An Oshkosh Corporation Company

Service and Maintenance Manual

Model
H800AJ

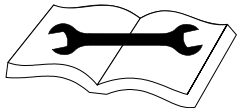
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SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

NOTICE

THIS MACHINE IS POWERED BY AN 84VDC (NOMINAL) ELECTRICAL SYSTEM THAT CAN RANGE UP TO 105VDC DURING NORMAL OPERATION, AND BY A 48VAC (NOMINAL) ELECTRICAL MOTOR SYSTEM THAT CAN RANGE UP TO 60VAC. BASED ON EMPLOYER, LOCAL, AND GOVERNMENTAL REGULATIONS AS THEY PERTAIN TO THIS MACHINE, SPECIFIC ELECTRICAL TRAINING AND CERTIFICATIONS MAY BE REQUIRED BEFORE SERVICING OR TROUBLESHOOTING.

A GENERAL

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

⚠ WARNING

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

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

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

⚠ WARNING

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

B HYDRAULIC SYSTEM SAFETY

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

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



C MAINTENANCE

⚠ WARNING

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

- ENSURE REPLACEMENT PARTS OR COMPONENTS ARE IDENTICAL OR EQUIVALENT TO ORIGINAL PARTS OR COMPONENTS.
- NO SMOKING IS MANDATORY. NEVER REFUEL DURING ELECTRICAL STORMS. ENSURE THAT FUEL CAP IS CLOSED AND SECURE AT ALL OTHER TIMES.
- REMOVE ALL RINGS, WATCHES AND JEWELRY WHEN PERFORMING ANY MAINTENANCE.
- DO NOT WEAR LONG HAIR UNRESTRAINED, OR LOOSE-FITTING CLOTHING AND NECKTIES WHICH ARE APT TO BECOME CAUGHT ON OR ENTANGLED IN EQUIPMENT.
- OBSERVE AND OBEY ALL WARNINGS AND CAUTIONS ON MACHINE AND IN SERVICE MANUAL.
- KEEP OIL, GREASE, WATER, ETC. WIPED FROM STANDING SURFACES AND HAND HOLDS.
- USE CAUTION WHEN CHECKING A HOT, PRESSURIZED COOLANT SYSTEM.
- NEVER WORK UNDER AN ELEVATED BOOM UNTIL BOOM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR BOOM SAFETY PROP HAS BEEN ENGAGED.
- BEFORE MAKING ADJUSTMENTS, LUBRICATING OR PERFORMING ANY OTHER MAINTENANCE, SHUT OFF ALL POWER CONTROLS.
- BATTERY SHOULD ALWAYS BE DISCONNECTEDDURING 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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SECTION 1. SPECIFICATIONS

1.1 OPERATING SPECIFICATIONS

Table 1-1. Operating Specifications

Travel Speed	3.0 MPH (4.83 Km/hr.)
Gradeability 2WD 4WD	 30% 45%
Platform height	80 ft. (24.38 m)
Horizontal reach	51.8 ft. (15.8 m)
Turning Radius (Outside) 2WS	 19 ft. 8 in. (6.02 m)
Turning Radius (Inside) 2WS	 12 ft. 6 in. (3.8 m)
Overall Width	8 ft. 2 in. (2.48 m)
Tailswing	3 ft. 6 in. (1.06 m)
Ground Clearance	11 ft. (28 cm)
Machine Height Stowed	9 ft. 10 in. (3 m)
Machine Length (Stowed)	36 ft.-6 in. (11.13 m)
Wheel base	10 ft. (3.05 m)
Boom Elevation - 800AJ Above Grade Below Grade	 +80 ft. (24.38 m) -13 ft. - 1 in. (3.99 m)
Max. Ground Bearing Pressure	76 psi. (5.3 kg/cm^2)
Max. Tire Load	17,755 lbs. (8054 kg)
Machine Weight approximately*	35,500 lb. (16,103 kg)
* Certain options or country standards can increase weight.	

1.2 TIRES

Table 1-2. Tire Specifications

Size	Type	Ply Rating	Load Range	Pressure
15-625	foam-filled	16	H	6.5 bar (94 psi)
18-625	foam-filled	16	H	5.9 bar (86 psi)
18-625	foam-filled	16	H	5.9 bar (86 psi)

1.3 CAPACITIES

Table 1-3. Capacities

Fuel Tank	Approx. 25 gallons (94.6 liters)
Hydraulic Tank	Approx. 21 gallons (79.5 liters)
Hydraulic System (Including Tank)	65 gallons (246 liters)
Drive Hub	44 ounces (1.3 liters)
Drive Brake	2.7 ounces (80 ml)
Engine Crankcase	6 quarts (5.7 liters)

1.4 ENGINE DATA

Table 1-4. Kubota D1305

Fuel	Diesel
Fuel Consumption	1.2 GPH (4.54 LPH)
No. of Cylinders	3
Max Rated Gross Output	24.8 hp (18.5 kW) @ 2600 rpm
High RPM	2600
Low RPM	1800
Oil Capacity w/filter	6 qts. (5.7 L)
Coolant Capacity (Engine Only)	0.45 gallons (1.7 liters)
Engine Dry Weight	247 lbs. (112 kg)
Acceptable Fuel Grades	
Low Sulfur (<500 ppm) or Ultra Low Sulfur (15 ppm) strongly recommended	
Up to 5% BioDiesel	

1.5 HYDRAULIC OIL

Table 1-5. Hydraulic Oil

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

NOTE: *Hydraulic oils must have anti-wear qualities at least to API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service. JLG Industries recommends Mobilfluid 424 hydraulic oil, which has an SAE viscosity index of 152.*

NOTE: *When temperatures remain consistently below 20 degrees F. (-7 degrees C.), JLG Industries recommends the use of Mobil DTE10.*

NOTE: *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.*

Table 1-6. Mobilfluid 424 Specs

SAE Grade	10W-30
ISO Grade	55
Gravity, API	29.0
Density, Lb/Gal. 60°F	7.35
Pour Point, Max	-46°F (-43°C)
Flash Point, Min.	442°F (228°C)
Viscosity	
Brookfield, cP at -18°C	2700
at 40° C	55 cSt
at 100° C	9.3 cSt
Viscosity Index	152

Table 1-7. Mobil DTE 10 Excel 32 Specs

ISO Viscosity Grade	#32
Pour Point, Max	-40°F (-54°C)
Flash Point, Min.	330°F (250°C)
Viscosity	
at 40° C	33cSt
at 100° C	6.6 cSt
at 100° F	190 SUS (32.7 cSt)
at 212° F	51.1 SUS (6.63 cSt)
cp at -30° F	6,200
Viscosity Index	164

Table 1-8. Mobil EAL H32 Specs

Type	Synthetic Biodegradable
ISO Viscosity Grade	32
Pour Point, Max	-38°F (-39°C)
Flash Point, Min.	514°F (268°C)
Operating Temp.	-20 to 200°F (-29 to 93°C)
Viscosity	
at 40° C	33.1 cSt
at 100° C	6.36 cSt
Viscosity Index	147

Table 1-9. Mobil EAL H46 Specs

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

Table 1-10. Quintolubric 888-46

Density	0.92 @ 15°C (59°F)
Pour Point	<-22°F (<-4°C)
Flash Point	572°F (300°C)
Fire Point	680°F (360°C)
Auto Ignition Temperature	>842°F (>450°C)
Viscosity	
at 0° C (32° F)	320 cSt
at 20° C (68° F)	109 cSt
at 40° C (104° F)	47.5 cSt
at 100° C (212° F)	9.5 cSt
Viscosity Index	190

1.6 CRITICAL STABILITY WEIGHTS

⚠ WARNING

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

Table 1-11. Critical Stability Weights

COMPONENTS		LBS.	KG.
Tire & Wheel Size (Foam Filled Only)	15-625	544	247
	18 -625	601	273
Engine (No added components)		247	112
Wheel Hubs		218	99
Platform	6 ft. (1.83 m)	205	93
	8 ft. (2.44 m)	230	105
Battery	12 V	66	30
	84 V	138	63

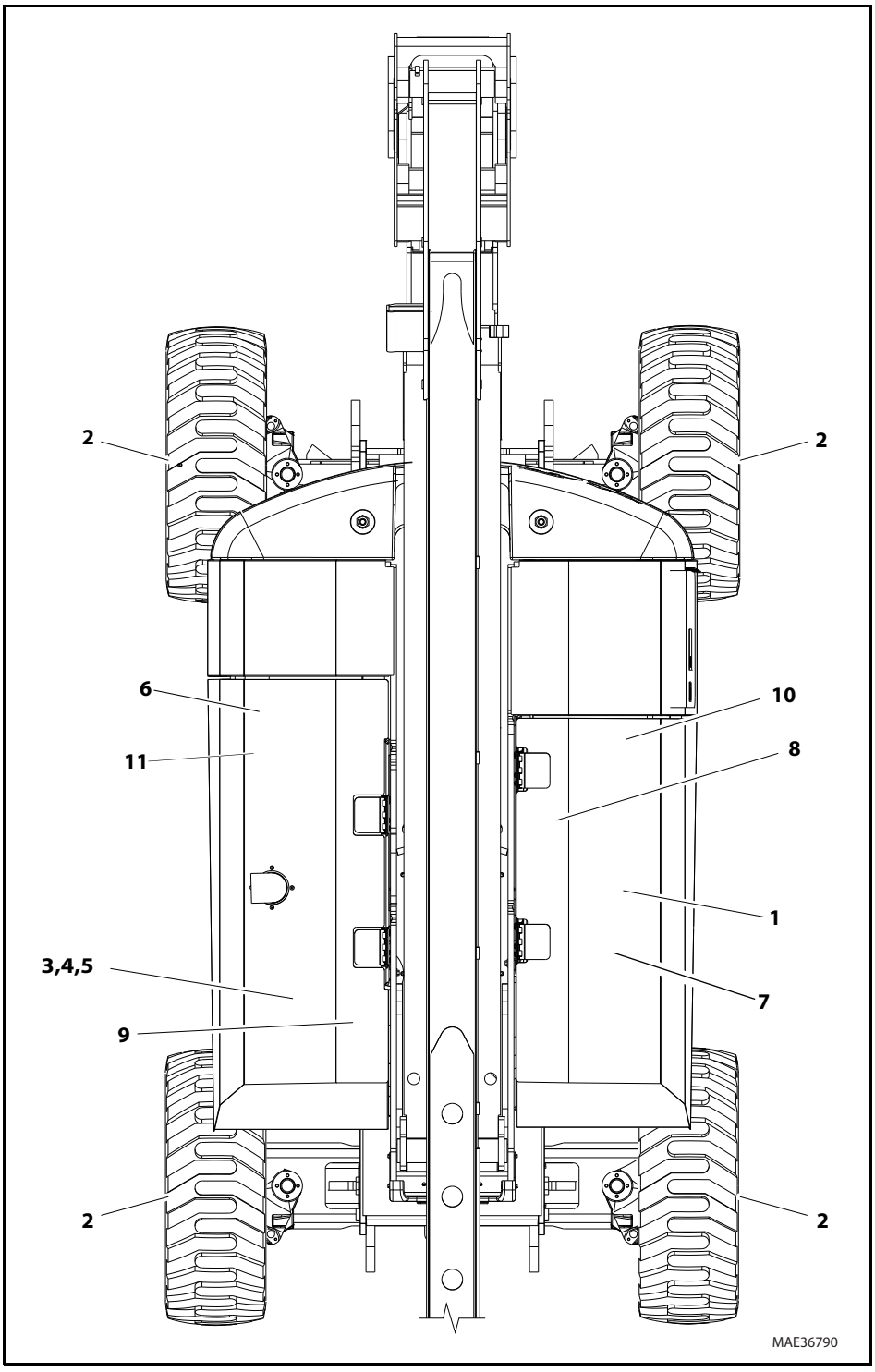


Figure 1-1. Maintenance and Lubrication Diagram

1.7 MAINTENANCE AND LUBRICATION

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

Table 1-12. Lubrication Specifications.

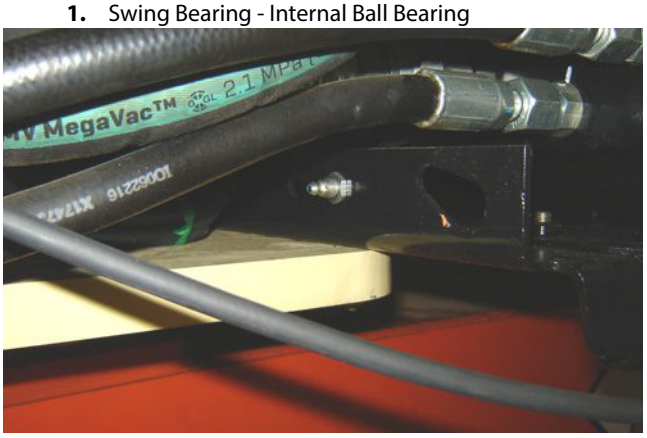
KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350° F (177° C). Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec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

NOTICE

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

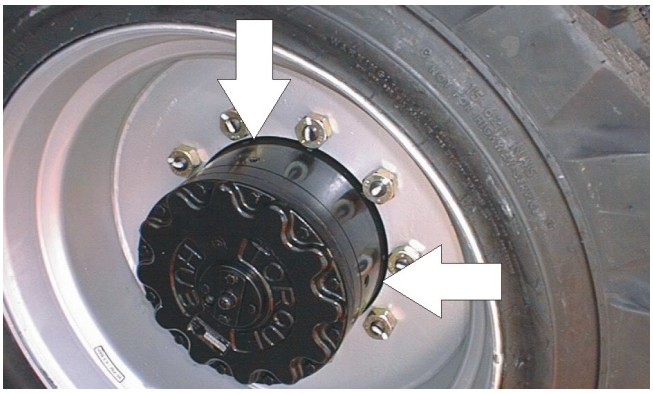
NOTE: *It is recommended as a good practice to replace all filters at the same time.*

1. Swing Bearing - Internal Ball Bearing



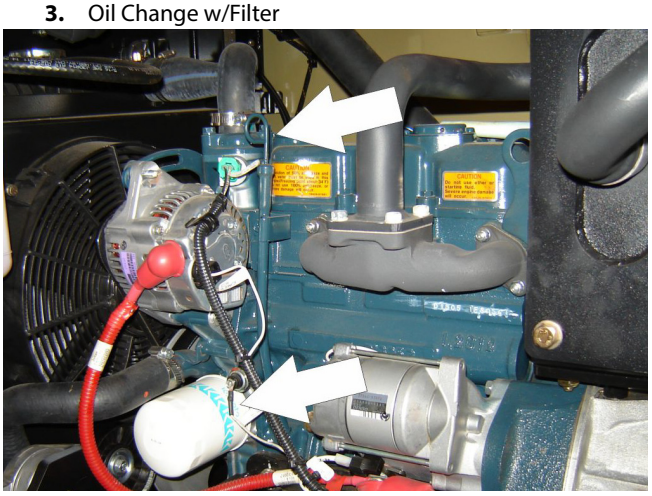
Lube Point(s) - 2 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
Comments - Remote Access.

2. Wheel Drive Hub



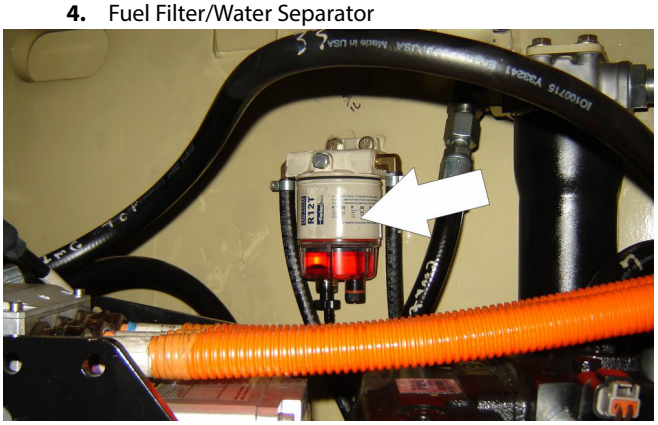
Lube Point(s) - Level/Fill Plug
Capacity - 17 oz. (0.5 L) - 1/2 Full
Lube - EPGL
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation
Comments - Place Fill port at 12 o'clock position and Check port at 3 o'clock position. Pour lubricant into fill port until it just starts to flow out of check port.

3. Oil Change w/Filter



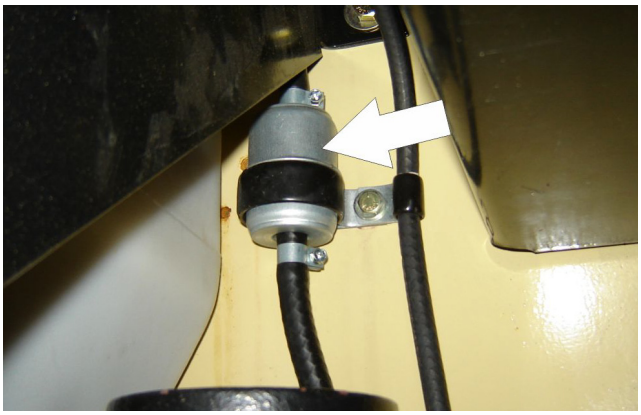
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 6 qt. (5.7 L) w/filter
Lube - EO
Interval - Change in accordance with engine manual
Comments - Check level daily/Adjust full level by mark on dipstick.

4. Fuel Filter/Water Separator



Lube Point(s) - Replaceable Element
Interval - Drain water daily; Change every year or 600hours of operation.

5. Fuel Strainer



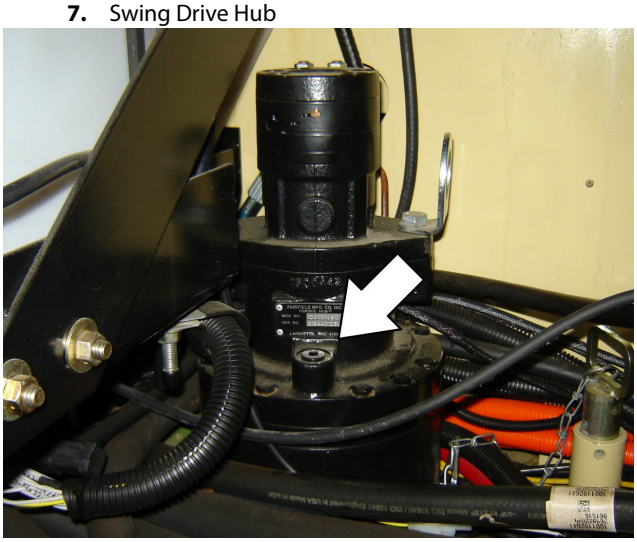
Lube Point(s) - Replaceable Element
Interval - Change every year or 600 hours of operation.

6. Radiator



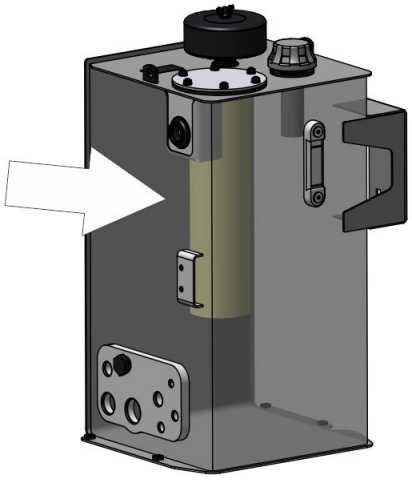
Lube Point(s) - Fill Cap
Lube - Anti-Freeze Coolant (Refer to Engine Manual for compatible coolants)
Capacity - 6 qt. (5.7 L)
Interval - Check coolant level daily. Ensure it is between the "FULL" and "LOW" lines. If coolant level is low, allow fluid to cool, then add as required.

7. Swing Drive Hub



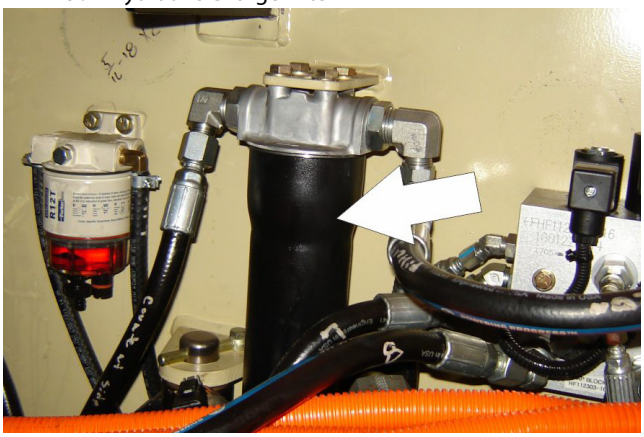
Lube Point(s) - Level/Fill Plug
Capacity - 43 oz. (1.3 L)
Lube - 90w80 Gear Oil
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation.

8. Hydraulic Return Filter



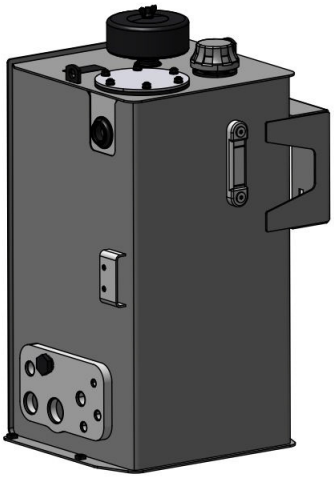
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

9. Hydraulic Charge Filter



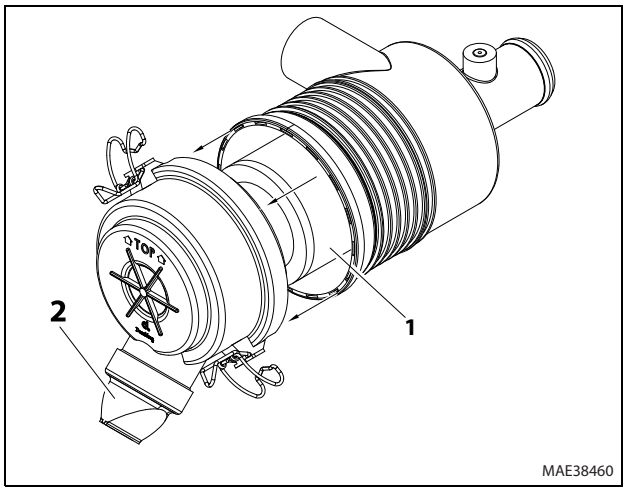
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter or as indicated by Condition Indicator.

10. Hydraulic Tank



Lube Point(s) - Fill Cap
Capacity - 25 gallons (94.5 L) total capacity, 21 gallons (79.5 L) to Full Mark on Sight Gauge; 59 gallons (223 L) System
Lube - HO
Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

11. Air Filter



Lube Point(s) - Replaceable Primary Filter Element (1) (Dry Type)
Interval - Every 6 months or 300 hours of operation. Under severe operating conditions (such as a very dusty work area) check condition of filter more often.

Once a week, squeeze the evacuator valve (2) on bottom of air cleaner assembly to allow collected debris to fall out of the air cleaner.

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)																		
SAE GRADE 5 BOLTS & GRADE 2 NUTS													SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*					
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry)		Torque Lubricated		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or Vibra-TITE™ 131)		Clamp Load	Torque (Dry or Loctite® 263) K= 0.20		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	8	0.9	6	0.7											
	48	0.1120	0.00661	420	9	1.0	7	0.8											
6	32	0.1380	0.00909	580	16	1.8	12	1.4											
	40	0.1380	0.01015	610	18	2.0	13	1.5											
8	32	0.1640	0.01400	900	30	3.4	22	2.5											
	36	0.1640	0.01474	940	31	3.5	23	2.6					1320	43	5				
10	24	0.1900	0.01750	1120	43	4.8	32	3.5					1580	60	7				
	32	0.1900	0.02000	1285	49	5.5	36	4					1800	68	8				
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12			2860	143	16	129	15		
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15			3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	17	23	13	18	19	26	16	22	4720	25	35	20	25	20	25
	24	0.3125	0.0580	3700	19	26	14	19	21	29	17	23	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48	28	38	7000	45	60	40	55	35	50
	24	0.3750	0.0878	5600	35	47	25	34	40	54	32	43	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75	45	61	9550	70	95	65	90	50	70
	20	0.4375	0.1187	7550	55	75	40	54	60	82	50	68	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116	68	92	12750	105	145	95	130	80	110
	20	0.5000	0.1599	10700	90	122	65	88	100	136	80	108	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163	98	133	16400	155	210	140	190	115	155
	18	0.5625	0.2030	12950	120	163	90	122	135	184	109	148	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224	135	183	20350	210	285	190	260	160	220
	18	0.6250	0.2560	16300	170	230	130	176	190	258	153	207	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	21300	260	353	200		285	388	240	325	30100	375	510	340	460	280	380
	16	0.7500	0.3730	23800	300	407	220	298	330	449	268	363	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646	386	523	41600	605	825	545	740	455	620
	14	0.8750	0.5090	32400	470	637	350	475	520	707	425	576	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	38600	640	868	480	651	675	918	579	785	51500	860	1170	770	1045	645	875
	12	1.0000	0.6630	42200	700	949	530	719	735	1000	633	858	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142	714	968	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	47500	880	1193	660	895	925	1258	802	1087	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175	1598	1009	1368	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	59600	1240	1681	920	1247	1300	1768	1118	1516	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074	1322	1792	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750	2380	1506	2042	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754	1755	2379	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300	3128	1974	2676	142200	3555	4835	3200	4350	2665	3625

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

NO. 5000059 REV. K

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

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

Values for Magni Coating Fasteners (Ref 4150701)																		
				SAE GRADE 5 BOLTS & GRADE 2 NUTS							SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*						
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15		Clamp Load	Torque (Dry or Loctite® 263) K= 0.17		Torque (Loctite® 242™ or 271™ OR Vibra-TITE™ 111 or 140) K=.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	7	0.8											
	48	0.1120	0.00661	420	8	0.9											
6	32	0.1380	0.00909	580	14	1.5											
	40	0.1380	0.01015	610	14	1.6											
8	32	0.1640	0.01400	900	25	2.8											
	36	0.1640	0.01474	940	26	2.9					1320	37	4				
10	24	0.1900	0.01750	1120	36	4.1					1580	51	6				
	32	0.1900	0.02000	1285	42	4.7					1800	58	7				
1/4	20	0.2500	0.0318	2020	86	9.7	80	9			2860	122	14	114	13		
	28	0.2500	0.0364	2320	99	11.1	95	11			3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	15	20	14	19	15	20	4720	20	25	20	25	20	25
	24	0.3125	0.0580	3700	15	20	15	21	15	20	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	4940	25	35	25	34	25	34	7000	35	50	35	50	35	50
	24	0.3750	0.0878	5600	30	40	28	38	25	34	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48	9550	60	80	55	75	50	70
	20	0.4375	0.1187	7550	45	60	44	60	40	54	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75	12750	90	120	85	115	80	110
	20	0.5000	0.1599	10700	75	100	71	97	65	88	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109	16400	130	175	125	170	115	155
	18	0.5625	0.2030	12950	105	145	97	132	90	122	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156	20350	180	245	170	230	160	220
	18	0.6250	0.2560	16300	145	195	136	185	125	170	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272	30100	320	435	300	410	280	380
	16	0.7500	0.3730	23800	255	345	238	324	225	306	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435	41600	515	700	485	660	455	620
	14	0.8750	0.5090	32400	400	545	378	514	355	483	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	38600	545	740	515	700	480	653	51500	730	995	685	930	645	875
	12	1.0000	0.6630	42200	600	815	563	765	530	721	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	47500	755	1025	713	969	670	911	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237	142200	3020	4105	2845	3870	2665	3625

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SECTION 2. GENERAL

2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

General

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

Preparation, Inspection, and Maintenance

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

Pre-Start Inspection

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

Pre-Delivery Inspection and Frequent Inspection

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

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

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

Annual Machine Inspection

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

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

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

Preventive Maintenance

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

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

Table 2-1. Inspection and Maintenance

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

2.2 SERVICE AND GUIDELINES

General

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

Safety and Workmanship

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

Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and foreign materials out of the vital components. Precautions have been taken to safeguard against this. Shields, covers, seals, and filters are provided to keep air, fuel, and oil supplies clean; however, these items must be maintained on a scheduled basis in order to function properly.
2. At any time when air, fuel, or oil lines are disconnected, clear adjacent areas as well as the openings and fittings themselves. As soon as a line or component is disconnected, cap or cover all openings to prevent entry of foreign matter.
3. Clean and inspect all parts during servicing or maintenance, and assure that all passages and openings are unobstructed. Cover all parts to keep them clean. Be sure all parts are clean before they are installed. New parts should remain in their containers until they are ready to be used.

Components Removal and Installation

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

Component Disassembly and Reassembly

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

Pressure-Fit Parts

When assembling pressure-fit parts, use an anti-seize or molybdenum disulfide base compound to lubricate the mating surface.

Bearings

1. When a bearing is removed, cover it to keep out dirt and abrasives. Clean bearings in nonflammable cleaning solvent and allow to drip dry. Compressed air can be used but do not spin the bearing.
2. Discard bearings if 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 install.
4. Lubricate new or used serviceable bearings before installation. When pressing a bearing into a retainer or bore, apply pressure to the outer race. If the bearing is to be installed on a shaft, apply pressure to the inner race.

Gaskets

Check 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

NOTICE

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

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

Hydraulic Lines and Electrical Wiring

Clearly mark or tag hydraulic lines 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 intervals. When recommended lubricants are not available, consult your local supplier for an equivalent that meets or exceeds the specifications listed.

Battery

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

Lubrication and Servicing

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

2.3 LUBRICATION AND INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g., using inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up or leaks in the pump supply (suction) lines.
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 as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.
3. Cloudy oils indicate a high moisture content which permits organic growth, resulting in oxidation or corrosion. If this condition occurs, 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 424 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 (-29 degrees C) 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 (-29 degrees C).*

Changing Hydraulic Oil

1. 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.
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 grease 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 CYLINDER DRIFT

Theory

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

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

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

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

Cylinder Leakage Test

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

Measure drift at cylinder rod with a calibrated dial indicator.

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

Cylinder leakage is acceptable if it passes this test.

Table 2-2. Cylinder Drift

Cylinder Bore Diameter		Max. Acceptable Drift in 10 Minutes	
inches	mm	inches	mm
3	76.2	0.026	0.66
3.5	89	0.019	0.48
4	101.6	0.015	0.38
5	127	0.009	0.22
6	152.4	0.006	0.15
7	177.8	0.005	0.13
8	203.2	0.004	0.10
9	228.6	0.003	0.08

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

Cylinder Thermal Drift

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

2.5 PINS AND COMPOSITE BEARING REPAIR GUIDELINES

Filament wound bearings.

1. Pinned joints should be disassembled and inspected if the following occurs:
   a. Excessive sloppiness in joints.
   b. Noise originating from 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 unless otherwise instructed (i.e. sheave pins).
   c. Pins should be inspected to ensure it is free of burrs, nicks, and scratches which would damage the bearing during installation and operation.

2.6 WELDING ON JLG EQUIPMENT

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

Do the Following When Welding on JLG Equipment

- Disconnect the battery.
- Ground only to structure being welded.
- Unplug all pressure transducers (Refer to Section 6 - JLG Control System

Do NOT Do the Following When Welding on JLG Equipment

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

NOTICE

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

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL		
	Pre-Delivery[1] or Frequent[2] Inspection	Annual[3] (Yearly) Inspection	Every 2 Years
Boom Assembly			
Boom Weldments	1,2,4	1,2,4	
Hose/Cable Carrier Installations	1,2,9,12	1,2,9,12	
Pivot Pins and Pin Retainers	1,2	1,2	
Sheaves, Sheave Pins	1,2	1,2	
Bearings	1,2	1,2	
Wear Pads	1,2	1,2	
Covers or Shields	1,2	1,2	
Extend/Retract Chain or Cable Systems	1,2,3	1,2,3	
Platform Assembly			
Platform		1,2	
Railing	1	1,2	
Gate	1,5	1,5	
Floor	1	1,2	
Rotator	5,9,15		
Lanyard Anchorage Point	1,2,10	1,2,10	
Turntable Assembly			
Swing Bearing or Worm Gear	1,2,14	1,2,3,13,14	
Oil Coupling	9		
Swing Drive System	11	11	
Turntable Lock	1,2,5	1,2,5	
Hood, Hood Props, Hood Latches	5	1,2,5	
Chassis Assembly			
Tires	16,17,18	16,17,18	
Wheel Nuts/Bolts	15	15	
Wheel Bearings			14,24
Oscillating Axle/Lockout Cylinder Systems		5,8	
Outrigger or Extendable Axle Systems	5,8	5,8	
Steer Components			
Drive Motors			
Drive Hubs	11	11	
Functions/Controls			
Platform Controls	5,6	6	

Table 2-3. Inspection and Preventive Maintenance Schedule

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

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL		
	Pre-Delivery[1] or Frequent[2] Inspection	Annual[3] (Yearly) Inspection	Every 2 Years
Walk-Around Inspection Performed			
Annual Machine Inspection Due	21		
No Unauthorized Modifications or Additions	21	21	
All Relevant Safety Publications Incorporated	21	21	
General Structural Condition and Welds	2,4	2,4	
All Fasteners, Pins, Shields, and Covers	1,2	1,2	
Grease and Lubricate to Specifications	22	22	
Function Test of All Systems	21	21, 22	
Paint and Appearance	7	7	
Stamp Inspection Date on Frame		22	
Notify JLG of Machine Ownership		22	

Footnotes:

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

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

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

Performance Codes:

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

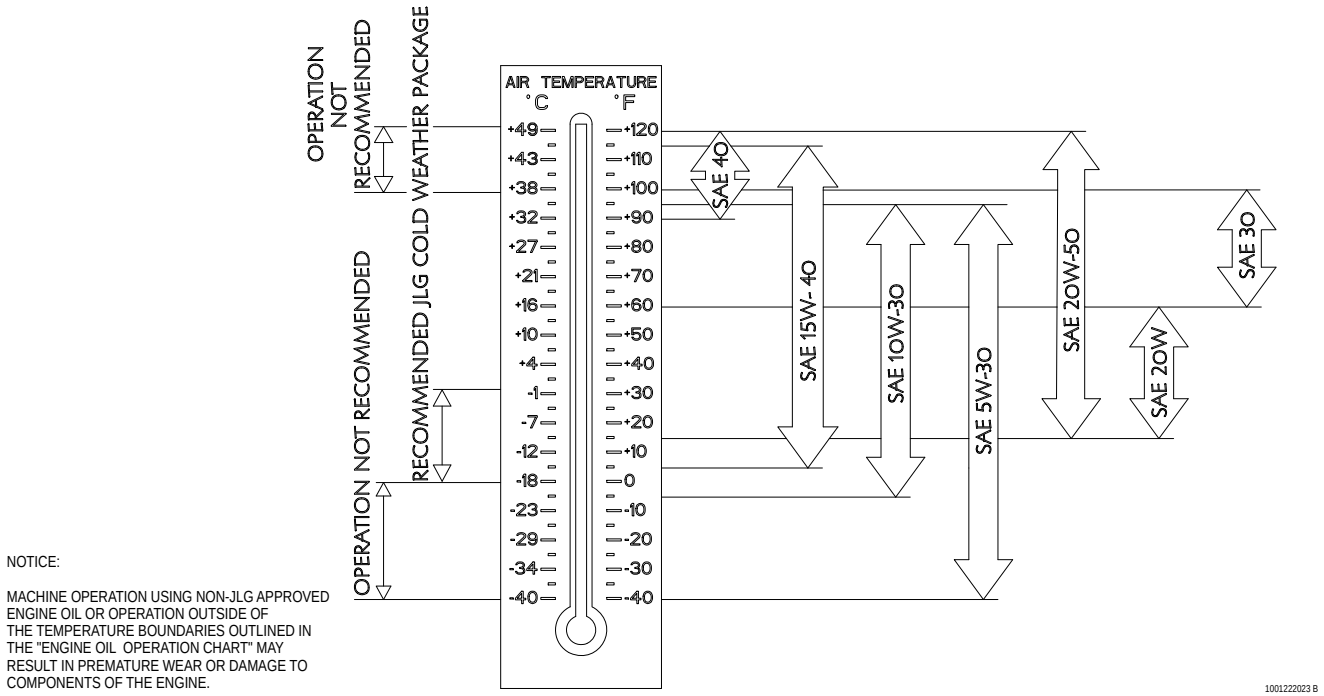
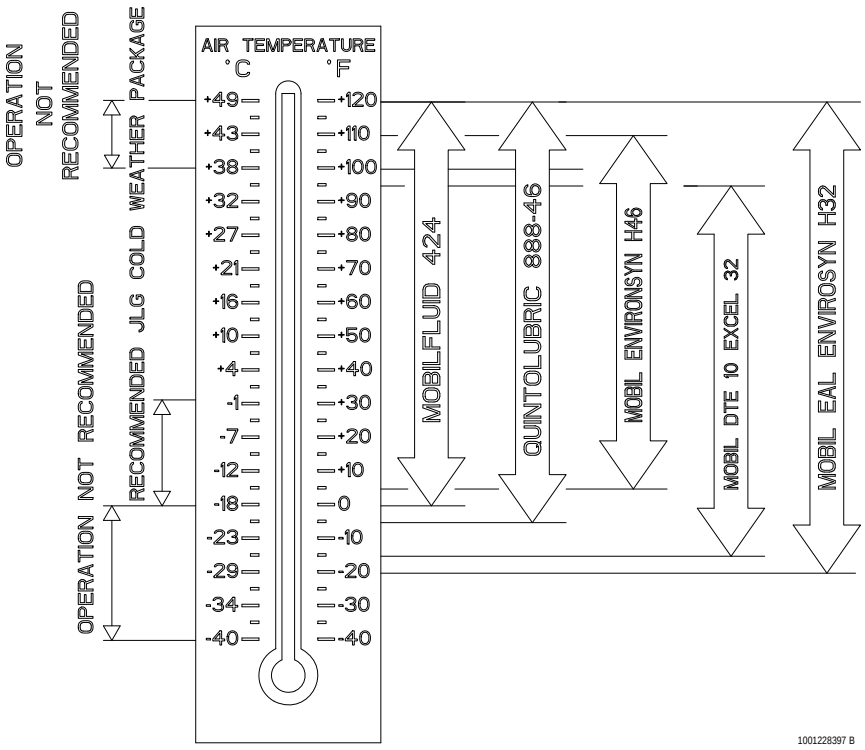


Figure 2-1. Engine Operating Temperature Specifications



Fluid	Properties		Base				Classification		
Description	Viscosity @ 40 °C (CST, Typical)	Visc Index	Mineral Oils	Vegetable Oils	Synthetic	Synthetic Polyol Esters	Readily Biodegradeable *	Virtually Non-toxic**	Fire Resistant***
Mobilfluid 424	55	152	X						
Mobil DTE 10 Excel 32	32.7	164	X						
Mobil EAL Envirosyn H 32	33.1	147			X		X		
Mobil Envirosyn H 46	48.8	145			X		X	X	
Quintolubric 888-46	47.5	190				X	X	X	X

NOTICE:
MACHINE OPERATION USING NON-JLG APPROVED HYDRAULIC FLUIDS OR OPERATION OUTSIDE OF THE TEMPERATURE BOUNDARIES OUTLINED IN THE "HYDRAULIC FLUID OPERATION CHART" MAY RESULT IN PREMATURE WEAR OR DAMAGE TO COMPONENTS OF THE HYDRAULIC SYSTEM.

MACHINE OPERATION TEMPERATURE BOUNDARIES CONTAINED IN THIS DOCUMENT APPLY TO THE FOLLOWING MODELS:
H800AJ

* Readily biodegradable classification indicates one of the following:
CO2 Conversion>60% per EPA560/6-82-003
CO2 Conversion>80% per CEC-L-33-A-93
** Virtually Non-toxic classification indicates an LC50>5000 ppm per OECD 203
*** Fire Resistant classification indicates Factory Mutual Research Corp. (FMRC) Approval

1001228397 B

Figure 2-2. Hydraulic Oil Operating Temperature Specifications

NOTES:

SECTION 3. CHASSIS & TURNTABLE

3.1 TIRES & WHEELS

Tire Damage

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

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

If a tire is damaged but is within the above noted criteria, the tire must be inspected on a daily basis to insure the damage has not propagated beyond the allowable criteria.

Tire Replacement

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

- Equal or greater ply/load rating and size of original
- Tire tread contact width equal or greater than original
- Wheel diameter, width, and offset dimensions equal to the original

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

Wheel Replacement

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

Wheel Installation

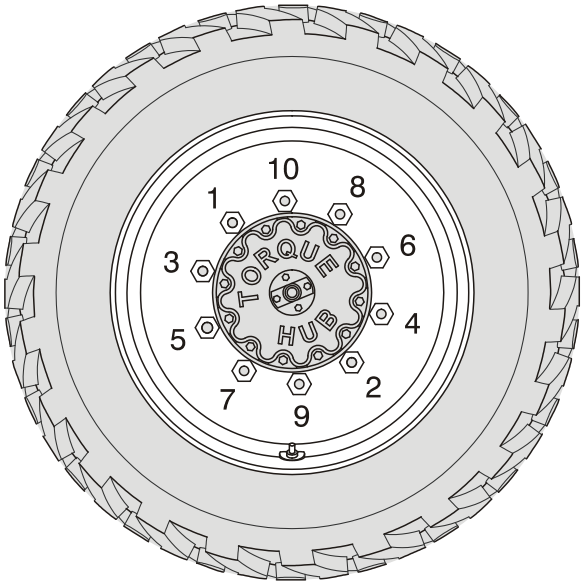
It is extremely important to apply and maintain proper wheel mounting torque.

⚠ WARNING

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

Tighten the lug nuts to the proper torque to prevent wheels from coming loose. Use a torque wrench to tighten the fasteners. If you do not have a torque wrench, tighten the fasteners with a lug wrench, then immediately have a service garage or dealer tighten the lug nuts to the proper torque. Over-tightening will result in breaking the studs or permanently deforming the mounting stud holes in the wheels. The proper procedure for attaching wheels is as follows:

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



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

Table 3-1. Wheel Torque Chart

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
70 ft. lbs. (95 Nm)	170 ft. lbs. (225 Nm)	300 ft. lbs. (405 Nm)

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

3.2 POWERTRAIN OPERATING MODES

The powertrain system consists of diesel engine, automotive style friction clutch, IMG, and hydraulic pumps. When the clutch is engaged, the diesel engine power transmits through the clutch to the shaft of the IMG, then to the hydraulic pumps.

There are two operation modes for the powertrain system – HYBRID Mode and ELECTRIC Mode. These modes can be selected through the Engine Start/Mode Select switch on the platform console.

Hybrid Mode

Under this mode, the engine is started with engine start switch on the platform console. Once started, the engine runs continually until either the Power/Emergency Stop is pressed down, or the mode selection switch is flipped to ELECTRIC Mode position. The clutch is engaged under this mode so engine, clutch, IMG, hydraulic pump turn at the same RPM.

The clutch is always engaged under this mode. So engine, clutch, IMG, hydraulic pump normally turn at the same RPM.

The engine drives the IMG to generate electricity to charge the battery pack and also drive the hydraulic pumps to provide energy needed to operate boom functions and drive functions. The engine runs on either 1800 RPM or 2600 RPM, controlled by system to achieve optimal system efficiency.

While the engine is the primary power source of the vehicle, some vehicle functions need the augmentation of additional power provided by the IMG to achieve maximum performances. The Hybrid Electric Control system can sense if the engine power is enough to operate the commanded function. The IMG will then utilize stored energy from the batteries to provide the additional power required for that function.

When the hydraulic pumps' demand for power is less than the full power available from the engine or the system is idling, depending on the State Of Charge (SOC) of the battery, the IMG could utilize engine power to generate electricity to charge the battery. When the battery stack is lower than 75%(?) SOC, the IMG will charge the battery pack at a higher rate until the battery stack reaches 90%(?) SOC (values configurable via Analyzer), then IMG will charge with a lower current.

The engine will run continuously. If the engine is not required for operation or battery charging, it will stop and can be restarted via footswitch-enable or a request from the engine start switch.

Electric Mode

In Electric mode, the engine does not run and the clutch is disengaged. The machine operates all functions using battery power only to drive the IMG, which in turn drives the hydraulic pumps.

If operated in this mode until the battery stack SOC reaches a Discharged state (Approximately 20%(?) SOC), the Low Battery indicator will warn the operator that HYBRID mode must be reactivated or the battery charger plugged into an external AC source. If the operation of the machine continues, the machine will eventually reach a Deeply Discharged state (Approximately 5%(?) SOC). In this condition, the operator will be allowed to return to transport position but will not be allowed to elevate above transport position afterward. In the event the battery stack is not recharged after the warning indicators are illuminated and the machine is stored, the Low Battery warning indicator will resume flashing after the Emergency Stop is reset.

Switching Between Modes on the Fly

If the selection switch is changed from HYBRID Mode to ELECTRIC Mode position while the engine is running, the clutch will disengage and the engine will stop automatically. The operator can continue operation under ELECTRIC Mode.

If the selection switch is changed from ELECTRIC Mode to HYBRID Mode position, the machine will engage the clutch. The operator must release the foot switch and press the HYBRID/ELECTRIC Mode Switch into the Engine Start position to start the engine. If the switch is in the HYBRID mode position and the engine is not running, the machine will not operate and will notify the operator with a flashing light.

Idle Reduction Stop Start

Idle Reduction Stop Start (IRSS) allows for the engine to shutdown when the machine does not need to high charge the 84V battery stack and the operator is not commanding machine functions. IRSS will shut down the engine once the machine has not been enabled for the amount of time defined in the HEC analyzer parameter (IRSS TIMER). The machine will then restart the engine when the operator steps back into the foot switch, or the coolant temperature drops below an acceptable threshold which would affect the engine ability to restart with no glow plugs or other cold weather assistance.

The machine permits IRSS when [PERSONALITIES - ENGINE - IRSS = ENABLED (Production Default = DISABLED)], when the machine is in Platform Mode of operation and when SkyPower is not active.

When IRSS is enabled, the engine will shut down once all the following conditions are met:

- The machine has not been enabled for the IRSS TIMER, which can be set by the operator from 10 to 1800 seconds (10 seconds to 30 minutes), in increments of 10 seconds. [PERSONALITIES - ENGINE - IRSS TIMER = 20s (Default)]
- High battery charging of the 84V stack is not required.
- The engine must be running and warmed up, which is defined when engine coolant temperature is above 70°C.

After the IRSS shuts down the engine the IRSS will restart the engine if any of the following conditions are true.

- The machine is enabled by the operator stepping into the foot switch, in anticipation of commanding a function.
- The coolant temperature drops below 60. When this threshold is met, a 3 second ground alarm warning is commanded and an additional 3 second delay must expire after the ground alarm has expired before the engine is automatically started.

There is an IRSS suspend override that can be triggered if the engine is starting after either of two progressive SOC% thresholds are met. The first temporary IRSS suspend will occur if operator starts the engine after IRSS has been activated by reaching the 80% High to Low Charge threshold. When the 90% Charging Stop threshold has been met, the engine will again be stopped due to IRSS. If the operator again starts the engine while above the 90% threshold, IRSS will be disabled and the engine will continue to run, indefinitely, until the operator turns the engine off, either by changing to Electric Mode, or powering down the machine with the ESTOP button.

IRSS will be cancelled if the SOC drops below the 80% threshold (-5% hysteresis, 75-80% reading), if the machine is powered down or if the machine is switched to Electric Mode. DTC008 (FUNCTIONS LOCKED OUT- SYSTEM POWERED DOWN) also cancels IRSS.

IRSS will be cancelled if:

- The SOC drops below the 80% threshold (-5% hysteresis, essentially 75-80% SOC reading), if the machine is powered down or if the machine is switched to Electric Mode.
- DTC008 (FUNCTIONS LOCKED OUT- SYSTEM POWERED DOWN) is triggered after the 15 minute unattended alarm is issued. This DTC is not triggered when machine is in Platform Mode and Above Elevation, so IRSS will not time out if the operator is working above elevation.
- The machine transitions through a power cycle.

3.3 DRIVE ORIENTATION SYSTEM



The Drive Orientation System (DOS) is intended to indicate to the operator conditions that could make the direction of movement of the chassis different than the direction of movement of the drive/steer control handle. The system indicates to the operator the need to match the black and white directional arrows on the platform control panel to the arrows on the chassis. The system uses a limit switch mounted on the underside of the turntable, an indicator light and an override switch on the platform display panel. The limit switch trips when the turntable is swung +/- 42 degrees off center of the normal driving position.

This occurs roughly when the boom is swung past a rear tire. When the turntable is in the normal drive position with the boom between the rear tires, no indications or interlocks are made. When the machine is actively driving when the turntable is swung past the switch point, the system is ignored until drive/steer is released. When drive is initiated with the boom swung past the switch point, the DOS indicator will flash and the drive/steer functions will be disabled. The operator must engage the DOS override switch to enable drive/steer (High Speed drive will remain disabled). When the DOS is enabled, the DOS indicator will be illuminated continuously and a 3-second enable timer will be started and will continue for 3 seconds after the end the last drive/steer command. If the timer expires, the DOS override switch must be re-engaged to enable drive/steer.

3.4 OSCILLATING AXLE SYSTEM

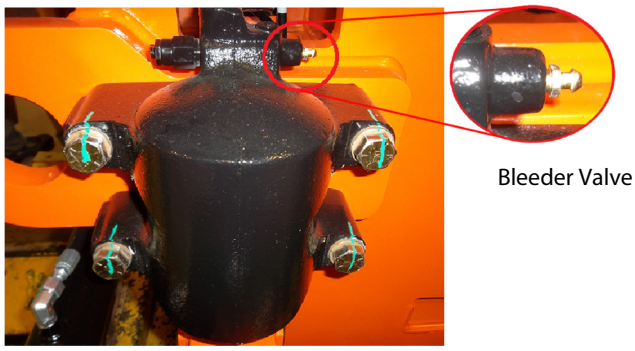
The oscillating front axle is attached to the frame by a pivot pin, which allows all four wheels to remain on the ground when traveling on rough terrain. The oscillating axle also incorporates two lockout cylinders connected between the frame and the axle. The lockout cylinders permit axle oscillation when the main boom is in Transport Position as described in the Above Elevation Cutout System (the tower boom position is not considered) and when the boom is oriented between the rear tires as described in the Drive Orientation System. In this system, both of these boom positions (swing and main boom elevate) are sensed by two switches set up in redundancy. One switch in each position is normally closed and opens when out of Transport Position (these are the same switches described in the Above Elevation Cutout System and in the Drive Orientation System. The other switch for each position is normally open and closes in the when in Transport Position.

The lockout cylinders will lock and hold the axle when the boom is in a position as described above (Main boom above horizontal or swung beyond the rear tires). The cylinders unlock when pilot pressure is applied to the holding valves mounted on the cylinders and lock when pilot pressure is removed.

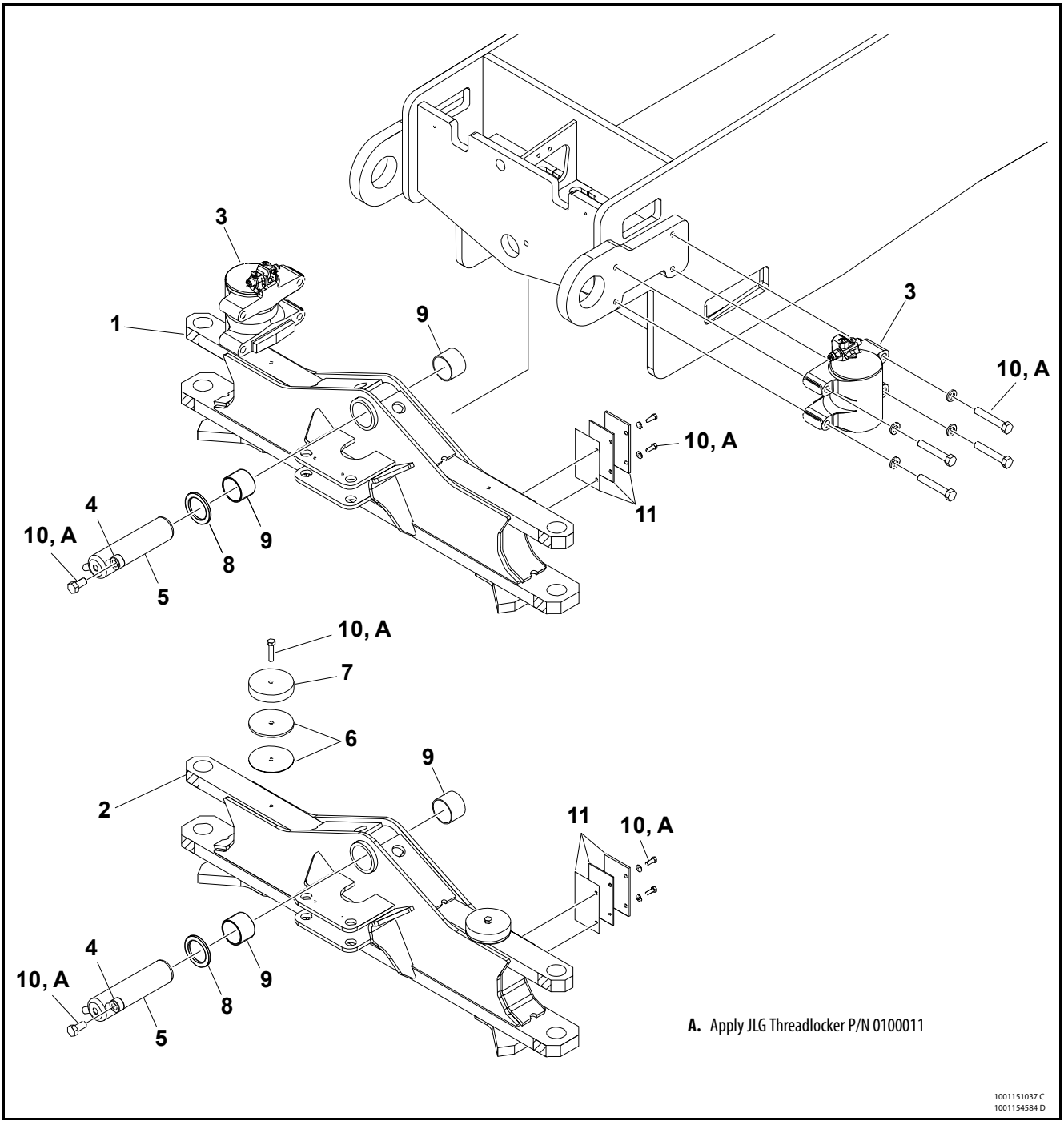
Pilot pressure is supplied via Drive Pump charge pressure. When the Main Boom is below horizontal and swung between the rear tires, the switches described above provide power to actuate the two control valves to supply charge pressure to the lock-out cylinder holding valves. This allows the cylinders to unlock which allows the axle to float. The first valve is normally closed and opens when actuated to allow flow to the lock-out cylinder circuit. The second valve (located between the first valve and the lock-out cylinders) is normally open to tank. This valve closes when actuated to block the tank path and force the flow to the lock-out cylinders. If either of these valves is in its normal state, the axle will be locked. The Ground Control Module supplies power to and monitors the state of the boom elevation and oscillating axle switches. If the switch states are not congruent, the Ground Control Module will remove power, thereby causing the oscillating axle to lock in the fail-safe position until power is cycled.

3.5 LOCKOUT CYLINDER BLEEDING

1. Start the engine.
2. Position the turntable to the normal stowed position.
3. Attach clear tubing to bleeder valve nipple.
4. Position a small bucket/bottle in front of the lockout cylinder bleeder valve and insert clear tubing.
5. Using a 3/8" wrench, loosen the bleeder valve, turning counterclockwise slowly. Bleed air from the top of lockout cylinder. Capture hydraulic oil until a steady unbroken stream of hydraulic oil is viewed. Tighten/close the bleeder valve while stream of hydraulic oil is running.
6. Locate the bleeder valve on the opposite side lockout cylinder. Repeat the process.

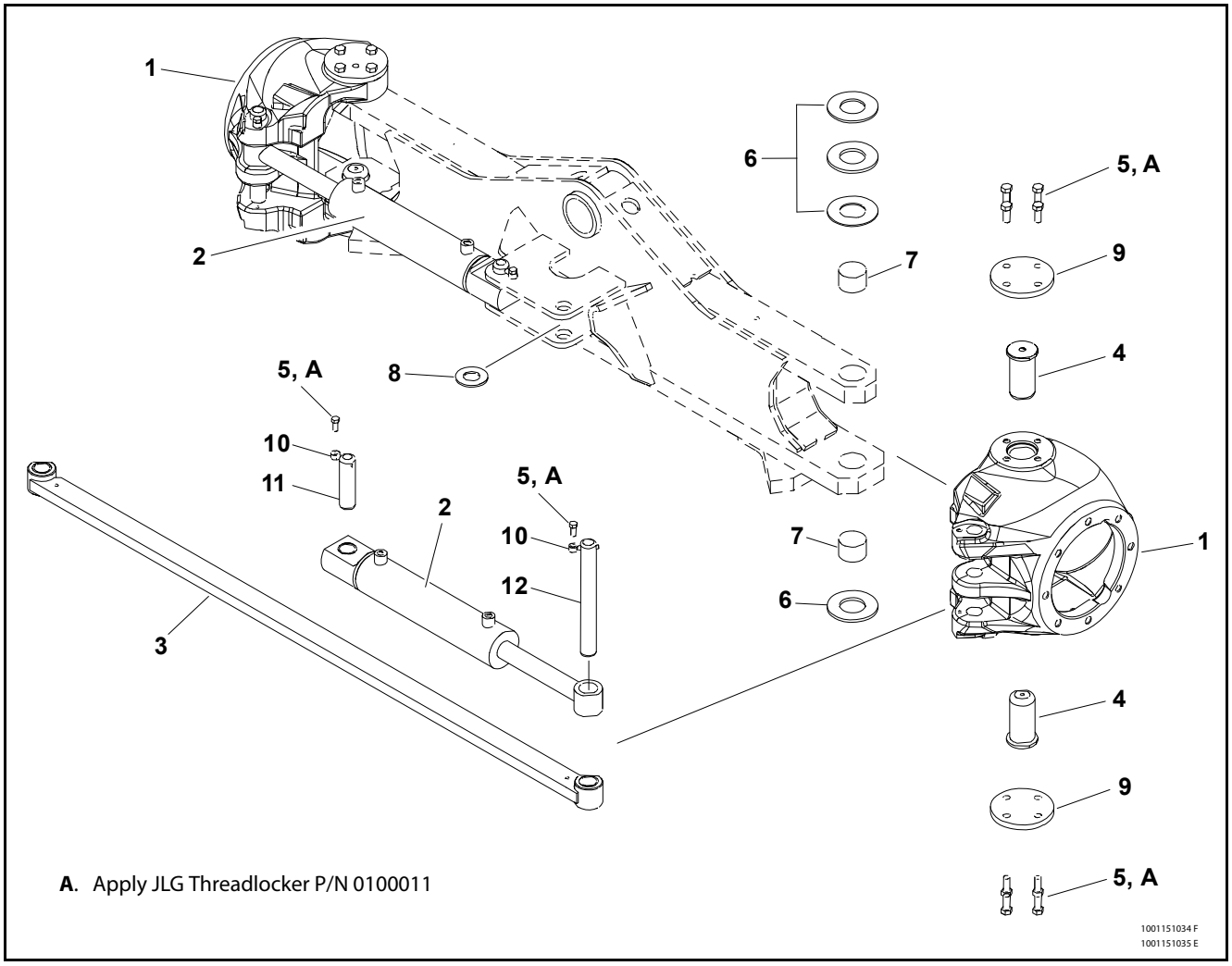


Bleeder Valve



1. Oscillating Axle
2. Fixed Axle
3. Axle Lockout Cylinder
4. Keeper Pin
5. Axle Pivot Pin
6. Shim
7. Stop Plate
8. Washer
9. Bushing
10. Bolt
11. Shim

Figure 3-1. Axle Installation



1. Drive Spindle
2. Steer Cylinder
3. Tie Rod
4. Kingpin
5. Bolt
6. Thrust Washer
7. Composite Bearing
8. Thrust Washer
9. Retaining Plate
10. Keeper PIN
11. Cylinder Pivot Pin
12. Cylinder Pivot Pin

Figure 3-2. Steering Installation

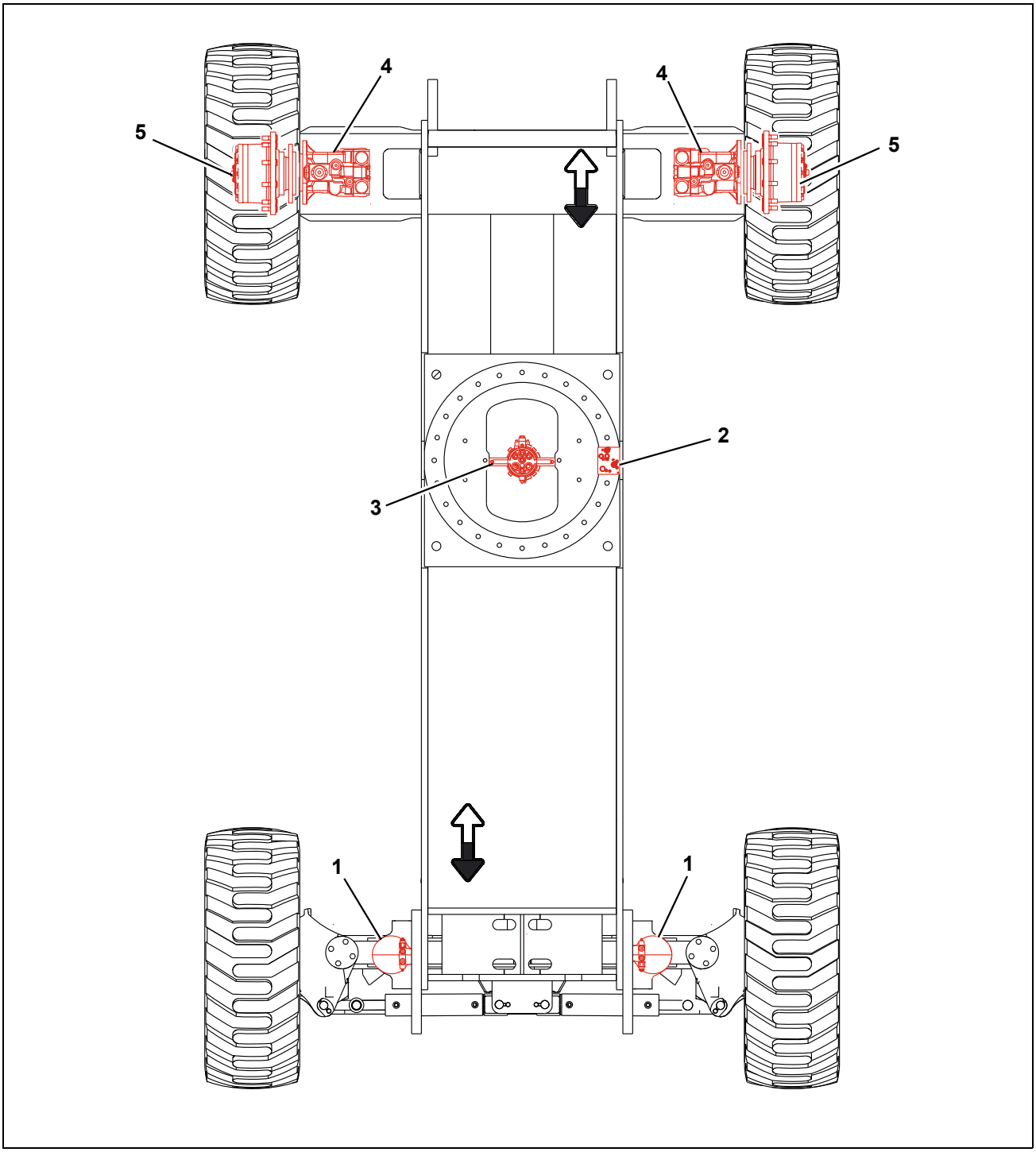
3.6 OSCILLATING AXLE LOCKOUT TEST

NOTICE

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

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

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



1. Axle Lockout Cylinder
2. Flow Drive Valve
3. Swivel
4. Drive Motor
5. Drive Hub

Figure 3-3. Chassis Component Location

3.7 DRIVE SYSTEM

The drive system consists of one variable displacement closed loop pump, four variable displacement piston motors, gear reduction hubs, and a traction control manifold that includes three flow dividers/combiners.

Drive speed is varied by a combination of drive pump displacement, engine & integrated motor/generator speed, and motor displacement. Traction control is full-time and is present in all drive modes. There are three drive modes that can be selected at the platform console. The functionality of the drive system is dependent on the position of the boom (In Transport or Out of Transport, refer to Section 4 for a detailed description of Beyond Transport Position - Drive Cut-back System). The following table describes how the system works in each drive mode.

Table 3-2. Drive Mode Speeds

Boom Position	Drive Selection		Engine Speed when Drive Control is Activated	Approx. Hybrid Mode Max Speed (MPH)	Approx. Electric Mode Max Speed (MPH)
In Transport	Max Speed	–	High – 2600 RPM	3.45	2.5
	Mid-Engine	–	Mid – 1800 RPM	0.8	0.5
	Max Torque	–	High – 2600 RPM	1.1	0.8
Out of Transport	Max Speed	–	High – 2600 RPM	0.2	0.2
	Mid-Engine	–	Mid– 1800 RPM	0.2	0.2
	Max Torque	–	High – 2600 RPM	0.2	0.2

3.8 DRIVE HUB (TORQUE)

Removal

NOTE: *Refer Figure 3-4., Drive Hub Removal and Installation.*

1. Place machine on the firm level surface.
2. Remove and cap all hydraulic hoses from the drive motor assembly.
3. Disconnect the electrical connections from the drive motor assembly.
4. Use suitable lifting device to support the drive hub assembly.

NOTE: *The drive hub assembly weighs approximately 135 lbs. (61 kg).*

5. Remove bolts attached drive hub to the frame.
6. Remove the drive hub assembly from machine and place in a clean work area.

Installation

1. Use suitable lifting device to support the drive hub assembly.

NOTE: *The drive hub assembly motor weighs approximately 135 lbs. (61 kg).*

2. Install the drive hub to the machine.
3. Use the eight bolts and attach the drive hub to the machine. Tighten the bolts to torque 300 ft.lbs. (406 Nm).
4. Reconnect electrical connections to the drive motor.
5. Install previously removed hydraulic hoses to drive motor.

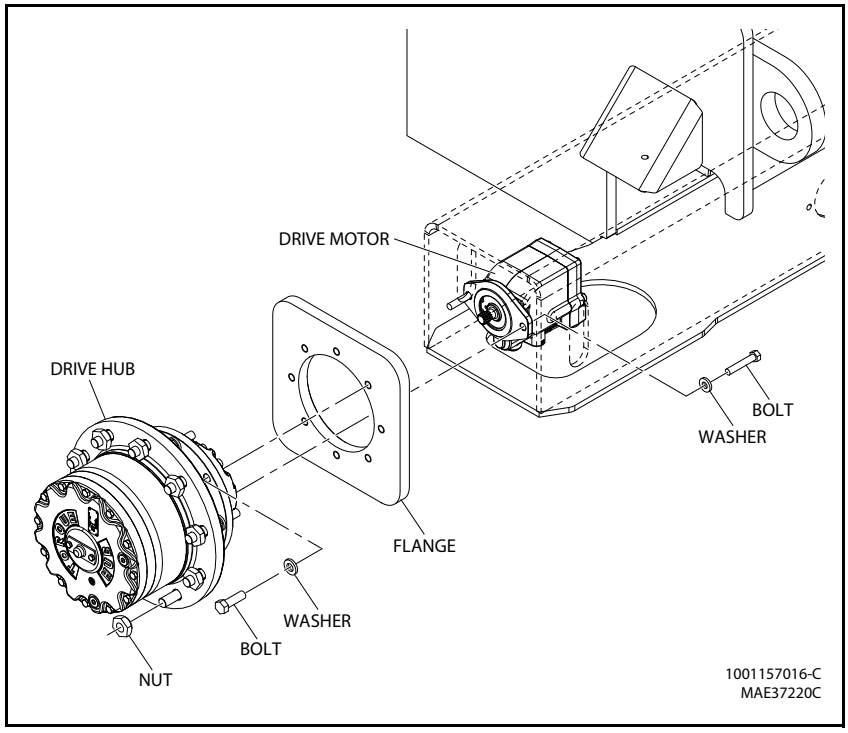


Figure 3-4. Drive Hub Removal and Installation

3.9 DRIVE HUB (PRIOR TO SN 0300247156)

Disassembly

1. Position hub over suitable container and remove drain plugs (10) from unit. Allow oil to completely drain, then replace drain plugs.
2. Remove bolts (41) securing cover assembly to hub (7). Remove cover assembly (23) and discard o-ring seal (22).
3. Lift carrier assembly and top thrust washer and thrust bearing(39, 40) from hub. Thrust washer may stick inside cover.
4. Pry ring gear (21) loose from hub and remove it. Remove o-ring seal (22) from hub counterbore and discard it.
5. Remove input gear (37) and thrust spacer (36) from input shaft assembly and remove input shaft assembly from hub.
6. Lift internal gear (12) and thrust washer and thrust bearing (39, 40) from hub. Thrust washer may stick to bottom of carrier.
7. Remove retaining ring (9) from spindle (1) and discard; lift hub from spindle.

⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL.

8. Remove inside bearing cone (6) and bearing shim (8).
9. If necessary, pry seal (2) out of hub using screwdriver or pry bar. With seal removed, outside bearing cone (4) can be removed.
10. If necessary, remove inner and outer bearing cups (3, 5) using a suitable slide hammer puller or driven out with a punch.
11. To remove the cluster gears from the carrier, drive the anti-roll pin into the planet shaft of the cluster gear. After the planet shaft is removed, the roll pin should be driven out of the planet shaft.

NOTICE

WHEN REBUILDING TORQUE HUB, REMOVE AND REPLACE ALL O-RINGS AND RETAINING RINGS.

Cleaning and Inspection

1. Thoroughly clean all parts in an approved cleaning solvent.
2. Inspect bearing cups and cones for damage, pitting, corrosion, or excessive wear. If necessary, replace bearings as a complete set ensuring that they remain covered until use.
3. Inspect bearing mounting surfaces on spindle, hub, input shaft and carrier. Replace components as necessary.
4. Inspect all geared components for chipped or broken teeth and for excessive or uneven wear patterns.
5. Inspect carrier for damage, especially in anti-roll pin and planet shaft hole areas.
6. Inspect all planet shafts for scoring or other damage.
7. Inspect all threaded components for damage including stretching, thread deformation, or twisting.
8. Inspect seal mounting area in hub for burrs or sharp edges. Dress applicable surfaces or replace components as necessary.
9. Inspect cover for cracks or other damage, and o-ring sealing area for burrs or sharp edges. Dress applicable surfaces or replace cover as necessary.

Repair

1. Cover Assembly.
   a. Remove two bolts (25) securing disconnect cap (26) to cover (23) and remove cap.
   b. Remove two bolts (25) securing cover cap (24) to cover and remove cap.
   c. Remove disconnect rod (27) from cap and remove o-rings (28, 29) from cover cap. Discard o-rings.
   d. If necessary, remove pipe plug (30) from cover.
   e. Clean and inspect parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.
   f. If removed, screw pipe plug into cover.
   g. Slip o-ring (29) over cover cap and against face.
   h. Place o-ring (28) into cover cap internal groove. Disconnect rod may be used to push o-ring into groove.
   i. Place cover cap into cover with large hole located over pipe plug. Secure cover cap to cover with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9.0 Nm).
   j. Place disconnect cap over cover cap with nipple facing out and secure with two bolts. Torque bolts to 70-80 in. lbs. (7.9-9.0 Nm).
   k. Turn cover over and push disconnect rod into cover cap. Rod will be held in place by friction from o-ring.

2. Carrier Assembly.

a. Drive anti-roll pin (19) into planet shaft (17) using a suitable punch.

b. Using a suitable press, press planet shaft from carrier (13). After planet shaft is removed, drive anti-roll pin from shaft.

c. Remove cluster gear (18) and thrust washers (14) from carriers.

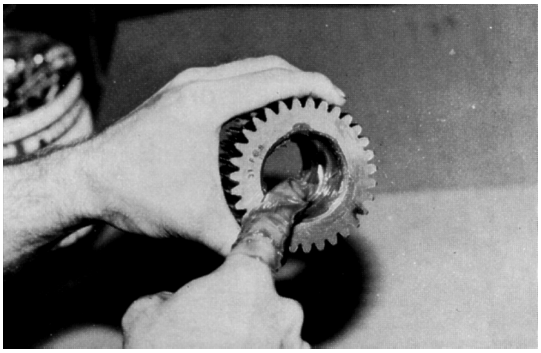
d. Remove needle rollers (15) from cluster gear bore.

e. Remove spacer (16) from cluster gear bore and remove second set of needle rollers (15).

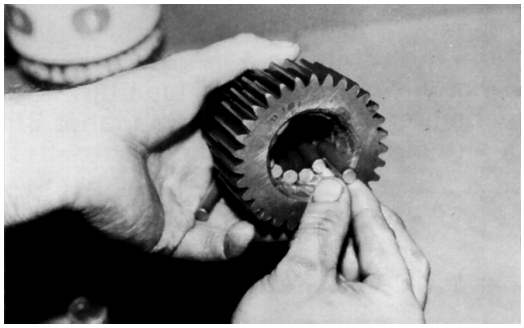
f. Repeat steps (a) through (e) for remaining two cluster gears.

g. Clean and inspect all parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.

h. Apply a coat of grease or petroleum jelly to cluster gear bore.



i. Place needle rollers into cluster gear bore.



j. Place spacer into opposite side of cluster gear and against needle rollers.Place second set of needle

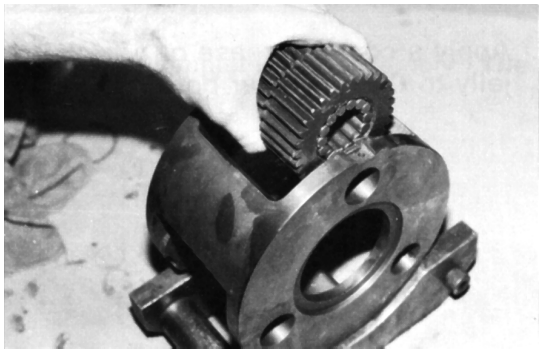


rollers into cluster gear.

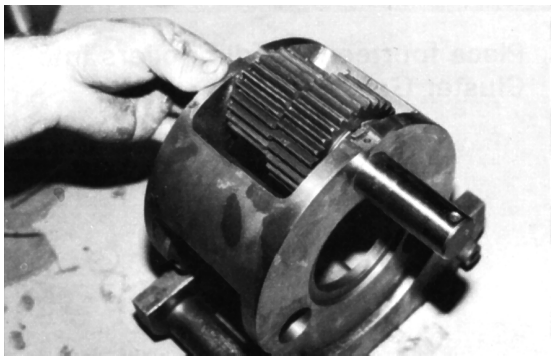
k. Apply grease or petroleum jelly to tang side of two thrust washers. Place thrust washers against bosses in carrier with washer tang fitting into slot in carrier outside diameter.



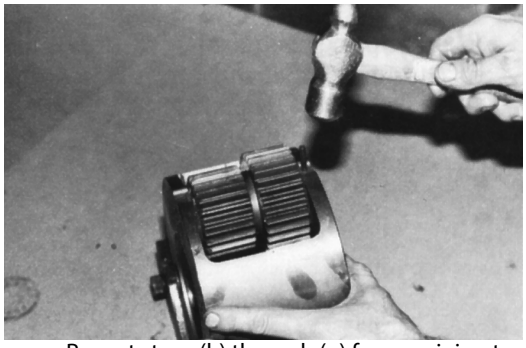
l. While keeping thrust washers in place, slide cluster gear into carrier with larger gear on side with small pin hole.



m. Line up cluster gear and thrust washers with hole in carrier and slide planet shaft through. Ensure chamfered side of hole in planet shaft is lined up with pin hole in carrier.



n. Drive anti-roll pin flush into carrier hole, locking planet shaft into place.



o. Repeat steps (h) through (o) for remaining two cluster gears.

3. Input Shaft Assembly.

⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING REMOVAL AND INSTALLATION

a. Carefully remove retaining ring (33) from counterbore in the spindle (1) and discard retaining ring.

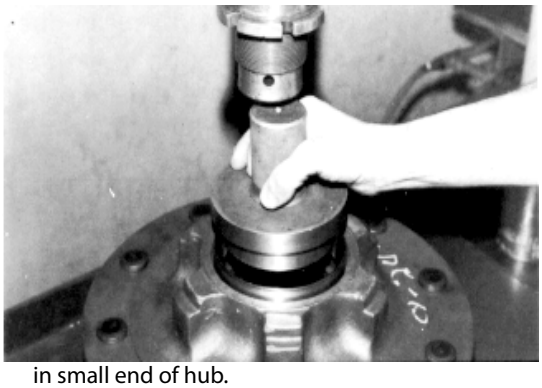
b. Remove two washers (31) and spring (32) from input shaft.

c. Clean and inspect all parts in accordance with Cleaning and Inspection procedures. Replace parts as necessary.

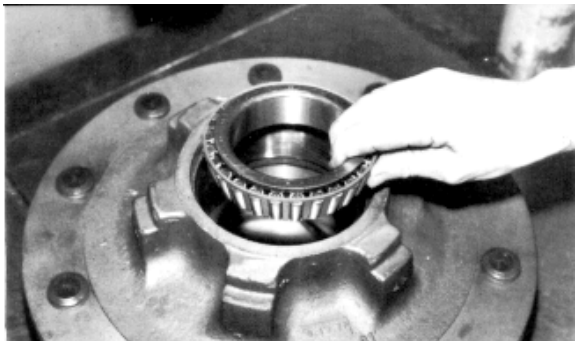
d. Place washer (31), spring (32), and washer (31), in that order, onto input shaft.

Assembly

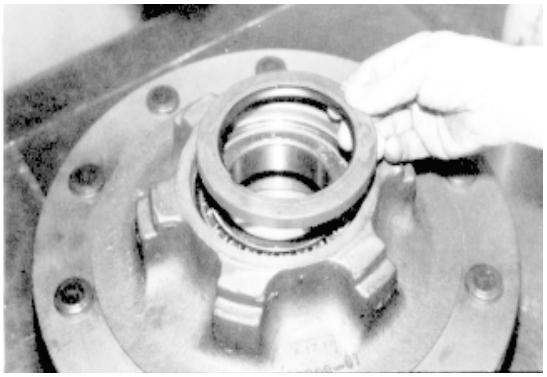
1. Using a suitable press, press new bearing cups (3, 5), with large inside diameters facing out, into hub (7) counterbores.Place bearing cone (4) into bearing cup (3)



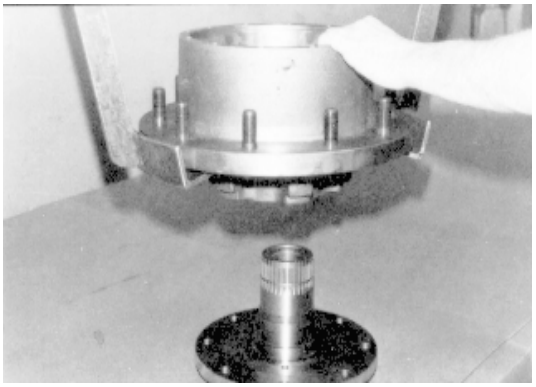
in small end of hub.



2. Press new seal (2) into hub counterbore with flat metal side facing in. Use a flat object to ensure that seal is pressed evenly and is flush with hub face.



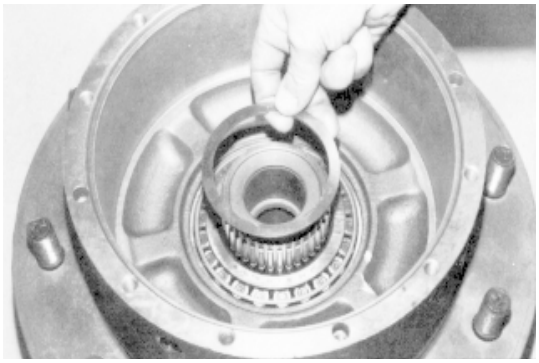
3. Lower hub onto spindle (1) with large open end up.



4. Place bearing cone (6) over end of spindle and into bearing cup.



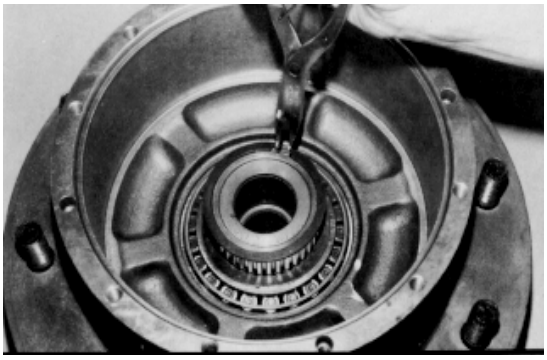
5. Place bearing shim (8) over end of spindle and against bearing cone.



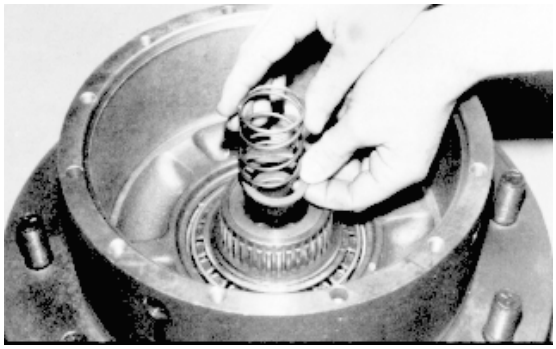
⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING RETAINING RING INSTALLATION.

6. Install retaining ring (9) completely into spindle groove and against bearing shim. Ensure retaining ring is entirely in groove.



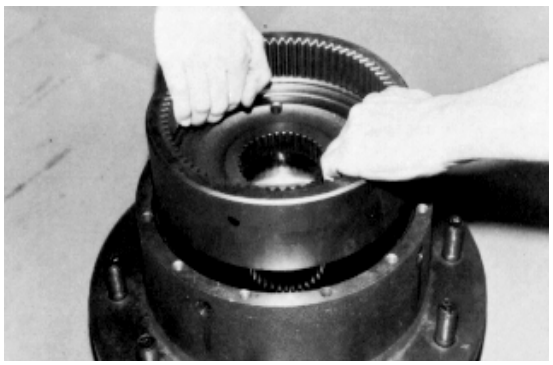
7. The disengage spacer and spring are installed into the counterbore of the spindle.



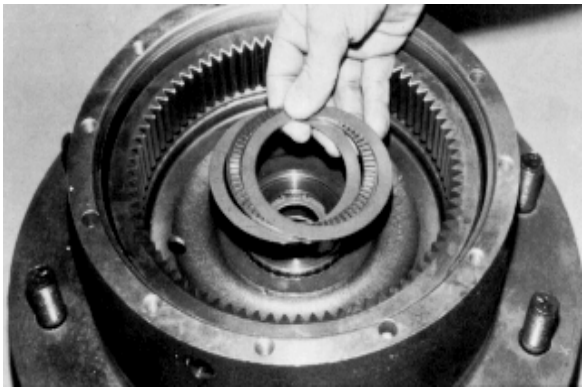
8. Install retaining ring into input shaft groove to secure spacers and spring to shaft.



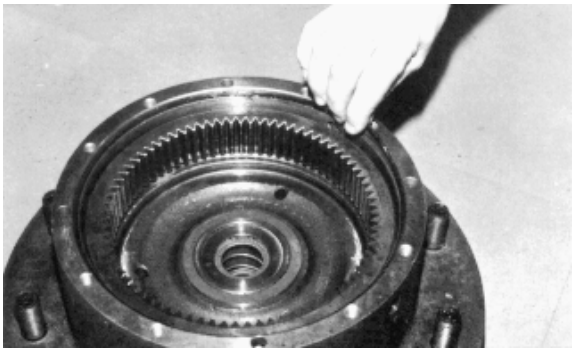
9. Place the internal gear (12) onto end of spindle by matching the bore spline, the spindle spline.



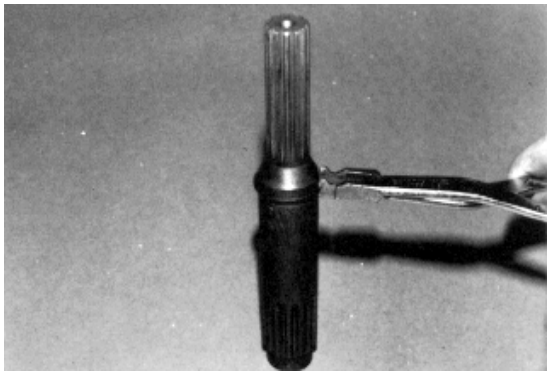
10. Install thrust washers and thrust bearing (39, 40) on the portion of the spindle which extends into the internal gear.



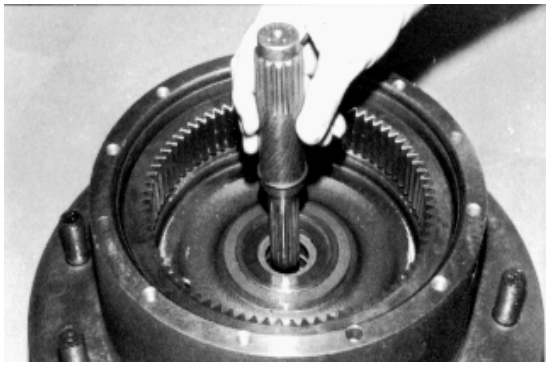
11. The o-ring is placed into the counterbore provided in the hub. Slight stretching may be necessary. Use sufficient grease or petroleum jelly to hold in place.



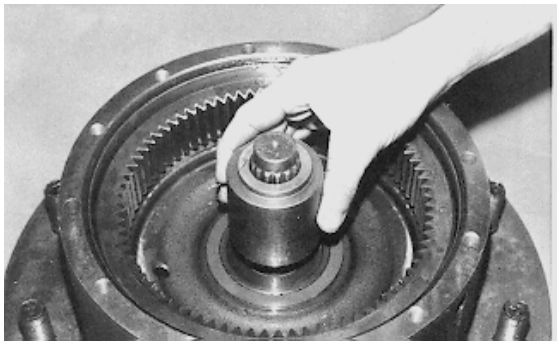
12. Install retaining ring (34) into input shaft retaining ring groove.



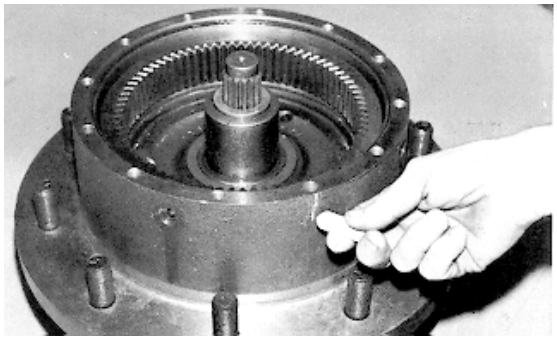
13. Place input shaft assembly (35) into spindle bore with unsplined end facing out.
The action of the spring should be checked at this point.



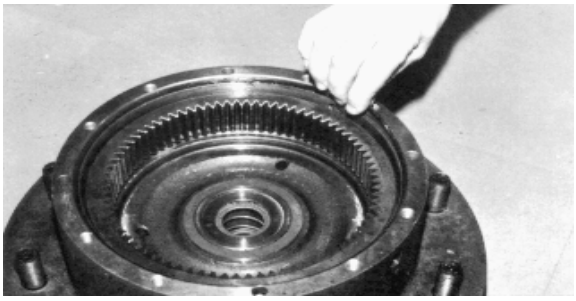
14. Place thrust spacer (36) over input shaft (35) with counterbore side facing spindle.



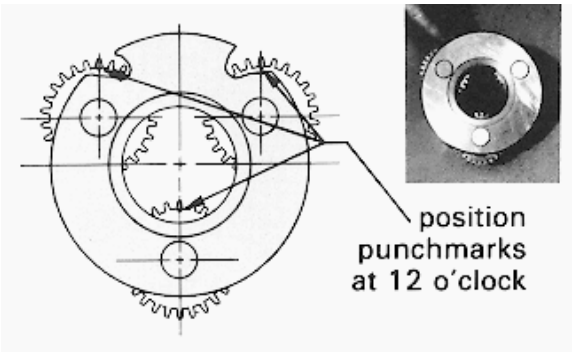
15. Locate the four counter reamed holes in the face of the hub, mark them for later identification.



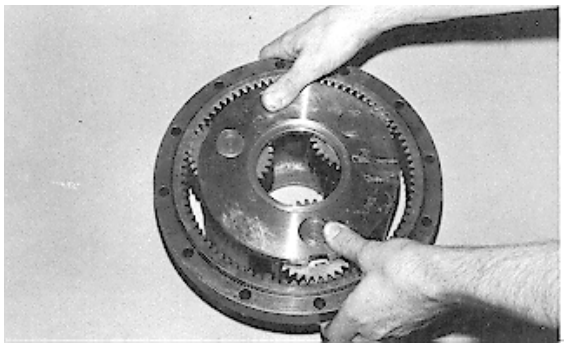
16. Place o-ring (22) into cover assembly counterbore. Use petroleum jelly or grease to hold o-ring in place. Slight stretching of o-ring may be necessary to insure proper seating.



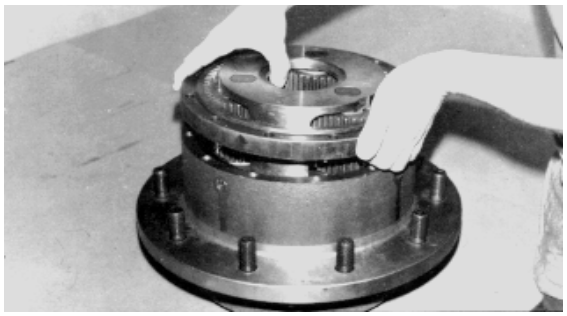
17. Place carrier assembly on a flat surface with large gears up and positioned as shown. Find punch marked tooth on each large gear and locate at 12 o'clock (straight up) from each planet pin. Marked tooth will be located just under carrier on upper two gears.



18. With shoulder side of ring gear (21) facing down, place ring gear over (into mesh with) large gears. Ensure punch marks remain in correct location during ring gear installation. The side of the ring gear with 'X' stamped on it should be up.

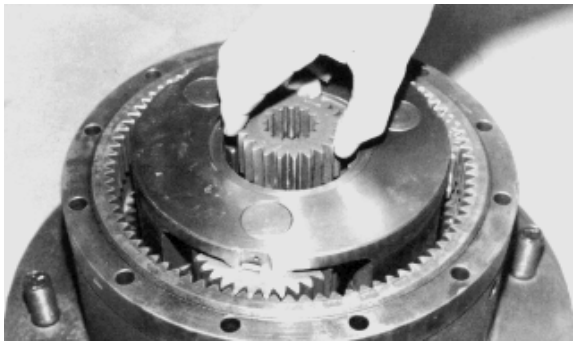


19. While holding ring gear, and cluster gears in mesh, place small side of cluster gears into mesh with internal gear. On ring gear, locate hole marked 'X' over one of the marked counterbored holes in hub.

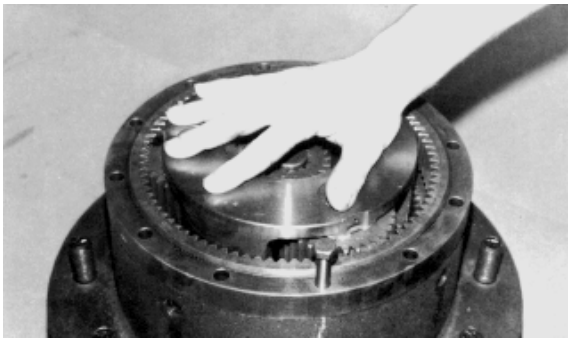


NOTE: *If gears do not mesh easily or carrier assembly does not rotate freely, then remove carrier and ring gear and check cluster gear timing.*

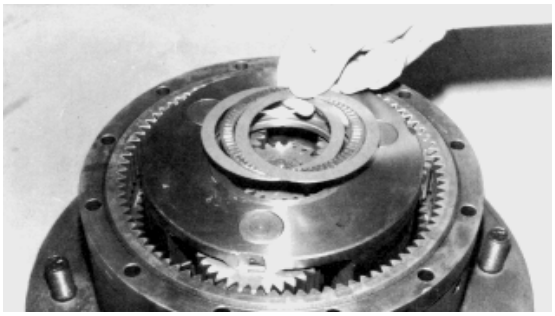
20. Install input gear (37) into the carrier assembly, meshing with large diameter cluster gears (18). Counterbore in bore of input gear must be to outside of carrier assembly.



21. After inserting at least one bolt in the proper location, rotate the carrier. Check freedom of rotation and timing.



22. Install thrust washers and thrust bearing (39, 40) into carrier counterbore.



23. Place o-ring (22) into cover assembly counterbore. Use petroleum jelly or grease to hold o-ring in place.

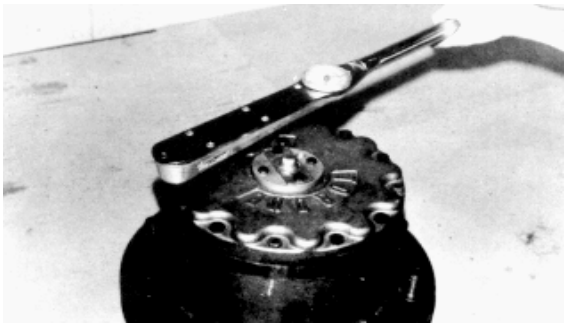


24. Place cover assembly over ring gear with oil level check plug in cover located approximately 90 degrees from oil fill plug in hub.

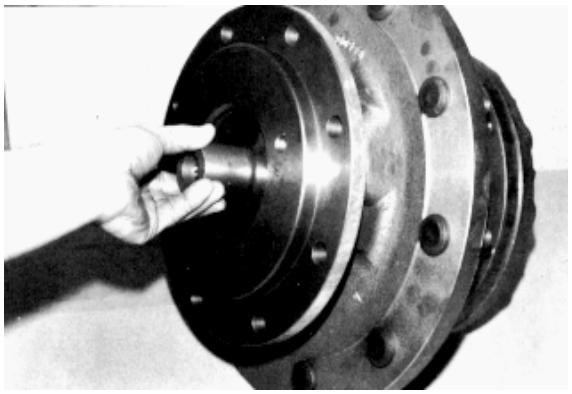
25. Locate four bolts (42), 90 degrees apart into counterbored holes in hub marked in step (16). Torque bolts to 47 ft. lbs. (64 Nm).



26. Install bolts (41) in remaining holes. Torque bolts to 47 ft. lbs. (64 Nm).



27. Place coupling (1) into spindle and onto input shaft.



28. Fill hub one-half full of EPGL 90 lubricant before operation.

1. Spindle
2. Seal
3. Bearing Cup
4. Bearing Cone
5. Bearing Cup
6. Bearing Cone
7. Hub
8. Thrust Washer
9. Retaining Ring
10. Plug
11. Wheel Bolt
12. Internal Gear
13. Carrier
14. Thrust Washer
15. Needle Roller
16. Spacer
17. Planet Shaft
18. Cluster Gear
19. Roll Pin
20. Not Used
21. Cluster Gear
22. O-ring
23. Cover
24. Cover Cap
25. Bolt
26. Disconnect Cap
27. Disconnect Rod
28. O-ring
29. O-ring
30. Pipe Plug
31. Washer
32. Spring
33. Retaining Ring
34. Retaining Ring
35. Input Shaft
36. Thrust Spacer
37. Input Gear
38. Not Used
39. Thrust Washer
40. Thrust Bearing
41. Bolt
42. Coupling

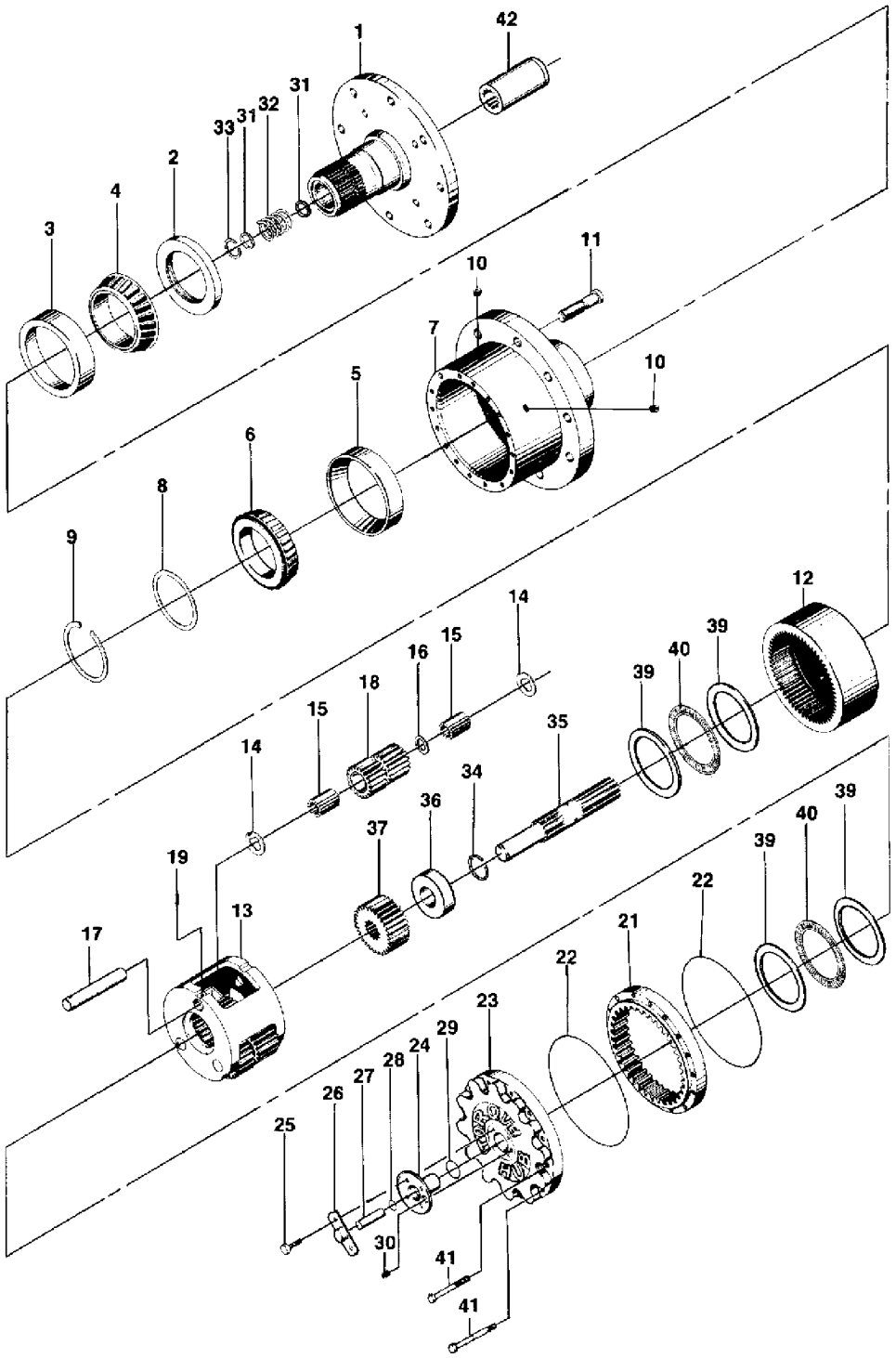


Figure 3-5. Drive Hub (Torque)

3.10 DRIVE HUB (SN 0300247156 TO PRESENT)

Assembly/Disassembly

For detail assembly/disassembly instruction, Refer to appropriate Drive Hub Manual.

3.11 DRIVE BRAKE (PRIOR TO SN 0300247156)

Disassembly

1. Supporting brake:, remove the six socket head capscrews and washers (13 & 14) in equal increments to ensure the spring pressure within the brake is reduced gradually and evenly.

   If a press is available, the cylinder housing (8) can be restrained while removing the six capscrews and washers (13 & 14).

   The brake assembly can now be fully dismantled and the parts examined.
2. Remove cylinder housing (8) and piston (9) subassembly and dismantle if required, removing O-ring seals (15 & 17) and backing rings (16 & 18) as necessary.
3. Remove gasket (7) from housing (2).
4. Remove friction plates (3 & 6) and pressure plate (4).
5. Remove two dowel pins (19).
6. Remove springs (22 & 23).
7. Should it be necessary to replace ball bearing (10) or shaft seal (12), reverse remainder of brake subassembly, supporting on face C of housing (2).
8. Remove internal retaining ring (11).
9. Using arbor press or similar to break Loctite seal, remove brake shaft (1) from housing (2) and lay aside.
10. Reverse housing (2) and press out ball bearing (10). Shaft seal (12) can also be removed if necessary.

Inspection

1. Inspect friction plates (3 & 6) and friction surface on pressure plate (4) for wear or damage.
2. Examine friction plates (3) and brake shaft (1) for wear or damage to the splines.
3. Examine input and output splines of brake shaft (1) for wear or damage.
4. Examine compression springs (22 & 23) for damage or fatigue.
5. Check ball bearing (10) for axial float or wear.
6. Examine O-ring seals (15 & 17) and backing rings (16 & 18) for damage.

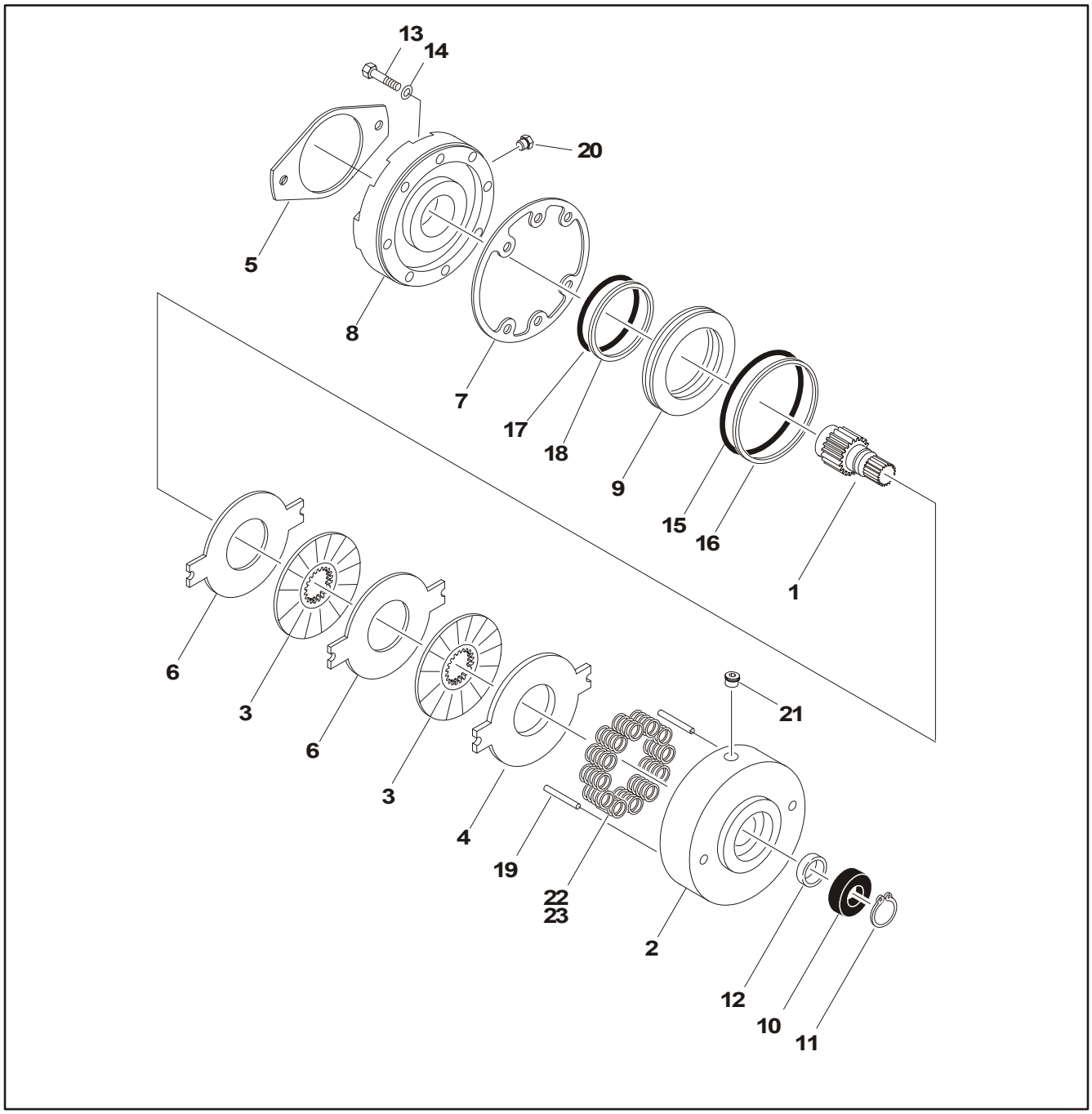
Assembly

1. Lightly lubricate rotary shaft seal (12) and assemble to housing (2) taking care not to damage seal lip.
2. Apply ring of Loctite 641 or equivalent adhesive to full circumference of housing (2) bearing recess adjacent to shoulder.

   Apply complete coverage of Loctite 641 to outside diameter of bearing (10) and assemble fully In housing (2), retaining with internal retaining ring (11). Remove excess adhesive with a clean cloth.

   Press shaft (1) through bearing (10), ensuring bearing inner ring Is adequately supported.
3. Assemble correct quantity of springs (22 & 23) in orientation required.
4. Lubricate O-ring seals (15 & 17) with Molykote 55M (or equivalent) silicon grease and assemble together with backing rings (16 & 18) to piston (9). To ensure correct brake operation. It is important that the backing rings are assembled opposite to the pressurized side of piston.
5. Correctly orientate piston (9) aligning spaces with the two dowel pin holes and, assemble into cylinder housing (8) taking care not to damage seals and carefully lay aside.
6. Locate 2-off pins (19) in housing (2) followed by pressure plate (4) and friction plates i.e. an inner (3) followed by an outer (6) in correct sequence.
7. Position gasket (7) in correct orientation.
8. Align two holes in cylinder with dowel pins (19) and assemble piston & cylinder sub-assembly to remainder of brake securing with 6 capscrews and washers (13 & 14). Torque to 55 ft.lbs. (75 Nm).

NOTE: *The use of a suitable press (hydraulic or arbor) pressing down on cylinder end face B will ease assembly of the capscrews (13).*



1. Shaft
2. Housing
3. Friction Plate
4. Pressure Plate
5. Gasket
6. Outer Plate
7. Gasket
8. Cylinder
9. Piston
10. Ball Bearing
11. Retaining Ring
12. Shaft Seal
13. Capscrew
14. Lockwasher
15. O-ring
16. Backup Ring
17. O-ring
18. Backup Ring
19. Dowel Pin
20. Plug
21. Plug
22. Spring (Natural)
23. Spring (Blue)

Figure 3-6. Drive Brake

3.12 DRIVE BRAKE (SN 0300247156 TO PRESENT)

For detail assembly/disassembly instruction, refer to appropriate Drive Brake Manual.

3.13 DRIVE MOTOR

Removal

NOTE: *Refer Figure 3-7., Drive Motor Removal and Installation.*

1. Place machine on the firm level surface.
2. Disconnect the battery power and all electrical connections from the drive motor.
3. Use suitable lifting device to support the drive motor.

NOTE: *The drive motor weighs approximately 34 lbs. (15 kg).*

4. Remove two bolts attached drive motor to the drive hub.
5. Remove the motor from machine and place in a clean work area.
6. Clean the motor for dirt. Remove rust or corrosion from coupling shaft.

Installation

1. Use suitable lifting device to support the drive motor.

NOTE: *The drive motor weighs approximately 34 lbs. (15 kg).*

2. Install the drive motor to the machine.

⚠ CAUTION

INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.

3. Make sure that the pump shaft is properly aligned.
4. Use the two bolts and attach the drive motor to the drive hub.
5. Reconnect all electrical connections to the drive motor.
6. Start the machine and check the motor for proper functioning.

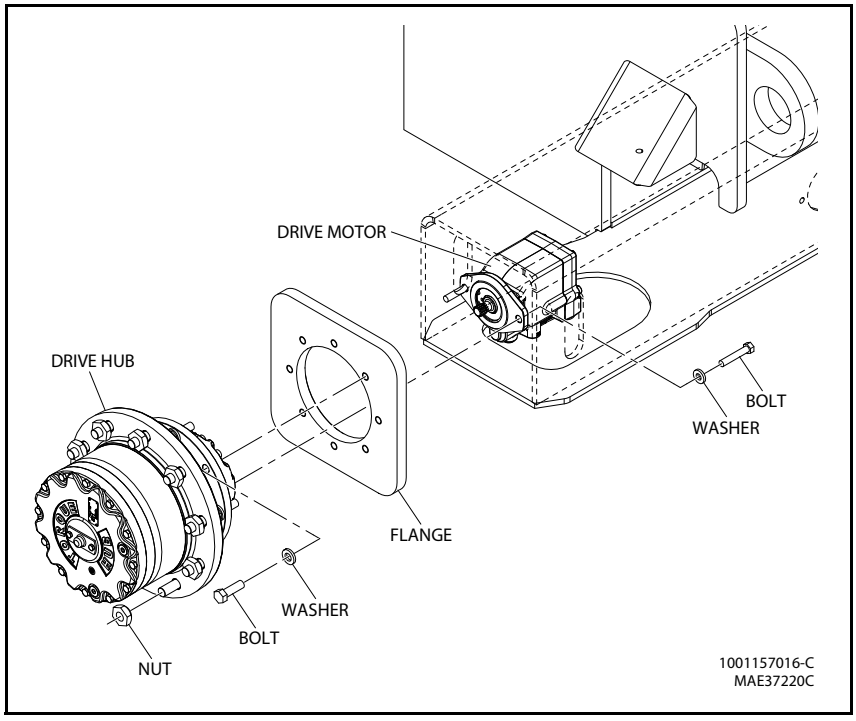


Figure 3-7. Drive Motor Removal and Installation

Description

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

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

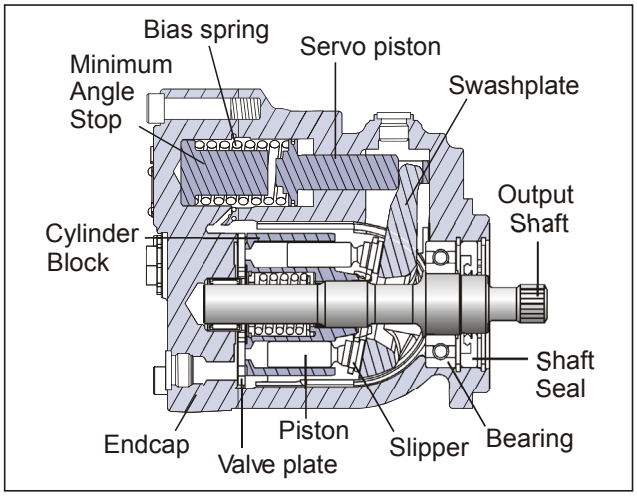
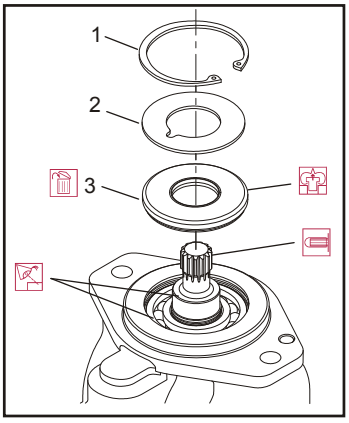


Figure 3-8. Drive Motor Cross Section

Shaft Seal Replacement

REMOVAL

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



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

Figure 3-9. Removing the Shaft Seal

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

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

INSPECT THE COMPONENTS

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

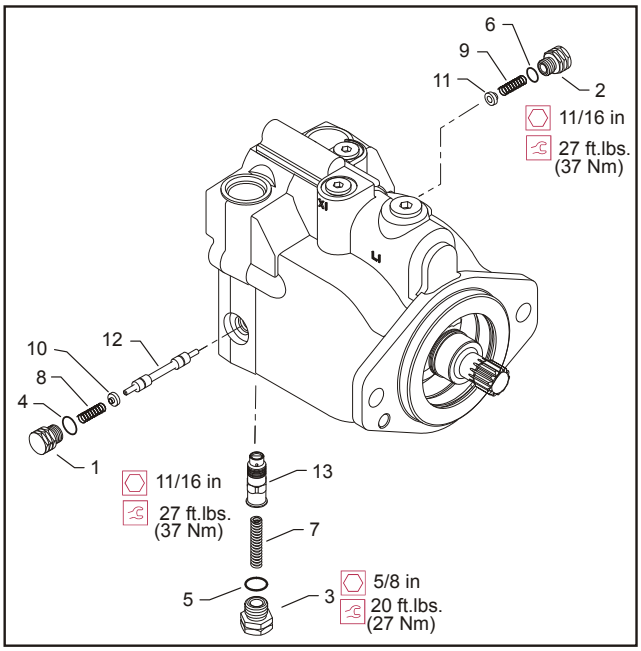
INSTALLATION

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

Loop Flushing Valve

REMOVAL

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



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

Figure 3-10. Loop Flushing Spool

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

INSPECT THE COMPONENTS

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

INSTALLATION

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

Troubleshooting

Table 3-3. Excessive Noise and/or Vibration

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

Table 3-4. System Operating Hot

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

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

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

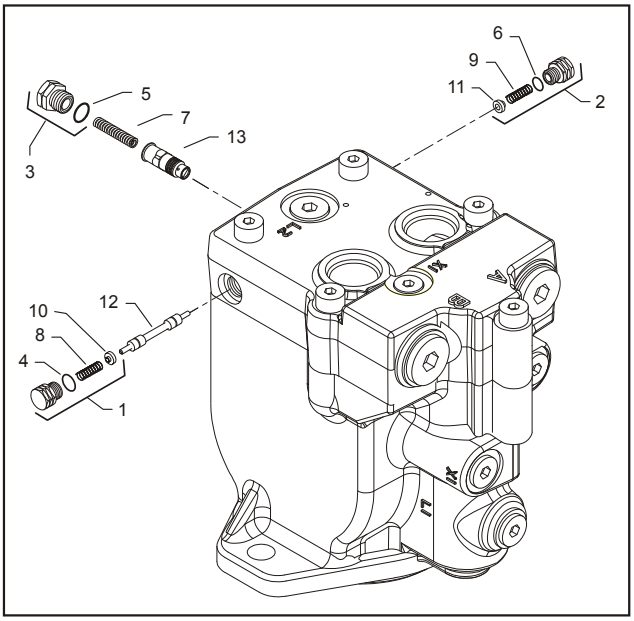
Disassembly

NOTE: *Removal of the endcap voids warranty.*

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

Replace all O-Rings and gaskets.

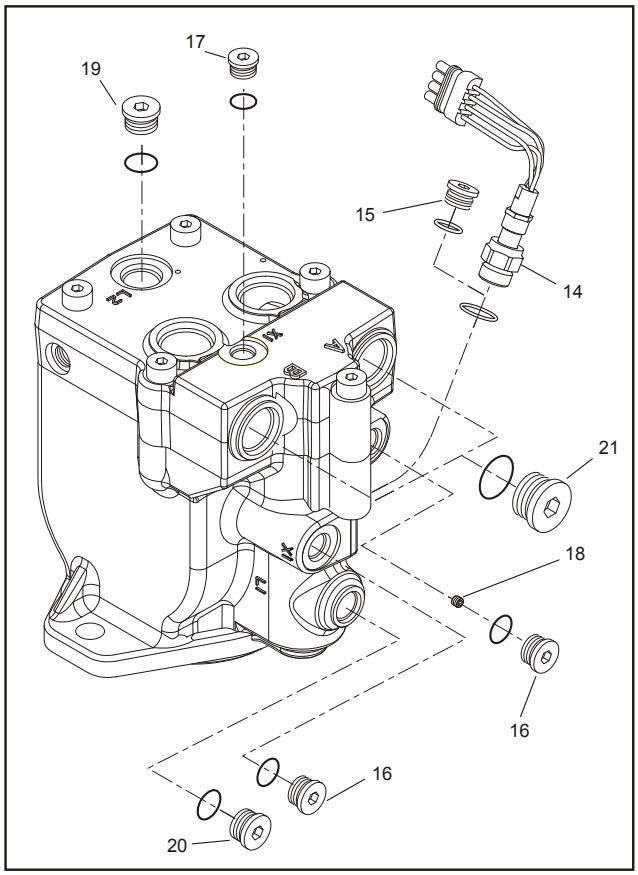
It is recommended that all O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



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

Figure 3-11. Loop Flushing Spool

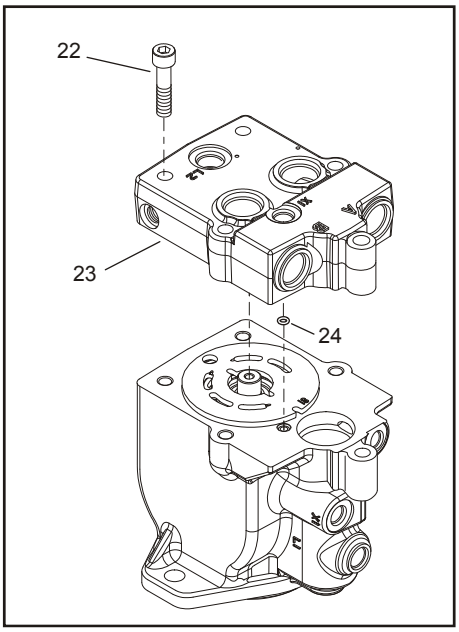
1. Using a 11/16 in wrench remove plug (1) and (2).
2. Using a 5/8 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



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

Figure 3-12. Plugs, Fittings, and Speed Sensor

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



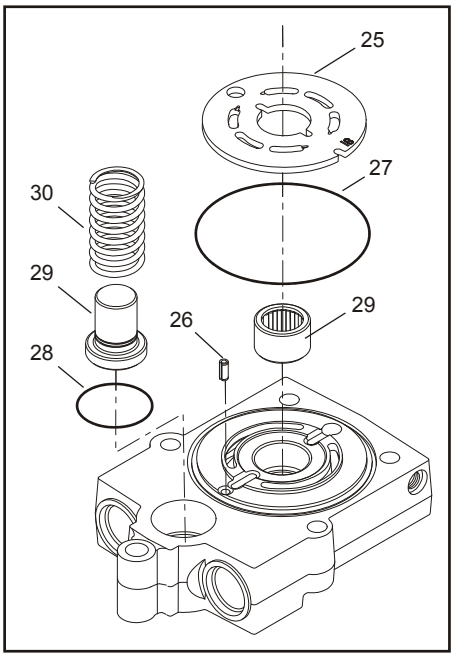
22. Screw
23. End Cap
24. O-ring

Figure 3-13. End Cap

13. Using an 8 mm internal hex wrench, remove the end-Capscrews (22).

14. Remove the endcap (23). Remove O-ring (24) from the housing or endcap.

When the end Capscrews are removed, pressure from the servo spring will cause the endcap to bind on the shaft. Press down on the portion of the endcap covering the servo piston and hold the endcap level while removing.



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

Figure 3-14. Valve Plate & Rear Shaft Bearing

NOTICE

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

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

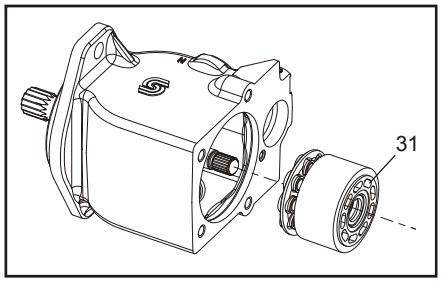
Each displacement has a unique valve plate. For identification, the last two digits of the valve plate part number are stamped on its surface.

16. Remove and discard the O-rings (27 and 28).

17. Remove the rear shaft bearing (29) from the endcap with a bearing puller.

The bearing may be difficult to remove with a puller. Try this as an alternative: Pack the bearing cavity with heavy grease. After the shaft is removed, insert it into the bearing cavity and tap lightly with a soft mallet on the splined end. The grease will force the bearing out. Use caution not to drive the bearing past the rear shaft journal as the bearing may become trapped on the shaft and damaged.

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



31. Cylinder Kit Assembly

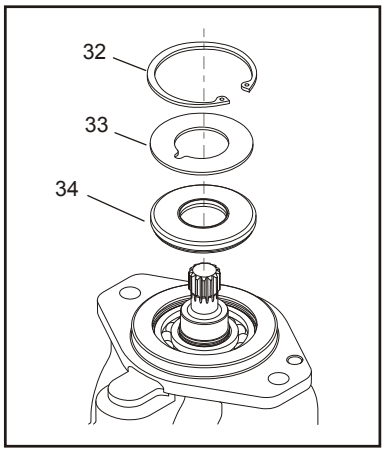
Figure 3-15. Cylinder Kit

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

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

Table 3-6. Displacement Identifiers

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

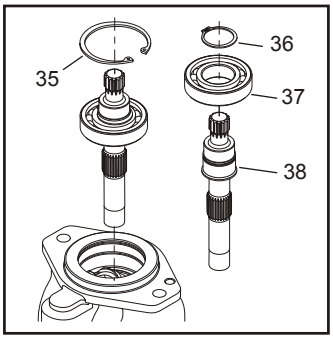


32. Snap Ring
33. Support Washer
34. Shaft Seal

Figure 3-16. Shaft Seal

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

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

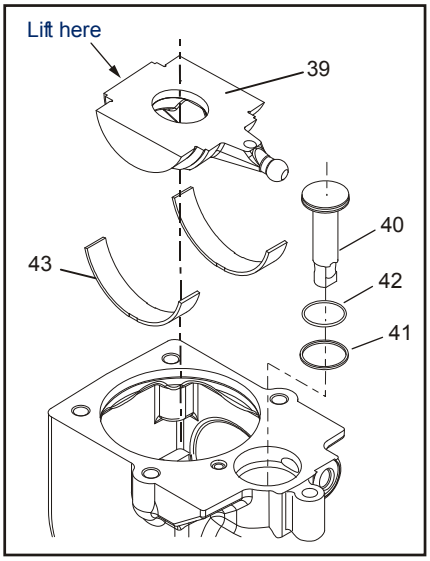


35. Inner Snap Ring
36. Snap Ring
37. Bearing
38. Shaft

Figure 3-17. Shaft & Front Bearing

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

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



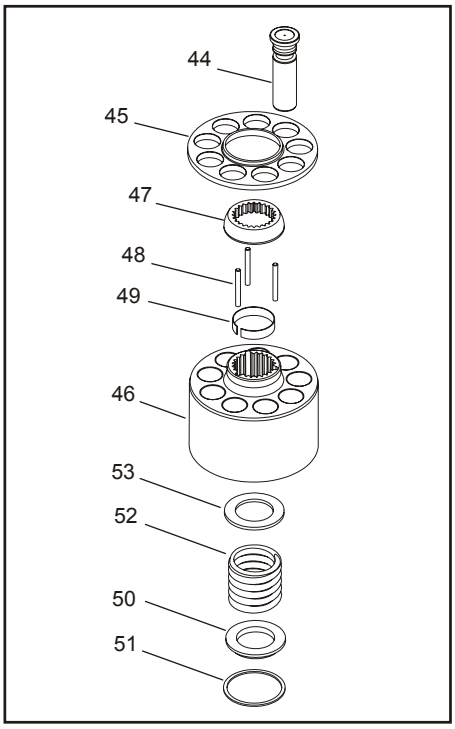
39. Swashplate
40. Servo Piston
41. Piston Seal
42. O-ring
43. Journal Bearings

Figure 3-18. Swash Plate & Servo Piston

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

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

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



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

Figure 3-19. Cylinder Kit Disassembly

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

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

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

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

⚠ WARNING

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

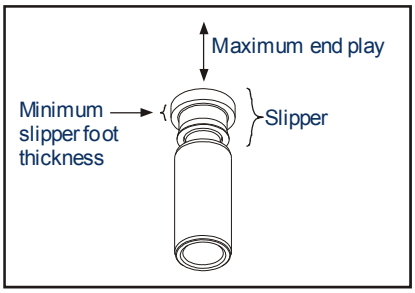
28. Turn the block over. Using a press, apply pressure on the block spring washer (50) to compress the block spring. Compress the spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind the spiral retaining ring (51). Carefully release the pressure and remove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

Inspection

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

PISTON

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



SLIPPERS

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

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

Table 3-7. Slipper Foot Thickness & End Play

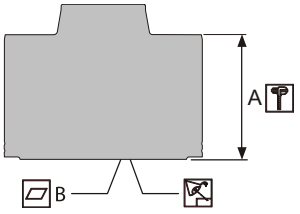
Measurement	L Frame mm (in.)	K Frame mm (in.)
Slipper Foot Thickness	2.71 (0.11)	4.07 (0.16)
Piston/Slipper End Play	0.15 (0.006)	

CYLINDER BLOCK

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

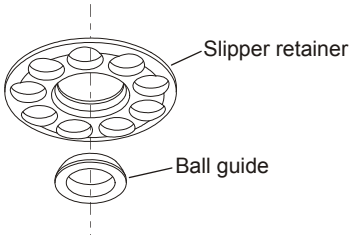
Table 3-8. Cylinder Block Measurements

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



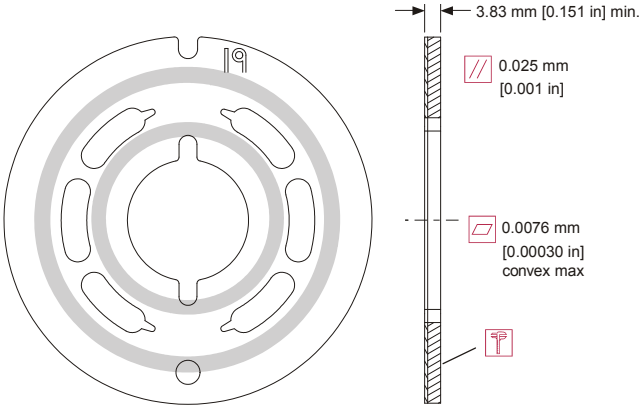
BALL GUIDE AND SLIPPER RETAINER

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



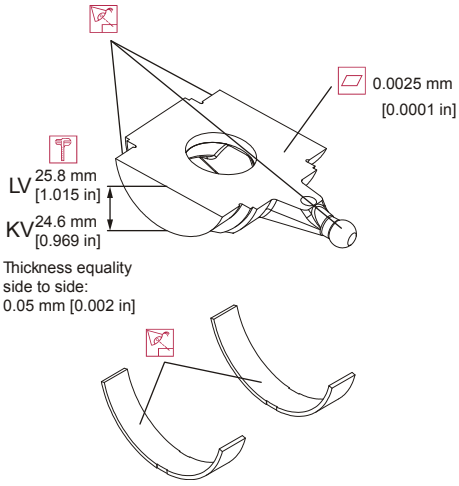
VALVE PLATE

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



SWASHPLATE AND JOURNAL BEARINGS

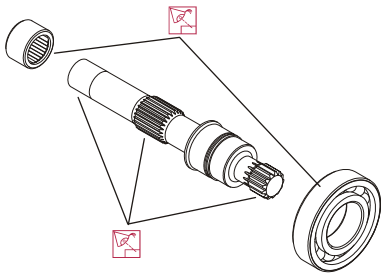
Inspect the running face, servo ball-joint, and swashplate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable providing the surface condition meets specifications shown. Measure the swashplate thickness from the journals to the running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



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

SHAFT BEARINGS

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

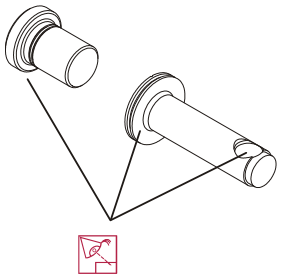


SHAFT

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

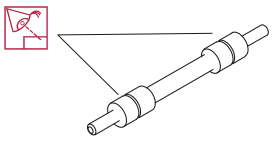
SERVO PISTON AND MINIMUM ANGLE STOP

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



LOOP FLUSHING SPOOL

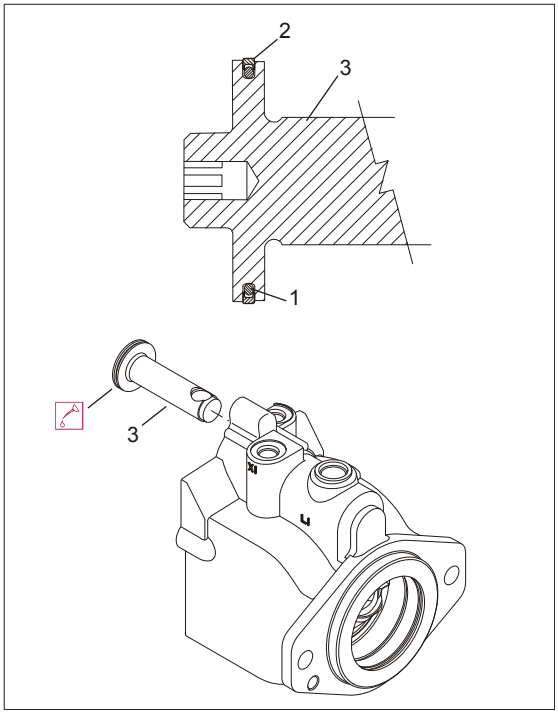
Inspect the loop flushing spool. Check for cracks or damage. Replace if necessary.



Assembly

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

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



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

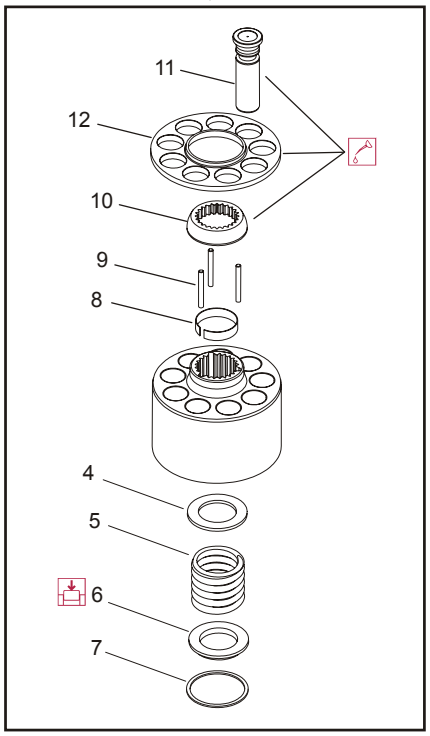
Figure 3-20. Servo Piston

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

⚠ WARNING

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

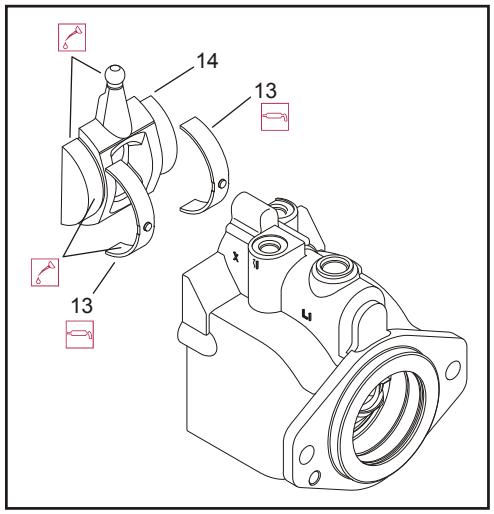
3. Install the inner block spring washer (4), block spring (5), and outer washer (6) into the cylinder block. Using a press, compress the block spring enough to expose the retaining ring groove. Wind the spiral retaining ring (7) into the groove in the cylinder block.



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

Figure 3-21. Cylinder Kit Assembly

4. Turn the block over and install the retaining ring (8), hold-down pins (9), and ball guide (10) to the cylinder block.
5. Install the pistons (11) to the slipper retainer (12). Install the piston/retainer assembly into the cylinder block. Ensure the concave surface of the retainer seats on the ball guide. If you're reusing the pistons, install them to the original block bores. Lubricate the pistons, slippers, retainer, and ball guide before assembly. Set the cylinder kit aside on a clean surface until needed.
6. Install the journal bearings (13) into the housing seats. Use assembly grease to keep the bearings seated during assembly. Ensure the locating nubs drop into the cavities in the seats. If you're reusing the bearings, install them in the original location and orientation. Lubricate the journal bearings.

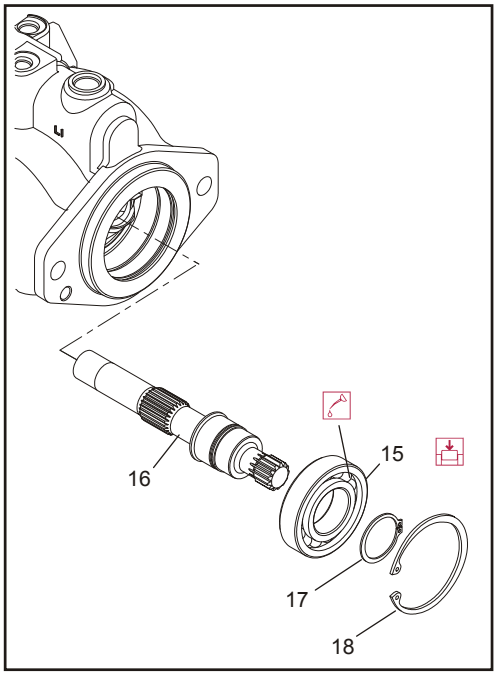


13. Journal Bearings
14. Swashplate

Figure 3-22. Swashplate and Journal Bearing

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

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

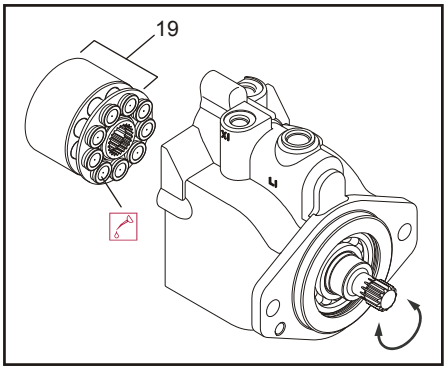


15. Front Shaft Bearing
16. Shaft
17. Snap Ring
18. Snap Ring

Figure 3-23. Shaft and Front Bearing

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

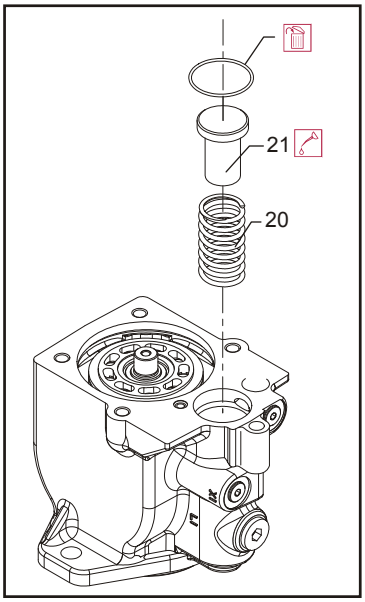
10. Verify swashplate and bearings are properly seated. Install the cylinder kit (19) onto the shaft. Install with the slippers facing the swashplate. Rock the shaft to align the block splines and slide the cylinder kit into place. Orient the motor with the shaft pointing downward and verify the cylinder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



19. Cylinder Kit

Figure 3-24. Cylinder Kit Installation

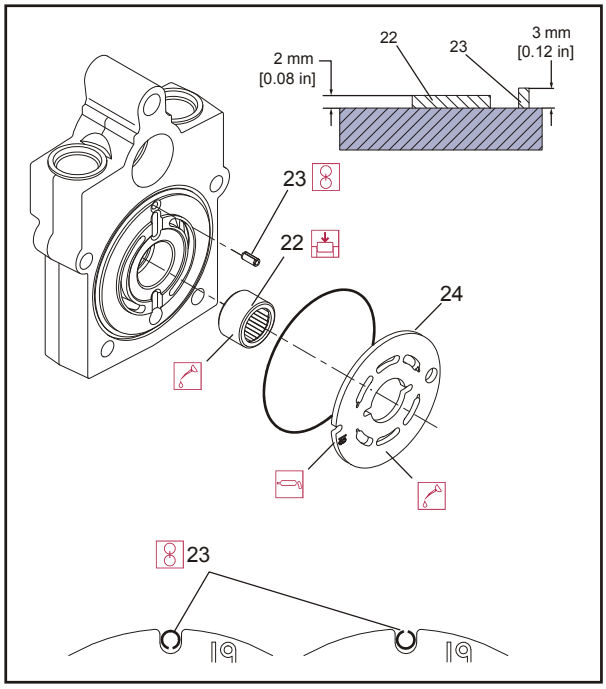
11. Lubricate and install the servo spring (20), and minimum angle stop (21) into the housing bore.



20. Servo Spring
21. Minimum Angle Stop

Figure 3-25. Servo Spring and Minimum Angle Stop

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



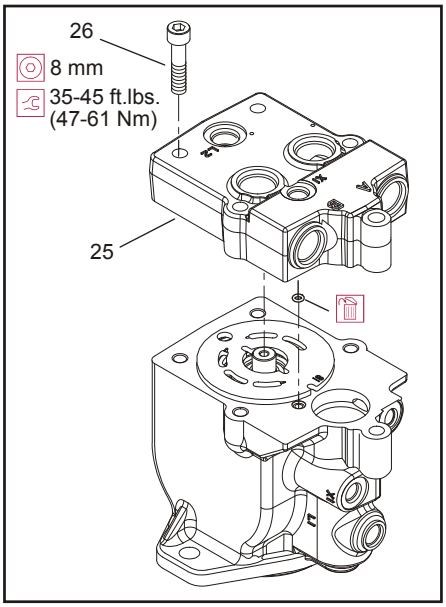
22. Rear Shaft Bearing
23. Timing Pin
24. Valve Plate

Figure 3-26. Valve Plate and Rear Bearing

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

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

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



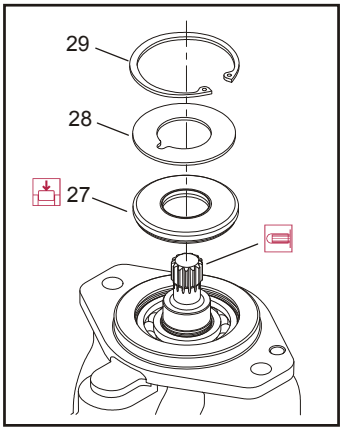
25. End Cap
26. Screw

Figure 3-27. End Cap

16. Using an 8 mm internal hex wrench, tighten the endCapscrews. Tighten the screws in opposite corners slowly and evenly to compress the servo spring and properly seat the endcap. Torque end Capscrews 35-45 ft.lbs. (47-61 Nm).

17. Before installing the shaft seal, ensure the shaft turns smoothly with less than 120 in.lbs. (13.5 Nm) of force. If the shaft does not turn smoothly within the specified maximum force, disassemble and check the unit.

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



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

Figure 3-28. Shaft Seal

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

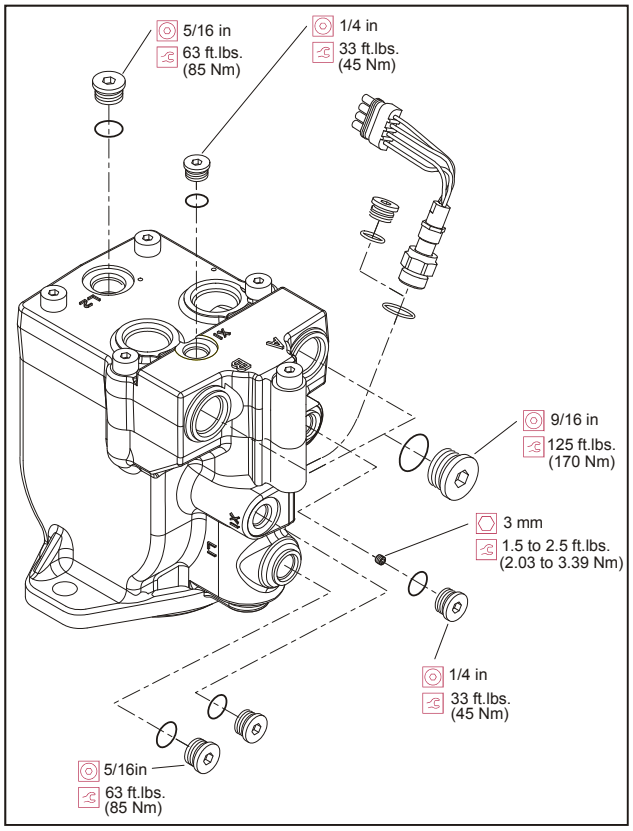
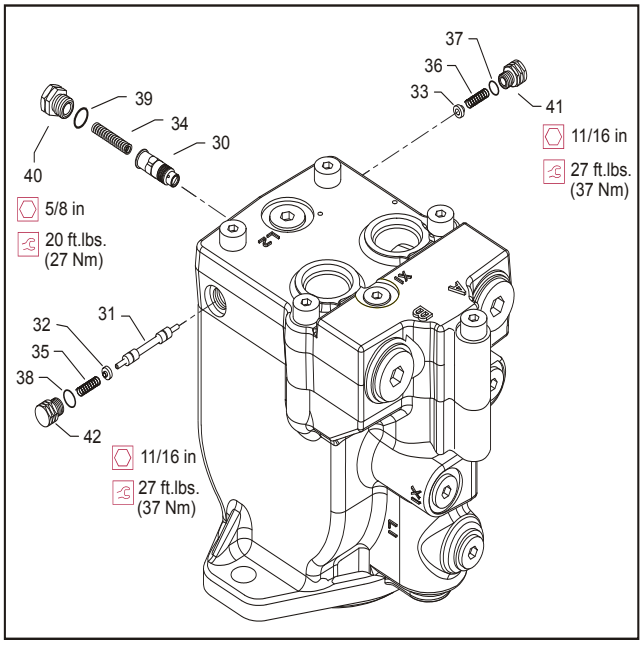


Figure 3-29. Plugs and Fittings Installation

20. Install orifice poppet (30).



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

Figure 3-30. Loop Flushing Spool

21. Install shift spool (31).

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

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

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

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

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

Initial Start-up Procedures

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

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

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

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

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

4. To ensure the pump and motor stay filled with oil, install case drain lines into the upper most case drain ports.

5. Install a 0 to 500 psi (0 to 35 bar) gauge in the charge pressure gauge port of the pump to monitor system pressure during start up.

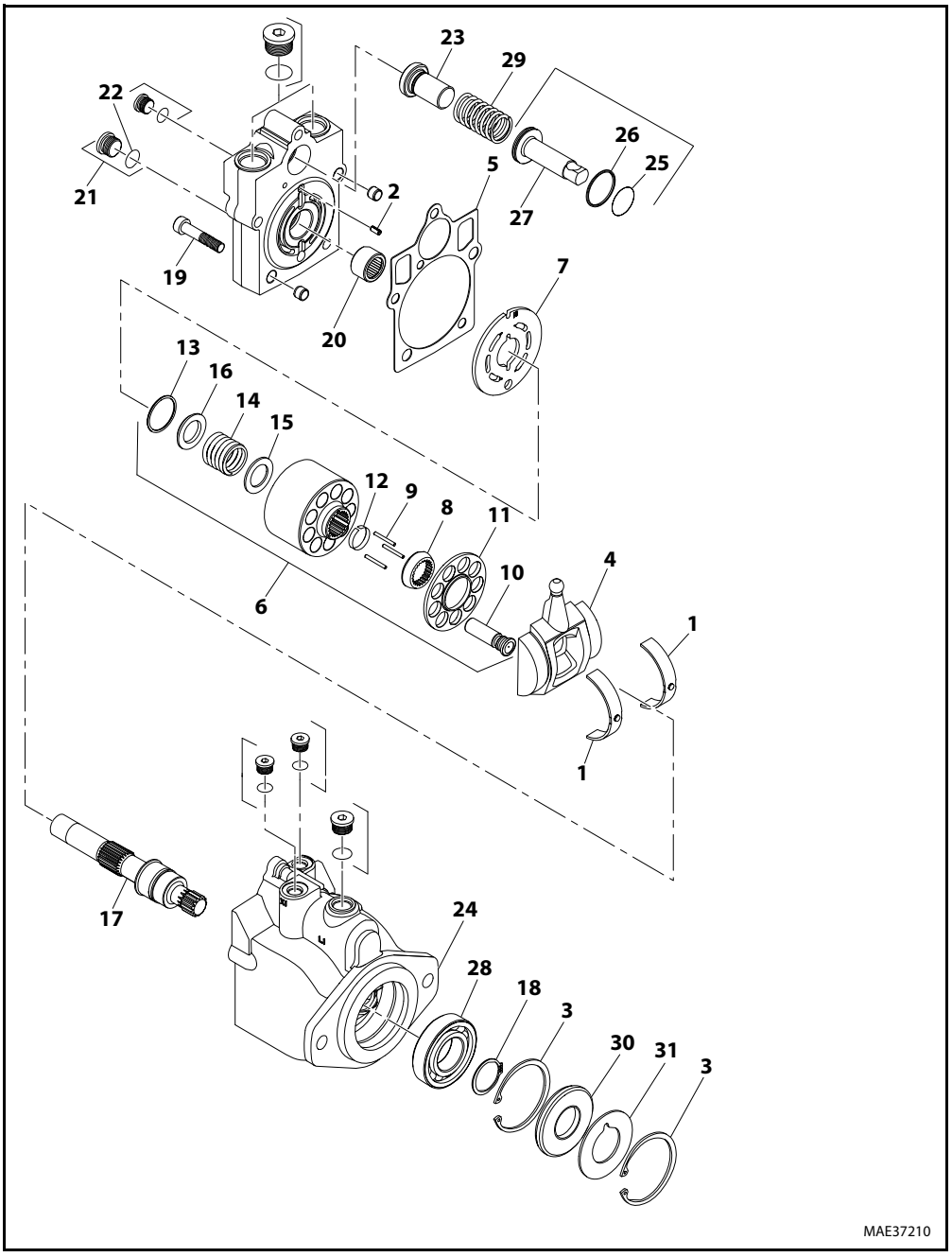
6. While watching the pressure gauge, run the engine at the lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shut down the prime mover, determine cause, and take corrective action.

7. Operate the hydraulic system for at least fifteen minutes under light load conditions.

8. Check and adjust control settings as necessary after installation.

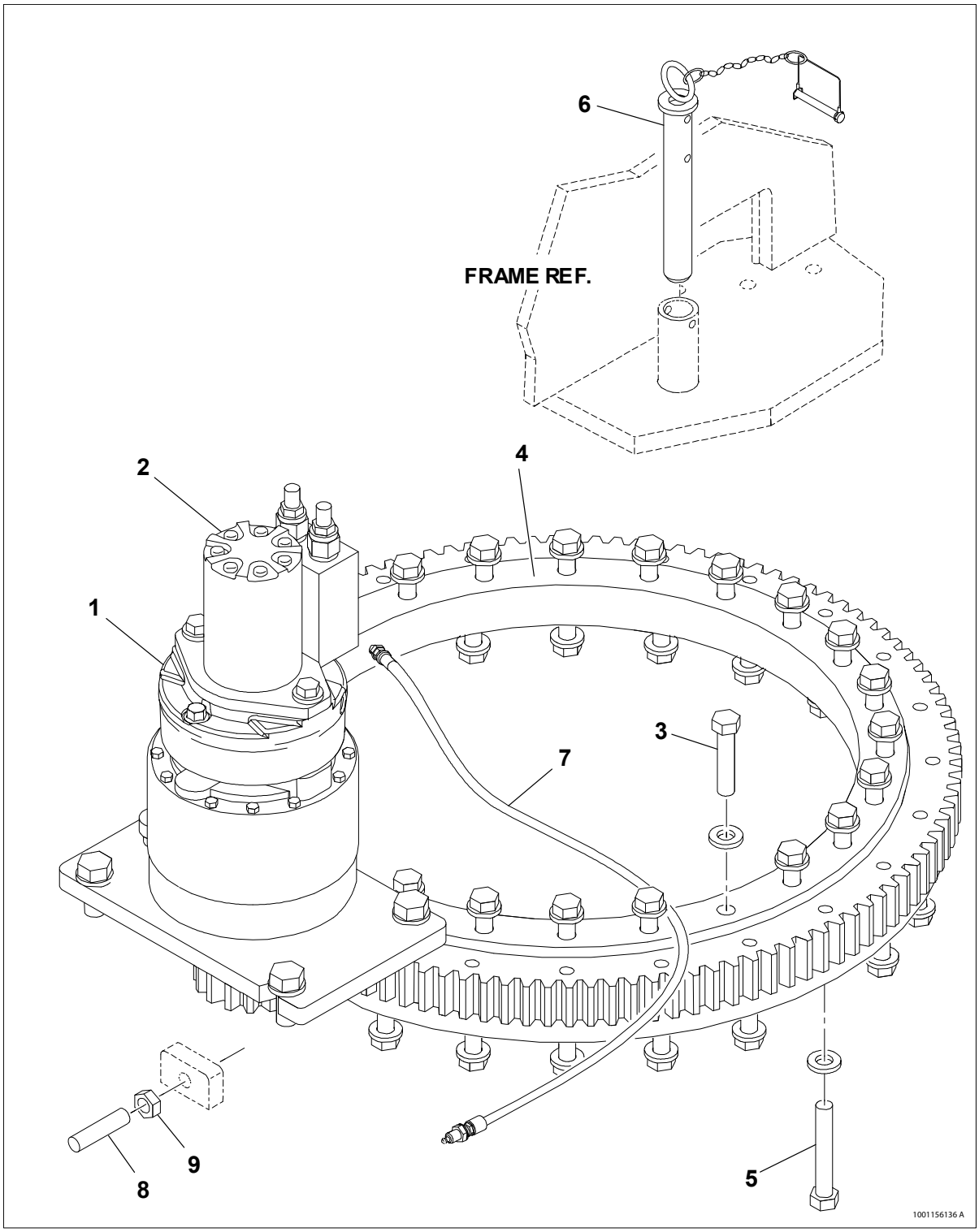
9. Shut down the prime mover and remove the pressure gauge. Replace plug at the charge pressure gauge port.

10. Check the fluid level in the reservoir; add clean filtered fluid if necessary. The motor is now ready for operation.



1. Journal Bearing
2. Pin
3. Retaining Pin
4. Swash Plate
5. Gasket
6. Cylinder Block
7. Valve Plate
8. Slipper Retainer
9. Slipper Hold Pin
10. Piston Assembly
11. Retainer Slipper
12. Retainer Hold Down
13. Retaining Ring
14. Spring
15. Washer
16. Retainer
17. Shaft
18. Retaining Ring
19. Screw
20. Bearing Needle
21. Plug
22. O-Ring
23. Seat Spring
24. Housing
25. O-Ring
26. Ring Seal
27. Piston
28. Bearing
29. Spring
30. Seal Lip
31. Washer

Figure 3-31. Drive Motor



1. Swing Drive
2. Swing Motor
3. Inner Race Bearing Bolt
4. Swing Bearing
5. Outer Race Bearing Bolt
6. Turntable Lock Pin
7. Grease Line
8. Bolt
9. Jam Nut

Figure 3-32. Swing System

3.14 SWING DRIVE

Roll, Leak And Brake Testing

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

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

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

Roll Test

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

Leak Test (Main Unit)

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

Brake Test

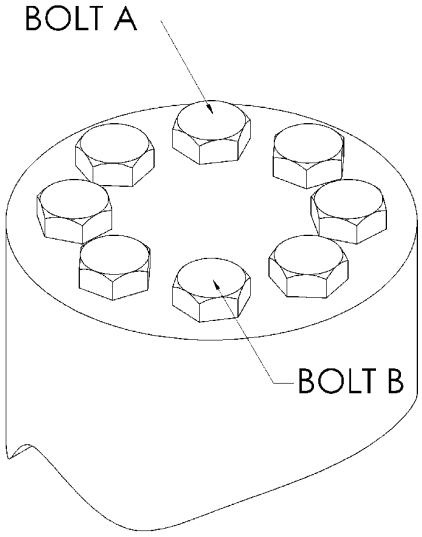
The brake test must be performed with the Motor removed and the Brake Test Plate (T-214404) installed. Install the Hex Bolts through Brake Test Plate and torque to 80 - 100 ft. lbs. (108-135 Nm). Install Roll Checking Tool (T-212731) and apply 210 psi (14 bar) to the o-ring port in the side of the Brake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

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

Tightening and Torquing Bolts

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

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

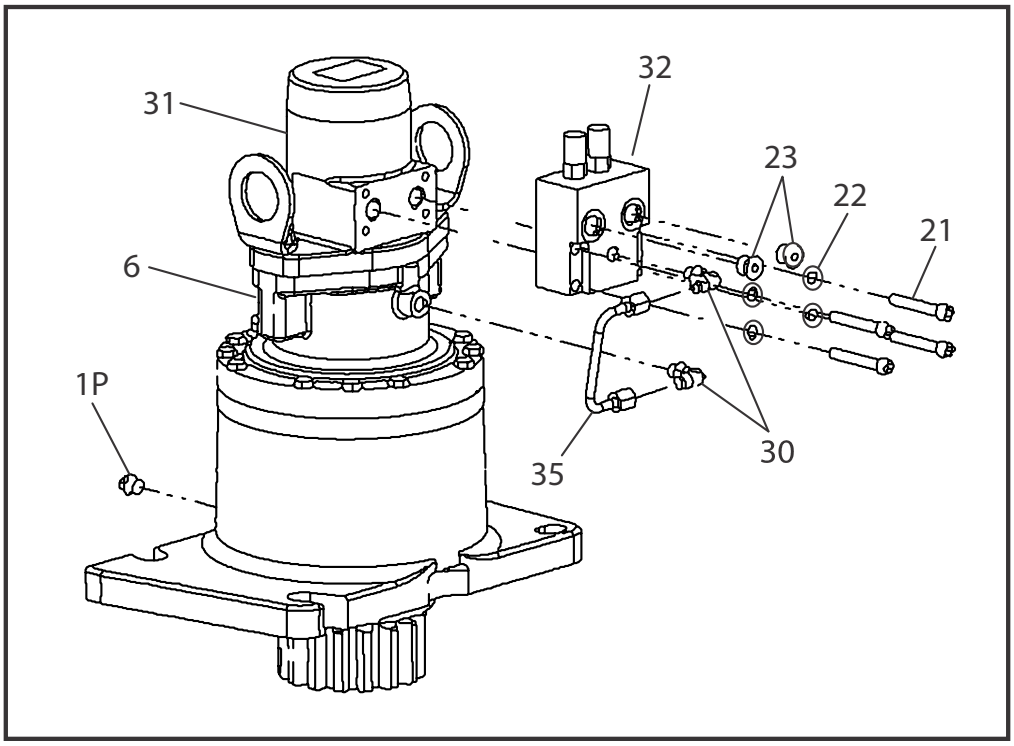


1. Tighten (but do not torque) bolt “A" until snug.
2. Go to the opposite side of the bolt circle and tighten bolt “B” until equally snug.
3. Crisscross around the bolt circle and tighten remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt “A”.
5. Using the same sequence,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

Motor Control Valve Disassembly

NOTE: *Refer to Figure 3-33.*

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



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

Figure 3-33. Motor Control Valve

Motor and Brake Disassembly

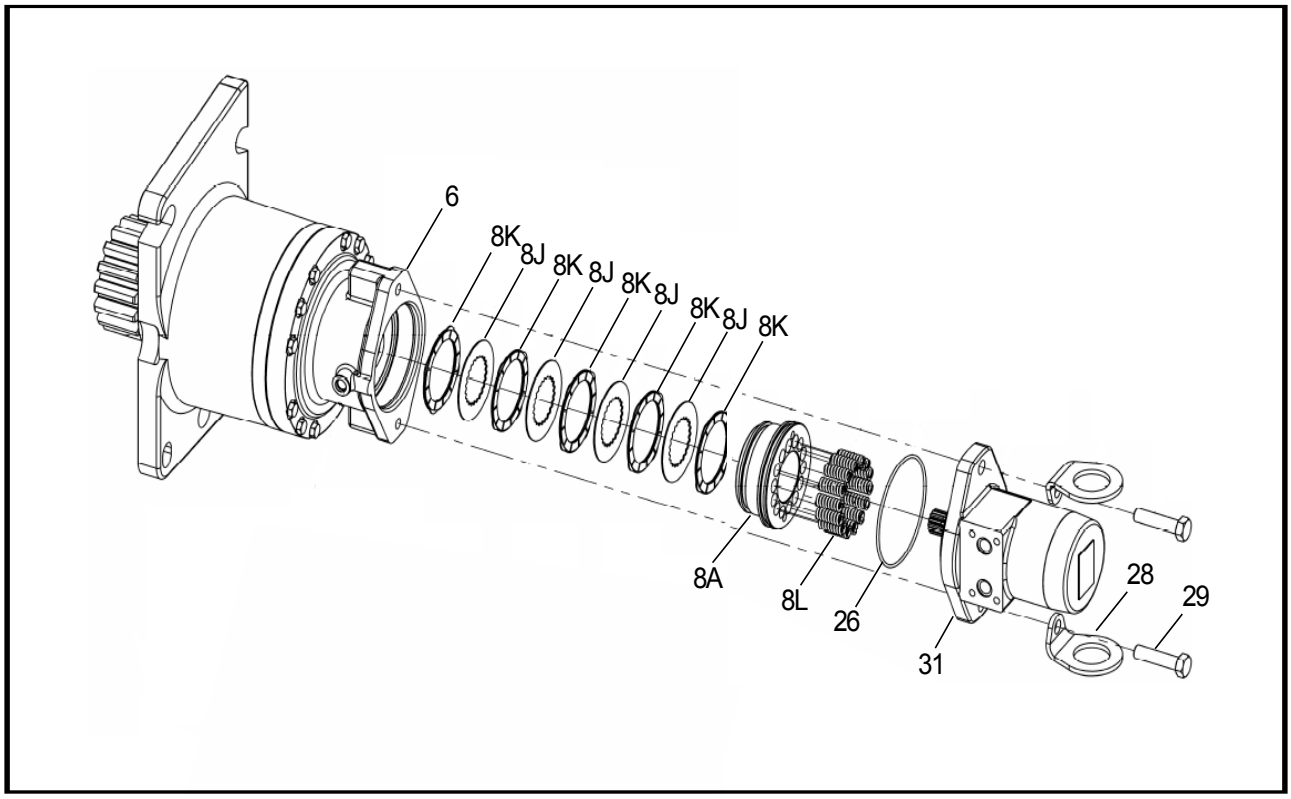
NOTE: *Refer to Figure 3-34., Motor and Brake*

1. With unit resting on bench with Motor (31) end up, loosen Hex Bolts (29) and remove Lift Lugs (28) from the Motor (31).
2. Pull Motor (31) straight up and remove Motor (31) from Brake Housing (6).
3. Remove O-ring (26) from between Motor (31) and Brake Housing (6).
4. Remove the Springs (8L) from the piston.
5. Apply less than 50 psi (3.45 bar) air to the "brake port" to remove Brake Piston (8A).

⚠ CAUTION

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

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



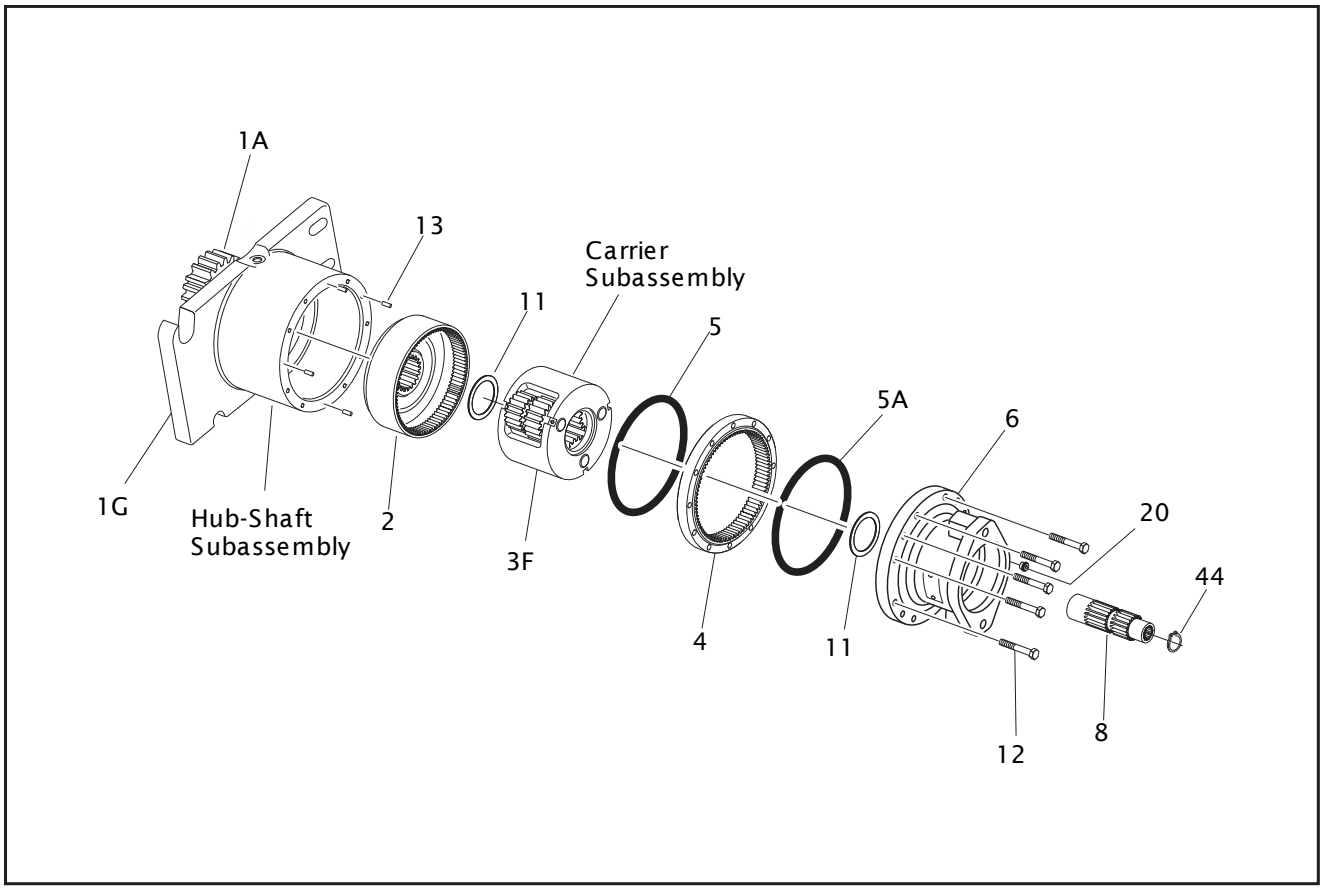
6. Brake Housing
8A. Brake Piston
8L. Spring
8J. Rotors
8K. Stator
26. O-ring
28. Lift Lug
29. Hex Bolt
31. Motor

Figure 3-34. Motor and Brake

Main Drive Disassembly

NOTE: *Refer to Figure 3-35., Main Drive Assembly*

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



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

Figure 3-35. Main Drive Assembly

Hub-Shaft Disassembly

NOTE: *Refer to Figure 3-36., Hub-Shaft*

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

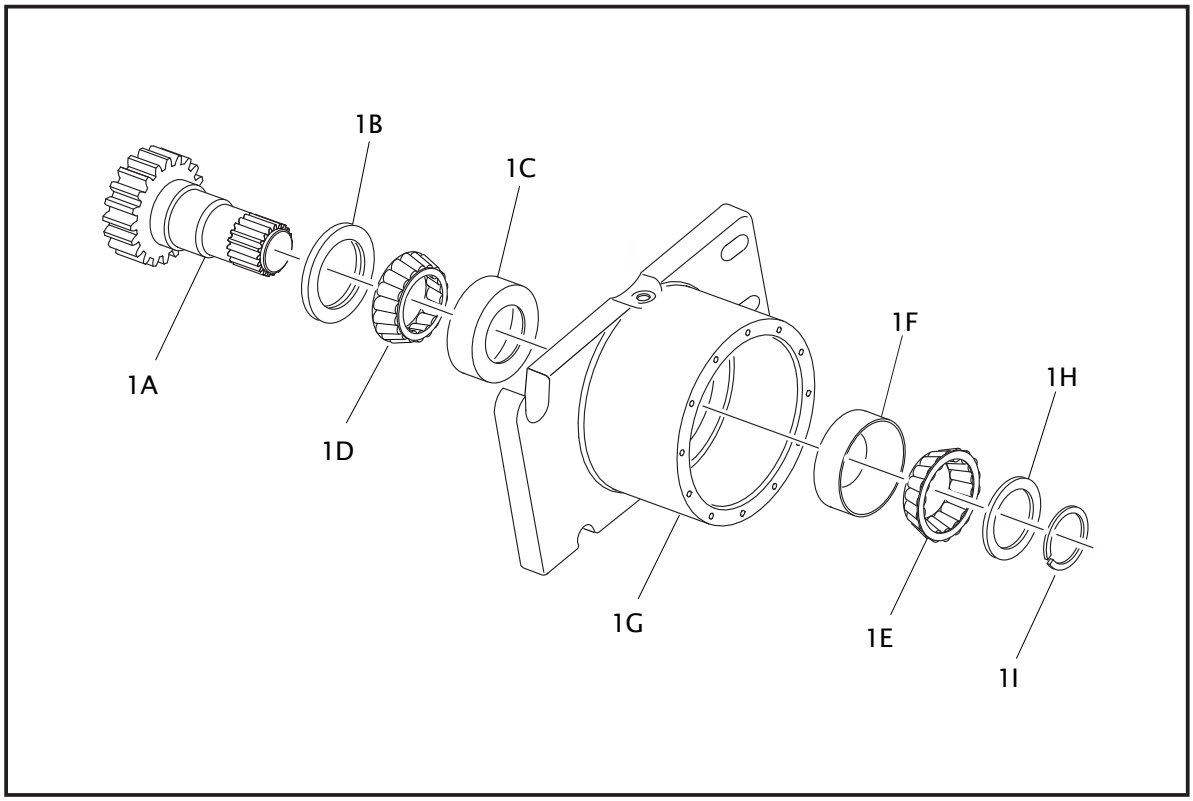
⚠ CAUTION

EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

2. Remove Thrust Washer (1H).
3. While supporting the Housing (1G) on the Output Shaft (1A) end, press the Output Shaft (1A) out of the Housing (1G).

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

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



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

Figure 3-36. Hub-Shaft

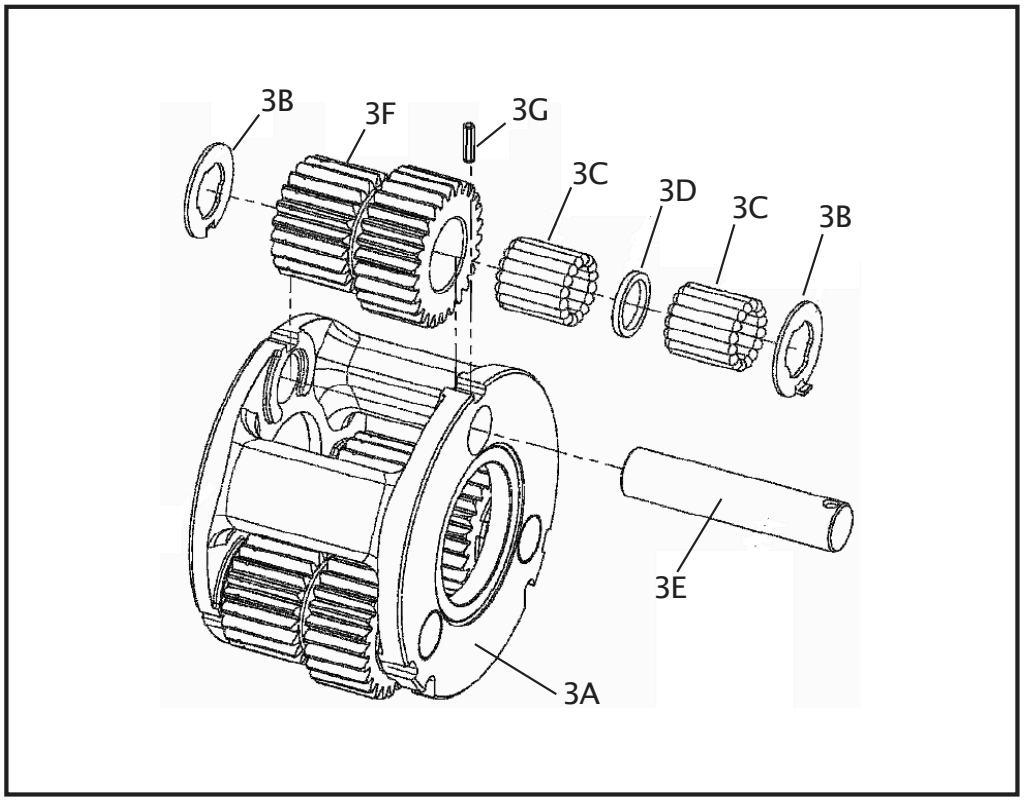
Carrier Disassembly

NOTE: *Refer to Figure 3-37., Carrier*

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

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

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



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

Figure 3-37. Carrier

Hub-Shaft Assembly

NOTE: *Refer to Figure 3-36., Hub-Shaft*

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

⚠ WARNING

EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

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

⚠ WARNING

EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

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

Carrier Assembly

NOTE: *Refer to Figure 3-37., Carrier*

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

Main Drive Assembly

NOTE: *Refer to Figure 3-35., Main Drive Assembly*

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

⚠ WARNING

BEWARE OF SHARP EDGES OF THE COUNTER BORE WHILE SEATING THIS ORING.

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

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

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

⚠ CAUTION

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

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

Motor and Brake Assembly

NOTE: *Refer to Figure 3-34., Motor and Brake*

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

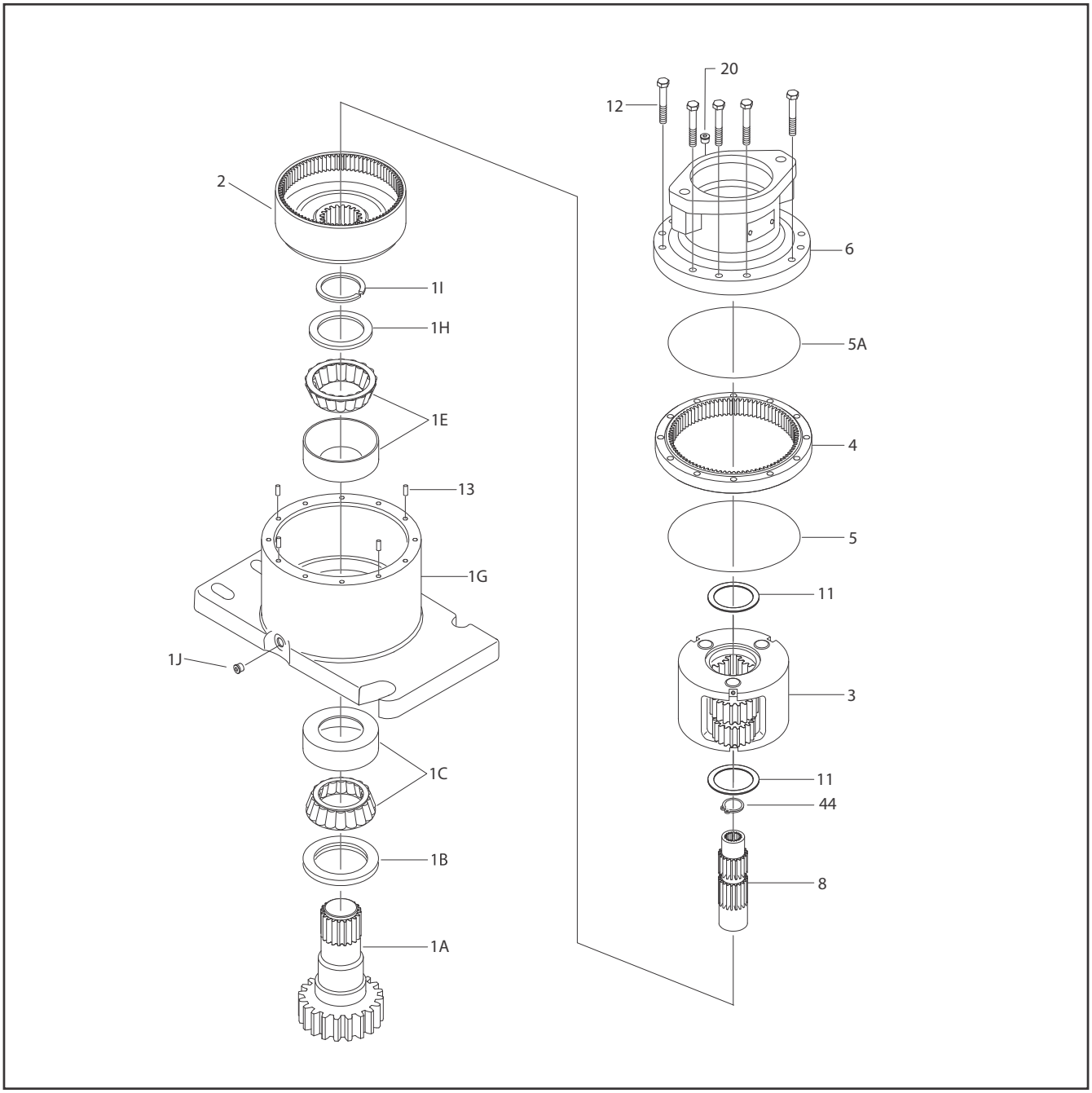
Motor Control Valve Assembly

NOTE: *Refer to Figure 3-33., Motor Control Valve*

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

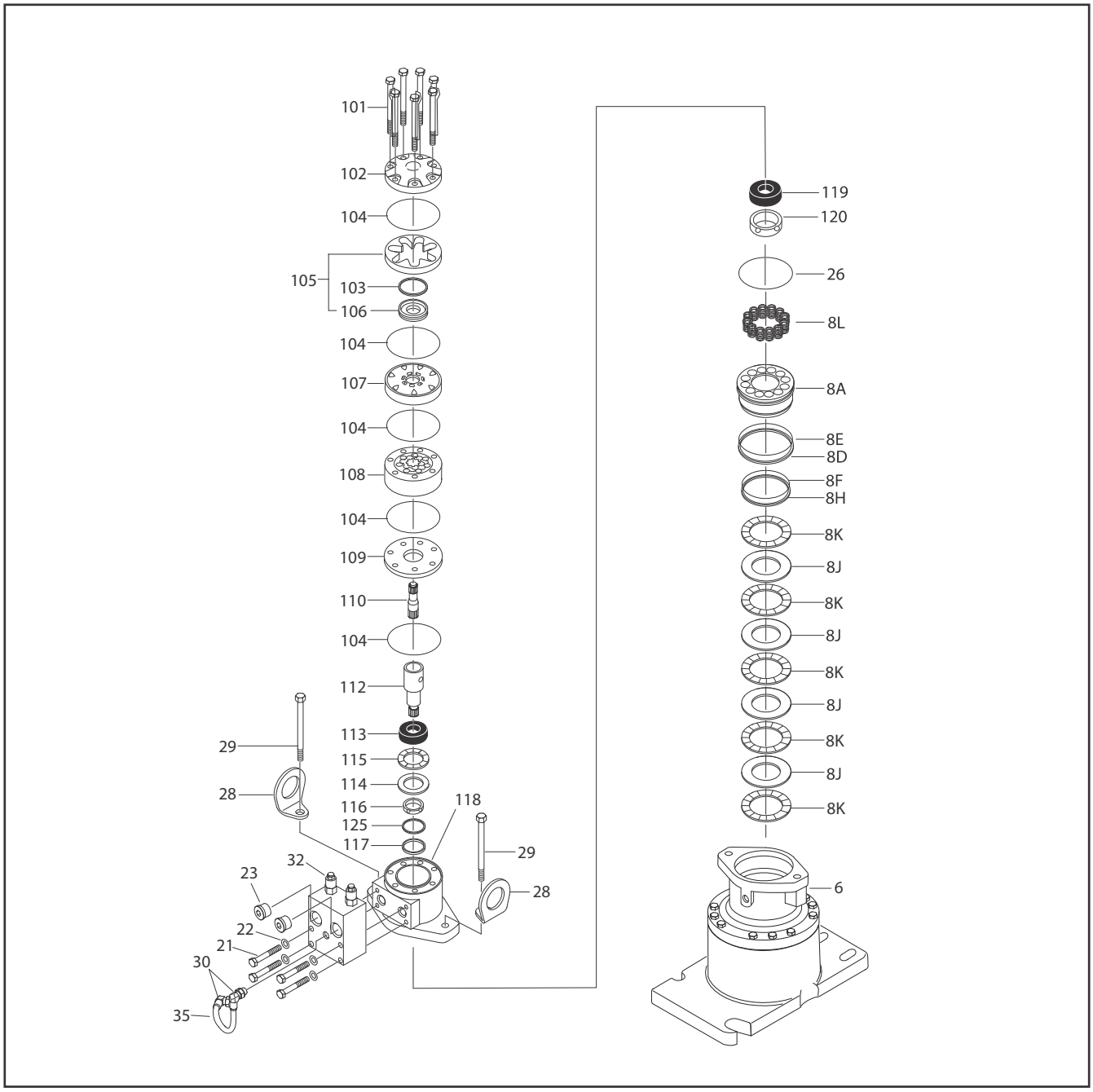
NOTE: *Be sure to align the holes in the control valve with the motor ports.*

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



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

Figure 3-38. Swing Drive Assembly



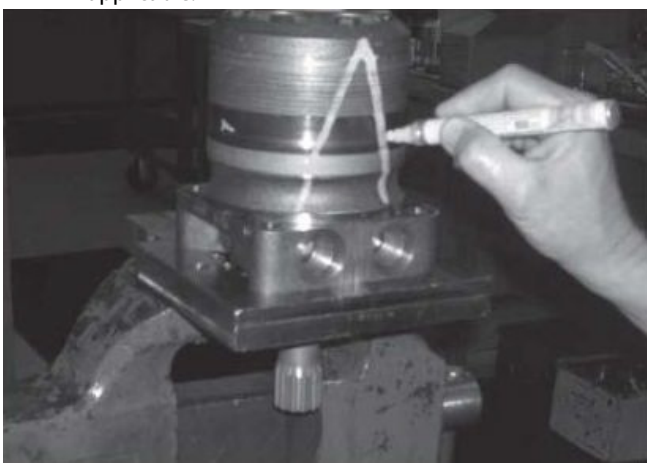
6. Brake Housing
8A. Piston
8D. O-Ring
8E. BackUp Ring
8F. O-Ring
8H. Backup Ring
8J. Rotor Disc
8K. Stator Disc
8L. Spring
21. Thrust Washer
22. Lock washer
23. Pipe Plug
26. O-Ring
28. Lifting lug
29. Bolt
30. Elbow
35. Tube
101. Bolt
102. End Cover
103. Commutator Seal
104. Ring Seal
105. Commutator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

Figure 3-39. Swing Motor and Brake Assembly

3.15 SWING MOTOR

Disassembly and inspection

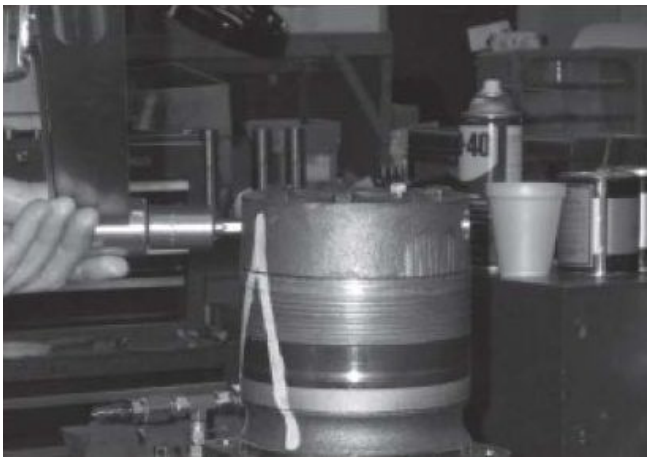
1. Place the Torqmotor™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

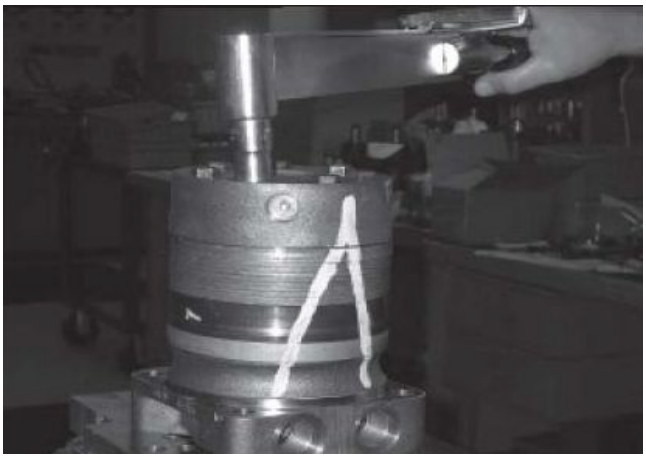


⚠ WARNING

IF THE TORQMOTOR™ IS NOT FIRMLY HELD IN THE VISE, IT COULD BE DISLODGED DURINGTHE SERVICE PROCEDURES, CAUSING INJURY.

2. Scribe an alignment mark down and across the Torqmotor™ components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 inch Allen wrench or 1 inch hex socket required.

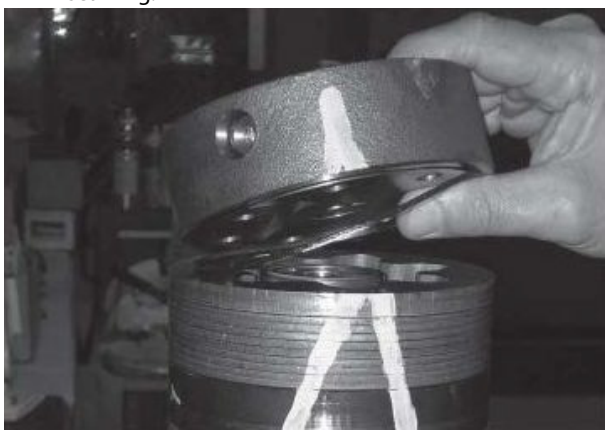




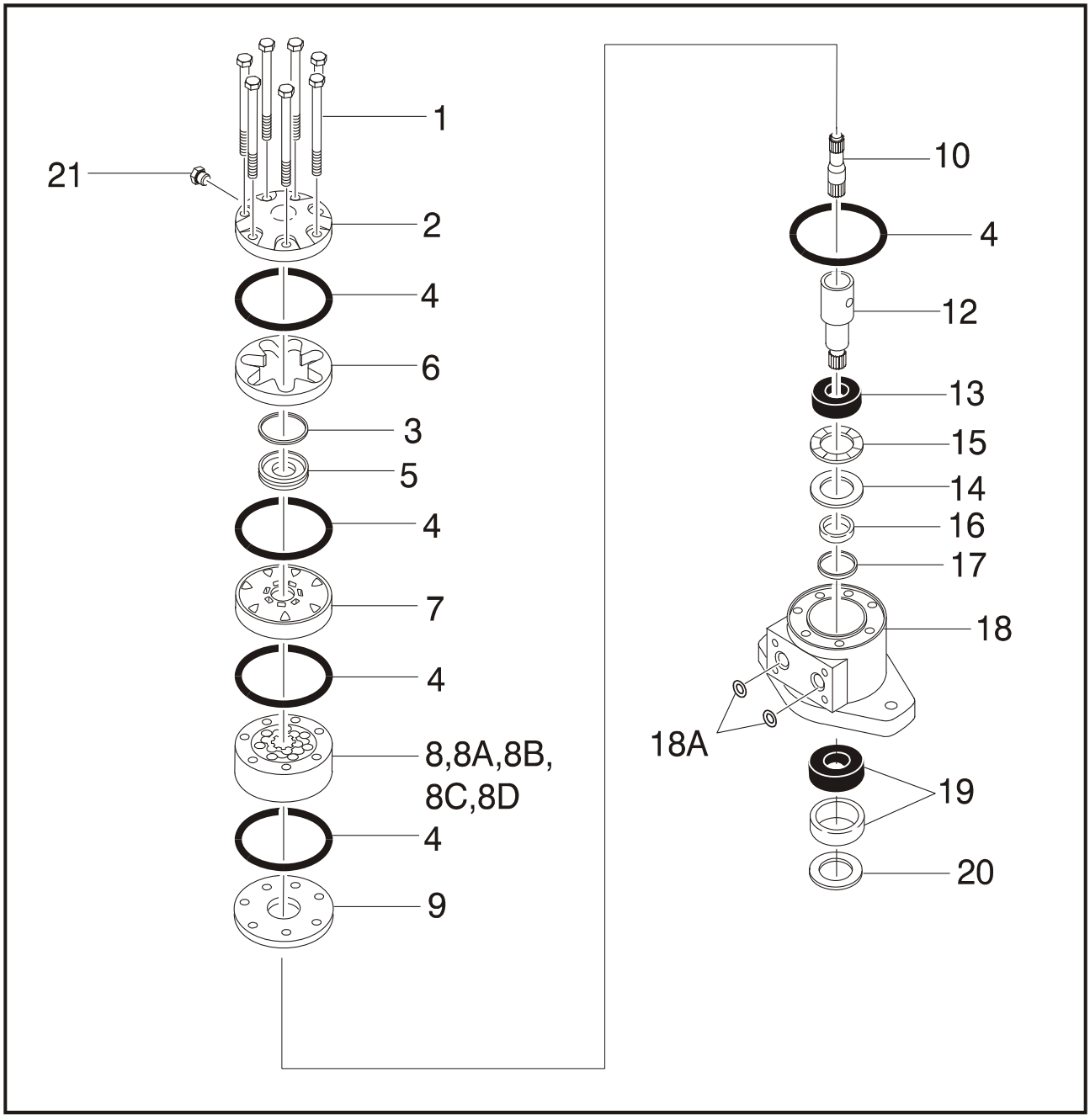
3. Remove the five, six, or seven special ring head bolts (1) using an appropriate 1/2 or 9/16 inch size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.



4. Remove end cover assembly (2) and seal ring (4). Discard seal ring.



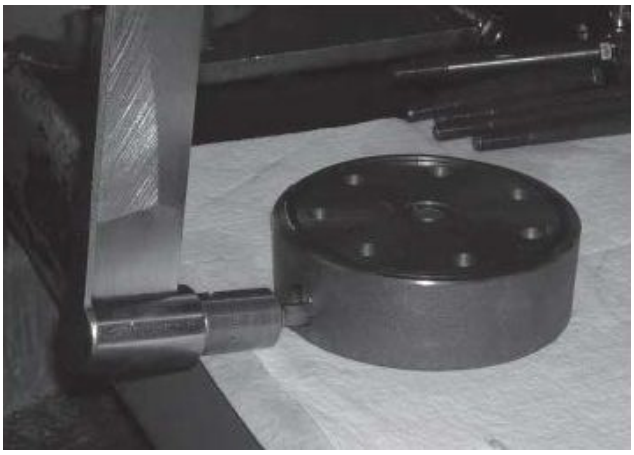
NOTE: *Refer to the appropriate "alternate cover construction" on the exploded view to determine the end cover construction being serviced.*



1. Special Bolts
2. End Cover
3. Seal Ring-Commutator
4. Seal Ring
5. Commutator Ring
6. Commutator Ring
7. Manifold
8. Rotor Set
8A. Rotor
8B. Stator or Stator Vane
8D. Stator Half
9. Wear Plate
10. Drive Link
11. Not Used
12. Coupling Shaft
13. Bearing/Bushing, Inner
14. Thrust Washer
15. Thrust Bearing
16. Seal
17. Backup Washer
18. Housing
18A. O-Ring
19. Bearing/Bushing, Outer
20. Dirt & Water Seal
21. Plug

Figure 3-40. Swing Drive Motor

5. If the end cover (2) is equipped with shuttle valve components, remove the two previously loosened plugs (21).



NOTICE

BE READY TO CATCH THE SHUTTLE VALVE OR RELIEF VALVE COMPONENTS THAT WILL FALL OUT OF THE END COVER VALVE CAVITY WHEN THE PLUGS ARE REMOVED.

NOTE: *O- ring is not included in seal kit but serviced separately, if required.*

NOTE: *The insert and if included the orifice plug in the end cover (2) must not be removed as they are serviced as an integral part of the end cover.*

6. Thoroughly wash end cover (2) in proper solvent and blow dry. Be sure the end cover valve apertures, including the internal orifice plug, are free of contamination. Inspect end cover for cracks and the bolt head recesses for good bolt head sealing surfaces. Replace end cover as necessary.



NOTE: *A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.*

7. Remove commutator ring (6). Inspect commutator ring for cracks, or burrs.



8. Remove commutator (5) and seal ring (3) Remove seal ring from commutator, using an air hose to blow air into ring groove until seal ring is lifted out and discard seal ring. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace commutator and commutator ring as a matched set.





9. Remove manifold (7) and inspect for cracks surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. A polished pattern on the ground surface from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.



NOTE: *The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides oft hem an if old to ensure that same surface is reassembled against the rotor set.*

10. Remove rotor set (8) and warplane (9), together to retain the rotor set in its assembled form, maintaining the same rotor vane (8C) to stator (8B) contact surfaces. The drive link (10) may come away from the coupling shaft (12) with the rotor set, and wear plate.You may have to shift the rotor set on the warplane to work the drive link out of the rotor (8A) and warplane. Inspect the rotor set in its assembled form for nicks, scoring, or spalling on any surface and for broken or worn splines. If the rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set. Inspect the warplane for cracks, brinelling, or scoring. Discard seal ring (4) that is between the rotor set and wear plate.



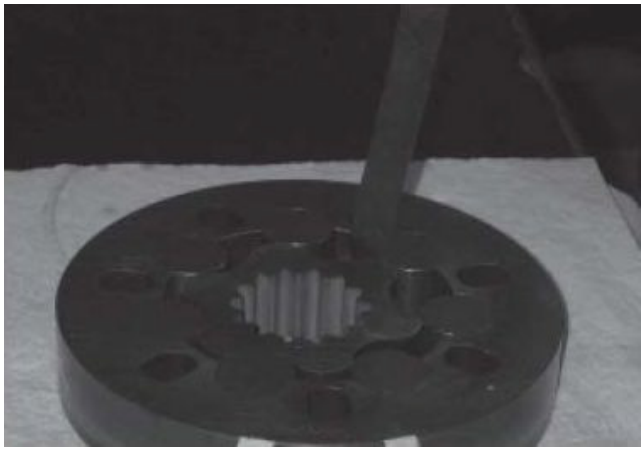
NOTE: *The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqmotor™ will ensure correct reassembly of rotor into stator and rotor set intoTorqmotor™.Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of rotor set and Torqmotor™.*



NOTE: *Series TG and TH may have a rotor set with two stator halves (8B & 8D) with a seal ring (4) between them and two sets of seven vanes (8C & 8E). Discard seal ring only if stator halves become disassembled during the service procedures.*

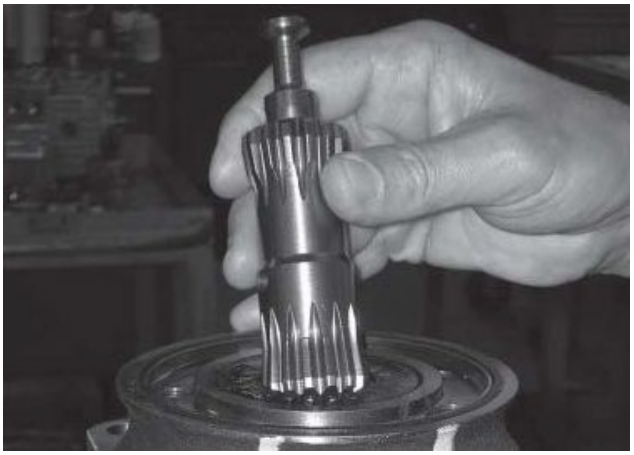
NOTE: *A polished pattern on the wear plate from rotor rotation is normal.*

11. Place rotor set (8) and wear plate (9) on a flat surface and center rotor (8A) in stator (8B) such that two rotor lobes (180 degrees apart) and a roller vane (8C) centerline are on the same stator centerline. Check the rotor lobe to roller vane clearance with a feeler gage at this common centerline. If there is more than 0.005 inches (0.13 mm) of clearance, replace rotor set.

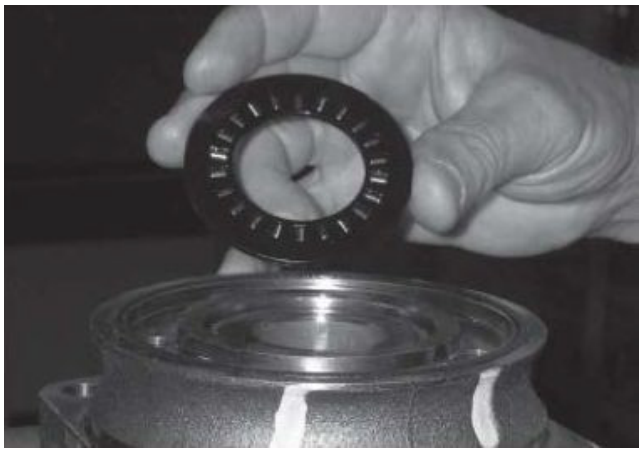


NOTE: *If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.*

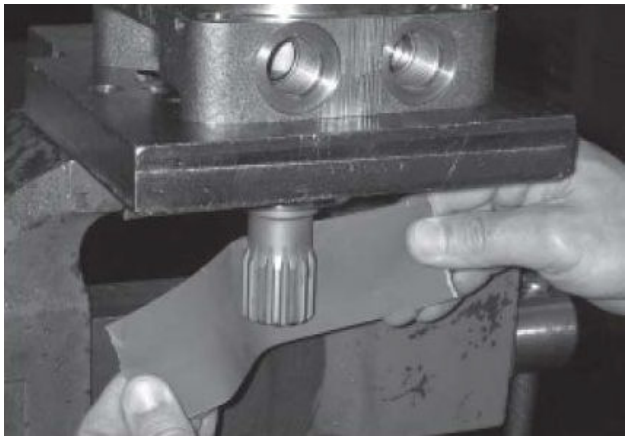
12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Remove and discard seal ring (4) from housing (18).



13. Remove thrust bearing (11) from top of coupling shaft (12). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.

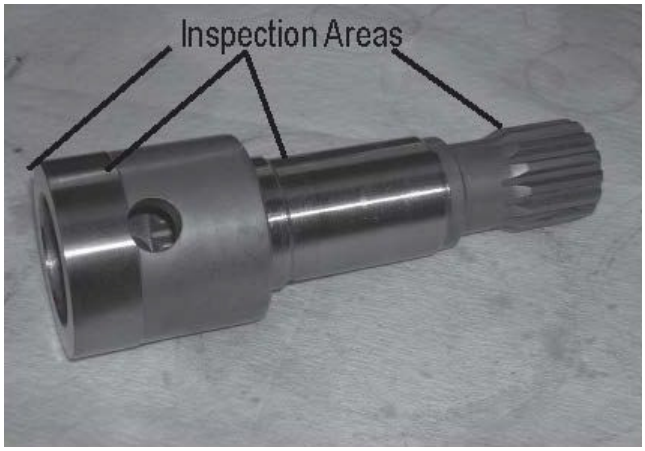


14. Check exposed portion of coupling shaft (12) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the seal and bearing. Crocus cloth or fine emery paper may be used. Remove any key (12A), nut (12B), washer (12C), bolt (12D), lock washer (12E), or retaining ring (12F).



15. Remove coupling shaft (12), by pushing on the output end of shaft. Inspect coupling shaft bearing and seal surfaces for spalling, nicks, grooves, severe wear or corrosion and discoloration. Inspect for damaged or worn internal and external splines or keyway. Replace coupling shaft if any of these conditions exist.





NOTE: *Minor shaft wear in seal area is permissible. If wear exceeds 0.020 inches (0.51 mm) diametrically, replace coupling shaft.*

NOTE: *A slight "polish" is permissible in the shaft bearing areas. Anything more would require coupling shaft replacement.*

16. Remove and discard seal ring (4) from housing (18).

17. Remove thrust bearing (15) and thrust washer (14) Inspect for wear, brinelling, corrosion and a full complement of retained rollers.



18. Remove seal (16) and backup washer (17) from Small Frame, housing (18). Discard both.



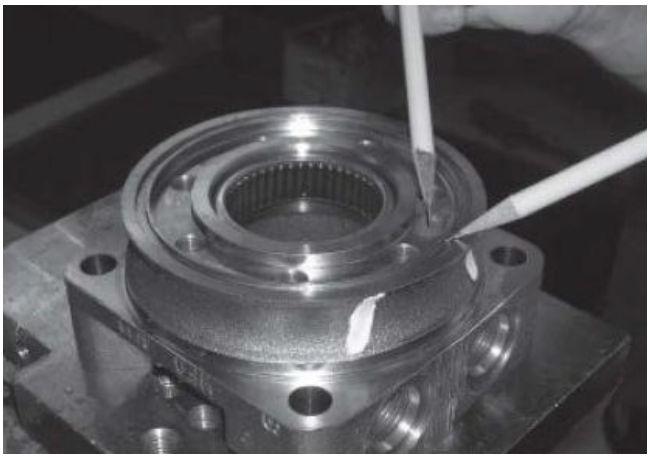


19. Remove housing (18) from vise, invert it and remove and discard seal

20. A blind hole bearing or seal puller is required.

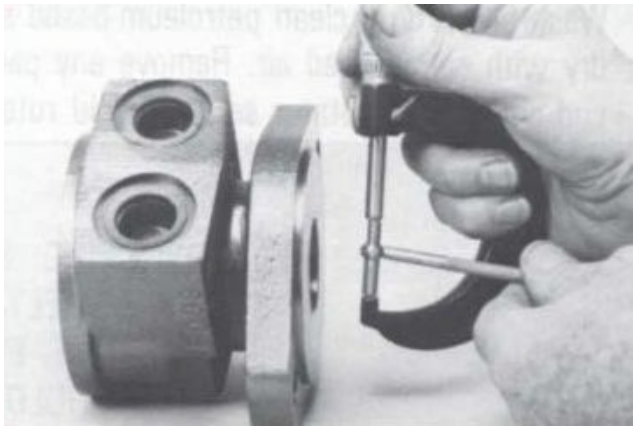


21. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly.



22. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate and orbit freely. All rollers and thrust washers must be free of brinelling and corrosion. The bushing (19) or (13) to coupling shaft diameter clearance must not exceed 0.010 inch (0.025 mm). A bearing, bushing, or thrust washer that does not pass inspection must be replaced. If the housing has passed this inspection the disassembly of the Torqmotor™ is completed.





NOTE: *The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counter bore should be measured and noted before removing the bearings/ bushings. This will facilitate the correct reassembly of new bearings/bushings.*



23. If the bearings, bushing or thrust washers must be replaced use a suitable size bearing puller to remove bearing/bushings (19) and (13) from housing (18) without damaging the housing. Remove thrust washers (14) and thrust bearing (15) if they were previously retained in the housing by bearing (13).





Assembly

Replace all seals and seal rings with new ones each time you reassemble the Torqmotor™ unit. Lubricate all seals and seal rings with SAE 10W40 oil or clean grease before assembly.

NOTE: *Individual seals and seal rings as well as a complete seal kit are available. The parts should be available through most OEM parts distributors or Parker approved Torqmotor™ distributors. (Contact your local dealer for availability).*

NOTE: *Unless otherwise indicated, do not oil or grease parts before assembly.*

Wash all parts in clean petroleum-based solvents before assembly. Blow them dry with compressed air. Remove any paint chips from mating surfaces of the end cover, commutator set, manifold rotor set, wear plate and housing and from port and sealing areas.

⚠ DANGER

SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

⚠ WARNING

WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.

1. If the housing (18) bearing components were removed for replacement, thoroughly coat and pack a new outer bearing/bushing (19) with clean corrosion resistant grease recommended in the material section. Press the new bearing/bushing into the counterbore at the mounting flange end of the housing, using the appropriate sized bearing mandrel, which will control the bearing/ bushing depth.

   Torqmotor™ housings require the use of bearing mandrel to press bearing/ bushing (19) into the housing to a required depth of 0.151/0.161 inches (3.84/4.09 mm) from the end of the bearing counterbore.





NOTE: *Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.*

NOTICE

IF THE BEARING MANDREL SPECIFIED IN THE "TOOLS AND MATERIALS REQUIRED FOR SERVICING" SECTION IS NOT AVAILABLE AND ALTERNATE METHODS ARE USED TO PRESS IN BEARING/BUSHING (13) AND (19) THE BEARING/BUSHING DEPTHS SPECIFIED MUST BE ACHIEVED TO INSURE ADEQUATE BEARING SUPPORT AND CORRECT RELATIONSHIP TO ADJACENT COMPONENTS WHEN ASSEMBLED.

NOTICE

BECAUSE THE BEARING/BUSHINGS (13) AND (19) HAVE A PRESS FIT INTO THE HOUSING THEY MUST BE DISCARDED WHEN REMOVED. THEY MUST NOT BE REUSED.



2. The Torqmotor™ inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to 0.03 inch (.76 mm) below the housing wear plate contact face. Use the opposite end of the bearing mandrel that was used to press in the outer bearing/ bushing (19).









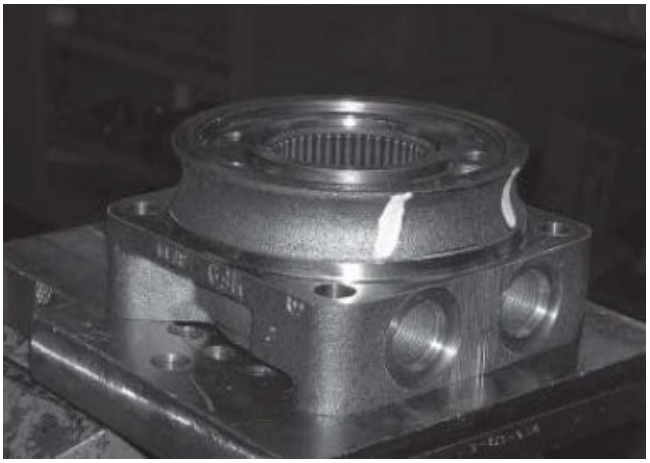
3. Press a new dirt and water seal (20) into the housing (18) outer bearing counterbore.

The Torqmotor™ dirt and water seal (20) must be pressed in until its flange is flush against the housing.





4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange.



5. On the Torqmotor™ assemble a new backup washer (17) and new seal (16) with the seal lip facing toward the inside of Torqmotor™, into their respective counterbores in housing (18) if they were not assembled in procedure 2.





NOTICE

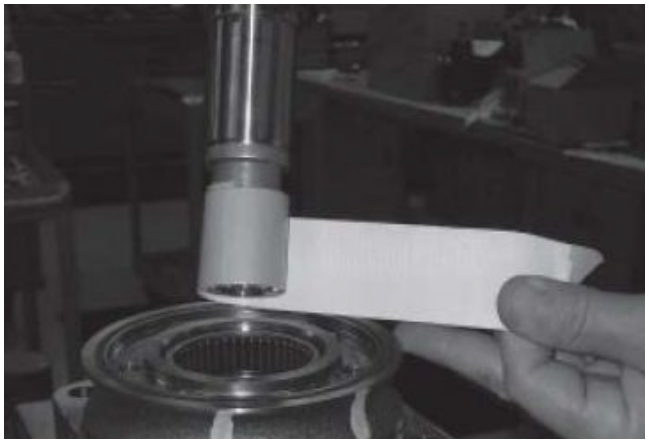
ORIGINAL DESIGN LARGE FRAME, TF & TG TORQMOTORS™ THAT DO NOT HAVE BACKUP WASHER (25) WHEN DISASSEMBLED MUST BE ASSEMBLED WITH A NEW BACKUP WASHER (17), NEW BACKUP WASHER (25), AND NEW SEAL (16).

6. Assemble thrust washer (14) then thrust bearing (15) that was removed from the Torqmotor™.



NOTE: *Torqmotors™ require one thrust washer (14) with thrust bearing (15).The coupling shaft will be seated directly against the thrust.*

7. Apply masking tape around splines or keyway on shaft (12) to prevent damage to seal.



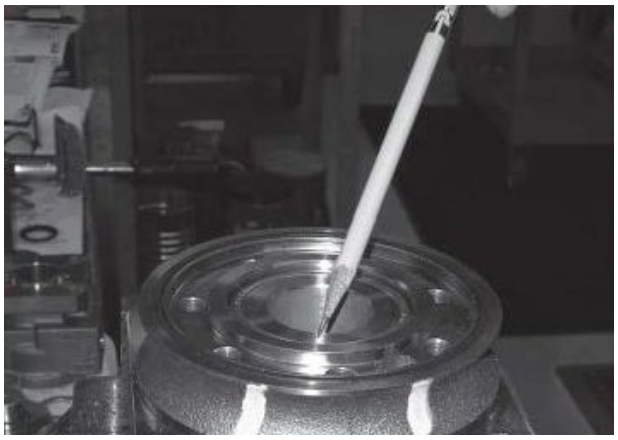
8. Be sure that a generous amount of clean corrosion resistant grease has been applied to the lower (outer) housing bearing/bushing (19). Install the coupling shaft (12) into housing (18), seating it against the thrust bearing (15) in the housings.



NOTICE

THE OUTER BEARING (19) IS NOT LUBRICATED BY THE SYSTEM'S HYDRAULIC FLUID. BE SURE IT IS THOROUGHLY PACKED WITH THE RECOMMENDED GREASE, PARKER GEAR GREASE SPECIFICATION #045236, E/M LUBRICANT #K-70M OR MOBIL MOBILITH SHC ® 460.

NOTE: *The coupling shaft (12) will be flush or just below the housing wear plate surface on Torqmotors™ when properly seated. The coupling shaft must rotate smoothly on the thrust bearing package.*





9. Apply a small amount of clean grease to a new seal ring (4) and insert it into the housing (18) seal ring groove.



NOTE: *One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures.The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF 2A bolts as required that are over 0.5 inch (12.7 mm) longer than the bolts (1) used in the Torqmotor™.*

10. Install drive link (10) the long splined end down into the coupling shaft (12) and engage the drive link splines into mesh with the coupling shaft splines.

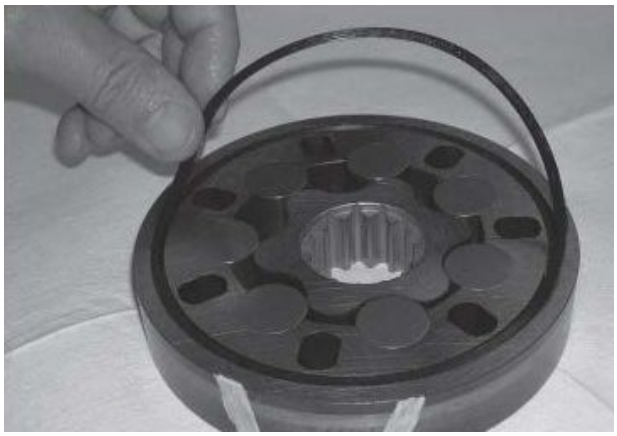


NOTE: *Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.*

11. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18).



12. Apply a small amount of clean grease to a new seal ring (4) and assemble it into the seal ring groove on the wear plate side of the rotor set stator (8B).



13. Install the assembled rotor set (8) onto wear plate (9) with rotor (8A) counterbore and seal ring side down and the splines into mesh with the drive link splines.

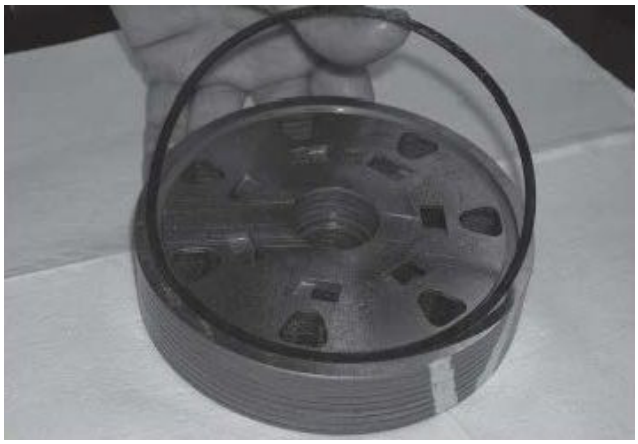


NOTE: *It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.*

NOTE: *If necessary, go to the appropriate, "Rotor Set Component Assembly Procedure."*

NOTE: *The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the rotor splines if apparent, to determine which side was down.The rotor set seal ring groove faces toward the wear plate (9).*

14. Apply clean grease to a new seal ring (4) and assemble it in the seal ring groove in the rotor set contact side of manifold (7).



NOTE: *The manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression left on the manifold by the rotor set is another indication of which surface must contact the rotor set.*

15. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



16. Apply grease to a new seal ring (4) and insert it in the seal ring groove exposed on the manifold.

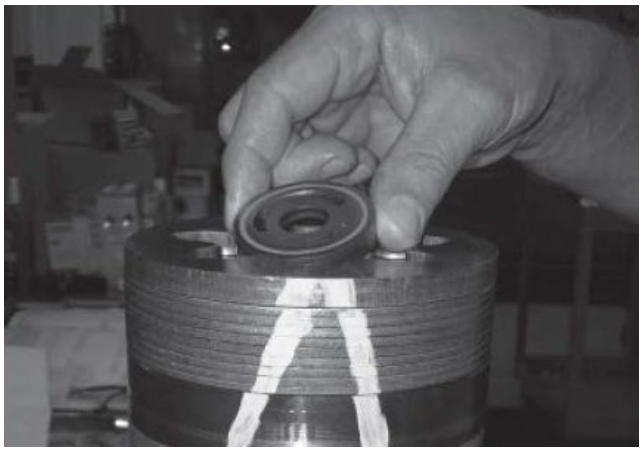


17. Assemble the commutator ring (6) over alignment studs onto the manifold.



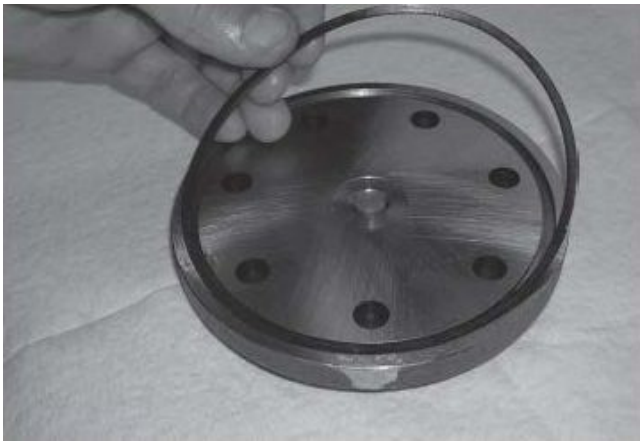
18. Assemble a new seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up.

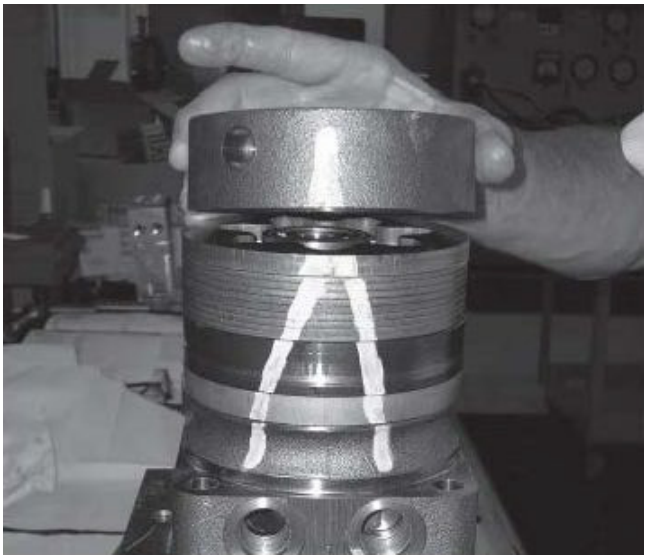




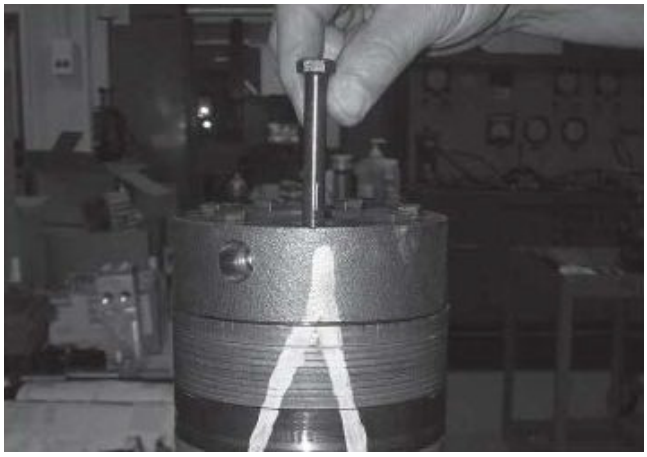


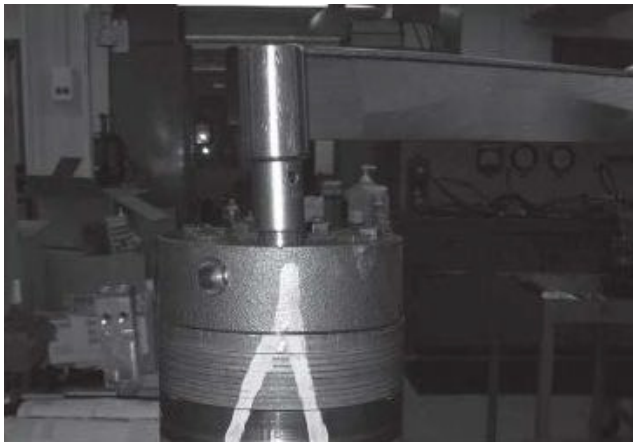
19. Assemble a new seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18).The correct 5 bolt end cover bolt hole relationship to housing port bosses.

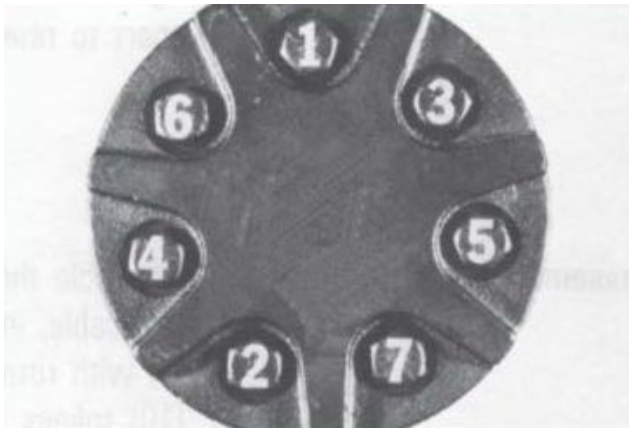




20. Assemble the 5 or 7 special bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 50-55 ft. lbs.(68-75 N m) for the seven 3/8-24 threaded bolts.





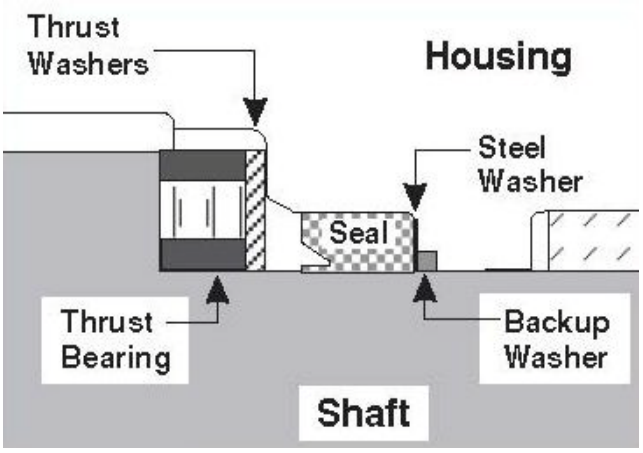


NOTE: *The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard and cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.*

21. Torque the two shuttle valve plug assemblies (21) in end cover assembly to 9-12 ft. lbs. (12-16 Nm) if cover is so equipped.

Torque the two relief valve plug assemblies (21) in end cover assembly to 45-55 ft. lbs.(61-75 Nm) if cover is so equipped.





One Piece Stator Construction

A disassembled rotor (8A) stator (8B) and vanes (8C) that cannot be readily assembled by hand can be assembled by the following procedures.

1. Place stator (8B) onto wear plate (9) with seal ring (4) side down, after following Torqmotor™ assembly procedures 1 through 13. Be sure the seal ring is in place.



2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

3. Assemble the rotor (8A), counterbore down if applicable, into stator (8B), and onto wear plate (9) with rotor splines into mesh with drive link (10) splines.



NOTE: *If the manifold side of the rotor was etched during Torqmotor disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wear plate.*

4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.



NOTICE

EXCESSIVE FORCE USED TO PUSH THE ROTOR VANES INTO PLACE COULD SHEAR OFF THE COATING APPLIED TO THE STATOR VANE POCKETS.

5. Grasp the output end of coupling shaft (12) with locking pliers or other appropriate turning device and rotate coupling shaft, drive link and rotor to seat the rotor and the assembled vanes (8C) into stator (8B), creating the necessary clearance to assemble the seventh or full complement of seven vanes. Assemble the seven vanes using minimum force.



6. Remove the two assembled bolts (1) if used to retain stator and wear plate.

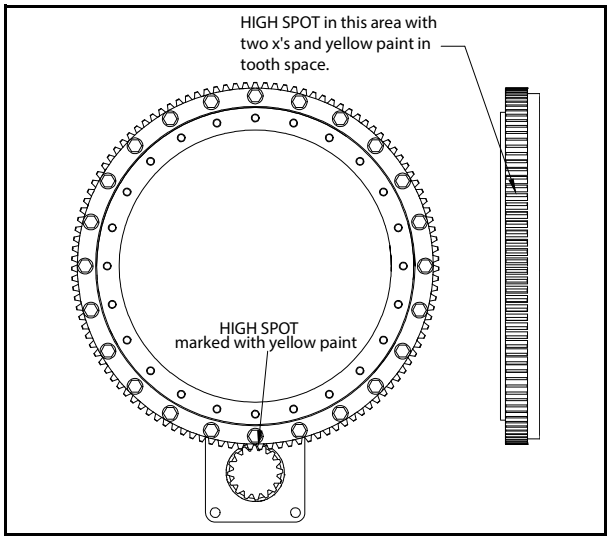
3.16 SWING HUB INSTALLATION

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

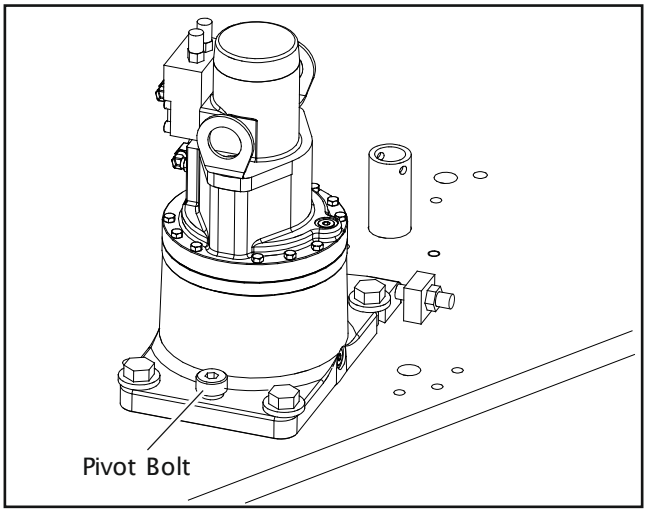
Procedure For Setting Swing Gear Backlash

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

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

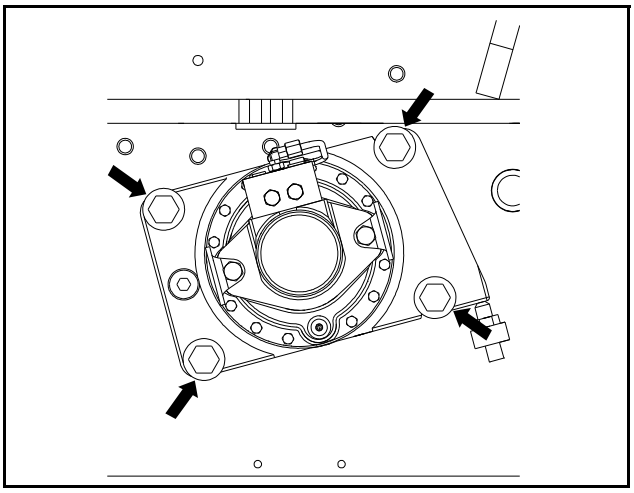


3. Apply JLG Threadlocker P/N 0100019 and torque pivot bolt to 205 ft. lbs. (280 Nm) (shown below).

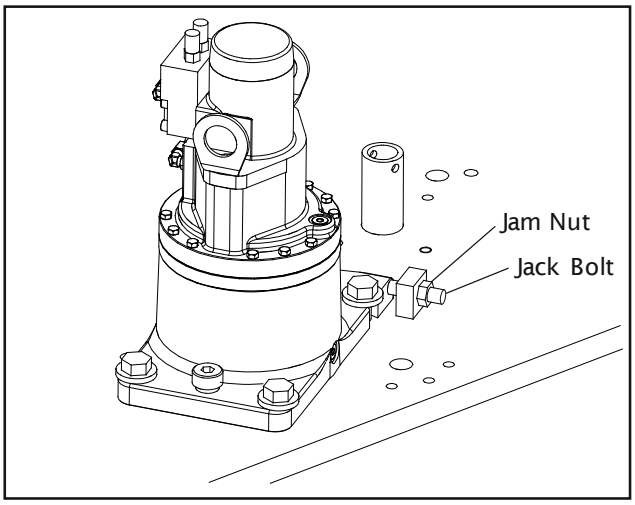


NOTE: *Make sure the turntable is properly supported during the following step. The turntable can swing a few degrees when the turntable lock is removed if the turntable is not balanced properly.*

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

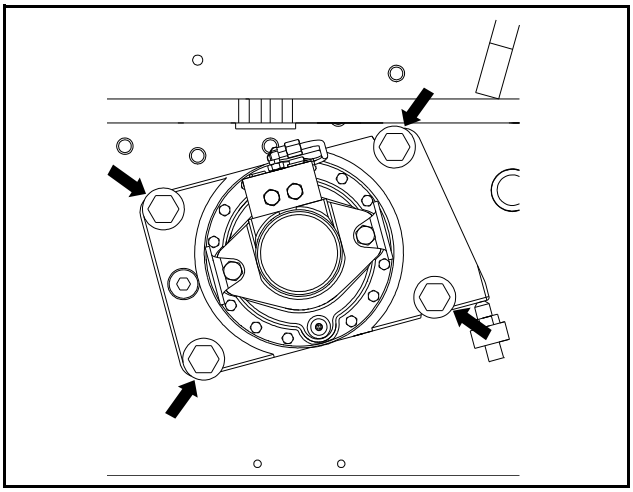


6. Tighten jack bolt until pinion is completely snug against shim and bearing then loosen jack bolt.

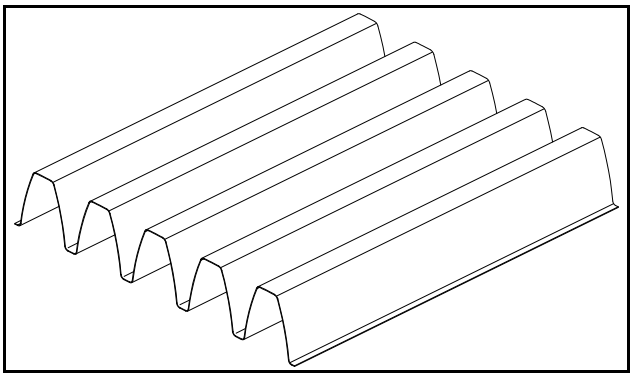


7. Apply JLG Threadlocker P/N 0100019 and torque jack bolt 50 ft. lbs. (68 Nm).
8. Apply JLG Threadlocker P/N 0100019 and tighten jam nut.

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

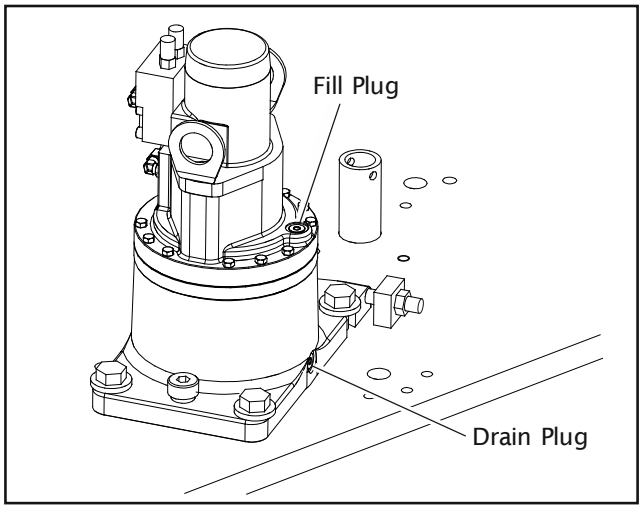


10. Remove shim and discard.



Swing Drive Lubrication

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

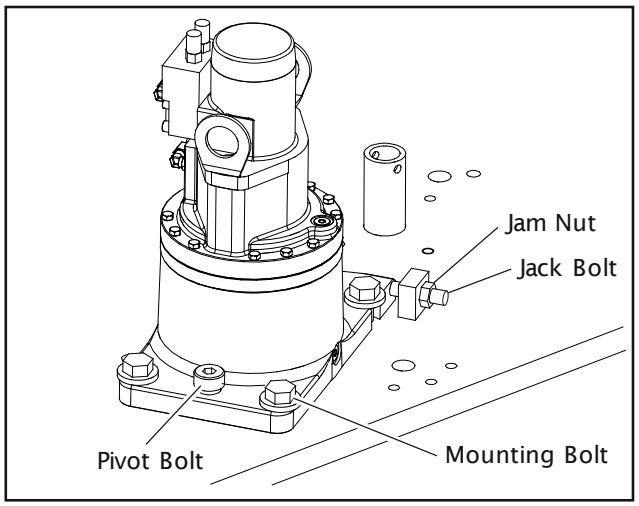


3.17 SWING HUB REMOVAL

1. Disconnect all wiring harness terminals connected to the swing motor.

2. Gently loosen the set screw. Do not remove.

3. Remove the pivot bolt using Allen Wrench.



4. Remove the mounting bolts securing swing drive hub to the turntable.

5. Using the suitable lifting device, remove the swing drive hub from mounting plate without damaging the swing gear.

6. Place swing drive hub in the clean area.

7. Refer to Section 3.14, Swing Drive for swing drive maintenance.

3.18 SWING BEARING

Turntable Bearing Mounting Bolt Condition Check

NOTICE

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

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 JLG Threadlocker P/N 0100019. 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 extended main boom to horizontal. (See Figure 3-42.)
   b. At the positions indicated on Figure 3-43. try to insert a.0015 feeler gauge between the bolt and hardened washer at the arrow indicated position.
   c. Ensure that the 0.0015" 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 main boom to full elevation.
   b. At the position indicated on Figure 3-41. try to insert the 0.0015" 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 3-43., try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.

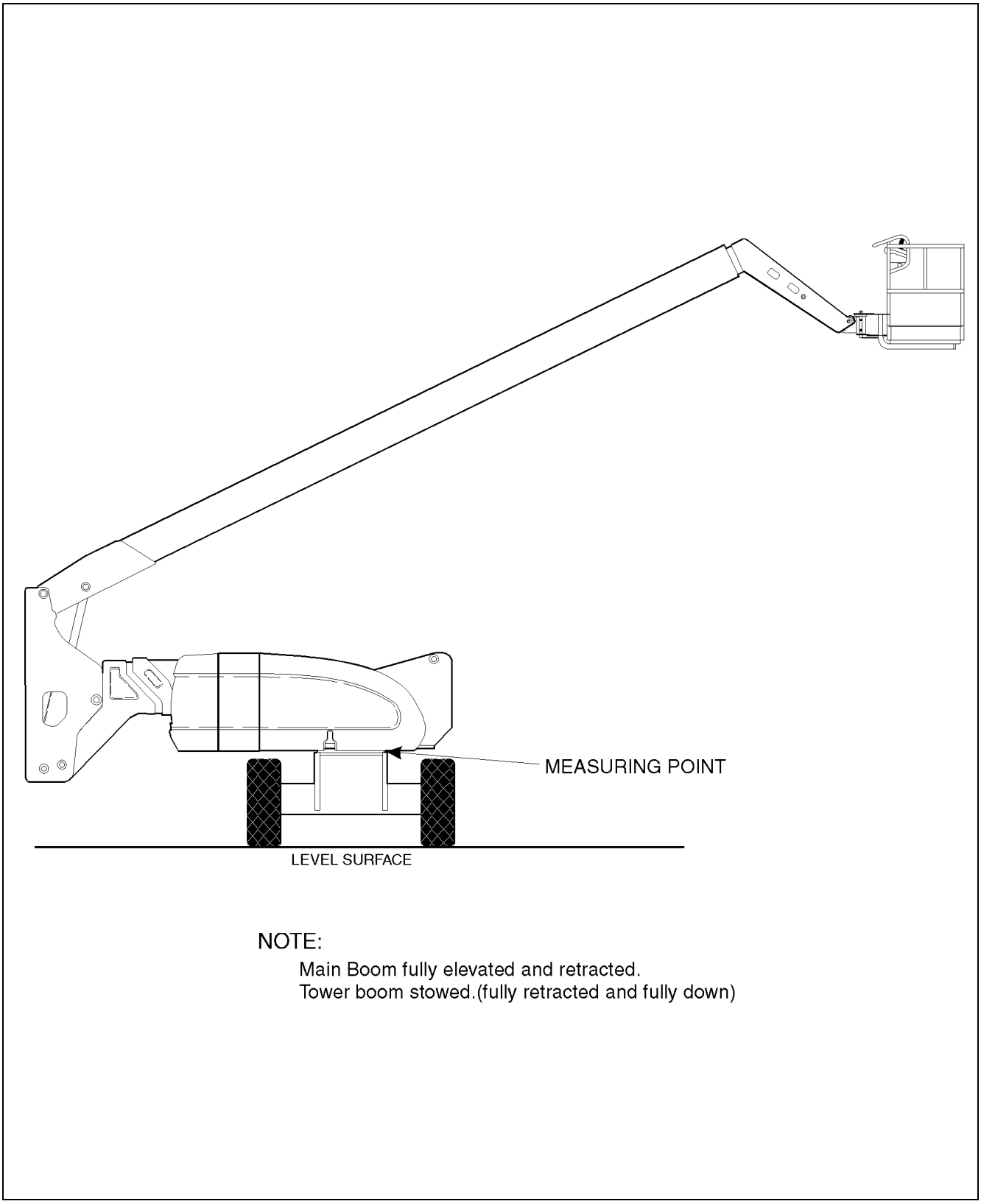


Figure 3-41. Swing Bearing Tolerance Boom Placement (Sheet 1 of 2)

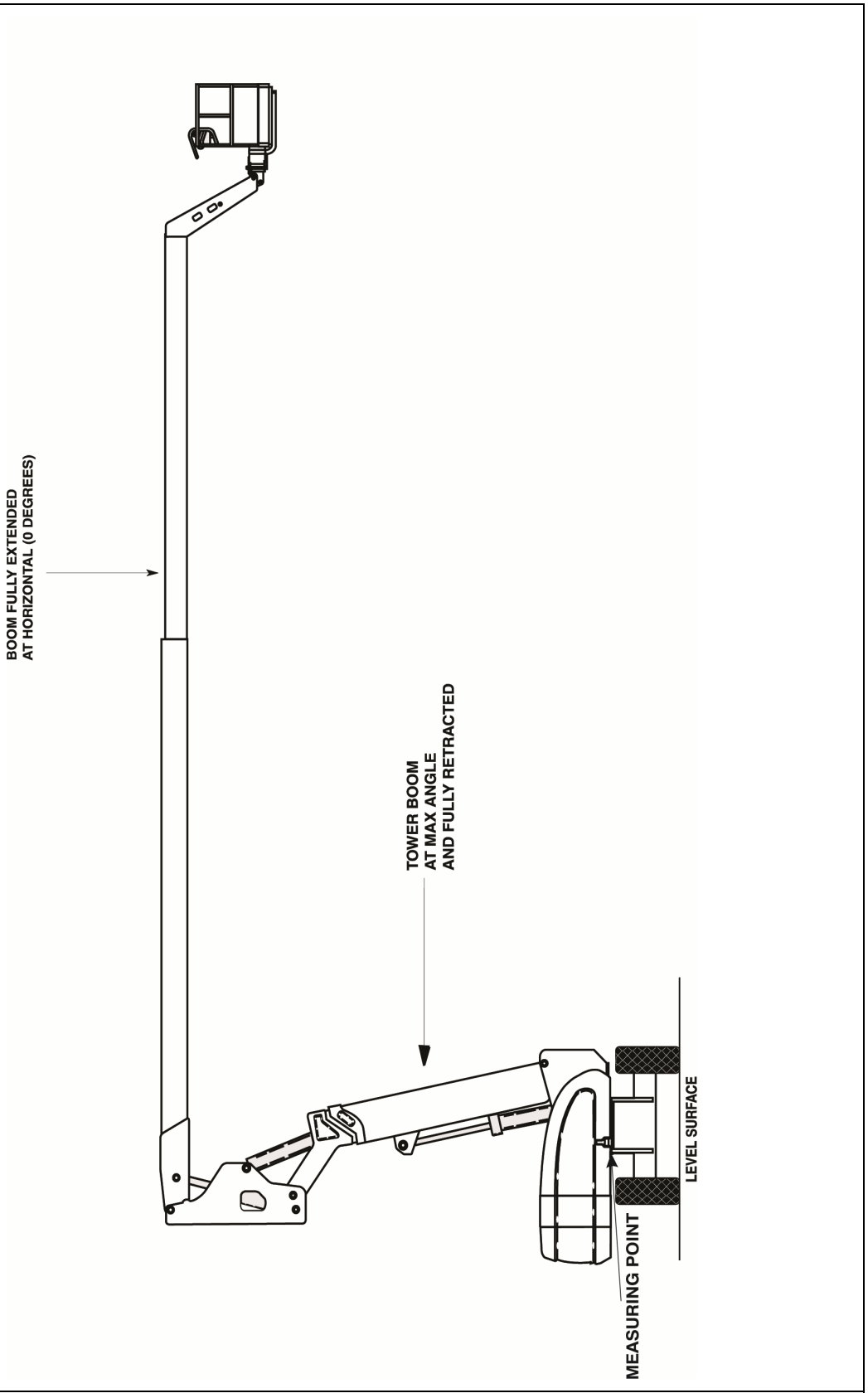


Figure 3-42. Swing Bearing Tolerance Boom Placement (Sheet 2 of 2)

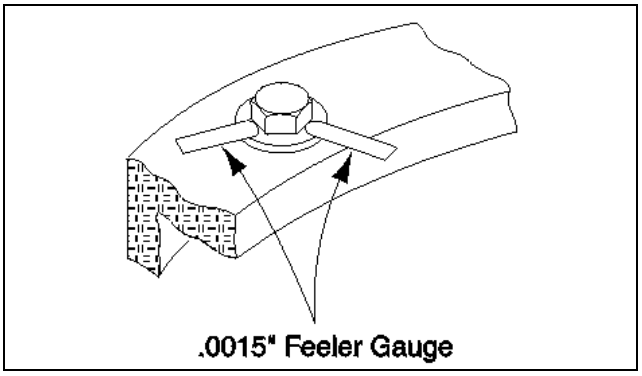


Figure 3-43. Swing Bolt Feeler Gauge Check

Wear Tolerance

1. From the underside of the machine, at rear center, with the main boom fully elevated and fully retracted, and tower boom stowed, as shown in Figure 3-41., Swing Bearing Tolerance Boom Placement (Sheet 1 of 2), using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. See Figure 3-44., Swing Bearing Tolerance Measuring Point
2. At the same point, with the main boom at horizontal and fully extended, and the tower boom fully elevated and fully retracted as shown in Figure 3-42., Swing Bearing Tolerance Boom Placement (Sheet 2 of 2). Using a magnetic base dial indicator, measure and record the distance between the swing bearing and turntable. See Figure 3-44., Swing Bearing Tolerance Measuring Point
3. If a difference greater than 0.079 in. (2.00 mm) is determined, the swing bearing should be replaced.
4. If a difference less than 0.079 in. (2.00 mm) is determined, and any of the following conditions exist, the bearing should be removed, disassembled, and inspected for the following:
   - **a.** Metal particles in the grease.
   - **b.** Increased drive power required.
   - **c.** Noise.
   - **d.** Rough rotation.
5. If bearing inspection shows no defects, reassemble and return to service.

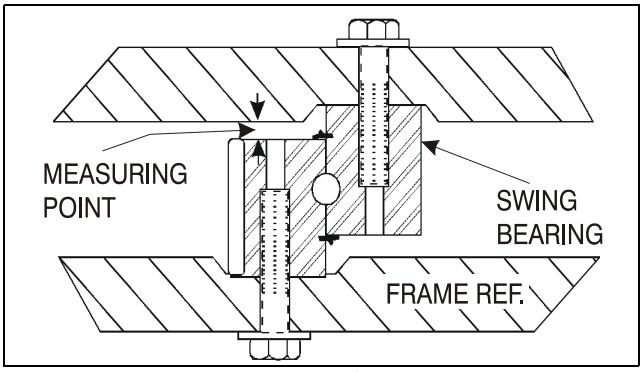


Figure 3-44. Swing Bearing Tolerance Measuring Point

Swing Bearing Replacement

REMOVAL

1. From Ground Control station, operate the boom adequately to provide access to frame opening to rotary coupling.

⚠ WARNING

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

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

NOTICE

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

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

8. Carefully place the turntable on a suitably supported trestle.

9. Use a suitable tool to scribe a line on the outer race of the swing bearing and the frame. This line will aid in aligning the bearing upon installation. Remove the bolts and washers which attach the outer race of the bearing to the frame. Discard the bolts. Use suitable lifting equipment to remove the bearing from the frame, then move the bearing to a clean, suitably supported work area.

INSTALLATION

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

⚠ CAUTION

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

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

NOTICE

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

3. Refer to the Torque Sequence diagram as shown in Figure 3-46., Swing Bearing Torque Sequence. Clean any residue off the new bearing bolts, then apply a light coating of JLG Threadlocker P/N 0100019 and install the bolts and washers through the frame and outer race of the bearing. Tighten the bolts to an initial torque of 190 Ft. lbs. (260 Nm) w/JLG Threadlocker P/N 0100019.

4. Remove the lifting equipment from the bearing.

5. Using suitable lifting equipment, carefully position the turntable assembly above the machine frame.

6. Carefully lower the turntable onto the swing bearing, ensuring that the scribed line of the inner race of the bearing aligns with scribed line on the turntable. If a new swing bearing is used, ensure that the filler plug fitting is at 90 degrees from the fore and aft center line of the turntable.

7. Clean any residue off the new bearing bolts, then apply a light coating of JLG Threadlocker P/N 0100019 and install the bolts and washers through the turntable and inner race of the bearing.

8. Following the Torque Sequence diagram shown in Figure 3-46., Swing Bearing Torque Sequence, tighten the bolts to a torque of 190 ft. lbs. (260 Nm) w/Loctite.

9. Remove the lifting equipment.

10. Install the rotary coupling retaining yoke brackets, apply a light coating of JLG Threadlocker P/N 0100011 to the attaching bolts and secure the yoke to the turntable with the mounting hardware.

11. Connect the hydraulic lines to the rotary coupling as tagged prior to removal.

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

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

Swing Bearing Torque Values

1. Outer Race - 190 ft. lbs. (260 Nm) w/JLG Threadlocker P/N 0100019.

2. Inner Race - 190 ft. lbs. (260 Nm) w/JLG Threadlocker P/N 0100019.

3. See Swing Bearing Torquing Sequence.

⚠ WARNING

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

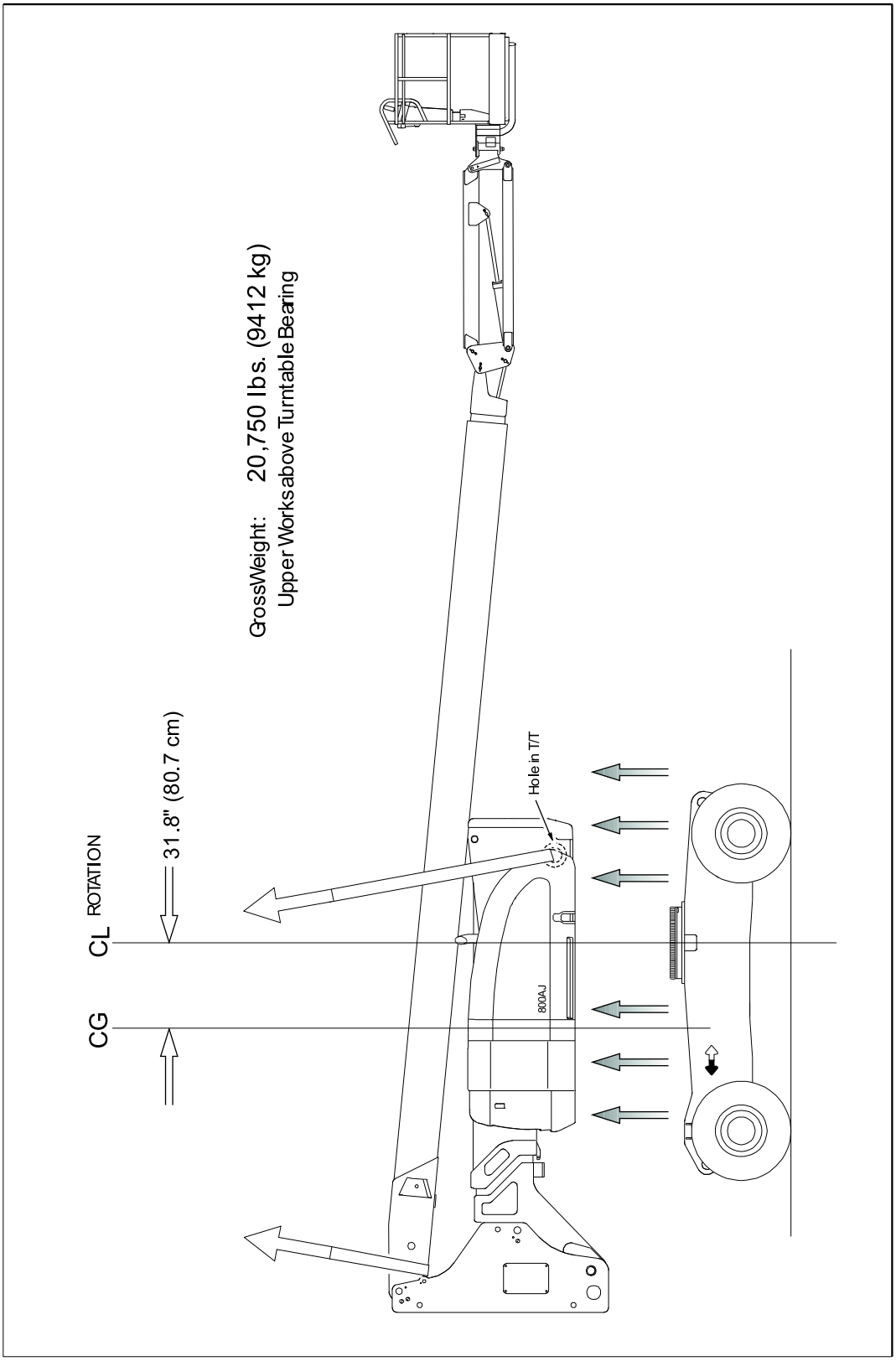
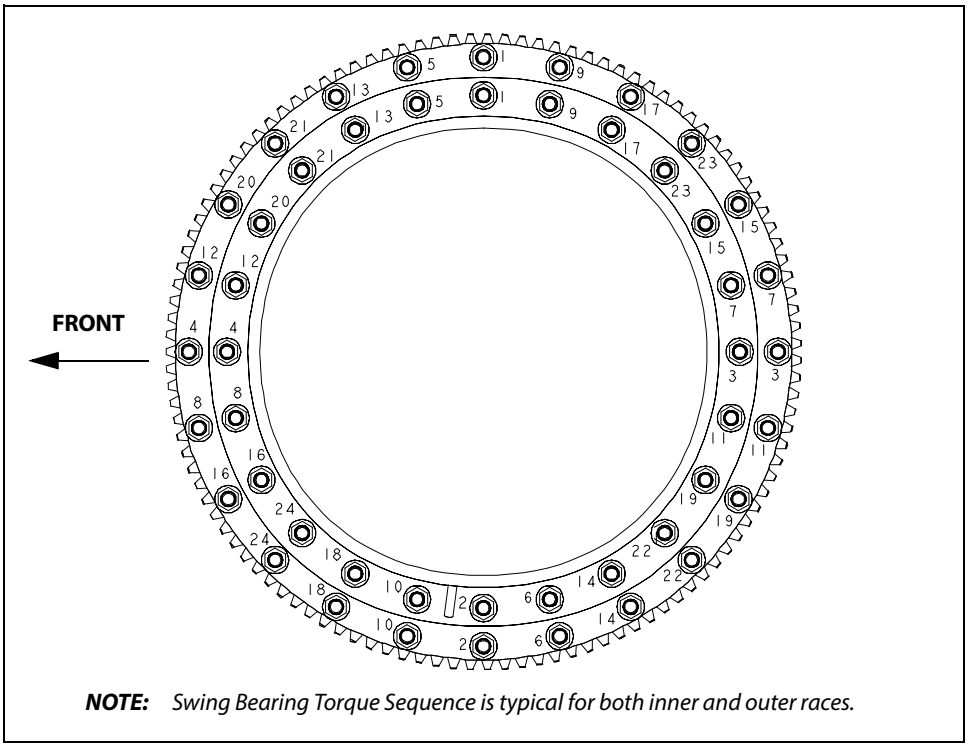


Figure 3-45. Swing Bearing Removal (800AJ)



NOTE: *Swing Bearing Torque Sequence is typical for both inner and outer races.*

Figure 3-46. Swing Bearing Torque Sequence

3.19 CHASSIS TILT INDICATOR SYSTEM

The Chassis Tilt Indicator System measures the turntable angle with respect to level ground. The tilt sensor has two settings: 5.0°/4.0° (depending on market) and 8.0° degrees.

The 5.0°/4.0° angle is used for the purpose of warning the operator by means of an audible alarm and the chassis tilt light in the platform display panel. This is a warning system only; the machine will continue to function. The operator is responsible for preventing the machine from attaining an unstable position.

The 8.0° angle is used exclusively for the purpose of automatically shifting the drive motors to the maximum displacement position (slow speed) when this angle is reached and the boom is in Transport position.

By default setting, when the boom is in Transport Position (refer to Section 4 - Boom for more information on Transport Position), and the chassis is at or above 8.0°, the drive and steer system will automatically switch into Max Torque mode that cuts back at speed. Other functions will automatically switch into creep mode.

The control system responds to indicated angle readings 0.25 degree smaller than the required angles to account for calibration and sensor variation.

3.20 ROTARY COUPLING

Use the following procedure to install the seal kit.

1. If not already removed, remove the axle oscillation valve from the cylinder barrel. The spool of the valve protrudes into the barrel and will damage the spool and seals if left in place.
2. Remove snap ring (7) from end.
3. Remove thrust ring (6) from the same end.
4. Remove center body (1) from housing (3).
5. Cut off old seals (2, 4, 5).
6. Remove proximity switch.
7. Assemble lip seals (2) in direction shown in Figure 3-47., Rotary Coupling Seal Installation.
8. Reassemble O-ring (4).
9. Heat cap seals (5) in hydraulic oil for 5 minutes at 300° F (149° C).
10. Assemble cap seals over O-rings.
11. Reinsert center body into housing (lube with hydraulic oil).
12. Replace thrust ring and snap ring.
13. Install proximity switch as shown in Figure 3-51.

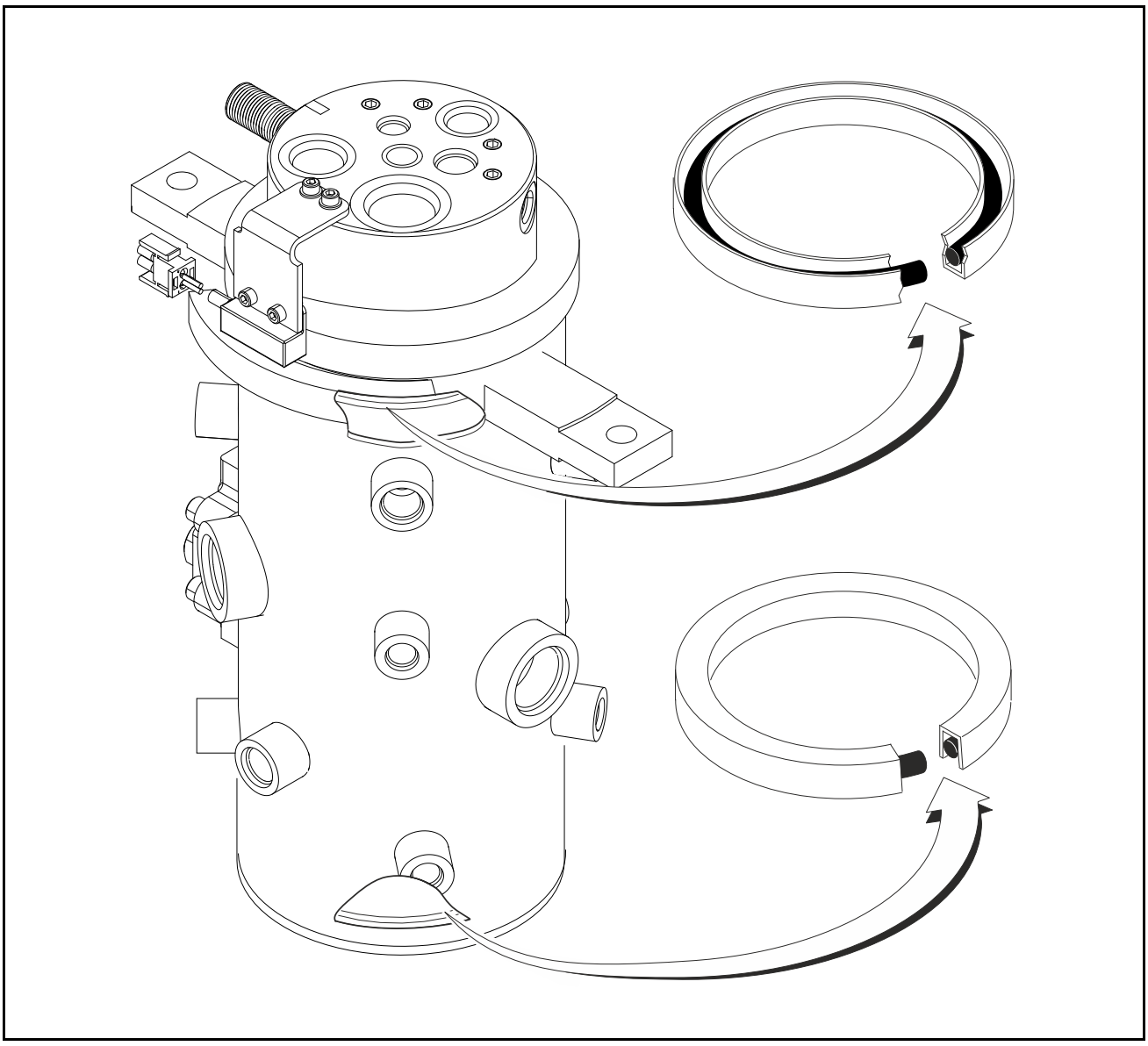
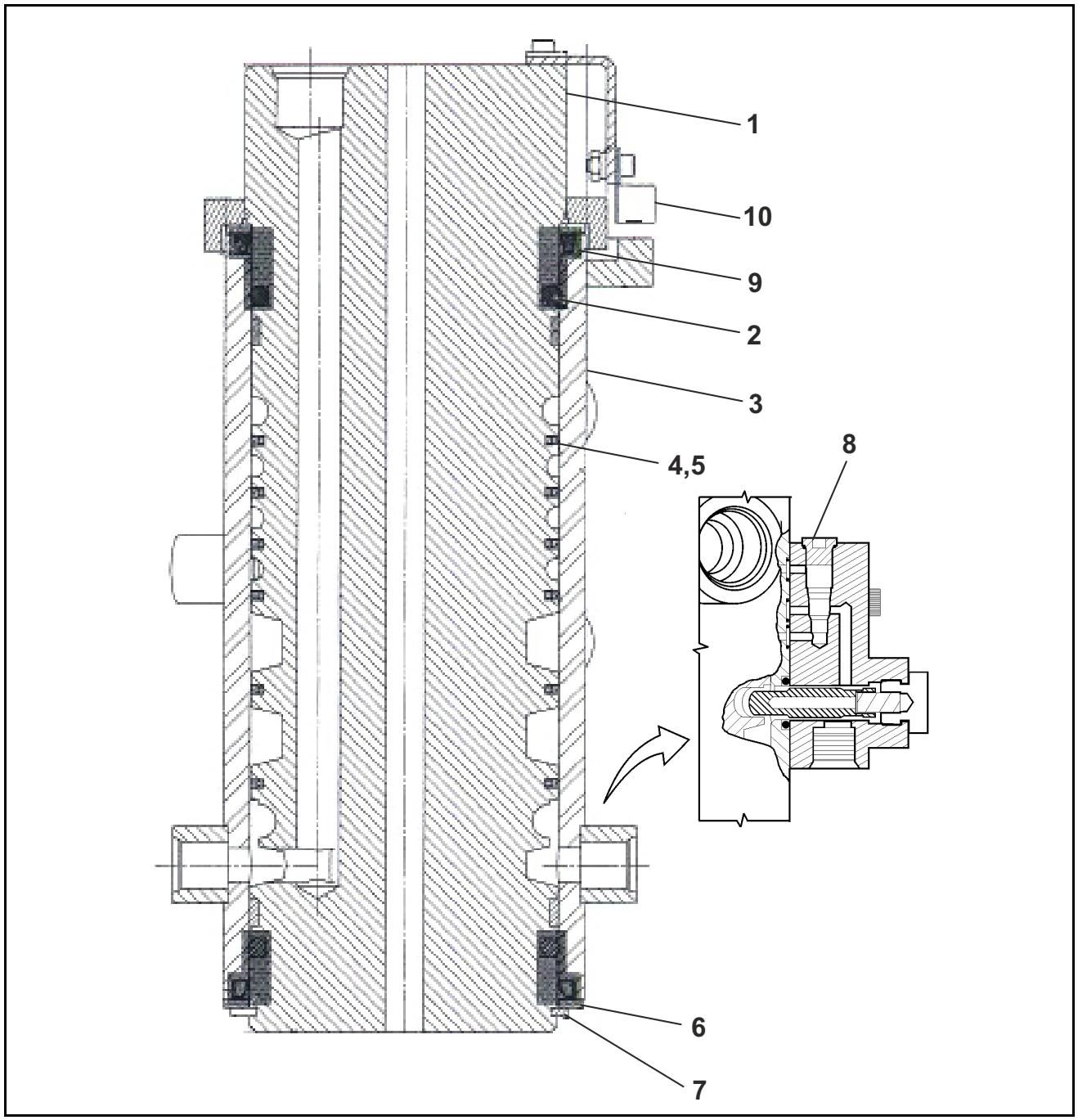
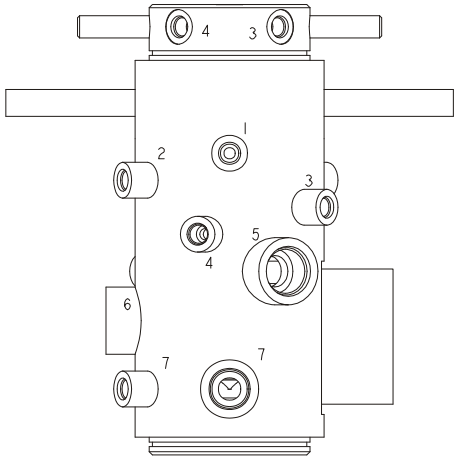


Figure 3-47. Rotary Coupling Seal Installation

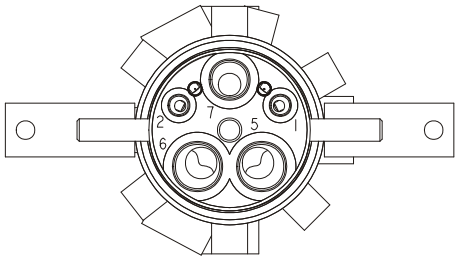


1. Center Body
2. Seal
3. Housing
4. O-ring
5. Seal
6. Thrust Ring
7. Snap Ring
8. Valve Block (Axle Oscillation)
9. O-ring
10. Proximity Switch

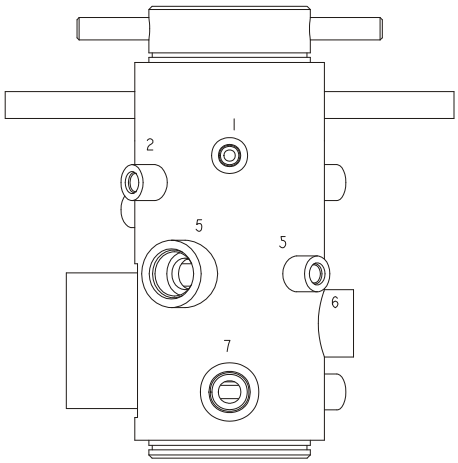
Figure 3-48. Rotary Coupling Cutaway



FRONT VIEW
(Facing Towards Rear of Machine)



TOP VIEW



REAR VIEW
(Facing Towards Front of Machine)

Figure 3-49. Rotary Coupling Port Location (7 Port)

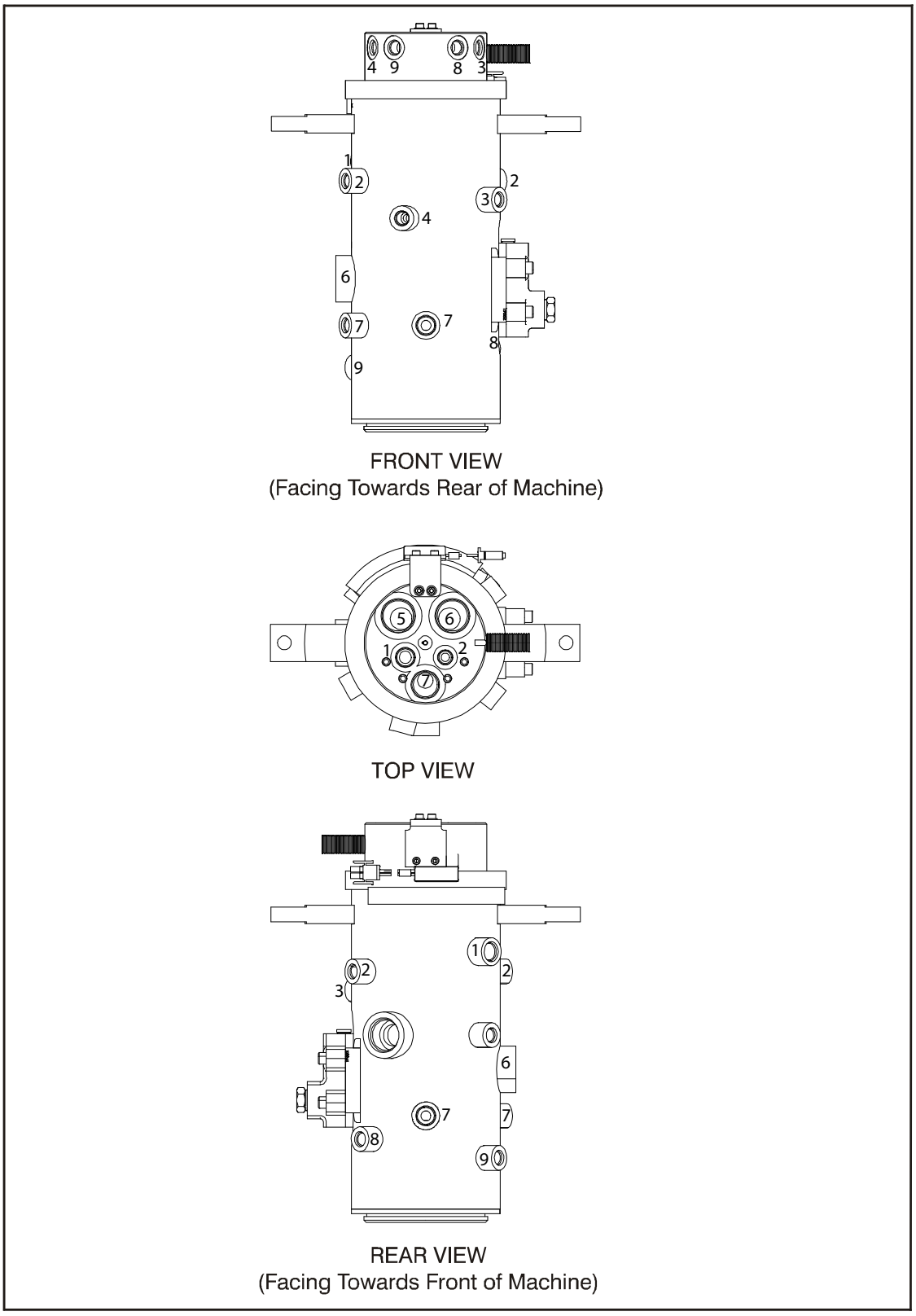
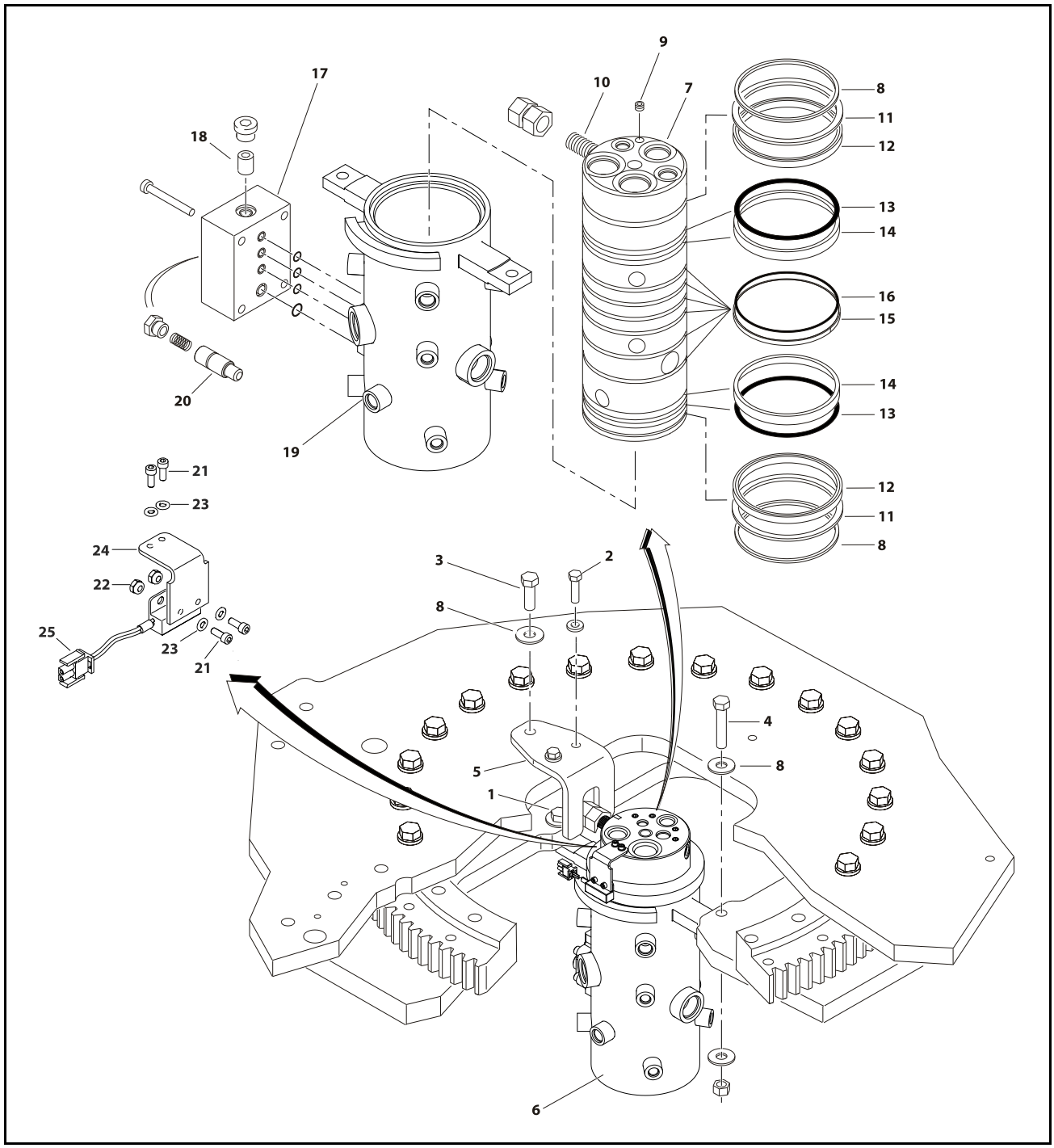


Figure 3-50. Rotary Coupling Port Location (9 Port)



1.	JLG Threadlocker	6.	Rotary Coupling	11.	Ring	16.	O-ring	21.	Bolt
2.	Bolt	7.	Spool	12.	Seal	17.	Valve	22.	Nut
3.	Bolt	8.	Retaining Ring	13.	O-ring	18.	Check Valve	23.	Washer
4.	Bolt	9.	Plug	14.	Bearing	19.	Case	24.	Bracket
5.	Bracket	10.	Torque Lug	15.	Cap Seal	20.	Plunger Valve	25.	Proximity Switch

Figure 3-51. Rotary Coupling Installation

Table 3-9. Coupling Port Information Table (7 port)

Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	2-8, 1-6	Drain	250 (17)	375 (26)

Table 3-10. Coupling Port Information Table (9 port)

Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	2	1-6, 1-16	Drive Reverse	4500(310)	6750(465)
6	1	-16	Drive Forward	4500 (310)	6750 (465)
7	3	2-8, 1-6	Drain	250 (17)	375 (26)
8	1	-6	Steer	2500 (172)	3750 (258.5)
9	1	-6	Steer	2500(172)	3750 (258.5)

3.21 GENERATOR

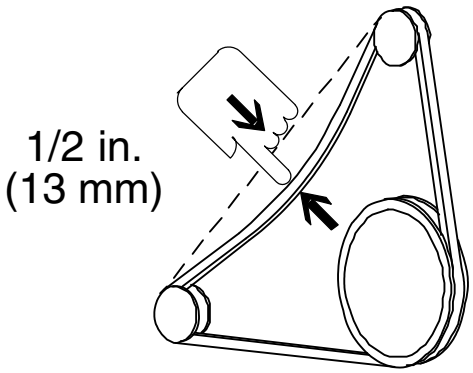
SkyPower

The optional 4kW and 7.5kW auxiliary generators can be powered by the engine only with the clutch engaged. When the aux generator is operational, excess power from the engine, coupled with power from the IMG can be used to drive the pumps to provide limited functionality. The performance of the drive and functions in this scenario will be less than in normal operation. In the event that the clutch is disengaged or the engine is reporting a code that could prevent it from providing full power, the SkyPower system will be disabled.

Maintenance Schedule

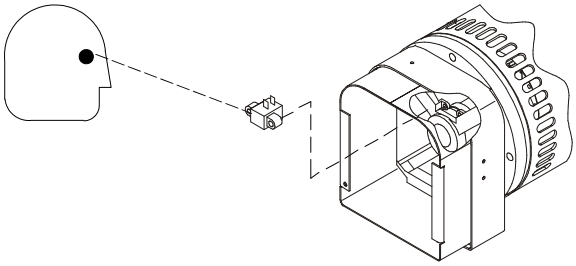
EVERY 250 HOURS

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

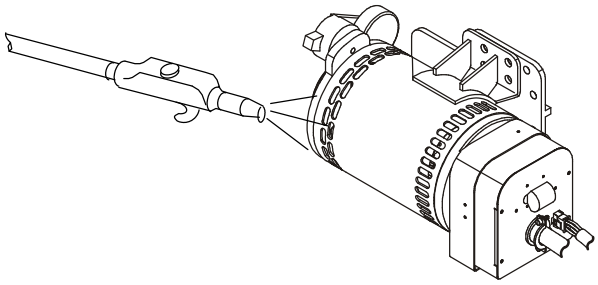


EVERY 500 HOURS

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



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

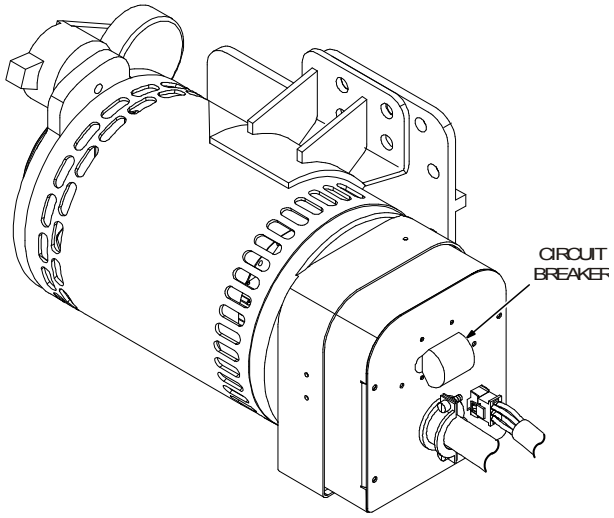


Overload Protection

⚠ CAUTION

STOP THE ENGINE WHENEVER CHECKING OR INSPECTING THE CIRCUIT BREAKER.

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



Inspecting Brushes, Replacing Brushes, and Cleaning Slip Rings

Refer to Figure 3-52., Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings.

INSPECTING BRUSH POSITION

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

INSPECTING BRUSHES

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

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

CLEANING SLIP RINGS

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

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

Clean the rings with 220 grit emery paper. Remove as little material as possible. If the rings are deeply pitted and do not clean up, consult generator factory service.

Reinstall the belt, brush holder assembly, and end panel.

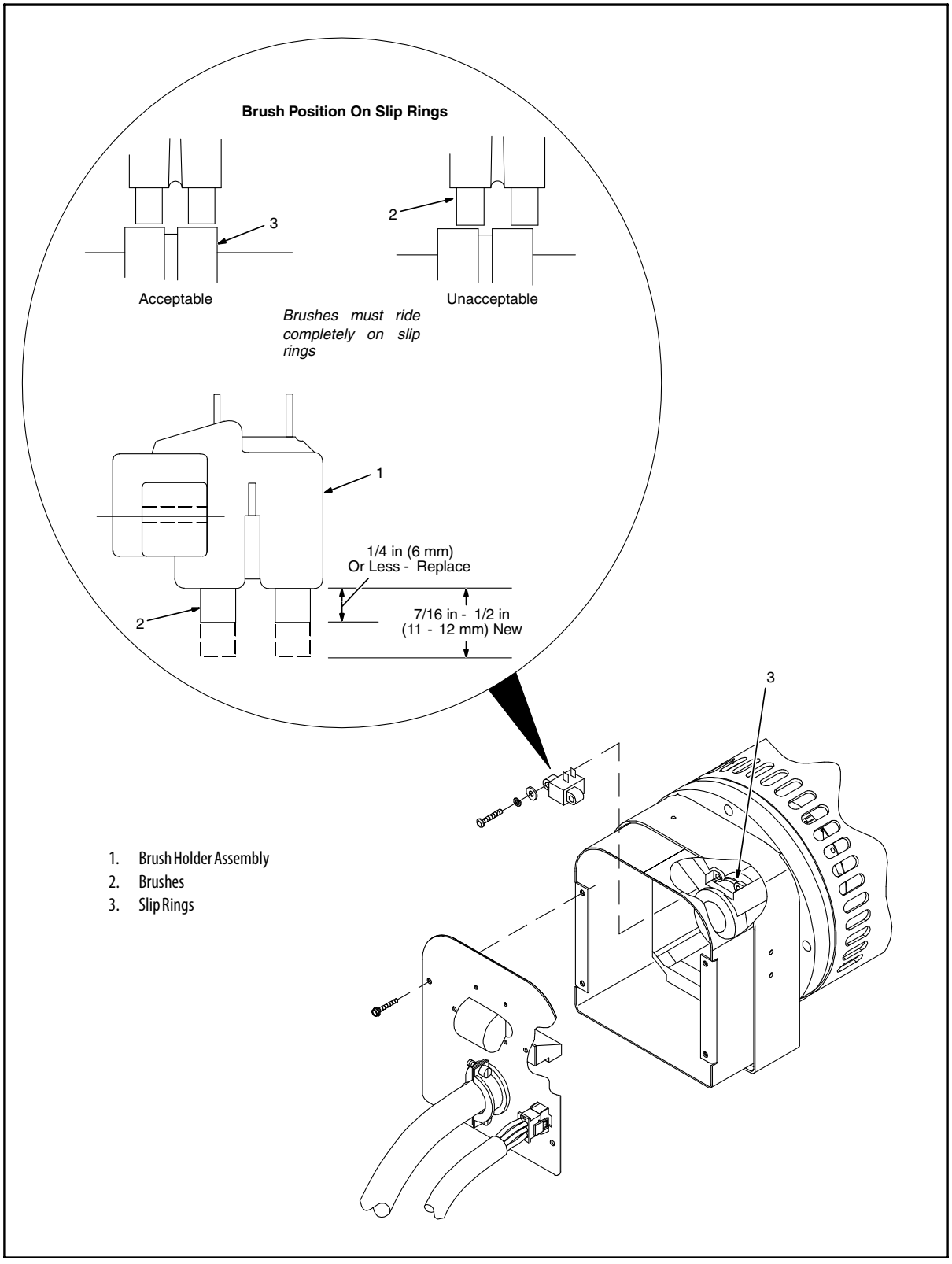


Figure 3-52. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

Troubleshooting

Table 3-11. Troubleshooting

Trouble	Remedy
No generator output at platform AC receptacles.	Be sure generator control switch is turned on at platform.
	Check and secure electrical connections at platform, generator, and control box.
	Be sure all equipment is turned off when starting unit.
	Reset circuit breaker CB1.
	Check plug PLG3 connection and/or connections at receptacles RC3 and RC5.
	Be sure + 12 volts DC input voltage is being supplied to control box.
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings (nominal reading is 26 ohms). Replace generator if rotor is open.
	Disconnect stator weld leads 1, 2, and 3 from circuit breaker CB1 , and check continuity between leads. Replace generator if necessary.
	Disconnect plug PLG4 and check continuity between exciter leads 5 and 6. Replace generator if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
Low generator output at platform AC receptacles.	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings nominal reading is 26 ohms). Replace generator if rotor is open.
	Disconnect stator weld leads 1, 2, and 3 from circuit breaker CB1, and check continuity between leads. Replace generator if necessary.
	Disconnect plug PLG4 and check continuity between exciter leads 5 and 6. Replace generator if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
High generator output at platform AC receptacles.	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes if necessary.
	Check power board PC1 and connections, and replace if necessary.
	Check control board PC2 and connections, and replace if necessary.
Erratic generator output at platform AC receptacles.	Check and secure electrical connections at platform, generator, and control box.
	Verify generator is running at 3600 rpm (60 Hz) or 3000 rpm (50 Hz).
	Check slip rings, wiring to brushes, and brush position on slip rings. Install new brushes n necessary.
	Disconnect leads 12 and 13 from brushes, and check continuity across slip rings nominal reading is 26 ohms). Replace generator if rotor is open.
	Check power board PC1 and connections, and replace if necessary
	Check control board PC2 and connections, and replace if necessary

Generator Disassembly and Assembly

Refer to Figure 3-54. and Figure 3-55. to determine if trouble is in stator, rotor, control box, or combination of these components.

1. Rotor
2. Stator Assembly

⚠ CAUTION

DO NOT DAMAGE ROTOR OR STATOR WINDINGS DURING DISASSEMBLY AND ASSEMBLY PROCEDURE.

DISASSEMBLY

1. Mark and disconnect all electrical leads, secure using cable ties.
2. Remove brush holder assembly.
3. Disassemble generator parts shown in Figure 3-53.
4. Clean all parts with approved solvent and dry with compressed air, If applicable.
5. Inspect all part for damage. Replace if necessary.

ASSEMBLY

1. Assemble generator parts using torque values in table.
2. Reconnect all leads. Use cable ties to secure leads away from moving or hot parts.

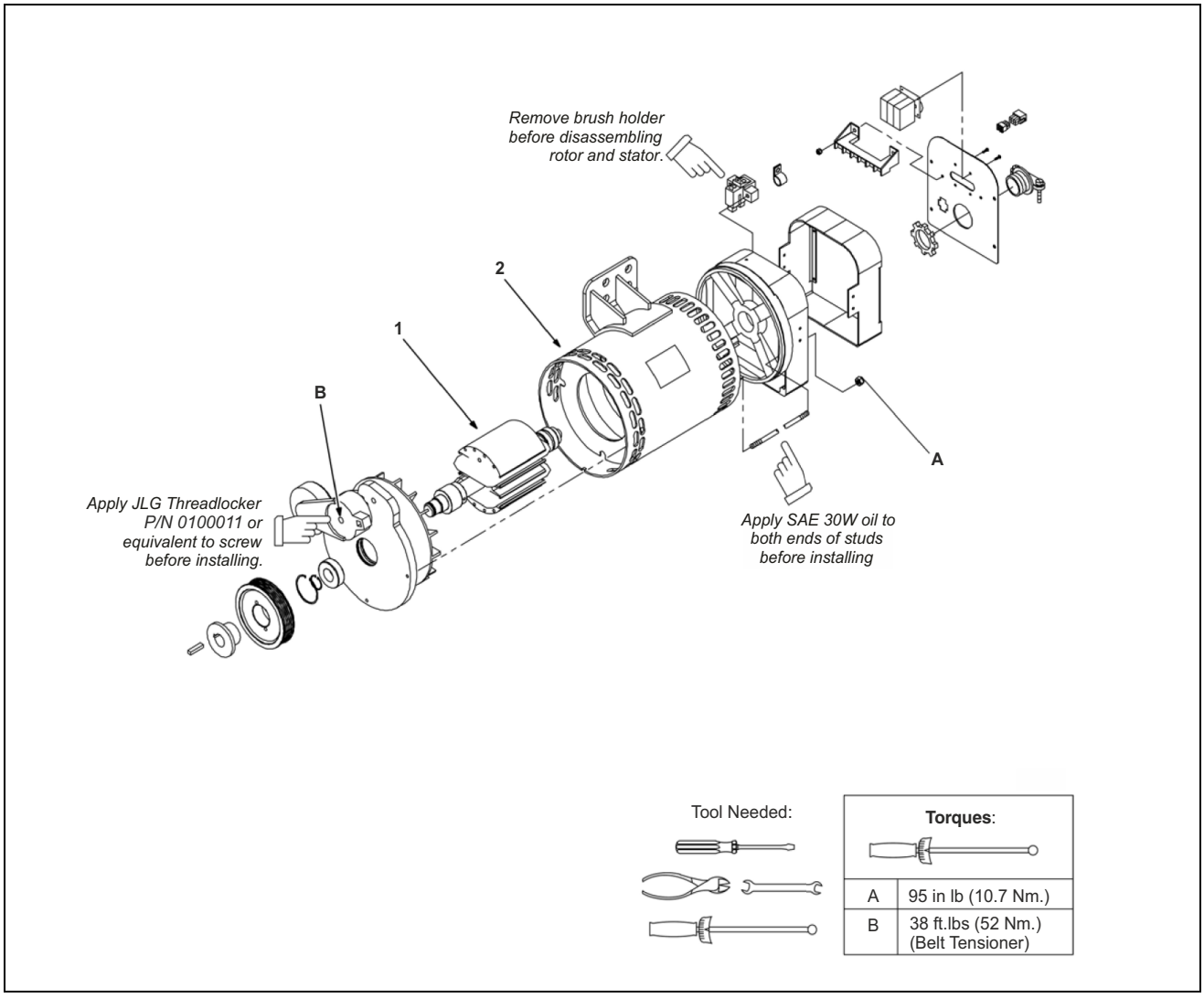


Figure 3-53. Generator Disassembly and Assembly

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Resistance Values	
a) Tolerance – ±10% unless specified	
b) Condition – 70°F (21°C); cold machine (no warm-up)	
c) Wiring Diagram	
d) Stop generator before checking resistance	
R1	26 ohms
R2	1 ohm
R3 thru R5	Less than 1 ohm

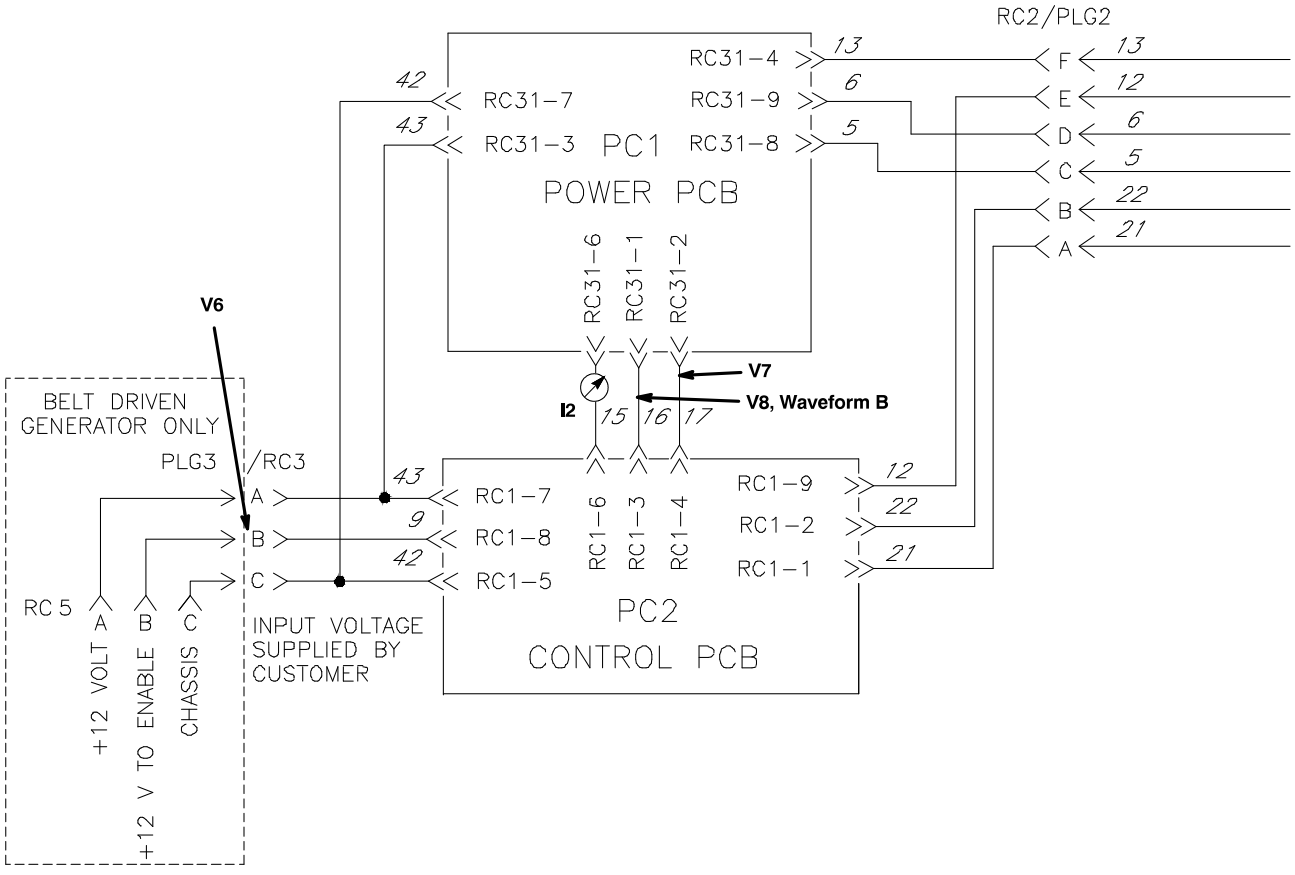
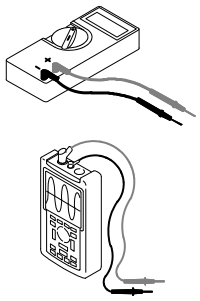


Figure 3-54. Generator Troubleshooting Circuit Diagram (Sheet 1 of 2)

Test Equipment Needed:



Amperage Readings	
a) Tolerance – ±5% unless specified	
b) Condition – 70°F (21°C); cold machine (no warm-up); no load	
I1	1 amps DC (60 Hz) No greater than 3.5 amps DC under load
I2	1 amps DC (60 Hz) No greater than 3.5 amps DC under load

Voltage Readings	
a) Tolerance – ±10% unless specified	
b) Condition – 70°F (21°C); cold machine (no warm-up); no load	
c) Weld/power rpm unless specified	
d) Reference – single arrow: reference to circuit common (lead 42); double arrow: reference to points indicated	
e) Wiring Diagram	
V1	Rotor: +25 volts DC at no load ±20%; +75 volts DC at full load ±10%
V2	Exciter: 150 volts AC
V3	Voltage Feedback: 240 volts AC
V4	Output (Odd Leg): 245 volts AC
V5	Output: 120 volts AC
V6	Generator Enable: +12 volts DC when generator is enabled (On); 0 volts DC when not enabled (Off)
V7	Shutdown Signal: +12 volts DC when shutdown is latched; 0 volts DC when not latched
V8	PWM Signal: 0 to +15 volts DC

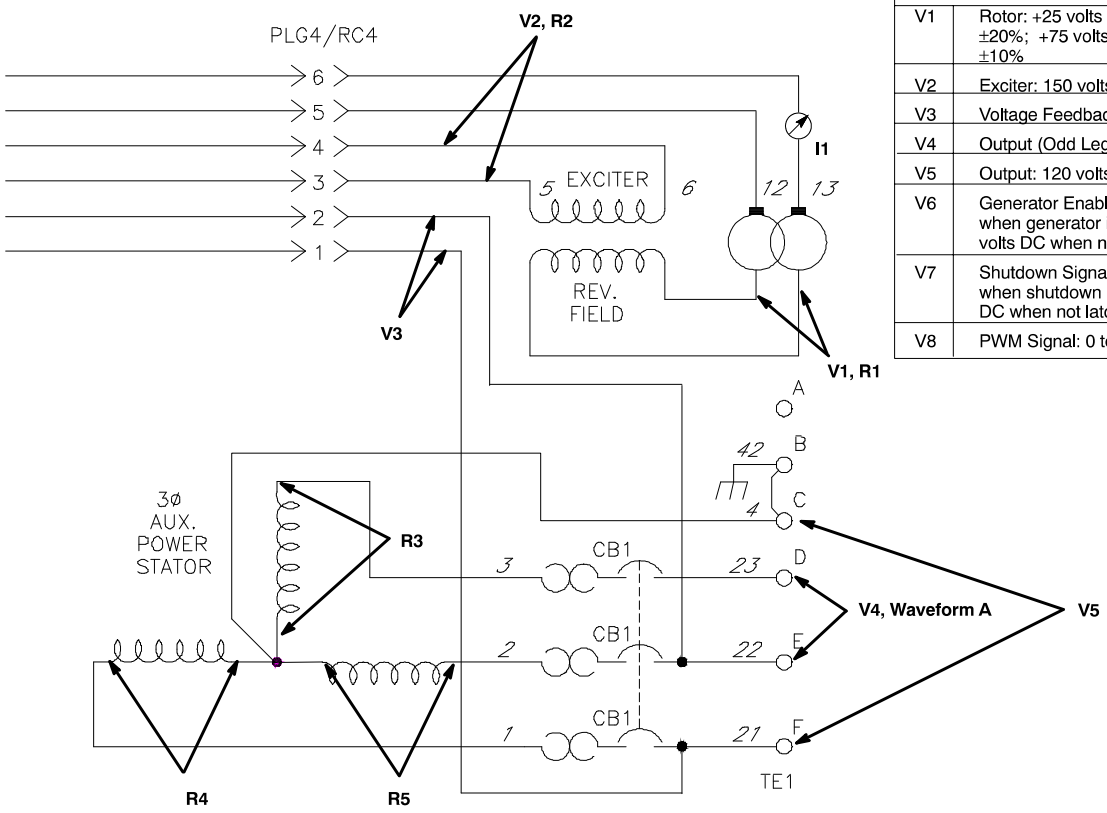


Figure 3-55. Generator Troubleshooting Circuit Diagram (Sheet 2 of 2)

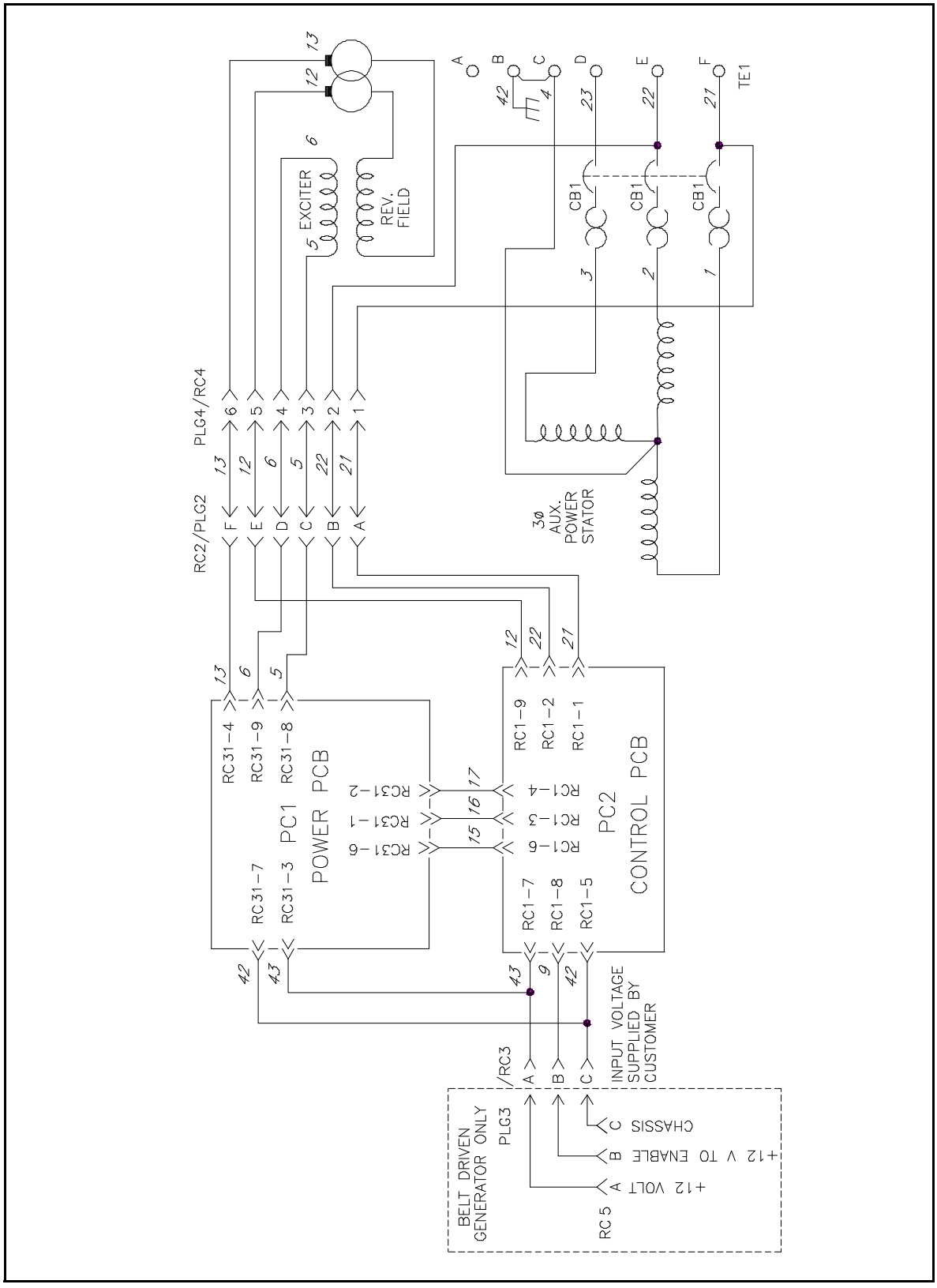


Figure 3-56. Generator Electrical Circuit Diagram

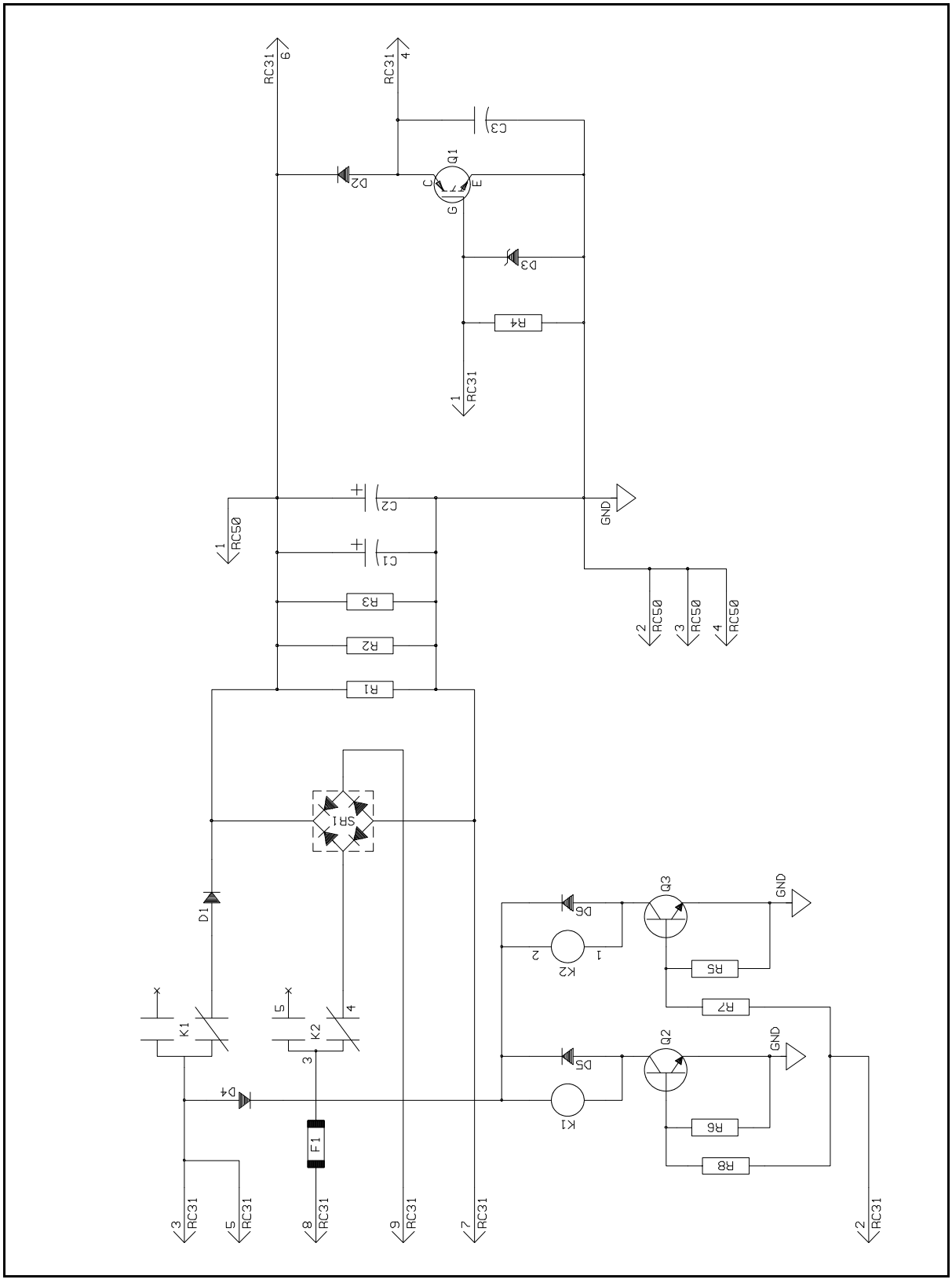


Figure 3-57. Power Board PC1 Electrical Circuit Diagram

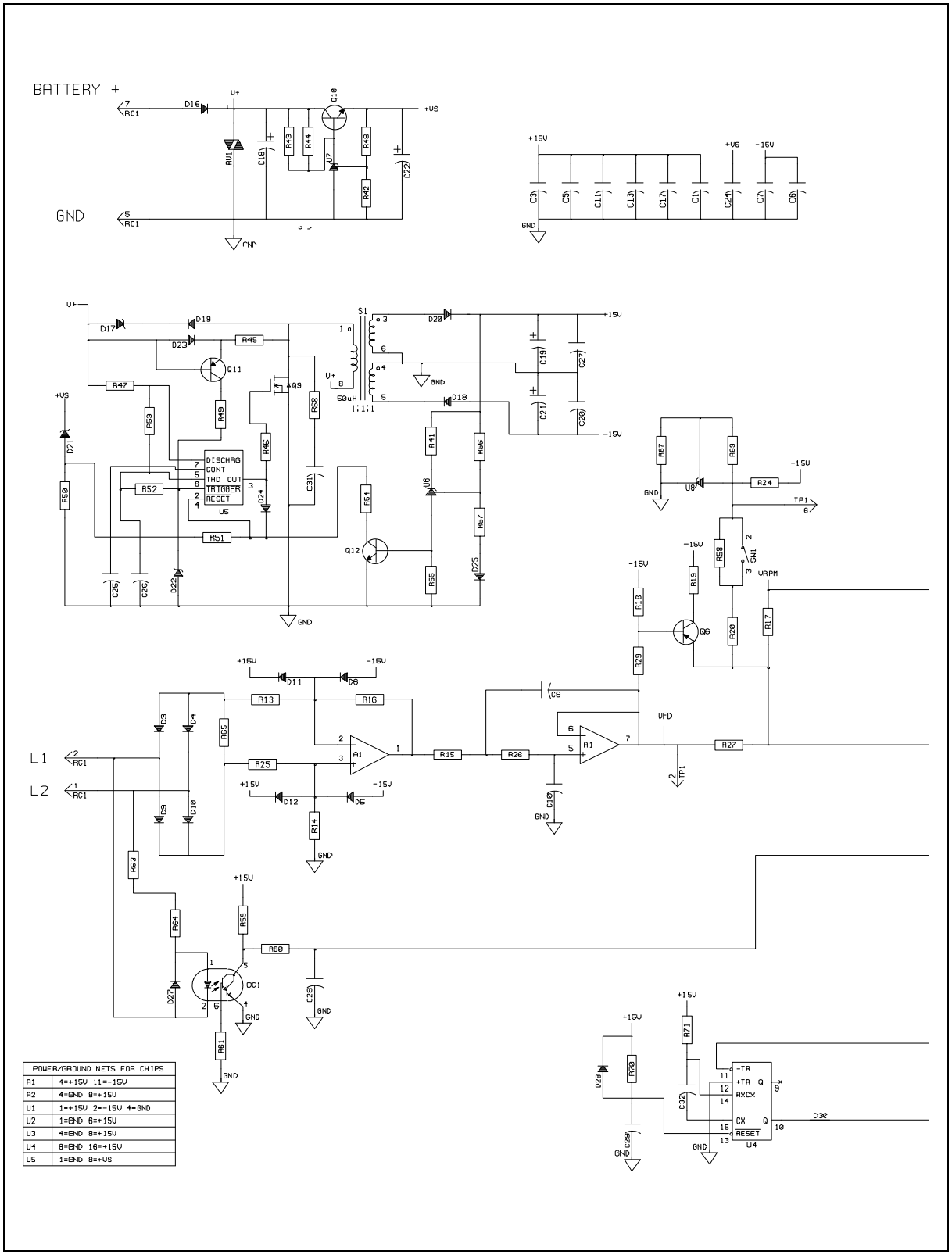


Figure 3-58. Power Board PC2 Electrical Circuit Diagram (Sheet 1 of 2)

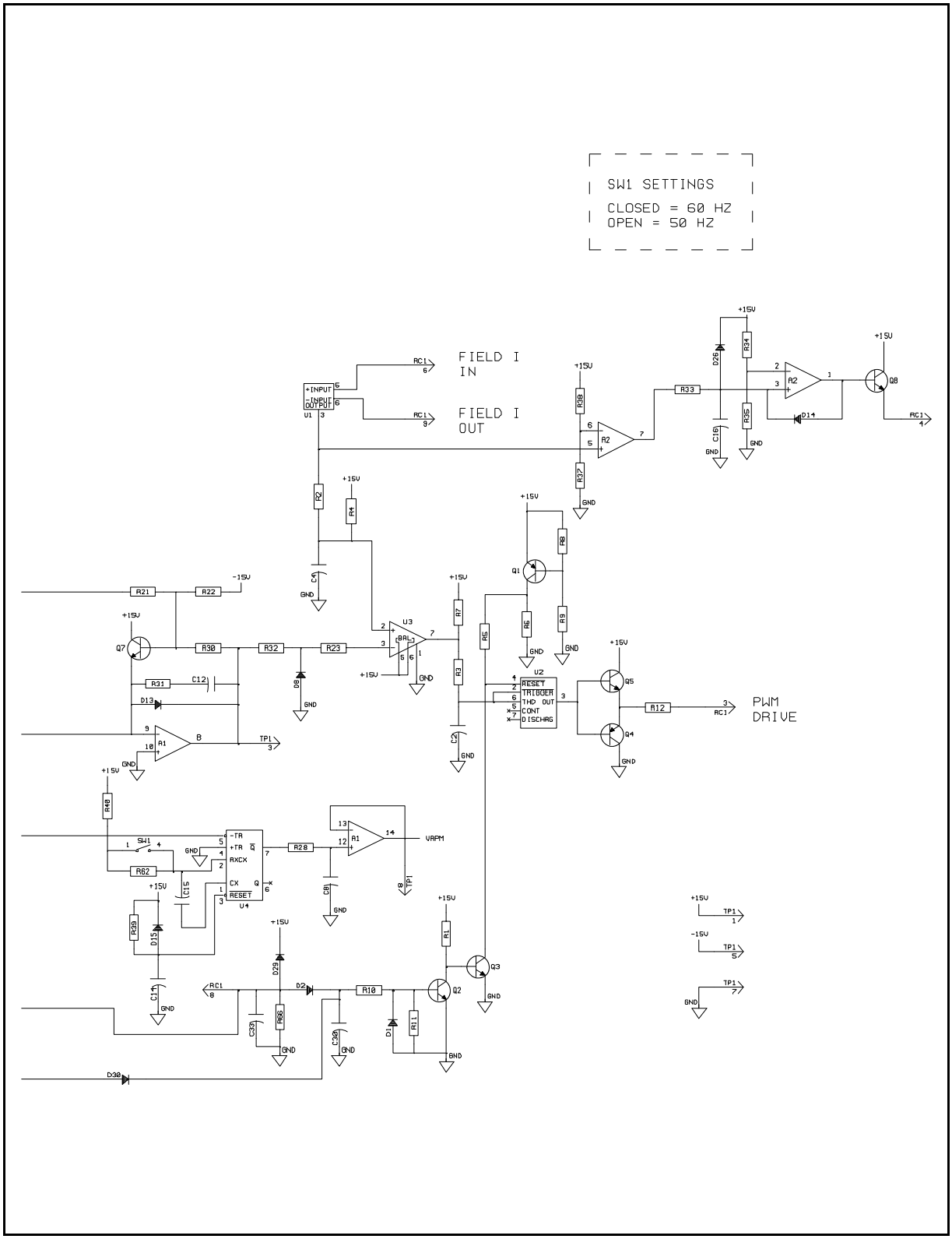


Figure 3-59. Power Board PC2 Electrical Circuit Diagram (Sheet 2 of 2)

Lead Connection List for Generator

NOTE: *Table shows physical lead connections and should be used with circuit diagram (table replaces wiring diagram).*

NOTE: *Apply small amount of dielectric grade, nonconductive electric grease to connectors where factory-applied grease had been present.*

Table 3-12. Lead Connection List for Generator

Leads	Connections
1A	STATOR TO CB1
2A	STATOR TO CB1
3A	STATOR TO CB1
4A	STATOR TO TE1 (C)
5A	STATOR TO RC4 (3)
5B	PLG2 (C) TO PLG4 (3)
5C	RC2 (C) PLG31 (8)
6A	STATOR TO RC4 (4)
6B	PLG2 (D) TO PLG4 (4)
6C	RC2 (D) PLG31 (9)
9A	RC5 (B) TO PLG3 (B) (Customer Supplied)
9B	RC3 (B) PLG1 (8)
12A	PLG2 (E) TO PLG4 (5)
12B	RC2 (E) PLG1 (9)
12C	RC4 (5) TO BRUSH
13A	PLG2 (F) TO PLG4 (6)
13B	RC2 (F) PLG31 (4)
13C	RC4 (6) TO BRUSH
15A	PLG1 (6) TO PLG31 (6)
16A	PLG1 (3) TO PLG31 (1)
17A	PLG1 (4) TO PLG31 (2)
21A	CB1 TO TE1 (F)
21B	PLG2 (A) TO PLG4 (1)
21C	PLG1 (1) TO RC2 (A)
21D	RC4 (1) TO CB1
22A	CB1 TO TE1 (E)
22B	PLG2 (B) TO PLG4 (2)
22C	PLG1 (2) TO RC2 (B)
22D	RC4 (2) TO CB1
23A	CB1 TO TE1 (D)
42A	RC5 (C) TO PLG3 (C) (Customer Supplied)
42B	RC3 (C) TO CONNECTION POINT 1
42C	PLG31 (7) TO CONNECTION POINT 1
42D	PLG1 (5) TO CONNECTION POINT 1
42F	END BELL SHROUD TO ENGINE MOUNT
42G	CHASSIS TO TE1 (B)
43A	RC5 (A) TO PLG3 (A) (Customer Supplied)
43B	RC3 (A) TO CONNECTION POINT 2
43C	PLG31 (3) TO CONNECTION POINT 2
43D	PLG1 (7) TO CONNECTION POINT 2

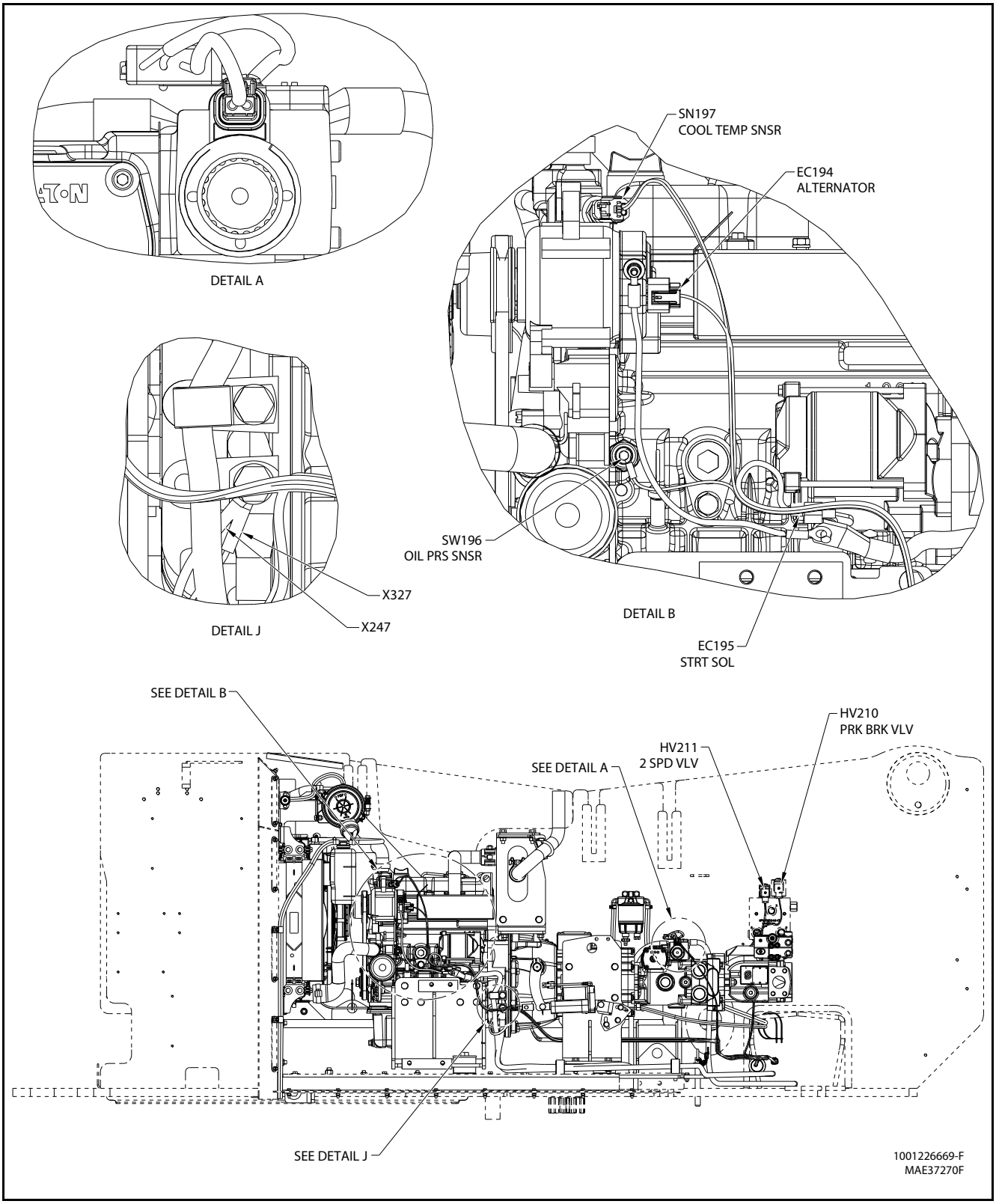


Figure 3-60. Engine Installation - Sheet 1 of 5

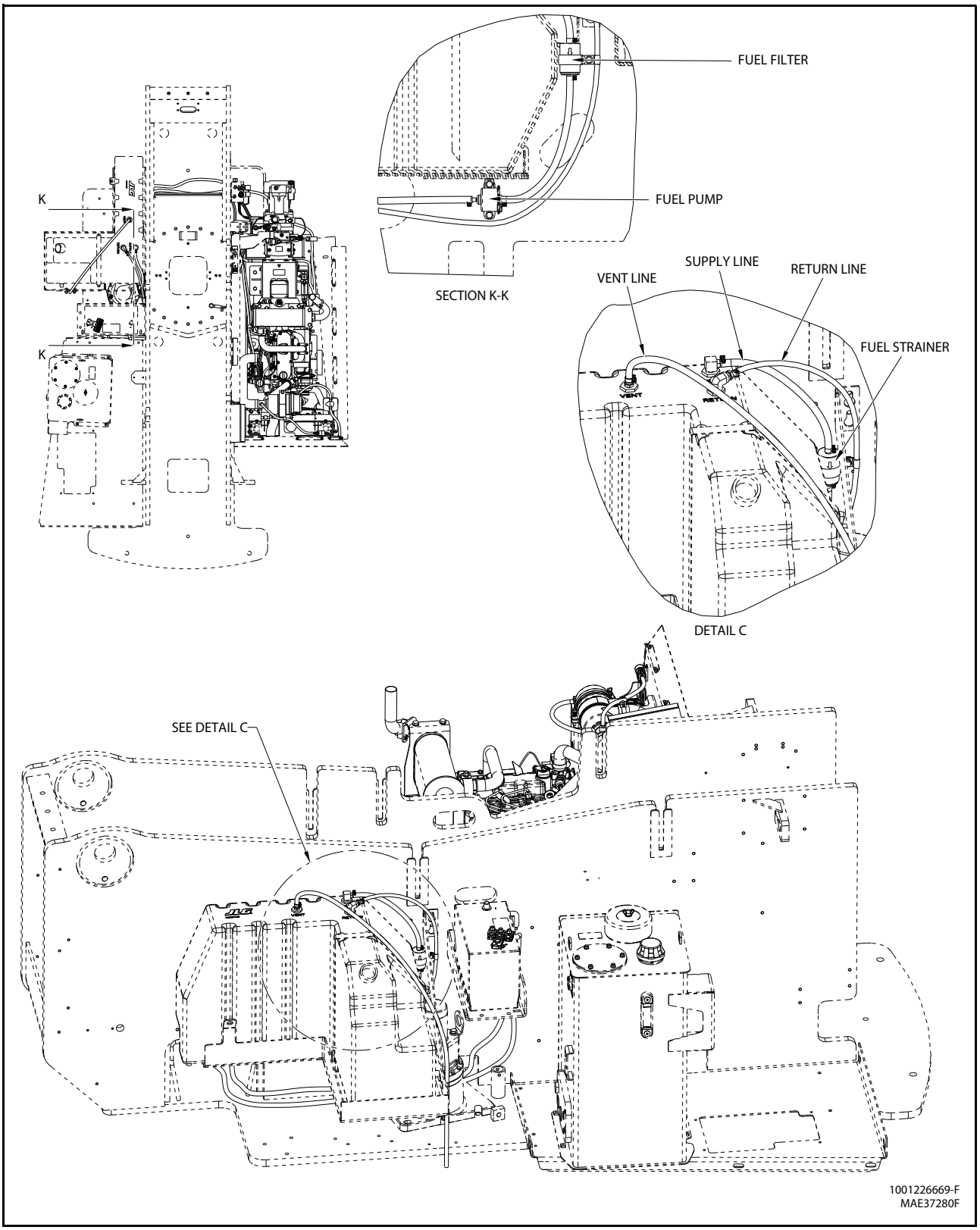


Figure 3-61. Engine Installation - Sheet 2 of 5

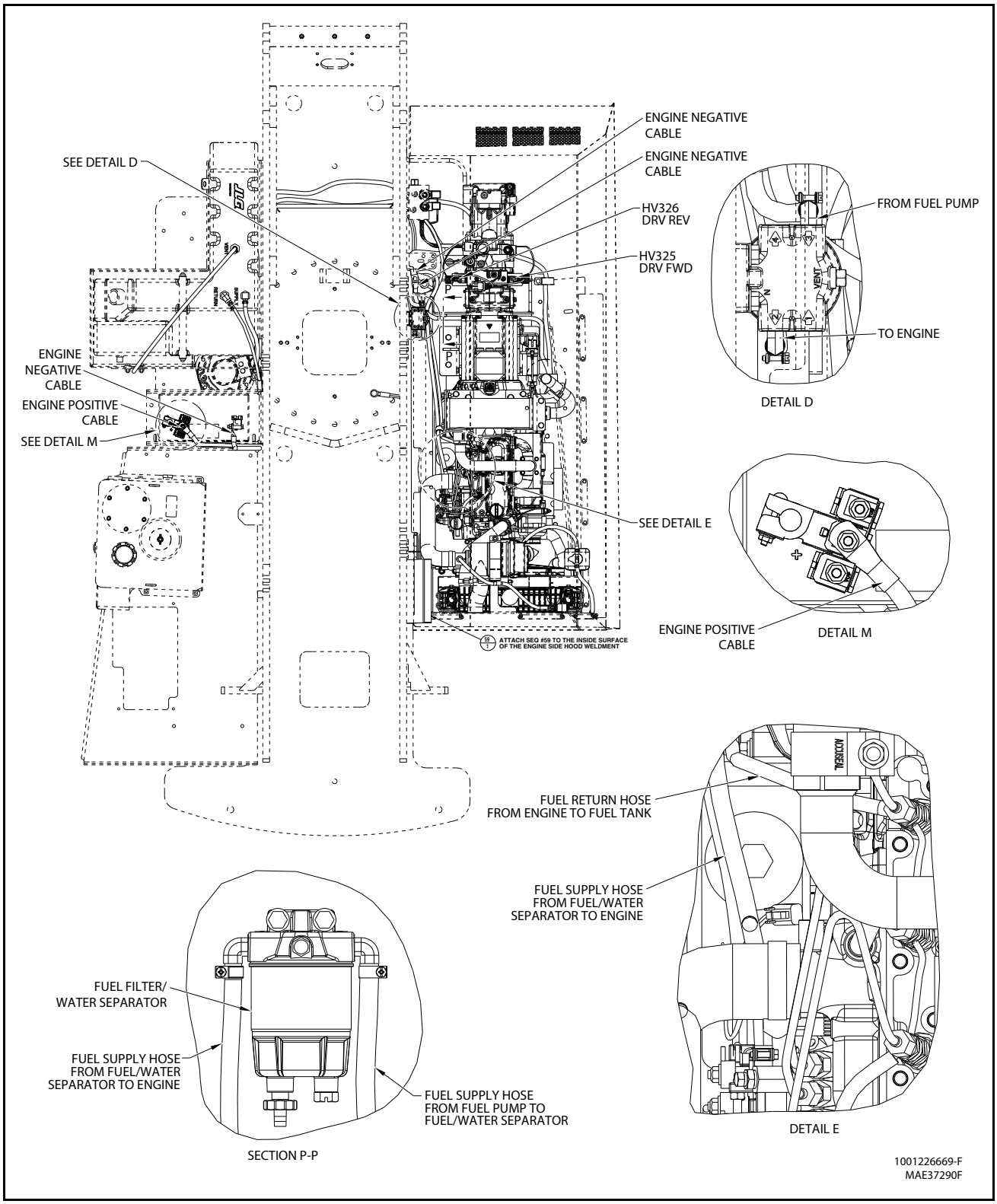


Figure 3-62. Engine Installation - Sheet 3 of 5

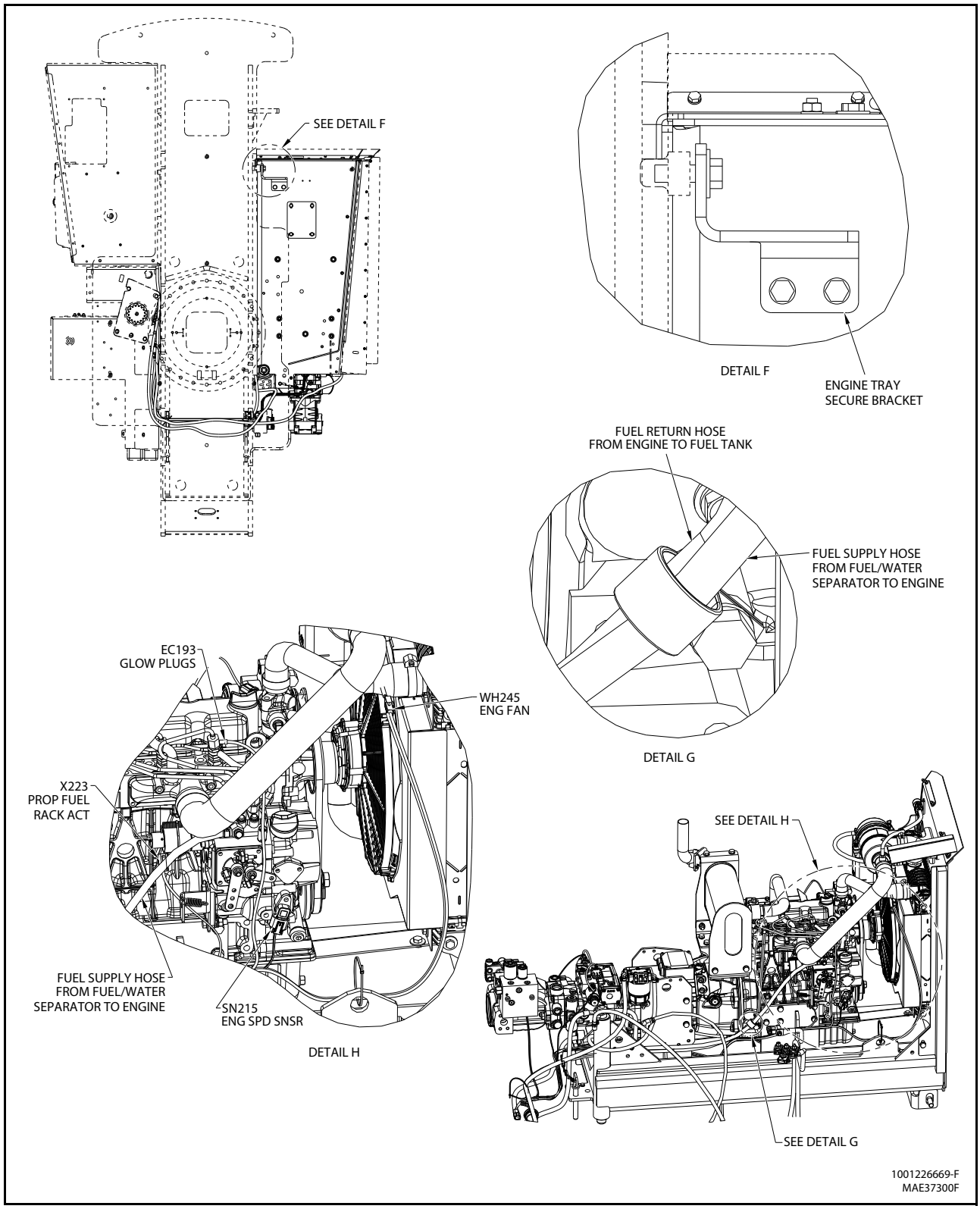


Figure 3-63. Engine Installation - Sheet 4 of 5

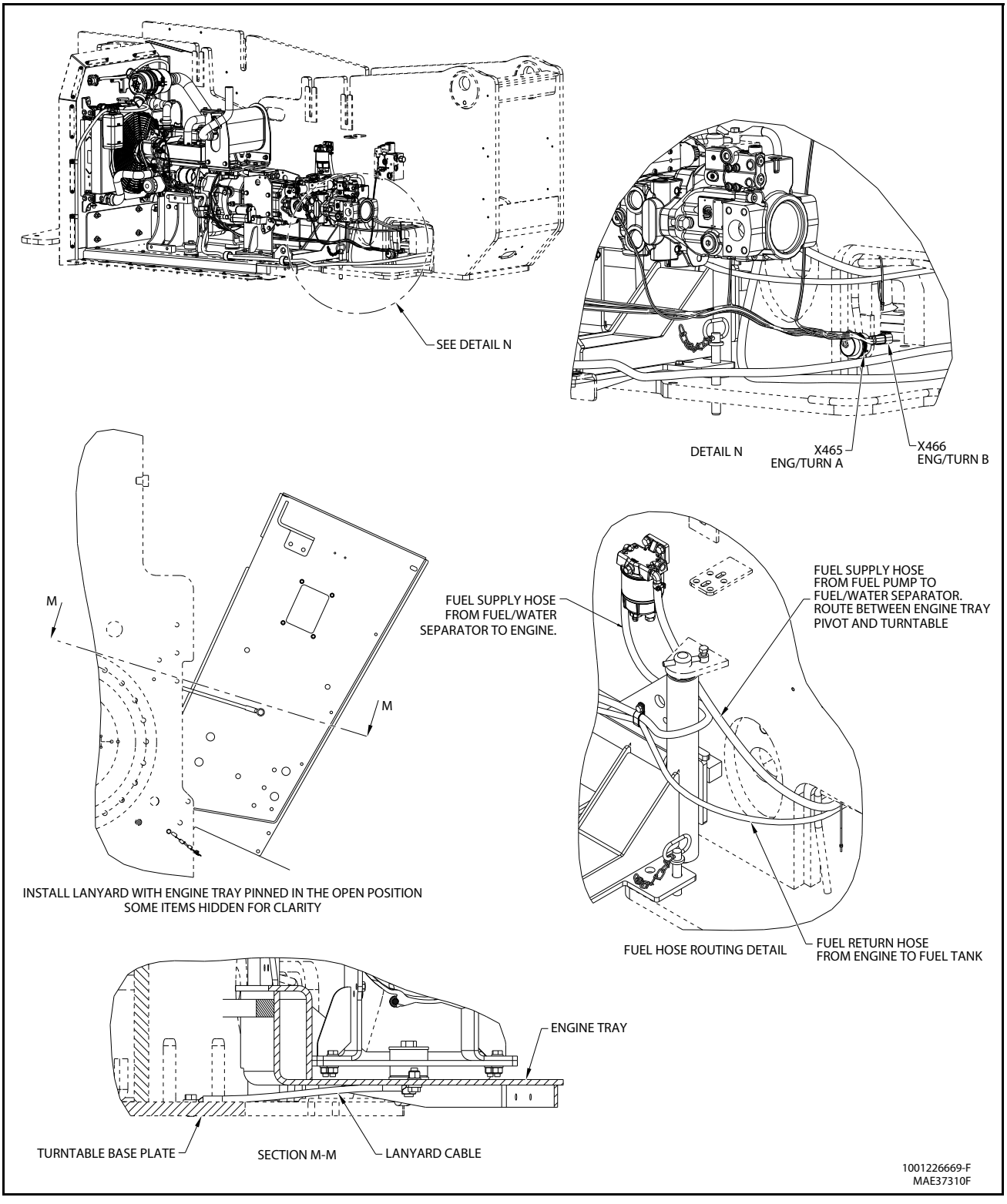


Figure 3-64. Engine Installation - Sheet 5 of 5

3.22 COLD START SYSTEM

The machine control system monitors the engine coolant and ambient temperature to make an assessment of cylinder preheating requirements. If the coolant temperature is below 122° F (50° C) when control power is turned on, the glow plugs will be automatically fired for a duration that is based on the ambient temperature up to a maximum of 20 seconds. During this preheat period, the glow plug indicators will flash. Dependent on ambient conditions, the glow plugs may continue to warm the cylinders shortly after engine start.

Engine Warmup

When it is below 32°F (0°C), the clutch is disengaged from the engine when started. When engine operating temperature reaches 86°F (30°C), the Integrated Motor Generator (IMG) will spin at 1800 rpm for 10 seconds. After the 10 second period, the clutch (also spinning at 1800 rpm) will engage with the IMG.

NOTE: *When in Engine Warmup, after turning on ignition, operator must wait until glow plug indicator light goes out before cranking engine. As soon as the operator begins to crank the engine to start, the indicator will come on steady and an Engine Warmup DTC will be set. When the engine reaches an operating temperature of 86°F (30°C) and the clutch engages, the light will go out and the DTC will go away.*

3.23 CLUTCH ADAPTER PLATE INSTALLATION

1. Place the Clutch Adapter Plate against the engine flywheel and start all bolts approximately 1/2 to 1 turn.
2. Using the pattern shown in Figure 3-65., Clutch Adapter Plate Torque Sequence, work back and forth around the pressure plate turning each bolt not more than 3 turns before turning the other bolts to a similar level.

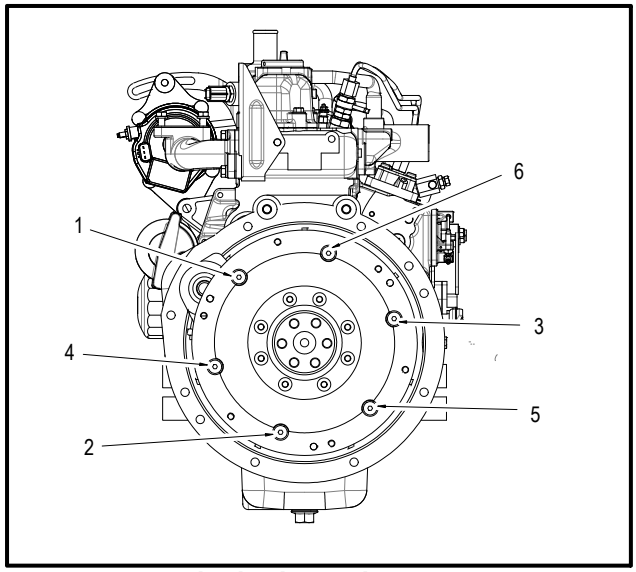


Figure 3-65. Clutch Adapter Plate Torque Sequence

3. Using the same torque pattern, torque each bolt to 16 ft.lbs. (22 Nm).
4.

3.24 CLUTCH KIT & RELEASE SHAFT INSTALLATION

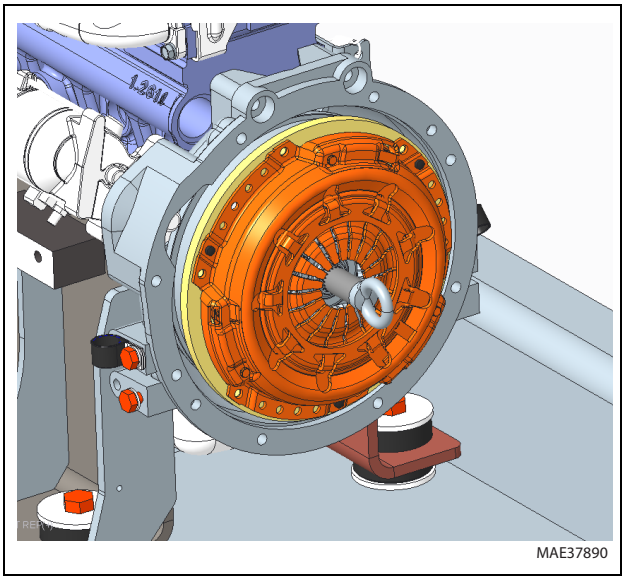
Clutch Kit

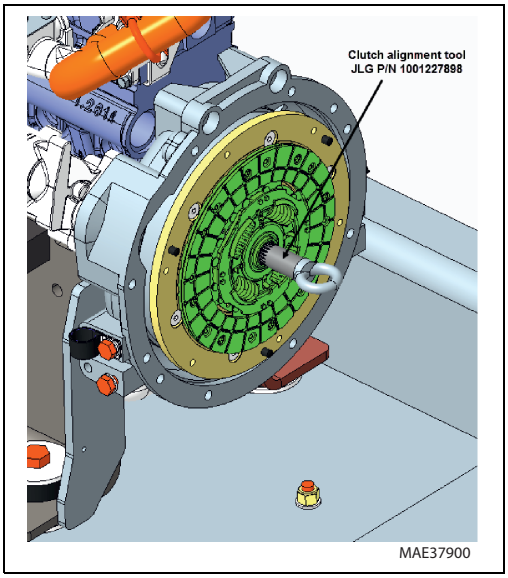
NOTE: *To properly install the clutch, JLG service tool PN 1001227898 must be used.*

NOTE: *Don't use power or air tools during this install.*

1. Apply blue JLG Threadlocker PN 0100011 to all bolts and start all bolts ½ to 1 turn.
2. Center the clutch disc in the pressure plate using JLG PN 1001227898.

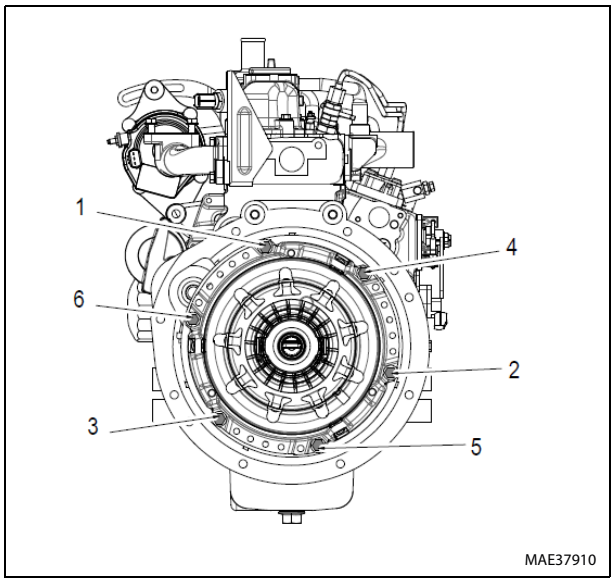
NOTE: *Disc orientation is critical. The hub must face outwards, Away from engine.*


MAE37890



MAE37900

3. Using an alternating star pattern (1-6) work around the pressure plate, turning each bolt no more than 3 turns before turning the other bolts to a similar level.

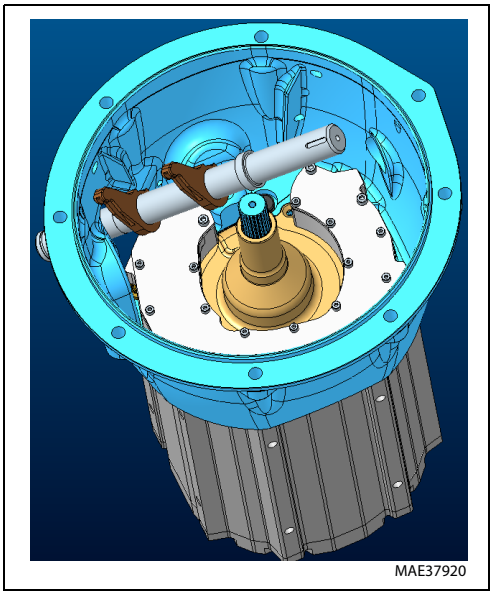


MAE37910

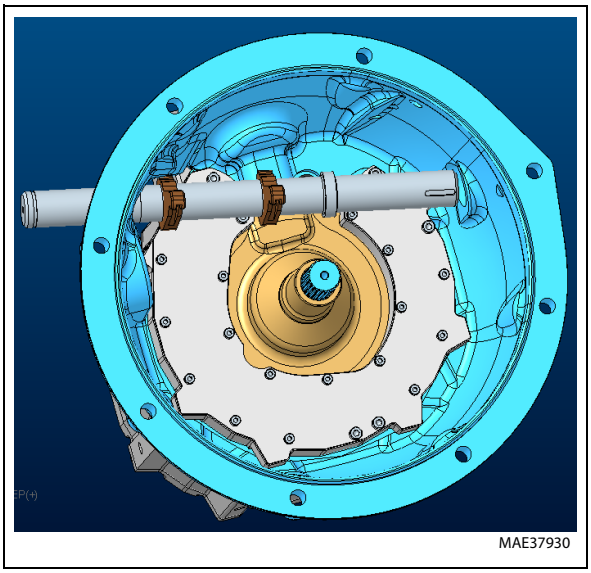
4. Continue step 3 until the pressure plate contacts the adapter plate at all 6 bolt locations.
5. Using the same pattern, torque each bolt to 35 - 25 Nm.

Release Shaft

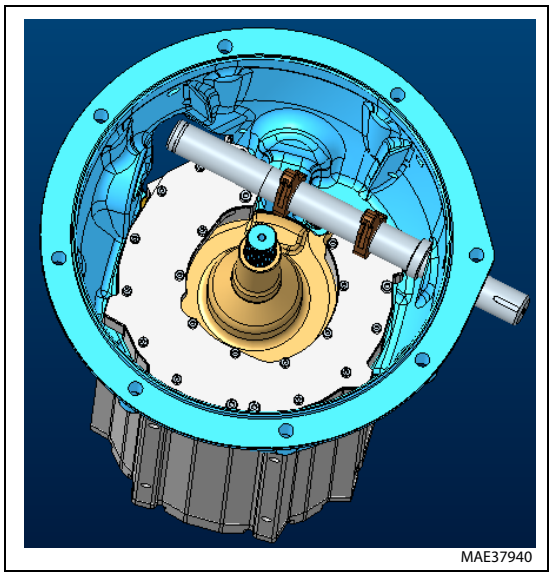
1. Insert shaft from the top of the IMG and through the opening on the side.


MAE37920

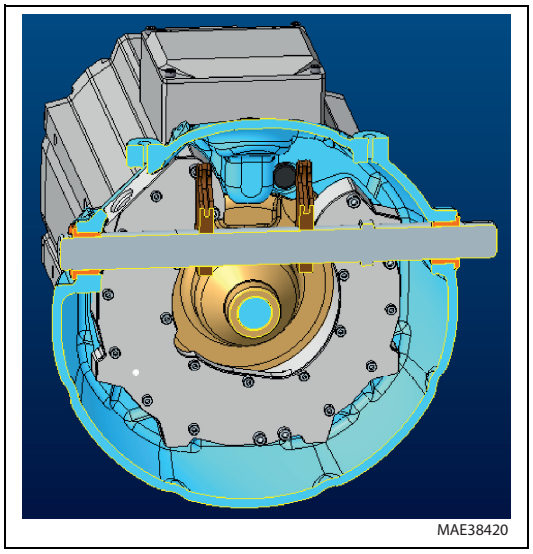
2. Align the shaft with the right side bore.


MAE37930

3. Insert shaft further into bearing bore at right.


MAE37940

4. Install bronze bearings, retaining clip on one end and actuation lever on the other.


MAE38420

3.25 CLUTCH INSTALLATION

1. Place the clutch against the adapter plate and start all retaining bolts approximately 1/2 turn.
2. Center the friction disk (clutch) in the pressure plate using the alignment tool.
3. Using the pattern shown in Figure 3-66., Clutch Plate Torque Sequence, work back and forth around the clutch turning each bolt not more than 3 turns before turning the other bolts to a similar level. Stop when the pressure plate contacts the flywheel adapter. Do not apply final torque.

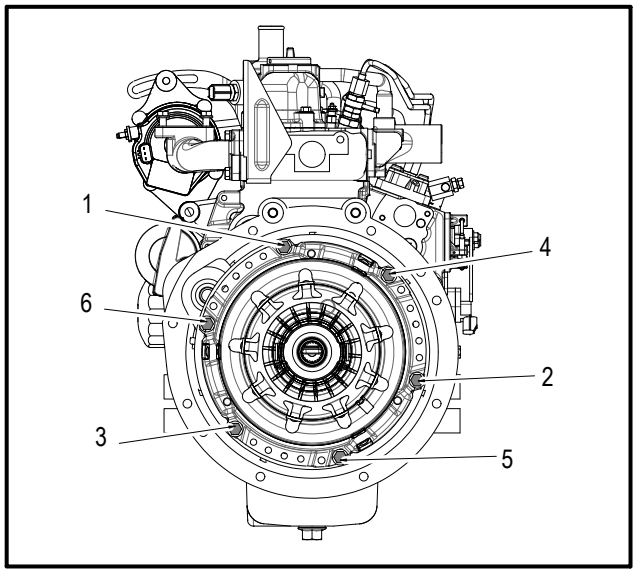


Figure 3-66. Clutch Plate Torque Sequence

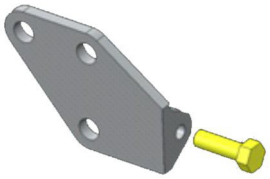
4. Using the same torque pattern, torque each bolt to 22 ±3.5 ft.lbs. (30 ± 5 Nm).

3.26 CLUTCH LINEAR ACTUATOR/THROWOUT BEARING POSITIONING INSTALLATION PROCEDURE

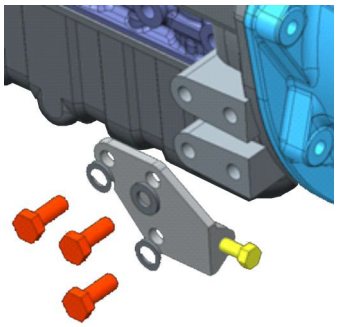
NOTE: *To properly position the clutch actuator/throwout bearing, the Service Kit (JLG PN 1001227147) must be used.*

NOTE: *If performing maintenance on machine and reusing linear actuator, before starting work on replacing clutch, disconnect forward pin, and allow linear actuator to hang from rear pin. Then with the machine on, turn machine to "Electric Mode." This will fully extend the linear actuator as required for steps 6 thru10.*

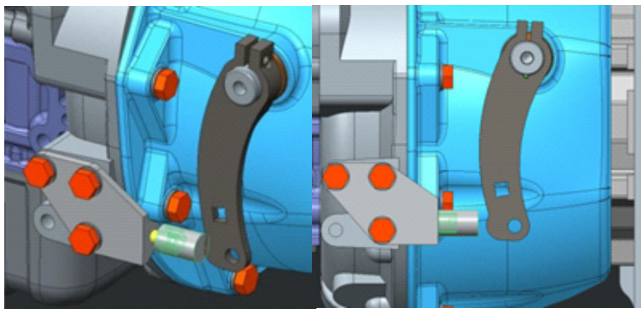
1. Install the adjustment bolt into the Clutch Gauge bracket, about halfway. The bolt will be adjusted later.



2. Assemble Clutch Gauge bracket onto outboard side of flywheel housing using the 3 bolts and washers provide with the kit.



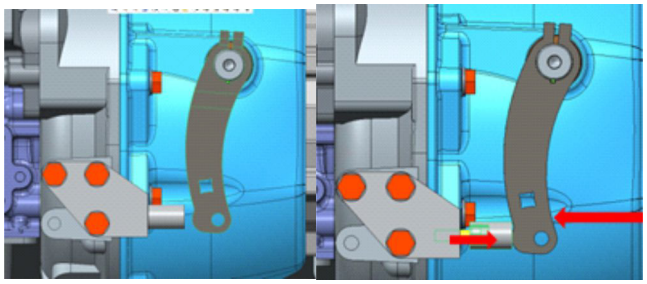
3. Assemble Clutch Gauge onto the end of the bolt. Rotate Clutch Gauge and bolt until Gauge is contacting the clutch gauge bracket.



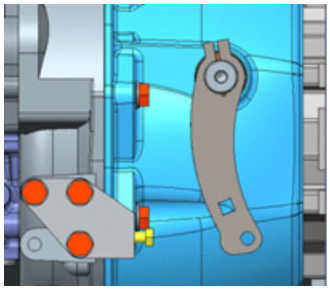
4. Lightly pull the clutch actuation lever arm toward the engine, until resistance is felt or it stops. This should not require excessive force.

NOTE: *The resistance or stop is the throwout bearing now lightly resting upon the spring of the pressure plate portion of the clutch inside the housing.*

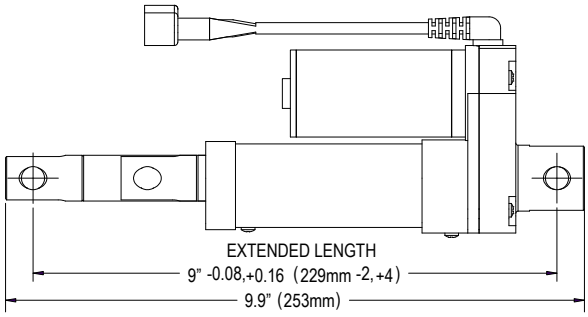
While holding clutch actuation lever in the position from the previous step, unscrew the bolt/Clutch Gauge until it lightly contacts the clutch actuation lever.



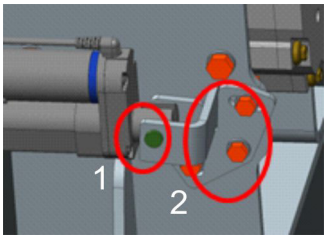
5. Now that the Clutch Gauge has set the bolt head height, release the clutch actuation lever and carefully remove the Clutch Gauge off of the bolt head, but leave the bolt position where it was set by the Gauge.



6. Before the continuing, ensure the Linear actuator is in the fully extended position as shown below.

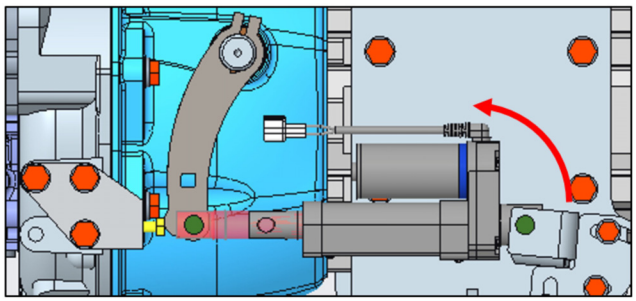


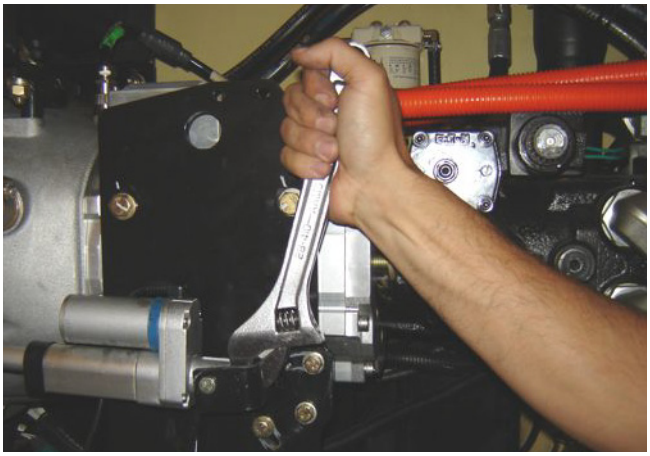
7. Pin the rear mounting hole of linear actuator to rear mounting bracket as shown by position 1 below. Three bolts in rear mounting bracket should be installed loosely to allow for movement of the bracket as shown by position 2 below.



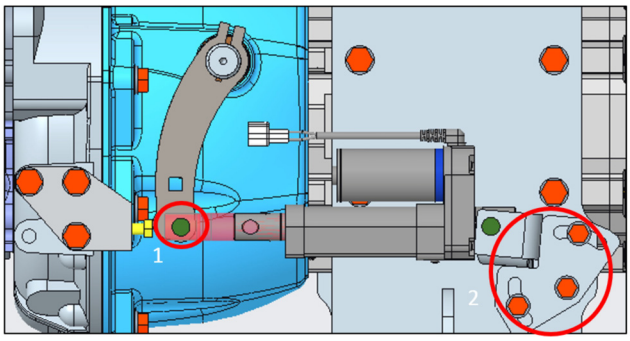
NOTE: *Steps 8 & 9 may require two people.*

8. Next using a wrench rotate the rear mounting bracket toward the engine until the lever arm makes contact with the bolt head as shown below. This requires some force to achieve, as it is compressing the pressure plate to set the full throwout bearing stroke possible by the linear actuator.

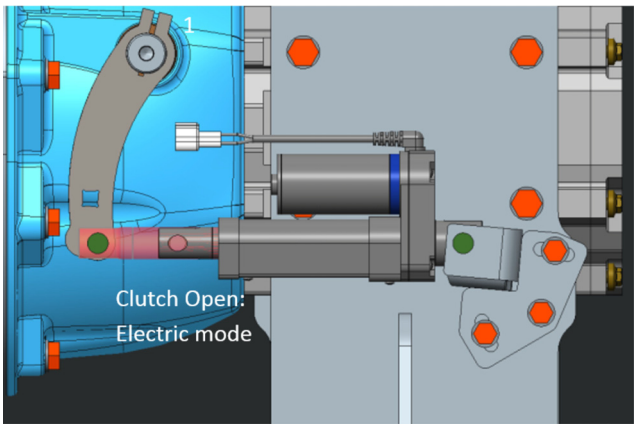




9. While the lever arm is still touching the bolt head from the previous step, assemble the linear actuator to the clutch actuation lever as shown below. Adjust rear linear actuator mounting bracket as needed to allow the pin hole to line up correctly. After hole is pinned, tighten down the three linear actuator mounting bracket bolts to set the position as shown below.



10. Remove the Clutch Gauge bracket from flywheel housing. Installation is now complete.



NOTE: *After the clutch linear actuator/throwout bearing position installation procedure is completed, the clutch will be in the "OPEN" state, corresponding to the Electric vehicle mode. The clutch will need to be cycled (linear actuator pulled in) to activate Hybrid mode.*

3.27 COUNTERWEIGHT

If the counterweight has been removed, ensure the retaining bolts are torqued to the proper value as shown in Figure 3-67., Counterweight Bolt Torque.

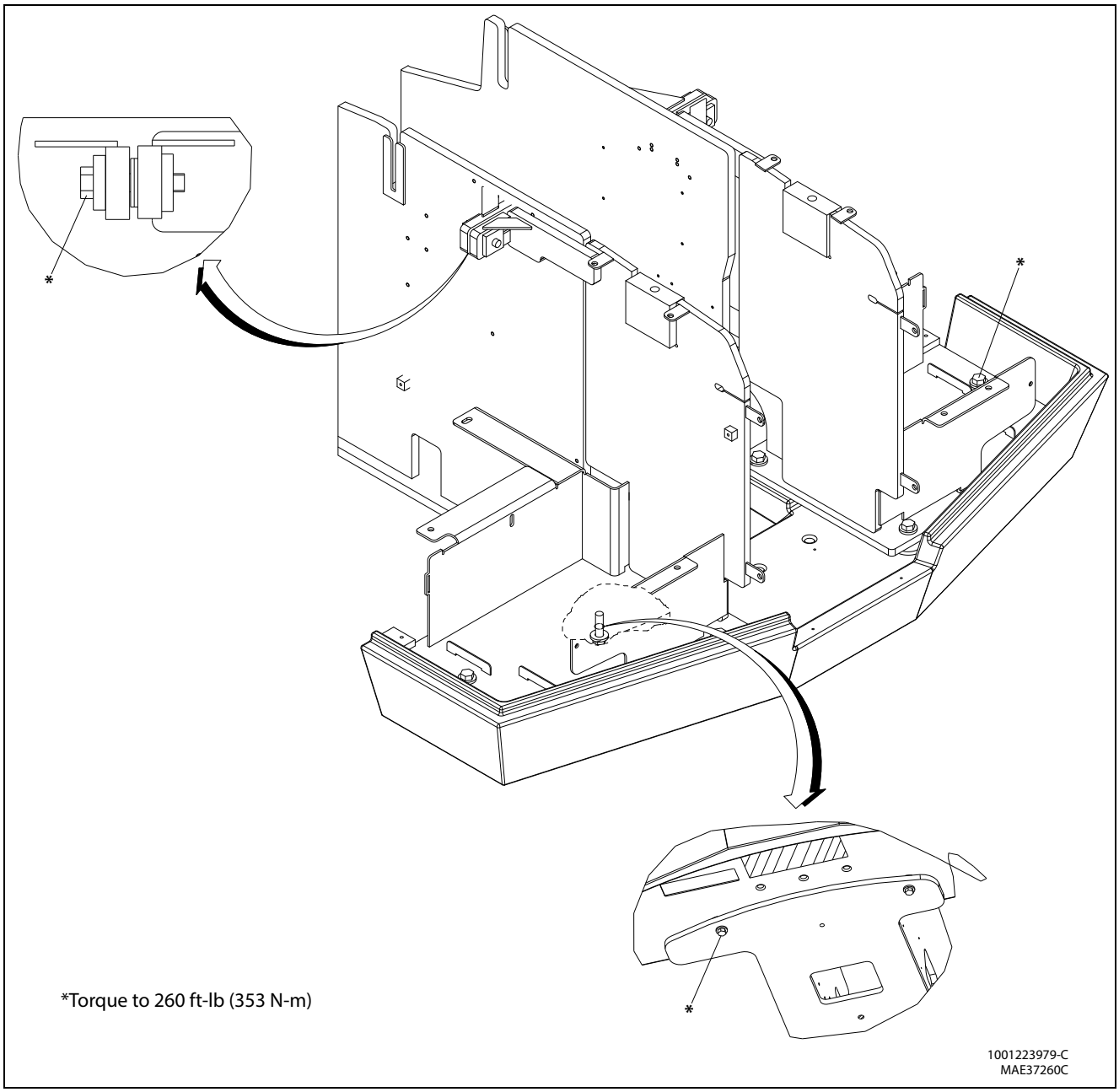


Figure 3-67. Counterweight Bolt Torque

SECTION 4. BOOM & PLATFORM

4.1 BOOM SYSTEMS

Switch Systems

The Capacity Indicator, Transport Position Interlock, and Above Elevation Systems use normally closed electrical switches with "positive opening" contacts.

Above Elevation (Above Horizontal) Cutout System

The above elevation cutout system uses a main boom angle switch and a tower boom angle switch to sense when the boom is raised substantially above horizontal. The articulated jib of the H800AJ may be in any position.

When above elevation the machine will be put into creep speed mode and will activate the Drive Speed Cutback. With the exception of the speed cutback, this is a warning system only. The machine will continue to function. The operator is responsible to prevent the machine from attaining an unstable position.

Beyond Transport Position - Drive Speed Cutback System

When above elevation, as described in the Above Elevation Cutout System, the engine speed is automatically restricted from attaining the high engine speed and the drive motors are automatically restricted to their maximum displacement position (slow speed). See Drive System for more details on the drive speeds and see the Chassis Tilt Indicator System in Section 3 for interaction with the tilt sensor.

Drive/Steer – Boom Function Interlock System (CE Only)

The transport position interlock system uses the Above Elevation (Above Horizontal) Cutout System switches with the addition of a main boom telescope switch to sense when the boom is out of the transport (nearly stowed) position. The jib of the machine may be in any position. All controls are simultaneously functional when the booms are within the transport position as on the standard machine. When the boom is beyond the transport position, the control functions are interlocked to prevent simultaneous operation of any boom function with drive/steer. The first function set to be operated in this mode, becomes the master function set. In other words, while operating drive/steer functions the boom functions are inoperable. Likewise, while operating boom functions drive/steer functions are inoperable.

Transport Position Interlock System (CE only)

The transport position interlock system uses the "above elevation cutout system" switches with the addition of a main boom telescope switch to sense when the boom is out of the transport (nearly stowed) position. The articulated jib of the 800AJ may be in any position All controls are simultaneously functional when the booms are within the transport position as on the standard machine. When the booms are outside of the transport position, the control functions are interlocked to prevent simultaneous operation of any boom function with drive/steer. The first function set to be operated in this mode, becomes the master function set. In other words, while operating drive/steer functions the boom functions are inoperable. Likewise, while operating boom functions drive/steer functions are inoperable. In addition to being an interlock, this system also disallows high speed operation while the booms are beyond the transport position. While in this position, the machine will respond in the same way as described in the Above Elevation Cutout System. As described in the Positive Opening Switch System, the "safe" condition of the machine is when the use of multiple function operation is allowed (at low boom angles and short boom lengths).

Platform Control Enable System



The platform controls make use of a time dependent enable circuit to limit the time availability of live or enabled controls. When the footswitch is depressed, the controls are enabled and the operator has 7 seconds to operate any control. The controls will remain enabled as long as the operator continues to use any function and will remain enabled 7 seconds after the last function has been used. While the controls are live, the enabled light will be illuminated in the platform display panel. When the time limit has been reached, the enabled light will turn off and the controls will be disabled. To continue use of the machine the controls must be re-enabled to start the timer system over again. This is done by releasing all functions, then releasing and re-depressing the footswitch.

Function Speed Control System

The platform controls for the platform rotate, platform level, jib lift, telescope, tower telescope, and tower lift functions are controlled through a common variable speed control knob. This knob provides a common control signal allowing a smooth ramp up and controlled maximum output speed. Each function has its own personality settings allowing the characteristics of each function to be modified using the standard analyzer. Not all functions will respond the same to the changes in the function speed knob position.

Platform

The standard platform utilizes a hinged swing gate for ease of entry and 3/4" expanded metal floor mesh. The optional drop bar gate platform utilizes 1/2" expanded metal floor mesh.

Main Lift End Stroke Dampening System

The main boom lift cylinder is constructed in a way that causes the lift cylinder oil flow to be restricted by an orifice while raising the boom within 5 degrees of maximum elevation. This restriction slows the boom lift speed while raising the boom. The oil flow is not restricted while lowering the boom and therefor the speed is not altered.

QuikStick Lift System

The main boom lift cylinder is pinned between the main boom and the nose of the tower fly boom. This causes an interdependency between the tower and main boom. The main boom changes angle when the tower is raised or lowered. In addition, the maximum angle achieved by the main boom is dependent on the position of the tower boom. When the tower boom is stowed, the main boom's maximum angle is 25 degrees. When the tower boom is fully raised, the main boom's maximum angle is 70 degrees. The main boom can be also be raised or lowered independent of the tower boom within the limits of the boom rests and main boom lift cylinder stroke to a minimum angle of -35 degrees. This allows the platform to reach the ground at any position of the tower boom.

Tower Boom Sequence Valve System

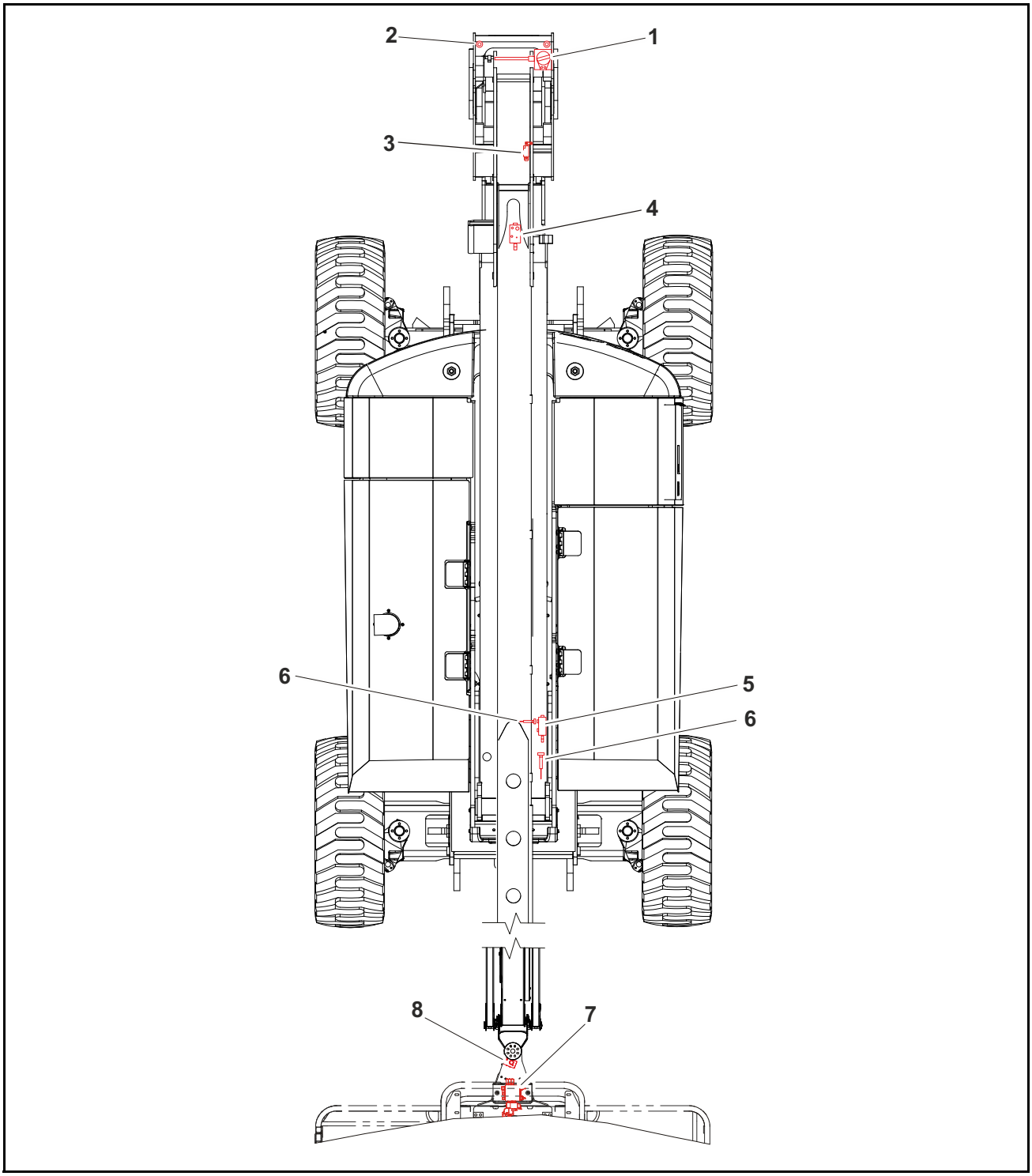
The two section tower boom uses two hydraulic lockout valves to prevent the boom from being telescoped until the boom is fully raised and to prevent the tower boom from being lowered until it is fully retracted. Until the valve mounted in the turntable is actuated by the cam on the tower lift cylinder barrel (at max tower angle), the tower telescope oil flow is blocked preventing the tower from telescoping out. Similarly, until the valve mounted on the tower fly boom is actuated by the tower base boom, the tower lift cylinder oil flow is blocked preventing the tower from lifting down. This is an automatic system.

Upright Level Override System

As the tower boom is raised the upright is leveled by a master-slave cylinder arrangement between the tower lift cylinder and the upright level cylinder. The upright can become out of level in two directions, towards the platform or away from the platform. If the upright is out of level towards the platform, it will automatically correct itself when the tower is lowered by dumping oil from the upright level cylinder over a relief valve mounted in the upright until the tower lift cylinder reaches the end of its stroke. If the upright is out of level away from the platform, the tower lift cylinder is fully retracted with stroke remaining in the upright level cylinder. To correct this condition a re-leveling valve (with a red pull knob) allows the tower to be raised (from ground control) without extending the upright level cylinder. The upright will then correct itself when the tower is lowered to the stowed position.

Ground Control Keyswitch System

The ground control keyswitch is used for selecting the active control of the machine between the platform or ground control stations and as another shut off switch for machine power. On the standard keyswitch, the key is removable only in the off position. This allows the ground control station to have ultimate priority over the platform control.



1. UMS Sensor
2. Main Boom Angle Switch
3. Tower Boom Angle Switch
4. Tower Telescope Plunger Valve
5. Tower Lift Plunger Valve
6. Proximity Switch
7. Rotator Valve
8. Platform Control Valve

Figure 4-1. Boom Component Location

4.2 MAIN BOOM ASSEMBLY

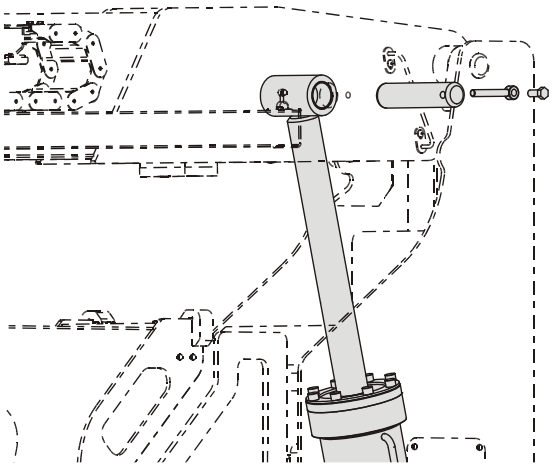
Removal

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

NOTICE

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

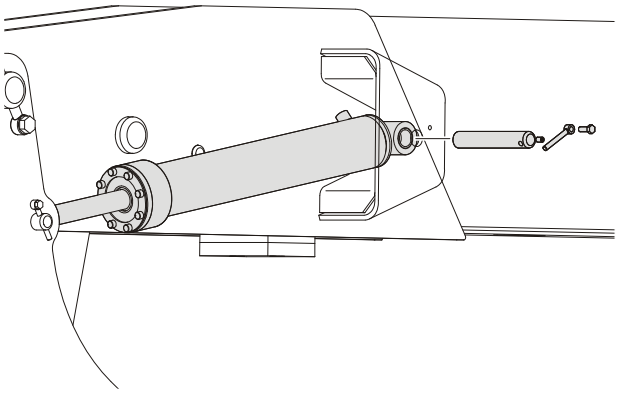
2. Tag and disconnect hydraulic lines from telescope cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Using a suitable brass drift and hammer, remove hardware securing the main boom lift cylinder rod end pin to the base boom section. Remove the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



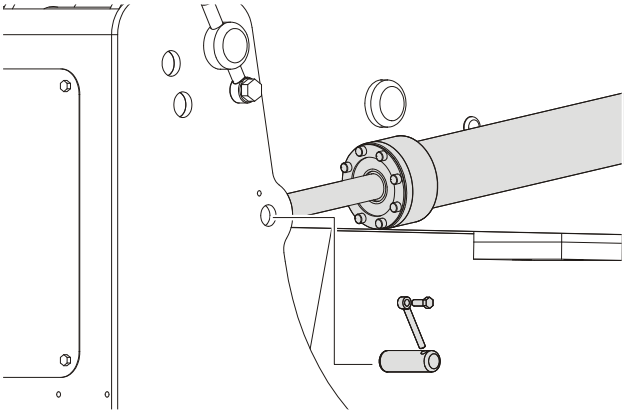
4. Remove the Master Cylinder as follows:
   a. Using an adequate supporting device, support the master cylinder so it doesn't fall when the retaining pins are removed.

NOTE: *The master cylinder weighs approximately 63 lbs. (28.6 kg).*

   b. Tag and disconnect hydraulic lines from Master Cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
   c. Remove the bolt and keeper pin securing the master cylinder barrel end pin to the base boom section. Next, install a 3/8-16 UNC threaded lifting eye into the threaded hole of the pin and pull pin out.

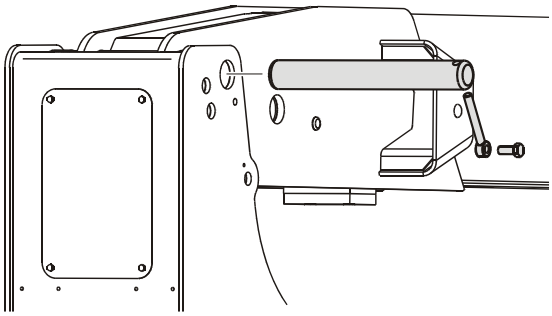


   d. Remove the bolt and keeper pin securing the master cylinder rod end pin to the upright. Remove the pin.



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

5. Remove the bolt and keeper pin securing the main boom to the upright. Using a suitable brass drift and hammer.



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

NOTE: *The main boom alone weighs approximately 2226 lbs. (1010 kg). Including the slave cylinder, rotator, and platform support the assembly weighs approximately 3185 lbs. (1445 kg).*

Disassembly

1. Remove hardware securing telescope cylinder to back end of the base boom section.
2. Remove hardware securing the powertrack to fly boom.
3. Remove hardware which secures the wear pads to the base boom section; remove the wear pads from the top, sides and bottom of the base boom section.
4. Using suitable lifting device, remove fly boom assembly from base section.
5. Using a suitable brass drift and hammer remove the telescope cylinder pin from fly boom section.
6. Pull the telescope cylinder partially from aft end of the fly boom section; secure the cylinder with a suitable sling and lifting device at approximately the center of gravity.
7. Carefully remove the telescope cylinder and place telescope cylinder on a suitable trestle.

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

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

Inspection

NOTE: *When inspecting pins and bearings, refer to Section 2, Pins and Composite Bearing Repair Guidelines.*

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

Assembly

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

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

NOTICE

WHEN ASSEMBLING BOOM SECTIONS, ENSURE THAT THE BOOM SLIDING TRAJECTORIES HAVE BEEN CLEARED OF CHAINS, TOOLS, AND OTHER OBSTRUCTIONS.

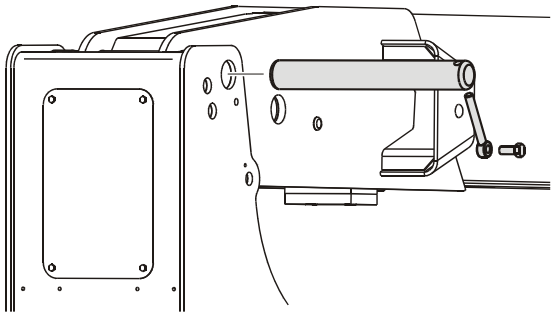
3. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the fly boom section.
4. Slide telescope cylinder into the aft end of fly boom section. Align attachment holes in fly boom section with hole in rod end of telescope cylinder.
5. Install telescope cylinder pin and secure with mounting hardware.
6. Secure the sling and lifting device at the fly boom assembly approximate center of gravity.
7. Slide fly boom assembly into the base boom section. Shim boom, if necessary, for a total of 1/32 inch (metric equivalent) clearance.
8. Install wear pads into the forward position of the base boom section. Shim boom, if necessary, for a total of 1/32 inch (metric equivalent) clearance.
9. Align the cylinder with the slots at aft end of base boom section, then secure cylinder with mounting hardware.

Installation

1. Using all applicable safety precautions, carefully lift boom assembly to align the pivot holes in the boom with those of the upright.

NOTE: *The main boom alone weighs approximately 2226 lbs. (1010 kg). Including the slave cylinder, rotator, and platform support the assembly weighs approximately 3185 lbs. (1445 kg).*

2. Using a suitable brass drift and hammer, install the pivot pin into the upright. Install the bolt and keeper pin securing the main boom pivot pin to the upright.

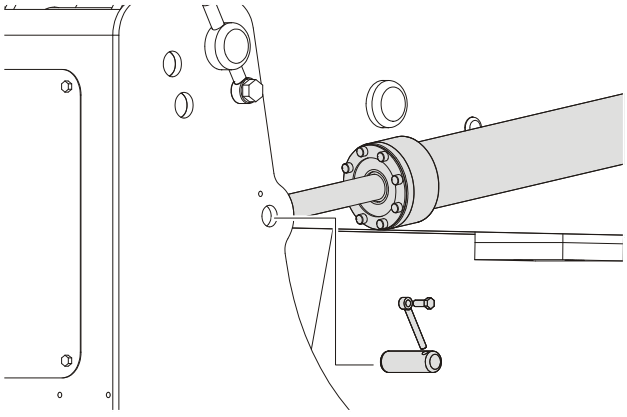


3. Install the Master Cylinder as follows:

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

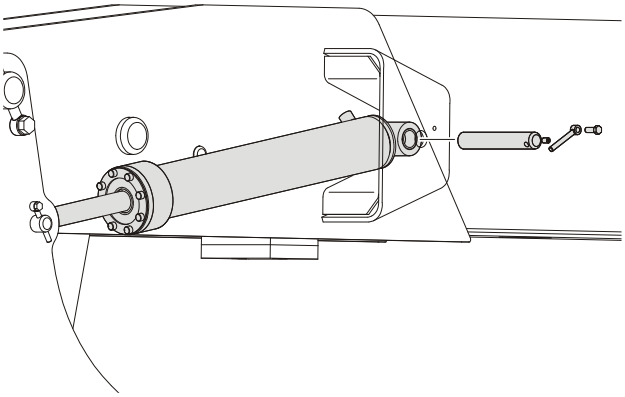
NOTE: *The master cylinder weighs approximately 63 lbs. (28.6 kg).*

   b. Install the master cylinder rod end pin. Install the bolt and keeper pin securing the master cylinder rod end pin to the upright.



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

   c. Install the barrel end retaining pin. Install the bolt and keeper pin securing the master cylinder barrel end pin to the base boom section.



   d. Connect hydraulic lines to the master cylinder as tagged during removal.

4.3 UPRIGHT

Removal

NOTICE

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

1. Remove the main boom assembly. Refer to Section 4.6, UMS Troubleshooting and Fault Messages.
2. Tag and disconnect hydraulic lines to the main boom lift cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove mounting hardware from main boom lift Cylinder barrel end. Using a suitable brass drift and hammer, remove pin (1) from Upright and remove Main Boom Lift Cylinder.

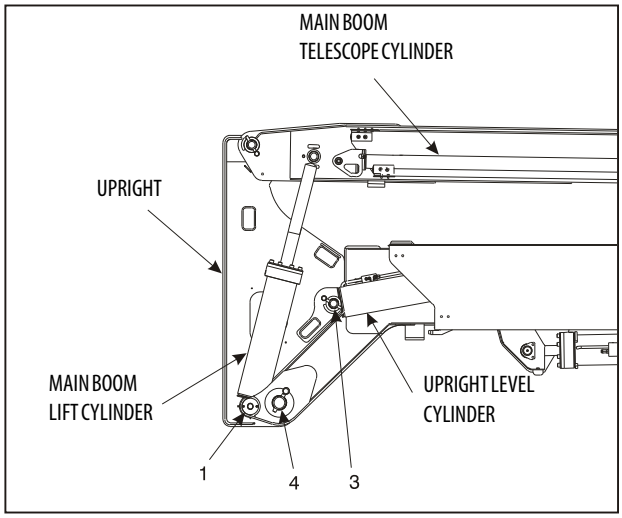


Figure 4-2. Location of Components - Upright

4. Disconnect wiring harness to horizontal limit switch.
5. Disconnect the Upright Level Cylinder as follows:
   a. Using a suitable lifting device, support the Upright.
   b. Remove mounting hardware securing hose bracket in upright, and remove the hose bracket.
   c. Remove mounting hardware securing the upright level cylinder to the upright. Using a suitable brass drift and hammer, remove pin (3) from upright and disconnect the upright level cylinder from the upright.
6. Remove mounting hardware from the Upright Pivot Pin using a suitable brass drift and hammer. Remove pin (4) from tower boom assembly and remove the upright from the machine.

NOTE: *Steps 7 thru 10 are only necessary if the upright level cylinder is to be removed.*

7. With upright removed, override tower telescope limit switch and extend the tower boom to gain access to the upright level cylinder rod end attach pin.
8. Tag and disconnect hydraulic lines to the upright lift cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
9. Using an overhead crane or suitable lifting device, support the upright lift cylinder, remove mounting hardware from the barrel end of the upright lift cylinder and remove the pin.
10. Carefully remove the upright lift cylinder and place on a suitable work surface.

Installation

NOTE: *Steps 1 thru 4 are only necessary if the upright level cylinder is to be removed.*

1. Using a suitable lifting device, carefully install the upright lift cylinder into place in the tower boom.
2. Install the pin and mounting hardware at the barrel end of the upright lift cylinder.
3. Connect the hydraulic lines to the upright lift cylinder as tagged during removal.
4. Override the tower telescope limit switch and retract the tower boom.
5. Using an adequate lifting device, install the upright into position. Install pin (4) into the tower boom assembly and secure it in place with the mounting hardware.
6. Connect the Upright Level Cylinder as follows:
   a. Align the holes in the cylinder and upright for pin (3), and install the pin into the upright and connect the upright level cylinder to the upright. Install the mounting hardware securing the pin.
   b. Install the hose bracket and secure in place with the mounting hardware.
7. Connect the wiring harness to horizontal limit switch.
8. Align the holes in the main boom lift cylinder and upright for pin (1) and install the pin. Secure the pin in place with the mounting hardware.
9. Connect the hydraulic lines to the main boom lift cylinder as tagged during removal.
10. Install the main boom. Refer to Section 4.6, UMS Troubleshooting and Fault Messages.

4.4 TOWER BOOM ASSEMBLY

Removal

NOTICE

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

1. Remove the main boom assembly. Refer to Section 4.6, UMS Troubleshooting and Fault Messages.
2. Using an overhead crane or suitable lifting device, support the entire Tower Boom Assembly and separately support the tower lift cylinder.
3. Remove mounting hardware from tower lift cylinder rod end. with a brass drift and hammer, remove the tower Lift cylinder Pin disconnecting the tower lift cylinder.
4. Remove mounting hardware from the tower boom pivot pin. Using a suitable brass drift and hammer, remove pin (1) from turntable assembly.
5. Using all applicable safety precautions, carefully lift the Tower Boom Assembly clear of turntable and lower to ground or a suitable supported work surface.
6. Remove mounting hardware from the upright leveling cylinder rod end. with a brass drift and hammer, remove the pin, disconnecting the upright cylinder. Remove with suitable lifting device.

NOTE: *Using a suitable lifting device, support the upright.*

7. Remove the Tower Fly as follows:
   a. Mark all hoses and wiring harnesses at bracket on rear end of tower base boom for future assembly. Remove hoses and wiring from tower boom Powertrack.
   b. Remove mounting hardware that secures the Powertrack to tower base boom and remove the Powertrack.
   c. Remove mounting hardware from tower boom telescope cylinder barrel and rod end.
   d. Slide the telescope cylinder out of the base boom, support with an overhead crane or suitable lifting device.
   e. Remove mounting hardware that secures the wear pads to the front of tower base boom section; Remove the wear pads from the top sides and bottom of the tower base boom.
   f. Using an overhead crane or suitable lifting device, remove the fly section.

Inspection

NOTE: *Refer to Section 2, Pins and Composite Bearing Repair Guidelines.*

1. Inspect tower boom pivot pin for wear scoring, tapering, and ovality, or other damage. Replace pins as necessary.
2. Inspect tower boom pivot attach points for scoring, tapering, and ovality, or other damage. Replace pins as necessary.

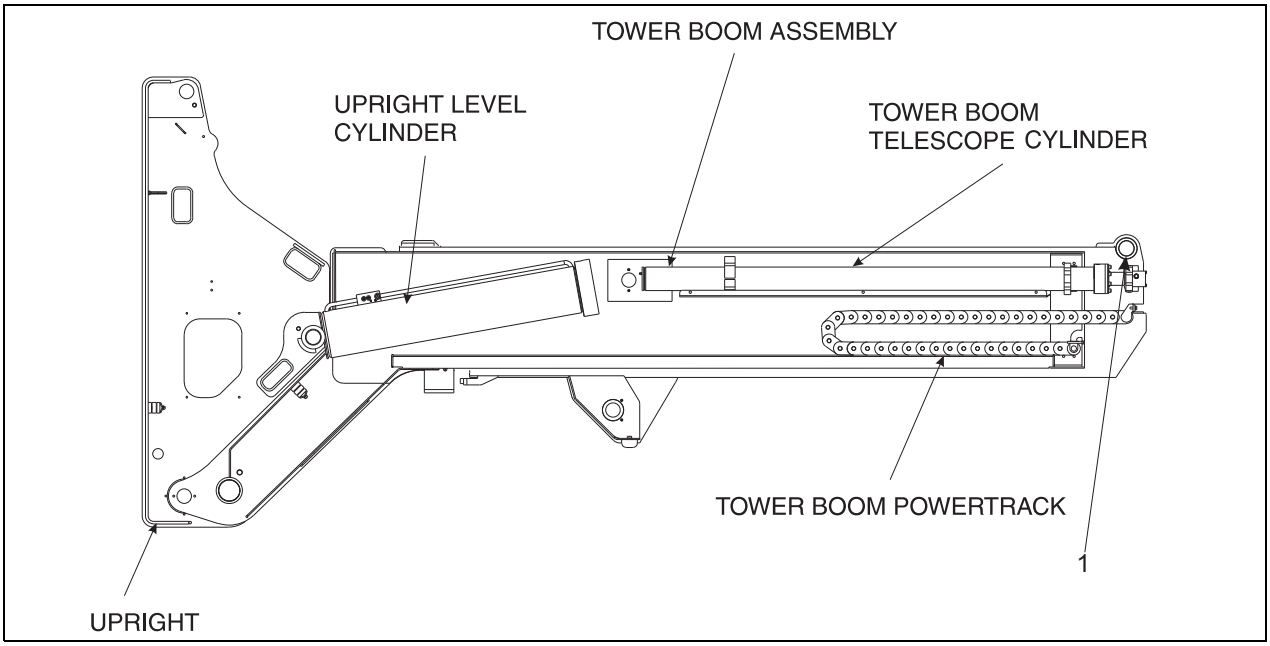


Figure 4-3. Location of Components - Tower Boom Powertrack

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

Assembly

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

1. Measure inside dimensions of the tower base section to determine the number of shims required for proper fit.
2. Install side, top, bottom wear pads to the aft end of tower fly section; shim evenly to the measurements of the inside of the base boom section.

NOTICE

WHEN ASSEMBLING TOWER BOOM SECTIONS, ENSURE THAT THE BOOM SLIDING TRAJECTORIES HAVE BEEN CLEARED OF CHAINS, TOOLS, AND OTHER OBSTRUCTIONS.

3. Align upright leveling cylinder with attach holes in tower fly boom. Using a soft head mallet, install the cylinder pin into tower fly boom and secure with mounting hardware.
4. Secure the sling and lifting device at the tower fly boom assembly's approximate center of gravity.
5. Slide tower fly boom assembly into the tower base boom section, for a total of 1/32 inch (metric equivalent) clearance.
6. Install wear pads into the forward position of the tower base boom section. Shim boom, if necessary, for a total of 1/32 inch (metric equivalent) clearance.
7. Align the telescope cylinder with the slots at the aft end of tower base boom section, then secure cylinder with mounting hardware.
8. Attach internal Powertrack to tower base boom at bottom only and extended out of boom that the Powertrack links are opened at top.
9. Attach hoses and wiring harnesses at front end of base boom and route thru the Powertrack. Secure hoses and wiring harnesses with hose brackets.
10. Roll the Powertrack back into the base boom section and attach loose end of the Powertrack to the inside top of the fly boom section.

Installation

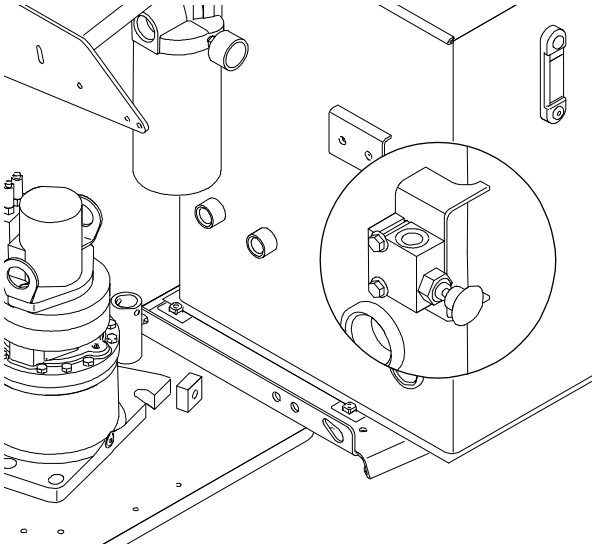
1. Using a suitable lifting device, position boom assembly on turntable so that the pivot holes in both boom and turntable are aligned.
2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on turntable.
3. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.
4. Connect all wiring connectors to the correct connectors.
5. Connect all hydraulic lines of boom assembly.
6. Using all applicable safety precautions, operate lifting device in order to position boom lift cylinder so that holes in the cylinder rod end and boom structure are aligned. Insert the lift cylinder pin, ensuring that location of hole in pin is aligned with attach point on boom.
7. Using all applicable safety precautions, operate from the lower controls and raise and extend boom fully, noting the performance of the extension cycle.
8. Retract and lower boom, noting the performance of the retraction cycle.

Tower Out of Sync

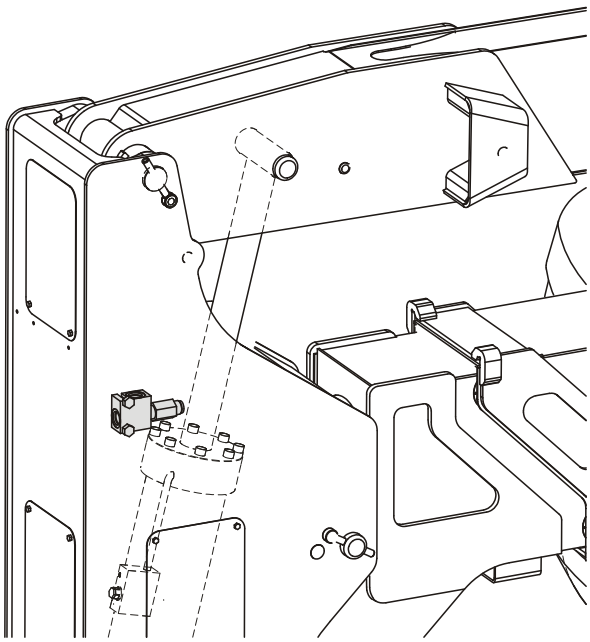
Tower is out of sync backwards, upright leaning toward the platform.

When towering down the upright cylinder bottoms out before the lower lift. Problems that could cause this are:

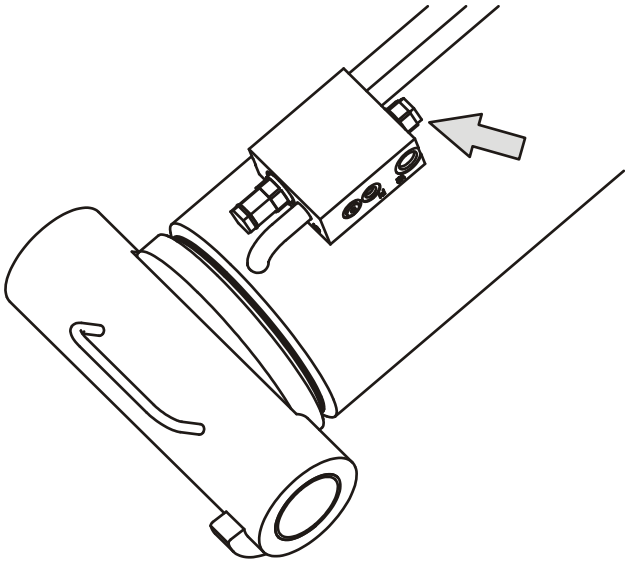
1. The releveling valve (red knob on the oil tank P/N: 4640866), this is a poppet valve that could be leaking fluid out of the closed loop. Manually opening the valve and flushing it can eliminate any contaminate on the seat. The seat could also be damaged, so replacing the cartridge might be necessary.



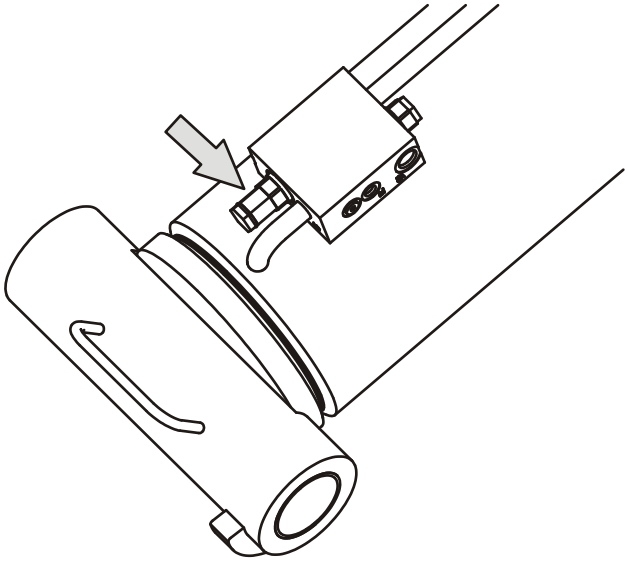
2. A relief valve is located in the upright. This relief valve could be leaking backwards out of the loop. Replace the cartridge. They are pre-set.



3. The counter/balance valve in the piston end of the upright level cylinder. There could be a leak path from the valve port to the pilot port.
   Replace the counter/balance valve.



4. The counter/balance valve in the rod end of the lower lift cylinder. There could be a leak path from the valve port to the pilot port. Replace the counter/balance valve.

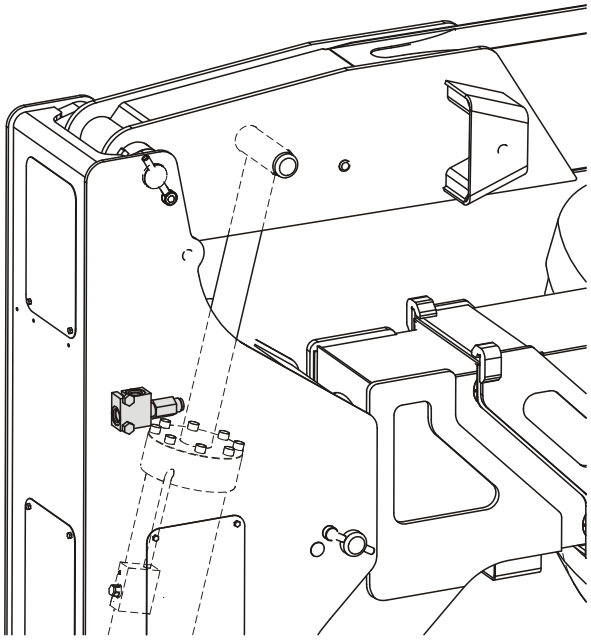


5. The packing on either the upright or lower cylinder can cause this. Do cylinder tests to determine if either cylinder needs new packing.

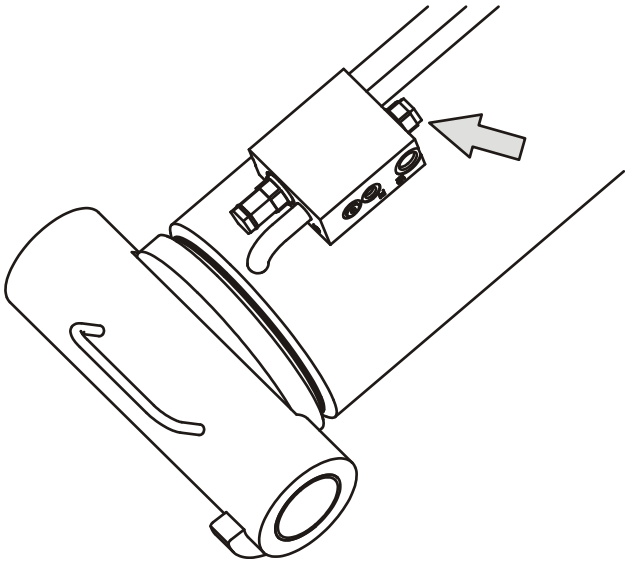
Tower is out of sync forwards, upright leaning toward the steer axle.

When towering down, the lower lift cylinder bottoms out before the upright level cylinder. This is caused by too much oil between the two cylinders. Problems that could cause this are:

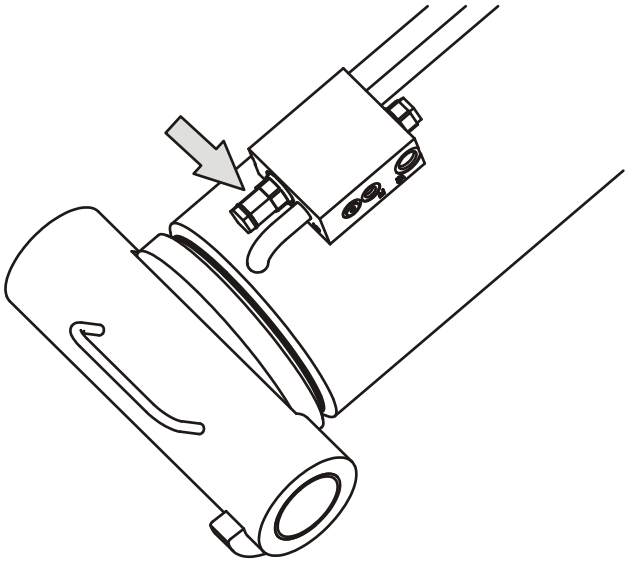
1. The relief valve located in the upright (P/N: 4640929). If this valve is set too low or has contaminate in it causing it to leak prematurely, when lifting down oil can pass through it causing the volume to grow between the cylinders. Flush the valve out and reinstall it, or replace the cartridge. The cartridge pressure is pre-set so no adjustment can be made.



2. The counterbalance valve in the piston end of the upright level cylinder. There could be a leak path from the pilot port to the valve port. Replace the counterbalance valve.



3. The counterbalance valve in the rod end of the lower lift cylinder. There could be a leak path from the pilot port to the valve port. Replace the counterbalance valve.



4. The packing on the lower lift cylinder can cause this. Do a cylinder test to check this out. Refer to Cylinder Drift Test in Section 2.

4.5 UPRIGHT MONITORING SYSTEM

The UMS provides a visual and audible warning to the operator when the limits of the upright assembly alignment have been reached. In addition, the UMS will not allow the tower boom to be lowered when the upright assembly is misaligned in a direction oriented away from the work platform.

Re-Synchronizing Upright

A pull type control valve allows the operator to adjust the upright level cylinder if the upright is not 90° (vertical) relative to the chassis (Refer to Figure 4-4.). This valve is located in the tank compartment area.

Perform the following steps with the aid of an assistant:

1. Turn the key switch to the ground control position.
2. Start the engine.
3. Pull and hold the red relevel knob located next to the main control valve. Refer to (See Figure 4-4.)
4. Raise the tower boom 6 feet (1.8 m).
5. Release the red relevel knob.
6. Lower the tower boom fully and continue to hold down the switch to Tower Down for an additional 20 seconds.
7. Repeat steps 3 thru 6 as necessary until the upright is 90° (vertical) relative to the chassis.

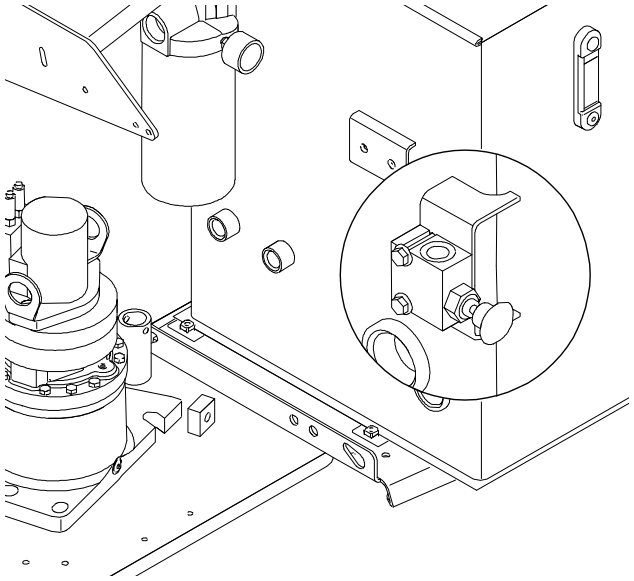


Figure 4-4. Releveling Valve

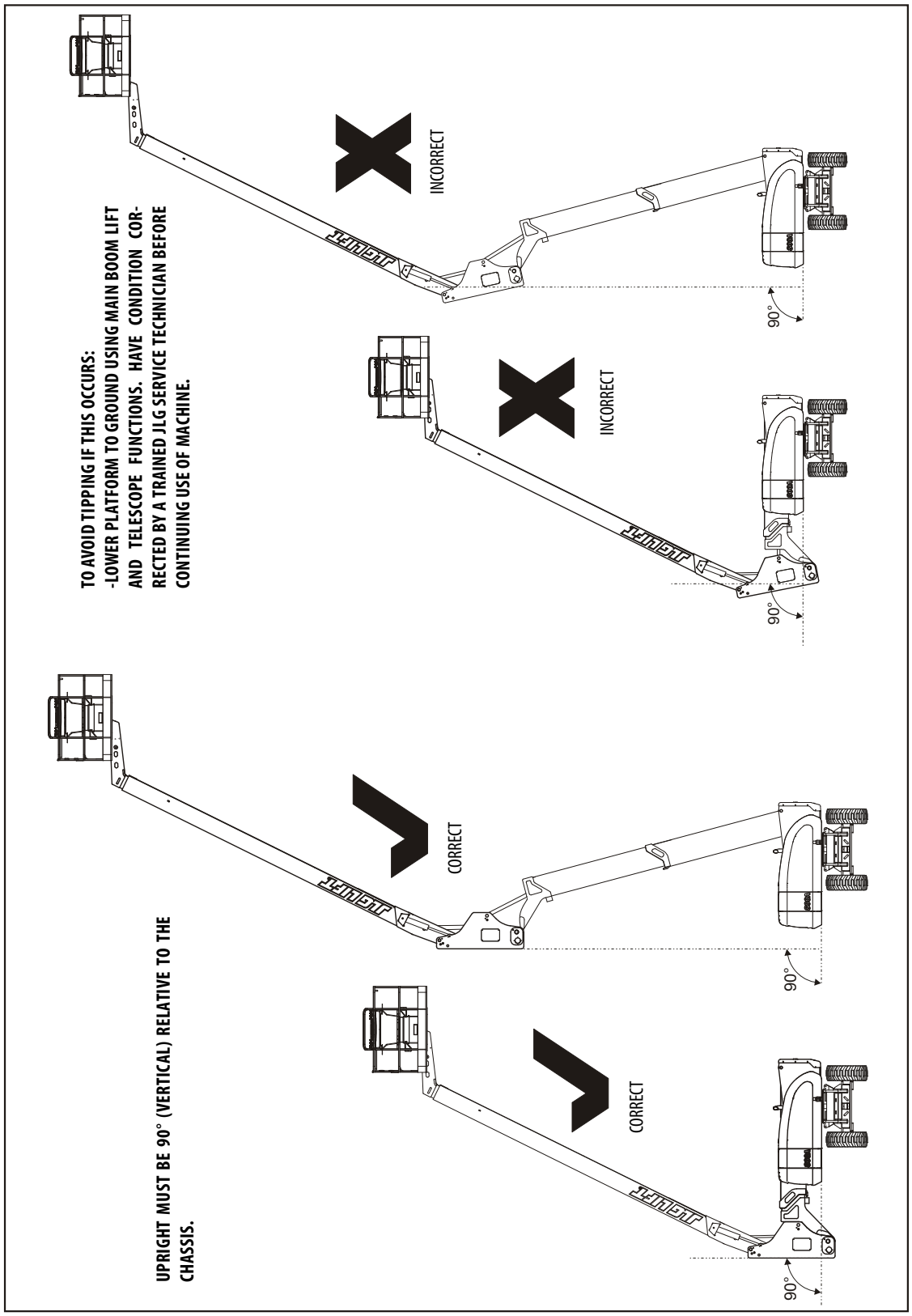


Figure 4-5. Boom Upright Positioning

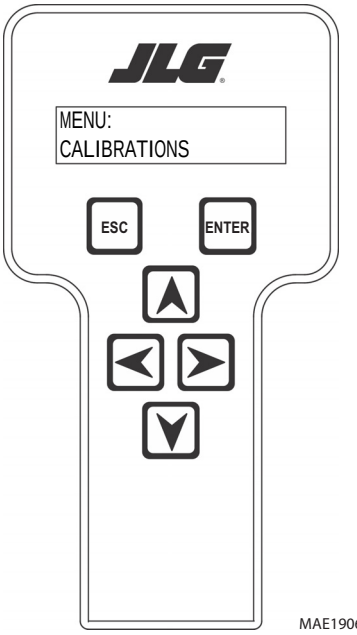
Calibration

1. Connect the JLG Hand-held analyzer to the original analyzer connection in the ground box.

NOTICE

DO NOT CONNECT TO THE ANALYZER CONNECTION PORT INSTALLED WITH THE UPRIGHT MONITORING SYSTEM MODULE.

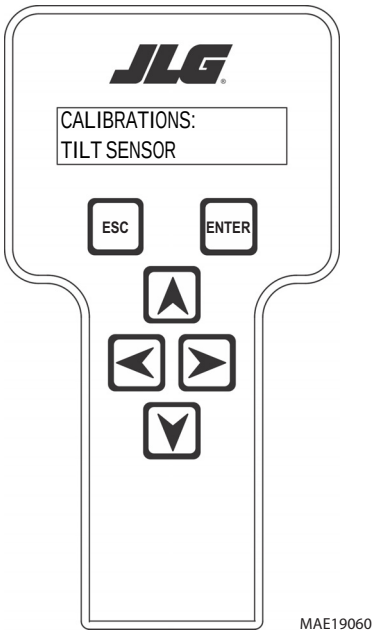
2. Pull out the emergency stop button at the ground control station and start the engine from the ground controls.
3. To calibrate the Upright Monitoring System through the hand-held analyzer, you must be in access level 1. To advance to access level 1, scroll to the ACCESS LEVEL menu and press "ENTER" (ENTER). Using the arrows on the keypad, enter the password "33271" and press "ENTER" (ENTER).
4. Calibrate the upright monitoring system sensor by the following procedure:
   a. In access level 1, scroll through the menu items until "CALIBRATIONS" is displayed on the second line of the analyzer screen. The screen will display the following:



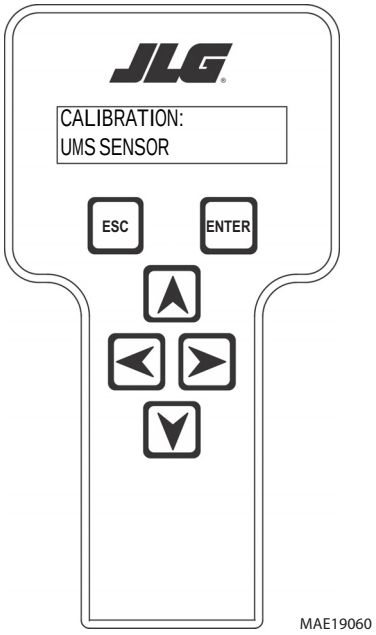
NOTICE

IT IS NOT NECESSARY TO CALIBRATE THE TILT SENSOR IN THE GROUND CONTROL MODULE AT THIS TIME. HOWEVER, WHEN THE TILT SENSOR IN THE GROUND CONTROL MODULE IS RECALIBRATED, THE UPRIGHT MONITORING SYSTEM TILT SENSOR MUST BE RECALIBRATED AS WELL.

   b. after pressing 'ENTER" one of the following screens will be displayed:

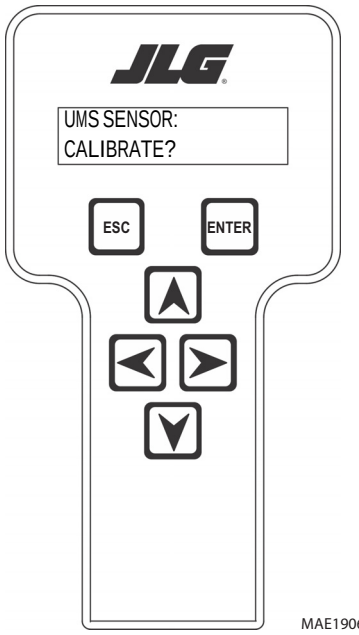


Or



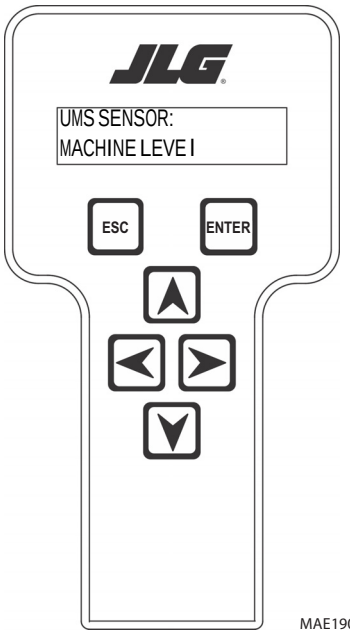
c. Scroll left to right through the above menu items until "UMS SENSOR" sub menu appears on the bottom line of the analyzer display. Press the "ENTER" key.

d. After selecting "UMS SENSOR", the following screen will appear:



NOTE: *By pressing the left or right arrow keys in this screen, you may view the output of the sensor.*

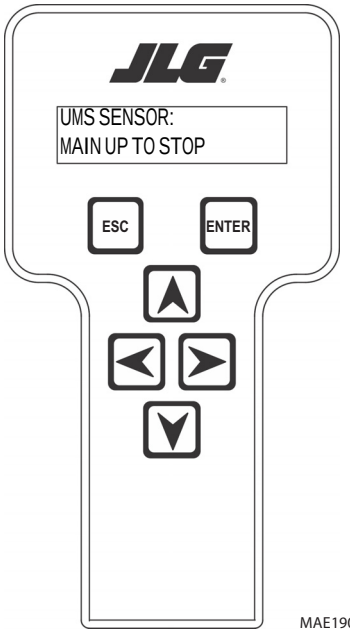
e. Press "ENTER" and the next screen will display the following, asking if the machine is on a level surface:



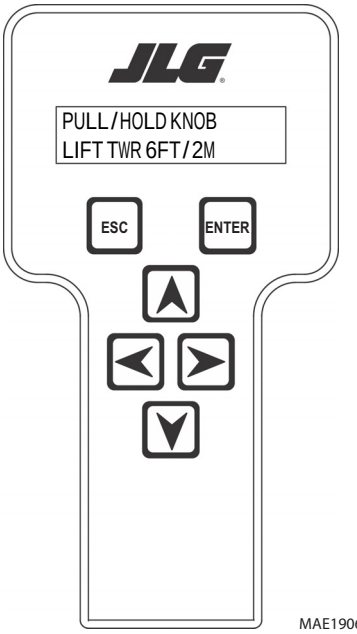
NOTICE

THE MACHINE MUST BE LEVEL FOR PROPER CALIBRATION.

f. Verify the machine is level and press "ENTER". The screen will display the following, asking you to fully elevate the main boom:



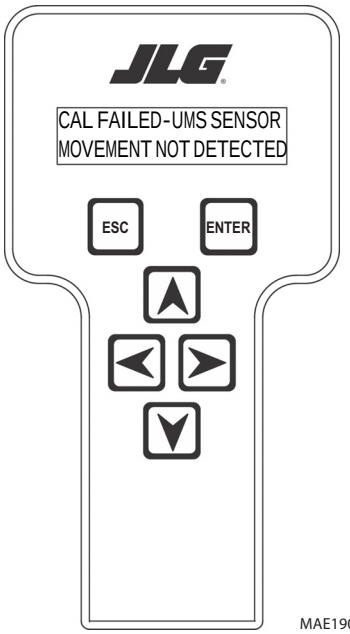
g. After the main boom has been fully elevated, press "ENTER" (ENTER). The analyzer will display the following:



NOTE: *By pressing the left or right arrows in this screen, you may view the output of each sensor.*

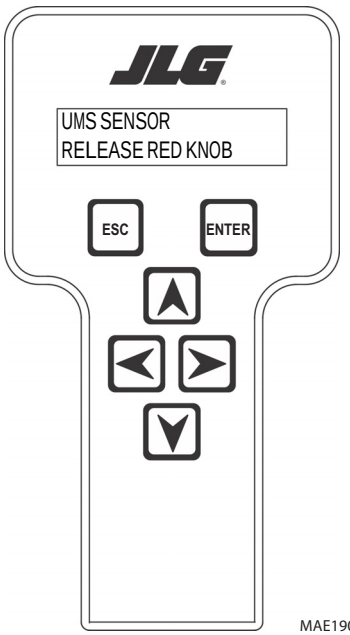
h. With the aid of an assistant, pull and hold the red re-leveling knob on the hydraulic tank while lifting the tower boom. Raise the tower boom six (6) feet or two (2) meters. After elevating the tower the required distance, press "ENTER" (ENTER).

If the upright monitoring system did not detect adequate sensor activity, the screen will display:

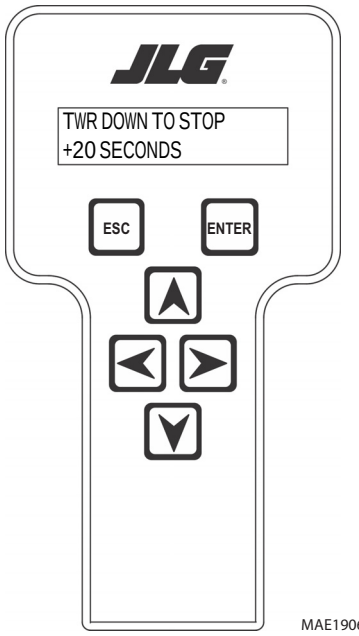


Should you get the above message, verify that the sensor is installed correctly and verify the sensor connection to the sensor harness is secure. Also, ensure the red knob is held fully open for the required time.

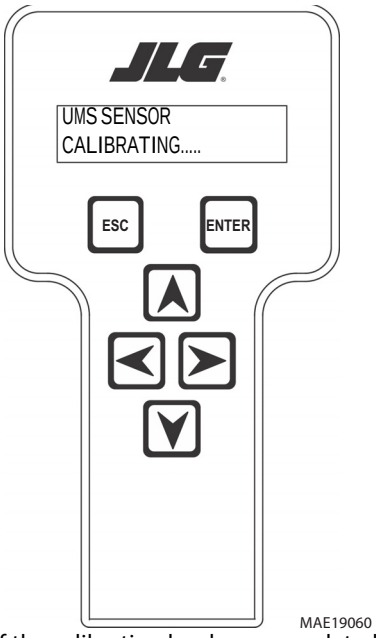
If the calibration is executing properly, you shall see the following display:



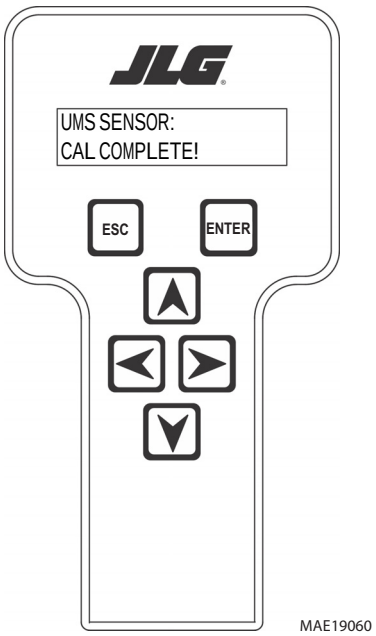
i. When viewing the above display, press "ENTER" (ENTER). The screen will display the following:



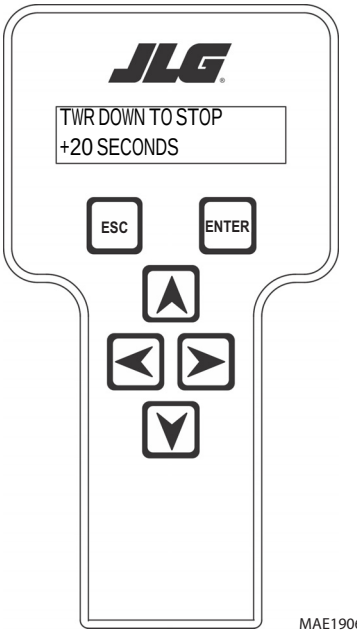
j. Lower the tower boom onto the boom stop. Continue to hold the tower boom down function for at least twenty (20) seconds **WITHOUT RELEASING THE FUNCTION SWITCH**. The calibration must recognize continuous activation of the tower down function switch for the required time.
After the required activation time has passed, release the function switch and press "ENTER" (ENTER). The analyzer will display the following message:



If the calibration has been completed successfully, the screen will automatically change to:



If the calibration has not been completed successfully, the display will automatically change to:



Repeat step j until the calibration time requirement has been satisfied.

⚠ WARNING

DO NOT RAISE THE TOWER BOOM AGAIN DURING CALIBRATION.

k. To correctly complete the calibration process, fully retract and fully lower the main boom. Once the machine is in the stowed position, turn off the machine and disconnect the analyzer.

Calibration Faults

CAL Failed-Chassis Not Level

In the event the turntable tilt switch input is logic low indicating that the machine is not level the UMS calibration screens shall display this fault.

CAL Failed-UMS Sensor Raw Output Out Of Range

The control system shall display a fault in the event the raw sensor output is greater then ±5° for the UMS sensor.

CAL Failed-Turntable Sensor Raw Output Out Of Range

The control system shall display a fault in the event the raw sensor output is greater then ±5° for the turntable sensor.

CAL Failed-Calibration Disrupted

If calibration is disrupted, the control system shall display this fault.

CAL Failed- UMS Sensor Movement Not Detected

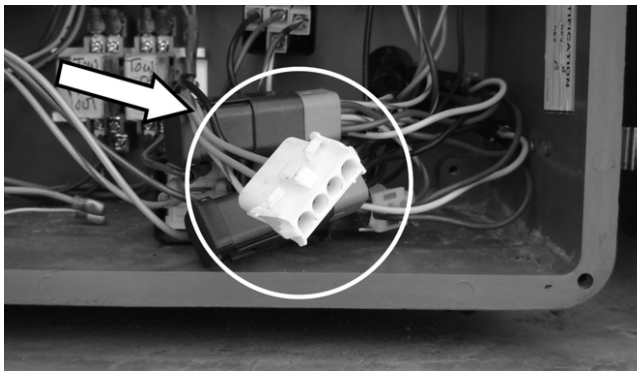
The UMS angle has not detected the required amount of movement during calibration.

Function Check

NOTICE

ON ADE EQUIPPED MACHINES, DO NOT CONNECT TO THE ANALYZER CONNECTION PORT INSTALLED WITH THE UPRIGHT MONITORING SYSTEM MODULE.

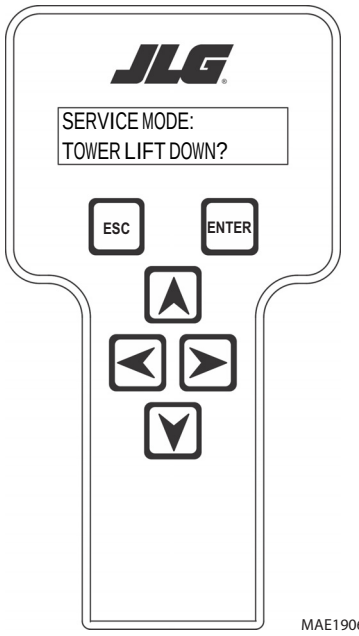
1. Connect the hand-held analyzer at the ground control station using the four-pin connector.



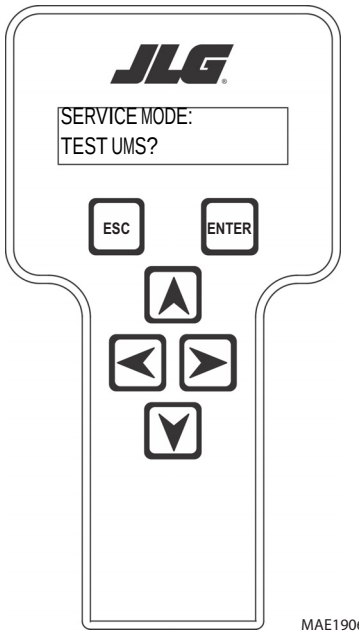
2. Pull out the emergency stop button at the ground control station and turn the key switch to ground controls. Start the engine.

3. Advance to access level 1 by scrolling to the ACCESS LEVEL menu and press "ENTER" ENTER. Using the arrows on the keypad, enter the password "33271" and press "ENTER" ENTER.

4. Scroll through the top level menu until SERVICE MODE appears. Press "ENTER" (ENTER) to select this menu item. After pressing "ENTER" one of the following screens will be displayed:

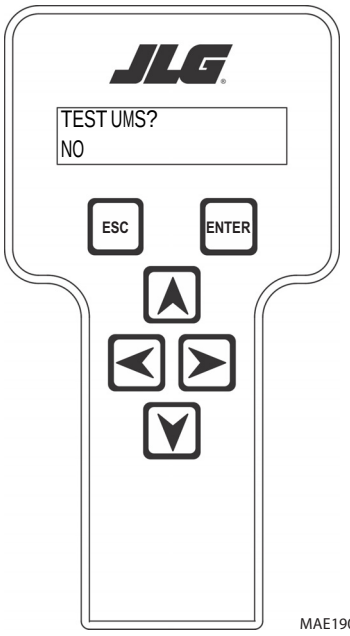


Or

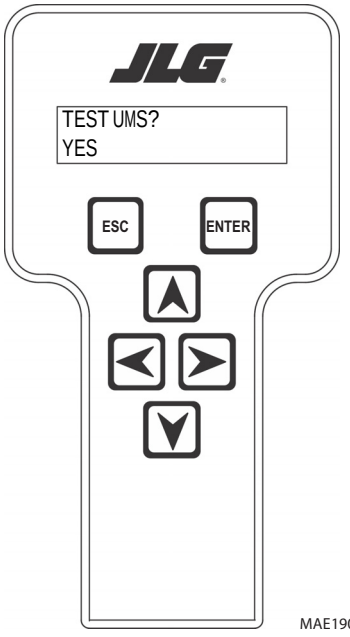


5. Scroll left to right through the above menu items until "TEST UMS?" sub menu appears on the bottom line of the analyzer display. Press the "ENTER" (ENTER) key.

6. The controller will now display the following:



or, by pressing the up and down arrow keys:



7. When the "YES" message is displayed, press the "ENTER" (ENTER) key to automatically perform a function test. Upon the function test, the system will activate the Upright Monitoring System, warning lights, and alarm. Verify that the alarm sounds, the boom malfunction indicator lights (platform and ground) are illuminated.

8. From the ground controls, raise the tower boom several feet. Verify that the tower boom will not lower.
9. To end the system test, press the Emergency Stop Switch (EMS) at the ground controls. Upon loss of power (pressing the EMS) to the system, the upright monitoring system will reset and all functionality will be restored to the machine.

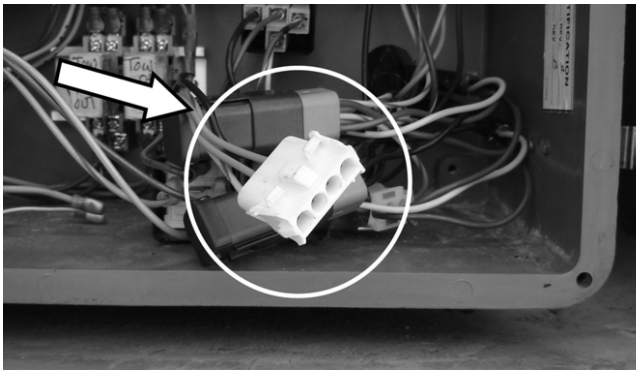
Service Mode/Tower Boom Retrieval

The UMS software incorporates a service mode to temporarily disengage the UMS and allow a tower lift down operation when the UMS has detected a backward stability concern.

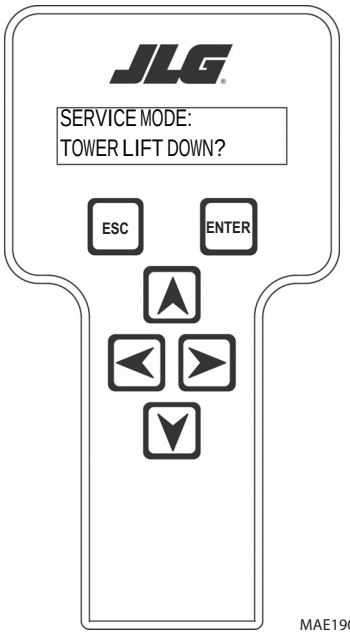
NOTICE

ON ADE EQUIPPED MACHINES, DO NOT CONNECT TO THE ANALYZER CONNECTION PORT INSTALLED WITH THE UPRIGHT MONITORING SYSTEM MODULE.

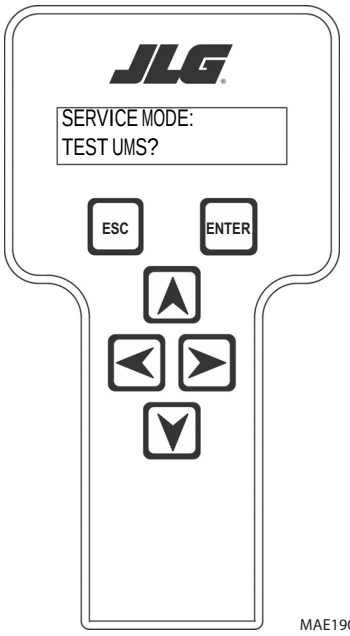
1. Connect the hand-held analyzer at the ground control station using the four-pin connector.



2. Pull out the emergency stop button at the ground control station and turn the key switch to ground controls. Start the engine.
3. Advance to access level 1 by scrolling to the ACCESS LEVEL menu and press "ENTER" (ENTER). Using the arrows on the keypad, enter the password "33271" and press "ENTER" (ENTER).
4. Scroll through the top level menu until SERVICE MODE appears. Press "ENTER" (ENTER) to select this menu item. After pressing "ENTER" one of the following screens will be displayed:

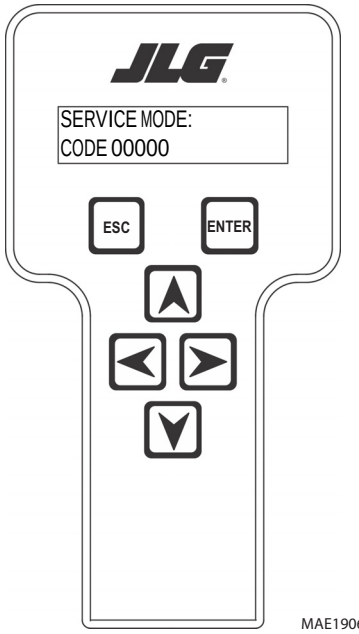


Or



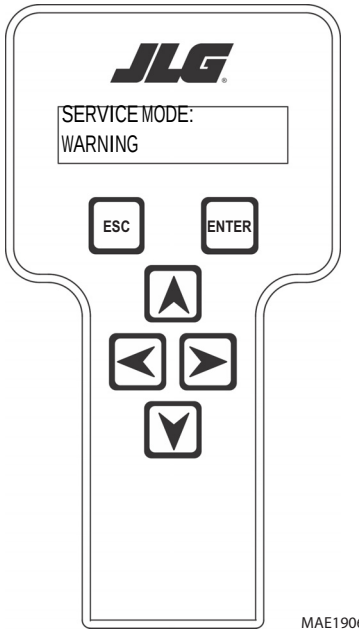
5. Scroll left to right through the above menu items until "TOWER LIFT DOWN?" sub menu appears on the bottom line of the analyzer display. Press the "ENTER" key.

6. The controller will now display the following:



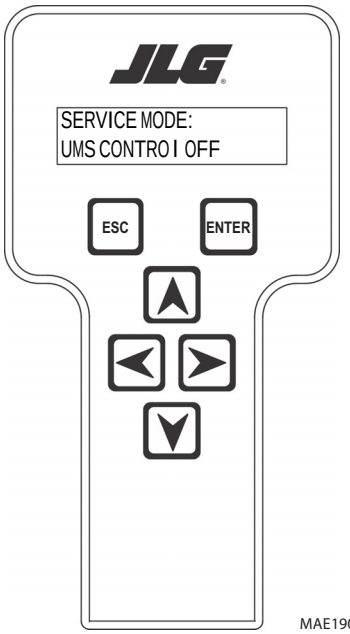
MAE19060

7. Enter the service code "**81075**" and press the "ENTER" key. The controller display will now display the following,



MAE19060

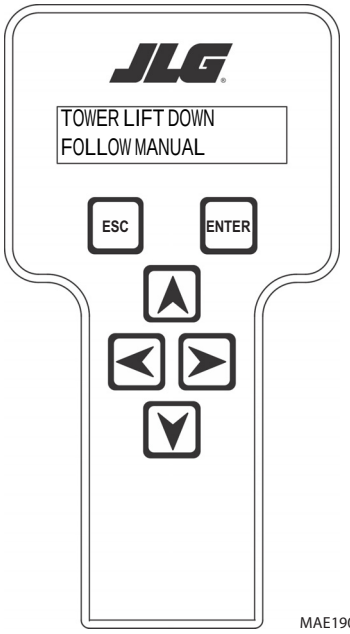
followed by:



MAE19060

The flashing and scrolling messages will repeat until the "ENTER" key is pressed.

8. When the "ENTER" key is pressed, the UMS will be disabled and the display will read:



MAE19060

9. Before using tower lift down adhere to the following:

- Make sure the main boom is fully retracted.
- Make sure the tower boom is fully retracted.
- Slowly lower the tower boom.

10. When the platform has been safely lowered to the ground, exit the service mode by pressing the Emergency Stop Switch (EMS) at the ground controls. Upon loss of power (pressing the EMS) to the system, the upright monitoring system will reset and all functionality will be restored to the machine.

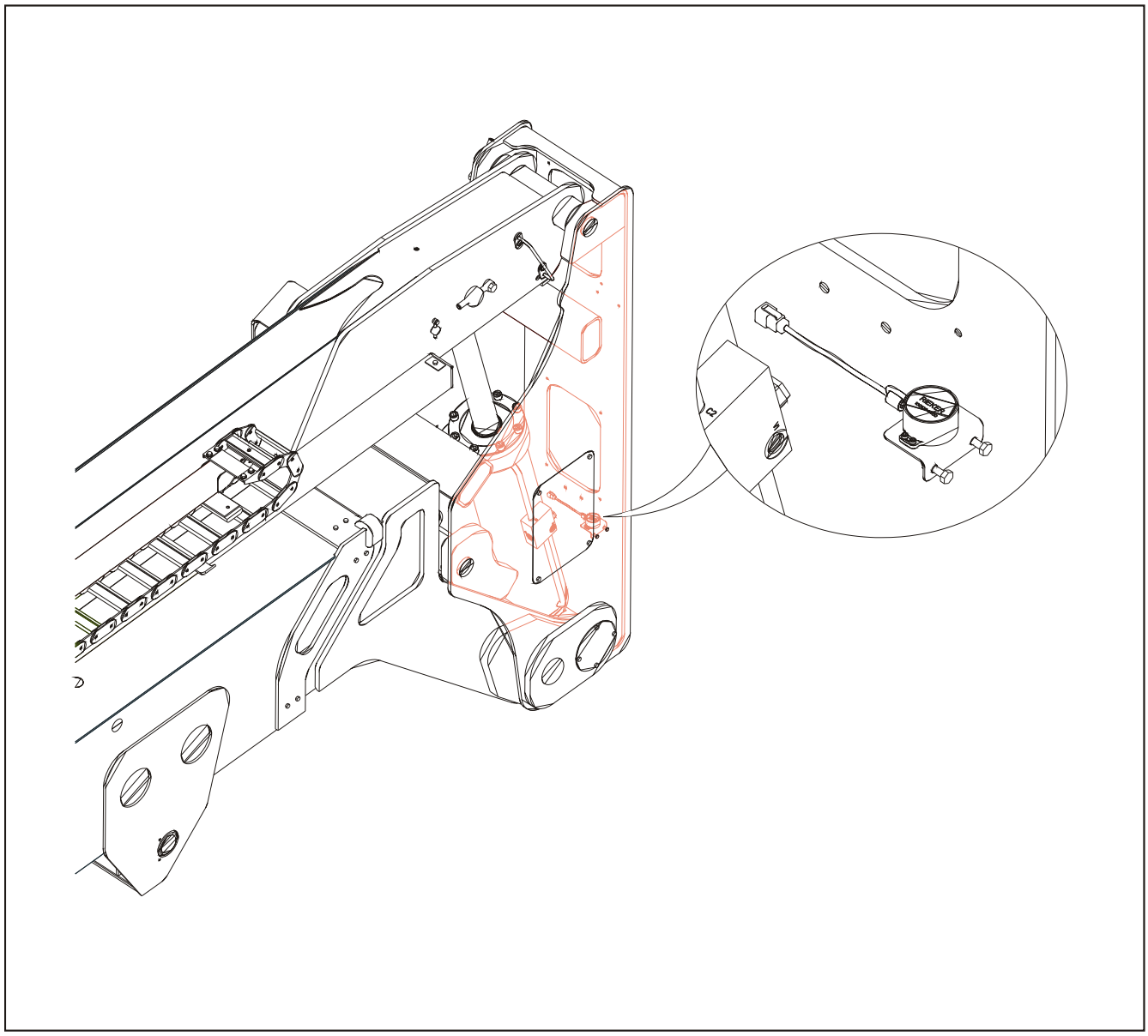


Figure 4-6. UMS Sensor Location

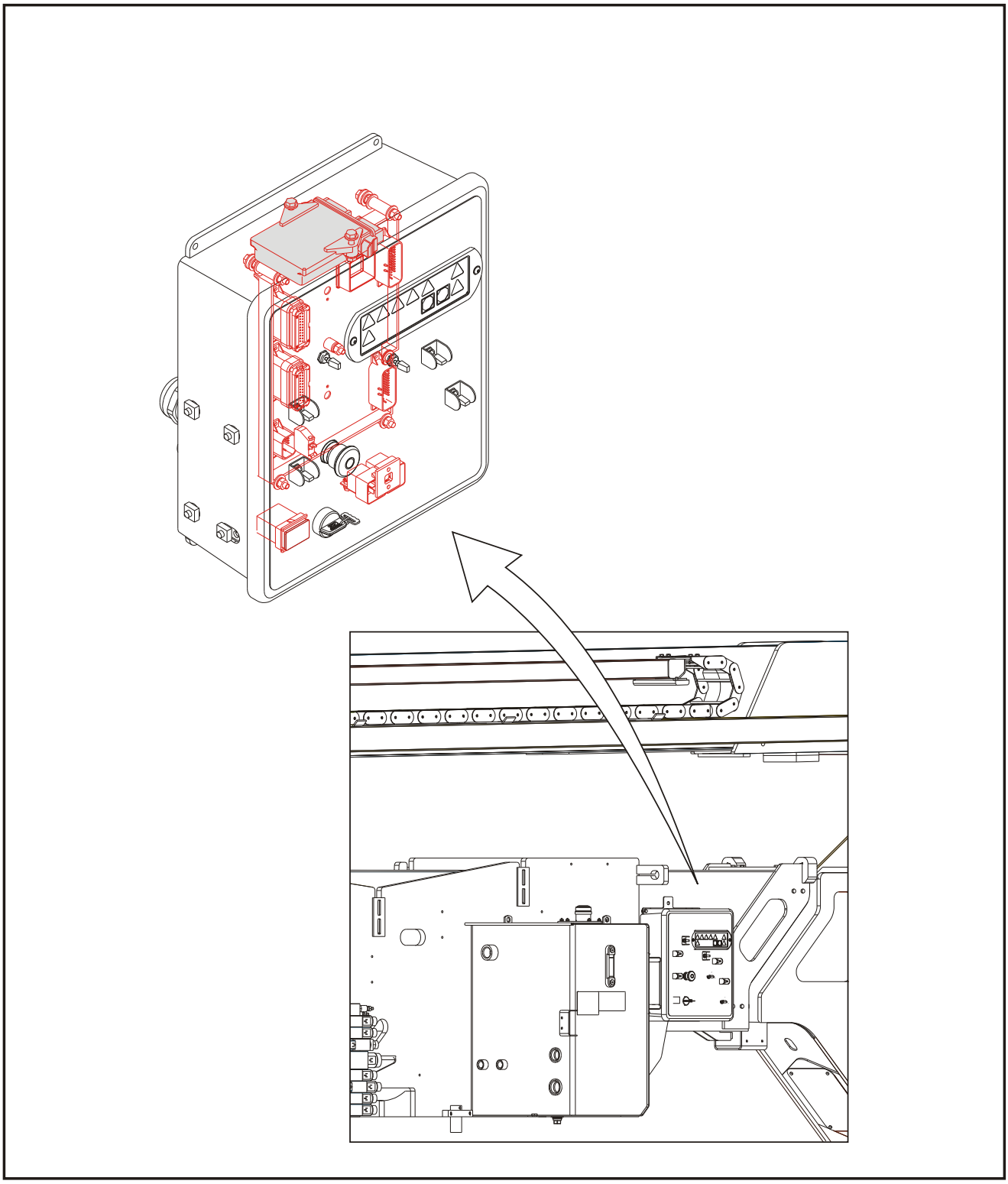


Figure 4-7. UMS Module Location

J1		J2	
1	IGN POWER (7-33V)	1	+5V ANALOG EXCITATION
2	GROUND	2	ANALOG INPUT 0
3	DIGITAL INPUT 0	3	ANALOG GROUND
4	DIGITAL INPUT 1	4	+5V ANALOG EXCITATION
5	DIGITAL INPUT 2	5	ANALOG INPUT 1
6	DIGITAL INPUT 3	6	ANALOG GROUND
7	DIGITAL OUTPUT 0 (PWM, IF)	7	ANALOG INPUT 2
8	DIGITAL OUTPUT 1 (PWM, IF)	8	ANALOG INPUT 3 (NOT POPULATED)
9	DIGITAL OUTPUT 2 (PWM, IF)	9	CANBUS HIGH
10	DIGITAL OUTPUT 3 (PWM, IF)	10	CANBUS LOW
11	DIGITAL OUTPUT 4 (PWM)	11	ANALYZER TRANSMIT
12	DIGITAL OUTPUT 5 (PWM)	12	ANALYZER RECEIVE

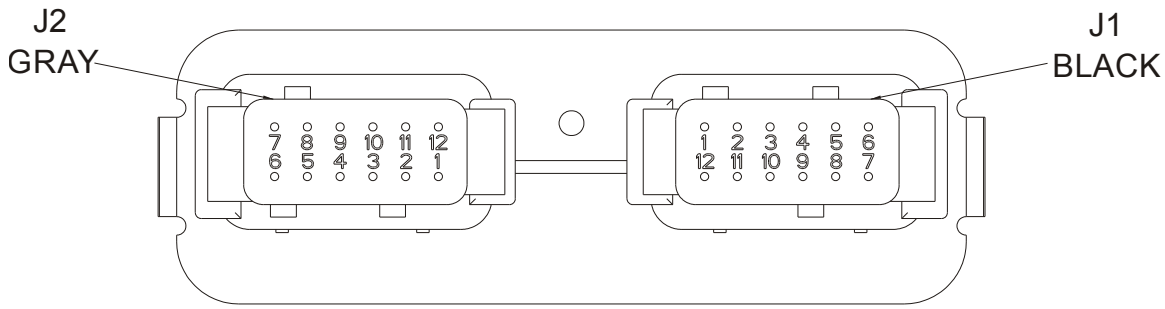


Figure 4-8. UMS Module Pin Identification

4.6 UMS TROUBLESHOOTING AND FAULT MESSAGES

Backward Stability Concern Message

2/5 UMS SENSOR BACKWARD LIMIT REACHED

When the upright angle relative to the turntable is higher than +2.5° (away from the work platform), tower lift down will be disallowed immediately. Tower Lift Down will be re-allowed when the upright angle relative to the turntable is less than 2.0°. If Tower Lift Down is disabled for more than 1.5 seconds, the ground boom malfunction indicator lamp, upright tilted lamp and platform alarm will light/sound continually and a fault shall be raised. These conditions will be latched along with Tower Lift Down until the upright angle is less than 2.0° for 2 seconds and the Tower Lift Down command is returned to neutral.

Solution:

- Inspect sensor mounting.
- Verify sensor calibration on level pad.
- Follow the corrective action listed on decal 1702265 located near the red knob of the machine.
- Inspect machine hydraulics. Refer to Holding Valve Checks in Section 5 - Hydraulics.

Forward Stability Concern Message

2/5 UMS SENSOR FORWARD LIMIT REACHED

When the upright angle relative to the turntable is less than –4.0° for longer than 1.5 seconds, the ground control boom malfunction indicator lamp, the platform malfunction indicator lamp, and platform alarm will light/sound continually and a fault will be raised. The light/alarm signal will stop only when the upright angle reaches values greater than –3.0° for 2 seconds.

Solution:

- Inspect sensor mounting.
- Verify sensor calibration on level pad.
- Tower lift down.
- Inspect machine hydraulics. Refer to Holding Valve Checks in Section 5 - Hydraulics.

Auto Detection Input Low Message

2/5 AUTO DETECTION INPUT LOW

If the UMS detects a valid ground module software version but digital input 2 is not tied high the UMS module shall report a fault.

Solution:

- Inspect wire harness, there should be 12 volts going into pin J1-5 (black connector) of UMS module.

UMS Sensor Communications lost

6/6 UMS SENSOR COMMUNICATIONS LOST

If the UMS detects a valid ground module software version but digital input 2 is not tied high the UMS module shall report a fault.

Solution:

- Inspect wire harness; CANbus communications are on pins J2-9 & J2-10 (gray connector) of the UMS module.
- Using access level 1 of the UMS module, under “DIAGNOSTICS” CAN, EX/SEC and TX/SEC should be values greater than 0. Also “BUS OFF:” and “BUS ERR:” should be 0 and “PASSIVE:” should be a low value.

Out of Usable Range Message

8/1 UMS SENSOR OUT OF USABLE RANGE

When both the Chassis tilt sensor and the UMS sensor read greater than 10° in the same direction the UMS will be disengaged until the condition no longer exists and a fault shall be raised.

Solution:

- Verify the message clears when operating the machine on grade less than 10°.
- Inspect sensor mounting.
- Verify sensor calibration on level pad.

UMS Sensor Not Calibrated Message

8/1 UMS SENSOR NOT CALIBRATED

If the control system detects a sensor out of range condition or a not calibrated fault with the UMS angle sensor, the control system shall report a fault and disable Tower Lift Down and activate the ground boom malfunction indicator lamp, upright tilted lamp and platform alarm continually

If the control system detects that the UMS angle sensor has not been calibrated, the ground boom malfunction lamp will flash at a 3 Hz rate until the system is calibrated or disabled.

Solution:

- Calibrate sensor.

UMS Sensor Faulted Message

8/1 UMS SENSOR FAULTED

If the system detects that the UMS sensor frequency outside the 100Hz +/- 5Hz range or the duty cycle is outside 50% +/- 21% range the control system shall report a fault.

Solution:

- Inspect wire harness going to the sensor and UMS module.
- Inspect sensor mounting.
- Replace sensor.

Incompatible Software Detected Message

9/9 INCOMPATIBLE SOFTWARE DETECTED

If the control system detects that the ground module software is incompatible with the UMS module, the UMS module shall report a fault and disable the footswitch signal to the ground module.

Solution:

- Update ground module software.

Calibration Faults

CAL FAILED-CHASSIS NOT LEVEL

The control system shall display a fault in the event the raw sensor output is greater than ±5° for the chassis sensor.

CAL FAILED-UMS SENSOR RAW OUTPUT OUT OF RANGE

The control system shall display a fault in the event the raw sensor output is greater then ±5° for the UMS sensor.

CAL FAILED-CALIBRATION DISRUPTED

If calibration is disrupted, the control system shall display this fault.

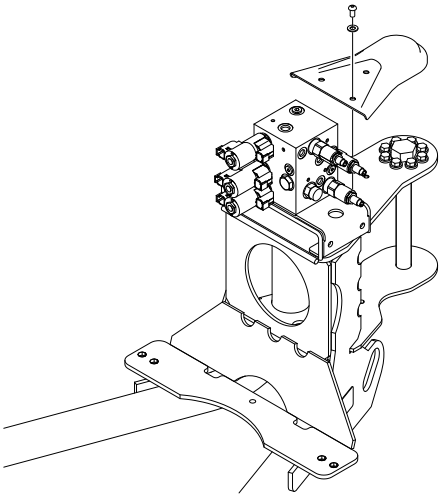
CAL FAILED- UMS SENSOR MOVEMENT NOT DETECTED

The UMS angle has not detected the required amount of movement during calibration.

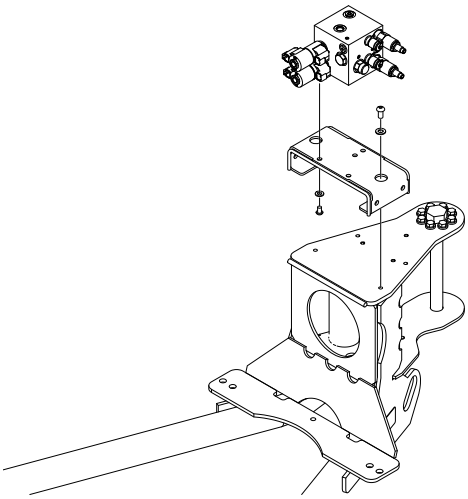
4.7 PLATFORM

Platform Valve Removal

1. Tag and disconnect the hydraulic lines from the platform control valve. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Remove hardware securing cover from the platform support. Remove cover.

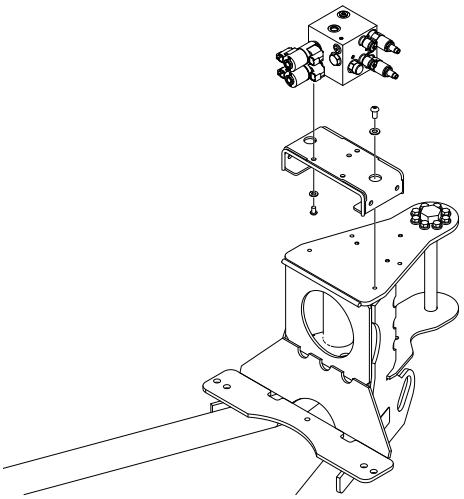


3. Remove hardware securing the mounting bracket to the platform support. Take out the mounting bracket along with platform control valve.
4. Remove hardware securing the platform control valve to the mounting bracket. Remove platform control valve.

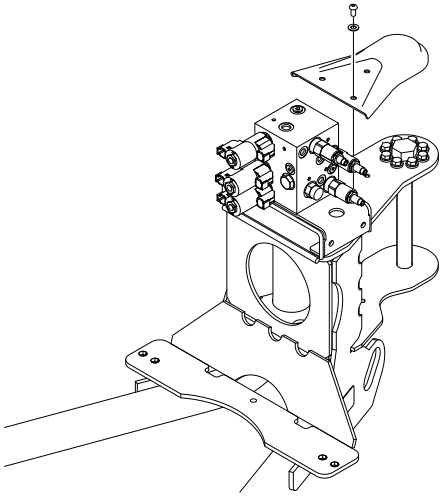


Platform Valve Installation

1. Install platform control valve onto the mounting bracket and secure using hardware.
2. Install the mounting bracket onto the platform support and secure using hardware.



3. Install cover onto the platform support securing hardware.



4. Remove tag and reconnect the hydraulic lines to the platform control valve.

Platform Support Removal

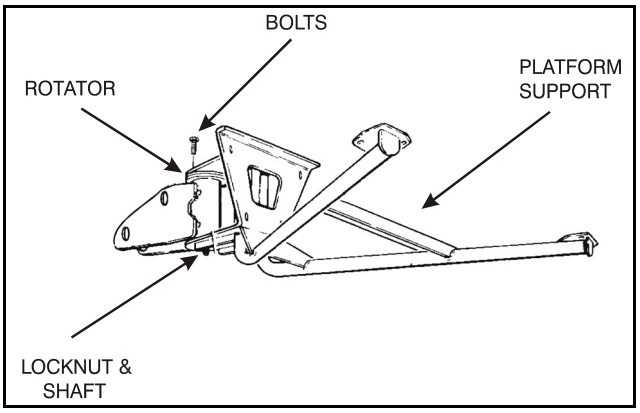
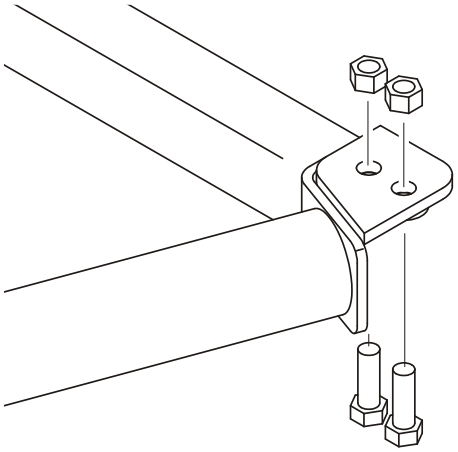


Figure 4-9. Location of Components Platform Support

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

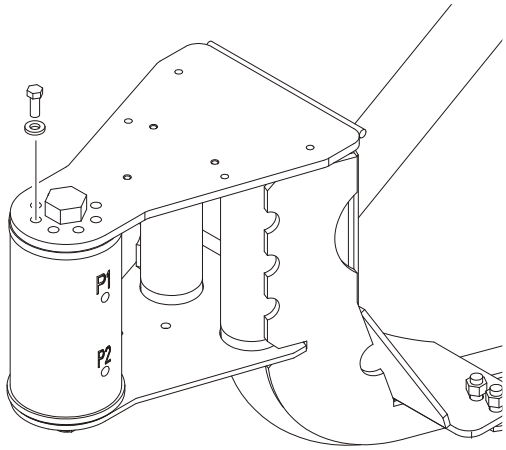
NOTE: *The platform weighs approximately 220 lbs (100 kg).*



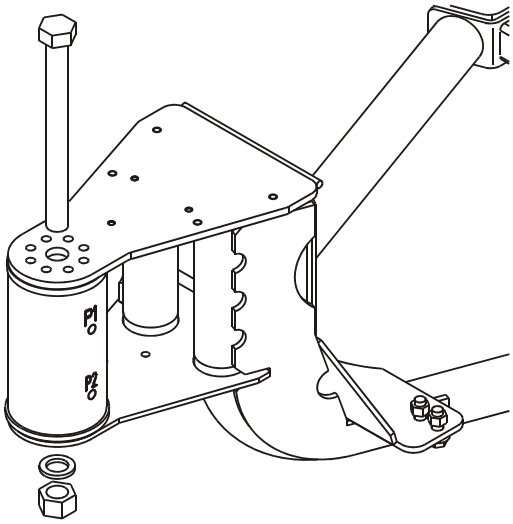
4. Using a suitable device, support the platform support.

NOTE: *The platform support weighs approximately 81.6 lbs. (37 kg).*

5. Remove the bolts and locknuts securing the support to the rotator.



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

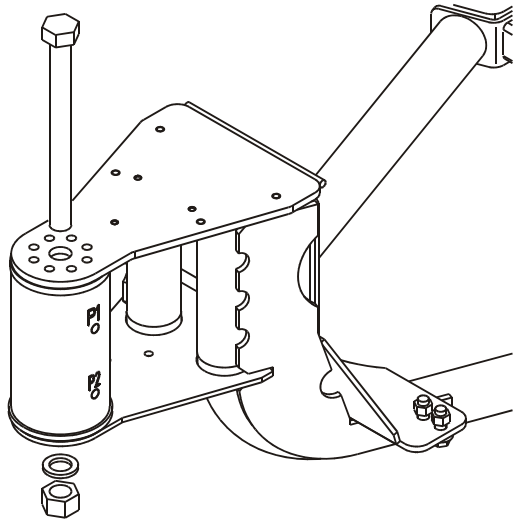


Support Installation

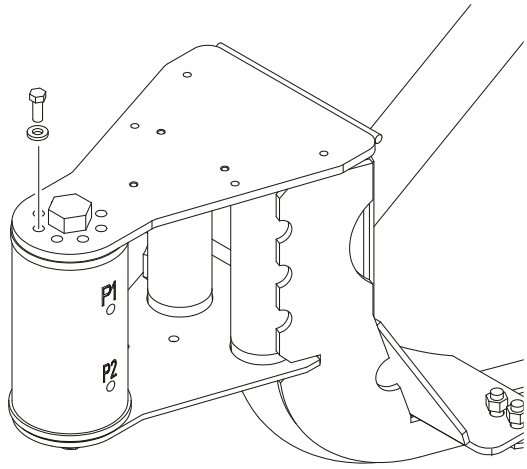
1. Using a suitable device, support the platform support and position it on the rotator.

NOTE: *The platform support weighs approximately 81.6 lbs. (37 kg).*

2. Install the rotator center bolt.

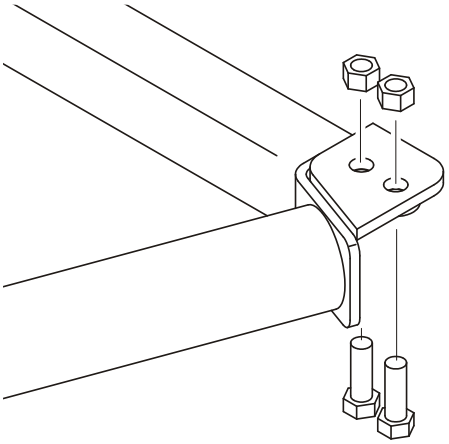


3. Apply JLG Threadlocker P/N 0100011 to the eight bolts and locknuts securing the support to the rotator and install the bolts and locknuts.



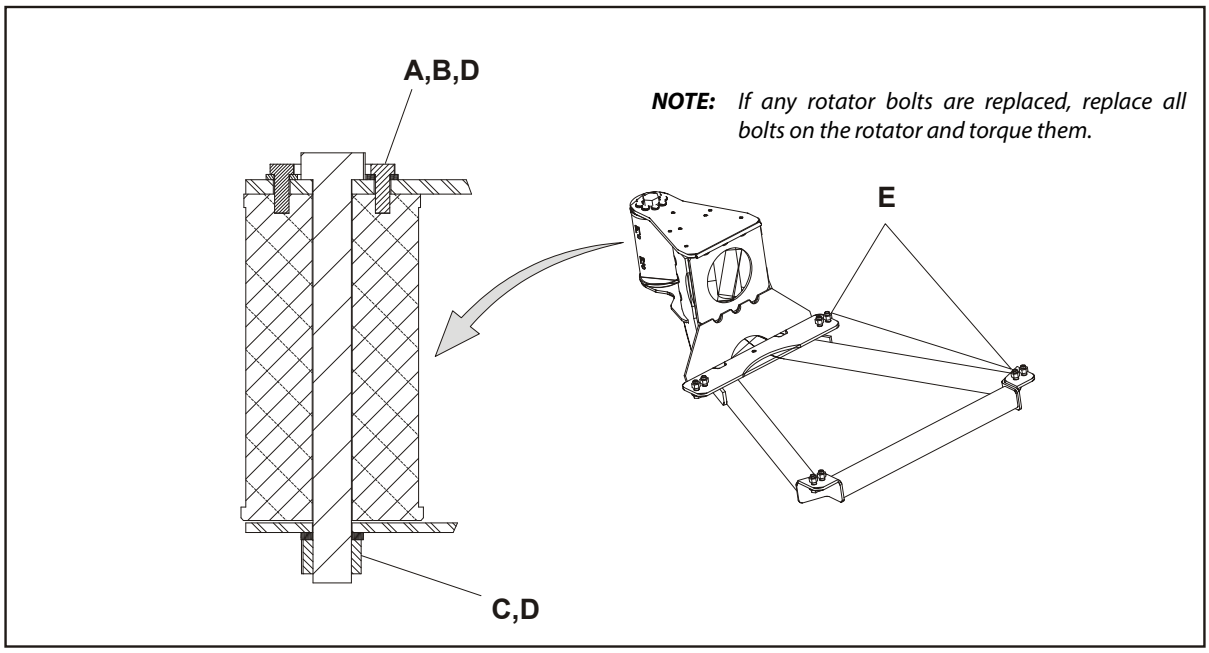
4. Torque the nut on the rotator center bolt to 586 ft. lbs. (795 Nm). Torque the retaining bolts to 40 ft. lbs. (55 Nm).

5. Position the platform on the platform support and install the bolts securing the platform to the platform support. Torque the bolts to 75 ft. lbs. (102 Nm).



6. Remove tag and reconnect the hydraulic lines to the rotator.

7. Connect the electrical cables to the platform control console.



A Torque to 40 ft.lbs. (55 Nm)
B JLG Thread locker (#0100011)
C Torque to 480 ft. lbs. (650 Nm)
D Check torque every 150 hours of operation
E Torque to 75 ft. lbs. (102 Nm)

Figure 4-10. Platform Support Torque Values

4.8 BOLT-ON EXTERNAL FALL ARREST

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

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

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

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

⚠ WARNING

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

⚠ WARNING

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

THE BOLT-ON EXTERNAL FALL ARREST SYSTEM REQUIRES AN ANNUAL INSPECTION AND CERTIFICATION. THE ANNUAL INSPECTION AND CERTIFICATION MUST BEPERFORMED BY A QUALIFIED PERSON OTHER THAN THE USER.

Inspection Before Use

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

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

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

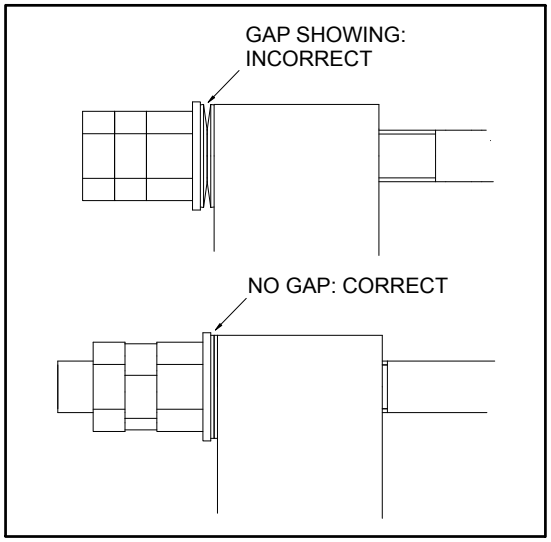
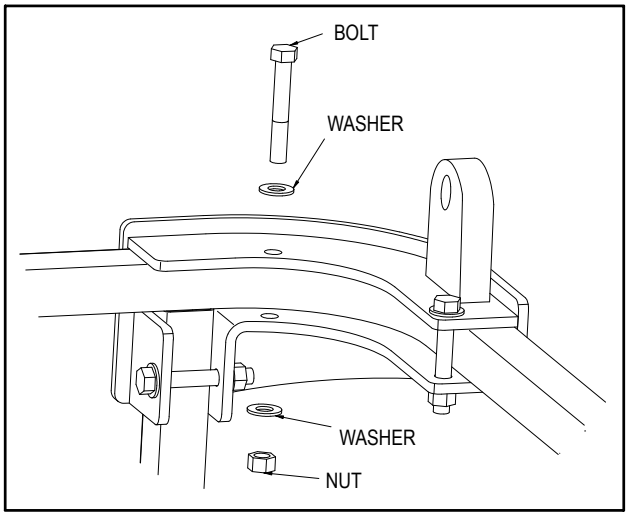


Figure 4-11. Bolt-On External Fall Arrest Cable Tension

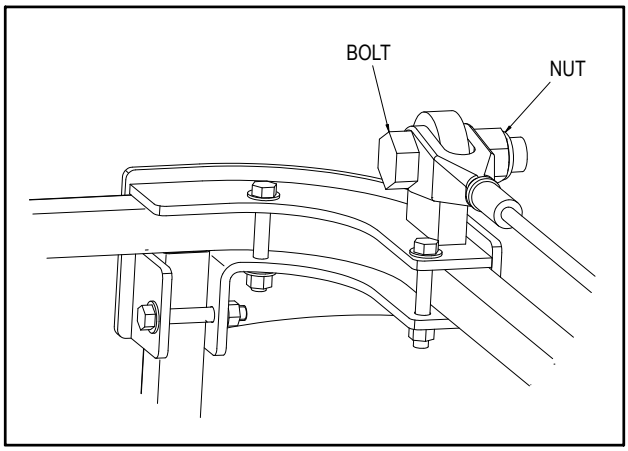
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are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

Installation

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

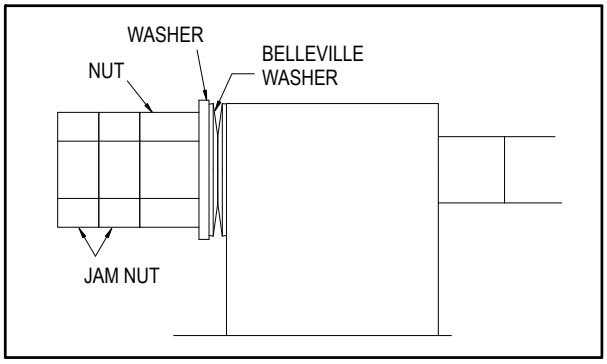


2. Attach the fall arrest cable to the right hand bracket Using the attaching bolt and nut. Orient the bolt as shown below. Do not tighten the nut so cable can still rotate.

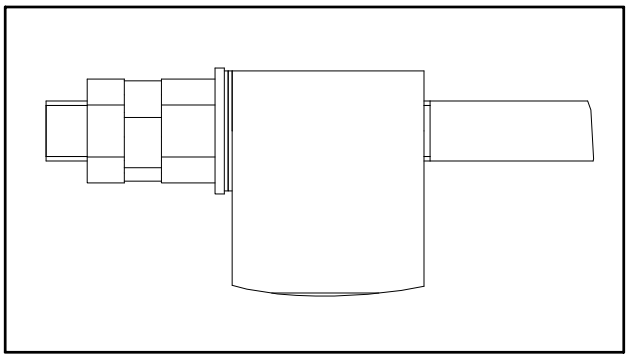


3. Install the Attachment Ring onto the cable.

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



5. Use the two jam nuts to prevent the cable from rotating while the nut is tightened. Tighten the nut until the belleville washers are fully compressed and no gap is present at the outside diameter of the washers. Ensure the cable has not rotated during tightening.



6. Tighten the first jam nut against the retaining nut to keep the nut from loosening. Tighten the remaining jam nut against the first jam nut.

7. Torque the nuts and bolts securing the brackets to 15 ft.lbs. (20 Nm).

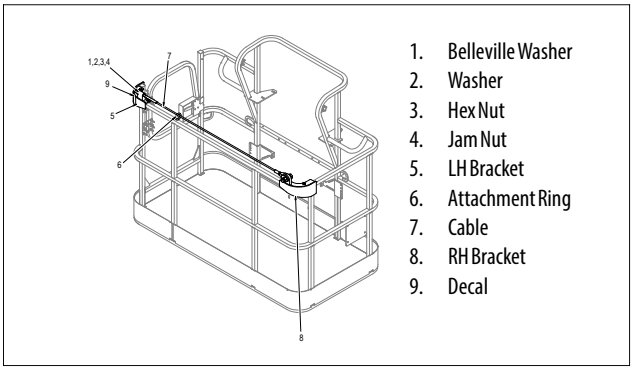


Figure 4-12. Bolt-On External Fall Arrest System

4.9 ARTICULATING JIB

NOTE: *Pin numbers listed in the following procedures are referenced in Figure 4-13., Location of Components-Articulating Jib.*

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

Removal

1. For platform/support removal see platform/support removal diagram. (See Section 4.7, Platform).
2. Position the articulating jib boom level with the ground.
3. Tag and disconnect hydraulic lines from level cylinder and lift cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
4. Remove mounting hardware from slave cylinder pin (1). Using a suitable brass drift and hammer, remove the cylinder pin from articulating jib boom.
5. 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 Pins and Composite Bearing Repair Guidelines in Section 2.*

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.
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.

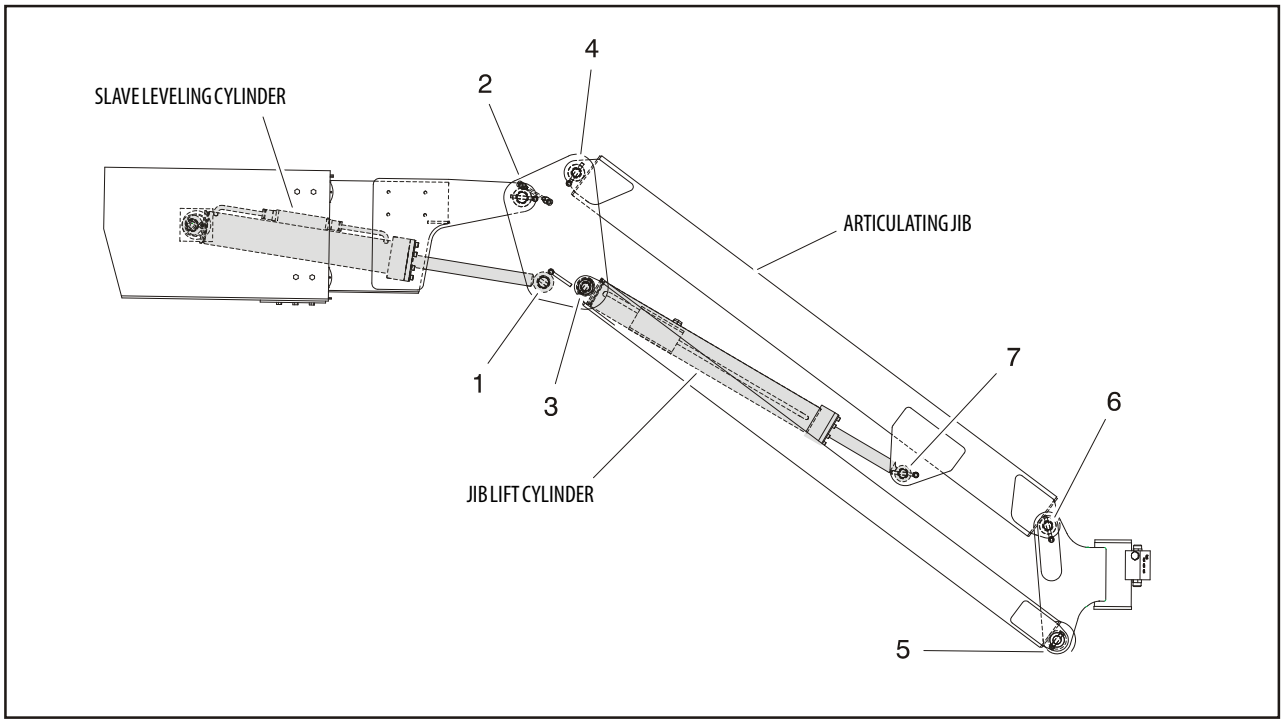


Figure 4-13. Location of Components-Articulating Jib

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

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 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.
3. 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.
4. 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.
5. 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.
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.
8. Untag and connect hydraulic lines from level cylinder and lift cylinder.

4.10 ROTATOR AND SLAVE CYLINDER

Removal

1. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Supporting the rotator, remove hardware from pin (1). Using a suitable brass drift and hammer remove pin (1) from the fly boom.
3. Remove the hardware from pin (2). Using a suitable brass drift and hammer, remove pin (2) from the fly boom and remove the rotator.
4. Telescope the fly section out approximately 20 inches (50 cm) to gain access to the slave leveling cylinder. (800 AJ only)
5. Supporting the slave, cylinder remove the hardware from pin (3). Using a suitable brass drift and hammer remove pin (3) from the fly boom.
6. 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.

4.11 SEQUENCE FOR HOSE REPLACEMENT IN THE TOWER BOOM

1. Remove the tower boom front cover bolts, exposing the Powertrack.
2. Remove bolts to disconnect the top bar of the Powertrack
3. Pull the Powertrack out of base boom. (as far as hoses will allow)
4. At left side rear of upright, remove access cover plate (4) bolts. (others if necessary)
5. Remove access cover plate, (4) bolts, from bottom front of fly boom.
6. Cut cable ties that attach hose to be replaced.
7. Disconnect hose that is to be replaced, and cap the male fitting.
8. Attach the new hose to the end of the hose to be replaced.
9. Pull these lines thru the upright and out the bottom, then feed back into the fly boom.
10. At the Powertrack, in front of the tower boom, open the Powertrack links to expose the hose to be replaced.
11. Pull hose to be replaced, attached to the new hose, thru the fly boom and thru the Powertrack links.
12. Disconnect new hose from the replaced hose and connect to fitting where the damaged hose was connected.
13. Roll Powertrack back into base, and attach the top bar of the Powertrack (2) bolts to the inside top of the fly boom section.
14. Check for leaks and hardware tightened securely.
15. Replace access cover plates and front cover.

4.12 LIMIT SWITCHES ADJUSTMENT

Main Boom Horizontal Limit Switch

1. Place machine on level surface.
2. Raise main boom 5 to 10 degrees above horizontal. limit switch should activate before this point.
3. Lower main boom until limit switch resets. This should be 1 degree above to 4 degrees below horizontal. (See Figure 4-15.) for adjustments.

NOTE: *Angle indicator should be placed approx. 2 ft. from the main boom pivot pin and the attach point on the main boom. Tower angle switch must be reset before main boom angle switch can be activated.*

Tower Boom Horizontal Limit Switch

1. Place machine on level surface.
2. Raise Tower Boom 8 to 13 degrees above horizontal. The tower angle limit switch should activate at this point.
3. Lower the tower boom until the limit switch resets. This should be 2 to 7 degrees below where the switch was activated. (See Figure 4-14. and Figure 4-15. for adjustments).

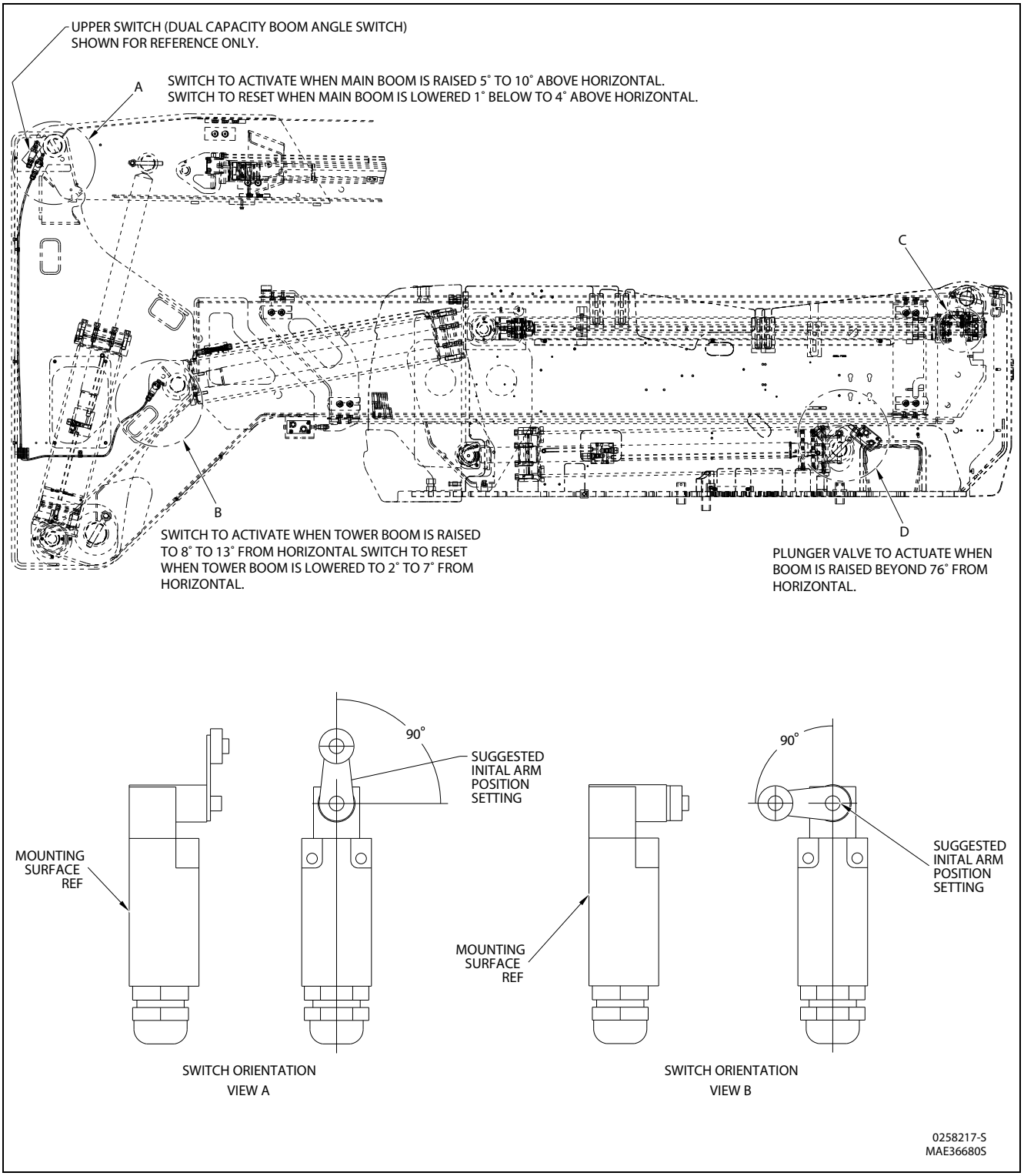


Figure 4-14. Boom Valve and Limit Switches Location (Sheet 1 of 2)

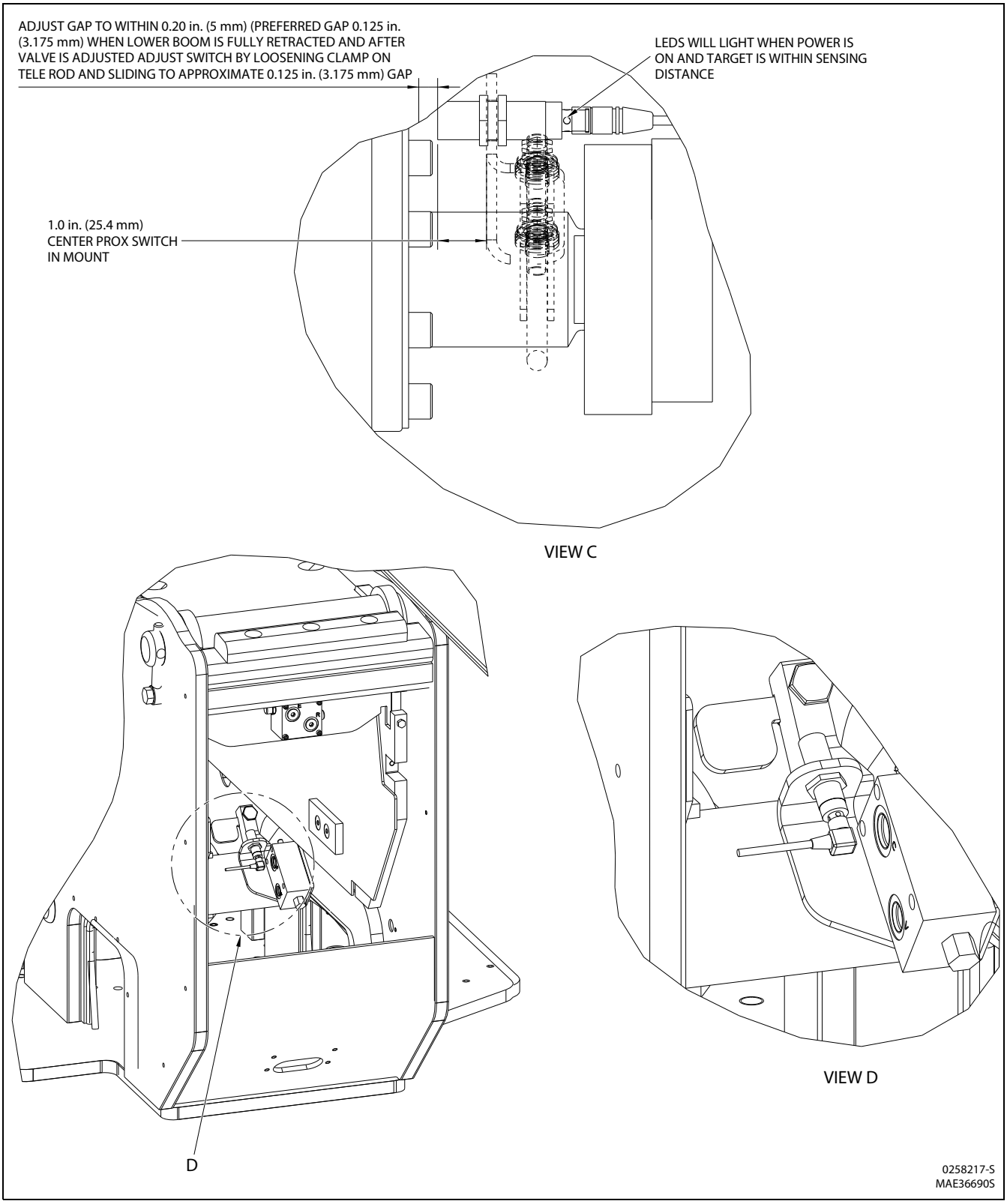


Figure 4-15. Boom Valve and Limit Switches Location (Sheet 2 of 2)

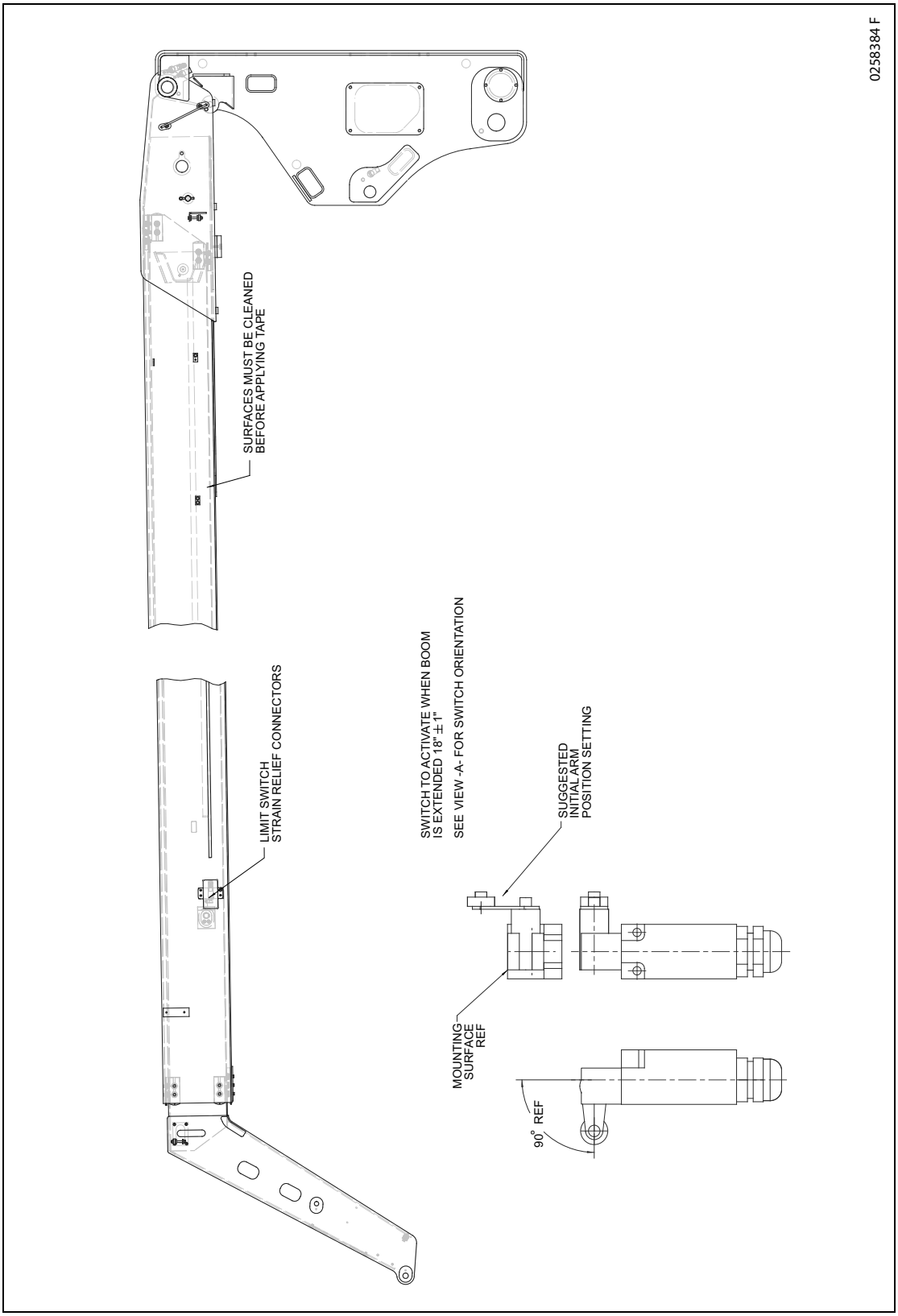


Figure 4-16. Transportation Switch Installation (CE only)

4.13 BOOM VALVE ADJUSTMENT

1. Adjust the screws so the plunger on the valves has 0.250 in. (6.35 mm) travel remaining when the lower boom is fully raised and retracted.
2. After the valves are adjusted, adjust the proximity switches to within 0.314 in. (8 mm) of their target. The LED's on the proximity switches will light when the power is on and the switch is within 0.314 in. (8 mm) of the target. There is a proximity switch to backup both valves.

NOTE: *The cam valve under the boom requires the tower boom to be completely lowered and the cam valve mounted on T/T requires the tower boom to be fully elevated prior to adjustment.*

Tower Boom

1. Shim up wear pads until 1/32 inch (0.8 mm) clearance to adjacent surface.
2. When adjusting wear pads, removing or adding shims, bolt length must also be changed.
   - **a.** When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   - **b.** When shims are removed, shorter bolts must be used so bolt does not protrude from insert and come into contact with boom surface.

Main Boom

1. Shim up wear pads to within 1/32 inch (0.8 mm) clearance between wear pad and adjacent surface.
2. Adjusting wear pads, removing or adding shims, bolt length must also be changed.
   - **a.** When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   - **b.** When shims are removed, shorter bolts must be used so bolt does not protrude from insert and Sheaves and wire rope must be replaced as sets.

4.14 BOOM CLEANLINESS GUIDELINES

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

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

4.15 MAIN BOOM POWERTRACK

Removal

1. Disconnect wiring harness connectors located in tower upright.

NOTICE

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

2. Tag and disconnect hydraulic lines from connectors at boom assembly. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Disconnect dual capacity indicator limit switch from side of boom section. (800A only)
4. Remove hydraulic lines and electrical cables from Powertrack.
5. Using suitable lifting equipment, adequately support Powertrack weight along entire length.
6. Remove hardware (1) securing the push tube on the fly boom section.
7. Remove hardware(2) securing the push tube on the mid boom section.
8. With Powertrack supported and using all applicable safety precautions, remove hardware (3), (4) and (5) securing rail to the base boom section. Remove Powertrack from boom section.

Installation

1. With powertrack supported and using all applicable safety precautions, install bolt(3), (4) and (5) securing rail to the base boom section.
2. With adequate support and lifting device align, place mid boom push tube on the mid boom section to get access to install hardware (2).
3. Install bolt(1) securing the push tube on the fly boom section.
4. Connect hydraulic lines and electrical cables to Powertrack. Uncap all hydraulic lines and ports.
5. Connect dual capacity indicator limit switch from side of boom section. (800A only)
6. Disconnect wiring harness connectors located in tower upright.

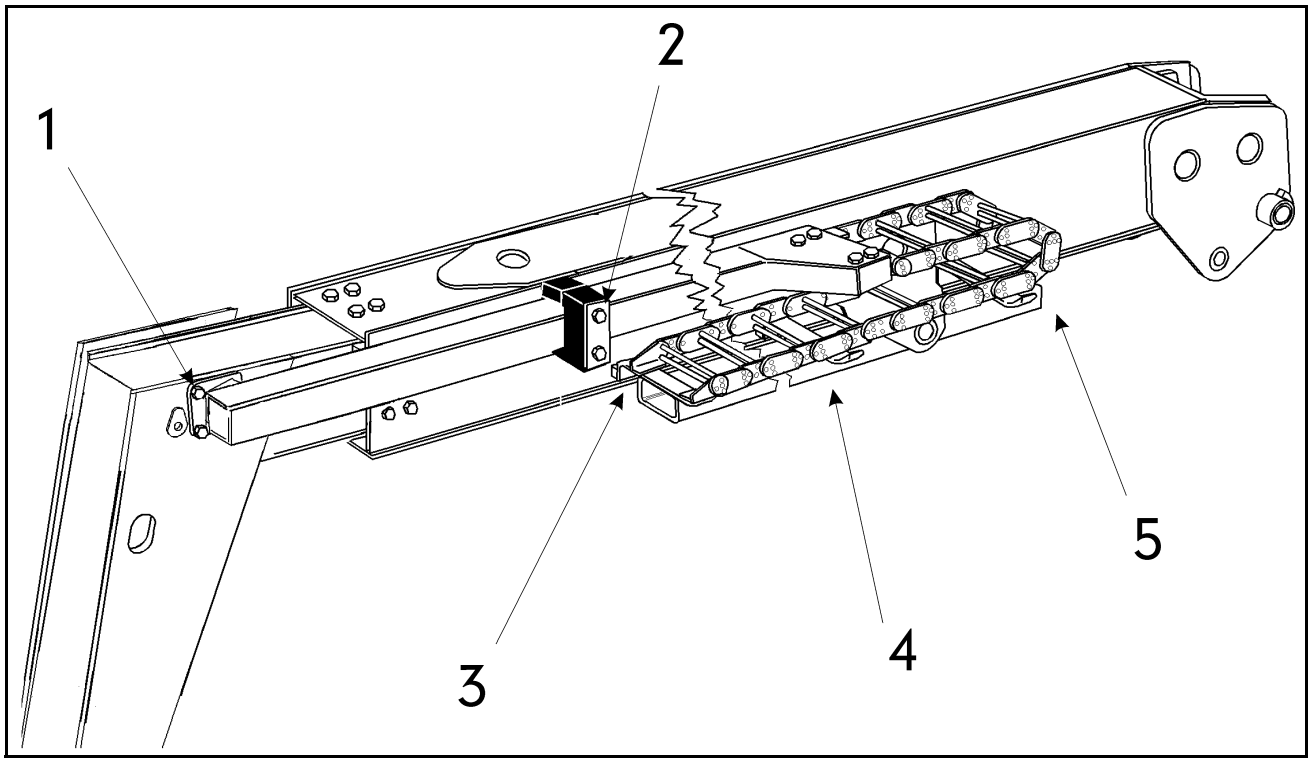


Figure 4-17. Main Boom Powertrack Removal and Installation

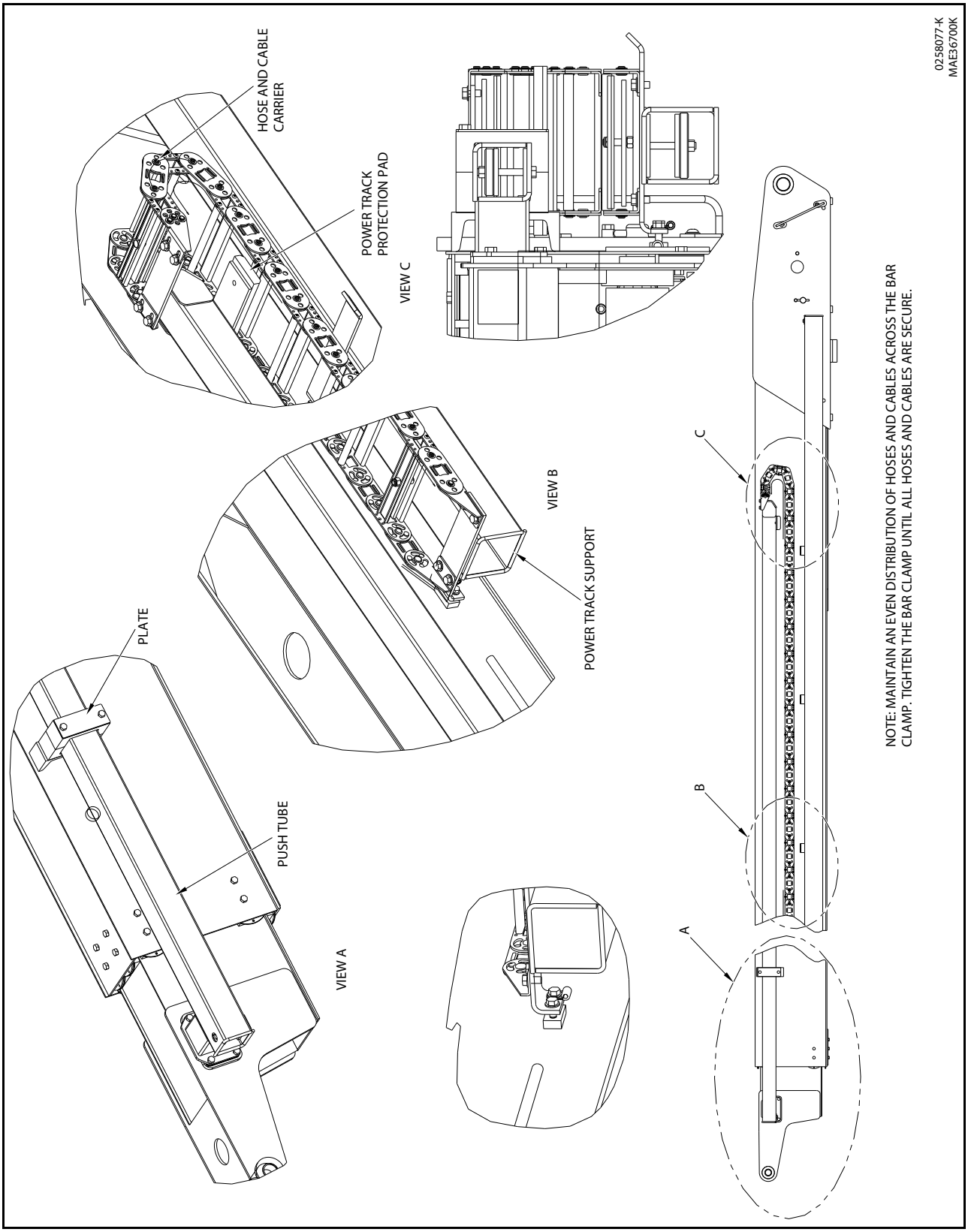


Figure 4-18. Powertrack Installation Main Boom

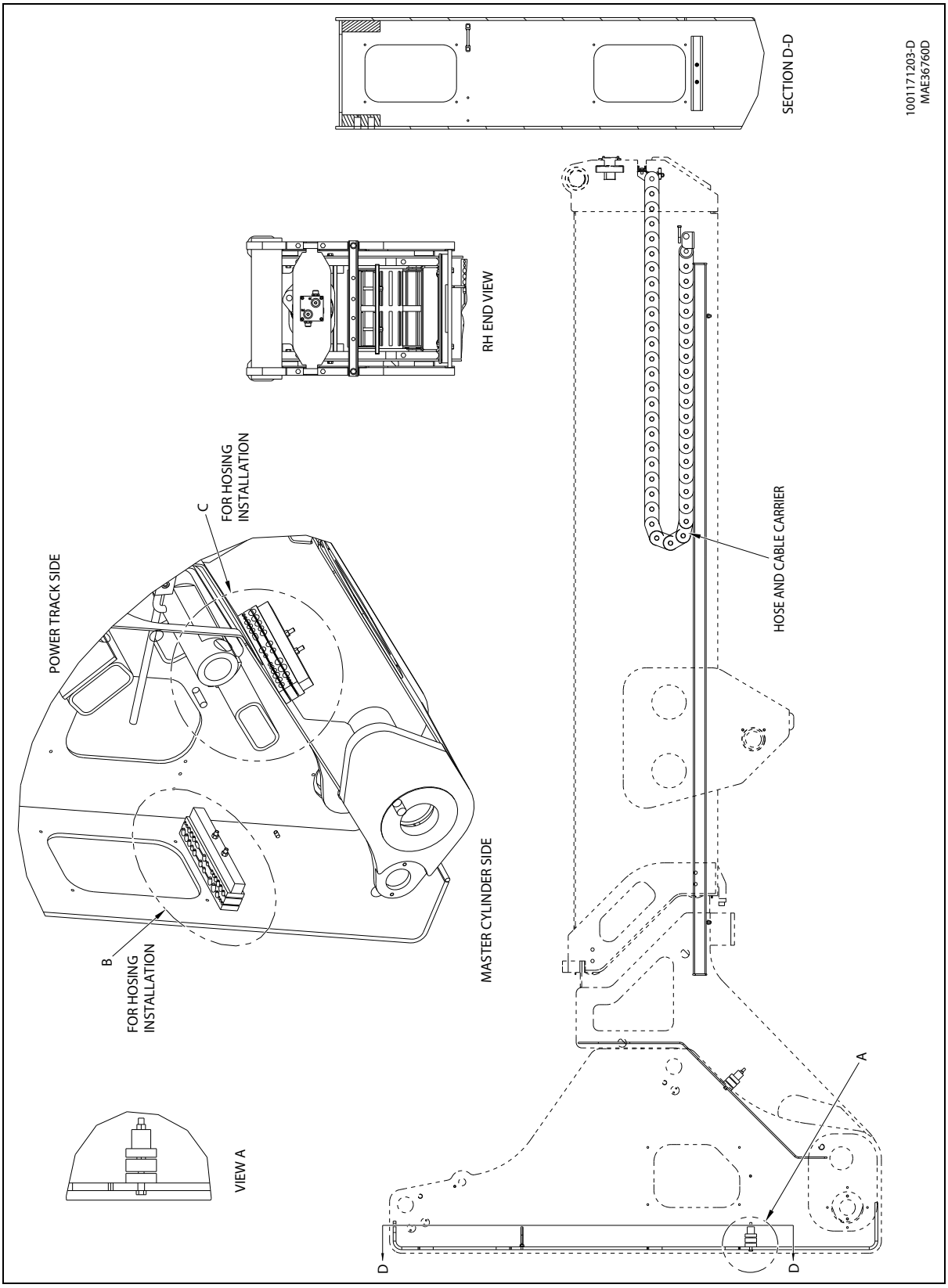


Figure 4-19. Powertrack Installation Tower Boom (Sheet 1 of 3)

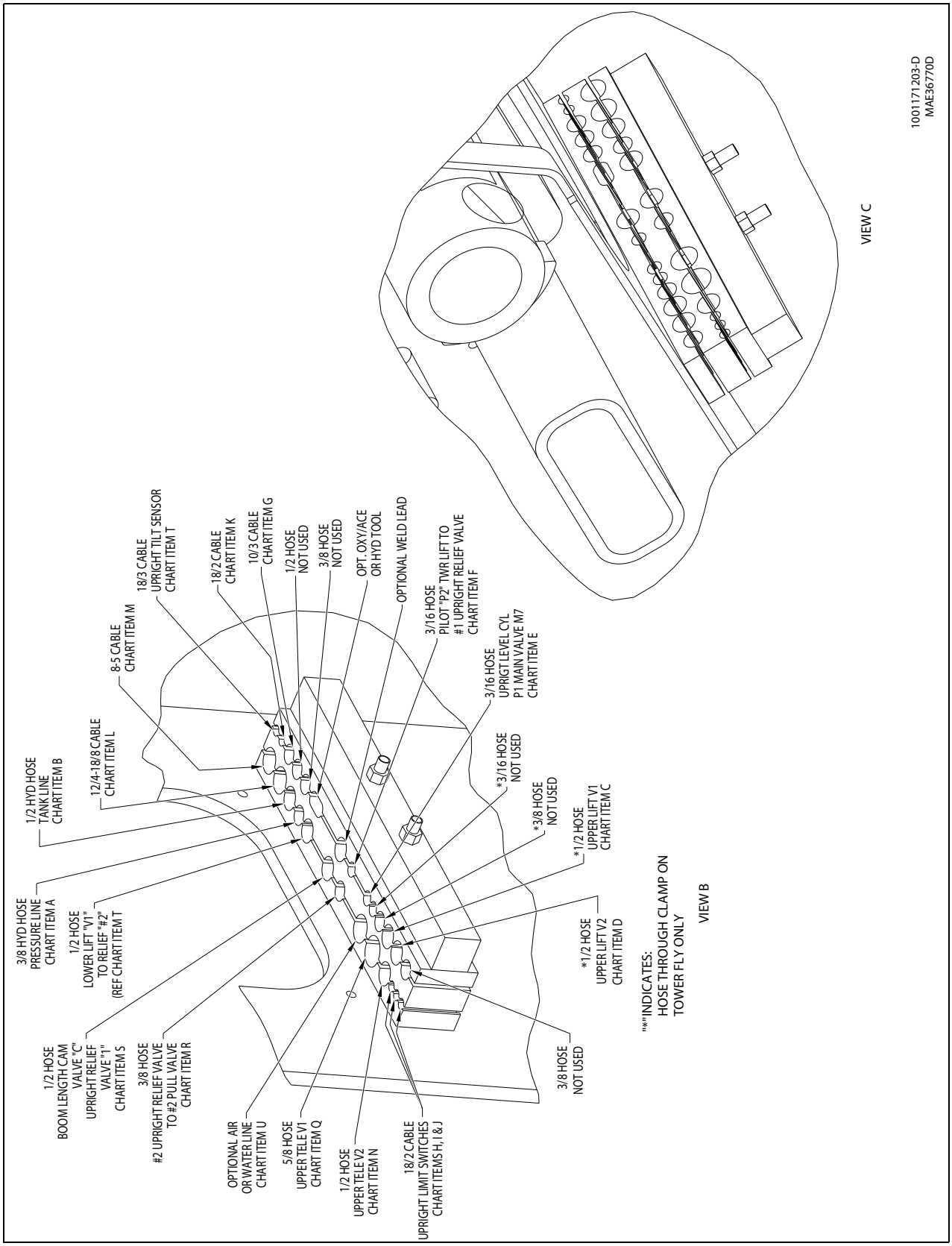
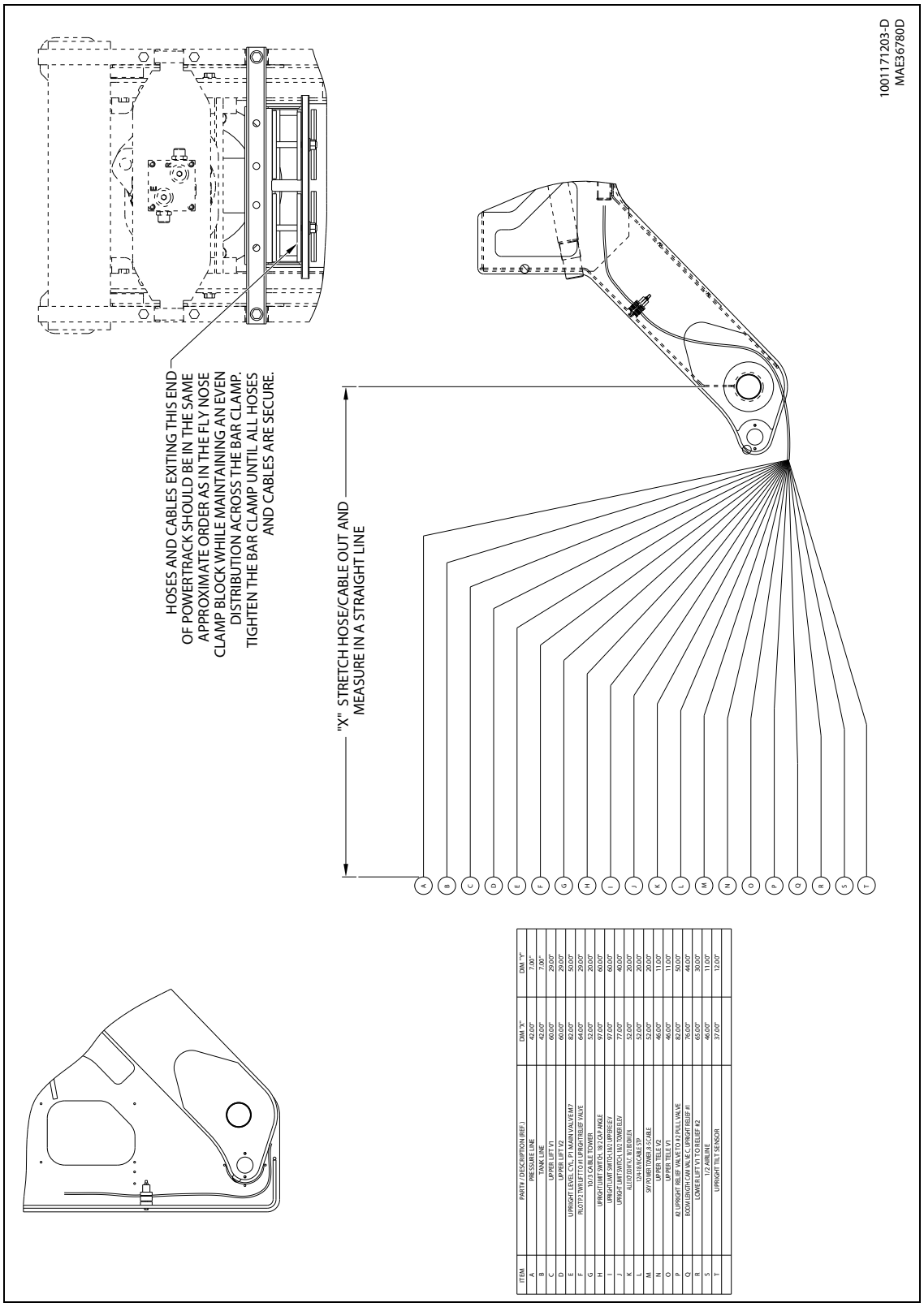


Figure 4-20. Powertrack Installation Tower Boom (Sheet 2 of 3)



ITEM	PARTS / DESCRIPTION (REF.)	DIM "A"	DIM "Y"
A	PRESSURE LINE	42.00"	7.00"
B	TANK LINE	42.00"	7.00"
C	UPPER LIFT V1	60.00"	29.00"
D	UPPER LIFT V2	60.00"	29.00"
E	UPRIGHT LEVEL CYL. MANIFOLD MAIN VALVE M7	64.00"	29.00"
F	PILOT 2 TWIST TO H. UPRIGHT RELIEF VALVE	64.00"	29.00"
G	10/3 CABLE TOWER	52.00"	20.00"
H	UPRIGHT LIMIT SWITCH, 10/2 CAP ANGLE	97.00"	60.00"
I	UPRIGHT LIMIT SWITCH, 10/2 UPRIGHT(LEV	97.00"	60.00"
J	UPRIGHT LIMIT SWITCH, 10/2 TOWER(LEV	77.00"	40.00"
K	ALLOY RAM CABLE REPAIR	52.00"	20.00"
L	10/3 CABLE UPPER	52.00"	20.00"
M	SKY POWER TOWER, 8 C CABLE	52.00"	20.00"
N	UPPER TELE V2	46.00"	11.00"
O	UPPER TELE V1	46.00"	11.00"
P	4J UPRIGHT RELIEF VALVE TO 4 J PULL VALVE	82.00"	50.00"
Q	BOOM UPRIGHT CAM VALVE C. UPRIGHT RELIEF #1	76.00"	44.00"
R	LOWER LIFT V1 VALVE RELIEF #2	65.00"	30.00"
S	LOWER LIFT CYLINDER	46.00"	11.00"
T	UPRIGHT TILT SENSOR	37.00"	12.00"

Figure 4-21. Powertrack Installation Tower Boom (Sheet 3 of 3)

4.16 POWERTRACK MAINTENANCE

Flat Bar Removal

NOTE: *Hoses shown in the Powertrack are for example only. Actual hose and cable arrangements will be different.*

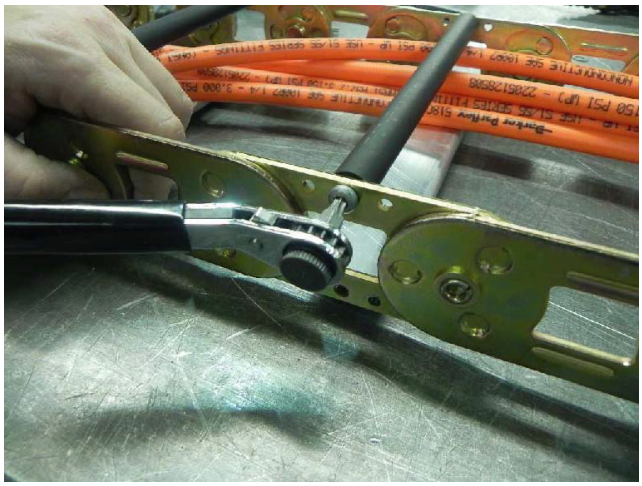


1. Use a small ¼" ratchet and a T-20 Torx bit. Remove the 8-32 x 0.500 screws from both sides. (If the track also has a flat bar on the inside of the track instead of round bar/poly, perform the same step to remove it.)

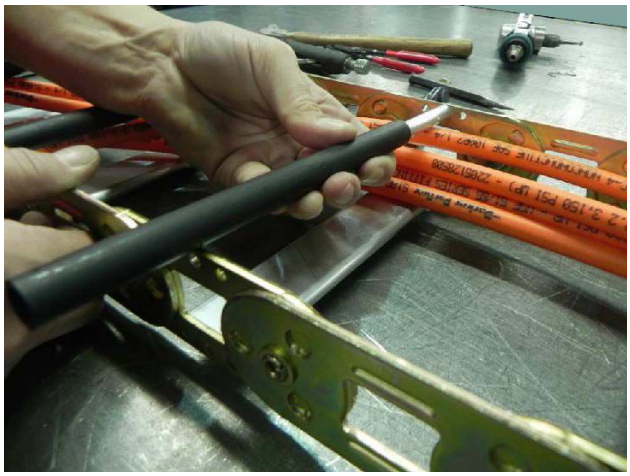


Round Bar/Poly Bar Removal

1. Use a small ¼" ratchet with a T-25 Torx bit. Remove the 10-24 x 0.812 screw. (If the bar spins then grip the bar and poly tightly with a vise-grip).

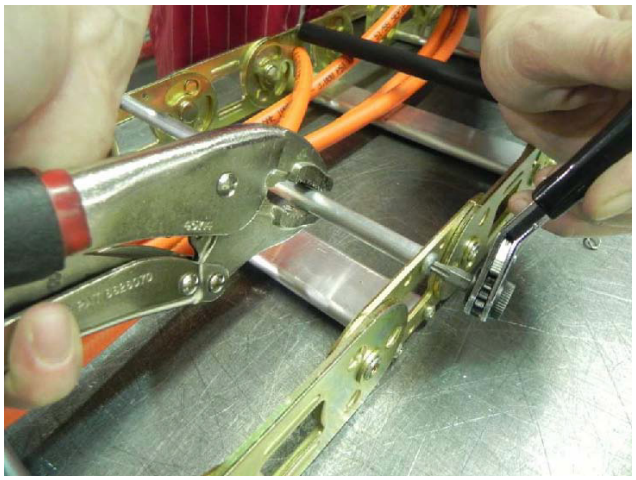


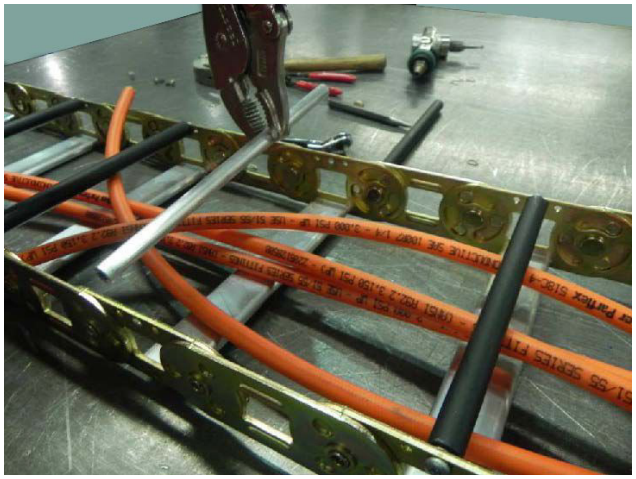
2. Lift up one end of the bar and slide the poly roller off.





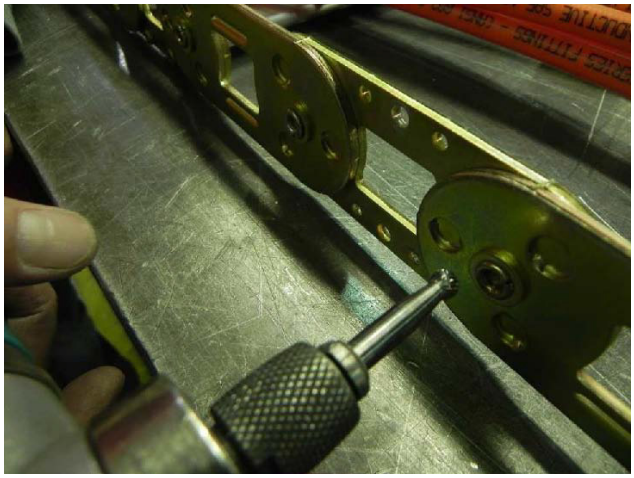
3. While gripping the bar tightly, remove the other 10-24 x 0.812 screw.



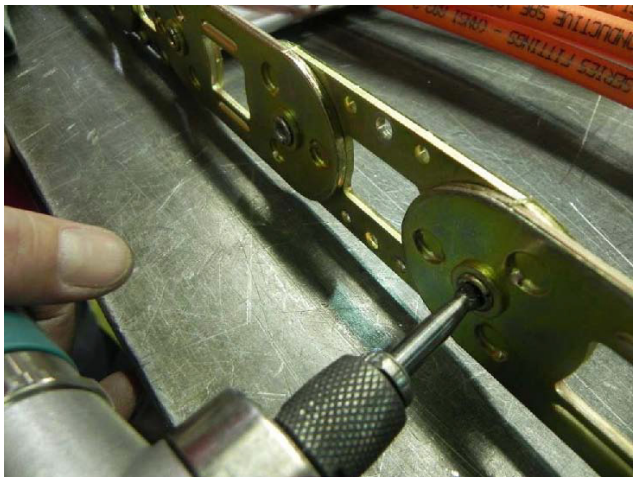


Removing and Installing Links

1. To remove the links, the rivets holding the links together must be removed. The following will show one way this can be done. Use a right angle die grinder with a ¼" ball double cut bur.



2. Insert the tool into the rolled over end of the rivet as shown. Grind out the middle of the rivet until the rolled over part of the rivet falls off. Repeat this step for all rivets that must be removed.

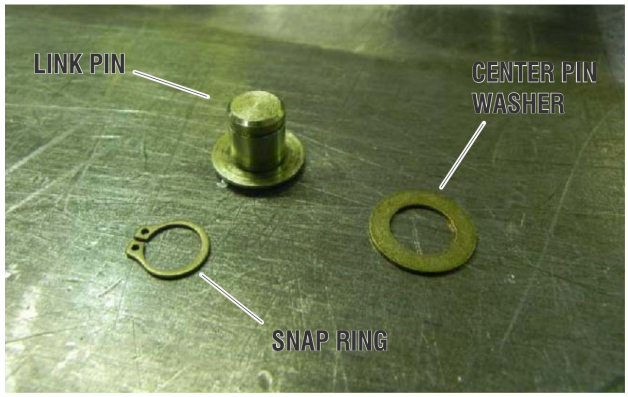


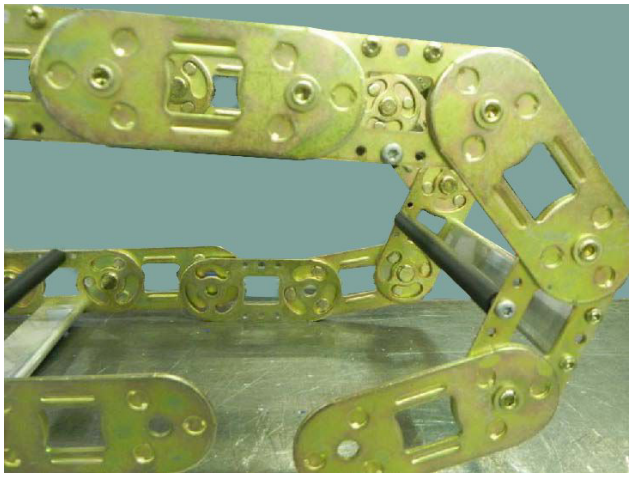
3. After grinding, it is sometimes necessary to use a center punch to punch out the rivet from the link.





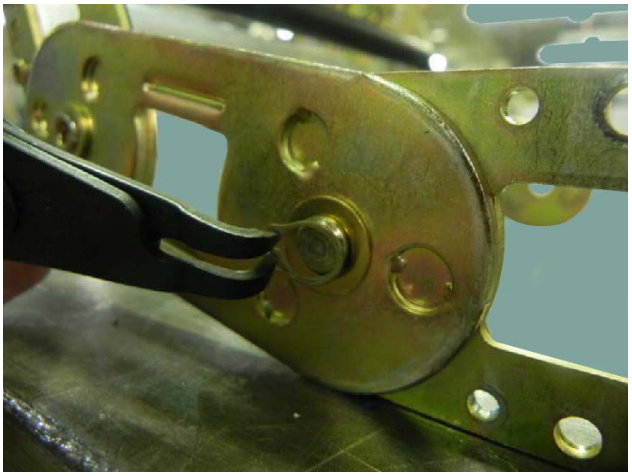
4. To install new links, extend the main moving end over the lower part of the track so the new connection point is in the curved part of the track. This will allow the round half-shears to be rotated in a way they will fit into the peanut-shaped cut-outs.



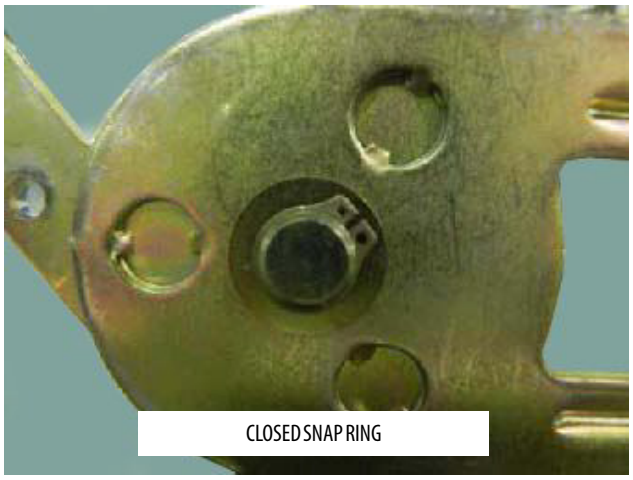


5. Install the pin into the center hole, then slide the washer over the pin. Install the snap ring into the groove in the pin.



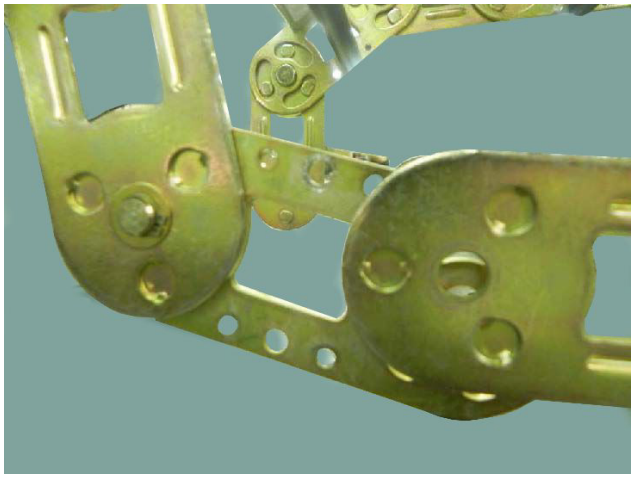


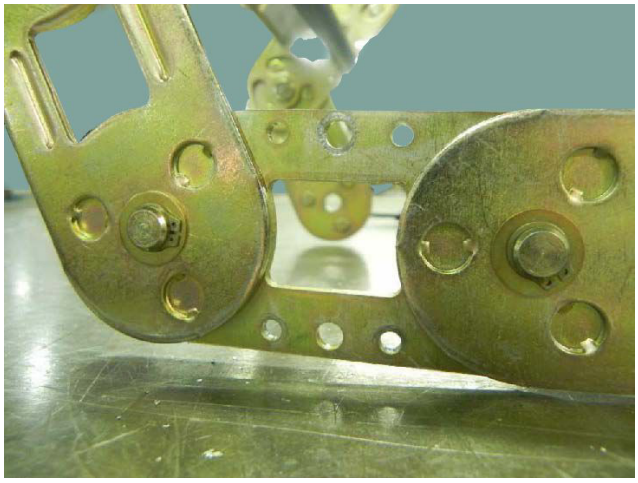
NOTE: *When installing snap rings make sure they are seated in the pin groove and closed properly.*





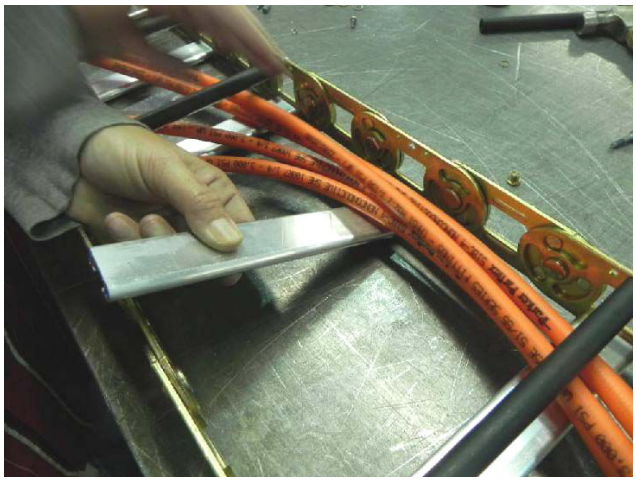
6. Install more pins, washers, and snap rings into all the links where a rivet was removed.

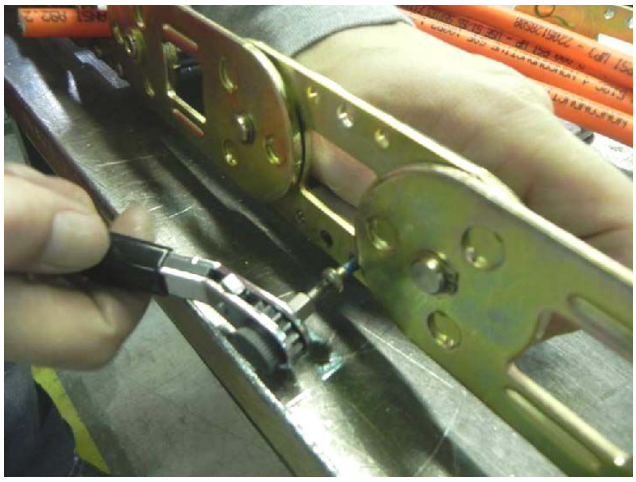




Installing a New Flat Bar

1. While holding the flat bar, install new 8-32 x 0.500 self threading torx screws into both holes on each side of track.

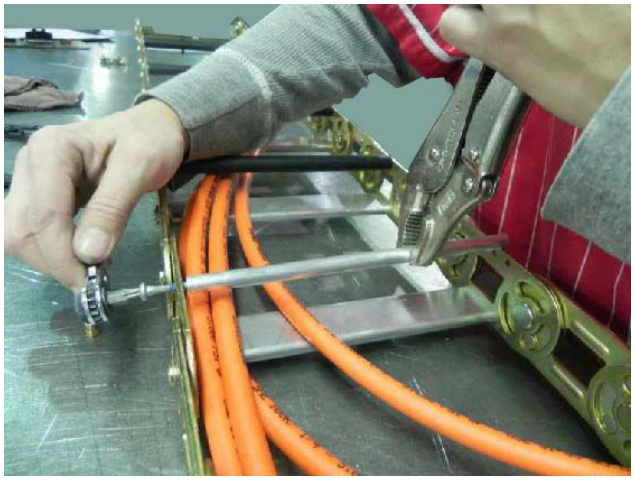




NOTE: *Maximum tightening torque for the 8-32 screw is 18-20 in-lbs (2-2.2 Nm).*

Installing a New Round Bar/Poly Roller

1. While tightly holding the round bar, install the new 10-24 x 0.812 self threading torx screw. Next lift up the other end and slide a new poly roller on. Install another 10-24 x 0.812 screw on the other side.



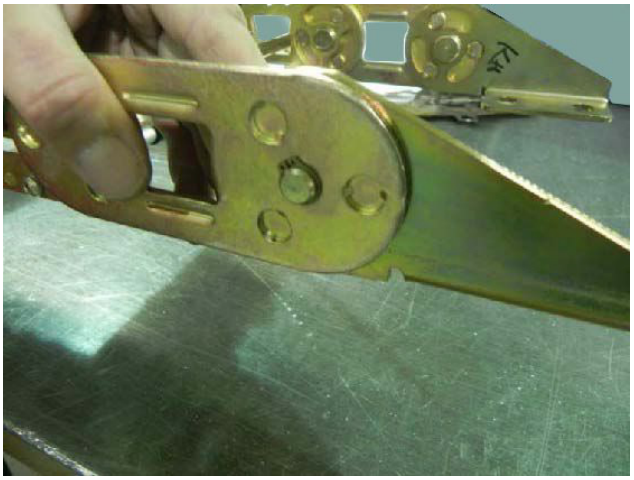




NOTE: *Maximum tightening torque for the 10-24 screw is 45-50 in-lbs (5-5.6 Nm).*

Replacing a Fixed End Bracket

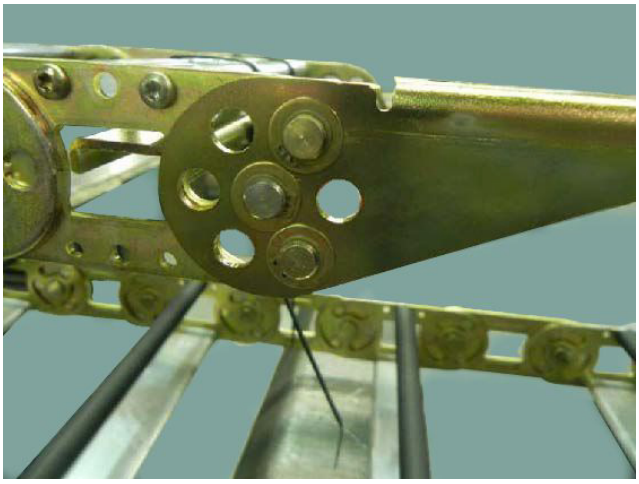
1. Remove the bracket by removing the center pin, washer, and snap ring. Install a new bracket then reinstall the pin, washer, and new snap ring. After installing the new bracket make sure that it rotates correctly.





Replacing a Moving End Bracket

1. Remove bracket by removing all pins, washers, and snap rings. Replace with a new bracket and reinstall the pins, washers, and new snap rings. After installing a new bracket make sure that it rotates correctly.

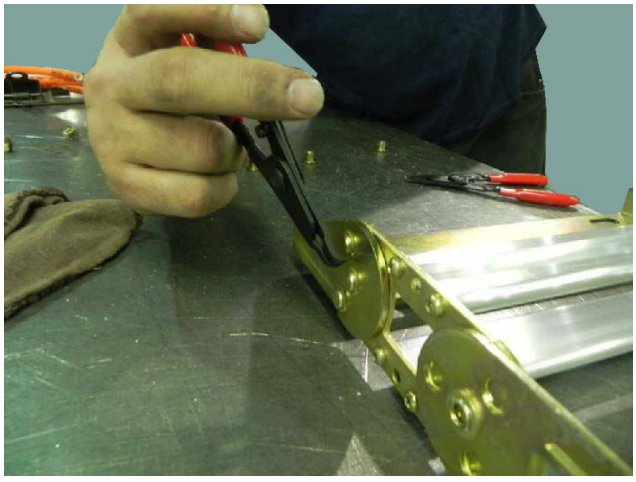


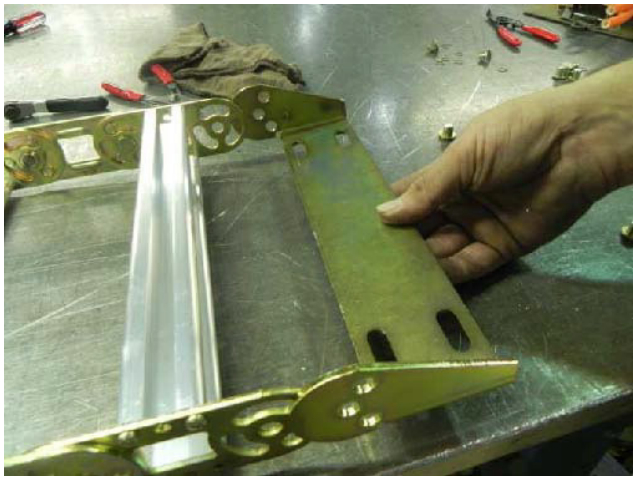


Replacing a One Piece Bracket

1. Remove all pins, washers, and snap rings and slide the bracket off of the links.

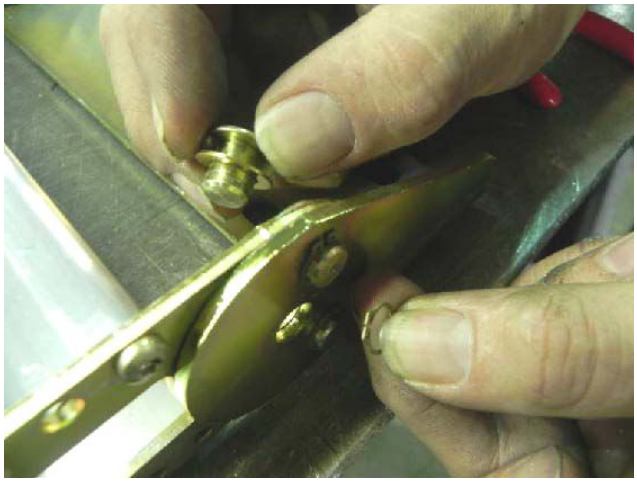


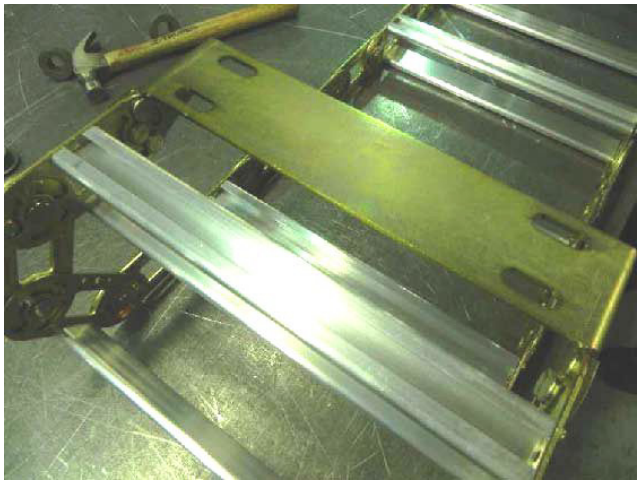




2. To install a new bracket, slide the bracket over the links and reinstall the pins, washers, and new snap rings. After installing the new bracket make sure that it rotates correctly.



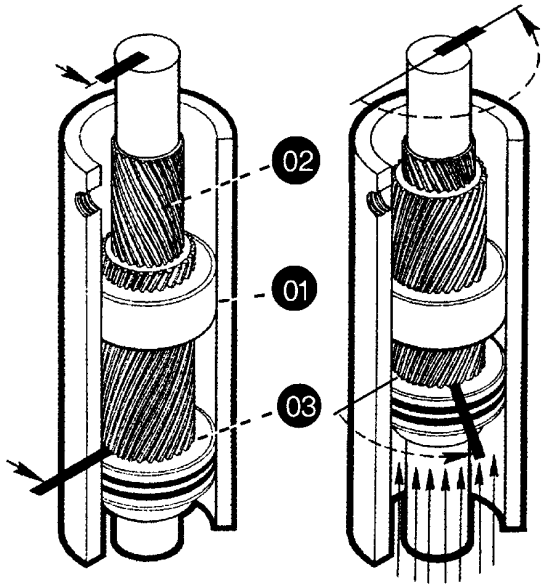




4.17 ROTATOR ASSEMBLY

Theory of Operation

The L20 Series rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert linear piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear teeth (01) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (02), and the annular piston sleeve (03). Helical spline teeth machined on the shaft engage matching splines on the in- side diameter of the piston. The outside diameter of the piston carries a second set of splines, of opposite hand, which engage with matching splines in the housing. As hydraulic pressure is applied, the piston is displaced axially within the housing - similar to the operation of a hydraulic cylinder - while the splines cause the shaft to rotate. When the control valve is closed, oil is trapped inside the actuator, preventing piston movement and locking the shaft in position.



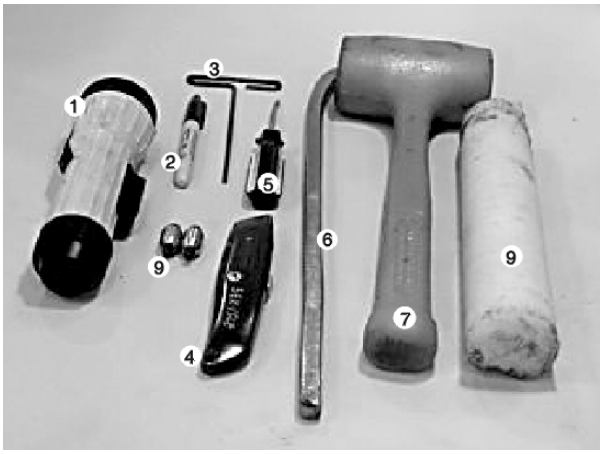
Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.

As fluid pressure is applied, the piston is displaced axially while the helical gearing causes the piston and shaft to rotate simultaneously. The double helix design compounds rotation: shaft rotation is about twice that of the piston.

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

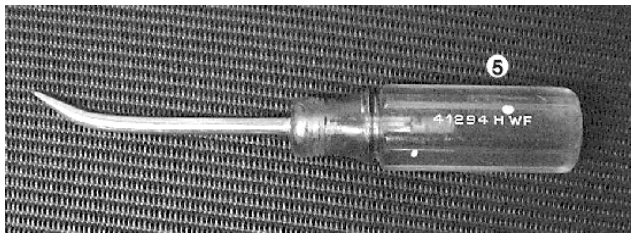
Required Tools

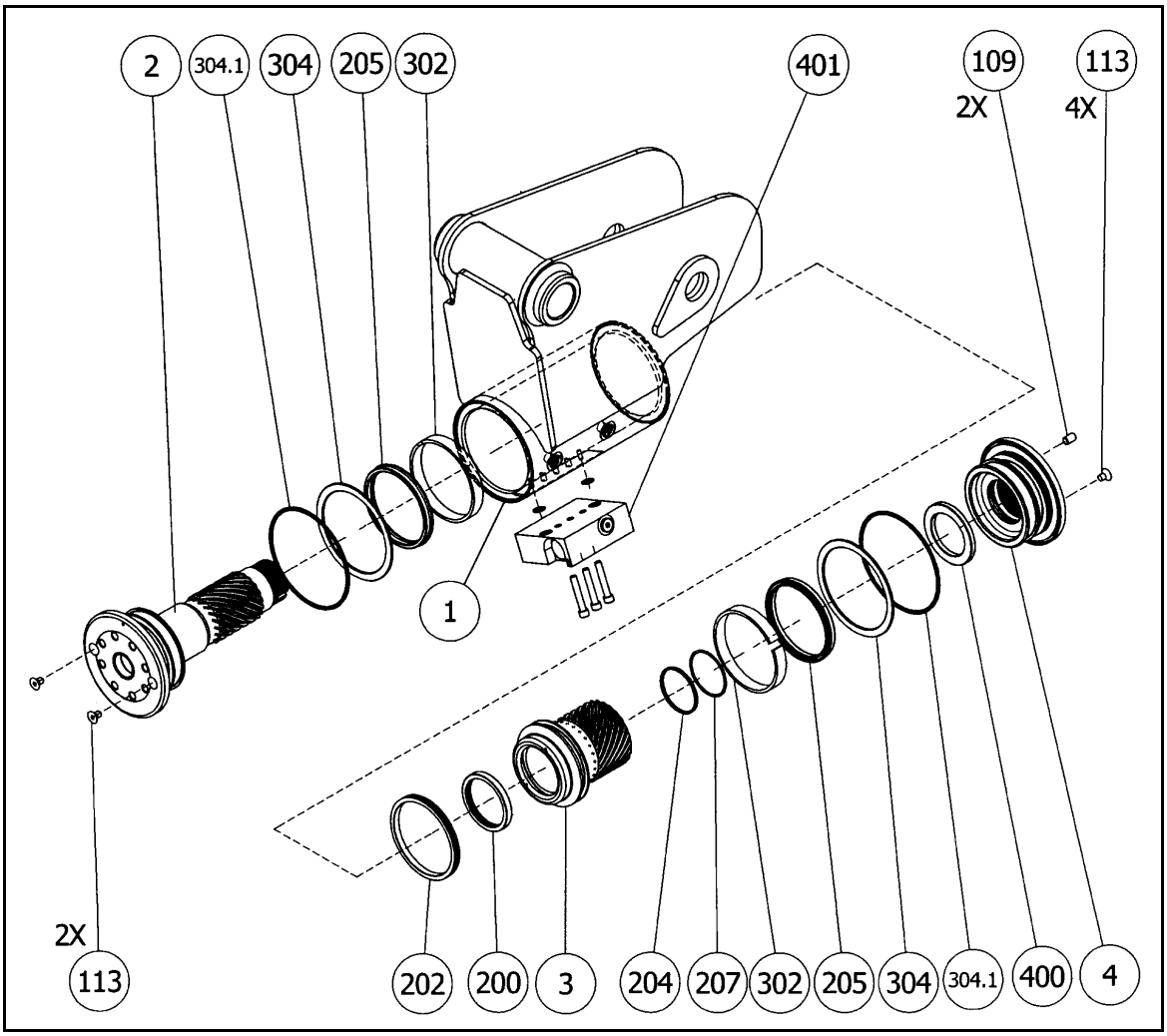
Upon assembly and disassembly of the actuator there are basic tools required. The tools and their intended functions are as follows:



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

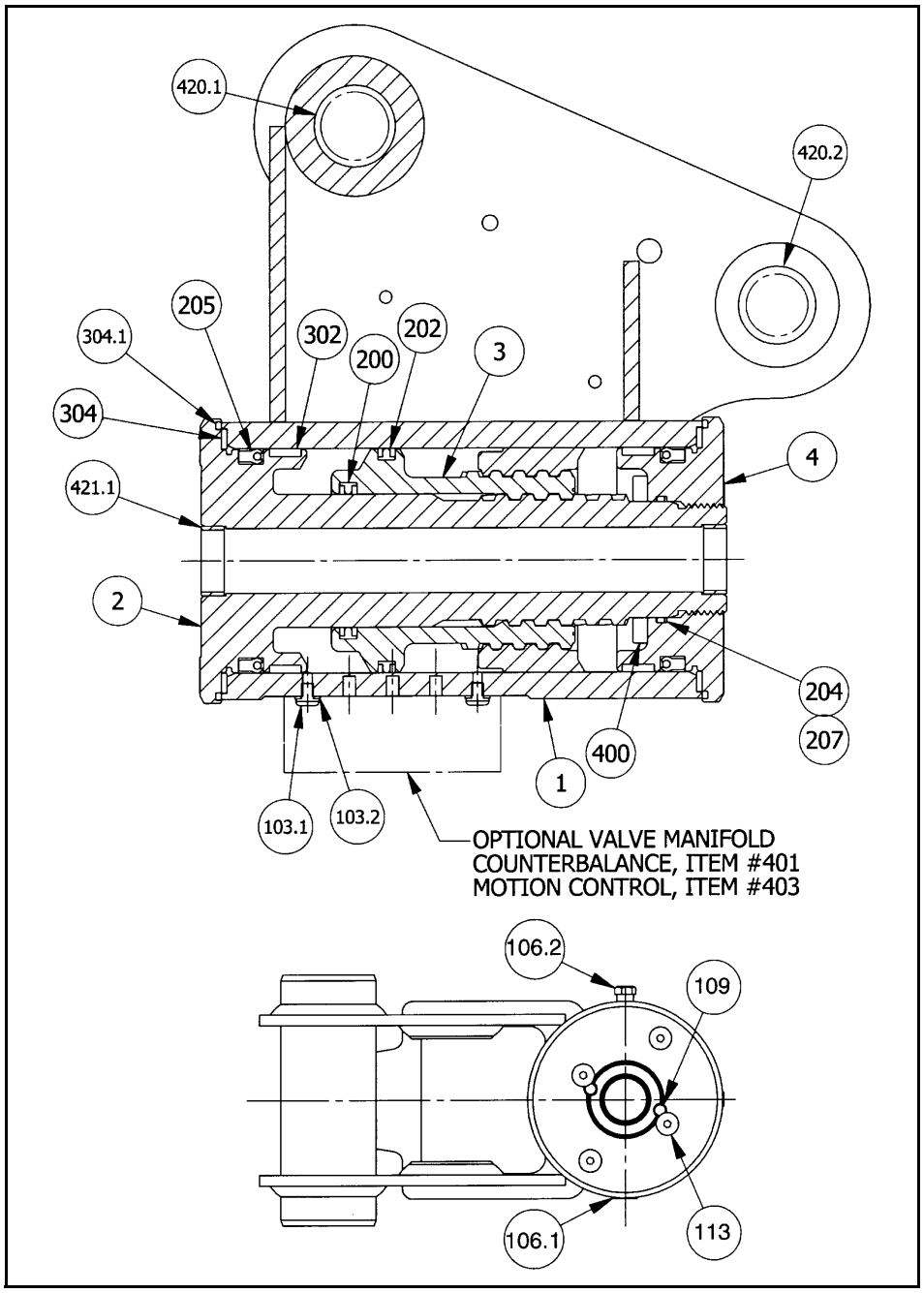
The seal tool is merely a customized standard flat head screwdriver. To make this tool you will need to heat the flat end with a torch. Secure the heated end of the screwdriver in a vice and physically bend the heated end to a slight radius. Once the radius is achieved round off all sharp edges of the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





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

Figure 4-22. Rotator - Exploded View



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

Figure 4-23. Rotator- Assembly Drawing

Disassembly

⚠ CAUTION

SECURE PRODUCT TO SLOTTED TABLE OR VISE.

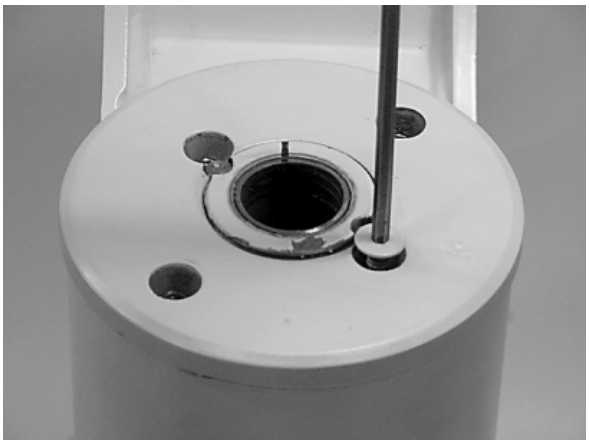
⚠ CAUTION

CONTENTS UNDER PRESSURE. WEAR APPROVED EYE PROTECTION. USE CAUTION WHEN REMOVING PORT PLUGS AND FITTINGS.

NOTICE

MAKE SURE WORK AREA IS CLEAN.

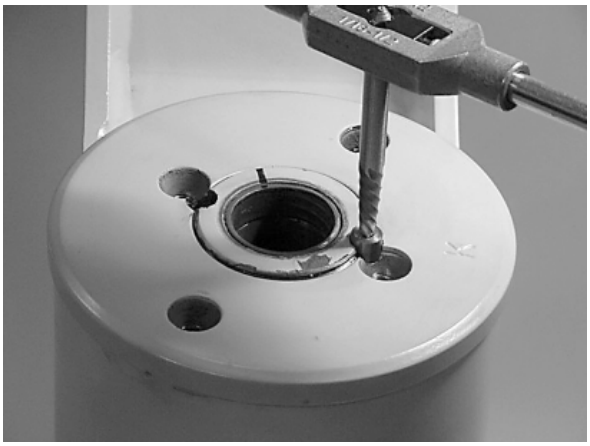
1. Remove the Capscrews (113) over end cap lock pins (109).



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

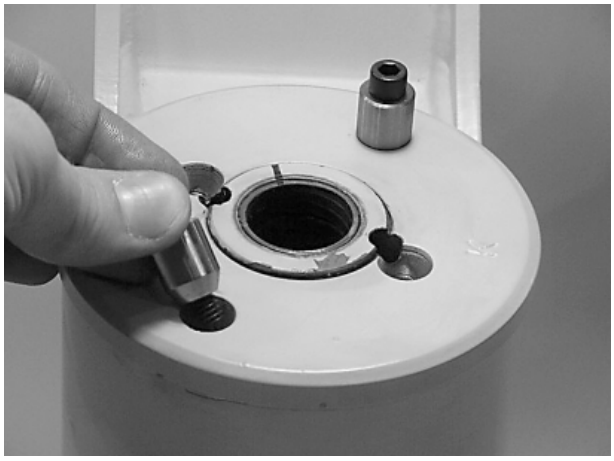


3. Remove the lock pins using an "Easy Out" (a size #2 is shown).



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

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



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



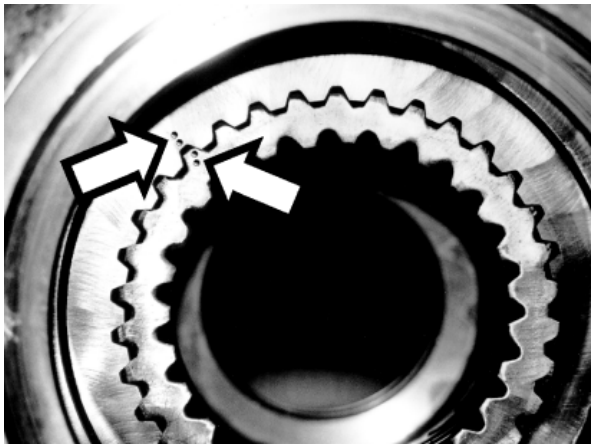
6. Remove the end cap (4) and set aside for later inspection.

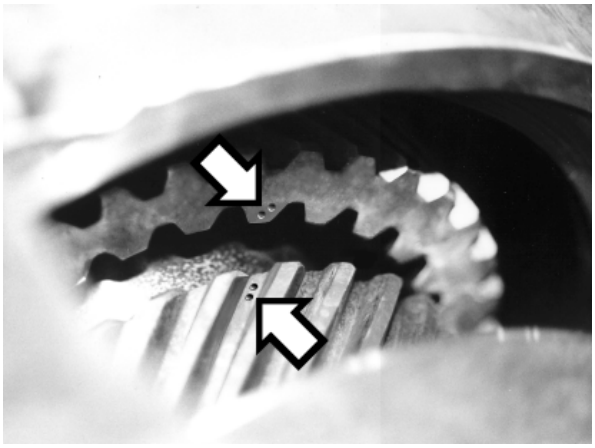


7. Remove the stop tube if equipped. The stop tube is an available option to limit the rotation of the actuator.



8. Every actuator has timing marks for proper engagement.

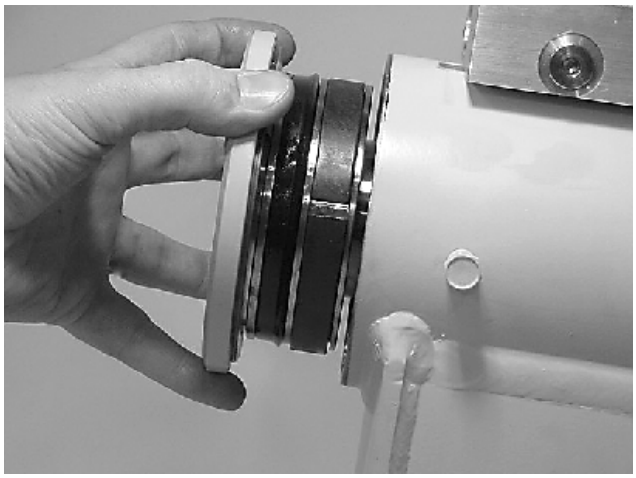




9. Prior to removing the shaft, (2), use a felt marker to clearly indicate the timing marks between shaft and piston. This will greatly simplify timing during assembly.



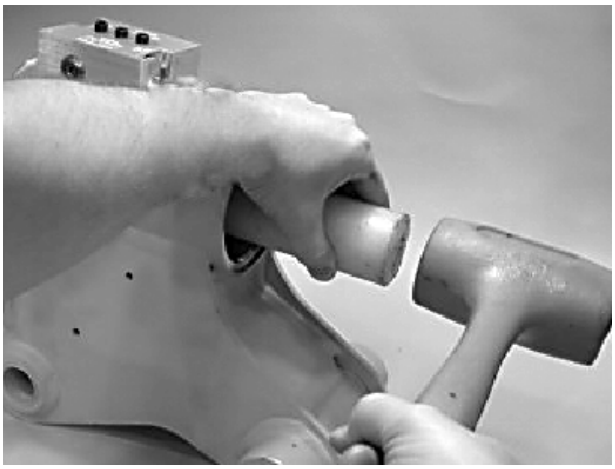
10. Remove the shaft (2). It may be necessary to strike the threaded end of the shaft with a rubber mallet.



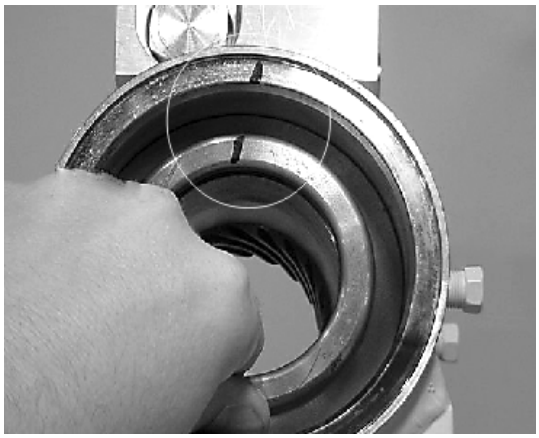
11. Before removing the piston (3), mark the housing (1) ring gear in relation to the piston O.D. gear. There should now be timing marks on the housing (1) ring gear, the piston (3) and the shaft (2).



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



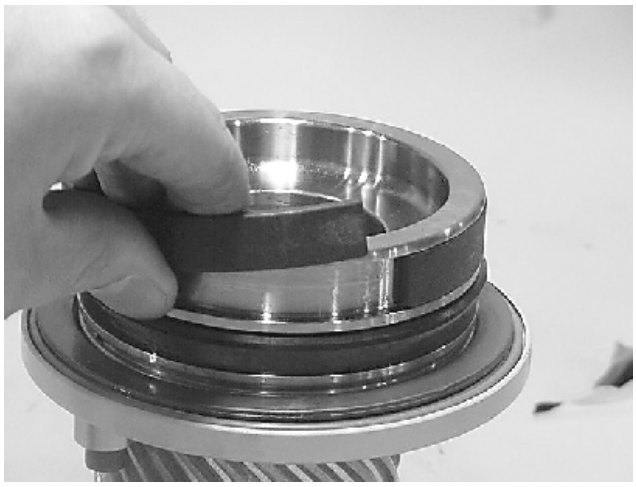
13. At the point when the piston gear teeth come out of engagement with the housing gear teeth, mark the piston and housing with a marker as shown.



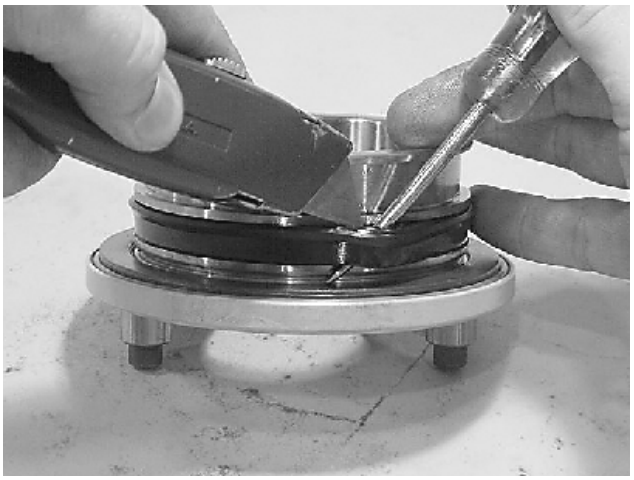
14. Remove the o-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.



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



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



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



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



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



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



Inspection

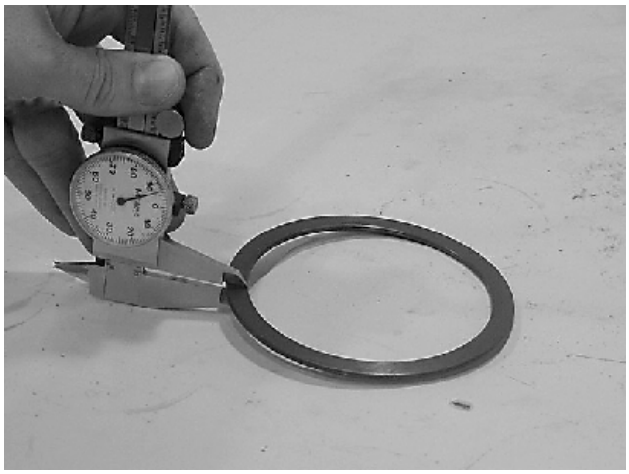
NOTICE

SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.

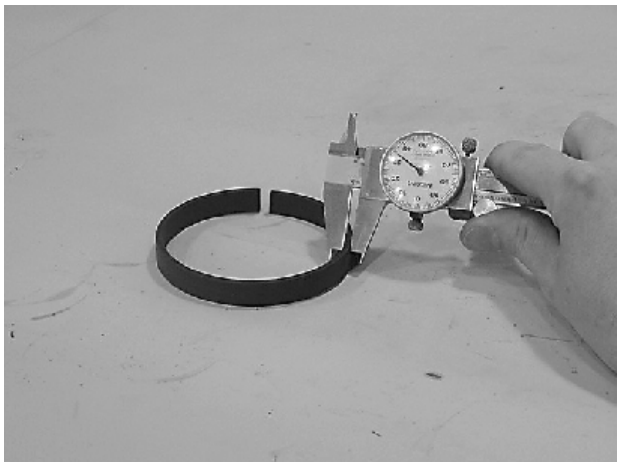
1. Clean all parts in a solvent tank and dry with compressed air prior to inspecting. Carefully inspect all critical areas for any surface finish abnormalities: Seal grooves, bearing grooves, thrust surfaces, rod surface, housing bore and gear teeth.



2. Inspect the thrust washers (304) for rough or worn edges and surfaces. Measure it's thickness to make sure it is within specifications (Not less than 0.092" or 2.34 mm).

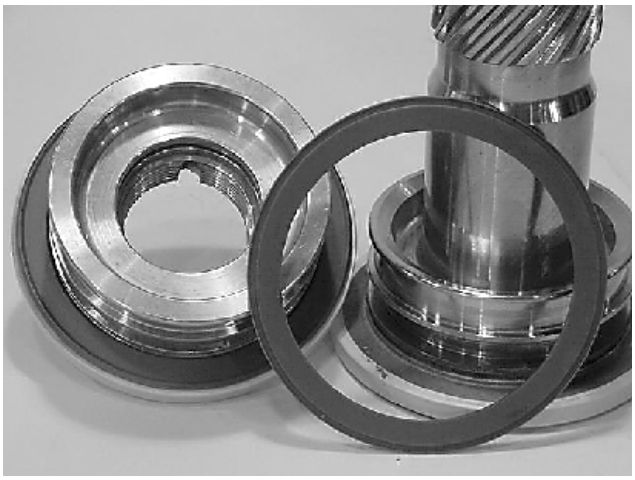


3. Inspect the wear guide condition and measure thickness (not less than 0.123" or 3.12 mm).

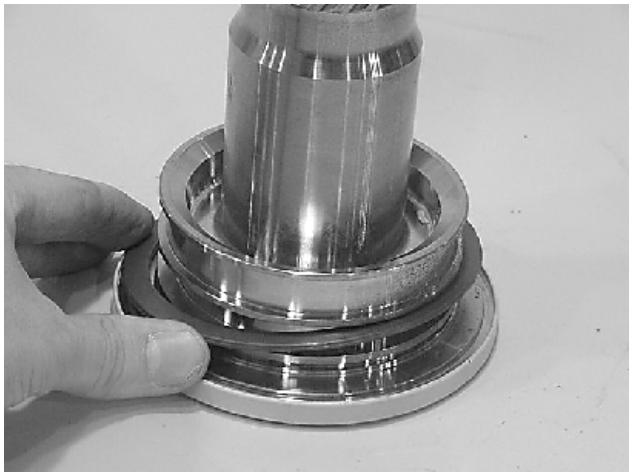


Assembly

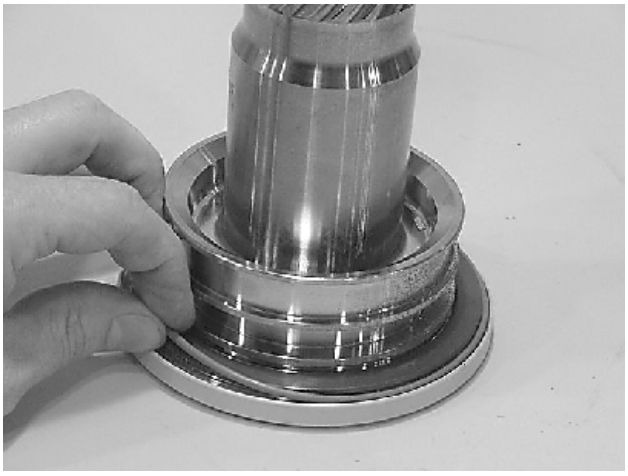
1. Gather all the components and tools into one location prior to re-assembly. Use the cut away drawing to reference the seal orientations.



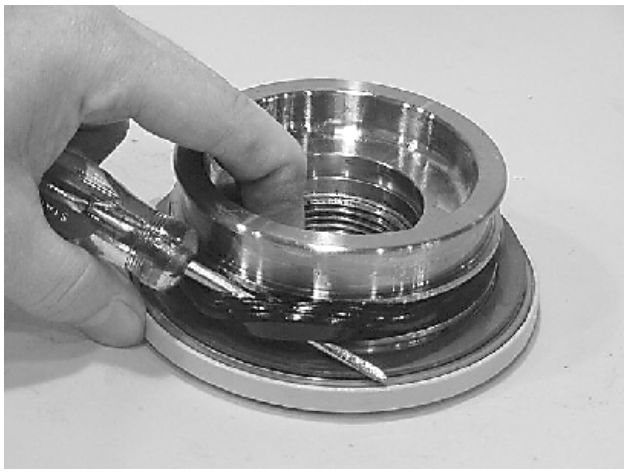
2. Install the thrust washer (304) onto shaft (2) and end cap (4).



3. Install the wiper seal (304.1/green 0-ring) into the groove on the shaft (2) and end cap (4) around the outside edge of the thrust washer (304).



4. Using a seal tool install the main pressure seal (205) onto shaft (2) and end cap (4). Use the seal tool in a circular motion.



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



6. Install the O-ring (204) and backup ring (207) into the inner seal groove on the end cap (4).



7. Install the inner T-seal (200) into the piston (3) using a circular motion.

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

   Each T-seal has 2 backup rings (see drawing for orientation).

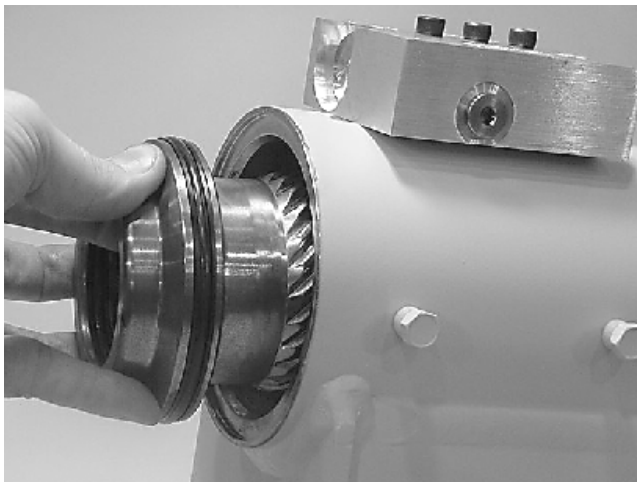


   Beginning with the inner seal (200) insert one end of b/u ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly.

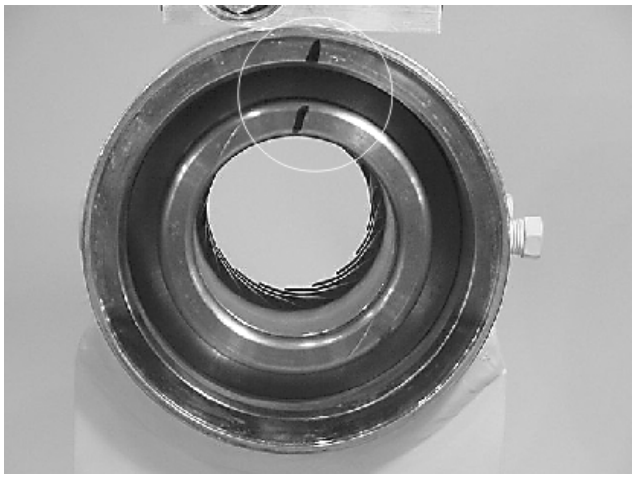
   Repeat this step for the outer seal (202).



8. Insert the piston (3) into the housing (1) as shown, until the outer piston seal (202) is touching inside the housing bore.



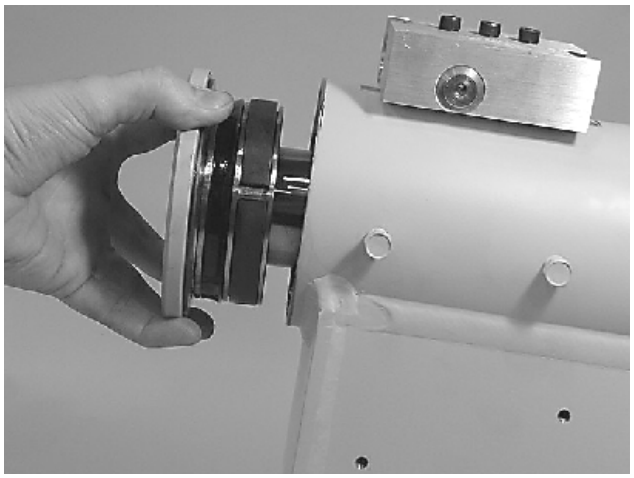
9. Looking from the angle shown, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.



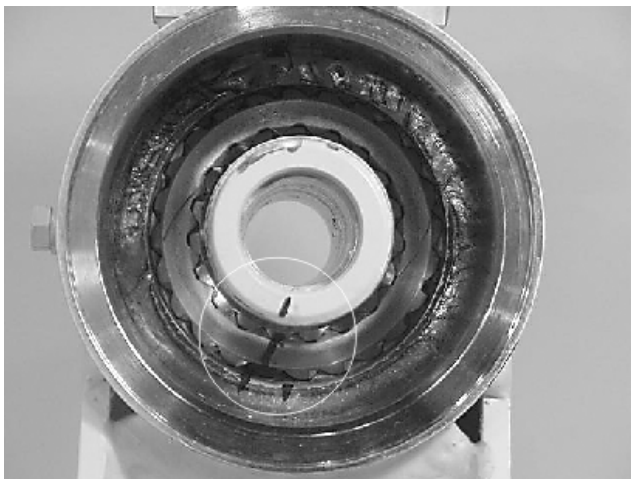
10. Looking from the opposite end of the housing (1) you can see if your timing marks are lining up. When they do, tap the piston (3) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.



11. Install the shaft (2) into the piston (3). Be careful not to damage the seals. Do not engage the piston gear teeth yet.



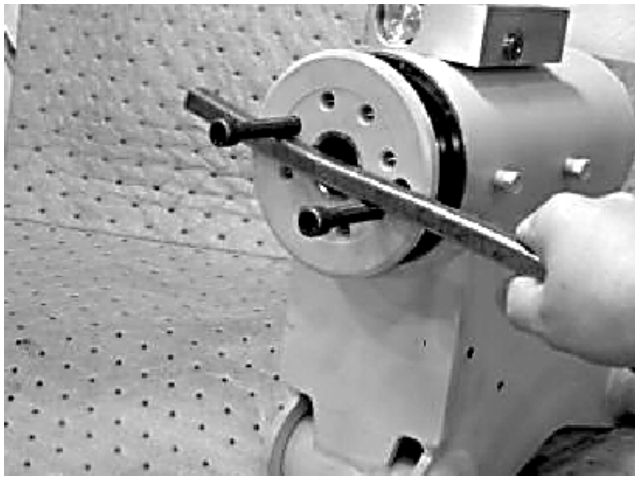
12. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.



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

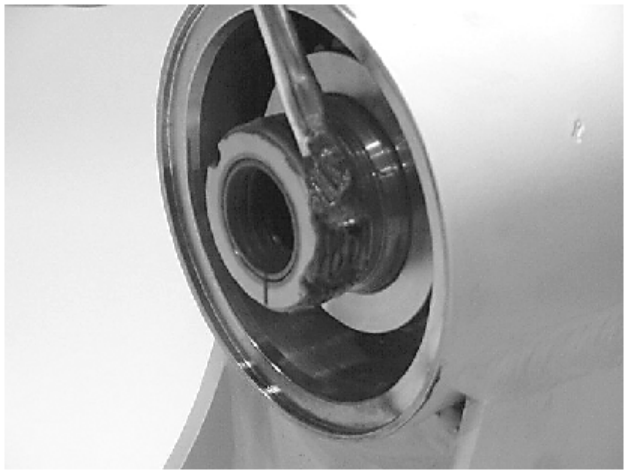
NOTICE

AS THE SHAFT IS ROTATED, BE CAREFUL NOT TO DISENGAGE THE PISTON AND HOUSE GEARING.



14. Install the stop tube onto the shaft end, if equipped. Stop tube is an available option to limit the rotation of an actuator.

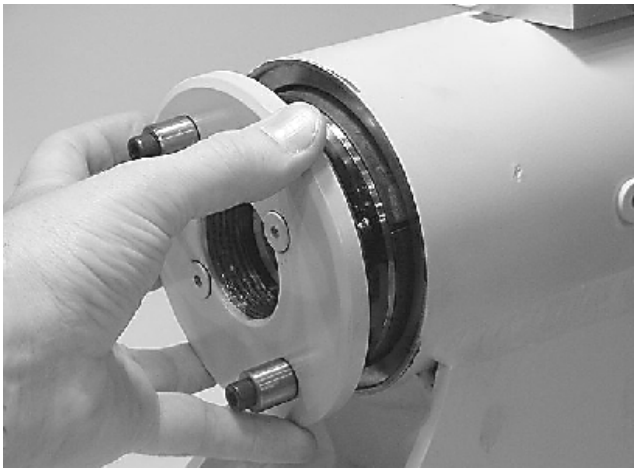
15. Coat the threads on the end of the shaft with anti-seize grease to prevent galling.



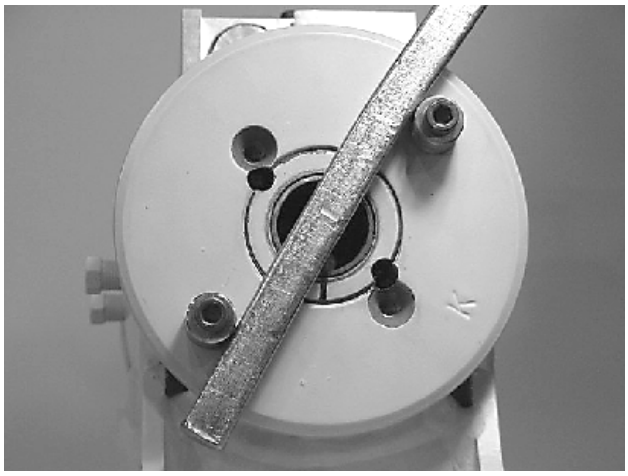
16. Install the 0-ring (204) and backup ring (207) into the inner seal groove on the end cap (4).



17. Thread the end cap (4) onto the shaft (2) end. Make sure the wear guide remains in place on the end cap as it is threaded into the housing (1).



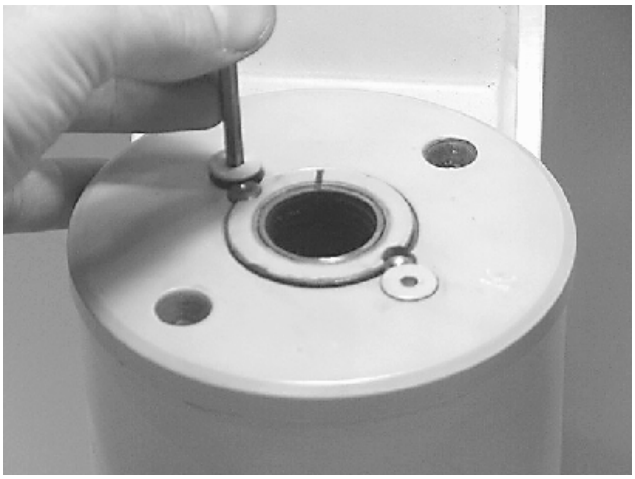
18. Tighten the end cap (4). In most cases the original holes for the lock pins will line up.



19. Place the lock pins (109) provided in the Helac seal kit in the holes with the dimple side up. Then, using a punch, tap the lock pins to the bottom of the hole.



20. Insert the set screws (113) over the lock pins. Tighten them to 25 in. lbs. (2.825 Nm).



Installing Counterbalance Valve

Refer to Figure 4-24., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old JLG Threadlocker P/N 0100011.
2. Make sure the new valve has the O-rings in the counterbores of the valve to seal it to the actuator housing.
3. The bolts that come with the valve are grade 8 bolts. New bolts should be installed with a new valve. JLG Threadlocker P/N 0100011 should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4-inch bolts 110 to 120 in.lbs. (12.4 to 13.5 Nm). Do not torque over 125 in.lbs. (14.1 Nm). Torque the 5/16-inch bolts 140 in.lbs. (15.8 Nm). Do not torque over 145 in.lbs. (16.3 Nm).
5. Make sure the valve is seated against the housing valve flat. If it is raised up on any side or corner, remove the valve to determine what the obstruction is. If possible, test this using a hydraulic hand pump or electric test.

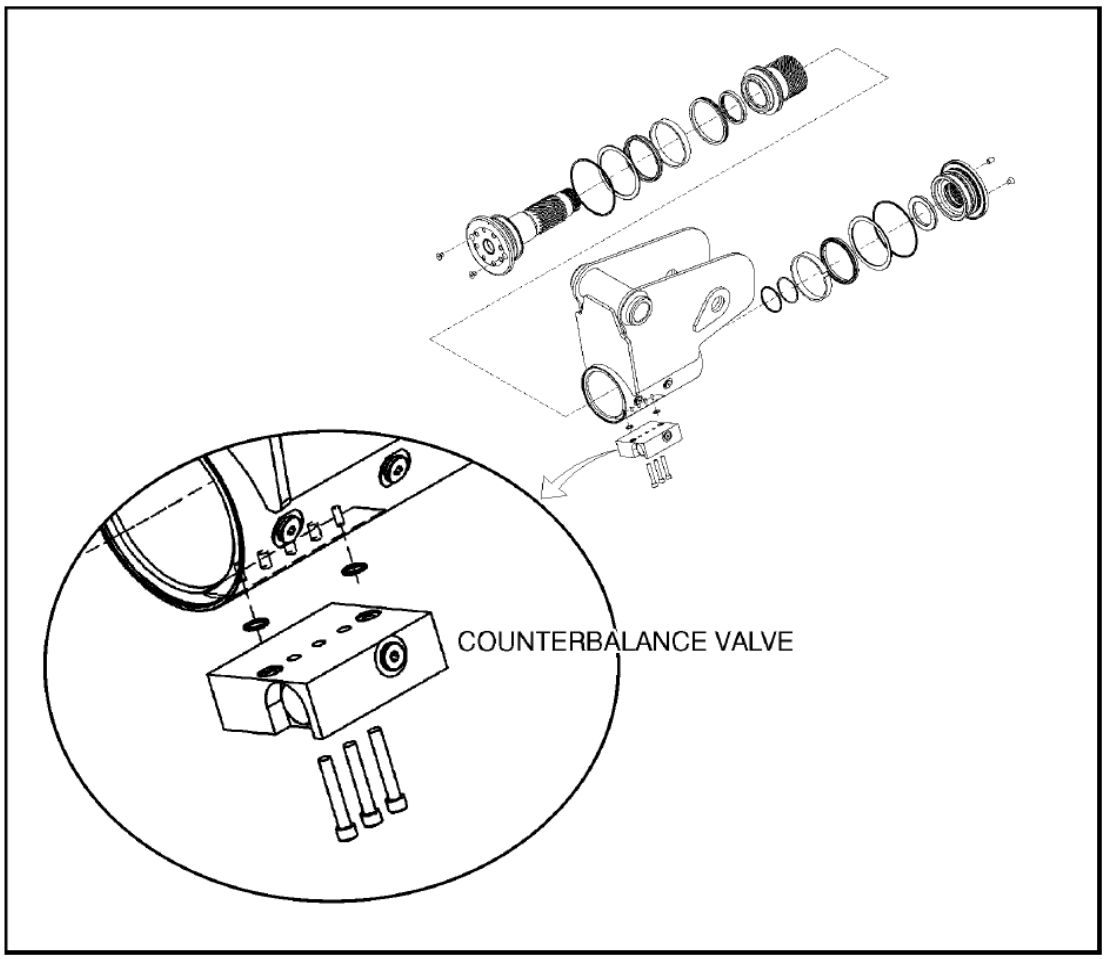


Figure 4-24. Rotator Counterbalance Valve

Greasing Thrust Washers

1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.

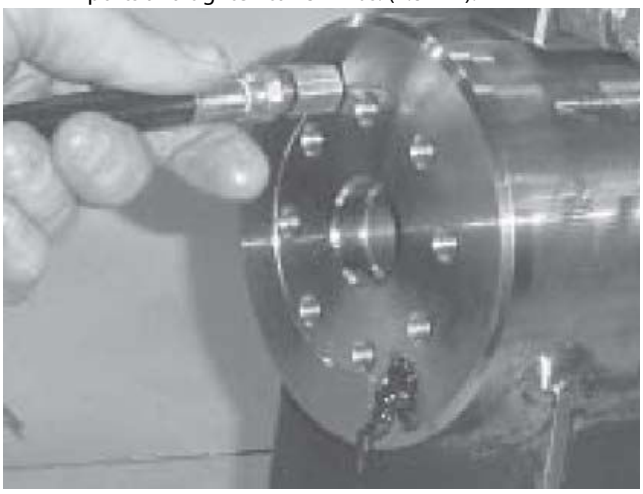
2. There are two grease ports located on both the shaft flange and the end cap. They are plugged with Capscrews (113) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view)



NOTICE

IF A HYDRAULIC TEST BENCH IS NOT AVAILABLE, THE ACTUATOR CAN BE ROTATED BY HAND, OPEN THE PRESSURE PORTS AND USE A PRY BAR WITH CAPSCREWS INSERTED INTO THE SHAFT FLANGE TO TURN THE SHAFT IN THE DESIRED DIRECTION.

3. Insert the tip of a grease gun into one port and apply grease to the shaft flange. Continue applying until grease flows from the opposite port. Cycle the actuator five times and apply grease again. Repeat this process on the end cap. Insert the Capscrews into the grease ports and tighten to 25 in-lbs. (2.8 Nm).



Testing the Actuator

If the equipment is available, the actuator should be tested on a hydraulic test bench. The breakaway pressure — the pressure at which the shaft begins to rotate — should be approximately 400 psi (28 bar). Cycle the actuator at least 25 times at 3000 psi (210 bar) pressure. After the 25 rotations, increase the pressure to 4500 psi (315 bar) to check for leaks and cracks. Perform the test again at the end of the rotation in the opposite direction.

TESTING THE ACTUATOR FOR INTERNAL LEAKAGE

If the actuator is equipped with a counterbalance valve, plug the valve ports. Connect the hydraulic lines to the housing ports. Bleed all air from the actuator (see Installation and Bleeding) Rotate the shaft to the end of rotation at 3000 psi (210 bar) and maintain pressure. Remove the hydraulic line from the non-pressurized side.

Continuous oil flow from the open housing port indicates internal leakage across the piston. Replace the line and rotate the shaft to the end of rotation in the opposite direction. Repeat the test procedure outlined above for the other port. If there is an internal leak, disassemble, inspect and repair.

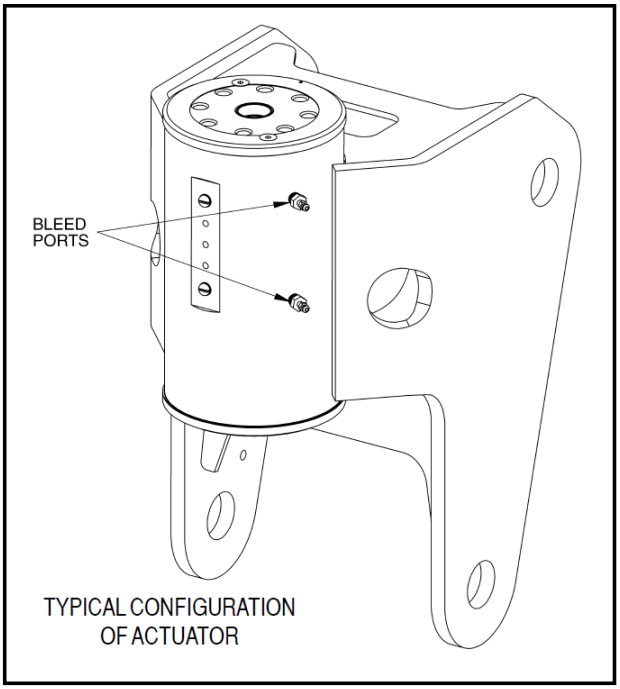
Installation and Bleeding

After installation of the actuator on the equipment, it is important that all safety devices such as tie rods or safety cables are properly reattached.

To purge air from the hydraulic lines, connect them together to create a closed loop and pump hydraulic fluid through them. Review the hydraulic schematic to determine which hydraulic lines to connect. The linear feet and inside diameter of the hydraulic supply lines together with pump capacity will determine the amount of pumping time required to fully purge the hydraulic system.

Bleeding may be necessary if excessive backlash is exhibited after the actuator is connected to the hydraulic system. The following steps are recommended when a minimum of two gallons (8 liters) is purged.

1. Connect a 3/16" inside diameter x 5/16" outside diameter x 5 foot clear, vinyl drain tube to each of the two bleed nipples. Secure them with hose clamps. Place the vinyl tubes in a clean 5-gallon container to collect the purged oil. The oil can be returned to the reservoir after this procedure is completed.



TYPICAL CONFIGURATION
OF ACTUATOR

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

4.18 FOOT SWITCH ADJUSTMENT

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

Troubleshooting

Table 4-1. Troubleshooting

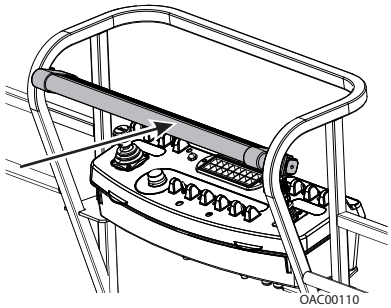
Problem	Cause	Solution
1. Shaft rotates slowly or not at all	a. Insufficient torque output	a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.
	b. Low rate of fluid flow	b. Inspect ports for obstructions and hydraulic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

4.19 SKYGUARD

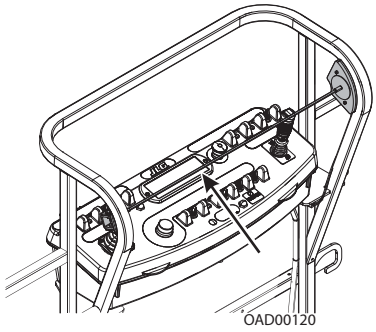
Operation

SkyGuard provides enhanced control panel protection. When the SkyGuard sensor is activated, functions in use at the time of actuation will reverse or cutout. The SkyGuard Function Table provides more details on these functions.

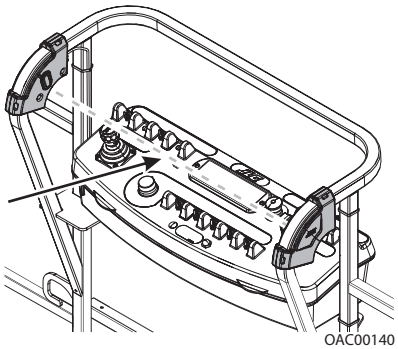
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



SkyGuard



SkyGuard SkyLine™



SkyGuard SkyEye™

⚠ WARNING

THE MACHINE OPERATOR IS REQUIRED TO PERFORM A DAILY FUNCTION TEST TO ENSURE PROPER OPERATION OF THE SKYGUARD SYSTEM.

Function Test

SKYGUARD ONLY

Perform this function test if **SkyGuard only** is selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops then telescope in function operates for a short duration. Additionally, verify Soft Touch/SkyGuard indicator light flashes and horn sounds. If machine is equipped with SkyGuard beacon, ensure it flashes when sensor activates.
3. With SkyGuard sensor still engaged, press and hold yellow Soft Touch/SkyGuard override button. Operate a function to verify operation can be resumed.
4. Disengage SkyGuard sensor, release controls, and recycle footswitch. Ensure normal operation available.

In Ground Mode:

Operation is allowed regardless of SkyGuard activation.

SOFT TOUCH ONLY

If **Soft Touch only** is selected in machine setup (refer to Table 6-2), machine will treat the Soft Touch/SkyGuard override switch as if it is a Soft Touch switch.

SKYGUARD NOT SELECTED IN MACHINE SETUP

If the SkyGuard system is installed on the machine, but no option is selected in the machine setup (refer to Table 6-2), SkyGuard sensor status will be ignored. No function cutout or reversal will be implemented.

Diagnostics & Troubleshooting

If SkyGuard does not function when the sensor is engaged, first verify the configuration under the
MACHINE SETUP: SKYGUARD OPTION menu using the handheld Analyzer. Ensure the selected configuration matches the actual system installed on the machine. If not, select the correct configuration, then verify operation.

Additionally, use the handheld analyzer to navigate to the DIAGNOSTICS: FEATURES → SKYGUARD INPUTS menu to determine additional SkyGuard fault information.

Engage the SkyGuard sensor and observe the Analyzer to determine if the switch/relay closes.

If the status of the switch/relay remains OPEN while the SkyGuard sensor is actively engaged, it is possible the sensor has failed and should be replaced immediately.

If the status of the switch/relay remains CLOSED while the SkyGuard sensor is actively engaged, a power or ground wire may not be making good contact or may be loose or broken. Additionally, there is a low probability that both relays may have failed.

If the switch/relay status is in disagreement, then one may have failed or is not installed correctly. In this case, the machine will be inoperable.

FAULT CODES

Refer to Table 6-14 for more fault code information

- **0039 -** SkyGuard switch activation fault
- **2563 -** switch disagreement fault

Table 4-2. SkyGuard Function Table

Drive Fwd	Drive Rev	Steer	Swing	Tower Lift up	Tower Tele Out	Tower Lift Down	Tower Tele In	Boom Lift up	Boom Lift Down	Boom Tele Out	Boom Tele In	Jib Lift	Basket Level	Basket Rorate
R*/C**	R	C	R	R	C	C	C	R	R	R	C	C	C	C
R = Indicates Reversal is Activated														
C = Indicates Cutout is Activated														
* If SkyGuard has been activated before Soft Touch the function will reverse, If Soft Touch has been activated before SkyGuard the function will cutout.														

NOTES:

SECTION 5. BASIC HYDRAULIC INFORMATION & HYDRAULIC SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

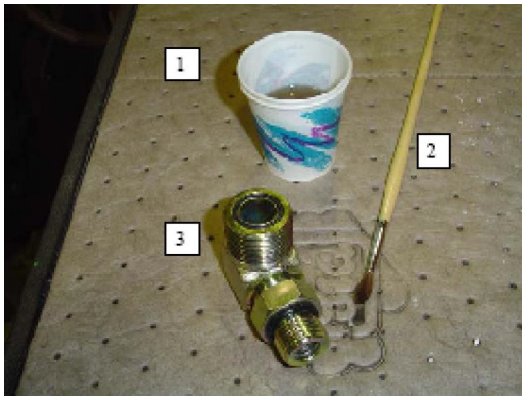
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

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

Cup and Brush

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

- A small container for hydraulic oil
- Small paint brush



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



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



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



Dip Method

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

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

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

1. Place the sponge inside the container and add hydraulic oil to the sponge until it is fully saturated.
2. Dip the fitting into the sponge using firm pressure. Upon lifting the fitting, a small droplet will form and drip from the bottom of the fitting. This should signify an even coating of oil on the fitting.



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



Spray Method

This method requires a pump or trigger spray bottle.

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



Brush-on Method

This method requires a sealed bottle brush.

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



5.2 HYDRAULIC CONNECTION ASSEMBLY AND TORQUE SPECIFICATION

Tapered Thread Types

NPTF = national tapered fuel (Dry Seal) per SAE J476/J512

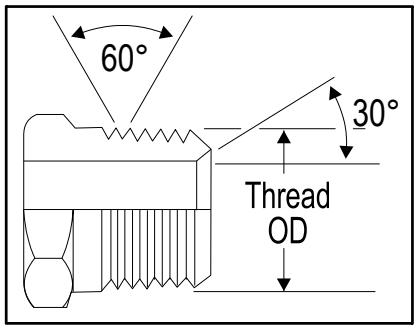


Figure 5-1. NPTF Thread

BSPT = British standard pipe tapered per ISO7-1

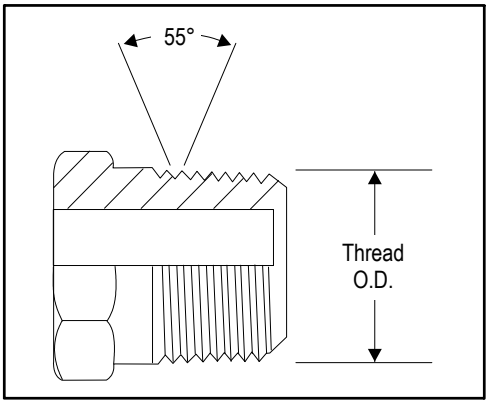


Figure 5-2. BSPT Thread

Straight Thread Types, Tube and Hose Connections

JIC = 37° flare per SAE J514

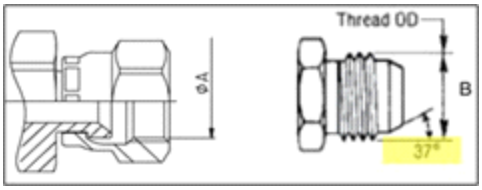


Figure 5-3. JIC Thread

SAE = 45° flare per SAE J512

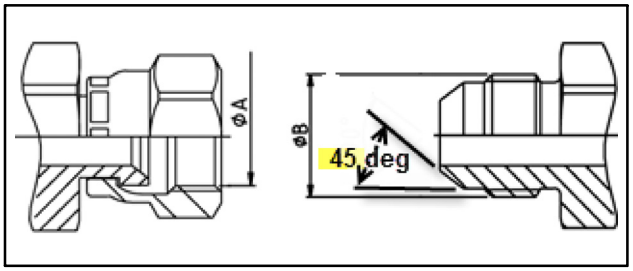


Figure 5-4. SAE Thread

ORFS = o-ring face seal per SAE J1453

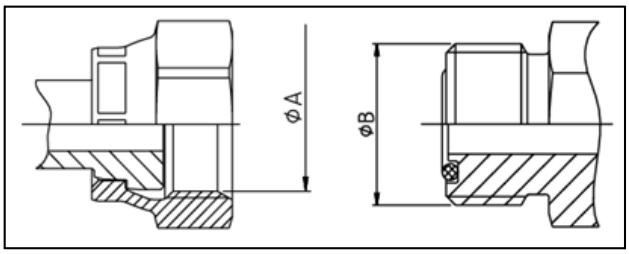


Figure 5-5. ORFS Thread

MBTL = metric flareless bite type fitting, pressure rating L (medium) per ISO 8434, DIN 2353

MBTS = metric flareless bite type fitting, pressure rating S (high) per ISO 8434, DIN 2353

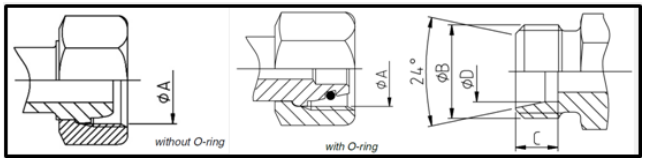


Figure 5-6. MTBL-MBTS Thread

BH = bulkhead connection – JIC, ORFS, MBTL, or MBTS types

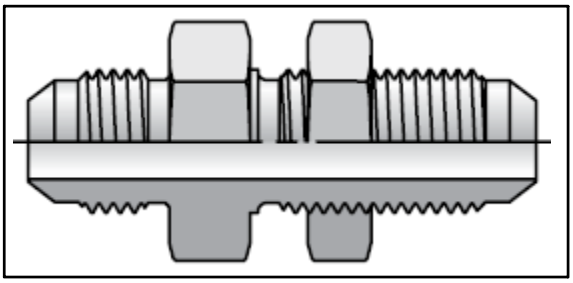


Figure 5-7. Bulkhead Thread

Straight Thread Types, Port Connections

ORB = o-ring boss per SAE J1926, ISO 11926

MPP = metric pipe parallel o-ring boss per SAE J2244, ISO 6149, DIN 3852

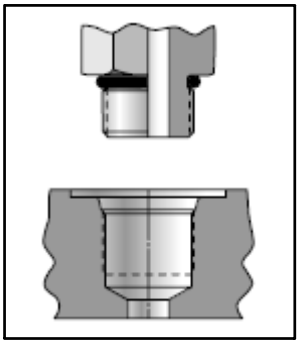


Figure 5-8. ORB-MPP Thread

MFF = metric flat face port per ISO 9974-1

BSPP = British standard parallel pipe per ISO 1179-1, DIN 3852-2

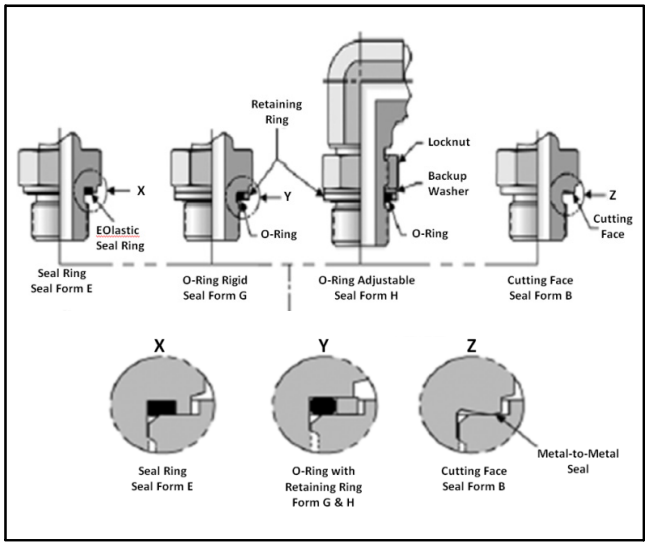


Figure 5-9. MFF-BSPP Thread

Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

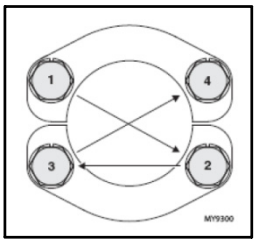


Figure 5-10. ORB-MPP Thread

Tightening Methods

Torque = Application of a twisting force to the applicable connection by use of a precise measurement instrument (i.e. torque wrench).

Finger Tight = The point where the connector will no longer thread onto the mating part when tightened by hand or fingers. Finger Tight is relative to user strength and will have some variance. The average torque applied by this method is 3 ft-lbs [4 N-m] Also referred to as 'Hand Tight.'

TFFT = Turns From Finger Tight; Application of a preload to a connection by first tightening the connection by hand (fingers) and applying an additional rotation counted by a defined number of turns by use of a tool.

FFWR = Flats from Wrench Resistance; Application of a preload to a connection by tightening to the point of initial wrench resistance and turning the nut a described number of 'flats'. A 'flat' is one side of the hexagonal tube nut and equates to 1/6 of a turn. Also referred to as the 'Flats Method.'

Assembly And Torque Specifications

Prior to selecting the appropriate torque from the tables within this section, it is necessary to properly identify the connector being installed. Refer to the Figures and Tables in this section.

GENERAL TUBE TYPE FITTING ASSEMBLY INSTRUCTIONS

1. Take precautions to ensure that fittings and mating components are not damaged during storage, handling or assembly. Nicks and scratches in sealing surfaces can create a path for leaks which could lead to component contamination and/or failure.
2. When making a connection to tubing, compression or flare, inspect the tube in the area of the fitting attachment to ensure that the tube has not been damaged.
3. The assembly process is one of the leading causes for contamination in air and hydraulic systems. Contamination can prevent proper tightening of fittings and adapters from occurring.
   - **a.** Avoid using dirty or oily rags when handling fittings.
   - **b.** If fittings are disassembled, they should be cleaned and inspected for damage. Replace fittings as necessary before re-installing.
   - **c.** Sealing compounds should be applied where specified; however, care should be taken not to introduce sealant into the system.
   - **d.** Avoid applying sealant to the area of the threads where the sealant will be forced into the system. This is generally the first two threads of a fitting.
   - **e.** Sealant should only be applied to the male threads.
   - **f.** Straight thread fittings do not require sealants. O-rings or washers are provided for sealing.
   - **g.** When replacing or installing an O-ring, care is to be taken while transferring the O-ring over the threads as it may become nicked or torn. When replacing an O-ring on a fitting, the use of a thread protector is recommended.
   - **h.** When installing fittings with O-rings, lubrication shall be used to prevent scuffing or tearing of the O-ring. See O-ring Installation (Replacement) in this section.
4. Take care to identify the material of parts to apply the correct torque values.
   - **a.** Verify the material designation in the table headings.
   - **b.** If specifications are given only for steel fittings and components, the values for alternate materials shall be as follows: Aluminum and Brass- reduce steel values by 35%; Stainless Steel- Use the upper limit for steel.
5. To achieve the specified torque, the torque wrench is to be held perpendicular to the axis of rotation.

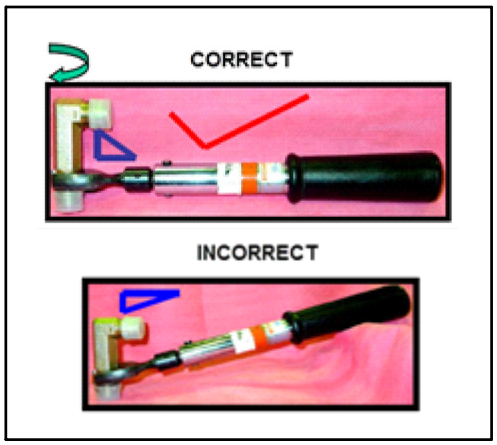


Figure 5-11. Torque Wrench Angle

6. Refer to the appropriate section in this manual for more specific instructions and procedures for each type of fitting connection

Assembly Instructions for American Standard Pipe Thread Tapered (NPTF) Connections.

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as Loctite 567, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

⚠ CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

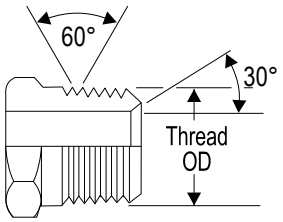
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-1, NPTF Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: *TFFT values provided in Table 5-1, NPTF Pipe Thread are applicable for the following material configurations:*

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-1. NPTF Pipe Thread



ØA dimension is measured on the 4th pitch of the thread

TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
Material	Dash Size	Thread Size	ØA*		
		(UNF)	(in)	(mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-27	0.40	10.24	2 to 3
	4	1/4-18	0.54	13.61	2 to 3
	6	3/8-18	0.67	17.05	2 to 3
	8	1/2-14	0.84	21.22	2 to 3
	12	3/4-14	1.05	26.56	2 to 3
	16	1-11 1/2	1.31	33.22	1.5 to 2.5
	20	1 1/4-11 1/2	1.65	41.98	1.5 to 2.5
	24	1 1/2-11 1/2	1.89	48.05	1.5 to 2.5
	32	2-11 1/2	2.37	60.09	1.5 to 2.5

* ØA thread dimension for reference only.

** See FFWR and TFFT Methods subsection for TFFT procedure requirements.

Assembly Instructions for British Standard Pipe Thread Tapered (BSPT) Connections

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as Loctite 567, to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

⚠ CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

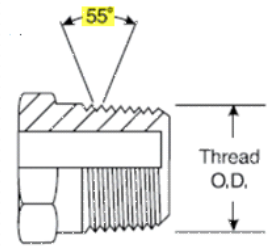
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-2, BSPT Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: *TFFT values provided in Table 5-2, BSPT Pipe Thread are applicable for the following material configurations:*

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-2. BSPT Pipe Thread



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
MATERIAL	Dash Size	Thread Size (BSPT)	ØA* (in)	ØA* (mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING COMPONENTS	2	1/8-28	0.38	9.73	2 to 3
	4	1/4-19	0.52	13.16	2 to 3
	6	3/8-19	0.66	16.66	2 to 3
	8	1/2-14	0.83	20.96	2 to 3
	12	3/4-14	1.04	26.44	2 to 3
	16	1-11	1.31	33.25	1.5 to 2.5
	20	1 1/4-11	1.65	41.91	1.5 to 2.5
	24	1 1/2-11	1.88	47.80	1.5 to 2.5
	32	2-11	2.35	59.61	1.5 to 2.5

* ØA thread dimension for reference only.

** See Appendix B for TFFT procedure requirements.

Assembly Instructions for 37° (JIC) Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting and start threads by hand.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

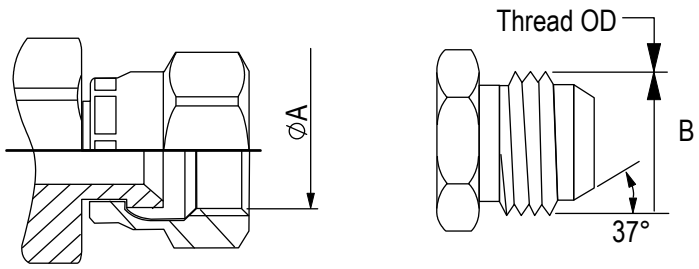
3. Torque assembly to value listed in Table Table 5-3, 37° Flare (JIC)Thread - Steel or Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass while using the Double Wrench Method per Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

NOTE: *Torque values provided in Table Table 5-3, 37° Flare (JIC)Thread - Steel and Table 5-4, 37° Flare (JIC)Thread - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-3. 37° Flare (JIC)Thread - Steel

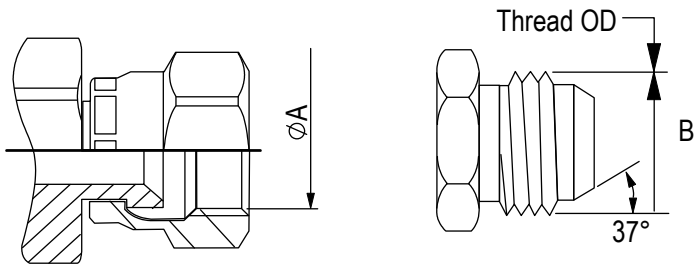


Type/Fitting Identification							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	7	8	9	10	--
	3	3/8-24	0.34	8.60	0.37	9.50	8	9	10	11	12	14	--
	4	7/16-20	0.39	10.00	0.44	11.10	13	14	14	18	19	19	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	14	15	15	19	20	21	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	22	23	24	30	31	33	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	42	44	46	57	60	63	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	60	63	66	81	85	89	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	84	88	92	114	120	125	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	100	105	110	136	142	149	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	118	124	130	160	168	176	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	168	176	185	228	239	251	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	195	205	215	264	278	291	3/4 to 1
	32	2 1/2-12	2.42	61.50	2.50	63.50	265	278	292	359	377	395	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

Table 5-4. 37° Flare (JIC)Thread - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	4	4	5	5	6	7	--
	3	3/8-24	0.34	8.60	0.37	9.50	5	6	7	7	8	9	--
	4	7/16-20	0.39	10.00	0.44	11.10	8	9	9	11	12	13	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	9	10	10	12	13	14	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	14	15	16	19	20	21	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	27	29	30	37	39	41	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	39	41	43	53	56	58	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	55	57	60	74	78	81	1 to 1-1/2
	14	13/16-12	1.11	28.30	1.19	30.10	65	68	72	88	93	97	1 to 1-1/2
	16	15/16-12	1.23	31.30	1.31	33.30	77	81	84	104	109	114	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	109	115	120	148	155	163	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	127	133	139	172	180	189	3/4 to 1
	32	2 1/2-12	2.42	61.50	2.50	63.50	172	181	189	234	245	257	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

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Assembly Instructions for 45° SAE Flare Fittings

1. Inspect the flare for obvious visual squareness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting.
3. Tighten fitting by hand until hand tight.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

Torque fitting to value listed in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass while using the Double Wrench Method outlined in this section. Refer to FFWR and TFFT Methods for procedure requirements if using the TFFT method.

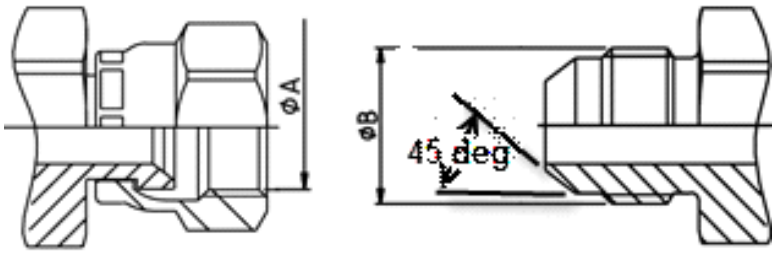
NOTE: *Torque values provided in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS

mating components.

Table 5-5. 45° Flare (SAE) - Steel

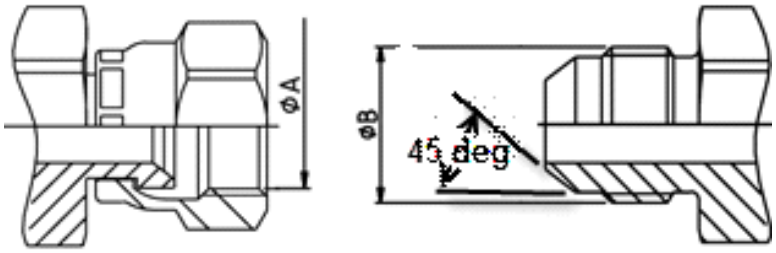


TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	13	14	14	18	19	19
	6	5/8-18	0.56	14.30	0.63	15.90	22	23	24	30	31	33
	8	3/4-16	0.69	17.50	0.75	19.10	42	44	46	57	60	62
	10	7/8-14	0.81	20.60	0.87	22.20	60	63	66	81	85	89
	12	11/16-14	0.98	25.00	1.06	27.00	84	88	92	114	119	125

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methodsfor FFWR procedure requirements.

Table 5-6. 45° Flare (SAE) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque					
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]		
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	8	9	9	11	12	12
	6	5/8-18	0.56	14.30	0.63	15.90	14	15	15	19	20	20
	8	3/4-16	0.69	17.50	0.75	19.10	27	29	30	37	39	41
	10	7/8-14	0.81	20.60	0.87	22.20	39	41	43	53	56	58
	12	11/16-14	0.98	25.00	1.06	27.00	55	58	61	75	79	83

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for TFFT procedure requirements.

Assembly Instructions for O-Ring Face Seal (ORFS) Fittings

1. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).
2. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Place the tube assembly against the fitting body so that the flat face comes in contact with the O-ring. Hand thread the nut onto the fitting body.
5. Torque nut to value listed in Table 5-7, O-ring Face Seal (ORFS) - Steel or Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass while using the Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

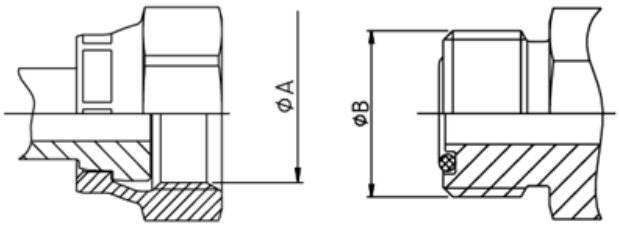
NOTE: *Torque values provided in Table 5-7, O-ring Face Seal (ORFS) - Steel and Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or

BRASS mating components

Table 5-7. O-ring Face Seal (ORFS) - Steel

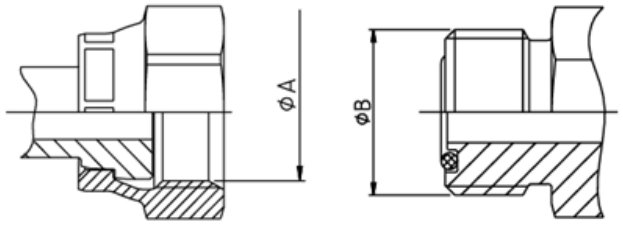


TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	18	19	20	25	26	27	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	30	32	33	40	43	45	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	40	42	44	55	57	60	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	60	63	66	81	85	89	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	85	90	94	115	122	127	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	110	116	121	149	157	164	1/4 to 1/2	1/2 to 3/4
	20	1 11/16-12	1.59	40.50	1.69	42.90	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	230	242	253	312	328	343	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	375	394	413	508	534	560	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methodsfor FFWR procedure requirements.

Table 5-8. O-ring Face Seal (ORFS) - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	0.51	13.00	0.56	14.20	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	6	11/16-16	0.63	15.90	0.69	17.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4
	8	13/16-16	0.75	19.10	0.81	20.60	26	28	29	35	38	39	1/4 to 1/2	1/2 to 3/4
	10	1-14	0.94	23.80	1.00	25.40	39	41	43	53	56	58	1/4 to 1/2	1/2 to 3/4
	12	13/16-12	1.11	28.20	1.19	30.10	55	58	61	75	79	83	1/4 to 1/2	1/2 to 3/4
	16	17/16-12	1.34	34.15	1.44	36.50	72	76	79	98	103	107	1/4 to 1/2	1/2 to 3/4
	20	1 11/16-12	1.59	40.50	1.69	42.90	98	103	108	133	140	146	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	12	13	13	16	18	18	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	20	21	22	27	28	30	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

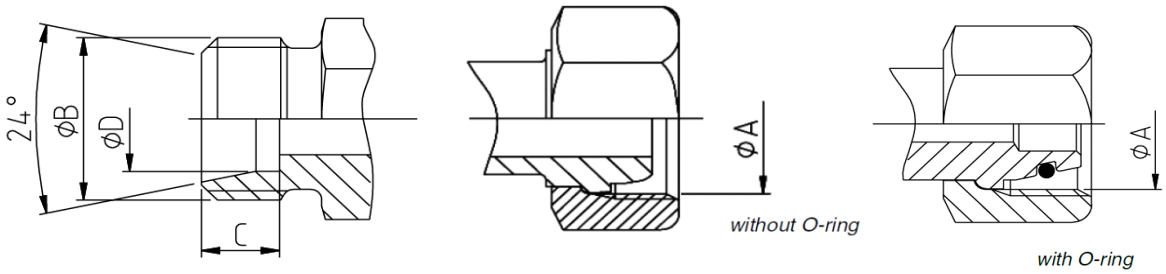
Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

⚠ CAUTION

A NON-SQUARE TUBE END CAN CAUSE IMPROPERLY SEATED FITTINGS AND LEAKAGE.

1. Inspect the components to ensure free of contamination, external damage, rust, splits, dirt, foreign matter, or burrs. Ensure tube end is visibly square. If necessary replace fitting or tube.
2. Lubricate thread and cone of fitting body or hardened pre-assembly tool, as well as the progressive ring and nut threads.
3. Slip nut and progressive ring over tube, assuring that they are in the proper orientation.
4. Push the tube end into the coupling body.
5. Slide collet into position and tighten until finger tight. Mark nut and tube in the finger-tight position. Tighten nut to the number of flats listed in Table Table 5-9, DIN 24°Cone (MBTL & MBTS) while using the Double Wrench Method. The tube must not turn with the nut.

Table 5-9. DIN 24°Cone (MBTL & MBTS)



TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)						
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Torque [Ft-Lb] Nom	Torque [Ft-Lb] Max	Torque [N-m] Min	Torque [N-m] Nom	Torque [N-m] Max	Flats from Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12x1.5	10.50	12.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the						1.5 to 1.75
		8	M14x1.5	12.50	14.00	7.00	8.20							1.5 to 1.75
		10	M16x1.5	14.50	16.00	7.00	10.20							1.5 to 1.75
		12	M18x1.5	16.50	18.00	7.00	12.20							1.5 to 1.75
		15	M22x1.5	20.50	22.00	7.00	15.20							1.5 to 1.75
		18	M26x1.5	24.50	26.00	7.50	18.20							1.5 to 1.75
		22	M30x2	27.90	30.00	7.50	22.20							1.5 to 1.75
		28	M36x2	33.90	36.00	7.50	28.20							1.5 to 1.75
		35	M45x2	42.90	45.00	10.50	35.30							1.5 to 1.75
		42	M52x2	49.90	52.00	11.00	42.30							1.5 to 1.75
	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque [Ft-Lb] Min	Torque [Ft-Lb] Nom	Torque [Ft-Lb] Max	Torque [N-m] Min	Torque [N-m] Nom	Torque [N-m] Max	Flats from Wrench Resistance (F.F.W.R)**
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)							
	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14x1.5	12.50	14.00	7.00	6.20	FFWR is the recommended method of fitting assembly. Torque values are application specific due to variability in the fitting supplier, coating, lubrication, and other physical characteristics of the connection. Refer to the specific procedure in the						1.5 to 1.75
		8	M16x1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
		10	M18x1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
		12	M20x1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
		14	M22x1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
		16	M24x1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
		20	M30x2	27.90	30.00	10.50	20.20							1.5 to 1.75
		25	M36x2	33.90	36.00	12.00	25.20							1.5 to 1.75
		30	M42x2	39.90	42.00	13.50	30.20							1.5 to 1.75
		38	M52x2	49.90	52.00	16.00	38.30							1.5 to 1.75

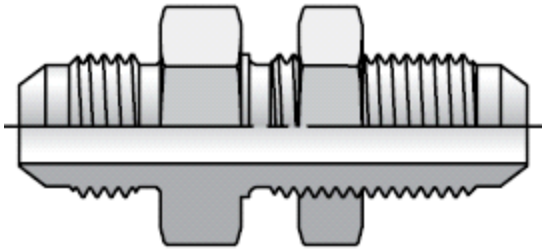
* ØA, ØB, C, & ØD thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

Assembly Instructions for Bulkhead (BH) Fittings

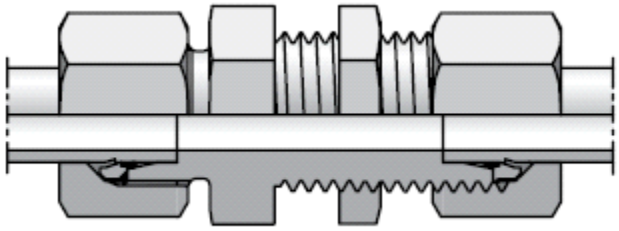
1. Ensure threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary replace fitting or adapter.
2. Remove the locknut from the bulkhead assembly.
3. Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
4. Hand thread the locknut onto the bulkhead end of the fitting body.
5. Torque nut onto fitting per Table 5-10 and Table 5-11 while using the Double Wrench Method.

Table 5-10. Bulkhead Fittings (BH) - INCH



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	O-RING FACE SEAL (ORFS) BULKHEAD FITTING	4	9/16-18	15	16	17	20	22	23
		6	11/16-16	25	27	28	34	37	38
		8	13/16-16	55	58	61	75	79	83
		10	1-14	85	90	94	115	122	127
		12	13/16-12	135	142	149	183	193	202
		14	15/16-12	170	179	187	230	243	254
		16	17/16-12	200	210	220	271	285	298
		20	111/16-12	245	258	270	332	350	366
		24	2-12	270	284	297	366	385	403
	TYPE	Dash Size	Thread Size	Torque					
				[Ft-Lb]			[N-m]		
			(UNF)	Min	Nom	Max	Min	Nom	Max
	37° FLARE (JIC) BULKHEAD FITTING	3	3/8-24	8	9	9	11	12	12
		4	7/16-20	13	14	14	18	19	19
		5	1/2-20	20	21	22	27	28	30
		6	9/16-18	25	27	28	34	37	38
		8	3/4-16	50	53	55	68	72	75
		10	7/8-14	85	90	94	115	122	127
		12	11/16-12	135	142	149	183	193	202
		14	13/16-12	170	179	187	230	243	254
		16	15/16-12	200	210	220	271	285	298
		20	15/8-12	245	258	270	332	350	366
		24	17/8-12	270	284	297	366	385	403
		32	21/2-12	310	326	341	420	442	462

Table 5-11. Bulkhead Fittings (BH) - METRIC



TYPE/FITTING IDENTIFICATION				FASTENING JAM NUT for Bulkhead Connectors					
MATERIAL	TYPE	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS	DIN 24° CONE FLARELESS BITE (MBTL) BULKHEAD FITTING	6	M12x1.5	14	15	16	19	20	22
		8	M14x1.5	17	18	19	23	24	26
		10	M16x1.5	22	23	24	30	31	33
		12	M18x1.5	35	37	39	47	50	53
		15	M22x1.5	44	47	50	60	64	68
		18	M26x1.5	70	75	80	95	102	108
		22	M30x2	115	120	125	156	163	169
		28	M36x2	150	157	164	203	213	222
		35	M45x2	155	162	169	210	220	229
		42	M52x2	220	230	240	298	312	325
	DIN 24° CONE FLARELESS BITE (MBTS) BULKHEAD FITTING	Connecting Tube O.D.	Thread M Size	Torque					
				[Ft-Lb]			[N-m]		
		(mm)	(metric)	Min	Nom	Max	Min	Nom	Max
		6	M14x1.5	17	15	16	23	20	22
		8	M16x1.5	22	18	19	30	24	26
		10	M18x1.5	35	23	24	47	31	33
		12	M20x1.5	40	35	37	54	47	50
		14	M22x1.5	44	47	50	60	64	68
		16	M24x1.5	70	75	80	95	102	108
		20	M30x2	115	120	125	156	163	169
		25	M36x2	150	157	164	203	213	222
		30	M42x2	155	162	169	210	220	229
		38	M52x2	220	230	240	298	312	325

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Assembly Instructions for O-Ring Boss (ORB) Fittings

1. Inspect components to ensure that male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Ensure proper O-ring is installed. If O-ring is missing install per O-ring Installation (Replacement).

⚠ CAUTION

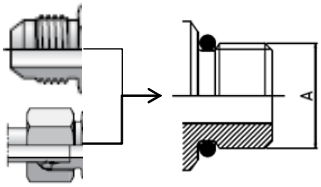
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-12 thru Table 5-17 while using the Double Wrench Method.
   a. The table headings identify the straight thread O-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread O-ring port.
   b. Torque values provided in Table 5-12 thru Table 5-17 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

Table 5-12. O-ring Boss (ORB) - Table 1 of 6



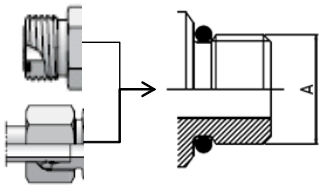
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(94)	10	10	11
	3	3/8-24	0.37	9.52	(155)	(163)	(171)	18	18	19
	4	7/16-20	0.44	11.11	22	23	24	29	31	33
	5	1/2-20	0.50	12.70	23	25	26	32	34	35
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560

TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(55)	(58)	(61)	6	7	7
	3	3/8-24	0.37	9.52	(101)	(106)	(111)	11	12	13
	4	7/16-20	0.44	11.11	14	15	16	19	20	22
	5	1/2-20	0.50	12.70	15	16	17	20	22	23
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-13. O-ring Boss (ORB) - Table 2 of 6

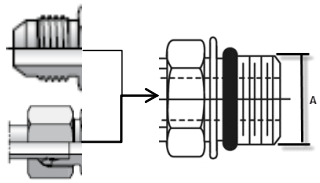


TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	26	27	28	35	37	38
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	17	18	18	23	24	24
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-14. O-ring Boss (ORB) - Table 3 of 6

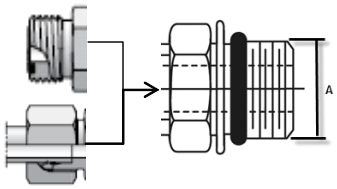


TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	7	7
	3	3/8-24	0.37	9.52	(100)	(105)	(110)	11	12	12
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	21	22	23	28	30	31
	6	9/16-18	0.56	14.28	29	31	32	40	42	43
	8	3/4-16	0.75	19.10	52	55	57	70	75	77
	10	7/8-14	0.87	22.22	85	90	94	115	122	127
	12	11/16-12	1.06	27.00	135	142	149	185	193	202
	14	13/16-12	1.19	30.10	175	184	193	235	249	262
	16	15/16-12	1.31	33.30	200	210	220	270	285	298
	20	15/8-12	1.63	41.30	250	263	275	340	357	373
	24	17/8-12	1.87	47.60	305	321	336	415	435	456
	32	21/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(39)	(41)	(43)	4	5	5
	3	3/8-24	0.37	9.52	(65)	(69)	(72)	7	8	8
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	15	19	20	20
	6	9/16-18	0.56	14.28	19	20	21	26	27	28
	8	3/4-16	0.75	19.10	34	36	37	46	49	50
	10	7/8-14	0.87	22.22	55	58	61	75	79	83
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	15/8-12	1.63	41.30	163	171	179	221	232	243
	24	17/8-12	1.87	47.60	198	208	218	268	282	296
	32	21/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-15. O-ring Boss (ORB) - Table 4 of 6



TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	15	16	17	20	22	23
	5	1/2-20	0.50	12.70	30	32	33	40	43	45
	6	9/16-18	0.56	14.28	35	37	39	46	50	53
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	--	--	--	--	--	--
	3	3/8-24	0.37	9.52	--	--	--	--	--	--
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	20	21	21	27	28	28
	6	9/16-18	0.56	14.28	23	24	24	31	33	33
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	11/16-12	1.06	27.00	88	93	97	119	126	132
	14	13/16-12	1.19	30.10	114	120	126	155	163	171
	16	15/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-16. O-ring Boss (ORB) - Table 5 of 6

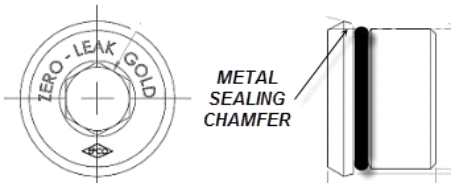


TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(30)	(32)	(33)	3	4	4
	3	3/8-24	0.37	9.52	(55)	(58)	(61)	6	7	7
	4	7/16-20	0.44	11.11	10	11	11	14	15	15
	5	1/2-20	0.50	12.70	14	15	16	19	20	22
	6	9/16-18	0.56	14.28	34	36	38	46	49	52
	8	3/4-16	0.75	19.10	60	63	66	80	85	89
	10	7/8-14	0.87	22.22	100	105	110	135	142	149
	12	1 1/16-12	1.06	27.00	135	142	149	185	193	202
	14	1 3/16-12	1.19	30.10	175	184	193	235	249	262
	16	1 5/16-12	1.31	33.30	200	210	220	270	285	298
	20	1 5/8-12	1.63	41.30	250	263	275	340	357	373
	24	1 7/8-12	1.87	47.60	305	321	336	415	435	456
	32	2 1/2-12	2.50	63.50	375	394	413	510	534	560
TYPE/FITTING IDENTIFICATION					HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(20)	(21)	(21)	2	2	2
	3	3/8-24	0.37	9.52	(36)	(38)	(40)	4	4	5
	4	7/16-20	0.44	11.11	6	7	7	8	9	9
	5	1/2-20	0.50	12.70	9	10	10	12	14	14
	6	9/16-18	0.56	14.28	22	24	25	30	33	34
	8	3/4-16	0.75	19.10	39	41	43	53	56	58
	10	7/8-14	0.87	22.22	65	69	72	88	94	98
	12	1 1/16-12	1.06	27.00	88	93	97	119	126	132
	14	1 3/16-12	1.19	30.10	114	120	126	155	163	171
	16	1 5/16-12	1.31	33.30	130	137	143	176	186	194
	20	1 5/8-12	1.63	41.30	163	171	179	221	232	243
	24	1 7/8-12	1.87	47.60	198	208	218	268	282	296
	32	2 1/2-12	2.50	63.50	244	256	268	331	347	363

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-17. O-ring Boss (ORB) - Table 6 of 6



TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	13/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
	32	2 1/2-12	2.50	63.50						

TYPE/FITTING IDENTIFICATION					ZERO LEAK GOLD® HOLLOW HEX PLUGS					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	2	3	4	3	4	5
	3	3/8-24	0.37	9.52	3	4	5	4	5	7
	4	7/16-20	0.44	11.11	7	8	9	9	11	12
	5	1/2-20	0.50	12.70	9	10	11	12	14	15
	6	9/16-18	0.56	14.28	11	12	13	15	16	18
	8	3/4-16	0.75	19.10	28	30	32	38	41	43
	10	7/8-14	0.87	22.22	46	48	50	62	65	68
	12	1 1/16-12	1.06	27.00	51	54	57	69	73	77
	14	13/16-12	1.19	30.10	Fitting size greater than -12 not typically specified on JLG applications. Consult specific service procedure if encountered.					
	16	1 5/16-12	1.31	33.30						
	20	1 5/8-12	1.63	41.30						
	24	1 7/8-12	1.87	47.60						
	32	2 1/2-12	2.50	63.50						

* ØA Thread OD dimension for reference only.

**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

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Assembly Instructions for Adjustable Port End Metric (MFF) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

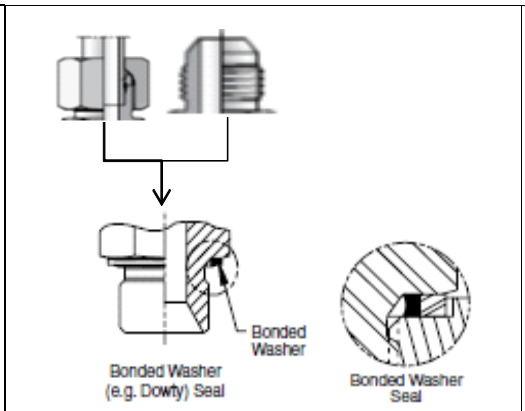
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

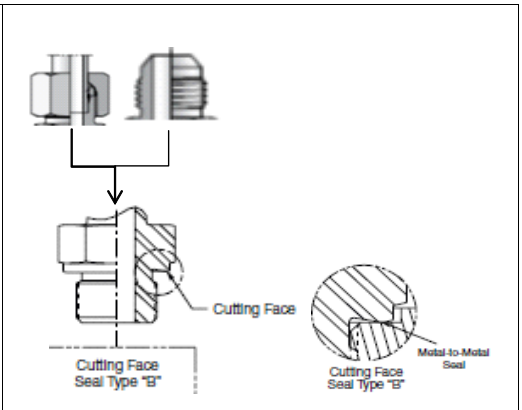
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, or Table 5-23 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-18, Table 5-19, Table 5-20, Table 5-21, Table 5-22, and Table 5-23 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

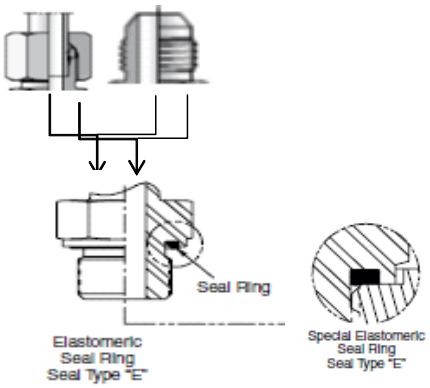
Table 5-18. Metric Flat Face Port (MFF) - L Series - Table 1 of 3

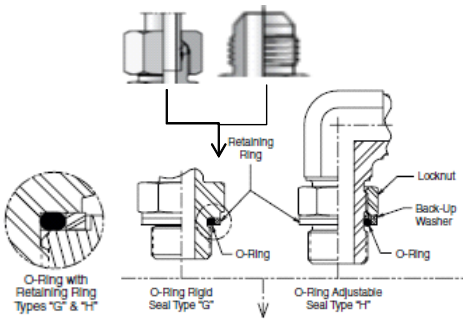




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	7	8	8	9	11	11	13	14	14	18	19	19
	M12x1.5	8	15	16	17	20	22	23	22	23	24	30	31	33
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	33	35	36	45	47	49	48	51	53	65	69	72
	M18x1.5	15	41	43	45	55	58	61	59	62	65	80	84	88
	M22x1.5	18	48	51	53	65	69	72	103	108	113	140	146	153
	M27x2	22	66	70	73	90	95	99	140	147	154	190	199	209
	M33x2	28	111	117	122	150	159	165	251	264	276	340	358	374
	M42x2	35	177	186	195	240	252	264	369	388	406	500	526	550
	M48x2	42	214	225	235	290	305	319	465	489	512	630	663	694
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	4	5	5	5	7	7	8	9	9	11	12	12
	M12x1.5	8	10	11	11	14	15	15	14	15	16	19	20	22
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	21	22	23	28	30	31	31	33	34	42	45	46
	M18x1.5	15	27	28	29	37	38	39	38	40	42	52	54	57
	M22x1.5	18	31	33	34	42	45	46	67	70	73	91	95	99
	M27x2	22	43	45	47	58	61	64	91	96	100	123	130	136
	M33x2	28	72	76	79	98	103	107	163	171	179	221	232	243
	M42x2	35	115	121	127	156	164	172	240	252	264	325	342	358
	M48x2	42	139	146	153	188	198	207	302	318	332	409	431	450

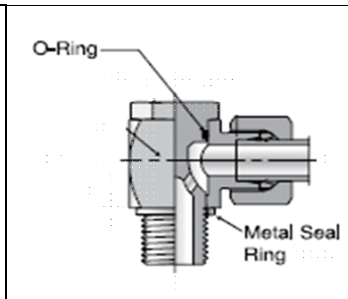
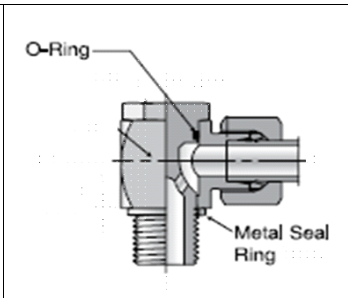
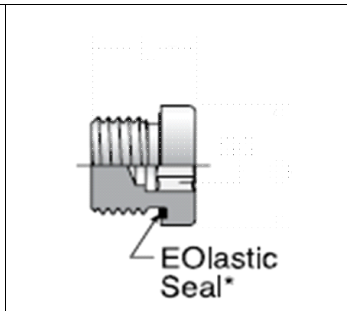
Table 5-19. Metric Flat Face Port (MFF) - L Series - Table 2 of 3





TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	15	18	19	20
	M12x1.5	8	18	19	20	25	26	27	18	19	20	25	26	28
	M14x1.5	10	33	35	36	45	47	49	30	31	32	40	42	44
	M16x1.5	12	41	43	45	55	58	61	41	43	45	55	58	61
	M18x1.5	15	52	55	57	70	75	77	52	54	57	70	74	77
	M22x1.5	18	92	97	101	125	132	137	66	70	73	90	95	99
	M27x2	22	133	140	146	180	190	198	133	139	146	180	189	198
	M33x2	28	229	241	252	310	327	342	229	240	252	310	326	341
	M42x2	35	332	349	365	450	473	495	332	348	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12
	M12x1.5	8	12	13	13	16	18	18	12	13	13	16	18	18
	M14x1.5	10	21	22	23	28	30	31	19	20	21	26	27	29
	M16x1.5	12	27	28	29	37	38	39	26	28	29	36	38	39
	M18x1.5	15	34	36	37	46	49	50	34	35	37	46	48	50
	M22x1.5	18	60	63	66	81	85	89	43	45	47	59	61	64
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

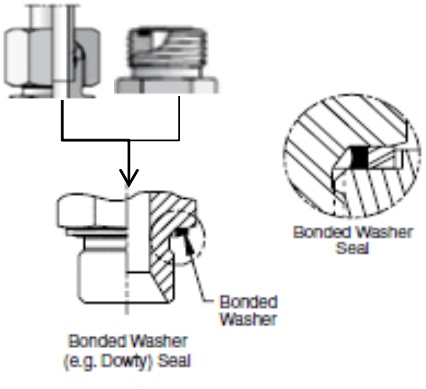
Table 5-20. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

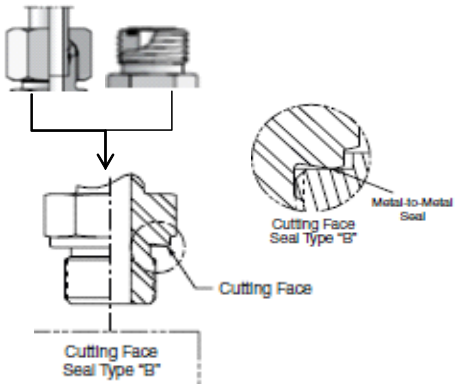
			
TYPE/FITTING IDENTIFICATION	**BANJO FITTINGS with L series DIN (MBTL) opposite end**	**HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end**	**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**

MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	13	14	14	18	19	19	13	14	14	18	19	19	9	10	10	12	14	14
	M12x1.5	8	26	28	29	35	38	39	33	35	36	45	47	49	18	19	20	25	26	27
	M14x1.5	10	37	39	41	50	53	56	41	43	45	55	58	61	26	28	29	35	38	39
	M16x1.5	12	44	46	48	60	62	65	59	62	65	80	84	88	41	43	45	55	58	61
	M18x1.5	15	59	62	65	80	84	88	74	78	81	100	106	110	48	51	53	65	69	72
	M22x1.5	18	89	94	98	120	127	133	103	108	113	140	146	153	66	70	73	90	95	99
	M27x2	22	96	101	106	130	137	144	236	248	260	320	336	353	100	105	110	135	142	149
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	166	175	183	225	237	248
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	266	280	293	360	380	397
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	266	280	293	360	380	397

MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	M12x1.5	8	17	18	19	23	24	26	21	22	23	28	30	31	12	13	13	16	18	18
	M14x1.5	10	24	26	27	33	35	37	27	28	29	37	38	39	17	18	19	23	24	26
	M16x1.5	12	29	30	31	39	41	42	38	40	42	52	54	57	27	28	29	37	38	39
	M18x1.5	15	38	40	42	52	54	57	48	51	53	65	69	72	31	33	34	42	45	46
	M22x1.5	18	58	61	64	79	83	87	67	70	73	91	95	99	43	45	47	58	61	64
	M27x2	22	62	66	69	84	89	94	153	161	169	207	218	229	65	69	72	88	94	98
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	108	114	119	146	155	161
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	173	182	190	235	247	258
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	173	182	190	235	247	258

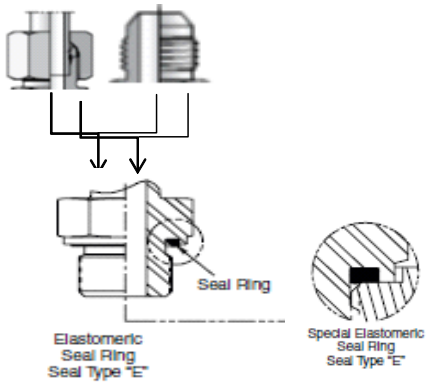
Table 5-21. Metric Flat Face Port (MFF) - S Series - Table 1 of 3

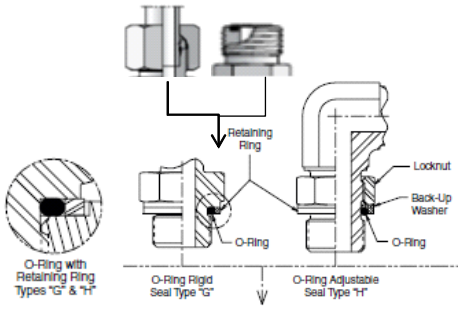




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	15	16	17	20	22	23	26	28	29	35	38	39
	M14x1.5	8	26	28	29	35	38	39	41	43	45	55	58	61
	M16x1.5	10	33	35	36	45	47	49	52	55	57	70	75	77
	M18x1.5	12	41	43	45	55	58	61	81	85	89	110	115	121
	M20x1.5	14	41	43	45	55	58	61	111	117	122	150	159	165
	M22x1.5	16	48	51	53	65	69	72	125	132	138	170	179	187
	M27x2	20	66	70	73	89	95	99	199	209	219	270	283	297
	M33x2	25	111	117	122	150	159	165	302	317	332	410	430	450
	M42x2	30	177	186	195	240	252	264	398	418	438	540	567	594
	M48x2	38	214	225	235	290	305	319	516	542	568	700	735	770
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M12x1.5	6	10	11	11	14	15	15	17	18	19	23	24	26
	M14x1.5	8	17	18	19	23	24	26	27	28	29	37	38	39
	M16x1.5	10	21	22	23	28	30	31	34	36	37	46	49	50
	M18x1.5	12	27	28	29	37	38	39	53	56	58	72	76	79
	M20x1.5	14	27	28	29	37	38	39	72	76	79	98	103	107
	M22x1.5	16	31	33	34	42	45	46	81	86	90	110	117	122
	M27x2	20	43	45	47	58	61	64	129	136	142	175	184	193
	M33x2	25	72	76	79	98	103	107	196	206	216	266	279	293
	M42x2	30	115	121	127	156	164	172	259	272	285	351	369	386
	M48x2	38	139	146	153	188	198	207	335	352	369	454	477	500

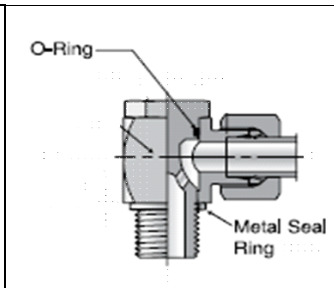
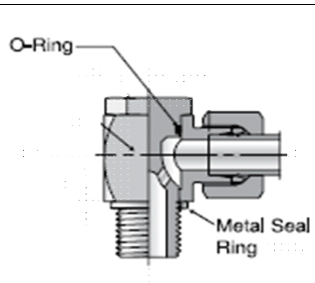
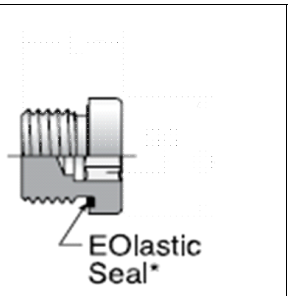
Table 5-22. Metric Flat Face Port (MFF) - S Series - Table 2 of 3





TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	26	28	29	35	38	39
	M12x1.5	8	33	35	36	45	47	49	41	43	45	55	58	61
	M14x1.5	10	52	55	57	70	75	77	52	55	57	70	75	77
	M16x1.5	12	66	70	73	90	95	99	66	70	73	90	95	99
	M18x1.5	15	92	97	101	125	132	137	92	97	101	125	132	137
	M22x1.5	18	100	105	110	135	142	149	100	105	110	135	142	149
	M27x2	22	133	140	146	180	190	198	133	140	146	180	190	198
	M33x2	28	229	241	252	310	327	342	229	241	252	310	327	342
	M42x2	35	332	349	365	450	473	495	332	349	365	450	473	495
	M48x2	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	17	18	19	23	24	26
	M12x1.5	8	21	23	23	29	31	32	27	28	29	37	38	39
	M14x1.5	10	34	36	37	46	49	50	34	36	37	46	49	50
	M16x1.5	12	43	45	47	58	61	64	43	45	47	58	61	64
	M18x1.5	15	60	63	66	81	85	89	60	63	66	81	85	89
	M22x1.5	18	65	69	72	88	94	98	65	69	72	88	94	98
	M27x2	22	86	91	95	117	123	129	86	91	95	117	123	129
	M33x2	28	149	157	164	202	213	222	149	157	164	202	213	222
	M42x2	35	216	227	237	293	308	321	216	227	237	293	308	321
	M48x2	42	259	272	285	351	369	386	259	272	285	351	369	386

Table 5-23. Metric Flat Face Port (MFF) - L Series - Table 3 of 3

																				
TYPE/FITTING IDENTIFICATION			**BANJO FITTINGS with S series DIN (MBTS) opposite end**						**HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end**						**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**					
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	26	28	29	35	38	39	33	35	36	45	47	49	--	--	--	--	--	--
	M12x1.5	8	37	39	41	50	53	56	41	43	45	55	58	61	--	--	--	--	--	--
	M14x1.5	10	44	46	48	60	62	65	59	62	65	80	84	88	--	--	--	--	--	--
	M16x1.5	12	59	62	65	80	84	88	74	78	81	100	106	110	--	--	--	--	--	--
	M18x1.5	15	81	85	89	110	115	121	92	97	101	125	132	137	59	62	65	80	84	88
	M22x1.5	18	89	94	98	120	127	133	100	105	110	135	142	149	--	--	--	--	--	--
	M27x2	22	100	105	110	135	142	149	236	248	260	320	336	353	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	266	280	293	360	380	397	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	398	418	438	540	567	594	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	516	542	568	700	735	770	--	--	--	--	--	--
MATERIAL	**Thread M Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**Torque**					
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M10x1	6	17	18	19	23	24	26	21	22	23	28	30	31	--	--	--	--	--	--
	M12x1.5	8	24	26	27	33	35	37	27	28	29	37	38	39	--	--	--	--	--	--
	M14x1.5	10	29	30	31	39	41	42	38	40	42	52	54	57	--	--	--	--	--	--
	M16x1.5	12	38	40	42	52	54	57	48	51	53	65	69	72	--	--	--	--	--	--
	M18x1.5	15	53	56	58	72	76	79	60	63	66	81	85	89	38	40	42	52	54	57
	M22x1.5	18	58	61	64	79	83	87	65	69	72	88	94	98	--	--	--	--	--	--
	M27x2	22	65	69	72	88	94	98	153	161	169	207	218	229	--	--	--	--	--	--
	M33x2	28	--	--	--	--	--	--	173	182	190	235	247	258	--	--	--	--	--	--
	M42x2	35	--	--	--	--	--	--	259	272	285	351	369	386	--	--	--	--	--	--
	M48x2	42	--	--	--	--	--	--	335	352	369	454	477	500	--	--	--	--	--	--

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Assembly Instructions for Metric ISO 6149 (MPP) Port Assembly Stud Ends

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not preinstalled, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

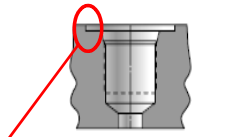
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-24 while using the Double Wrench Method.
   a. The table headings identify the Metric port and the type on the other side of the fitting. The torque will be applied to the Metric port.
   b. Torque values provided in Table 5-24 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

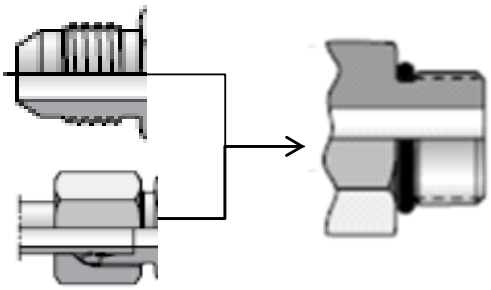
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

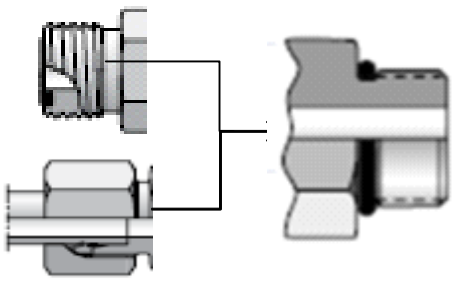
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)



Note: Metric O-ring only style (ISO 6149) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB),**but is not interchangeable.**





TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10x1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12x1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14x1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16x1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18x1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20x1.5	--	--	--	--	--	--	--	59	62	65	80	84	88
	M22x1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27x2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30x2	--	95	100	105	130	136	142	175	184	193	237	249	262
	M33x2	25	120	126	132	160	171	179	230	242	253	310	328	343
	M38x2	--	135	142	149	183	193	202	235	247	259	319	335	351
	M42x2	30	155	163	171	210	221	232	245	258	270	330	350	366
	M48x2	38	190	200	209	260	271	283	310	326	341	420	442	462
	M60x2	50	230	242	253	315	328	343	370	389	407	500	527	552
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M8x1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10x1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12x1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14x1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16x1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18x1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20x1.5	--	--	--	--	--	--	--	30	40	42	41	54	57
	M22x1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27x2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30x2	--	62	65	68	84	88	92	114	120	125	155	163	169
	M33x2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38x2	--	88	93	97	119	126	132	153	161	168	207	218	228
	M42x2	30	101	106	111	137	144	150	159	168	176	216	228	239
	M48x2	38	124	130	136	168	176	184	202	212	222	274	287	301
	M60x2	50	150	157	164	203	213	222	241	253	265	327	343	359

Assembly instructions for Adjustable Port End (BSPP) Fittings

1. Inspect components to ensure that male and female threads and surfaces are free of rust, splits, dirt, foreign matter, or burrs.
2. If O-ring is not preinstalled, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

⚠ CAUTION

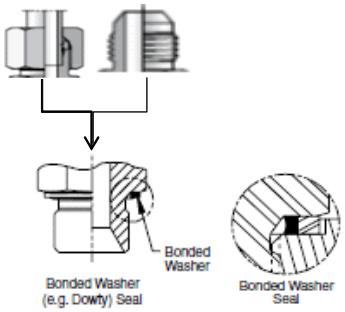
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

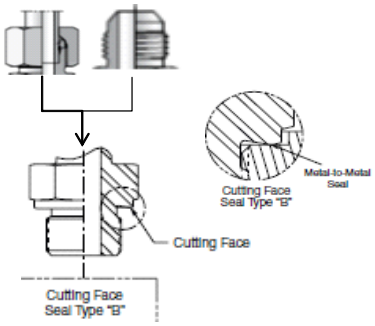
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, or Table 5-30 while using the Double Wrench Method.
   a. The table headings identify the BSPP port and the type on the other side of the fitting. The torque will be applied to the BSPP port.
   b. Torque values provided in Table 5-25, Table 5-26, Table 5-27, Table 5-28, Table 5-29, and Table 5-30 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counter bore of the port.

Table 5-25. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3





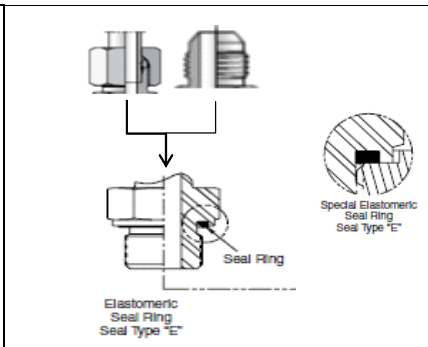
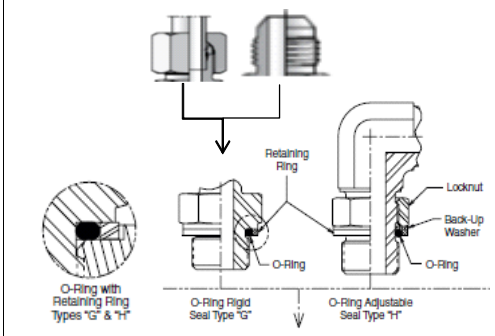
TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B** (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	7	8	8	9	11	11	13	14	14	18	19	19
	G 1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G 1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G 3/8A	12	33	35	36	45	47	49	52	55	57	70	75	77
	G 1/2A	15	48	51	53	65	69	72	103	108	113	140	146	153
	G 1/2A	18	48	51	53	65	69	72	74	78	81	100	106	110
	G 3/4A	22	66	70	73	90	95	99	133	140	146	180	190	198
	G 1A	28	111	117	122	150	159	165	243	255	267	330	346	362
	G 1-1/4A	35	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	42	214	225	235	290	305	319	465	489	512	630	663	694
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/8A	6	4	5	5	5	7	7	8	9	9	11	12	12
	G 1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G 1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G 3/8A	12	21	22	23	28	30	31	34	36	37	46	49	50
	G 1/2A	15	31	33	34	42	45	46	67	70	73	91	95	99
	G 1/2A	18	31	33	34	42	45	46	48	51	53	65	69	72
	G 3/4A	22	42	45	47	57	61	64	86	91	95	117	123	129
	G 1A	28	72	76	79	98	103	107	158	166	174	214	225	236
	G 1-1/4A	35	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	42	139	146	153	188	198	207	302	318	333	409	431	451

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-26. British Standard Parallel Pipe Port (BSPP) - L Series - Table 2 of 3

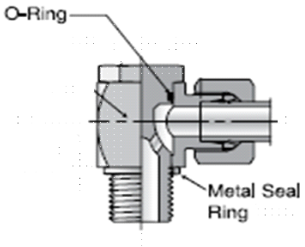
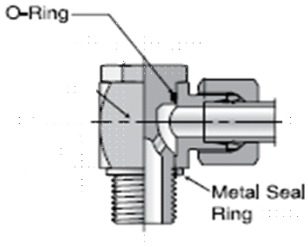
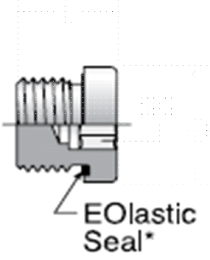
TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19
	G1/4A	8	26	28	29	35	38	39	26	28	29	35	38	39
	G1/4A	10	26	28	29	35	38	39	26	28	29	35	38	39
	G3/8A	12	52	55	57	70	75	77	52	55	57	70	75	77
	G1/2A	15	66	70	73	90	95	99	66	70	73	90	95	99
	G1/2A	18	66	70	73	90	95	99	66	70	73	90	95	99
	G3/4A	22	133	140	146	180	190	198	133	140	146	180	190	198
	G1A	28	229	241	252	310	327	342	229	241	252	310	327	342
	G1-1/4A	35	332	349	365	450	473	495	332	349	365	450	473	495
	G1-1/2A	42	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12
	G1/4A	8	17	18	19	23	24	26	17	18	19	23	24	26
	G1/4A	10	17	18	19	23	24	26	17	18	19	23	24	26
	G3/8A	12	34	36	37	46	49	50	34	36	37	46	49	50
	G1/2A	15	43	45	47	58	61	64	43	45	47	58	61	64
	G1/2A	18	43	45	47	58	61	64	43	45	47	58	61	64
	G3/4A	22	86	91	95	117	123	129	86	91	95	117	123	129
	G1A	28	149	157	164	202	213	222	149	157	164	202	213	222
	G1-1/4A	35	216	227	237	293	308	321	216	227	237	293	308	321
	G1-1/2A	42	259	272	285	351	369	386	259	272	285	351	369	386

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-27. British Standard Parallel Pipe Port (BSPP) - L Series - Table 3 of 3

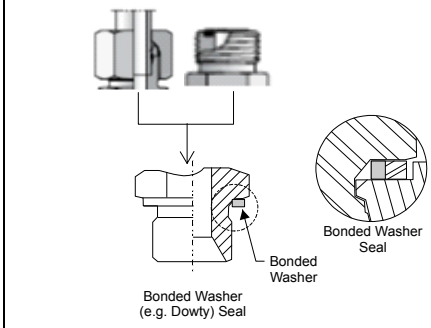
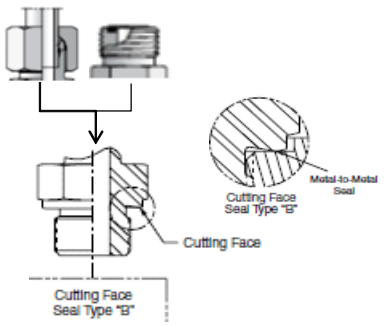
											
TYPE/FITTING IDENTIFICATION			**BANJO FITTINGS with L series DIN (MBTL) opposite end**			**HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end**			**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**		
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**			**Torque**			**Torque**		
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15
	G1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65
	G1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153
	G1A	28	--	--	--	--	--	--	236	248	260	320	336	353	148	156	163	200	212	221
	G1-1/4A	35	--	--	--	--	--	--	398	418	438	540	567	594	295	313.5	332	400	425	450
	G1-1/2A	42	--	--	--	--	--	--	516	542	568	700	735	770	332	349	365	450	473	495
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**			**Torque**			**Torque**											
			[Ft-Lb]			**[N-m]**			**[Ft-Lb]**			**[N-m]**			**[Ft-Lb]**			**[N-m]**		
	(metric)	**(mm)**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**	**Min**	**Nom**	**Max**
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	G1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42
	G1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99
	G1A	28	--	--	--	--	--	--	153	161	169	207	218	229	96	101	106	130	137	144
	G1-1/4A	35	--	--	--	--	--	--	259	272	285	351	369	386	216	227	237	293	308	321
	G1-1/2A	42	--	--	--	--	--	--	335	352	369	454	477	500	216	227	237	293	308	321

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-28. British Standard Parallel Pipe Port (BSPP) - S Series - Table 1 of 3

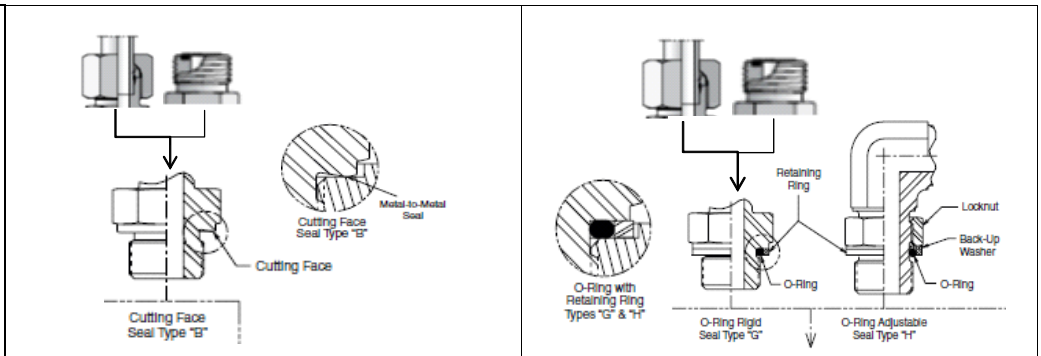
TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	26	28	29	35	38	39	41	43	45	55	58	61
	G 1/4A	8	26	28	29	35	38	39	41	43	45	55	58	61
	G 3/8A	10	33	35	36	45	47	49	66	70	73	90	95	99
	G 3/8A	12	33	35	36	45	47	49	66	70	73	90	95	99
	G 1/2A	14	48	51	53	65	69	72	111	117	122	150	159	165
	G 1/2A	16	48	51	53	65	69	72	96	101	106	130	137	144
	G 3/4A	20	66	70	73	90	95	99	199	209	219	270	283	297
	G 1A	25	111	117	122	150	159	165	251	264	276	340	358	374
	G 1-1/4A	30	177	186	195	240	252	264	398	418	438	540	567	594
	G 1-1/2A	38	214	225	235	290	305	319	516	542	568	700	735	770
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	17	18	19	23	24	26	27	28	29	37	38	39
	G 1/4A	8	17	18	19	23	24	26	27	28	29	37	38	39
	G 3/8A	10	21	22	23	28	30	31	43	45	47	58	61	64
	G 3/8A	12	21	22	23	28	30	31	43	45	47	58	61	64
	G 1/2A	14	31	33	34	42	45	46	72	76	79	98	103	107
	G 1/2A	16	31	33	34	42	45	46	62	66	69	84	89	94
	G 3/4A	20	43	45	47	58	61	64	129	136	142	175	184	193
	G 1A	25	72	76	79	98	103	107	163	171	179	221	232	243
	G 1-1/4A	30	115	121	127	156	164	172	259	272	285	351	369	386
	G 1-1/2A	38	139	146	153	188	198	207	335	352	369	454	477	500

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-29. British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3



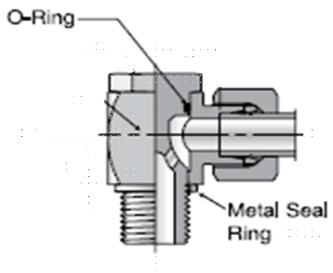
TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	41	43	45	55	58	61	26	28	29	35	38	39
	G 1/4A	8	41	43	45	55	58	61	26	28	29	35	38	39
	G 3/8A	10	59	62	65	80	84	88	52	55	57	70	75	77
	G 3/8A	12	59	62	65	80	84	88	52	55	57	70	75	77
	G 1/2A	14	85	90	94	115	122	127	66	70	73	90	95	99
	G 1/2A	16	85	90	94	115	122	127	66	70	73	90	95	99
	G 3/4A	20	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	25	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	30	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	38	398	418	438	540	567	594	398	418	438	540	567	594
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	27	28	29	37	38	39	17	18	19	23	24	26
	G 1/4A	8	27	28	29	37	38	39	17	18	19	23	24	26
	G 3/8A	10	38	40	42	52	54	57	34	36	37	46	49	50
	G 3/8A	12	38	40	42	52	54	57	34	36	37	46	49	50
	G 1/2A	14	55	58	61	75	79	83	43	45	47	58	61	64
	G 1/2A	16	55	58	61	75	79	83	43	45	47	58	61	64
	G 3/4A	20	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	25	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	30	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	38	259	272	285	351	369	386	259	272	285	351	369	386

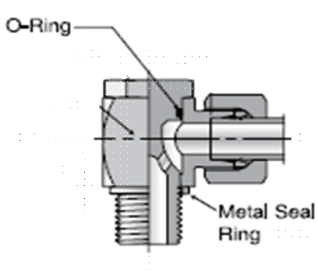
* Typical for JLG Straight Male Stud Fittings

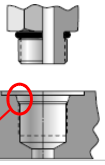
** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-30. British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3







Note: BSPP O-ring only style (ISO 228-1) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB),**but is not interchangeable. Not typically used on JLG machines.**

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						JIS/BSPP O-RING ONLY					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	30	32	33	40	43	45	33	35	36	45	47	49	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G 3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G 1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G 1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						
	G 3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254						
	G 1A	25	--	--	--	--	--	--	236	248	260	320	336	353						
	G 1-1/4A	30	--	--	--	--	--	--	398	418	438	540	567	594						
	G 1-1/2A	38	--	--	--	--	--	--	516	542	568	700	735	770						
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	20	21	21	27	28	28	22	22	23	30	30	31	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G 3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G 1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G 1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G 3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G 1A	25	--	--	--	--	--	--	153	161	169	207	218	229						
	G 1-1/4A	30	--	--	--	--	--	--	259	272	285	351	369	386						
	G 1-1/2A	38	--	--	--	--	--	--	335	352	368	454	477	499						

* Typical for JLG Straight Male Stud Fittings

** Non typical for JLG Straight Male Stud Fittings, reference only.

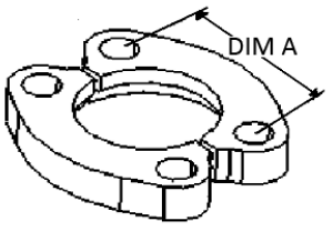
*** Typical for JLG Adjustable Fittings

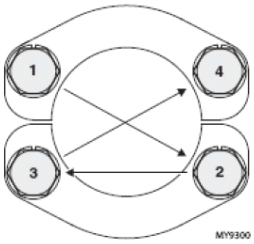
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Assembly Instructions for Flange Connections: (FL61 and FL62)

1. Make sure sealing surfaces are free of rust, splits, scratches, dirt, foreign matter, or burrs.
2. See Figure for O-ring installation instructions.
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. Position flange and clamp halves.
5. Place lock washers on bolt and bolt through clamp halves.
6. Tighten all bolts by hand.
7. Torque bolts in diagonal sequence in two or more increments to the torque listed on Table Table 5-31and Table 5-32.

Table 5-31. Flange Code (FL61 & FL62) - Inch Fasteners

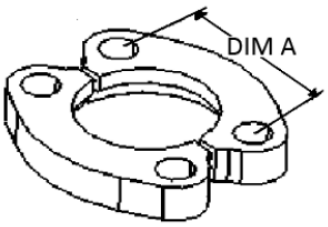


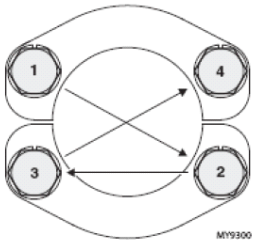


TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)													
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws						
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	5/16-18	18	19	19	24	25	26	24	25	26	32	34	35	
	12	0.75	19	1.88	47.75	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66	
	16	1.00	25	2.06	52.32	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66	
	20	1.25	32	2.31	58.67	7/16-14	52	54	57	70	74	77	68	71	75	92	97	101	
	24	1.50	38	2.75	69.85	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165	
	32	2.00	51	3.06	77.72	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165	
	40	2.50	64	3.50	88.90	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165	
	48	3.00	76	4.19	106.43	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325	
	56	3.50	89	4.75	120.65	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325	
	64	4.00	102	5.13	130.30	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325	
	80	5.00	127	6.00	152.40	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325	
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws						
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	5/16-18	--	--	--	--	--	--	24	25	26	32	34	35	
	12	0.75	19	2.00	50.80	3/8-16	--	--	--	--	--	--	44	46	49	60	63	66	
	16	1.00	25	2.25	57.15	7/16-14	--	--	--	--	--	--	68	71	75	92	97	101	
	20	1.25	32	2.62	66.55	1/2-13	--	--	--	--	--	--	111	116	122	150	158	165	
	20	1.25	32	2.62	66.55	--	--	--	--	--	--	--	--	--	--	--	--	--	
	24	1.50	38	3.12	79.25	5/8-11	--	--	--	--	--	--	218	228	239	295	310	325	
	32	2.00	51	3.81	96.77	3/4-10	--	--	--	--	--	--	332	348	365	450	473	495	

* A dimension for reference only.

Table 5-32. Flange Code (FL61 & FL62) - Metric Fasteners





TYPE/FITTING IDENTIFICATION						STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)													
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
	12	0.75	19	1.88	47.75	M8x1.25	18	19	19	24	25	26	18	19	19	24	25	26
	16	1.00	25	2.06	52.32	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	20	1.25	32	2.31	58.67	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	24	1.50	38	2.75	69.85	M10x1.5	37	39	41	50	53	55	37	39	41	50	53	55
	32	2.00	51	3.06	77.72	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	40	2.50	64	3.50	88.90	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	48	3.00	76	4.19	106.43	M12x1.75	68	71	75	92	97	101	68	71	75	92	97	101
	56	3.50	89	4.75	120.65	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	64	4.00	102	5.13	130.30	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
	80	5.00	127	6.00	152.40	M16x2	155	163	170	210	221	231	155	163	170	210	221	231
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	M8x1.25	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	M10x1.5	--	--	--	--	--	--	52	54	57	70	74	77
	16	1.00	25	2.25	57.15	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M12x1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M14x2	--	--	--	--	--	--	133	139	146	180	189	198
	24	1.50	38	3.12	79.25	M16x2	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	M20x2.5	--	--	--	--	--	--	406	426	446	550	578	605

* A dimension for reference only.

Double Wrench Method

To prevent undesired hose or connector rotation, two wrenches must be used; one torque wrench and one backup wrench. If two wrenches are not used, inadvertent component rotation may occur which absorbs torque and causes improper joint load and leads to leaks. For hose connections, the 'layline' printed on the hose is a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted. See Figure 5-12. for double wrench method requirements.

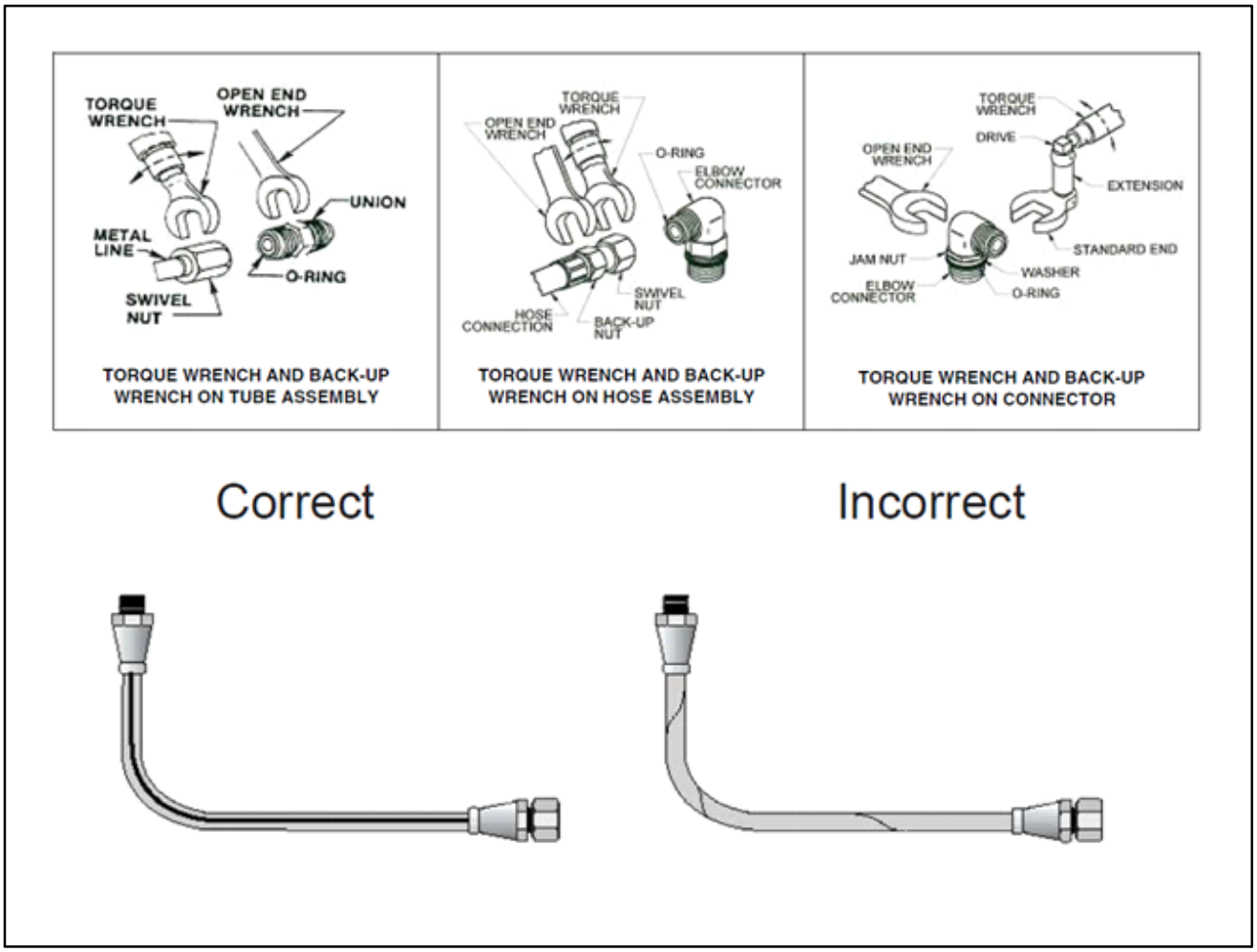


Figure 5-12. Double Wrench Method

FFWR and TFFT Methods

FFWR (FLATS FROM WRENCH RESISTANCE METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter. See Figure B.1.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten as shown in Figure B.1. The nut is to be rotated clockwise the number of hex flats as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened. See Figure 5-13.

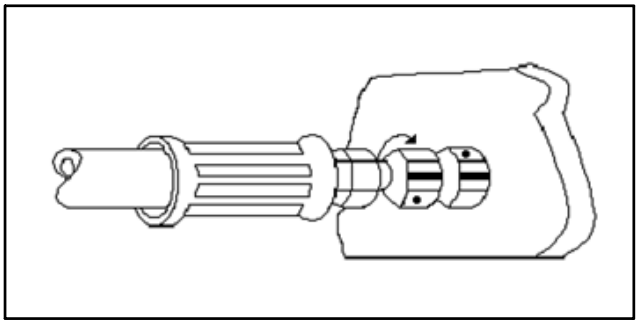


Figure 5-13. FFWR Method

TFFT (TURNS FROM FINGER TIGHT METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of turns as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

Adjustable Stud End Assembly

For Adjustable Stud End Connections; the following assembly steps are to be performed:

1. Lubricate the o-ring with a light coat of hydraulic oil.
2. Position #1 – The o-ring should be located in the groove adjacent to the face of the backup washer. The washer and o-ring should be positioned at the extreme top end of the groove as shown.
3. Position #2 – Position the locknut to just touch the backup washer as shown. The locknut in this position will eliminate potential backup washer damage during the next step.
4. Position #3 – Install the connector into the straight thread box port until the metal backup washer contacts the face of the port as shown.
5. Position #4 – Adjust the connector to the proper position by turning out (counterclockwise) up to a maximum of one turn as shown to provide proper alignment with the mating connector, tube assembly, or hose assembly.
6. Position #5 – Using two wrenches, use the backup wrench to hold the connector in the desired position and then use the torque wrench to tighten the locknut to the appropriate torque.
7. Visually inspect, where possible, the joint to ensure the o-ring is not pinched or bulging out from under the washer and that the backup washer is properly seated flat against the face of the port.

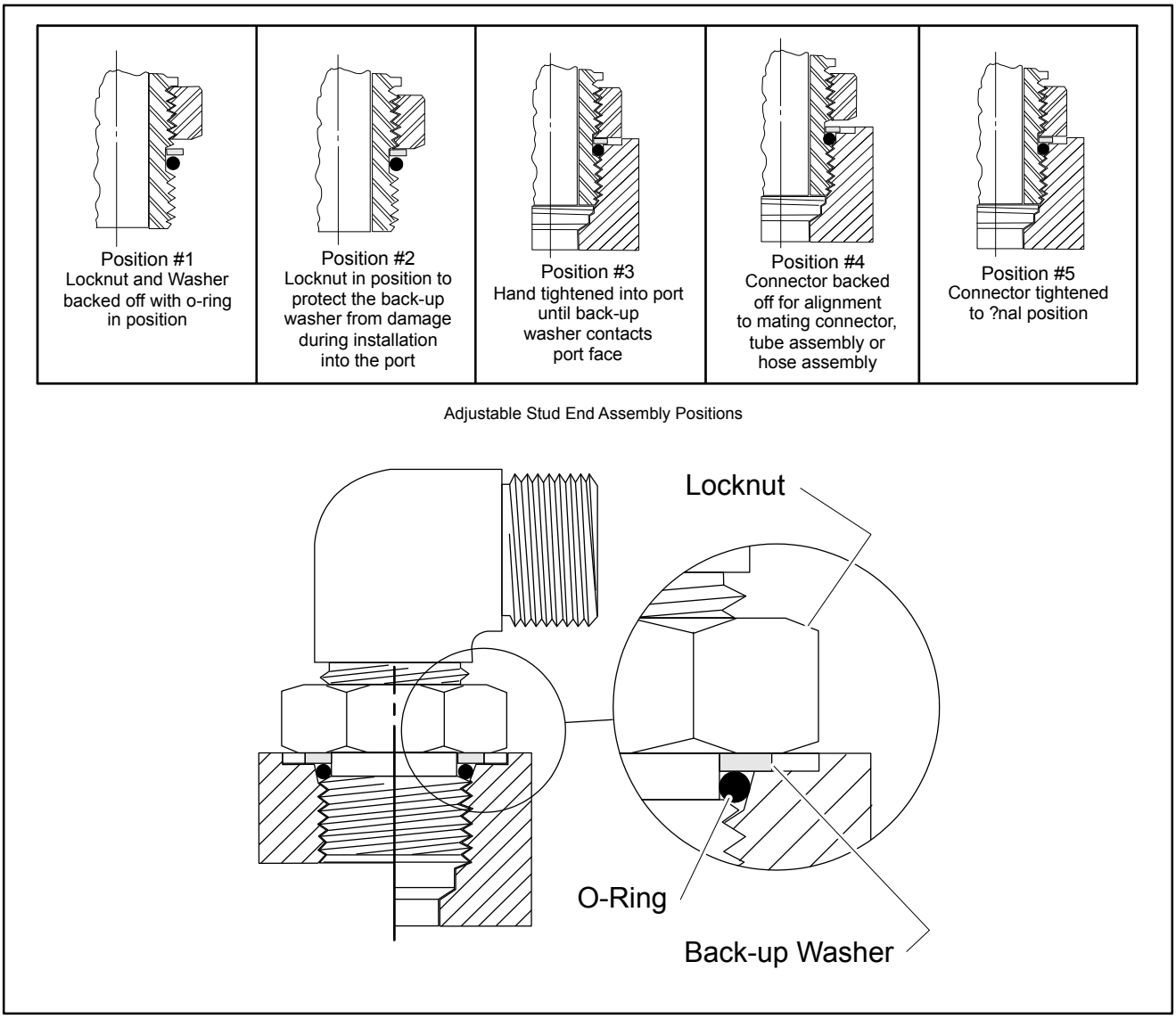


Figure 5-14. Adjustable Stud End Assembly

O-ring Installation (Replacement)

Care must be taken when installing O-rings over threads during replacement or installation. O-rings could become nicked or torn. A damaged O-ring could lead to leakage problems.

1. Inspect O-ring for tears or nicks. If any are found replace O-ring.
2. Ensure proper O-ring to be installed. Many O-rings look the same but are of different material, different hardness, or are slightly different diameters or widths.
3. Use a thread protector when replacing O-rings on fittings.
4. In ORB; ensure O-ring is properly seated in groove. On straight threads, ensure O-ring is seated all the way past the threads prior to installation.
5. Inspect O-ring for any visible nicks or tears. Replace if found.

5.3 HYDRAULIC CYLINDERS

Axle Lockout Cylinder

DISASSEMBLY

NOTICE

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

⚠ WARNING

ROD CAN FALL OUT OF BARREL AND CAUSE INJURY OR DAMAGE TO THE EQUIPMENT. BE CAREFUL WHEN REMOVING AXLE CYLINDER. OPENING BLEED VALVE CAN CAUSE ROD TO FALL OUT OF BARREL.

1. Open bleeder valve. Rotate rod and remove from barrel.
2. Remove wiper. Do not scratch barrel bore.
3. Remove two wear rings and rod seal from grooves of rod bore. Do not scratch barrel bore.
4. Remove counterbalance valve.

CLEANING AND INSPECTION

1. Inspect bore and rod for scoring, pitting, or excessive wear.
2. Remove minor surface blemishes with wet sandpaper. Pitting requires replacement of barrel and rod.
3. Clean all parts with approved solvent and dry with compressed air.

ASSEMBLY

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

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

NOTICE

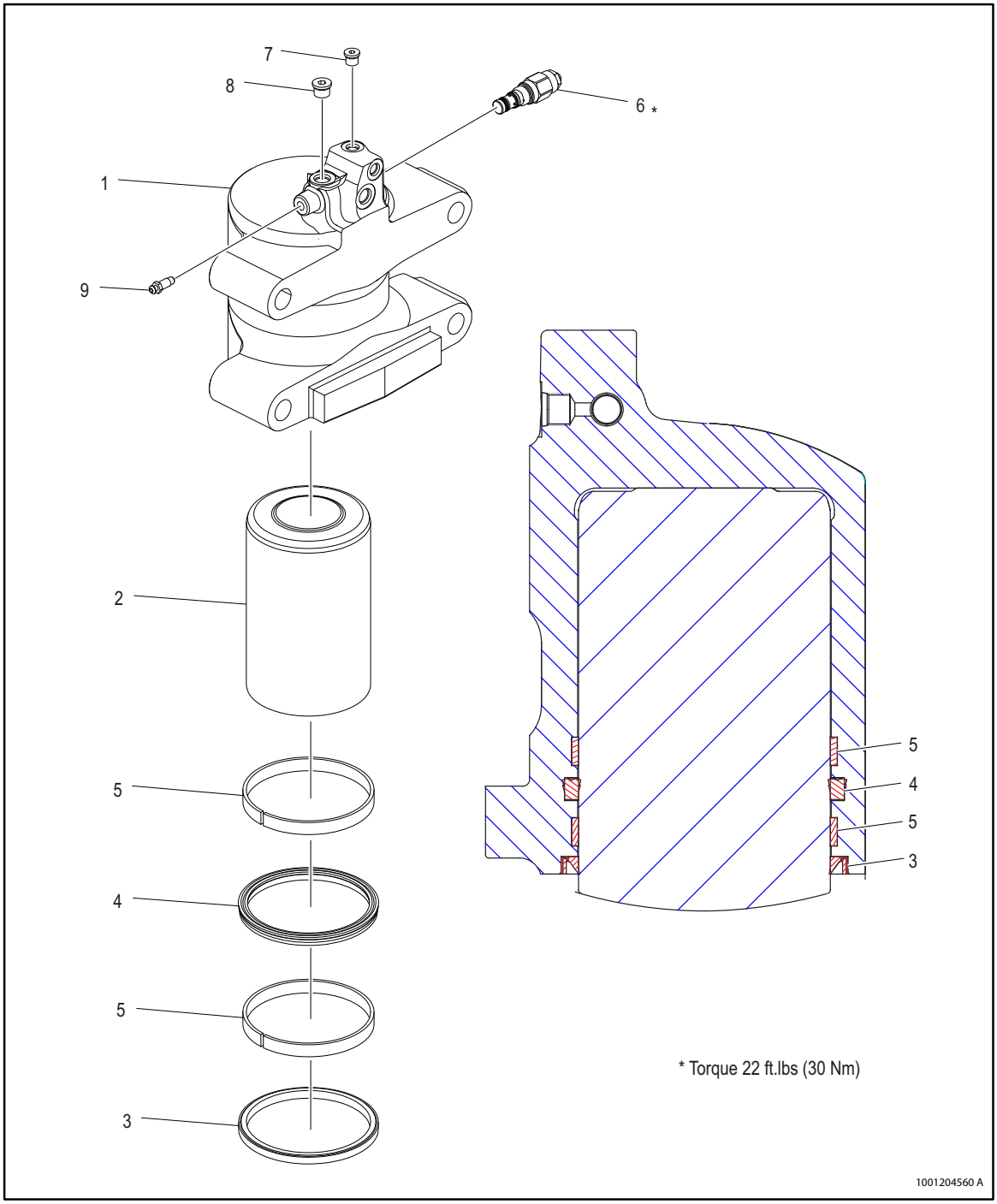
WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

1. Install two new wear rings and rod seal in rod bore grooves. Make sure they are not twisted.
2. Install new wiper in barrel.
3. Lubricate rod bore with clean hydraulic fluid.

NOTICE

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

4. Install rod in bore and push to top of the bore.
5. Install counterbalance valve. Torque to 22 ft.lbs. (30 Nm).
6. Bleed system.



1. Barrel
2. Rod
3. Wiper
4. Rod Seal
5. Wear Ring
6. Counterbalance Valve
7. O-ring Plug
8. O-ring Plug
9. Bleeder Valve

Figure 5-15. Axle Lockout Cylinder

Slave Cylinder

DISASSEMBLY

NOTICE

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. Remove cartridge valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

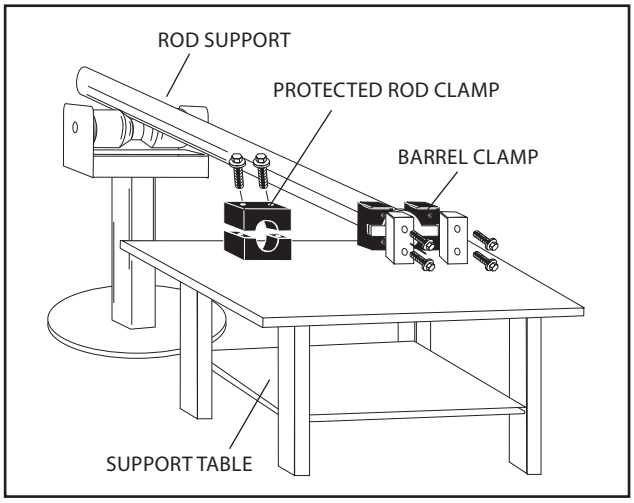


Figure 5-16. Cylinder Barrel Support

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

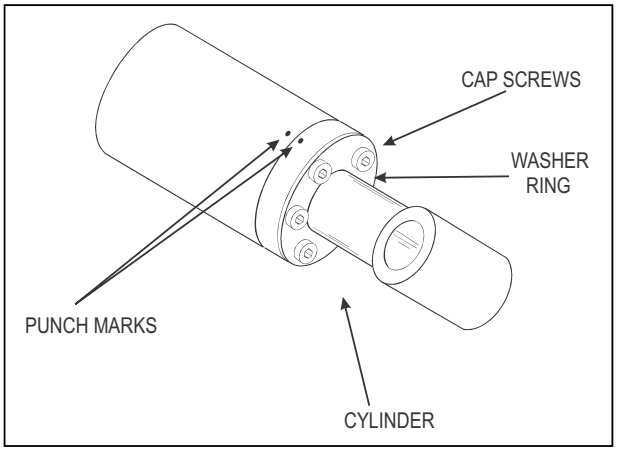


Figure 5-17. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

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.

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

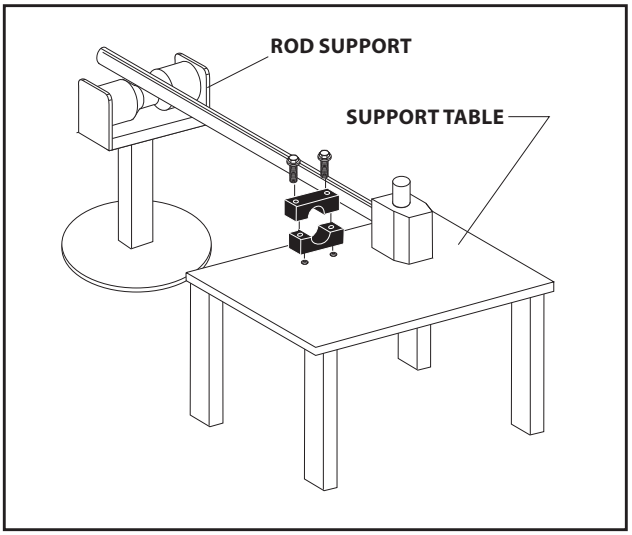
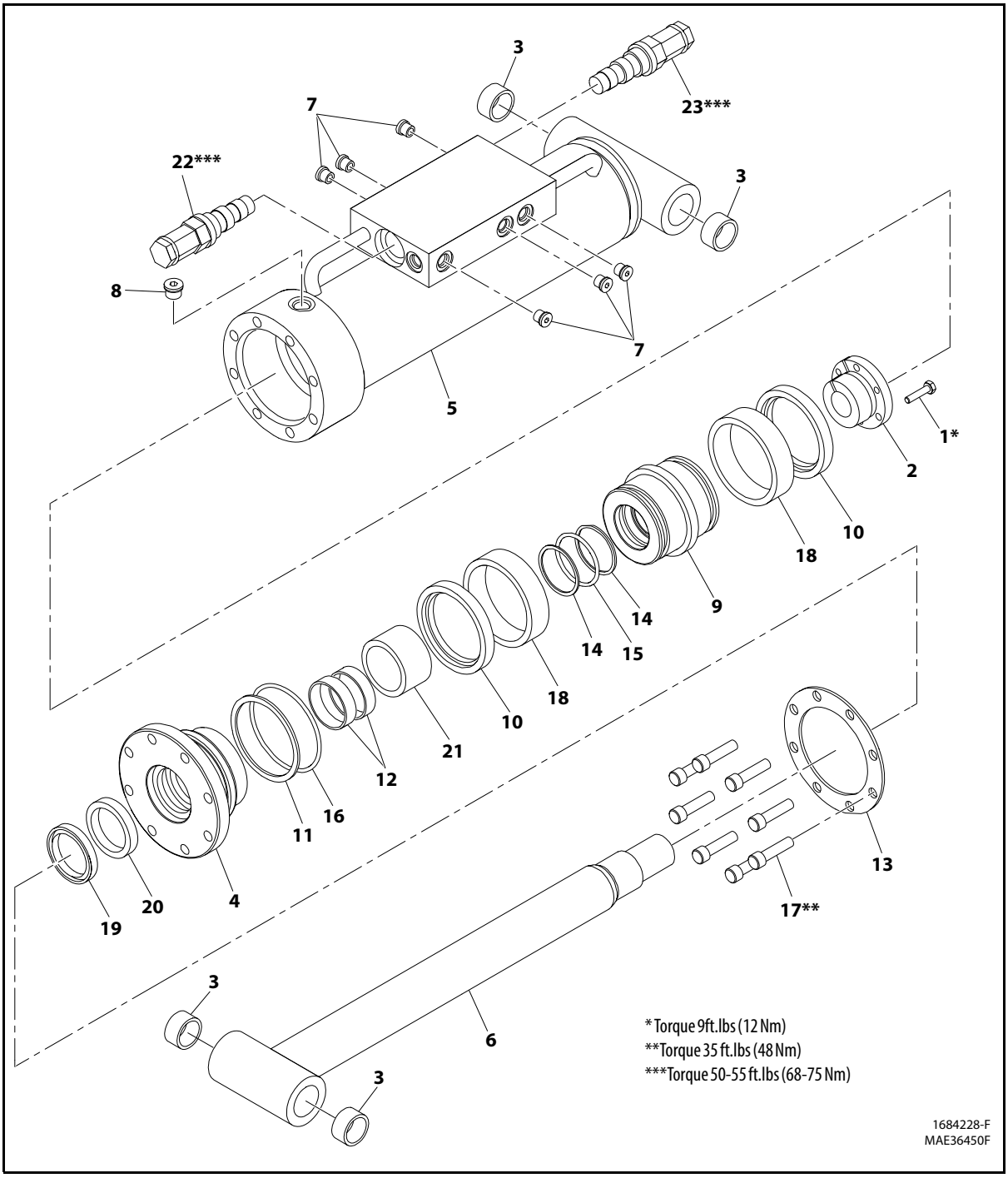
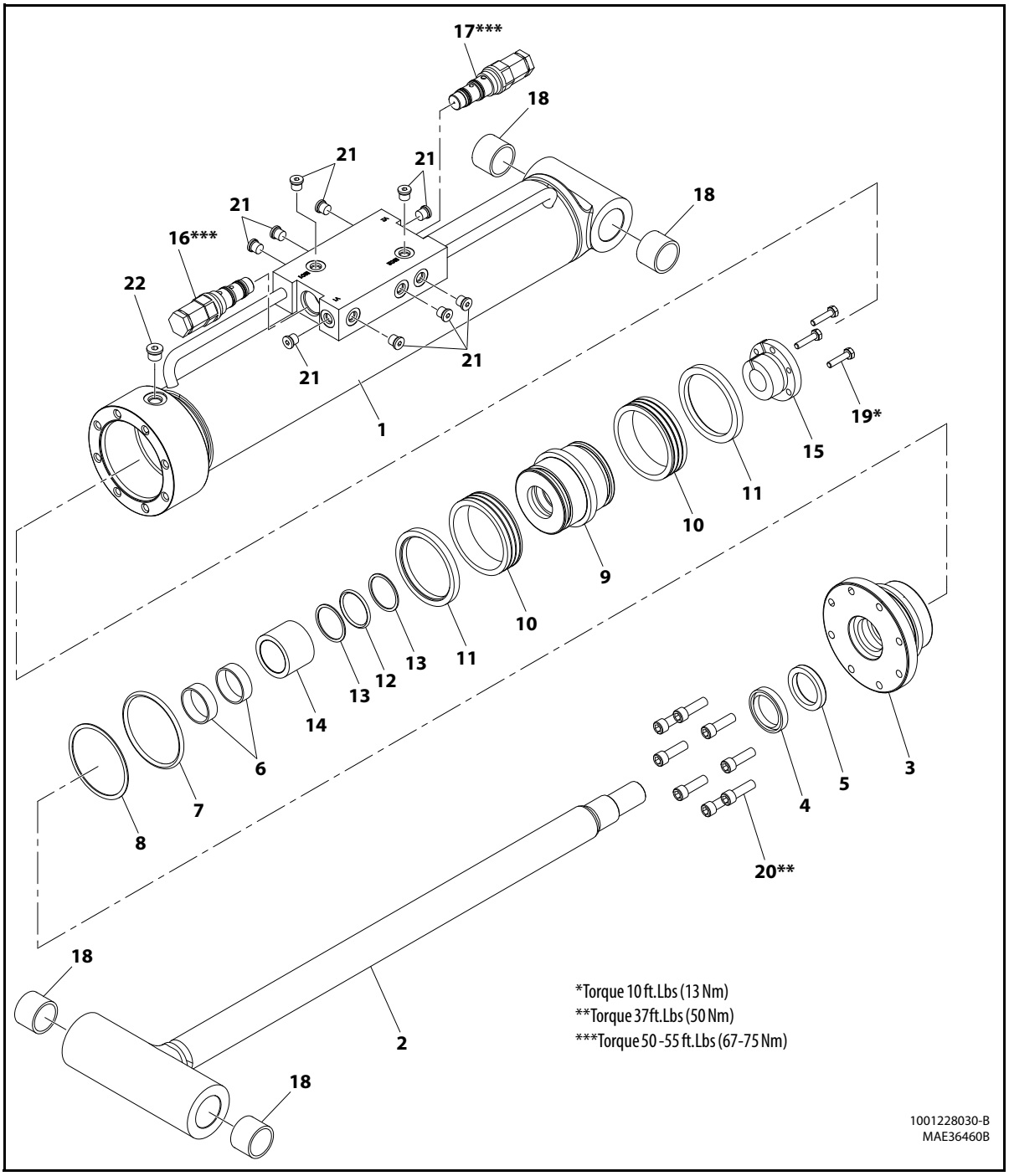


Figure 5-18. Cylinder Rod Support



1. Capscrew
2. Tapered Bushing
3. Bushing
4. Head
5. Barrel
6. Rod
7. Plug
8. Plug
9. Piston
10. Lock Ring
11. Backup Ring
12. Wear Ring
13. Washer Ring
14. Backup Ring
15. O-ring
16. O-ring
17. Capscrew
18. Seal
19. Wiper
20. Seal
21. Tube Spacer
22. Cartridge Valve
23. Cartridge Valve

Figure 5-19. Slave Cylinder (Prior to SN 0300247156)



1.	Barrel	6.	Wear Ring	11.	Lock Ring	16.	Cartridge valve	21.	O-Ring Plug
2.	Rod	7.	O-Ring	12.	O-Ring	17.	Cartridge valve	22.	O-Ring Plug
3.	Head	8.	Backup Ring	13.	Backup Ring	18.	Bushing		
4.	Wiper	9.	Piston	14.	Spacer	19.	Bolt		
5.	Seal	10.	Seal	15.	Tapered Bushing	20.	Capscrewl		

Figure 5-20. Slave Cylinder (SN 0300247156 to Present)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

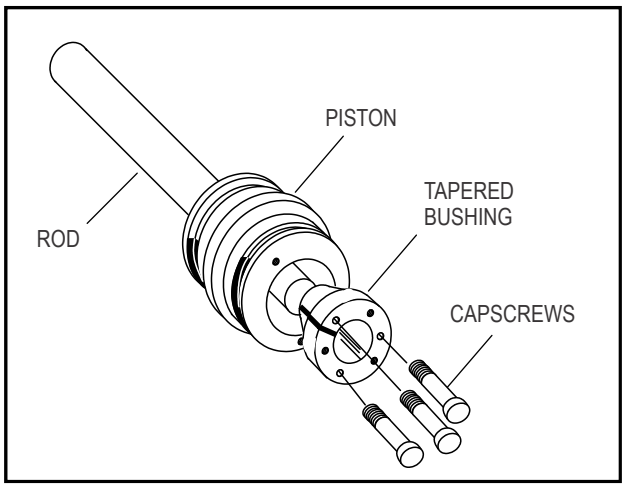


Figure 5-21. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove piston spacer, if applicable, from the rod.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup 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 piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. 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 steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

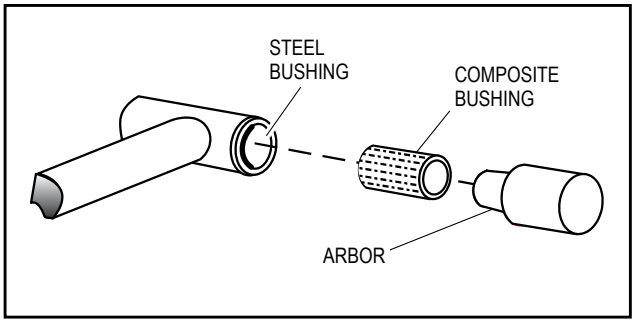


Figure 5-22. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.

13. If applicable, inspect port block fittings and holding valve. Replace as necessary.

14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.

15. 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.*

NOTE: *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.

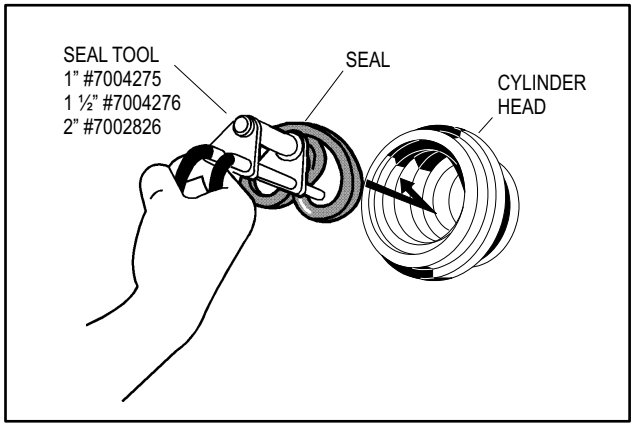


Figure 5-23. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

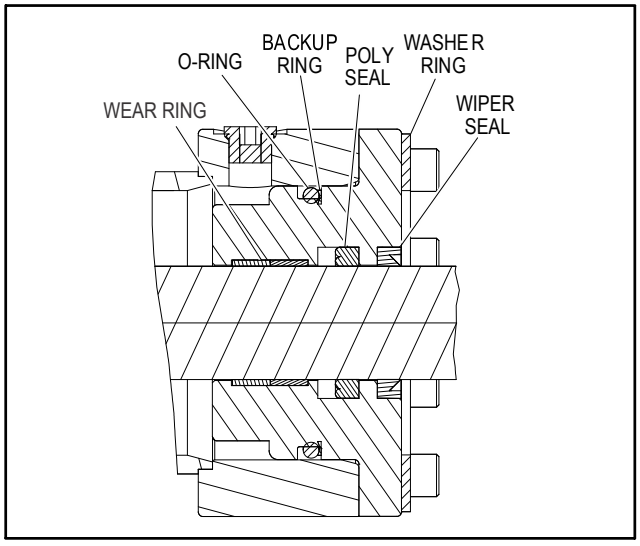


Figure 5-24. Cylinder Head Seal Installation

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.

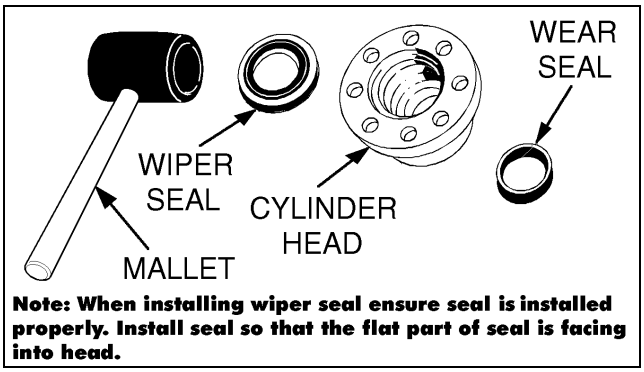


Figure 5-25. Wiper Seal Installation

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

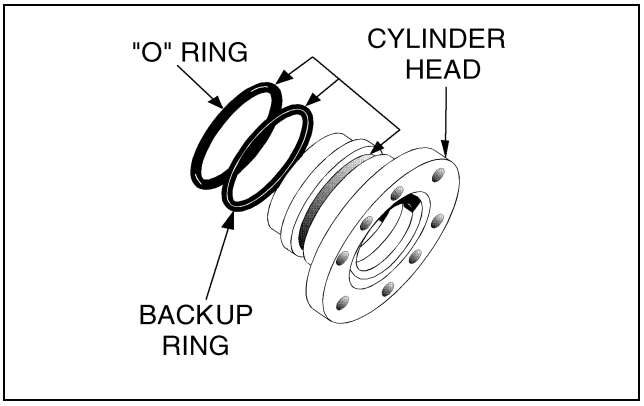


Figure 5-26. Installation of Head Seal Kit

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. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

6. Place a new o-ring and backup rings in the inner piston diameter groove.

7. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

8. 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.*

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

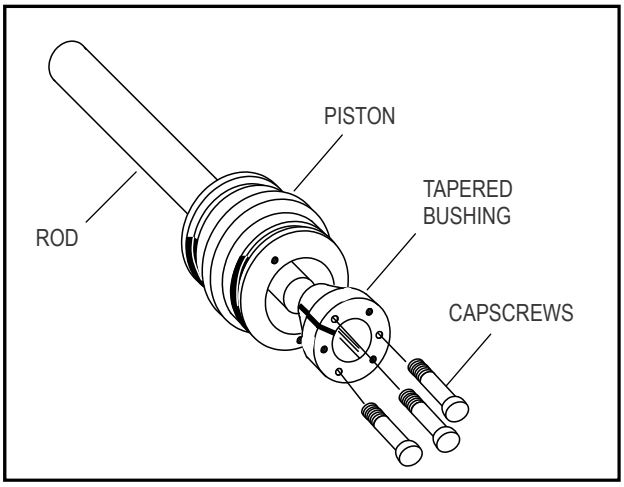


Figure 5-27. Tapered Bushing Removal

10. Tighten the capscrews evenly and progressively in rotation.

11. 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.

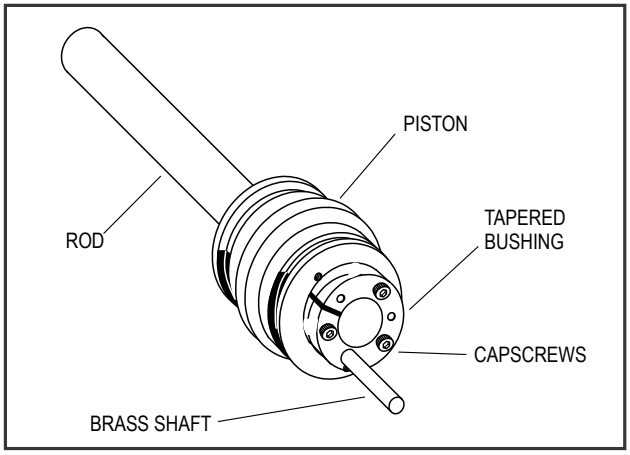


Figure 5-28. Seating the Tapered Bearing

12. Rotate the capscrews evenly and progressively in rotation.

13. Remove the cylinder rod from the holding fixture.

NOTICE

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

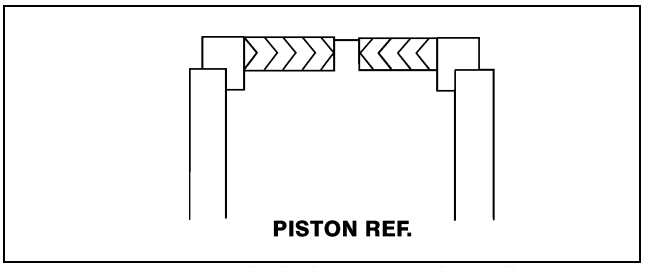


Figure 5-29. Hydrolock Piston Seal Installation

14. Place new hydrolock seal and guidelock 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).

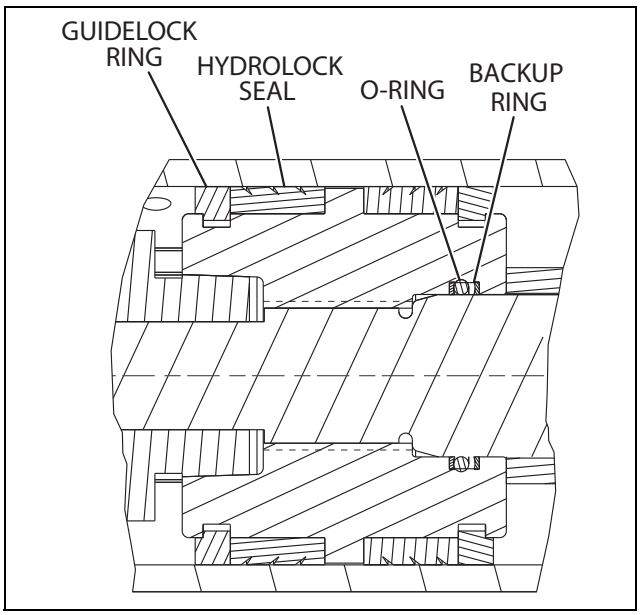


Figure 5-30. Piston Seal Kit Installation

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

NOTICE

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.

16. 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.

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

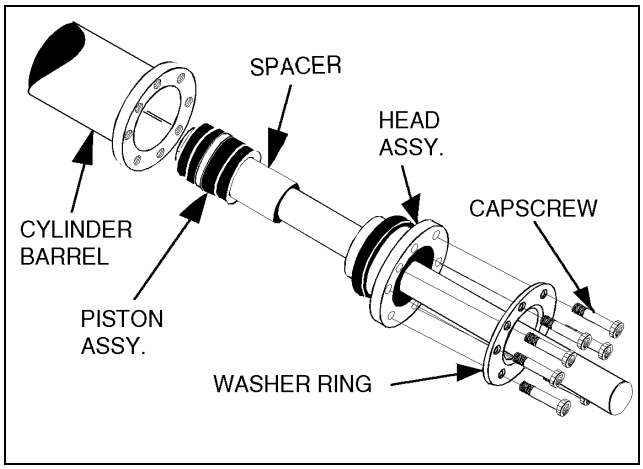


Figure 5-31. Rod Assembly Installation

18. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts.

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

20. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valve to 50-55 ft.lbs. (68-75 Nm).

Upright Level Cylinder

DISASSEMBLY

NOTICE

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. Remove the cartridge valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

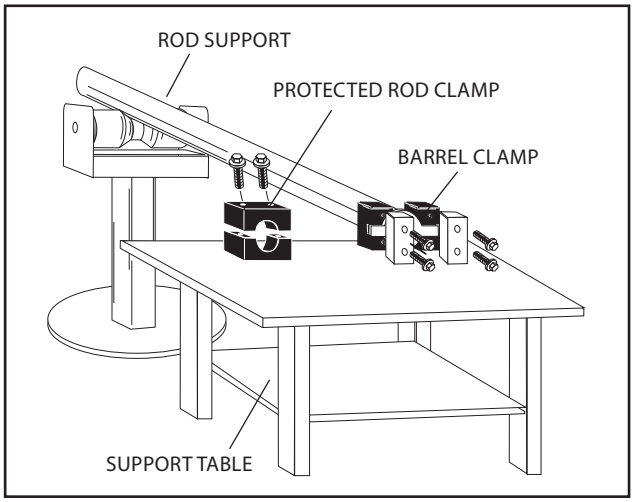


Figure 5-32. Cylinder Barrel Support

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

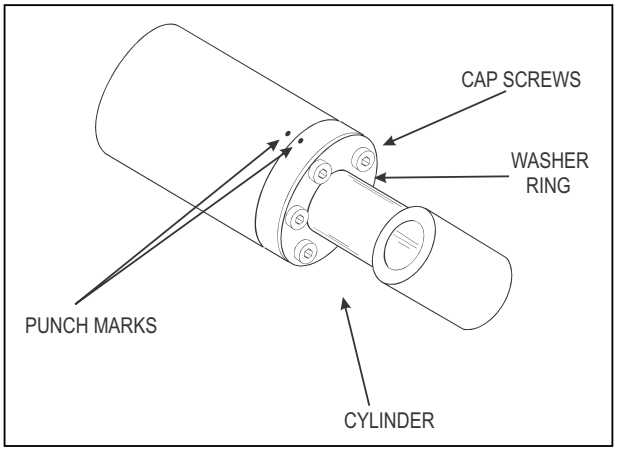


Figure 5-33. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

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.

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

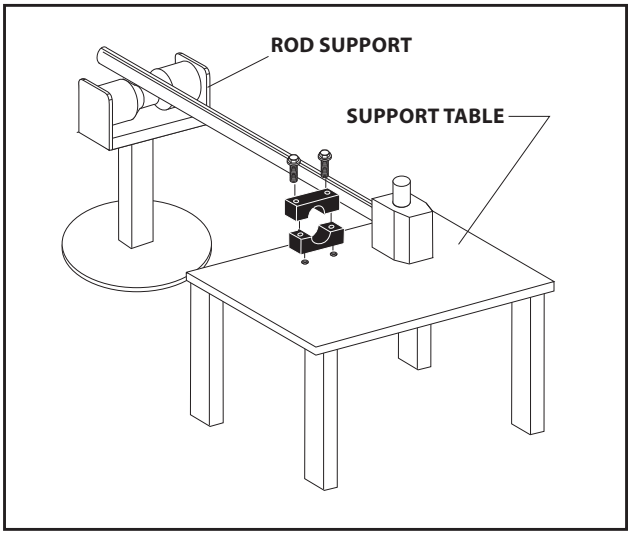
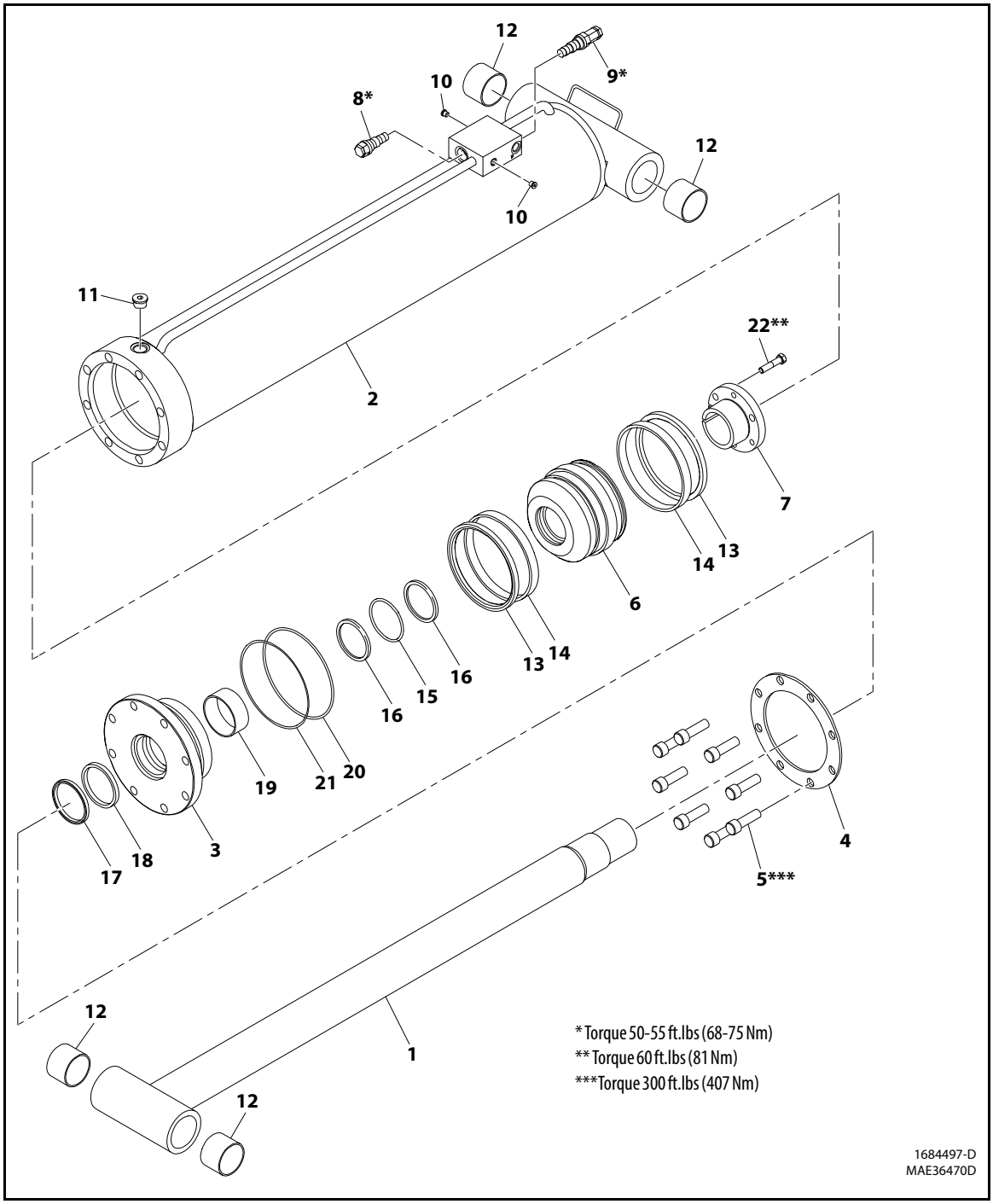
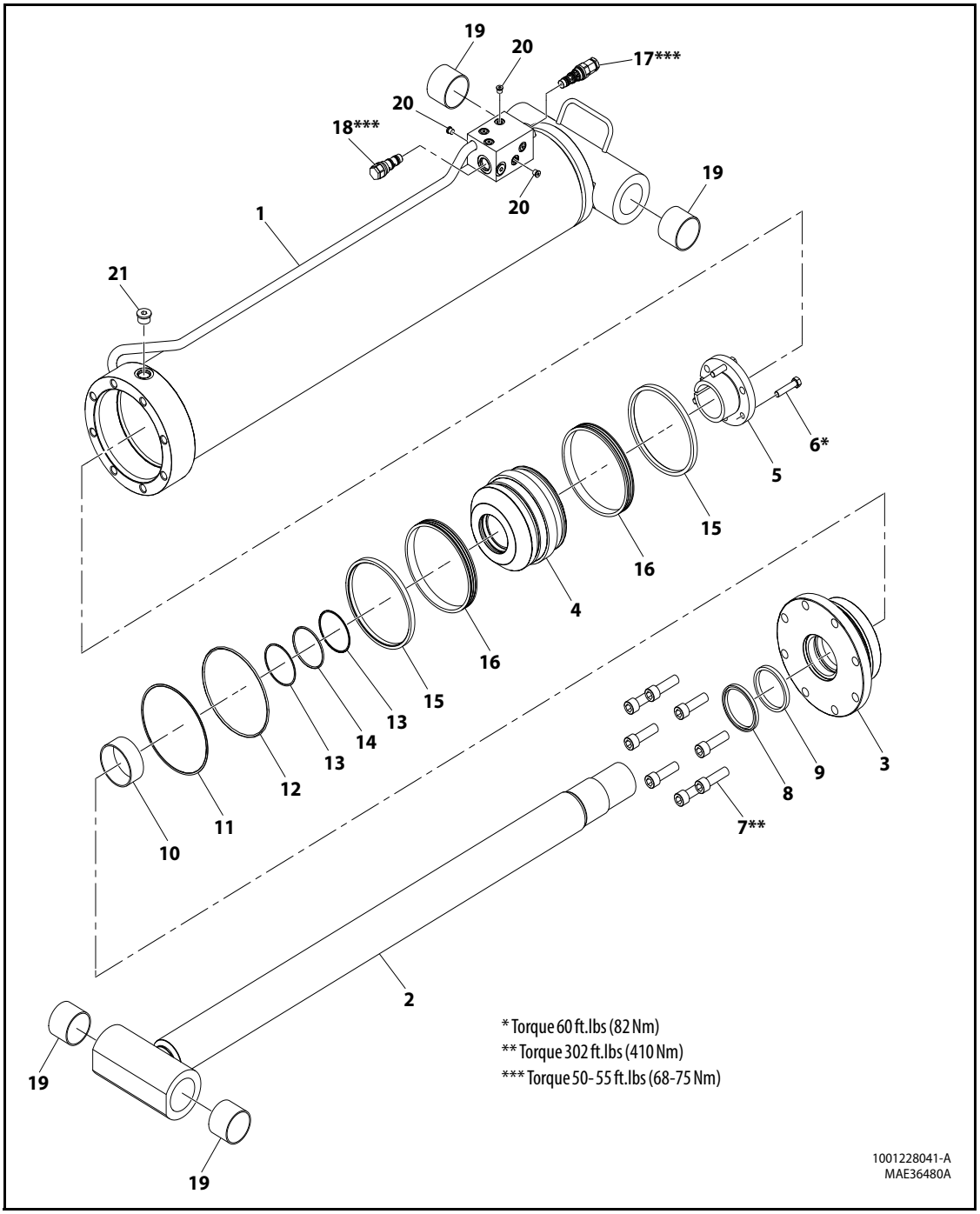


Figure 5-34. Cylinder Rod Support



1. Rod
2. Barrel
3. Head
4. Washer Ring
5. Bolt
6. Piston
7. Tapered Bushing
8. Cartridge Valve
9. Cartridge Valve
10. O-ring Plug
11. O-ring Plug
12. Bushing
13. Lock Ring
14. Seal
15. Washer Ring
16. Backup Ring
17. Wiper
18. Rod Seal
19. Wear Ring
20. O-ring
21. Backup Ring
22. Bolt

Figure 5-35. Upright Level Cylinder (Prior to 0300247156)



1. Barrel
2. Rod
3. Head
4. Piston
5. Tapered Bushing
6. Bolt
7. Capscrew
8. Wiper
9. Rod Seal
10. Wear Ring
11. Backup Ring
12. O-Ring
13. Backup Ring
14. Washer Ring
15. Lock Ring
16. Seal
17. Cartridge Valve
18. Cartridge Valve
19. Bushing
20. O-Ring Plug
21. O-Ring Plug

Figure 5-36. Upright Level Cylinder (SN 0300247156 to Present)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

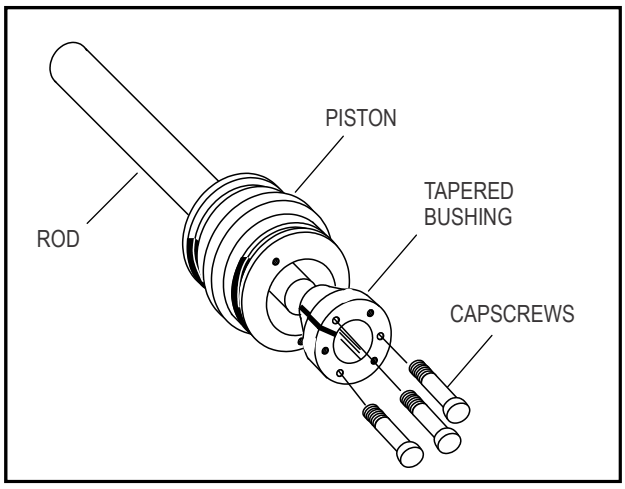


Figure 5-37. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup 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 piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. 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 steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

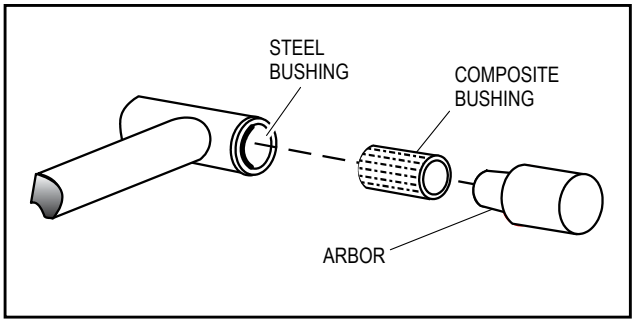


Figure 5-38. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. 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.*

NOTE: *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.

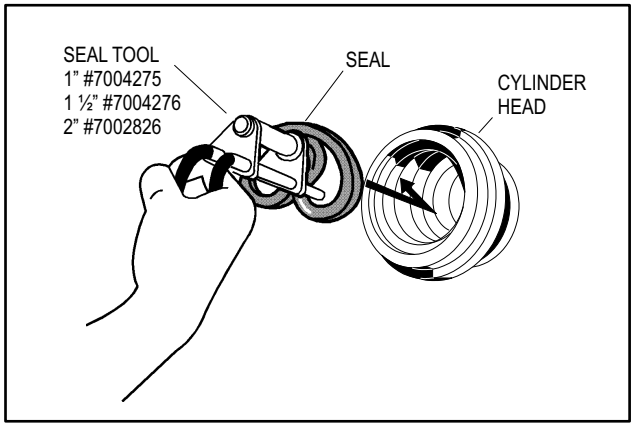


Figure 5-39. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

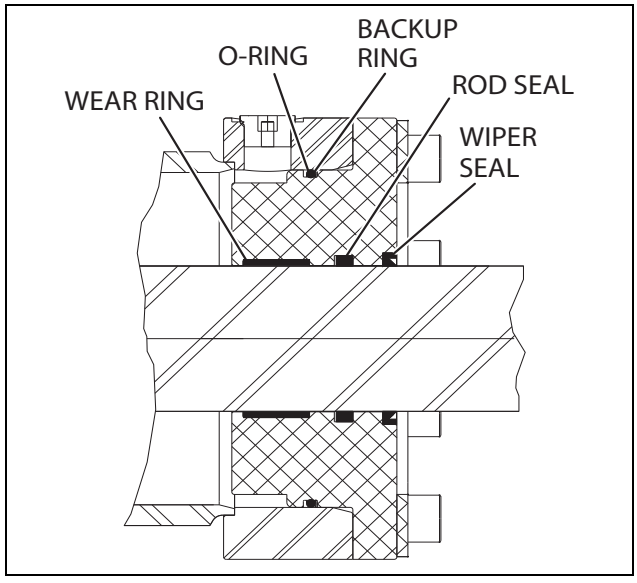


Figure 5-40. Cylinder Head Seal Installation

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.

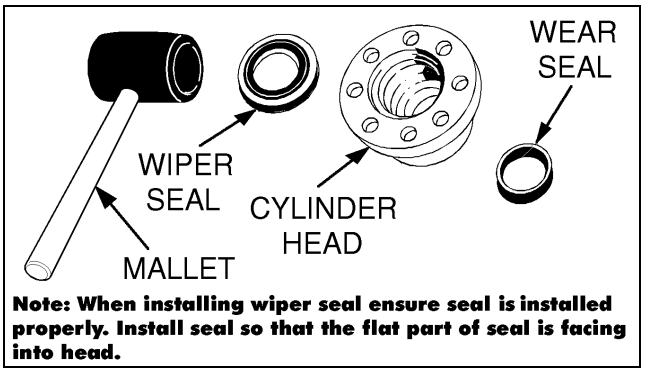


Figure 5-41. Wiper Seal Installation

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

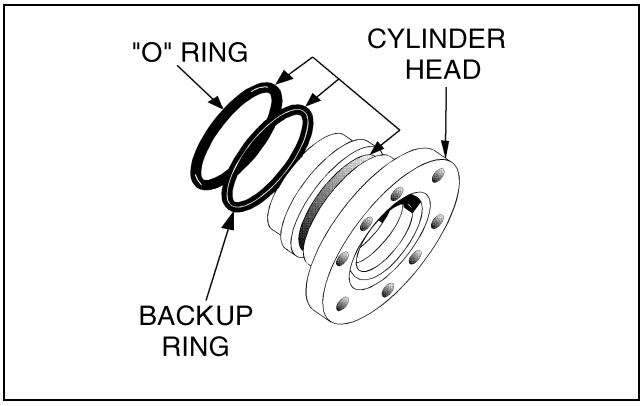


Figure 5-42. Installation of Head Seal Kit

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. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

6. Place a new o-ring and backup rings in the inner piston diameter groove.

7. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

8. Thread piston onto rod and install the tapered bushing.

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

9. Install the bolt in tapered bushing.

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

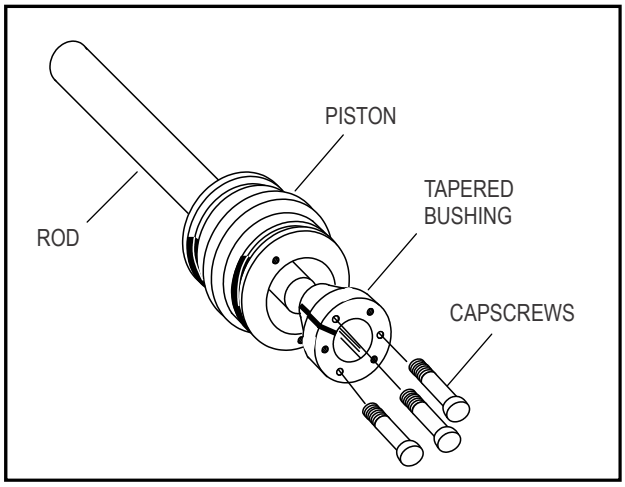


Figure 5-43. Tapered Bushing Removal

11. Tighten the capscrews evenly and progressively in rotation to 60 ft.lbs. (81 Nm).

12. 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.

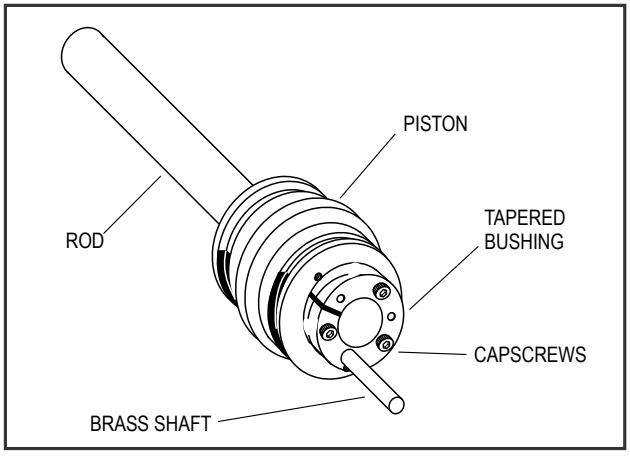


Figure 5-44. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 60 ft.lbs. (81 Nm).

14. Remove the cylinder rod from the holding fixture.

NOTICE

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

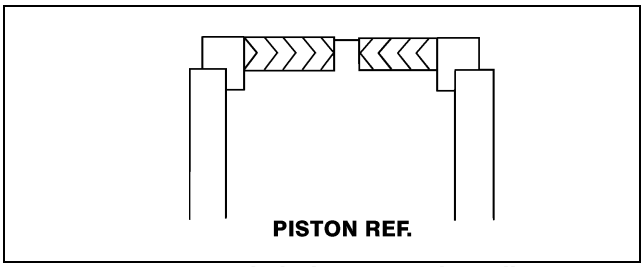


Figure 5-45. Hydrolock Piston Seal Installation

15. Place new hydrolock seal and guidelock 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).

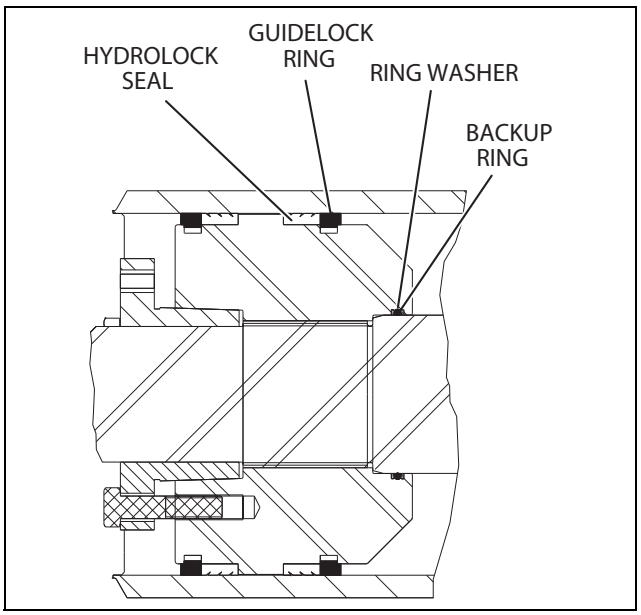


Figure 5-46. Piston Seal Kit Installation

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

NOTICE

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.

17. 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.

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

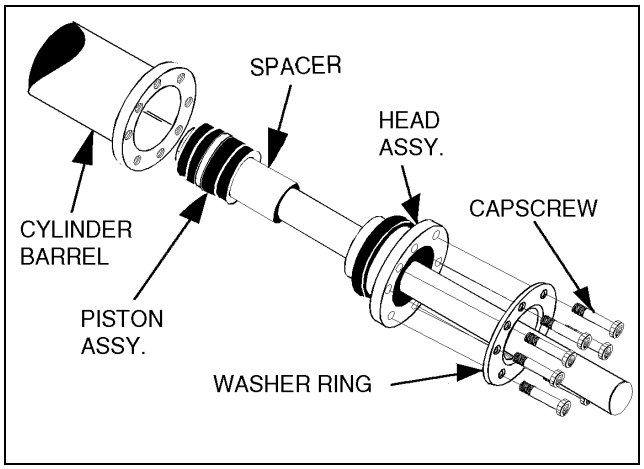


Figure 5-47. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts.

20. 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.

21. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable.

Jib Lift Cylinder (800AJ Only)

DISASSEMBLY

NOTICE

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. Remove the counterbalance holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

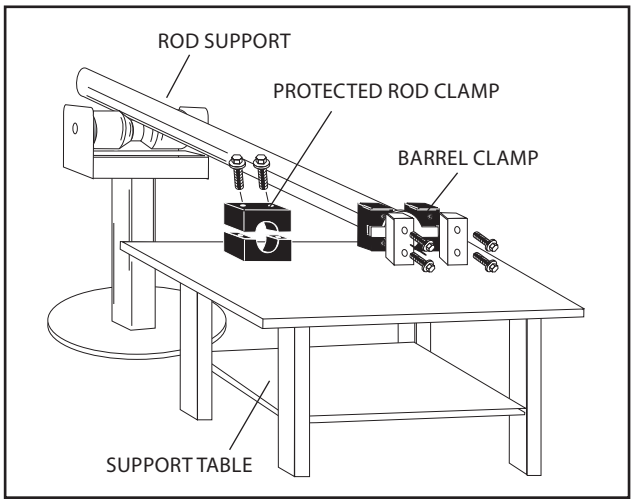


Figure 5-48. Cylinder Barrel Support

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

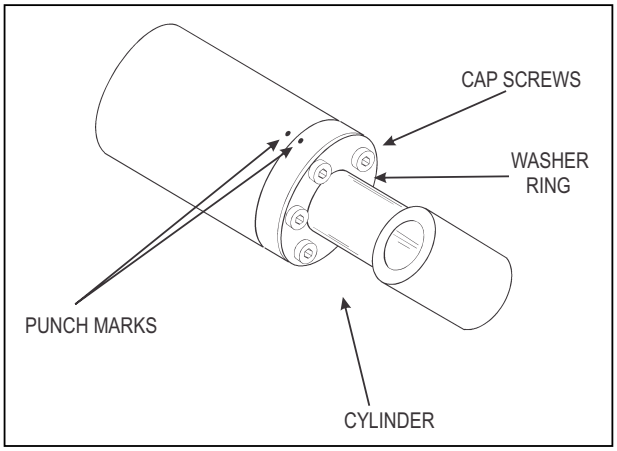


Figure 5-49. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

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.

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

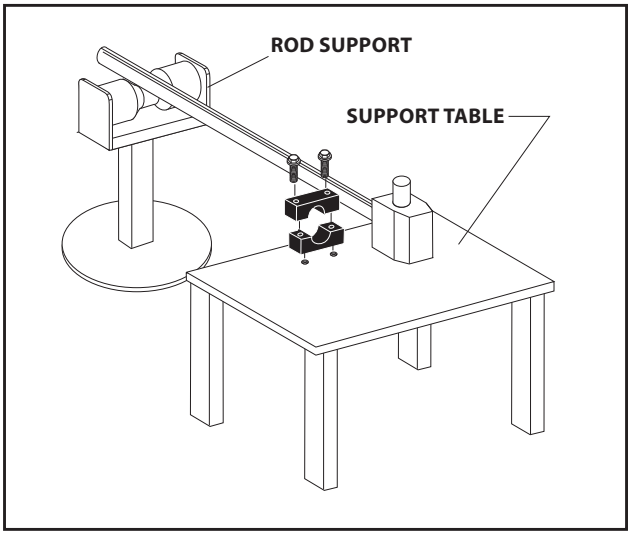
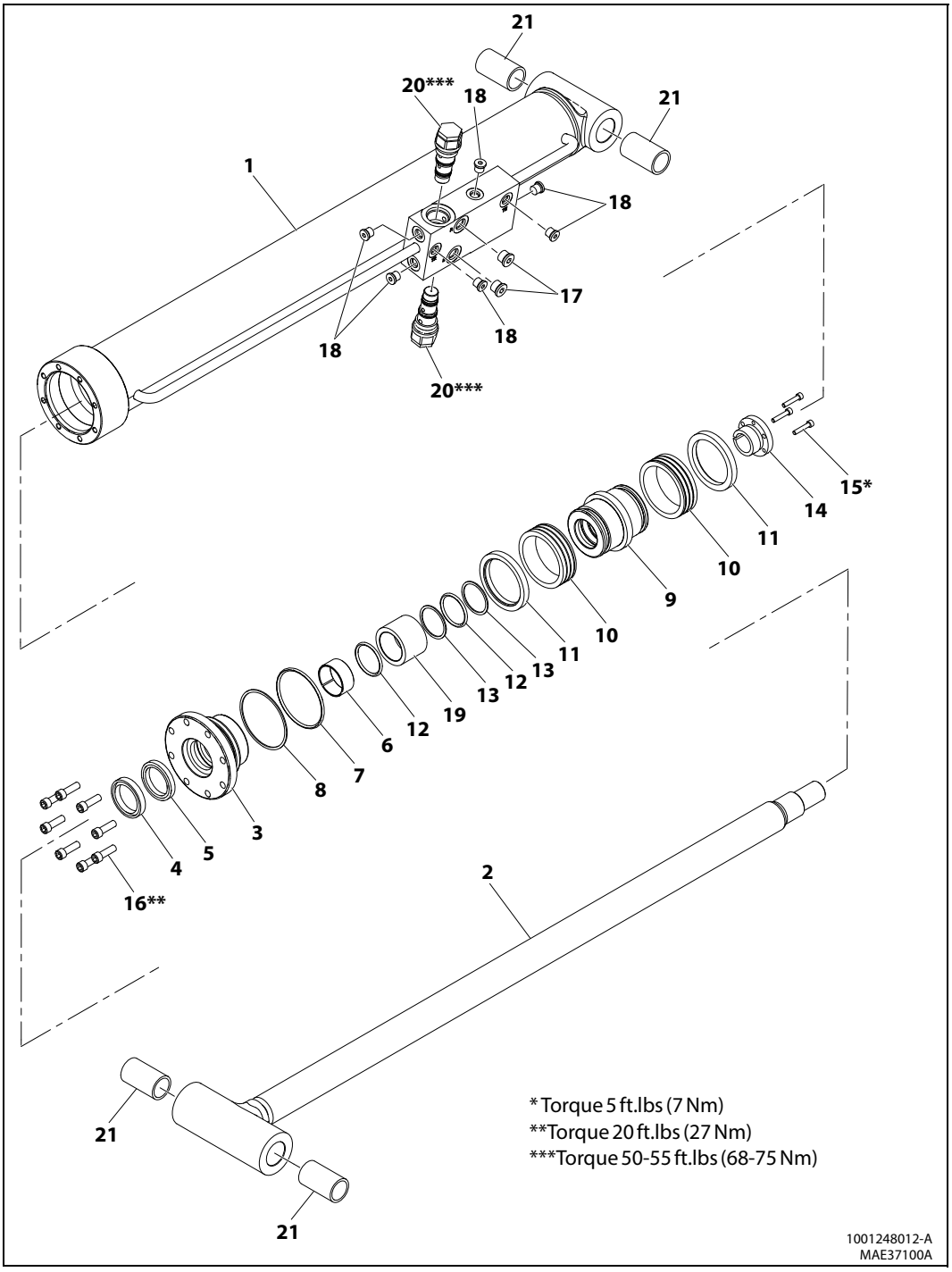


Figure 5-50. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Wiper
5. Rod Seal
6. Wear Ring
7. O-Ring
8. Backup Ring
9. Piston
10. Seal
11. Lock Ring
12. O-Ring
13. Backup Ring
14. Tapered Bushing
15. Capscrew
16. Capscrew
17. O-ring Plug
18. O-ring Plug
19. Spacer
20. Cartridge valve
21. Bushing

Figure 5-51. Jib Lift Cylinder (800AJ Only)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

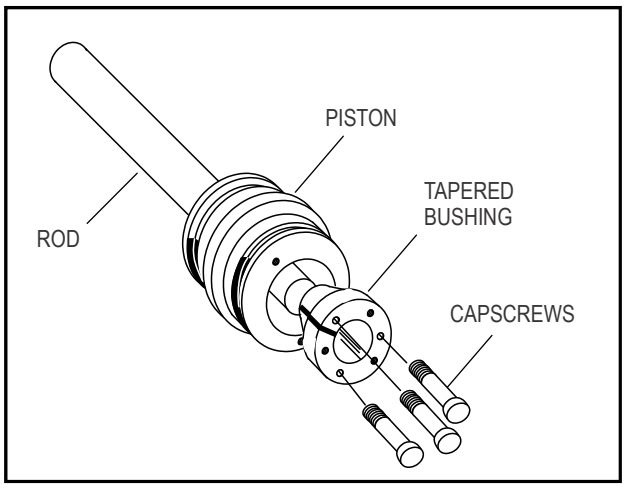


Figure 5-52. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove piston spacer, if applicable, from the rod.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup 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 piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. 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 steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

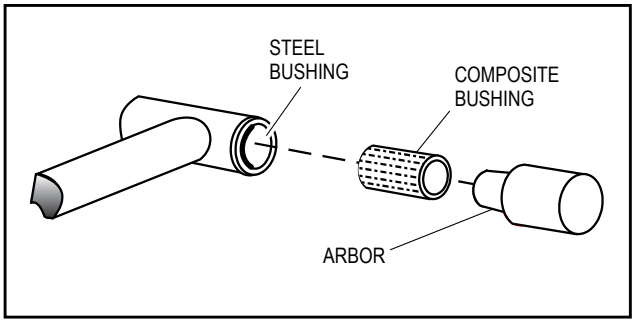


Figure 5-53. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. 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.*

NOTE: *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.

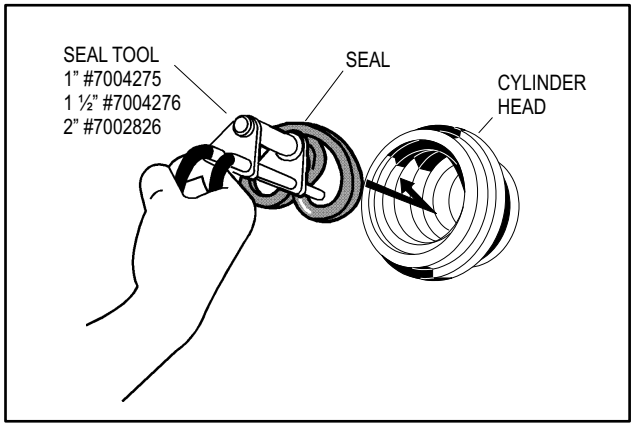


Figure 5-54. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

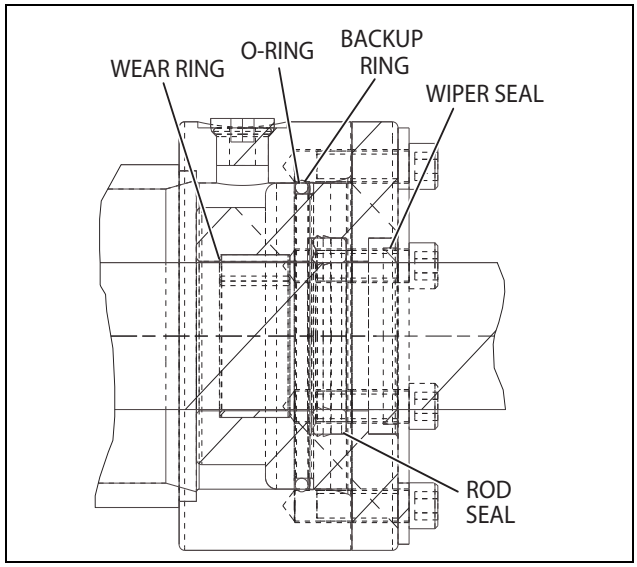


Figure 5-55. Cylinder Head Seal Installation

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.

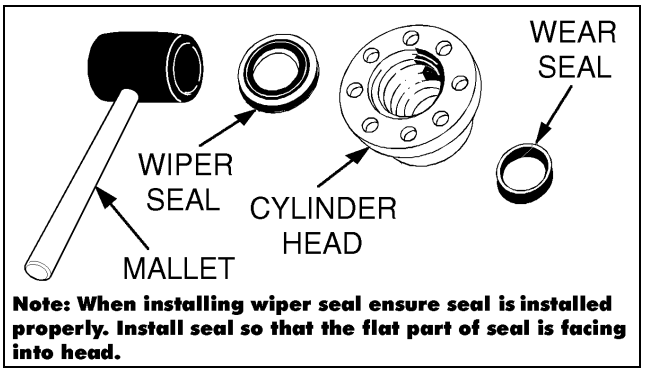


Figure 5-56. Wiper Seal Installation

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

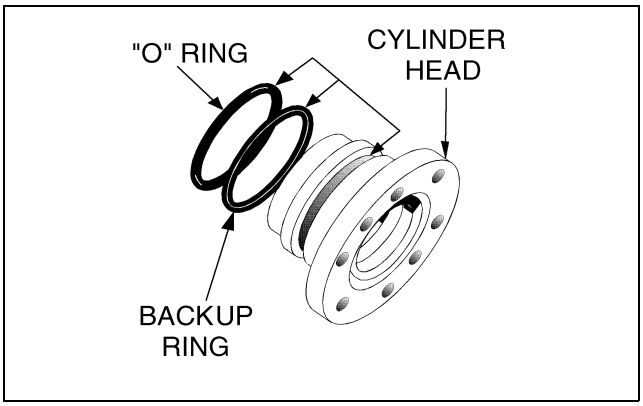


Figure 5-57. Installation of Head Seal Kit

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. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

7. Place a new o-ring and backup rings in the inner piston diameter groove.

8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

9. 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.*

10. Install the bolts in tapered bushing.

11. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

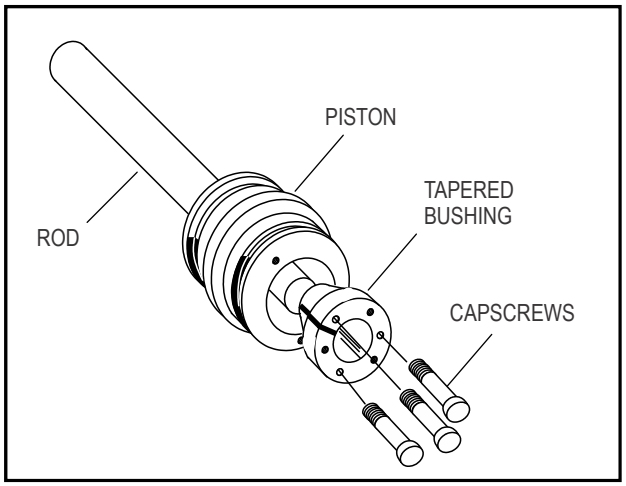


Figure 5-58. Tapered Bushing Removal

12. Tighten the capscrews evenly and progressively in rotation to 5 ft.lbs. (7 Nm).

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.

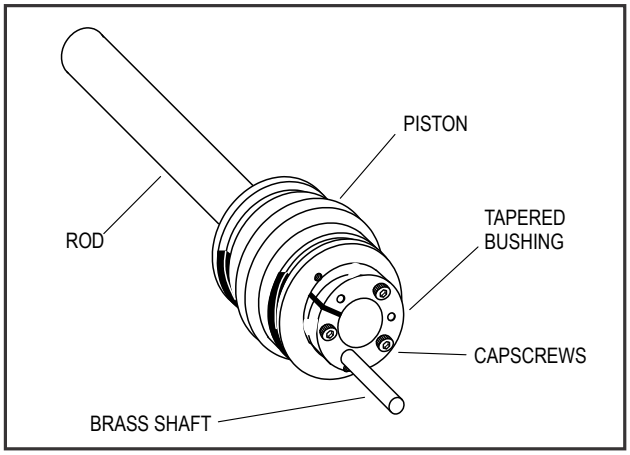


Figure 5-59. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation to 5 ft.lbs. (7 Nm).

15. Remove the cylinder rod from the holding fixture.

NOTICE

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

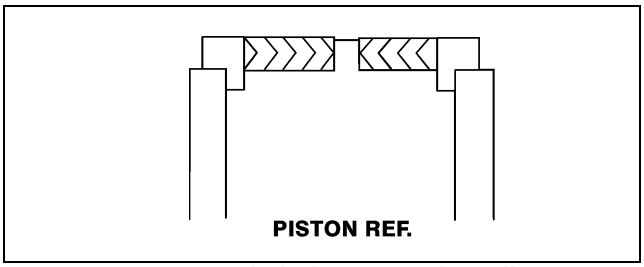


Figure 5-60. Hydrolock Piston Seal Installation

16. Place new hydrolock seal and guidelock 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).

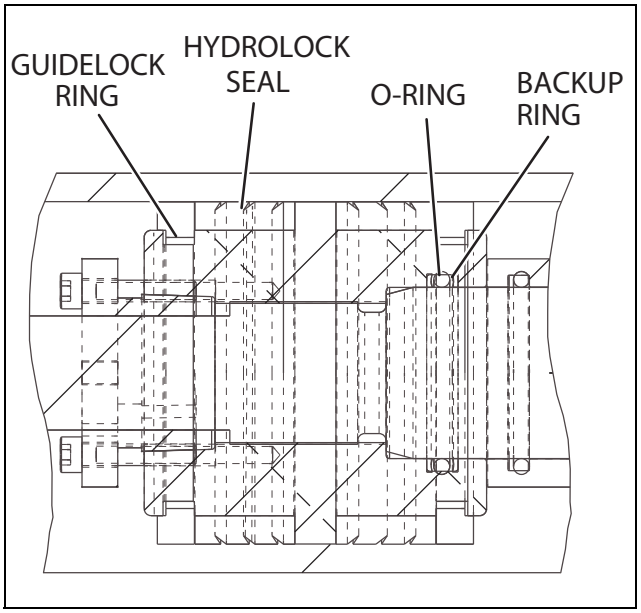


Figure 5-61. Piston Seal Kit Installation

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

NOTICE

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.

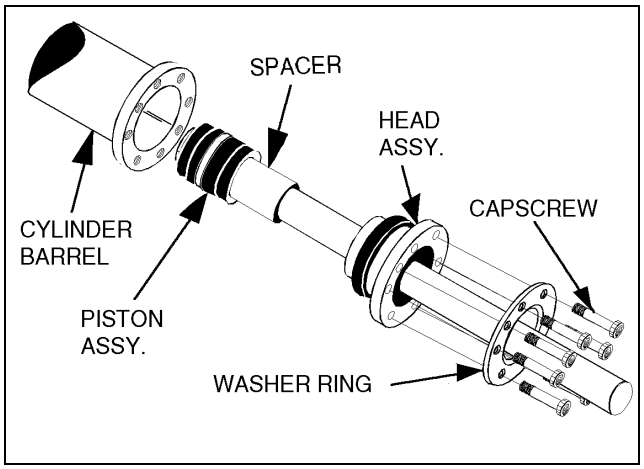


Figure 5-62. Rod Assembly Installation

20. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 20 ft.lbs. (27 Nm).

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. Torque valves to 50-55 ft.lbs. (68-75 Nm).

Main Boom Lift Cylinder

DISASSEMBLY

NOTICE

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. Remove the cartridge valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

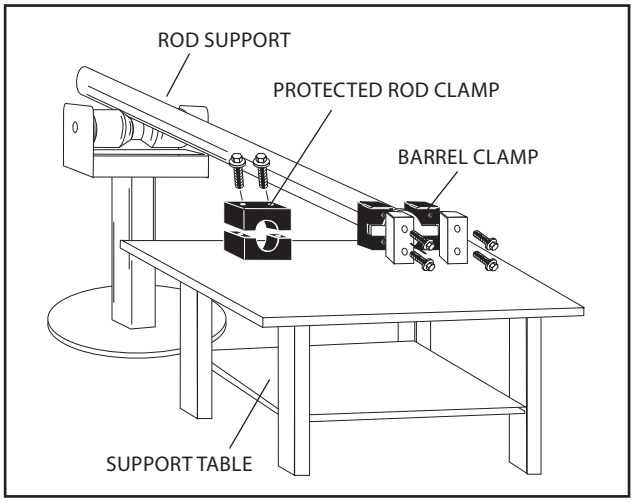


Figure 5-63. Cylinder Barrel Support

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

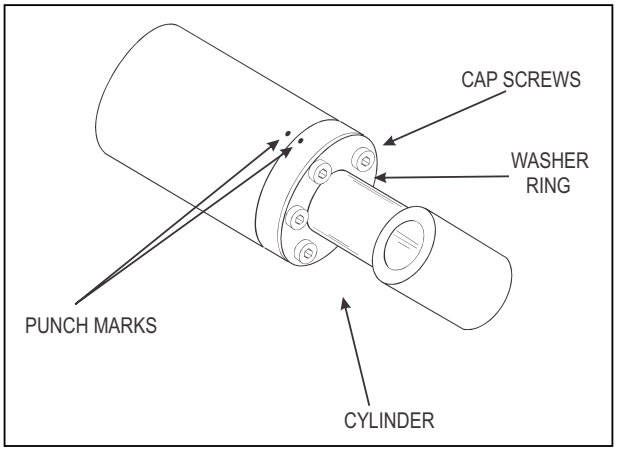


Figure 5-64. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

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.

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

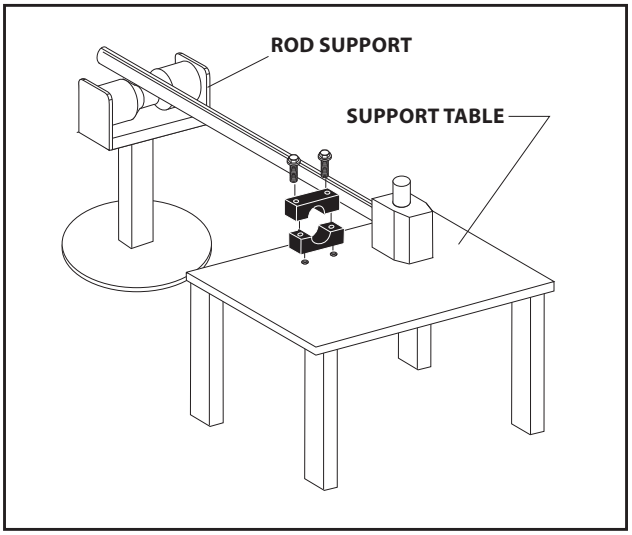
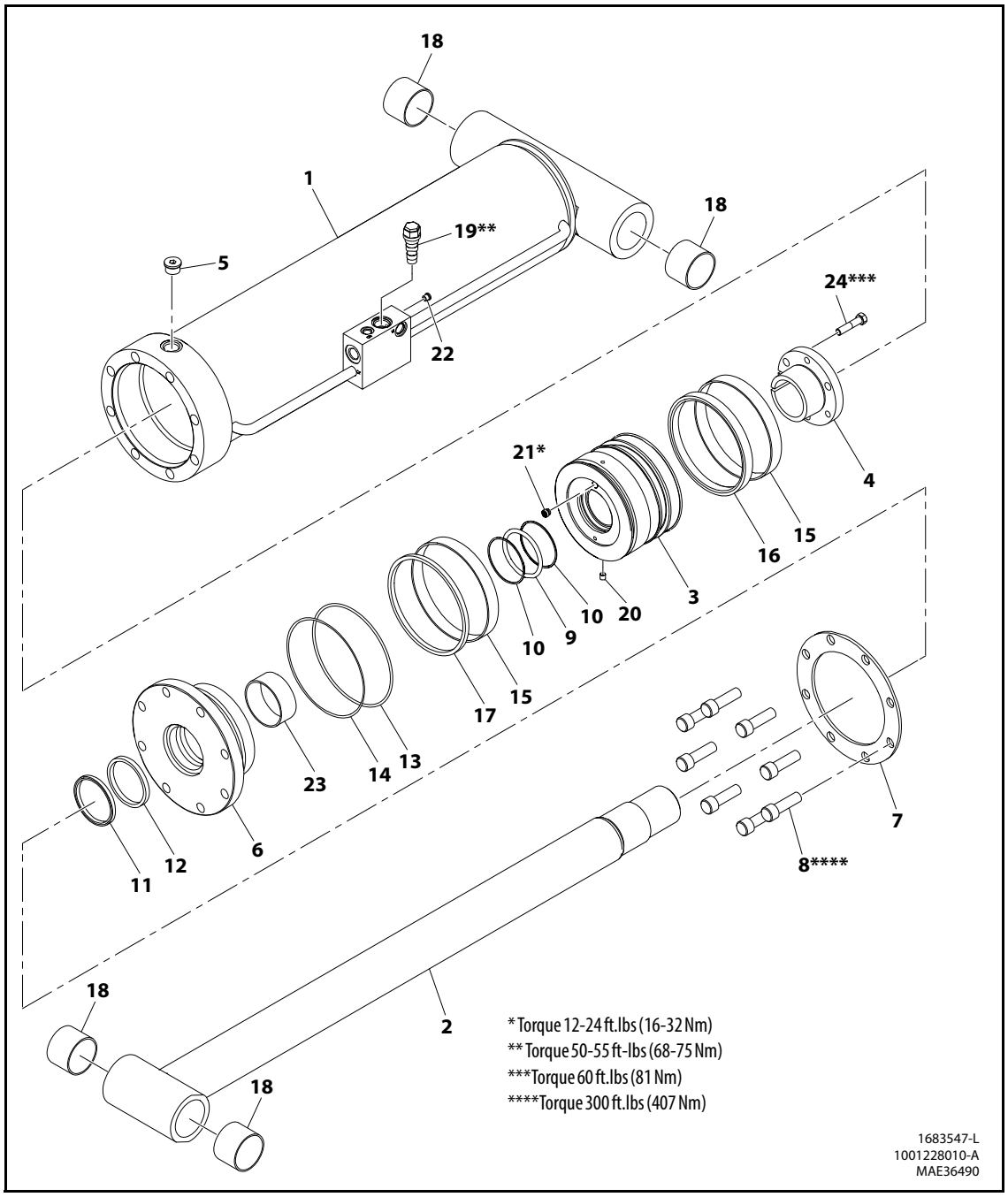


Figure 5-65. Cylinder Rod Support



1. Barrel
2. Rod
3. Piston
4. Tapered Bushing
5. O-ring Plug
6. Head
7. Washer Ring
8. Bolt
9. O-ring
10. Backup Ring
11. Wiper
12. Rod Seal
13. O-ring
14. Backup Ring
15. Wear Ring
16. T-Seal
17. Seal
18. Bushing
19. Cartridge Valve
20. Orifice
21. Check Valve
22. Plug
23. Wear Ring
24. Bolt

Figure 5-66. Main Boom Lift Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

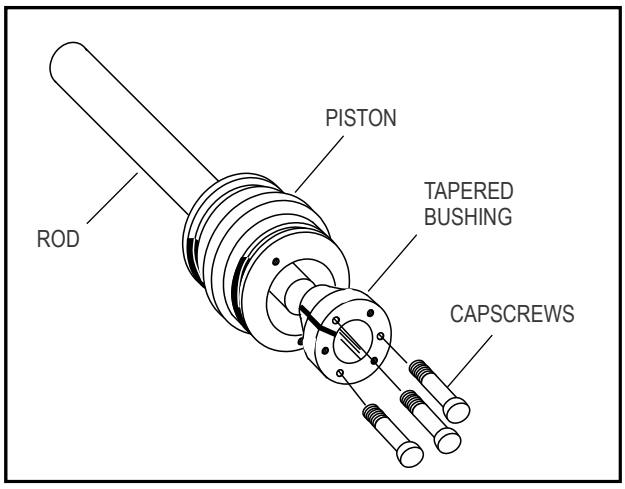


Figure 5-67. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove check valve from the piston.
14. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup 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 piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. 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 steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

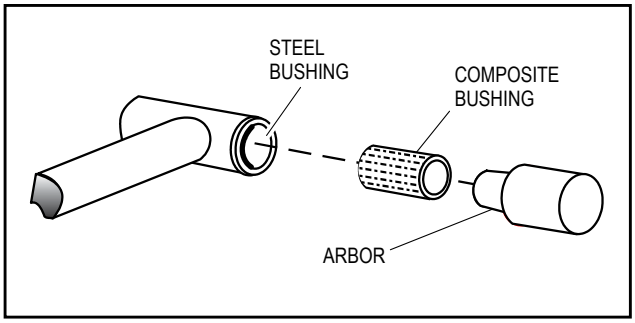


Figure 5-68. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. 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.*

NOTE: *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.

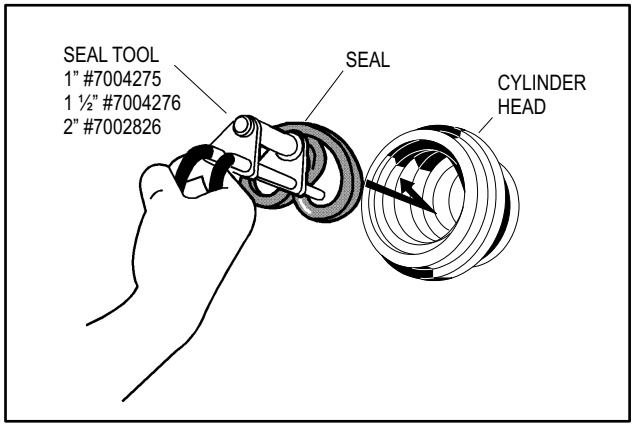


Figure 5-69. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

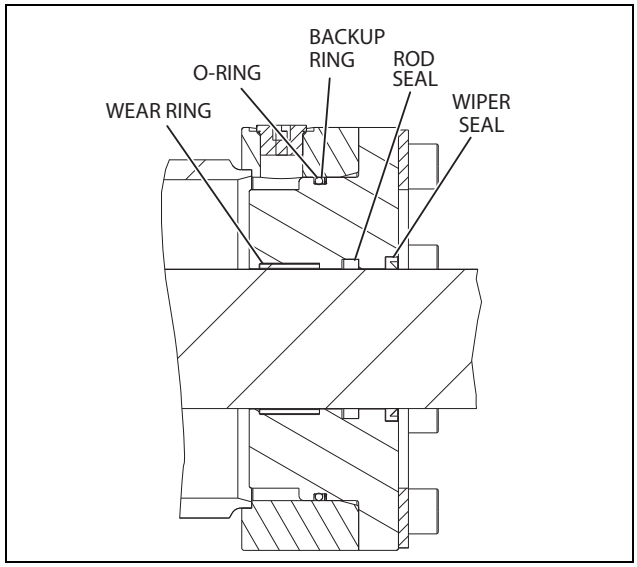


Figure 5-70. Cylinder Head Seal Installation

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.

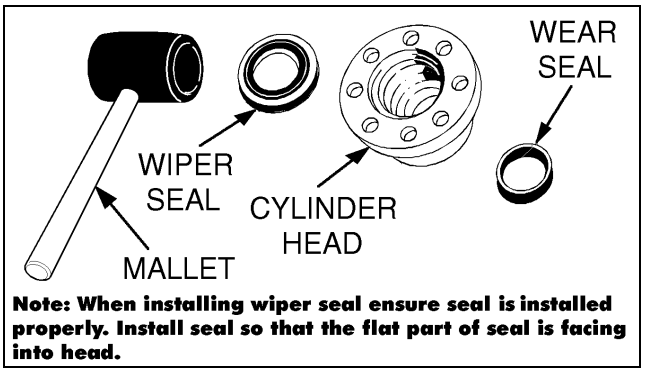


Figure 5-71. Wiper Seal Installation

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

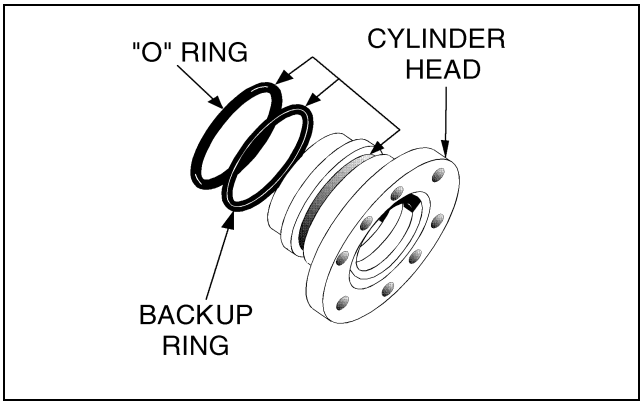


Figure 5-72. Installation of Head Seal Kit

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. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

6. Place a new o-ring and backup rings in the inner piston diameter groove.

7. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

8. Thread piston onto rod hand tight and install the tapered bushing.

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

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

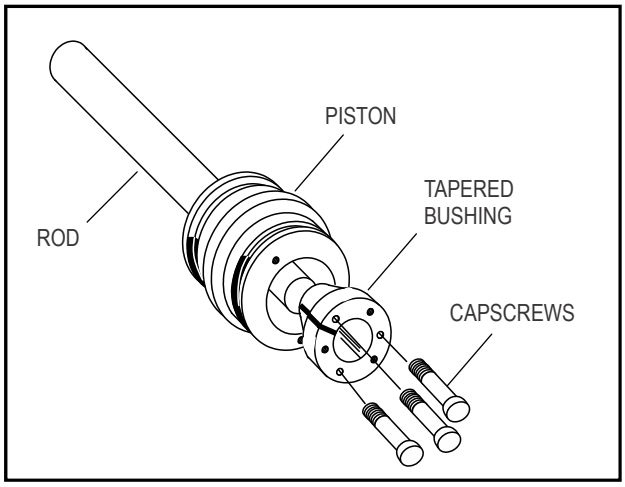


Figure 5-73. Tapered Bushing Removal

10. Tighten the capscrews evenly and progressively in rotation to 60 ft.lbs. (81 Nm).

11. 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.

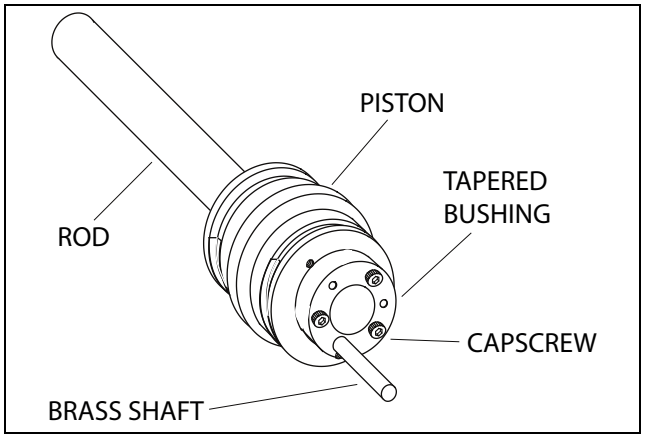


Figure 5-74. Seating the Tapered Bearing

12. Rotate the capscrews evenly and progressively in rotation to 60 ft.lbs. (81 Nm).
13. Remove the cylinder rod from the holding fixture.
14. Place new T-seal and wear 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).

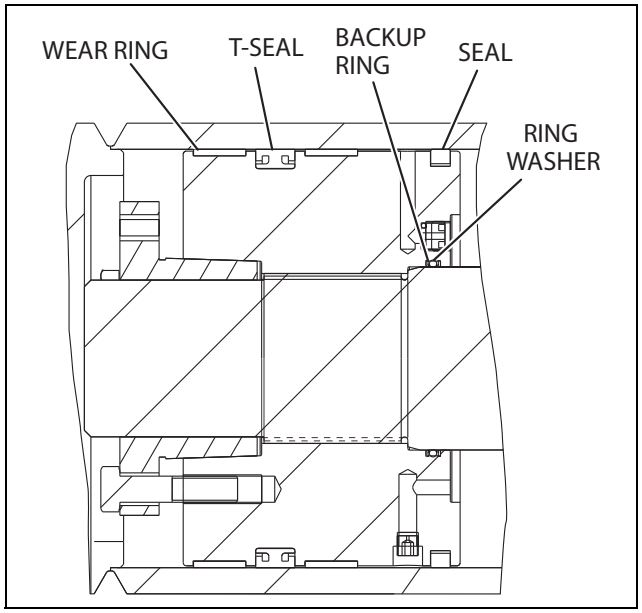


Figure 5-75. Piston Seal Kit Installation

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

NOTICE

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.

16. 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.
17. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

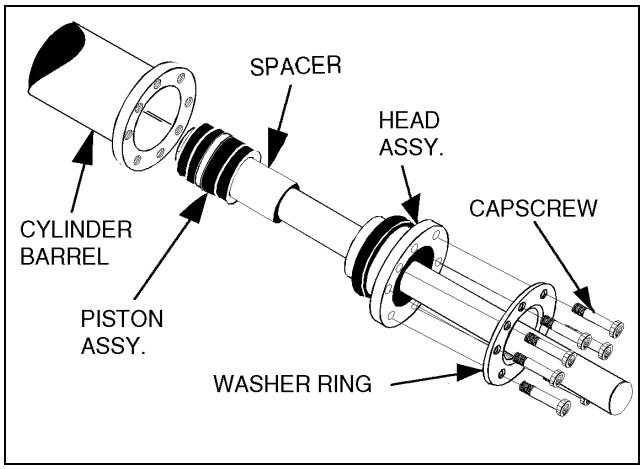


Figure 5-76. Rod Assembly Installation

18. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 300 ft.lbs. (407 Nm).
19. 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.
20. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft.lbs. (68-75 Nm).

Tower Boom Lift Cylinder

DISASSEMBLY

NOTICE

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. Remove the cartridge valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

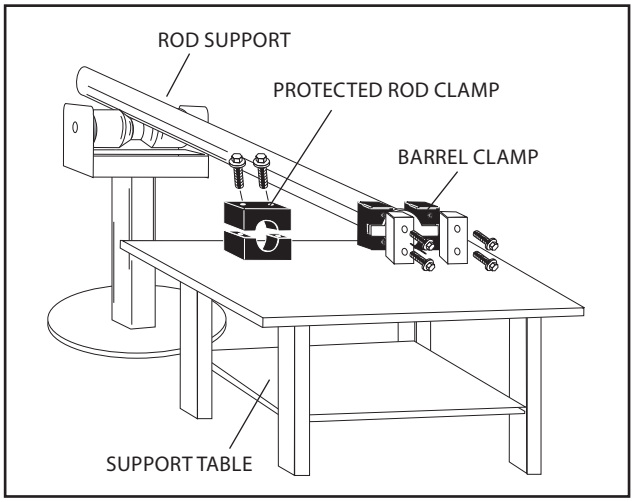


Figure 5-77. Cylinder Barrel Support

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

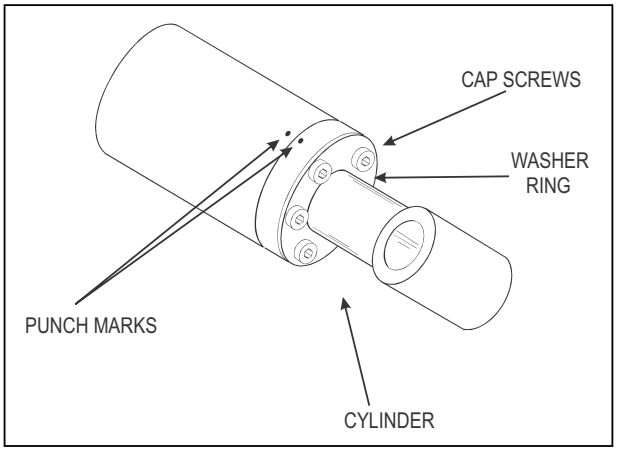


Figure 5-78. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

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.

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

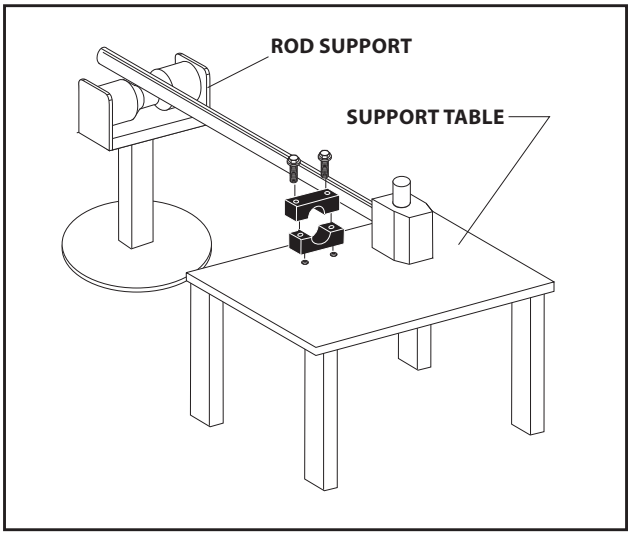
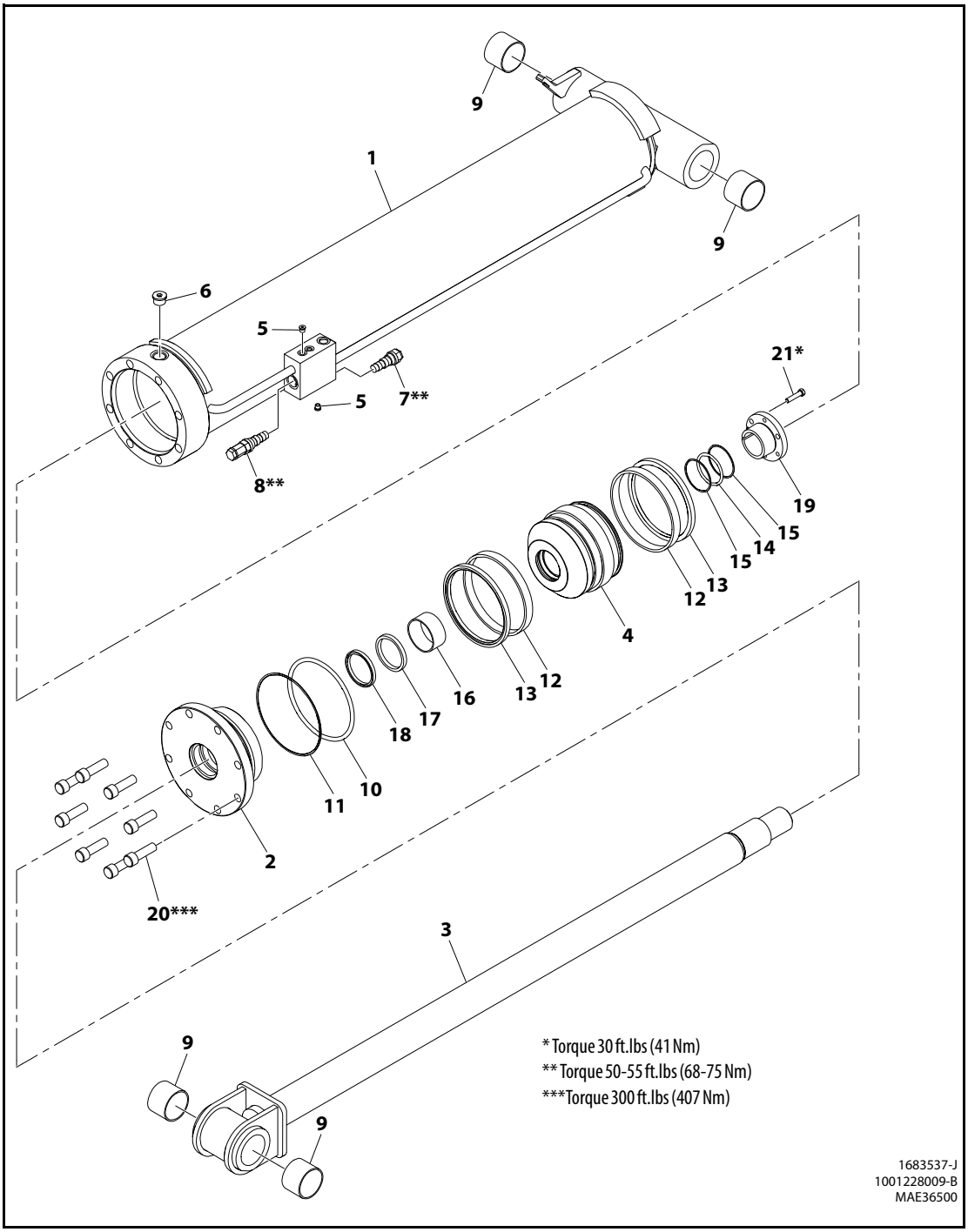


Figure 5-79. Cylinder Rod Support



1. Barrel
2. Head
3. Rod
4. Piston
5. O-ring Plug
6. O-ring Plug
7. Cartridge Valve
8. Cartridge Valve
9. Bushing
10. O-ring
11. Lock Ring
12. Seal
13. Lock Ring
14. O-ring
15. Backup Ring
16. Wear Ring
17. Seal
18. Wiper
19. Tapered Bushing
20. Capscrew
21. Bolt

Figure 5-80. Tower Boom Lift Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

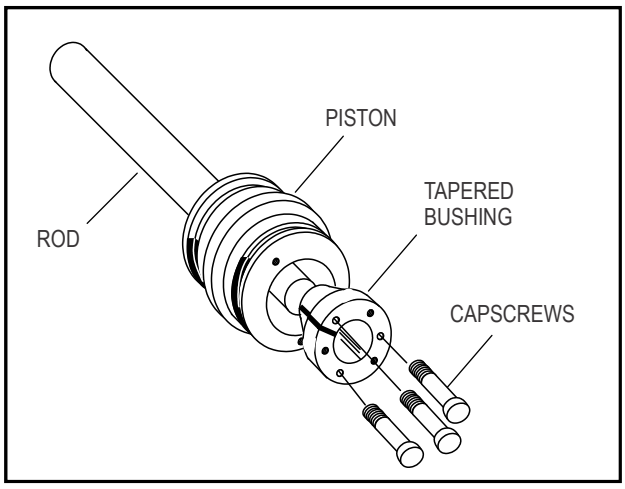


Figure 5-81. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup 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 piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. 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 steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

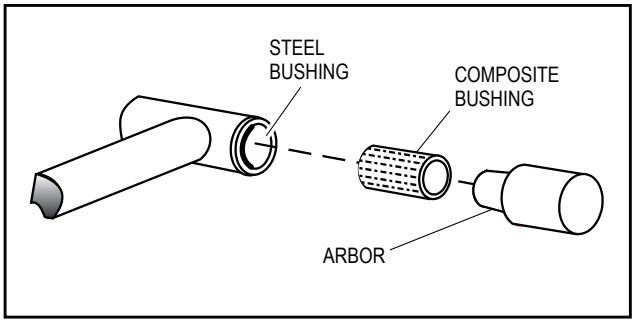


Figure 5-82. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. 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.*

NOTE: *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.

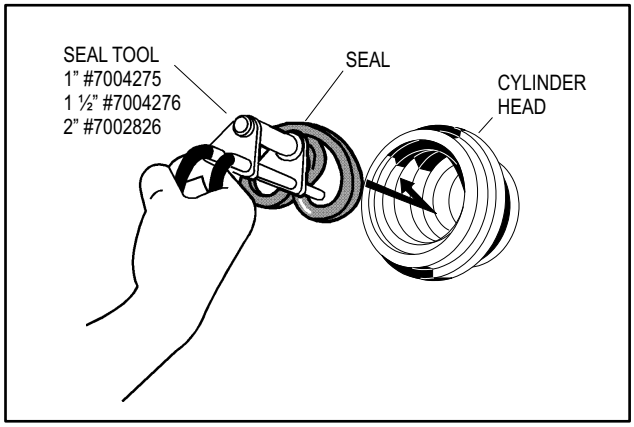


Figure 5-83. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

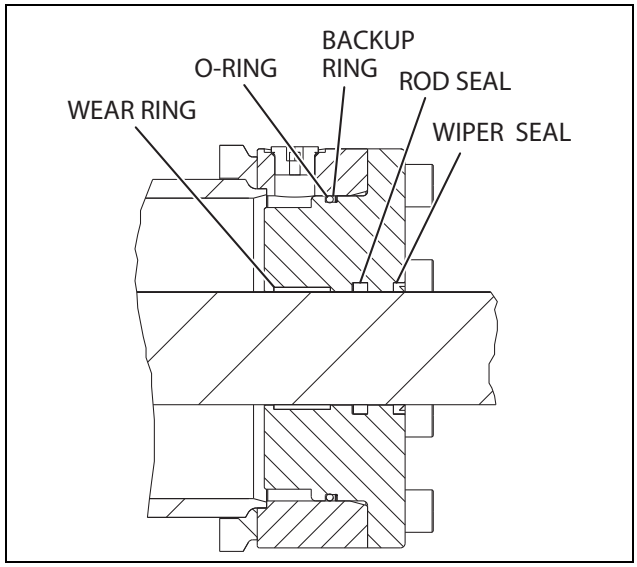


Figure 5-84. Cylinder Head Seal Installation

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.

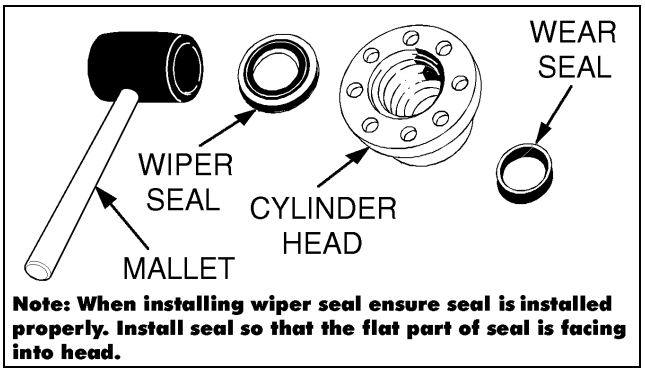


Figure 5-85. Wiper Seal Installation

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

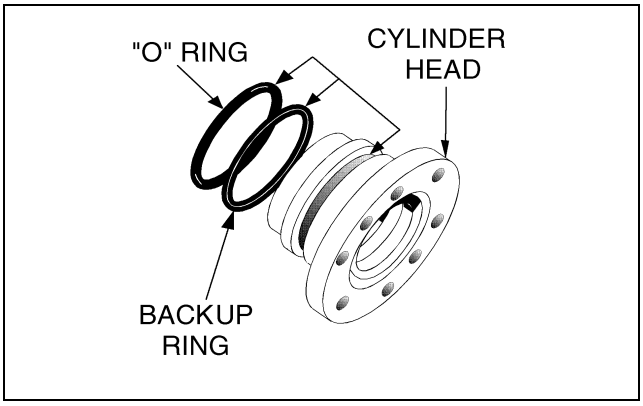


Figure 5-86. Installation of Head Seal Kit

4. 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. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

6. Place a new o-ring and backup rings in the inner piston diameter groove.

7. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

8. Thread piston onto rod hand tight and install the tapered bushing.

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

9. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

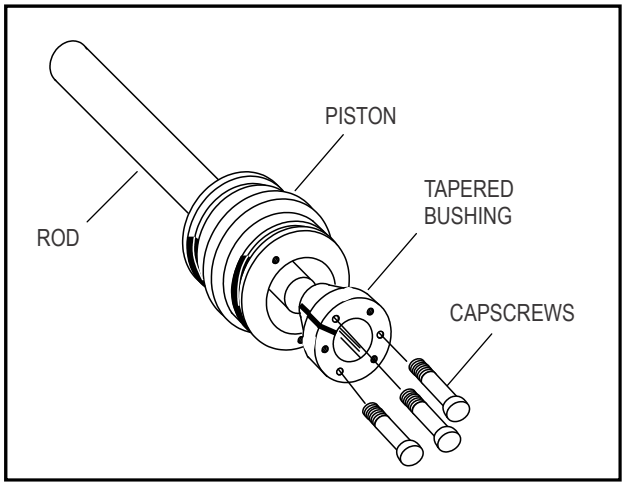


Figure 5-87. Tapered Bushing Removal

10. Tighten the capscrews evenly and progressively in rotation to 30 ft.lbs. (41 Nm).

11. 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.

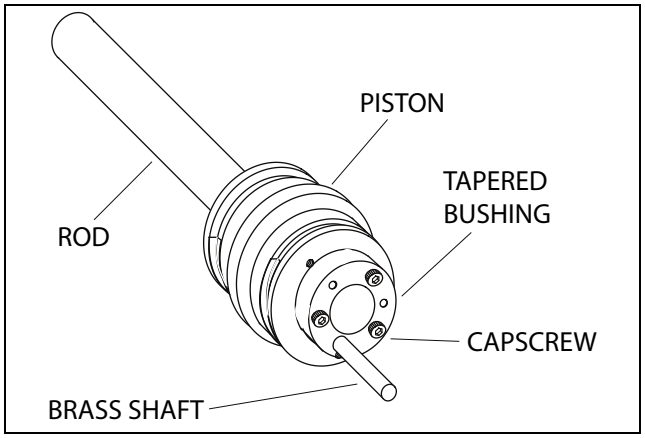


Figure 5-88. Seating the Tapered Bearing

12. Rotate the capscrews evenly and progressively in rotation to 30 ft.lbs. (41 Nm).

13. Remove the cylinder rod from the holding fixture.

NOTICE

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

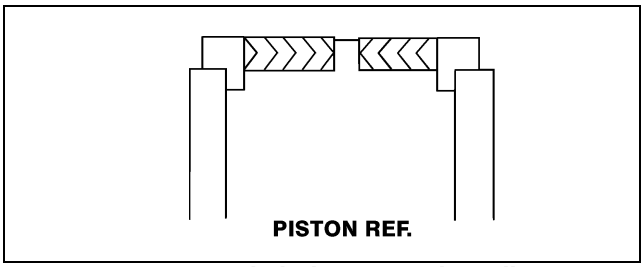


Figure 5-89. Hydrolock Piston Seal Installation

14. Place new hydrolock seal and guidelock 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).

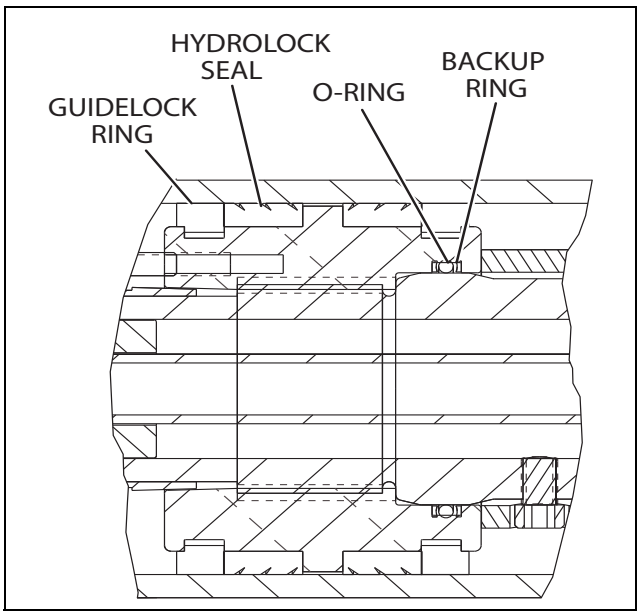


Figure 5-90. Piston Seal Kit Installation

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

NOTICE

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.

16. 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.

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

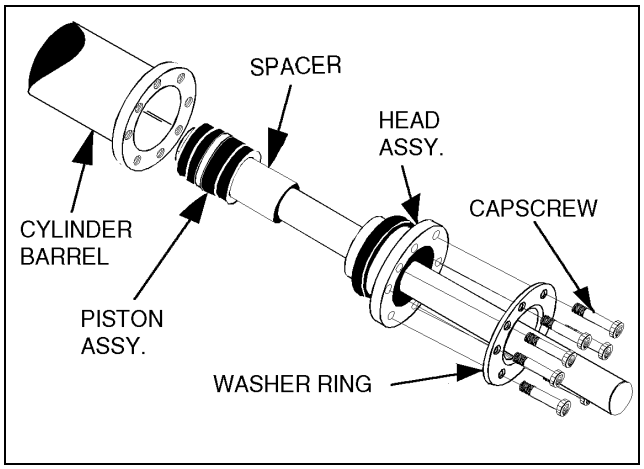


Figure 5-91. Rod Assembly Installation

18. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 300 ft.lbs. (407 Nm).

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

20. If applicable, install the cartridge-type holding valve and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft.lbs. (68-75 Nm).

Master Cylinder

DISASSEMBLY

NOTICE

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. Place the cylinder barrel into a suitable holding fixture.

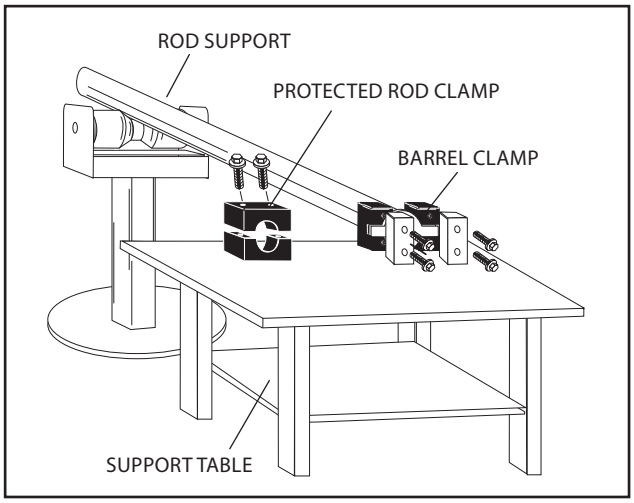


Figure 5-92. Cylinder Barrel Support

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

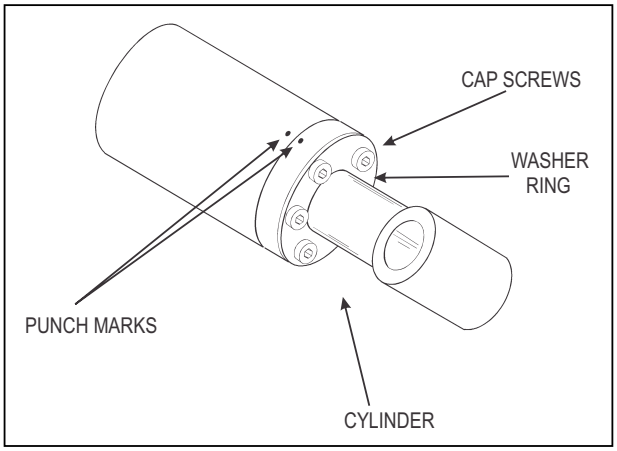


Figure 5-93. Capscrew Removal

5. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

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.

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

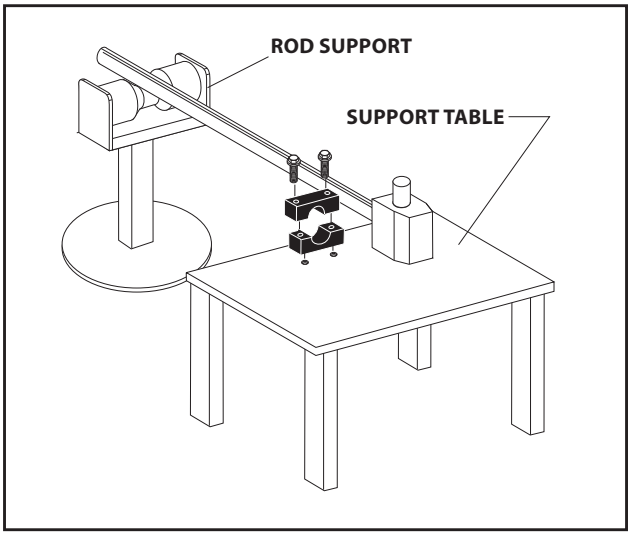
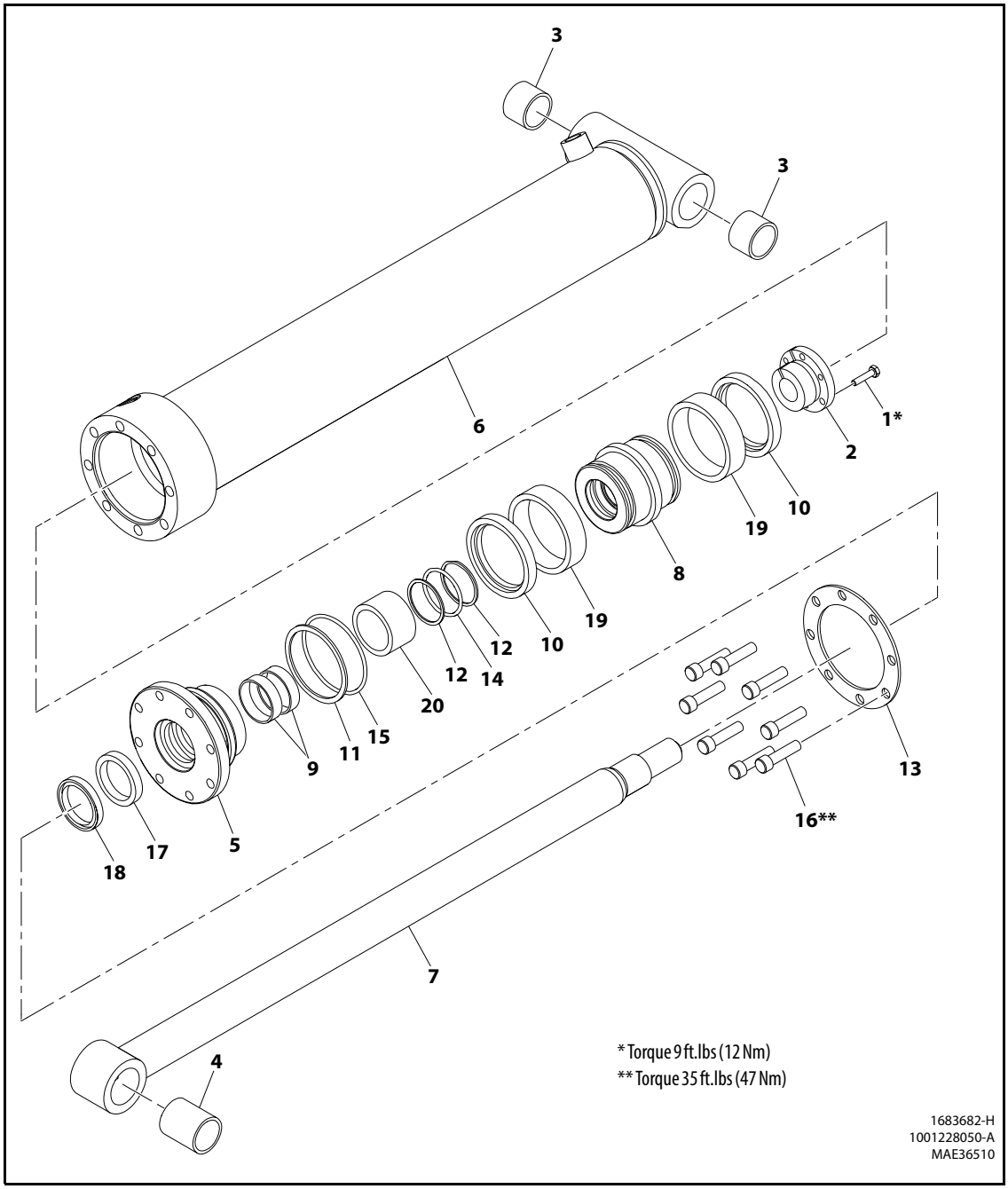


Figure 5-94. Cylinder Rod Support



1. Capscrew
2. Tapered Bushing
3. Bushing
4. Bushing
5. Head
6. Barrel
7. Rod
8. Piston
9. Wear Ring
10. Lock Ring
11. Backup Ring
12. Backup Ring
13. Washer Ring
14. O-ring
15. O-ring
16. Capscrew
17. Rod Seal
18. Wiper
19. Seal
20. Tube Spacer

Figure 5-95. Master Cylinder

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
9. Remove the bushing from the piston.

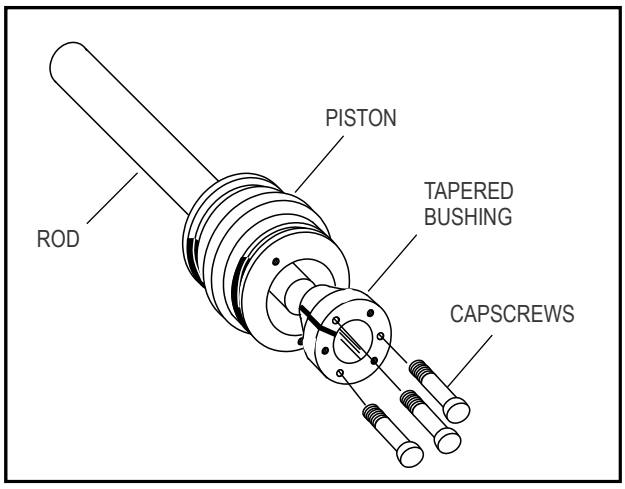


Figure 5-96. Tapered Bushing Removal

10. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
11. Remove and discard the piston o-rings, seal rings, and backup rings.
12. Remove piston spacer from the rod.
13. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup 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 piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. 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 steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

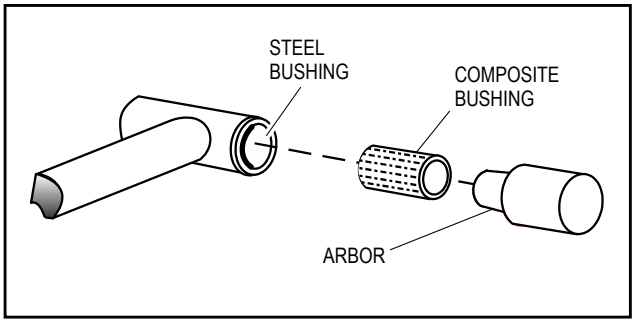


Figure 5-97. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. 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.*

NOTE: *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.

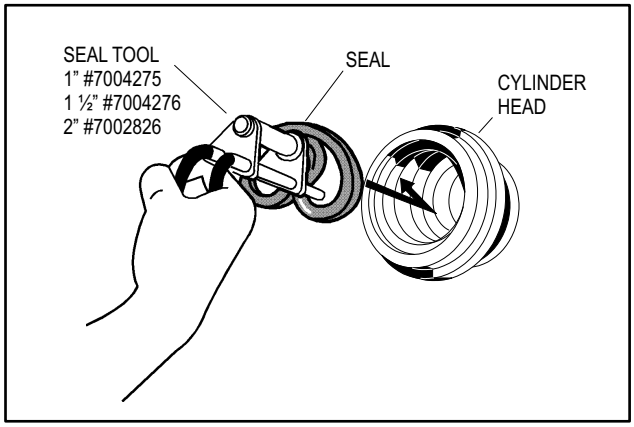


Figure 5-98. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

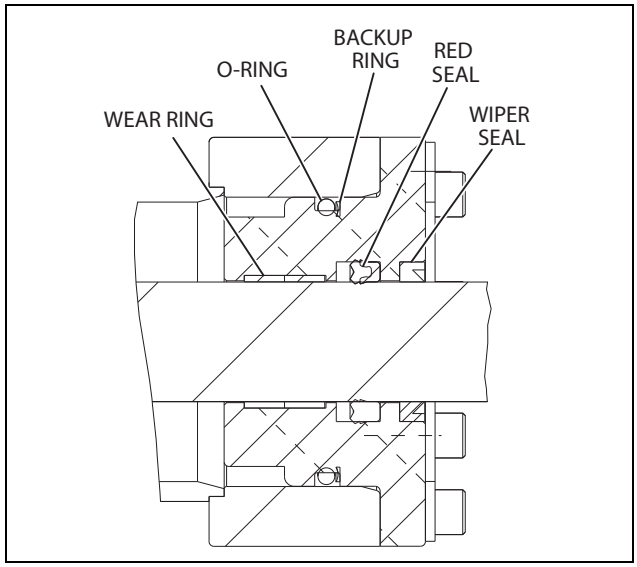


Figure 5-99. Cylinder Head Seal Installation

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.

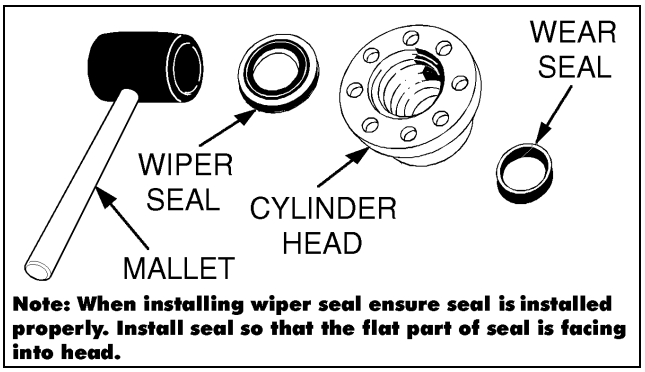


Figure 5-100. Wiper Seal Installation

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

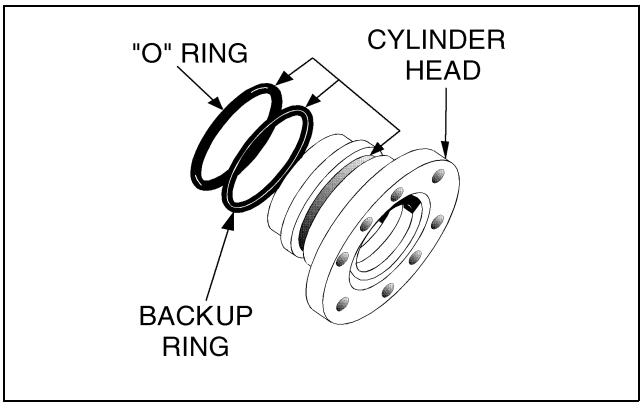


Figure 5-101. Installation of Head Seal Kit

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. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

6. Place a new o-ring and backup rings in the inner piston diameter groove.

7. Install piston spacer onto the cylinder rod.

8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

9. 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.*

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

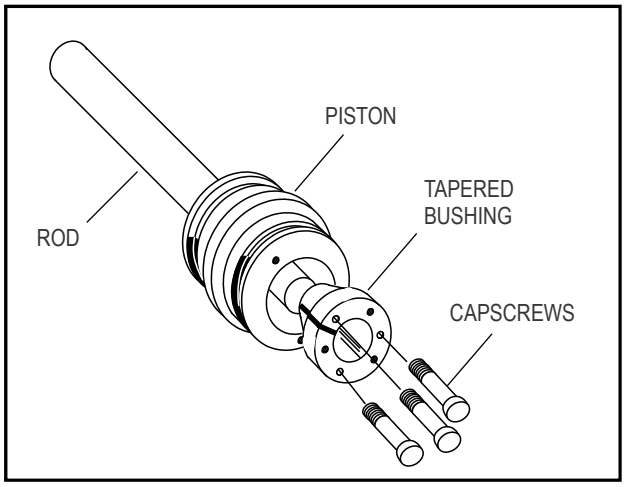


Figure 5-102. Tapered Bushing Removal

11. Tighten the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

12. 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.

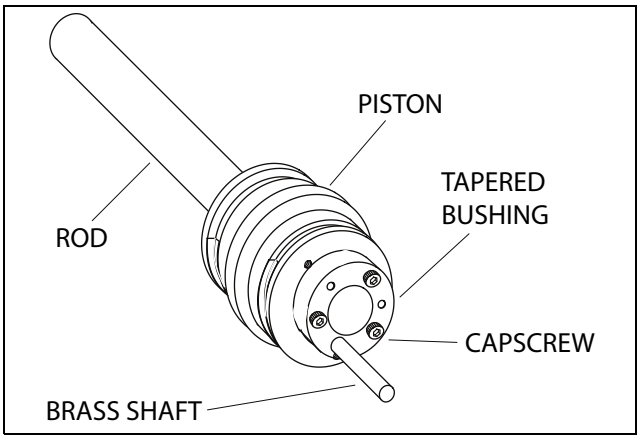


Figure 5-103. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

14. Remove the cylinder rod from the holding fixture.

NOTICE

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

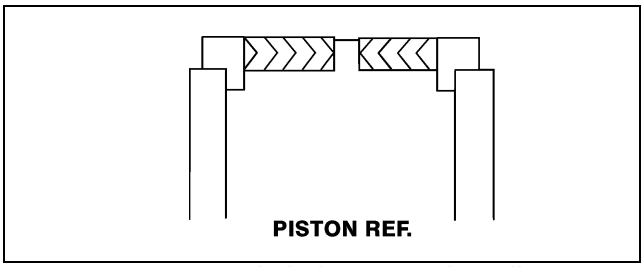


Figure 5-104. Hydrolock Piston Seal Installation

15. Place new hydrolock seal and guidelock 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).

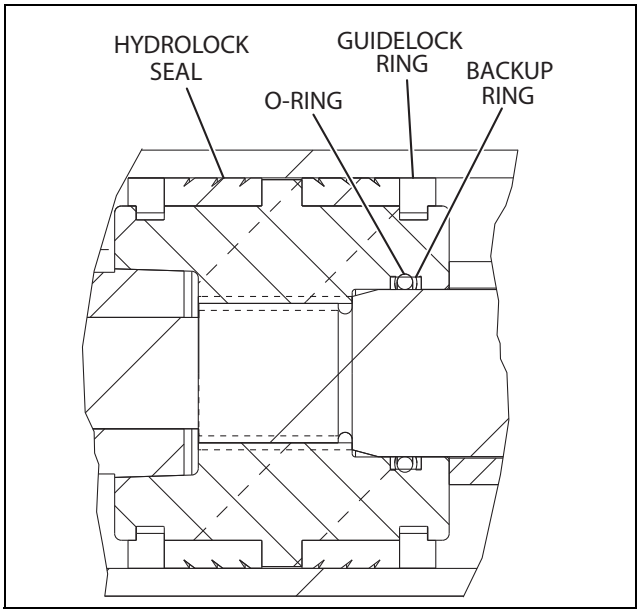


Figure 5-105. Piston Seal Kit Installation

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

NOTICE

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.

17. 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.

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

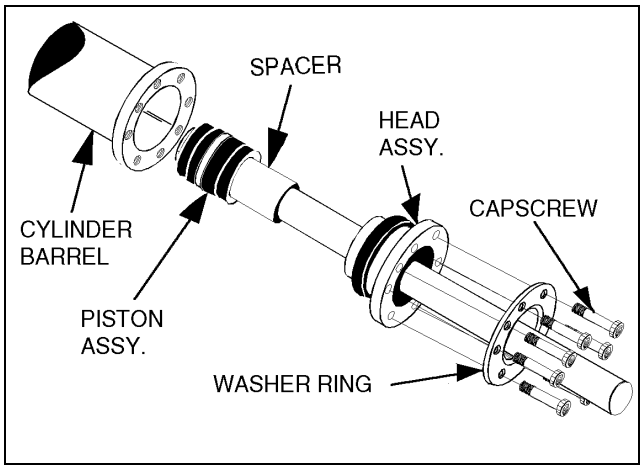


Figure 5-106. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 35 ft.lbs. (50 Nm).

Steer Cylinder

DISASSEMBLY

NOTICE

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. Place the cylinder barrel into a suitable holding fixture.

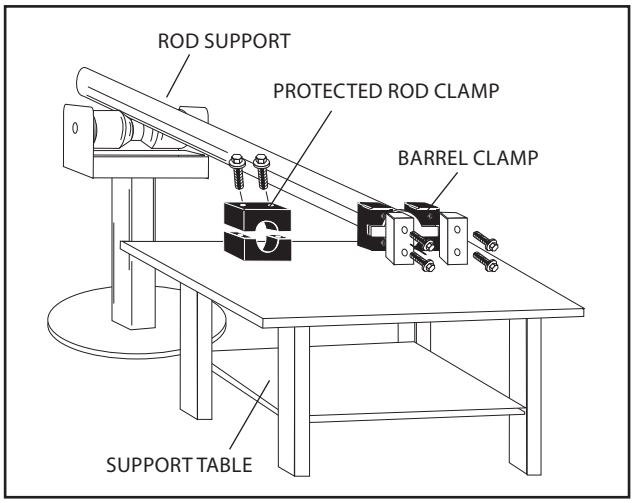


Figure 5-107. Cylinder Barrel Support

4. Using a hook spanner, loosen the spanner nut retainer and remove spanner nut from cylinder barrel.

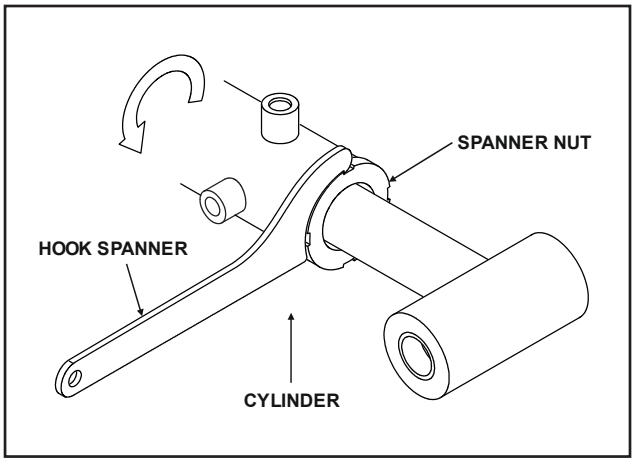


Figure 5-108. Spanner Nut Removal

5. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

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.

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

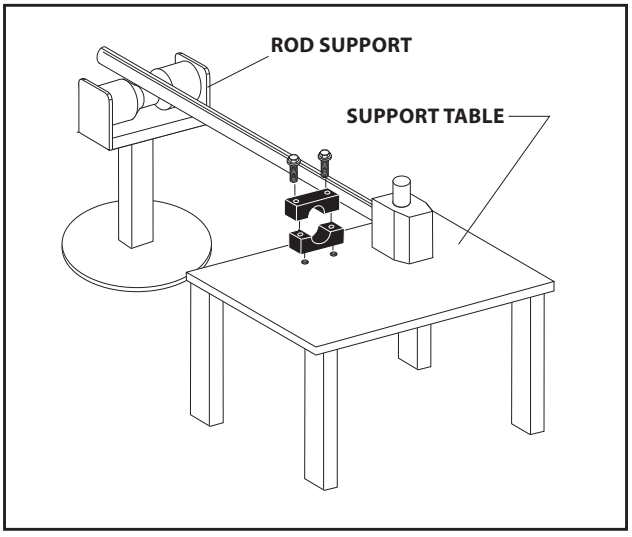
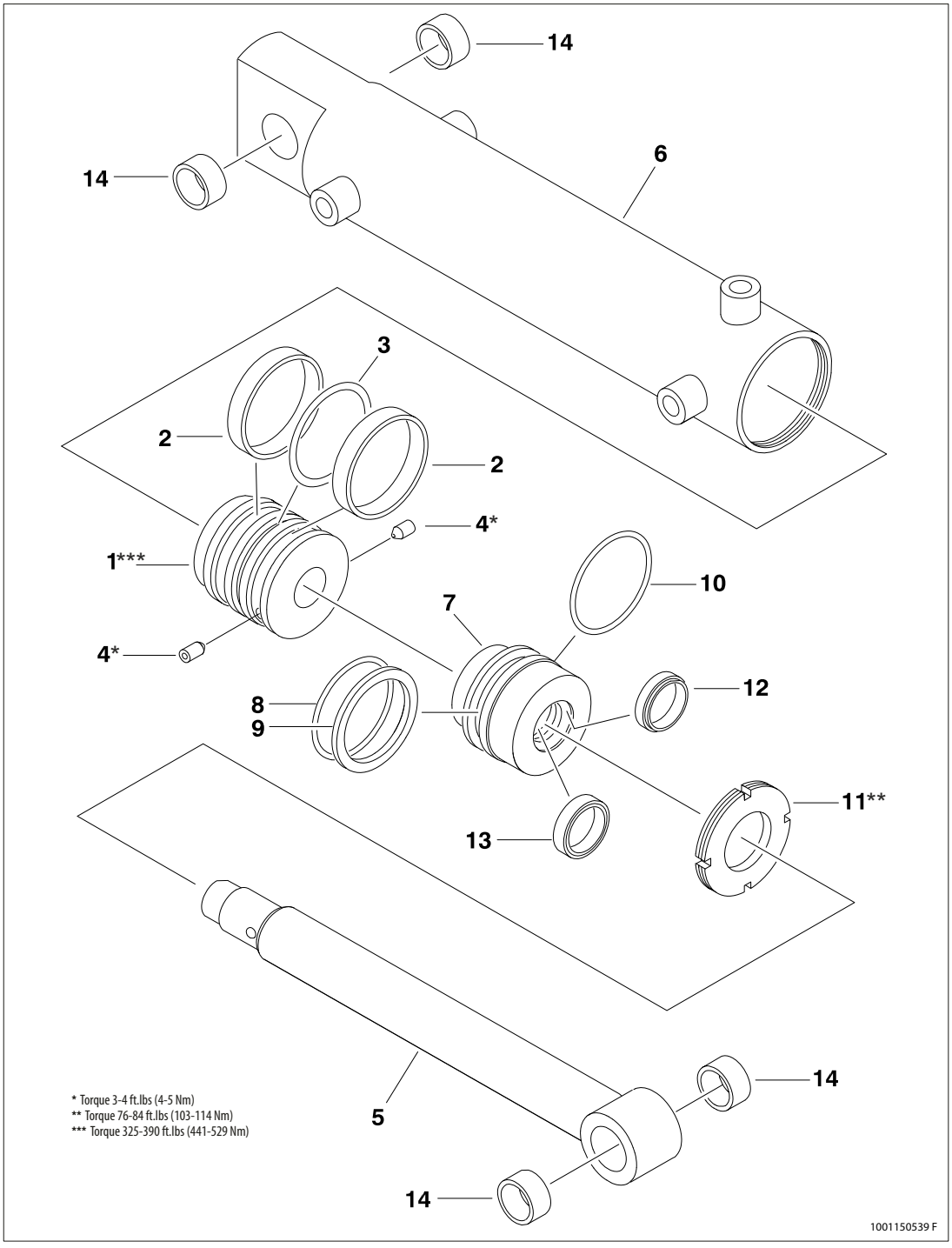


Figure 5-109. Cylinder Rod Support



1. Piston
2. Wear Ring
3. Seal
4. Setscrew
5. Rod
6. Barrel
7. Head
8. O-ring
9. Backup Ring
10. C-Ring
11. Spanner Nut
12. Wiper Seal
13. Rod Seal
14. Bushing

Figure 5-110. Steer Cylinder

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Remove the setscrews from the piston.
9. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
10. Remove and discard the piston seal and wear rings.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, c-ring, rod seal, and wiper seal.

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 piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of barrel for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. 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 steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

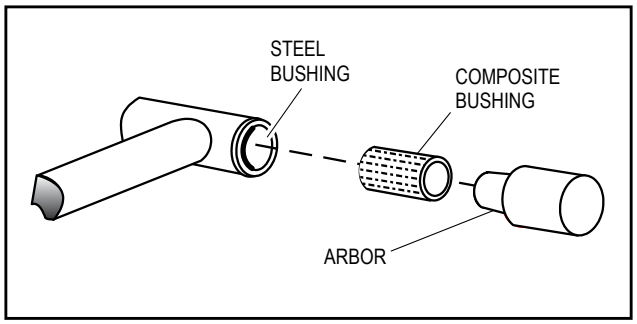


Figure 5-111. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
13. If applicable, inspect port block fittings and holding valve. Replace as necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.
15. 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.*

NOTE: *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.

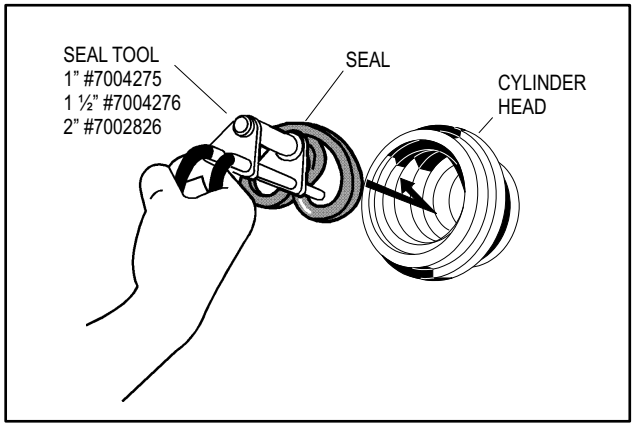


Figure 5-112. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

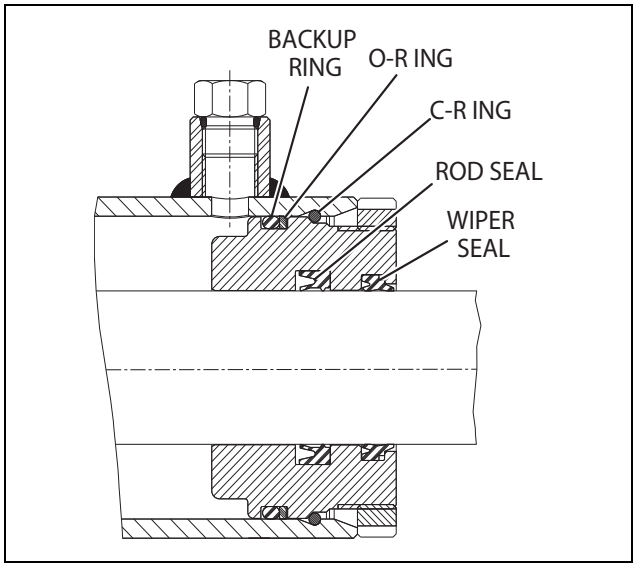


Figure 5-113. Cylinder Head Seal Installation

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.

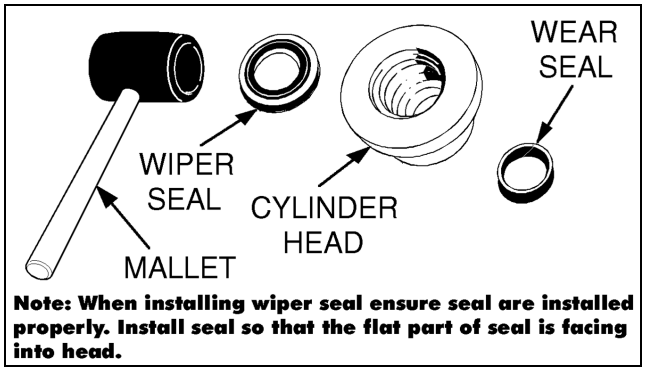


Figure 5-114. Wiper Seal Installation

3. Place a new o-ring, backup ring and c-ring in the applicable outside diameter groove of the cylinder head.

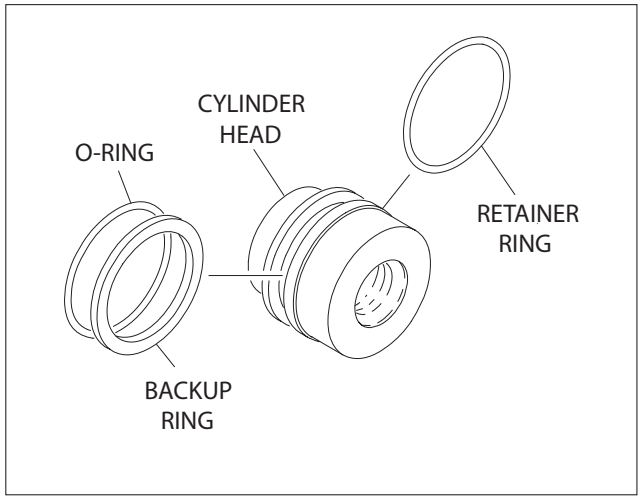


Figure 5-115. Installation of Head Seal Kit

4. Install spanner nut 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. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

6. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

7. Install the setscrews on the piston.

8. Remove the cylinder rod from the holding fixture.

9. Place new seal and wear ring in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

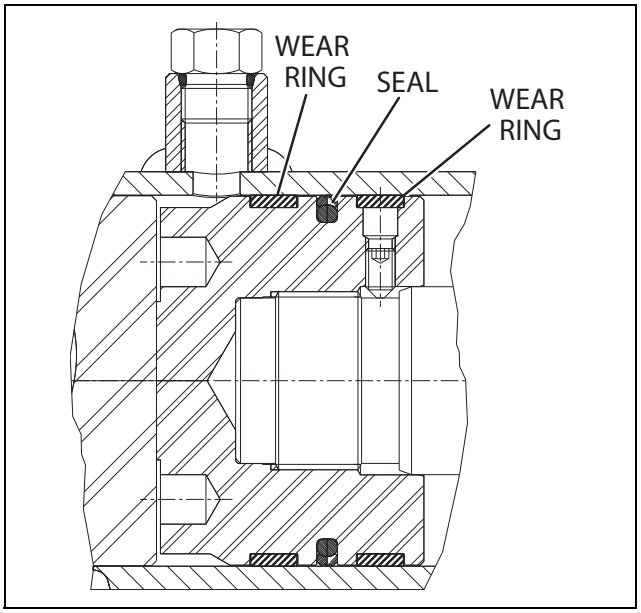


Figure 5-116. Piston Seal Kit Installation

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

NOTICE

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.

11. 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.

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

13. Secure spanner nut into the cylinder barrel. Torque nut to 325-390 ft.lbs. (441-529 Nm).

14. 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, if applicable.

Main Boom Telescope Cylinder

DISASSEMBLY

NOTICE

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. Remove capscrews and valve assembly from the barrel end. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

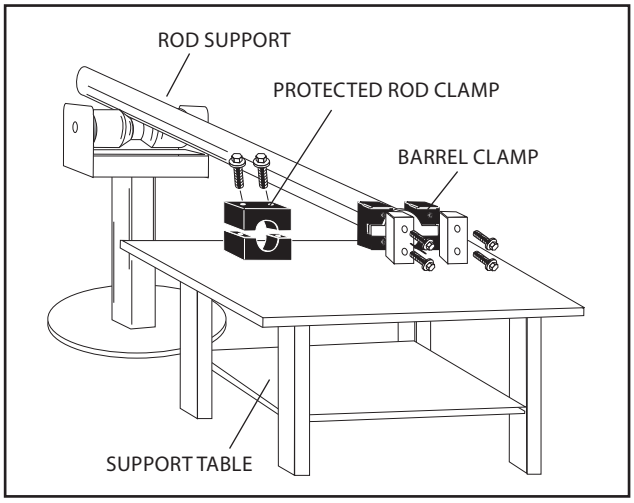


Figure 5-117. Cylinder Barrel Support

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

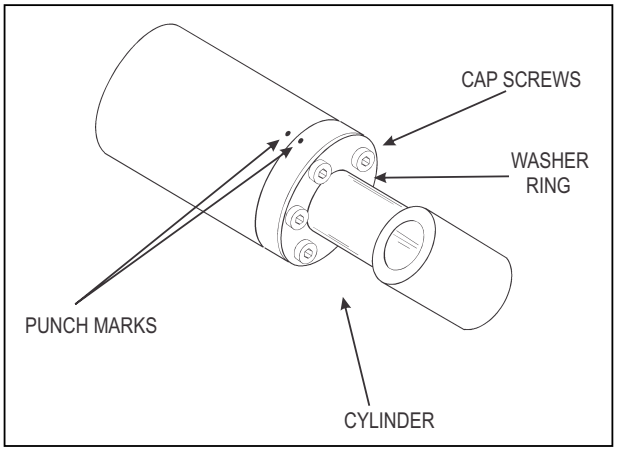


Figure 5-118. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

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.

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

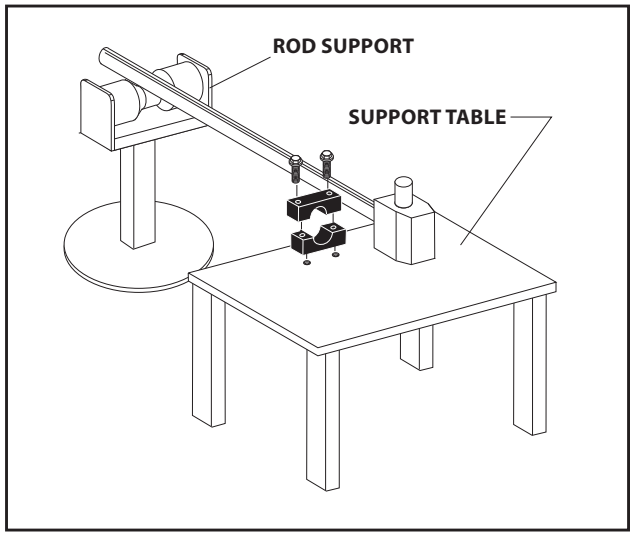
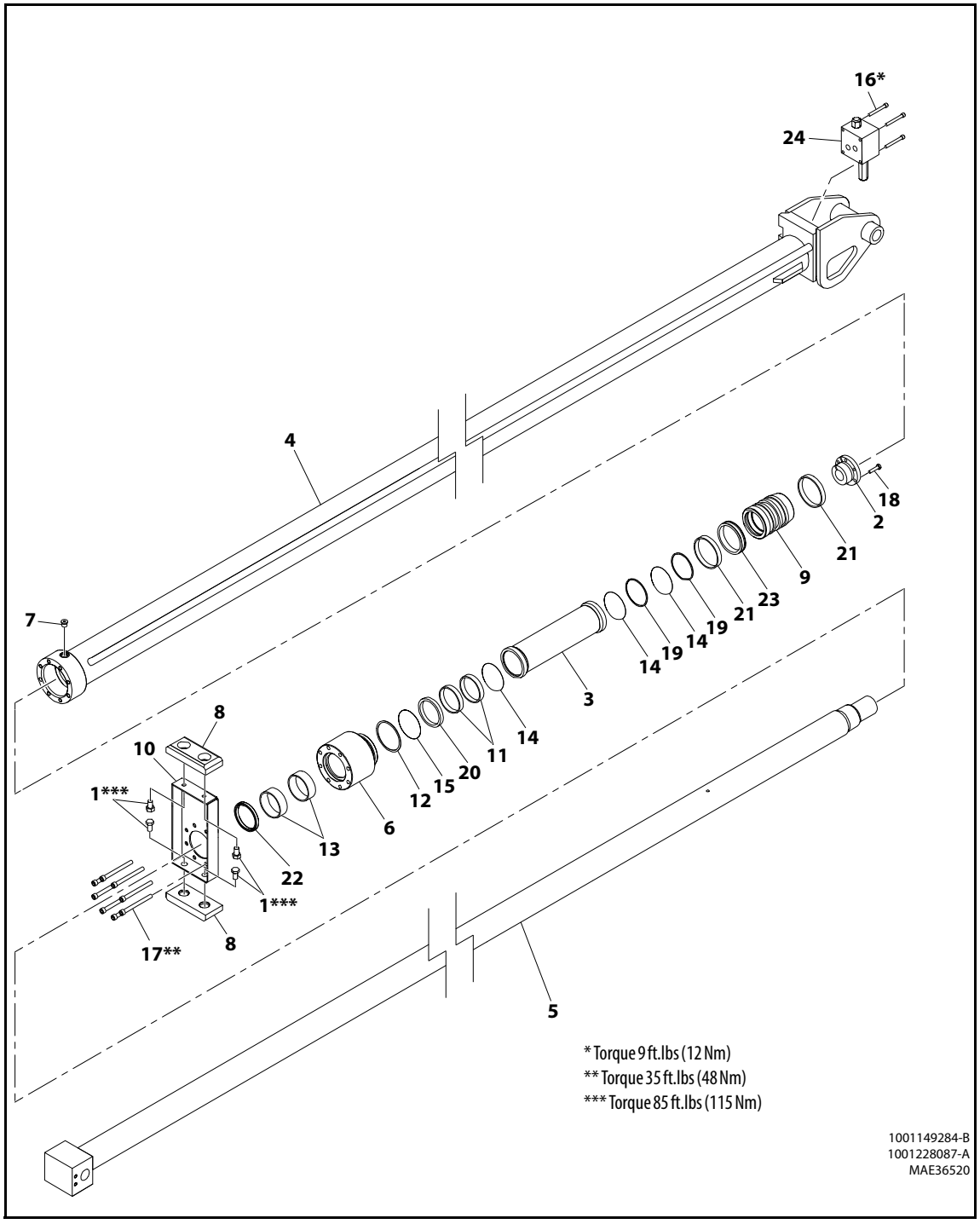


Figure 5-119. Cylinder Rod Support



1. Bolt	6. Head	11. Wear Ring	16. Capscrew	21. Wear Ring
2. Tapered Bushing	7. O-ring Plug	12. Backup Ring	17. Capscrew	22. Wiper
3. Tube Spacer	8. Wear Pad	13. Wear Ring	18. Bolt	23. T-Seal
4. Barrel	9. Piston	14. O-ring	19. Backup Ring	24. Valve Assembly
5. Rod	10. Plate	15. O-ring	20. Rod Seal	

Figure 5-120. Main Boom Telescopic Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

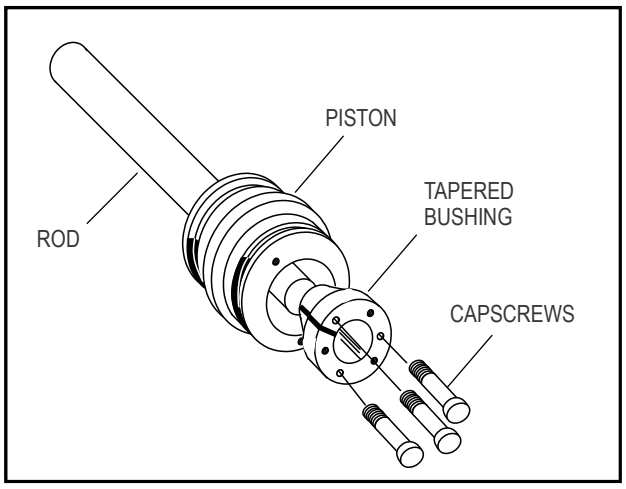


Figure 5-121. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove o-rings from piston spacer. Remove piston spacer from the rod.
14. Remove capscrews to remove plate and wear pads.
15. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup 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 piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. 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 steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

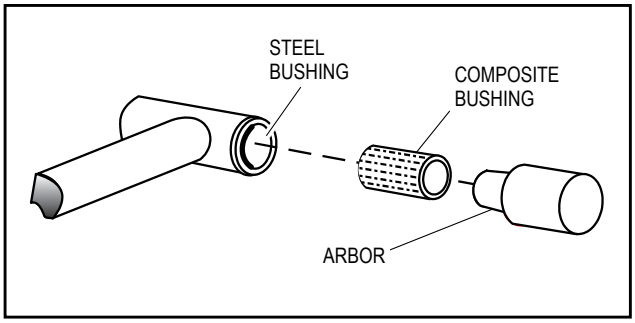


Figure 5-122. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.

13. If applicable, inspect port block fittings and holding valve. Replace as necessary.

14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.

15. 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.*

NOTE: *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.

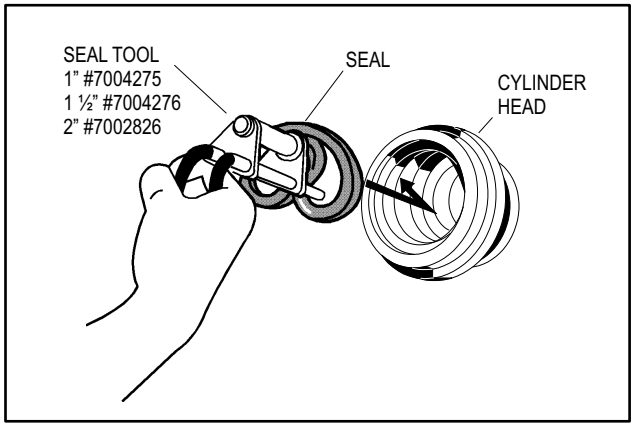


Figure 5-123. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

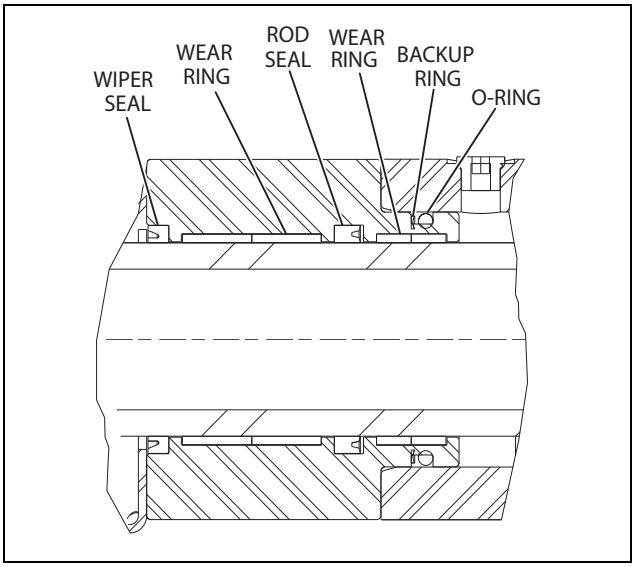


Figure 5-124. Cylinder Head Seal Installation

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.

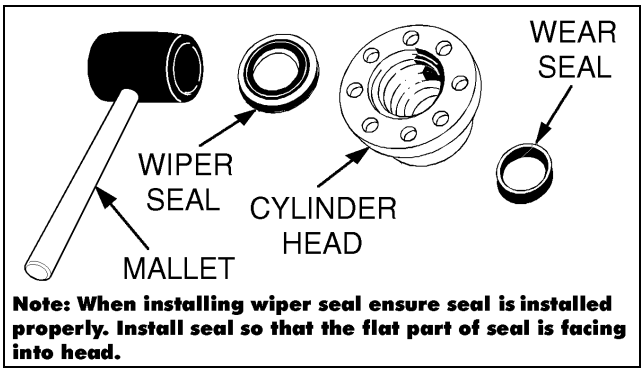


Figure 5-125. Wiper Seal Installation

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

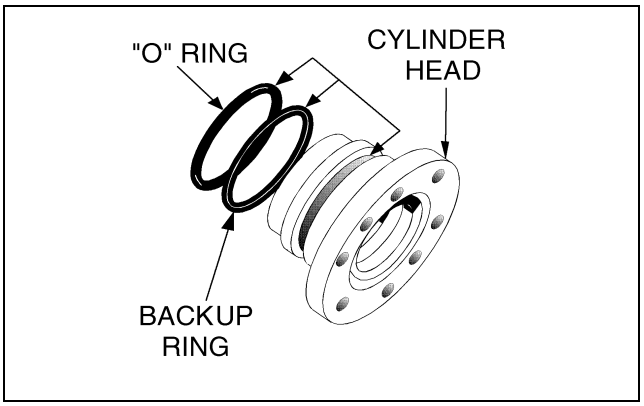


Figure 5-126. Installation of Head Seal Kit

4. Install plate on to the rod. Use capscrews to attach wear pads on the plate.
5. 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.
6. Install o-rings inside grooves of the piston spacer. Carefully slide the spacer on the rod.
7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
8. Place a new o-ring and backup rings in the inner piston diameter groove.
9. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup 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.*

11. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

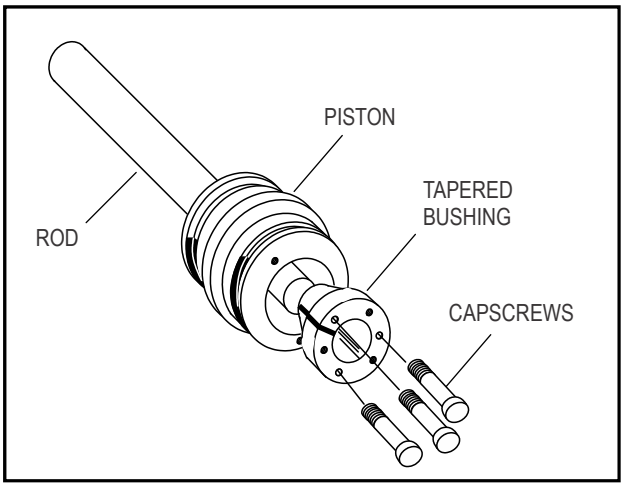


Figure 5-127. Tapered Bushing Removal

12. Tighten the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).
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.

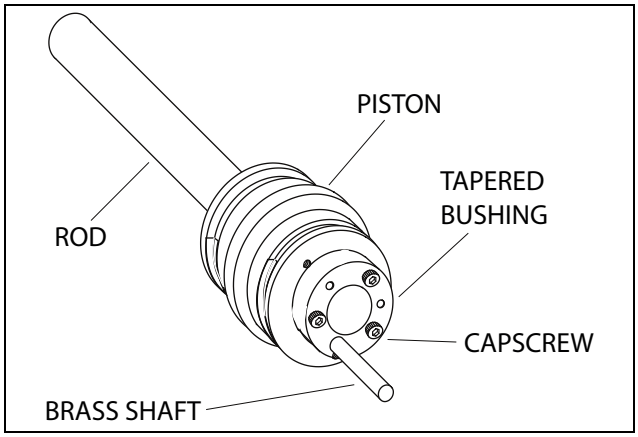


Figure 5-128. Seating the Tapered Bearing

14. Rotate the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

15. Remove the cylinder rod from the holding fixture.

16. Place new hydrolock seal and guidelock 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).

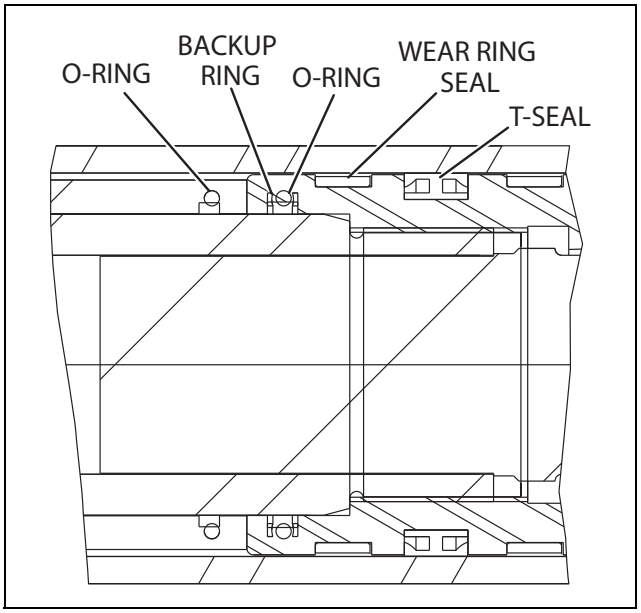


Figure 5-129. Piston Seal Kit Installation

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

NOTICE

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.

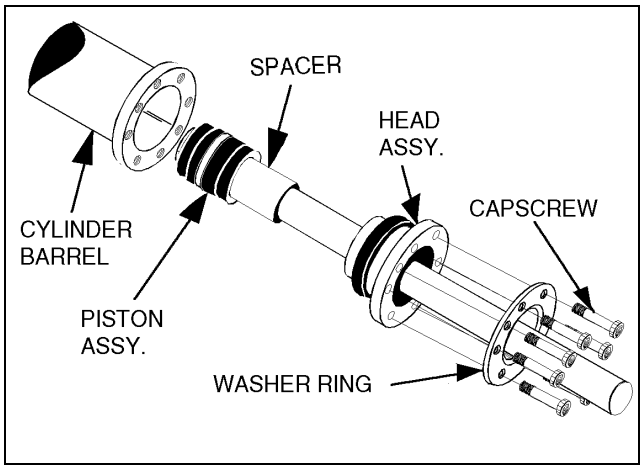


Figure 5-130. Rod Assembly Installation

20. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 35 ft.lbs. (50 Nm).

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

22. Install the valve assembly. Torque capscrews to 9 ft.lbs. (12 Nm).

Tower Boom Telescope Cylinder

DISASSEMBLY

NOTICE

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.

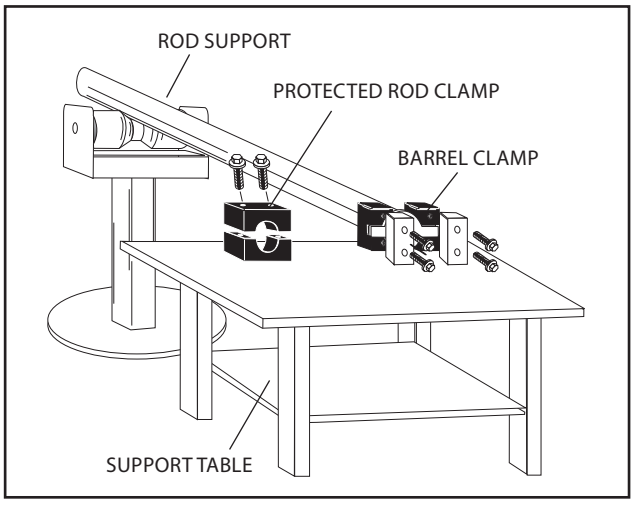


Figure 5-131. Cylinder Barrel Support

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

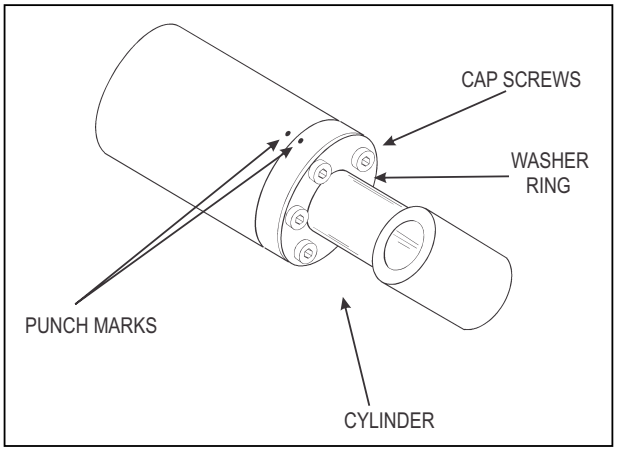


Figure 5-132. Capscrew Removal

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

NOTICE

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.

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

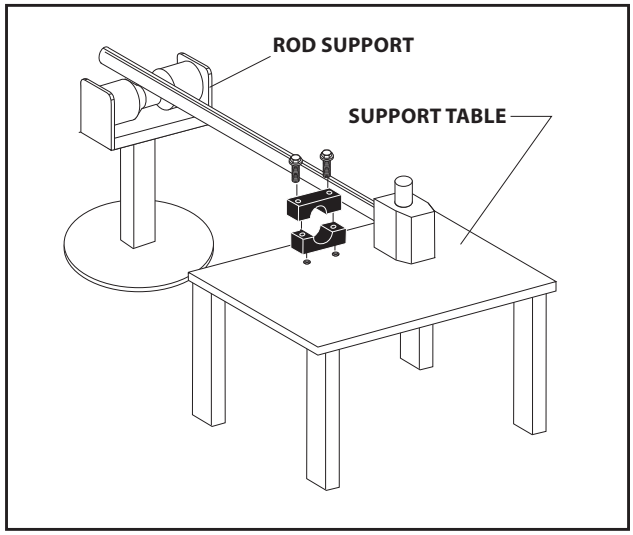
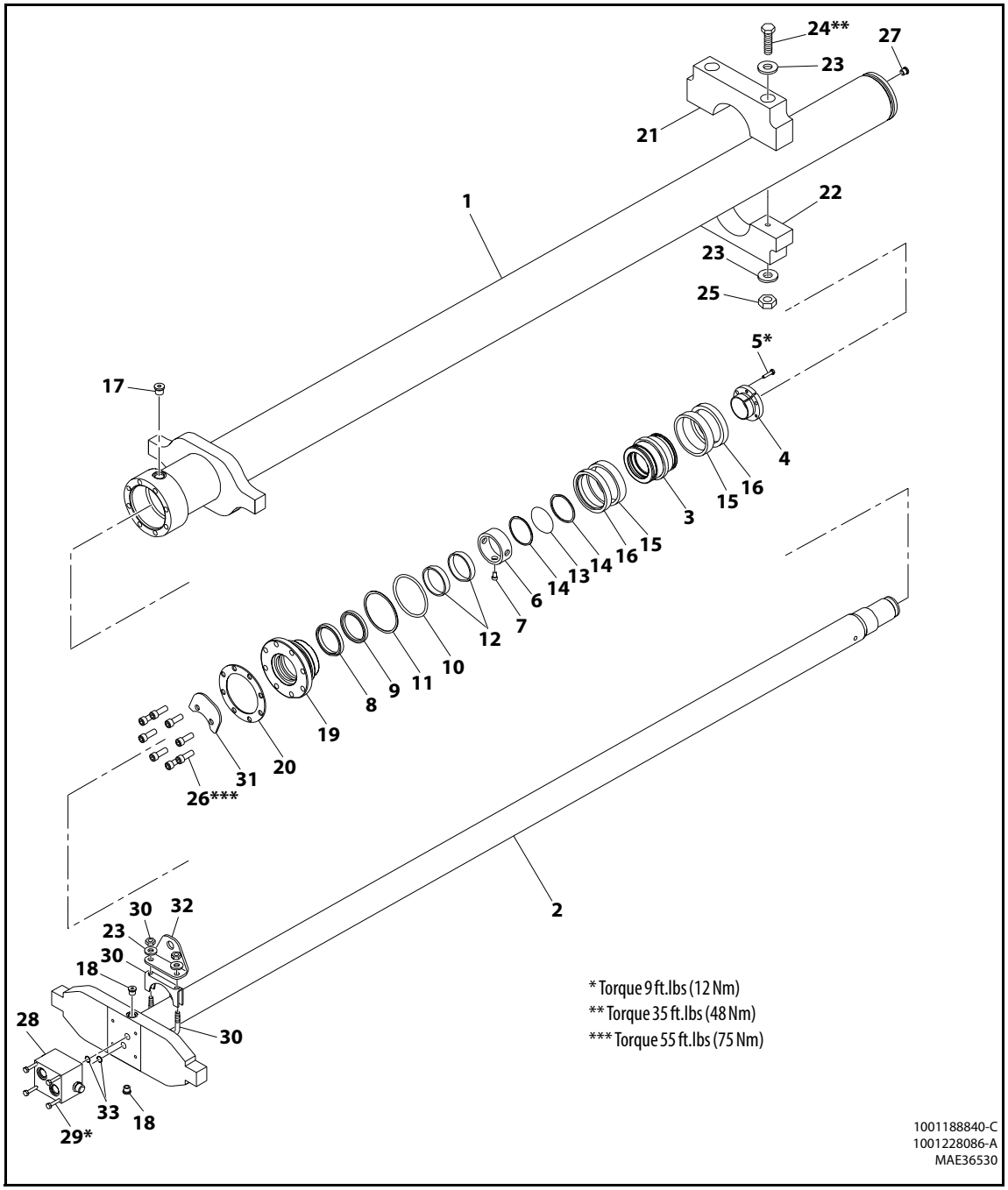


Figure 5-133. Cylinder Rod Support



1. Barrel
2. Rod
3. Piston
4. Tapered Bushing
5. Bolt
6. Tube Spacer
7. Setscrew
8. Wiper
9. Seal
10. O-ring
11. Backup Ring
12. Wear Ring
13. O-ring
14. Backup Ring
15. Seal
16. Lock Ring
17. O-ring Plug
18. O-ring Plug
19. Head
20. Washer Ring
21. Support Pad
22. Support Pad
23. Flatwasher
24. Bolt
25. Locknut
26. Capscrew
27. O-ring Plug
28. Valve Assembly
29. Capscrew
30. Clamp
31. Target Plate
32. Target Plate
33. O-ring

Figure 5-134. Tower Boom Telescopic Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

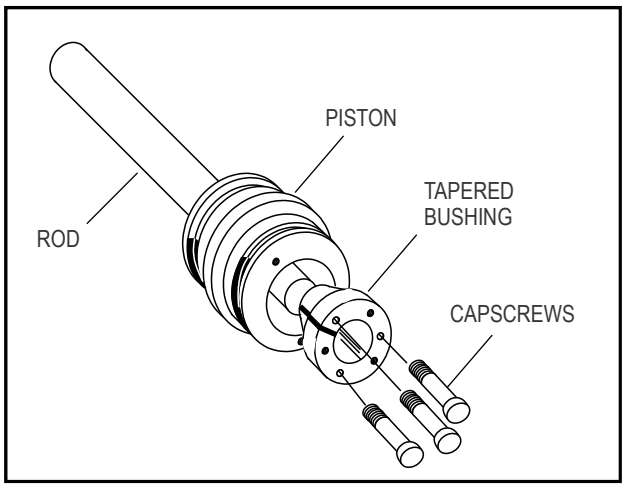


Figure 5-135. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove setscrew from the piston spacer. Remove spacer from the rod.
14. Remove the rod from the holding fixture. Remove capscrews, target plate and washer ring. Remove the cylinder head gland. Discard the o-rings, backup 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 piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. 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 steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

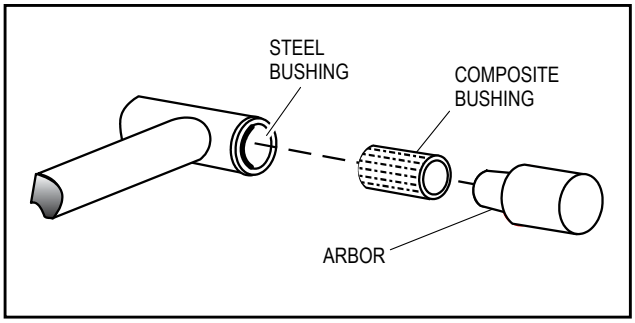


Figure 5-136. Composite Bearing Installation

12. Inspect spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.

13. If applicable, inspect port block fittings and holding valve. Replace as necessary.

14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.

15. 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.*

NOTE: *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.

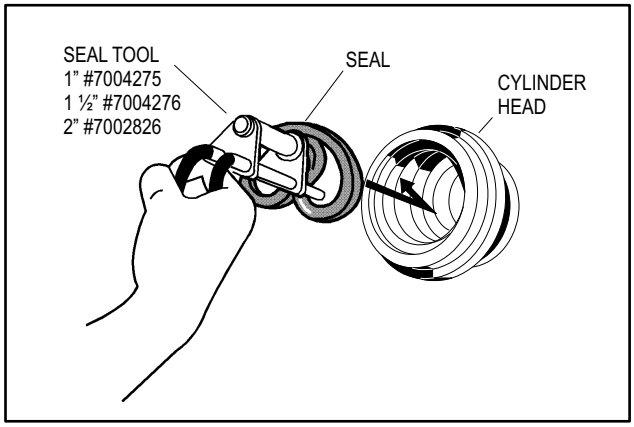


Figure 5-137. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

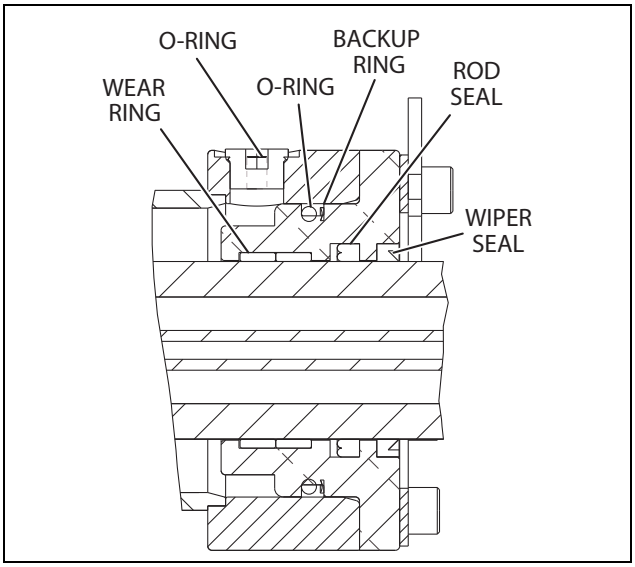


Figure 5-138. Cylinder Head Seal Installation

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.

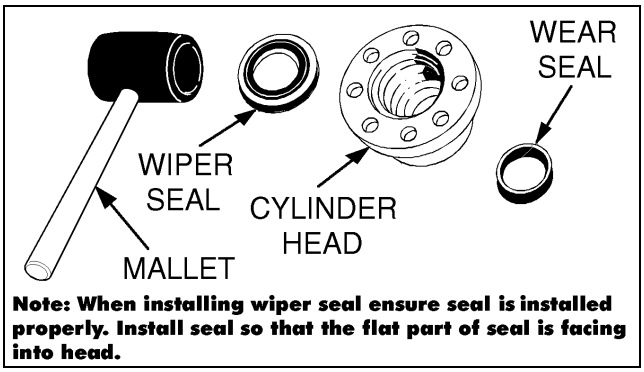


Figure 5-139. Wiper Seal Installation

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

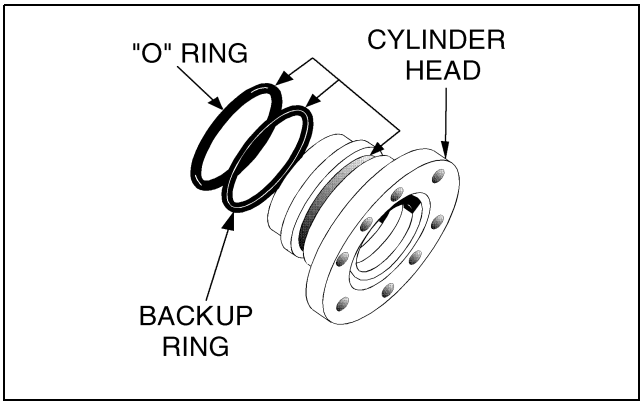


Figure 5-140. Installation of Head Seal Kit

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. Install setscrew on the spacer.

6. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.

7. Place a new o-ring and backup rings in the inner piston diameter groove.

8. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.

9. 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.*

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

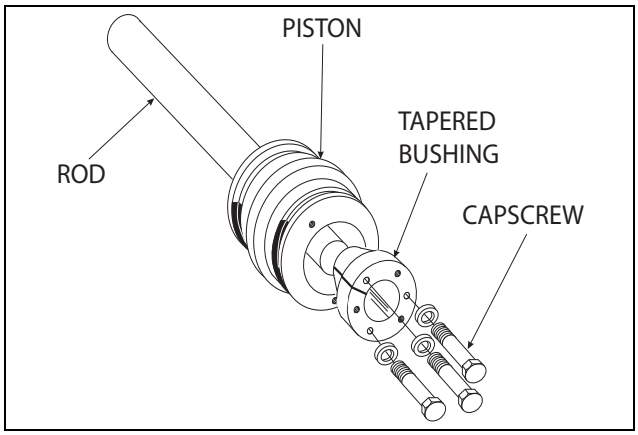


Figure 5-141. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

12. 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.

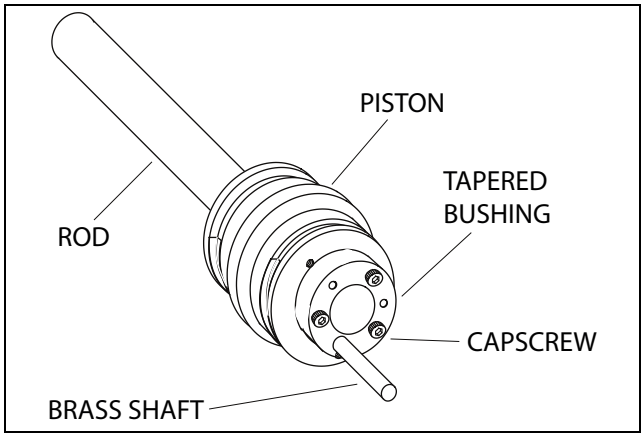


Figure 5-142. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation to 9 ft.lbs. (12 Nm).

14. Remove the cylinder rod from the holding fixture.

NOTICE

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

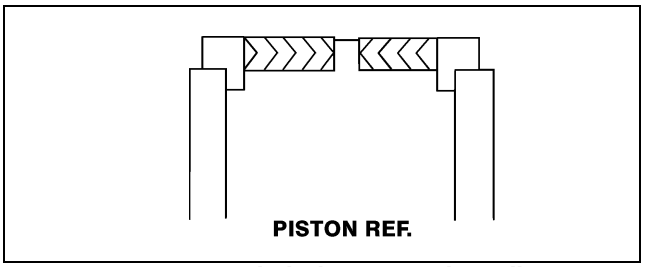


Figure 5-143. Hydrolock Piston Seal Installation

15. Place new hydrolock seal and guidelock 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).

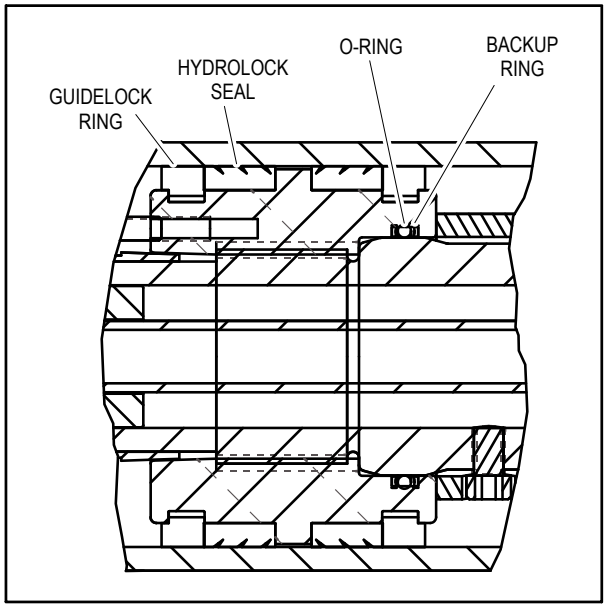


Figure 5-144. Piston Seal Kit Installation

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

NOTICE

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.

17. 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.

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

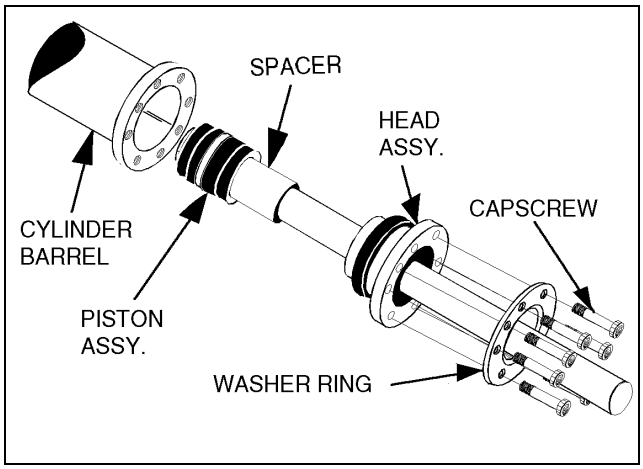


Figure 5-145. Rod Assembly Installation

19. Apply JLG Threadlocker P/N 0100011 to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 55 ft.lbs. (74 Nm).

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

21. Install the valve assembly. Torque capscrews to 9 ft.lbs. (12 Nm).

5.4 PRESSURE SETTING PROCEDURES

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within ± 5% of specified pressures.

To ensure all pressures are set correctly, the following procedures must be followed in order.

1. All applicable steps must be followed.
2. Set up of the function pump.
3. Adjustments Made at the Main Valve Block.
4. Adjustments Made at the Platform Valve Block

Set Up the Function Pump

(the pump that is mounted on the back of the drive pump).

1. **Set Stand by pressure or load sense pressure**

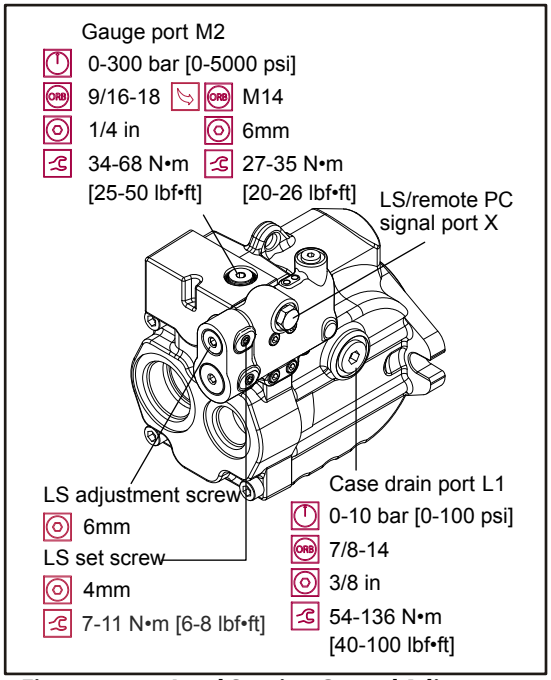


Figure 5-146. Load Sensing Control Adjustment

   a. Install a low pressure gauge at port **"MP"** of the main valve block. A gauge capable of reading **400 psi (27.58 bar)**.

   b. Start the engine and let it idle. The gauge should be reading **400-440 psi (28-30 bar).**

   c. To make an adjustment to this pressure, go to the engine compartment, locate the function pump. There are (2) adjustments at the top of the pump. They are located on the pump compensator which has (4) bolts mounting it to the pump. The stand by adjustment is at the top.

   d. To adjust this, a 4 mm and 6 mm Allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine. First, using the 4 mm wrench, loosen the setscrew on the side of the compensator (facing you) which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it 1 turn.

   e. Then using the 6 mm wrench adjust the main adjustment clockwise to increase or counter-clockwise to decrease. The pressure should read between **400-440 psi (27.58-30.34 bar)**.

2. **Set High pressure relief**

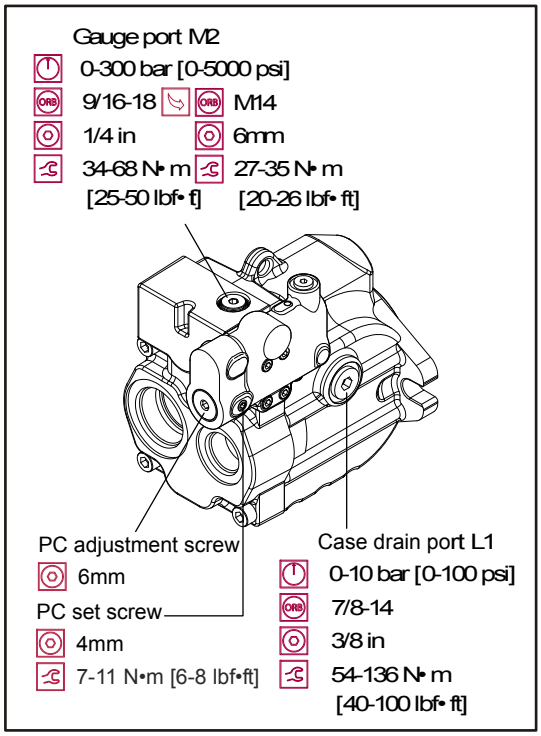


Figure 5-147. Pressure Compensation Control Adjustment

   a. Install a high pressure gauge at the **"MP"** port of the main valve block.

   b. Activate main boom telescope in. The gauge should read **2600-2700 psi (179-186 bar).**

c. To make an adjustment to this pressure, go back to the engine compartment to the function pump. The high pressure relief adjustment is the lower one of the (2) on the compensator. To adjust this, a 4 mm and 6 mm Allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine.

d. First, using the 4 mm wrench, loosen the setscrew on the side of the compensator (facing you) which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it 1 turn.

e. Then using the 6 mm wrench adjust the main adjustment clockwise to increase or counter-clockwise to decrease. This is the **maximum** relief pressure for all functions governed by this pump.

Adjustments Made at the Main Valve Block

MAIN LIFT DOWN

3. Install a high pressure gauge (3000 psi) into the external pressure tap at the tee fitting in port L.S of main control valve. Right side of manifold.

4. Activate main boom lift down. The gauge should read **2100 psi (145 bar)**.

5. The adjustment cartridge is located to the right of port # T2. Turn clockwise to increase, counterclockwise to decrease.

SWING

NOTE: *left and right are done with one adjustment.*

1. Install a high pressure gauge at the "**MP**" port of the main valve block. Lock the turn-table lock pin.

2. Activate swing, the gauge should read **1400 psi (97 bar)**. The adjustment cartridge is located on the right side of the block, right above "**MP**".

3. Turn clockwise to increase, and counterclockwise to decrease.

2 WHEEL STEER

1. Install a high pressure gauge at the "**MS**" port of the main valve block. Activate steer left or right. The gauge should read **1800 psi (124 bar)** (2-wheel steer) both directions.

2. One relief cartridge is located on the right side of the block, above port "**MS**". The other one is located on the left side next to port #15.

3. Turn clockwise to increase, and counterclockwise to decrease.

4 WHEEL STEER

1. Install a high pressure gauge at the "**MS**" port of the main valve block.

2. Activate front wheel steer left or right. One relief cartridge is located on the right side of the block, above port "**MS**". The other one is located on the left side next to port #15.Turn clockwise to increase, counterclockwise to decrease.

3. Adjust **2350 psi (162 bar)** front steer. Remove the coil from the front wheel steer directional valve.

4. Activate 4 wheel steer. Adjust the rear wheel steer reliefs to **2250 psi (155 bar)**. Those reliefs are located on the both sides of the 4-wheel steer block bolted on the top of the main control valve.

5. There must be a minimum of 100 psi difference between the front axle reliefs and rear axle reliefs.

TOWER TELESCOPE OUT

1. Install a high pressure gauge at gauge port **"M2"** located on the right side of the valve block, at the bottom.

2. Activate tower telescope out, the gauge should read **2200 psi (152 bar)**. This can be done with the tower lift down or up. If the tower lift is up, you must run tower telescope out to the end of stroke.

3. The tower telescope out relief valve is located on the left side, at the bottom next to port #2. Turn clockwise to increase, counterclockwise to decrease.

Adjustments Made at the Platform Valve Block

PLATFORM LEVEL UP

1. Install a high pressure gauge at the gauge port **"M1"** of the platform valve. There is pressure trapped at this test port.

2. To release this Pressure, activate level down to the end of stroke (the pressure in the up side goes to 0). This will allow you to snap a gauge on at this port.

3. Activate level up to the end of stroke, the gauge should read 2600-2700 psi (179-186 bar). The level up relief valve is located next to the port **"M1"**.

4. Turn clockwise to increase, and counterclockwise to decrease.

PLATFORM LEVEL DOWN

1. Install a high pressure gauge at gauge port **"M2"**, of the Platform Valve.
2. To get a gauge on this point activate level up to the end of stroke (the pressure in the down side will go to 0, allowing you to snap a gauge on).
3. Activate level down to the end of stroke, reading 1800 psi. The level down relief valve is located next to Port **"M2".**
4. Turn clockwise to increase, counterclockwise to decrease.

ARTICULATING JIB DOWN.

1. Install a high pressure gauge at the gauge port **"M3"** of the platform valve.
2. Activate jib down, you should read **1500 psi (103 bar)**. The down relief valve is located next to port **M3**.
3. Turn clockwise to increase, and counterclockwise to decrease.

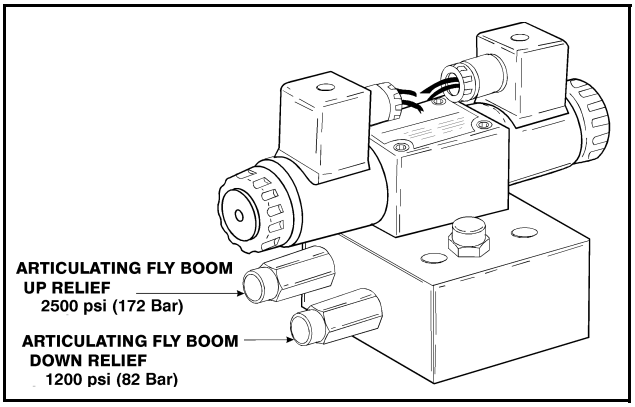


Figure 5-148. Articulating Jib Boom Pressure adjust.

4 WHEEL STEER (IF EQUIPPED)

1. At the platform console using the steer select switch activate "4 wheel steer".
2. Install a pressure gauge in port **"G"** on the control valve.
3. With the aid of an assistant, activate steer left and right, adjust front steer relief valve to **2500 psi (172.4 bar)**. This pressure only affects the front axle.
4. At the platform console using the steer select switch activate "crab" or "coordinated" steer.
5. At the main control valve block disconnect the wire din connectors on the front steer valve. When steer is activated only the rear steer will work.
6. Install a pressure gauge in port **"G"** on the control valve.
7. With the aid of an assistant, activate steer left and right, adjust rear steer relief valve to **2500 psi (172 bar)** Reading at the valve bank. **2500 psi (172 bar)** will give you **2000 psi (138 bar)** at the cylinders.
8. Re-connect the front steer din connectors at the valve bank.

5.5 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

From a hydrostatic component standpoint, the goal at system start up is to put into functional operation, the hydrostatic system in such a way as to preserve the designed life span of the system. The following start-up procedure should be adhered to whenever a new pump or motor is initially installed into a machine, or a system is restarted after either a pump or motor has been removed and/or replaced.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTIONS DISCONNECTED, ETC.). WHILE PERFORMING THE PROCEDURE IN ORDER TO PREVENT INJURY. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING THE VEHICLE/MACHINE.

Prior to installing the pump and/or motor, inspect the unit(s) for damage that may have been incurred during shipping and handling. Make certain that all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

NOTE: *If a pump or motor is being replaced due to internal damage, the remaining units (pump or motors) need to be inspected for damage and contamination, and the entire hydraulic system will need to be flushed and the fluid replaced. Failure to do so may cause considerable damage to the entire system.*

The inlet line leading from the reservoir to the pump must be filled prior to start-up. Check the inlet line for property tightened fittings and make sure it is free of restrictions and air leaks.

NOTE: *In most cases, the reservoir is above the pump inlet so that the pressure head created by the higher oil level helps to keep the inlet pressures within an acceptable range and prevent high vacuum levels. However, due to hose routing or low reservoir locations, there may be air trapped within this line. It is important to assure that the air is bled from this line. This can be accomplished by loosening the hose at the fitting closest the pump. When oil begins to flow, the line is full, the air has been purged, and the fitting can be retightened to its specified torque. If the tank needs to be pressurized in order to start the flow of oil, a vacuum reading should be taken at the inlet of the pump during operation in order to verify that the pump is not being asked to draw an inlet vacuum higher than it is capable of.*

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the main case drain port.

NOTE: *It is highly recommended to use the highest possible case drain port, this ensures that the housing contains as much oil as possible and offers the greatest amount of lubrication to the internal components.*

NOTE: *In initial start-up conditions, it may be convenient to fill the housing, just prior to installing the case drain line. Component, (especially motor), location may be such that access to the case drain port after installation is not realistic.*

NOTE: *Make certain that the oil being used to fill the component housing is as clean as possible, and store the fill container in such a way as to prevent it from becoming contaminated.*

Install a 60 bar (or 1000 psi) pressure gauge in the charge pressure gauge port in order to monitor the charge pressure during start-up.

It is recommended that the external control input signal, (electrical connections for EDC), be disconnected at the pump control until after initial start-up. This will ensure that the pump remains in its neutral position.

⚠ WARNING

DO NOT START THE ENGINE UNLESS PUMP IS IN THE NEUTRAL POSITION (0 DEGREES SWASHPLATE ANGLE). TAKE PRECAUTIONS TO PREVENT MACHINE MOVEMENT IN CASE PUMP IS ACTUATED DURING INITIAL START-UP.

"Jog" or slowly rotate the engine until charge pressure starts to rise. Start the engine and run at the lowest possible RPM until charge pressure has been established. Excess air should be bled from the system lines as close to the motors as possible.

NOTE: *With the engine on low idle, "crack", (loosen-don't remove), the system lines at the motor(s). Continue to run the engine at low idle and tighten the system lines as soon as oil is observed to leak from them. When oil is observed to "leak" at the motor the line is full, the air has been purged, and the system hoses should be retightened to their specified torque.*

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code. If charge pressure is inadequate, shut down and determine the cause for improper pressure.

⚠ WARNING

INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATOR'S ABILITY TO CONTROL THE MACHINE.

Shut down the engine and connect the external control input signal. Also reconnect the machine function(s), if disconnected earlier. Start the engine, checking to be certain the pump remains in neutral. With the engine at normal operating RPM, slowly check for forward and reverse machine operation.

Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

Shut down engine, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

The machine is now ready for operation.

5.6 HYDRAULIC DRIVE PUMP PRE-FILL PROCEDURE

⚠ CAUTION

HYDRAULIC DRIVE PUMP MUST BE PRE-FILLED BEFORE STARTING THE ENGINE. FAILURE TO DO SO CAN CAUSE PREMATURE FAILURE OF THE PUMP.

1. Fill the hydraulic reservoir.
2. Determine if the hydraulic oil tank sight level gauge is higher than other hydraulic components.
   - **a.** Determine if the hydraulic oil tank sight level gauge is higher than the hydraulic drive pump assembly.
   - **b.** Determine if the hydraulic oil tank sight level gauge is higher than all hydraulic hope loops and the routings between the hydraulic tanks and the hydraulic drive pump assembly.
   - **c.** If sight level gauge is the highest hydraulic oil level point, proceed to step 3.
   - **d.** if sight level gauge is NOT the highest oil level point, low pressure air may need to applied to the hydraulic oil tank (fill cap via air regulator) in conjunction with step 4 to get hydraulic oil to move over the air locks created by these high spots.
3. If the machine is to be equipped with a hydraulic oil cooler option.
   - **a.** Determine if there is hydraulic “tee” fittings installed at the hydraulic drive pump that has a “cap” fittings attached to it. (this will generally be at or near the top of the hydraulic drive pump body). This “cap” fitting is to be used to manually fill the hydraulic drive pump case.
   - **b.** Remove “cap” fitting.
   - **c.** Fill hydraulic drive pump case with hydraulic oil.
   - **d.** Attach and torque “cap” fitting.
   - **e.** Pre-filling of hydraulic drive pump w/oil cooler option is complete. (Step #4 can be omitted at this point).
4. If machine is NOT equipped with a hydraulic oil cooler option.
   - **a.** Locate a case access port on the hydraulic drive pump. Preferably one located on at or near the top or under sides of the pump.
   - **b.** Using the proper wrench, Remove the O-ring plug to allow air to escape from the hydraulic drive pump case.
   - **c.** Hydraulic oil will flow by gravity from the hydraulic tank to the drive pump.
   - **d.** The pump is full, when hydraulic oil starts to flow out of this port.
   - **e.** Install the O-ring plug and torque.
5. Pre-filled of the hydraulic drive pump is complete.

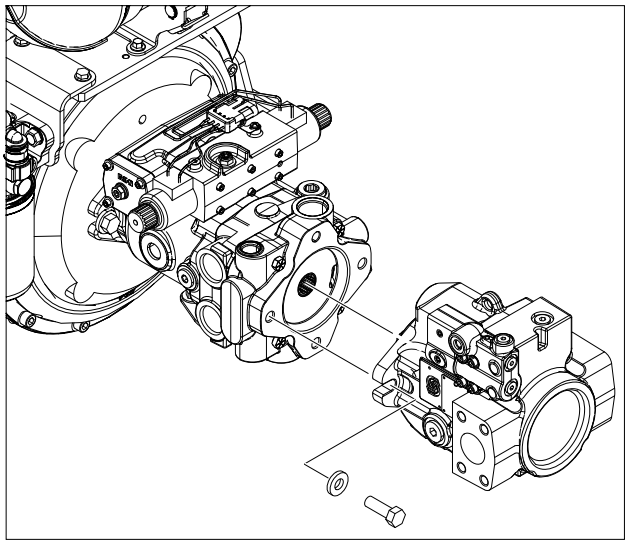
5.7 FUNCTION PUMP

Removal

1. Place machine on level surface and allow the engine and system fluids to cool.
2. Properly relieve any pressure in hydraulic system.
3. Tag and disconnect the hydraulic lines and fittings from the function pump. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

NOTE: *The function pump weighs approximately 35 lbs. (16 kg).*

4. Use a suitable device to support the function pump.
5. Remove two bolts and washers attaching the function pump to the drive pump. Remove function pump from the machine as shown.



6. Remove and discard o-ring, if applicable.
7. Place function pump in the clean work area.

Installation

NOTE: *The function pump weighs approximately 35 lbs. (16 kg).*

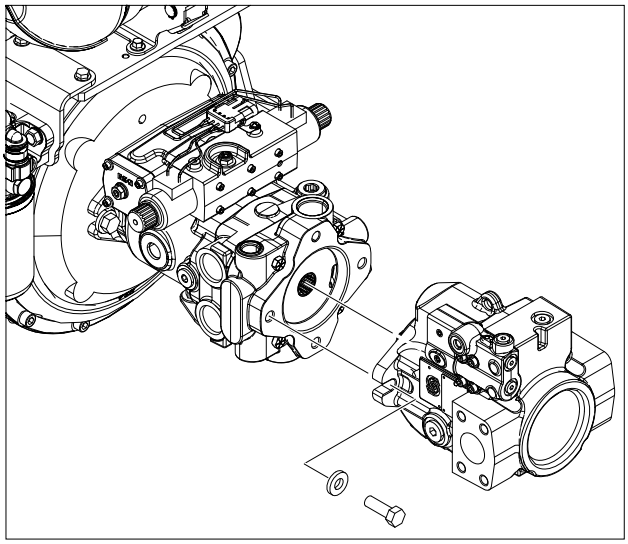
1. Use a suitable device to support the function pump.
2. If applicable, install the o-ring on to the function pump.
3. Align and install the function pump to the drive pump.

NOTE: *Make sure that the pump shaft is properly aligned.*

⚠ CAUTION

INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.

4. Secure function pump with two bolts and washers as shown. Apply JLG Threadlocker P/N 0100011 to the bolts before installation. Torque bolts to 85 ft. lbs. (116Nm).



5. Remove tag and reconnect the hydraulic lines to the function pump.
6. Reconnect the battery power and make sure for proper working of the function pump.

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Table 5-33. Symbols Used

Symbol	Meaning	Symbol	Meaning
	Non-reusable part, use a new part		Inspect for wear or damage
	Option - either part may exist		Note correct orientation
	Internal hex head		Torque specification
ORB	O-ring boss port		Pull out with tool - press fit
	Lubricate with hydraulic fluid		Cover splines with installation sleeve
	Apply grease /petroleum jelly		Pressure measurement / gauge location or specification
The symbols above can be found in the pump illustrations. The legend above is provided to define each symbol and explain its purpose.			

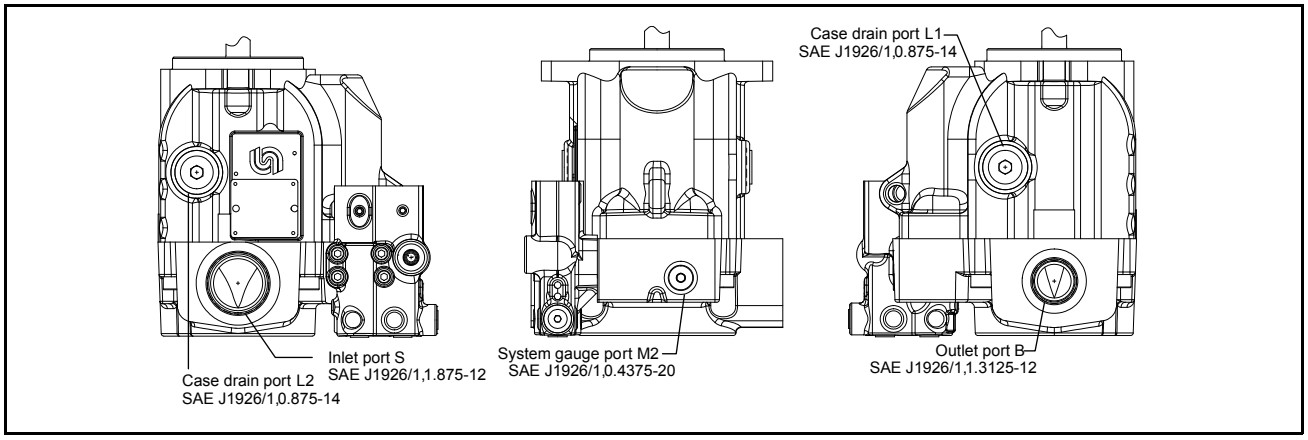


Figure 5-149. Gauge Port Locations

Table 5-34. Gauge and Port information

Port	Purpose	Range of Pump	Fitting
M2	System pressure	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting
M4	Servo pressure	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting
L1,L2	Case pressure	0-100 psi [0-10 bar]	7/8 - 14 o-ring fitting
X1	Load Sense signal	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting (tee into Load Sense signal line)

Initial Start-up Procedures

Follow this procedure when starting-up a new pump or when the pump has been removed.

1. Install the pump on the engine. Ensure the pump shaft is properly aligned.

⚠ CAUTION

INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.

2. Fill the main pump housing with clean hydraulic fluid. Pour filtered oil directly into the main most case drain port.
3. Fill the inlet line leading from the pump to the reservoir. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
4. To ensure the pump stays filled with oil, install the case drain line in the main most case drain port.
5. Install a gauge at port M2 to monitor system pressure during start up.
6. While watching the pressure gauge installed at M2, jog the engine or run at the lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shutdown the engine, determine cause, and take corrective action. Refer to Troubleshooting.
7. Operate the hydraulic system for at least fifteen minutes under light load conditions.
8. Check and adjust control settings as necessary after installation. Refer to Adjustments.
9. Shut down the engine and remove the pressure gauge. Replace plug at port M2.
10. Check the fluid level in the reservoir; add clean filtered fluid if necessary. The pump is now ready for operation.

Troubleshooting

Table 5-35. Excessive Noise and/ or Vibration

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will cause cavitation.	Fill the reservoir to proper level.
Check for air in system.	Air in system will cause noisy, erratic control.	Purge air and tighten fittings. Check inlet for leaks.
Check pump inlet pressure / vacuum.	Improper inlet conditions will cause erratic behavior and low output flow.	Correct pump inlet pressure / vacuum conditions. Refer to Hydraulic parameters.
Inspect shaft couplings.	A loose or incorrect shaft coupling will cause excessive noise and/or vibration.	Repair or replace coupling and ensure that correct coupling is being used.
Check shaft alignment.	Misaligned shafts will create excessive noise and/or vibration.	Correct shaft misalignment.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.

Table 5-36. Actuator Response Is Sluggish

Item	Description	Action
Check external system relief valve setting.	Low external relief valve setting will slow down system.	Adjust external relief valve setting per manufacturer's recommendations. External relief setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and LS control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check Load Sense control signal pressures.	Incorrect Load Sense signal will not allow pump to operate correctly.	Inspect system, ensure that proper Load Sense signal is transmitted to the pump.
Internal system leaks.	Worn internal parts will not allow the pump to operate properly.	Refer to Authorized Service Center for repairs as required.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system valving.	Malfunctioning valving may not allow system to respond properly.	Repair or replace system valving as required.
Check pump case pressure.	High case pressure will cause the system to be sluggish.	Correct case drain line restrictions.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.

Table 5-37. System Operating Hot

Item	Description	Action
Check fluid level in reservoir.	Insufficient volume of hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level. Verify proper size of reservoir.
Inspect heat exchanger. Check air flow and input air temperature for the heat exchanger.	Insufficient air flow, high input air temperature, or undersized heat exchanger will not meet cooling demands of the system.	Clean, repair, or replace heat exchanger as required. Verify proper size of heat exchanger.
Check external system relief valve setting.	Fluid passing through relief valve adds heat to system.	Adjust external system relief valve setting per manufacturer's recommendations. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check pump inlet pressure / vacuum.	High inlet vacuum adds heat to system.	Correct inlet pressure / vacuum conditions.

Table 5-38. Low Pump Output Flow

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will limit output flow and cause internal damage to pump.	Fill the reservoir to proper level.
Hydraulic fluid viscosity above acceptable limits.	Fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system relief valve setting.	External relief valve set below Pressure Compensator setting will cause low output flow.	Adjust external relief valve per manufacturer's recommendation. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and Load Sense control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.
Check input speed.	Low input speeds decrease flow.	Adjust input speed.
Check pump rotation.	Incorrect rotational configuration will cause low flow.	Use pump with appropriate rotational configuration.

Table 5-39. Pressure or Flow Instability

Item	Description	Action
Check for air in system.	Air in system will cause erratic operation.	Activate Pressure Compensator, allowing system to bleed air. Check inlet line for leaks and eliminate source of air ingression.
Check control spools.	Sticking control spools will cause erratic operation.	Inspect spools for free movement in bore. Clean or replace as needed.
Check Load Sense setting.	Low Load Sense setting may cause instability.	Adjust Load Sense setting to proper level. See Adjustments.
Check Load Sense signal line.	Blocked Load Sense signal line will interfere with proper Load Sense operation.	Remove blockage.
Check external relief valve and Pressure Compensator setting.	Insufficient pressure differential between Pressure Compensator Pressure Compensator setting and external relief valve.	Adjust external relief valve or Pressure Compensator control settings to appropriate level. Relief valve setting must be above Pressure Compensator setting for proper operation.
Check external relief valve.	Chattering external relief valve may cause unstable feedback to pump control.	Adjust or replace relief valve.

Table 5-40. System Pressure Not Reaching Pressure Compensator Setting

Item	Description	Action
Check Pressure Compensator control setting.	System pressure will not rise above Pressure Compensator setting.	Adjust Pressure Compensator to appropriate setting.
Check external relief valve.	External relief valve setting below Pressure Compensator setting will prevent pressure compensation.	Adjust external relief valve per manufacturer's recommendations. External relief valve must be set above Pressure Compensator setting for proper operation.
Inspect Pressure Compensator control spring.	Broken, damaged, or missing spring will cause erratic operation.	Replace spring as required.
Inspect Pressure Compensator spool for wear.	Wear of the Pressure Compensator spool will cause internal leakage in the control.	Replace the spool as required.
Inspect Pressure Compensator spool for proper orientation.	Improper orientation will result in poor operation.	Correct orientation of spool.
Check Pressure Compensator control for contamination.	Contamination may interfere with movement of the Pressure Compensator Spool.	Clean Pressure Compensator control components, take appropriate action to eliminate contamination.

Table 5-41. High Inlet Vacuum

Item	Description	Action
⚠ CAUTION **HIGH INLET VACUUM CAUSES CAVITATION WHICH CAN DAMAGE INTERNAL PUMP COMPONENTS.**		
Check fluid temperature.	Low temperature increases viscosity. High fluid viscosity causes high inlet vacuum.	Allow system to warm up before operation.
Inspect inlet screen.	Blocked or restricted inlet screen will cause high inlet vacuum.	Clean screen / remove blockage.
Check inlet piping.	Too many fittings, bends, or long piping will cause high inlet vacuum.	Eliminate fittings to make path more direct.
Hydraulic fluid viscosity above acceptable limits.	High fluid viscosity causes high inlet vacuum.	Select fluid with appropriate viscosity for expected operating temperature.

Shaft Seal Replacement

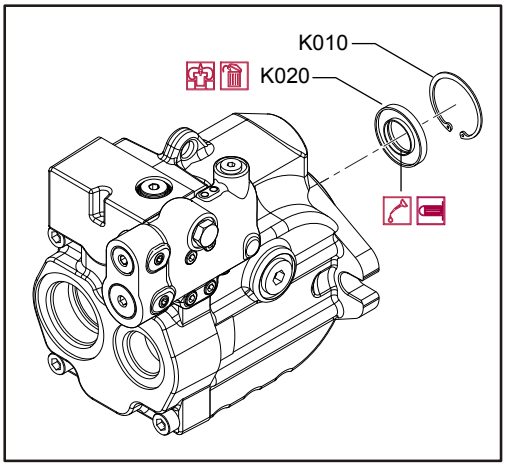


Figure 5-150. Shaft Seal and Retaining Ring

A lip type shaft seal is used in the pump and can be replaced without major disassembly of the unit. Replacement of the shaft seal requires removal of the pump from the machine.

REMOVAL

1. Using the appropriate snap-ring pliers, remove the retaining ring (K010) from the housing.
2. Remove the shaft seal (K020) from the bore in the pump housing and discard. Avoid damaging the pump housing or shaft. Puncture the face of the seal with a packing hook, or use a slide-hammer type puller to remove the seal.

INSTALLATION

1. Inspect the pump housing and new seal for damage. Inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.
2. Lubricate the lip of the new shaft seal with clean hydraulic fluid. Place a protective sleeve over the shaft end to prevent damage to the seal during installation.

⚠ CAUTION

PREMATURE BEARING FAILURE CAN RESULT IF THE SHAFT SEAL CONTACTS THE SHAFT BEARING. PRESS THE SEAL INTO THE HOUSING ONLY FAR ENOUGH TO CLEAR THE RETAINING RING GROOVE.

3. Keeping the seal perpendicular to the shaft, press the new seal into the housing just far enough to clear the retaining ring groove. Install seal with the cupped side toward the shaft bearing. Do not damage the seal during installation.
4. Using the appropriate snap ring pliers, install the seal retaining ring.
5. Remove the installation sleeve.

Control Assembly

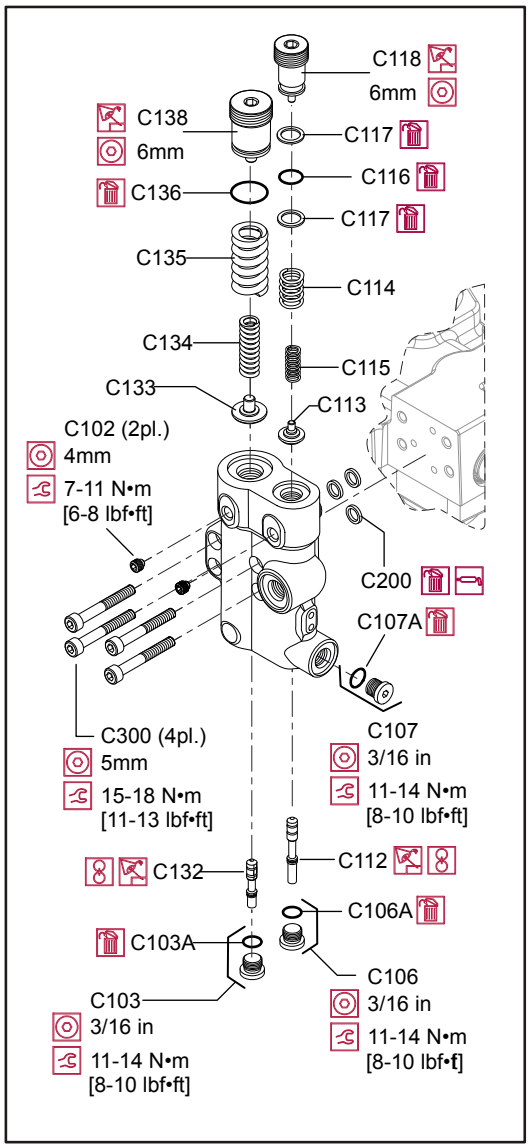


Figure 5-151. Control Assembly

DISASSEMBLY

1. Remove the four screws (C300) holding the control housing onto the end cap.
2. Remove the control and discard the three interface o-rings (C200).
3. Remove the Pressure Compensator set screw (C102), Pressure Compensator adjustment screw (C138), o-ring (C136), springs (C135, C134), and seat (C133). Discard the o-ring.
4. Remove the plug (C103), o-ring (C103A),and Pressure Compensator spool (C132) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.
5. Remove the plug (C107) and o-ring (C107A); discard the o-ring.

NOTE: *For Pressure Compensator only controls, skip steps 6 and 7.*

6. Remove the Load Sense set screw (C102), Load Sense adjustment screw (C118), o-ring (C116), backup rings (C117), springs (C114, C115), and seat (C113); discard the o-ring.
7. Remove the plug (C106), o-ring (C106A), and Load Sense spool (C112) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.

INSPECTION

1. Inspect the adjustment screws for wear at the tips and where they contact the springs; replace as necessary.
2. Inspect the springs and spring guides for wear or damage; replace as necessary.
3. Carefully inspect the spools. Ensure the sealing lands are free of nicks and scratches. Check the ends that contact the spring guides for wear. Replace spools as necessary.
4. Inspect the control housing for damage. Check the spool bores for excessive wear.
5. Clean all parts and lubricate spools, springs, guides and new o-rings with clean hydraulic fluid.

REASSEMBLY

1. Install the Pressure Compensator spool, spherical end first, into the Pressure Compensator bore. The Pressure Compensator spool is the shorter of the two. Using a new o-ring, install the plug (C103). Torque to 8-10 ft.lb. [11-14 Nm].
2. Place the two Pressure Compensator springs onto the spring guide and install into the Pressure Compensator bore. Place a new o-ring onto the Pressure Compensator adjustment screw and thread it into the Pressure Compensator bore until flush, then make another full turn. Install and torque the set screw to 6-8 ft.lb. [7-11 Nm].

NOTE: *For Pressure Compensator only controls, skip steps 15 and 16.*

3. Install the Load Sense spool, spherical end first, into the Load Sense bore. The Load Sense spool is the longer of the two. Using a new o-ring, install the plug (C106). Torque to 8-10 ft.lb. [11-14 Nm].
4. Place the two Load Sense springs onto the spring guide and install into the Load Sense bore. Place a new o-ring and backup rings onto the Load Sense adjustment screw and thread it into the Load Sense bore until flush, then make another full turn. Install and torque the set screw to 6-8 ft.lb. [7-11 Nm].
5. Using a new o-ring, install the plug (C107). Torque to 8-10 ft.lb. [11-14 Nm].
6. Using petroleum jelly to retain them, install the three interface o-rings (C200) in the recesses on the control housing.
7. Install the control assembly onto the endcap using the four screws (C300). Torque to 11-13 ft.lb. [15-18 Nm]. Torque screws in a criss-cross pattern and re-torque the first screw to ensure proper torque retention.

Plug and Fitting Sizes and Torques

If any plugs or fittings are removed from the unit during service, install and torque as indicated here. This drawing is a composite. Your configuration may differ but the appropriate wrench size and torque can be found here.

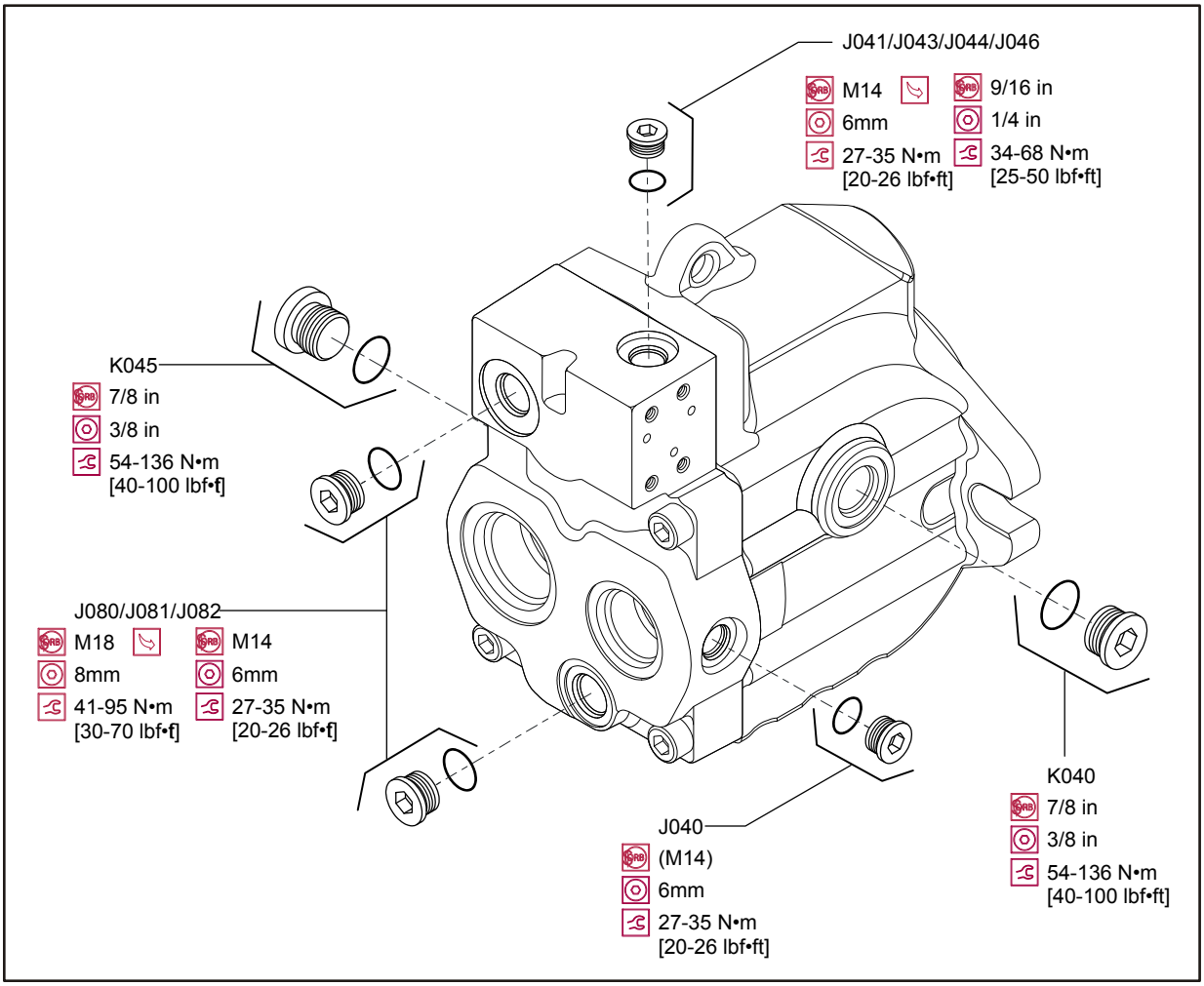


Figure 5-152. Plug Locations, Sizes, and Torques

5.8 DRIVE PUMP

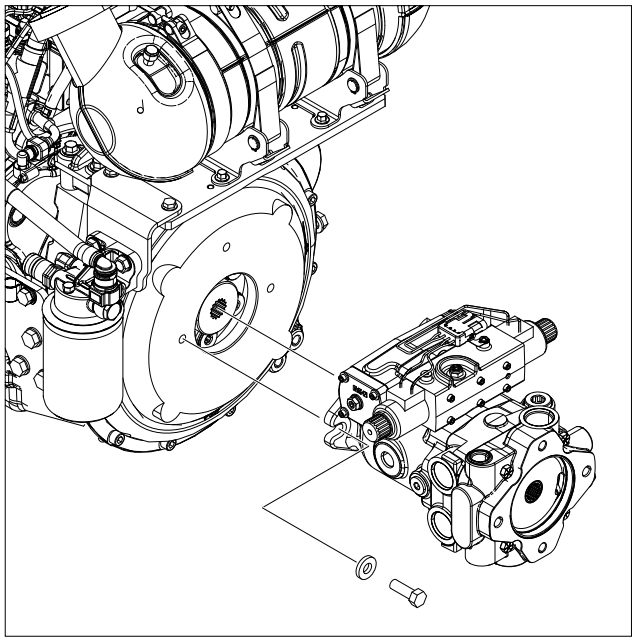
Removal

NOTE: *Remove the function pump from the machine first, refer Section 5.7, Function Pump.*

1. Tag and disconnect the hydraulic lines and fittings from the drive pump. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

NOTE: *The drive pump weighs approximately 62 lbs. (28 kg).*

2. Use a suitable device to support the drive pump.
3. Remove two bolts and washers attaching the drive pump to the engine assembly. Remove drive pump from the machine as shown.



4. Remove and discard o-ring from the drive pump groove.
5. Place drive pump in the clean work area.

Installation

NOTE: *The drive pump weighs approximately 62 lbs. (28 kg).*

1. Use a suitable device to support the drive pump.
2. Install the new o-ring in to the drive pump groove.
3. Align and install the drive pump to the engine assembly.

NOTE: *Make sure that the pump shaft is properly aligned.*

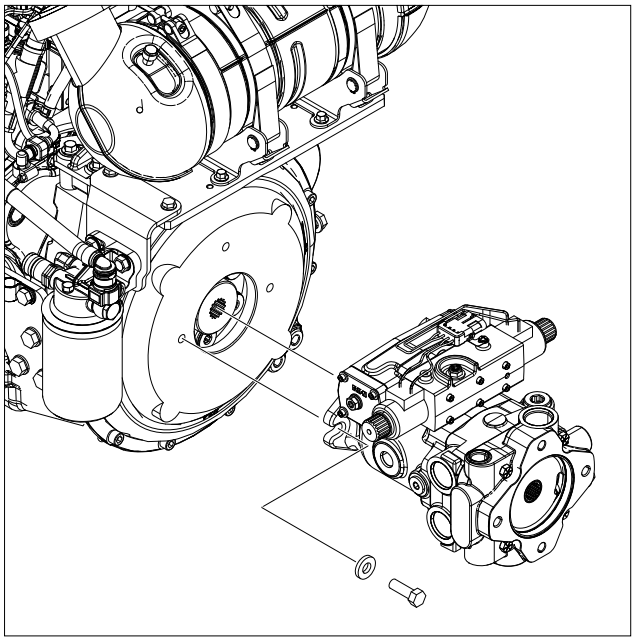
⚠ CAUTION

INCORRECT SHAFT ALIGNMENT MAY RESULT IN DAMAGE TO DRIVE SHAFT, BEARINGS, OR SEAL WHICH CAN CAUSE EXTERNAL OIL LEAKAGE.

4. Secure drive pump with two bolts and washers as shown.

NOTE: *Apply JLG Threadlocker P/N 0100011 to the bolts before installation.*

5. Torque bolt to 46-56 ft.lbs. (62-76 Nm)



6. Remove tag and reconnect the hydraulic lines and fittings to the drive pump.

Servo Controlled Piston Pump

DISASSEMBLY

The following instructions apply to a single servo controlled piston pump with or without a gerotor charge pump. A tandem pump assembly should be separated into individual pumps before disassembly.

1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the Capscrews up. Mark the relationship of the working ports (for assembly identification) to the servo control assembly with a scribe. Remove the four Capscrews retaining endcover.
2. Lift the charge pump adapter assembly straight up off endcover, shaft and gerotor. Gerotor may stay in adapter or on endcover.
3. Remove o-ring from charge pump adapter.
4. Remove outer gerotor ring from either the charge pump adapter or the inner gerotor ring.

NOTE: *Refer to "Charge Pump Adapter Assembly" for disassembly and inspection of charge pump adapter assembly.*

5. Remove the inner gerotor ring and key from drive shaft or inner gerotor ring and coupler assembly from shaft.
6. Lift endcover straight up off shaft and housing. Remove valve plate from endcover or from rotating kit assembly, still in housing.
7. From endcover, remove bypass valve or plug, and relief valve assemblies. Note: Mark the relief valve in relationship to the cavity it was removed, for reassembly purposes.

Endcover Inspection

- Check the bearing (press fit) in endcover. If needles remain in cage, move freely, and setting is at the dimension shown in Figure 5-153. removal not required.
- Check roll pin in endcover. If tight and set to the dimension shown in Figure 5-153. removal not required.

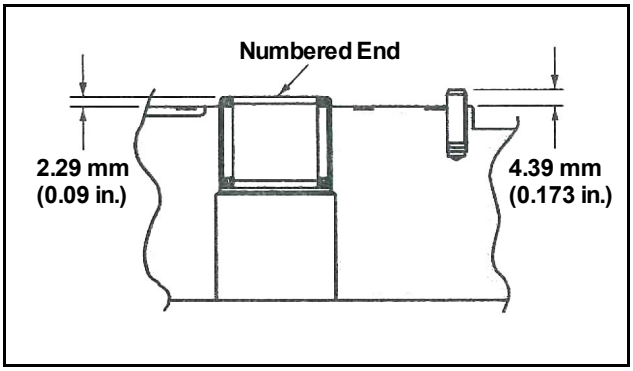


Figure 5-153. Endcover Inspection

1. Remove housing gasket from housing or endcover.
2. With pump still in vise, remove the six Capscrews retaining the manual servo control assembly. Remove the control assembly and control housing gasket from the housing. Remove orifice plates, noting location for reassembly. Remove nut and lock washer from control arm, remove arm. Note position of control arm for reassembly.

NOTE: *Refer to "Manual Servo Control Basic Assembly" for disassembly and Inspection of control assembly.*

3. To remove rotating kit assembly from housing, first remove pump from vise holding the rotating kit assembly in position. Lower pump so that the shaft end (flange end) is up. Set the rear of housing onto table with housing flat and rotating kit assembly at rest on table. (Hole in table, for protruding shaft, is required.) Lift and remove the housing and shaft from rotating kit assembly, and swashplate.
4. Remove swash plate from rotating kit assembly and servo piston follower from swashplate.

NOTE: *Refer to "Rotating Kit Assembly" for disassembly and Inspection of rotating kit.*

Swashplate Inspection

- The finish on the piston shoe surfaces of the swash plate should show no signs of scoring.
- Inspect swashplate bushing surface for wear and surface for coating transfer from bushing.

1. To remove servo piston assembly from housing, start with the four each Capscrews and washers retaining each cover plate.
2. In removing the cover plate from the servo piston bolt, remove jam nut, washer, and seal washer. Hold the servo piston bolt with hex key and unscrew cover plate off of bolt.
3. Remove servo piston assembly and seal sub-assemblies (two sets) from housing.

NOTE: *Disassembly of servo piston assembly is not required.*

4. Remove retaining ring from the front of housing. Press the shaft, shaft seal or spacer, and washer from housing. Remove retaining ring, thrust washer, thrust bearing, second thrust washer, and second retaining ring from shaft.

Housing Inspection

- Check the bearing (press fit) in housing. If needles remain in cage, move freely, and setting at the dimension shown in Figure 5-154., removal not required.

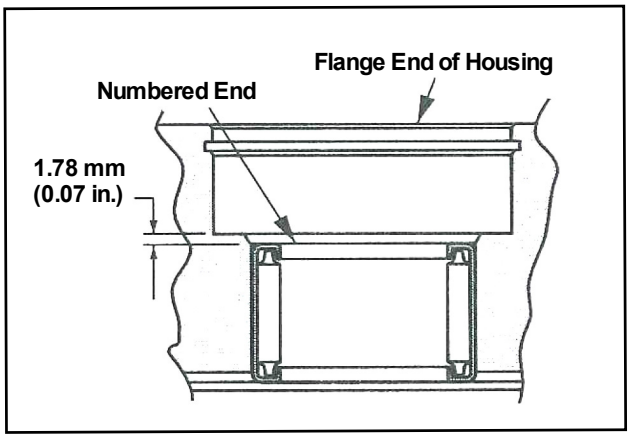


Figure 5-154. Housing Inspection

1. To remove cradle sub-assembly, remove the two Capscrews retaining cradle inside housing. Removing cradle subassembly from housing.
2. Remove button head Capscrews (2 Qty.) to remove bushing from cradle.

Bushing Inspection

- Inspect bushing for contamination embedment within coating of bushing surface coming in contact with swashplate.

1. Remove all plugs from housing.
2. Discard the shaft seal, gaskets, and o-rings from all assemblies. Replace with new seals upon reassembly.

ASSEMBLY

1. All parts should be cleaned and critical moving parts lubricated before reassembly.
2. If necessary, press new bearing in housing to dimension shown in Figure 5-154. with the numbered end of bearing outward.
3. Install the two new seal sub-assemblies into the servo piston cavity of housing.
4. Screw the cover plate onto the servo piston assembly. Install new cover plate gasket in place on housing. Install servo piston assembly and cover plate into servo piston bore in right side of housing (as shown in Figure 5-155. Retain cover plate with four each washers and Capscrews. Torque Capscrews 40 to 48 in.lbs (4.5 to 5.4 Nm). To obtain neutral, centering the servo piston assembly is required. Measure in from the left side and set servo piston 0.5 in. (12.7 mm) from surface of housing servo bore as shown in Figure 5-155.

NOTE: *Re-adjustment may be required for neutral at unit start-up.*

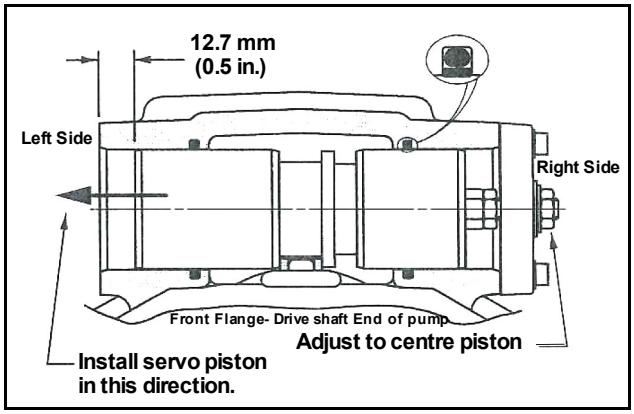


Figure 5-155. Servo Piston Installation

5. Install new seal washer, washer, and jam nut to servo piston bolt. Holding servo piston bolt with hex key wrench Torque jam nut (150 to 160 in.lbs) 17 to 18 Nm. Check the centering of servo piston assembly. Install new cover plate gasket and cover plate to left side of servo piston and retain with four each washers and #10-24 Capscrews. Torque Capscrews 40 to 48 in.lbs (4.5 to 5.4 Nm).

6. To assemble cradle sub-assembly, install bushing onto cradle retaining with button head Capscrews. Torque button head Capscrew 14 to 16 in.lbs (1.6 to 1.8 Nm).

7. Place cradle sub-assembly into housing making sure cradle is completely seated into housing. Retain cradle sub-assembly with two Capscrews. Torque Capscrews 20 to 24 ft.lbs (27 to 33 Nm).

8. To install shaft, place exterior retaining ring, thrust race, thrust bearing, second thrust race, and second retaining ring onto shaft. Position washer and shaft seal or spacer onto shaft.

9. Install shaft assembly into front of housing for units with spacer, retain with interior retaining ring and go on to step 10. For units with shaft seal. seat seal into position with seal driver and retain with interior retaining ring.

10. Install servo piston follower onto swashplate dowel pin. Install swashplate carefully onto bushing (coat bushing surface with hydraulic oil), aligning servo piston follower with slot in servo piston assembly.

NOTE: *Refer to "Rotating Kit Assembly" for reassembly of rotating kit assembly.*

11. To install rotating kit assembly, leave housing and shaft in the horizontal position. Holding swashplate into position with screw driver thru controller linkage passageway at the top of housing. place rotating kit assembly over shaft and into housing until pistons are in against swashplate. Make sure all parts are in housing completely and properly positioned. Return the pump to the vise with open end of housing up. clamping housing on the outer portion of the flange.

12. Install gasket on to housing.

13. If necessary, press new bearing and roll pin in endcover to dimension shown in figure 1-3. Bearing installed with the numbered end outward. Roll pin installed with split oriented away from bearing.

14. Install new o-ring on relief valves. Install relief valve in its original cavity in endcover that it was removed. Torque 100 to 110 ft.lbs (136 to 149 Nm).

15. Install new o-ring on bypass valve or plug. Install bypass valve or plug into endcover. Note: Make sure paddle of bypass valve is perpendicular to relief valve axis prior to installing or damage could result.

16. Apply a small amount of petroleum jelly to the steel side of valve plate to hold in place for installation. Aligning the index pin, place the valve plate in position onto the endcover, with steel side against endcover.

17. Install endcover assembly onto housing assembly. Make sure ports are positioned correctly, valve plate and gasket stay in place.

18. Install key and inner ring gerotor onto shaft or coupler assembly. Lubricate inner ring gerotor.

NOTE: *Refer to "Charge Pump Adapter Assembly" for assembly of charge relief valve in adapter plate.*

19. Insta ll o-ring and outer ring gerotor onto adapter plate. Lubricate both a-ring and outer ring to hold in position during assembly of adapter plate. Install adapter plate onto endcover. Make sure o-ring and gerotor ring stay in place.

20. Retain endcover and adapter plate (when used) with four Capscrews, Torque 27 to 31 ft.lbs (37 to 42 Nm).

NOTE: *Refer to "Manual Servo Control Basic Assembly" for reassembly of manual servo control assembly.*

21. Install control housing gasket onto housing. Install orifices into control assembly and retain in position with petroleum jelly. Position the feedback link at 90 degrees from control housing. Install manual servo control assembly onto housing making sure feedback link entered small groove in servo piston assembly.

22. Retain control assembly with six Capscrews, torque 40 to 48 in.lbs (4.5 to 5.4 Nm).

23. Install control arm onto control assembly input arm. Retain with lock washer and nut, torque 4 to 6 ft.lbs (5 to 8 Nm).

24. Install new o-rings on all plugs. Install plugs into housing. Torque 3/4 in. plug 21 to 24 ft.lbs (28 to 32 Nm). Torque 1-1/4 in. plug 40 to 45 ft.lbs (54 to 61 Nm).

25. Refer to "Start-up Procedure".

Charge Pump Adapter Assembly

DISASSEMBLY

1. Remove plug, shims, spring, and poppet from adapter assembly as shown in Figure 5-157.

Inspection

- Inspect the charge pump relief valve seat inside the charge pump adapter. Check to insure that seat is smooth and free of burrs or other defects.
- Inspect the charge pump relief valve spring.
- Inspect the bearing or bushing inside the charge pump adapter. The bearing needles must remain in the bearing cage and bearing at dimension shown in Figure 5-156. The bushing must have no excessive scoring.
- Inspect the gerotor pocket inside the charge pump adapter assembly. It should not be scored excessively.

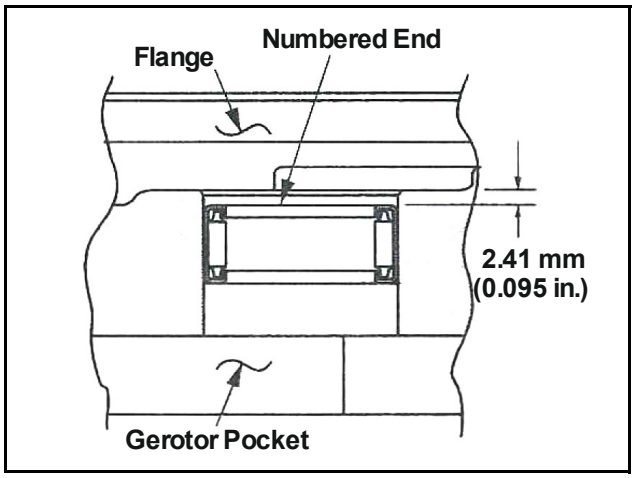
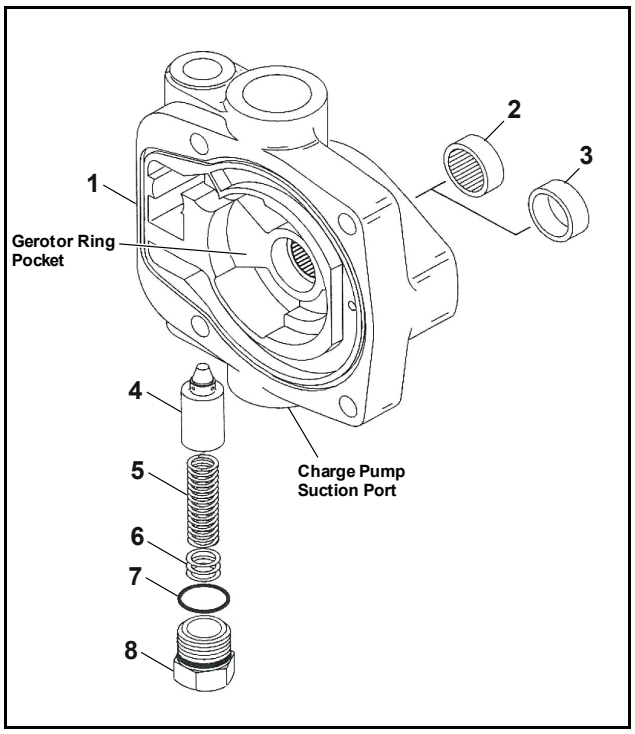


Figure 5-156. bearing or bushing Inspection

ASSEMBLY

1. If necessary, press new bearing or bushing in adapter assembly. The bearing to dimension shown in Figure 5-156. with the numbered end of bearing outward and closest to mounting flange. The bushing is to be pressed flush to 0.254 mm [0.010 in.) recessed.
2. Install poppet. spring, shims, new o-ring on plug, and plug into adapter assembly. Torque plug 30 to 27 ft.lbs. (40.7 to 36.6 Nm).



1. Charge Pump Adapter
2. Bearing
3. Bushing
4. Poppet
5. Spring
6. Shims
7. O-ring
8. Plug

Figure 5-157. Charge Pump Adapter Assembly

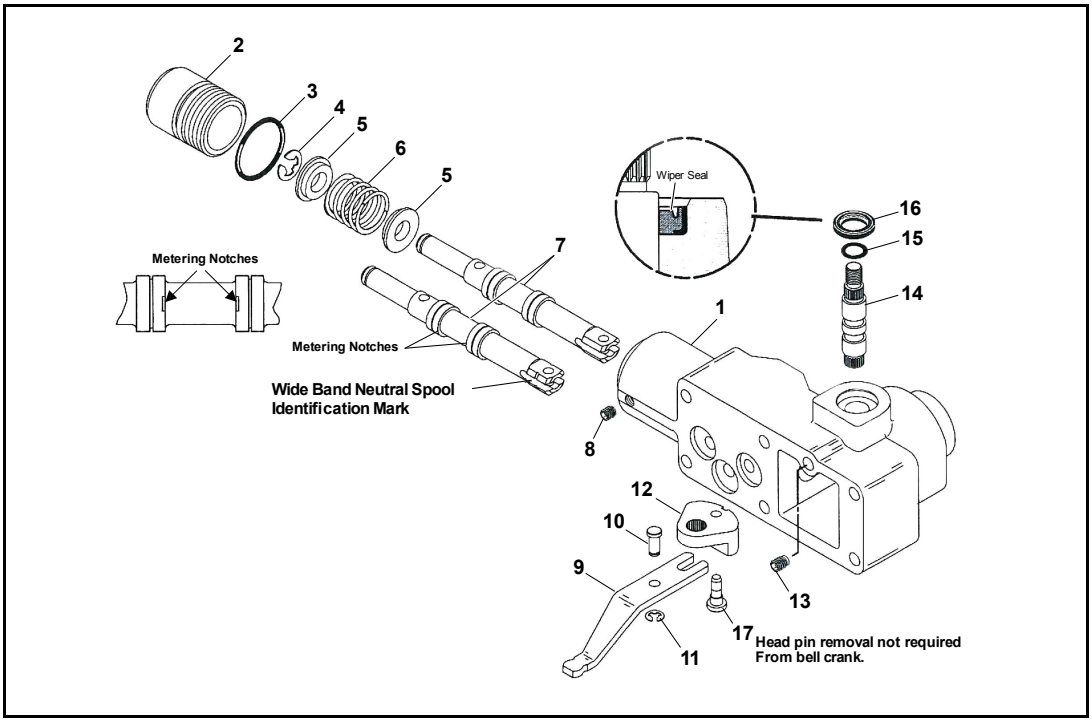
Manual Servo Control Basic Assembly

DISASSEMBLY

1. Remove wiper seal with screw driver. Remove set screw retaining input shaft and remove input shaft from control housing.
2. Remove set screw from plug retaining valve spool and remove plug.
3. Remove E-ring from pin retaining feedback link and valve spool. Remove pin. feedback link. valve spool, and bell crank from control housing.
4. Compress spring and remove E-ring. spring retainer. spring. and second spring retainer from valve spool.
5. Remove o-rings from plug and input shaft. Clean all parts and lubricate in prep for reassembly.

ASSEMBLY

1. Install spring retainer, spring. and second spring retainer onto spool. Compress spring with retainer and retain with E-ring onto valve spool.
2. Install valve spool into control housing making sure that metering notches on valve spool can be seen in the metering ports. Notches shown in Figure 5-158.
3. Position bell crank in housing. Slide feedback link into position between clevis on valve spool. aligning holes, and install dowel pin retaining with E-ring.
4. Install new o-ring onto input shaft. Hold bell crank in position with feedback link slot and align splined hole of bell crank with input shaft cavity. Install input shaft into control housing and bell crank.
5. JLG Threadlocker P/N 0100011 or equivalent to set screw and install, retaining input shaft. Adjust set screw until it bottoms out on input shaft and back out one-quarter turn.
6. Install wiper seal on input shaft as shown in Figure 5-158. Install new o-ring onto plug. retaining valve spool, and install plug. Adjust plug until there is no play in the valve spool with input shaft held stationary. Lock in place with set screw. Torque set screw 17 to 25 in.lbs (2 to 3 Nm).



1. Control Housing
2. Plug
3. O-ring
4. Retaining Ring
5. Spring Retainer
6. Spool Centering Spring
7. Valve Spool
8. Set Screw
9. Feedback Link
10. Dowel Pin
11. Retaining Ring
12. Bell Crank
13. Set Screw
14. Input Shaft
15. O-ring
16. Wiper Seal
17. Head Pin

Figure 5-158. Manual Servo Control Basic Assembly

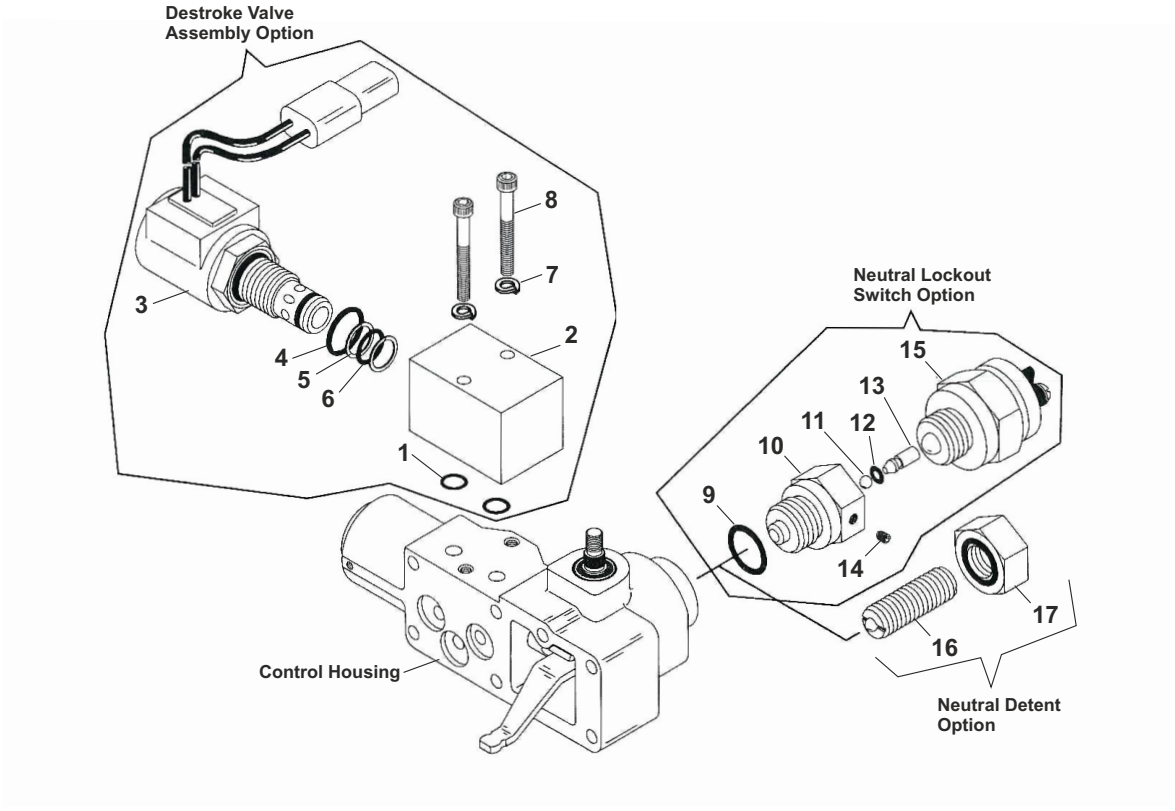
Manual Servo Control Assembly Options

DISASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Remove the two Capscrews and lock washers from manifold. Removing destroke valve assembly and two a-rings.
2. Remove destroke valve from manifold in order to remove o-rings and backup washers. Note: in order to remove destroke valve the solenoid may need to be removed from core first (not shown).

ASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Install new o-rings and backup washers onto destroke valve.
2. Install destroke valve into manifold by hand until top o-ring is met by manifold. Then wrench tighten to 25 ft.lbs. (34 Nm) max. Loosen Nut retaining coil to reposition if necessary and re-torque 4 to 5 ft.lbs. (5.4 to 7 Nm).
3. Lubricate the two o-rings and install onto manifold. Install destroke valve assembly onto control assembly. Retain with lock washers and Capscrews. Torque 2.2 to 2.6 ft.lbs. (3 to 3.5 Nm).



1. O-ring
2. manifold
3. Destroke Valve
4. O-ring
5. Backup Washer
6. O-ring
7. Lock Washer
8. Capscrew
9. O-ring
10. Neutral Lockout Adapter
11. Ball
12. O-ring
13. Pin
14. Set Screw
15. Neutral Lockout Switch
16. Ball Plunger
17. Nut Seal

Figure 5-159. Manual Servo Control Basic Assembly Option

DISASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION

1. Loosen set screw in adapter and remove neutral lockout switch from adapter.
2. Remove neutral lockout adapter from control assembly.
3. Remove pin, ball. and a-rings from adapter.

ASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION

1. Install new a-ring onto adapter and new o-ring onto pin.
2. Install ball and pin into adapter. Lubricate with petroleum jelly to hold in place during installation.
3. Install adapter into control assembly. Torque 44 to 53 ft.lbs. (60 to 70 Nm).
4. Apply Loctite #222 or equivalent to threads of switch and install neutral lockout switch into adapter. The adjustment procedures for the switch are as follows.
   a. Install switch, while moving control arm back and forth, until “detent” action is detected. Back out the switch until the “detent” action is very slight.
   b. Obtain a test light or use a multimeter. Attach the leads from the test light to the switch or the wiring connector.
   c. Move the control arm out of the detent position. The test light will go on. Screw in the switch until the light goes off. Mark this as position “A”. See Figure 5-160. Move the control arm to the detent position and the test light should come back on.
   d. Leaving the control arm in the detent position, the light will remain on. Screw in the switch until the light goes off. Mark this position"B".
   e. Unscrew the switch one third of the distance between "B" and "A". Install and tighten the hex socket head set screw in one of the main quadrants of the hex of the switch adapter. See Figure 5-160. Torque set screw 2.3 to 2.8 in.lbs (3.2 to 3.8 Nm).
5. Test the switch by moving the control arm to the detent position, the light should be on. Move the control arm out of detent, the light should go off.
6. Remove test light and put servo control assembly into operation.

DISASSEMBLY - NEUTRAL DETENT OPTION

1. Loosen seal nut and remove ball plunger from control housing.

ASSEMBLY- NEUTRAL DETENT OPTION

1. Install ball plunger into control housing until contact with bell crank detent is detected. After contact screw in 1/2 turn and retain with seal nut. Torque nut 10 to 22 ft.lbs. (14 to 30 Nm).

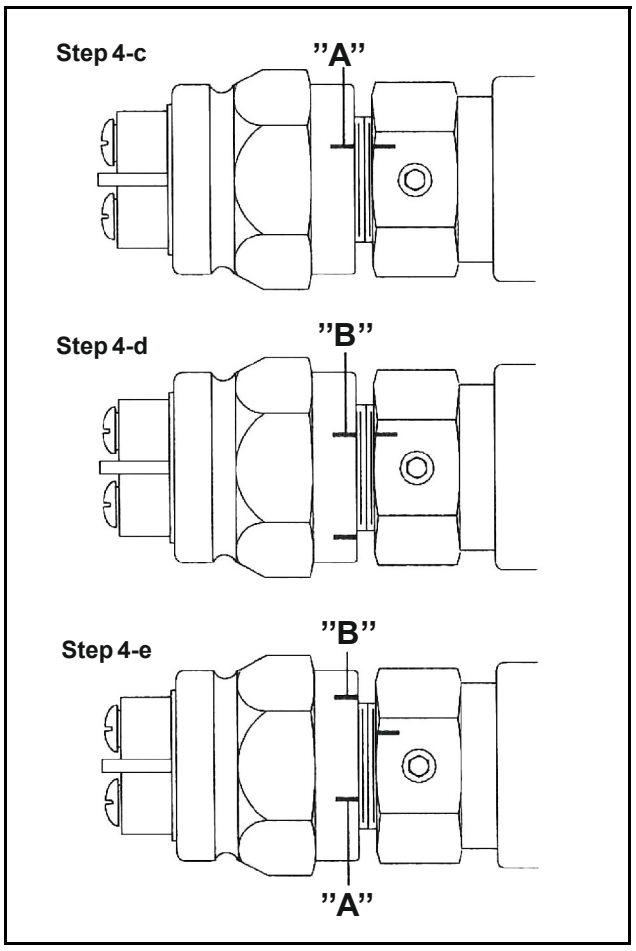


Figure 5-160. Neutral Lockout Switch Assembly

Rotating Kit Assembly

DISASSEMBLY

Disassembly of rotating assembly is required for inspection only.

1. Remove the nine piston assemblies, shoe retainer, and shoe retainer pivot from cylinder barrel.

Inspection

- Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the swashplate. **Do not lap piston shoes.**
- Examine the shoe retainer for wear in the pivot area.
- Examine the pivot to insure smoothness and no signs of wear.
- Inspect the cylinder barrel surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. Do not lap piston block.
- The pistons should move freely in the cylinder barrel bore. If they are sticky in the bore, examine the bore for scoring or contamination.

2. To inspect pins and spring caution should be taken in removing spring. The spring is highly compressed and the retaining ring should not be removed without compressing the spring safely.

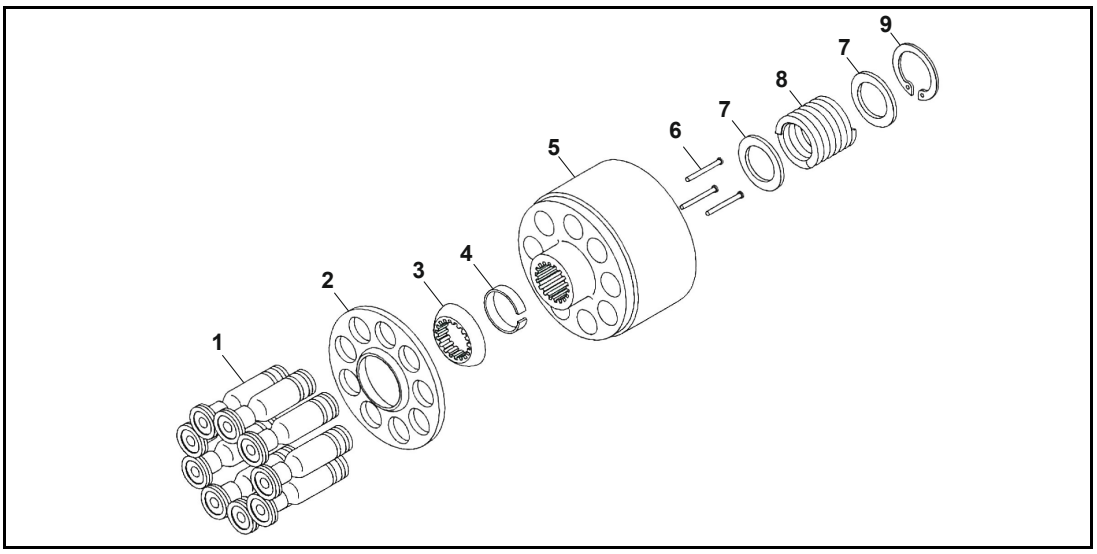
The following parts are required to disassemble the cylinder barrel:

2 ea.	3/8 in. I.D. x 1-1/8 in. O.D. flat washers
1 ea.	3/8 in. x 3-1/4 in. N.C. Capscrew, and
1 ea.	3/8 in. N.C. nut

To remove spring, place one of the flat washers over the 3/8 in. x 3-1/4 in. Capscrew. Put Capscrew through the center of the cylinder barrel and apply the second washer. Let washer rest on the three pins and retain with nut. Turning nut and compressing spring inside the barrel. Use a pair of retaining ring pliers and remove the internal retaining ring. Remove nut, bolt, and the two washers from barrel. Remove the washer, spring, second washer, three pins, and pin keeper at the same time.

ASSEMBLY

1. To reassemble the rotating kit assembly complete the following: Compress the pin keeper and install in the spline of the cylinder barrel. Insta ll the three pins with head end to the inside of the barrel and position in the special grooves of the cylinder barrel spline.
2. Install the washer, spring, and second washer into the cylinder barrel. Use the two 3/8 in. I. D. washers, nut, and 3/8 in. x 3-1/4 in. Capscrew to compress the spring and retain with retaining ring. Remove the nut. Capscrew, and the two washers.
3. Install the pivot onto the three pins, shoe retainer on the pivot, and piston assemblies thru the shoe retainer and into cylinder barrel. resting on shoe retainer.



1. Piston assemblies
2. Shoe Retainer
3. Shoe Retainer Pivot
4. Retainer
5. Cylinder Barrel
6. Pins
7. Washer
8. Spring
9. Retaining Ring

Figure 5-161. Rotating Kit Assembly

Fault- logic Trouble Shooting

Match the transmission symptoms with the problem statements and follow the action steps shown in the box diagrams. This will give expedient aid in correcting minor problems eliminating unnecessary machine down time.

Following the fault - logic diagrams are diagram action comments of the action steps shown in the diagrams. Where applicable, the comment number of the statement appears in the action block of the diagrams.

RECOMMENDED GAUGE LOCATIONS

Gauges Recommended

Inlet vacuum gauge: 30 PSI to 14.8 PSI (2 bar to 1 bar)

System pressure gauge: 10,000 PSI (700 bar)

Charge pressure gauge: 0 to 600 PSI (0 to 50 bar)

Case pressure gauge: 0 to 300 PSI (0 to 25 bar)

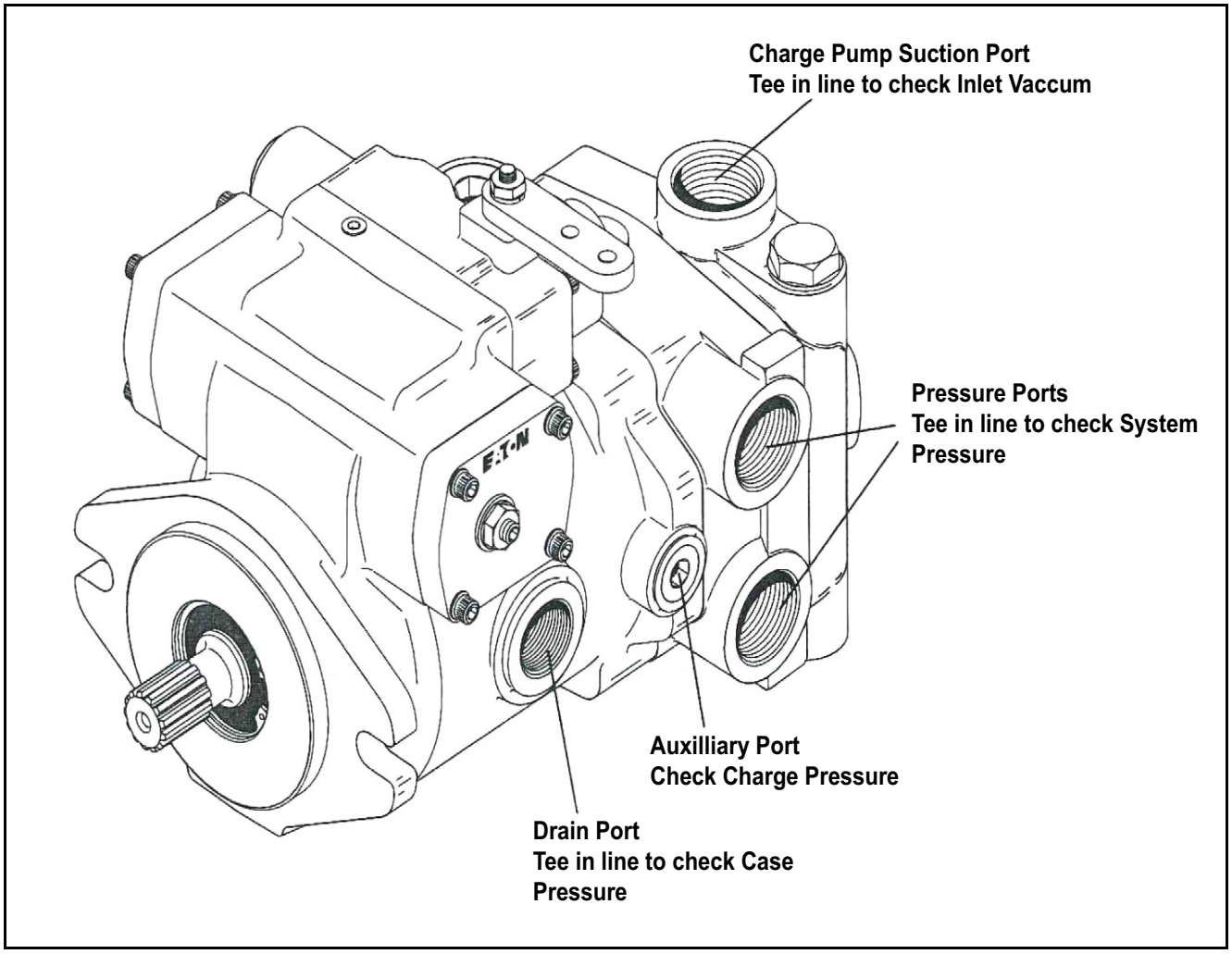


Figure 5-162. Gauge Locations

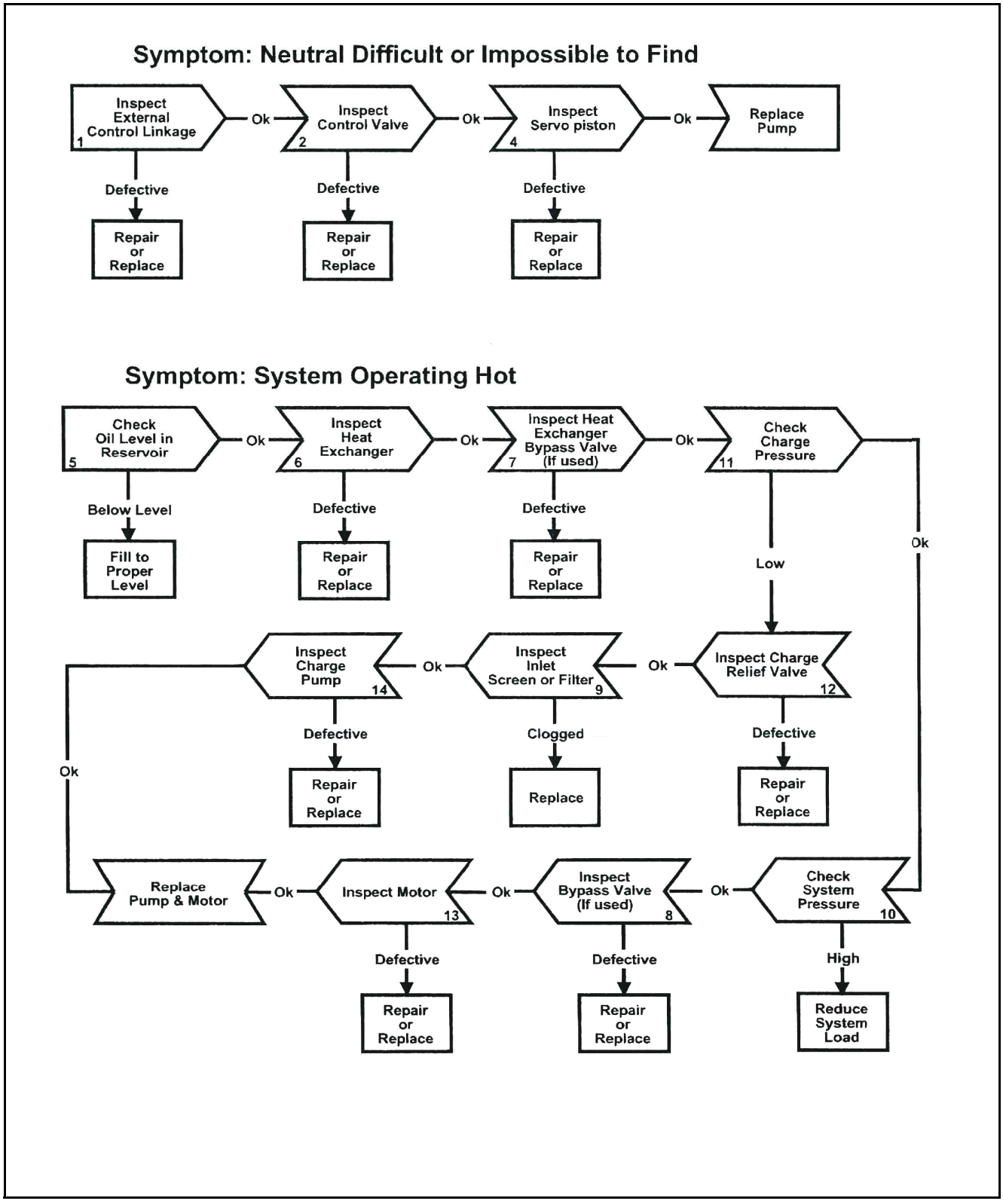


Figure 5-163. Fault- logic Troubleshooting

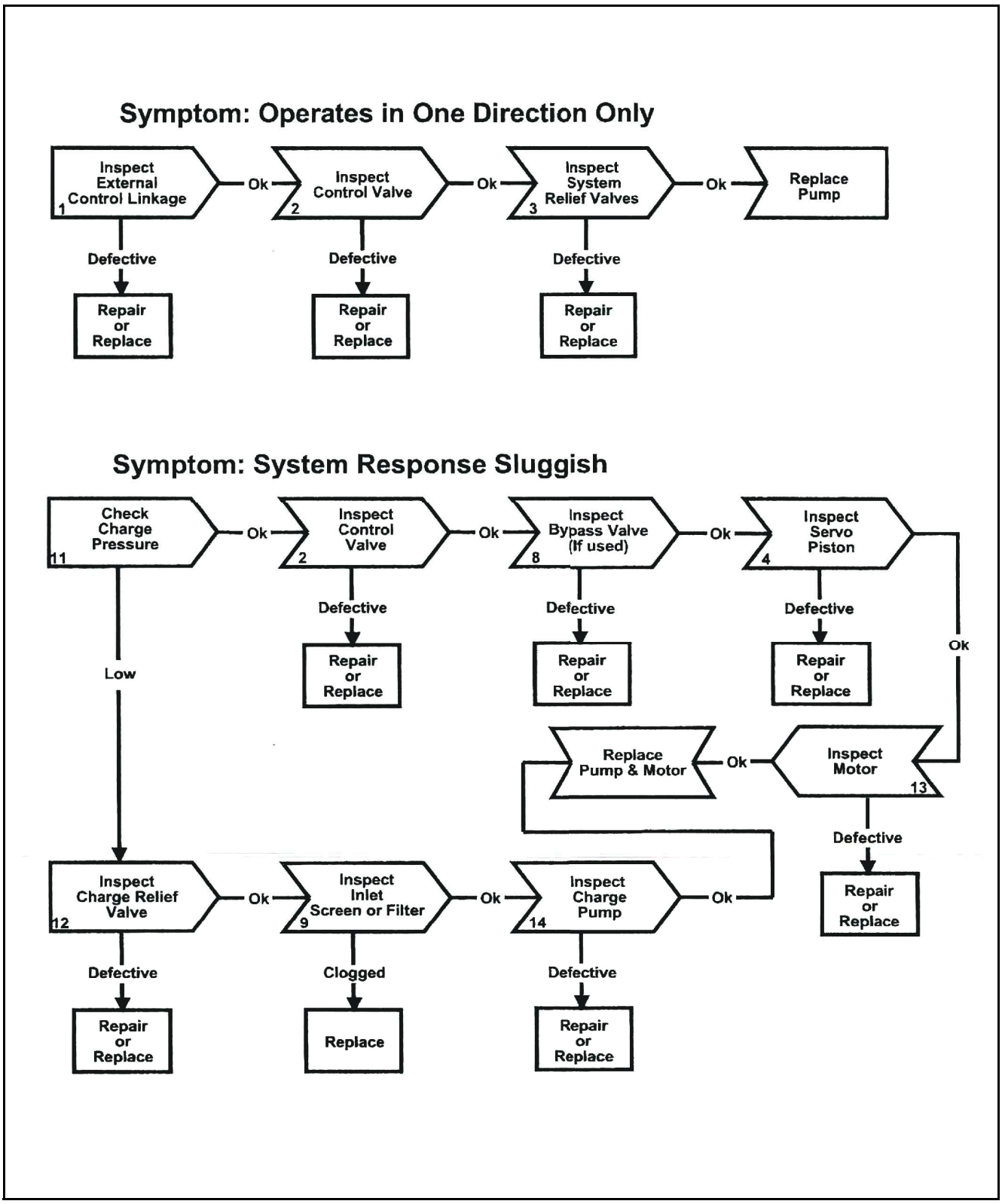


Figure 5-164. Fault- logic Troubleshooting

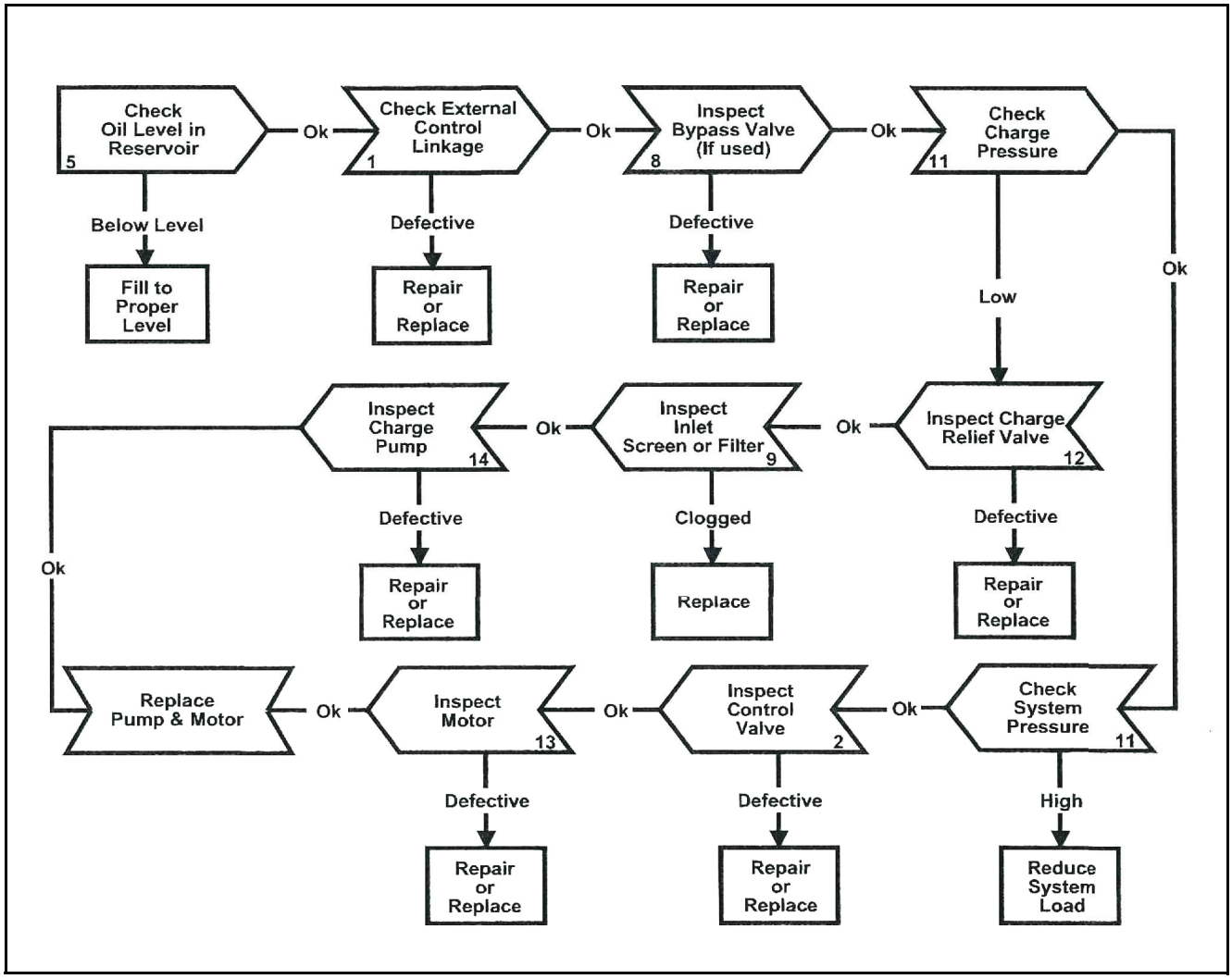


Figure 5-165. Fault- logic Troubleshooting

DIAGRAM ACTION STEP COMMENTS

1. **Inspect External Control Linkage for:**
   - **a.** Misadjusted or disconnected
   - **b.** Binding, bent or broken
2. **Inspect Control Valve for:**
   - **a.** Plugged control orifice(s)
   - **b.** Damaged mounting gasket
   - **c.** Misadjusted, damaged or broken neutral return spring
   - **d.** Broken control connector pin
   - **e.** Faulty destroke valve (if used)
   - **f.** Galled or stuck control spool
   - **g.** Neutral detent or lockout switch misadjusted (if used)
3. **Inspect System Relief Valves for:**
   - **a.** Improper pressure relief setting
   - **b.** Damaged or broken spring
   - **c.** Valve held off seat
   - **d.** Damaged valve seat
4. **Inspect Servo Piston for:**
   - **a.** Misadjusted, damaged or broken neutral return spring assembly
   - **b.** Galled or stuck servo piston
   - **c.** Damaged or missing o-ring and/or backup ring
5. **Check Oil Level in Reservoir:**
   - **a.** Consult owner/operators manual for the proper type fluid and level
6. **Inspect Heat Exchanger for:**
   - **a.** Obstructed air flow (air cooled)
   - **b.** Obstructed water flow (water cooled)
   - **c.** Improper plumbing (inlet to outlet)
   - **d.** Obstructed fluid flow
7. **Inspect Heat Exchanger Bypass Valve for:**
   - **a.** Improper pressure adjustment
   - **b.** Stuck or broken valve
8. **Inspect Bypass Valve for: {if used)**
   - **a.** Held in a partial or full open position
9. **Inspect Inlet Screen or Filter for:**
   - **a.** Plugged or clogged screen or filter element
   - **b.** Obstructed inlet or outlet
   - **c.** Open inlet to charge pump
10. **Check System Pressure:**
    - **a.** See Figure 5-162. for location of pressure gauge installation
    - **b.** Consult owner/operators manual for maximum system relief valve settings
11. **Check Charge Pressure:**
    - **a.** See Figure 5-162. for location of charge pressure gauge installation
    - **b.** Consult owner/operators manual for maximum charge relief valve settings
12. **Inspect Charge Relief Valve for:**
    - **a.** Improper charge relief pressure setting
    - **b.** Damaged or broken spring
    - **c.** Poppet valve held off seat
13. **Inspect Motor for:**
    - **a.** Consult owner/operator manual for motor operation and trouble shooting
14. **Inspect Charge Pump for:**
    - **a.** Broken or missing drive key
    - **b.** Damaged or missing o-ring
    - **c.** Excessive gerotor clearance
    - **d.** Galled or broken gerotor set

System/Charge Relief Valve Pressure Settings

Inlet Vacuum	2.94 PSI (0.203 bar) max.
Case Pressure	25 PSI (1.7 bar) maximum
Charge Pressure	250 to 300 PSI (17.24 to 20.68 bar)
System Pressure	5000 PSI (345 bar) maximum
	3000 PSI (207 bar) continuous

The high pressure relief valves are all factory preset and cannot be readjusted.

The pressure setting is stamped on each valve with a three digit number. To identify, multiply the noted number by 10 to get the valves pressure setting.

Example: 10 x 500 = 5000 PSI (345 bar)

Start-up Procedure

When initially starting a new or a rebuilt transmission system. it is extremely important that the start-up procedure be followed. It prevents the chance of damaging the unit which might occur if the system was not properly purged of air before start-up.

1. After the transmission components have been properly installed, fill the servo pump housing at least half full with filtered system oil. Connect all hydraulic lines and check to be sure they are tight.
2. Install and adjust all control linkage.
3. Fill the reservoir with an approved oil that has been filtered through a 10 micron filter. Refer to Eaton Hydraulics Technical Data sheet number 3-401 titled Hydraulic Fluid Recommendations.
4. Gasoline or L.P. engines: remove the coil wire and turn the engine over for 15 seconds. Diesel engines: shut off the fuel flow to the injectors and turn the engine over for 15 seconds.
5. Replace the coil wire or return the fuel flow to the injectors. Place the transmission unit in the neutral position, start the engine and run it at a low idle. The charge pump should immediately pick up oil and fill the system. If there is no indication of fill in 30 seconds, stop engine and determine the cause.
6. After the system starts to show signs of fill, slowly move pump swashplate to a slight cam angle. Continue to operate system slowly with no load on motors until system responds fully.
7. Check fluid level in the reservoir and refill if necessary to the proper level with an approved filtered oil.
8. Check all line connections for leaks and tighten if necessary.
9. The machine is now ready to be put into operation.
10. Frequent filter changes are recommended for the first two changes after placing the machine back into operation. Change the first filter in 3-5 hours and the second at approximately 50 hours. Routinely scheduled filter changes are recommended for maximum life of the hydraulic system.

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5.9 HYDRAULIC SCHEMATIC

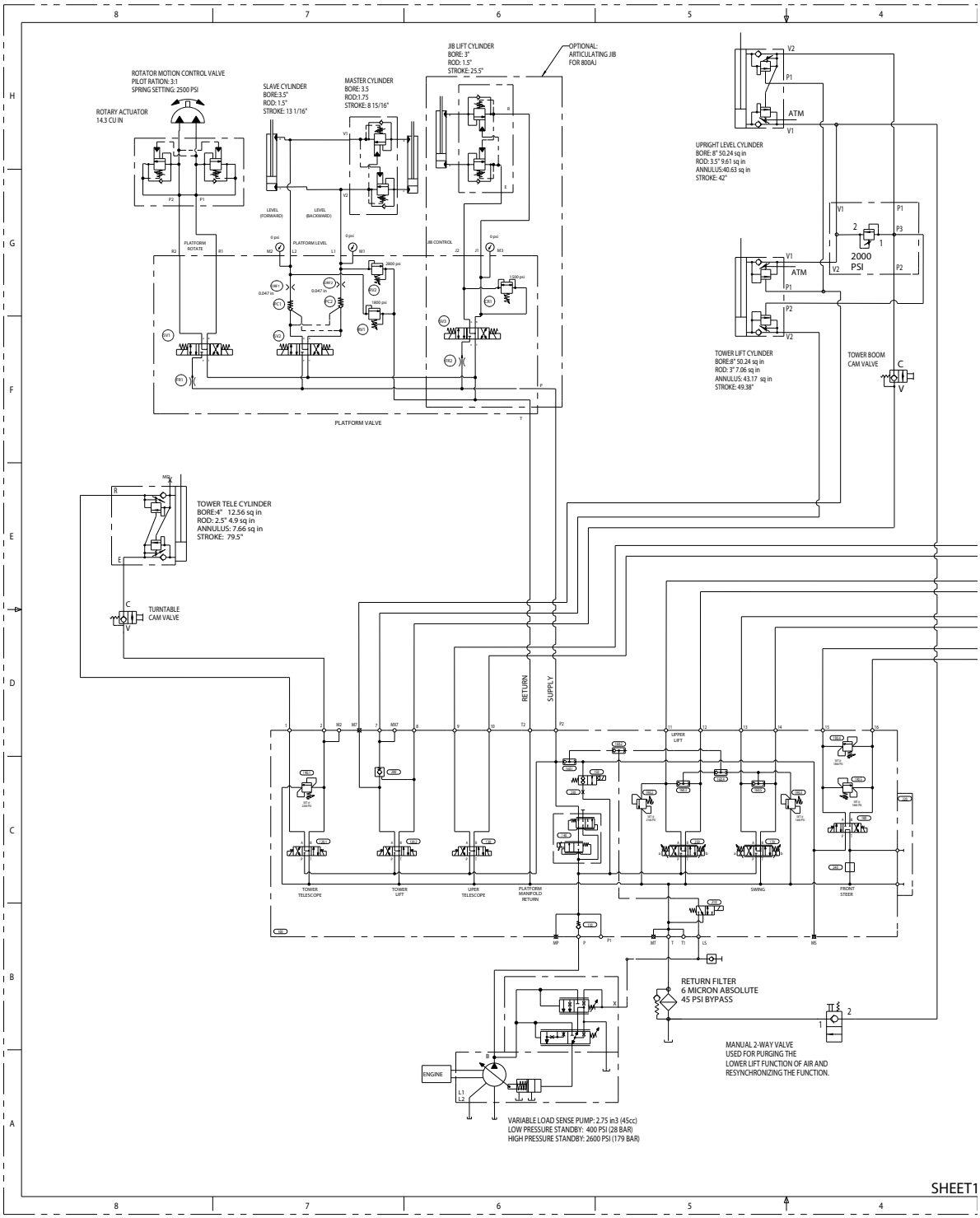


Figure 5-166. Hydraulic Schematic - Sheet 1 of 4

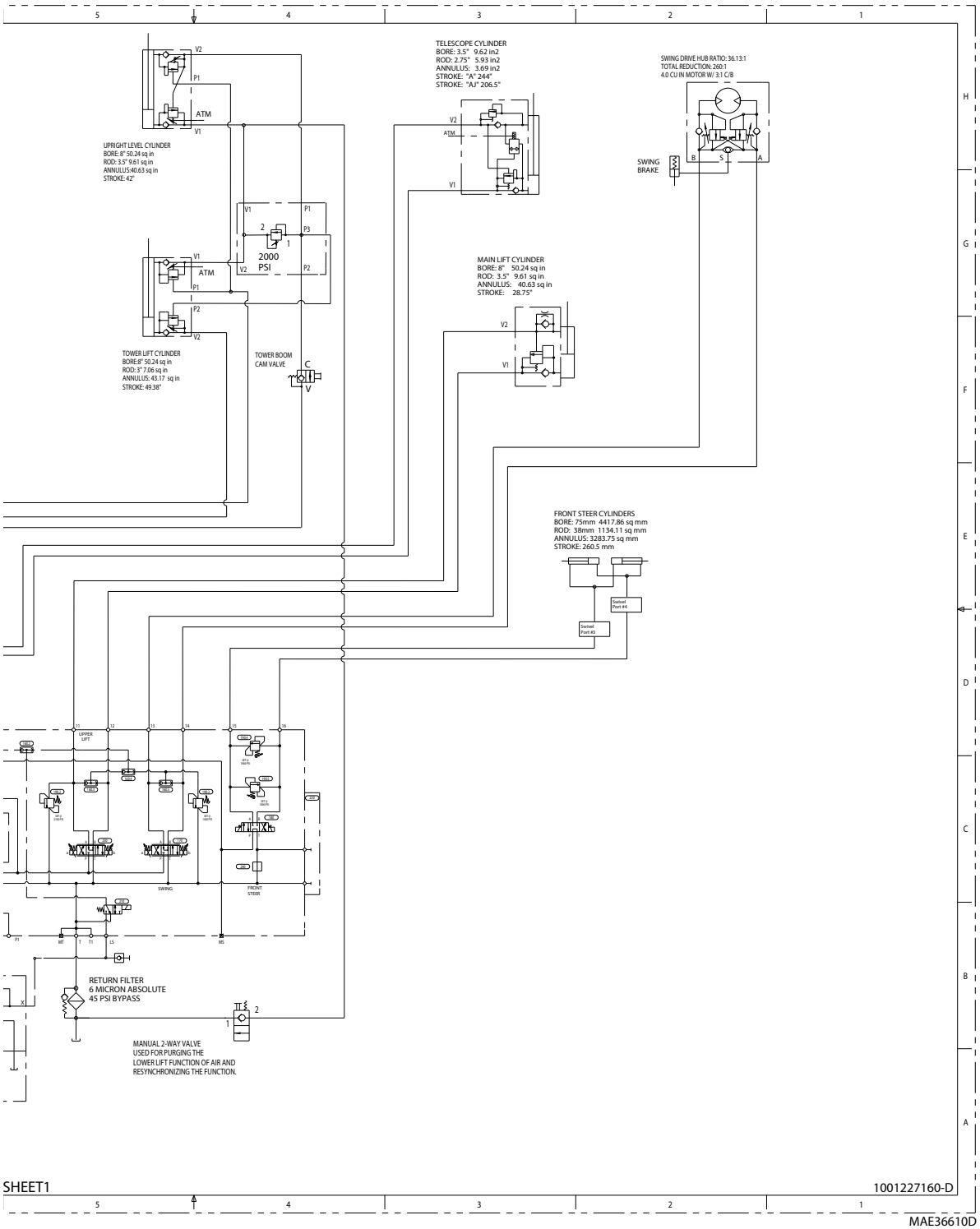


Figure 5-167. Hydraulic Schematic - Sheet 2 of 4

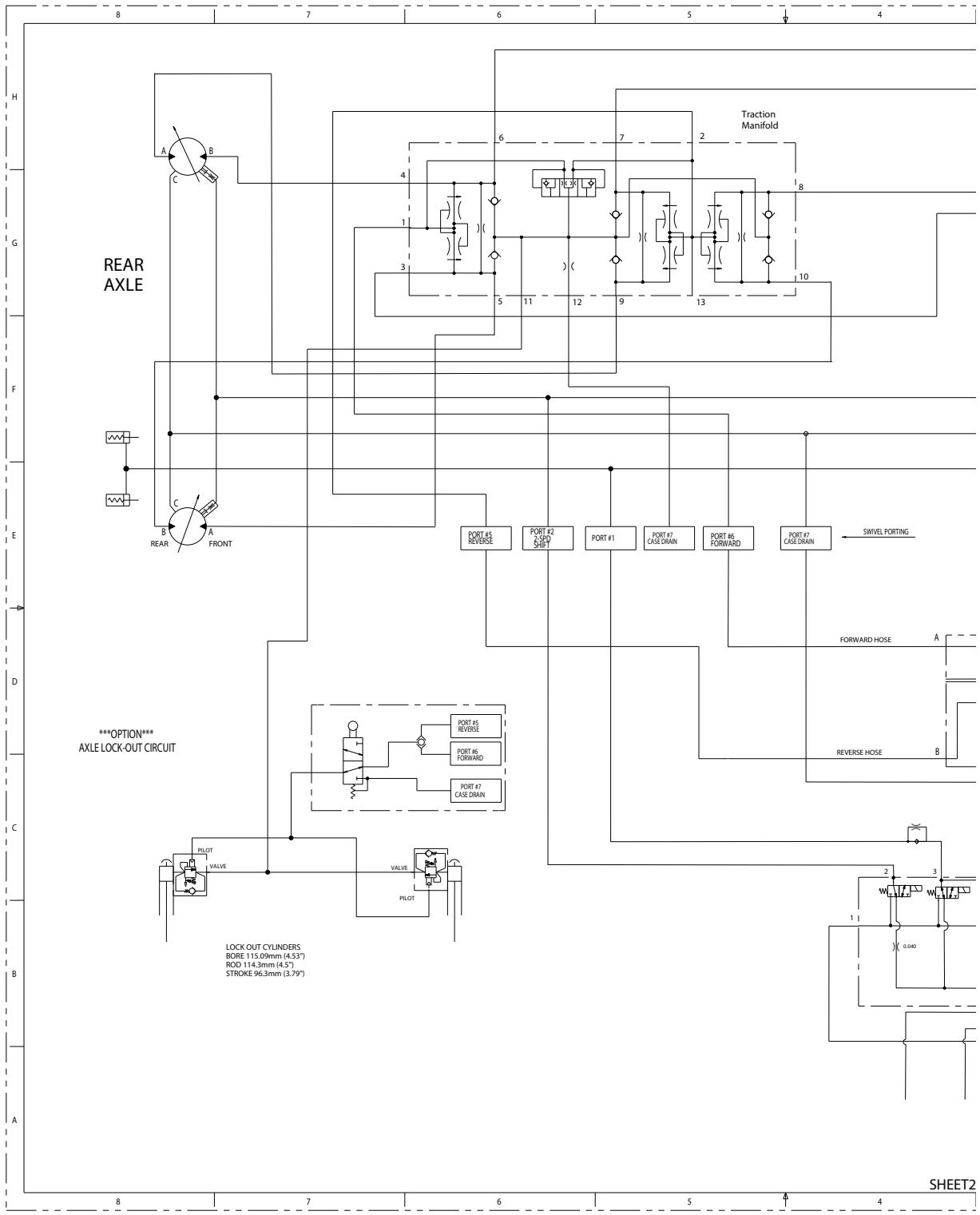


Figure 5-168. Hydraulic Schematic - Sheet 3 of 4

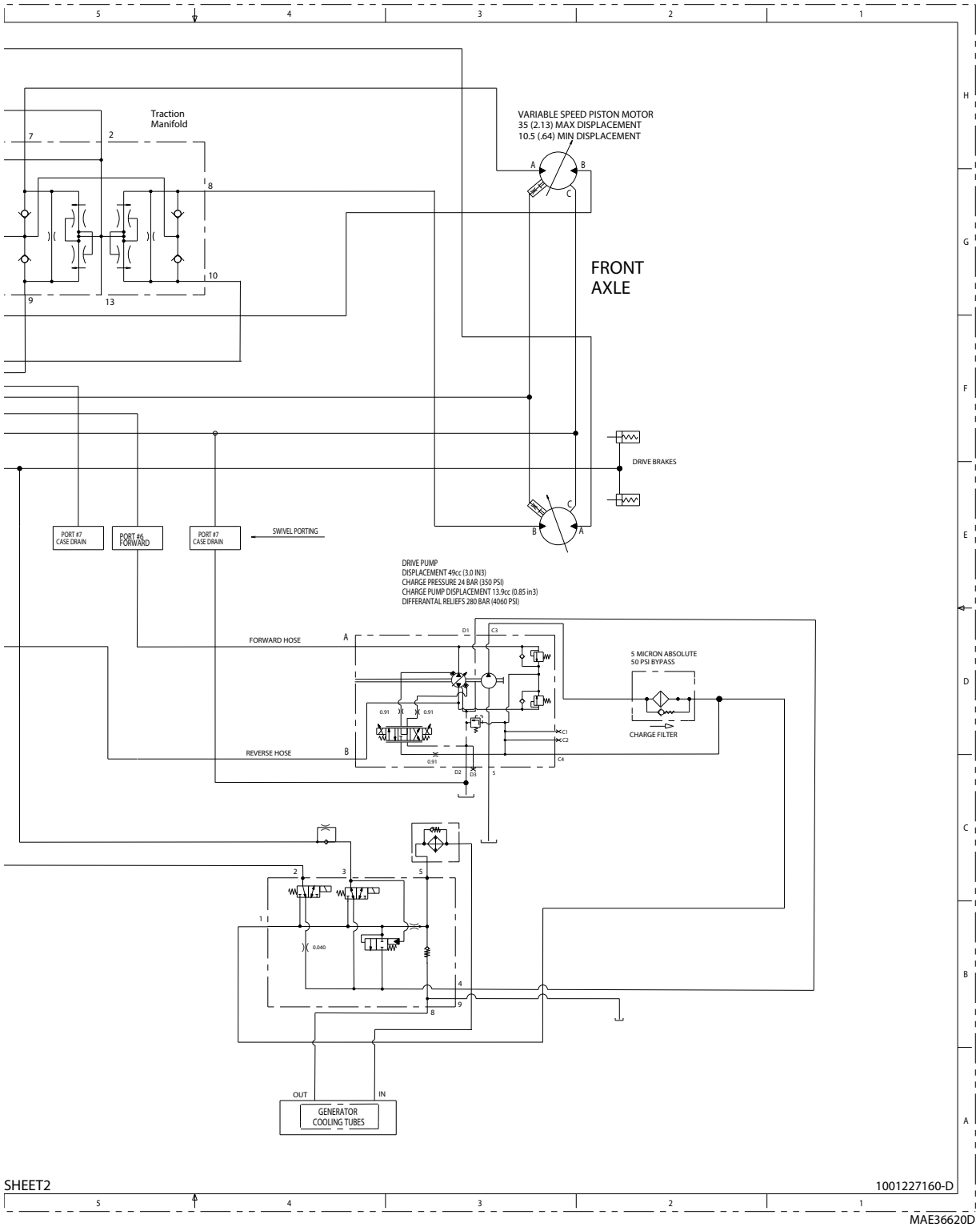


Figure 5-169. Hydraulic Schematic - Sheet 4 of 4

NOTES:

SECTION 6. JLG CONTROL SYSTEM

6.1 INTRODUCTION

NOTICE

THIS MACHINE IS POWERED BY AN 84VDC (NOMINAL) ELECTRICAL SYSTEM THAT CAN RANGE UP TO 105VDC DURING NORMAL OPERATION, AND BY A 48VAC (NOMINAL) ELECTRICAL MOTOR SYSTEM THAT CAN RANGE UP TO 60VAC. BASED ON EMPLOYER, LOCAL, AND GOVERNMENTAL REGULATIONS AS THEY PERTAIN TO THIS MACHINE, SPECIFIC ELECTRICAL TRAINING AND CERTIFICATIONS MAY BE REQUIRED BEFORE SERVICING OR TROUBLESHOOTING.

The machine has two separate battery systems, 12 Volt and 84 Volt.

The 12 Volt system powers the control modules (e.g., UGM), hydraulic valves, clutch actuation, fans, and the engine start/alternator system.

The 84 Volt system powers the Integrated Motor Generator (IMG) and the mobile battery charging system, which includes the battery boxes, IMG control enclosure, 84V/12V DC/DC converter. The two battery chargers are powered by AC mains power in the range 85-245 VAC, 45-65 Hz.

The JLG designed Control System is the 12 volt based control system installed on the boom lift and includes Universal Ground Module (UGM), Platform and HEC modules.

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

The main lift, swing, and drive are controlled by individual joysticks, 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 control system will control the voltage output to the valves and pump, as programmed for smooth operation and maximum cycle time. Ground control speeds for all boom functions can also be programmed into the control system.

The JLG Control System ground control module has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment may be added later but must be programmed into the control system when installed.

The HEC module is responsible for commanding Hybrid control functions and processing Hybrid related feedback signals.

6.2 JLG CONTROL SYSTEM ANALYZER KIT INSTRUCTIONS

NOTICE

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

NOTICE

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

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer Kit, JLG part no. 2901443) which will display two lines of information at a time, by scrolling through the program.

This Analyzer kit can be plugged into the UGM and also the HEC.

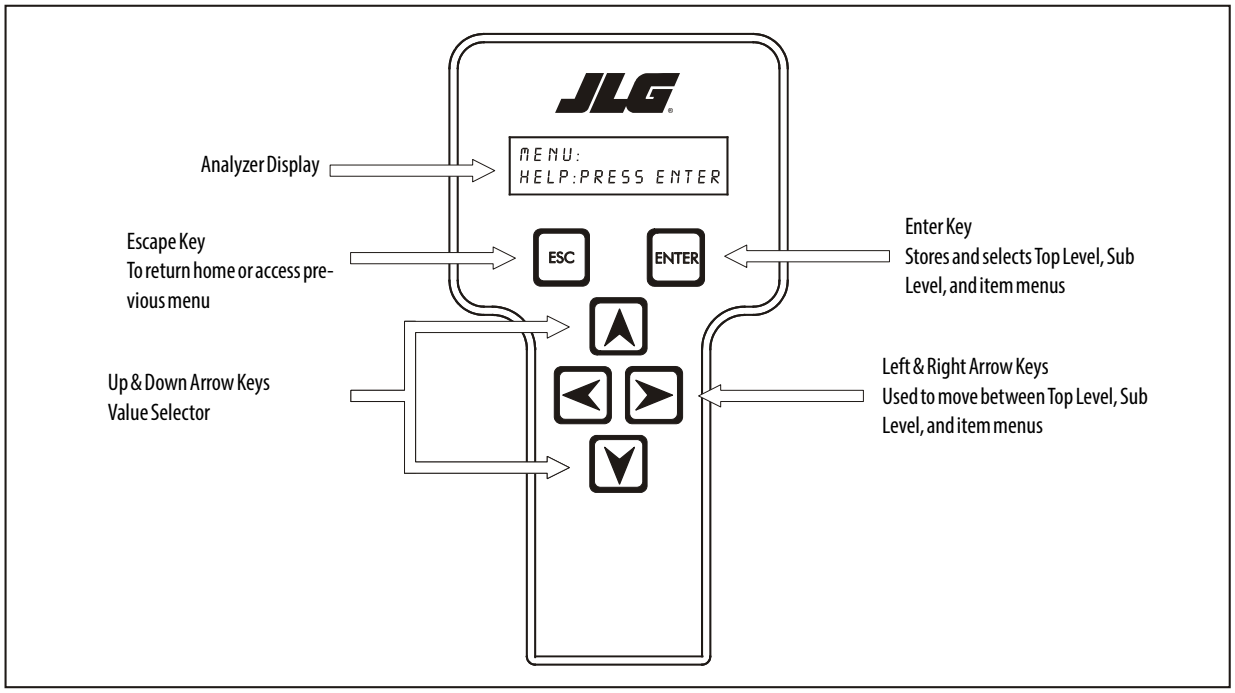


Figure 6-1. Hand Held Analyzer

To Connect the JLG Control System Analyzer

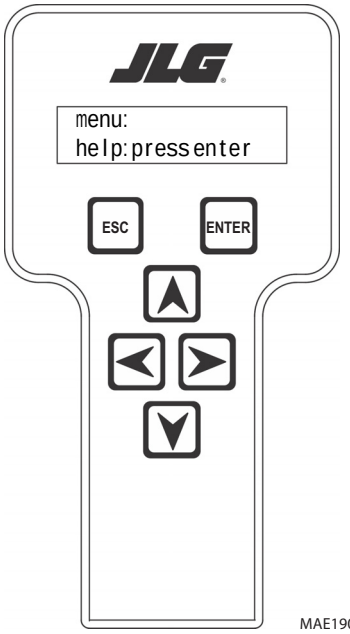
1. Connect the four pin end of the cable supplied with the analyzer, to the control module located in the platform box or at the HEC module and connect the remaining end of the cable to the analyzer.

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 Escape  ; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level UGM menus are as follows:

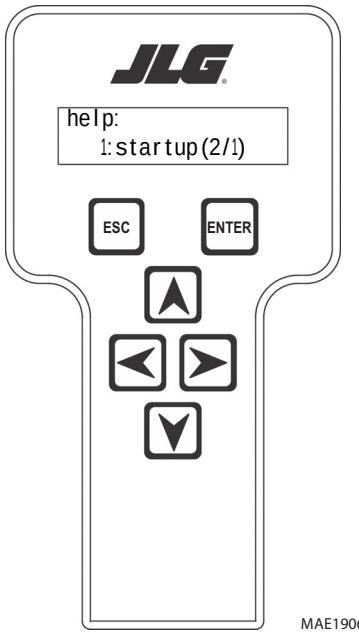
HELP
DIAGNOSTICS
ACTIVATE TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
LEVEL VEHICLE (level 1 only)
CALIBRATIONS (view only)

The top level HEC menus are as follows:

HELP
DIAGNOSTICS
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP

If you press **ENTER** 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** ENTER is pressed again, the display moves to the following display:



MAE19060

LOGGED HELP
1: STARTUP (2/1)

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

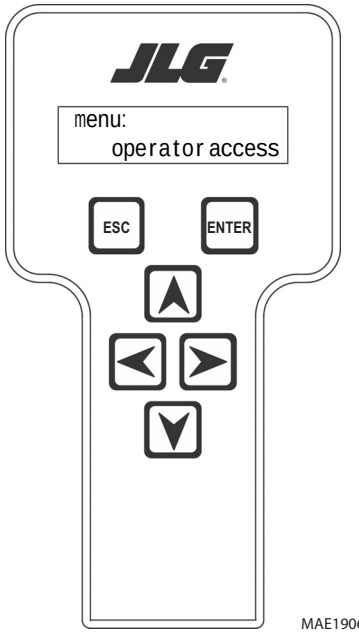
When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

Pressing **ENTER** 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 OPERATOR ACCESS. Remember, you may always cancel a selected menu item by pressing the **ESCAPE** ESC key.

Changing the Access Level of the Hand Held Analyzer

When the analyzer is first connected, you will be in Operator Access 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:



MAE19060

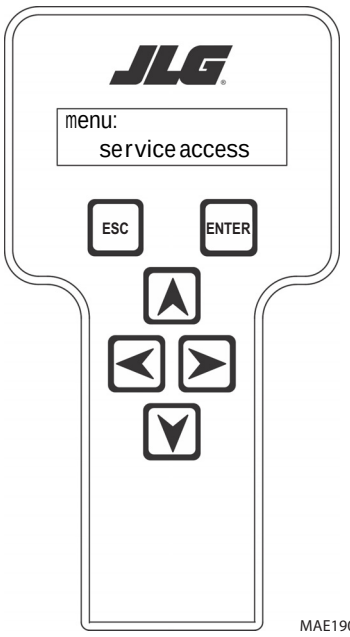
Press **ENTER** ENTER to select the **ACCESS LEVEL** menu.

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** ENTER. The access level should display the following, if the password was entered correctly:



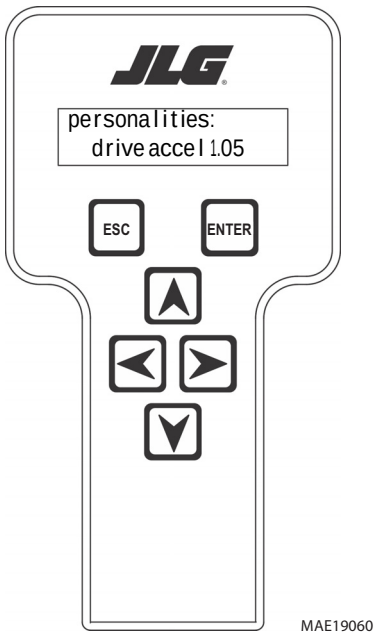
MAE19060

MENU:
SERVICE ACCESS

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

Adjusting Parameters Using the Hand Held Analyzer

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

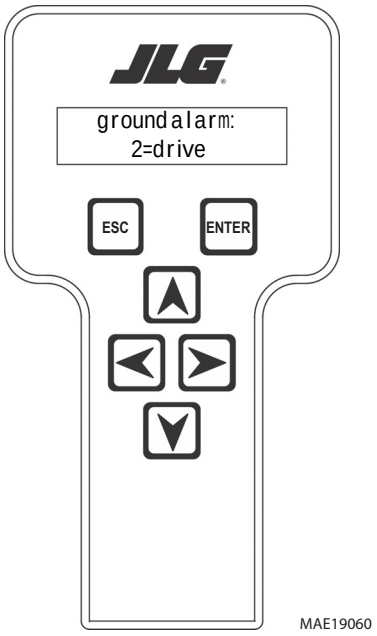


DRIVE:
ACCEL 1.5s

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at 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 Personality Ranges/Defaults 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.

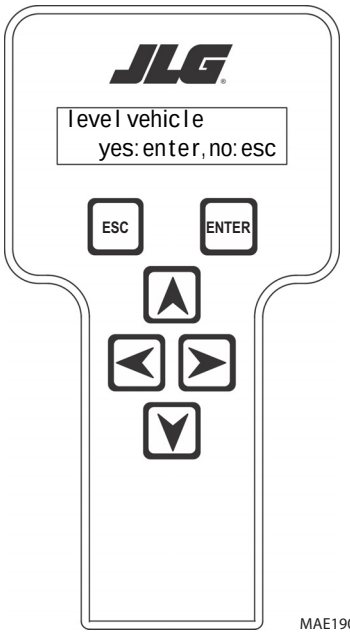
NOTICE

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.

Level Vehicle Description

⚠ WARNING

DO NOT LEVEL VEHICLE EXCEPT ON A LEVEL SURFACE.



MAE19060

LEVEL VEHICLE
YES:ENTER, NO:ESC

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

Ground Control Console Display Gauge

(See Figure 6-5., Ground Control Console Display Gauge)

The Display Gauge shows engine hours, fuel level or battery level (if applicable), and Diagnostic Trouble Codes (DTCs) from both the JLG Control System. During machine start up, with no active DTCs in the control system, the splash screen will show for 3 seconds and then switch to main screen. If there is an active DTC while powering up the machine, the splash screen will show for 3 seconds, and then launch the Diagnostics Screen. The indicator lamp will light when there is an active DTC in the Fault Log.

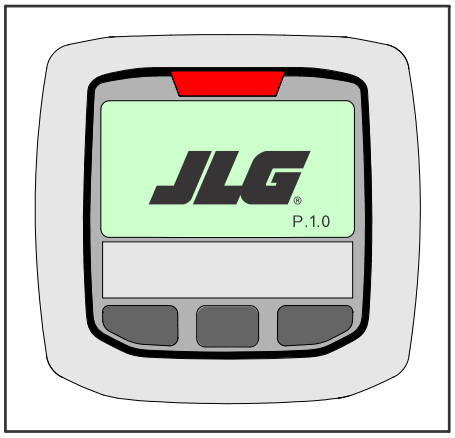


Figure 6-2. Splash Screen

The Diagnostic Screen will show active and inactive faults from the JLG Control System on the screen. An asterisk (*) will be displayed to show active faults.

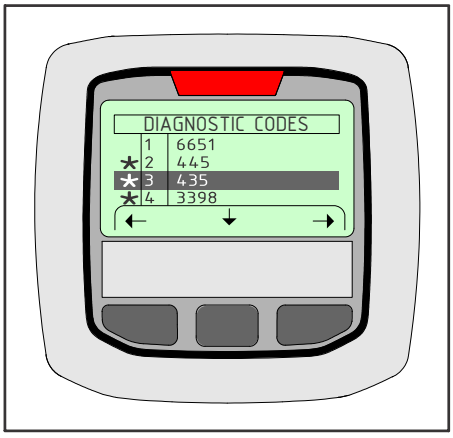


Figure 6-3. Diagnostic Screen

The Engine Diagnostics Screen will show SPN (Suspect Parameter Number), FMI (Failure Mode Identifier), and Occurrence count information. Engine SPN text is not scrollable. If there is more than one engine trouble code, the operator must exit from the Engine DTC Screen to see other SPN and FMI information.

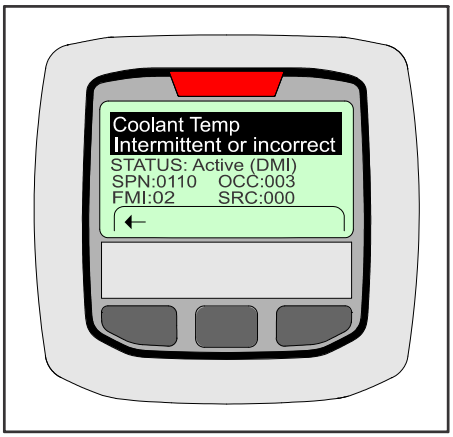


Figure 6-4. Engine Diagnostic Screen

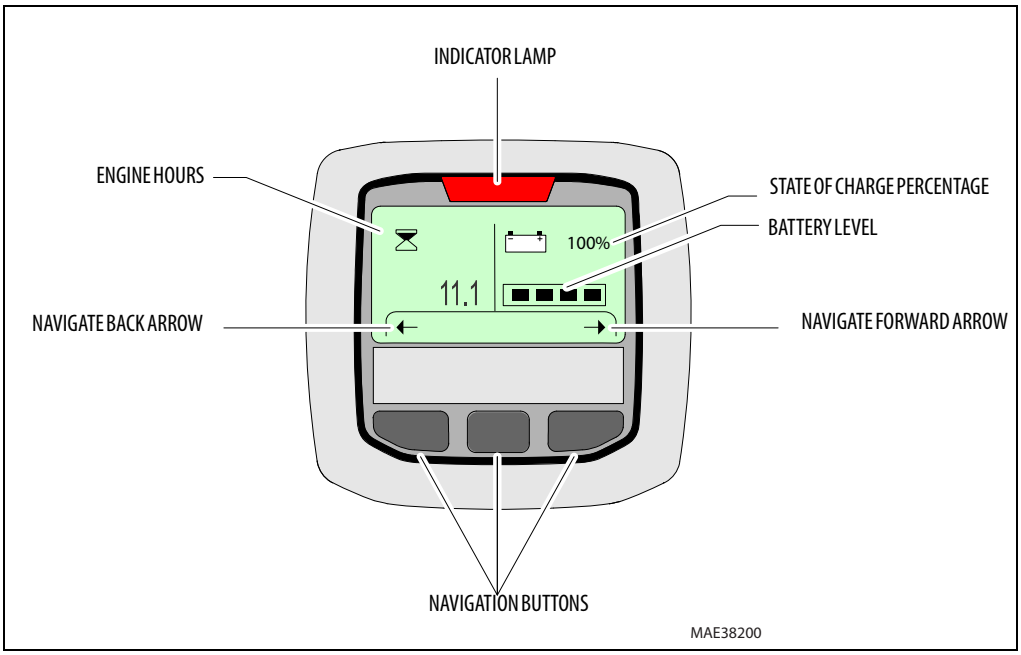


Figure 6-5. Ground Control Console Display Gauge

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
ACCEL	ACCELERATE
ACT	ACTIVE
A/D	ANALOG DIGITAL CONVERTER COUNT
AMB.	AMBIENT
ANG	ANGLE
AUX	AUXILIARY
BCS	BOOM CONTROL SYSTEM
BM	BOOM LENGTH ANGLE MODULE
BLAM	BOOM LENGTH ANGLE MODULE
BR	BROKEN
BSK	BASKET
CAL	CALIBRATION
CL	CLOSED
CM	CHASSIS MODULE
CNTL	CONTROL
CNTRL	CONTROL
C/O	CUT OUT
CONT(S)	CONTRACTOR(S)
COOR	COORDINATED
CRK PT	CRACK POINT
CRP	CREEP
CUT	CUTOUT
CYL	CYLINDER
DECEL	DECELERATE
D	DOWN
DN	DOWN
DWN	DOWN
DEG.	DEGREE
DOS	DRIVE ORIENTATION SYSTEM
DRV	DRIVE
E	ERROR
E&T	ELEVATED & TILTED
ELEV	ELEVATION
ENG	ENGINE
EXT	EXTEND
F	FRONT
FL	FLOW
FNT	FRONT
FOR	FORWARD
FWD	FORWARD
FSW	FOOT SWITCH
FUNC	FUNCTION
G	GROUND

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
GND	GROUND
GRN	GREEN
GM	GROUND MODULE
H	HOURS
HW	HARDWARE
HWFS	HARDWARE FAILSAFE
I	IN or CURRENT
JOY	JOYSTICK
L	LEFT
LB	POUND
LEN	LENGTH
LIM	LIMIT
LT	LEFT
LVL	LEVEL
M	MINUTES
MIN	MINIMUM
MAX	MAXIMUM
M	MAIN
MN	MAIN
NO	NORMALLY OPEN or NO
NC	NORMALLY CLOSED
O	OUT
O/C	OPEN CIRCUIT
OP	OPEN
O/R	OVERRIDE or OUTRIGGER
O//R	OVERRIDE
OSC	OSCILLATING
OVRD	OVERRIDE
P	PLATFORM
P	PRESSURE
PCV	PROPORTIONAL CONTROL VALVE
PLAT	PLATFORM
PLT	PLATFORM
PM	PLATFORM MODULE
POT	POTENTIOMETER
PRES	PRESSURE
PRS	PRESSURE
PT	POINT
R	REAR or RIGHT
REV	REVERSE or REVISION
RET	RETRACT
ROT.	ROTATE
RT	RIGHT

Table 6-1. Analyzer Abbreviations

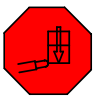
ABBREVIATION	MEANING
S/C	SHORT CIRCUIT
SEL	SELECTOR
SN	SERIAL NUMBER
SPD	SPEED
STOW	STOWED
STOWD	STOWED
SW	SWITCH or SOFTWARE
TELE	TELESCOPE
TEMP	TEMPERATURE
TORQ.	TORQUE
TRN	TRANSPORT
T/T	TURNTABLE
T	TOWER
TURNTBL	TURNTABLE
TWR	TOWER
U	UPPER or UP
V	VOLT
VER	VERSION
VLV	VALVE
WIT	WITNESS
YEL	YELLOW

6.3 PLATFORM LOAD SENSING SYSTEM

The Platform Load Sensing (LSS) System consists of a single load cell mounted within the platform support. This system compares the designed capacity (500 lb (230 kg)) to the measured weight in the platform.

If the actual platform load exceeds the selected Rated Load, the following will occur:

1. The Overload Visual Warning Indicator will flash at the selected control position (platform or ground).



2. The Platform and Ground Alarms will sound 5 seconds On, and 2 seconds Off.
3. All normal movement will be prevented from the platform control position (optional - ground control functions may be prevented).
4. Further movement is permitted by:
   - **a.** Removing the excess platform load until actual platform load is less than Rated Load.
   - **b.** Operation of the overriding emergency system (Auxiliary Power Unit).
   - **c.** By an authorized person at the ground control position (optional - ground control functions may be prevented).

NOTICE

THE LOAD SENSING SYSTEM MUST BE CALIBRATED WHEN ONE OR MORE OF THE FOLLOWING CONDITIONS OCCUR:

- **a.** LSS Sensor removal or replacement
- **b.** Addition or removal of certain platform mounted accessories. (Refer to Calibration)
- **c.** Platform is removed, replaced, repaired or shows evidence of impact.

NOTICE

THE LOAD SENSING SYSTEM REQUIRES PERIODIC FUNCTION VERIFICATION NOT TO EXCEED 6 MONTHS FROM PREVIOUS VERIFICATION. REFER TO TESTING & EVALUATION.

All calibration procedures are menu driven through the use of a JLG Analyzer.

Diagnostic Menu

The Diagnostic Menu is another troubleshooting tool for the Load Sensing System. Sensor and status information is presented in real-time for the technician. Several sub-menus exist to organize the data.

To access the Diagnostic Menu, use the LEFT  and RIGHT  Arrow keys to select DIAGNOSTICS from the Top Level Menu. Press the ENTER key  to view the menu.

Press the LEFT and RIGHT Arrow keys to view the displays and select the various sub-menus. To access a sub-menu, press the ENTER key. Once in a sub-menu, press the LEFT and RIGHT Arrow keys to view the various displays (just like a Top Level menu). To exit a sub-menu, press the ESC key  .

Table 6-2, Diagnostic Menu Descriptions details the structure of the Diagnostic Menu, and describes the meaning of each piece of information presented.

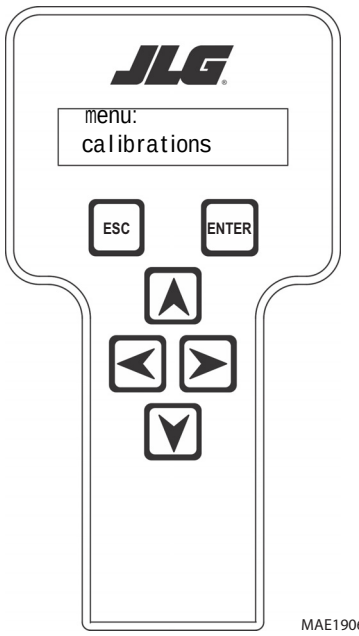
Table 6-2. Diagnostic Menu Descriptions

Diagnostics Menu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
PLATFORM LOAD	STATE:	OK / OVERLOAD	LSS Status.
PLATFORM LOAD	ACTUAL:	XXX.X KG	Calibrated weight of the platform. ??? if Platform Load is Unhealthy**.
PLATFORM LOAD (service*)	GROSS:	XXX.X KG	Gross weight of the platform. ??? if both Cells are Unhealthy**.
PLATFORM LOAD (service*)	OFFSET 1:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	OFFSET 2:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	ACCESSORY	XXX.X KG	Stored accessory weight. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	UNRESTRICT	XXX.X KG	UGM will set Unrestricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RESTRICT	XXX.X KG	UGM will set Restricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RAW 1:	XXX.X KG	Gross value from Cell 1. ??? if Unhealthy**.
PLATFORM LOAD (service*)	RAW 2:	XXX.X KG	Gross value from Cell 2. ??? if Unhealthy**.

* Indicates only visible in service view mode
** Typically indicates a DTC is active

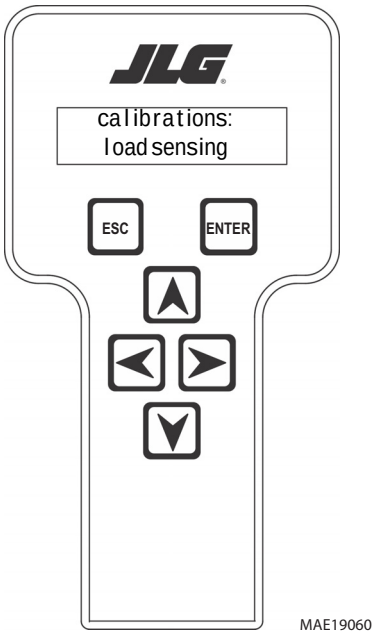
Calibration Procedure

1. Remove everything from the platform, except permanently fixed JLG Accessories, to allow the Load Sensing System to record its' weight during calibration. This includes all tools, debris, and customer-installed devices.
2. Plug the JLG Analyzer into the Machine at the Ground Station and enter Service Access Password 33271.
3. The platform should be approximately level for calibration. Level the platform from ground control (if necessary) to within +/- 5°.
4. To access the Calibration Menu, use the LEFT and RIGHT Arrow keys to select CALIBRATION from the Top Level Menu. The screen will read:

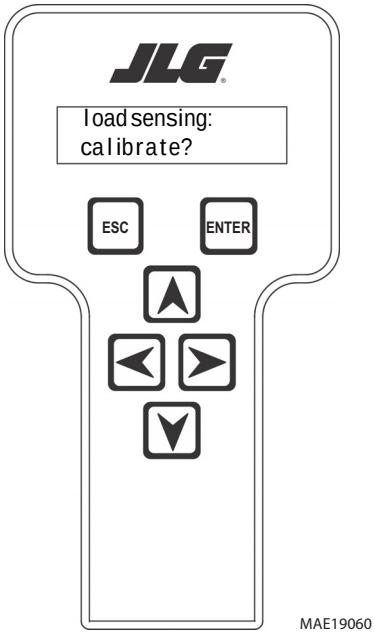


NOTE: *The Calibration Menu is not available in OPERATOR ACCESS.*

5. Press the ENTER key ENTER to view the menu. Upon entry to the Calibration Menu, the JLG Control System will link to the Analyzer and the screen will read:



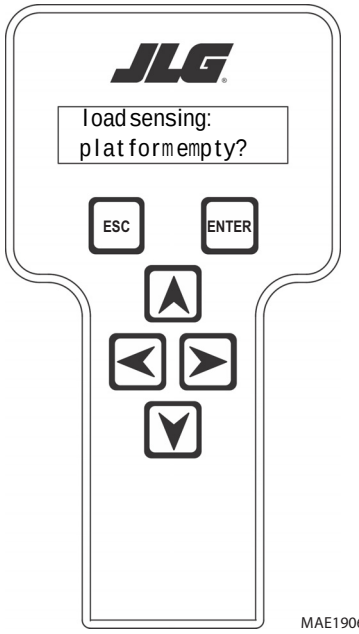
6. Press Enter ENTER. The Screen will read:



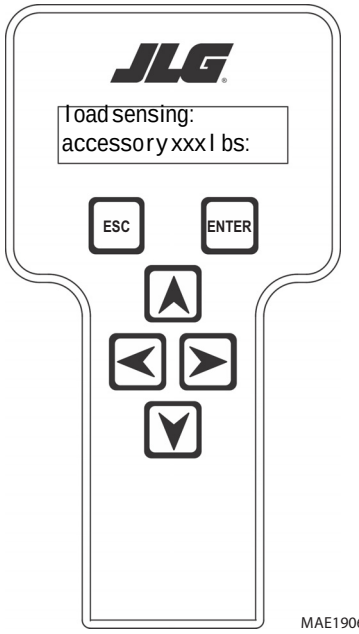
NOTE: *Calibration will auto fail if LSS DTC's are active (443, 444, 4479, 4480, 663, 821, 822, 823, 824, 8218, 8222 -> 8238, 991, 992, 993, 994 or 99285).*

Pressing the ESC key [ESC] after starting calibration and before calibration is complete will display the CAL FAILED message. This will not disturb the prior calibration information.

7. Press ENTER [ENTER]. The analyzer screen will read:



8. If the platform is empty, press ENTER [ENTER]. The screen will read:



NOTE: *Accessory weight will reset to 0 lbs. each time the machine is re-calibrated and will need to be re-entered.*

NOTE: *The Accessory weight will be temporarily stored in the Control System until calibration has been completed successfully.*

Refer to Table 6-3, Accessory Weights. Use the up and down analyzer keys to enter the accessory weight(s) (in lbs). When all the accessory weights are entered, press ENTER [ENTER]. The screen will read:

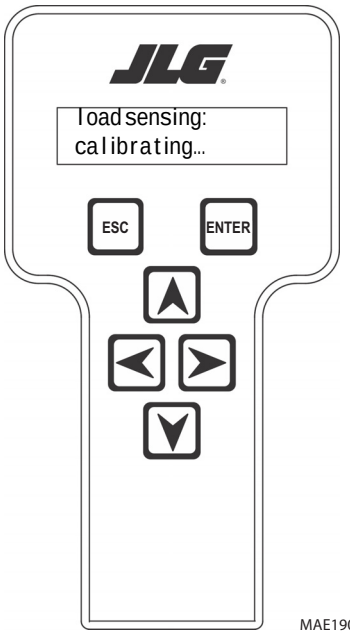


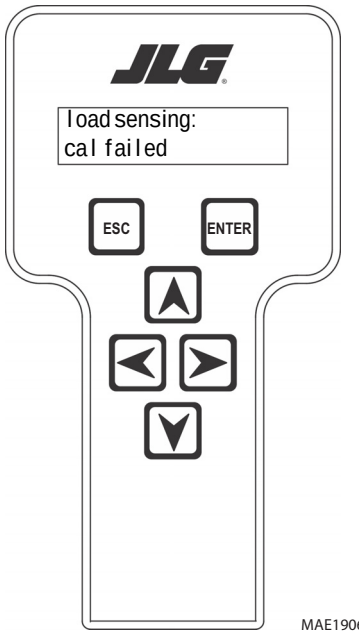
Table 6-3. Accessory Weights

Accessory	Weight
SkyWelder (stick welder)	70 lb (32 kg)
SkyWelder Prep	Prep only = 15 lb (7 kg) Full install = 70 lb (32 kg)
SkyCutter (plasma cutter)	70 lb (32 kg)
SkCutter / SkyWelder Combo	140 lb (64 kg)
Fire Extinguisher	45 lb (20 kg)
Overhead SoftTouch	80 lb (36 kg)
Work Surface	20 lb (9 kg)

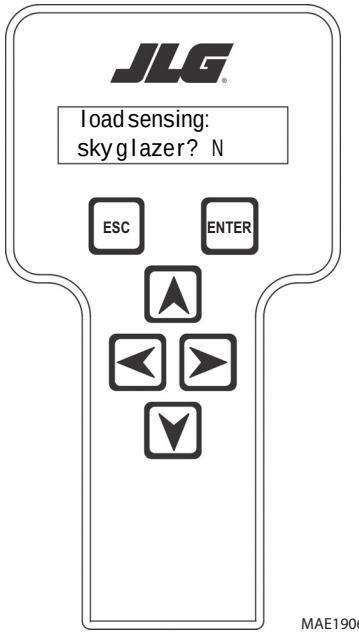
NOTE: *Not all Accessories are available on every JLG model. Some Accessory combinations are prohibited due to excessive weight and/or load restriction. If any installed JLG Accessories are labeled with weight decals but are not listed in the table above, include their weight when entering the ACC WEIGHT value.*

9. The control system will calculate the load cell readings and ensure it is greater than 130 lbs. (59 kg), but less than 575 lbs.(261 kg).

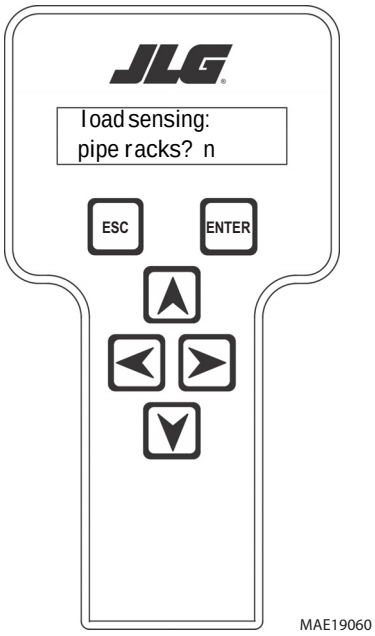
If the platform weight is not within the allowed range, the calibration attempt will be unsuccessful and the Analyzer will show the following:



10. Press ENTER (ENTER). The control system will ask for installed accessories. The screen will show the following:



11. Use the analyzer keys to select N for no or Y for yes. Press ENTER (ENTER). The screen will read:



12. Use the analyzer keys to select N for no or Y for yes. Press ENTER (ENTER). The control system will default to an estimate of unrestricted capacity, which can be adjusted if necessary. Refer to Table 6-4, SkyGlazier Capacity Reductions and Table 6-5, Pipe Rack Capacity Reductions.

The screen will read:

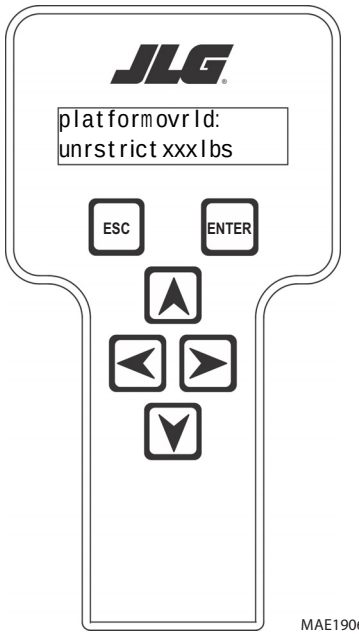


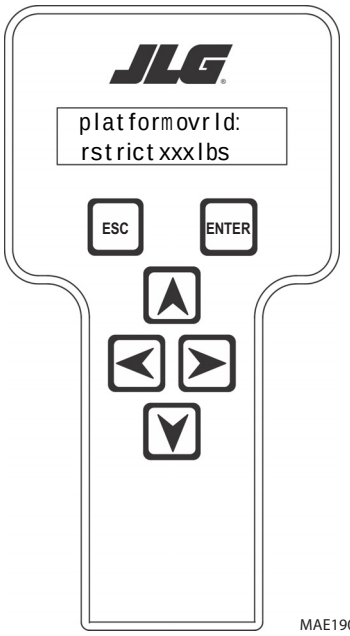
Table 6-4. SkyGlazier Capacity Reductions

Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	400 lb (181 kg)	n/a
600 lb (272 kg)	400 lb (181 kg)	n/a
750 lb (340 kg)	n/a	590 lb (268 kg)
1000 lb (454 kg)	n/a	750 lb (340 kg)
Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.		

Table 6-5. Pipe Rack Capacity Reductions

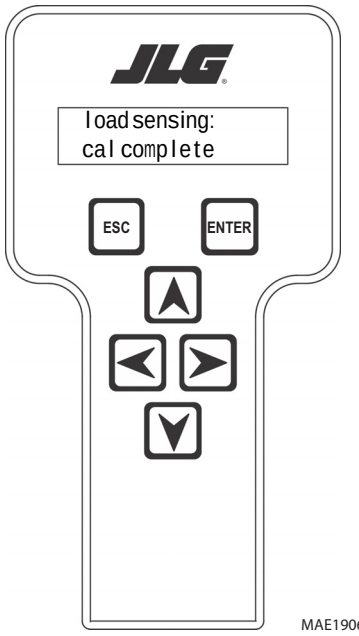
Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	n/a
550 lb (250 kg)	450 lb (204 kg)	n/a
600 lb (272 kg)	500 lb (227 kg)	n/a
750 lb (340 kg)	n/a	650 lb (295 kg)
1000 lb (454 kg)	n/a	900 lb (408 kg)
Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.		

13. Press ENTER (ENTER). The following screen will be displayed for restricted capacity, which can be adjusted if necessary. Refer to Table 6-4, SkyGlazier Capacity Reductions and Table 6-5, Pipe Rack Capacity Reductions.



14. Press ENTER 

. If calibration is successful, the screen will read:



MAE19060

Testing & Evaluation

Refer to Troubleshooting if the Load Sensing System fails to meet these guidelines.

1. Connect the JLG Analyzer.
2. Level the Platform. The platform should be approximately level for analysis, or the guidelines below will not be applicable. Level the platform from Ground Control (if necessary) to within ±5 degrees.
3. Observe the Empty Platform Weight. Proceed to the DIAGNOSTICS, PLTLOAD sub-menu and observe the measured platform load. All tools, debris, and customer-installed devices shall be removed during evaluation. Ideally, the PLTLOAD should be zero but can vary ±15lbs (± 7kg). Further, the reading should be stable and should not vary by more than ±2lbs (±1kg) (unless there is heavy influence from wind or vibration).
4. Use the Technician's Weight to Evaluate. The technician should enter the platform and record the PLTLOAD reading while standing in the center of the platform.
5. Confirm Control System Warnings and Interlocks. Using the keyswitch, select Platform Mode and power-up. Start the vehicle's engine and ensure that all controls are functional and the Load Sensing System's Overload Visual and Audible Warnings are not active. Simulate an Overload by unplugging the Shear Beam Load Cell. The Overload Visual Warning should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, and 2 seconds Off. With the engine running, all control should be prevented. Cycle the Platform EMS to stop the engine and then power-up again. The Overload Visual and Audible Warning should continue. Confirm that controls are responsive when using the Auxiliary Power Unit for emergency movement. Reconnect the Load Cell. The Overload Visual and Audible Warnings should cease and normal control function should return. Switch the vehicle's keyswitch to Ground Mode and repeat the above procedure. The Overload Visual Warning at the Ground Controls should flash, and the Audible Warning (at Platform and Ground) should sound for 5 seconds On, 2 seconds Off. However, the controls should remain functional when using the engine and the Auxiliary Power Unit (if the Control System's MACHINE SETUP, LOAD is set to "2=CUTOUT PLT". If set to "3=CUTOUT ALL", then Ground Controls will be prevented when using the engine as in the platform).
6. Confirm Control System Capacity Indication (optional for vehicles with Dual Capacity Ratings). For vehicles equipped with a Capacity Select switch on the Platform Console Box, it is necessary to examine an additional interface between the Load Sensing System and the Control System. Using the keyswitch, select Platform Mode and power-up. If necessary, put the boom in the transport position (completely stowed) and center the Jib Plus (if equipped). Place the Capacity Select switch in the unrestricted position and ensure that the proper indicator illuminates on the Platform Console Box. Plug the JLG Analyzer into the Analyzer connection and proceed to the DIAGNOSTICS, SYSTEM submenu. Ensure that the CAPACITY displays indicate OFF. Place the Capacity Select switch in the unrestricted position (if so equipped) and ensure that the proper indicator illuminates on the Platform Console Box (but does not flash). For vehicles with unrestricted capacity, ensure that the unrestricted CAPACITY display indicates ON but the restricted CAPACITY indicates OFF. For vehicles with restricted capacity, ensure that the unrestricted CAPACITY display indicates OFF but the restricted CAPACITY indicates ON.
7. Confirm Load Sensing System Performance with Calibrated Weights. Operate the vehicle from Ground Control and place the boom in the transport position (fully stowed) for safety. Plug the JLG Analyzer into the control system connection and proceed to the DIAGNOSTICS, PLTLOAD display. Place 500lbs (230kg) in the platform and ensure that PLTLOAD is with ±5% of the actual weight. For Dual Capacity vehicles, do the same for the alternate capacity (unrestricted or restricted).

Troubleshooting

The following tables are furnished to provide possible resolutions for common difficulties. Difficulties are classified as General, Calibration, Measurement Performance, and Host System Functionality.

Table 6-6. LSS Troubleshooting Chart

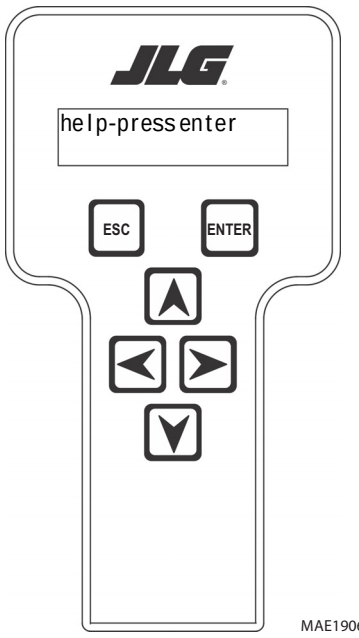
Difficulty	Possible Resolution
Empty Platform Weight (DIAGNOSTICS, PLATFORM LOAD) is not within ±15lbs (±7kg) of zero. or Platform Load readings (DIAGNOTICS, PLTLOAD) are unstable by more than ±2lbs (±1kg) (without the influence of vibration or wind). or There are large variations in Platform Load (DIAGNOSTICS, PLTLOAD) based on the location of the load. Tolerance to variations is 20lbs for an evaluation using the technician's weight, and ±5% of Rated Load when using calibrated weights.	The LSS System is unable to properly measure the platform weight. 1. The Load Cell is not properly plugged into the LSS Harness. It is possible poor electrical contact is made. 2. Wiring leading to the Load Cell is damaged. Carefully inspect sensor wiring where it passes through cable clamps for signs of damage. Inspect wiring where damage to the channel is apparent. 3. The Load Cell was not assembled properly during installation. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable. It is often helpful to apply slight downward pressure above the sensor and observe that its output increases (increasing force measurement; decreasing means the sensor is mounted upside-down). 4. The Load Cell is contaminated by debris or moisture. Examine the sensor's reading using the JLG Analyzer. Proceed to the DIAGNOSTICS, CELL, LOAD displays and determine if the readings are reasonable and stable (not changing by more than ±2lbs (±1kg) (without the influence of vibration or wind). Lack of measurement stability is a key indication of contamination. Unplug the connector and inspect for dirt or moisture. Look carefully into the female connector on the sensor's cordset for evidence of contamination. Debris should be brushed away with a soft bristle brush (do not introduce any cleaners as they will leave conductive residue). Moisture should be allowed to evaporate or accelerated with a heat-gun (use low heat and be carefully to not melt connector materials). Moisture intrusion into the molded portion of the connector (capillary action into the wire bundle) or the Shear Beam Load Cell itself will require replacement of the sensor. 5. The Load Cell has been mechanically damaged. If the Load Cell is physically deformed or has damage to the cover it should be replaced immediately. It is also possible to have invisible mechanical damage resulting from an extreme overload (>6000lbs [>2722kg]).
The Visual and Audible Overload Warnings fail to sound when platform is loaded beyond Rated Load, or when simulated by unplugging the Load Cell. Controls remain functional at Platform and Ground Control positions.	The Control System is failing to regard the overload signal from the LSS System, or the signal is shorted. 1. The Load Sensing System must be enabled within the Control System. Plug the JLG Analyzer into the Control System, enter the Access Level 1 password (33271), and examine the MACHINE SETUP, LOAD sub-menu. The selection "2=CUTOUT PLT" should be displayed (platform controls prevented during overload, ground controls remain operational). In country- or customer-specific circumstance, the selection "3=CUTOUT ALL" is used (platform and ground controls prevented during overload).
The Ground Audible Warning fails to sound, but the Platform Audible Warning sounds properly.	The Ground Alarm is missing or improperly installed. Verify that the device is mounted. Verify wiring from the Main Terminal Box and Ground Module.
Controls remain functional at the Ground Control position during an overload, or when simulated by unplugging the Load Cell. The Controls at the Platform Control position are prevented when using the engine, but not when using the Auxiliary Power Unit.	The JLG Control System is configured to prevent platform controls only in the event of overload. Alternately, the Host Control System can be configured to prevent ground and platform controls for country- or customer-specific circumstances. Using the JLG Analyzer, enter the Access Level 1 password (33271). Proceed to the MACHINE SETUP, LOAD sub-menu. Set this parameter to "2=CUTOUT PLT" to prevent platform controls in the event of overload. Set this parameter to "3=CUTOUT ALL" to prevent platform and ground controls in the event of overload.

6.4 RESETTING THE MSSO SYSTEM

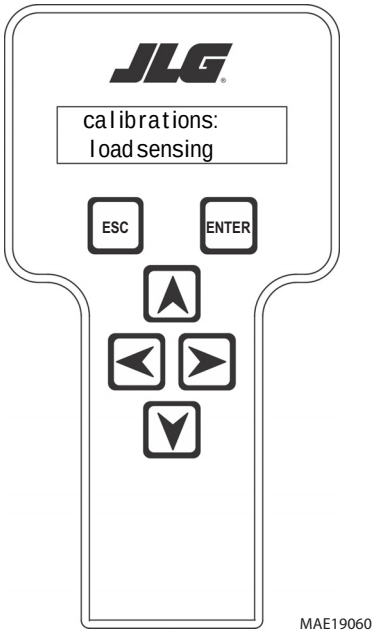
1. Use the following procedure to reset the MSSO system.
2. Position the Platform/Ground select switch to the desired position.
3. Plug the analyzer into the connector coming from the ground control module or from the platform console.

NOTE: *If performing the procedure from the platform console, the Emergency Stop switch on the ground console must also be pulled out.*

4. Pull out the Emergency Stop switch.
5. The analyzer screen should read:

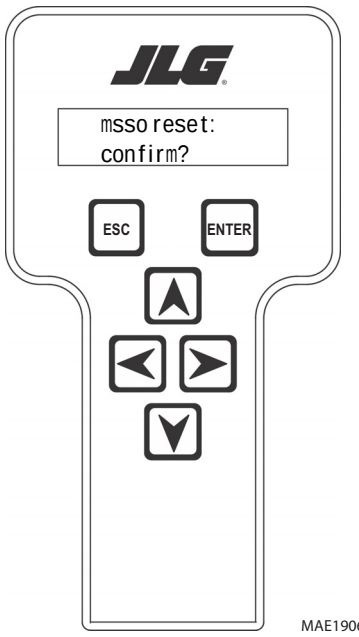


6. Use the arrow button to reach OPERATOR ACCESS. Press Enter  .
7. Enter the Access Code, 33271.
8. Use the right Arrow key to reach MENU: CALIBRATIONS. Press Enter  .
9. Use the arrow keys to reach the LOAD SENSING menu. The screen should read:



10. Press ENTER  .
11. Use the Down  arrow to reach MSSO RESET.

12. Press Enter (ENTER). The screen will read:



13. Press Enter (ENTER). The JLG Control System will reset an active 873 DTC and the MSSO System will be reset. Press Escape (ESC) to return to the CALIBRATIONS menu.

6.5 MACHINE CONFIGURATION PROGRAMMING INFORMATION

Table 6-7. Machine Configuration Programming Information (Software Version P1.1)

Configuration Digit	Number	Description	Default Number
NOTE: *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.*			
MODEL NUMBER: 1	1	**H800A**	**1**
MARKET: 2	**0** 1 2 3 4 5 6	**ANSI USA** ANSI EXPORT CSA CE AUSTRALIA JAPAN GB	**0**

Table 6-7. Machine Configuration Programming Information (Software Version P1.1)

Configuration Digit	Number	Description	Default Number
ENGINE: 3* *Engine selections vary depending on model selection.	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	**18**
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C (Tier 2)	
	8	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	9	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	10	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	11	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	12	DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)	
	13	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	14	PERKINS ECM	
	15	CAT ECM	
	16	DEUTZ EMR4: Deutz Engine Control Module (Tier 4 Final)	
	17	FORD DUAL FUEL	
	18	**KUBOTA D1305**	
FLYWHEEL TEETH: 4	0	133 TEETH: 133 flywheel teeth.	**2**
	1	110 TEETH: 110 flywheel teeth.	
	2	**23 Teeth.**	

Table 6-7. Machine Configuration Programming Information (Software Version P1.1)

Configuration Digit	Number	Description	Default Number
GLOW PLUG: 5	0 1 **2**	NO GLOW PLUGS: No glow plugs installed. AIR INTAKE: Glow plugs installed in the air intake on the manifold. **IN-CYLINDER: Glow plugs installed in each cylinder.**	**2**
STARTER LOCKOUT: 6	**0** 1	**DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.** ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	**0**
ENGINE SHUTDOWN: 7	**0** **1**	DISABLED: No engine shutdown. **ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.**	**1**
FUEL CUTOUT 8 * This menu item is only visible if non dual fuel engines are selected.	**0** 1 2	**RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached.** ONE RESTART: Engine allowed to be restarted once for 2 minutes when very low fuel level is reached. ENGINE STOP: Engine not able to restart when very low fuel level is reached.	**0**

Table 6-7. Machine Configuration Programming Information (Software Version P1.1)

Configuration Digit	Number	Description	Default Number
TILT: 9* *Certain market selections will limit tilt options and alter default setting. *Note: Any of the selections above will light the tilt lamp when a tilted condition occurs and will sound the platform alarm when the machine is also above elevation.*	1	5 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep.	**7**
	2	4 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep.	
	3	3 DEGREES: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also reduces drive speed to creep.	
	4	4 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	5	3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	6	5 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	7	**5 DEG + DRV CUT Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.**	
	8	4 DEG + DRV CUT Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
	9	3 DEG + DRV CUT Reduces the maximum speed of all boom functions to	
JIB: 10* *Only visible under certain model selections.	0	NO: No jib installed.	**1**
	1	**YES: Jib installed which has up and down movements only.**	
4 WHEEL STEER: 11* *Only visible under certain model selections.	**0**	**NO: No four-wheel steer installed.**	**0**
	1	YES: Four-wheel steer installed.	
ST TOUCH / SKYGUARD: 12	0	NONE: No soft touch or skyguard system installed.	**2**
	1	SOFT TOUCH - Soft touch only installed.	
	2	**SKYGUARD - Skyguard only installed.**	
	3	BOTH (CUTOUT) - Soft touch and Skyguard installed.	

Table 6-7. Machine Configuration Programming Information (Software Version P1.1)

Configuration Digit	Number	Description	Default Number
GEN SET/WELDER: 13	**0** 1	**NO: No generator installed.** BELT DRIVE: Belt driven setup.	**0**
H & T LIGHTS: 14	**0** 1	**NO: No head and tail lights installed.** YES: Head and tail lights installed.	**0**
LOAD SYSTEM: 15* *Certain market selectors will limit load system options or alter default settings.	**1** 2 3 4 5	**NO: No load sensor installed.** WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF). CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF). SPECIAL 1: Functions in creep, overload lamp lit, disables main telescope out & main lift up, platform alarm beeps (5 sec ON, 2 sec OFF).	**1**
LOAD SENSOR: 16* *Only visible if Load Sensor Menu selection is not 0 and under certain market selections. *Certain market selections will limit load sensor options.	0 1 **2**	1 ON ROTATOR: Use the on-board load sensor for all models except those which use the Leveling Platform Module. 4 UNDER PLATFORM: Use the EIM for load sensing. **SINGLE CELL: Single Cell, CANbus based sensor.**	**2**
FUNCTION CUTOUT: 17* *Only visible under certain market selections. *Certain market selections will limit function cutout options or alter default setting.	**0** 1 2 3	**NO: No drive cutout.** BOOM CUTOUT: Boom function cutout while driving above elevation. DRIVE CUTOUT: Drive & steer cutout above elevation. DRIVE CUT E&T: Drive & steer cutout above elevation and tilted.	**0**

Table 6-7. Machine Configuration Programming Information (Software Version P1.1)

Configuration Digit	Number	Description	Default Number
GROUND ALARM: 18* *Certain market selections will alter default setting.	0 1 2 **3**	NO: No ground alarm installed. DRIVE: Travel alarm sounds when the drive function is active (Option). DESCENT: Descent alarm sounds when lift down is active (Option). **MOTION: Motion alarm sounds when any function is active (Option).**	**3**
DRIVE: 19* *Only visible under certain model selections.	**0** 1 2	**4WD: Four wheel drive.** 2WD: Two wheel drive. 2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	**0**
DISPLAY UNITS: 20* *Certain market selections will alter default setting.	**0** 1	**IMPERIAL: DEG F , PSI, LBS.** METRIC: DEG C, KPA, KGS	**0**
DRIVE CONTROL: 21	0 1 **2**	NORMAL: Drive coils are energized from the Ground Module. PROPULSION: Drive coils are energized from the Propulsion Module. **ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.**	**2**
DRIVE PUMP 22 *Only visible on 600A, 600S, and 800S models, H800AJ	0 **1** 2 3	SAUER DANFOSS: Machine equipped with Sauer Danfoss drive pump **EATON: Machine equipped with Eaton drive pump** M46 - XXXX: Machine equipped with M46 - XXXX drive pump 830XXXXX: Machine equipped with 830XXXXX: drive pump	**1**
BOOM CONTROL: 23	0 **1**	NORMAL: Boom function coils are energized from the Ground Module. **ENHANCED: Boom function are energized from the Ground Module and the ground side of the drive coils and brought back to current feedback returns.**	**1**
FUNCTION SPEED KNOB 24	**0** 1	**YES: Machine is equipped with Function Speed Knob.** NO: Machine is equipped with Operation Speed Switch.	**0**

Table 6-7. Machine Configuration Programming Information (Software Version P1.1)

Configuration Digit	Number	Description	Default Number
CLEARSKY: 25	**0** 1	**NO: Clearsky (telematics) option is disabled.** YES: Clearsky (telematics) option is enabled.	**0**
CRIBBING OPTION: 26	**0** 1	**NO: Cribbing Option is disabled.** YES: Cribbing Option is enabled.	**0**
ALARM / HORN: 27	**0** 1	**SEPERATE: Separate alarm and horn.** COMBINED: Combination alarm / horn.	**0**
ALERT / BEACON: 28	**0** 1	**OFF FOR CREEP: Alert beacon will not flash while in Creep.** 20FPS FOR CREEP: Alert beacon will flash at 20FPS while in Creep.	**0**
TEMP CUTOUT: 29	**0** 1	**NO: Temp Cutout is Disabled** YES: Temp Cutout is Enabled	**0**
PLAT LVL OVR CUT: 30	**0** 1	**NO: Platform Level Override will always be functional.** YES: Platform Level Override will only be functional when In Transport.	**0**

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Table 6-8. H800A Machine Configuration Programming Settings (Software Version P1.1)

	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Market	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Engine	**18**	**18**	**18**	**18**	**18**	**18**	
Flywheel Teeth	**2**	**2**	**2**	**2**	**2**	**2**	
Glow Plugs	**2**	**2**	**2**	**2**	**2**	**2**	
Starter Lockout	**0**	**0**	**0**	**0**	**0**	**0**	
Engine Shutdown	**1**	**1**	**1**	**1**	**1**	**1**	
Fuel Cutout	**0**	**0**	**0**	**0**	**0**	**0**	
Tilt	1	1	1	X	X	1	
	2	2	2	X	2	2	
	3	3	3	X	3	3	
	4	4	4	4	4	4	
	5	5	5	5	5	5	
	6	6	6	X	X	6	
	7	**7**	**7**	X	X	**7**	
	8	8	8	**8**	**8**	8	
	9	9	9	9	9	9	
Jib	**1**	**1**	**1**	**1**	**1**	**1**	
4 Wheel Steer	**0**	**0**	**0**	**0**	**0**	**0**	
Soft Touch/Skyguard	**2**	**2**	**2**	**2**	**2**	**2**	
Gen Set / Welder	**0**	**0**	**0**	**0**	**0**	**0**	
	1	1	1	1	1	1	
Head & Taillights	**0**	**0**	**0**	**0**	**0**	**0**	
	1	1	1	1	1	1	
Load System	**1**	**1**	**1**	1	1	1	
	X	X	X	X	X	X	
	X	***3***	X	3	**3**	**3**	
	X	4	X	**4**	X	4	
	X	X	X	X	X	X	
Load Sensor	X	X	X	X	X	X	
	X	X	X	X	X	X	
	2	**2**	**2**	**2**	**2**	**2**	
Function Cutout	**0**	**0**	**0**	0	**0**	**0**	
	X	1	1	**1**	1	1	
	2	2	2	X	2	2	
	X	X	X	X	X	X	
Ground Alarm	0	0	0	0	0	0	
	1	1	1	1	1	1	
	2	2	2	2	2	2	
	3	**3**	**3**	**3**	**3**	**3**	
Drive Type	**0**	**0**	**0**	**0**	**0**	**0**	

Table 6-8. H800A Machine Configuration Programming Settings (Software Version P1.1)

	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Display Units	**0**	**0**	0	0	0	0	
	1	1	**1**	**1**	**1**	**1**	
Drive Control	**2**	**2**	**2**	**2**	**2**	**2**	
Drive Pump	**1**	**1**	**1**	**1**	**1**	**1**	
Boom Control	**1**	**1**	**1**	**1**	**1**	**1**	
Function Speed Knob	**0**	**0**	**0**	**0**	**0**	**0**	
Clearsky	**0**	**0**	**0**	**0**	**0**	**0**	
	1	1	1	1	1	1	
Cribbing Option	**0**	**0**	**0**	**0**	**0**	**0**	
	1	1	1	1	1	1	
Alarm / Horn	**0**	**0**	**0**	**0**	**0**	**0**	
	1	1	1	1	1	1	
Alert Beacon	**0**	**0**	**0**	**0**	**0**	**0**	
	1	1	1	1	1	1	
Temp Cutout	**0**	**0**	**0**	**0**	**0**	**0**	
	X	1	X	1	X	X	
Plat Lvl Ovr Cut	**0**	**0**	**0**	**0**	**0**	**0**	
	1	1	1	1	1	1	

BOLD TEXT indicates the default setting. Plain text indicates another available selection. ***ITALIC TEXT*** indicates the default when option is factory installed. SHADED CELLS indicate hidden menu or selection.

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6.6 MACHINE PERSONALITY SETTINGS AND FUNCTION SPEEDS

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

Table 6-9. Machine Personality Settings

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PERSONALITY ADJUSTMENT	RANGE	DEFAULTS
DRIVE:	ACCELeration	0.0 to 5.0s	3.5
	DECELeration	0.0 to 3.0s	2
	FORward MINimum speed	1 to 35%	30
	FORward MAXimum speed	1 to 100%	75
	REVerse MINimum speed	1 to 35%	30
	REVerse MAXimum speed	1 to 100%	75
	ELEVATED MAXimum speed	1 to 100%	34
	CREEP MAXimum speed	1 to 90%	32
STEER:	MAXimum speed	1 to 100%	100
MAIN LIFT:	ACCELeration	0.0 to 5.0s	2.5
	DECELeration	0.0 to 3.0s	1.0
	MINimum Up speed	1 to 60%	40
	MAXimum Up speed	1 to 100%	80
	CREEP maximum Up speed	1 to 65%	53
	MINimum Down speed	1 to 60%	40
	MAXimum Down speed	1 to 100%	85
	CREEP maximum Down speed	1 to 75%	53
TOWER LIFT:	ACCELeration	0.0 to 5.0s	2.2
	DECELeration	0.0 to 3.0s	0.7
	MINimum UP speed	1 to 60%	35
	MAXimum UP speed	1 to 100%	87
	MINimum DOWN speed	1 to 60%	35
	MAXimum DOWN speed	1 to 100%	81

Table 6-9. Machine Personality Settings

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PERSONALITY ADJUSTMENT	RANGE	DEFAULTS
SWING	ACCELeration	0.0 to 5.0s	2.8
	DECELeration	0.0 to 3.0s	1.5
	MINimum LEFT speed	1 to 50%	40
	MAXimum LEFT speed	1 to 100%	69
	CREEP maximum LEFT speed	1 to 65%	60
	MINimum RIGHT speed	1 to 50%	55
	MAXimum RIGHT speed	1 to 100%	69
	CREEP maximum RIGHT speed	1 to 65%	58
MAIN TELESCOPE:	ACCELeration	0.0 to 5.0s	2.5
	DECELeration	0.0 to 3.0s	1.0
	MINimum IN speed	1 to 65%	40
	MAXimum IN speed	1 to 100%	75
	MINimum OUT speed	1 to 65%	40
	MAXimum OUT speed	1 to 100%	75
TELESCOPE TOWER:	ACCELeration	0.0 to 5.0s	1.0
	DECELeration	0.0 to 3.0s	0.5
	MINimum IN speed	1 to 65%	35
	MAXimum IN speed	1 to 100%	70
	MINimum OUT speed	1 to 65%	50
	MAXimum OUT speed	1 to 100%	85
PLATFORM LEVEL:	ACCELeration	0.0 to 5.0s	1.5
	DECELeration	0.0 to 3.0s	0.0
	MINimum UP speed	1 to 65%	26
	MAXimum UP speed	1 to 100%	40
	MINimum DOWN speed	1 to 65%	25
	MAXimum DOWN speed	1 to 100%	40
	Medium Speed	0.01 to 1.00	0.60
PLATFORM ROTATE:	ACCELeration	0.0 to 5.0s	1.5
	DECELeration	0.0 to 3.0s	0.0
	MINimum LEFT speed	1 to 100%	24
	MAXimum LEFT speed	1 to 100%	35
	MINimum RIGHT speed	1 to 100%	24
	MAXimum RIGHT speed	1 to 100%	35

Table 6-9. Machine Personality Settings

SUBMENU (DISPLAYED ON ANALYZER 1ST LINE)	PERSONALITY ADJUSTMENT	RANGE	DEFAULTS
JIB LIFT	Lift ACCELeration	0.0 to 5.0s	3.5
	Lift DECELeration	0.0 to 3.0s	0.5
	MINimum UP speed	1 to 65%	26
	MAXimum UP speed	1 to 100%	42
	MINimum down	1 to 65%	26
	Max Down	1 to 100%	35
GROUND MODE	Tower LIFT UP speed	1 to 100%	86
	Tower LIFT DOWN speed	1 to 100%	80
	Main LIFT UP speed	1 to 100%	79
	Main LIFT DOWN speed	1 to 100%	84
	SWING speed	1 to 100%	68
	Main TELEscope speed	1 to 100%	74
	Tower TELEscope speed	1 to 100%	69
	PLATFORM ROTATE speed	1 to 100%	34
	PLATFORM LEVEL speed	1 to 100%	39
	JIB LIFT speed	1 to 100%	34
Note: Ground Mode speed are automatically limited to being lower than platform speed for a given function.			

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6.7 MACHINE ORIENTATION WHEN SETTING FUNCTION SPEEDS

Tower Lift: Main Boom Horizontal, Telescoped In. Tower Lift Up, Record Time. Tower Lift Down, Record Time.

Tower Telescope: Tower Lift Fully Elevated, Main Boom Horizontal, Telescoped In. Tower Tele Out, Record Time. Tower Tele In, Record Time.

Lift: Tower Lift Fully Elevated, Tower Telescope Fully Extended, Main Telescope Fully Retracted.

Swing: Boom at Full Elevation. Telescope Retracted. Swing the Turntable off center and stop. Swing the opposite direction and start the test when the turntable is centered up. This eliminates ramp up and down on the controller affecting times.

Telescope: Boom at Full Elevation; Telescope Retracted; Telescope Out, Record Time. Telescope In, Record Time.

Drive (Forward/Reverse): Test should be done on a smooth level surface. Drive Select Switch should be set to high speed. Start approximately 25 ft. (7.62 m) from the starting point so that the unit is at maximum speed when starting the test. Results should be recorded for a 200 ft. (60.96 m) course. Drive Forward, Record Time. Drive Reverse, Record Time.

Drive (Above Horizontal): Test should be done on a smooth, level surface. Drive Select Switch should be set to Low Engine, Low Drive. The Platform Speed Control Knob should be positioned to Creep Speed. This simulates machine speed when the boom is above horizontal. Results should be recorded for a 50 ft. (15.2 m) course. Drive Forward, Record Time. Drive Reverse, Record Time.

Platform Rotate: Platform level and completely rotated one direction. Rotate the opposite direction, Record Time. Rotate the other direction, Record Time.

Articulating Jib: Platform level and centered with the boom. Start with the Jib down. Jib Up, Record Time. Jib Down, Record Time.

Test Notes

1. Stop watch should be started with the function, not with the controller or switch.
2. Drive test results reflect 15x19.5 or 18x19.5 tires, pneumatic or foam filled.
3. All speed tests are run from the platform. These speeds do not reflect the ground control operation.
4. The platform speed knob control must be at full speed (turned clockwise completely).
5. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).
6. Some flow control functions may not work with the speed knob clicked into the creep position.

Table 6-10. Function Speeds

Function	Speed Tolerance Hybrid Mode (In Seconds)	Speed Tolerance Electric Mode (In Seconds)
Main Lift Up	45 - 50	45 - 50
Main Lift Down	45 - 50	45 - 50
Swing Right & Left	79 - 101	79 - 101
NOTE: *No more than 10% difference between swing left and swing right.*		
Main Telescope Out	30-40	30-40
Main Telescope In	24-34	24-34
Platform Rotate Right & Left	19 - 30	19 - 30
NOTE: *No more that 15% difference between rotator left and rotator right.*		
Jib Up	20-30	20-30
Jib Down	30-40	30-40
Tower Lift Up	60 - 75	60 - 75
Tower Lift Down	44 - 53	44 - 53
Tower Telescope Out	24 - 32	24 - 32
Tower Telescope In	15-25	15-25
Drive (4WD) Forward & Reverse	33-45 (FWD) 115-125 (Rev)	46-63 (FWD) 179-189 (Rev)
Drive Horizontal Above Elevation (4WD) Forward & Reverse (CE)	122 Min	122 Min
Drive Horizontal Above Elevation 4WD Forward & Reverse (ANSI)	122 Min	122 Min

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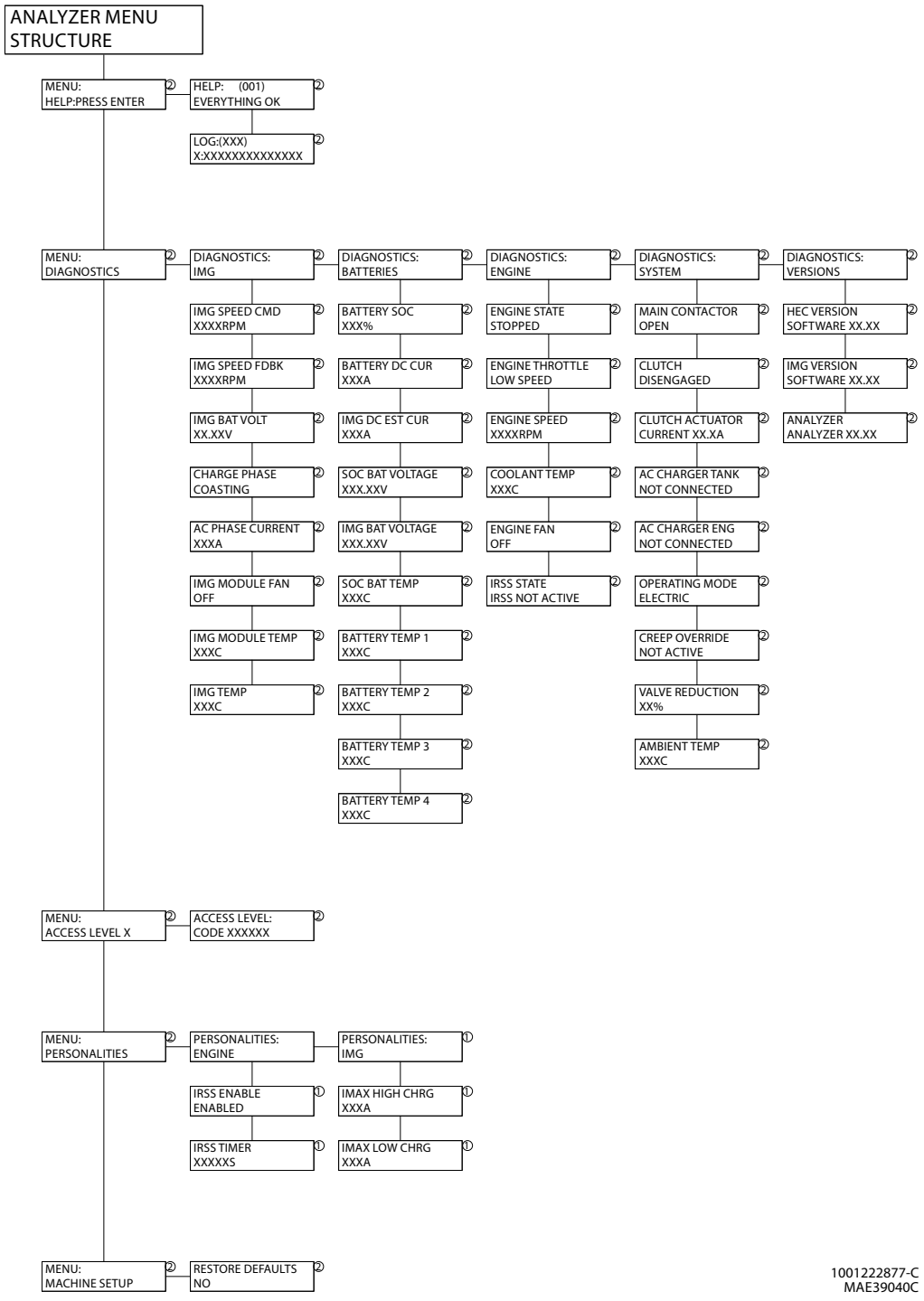


Figure 6-6. Analyzer Flow Chart (Software Version P1.1)

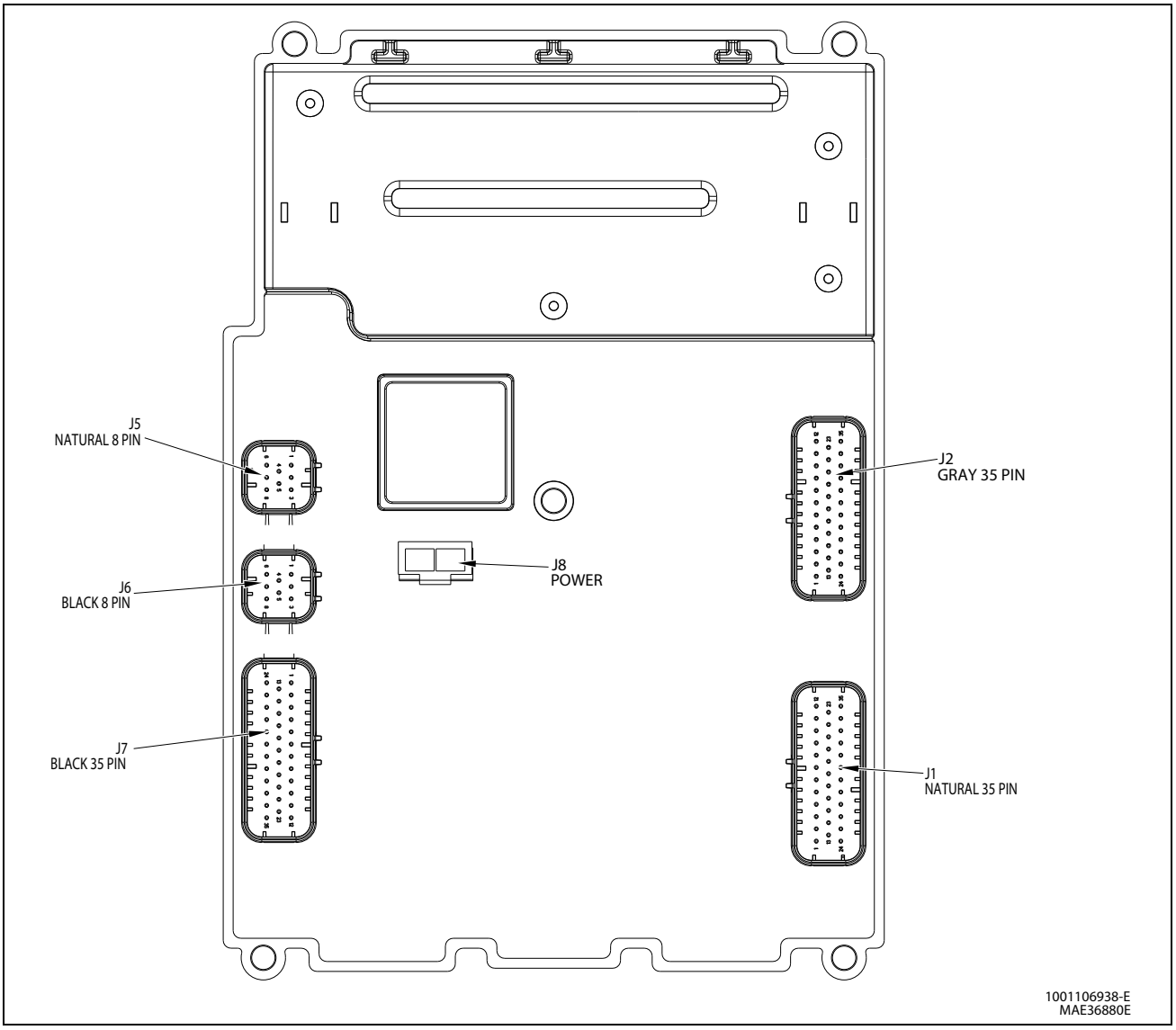


Figure 6-7. Platform Control Module

Connector	Pin	Assignment	Function
J1 NATURAL	1	TOWER LIFT UP	DIGITAL INPUT
	2	TOWER LIFT DOWN	DIGITAL INPUT
	3	TOWER TELESCOPE IN	DIGITAL INPUT
	4	TOWER TELESCOPE OUT	DIGITAL INPUT
	5	MAIN TELESCOPE IN	DIGITAL INPUT
	6	MAIN TELESCOPE OUT	DIGITAL INPUT
	7	PLATFORM ROTATE RIGHT	DIGITAL INPUT
	8	PLATFORM ROTATE LEFT	DIGITAL INPUT
	9	PLATFORM LEVEL UP	DIGITAL INPUT
	10	PLATFORM LEVEL DOWN	DIGITAL INPUT
	11	JIB UP	DIGITAL INPUT
	12	JIB DOWN	DIGITAL INPUT
	13	SPEED PUMP POTENTIOMETER GROUND	GROUND
	14	ENGINE START	DIGITAL INPUT
	15	ELEC MODE	DIGITAL INPUT
	16	CRAB STEER SELECT	DIGITAL INPUT
	17	COORDINATED STEER SELECT	DIGITAL INPUT
	18	SWITCH POWER	BATTERY VOLTAGE
	19	UNALLOCATED	DIGITAL INPUT
	20	UNALLOCATED	DIGITAL INPUT
	21	UNALLOCATED	DIGITAL INPUT
	22	DRIVE ORIENTATION SYSTEM FEATURE ENABLE	DIGITAL INPUT
	23	SKYGUARD INPUT #2	DIGITAL INPUT
	24	UNALLOCATED	DIGITAL INPUT
	25	UNALLOCATED	DIGITAL INPUT
	26	UNALLOCATED	DIGITAL INPUT
	27	TWO SPEED VALVE (HIGHENGINE)	DIGITAL INPUT
	28	TORQUE MODE	DIGITAL INPUT
	29	SOFT TOUCH OVER RIDE	DIGITAL INPUT
	30	HEAD/TAIL LIGHT	DIGITAL INPUT
	31	HORN	DIGITAL INPUT
	32	CREEP MODE	DIGITAL INPUT
	33	UNALLOCATED	DIGITAL INPUT
	34	SPEED PUMP POTENTIOMETER REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	35	SPEED PUMP POTENTIOMETER	DIGITAL INPUT

Connector	Pin	Assignment	Function
J5 NATURAL	1	LIFT/SWING JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	LIFT CENTER TAP	INPUT
	3	LIFT SIGNAL	INPUT
	4	SWING SIGNAL	INPUT
	5	SWING CENTER TAP	INPUT
	6	NOT CONNECTED	INPUT
	7	LIFT/SWING JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND

Connector	Pin	Assignment	Function
J6 BLACK	1	DRIVE/STEER JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	DRIVE CENTER TAP	INPUT
	3	DRIVE SIGNAL	INPUT
	4	STEER SIGNAL	INPUT
	5	STEER LEFT	INPUT
	6	STEER RIGHT	INPUT
	7	DRIVE/STEER JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND

Connector	Pin	Assignment	Function
J8	1	MODULE GROUND	GROUND
	2	MODULE POWER	BATTERY VOLTAGE

Connector	Pin	Assignment	Function
J2 GRAY	1	UNALLOCATED	DIGITAL INPUT
	2	UNALLOCATED	DIGITAL INPUT
	3	BATTERY VOLTAGE	BATTERY VOLTAGE
	4	DRIVE ORIENTATION SYSTEM OVERRIDE SWITCH	HS DIGITAL INPUT
	5	UNALLOCATED	LAMP OUTPUT
	6	CHASSIS TILTED INDICATOR	LAMP OUTPUT
	7	FUNCTION ENABLE INDICATOR	LAMP OUTPUT
	8	VEHICLE SYSTEM DISTRESS INDICATOR	LAMP OUTPUT
	9	CREEP SPEED INDICATOR	LAMP OUTPUT
	10	UNALLOCATED	LAMP OUTPUT
	11	PLATFORM OVER LOADED INDICATOR	LAMP OUTPUT
	12	UNALLOCATED	LAMP OUTPUT
	13	UNALLOCATED	LAMP OUTPUT
	14	DRIVE ORIENTATION SYSTEM INDICATOR	LAMP OUTPUT
	15	GENERATOR ON INDICATOR	LAMP OUTPUT
	16	SOFT TOUCH TRIGGERED INDICATOR	LAMP OUTPUT
	17	GLOW PLUG ENGAGED INDICATOR	LAMP OUTPUT
	18	LAMP RETURN	GROUND
	19	LOW FUEL	LAMP OUTPUT
	20	UPRIGHT TILTED INDICATOR	LAMP OUTPUT
	21	BATTERY SOC	LAMP OUTPUT
	22	BATTERY SOC	LAMP OUTPUT
	23	BATTERY SOC	LAMP OUTPUT
	24	BATTERY SOC	LAMP OUTPUT
	25	BATTERY LEVEL INDICATORS RETURN	GROUND
	26	ANALYZER POWER	ANALYZER POWER
	27	ANALYZER GROUND	ANALYZER GROUND
	28	ANALYZER RX	ANALYZER RX
	29	ANALYZER TX	ANALYZER TX
	30	BATTERY VOLTAGE	BATTERY VOLTAGE
	31	BATTERY VOLTAGE	BATTERY VOLTAGE
	32	BATTERY VOLTAGE	BATTERY VOLTAGE
	33	BATTERY VOLTAGE	BATTERY VOLTAGE
	34	SWITCH POWER	BATTERY VOLTAGE
	35	FULL BATTERY SOC INDICATOR	LAMP OUTPUT

Connector	Pin	Assignment	Function
J7 BLACK	1	GROUND MODE	GROUND MODE
	2	PLATFORM EMS	PLATFORM EMS
	3	PLATFORM EMS TO GROUND MODULE	PLATFORM MODE
	4	FOOTSWITCH (FUNCTIONENABLESWITCH) POWER	BATTERY VOLTAGE
	5	GENERATOR SWITCH POWER	BATTERY VOLTAGE
	6	UNALLOCATED	BATTERY VOLTAGE
	7	LSS	BATTERY VOLTAGE
	8	FOOTSWITCH SIGNAL	DIGITAL INPUT
	9	GENERATOR ON SIGNAL	DIGITAL INPUT
	10	+7 REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	11	UNALLOCATED	ANALOG INPUT
	12	UNALLOCATED	ANALOG INPUT
	13	UNALLOCATED	ANALOG INPUT
	14	GROUND RETURN	GROUND
	15	+7 REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	16	UNALLOCATED	GROUND
	17	UNALLOCATED	HSDIGITALINPUT
	18	SKYGUARD INPUT #1	HS DIGITAL INPUT
	19	PLATFORM ALARM	LAM POUTPUT
	20	ALARM RETURN	GROUND
	21	PLATFORM LEVEL UP	ME DIGITAL OUTPUT
	22	PLATFORM LEVEL DOWN	ME DIGITAL OUTPUT
	23	GROUND RETURN	GROUND
	24	GROUND RETURN	GROUND
	25	JIB UP	ME DIGITAL OUTPUT
	26	JIB DOWN	ME DIGITAL OUTPUT
	27	UNALLOCATED	ME DIGITAL OUTPUT
	28	UNALLOCATED	ME DIGITAL OUTPUT
	29	GROUND RETURN	GROUND
	30	CAN LOW (CAN 1)	CAN LOW
	31	CAN HIGH (CAN 1)	CAN HIGH
	32	UNALLOCATED (CAN 1)	CAN SHIELD
	33	PLATFORM ROTATE LEFT	ME DIGITAL OUTPUT
	34	PLATFORM ROTATE RIGHT	ME DIGITAL OUTPUT
	35	GROUND RETURN	GROUND

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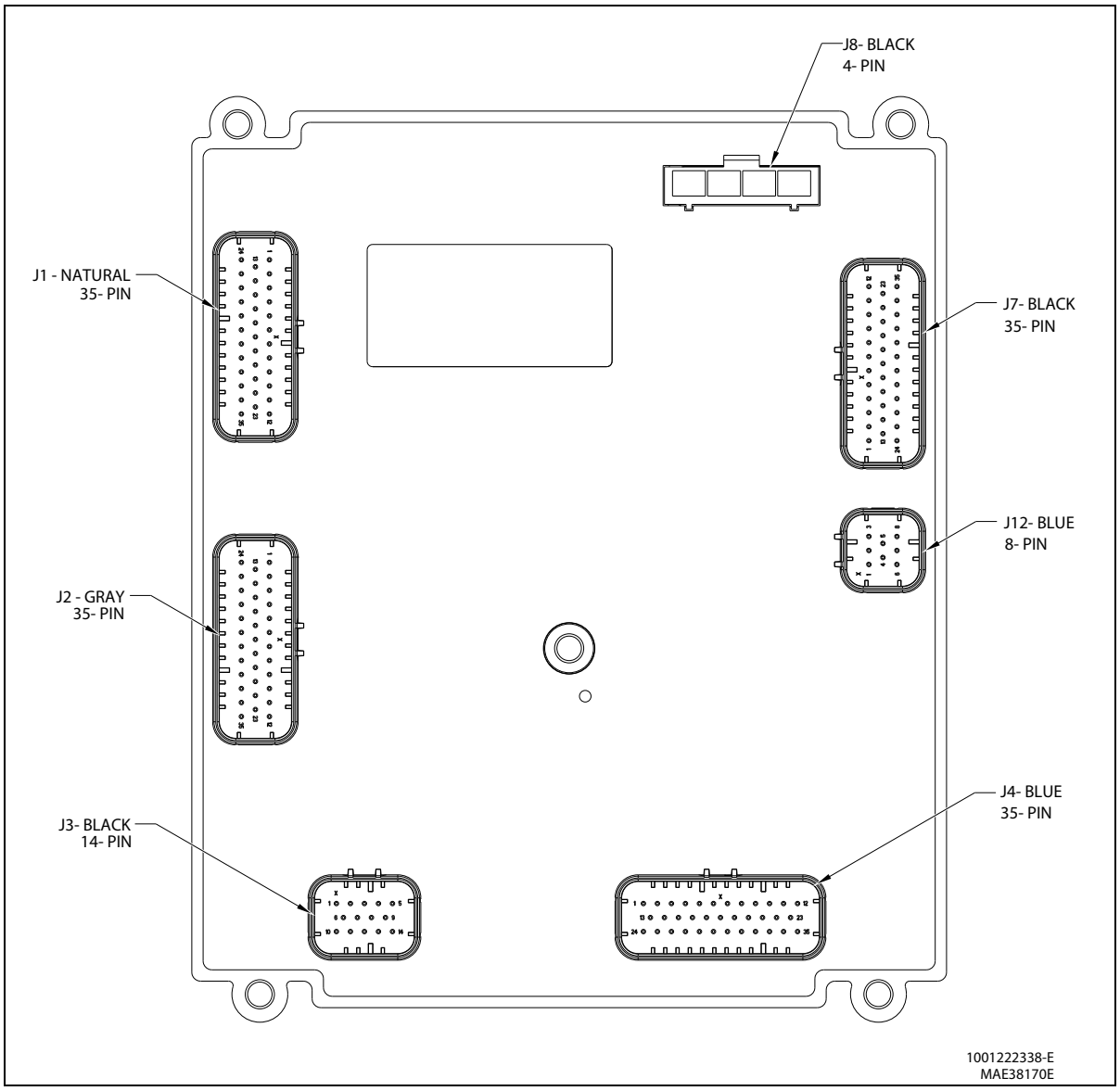


Figure 6-8. Ground Control Module

Connector	Pin	Function	Type	
J1 (Natural)	1	THROTTLEACTUATOR(2-SPEED)RELAY	DIGITAL	OUTPUT
	2	FUELPUMPRELAY	DIGITAL	OUTPUT
	3	DRIVEFORWARDVALVE	DIGITAL	OUTPUT
	4	ENGINESPEEDSENSORGROUND	GROUND	INPUT
	5	PARKBRAKE/2-SPEEDVALVESGROUND	GROUND	INPUT
	6	DRIVEREVERSEVALVE	DIGITAL	OUTPUT
	7	RUN/STOPACTUATORRELAY	DIGITAL	OUTPUT
	8	COOLANTTEMPSENSORGROUND	GROUND	INPUT
	9	GLOWPLUG/STARTERGROUND	GROUND	INPUT
	10	RUN/STOPACTUATORHOLDSIGNAL	DIGITAL	OUTPUT
	11	ENGINESTARTERSOLENOIDRELAY	DIGITAL	OUTPUT
	12	GLOWPLUGsRELAY	DIGITAL	OUTPUT
	13	UNUSED	DIGITAL	OUTPUT
	14	ENGINECOOLANTTEMPERATURESENSOR	ANALOG	INPUT
	15	ENGINEOILPRESSURESWITCH	ANALOG	INPUT
	16	ENGINESPEEDSENSOR	FREQUENCY	INPUT
	17	RUN/STOP/FUELPUMPRELAYGROUND	GROUND	INPUT
	18	SKYPOWER(OPTION)GROUND	GROUND	INPUT
	19	FANRELAYGROUND(ENGINE/IMG/IMGCONTROLLER	GROUND	INPUT
	20	2SPEEDVALVE	DIGITAL	OUTPUT
	21	UNUSED	DIGITAL	INPUT
	22	SKYPOWER(OPTION)EXCITATION	DIGITAL	OUTPUT
	23	PRARKINGBRAKEVALVE	DIGITAL	OUTPUT
	24	UNUSED	N/C	N/C
	25	UNUSED(RESERVEDFORRS-485HIGH)	SERIAL	I/O
	26	UNUSED(RESERVEDFORRS-485LOW)	SERIAL	I/O
	27	THROTTLEACTUATOR(2-SPEED)/HEAD/TAILLIGHTRELAYGROUND	GROUND	INPUT
	28	ANALYZERPOWER	VOLTAGE	OUTPUT
	29	ANALYZERRS-232RX	SERIAL	INPUT
	30	ANALYZERRS-232TX	SERIAL	OUTPUT
	31	ANALYZERGROUND	GROUND	INPUT
	32	ENGINEALTERNATOREXCITATION	DIGITAL	OUTPUT
	33	THROTTLEACTUTOR(2-SPEED)GROUND	GROUND	INPUT
	34	UNUSED	DIGITAL	INPUT
	35	UNUSED	DIGITAL	INPUT

Connector	Pin	Function	Type	
J2 (Gray)	1	STEER DUMP VALVE	DIGITAL	OUTPUT
	2	GROUND ALARM	DIGITAL	OUTPUT
	3	TOWER TELESCOPE IN VALVE	DIGITAL	OUTPUT
	4	MAIN TELESCOPE IN VALVE	DIGITAL	OUTPUT
	5	UNUSED	DIGITAL	OUTPUT
	6	FUEL LEVEL SENSOR GROUND	GROUND	INPUT
	7	UNUSED	DIGITAL	OUTPUT
	8	RIGHT FRONT STEERVALVE	DIGITAL	OUTPUT
	9	REAR RIGHT STEER VALVE	DIGITAL	OUTPUT
	10	UNUSED	DIGITAL	OUTPUT
	11	MAIN LIFTUP VALVE	DIGITAL	OUTPUT
	12	UNUSED	DIGITAL	OUTPUT
	13	MAIN DUMP VALVE	DIGITAL	OUTPUT
	14	ALARM/STEERDUMPGROUND	GROUND	INPUT
	15	TOWERTELESCOPEOUTVALVE	DIGITAL	OUTPUT
	16	MAINTELESCOPEOUTVALVE	DIGITAL	OUTPUT
	17	MAINDUMP/TELE/LEFT/TOWERVALVESGROUND	GROUND	INPUT
	18	UNUSED	GROUND	INPUT
	19	LEFTFRONT STEER VALVE	DIGITAL	OUTPUT
	20	REAR LEFT STEERVALVE	DIGITAL	OUTPUT
	21	UNUSED	DIGITAL	OUTPUT
	22	MAIN LIFT DOWNVALVE	DIGITAL	OUTPUT
	23	UNUSED	DIGITAL	OUTPUT
	24	UNUSED	DIGITAL	INPUT
	25	FUELSENSOR	ANALOG	INPUT
	26	HEAD/TAILLIGHTENABLERELAY	DIGITAL	OUTPUT
	27	HORN/GROUNDALARMOUTPUT	DIGITAL	OUTPUT
	28	MSSOCONFIGUREATIONPOWER	GROUND	INPUT
	29	UNUSED	GROUND	INPUT
	30	STEER/STEERDUMPVALVESGROUND	GROUND	INPUT
	31	FLOWCONTROLVALVE	DIGITAL	OUTPUT
	32	TOWERLIFTDOWNVALVE	DIGITAL	OUTPUT
	33	TOWERLIFTUPVALVE	DIGITAL	OUTPUT
	34	SWINGLEFTVALVE	DIGITAL	OUTPUT
	35	SWINGRIGHTVALVE	DIGITAL	OUTPUT

Connector	Pin	Function	Type	
J4 (Blue)	1	CRIBBINGENABLEDINDICATOR	DIGITAL	OUTPUT
	2	UNRESTRICTEDINDICATOR	DIGITAL	OUTPUT
	3	GLOWPLUGINDICATOR	DIGITAL	OUTPUT
	4	ENGINESTARTSWITCH	DIGITAL	INPUT
	5	PLATFORMLEVELDOWNSWITCH	DIGITAL	INPUT
	6	PLATFORMROTATELEFTSWITCH	DIGITAL	INPUT
	7	MAINTELESCOPEINSWITCH	DIGITAL	INPUT
	8	JIBLIFTDOWNSWITCH	DIGITAL	INPUT
	9	UNUSED	DIGITAL	INPUT
	10	TOWERLIFTUPSWITCH	DIGITAL	INPUT
	11	TOWERTELEINSWITCH	DIGITAL	INPUT
	12	UNUSED	DIGITAL	OUTPUT
	13	LOWFUELINDICATOR	DIGITAL	OUTPUT
	14	PLATFORMOVERLOADEDINDICATOR	DIGITAL	OUTPUT
	15	BOOMMALFUNCTIONINDICATOR	DIGITAL	OUTPUT
	16	EMERGENCYDESCENT/FUNCTIONENABLESWITCH	DIGITAL	INPUT
	17	PLATFORMLEVELUPSWITCH	DIGITAL	INPUT
	18	PLATFORMROTATERIGHTSWITCH	DIGITAL	INPUT
	19	JIBLIFTUPSWITCH	DIGITAL	INPUT
	20	UNUSED	DIGITAL	INPUT
	21	TOWERLIFTDOWNSWITCH	DIGITAL	INPUT
	22	TOWERTELEOUTSWITCH	DIGITAL	INPUT
	23	MAINLIFTUPSWITCH	DIGITAL	INPUT
	24	UNUSED	VBAT	OUTPUT
	25	SWITCHESPOWER	VBAT	OUTPUT
	26	BATTERYLOW/NOTCHARGINGINDICATOR	DIGITAL	OUTPUT
	27	RESTRICTEDINDICATOR	DIGITAL	OUTPUT
	28	CHECKENGINEINDICATOR	DIGITAL	OUTPUT
	29	SYSTEMDISTRESSINDICATOR	DIGITAL	OUTPUT
	30	MAINTELESCOPEOUTSWITCH	DIGITAL	INPUT
	31	INDICATORSGROUND	GROUND	INPUT
	32	UNUSED	GROUND	INPUT
	33	MAINLIFTDOWNSWITCH	DIGITAL	INPUT
	34	SWINGLEFTSWITCH	DIGITAL	INPUT
	35	SWINGRIGHTSWITCH	DIGITAL	INPUT

Connector	Pin	Function	Type	
J7 (Black)	1	PLATFORMEMS	DIGITAL	INPUT
	2	PLATFORMMODE	DIGITAL	INPUT
	3	GROUNDMODE	DIGITAL	INPUT
	4	CAPACITYANGLESWITCH	ANALOG	INPUT
	5	UNUSED	VOLTAGE	OUTPUT
	6	UNUSED	TERM	I/O
	7	CAPACITYLENGTHSWITCH	ANALOG	INPUT
	8	UNUSED	ANALOG	INPUT
	9	UNUSED	GROUND	INPUT
	10	UNUSED	GROUND	INPUT
	11	ELEVATIONSWITCH	DIGITAL	INPUT
	12	UNUSED	DIGITAL	INPUT
	13	CAN1HIGH	SERIAL	I/O
	14	GROUNDMODEPOWERTOPLATFORM	DIGITAL	INPUT
	15	FOOTSWITCH	DIGITAL	INPUT
	16	CAPACITYANGLESWITCHPOWER	VOLTAGE	OUTPUT
	17	UNUSED	TERM	I/O
	18	UNUSED	GROUND	INPUT
	19	TOWERSWTICHESGROUND	GROUND	INPUT
	20	UNUSED	ANALOG	INPUT
	21	TOWERTELESCOPERETRACTEDSWITCH	DIGITAL	INPUT
	22	TOWERLIFTSWITCH	DIGITAL	INPUT
	23	JUMPER	DIGITAL	INPUT
	24	CAN1LOW	SERIAL	I/O
	25	UNUSED	GROUND	INPUT
	26	CAPACITYLENGHTSWITCHPOWER	VOLTAGE	OUTPUT
	27	UNUSED	VOLTAGE	OUTPUT
	28	UNUSED	GROUND	INPUT
	29	BOOMELEVATIONSWITCHPOWER	VBAT	OUTPUT
	30	JUMPERPOWER	VBAT	OUTPUT
	31	UNUSED	VBAT	OUTPUT
	32	UNUSED	VBAT	OUTPUT
	33	TOWERTELESCOPERETRACTEDSWTICHPOWER	VBAT	OUTPUT
	34	TOWERLIFTSWITCHPOWER	VBAT	OUTPUT
	35	DOSSWITCH	DIGITAL	INPUT

Connector	Pin	Function	Type	
J3 (Black)	1	DRIVEVALVESCURRENTFEEDBACK	GROUND	INPUT
	2	THROTTLECURRENTFEEDBACK	GROUND	INPUT
	3	UMSSENSORGROUND	GROUND	INPUT
	4	SWINGVALVESCURRENTFEEDBACK	GROUND	INPUT
	5	UNUSED	GROUND	INPUT
	6	FLOWCONTROLVALVECURRENTFEEDBACK	GROUND	INPUT
	7	ENGINESPEEDSENSOR/UMSSENSORPOWER	VBAT	OUTPUT
	8	UMSSENSOR	DIGITAL	INPUT
	9	CRIBBINGENABLESWITCH	DIGITAL	INPUT
	10	UNUSED	DIGITAL	INPUT
	11	MSSOCONFIGURATION	DIGITAL	INPUT
	12	UNUSED	VOLTAGE	OUTPUT
	13	UNUSED	ANALOG	INPUT
	14	MAINLIFTVALVESCURRENTFEEDBACK	GROUND	INPUT

Connector	Pin	Function	Type	
J12 (Blue)	1	UNUSED	FREQUENCY	INPUT
	2	UNUSED	FREQUENCY	INPUT
	3	CAN2HIGH(ISOLATED)	SERIAL	I/O
	4	CAN2LOW(ISOLATED)	SERIAL	I/O
	5	MSSOSWITCHGROUND	GROUND	INPUT
	6	UNUSED	SERIAL	I/O
	7	UNUSED	SERIAL	I/O
	8	MSSOSWITCH	DIGITAL	INPUT

Connector	Pin	Function	Type	
J8 (Black)	1	MODULEGROUND	GROUND	OUTPUT
	2	MODULEPOWER	VBAT	INPUT
	3	UNSED	GROUND	INPUT
	4	UNSED	VBAT	OUTPUT

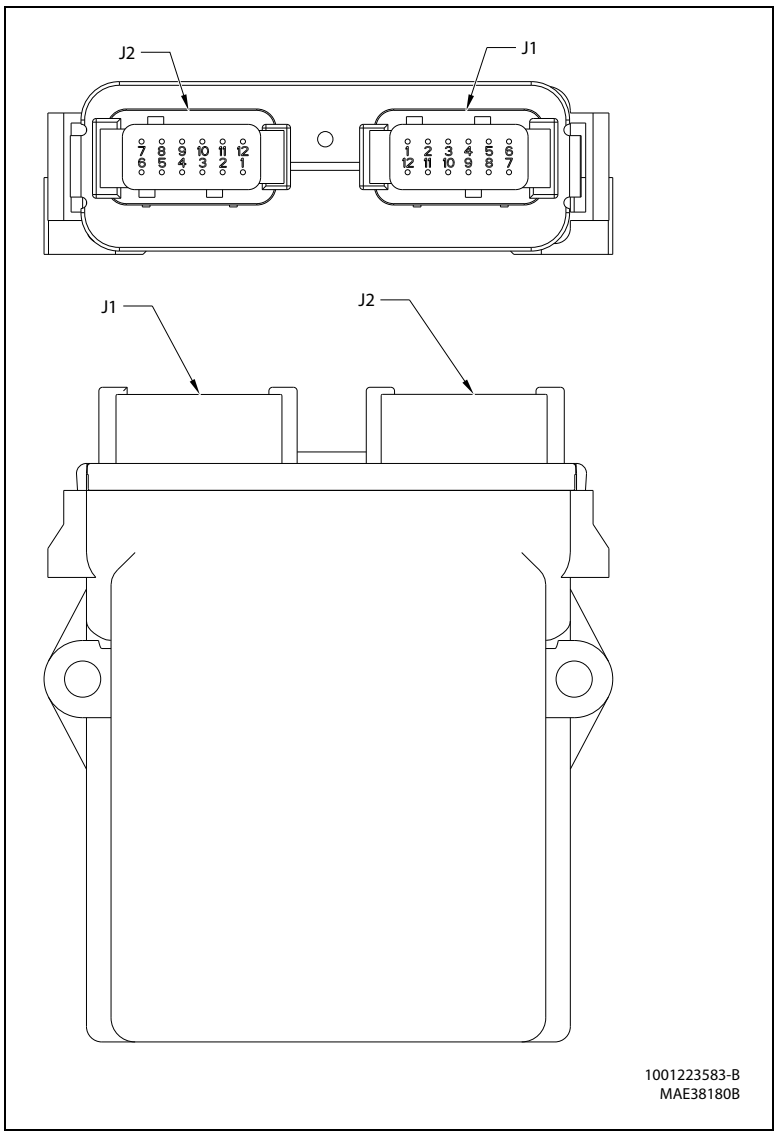


Figure 6-9. HEC Module

CONNECTOR	PIN	TAGNAME	DESCRIPTION	TYPE	
J1(BLACK)	1	12VSYSTEMIGN	IGNITION	POWER	INPUT
	2	12VSYSTEMGND	ACCESSORYMODULEGROUND	POWER	INPUT
	3	SPARE		DIGITAL	INPUT
	4	SPARE		DIGITAL	INPUT
	5	SPARE		DIGITAL	INPUT
	6	SPARE		DIGITAL	INPUT
	7	IMGCONTROLLER COOLING FAN	IMGCONTROLLERFAN	DIGITAL	OUTPUT
	8	SPARE		DIGITAL	OUTPUT
	9	SPARE		DIGITAL	OUTPUT
	10	ENGINE COOLING FAN	ENGINEFAN	DIGITAL	OUTPUT
	11	SPARE		DIGITAL	OUTPUT
	12	SPARE		DIGITAL	OUTPUT
J2(GREY)	1	SPARE		POWER	OUTPUT
	2	SPARE		ANALOG	INPUT
	3	SPARE		POWER	OUTPUT
	4	SPARE		POWER	OUTPUT
	5	SPARE		ANALOG	INPUT
	6	SPARE		POWER	OUTPUT
	7	SPARE		ANALOG	INPUT
	8	SPARE		ANALOG	INPUT
	9	CANH	CANBUSHIGH	SERIAL	I/O
	10	CANL	CANBUSLOW	SERIAL	I/O
	11	TX_ANALYZER	RS-232TRANSMIT	SERIAL	OUTPUT
	12	RX_ANALYZER	RS-232RECEIVE	SERIAL	INPUT

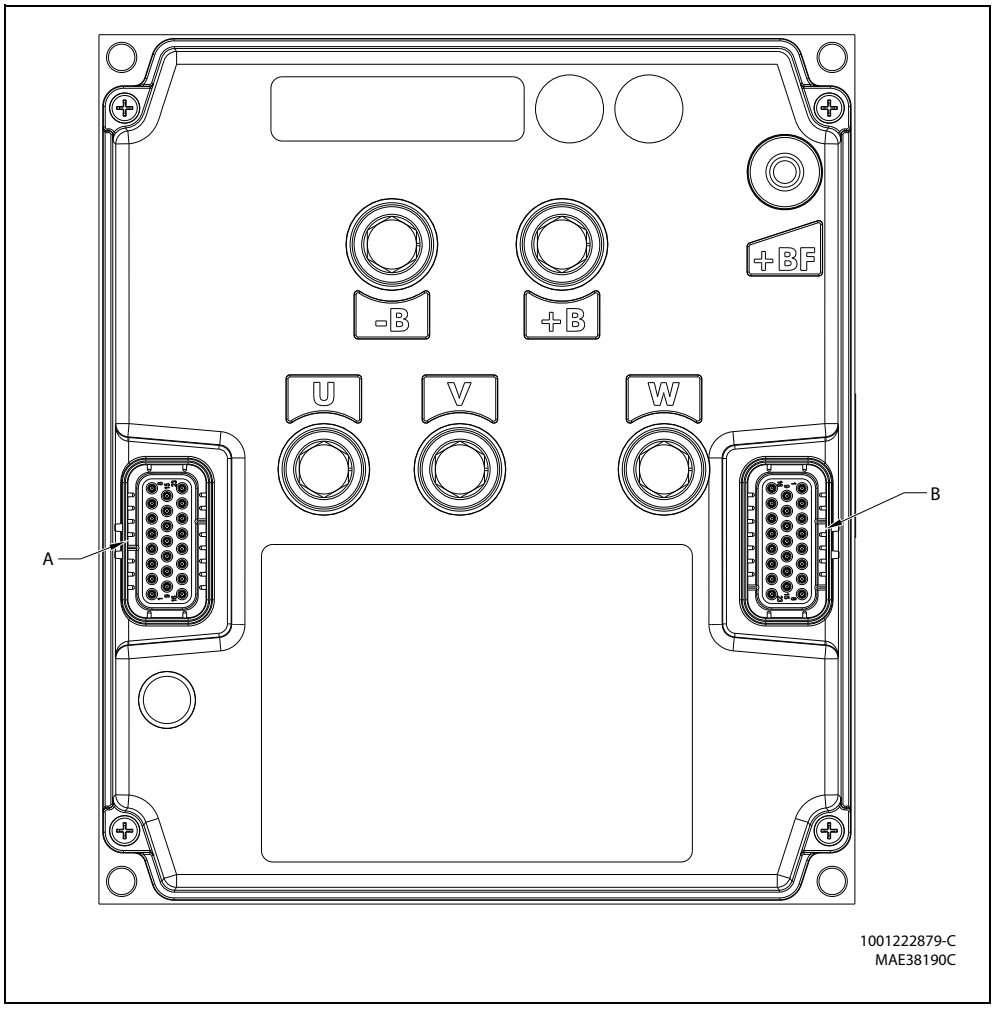


Figure 6-10. IMG Controller

CONNECTOR	PIN	FUNCTION	TYPE	
A	1	IMG_CONTROLLER_IGN	LOGICPOWERIN	POWER
	2	SPARE	POWEROUT	POWER
	3	SPARE	ANALOGIN	INPUT
	4	SPARE	HSDIGITALIN	INPUT
	5	SPARE	HSDIGITALIN	INPUT
	6	CHARGER1_INTERLOCK_A	LSDIGITALIN	INPUT
	7	SPARE	ENCODERCHA	INPUT
	8	SPARE	ENCODERPWR	POWER
	9	BATT_ANALOG_SENSE_GND	ANALOGGND	POWER
	10	SPARE	ANALOGIN	INPUT
	11	SPARE	HSDIGITALIN	INPUT
	12	SPARE	CAN1TERMINATOR	COMMUNICATION
	13	CHARGER2_INTERLOCK_B	LSDIGITALIN	INPUT
	14	SPARE	ENCODERCHB	INPUT
	15	LS_DIG/IMG_TEMP_GND	ENCODERGND	POWER
	16	MAIN_CONTACTOR_LS_DRV	PWMDIGITALOUT	OUTPUT
	17	SPARE	POWERIN	POWER
	18	SPEED_CONVERTER_PULSE	LSDIGITALOUT	OUTPUT
	19	SPEED_CONVERTER_CHARGE	LSDIGITALOUTPWM	OUTPUT
	20	CAN2-L	CAN1SIGNAL	COMMUNICATION
	21	CAN2-H	CAN1SIGNAL	COMMUNICATION
	22	N/C	CAN1GROUND	POWER
	23	IMG_TEMP+	ANALOG/DIGITALTEMP	INPUT

6.8 CANBUS COMMUNICATIONS

CANbus: CAN (Control Area Network) is a two wire differential serial link between the Platform Module, Universal Ground Module (UGM) and HEC module providing bi-directional communications. This machine has two CANbus communications. CAN1 connects ground display, HEC module and clutch control module. CAN2 connects Universal Ground Module (UGM), IMG module and SoC device.

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

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

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

A complete CANbus circuit is approximately 60 ohms, which can be verified at the "T" fitting inside the ground station or below the BLAM. Each individual circuit from the modules is approximately 120 ohms.

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

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

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

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

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

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

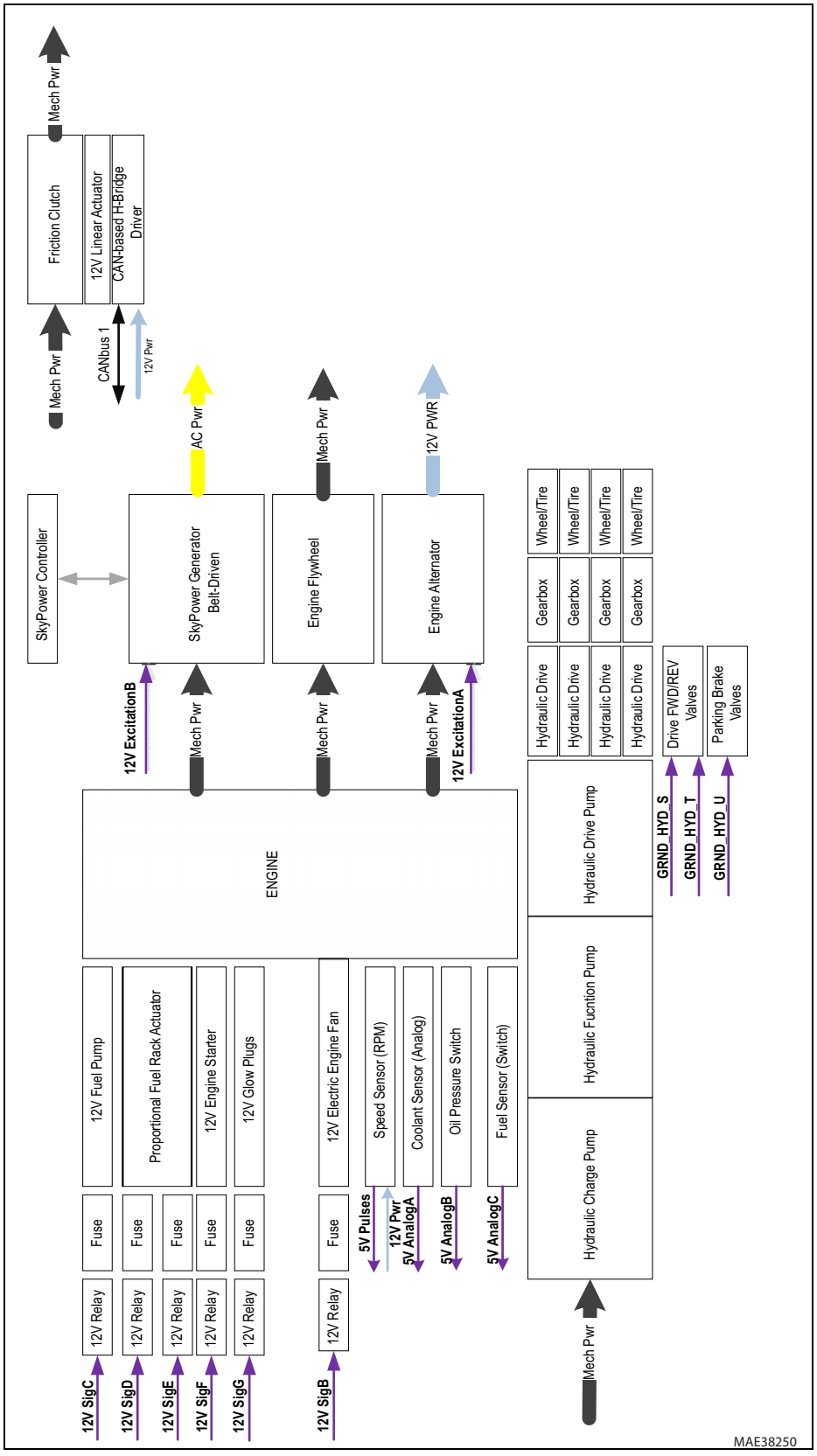


Figure 6-11. Control System Block Diagram - Sheet 1 of 4

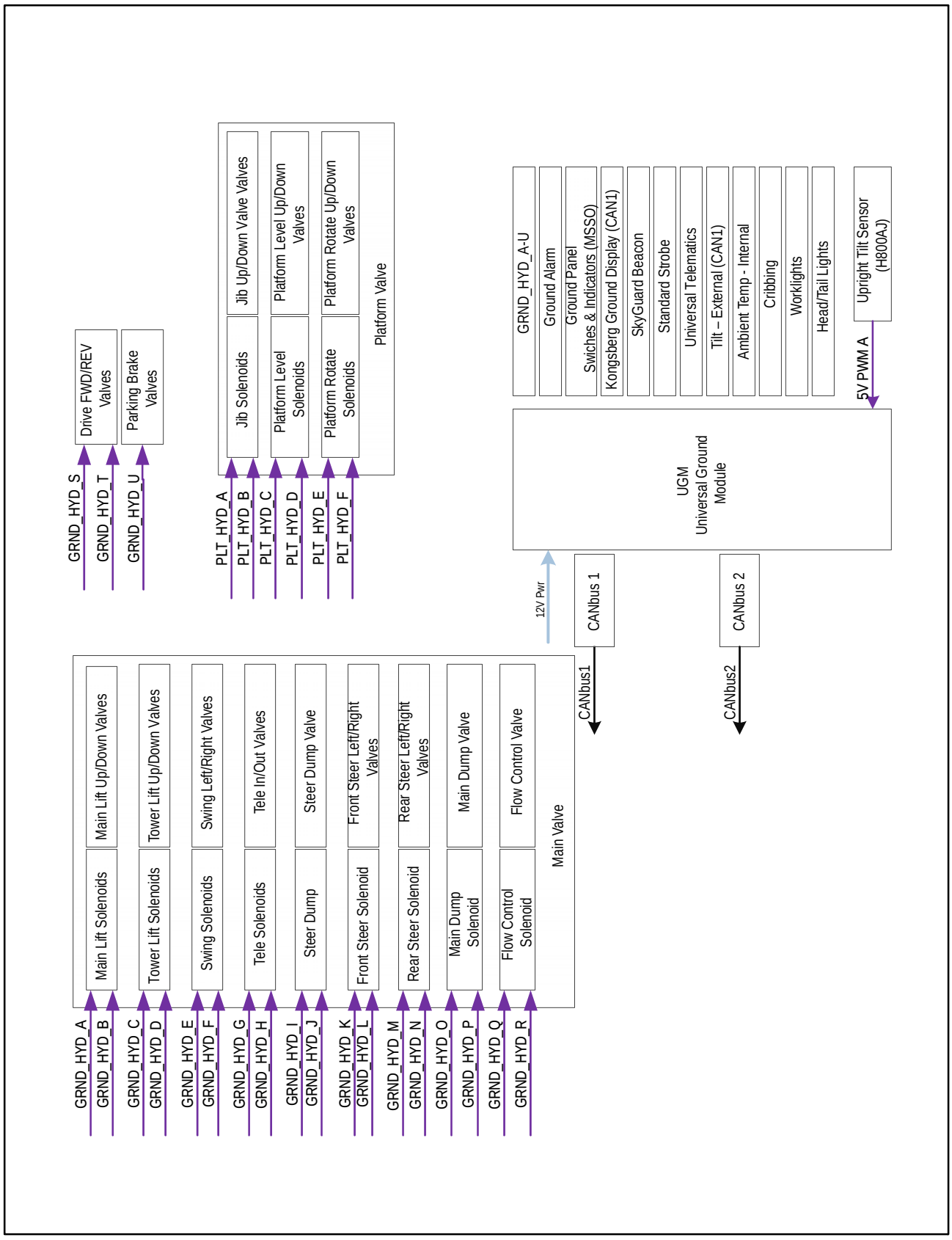


Figure 6-12. Control System Block Diagram - Sheet 2 of 4

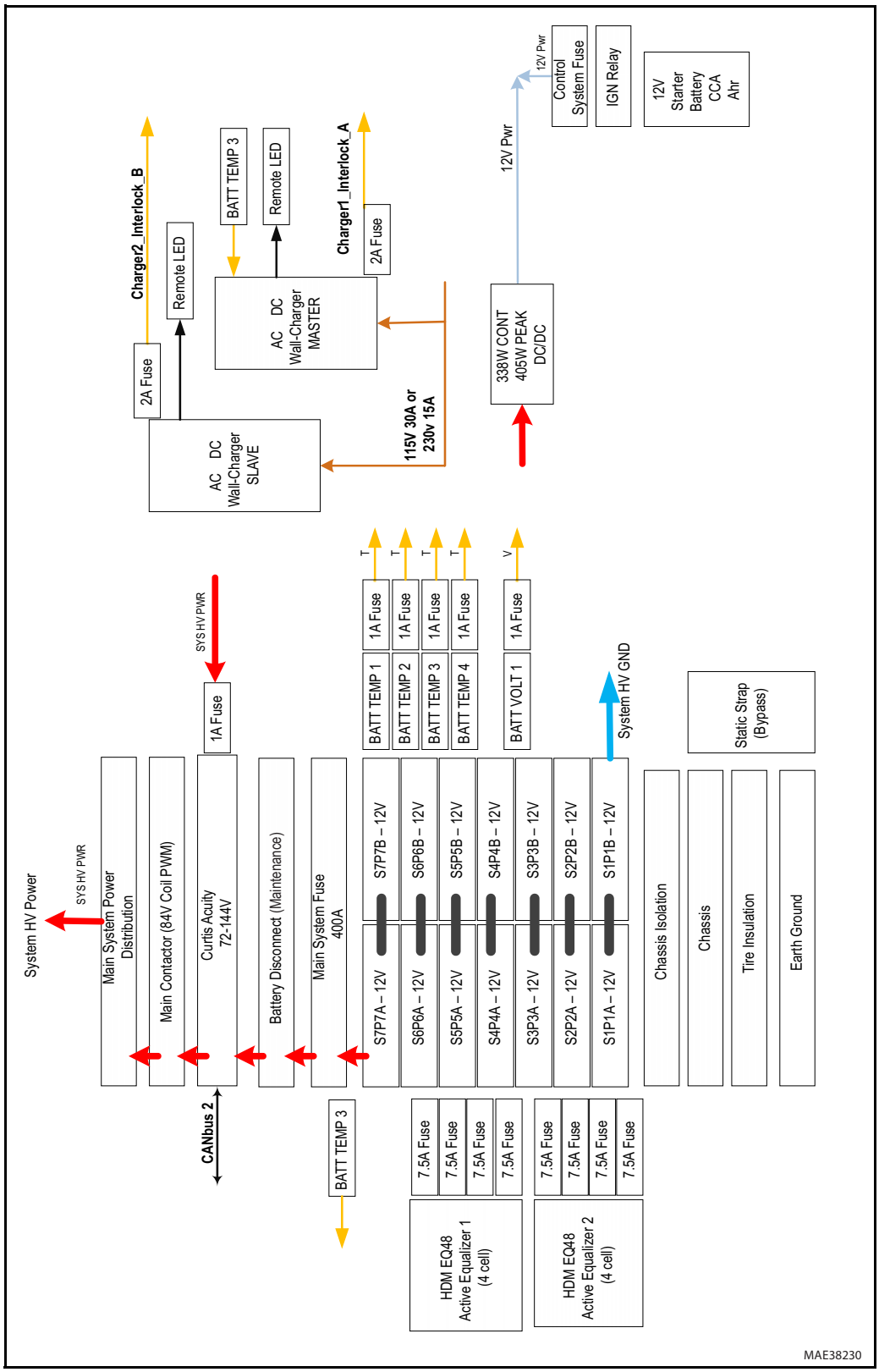


Figure 6-13. Control System Block Diagram - Sheet 3 of 4

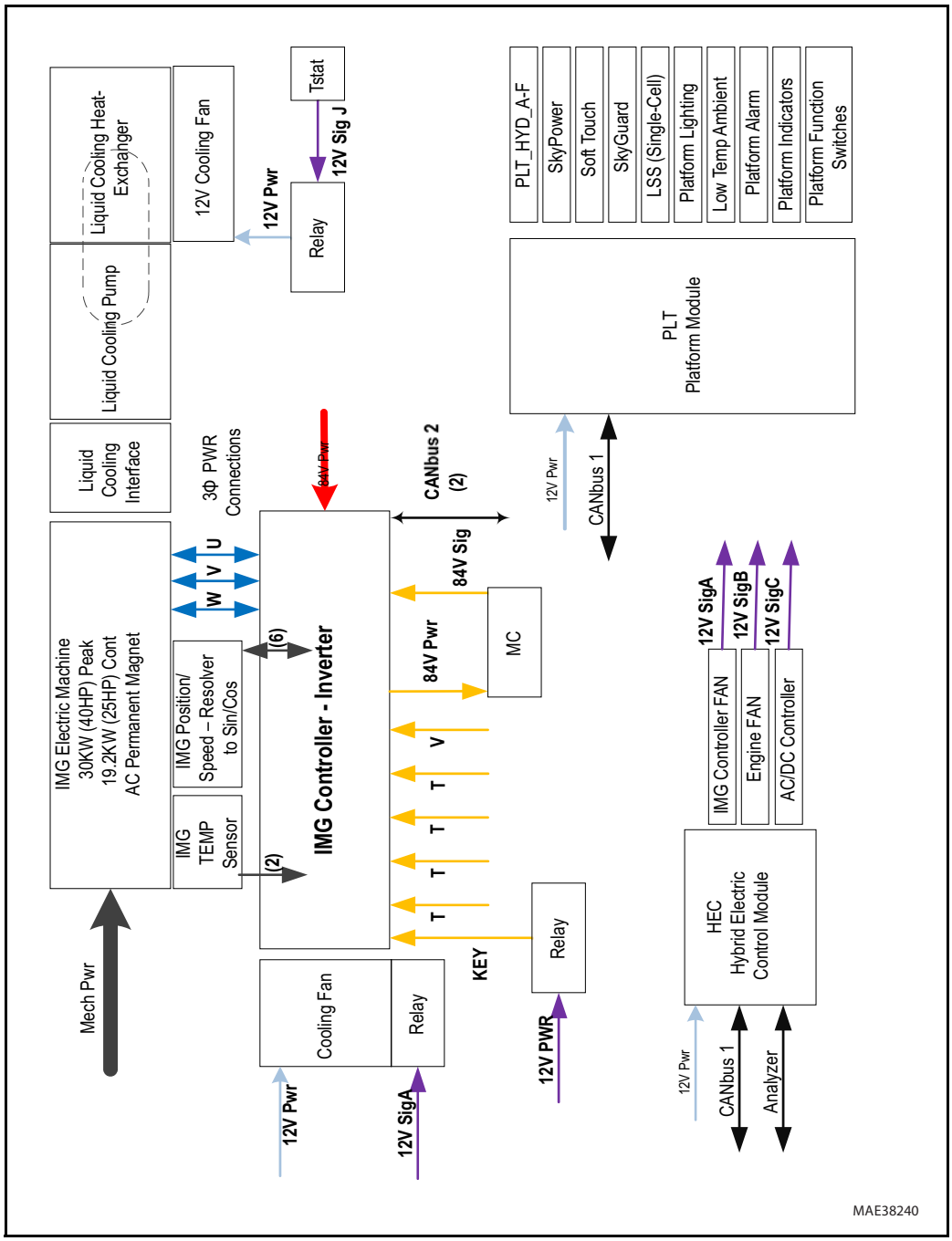


Figure 6-14. Control System Block Diagram - Sheet 4 of 4

6.9 DIAGNOSTIC TROUBLE CODE CHART

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
001	00	1	EVERYTHING OK	The normal help message in Platform Mode.	No response required for this DTC.
002	00	2	GROUND MODE OK	The normal help message in Platform Mode.	No response required for this DTC.
0010	00	10	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION	Drive speed is limited to "ELEVATED MAX" while the vehicle is out of transport position.The normal help message in Ground Mode.	Response described in Drive Modes section.
000	**00**	**0**	**<<< HELP COMMENT >>>**		
0011	00	11	FSW OPEN (Foot switch open)	A drive / boom function was selected with the Footswitch open.	The UGM shall not Enable the Machine.
0012	00	12	RUNNING AT CREEP - CREEP SWITCH OPEN	All functions at creep while the Creep Switch is open.	The UGM shall limit the machine to Creep speed.
0013	00	13	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	All functions at creep while the Platform is elevated and the Chassis is tilted.	
0014	00	14	CHASSIS TILT SENSOR OUT OF RANGE	The Chassis is tilted > 19 degrees for more then 4 seconds.	Not reported during power-up.
0015	00	15	LOAD SENSOR READING UNDER WEIGHT	The Load Sensing System indicates > 20% under calibrated zero point.	
0031	00	31	FUEL LEVEL LOW - ENGINE SHUTDOWN	Engine Shutdown has occurred due to Fuel Level = EMPTY condition.	Response described in Fuel Shutdown section.
0035	00	35	APU ACTIVE	Auxiliary Power/Emergency Descent Mode is active.	Response described in Auxiliary Power/Emergency Descent Mode section.
0039	00	39	SKYGUARD ACTIVE - FUNCTIONS CUTOUT	Response described in Auxiliary Power/ Emergency Descent Mode section.	Response described in Sky-Guard section.
0040	00	40	RUNNING AT CREEP - CREEP SWITCH CLOSED	All Function speeds are limited to creep because the creep switch is closed.	
210	**21**	**0**	**<<< POWER-UP >>>**		
211	21	1	POWER CYCLE	The normal help message is issued at each power cycle.	
212	21	2	KEYSWITCH FAULTY	Both Platform and Ground modes are selected simultaneously.	The UGM shall assume a station selection of Ground.
213	21	3	FSW FAULTY	Both Footswitches are closed for more then one second.	The UGM shall not Enable the Machine.
220	**22**	**0**	**<<< PLATFORM CONTROLS >>>**		
227	22	7	STEER SWITCHES FAULTY	Both Steer Left and Steer Right inputs are closed simultaneously.	The UGM shall prohibit Steer; The UGM shall limit Drive to Creep The Steer Left switch input = Low; The Steer Right switch input = Low; Steer and full Drive speed permitted after controls are initialized

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
2211	22	11	FSW INTERLOCK TRIPPED	The Footswitch was closed for more then seven seconds.	Can be reported during power- up.
2212	22	12	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A drive function was selected with Foot-switch open.	Can be reported during power- up.
2213	22	13	STEER LOCKED - SELECTED BEFORE FOOTSWITCH	A steer function was selected with Foot-switch open.	The UGM shall not Enable the Machine.
2214	22	14	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE	Drive/Steer was selected before Enable switch activated.	
2216	22	16	D/S JOY. OUT OF RANGE HIGH	The D/S Joystick reference voltage is > 8.1V.	Resistive joysticks. If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2217	22	17	D/S JOY. CENTER TAP BAD	The D/S Joystick center tap voltage is < 3.08V or > 3.83V.	Resistive joysticks. - There is a +/-.1V range. around these values due to resistor tolerances.
2219	22	19	L/S JOY. OUT OF RANGE HIGH	The L/S Joystick reference voltage is > 8.1V.	Resistive joysticks. - If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2220	22	20	L/S JOY. CENTER TAP BAD	The L/S Joystick center tap voltage is < 3.08V or > 3.83V.	Resistive joysticks. - There is a +/- .1V range. around these values due to resistor tolerances.
2221	22	21	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A lift / swing function was selected with Footswitch open.	If triggered by the Lift and/or Swing joystick not being in the neutral position at Startup, the UGM shall pro-hibit Lift and Swing. If triggered by Lift and/or Swing joystick is not in the neutral position when Foot-switch becomes active or while DTC 2212, 2213 or 2223 is active, the UGM shall not Enable the Machine.
2222	22	22	WAITING FOR FSW TO BE OPEN	The Footswitch was closed during Platform selection.	Can be reported during power- up.
2223	22	23	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE	A boom function was selected with Foot-switch open.	The UGM shall not Enable the Machine.
2224	22	24	FOOTSWITCH SELECTED BEFORE START	The Footswitch was closed during engine start.	The UGM shall prohibit Engine Start.
2269	22	69	FUNCTION PROBLEM - HIGH SPEED & CREEP ACTIVE TOGETHER		

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
234	23	4	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	A boom function has both directions selected together.	Disable whichever boom functions whose boom control inputs are triggering the fault. If Engine Start/Aux at fault, disable Engine Start but permit Auxiliary Power/ Emergency Descent.
235	23	5	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER	A boom function was selected before aux power.	
236	23	6	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH	A boom function was selected before engine start.	
237	23	7	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH	The Start Switch was closed during power-up.	The UGM shall prohibit Engine Start.
23163	23	163	FUNCTION PROBLEM - MSSO PERMANENTLY SELECTED	The MSSO switch input = Low at Startup.	No response required for this DTC Power Cycled.
240	**24**	**0**	**<<< OTHER CONTROLS >>>**		
241	24	1	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE LOW	MACHINE SETUP > TEMP CUTOUT = YES; Ambient Temperature sensor reading -50C.	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; If the Machine is in Ground Mode; No response required for this DTC.
242	24	2	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE HIGH	Ambient Temperature sensor reading ≥ 85C.	Check Ambient Temperature sensor reading < 85C.
250	**25**	**0**	**<<< FUNCTION PREVENTED >>>**		
259	25	9	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS	The model selection has been changed.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
2513	25	13	GENERATOR MOTION CUTOUT ACTIVE	Driving is not possible while the vehicle generator is running AND is configured to prevent drive.	The UGM shall not Enable the Machine.
2514	25	14	BOOM PREVENTED - DRIVE SELECTED	Boom functions are not possible while the vehicle is being driven AND is configured to not allow simultaneous drive & boom operation.	The UGM shall prohibit all boom functions.
2516	25	16	DRIVE PREVENTED - ABOVE ELEVATION	Driving is not possible while Boom functions are selected AND is configured to not allow simultaneous drive & boom operation.	The UGM shall prohibit Drive and Steer.
2517	25	17	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	Driving is not possible while the vehicle is tilted and above elevation AND is configured to prevent drive while tilted and above elevation.	The UGM shall prohibit Drive and Steer.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
2518	25	18	DRIVE PREVENTED - BOOM SELECTED	MACHINE SETUP > FUNCTION CUTOUT = BOOM CUTOUT The boom is Above Elevation Any boom function is already active The operator attempts to activate Drive or Steer.	The UGM shall prohibit Drive and Steer.
2519	25	19	DRIVE PREVENTED - TILTED & EXTENDED OR HIGH ANGLE	Drive Selected while tilted and extended and tilt is configured to cutout drive.	
2520	25	20	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER		
2530	25	30	UMS SENSOR FORWARD LIMIT REACHED	The Upright angle relative to the turntable is less than -4.0 degree.	
2531	25	31	UMS SENSOR OUT OF USABLE RANGE	Both the turntable tilt sensor and the UMS sensor read greater then +/-10 degree in the same direction.	
2532	25	32	UMS SENSOR BACKWARD LIMIT REACHED	The Upright angle relative to the turntable is greater than +2.5 degree.	
2563	25	63	SKYGUARD SWITCH - DISAGREEMENT	MACHINE SETUP > SKYGUARD = YES; Machine is in Platform Mode; [(SkyGuard input #1 Platform Module J7-18) ≠ (SkyGuard input #2 Platform Module J1-23)] > 160ms	Response detailed in Sky-Guard section.
2568	25	68	TEMPERATURE CUTOUT ACTIVE - AMBIENT TEMPERATURE TOO LOW	Low Temperature Cutout = Active	If the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
2576	25	76	PLATFORM LEVEL PREVENTED - ABOVE ELEVATION	Platform Level Override Cutout = Enabled; The Platform Level Up or Down switch input = High; Footswitch is active.	The UGM shall suspend Platform Level Up and Down commands; The UGM shall prohibit Platform Level Up and Down
2577	25	77	DRIVE PREVENTED - START BATTERY CONNECTED	Start battery is connected	Check the battery.
330	**33**	**0**	**<<< GROUND OUTPUT DRIVER >>>**		
331	33	1	BRAKE - SHORT TO BATTERY	There is a Short to Battery to the Brake Valve.	Check Harness for damage.
332	33	2	BRAKE - OPEN CIRCUIT	There is an Open Circuit to the Brake Valve.	Check Harness for damage.
3311	33	11	GROUND ALARM - SHORT TO BATTERY	There is a Short to Battery to the Ground Alarm.	Ground Alarm equipped vehicles only.
3336	33	36	ALTERNATOR POWER - SHORT TO GROUND	There is a Short to Ground to the Alternator/ECM.	Check Harness for damage.
3340	33	40	AUX POWER - SHORT TO GROUND	There is a Short to Ground to the Auxiliary Power Pump Relay.	Check Harness for damage.
3341	33	41	AUX POWER - OPEN CIRCUIT	There is an Open Circuit to the Auxiliary Power Pump Relay.	Check Harness for damage.
3342	33	42	AUX POWER - SHORT TO BATTERY	There is a Short to Battery to the Auxiliary Power Pump Relay.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3346	33	46	ELECTRIC FAN - SHORT TO GROUND	There is a short to ground to the Electric Fan.	Check Harness for damage.
3347	33	47	ELECTRIC FAN - OPEN CIRCUIT	There is an Open Circuit to the Electric Fan.	Check Harness for damage.
3348	33	48	ELECTRIC FAN - SHORT TO BATTERY	There is a Short to Battery to the Electric Pump.	Check Harness for damage.
3349	33	49	ELECTRIC PUMP - SHORT TO GROUND	There is a Short to Ground to the Pump Relay.	Check Harness for damage.
3350	33	50	ELECTRIC PUMP - OPEN CIRCUIT	There is an Open Circuit to the Pump Relay.	Check Harness for damage.
3351	33	51	ELECTRIC PUMP - SHORT TO BATTERY	There is a Short to Battery to the Pump Relay.	Check Harness for damage.
3352	33	52	LP LOCK - SHORT TO GROUND	There is an Open Circuit to the LP Lock.	Check Harness for damage.
3353	33	53	LP LOCK - OPEN CIRCUIT	There is an Open Circuit to the LP Lock.	Check Harness for damage.
3354	33	54	LP LOCK - SHORT TO BATTERY	There is a short to Battery to the LP Lock.	Check Harness for damage.
3355	33	55	LP START ASSIST - SHORT TO GROUND	There is a short to ground to the LP Start Assist.	Check Harness for damage.
3356	33	56	LP START ASSIST - OPEN CIRCUIT	There is an Open Circuit to the LP Start Assist.	Check Harness for damage.
3357	33	57	LP START ASSIST - SHORT TO BATTERY	There is a short to battery to the LP Start Assist.	Check Harness for damage.
3358	33	58	MAIN DUMP VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Dump Valve.	Check Harness for damage.
3359	33	59	MAIN DUMP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Dump Valve.	Check Harness for damage.
3360	33	60	MAIN DUMP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Dump Valve.	Check Harness for damage.
3361	33	61	BRAKE - SHORT TO GROUND	There is a Short to Ground to the Brake Valve.	Check Harness for damage.
3362	33	62	START SOLENOID - SHORT TO GROUND	There is a Short to Ground to the Start Relay.	Check Harness for damage.
3363	33	63	START SOLENOID - OPEN CIRCUIT	There is an Open Circuit to the Start Relay.	Check Harness for damage.
3364	33	64	START SOLENOID - SHORT TO BATTERY	There is a Short to Battery to the Start Relay.	Check Harness for damage.
3365	33	65	STEER DUMP VALVE - SHORT TO GROUND	There is a Short to Ground to the Steer Dump Valve.	Check Harness for damage.
3366	33	66	STEER DUMP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Steer Dump Valve.	Check Harness for damage.
3367	33	67	STEER DUMP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Steer Dump Valve.	Check Harness for damage.
3368	33	68	TWO SPEED VALVE - SHORT TO GROUND	There is a Short to Ground to the Two Speed Valve.	Check Harness for damage.
3369	33	69	TWO SPEED VALVE - OPEN CIRCUIT	There is an Open Circuit to the Two Speed Valve.	Check Harness for damage.
3370	33	70	TWO SPEED VALVE - SHORT TO BATTERY	There is a Short to Battery to the Two Speed Valve.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3371	33	71	GROUND ALARM - SHORT TO GROUND	There is a Short to Ground to the Ground Alarm.	Check Harness for damage.
3372	33	72	GROUND ALARM - OPEN CIRCUIT	There is an Open Circuit to the Ground Alarm.	Check Harness for damage.
3373	33	73	GEN SET/WELDER - SHORT TO GROUND	There is a Short to Ground to the Generator Relay.	Check Harness for damage.
3374	33	74	GEN SET/WELDER - OPEN CIRCUIT	There is an Open Circuit to the Generator Relay.	Check Harness for damage.
3375	33	75	GEN SET/WELDER - SHORT TO BATTERY	There is a Short to Battery to the Generator Relay.	Check Harness for damage.
3376	33	76	HEAD TAIL LIGHT - SHORT TO GROUND	There is a Short to Ground to the Head Light Relay.	Check Harness for damage.
3377	33	77	HEAD TAIL LIGHT - OPEN CIRCUIT	There is an Open Circuit to the Head Light Relay.	Check Harness for damage.
3378	33	78	HEAD TAIL LIGHT - SHORT TO BATTERY	There is a Short to Battery to the Head Light Relay.	Check Harness for damage.
3379	33	79	HOUR METER - SHORT TO GROUND	There is a Short to Ground to the Hour Meter.	Check Harness for damage.
3382	33	82	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Valve	Check Harness for damage.
3383	33	83	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
3384	33	84	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Up Valve	Check Harness for damage.
3388	33	88	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Down Valve	Check Harness for damage.
3389	33	89	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
3390	33	90	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Down Valve	Check Harness for damage.
3394	33	94	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Left Valve.	Check Harness for damage.
3395	33	95	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Left Valve.	Check Harness for damage.
3396	33	96	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Left Valve.	Check Harness for damage.
3397	33	97	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Right Valve.	Check Harness for damage.
3398	33	98	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Right Valve.	Check Harness for damage.
3399	33	99	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Right Valve.	Check Harness for damage.
33100	33	100	JIB LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Up Valve.	Check Harness for damage.
33101	33	101	JIB LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Up Valve.	Check Harness for damage.
33102	33	102	JIB LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Up Valve.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33103	33	103	JIB LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Down Valve.	Check Harness for damage.
33104	33	104	JIB LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Down Valve.	Check Harness for damage.
33105	33	105	JIB LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Down Valve.	Check Harness for damage.
33106	33	106	TOWER LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift Up Valve.	Check Harness for damage.
33107	33	107	TOWER LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift Up Valve.	Check Harness for damage.
33108	33	108	TOWER LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift Up Valve.	Check Harness for damage.
33109	33	109	TOWER LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift Down Valve.	Check Harness for damage.
33110	33	110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift Down Valve.	Check Harness for damage.
33111	33	111	TOWER LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift Down Valve.	Check Harness for damage.
33112	33	112	TOWER TELESCOPE IN VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope In Valve.	Check Harness for damage.
33113	33	113	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Telescope In Valve.	Check Harness for damage.
33114	33	114	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope In Valve.	Check Harness for damage.
33115	33	115	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope Out Valve.	Check Harness for damage.
33116	33	116	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Telescope Out Valve.	Check Harness for damage.
33117	33	117	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope Out Valve.	Check Harness for damage.
33118	33	118	SWING RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Right Valve.	Check Harness for damage.
33119	33	119	SWING RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Right Valve.	Check Harness for damage.
33120	33	120	TELESCOPE IN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Telescope In Valve.	Check Harness for damage.
33121	33	121	SWING RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Swing Right Valve.	Check Harness for damage.
33122	33	122	SWING LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Left Valve.	Check Harness for damage.
33123	33	123	TELESCOPE OUT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Telescope Out Valve.	Check Harness for damage.
33130	33	130	THROTTLE ACTUATOR - SHORT TO GROUND	There is a Short to Ground to the Throttle Actuator.	Check Harness for damage.
33131	33	131	THROTTLE ACTUATOR - OPEN CIRCUIT	There is an Open Circuit to the Throttle Actuator.	Check Harness for damage.
33132	33	132	THROTTLE ACTUATOR - SHORT TO BATTERY	There is a Short to Battery to the Throttle Actuator.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33170	33	170	LIFT DOWN VALVE - OPEN CIRCUIT	There is a Short to Ground to the Lift Down Valve.	Check Harness for damage.
33171	33	171	LIFT DOWN VALVE - SHORT TO BATTERY	There is an Open Circuit to the Lift Down Valve.	Check Harness for damage.
33172	33	172	LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Battery to the Lift Down Valve.	Check Harness for damage.
33175	33	175	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Left Valve.	Check Harness for damage.
33176	33	176	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Left Valve.	Check Harness for damage.
33177	33	177	JIB ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Left Valve.	Check Harness for damage.
33178	33	178	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Right Valve.	Check Harness for damage.
33179	33	179	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Right Valve.	Check Harness for damage.
33180	33	180	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Right Valve.	Check Harness for damage.
33182	33	182	LIFT VALVES - SHORT TO BATTERY	There is a Short to Battery to the Lift Valves.	Check Harness for damage.
33186	33	186	TELESCOPE OUT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope Out Valve.	Check Harness for damage.
33188	33	188	TELESCOPE OUT VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope Out Valve.	Check Harness for damage.
33189	33	189	TELESCOPE IN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope In Valve.	Check Harness for damage.
33190	33	190	TELESCOPE IN VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope In Valve.	Check Harness for damage.
33207	33	207	HORN - OPEN CIRCUIT	There is an Open Circuit to the Horn.	Check Harness for damage.
33208	33	208	HORN - SHORT TO BATTERY	There is a Short to Battery to the Horn.	Check Harness for damage.
33209	33	209	HORN - SHORT TO GROUND	There is a Short to Ground to the Horn.	Check Harness for damage.
33279	33	279	GLOWPLUG - OPEN CIRCUIT	There is an Open Circuit to the Glow Plugs.	Check Harness for damage.
33280	33	280	GLOWPLUG - SHORT TO BATTERY	There is a Short to Battery to the Glow Plugs.	Check Harness for damage.
33281	33	281	GLOWPLUG - SHORT TO GROUND	There is a Short to Ground to the Glow Plugs.	Check Harness for damage.
33287	33	287	LIFT - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized
33295	33	295	SWING LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Left Valve.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33306	33	306	SWING LEFT VALVE - SHORT TO BATTERY	There is short to Battery to the Swing Left Valve.	Check Harness for damage.
33314	33	314	FLOW CONTROL VALVE - OPEN CIRCUIT	There is an Open Circuit to the Flow Control Valve.	Check Harness for damage.
33315	33	315	FLOW CONTROL VALVE - SHORT TO BATTERY	There is short to Battery to the Flow Control Valve	Check Harness for damage.
33316	33	316	FLOW CONTROL VALVE - SHORT TO GROUND	There is short to Ground to the Flow Control Valve	Check Harness for damage.
33317	33	317	DRIVE FORWARD VALVE - OPEN CIRCUIT	There is an Open Circuit to the Drive Forward Valve.	Check Harness for damage.
33318	33	318	DRIVE FORWARD VALVE - SHORT TO BATTER	There is short to Battery to the Drive Forward Valve.	Check Harness for damage.
33319	33	319	DRIVE FORWARD VALVE - SHORT TO GROUND	There is short to Gropund to the Drive Forward Valve.	Check Harness for damage.
33320	33	320	DRIVE REVERSE VALVE - OPEN CIRCUIT	There is an Open Circuit to the Drive Reverse Valve.	Check Harness for damage.
33321	33	321	DRIVE REVERSE VALVE - SHORT TO BATTERY	There is a short to Battery to the Drive Reverse Valve.	Check Harness for damage.
33322	33	322	DRIVE REVERSE VALVE - SHORT TO GROUND	There is a short to Ground to the Drive Reverse Valve.	Check Harness for damage.
33323	33	323	LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Lift Up Valve.	Check Harness for damage.
33324	33	324	LIFT UP VALVE - SHORT TO BATTERY	There is a short to Battery to the Lift Up Valve.	Check Harness for damage.
33325	33	325	LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Lift Up Valve.	Check Harness for damage.
33331	33	331	DRIVE - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33410	33	410	DRIVE - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33412	33	412	SWING VALVES - SHORT TO BATTERY	There is a short to Battery to the Swing Valves.	Check Harness for damage.
33414	33	414	SWING - CURRENT FEEDBACK READING TOO LOW	Current feedback into controller is below threshold value.	Check wiring and coil.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33415	33	415	FLOW CONTROL VALVE - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second .	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33417	33	417	LIFT - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized.
33418	33	418	SWING - CURRENT FEEDBACK READING LOST	Current feedback into controller not detected.	Check wiring and coil.
33419	33	419	FLOW CONTROL VALVE - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output >40% for a period of 100ms.	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33488	33	488	SWING FLOW CONTROL VALVE - SHORT TO GROUND	There is a short to the Ground to the Swing Flow Control Valve.	Check Harness for damage.
33575	33	575	ECM PULL DOWN RESISTOR - OPEN CIRCUIT	There is an Open Circuit to the ECM Pull Down Resistor.	Check Harness for damage.
340	**34**	**0**	**<<< PLATFORM OUTPUT DRIVER >>>**		
341	34	1	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
342	34	2	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Up Valve.	Check Harness for damage.
343	34	3	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Valve.	Check Harness for damage.
344	34	4	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
345	34	5	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
346	34	6	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Level Down Valve.	Check Harness for damage.
347	34	7	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	There is a short to the Ground to the Platform Level Down Valve.	Check Harness for damage.
348	34	8	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
349	34	9	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Left Valve.	Check Harness for damage.
3410	34	10	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Rotate Left Valve.	Check Harness for damage.
3411	34	11	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	There is a short to Ground to the Platform Rotate Left Valve.	Check Harness for damage.
3412	34	12	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Right Valve.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3413	34	13	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Rotate Right Valve.	Check Harness for damage.
3414	34	14	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	There is a short to Ground to the Platform Rotate Right Valve.	Check Harness for damage.
3415	34	15	JIB LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Up Valve.	Check Harness for damage.
3416	34	16	JIB LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Up Valve.	Check Harness for damage.
3417	34	17	JIB LIFT UP VALVE - SHORT TO GROUND	There is a short to Ground to the JIB Lift Up Valve.	Check Harness for damage.
3418	34	18	JIB LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Down Valve.	Check Harness for damage.
3419	34	19	JIB LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Down Valve.	Check Harness for damage.
3420	34	20	JIB LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Down Valve.	Check Harness for damage.
3421	34	21	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Left Valve.	Check Harness for damage.
3422	34	22	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Left Valve.	Check Harness for damage.
3423	34	23	JIB ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Left Valve.	Check Harness for damage.
3424	34	24	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Right Valve.	Check Harness for damage.
3425	34	25	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Right Valve.	Check Harness for damage.
3426	34	26	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Right Valve.	Check Harness for damage.
430	**43**	**0**	**<<< ENGINE >>>**		
431	43	1	FUEL SENSOR - SHORT TO BATTERY OR OPEN CIRCUIT	The Fuel Sensor reading is > 4.3V.	Energize fuel sensor per System Indicators
432	43	2	FUEL SENSOR - SHORT TO GROUND	The Fuel Sensor reading is < 0.2V.	Energize fuel sensor per System Indicators
433	43	3	OIL PRESSURE - SHORT TO BATTERY	The Oil Pressure Sensor reading is > 6.6V.	Deutz engine only.
434	43	4	OIL PRESSURE - SHORT TO GROUND	The Oil Pressure Sensor reading is < 0.1V for more then 5 seconds.	Deutz engine only. - Not reported during engine start.
435	43	5	COOLANT TEMPERATURE - SHORT TO GROUND	The Coolant Temperature Sensor reading is < 0.1V.	Deutz engine only.
436	43	6	FORD FAULT CODE ##	All ford fault codes except 63 are simply passed through from the Ford ECM. They only occur if a Ford Engine is selected in the machine configuration digits. Can be reported during power-up sequence.	

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
437	43	7	ENGINE TROUBLE CODE	Displays engine SPN FMI code.	Report and log in Help If [(MACHINE SETUP > DEUTZ EMR2) or (MACHINE SETUP > DEUTZ EMR4) and SPN:FMI = 535:7], prohibit engine cranking.
438	43	8	HIGH ENGINE TEMP	(Ford engine only) The engine temperature is > 117 C. (Deutz engine only) The engine temperature is > 130 C.	Ford / Deutz engine only.
439	43	9	AIR FILTER BYPASSED	The Air Filter is clogged.	Check Airfilter for clogging
4310	43	10	NO ALTERNATOR OUTPUT	Battery voltage is < 11.5 volts for more then 15 seconds after engine start.	Activate the No Charge indicator J4-26 per System Indicators.
4311	43	11	LOW OIL PRESSURE	(Ford engine only) The ECM has reported a low oil pressure fault. (Deutz engine only) Oil pressure is < 8 PSI for more then 10 seconds after engine start.	Ford / Deutz engine only.
4312	43	12	485 COMMUNICATIONS LOST	This fault only occurs with a Ford Engine. It occures when no response are received from the ECM for 2.5 seconds. Can be reported during power-up sequence.	
4313	43	13	THROTTLE ACTUATOR FAILURE	The engine RPM is > XXX for more then XX seconds.	
4314	43	14	WRONG ENGINE SELECTED - ECM DETECTED	A ECM was detected with a non- ECM type engine selected.	
4322	43	22	LOSS OF ENGINE SPEED SENSOR	The engine RPM sensor indicates 0 RPM AND the Oil Pressure Sensor indicates > 8 PSI for three seconds.	Diesel engine only.
4323	43	23	SPEED SENSOR READING INVALID SPEED	The engine RPM sensor indicates > 4000 RPM.	Diesel engine only.
4331	43	31	SOOT LOAD WARNING - LOW	SPN/FMI 3719 / 16 3703 / 31	Check Engine.
4332	43	32	SOOT LOAD WARNING - HIGH	SPN/FMI 3719 / 0 3714 / 31	Check Engine.
4333	43	33	SOOT LOAD WARNING - SEVERE	SPN/FMI 3715 / 31	Check Engine.
4334	43	34	ENGINE COOLANT - LOW LEVEL	MACHINE SETUP > ENGINE = DEUTZ EMR4; ECM transmits a J1939 DM1 message for an engine coolant low level fault (SPN:FMI 111:1) on CAN2 or uses the J1939 Transport Protocol every one second to send this information if multiple engine faults exist.	MACHINE SETUP > ENGINE SHUTDOWN = ENABLED then shutdown the engine; Activate High Engine Temperature indicator J4-28.
440	**44**	**0**	**<<< BATTERY SUPPLY >>>**		
441	44	1	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN	Battery voltage is < 9V.	
442	44	2	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN	Battery voltage is > 16V.	
445	44	5	BATTERY VOLTAGE LOW	Battery voltage is < 11V for more then 5 seconds.	

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
660	**66**	**0**	**<<< COMMUNICATION >>>**		
662	66	2	CANBUS FAILURE - PLATFORM MODULE	Platform Module CAN communication lost.	
664	66	4	CANBUS FAILURE - ACCESSORY MODULE	The accessory module is not receiving CAN messages. This is probably due to wiring problem.	Check the Wiring.
666	66	6	CANBUS FAILURE - ENGINE CONTROLLER	Engine Control Module CAN	ECM equipped engine only.
6620	66	20	CANBUS FAILURE - UMS SENSOR	communication lost.	
6622	66	22	CANBUS FAILURE - TCU MODULE	Machine Setup/ Telematics=YES, No device heartbeat for 30 sec	
6623	66	23	CANBUS FAILURE - GATEWAY MODULE	Machine Setup/ Telematics=YES, No device heartbeat for 30 sec	
6629	66	29	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH		
6657	66	57	CANBUS FAILURE - TEMPERATURE SENSOR	MACHINE SETUP > TEMP CUTOUT = YES; UGM does not receive any CAN messages from the Ambient Temperature sensor in 250ms	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
671	67	1	ACCESSORY FAULT		
680	**68**	**0**	**<<< TELEMATICS >>>**		
681	68	1	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP		
810	**81**	**0**	**<<< TILT SENSOR >>>**		
813	81	3	CHASSIS TILT SENSOR NOT CALIBRATED	The Chassis Tilt Sensor has not been calibrated.	
815	81	5	CHASSIS TILT SENSOR DISAGREEMENT		
816	81	6	UMS SENSOR NOT CALIBRATED	The Control System detects a sensor out of range condition or a not calibrated fault with UMS angle sensor	
817	81	7	UMS SENSOR FAULT	The system detects that the UMS sensor frequency outside the 100Hz+/- 5Hz range or the duty cycle is outside 50% +/- 21% Range	
820	**82**	**0**	**<<< PLATFORM LOAD SENSE >>>**		
825	82	5	LSS HAS NOT BEEN CALIBRATED	The Load Sensing System Module has not been calibrated.	UGM to set Platform Load State = Overloaded

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
826	82	6	RUNNING AT CREEP - PLATFORM OVERLOADED	All functions at creep, the Load Sensing System indicates the Platform is overloaded AND is configured to warn only while the Platform is overloaded.	
827	82	7	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED	Driving and boom functions are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent drive and boom functions while the Platform is overloaded.	
828	82	8	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED	Lift up and telescope out are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent Lift up and telescope out while the Platform is overloaded.	
8639	86	39	FRONT LEFT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Front Left Steer Valve	Check Harness for damage.
8640	86	40	FRONT LEFT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Front Left Steer Valve	Check Harness for damage.
8641	86	41	FRONT LEFT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Front Left Steer Valve	Check Harness for damage.
8642	86	42	FRONT RIGHT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Front Right Steer Valve	Check Harness for damage.
8643	86	43	FRONT RIGHT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Front Right Steer Valve	Check Harness for damage.
8644	86	44	FRONT RIGHT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Front Right Steer Valve	Check Harness for damage.
8645	86	45	REAR LEFT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Rear Left Steer Valve	Check Harness for damage.
8646	86	46	REAR LEFT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Rear Left Steer Valve	Check Harness for damage.
8647	86	47	REAR LEFT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Rear Left Steer Valve	Check Harness for damage.
8648	86	48	REAR RIGHT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Rear Right Steer Valve	Check Harness for damage.
8649	86	49	REAR RIGHT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Rear Right Steer Valve	Check Harness for damage.
8650	86	50	REAR RIGHT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Rear Right Steer Valve	Check Harness for damage.
871	87	1	RETURN FILTER BYPASSED	Hydraulic Return Filter Clogged	Check Hydraulic Return Filter.
872	87	2	CHARGE PUMP FILTER BYPASSED	Charge Pump Filter Clogged	Check Charge Pump Filter.
873	87	3	MACHINE SAFETY SYSTEM OVERRIDE OCCURRED	MSSO = Active	Response described in MSSO Influence on Machine Operation section.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
998	99	8	EEPROM FAILURE - CHECK ALL SETTINGS	The Ground Module has reported an EEPROM failure.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start); reset the section of EEPROM where the failure occurred to defaults.
9910	99	10	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	The Platform Module software version is not compatible with the rest of the system.	Activate the platform alarm continuously Creep mode is active If Platform Mode is active, disable all Drive, Steer, and Boom functions and do not permit Machine Enable.
9914	99	14	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	The Platform Module software requires an update.	
9915	99	15	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	The Chassis Tilt Sensor gain calibration has been lost.	
9916	99	16	CHASSIS TILT SENSOR GAIN OUT OF RANGE	The Chassis Tilt Sensor gain calibration has become corrupted.	
9919	99	19	GROUND SENSOR REF VOLTAGE OUT OF RANGE	The Ground Module has reported that its sensor reference voltage is outside acceptable range.	Not reported during power-up.
9920	99	20	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	The Platform Module has reported that its sensor reference voltage is outside acceptable range.	Not reported during power-up.
9921	99	21	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY	The Ground Module has reported that its high side driver cutout failed.	
9922	99	22	PLATFORM MODULE FAILURE - HWFS CODE 1	The Platform Module has reported that the V(Low) FET has failed.	
9923	99	23	GROUND MODULE FAILURE - HWFS CODE 1	The Ground Module has reported that the V(Low) FET has failed.	
9924	99	24	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED	The machine is powered up and no model has been selected yet in the MACHINE SETUP menu	Display ??? or NO MODEL at Analyzer MACHINE SETUP menu MACHINE SETUP->MODEL NUMBER Do not report any other faults Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
9944	99	44	CURRENT FEEDBACK GAINS OUT OF RANGE	The factory set current feedback gains are out of range.	A gain of 1 is used for the factory gain(s) that was out of range; all functions shall be placed in Creep mode.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
9945	99	45	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	The factory set current feedback checksum is not correct.	
9979	99	79	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER	Temporary fault for the telematics project. The model needs to be a 600S or 1350S if not this fault will be generated and Platform controls will be prevented. This fault was to ensure that the software will only work for these two models.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).

6.10 DIAGNOSTIC TROUBLE CODE CHART- ADDITIONAL HEC FAULTS

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action
008	FUNCTIONS LOCKED OUT- SYSTEM POWERED DOWN	After 5 minutes, the HEC shall enable the Platform Alarm/Annunciation via UGM and display at HEC analyzer as active. After 10 additional minutes, the HEC shall open Main Contactor and trigger DTC008 via the UGM and Ground Display; the HEC shall also prohibit all functions; the HEC shall also command Engine Shutdown and prevent Engine Start	Machine is enabled or the engine is started within 10 minutes of the platform alarm being initially triggered; Power Cycle after 15 minutes	Activate function if < 15 minutes or cycle power to reset unattended alarm
0054	IMG MODULE - AT CURRENT LIMIT	HEC shall limit the machine to Creep speed	HEC detects that the IMG Current is < 540Arms for 15000ms (reported by IMG Module); Full speed permitted after controls are initialized	Determine if any wheel resistance exists that could contribute to maximum current draw (i.e. locked hub) or if environmental factors are contributing (i.e. steep grade, cold oil in hubs or hydraulic system)
23204	CHARGE INTERLOCK - INVALID SIGNAL	No response required	Power Cycled	Check that both Chargers are plugged in. Check wiring for both Charger interlock signals. Check interlock relay in both Chargers.
2538	FUNCTION PREVENTED - CHARGER CONNECTED	HEC shall prohibit all functions per Charger Interlock section	Not all of the trigger conditions are met	Check that both Chargers are plugged in. Check wiring for both Charger interlock signals. Check X314 & X314B and C04-8-2 & C05-8-2 for proper mating. Check interlock relay in both Chargers for proper functionality.
2589	TOWER PREVENTED - DRIVE SELECTED IN ELECTRIC MODE	HEC shall implement a hydraulic valve reduction of 50%	Not all of the trigger conditions are met	Verify that Drive is selected or if there is a faulty signal from the Joystick or Tower Switch.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

319	MAIN CONTACTOR - PERMANENTLY OFF	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify Main Contactor is not damaged.
				Verify that Main Contactor is properly connected, both coil (RL269) and power contacts (RL269-1 and RL269-2).
				Verify Main 84V fuse is intact (X265-X266).
				Verify auxiliary contacts in battery maintenance disconnect (SW269 & X542) that breaks the driver signal @ RL269-Pin 1.

3110	MAIN CONTACTOR - SHORT TO GROUND OR OPEN CIRCUIT	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify Main Contactor coil is properly connected (RL269=Pins 1 & 2).
				With power off and coil disconnected, check if there is a short or a low impedance from A16 to 84V B- (of IMG Controller) with battery maintenance disconnect On.
				Verify that coil resistance is approx. 1Kohm.
				If coil is properly connected and impedance is OK, Internal failure, replace module.

3111	MAIN CONTACTOR - SHORT TO BATTERY	If (Hybrid Mode = Electric or Hybrid), HEC / IMG Module shall command the Main Contactor open;
		
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify wiring and that no fault exists that would short 84V to the low-side of the contactor coil (RL269-Pin 1 & C06-A-16). 84V should be present on the high-side of the contactor coil (RL269-Pin 2).

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

3112	MAIN CONTACTOR – WAITING FOR MOTOR RPM TO BE ZERO	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions, and command engine shutdown
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			IMG Module not reporting 159	Exists if rotation is detected on the IMG before the Main Contactor is closed.
				Check that engine is not rotating before Main Contactor is closed.
				Check that IMG sensor cable is not disconnected at the IMG (X483) or at the Resolver Converter input (XCNA).

3212	MAIN CONTACTOR - WELDED OR MISWIRED	If (HybdMode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify that Main Contactor is properly connected at power contacts (RL269-1 and RL269-2) and that nothing is bridging across the contacts.
				With contactor disconnected, verify that internal contacts are not welded (reading short); High impedance should exist between the two power contacts (open-circuit).

4237	IMG MODULE TEMPERATURE - OUT OF RANGE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			HEC no longer detects Zapi code;
			
			Full speed permitted after controls are initialized
				Internal failure of IMG Controller temperature sensor. Replace Controller.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action
4238	IMG MODULE - TEMPERATURE TOO HIGH	If Not Charging Battery (HECFLGChrgMde = 0) HEC shall set machine to CREEP @ 95°C; If IMG Temp is >=105°C suspend all functions (Machine Enable = 0) IMG Module shall decrease allowed IMG Max Traction Current (0x203F) linearly between 85°C (100%) and 105°C (0%) If Charging Battery (HECFLGChrgMde = 1) HEC shall decrease allowed charge current [HECCTLIMGBatCurLmt] by 5% for every 1°C over 85°C; If IMG Temp is >=105°C disable charging. IMG Module shall decrease allowed IMG Max Braking Current [from 252Arms] linearly between 85°C(100%) and 105°C (0%).	[HEC no longer detects Zapi code and [HEC detects IGM Module temperature < 85°C for 500ms (reported by IMG Module) and Controls Initialized]]	Verify that IMG MODULE TEMP diagnostic temperature is displaying a reasonable temperature for the activity in process. Typically not > 85 ?. Check IMG Fan Fuse (Position 5, 15A) Check IMG FAN is operating properly: ON @ 65 ?/149 °F OFF @ 55 ?/131 149 °F Check IMG FAN wiring and relay, driven by HEC output CO3-J1-7.

4335	ENGINE RPM TOO HIGH	If (Hybrid Mode = Engine or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Engine or Hybrid), the HEC shall prohibit all functions;
		
		If (Hybrid Mode = Engine or Hybrid), the HEC shall command Engine Shutdown and prevent Engine Start;
			Power Cycled	Typically triggered when IMG is braking against the engine while driving downhill and engine over speeds due to braking load.
				Check diagnostic feedback from IMG Speed Sensor (IMG SPEED FDBK) & Engine Speed Sensor (ENGINE SPEED)

4378	ENGINE ONLY MODE ACTIVE	HEC shall disable Hybrid System. Place machine in CREEP	Power Cycled OR Hybrid Mode = Electric	Check HEC for Hybrid related DTCs when UGM reports DTC 674. Engine-Only Mode is response to a number of Hybrid related faults. This will point to another HEC triggered DTC that is simultaneously active.
4417	BATTERY POWER LOW	No response required	Not all of the trigger conditions are met	Verify that SOC% reading is < 20%. This is a normal response to Low SOC and is designed to notify the operator that the 84V battery is in need of charging, either by IMG or Wall-Charger.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action
4420	BATTERY DEEPLY DISCHARGED	No response required	Not all of the trigger conditions are met	Verify that SOC% reading is <5%. This is a normal response to VERY Low SOC and is designed to notify the operator that the 84V battery is in need of charging, either by IMG or Wall-Charger.

4431	BATTERY TEMPERATURE - TOO HIGH	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Battery temperature returns to within acceptable range, BATT HITEMP – 5 degrees
			
			Note: BATT HITEMP defined in High Battery Temperature section in SRD
				Verify that the top of the 84V stack battery is > 55 ? using SOC BAT TEMP diagnostic temperature reading.
				Verify SOC device temperature sensor wiring.
				
				Battery temperature increases with heavy charge and discharge currents. In high ambient temperatures <40 ? , the battery temperature is expected to be > 55 ? with heavy usage.

4434	ENGINE START FAILED - TOO MANY ATTEMPTS	If (Hybrid Mode = Engine or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Engine or Hybrid), the HEC shall prohibit all functions;
		
		If (Hybrid Mode = Engine or Hybrid), the HEC shall command Engine Shutdown and prevent Engine Start;
			Power Cycled	Cycle power and resume engine start process.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

4466	CONTROL VOLTAGE TOO LOW - SYSTEM SHUTDOWN	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Very that 12V starter battery is properly charged and that the DC/DC converter output is 13.5V while in Electric Mode.
				Check DC/DC fuse (FC456-1 & FC456-2) if no DC/DC output.
				Check 12V starter battery wiring.
				Check alternator output in Hybrid Mode
				Check DC/DC wiring in Electric Mode.

4467	CONTROL VOLTAGE TOO HIGH - SYSTEM SHUTDOWN	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Very that 12V starter battery is properly charged and that the DC/DC converter output is 13.5V while in Electric Mode.
				Check DC/DC fuse (FC456-1 & FC456-2) if no DC/DC output.
				Check 12V starter battery wiring.
				Check alternator output in Hybrid Mode
				Check DC/DC wiring in Electric Mode.

4468	CONTROL VOLTAGE TOO LOW	No response required	Power Cycled	Very that 12V starter battery is properly charged and that the DC/DC converter output is 13.5V while in Electric Mode. Check DC/DC fuse (FC456-1 & FC456-2) if no DC/DC output. Check 12V starter battery wiring. Check alternator output in Hybrid Mode Check DC/DC wiring in Electric Mode.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

4487	IMG TEMPERATURE - OUT OF RANGE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify that diagnostic reading IMG Temp is reporting a temperature out of range > 170°C.
				Check IMG Temperature sensor wiring with cable disconnected.
				Internal IMG sensor may be damaged. Check Ohm reading with DMM at X483B (IMG bell housing connector) Pins G & H:
				498 ohms @ 0C/32F
				538 ohms @ 10C/50F
				603 ohms @ 25C/77F
				635 ohms @ 32C/89.6F
				663 ohms @ 38C/100.4F

4488	IMG TEMPERATURE - TOO HIGH	If Not Charging Battery (HECFLGChrgMde = 0): HEC shall set machine to CREEP @ 150C); If IMG Temp is >=160°C suspend all functions (Machine Enable = 0). IMG Module shall decrease allowed IMG Max Traction Current (0x203F) linearly between 150°C (100%) and 170°C (0%) If Charging Battery (HECFLGChrgMde = 1): HEC shall decrease allowed charge current [HECCTLIMGBatCurLmt] by 5% for every 1°C over 140°C; If IMG Temp is >=160°C disable charging until < 140°C. IMG Module shall decrease allowed IMG Max Braking Current [from 252Arms] linearly between 150°C(100%) and 170°C (0%)).	[HEC no longer detects Zapi code and [HEC detects IGM temperature < 140°C for 500ms and Controls Initialized]]	Verify that IMG TEMP diagnostic temperature is displaying a reasonable temperature for the activity in process (i.e. ambient, long IMG run time in traction, charging, etc). Long-term Traction and Charging is typically in the range of 100-120 ?. Temperatures > 140 ? are possible on steep grades.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

4489	IMG MODULE - VOLTAGE OUT OF RANGE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			HEC no longer detects Zapi code;
			
			Full speed permitted after controls are initialized
				Verify diagnostic voltage IMG BAT VOLT or Measure DC voltage @ A1 (with DMM) with respect to 84V B- on IMG Controller during operation that caused this DTC to trigger; verify voltage spike to ≥ 116Vdc or voltage dip to ≤ 30C.
				Verify 84Vdc battery stack voltage.

4490	IMG SPEED SENSOR - NOT RESPONDING PROPERLY	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify diagnostic IMG SPEED FDBK to see if it matches IMG SPEED CMD.
				If DTC is triggered at startup with no rotation, verify that Resolver Converter connections are properly made and wiring is correct and not damaged (X346B, XCNB & XCNC).

4491	IMG SPEED SENSOR - RPM NOT AS EXPECTED	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify diagnostic IMG SPEED FDBK to see if it matches IMG SPEED CMD.
				IMG Speed should never be > 2600 RPM for all functions and applications. Functions will be 1800 or 2600 RPM.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

4492	IMG OUTPUT - OUT OF RANGE LOW	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Check IMG Phase connections U, V, W to the IMG Control Module for shorts, opens, loose connection or improper connection.
				Check disconnected cables for U, V, W short-circuit from center conduction to shield.
				If not a connection issue, Internal failure, replace module

4493	IMG OUTPUT - OUT OF RANGE HIGH	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Check IMG Phase connections U, V, W to the IMG Control Module for shorts or improper connection.
				If not a connection issue, Internal failure, replace module.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

4494	IMG MOTOR - STALLED	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Check for any impediment that could cause the IMG to not freely rotate.
				Check for hydraulic issues that would load down the IMG in Electric Mode or IMG/Engine in Hybrid Mode.
				Check for IMG SPEED FDBK to make sure it is not 0 RPM. If 0 RPM, check Resolver Converter and wiring (XCNA, XCNB, XCNC), as well as IMG Resolver wiring (X483).
				This results in high AC phase current with rotation not matching commanded speed.

4495	IMG MOTOR - ROTATION OPPOSITE CONTROL	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Check IMG and IMG Controller Phase wiring for proper U, V, W phasing.
				This is typically caused by two phases that are swapped.

4496	IMG MOTOR - OPEN CIRCUIT	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Check IMG Phase connections U, V, W to the IMG Control Module for opens or loose connection.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

44100	WRONG BATTERY STACK VOLTAGE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Check 84V battery state of charge, BATTERY SOC diagnostic.
				Check 84V Battery Voltage, SOC BAT VOLTAGE diagnostic.
				Check all 84V battery stack wiring.

44101	IMG MOTOR - FEED-BACK FAILURE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal controller failure. Replace controller.

44102	UNCOMMANED ENGINE RPM	If (Hybrid Mode = Electric), HEC shall suspend all functions & remove machine enable;
		
		If (Hybrid Mode = Electric), the HEC shall prohibit all functions, including machine enable;
			Power Cycled	Check clutch position to make sure it is not engaged in Electric Mode.
				Verify operation of H-bridge controller that drives the linear actuator to engage and disengage the clutch to make sure there is not impingement or binding of the linear actuator.
				Check linear actuator connections at H-bridge module (X387) and actuator (X389).
				Check H-bridge fuse, Position 19, 5A.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action
44103	BATTERY TEMPERATURE SENSOR #1 - OUT OF RANGE	No response required	Not all of the trigger conditions are met;	Verify connection at SN309 & X403. Verify fuse at FC419, 1A. Verify that battery temperature sensor @ 84V battery is properly connected and not damaged. 10K @ 25C, NTC, so as temperature goes down,resistance goes up and as temperature goes up, resistance goes down. Range: 674 ohms - 176Kohms (-30? to 60?/-22°F to 140°F).
44104	BATTERY TEMPERATURE SENSOR #2 - OUT OF RANGE	No response required	Not all of the trigger conditions are met;	Verify connection at SN310. Verify fuse at FC420, 1A. Verify that battery temperature sensor @ 48V battery is properly connected and not damaged. 10K @ 25C, NTC, so as temeprature goes down,resistance goes up and as temperature goes up, resistance goes down. Range: 674 ohms - 176Kohms (-30? to 60?/-22°F to 140°F).
44105	BATTERY TEMPERATURE SENSOR #3 - OUT OF RANGE	No response required	Not all of the trigger conditions are met;	Verify connection at SN311. Verify fuse at FC422, 1A. Verify that battery temperature sensor @ 36V battery is properly connected and not damaged. 10K @ 25C, NTC, so as temperature goes down,resistance goes up and as temperature goes up, resistance goes down. Range: 674 ohms - 176Kohms (-30? to 60?/-22°F to 140°F).
44106	BATTERY TEMPERATURE SENSOR #4 - OUT OF RANGE	No response required	Not all of the trigger conditions are met;	Verify connection at SN312. Verify fuse at FC423, 1A. Verify that battery temperature sensor @ 24V battery is properly connected and not damaged. 10K @ 25C, NTC, so as temperature goes down,resistance goes up and as temperature goes up, resistance goes down. Range: 674 ohms - 176Kohms
44108	CLUTCH ACTUATOR - SHORT TO BATTERY	HEC shall disable the Clutch Actuator; HEC shall limit the machine to Creep speed	Power Cycled	Verify wiring between H-Bridge controller and linear actuator, between connectors X387 and X389.
44109	CLUTCH ACTUATOR - SHORT TO GROUND	HEC shall disable the Clutch Actuator HEC shall limit the machine to Creep speed	Power Cycled	Verify wiring between H-Bridge controller and linear actuator, between connectors X387 and X389.
44110	CLUTCH ACTUATOR - OPEN CIRCUIT	HEC shall disable the Clutch Actuator; HEC shall limit the machine to Creep speed	Power Cycled	Verify wiring between H-Bridge controller and linear actuator, between connectors X387 and X389. Verify internal limit switches of linear actuator, at both end stops, are not damaged.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action
44111	CLUTCH ACTUATOR - CURRENT TOO HIGH	HEC shall disable the Clutch Actuator HEC shall limit the machine to Creep speed	Power Cycled	Verify that clutch actuator and clutch arm is not binding up. Verify that clutch actuator can move easily from extended to retracted and from retracted to extended. Verify CLUTCH ACTUATOR CURRENT in diagnostic is < 5A.

44112	ENGINE / IMG SPEED DISAGREEMENT	If (Hybrid Mode = Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Hybrid), the HEC shall prohibit all functions;
		If (Hybrid Mode = Hybrid), the HEC shall command Engine Shutdown and prevent Engine Start;
			Power Cycled	Verify that clutch is not slipping.
				Verify that cluch is not partially engaged.

44113	IMG OUTPUT - PHASE SHORT	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify IMG phase cables U, V, W and terminals are not shorted to each other or anything else.

44114	IMG MODULE - OVERLOAD	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify that hydraulic functions are not encountering additional resistance.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

44115	IMG MODULE – WAITING FOR POWER BRIDGE TO CLOSE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify that engine/IMG is not rotating before the Main Contactor is closed.

44116	SYSTEM VOLTAGE TOO LOW – SYSTEM SHUTDOWN	If (Hybrid Mode = Hybrid, HEC shall put all functions in Creep.
		If (Hybrid Mode = Electric, the HEC shall suspend and prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify 84V BATTERY SOC diagnostic.
				Recharge 84V Battery.

44117	STATE OF CHARGE SENSOR – FAULTY TEMPERATURE READING	HEC shall limit machine to creep speed; HEC shall prohibit charge and shutdown the engine (enable engine only mode); HEC shall assign SOC% to 'error / unknown'.	Power Cycled	Verify SOC BAT TEMP diagnostic. Potential internal SOC Device error. The difference between diagnostics BATTERY TEMP 1 and SOC BAT TEMP must be less than 15C for 20 sec.
44118	STATE OF CHARGE SENSOR – FAULTY VOLTAGE READING	HEC shall limit machine to creep speed; HEC shall prohibit charge and shutdown the engine (enable engine only mode); HEC shall assign SOC% to 'error / unknown'.	Power Cycled	Verify SOC BAT VOLTAGE diagnostic. Potential internal SOC Device error. The difference between diagnosticsIMG BAT VOLT and SOC BAT VOLTAGE must be less than 5V for 20 sec.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action
44119	STATE OF CHARGE SENSOR – FAULTY CURRENT READING	HEC shall limit machine to creep speed; HEC shall prohibit charge and shutdown the engine (enable engine only mode); HEC shall assign SOC% to 'error / unknown'.	Power Cycled	Verify SOC BAT TEMP diagnostic. Potential internal SOC Device error. The difference between diagnostics BATTERY TEMP 1 and SOC BAT TEMP must be less than 15C for 20 sec.
6665	CANBUS FAILURE - CLUTCH ACTUATOR MODULE	HEC shall limit the machine to Creep speed	HEC receives CAN messages from the Clutch Actuator Module.	Verify CAN 1 bus connector @ X387 and impedance of 60 ohms across CAN H and CAN L.. If not connection issue, internal H-Bridge Module failure. If this persists or causes the machine to not function properly, replace the module.
6666	CANBUS FAILURE - HYBRID ELECTRIC CONTROL MODULE		Not all of the trigger conditions are met.	Verify the CAN 1 bus connector C03-J2 Pins 9 & 10. Verify all connections at MS-385 CAN-T. Also verify impedance of 60 ohms across CAN H and CAN L.

6668	CANBUS FAILURE - INTEGRATED MOTOR GENERATOR MODULE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			HEC receives CAN messages from the IMG Module;
			
			Full speed permitted after controls are initialized
			
			IMG Module shall recover if CAN communication is re-established.
				Verify the CAN 2 bus connections at C06-A Pins 20 & 21.
				Verify connections at MS331 CAN-T.
				Verify impedance of 60 ohms across CAN H and CAN L.
				Verify battery maintenance disconnect is On.
				Verify 84V Enable fuse at FC457, 10A, located below battery maintenance switch.
				Verify signal at MiniTactor RL272 that feeds 84V logic power to C06-A Pin 1.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action
6669	CANBUS FAILURE - STATE OF CHARGE SENSOR	HEC shall limit machine to creep speed; HEC shall prohibit charge and shutdown the engine (enable engine only mode); HEC shall assign SOC% to 'error / unknown'.	Not all of the trigger conditions are met; Engine only mode available upon restart.	Verify fuse at FC356, 1A and power to the module X322 Pins 1 & 2. Verify the CAN 2 bus connections at X344 Pins G & H. Verify CAN 2 bus connection at X403. Verify CAN 2 bus connections X323 Pins A & B. Verify impedance of 60 ohms across CAN H and CAN L. Verify all connections at MS331.

99281	HYBRID FUNCTIONS LOCKED OUT - IMPROPER MOTOR PARAMETERS	If (HybridMode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal EEPROM error, replace module or reprogram motor parameters if proper tools are available.

99298	IMG MODULE - EEPROM FAILURE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal EEPROM error, replace module or reprogram motor parameters.

99299	IMG MODULE - PROTECTION FAILURE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (HybdMode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Logic Board Error, replace module.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action
99300	FUNCTIONS LOCKED OUT - IMG MODULE SOFTWARE VERSION IMPROPER	HEC shall suspend all functions; HEC shall prohibit all functions; HEC / IMG Module shall command the Main Contactor open; HEC shall command Engine Shutdown and prevent Engine Start	Power Cycled	Reprogram modules as required..

99301	IMG MODULE - CONTACTOR DRIVER FAILURE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99302	IMG MODULE - WATCHDOG RESET	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99303	IMG MODULE - RAM FAILURE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

99304	IMG MODULE - CHECK POWER CIRCUITS OR MOSFET SHORT CIRCUIT	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99305	IMG MODULE - DATA ACQUISITION ERROR	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99306	IMG MODULE - CURRENT FEEDBACK OUT OF RANGE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99307	IMG MODULE - WRONG LOGIC VOLTAGE AT POWER-ON	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

99308	IMG MODULE - CAPACITOR BANK FAULT	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Verify that no other path/load can sink current from the A1 pin on IMG Controller.
				If Internal Module Error, replace module.

99309	IMG MODULE - A/D FAILURE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99310	IMG MODULE - INTERNAL CANBUS FAILURE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99311	IMG MODULE - HARDWARE FAULT	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

99312	IMG MODULE - CURRENT MEASUREMENT ERROR	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99313	IMG MODULE - CURRENT FEEDBACK GAIN OUT OF RANGE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99314	IMG MODULE - INTERNAL ERROR	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99315	IMG MODULE - POWER MEASUREMENT ERROR	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action
99316	CLUTCH ACTUATOR MODULE - INTERNAL ERROR	HEC shall disable the Clutch Actuator; HEC shall limit machine to CREEP speed.	Power Cycled	Internal Module Error, replace module.

99318	IMG MODULE - VDC SHORTED	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99319	IMG MODULE - POSITIVE LC OPEN	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

99320	IMG MODULE - LC COIL OPEN	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

99321	IMG MODULE - EEPROM PARAMA-TER RESTORE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Result of clearing EEPROM so that values are set to default values.

99322	IMG MODULE - SIN COS FAILURE	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	TBD
				Internal Module Error, replace module.

99323	IMG MODULE - SIN COS SHORTED	If (Hybd Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	TBD
				Internal Module Error, replace module.

99324	IMG MODULE - SIN COS OVERLOAD	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	TBD
				Internal Module Error, replace module.

Table 6-12. Diagnostic Trouble Code Chart - Additional HEC Faults

DTC	JLG Help Message	Required Control Response or State Assignment[2,3]	Conditions Required for Movement and/or to Clear Fault	Corrective Action

99325	IMG MODULE - SIN COS OPEN	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	TBD
				Internal Module Error, replace module.

99326	IMG MODULE - SOFTWARE IMPROPER	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Reprogram modules as required..

99327	IMG MODULE - REDUNDANT SOFTWARE VERSION MISSMATCH	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Reprogram modules as required.

99331	IMG MODULE - SPEED CALCULATION MISMATCH	If (Hybrid Mode = Electric or Hybrid), HEC shall suspend all functions;
		
		If (Hybrid Mode = Electric or Hybrid), the HEC shall prohibit all functions;
		
		HEC / IMG Module shall command the Main Contactor open;
		If (Hybrid Mode = Engine), the HEC shall limit the machine to Creep speed after Controls initialized and trigger DTC 4378
			Power Cycled	Internal Module Error, replace module.

6.11 DIAGNOSTIC TROUBLE CODE CHART - HYBRID UGM

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
11	EVERYTHING OK	No response required for this DTC	N/A	
21	GROUND MODE OK	No response required for this DTC	N/A	
8	FUNCTIONS LOCKED OUT- SYSTEM POWERED DOWN	UGM shall activate Unattended Audible alarm and issue DTC. HEC shall issue DTC.	HECFLGUnAtndAlrm=0	
101	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION	UGM shall apply requirements in Drive/Steer Speed Reductions section. Drive speed is limited to "ELEVATED MAX" while the vehicle is out of transport position	Machine is not Out of Transport	
111	FSW OPEN	The UGM shall not Enable the Machine	Controls initialized	
121	RUNNING AT CREEP - CREEP SWITCH OPEN	The UGM shall limit the machine to Creep speed	Platform creep switch input = Low	
131	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	UGM shall limit the machine to Creep speed	Not all of the trigger conditions are met	

15	LOAD SENSOR READING UNDER WEIGHT	If the UGM determines that CLCPltfmLd > -22.7kg (-50lbs) for 5 seconds the fault is set not active.
		If 1-cell LSS Configured AND If [(DTC 0015 is active AND PltfmOvrLd_Wght == TRUE) AND (APUactive == FALSE AND HydCMDActive == TRUE)]
		Then
		SET all (Functions)OK_LSS = FALSE
		Else
		SET all (Functions)OK_LSS = TRUE
		End If
			Not all of the trigger conditions are met	

31	FUEL LEVEL LOW - ENGINE SHUTDOWN	Interlock requirements specified in Fuel Shutdown section.	Power Cycle	
39	SKYGUARD ACTIVE - FUNCTIONS CUTOUT	Refer to SkyGuard System Detailed Requirements and Logic section for machine response	Not all of the trigger conditions are met	
40	RUNNING AT CREEP - CREEP SWITCH CLOSED	All functions are limited to CREEP Speed	Not all of the trigger conditions are met	
211	POWER CYCLE	No response required	N/A	
212	KEYSWITCH FAULTY	The UGM assumes a station selection of Ground Mode	J7-3 or J7-2 = LOW	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
213	FSW FAULTY	Machine is not allowed to enter the Machine Enabled state	Power Cycle	
227	STEER SWITCHES FAULTY	UGM prohibits Steer Left and Right; Drive speed limited to Creep	UGM detects that both steer switches are not active at the same time; steer and full Drive speed permitted after controls are initialized	
2211	FSW INTERLOCK TRIPPED	The Machine Enabled state is disabled	The footswitch is released	
2212	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	If triggered by the drive joystick not being in the neutral position immediately following the startup period, then disable drive and steer. If triggered by a proper machine enable signal being received while the drive joystick is not in the neutral position, then do not allow the machine to enter the Machine Enabled state (7-second timer does not begin)	If triggered by the drive joystick not being in the neutral position immediately following Start Up, then when Drive joystick is returned to its neutral position and the machine is not in the Enabled state. If triggered by proper machine enable signal being received while the drive joystick is not in the neutral position then when the Drive joystick is returned to neutral or the footswitch is released	
2213	STEER LOCKED - SELECTED BEFORE FOOTSWITCH	UGM shall prohibit the machine from entering the Machine Enabled state (7-second timer does not begin)	When the steer controls are returned to neutral or the footswitch is released	
2214	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE			
2216	D/S JOY. OUT OF RANGE HIGH	UGM shall prohibit Drive; Steer still permitted	The PM no longer reports the fault	
2217	D/S JOY. CENTER TAP BAD	UGM shall prohibit Drive; Steer still permitted	The PM detects that the drive/steer center tap voltage is between 3.31 and 3.75 volts and no longer reports the fault to the UGM	
2219	L/S JOY. OUT OF RANGE HIGH	UGM shall disable Lift and Swing in Platform Mode.	The PM no longer reports the fault	
2220	L/S JOY. CENTER TAP BAD	UGM shall disable Lift and Swing in Platform Mode.	The PM detects that the lift/swing center tap voltage is between 3.31 and 3.75 volts and no longer reports the fault to the UGM	
2221	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	If fault occurs at startup, disable Lift and Swing in Platform Mode If fault occurs by receipt of a proper enable signal, then machine is not permitted to enter the Machine Enabled state (7-second timer does not begin).	If triggered by the Lift/Swing controls not being in the neutral position immediately following Start Up, then when Lift/Swing controls are returned to neutral and the machine is not in the Enabled state. If triggered by proper machine enable signal being received while the Lift/Swing controls are not in the neutral position, then when the Lift/Swing controls are returned to neutral or the footswitch is released.	
2222	WAITING FOR FSW TO BE OPEN	UGM shall prohibit the machine from entering the Machine Enabled state	Footswitch is disengaged	
2223	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE	Machine is not allowed to enter the Machine Enabled state (7-second timer does not begin)	None of the boom controls that trigger this fault are engaged or the Footswitch is disengaged.	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
2224	FOOTSWITCH SELECTED BEFORE START			
2269	FUNCTION PROBLEM - HIGH SPEED & CREEP ACTIVE TOGETHER			
2286	FUNCTION PROBLEM – SOFT TOUCH/SKYGUARD OVERRIDE PERMANENTLY SELECTED	No response required for this DTC	The Soft Touch / SkyGuard Override switch input = Low	
234	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	Disable whichever boom functions whose boom control inputs are triggering the fault. If Engine Start/Aux at fault, disable Manual Engine Start but permit Auxiliary Power/Emergency Descent.	None of the boom controls that trigger this fault have both of their direction inputs engaged at the same time	
236	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH			
237	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH	UGM shall prevent engine start	Not all of the trigger conditions are met	
23163	FUNCTION PROBLEM - MSSO PERMANENTLY SELECTED	No inhibits required; MSSO permitted if requirements of MSSO section are met	Function switch returns to neutral and the machine is not in the Enabled state.	
241	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE LOW	If the machine is in Platform Mode and above Elevation, UGM shall suspend motion and set Low Temperature Cutout state = Faulty; all functions limited to Creep speed after controls initialized If the Machine is in Platform Mode and Not Above Elevation, UGM shall suspend motion; all functions except Drive/Steer limited to Creep speed after controls initialized If the machine is in Ground Mode, no response required.	Ambient Temperature sensor reading > -50 °C; speed restrictions removed after controls are initialized	
242	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE HIGH	If the machine is in Platform Mode and above Elevation, UGM shall suspend motion and set Low Temperature Cutout state = Faulty; all functions limited to Creep speed after controls initialized If the Machine is in Platform Mode and Not Above Elevation, UGM shall suspend motion; all functions except Drive/Steer limited to Creep speed after controls initialized If the machine is in Ground Mode, no response required.	Ambient Temperature sensor reading < 85 °C; speed restrictions removed after controls are initialized	
259	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS	UGM shall suspend all machine functions and disable all outputs and prevent engine start.	Power Cycle	
2514	BOOM PREVENTED - DRIVE SELECTED	UGM shall disable all boom functions	Not all of the trigger conditions are met	
2516	DRIVE PREVENTED - ABOVE ELEVATION	UGM shall disable Drive and Steer	Not all of the trigger conditions are met	
2517	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	UGM shall provide functionality as they pertain to Drive and Steer	At least one of the trigger conditions is not met; then non-Creep function speed permitted after controls initialized.	
2518	DRIVE PREVENTED - BOOM SELECTED	UGM shall disable Drive and Steer	Not all of the trigger conditions are met	
2520	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER	All functions prohibited	Not all trigger conditions met	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
2530	UMS SENSOR FORWARD LIMIT REACHED			
2531	UMS SENSOR OUT OF USABLE RANGE			
2532	UMS SENSOR BACKWARD LIMIT REACHED			
2549	DRIVE & BOOM PRVENTED – SOFT TOUCH ACTIVE	Refer to Soft Touch System Detailed Requirements and Logic section for machine response	Not all trigger conditions met	
2563	SKYGUARD SW - DISAGREEMENT	Response detailed in SkyGuard section.	[{SkyGuard inputs (Platform Module J7-18 = High) and (Platform Module J1-23 = High)} and (Footswitch State = Not Depressed)]	
2568	TEMPERATURE CUTOUT ACTIVE - AMBIENT TEMPERATURE TOO LOW	If the machine is in Platform Mode and Above Elevation, UGM shall suspend motion and set Low Temperature Cutout state = Active; all functions limited to Creep speed after controls initialized If the Machine is in Platform Mode and Not Above Elevation, UGM shall suspend motion; all functions except Drive/Steer limited to Creep speed after controls initialized	Low Temperature Cutout = Inactive; speed restrictions removed after controls are initialized	
2576	PLATFORM LEVEL PREVENTED - ABOVE ELEVATION	The UGM shall prohibit Platform Level Up and Down override leveling	Not all of the trigger conditions are met	
2578	FUNCTION PREVENTED - TILTED & ABOVE ELEVATION	UGM shall provide functionality as they pertain to the hydraulic functions.	Not all trigger conditions met	
331	BRAKE - SHORT TO BATTERY			
332	BRAKE - OPEN CIRCUIT			
3311	GROUND ALARM - SHORT TO BATTERY			
3358	MAIN DUMP VALVE - SHORT TO GROUND	UGM shall suspend and prohibit UGM High Flow Dump, Swing, Tower Lift Up, and Lift Up.	Power Cycle	
3359	MAIN DUMP VALVE - OPEN CIRCUIT	UGM shall suspend and prohibit UGM High Flow Dump, Swing, Tower Lift Up, and Lift Up.	Power Cycle	
3360	MAIN DUMP VALVE - SHORT TO BATTERY	UGM shall suspend and prohibit UGM High Flow Dump, Swing, Tower Lift Up, and Lift Up.	Power Cycle	
3361	BRAKE - SHORT TO GROUND			
3362	START SOLENOID - SHORT TO GROUND	UGM shall disable starter output, disable charging, and prevent engine start	Power Cycle	
3363	START SOLENOID - OPEN CIRCUIT	No response required.	UGM no longer detects open circuit	
3364	START SOLENOID - SHORT TO BATTERY	UGM shall disable starter output, disable charging, command engine shutdown, and prevent engine start	Power Cycle	
3365	STEER DUMP VALVE - SHORT TO GROUND	UGM shall suspend Drive/Steer and shall limit Drive to Creep speed after controls initialized. UGM shall suspend and prohibit Steer (Low Flow) Dump, Steer, Flow Control, Tele, Jib Up, Platform Level, and Platform Rotate functions.	Power Cycle	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
3366	STEER DUMP VALVE - OPEN CIRCUIT	UGM shall suspend Drive/Steer and shall limit Drive to Creep speed after controls initialized. UGM shall suspend and prohibit Steer (Low Flow) Dump, Steer, Flow Control, Tele, Jib Up, Platform Level, and Platform Rotate functions.	Power Cycle	
3367	STEER DUMP VALVE - SHORT TO BATTERY	UGM shall suspend Drive/Steer and shall limit Drive to Creep speed after controls initialized. UGM shall suspend prohibit Steer (Low Flow) Dump, Steer, Flow Control, Tele, Jib Up, Platform Level, and Platform Rotate functions.	Power Cycle	
3368	TWO SPEED VALVE - SHORT TO GROUND			
3369	TWO SPEED VALVE - OPEN CIRCUIT			
3370	TWO SPEED VALVE - SHORT TO BATTERY			
3371	GROUND ALARM - SHORT TO GROUND	MACHINE SETUP → ALARM/HORN = SEPARATE: UGM shall prohibit J2-2 output.	Power Cycle	
3372	GROUND ALARM - OPEN CIRCUIT	MACHINE SETUP → ALARM/HORN = SEPARATE: No response required for this DTC.	Power Cycle	
3373	GEN SET/WELDER - SHORT TO GROUND			
3374	GEN SET/WELDER - OPEN CIRCUIT			
3375	GEN SET/WELDER - SHORT TO BATTERY			
3376	HEAD TAIL LIGHT - SHORT TO GROUND	UGM shall disable H&T Light relay output	Power Cycle	
3377	HEAD TAIL LIGHT - OPEN CIRCUIT	No response required.	The UGM no longer detects open circuit	
3378	HEAD TAIL LIGHT - SHORT TO BATTERY	UGM shall disable H&T Light relay output	Power Cycle	
3382	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	UGM shall disable Platform Level Up; Level Down speed shall be limited to Creep	Power Cycle	
3383	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	UGM shall suspend Platform Level; UGM shall limit Platform Level speed to Creep after controls initialized	UGM no longer detects open circuit; speed restrictions removed after controls are initialized	
3384	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	UGM shall disable UGM Platform Level and Flow Control valves	Power Cycle	
3388	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	UGM shall disable UGM Platform Level	Power Cycle	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
3389	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	UGM shall suspend Platform Level; UGM shall prohibit Platform Level Up and limit Platform Level Down speed to Creep after controls initialized	UGM no longer detects open circuit; Platform Level Up permitted and speed restrictions removed after controls are initialized	
3390	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	UGM disables Platform Level Up, Level Down, and Flow Control Valve outputs	Power Cycle	
3394	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND			
3395	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT			
3396	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY			
3397	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND			
3398	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT			
3399	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY			
33100	JIB LIFT UP VALVE - SHORT TO GROUND			
33101	JIB LIFT UP VALVE - OPEN CIRCUIT			
33102	JIB LIFT UP VALVE - SHORT TO BATTERY			
33103	JIB LIFT DOWN VALVE - SHORT TO GROUND			
33104	JIB LIFT DOWN VALVE - OPEN CIRCUIT			
33105	JIB LIFT DOWN VALVE - SHORT TO BATTERY			
33106	TOWER LIFT UP VALVE - SHORT TO GROUND	UGM disables Tower Lift Up output; Tower Lift Down speed limited to Creep after controls initialized	Power Cycle	
33107	TOWER LIFT UP VALVE - OPEN CIRCUIT	The UGM detects an open circuit at this output J2-33	The UGM shall suspend Tower Lift and revert to Open Loop Current control for Tower Lift; UGM shall limit Tower Lift speed to Creep after controls initialized	
33108	TOWER LIFT UP VALVE - SHORT TO BATTERY			
33109	TOWER LIFT DOWN VALVE - SHORT TO GROUND	UGM shall disable Tower Lift Up and Down	Power Cycle	
33110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT	The UGM shall suspend Tower Lift and revert to Open Loop Current control for Tower Lift; UGM shall prohibit Tower Lift Up and shall limit Tower Lift Down speed to Creep after controls initialized	UGM no longer detects open circuit; Tower Lift Up permitted and speed restriction removed for Tower Lift Down after controls are initialized	
33111	TOWER LIFT DOWN VALVE - SHORT TO BATTERY			

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
33112	TOWER TELESCOPE IN VALVE - SHORT TO GROUND			
33113	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT			
33114	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY			
33115	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND			
33116	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT			
33117	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY			
33118	SWING RIGHT VALVE - SHORT TO GROUND	UGM shall disable Swing Left and Right	Power Cycle	
33119	SWING RIGHT VALVE - OPEN CIRCUIT	The UGM shall suspend Swing and revert to Open Loop Current control for Swing; UGM shall limit Swing speed to Creep after controls initialized	UGM no longer detects open circuit; speed restriction removed after controls are initialized	
33120	MAIN TELESCOPE IN VALVE - SHORT TO BATTERY	UGM shall disable Telescope and Flow Control valves	Power Cycle	
33121	SWING RIGHT VALVE - SHORT TO BATTERY			
33122	SWING LEFT VALVE - SHORT TO GROUND	UGM shall disable Swing Left and Right	Power Cycle	
33123	MAIN TELESCOPE OUT VALVE - SHORT TO BATTERY	UGM shall disable Telescope and Flow Control valves	Power Cycle	
33170	MAIN LIFT DOWN VALVE - OPEN CIRCUIT			
33171	MAIN LIFT DOWN VALVE - SHORT TO BATTERY			
33172	MAIN LIFT DOWN VALVE - SHORT TO GROUND			
33182	MAIN LIFT VALVES - SHORT TO BATTERY			
33186	MAIN TELESCOPE OUT VALVE - OPEN CIRCUIT			
33188	MAIN TELESCOPE OUT VALVE - SHORT TO GROUND			
33189	MAIN TELESCOPE IN VALVE - OPEN CIRCUIT			
33190	MAIN TELESCOPE IN VALVE - SHORT TO GROUND			
33207	HORN - OPEN CIRCUIT			
33208	HORN - SHORT TO BATTERY			

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
33209	HORN - SHORT TO GROUND			
33267	ENGINE FUEL RELAY – OPEN CIRCUIT	UGM shall disable this output, command engine shutdown and prevent engine start UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
33268	ENGINE FUEL RELAY - SHORT TO BATTERY	Only detected at Startup UGM shall disable this output, command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
33269	ENGINE FUEL RELAY - SHORT TO GROUND	UGM shall disable this output, command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
33279	GLOWPLUG - OPEN CIRCUIT	No response required. Engine start will proceed without glow.	Power Cycle	
33280	GLOWPLUG - SHORT TO BATTERY	UGM shall disable Glow Plug relay output	Power Cycle	
33281	GLOWPLUG - SHORT TO GROUND	Before Start: UGM shall disable Glow Plug relay output and prohibit glow plug cycle. After	Power Cycle	
33287	LIFT - CURRENT FEEDBACK READING TOO LOW	UGM shall suspend Lift Up/Down command and revert to Open Loop Current control for Lift; Lift speed limited to Creep after both Lift Up/Down controls have been returned to neutral and machine is not Enabled	Power Cycle	
33295	SWING LEFT VALVE - OPEN CIRCUIT	The UGM shall suspend Swing command and revert to Open Loop Current control for Swing; UGM shall limit Swing speed to Creep after controls initialized	UGM no longer detects open circuit; restrictions on Swing speed shall be removed after controls are initialized	
33306	SWING LEFT VALVE - SHORT TO BATTERY			
33314	FLOW CONTROL VALVE - OPEN CIRCUIT			
33315	FLOW CONTROL VALVE - SHORT TO BATTERY			
33316	FLOW CONTROL VALVE - SHORT TO GROUND			
33317	DRIVE FORWARD VALVE - OPEN CIRCUIT			
33318	DRIVE FORWARD VALVE - SHORT TO BATTERY			
33319	DRIVE FORWARD VALVE - SHORT TO GROUND			
33320	DRIVE REVERSE VALVE - OPEN CIRCUIT			
33321	DRIVE REVERSE VALVE - SHORT TO BATTERY			
33322	DRIVE REVERSE VALVE - SHORT TO GROUND			
33323	MAIN LIFT UP VALVE - OPEN CIRCUIT			

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
33324	MAIN LIFT UP VALVE - SHORT TO BATTERY			
33325	MAIN LIFT UP VALVE - SHORT TO GROUND			
33331	DRIVE - CURRENT FEEDBACK READING TOO LOW			
33410	DRIVE - LOSS OF CURRENT FEEDBACK			
33412	SWING VALVES - SHORT TO BATTERY			
33414	SWING - CURRENT FEEDBACK READING TOO LOW	The UGM commanded current > 250mA The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	UGM shall suspend Swing Left/Right command and revert to Open Loop Current control for Swing; Swing speed limited to Creep after both Swing Left/Right have been returned to neutral and machine is not Enabled	
33415	FLOW CONTROL - CURRENT FEEDBACK READING TOO LOW	UGM shall suspend and revert to Open Current loop control for Flow Control Valve; Tele In/Out, Jib Up, Rotate Right/Left, and Level Up/Down speed limited to Creep after controls for those functions have all been simultaneously returned to neutral and machine is not Enabled	Power Cycle	
33417	LIFT - LOSS OF CURRENT FEEDBACK	UGM shall suspend Lift Up/Down command and revert to Open Loop Current control for Lift; Lift speed limited to Creep after both Lift Up/Down controls have been returned to neutral and machine is not Enabled	Power Cycle	
33418	SWING - LOSS OF CURRENT FEEDBACK	UGM shall suspend Swing Left/Right command and revert to Open Loop Current control for Swing; Swing speed limited to Creep after both Swing Left/Right have been returned to neutral and machine is not Enabled	Power Cycle	
33419	FLOW CONTROL - LOSS OF CURRENT FEEDBACK	UGM shall suspend and revert to Open Current loop control for Flow Control Valve; Tele In/Out, Jib Up, Rotate Right/Left, and Level Up/Down speed limited to Creep after controls for those functions have all been simultaneously returned to neutral and machine is not Enabled	Power Cycle	
33488	DRIVE VALVES - SHORT TO BATTERY			
341	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT			
342	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY			
343	PLATFORM LEVEL UP VALVE - SHORT TO GROUND			
344	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT			

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
345	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT			
346	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY			
347	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND			
348	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT			
349	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	The UGM shall suspend commands to PM for Platform Rotate; UGM shall limit Platform Rotate speed to Creep after controls are initialized	The PM no longer detects open circuit; speed restrictions shall be removed after controls are initialized	
3410	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	UGM shall disable commands to Platform Module for Platform Rotate and Flow Control valve outputs	Power Cycle	
3411	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	UGM shall disable commands to Platform Module for Platform Rotate Left	Power Cycle	
3412	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	The UGM shall suspend commands to PM for Platform Rotate; UGM shall limit Platform Rotate speed to Creep after controls are initialized	The PM no longer detects open circuit; speed restrictions shall be removed after controls are initialized	
3413	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	UGM shall disable commands to Platform Module for Platform Rotate and Flow Control valve outputs	Power Cycle	
3414	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	UGM shall disable commands to Platform Module for Platform Rotate Right	Power Cycle	
3415	JIB LIFT UP VALVE - OPEN CIRCUIT	The UGM shall command Platform Module to suspend Jib Lift; UGM shall limit Jib Lift speed to Creep after controls are initialized	The PM no longer detects open circuit; speed restrictions shall be removed after controls are initialized	
3416	JIB LIFT UP VALVE - SHORT TO BATTERY	UGM shall disable Jib Lift Up and Flow Control valve outputs; Jib Lift Down speed limited to Creep	Power Cycle	
3417	JIB LIFT UP VALVE - SHORT TO GROUND	The UGM shall command Platform Module to suspend Jib Lift outputs; UGM shall disable Jib Lift Up.	Power Cycle	
3418	JIB LIFT DOWN VALVE - OPEN CIRCUIT	UGM shall command PM to suspend Jib Lift; UGM shall prohibit Jib Lift Up and limit Jib Lift Down speed to Creep after controls are initialized	The PM no longer detects open circuit; speed restrictions shall be removed and motion permitted after controls are initialized	
3419	JIB LIFT DOWN VALVE - SHORT TO BATTERY	UGM shall command Platform Module to disable Jib Lift outputs	Power Cycle	
3420	JIB LIFT DOWN VALVE - SHORT TO GROUND	UGM shall command to Platform Module to disable Jib Lift outputs	Power Cycle	
431	FUEL SENSOR - SHORT TO BATTERY OR OPEN CIRCUIT	UGM shall respond with functionality detailed in the System Indicators and GenSet/Fuel sections	Power Cycle	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
432	FUEL SENSOR - SHORT TO GROUND	UGM shall respond with functionality detailed in the System Indicators and GenSet/Fuel sections	Power Cycle	
433	OIL PRESSURE - SHORT TO BATTERY	UGM shall illuminate the Engine Distress Lamp; If MACHINE SETUP -> ENGINE SHUTDOWN = ENABLED; UGM shall command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
435	COOLANT TEMPERATURE SHORT TO GROUND	UGM assumes maximum temperature exceeded; UGM shall illuminate the Engine Distress Lamp; If MACHINE SETUP -> ENGINE SHUTDOWN = ENABLED; UGM shall command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	All trigger conditions have been cleared	
438	HIGH ENGINE TEMP	UGM assumes maximum temperature exceeded; UGM shall illuminate the Engine Distress Lamp; If MACHINE SETUP -> ENGINE SHUTDOWN = ENABLED; UGM shall command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
4310	NO ALTERNATOR OUTPUT			
4311	LOW OIL PRESSURE	UGM shall illuminate the Engine Distress Lamp; If MACHINE SETUP -> ENGINE SHUTDOWN = ENABLED; UGM shall command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
4313	THROTILEACTUATORFAILURE			
4322	LOSS OF ENGINE SPEED SENSOR	UGM shall command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
4323	ENGINE SPEED SENSOR READING – INVALID	UGM shall command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
4326	FUEL ACTUATOR – SHORT TO GROUND	Only detected at Startup UGM shall disable this output, command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
4327	FUEL ACTUATOR - OPEN CIRCUIT	UGM shall disable this output, command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
4328	FUEL ACTUATOR - SHORT TO BATTERY	UGM shall disable this output and open low side FET. UGM shall command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
4330		UGM shall disable this output, command engine shut-down and prevent engine start	Power Cycle	
4353	ENGINE COOLANT TEMPERATURE SENSOR – OUT OF RANGE LOW	If MACHINE SETUP → ENGINE SHUTDOWN = ENABLED, UGM shall shut down engine and not permit engine start	Power Cycle	
4376	FUNCTIONS PREVENTED – ENGINE OIL WARM-UP ACTIVE	UGM shall display DTC upon HEC request; No further system response	HECFLGEngWrmUp=0	
4377	FUEL ACTUATOR FAILURE	UGM shall command engine shutdown and prevent engine start; UGM shall flash the Engine Distress Lamp at 3Hz	Power Cycle	
441	BATTERY VOLTAGE TOO LOW – SYSTEM SHUTDOWN	UGM shall command engine shutdown and prevent engine start; UGM shall prevent all functions; UGM shall disable the IMG	Power Cycle	
442	BATTERY VOLTAGE TOO HIGH – SYSTEM SHUTDOWN	UGM shall command engine shutdown and prevent engine start; UGM shall prevent all functions; UGM shall disable the IMG	Power Cycle	
443	LSS BATTERY VOLTAGE TOO HIGH	SET PltfmOvrLd_DTC = TRUE	Not all of the trigger conditions are met	
444	LSS BATTERY VOLTAGE TOO LOW	SET PltfmOvrLd_DTC = TRUE	Not all of the trigger conditions are met	
445	BATTERY VOLTAGE LOW			
4434	ENGINE START FAILED – TOO MANY ATTEMPTS			
4479	LSS BATTERY VOLTAGE – INITIALIZATION ERROR	SET PltfmOvrLd_DTC = TRUE	Power Cycle	
4480	LSS BATTERY VOLTAGE – NOT CALIBRATED	SET PltfmOvrLd_DTC = TRUE	Power Cycle	
662	CANBUS FAILURE – PLATFORM MODULE			
663	CANBUS FAILURE – LOAD SENSING SYSTEM MODULE	SET PltfmOvrLd_DTC = TRUE SET PltfmGrs1SnsrOK = FALSE SET PltfmGrs2SnsrOK = FALSE	Not all of the trigger conditions are met	
664	CANBUS FAILURE – ACCESSORY MODULE	If in Platform mode, UGM shall suspend all machine functions and disable all outputs. Jib Lift and Platform Rotate also disable in Ground Mode. If MACHINE SETUP → POWER INVERTER = YES, UGM to retain state of Inverter switch and GenSet Enable switch at the state prior to CAN1 loss until CAN1 is restored or Power Cycle.	CAN1 messages are received from the PM and controls are initialized	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
6620	UMS SENSOR COMMUNICATIONS LOST			
6622	CANBUS FAILURE – TCU MODULE	No function inhibits required	Not all of the trigger conditions are met	
6623	CANBUS FAILURE – GATEWAY MODULE	No function inhibits required	Not all of the trigger conditions are met	
6629	CANBUS FAILURE – TELEMATICS CANBUS LOADING TOO HIGH	No function inhibits required	Zero Configuration Status (Status Byte = 00) sent on first byte	
6635	CANBUS FAILURE – CHASSIS TILT SENSOR	For Tilt and Grade considerations (machine tilted), display ?? on Analyzer for X/Y axes, and externally report X and Y axes = 20°	CAN1 messages are received from the sensor and controls are initialized	
6651	CANBUS FAILURE – GROUND DISPLAY	No response required	CAN1 messages are received from the sensor and controls are initialized	
6657	CANBUS FAILURE – TEMPERATURE SENSOR	No response required	CAN1 messages are received from the sensor and controls are initialized	
6666	CANBUS FAILURE – HYBRID ELECTRIC CONTROL MODULE	UGM shall suspend all functions; If Engine State = Running, the UGM shall limit the machine to Creep speed after Controls initialized	CAN1 messages are received from the HEC and controls are initialized	
6666	CANBUS FAILURE – STATE OF CHARGE SENSOR	UGM Shall assign SOC% to an "unknown value" UGM shall flash all 4 bar displays (PLT and GND) and display '???' in place of GND SOC reading.	CAN1 messages are received from the sensor	
674	HYBRID ELECTRIC CONTROL DTC ACTIVE	No response required	Not all of the trigger conditions are met	
681	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP	UGM shall limit all machine function speeds to Creep and lock in Transport position	Cleared by ClearSky TCU	
813	CHASSIS TILT SENSOR NOT CALIBRATED	UGM shall consider the Chassis Tilt reading to be unhealthy	Chassis Tilt sensor calibrated	
814	CHASSIS TILT SENSOR OUT OF RANGE	UGM shall consider the Chassis Tilt reading to be unhealthy	Not all of the trigger conditions are met	
816	UMS SENSOR NOT CALIBRATED			
817	UMS SENSOR FAULT			
818	TILT SENSOR STAGNANT	UGM shall consider the Chassis Tilt reading to be unhealthy	Power Cycle	
825	LSS HAS NOT BEEN CALIBRATED	SET PltfmOvrLd_DTC = TRUE SET PltfmLdSnsrOK_DTC = TRUE	Not all of the trigger conditions are met	
826	RUNNING AT CREEP - PLATFORM OVERLOADED	The UGM shall set Platform Load State = Overloaded and provide the operation/interlocks described Load Sensing System section	UGM determines that the Platform is not Overloaded; motion restrictions removed after controls initialized	
827	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED	The Platform is Overloaded and Machine Setup → LOAD SYSTEM = CUTOUT PLATFORM, Platform Mode is active, and conditions of Table 6-7 apply. -or- The Platform is Overloaded and Machine Setup → LOAD SYSTEM = CUTOUT ALL and conditions of Table 6-7 apply.	Refer to Table 6-7 for machine response.	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
828	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED			
8211	LSS READING UNDER WEIGHT	SET PltfmOvrLd_DTC = TRUE	Power Cycle	
8218	LSS SENSOR DISAGREEMENT	If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If	Power Cycle	
8222	LSS STRAIN GAUGE 1 - STAGNANT	If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8223 – LSS STRAIN GUAGE 2 - STAGNANT is active) or (PltfmGrs2SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8223	LSS STRAIN GAUGE 2 - STAGNANT	If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8222 – LSS STRAIN GUAGE 1 - STAGNANT is active) or (PltfmGrs1SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8224	LSS STRAIN GAUGE 1 - OUT OF RANGE LOW	SET PltfmGrs1SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8223 – LSS STRAIN GUAGE 2 - STAGNANT is active) or (PltfmGrs2SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
8225	LSS STRAIN GAUGE 2 - OUT OF RANGE LOW	SET PltfmGrs2SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8222 – LSS STRAIN GUAGE 1 - STAGNANT is active) or (PltfmGrs1SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8226	LSS STRAIN GAUGE 1 - OUT OF RANGE HIGH	SET PltfmGrs2SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8222 – LSS STRAIN GUAGE 1 - STAGNANT is active) or (PltfmGrs1SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8227	LSS STRAIN GAUGE 2 - OUT OF RANGE HIGH	SET PltfmGrs2SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8222 – LSS STRAIN GUAGE 1 - STAGNANT is active) or (PltfmGrs1SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8228	LSS STRAIN GAUGE 1 - INITIALIZATION ERROR	SET PltfmGrs1SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8223 – LSS STRAIN GUAGE 2 - STAGNANT is active) or (PltfmGrs2SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
8229	LSS STRAIN GAUGE 2 - INITIALIZATION ERROR	SET PltfmGrs2SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8222 – LSS STRAIN GUAGE 1 - STAGNANT is active) or (PltfmGrs1SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8230	LSS STRAIN GAUGE 1 - NOT CALIBRATED	SET PltfmGrs1SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8223 – LSS STRAIN GUAGE 2 - STAGNANT is active) or (PltfmGrs2SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8231	LSS STRAIN GAUGE 2 - NOT CALIBRATED	SET PltfmGrs2SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8222 – LSS STRAIN GUAGE 1 - STAGNANT is active) or (PltfmGrs1SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8232	LSS STRAIN GAUGE 1 - SENSOR DEFECT	SET PltfmGrs1SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8223 – LSS STRAIN GUAGE 2 - STAGNANT is active) or (PltfmGrs2SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
8233	LSS STRAIN GAUGE 2 - SENSOR DEFECT	SET PltfmGrs2SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8222 – LSS STRAIN GUAGE 1 - STAGNANT is active) or (PltfmGrs1SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8234	LSS STRAIN GAUGE 1 - NOT INSTALLED	SET PltfmGrs1SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8223 – LSS STRAIN GUAGE 2 - STAGNANT is active) or (PltfmGrs2SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8235	LSS STRAIN GAUGE 2 - NOT INSTALLED	SET PltfmGrs2SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8222 – LSS STRAIN GUAGE 1 - STAGNANT is active) or (PltfmGrs1SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8236	LSS NOT DETECTING CHANGE	SET PltfmOvrLd_DTC == TRUE	Power Cycle	
8237	LSS STRAIN GAUGE 1 - A/D DEFECT	SET PltfmGrs1SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE} Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8223 – LSS STRAIN GUAGE 2 - STAGNANT is active) or (PltfmGrs2SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
8238	LSS STRAIN GAUGE 2 - A/D DEFECT	SET PltfmGrs2SnsrOK = FALSE If {PltfmOvrLd_Wght == FALSE and MachineConfigLdSysActive == TRUE } Then SET LSSCreep_DTC = TRUE End If If [(DTC 8218 – LSS SENSOR DISAGREEMENT or DTC 8222 – LSS STRAIN GUAGE 1 - STAGNANT is active) or (PltfmGrs1SnsrOK == FALSE)] Then SET PltfmOvrLd_DTC = TRUE End If	Power Cycle	
8639	FRONT LEFT STEER VALVE - OPEN CIRCUIT	UGM shall limit Drive and Steer speed to Creep	UGM no longer detects open circuit; Creep restriction removed after fault clears and controls initialized	
8640	FRONT LEFT STEER VALVE - SHORT TO BATTERY	UGM shall disable Drive and Steer	Power Cycle	
8641	FRONT LEFT STEER VALVE - SHORT TO GROUND	UGM shall disable Steer Left and Right outputs and limit Drive to Creep	Power Cycle	
8642	FRONT RIGHT STEER VALVE - OPEN CIRCUIT	UGM shall limit Drive and Steer speed to Creep	UGM no longer detects open circuit; Creep restriction removed after fault clears and controls initialized	
8643	FRONT RIGHT STEER VALVE - SHORT TO BATTERY	UGM shall disable Drive and Steer	Power Cycle	
8644	FRONT RIGHT STEER VALVE - SHORT TO GROUND	UGM shall disable Steer Left and Right outputs and limit Drive to Creep	Power Cycle	
8645	REAR LEFT STEER VALVE - OPEN CIRCUIT			
8646	REAR LEFT STEER VALVE - SHORT TO BATTERY			
8647	REAR LEFT STEER VALVE - SHORT TO GROUND			
8648	REAR RIGHT STEER VALVE - OPEN CIRCUIT			
8649	REAR RIGHT STEER VALVE - SHORT TO BATTERY			
8650	REAR RIGHT STEER VALVE - SHORT TO GROUND			
873	MACHINE SAFETY SYSTEM OVERRIDE OCCURRED	Machine response as described in the MSSO section	Fault shall be considered active and retained through power cycle; reset only via Analyzer/Calibrations	
998	EEPROM FAILURE - CHECK ALL SETTINGS	UGM shall suspend all machine functions and disable all outputs and reset the section of EEPROM where the failure occurred to defaults (if occurs to MACHINE SETUP, reset to NO MODEL???)	Power Cycle	
9910	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	UGM shall suspend all machine functions and disable all outputs and activate the platform alarm continuously. If in Platform mode, disable all Drive, Steer, and Boom functions; otherwise, restrict functions to Creep	Not all of the trigger conditions are met	
9914	PLATFORM MODULE SOFTWARE UPDATE REQUIRED			
9919	GROUND SENSOR REF VOLTAGE OUT OF RANGE	UGM shall command engine shutdown and disable engine start operations; otherwise, no interlocks required.	Power Cycle	
9920	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	UGM shall suspend motion. If in Platform mode, all function speeds shall be limited to Creep	Power Cycle	

Table 6-13. Diagnostic Trouble Code Chart - Hybrid UGM

DTC	JLG Help Message	Required Control Response or State Assignment	Conditions Required for Movement and/or to Clear Fault	Corrective Action
9921	GROUND MODULE FAILURE:HIGH SIDE DRIVER CUTOUT FAULTY	UGM shall suspend all machine functions and disable all outputs. UGM shall prohibit the machine from entering the Machine Enabled state (7-second timer does not begin)	Power Cycle	
9922	PLATFORM MODULE FAILURE: HWFS CODE 1	No response required.	Power Cycle	
9923	GROUND MODULE FAILURE: HWFS CODE 1			
9924	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED	UGM shall suspend all machine functions and disable all outputs. UGM shall display ??? or NO MODEL at Analyzer MACHINE SETUP menu MACHINE SETUP→MODEL NUMBER; UGM shall not report any other faults and shall disable all machine functions	Power Cycle	
9944	CURRENT FEEDBACK GAINS OUT OF RANGE	A gain of 1 is used for the factory gain(s) that was out of range; all functions shall be placed in Creep mode.	Power Cycle	
9945	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	UGM shall suspend all machine functions and disable all outputs	Power Cycle	
9979	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER	UGM shall suspend all machine functions and disable all outputs. (i.e., command engine shutdown and do not permit start)	Power Cycle	
99285	LSS - FACTORY CALIBRATION ERROR	SET PltfmOvrLd_DTC == TRUE	Power Cycle	

SECTION 7. BASIC ELECTRICAL INFORMATION & ELECTRICAL SCHEMATICS

7.1 GENERAL

This section contains basic electrical information and schematics to be used for locating and correcting most of the operating problems which may develop. If a problem should develop which is not presented in this section or which is not corrected by listed corrective actions, technically qualified guidance should be obtained before proceeding with any maintenance.

NOTE: *Some of the procedures/connectors shown in this section may not be applicable to all models.*

7.2 MULTIMETER BASICS

A wide variety of multimeters or Volt Ohm Meters (VOM) can be used for troubleshooting your equipment. This section shows diagrams of a common, digital VOM configured for several different circuit measurements. Instructions for your VOM may vary. Please consult the meter operator's manual for more information.

Grounding

"Grounding the meter" means to take the black lead (which is connected to the COM (common) or negative port) and touch it to a good path to the negative side of the Voltage source.

Backprobing

To "backprobe" means to take the measurement by accessing a connector's contact on the same side as the wires, the back of the connector. Readings can be done while maintaining circuit continuity this way. If the connector is the sealed type, great care must be taken to avoid damaging the seal around the wire. It is best to use probes or probe tips specifically designed for this technique, especially on sealed connectors. Whenever possible insert probes into the side of the connector such that the test also checks both terminals of the connection. It is possible to inspect a connection within a closed connector by backprobing both sides of a connector terminal and measuring resistance. Do this after giving each wire a gentle pull to ensure the wires are still attached to the contact and contacts are seated in the connector.

Min/Max

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

Polarity

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

Scale

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

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

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

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

Example: 1.2 kW = 1200 W
Example: 50 mA = 0.05 A

Voltage Measurement

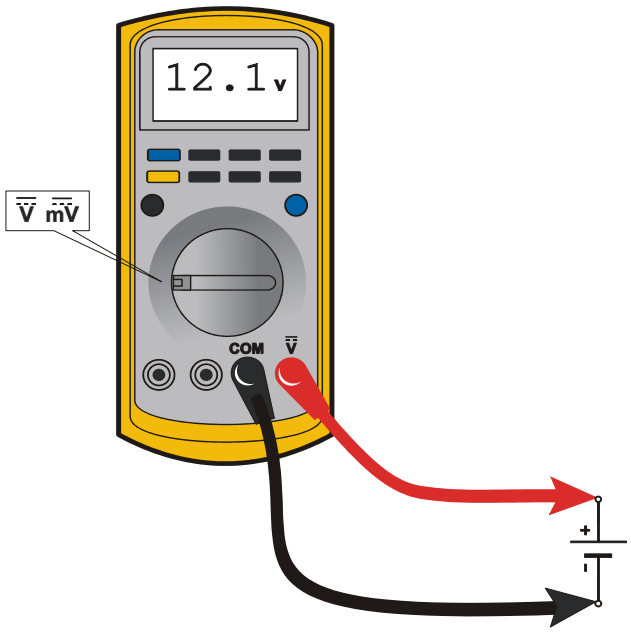


Figure 7-1. Voltage Measurement (DC)

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

Resistance Measurement

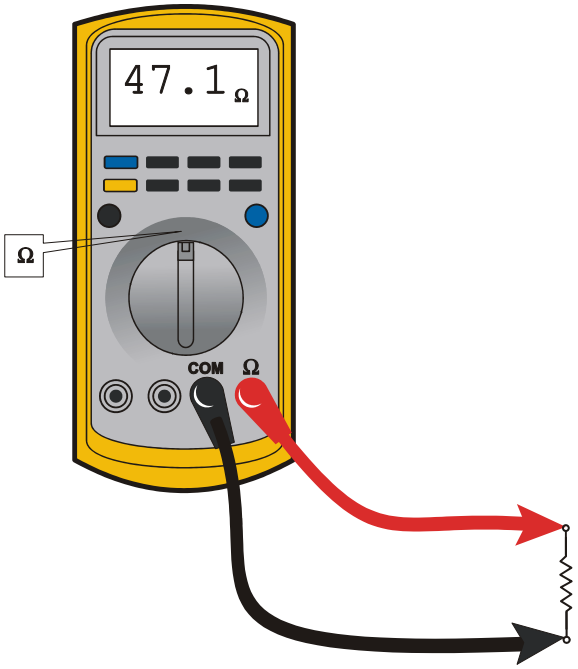


Figure 7-2. Resistance Measurement

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

Continuity Measurement

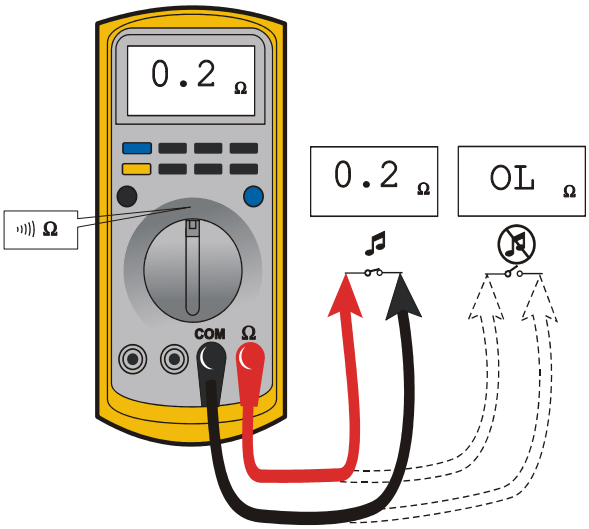


Figure 7-3. Continuity Measurement

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

Current Measurement

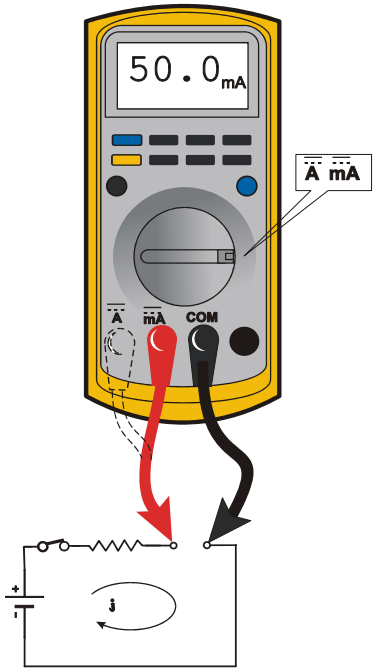


Figure 7-4. Current Measurement (DC)

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

7.3 APPLYING SILICONE DIELECTRIC COMPOUND TO ELECTRICAL CONNECTIONS

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

NOTICE

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

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

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

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

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

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

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

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

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

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

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

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

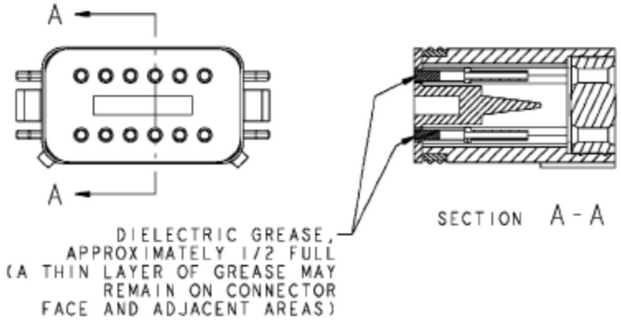
When applied to electrical connections, dielectric grease helps to prevent corrosion of electrical contacts and improper conductivity between contacts from moisture intrusion. Open and sealed connectors benefit from the application of dielectric grease.

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

Installation of Dielectric Grease

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

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



Deutsch HD, DT, DTM, DRC Series

The Deutsch connector system is commonly used for harsh environment interconnect. Follow the installation instructions.



AMP Seal

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

Apply dielectric grease to the male contact. If trapped air prevents the connector from latching, pierce one of the unused wire seals. After assembly, install a seal plug (JLG #4460905) to prevent moisture ingress.

Note that seal plugs may be installed by the wire harness manufacturer if an unused wire seal becomes compromised (wire inserted in the wrong cavity during assembly and then corrected).



Figure 7-5. Application to plug/male connector housing

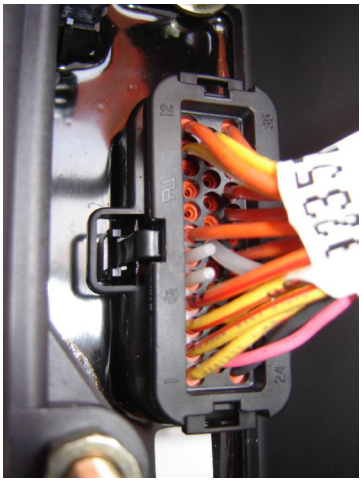
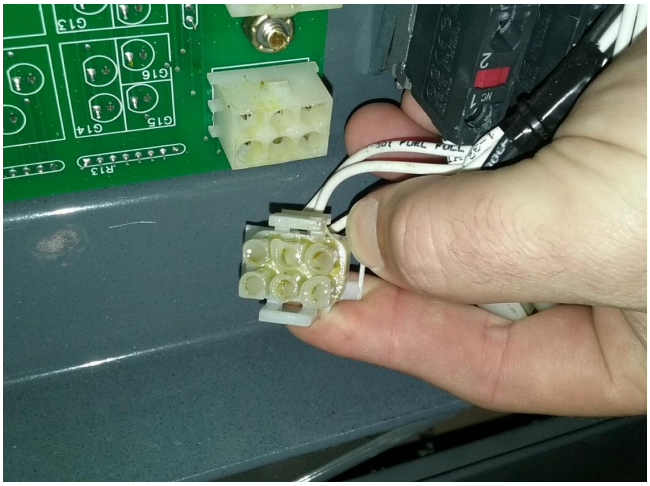


Figure 7-6. Use of Seal Plugs

AMP Mate-N-Lok

Follow the installation instructions.



DIN Connectors

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



Exclusions

A limited number of connectors do not benefit from dielectric grease, or may be permanently damaged by application. Dielectric grease may not be required in properly sealed enclosures.

Brad Harrison / Phoenix Contact M12

The connector uses gold contact material to resist corrosion and an o-ring seal for moisture integrity. If dielectric grease is mistakenly applied to this connector system, the low-force contacts cannot displace the grease to achieve electrical contact. Once contaminated, there is no practical way to remove the dielectric grease (replacement of female contacts required). The JLG Load Sensing System and 1250AJP Rotary Angle Sensors are examples of components with the M12 connector system.



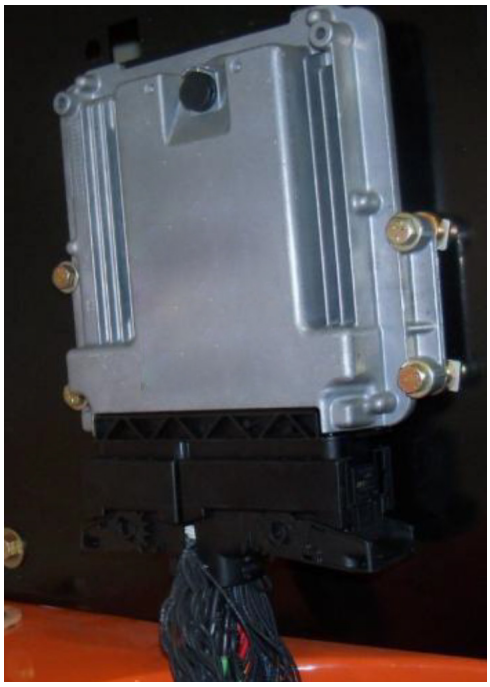
Figure 7-7. Brad-Harrison M12



Figure 7-8. Phoenix Contact M12

Engine Control Unit Connectors

This type of connector uses back-seals for moisture integrity. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease. The EMR2 engine control module from Deutz employs this connector system (for example).



Sealed Enclosures

Application of dielectric grease is not required in properly sealed enclosures. To meet criteria, the enclosure must be rated to at least IP66 (dust tight; protected from powerful jets of water). The enclosure must be fitted with a high quality, continuous gasket and all wiring must pass through cable entrances.



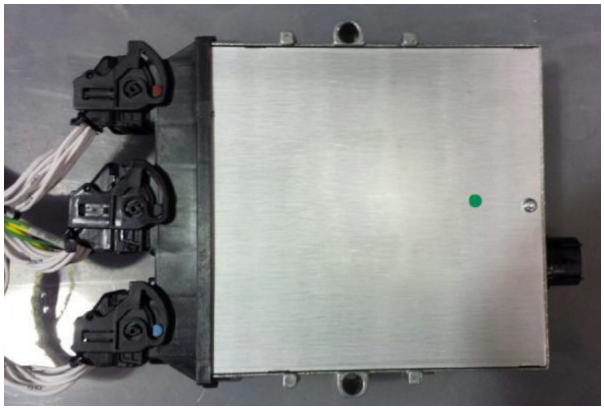
MIL-C-5015 Spec Connector's

Crown Connector Inc's recommendation is to not use dielectric grease for this series connector. For similar model series connectors, the manufacturer should be contacted for confi mation before applying dielectric grease. A typical application for this connector is on David Clark Intercom connections in Aerial Work Platforms.



Molex CMC Series Connectors

The CMC connector family is a sealed, high-density connection system using matte-seal technology for CP 0.635 and 1.50 mm terminals. To guarantee IP6K7 and IP6K9 sealing, a seal plug option is used. However, the low-force contacts cannot displace dielectric grease and create electrical contact. It is possible to use solvents (i.e. contact cleaner or mineral spirits) for the removal of improperly applied dielectric grease. The flexbox control modules from JDES employ this connector system (for example).



7.4 AMP CONNECTOR

Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

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

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on the inside of the connector after the mating of the housing to the header. This is easily achieved by using a syringe to fill the header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling the housing to the header, it is possible that the housing will become air locked, thus preventing the housing latch from engaging.
2. Pierce one of the unused wire seals to allow the trapped air inside the housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 7-9.). Proceed as follows:

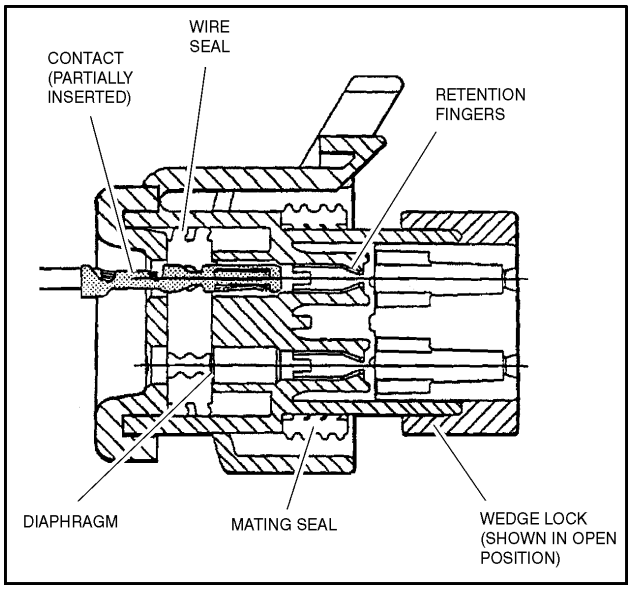


Figure 7-9. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-11.).
2. Pull back on the contact wire with a force of 1 or 2 lbs. to be sure the retention fingers are holding the contact (See Figure 7-11.)

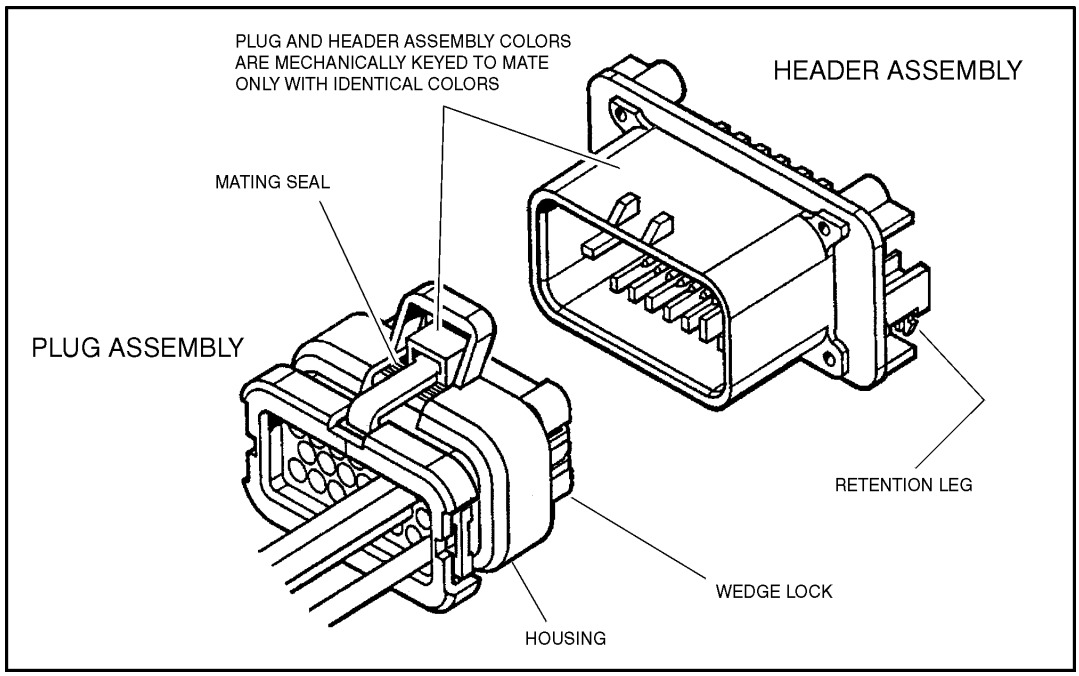


Figure 7-10. AMP Connector

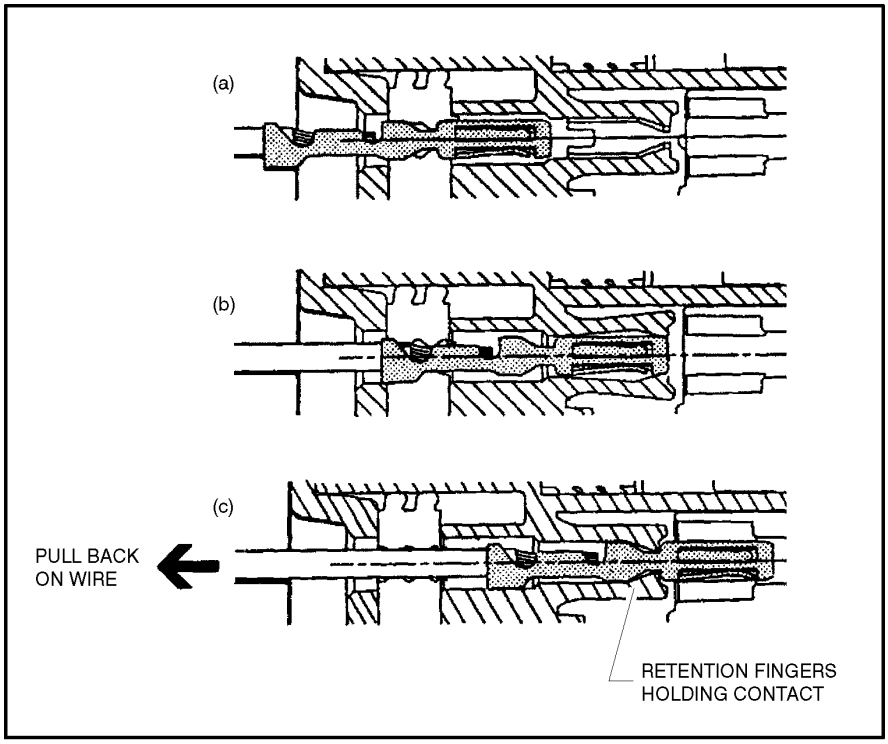


Figure 7-11. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (See Figure 7-12.).

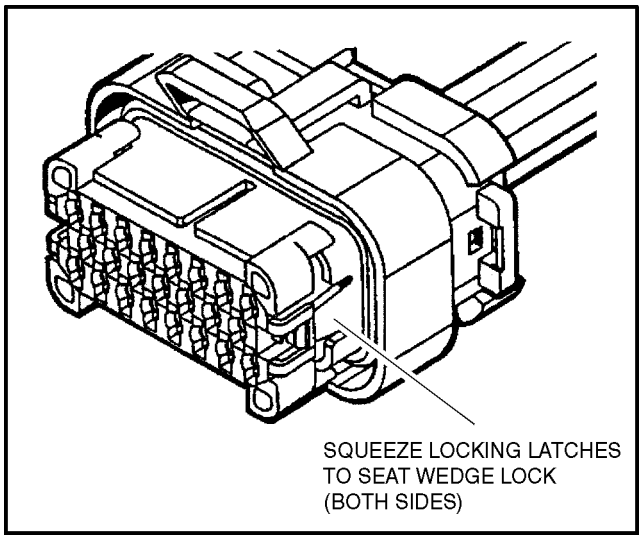


Figure 7-12. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-13.).

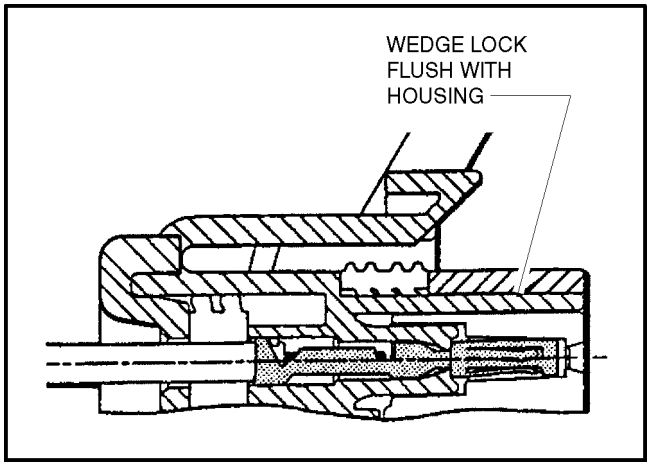


Figure 7-13. Connector Assembly Figure 4

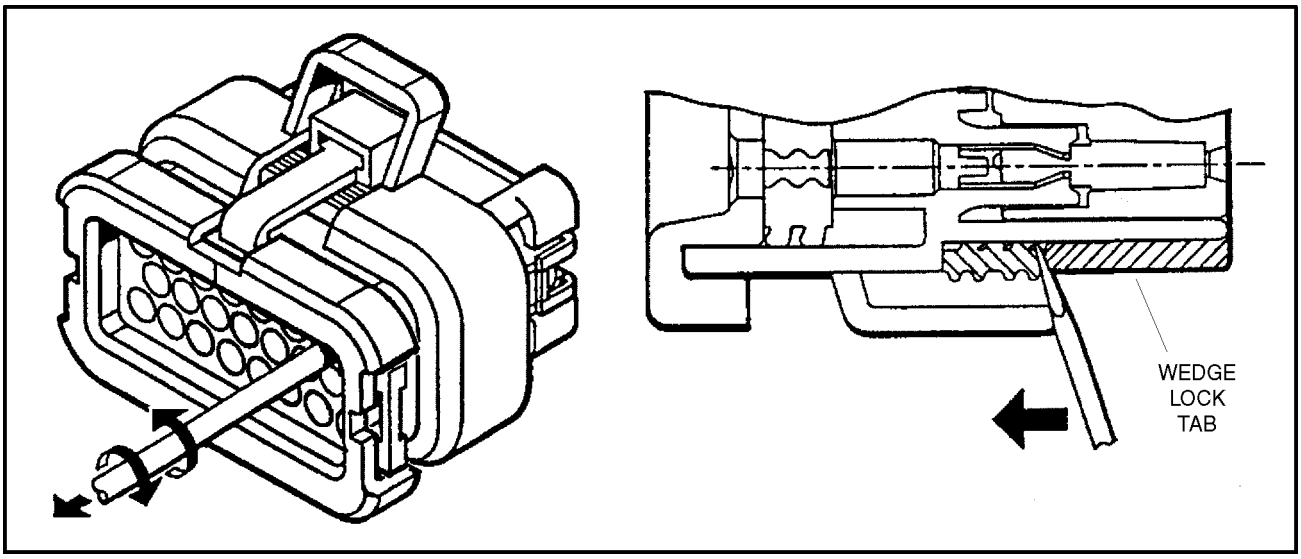


Figure 7-14. Connector Disassembly

Disassembly

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

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

Wedge Lock

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

Service - Voltage Reading

NOTICE

DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the AMPSEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

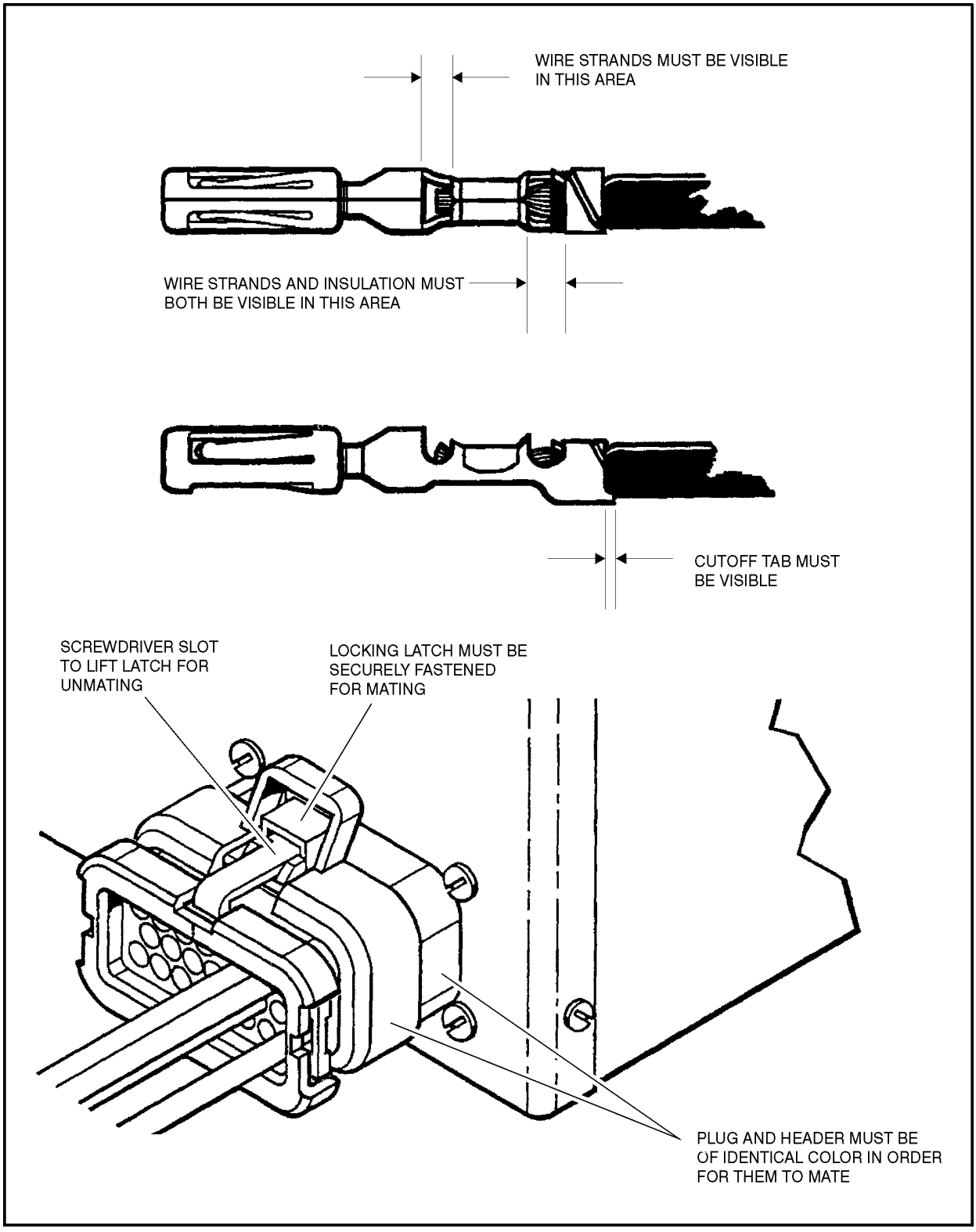


Figure 7-15. Connector Installation

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

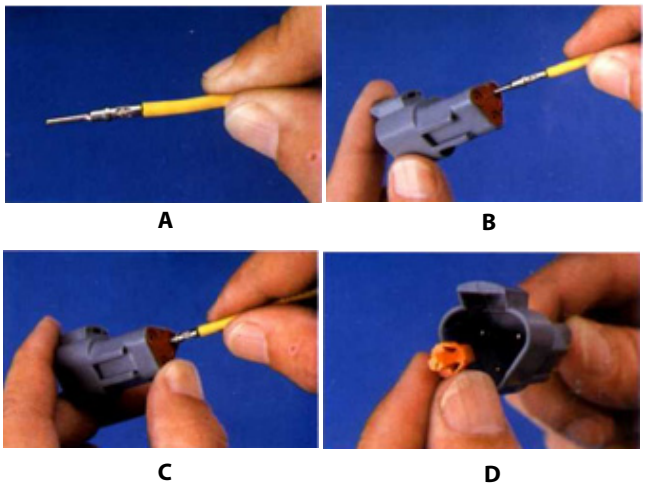


Figure 7-16. DT/DTP Contact Installation

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

NOTE: *The receptacle is shown - use the same procedure for plug.*

DT/DTP Series Disassembly

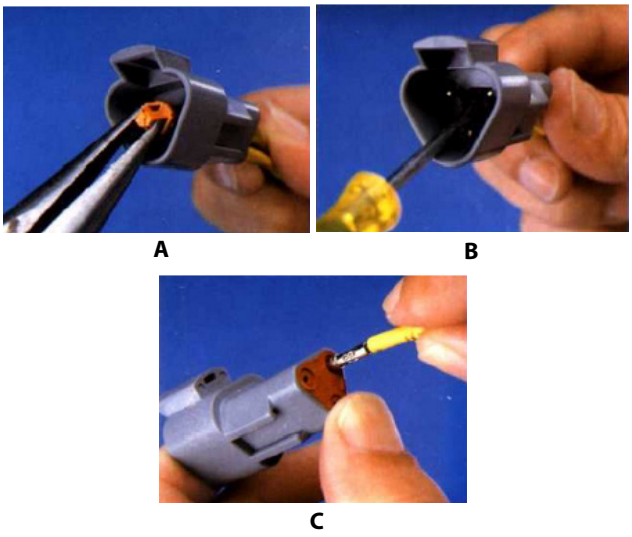


Figure 7-17. DT/DTP Contact Removal

5. Remove wedgelock using needlenose pliers or a hook shaped wire to pull wedge straight out.
6. To remove the contacts, gently pull wire backwards, while at the same time releasing the locking finger by moving it away from the contact with a screwdriver.
7. Hold the rear seal in place, as removing the contact may displace the seal.

HD30/HDP20 Series Assembly

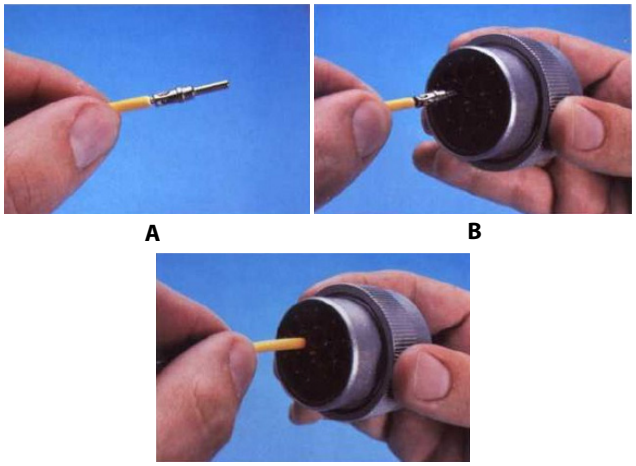


Figure 7-18. HD/HDP Contact Installation

8. Grasp contact about 25mm behind the contact crimp barrel.
9. Hold connector with rear grommet facing you.
10. Push contact straight into connector grommet until a positive stop is felt. A slight tug will confirm that it is properly locked in place.

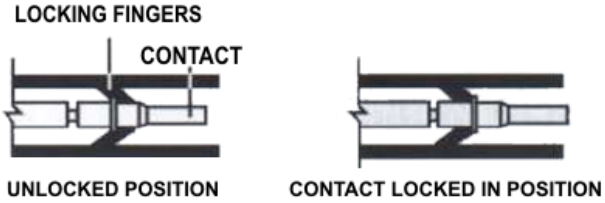


Figure 7-19. HD/HDP Locking Contacts Into Position

NOTE: *For unused wire cavities, insert sealing plugs for full environmental sealing*

HD30/HDP20 Series Disassembly

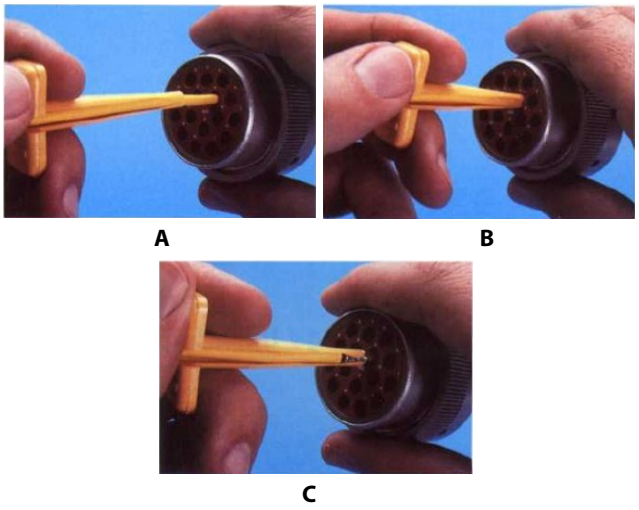


Figure 7-20. HD/HDP Contact Removal

11. With rear insert toward you, snap appropriate size extractor tool over the wire of contact to be removed.
12. Slide tool along into the insert cavity until it engages contact and resistance is felt.
13. Pull contact-wire assembly out of connector.

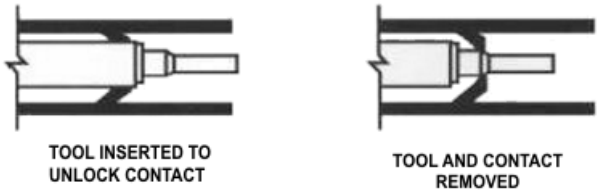


Figure 7-21. HD/HDP Unlocking Contacts

NOTE: *Do Not twist or insert tool at an angle.*

7.6 DC POWER SYSTEMS

NOTICE

THIS MACHINE IS POWERED BY AN 84VDC (NOMINAL) ELECTRICAL SYSTEM THAT CAN RANGE UP TO 105VDC DURING NORMAL OPERATION, AND BY A 48VAC (NOMINAL) ELECTRICAL MOTOR SYSTEM THAT CAN RANGE UP TO 60VAC. BASED ON EMPLOYER, LOCAL, AND GOVERNMENTAL REGULATIONS AS THEY PERTAIN TO THIS MACHINE, SPECIFIC ELECTRICAL TRAINING AND CERTIFICATIONS MAY BE REQUIRED BEFORE SERVICING OR TROUBLESHOOTING.

The machine has two (2) separate battery systems: 12V and 84V.

The 12V system powers the control modules (e.g., UGM), hydraulic valves, clutch actuation, fans, and engine start/alternator system. The 84V system powers the IMG and the battery charging system, which includes the battery boxes, IGM control enclosure, 84V/12V DC/DC converter, and the two battery chargers.

With a fully assembled and connected machine, all energized points in the 84V system are inaccessible, so the JLG Analyzer must be used to perform diagnostics on the 84V system.

NOTICE

ALL THE COVERS MUST REMAIN INSTALLED ON THE MACHINE UNTIL THE POWER IN THE 84V SYSTEM IS REDUCED.

⚠ WARNING

DEATH OR SERIOUS INJURY MAY RESULT IF THESE INSTRUCTIONS ARE NOT FOLLOWED.

⚠ DANGER

DEATH OR SERIOUS INJURY MAY RESULT IF THESE INSTRUCTIONS ARE NOT FOLLOWED.

7.7 HOT WEATHER OPERATION

Machine also has multiple sensors to monitor temperatures of the Integrated Motor/Generator (IMG), IMG Controller, battery pack, and engine coolant. If temperatures are over their respective pre-set values, distress signals will be displayed. Machine will cut back in power available and eventually be disabled if high component temperatures persistent. This will prevent permanent damage to power components.

7.8 COLD WEATHER OPERATION

The battery capacity will decrease as ambient temperature drops. Typically the battery will decrease to 50% of its specification capacity when temperature is around -20°C / -4°F, even though the analyzer or battery gauge may still show 100% State of Charge (SOC).

Under low ambient temperature, charging the machine with wall AC power may not return the battery pack to 100% charge even though the charger stops charging automatically and displays a green light. It is recommended to charge the machine in warmer ambient conditions. The optional cold weather package could improve the charging capability under this condition.

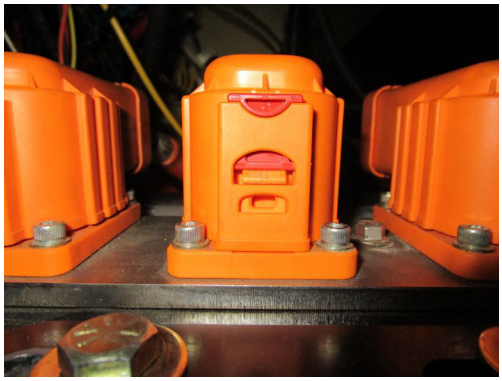
When the IMG temperature is below 0°C / 32°F, the software will reduce power available to prevent large current spikes from tripping the fuses. When the IMG temperature returns to normal due to operation, the power level will be return to normal.

The machine is available with a Cold Weather Package for environments below freezing temperature. With Cold Weather Package and proper operational practices, machine shall be operational properly down to -20°C / -4°F, though may require special considerations beyond general guidelines in operation and maintenance.

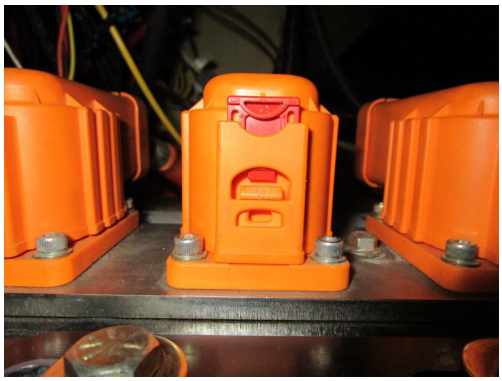
Operation below -20°C / -4°F is not recommended at this point of time due to concerns on reductions in battery capacity.

7.9 DISCONNECTING BATTERY BOX CONNECTORS

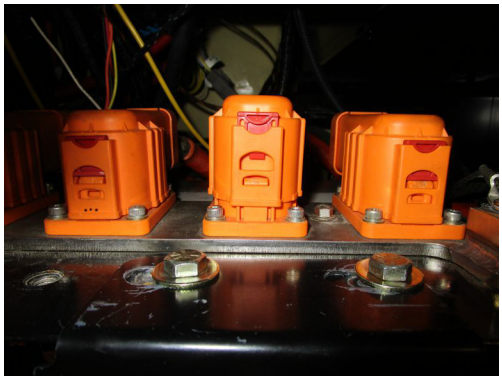
The following steps need to be followed in order to properly disconnect the battery box cable connectors.



1. Release CPA to pre-lock position. Pull up on the red tab on the cable end of the connector.

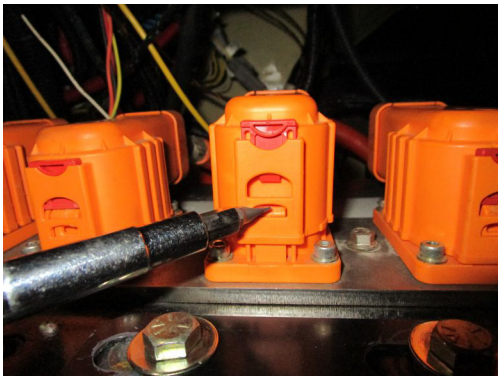


2. At same time press lock latch in pre lock area with finger or tool. Pull the connector up to the first notch.

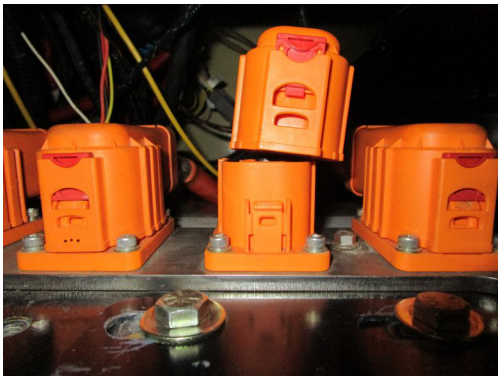


NOTE: *When the connector is pulled up to the first notch, it is still connected and current will still flow through it.*

3. Press lock latch in second area with finger or small tool. Using a screwdriver or similar device, press in on the tab to release the cable end of the connector from the box end of the connector.



4. At same time completely pull the cable end of the connector away from the box end of the connector to ensure no power will flow through it.



7.10 BATTERY PACK

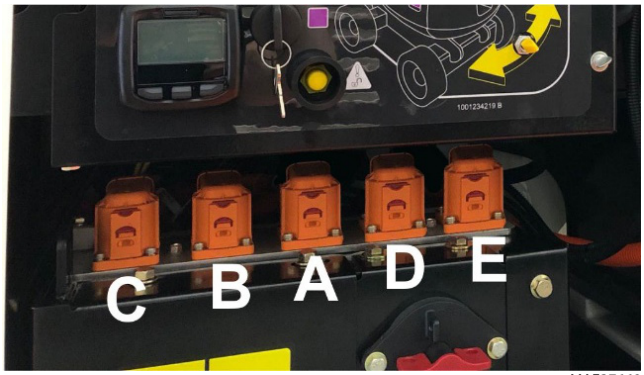
The battery pack consists of fourteen 12V, sealed AGM maintenance free batteries. The batteries are packed in two banks in parallel, with each pack consisting of seven batteries connected in series to become an 84 VDC system. Each battery bank is 48V when separated.

Reducing System Voltage

This procedure is to be performed for work on compartments at the battery boxes and IGM control box.

Refer to the following procedure to reduce system voltage

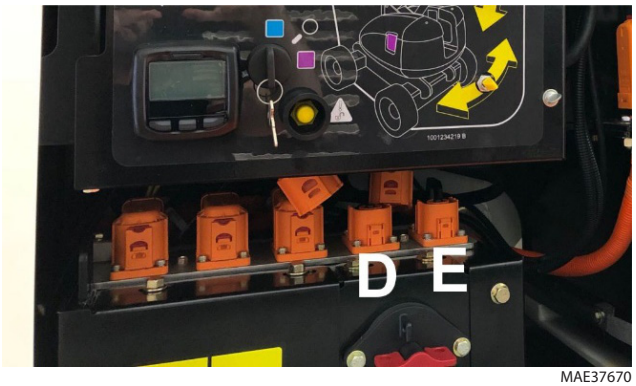
At the IGM control box (tank side of machine):



MAE37660

NOTE: *Use above image as a reference for connector name.*

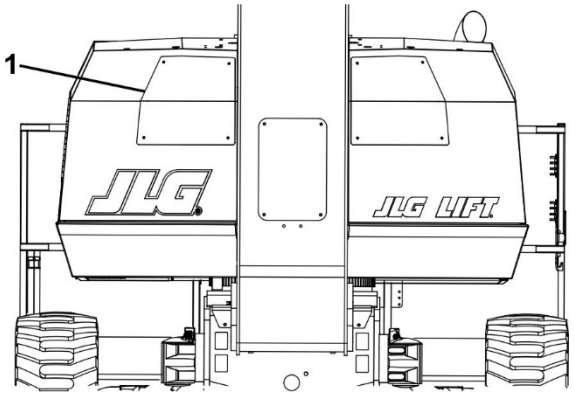
NOTE: *Refer to Section 7.9, Disconnecting Battery Box Connectors for connector discconecting procedure.*



MAE37670

1. Disconnect connector D.
2. Disconnect connector E.

Tank front side of machine



MAE37680

3. Remove cover (1) using a 5/32 allen wrench.



MAE37690

4. Disconnect connector C.
5. Disconnect connector B.

NOTE: *Connector "C" must be disconnected before connector "B".*



MAE37700

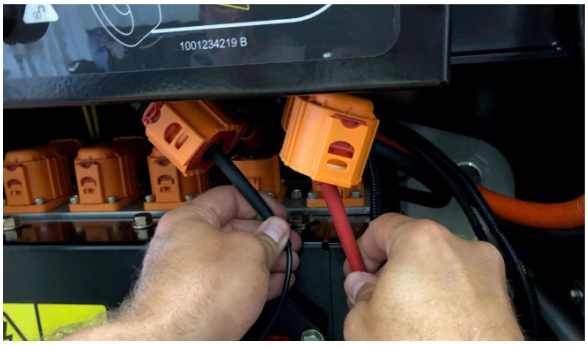
Figure 7-22. 84V hybrid round connector on tank side



MAE37710

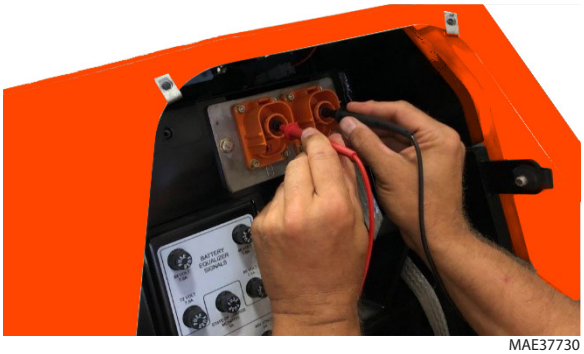
Figure 7-23. 84V hybrid round connector on engine side

6. Disconnect the 84V hybrid round connector (1) located on each side of the machine
7. Perform the following checks to confirm system voltage has been sufficiently reduced:



MAE37720

   a. Check voltage between connectors D and E (on tank side of machine). This check should yield a result of 0V.



MAE37730

   b. Check voltage between connectors B and C (at front of machine). This check should yield a result of 12V-13V.

NOTE: *The tank and engine side battery stack will still be roughly 48V depending on battery charge level. The 12V system will still be at full power.*

Restoring System Voltage

To restore system voltage back to 84V, reverse the Reducing System Voltage procedure.

Battery Pack Charging System

The machine offers two methods of charging the battery stack. The primary method of charging the battery pack is the is the diesel engine, which powers the Integrated Motor Generator (IMG) which in turn charges the battery stack. When the diesel engine is running, the Hybrid Electric Control system determines how and when the IMG would charge the battery depending on State of Charge (SOC) of the battery pack, and the available power from diesel engine for charging at the point of the time. The second method to recharge the battery stack is the onboard battery chargers. The chargers are located on the turntable and work with a 120VAC or 240VAC external power source. The chargers are set up as primary and secondary chargers. Both chargers work in tandem through the Bulk Charging phase (up to approximately 90% SOC). Above 90%, a single charger will perform the Absorption and Float Charging phases.

Long Term Storage Guidelines

When the machine is stored for more than 45 days, to prevent a permanent loss of battery capacity, it is important to recharge the battery pack using the machine's wall AC charger before use.

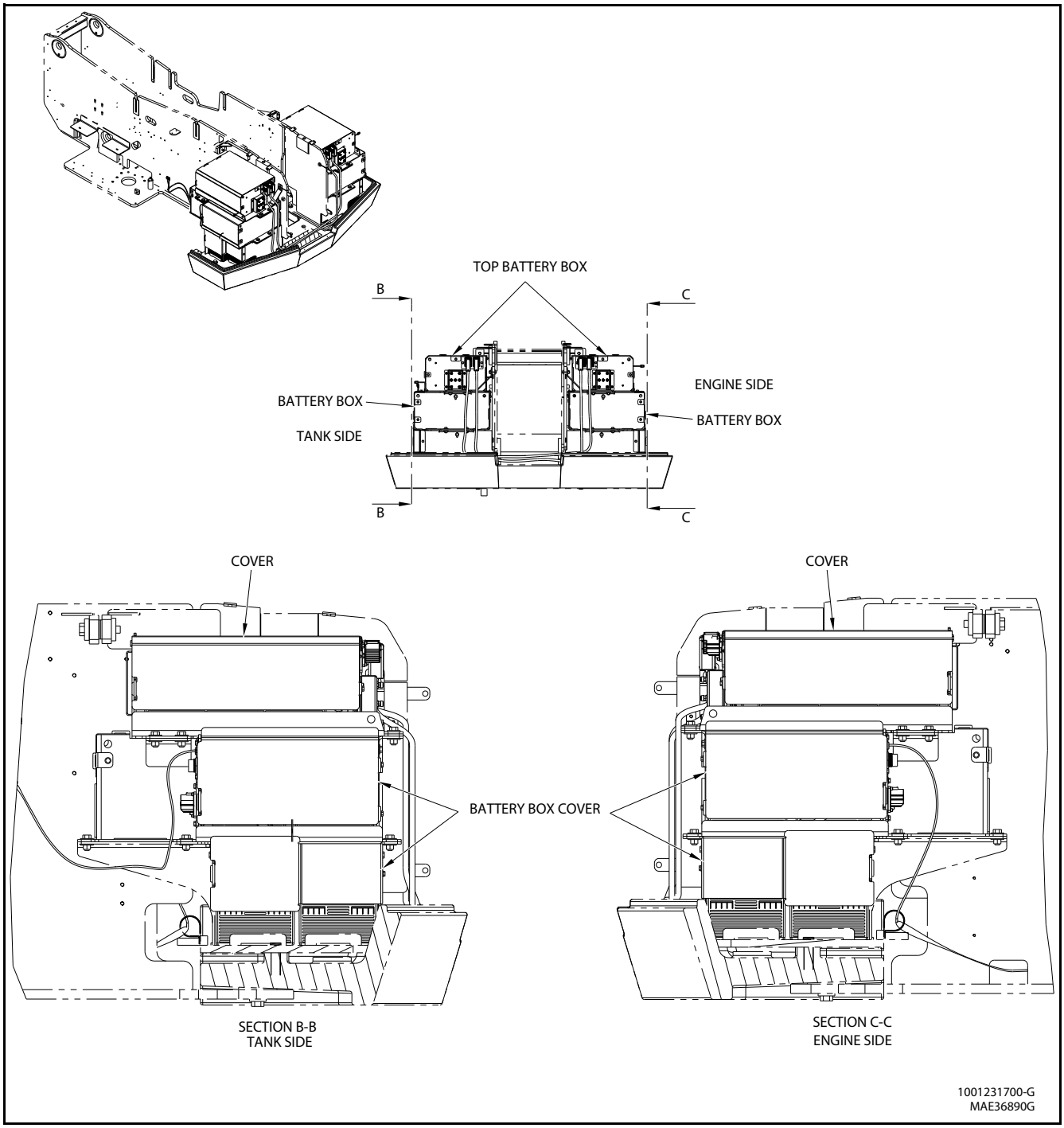


Figure 7-24. Battery Box - Sheet 1 of 15

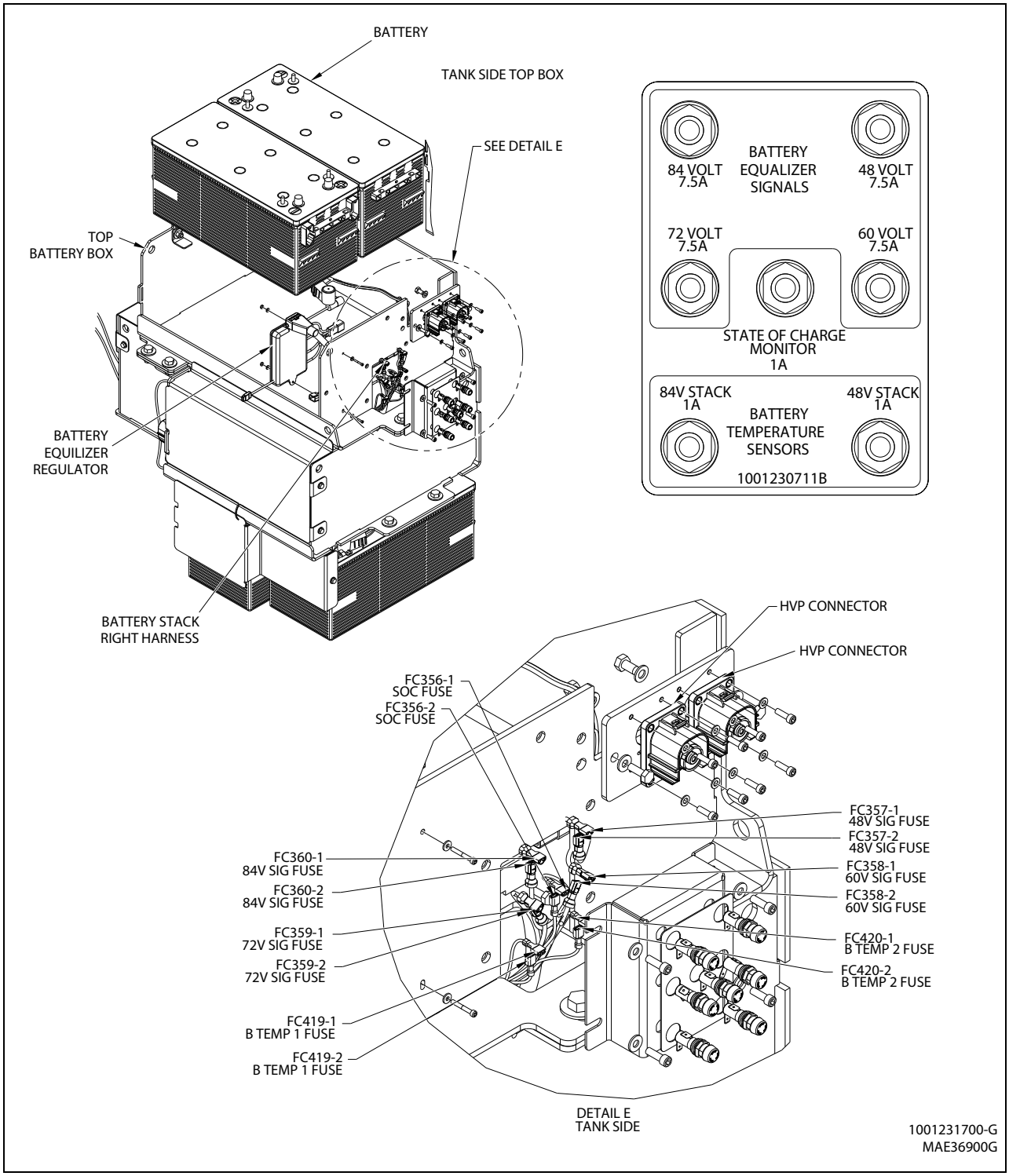


Figure 7-25. Battery Box - Sheet 2 of 15

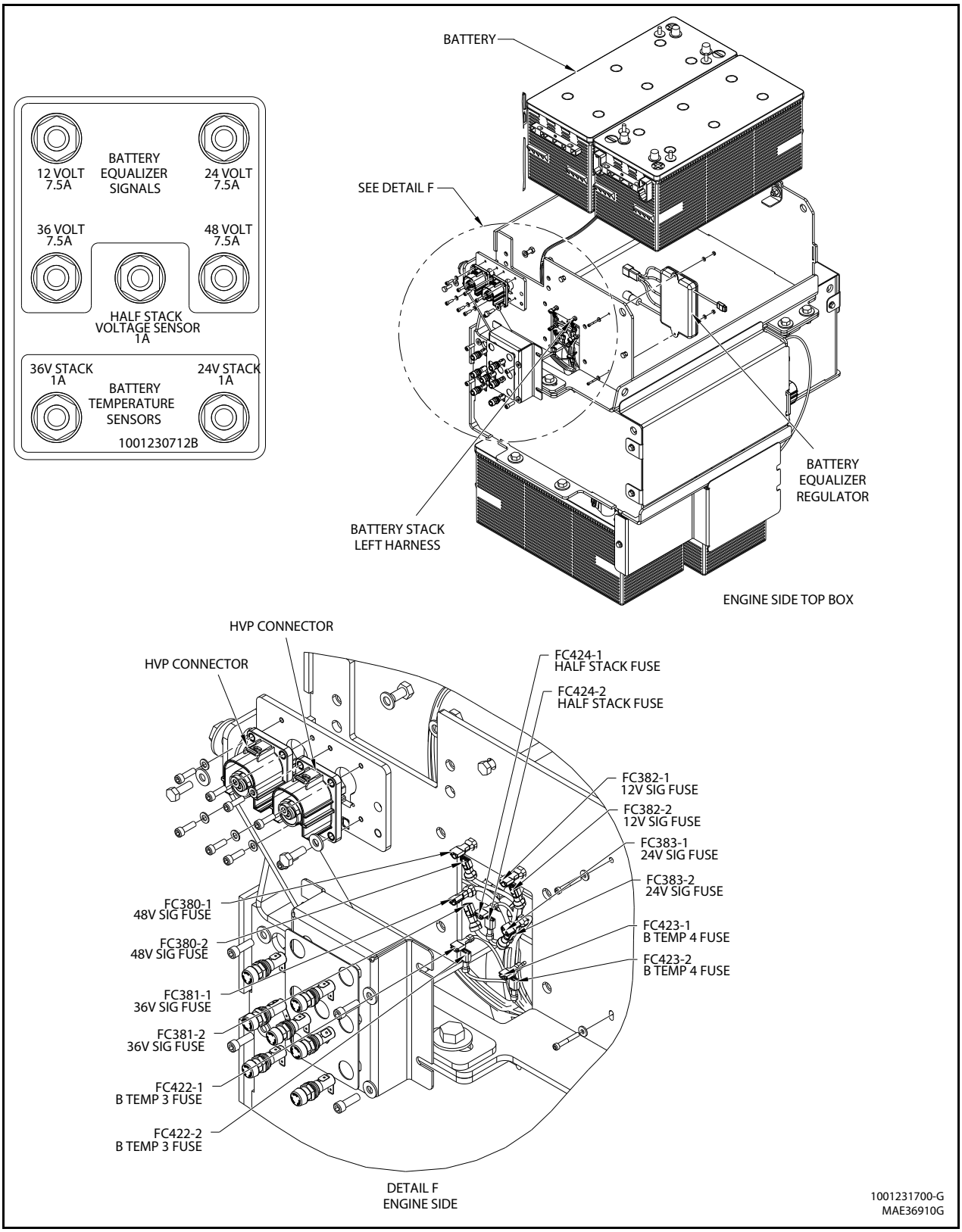


Figure 7-26. Battery Box - Sheet 3 of 15

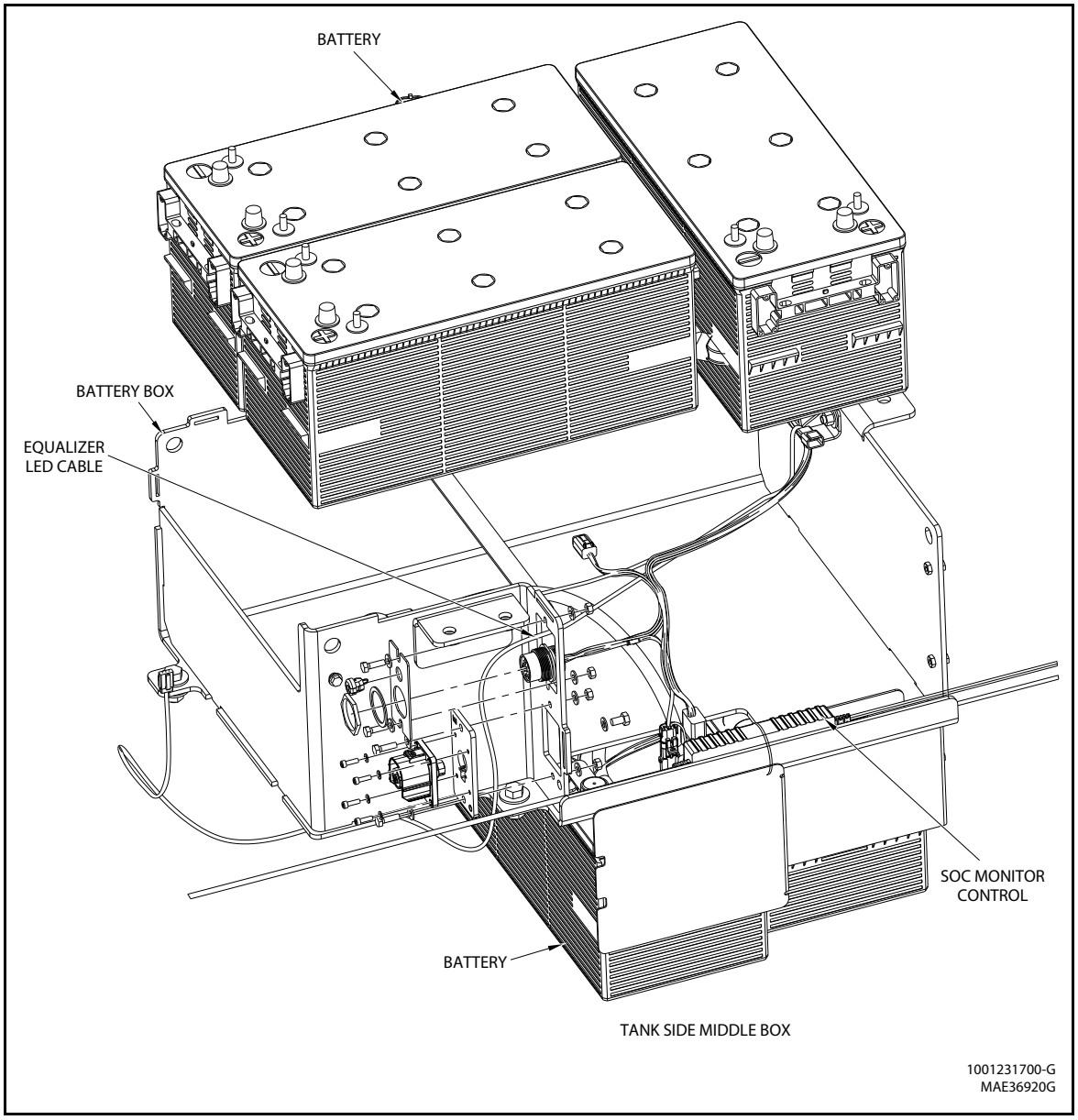


Figure 7-27. Battery Box - Sheet 4 of 15

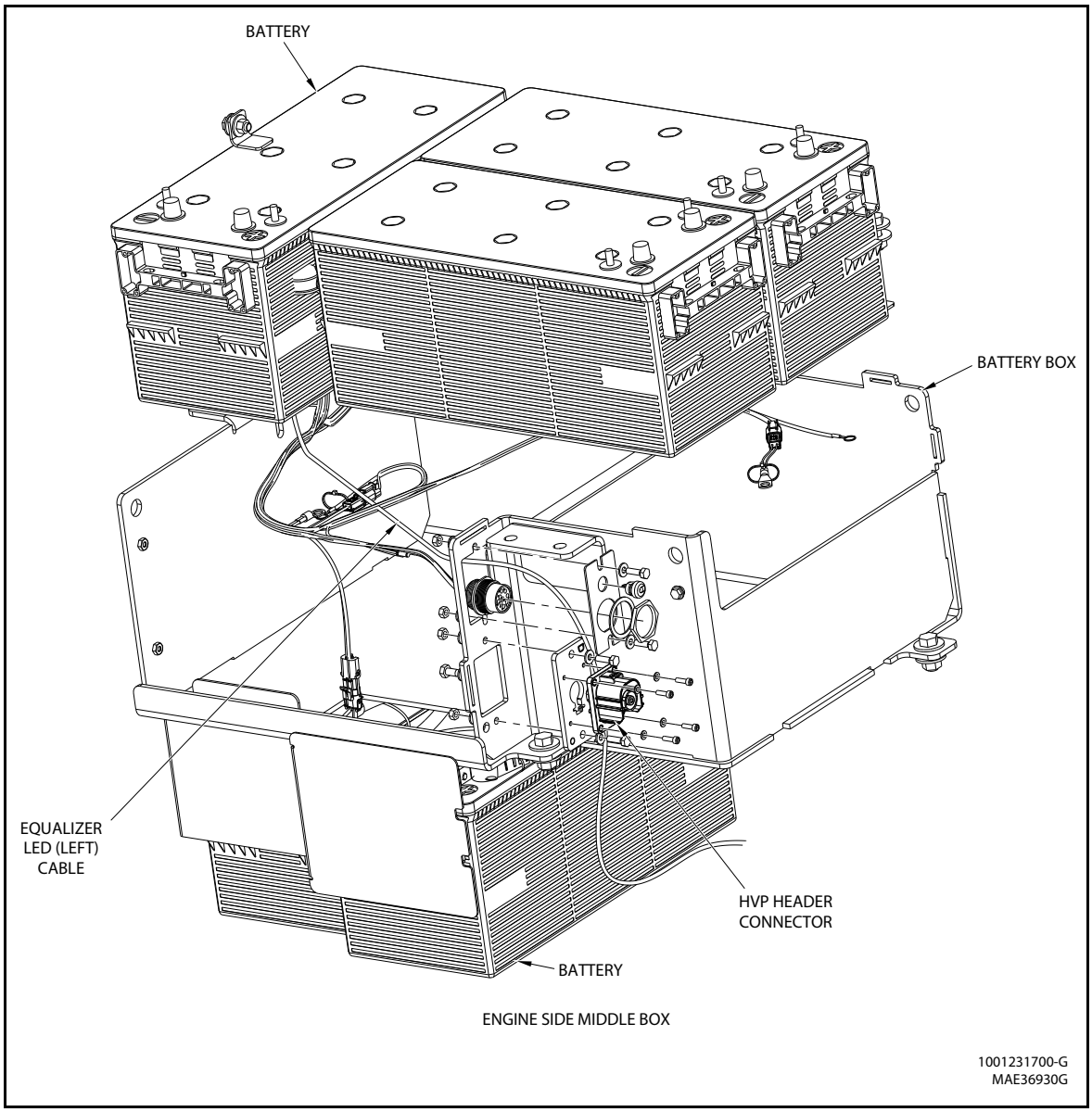


Figure 7-28. Battery Box - Sheet 5 of 15

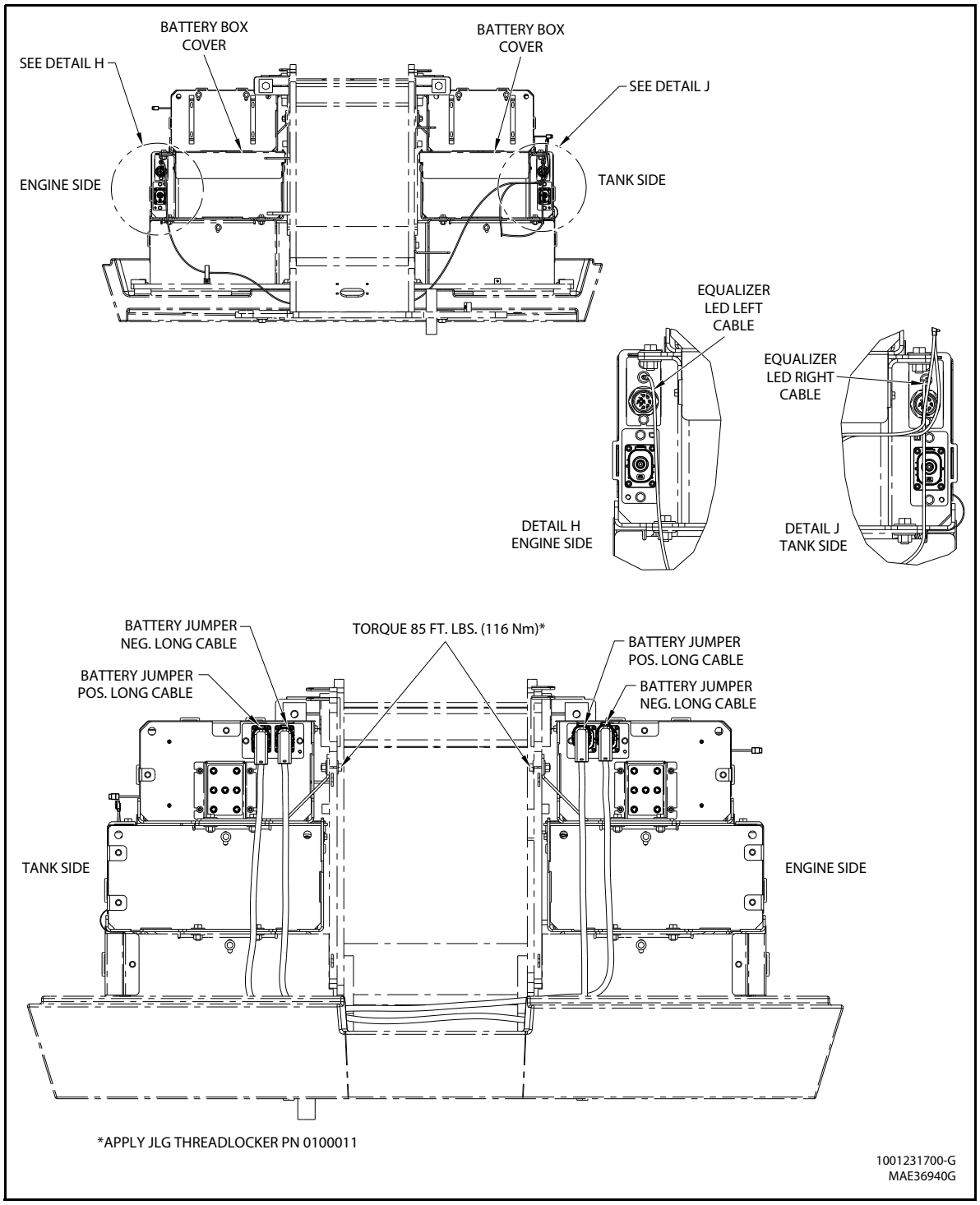


Figure 7-29. Battery Box - Sheet 6 of 15

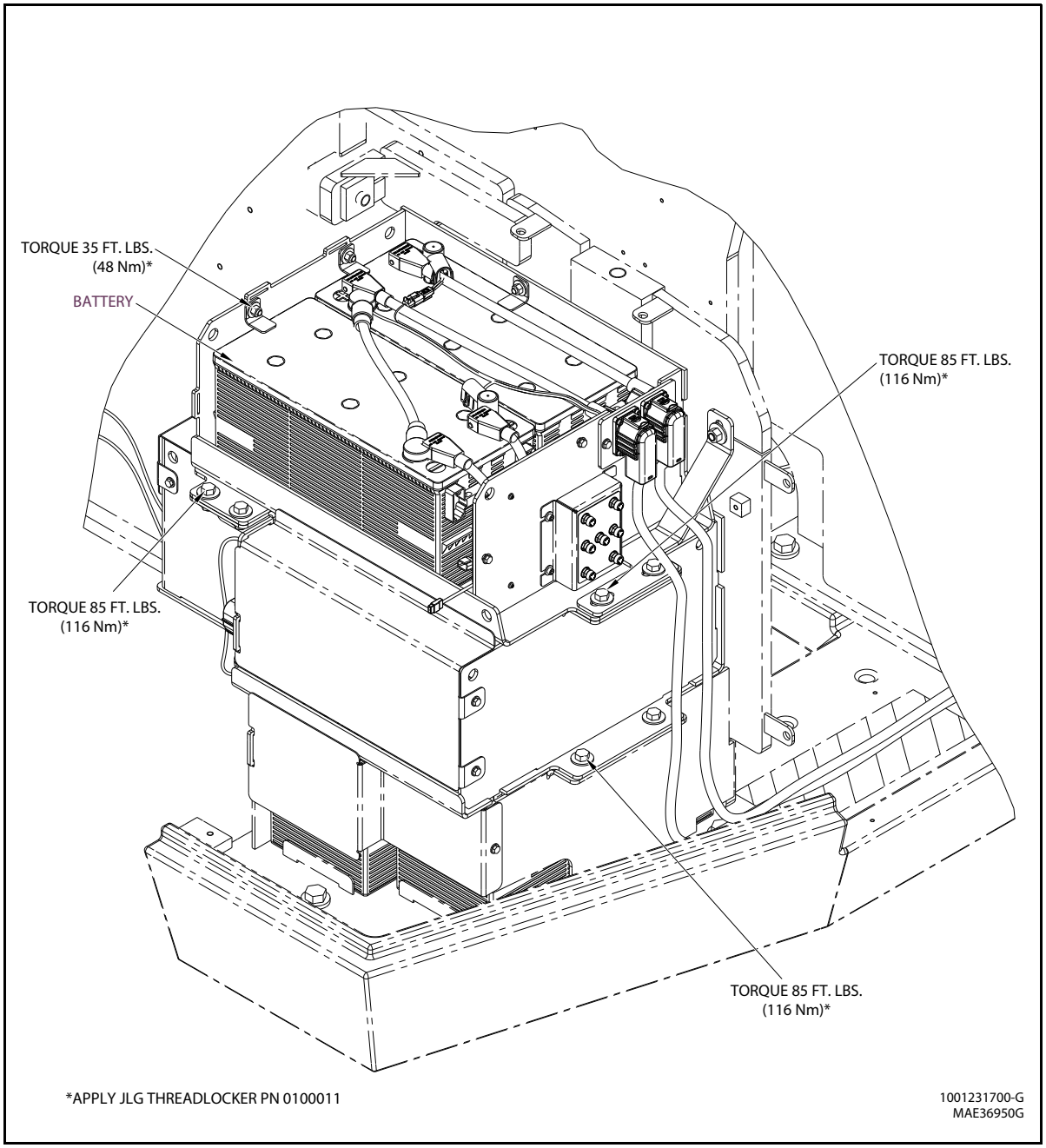


Figure 7-30. Battery Box - Sheet 7 of 15

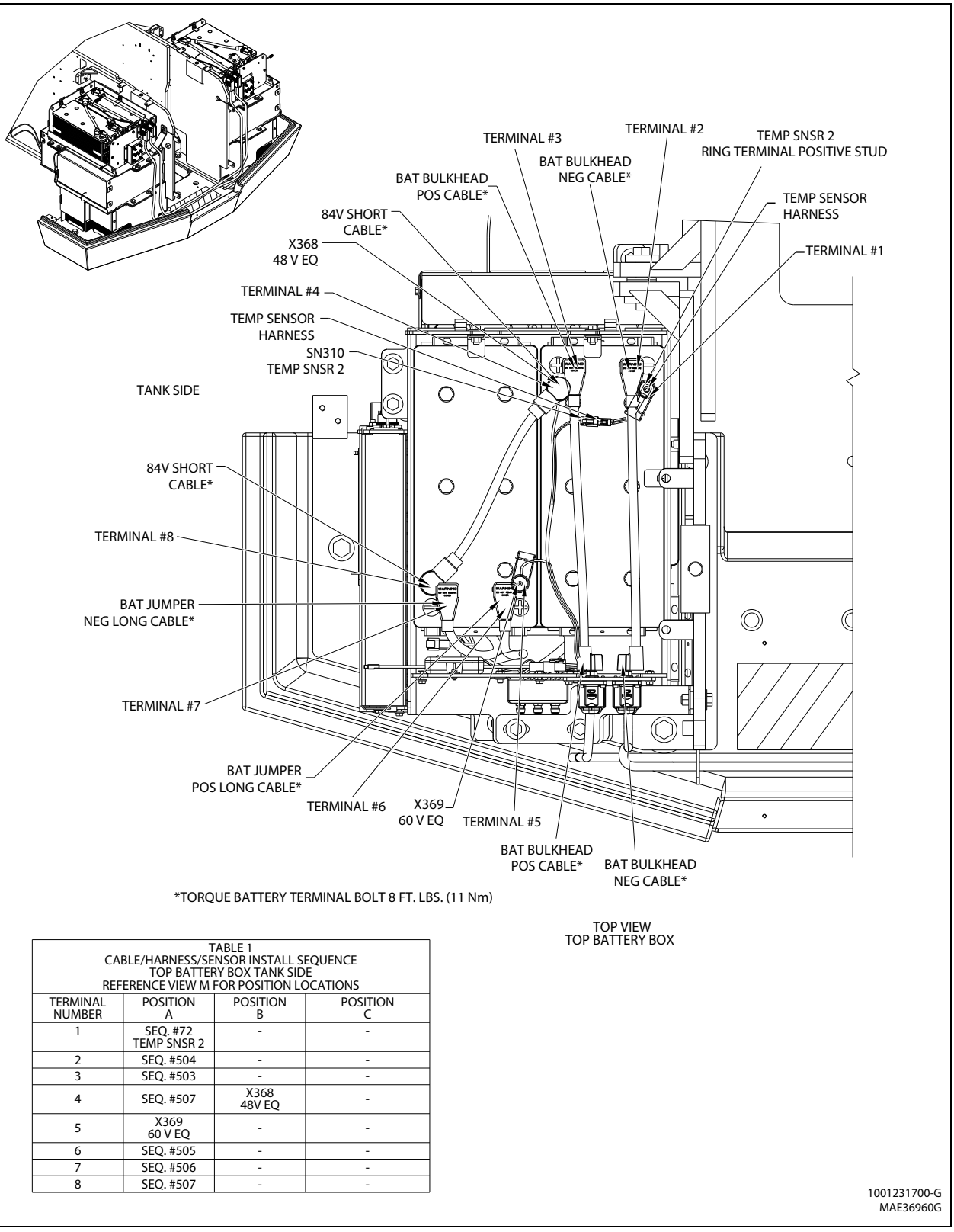
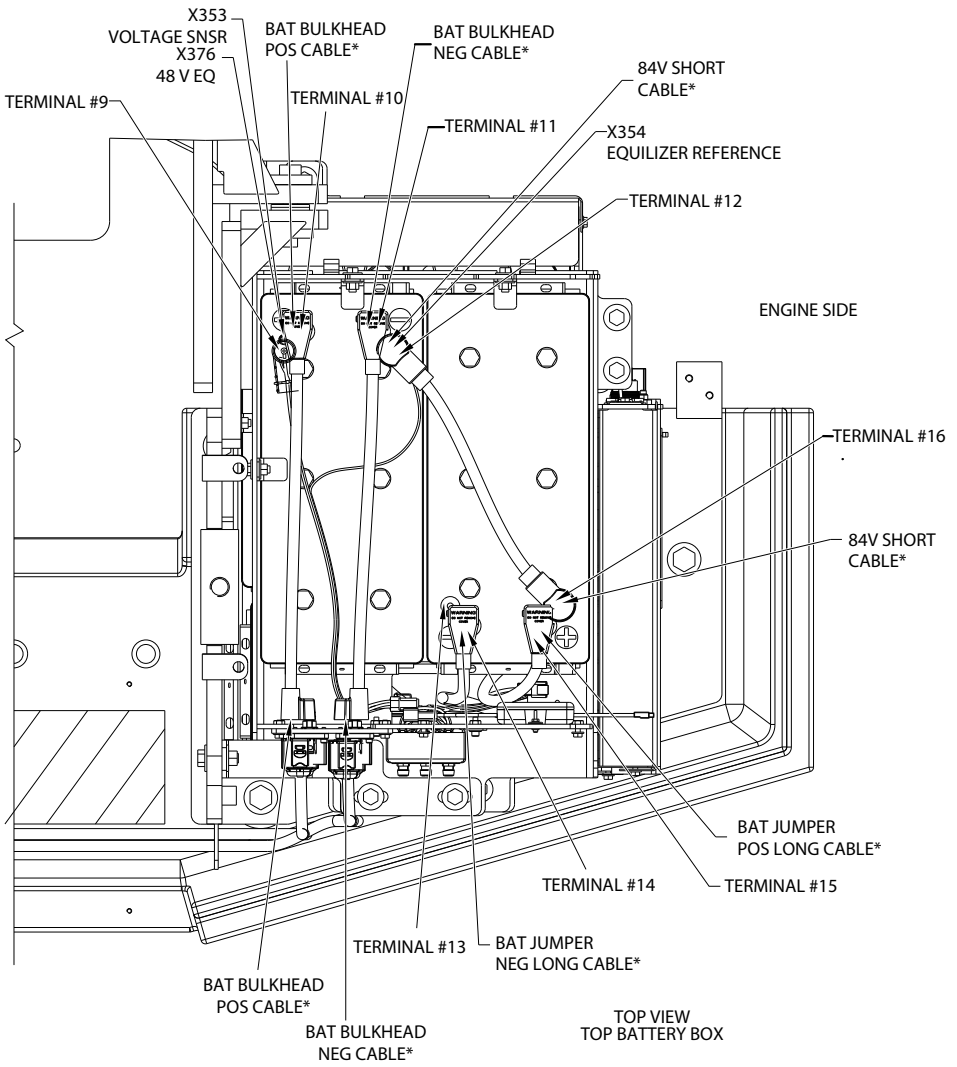


TABLE 1 CABLE/HARNESS/SENSOR INSTALL SEQUENCE TOP BATTERY BOX TANK SIDE REFERENCE VIEW M FOR POSITION LOCATIONS			
TERMINAL NUMBER	POSITION A	POSITION B	POSITION C
1	SEQ. #72 TEMP SNSR 2	-	-
2	SEQ. #504	-	-
3	SEQ. #503	-	-
4	SEQ. #507	X368 48V EQ	-
5	X369 60 V EQ	-	-
6	SEQ. #505	-	-
7	SEQ. #506	-	-
8	SEQ. #507	-	-

1001231700-G
MAE36960G

Figure 7-31. Battery Box - Sheet 8 of 15



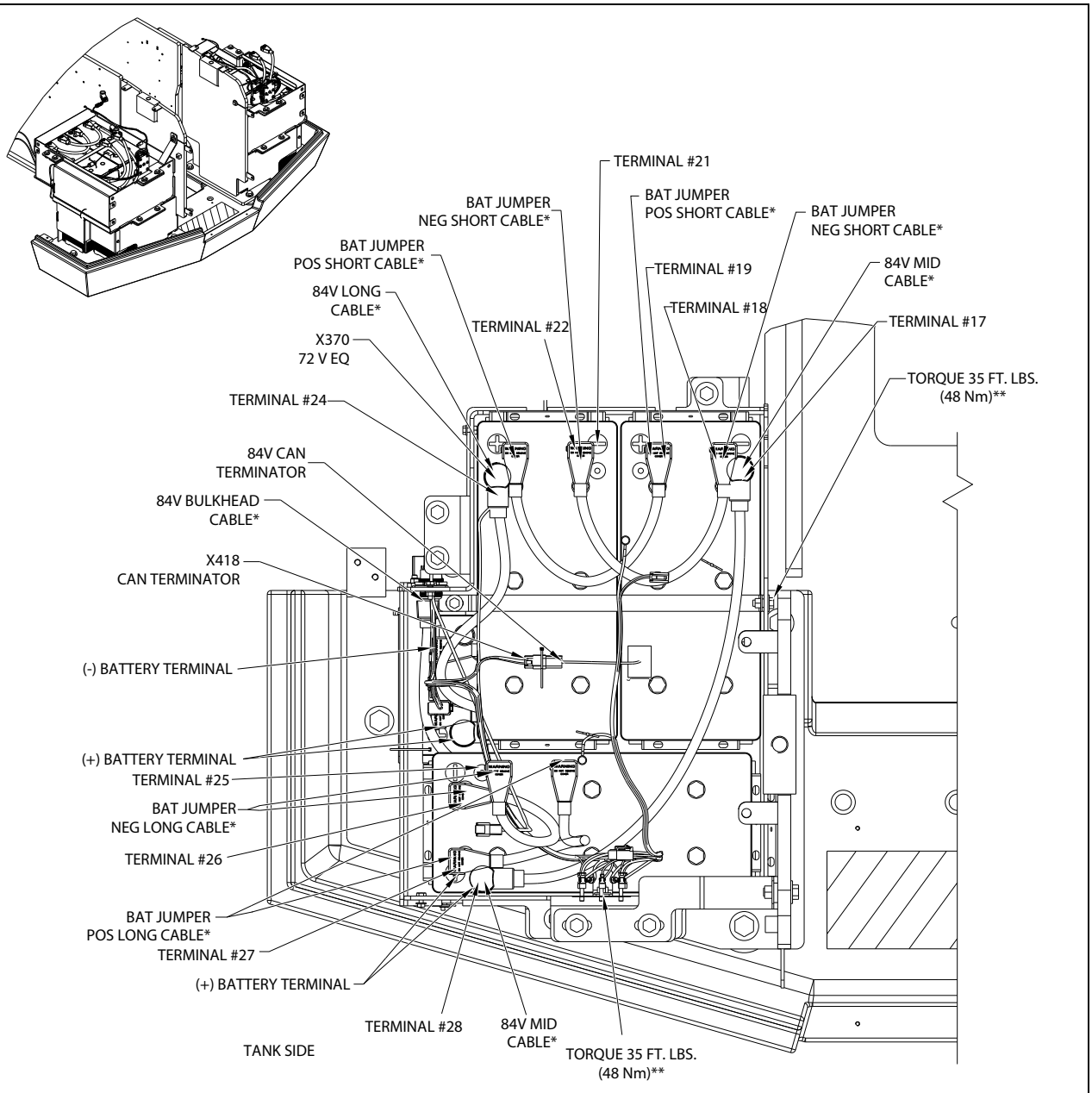
*TORQUE BATTERY TERMINAL BOLT 8 FT. LBS. (11 Nm)

TABLE 2
CABLE AND HARNESS INSTALL SEQUENCE
TOP BATTERY BOX ENGINE SIDE
REFERENCE VIEW M FOR POSITION LOCATIONS

TERMINAL NUMBER	POSITION A	POSITION B	POSITION C
9	X353 VOLTAGE SNSR	X376 48 V EQ	-
10	SEQ. #503	-	-
11	SEQ. #504	-	-
12	SEQ. #507	X354 EQUILIZER REFERENCE	-
13	-	-	-
14	SEQ. #506	-	-
15	SEQ. #505	-	-
16	SEQ. #507	-	-

1001231700-G
MAE36970G

Figure 7-32. Battery Box - Sheet 9 of 15



*TORQUE BATTERY TERMINAL BOLT 8 FT. LBS. (11 Nm)
**APPLY JLG THREADLOCKER PN 0100011

TABLE 3
CABLE/HARNESS/SENSOR INSTALL SEQUENCE
MIDDLE BATTERY BOX TANK SIDE
REF VIEW N FOR POSITION LOCATIONS

TERMINAL NUMBER	POSITION A	POSITION B	POSITION C
17	SEQ. #508	-	-
18	SEQ. #502	-	-
19	SEQ. #501	-	-
20	-	-	-
21	-	-	-
22	SEQ. #502	-	-
23	SEQ. #501	-	-
24	SEQ. #509	X370 72 V EQ	-
25	-	-	-
26	SEQ. #506	-	-
27	SEQ. #505	-	-
28	SEQ. #508	-	-

1001231700-G
MAE36980G

Figure 7-33. Battery Box - Sheet 10 of 15

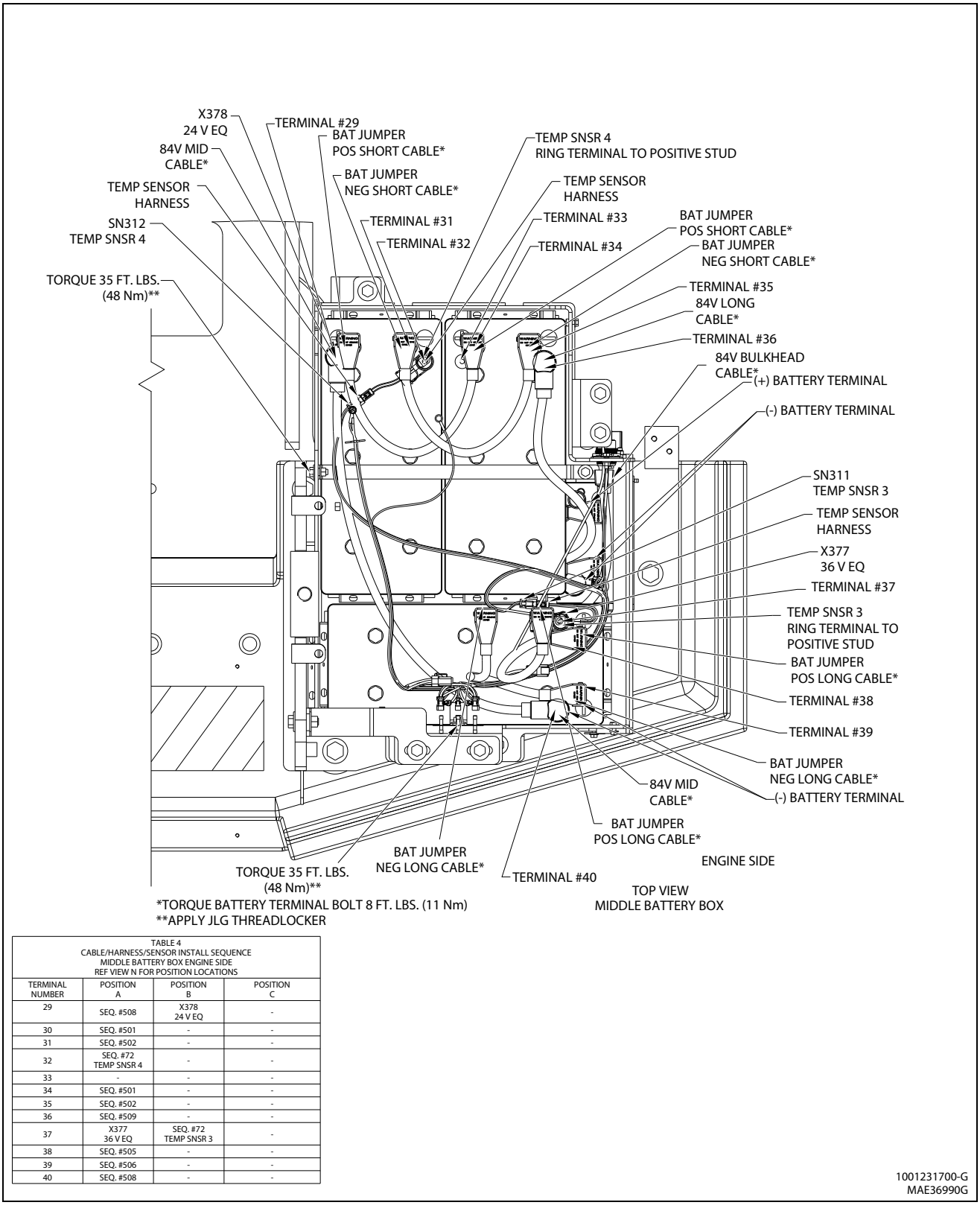
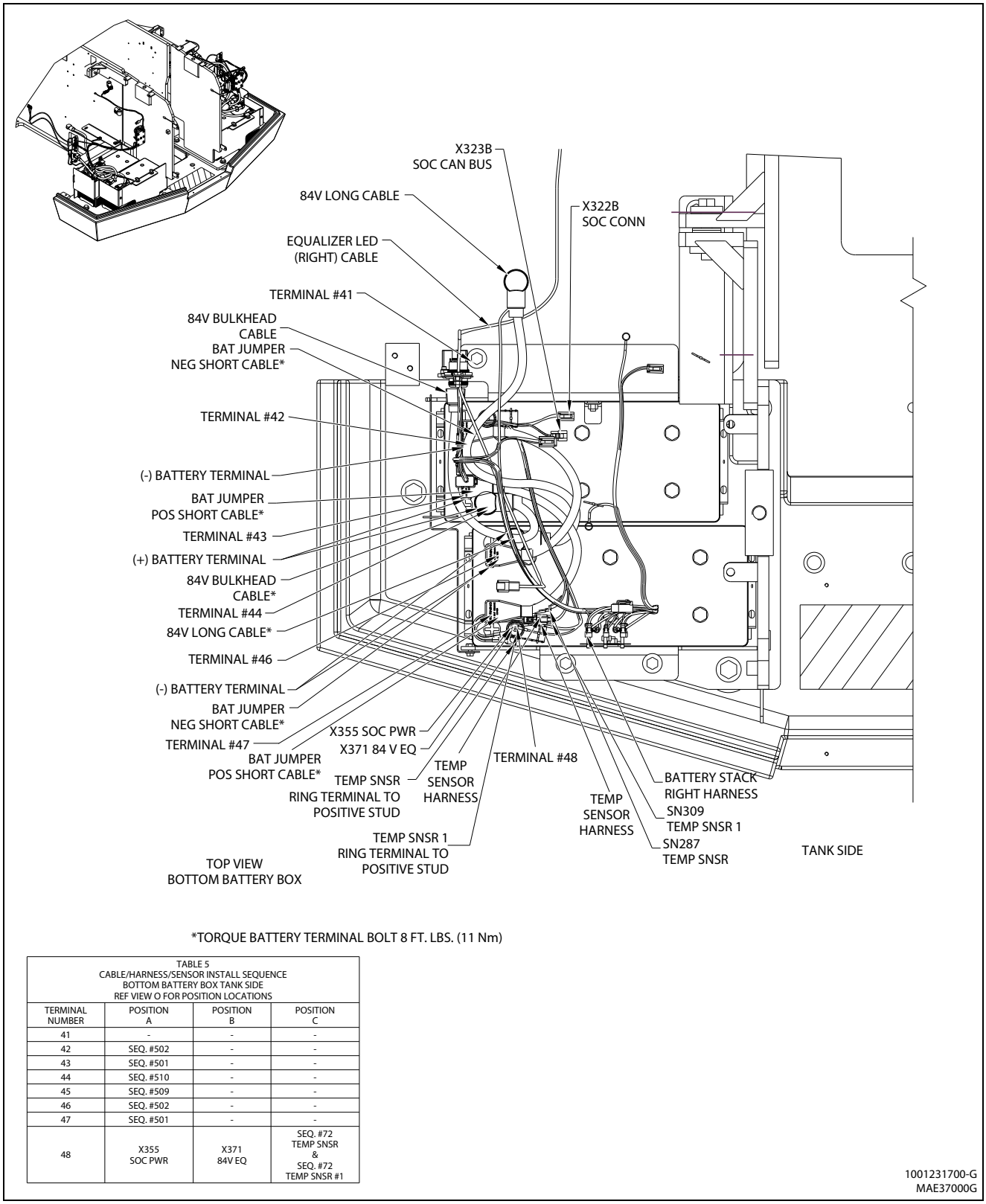


TABLE 4
CABLE/HARNESS/SENSOR INSTALL SEQUENCE
MIDDLE BATTERY BOX ENGINE SIDE
REF VIEW N FOR POSITION LOCATIONS

TERMINAL NUMBER	POSITION A	POSITION B	POSITION C
29	SEQ. #508	X378 24 V EQ	-
30	SEQ. #501	-	-
31	SEQ. #502	-	-
32	SEQ. #72 TEMP SNSR 4	-	-
33	-	-	-
34	SEQ. #501	-	-
35	SEQ. #502	-	-
36	SEQ. #509	-	-
37	X377 36 V EQ	SEQ. #72 TEMP SNSR 3	-
38	SEQ. #505	-	-
39	SEQ. #506	-	-
40	SEQ. #508	-	-

1001231700-G
MAE36990G

Figure 7-34. Battery Box - Sheet 11 of 15



*TORQUE BATTERY TERMINAL BOLT 8 FT. LBS. (11 Nm)

TABLE 5
CABLE/HARNESS/SENSOR INSTALL SEQUENCE
BOTTOM BATTERY BOX TANK SIDE
REF VIEW O FOR POSITION LOCATIONS

TERMINAL NUMBER	POSITION A	POSITION B	POSITION C
41	-	-	-
42	SEQ. #502	-	-
43	SEQ. #501	-	-
44	SEQ. #510	-	-
45	SEQ. #509	-	-
46	SEQ. #502	-	-
47	SEQ. #501	-	-
48	X355 SOC PWR	X371 84V EQ	SEQ. #72 TEMP SNSR & SEQ. #72 TEMP SNSR #1

1001231700-G
MAE37000G

Figure 7-35. Battery Box - Sheet 12 of 15

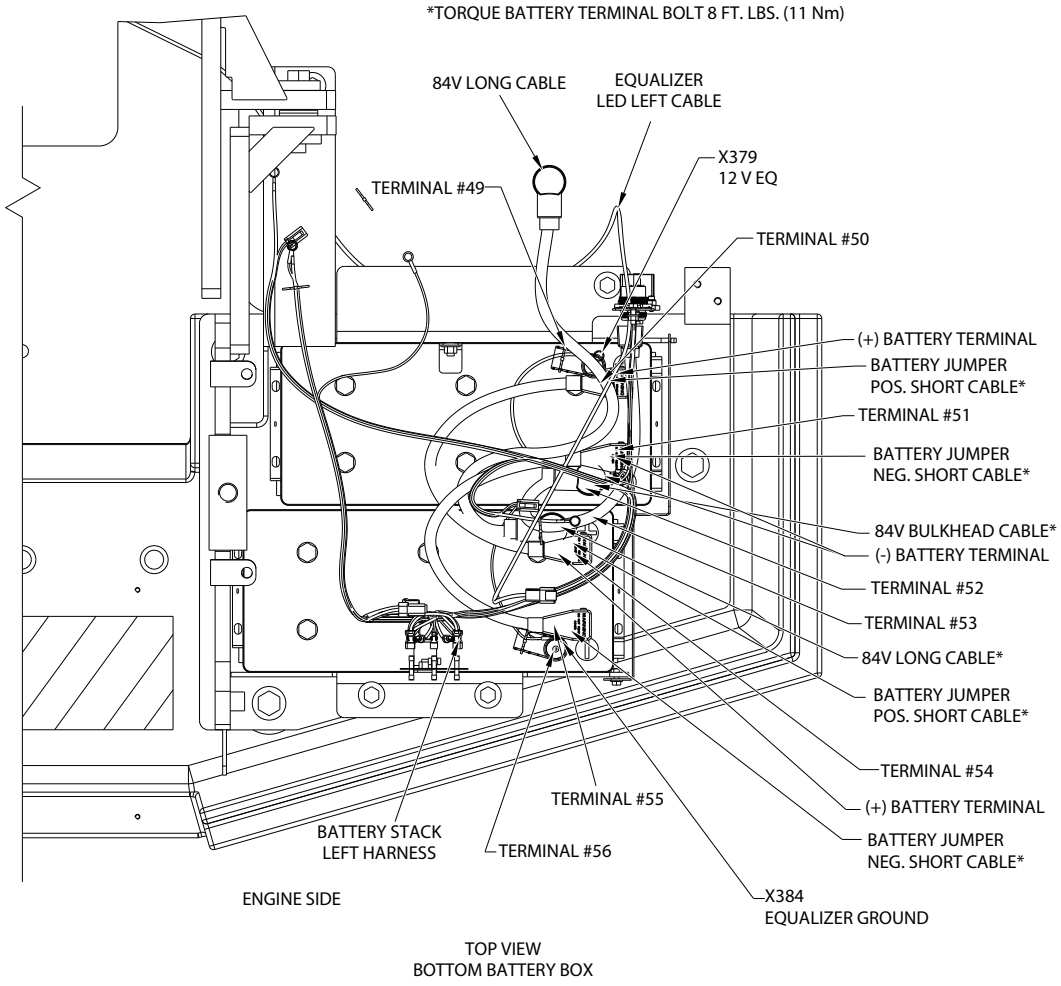


TABLE 6 CABLE/HARNESS/SENSOR INSTALL SEQUENCE BOTTOM BATTERY BOX ENGINE SIDE REF VIEW O FOR POSITION LOCATIONS			
TERMINAL NUMBER	POSITION A	POSITION B	POSITION C
49	X379 12 V EQ	-	-
50	SEQ. #501	-	-
51	SEQ. #502	-	-
52	SEQ. #510	-	-
53	SEQ. #509	-	-
54	SEQ. #501	-	-
55	SEQ. #502	-	-
56	X384 EQUILIZER GROUND	-	-

1001231700-G
MAE37010G

Figure 7-36. Battery Box - Sheet 13 of 15

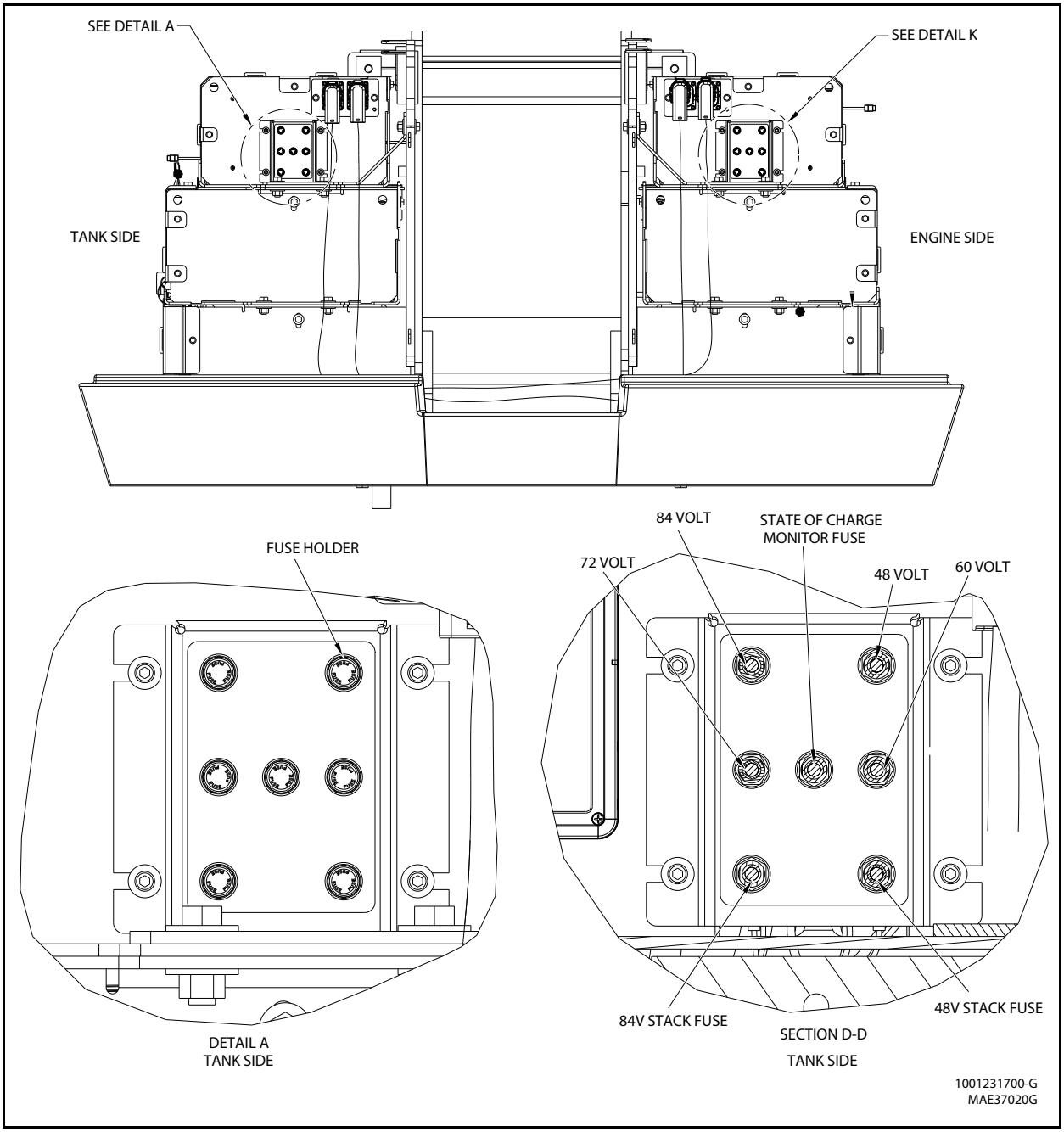


Figure 7-37. Battery Box - Sheet 14 of 15

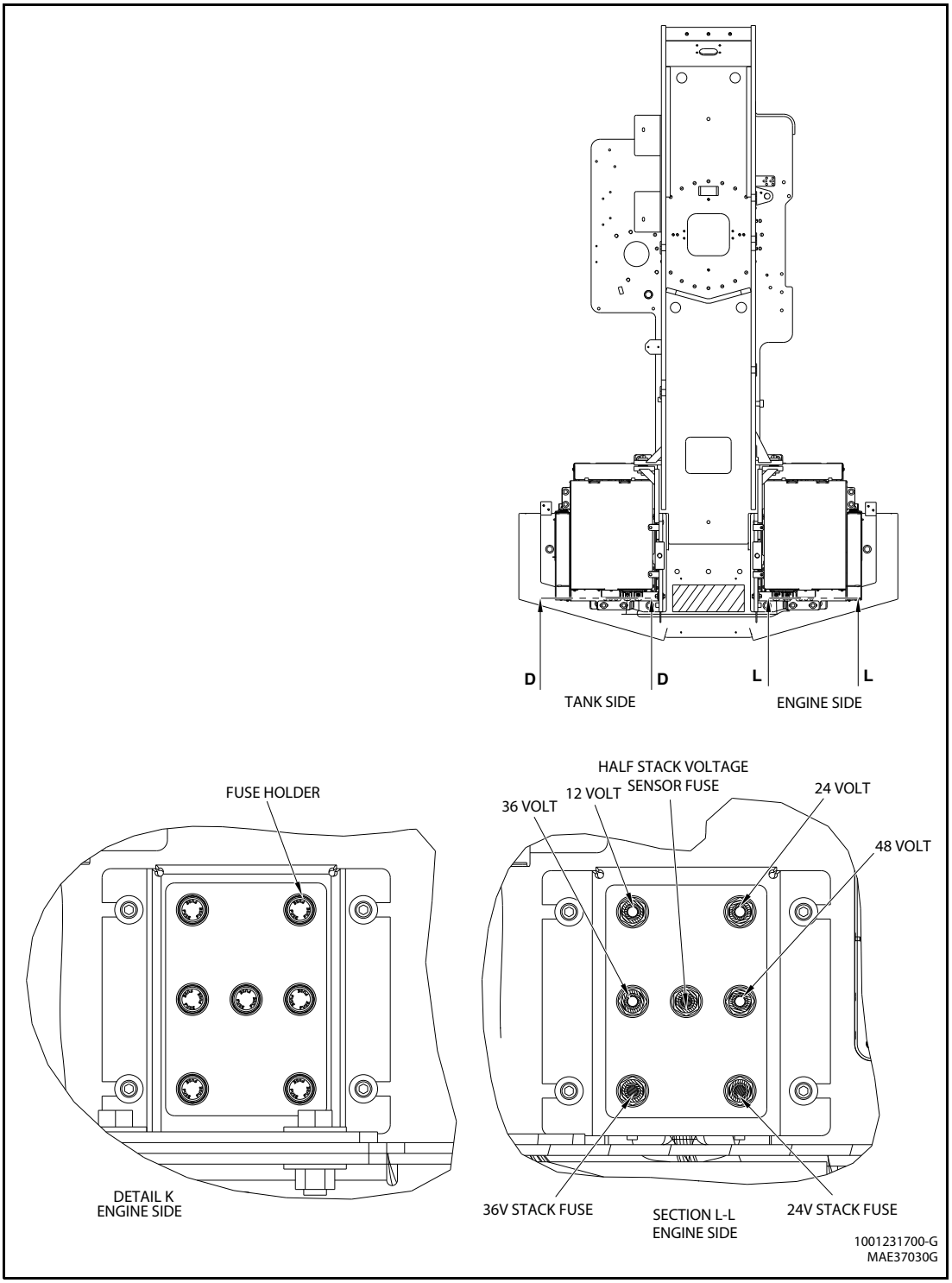


Figure 7-38. Battery Box - Sheet 15 of 15

7.11 IMG BOX

Within the IMG Box, there is both 84V AC and DC current present. The Rotary Disconnect (to be used for maintenance) is DPST to enable 84V isolation.

The Main Contactor is controlled by controllers and the Emergency Stop Switch.

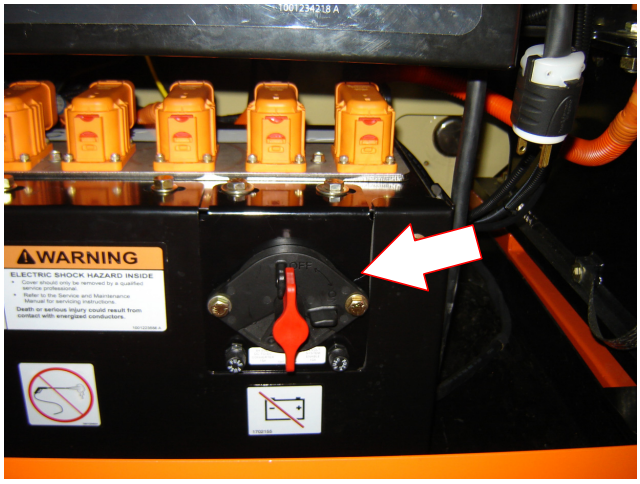
The IMG controller converts DC to AC and back to power the IMG or charge batteries. It also monitors battery and IMG health.

When running in hybrid or electric mode, the IMG uses power from the battery stack.

When engine is running and no function is operating, IMG is charging batteries

If service is needed on the IMG;

1. Turn power off at the rotary disconnect and lock it out.



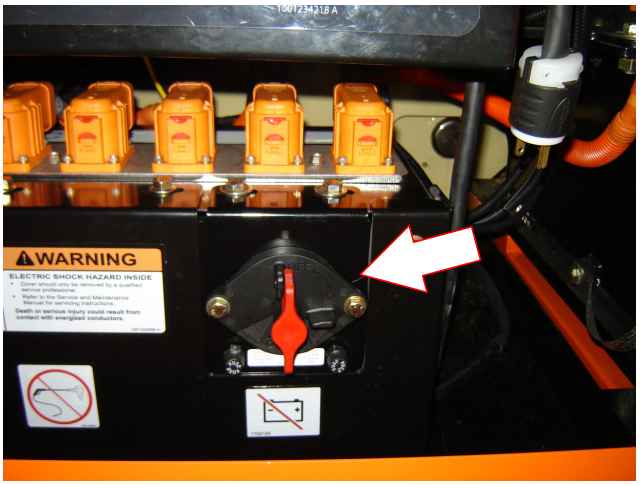
2. Disconnect the IMG sensor cable

Partially Isolating System Voltage

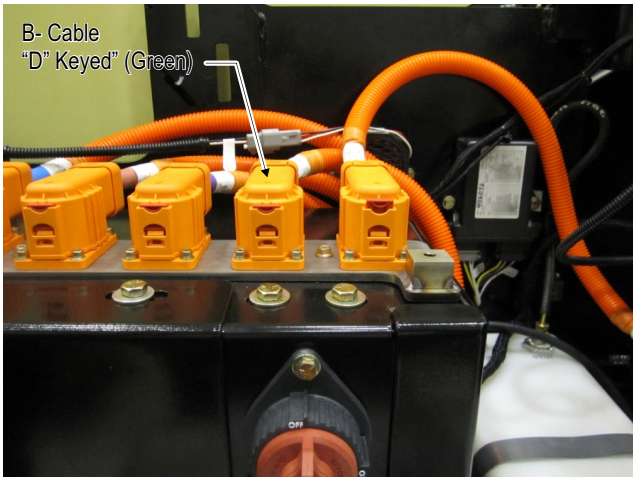
This procedure is to be performed for work on IMG/IMG control components. The disconnect steps below will reduce the System Voltage for working on the following components "downstream" of IMG box:

- on the IMG electrical connections
- on the cabling between IMG control enclosure and IMG
- within the IMG control enclosure

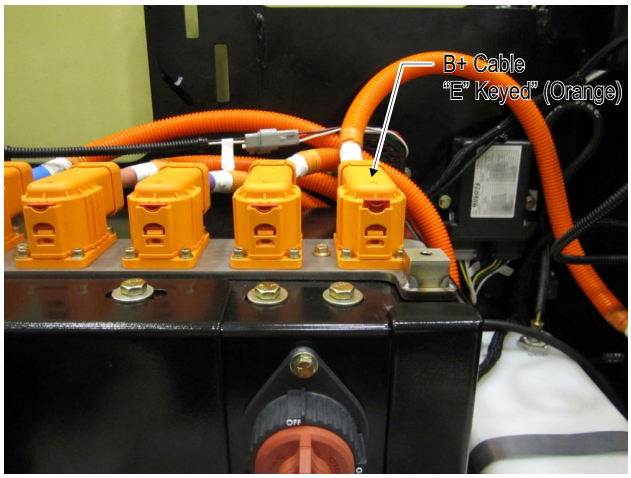
1. Turn the Maintance disconnect switch to the "OFF" position.



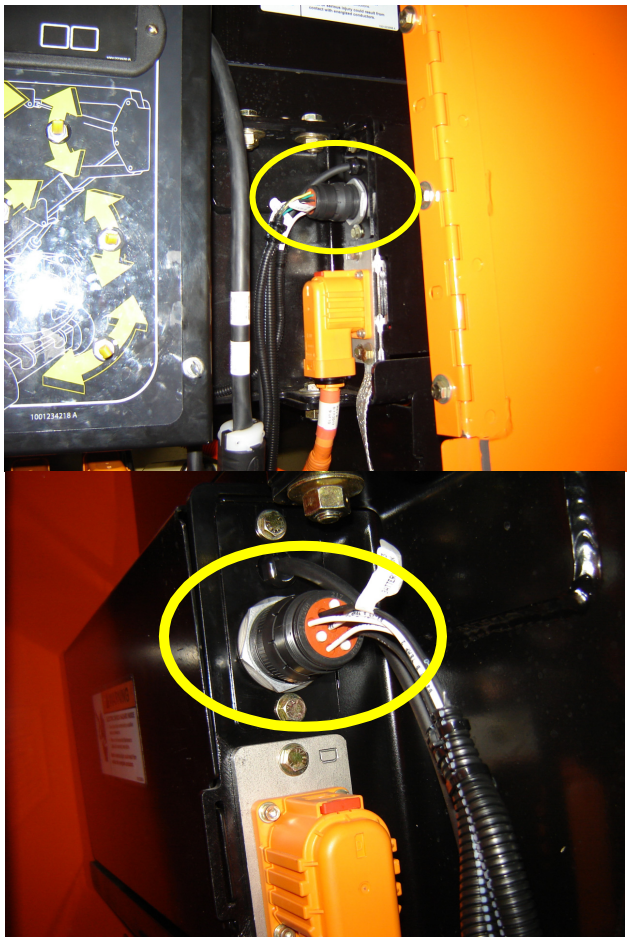
2. Disconnect the B- cable, "D" keyed (Green).



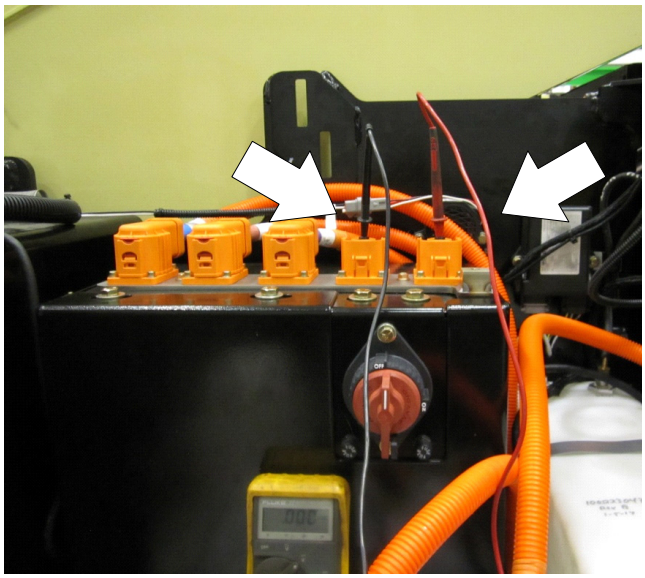
3. Disconnect the B+ cable, "E" keyed (Orange).



4. Disconnect the 84V hybrid harness (round connector) located on each battery box.



5. Check the voltage at the IMG connectors and verify the reading = 0V.



The battery stack and the charging system will still be energized with 84V, but the components above will be isolated to permit work

Remember: Nothing in this procedure affects the power available in the 12V system, so that system will still be fully energized

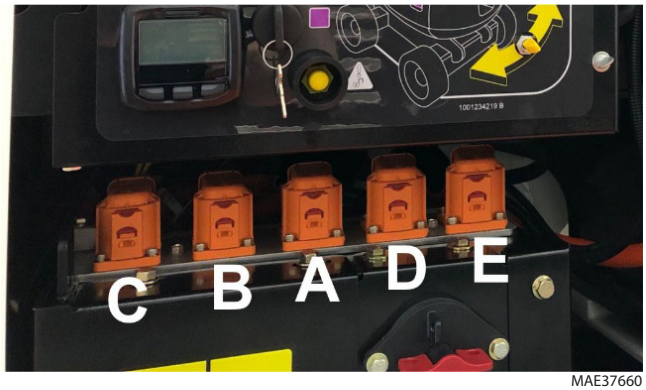
7.12 IMG CONTROLLER

Refer to Figure 7-43. thru Figure 7-48.

The IMG Controller monitors the battery stacks through voltage sensors, temperature probes and State of Charge device (SOC). It also converts DC to AC and vise versa. In addition, it monitors the IMG sensors and has an isolated CAN 2 channel that is 84V.

Removal

At the IGM control box (tank side of machine):



MAE37660

NOTE: *Use above image as a reference for connector name.*

NOTE: *Refer to Section 7.9, Disconnecting Battery Box Connectors for connector discconecting procedure.*



MAE37670

1. Disconnect the “D” keyed connector.
2. Disconnect the “E” keyed connector.



MAE37700

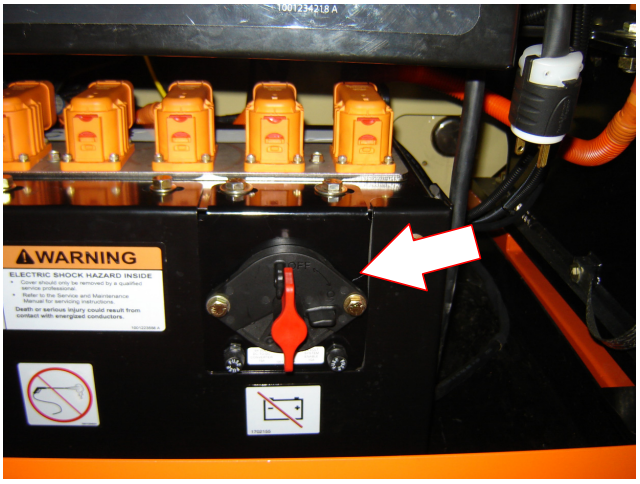
Figure 7-39. 84V hybrid round connector on tank side



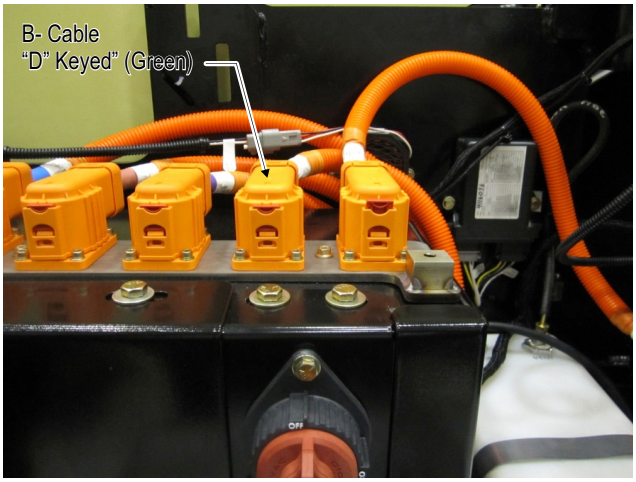
MAE37710

Figure 7-40. 84V hybrid round connector on engine side

3. Disconnect the 84V hybrid round connector (1) located on each side of the machine
4. Turn off the power at the maintenance disconnect switch.



5. Disconnect and completely remove the B- cable, “D” keyed (Green) from the IMG box.



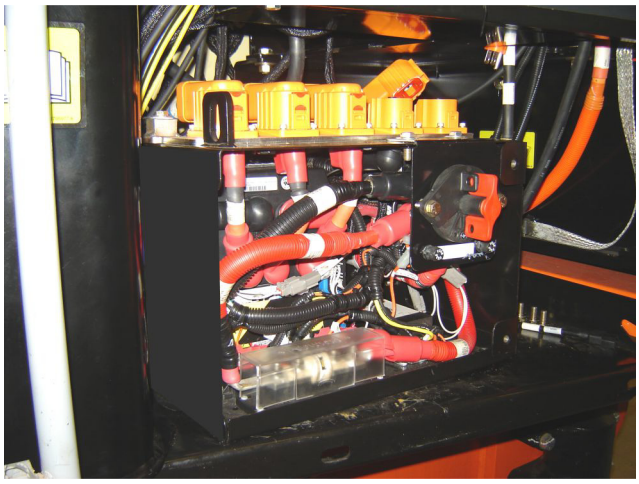
6. Disconnect and completely remove the B+ cable, “E” keyed (Orange) from the IMG box.



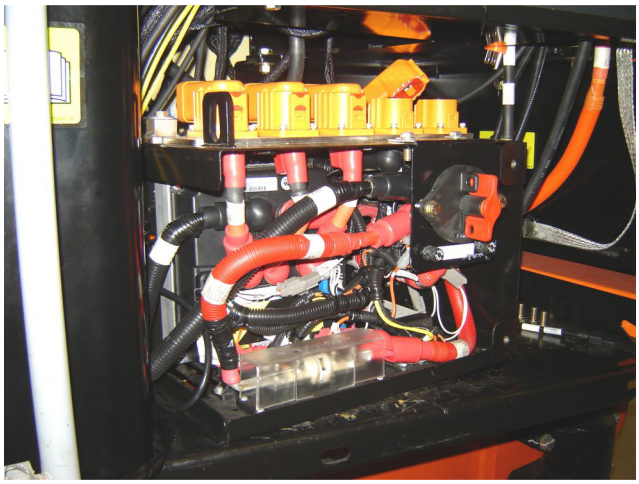
7. Remove the hood section that covers the IMG Box.



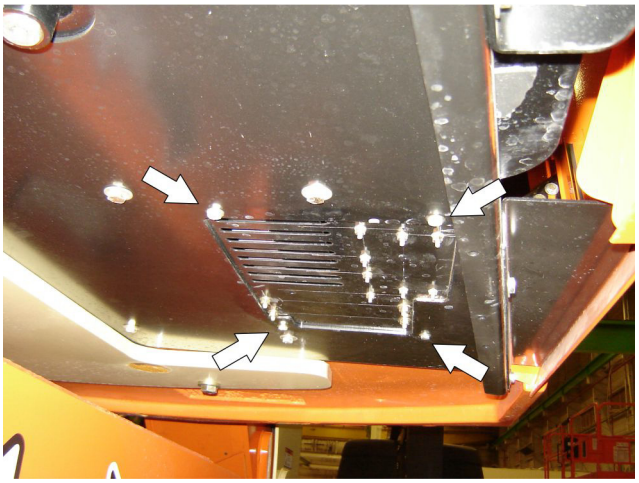
8. Remove the front cover from the box.



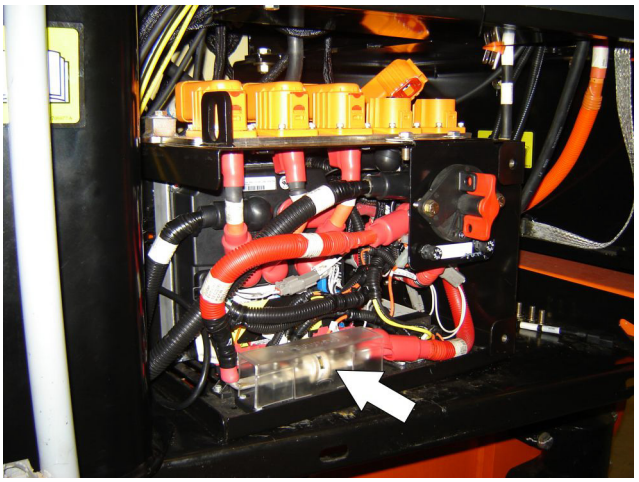
9. Remove the left hand side cover from the box.



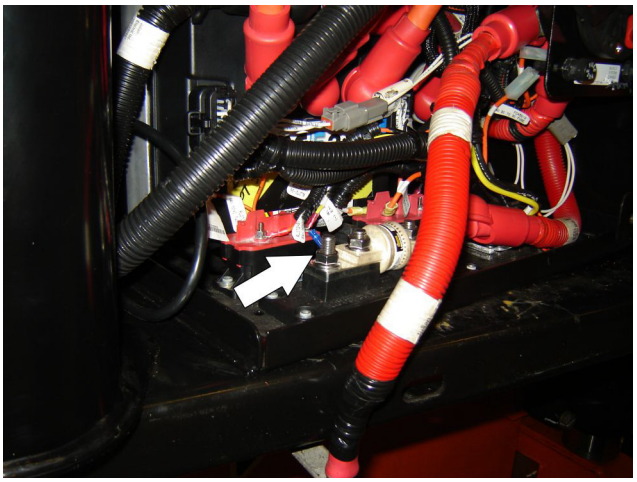
10. Remove the bolts that secure the IMG Box to the turntable side tray.



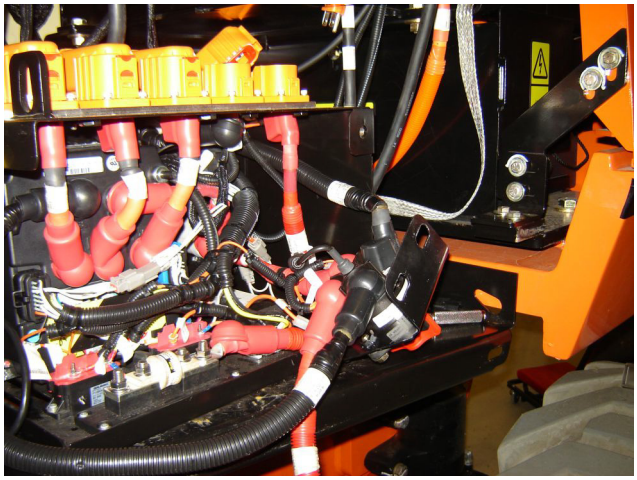
11. Remove the plastic cover from the fuse holder.



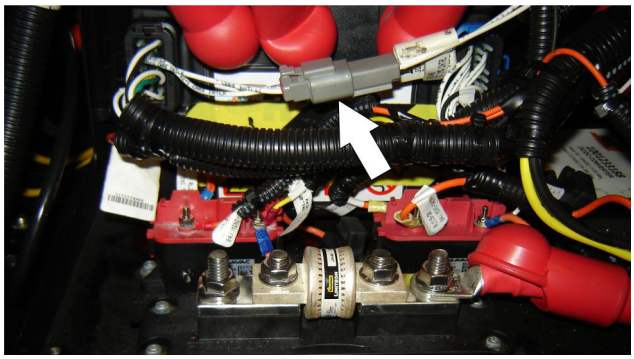
12. Tag and disconnect the Left Hand cable coming from the fuse.

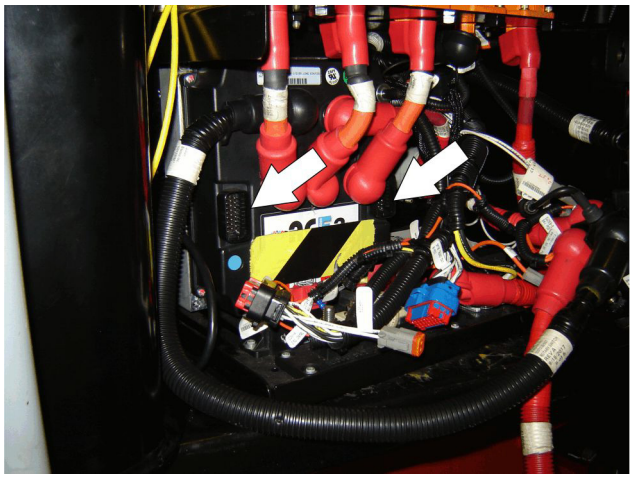


13. Remove the bolts securing the maintenance disconnect switch mounting bracket to the box. Pull the switch and bracket assembly away from the box.

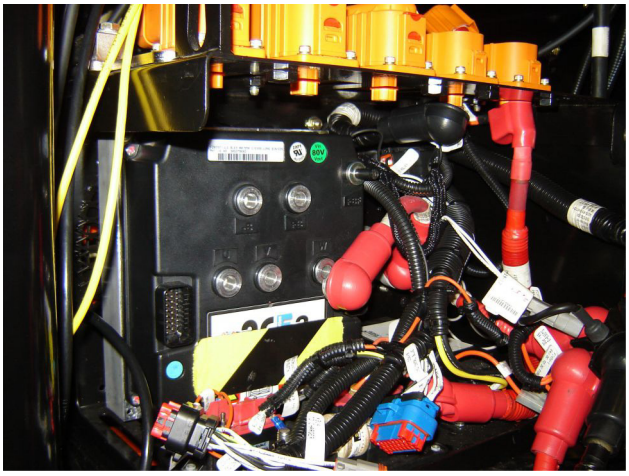


14. Tag and disconnect the connection for the battery charger and the control harnesses from the IMG Controller.





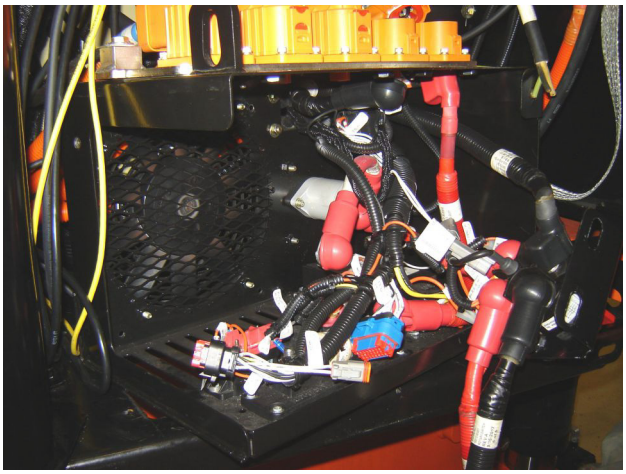
15. Tag, disconnect, and remove the power cables from the connectors and controller for clearance.



16. Remove the allen screws that secure the IMG Controller to the box. Pull the box out enough to gain access to the retaining nuts at the back of the box.

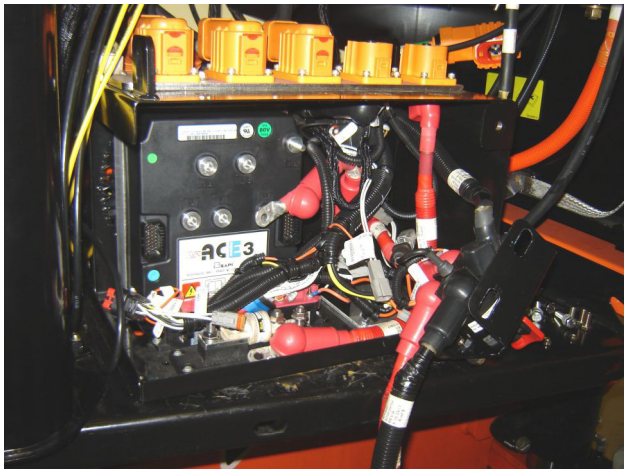


17. Remove the IMG Controller.

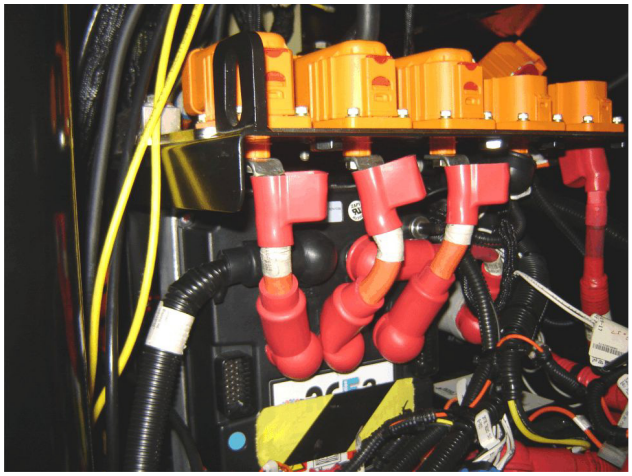


Installation

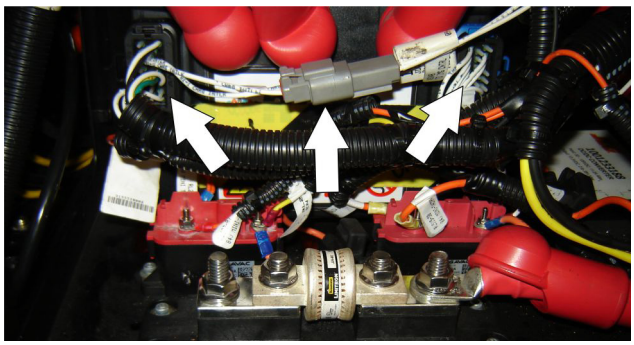
1. Install the IMG Controller to the box using the allen screws and retaining nuts. If installing a new controller, make sure to remove the standoffs from the old controller for proper installation. Push the box back in place.



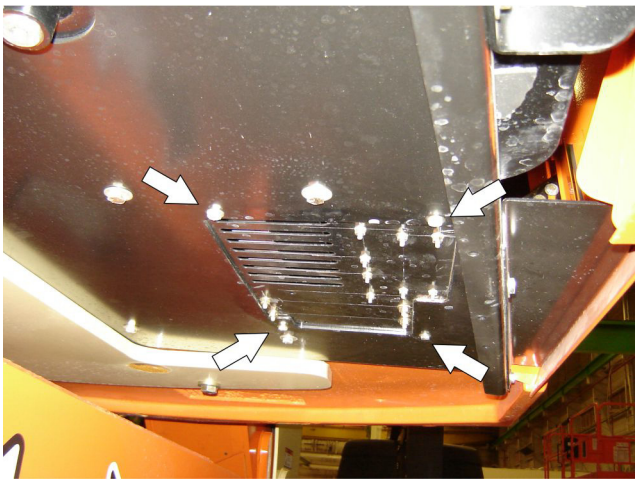
2. Install the power cables to the controller as tagged during removal. Torque all fasteners 9.5 to 11 ft. lbs. (13 to 15 Nm).



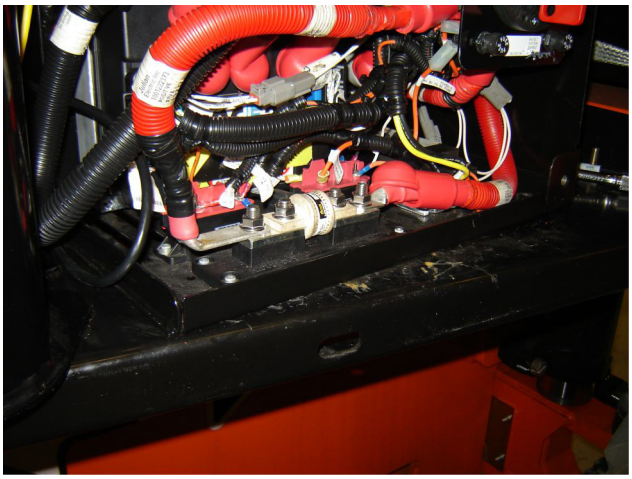
3. Plug the connectors back into the controller as tagged during removal. Reconnect the harness for the battery charger.



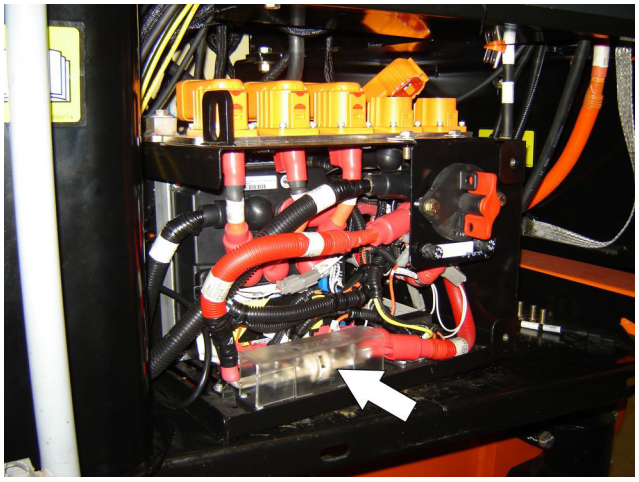
4. Position the maintenance disconnect and bracket assembly in place and secure with the attaching bolts.
5. Install the bolts that secure the IMG box to the turntable side tray.



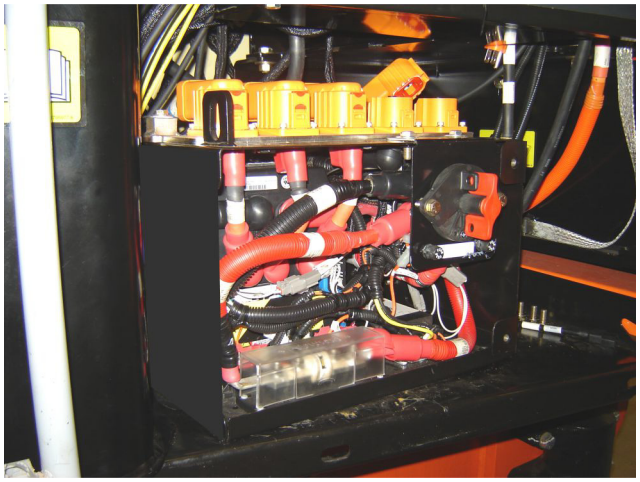
6. Install the power cable onto the fuse as tagged during removal.



7. Install the plastic cover back onto the fuse holder.



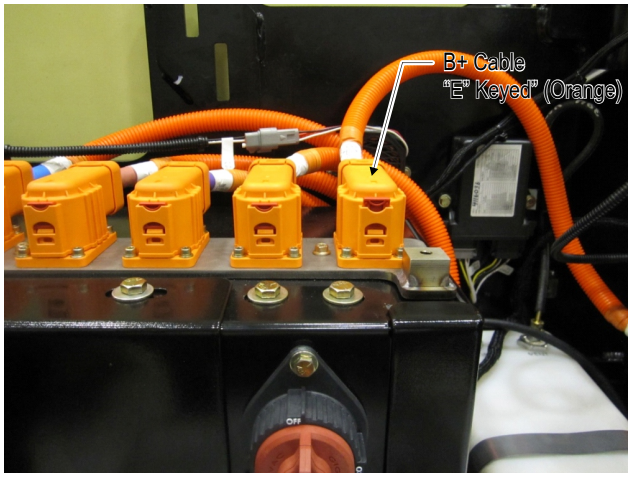
8. Install the left side cover onto the box.



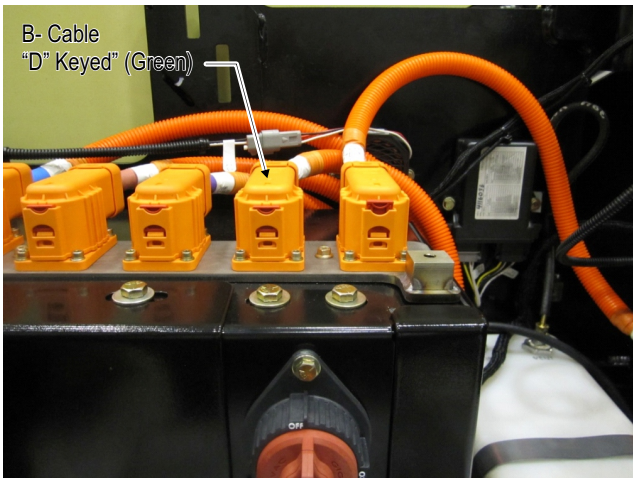
9. Install the front cover onto the box.

10. Install the hood.

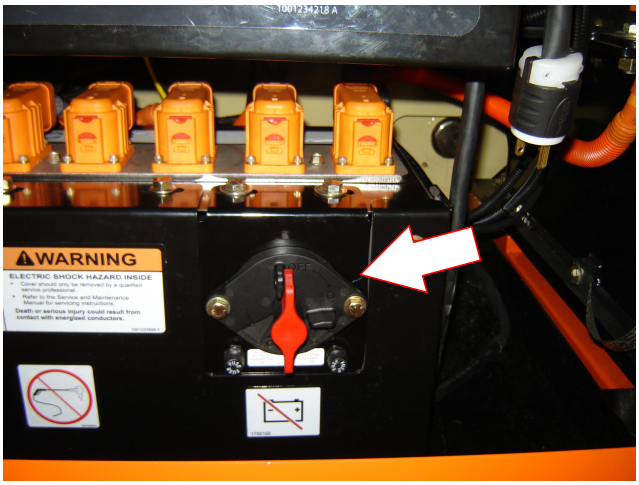
11. Connect the B+ cable, “E” keyed (Orange) as tagged during removal.



12. Connect the B- cable, “D” keyed (Green) as tagged during removal.



13. Turn the power on at the maintenance disconnect switch.



14. Connect the 84V hybrid round connector (1) located on each side of the machine.



MAE37710

Figure 7-41. 84V hybrid round connector on engine side



MAE37700

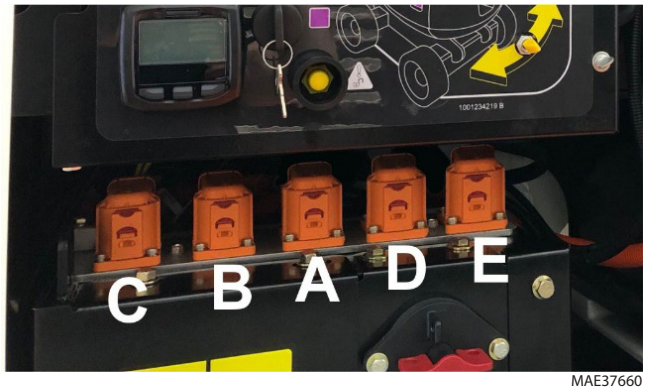
Figure 7-42. 84V hybrid round connector on tank side

15. Connect connector E.

16. Disconnect connector D.



MAE37670



MAE37660

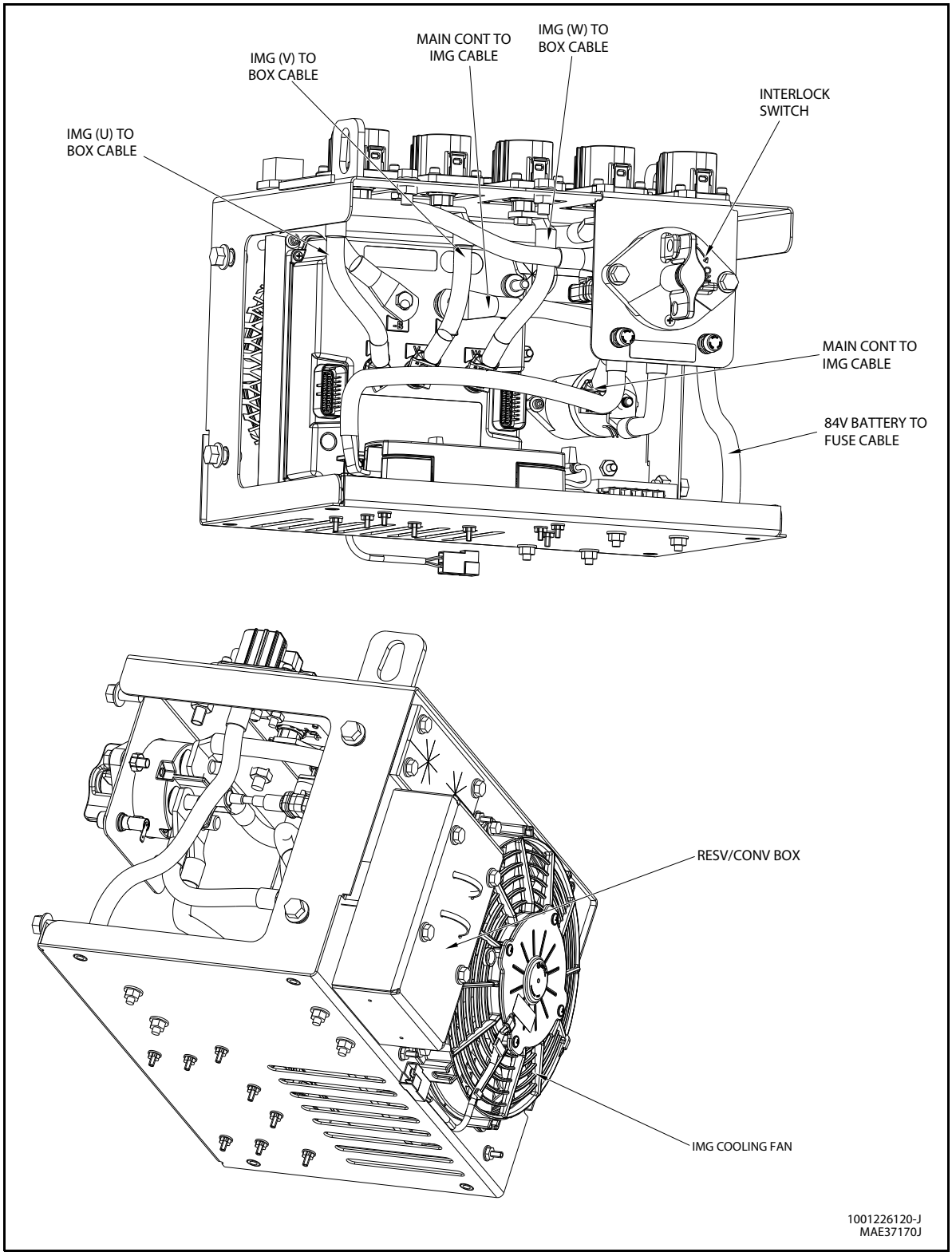


Figure 7-43. IMG Box - Sheet 1 of 6

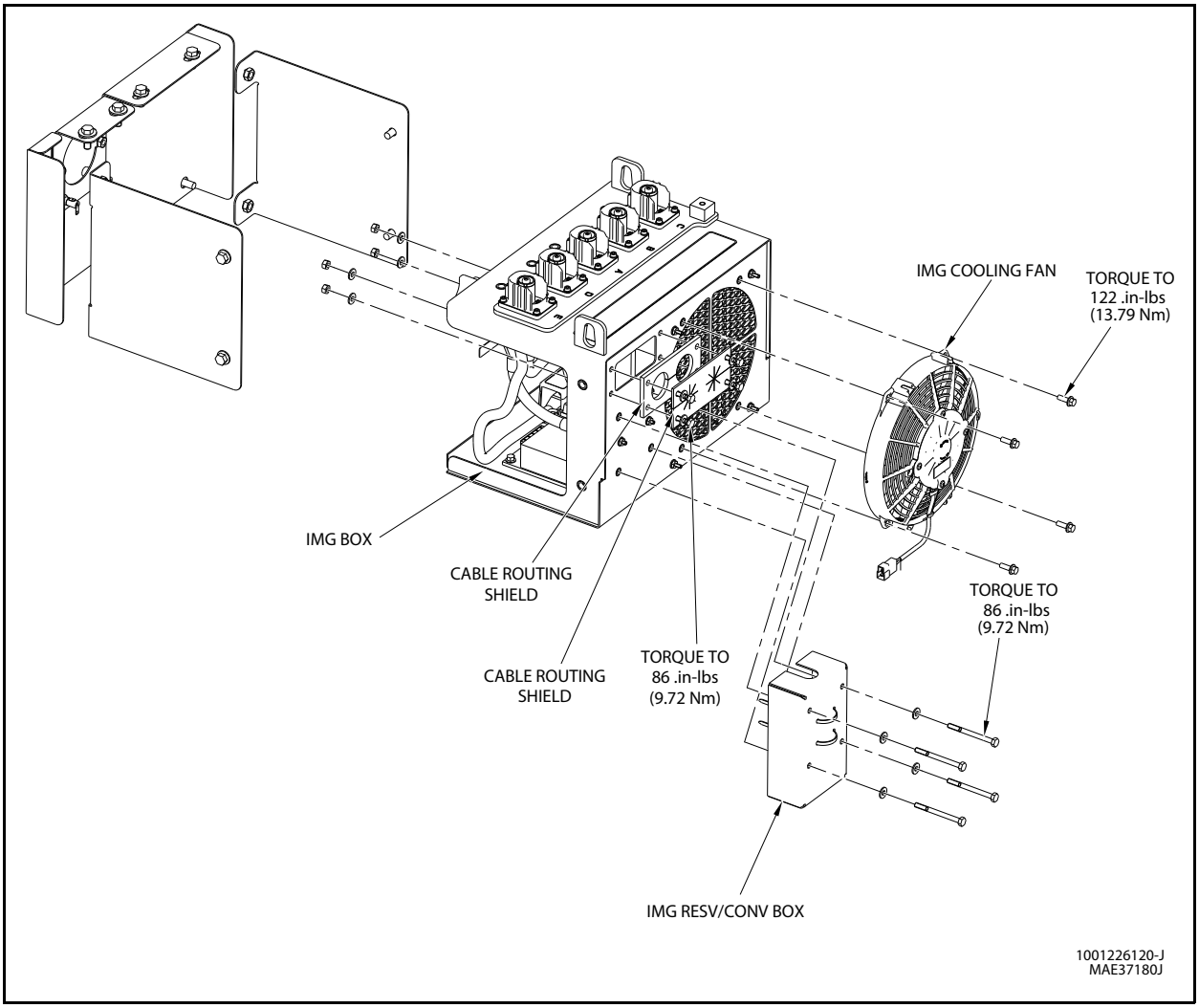


Figure 7-44. IMG Box - Sheet 2 of 6

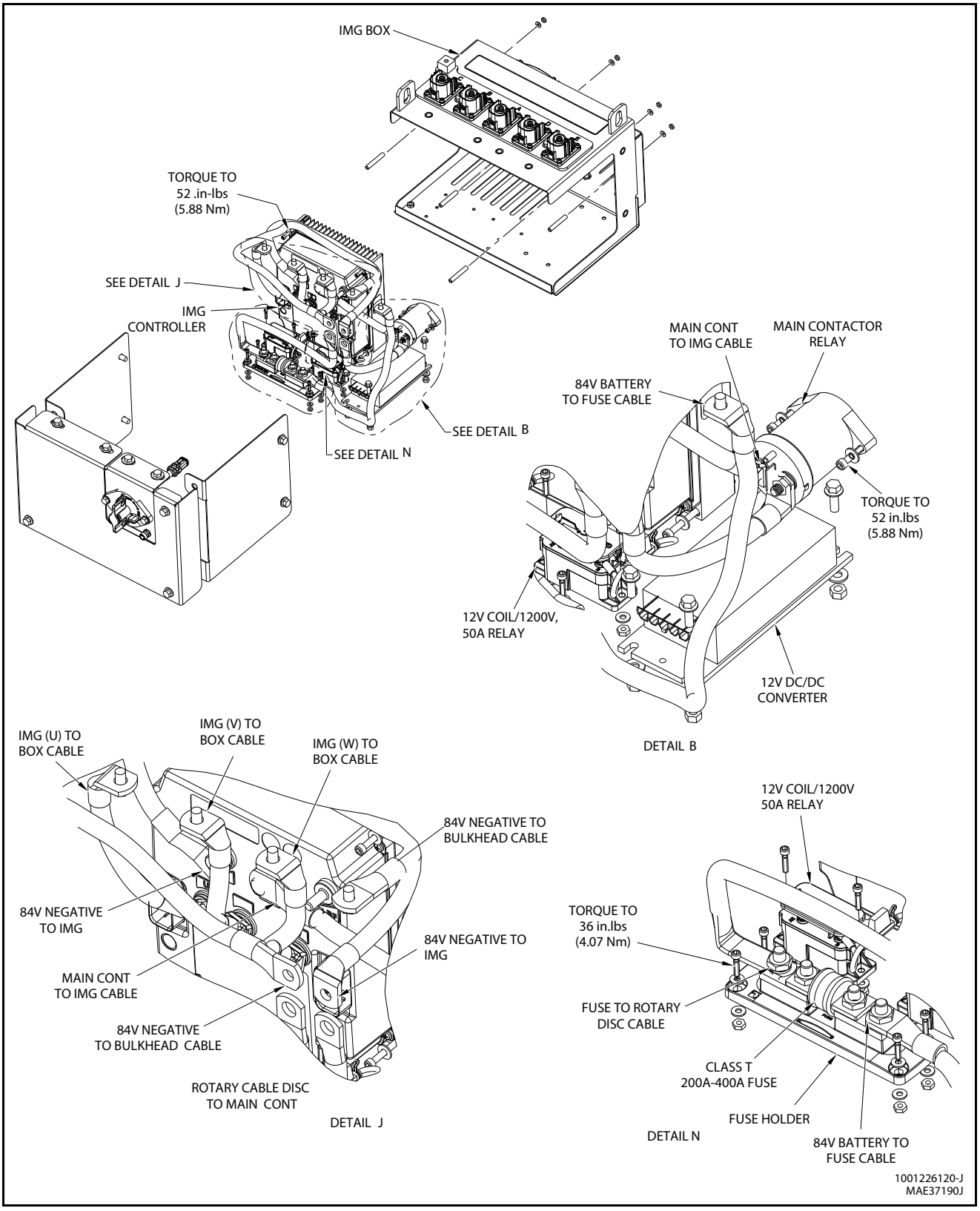


Figure 7-45. IMG Box - Sheet 3 of 6

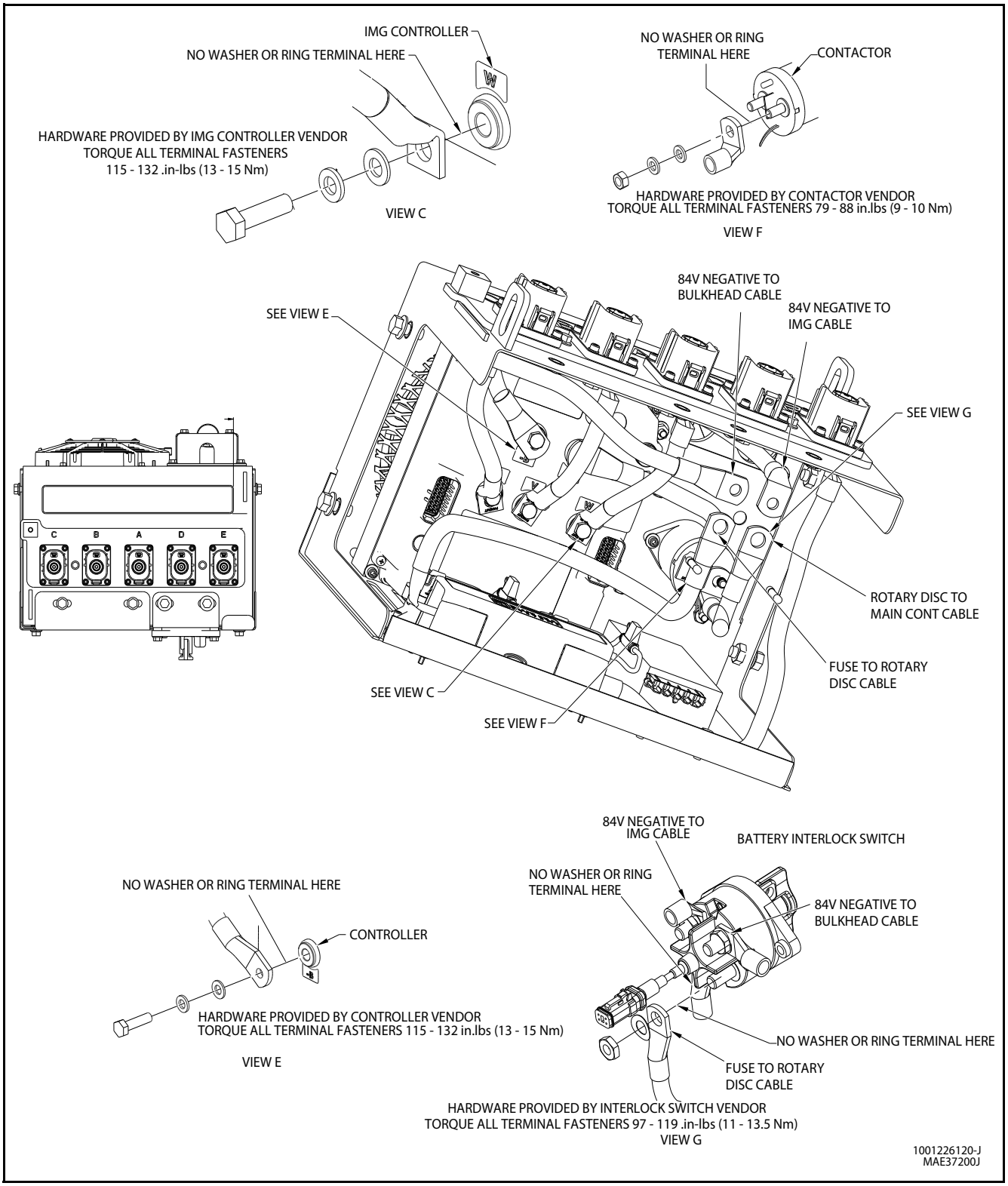


Figure 7-46. IMG Box - Sheet 4 of 6

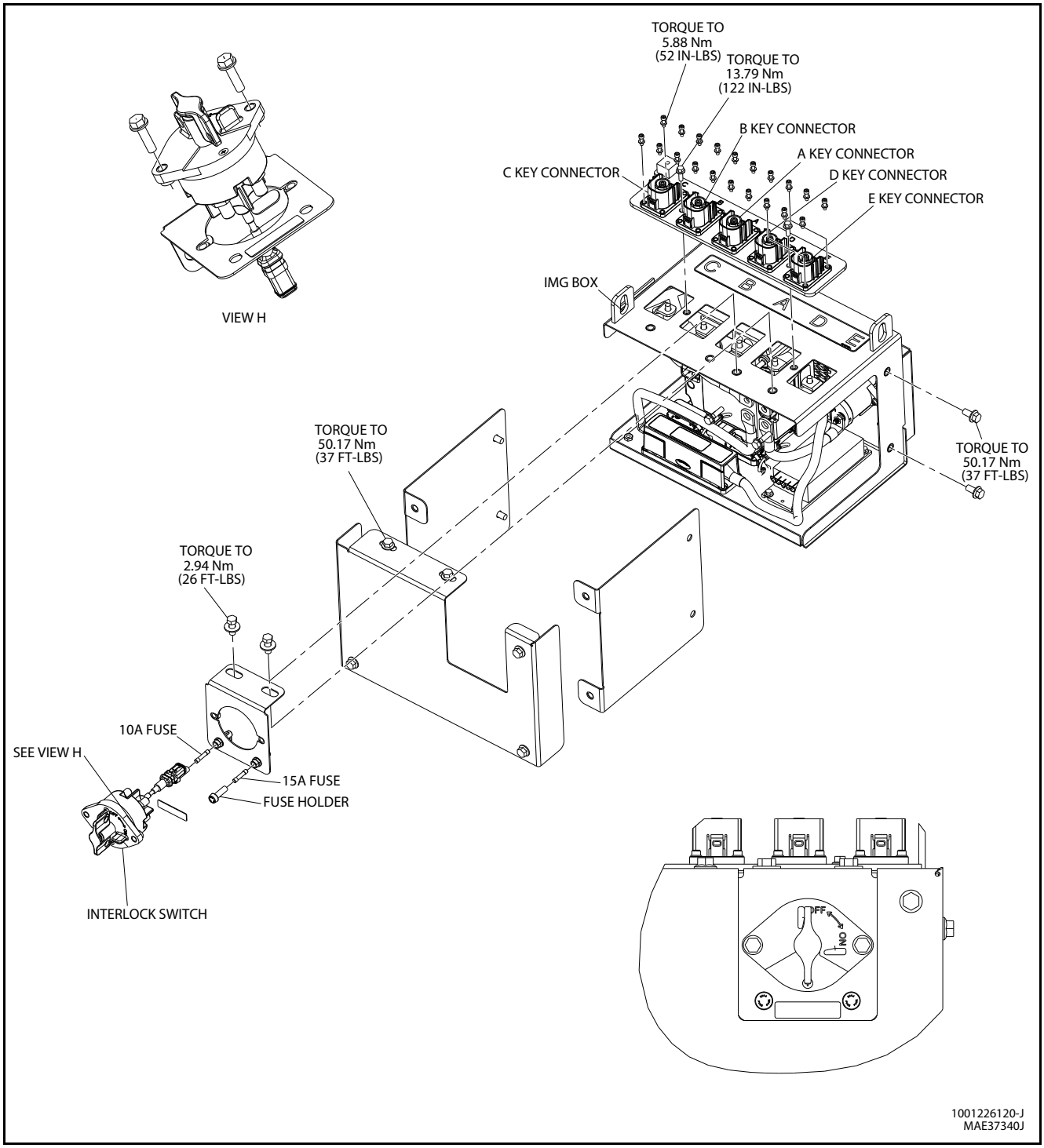


Figure 7-47. IMG Box - Sheet 5 of 6

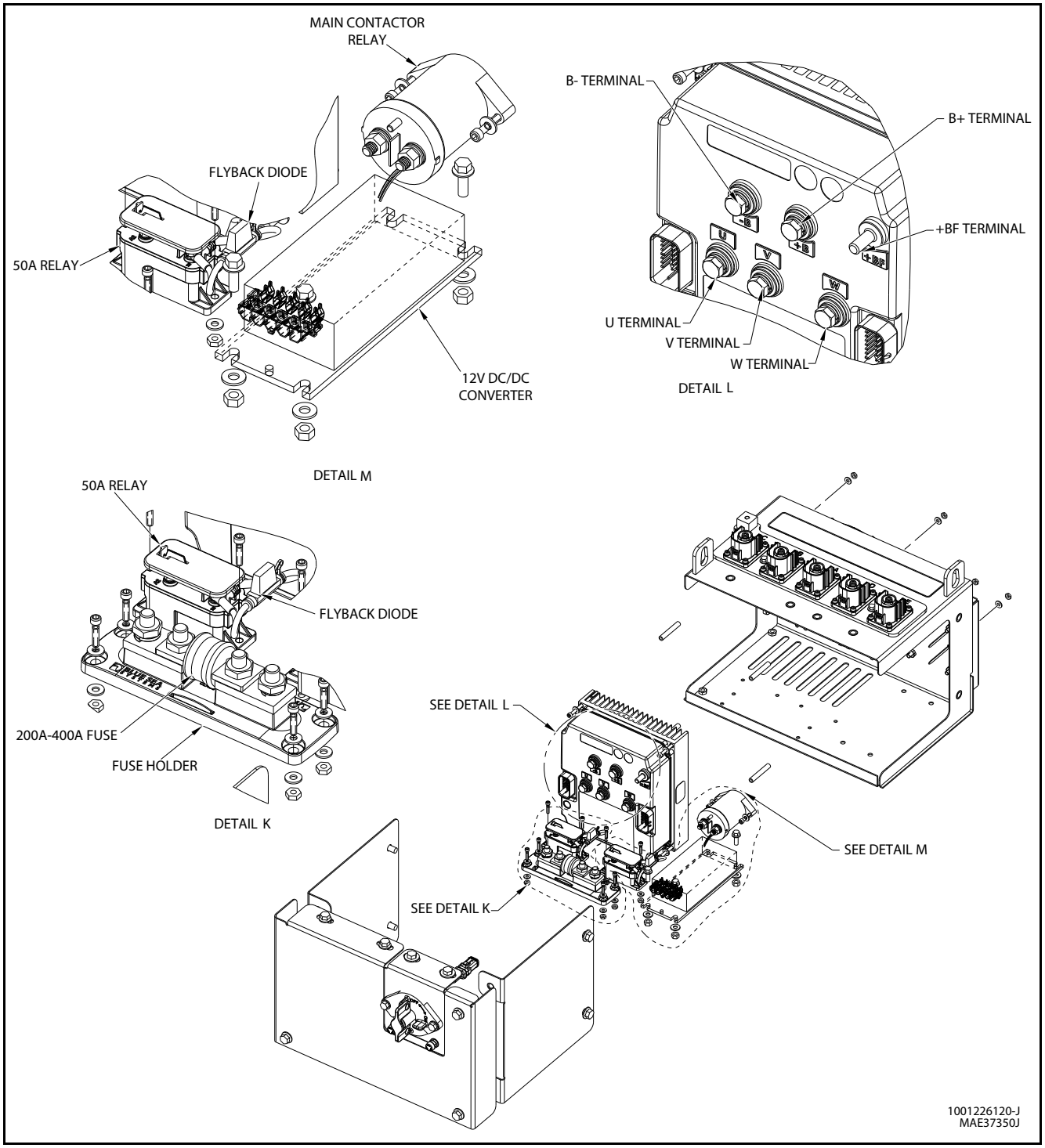


Figure 7-48. IMG Box - Sheet 6 of 6

7.13 HYBRID ELECTRIC CONTROLLER

The Hybrid Electric Controller (HEC) Monitors the hybrid systems and contols the following:

- Controls fans
- Controls DC/DC converter
- DC/DC converter
- Converts 84V to 12V
- Charges 12V battery when engine is not running

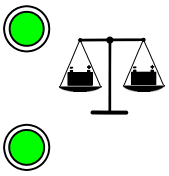
7.14 RESOLVER/CONVERTER

The Resolver/Converter translates the IMG signals so the IMG controller can understand them. It is located behind the IMG box.

7.15 STATE OF CHARGE DEVICE

The State of Charge Device (SOC) monitors current to and from batteries, battery stack voltage, and temperature. It communicates to the IMG controller by way of the CAN 2 circuit.

7.16 BATTERY EQUALIZER



There is one battery equalizer for each battery stack. The equalizer monitors the health of the battery stacks. If one pair drops too much, it will take power from a stronger pair to charge them up. Each lead is fused and an LED on the Ground control box shows the status of the batteries. The Battery Balance Indicator displays the state of charge balance of the battery packs. The lights will glow a steady green when the battery pack is balanced or a steady red when the batteries are too far out of balance, resulting in a system shutdown condition. For conditions in between, the light will be green and blink orange at different rates depending upon how far from the normal range the battery packs are (for example, the further out of balance the battery pack is, the faster it will blink. When the battery pack is close to being balanced and is equalizing, the light will blink green.

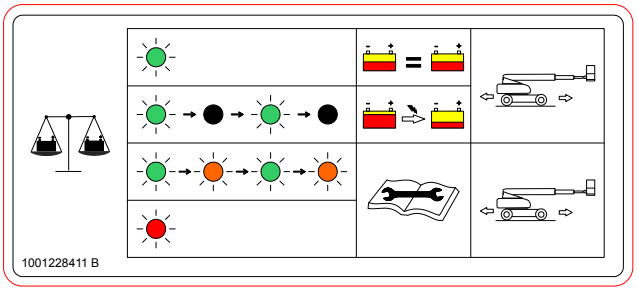


Table 7-1. Battery Equalizer LEDs

MODE	LED	LED INDICATOR	CONDITION
Balanced		Steady Green	Voltage Differential <0.4V (+/-0.4)
Equalizing		Blink Green 1 Sec On/1 Sec Off	Voltage Differential >0.6V (+/-0.4)
Battery #1 Low/Over Warning (Gnd~12V Connection)		Green / Blink Orange 1x Per 4 Sec	Gnd~12V Conn When Battery #1 Exceeded Normal Range <10.5V or >16.5V (+/-0.4)
Battery #2 Low/Over Warning (12V~24V Connection)		Green / Blink Orange 2x Per 4 Sec	12V~24V Conn When Battery #2 Exceeded Normal Range <10.5V or >16.5V (+/-0.4)
Battery #3 Low/Over Warning (24V~36V Connection)		Green / Blink Orange 3x Per 4 Sec	24V~36V Conn When Battery #3 Exceeded Normal Range <10.5V or >16.5V (+/-0.4)
Battery #4 Low/Over Warning (36V~48V Connection)		Green / Blink Orange 4x Per 4 Sec	36V~48V Conn When Battery #4 Exceeded Normal Range <10.5V or >16.5V (+/-0.4)
Auto Shutdown		Steady Red	1) Diff Voltage >4V (+/-0.4) - or- 2) Any 12V, 24V, 36V, or 48V Lead Disconnected

7.17 BATTERY CHARGERS

The machine incorporates two battery chargers (primary and a secondary) which operate on 220V or 110V. Both chargers operate initially and the primary does the finish charging. 220V charging is the preferred voltage for charging the batteries.

NOTICE

JLG MACHINES EQUIPPED WITH DELTA Q BATTERY CHARGERS ARE DESIGNED FOR THE BEST PERFORMANCE WITH OEM FACTORY APPROVED BATTERIES.

APPROVED JLG REPLACEMENT BATTERIES ARE AVAILABLE THROUGH JLG'S AFTERMARKET PARTS DISTRIBUTION CENTERS OR JLG'S AFTERMARKET PROGRAMS. FOR ASSISTANCE WITH PROPER BATTERY REPLACEMENT, PLEASE CONTACT YOUR LOCAL JLG SUPPORT OFFICE.

BATTERIES APPROVED BY JLG HAVE BEEN TESTED FOR COMPATIBILITY WITH THE ALGORITHM PROGRAMMING OF THE DELTA Q BATTERY CHARGER TO OPTIMIZE BATTERY LIFE AND MACHINE CYCLE TIMES. THE USE OF NON APPROVED BATTERIES IN YOUR JLG EQUIPMENT MAY RESULT IN PERFORMANCE ISSUES OR BATTERY CHARGER FAULT CODES. JLG ASSUMES NO RESPONSIBILITY FOR SERVICE OR PERFORMANCE ISSUES ARISING FROM THE USE OF NON APPROVED BATTERIES.

Battery Charging

IF CHARGING THE MACHINE USING STANDARD 110V 15 OR 20A OUTLETS, EACH CHARGER MUST BE PLUGGED INTO A SEPARATE CIRCUIT. FOR EXAMPLE, EACH OUTLET USED TO PLUG EACH CHARGER INTO MUST BE CONTROLLED BY AN INDIVIDUAL CIRCUIT BREAKER IN THE ELECTRICAL SERVICE PANEL. THE CHARGERS CANNOT BOTH BE PLUGGED INTO MULTIPLE OUTLETS CONTROLLED BY ONLY ONE CIRCUIT BREAKER. IF USING 220V TO CHARGE, A STANDARD 220V 15A CIRCUIT MAY BE USED.

NOTE: *Be sure that machine is parked in a well ventilated area before charging begins.*

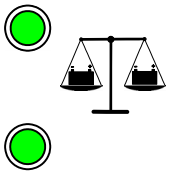
⚠ CAUTION

ONLY PLUG THE CHARGER INTO A PROPERLY INSTALLED AND GROUNDED OUTLET. DO NOT USE GROUND ADAPTORS OR MODIFY PLUG. DO NOT TOUCH NON-INSULATED PORTION OF OUTPUT CONNECTOR OR NON-INSULATED BATTERY TERMINAL.
DO NOT OPERATE CHARGER IF THE AC SUPPLY CORD IS DAMAGED OR IF THE CHARGER HAS BEEN DAMAGED IN ANY WAY.

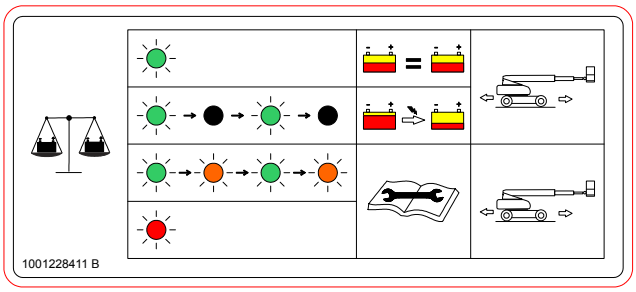
1. The battery charger AC input plug is located near the ground control console.
2. Connect the charger AC input plug to a grounded outlet using a 3 wire heavy duty extension cord.
3. After connecting the charger to an AC outlet at the start of the charging cycle, check the Charger Status and Battery Balance indicators on the Ground Control console.

Ground Panel Indicators

BATTERY BALANCE INDICATOR

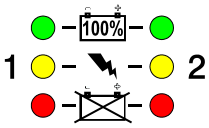


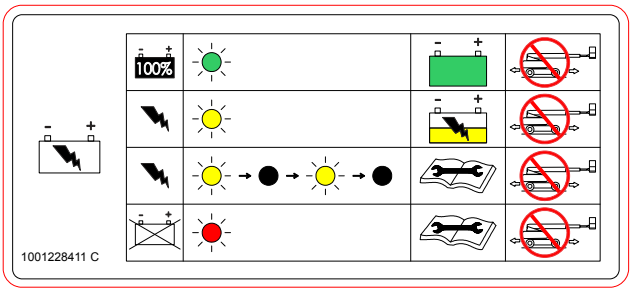
The Battery Balance Indicator displays the state of charge balance of the battery packs. The lights will glow a steady green when the battery pack is balanced or a steady red when the batteries are too far out of balance, resulting in a system shutdown condition. For conditions in between, the light will be green and blink orange at different rates depending upon how far from the normal range the battery packs are (for example, the further out of balance the battery pack is, the faster it will blink. When the battery pack is close to being balanced and is equalizing, the light will blink green.



CHARGER STATUS

The Charger Status LEDs give a visual indicator of the status of the battery charger. The red LED indicates Charging Abnormal. The yellow LED indicates charging in progress. The green LED indicates charging is complete. There is one set of LEDs for each battery pack.





Indications on the Charger 3-LED Display

The charger may become hot during charging. Use hand protection to safely handle the charger during charging.

Extension cords must be 3-wire cord no longer than 30m (100') at 10 AWG or 7.5m (25') at 16 AWG per UL guidelines.

Only connect one QuiQ Charger to a single 120VAC 15A circuit, or the circuit may become overloaded.

The charger will conduct a self-test after being powered on, visible by flashing all of its LEDs in sequence.

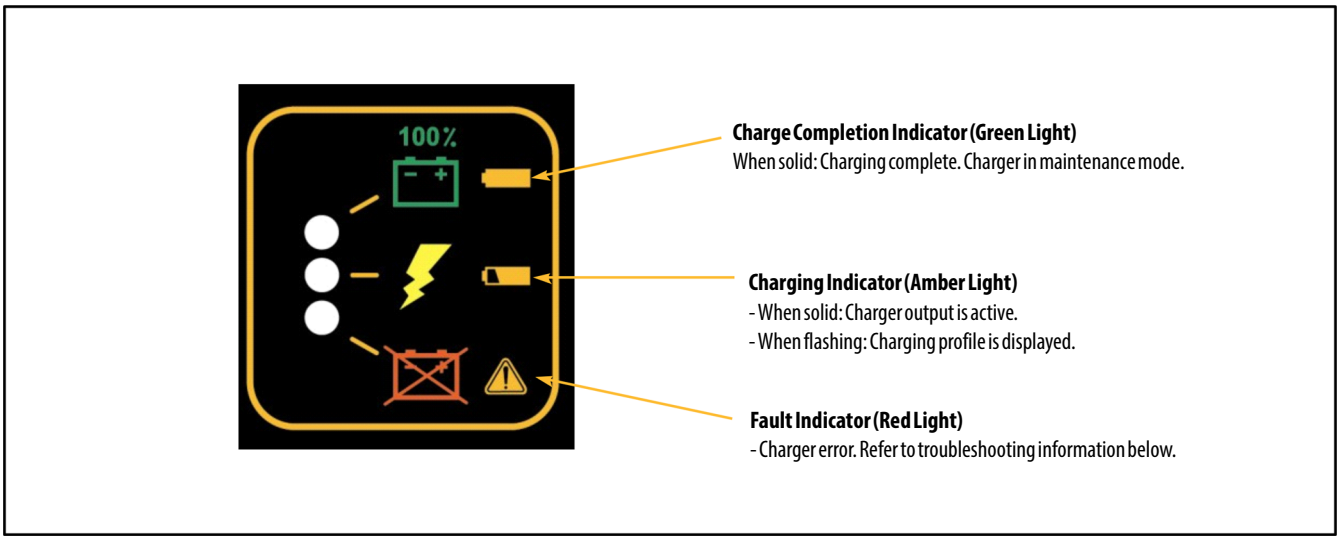


Figure 7-49. Battery Charger LED Display

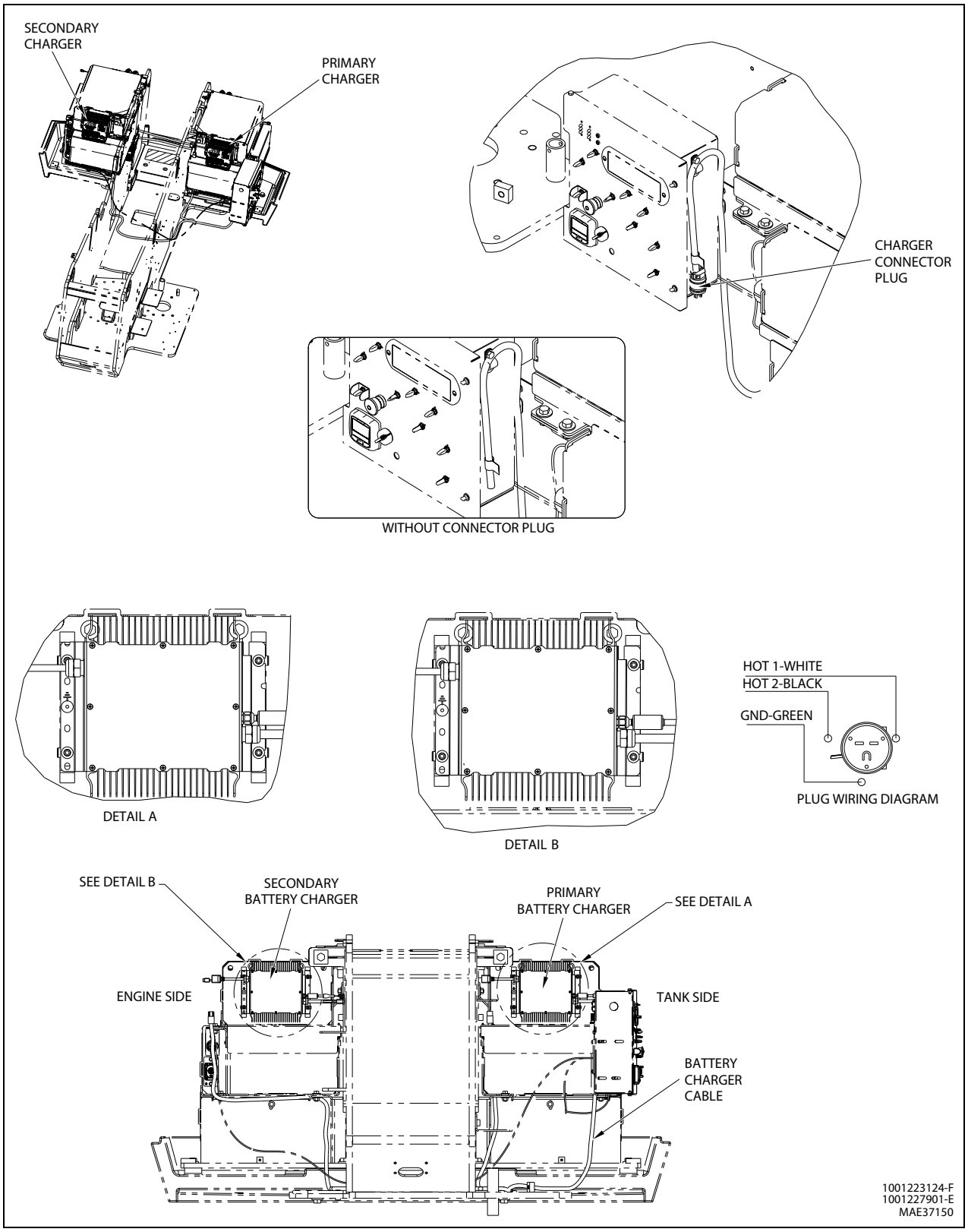


Figure 7-50. Battery Charger Installation

Troubleshooting Instructions (Wall - Charge)

If a fault occurs, count the number of red flashes between pauses and refer to the table below.

Table 7-2. LED Flashes

Flashes	Cause	Solution
	Battery high voltage	Check battery size and condition. This fault will clear automatically once the condition has been corrected.
	Battery low voltage	Check battery size and condition. This fault will clear automatically once the condition has been corrected.
	Charge timeout caused by battery pack not reaching required voltage; or charger output reduced due to high temperatures.	Check connections, that battery type matches selected charge profile and operate the charger at a lower ambient temperature. Reset the charger by interrupting AC power for 15+ seconds.
	Battery could not be trickle charged up to minimum voltage.	Check for shorted or damaged cells. Reset the charger by interrupting AC power for 15+ seconds.
	Charger shutdown due to high internal temperature.	Ensure sufficient cooling airflow. Reset the charger by interrupting AC power for 15+ seconds.
	Internal charger fault	Reset the charger by interrupting AC power for 15+ seconds. Return to service depot if fault persists.

Table 7-3. Detailed LED Fault Indications

Flashes	Explanation and Solution
	High Battery Voltage Detected - starting voltage above 2.5V/cell or voltage during charge rose above 2.7V/cell (algorithm dependent). - Check that the battery charger voltage is consistent with the battery pack voltage. - Check for wiring errors. - Occasionally a new, fully charged battery pack may cause this condition. Use this pack before charging it again. - Disconnect any other sources during charging. - If this problem does not clear after the battery voltage is measured to be less than 2.5V per cell, contact Delta-Q. - This fault will automatically clear and the charger will restart charging when the voltage drops to within operating range.
	Low Battery Voltage Detected - starting voltage below 0.5V/cell - Check the battery and connections to the battery. - Check the nominal battery voltage. Confirm that the nominal battery voltage is the same as the charger voltage. - If this problem does not clear after the battery voltage is measured to be higher than 1V per cell and all connections are good, contact Delta-Q. - This fault will clear automatically when the returns within range.
	Charge Timeout - Indicates the battery failed to charge within the time allowed by the charge algorithm. This could occur if the battery is of larger capacity than the algorithm is intended for. In unusual cases it could mean charger output is reduced due to high ambient temperature. It can also occur if the battery is damaged, old, or in poor condition. - Check the battery for damage such as shorted cells and insufficient water. Try the charger on a good battery. - If the same fault occurs on a good battery, check the connections on the battery and connection to AC power, and AC voltage. - Confirm that the nominal battery pack voltage is the same as the battery charger voltage. - If a charger displays this fault on a battery pack, and the pack is of questionable status, reset the charger by disconnecting AC power for 30 seconds, and then reconnect the AC to start a new charge cycle. After a few charge cycles this problem could stop occurring as the pack "recovers." - This fault must be cleared manually by unplugging the AC, waiting 30 seconds and reconnecting the ac power.
	Check Battery - This fault indicates the battery pack could not be trickle charged up to the minimum level required for the normal charge cycle to be started. - Check that none of the battery pack connections between modules are reversed or incorrectly connected. - Check that one or more cells in the battery are not shorted. - Confirm that the nominal battery pack voltage is the same as the battery charger voltage. - Try the charger on a good battery. - If this fault occurs the battery pack is likely in poor condition. Try to recover the pack with a charger that can charge the individual batteries - such as an automotive charger. Be sure to set this charger to the appropriate voltage - 6V per 6V battery, 12V per 12V string/battery.
	Over-Temperature: This fault indicates the charger has become too hot during operation and has shut down. This extra fault indication (as opposed to the flashing ammeter described above), indicates an even higher temperature was reached inside the charger. Though not damaging to the charger, charge time will be extended significantly - This fault indication will not clear automatically, but the charger will restart charging automatically when the temperature drops. The fault indication must be cleared manually by unplugging the AC power, waiting 30 seconds and reconnecting the AC. - If possible, install the charger in a cooler location or increase cooling airflow to the cooling fins. - Confirm that dirt or mud is not blocking the cooling fins of the charger. If required, clean the charger by rinsing it with a low-pressure hose.
	QuiQ Internal Fault: This fault indicates that the batteries will not accept charge current, or an internal fault has been detected in the charger. This fault will nearly always be set within the first 30 seconds of operation. If it occurs after the charger has started charging normally, be sure to make a note of it. - Try to clear the fault by unplugging AC power, waiting 30 seconds and reconnecting the AC. - Check all battery connections. Look for a high resistance connection. The most likely reason for this fault is a fault in the battery such as a bad battery connection, an open cell, or insufficient water. - Other electrical hardware such as contactors, switches, etc. which are badly wired may also cause this fault. - This fault will occur if an internal fuse inside the charger blows. If the green wire is shorted to ground even momentarily this fuse will blow. To check the fuse, measure with an ohmmeter between the green and red wires with the AC disconnected. If a short circuit is not measured, the fuse has blown. Contact Delta-Q - If this fault occurs after battery charging has started, confirm that AC power was not interrupted and that all battery connections are good. - If all battery connections are good, an internal fault has been detected. Contact Delta-Q.

Table 7-4. Charger/Converter Troubleshooting

Symptom	Possible Causes and Solutions
No or low output	- Input voltage out of range: - 35 - 87V for the 48V model - 50 - 130V for the 72V model - Unit overheating - increase cooling air flow - Short circuit detected - Poor connections - Inspect connections - Converter damaged
No switched output	- Switched input voltage out of range: - 8 - 87V for the 48V model - 8 - 130V for the 72V model - Switching input circuit damaged from high voltage - Poor connections - Inspect connections
Turn-on or turn-off delay greater than 3 seconds	- Switched input circuit variability - no action required
Wiring or connectors overheating	- Wire gauge too small (minimum 18AWG) - More than 18A drawn from single connector

Table 7-5. Other Conditions

Indication	Explanation and Solution
AC on LED lit, charger won't start charging.	Charger has detected a condition that does not allow it to charge - This condition is generally corrected by resetting the charger by removing AC power for 30 seconds and reconnecting it.
Excessive battery watering or strong sulphur (rotten egg) smell	Overcharging or high battery temperature. These symptoms are unlikely to be caused by too high a charge current since the maximum charge current of the charger will be small compared to even a moderately sized battery pack. The most likely cause for this problem is incorrect charge algorithm setting and/or high ambient temperatures. - Confirm that the battery pack is not too small - Delta-Q chargers are usually used with batteries larger than 50Ah. - Confirm that the nominal battery voltage matches the charger output voltage. - Confirm the correct battery charge algorithm. If the battery pack is new, the algorithm will need to be changed if the pack is not the same as the old one. Refer to the Product Manual for instructions on how to determine and change the battery charge algorithm. - If the pack is older, it is possible sulphation has taken root. Increased resistance of the battery pack due to this will cause excessive heat and water usage.
Charger operates at low current only	Delta-Q charge algorithms only operate at a low current, usually 2-5A if the battery voltage is less than 2.0V/cell. This is to slowly recharge an over discharged battery to avoid damaging it. - Check the battery pack voltage, if it is <2.0V/cell then this low current is normal.
Charger restarts automatically	There are two features of algorithms that may cause this: - Maintenance Mode - charger automatically restarts after 14d or 30d, or when the battery voltage falls below 2.08V/cell or 1.5V/cell. These settings are algorithm dependent. - Battery overvoltage - If the battery is very resistive, sometimes in new batteries, the voltage may rise so quickly the charger trips off due to overvoltage. It will then restart the charge cycle when the voltage falls back into range.
Difficulty changing the default battery charge algorithm	- The mode to change the battery charge algorithm can only be selected during the first 10 seconds of operation. Refer to the Product Manual for instructions. - If the 10 second window is missed, cycle AC power by unplugging the charger, waiting 30 seconds, and reconnecting AC power. - To extend Battery Charge Algorithm Change Mode by 30 seconds (120 seconds on newer models), connect the charger output to a good battery for approximately 1 second and then disconnect the battery again.

Table 7-6. Part Number Reference

JLG Part Number	Factory Set Algorithm	Delta-Q Part Number
1001222359	143	912-8400-04
1001222360	222	912-8400-05

Table 7-7. Charging Profile (Algorithm) Matrix

	Description	Optimized Battery	JLG Part Number	Approved Battery Manufacturers	Other Tested Batteries	May be Compatible with *
#143	Discover AGM (200-400Ah), temperature compensated	Discover AGM	1001102534	DISCOVER EVL16A-A	N/A	200-400Ah AGM
#222	Discover EV4DA-A battery	Discover AGM	1001231249	Discover EV4DA-A	N/A	

Instructions for using the Delta-Q QuiQ Programmer CTQuiQ Programming Kit



CONTENTS OF THE QUIQ PROGRAMMING KIT (JLG PART NUMBER: 2915230)

- - QuiQ USB Interface Module
- - QuiQ Programmer CT Installation CD
- - USB Cable
- - Wire Assembly
- - QuiQ Programmer CT Instructions

Figure 7-51. QuiQ Programming Kit

With QuiQ Programmer CT you can:

- - Add a battery charge algorithm
- - Select a different algorithm for battery charging
- - Delete a battery charge algorithm
- - Upgrade the software in your QuiQ or QuiQ-dci charger
- - View charge tracking data from charger
- - Upload Charge Events to Delta-Q's Online Charge Event Database

INSTALLING QUIQ PROGRAMMER CT SOFTWARE AND DRIVERS

You will find the QuiQ Programmer CT application on the QuiQ Programmer CT installation CD. QuiQ Programmer CT requires a PC with a minimum of 512 MB of RAM, running 32-bit or 64-bit edition of Windows XP, Vista, or 7.

To install QuiQ Programmer CT Insert the QuiQ Programmer Installation CT CD into the CD or DVD drive of your PC (label must be facing up). If the setup application does not launch the QuiQ Programmer CT installer automatically (this will depend on your computer's security settings and configuration), click the Start button (or  icon) on the taskbar; click My Computer; double click the drive labeled QuiQ Programmer CT; double click Setup.exe to launch the installer. You may also use Windows Explorer to navigate to Setup.exe. Then follow the instructions on your screen to complete the software installation.

NOTE: *If your computer is running Windows XP Professional 64-bit, you must install x64 .NET Framework 2.0 before installing QuiQ Programmer CT. You will find x64 .NET Framework 2.0 on the CD in the subfolder Net64Fx.Double click Net64Fx.exe to start installing the software.*

Connecting a QuiQ Charger to your Computer

⚠ WARNING

CHARGER OUTPUTS GREATER THAN 40VDC POSE AN ENERGY AND/OR SHOCK HAZARD UNDER NORMAL USE. DO NOT ENERGIZE CHARGER WITH AC UNTIL WIRE ASSEMBLY CLIPS ARE SECURELY CONNECTED TO CHARGER OUTPUT, AND ALL LEADS ARE SECURED AGAINST MOVEMENT.

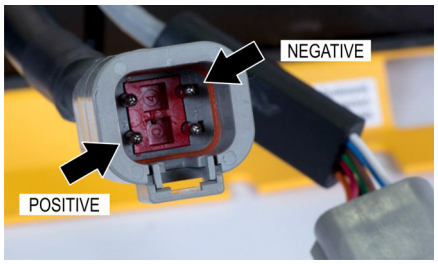
⚠ WARNING

ENSURE THE BATTERY LEADS FROM THE USB INTERFACE MODULE ARE PROTECTED FROM SOURCES OF ELECTROSTATIC DISCHARGE THAT MAY DAMAGE THE UNIT.

To connect a QuiQ charger to your computer:

NOTE: *QuiQ Programmer CT must be installed on your computer before you connect a QuiQ charger.*

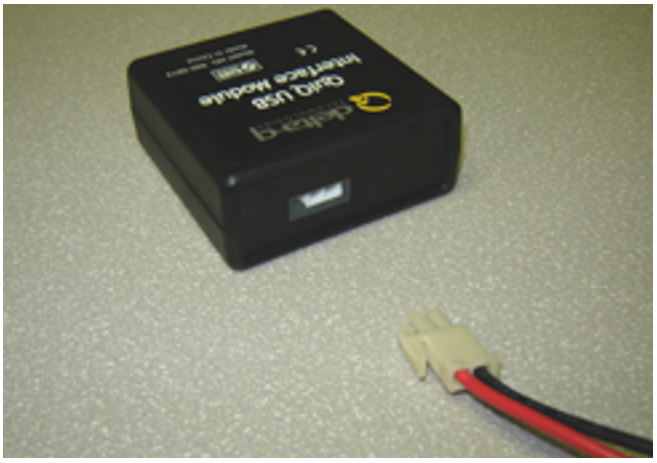
1. Disconnect AC power from the QuiQ charger.
2. Disconnect the QuiQ charger from all batteries.
3. Connect the Wire Assembly red clip to the charger positive wire (red).



4. Connect the Wire Assembly black clip to the charger negative wire (black).



5. Connect the Wire Assembly to the QuiQ USB Interface Module.



6. Connect the USB cable upstream end to an open USB port on your PC.



7. Connect the USB cable downstream end to the QuiQ USB Interface Module.



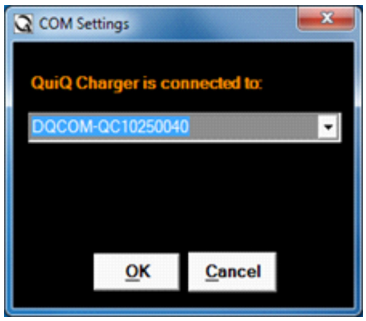
8. Upon connection, Windows will detect the QuiQ USB Interface Module and install drivers for it. If Windows does not detect the QuiQ Module you will need to reinstall QuiQ Programmer CT. See section Installing QuiQ Programmer CT Software and Drivers.
9. Connect the QuiQ charger to AC power.

NOTE: *For a reliable connection, ensure that the bare leads do not touch each other or other metallic objects.*

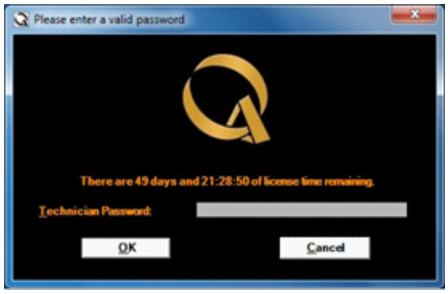
Starting QuiQ Programmer CT

START APPLICATION IN USER MODE

1. To start QuiQ Programmer CT, select Program/QuiQ Programmer CT/QuiQ Programmer CT from the Start Menu.
2. If your installation has not been registered with a license key, starting the application in User Mode is the only option. First select the Dongle you wish to connect in the COM Setting dialog.



3. Then, the QuiQ Programmer CT starts. If your installation has been registered with a license key, then upon starting the application the login dialog appears:



Click on “Cancel” to start the application in User Mode.

4. The QuiQ Programmer CT interface will appear. The connection status area at the bottom of the window will indicate if the QuiQ USB Interface Module is properly connected to your PC and the QuiQ charger.



If the connection area displays Status: No Connection, then QuiQ Programmer is unable to communicate with your charger. This may be due to one of the following:

- The charger is not connected to the PC. Ensure that all wires are connected (see section Connecting a QuiQ Charger to your Computer).
- The wrong COM port was chosen. Exit QuiQ Programmer CT; restart QuiQ Programmer CT and choose the correct COM port (see step 2 above).
- The USB connection may be temporarily disabled. Exit QuiQ Programmer CT; disconnect the USB cable from your PC; wait 5 seconds, then re-connect the USB cable to your PC. Start QuiQ Programmer CT and choose the correct COM port. See Starting QuiQ Programmer step 2.
- The charger is not connected to an AC power source. Ensure that the charger is connected to AC.
- The QuiQ USB Interface Module driver was installed incorrectly. Exit QuiQ Programmer CT. Disconnect the QuiQ USB Interface Module USB cable from your PC. Remove QuiQ Programmer software from your computer. Reinstall QuiQ Programmer CT.

Programming Delta-Q QuiQ and QuiQ-dci Chargers

Click on the Charger Status tab to activate the Charger Status tab. Then click Browse, to select the folder on your PC containing the QuiQ charger software and algorithms.

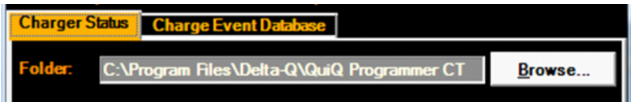
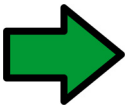
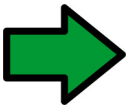


Table 7-8. Programming Delta-Q QuiQ and QuiQ-dci Chargers

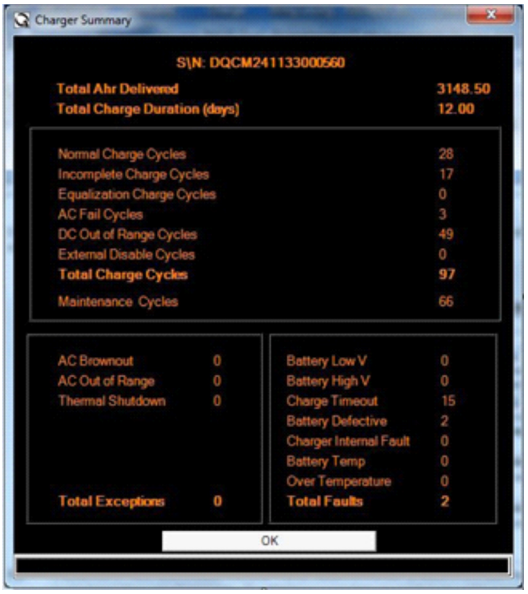
What do you want to do?	Icon	Action
Add a charge algorithm to the charger		In the Battery Charge Algorithms list, on the QuiQ Programmer CT user interface, select the algorithms that you want to add to the charger; click the Add to Charger icon.
Upgrade the charger software		In the Charger Software Versions list, on the QuiQ Programmer CT user interface, select the software version that you want to add to the charger; click the Add to Charger icon. Software may take up to 90 seconds to load.
Select a different default algorithm		In the Algorithms Present list on the QuiQ Programmer CT user interface, select the algorithm that you want to set as the default charge algorithm; click Set as Default icon.
Delete an algorithm from the charger		In the Algorithms Present list on the QuiQ Programmer CT user interface, select the algorithms that you want to delete from the charger; click the Delete from Charger icon. Note: You cannot undo an algorithm deletion.
Tip: To select two or more items one after the other in a list, select the first item, press and hold down the SHIFT key on your keyboard, then select the last item. To select two or more items in a list that may not be one after the other, press and hold down the CRTL key, and select the items.		

View Charge Tracking Data with QuiQ Programmer CT

Requirement: To view the charge tracking data in your charger, your charger must have version 3.X software. Note that only chargers with serial number beginning with "DQCM" may have version 3.X software programmed in it.

Start Application in User Mode

- Click on the Charge Event Database tab. This will display the Charger Summary Dialog for that summarizes charge data for the connected charger.



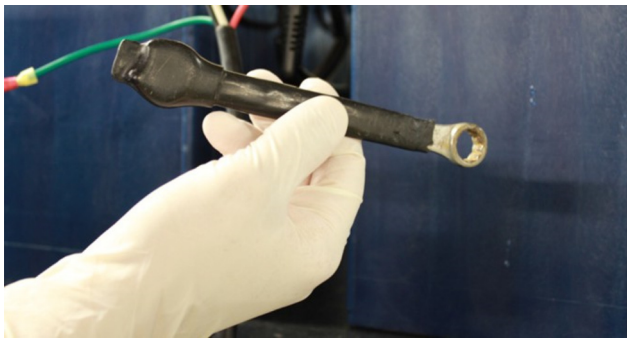
Selecting a Charge Profile

Delta-Q's QuiQ Charger can store up to 10 charging profiles, also called charge algorithms. This section shows how to identify the default profile and select a new profile using the "tap method."

QuiQ chargers are reprogrammable using the QuiQ Programmer supplied by Delta-Q to its OEM partners. Pre-2006 QuiQ chargers with serial number prefix DQCP allow pre-loaded profiles to be selected, but cannot be reprogrammed with new profiles.

IDENTIFY THE DEFAULT PROFILE

1. Required supplies include an insulated wrench, eye protection and gloves.



2. Disconnect the AC power source from the charger, either from the wall outlet, or from the IEC320 connector on the charger.
3. Disconnect power from the batteries using the battery disconnect on the side of the machine.
4. Reconnect AC power.
5. For 11 seconds after the self-test, the charger will display its default charge profile. Profiles are indicated by the number of consecutive flashes followed by a pause

   (e.g. #2 = ).

   5b. Charge profiles in the double digits will display in the same way, by one or more flashes, a pause, then one or more flashes

   (e.g. #42 = )
6. After 11 seconds the red fault light will then blink.

SELECT A NEW PROFILE

1. Disconnect the AC power source from the charger, either from the wall outlet, or from the IEC320 connector on the charger.
2. Reconnect AC power.
3. Touch the positive lead to the positive terminal for 3 seconds (+/- 0.5 seconds), then remove the lead. You will see the next profile displayed on the charger's display. Repeat this step until you reach the desired charge profile.
4. When the charger displays the desired charge profile, apply the positive lead to the positive battery terminal for 10 seconds. When the charge profile is locked, you will hear a click from the charger.
5. Disconnect AC power, wait for the LED indicator display to turn off, then reconnect AC power.
6. Check the LED display to ensure that the desired charge profile is selected.
7. Disconnect the charger from AC power and wait for the LED indicator display to turn off.
8. Reconnect the positive lead to the positive battery terminal.

Battery Testing

As part of regular maintenance, battery testing using a discharge tester or calibrated load is recommended. Battery condition can be determined by comparing actual discharge capacity versus a battery manufacturer's stated reserve capacity (RC). Discharge testing can also help identify defective batteries or cells in battery packs which need attention. Industry standard battery discharge machines use the following rates of discharge to measure battery capacity:

Battery Pack Size (Nominal)	24V	36V	48V
Discharge Rate (Amps)	75	75	56
Cutoff Voltage (1.75Vpc)	21	31.5	42

PROCEDURE:

- Using Delta-Q charger, fully charge the battery pack (indicated by solid green 100% LED)
- Using a discharge tester/load rated for the nominal battery pack size, discharge the pack at a rate appropriate for the type of battery modules in use (see chart above) until the pack voltage reaches 1.75 volts per cell (see chart above)
- Compare the duration of the discharge test (in minutes) to the manufacturer's rated reserve capacity for your specific battery make and model. A Trojan T-105 battery reserve capacity specification @75A is shown as an example:

PRODUCT SPECIFICATIONS

BCI GROUP SIZE	TYPE	CAPACITY [A] Minutes		CAPACITY [B] Amp-Ho		
		@25 Amps	@75 Amps	5-Hr Rate	10-Hr Rate	20-H
6 VOLT DEEP CYCL						
GC2	T-105	447	115	185	207	2

There is no set pass/fail criteria for battery discharge times but use the following results as a guide:

- 80 - 100 % rated capacity minutes - Good
- 50 -80 % rated minutes - Acceptable
- Under 50 % - One or more defective batteries. Battery service recommended

A method used to identify a battery with a weak or shorted cell(s) is to restart a discharge tester after reaching the cutoff voltage. Measure the voltage of each battery with the discharge tester running (or under load). A battery with a weak cell under load will have a lower voltage compared to other batteries in a pack.

7.18 CLEARSKY™ / TELEMATICS GATEWAY

ClearSky™ is a system that communicates with relevant data points on the machine and transmits real-time machine data via cellular for viewing access through the internet. The system consists of a control unit and a GPS antenna. If not equipped, the machine is ClearSky™ ready with locations existing for the control unit and the antenna, as well as wiring connections available for “plug and play” operation.

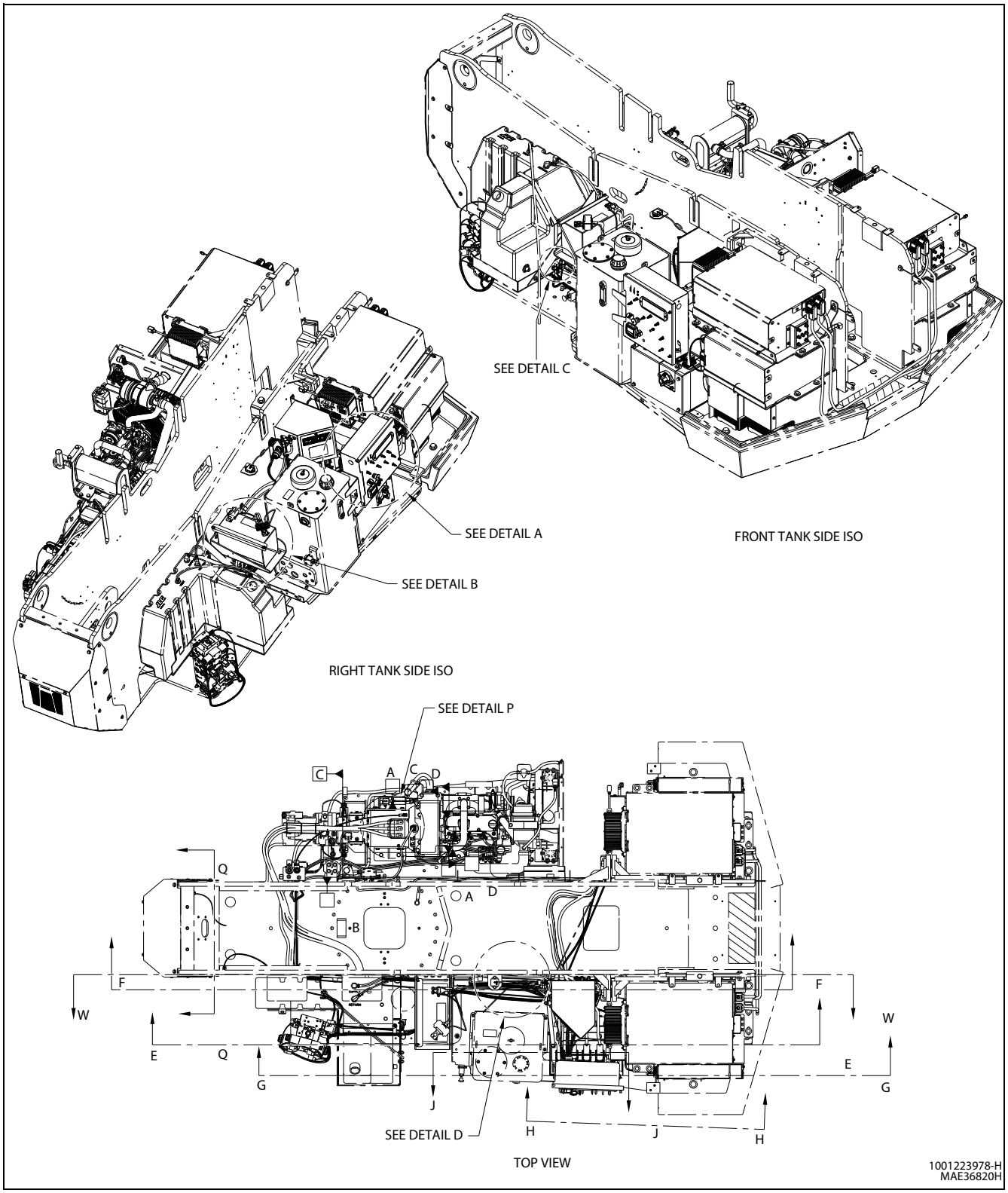


Figure 7-52. Electrical Installation - Sheet 1 of 8

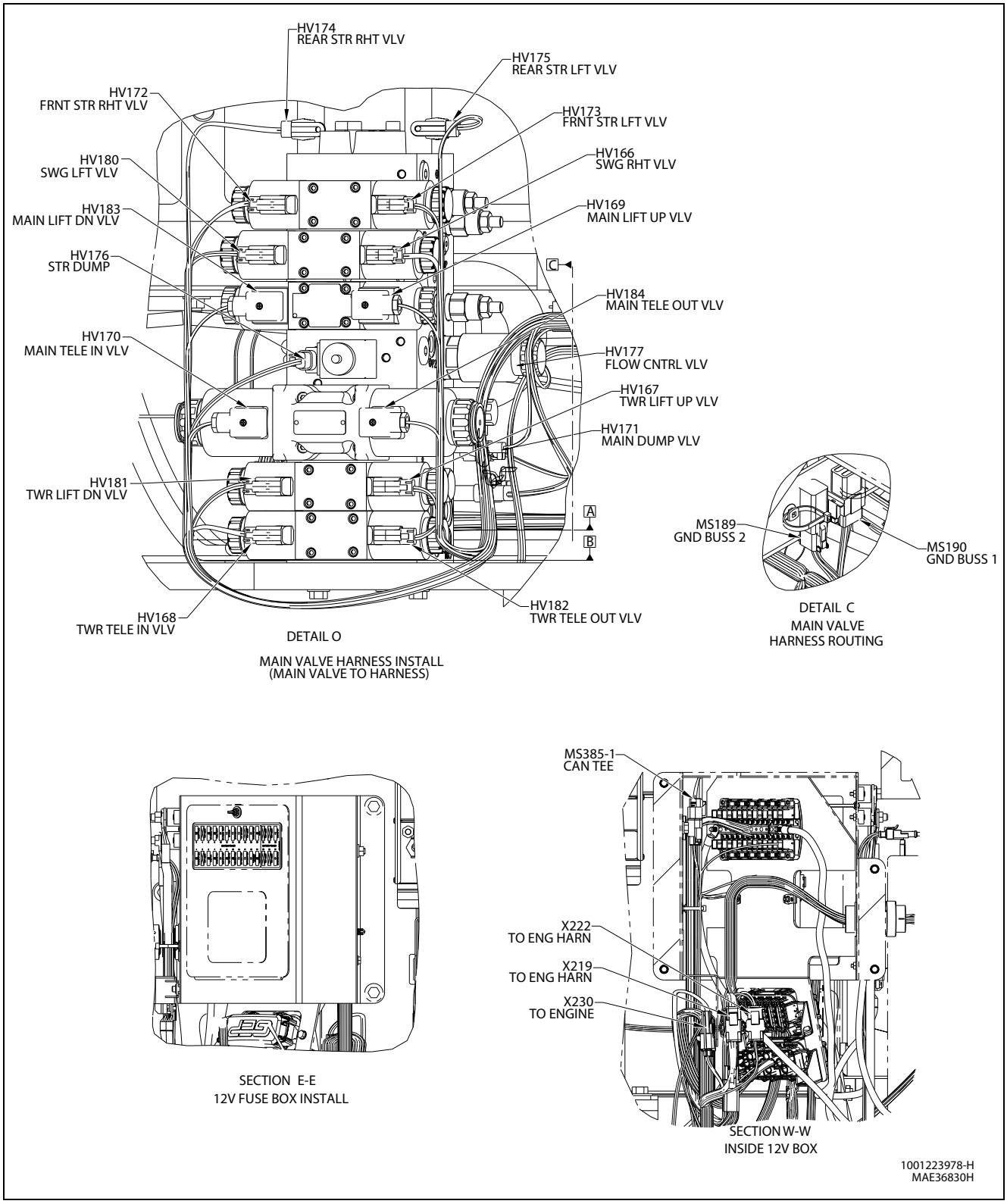


Figure 7-53. Electrical Installation - Sheet 2 of 8

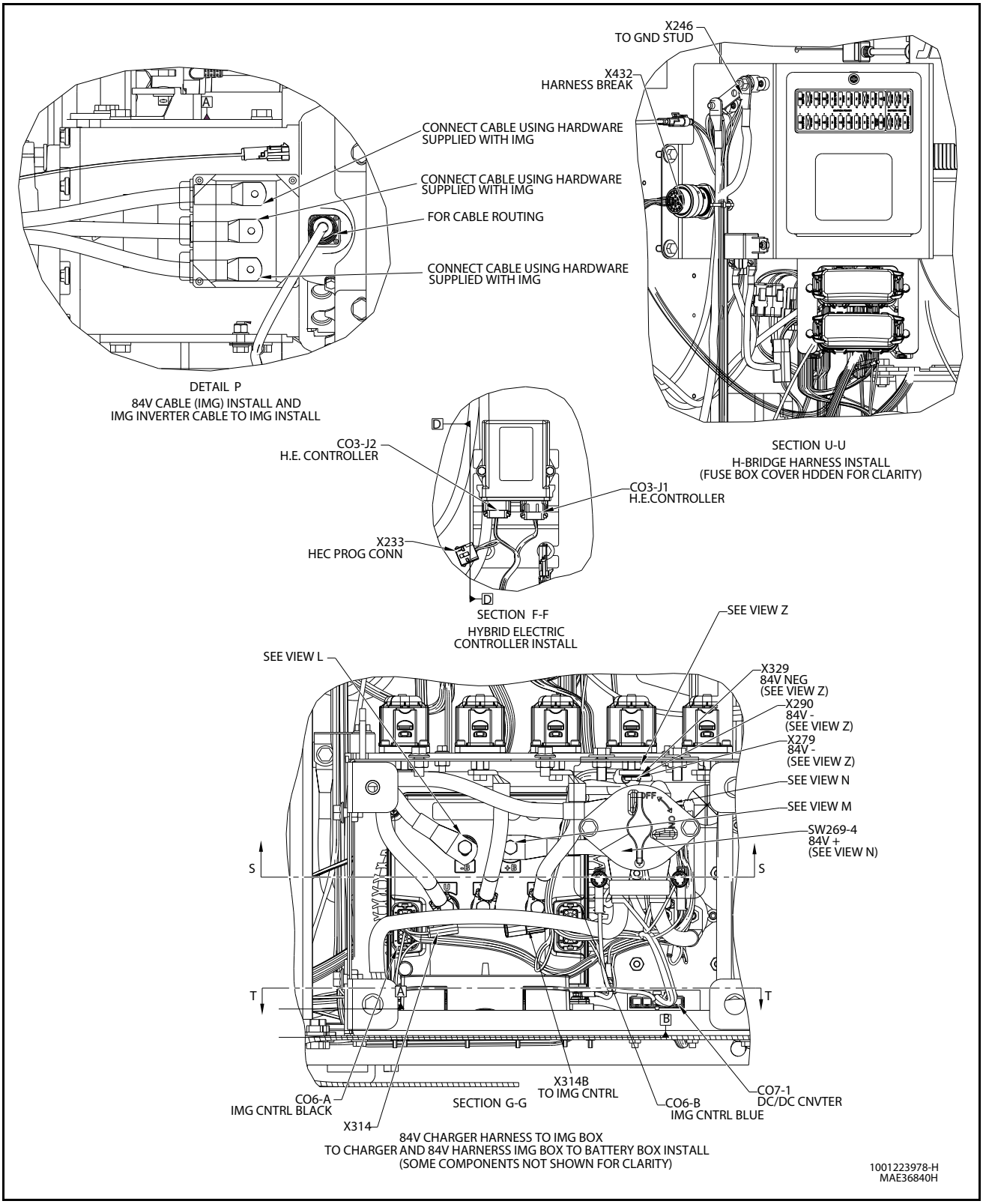


Figure 7-54. Electrical Installation - Sheet 3 of 8

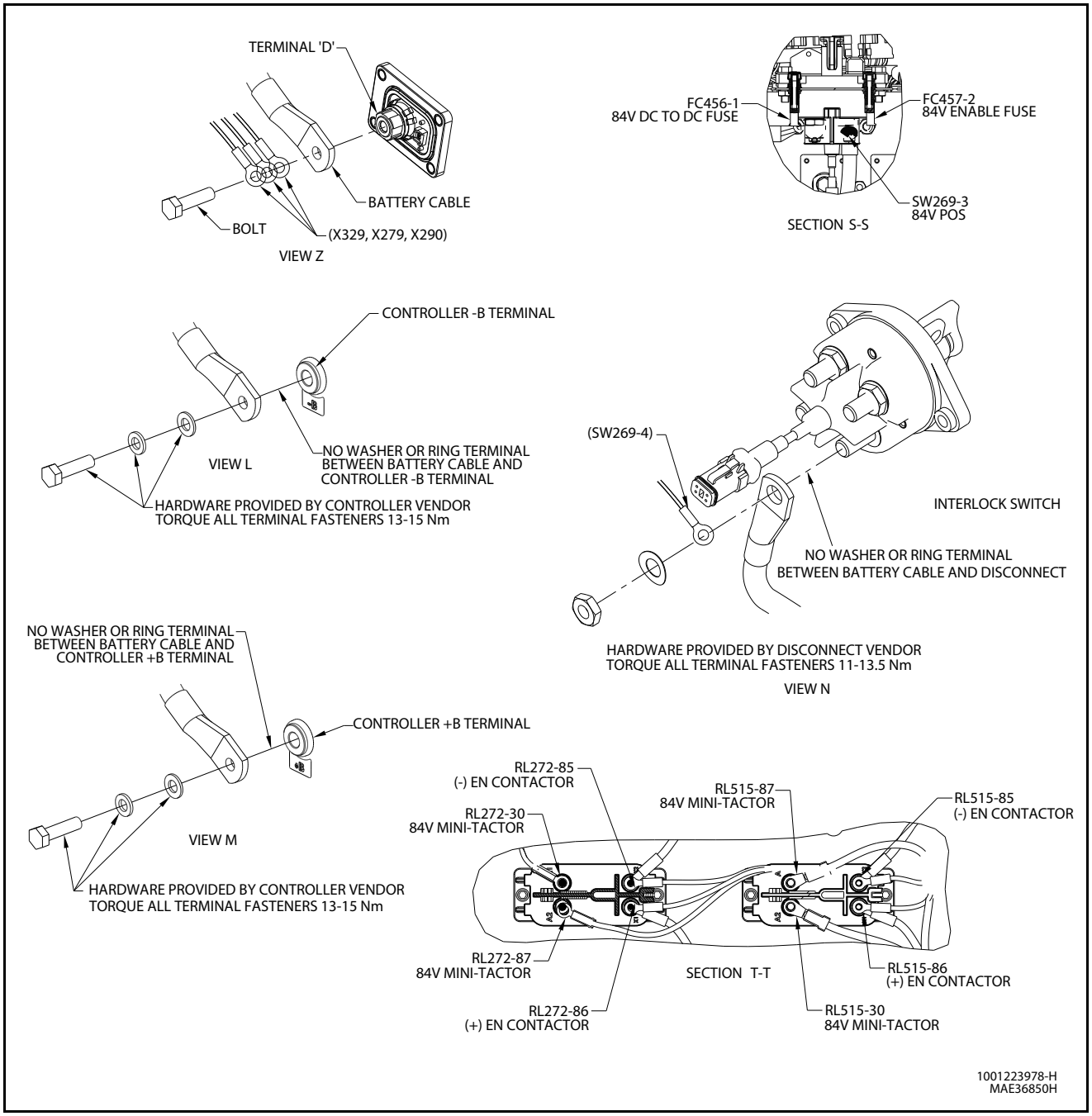


Figure 7-55. Electrical Installation - Sheet 4 of 8

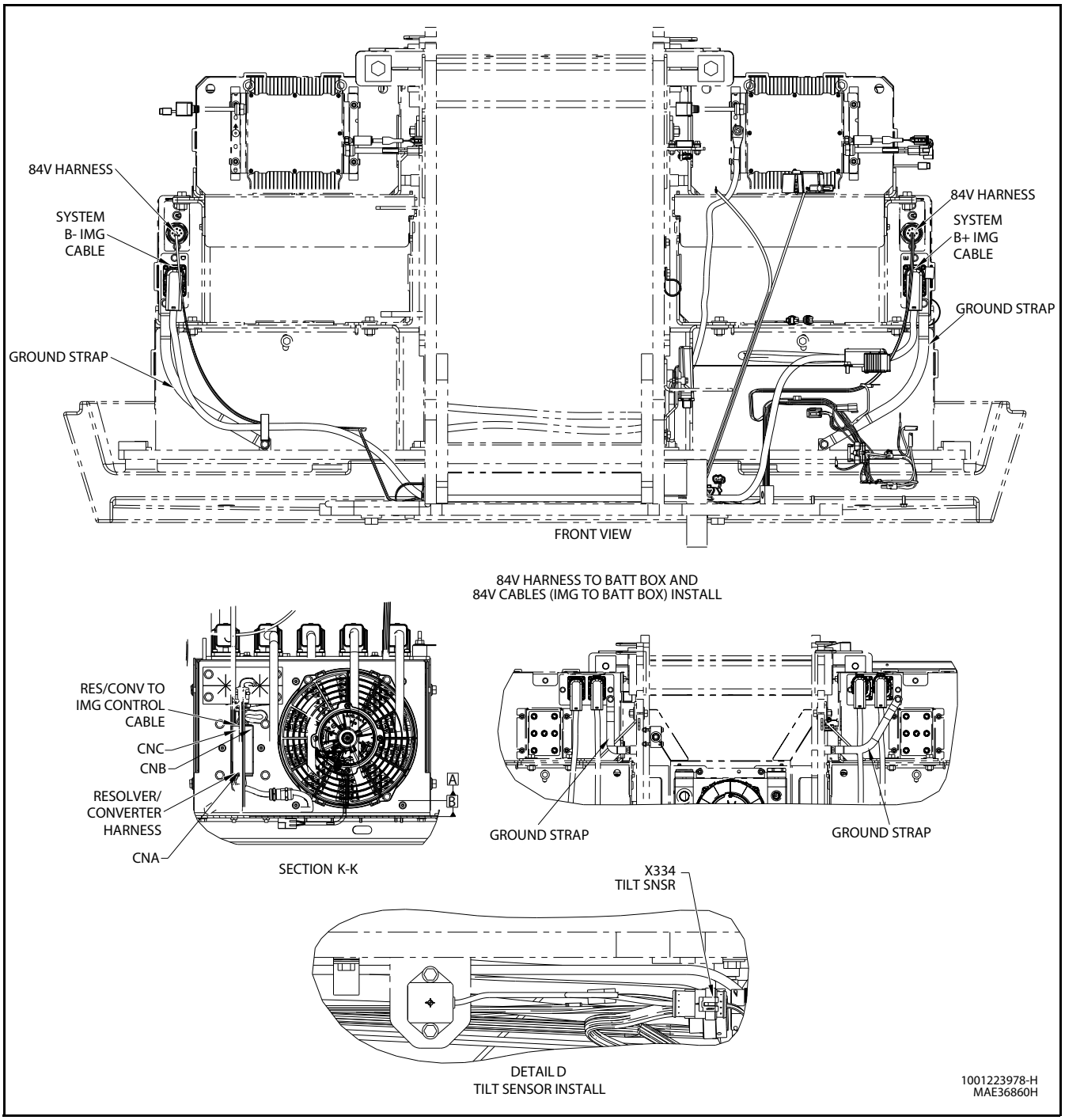


Figure 7-56. Electrical Installation - Sheet 5 of 8

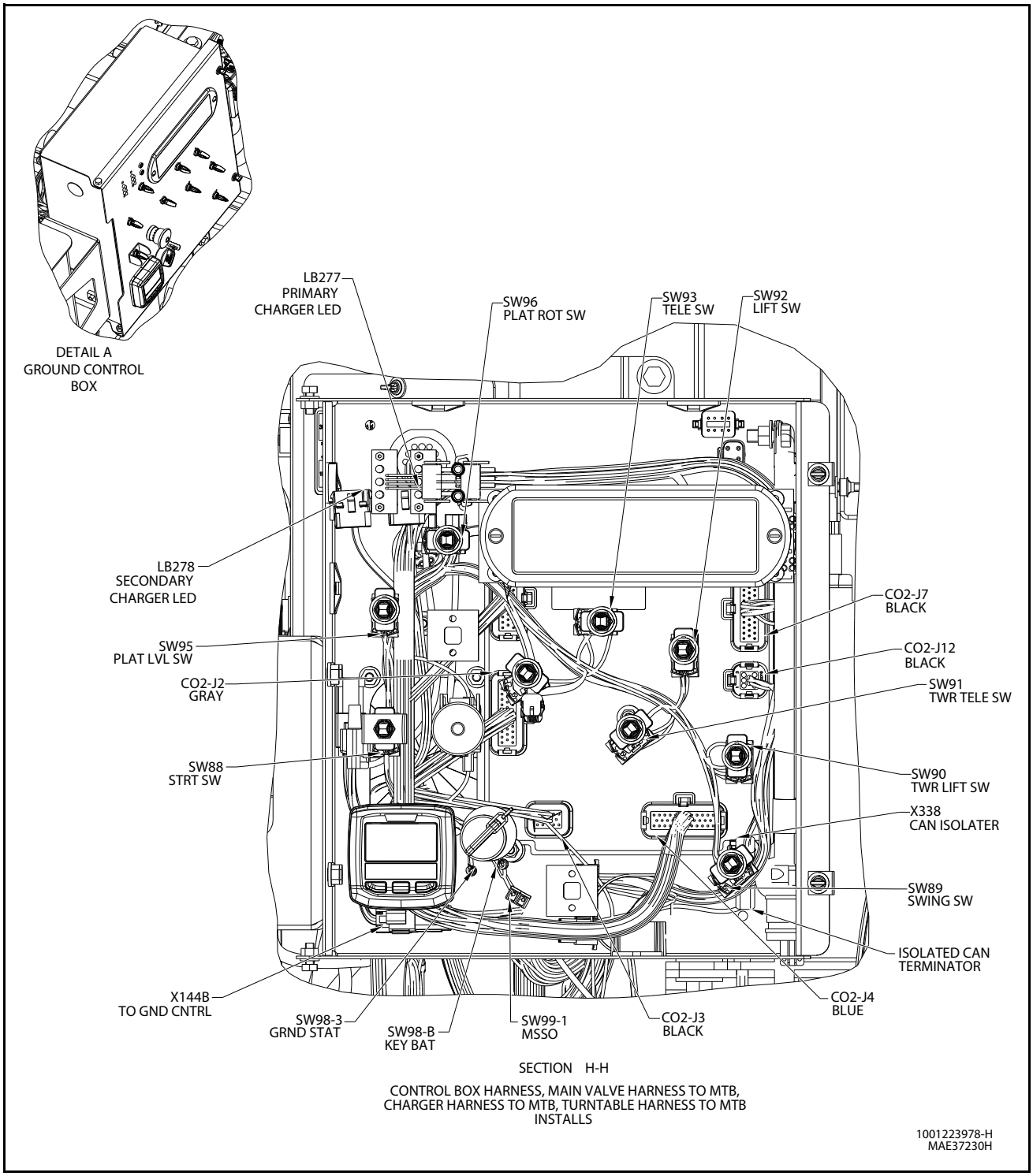


Figure 7-57. Electrical Installation - Sheet 6 of 8

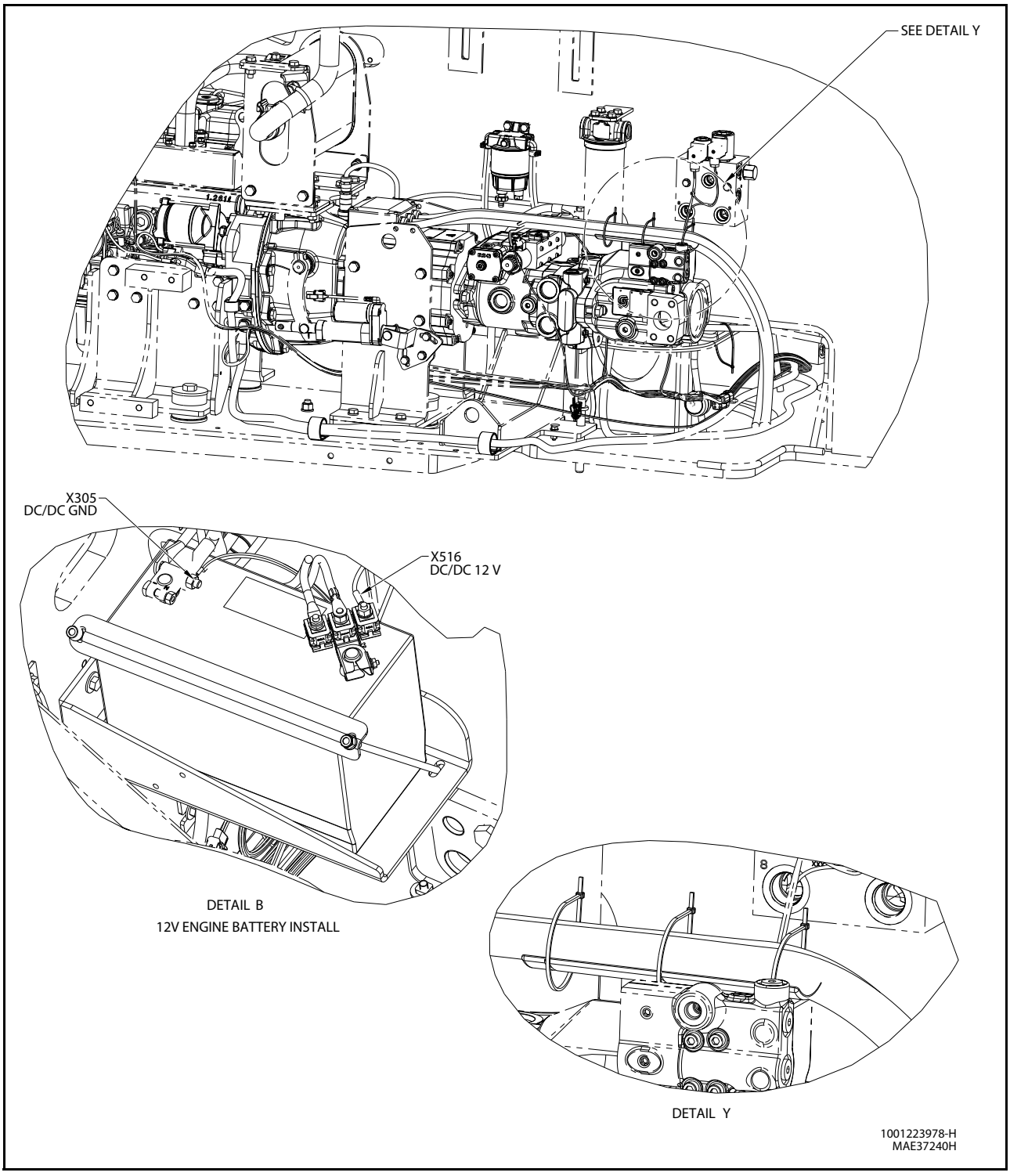


Figure 7-58. Electrical Installation - Sheet 7 of 8

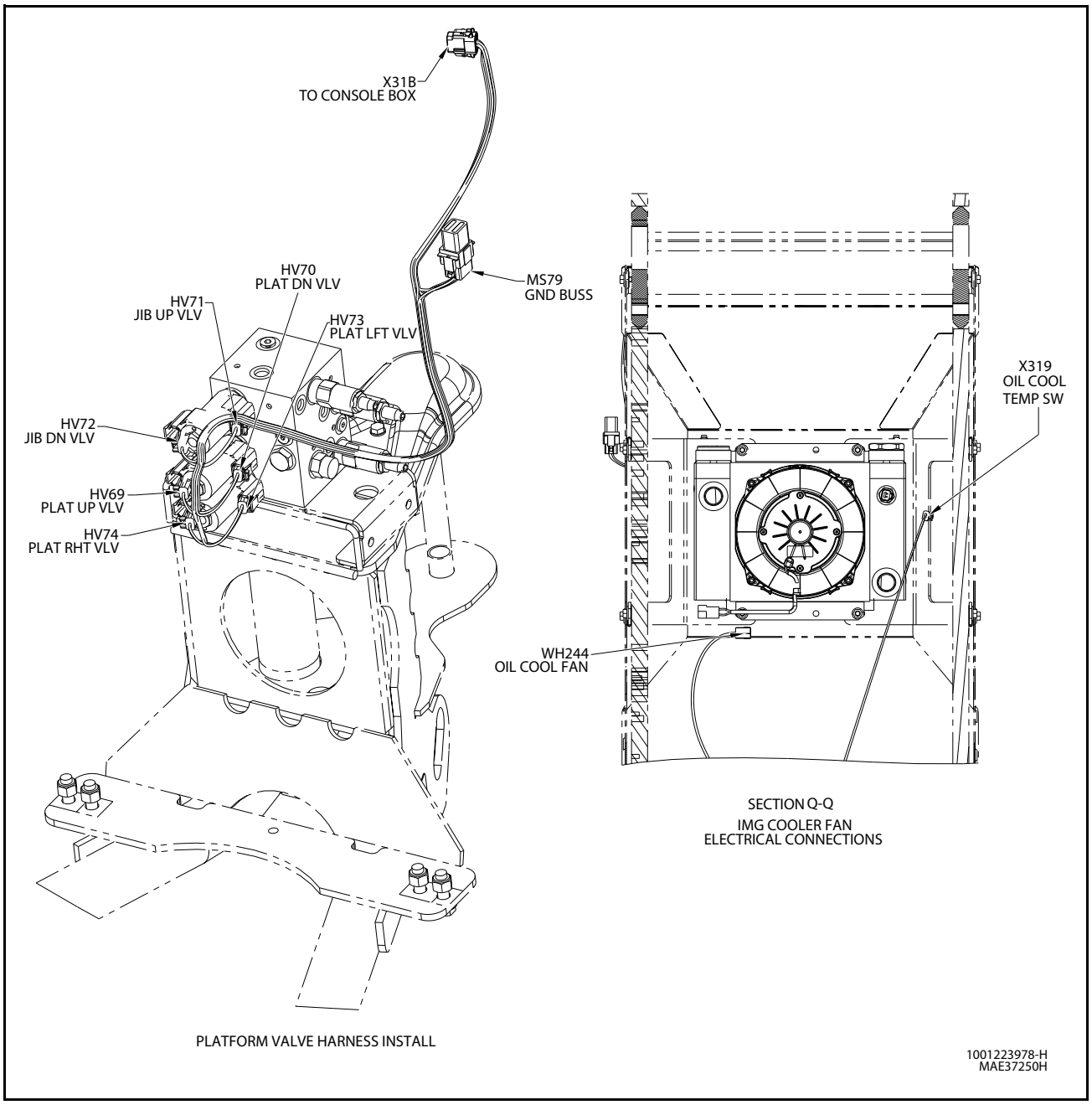


Figure 7-59. Electrical Installation - Sheet 8 of 8

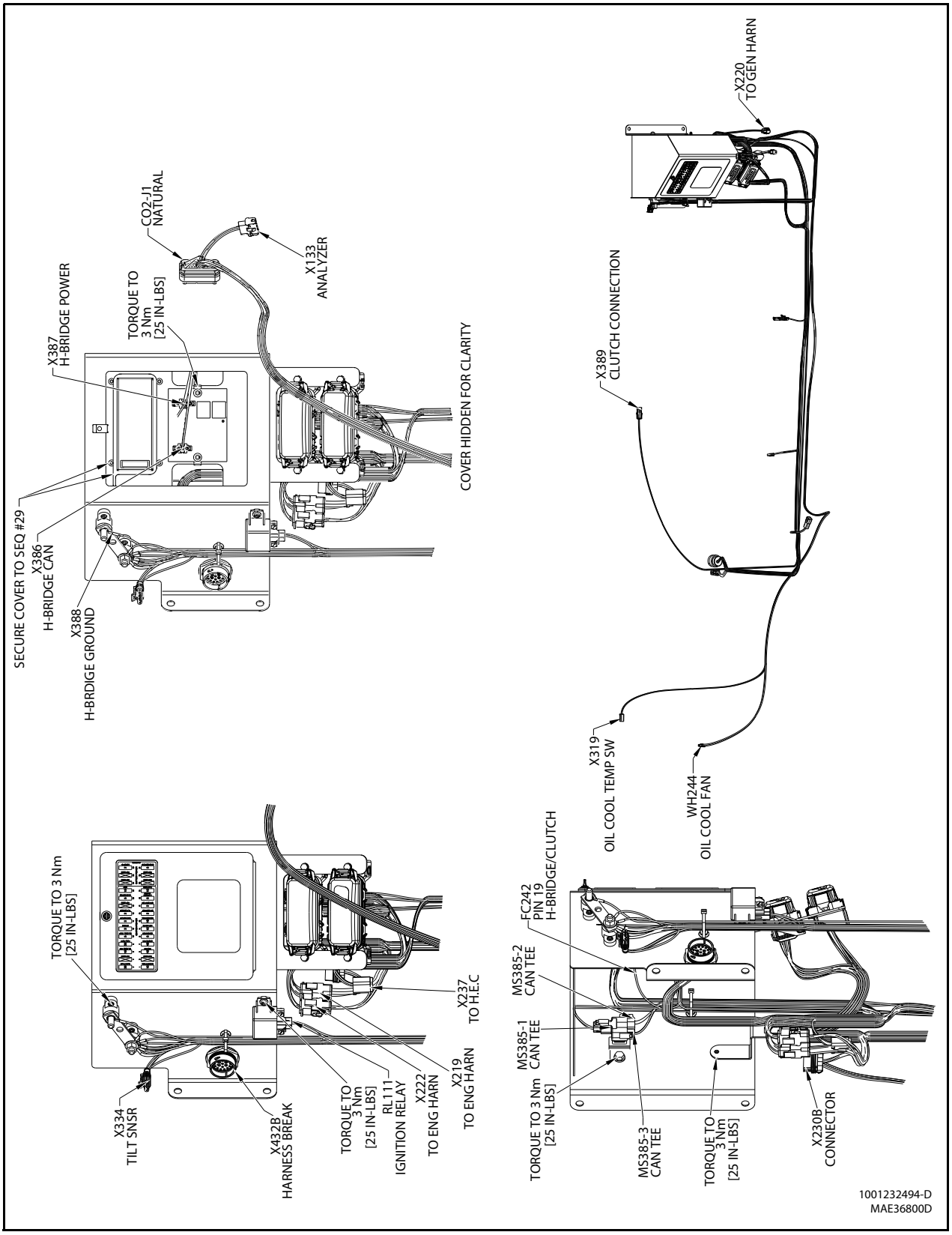


Figure 7-60. Fuse Panel - Sheet 1 of 2

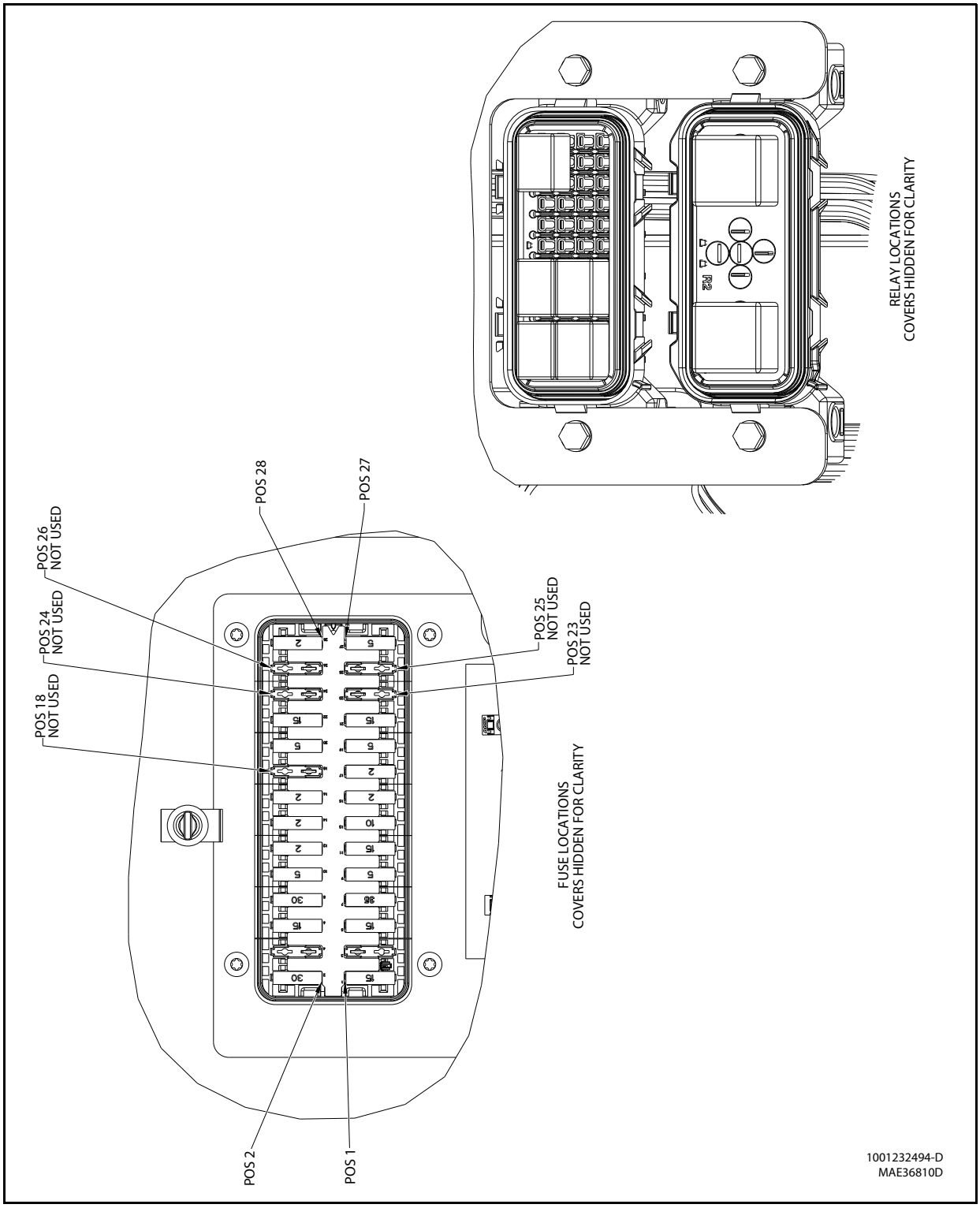


Figure 7-61. Fuse Panel - Sheet 2 of 2

7.19 WIRING HARNESS CONNECTOR LABELS AND WIRING HARNESSES

Connector Labels

Connectors between harnesses are identified by the prefix "X" and a sequentially assigned number. An optional suffix (letters & numbers) may be added when multiple terminations occur at one device or when there are optional connections.

Examples:

X25 connects to X25 in another harness.

X65A, X65B connect to different portions of one device

X163 connects to X163A in ANSI and X163B in CE machines

Component Labels

Every component on the vehicle has a unique identification. A standard prefix letter is assigned according to the table below, followed by a unique sequential number. An optional suffix (letters & numbers) may be added when multiple terminations occur at one device.

Terminals that are not loaded into connectors are considered independent components and labeled in the same fashion.

Table 7-9. Wiring Harness Connector Labels

Component	Category	Label
Audible	Alarms	AH
	Horns	
Battery	Batteries	BT
	Battery Terminals	
Control Module	Ground	CO
	LSS	
	Platform	
Engine	Alternator	EC
	Cold Start	
	Controller	
	Coolant Temp	
	Fuel Pump	
	Fuel Solenoid	
	Glow Plugs	
	Oil Pressure	
	Starter	
Fuse & CB Fuse FC	Fuse	FC
	Fusible Link	FC
	Circuit Breaker	CB
Gauge & Display	Board	GD
	Cluster	
	Hour meter	
	LMI	
	Speedometer	
Inline	Resistor	R
	Diode	D
Joystick & Steering	Electronic	JS
	Hydraulic	
Lights	Dome	LB
	Headlights	
	Simple	
	Taillights	
Membrane Panel		MP
Miscellaneous	Radio	MS
	Speakers	
	Splice Blocks	
	T-Connectors	

Table 7-9. Wiring Harness Connector Labels

Component	Category	Label
Other Switches	Disconnect	SW
	EMS	
	Foot	
	HVAC	WH
	Key	SW
	Park brake	
	Pump pot	
	Push	
	Shifter	
	Turn signal	
Relay	5 Pin	RL
	4 Pin	
	Contactor	
	Power module	
Rocker Switch		SW
Sensor	Angle	SN
	Fuel	
	Length	
	Limit	
	Load	
	Pressure	
	Proximity	
	Speed	
	Temperature	
Terminals	Pins	T
	Sockets	
	Male Blades	
	Female Blades	
	Rings	
	Forks	
Toggle Switch	DPDT	SW
	DPST	
	SPDT	
	SPST	
	Special	
Valves	Simple	HV
	Suppression	

Examples:
T67 is a ring terminal connected during installation.
C01-J3 is the J3 connector for a UGM control module.
EC9 is a glow plug supplied with the engine

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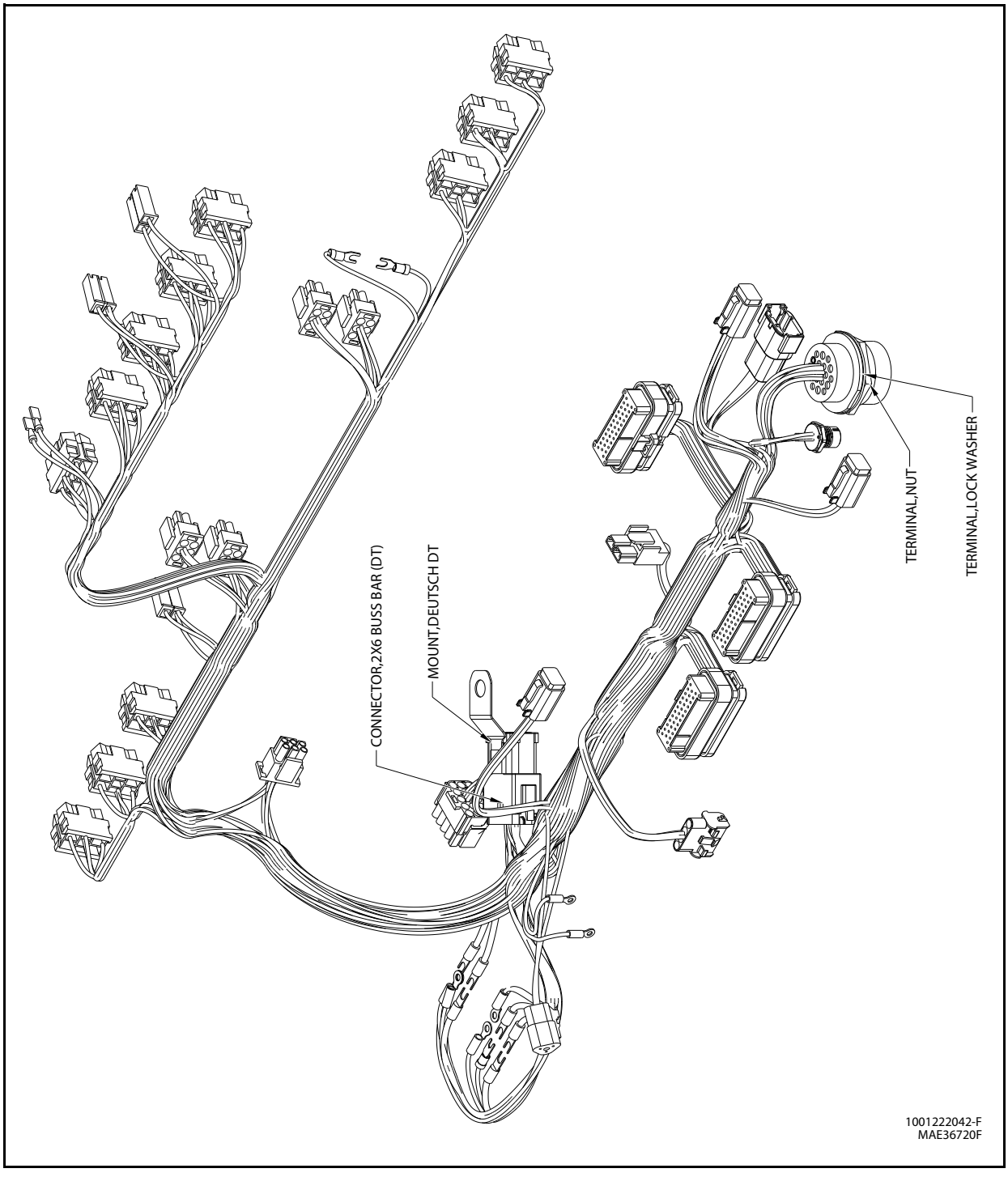


Figure 7-62. Console Box Harness - Sheet 1 of 4

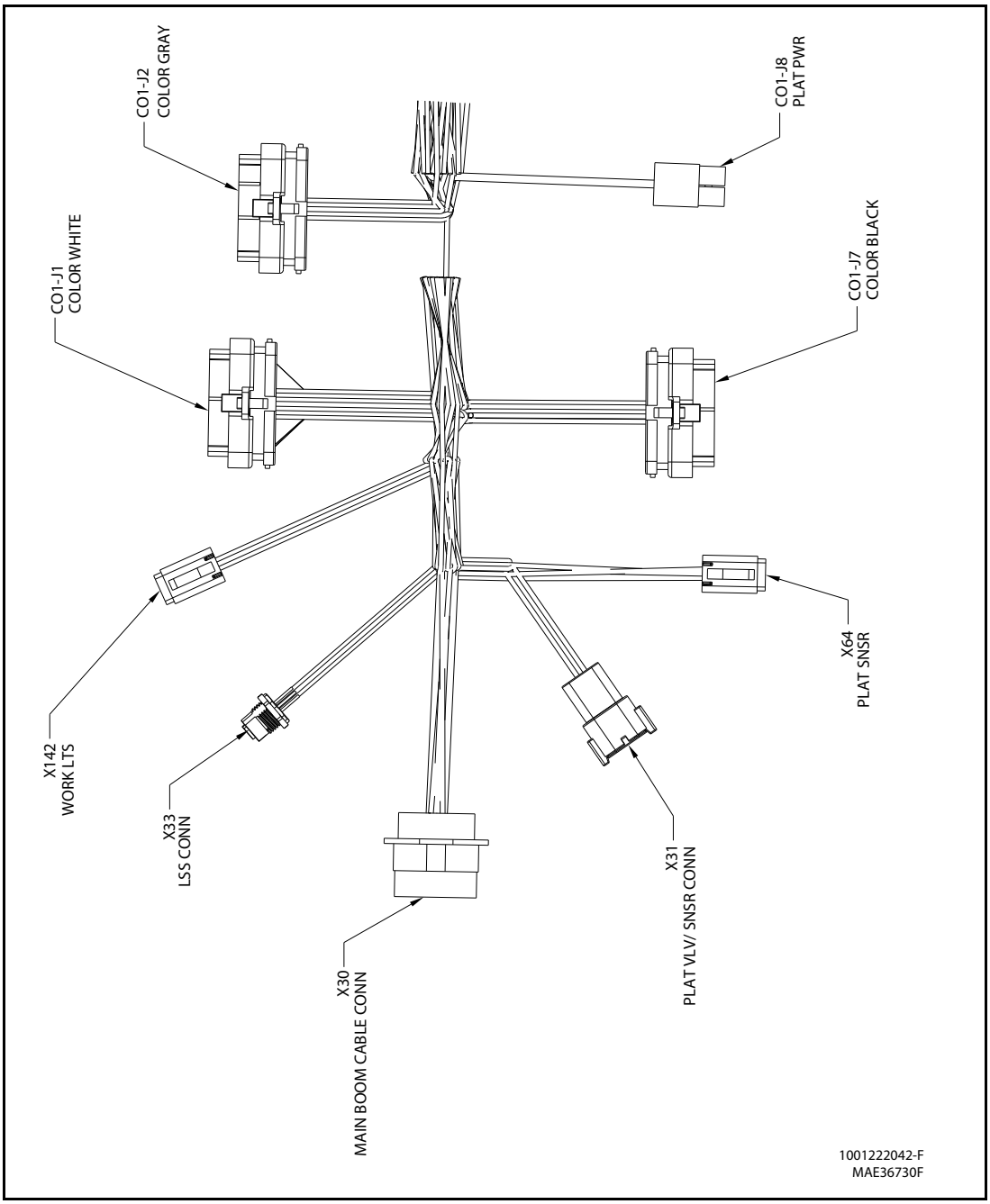


Figure 7-63. Console Box Harness - Sheet 2 of 4

C01-J1 COLOR WHITE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-1TWRUP	18AWG	GXL	SW08(3)
2	WHT	6-1TWRDN	18AWG	GXL	SW08(1)
3	WHT	7-1TWRIN	18AWG	GXL	SW09(1)
4	WHT	8-1TWROUT	18AWG	GXL	SW09(3)
5	WHT	9-1TELEIN	18AWG	GXL	SW10(3)
6	WHT	10-1TELEOUT	18AWG	GXL	SW10(1)
7	WHT	11-1PLATRHT	18AWG	GXL	SW11(3)
8	WHT	12-1PLATLFT	18AWG	GXL	SW11(1)
9	WHT	13-1PLATUP	18AWG	GXL	SW12(3)
10	WHT	14-1PLATDN	18AWG	GXL	SW12(1)
11	WHT	15-1JIBUP	18AWG	GXL	SW13(3)
12	WHT	16-1JIBDN	18AWG	GXL	SW13(1)
13	BLK	0-1	18AWG	GXL	SW24(5)
14	WHT	48-1ENGSTRT	18AWG	GXL	SW14(1)
15	WHT	48-29HYBSYSEN	18AWG	GXL	SW14(3)
16	WHT	17-1CRBSTR	18AWG	GXL	SW21(1)
17	WHT	18-1COORSTR	18AWG	GXL	SW21(3)
18	YEL	2-1	18AWG	GXL	SW16(2)
19					
20	WHT	55-6SOFTTOUCH	18AWG	GXL	X64(6)
21	WHT	49-31RESTRICTED	18AWG	GXL	SW17(3)
22	WHT	50-2DOSENABLE	18AWG	GXL	C01-J2(30)
23	WHT	65-2PLATINPUT2	18AWG	GXL	X64(5)
24					
25					
26					
27	WHT	46-1MAXSPD	18AWG	GXL	SW22(3)
28	WHT	46-2MAXTORQ	18AWG	GXL	SW22(1)
29	WHT	55-1S.T./SKYG	18AWG	GXL	SW45-2(1)
30	WHT	55-2HEAD/TAILLT	18AWG	GXL	SW26-2(1)
31	WHT	19-1HORN	18AWG	GXL	SW25-2(1)
32	WHT	20-1CREEP	18AWG	GXL	SW24(2)
33					
34	WHT	20-37VPWR	18AWG	GXL	SW24(4)
35	WHT	20-2FUNCSPD	18AWG	GXL	SW24(6)

X30 MAIN BOOM CABLE CONN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	GRN	CH1TOMS29	18AWG	GXL	MS29(6)
3	YEL	CH1TOMS29	18AWG	GXL	MS29(3)
4	YEL	2-12-1-1	18AWG	GXL	C01-J7(3)
5	YEL	2-13	18AWG	GXL	SW18-2(2)
6					
7					
8					
9					
10	YEL	2-14-2-2	12AWG	GXL	X53(1)
11	WHT	49-11GNDMODE	18AWG	GXL	C01-J7(1)
12	YEL	2-14-2-1	12AWG	GXL	X54(1)
13					
14					
15					
16	BLK	0-6-2	12AWG	GXL	X50(1)
17					
18	BLK	0-6-1	12AWG	GXL	X49(1)
19					

C01-J2 COLOR GRAY					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3					
4	WHT	50-1 DOS	18AWG	GXL	SW16(1)
5					
6	WHT	49-1 TILT LT	18AWG	GXL	GD20-J4(5)
7	WHT	49-2 ENABLE LT	18AWG	GXL	GD20-J2(2)
8	WHT	49-3 SYS FAIL	18AWG	GXL	GD20-J3(6)
9	WHT	20-4 CREEP LT	18AWG	GXL	GD20-J2(1)
10					
11	WHT	49-5 OVER LOAD LT	18AWG	GXL	GD20-J4(3)
12					
13					
14	WHT	50-3 DOS LT	18AWG	GXL	GD20-J3(3)
15	WHT	55-3 GEN LT	18AWG	GXL	GD20-J4(2)
16	WHT	55-4 S.T/SKYG LT	18AWG	GXL	LB27+(1)
17	WHT	48-2 GLOW LT	18AWG	GXL	GD20-J4(6)
18	BLK	0-2	18AWG	GXL	GD20-J2(6)
19	WHT	48-35 LOW FUEL	18AWG	GXL	GD20-J3(1)
20	WHT	49-4 BOOM MALF	18AWG	GXL	GD20-J3(5)
21	WHT	48-3 LOW BATT LT	18AWG	GXL	GD20-J2(3)
22	WHT	48-4 1/4 BATT	18AWG	GXL	GD20-J1(1)
23	WHT	48-5 3/4 BATT	18AWG	GXL	GD20-J1(3)
24	WHT	48-6 1/2 BATT	18AWG	GXL	GD20-J1(2)
25	BLK	0-3	18AWG	GXL	GD20-J1(4)
26	WHT	4-1 9.5 VPWR	18AWG	GXL	X28(1)
27	BLK	0-4	18AWG	GXL	X28(4)
28	WHT	4-2 RX	18AWG	GXL	X28(2)
29	WHT	4-3 TX	18AWG	GXL	X28(3)
30	WHT	50-2 DOS ENABLE	18AWG	GXL	C01-J1(22)
31					
32					
33					
34					
35	WHT	48-7 BATT FULL	18AWG	GXL	GD20-J1(6)

X33 LSS CONN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	2-7	20AWG	CABLE	C01-J7(7)
3	BLU	0-9	20AWG	CABLE	C01-J7(14)
4	BLK	CH1 TO X33	20AWG	CABLE	MS29(2)
5	GRY	CH1 TO X33	20AWG	CABLE	MS29(5)

X64 PLAT SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-3-4	18AWG	GXL	X57(1)
2	BLK	0-6-3	18AWG	GXL	X60(1)
3	WHT	55-6-1 SOFT TOUCH	18AWG	GXL	X47(13)
4	WHT	65-1 PLAT INPUT1	18AWG	GXL	C01-J7(18)
5	WHT	65-2 PLAT INPUT2	18AWG	GXL	C01-J1(23)
6	WHT	55-6 SOFT TOUCH	18AWG	GXL	C01-J1(20)

C01-J8 PLATPWR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-6	12AWG	GXL	X59(1)
2	YEL	2-3	12AWG	GXL	X55(1)

X142 WORKLTS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-6-5	18AWG	GXL	X51(1)
2	YEL	2-3-6	18AWG	GXL	X52(1)
3	BLK	0-6-6	18AWG	GXL	X51(1)
4	YEL	2-3-7	18AWG	GXL	X52(1)

X31 PLATVLV/SNSRCONN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	16-2JIBDNVLV	18AWG	GXL	C01-J7(26)
2	WHT	12-2PLATLFTVLV	18AWG	GXL	C01-J7(33)
3	WHT	11-2PLATRHTVLV	18AWG	GXL	C01-J7(34)
4					
5	BLK	0-12	16AWG	GXL	C01-J7(23)
6	WHT	14-2PLATDNVLV	18AWG	GXL	C01-J7(22)
7	WHT	13-2PLATUPVLV	18AWG	GXL	C01-J7(21)
8	WHT	15-2JIBUPVLV	18AWG	GXL	C01-J7(25)

C01-J7 COLORBLACK					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-11GNDMODE	18AWG	GXL	X30(11)
2	YEL	2-13	18AWG	GXL	SW18-1(1)
3	YEL	2-12-1-1	18AWG	GXL	X30(4)
4	YEL	2-5	18AWG	GXL	X47(8)
5	YEL	2-4	18AWG	GXL	X47(2)
6					
7	WHT	2-7	20AWG	CABLE	X33(2)
8	WHT	49-9PLATFTSW	18AWG	GXL	X47(7)
9	WHT	55-5GEN	18AWG	GXL	X47(1)
10					
11					
12					
13					
14	BLU	0-9	20AWG	CABLE	X33(3)
15					
16					
17					
18	WHT	65-1PLATINPUT1	18AWG	GXL	X64(4)
19	WHT	49-8ALARM	18AWG	GXL	AH48+(1)
20	BLK	0-5	18AWG	GXL	AH48-(1)
21	WHT	13-2PLATUPVLV	18AWG	GXL	X31(7)
22	WHT	14-2PLATDNVLV	18AWG	GXL	X31(6)
23	BLK	0-12	16AWG	GXL	X31(5)
24					
25	WHT	15-2JIBUPVLV	18AWG	GXL	X31(8)
26	WHT	16-2JIBDNVLV	18AWG	GXL	X31(1)
27					
28					
29					
30	GRN	CH1TOC01-J7	18AWG	GXL	MS29(8)
31	YEL	CH1TOC01-J7	18AWG	GXL	MS29(11)
32					
33	WHT	12-2PLATLFTVLV	18AWG	GXL	X31(2)
34	WHT	11-2PLATRHTVLV	18AWG	GXL	X31(3)
35	BLK	0-7	18AWG	GXL	LB27-(1)

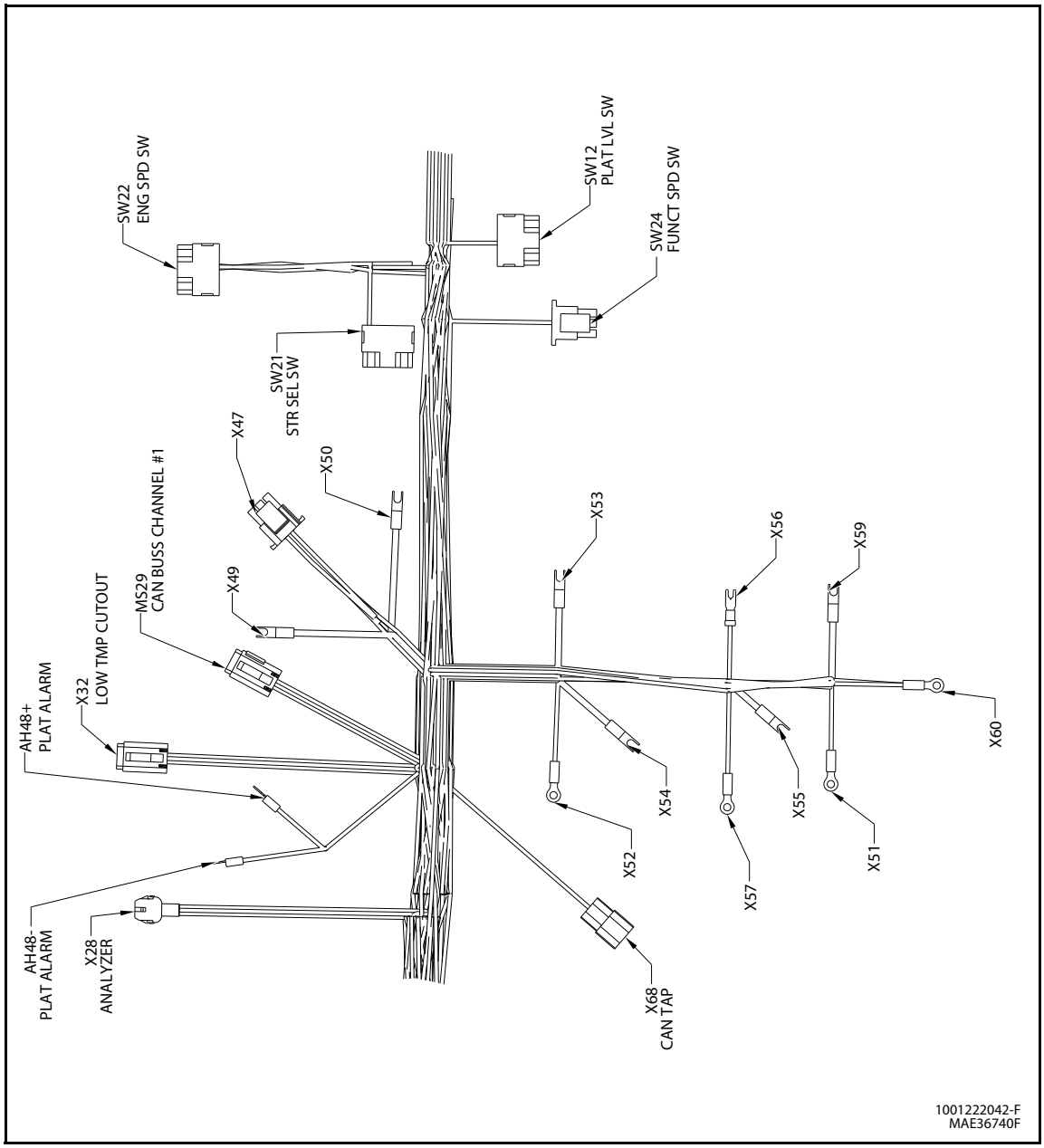


Figure 7-64. Console Box Harness - Sheet 3 of 4

X28 ANALYZER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-19.5 VPWR	18AWG	GXL	C01-J2(26)
2	WHT	4-2 RX	18AWG	GXL	C01-J2(28)
3	WHT	4-3 TX	18AWG	GXL	C01-J2(29)
4	BLK	0-4	18AWG	GXL	C01-J2(27)

AH48- PLAT ALARM					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-5	18AWG	GXL	C01-J7(20)

AH48+ PLAT ALARM					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-8 ALARM	18AWG	GXL	C01-J7(19)

X49 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-6-1	12AWG	GXL	X30(18)

X54 TO IGN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-2-1	12AWG	GXL	X30(12)

X60 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-6-3	18AWG	GXL	X64(2)
1	BLK	0-6-4	18AWG	GXL	X32(2)

X59 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-6	12AWG	GXL	C01-J8(1)

X53 TO IGN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-2-2	12AWG	GXL	X30(10)

X51 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-6-5	18AWG	GXL	X142(1)
1	BLK	0-6-6	18AWG	GXL	X142(3)

MS29 CANBUSS CHANNEL#1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CH1TOX68	18AWG	GXL	X68(A)
2	BLK	CH1TOX33	20AWG	CABLE	X33(4)
3	YEL	CH1TOMS29	18AWG	GXL	X30(3)
4	GRN	CH1TOX68	18AWG	GXL	X68(B)
5	GRY	CH1TOX33	20AWG	CABLE	X33(5)
6	GRN	CH1TOMS29	18AWG	GXL	X30(2)
7					
8	GRN	CH1TOC01-J7	18AWG	GXL	C01-J7(30)
9	GRN	CH1TOX32	18AWG	GXL	X32(3)
10					
11	YEL	CH1TOC01-J7	18AWG	GXL	C01-J7(31)
12	YEL	CH1TOX32	18AWG	GXL	X32(4)

X47 PLAT SW/SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	55-5GEN	18AWG	GXL	C01-J7(9)
2	YEL	2-4	18AWG	GXL	C01-J7(5)
3					
4					
5					
6					
7	WHT	49-9PLATFTSW	18AWG	GXL	C01-J7(8)
8	YEL	2-5	18AWG	GXL	C01-J7(4)
9					
10					
11					
12					
13	WHT	55-6-1SOFTTOUCH	18AWG	GXL	X64(3)
14					
15					

X50 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-6-2	12AWG	GXL	X30(16)

X52 TO IGN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-3-6	18AWG	GXL	X142(2)
1	YEL	2-3-7	18AWG	GXL	X142(4)

X57 TO IGN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-3-4	18AWG	GXL	X64(1)

X55 TO IGN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-3	12AWG	GXL	C01-J8(2)

SW22 ENG SPD SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	46-2 MAX TORQ	18AWG	GXL	C01-J1(28)
2	YEL	2-1-7	18AWG	GXL	SW21(2)
2	YEL	2-1-8	18AWG	GXL	SW24(3)
3	WHT	46-1 MAX SPD	18AWG	GXL	C01-J1(27)
4					
5					
6					

SW21 STR SEL SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	17-1 CRB STR	18AWG	GXL	C01-J1(16)
2	YEL	2-1-6	18AWG	GXL	SW12(2)
2	YEL	2-1-7	18AWG	GXL	SW22(2)
3	WHT	18-1 COOR STR	18AWG	GXL	C01-J1(17)
4					
5					
6					

SW24 FUNCT SPD SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	20-1 CREEP	18AWG	GXL	C01-J1(32)
3	YEL	2-1-8	18AWG	GXL	SW22(2)
3	YEL	2-1-9	18AWG	GXL	SW11(2)
4	WHT	20-37V PWR	18AWG	GXL	C01-J1(34)
5	BLK	0-1	18AWG	GXL	C01-J1(13)
6	WHT	20-2 FUN CSPD	18AWG	GXL	C01-J1(35)

SW12 PLAT LVL SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	13-1 PLAT UP	18AWG	GXL	C01-J1(9)
2	YEL	2-1-4	18AWG	GXL	SW25-1(1)
2	YEL	2-1-6	18AWG	GXL	SW21(2)
3	WHT	14-1 PLAT DN	18AWG	GXL	C01-J1(10)
4					
5					
6					

X32 LOWTMPCUTOUT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-3-3	18AWG	GXL	X56(1)
2	BLK	0-6-4	18AWG	GXL	X60(1)
3	GRN	CH1 TO X32	18AWG	GXL	MS29(9)
4	YEL	CH1 TO X32	18AWG	GXL	MS29(12)

X68CANTAP					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CH1 TO X68	18AWG	GXL	MS29(1)
B	GRN	CH1 TO X68	18AWG	GXL	MS29(4)
C					

X56TOIGN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-3-3	18AWG	GXL	X32(1)

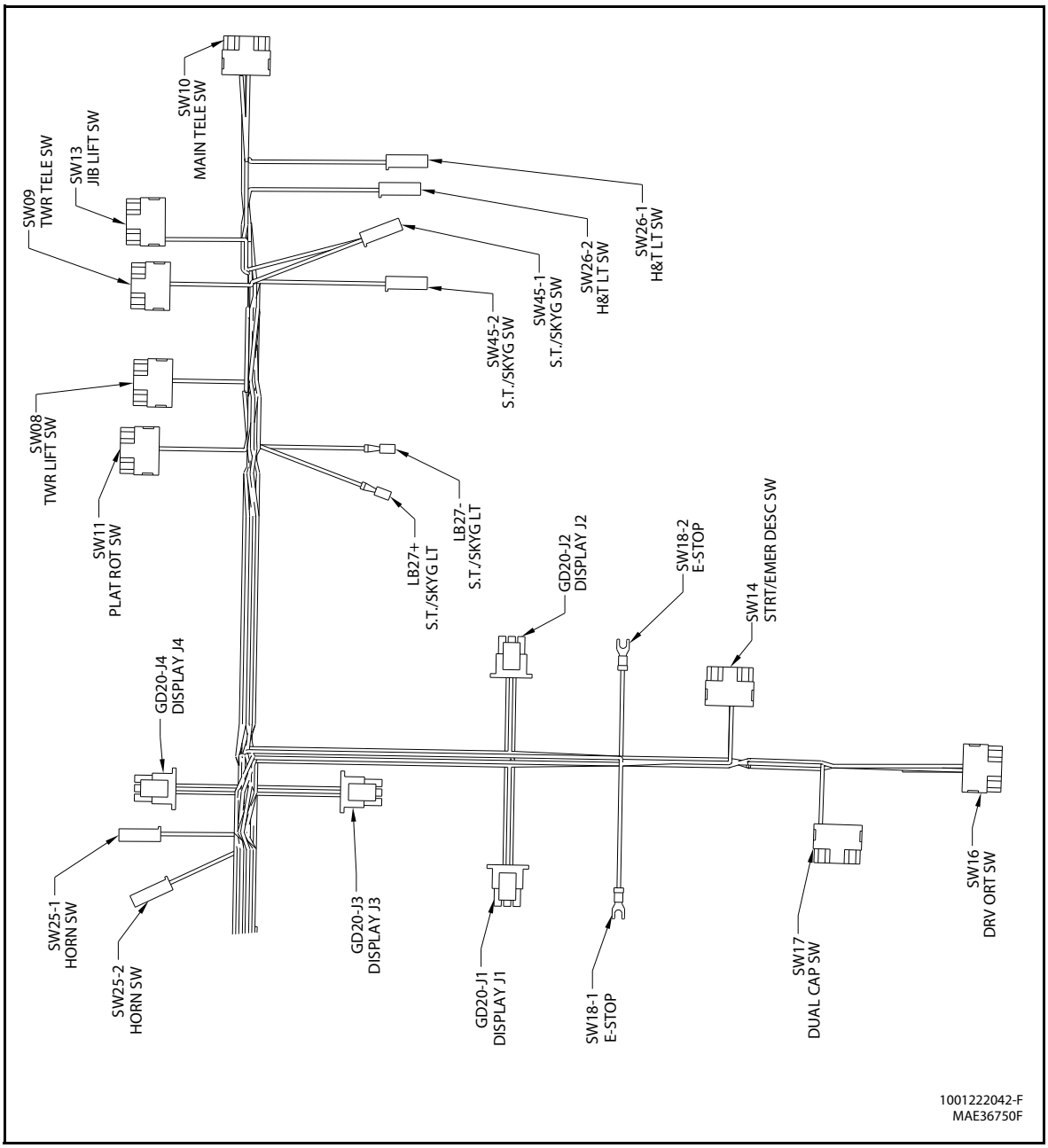


Figure 7-65. Console Box Harness - Sheet 4 of 4

SW17 DUAL CAPSW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	YEL	2-1-1	18AWG	GXL	SW16(2)
2	YEL	2-1-2	18AWG	GXL	SW14(2)
3	WHT	49-31 RESTRICTED	18AWG	GXL	C01-J1(21)
4					
5					
6					

SW16 DRV ORT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	50-1 DOS	18AWG	GXL	C01-J2(4)
2	YEL	2-1	18AWG	GXL	C01-J1(18)
2	YEL	2-1-1	18AWG	GXL	SW17(2)
3					
4					
5					
6					

SW18-1 E-STOP					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-13	18AWG	GXL	C01-J7(2)

GD20-J2 DISPLAY J2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	20-4 CREEP LT	18AWG	GXL	C01-J2(9)
2	WHT	49-2 ENABLE LT	18AWG	GXL	C01-J2(7)
3	WHT	48-3 LOW BATT LT	18AWG	GXL	C01-J2(21)
4					
5					
6	BLK	0-2	18AWG	GXL	C01-J2(18)

GD20-J1 DISPLAY J1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-4 1/4 BATT	18AWG	GXL	C01-J2(22)
2	WHT	48-6 1/2 BATT	18AWG	GXL	C01-J2(24)
3	WHT	48-5 3/4 BATT	18AWG	GXL	C01-J2(23)
4	BLK	0-3	18AWG	GXL	C01-J2(25)
5					
6	WHT	48-7 BATT FULL	18AWG	GXL	C01-J2(35)

SW14 STRT/EMER DESC SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-1 ENG STRT	18AWG	GXL	C01-J1(14)
2	YEL	2-1-2	18AWG	GXL	SW17(2)
2	YEL	2-1-3	18AWG	GXL	SW25-1(1)
3	WHT	48-29 HYB SYS EN	18AWG	GXL	C01-J1(15)
4					
5					
6					

SW18-2 E-STOP					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
2	YEL	2-13	18AWG	GXL	X30(5)

SW08 TWR LIFT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-1TWR UP	18AWG	GXL	C01-J1(1)
2	YEL	2-1-10	18AWG	GXL	SW11(2)
2	YEL	2-1-11	18AWG	GXL	SW09(2)
3	WHT	6-1TWR DN	18AWG	GXL	C01-J1(2)
4					
5					
6					

SW25-2 HORN SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	19-1 HORN	18AWG	GXL	C01-J1(31)

SW25-1 HORNSW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-1-3	18AWG	GXL	SW14(2)
1	YEL	2-1-4	18AWG	GXL	SW12(2)

LB27+ S.T./SKYG LT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	55-4 S.T/SKYG LT	18AWG	GXL	C01-J2(16)

GD20-J4 DISPLAY J4					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	55-3 GEN LT	18AWG	GXL	C01-J2(15)
3	WHT	49-5 OVER LOAD LT	18AWG	GXL	C01-J2(11)
4					
5	WHT	49-1 TILT LT	18AWG	GXL	C01-J2(6)
6	WHT	48-2 GLOW LT	18AWG	GXL	C01-J2(17)

LB27- S.T./SKYG LT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-7	18AWG	GXL	C01-J7(35)

SW45-2 S.T./SKYG SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	55-1 S.T./SKYG	18AWG	GXL	C01-J1(29)

SW45-1 S.T./SKYG SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-1-12	18AWG	GXL	SW09(2)
1	YEL	2-1-13	18AWG	GXL	SW13(2)

SW26-1 H&T LT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-1-15	18AWG	GXL	SW10(2)

SW26-2 H&T LT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	55-2 HEAD/TAIL LT	18AWG	GXL	C01-J1(30)

GD20-J4 DISPLAY J4					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	55-3 GEN LT	18AWG	GXL	C01-J2(15)
3	WHT	49-5 OVER LOAD LT	18AWG	GXL	C01-J2(11)
4					
5	WHT	49-1 TILT LT	18AWG	GXL	C01-J2(6)
6	WHT	48-2 GLOW LT	18AWG	GXL	C01-J2(17)

LB27- S.T./SKYG LT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-7	18AWG	GXL	C01-J7(35)

SW45-2 S.T./SKYG SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	55-1 S.T./SKYG	18AWG	GXL	C01-J1(29)

SW45-1 S.T./SKYG SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-1-12	18AWG	GXL	SW09(2)
1	YEL	2-1-13	18AWG	GXL	SW13(2)

SW26-1 H&T LT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-1-15	18AWG	GXL	SW10(2)

SW26-2 H&T LT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	55-2 HEAD/TAIL LT	18AWG	GXL	C01-J1(30)

GD20-J3 DISPLAY J3					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-35 LOW FUEL	18AWG	GXL	C01-J2(19)
2					
3	WHT	50-3 DOS LT	18AWG	GXL	C01-J2(14)
4					
5	WHT	49-4 BOOM MALF	18AWG	GXL	C01-J2(20)
6	WHT	49-3 SYS FAIL	18AWG	GXL	C01-J2(8)

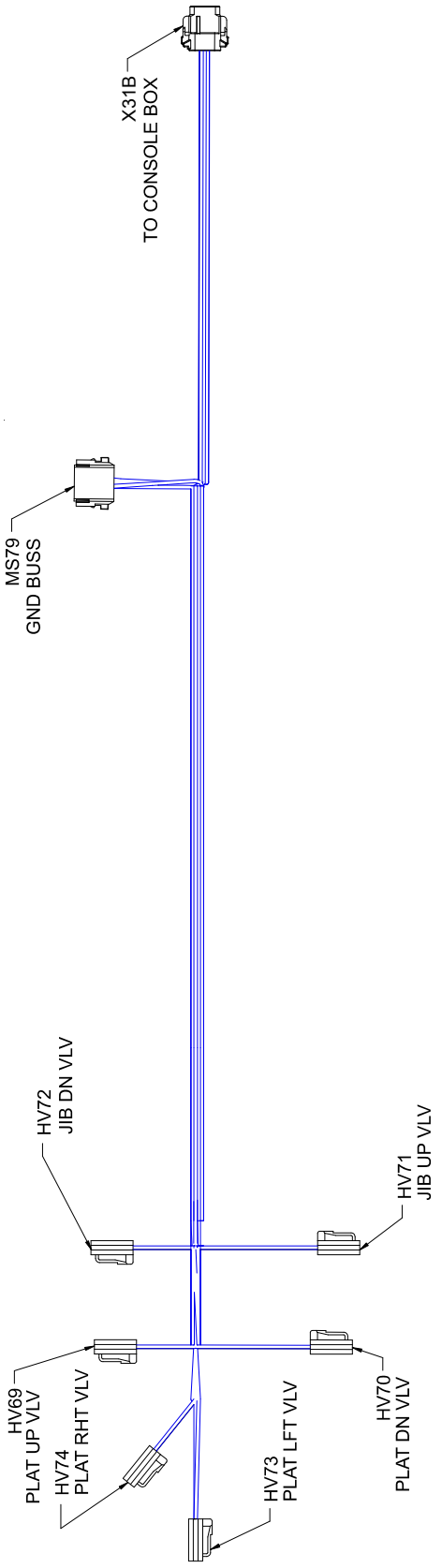
SW11 PLAT ROT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	11-1 PLAT RHT	18AWG	GXL	CO1-J1(7)
2	YEL	2-1-10	18AWG	GXL	SW08(2)
2	YEL	2-1-9	18AWG	GXL	SW24(3)
3	WHT	12-1 PLAT LFT	18AWG	GXL	CO1-J1(8)
4					
5					
6					

SW10 MAIN TELE SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	9-1 TELE IN	18AWG	GXL	CO1-J1(5)
2	YEL	2-1-14	18AWG	GXL	SW13(2)
2	YEL	2-1-15	18AWG	GXL	SW26-1(1)
3	WHT	10-1 TELE OUT	18AWG	GXL	CO1-J1(6)
4					
5					
6					

SW09 TWR TELE SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	7-1 TWR IN	18AWG	GXL	CO1-J1(3)
2	YEL	2-1-11	18AWG	GXL	SW08(2)
2	YEL	2-1-12	18AWG	GXL	SW45-1(1)
3	WHT	8-1 TWR OUT	18AWG	GXL	CO1-J1(4)
4					
5					
6					

SW13 JIBLIFTSW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	15-1 JIB UP	18AWG	GXL	CO1-J1(11)
2	YEL	2-1-13	18AWG	GXL	SW45-1(1)
2	YEL	2-1-14	18AWG	GXL	SW10(2)
3	WHT	16-1 JIB DN	18AWG	GXL	CO1-J1(12)
4					
5					
6					

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WIRE NO	COLOR	WIRE GAUGE	JACKET	LENGTH (mm)	FROM		TO	
					REFERENCE	PIN	REFERENCE	PIN
0-12-2	BLK	18	GXL	622	HV72	2	MS79	2
0-12-3	BLK	18	GXL	728	HV74	2	MS79	3
0-12-4	BLK	18	GXL	766	HV73	2	MS79	4
0-12-5	BLK	18	GXL	723	HV70	2	MS79	5
0-12-6	BLK	18	GXL	691	HV69	2	MS79	6
0-12-7	BLK	18	GXL	665	HV71	2	MS79	8
0-12	BLK	16	GXL	359	X31B	5	MS79	7
11-2	WHT	18	GXL	987	X31B	3	HV74	1
12-2	WHT	18	GXL	1034	X31B	2	HV73	1
13-2-1	WHT	18	GXL	945	X31B	7	HV69	1
14-2-1	WHT	18	GXL	993	X31B	6	HV70	1
15-2	WHT	18	GXL	919	X31B	8	HV71	1
16-2	WHT	18	GXL	876	X31B	1	HV72	1

Figure 7-66. Platform Valve Harness

MS79 GND BUSS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	BLK	0-12-2	18AWG	GXL	HV72(2)
3	BLK	0-12-3	18AWG	GXL	HV74(2)
4	BLK	0-12-4	18AWG	GXL	HV73(2)
5	BLK	0-12-5	18AWG	GXL	HV70(2)
6	BLK	0-12-6	18AWG	GXL	HV69(2)
7	BLK	0-12	16AWG	GXL	X31B(5)
8	BLK	0-12-7	18AWG	GXL	HV71(2)

X31B TO PLAT HARN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	16-2 JIB DN VLV	18AWG	GXL	HV72(1)
2	WHT	12-2 PLAT LFT VLV	18AWG	GXL	HV73(1)
3	WHT	11-2 PLAT RHT VLV	18AWG	GXL	HV74(1)
4					
5	BLK	0-12	16AWG	GXL	MS79(7)
6	WHT	14-2-1 PLAT DN VLV	18AWG	GXL	HV70(1)
7	WHT	13-2-1 PLAT UP VLV	18AWG	GXL	HV69(1)
8	WHT	15-2 JIB UP VLV	18AWG	GXL	HV71(1)

HV71 JIB UP VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	15-2 JIB UP VLV	18AWG	GXL	X31B(8)
2	BLK	0-12-7	18AWG	GXL	MS79(8)

HV70 PLAT DN VLV					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	14-2-1 PLAT DN VLV	18AWG	GXL	X31B(6)
2	BLK	0-12-5	18AWG	GXL	MS79(5)

HV73 PLAT LF TVLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	12-2 PLAT LFT VLV	18AWG	GXL	X31B(2)
2	BLK	0-12-4	18AWG	GXL	MS79(4)

HV74 PLAT RHT VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	11-2PLATRHTVLV	18AWG	GXL	X31B(3)
2	BLK	0-12-3	18AWG	GXL	MS79(3)

HV69 PLAT UP VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	13-2-1 PLAT UP VLV	18AWG	GXL	X31B(7)
2	BLK	0-12-6	18AWG	GXL	MS79(6)

HV72 JIB DN VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	16-2JIBDNVLV	18AWG	GXL	X31B(1)
2	BLK	0-12-2	18AWG	GXL	MS79(2)

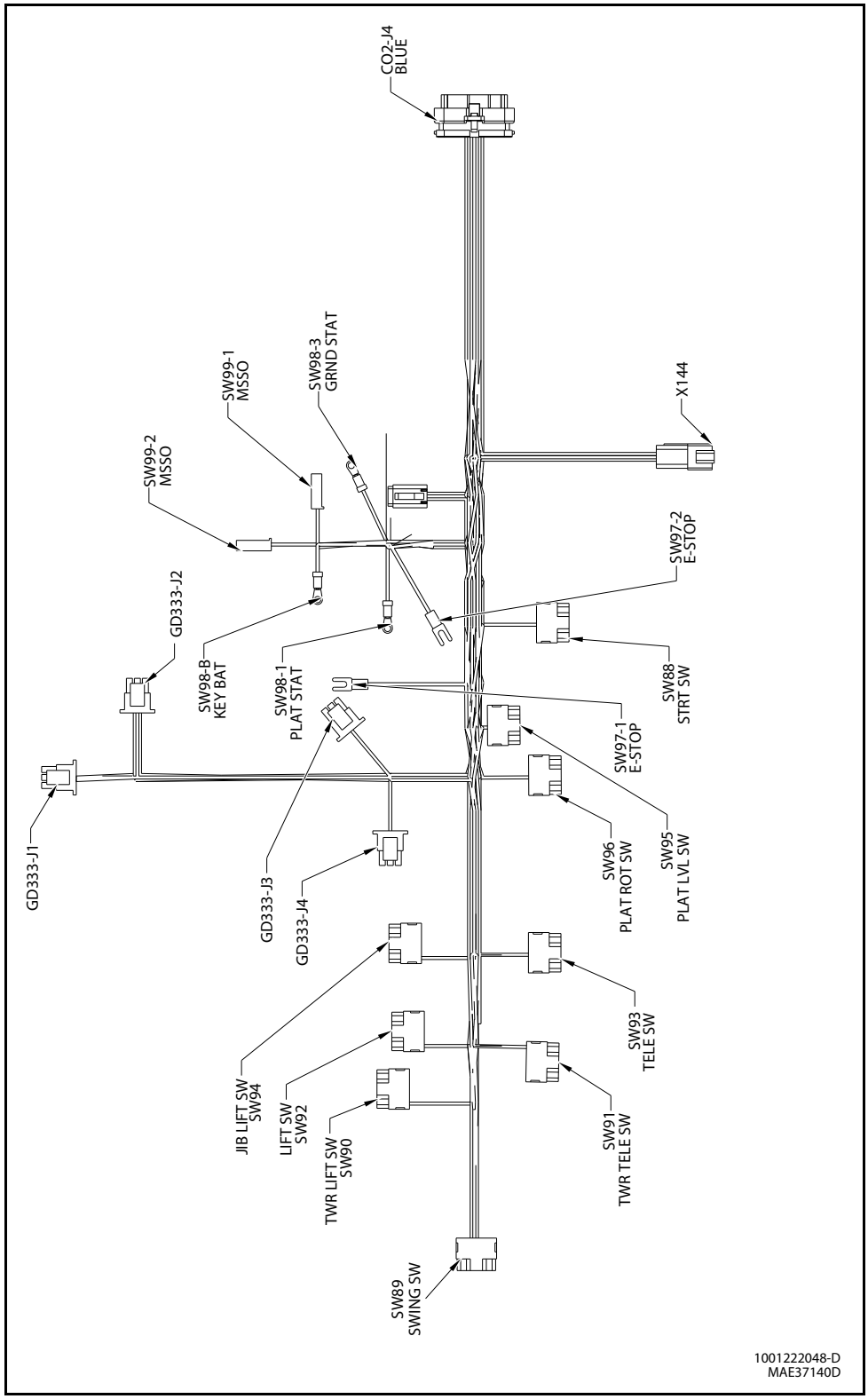


Figure 7-67. Ground Control Harness

C02-J4 BLUE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-14 CRIBBING LT	18AWG	GXL	GD333-J3(1)
2					
3	WHT	48-9 GLOW LT	18AWG	GXL	GD333-J2(3)
4	WHT	48-8 ENG STRT	18AWG	GXL	SW88(1)
5	WHT	14-3 PLAT DN	18AWG	GXL	SW95(3)
6	WHT	12-3 PLAT LFT	18AWG	GXL	SW96(3)
7	WHT	9-2 TELE IN	18AWG	GXL	SW93(1)
8	WHT	16-3 JIB DN	18AWG	GXL	SW94(3)
9					
10	WHT	5-2 TWR UP	18AWG	GXL	SW90(1)
11	WHT	7-2 TWR IN	18AWG	GXL	SW91(3)
12					
13	WHT	48-37 LOW FUEL	18AWG	GXL	GD333-J1(5)
14	WHT	49-13 OVER LOAD LT	18AWG	GXL	GD333-J3(6)
15	WHT	49-10 BM MALF LT	18AWG	GXL	GD333-J2(1)
16	WHT	48-34 EMER DESC	18AWG	GXL	SW88(3)
17	WHT	13-3 PLAT UP	18AWG	GXL	SW95(1)
18	WHT	11-3 PLAT RHT	18AWG	GXL	SW96(1)
19	WHT	15-3 JIB UP	18AWG	GXL	SW94(1)
20					
21	WHT	6-2 TWR DN	18AWG	GXL	SW90(3)
22	WHT	8-2 TWR OUT	18AWG	GXL	SW91(1)
23	WHT	23-1 LIFT UP	18AWG	GXL	SW92(1)
24					
25	YEL	2-11	18AWG	GXL	SW88(2)
26					
27					
28	WHT	48-10 ENG DEST LT	18AWG	GXL	GD333-J4(2)
29	WHT	48-11 SYS DEST	18AWG	GXL	GD333-J4(3)
30	WHT	10-2 TELE OUT	18AWG	GXL	SW93(3)
31	BLK	0-13	18AWG	GXL	GD333-J1(4)
32					
33	WHT	24-1 LIFT DN	18AWG	GXL	SW92(3)
34	WHT	22-1 SWG LFT	18AWG	GXL	SW89(3)
35	WHT	21-1 SWG RHT	18AWG	GXL	SW89(1)

X144					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-13	18AWG	GXL	SW98-1(1)
2	YEL	2-12-2	18AWG	GXL	SW98-3(1)
3	YEL	2-12-3	18AWG	GXL	SW98-3(1)
4	RED	1-1	16AWG	GXL	SW97-1(1)
5	BLK	0-14-2	18AWG	GXL	X101(1)
6	YEL	2-14-3	18AWG	GXL	X101(2)
7	GRN	CH#1 TO DISPLAY	18AWG	GXL	X101(4)
8	YEL	CH#1 TO DISPLAY	18AWG	GXL	X101(3)
9	WHT	49-16 MSSO	18AWG	GXL	SW99-2(1)
10					
11					
12	YEL	55-7 PLAT STAT SEL	18AWG	GXL	SW98-1(1)

X101 DISPLAY					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-2	18AWG	GXL	X144(5)
2	YEL	2-14-3	18AWG	GXL	X144(6)
3	YEL	CH#1 TO DISPLAY	18AWG	GXL	X144(8)
4	GRN	CH#1 TO DISPLAY	18AWG	GXL	X144(7)
5					
6					

SW98-3 GRND STAT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-12-2	18AWG	GXL	X144(2)
1	YEL	2-12-3	18AWG	GXL	X144(3)

SW99-1 MSSO					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-20	18AWG	GXL	GD333-J2(6)

SW99-2 MSSO					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-16MSSO	18AWG	GXL	X144(9)

SW98-B KEYBAT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-1	16AWG	GXL	SW97-2(2)

SW98-1 PLAT STAT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-13	18AWG	GXL	X144(1)
1	YEL	55-7 PLAT STAT SEL	18AWG	GXL	X144(12)

SW97-2 E-STOP					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
2	RED	1-1	16AWG	GXL	SW98-B(1)

SW88 STRT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-8 ENG STRT	18AWG	GXL	CO2-J4(4)
2	YEL	2-11	18AWG	GXL	CO2-J4(25)
2	YEL	2-11-1	18AWG	GXL	SW89(2)
3	WHT	48-34 EMER DESC	18AWG	GXL	CO2-J4(16)
4					
5					
6					

SW97-1 E-STOP					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-1	16AWG	GXL	X144(4)

SW95 PLAT LVL SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	13-3 PLAT UP	18AWG	GXL	CO2-J4(17)
2	YEL	2-11-7	18AWG	GXL	SW94(2)
2	YEL	2-11-8	18AWG	GXL	SW96(2)
3	WHT	14-3 PLAT DN	18AWG	GXL	CO2-J4(5)
4					
5					
6					

SW96 PLAT ROT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	11-3 PLAT RHT	18AWG	GXL	CO2-J4(18)
2	YEL	2-11-8	18AWG	GXL	SW95(2)
3	WHT	12-3 PLAT LFT	18AWG	GXL	CO2-J4(6)
4					
5					
6					

SW93 TELE SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	9-2 TELE IN	18AWG	GXL	CO2-J4(7)
2	YEL	2-11-5	18AWG	GXL	SW92(2)
2	YEL	2-11-6	18AWG	GXL	SW94(2)
3	WHT	10-2 TELE OUT	18AWG	GXL	CO2-J4(30)
4					
5					
6					

SW94 JIB LIFT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	15-3 JIB UP	18AWG	GXL	CO2-J4(19)
2	YEL	2-11-6	18AWG	GXL	SW93(2)
2	YEL	2-11-7	18AWG	GXL	SW95(2)
3	WHT	16-3 JIB DN	18AWG	GXL	CO2-J4(8)
4					
5					
6					

GD333-J1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3					
4	BLK	0-13	18AWG	GXL	CO2-J4(31)
4	BLK	0-13-1	18AWG	GXL	GD333-J2(6)
5	WHT	48-37 LOW FUEL	18AWG	GXL	CO2-J4(13)
6					

GD333-J3					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-14 CRIBBING LT	18AWG	GXL	CO2-J4(1)
2					
3					
4					
5					
6	WHT	49-13 OVER LOAD LT	18AWG	GXL	CO2-J4(14)

GD333-J2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-10 BM MALF LT	18AWG	GXL	CO2-J4(15)
2					
3	WHT	48-9 GLOW LT	18AWG	GXL	CO2-J4(3)
4					
5					
6	BLK	0-20	18AWG	GXL	SW99-1(1)
6	BLK	0-13-1	18AWG	GXL	GD333-J1(4)

GD333-J4					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	48-10 ENG DEST LT	18AWG	GXL	CO2-J4(28)
3	WHT	48-11 SYS DEST	18AWG	GXL	CO2-J4(29)
4					
5					
6					

SW92 LIFT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	23-1 LIFT UP	18AWG	GXL	CO2-J4(23)
2	YEL	2-11-4	18AWG	GXL	SW91(2)
2	YEL	2-11-5	18AWG	GXL	SW93(2)
3	WHT	24-1 LIFT DN	18AWG	GXL	CO2-J4(33)
4					
5					
6					

SW91 TWR TELE SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	8-2 TWR OUT	18AWG	GXL	CO2-J4(22)
2	YEL	2-11-3	18AWG	GXL	SW90(2)
2	YEL	2-11-4	18AWG	GXL	SW92(2)
3	WHT	7-2 TWR IN	18AWG	GXL	CO2-J4(11)
4					
5					
6					

SW89 SWING SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	21-1 SWG RHT	18AWG	GXL	CO2-J4(35)
2	YEL	2-11-1	18AWG	GXL	SW88(2)
2	YEL	2-11-2	18AWG	GXL	SW90(2)
3	WHT	22-1 SWG LFT	18AWG	GXL	CO2-J4(34)
4					
5					
6					

SW90 TWR LIFT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-2 TWR UP	18AWG	GXL	CO2-J4(10)
2	YEL	2-11-2	18AWG	GXL	SW89(2)
2	YEL	2-11-3	18AWG	GXL	SW91(2)
3	WHT	6-2 TWR DN	18AWG	GXL	CO2-J4(21)
4					
5					
6					

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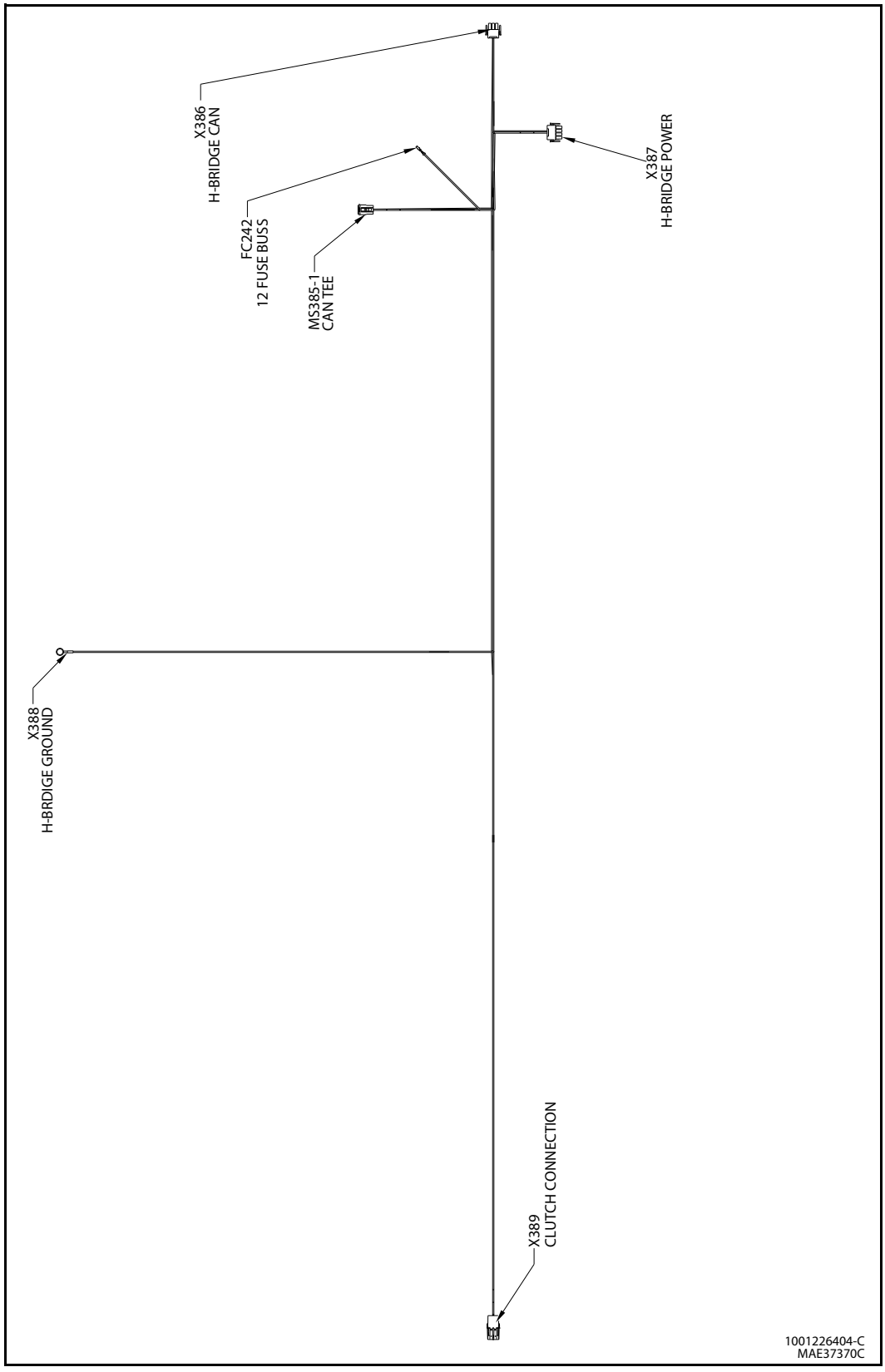


Figure 7-68. H-Bridge/Clutch Harness

X389 CLUTCH CONNECTION					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	CLUTCH	18AWG	GXL	X387(2)
B	RED	CLUTCH	18AWG	GXL	X387(3)

X388 H-BRDIGE GROUND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	047	18AWG	GXL	X387(4)

MS385-1 CAN TEE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CH#1 TO H-BRIDGE	18AWG	GXL	X386(1)
B	GRN	CH#1 TO H-BRIDGE	18AWG	GXL	X386(2)
C					

FC242 12 FUSE BUSS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
19	YEL	2-14-19	18AWG	GXL	X387(1)

X387 H-BRIDGE POWER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-19	18AWG	GXL	FC242(19)
2	BLK	CLUTCH	18AWG	GXL	X389(A)
3	RED	CLUTCH	18AWG	GXL	X389(B)
4	BLK	047	18AWG	GXL	X388(1)

X386 H-BRIDGE CAN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CH#1 TO H-BRIDGE	18AWG	GXL	MS385-1(A)
2	GRN	CH#1 TO H-BRIDGE	18AWG	GXL	MS385-1(B)
3					

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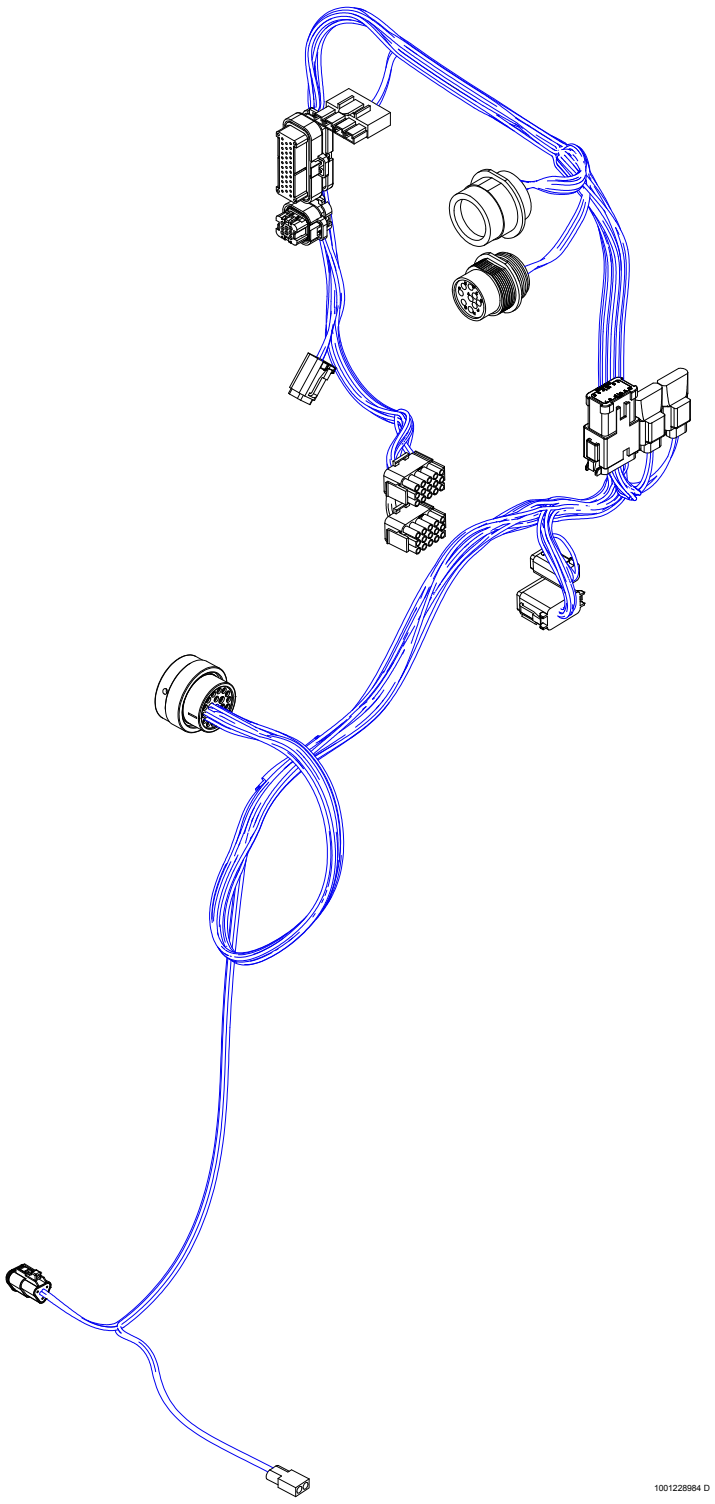


Figure 7-69. Turntable Harness - Sheet 1 of 2

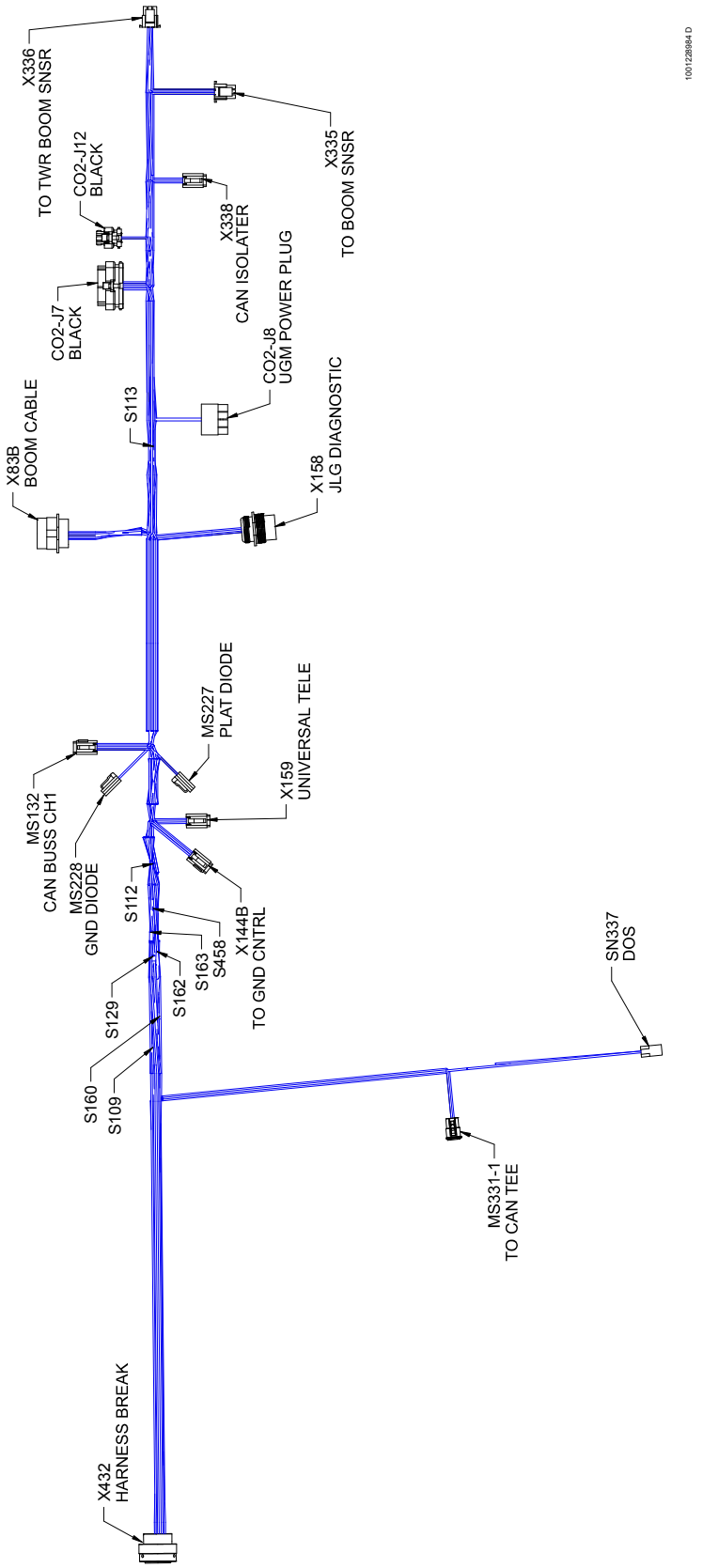


Figure 7-70. Turntable Harness - Sheet 2 of 2

X432 HARNESS BREAK					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	RED	1-1	16AWG	GXL	X144B(4)
B	YEL	2-14-21	12AWG	GXL	S109(2)
C	YEL	2-14-14	18AWG	GXL	X144B(6)
D	YEL	2-14-22	12AWG	GXL	CO2-J8(2)
E	BLK	0-14-4	12AWG	GXL	CO2-J8(1)
F	BLK	0-14-2	18AWG	GXL	X144B(5)
G	BLK	0-14-3	10AWG	GXL	S129(2)
H	YEL	2-14-11	18AWG	GXL	S458(2)
J	BLK	0-14-7	18AWG	GXL	X336(15)
K	RED	1-3	18AWG	GXL	S160(1)
L	YEL	2-14-20	18AWG	GXL	S163(2)
M	BLK	0-14-6	18AWG	GXL	S162(2)
N	GRN	CH#1 TO MS385	18AWG	GXL	MS132(9)
P	YEL	CH#1 TO MS385	18AWG	GXL	MS132(12)
R	YEL	2-14-17	18AWG	GXL	SN337(2)
S	YEL	CH#1 TO TILT SNSR	18AWG	GXL	MS132(2)
T	GRN	CH#1 TO TILT SNSR	18AWG	GXL	MS132(5)
U	YEL	2-12	18AWG	GXL	S112(2)
V					
W					
X					

MS331-1 TO CAN TEE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CH#2 TO IMG CNTRL	18AWG	GXL	X338(2)
B	GRN	CH#2 TO IMG CNTRL	18AWG	GXL	X338(1)
C	BLK	0-50	18AWG	GXL	CO2-J12(5)

SN337 DOS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-17 DRV ORNT	18AWG	GXL	CO2-J7(35)
2	YEL	2-14-17	18AWG	GXL	X432(R)

S109					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-21-1	12AWG	GXL	X83B(12)
1	YEL	2-14-21-2	12AWG	GXL	X83B(10)
2	YEL	2-14-21	12AWG	GXL	X432(B)

MS227 PLAT DIODE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-12-1	18AWG	GXL	S112(1)
2	YEL	2-12-1	18AWG	GXL	S113(1)

S160					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-3	18AWG	GXL	X432(K)
2	RED	1-3-1	18AWG	GXL	X159(1)
2	RED	1-3-2	18AWG	GXL	X158(B)

S129					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-3-1	12AWG	GXL	X83B(16)
1	BLK	0-14-3-2	12AWG	GXL	X83B(18)
2	BLK	0-14-3	10AWG	GXL	X432(G)

S162					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-6-1	18AWG	GXL	X159(2)
1	BLK	0-14-6-2	18AWG	GXL	X158(A)
2	BLK	0-14-6	18AWG	GXL	X432(M)

S163					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-5-1	18AWG	GXL	X159(3)
1	YEL	2-14-5-2	18AWG	GXL	X158(H)
2	YEL	2-14-20	18AWG	GXL	X432(L)

S458					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-11-1	18AWG	GXL	X336(14)
1	YEL	2-14-11-2	18AWG	GXL	X336(12)
2	YEL	2-14-11	18AWG	GXL	X432(H)

S112					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-12-1	18AWG	GXL	MS227(1)
1	YEL	2-12-2	18AWG	GXL	MS228(1)
2	YEL	2-12	18AWG	GXL	X432(U)

MS228 GND DIODE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-12-2	18AWG	GXL	S112(1)
2	YEL	2-12-2	18AWG	GXL	X144B(2)

X159 UNIVERSAL TELE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-3-1	18AWG	GXL	S160(2)
2	BLK	0-14-6-1	18AWG	GXL	S162(1)
3	YEL	2-14-5-1	18AWG	GXL	S163(1)
4	YEL	55-7 PLAT STAT SEL	18AWG	GXL	X144B(12)

X144B TO GND CNTRL					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-13	18AWG	GXL	X83B(5)
2	YEL	2-12-2	18AWG	GXL	MS228(2)
3	YEL	2-12-3	18AWG	GXL	CO2-J7(3)
4	RED	1-1	16AWG	GXL	X432(A)
5	BLK	0-14-2	18AWG	GXL	X432(F)
6	YEL	2-14-14	18AWG	GXL	X432(C)
7	GRN	CH#1 TO DISPLAY	18AWG	GXL	MS132(8)
8	YEL	CH#1 TO DISPLAY	18AWG	GXL	MS132(11)
9	WHT	49-16 MSSO	18AWG	GXL	CO2-J12(8)
10					
11					
12	YEL	55-7 PLAT STAT SEL	18AWG	GXL	X159(4)

MS132 CAN BUSS CH1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	CH#1 TO J7-13	18AWG	GXL	CO2-J7(13)
2	YEL	CH#1 TO TILT SNSR	18AWG	GXL	X432(S)
3	YEL	CH#1 TO JLG DIAG	18AWG	GXL	X158(C)
4	GRN	CH#1 TO J7-24	18AWG	GXL	CO2-J7(24)
5	GRN	CH#1 TO TILT SNSR	18AWG	GXL	X432(T)
6	GRN	CH#1 TO JLG DIAG	18AWG	GXL	X158(D)
7	GRN	CH#1 TO PLATFORM	18AWG	GXL	X83B(2)
8	GRN	CH#1 TO DISPLAY	18AWG	GXL	X144B(7)
9	GRN	CH#1 TO MS385	18AWG	GXL	X432(N)
10	YEL	CH#1 TO PLATFORM	18AWG	GXL	X83B(3)
11	YEL	CH#1 TO DISPLAY	18AWG	GXL	X144B(8)
12	YEL	CH#1 TO MS385	18AWG	GXL	X432(P)

X158 JLG DIAGNOSTIC					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	0-14-6-2	18AWG	GXL	S162(1)
B	RED	1-3-2	18AWG	GXL	S160(2)
C	YEL	CH#1 TO JLG DIAG	18AWG	GXL	MS132(3)
D	GRN	CH#1 TO JLG DIAG	18AWG	GXL	MS132(6)
E					
F					
G					
H	YEL	2-14-5-2	18AWG	GXL	S163(1)
J					

X83B BOOM CABLE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	GRN	CH#1 TO PLATFORM	18AWG	GXL	MS132(7)
3	YEL	CH#1 TO PLATFORM	18AWG	GXL	MS132(10)
4	YEL	2-12-1-1	18AWG	GXL	S113(1)
5	YEL	2-13	18AWG	GXL	X144B(1)
6	WHT	49-15 FOOT SW	18AWG	GXL	CO2-J7(15)
7					
8					
9	BLK	0-57	18AWG	GXL	CO2-J7(10)
10	YEL	2-14-21-2	12AWG	GXL	S109(1)
11	WHT	49-11 GND MODE	18AWG	GXL	CO2-J7(14)
12	YEL	2-14-21-1	12AWG	GXL	S109(1)
13					
14					
15					
16	BLK	0-14-3-1	12AWG	GXL	S129(1)
17					
18	BLK	0-14-3-2	12AWG	GXL	S129(1)
19					

S113					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-12-1	18AWG	GXL	MS227(2)
1	YEL	2-12-1-1	18AWG	GXL	X83B(4)
2	YEL	2-12-1-2	18AWG	GXL	CO2-J7(1)
2	YEL	2-12-1-3	18AWG	GXL	CO2-J7(2)

CO2-J8 UGM POWER PLUG					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-4	12AWG	GXL	X432(E)
2	YEL	2-14-22	12AWG	GXL	X432(D)
3					
4					

CO2-J12 BLACK					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3	YEL	CH#2 TO TERMINATOR	18AWG	GXL	X338(4)
4	GRN	CH#2 TO TERMINATOR	18AWG	GXL	X338(3)
5	BLK	0-50	18AWG	GXL	MS331-1(C)
6					
7					
8	WHT	49-16 MSSO	18AWG	GXL	X144B(9)

X338 CAN ISOLATER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	GRN	CH#2 TO IMG CNTRL	18AWG	GXL	MS331-1(B)
2	YEL	CH#2 TO IMG CNTRL	18AWG	GXL	MS331-1(A)
3	GRN	CH#2 TO TERMINATOR	18AWG	GXL	CO2-J12(4)
4	YEL	CH#2 TO TERMINATOR	18AWG	GXL	CO2-J12(3)

X335 TO BOOM SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-33 ELEV CUTBK SW	18AWG	GXL	C02-J7(11)
2					
3					
4					
5					
6	WHT	49-32 ELEV SW SUP	18AWG	GXL	C02-J7(29)
7	WHT	49-31CAP LNTH SUP	18AWG	GXL	C02-J7(26)
8	WHT	49-30 CAP LNTH SW	18AWG	GXL	C02-J7(7)
9	WHT	49-29 CAP ANG SUP	18AWG	GXL	C02-J7(16)
10	WHT	49-28 CAP ANG SW	18AWG	GXL	C02-J7(4)
11					
12					
13					
14					
15					

X336 TO TWR BOOM SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-42-1	18AWG	GXL	X336(4)
2	WHT	49-37 TWR LIFT PROX	18AWG	GXL	C02-J7(34)
3	WHT	49-36 TWR LFT PROX	18AWG	GXL	C02-J7(22)
4	BLK	0-42	18AWG	GXL	C02-J7(19)
5	WHT	49-35 TWR TELE PROX	18AWG	GXL	C02-J7(33)
6	WHT	49-34 TWR TELE PROX	18AWG	GXL	C02-J7(21)
7					
8					
9					
10					
11					
12	YEL	2-14-11-2	18AWG	GXL	S458(1)
13					
14	YEL	2-14-11-1	18AWG	GXL	S458(1)
15	BLK	0-14-7	18AWG	GXL	X432(J)

C02-J7 BLACK					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-12-1-2	18AWG	GXL	S113(2)
2	YEL	2-12-1-3	18AWG	GXL	S113(2)
3	YEL	2-12-3	18AWG	GXL	X144B(3)
4	WHT	49-28 CAP ANG SW	18AWG	GXL	X335(10)
5					
6					
7	WHT	49-30 CAP LNTH SW	18AWG	GXL	X335(8)
8					
9					
10	BLK	0-57	18AWG	GXL	X83B(9)
11	WHT	49-33 ELEV CUTBK SW	18AWG	GXL	X335(1)
12					
13	YEL	CH#1 TO J7-13	18AWG	GXL	MS132(1)
14	WHT	49-11 GND MODE	18AWG	GXL	X83B(11)
15	WHT	49-15 FOOT SW	18AWG	GXL	X83B(6)
16	WHT	49-29 CAP ANG SUP	18AWG	GXL	X335(9)
17	WHT	49-40 CAN TERM JUMPER	18AWG	GXL	C02-J7(6)
18					
19	BLK	0-42	18AWG	GXL	X336(4)
20					
21	WHT	49-34 TWR TELE PROX	18AWG	GXL	X336(6)
22	WHT	49-36 TWR LFT PROX	18AWG	GXL	X336(3)
23	YEL	2-11-9	18AWG	GXL	C02-J7(30)
24	GRN	CH#1 TO J7-24	18AWG	GXL	MS132(4)
25					
26	WHT	49-31 CAP LNTH SUP	18AWG	GXL	X335(7)
27					
28					
29	WHT	49-32 ELEV SW SUP	18AWG	GXL	X335(6)
30					
31					
32					
33	WHT	49-35 TWR TELE PROX	18AWG	GXL	X336(5)
34	WHT	49-37 TWR LIFT PROX	18AWG	GXL	X336(2)
35	WHT	49-17 DRV ORNT	18AWG	GXL	SN337(1)

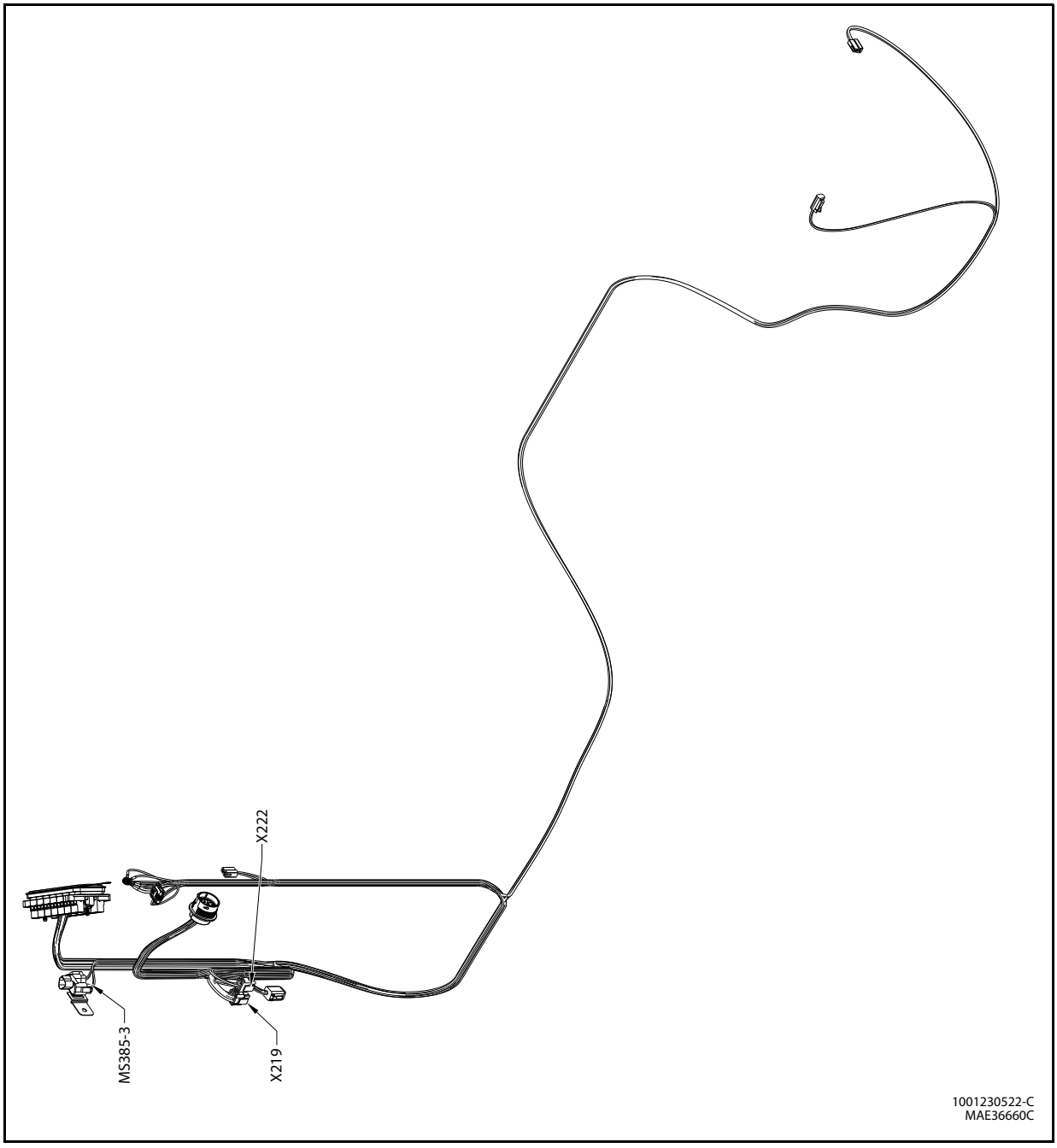


Figure 7-71. Turntable Fuse Panel Harness - Sheet 1 of 3

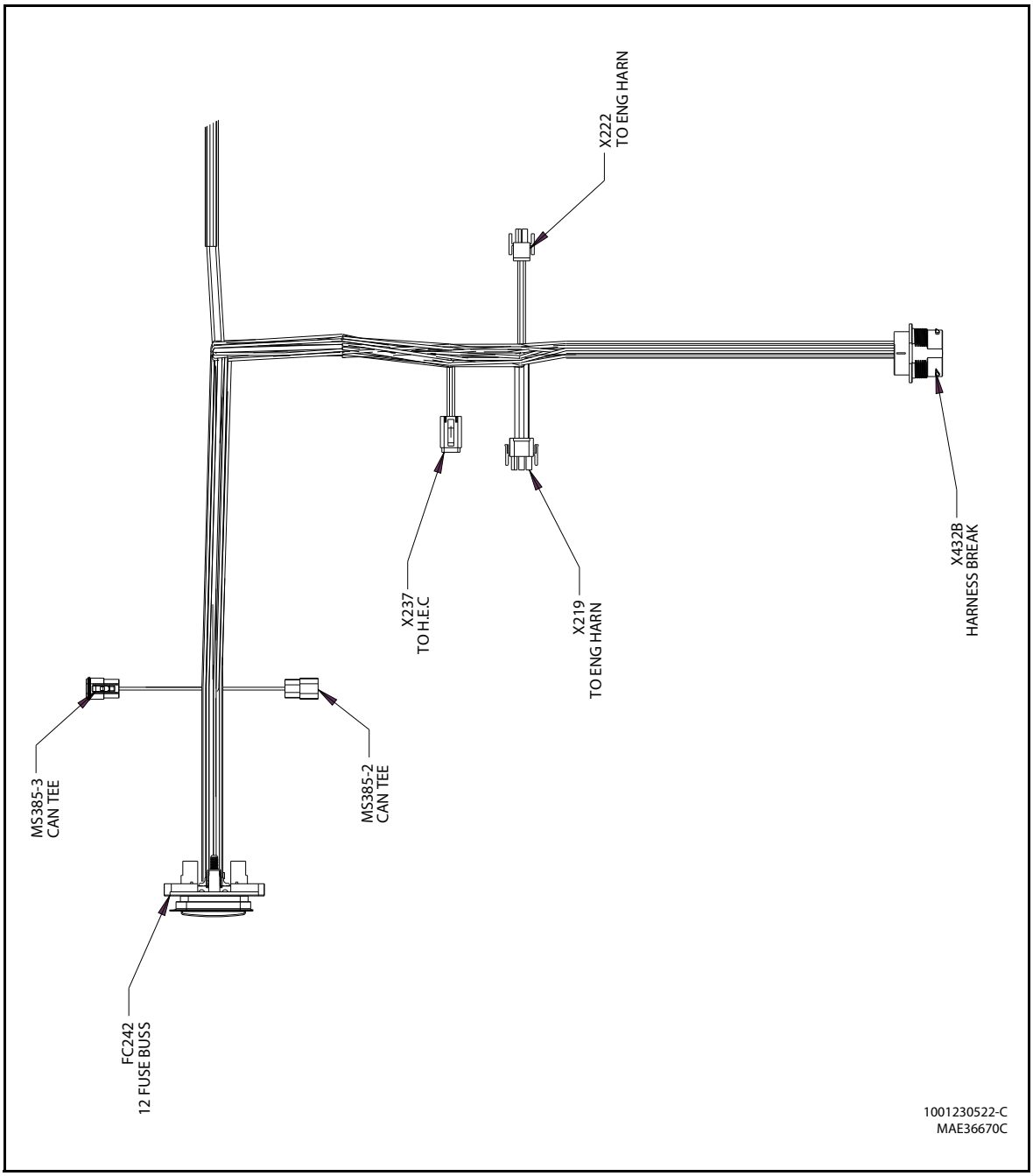


Figure 7-72. Turntable Fuse Panel Harness - Sheet 2 of 3

FC242 12 FUSE BUSS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-1	10AWG	GXL	X219(4)
2	YEL	2-14-2	10AWG	GXL	X219(5)
3	YEL	2-14-4	12AWG	GXL	X219(7)
4	YEL	2-14-5	12AWG	GXL	X219(8)
5	YEL	2-14-7	12AWG	GXL	X219(2)
6	YEL	2-14-8	12AWG	GXL	X219(3)
7	YEL	2-14-9	10AWG	GXL	X219(6)
8	YEL	2-14-3	16AWG	GXL	X222(4)
9	YEL	2-14-6	18AWG	GXL	X222(3)
10	YEL	2-14-10	18AWG	GXL	X319(1)
11	YEL	2-14-15	14AWG	GXL	X222(2)
12	YEL	2-14-11	18AWG	GXL	X432B(H)
13	YEL	2-14-12	18AWG	GXL	X237(1)
14	YEL	2-14-14	18AWG	GXL	X432B(C)
15	YEL	2-14-13	18AWG	GXL	X237(4)
16	YEL	2-14-16	18AWG	GXL	X334(1)
17	YEL	2-14-17	18AWG	GXL	X432B(R)
18					
19					
20	YEL	2-14-20	18AWG	GXL	X432B(L)
21	YEL	2-14-21	12AWG	GXL	X432B(B)
22	YEL	2-14-22	12AWG	GXL	X432B(D)
23					
24					
25					
26					
27	RED	1-3	18AWG	GXL	X432B(K)
28	RED	1-1	16AWG	GXL	X432B(A)

MS385-2 CAN TEE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CH#1 TO HEC	18AWG	GXL	X237(5)
B	GRN	CH#1 TO HEC	18AWG	GXL	X237(6)
C					

MS385-3 CAN TEE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CH#1 TO MS385	18AWG	GXL	X432B(P)
B	GRN	CH#1 TO MS385	18AWG	GXL	X432B(N)
C					

X237 TO H.E.C					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-12	18AWG	GXL	FC242(13)
2	BLK	0-14-5	18AWG	GXL	X127(1)
3					
4	YEL	2-14-13	18AWG	GXL	FC242(15)
5	YEL	CH#1TO HEC	18AWG	GXL	MS385-2(A)
6	GRN	CH#1TO HEC	18AWG	GXL	MS385-2(B)

X219 TO ENG HARN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-27 OIL COOL FAN	12AWG	GXL	WH244(2)
2	YEL	2-14-7	12AWG	GXL	FC242(5)
3	YEL	2-14-8	12AWG	GXL	FC242(6)
4	YEL	2-14-1	10AWG	GXL	FC242(1)
5	YEL	2-14-2	10AWG	GXL	FC242(2)
6	YEL	2-14-9	10AWG	GXL	FC242(7)
7	YEL	2-14-4	12AWG	GXL	FC242(3)
8	YEL	2-14-5	12AWG	GXL	FC242(4)
9					

X222 TO ENG HARN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-21 OIL COOL FAN	18AWG	GXL	X319(2)
2	YEL	2-14-15	14AWG	GXL	FC242(11)
3	YEL	2-14-6	18AWG	GXL	FC242(9)
4	YEL	2-14-3	16AWG	GXL	FC242(8)
5					
6					

X432B HARNESS BREAK					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	RED	1-1	16AWG	GXL	FC242(28)
B	YEL	2-14-21	12AWG	GXL	FC242(21)
C	YEL	2-14-14	18AWG	GXL	FC242(14)
D	YEL	2-14-22	12AWG	GXL	FC242(22)
E	BLK	0-14-4	12AWG	GXL	X124(1)
F	BLK	0-14-2	18AWG	GXL	X126(1)
G	BLK	0-14-3	10AWG	GXL	X125(1)
H	YEL	2-14-11	18AWG	GXL	FC242(12)
J	BLK	0-14-7	18AWG	GXL	X165(1)
K	RED	1-3	18AWG	GXL	FC242(27)
L	YEL	2-14-20	18AWG	GXL	FC242(20)
M	BLK	0-14-6	18AWG	GXL	X161(1)
N	GRN	CH#1 TO MS385	18AWG	GXL	MS385-3(B)
P	YEL	CH#1 TO MS385	18AWG	GXL	MS385-3(A)
R	YEL	2-14-17	18AWG	GXL	FC242(17)
S	YEL	CH#1 TO TILT SNSR	18AWG	GXL	X334(3)
T	GRN	CH#1 TO TILT SNSR	18AWG	GXL	X334(4)
U	YEL	2-12	18AWG	GXL	RL111(1)
V					
W					
X					

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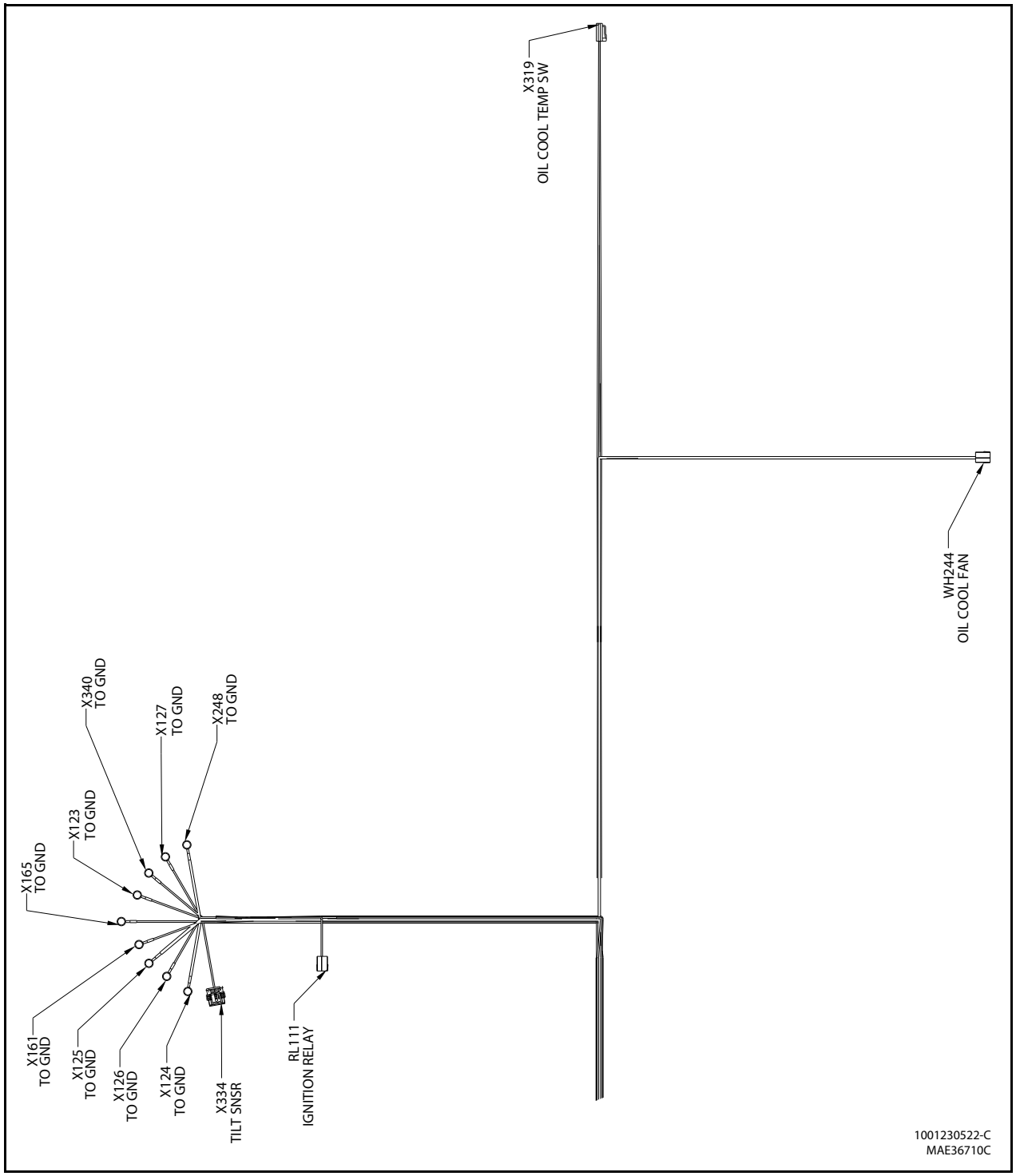


Figure 7-73. Turntable Fuse Panel Harness - Sheet 3 of 3

RL111 IGNITION RELAY					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-12	18AWG	GXL	X432B(U)
2	BLK	0-14-1	18AWG	GXL	X123(1)

X334 TILT SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-16	18AWG	GXL	FC242(16)
2	BLK	0-40	18AWG	GXL	X340(1)
3	YEL	CH#1 TO TILT SNSR	18AWG	GXL	X432B(S)
4	GRN	CH#1 TO TILT SNSR	18AWG	GXL	X432B(T)

X124 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-4	12AWG	GXL	X432B(E)

X126 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-2	18AWG	GXL	X432B(F)

X125 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-3	10AWG	GXL	X432B(G)

X161 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-6	18AWG	GXL	X432B(M)

X165 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-7	18AWG	GXL	X432B(J)

X123 TO GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-1	18AWG	GXL	RL111(2)

X340 TO GND					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	0-40	18AWG	GXL	X334(2)

X127 TO GND					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	0-14-5	18AWG	GXL	X237(2)

X248 TO GND					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	0-40-1	12AWG	GXL	WH244(1)

WH244 OILCOOL FAN					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	0-40-1	12AWG	GXL	X248(1)
2	WHT	49-27 OIL COOL FAN	12AWG	GXL	X219(1)

X319 OIL COOLT EMP SW					
CONN POS	**WIRE COLOR**	**WIRE LABEL**	**GAUGE**	**JACKET**	**TO**
1	YEL	2-14-10	18AWG	GXL	FC242(10)
2	WHT	49-21 OIL COOL FAN	18AWG	GXL	X222(1)

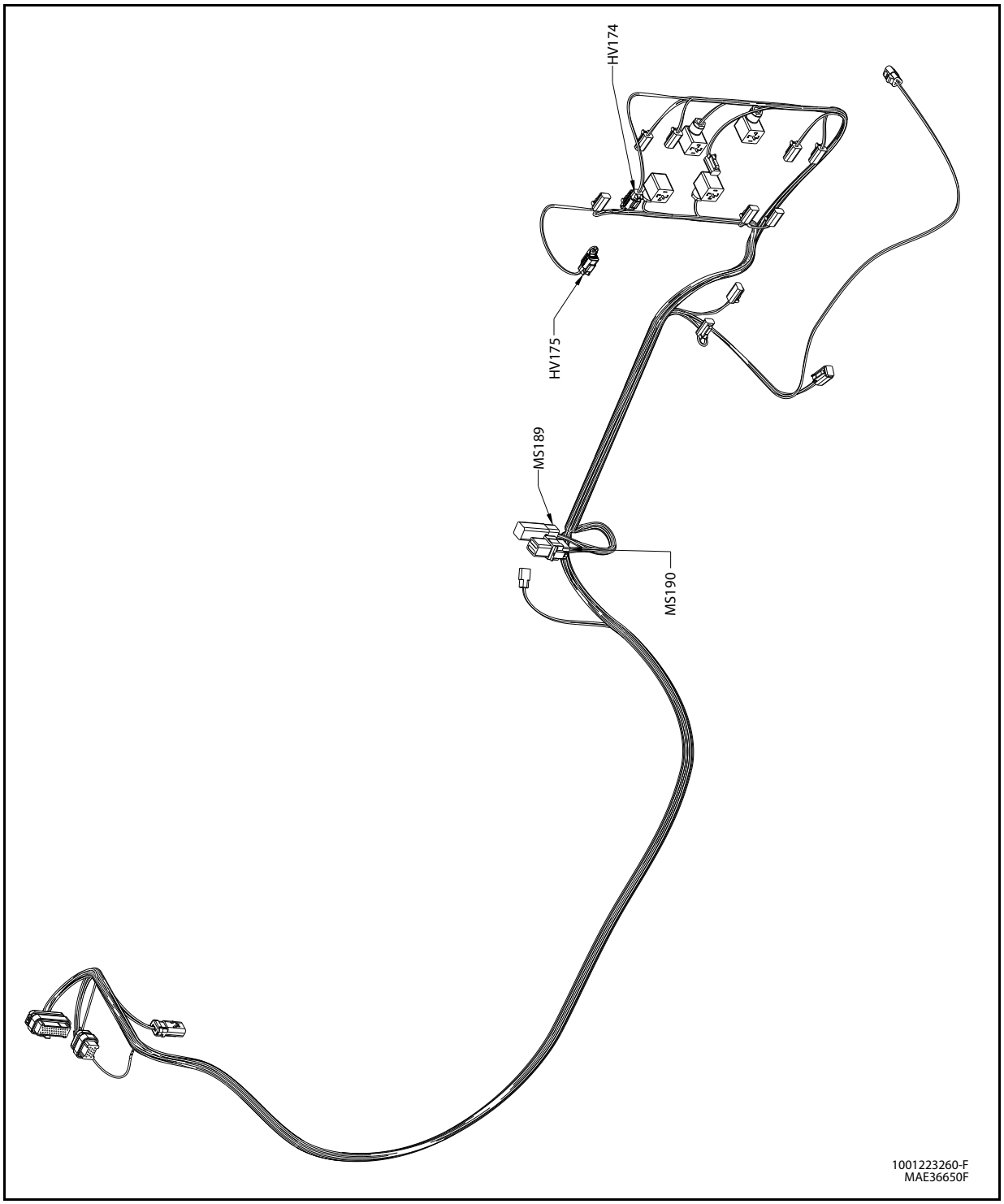


Figure 7-74. Main Valve Harness - Sheet 1 of 2

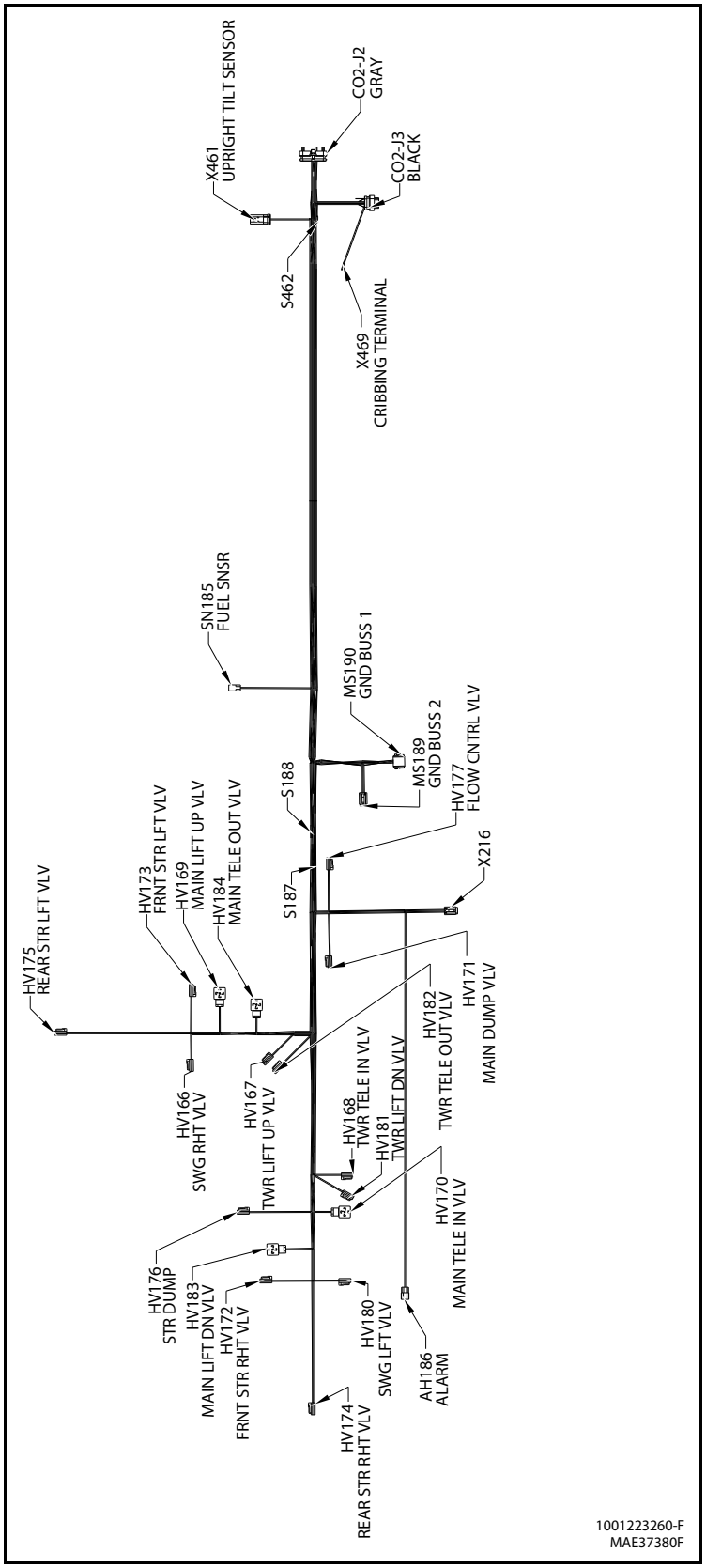


Figure 7-75. Main Valve Harness - Sheet 2 of 2

HV174- REAR STR RHT VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	26-3 REAR STR RHT VLV	18AWG	GXL	CO2-J2(9)
2	BLK	0-23-3	18AWG	GXL	MS189(3)

HV172 FRNT STR RHT VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	26-1 FRNT STR RHT VLV	18AWG	GXL	CO2-J2(8)
2	BLK	0-23-1	18AWG	GXL	MS189(5)

HV180 SWG LFT VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	22-2 SWG LFT VLV	18AWG	GXL	CO2-J2(34)
2	WHT	60-1-1 SWING RTN	18AWG	GXL	S187(2)

HV183- MAIN LIFT DN VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	24-2 LIFT DN VLV	18AWG	GXL	CO2-J2(22)
2	WHT	60-2-1 MAIN LIFT RTN	18AWG	GXL	S188(2)

HV176 STR DUMP					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	3-4 STR DUMP VLV	18AWG	GXL	CO2-J2(1)
2	BLK	0-23-5	18AWG	GXL	MS189(1)

HV170 MAIN TELE IN VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	9-3TELEINVLV	18AWG	GXL	CO2-J2(4)
2	BLK	0-24-5	18AWG	GXL	MS190(3)

HV181 TWR LIFT DN VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	6-3 TWR DN VLV	18AWG	GXL	CO2-J2(32)
2	BLK	0-24-2	18AWG	GXL	MS190(6)

S462					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-16	18AWG	GXL	CO2-J3(7)
2	YEL	2-16-1	18AWG	GXL	X216(2)
2	YEL	2-16-2	18AWG	GXL	X461(1)

HV168 TWR TELE IN VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	7-3 TWR IN VLV	18AWG	GXL	CO2-J2(3)
2	BLK	0-24-3	18AWG	GXL	MS190(5)

HV175 REAR STR LFT VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	26-4 REAR STR LFT VLV	18AWG	GXL	CO2-J2(20)
2	BLK	0-23-4	18AWG	GXL	MS189(2)

HV166 SWG RHT VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	21-2 SWG RHT VLV	18AWG	GXL	CO2-J2(35)
2	WHT	60-1-2 SWG RTN	18AWG	GXL	S187(2)

HV173 FRNT STR LFT VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	26-2 FRNT STR LFT VLV	18AWG	GXL	CO2-J2(19)
2	BLK	0-23-2	18AWG	GXL	MS189(4)

HV169 MAIN LIFT UP VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	23-2 LIFT UP VLV	18AWG	GXL	CO2-J2(11)
2	WHT	60-2-2 MAIN LIFT RTN	18AWG	GXL	S188(2)

HV184- MAIN TELE OUT VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	10-3 TELE OUT VLV	18AWG	GXL	CO2-J2(16)
2	BLK	0-24-6	18AWG	GXL	MS190(2)

HV167 TWR LIFT UP VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	5-3 TWR UP VLV	18AWG	GXL	CO2-J2(33)
2	BLK	0-24-1	18AWG	GXL	MS190(7)

X461 UP RIGHT TILT SENSOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-16-2	18AWG	GXL	S462(2)
2	WHT	49-40 UP RIGHT TILT	18AWG	GXL	CO2-J3(8)
3	BLK	0-57	18AWG	GXL	CO2-J3(3)

HV182 TWR TELE OUT VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	8-3 TWR OUT VLV	18AWG	GXL	CO2-J2(15)
2	BLK	0-24-4	18AWG	GXL	MS190(4)

HV171 MAIN DUMP VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	3-2 MAIN DUMP VLV	18AWG	GXL	CO2-J2(13)
2	BLK	0-24-7	18AWG	GXL	MS190(1)

HV177 FLOW CNTRL VLV					
CONN POS	WIREC OLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	3-3 FLOW CNTRL VLV	18AWG	GXL	CO2-J2(31)
2	WHT	60-3 FLOW CNTRL RTN	18AWG	GXL	CO2-J3(6)

AH186 ALARM					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	49-18 ALARM/HORN	18AWG	GXL	CO2-J2(27)
B					
C	BLK	0-22	18AWG	GXL	CO2-J2(14)

X469 CRIBBING TERMINAL					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	52-75 CRIBBING	18AWG	GXL	CO2-J3(9)

X216					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	60-4 DRIVE RTN	18AWG	GXL	CO2-J3(1)
2	YEL	2-16-1	18AWG	GXL	S462(2)
3	WHT	60-5 THROTTLE R TN	18AWG	GXL	CO2-J3(2)
4	WHT	55-9 H&T LT SIG	18AWG	GXL	CO2-J2(26)

S188					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	60-2 MAIN LIFT RTN	18AWG	GXL	CO2-J3(14)
2	WHT	60-2-1 MAIN LIFT RTN	18AWG	GXL	HV183(2)
2	WHT	60-2-2 MAIN LIFT RTN	18AWG	GXL	HV169(2)

S187					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	60-1 SWG RTN	18AWG	GXL	CO2-J3(4)
2	WHT	60-1-1 SWING RTN	18AWG	GXL	HV180(2)
2	WHT	60-1-2 SWG RTN	18AWG	GXL	HV166(2)

SN185 FUEL SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-30 FUEL SNSR	18AWG	GXL	CO2-J2(25)
2	BLK	0-21	18AWG	GXL	CO2-J2(6)

CO2-J2 GRAY					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	3-4 STR DUMP VLV	18AWG	GXL	HV176(1)
2					
3	WHT	7-3 TWR IN VLV	18AWG	GXL	HV168(1)
4	WHT	9-3 TELE IN VLV	18AWG	GXL	HV170(1)
5					
6	BLK	0-21	18AWG	GXL	SN185(2)
7					
8	WHT	26-1 FRNT STR RHT VLV	18AWG	GXL	HV172(1)
9	WHT	26-3 REAR STR RHT VLV	18AWG	GXL	HV174(1)
10					
11	WHT	23-2 LIFT UP VLV	18AWG	GXL	HV169(1)
12					
13	WHT	3-2 MAIN DUMP VLV	18AWG	GXL	HV171(1)
14	BLK	0-22	18AWG	GXL	AH186(C)
15	WHT	8-3 TWR OUT VLV	18AWG	GXL	HV182(1)
16	WHT	10-3 TELE OUT VLV	18AWG	GXL	HV184(1)
17	BLK	0-24	16AWG	GXL	MS190(8)
18					
19	WHT	26-2 FRNT STR LFT VLV	18AWG	GXL	HV173(1)
20	WHT	26-4 REAR STR LFT VLV	18AWG	GXL	HV175(1)
21					
22	WHT	24-2 LIFT DN VLV	18AWG	GXL	HV183(1)
23					
24					
25	WHT	48-30 FUEL SNSR	18AWG	GXL	SN185(1)
26	WHT	55-9 H&T LT SIG	18AWG	GXL	X216(4)
27	WHT	49-18 ALARM/HORN	18AWG	GXL	AH186(A)
28	WHT	49-50 MSSO CONFIG	18AWG	GXL	CO2-J3(11)
29					
30	BLK	0-23	16AWG	GXL	MS189(6)
31	WHT	3-3 FLOW CNTRL VLV	18AWG	GXL	HV177(1)
32	WHT	6-3 TWR DN VLV	18AWG	GXL	HV181(1)
33	WHT	5-3 TWR UP VLV	18AWG	GXL	HV167(1)
34	WHT	22-2 SWG LFT VLV	18AWG	GXL	HV180(1)
35	WHT	21-2 SWG RHT VLV	18AWG	GXL	HV166(1)

MS189 GND BUSS 2					
CONN POS	WIREC OLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-23-5	18AWG	GXL	HV176(2)
2	BLK	0-23-4	18AWG	GXL	HV175(2)
3	BLK	0-23-3	18AWG	GXL	HV174(2)
4	BLK	0-23-2	18AWG	GXL	HV173(2)
5	BLK	0-23-1	18AWG	GXL	HV172(2)
6	BLK	0-23	16AWG	GXL	CO2-J2(30)

MS190 GND BUSS 1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-24-7	18AWG	GXL	HV171(2)
2	BLK	0-24-6	18AWG	GXL	HV184(2)
3	BLK	0-24-5	18AWG	GXL	HV170(2)
4	BLK	0-24-4	18AWG	GXL	HV182(2)
5	BLK	0-24-3	18AWG	GXL	HV168(2)
6	BLK	0-24-2	18AWG	GXL	HV181(2)
7	BLK	0-24-1	18AWG	GXL	HV167(2)
8	BLK	0-24	16AWG	GXL	CO2-J2(17)

CO2-J3 BLACK					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	60-4 DRIVE RTN	18AWG	GXL	X216(1)
2	WHT	60-5 THROTTLE RTN	18AWG	GXL	X216(3)
3	BLK	0-57	18AWG	GXL	X461(3)
4	WHT	60-1 SWG RTN	18AWG	GXL	S187(1)
5					
6	WHT	60-3 FLOW CNTRL RTN	18AWG	GXL	HV177(2)
7	YEL	2-16	18AWG	GXL	S462(1)
8	WHT	49-40 UP RIGHT TILT	18AWG	GXL	X461(2)
9	WHT	52-75 CRIBBING	18AWG	GXL	X469(1)
10					
11	WHT	49-50 MSSO CONFIG	18AWG	GXL	CO2-J2(28)
12					
13					
14	WHT	60-2 MAIN LIFT RTN	18AWG	GXL	S188(1)

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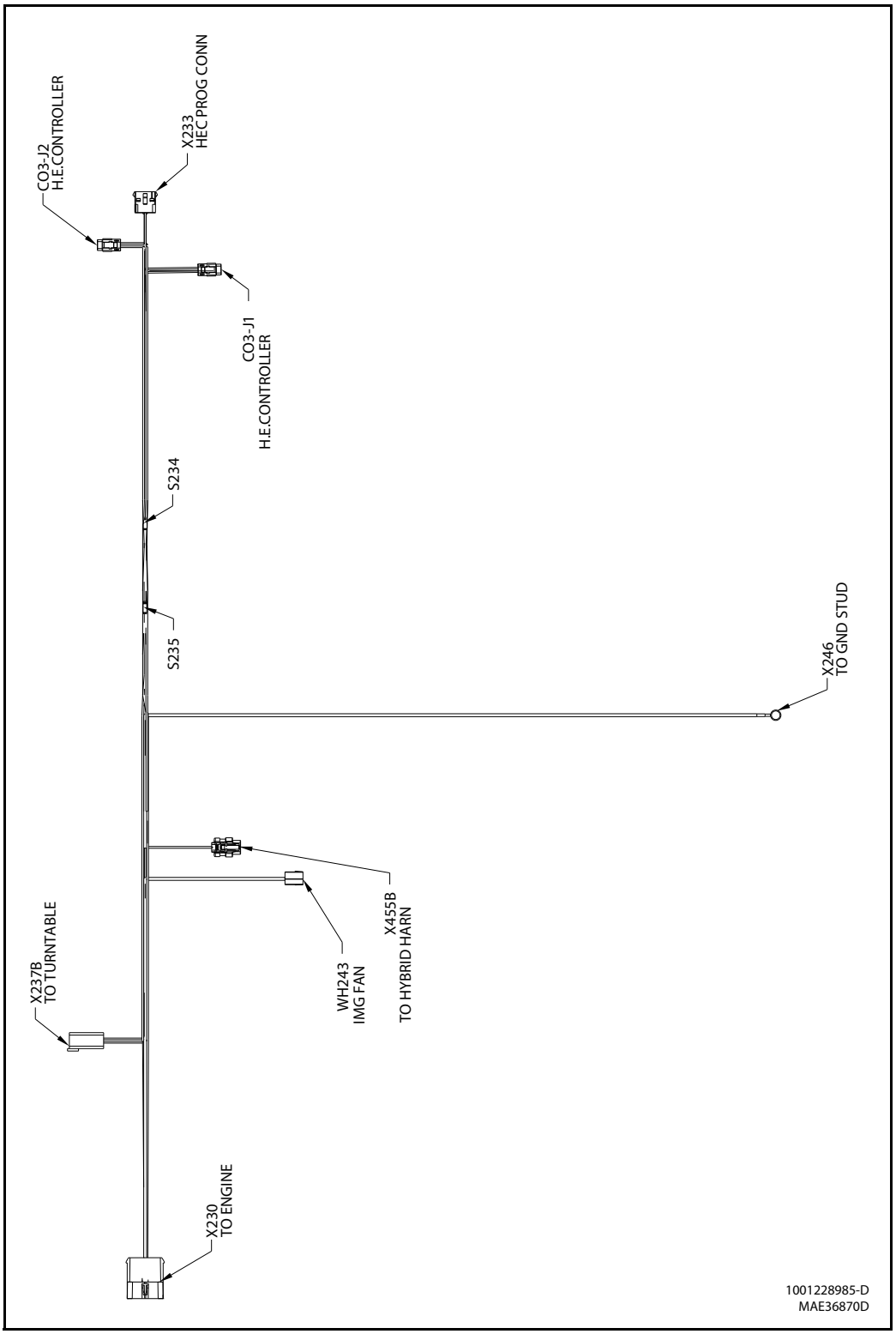


Figure 7-76. Controller Harness

WH243					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-8-1	12AWG	GXL	X246(1)
2	WHT	49-25 IMG FAN	12AWG	GXL	X230(E)

X455B-TOHYBRIDHARN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-13	18AWG	GXL	X237B(4)
2	BLK	0-14-8-2	18AWG	GXL	X246(1)
3	WHT	49-57 DC/DC CONT	18AWG	GXL	C03-J1(8)

X237B TO TURN TABLE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-12	18AWG	GXL	S234(1)
2	BLK	0-14-5	18AWG	GXL	S235(1)
3					
4	YEL	2-14-13	18AWG	GXL	X455B(1)
5	YEL	CH#1 TO HEC CONT	18AWG	GXL	C03-J2(9)
6	GRN	CH#1 TO HEC CONT	18AWG	GXL	C03-J2(10)

X230 TO ENGINE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	49-20 IMG FAN	18AWG	GXL	C03-J1(7)
B					
C					
D	WHT	49-23 ENG FAN	18AWG	GXL	C03-J1(10)
E	WHT	49-25 IMG FAN	12AWG	GXL	WH243(2)

X246					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-8-1	12AWG	GXL	WH243(1)
1	BLK	0-14-8-2	18AWG	GXL	X455B(2)

S235					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-5	18AWG	GXL	X237B(2)
2	BLK	0-14-5-1	18AWG	GXL	C03-J1(2)
2	BLK	0-14-5-2	18AWG	GXL	X233(4)

C03-J1 H.E.CONTROLLER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-12-1	18AWG	GXL	S234(2)
2	BLK	0-14-5-1	18AWG	GXL	S235(2)
3					
4					
5					
6					
7	WHT	49-20 IMG FAN	18AWG	GXL	X230(A)
8	WHT	49-57 DC/DC CONT	18AWG	GXL	X455B(3)
9					
10	WHT	49-23 ENG FAN	18AWG	GXL	X230(D)
11					
12					

C03-J2 H.E.CONTROLLER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3					
4					
5					
6					
7					
8					
9	YEL	CH#1 TO HEC CONT	18AWG	GXL	X237B(5)
10	GRN	CH#1 TO HEC CONT	18AWG	GXL	X237B(6)
11	WHT	4-7 TX	18AWG	GXL	X233(3)
12	WHT	4-8 RX	18AWG	GXL	X233(2)

X233 HEC PROG CONN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-12-2	18AWG	GXL	S234(2)
2	WHT	4-8 RX	18AWG	GXL	C03-J2(12)
3	WHT	4-7 TX	18AWG	GXL	C03-J2(11)
4	BLK	0-14-5-2	18AWG	GXL	S235(2)

S234					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-12	18AWG	GXL	X237B(1)
2	YEL	2-14-12-1	18AWG	GXL	C03-J1(1)
2	YEL	2-14-12-2	18AWG	GXL	X233(1)

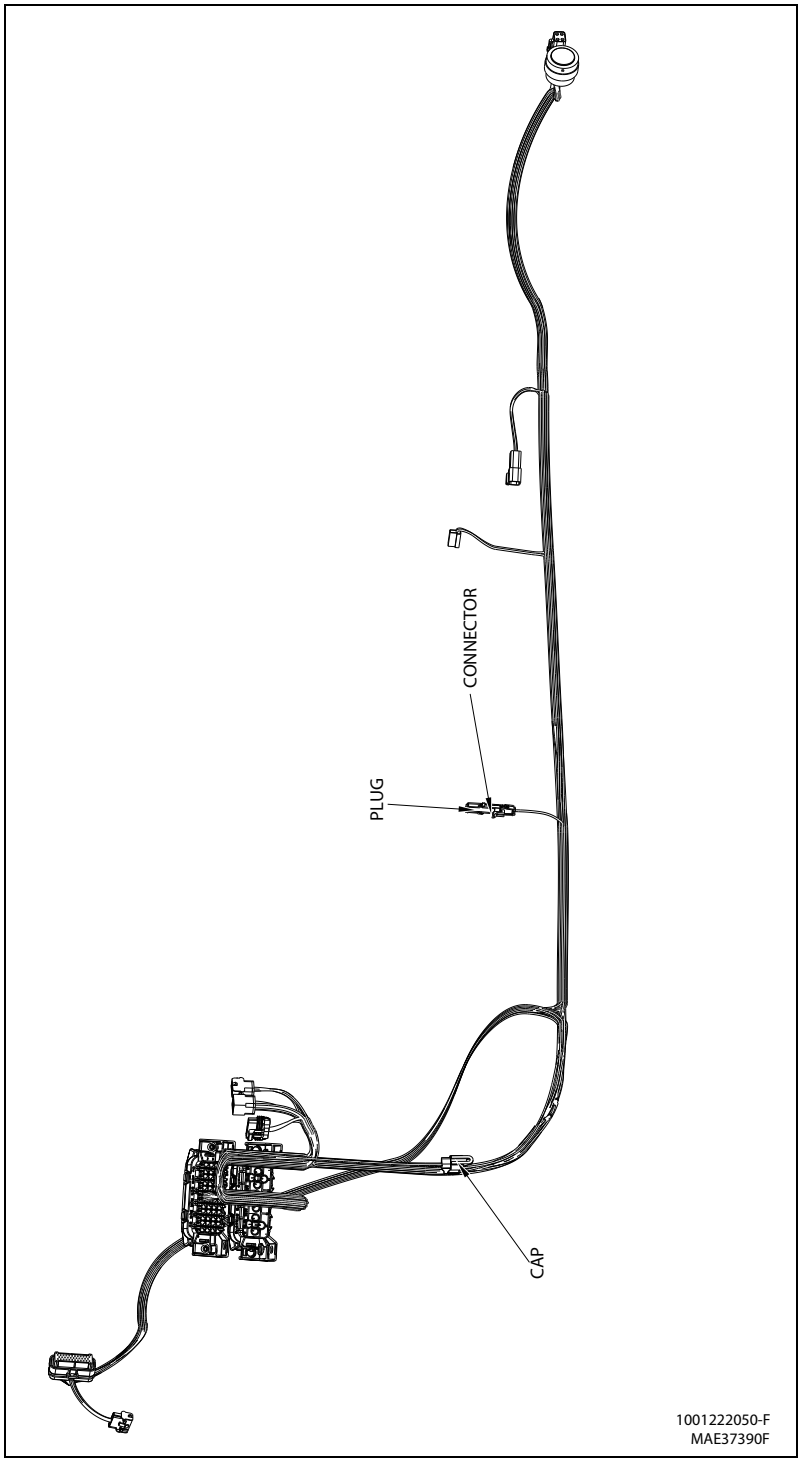


Figure 7-77. Engine Harness - Sheet 1 of 2

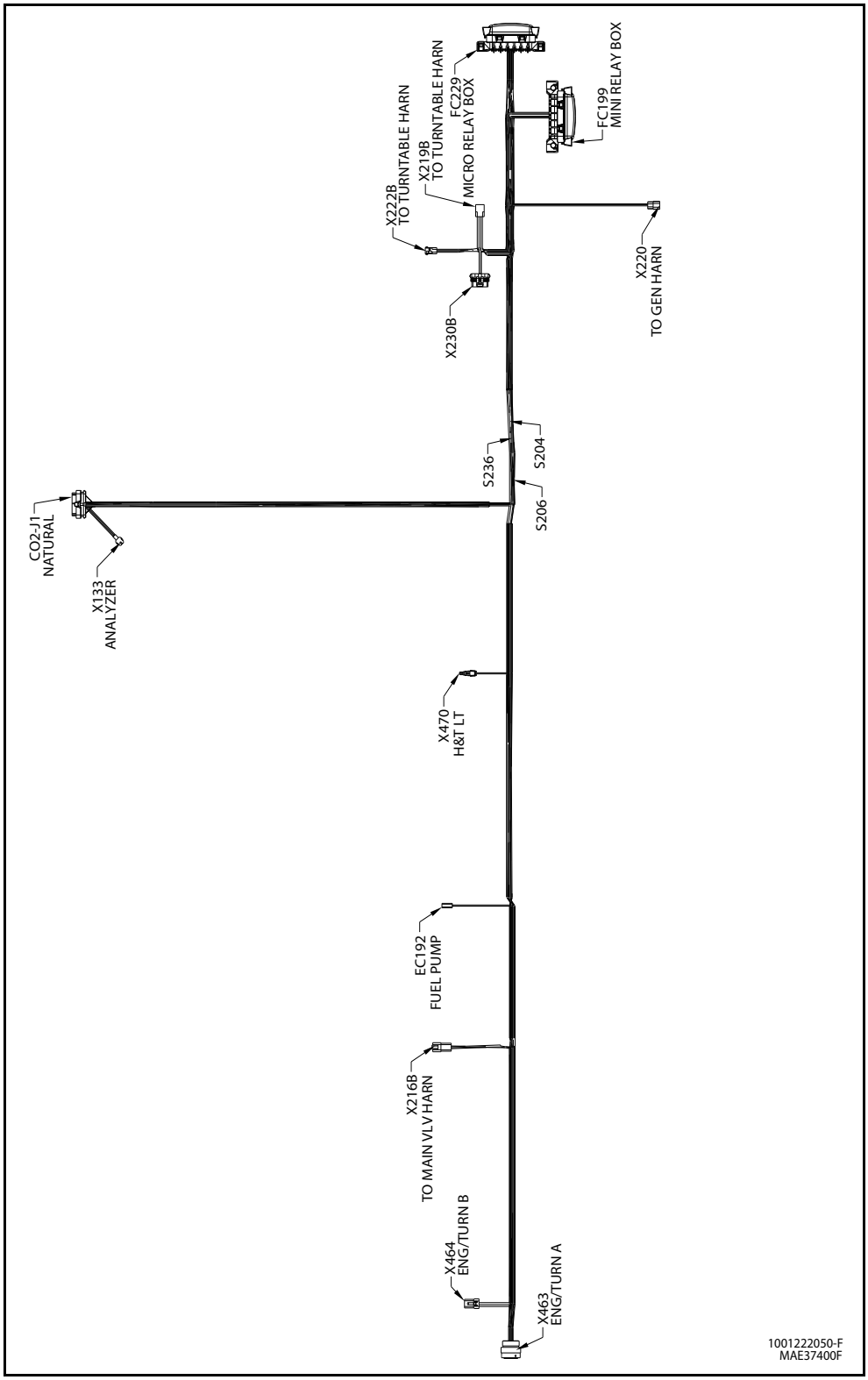


Figure 7-78. Engine Harness - Sheet 2 of 2

X463 ENG/TURN A					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	60-4 DRIVE RTN	18AWG	GXL	X216B(1)
B	WHT	25-2 DRV REV	18AWG	GXL	CO2-J1(6)
C	WHT	25-1 DRV FWD	18AWG	GXL	CO2-J1(3)
D	WHT	25-32 SPD	18AWG	GXL	CO2-J1(20)
E	BLK	0-18	18AWG	GXL	CO2-J1(5)
F	WHT	25-4 PRK BRK	18AWG	GXL	CO2-J1(23)
G					
H					
J					
K					
L					
M					
N	WHT	60-5 THROTTLE RTN	18AWG	GXL	X216B(3)
O	BLK	0-27	16AWG	GXL	EC192(2)
P	WHT	48-13 THR ACT	18AWG	GXL	CO2-J1(1)
Q	WHT	48-16 ALT EXC	18AWG	GXL	CO2-J1(32)
R	YEL	2-16-1	18AWG	TXL	X216B(2)
S	WHT	48-21 ENG SPD SNSR	18AWG	TXL	CO2-J1(16)
T	BLK	0-16	18AWG	TXL	CO2-J1(4)
U					
V	WHT	48-20 OIL PRS	18AWG	GXL	CO2-J1(15)
W	WHT	48-19 TEMP SNSR	18AWG	GXL	CO2-J1(14)
X	BLK	0-19	18AWG	GXL	CO2-J1(8)

X464 ENG/TURN B					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-26 ENG FAN	10AWG	GXL	FC199(12)
2					
3	WHT	48-23 GLOW	10AWG	GXL	FC199(2)
4	WHT	48-22 START	10AWG	TXL	FC229(14)

X216B TO MAIN VLV HARN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	60-4 DRIVE RTN	18AWG	GXL	X463(A)
2	YEL	2-16-1	18AWG	TXL	X463(R)
3	WHT	60-5 THROTTLE RTN	18AWG	GXL	X463(N)
4	WHT	55-9 H&T LT SIG	18AWG	GXL	FC229(37)

EC192 TO MAIN VALVE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-24 FUL PMP	16AWG	GXL	FC229(2)
2	BLK	0-27	16AWG	GXL	X463(0)

X470 H&T LT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	55-10 HEAD & TAIL	16AWG	GXL	FC229(38)

X133 ANALYZER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	4-49.5 V PWR	18AWG	GXL	CO2-J1(28)
2	WHT	4-5 RX	18AWG	GXL	CO2-J1(29)
3	WHT	4-6 TX	18AWG	GXL	CO2-J1(30)
4	BLK	0-15	18AWG	GXL	CO2-J1(31)

C02-J1 NATURAL					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-13 THR ACT	18AWG	GXL	X463(P)
2	WHT	48-14 FUL RLY	18AWG	GXL	FC229(1)
3	WHT	25-1 DRV FWD	18AWG	GXL	X463(C)
4	BLK	0-16	18AWG	TXL	X463(T)
5	BLK	0-18	18AWG	GXL	X463(E)
6	WHT	25-2 DRV REV	18AWG	GXL	X463(B)
7					
8	BLK	0-19	18AWG	GXL	X463(X)
9	BLK	0-25	18AWG	GXL	S204(2)
10					
11	WHT	48-17 STRT RLY	18AWG	GXL	FC229(13)
12	WHT	48-18 GLOW RLY	18AWG	GXL	FC199(5)
13					
14	WHT	48-19 TEMP SNSR	18AWG	GXL	X463(W)
15	WHT	48-20 OIL PRS	18AWG	GXL	X463(V)
16	WHT	48-21 ENG SPD SNSR	18AWG	TXL	X463(S)
17	BLK	0-26	18AWG	GXL	S206(2)
18	BLK	0-28	18AWG	GXL	X220(C)
19	BLK	0-30	16AWG	GXL	S236(2)
20	WHT	25-32 SPD	18AWG	GXL	X463(D)
21					
22	WHT	48-24 GEN	18AWG	GXL	X220(B)
23	WHT	25-4 PRK BRK	18AWG	GXL	X463(F)
24					
25					
26					
27	BLK	0-17	18AWG	GXL	FC229(46)
28	WHT	4-49.5 V PWR	18AWG	GXL	X133(1)
29	WHT	4-5 RX	18AWG	GXL	X133(2)
30	WHT	4-6 TX	18AWG	GXL	X133(3)
31	BLK	0-15	18AWG	GXL	X133(4)
32	WHT	48-16 ALT EXC	18AWG	GXL	X463(Q)
33					
34					
35					

S206 TO TURN TABLE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-26-1	18AWG	GXL	FC229(10)
1	BLK	0-26-2	18AWG	GXL	FC229(22)
2	BLK	0-26	18AWG	GXL	C02-J1(17)

S236 TO TURN TABLE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-30-1	18AWG	GXL	FC229(12)
1	BLK	0-30-2	18AWG	GXL	FC229(24)
2	BLK	0-30	16AWG	GXL	C02-J1(19)

S204					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-25-1	18AWG	GXL	FC199(6)
1	BLK	0-25-2	18AWG	GXL	FC199(1)
1	BLK	0-30-3	18AWG	GXL	FC199(11)
2	BLK	0-25	18AWG	GXL	C02-J1(9)

X230B					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	49-20 IMG FAN	18AWG	GXL	FC229(3)
B					
C					
D	WHT	49-23 ENG FAN	18AWG	GXL	FC199(15)
E	WHT	49-25 IMG FAN	12AWG	GXL	FC229(4)

X222B TO TURN TABLE HARN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-21 OIL COOL FAN	18AWG	GXL	FC229(15)
2	YEL	2-14-15	14AWG	GXL	FC229(45)
3	YEL	2-14-6	18AWG	GXL	X220(A)
4	YEL	2-14-3	16AWG	GXL	FC229(9)
5					
6					

X219B TO TURN TABLE HARN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-270ILCOOLFAN	12AWG	GXL	FC229(16)
2	YEL	2-14-7	12AWG	GXL	FC229(11)
3	YEL	2-14-8	12AWG	GXL	FC229(23)
4	YEL	2-14-1	10AWG	TXL	FC229(21)
5	YEL	2-14-2	10AWG	GXL	FC199(4)
6	YEL	2-14-9	10AWG	GXL	FC199(14)
7					
8					
9					

X220 TO H.E.CONTROLLER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	2-14-6	18AWG	GXL	X222B(3)
B	WHT	48-24 GEN	18AWG	GXL	CO2-J1(22)
C	BLK	0-28	18AWG	GXL	CO2-J1(18)

FC199 MINI RELAY BOX					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-25-2	18AWG	GXL	S204(1)
2	WHT	48-23 GLOW	10AWG	GXL	X464(3)
3					
4	YEL	2-14-2	10AWG	GXL	X219B(5)
5	WHT	48-18 GLOW RLY	18AWG	GXL	CO2-J1(12)
6	BLK	0-25-1	18AWG	GXL	S204(1)
7					
8					
9					
10					
11	BLK	0-30-3	18AWG	GXL	S204(1)
12	WHT	49-26 ENG FAN	10AWG	GXL	X464(1)
13					
14	YEL	2-14-9	10AWG	GXL	X219B(6)
15	WHT	49-23 ENG FAN	18AWG	GXL	X230B(D)

FC229 MICRO RELAY BOX					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-14 FUL RLY	18AWG	GXL	CO2-J1(2)
2	WHT	48-24 FUL PMP	16AWG	GXL	EC192(1)
3	WHT	49-20 IMG FAN	18AWG	GXL	X230B(A)
4	WHT	49-25 IMG FAN	12AWG	GXL	X230B(E)
6					
8					
9	YEL	2-14-3	16AWG	GXL	X222B(4)
10	BLK	0-26-1	18AWG	GXL	S206(1)
11	YEL	2-14-7	12AWG	GXL	X219B(2)
12	BLK	0-30-1	18AWG	GXL	S236(1)
13	WHT	48-17 STRT RLY	18AWG	GXL	CO2-J1(11)
14	WHT	48-22 START	10AWG	TXL	X464(4)
15	WHT	49-21 OIL COOL FAN	18AWG	GXL	X222B(1)
16	WHT	49-27 OIL COOL FAN	12AWG	GXL	X219B(1)
18					
20					
21	YEL	2-14-1	10AWG	TXL	X219B(4)
22	BLK	0-26-2	18AWG	GXL	S206(1)
23	YEL	2-14-8	12AWG	GXL	X219B(3)
24	BLK	0-30-2	18AWG	GXL	S236(1)
25					
26					
27					
28					
30					
32					
33					
34					
35					
36					
37	WHT	55-9 H&T LT SIG	18AWG	GXL	X216B(4)
38	WHT	55-10 HEAD&TAIL	16AWG	GXL	X470(1)
39					
40					
42					
44					
45	YEL	2-14-15	14AWG	GXL	X222B(2)
46	BLK	0-17	18AWG	GXL	CO2-J1(27)
47					
48					

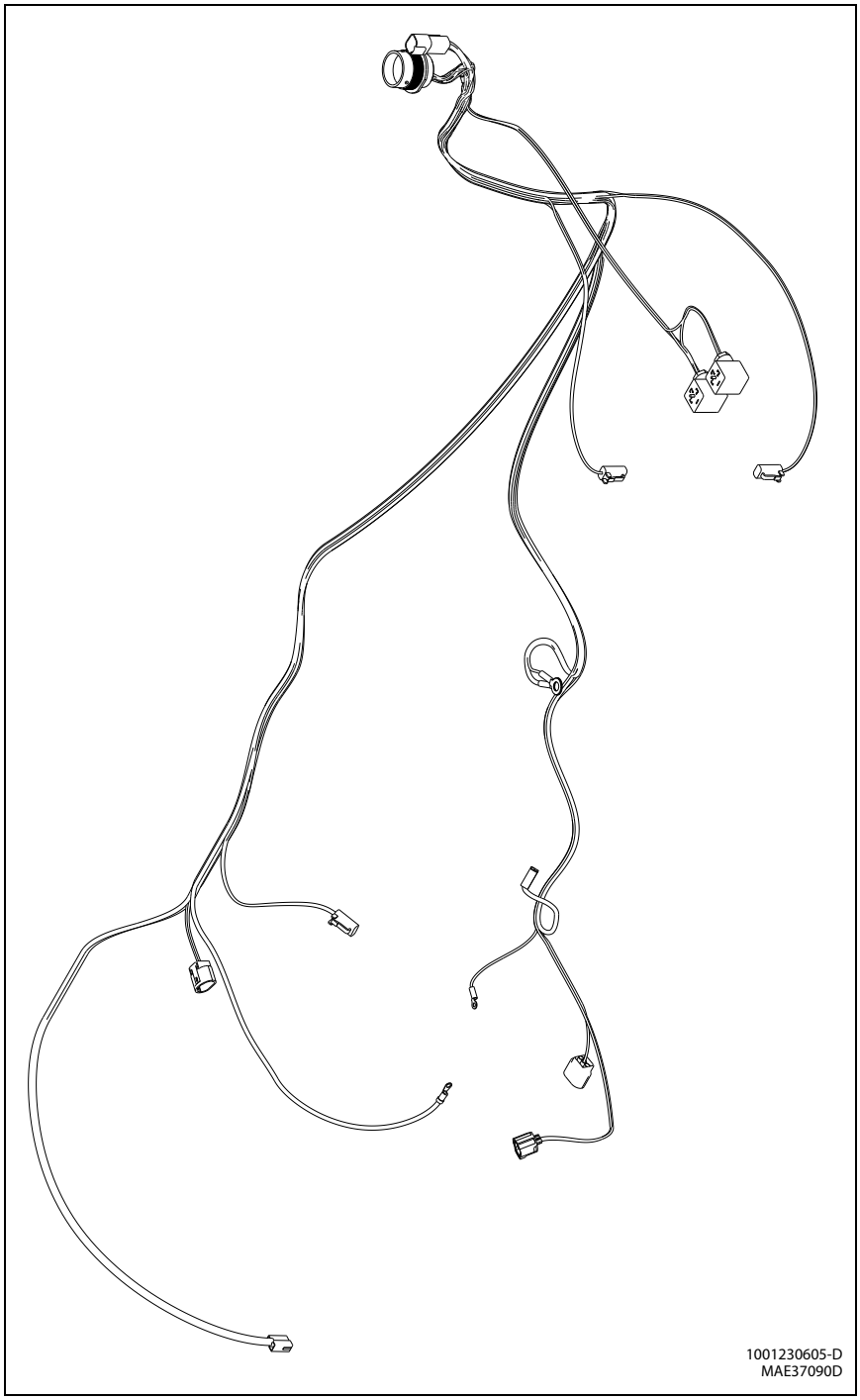


Figure 7-79. Engine Tray Harness - Sheet 1 of 2

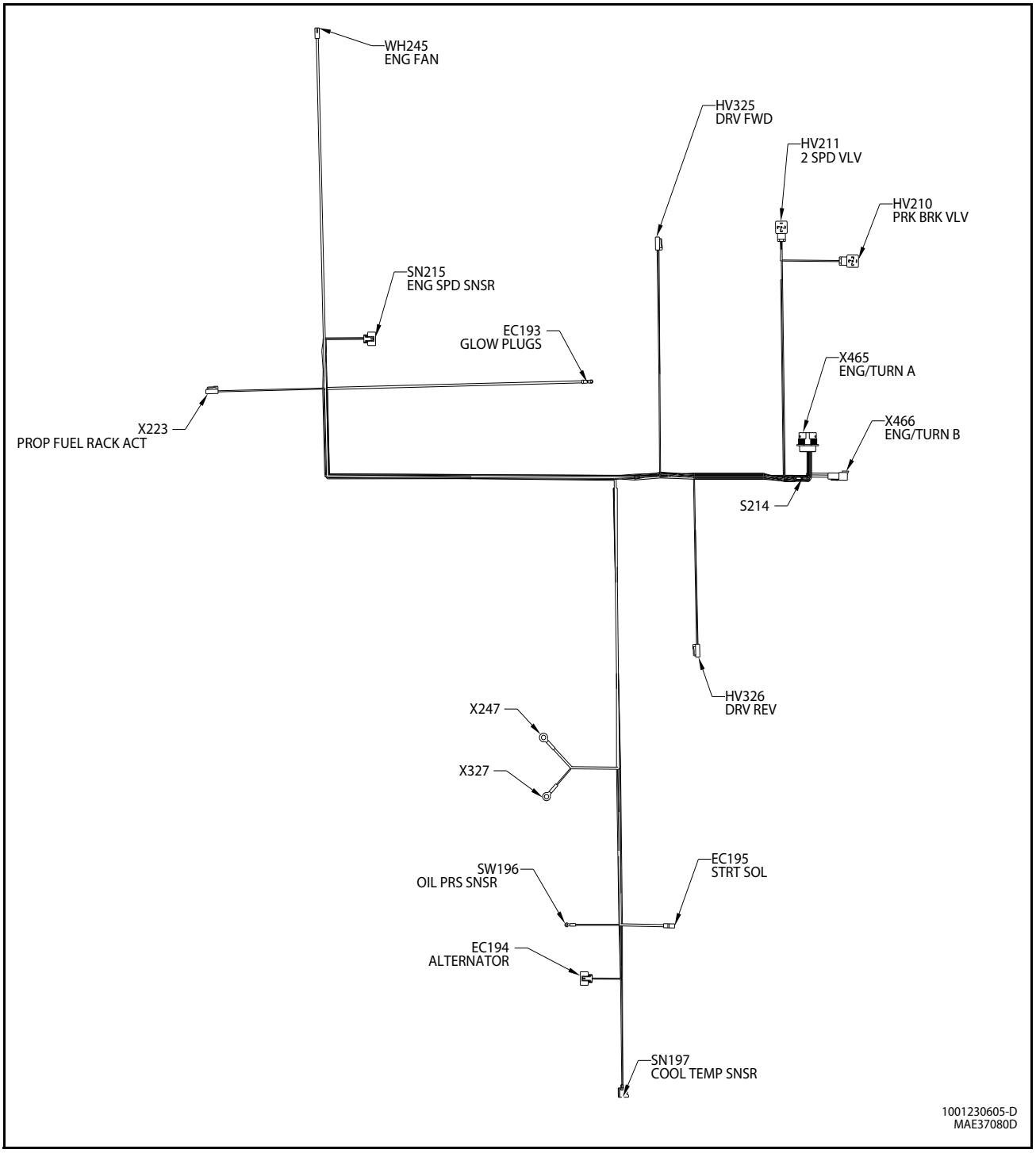


Figure 7-80. Engine Tray Harness - Sheet 2 of 2

WH245 ENG FAN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-9	10AWG	GXL	X247(1)
2	WHT	49-26 ENG FAN	10AWG	GXL	X466(1)

SN215 ENG SPD SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-16-1	18AWG	TXL	X465(R)
2	WHT	48-21 ENG SPD SNSR	18AWG	TXL	X465(S)
3	BLK	0-16	18AWG	TXL	X465(T)

X223 PROP FUEL RACK ACT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	60-5 THROTTLE RTN	18AWG	GXL	X465(N)
2	WHT	48-13 THR ACT	18AWG	GXL	X465(P)

X247 TO GROUND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-9	10AWG	GXL	WH245(1)

X327 TO GROUND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-27	16AWG	GXL	X465(0)

EC193 GLOW PLUGS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-23GLOW	10AWG	GXL	X466(3)

SW196 OIL PRS SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-20 OIL PRS	18AWG	GXL	X465(V)

EC194 ALTERNATOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	48-16 ALT EXC	18AWG	GXL	X465(Q)
3					

SN197 COOL TEMP SNSR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-19 TEMP SNSR	18AWG	GXL	X465(W)
2	BLK	0-19	18AWG	GXL	X465(X)

HV325 DRV FWD					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	25-1 DRV FWD	18AWG	GXL	X465(C)
2	WHT	60-4-1 DRIVE RTN	18AWG	GXL	S214(1)

HV326 DRV REV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	25-2DRVREV	18AWG	GXL	X465(B)
2	WHT	60-4-2DRIVERTN	18AWG	GXL	S214(1)

HV211 2 SPD VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	25-32 SPD	18AWG	GXL	X465(D)
2	BLK	0-18	18AWG	GXL	X465(E)
2	BLK	0-18-1	18AWG	GXL	HV210(2)

HV210 PRK BRK VLV					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	25-4 PRK BRK	18AWG	GXL	X465(F)
2	BLK	0-18-1	18AWG	GXL	HV211(2)

EC195 STRT SOL					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	48-22 START	10AWG	GXL	X466(4)

S214					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	60-4-1DRIVERTN	18AWG	GXL	HV325(2)
1	WHT	60-4-2DRIVERTN	18AWG	GXL	HV326(2)
2	WHT	60-4DRIVERTN	18AWG	GXL	X465(A)

X466 ENG/TURN B					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-26 ENG FAN	10AWG	GXL	WH245(2)
2					
3	WHT	48-23 GLOW	10AWG	GXL	EC193(1)
4	WHT	48-22 START	10AWG	GXL	EC195(1)

X465 ENG/TURN A					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	60-4 DRIVE RTN	18AWG	GXL	S214(2)
B	WHT	25-2 DRV REV	18AWG	GXL	HV326(1)
C	WHT	25-1 DRV FWD	18AWG	GXL	HV325(1)
D	WHT	25-3 2 SPD	18AWG	GXL	HV211(1)
E	BLK	0-18	18AWG	GXL	HV211(2)
F	WHT	25-4 PRK BRK	18AWG	GXL	HV210(1)
G					
H					
J					
K					
L					
M					
N	WHT	60-5 THROTTLE RTN	18AWG	GXL	X223(1)
O	BLK	0-27	16AWG	GXL	X327(1)
P	WHT	48-13 THR ACT	18AWG	GXL	X223(2)
Q	WHT	48-16 ALT EXC	18AWG	GXL	EC194(2)
R	YEL	2-16-1	18AWG	GXL	SN215(1)
S	WHT	48-21 ENG SPD SNSR	18AWG	GXL	SN215(2)
T	BLK	0-16	18AWG	GXL	SN215(3)
U					
V	WHT	48-20 OIL PRS	18AWG	GXL	SW196(1)
W	WHT	48-19 TEMP SNSR	18AWG	GXL	SN197(1)
X	BLK	0-19	18AWG	GXL	SN197(2)

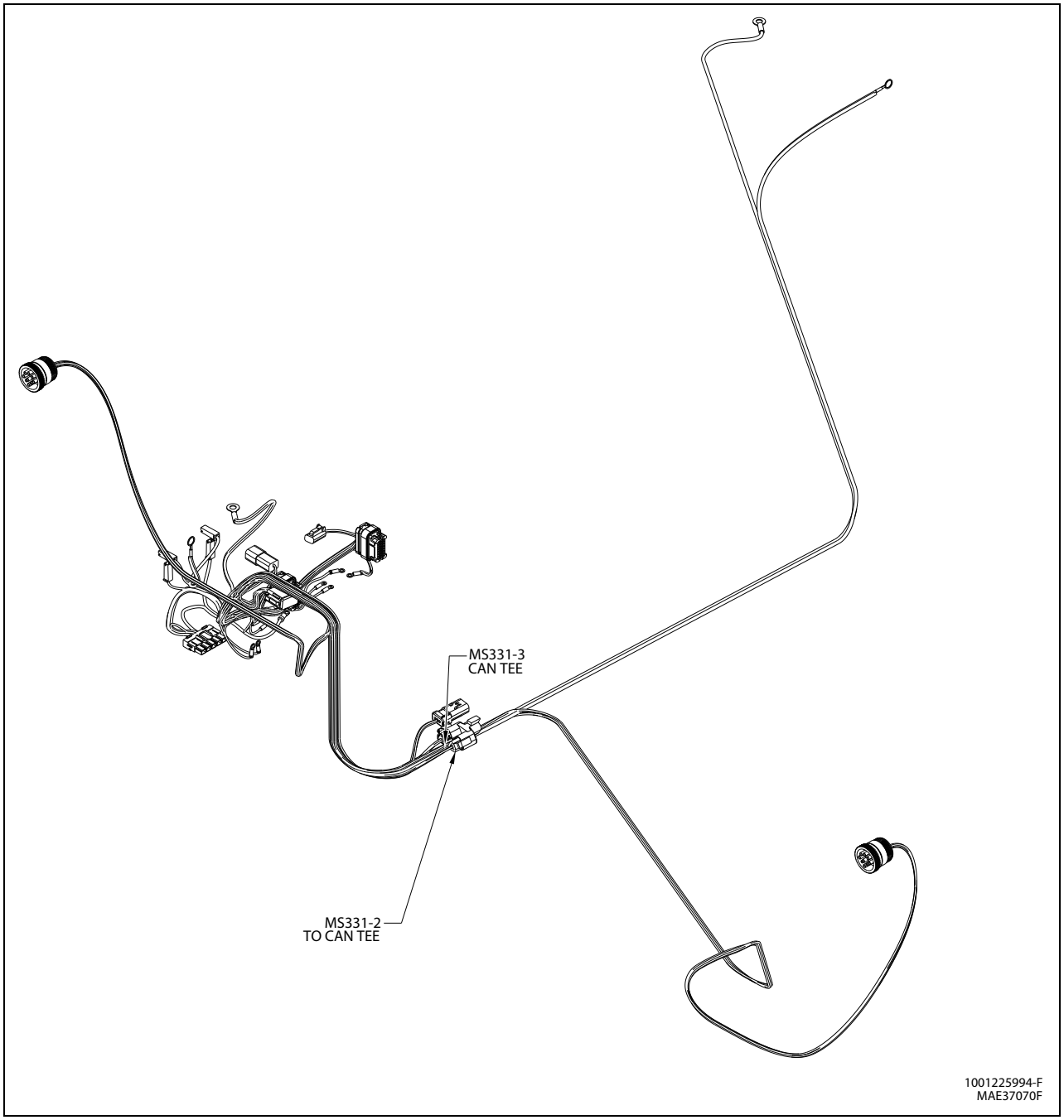


Figure 7-81. Hybrid Harness - Sheet 1 of 3

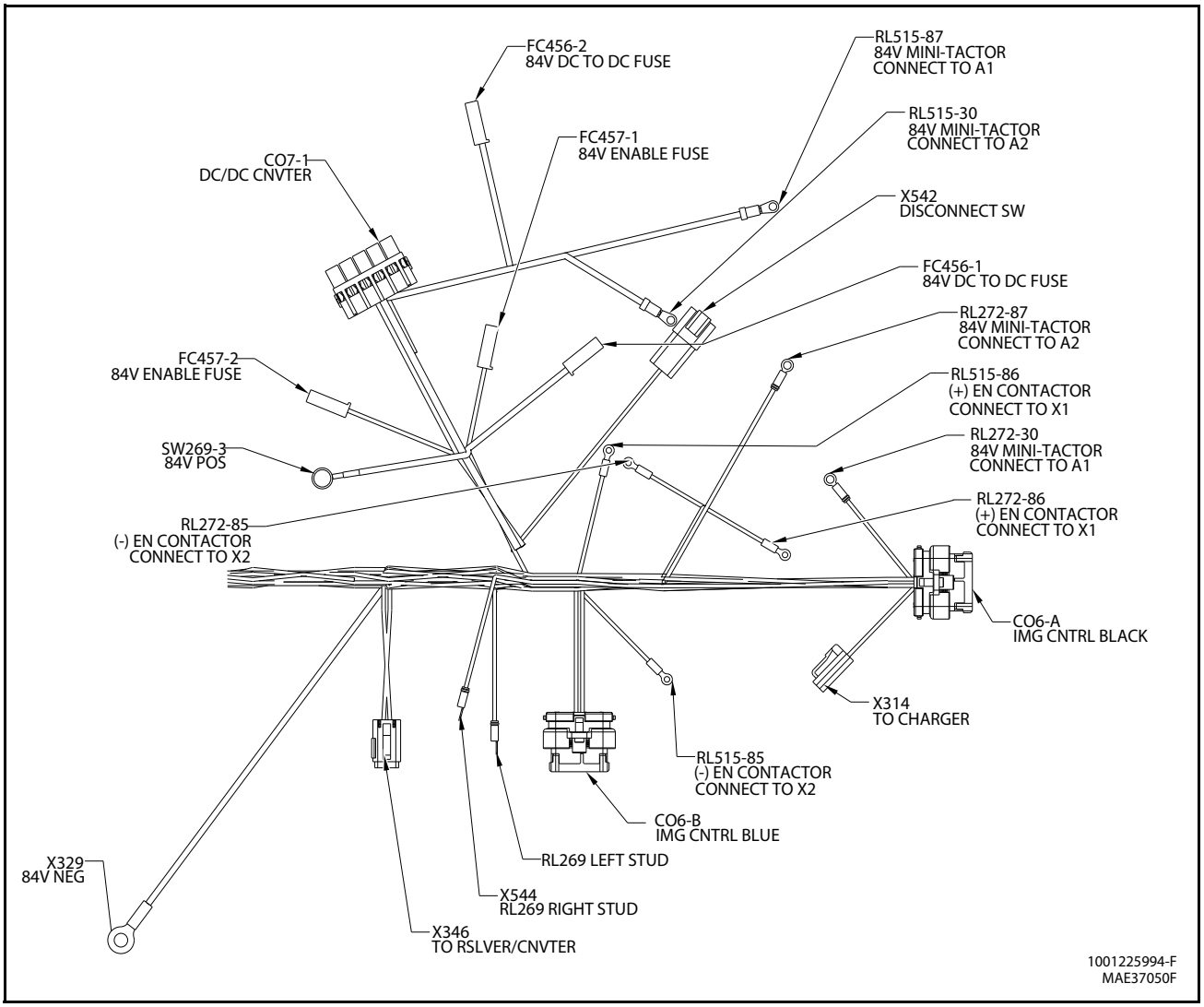


Figure 7-82. Hybrid Harness - Sheet 2 of 3

X329 84V NEG					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-36 84V GND	12AWG	GXL	CO7-1(3)
1	BLK	0-46	16AWG	GXL	X344(A)

X346 TO RSLVER/CNVTER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-46	18AWG	GXL	CO6-A(15)
2					
3	WHT	84-22 SPD PULSE	18AWG	GXL	CO6-A(18)
4	WHT	84-18 IMG SPD SIN	18AWG	GXL	CO6-B(7)
5	WHT	84-16 IMG SPD COS	18AWG	GXL	CO6-B(14)
6	WHT	84-19 SPD VFB	18AWG	GXL	CO6-B(3)
7	WHT	84-17 IMG SPD PWR	18AWG	GXL	CO6-B(8)
8					
9	WHT	84-20 SPD CHRG	18AWG	GXL	CO6-A(19)
10	BLK	0-39-3	18AWG	GXL	S345(2)
11					
12	WHT	84-21 IMG TEMP	18AWG	GXL	CO6-A(23)

X544 RL269 RIGHT STUD					
CONN POS	WIREC OLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-1-2	18AWG	GXL	RL272-30(1)

X543 RL269 LEFT STUD					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	84-3-2 MAIN CONT	18AWG	GXL	X542(3)

SW269-3 84V POS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-1	16AWG	GXL	FC457-2(1)
1	ORG	84-5	12AWG	GXL	FC456-1(1)

RL515-85 (-)EN CONTACTOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-35-1 12V GND	18AWG	GXL	X305(1)

FC457-2 84V ENABLE FUSE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-1	16AWG	GXL	SW269-3(1)

FC457-1 84V ENABLE FUSE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-1	16AWG	GXL	RL272-87(1)

FC456-1 84V DC TO DC FUSE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-5	12AWG	GXL	SW269-3(1)

CO7-1 DC/DC CNVTER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-35 12V GND	10AWG	GXL	X305(1)
2	YEL	2-15	10AWG	GXL	X516(1)
3	BLK	0-36 84V GND	12AWG	GXL	X329(1)
4	ORG	84-5 DC TO DC PWR	12AWG	GXL	RL515-87(1)
5					

X542 DISCONNECT SW					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2					
3	WHT	84-3-2 MAIN CONT	18AWG	GXL	X543(1)
4	WHT	84-3 MAIN CONT	18AWG	GXL	C06-A(16)

FC456-2 84V DC TO DC FUSE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-5 DC TO DC PWR	12AWG	GXL	RL515-30(1)

RL515-87 84V MINI-TACTOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-5DCTODCPWR	12AWG	GXL	C07-1(4)

RL515-30 84V MINI-TACTOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-5 DC TO DC PWR	12AWG	GXL	FC456-2(1)

RL515-86 (+) EN CONTACTOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-57 DC/DC CONT	18AWG	GXL	X455(3)

C06-B IMG CNTRL BLUE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1					
2	WHT	84-11 HALF STACK V	18AWG	GXL	X343(D)
3	WHT	84-19 SPD V FB	18AWG	GXL	X346(6)
4					
5					
6					
7	WHT	84-18 IMG SPD SIN	18AWG	GXL	X346(4)
8	WHT	84-17 IMG SPD PWR	18AWG	GXL	X346(7)
9					
10					
11					
12					
13					
14	WHT	84-16 IMG SPD COS	18AWG	GXL	X346(5)
15	BLK	0-39	18AWG	GXL	S345(2)
16	WHT	84-15 B TEMP 1	18AWG	GXL	X344(B)
17	WHT	84-14 B TEMP 2	18AWG	GXL	X344(C)
18	WHT	84-13 B TEMP 3	18AWG	GXL	X343(A)
19	WHT	84-12 B TEMP 4	18AWG	GXL	X343(B)
20					
21					
22					
23					

RL272-85 (-) EN CONTACTOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-14-8-2	18AWG	GXL	X455(2)

RL272-86 (+)EN CONTACTOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-13	18AWG	GXL	X455(1)

RL272-30 84V MINI-TACTOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-1	18AWG	GXL	C06-A(1)
1	ORG	84-1-2	18AWG	GXL	X544(1)

X314 TO CHARGER					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	82-1 CHRG INTLK	18AWG	GXL	C06-A(13)
2	WHT	82-2 CHRG INTLK	18AWG	GXL	C06-A(6)

RL272-87 84V MINI-TACTOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-1	16AWG	GXL	FC457-1(1)

.

C06-A IMG CNTRL BLACK					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORG	84-1	18AWG	GXL	RL272-30(1)
2					
3					
4					
5					
6	WHT	82-2 CHRG INTLK	18AWG	GXL	X314(2)
7					
8					
9					
10					
11					
12					
13	WHT	82-1 CHRG INTLK	18AWG	GXL	X314(1)
14					
15	BLK	0-46	18AWG	GXL	X346(1)
16	WHT	84-3 MAIN CONT	18AWG	GXL	X542(4)
17					
18	WHT	84-22 SPD PULSE	18AWG	GXL	X346(3)
19	WHT	84-20 SPD CHRG	18AWG	GXL	X346(9)
20	GRN	CH#2 TO IMG	18AWG	GXL	MS331-3(B)
21	YEL	CH#2 TO IMG	18AWG	GXL	MS331-3(A)
22	BLK	0-50	18AWG	GXL	MS331-3(C)
23	WHT	84-21 IMG TEMP	18AWG	GXL	X346(12)

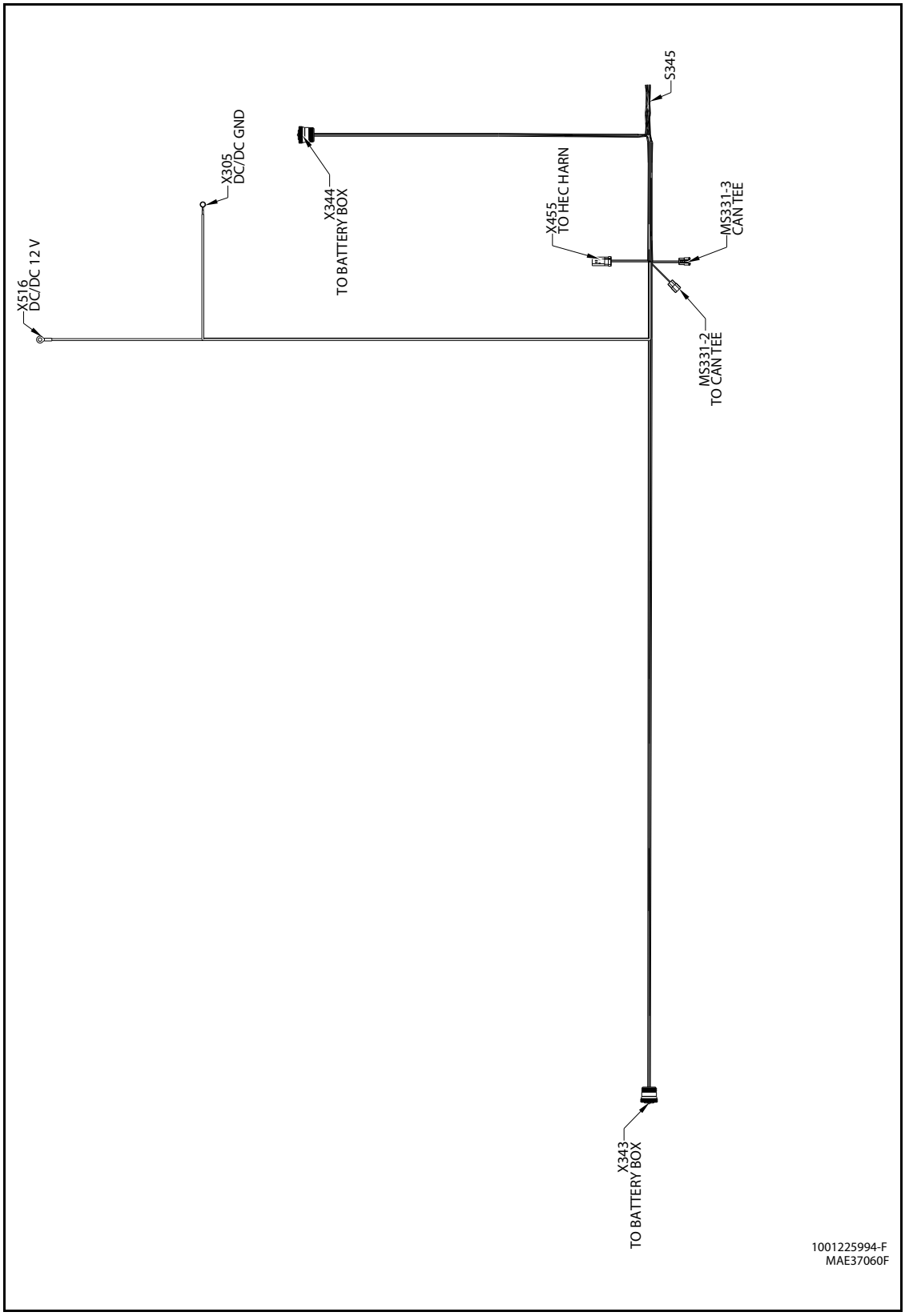


Figure 7-83. Hybrid Harness - Sheet 3 of 3

X343 TO BATTERY BOX					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	WHT	84-13 B TEMP 3	18AWG	GXL	CO6-B(18)
B	WHT	84-12 B TEMP 4	18AWG	GXL	CO6-B(19)
C					
D	WHT	84-11 HALF STACK V	18AWG	GXL	CO6-B(2)
E					
F	BLK	0-39-2	18AWG	GXL	S345(1)
G					
H					
J	BLK	0-45	16AWG	GXL	X344(J)

X516 DC/DC 12V					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-15	10AWG	GXL	CO7-1(2)

MS331-2 TO CAN TEE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CH#2 TO SOC	18AWG	GXL	X344(H)
B	GRN	CH#2 TO SOC	18AWG	GXL	X344(G)
C					

MS331-3 CAN TEE					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CH#2 TO IMG	18AWG	GXL	CO6-A(21)
B	GRN	CH#2 TO IMG	18AWG	GXL	CO6-A(20)
C	BLK	0-50	18AWG	GXL	CO6-A(22)

X305 DC/DC GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-35 12V GND	10AWG	GXL	CO7-1(1)
1	BLK	0-35-1 12V GND	18AWG	GXL	RL515-85(1)

X344 TO BATTERY BOX					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	0-46	16AWG	GXL	X329(1)
B	WHT	84-15 B TEMP 1	18AWG	GXL	CO6-B(16)
C	WHT	84-14 B TEMP 2	18AWG	GXL	CO6-B(17)
D					
E					
F	BLK	0-39-1	18AWG	GXL	S345(1)
G	GRN	CH#2 TO SOC	18AWG	GXL	MS331-2(B)
H	YEL	CH#2 TO SOC	18AWG	GXL	MS331-2(A)
J	BLK	0-45	16AWG	GXL	X343(J)

S345					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-39-1	18AWG	GXL	X344(F)
1	BLK	0-39-2	18AWG	GXL	X343(F)
2	BLK	0-39	18AWG	GXL	CO6-B(15)
2	BLK	0-39-3	18AWG	GXL	X346(10)

X455 TO HEC HARN					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	2-14-13	18AWG	GXL	RL272-86(1)
2	BLK	0-14-8-2	18AWG	GXL	RL272-85(1)
3	WHT	49-57 DC/DC CONT	18AWG	GXL	RL515-86(1)

RL515-85 (-)EN CONTACTOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-35-1 12V GND	18AWG	GXL	X305(1)

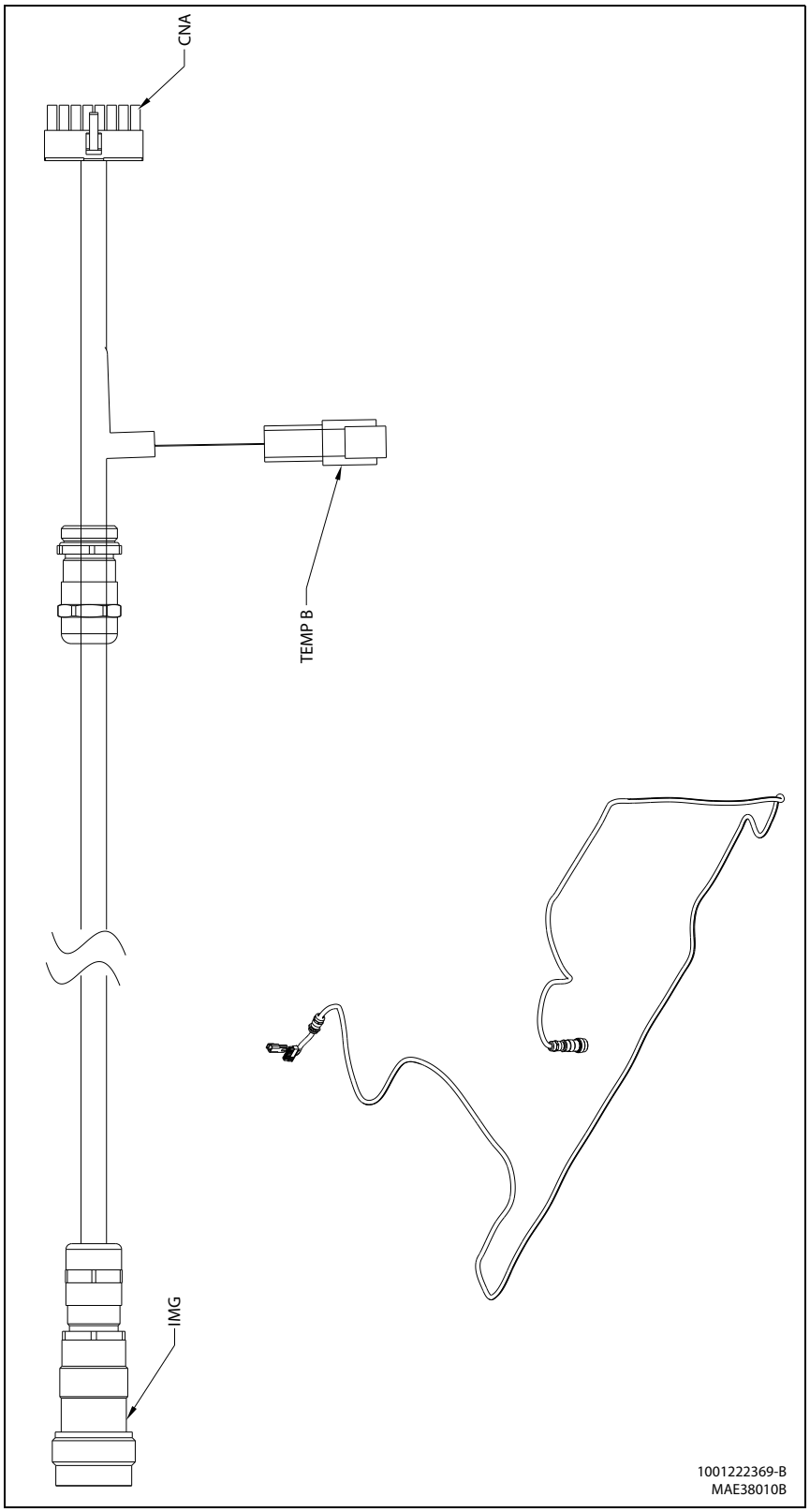


Figure 7-84. Battery Converter Harness

IMG					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
A	BLU	SIN+,S2	22AWG	CABLE	CNA(9)
B	VIO	SIN-,S4	22AWG	CABLE	CNA(1)
C	BLK	THERM	22AWG	CABLE	NC
D	BWN	THERM	22AWG	CABLE	NC
E	YEL	COS+,S1	22AWG	CABLE	CNA(12)
F	GRN	COS-,S3	22AWG	CABLE	CNA(4)
G	GRY	THERM	22AWG	CABLE	TEMPB(1)
H	WHT	THERM	22AWG	CABLE	TEMPB(2)
J	RED	REF+,R1	22AWG	CABLE	CNA(16)
K	ORN	REF-,R2	22AWG	CABLE	CNA(8)
L					
M					
N					
P					
R					
S					
T					
U					
V					

TEMPB					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	GRY	THERM	22AWG	CABLE	IMG(G)
2	WHT	THERM	22AWG	CABLE	IMG(H)

CNA					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	VIO	SIN-,S4	22AWG	CABLE	IMG(B)
2					
3					
4	GRN	COS-,S3	22AWG	CABLE	IMG(F)
5					
6					
7					
8	ORN	REF-,R2	22AWG	CABLE	IMG(K)
9	BLU	SIN+,S2	22AWG	CABLE	IMG(A)
10					
11					
12	YEL	COS+,S1	22AWG	CABLE	IMG(E)
13					
14					
15					
16	RED	REF+,R1	22AWG	CABLE	IMG(J)

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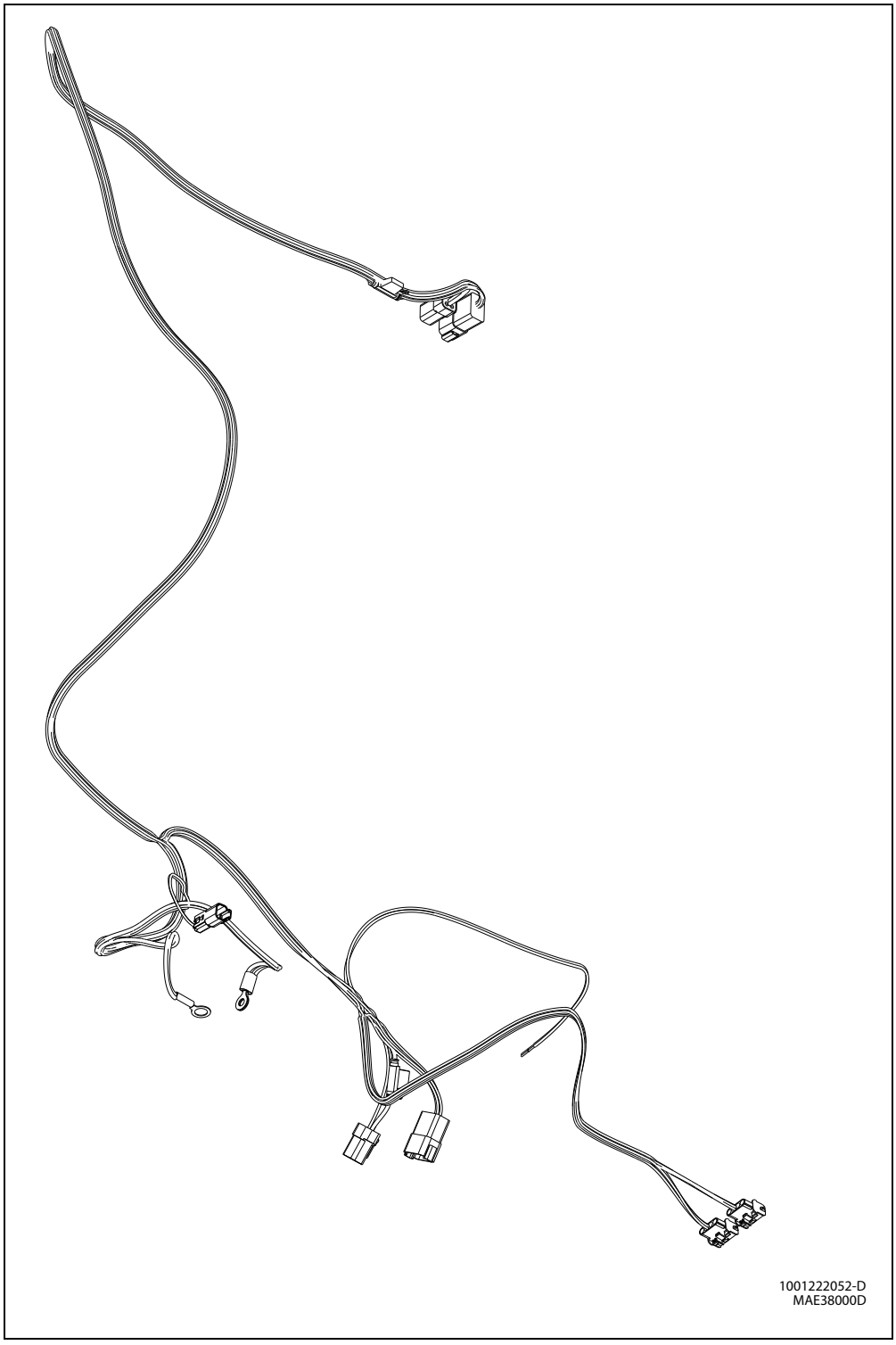


Figure 7-85. Battery Charger Harness - Sheet 1 of 2

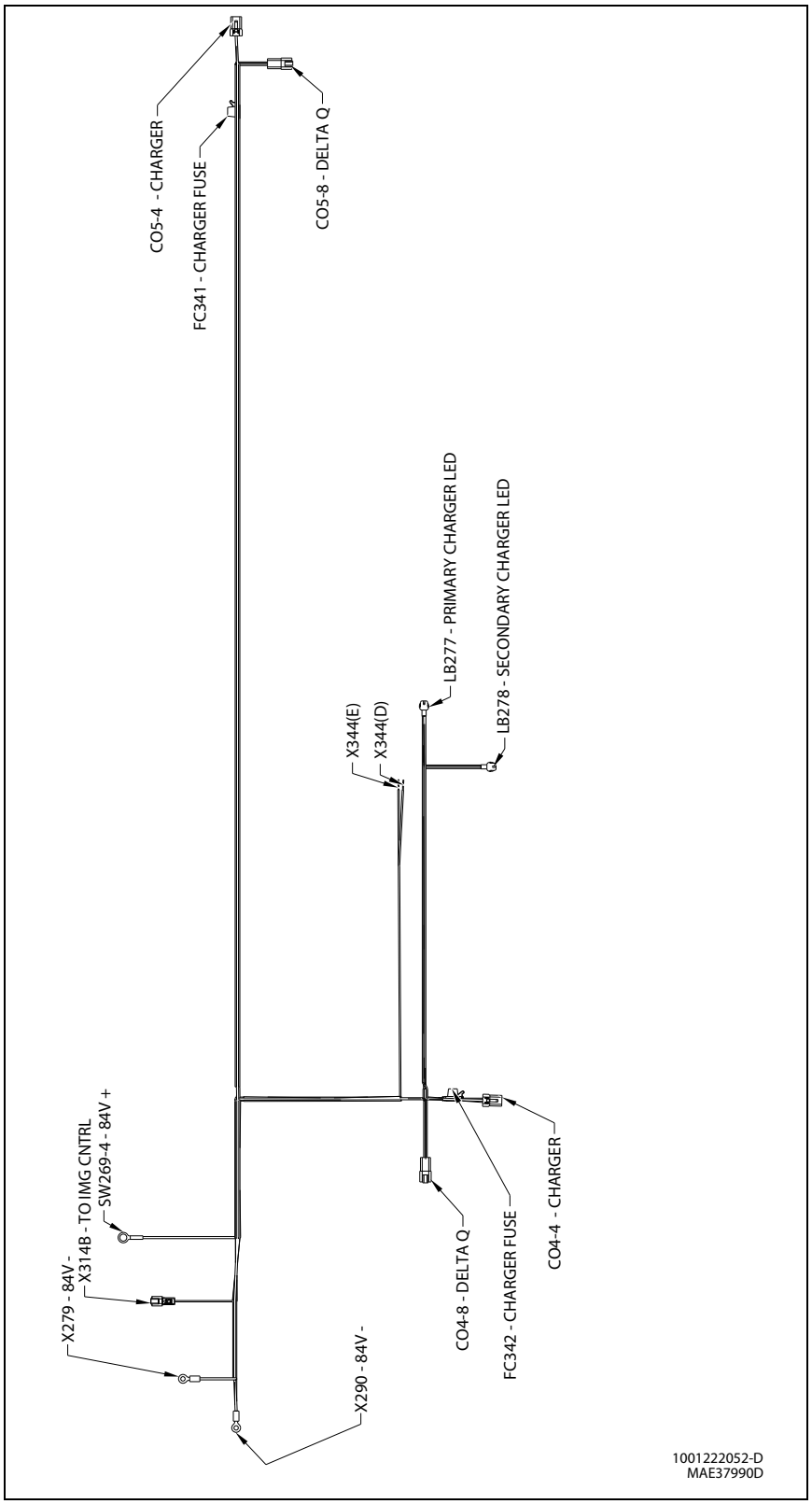


Figure 7-86. Battery Charger Harness - Sheet 2 of 2

X290-84V-					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-37	12AWG	GXL	CO5-4(1)
1	BLK	0-33-1	18AWG	GXL	CO5-8(8)

X279-84V-					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-33	18AWG	GXL	CO4-8(8)
1	BLK	0-38	12AWG	GXL	CO4-4(1)

X344(D)-					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	81-1TEMPSEN	16AWG	GXL	CO4-4(3)

X344(E)-					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	81-2TEMPRTN	16AWG	GXL	CO4-4(4)

FC342-CHARGERFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-7	12AWG	GXL	SW269-4(1)
2	ORG	84-7	12AWG	GXL	CO4-4(2)

X314B - TOIMGCNTRL					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	82-1CHRGINTLK	18AWG	GXL	CO5-8(2)
2	WHT	82-2CHRGINTLK	18AWG	GXL	CO4-8(2)

SW269-4-84V+					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-6	12AWG	GXL	FC341(1)
1	ORG	84-7	12AWG	GXL	FC342(1)

FC341-CHARGERFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-6	12AWG	GXL	SW269-4(1)
2	ORG	84-6	12AWG	GXL	CO5-4(2)

CO4-4-CHARGEROUTPUT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-38	12AWG	GXL	X279(1)
2	ORG	84-7	12AWG	GXL	FC342(2)
3	WHT	81-1TEMPSEN	16AWG	GXL	X344(D)(1)
4	WHT	81-2TEMPRTN	16AWG	GXL	X344(E)(1)

CO5-8-DELTAQ					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1					
2	WHT	82-1CHRGINTLK	18AWG	GXL	X314B(1)
3	WHT	80-6REDLED	18AWG	GXL	LB278(4)
4	WHT	80-4YELLED	18AWG	GXL	LB278(2)
5	BLK	0-32	18AWG	GXL	LB278(1)
6	WHT	80-2GRNLED	18AWG	GXL	LB278(3)
7					
8	BLK	0-33-1	18AWG	GXL	X290(1)

C05-4-CHARGEROUTPUT					
CONN POS	**WIRE COLOR**	**WIRELABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	0-37	12AWG	GXL	X290(1)
2	ORG	84-6	12AWG	GXL	FC341(2)
3					
4					

LB277-PRIMARYCHARGERLED					
CONN POS	**WIRE COLOR**	**WIRELABEL**	**GAUGE**	**JACKET**	**TO**
1	BLK	0-31	18AWG	GXL	C04-8(5)
2	WHT	80-3YELLED	18AWG	GXL	C04-8(4)
3	WHT	80-1GRNLED	18AWG	GXL	C04-8(6)
4	WHT	80-5REDLED	18AWG	GXL	C04-8(3)

C04-8-DELTAQ					
CONN POS	**WIRE COLOR**	**WIRELABEL**	**GAUGE**	**JACKET**	**TO**
1					
2	WHT	82-2CHRGINTLK	18AWG	GXL	X314B(2)
3	WHT	80-5REDLED	18AWG	GXL	LB277(4)
4	WHT	80-3YELLED	18AWG	GXL	LB277(2)
5	BLK	0-31	18AWG	GXL	LB277(1)
6	WHT	80-1GRNLED	18AWG	GXL	LB277(3)
7					
8	BLK	0-33	18AWG	GXL	X279(1)

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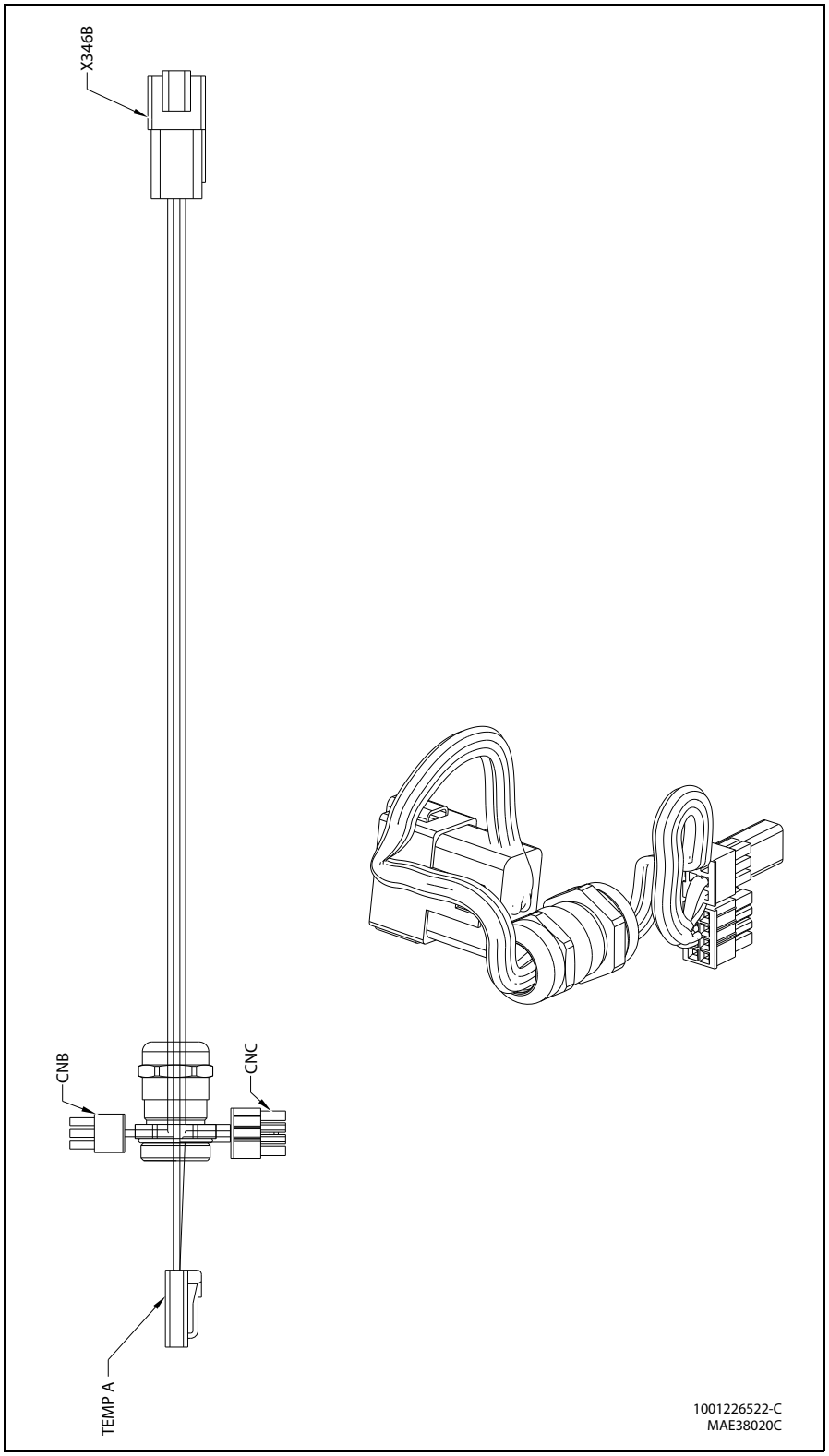


Figure 7-87. Battery Converter cable

CNB					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BRN	84-17IMGSPDPWR	18AWG	CABLE	X346B(7)
2	BLU/ BLK	0-44	18AWG	CABLE	X346B(10)
3					
4					
5					
6					

TEMPA					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK/ RED	84-21IMGTEMP	18AWG	CABLE	X346B(12)
2	BLK	0-46	18AWG	CABLE	X346B(1)

CNC					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLU	84-18IMGSPDSIN	18AWG	CABLE	X346B(4)
2	YEL	84-19SPDVFB	18AWG	CABLE	X346B(6)
3					
4	RED	84-22SPDPULSE	18AWG	CABLE	X346B(3)
5	ORN	84-16IMGSPDCOS	18AWG	CABLE	X346B(5)
6					
7					
8	RED/ BLK	84-20SPDCHRG	18AWG	CABLE	X346B(9)

X346B					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-46	18AWG	CABLE	TEMPA(2)
2					
3	RED	84-22SPDPULSE	18AWG	CABLE	CNC(4)
4	BLU	84-18IMGSPDSIN	18AWG	CABLE	CNC(1)
5	ORN	84-16IMGSPDCOS	18AWG	CABLE	CNC(5)
6	YEL	84-19SPDVFB	18AWG	CABLE	CNC(2)
7	BRN	84-17IMGSPDPWR	18AWG	CABLE	CNB(1)
8					
9	RED/ BLK	84-20SPDCHRG	18AWG	CABLE	CNC(8)
10	BLU/ BLK	0-44	18AWG	CABLE	CNB(2)
11					
12	BLK/ RED	84-21IMGTEMP	18AWG	CABLE	TEMPA(1)

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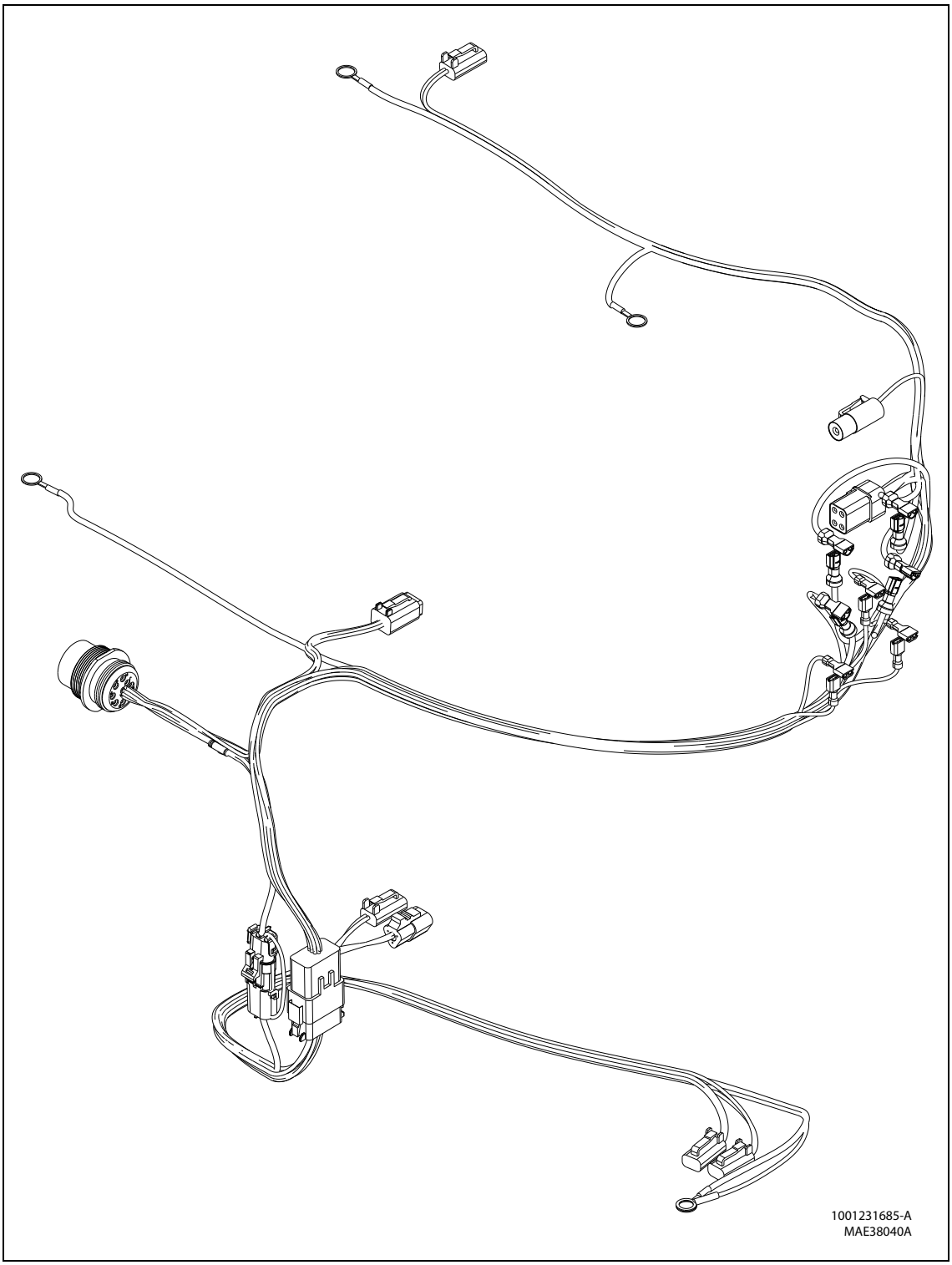


Figure 7-88. Battery Stack Harness (RH) - Sheet 1 of 2

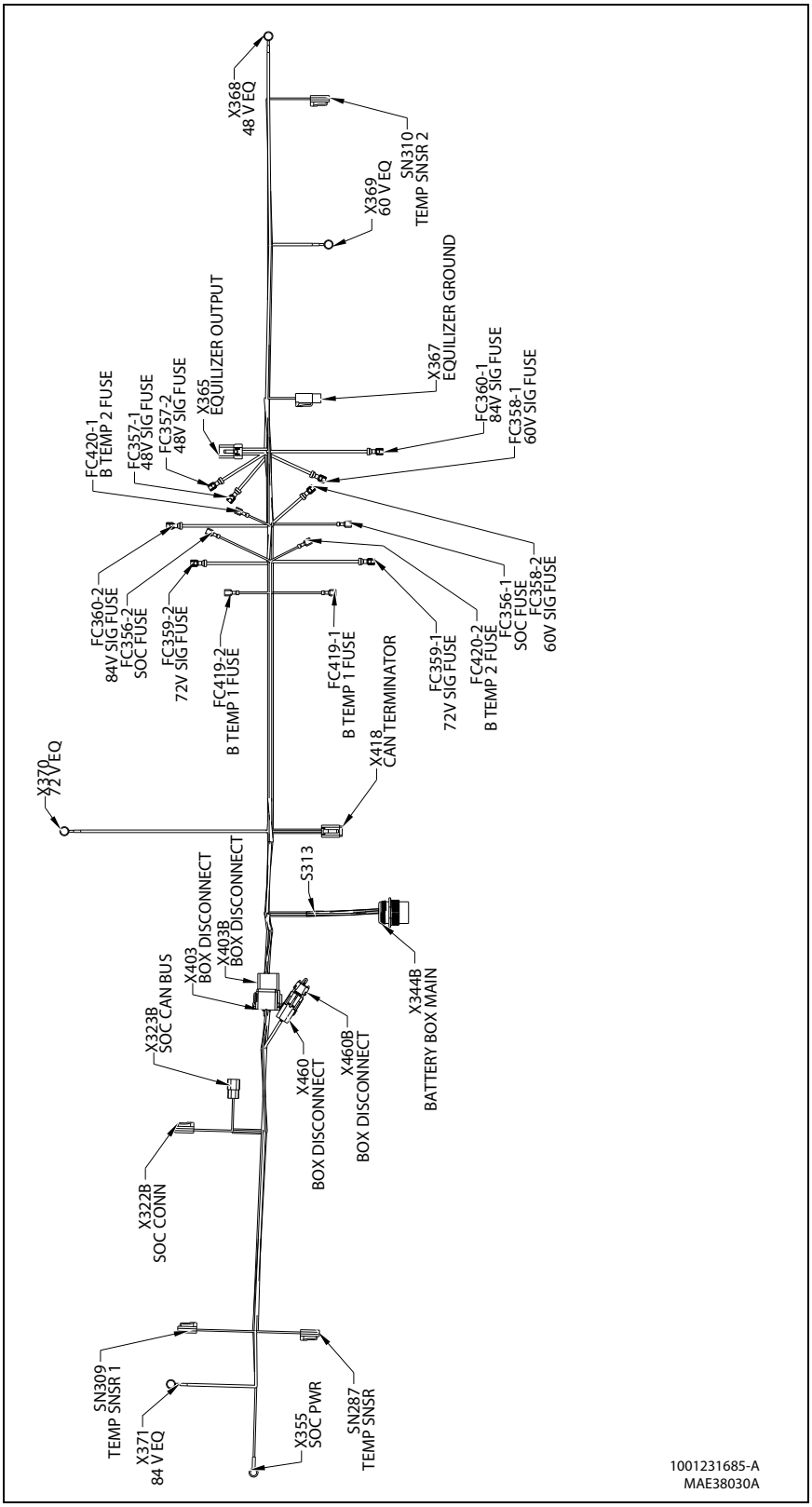


Figure 7-89. Battery Stack Harness (RH) - Sheet 2 of 2

X355-SOCPWR					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-29SOCPWR	16AWG	GXL	X403(11)

X371-84VEQ					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2884VOLT	12AWG	GXL	X460(2)

SN309-					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-15BTEMP1	18AWG	GXL	X403(9)
2	BLK	0-39-1-1	18AWG	GXL	X403(10)

SN287-TEMPSNSR					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	81-2TEMPRTN	16AWG	GXL	X403(4)
2	WHT	81-1TEMPSEN	16AWG	GXL	X403(3)

X460-BOXDISCONNECT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
2	ORG	84-2884VOLT	12AWG	GXL	X371(1)

X460B-BOXDISCONNECT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
2	ORG	84-2884VOLT	12AWG	GXL	FC360-1(1)

X322B-SOCCONN					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-29SOCPWR	16AWG	GXL	X403(8)
2	BLK	0-46	16AWG	GXL	X403(7)

X323B- SOC CAN BUS					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
A	YEL	CH#2TOSOC	18AWG	GXL	X403(5)
B	GRN	CH#2TOSOC	18AWG	GXL	X403(6)
C					

X403-BOXDISCONNECT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
2					
3	WHT	81-1TEMPSEN	16AWG	GXL	SN287(2)
4	WHT	81-2TEMPRTN	16AWG	GXL	SN287(1)
5	YEL	CH#2TOSOC	18AWG	GXL	X323B(A)
6	GRN	CH#2TOSOC	18AWG	GXL	X323B(B)
7	BLK	0-46	16AWG	GXL	X322B(2)
8	ORG	84-29SOCPWR	16AWG	GXL	X322B(1)
9	WHT	84-15BTEMP1	18AWG	GXL	SN309(1)
10	BLK	0-39-1-1	18AWG	GXL	SN309(2)
11	ORG	84-29SOCPWR	16AWG	GXL	X355(1)
12					

X403- BOX DISCONNECT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
2					
3	WHT	81-1TEMPSEN	16AWG	GXL	X344B(D)
4	WHT	81-2TEMPRTN	16AWG	GXL	X344B(E)
5	YEL	CH#2TOSOC	18AWG	GXL	X418(4)
6	GRN	CH#2TOSOC	18AWG	GXL	X418(3)
7	BLK	0-46	16AWG	GXL	X344B(A)
8	ORG	84-29SOCPWR	16AWG	GXL	FC356-1(1)
9	WHT	84-15BTEMP1	18AWG	GXL	FC419-1(1)
10	BLK	0-39-1-1	18AWG	GXL	S313(1)
11	ORG	84-29SOCPWR	16AWG	GXL	FC356-2(1)
12					

S313					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-39-1-1	18AWG	GXL	X403B(10)
1	BLK	0-39-1-2	18AWG	GXL	SN310(2)
2	BLK	0-39-1	18AWG	GXL	X344B(F)

X344B-BATTERYBOXMAIN					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
A	BLK	0-46	16AWG	GXL	X403B(7)
B	WHT	84-15BTEMP1	18AWG	GXL	FC419-2(1)
C	WHT	84-14BTEMP2	18AWG	GXL	FC420-2(1)
D	WHT	81-1TEMPSEN	16AWG	GXL	X403B(3)
E	WHT	81-2TEMPRTN	16AWG	GXL	X403B(4)
F	BLK	0-39-1	18AWG	GXL	S313(2)
G	GRN	CH#2TOSOC	18AWG	GXL	X418(1)
H	YEL	CH#2TOSOC	18AWG	GXL	X418(2)
J	BLK	0-45	16AWG	GXL	X367(1)

X418-CANTERMINATOR					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	GRN	CH#2TOSOC	18AWG	GXL	X344B(G)
2	YEL	CH#2TOSOC	18AWG	GXL	X344B(H)
3	GRN	CH#2TOSOC	18AWG	GXL	X403B(6)
4	YEL	CH#2TOSOC	18AWG	GXL	X403B(5)

X370-72VEQ					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2772VOLT	12AWG	GXL	FC359-1(1)

FC419-1-BTEMP1FUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-15BTEMP1	18AWG	GXL	X403B(9)

FC359-1-72VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2772VOLT	12AWG	GXL	X370(1)

FC420-2-BTEMP2FUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-14BTEMP2	18AWG	GXL	X344B(C)

FC356-1-SOCFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-29SOCPWR	16AWG	GXL	X403B(8)

FC358-2-60V SIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2660VOLT	12AWG	GXL	X365(2)

FC358-1-60V SIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2660VOLT	12AWG	GXL	X369(1)

FC360-1-84VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2884VOLT	12AWG	GXL	X460B(2)

X367-EQUILIZERGROUND					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-45	16AWG	GXL	X344B(J)

FC419-2-BTEMP1FUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-15BTEMP1	18AWG	GXL	X344B(B)

FC359-2-72VSIGFUSE					
CONNPOS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2772VOLT	12AWG	GXL	X365(3)

FC356-2-SOCFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-29SOCPWR	16AWG	GXL	X403B(11)

X368-48VEQ					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2548VOLT	12AWG	GXL	FC357-1(1)

FC360-2-84VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2884VOLT	12AWG	GXL	X365(4)

FC420-1-BTEMP2FUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-14BTEMP2	18AWG	GXL	SN310(1)

FC357-1-48VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2548VOLT	12AWG	GXL	X368(1)

FC357-2-48VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2548VOLT	12AWG	GXL	X365(1)

X365-EQUILIZEROUTPUT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2548VOLT	12AWG	GXL	FC357-2(1)
2	ORG	84-2660VOLT	12AWG	GXL	FC358-2(1)
3	ORG	84-2772VOLT	12AWG	GXL	FC359-2(1)
4	ORG	84-2884VOLT	12AWG	GXL	FC360-2(1)

SN310-TEMPSNSR2					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-14BTEMP2	18AWG	GXL	FC420-1(1)
2	BLK	0-39-1-2	18AWG	GXL	S313(1)

X369-60VEQ					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-2660VOLT	12AWG	GXL	FC358-1(1)

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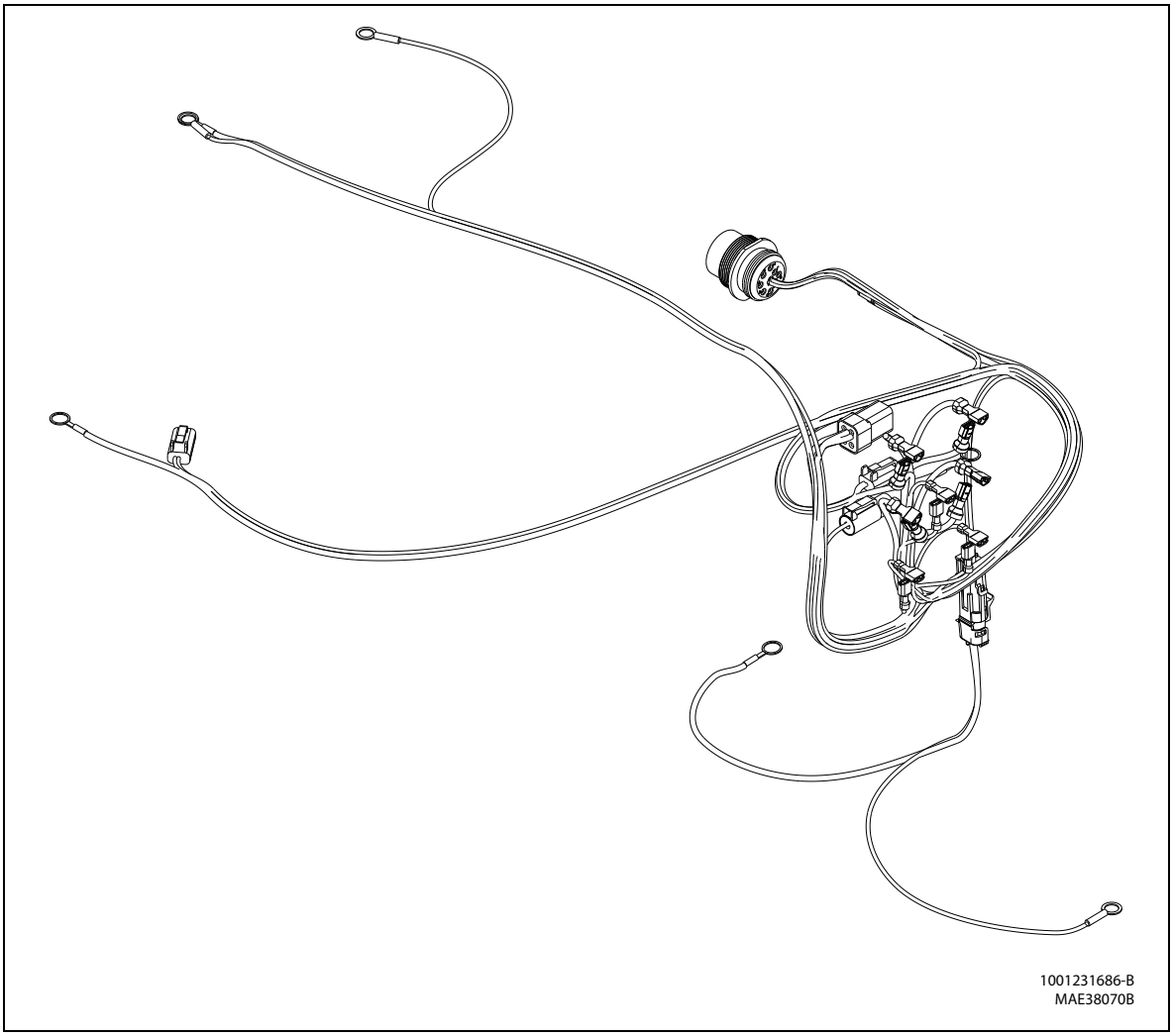


Figure 7-90. Battery Stack Harness (LH) - Sheet 1 of 3

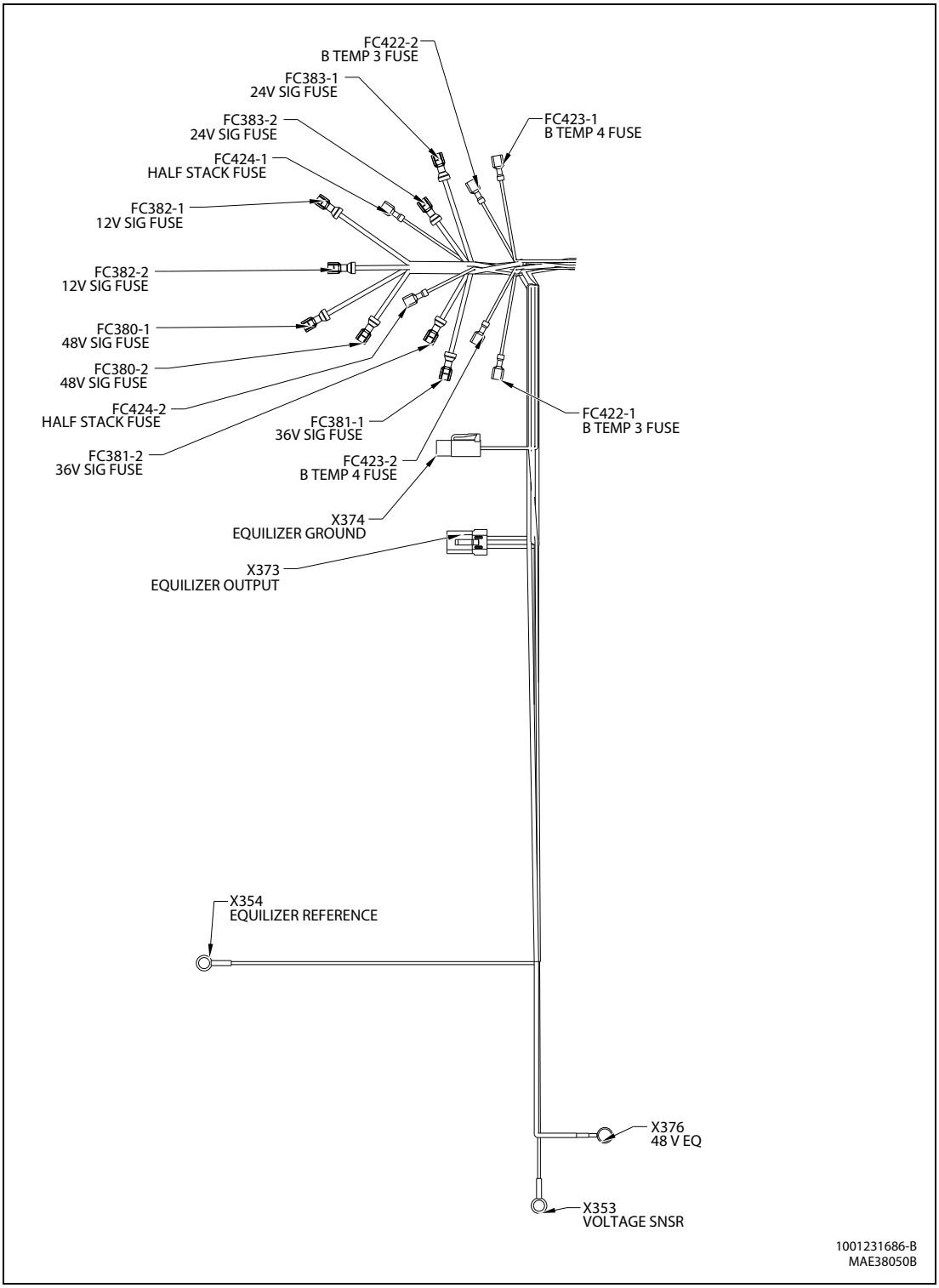


Figure 7-91. Battery Stack Harness (LH) - Sheet 2 of 3

X374-EQUILIZERGROUND					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-47	16AWG	GXL	X425B(1)

X373-EQUILIZEROUTPUT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3012VOLT	12AWG	GXL	FC382-2(1)
2	ORG	84-3124VOLT	12AWG	GXL	FC383-2(1)
3	ORG	84-3236VOLT	12AWG	GXL	FC381-2(1)
4	ORG	84-3348VOLT	12AWG	GXL	FC380-2(1)

X354-EQUILIZERREFERENCE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-45	16AWG	GXL	X343B(J)

X353-VOLTAGESNSR					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-11HALFSTACKV	18AWG	GXL	FC424-2(1)

FC422-1-BTEMP3FUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-13BTEMP3	18AWG	GXL	SN311(1)

FC423-2-BTEMP4FUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-12BTEMP4	18AWG	GXL	SN312(1)

FC381-1-36VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3236VOLT	12AWG	GXL	X377(1)

FC381-2-36V SIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3236VOLT	12AWG	GXL	X373(3)

FC424-2-HALFSTACKFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-11HALFSTACKV	18AWG	GXL	X353(1)

FC380-2-48V SIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3348VOLT	12AWG	GXL	X373(4)

FC380-1-48VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3348VOLT	12AWG	GXL	X376(1)

X376-48VEQ					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3348VOLT	12AWG	GXL	FC380-1(1)

FC382-2-12VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3012VOLT	12AWG	GXL	X373(1)

FC382-1-12VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3012VOLT	12AWG	GXL	X425B(2)

FC424-1-HALFSTACKFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-11HALFSTACKV	18AWG	GXL	X343B(D)

FC422-2-BTEMP3FUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-13BTEMP3	18AWG	GXL	X343B(A)

FC383-2-24VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3124VOLT	12AWG	GXL	X373(2)

FC423-1-BTEMP4FUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-12BTEMP4	18AWG	GXL	X343B(B)

FC383-1-24VSIGFUSE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3124VOLT	12AWG	GXL	X378(1)

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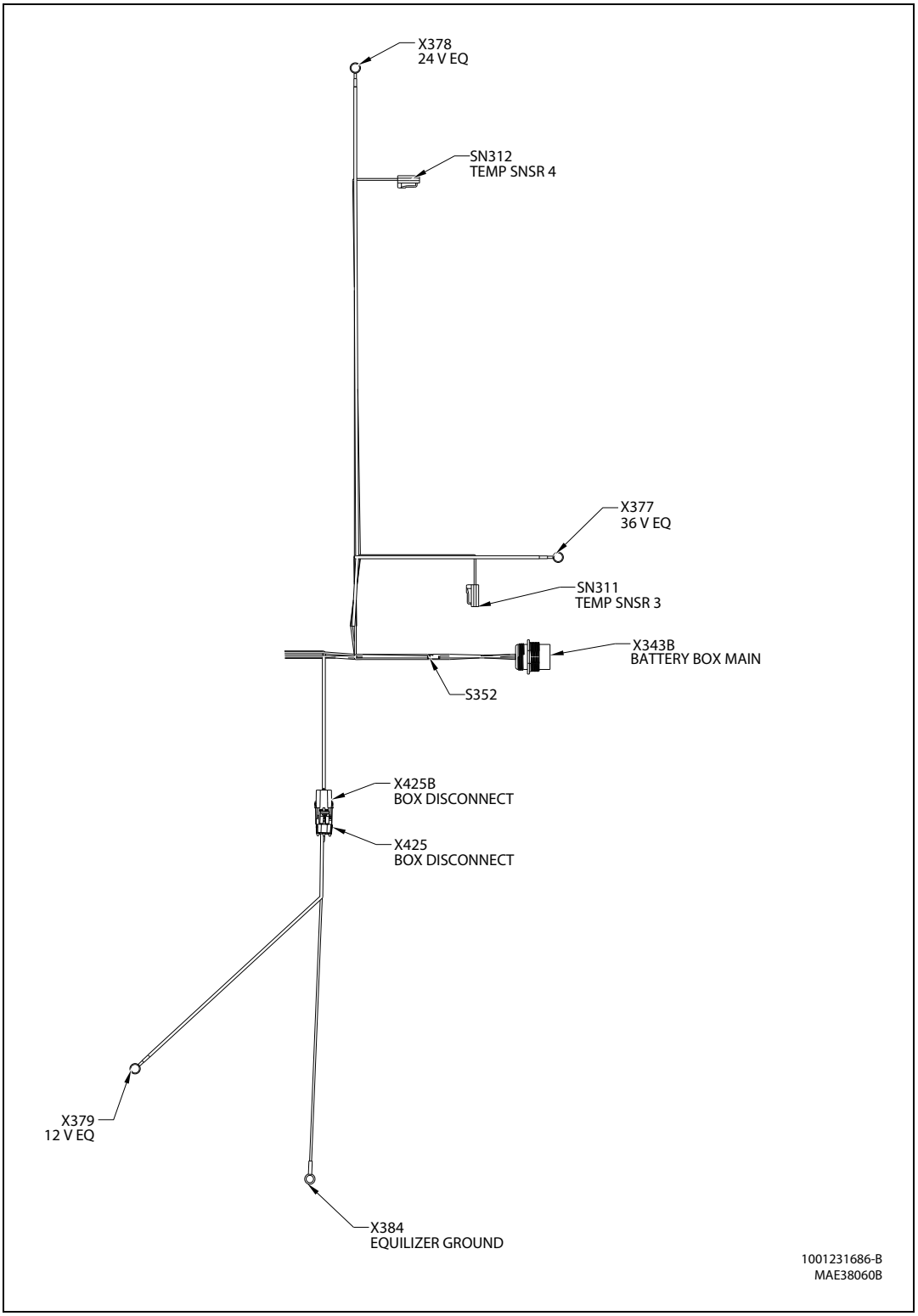


Figure 7-92. Battery Stack Harness (LH) - Sheet 3 of 3

X378-24VEQ					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3124VOLT	12AWG	GXL	FC383-1(1)

SN312-TEMPSNSR4					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-12BTEMP4	18AWG	GXL	FC423-2(1)
2	BLK	0-39-2-2	18AWG	GXL	S352(2)

X377-36VEQ					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	ORG	84-3236VOLT	12AWG	GXL	FC381-1(1)

SN311-TEMPSNSR3					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	84-13BTEMP3	18AWG	GXL	FC422-1(1)
2	BLK	0-39-2-1	18AWG	GXL	S352(2)

X343B-BATTERYBOXMAIN					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
A	WHT	84-13BTEMP3	18AWG	GXL	FC422-2(1)
B	WHT	84-12BTEMP4	18AWG	GXL	FC423-1(1)
C					
D	WHT	84-11HALFSTACKV	18AWG	GXL	FC424-1(1)
E					
F	BLK	0-39-2	18AWG	GXL	S352(1)
G					
H					
J	BLK	0-45	16AWG	GXL	X354(1)

S352					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-39-2	18AWG	GXL	X343B(F)
2	BLK	0-39-2-1	18AWG	GXL	SN311(2)
2	BLK	0-39-2-2	18AWG	GXL	SN312(2)

X425B-BOXDISCONNECT					
CONNPOS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	0-47	16AWG	GXL	X374(1)
2	ORG	84-3012VOLT	12AWG	GXL	FC382-1(1)

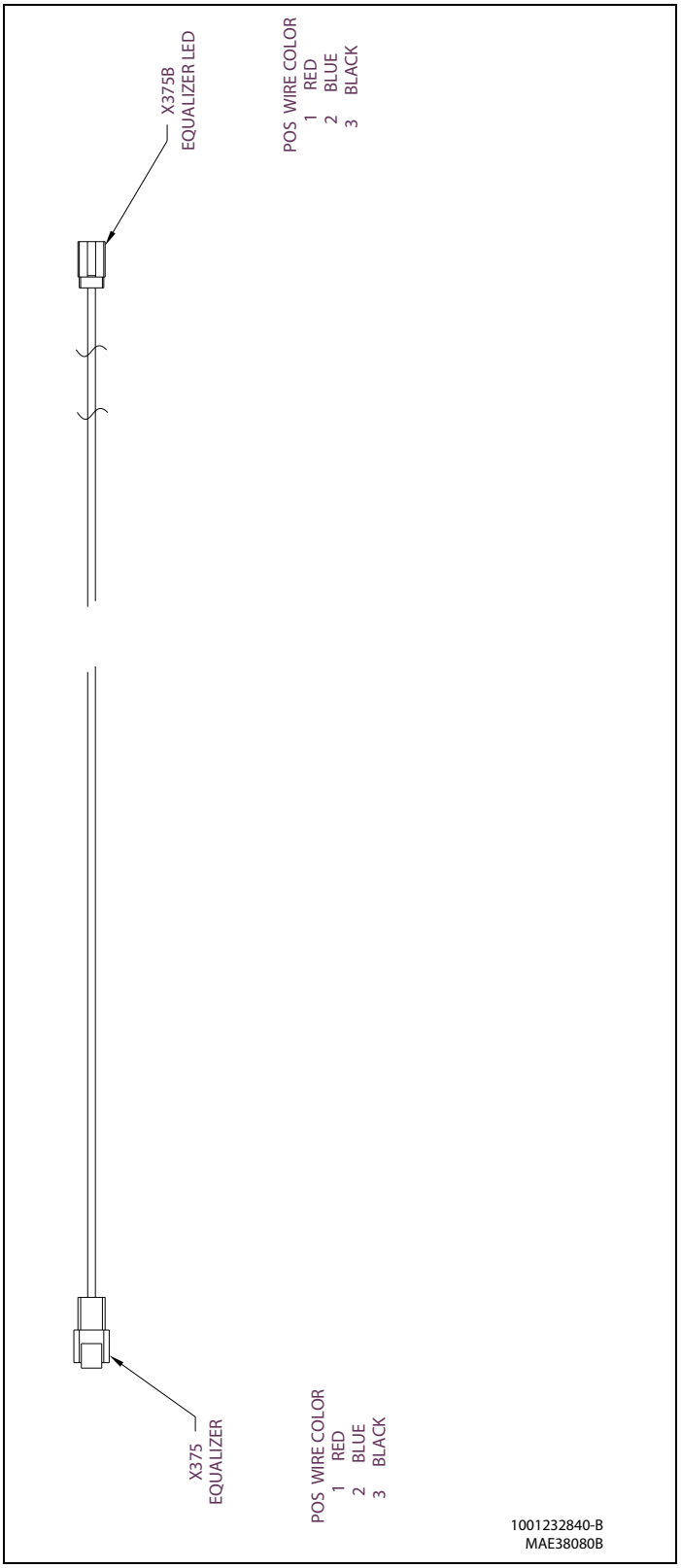


Figure 7-93. Equalizer Cable (LT)

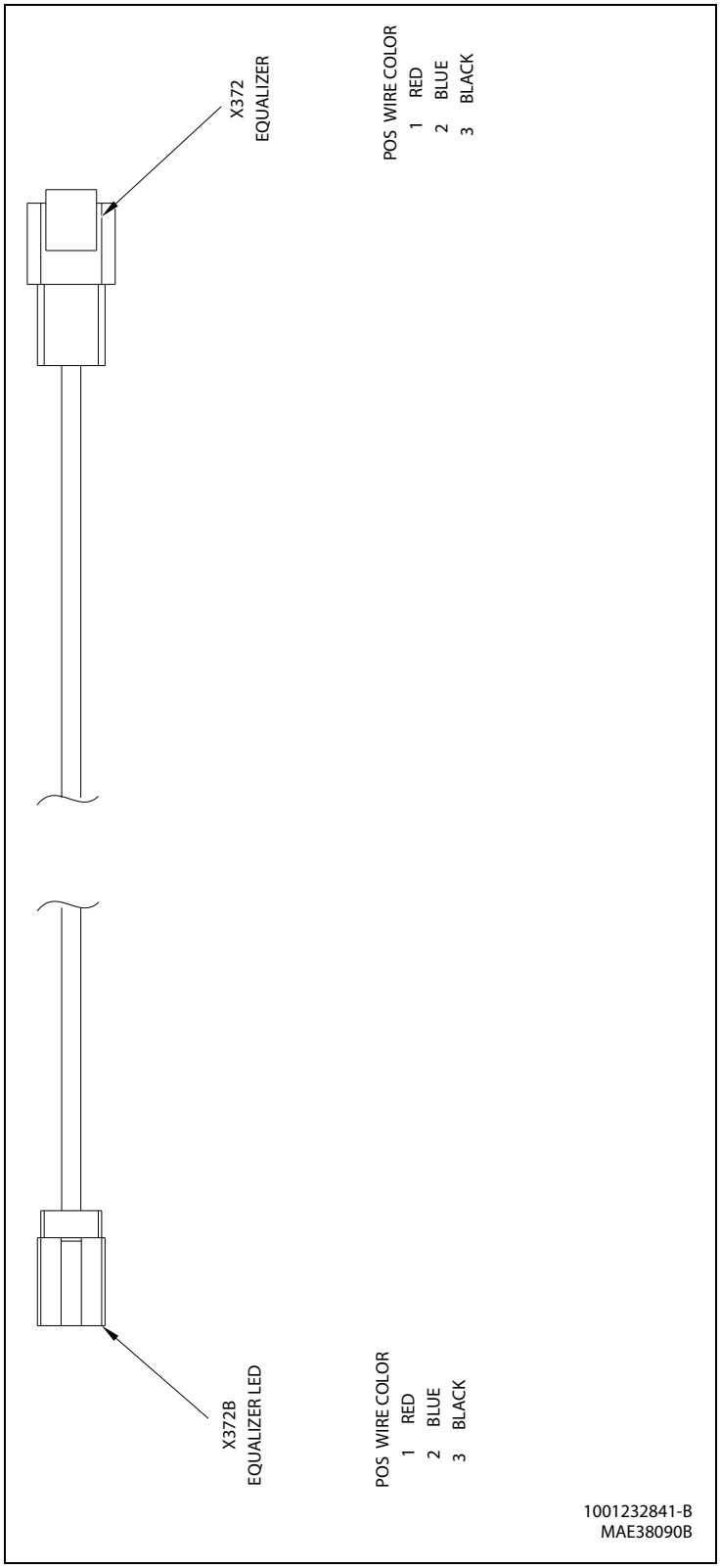


Figure 7-94. Equalizer Cable (RT)

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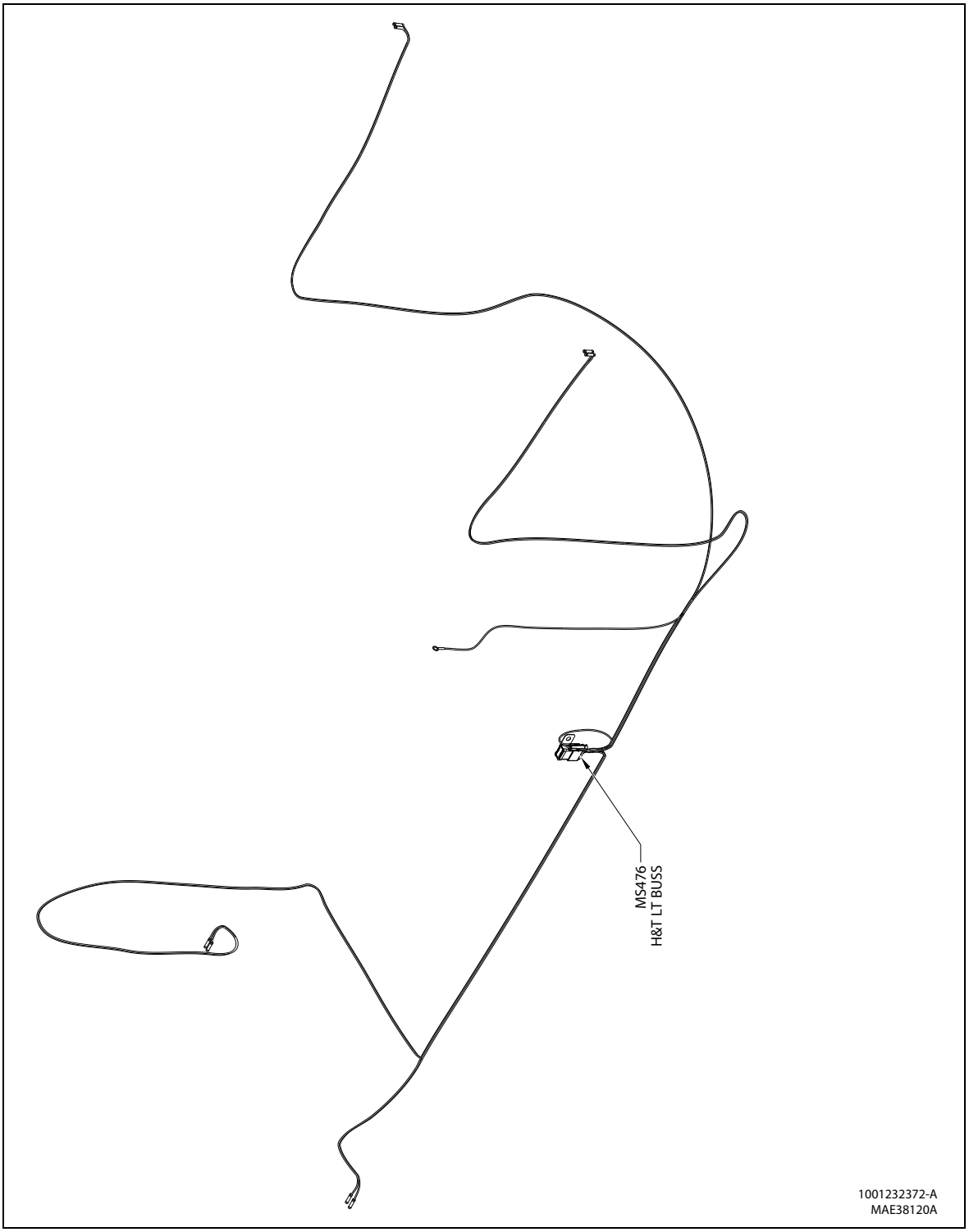


Figure 7-95. HRT Light Harness - Sheet 1 of 2

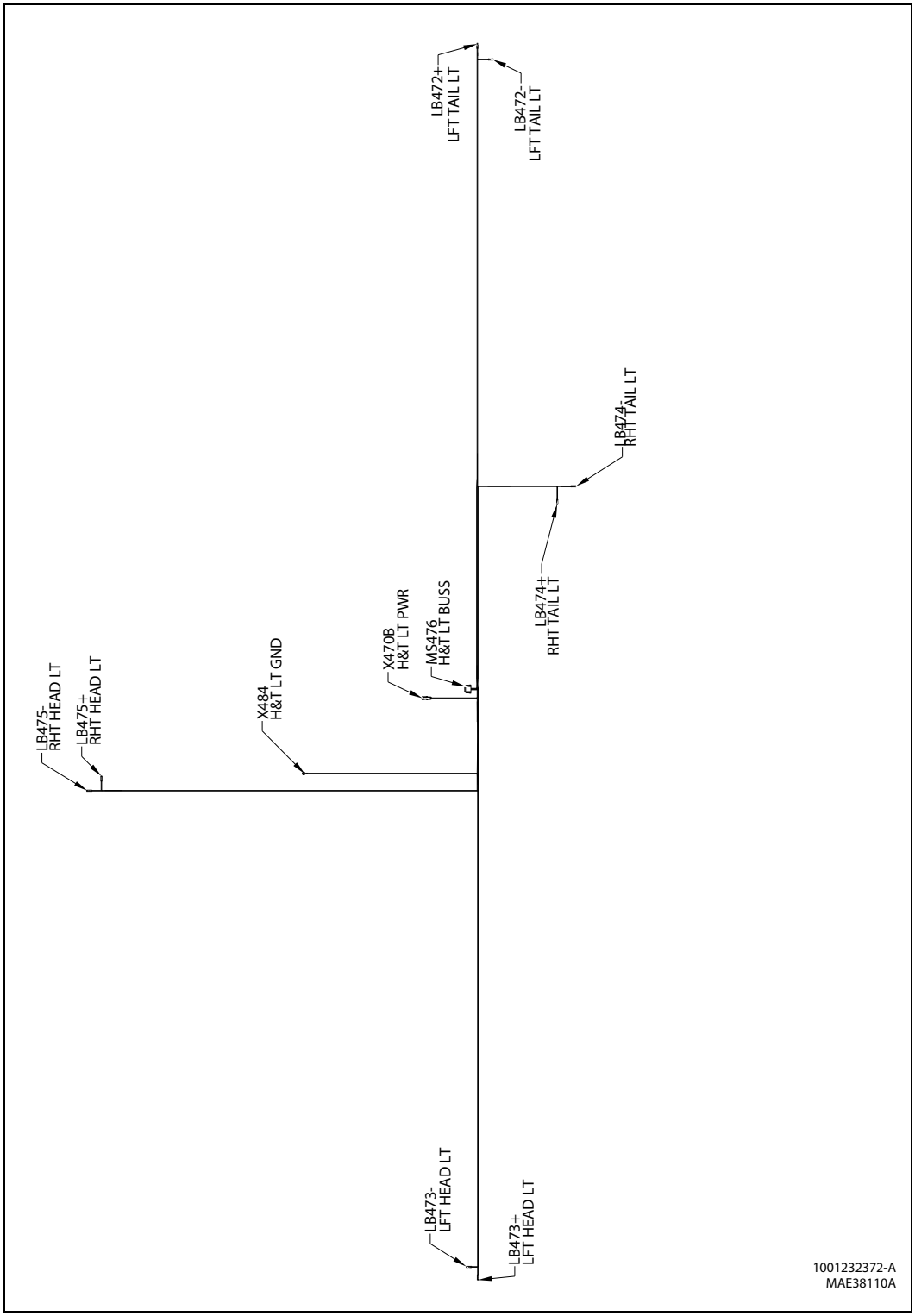


Figure 7-96. HRT Light Harness - Sheet 2 of 2

LB473+ - LFT HEAD LT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	16/2-1060341	16AWG	CABLE	MS476(6)

LB473- - LFT HEAD LT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	16/2-1060341	16AWG	CABLE	MS476(2)

LB475- - RHT HEAD LT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	16/2-1060341	16AWG	CABLE	MS476(10)

LB475+ - RHT HEAD LT					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	16/2-1060341	16AWG	CABLE	MS476(8)

X484- H&T LT GND					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-00	16AWG	GXL	MS476(12)

X470B-H&TLTPWR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	WHT	49-45H&TLT	16AWG	GXL	MS476(4)

LB472+- LFTTAIL LT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	16/2-1060341	16AWG	CABLE	MS476(5)

LB472--LFTTAILLT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	16/2-1060341	16AWG	CABLE	MS476(1)

LB474- - RHTTAIL LT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	16/2-1060341	16AWG	CABLE	MS476(11)

LB474+ - RHTTAIL LT					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	16/2-1060341	16AWG	CABLE	MS476(9)

MS476 - H&T LT BUSS					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	16/2-1060341	16AWG	CABLE	LB472-(1)
2	BLK	16/2-1060341	16AWG	CABLE	LB473-(1)
3					
4	WHT	49-45H&TLT	16AWG	GXL	X470B(1)
5	WHT	16/2-1060341	16AWG	CABLE	LB472+(1)
6	WHT	16/2-1060341	16AWG	CABLE	LB473+(1)
7					
8	WHT	16/2-1060341	16AWG	CABLE	LB475+(1)
9	WHT	16/2-1060341	16AWG	CABLE	LB474+(1)
10	BLK	16/2-1060341	16AWG	CABLE	LB475-(1)
11	BLK	16/2-1060341	16AWG	CABLE	LB474-(1)
12	BLK	0-00	16AWG	GXL	X484(1)

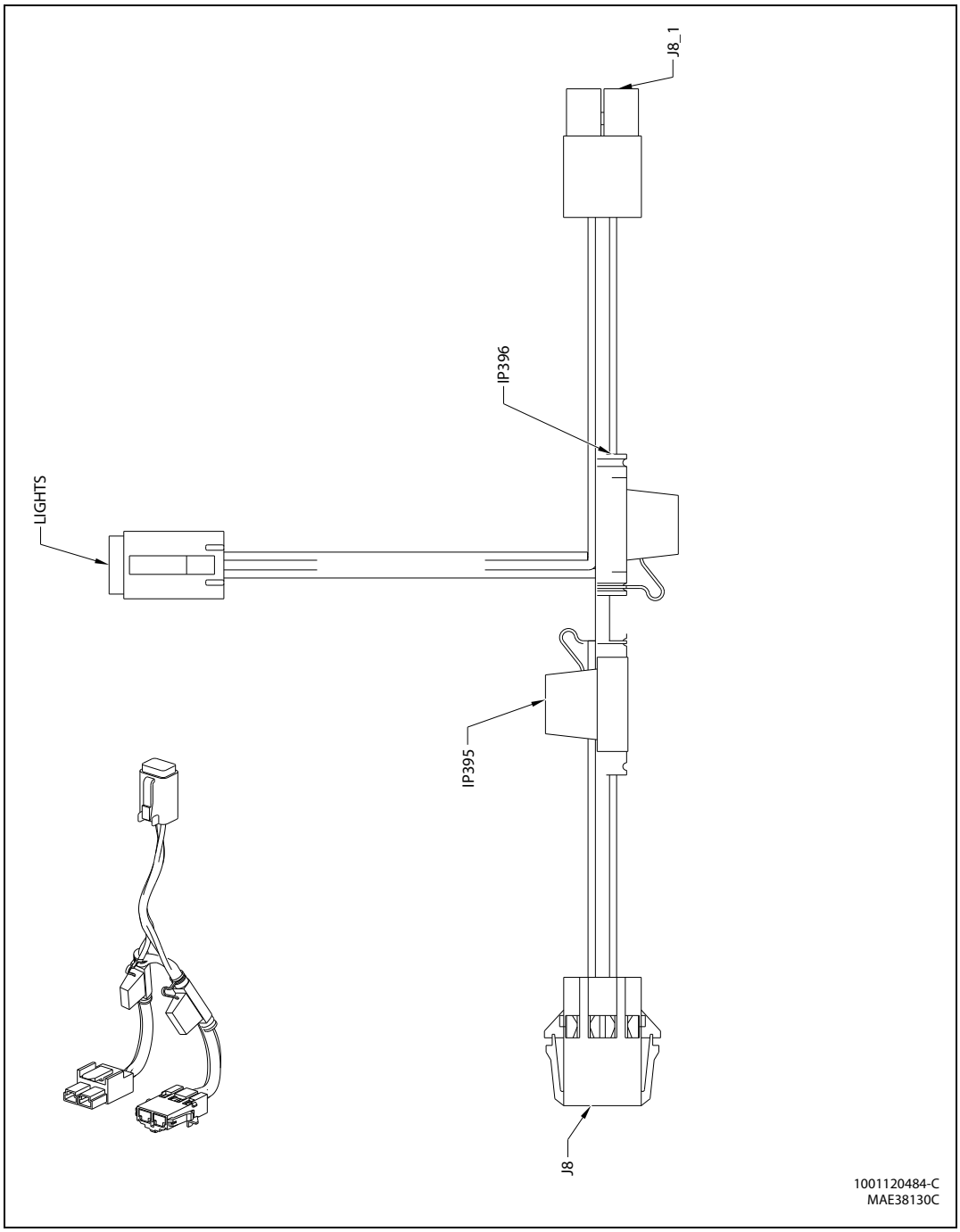


Figure 7-97. PLT Work Light Harness

J8_1					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	-	12AWG	GXL	J8(1)
1	BLK	-	16AWG	GXL	LIGHTS(3)
2	YEL/RED	-	12AWG	GXL	J8(2)
2	-	SEENOTE3			IP396(2)

IP396					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	-	SEENOTE3			LIGHTS(4)
2	-	SEENOTE3			J8_1(2)

LIGHTS					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	-	16AWG	GXL	J8(1)
2	-	SEENOTE3			IP395(1)
3	BLK	-	16AWG	GXL	J8_1(1)
4	-	SEENOTE3			IP396(1)

IP395					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	-	SEENOTE3			LIGHTS(2)
2	-	SEENOTE3			J8(2)

J8					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	-	12AWG	GXL	J8_1(1)
1	BLK	-	16AWG	GXL	LIGHTS(1)
2	YEL/RED	-	12AWG	GXL	J8_1(2)
2	-	SEENOTE3			IP395(2)

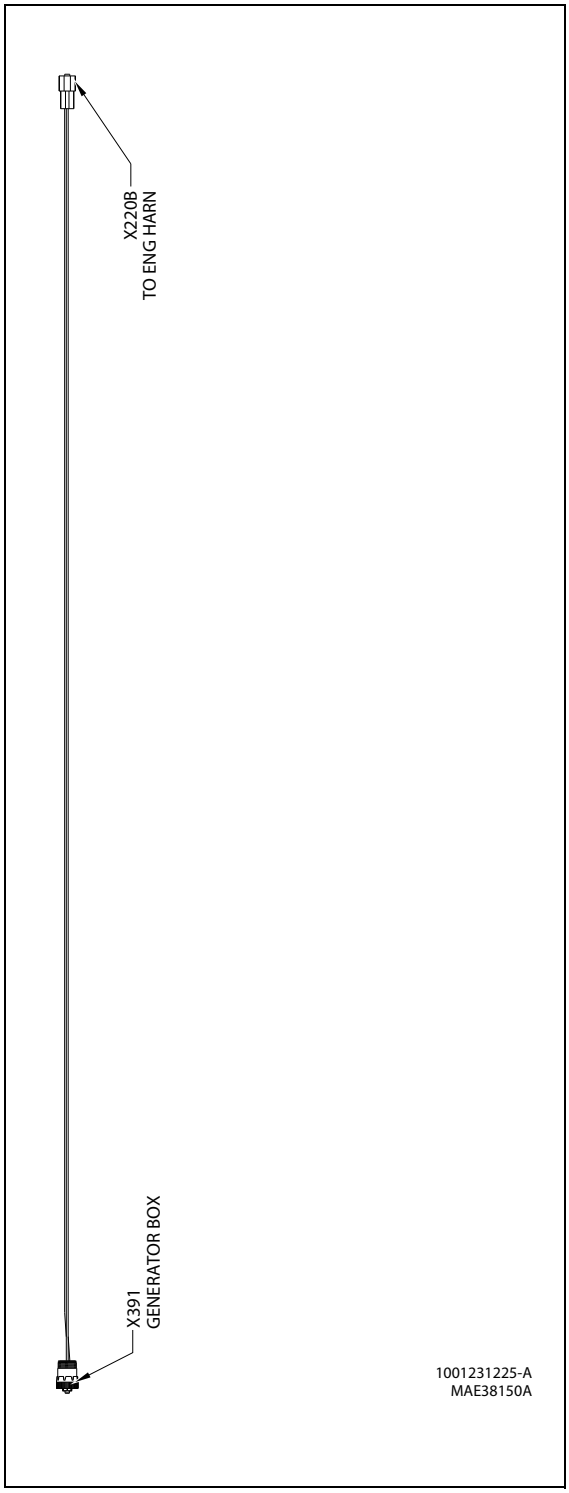


Figure 7-98. Generator Light Harness

X391GENERATORBOX					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
A	YEL	2-14-6	18AWG	GXL	X220B(A)
B	WHT	48-24GEN	18AWG	GXL	X220B(B)
C	BLK	0-28	18AWG	GXL	X220B(C)

X220B TOENGHARN					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
A	YEL	2-14-6	18AWG	GXL	X391(A)
B	WHT	48-24GEN	18AWG	GXL	X391(B)
C	BLK	0-28	18AWG	GXL	X391(C)

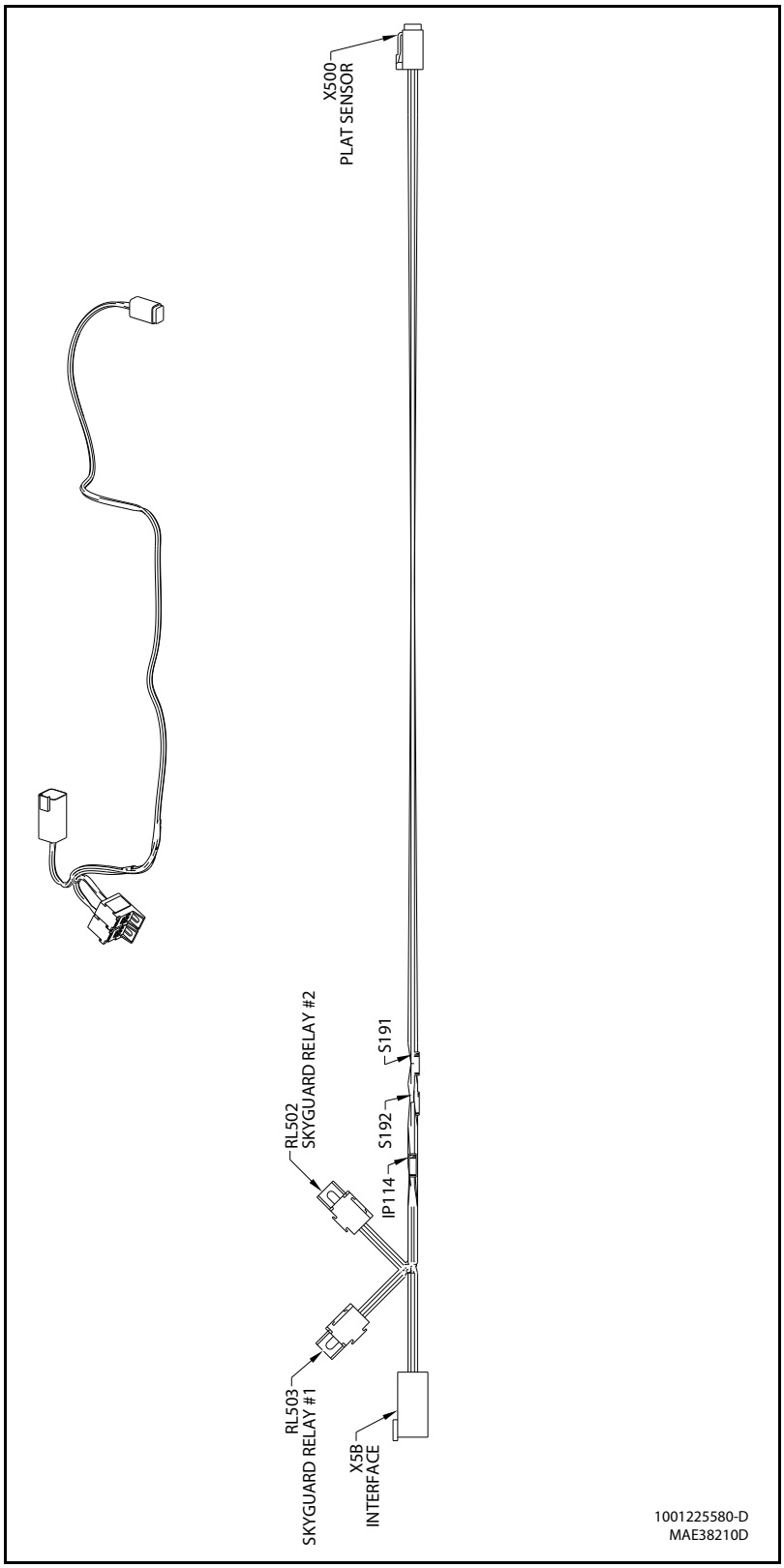


Figure 7-99. Skyguard Harness

X5B- INTERFACE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	T0
1	WHT	P2	18AWG	GXL	IP114(1)
2	WHT	P6	18AWG	GXL	X500(2)
3					
4	WHT	P1	18AWG	GXL	RL503(87)
5	WHT	P3	18AWG	GXL	RL502(87)
6					

RL503-SKYGUARDRELAY#1					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	T0
30	WHT	P9-1	18AWG	GXL	IP114(1)
85	WHT	P5-1	18AWG	GXL	S191(1)
86	WHT	P4-1	18AWG	GXL	S192(1)
87	WHT	P1	18AWG	GXL	X5B(4)
87A					

RL502-SKYGUARDRELAY#2					
CONNPOS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	T0
30	WHT	P9-2	18AWG	GXL	IP114(1)
85	WHT	P5-2	18AWG	GXL	S191(1)
86	WHT	P4-2	18AWG	GXL	S192(1)
87	WHT	P3	18AWG	GXL	X5B(5)
87a					

S192					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	T0
1	WHT	P4-1	18AWG	GXL	RL503(86)
1	WHT	P4-2	18AWG	GXL	RL502(86)
2	WHT	P4	18AWG	GXL	X500(3)

S191					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	T0
1	WHT	P5-1	18AWG	GXL	RL503(85)
1	WHT	P5-2	18AWG	GXL	RL502(85)
2	WHT	P5	18AWG	GXL	X500(4)

X500 - PLATSENSOR					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	T0
1	WHT	P10	18AWG	GXL	IP114(2)
2	WHT	P6	18AWG	GXL	X5B(2)
3	WHT	P4	18AWG	GXL	S192(2)
4	WHT	P5	18AWG	GXL	S191(2)

IP114					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	T0
1	WHT	P2	18AWG	GXL	X5B(1)
1	WHT	P9-1	18AWG	GXL	RL503(30)
1	WHT	P9-2	18AWG	GXL	RL502(30)
2	WHT	P10	18AWG	GXL	X500(1)

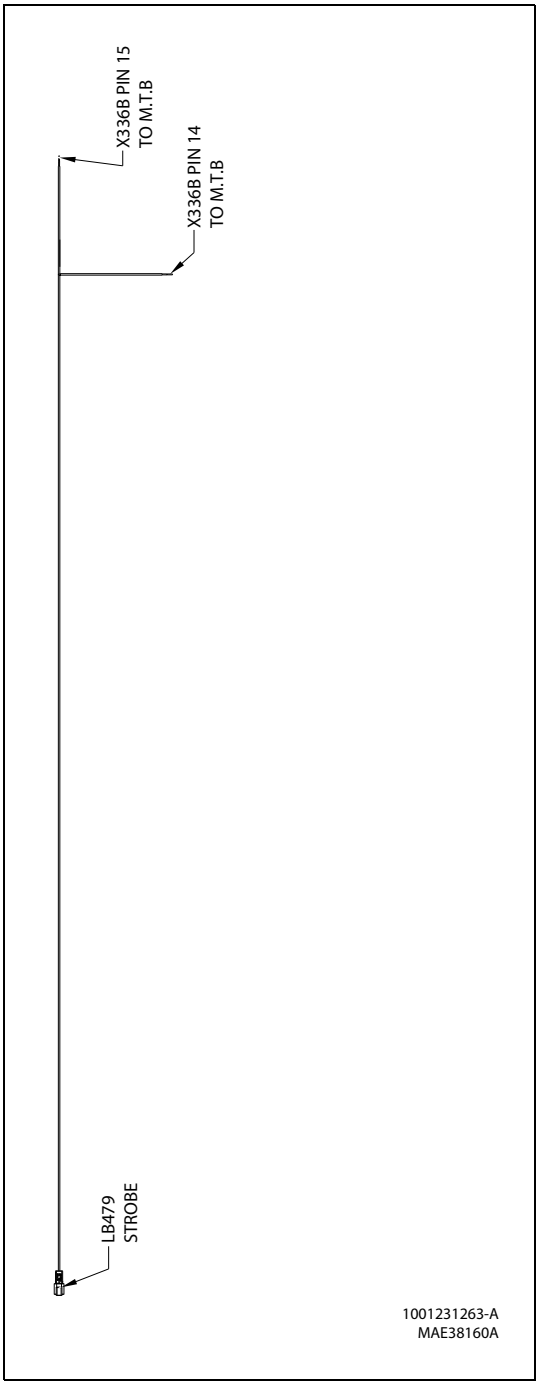


Figure 7-100. Strobe Harness

LB479STROBE					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	16/2-1060341	16AWG	CABLE	X336BPIN14(1)
2	BLK	16/2-1060341	16AWG	CABLE	X336BPIN15(1)

X336BPIN14TOM.T.B					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	WHT	16/2-1060341	16AWG	CABLE	LB479(1)

X336BPIN15TOM.T.B					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	16/2-1060341	16AWG	CABLE	LB479(2)

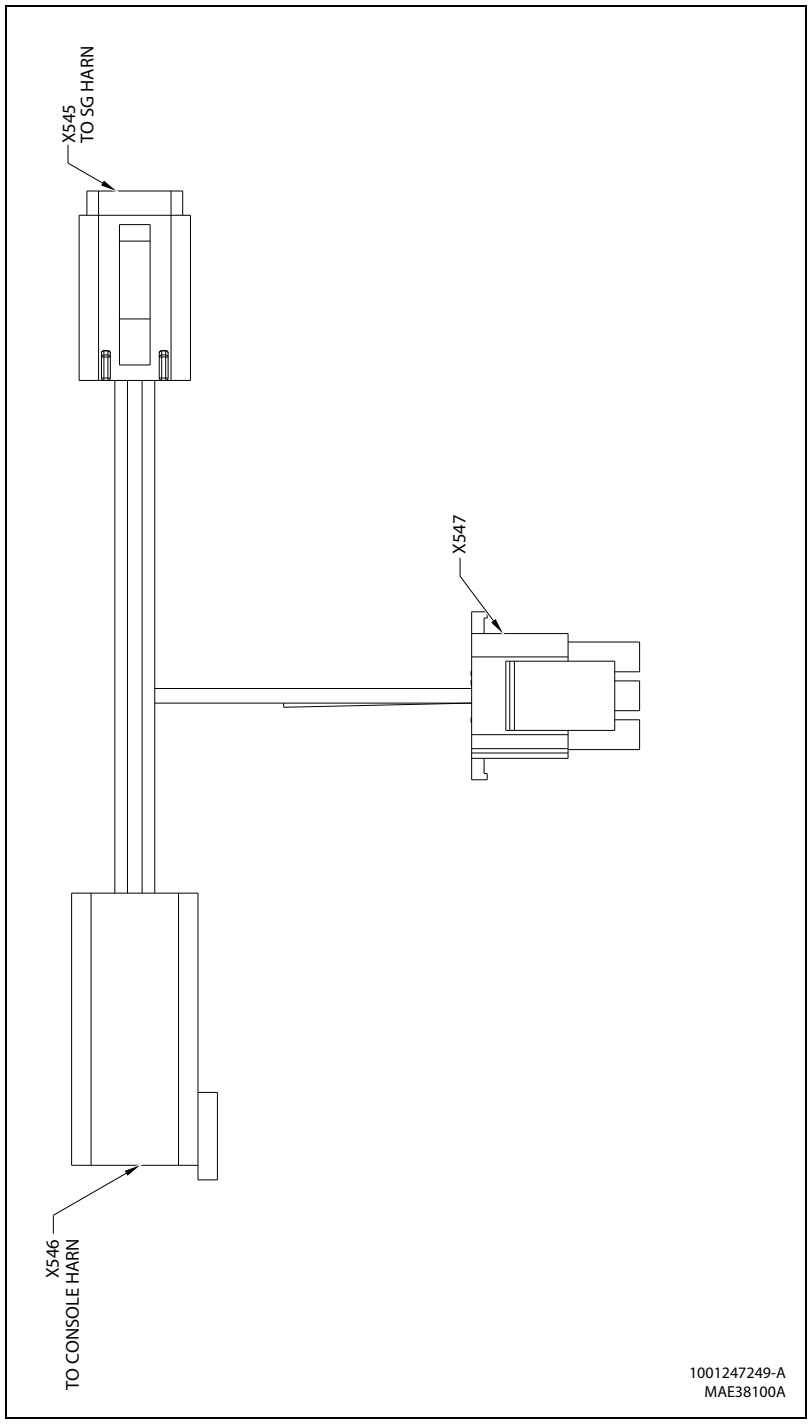


Figure 7-101. Soft Touch Harness

X546					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	YEL	2-3-4	18AWG	GXL	X547(6)
2	BLK	0-6-3	18AWG	GXL	X545(2)
3	WHT	55-6-1	18AWG	GXL	X545(3)
4	WHT	65-1	18AWG	GXL	X545(4)
5	WHT	65-2	18AWG	GXL	X545(5)
6	WHT	55-6	18AWG	GXL	X545(6)

X545					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	YEL	2-3-4-3	18AWG	GXL	X547(3)
2	BLK	0-6-3	18AWG	GXL	X546(2)
3	WHT	55-6-1	18AWG	GXL	X546(3)
4	WHT	65-1	18AWG	GXL	X546(4)
5	WHT	65-2	18AWG	GXL	X546(5)
6	WHT	55-6	18AWG	GXL	X546(6)

X547					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1					
2					
3	YEL	2-3-4-3	18AWG	GXL	X545(1)
4					
5	YEL	2-3-4-2	18AWG	GXL	X547(4)
6	YEL	2-3-4	18AWG	GXL	X546(1)
7					
8					
9					
10					
11					
12					
13					
14					
15					

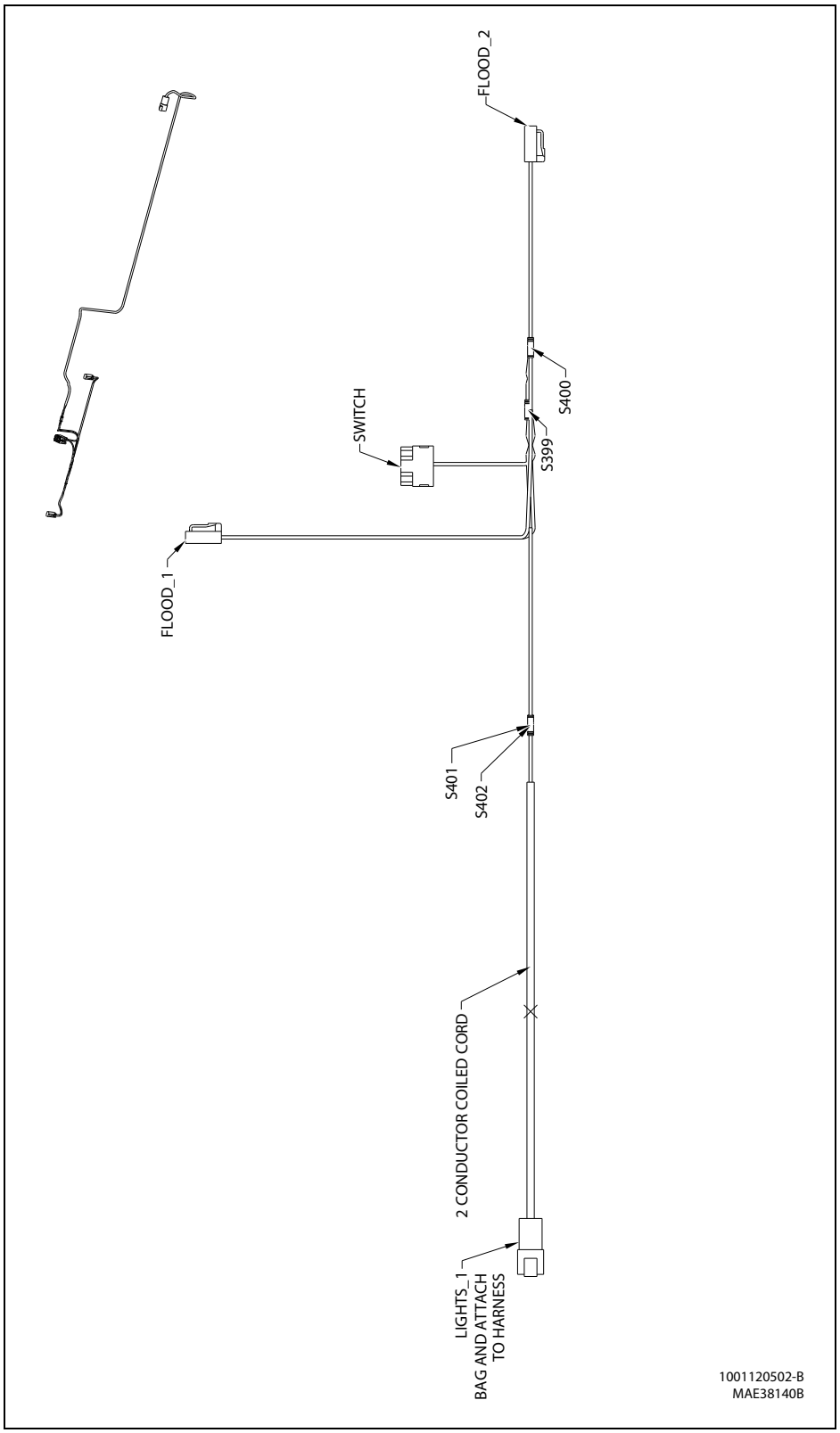


Figure 7-102. PLT Flood Light Harness

LIGHTS_1					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	SEENOTE4	16AWG	CABLE	S401(2)
2	WHT	SEENOTE4	16AWG	CABLE	S402(2)
3					
4					

S402					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	YEL/RED	--	16AWG	GXL	SWITCH(2)
2	WHT	SEENOTE4	16AWG	CABLE	LIGHTS_1(2)

S401					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	--	16AWG	GXL	S399(1)
2	BLK	SEENOTE4	16AWG	CABLE	LIGHTS_1(1)

FLOOD_1					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	YEL/RED	--	16AWG	GXL	S400(1)
2	BLK	--	16AWG	GXL	S399(1)

SWITCH					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1					
2	YEL/RED	--	16AWG	GXL	S402(1)
3	YEL/RED	--	16AWG	GXL	S400(1)
4					
5					
6					

S399					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	BLK	--	16AWG	GXL	FLOOD_1(2)
1	BLK	--	16AWG	GXL	S401(1)
2	BLK	--	16AWG	GXL	FLOOD_2(2)

S400					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	YEL/RED	--	16AWG	GXL	FLOOD_1(1)
1	YEL/RED	--	16AWG	GXL	SWITCH(3)
2	YEL/RED	--	16AWG	GXL	FLOOD_2(1)

FLOOD_2					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	YEL/RED	--	16AWG	GXL	S400(2)
2	BLK	--	16AWG	GXL	S399(2)

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7.20 ELECTRICAL SCHEMATICS

2 CONSOLE BOX

CONSOLE BOX ASSEMBLY
CONSOLE BOX HARNESS

3 PLATFORM VALVE

PLATFORM VALVE HARNESS

4 TURNTABLE

GROUND CONTROL HARNESS
H-BRIDGE/CLUTCH HARNESS
TURNTABLE HYBRID HARNESS
TURNTABLE-FUSE PANEL HARNESS

5 HYDRAULICS & ENGINE

MAIN VALVE H800 HARNESS
KUBOTA ENGINE HARNESS
HYBRID ENGINE TRAY HARNESS

6 HYBRID/ELECTRIC & IMG CONTROLLERS

H.E.CONTROLLER HARNESS
HYBRID 84V H800 HARNESS
BATTERY CHARGER HARNESS

7 RESOLVER/CONVERTER & IMG

RESOLVER CONVERTER HARNESS
RES/CONV TO IMG CONT CABLE
3-PHASE MOTOR CABLE (U)
3-PHASE MOTOR CABLE (V)
3-PHASE MOTOR CABLE (W)
IMG (U) TO BOX
IMG (V) TO BOX
IMG (W) TO BOX

8 BATTERY BOXES

BATTERY STACK RIGHT HARNESS
BATTERY STACK LEFT HARNESS
EQUALIZER LED (LEFT) CABLE
EQUALIZER LED (RIGHT) CABLE

9 OPTIONS

HEAD & TAIL LTS HARNESS
HYBRID STROBE CABLE
GENERATOR ENABLE HARNESS
SKYGUARD, GEN 2 PLAT INTERFACE

10 GENERATOR

Figure 7-103. Electrical Schematics - Sheet 1 of 19

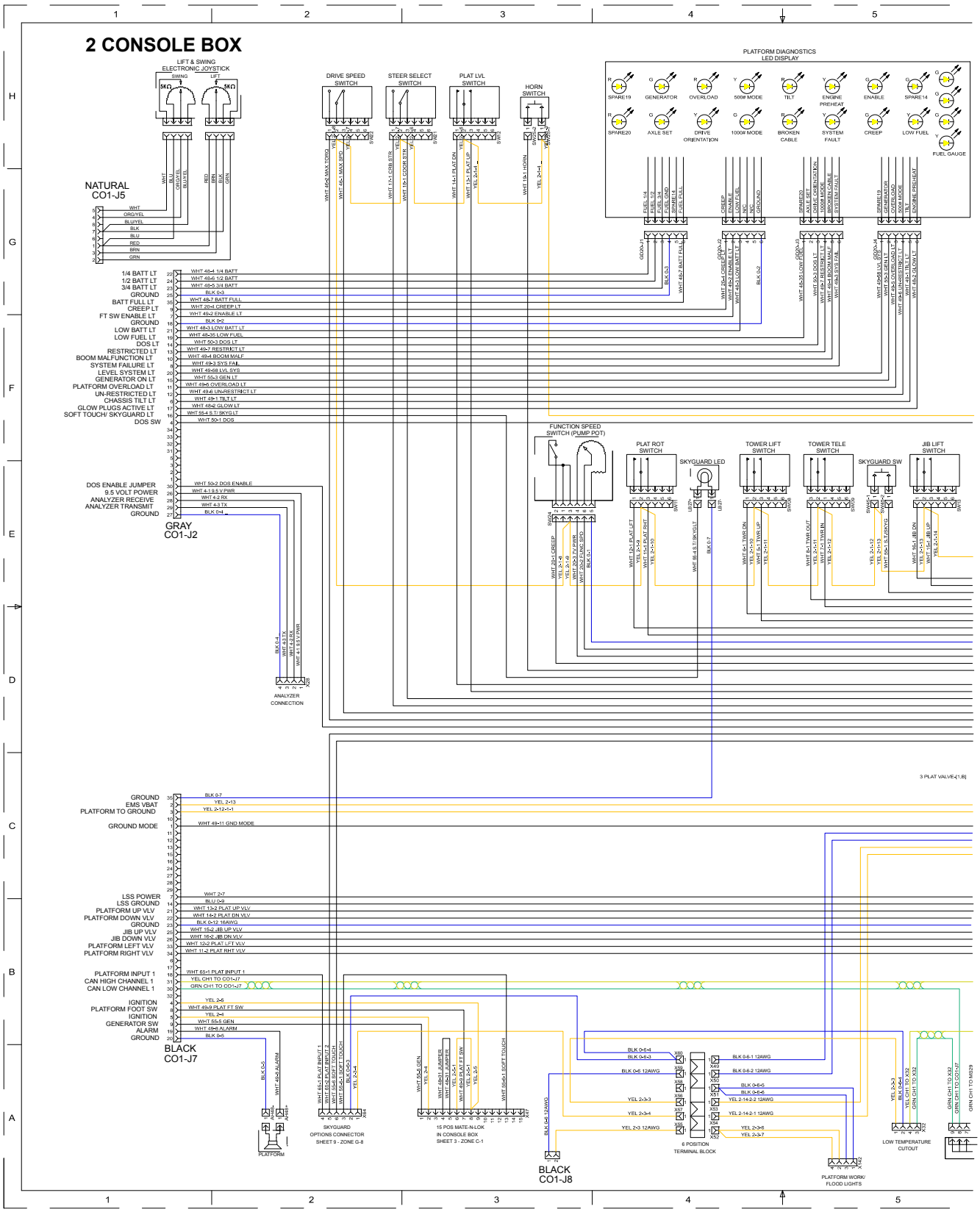


Figure 7-104. Electrical Schematics - Sheet 2 of 19

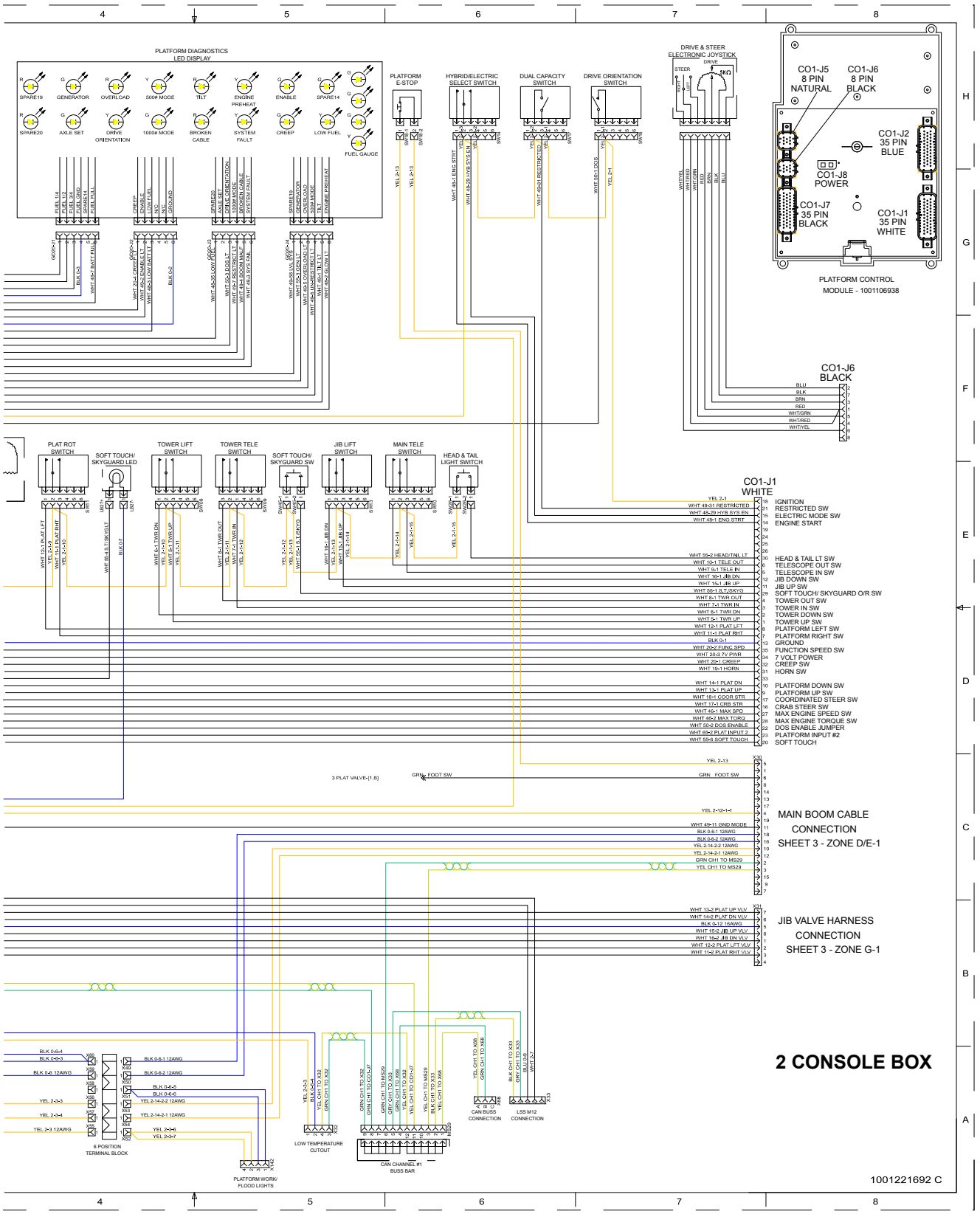


Figure 7-105. Electrical Schematics - Sheet 3 of 19

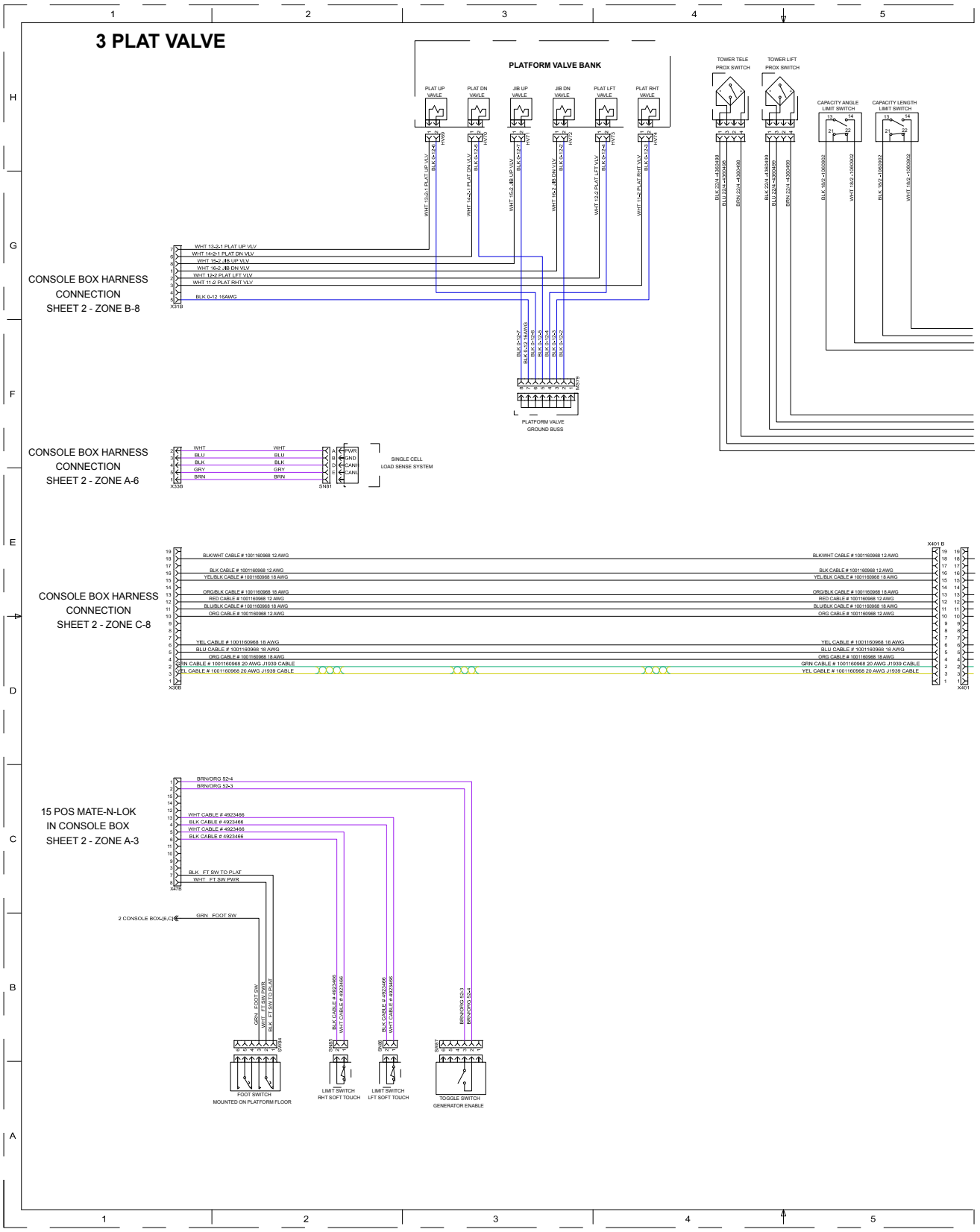


Figure 7-106. Electrical Schematics - Sheet 4 of 19

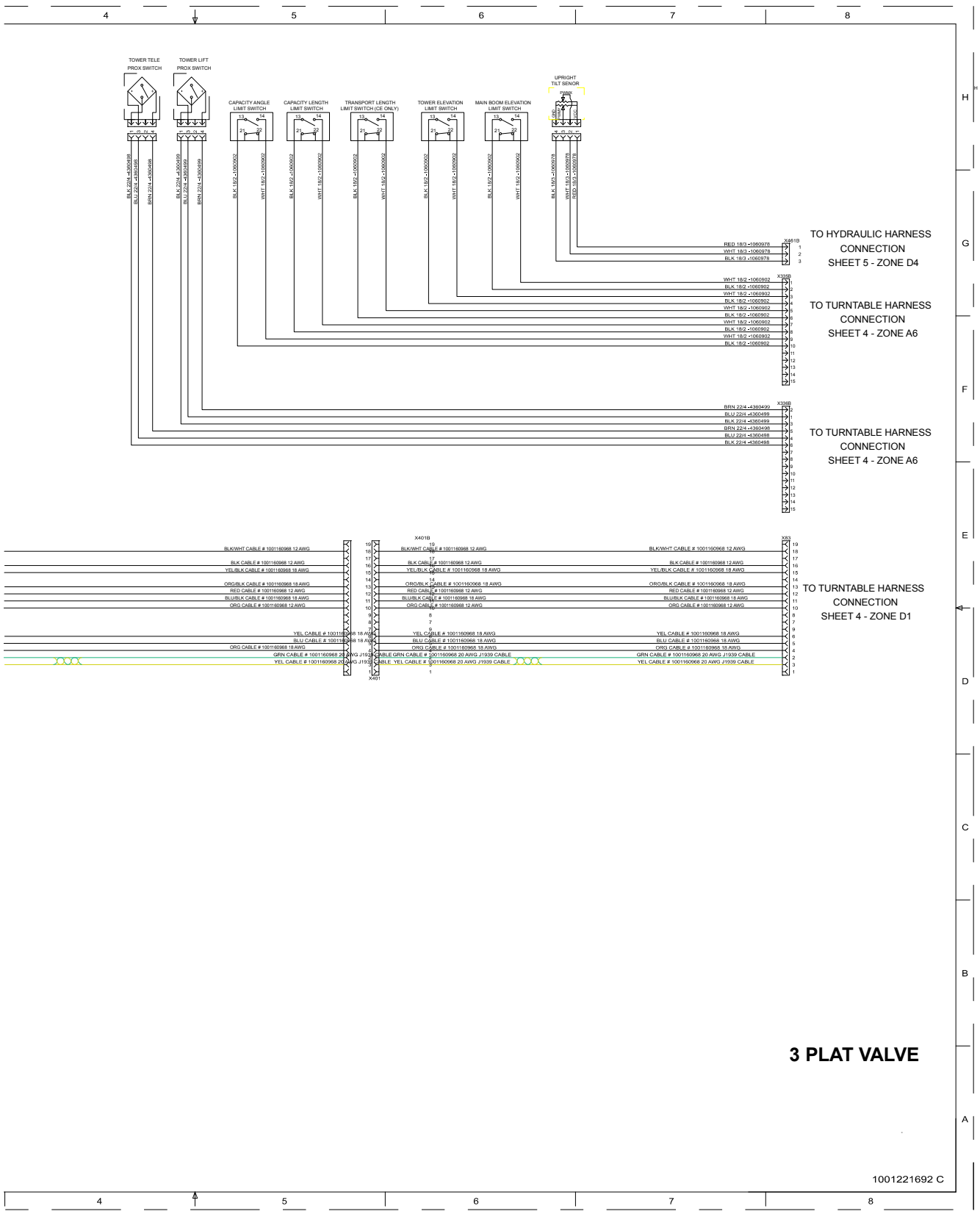


Figure 7-107. Electrical Schematics - Sheet 5 of 19

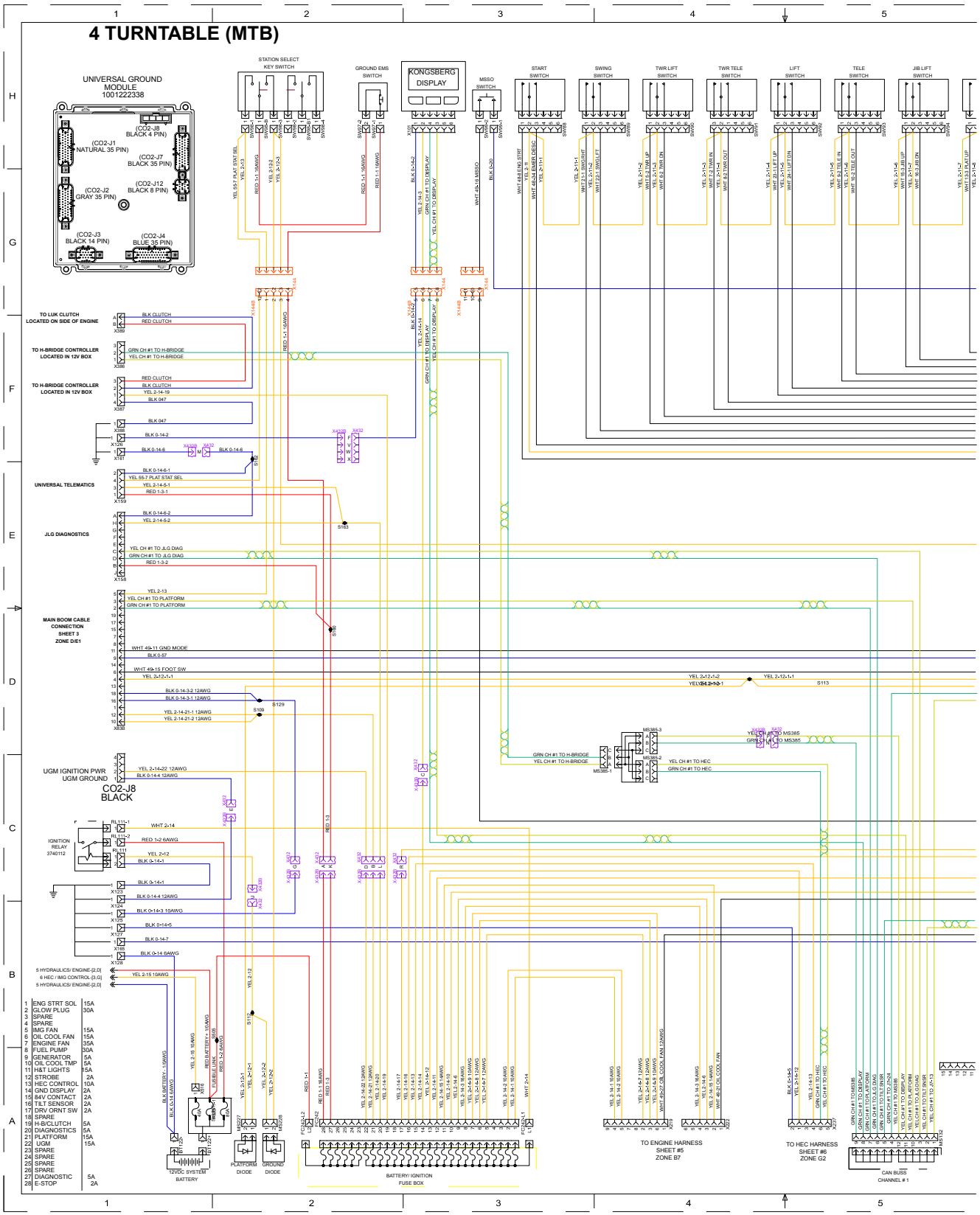


Figure 7-108. Electrical Schematics - Sheet 6 of 19

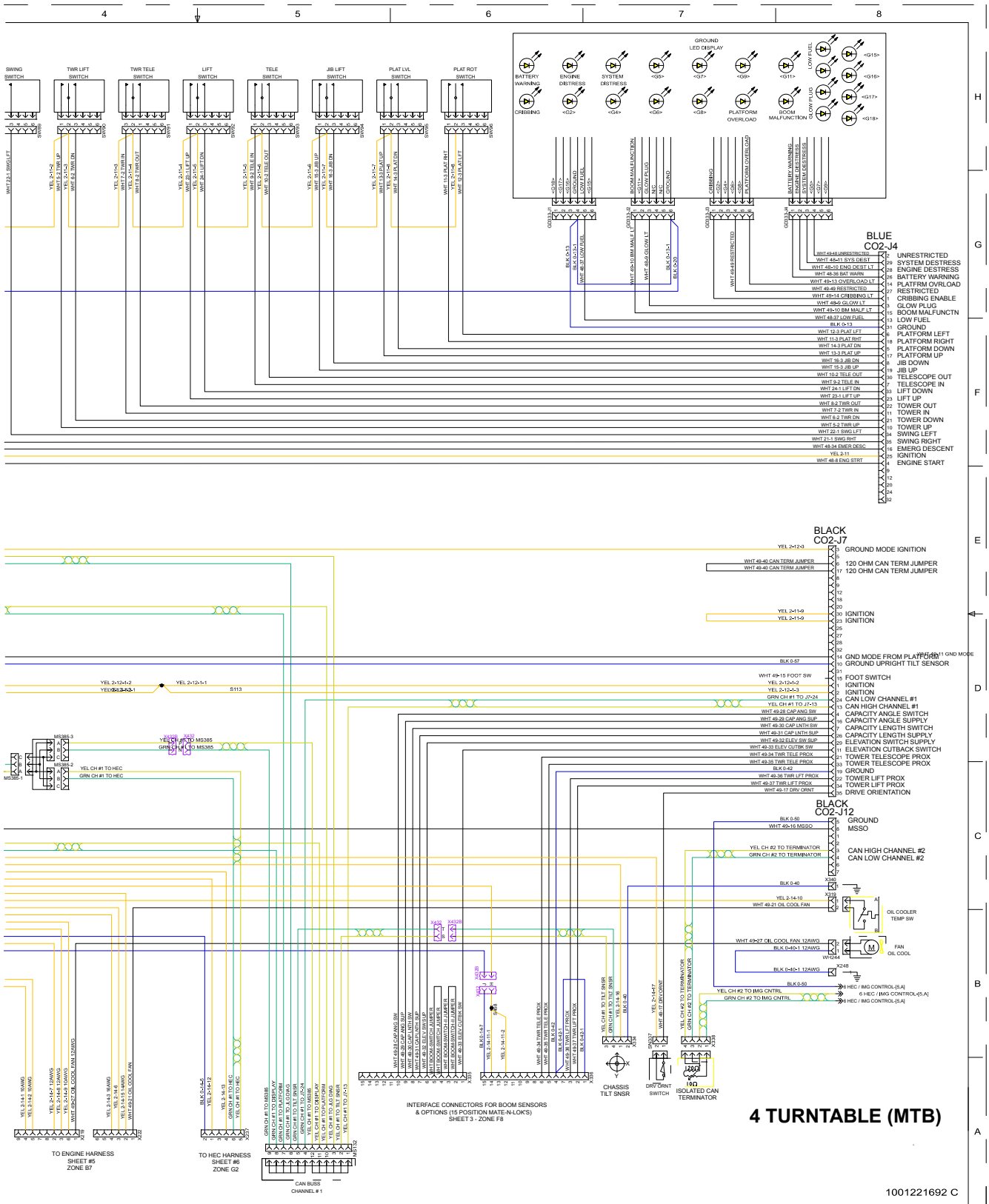


Figure 7-109. Electrical Schematics - Sheet 7 of 19

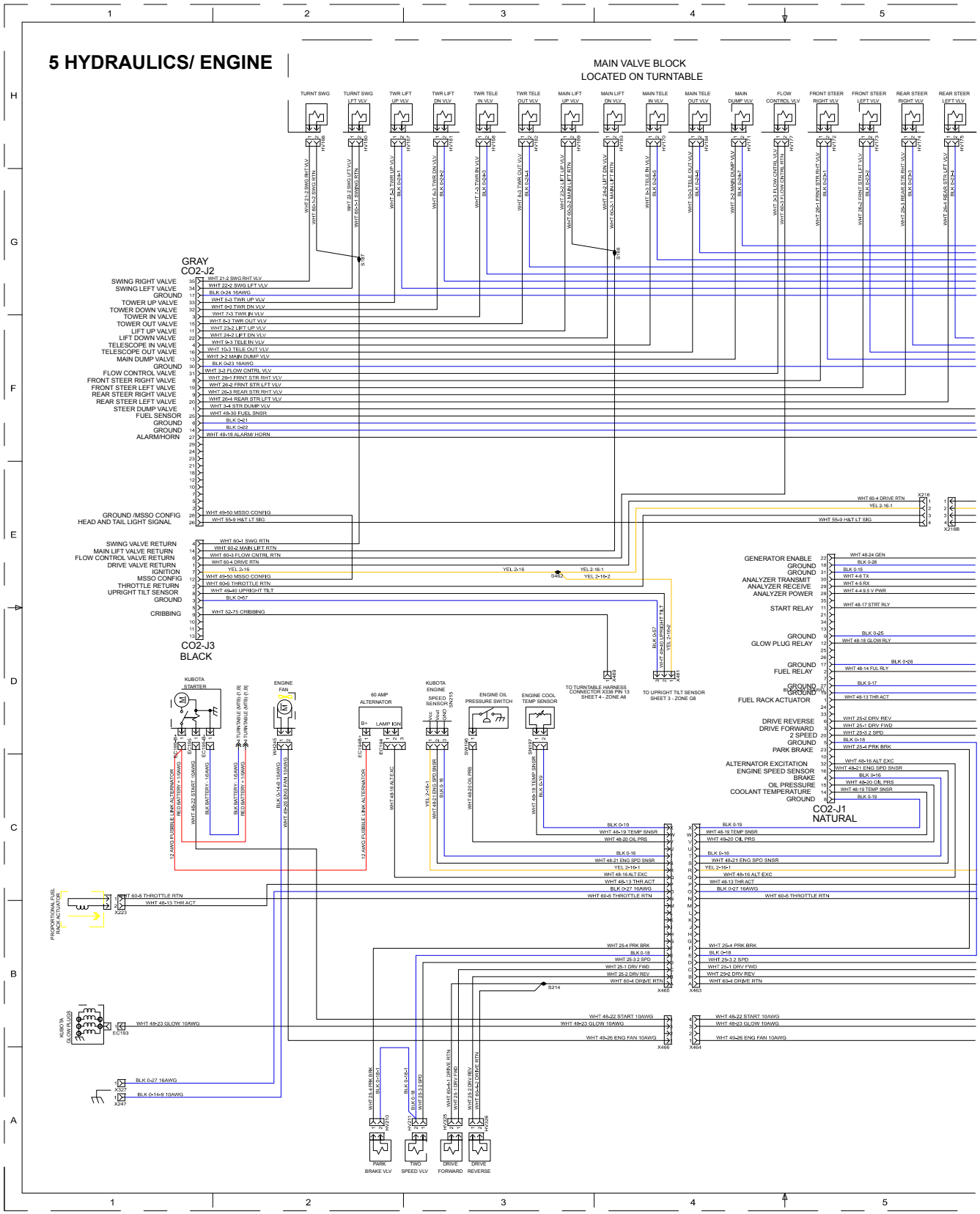


Figure 7-110. Electrical Schematics - Sheet 8 of 19

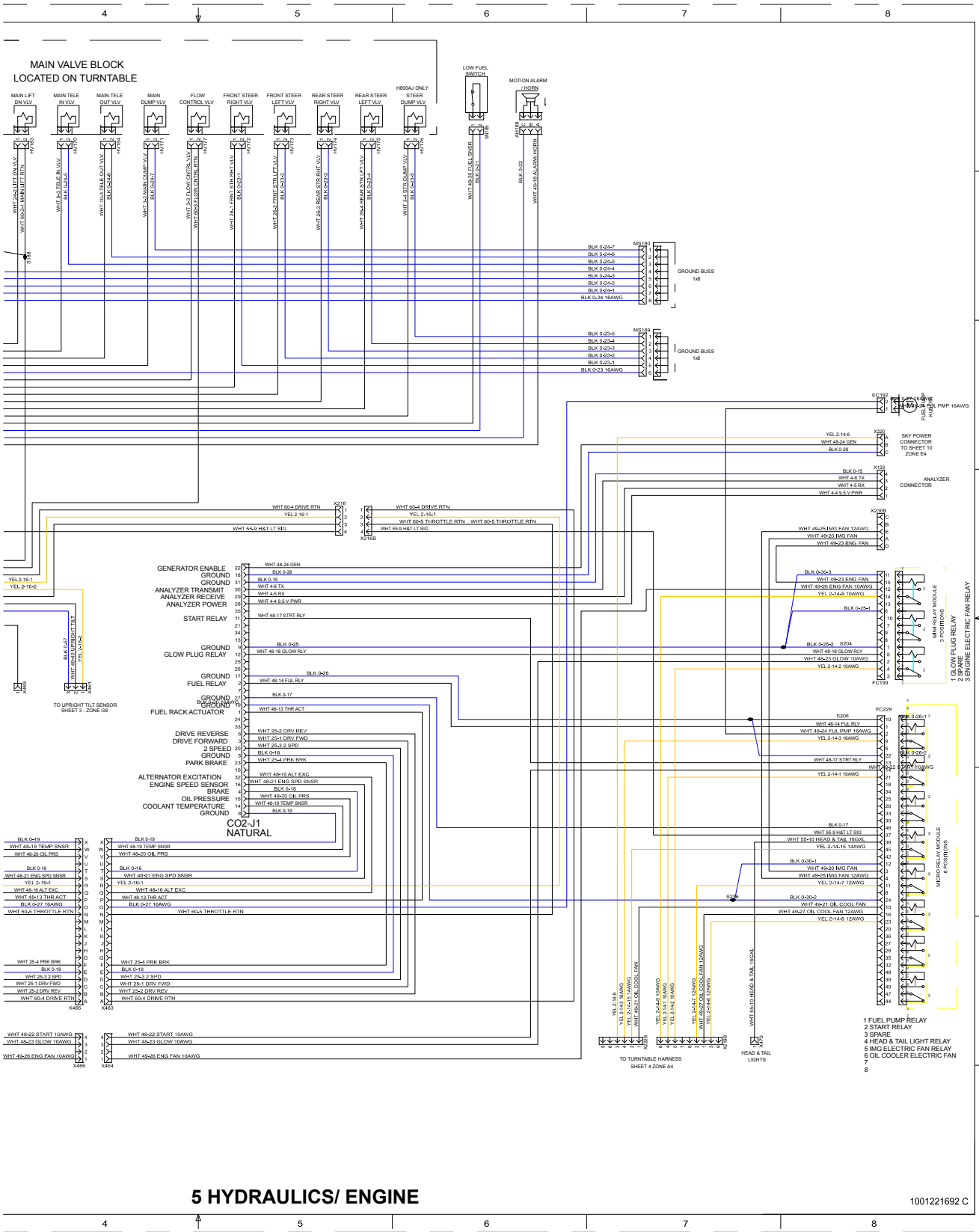


Figure 7-111. Electrical Schematics - Sheet 9 of 19

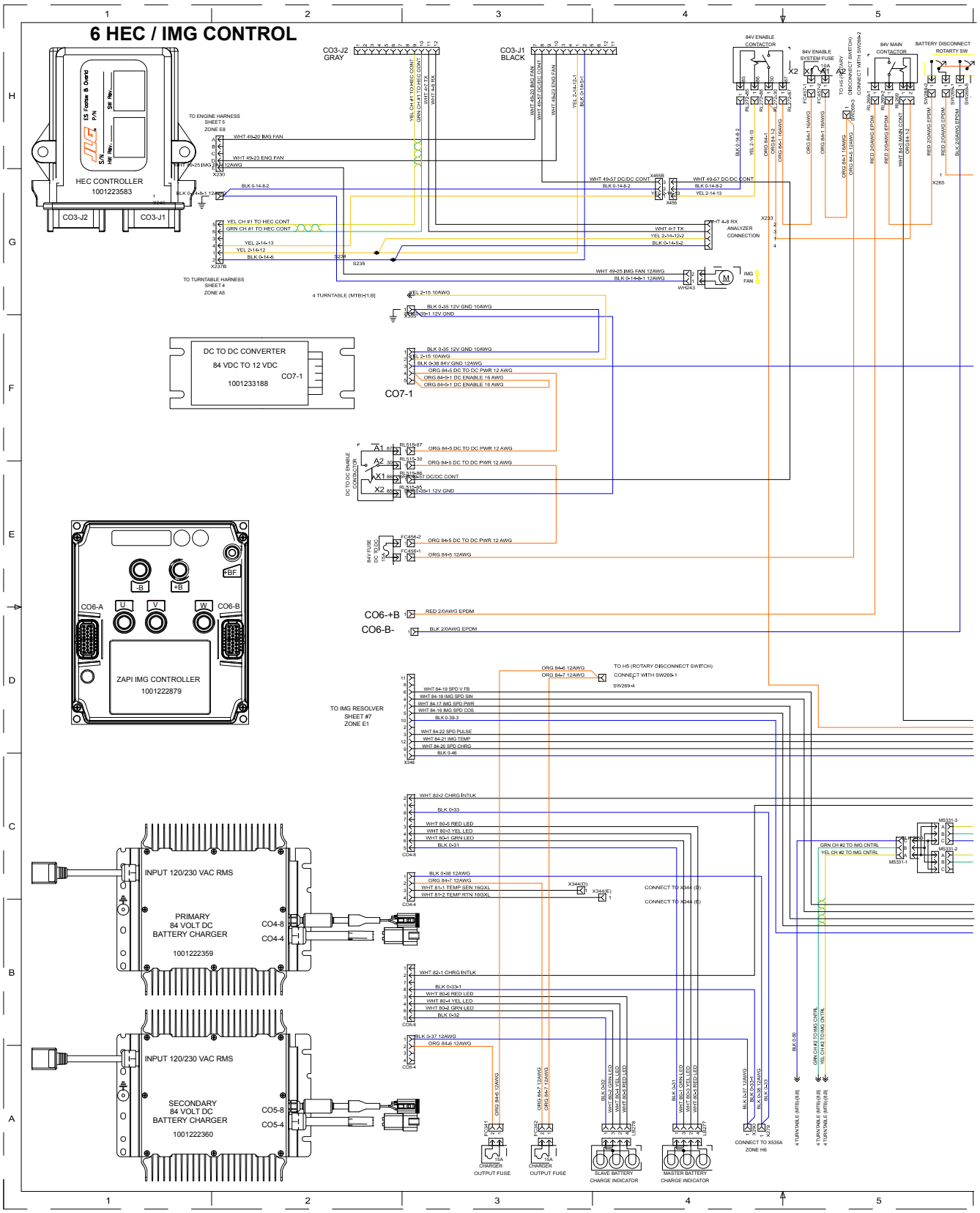


Figure 7-112. Electrical Schematics - Sheet 10 of 19

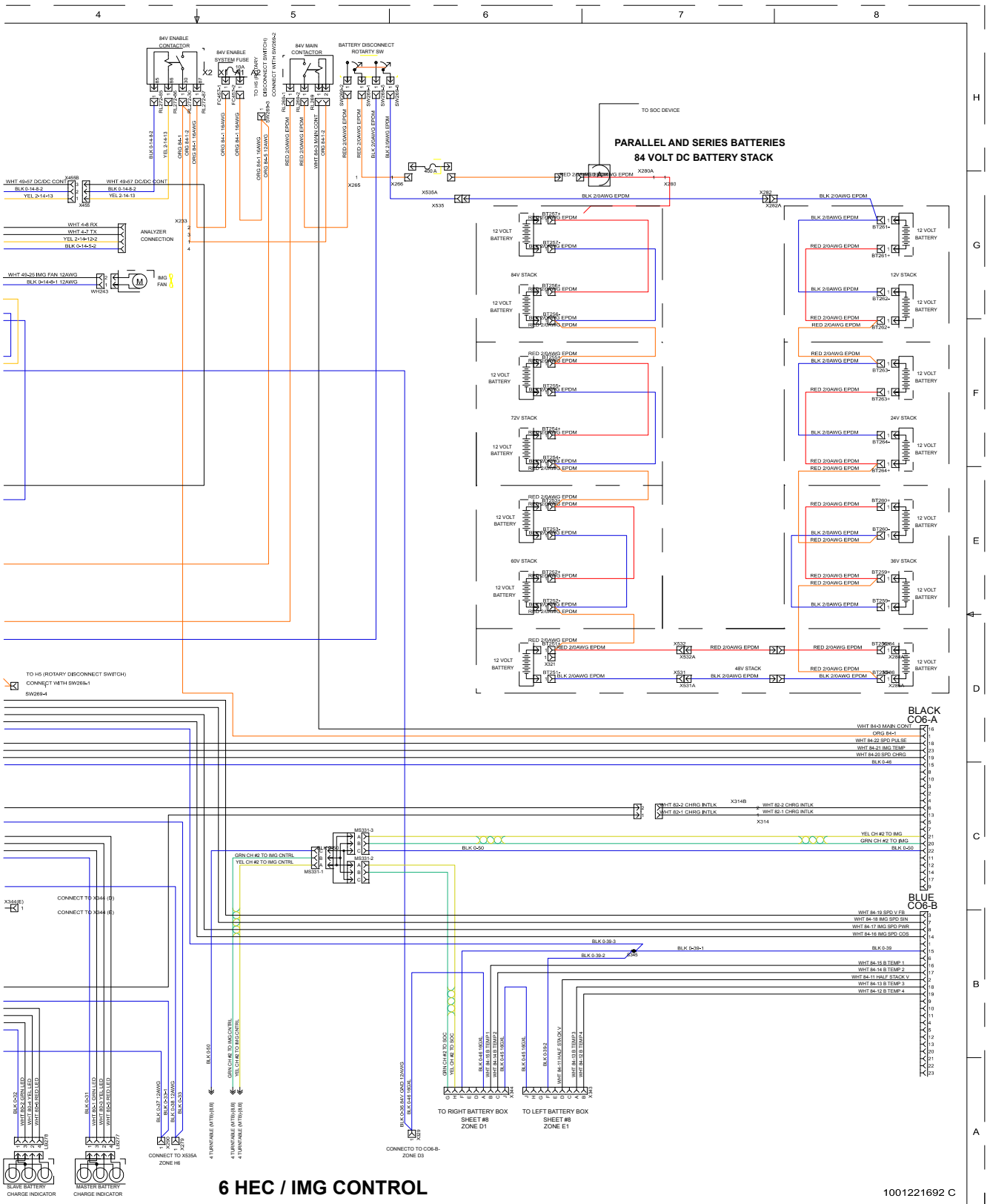


Figure 7-113. Electrical Schematics - Sheet 11 of 19

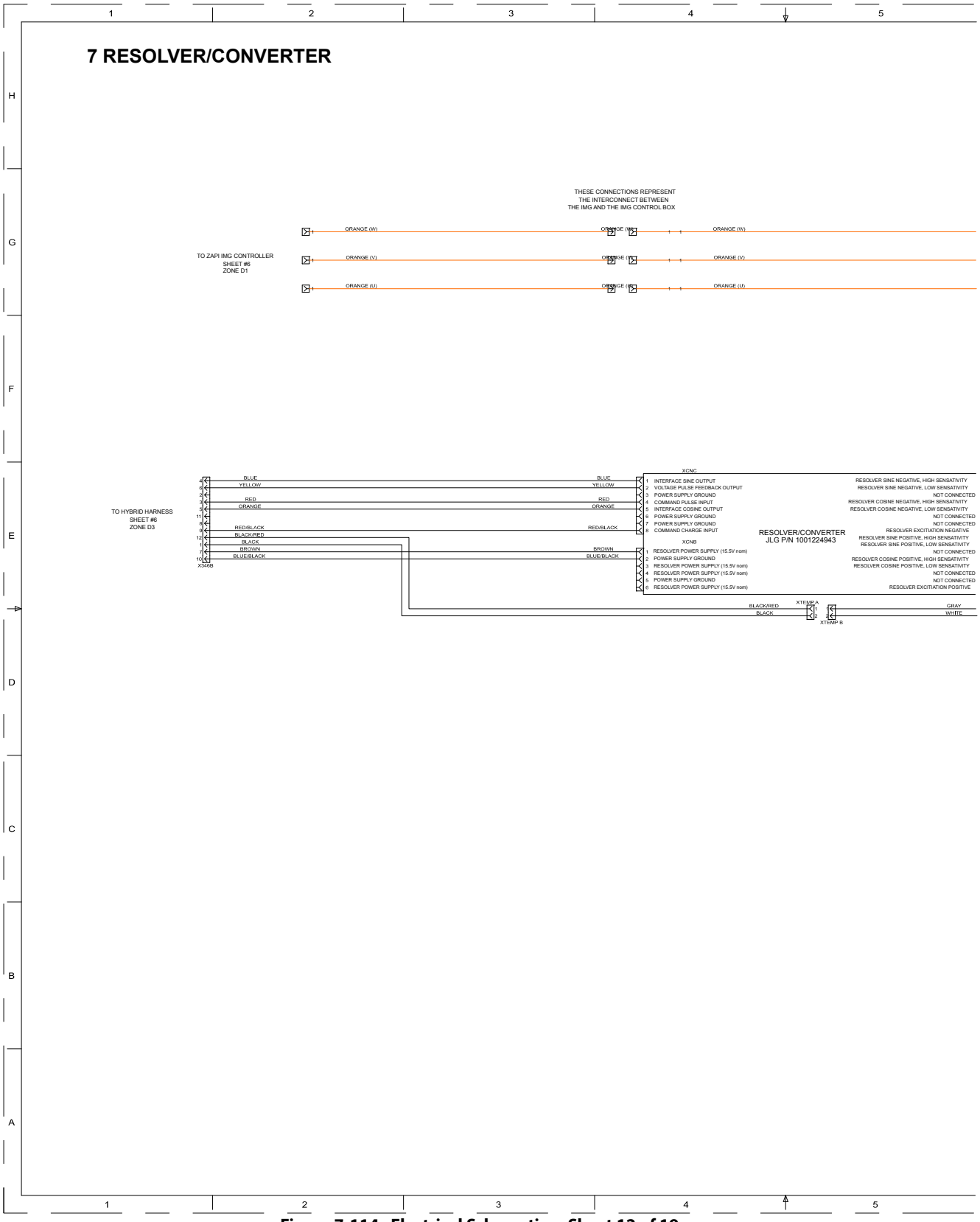


Figure 7-114. Electrical Schematics - Sheet 12 of 19

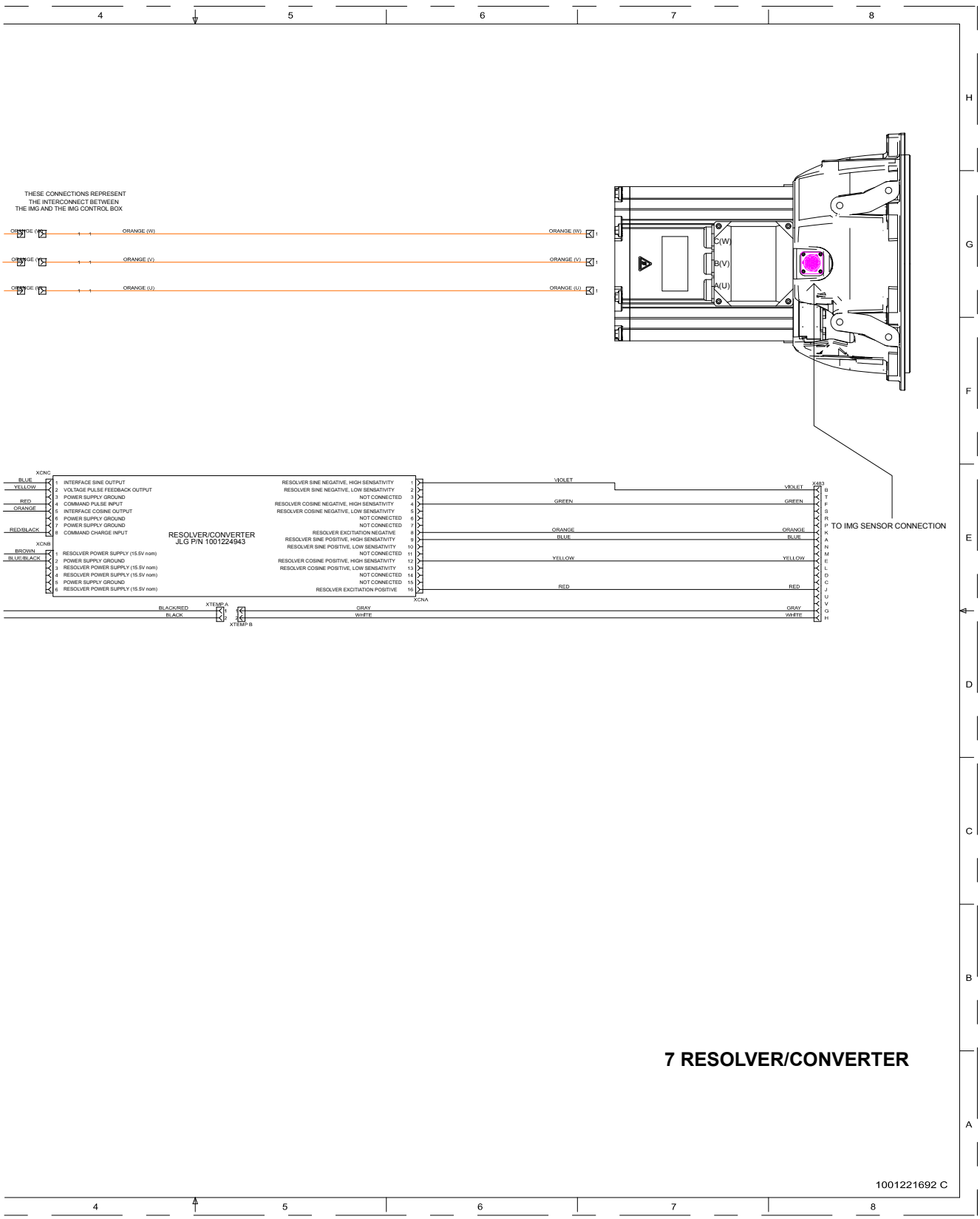


Figure 7-115. Electrical Schematics - Sheet 13 of 19

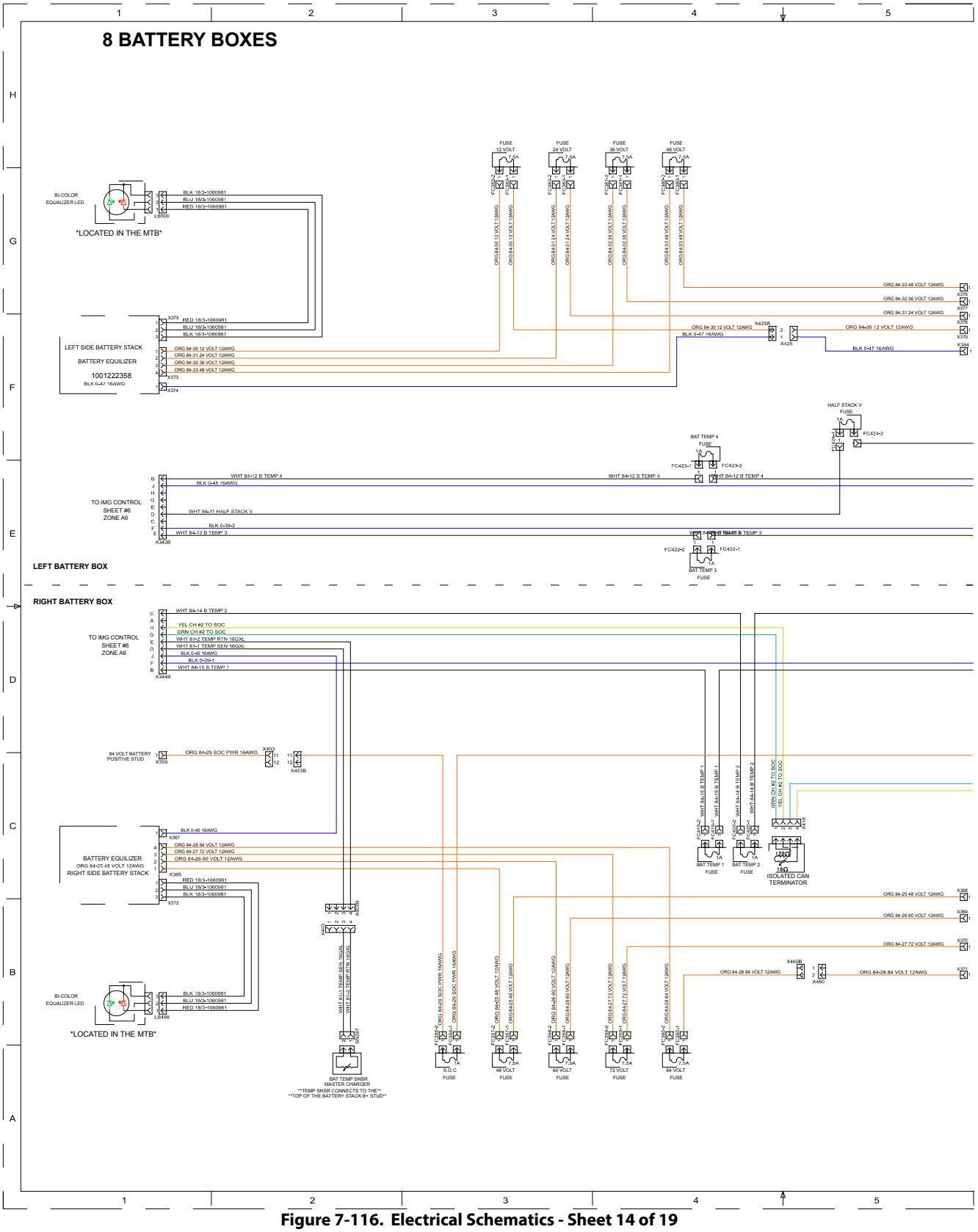


Figure 7-116. Electrical Schematics - Sheet 14 of 19

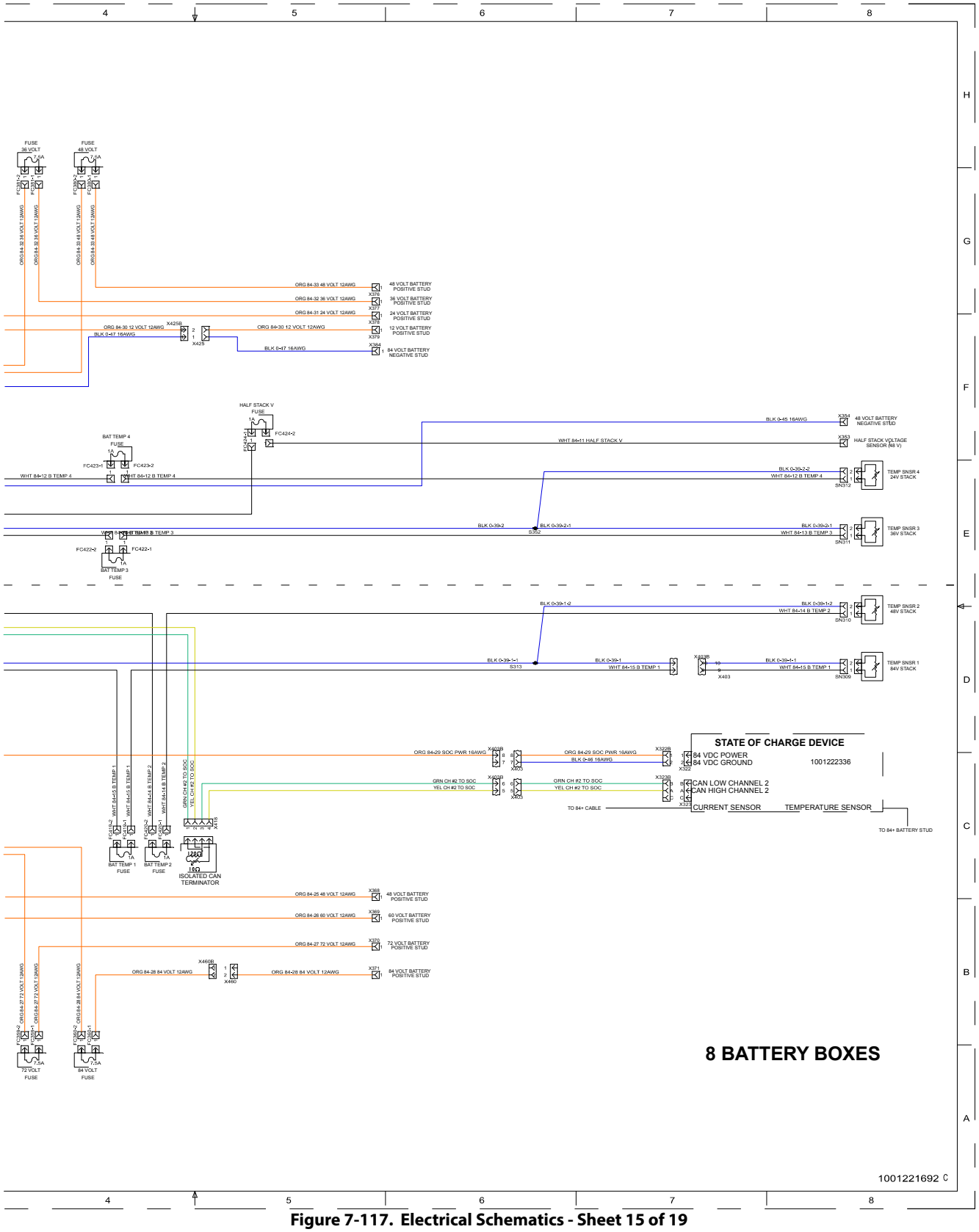


Figure 7-117. Electrical Schematics - Sheet 15 of 19

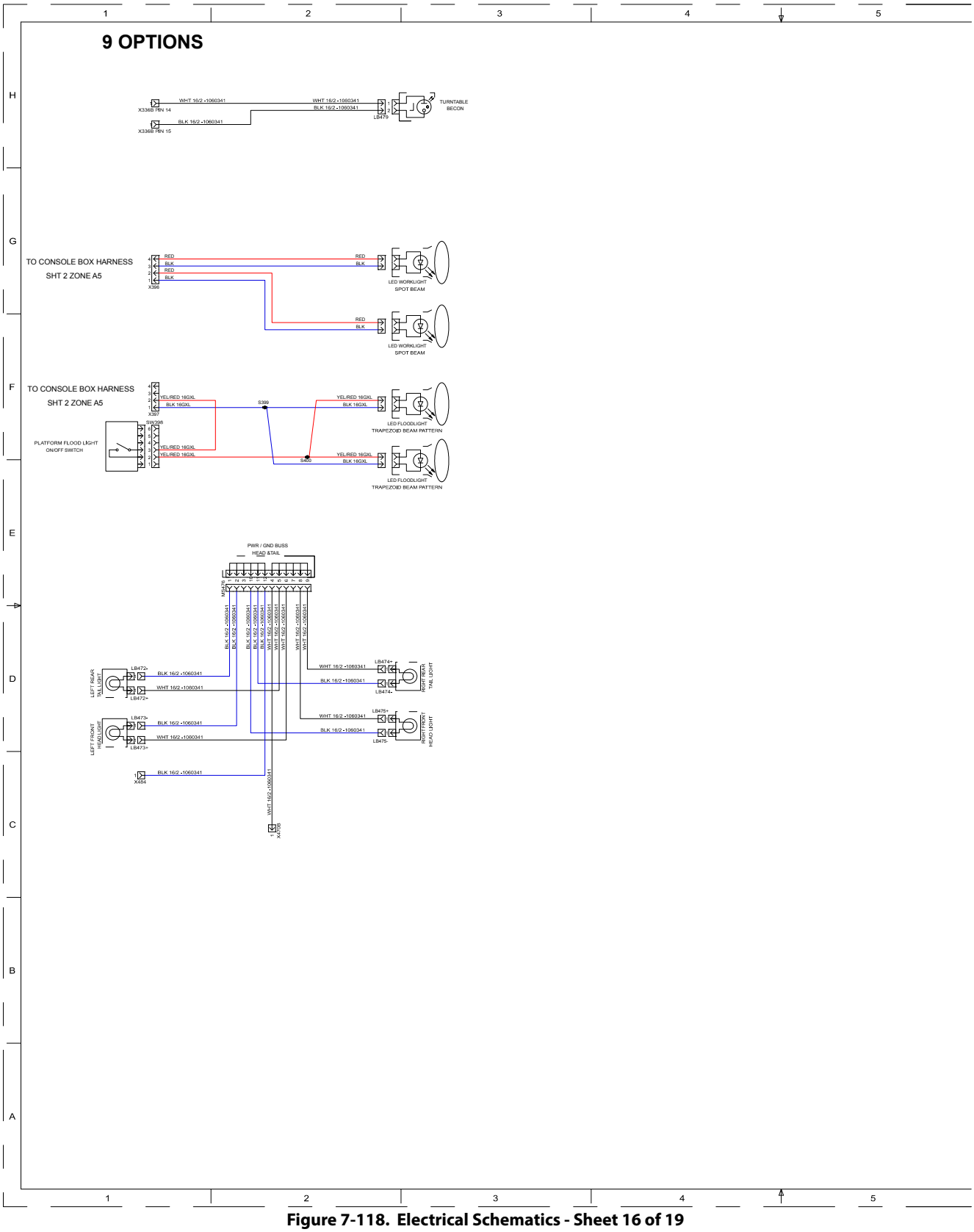
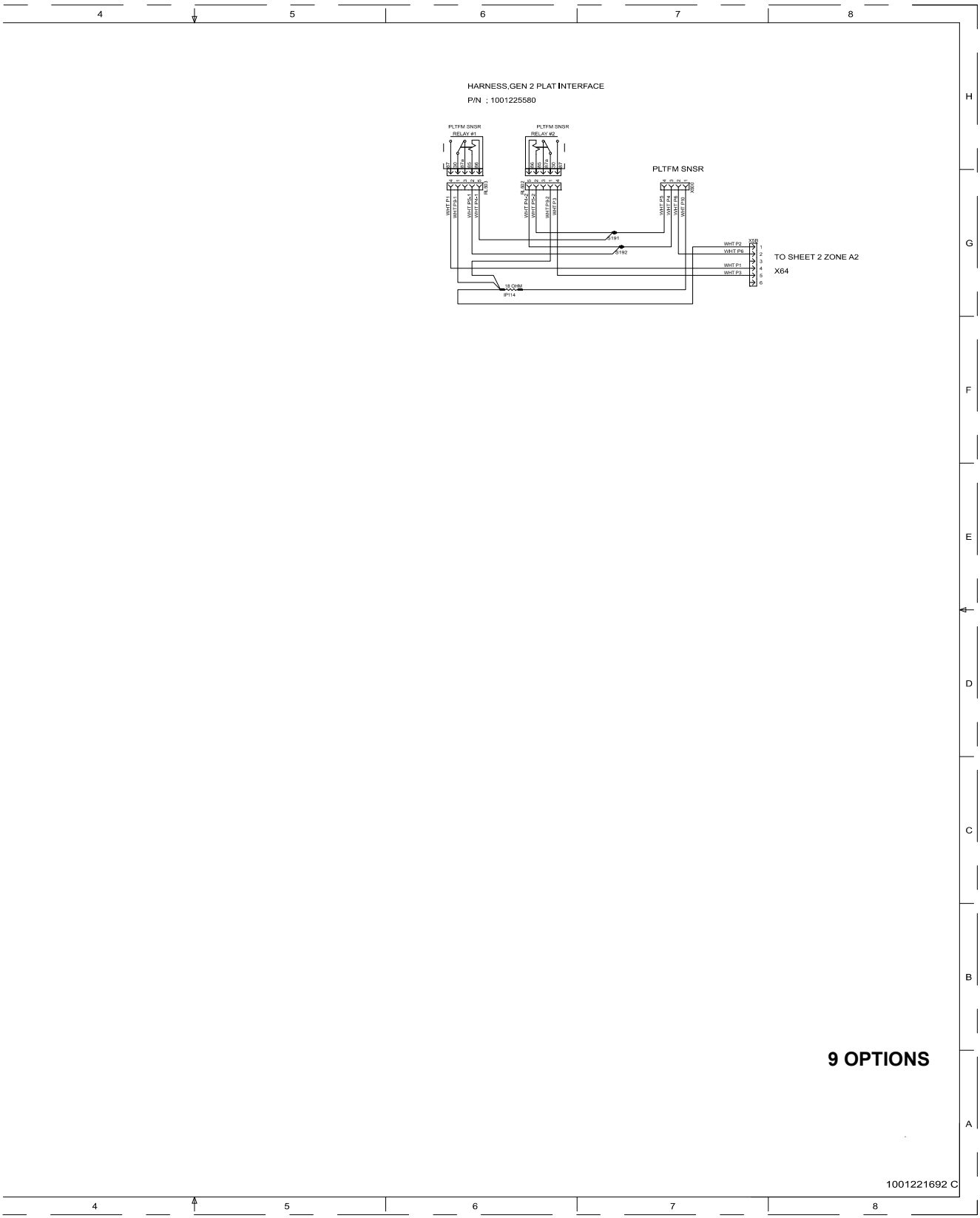


Figure 7-118. Electrical Schematics - Sheet 16 of 19


4
5
6
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H
G
F
E
D
C
B
A
HARNESS,GEN 2 PLAT INTERFACE
P/N ; 1001225580
PLTFM SNSR
RELAY #1
PLTFM SNSR
RELAY #2
PLTFM SNSR
J1
J2
J3
J4
J5
J6
J7
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J10
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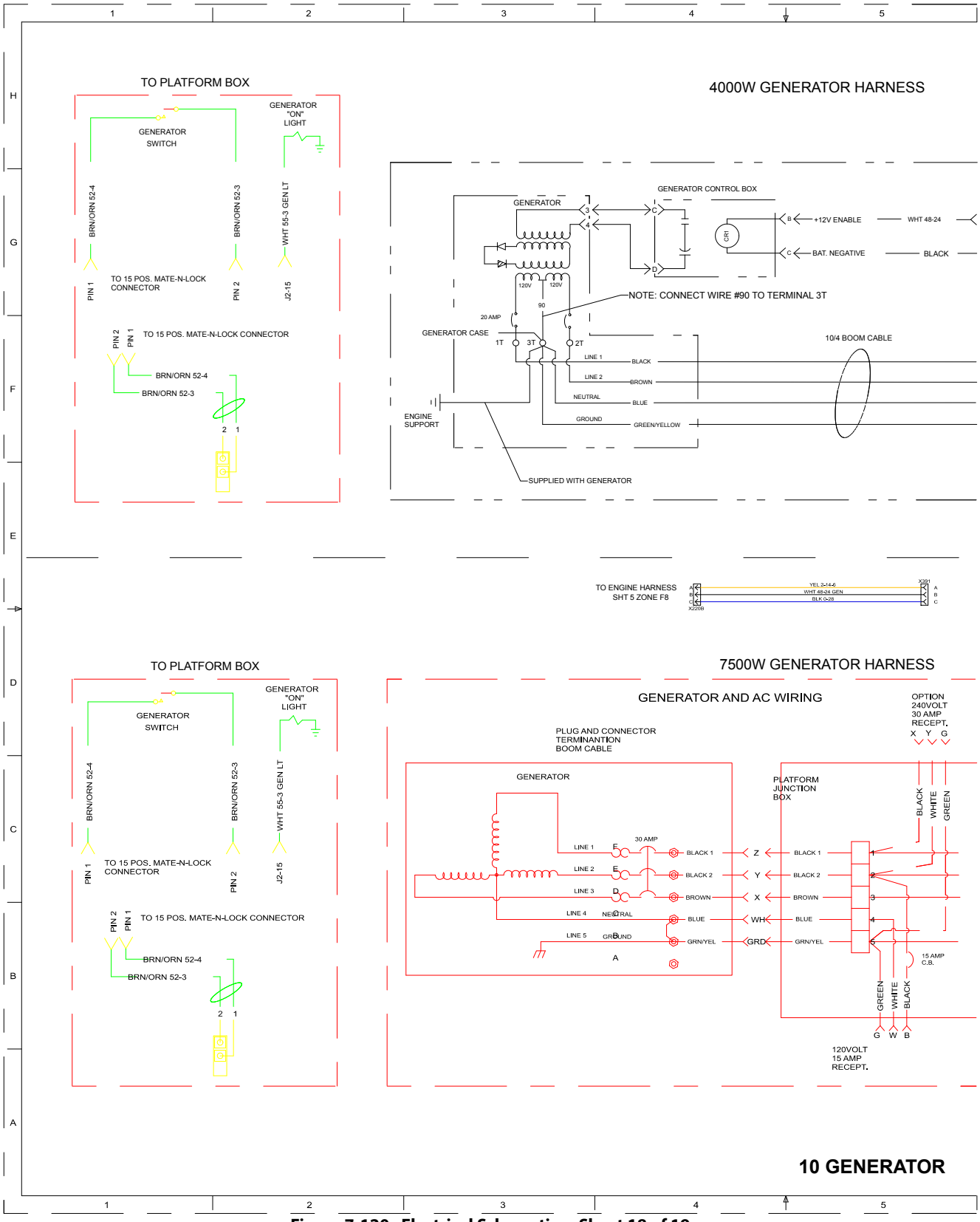


Figure 7-120. Electrical Schematics - Sheet 18 of 19

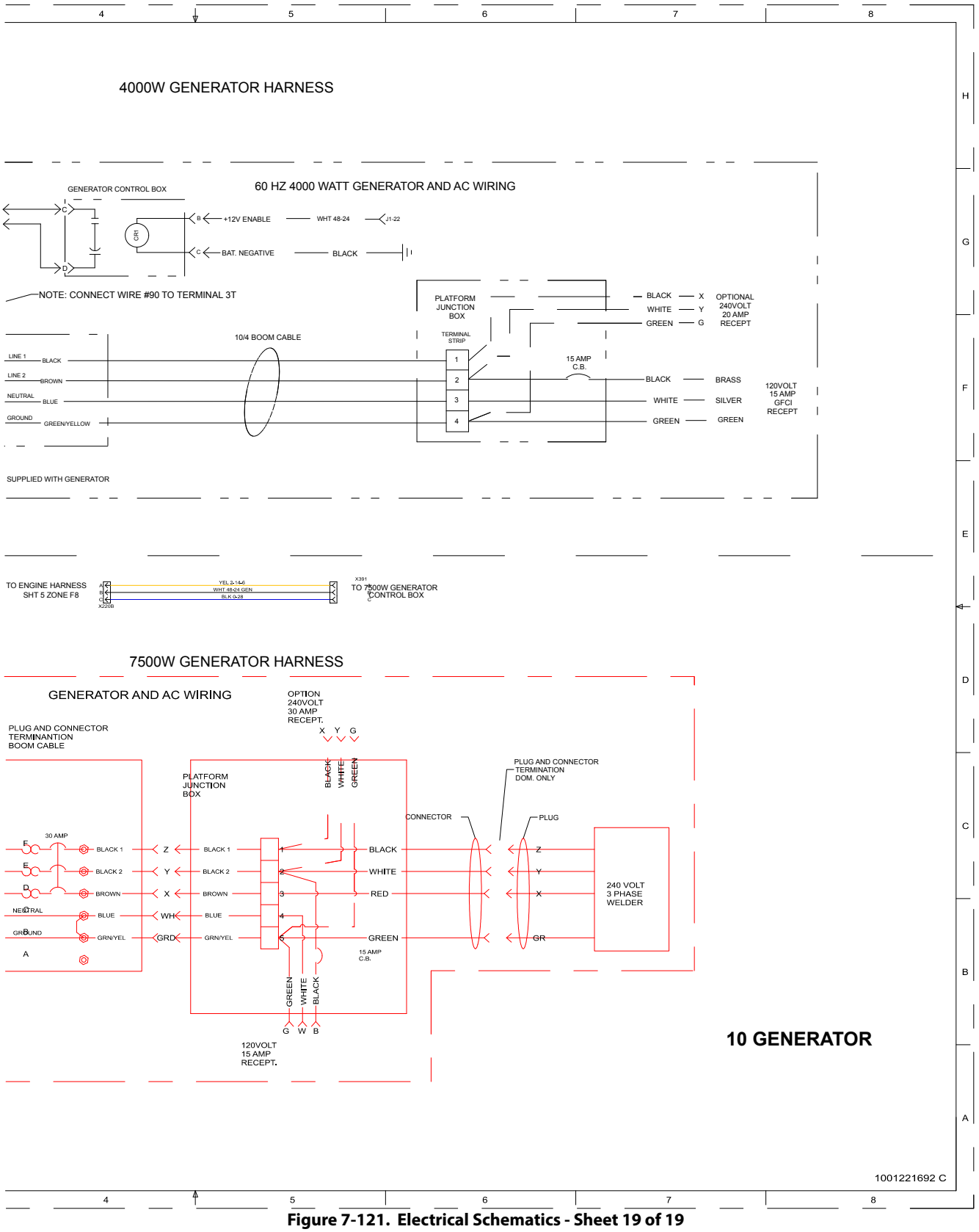


Figure 7-121. Electrical Schematics - Sheet 19 of 19

NOTES:



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