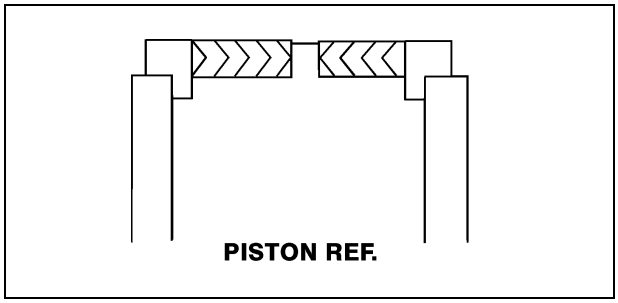


Figure 2-14. Poly-Pak Piston Seal Installation

17. Position the cylinder barrel in a suitable holding fixture.

⚠ IMPORTANT

EXTREME CARE SHOULD BE TAKEN WHEN INSTALLING THE CYLINDER ROD, HEAD, AND PISTON. AVOID PULLING THE ROD OFF-CENTER, WHICH COULD CAUSE DAMAGE TO THE PISTON AND CYLINDER BARREL SURFACES.

18. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.

19. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

20. Secure the cylinder head gland using the washer ring and socket head bolts.

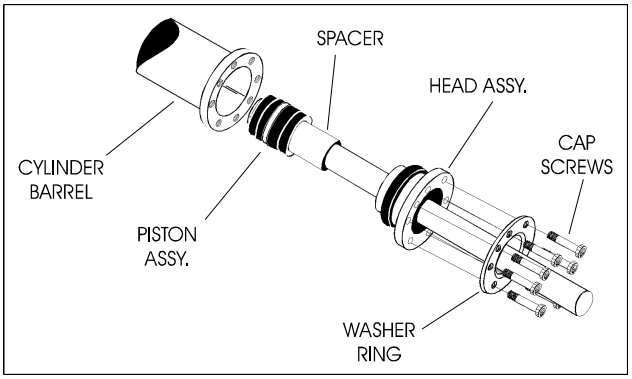


Figure 2-15. Rod Assembly Installation

21. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.

22. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. (See Table 2-3, Holding Valve Torque Specifications).

⚠ CAUTION

IF THE CYLINDER IS TO BE TESTED PRIOR TO INSTALLATION ON THE MACHINE, EXTREME CARE SHOULD BE USED TO INSURE THAT THE OUTER END OF THE ROD IS SUPPORTED. USE EITHER A TRAVELING OVERHEAD HOIST, FORK-LIFT, OR OTHER MEANS TO SUPPORT THE OVERHANGING WEIGHT OF THE EXTENDING ROD.

Table 2-1.Cylinder Head and Tapered Bushing Torque Specifications

Description	Head Torque Value (Wet)	Tapered Bushing Torque Value (Wet)
E.A.R. Cylinder	30 ft. lbs (41 Nm)	5 ft. lbs. (7 Nm)
Level Cylinder (M45AJ)	30 ft. lbs (41 Nm)	5 ft. lbs. (7 Nm)
Master Cylinder (M45AJ)	30 ft. lbs. (41 Nm)	5 ft. lbs. (7 Nm)

Table 2-2. Cylinder Piston Nut Torque Specifications)

Description	Nut Torque Valve (Wet)	Setscrew Torque Value (Dry)
Upper Lift Cylinder	200 ft. lbs. (270 Nm)	100 in. lbs. (11 Nm)
Mid Lift Cylinder	400 ft. lbs. (542 Nm)	100 in. lbs. (11 Nm)
Lower Lift Cylinder	400 ft. lbs. (542 Nm)	100 in. lbs. (11 Nm)
Level Cylinder (M45 A)	80 ft. lbs. (108 Nm)	100 in. lbs. (11 Nm)
Master Cylinder (M45A)	80 ft. lbs. (108 Nm)	100 in. lbs. (11 Nm)

Table 2-3. Holding Valve Torque Specifications

Description	Torque Value
SUN - 7/8 HEX M20 X 1.5 THDS.	30-35 ft. lbs. (41-48 Nm)
SUN - 1 1/8 HEX 1 -14 UNS THDS.	45-50 ft. lbs. (61-68 Nm)
SUN - 1 1/4 HEX M36 X 2 THDS.	150-160 ft. lbs. (204-217 Nm)
RACINE - 1 1/8 HEX 1 1/16 - 12 THDS.	50-55 ft. lbs. (68-75 Nm)
RACINE - 1 3/8 HEX 1 3/16 - 12 THDS.	75-80 ft. lbs. (102-109 Nm)
RACINE - 1 7/8 HEX 1 5/8 - 12 THDS.	100-110 ft. lbs. (136-149 Nm)

2.8 CYLINDER REMOVAL AND INSTALLATION

Upper (Main) Boom Lift Cylinder Removal

1. Place the machine on a flat and level surface. Place the Upper Boom in a horizontal position. Place Lower and Mid Booms 5 degree above horizontal. Shut down machine and prop boom.
2. Tag, disconnect and cap the upper boom lift cylinder hydraulic lines and ports.
3. Remove the hardware securing the cylinder rod attach pin #1 to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin #1.

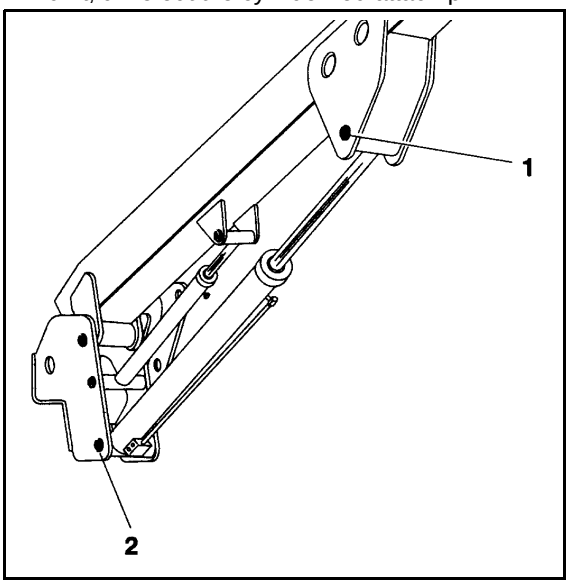


Figure 2-16. Upper Boom Lift Cylinder Removal

4. Secure the cylinder with suitable slings or supports as required. Remove the hardware securing the barrel end attach pin #2. Using a suitable brass drift, drive out the barrel end attach pin #2.
5. Remove the cylinder from the boom and place in a suitable work area.

Upper (Main) Boom Lift Cylinder Installation

NOTE: *Coat I.D. of bushings with specified lubricant prior to installing pins.*

1. Install Lift Cylinder in place using suitable slings or supports, aligning attach pin mounting holes on upright.
2. Using a suitable drift, drive the barrel end attach pin #2 through the mounting holes in the lift cylinder and upright. Secure in place with pin retaining hardware.
3. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.
4. With function speed switch at its slowest setting, extend the cylinder rod until attach pin hole aligns with those in boom. Using a suitable drift, drive the cylinder rod attach pin #1 through the aligned holes. Secure the pin in place with pin retaining hardware.
5. Cycle cylinder completely to check for proper functioning. Place boom in stowed position. Check hydraulic fluid level and adjust accordingly.

Mid Boom Lift Cylinder Removal

1. Place machine on flat and level surface. Place the Upper Boom in a horizontal position. Place the Mid Boom in a 10 degree elevated position. Support Upper Boom with a prop. Support upright with an overhead crane.
2. Using slings, restrain the lower lift cylinder.
3. Remove the hardware securing the cylinder rod attach pin #3 to the boom. Using an appropriate brass drift, drive out the cylinder rod attach pin #3.

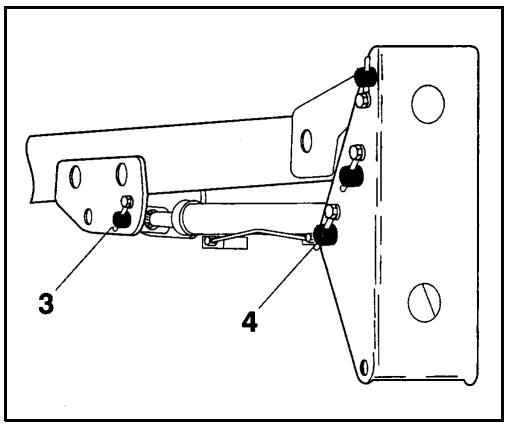


Figure 2-17. Mid Boom Lift Cylinder Removal

4. Tag, disconnect and cap the lift cylinder hydraulic lines and ports.
5. Remove the hardware securing the barrel end attach pin #4 to the boom. Using an appropriate brass drift, drive out the cylinder barrel pin #4.
6. Carefully remove cylinder from boom. Place in a suitable work area.

Mid Boom Lift Cylinder Installation.

NOTE: *Coat I.D. of bushings with specified lubricant prior to installing pins.*

1. With the booms positioned and supported, place cylinder in position and secure in place using slings.
2. Install the cylinder barrel pin #4, being sure to align the hole in the cylinder barrel pin with the retaining pin screw hole. When holes align, install hardware.
3. Correctly install hydraulic lines to cylinder as previously tagged. Extend cylinder rod slowly until attach pin hole aligns with those in boom.
4. Using a suitable brass drift, drive the cylinder rod attach pin #3 through the aligned holes. Secure the pin in place using retaining hardware.
5. Remove boom prop and overhead crane. Take the lift cylinder through one complete cycle to assure correct functioning. Place boom in stowed position. Check hydraulic fluid and adjust accordingly.

Lower Boom Lift Cylinder Removal

1. Place machine on flat and level surface. Place the Upper Boom in a horizontal position. Place the Mid and Lower Booms in a 10 degree elevated position. Support Upper Boom with a prop. Support upright with an overhead crane.
2. Using slings, restrain the lower lift cylinder.
3. Remove the hardware securing the cylinder rod attach pin #5 to the boom. Using an appropriate brass drift, drive out the cylinder rod attach pin #5.

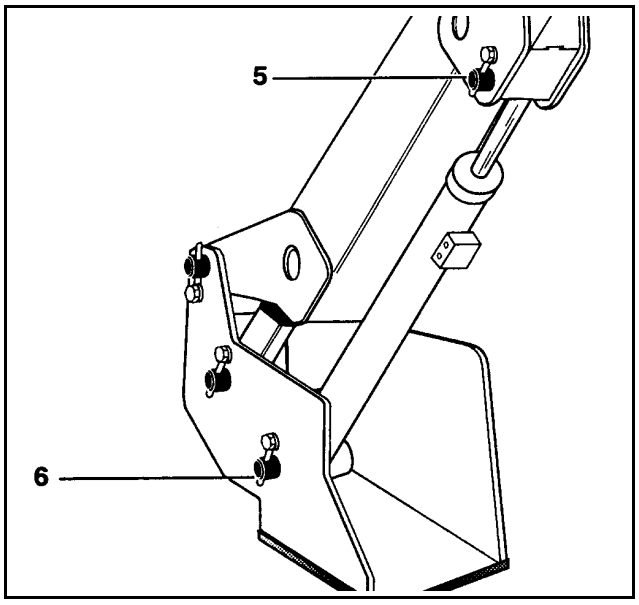


Figure 2-18. Lower Boom Lift Cylinder Removal

4. Tag, disconnect and cap the lift cylinder hydraulic lines and ports.
5. Remove the hardware securing the barrel end attach pin #6 to the boom. Using an appropriate brass drift, drive out the cylinder barrel pin #6.
6. Carefully remove cylinder from boom. Place in a suitable work area.

Lower Boom Lift Cylinder Installation

NOTE: *Coat I.D. of bushings with specified lubricant prior to installing pins.*

1. With the booms positioned and supported, place cylinder in position and secure in place using slings.
2. Install the cylinder barrel pin #6, being sure to align the hole in the cylinder barrel pin with the retaining pin screw hole. When holes align, install hardware.
3. Correctly install hydraulic lines to cylinder as previously tagged. Extend cylinder rod slowly until attach pin hole aligns with those in boom.
4. Using a suitable brass drift, drive the cylinder rod attach pin #5 through the aligned holes. Secure the pin in place using retaining hardware.
5. Remove boom prop and overhead crane. Take the lift cylinder through one complete cycle to assure correct functioning. Place boom in stowed position. Check hydraulic fluid and adjust accordingly.

Upper Boom Telescope Cylinder Removal

1. Place machine on flat and level surface, with Upper Boom in the horizontal position. Extend Upper Boom until fly attach pin #1 is accessible on fly.

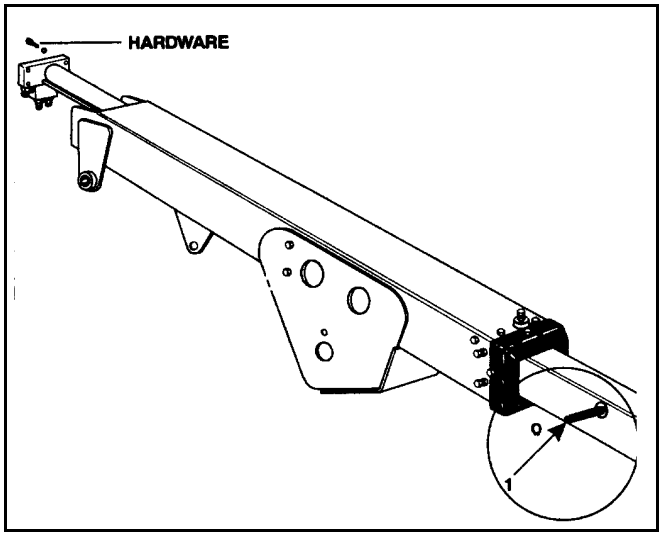


Figure 2-19. Upper Telescope Cylinder Removal

2. Support Upper Boom basket end with a prop. Support Upper Upright end with an overhead crane.
3. Tag, disconnect hydraulic lines to telescope cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
4. Remove the retaining rings that retain the telescope cylinder rod to the fly boom.
5. Using a suitable brass drift, carefully drive the telescope cylinder rod pin #1 from the fly boom.
6. Remove the four (4) bolts securing the telescope cylinder barrel end to the base boom.

NOTE: *Care should be taken when removing the telescope cylinder, do not leave cylinder rest on powertrack which could cause damage to powertrack.*

7. Using a suitable brass drift, carefully drive the telescope cylinder pin from the base boom.
8. Attach a suitable sling to the telescope cylinder. Using a suitable lifting device attached to the sling carefully pull the telescope cylinder from the boom assembly.
9. Using another lifting device, support the rod end of the cylinder and remove the cylinder from the boom assembly.
10. Carefully lift the cylinder clear of the boom assembly and lower to the ground or suitably supported work area.

Upper Boom Telescope Cylinder Installation

1. Attach a hydraulic power supply to the telescope cylinder ports. Using suitable supports or lifting devices at each end of the cylinder, extend the rod so that the cylinder pin attach holes are the same distance apart as the boom pin attach holes.
2. Using suitable lifting equipment, carefully lower the cylinder to the boom assembly.
3. Using another lifting device, support the rod end of the cylinder and install the cylinder into the boom assembly.
4. Remove lifting devices from the telescope cylinder.
5. Carefully install the telescope cylinder rod pin #1 through the fly boom and secure it with the retaining rings.
6. Carefully install the telescope cylinder barrel end to base, securing cylinder to the base boom with four (4) bolts and hardware.
7. Remove applicable hydraulic line and port caps and correctly connect the hydraulic lines to the telescope cylinder. Ensure all hoses are correctly routed.
8. Remove boom prop and overhead crane. Activate hydraulic system.
9. Using all applicable safety precautions, operate the boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
10. Check fluid level of hydraulic tank and add as necessary.

2.9 WEAR PADS

1. Shim up wear pads until snug to adjacent surface.
2. Replace wear pads when worn to thickness shown below.

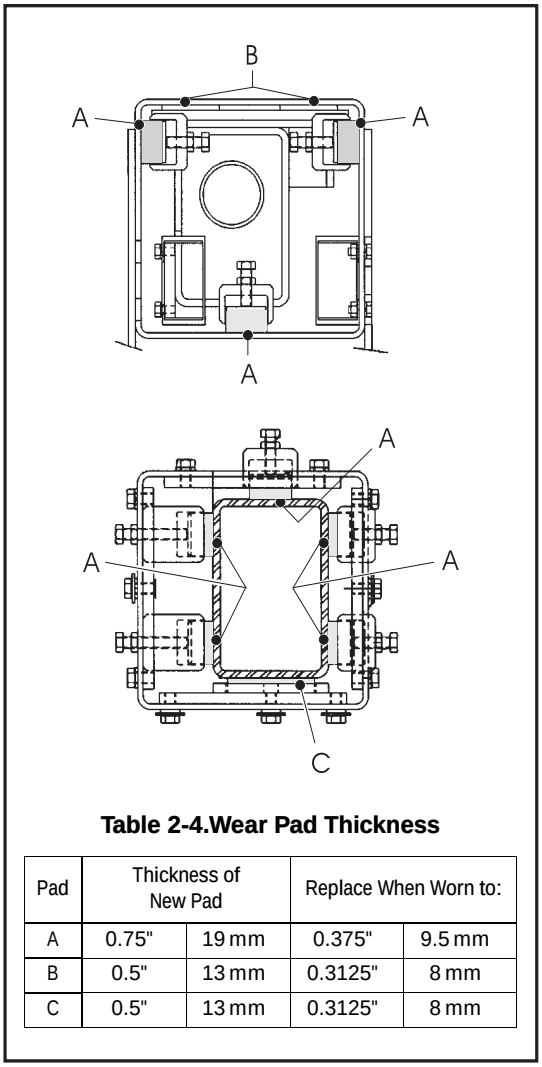


Table 2-4.Wear Pad Thickness

Pad	Thickness of New Pad		Replace When Worn to:	
A	0.75"	19 mm	0.375"	9.5 mm
B	0.5"	13 mm	0.3125"	8 mm
C	0.5"	13 mm	0.3125"	8 mm

Figure 2-20. Wear Pad Thickness

3. Adjust wear pads as follows:
   a. Loosen jam nut on adjustment bolt, turn bolt CW until wear pad is snug to adjacent surface.
   b. After adjustments have been made, tighten the jam nuts on wear pad bolts.

2.10 BOOM MAINTENANCE

Removal

1. Remove the platform/support as follows:
   a. Disconnect electrical cable from control console.
   b. Using an overhead crane or suitable lifting device, strap support the platform/support.
   c. Remove hardware from pin #1. Using a suitable brass drift and hammer, remove pin #1 from the platform support.
   d. Supporting the platform/support, remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 from the fly boom and remove the rotator.
   e. Supporting the slave cylinder, remove the hardware from pin #3. Using a suitable brass drift and hammer, remove pin #3 from the fly boom.
   f. Tag and disconnect hydraulic lines to the slave leveling cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports. Remove the slave cylinder.
2. Remove the boom from upright as follows:
   a. Remove hardware securing the cover plate on the side of the base boom section and remove hose clamps. Disconnect wiring harness from ground control harness connector.

⚠ CAUTION

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

   b. Tag and disconnect hydraulic lines from boom to control valve. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
   c. Using a suitable lifting equipment, adequately support boom weight along entire length.

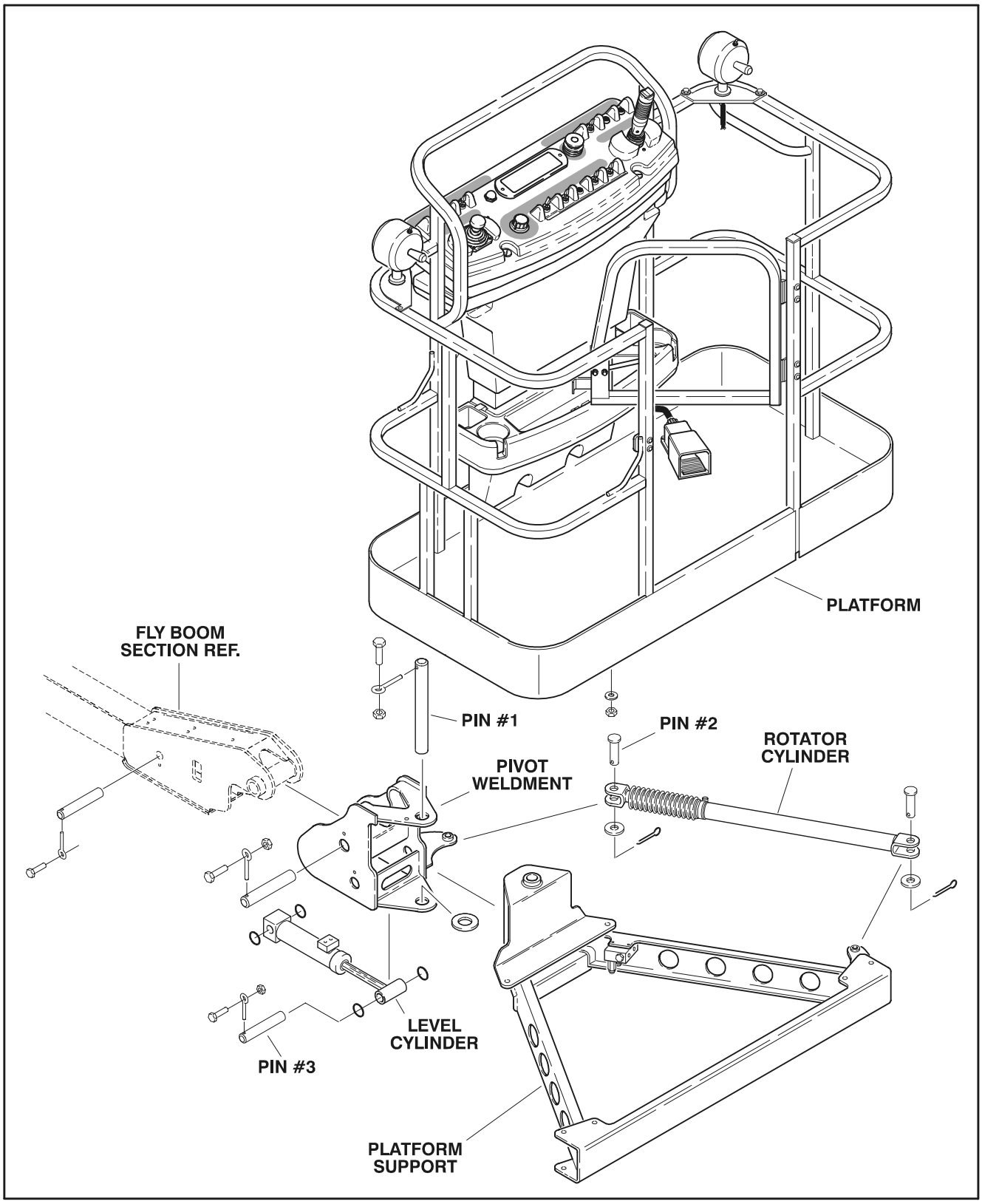


Figure 2-21. Platform Components and Attaching Hardware (M45A & E45A)

d. Remove hardware securing the lift cylinder pin #1. Using a suitable brass drift and hammer, remove pin #1 from the base boom.

e. Remove hardware securing the master cylinder pin #2. Using a suitable brass drift and hammer, remove pin #2 from the base boom.

f. Remove hardware securing the base boom pin #3. Using a suitable brass drift and hammer, remove pin #3 from the upright.

g. Using all applicable safety precautions, carefully lift boom assembly clear of upright and lower to ground or suitable supported work surface.

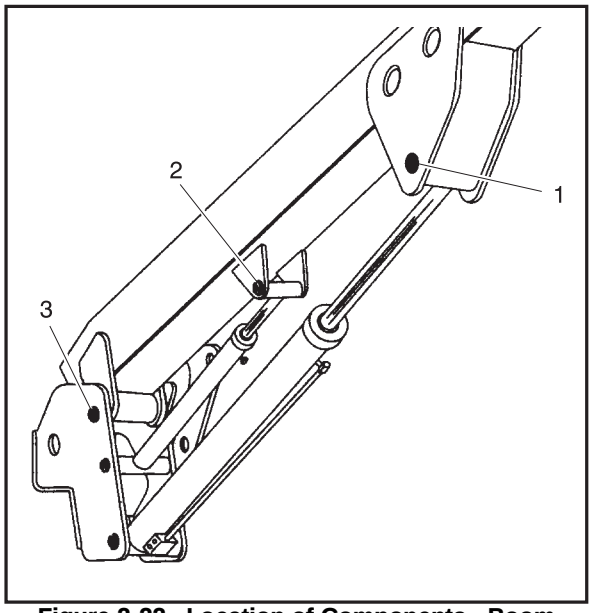


Figure 2-22. Location of Components - Boom Removal

Disassembly Boom Sections

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 pin #1. 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 #1 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 LET 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 cover on base boom section.
9. Loosen jam nuts on front wear pad adjustments and loosen adjustments.
10. Remove hardware securing the front wear pads on base boom section, remove wear pads.
11. Remove wire clamp on the inside of the fly nose.
12. Manually push the fly boom section into base boom section to gain access to the powertrack attachment bolts on the right side of the base boom section.
13. Remove hardware securing the powertrack to the aft end of the fly boom section.
14. Using a suitable lifting device, remove fly boom from boom section.
15. Remove hydraulic lines and electrical cables from powertrack.
16. Remove hardware securing powertrack to the base boom section. Remove powertrack.

Inspection

1. Inspect boom pivot pin for wear, scoring or other damage, and for tapering or ovality. Replace pin as necessary.
2. Inspect lift and master cylinder pins for wear, scoring or other damage, and for 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 as shown in Section 2.9, Wear Pads.
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.

Assembly

1. Install power track to the attach point on the inside of the base boom section. Secure power track with 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 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. 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. 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.

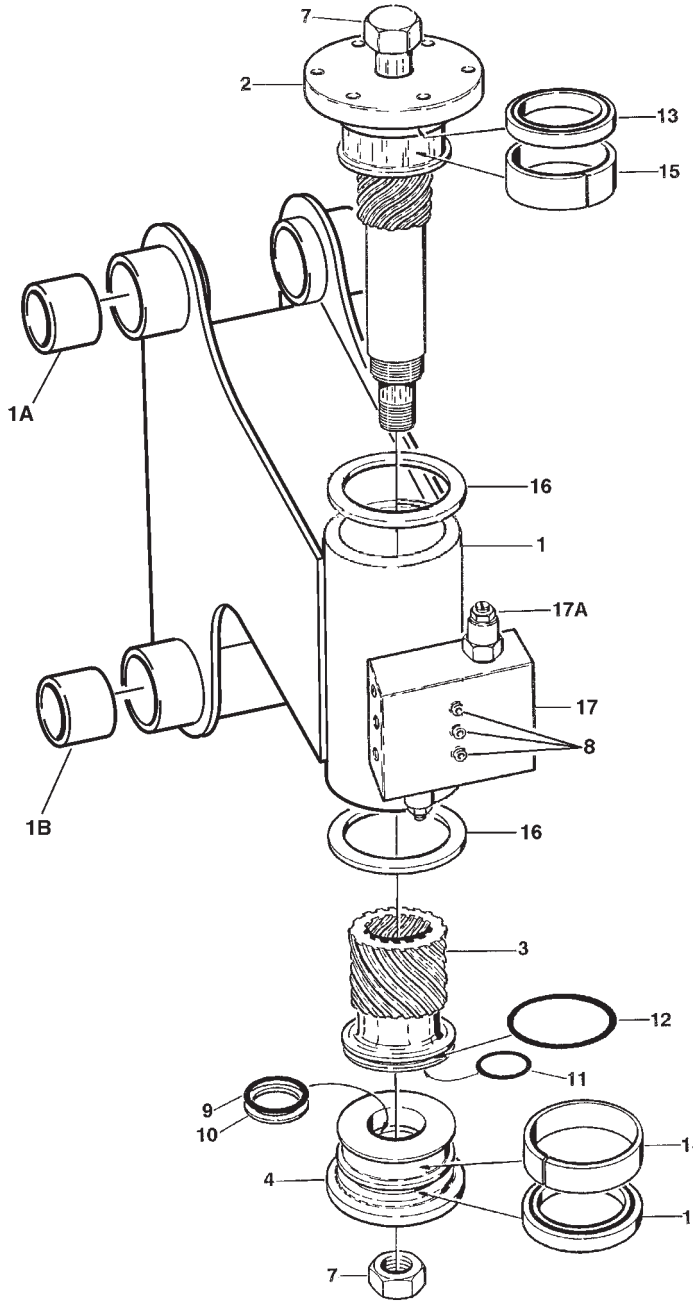
Installation

1. Using suitable lifting equipment, position boom assembly on upright so that boom pivot holes in both boom and upright 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 and master cylinders so that holes in cylinder rod ends and boom structure are aligned. 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 slave leveling cylinder to the boom assembly.
7. Install the platform to the boom assembly.
8. Connect all hosing and wiring at platform control station.
9. Using all safety precautions, operate machine systems and extend and retract boom for four or five cycles.
10. Shut down machine systems and check for leakage.

2.11 ROTATOR - HELAC

Disassembly

1. Place actuator on a clean workbench.
2. Remove all hydraulic fittings.
3. Remove the nut from the bottom of the tie rod assembly.



1. Case
1A. Garmax Bushing
1B. Garmax Bushing
2. Shaft
3. Piston Sleeve
4. End Cap
7. Tie Rod Assembly
8. Hardware Kit
9. Cap Seal
10. Back-Up Cap Ring
11. Rod Seal
12. Piston Seal
13. Bearing Packing
14. Cap Bearing
15. Shaft Bearing
16. Thrust Washer
17. Counterbalance Valve
17A. Cartridge Valve

Figure 2-23. Rotator Assembly (Helac)

4. Place two (2) 3/8"x16NC bolts in threaded holes in bottom of the actuator. Using a suitable bar, unscrew the end cap (5). Remove the end cap from the actuator housing (1).

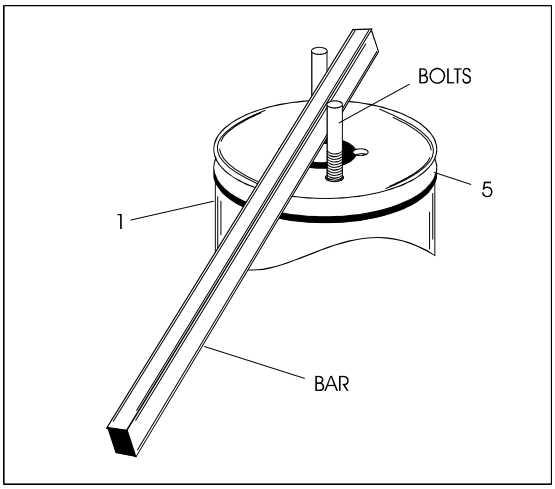


Figure 2-24. Removing End Cap

5. Remove the shaft (2) from piston sleeve (3) and the actuator housing (1).

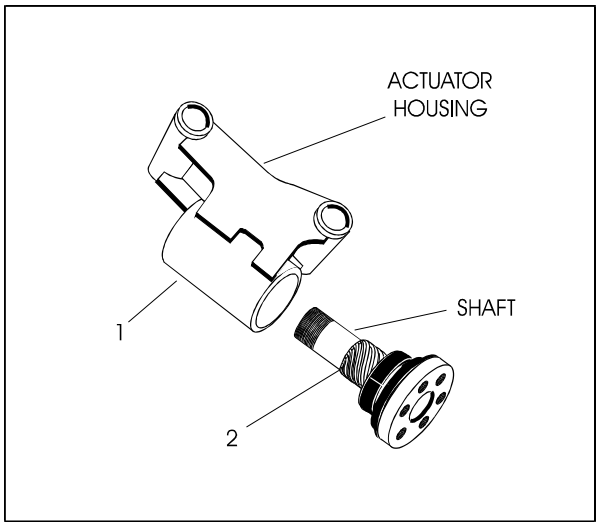


Figure 2-25. Removing Shaft from Housing

6. Remove piston sleeve (3) from housing (1).

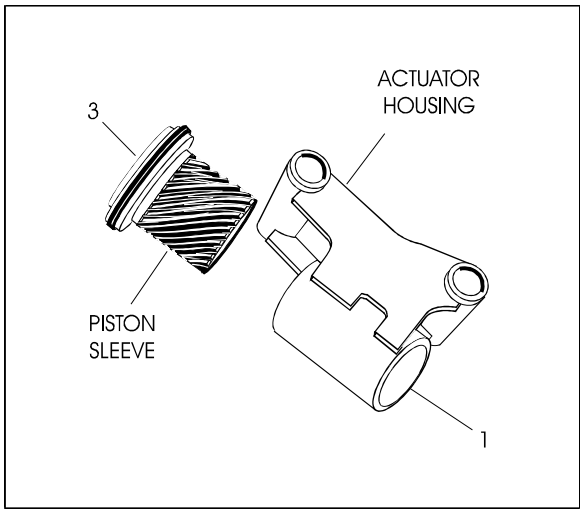


Figure 2-26. Removing Sleeve from Housing

7. Remove all seals and bearings from grooves. Discard seals.

Inspection

1. Clean all parts thoroughly.
2. Closely inspect all parts for excessive wear, cracks and chips. Replace parts as necessary.

NOTE: *A small amount of wear in the spline teeth will have little effect on the actuator strength. New spline sets are manufactured with a backlash of about 0.005 in. per mating set. After long service, a backlash of about 0.015 per set may still be acceptable in most cases, depending on the required accuracy of the application.*

3. Check the ring gear for wear and weld damage to the pins.
4. Inspect the cylinder bore for wear and scratches.

Assembly

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

1. Install new seal (7 and 6) on the piston sleeve (3).

NOTE: *Apply a coat of grease to the thrust ring before sliding onto the shaft.*

2. Install new seal (13), thrust washer (16) and bearing (15) on shaft (2).

NOTE: *Apply a coat of grease to the thrust washer before sliding onto the end cap.*

3. Install new seals (9), back-up ring (10), cap bearing (14), bearing packing (13) and thrust ring (16) on end cap (4).
4. Place the actuator in the vertical position, install the piston sleeve (3) in timed relation to the housing (1).

⚠ CAUTION

DO NOT MISALIGN THE SLEEVE TOO MUCH ANY ONE WAY, AS IT WILL MARK THE CYLINDER BORE.

NOTE: *The timing marks (the small punch marks on the face of each gear), must be aligned for proper shaft orientation. (See Actuator Timing.)*

5. Install the shaft (2) into housing (1) by aligning the proper punched timing marks.

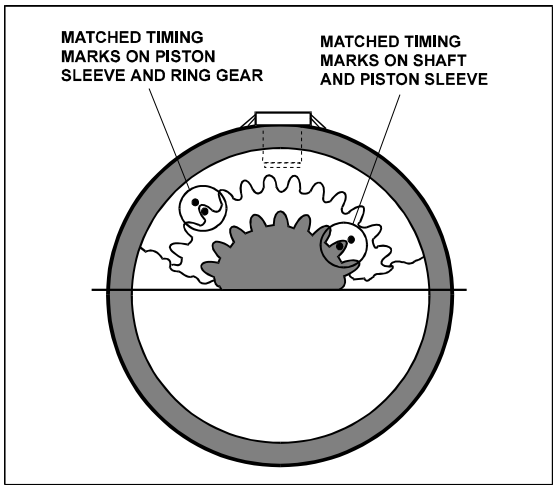


Figure 2-27. Actuator Timing

6. Temporarily tape the threaded portion of the shaft will help installation past the shaft seals (masking tape).
7. Install the tie rod assembly and secure in place with the nut.

2.12 BOOM LIMIT SWITCHES

Refer to Figure 2-28., Boom Limit Switches for adjustments to be made to the two Boom Limit Switches which bolt in place on the upright.

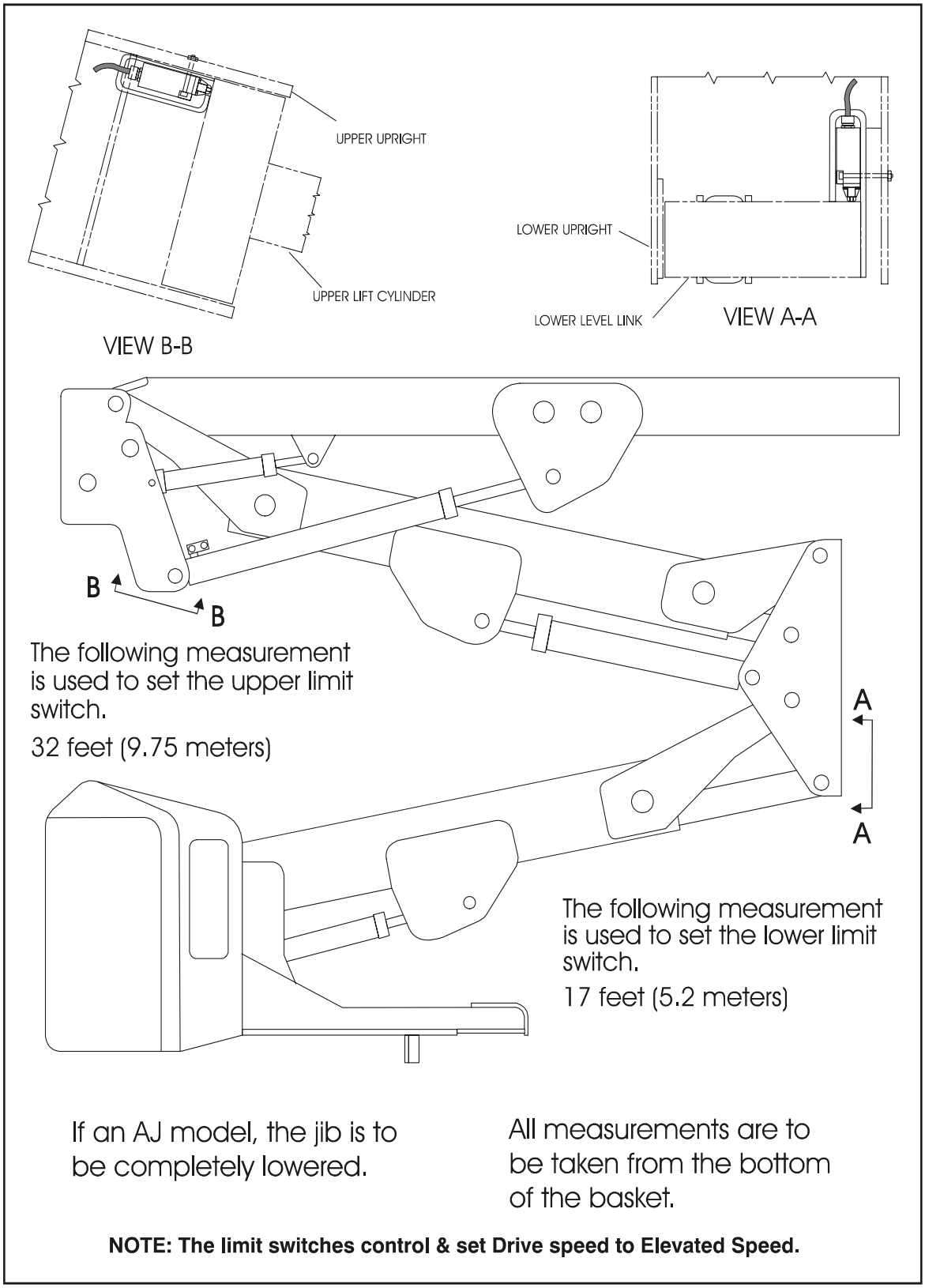


Figure 2-28. Boom Limit Switches

2.13 ARTICULATING JIB BOOM

Removal

1. For platform/support removal see platform/support removal diagram. See Section 2.10, Boom Maintenance.
2. Position the articulating jib boom level with ground.
3. Remove mounting hardware from slave leveling cylinder pin #1. Using a suitable brass drift and hammer, remove the cylinder pin from articulating jib boom.

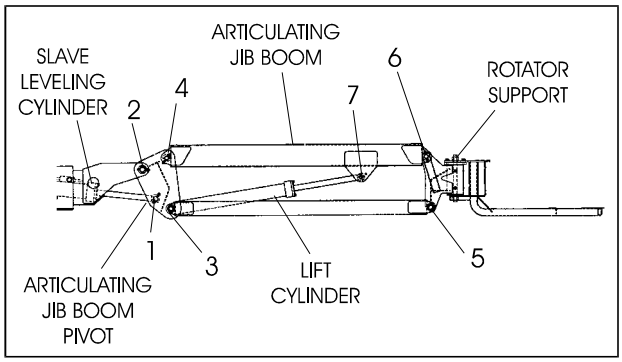


Figure 2-29. Location of Components - Articulating Jib Boom

4. Remove mounting hardware from articulating jib boom pivot pin #2. Using a suitable brass drift and hammer, remove the pivot pin from boom assembly.

Disassembly

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

Inspection

NOTE: *When inspecting pins and bearings refer to Section 2.19, Pins and Gar-max Bearing Repair Guidelines.*

1. Inspect articulating fly boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
2. Inspect articulating fly boom pivot attach points for scoring, tapering and ovality, or other damage. Replace pins as necessary.
3. Inspect inner diameter of articulating fly boom pivot bearings for scoring, distortion, wear, or other damage. Replace bearings as necessary. (See Section 2.7, Cylinder Repair For Bearing Replacement).
4. Inspect lift cylinder attach pin for wear, scoring, tapering and ovality, or other damage. Ensure pin surfaces are protected prior to installation. Replace pins as necessary.
5. Inspect inner diameter of rotator attach point bearings for scoring, distortion, wear, or other damage. Replace bearing as necessary. (See Section 2.7, Cylinder Repair For Bearing Replacement).
6. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
7. Inspect structural units of articulating jib boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Assembly

NOTE: *For location of components See Section 2-29., Location of Components - Articulating Jib Boom.*

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

mallet, install pivot pin #2 into fly boom assembly and secure with mounting hardware.

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

2.14 SWING BEARING

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.*

1. Check the frame to bearing. Attach bolts as follows:
   a. Elevate the fully retracted boom to 70 degrees (full elevation).
   b. At the positions indicated on Figure 2-31. try and insert the .0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
   c. Assure that the .0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
   d. Swing the turntable 90 degrees, and check some selected bolts at the new position.
   e. Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.
2. Check the turntable to bearing. Attach bolts as follows:
   a. Elevate the fully retracted boom to 70 degrees (full elevation).
   b. At the positions indicated on Figure 2-30. try and insert the .0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
   c. Lower the boom to horizontal and fully extend the boom.
   d. At the position indicated on Figure 2-30. try and insert the .0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.

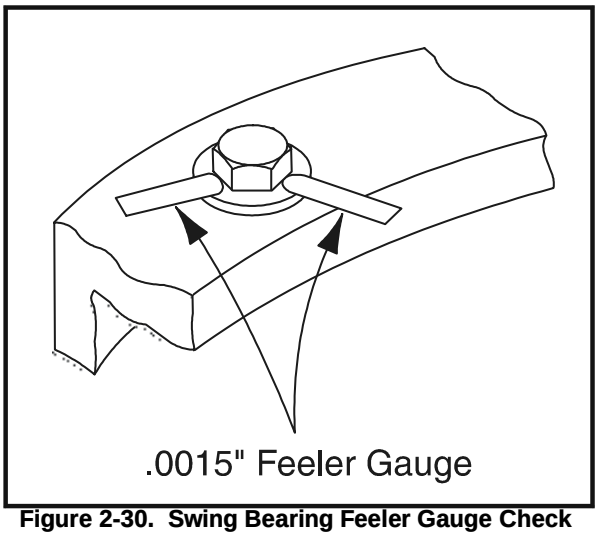


Figure 2-30. Swing Bearing Feeler Gauge Check

Wear Tolerance

1. With the boom positioned over the side of the machine, the Upper Boom horizontal with telescope fully extended and Mid/Lower Boom stowed, (See Figure 2-31.), using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. (See Figure 2-32.)
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, (See Figure 2-31.) using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable (See Figure 2-32.).

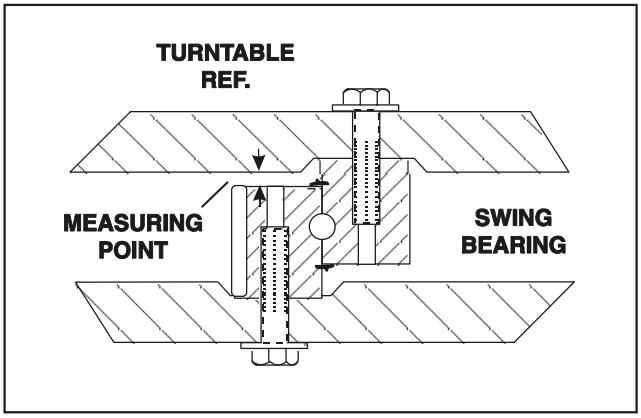


Figure 2-32. Swing Bearing Tolerance Measuring Point

3. If a difference greater than 0.057 in. (1.40 mm) is determined, the swing bearing should be replaced.

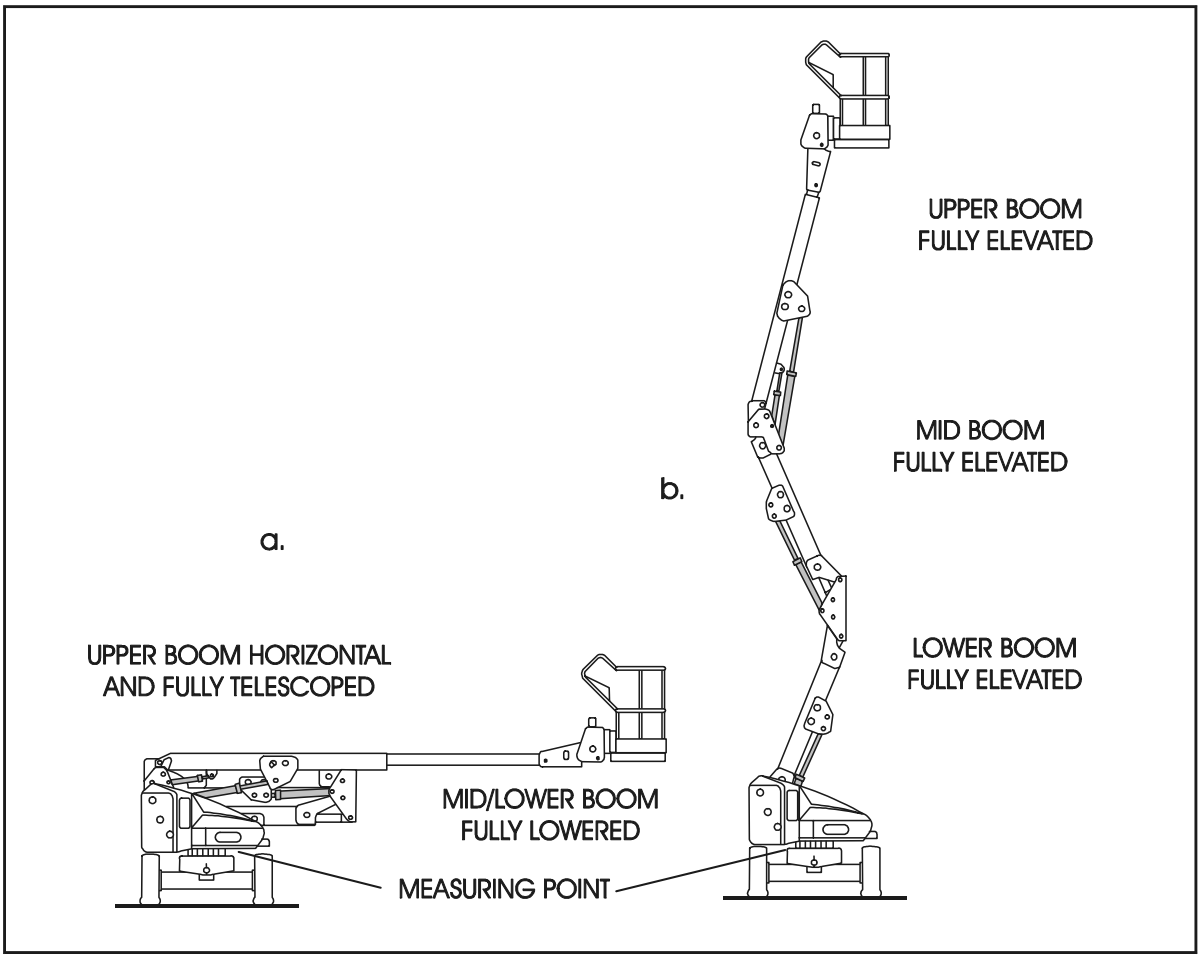


Figure 2-31. Swing Bearing Tolerance Boom Placement

4. 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.
5. If bearing inspection shows no defects, reassemble bearing and return to service.

Replacement of Swing Bearing

1. Removal.
   a. Attach an adequate support sling to the boom and draw all slack from sling. Prop or block the boom if feasible.
   b. 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.
   c. Attach suitable overhead lifting equipment to the base of turntable weldment.
   d. 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.
   e. Use the lifting equipment to carefully lift the complete turntable assembly from the bearing. Ensure that no damage occurs to the turntable, bearing or frame mounted components.
   f. Carefully place the turntable on a suitably supported trestle.
   g. 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.

h. Remove the two capscrews securing the bearing to the rotation box to separate the two for inspection.

2. Installation.

a. 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.

b. 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 2-33., Swing Bearing Torquing Sequence.

c. Apply Tribol Molub-Alloy 936 Open Gear Compound to bearing and worm gear teeth.

d. Grease bearing with Mobilith SHC Bearing Grease. Grease fitting is on inside wall of inner race of bearing.

NOTE: *If Tribol Molub-Alloy 936 Open Gear Compound or Mobilith SHC Bearing Grease are not available, Multi-Purpose Grease (MPG) can be substituted, however the service interval will be shorter.*

e. 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.

f. 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.

g. Following the torque sequence diagram shown in Figure 2-33., 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).

h. Remove lifting equipment from bearing.

i. Use suitable lifting equipment to carefully position the turntable assembly above the machine frame.

j. 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.

k. Apply a light coating of Loctite 271 to the new bearing bolts and install through the turntable and inner race of bearing.

l. Following the torque sequence shown in Figure 2-33., 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).

m. Remove the lifting equipment.

n. Route hydraulic lines through center of turntable and frame and connect as tagged prior to removal.

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

Swing Bearing Torque Values

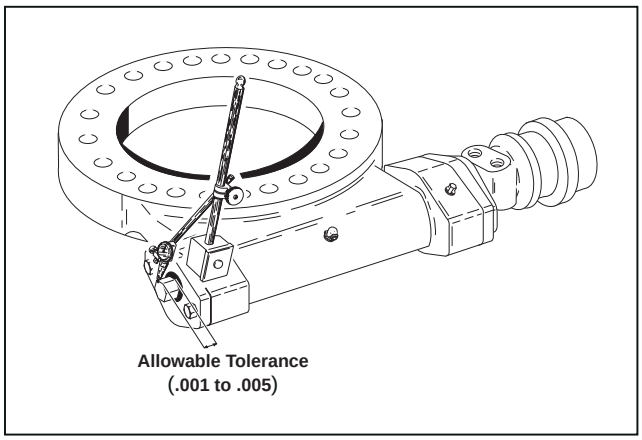
1. Dry - 220 ft. lbs. (298 Nm).
2. Loctite - 240 ft. lbs. (326 Nm).

Checking Worm Gear End Play

NOTE: *JLG Industries requires that a annual inspection be performed on the worm gear end play.*

1. Using a dial indicator, measure end play of worm gear, by applying side to side movement by hand to platform.

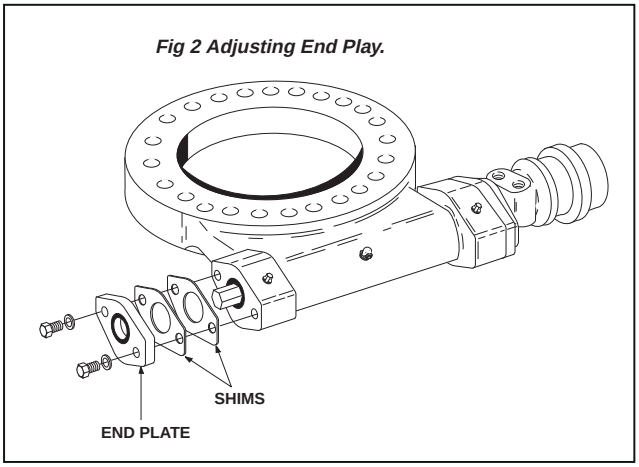
2. If tolerance exceeds .010", reduce end play to less than .005". Refer to Adjusting End Play.



Adjusting End Play

1. Remove end plate.
2. Measure and record total thickness of existing shim pack.
3. Determine thickness of shim pack required to obtain .001" - .005" end play.
4. Adjust shim pack thickness as required to obtain proper end play. Reduce end play by removing thicker shims and replacing with thinner shims, included in kit.
5. Replace end plate and torque bolts to 90 ft. lbs. (122 Nm).
6. Recheck end play.

Fig 2 Adjusting End Play.



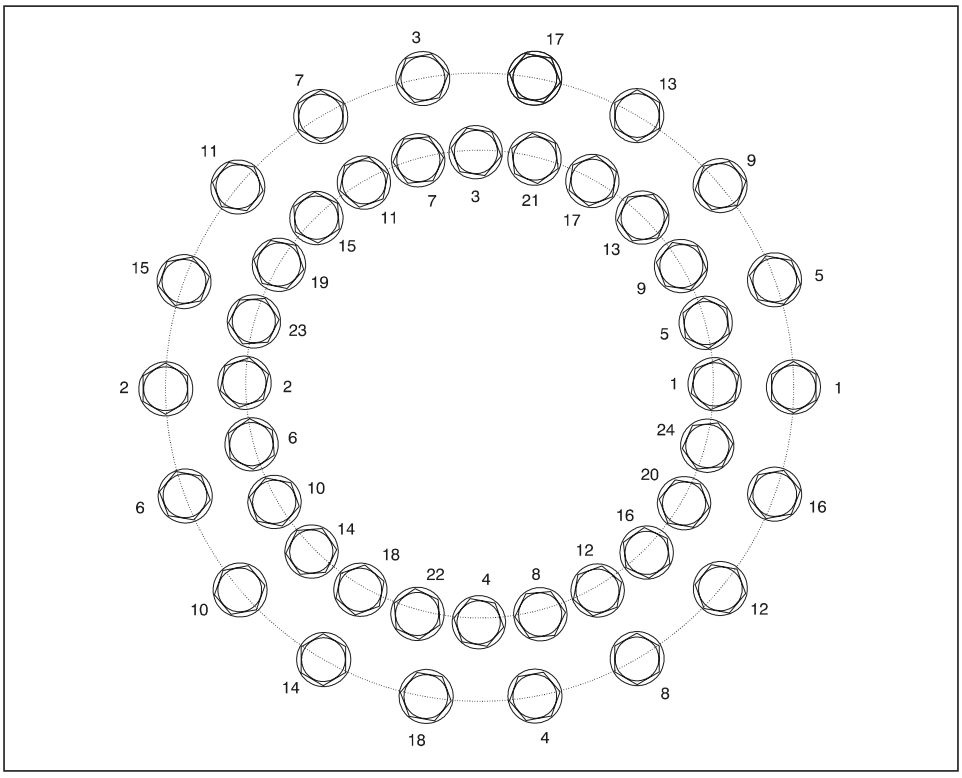


Figure 2-33. Swing Bearing Torquing Sequence

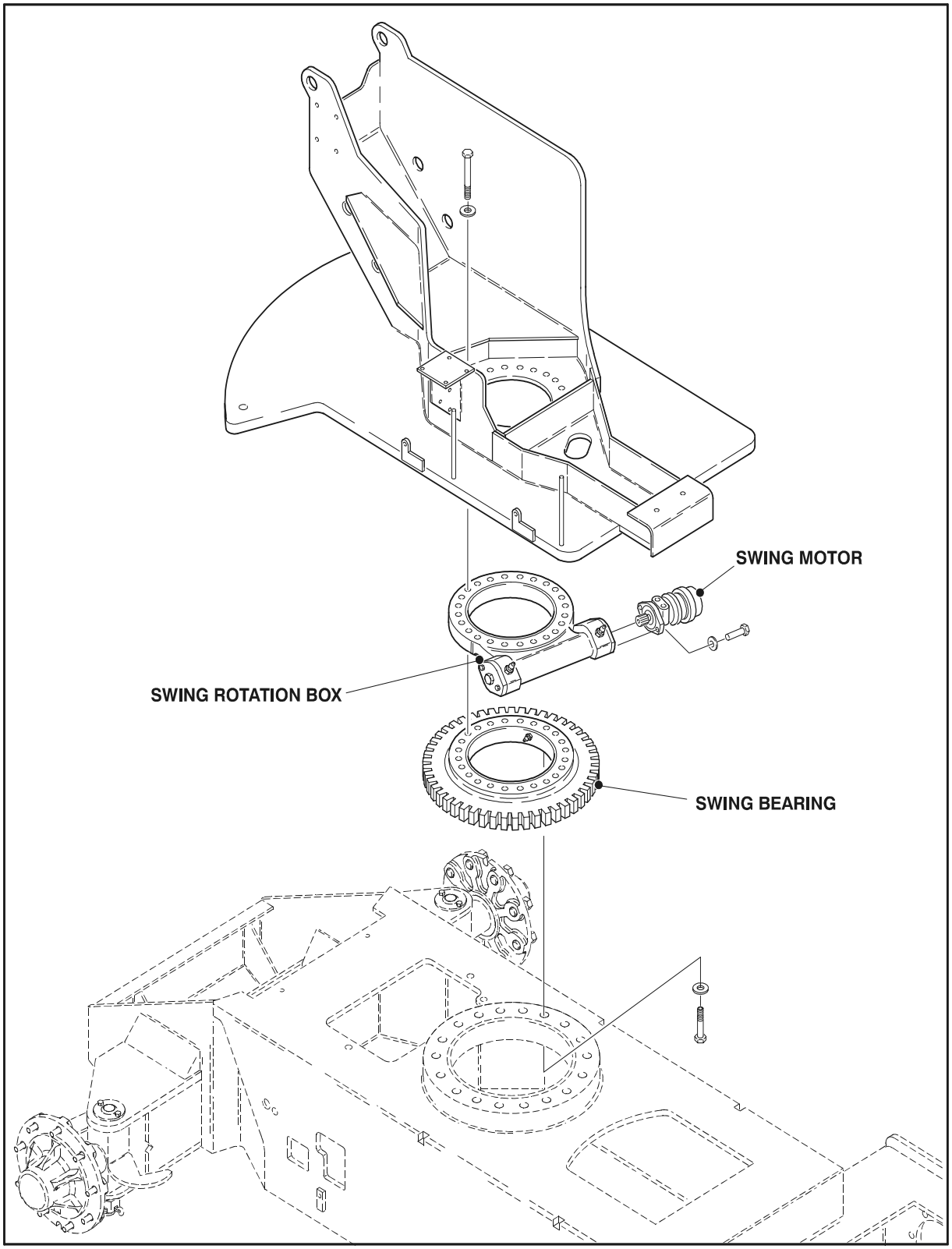


Figure 2-34. Swing Components

2.15 MID AND LOWER LIFT CYLINDER BLEEDING PROCEDURE

NOTE: *Bleeding procedure should only be necessary if rebuilding or replacing lift cylinder.*

1. Check oil level in the hydraulic oil tank (all booms must be retracted).
2. Lay an oil drip pan under the rod end port block (Mid Cylinder) and crack bleeder open from the fitting in the port block.
3. From the platform, turn the speed control knob to the slow position.
4. Lift up very slowly. This will force any air out of the circuit. If the lower boom is not extending, turn the speed control up very slowly until the lower boom starts to move.
5. Raise the lower boom approx. 1 foot (30.5 cm), then close bleeder while the boom is still moving.
6. Lift down all the way.
7. Repeat this procedure until all air has been purged from the circuit. Re-check the hydraulic oil level.
8. To test, cycle the lower lift function 3-4 times to see if both cylinders stop at the same time when fully extended.

2.16 BOOM SYNCHRONIZING PROCEDURE

NOTE: *If the Lower Boom assembly does not fully lower:*

1. Remove all personnel from the platform.
2. Pull the red knob located under the main control valve.
3. From Ground Control, activate the lift control switch, raise Lower Boom 6 feet (1.8m).
4. After raising Lower Boom, release the red knob.
5. Activate Lower Boom Down, fully lower boom.
6. Repeat step 1 thru 5 if necessary.

2.17 DRIVE HUB

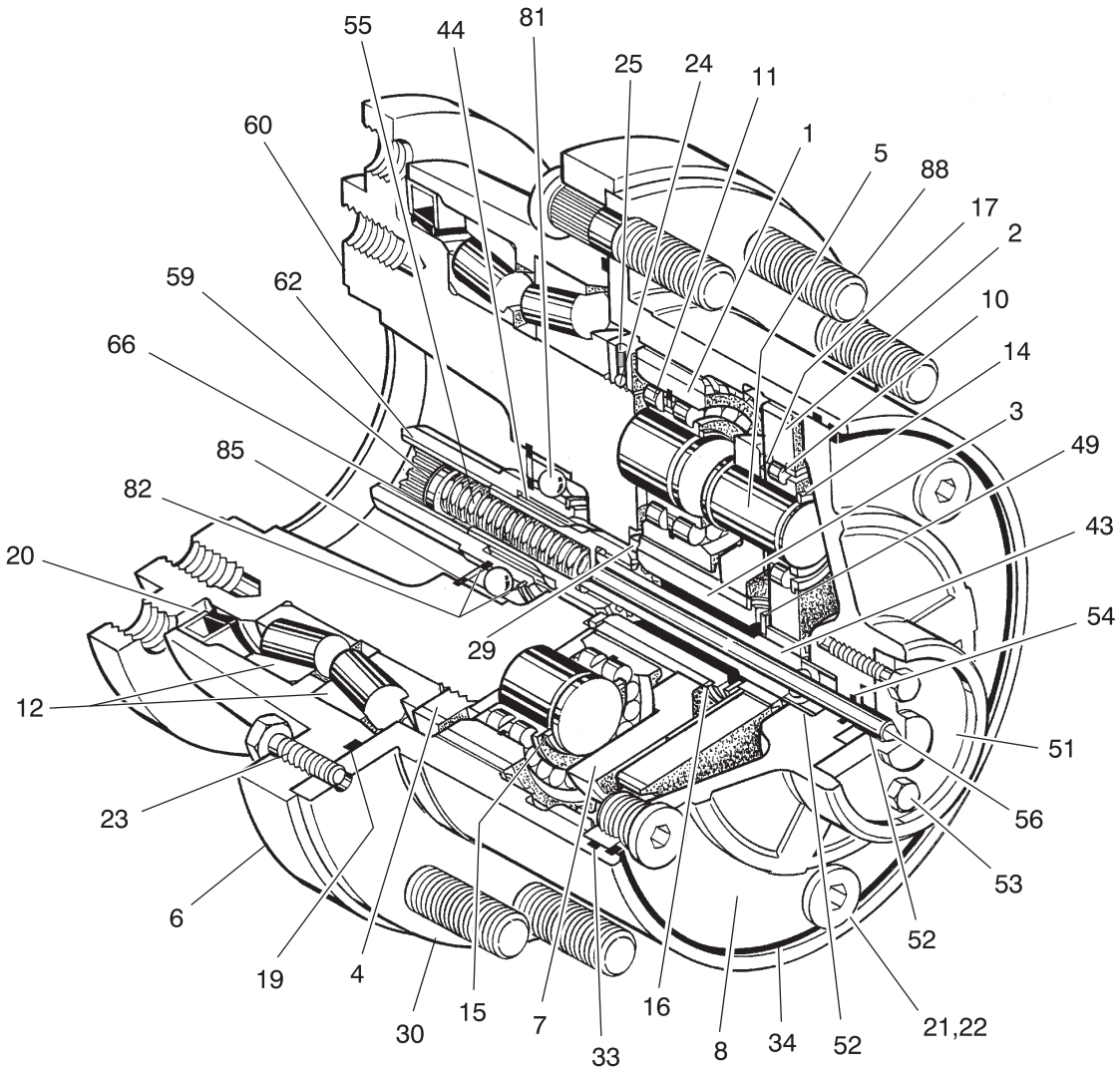
Setting of Tapered Roller Bearings

NOTE: *The numbers in parentheses ( ) reference the figure Drive Hub- Cutaway.*

1. De-grease threads of the spindle (60) and shaft nut (4).
2. Spin the shaft nut onto spindle by hand to insure the threads are in good condition.
3. Apply Loctite 270 evenly to threads of the shaft nut.
4. Rotate the support ring repeatedly in one direction only, during setting of the tapered roller bearings.
5. Tighten shaft nut to 626 ft. lbs. (850 Nm).
6. Do not use the hub for 24 hours to allow the Loctite to harden properly.
7. Do not fill with oil for 24 hours to allow the Loctite to harden properly.

Securing of the Shaft Nut

1. After proper bearing setting is completed, use a suitable punch to place ball (24) 0.04 to 0.05 inches (1.1 to 1.3 mm) into the spindle thread. Then set ball (24) in position by punching in expander (25).



1. Planet Gear
2. Planet Gear
3. Sun Gear
4. Shaft Nut
5. Planet Bolt
6. Support Ring
7. Planet Carrier
8. Cover
9. (Not Used)
10. Roller Bearing
11. Roller Bearing
12. Tapered Roller Bearing
13. (Not Used)
14. Retaining Ring
15. Retaining Ring
16. Retaining Ring
17. Support Disc
18. (Not Used)
19. O Ring
20. Ring Seal
21. Screw Plug
22. Seal Ring
23. Bolt
24. Ball
25. Expander
26. thru 28. (Not Used)
29. Washer
30. Ring Gear
31. thru 32. (Not Used)
33. O Ring
34. Spring
35. thru 42. (Not Used)
43. Sun Gear Shaft
44. Input Shaft
45. thru 48. (Not Used)
49. Washer
50. (Not Used)
51. Cover
52. Disc
53. Bolt
54. O Ring
55. Pressure Spring
56. Shaft Rod
57. thru 58. (Not Used)
59. Rotor Disc
60. Spindle
61. (Not Used)
62. Coupler
63. thru 65. (Not Used)
66. Retaining Ring
67. thru 80. (Not Used)
81. Ball Bearing
82. Retaining Ring
83. Retaining Ring
84. thru 87. (Not Used)
88. Wheel Stud

Figure 2-35. Drive Hub - Cutaway

2.18 DRIVE BRAKE - MICO

Disassembly

1. Remove pressure plate (3) from cover (21) by removing cap screws (1) and washers (2).

⚠ CAUTION

PRESSURE PLATE IS UNDER SPRING TENSION OF APPROXIMATELY 1500 LBS (680 KGF). THE FOUR CAP SCREWS SHOULD BE LOOSENED EVENLY TO RELIEVE THIS FORCE. IF A HYDRAULIC PRESS IS AVAILABLE, 3000 LBS (1361 KGF) MINIMUM, THE PRESSURE PLATE CAN BE HELD IN POSITION WHILE REMOVING THE CAP SCREWS AND WASHERS

2. Remove case seal (4) from cover (21).
3. Remove piston (7) from pressure plate (3).
4. Remove o-ring (5), back-up ring (6), o-ring (8) and back-up ring (9) from piston (7).
5. Remove stack assembly, consisting of stator disc (11), sensor ring (12), rotor disc (13), and plate (14) from cover (20).
6. Remove dowel pins (20), springs (15) and spring retainer (16) from cover (21). Note number and pattern of springs.
7. Remove retaining ring (17) from cover (21).
8. Remove shaft (10) by pressing or using a soft mallet on male end of shaft (10).
9. Remove retaining ring (19) and bearing (18) from shaft (10).
10. Press rotary oil seal (22) from cover (21).

Assembly.

NOTE: *Lubricate all rubber components from the repair kit with clean type fluid used in the system.*

1. Clean all parts thoroughly before assembly.
2. Press new rotary seal (22) into cover (21). Note direction of seal.
3. Install new bearing (18) and retaining ring (19) on shaft (10).
4. Install shaft assembly and retaining ring (17) in cover (21)
5. Install dowel pins (20), spring retainer (16) and springs (15) in cover plate (21). Be sure to use the same number of springs and spring pattern as recorded during disassembly.
6. Position plate (14) on springs (15).

NOTE: ***Disc (13 &11) and plate (14) must remain dry during installation. No oil residue must be allowed to contaminate disc surfaces.***

7. Place a new friction disc (13) on shaft (10) until it contacts plate (14). Install stator disc (11).
8. Install new o-ring (5), new back-up ring (6), new o-ring (8) and new back-up ring (9) on piston (7). Note order of o-rings. Insert piston (7) into pressure plate (3). Be careful not to shear o-rings or back-up rings.
9. Install new case seal (4) in cover (21).
10. Position pressure plate (3) on cover (21) aligning dowel pins (20) with holes in pressure plate.
11. Install cap screws (1) and washers (2) and tighten evenly to draw pressure plate (3) to cover (21). Torque cap screws 55 lb.-ft. (74.6 N-m).

NOTE: ***A hydraulic press will simplify installation of pressure plate on cover. Clamp pressure plate in position while tightening the cap screws.***

⚠ CAUTION

IF HYDROSTATIC BENCH TESTING IS PERFORMED ON THE BRAKE ASSEMBLY, RELEASE PRESSURE SHOULD NOT EXCEED 2000 PSI (137.9 BAR) UNLESS TWO ADDITIONAL BOLTS ARE USED FOR SUPPLEMENTAL CLAMPING.

Bleeding

1. Install brake in system and connect pressure lines.
2. Bleed pressure release section of brake by pressurizing side inlet port and allowing air to escape from top port. Pressure should not exceed 100 lb(6.9 bar) during bleeding.
3. Apply sufficient pressure to release brake and check for proper operation in system.

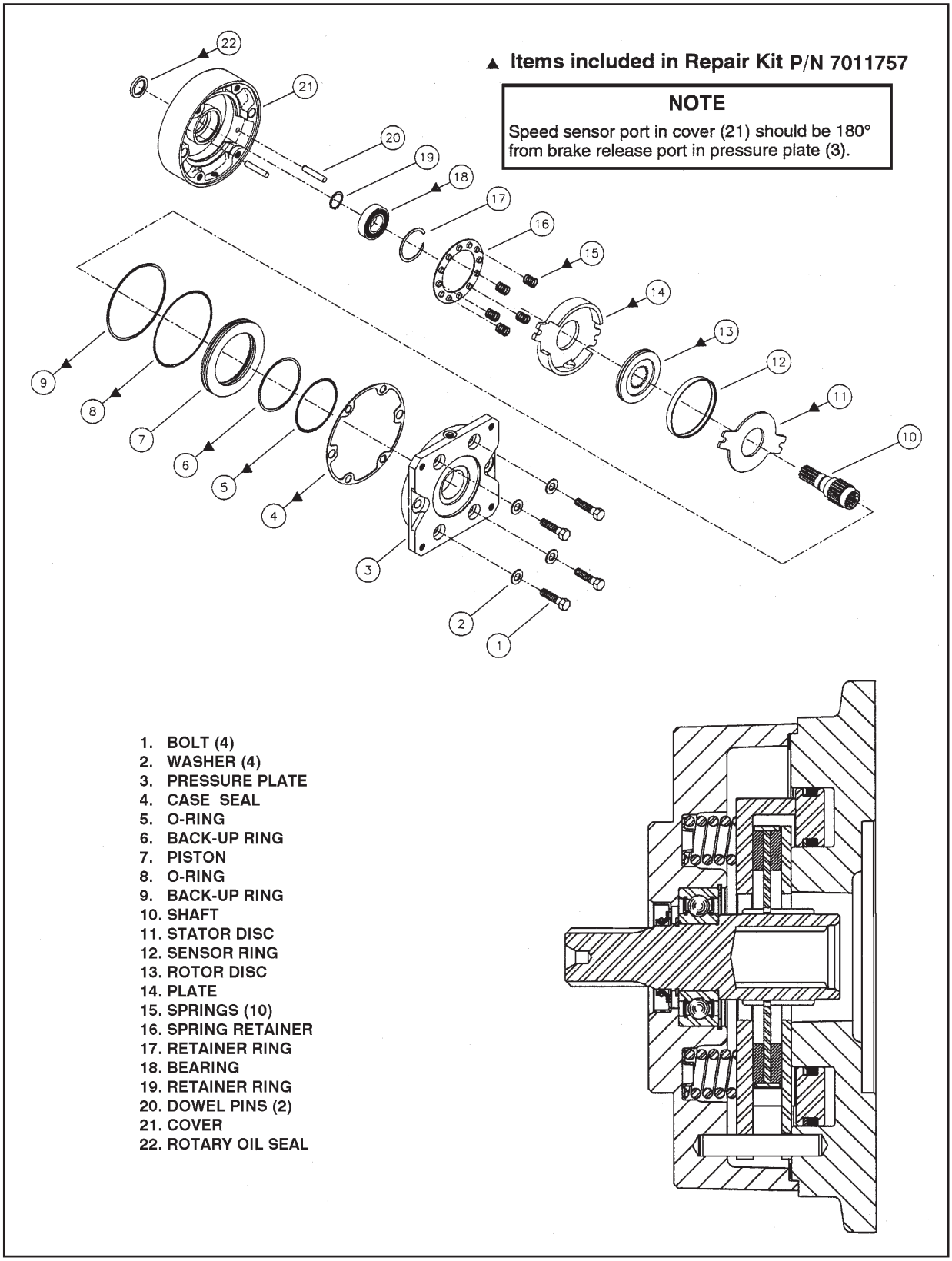


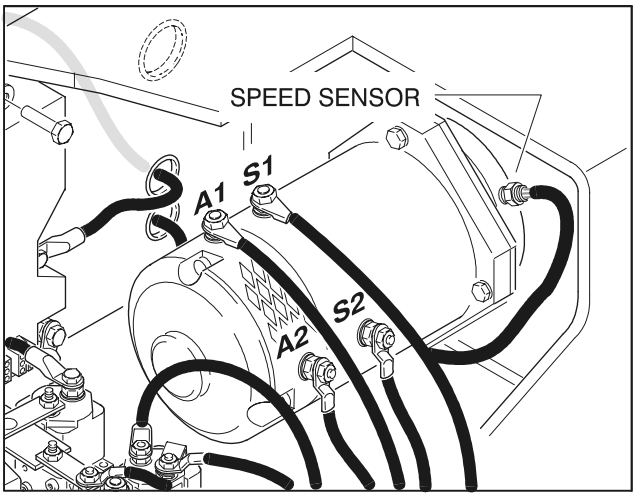
Figure 2-36. Drive Brake - Mico

2.19 PINS AND GAR-MAX 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 the joint during operation.
2. Filament wound bearings should be replaced if any of the following is observed:
   a. Frayed or separated fibers on the liner surface.
   b. Cracked or damaged liner backing.
   c. Bearings that have moved or spun in their housing.
   d. Debris embedded in liner surface.
3. Pins should be replaced if any of the following is observed (pin should be properly cleaned prior to inspection):
   a. Detectable wear in the bearing area.
   b. Flaking, pealing, scoring, or scratches on the pin surface.
   c. Rusting of the pin in the bearing area.
4. Re-assembly of pinned joints using filament wound bearings.
   a. Housing should be blown out to remove all dirt and debris...bearings and bearing housings must be free of all contamination.
   b. Bearing / pins should be cleaned with a solvent to remove all grease and oil...filament wound bearing are a dry joint and should not be lubricated.
   c. Pins should be inspected to ensure it is free of burrs, nicks, and scratches which would damage the bearing during installation and operation.

2.20 SPEED SENSOR ADJUSTMENT



For proper drive operation, the speed sensors must be properly installed and adjusted. The sensor operates on a leading pulse to show direction. If installed wrong, the sensor will not be able to sense the proper direction.

⚠ WARNING

IF BOTH SPEED SENSORS ARE INSTALLED WRONG, THE CONTROLLER WILL THINK THE MACHINE IS ON A HILL AND WILL GO INTO FULL SPEED MODE IMMEDIATELY WHEN DRIVE IS SELECTED. THE MACHINE WILL NOT STOP UNLESS THE FOOTSWITCH IS RELEASED OR THE EMS IS PUSHED IN.

IF ONLY ONE SENSOR IS INSTALLED WRONG, THE CONTROLLER SENSES A PROBLEM AND THE MACHINE WILL ONLY DRIVE AT CREEP SPEED. IF BOTH SENSORS ARE ADJUSTED TOO FAR OUT, THE CONTROL SYSTEM CONTROLLER WILL NOT DRIVE THE MACHINE.

Adjustment Procedure

1. Back off the locking nut and o-ring.
2. Thread the sensor in until it bottoms out (don't use excessive force).
3. Back-off 1-2 turns and align the notch with the axis of the brake. Refer to Figure 2-37., Speed Sensor Orientation.
4. Use a 1/2" wrench to hold the sensor and a 11/16" wrench to snug the lock nut to the brake.

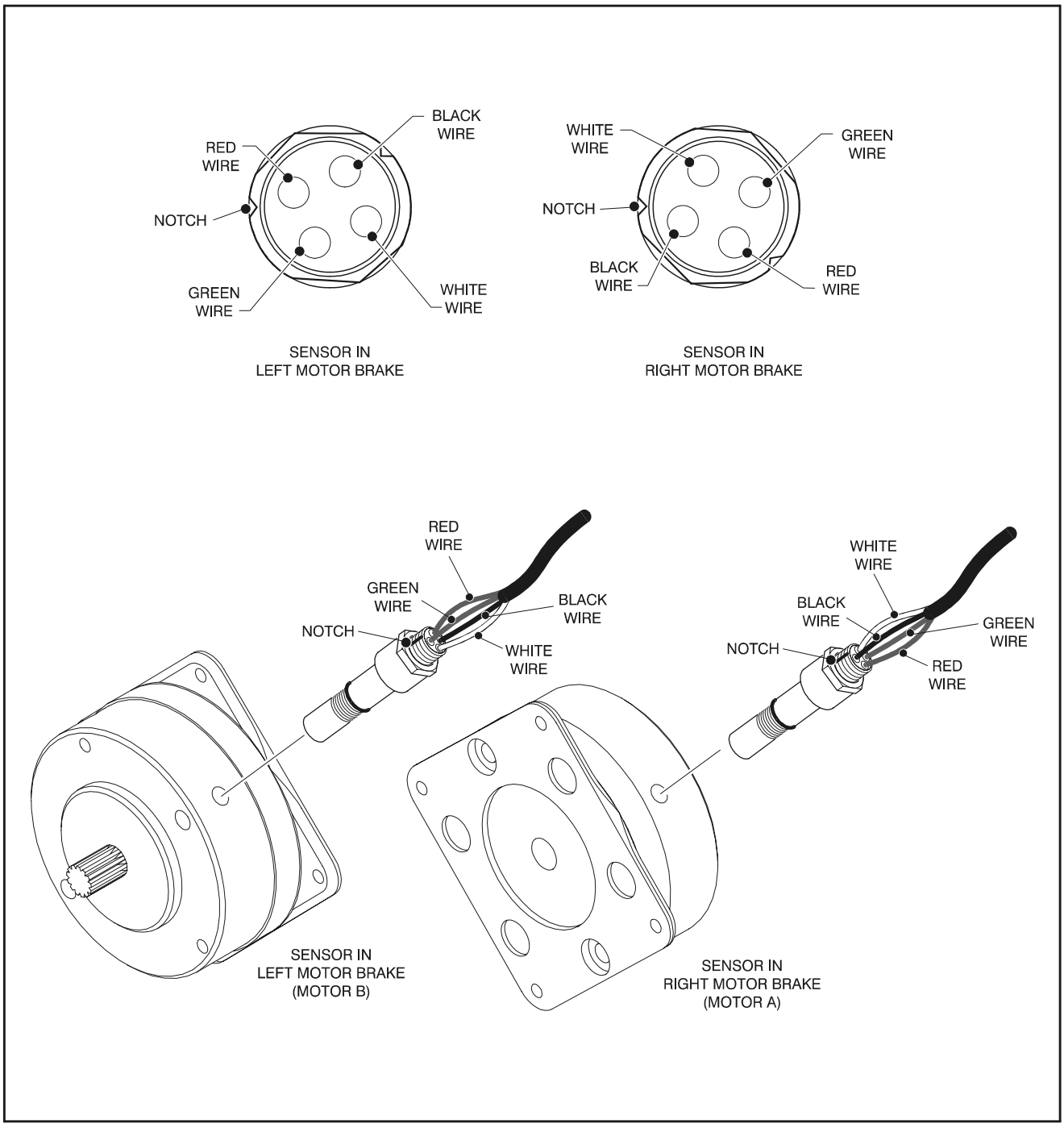


Figure 2-37. Speed Sensor Orientation

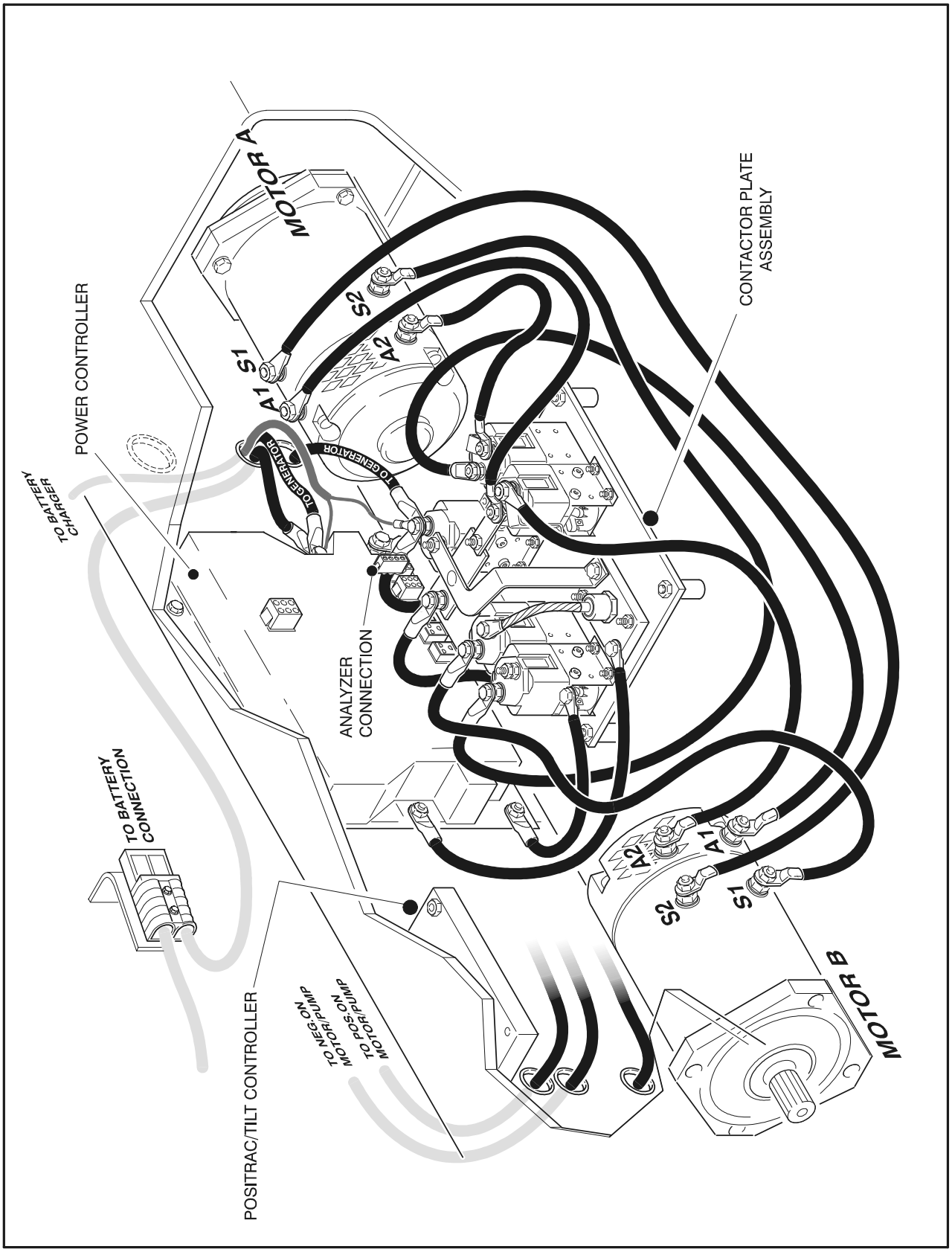
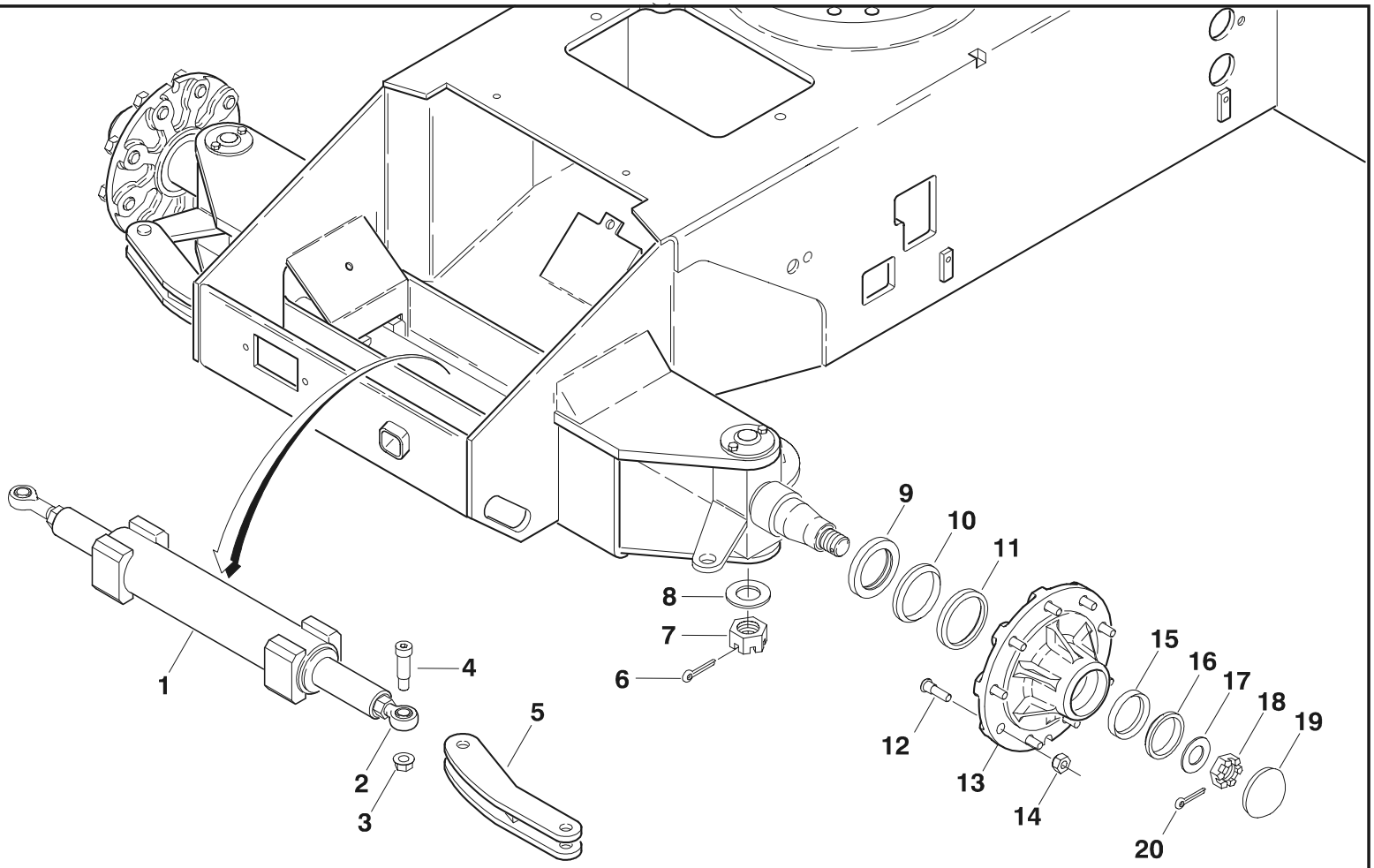


Figure 2-38. Frame Mounted Electrical Components



1. Steer Cylinder
2. Rod End
3. Nut
4. Shoulder Screw
5. Steer Link
6. Cotter Pin
7. Castle Nut
8. Thrust Washer
9. Lip Seal
10. Bearing Cone
11. Inner Bearing Cup
12. Wheel Stud
13. Hub
14. Lug Nut
15. Outer Bearing Cup
16. Outer Bearing Cone
17. Tanged Washer
18. Castle Nut
19. Dust Cap
20. Cotter Pin

Figure 2-39. Steering Components and Spindles

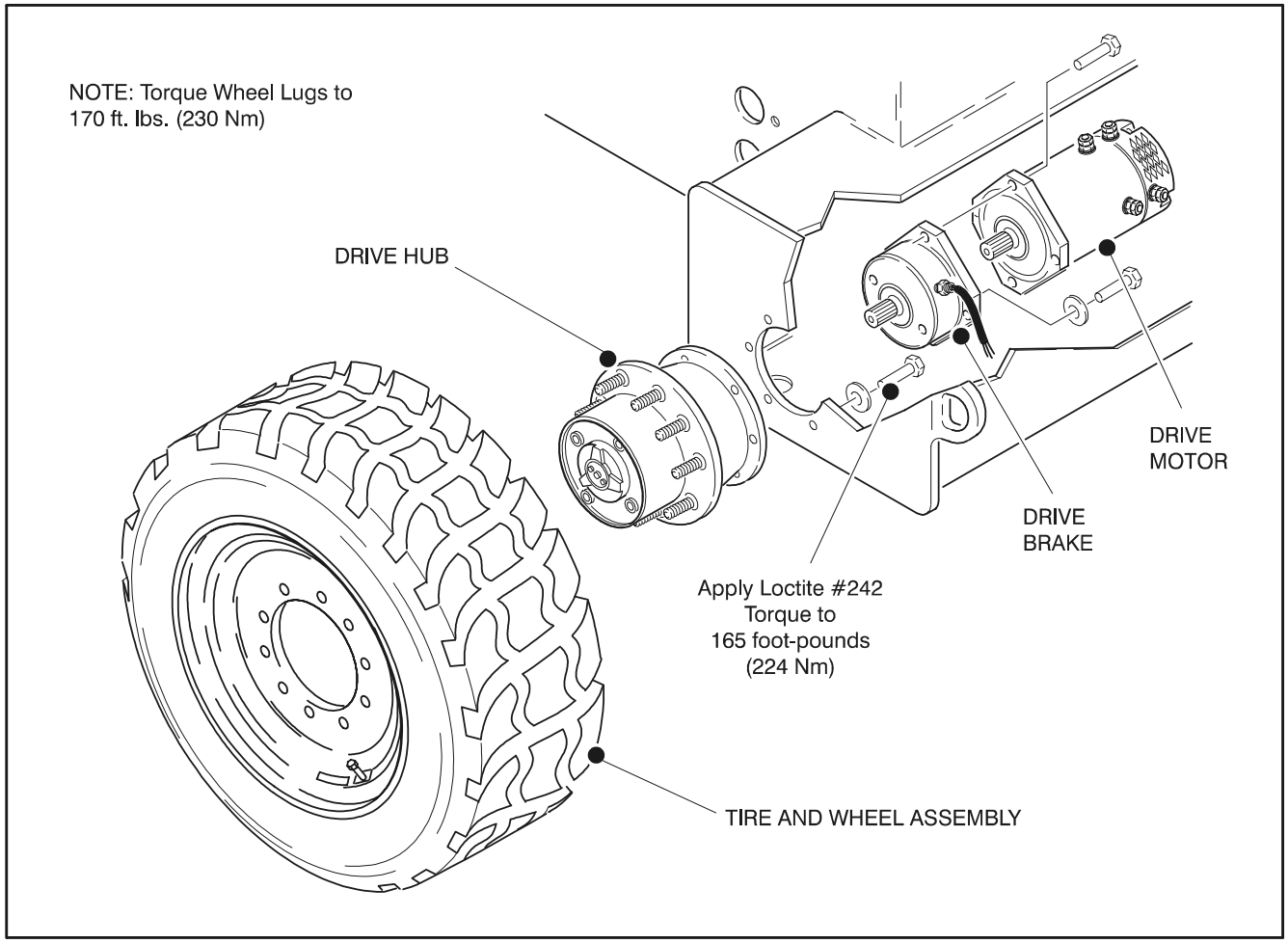


Figure 2-40. Drive Components

2.21 FOOTSWITCH ADJUSTMENT

Adjust switch so that functions will operate when pedal is at center of travel. If switch operates within last 1/4 inch (6.35 mm) of travel, top or bottom, it should be adjusted.

2.22 POSITRAC/TILT MODULE

When installing a new positrac/tilt module, always ensure that it is calibrated using the JLG Control System analyzer before operating the machine. Refer to Section 2.24, JLG Control System Analyzer Kit Instructions. Use a standard bubble level in two different directions to ensure that the machine's frame is level prior to installing the new positrac/tilt module.

1. Place the machine on a flat, level surface. Check for level by placing a bubble level on the frame in both directions.
2. Plug in the analyzer (Analyzer - p/n 1600244, Cable - p/n 1600633) into port J9 on the power module or port J1 on the platform module.
3. Use the right arrow key to curse over to "ACCESS LEVEL 2". Depress Enter.

4. Use Up/Down arrow keys to enter the following password "33271". Depress Enter.
5. Use the right arrow key to curse over to "LEVEL VEHICLE". Depress Enter. Depress Enter again.
6. Verify that the tilt reading is now "0.0; 0.0".

⚠ WARNING

TO ASSURE PROPER OPERATION, THE MACHINE MUST BE LEVEL WHEN INSTALLING AND CALIBRATING A NEW POSI-TRAC/TILT MODULE.

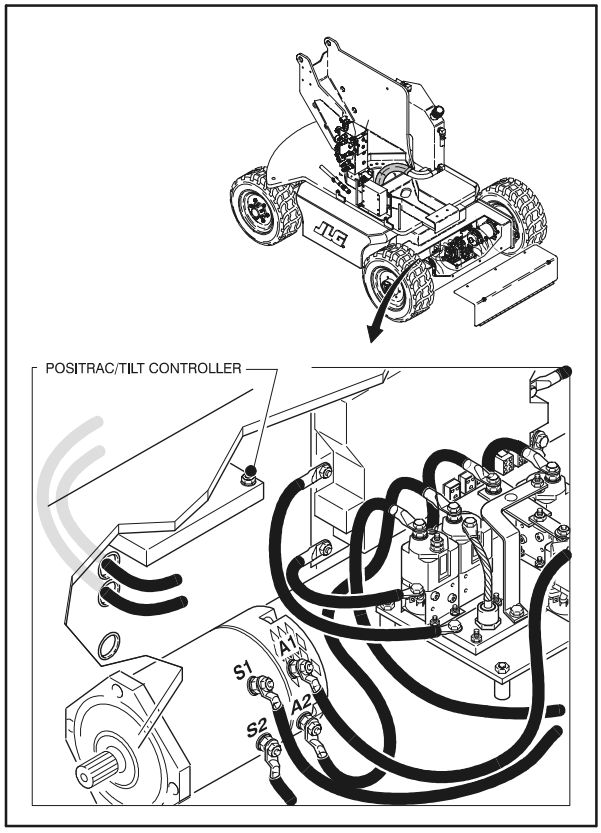


Figure 2-41. Tilt Sensor Location

2.23 PRESSURE SETTING PROCEDURES

Main Relief

1. Install pressure gauge at port “G” on Steer/Brake valve.
2. Activate and bottom out either Upper or Lower Lift Up. Adjust Main Relief to value in Pressure Settings chart.

Upper Lift Down Relief

1. With pressure gauge at “G” port on main valve, activate and bottom out Upper Lift Down.
2. Adjust Upper Lift Relief to value in the Pressure Settings chart.

Mid/Lower Lift Down Relief

1. With pressure gauge at “G” port on main valve, activate and bottom out Mid/Lower Lift Down.
2. Adjust Mid/Lower Lift Relief to value in the Pressure Settings chart.

Telescope In Relief

1. With pressure gauge at “G” port on main valve, activate and bottom out Telescope In.
2. Adjust Telescope In Relief to value in the Pressure Settings chart.

Platform Level Up Relief

1. With pressure gauge at “G” port on main valve, activate and bottom out Platform Level Up.
2. Adjust Platform Level Up Relief to value in the Pressure Settings chart.

Platform Level Down Relief

1. With pressure gauge at “G” port on main valve, activate and bottom out Platform Level Down.
2. Adjust Platform Level Down Relief to value in the Pressure Settings chart.

Steer Relief

1. With pressure gauge at “G” port on steer/brake valve, activate and bottom out Steer Left or Right.
2. Adjust Steer Relief to value in the Pressure Settings chart.
3. Shut down hydraulic system and remove pressure gauge.

Table 2-4.Pressure Settings

Function	PSI	Bar
Main Valve		
Upper Lift Down Relief	550	38
Mid/Lower Lift Down Relief	1700	117
Telescope In Relief	2150	148
Platform Level Up Relief	2500	172
Platform Level Down Relief	1200	83
Brake/Steer Valve		
Steer Relief	2300	159
Main Relief	3200	221
Jib Valve		
Jib Relief (Up and Down)	1500	103

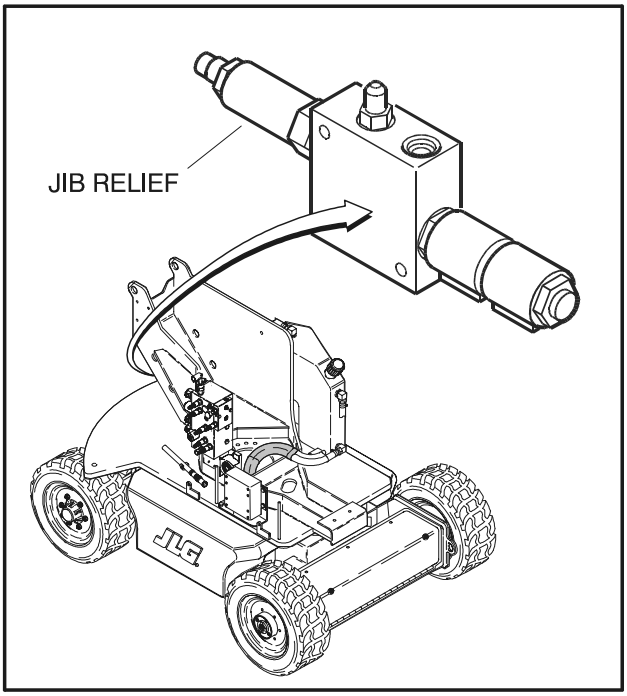


Figure 2-42. Jib Valve Location

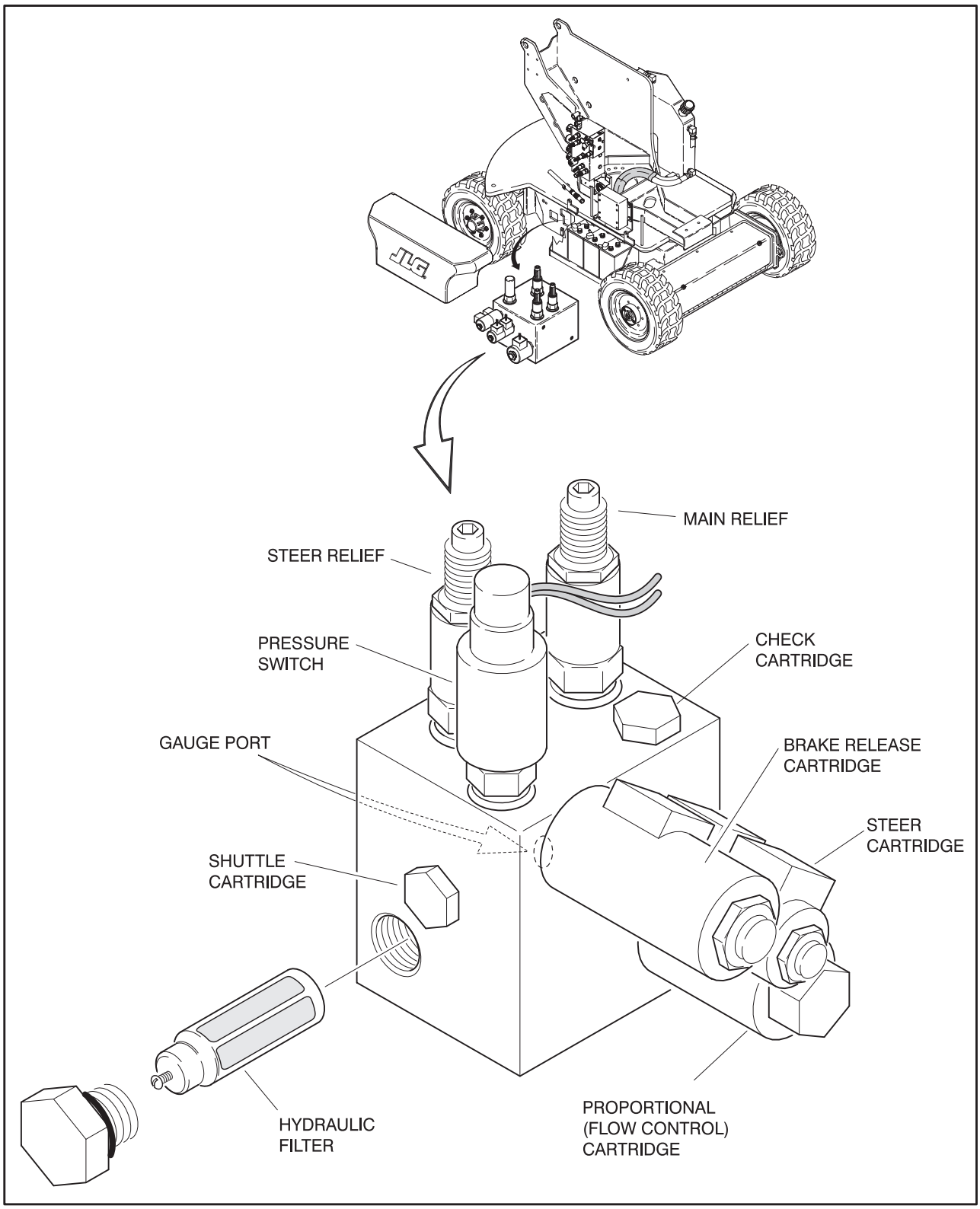


Figure 2-43. Brake/Steer Valve Components

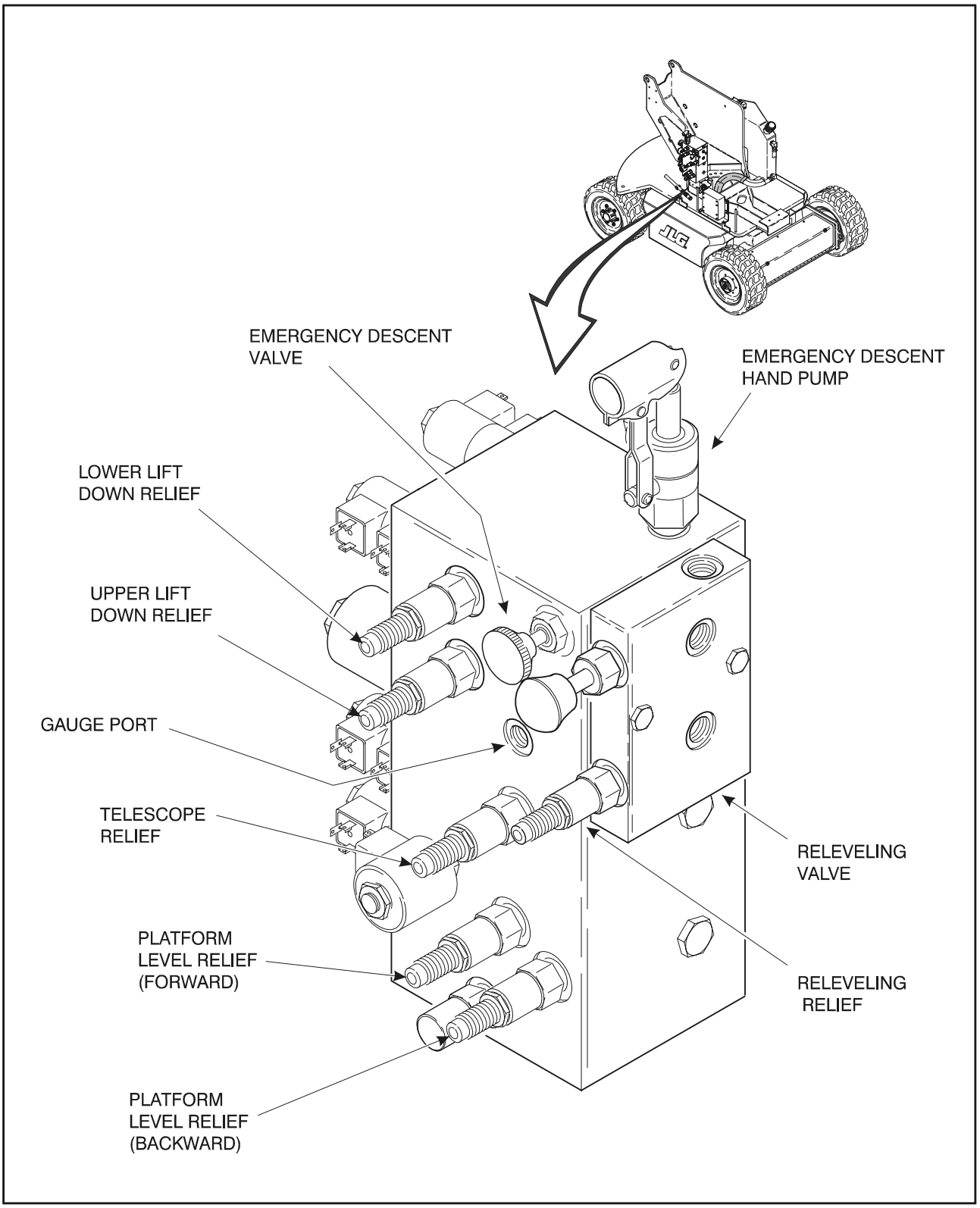


Figure 2-44. Main Valve Components

2.24 JLG CONTROL SYSTEM ANALYZER KIT INSTRUCTIONS

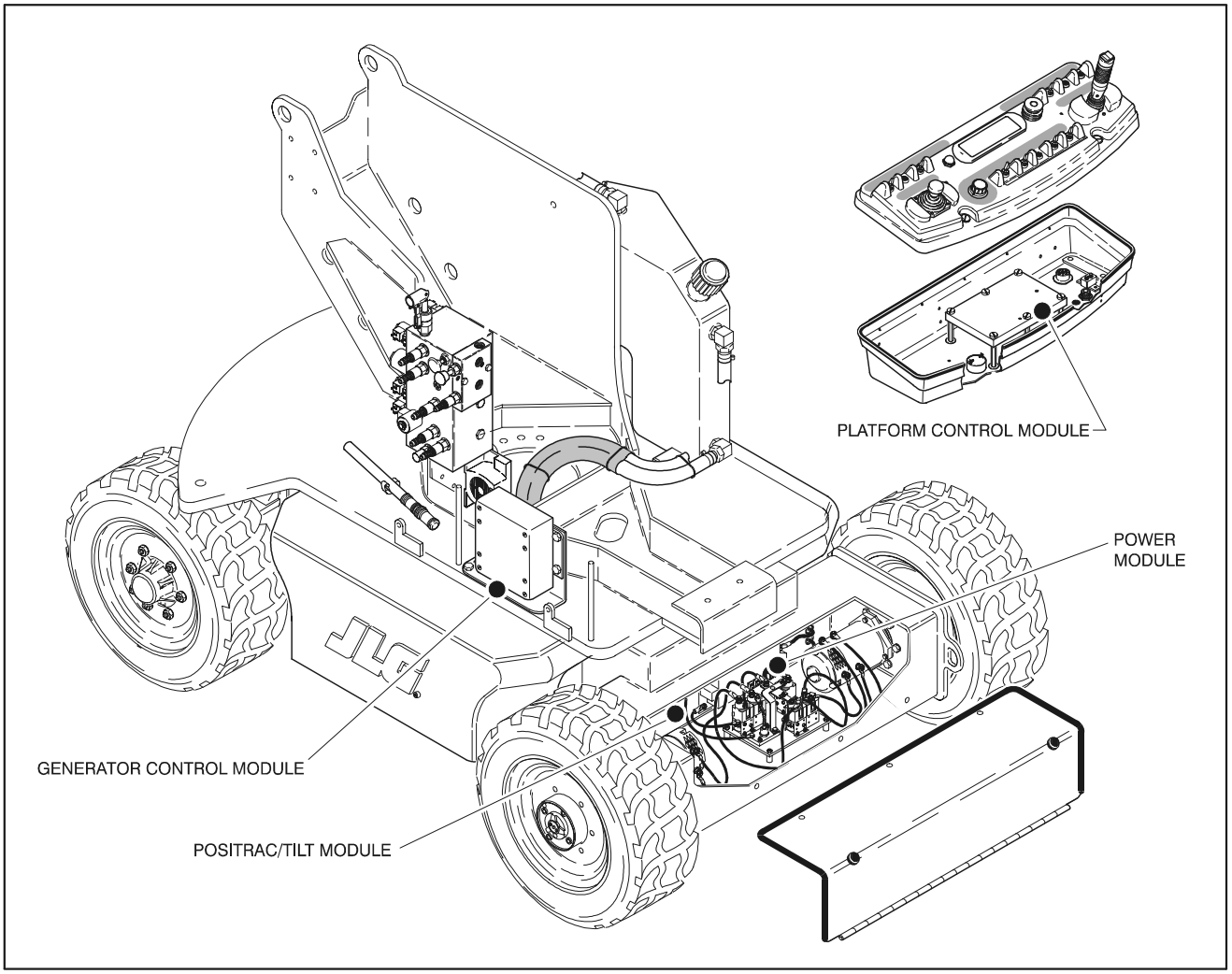


Figure 2-45. Control Module Location

Introduction

⚠ IMPORTANT

WHEN INSTALLING A NEW POWER MODULE CONTROLLER ON THE MACHINE, IT WILL BE NECESSARY TO PROGRAM THE CONTROLLER FOR THE PROPER MACHINE CONFIGURATION, INCLUDING OPTIONS.

⚠ IMPORTANT

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

The JLG designed Control System is a 48 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 and max.-speed for all boom, drive, and steering functions.

The upper lift, swing, and drive are controlled by individual joysticks, with steering being controlled by a rocker switch built into the top the drive joystick. To activate Drive, Lift, and Swing simply pull up on the slide lock location on the joystick and move the handle into the direction desired.

The motor controller will control current output, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the motor controller. The motor controller also features an adjustable time limit for positive traction.

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 an hour meter, beacon light, function cutout, and ground alarm. These options may be added later but must be programmed into the motor controller when installed.

The Control System may be accessed in one of two ways: Utilizing a custom designed, hand held analyzer (Analyzer, JLG part no. 1600244 & Cable, JLG part no. 1600633) which will display two lines of information at a time, by scrolling through the program.

NOTE: *Each module has a label with the JLG part number and a serial number which contains a date code.*

The following instructions are for using the hand held analyzer.

To Connect the JLG Control System Analyzer

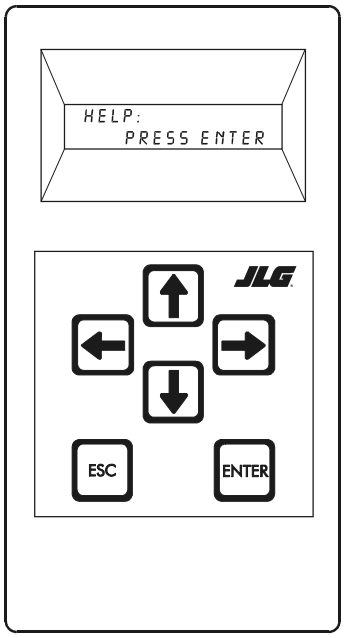
1. Connect the four pin end of the cable supplied with the analyzer, to the motor controller module located in the platform box or at the power module and connect the remaining end of the cable to the analyzer.

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.

Using the Analyzer

With the machine power on and the analyzer connected properly, the analyzer will display the following:



HELP:
PRESS ENTER

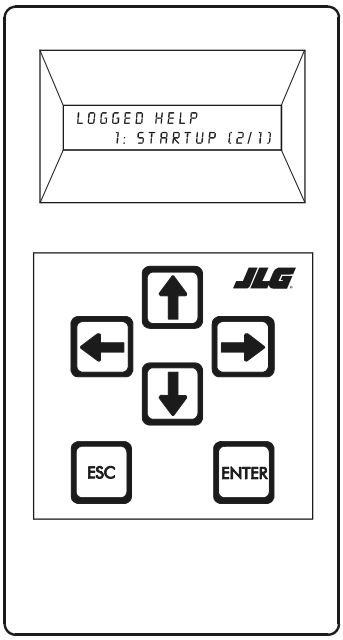
At this point, using the **RIGHT** and **LEFT** arrow keys, you can move between the top level menu items. To select a displayed menu item, press **ENTER**. To cancel a selected menu item, press ESC.; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

HELP
DIAGNOSTICS
ACTIVATE TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
LEVEL VEHICLE (level 1 only)
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: STARTUP (2/1)

At this point, the analyzer will display the last fault the system has seen, if any are present. You may scroll through the fault logs to view what the last 25 faults were. Use the right and left arrow keys to scroll through the fault logs. To return to the beginning, press **ESC.** two times. **STARTUP (2/1)** indicates a power up.

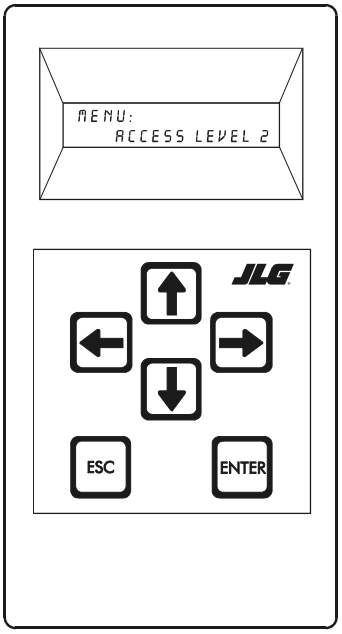
When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

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

Changing the Access Level of the Hand Held Analyzer

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



MENU:
ACCESS LEVEL 2

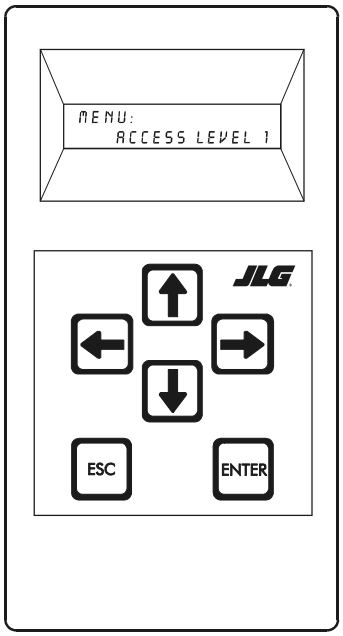
Press **ENTER** to select the **ACCESS LEVEL** menu.

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.

Once the correct password is displayed, press **ENTER**. The access level should display the following, if the password was entered correctly:

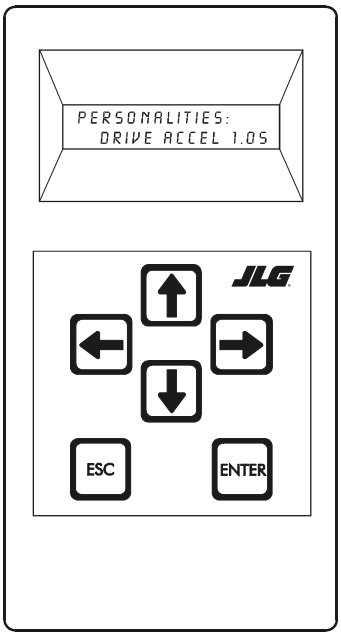


MENU:
ACCESS LEVEL 1

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

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:

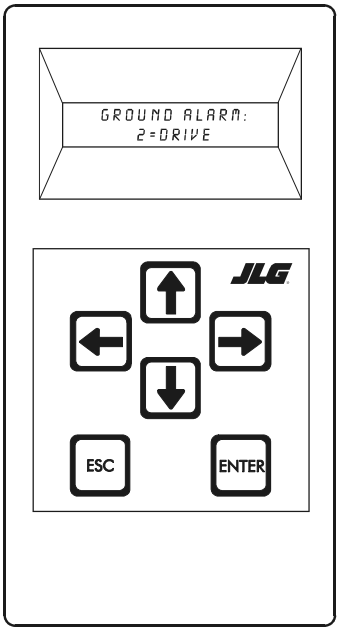


PERSONALITIES:
DRIVE ACCEL 1.0s

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 won arrows, check the access level to ensure you are at access level 1.

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 = DRIVE

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

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

NOTE: *Refer to Table 2-5, Personality Ranges/Defaults, and Table 2-6, Machine Setup Descriptions 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.

⚠ IMPORTANT

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

Machine Personality Settings

NOTE: *Personality settings can be adjusted within the adjustment range in order to achieve optimum machine performance.*

Table 2-5. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS
DRIVE	ACCELeration	0.5s to 5.0s	1.0
	DECELeration	0.1s to 2.0s	0.5
	MINimum speed	0 to 25%	3
	MAXimum speed	0 to 100%	100
	ELEVATED MAXimum speed	0 to 25%	20 10 for CE spec E45AJ
	CREEP MAXimum speed	0 to 45%	30
	POSITRAC time	0 to 60s	10
	POSITRAC current	50-250 A	170A
LOWER LIFT	ACCELeration	0.5 to 5.0s	1.0
	DECELeration	0.0 to 3.0s	0.5
	MINimum UP speed	0 to 30%	19
	MAXimum UP speed	0 to 100%	95
	MINimum DOWN speed	0 to 20%	7
	MAXimum DOWN speed	0 to 100%	47
UPPER LIFT	ACCELeration	0.5 to 5.0	2.0
	DECELeration	0.1 to 3.0	1.0
	MINimum UP speed	0 to 20	9
	MAXimum UP speed	0 to 100	67
	CREEP Maximum UP speed	0 to 50	30
	MINimum DOWN speed	0 to 10	2
	MAXimum DOWN speed	0 to 100	40
	CREEP maximum DOWN speed	0 to 30	10

Table 2-5. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS
SWING	ACCELeration	0.5 to 5.0s	2.7
	DECELeration	0.0 to 3.0s	1.8
	MINimum LEFT speed	0 to 10%	1
	MAXimum LEFT speed	0 to 60%	25
	CREEP maximum LEFT speed	0 to 35%	15
	MINimum RIGHT speed	0 to 10%	1
	MAXimum RIGHT speed	0 to 60%	25
	CREEP maximum RIGHT speed	0 to 35%	15
TELEscope	ACCELeration	0.5 to 5.0	1.0
	DECELeration	0.1 to 3.0	0.5
	MINimum IN speed	0 to 20	8
	MAXimum IN speed	0 to 100	60
	MINimum OUT speed	0 to 20	5
	MAXimum OUT speed	0 to 100	70
BASKET LEVEL	ACCELeration	0.5 to 5.0	1.0
	DECELeration	0.1 to 3.0	1.0
	MINimum UP speed	0 to 20	8
	MAXimum UP speed	0 to 50	20
	MINimum DOWN speed	0 to 20	5
	MAXimum DOWN speed	0 to 60	14
BASKET ROTATE	ACCELeration	0.5 to 5.0	1.5
	DECELeration	0.1 to 3.0	1.0
	MINimum LEFT speed	0 to 15	2
	MAXimum LEFT speed	0 to 100	23
	MINimum RIGHT speed	0 to 15	2
	MAXimum RIGHT speed	0 to 100	27

Table 2-5. Personality Ranges/Defaults

FUNCTION	PERSONALITY	RANGE	DEFAULTS
JIB	ACCELeration	0.5 to 5.0	1.5
	DECELeration	0.5 to 3.0	0.5
	MINimum UP speed	0 to 50	9
	MAXimum UP speed	0 to 100	50
	MINimum DOWN speed	0 to 25	6
	MAXimum DOWN speed	0 to 100	35
	MINimum RIGHT speed	0 to 50	5
	MAXimum RIGHT speed	0 to 100	20
	MINimum LEFT speed	0 to 50	5
	MAXimum LEFT speed	0 to 100	20
STEER	MINimum speed	0 to 100	75
	MAXimum speed	0 to 100	100
GROUND MODE	Lower LIFT UP speed	0 to 100	73
	Lower LIFT DOWN speed	0 to 100	36
	UPPER LIFT speed	0 to 100	51
	SWING speed	0 to 100	19
	TELEscope speed	0 to 100	53
	BASKET ROTATE speed	0 to 100	21
	BASKET LEVEL speed	0 to 100	30
	JIB SWING speed	0 to 100	N/A
	JIB LIFT speed	0 to 100	45

Table 2-6. Machine Setup Descriptions

MODEL NUMBER...	Displays/adjusts machine model NOTE: all personalities reset to default when model number is altered
TILT...	Displays/adjusts tilt sensor function
DRIVE CUTOUT...	Displays/adjusts drive cutout switch presence/ function
FUNCTION CUTOUT...	Displays/adjusts function cutout switch presence/function
JIB. . .	Displays/adjusts jib presence
GROUND ALARM...	Displays/adjusts ground alarm presence/ function
PLATFORM ALARM...	Displays/adjusts platform alarm presence/ function
BATTERY MONITOR...	Displays/adjusts battery monitor, which indicates “WATER BATTERIES” after a number of charge/discharge cycles

Machine Configuration Programming Information

NOTE: *The following information is to be used when working with the MACHINE SETUP menu. When configuring the machine, the machine configuration must be completed before any personality settings can be changed. Changing the personality settings first and then changing the model number of the machine configuration will cause the personality settings to return to default values.*

Default settings will be shown in bold type.

1. MODELS (names may change)

   1=E300
   2=M45; E45

2. TILT SENSOR

   When tilted the tilt light is lit (continuously) and drive speed is reduced to the creep speed setting

   1=5 degree - reduces the maximum speed of all platform functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted. (Domestic/Japan)

   2=3 degree - reduces the maximum speed of all platform functions to creep when tilted and above elevation. Reduces drive speed to creep when tilted. (European/Australian)

   3=3 degree - cuts out drive and reduces functions to creep speed when active and above elevation. Reduces drive speed to creep when tilted only. (Option)

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 tilted and above elevation.*

3. DRIVE CUTOUT

   0=Battery Charger Cutout - cuts out drive when the battery charger is plugged in
   1= Battery Charger Cutout and Simultaneous Drive and Boom functions disabled above elevation (European/Australian)
   2= Battery Charger Cutout and Drive Cutout above elevation (Option)

4. FUNCTION CUTOUT LIMIT SWITCH

   0= No Function Cutout
   1= Cuts out all boom functions when switch opens (Option)
   2= Cuts out all functions when the switch opens (Option)

5. JIB

   0=No jib installed
   1=Jib installed which has up and down movements only (Option)
   2=Jib installed which has up and down movements and side to side movements (Option)

6. GROUND ALARM

   0= No ground alarm installed
   1= Travel Alarm - Sounds when the drive function is active (Option)
   2= Descent Alarm - Sounds when either lift down is active (Option)

3= Motion Alarm - Sounds when any function is active (Option)

7. PLATFORM ALARM

   0= Sounds continuously when above elevation and tilted only.
   1= Sounds continuously when above elevation and tilted, and in conjunction with fault code flashes (Option)

8. BATTERY MONITOR

   0=No Battery Monitor
   1-20= Number of Charge/Discharge Cycles

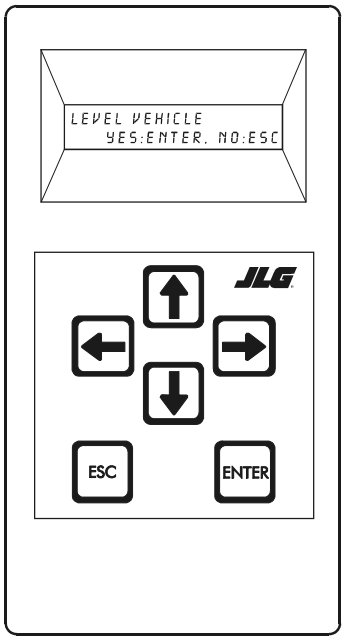
Level Vehicle Description

IMPORTANT

A NEW TILT MODULE WILL ACT AS IF IT IS TILTED ALL OF THE TIME UNTIL THE FOLLOWING PROCEDURE IS PERFORMED.

WARNING

DO NOT LEVEL VEHICLE EXCEPT ON A LEVEL SURFACE.



LEVEL VEHICLE
YES:ENTER, NO:ESC

Not available at password level 2 ENTER confirms that vehicle is currently level, and zeroes the tilt sensor measurements

Help Descriptions and Fault Flash Codes

Table 2-7. JLG Control System Flash Codes

Code	Description
2-1	Faulty Footswitch/EMS
2-2	Drive/Steer inputs/Footswitch Interlocks
2-3	Boom function inputs/Lift-Swing Joystick
2-5	Function Cutout/Drive Cutout
3-1	Contactors miswired/Motors miswired
3-2	Line contactor welded
3-3	Contactor short circuit or valve short circuit
3-5	Brake pressure input
4-2	Controller Overtemperature
4-4	Battery voltage out of range
5-5	Speed Sensor input
6-6	CANbus inputs
7-7	Traction /Pump motor wiring or motor faulty
9-9	Power Module Failure

Table 2-8. Help Descriptions and Fault Flash Codes

Flash Code	Description
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.	
	EVERYTHING OK The "normal" help message in platform mode
	GROUND MODE OK The "normal" help message in ground mode
	BRAKES RELEASED Indicates manual brake release in ground mode
	DRIVING AT CREEP - TILTED Drive speed is limited to creep because the vehicle is tilted.
	FWS OPEN A drive or boom function has been selected but footswitch is open.
	PUMP MOTOR AT CURRENT LIMIT Pump current has reached controller current limit or safe operating area limit.
	RUNNING AT CREEP - CREEP SWITCH OPEN All function speeds are limited to creep because the creep switch is open.
	RUNNING AT CUTBACK - ABOVE ELEVATION All function speeds are limited to cutback speed because the vehicle is above elevation.
	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION All function speeds are limited to creep because the vehicle it tilted and above elevation.
	TESTS ACTIVE - RECYCLE EMS TO END The system tests have been activated; normal vehicle operation is not allowed.
	TILT MODULE FAILURE: BAD TILT SENSOR There is a problem with the tilt sensor interface circuitry; the controller defaults to massively tilted and does not try to prevent vehicle roll on the grade.
	TRACTION MOTOR AT CURRENT LIMIT Traction current has reached controller current limit or safe operating area limit.
	WATER BATTERIES The batteries have been charged a number of times (set by machine digit) and need a top-up; when this is done the count will reset
2/1	**Flash code 2/1 indicates problems with the footswitch.**
	FWS FAULTY The two footswitch signals do not agree. EMS recycle required.
	START UP Neither EMS input is active - the system is just switching on or is discharging the capacitor bank. A welded line contactor might also cause this

Table 2-8. Help Descriptions and Fault Flash Codes

2/2	**Flash code 2/2 indicates problems with drive & steer selection.**
	DRIVE JOYSTICK FAULTY The drive joystick center tap is out of valid range, or the wiper is wire-off.
	DRIVE LOCKED - JOYSTICK MOVED BEFORE EMS/FWS Drive was selected before and during footswitch closure.
	FWS INTERLOCK TRIPPED Footswitch was closed for seven seconds with no function selected.
	STEER LOCKED - SELECTED BEFORE EMS/FWS Steer was selected before and during footswitch closure.
	STEER SWITCHES FAULTY Both steer switches are active together.
	WAITING FOR FWS TO BE OPEN Footswitch was closed when platform mode was selected.
	JOYSTICK FAULTS - CHECK PLATFORM BOX WIRING More than one of the drive, lift and swing joystick center tap or wiper voltages is out of range. This is probably due to a short-circuit across a joystick port.
2/3	**Flash code 2/3 indicates problems with boom function selection.**
	LIFT/SWING JOYSTICK FAULTY The lift or swing Joystick center tap is out of valid range, or the wiper is wire-off.
	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE EMS/FWS Upper Lift or swing was selected before and during footswitch closure.
	PUMP POT FAULTY The pump pot is open-circuit; all platform boom functions except upper lift & swing will run at creep.
	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 EMS/FWS A boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before and during footswitch closure.
	PUMP SWITCHED LOCKED - SELECTED BEFORE EMS A ground boom function (lower lift, telescope, basket level, basket rotate, jib) was selected before keyswitch.
	SWING/LIFT JOYSTICK FAULTY The swing joystick center tap is out of valid range, or the wiper is wire-off.

Table 2-8. Help Descriptions and Fault Flash Codes

2/5	**Flash code 2/5 indicates that a function is prevented due to a cutout.**
	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.
	BOOM PREVENTED - FUNCTION CUTOUT ACTIVE A boom function is selected while function cutout is active and configured to cutout boom functions.
	DRIVE & BOOM PREVENTED - FUNCTION CUTOUT ACTIVE Drive or a boom function is selected while function cutout is active and configured to cutout all functions.
	DRIVE PREVENTED - ABOVE ELEVATION Drive is selected while above elevation and drive cutout is configured to prevent drive.
	DRIVE PREVENTED - BOOM MOVEMENT SELECTED Drive is selected while a boom function is selected and drive cutout is configured to prevent simultaneous drive & boom operation.
	DRIVE PREVENTED - CHARGER CONNECTED Drive is selected while the charger is on (indicated by drive cutout being active) and drive cutout is configured to prevent drive.
	DRIVE PREVENTED - TILTED AND ABOVE ELEVATION Drive is selected while drive cutout is active and drive cutout is configured to prevent drive.
	TILT MODULE FAILURE: NOT COMMUNICATING There is a problem with the positrac/tilt module; the controller defaults to massively tilted and does not try to prevent vehicle roll on the grade.
3/1	**Flash code 3/1 indicates that a contactor did not close when energized.**
	LINE & DIRECTION CONTACTORS MISWIRED When the line contactor was closed traction point A went high (and the capacitor bank charge did not increase to battery supply) - this occurs if the line contactor coil wiring is swapped with that for a direction contactor coil.
	OPEN-CIRCUIT FORWARD DIRECTION CONTACTOR OR TRACTION MOTOR Traction point A did not go high when forward contactor was energized (this could be due to traction motor open-circuit or a power wiring error).
	OPEN-CIRCUIT LINE CONTACTOR OR TRACTION MOTOR The capacitor bank charge did not increase to battery supply when line contactor was energized (this could be due to a power wiring error).
	OPEN-CIRCUIT REVERSE DIRECTION CONTACTOR Traction point A did not go high when reverse contactor was energized (this could be due to traction motor open-circuit or a power wiring error).
3/2	**Flash code 3/2 indicates that a contactor did not open when energized.**
	WELDED LINE CONTACTOR The capacitor bank charge did not decrease from battery supply when line contactor was deenergized (this could be due to a power wiring error). WARNING: If the line contactor is welded, the controller will not switch off when EMS or keyswitch is turned off.

Table 2-8. Help Descriptions and Fault Flash Codes

3/3	**Flash code 3/3 indicates that a contactor coil is short-circuited.**
	OVERLOADED VALVE SUPPLY-CHECK WIRING. There is a high current draw from the valve supply when no valve is energized; this is probably due to a wiring error at the ground module.
	SHORT-CIRCUIT FORWARD CONTACTOR COIL The forward contactor was not energized when required, due to coil overcurrent protection.
	SHORT-CIRCUIT LINE CONTACTOR COIL The line contactor was not energized when required, due to coil overcurrent protection.
	SHORT-CIRCUIT REVERSE CONTACTOR COIL The reverse contactor was not energized when required, due to coil overcurrent protection.
3/5	**Flash code 3/5 indicates that there is a brake pressure problem.**
	BRAKES DID NOT LOCK Brake pressure did not clear when the brake valve was deenergized.
	BRAKES DID NOT RELEASE No brake pressure was detected when running the pump motor and energizing the brake valve
4/2	**Flash code 4/2 indicates that the controller is over temperature.**
	CONTROLLER TOO HOT - PLEASE WAIT The controller heatsink temperature reached 75 degrees. The controller is shut down until it cools to below 70 degrees.
4/4	**Flash code 4/4 indicates problems with the battery supply.**
	BATTERY LOW Battery voltage is below 40V. This is a warning - the controller does not shut down.
	BATTERY TOO HIGH - SYSTEM SHUT DOWN Battery voltage is above 62V. EMS recycle required.
	BATTERY TOO LOW - SYSTEM SHUT DOWN Battery voltage is below 33V. EMS recycle required.
5/5	**Flash code 5/5 indicates problems with vehicle speed or the encoder.**
	NO VEHICLE MOVEMENT DETECTED AT MAXIMUM POWER No speed was measured with traction motor full on. This could be due to a traction motor fault, a power wiring error, a speed encoder fault, the brakes not releasing (although brake Pressure is OK) or the vehicle being overloaded so that the motor cannot turn the wheels.
	DRIVE PREVENTED - BOTH SPEED ENCODERS FAULTY Both speed encoder input voltages are out of range.
	LEFT SPEED ENCODER FAULTY The left speed encoder input voltages are out of range. The vehicle will continue to drive at cutback using the right speed encoder.
	RIGHT SPEED ENCODER FAULTY The right speed encoder input voltages are out of range. The vehicle will continue to drive at cutback using the left speed encoder.
	SPEED ENCODERS READING INVALID SPEED One or both speed encoders is indicating an impossible number of pulses. This is probably due to a faulty speed encoder.
	VEHICLE RUNAWAY - CHECK SPEED ENCODERS Speed in the wrong direction was measured with traction motor full on. This is probably due to the speed encoder being fitted incorrectly; it could also be due to a speed encoder fault or faults as for "NO VEHICLE MOVEMENT DETECTED" with the vehicle on a grade.

Table 2-8. Help Descriptions and Fault Flash Codes

6/6	**Flash code 6/6 indicates problems with the CANbus.**
	48V PROTECTION TRIPPED - CHECK INTER-MODULE WIRING The power module is not receiving acknowledgments from the platform or ground modules to transmitted data, and the protection circuit which supplies the platform and ground modules has tripped. This is probably due to wiring problems at the platform or ground module.
	CANbus FAILURE: GROUND MODULE The power module is receiving from the platform module but not the ground module. This should not be possible!
	CANbus FAILURE: PLATFORM MODULE The power module is receiving from the ground module but not the platform module. This is probably due to wiring problems between the platform and ground modules.
	CANbus FAILURE: POWER MODULE The power module is not receiving acknowledgments from the platform or ground modules to transmitted data. This is probably due to wiring problems between the ground and power modules.
7/7	**Flash code 7/7 indicates problems with a motor.**
	CAPACITOR BANK FAULT - CHECK POWER CIRCUITS The capacitor bank is not charging. This is probably due to a power wiring error causing illegal current drain; it could also be due to a very low battery supply.
	OPEN-CIRCUIT PUMP MOTOR Pump point A is collapsing when the pump MOSFETs are pulsed. This is probably due to an open circuit pump motor or a power wiring error.
	OPEN-CIRCUIT DIRECTIONAL CONTACTOR OR TRACTION MOTOR Traction point A is collapsing when the traction MOSFETs are pulsed. This is probably due to an open circuit traction motor or a power wiring error. NOTE: This fault is unlikely to be seen due to interaction with speed control...
	PUMP POINT A LOW - CHECK POWER CIRCUITS Pump point A is near 0V when the pump MOSFETs are off. This is probably due to a power
	STALLED TRACTION MOTOR The power module traction MOSFET protection circuit is active. This is due to massive current drain and could be a stalled traction motor or a power wiring error.
	STALLED PUMP MOTOR The power module pump MOSFET protection circuit is active. This is due to massive current drain and could be a stalled pump motor or a power wiring error.
	TRACTION MOTOR OVERLOADED The traction motor has been operating in current limit at a low percentage on for a period of time greater than 10 seconds.
	PUMP MOTOR OVERLOADED The pump motor has been operating in current limit at a low percentage on for a period of time greater than 10 seconds.
	TRACTION CURRENT AT ZERO - CHECK SHUNT WIRING Traction current measurement is at zero. This is probably due to an open-circuit between the current measurement shunt and the power module.
	TRACTION POINT A HIGH - CHECK POWER CIRCUITS Traction point A is near battery supply when neither direction contactor is energized and the traction MOSFETs are off. This could be due to a welded direction contactor or a power wiring error.
	TRACTION POINT A LOW - CHECK POWER CIRCUITS Traction point A is near 0V when neither direction contactor is energized and the traction MOSFETs are off. This could be due to a power wiring error.

Table 2-8. Help Descriptions and Fault Flash Codes

9/9	**Flash code 9/9 indicates problems with the controller.**
	POWER MODULE FAILURE: CONTACTOR DRIVE CODE 1 A contactor remained energized when turned off.
	POWER MODULE FAILURE: HWFS CODE 2 The hardware failsafe tests did not complete because traction point A is not safe, or the hardware failsafe is permanently tripped.
	POWER MODULE FAILURE: HWFS CODE 3 The hardware failsafe tests did not complete because a contactor was energized when all should be turned off
	POWER MODULE FAILURE: HWFS CODE 4 The hardware failsafe tests did not complete because the hardware failsafe tripped immediately when the traction MOSFETs were turned on.
	POWER MODULE FAILURE: HWFS CODE 10 The hardware failsafe tests failed because the hardware failsafe did not trip within the allowed test time.
	POWER MODULE FAILURE: HWFS CODE 11 The hardware failsafe tests failed because the hardware failsafe tripped too slowly.
	POWER MODULE FAILURE: HWFS CODE 12 The hardware failsafe tests failed because the hardware failsafe tripped too quickly.
	POWER MODULE FAILURE: HWFS CODE 13 The hardware failsafe tests failed because the hardware failsafe remained tripped when the traction MOSFETs were turned off.
	POWER MODULE FAILURE: HWFS CODE 14 The hardware failsafe tests failed because the line contactor could still be energized when the hardware failsafe was tripped
	POWER MODULE FAILURE: HWFS CODE 15 The hardware failsafe tests failed because the contactor drive failsafe did not trip within the allowed test time.
	POWER MODULE FAILURE: HWFS CODE 16 The hardware failsafe tests failed because the contactor drive failsafe tripped too slowly.
	POWER MODULE FAILURE: HWFS CODE 17 The hardware failsafe tests failed because the contactor drive failsafe tripped too quickly.
	POWER MODULE FAILURE: HWFS TEST STALLED The hardware failsafe tests did not complete, but no reason can be determined.
	POWER MODULE FAILURE: BAD TEMPERATURE SENSOR The temperature sensor measurement is invalid, this is probably due to a disconnected wire within the power module. The possibility of other disconnected wires (which could cause dangerous system function) means that the controller is shut down.
	POWER MODULE FAILURE: S/C LINE CONTACTOR DRIVER The line contactor energized when the footswitch was closed, before it was turned on, this is probably due to a failed driver within the power module, although it could be due to bad power module wirings

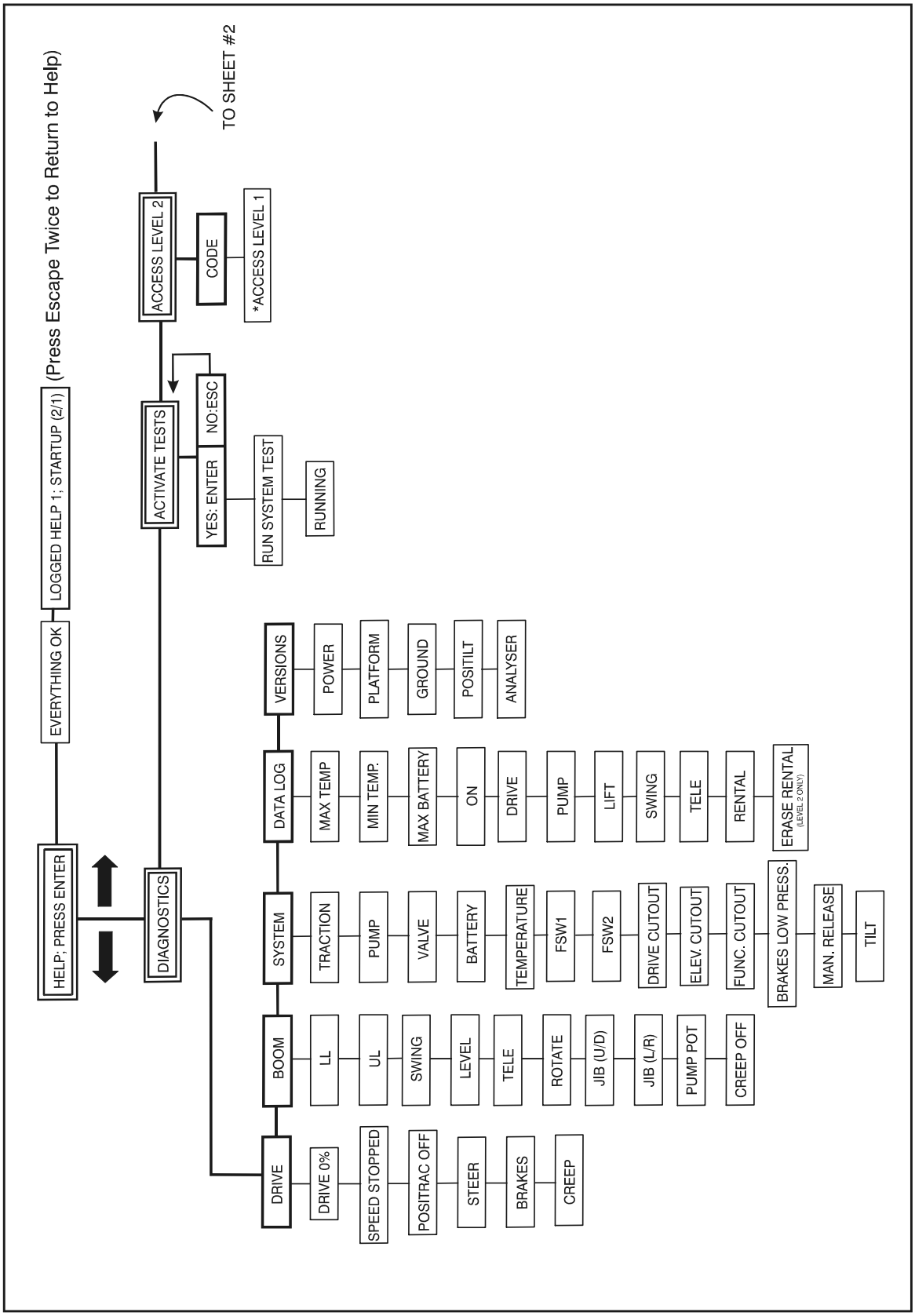


Figure 2-46. Analyzer Flow Chart - Sheet 1 of 2

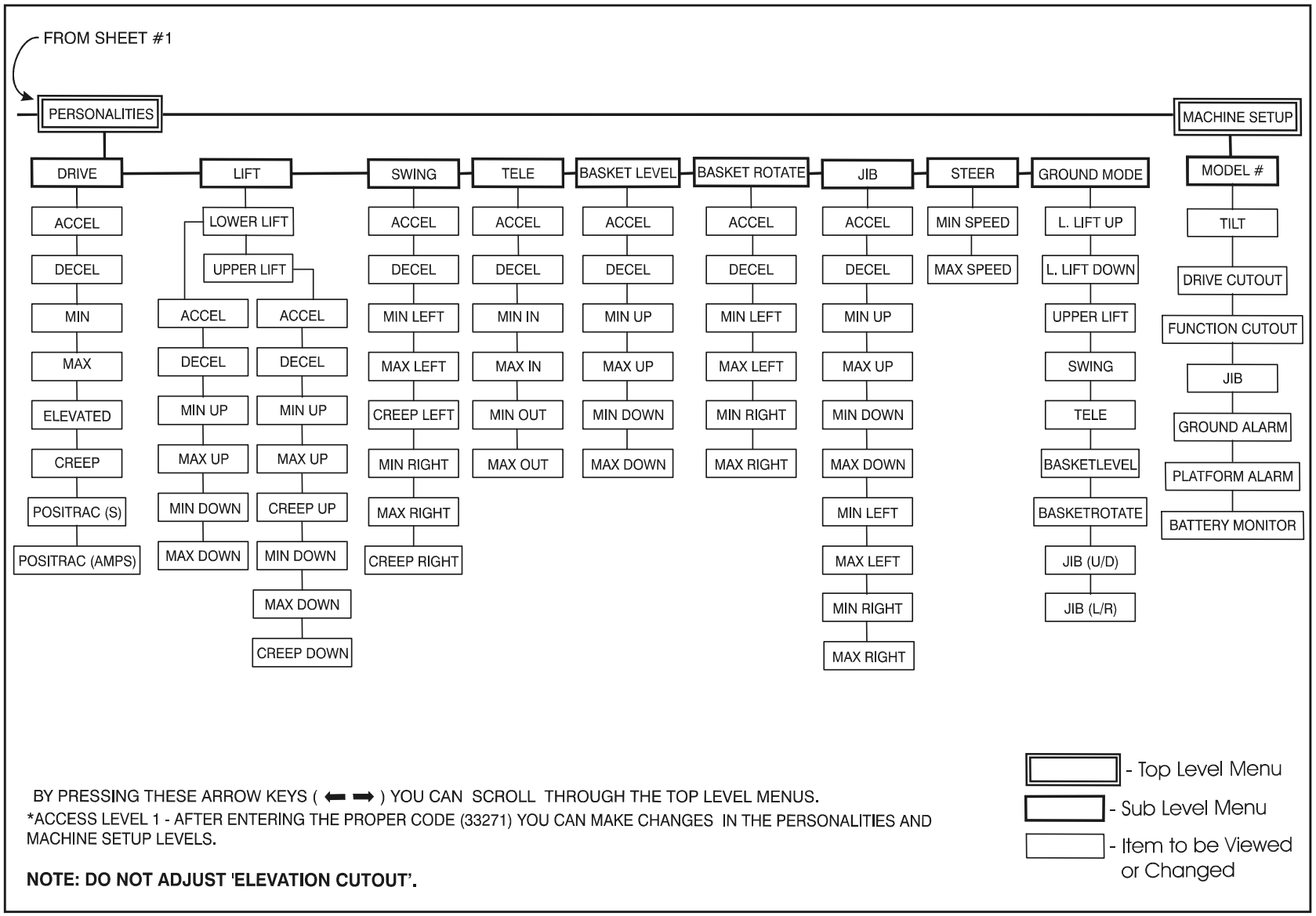


Figure 2-47. Analyzer Flow Chart - Sheet 2 of 2

Analyzer Diagnostics Menu Structure

In the following structure descriptions, an intended item is selected by pressing ENTER; pressing ESC steps back to the next outer level. The LEFT/RIGHT arrow keys move between items in the same level. The UP/DOWN arrow keys alter a value if allowed

Table 2-9. DIAGNOSTICS - Menu Descriptions

DRIVE	
DRIVE . . .	Displays drive joystick direction & demand
SPEED . . .	Displays vehicle direction & speed
POSITRAC . . .	Displays positrac status
STEER . . .	Displays steer switch direction & demand NOTE: steer demand is inversely proportional to vehicle speed
BRAKES . . .	Displays brake control system status
CREEP . . .	Displays pump pot creep switch status
BOOM	
LL....	Displays lower lift switch direction & demand NOTE: demand is controlled by the pump pot
UL . .	Displays upper lift joystick direction & demand
SWING . . .	Displays swing joystick direction & demand
LEVEL .. .	Displays basket level switch direction & demand NOTE: demand is controlled by the pump pot
TELE . . .	Displays telescope switch direction & demand NOTE: demand is controlled by the pump pot
ROTATE . .	Displays basket rotate switch direction & demand NOTE: demand is controlled by the pump pot
JIB (U/D) ..	Displays jib lift switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
JIB (L/R)	Displays jib swing switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
PUMP POT ...	Displays pump pot demand
CREEP . . .	Displays pump pot creep switch status
SYSTEM	
TRACTION . . .	Displays measured traction motor current
PUMP ...	Displays measured pump motor current
VALVE . . .	Displays measured valve (12V supply) current NOTE: this includes current for the ground alarm & hourmeter, but not for any lamps
BATTERY . . .	Displays measured battery voltage
TEMPERATURE . . .	Displays measured heatsink temperature
FSW1 . . .	Displays footswitch status
FSW2 . . .	Displays footswitch status NOTE: FSW2 is wired to the platform module
DRIVE CUTOUT ...	Displays drive cutout switch status
ELEV. CUTOUT ...	Displays elevation cutout switch status
FUNC. CUTOUT ...	Displays function cutout switch status
BRAKES . . .	Displays brake pressure switch status
MAN.RELEASE . . .	Displays manual brake release switch status

Table 2-9. DIAGNOSTICS - Menu Descriptions

TILT . . .	Displays measured vehicle tilt The first value indicates tilt in die forwards reverse direction (pitch) The second value indicates tilt in the left/ right direction (roll)
DATALOG	
MAX.TEMP . . .	Displays maximum measured heatsink temp.
MIN.TEMP . . .	Displays minimum measured heatsink temp.
MAX . BATTERY . .	Displays maximum measured battery voltage
ON . . .	Displays total controller on (EMS) time
DRIVE . . .	Displays total controller drive operation time
PUMP ...	Displays total controller pump running time NOTE: includes all boom functions, steer and brake release
LIFT . ..	Displays total controller lift operation time
SWING . . .	Displays total controller swing operation time
TELE . . .	Displays total controller tele operation time
RENTAL . . .	Displays total controller operation time NOTE: can be reset
ERASE RENTAL YES:ENTER, NO:ESC ENTER	Not available at password level 2 Enter resets rental datalog time to zero
VERSIONS	
POWER	Displays power software version
PLATFORM	Displays platform software version
GROUND	Displays ground software version
POSITILT	Displays positilt software version
ANALYZER	Displays analyzer software version

System Self Test

The system self test is utilized to locate typical problems. See Table 2-10, System Test Descriptions and Table 2-11, System Test Messages for information concerning the tests performed and available messages in this mode.

1. When the keyswitch is in the platform position and the self test enabled, the self test function will test all valves, contactors, platform inputs, indicator lamps, and system alarms for various fault conditions.

   When the keyswitch is in the ground position, the self test function will test all valves, the line contactor, ground control inputs, and the ground alarm output for various fault conditions.

2. In order to test the inputs on the machine, the controller will ask the service technician to perform various tasks at the appropriate operator control station. An example of this is "Close LLU Switch". The controller expects the operator to close the lower lift up switch. When the controller sees that the lower lift up switch has been closed, it will move on to the next input, lower lift down LLD. If the switch is faulty or the wiring is faulty, the controller will not move on to the next input. The controller will continue to wait for the closure of the input. If the operator knows the switch is faulty and wants to continue the tests he must simply press the enter key on the analyzer to continue.

3. After the controller has conducted the tests from the chosen operator station, it will display "TESTS COMPLETE". This indicates that the controller has checked all inputs and outputs for that station.

⚠ IMPORTANT

IN ORDER FOR THE MACHINE TO FUNCTION AFTER THE SELF TEST IS COMPLETE, POWER MUST BE RECYCLED USING THE EMS OR THE KEYSWITCH.

Table 2-10. System Test Descriptions

ACTIVATE TESTS YES:ENTER, NO:ESC	Not available once tests are activated ENTER activates system tests NOTE: cannot be done while controller is in use (footswitch closed) and for a short time afterwards
RUN SYSTEM TEST	ENTER starts system test Not available until tests are activated Displays messages while system test runs Some messages are prompts, requiring user intervention. ENTER can be pressed if a fault is found, to confirm that the fault has been noted and to continue the system test. NOTE: a flashing message is critical, and prevents the system test running

Table 2-11. System Test Messages

RUNNING	Initial display when system test is run; certain "critical" checks are made. Problems which can be reported include: ONLY 1 ANALYZER! Do not connect two Analyzers while running the system test. BAD POWER WIRING The capacitor bank is not charged or pump point A is low or traction point A is high or low. Check all power wiring. LINE CONT WELDED The capacitor bank is at battery voltage. Check line contactor. Check all power wiring. BATTERY TOO LOW The system test cannot run with battery voltage below minimum. BATTERY TOO HIGH The system test cannot run with battery voltage above maximum. CHECK CAN WIRING The system test cannot run in platform mode unless data is being received from the platform, ground and positrac/tilt modules. The system test cannot run in ground mode unless data is being received from the ground and positrac/tilt modules. CHECK LEFT SPD. There is an open- or short- circuit in the left speed encoder wiring. Check left speed encoder. CHECK RIGHT SPD. There is an open- or short- circuit in the right speed encoder wiring. Check right speed encoder. CHECK SHUNT The traction current measurement is open-circuit. Check wiring between power module and contactor panel. BAD PUMP WIRING Pump point A is not high, probably caused by an open-circuit pump motor or wiring. Check all power wiring. Check pump motor. BAD POWER MODULE An internal problem was detected in the power module. BAD POWER WIRING Traction point A is high, probably caused by incorrect faction motor wiring. Check all power wiring. Check traction motor. HIGH TILT ANGLE The vehicle is very tilted, or the tilt sensor has been damaged. Check tilt sensor. HOT POWER MODULE The heatsink temperature exceeds 75 C; this is only a warning. BAD I/O PORTS The controller detected a problem with its internal circuits at switchon. 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 switchon. Check and, if necessary correct, all personality settings. WAIT:CAPBANK HI This message can be displayed if the system test is run shortly after the vehicle was used; after a short wait, it should clear. OPEN FWS In platform mode, the footswitch must be open at the start of the test. CLOSE FWS In platform mode, the footswitch must be closed when this message is displayed; the foot switch MUST BE KEPT CLOSED during the valve & contactor tests. BAD FWS 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.

Table 2-11. System Test Messages

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. The valves are tested in the order: PROP (main proportional), LL U, LL D, UL U, UL D, SWING L, SWING R, SWING REST, LEVEL U, LEVEL D, ROTATE L, ROTATE R, JIB U, JIB D, TELE I, TELE O, BYPASS, STEER L, STEER R, STEER PROP, BRAKE NOTE: in platform mode, the footswitch must be closed. NOTE: jib valves are not tested if JIB = NO Problems which can be reported include: CANT TEST VALVES There is a wiring problem which prevents the valve test from functioning correctly. Check valve wiring. Check ground alarm wiring. valvename S/C The named valve is drawing too much current so is presumed to be short-circuit. Check valve wiring. valvename O/C The named valve is drawing too little current so is presumed to be open-circuit. Check valve wiring.
VALVE TEST DONE	Indicates that the valve test is complete (with or without faults).
TESTING CONTS	Indicates that the contactor test is beginning. In platform mode, the forward & reverse direction contactors are energized and de-energized; checks are made that they close & open correctly and for short-circuit coils. In platform and ground mode, the line contactor is energized and de-energized; checks are made that it closed & opened correctly and for a short-circuit coil. In platform mode, the positrac contactors are energized and de-energized; checks are made for short-circuit and open-circuit coils. Problems which can be reported include: CANT TEST CONTS There is a wiring problem which prevents the contactor test from functioning correctly. Check power wiring. Check contactor wiring. BAD CONT WIRING There is a wiring problem which caused the capacitor bank to be charged when a direction contactor was energized; probably the wiring to the contactor coils is incorrect. Check contactor wiring. Check power wiring. contname WELDED The named contactor appears to have not opened. Check named contactor. Check power wiring. contname COIL S/C The named contactor coil overloaded its driver circuit so is presumed to be short-circuit. Check contactor wiring. contname DIDN'T CLOSE The named contactor appears to have not closed. Check contactor wiring. Check power wiring.
CONT TEST DONE	Indicates that the contactor test is complete (with or without faults).

Table 2-11. System Test Messages

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, inputs are tested in the order: UL U, UL D, UL JOY., SWING L, SWING R, SWING JOY., LEVEL U, LEVEL D, PUMP POT., ROTATE L, ROTATE R, LL U, LL D, JIB U, JIB D, TELE I, TELE O, DRIVE FWD, DRIVE REV, DRIVE JOY., STEER L, STEER R, POSITRAC, DRIVE C/O, ELEV. C/O, FUNC. C/O, BRAKE PRES In ground mode, inputs are tested in the order: ROTATE L, ROTATE R, LEVEL U. LEVEL D, JIB U. JIB D, TELE I, TELE O, UL U, UL D, LL U, LL D, SWING L, SWING R, ELEV. C/O, FUNC. C/O, BRAKE PRES, MAN. BRAKE 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 which can be reported include: CHECK switchname The named switch is not in its "normal" position. Check switch & wiring. CHECK switchname JOY. The named joystick appears to be faulty. Check joystick.
INPUTS DONE	Indicates that the inputs test is complete (with or without faults).
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 to continue the test. Lamps are tested in the order: ENABLE, FAULT, TILT, CREEP, POSITRAC, WATER. NOTE: lamps which are not in use (due to the settings of machine digits) are not checked. NOTE: lamps are only tested in platform mode. Problems which can be reported include: lampname S/C A short-circuit condition appeared while the named lamp was being tested, presumably because it is short-circuit.
LAMP TEST DONE	Indicates that the lamps test is complete.
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 to continue the test. Alarms are tested in the order: P.ALARM, G.ALARM. NOTE: the platform alarm is only tested in platform mode. NOTE: the ground alarm is not tested if GROUND ALARM = NO. Problems which can be reported include: alarmname S/C A short-circuit condition appeared while the named alarm was being tested, presumably because it is short-circuit.
ALARM TEST DONE	Indicates that the alarms test is complete.

Table 2-11. System Test Messages

TEST ALL INPUTS?	Prompts whether to check every operator input. If ESC is pressed, the system test ends. If ENTER is pressed, each operator input is prompted for in turn. In platform mode, operator inputs are tested in the order: UL U, UL D, SWING L, SWING R, LEVEL U, LEVEL D, PUMP POT, CREEP, ROTATE L, ROTATE R, LL U, LL D, JIB U, JIB D, TELE I, TELE O, DRIVE FWD, DRIVE REV, STEER L, STEER R, POSITRAC In ground mode, operator inputs are tested in the order: ROTATE L, ROTATE R. LEVEL U. LEVEL D, JIB U. JIB D, TELE I, TELE O. UL U. IJL D, LL U. LL D, SWING L, SWING R NOTE: the jib switches are not tested if JIB = NO. Prompts displayed during the operator input test include: CLOSE switchname The named switch should be closed. OPEN switchname The named switch should be opened. joystickname direction TO MAX The named joystick should be pushed to its full extent in the named direction. joystickname direction 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 to return to the RUN SYSTEM TEST Analyzer menu.

2.25 GENERATOR

NOTE: *Throughout the Generator section, the abbreviations RBS and CTS are used. RBS stands for Rotary Battery System, which is the generator system. CTS stands for Call To Start, which is the electronic inputs which signal the generator to start and charge the batteries.*

The generator consists of a drive engine, controller, and related components.

- **Alternator**

The alternator is a brushless, DC output alternator. The 3 phase output of the alternator is full wave rectified and directed to the output terminator.

The output rating is 58 volts DC at 45 amps. Voltage regulation and current limiting is provided by the Engine/Generator Controller.

The rectifier diodes and output current sensor are located in the alternator end.

- **Dynamo and Dynamo Voltage Regulator**

The engine is equipped with a 12 Volt, 15 Amp DC output dynamo.

- **Dynamo Output Fuse**

The dynamo output fuse is used to protect the output of the dynamo. This fuse is rated at 20 Amps DC, slow blow and is located on the left side of the engine.

- **Control Fuse**

This fuse provides power to the engine/generator and the relays for start control, fuel control, and pre-heater. This fuse is rated at 15 Amps DC and is located on the right side of the engine.

- **Start Battery**

A 12 volt lead-acid battery is utilized to provide starting power for the generator and power for the generator controls. This battery is charged by the engine dynamo and dynamo regulator when the engine is running.

- **Engine Starter**

The engine is equipped with a 12 Volt DC starter. This starter provides mechanical power to crank the engine. Electrical power for the starter is provided by the start battery. The starter is energized by the start control relay.

- **Start Control Relay**

The start control relay energizes the solenoid of the engine starter and the pull coil of the engine fuel solenoid. The start control relay is located on the fuel solenoid bracket on the right side of the engine. The start control relay is energized by the engine/generator controller.

- **Fuel Control Relay**

The fuel control relay energizes the hold coil of the fuel solenoid. The fuel control relay is energized by the engine/generator controller.

- **Fuel Solenoid**

The fuel solenoid actuates the run/stop lever of the engine. This solenoid has a pull and hold coil. The pull coil is energized by the start control relay and the hold coil is energized by the fuel control relay.

- **Engine Oil Temperature Sensor**

The engine oil temperature sensor is used to sense the temperature of the oil in the sump of the engine. This sensor provides a signal to the engine/generator controller for high engine temperature shutdown.

- **Alternator Output Current Sensor**

The alternator output current sensor provides a signal proportional to the output current of the alternator to the engine/generator controller. This signal is used by the controller to regulate the current output of the alternator. The output current is regulated at 55 Amps DC. The alternator output current sensor is located inside the rear cover of the alternator.

- **Engine Speed Sensor**

The engine speed sensor provides a signal proportional to the rotational speed of the engine to the engine/generator controller. This signal is used by the controller to determine starter cut-out, overspeed fault, and underspeed fault. This signal has failsafe protection, if it is not present at the controller, the unit will fault with a loss of speed signal indication. The engine speed sensor is located inside the recoil starter cover at the front of the engine.

- **Engine Low Oil Pressure Switch**

The engine is equipped with a low oil pressure switch. The switch is closed when the oil pressure is below 14.2 psi (1 Bar).

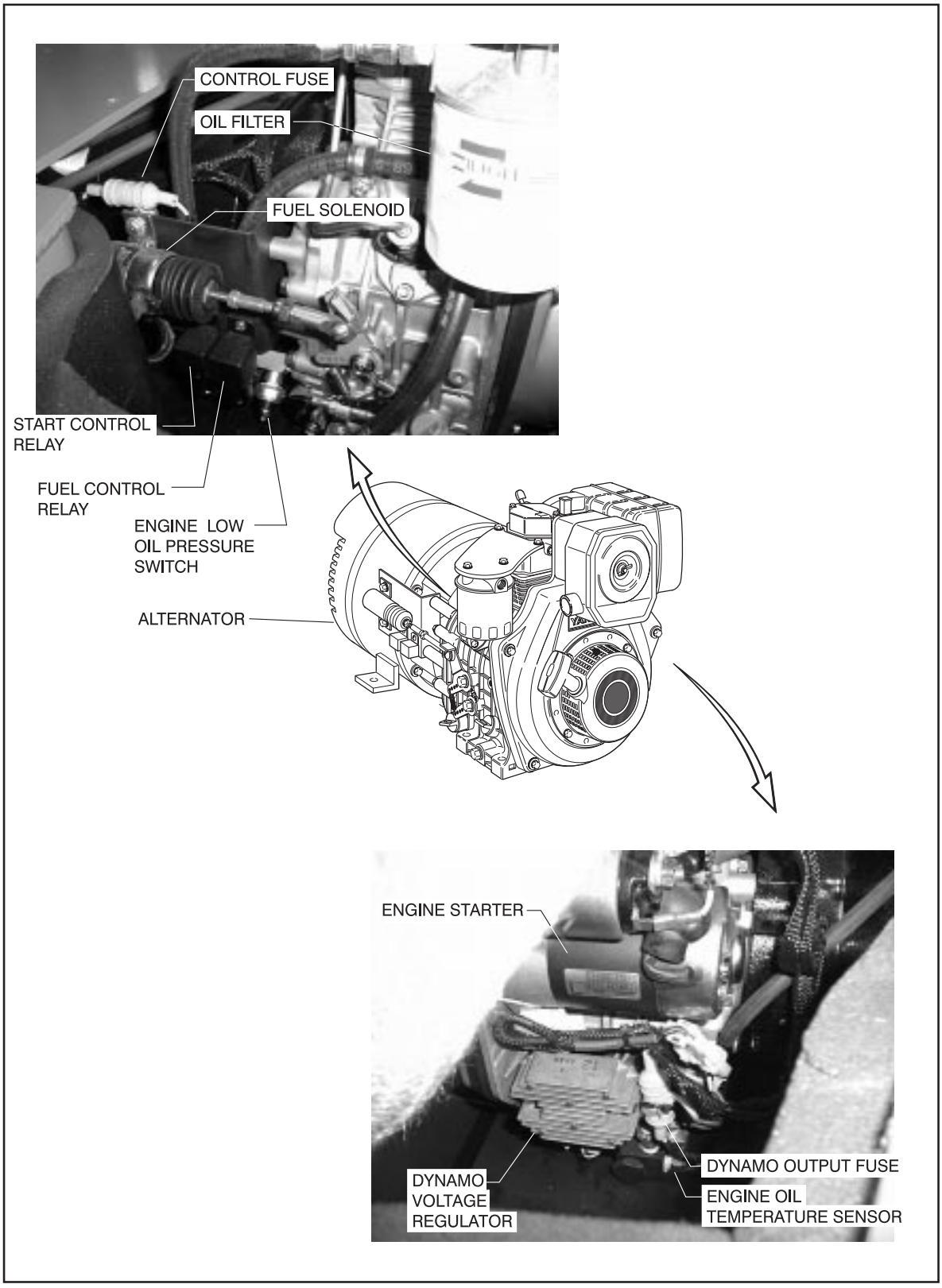


Figure 2-48. Generator Components

Timing Sequences

- **RBS Prestart Sequence**

1. Time Delay Engine Start (TDES)

   TDES is the period which the RBS waits to verify that the CTS is valid rather than a transient condition.

2. Time Delay Pre-Heat (TDPH)

   TDPH, if enabled, occurs after TDES has elapsed and the engine temperature is below the factory set engine preheat temperature setting. The engine preheater will be energized for the factory set preheat delay period.

Table 2-12. RBS Prestart Sequence

CTS (Call to Start)
TDES (Engine Start)
Preheat Delay
RBS Startup Sequence

- **RBS Startup Sequence**

1. Crank Time

   The RBS will crank for a period up to the crank time or until the engine starts.

2. Rest Time

   If the engine does not successfully start, the RBS will wait for the rest time before attempting to crank the engine again.

3. Crank Cycles

   The RBS will attempt to start the engine up until the number of crank cycles is reached. If the RBS does not start, an Overcrank fault is indicated.

4. Time Delay Bypass (TDBP)

   Once the engine starts, TDBP must elapse before low oil pressure and underspeed shutdowns are activated. This allows the engine to come up to normal operating conditions before enabling these shutdowns are monitored.

Table 2-13. RBS Startup Sequence

Crank Time -> Rest Time (Until Engine Start or # of Crank Cycles)
TDBP Bypass
Normal Running Operation

- **RBS Shutdown Sequence**

Once all CTS conditions have been removed, the RBS will begin the shutdown sequence. If a CTS condition is initiated during the shutdown sequence, the RBS will return to normal running operation until the CTS is removed.

1. Time Delay Engine Run (TDER)

   Once the CTS condition is removed, the TDER period begins. This period ensures that no further CTS conditions occur prior to the cooldown period.

2. Time Delay Cooldown (TDC)

   Once the TDER period ends, the alternator output is reduced to a minimal level in order to allow the engine to cool down for the TDC period. If a CTS is received during the TDC period, the CTS must last for at least the TDES period for the RBS to return to normal running operation.

Table 2-14. RBS Shutdown Sequence

Remove CTS
TDER Engine Run
TDC Cooldown
Engine Stop

To Connect the JLG Control System Analyzer to the Generator

The JLG Control System Analyzer can be used to monitor generator settings and conditions. Connect the analyzer as follows:

1. Connect the four pin end of the cable supplied with the analyzer, to the connector behind the ground control module located on the left side of the machine next to the ground control station and connect the remaining end of the cable to the analyzer. The ground control module contains the settings for the generator.

NOTE: *The cable has a four pin connector at each end of the cable; the cable cannot be connected backwards.*

2. Power up the Analyzer by pulling out the ground station EMS and positioning the Generator Enable switch on the platform control box to the "on" position. Refer to Figure 2-49., Generator System Analyzer Flow Chart

Alarms and Fault Flash Codes

In the event of an RBS alarm, a flash code will be issued and an alarm indicated on the analyzer.

NOTE: *Alarms must be reset once the fault has been corrected.*

Table 2-15. Generator System Flash Codes

Code	Alarm	Description
1-1	Low Oil Pressure	Shutdown due to low engine oil pressure
1-2	High Engine Temperature	Shutdown due to high engine oil temperature
1-3	Engine Overspeed	Shutdown due to high engine speed
1-4	Engine Underspeed/Overcrank	Shutdown due to engine overcrank or underspeed
1-5	No Speed Signal	Shutdown due to loss of speed signal
2-1	Overvoltage	Shutdown due to high output voltage
2-2	Engine Starting System fault	Alarm not a shutdown; Indicates problem with the engine starting system
2-3	Not Used	Not Used
2-4	Loss of Voltage Sense	Shutdown due to loss of voltage sensing
Continuous	Unit Disabled	No Faults. RBS enabled and can respond to any CTS
Off	Unit Disabled	RBS off or disabled; Will not respond to any CTS

- **Low Oil Pressure**

Enabled once TDBP (time delay bypass) period has elapsed after engine startup. If the low engine oil pressure switch closes, the engine will stop immediately and a low oil pressure alarm will be indicated.

- **High Engine Temperature**

If the engine oil temperature exceeds the high engine temperature setting, the engine will stop immediately and a low oil pressure alarm will be indicated.

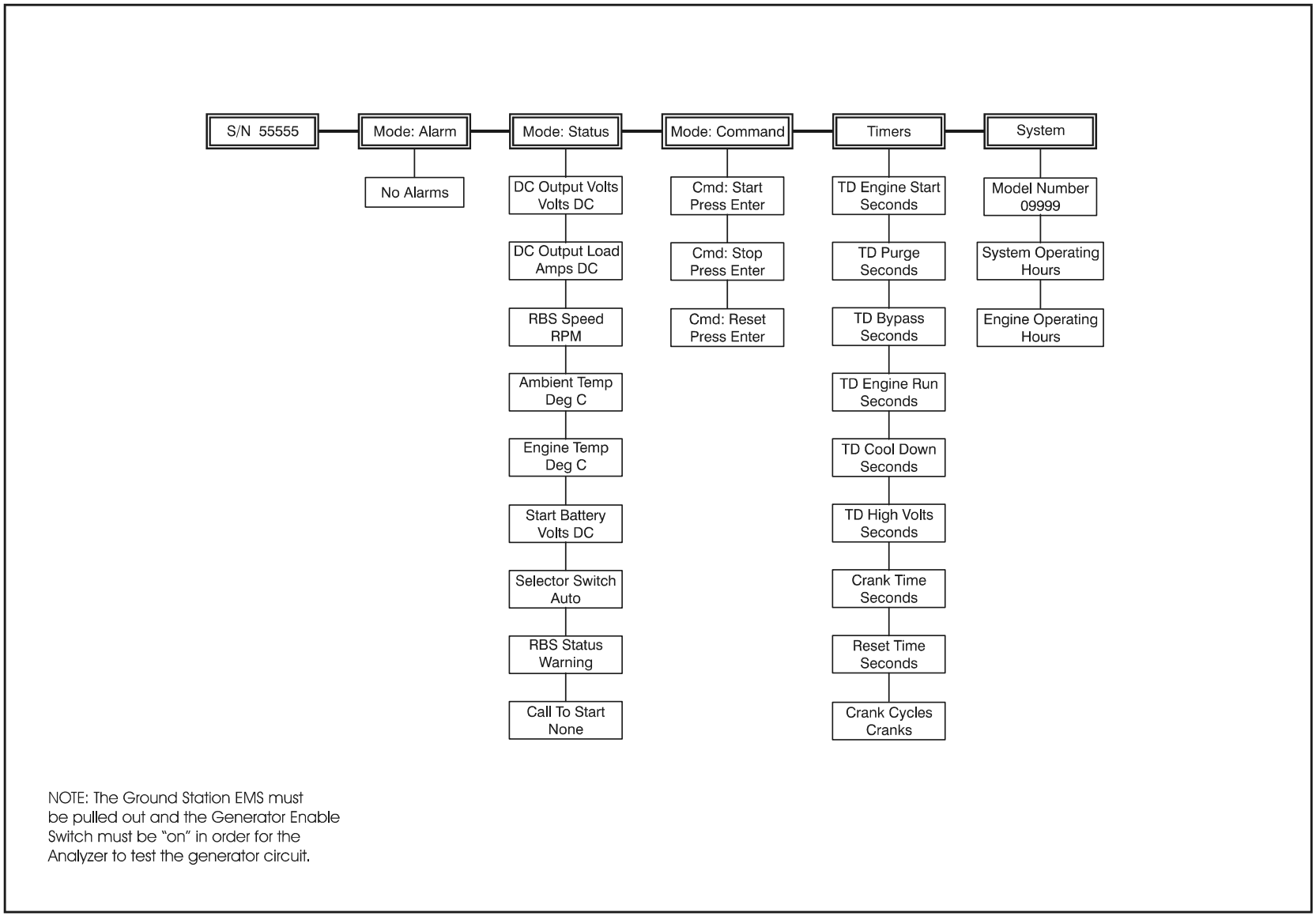


Figure 2-49. Generator System Analyzer Flow Chart

- **Overspeed**

If the engine speed exceeds the overspeed limit, the engine will stop immediately and an overspeed alarm will be indicated.

- **Underspeed**

Enabled once TDBP (time delay bypass) period has elapsed after engine startup. If the engine speed drops below the underspeed limit, the engine will stop immediately and an engine underspeed alarm will be indicated.

- **Overcrank**

If the engine fails to start after a set number of start attempts, the RBS will cease attempts to restart and an engine overcrank alarm will be indicated.

- **No Speed Signal**

In the event of a loss of speed signal, the RBS will shutdown and an engine no speed signal alarm will be indicated. This shutdown is delayed by a factory set period to ensure the fault was not momentary.

- **Overvoltage**

If the voltage measured at the alternator output exceeds the high voltage setting, the RBS will stop immediately and an RBS high output alarm will be indicated. This shutdown is delayed by a factory set period to ensure the fault was not caused by a transient condition. This feature protects the batteries and load from high DC voltages.

- **Engine Starting System Fault**

Indicates a problem with either the engine start battery, engine magneto, or magneto voltage regulator.

- **Loss Of Voltage Sense**

If the voltage measured at the alternator output is less than half of the system nominal voltage, the RBS will stop immediately and an RBS loss of voltage sense alarm will be indicated. This feature protects the batteries and load from high DC voltages due to a loss of output control.

- **Run Inhibited**

The RBS unit is disabled by the run inhibited input.

Output Current and Voltage Settings

- **Normal/Extended Output Voltage**

The normal/extended output voltage setting is the voltage at which the alternator changes under normal operating conditions.

- **Current Limit**

The current limit setting determines the maximum alternator output current.

- **High Voltage Shutdown Level**

This setting determines the alternator output voltage at which the high voltage shutdown occurs. This protects the load from abnormally high voltages.

- **Finish Charging Current**

The finish charging current determines the level of the current alternator output must drop below for a low battery voltage CTS to be removed. This ensures that the batteries have accepted sufficient charge prior to shutting down the RBS. This level is used along with the low battery voltage remove CTS level to determine when the RBS removes the CTS after a low battery voltage CTS. If the charging current falls below the finish charging current while another CTS is active, the RBS will continue to operate at the normal/extended output voltage until all CTS's are removed.

2.26 PREVENTIVE MAINTENANCE AND INSPECTION SCHEDULE

The preventive maintenance and inspection checks are listed and defined in the following table. This table is divided into two basic parts, the "AREA" to be inspected, and the "INTERVAL" at which the inspection is to take place. Under the "AREA" of the table, the various systems along with components that make up that system are listed. The "INTERVAL" portion of the table is divided into five columns representing the various inspection time periods. The numbers listed within the interval column represent the applicable inspection code for which that component is to be checked.

The checks and services listed in this schedule are not intended to replace any local or regional regulations that may pertain to this type of equipment nor should the lists be considered as all inclusive. Variances in interval times may occur due to climate and/or conditions and depending on the location and use of the machine.

JLG Industries requires that a complete annual inspection be performed in accordance with the "Annual Machine Inspection Report" form. Forms are supplied with each new machine and are also available from JLG Customer Service. Forms must be completed and returned to JLG Industries.

⚠ IMPORTANT

JLG INDUSTRIES REQUIRES THAT A COMPLETE ANNUAL INSPECTION BE PERFORMED IN ACCORDANCE WITH THE "ANNUAL MACHINE INSPECTION REPORT" FORM.

This machine requires periodic safety and maintenance inspections by a JLG Dealer. A decal located on the turntable affords a place to record (stamp) inspection dates. Notify dealer if inspection is overdue.

The inspection and maintenance code numbers are as follows:

1. Check for proper and secure installation.
2. Check for visible damage and legibility.
3. Check for proper fluid level.
4. Check for any structural damage; cracked or broken welds; bent or warped surfaces.
5. Check for leakage.
6. Check for presence of excessive dirt or foreign material.
7. Check for proper operation and freedom of movement.
8. Check for excessive wear or damage.
9. Check for proper tightness and adjustment.
10. Drain, clean and refill.
11. Check for proper operation while engine is running.
12. Check for proper lubrication.
13. Check for evidence of scratches, nicks or rust and for straightness of rod.
14. Check for condition of element; replace as necessary.
15. Check for proper inflation.
16. Clean or replace suction screen.
17. Drain and clean.

* To be performed quarterly.

** Inspection and Maintenance Code 10, 12, 16 to performed every two years.

Table 2-16.Preventive Maintenance and Inspection Schedule

AREA		INTERVAL					
		DAILY	WEEKLY	MONTHLY	3 MONTH	6 MONTH	YEARLY
	BOOM						
1.	Platform	1,4					
2.	Platform Gate	1,4		12			
3.	Platform Rotator		5,11				
4.	Footswitch	1,11					
5.	Controllers	1,11					
6.	Switches	1,11					
7	Lift Up/Platform Down Disable Switch*				1,7,9		
7.	Placards and Decals	1,2					
8.	Control Tags	1,2					
9.	Valves	1,11	5,6				
10.	Carrier (Hoses and Cables)	1	4,8				
11.	Lockout Cylinders (If equipped)	1	5				
12.	Pins			8			
13.	Bushings			8			
14.	Wear Pads			8			
15.	Cylinders		1,5,6,13				
17.	Drift Test*						

Table 2-16.Preventive Maintenance and Inspection Schedule

	AREA	INTERVAL					
		DAILY	WEEKLY	MONTHLY	3 MONTH	6 MONTH	YEARLY
	TURNTABLE						
1.	Engine Oil (see mfg. manual)	3	5				
2.	Battery	3	5				
3.	Radiator	3	5				
4.	Air Cleaner	1	14				
5.	Exhaust System	1		1,5			
6.	Spark Arrester	1		1,5	17		
7.	Engine Mount			1			
8.	Ground Controls	1,2,11					
9.	Main Hydraulic Pump	1	5				
10.	Auxiliary Power Pump	1	5				
11.	Valves	1,11	5				
12.	Hydraulic Filters	14	5				
13.	Hydraulic Hoses	1	5				
14.	Hydraulic Oil Tank**	3	5	4			
15.	Breather Hydraulic Tank		6,14				
16.	Fuel Tank	3,5		4			
17.	Cylinders		1,5,6,13	4			
18.	Hood Doors	1					
19.	Turntable Locking Pin	1,7					
20.	Horizontal Limit Switch	1,7					
21.	Oil Coupling		5				
22.	Placards and Decals	1,2					
23.	Swing Bearing		1		9, 12		
24.	Swing Brake		1,5,6	8			
25.	Swing Hub				3,9		

Table 2-16.Preventive Maintenance and Inspection Schedule

AREA		INTERVAL					
		DAILY	WEEKLY	MONTHLY	3 MONTH	6 MONTH	YEARLY
	CHASSIS						
1.	Wheel and Tire Assembly	1	8,9,15				
2.	Drive Motors		1,5,6				
3.	Drive Torque Hubs**		1,5,6		3		
4.	Drive Brakes		1,5,6				
5.	Steer Cylinders	1	1,5,6,13				
6.	Steer Components	1	4,6	8			
7.	Lockout Cylinders (if equipped)*	1	5,13	8			
8.	Hydraulic Hoses	1					
9.	Placards and Decals	1,2					
10.	Wheel Bearings			8			
11.	Swing Bearing/Worm Gear		1		9,12		

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SECTION 3. TROUBLESHOOTING

3.1 GENERAL

This section contains troubleshooting information 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.

3.2 TROUBLESHOOTING.

The troubleshooting procedures applicable to the aerial platform are listed and defined in Tables 3-1 through 3-6. As an aid to table use, the aerial platform is divided into four major groups, each covered separately within this section. These groups are as follows: elevation system, chassis assembly, hydraulic system and electrical system.

Each malfunction within an individual group or system is followed by a listing of probable causes which will enable determination of the applicable remedial action. The probable causes and the remedial action should, where possible, be checked in the order listed in the tables.

It should be noted that there is no substitute for a thorough knowledge of the equipment and related systems.

It should be recognized that the majority of the problems arising in the machine will be centered in the hydraulic and electrical systems. For this reason, every effort has been made to ensure that all likely problems in these areas are given the fullest possible treatment. In the remaining machine groups, only those problems which are symptomatic of greater problems which have more that one probable cause and remedy are included. This means that problems for which the probable cause and remedy may be immediately obvious are not listed in this section.

The first rule for troubleshooting any circuit that is hydraulically operated and electrically controlled is to determine if the circuit is lacking hydraulic oil and electrical control power. This can be ascertained by overriding the bypass valve so that oil is available to the function valve, then overriding the function valve mechanically. If the function performs satisfactorily, the problem exists with the control circuit.

3.3 HYDRAULIC CIRCUIT CHECKS.

The reference for improper function of a hydraulic system, where the cause is not immediately apparent, should be the Troubleshooting Chart. The best place to begin the problem analysis is at the power source (pump). Once it is determined that the pump is serviceable, then a systematic check of the circuit components, beginning with the control, would follow. For aid in troubleshooting, refer to the Illustrated Parts Manual for hydraulic diagrams of the various circuits

Table 3-1.Platform Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Automatic leveling inoperative.		
	Hydraulic system oil low.	Replenish oil as necessary.
	Dual check valves dirty/inoperative.	Clean or replace as necessary.
	Restricted or broken hydraulic line or fitting on slave cylinder or main lift cylinder.	Clean, repair, or replace line or fitting.
	Worn seal(s) in slave level or main lift cylinder.	Replace seal(s).
	Counterbalance valve in slave cylinder defective.	Replace counterbalance valve.
	Slave level or main lift cylinder not functioning properly.	Slave level or main lift cylinder not functioning properly.
Platform will not maintain level attitude.		
	Counterbalance valve on slave leveling cylinder improperly adjusted or not functioning properly.	Replace valve.
	Worn seal(s) in slave level or main lift cylinder.	Replace seal(s).
	Damaged slave level or main lift cylinder.	Repair or replace cylinder.
No response to platform leveling controls.		
	Level function not activated within 7 seconds after footswitch was depressed.	Recycle footswitch.
	Level control switch inoperative.	Repair or replace control switch lever.
	Hydraulic system oil low.	Replenish oil as necessary.
	Proportional Flow Regulator not powered.	Wiring: Run System Test
	Restricted or broken hydraulic line or fitting.	Clean, repair, or replace line or fitting.
	Directional valve not functioning properly.	Repair or replace valve.
	No electric power to directional control valve.	See proper wiring diagram/Run System Test.
	Slave cylinder not functioning properly.	Repair or replace pump.
Platform will not adjust "up" or "down" to level.		
	Hydraulic pump not functioning properly.	Run System Test.
	Restricted or broken hydraulic line or fitting.	Clean, repair, or replace line or fitting.
	Slave cylinder not functioning properly.	Repair or replace cylinder.
	Electrical failure.	See proper wiring diagram/Run System Test.
	Orifice plugged.	Clean orifice.

Table 3-1.Platform Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	Proportional Flow Regulator not powered.	Check wiring/Run System Test.
	Personalities not set correctly	Check settings.

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Table 3-2.Boom Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	CONTROL VALVES	
Valve spool sticking.		
	Dirt in oil causing excessive temperature build-up.	Flush system and change oil using recommended viscosity
	Moisture in oil.	Flush system and change oil using recommended viscosity
	Incorrect valve mounting causing warping of the unit.	Loosen valve and check mounting. Repair as necessary.
	Valve spool scored.	Remove valve and repair or replace as necessary.
	Tie-bolts in valve over torqued.	Correctly torque bolts.
	Return spring weak or broken.	Remove valve and repair or replace as necessary.
	Relief valve malfunctioning causing excessive pressure within valve.	Check pressure delivery to and from valve and repair or replace as necessary.
Valve leaking.		
	Dirt or other foreign material under seal.	Remove and repair valve as necessary.
	Valve spool scored.	Remove valve and repair or replace as necessary.
	Excessive back pressure caused by restricted return line to reservoir.	Remove line and clear obstruction or replace line as necessary.
	Damaged valve seals.	Remove valve and repair or replace as necessary.
	BOOM ELEVATION SYSTEM.	
No response to lift control switch/Joystick.		
	Lift function not activated within 7 seconds after footswitch was depressed.	Recycle footswitch.
	Lift control switch inoperative.	Repair or replace control switch/Run System Test.
	Lift cylinder holding valve inoperative.	Repair or replace holding valve.
	Bypass valve not operating.	Determine cause and repair or replace valve.
	Electrical malfunction.	See wiring diagram/Run System Test.
	Hydraulic system oil low.	Replenish oil as necessary.

Table 3-2.Boom Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	Restricted or broken supply line on valve bank or hydraulic pump.	Clean or replace line.
	Directional valve not functioning properly.	Repair or replace valve.
	Lift cylinder not functioning properly.	Repair or replace cylinder
Boom will not raise.		
	Lift function not activated within 7 seconds after footswitch was depressed.	Recycle footswitch.
	Load capacity exceeded (personnel or equipment on platform).	Reduce load.(Refer to capacity placard.)
	Lift switch/Joystick not functioning.	Check wiring/Run System Test.
	Hydraulic system oil low.	Replenish oil as necessary.
	Electrical failure to valves.	See proper wiring diagram/Runs System Test.
	Restricted or broken hydraulic line or fitting.	Clean, repair, or replace line or fitting.
	Directional valve not functioning properly.	Repair or replace valve.
	Pressure relief valve not functioning properly.	Re-adjust or replace valve.
	Lift cylinder not functioning properly.	Repair or replace cylinder.
	Binding lift cylinder or boom pivot pin.	Repair or replace cylinder or pin.
Boom will not lower.		
	See: Boom will not raise.	
	Pressure relief valve not functioning properly.	Re-adjust or replace valve.
	Holding valve not functioning properly.	Re-adjust or replace valve.
Boom raises and lowers erratically.		
	Hydraulic system oil low.	Replenish oil as required.
	Restricted or broken hydraulic line or fitting.	Clean, repair, or replace line or fitting.
	Counterbalance valve on lift cylinder improperly adjusted or not functioning properly.	Replace valve.
	Directional valve not functioning properly.	Repair or replace valve.
	Worn seals in lift cylinder.	Replace seals.
	Cylinder not functioning properly.	Repair or replace cylinder.
Boom drifts down.		
	Worn seals in lift cylinder.	Replace seals.

Table 3-2.Boom Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Function Speed and Drive Speed does not operate below horizontal.		
	Damaged wiring on level limit switch.	Repair or replace wiring/Run System Test
	Creep Switch Open.	Replace switch/Run System Test
	Machine Tilted	Level machine.
	Speed Sensor Failure.	Replace Sensor.
LOWER LIFT FUNCTION.		
If the boom assembly does not fully lower.		
	The Mid and Lower Booms are out of synchronization.	Refer to synchronize procedure.
MAIN TELESCOPE SYSTEM.		
No response to telescope control.		
	Telescope function not activated within 7 seconds after footswitch was depressed.	Recycle footswitch.
	Telescope control switch inoperative.	Repair or replace control switch/Run System Test
	Hydraulic system oil low.	Replenish oil as necessary.
	Damaged wiring on control switch or solenoid valve.	Repair or replace wiring/Run System Test
	Directional valve not functioning properly.	Repair or replace valve.
	Restricted or broken supply line on valve bank or hydraulic pump.	Clean or replace line.
	Proportional Flow Regulator Not Powered.	Check wiring/Run System Test.
	Telescope cylinder not functioning properly.	Repair or replace cylinder.
	Hydraulic pump not functioning properly.	Repair or replace pump/Run System Test.
Boom will not extend.		
	Telescope function not activated within 7 seconds after footswitch was depressed.	Recycle footswitch.
	Directional valve not functioning properly.	Repair or replace control valve.
	Restricted or broken hydraulic line or fitting.	Clean, repair, or replace line or fitting.
	Pressure setting incorrect.	Check pressure/re-adjust as necessary.
	Telescope cylinder not functioning properly.	Repair or replace cylinder.
	Personality Setting incorrect.	Set to Factory Default.

Table 3-2.Boom Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Boom extends and retracts erratically.		
	Hydraulic system oil low.	Replenish oil as necessary.
	Wear pads worn.	Replace pads as required.
	Restricted or broken hydraulic line or fitting.	Clean, repair, or replace line or fitting.
	Directional valve not functioning properly.	Repair or replace valve.
	Worn seals in telescope cylinder.	Replace seals.
	Cylinder not functioning properly.	Repair or replace cylinder.
	Counterbalance valve not functioning properly.	Replace counterbalance valve.
BOOM SWING SYSTEM		
No response to swing control.		
	Swing function not activated within 7 seconds after footswitch was depressed.	Recycle footswitch.
	Hydraulic system oil low.	Replenish oil as necessary.
	Swing Joystick not functioning.	Repair or replace swing joystick/Run System Test.
	Restricted or broken supply line on valve bank or hydraulic pump.	Clean or replace line.
	Directional valve not functioning properly.	Repair or replace valve.
	Swing motor not functioning properly.	Repair or replace motor.
	Foreign objects(s) wedged between swing motor pinion and swing gear.	Remove objects, check for damage, and repair or replace component(s) as required.
	No electric power to valve.	See proper wiring diagram/Run System Test.
Boom will swing in one direction only.		
	Restricted or broken hydraulic line or fitting.	Clean, repair, or replace line or fitting.
	Directional valve not functioning properly.	Repair or replace valve.
	Foreign object(s) wedged between swing motor pinion and swing gear.	Remove object(s), check for damage and repair or replace component(s) as required.
	Swing Joystick not functioning properly.	Repair or replace swing joystick/Run System Test.

Table 3-2.Boom Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Boom swings erratically in either direction.		
	Hydraulic system oil low.	Replenish oil as necessary.
	Lack of lubricant on swing gear or speed reducer pinion.	Lubricate as required. (See Lubrication Chart.)
	Swing motor not functioning properly.	Repair or replace swing control switch.
	Worn or broken teeth on swing gear or swing motor pinion.	Replace gear(s) as required.
	Restrictor valves(s) plugged.	Clean or replace restrictor valve.

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Table 3-3.Turntable Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
CONTROL VALVE.		
Valve Spool Sticking.		
	Dirt in oil causing excessive temperature built-up.	Change oil using recommended viscosity and flush system.
	Incorrect valve mounting causing warping of the unit.	Loosen valve and check mounting.Repair as necessary.
	Valve spool scored.	Remove valve and repair or replace as necessary.
	Return spring weak or broken.	Remove valve and repair or replace as necessary.
	Relief valve malfunctioning causing excessive pressure within valve.	Check pressure delivery to and from valve and repair or replace as necessary.
Valve leaking.		
	Dirt or other foreign material under seal.	Remove and replace valve as necessary.
	Valve spool scored.	Repair or replace valve.
	Excessive back pressure caused by restricted return line to reservoir.	Remove line and clear obstruction or replace line as necessary.
	Damaged valve seals.	Repair or replace valve as necessary.

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Table 3-4.Chassis Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
GENERATOR.		
Engine will not start.		
	Enable switch is open.	Actuate switch.
	Fuses open.	Determine and correct cause; replace fuse.
	Ground EMS is open.	Pull out EMS to activate.
	Defective starter motor.	Replace starter motor.
	Damaged wiring in ignition circuit (broken wire on starter).	Repair, replace wiring.
	Manual start switch not functioning properly.	Replace switch/check wiring.
	Ignition relay not functioning properly.	Replace relay.
	Ignition circuit shorted to ground.	See proper wiring diagram.
	Battery cable(s) not making contact.	Clean and tighten cable(s).
Engine will not start (ignition OK).		
	No fuel.	Replenish fuel as necessary.
	Clogged fuel filter.	Replace fuel filter.
	Choke solenoid malfunction.	Replace choke solenoid.
	Restricted or broken fuel line.	Clean or replace fuel line.
	Fuel shut-off valve in carburetor stuck or frozen.	Repair or replace fuel shut-off. Check for electrical power.
	Battery discharged.	Charge battery, replace if defective.
	Cam timing belt jumped time or broken.	Repair or replace timing belt.
	Ignition timing slipped.	Repair timing.
Engine surges.		
	Governor not adjusted properly.	Correctly adjust governor.
Strong fuel odor.		
	Fuel tank overfilled.	Check fuel tank and immediately wipe up spilled fuel.
	Fuel tank damaged.	Drain all fuel from tank and remove tank for replacement or repair.
	Fuel line from tank damaged.	Replace fuel line.
	Carburetor flooding.	Repair, replace or adjust carburetor.

Table 3-4.Chassis Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
FRONT FRAME AXLE AREA.		
One or both wheels will not steer.		
	Steering link or tie rod broken or attaching hardware missing.	Replace steering link, tie rod or hardware as necessary.
One or both front wheels will not rotate or rotate erratically.		
	Wheel hub or bearings damaged or not lubricated.	Replace hub or bearings as necessary and repack bearings with approved grease.
REAR FRAME AXLE AREA.		
Difficulty encountered when moving machine.		
	Load capacity exceeded.	Reduce load. Apply loads only in accordance with load capacity indicator.
	Hubs Disconnected.	Engage hubs as outlined in Operators Manual.
	Machine being moved up too steep a grade.	Remove machine from grade and check that drive system operates correctly.
	Grade too steep.	See WARNING Placard on platform for specified grades and sideslopes.
	Towing valve not closed.	Close towing valve.
	Drive wheel tire treads worn smooth.	Replace tires as necessary and inflate to specified pressure.
	Drive brakes "dragging".	Re-adjust pressure.
	System pressure too low.	Re-adjust pressure.
	Drive hub(s) defective.	Repair or replace hub.
DRIVE SYSTEM.		
No response to control.		
	Drive function not activated within 7 seconds after footswitch was depressed.	Recycle footswitch.
	Hydraulic system oil low.	Replenish oil as necessary.
	Hydraulic pump not functioning properly.	Repair or replace pump.
	Restricted or broken pump supply line.	Clean, repair or replace line.
	Restricted or broken line on valve bank.	Clean, repair or replace line.
	Air in wheel brake circuit.	Bleed circuit, determine and correct cause.
	Damaged wiring on joystick.	Repair or replace wiring /Run System Test.

Table 3-4.Chassis Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	Joystick not functioning properly.	Replace joystick/Run System Test.
	Charger plugged in.	Check help message.
	Drive prevented.	Check help message.
	Brake(s) not releasing.	Determine cause and repair or replace.
Machine will not travel in forward.		
	Hydraulic system oil low.	Replenish oil as necessary.
	Restricted or broken hydraulic line or fitting.	Clean, repair or replace line or fitting.
Motor turns slowly at maximum command.		
	Cutback - Tilted	Check help message.
	Speed Sensor	Check help message.
	Cutback - Elevation.	Check elevation switch.
Poor response, function shuts off slowly when command is removed.		
	Ramp set too high in controller.	Check personality.
	Sticking control handle.	Repair or replace controller.
STEERING SYSTEM.		
No response to steer control.		
	Hydraulic system pressure too low.	Adjust pressure.
	Damaged wiring on control switch or solenoid valve.	Check wiring/Run System test.
	Control switch not functioning properly.	Run system test.
	Restricted or broken hydraulic line on valve bank, hydraulic pump or rotary coupling. (If equipped.)	Clean, repair or replace line.
	Steer proportional flow valve not functioning properly.	Run System Test.
	Steer control valve not functioning properly.	Repair or replace valve.
	Steer cylinder not functioning properly.	Repair or replace cylinder.
Machine hard to steer or steering is erratic.		
	Hydraulic system oil low.	Replenish oil as necessary.
	Restricted hydraulic line or fitting.	Clean, repair or replace line or fitting.
	Steer system pressure low.	Adjust pressure.
	Bent linkage (tie rods).	Repair or replace linkage as required.

Table 3-4.Chassis Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	Proportional Flow Valve not functioning properly.	Repair or replace valve.
	Hydraulic pump not functioning properly.	Repair or replace pump.
	Personality Settings Incorrect.	Adjust settings.
	Steer cylinder not functioning properly.	Repair or replace cylinder.
Steering inoperative.		
	Damaged wiring on control switch or solenoid valve.	See proper wiring diagram/Run System Test.
	Solenoid valve not functioning properly.	Repair or replace valve.
	Control switch not functioning properly.	Replace switch/Run System Test.
	Relief valve improperly set or not functioning properly.	Reset, repair or replace valves as required.
	Steer cylinder not functioning properly.	Repair or replace cylinder.
Machine will not steer left or to the right.		
	Wiring on control switch is damaged.	See proper wiring diagram/Run System Test.
	Wiring on solenoid valve damaged.	Repair or replace wiring/Run System Test.
	Coil in solenoid damaged.	Replace coil.
	No oil flow or pressure to steer circuit.	Take pressure reading at steer valve and adjust as necessary.
	Bent cylinder rod.	Repair or replace cylinder.
	Damaged tie rod.	Replace tie rod.
	Cylinder packing defective.	Repair or replace cylinder.
Machine wanders; steering not firm.		
	Crossover relief valve set too low or not functioning properly.	Reset, repair or replace valve as required.
	Steer linkages loose.	Tighten linkage.
	Steer wheel toe-in not set properly.	Adjust toe-in for 1/4 inch overall.
	Spindle bushings badly worn.	Replace bushings.
DRIVE BRAKE.		
Brake Slips		
	Excessive pressure in hydraulic system.	Check hydraulic filter, restrictions in other hydraulic components.
	Disc plates worn.	Check disc thickness.
	Springs broken or have taken a permanent set.	Check release pressure.

Table 3-4.Chassis Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Brake Drags or runs hot.		
	Low actuation pressure.	Place pressure gauge in bleed port & check pressure with system on.
	Bearing failure.	Replace bearing.
Brake will not release.		
	Stuck or clogged valve.	Place pressure gauge in bleed port - check for adequate pressure. Replace defective line or component.
	Bad o-rings.	Replace o-rings.
	Discs frozen.	Replace disc stack.

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Table 3-5.Hydraulic System - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
HYDRAULIC SYSTEMS - GENERAL.		
Hydraulic pump noisy.		
	Air entering system through broken line or fitting. (Suction Side.)	Repair or replace line or fitting.
	Air bubbles in oil. (Reservoir oil too low.	Replenish oil as required.
	Suction hose squeezed shut.	Determine cause and repair.
	Oil filter dirty.	Replace hydraulic filter.
	Wrong type of hydraulic oil.	Replace hydraulic oil.
Pump cavitating. (Vacuum in pump due to oil starvation.)		
	Restricted suction line.	Clean, repair, or replace line.
	Restricted reservoir air vent.	Clean or replace vent.
	Oil viscosity too high.	Drain system and replace with recommended oil. (Refer to Hydraulic Oils.)
	Air leak in suction side of tank.	Repair leak.
System overheating.		
	Oil viscosity too high.	Drain system and replace with recommended oil. (Refer to Hydraulic Oils.)
	Bypass valve not operating properly.	Repair or replace valve.
	Main relief valve set too low.	Reset valve as required.
	Hydraulic system oil low.	Replenish oil as necessary.
	Port relief set too high.	Reset valve as required.
	Restricted or blocked return line.	Repair or replace line.
Pump not delivering oil.		
	Restricted suction line.	Clean, repair, or replace line.
	Air entering system through broken line or fitting.	Repair or replace line or fitting.
	Broken pump drive shaft/pump coupling.	Repair or replace pump/pump coupling. Note: Any time pump or pump drive coupling is removed coat pump and drive coupling splines with Lithium Soap Base Grease (TEXACO CODE 1912 OR EQUIVALENT).

Table 3-5.Hydraulic System - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Function sluggish during operation. (System pressure too low.)		
	Main relief valve set too low.	Reset valve as required.
	Pump section not delivering sufficient oil.	Repair or replace pump section or pump.
	Main relief valve stuck in open position.	Clean, repair, or replace valve. (Check system oil for contamination.)
	Oil viscosity too low.	Drain system and replace with recommended oil. (Refer to Hydraulic Oils.)
	Leak in component, line or fitting.	Repair or replace component, line or fitting.
	Scored valve spool; scored cylinder.	Replace valve; replace cylinder.
	Hydraulic Filter clogged.	Replace filter.
	Amperage too low on controller.	Correctly adjust controller.
	Low voltage in electrical system.	Correct low voltage problem.
System(s) operate erratically.		
	Sticking or binding valve spools, pistons.	Clean, repair, or replace components as required.

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Table 3-6.Electrical System - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
PLATFORM CONTROLS.		
No power to platform controls.		
	15 Amp self-reset circuit breaker open.	Check footswitch to ensure that both switches are making contact when pedal is depressed. Repair or replace footswitch as necessary.
	Contact block in footswitch malfunctioning.	Repair, replace or adjust contact block as required.
	Faulty power circuit wiring.	Check wiring continuity. Refer to proper wiring diagram.
	Platform EMS or Ground EMS switch in wrong position.	Place switch to correct position.
ENGINE STARTER SYSTEM (GENERATOR).		
Starter will not crank.		
	Discharged battery or loose battery terminals.	Check and charge battery or replace battery as necessary. Clean and secure battery terminals.
	Starter relay faulty or faulty relay connections.	Using a test meter, check relay coil terminals for presence of electrical power and for energization of relay coil. Also check relay terminals for correct switching of contacts. Replace relay as necessary.
	Malfunctioning starter solenoid or motor.	Replace solenoid or motor in accordance with applicable manufacturer's manual.
	Malfunctioning manual start switch.	Using a test meter, check ignition switch for correct switching of contacts. Replace switch as necessary.
	Faulty ignition and/or starter circuit wiring.	Check wiring continuity. See proper wiring diagram.
	Faulty start switch.	Replace switch.
INSTRUMENTS AND INDICATORS.		
Travel warning horn inoperative.		
	Machine set-up incorrect.	Adjust control module settings properly.
	Damaged wiring in horn circuit.	Repair or replace wiring/Run System Test.
	Damaged horn.	Replace horn.

Table 3-6.Electrical System - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Hourmeter inoperative.		
	Damaged wiring in hourmeter circuit.	Repair or replace wiring.
	Inoperative hourmeter.	Replace hourmeter.
Platform alarm circuit.		
	Platform alarm inoperative.	Check platform alarm/Run System Test.
	Defective bulb in tilt light.	Replace bulb.

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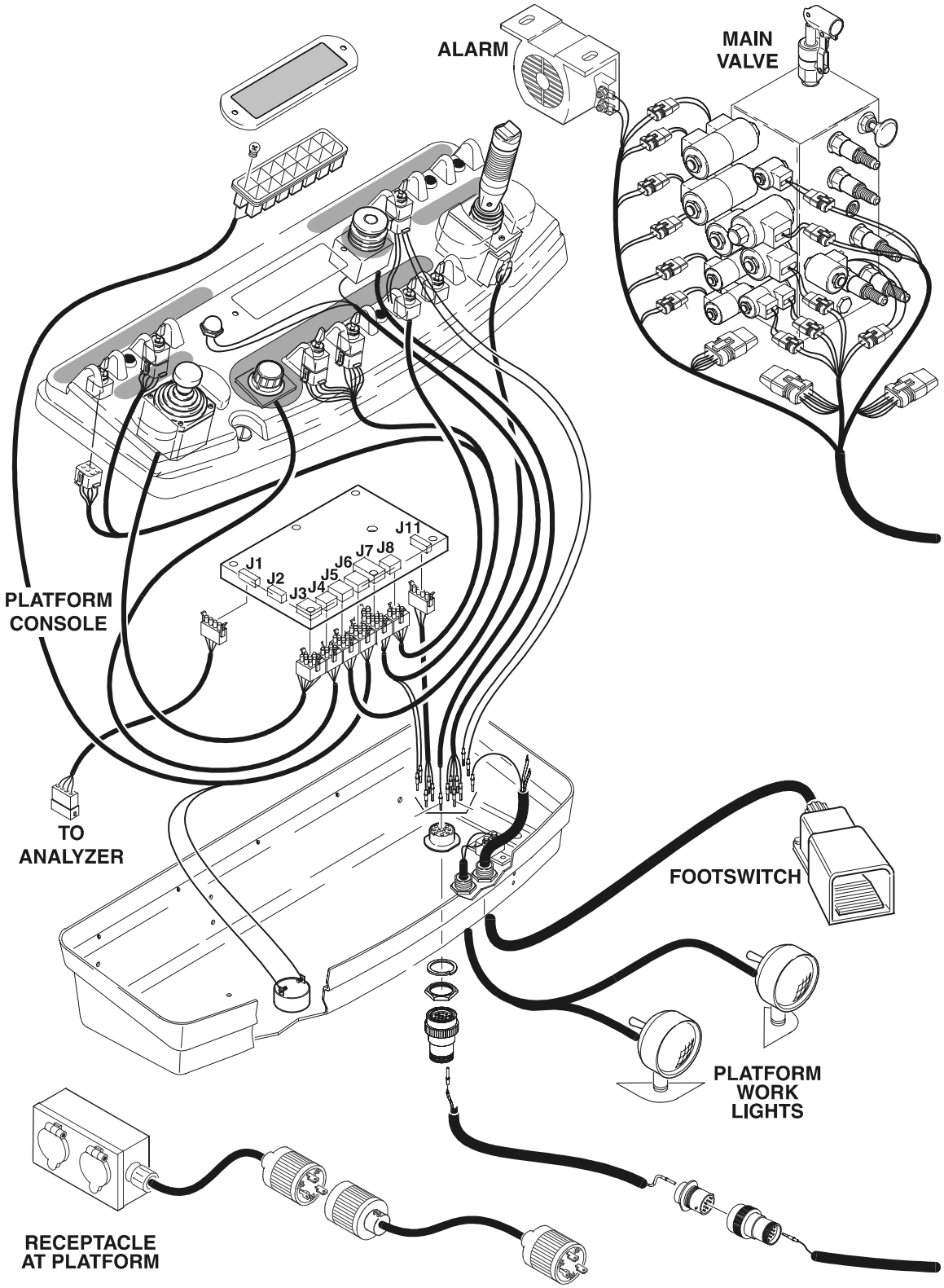

Figure 3-1. Electrical Components Installation - Sheet 1

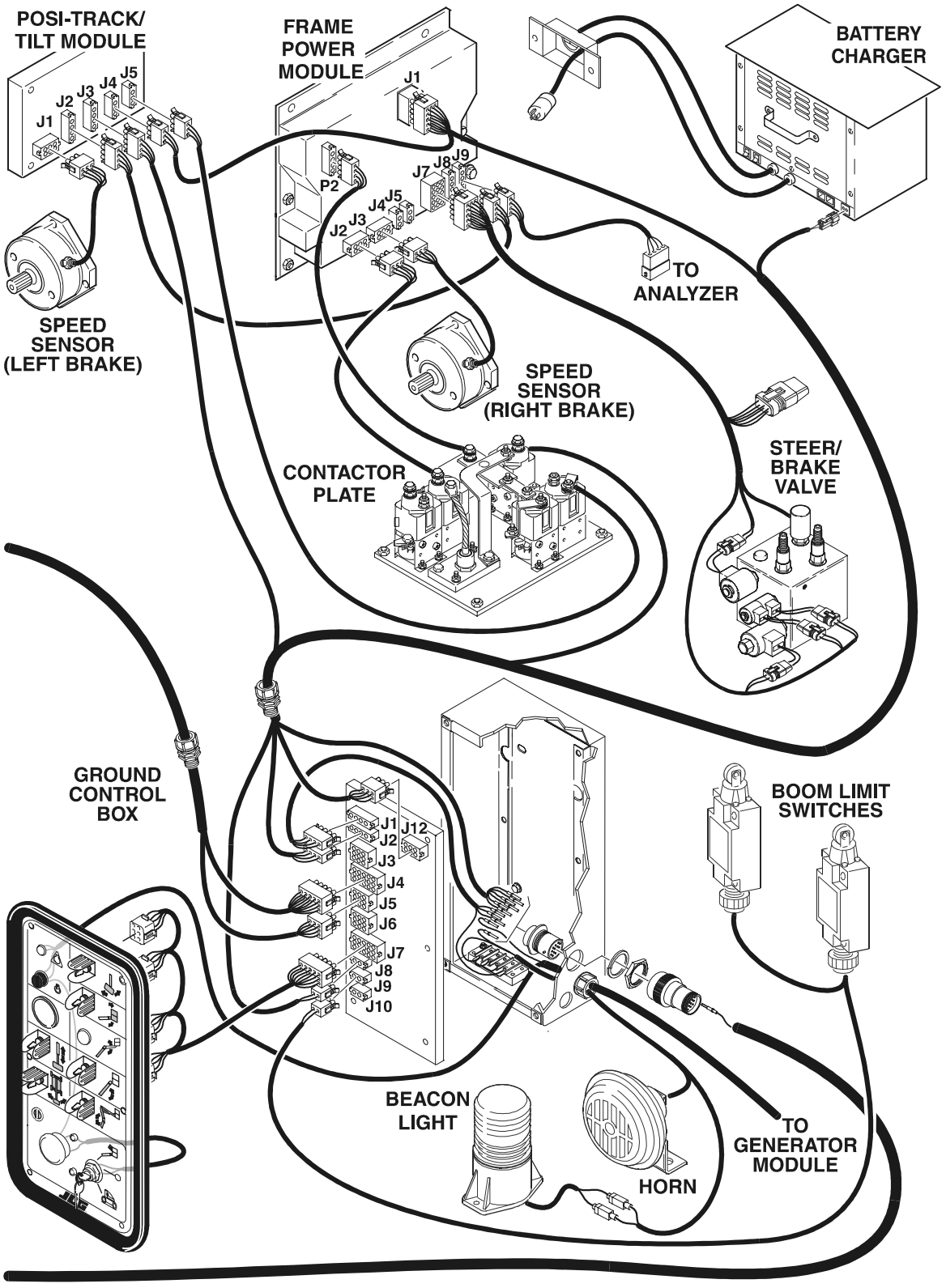

Figure 3-2. Electrical Components Installation - Sheet 2

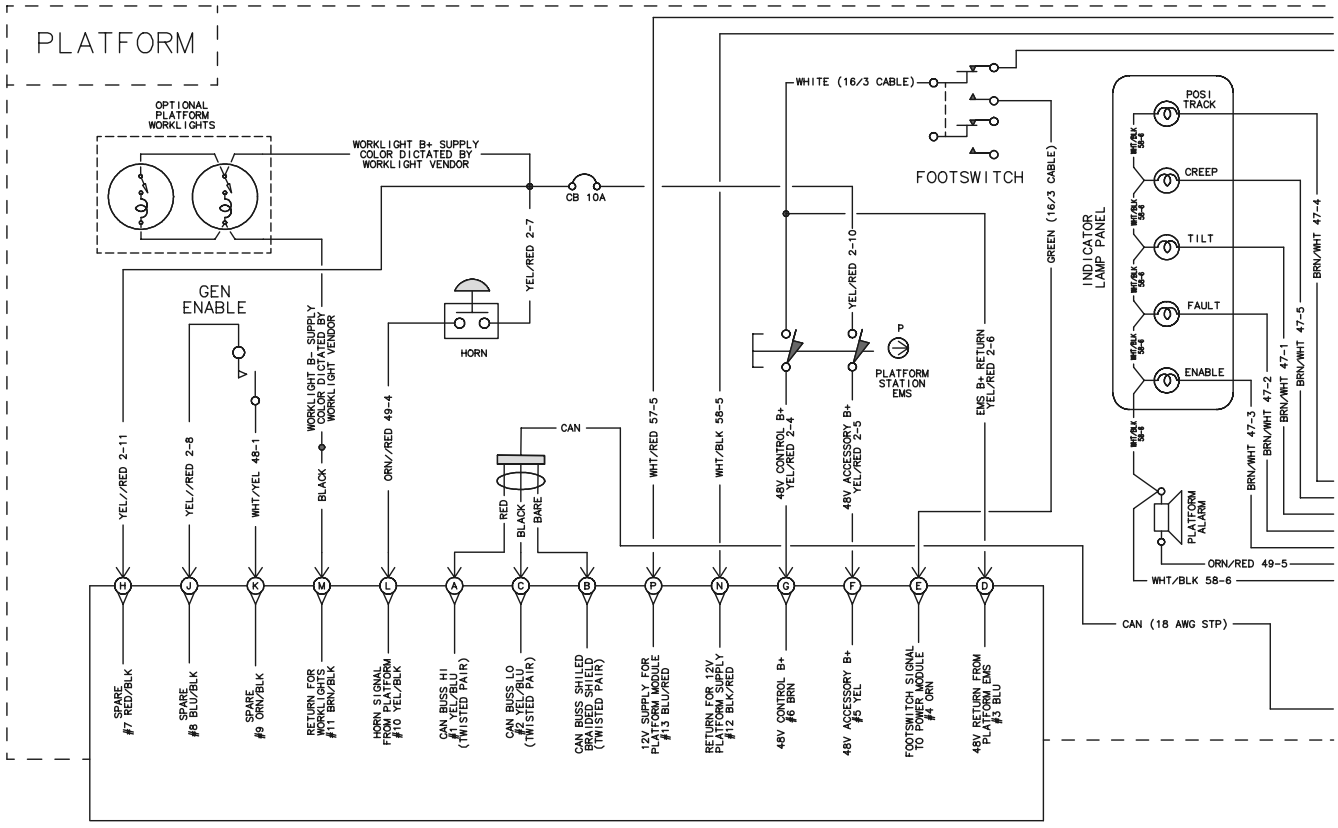

Figure 3-3. Platform Electrical Schematic - Sheet 1 of 2

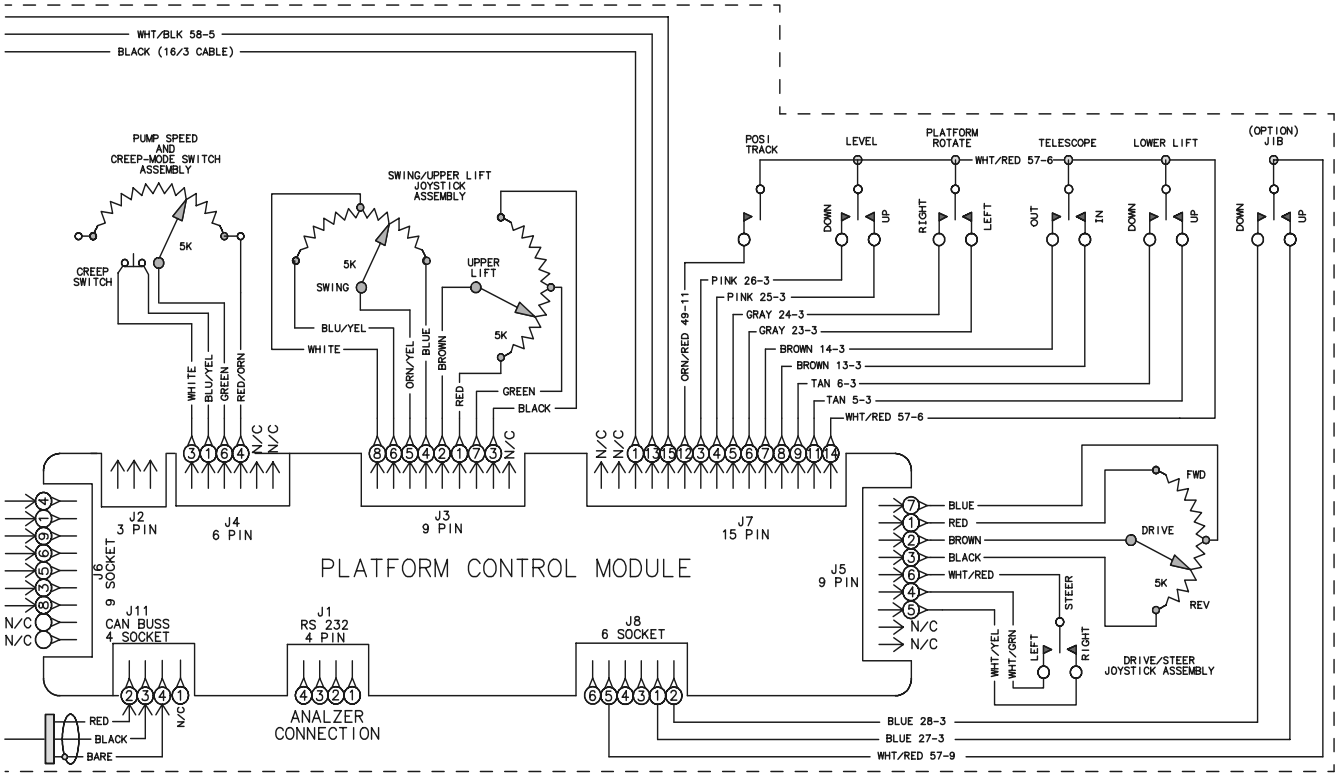

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Figure 3-4. Platform Electrical Schematic - Sheet 2 of 2

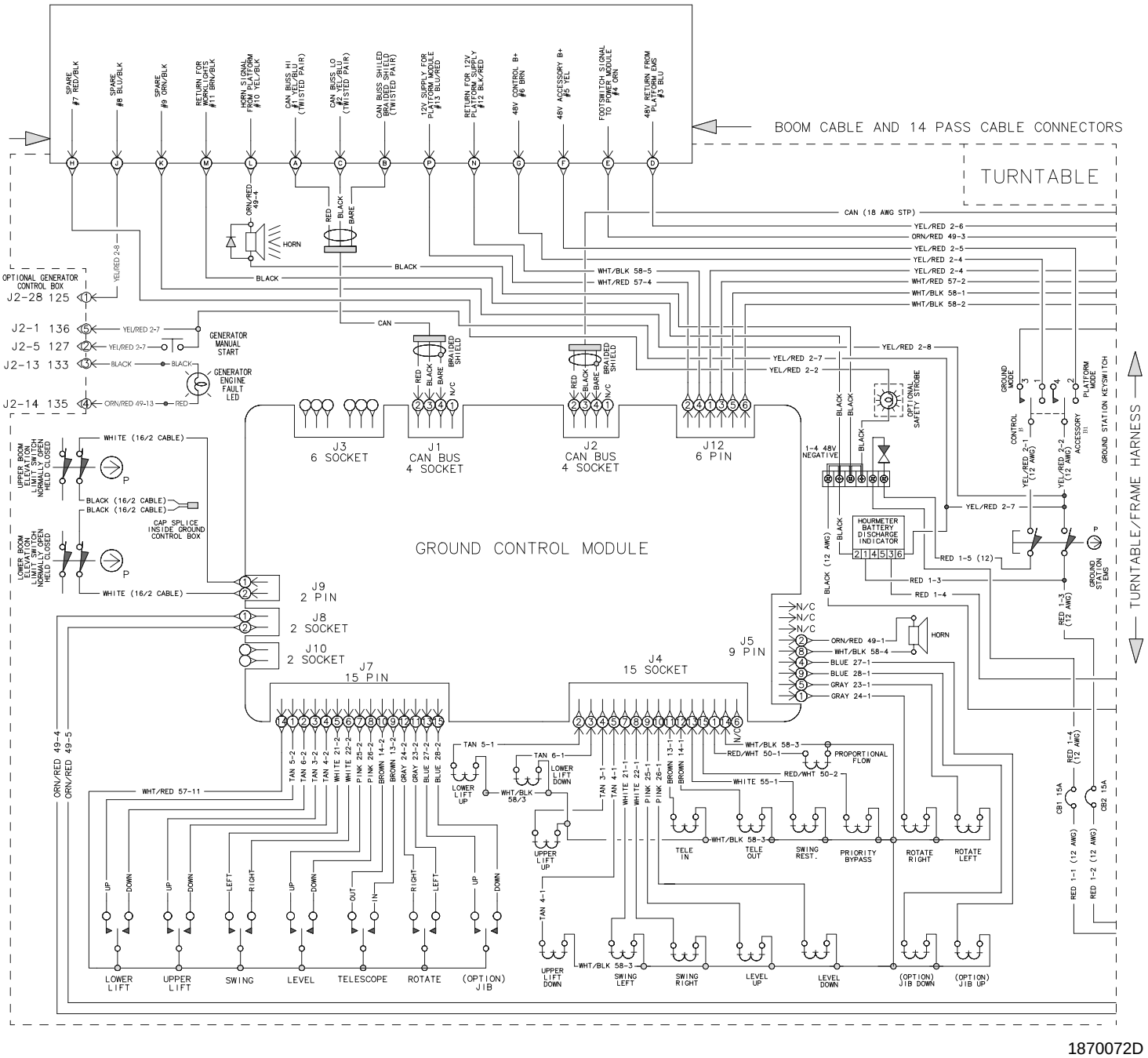

Figure 3-5. Turntable Electrical Schematic

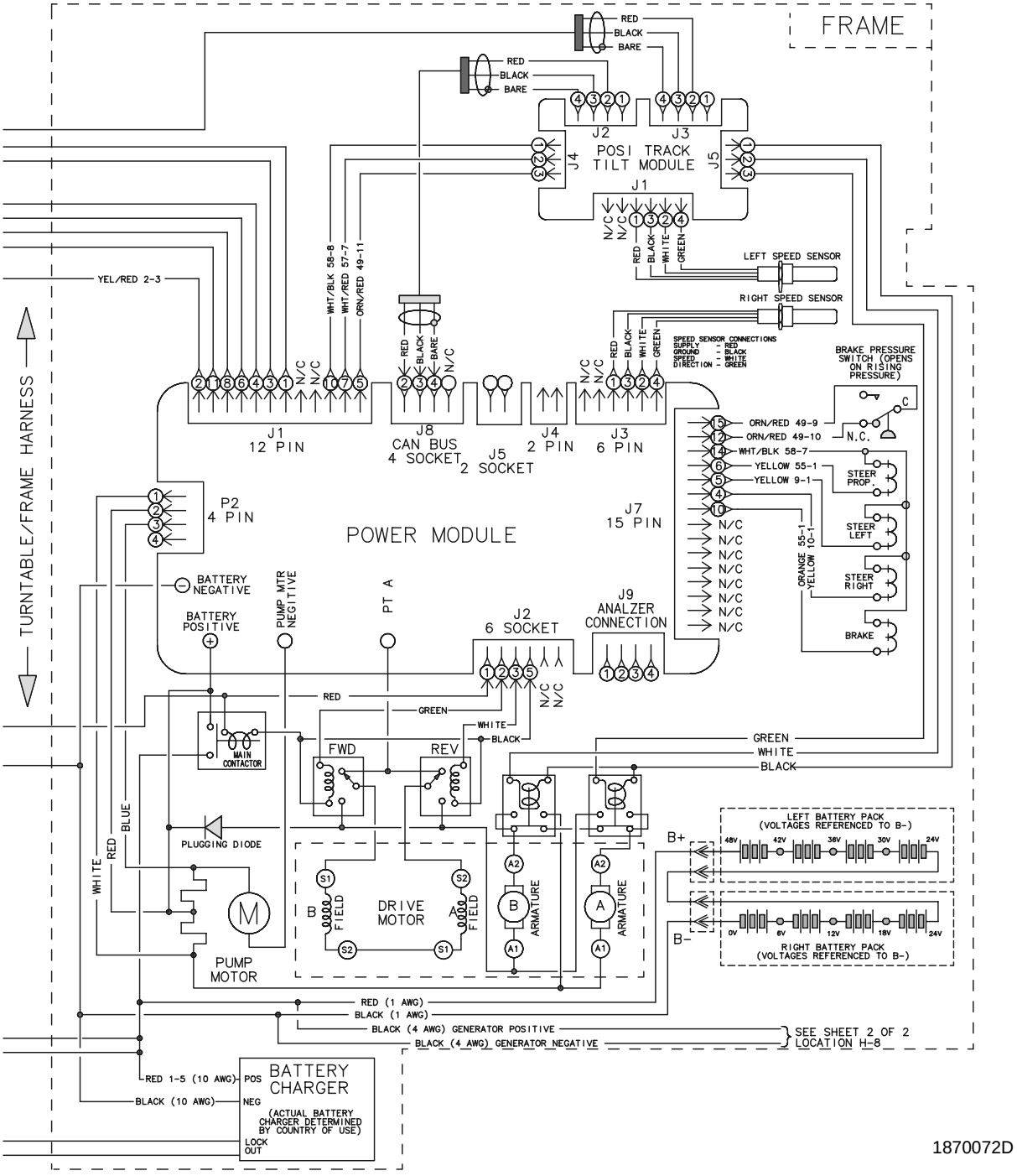

Figure 3-6. Frame Electrical Schematic

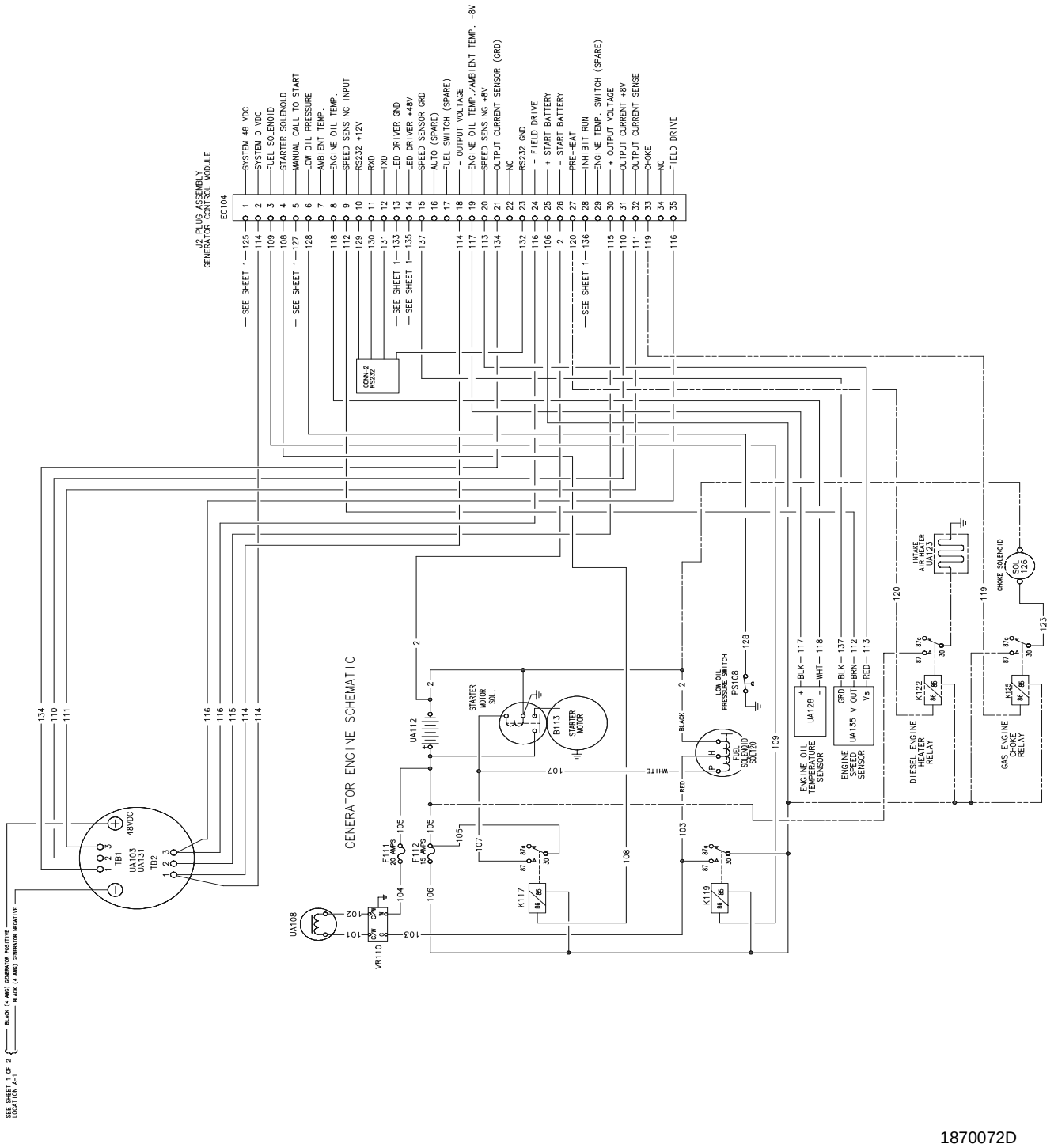

Figure 3-7. On Board Generator Electrical Schematic

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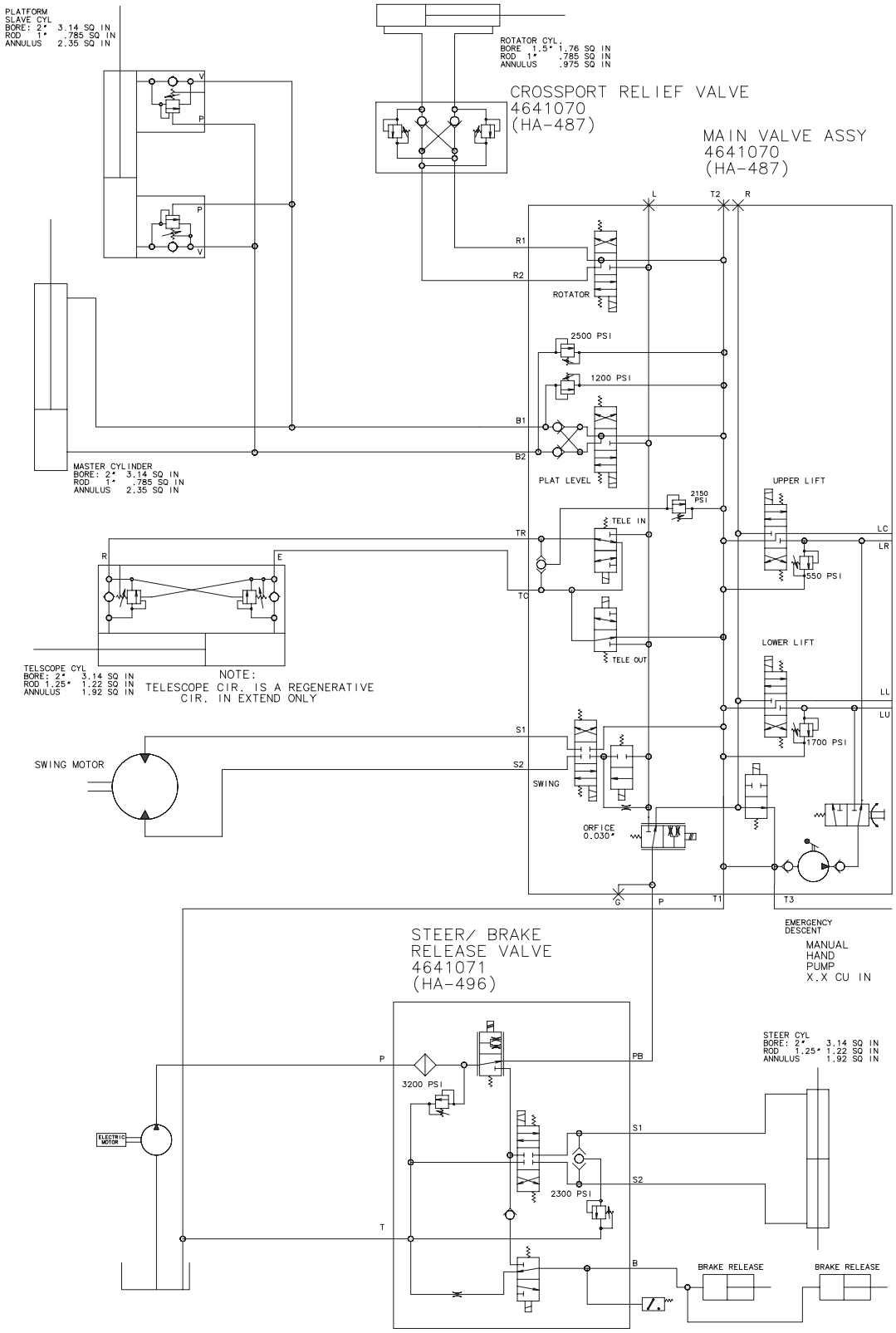

Figure 3-8. Hydraulic Schematic - M45A/E45A - Sheet 1 of 2

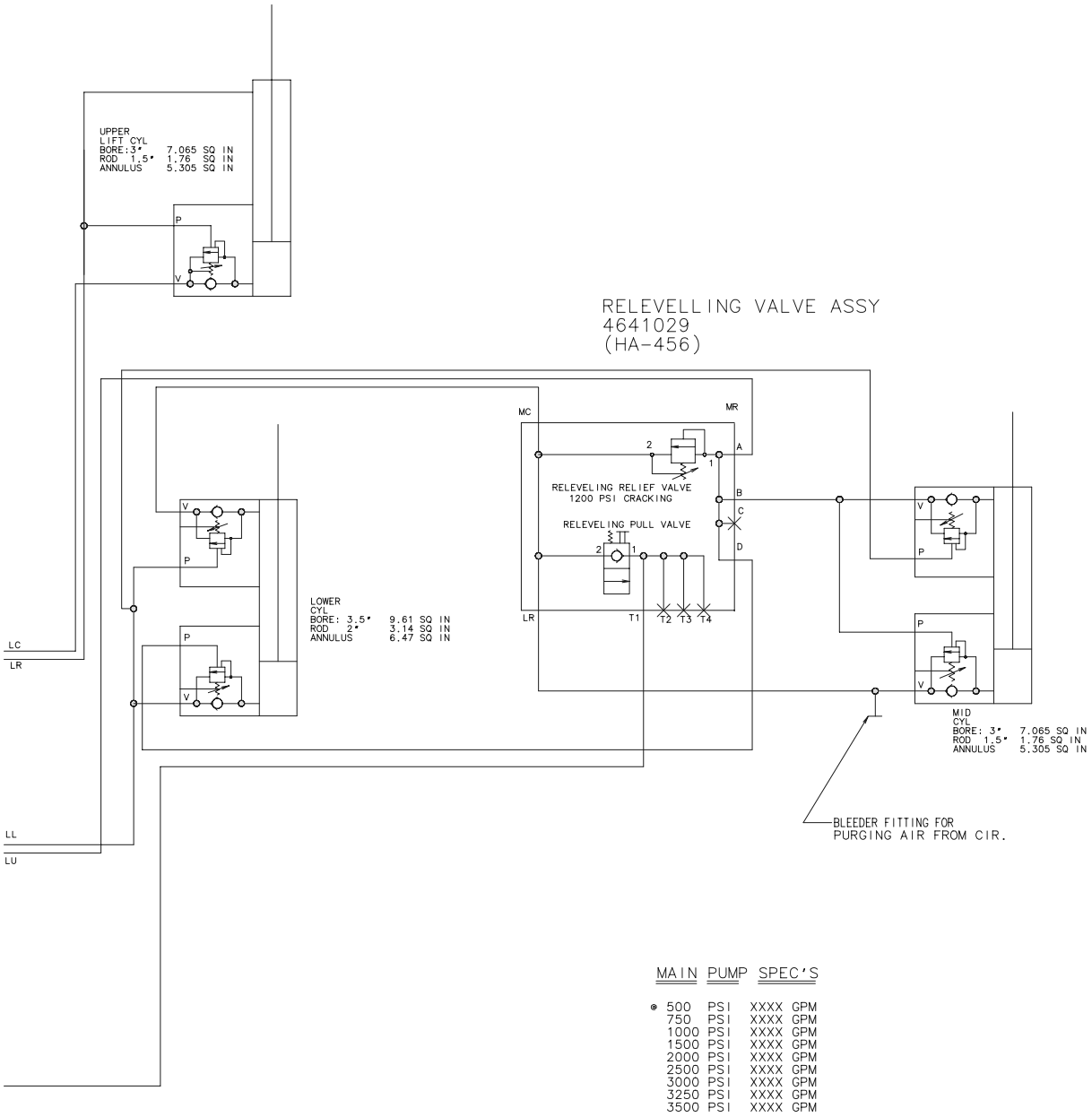

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Figure 3-9. Hydraulic Schematic - M45A/E45A - Sheet 2 of 2

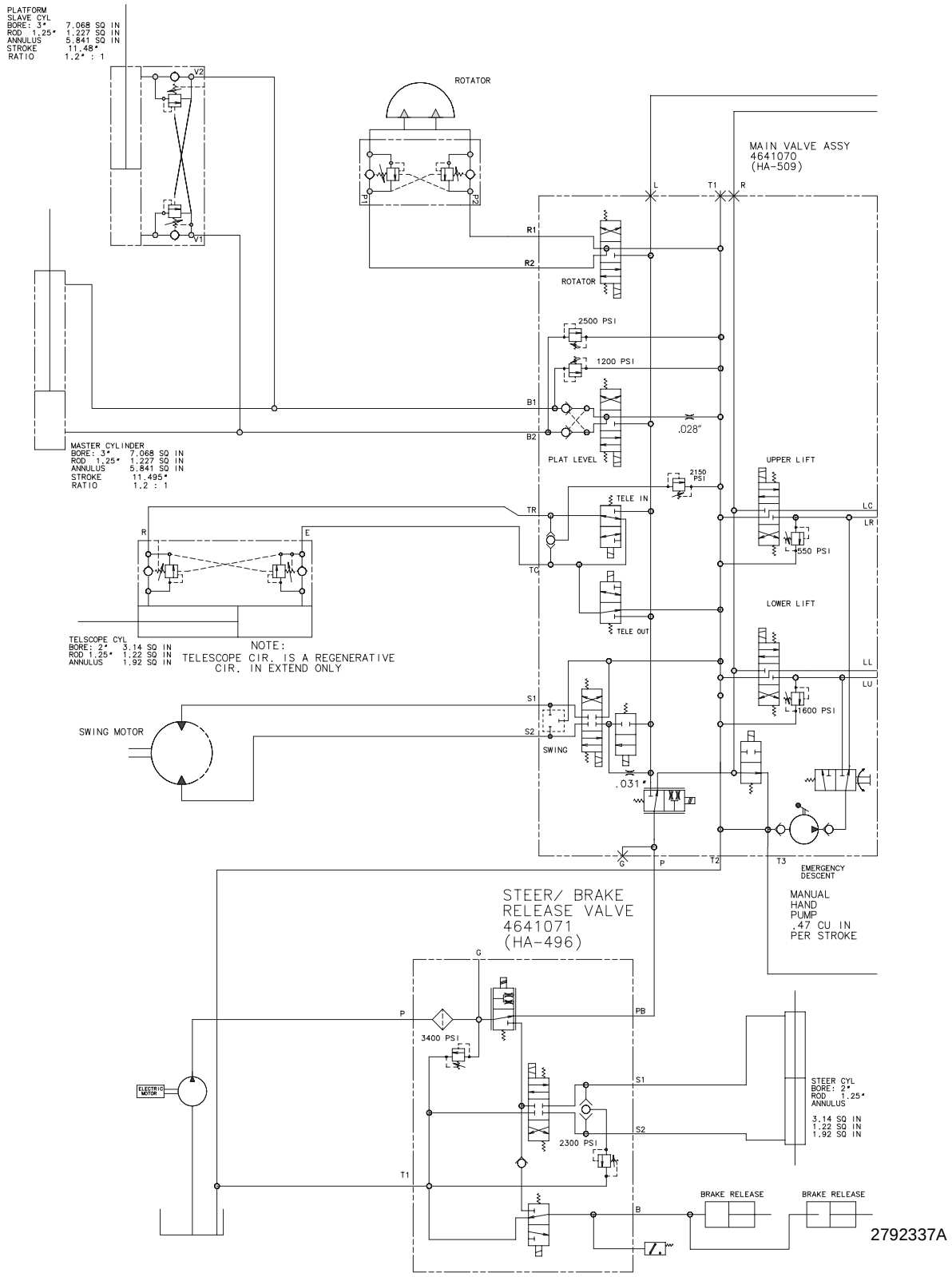

Figure 3-10. Hydraulic Schematic - M45AJ/E45AJ - Sheet 1 of 2

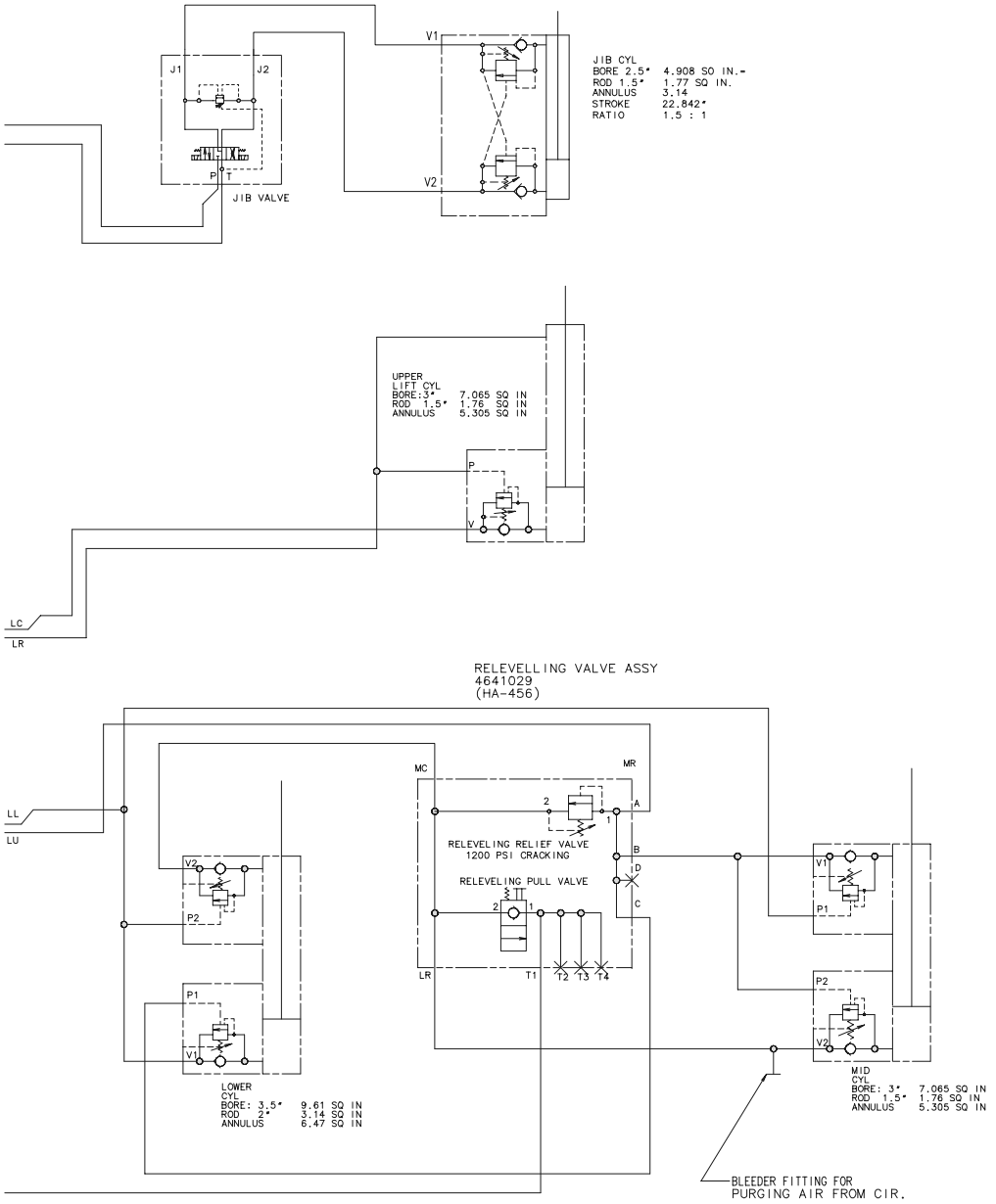

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Figure 3-11. Hydraulic Schematic - M45AJ/E45AJ - Sheet 2 of 2

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