An Oshkosh Corporation Company

Service and Maintenance Manual

Model
800S HC3
860SJ HC3

PVC 2107

31219077

July 12, 2021 - Rev A

ANSI

CE

UK CA

EAC

AS/NZS

SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

A GENERAL

This section contains the general safety precautions which must be observed during maintenance of the Mobile Elevating Work Platform (MEWP). 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 A MOBILE ELEVATING 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.

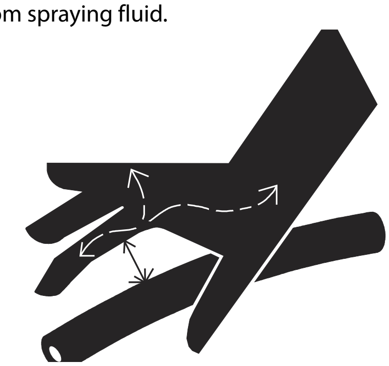
⚠ WARNING

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.

- USE ONLY REPLACEMENT PARTS OR COMPONENTS THAT ARE APPROVED BY JLG. TO BE CONSIDERED APPROVED, REPLACEMENT PARTS OR COMPONENTS MUST BE 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 DISCONNECTED DURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

REVISON LOG

Original Issue	A - July 12, 2021

SECTION NO.	TITLE	PAGE NO.

FIGURE NO.	TITLE	PAGE NO.

FIGURE NO.	TITLE	PAGE NO.

FIGURE NO.	TITLE	PAGE NO.

TABLE NO.	TITLE	PAGE NO.

SECTION 1. SPECIFICATIONS

1.1 OPERATING SPECIFICATIONS

Machine Specifications

Maximum Work Load (Capacity) All Markets Unrestricted Restricted Restricted	 500 lb (227 kg) 750 lb (340 kg) 1000 lb (454kg)
Maximum Operating Slope	4°
Maximum Travel Grade (Gradeability)* 800S 2WD 4WD 860SJ 4WD	 25% 45% 45%
Maximum Travel Grade (Side Slope)*	4°
Maximum Vertical Platform Height 800S 860SJ	 80 ft. (24.38 m) 86 ft. (26.21 m)
Maximum Horizontal Platform Reach 800S 860SJ	 71 ft. 3 in. (21.72 m) 74 ft. 8.9 in. (22.78 m)
Turning Radius- 2WS (600S/660SJ) Outside Inside	 21.7 ft. (6.6 m) 14.76 ft. (4.5 m)
Maximum Drive Speed 800S 860SJ	 3.48 mph (5.6 kph) 3.8 mph (6.3 kph)
Max. Hydraulic System Pressure	4500 psi (310 Bar)
Maximum Wind Speed	28 mph (12.5 m/s)
Maximum Manual Force	400 N
Electrical System Voltage	12 Volts
Gross Machine Weight (Platform Empty) 800S 860SJ	 33,030 lb (14,982 kg) 38,040 lb (17,255 kg)
* With boom in stowed position	

1.2 SPECIFICATIONS AND PERFORMANCE DATA

Swing	360°
Tail Swing	4 ft. 8.9 in. (1.44 m)
Platforms	36 in. x 96 in. (0.91 m x 2.44 m)
Overall Width	8 ft. 1.52 in. (2.48 m)
Stowed Height	9 ft. 8.1 in. (2.95 m)
Stowed Length 800S 860SJ	 37 ft. 6 in. (11.43 m) 40 ft. 0.4 in. (12.20 m)
Wheel base	10 ft. 0.9 in. (3.07 m)
Ground Clearance 800S 860SJ	 11.1 in. (0.28 m) 1 ft. (0.3 m)
Drive Speed 800S 860SJ	 3.48 mph (5.6 kph) 3.8 mph (6.3 kph)
Ground Bearing Pressure - 800S	72 psi (5.06 kgm/cm^2)
Ground Bearing Pressure - 860SJ	81 psi (5.7 kgm/cm^2)
Occupied Floor Area	107.17 ft.^{2} (9.96 m^2)

1.3 CAPACITIES

Fuel Tank (Diesel)	Approx. 31 gallons (117 liters)
Fuel Tank (Optional) (Gas)	
Drive Hub	58 ounces (1.7 L)
Hydraulic Tank (to Full Line on Sight Gauge)	Approx. 21 gallons (79.4 liters)
Engine Oil Capacity Deutz D2011L04 Deutz TD 2.9L4 Ford MSG425-DF	 11 Quarts (10.5 L) 9.4 Quarts (8.9 L) 7 Quarts (6.6 L)

1.4 COMPONENT DATA

Engine Data

Table 1-1. Deutz D2011L04 Specs

Fuel	Diesel (10,000 ppm Max Sulfur Content)
Max Output (Power)	61.6 hp (46 kW) @ 2600 rpm
Max Output (Torque)	140 ft.lbs. (190 Nm) @ 1700 rpm
Oil Capacity	11 Quarts (10.5 L)
Low RPM	1000 ± 50 rpm
High RPM	2600 ± 50 rpm
Alternator	12 V, 55 Amp
Battery	950 Cold Cranking Amps, 205 Minutes Reserve Capacity, 12 VDC
Average Fuel Consumption (may vary with application)	0.88 GPH (3.33 lph)

Table 1-2. Deutz TD 2.9 L4 T4F Specs

Fuel	Ultra Low Sulfur Diesel (15 ppm)
Max Output (Power)	67 hp (50 kW) @ 2600 rpm
Max Output (Torque)	173 ft. lbs. (234 Nm) @ 1800 rpm
Oil Capacity	9.4 Quarts (8.9 L)
Cooling System Capacity	3.3 Gallon (12.5 L)
Low RPM	1200 ±50 rpm
High RPM	2600 ±50 rpm
Alternator	12 V, 55 Amp
Battery	950 Cold Cranking Amps, 205 Minutes Reserve Capacity, 12 VDC
Average Fuel Consumption (may vary with application)	1.06 GPH (4.0 LPH)

Table 1-3. Ford 2.5L DF, MSG-425 Specs

Fuel	Unleaded Gasoline: 87 -89 Octane Ethanol/Gasoline Mix: 10% Ethanol max Propane: HD-SLPG
Max Output (Power) Gasoline LP	 84 hp (62 kW) @ 3200 rpm 80 hp (59 kW)@ 3200 rpm
Max Output (Torque) Gasoline LP	 142 ft. lbs. (192Nm) @2400 RPM 145 ft. lbs. (197Nm) @2400 RPM
Oil Capacity	7 qt (6.6 L)
Coolant System Capacity	2 Gallon (7.5 L)
Low RPM	1000 ±50 rpm
High RPM	3200 ±50 rpm
Alternator	12V, 150 Amp
Battery	950 Cold Cranking Amps, 205 Minutes Reserve Capacity, 12 VDC
Average Fuel Consumption (may vary with application) Gasoline LP	 0.99 GPH (3.74 LPH) 0.68 GPH (2.57 LPH)

Table 1-4. Deutz TD 2.9 L4 Stage V Specs

Fuel	Diesel (10,000 ppm Max Sulfur Content)
Max Output (Power)	61.6 hp (46 kW) @ 2600 rpm
Max Output (Torque)	140 ft.lbs. (190 Nm) @ 1700 rpm
Oil Capacity	11 Quarts (10.5 L)
Cooling System	0.92 Gallons (3.5 L)
Low RPM	1000 ± 50 rpm
High RPM	2600 ± 50 rpm
Alternator	12 V, 55 Amp
Battery	950 Cold Cranking Amps, 205 Minutes Reserve Capacity, 12 VDC
Average Fuel Consumption (may vary with application)	1.4 GPH (5.4 lph)

Battery

Voltage	12 Volt
Type	31-950
Cold Cranking Amps	950 CCA @ 0° F (-18° C)
Reserve Capacity	205 Minutes @ 80° F (27° C)

1.5 TIRES

Size	Type	Ply Rating	Load Range	Pressure
15 - 625	Foam-Filled	16	H	N/A
18 - 625	Foam-Filled	16	H	N/A

1.6 TORQUE REQUIREMENTS

Description	Torque Value (Dry)	Interval Hours
Wheel Lugs	300 ft. lbs. (407 Nm)	150
Swing Bearing Bolts	190 ft. lbs. (258 Nm)	50/600*
Starter Solenoid Contacts Coil	 95 in. lbs. (9.5 Nm) 40 in. lbs. (4 Nm)	As required
*Check swing bearing bolts for security after first 50 hours of operation and every 600 hours thereafter (See Swing Bearing in Section 3).		
NOTE: *When maintenance becomes necessary or a fastener has loosened, refer to the Torque Chart to determine proper torque value.*		

1.7 LUBRICATION

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 Standard UTTO Fluid, 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 Premium Hydraulic Fluid.*

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 1-5. Standard UTTO Hydraulic Fluid Specs

Inspection Data	Recommended SHELL SPIRAX S4 TXM	Optional MOBIFLUID 424
ISO Viscosity Grade	68	68
Spec Gravity API	0.882	0.880
Flash Point, °F (°C)	428 (220)	442 (228)
Pour Point, °F (°C)	-44 (-42)	-46 (-43)
Base Oil Type	HV	HV
Viscosity		
Viscosity, cST at 40° C	66.93	60.21
Viscosity, cST at 100° C	10.53	9.26
Viscosity Index	146	134

Table 1-6. UCon Hydrolube HP-5046D Specs

Inspection Data	Required
ISO Viscosity Grade	46
Specific Gravity at 25° C	1.088
Pour Point, ° F (° C)	-81.4 (-63)
pH	9.0 - 10.
Viscosity	
Viscosity, cST at 0° C	340
Viscosity, cST at 40° C	46
Viscosity, cST at 65° C	22
Viscosity Index	192

Table 1-7. Premium Hydraulic Fluid (VG 32) Specs

Inspection Data	Recommended SHELL TELLUS S2 VX 32	Optional PREMIUM HYDRAULIC FLUID
ISO Viscosity Grade	32	32
Specific Gravity	0.854	0.847
Pour Point, ° F (° C)	-38.2 (-39)	-65.2 (-54)
Flash Point, ° F(° C)	419 (215)	482 (250)
Base Oil Type	HV	HV
Viscosity		
Viscosity, cST at 40° C	33.01	32.76
Viscosity, cST at 100° C	6.26	6.58
Viscosity Index	142	161

Table 1-8. Biodegradable Synthetic Hydraulic Fluid (VG 46) Specs

Inspection Data	Recommended SHELL NATURELLE HF-E46	Optional MOBIL EAL ENVIROSYN H46
ISO Viscosity Grade	46	46
Specific Gravity	0.921	0.874
Pour Point, ° F (° C)	-43.6 (-42)	-49 (-45)
Flash Point, ° F(° C)	611.6 (322)	500 (260)
Base Oil Type	POLYOL ESTER	FATTY ACID ESTER
	HEES	-
	HFDU	-
Auto-Ignition Temp, ° C	>400	
Biodegradability (% 28 Days)	76	>60
Viscosity		
Viscosity, cST at 40° C	46.20	43.42
Viscosity, cST at 100° C	9.41	7.69
Viscosity Index	193	147

Table 1-9. Premium Hydraulic Fluid (All Weather) Specs

Inspection Data	Unsheared	Sheared	Unsheared	Sheared
	Recommended SHELL TELLUS S4 VX 32		Optional MOBIL UNIVIS HVI 26	
ISO Viscosity Grade	32		26	
Specific Gravity	0.866	-	0.89	-
Flash Point, ° F(° C)	>212 (>100)		>201.2 (>94)	
Pour Point, ° F (° C)	-76 (-60)		-76 (-60)	
Base Oil Type	HV		HV	
Viscosity				
Viscosity, cST at 40° C	31.41	21.64	25.78	15.28
Relative Viscosity Loss	31.1%		40.7%	
Viscosity, cST at 100° C	9.17	6.10	8.74	5.02
Relative Viscosity Loss	33.5%		42.6%	
Viscosity Index	296	258	352	304

1.8 PRESSURE SETTINGS

Telescope In	2600 psi (179 Bar)
Swing, Left & Right	1575 psi (109 Bar)
Steer	2500 psi (172 Bar)
Platform Level Up	2600 psi (179 Bar)
Platform Level Down	1800 psi (124 Bar)
Jib Down	1900 psi (131 Bar)

1.9 MAJOR COMPONENT WEIGHTS

Component	Pounds	Kilograms
Turntable (bare) (860SJ)	3272	1484
Turntable (bare) (800S)	3302	1498
Counterweight (860SJ)	8750	3969
Counterweight (800S)	7000	3175
Upright	1127	511
Tower (860SJ)	697	316
Tower (800S)	489	222
Fly Boom (860SJ)	484	220
Fly Boom (800S)	488	221
Mid Boom (860SJ)	338	153
Mid Boom (800S)	726	330
Base Boom (860SJ)	1480	672
Base Boom (800S)	1497	680
Boom Assembly (860SJ)	3488	1582
Boom Assembly (800S)	3505	1590
Telescope Cylinder (860SJ)	589	267
Telescope Cylinder (800S)	606	275
Slave Cylinder (860SJ)	99	45
Slave Cylinder (800S)	63	29
Torque Hub	223	101
Tire & Wheel (FF) (15-625)	544	247
Tire & Wheel (FF) (18-625)	601	273
Lift Cylinder (860SJ)	620	281
Lift Cylinder (800S)	692	314
Deutz TD2.9L	1433	650
Deutz D2011L04	983	445
Deutz TD 2.9L4	1511	686
Ford MSG425-DF	353	160

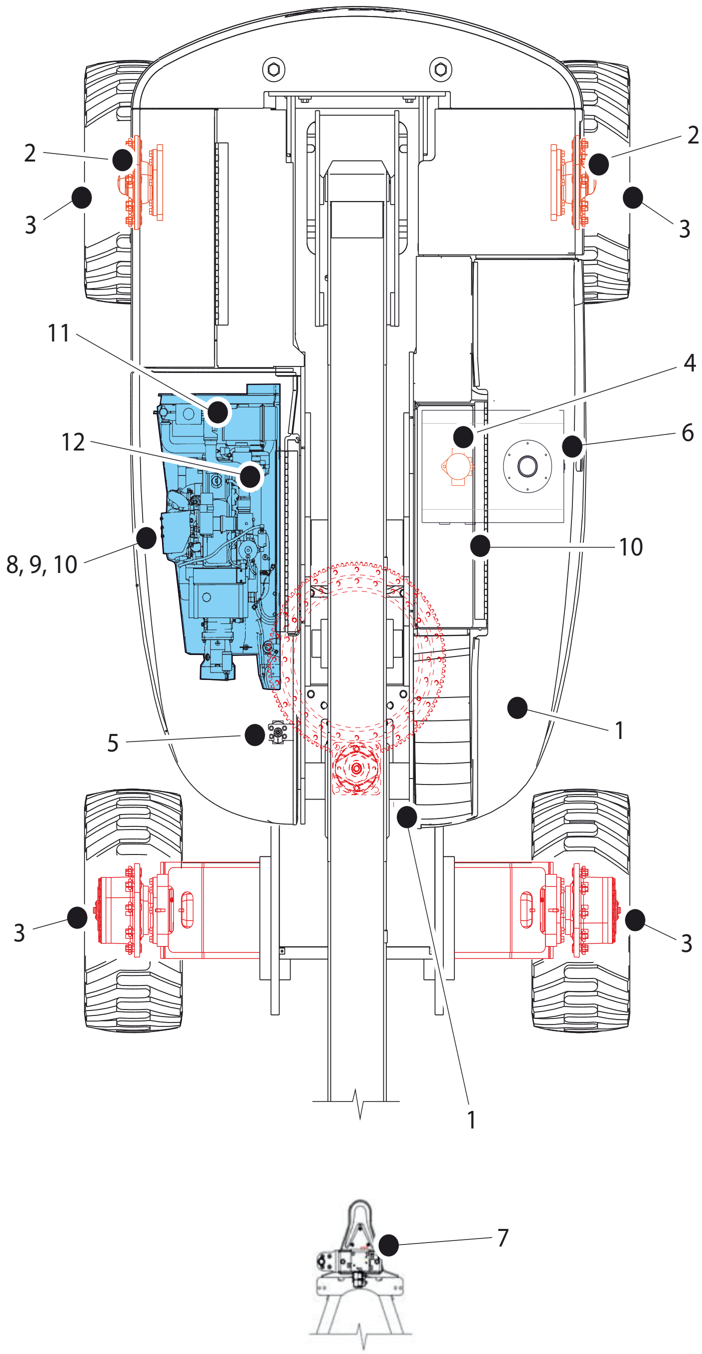


Figure 1-1. Operator Maintenance and Lubrication Diagram

1.10 OPERATOR MAINTENANCE

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

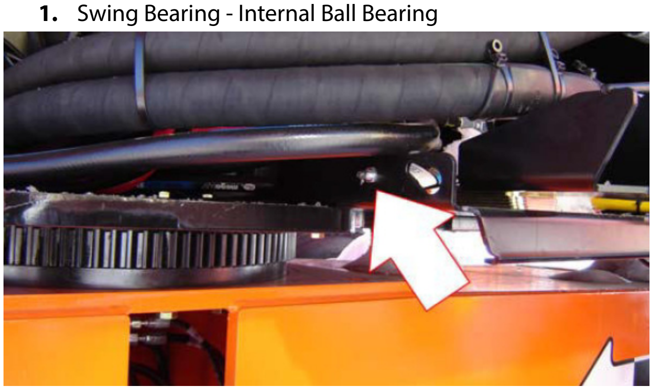
KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350° F (177° C). Excellent water resistance and adhesive qualities, and being of extreme pressure type (Timken OK 40 pounds minimum).
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL Spec MIL-L-2105.
HO	Hydraulic Oil. API service classification GL-3, e.g. Mobilfluid 424.
EO	Engine (crankcase). Gas (5W30) - API SN, -Arctic ACEA AI/BI, A5/B5 - API SM, SL, SJ, EC, CF, CD - ILSAC GF-4. Diesel (15W40, 5W30 Arctic) - API CJ-4.

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.

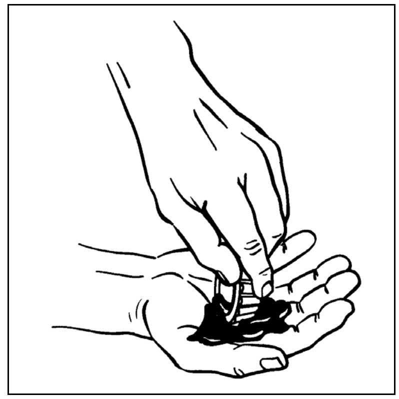
NOTE: *It is recommended as a good practice to replace all filters at the same time.*

1. Swing Bearing - Internal Ball Bearing



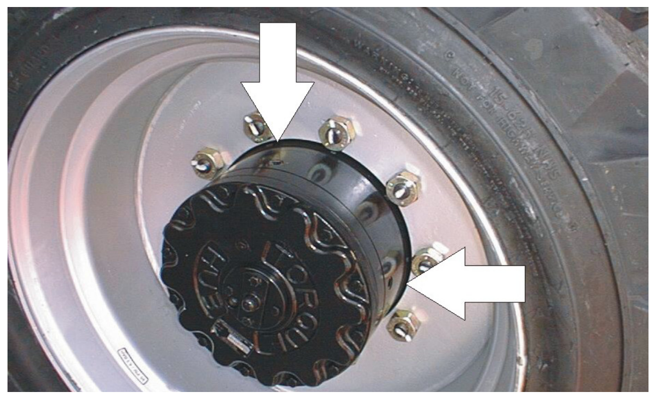
Lube Point(s) - 1 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hrs of operation
Comments - Remote Access.

2. Wheel Bearings



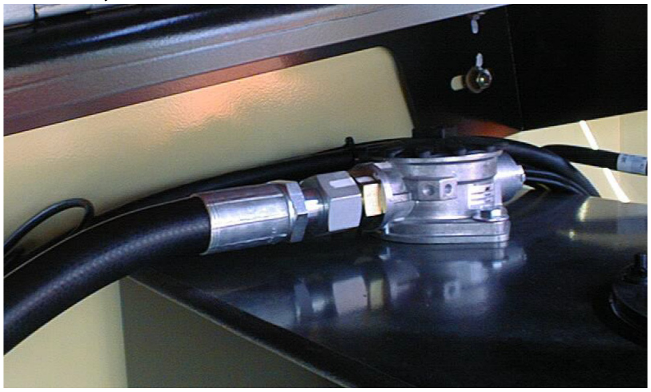
Lube Point(s) - Repack
Capacity - A/R
Lube - MPG
Interval - Every 2 years or 1200 hours of operation.

3. Wheel Drive Hub



Lube Point(s) - Level/Fill Plug
Capacity - 44 oz. (1.3 L) - 1/2 Full
Lube - EPGL
Interval - Check level every 3 months or 150 hours 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.

4. Hydraulic Return Filter



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

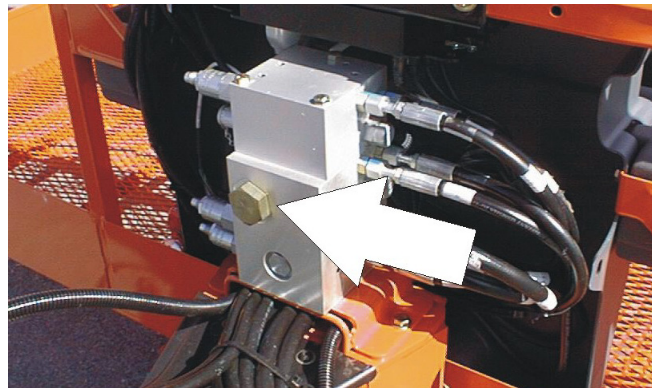
5. Hydraulic Charge Filter

Interval - Change after first 50 hours and every 6 months or 300 hours thereafter or as indicated by Condition Indicator (if equipped).

6. Hydraulic Tank

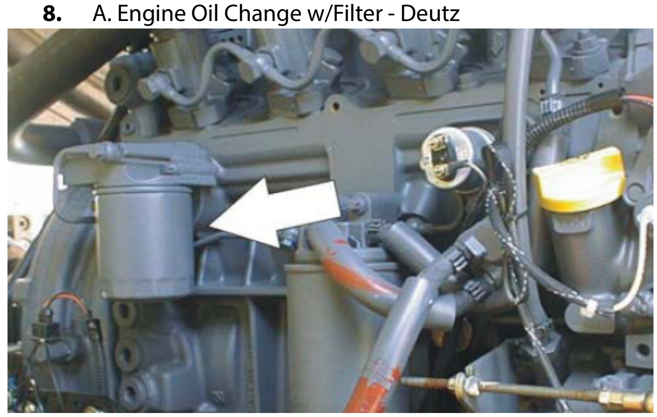
Lube Point(s) - Fill Cap
Capacity - Tank (to Full mark on sight gauge)- Approx. 21 gallons (79.5 liters)
System Capacity - 59 gallons (223 liters)
Lube - HO
Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

7. Platform Filter



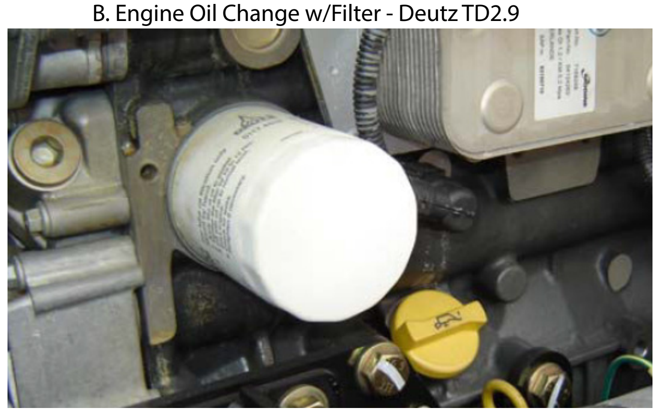
Interval - Change as necessary.

8. A. Engine Oil Change w/Filter - Deutz



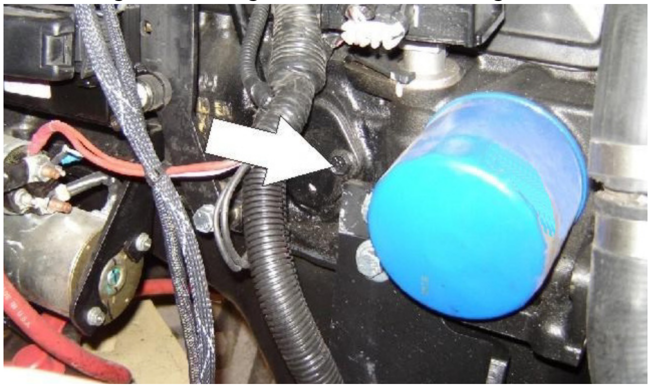
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 11 Quarts(10.5 L)
Interval - Every Year or 1200 hours of operation
Comments - Check level daily/Change in accordance with engine manual. Use Deutz approved engine oil type.

B. Engine Oil Change w/Filter - Deutz TD2.9



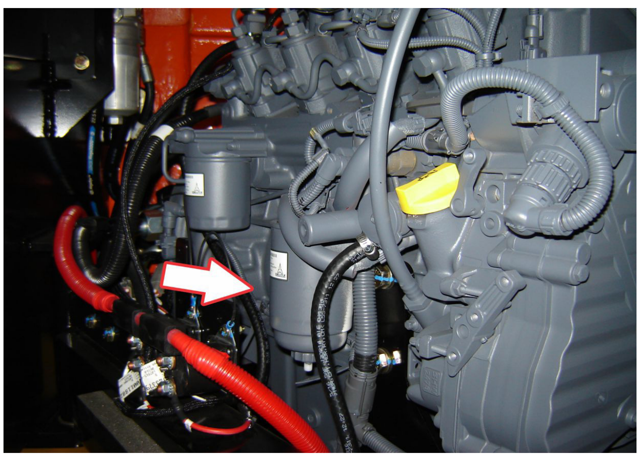
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 9.6 Quarts (9.0 L)
Interval - Every Year or 600 hours of operation
Comments - Check level daily/Change in accordance with engine manual. Use Deutz approved engine oil type.

9. Engine Oil Change w/Filter - Ford 2.5L Engine



Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 7 Quarts (6.6 L) w/filter
Interval - Every Year or 300 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

10. A. Fuel Filter - Deutz D2011



Lube Point(s) - Replaceable Element
Interval - Filter must be replaced every year or 600 hours of operation (whichever comes first).

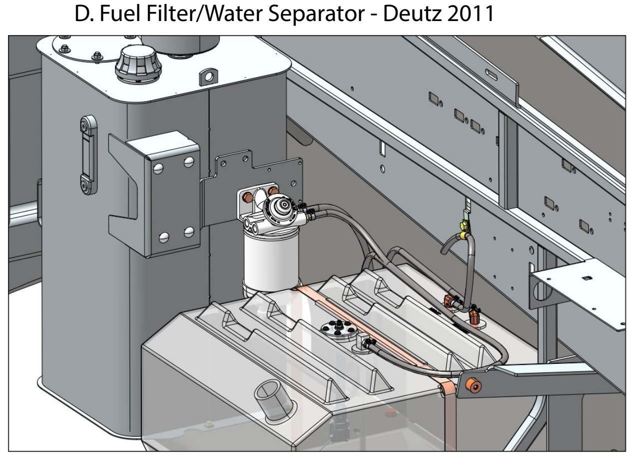
B. Fuel Pre-Filter - Deutz TD2.9 (On Hydraulic Tank)

Lube Point(s) - Replaceable Element
Interval - Drain water daily; Filter must be replaced every year or 600 hours of operation (whichever comes first).

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

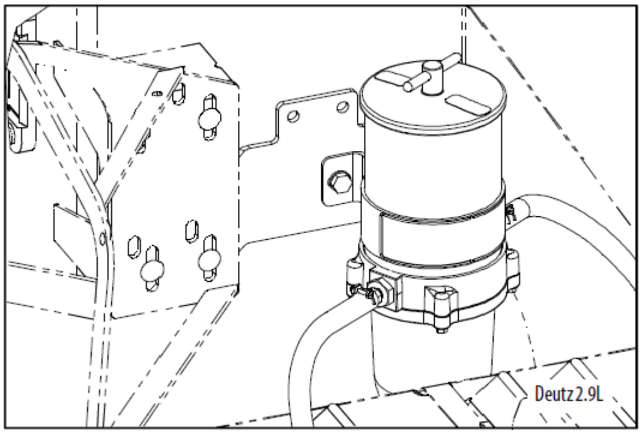
Lube Point(s) - Replaceable Element
Interval - Filter must be replaced every year or 600 hours of operation (whichever comes first).

D. Fuel Filter/Water Separator - Deutz 2011



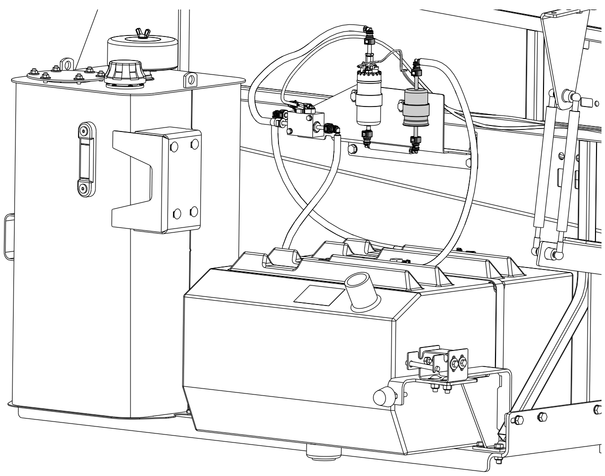
Lube Point(s) - Replaceable Element (optional fuel filter)
Interval - Drain water daily; Every year or 600 hours of operation (whichever comes first).

E. Fuel Filter/Water Separator - Deutz TD 2.9 L4



Lube Point(s) - Replaceable Element
Interval - Drain water daily; Every year or 600 hours of operation (Whichever comes first).

F. Fuel Filter - Ford MSG425



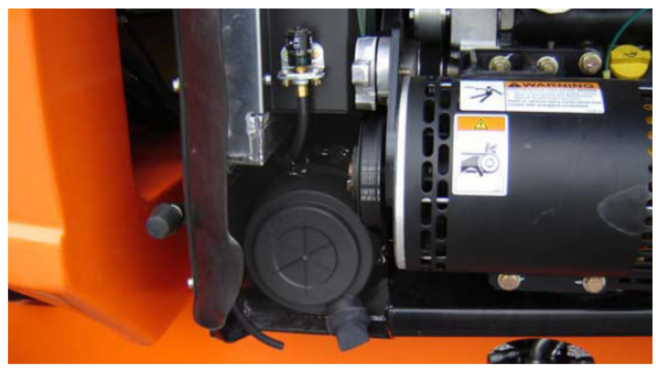
MAE21960

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

11. A. Air Filter

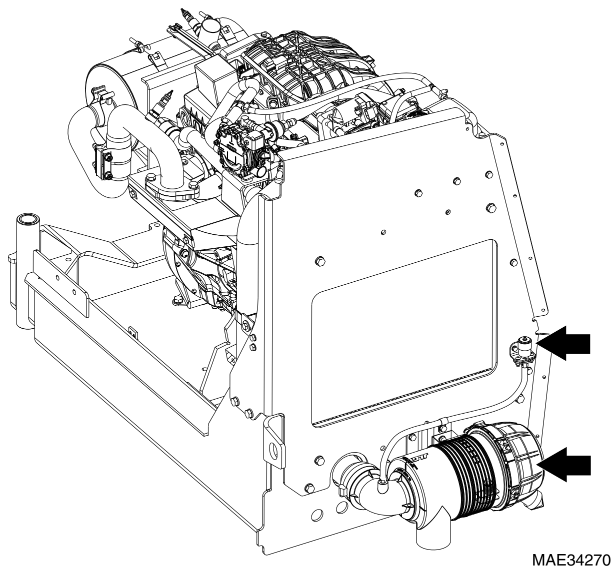
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator.

B. Air Filter (Deutz TD 2.9)



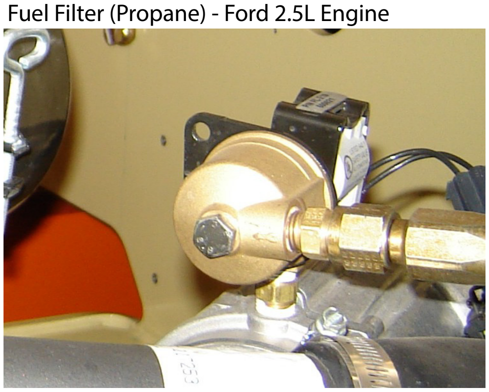
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator.

C. Air Filter - Ford MSG425



Interval - Replaceable Element
Comments - Every 6 months or 300 hours of operation or as indicated by the condition indicator.

12. Fuel Filter (Propane) - Ford 2.5L Engine



Interval - 3 Months or 150 hours of operation
Comments - Replace filter. Refer to engine service manual.

13. Engine Coolant

A. Deutz TD2.9L4
Lube Point(s) - Fill Cap
Capacity - 9.4 quart (8.9 L)
Lube - Anti-Freeze
Interval - Check level daily; change every 1000 hours or two years, whichever comes first.

B. Ford MSG425
Lube Point(s) - Fill Cap
Capacity - 2 gal. (7.5 L)
Lube - Anti-Freeze
Interval - Check level daily; change every 1000 hours or two years, whichever comes first.

14. Diesel Particulate Filter (DPF) - If Equipped

For Detail Inspection and Maintenance of DPF filter refer Section 3.27, Diesel Particulate Filter (If Equipped).

1.11 SERIAL NUMBER LOCATION

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

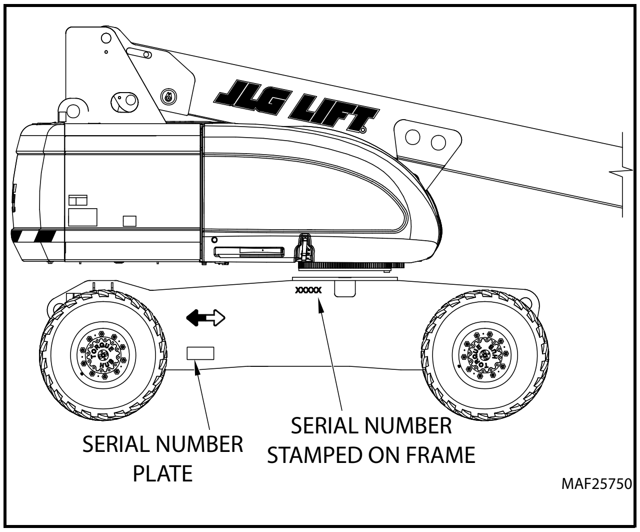


Figure 1-2. Serial Number Locations

1.12 THREADLOCKING COMPOUND

JLG PN	Loctite®	ND Industries	Description
0100011	242™	Vibra-TITE™ 121	Medium Strength (Blue)
1001095650	243™	Vibra-TITE™ 122	Medium Strength (Blue)
0100019	271™	Vibra-TITE™ 140	High Strength (Red)
0100071	262™	Vibra-TITE™ 131	Medium - High Strength (Red)

NOTE: *Loctite® 243™ can be substituted in place of Loctite® 242™. Vibra-TITE™ 122 can be substituted in place of Vibra-TITE™ 121.*

1.13 TORQUE CHARTS

SAE Fastener Torque Chart

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)												
SAE GRADE 5 BOLTS & GRADE 2 NUTS												
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry)		Torque Lubricated		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or Vibra-TITE™ 111)	
		In	Sq In	LB	IN-LB	[N.m]	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				
10	24	0.1900	0.01750	1120	43	4.8	32	3.5				
	32	0.1900	0.02000	1285	49	5.5	36	4				
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12		
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15		
		In	Sq In	LB	FT-LB	[N.m]	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
	24	0.3125	0.0580	3700	19	26	14	19	21	29	17	23
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48	28	38
	24	0.3750	0.0878	5600	35	47	25	34	40	54	32	43
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75	45	61
	20	0.4375	0.1187	7550	55	75	40	54	60	82	50	68
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116	68	92
	20	0.5000	0.1599	10700	90	122	65	88	100	136	80	108
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163	98	133
	18	0.5625	0.2030	12950	120	163	90	122	135	184	109	148
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224	135	183
	18	0.6250	0.2560	16300	170	230	130	176	190	258	153	207
3/4	10	0.7500	0.3340	21300	260	353	200	271	285	388	240	325
	16	0.7500	0.3730	23800	300	407	220	298	330	449	268	363
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646	386	523
	14	0.8750	0.5090	32400	470	637	350	475	520	707	425	576
1	8	1.0000	0.6060	38600	640	868	480	651	675	918	579	785
	12	1.0000	0.6630	42200	700	949	530	719	735	1000	633	858
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142	714	968
	12	1.1250	0.8560	47500	880	1193	660	895	925	1258	802	1087
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175	1598	1009	1368
	12	1.2500	1.0730	59600	1240	1681	920	1247	1300	1768	1118	1516
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074	1322	1792
	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750	2380	1506	2042
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754	1755	2379
	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300	3128	1974	2676

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

5000059K

SAE Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) K=0.20		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) 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]
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	1320	43	5				
10	24	0.1900	0.01750	1580	60	7				
	32	0.1900	0.02000	1800	68	8				
1/4	20	0.2500	0.0318	2860	143	16	129	15		
	28	0.2500	0.0364	3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	25	35	20	25	20	25
	24	0.3125	0.0580	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	7000	45	60	40	55	35	50
	24	0.3750	0.0878	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	9550	70	95	65	90	50	70
	20	0.4375	0.1187	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	12750	105	145	95	130	80	110
	20	0.5000	0.1599	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	16400	155	210	140	190	115	155
	18	0.5625	0.2030	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	20350	210	285	190	260	160	220
	18	0.6250	0.2560	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	30100	375	510	340	460	280	380
	16	0.7500	0.3730	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	41600	605	825	545	740	455	620
	14	0.8750	0.5090	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	51500	860	1170	770	1045	645	875
	12	1.0000	0.6630	59700	995	1355	895	1215	745	1015
1 1/8	7	1.1250	0.7630	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	77000	1445	1965	1300	1770	1085	1475
1 1/4	7	1.2500	0.9690	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	96600	2015	2740	1810	2460	1510	2055
1 3/8	6	1.3750	1.1550	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	118100	2705	3680	2435	3310	2030	2760
1 1/2	6	1.5000	1.4050	126500	3165	4305	2845	3870	2370	3225
	12	1.5000	1.5800	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

5000059K

SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 5 BOLTS & GRADE 2 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	
		In	Sq In	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				
10	24	0.1900	0.01750	1120	36	4.1				
	32	0.1900	0.02000	1285	42	4.7				
1/4	20	0.2500	0.0318	2020	86	9.7	80	9		
	28	0.2500	0.0364	2320	99	11.1	95	11		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	15	20	14	19	15	20
	24	0.3125	0.0580	3700	15	20	15	21	15	20
3/8	16	0.3750	0.0775	4940	25	35	25	34	25	34
	24	0.3750	0.0878	5600	30	40	28	38	25	34
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48
	20	0.4375	0.1187	7550	45	60	44	60	40	54
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75
	20	0.5000	0.1599	10700	75	100	71	97	65	88
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109
	18	0.5625	0.2030	12950	105	145	97	132	90	122
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156
	18	0.6250	0.2560	16300	145	195	136	185	125	170
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272
	16	0.7500	0.3730	23800	255	345	238	324	225	306
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435
	14	0.8750	0.5090	32400	400	545	378	514	355	483
1	8	1.0000	0.6060	38600	545	740	515	700	480	653
	12	1.0000	0.6630	42200	600	815	563	765	530	721
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809
	12	1.1250	0.8560	47500	755	1025	713	969	670	911
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237

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

5000059K

SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) 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	
		In	Sq In	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	1320	37	4				
10	24	0.1900	0.01750	1580	51	6				
	32	0.1900	0.02000	1800	58	7				
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	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
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	410	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	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

5000059K

SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SOCKET HEAD CAPSCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		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	
		In	Sq In	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		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	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
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	415	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	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
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.

5000059K

SAE Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*										
SOCKET HEAD CAPSCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		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	
		In	Sq In	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		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	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
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	415	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	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
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.

5000059K

Metric Fastener Torque Chart

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*							
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS							
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™)	Torque (Lube)	Torque (Loctite® 262™ or 271™ or Vibra-TITE™ 131)	Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 141)
		Sq mm	KN	[N.m]		[N.m]	[N.m]
3	0.5	5.03	2.19	1.3	1.0	1.2	1.4
3.5	0.6	6.78	2.95	2.1	1.6	1.9	2.3
4	0.7	8.78	3.82	3.1	2.3	2.8	3.4
5	0.8	14.20	6.18	6.2	4.6	5.6	6.8
6	1	20.10	8.74	11	7.9	9.4	12
7	1	28.90	12.6	18	13	16	19
8	1.25	36.60	15.9	26	19	23	28
10	1.5	58.00	25.2	50	38	45	55
12	1.75	84.30	36.7	88	66	79	97
14	2	115	50.0	140	105	126	154
16	2	157	68.3	219	164	197	241
18	2.5	192	83.5	301	226	271	331
20	2.5	245	106.5	426	320	383	469
22	2.5	303	132.0	581	436	523	639
24	3	353	153.5	737	553	663	811
27	3	459	199.5	1080	810	970	1130
30	3.5	561	244.0	1460	1100	1320	1530
33	3.5	694	302.0	1990	1490	1790	2090
36	4	817	355.5	2560	1920	2300	2690
42	4.5	1120	487.0	4090	3070	3680	4290

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

5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%
3. * ASSEMBLY USES HARDENED WASHER
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.

Metric Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS, CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAPSCREWS M3 - M5*						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.20	Torque (Lube 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]
3	0.5	5.03	3.13			
3.5	0.6	6.78	4.22			
4	0.7	8.78	5.47			
5	0.8	14.20	8.85			
6	1	20.10	12.5			
7	1	28.90	18.0	25	23	19
8	1.25	36.60	22.8	37	33	27
10	1.5	58.00	36.1	70	65	55
12	1.75	84.30	52.5	125	115	95
14	2	115	71.6	200	180	150
16	2	157	97.8	315	280	235
18	2.5	192	119.5	430	385	325
20	2.5	245	152.5	610	550	460
22	2.5	303	189.0	830	750	625
24	3	353	222.0	1065	960	800
27	3	459	286.0	1545	1390	1160
30	3.5	561	349.5	2095	1885	1575
33	3.5	694	432.5	2855	2570	2140
36	4	817	509.0	3665	3300	2750
42	4.5	1120	698.0	5865	5275	4395

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

5000059K

2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%
3. * ASSEMBLY USES HARDENED WASHER
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.

Metric Fastener Torque Chart (Continued)

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lube 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]
3	0.5	5.03	2.19	1.1	1.1	1.0
3.5	0.6	6.78	2.95	1.8	1.7	1.5
4	0.7	8.78	3.82	2.6	2.4	2.3
5	0.8	14.20	6.18	5.3	4.9	4.6
6	1	20.10	8.74	9	8.4	7.9
7	1	28.90	12.6	15	14	13
8	1.25	36.60	15.9	22	20	19
10	1.5	58.00	25.2	43	40	38
12	1.75	84.30	36.7	75	70	66
14	2	115	50.0	119	110	105
16	2	157	68.3	186	175	165
18	2.5	192	83.5	256	240	225
20	2.5	245	106.5	362	340	320
22	2.5	303	132.0	494	465	435
24	3	353	153.5	627	590	555
27	3	459	199.5	916	860	810
30	3.5	561	244.0	1245	1170	1100
33	3.5	694	302.0	1694	1595	1495
36	4	817	355.5	2176	2050	1920
42	4.5	1120	487.0	3477	3275	3070

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
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.

5000059K

Metric Fastener Torque Chart (Continued)

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS, CLASS 12.9 SOCKET HEAD CAPSCREWS M6 AND ABOVE*						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lube 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]
3	0.5	5.03	3.13			
3.5	0.6	6.78	4.22			
4	0.7	8.78	5.47			
5	0.8	14.20	8.85			
6	1	20.10	12.5	13	12	11
7	1	28.90	18.0	21	20	19
8	1.25	36.60	22.8	31	29	27
10	1.5	58.00	36.1	61	58	55
12	1.75	84.30	52.5	105	100	95
14	2	115	71.6	170	160	150
16	2	157	97.8	265	250	235
18	2.5	192	119.5	365	345	325
20	2.5	245	152.5	520	490	460
22	2.5	303	189.0	705	665	625
24	3	353	222.0	905	850	800
27	3	459	286.0	1315	1235	1160
30	3.5	561	349.5	1780	1680	1575
33	3.5	694	432.5	2425	2285	2140
36	4	817	509.0	3115	2930	2750
42	4.5	1120	698.0	4985	4690	4395

NOTES:
1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K
2. ALL TORQUE VALUES ARE STATIC TORQUE MEASURED PER STANDARD AUDIT METHODS TOLERANCE = ±10%
3. * ASSEMBLY USES HARDENED WASHER
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.

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 Mobile Elevating Work Platform. 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 Operation and Safety Manual for completion procedures for the Pre-Start Inspection. The Operation 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.
Preventative Maintenance	At intervals as specified in the Service and Maintenance Manual.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual

2.2 SERVICE AND GUIDELINES

General

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

Safety and Workmanship

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

Cleanliness

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

Components Removal and Installation

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

Component Disassembly and Reassembly

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

Pressure-Fit Parts

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

Bearings

1. When a bearing is removed, cover it to keep out dirt and abrasives. Clean bearings in nonflammable cleaning solvent and allow to drip dry. Compressed air can be used but do not spin the bearing.
2. Discard bearings if 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. Always use new replacement hardware when installing locking fasteners.Use bolts of proper length. A bolt which is too long will bottom before the head is tight against its related part. If a bolt is too short, there will not be enough thread area to engage and hold the part properly. When replacing bolts, use only those having the same specifications of the original, or one which is equivalent.
2. Unless specific torque requirements are given within the text, 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 can enter the system by hydraulic oil and through maintenance; allowing moisture, grease, filings, sealing components, sand, or other contaminants to enter; or allowing the pump to cavitate due to insufficient system warm-up or leaks in 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 high moisture, air or water 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.

Changing Hydraulic Oil

1. Filter elements must be changed after the first 50 hours of operation and every 300 hours (unless specified otherwise) 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 TEST

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

DO NOT Do the Following When Welding on JLG Equipment

- Ground on frame and weld on any other area than the chassis.
- Ground on turntable and weld on any other area than the turntable.
- Ground on the platform/support and weld on any other area than 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.).

NOTE: *Refer the Operation and Safety Manual for completion procedures for the Pre-Start Inspection.*

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	Inspections	
	Pre-Delivery[1] or Frequent [2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
Boom Assembly		
Boom Weldments	1, 2	1, 2
Hose/Cable Carrier Installations	1, 2	1, 2
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[4]	1, 2	1, 2
Platform Assembly		
Railing	2	2
Gate	1, 2, 3	1, 2, 3
Floor	2	2
Rotator	1, 2, 3, 4	1, 2, 3, 4
Lanyard Anchorage Point	1, 2, 6	1, 2, 6
Turntable Assembly		
Swing Bearing or Worm Gear	1[50], 2	1[50], 2
Oil Coupling	4	4
Swing Drive System	1, 4	1, 4
Turntable Lock	1, 2, 3	1, 2, 3
Hood, Hood Props, Hood Latches	3	3
Chassis Assembly		
Tires	1, 2	1, 2
Wheel Nuts/Bolts	1[50]	1[50]
Wheel Bearings	1, 2, 4, 5	1, 2, 4, 5
Oscillating Axle/Lockout Cylinder Systems	1, 2, 4, 5	1, 2, 4, 5
Steer Components	1, 2	1, 2
Spindle Thrust Bearing/Washers	1, 2	1, 2
Drive Hubs	1, 4	1, 4

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	Inspections	
	Pre-Delivery[1] or Frequent [2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
Functions/Controls		
Platform Controls return to neutral/off when released	1, 3, 6, 9	1, 3, 6, 9
Ground Controls return to neutral/off when released	1, 3, 6, 9	1, 3, 6, 9
Function Control Locks, Guards, or Detents	1, 3, 9	1, 3, 9
Footswitch (shuts off function when released)	1, 3, 9	1, 3, 9
Emergency Stop Switches (Ground & Platform) arrest all platform movement	1, 3, 6	1, 3, 6
Function Limit or Cutout Switch Systems	1, 3, 9	1, 3, 9
Capacity Indicator	1, 3, 9	1, 3, 9
Drive Brakes	1, 3, 9	1, 3, 9
Swing Brakes	1, 3, 9	1, 3, 9
Auxiliary Power	1, 3, 9	1, 3, 9
Power System		
Engine Idle, Throttle, and RPM	1, 3, 7	1, 3, 7
Engine Fluids: Oil	4	4
Engine Fluids: Coolant	1, 4, 7	1, 4, 7
Air Filter	1, 4	1, 4
Fuel Filter(s)	1, 5	1, 5
Drain Oil Build Up in 2-Stage Vaporizer (LP Only)	1, 4	1, 4
Exhaust System	1, 4	1, 4
Batteries	1, 4	1, 4
Battery Fluid	4	4
Battery Charger	1, 3	1, 3
Intake System	1, 2	1, 2
Glow Plug (Diesel Only)	1, 2, 3	1, 2, 3
Serpentine Belt, Tensioner, Pulleys	1, 2, 3	1, 2, 3
Fuel Reservoir, Cap, and Breather	1, 2, 4	1, 2, 4
Hydraulic/Electric System		
Hydraulic Pumps	1, 2, 4	1, 2, 4
Hydraulic Cylinders	1, 2, 4, 5	1, 2, 4, 5
Cylinder Attachment Pins and Pin Retainers	1, 2	1, 2
Hydraulic Hoses, Lines, and Fittings	1, 2, 4	3
Hydraulic Reservoir, Cap, and Breather	1, 2, 3, 4, 5	1, 2, 3, 4, 5
Hydraulic Filter(s)	1, 4, 5	1, 4, 5
Hydraulic Fluid	4, 5	4, 5
Electrical Connections	1, 2	1, 2
Instruments, Gauges, Switches, Lights, Horn	1, 3	1, 3

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	Inspections	
	Pre-Delivery[1] or Frequent[2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
General		
All Decals/Placards Installed, Secure, Legible	9	9
Annual Machine Inspection Due	-	9
No Unauthorized Modifications or Additions	9	9
All Relevant Safety Publications Incorporated	9	9
General Structural Condition and Welds	2	2
All Fasteners, Pins, Shields, and Covers	1, 2	1, 2
Grease and Lubricate to Specifications	9	9
Function Test of All Systems	9	9
Paint and Appearance	5	5
Stamp Inspection Date on Frame	-	9
Notify JLG of Machine Ownership	-	9

Footnotes:

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

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

[3] Annually, no later than 13 months from the date of the prior inspection, Includes all daily and quarterly inspections, mandated by regulating body

[4] Replace every 12 years or 7,000 hours

[50] Indicates a 50 hour interval required to perform task after initial use of machine. This only occurs once in machine life

[250] Indicates a 250 hour interval required to perform task after initial use of machine. This only occurs once in machine life

Performance Codes:

1 - Check for proper and secure: installation, adjustment, or torque
2 - Visual inspection for damage: (cracks, corrosion, abrasions, distortion, excessive wear, broken welds, gouges, chafing and threads showing)
3 - Proper operation
4 - Check for proper sealing, signs of leakage and fluid level
5 - Clean and free of debris
6 - Decals installed and legible
7 - Check for proper tolerances, routing, and lubrication
8 - Fully Charged
9 - Verify/Perform

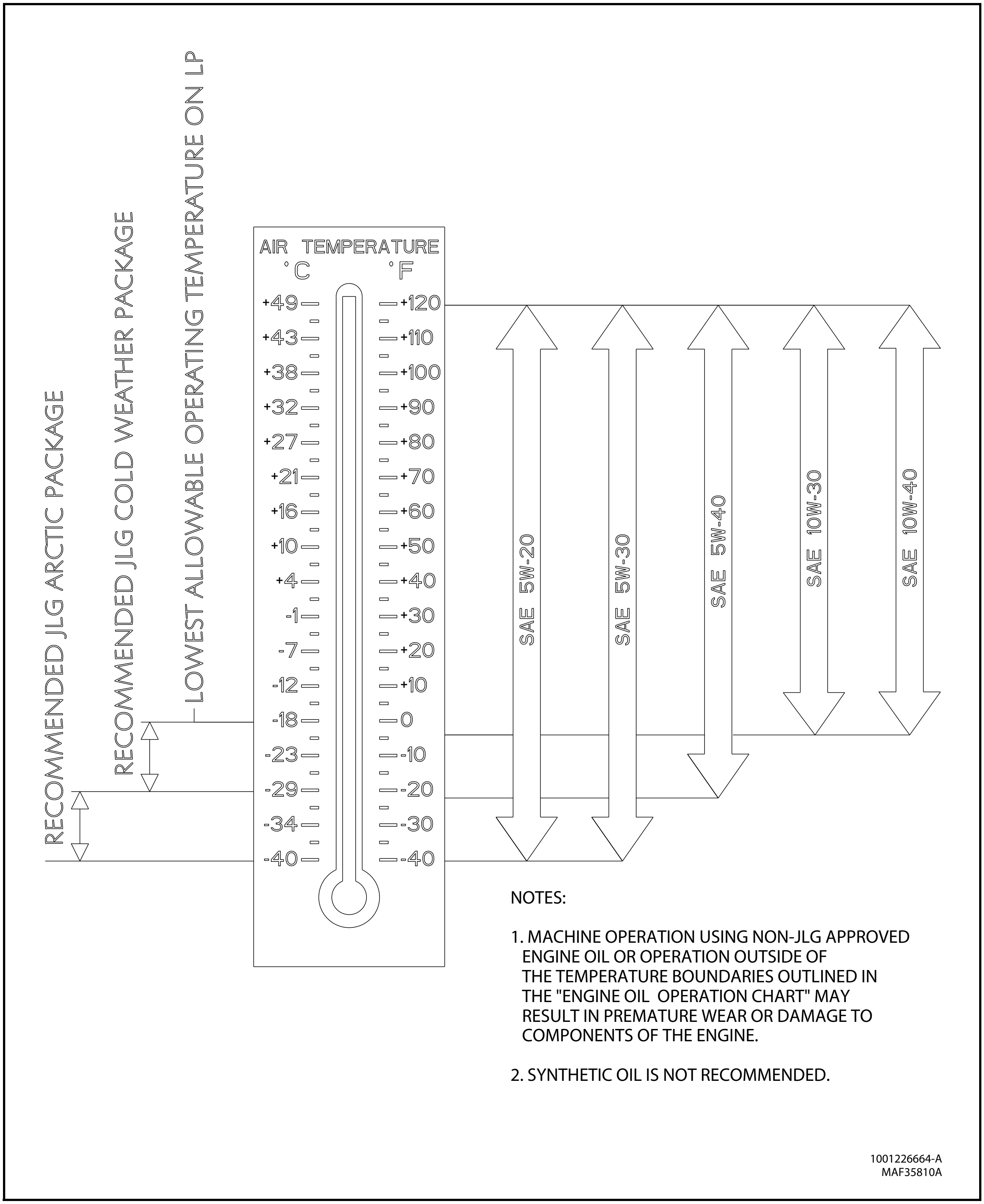


Figure 2-1. Engine Operating Temperature Specifications - Ford

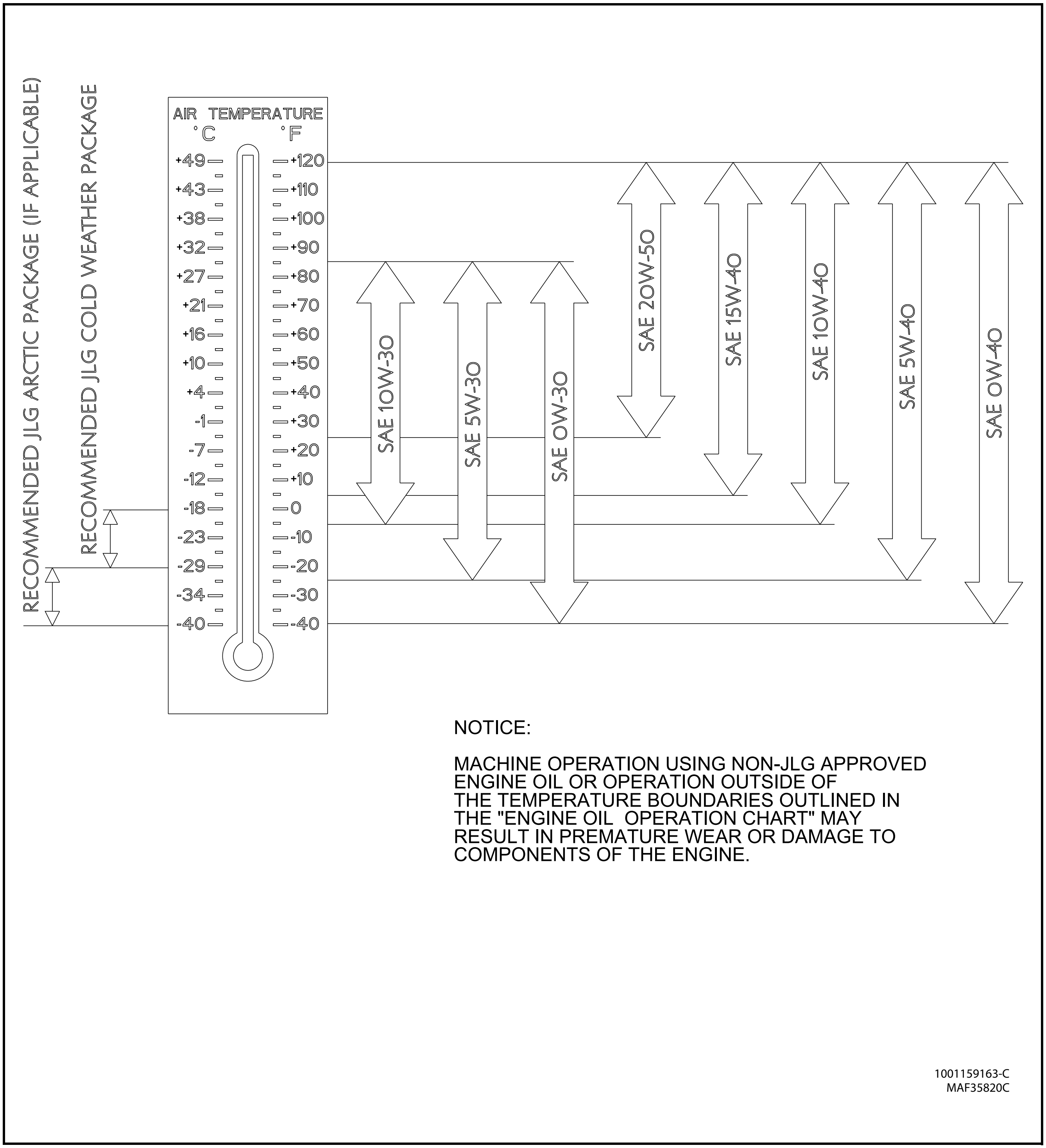


Figure 2-2. Engine Operating Temperature Specifications - Deutz TD 2.9L4

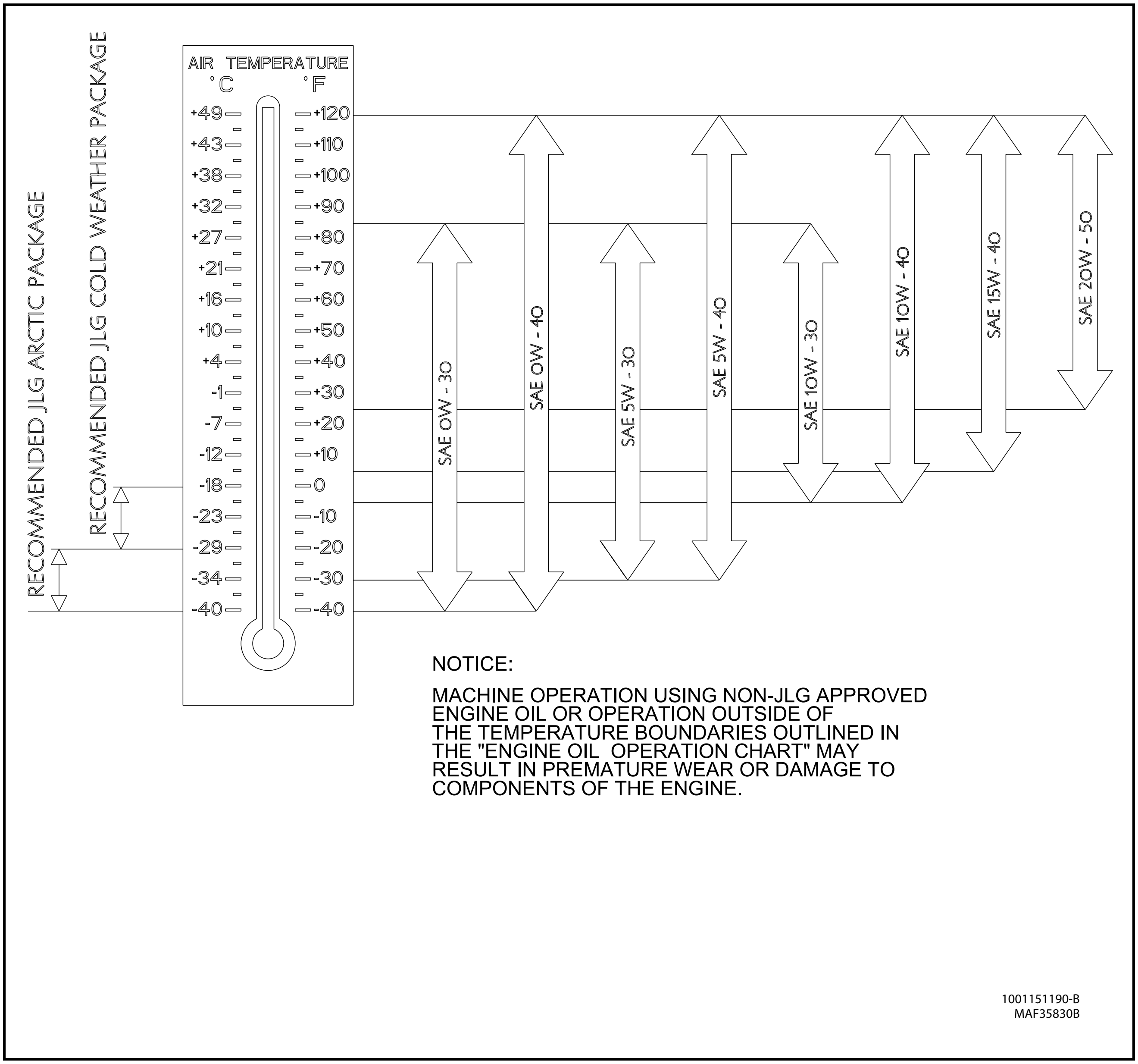
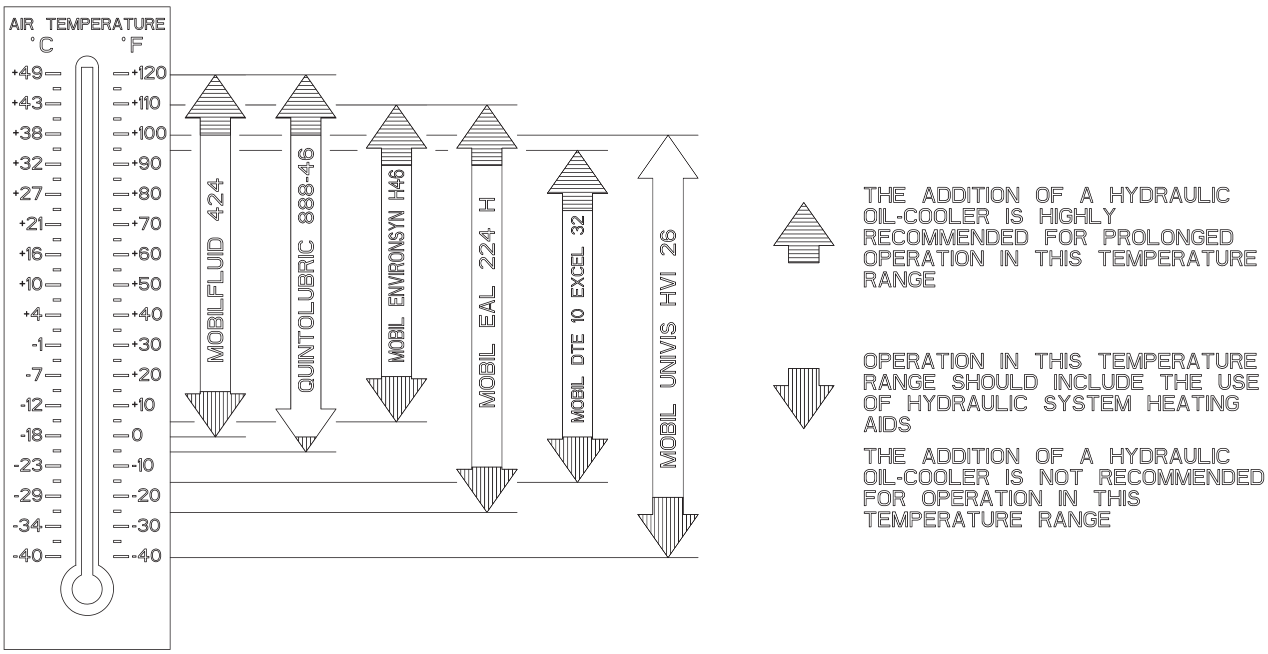


Figure 2-3. Engine Operating Temperature Specifications - Deutz D2011L04



FluidPropertiesBaseClassifications									
Description	Viscosity at 40° C (cSt, Typical)	Viscosity Index	Mineral Oils	Vegetable Oils	Synthetic	Synthetic Polyol Esters	Readily Biodegradable*	Virtually Non-toxic**	Fire Resistant***
Mobilfluid 424	55	145	X						
Mobil DTE 10 Excel 3232141X									
Univis HVI 26	26	376	X						
Mobil EAL 224 H47212XXX									
Mobil Envirosyn H 4649145XXX									
Quintolubric 888-4650185XXXX									

* Readily biodegradable classification indicates one of the following:

CO2 Conversion > 60% per EPA 560/6-82-003

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

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.

1001206353-B
MAF00021B

Figure 2-4. Hydraulic Oil Operating Temperature Specifications

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 in. (7.5 cm) in total length.
- any tears or rips (ragged edges) in the cord plies which exceeds 1 in. (2.5 cm) in any direction.
- any punctures which exceed 1 in. in diameter.
- any damage to the bead area cords of the tire.

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

Tire Replacement

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

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

Unless specifically approved by JLG Industries Inc. do not replace a foam filled or ballast filled tire assembly with a pneumatic tire. Due to size variations between tire brands, both tires on the same axle should be the same and all four tires should contain the same fill media.

Wheel Replacement

The rims installed on each product model have been designed for stability requirements which consist of track width 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.

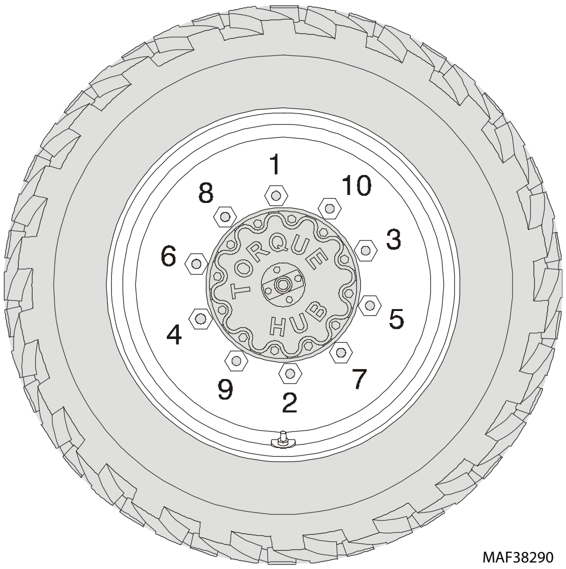
⚠ WARNING

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.

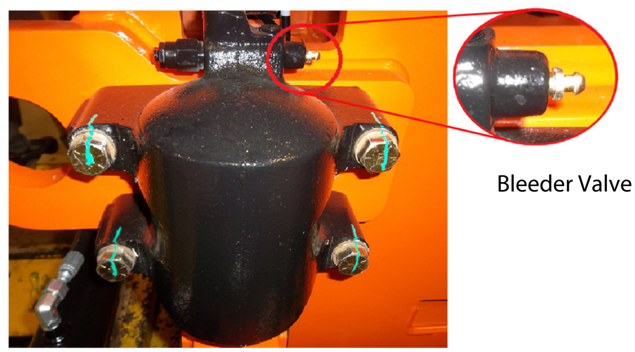
Table 3-1. Wheel Torque Chart

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
70 ft. lbs. (95 Nm)	170 ft. lbs. (230 Nm)	300 ft. lbs. (406 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 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 in. 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.



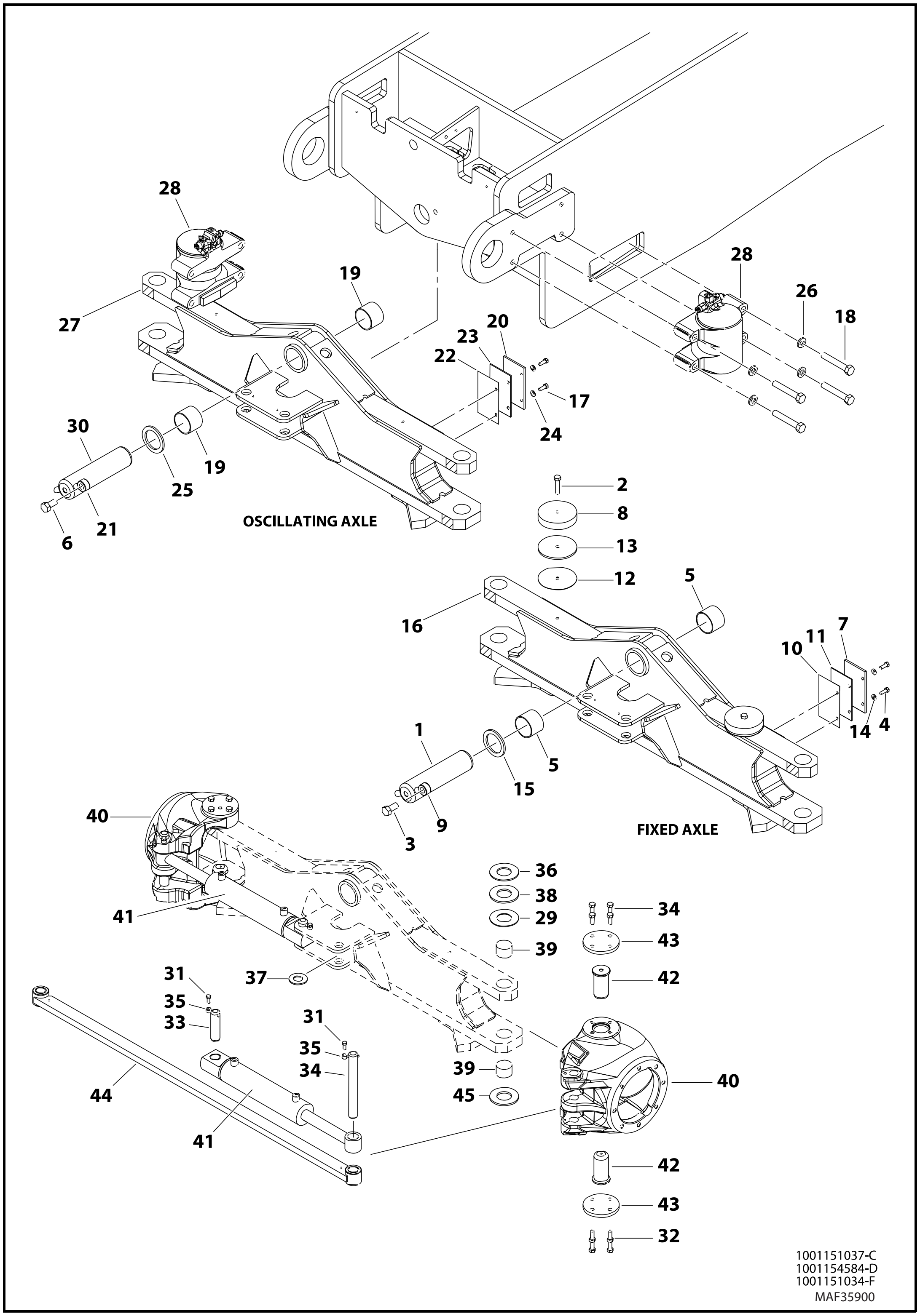


Figure 3-1. Axle and Steering Installation without Tow Package- Sheet 1 of 2

1. Pin
2. Bolt
3. Bolt
4. Bolt
5. Bushing
6. Bolt
7. Shim Wear
8. Stop Plate
9. Pin Keeper
10. Shim
11. Shim
12. Shim
13. Shim
14. Flat Washer
15. Special Washer
16. Axle
17. Bolt
18. Bolt
19. Bushing
20. Wear Shim
21. Keeper Shaft
22. Wear Shim
23. Wear Shim
24. Flat Washer
25. Special Washer
26. Flat Washer
27. Axle
28. Axle Lockout Cylinder
29. Thrust Washer
30. Pin
31. Bolt
32. Bolt
33. Pin
34. Pin
35. Pin Keeper
36. Thrust Washer
37. Special Washer
38. Thrust Washer
39. Bearing
40. Spindle
41. Steer Cylinder Assembly
42. Kingpin
43. Plate
44. Tie-Rod
45. Thrust Washer

Figure 3-2. Axle and Steering Installation without Tow Package- Sheet 2 of 2

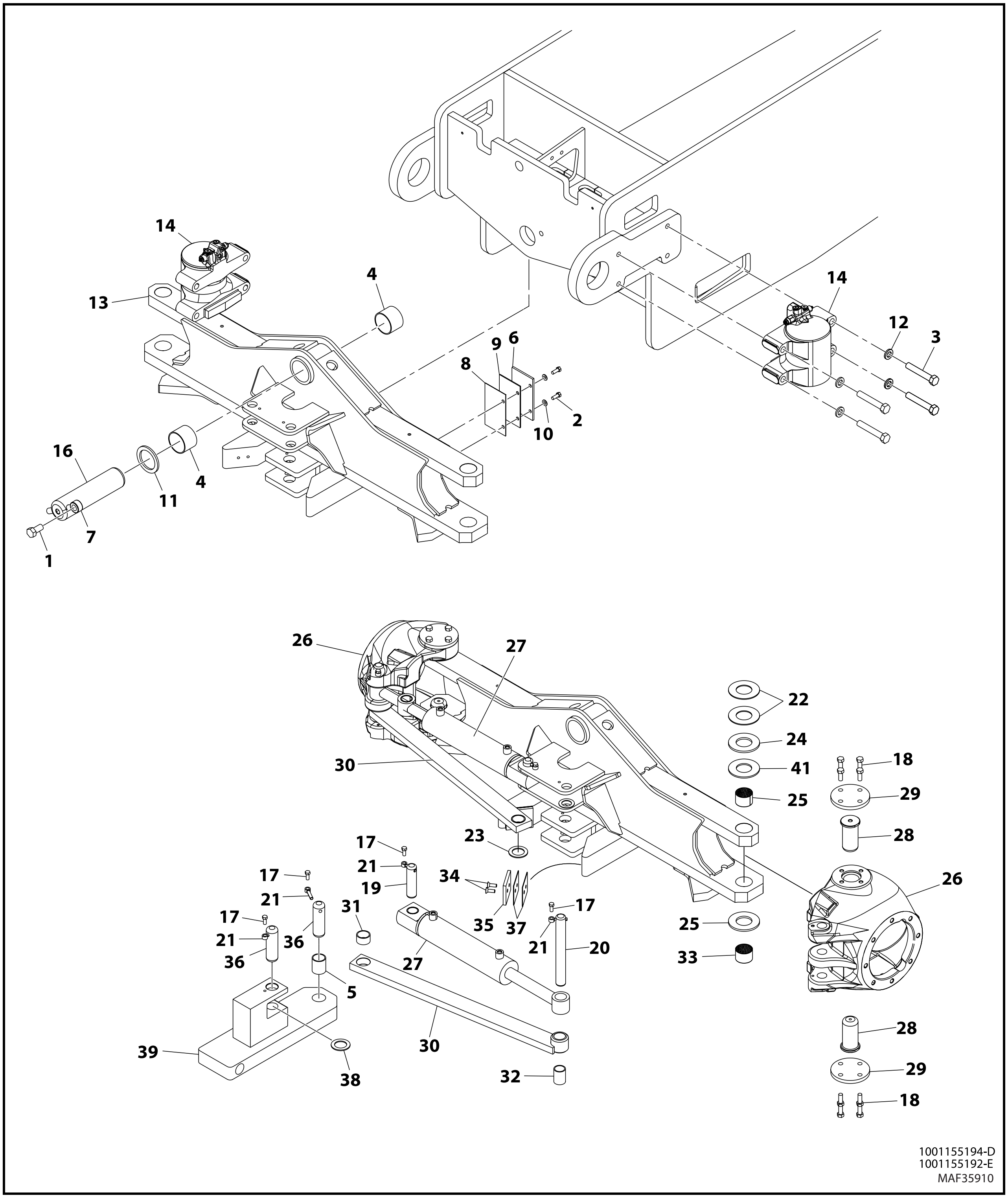


Figure 3-3. Axle and Steering Installation with Tow Package- Sheet 1 of 2

1. Bolt
2. Bolt
3. Bolt
4. Bushing
5. Bushing
6. Axle Wear Shim
7. Keeper Shaft
8. Axle Wear Shim
9. Axle Wear Shim
10. Flat Washer
11. Special Washer
12. Flat Washer
13. Axle
14. Axle Lockout Cylinder
15. Thrust Washer
16. Pin
17. Bolt
18. Bolt
19. Pin
20. Pin
21. Pin Keeper
22. Thrust Washer
23. Special Washer
24. Thrust Washer
25. Bearing
26. Spindle
27. Steer Cylinder
28. Kingpin
29. Plate
30. Tie-rod
31. Bushing
32. Bushing
33. Thrust Washer
34. Screw
35. Stop Pad
36. Hitch Pin
37. Shim
38. Thrust Washer
39. Link

Figure 3-4. Axle and Steering Installation with Tow Package- Sheet 2 of 2

3.3 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.

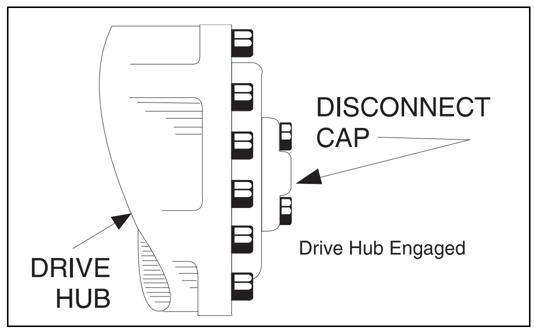
NOTE: *Ensure boom is fully retracted, lowered and centered between drive wheels prior to beginning lockout cylinder test.*

1. Place a 6 in. (15.2 cm) high block with ascension ramp in front of left front wheel.
2. From platform control console, start engine.
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 or right rear wheel remains elevated 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 in. (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 qualified personnel correct the malfunction prior to any further operation.

3.4 FREE WHEELING OPTION

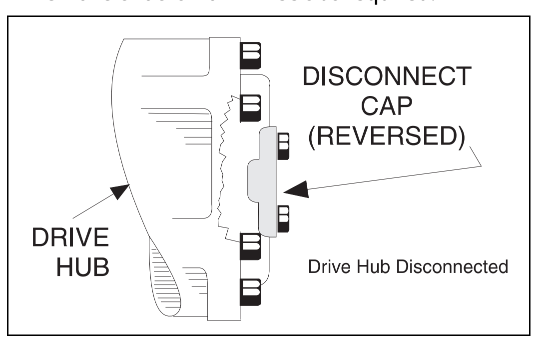
To Disengage Drive Motors and Brakes (Free Wheel) for Emergency Towing

1. Chock wheels securely if not on flat level surface.
2. Disconnect both drive hubs by reversing the disconnect caps in the center of the hubs.
3. If equipped, move steer/tow selector valve to float (tow) position by pulling control knob out.



To Engage Drive Motors and Brakes (Normal Operation)

1. If equipped, move steer/tow valve to steer position by pushing valve knob in.
2. Connect both drive hubs by inverting disconnect cap in center of hub.
3. Remove chocks from wheels as required.



3.5 WHEEL DRIVE ASSEMBLY (2WD)

Removal

NOTE: *The drive motor can be removed through the axle flange as part of the wheel drive assembly or they can be removed separately through the bottom of the frame while leaving the torque hub bolted to the axle.*

1. Use a jack to lift the frame enough so the tire and wheel assembly is off of the ground. Place blocking strong enough to support the weight of the machine under the frame and remove the jack.

NOTE: *The foam-filled tire & wheel assembly weighs approximately 2176 lb (987 kg).*

2. Remove hardware securing wheel and remove wheel assembly. Using suitable lifting device lift the wheel assembly and place in a suitable area.
3. Tag and disconnect the hydraulic lines running to the drive motor. Cap or plug all openings to ensure no dirt enters the hydraulic system.

NOTE: *The torque hub and drive motor assembly weighs approximately 275 lb (125 kg).*

4. Use a supporting device capable of handling the weight of the torque hub, drive brake and drive motor and unbolt the torque hub from the frame. Remove the entire assembly from the machine.
5. Remove the capscrews and washers that secure the drive motor to the torque hub and remove the drive motor. Remove and discard the brake gasket between the drive motor and torque hub.

Installation

NOTE: *The torque hub and drive motor assembly weighs approximately 275 lb (125 kg).*

NOTE: *The foam-filled tire & wheel assembly weighs approximately 2176 lb (987 kg).*

1. Install a new brake gasket between the drive motor and torque hub. Apply a coat of Medium Strength Threadlocking Compound on capscrews. Install the washers and capscrews to secure the torque hub and drive motor and torque to 70 ft. lbs. (95 Nm).
2. Place the torque hub flange against the mounting flange on the axle and fasten it in place with the bolts and washers. Torque the bolts to 190 ft. lbs. (260 Nm).
3. Using adequate support to install wheel on wheel assembly and secure with bolts and washers. Torque the lugnuts to 300 ft. lbs. (407 Nm).
4. Install the tire and wheel assembly.

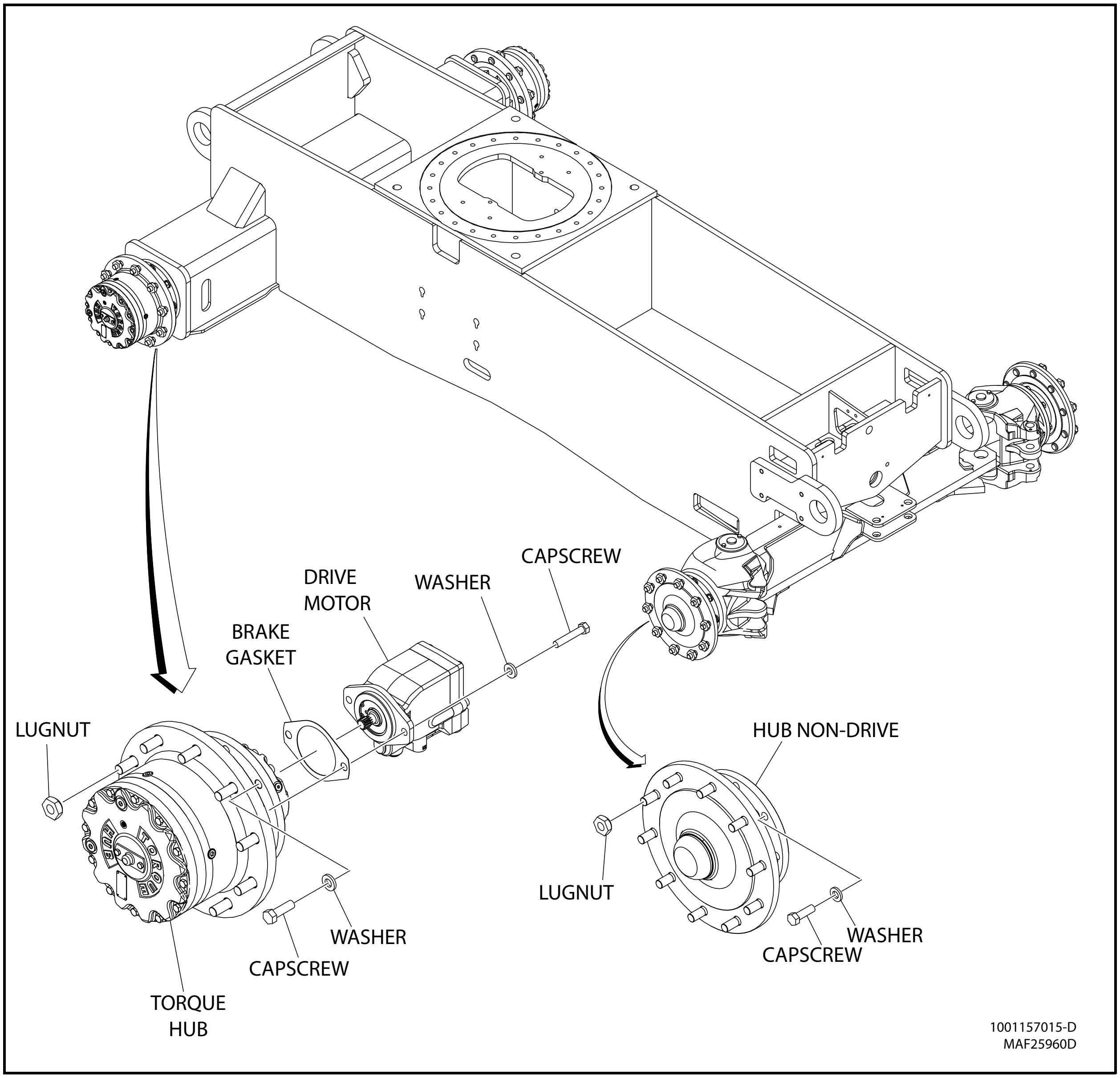


Figure 3-5. Torque Hub Installation (2WD)

3.6 WHEEL DRIVE ASSEMBLY (4WD)

Removal

NOTE: *The drive motor can be removed through the axle flange as part of the wheel drive assembly or they can be removed separately through the bottom of the frame while leaving the torque hub bolted to the axle.*

1. Use a jack to lift the frame enough so the tire and wheel assembly is off of the ground. Place blocking strong enough to support the weight of the machine under the frame and remove the jack.

NOTE: *The foam-filled tire & wheel assembly weighs approximately 2176 lb (987 kg).*

2. Remove hardware securing wheel and remove wheel assembly. Using suitable lifting device lift the wheel assembly and place in a suitable area.
3. Tag and disconnect the hydraulic lines running to the drive motor. Cap or plug all openings to ensure no dirt enters the hydraulic system.

NOTE: *The torque hub and drive motor assembly weighs approximately 270 lb (122 kg).*

4. Use a supporting device capable of handling the weight of the torque hub and drive motor and unbolt the torque hub from the frame. Remove the entire assembly from the machine.
5. Remove the capscrews and washers that secure the drive motor to the torque hub and remove the drive motor. Remove and discard the brake gasket between the drive motor and torque hub.

Installation

NOTE: *The torque hub and drive motor assembly weighs approximately 270 lb (122 kg).*

NOTE: *The foam-filled tire & wheel assembly weighs approximately 2176 lb (987 kg).*

1. Install a new brake gasket between the drive motor and torque hub. Apply a coat of Medium Strength Threadlocking Compound on capscrews.
2. Install the washers and capscrews to secure the torque hub and drive motor and torque to 70 ft. lbs. (95 Nm).
3. Place the torque hub flange against the mounting flange on the axle and fasten it in place with the bolts and washers. Torque the bolts to 190 ft. lbs. (260 Nm).
4. Using adequate support to install wheel on wheel assembly and secure with bolts and washers. Torque the lugnuts to 300 ft. lbs. (407 Nm).
5. Install the tire and wheel assembly.

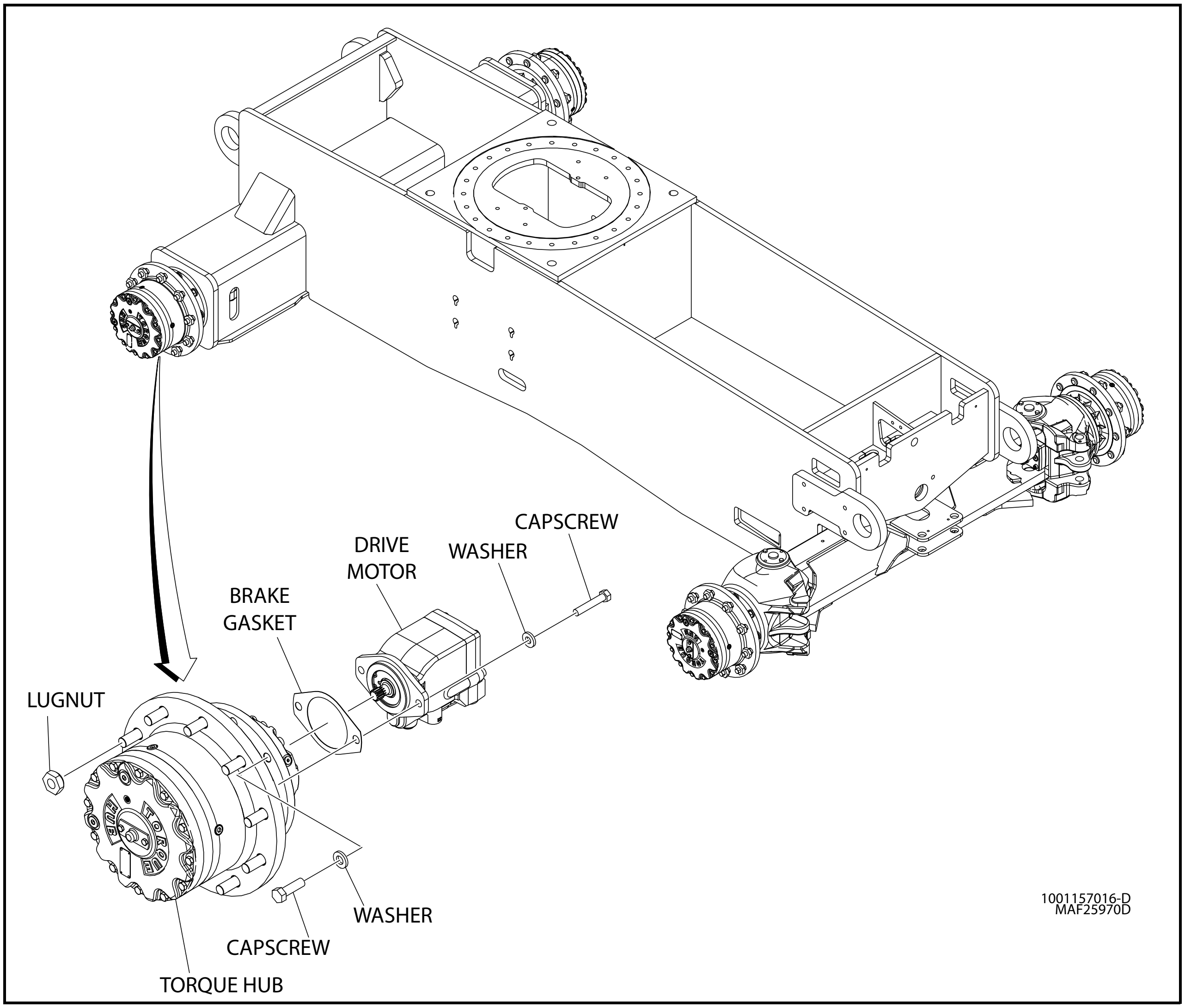


Figure 3-6. Torque Hub Installation (4WD)

3.7 DRIVE HUB

Roll and Leak Test

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

THE ROLL TEST

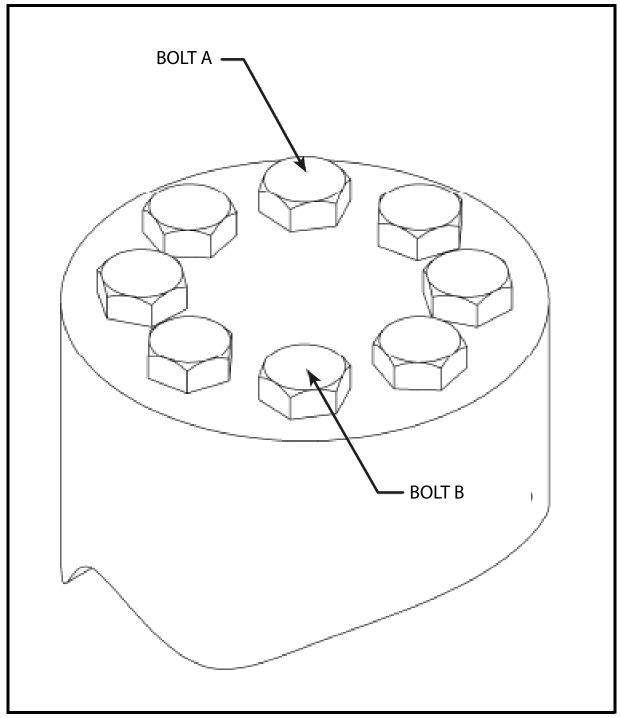
The purpose of the roll test is to determine if the unit's gears are rotating consistently, easily and properly. Release the brake by applying 400 psi (27.5 bar) to the brake port. To perform a roll test, use the recommended tool from table below (or something equivalent) to apply constant rotational force to the input of the gearbox. If more drag is felt in the gears only at certain points, then the gears are not rolling consistently and easily 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 the unit seem to roll hard as long as they roll with consistency. Rotate the gearbox both clockwise and counterclockwise the same number of turns as the ratio of the unit. The gearbox ratio is the same number as the last three numbers on the ID tag.

THE LEAK TEST

The purpose of a leak test is to make sure the unit is airtight. To perform a leak test use the leak test fixture from the table below. If the tool is not available, the gearbox must be sealed to perform the test. This can be accomplished by assembling the sealed input device onto the gearbox at the input end and replace one of the oil plugs with an air chuck. Do not exceed 10 psi (0.7 bar) pressure during the leak test. Higher pressure will create a false sealing effect in assemblies with lip-seals. The unit has a leak if the pressure gauge reading on your leak check fitting starts to fall after the gearbox 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 and 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.

TIGHTENING AND TORQUING BOLTS

If an air impact wrench is used to tighten bolts, extreme care should be taken to ensure 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 the remaining bolts.
4. 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.

Disassembly

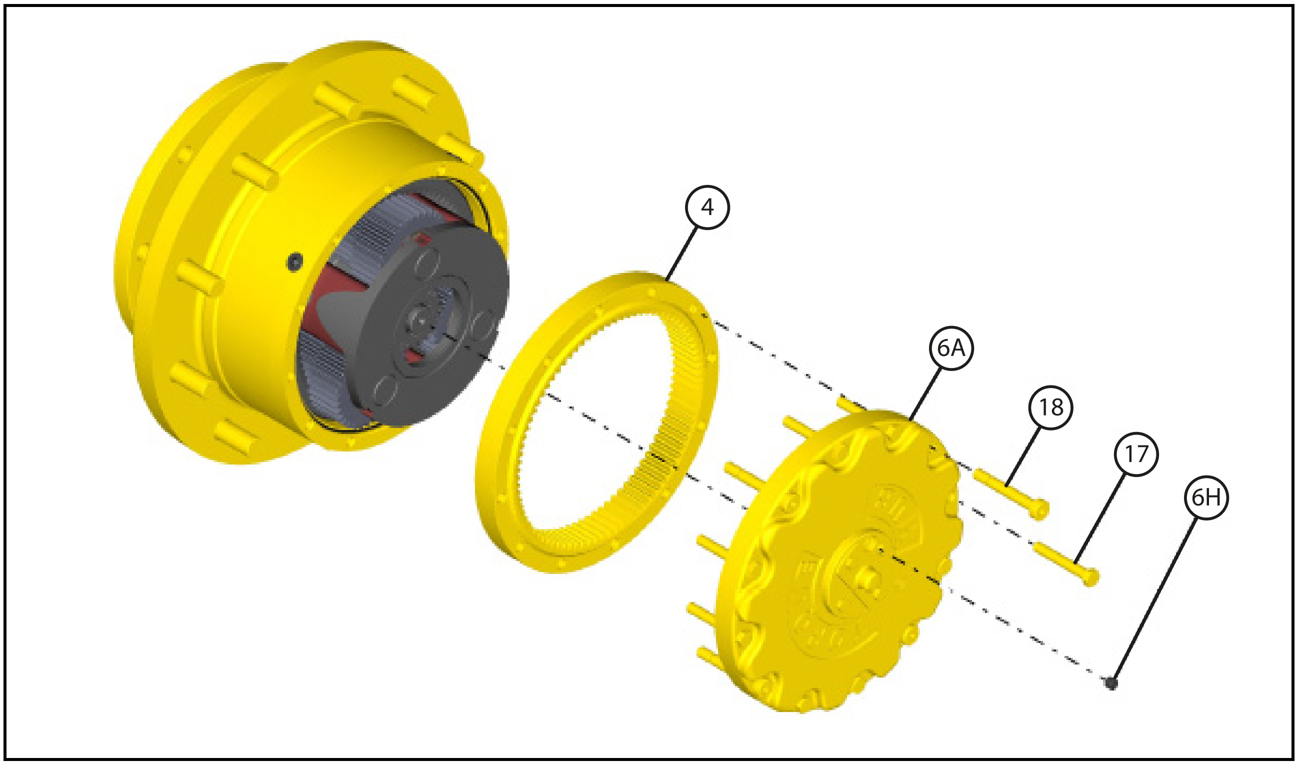
MAIN COVER PLATE DISASSEMBLY

NOTE: *Refer to Figure 3-7.,Figure 3-8. & Figure 3-9.*

1. Perform roll check and leak check prior to disassembling the unit.
2. Remove the magnetic pipe plug (6H) from cover plate (6A) and drain the oil out of the gearbox.

NOTE: *Record the condition and volume of the oil.*

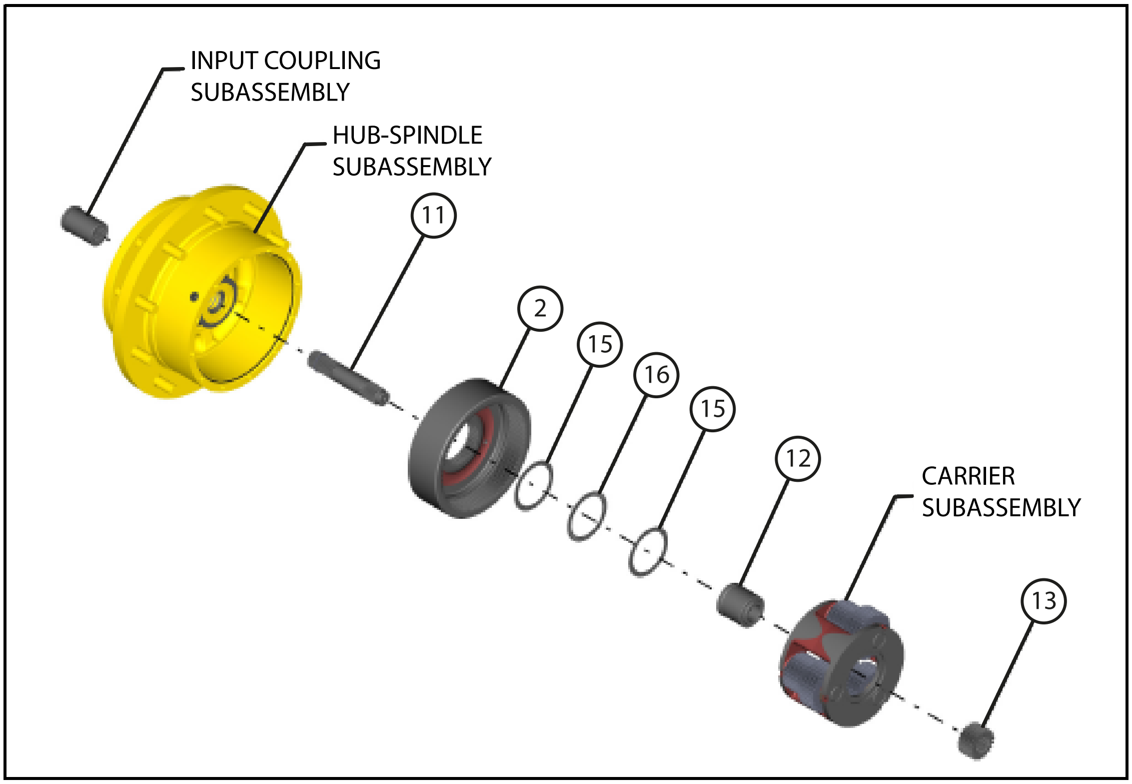
3. Remove eight bolts (17) followed by four special bolts (18) from cover subassembly.
4. Lift the cover subassembly off of the unit.
5. Lift ring gear (4) off the unit.



4. Ring Gear
6A. Cover Plate
6H. Pipe Plug
17. Hex Bolt
18. Special Bolt

Figure 3-7. Main Cover Plate Disassembly

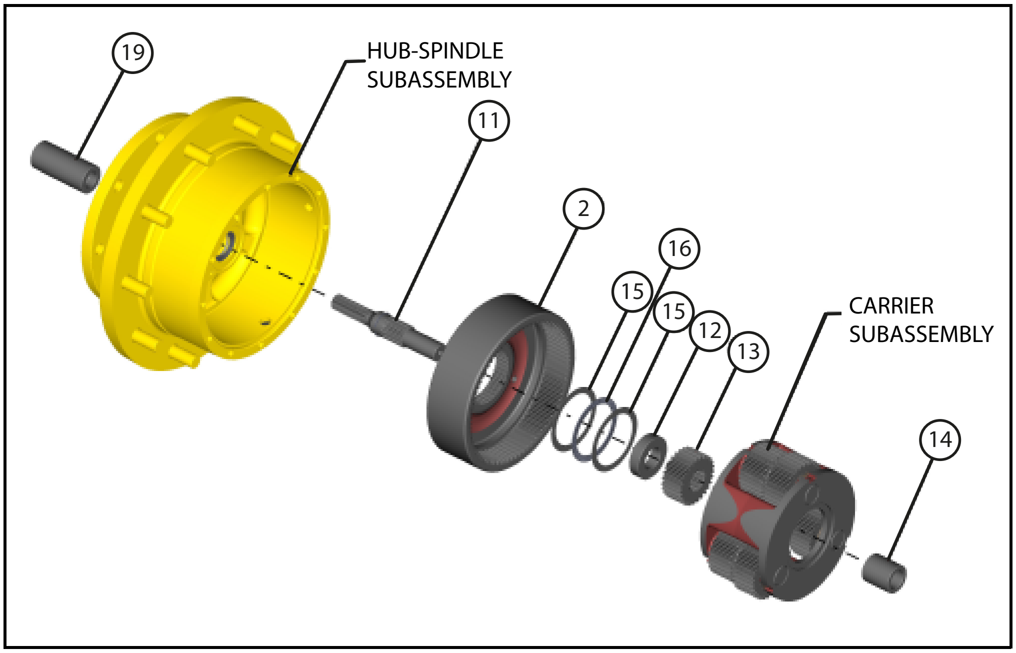
6. If applicable remove spacer (14) from the input shaft (11).
7. Remove the sun gear (13).
8. Lift out the Carrier subassembly from the unit.
9. Remove the input spacer (12) from the unit.
10. Remove two thrust spacers (15) and thrust bearing (16) from the internal gear (2).
11. Remove internal gear (2) from the unit.
12. Remove input shaft subassembly from the hub spindle subassembly.
13. Take out input coupling subassembly of the hub spindle subassembly.



2. Internal Gear
11. Input Shaft
12. Input Spacer
13. Sun Gear
15. Thrust Washer
16. Thrust Bearing

Figure 3-8. Carrier Subassembly Removal

NOTE: *Figure 3-7. refers to 30, 35, 50, 64 & 73: 1 Ratios.*



2. Internal Gear
11. Input Shaft
12. Input Spacer
13. Sun Gear
14. Spacer
15. Thrust Washer
16. Thrust Bearing
19. Coupling

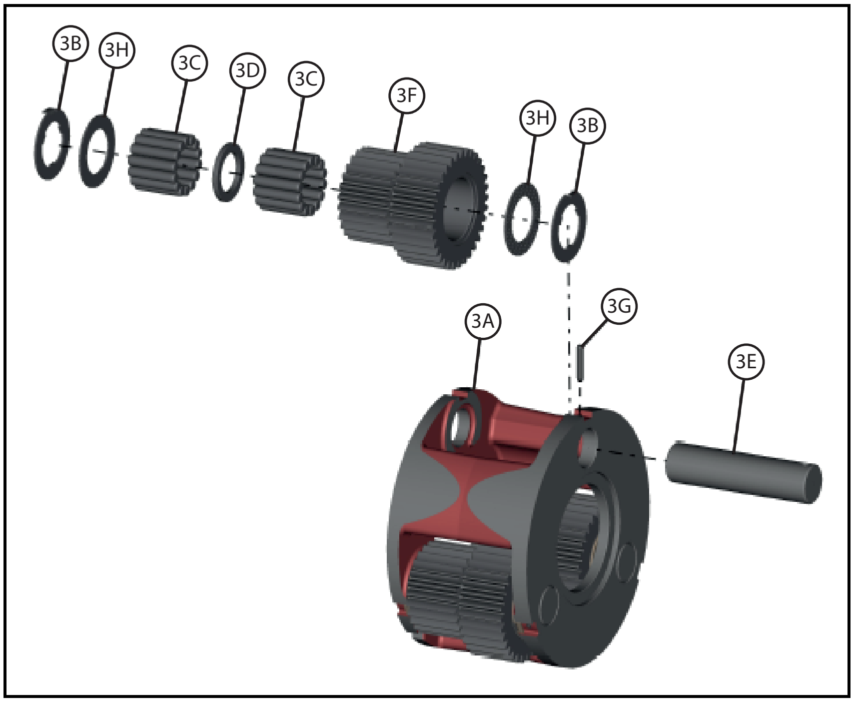
Figure 3-9. Carrier Subassembly Removal

NOTE: *Figure 3-8. refers to 18, 24, 31 & 43: 1 Ratios.*

CARRIER DISASSEMBLY

NOTE: *Refer to Figure 3-10.*

1. Drive planet shaft (3E) out of the carrier pin holes, forcing the roll pin (3G) to sheer off.
2. Hold on to the planet gear (3F) and push the planet shaft (3E) out of the carrier (3A) the thrust washers (3B) & (3h) will slide off the shaft as it is removed.
3. Using a hammer and punch, drive the roll pin (3G) out of the planet shaft (3E) and carrier (3A).
4. Remove first set of needle bearings (3C) from the inside of the planet gear (3F).
5. Remove thrust washer (3D) from planet gear (3F).
6. Remove second set of needle bearings (3C) from the inside of the planet gear (3F).
7. Repeat steps from 1 to 6 for the remaining two planet gears (3F).



3A. Carrier
3B. Washer
3C. Needle Bearing
3D. Thrust Washer
3E. Planet Shaft
3F. Cluster Gear
3G. Roll Pin
3H. Ball Indent Washer

Figure 3-10. Carrier Disassembly

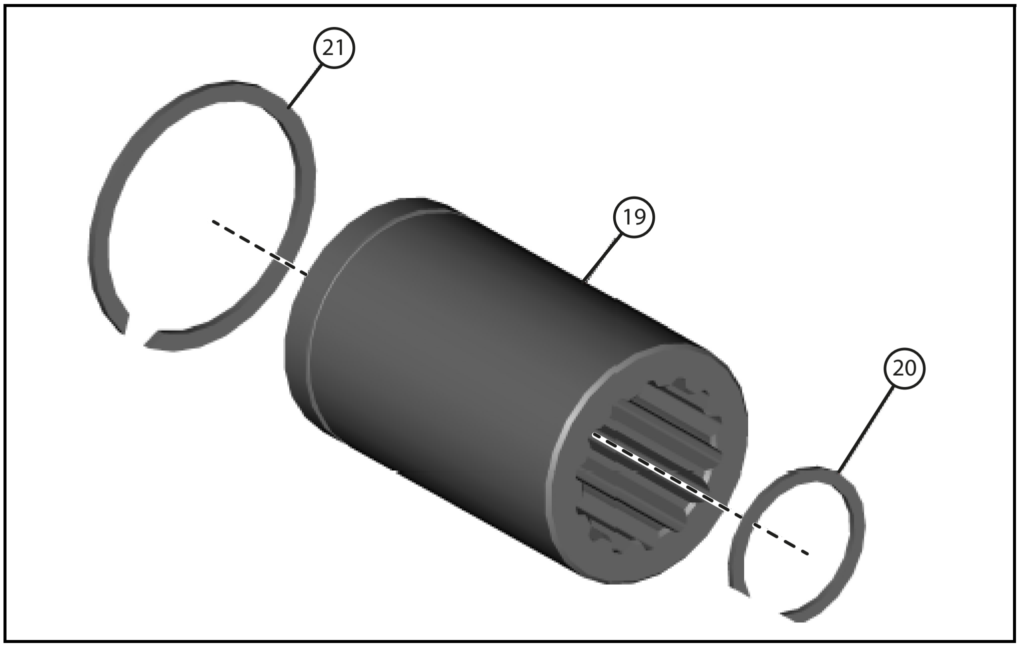
COUPLING DISASSEMBLY

NOTE: *Refer to Figure 3-11.*

CAUTION

SAFETY GLASSES MUST BE WORN DURING THIS NEXT STEPS.

1. If necessary, remove Internal retaining ring (20) from the groove of coupling (19).
2. If necessary, remove external retaining ring (21) from the groove of coupling (19).



19. Coupling
20. Internal Retaining Ring
21. External Retaining Ring

Figure 3-11. Coupling Disassembly

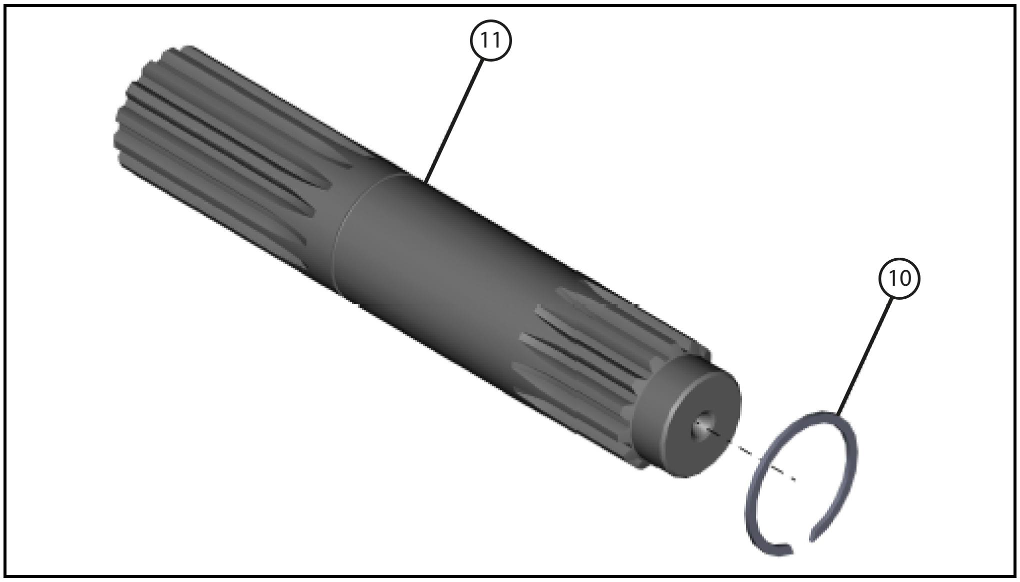
INPUT SHAFT DISASSEMBLY

NOTE: *Refer to Figure 3-12.*

CAUTION

SAFETY GLASSES MUST BE WORN DURING THIS NEXT STEPS.

1. If necessary, remove external retaining ring (10) from the groove of the input shaft (11).



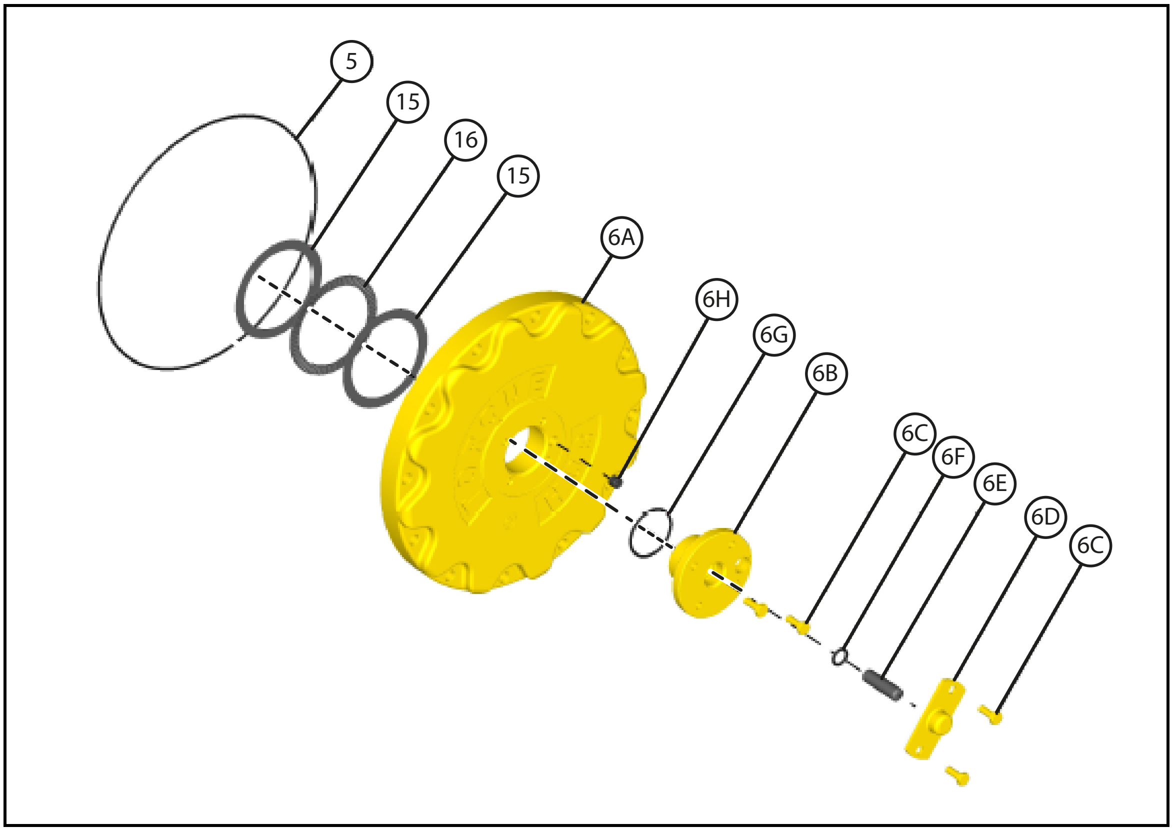
10. External Retaining Ring
11. Input Shaft

Figure 3-12. Input Shaft Disassembly

COVER DISASSEMBLY

NOTE: *Refer to Figure 3-13.*

1. Remove the O-ring (5) from groove in cover (6A) and discard O-ring (5).
2. Remove two thrust washers (15) and thrust bearing (16) from cover (6A).
3. Remove two hex bolts (6C) from disengage cap (6D), if required.
4. Remove the disengage cap (6D) from the cover cap (6B).
5. Pull the disengage rod (6E) out of the cover cap (6B).
6. Remove O-ring (6F) from the cover cap (6B) and discard it.
7. Remove two hex bolts (6C) from cover cap (6B), if required.
8. Remove cover cap (6B) from cover plate (6A).
9. Remove O-ring (6G) and discard it.
10. Remove pipe plug (6H) from the cover (6A).



5. O-ring
6A. Cover Plate
6B. Cover Cap
6C. Hex Bolt
6D. Disengage Cap
6E. Disengage Rod
6F. O-ring
6G. O-ring
6H. Pipe Plug
15. Thrust Washer
16. Thrust Bearing

Figure 3-13. Cover Disassembly

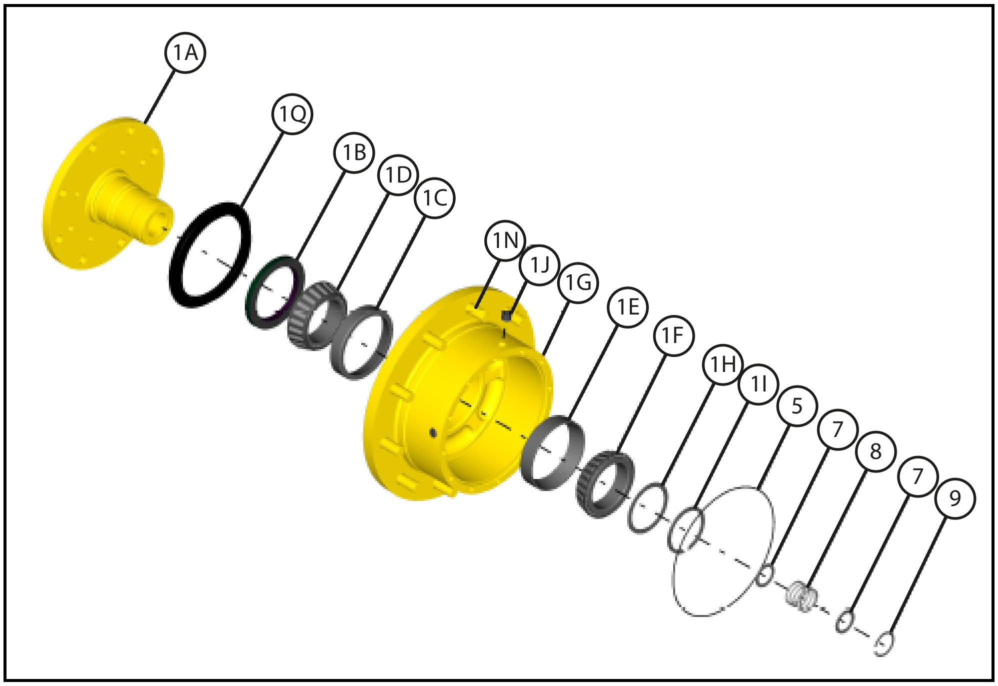
HOUSING-SPINDLE DISASSEMBLY

NOTE: *Refer to Figure 3-14.*

CAUTION

SAFETY GLASSES MUST BE WORN DURING THESE NEXT STEPS.

1. Remove Internal retaining ring (9) from the groove of the spindle (1A).
2. Remove thrust washer (7) from the spindle (1A).
3. Remove spring (8) from the spindle (1A).
4. Remove thrust washer (7) from the spindle (1A).
5. Set the unit on a bench so that the spindle (1A) flange is down.



1A. Spindle
1B. Lip Seal
1C. Bearing Cup
1D. Bearing Cone
1E. Bearing Cup
1F. Bearing Cone
1G. Housing
1H. Thrust Washer
1I. External Retaining Ring
1J. Pipe Plug
1N. Stud
1Q. Boot Seal
5. O-ring
7. Thrust Washer
8. Spring
9. Internal Retaining Ring

Figure 3-14. Housing Spindle Disassembly

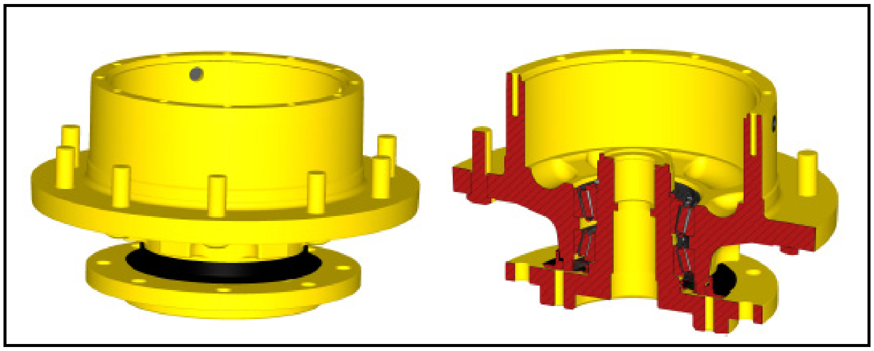


Figure 3-15. Housing Cross Section

6. Remove the O-ring (5) from the housing (1G) and discard it.

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THESE NEXT STEPS.

7. Remove retaining ring (1I) from the groove of spindle (1A).

8. Remove thrust washer (1H) from the spindle (1A).

9. Remove two pipe plugs (1J) from the housing (1G).

10. Turn the unit over and carefully place the unit on a support base until the spindle (1A) post rests on it. Ensure there is enough gap to lower the housing (1G) down.

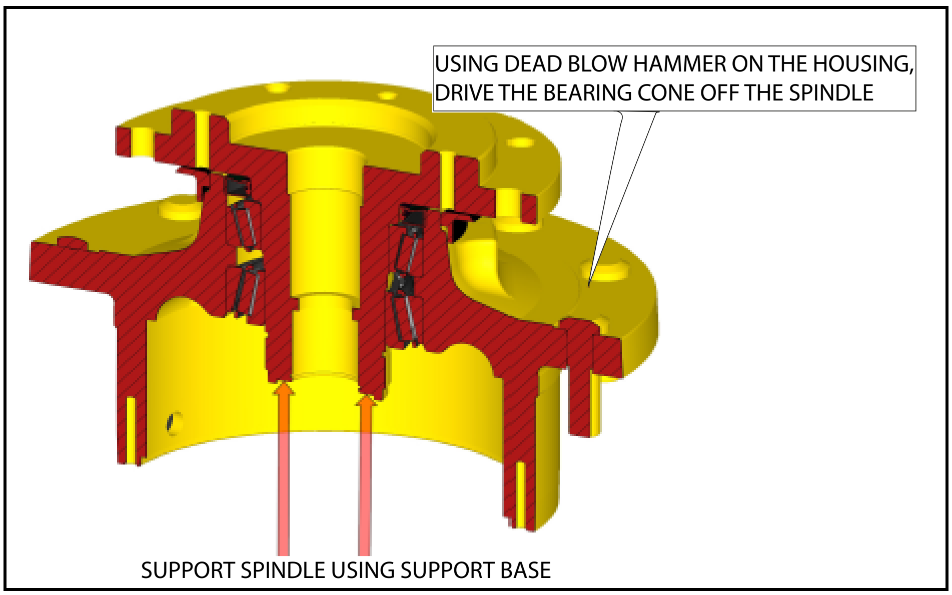


Figure 3-16. Housing Cross Section

11. Use a dead blow hammer on the housing (1G) flange to drive the inboard bearing cone (1F) off of the spindle (1A).

12. Lift the spindle (1A) out of the housing (1G).

13. If required, remove boot seal (1Q) from the housing (1G).

14. Remove lip seal (1B) from the housing (1G).

15. Remove the bearing cone (1D) from the bearing cup (1C).

16. Using a hammer and punch drive the inboard bearing cup (1E) out of the housing (1G). Be careful not to damage the counterbore in the housing.

17. Turn the housing (1G) over and drive the outboard bearing cup (1C) out of the housing (1G). Be careful not to damage the counterbore in the housing.

Assembly

COVER SUBASSEMBLY

NOTE: *Refer to Figure 3-13.*

1. Screw pipe plug (6H) into cover plate (6A) using thread sealant and hand hexagonal wrench.
2. Apply grease and position o-ring (6G) over cover cap (6B) until it rests against the flange.
3. Blow out internal groove of cover cap (6B) with air hose. Place greased o-ring (6F) into internal groove of cover cap (6B).

NOTE: *The disconnect rod (6E) may be used to push the greased o-ring (6F) into position in the o-ring groove of the cover cap (6B).*

4. Place cover cap (6B) into cover plate (6A) with larger flange hole on cover cap (6B) located over pipe plug (6H) fasten cover cap (6B) with two bolts (6C) located 180 degrees apart. Torque bolts to 70-80 in. lbs. (95- 108 Nm).
5. Place disengage cap (6D) on cover cap (6B) with nipple facing out. Secure with two bolts (6C) located 180 degrees apart. Torque bolts (6C) to 70-80 in. lbs. (95-108 Nm).
6. Turn cover plate (6A) over and push disconnect rod (6E) into cover cap (6B), until disconnect rod (6E) bottoms out on the disengage cap (6D).
7. Grease and install o-ring (5) into groove on the cover plate (6A).
8. Grease and install thrust washers (15) and thrust bearing (16) into cover plate (6A).

NOTE: *Thrust washers (15) has to be assembled onto either sides of thrust bearing (16) and then, this has to be greased and installed as a single unit into cover plate (6A).*

CARRIER SUBASSEMBLY

NOTE: *Refer to Figure 3-10.*

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 first row of 14 needle rollers (3C) into the bore of cluster gear (3F).

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

3. Place one spacer (3D) on top of the needle rollers (3C) inside the planet gear (3F).
4. Install second row of 14 needle rollers (3C) into the bore of cluster gear (3F) against spacer (3D). Grease and install ball indent washers (3H) onto the counterbores of either sides of cluster gear (3F) with indents away from the cluster gears.
5. Place carrier (3A) into tool fixture so that one of the roll pin holes is straight up.
6. Start planet shaft (3E), with end opposite roll pin hole first, through the planet shaft hole in carrier (3A), making sure that the roll pin hole with the large chamfer in the planet shaft is straight up.
7. Using ample grease to hold it in position, slide one thrust washer (3B) over planet shaft (3E) with tang resting in the cast slot of carrier (3A).
8. With large end of cluster gear (3F) facing the roll pin hole in the carrier (3A), place cluster gear (3F) into position in carrier (3A) and push planet shaft (3E) through the cluster gear (3F) without going all the way through.
9. Slide the second thrust washer (3B) between the cluster gear (3F) and the carrier (3A) with the tang of washer located in the cast slot of carrier (3A). Finish sliding planet shaft (3E) through the thrust washers (3H) & (3B) and into carrier (3A).
10. Position the 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 in. (3.17 mm) diameter punch.
11. After using a 3/16 in. (4.76 mm) punch to align the two roll pin holes. Drive the roll pin (3G) through carrier (3A) and into planet shaft (3E) until the roll pin (3G) is flush with the bottom of the cast tang slot in the carrier (3A). Use a ¼ in. (6.35 mm) pin punch to make sure the roll pin (3G) is flush in the slot.
12. Repeat the steps from 1 through 11 for the remaining two cluster gears (3F).

HOUSING SPINDLE SUBASSEMBLY

NOTE: *Refer to Figure 3-14.*

1. If required, using stud pressing fixture press studs (1N) into the flange holes of the hub (1G), be sure stud heads are tight to the hub flange face.
2. Place hub (1G) on table such that long hub end is up.
3. Press bearing cup (1E) using T148905 with the large diameter side up into cover end of hub (1G).
4. Turn hub (1G) over and press bearing cup (1C) into hub (1G) using T148905 with small diameter side up.

NOTE: *Apply generous amount of lubricating oil on all bearings at the time of installation.*

5. Place bearing cone (1D) on bearing cup (1C).
6. Press bearing seal (1B) with the open face down into the hub (1G), be sure seal is flush with the hub face.

NOTE: *Generally Seals should not be reused.*

7. If the unit requires seal boot (1Q) place on hub (1G) with flange end facing up. Coat the inside surface of the seal - boot - flange with liberal amount of grease.
8. Place spindle (1A) with large diameter end down on the bench and coat the seal shoulder with oil.
9. Place hub (1G) onto spindle (1A) making sure the seal (1B) is in position on the seal shoulder of spindle (1A).

NOTE: *The bearing cone (1F) is a press fit onto spindle (1A) and is installed using snap ring assembly tool T205660.*

10. Place snap ring assembly tool T205660 onto spindle (1A).
11. Place bearing cone (1F) onto the tapered portion of snap ring assembly tool T205660.
12. Place spacer (1H) and retaining ring (1I) onto the top of the bearing cone (1F).
13. Slowly press bearing cone (1F) spacer (1H) and retaining ring (1I) all at once using a bearing pressing tool, T137970, until the retaining ring (1I) falls into the retaining ring groove on the spindle (1A).
14. Install pipe plug (1J) into hub (1G).
15. Grease and install o-ring (5) into hub (1G).
16. Grease and install thrust washer (7) into spindle (1A).
17. Install spring (8) into spindle (1A) until it bottoms on thrust washer (7).
18. Grease and place second thrust washer (7) on spring (8).
19. Using retaining ring pliers, push retaining ring (9) against thrust washer (7) until retaining ring snaps into place in the spindle (1A) groove.

COUPLING SUBASSEMBLY

NOTE: *Refer to Figure 3-11.*

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THESE NEXT STEPS.

1. If necessary, install external retaining ring (21) into groove on OD of coupling (19).
2. If necessary, install Internal retaining ring (20) into retaining ring groove of the coupling (19).

INPUT SHAFT SUBASSEMBLY

NOTE: *Refer to Figure 3-12.*

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THESE NEXT STEPS.

1. If necessary, install retaining ring (10) onto the groove of input shaft (11).

CARRIER SUBASSEMBLY

NOTE: *Refer to Figure 3-7., Figure 3-8. & Figure 3-9.*

1. Place hub-spindle subassembly on the table with spindle flange side down.
2. Set the internal gear (2) with the spline down, so that the spline of the spindle (1A) is in mesh with the internal spline of the internal gear (2).
3. Install input shaft subassembly with the retaining ring end down into the spindle counterbore.
4. Slide thrust spacer (12) over the input shaft (11) make sure the large end is against the spindle (1A).

NOTE: *Refer to Figure 3-9. with 18, 24, 31 & 43: 1 Ratios.*

5. Place carrier subassembly with the large end of cluster gears facing up. Position all three punch marks on the face of large gears at 12 o'clock and secure the gear teeth using timing fixture.
6. With longer shoulder side of ring gear (4) facing down, place the ring gear into mesh with the cluster gear (3F) and remove this assembly from timing fixture.

NOTE: *Be sure that the punch marks remain in their correct location during ring gear (4) installation.*

7. Place Thrust washer (15), thrust bearing (16) and thrust washer (15), in order on the pilot diameter on internal gear (2).

NOTE: *For 30, 35, 50, 54 & 73:1 ratios Skip step 8.*

8. Install input gear (13) with counterbore down in mesh with the input shaft (11) splines counterbore down.
9. With small end of cluster gear (3F) down and while holding ring gear (4) in mesh with carrier sub assembly, place assembly into internal gear (2).

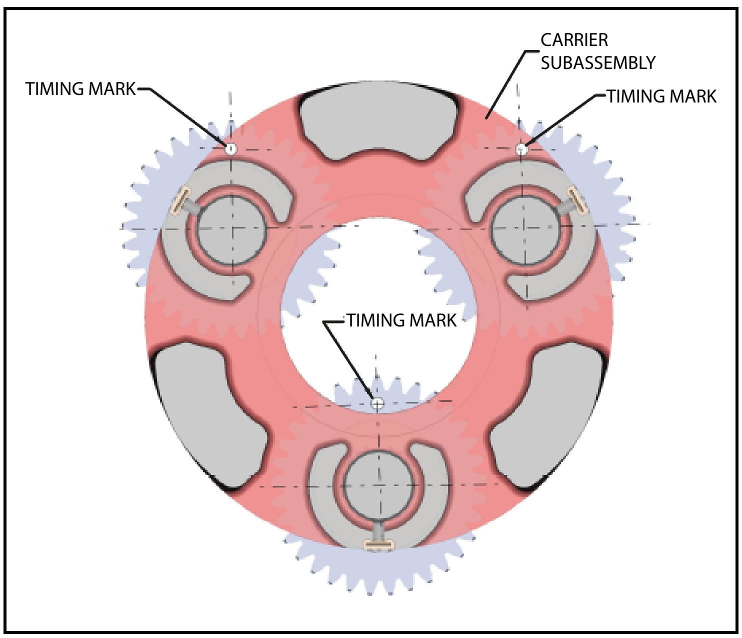


Figure 3-17. Timing Mark on Carrier Subassembly

10. Once in place rotate the ring gear (4) until hole marked "X" is aligned with one of shoulder bolt holes in hub (1G).

NOTE: *If the gears do not mesh easily or carrier sub assembly does not rotate freely, then remove the carrier and Ring gear and check timing (Step 5).*

NOTE: *Check each cluster gear (3F) to make sure that the timing punch-marks is in line with a tooth on the large end & a tooth on the small end of the cluster gear. THESE TWO TEETH MUST BE IN LINE WITH THE PUNCH-MARKS ON EVERY CLUSTER GEAR (3F).*

NOTE: *For 30, 35, 50, 54 & 73:1 ratios Skip step 11.*

11. Install spacer (14) onto the input shaft (11) against the input gear (13).

NOTE: *Refer to Figure 3-9. with 18, 24, 31 & 43: 1 Ratios*

NOTE: *For 18,24, 37 & 43:1 ratios Skip step 12.*

12. Install input gear (13) with counterbore down to mesh with the teeth of cluster gear (3F).

13. Install cover subassembly onto the ring gear (4) being sure that the pipe plugs in the hub (1G) and cover (6A) are in time with each other. Be sure the thrust washers (15) & (16) remain on the cover (6).

14. Install four shoulder bolts (18) into the four marked counterbore holes in the hub (1G) start shoulder bolts (18) by hand for the length of at least two threads or two full turns before running down and torque to 45-47 ft. lbs. (61- 64 Nm).

15. Place the remaining eight bolts (17) into the remaining holes and torque to 45-47 ft. lbs. (61- 64 Nm).

16. Turn the assembly over and insert Input Coupling Sub-assembly into the spindle (1A) counterbore.

17. The unit should now be leak and roll checked as per "The Roll Test" and "The Leak Test". The motor can be reinstalled into the gearbox for the leak check to seal it off and the unit pressurized through a pipe plug hole on the cover.

3.8 DRIVE BRAKE

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 Threadlocking Compound 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.

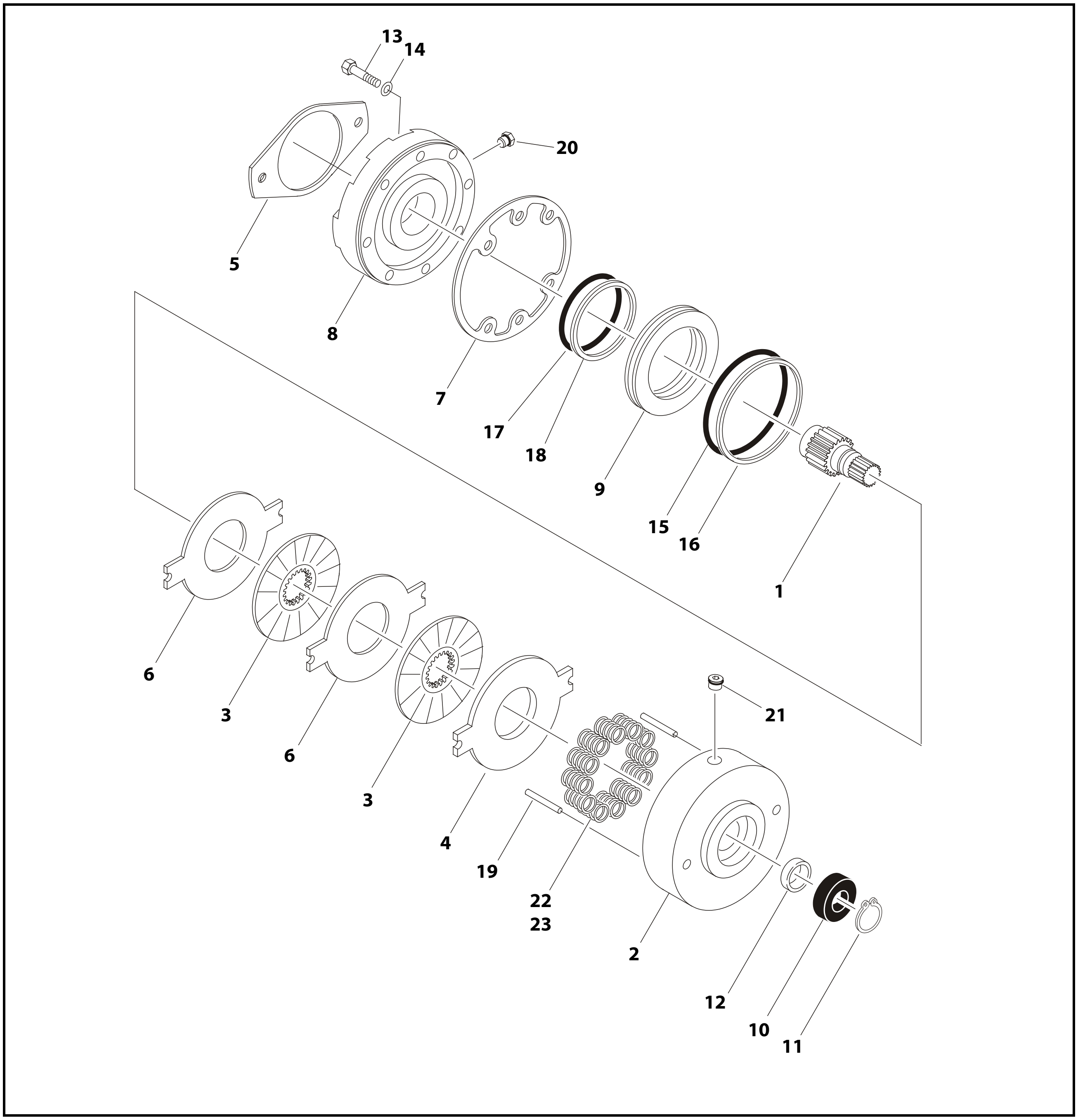
Assembly

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

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

Figure 3-18. Drive Brake

3.9 DRIVE MOTOR

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.

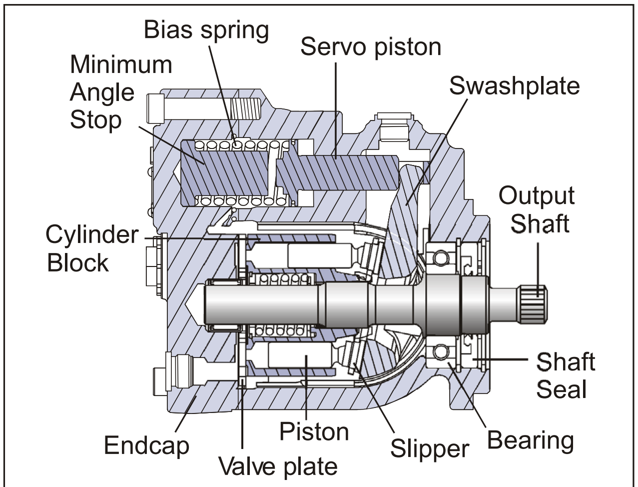
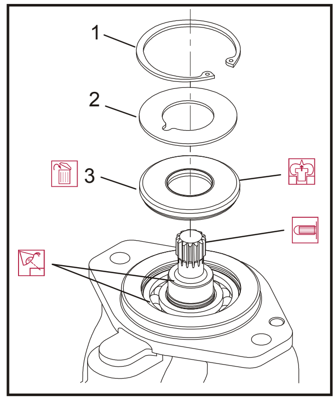


Figure 3-19. Drive Motor Cross Section

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 3-20. Removing the Shaft Seal

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

NOTE: *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.

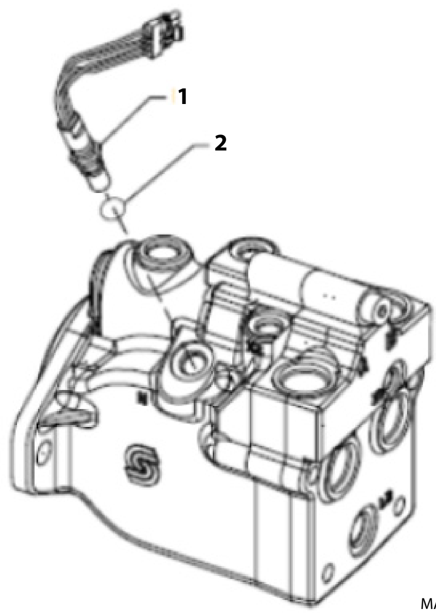
INSTALLATION

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.

Speed Sensor Replacement

REMOVAL

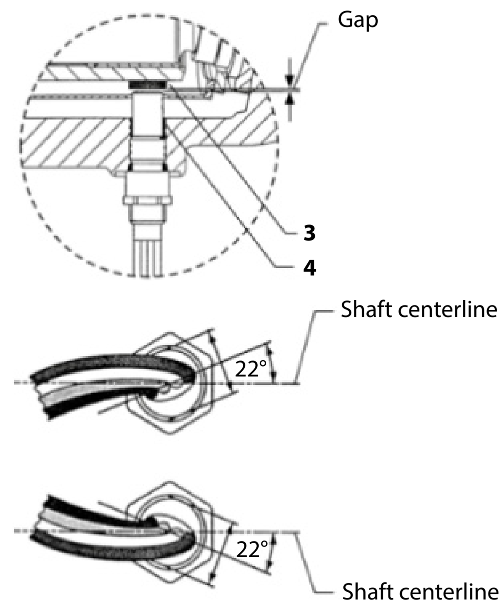
1. Disconnect the speed sensor electrical connector.
2. Using an 11/16 in. wrench, loosen the locknut.
3. Using a 1/2 in. wrench, remove the speed sensor and o-ring from the motor.



MAF35990

INSTALLATION

1. Turn speed sensor with o-ring (2) in (CW) by hand until bottom end gently touches the speed ring (3).
2. Back out speed sensor (CCW) 1/4 turn. Continue backing out until the flats are 22° either side of the motor shaft center line (20° to 30° is acceptable). Do not back out more than 3/4 turn from touching bottom.
3. Using a 1/2 in. wrench to hold the speed sensor (4), torque the lock nut (1) to 10 ft. lbs. (13 Nm) with an 11/16 in. wrench.
4. Plug in electrical connection and start machine to test for proper operation.



MAF36000

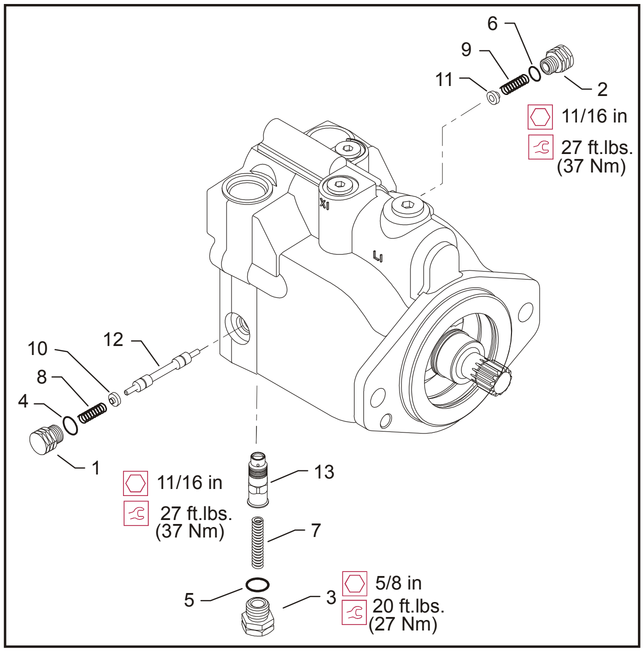
ADJUSTMENT AND TROUBLESHOOTING

1. Wire configuration
   Red = Power
   White = Speed signal
   Black = Ground (common)
   Green = Direction
2. Speed signal
   Check for speed output using a Volt Ohm Meter (VOM). Place VOM across the ground and speed pins or terminals, (Black = Ground, White = Speed Signal) and set VOM to the DC Volt scale and low range. To check for an output, turn pump or motor very slowly by hand or check output just as the prime mover is coming to a stop.
   Note a voltage pulse at meter. It will likely be difficult to read exact, simply note a pulse (approximately 60 pulses per rev). If there is no indication of a pulse, repeat installation steps and recheck.
3. Directional signal
   Check for a direction signal change using a VOM. Use the same VOM setup as in the above speed signal check. Turn the motor slowly and note a polarity change (±) on the VOM display as you change the motor direction.

Loop Flushing Valve

REMOVAL

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



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

Figure 3-21. 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

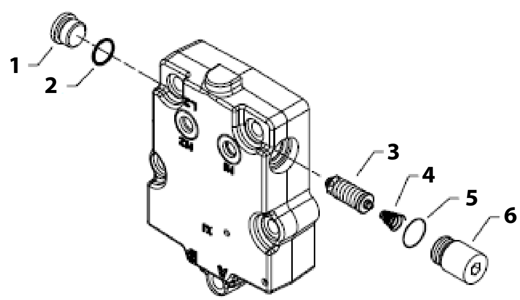
1. Install orifice poppet (13).
2. Install shift spool (12).
3. Install spring retaining washers onto springs (10 and 11).
4. Carefully install centering springs (7, 8 and 9).
5. Install new O-rings (6, 4 and 5).
6. Using a 1/4 in. hex wrench torque plug (3) to 20 ft. lbs. (27 Nm).
7. Using a 11/16 in.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

Anti-Cavitation Valve

REMOVAL

The anti-cavitation valve is installed into the high pressure port. The high pressure port depends on motor rotation. If rotation is counterclockwise, the high pressure port is A. If rotation is clockwise, the high pressure port is B.

1. Using a 5/16 in. internal hex wrench remove valve plug (6). Remove and discard O-ring (5).
2. Remove spring (4) and relief valve (3) from end cap.
3. Using a 5/16 in. internal hex wrench remove plug (1). Remove and discard O-ring (2).



MAF36010

INSPECT THE COMPONENTS

Inspect sealing area for rust, wear, or contamination. Check spring (4) and relief valve (3) for wear and damage. Relief valve (3) is non-serviceable, replace as complete unit if damaged.

INSTALLATION

1. Lubricate and insert relief valve (3) and spring (4) in original location.
2. Lubricate and install new O-ring (5) on valve plug (6).
3. If needed lubricate and install new O-ring (2) on plug (1).
4. Using a 5/16 in. internal hex wrench to install valve plug (6) into port with relief valve (3). Torque to 59 ft. lbs. (80 Nm).
5. If needed using a 5/16 in. internal hex wrench to install plug (1) into port without relief valve (3). Torque to 59 ft. lbs. (80 Nm).

Troubleshooting

Table 3-2. Excessive Noise and/or Vibration

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

Table 3-3. System Operating Hot

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

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

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

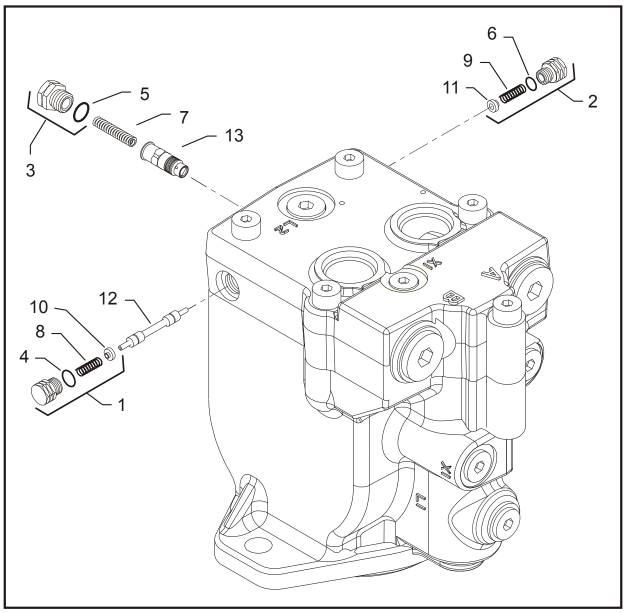
Disassembly

NOTE: *Removal of the end cap 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.

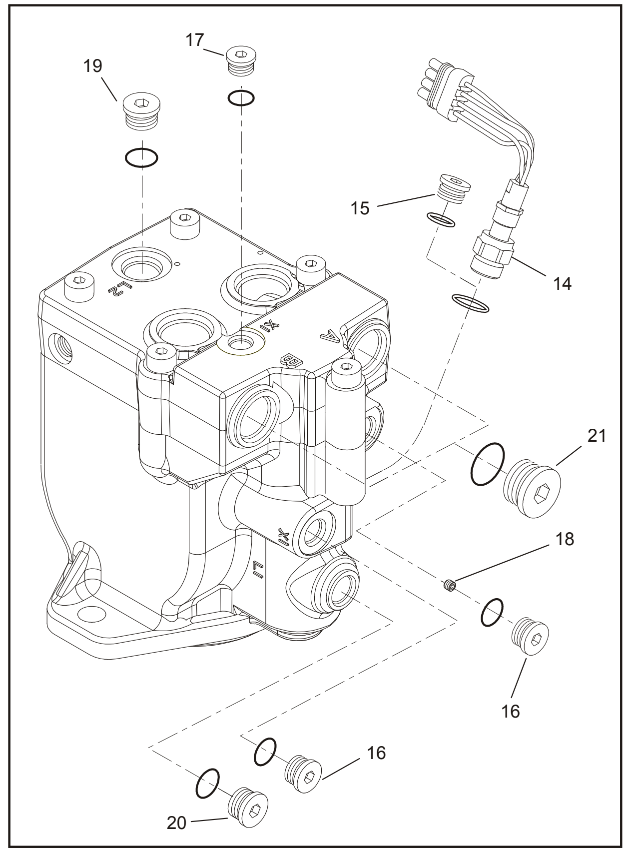
It is recommended that all O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



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 3-22. Loop Flushing Spool

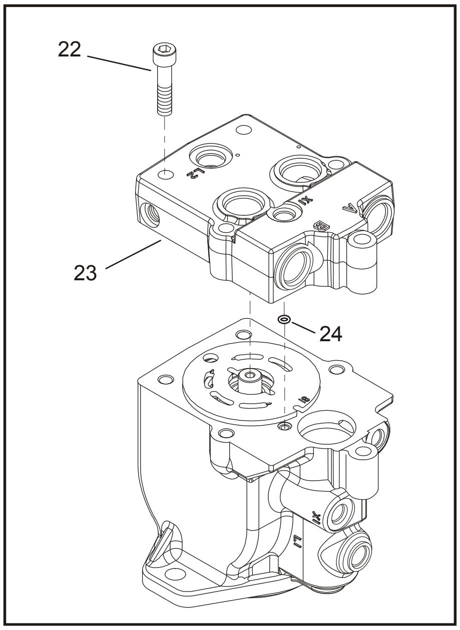
1. Using a 11/16 in. wrench remove plug (1) and (2).
2. Using a 5/8 in. hex wrench remove plug (3).
3. Remove O-rings (4, 5 and 6).
4. Using pliers, remove centering springs (7, 8 and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



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 3-23. Plugs, Fittings and Speed Sensor

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

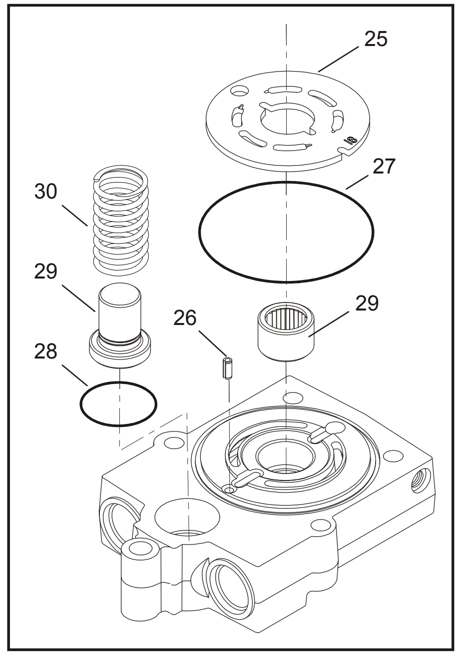


22. Screw
23. End Cap
24. O-ring

Figure 3-24. End Cap

13. Using an 8 mm internal hex wrench, remove the end capscrews (22).
14. Remove the end cap (23). Remove O-ring (24) from the housing or end cap.

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



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

Figure 3-25. Valve Plate & Rear Shaft Bearing

CAUTION

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

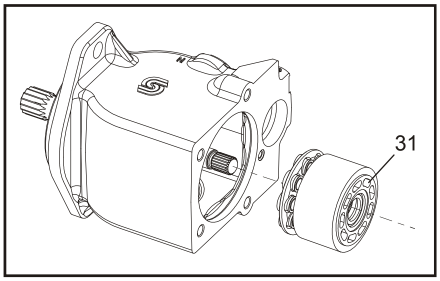
15. Remove the valve plate (25) and timing pin (26) from the end cap.

NOTE: *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 end cap with a bearing puller.

NOTE: *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

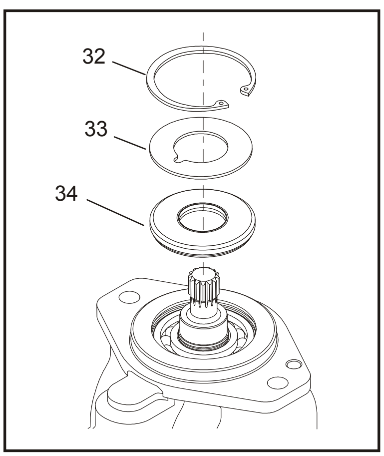
Figure 3-26. Cylinder Kit

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 3-5. Displacement Identifiers

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

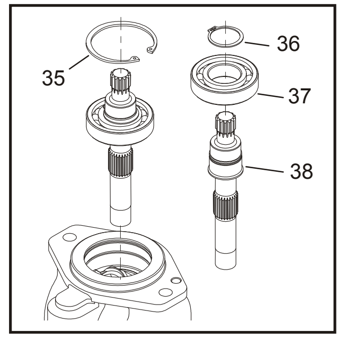


32. Snap Ring
33. Support Washer
34. Shaft Seal

Figure 3-27. 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.

NOTE: *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.*

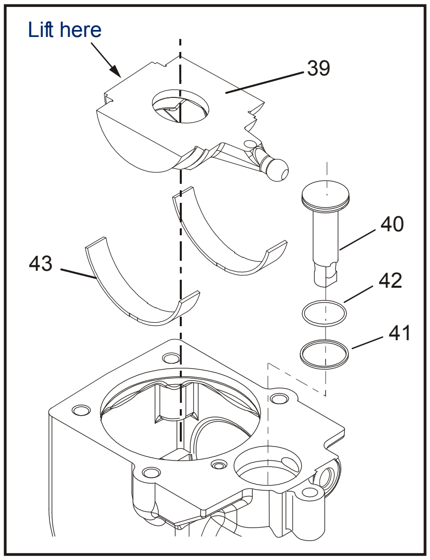


35. Inner Snap Ring
36. Snap Ring
37. Bearing
38. Shaft

Figure 3-28. 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).



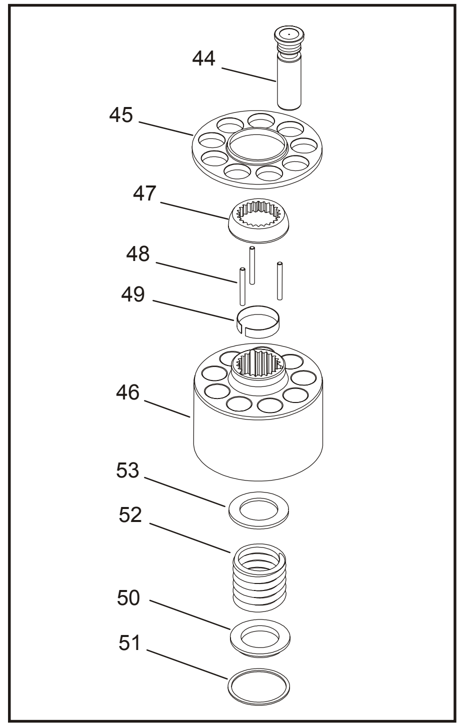
39. Swashplate
40. Servo Piston
41. Piston Seal
42. O-ring
43. Journal Bearings

Figure 3-29. Swashplate & 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 3-30. Cylinder Kit Disassembly

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

NOTE: *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.

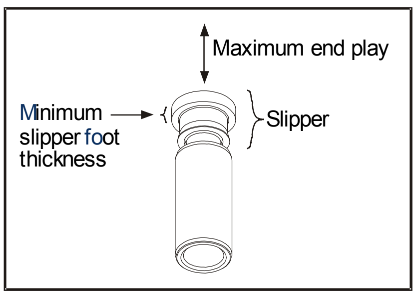
28. Turn the block over. Using a press, apply pressure on the block spring washer (50) to compress the block spring. Compress the spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind the spiral retaining ring (51). Carefully release the pressure and remove 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 end cap 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 3-6. Slipper Foot Thickness & End Play

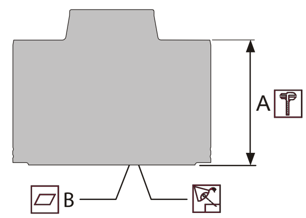
Measurement	L Frame mm (in.)	K Frame mm (in.)
Slipper Foot Thickness	2.71 (0.11)	4.07 (0.16)
Piston/Slipper End Play	0.15 (0.006)	

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 3-7, Cylinder Block Measurements.

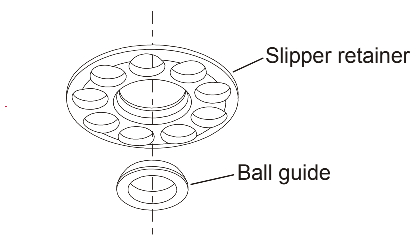
Table 3-7. Cylinder Block Measurements

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 (7.9)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)	0.002 (0.0000079)



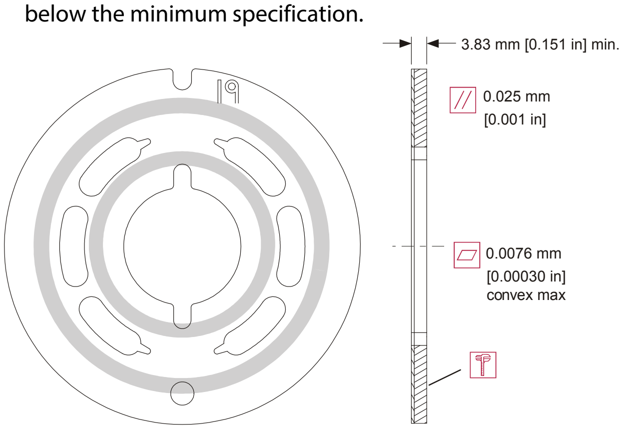
BALL GUIDE AND SLIPPER RETAINER

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.



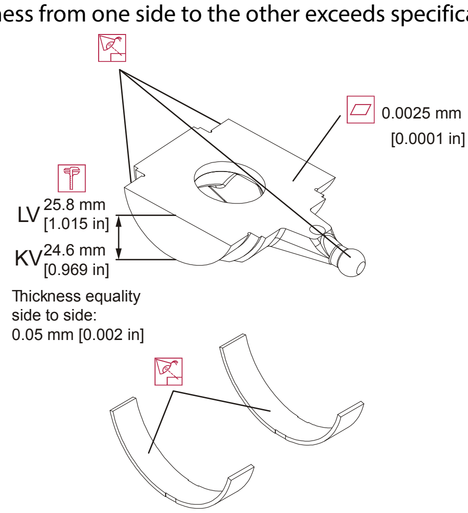
VALVE PLATE

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

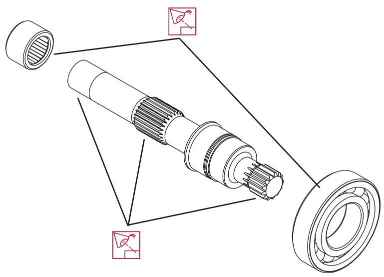
Inspect the running face, servo ball-joint and swashplate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable providing the surface condition meets specifications shown. Measure the swashplate thickness from the journals to the running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

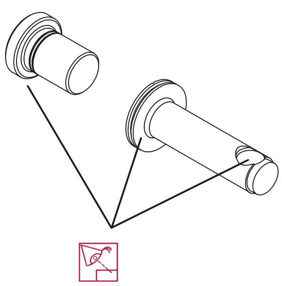


SHAFT

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.

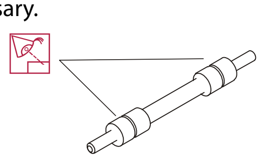
SERVO PISTON AND MINIMUM ANGLE STOP

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



LOOP FLUSHING SPOOL

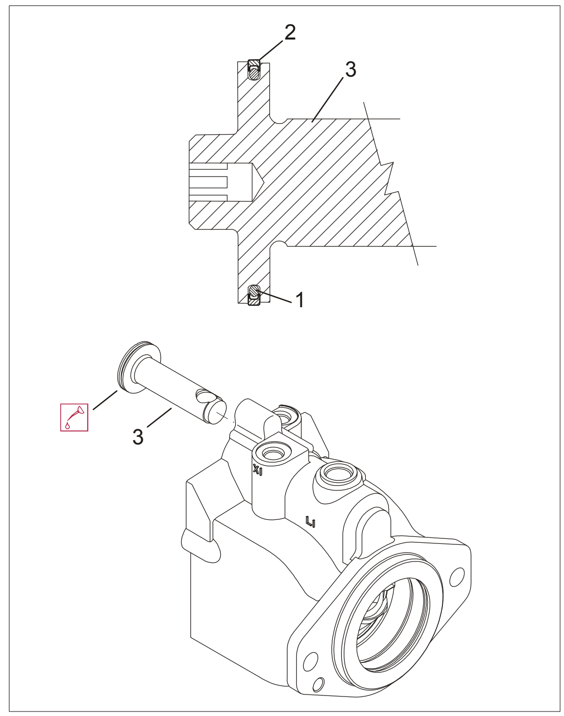
Inspect the loop flushing spool. Check for cracks or damage. Replace if necessary.



Assembly

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

NOTE: *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

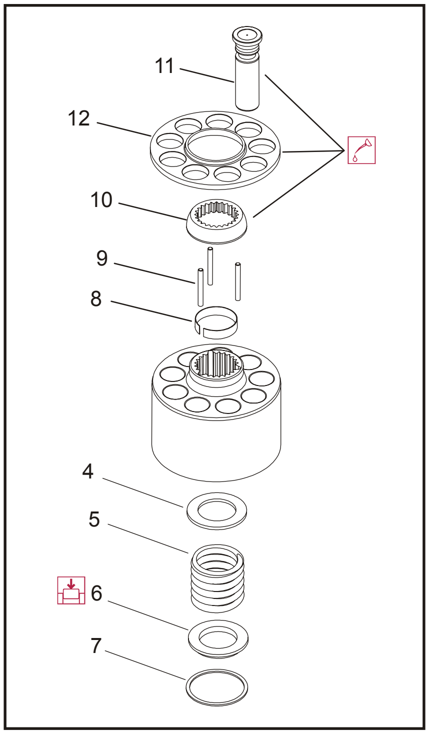
Figure 3-31. Servo Piston

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.



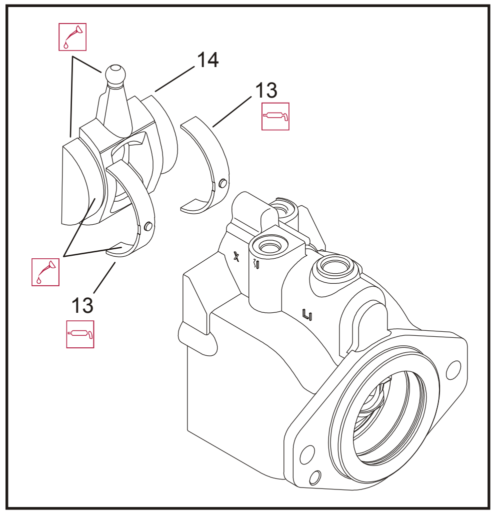
4. Block Spring Washer
5. Block Spring
6. Outer Washer
7. Spiral Retaining Ring
8. Retaining Ring
9. Holddown Pins
10. Ball Guide
11. Piston
12. Slipper Retainer

Figure 3-32. 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.

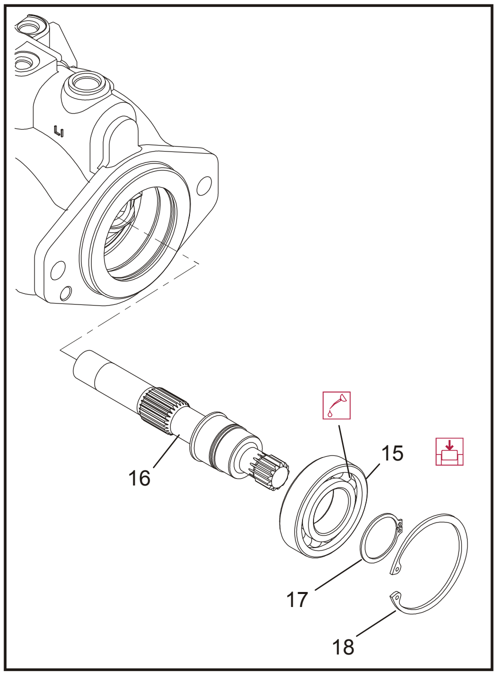


13. Journal Bearings
14. Swashplate

Figure 3-33. 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.

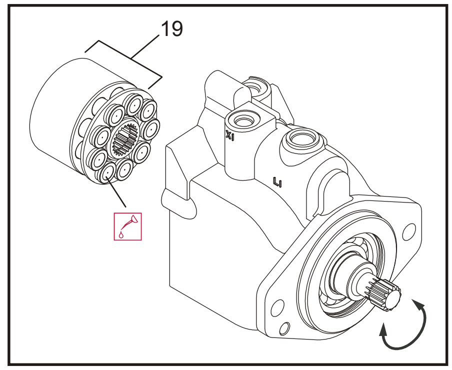


15. Front Shaft Bearing
16. Shaft
17. Snap Ring
18. Snap Ring

Figure 3-34. 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).

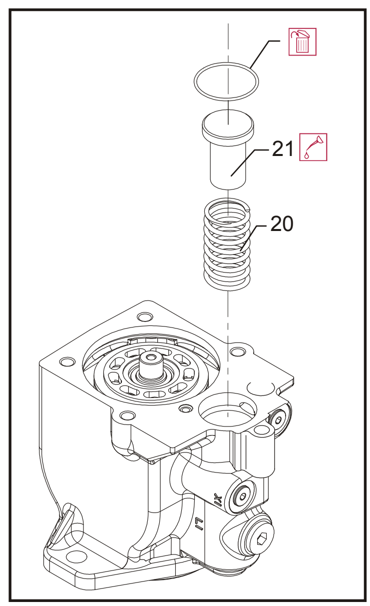
10. Verify swashplate and bearings are properly seated. Install the cylinder kit (19) onto the shaft. Install with the slippers facing the swashplate. Rock the shaft to align the block splines and slide the cylinder kit into place. Orient the motor with the shaft pointing downward and verify the cylinder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



19. Cylinder Kit

Figure 3-35. Cylinder Kit Installation

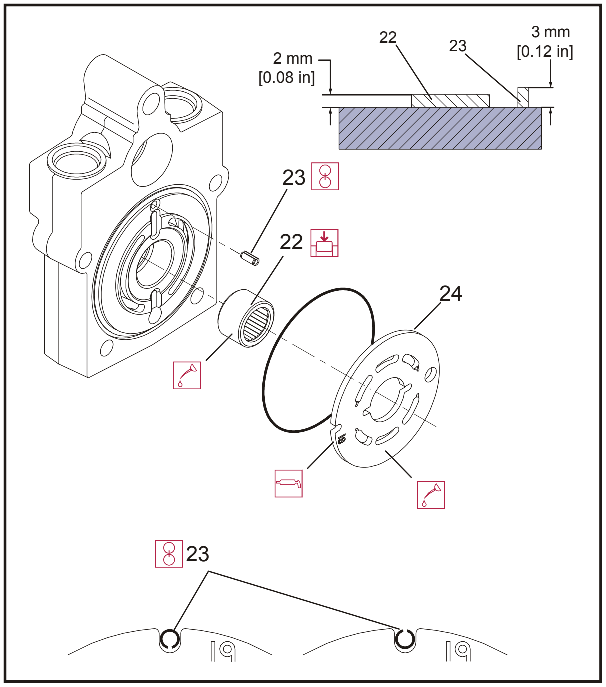
11. Lubricate and install the servo spring (20) and minimum angle stop (21) into the housing bore.



20. Servo Spring
21. Minimum Angle Stop

Figure 3-36. Servo Spring and Minimum Angle Stop

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



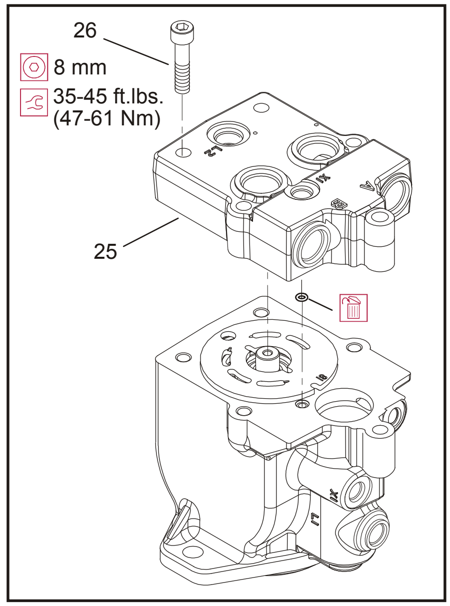
22. Rear Shaft Bearing
23. Timing Pin
24. Valve Plate

Figure 3-37. Valve Plate and Rear Bearing

13. Install timing pin (23) into its bore in the end cap. 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 end cap surface.

14. Install the valve plate (24) onto the end cap. 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 end cap side of the valve plate to keep it in place during installation.

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



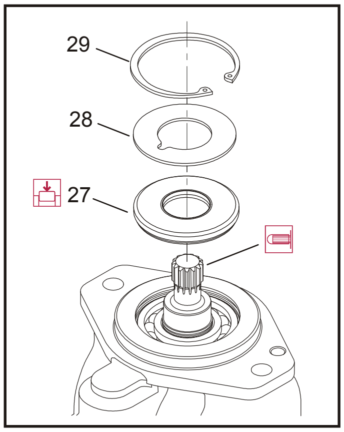
25. End Cap
26. Screw

Figure 3-38. End Cap

16. Using an 8 mm internal hex wrench, tighten the end capscrews. Tighten the screws in opposite corners slowly and evenly to compress the servo spring and properly seat the end cap. 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 3-39. Shaft Seal

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

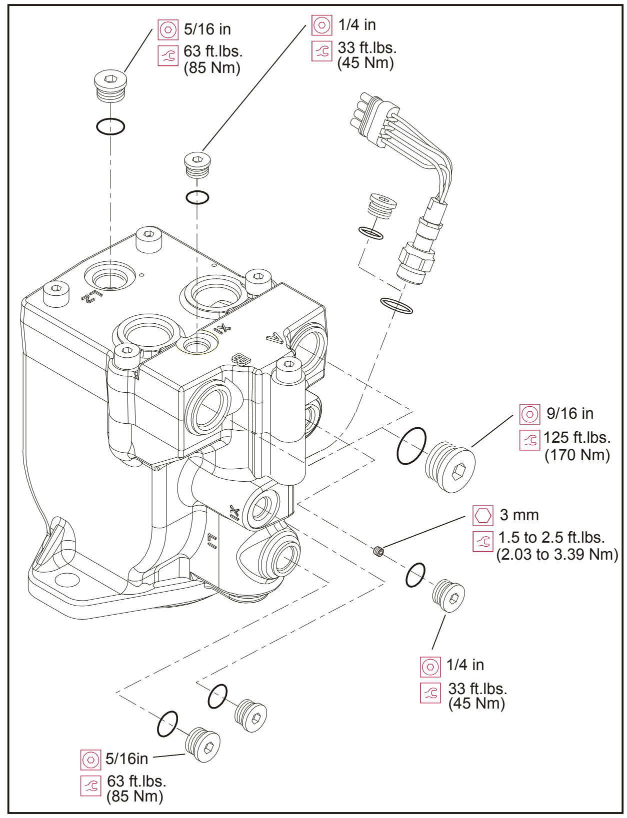
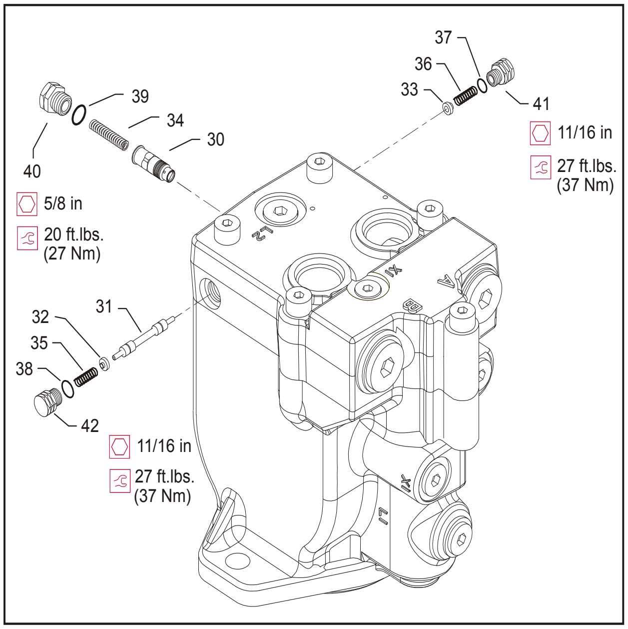


Figure 3-40. Plugs and Fittings Installation

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 3-41. 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.

⚠ WARNING

UNINTENDED MOVEMENT OF THE MACHINE OR MECHANISM MAY CAUSE INJURY TO THE TECHNICIAN OR BYSTANDERS. TO PROTECT AGAINST UNINTENDED MOVEMENT, SECURE THE MACHINE OR DISABLE / DISCONNECT THE MECHANISM WHILE SERVICING.

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.

NOTE: *Follow recommendations in the vehicle / machine operator's manual for prime mover start up procedures.*

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.

3.10 CHASSIS TILT INDICATOR SYSTEM

The Chassis Tilt Indicator System measures the turntable angle with respect to ground level. The control system compares the reading to a preset turntable tilt angle value.

When machine is in transport position (see “Default tilt sensor preset value is 4 degree, but it can be selected between 4 degree and 3 degree by JLG hand held Analyzer.” for detail), it can travel at up to maximum speed until it tilts more than 8 degree, then the system will limit the drive speed to maximum displacement mode (slow drive speed).

When machine is out of transport position and the turntable tilts more than the preset value, the boom functions can only operate in creep speed mode and the drive function is disabled. The operator must return the machine into transport mode in order to continue drive the machine.

Default tilt sensor preset value is 4 degree, but it can be selected between 4 degree and 3 degree by JLG hand held Analyzer.

3.11 DRIVE ORIENTATION SYSTEM

This 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 proximity switch mounted on the hydraulic swivel, an indicator light and a spring return override switch on the platform display panel. The proximity switch trips when the turntable is swing +/- 45 degrees off center of the normal driving position. This occurs roughly when the main boom is swing 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 swing past the switch point, the system is ignored until drive/steer is released.

When drive is initiated with the boom swing 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 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 of the last drive/steer command. If the timer expires, the DOS override switch must be re-engaged to enable drive/steer.

3.12 DRIVE SYSTEM

The four-wheel 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 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) using the “Beyond Transport - Drive Speed Cutback System”.

The following chart describes how the system works in each drive mode. Actual RPM may vary according to selected engine. See commanded engine RPM for specific Engine Speed value.

Table 3-8. Drive Mode Speeds

Boom Position	Drive Selection (Toggle Switch Location on the Platform Console)		Engine Speed when Drive Control is Activated	Approx. Max. Speed (MPH)
In Transport	Max Speed	–	High – 2600 RPM	3.8
	Mid-Engine	–	Mid – 1800 RPM	0.9
	Max Torque	–	High – 2600 RPM	1.3
Out of Transport	Max Speed	–	High – 2600 RPM	0.4
	Mid-Engine	–	Mid– 1800 RPM	0.4
	Max Torque	–	High – 2600 RPM	0.4

3.13 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. Remove Motor and release the brake by applying 400 psi to the brake port.

To perform a roll test, use a tool capable of applying constant rotational force to the input of the gearbox.

If more drag is felt in the gears only at certain points, then the gears are not rolling consistently and easily 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 the unit seem to roll hard as long as they roll with consistency.

Rotate the gearbox 36 revolutions both clockwise and counterclockwise.

Leak Test (Main Unit)

The purpose of a leak test is to make sure the unit is airtight. Use tool T201476 refer to Figure 3-56. for details to perform the leak test. If the tool is not available, the gearbox must be sealed to perform the test. This can be accomplished by assembling the sealed input device onto the gearbox at the input end and replace one of the oil plugs with an air chuck.

NOTE: *Do not exceed 10 psi (0.7 Bar) pressure during the leak test.*

Higher pressure will create a false sealing effect in assemblies with lip-seals. The unit has a leak if the pressure gauge reading on your leak check fitting starts to fall after the gearbox 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 and 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

Prior to brake check remove Motor, Tubing and Elbow as per Motor disassembly instruction. To perform a brake check, use a 7/16-20 thread fitting. Install a hydraulic hand pump with pressure gauge into brake port in Brake Housing using thread fitting.

Place ROLL TEST Tool previously used or equivalent into Sun Gear (8). Apply 25 in.lbs. (2.7 Nm) torque.

While trying to rotate tool, pump the handle on the hydraulic hand pump and increase the pressure until the brake releases. The brake is released when you are able to rotate the tool.

Record the release pressure. If brake does not release within 197 to 210 psi, check to see if it has the proper number of springs using the SPRING CHECKING PROCEDURE.

Increase to maximum pressure to 2000 psi and hold at that pressure for one minute. If the brake does not leak or lose pressure, the unit has passed the brake test. If brake loses pressure, contact JLG service department.

While brake is still released, roll check the unit for one revolution of the output member by rotating the tool. Bleed off pressure slowly while rotating the ROLL TEST Tool previously used.

Record the pressure at which the brake locks up. Using a clean rag, wipe off excess fluid from around brake port and install the pipe plug.

Spring Checking Procedure

Install two Flat Socket Head Capscrews 0.250-20 UNC, 1/2 in. length into holes in brake piston. Tighten bolts evenly to ensure that brake piston remains straight while being compressed into brake cavity of brake housing.

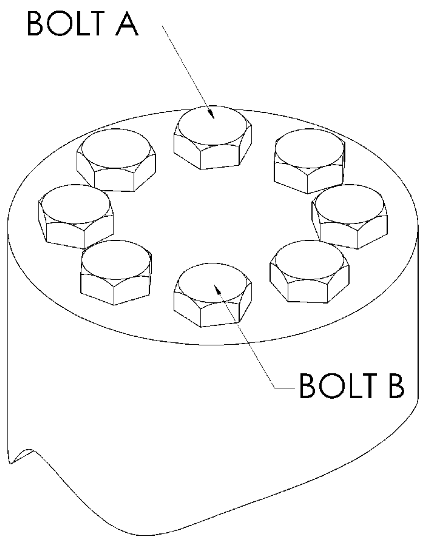
Carefully remove retaining ring from brake housing. Slowly remove bolts evenly from the input brake. Remove the pressure plate from the end of the input brake and count the number of springs in brake.

If number of springs matches the number 14, go to the next step. If number of springs does not matches the number 14, install the correct number of springs.

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.

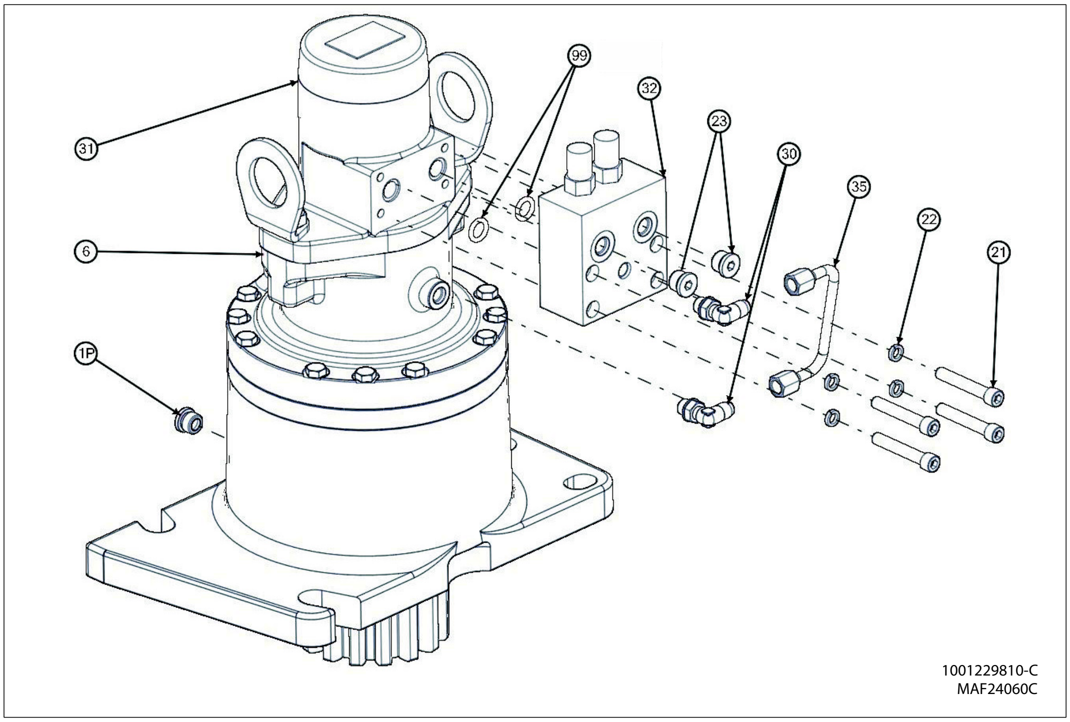


1. Tighten (but do not torque) bolt “A" until snug.
2. Go to the opposite side of the bolt circle and tighten bolt “B” until equally snug.
3. Crisscross around the bolt circle and tighten remaining bolts.
4. Now use a torque wrench to apply the specified torque to bolt “A”.
5. Using the same sequence,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

Motor Control Valve Disassembly

NOTE: *Refer to Figure 3-42.*

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).
7. Remove O-ring (99) between Motor Control Valve (32) and Motor (31). Discard O-ring.



1P. O-ring Plug	30. Elbow Fitting
6. Hydraulic Brake	31. Hydraulic Motor
21. Hex Bolt	32. Motor Control Valve
22. Lockwasher	35. Hydraulic Tubing
23. Plug	99. O-ring

Figure 3-42. Motor Control Valve

Motor and Brake Disassembly

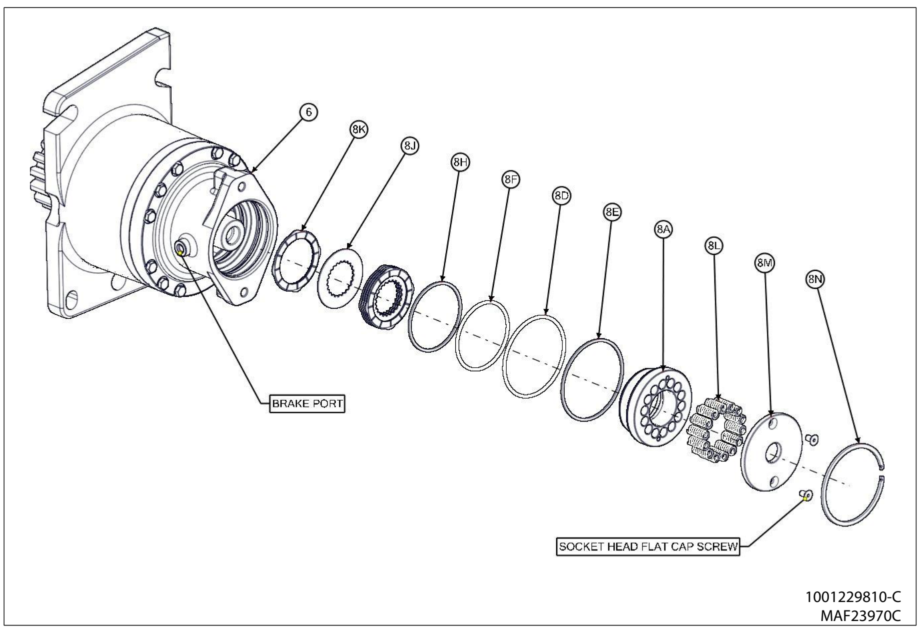
NOTE: *Refer to Figure 3-43.*

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. Insert and tighten the 0.250 – 20 UNC flat Socket Head Capscrews through the Pressure Plate (8M) and into the Brake Piston (8A) to compress the springs and relieve pressure on the Retaining Ring (8N).
5. Using retaining ring pliers, remove Retaining Ring (8N) which holds the Brake Piston assembly in place.
6. Lift Brake Piston Assembly (8A) out of the Brake Housing (6). If the Brake Piston assembly (8A) will not lift out, apply less than 50 psi air to the “brake port” to remove Brake Piston(8A). Remove the Inner (Rotor) (8J), Outer (Stator) Plates (8K), from inside Brake Housing (6).
7. Remove O-rings (8D, 8F) and Backup Rings (8E, 8H) from the Brake Housing (6). Discard O-rings and Backup Rings.
8. Remove 0.250 – 20 UNC flat Socket Head Capscrews and lift the Pressure Plate (8M) from the Brake Piston (8A).
9. 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.

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



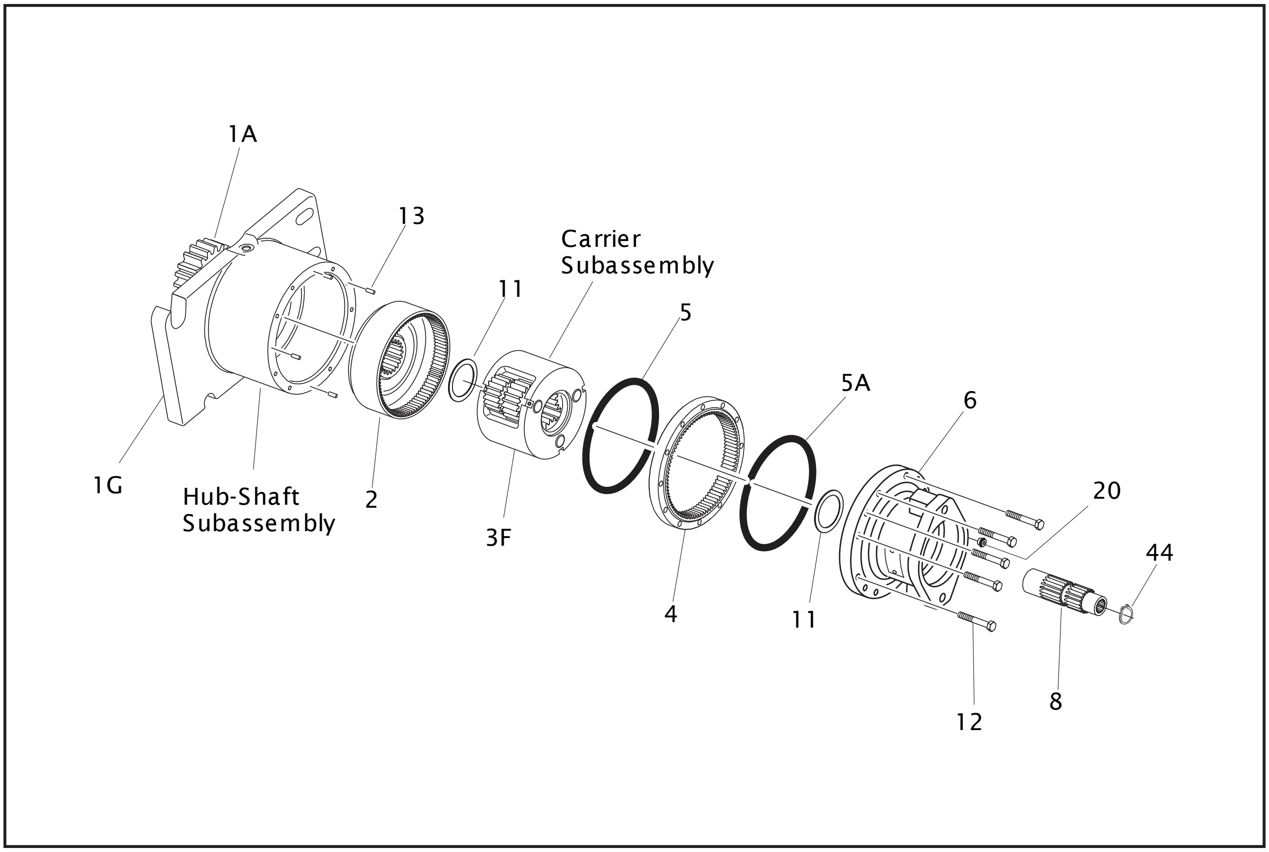
6. Brake Housing
8A. Brake Piston
8D. O-ring
8E. O-ring/Backup Ring
8F. O-ring
8H. O-ring/Backup Ring
8J. Brake Rotor
8K. Brake Stator
8L. Spring
8M. Pressure Plate
8N. Internal Retaining Ring

Figure 3-43. Motor and Brake

Main Drive Disassembly

NOTE: *Refer to Figure 3-44.*

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



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

Figure 3-44. Main Drive Assembly

Hub-Shaft Disassembly

NOTE: *Refer to Figure 3-45.*

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

CAUTION

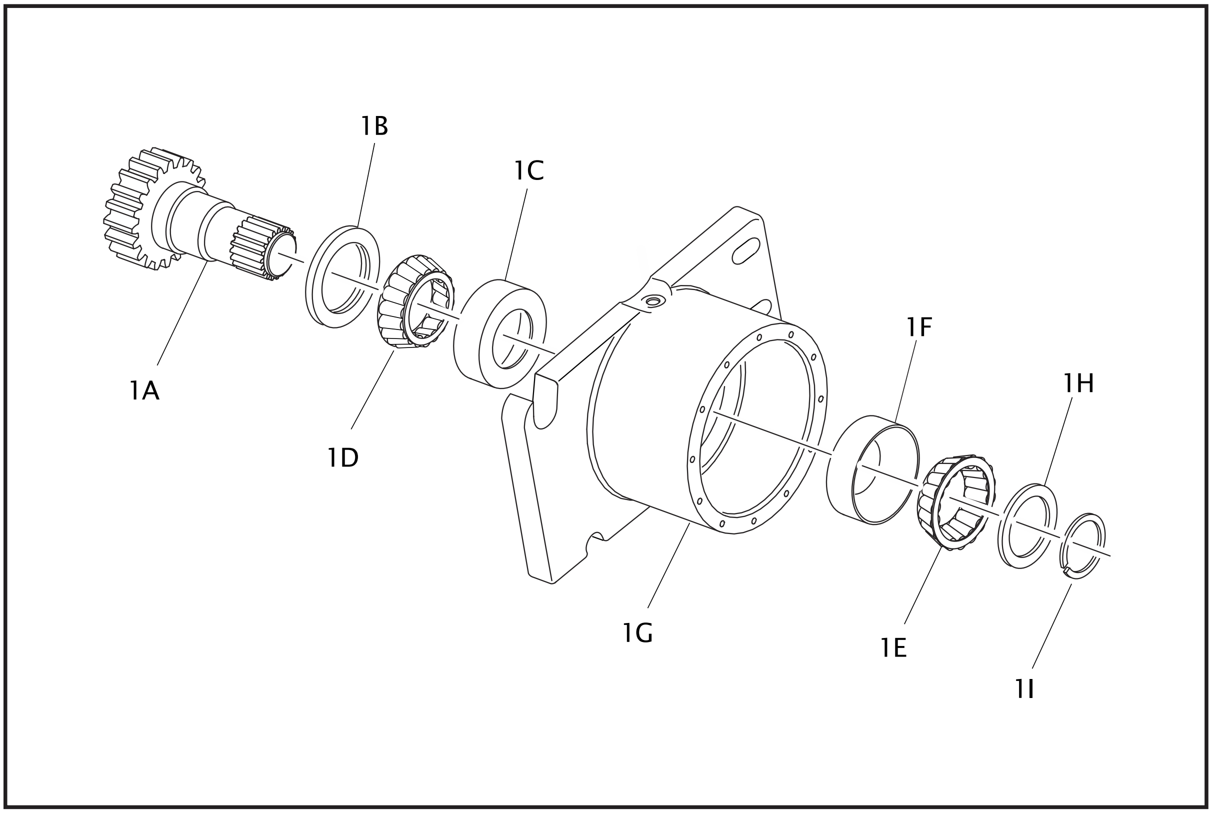
EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

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).

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



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 3-45. Hub-Shaft

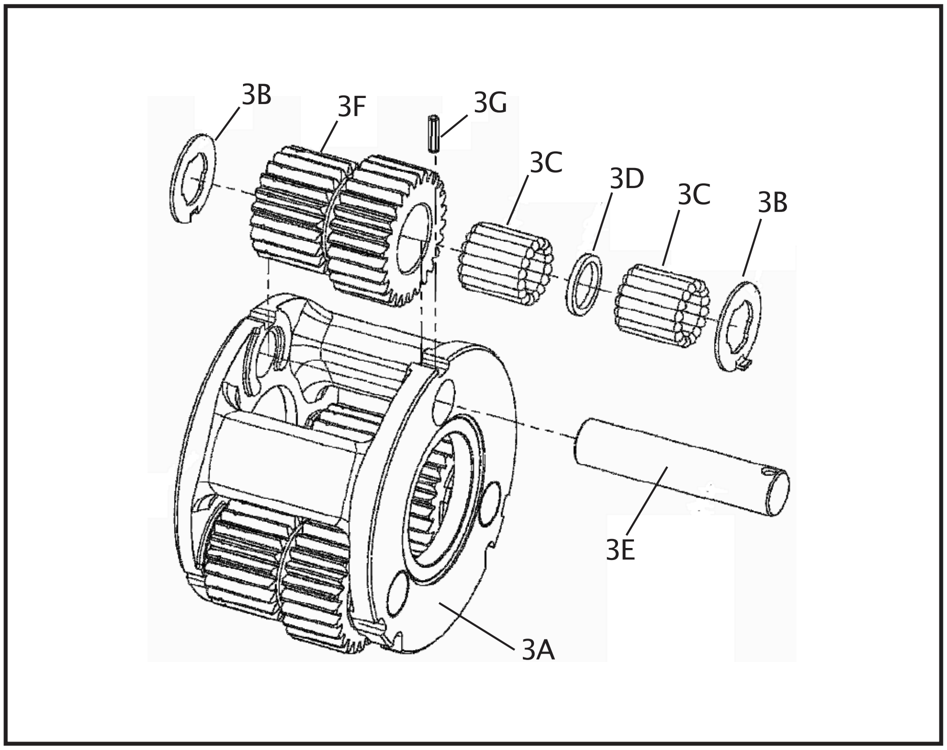
Carrier Disassembly

NOTE: *Refer to Figure 3-46.*

1. Using a 3/16 in. 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 3-46. Carrier

Hub-Shaft Assembly

NOTE: *Refer to Figure 3-45.*

1. Press Bearing Cup (1C) into Housing (1G) taking care to ensure 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 ensure 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 3-46.*

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 in. (3 mm) diameter punch.
10. After using a 3/16 in. (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 through 10 for the remaining two Cluster Gears (3F).

Main Drive Assembly

NOTE: *Refer to Figure 3-44.*

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 counterbore holes in Hub (IG).
4. Install Thrust Washer (11) in counterbore of Carrier Sub-Assembly (Small Cluster-Gear end) Use grease to hold in place.
5. Place O-ring (5) into Hub counterbore. Use grease to hold O-ring in place.

⚠ WARNING

BEWARE OF SHARP EDGES OF THE COUNTERBORE 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 counterbored 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 counterbore on the face of the carrier. Use grease to hold in place.
10. Place O-ring (5A) into counterbore or Brake Housing (6). Use grease to hold O-Ring in place.

⚠ CAUTION

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

11. Install the Brake Housing (6), taking care to correctly align Pipe Plug (20) with those in the Hub (1G).
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 80W90 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 Brake Housing (6) torque to 23-24 ft. lbs. (31-32 Nm).

Motor and Brake Assembly

NOTE: *Refer to Figure 3-43.*

1. Starting with a Stator (8K), alternately stack and install Stators (8K) into Lobes of Brake Housing (6) and Rotors (8J) (internal splines) onto splines of Sun Gear (8).

NOTE: *There should always be a Stator on the top and bottom of the stack.*

2. Insert Brake Piston (8A) completely into Brake Housing (6) without O-rings (8D, 8F) and Backup Rings (8E, 8H) to check fit of brake. The Brake Piston (8A) should slide into Brake Housing (6) without being forced. If Brake Piston (8A) does not fit, check for burrs or size problems before proceeding.
3. Grease O-rings (8D, 8F) and install smaller diameter O-Ring (8F) into smaller diameter O-Ring groove in Brake Housing (6) and install larger diameter O-Ring (8D) into larger diameter O-Ring groove in Brake Housing (6).
4. Insert smaller diameter Solid Backup Ring (8H) into smaller groove in Brake Housing (6) between O-Ring (8F) and side of groove towards Output Shaft (1A).
5. Insert larger diameter Solid Backup Ring (8E) into groove in Brake Housing (6) between O-Ring (8D) and side of groove towards Motor (31).
6. Lightly grease cylinder walls of Brake Housing (6) and install Brake Piston (8A) into Brake Housing (6). If necessary, place T-134711 on top of brake and lightly tap until Brake Piston (8A) contacts brake disk stack.
7. Insert 8 Springs (8L) into Brake Piston (8A) spring holes.
8. Install Pressure Plate (8M) into Brake Housing (6) bore and onto top of Springs (8L).
9. Insert and tighten the 0.250 – 20 UNC Flat Head Capscrews through the Pressure Plate (8M) and into the Brake Piston (8A) to compress the springs. Tighten Socket Head Capscrews incrementally to evenly compress the Springs (8L).

CAUTION

CAUTION: SAFETY GLASSES MUST BE WORN DURING THESE NEXT STEPS.

10. Using retaining ring pliers, install large Retaining Ring (8N) into groove in Brake Housing (6) making sure that it is seated properly.

NOTE: *Use caution when installing retaining ring (8N) into Brake Housing (6). It may cause injury if it slips out of retaining ring pliers.*

11. Remove the Flat Head Capscrews from the Brake Piston (8A) incrementally to release the tension of the springs slowly. Discard Flat Head Capscrews.
12. The Unit should undergo brake test refer instruction on page 48.
13. Grease and install the O-Ring (26) into the Motor (31) pilot.
14. Install Motor (31) into the Brake Housing (6). Insure the motor valve mounting face is aligned with the radial brake release port in the Housing (1G).
15. Install Bolts (29) into Brake Housing (6) through Lifting Lugs (28) and Motor (31) flange. Torque bolts to 80-100 ft. lbs. (108-136 Nm).

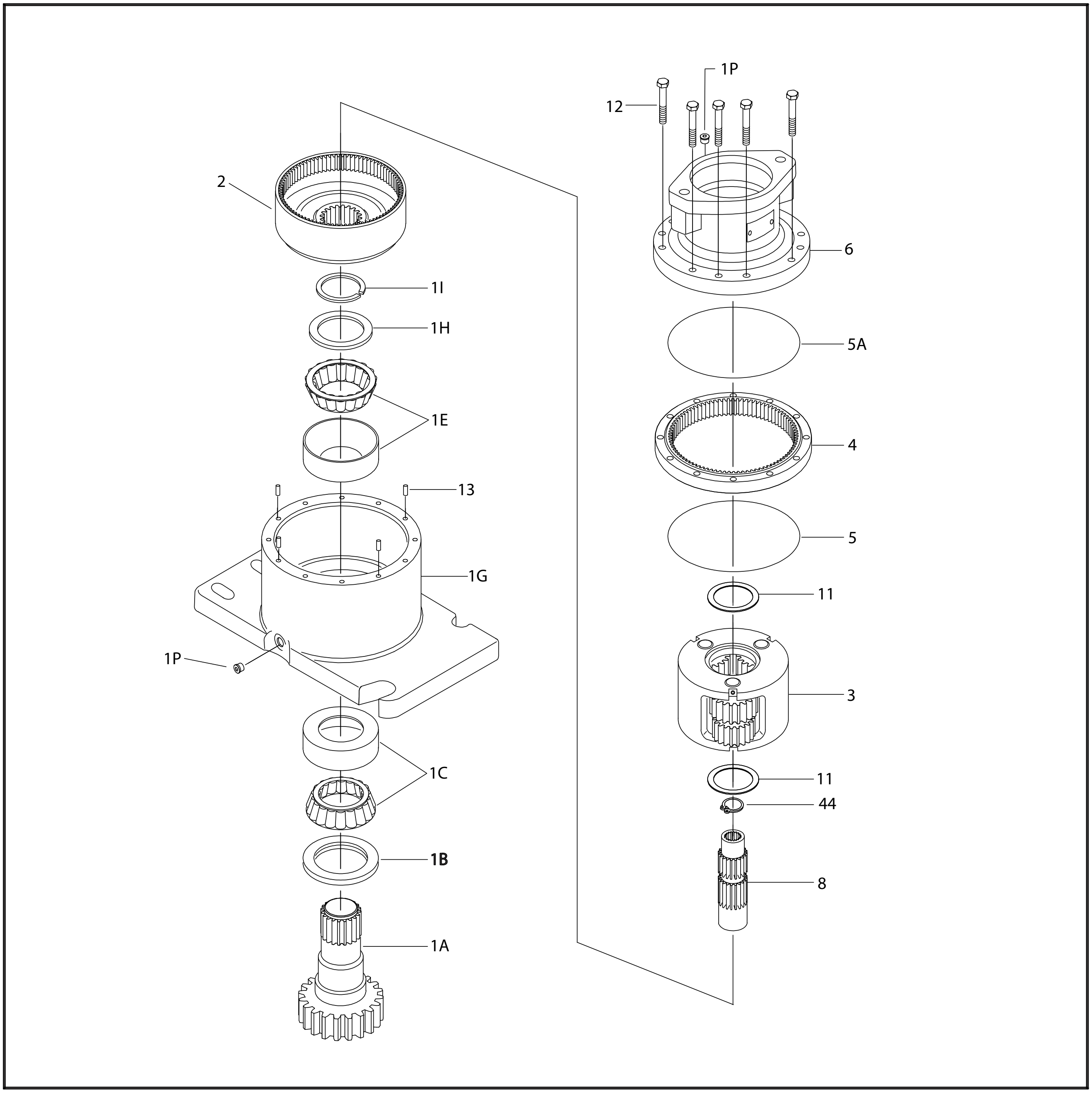
Motor Control Valve Assembly

NOTE: *Refer to Figure 3-42.*

1. Install O-Rings (99) into counterbore on Motor Valve face. Assemble the Motor control Valve (32) onto the Motor (31) with Bolt (21) and Lock Washers (22). Torque Bolts (21) to 18-20 ft. lbs. (23-26 Nm).

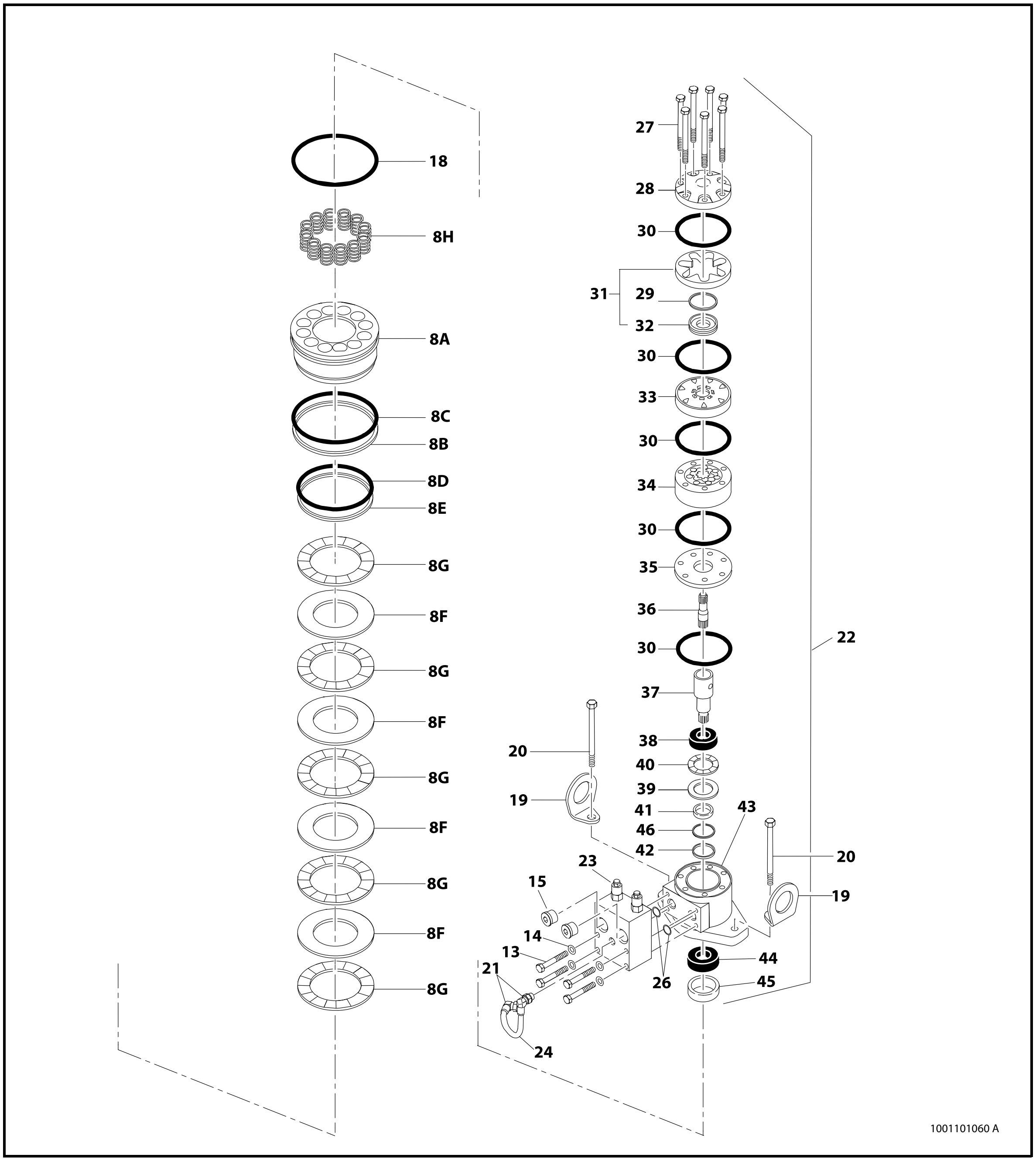
NOTE: *Be sure to align the holes in the control valve with the motor ports.*

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 18-20 ft. lbs. (23-26 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 18-20 ft. lbs. (23-26 Nm).



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

Figure 3-47. Swing Drive Assembly



8A. Piston
8B. O-Ring
8C. Backup Ring
8D. O-Ring
8E. Backup Ring
8F. Rotor Disc
8G. Stator Disc
8H. Spring
13. Thrust Washer
14. Lock washer
15. Pipe Plug
18. 0-Ring
19. Lifting lug
20. Bolt
21. Elbow
24. Tube
26. O-ring
27. Bolt
28. End Cover
29. Commutator Seal
30. Ring Seal
31. Commutator and Ring Assy
32. Ring
33. Manifold
34. Rotor Set
35. Wear Plate
36. Drive Link
37. Coupling Shaft
38. Inner Bearing
39. Thrust Washer
40. Thrust Bearing
41. Inner Seal
43. Backup Washer
43. Housing
44. Backup Washer
45. Seal
46. Washer

Figure 3-48. Swing Motor and Brake Assembly

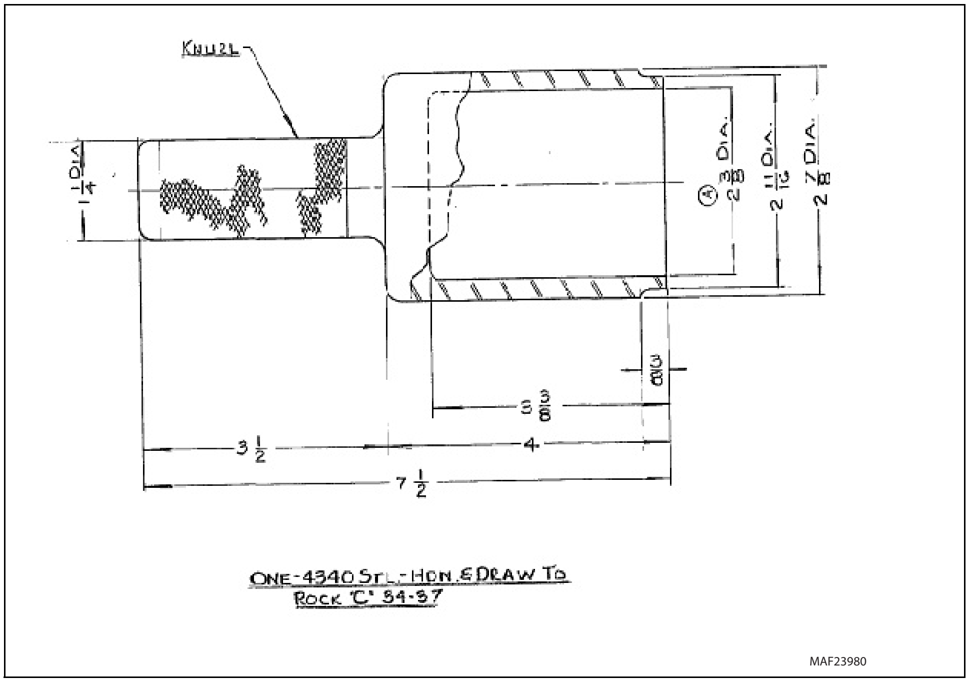


Figure 3-49. Bearing Cone Press Tool (T144566)

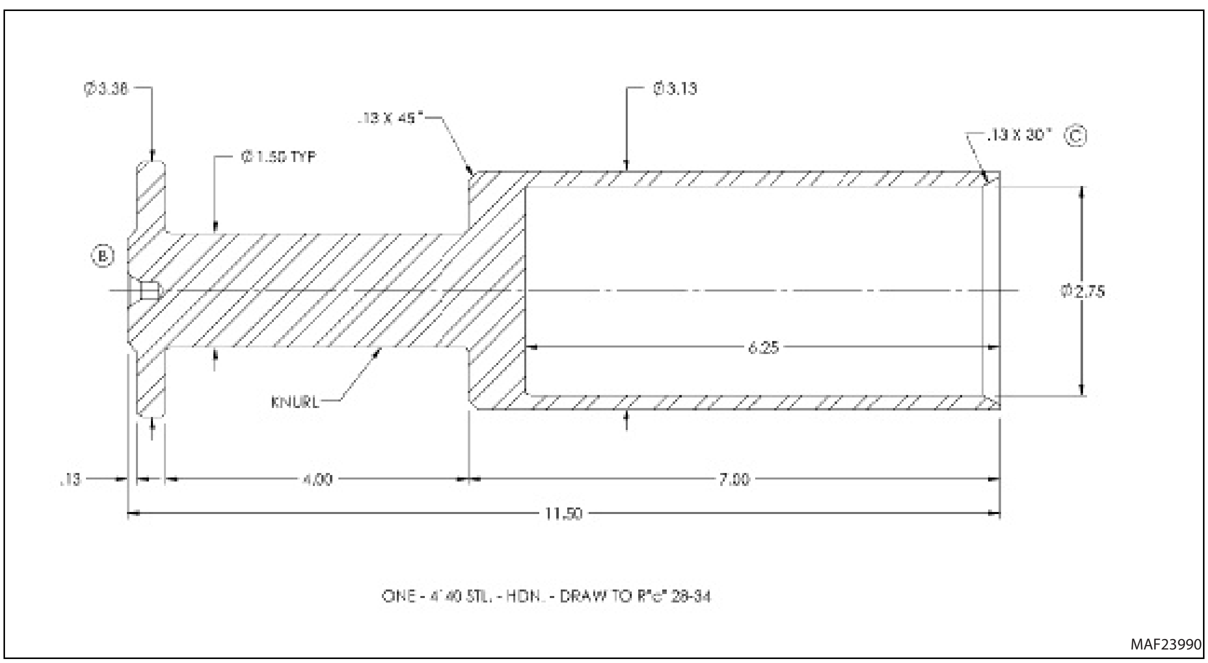


Figure 3-50. Bearing Cone Pressing Tool (T145741)

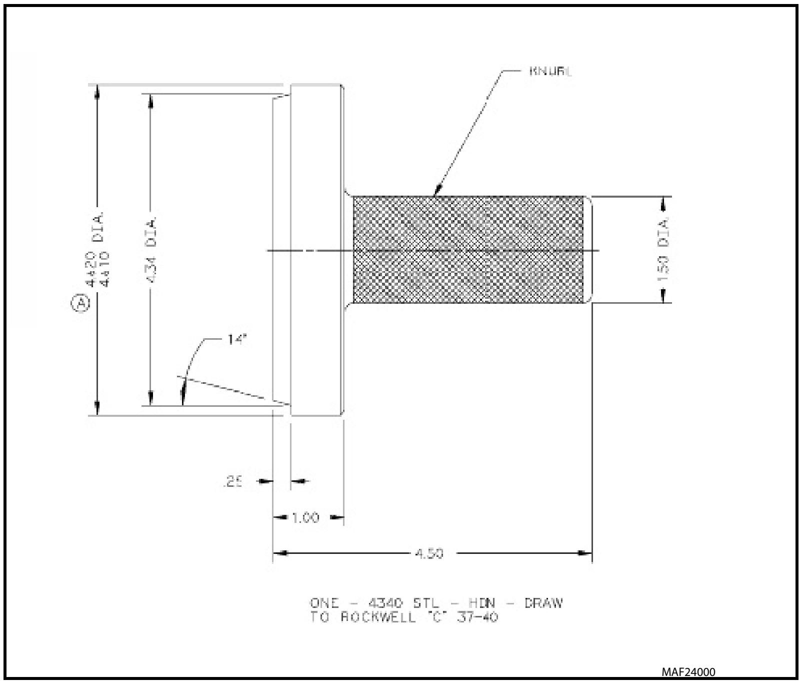


Figure 3-51. Bearing Cup Pressing Tool (T149013)

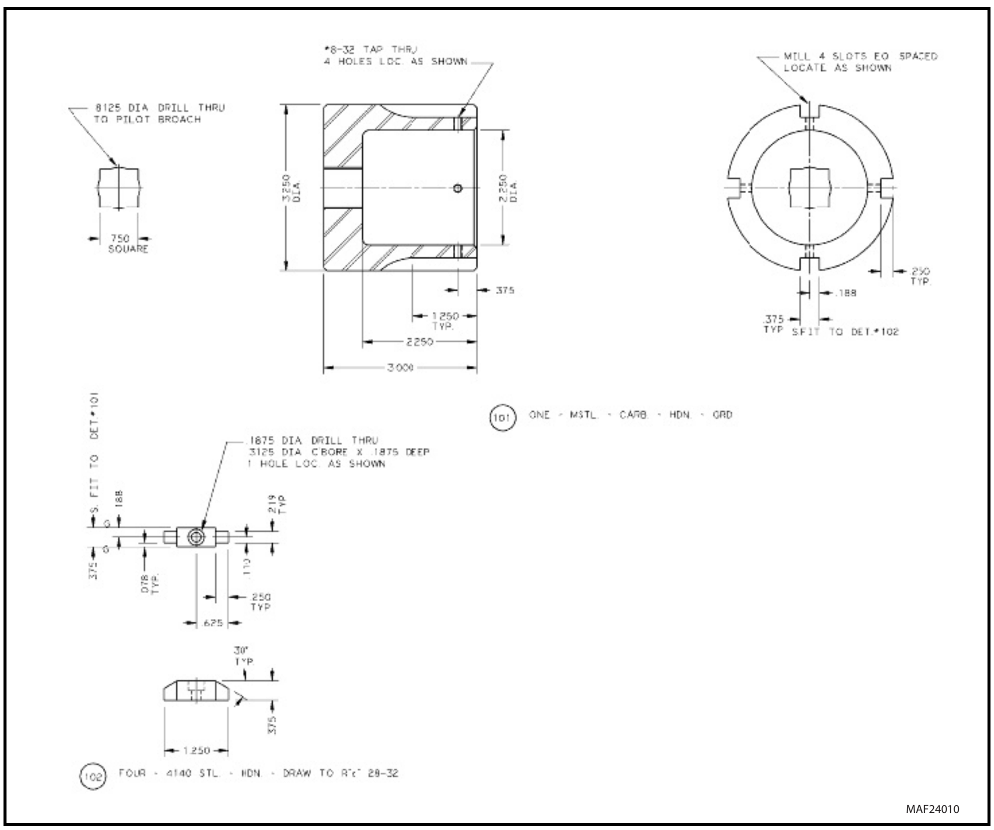


Figure 3-52. Locknut Wrench Tool (T151047)

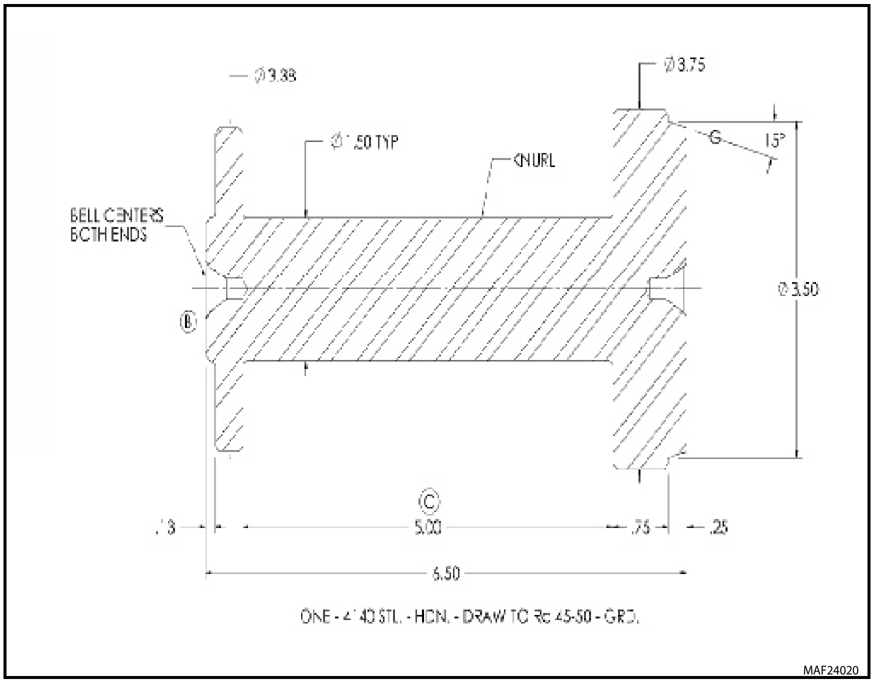


Figure 3-53. Bearing Cup Pressing Tool (T155291)

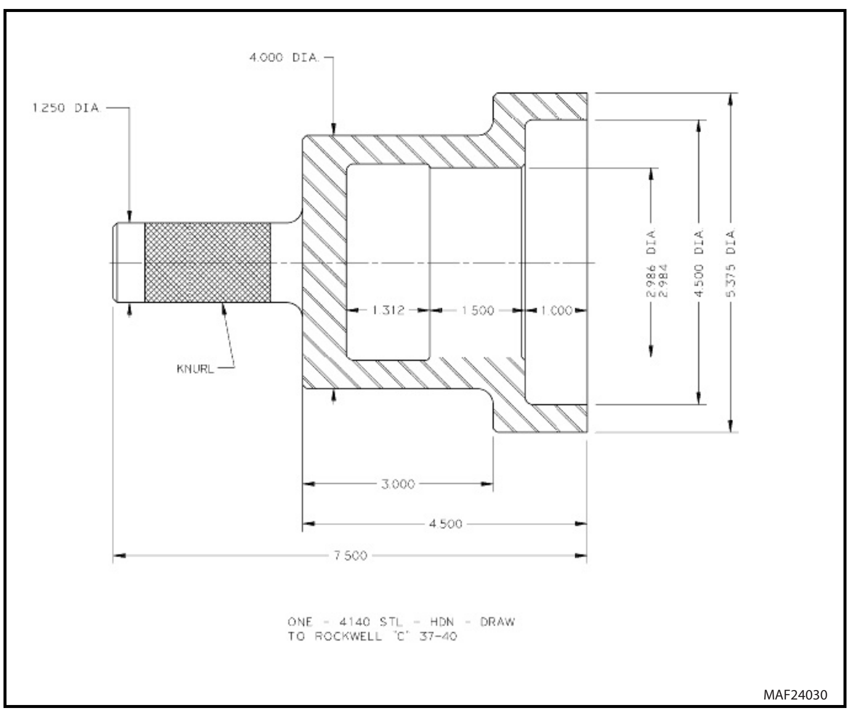


Figure 3-54. Seal Press Tool (T175741)

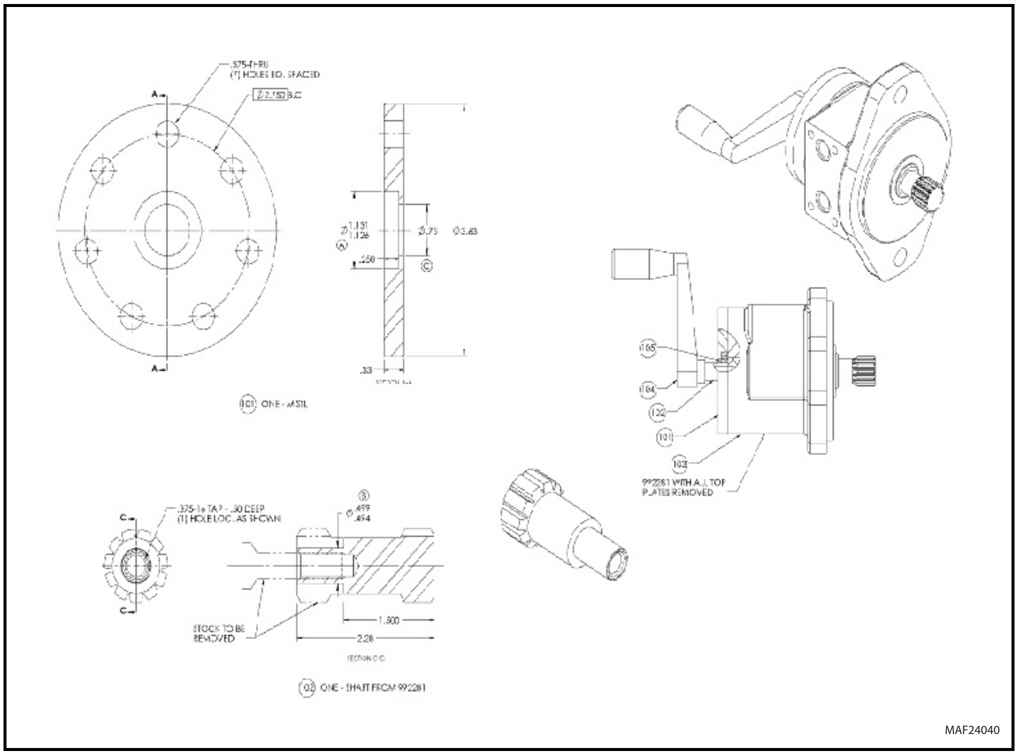


Figure 3-55. Swing Drive Test Plate (T187845)

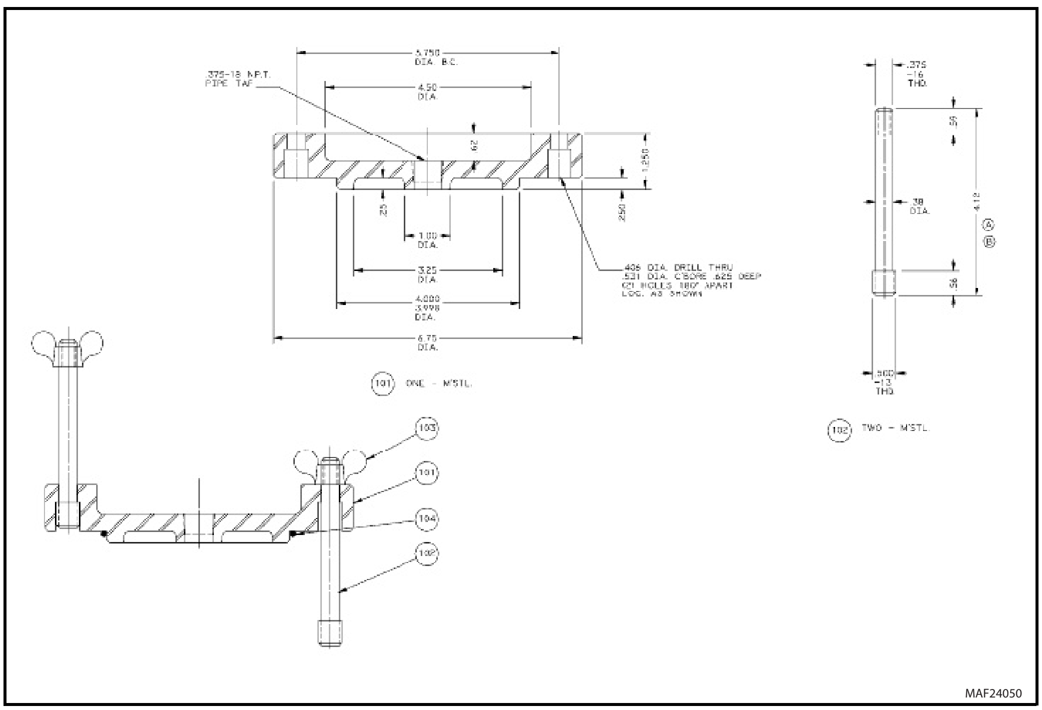
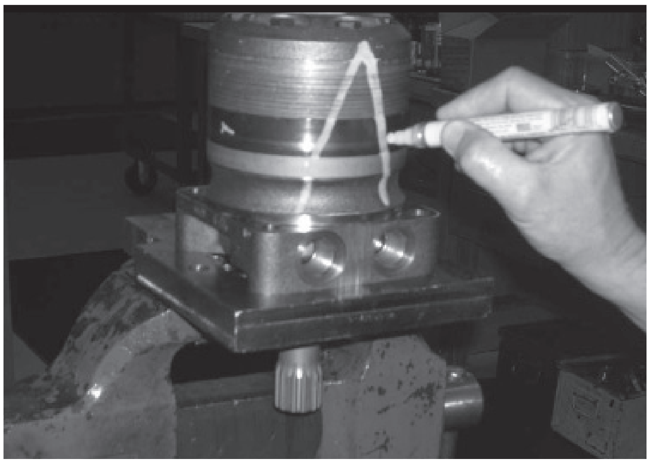


Figure 3-56. Leak Test Adapter Plate (T201476)

3.14 SWING MOTOR

Disassembly and Inspection

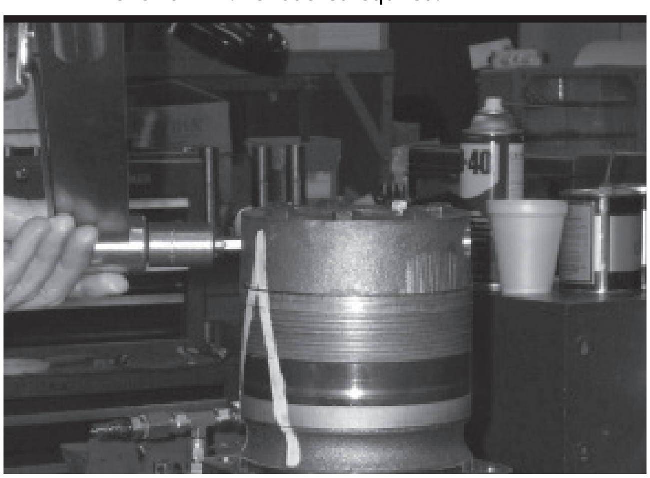
1. Place the Torqmotor™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

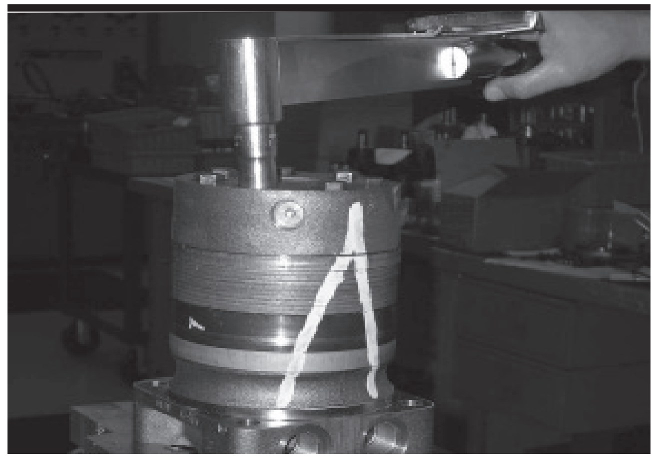


WARNING

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

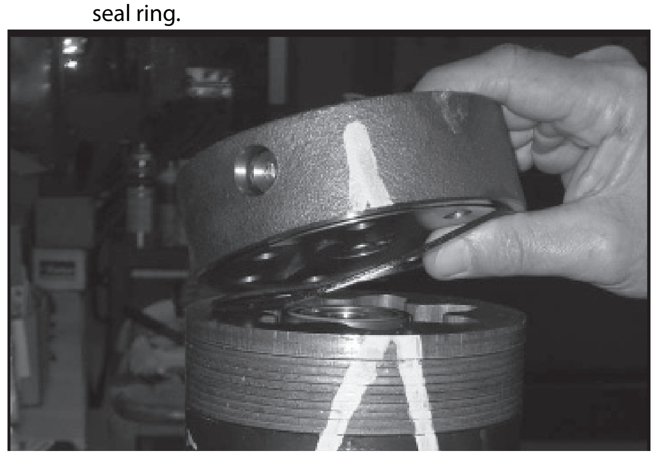
2. Scribe an alignment mark down and across the Torqmotor™ components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 in. Allen wrench or 1 in. hex socket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



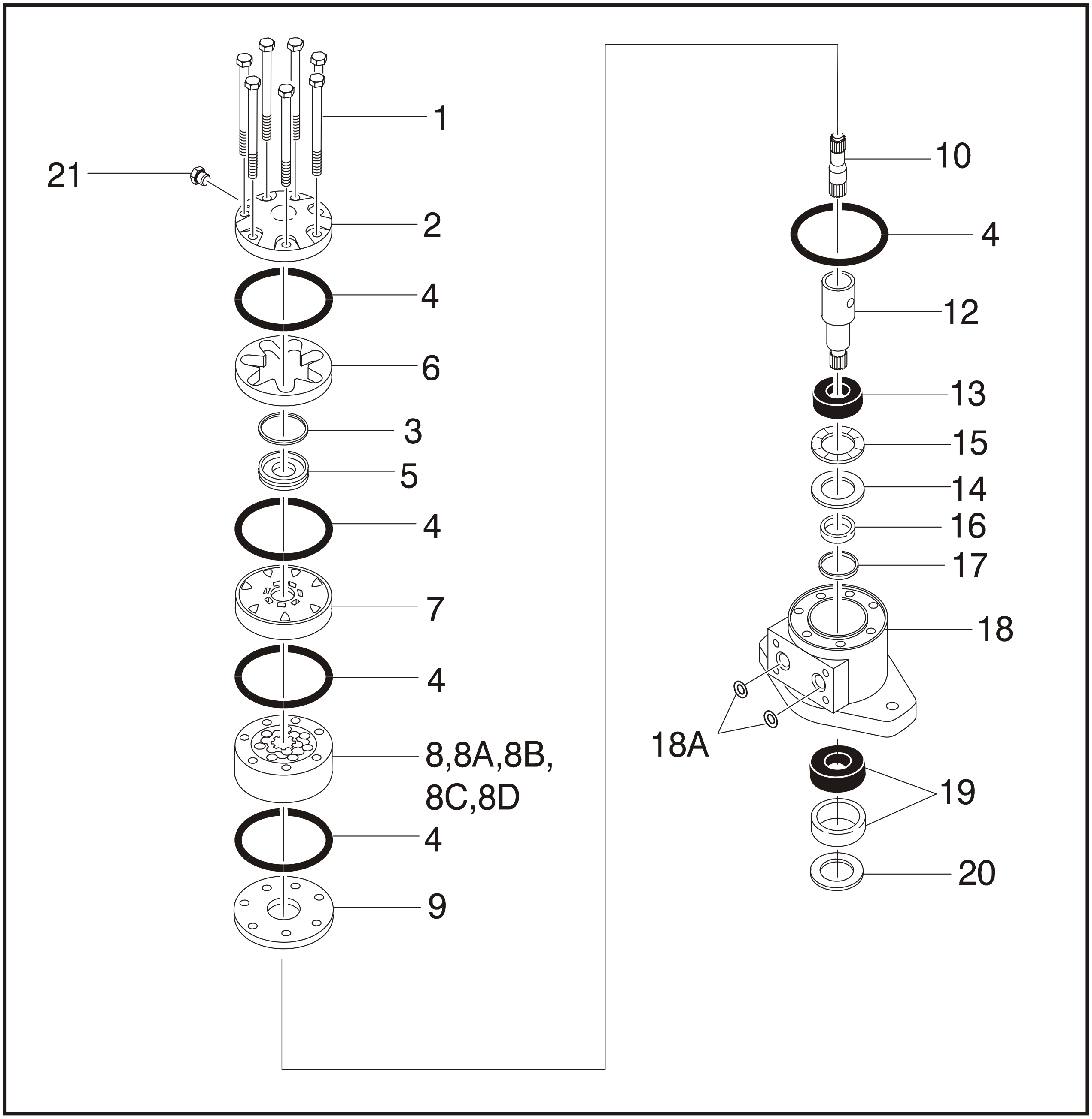


3. Remove the five, six, or seven special ring head bolts (1) using an appropriate 1/2 or 9/16 in. size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.

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



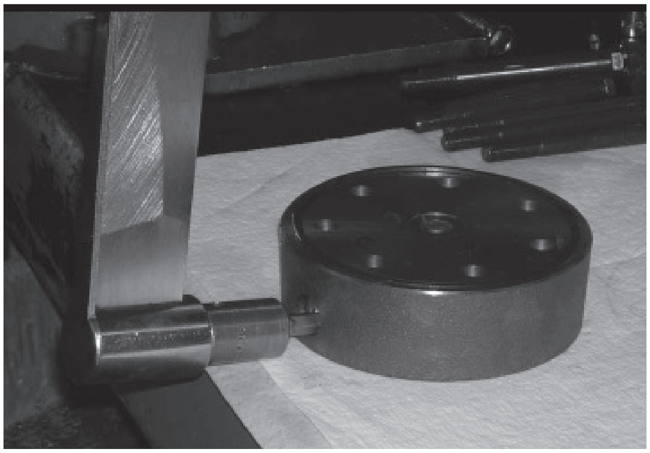
NOTE: *Refer to the appropriate “alternate cover construction” on the exploded view to determine the end cover construction being serviced.*



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 3-57. Swing Drive Motor

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



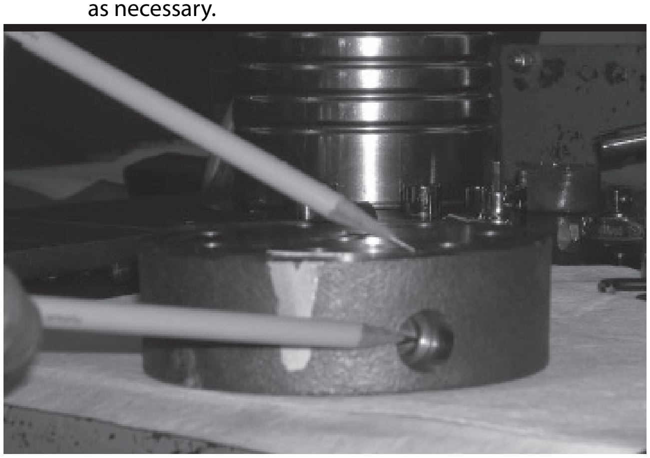
NOTICE

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.*

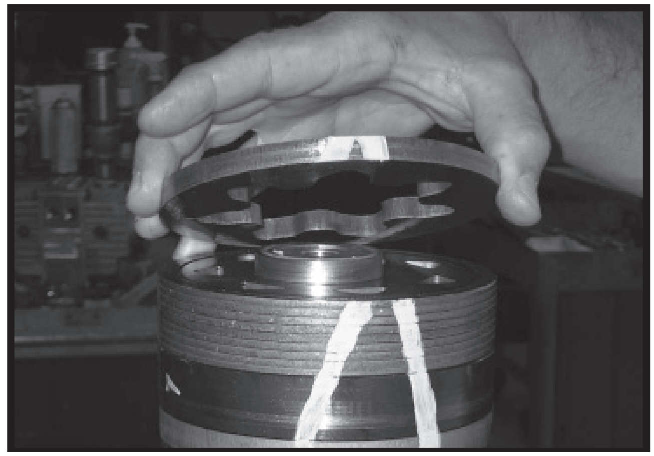
NOTE: *The insert and if included the orifice plug in the end cover (2) must not be removed as they are serviced as an integral part of the end cover.*

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.

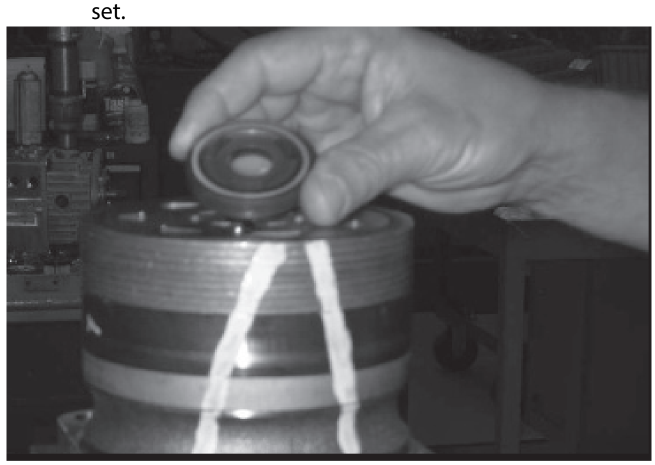


NOTE: *A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold and rotor set.*

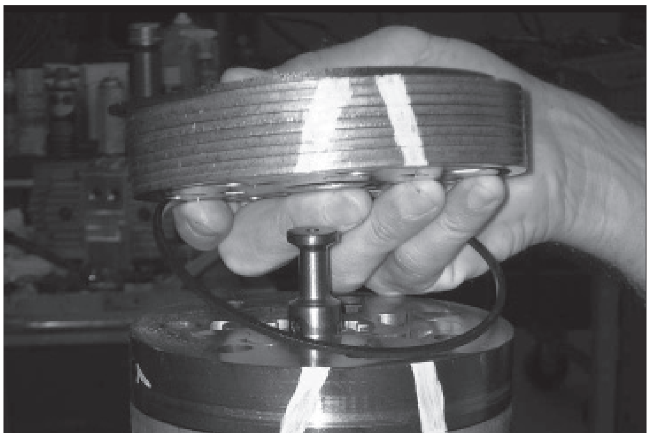
7. Remove commutator ring (6). Inspect commutator ring for cracks, or burrs.



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.

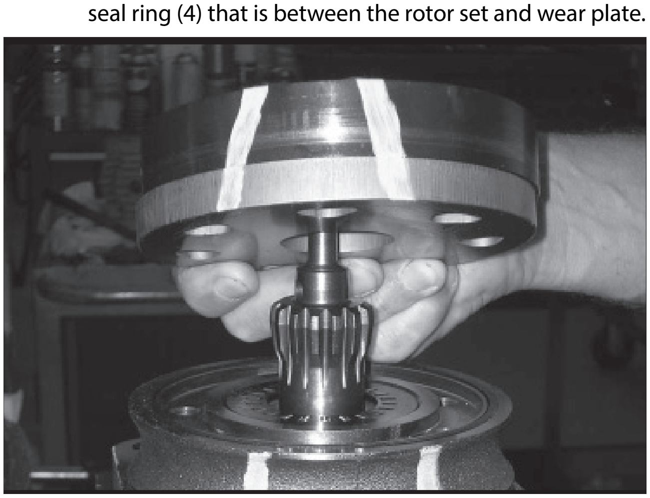


9. Remove manifold (7) and inspect for cracks surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. A polished pattern on the ground surface from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.



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.

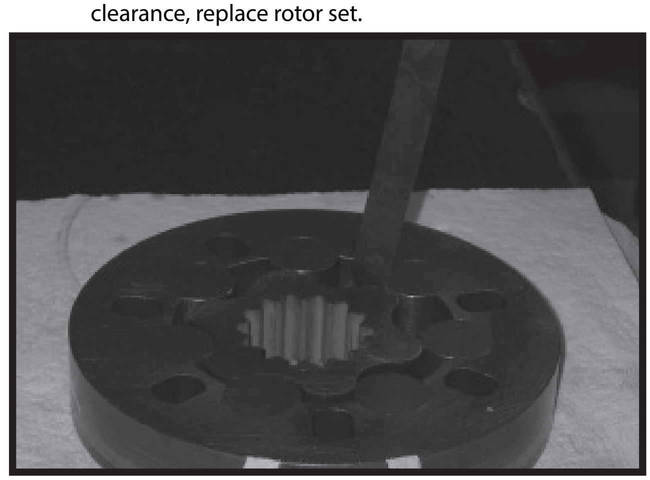


NOTE: *The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqmotor™ will ensure correct reassembly of rotor into stator and rotor set intoTorqmotor™. Marking 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.*

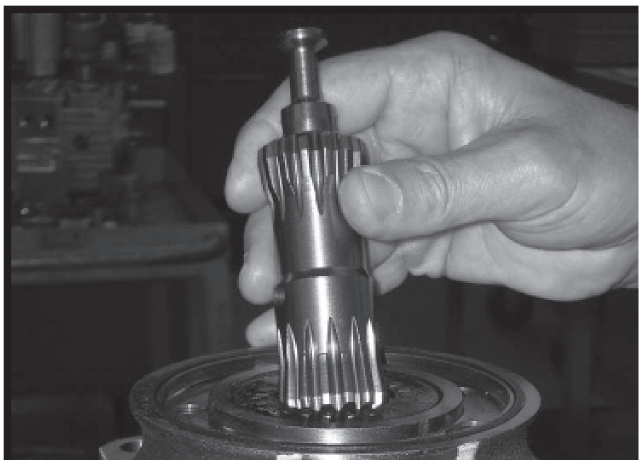
NOTE: *A polished pattern on the wear plate from rotor rotation is normal.*

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 in. (0.13 mm) of clearance, replace rotor set.

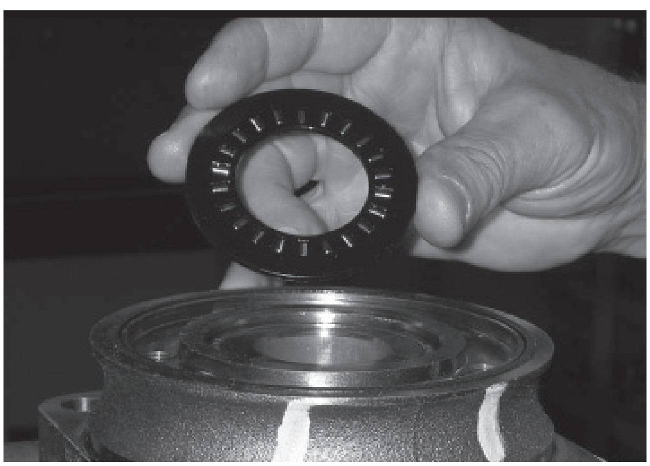


NOTE: *If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.*

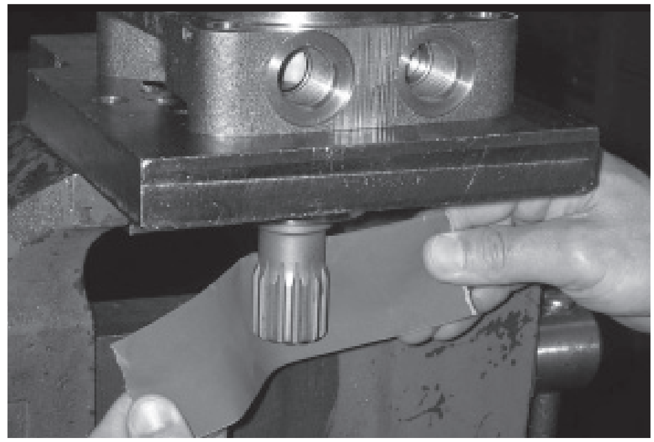
12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Remove and discard seal ring (4) from housing (18).



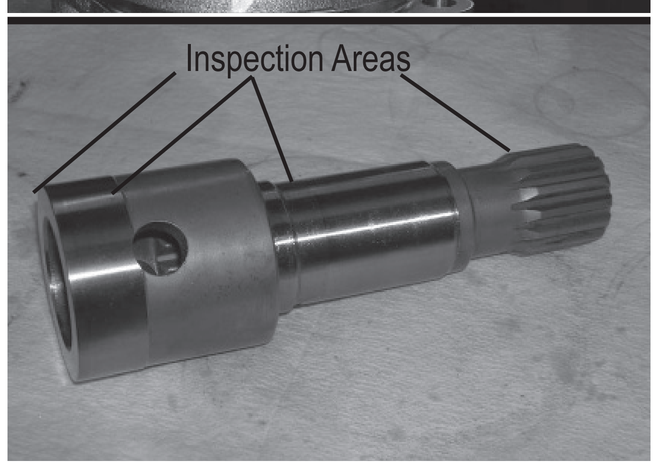
13. Remove thrust bearing (11) from top of coupling shaft (12). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.



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.

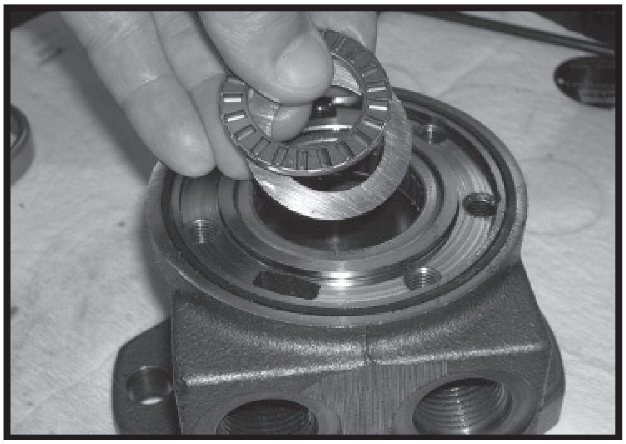


NOTE: *Minor shaft wear in seal area is permissible. If wear exceeds 0.020 in. (0.51 mm) diametrically, replace coupling shaft.*

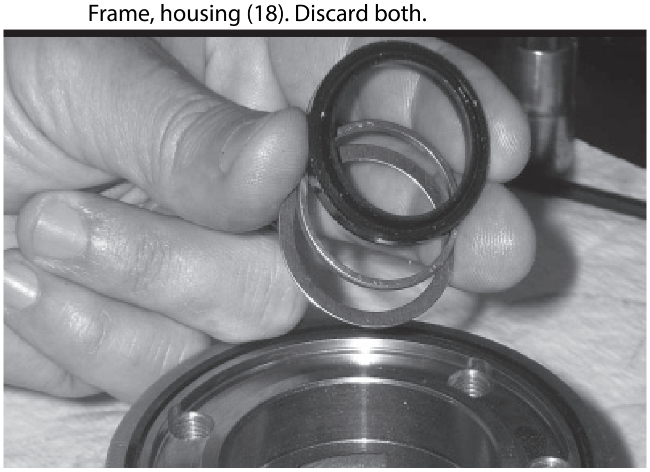
NOTE: *A slight "polish" is permissible in the shaft bearing areas. Anything more would require coupling shaft replacement.*

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.

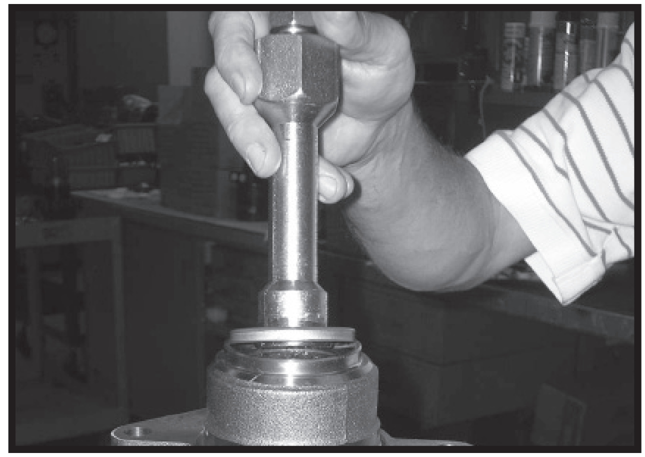


18. Remove seal (16) and backup washer (17) from Small Frame, housing (18). Discard both.

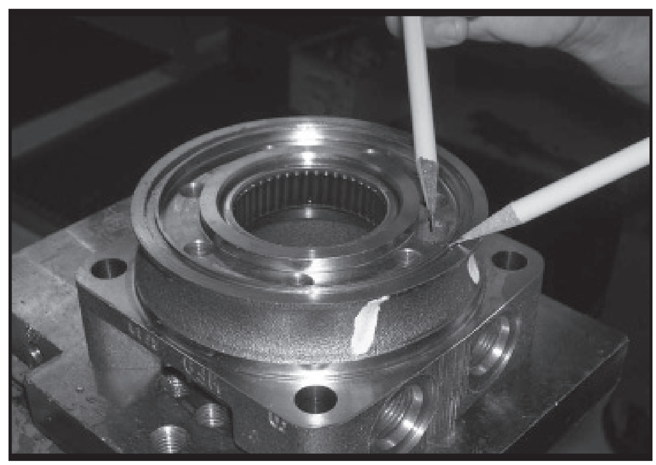


19. Remove housing (18) from vise, invert it and remove and discard seal

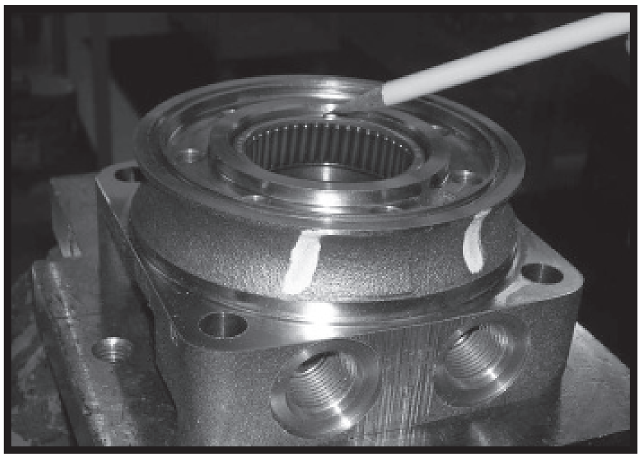
20. A blind hole bearing or seal puller is required.

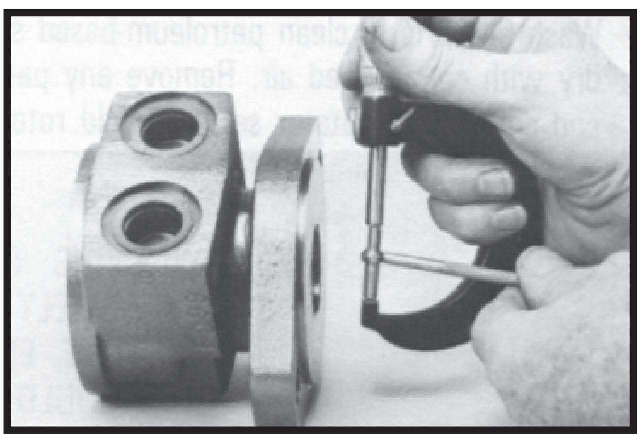


21. Inspect housing (18) assembly for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly.

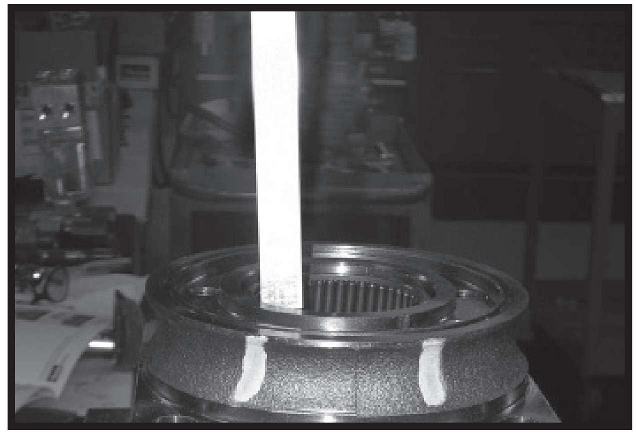


22. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate 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 in. (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.

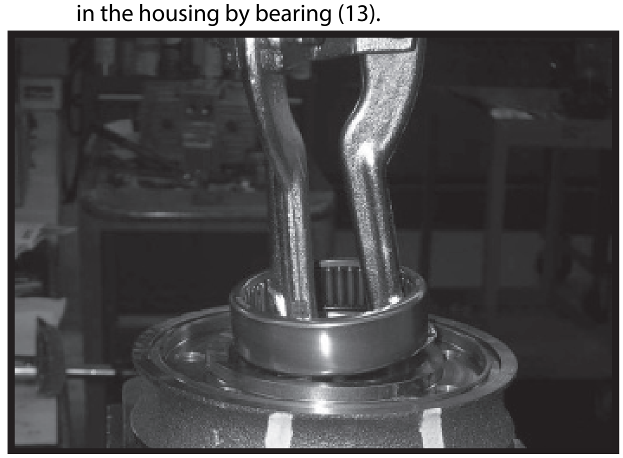


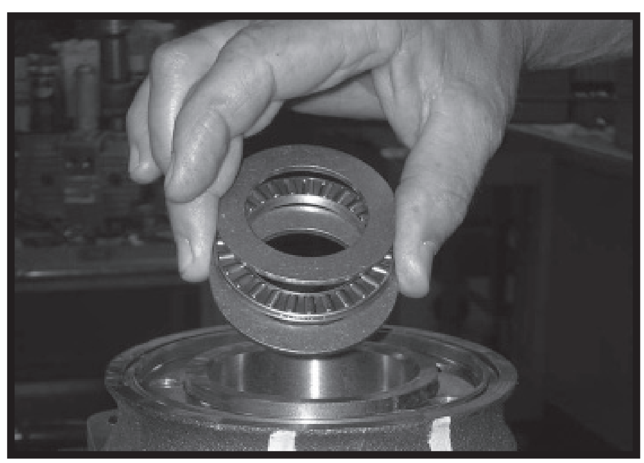


NOTE: *The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counterbore should be measured and noted before removing the bearings/ bushings. This will facilitate the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

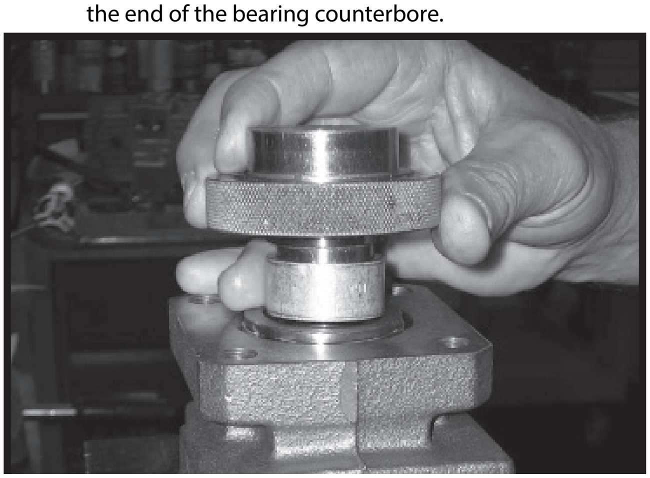
SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

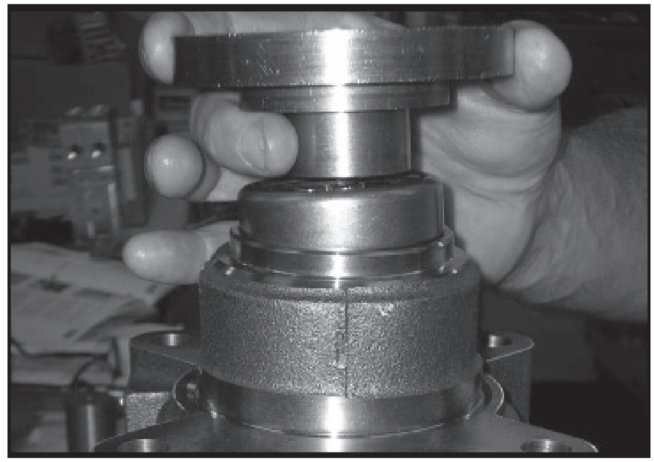
⚠ WARNING

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 in. (3.84/4.09 mm) from the end of the bearing counterbore.





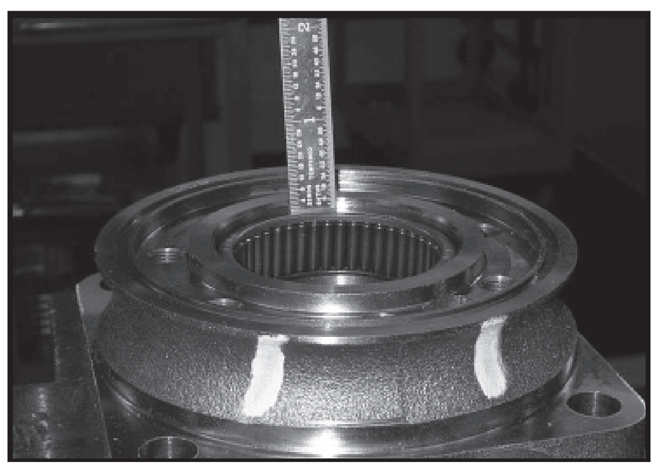
NOTE: *Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.*

NOTICE

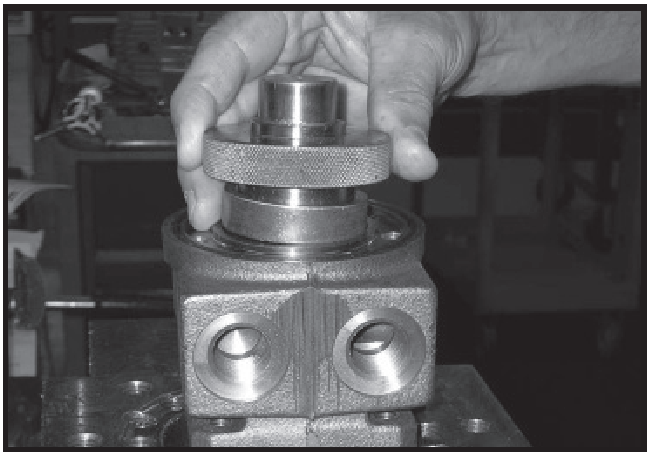
IF THE BEARING MANDREL SPECIFIED IN THE "TOOLS AND MATERIALS REQUIRED FOR SERVICING" SECTION IS NOT AVAILABLE AND ALTERNATE METHODS ARE USED TO PRESS IN BEARING/BUSHING (13) AND (19) THE BEARING/BUSHING DEPTHS SPECIFIED MUST BE ACHIEVED TO ENSURE ADEQUATE BEARING SUPPORT AND CORRECT RELATIONSHIP TO ADJACENT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

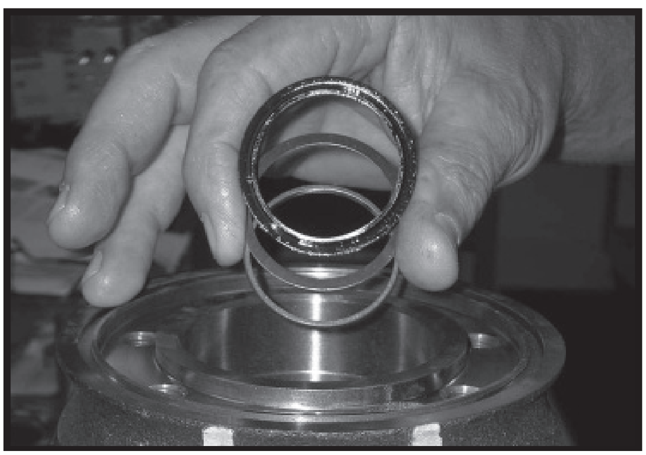
NOTICE

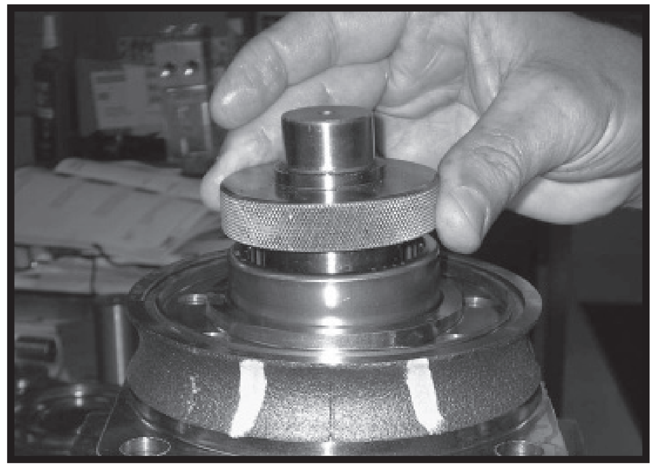
BECAUSE THE BEARING/BUSHINGS (13) AND (19) HAVE A PRESS FIT INTO THE HOUSING THEY MUST BE DISCARDED WHEN REMOVED. THEY MUST NOT BE REUSED.



2. The Torqmotor™ inner housing bearing/bushing (13) can now be pressed into its counterbore in housing (18) flush to 0.03 in. (.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).

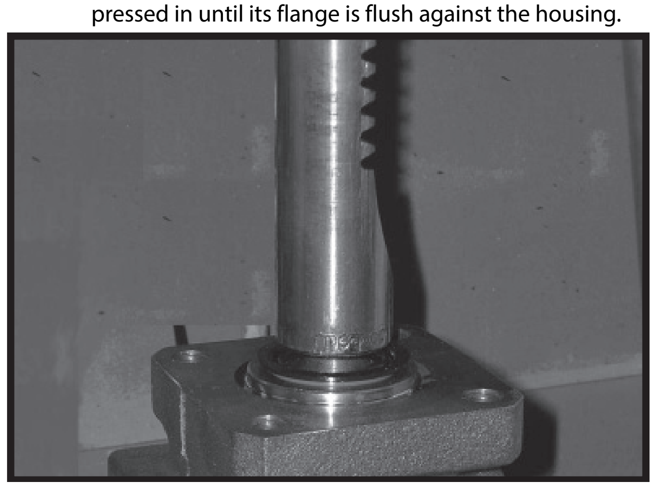


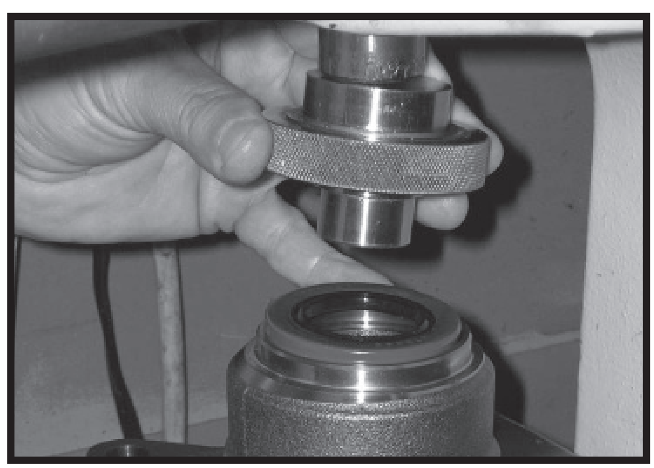




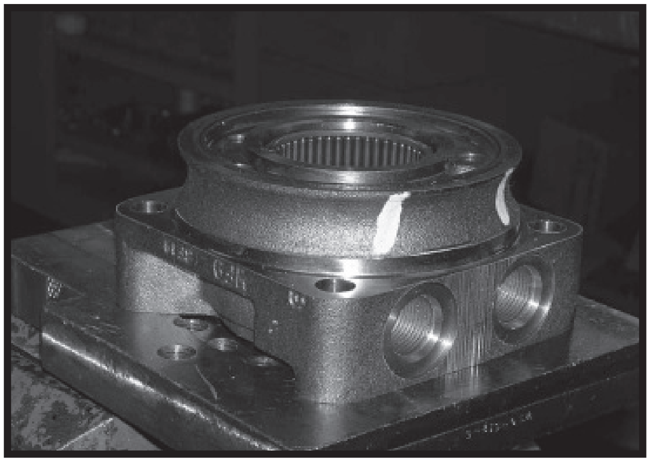
3. Press a new dirt and water seal (20) into the housing (18) outer bearing counterbore.

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

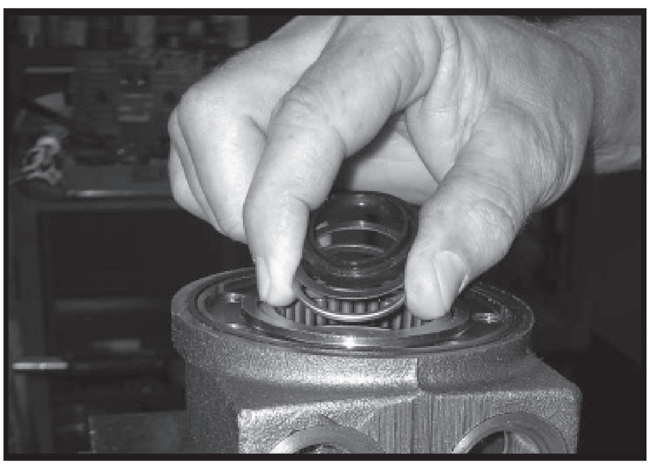


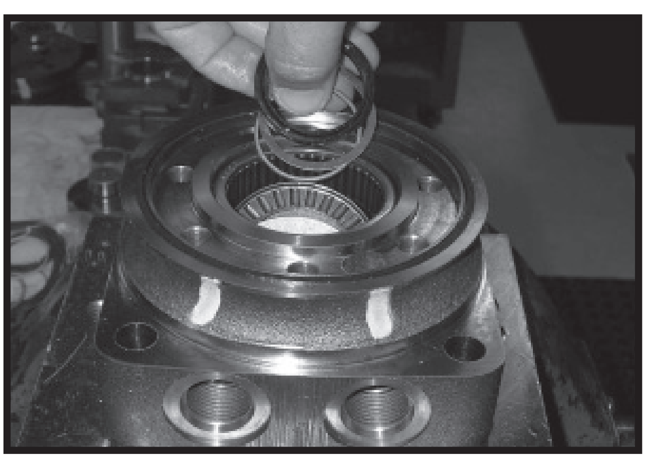


4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange.



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.

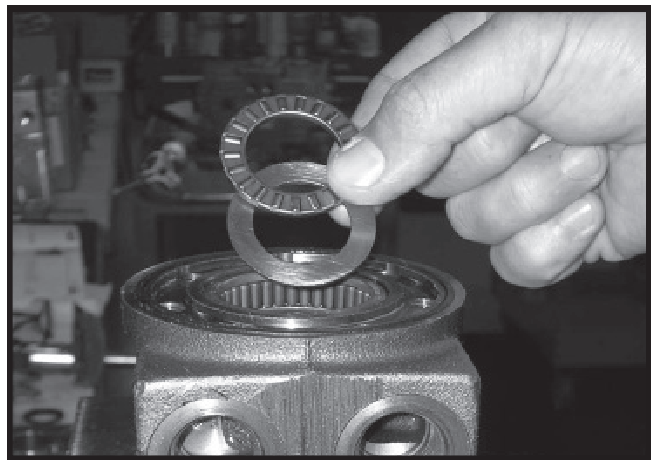




NOTICE

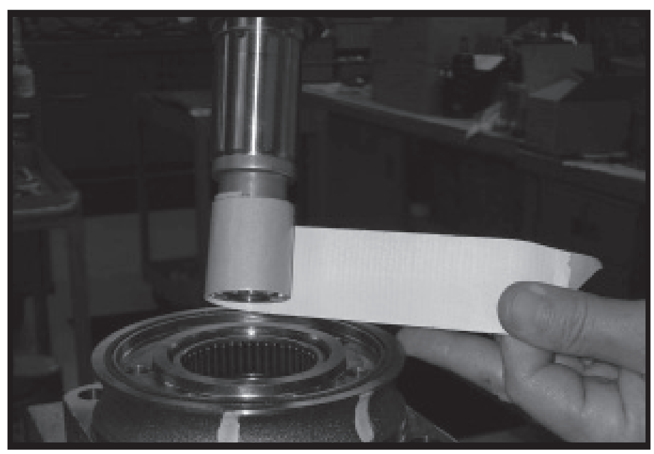
ORIGINAL DESIGN LARGE FRAME, TF & TG TORQMOTORS™ THAT DO NOT HAVE BACKUP WASHER (25) WHEN DISASSEMBLED MUST BE ASSEMBLED WITH A NEW BACKUP WASHER (17), NEW BACKUP WASHER (25) AND NEW SEAL (16).

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

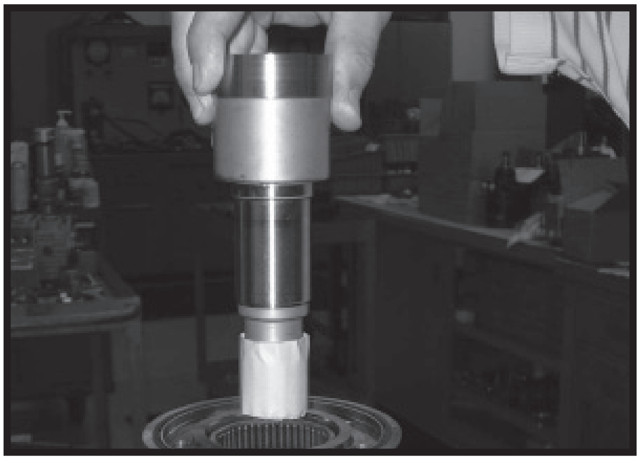


NOTE: *Torqmotors™ require one thrust washer (14) with thrust bearing (15). The coupling shaft will be seated directly against the thrust.*

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.



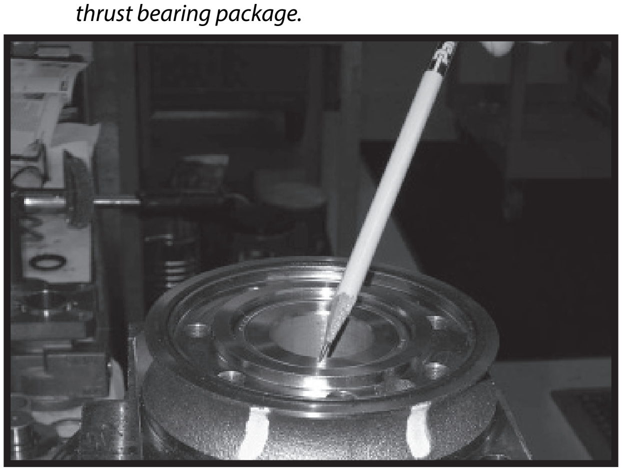
NOTICE

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.

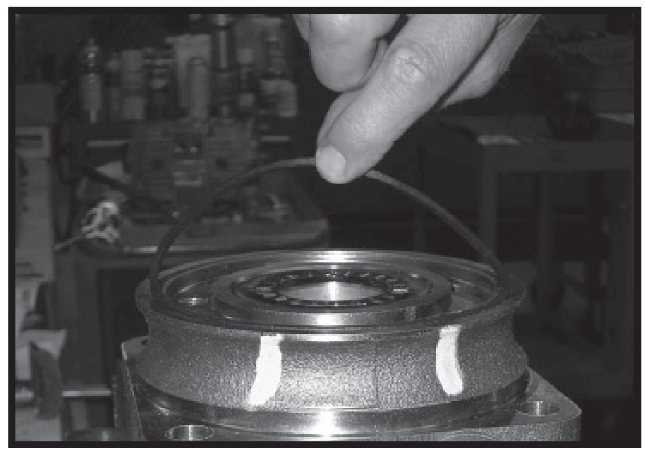
NOTE: *Mobil Mobilith SHC ® 460.*

NOTE: *A 102Tube (PN 406010) is included in each seal kit.*

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.*

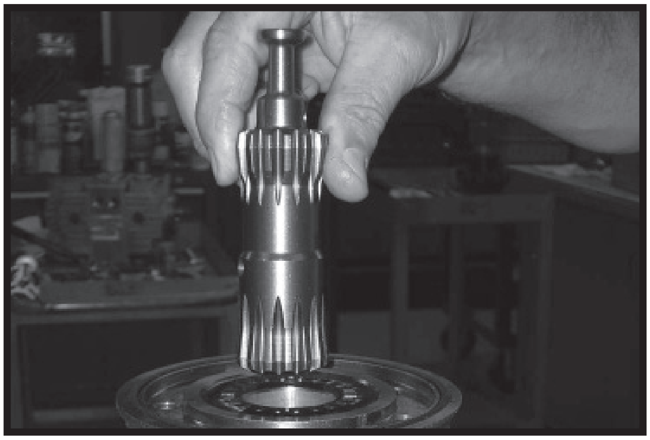


9. Apply a small amount of clean grease to a new seal ring (4) and insert it into the housing (18) seal ring groove.



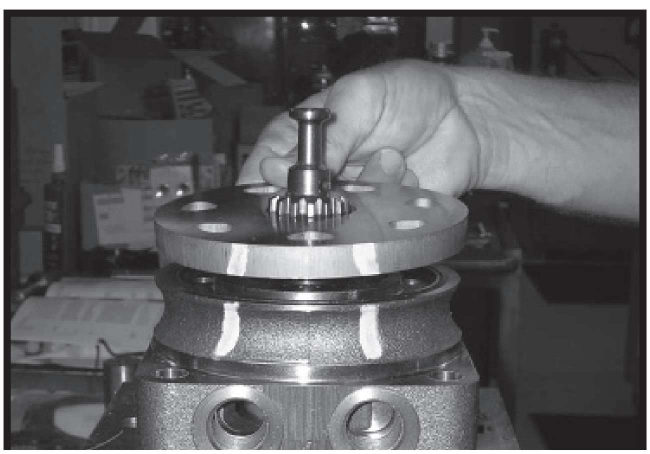
NOTE: *One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF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

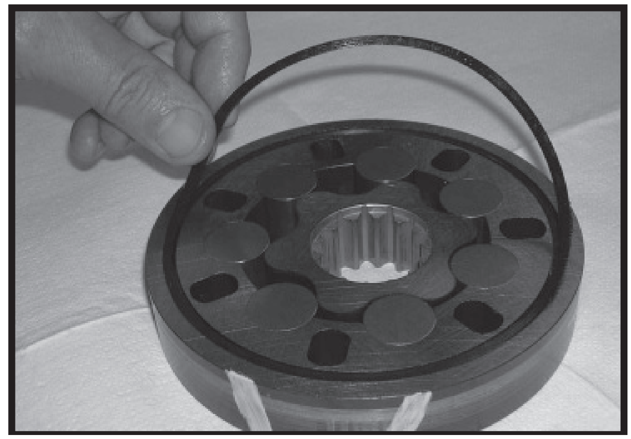


NOTE: *Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.*

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).



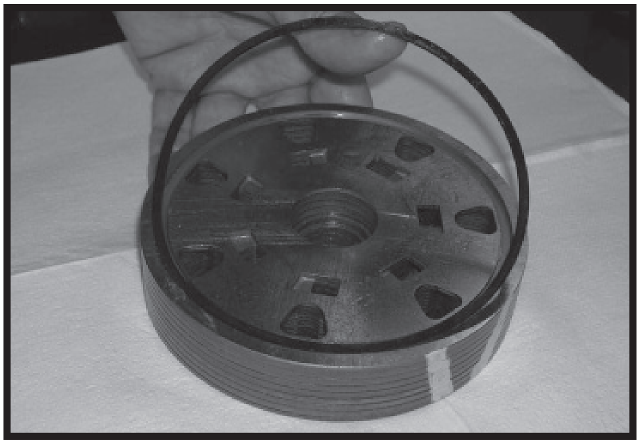
13. Install the assembled rotor set (8) onto wear plate (9) with rotor (8A) counterbore and seal ring side down and the splines into mesh with the drive link splines.

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."*

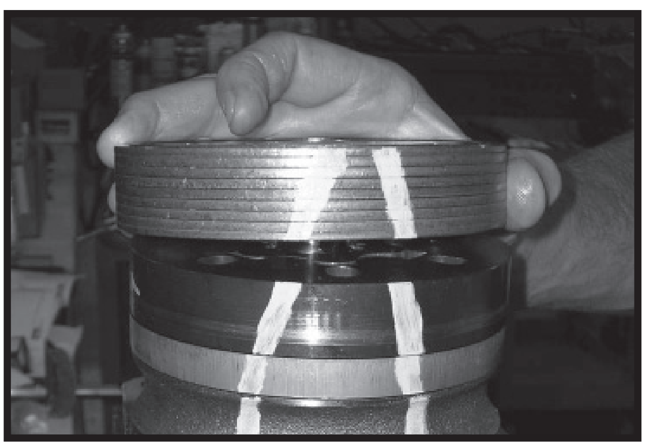
NOTE: *The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the 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).

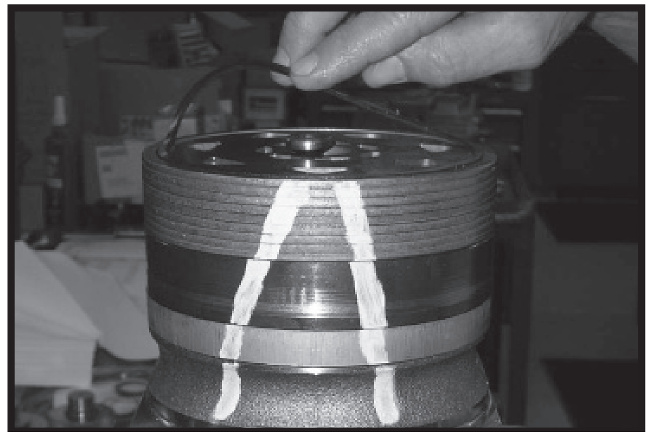


NOTE: *The manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression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

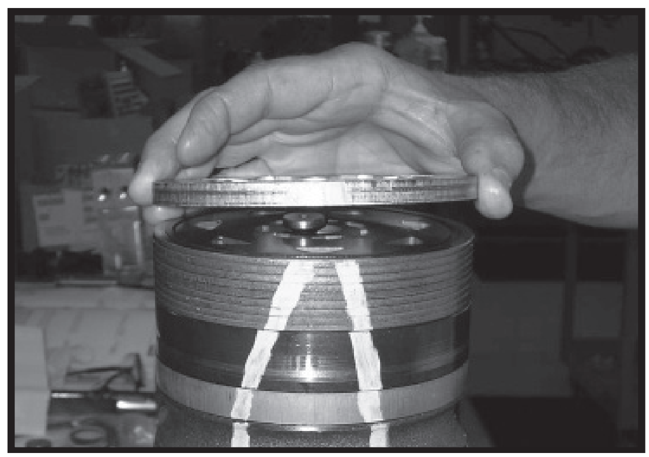
15. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



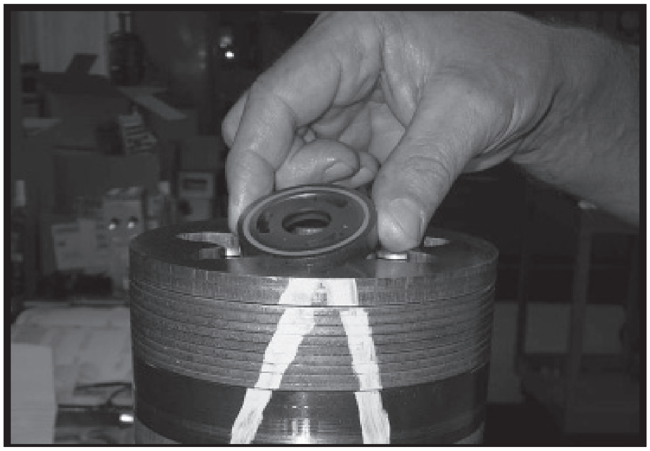
16. Apply grease to a new seal ring (4) and insert it in the seal ring groove exposed on the manifold.



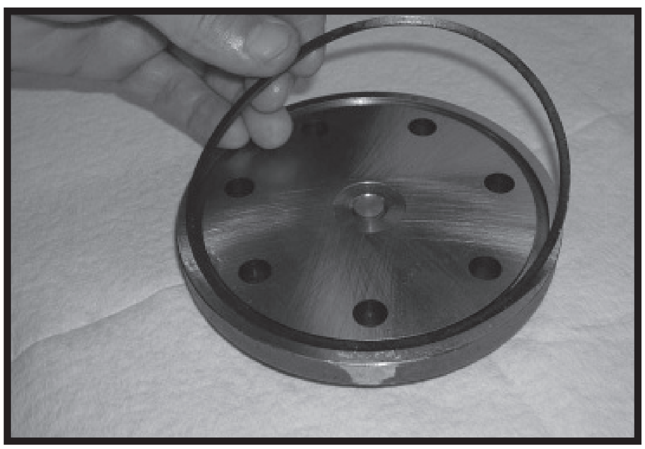
17. Assemble the commutator ring (6) over alignment studs onto the manifold.

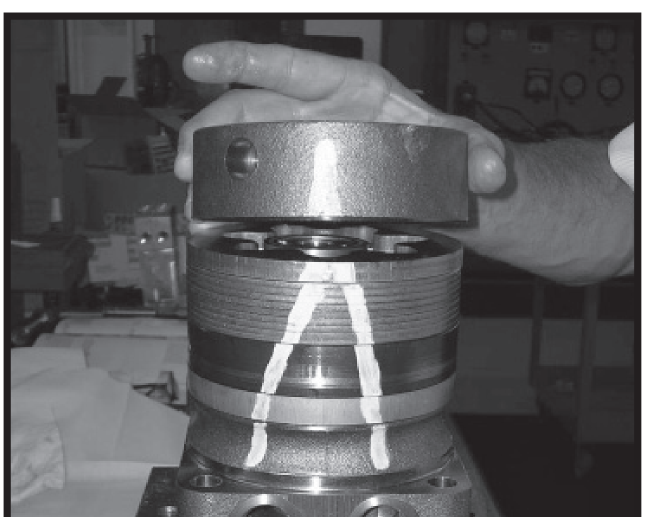


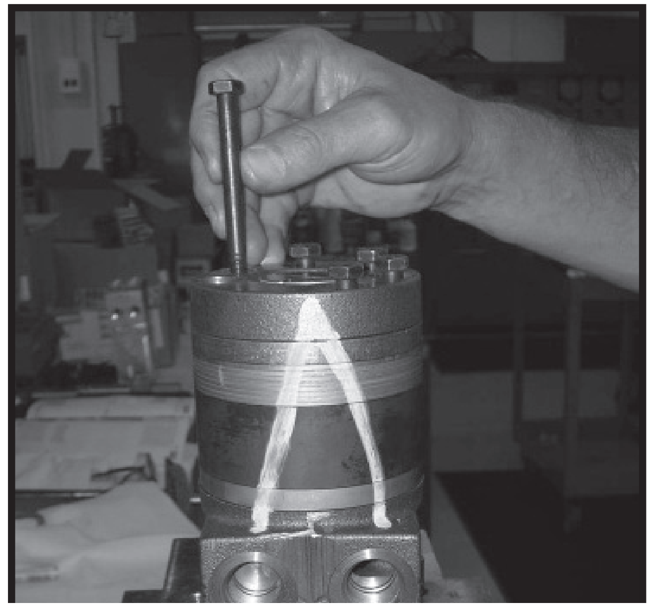
18. Assemble a new seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up.



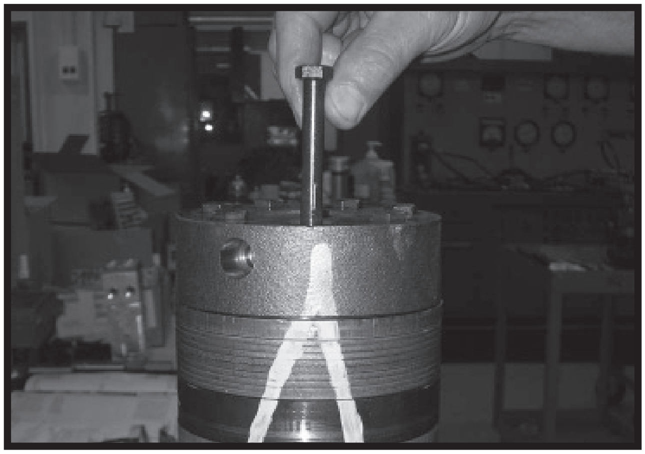
19. Assemble a new seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18). The correct 5 bolt end cover bolt hole relationship to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

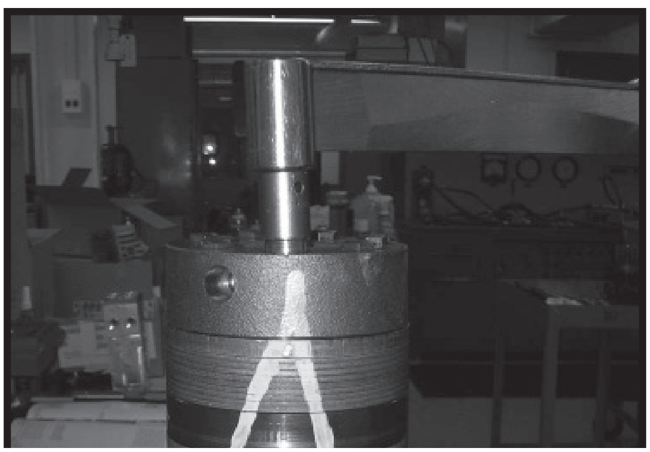


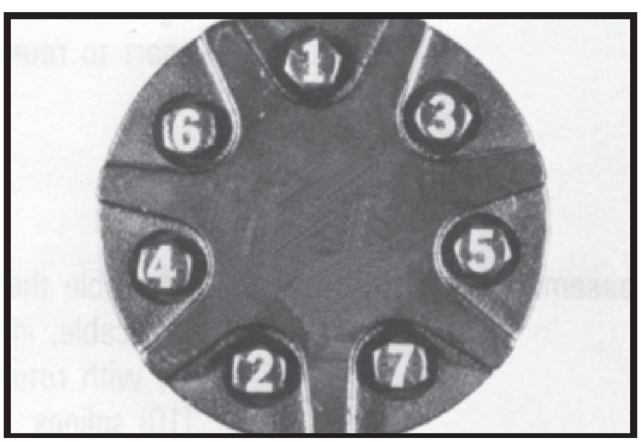




20. Assemble the 5 or 7 special bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 50-55 ft. lbs. (68-75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



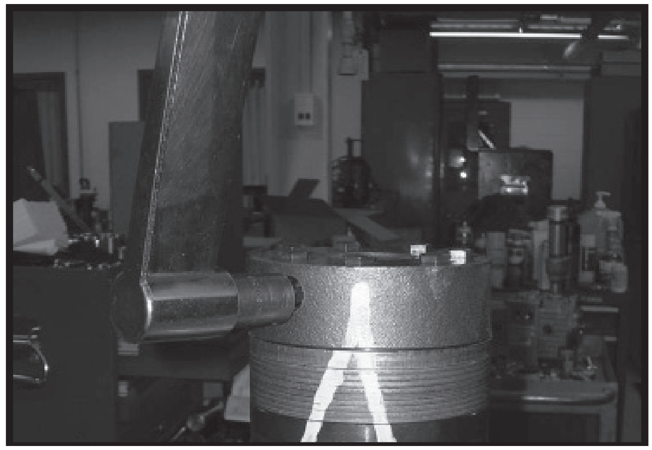


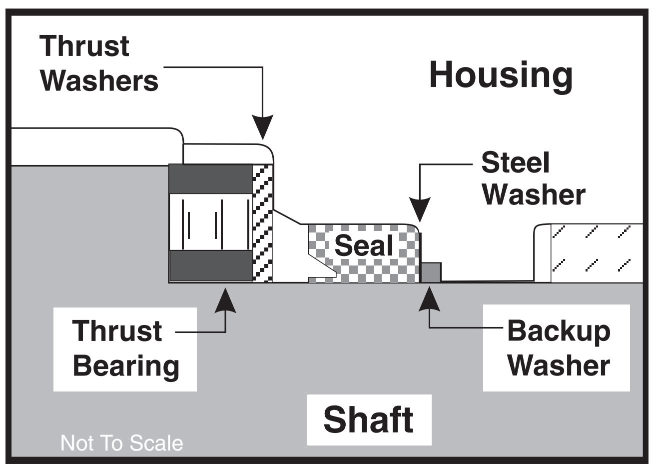


NOTE: *The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard and cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.*

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.





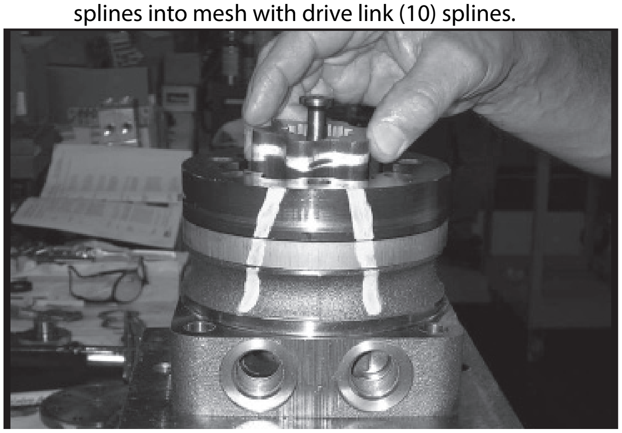
One Piece Stator Construction

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.

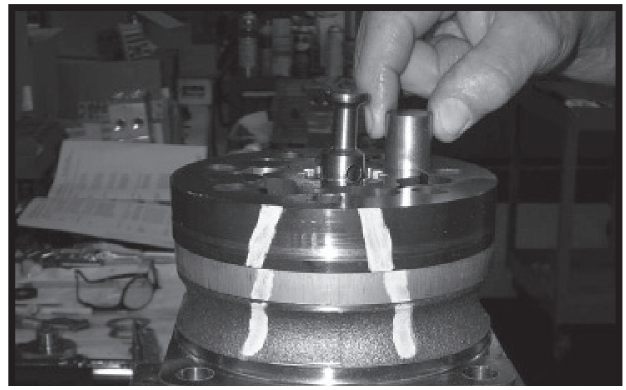
2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

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.

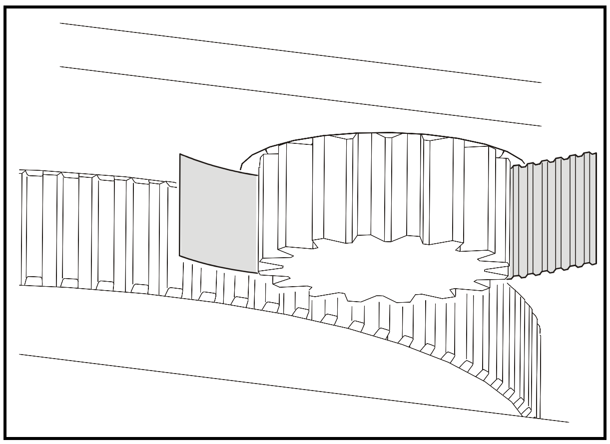
6. Remove the two assembled bolts (1) if used to retain stator and wear plate.

3.15 Procedure For Setting Swing Gear Backlash

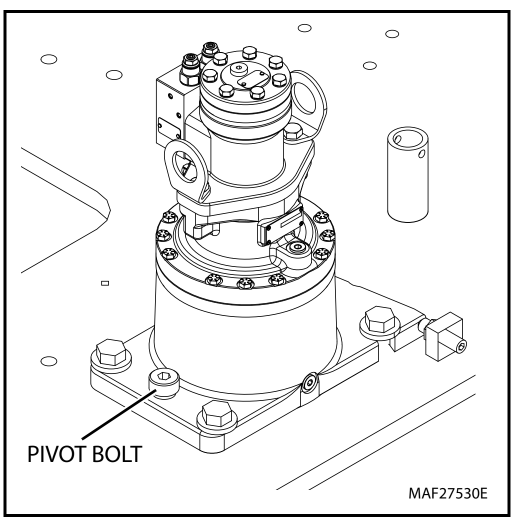
Ensure mounting plate and turntable base plate are clean and painted with a uniform coating of minimum thickness (no runs, drips, etc.).

Set backlash to 0.008 to 0.012 in. (0.203 - 0.304 mm) using the following procedure:

1. Place the machine on firm, level ground.
2. Place shim (JLG PN 1001125492) between pinion and bearing at bearing high spot (shown below). The bearing high spot should be stamped with "X" on the surface below teeth and marked with yellow paint in the tooth space.

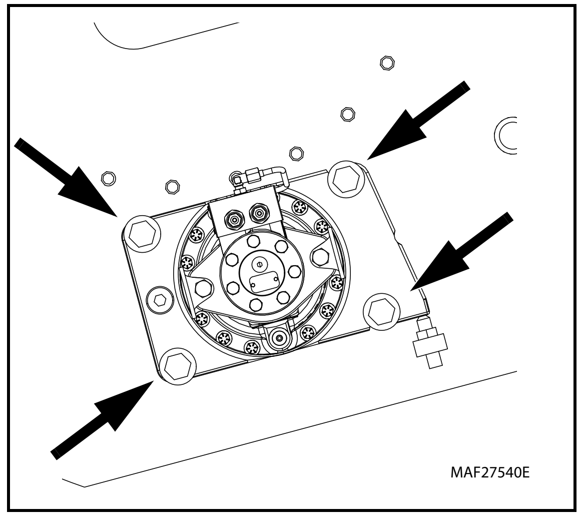


3. Apply High Strength Threadlocking Compound and torque pivot bolt to 205 ft. lbs. (280 Nm) (shown below).

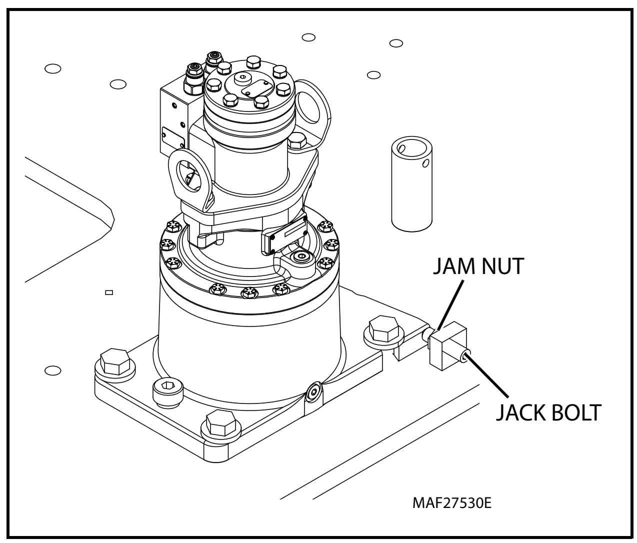


NOTE: *Torque shoulder bolt against turntable baseplate. Shoulder bolt will not tighten against the swing drive mounting plates.*

4. Remove turntable lock pin.
5. Apply High Strength Threadlocking Compound and pre-torque swing drive mounting bolts to 30 ft. lbs. (42 Nm).

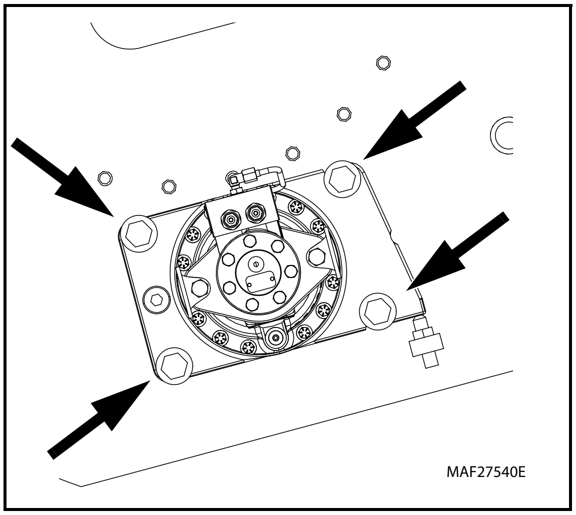


6. Tighten the setscrew until the pinion is completely snug against the shim and bearing and then back off the setscrew.

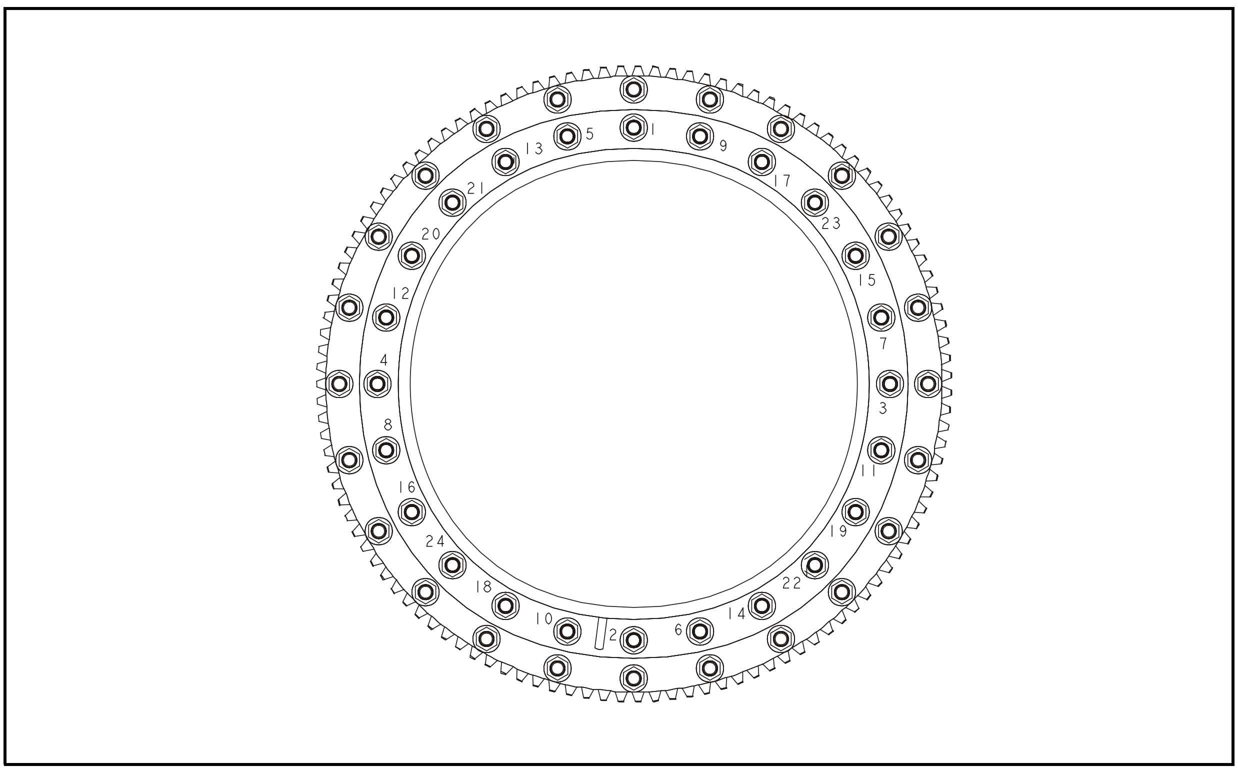


7. Apply High Strength Threadlocking Compound and torque jack bolt 50 ft. lbs. (68 Nm).
8. Apply High Strength Threadlocking Compound to the jam nut and tighten.

9. Torque the capscrews shown in step 5 to 340 ft. lbs. (461 Nm).

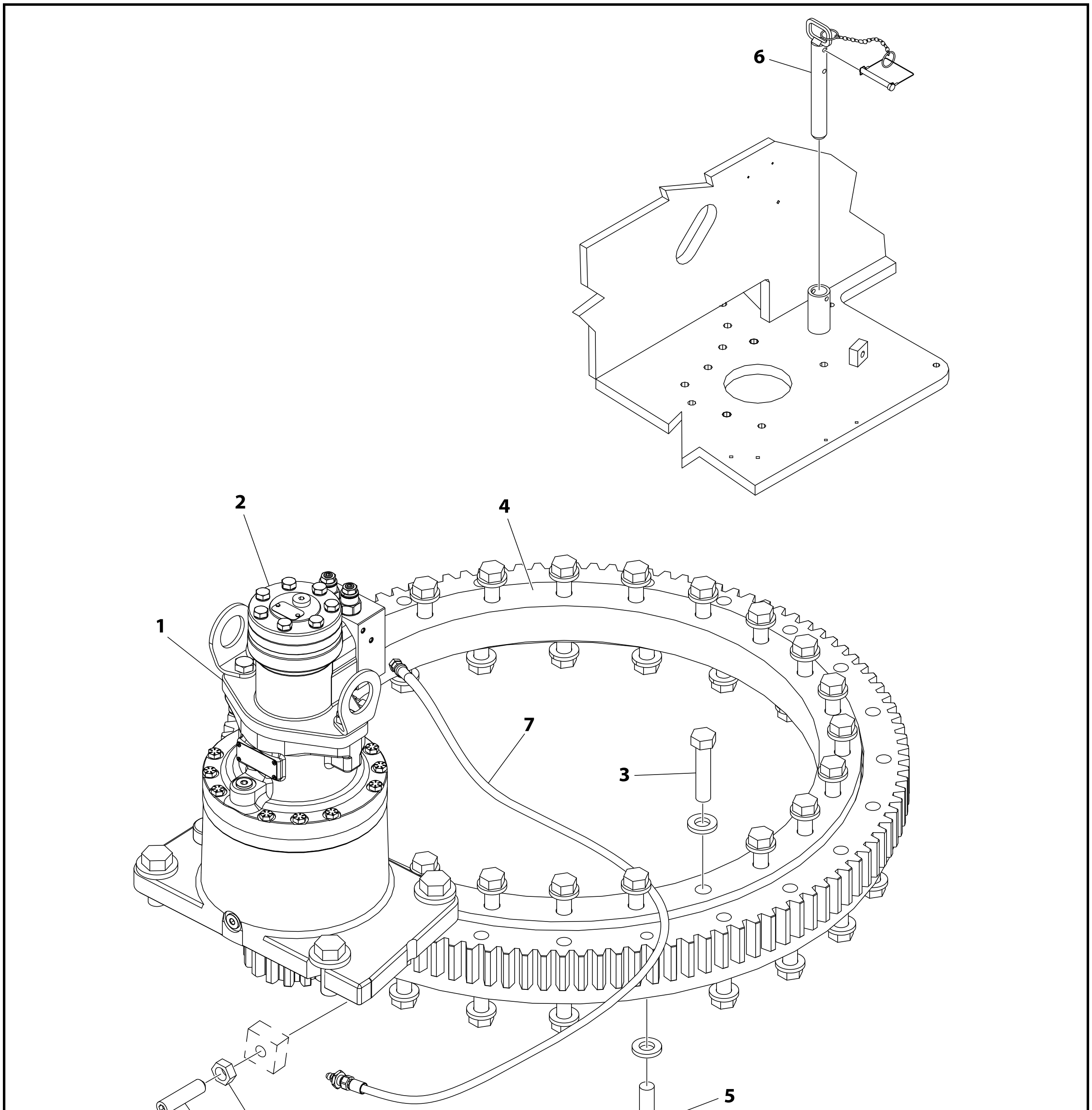


10. Remove shim and discard.



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

Figure 3-58. Swing Bearing Torque Sequence



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

Figure 3-59. Swing Drive and Turntable Bearing

3.16 SWING BEARING

Turntable Bearing Mounting Bolt Condition Check

NOTICE

THE SWING BEARING IS ONE OF THE MOST CRITICAL POINTS ON A MOBILE ELEVATING WORK PLATFORM. 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 High Strength Threadlocking Compound. 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 3-61.).
   - **b.** At the positions indicated on Figure 3-62. try to insert a 0.0015 in. feeler gauge between the bolt and hardened washer at the arrow indicated position.
   - **c.** Ensure that the 0.0015 in. 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 3-60., try to insert the 0.0015 in. 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 3-62., try and insert the 0.0015 in. feeler gauge between the bolt head and hardened washer at the arrow indicated position.

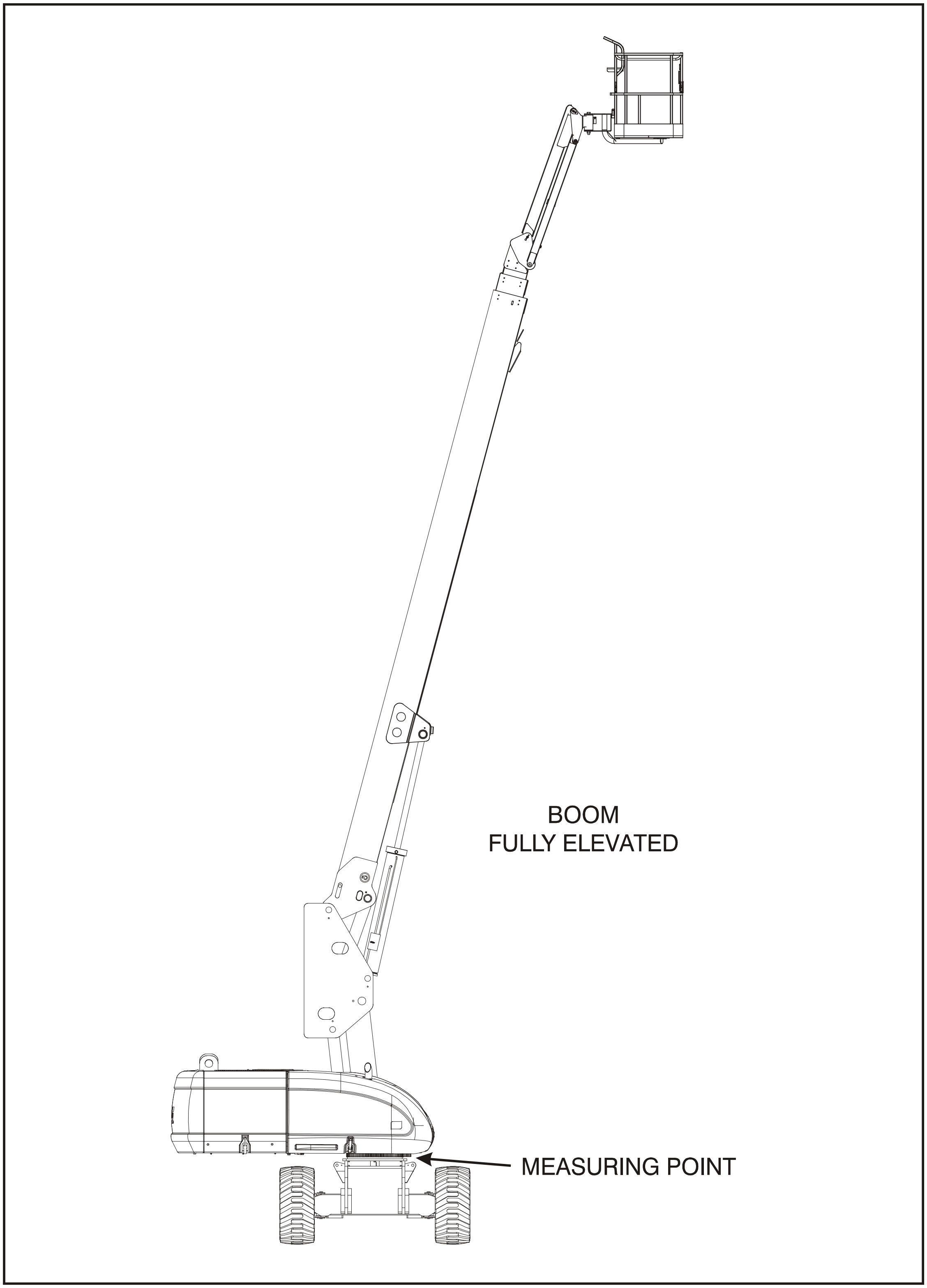


Figure 3-60. Swing Bearing Tolerance Boom Placement (Sheet 1 of 2)

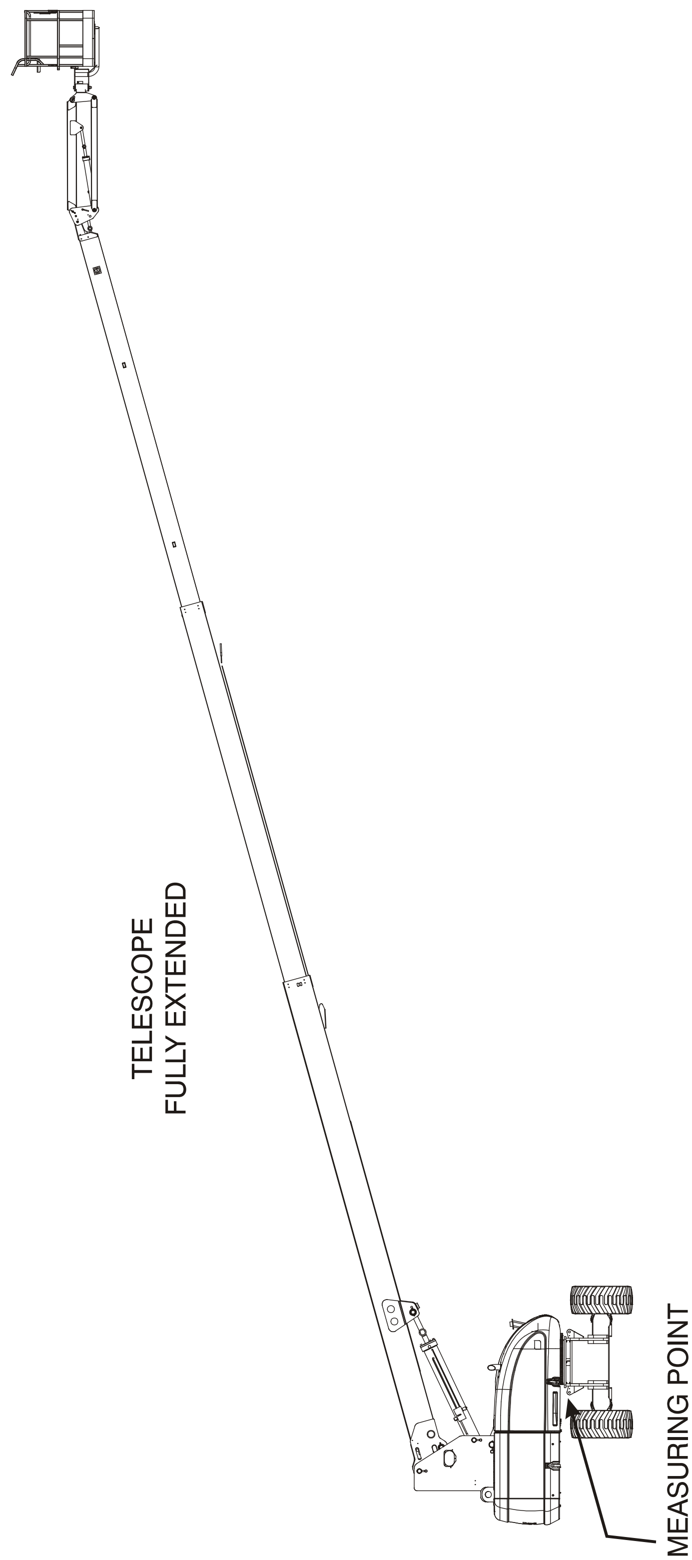


Figure 3-61. Swing Bearing Tolerance Boom Placement (Sheet 2 of 2)

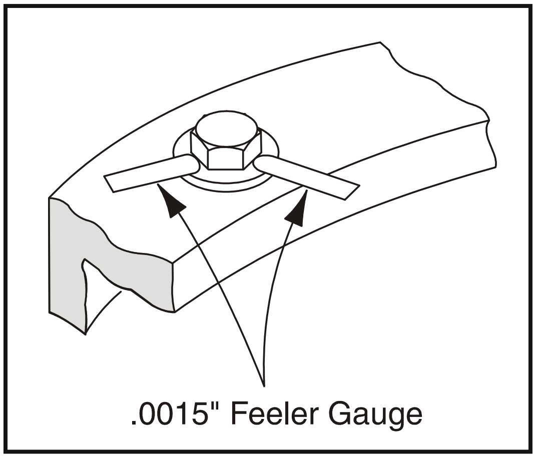


Figure 3-62. Swing Bolt Feeler Gauge Check

Wear Tolerance

1. From the underside of the machine, at rear center, with the main boom fully elevated and fully retracted as shown in Figure 3-60., 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 3-63., Swing Bearing Tolerance Measuring Point.
2. At the same point, with the main boom at horizontal and fully extended as shown in Figure 3-61., 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 3-63., 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.

NOTICE

THE SWING BEARING IS ONE OF THE MOST CRITICAL POINTS ON A MOBILE ELEVATING WORK PLATFORM. IT IS HERE THAT THE STRESSES OF LIFTING ARE CONCENTRATED, AT THE CENTER OF ROTATION. BECAUSE OF THIS, PROPER MAINTENANCE OF THE SWING BEARINGBOLTS IS A MUST FOR SAFE OPERATION.

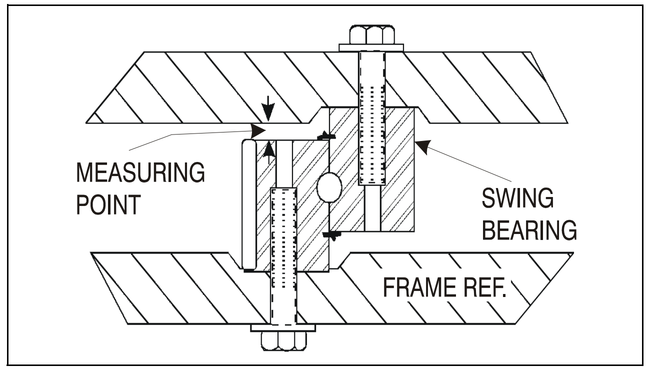


Figure 3-63. Swing Bearing Tolerance Measuring Point

Swing Bearing 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.

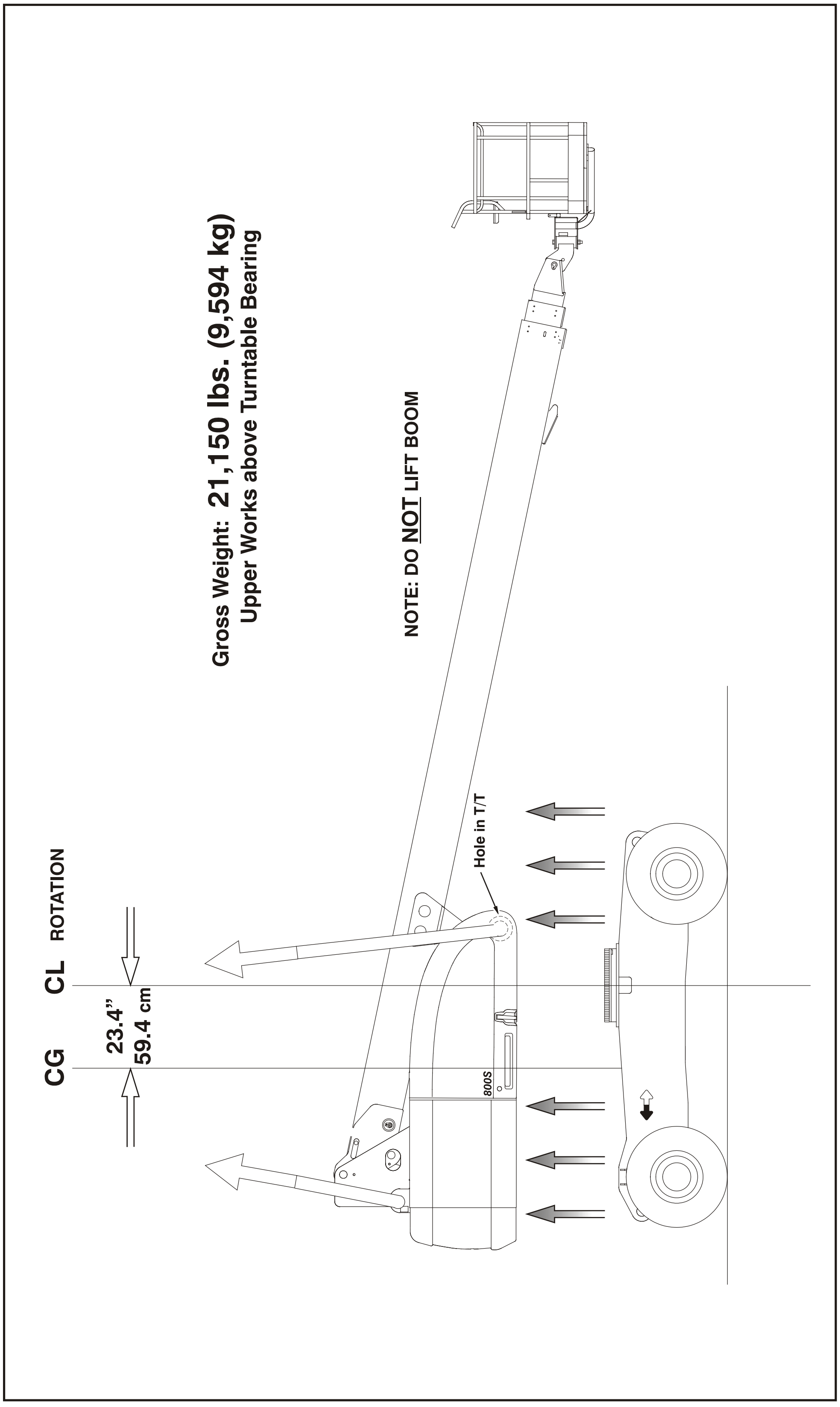


Figure 3-64. Swing Bearing Removal (800S)

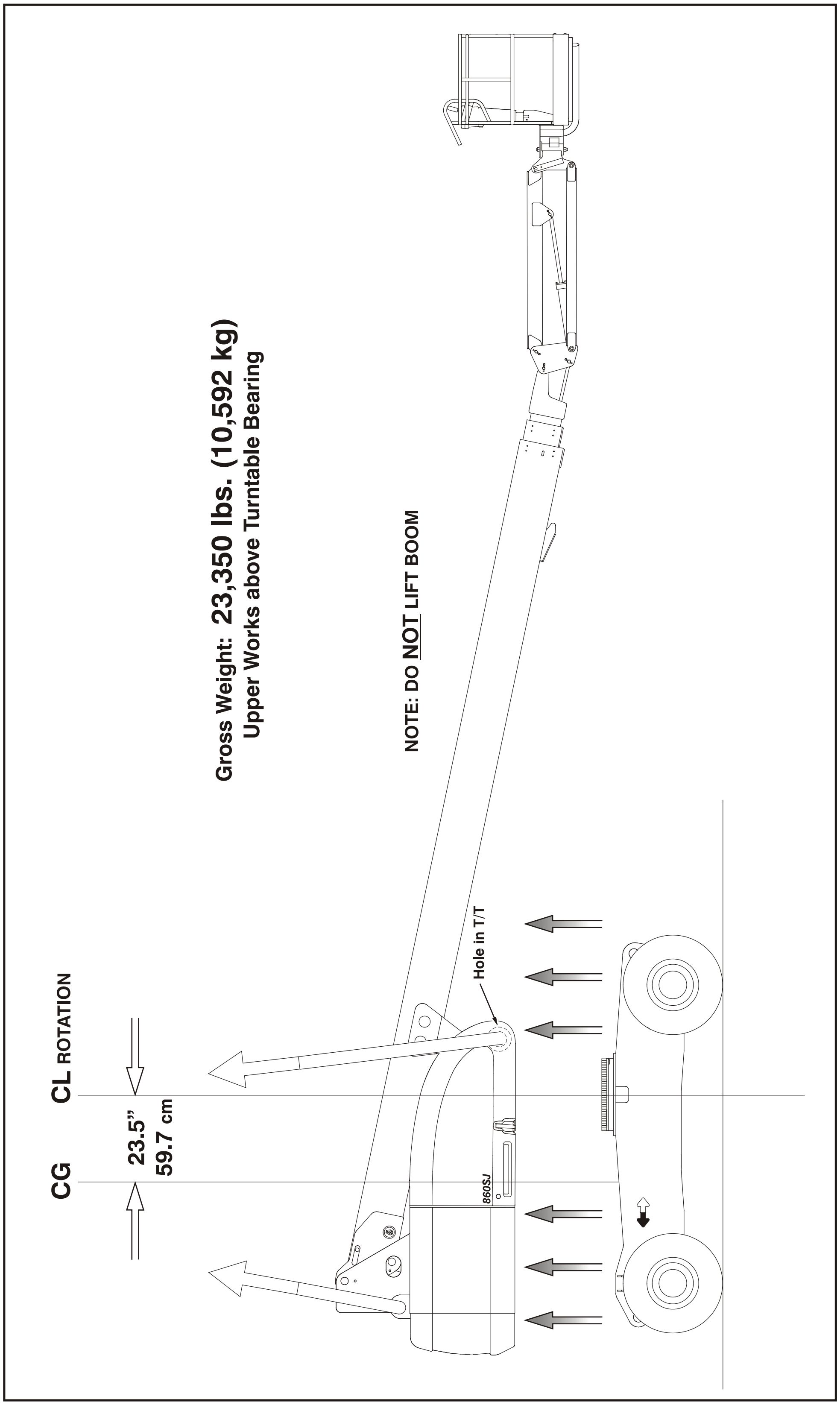


Figure 3-65. Swing Bearing Removal (860SJ)

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.

SWING BEARING 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 High Strength Threadlocking Compound 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 3-58., Swing Bearing Torque Sequence. Clean any residue off the new bearing bolts, then apply a light coating of High Strength Threadlocking Compound 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/High Strength Threadlocking Compound.

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 High Strength Threadlocking Compound and install the bolts and washers through the turntable and inner race of the bearing.

8. Following the Torque Sequence diagram shown in Figure 3-58., Swing Bearing Torque Sequence, tighten the bolts to a torque of 190 ft. lbs. (260 Nm).

9. Remove the lifting equipment.

10. Install the rotary coupling retaining yoke brackets, apply a light coating of High Strength Threadlocking Compound 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. (258 Nm) w/High Strength Threadlocking Compound.

2. Inner Race - 190 ft. lbs. (258 Nm) w/High Strength Threadlocking Compound.

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.

3.17 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 (3) 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 3-66., 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.

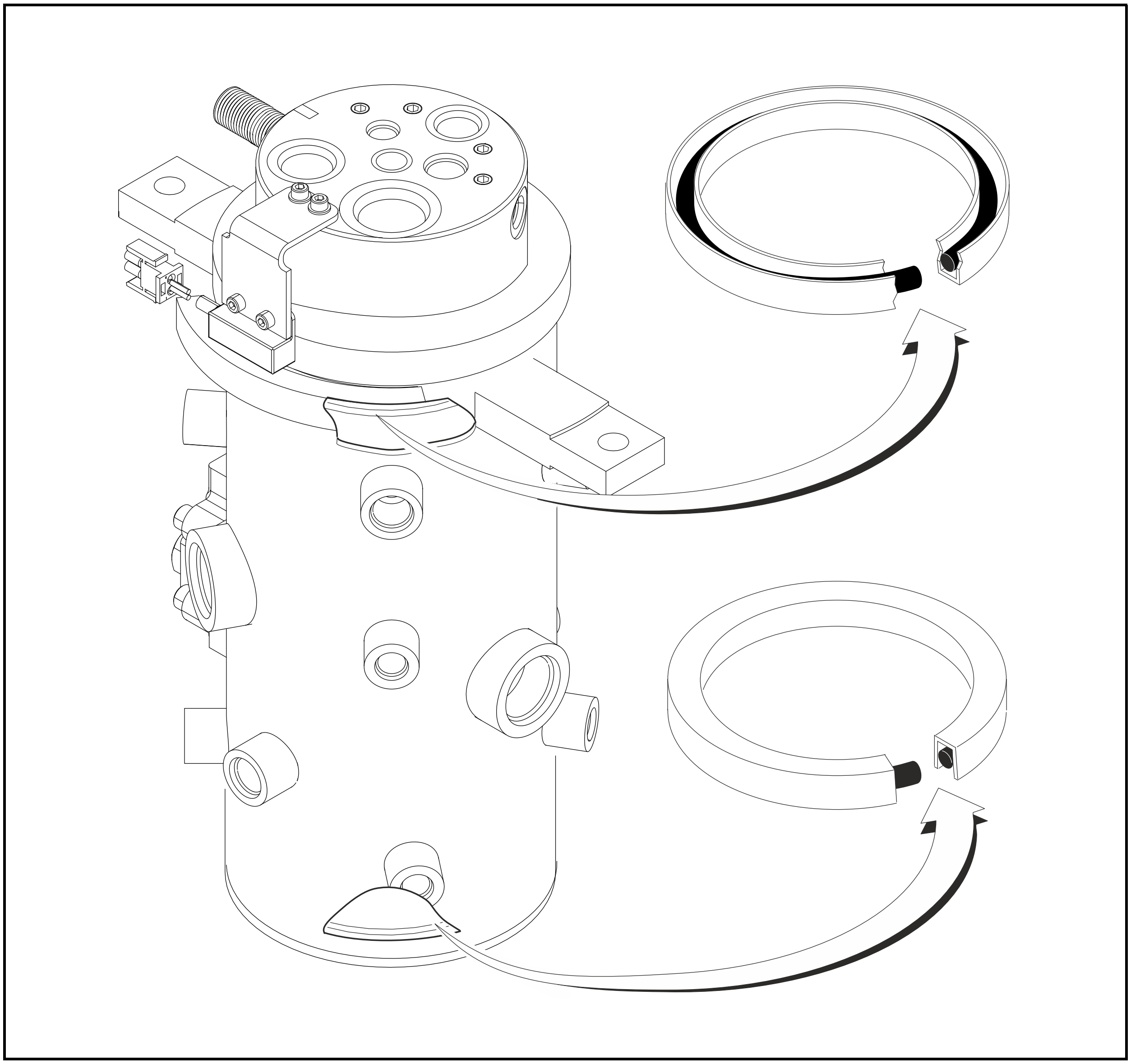
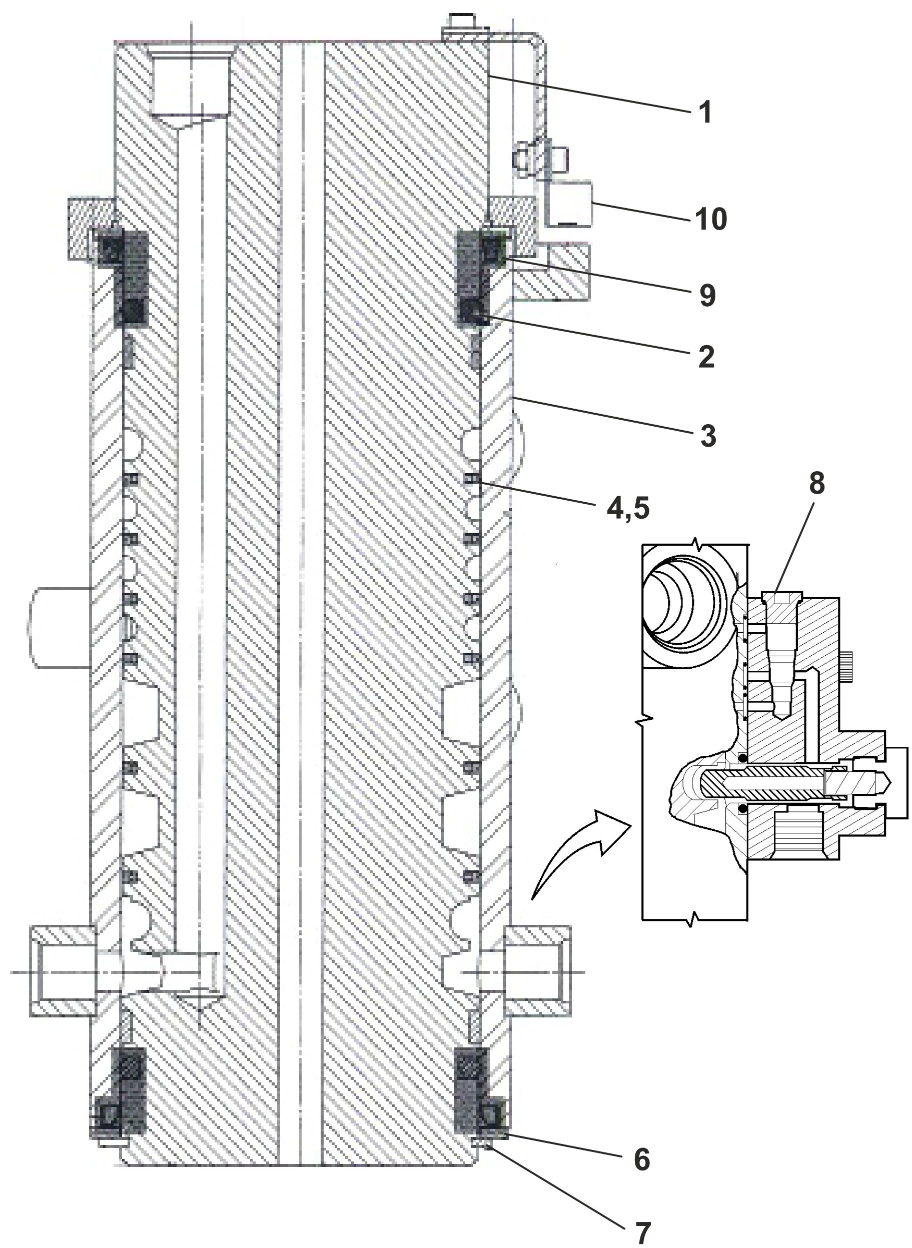


Figure 3-66. Rotary Coupling Seal Installation



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 3-67. Rotary Coupling Cutaway

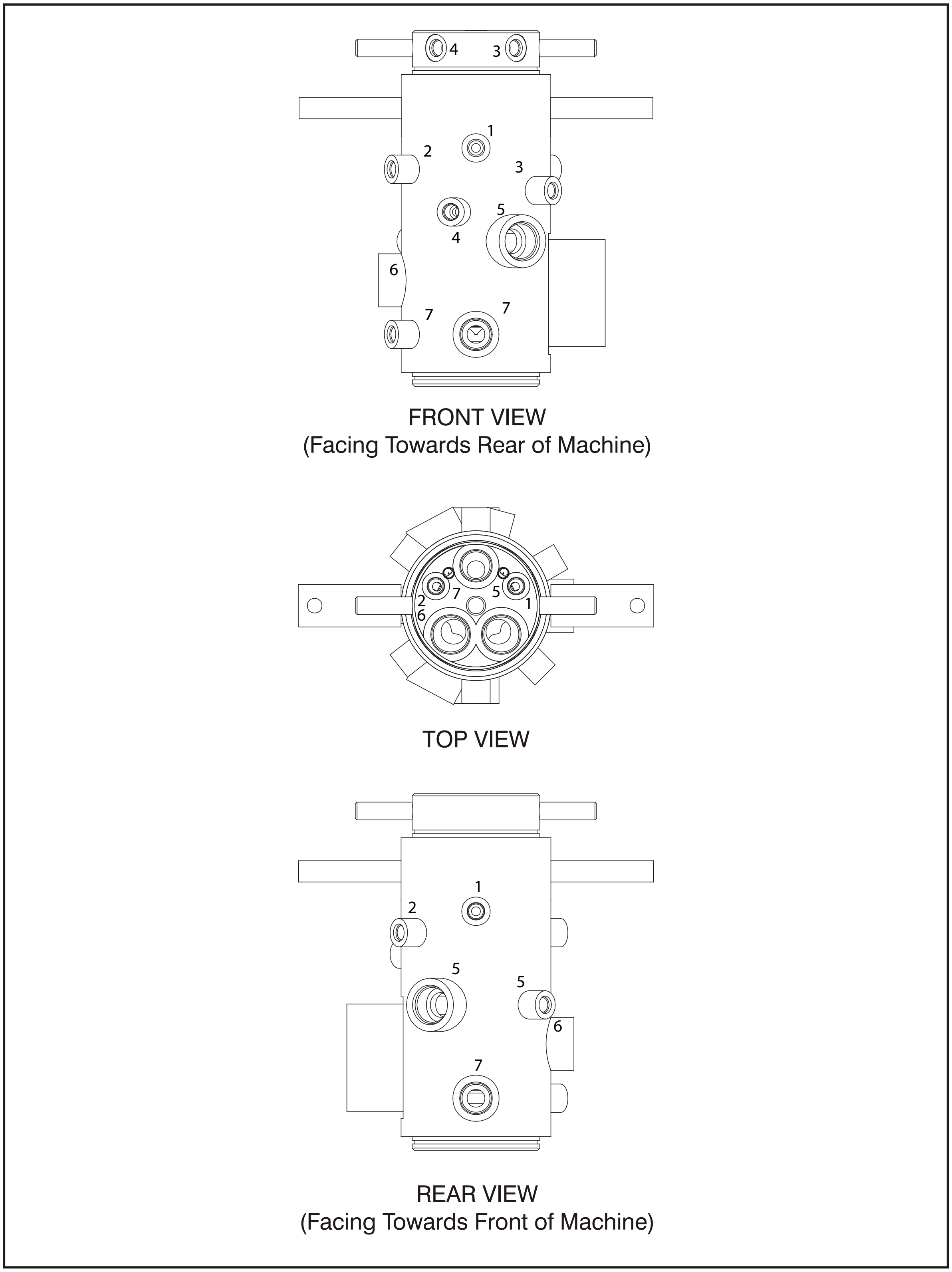
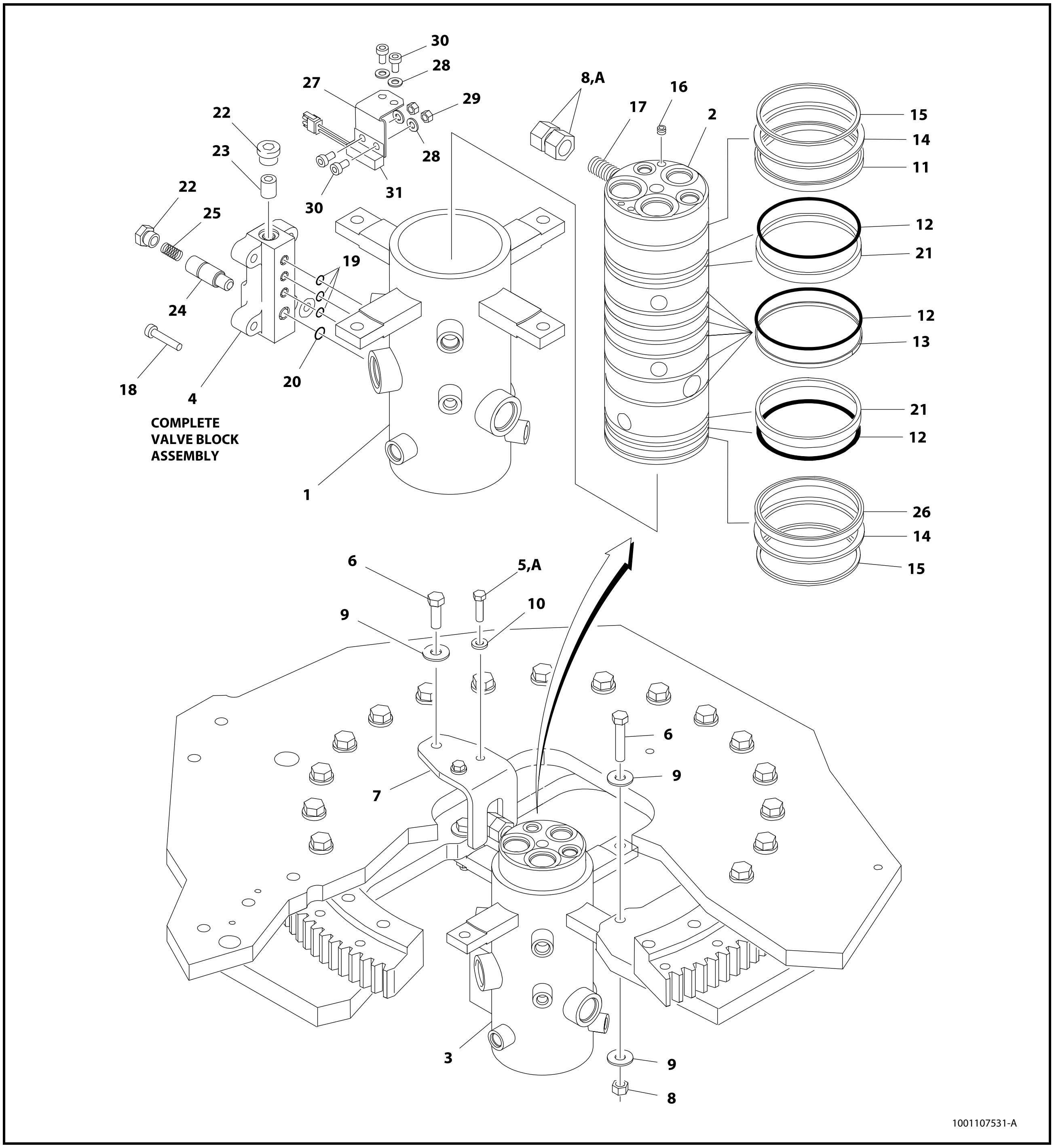


Figure 3-68. Rotary Coupling Port Location (7 Port)



1. Housing
2. Body
3. Rotary Coupling
4. Block Valve Assembly
5. Bolt
6. Bolt
7. Bracket
8. Locknut
9. Washer
10. Washer
11. Seal
12. O-ring
13. Cap Seal
14. Thrust Ring
15. Retaining Ring
16. Plug
17. Torque Lug
18. Capscrew
19. O-ring
20. O-ring
21. Bearing
22. Plug
23. Check Valve
24. Plunger Valve
25. Spring
26. Seal
27. Bracket
28. Washer
29. Locknut
30. Capscrew
31. Proximity Switch

Figure 3-69. Rotary Coupling Installation

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

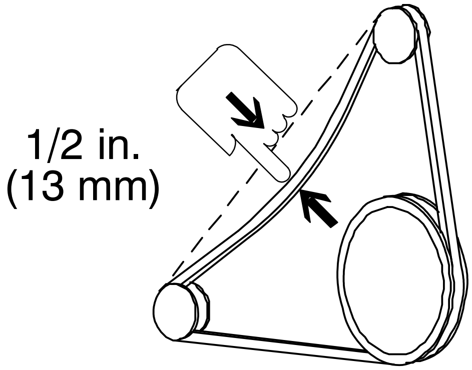
Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive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

3.18 GENERATOR

Maintenance Schedule

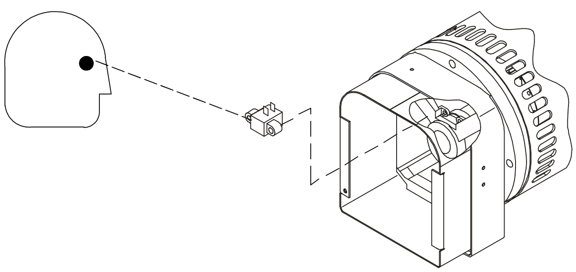
EVERY 250 HOURS

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

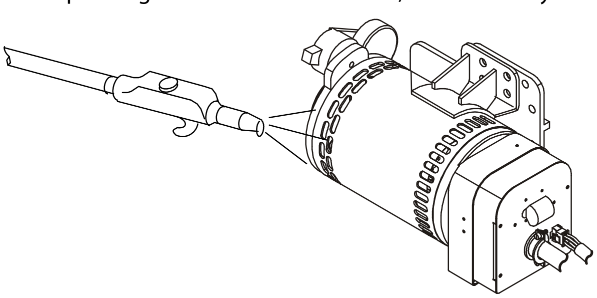


EVERY 500 HOURS

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.

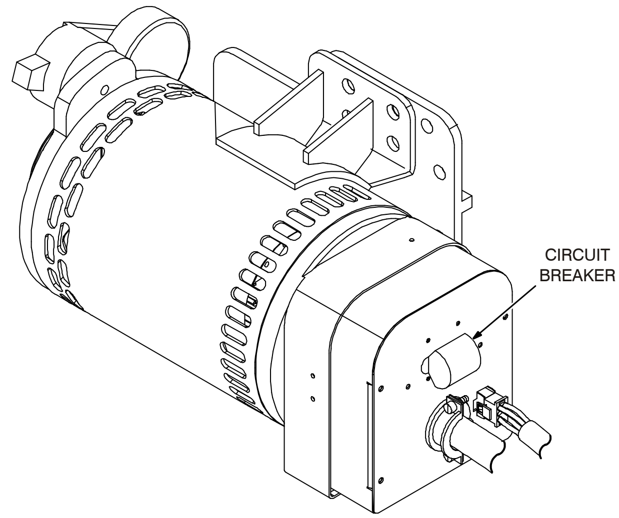


Overload Protection

⚠ 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 3-70., 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.

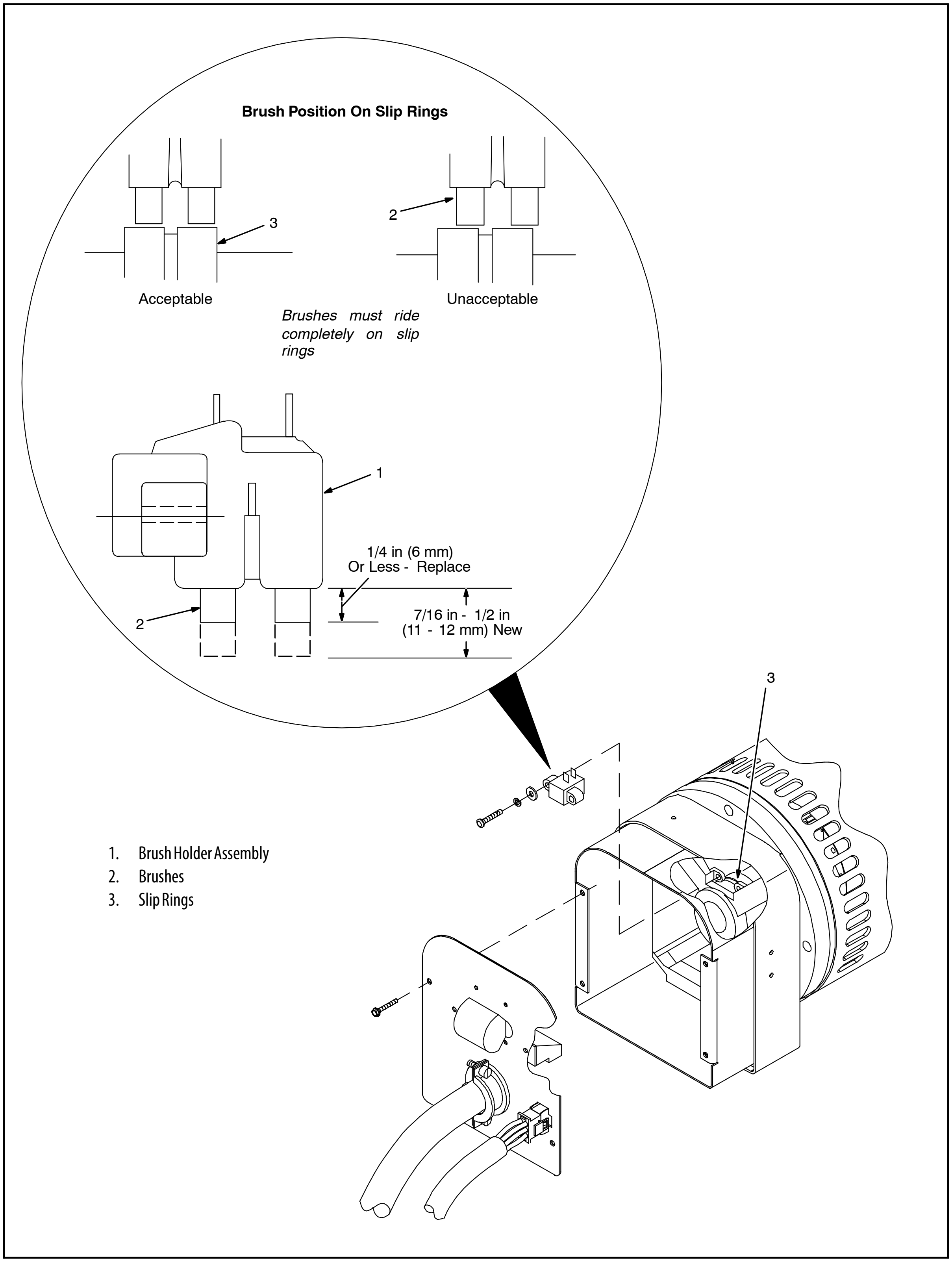


Figure 3-70. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

Troubleshooting

Table 3-10. 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 3-72. and Figure 3-73. 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 3-71.
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.

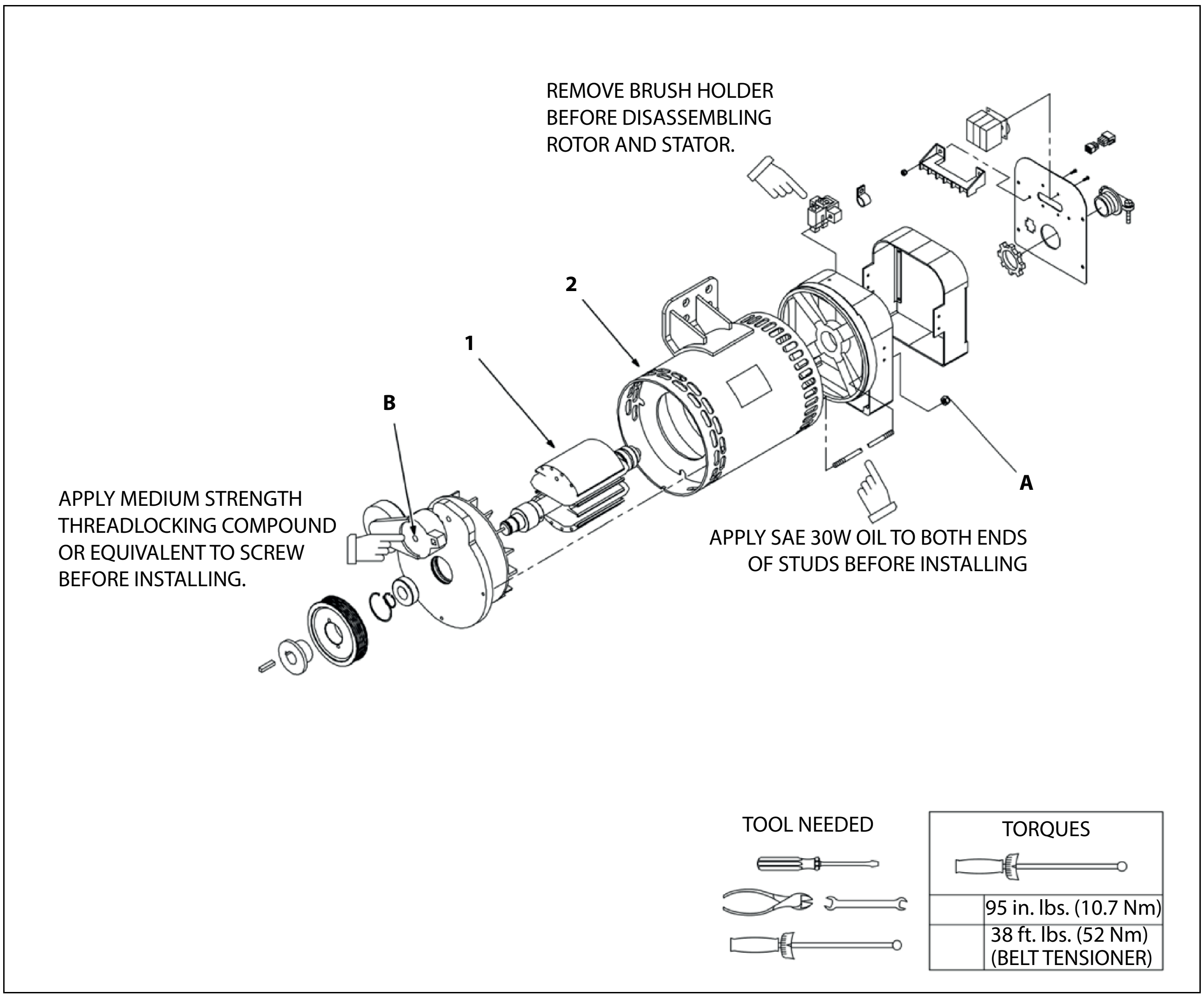


Figure 3-71. Generator Disassembly and Assembly

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

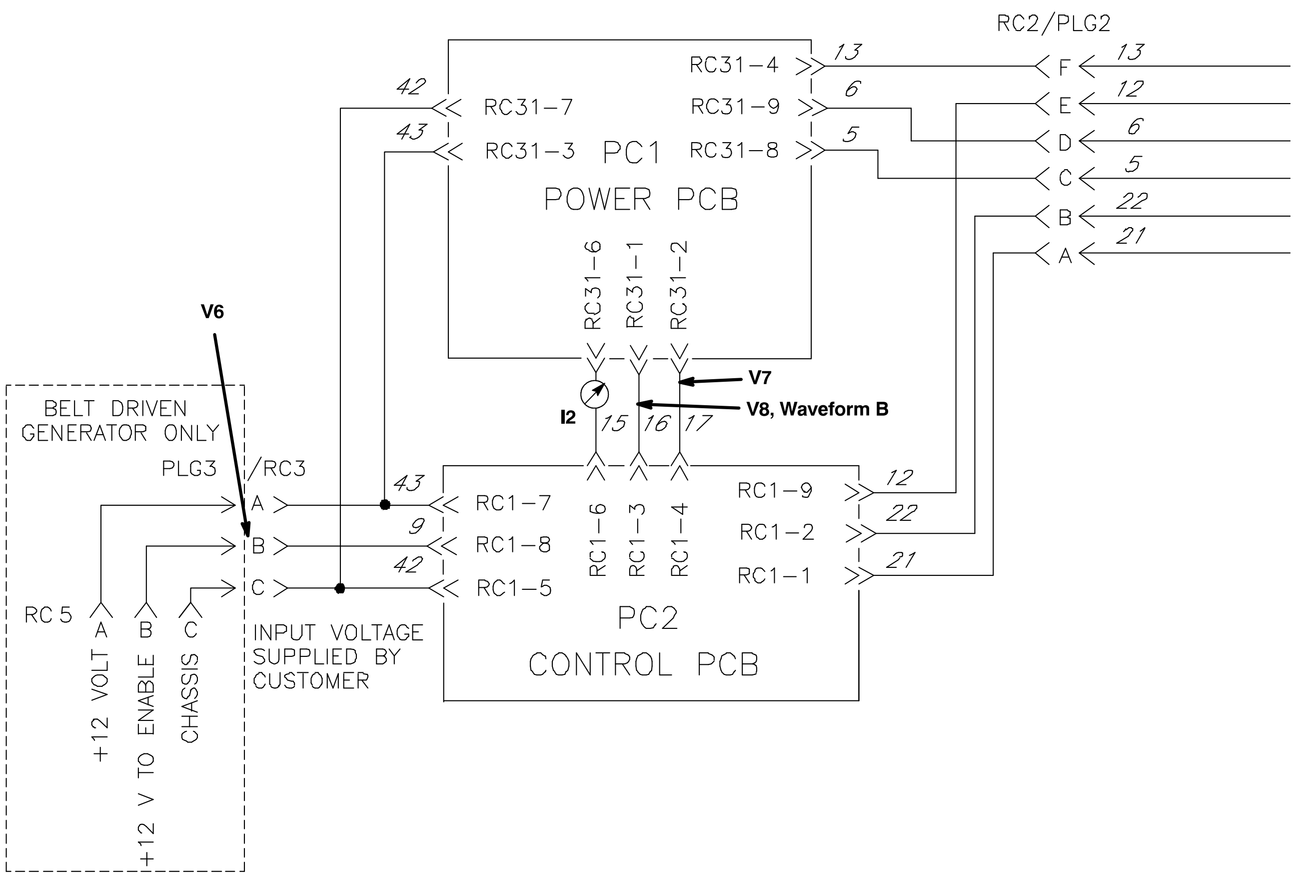
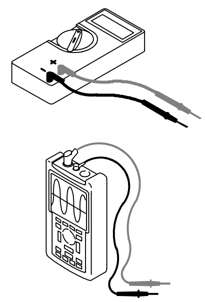


Figure 3-72. Generator Troubleshooting Circuit Diagram (Sheet 1 of 2)

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

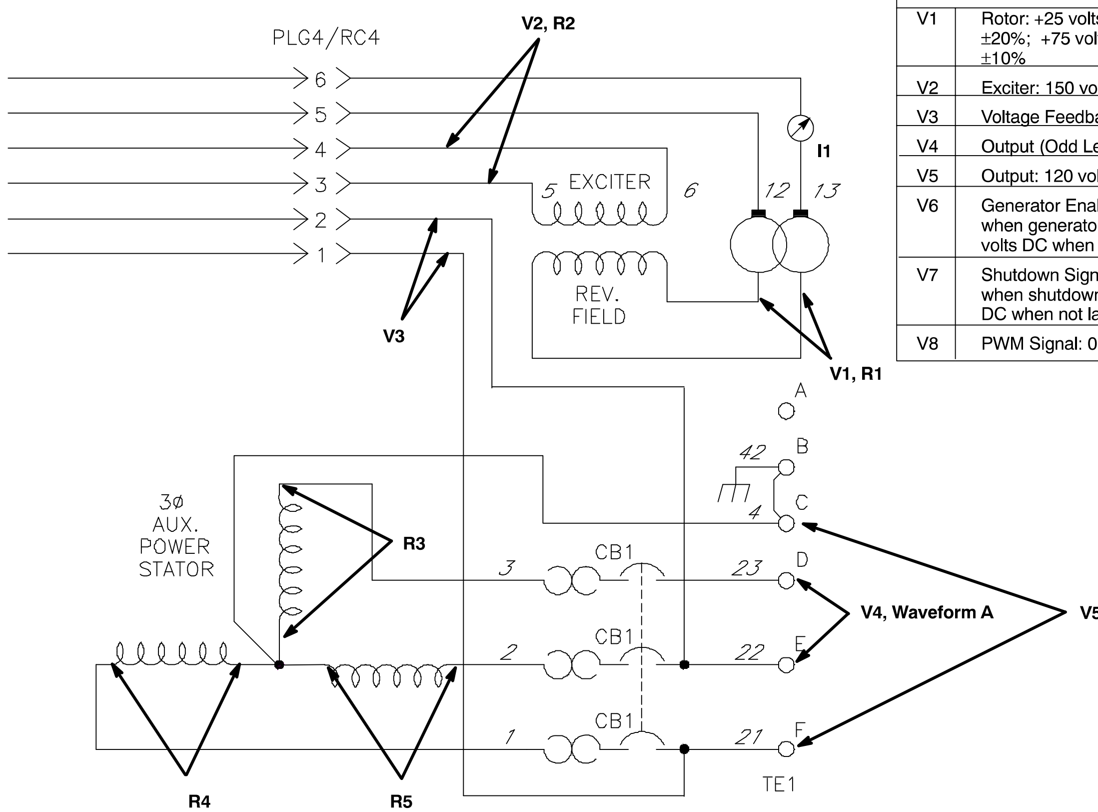


Figure 3-73. Generator Troubleshooting Circuit Diagram (Sheet 2 of 2)

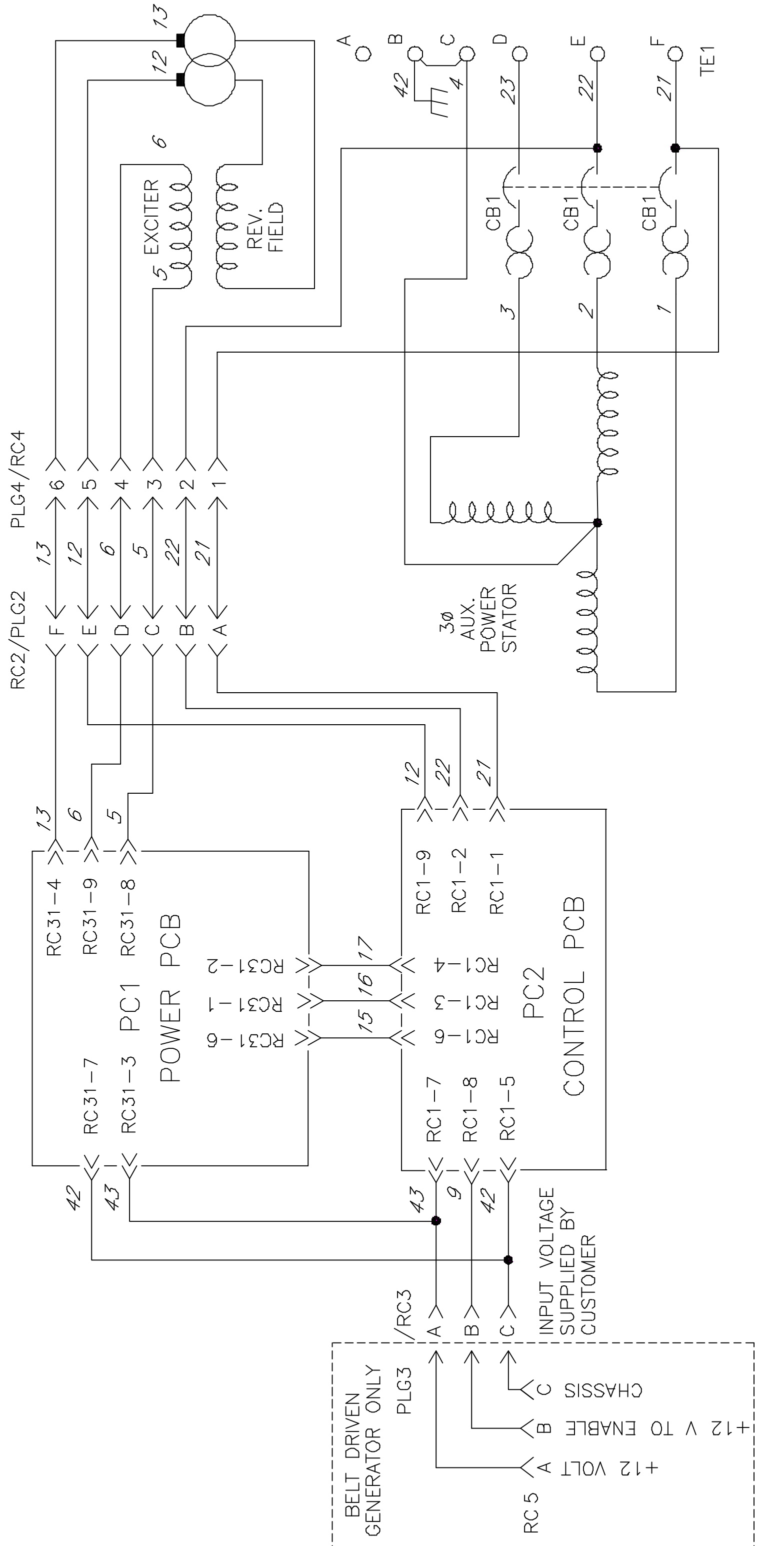


Figure 3-74. Generator Electrical Circuit Diagram

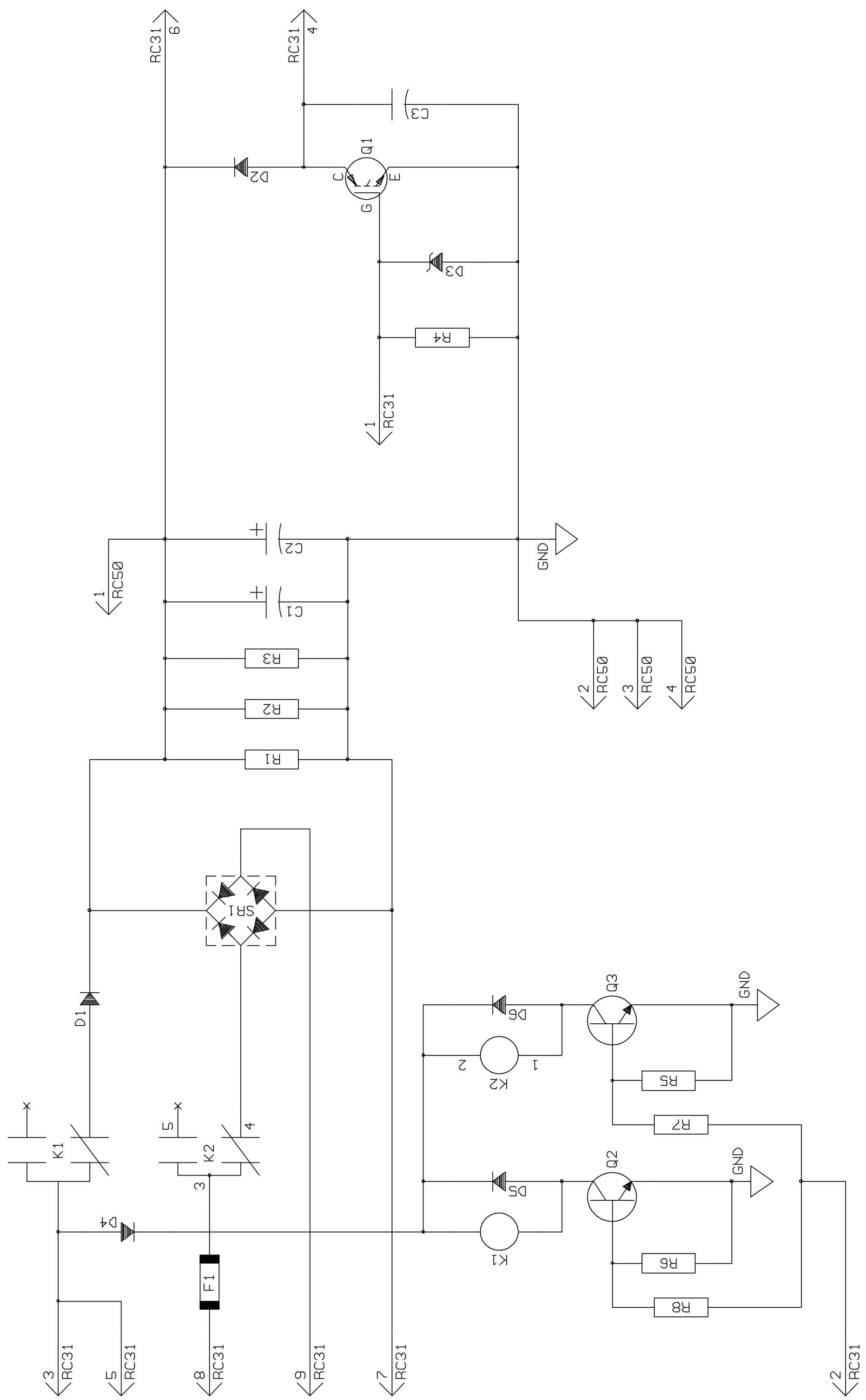
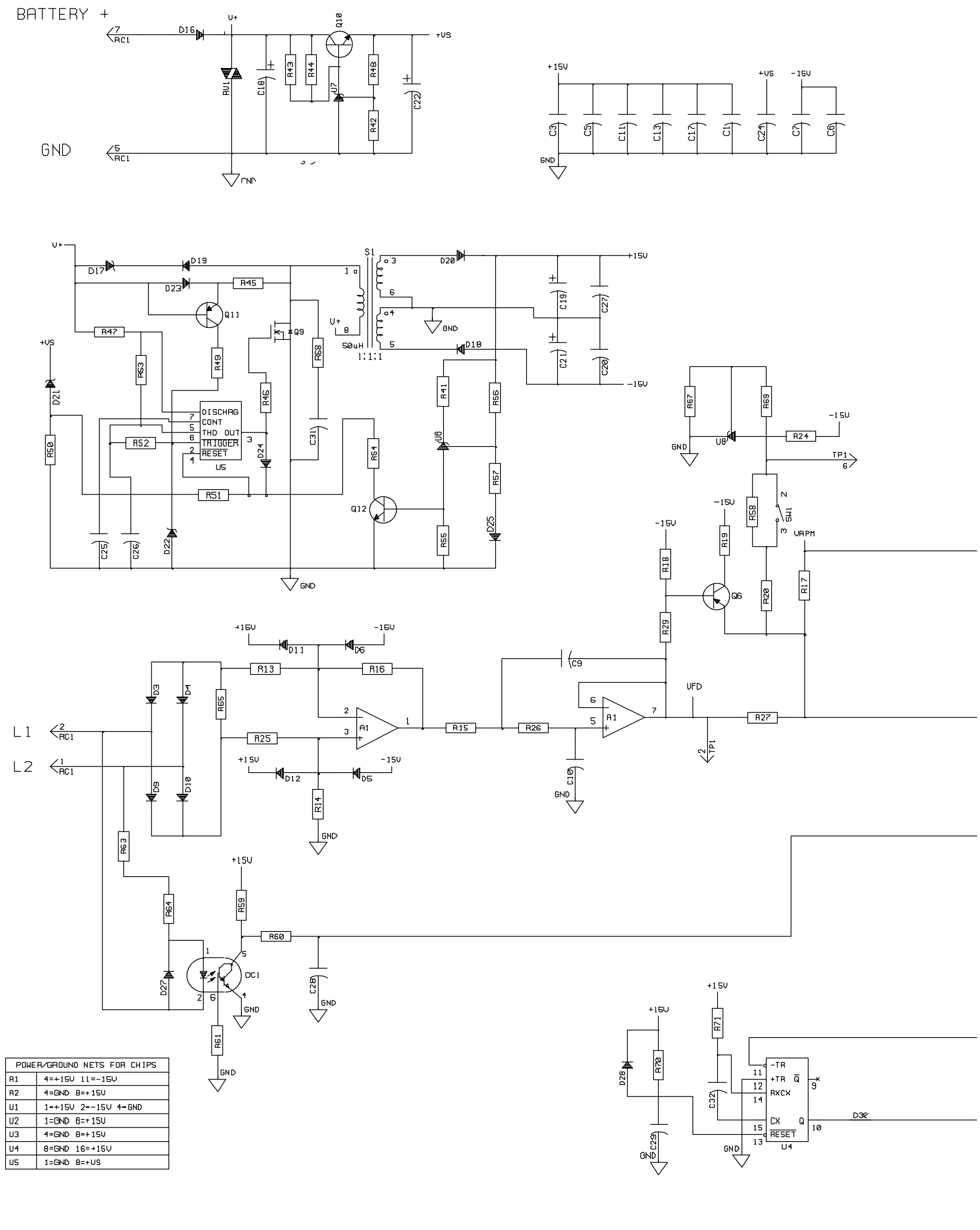


Figure 3-75. Power Board PC1 Electrical Circuit Diagram



POWER/GROUND NETS FOR CHIPS	
A1	4=+15V 11=-15V
A2	4=GND 8=+15V
U1	1=+15V 2=-15V 4=GND
U2	1=GND 6=+15V
U3	4=GND 8=+15V
U4	8=GND 16=+15V
U5	1=GND 8=+VS

Figure 3-76. Power Board PC2 Electrical Circuit Diagram (Sheet 1 of 2)

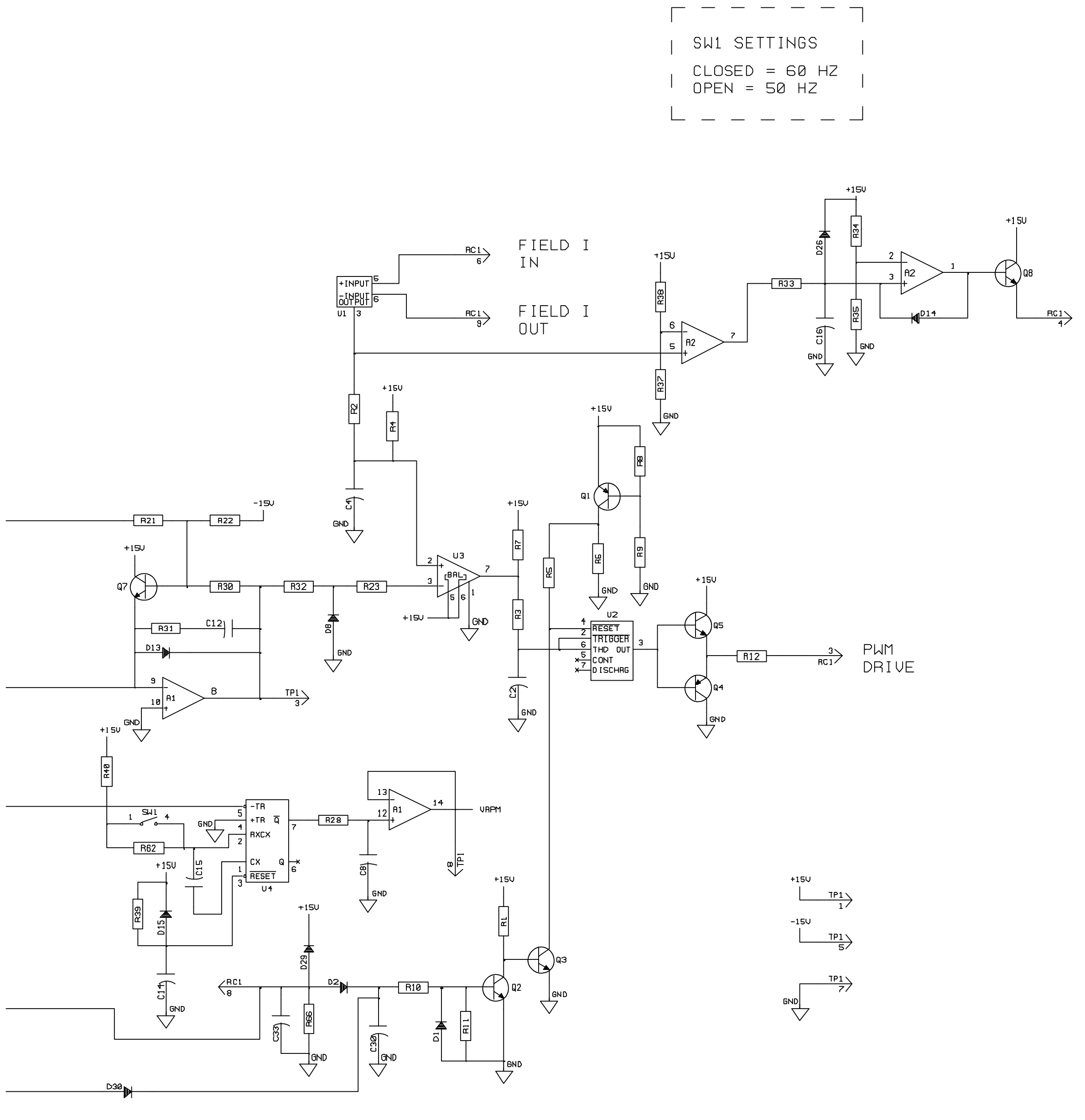


Figure 3-77. Power Board PC2 Electrical Circuit Diagram (Sheet 2 of 2)

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 3-11. 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

3.19 GENERATOR PULLEY

Removal

1. Remove the hardware securing the pulley belt tensioner assembly (1) to the generator (4) and remove pulley belt tensioner.
2. Remove hardware attaching tapered bushing (2) to the pulley (3) and remove tapered bushing and pulley from the generator shaft.

NOTE: *The Generator approximately weighs 106.9 lb (48.5 kg).*

3. Using suitable lifting equipment, adequately support engine assembly weight along entire length.
4. Remove the hardware securing generator (4) to the engine and remove generator from engine assembly.

Installation

1. Install generator (4) to the engine and secure with hardware.
2. Install generator pulley (3) and tapered bushing (2) on the generator shaft and secure with hardware. Torque hardwares to 8.8 ft. lbs. (12 Nm).

NOTE: *Ensure that generator pulley is aligned with engine pulley.*

3. Install pulley belt tensioner assembly (1) to generator and secure with hardware.

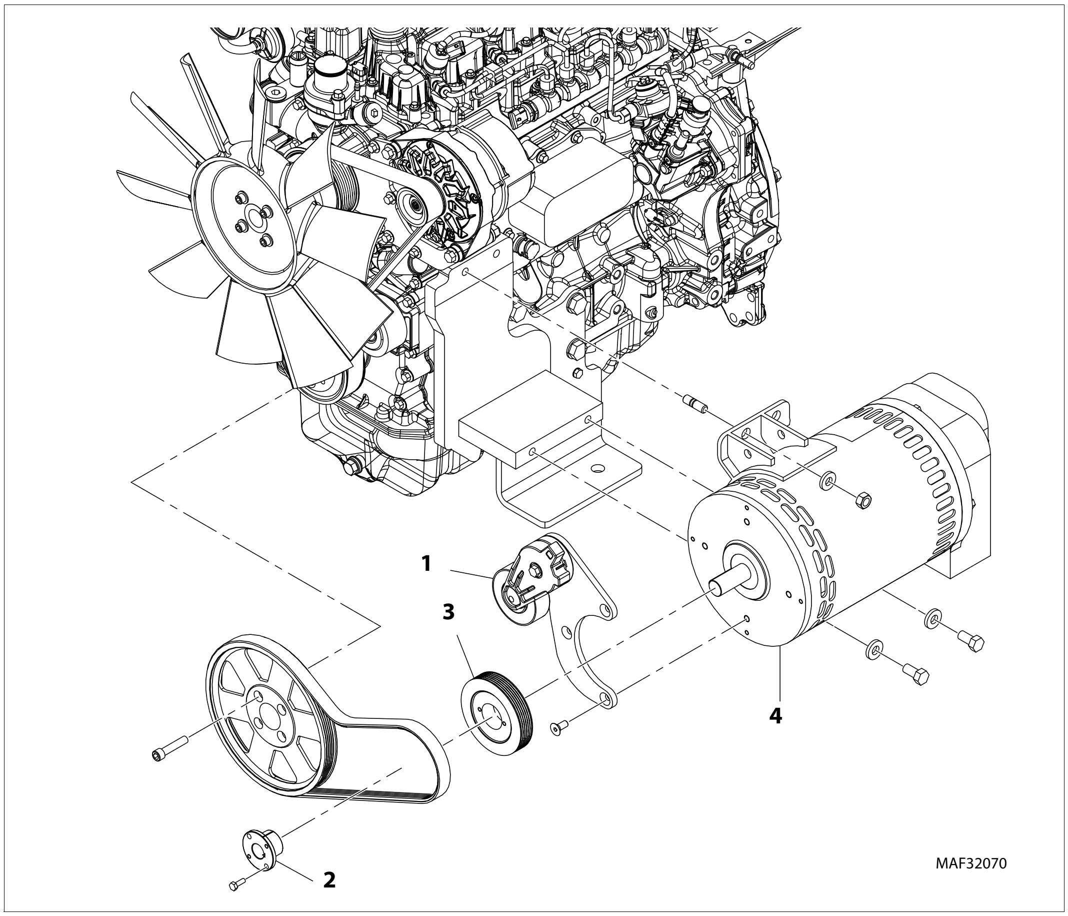


Figure 3-78. Generator Pulley

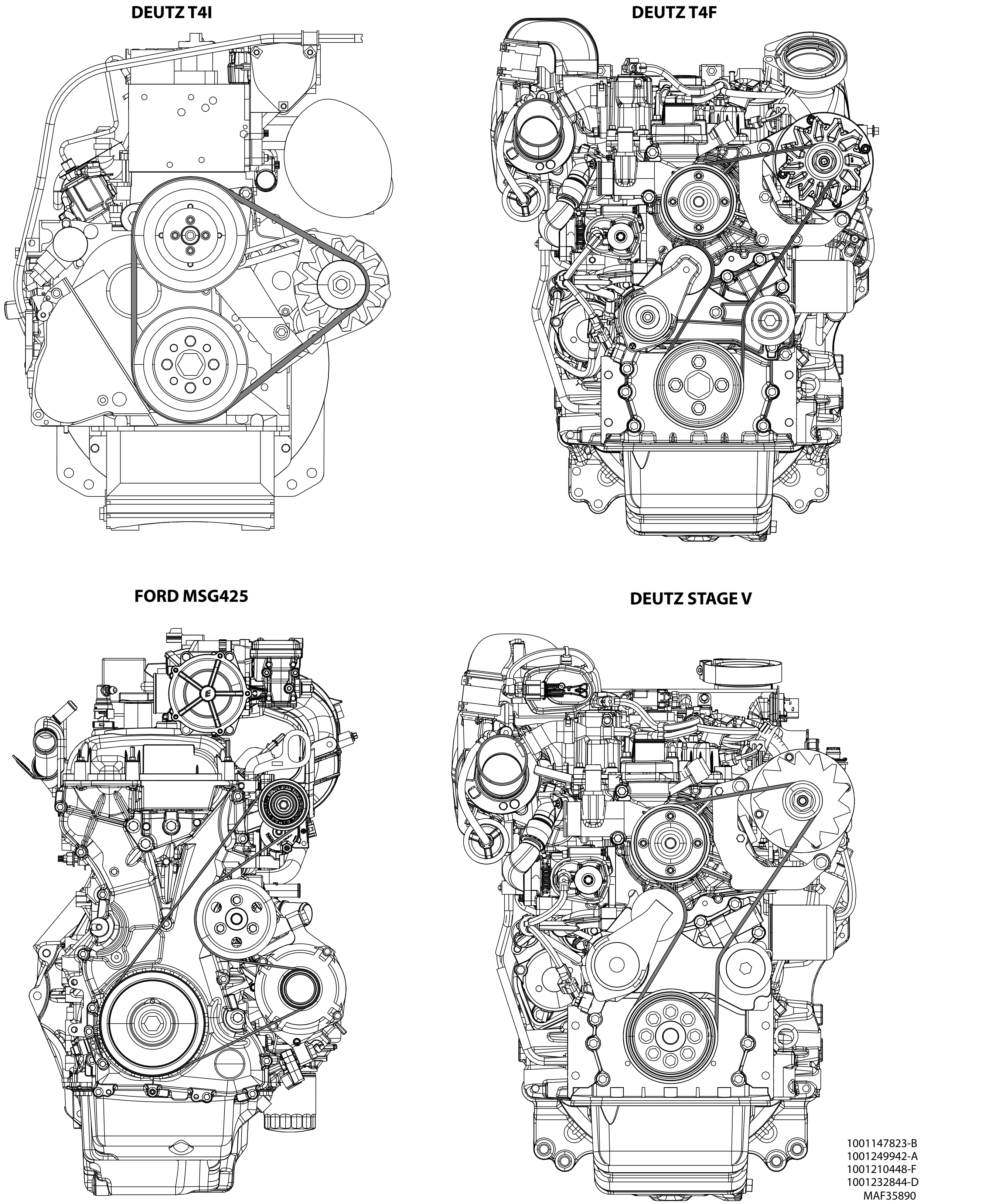


Figure 3-79. Belt Routing

3.20 FORD ENGINE

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

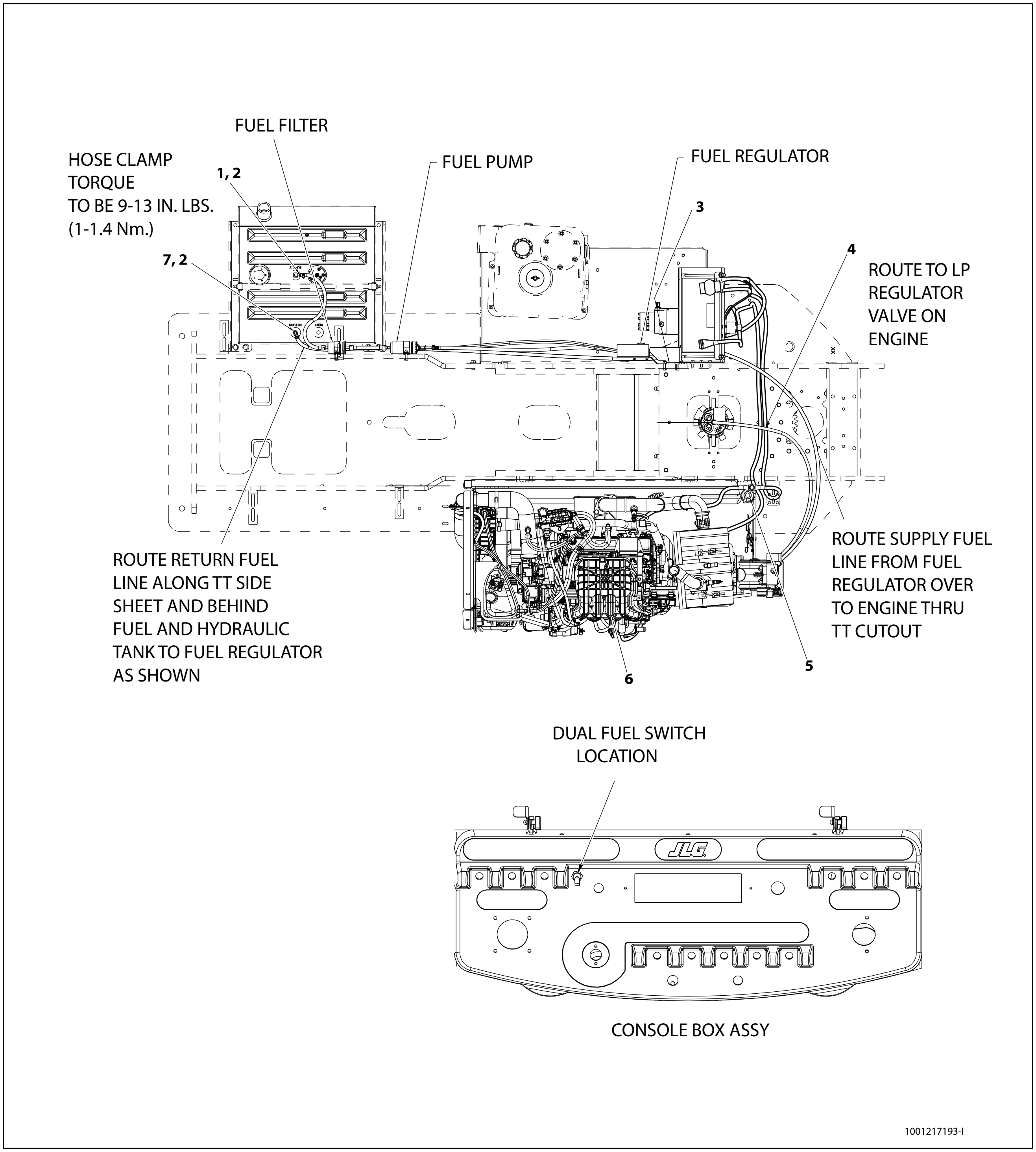


Figure 3-80. Ford Engine Installation - Sheet 1 of 4

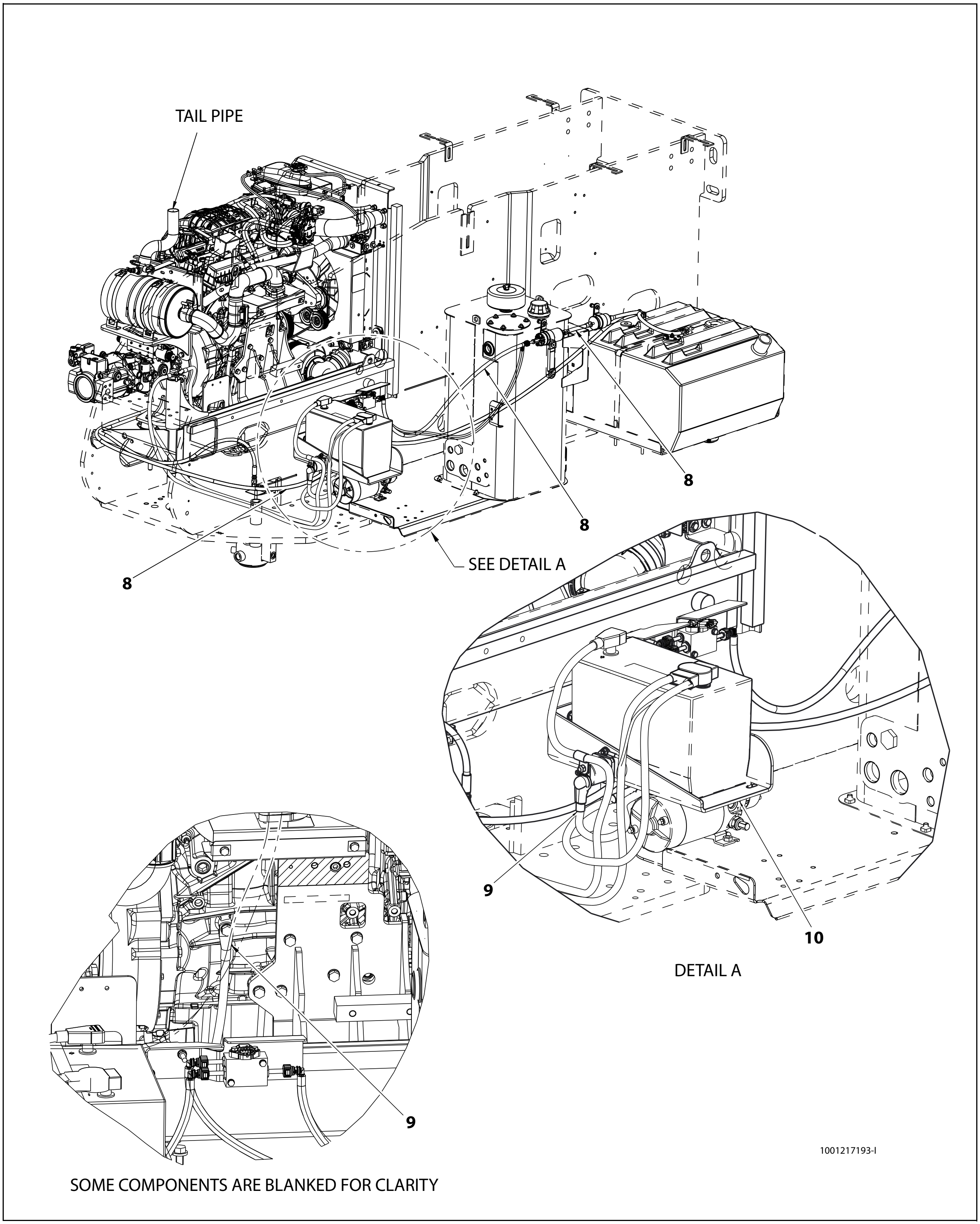
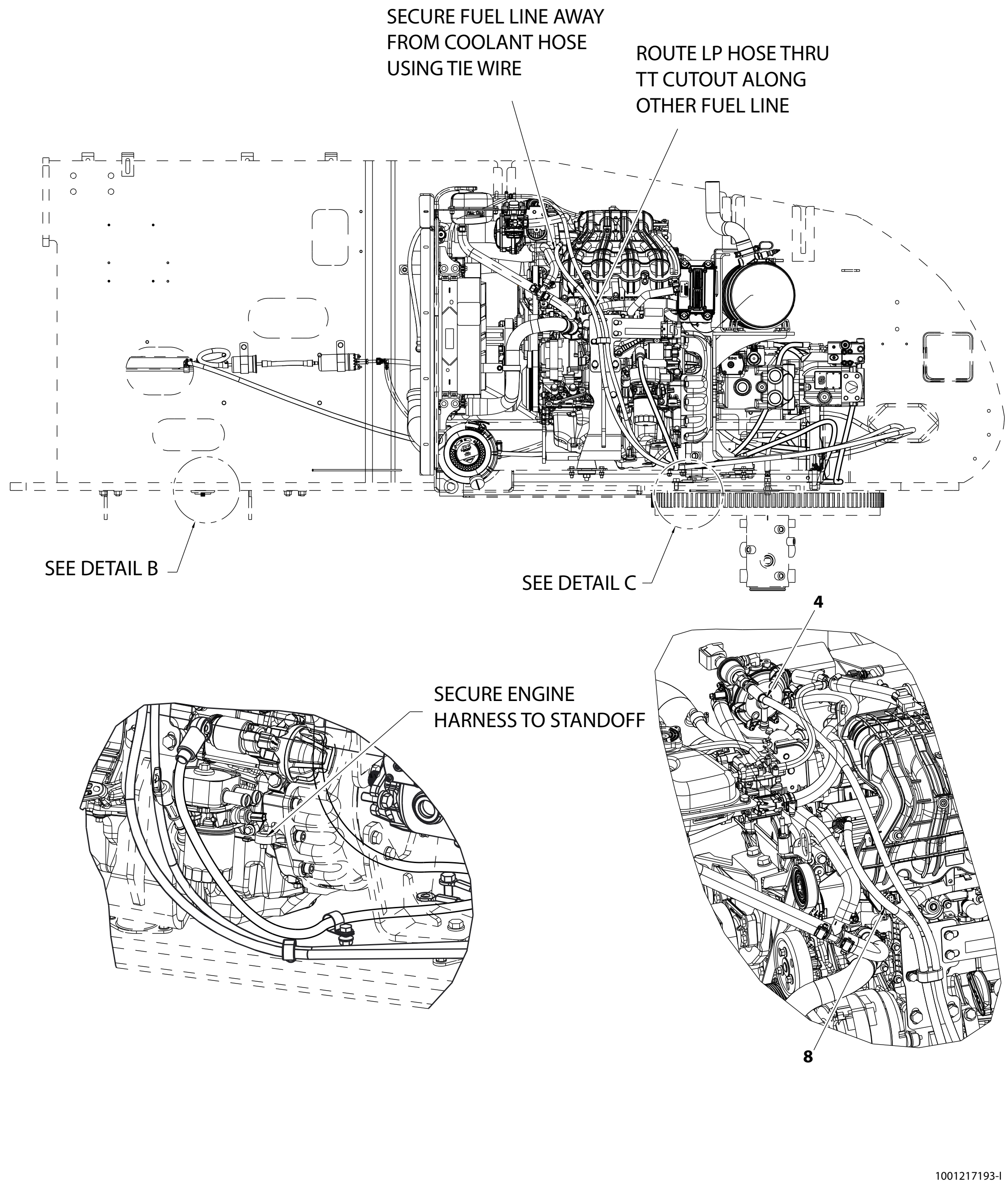


Figure 3-81. Ford Engine Installation - Sheet 2 of 4



1. High Pressure Fuel Hose
2. Hose Clamp
3. Fuel Regulator Mount Bracket
4. LP Gas Hose
5. Engine Tray Pin
6. Ford Engine with Pumps
7. High Pressure Fuel Hose
8. High Pressure Fuel Hose
9. Battery Cable Kit
10. Battery Bracket

Figure 3-82. Ford Engine Installation - Sheet 3 of 4

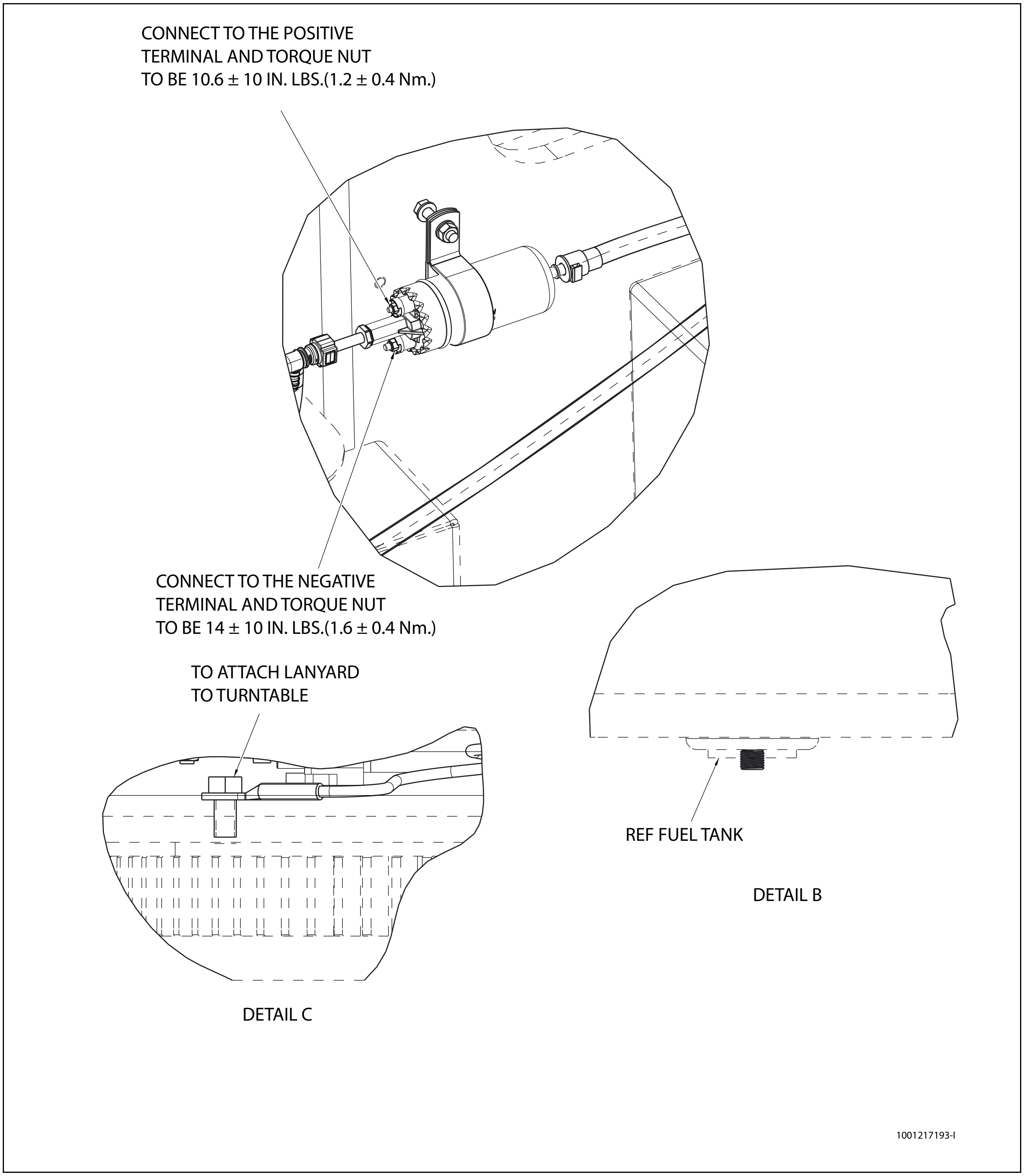


Figure 3-83. Ford Engine Installation - Sheet 4 of 4

Table 3-12. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
0	31	1531	Gov1/2/3 interlock failure
0	31	1621	RS-485 Rx inactive
0	31	1622	RS-485 Rx noise
0	31	1623	RS-485 Rx bad packet format
0	31	1624	RS-485 remote shutdown request
29	0	2116	FPP2 higher than IVS
29	1	2140	FPP2 lower than IVS
29	3	2128	FPP2 voltage high
29	4	2127	FPP2 voltage low
51	0	221	TPS1-2 higher than expected
51	1	121	TPS1-2 lower than expected
51	3	123	TPS1 voltage high
51	4	122	TPS1 voltage low
51	7	2111	Unable to reach lower TPS
51	7	2112	Unable to reach higher TPS
51	31	2135	TPS1/2 simultaneous voltages out-of-range
84	8	502	Roadspeed input loss of signal
91	0	2115	FPP1 higher than IVS
91	1	2139	FPP1 lower than IVS
91	3	2122	FPP1 voltage high
91	4	2123	FPP1 voltage low
91	9	1651	J1939 ETC message receipt loss while in-gear
91	16	2126	FPP1-2 higher than expected
91	18	2121	FPP1-2 lower than expected
91	19	1630	J1939 ETC message receipt loss
91	31	1121	FPP1/2 simultaneous voltages out-of-range (redundancy lost)
94	0	88	Fuel pressure higher than expected
94	1	87	Fuel pressure lower than expected
94	3	92	FP high voltage
94	4	91	FP low voltage
100	0	521	Oil pressure sender high pressure
100	1	524	Oil pressure low
100	1	524	Oil pressure sender low pressure
100	3	523	Oil pressure sender high voltage
100	4	522	Oil pressure sender low voltage
100	18	520	Oil pressure sender low pressure stage 1
102	0	234	Boost control overboost failure
102	1	299	Boost control underboost failure
102	2	236	TIP active
102	3	238	TIP high voltage
102	4	237	TIP low voltage
105	0	127	IAT higher than expected stage 2

Table 3-12. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
105	3	113	IAT voltage high
105	4	112	IAT voltage low
105	15	111	IAT higher than expected stage 1
106	4	107	MAP voltage low
106	16	108	MAP pressure high
108	0	2229	BP pressure high
108	1	129	BP pressure low
110	0	217	ECT higher than expected stage 2
110	0	1522	CHT higher than expected stage 2
110	3	118	ECT voltage high
110	4	117	ECT voltage low
110	15	116	ECT higher than expected stage 1
110	16	1521	CHT higher than expected stage 1
168	15	563	Vbat voltage high
168	17	562	Vbat voltage low
173	0	2428	EGT temperature high
174	3	183	FT high voltage
174	4	182	FT low voltage
441	0	1417	EMWT1 higher than expected stage 2
441	3	1411	EMWT1 voltage high
441	4	1413	EMWT1 voltage low
441	15	1415	EMWT1 higher than expected stage 1
442	0	1418	EMWT2 higher than expected stage 2
442	3	1412	EMWT2 voltage high
442	4	1414	EMWT2 voltage low
442	15	1416	EMWT2 higher than expected stage 1
515	0	1112	RPM above spark rev limit level
515	15	219	RPM higher than max allowed govern speed
515	16	1111	RPM above fuel rev limit level
558	5	2130	IVS stuck at-idle, FPP1/2 match
558	6	2131	IVS stuck off-idle, FPP1/2 match
628	13	601	Microprocessor failure - FLASH
629	31	606	Microprocessor failure - COP
629	31	1612	Microprocessor failure - RTI 1
629	31	1613	Microprocessor failure - RTI 2
629	31	1614	Microprocessor failure - RTI 3
629	31	1615	Microprocessor failure - A/D
629	31	1616	Microprocessor failure - Interrupt
630	12	604	Microprocessor failure - RAM
632	31	359	Fuel run-out longer than expected
636	2	336	CRANK input signal noise
636	4	337	Crank signal loss
636	8	16	Crank and/or cam could not synchronize during start

Table 3-12. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
639	12	1626	CAN-J1939 Tx fault
639	12	1627	CAN-J1939 Rx fault
639	13	1628	J1939 CAN address / engine-number conflict
645	3	2619	Tach output short to power
645	4	2618	Tach output ground short
651	5	261	Injector 1 open or short to ground
651	6	262	Injector 1 coil shorted
652	5	264	Injector 2 open or short to ground
652	6	265	Injector 2 coil shorted
653	5	267	Injector 3 open or short to ground
653	6	268	Injector 3 coil shorted
654	5	270	Injector 4 open or short to ground
654	6	271	Injector 4 coil shorted
655	5	273	Injector 5 open or short to ground
655	6	274	Injector 5 coil shorted
656	5	276	Injector 6 open or short to ground
656	6	277	Injector 6 coil shorted
657	5	279	Injector 7 open or short to ground
657	6	280	Injector 7 coil shorted
658	5	282	Injector 8 open or short to ground
658	6	283	Injector 8 coil shorted
659	5	285	Injector 9 open or short to ground
659	6	286	Injector 9 coil shorted
660	5	288	Injector 10 open or short to ground
660	6	289	Injector 10 coil shorted
695	9	1629	J1939 TSC1 message receipt loss
697	3	1632	PWM1-Gauge1 short to power
697	5	1631	PWM1-Gauge1 open / ground short
698	3	1634	PWM2-Gauge2 short to power
698	5	1633	PWM2-Gauge2 open / ground short
699	3	1636	PWM3-Gauge3 short to power
699	5	1635	PWM3-Gauge3 open / ground short
700	3	1638	PWM4 short to power
700	5	1637	PWM4 open / ground short
701	3	1511	AUX analog Pull-Up 1 high voltage
701	4	1512	AUX analog Pull-Up 1 low voltage
702	3	1513	AUX analog Pull-Up 2 high voltage
702	4	1514	AUX analog Pull-Up 2 low voltage
703	3	1517	AUX analog Pull-Up 3 high voltage
703	4	1518	AUX analog Pull-Up 3 low voltage
704	3	1541	AUX analog Pull-Up/Down 1 high voltage
704	4	1542	AUX analog Pull-Up/Down 1 low voltage
705	3	1543	AUX analog Pull-Up/Down 2 high voltage

Table 3-12. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
705	4	1544	AUX analog Pull-Up/Down 2 low voltage
706	3	1545	AUX analog Pull-Up/Down 3 high voltage
706	4	1546	AUX analog Pull-Up/Down 3 low voltage
707	3	1551	AUX digital 1 high voltage
707	4	1552	AUX digital 1 low voltage
708	3	1553	AUX digital 2 high voltage
708	4	1554	AUX digital 2 low voltage
709	3	1555	AUX digital 3 high voltage
709	3	1555	Water Intrusion Detection
709	4	1556	AUX digital 3 low voltage
710	3	1515	AUX analog Pull-Down 1 high voltage
710	4	1516	AUX analog Pull-Down 1 low voltage
711	3	1561	AUX analog Pull-Down 2 high voltage
711	4	1561	AUX analog Pull-Down 2 low voltage
712	3	1561	AUX analog Pull-Down 3 high voltage
712	4	1561	AUX analog Pull-Down 3 low voltage
713	3	1547	AUX analog Pull-Up/Down 4 high voltage
713	4	1548	AUX analog Pull-Up/Down 4 low voltage
723	2	341	CAM input signal noise
723	4	342	Loss of CAM input signal
731	2	326	Knock1 excessive or erratic signal
731	4	327	Knock1 sensor open or not present
920	3	1643	Buzzer control short to power
920	4	1641	Buzzer control ground short
920	5	1642	Buzzer open
924	3	1640	PWM5 short to power
924	5	1639	PWM5 open / ground short
925	3	1662	PWM6 short to power
925	5	1661	PWM6 open / ground short
926	3	1664	PWM7 short to power
926	5	1663	PWM7 open / ground short
1079	3	643	Sensor supply voltage 1 high
1079	4	642	Sensor supply voltage 1 low
1079	31	1611	Sensor supply voltage 1 and 2 out-of-range
1080	3	653	Sensor supply voltage 2 high
1080	4	652	Sensor supply voltage 2 low
1110	31	1625	J1939 shutdown request
1192	3	1131	WGP voltage high
1192	4	1132	WGP voltage low
1213	3	1645	MIL control short to power
1213	4	1644	MIL control ground short
1213	5	650	MIL open
1268	5	2300	Spark coil 1 primary open or short to ground

Table 3-12. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
1268	6	2301	Spark coil 1 primary shorted
1269	5	2303	Spark coil 2 primary open or short to ground
1269	6	2304	Spark coil 2 primary shorted
1270	5	2306	Spark coil 3 primary open or short to ground
1270	6	2307	Spark coil 3 primary shorted
1271	5	2309	Spark coil 4 primary open or short to ground
1271	6	2310	Spark coil 4 primary shorted
1272	5	2312	Spark coil 5 primary open or short to ground
1272	6	2313	Spark coil 5 primary shorted
1273	5	2315	Spark coil 6 primary open or short to ground
1273	6	2316	Spark coil 6 primary shorted
1274	5	2318	Spark coil 7 primary open or short to ground
1274	6	2319	Spark coil 7 primary shorted
1275	5	2321	Spark coil 8 primary open or short to ground
1275	6	2322	Spark coil 8 primary shorted
1276	5	2324	Spark coil 9 primary open or short to ground
1276	6	2325	Spark coil 9 primary shorted
1277	5	2327	Spark coil 10 primary open or short to ground
1277	6	2328	Spark coil 10 primary shorted
1321	3	617	Start relay coil short to power
1321	4	616	Start relay ground short
1321	5	615	Start relay coil open
1323	11	1311	Cylinder 1 misfire detected
1323	31	301	Cylinder 1 emissions/catalyst damaging misfire
1324	11	1312	Cylinder 2 misfire detected
1324	31	302	Cylinder 2 emissions/catalyst damaging misfire
1325	11	1313	Cylinder 3 misfire detected
1325	31	303	Cylinder 3 emissions/catalyst damaging misfire
1326	11	1314	Cylinder 4 misfire detected
1326	31	304	Cylinder 4 emissions/catalyst damaging misfire
1327	11	1315	Cylinder 5 misfire detected
1327	31	305	Cylinder 5 emissions/catalyst damaging misfire
1328	11	1316	Cylinder 6 misfire detected
1328	31	306	Cylinder 6 emissions/catalyst damaging misfire
1329	11	1317	Cylinder 7 misfire detected
1329	31	307	Cylinder 7 emissions/catalyst damaging misfire
1330	11	1318	Cylinder 8 misfire detected
1330	31	308	Cylinder 8 emissions/catalyst damaging misfire
1347	5	628	Fuel-pump high-side open or short to ground
1347	6	629	Fuel-pump high-side short to power
1348	3	629	Fuel pump relay coil short to power
1348	4	628	Fuel pump relay control ground short
1348	5	627	Fuel pump relay coil open

Table 3-12. CAN to DTC Cross Reference (Ford Engine)

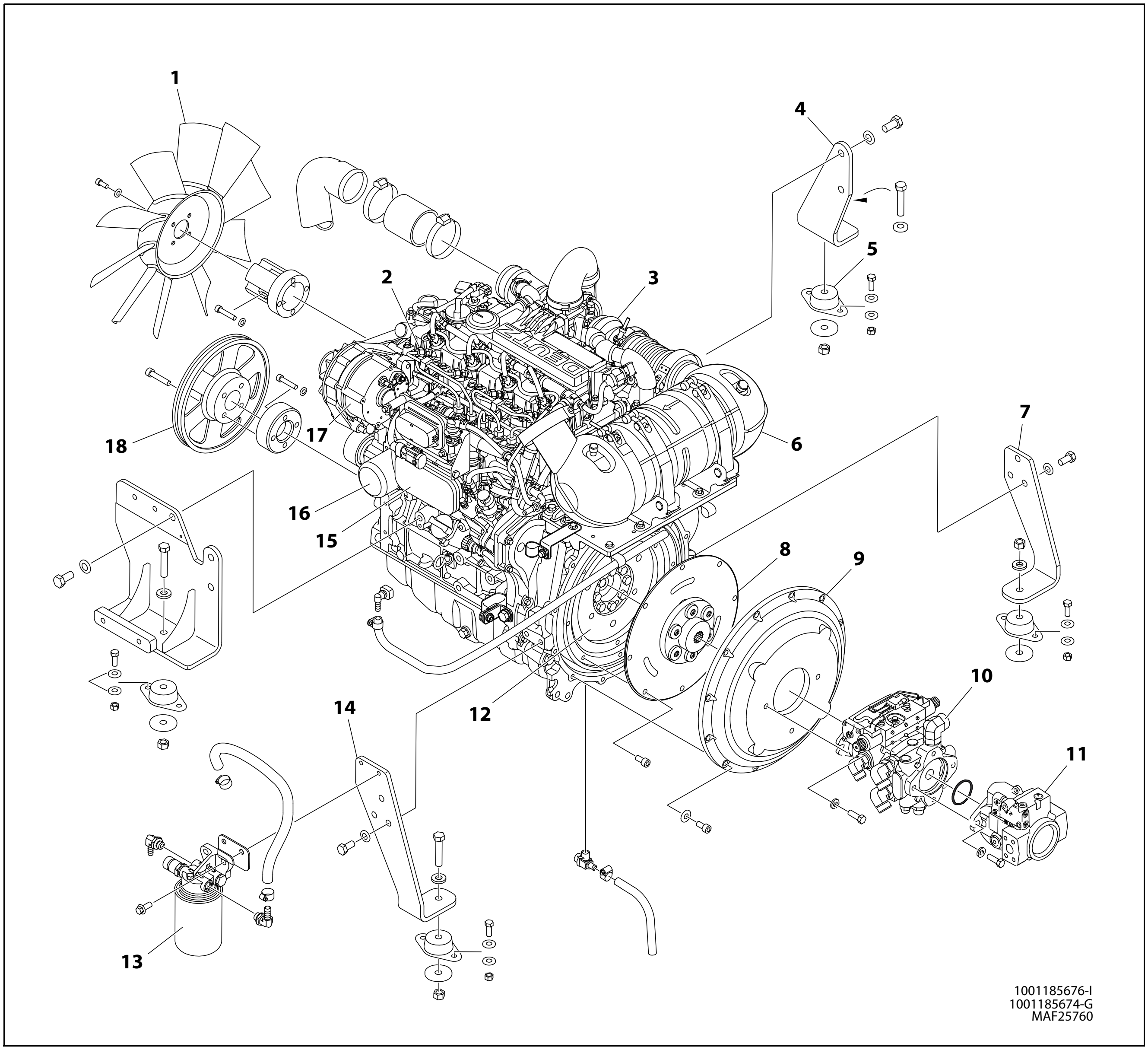
SPN	FMI	DTC	DTC and Description
1385	0	1425	ERWT1 higher than expected stage 2
1385	3	1419	ERWT1 voltage high
1385	4	1421	ERWT1 voltage low
1385	15	1423	ERWT1 higher than expected stage 1
1386	0	1426	ERWT2 higher than expected stage 2
1386	3	1420	ERWT2 voltage high
1386	4	1422	ERWT2 voltage low
1386	15	1424	ERWT2 higher than expected stage 1
1485	3	687	Power relay coil short to power
1485	4	686	Power relay ground short
1485	5	685	Power relay coil open
2646	3	1666	PWM8 short to power
2646	5	1665	PWM8 open / ground short
2647	3	1670	PWM9 short to power
2647	5	1669	PWM9 open / ground short
3050	11	420	Catalyst inactive on gasoline (Bank 1)
3050	11	1165	Catalyst inactive on LPG
3050	11	1166	Catalyst inactive on NG
3051	11	430	Catalyst inactive on gasoline (Bank 2)
3056	3	8906	UEGO return voltage shorted high
3056	4	8907	UEGO return voltage shorted low
3217	3	8910	UEGO sense cell voltage high
3217	4	8911	UEGO sense cell voltage low
3217	5	134	EGO1 open / lazy
3218	3	8908	UEGO pump voltage shorted high
3218	4	8909	UEGO pump voltage shorted low
3221	3	8904	UEGO cal resistor voltage high
3221	4	8905	UEGO cal resistor voltage low
3221	31	8901	UEGO microprocessor internal fault
3222	0	8916	UEGO sense cell impedance high
3222	3	8902	UEGO heater supply high voltage
3222	4	8903	UEGO heater supply low voltage
3222	10	8914	UEGO sense cell slow to warm up
3225	0	8917	UEGO pump cell impedance high
3225	1	8918	UEGO pump cell impedance low
3225	3	8912	UEGO pump voltage at high drive limit
3225	4	8913	UEGO pump voltage at low drive limit
3225	10	8915	UEGO pump cell slow to warm up
3227	5	154	EGO2 open / lazy
3256	5	140	EGO3 open / lazy
3266	5	160	EGO4 open / lazy
3468	3	188	Gaseous fuel temperature sender high voltage
3468	4	187	Gaseous fuel temperature sender low voltage

Table 3-12. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
3673	3	223	TPS2 voltage high
3673	4	222	TPS2 voltage low
4236	0	1151	Closed-loop LPG high
4236	0	1153	Closed-loop NG high
4236	0	1155	Closed-loop gasoline bank1 high
4236	1	1152	Closed-loop LPG low
4236	1	1154	Closed-loop NG low
4236	1	1156	Closed-loop gasoline bank1 low
4237	0	171	Adaptive-learn gasoline bank1 high
4237	0	1161	Adaptive-learn LPG high
4237	0	1163	Adaptive-learn NG high
4237	1	172	Adaptive-learn gasoline bank1 low
4237	1	1162	Adaptive-learn LPG low
4237	1	1164	Adaptive-learn NG low
4238	0	1157	Closed-loop gasoline bank2 high
4238	1	1158	Closed-loop gasoline bank2 low
4239	0	174	Adaptive-learn gasoline bank2 high
4239	1	175	Adaptive-learn gasoline bank2 low
520197	2	331	Knock2 excessive or erratic signal
520197	4	332	Knock2 sensor open or not present
520199	11	1122	FPP1/2 do not match each other or IVS (redundancy lost)
520199	11	2120	FPP1 invalid voltage and FPP2 disagrees with IVS (redundancy lost)
520199	11	2125	FPP1/2 do not match each other or IVS (redundancy lost)
520201	5	509	IAC coil open/short
520201	6	508	IAC ground short
520226	3	916	Shift actuator feedback out-of-range
520226	7	919	Shift unable to reach desired gear
520226	31	920	Shift actuator or drive circuit failed
520260	0	1171	MegaJector delivery pressure higher than expected
520260	1	1172	MegaJector delivery pressure lower than expected
520260	3	1174	MegaJector voltage supply high
520260	4	1175	MegaJector voltage supply low
520260	12	1176	MegaJector internal actuator fault detection
520260	12	1177	MegaJector internal circuitry fault detection
520260	12	1178	MegaJector internal comm fault detection
520260	31	1173	MegaJector comm lost
520401	0	1182	Fuel impurity level high
520800	7	11	Intake cam / distributor position error
520801	7	24	Exhaust cam position error
520803	31	1183	MegaJector autozero / lockoff failure

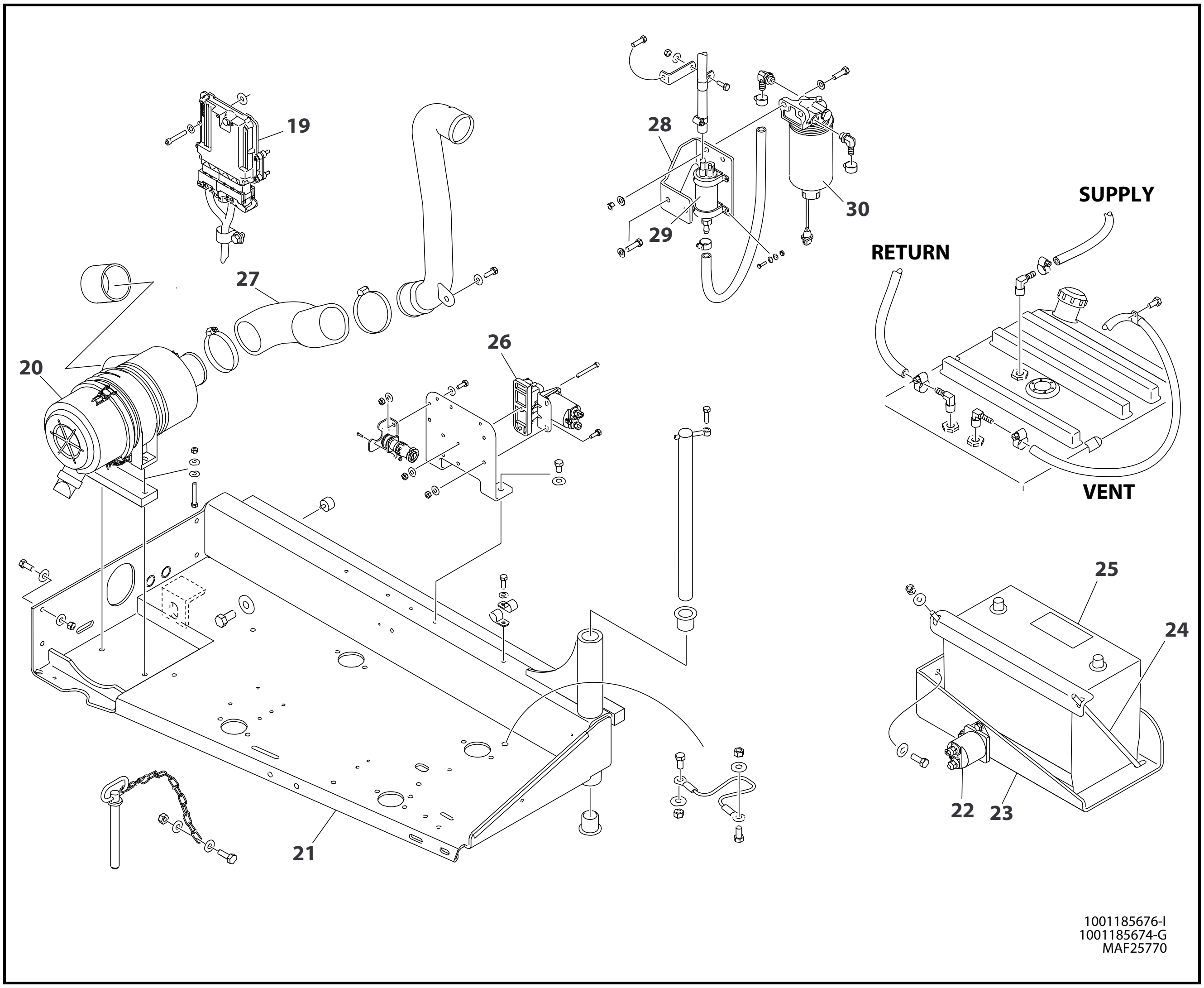
NOTE: *For detail Diagnostic Trouble Code of Ford Engine refer DTC manual (PN 3128850).*

3.21 DEUTZ TD2.9L4 T4F



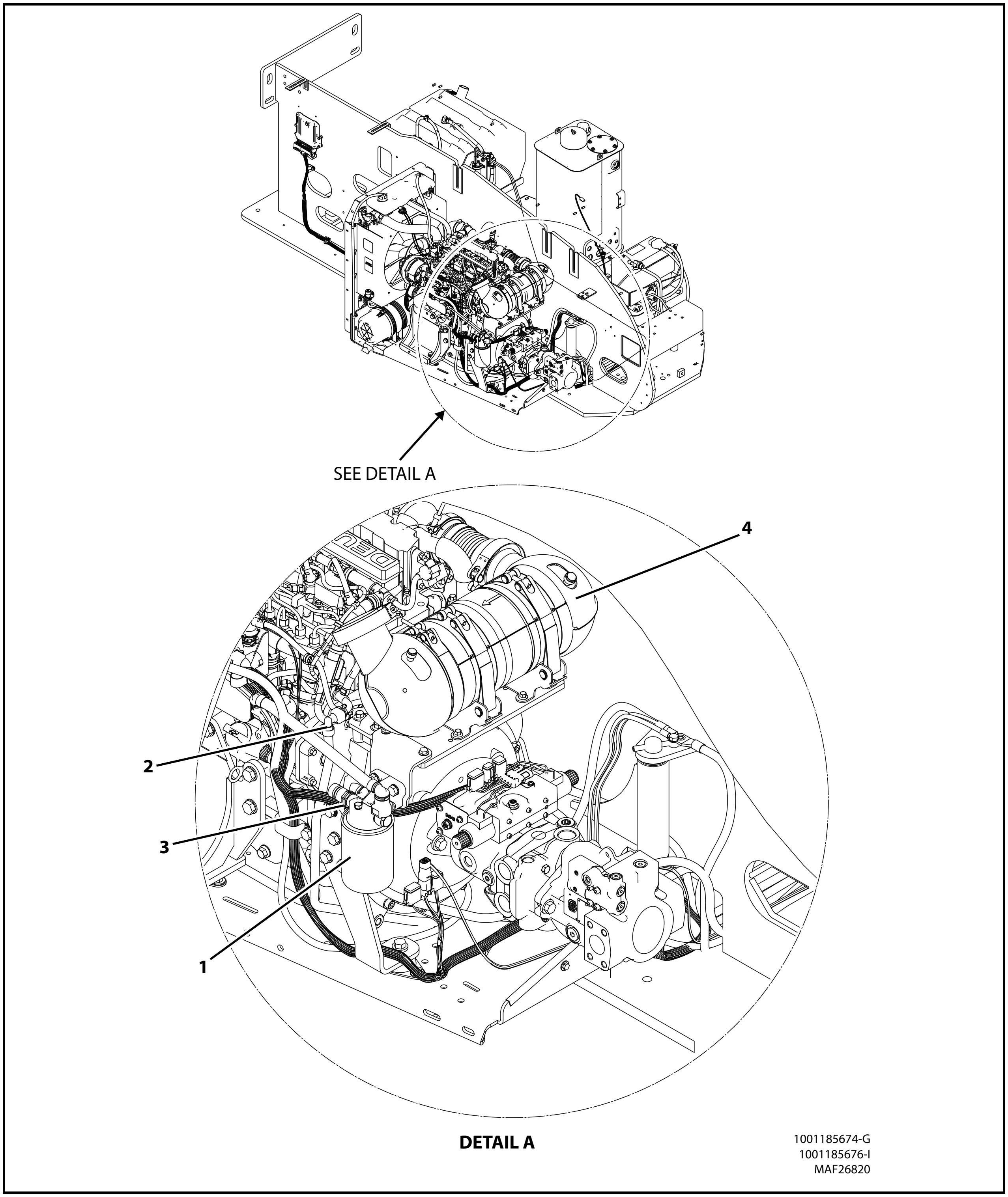
1. Fan	7. Rear Engine Mount	13. Fuel Filter
2. Fuel Injector	8. Coupling	14. Front Engine/Generator Mount
3. Turbocharger	9. Pump Adapter Plate	15. Oil Cooler
4. Front Engine Mount	10. Pump Assembly	16. Oil Filter
5. Motor Mount	11. Gear Pump Assembly	17. Alternator
6. Muffler	12. Flywheel	18. Pulley

Figure 3-84. Deutz TD2.9L4 T4F Engine Components - Sheet 1 of 2



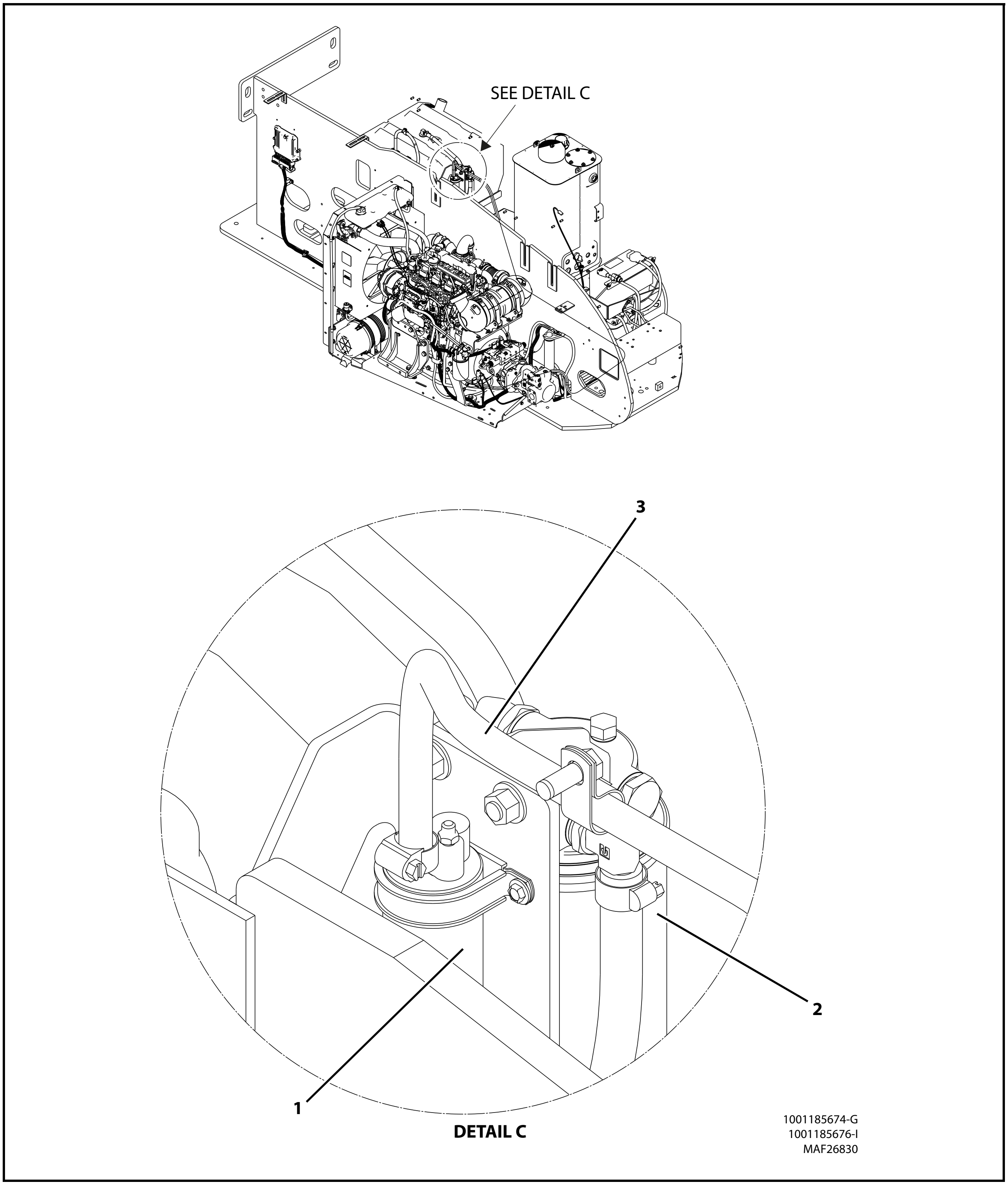
19. Engine Control Unit
20. Air Cleaner Assembly
21. Tray
22. Relay
23. Battery Bracket
24. Battery Hold-down
25. Battery
26. Power Module Relay
27. Intake Pipe
28. Fuel Pump Mount Plate
29. Fuel Pump
30. Fuel Filter

Figure 3-85. Deutz TD2.9L4 T4F Engine Components - Sheet 2 of 2



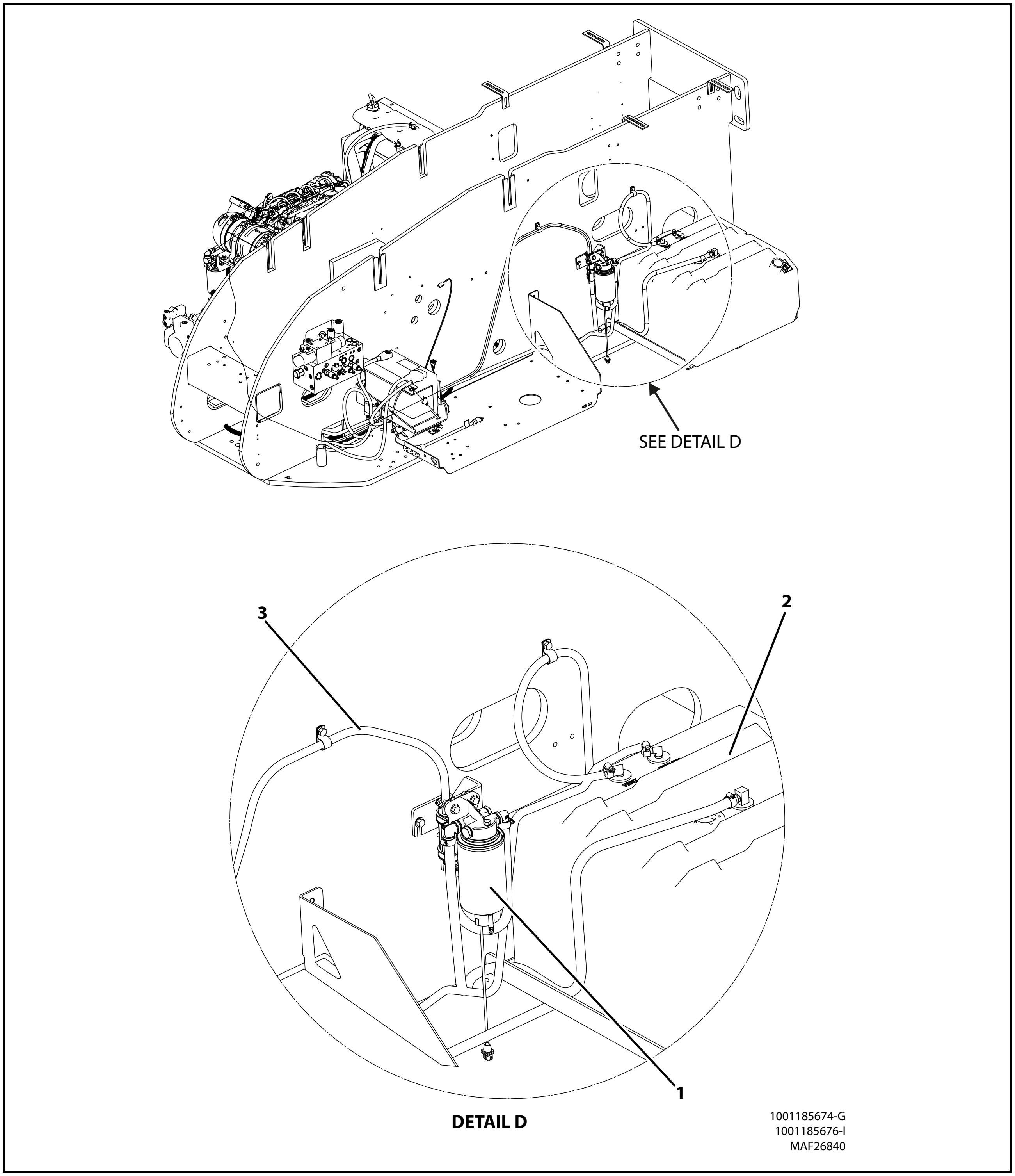
1. Fuel Filter
2. Return Fuel Line
3. Supply Line End
4. Air Cleaner Assembly

Figure 3-86. Deutz TD2.9L4 T4F Engine Installation - Sheet 1 of 7



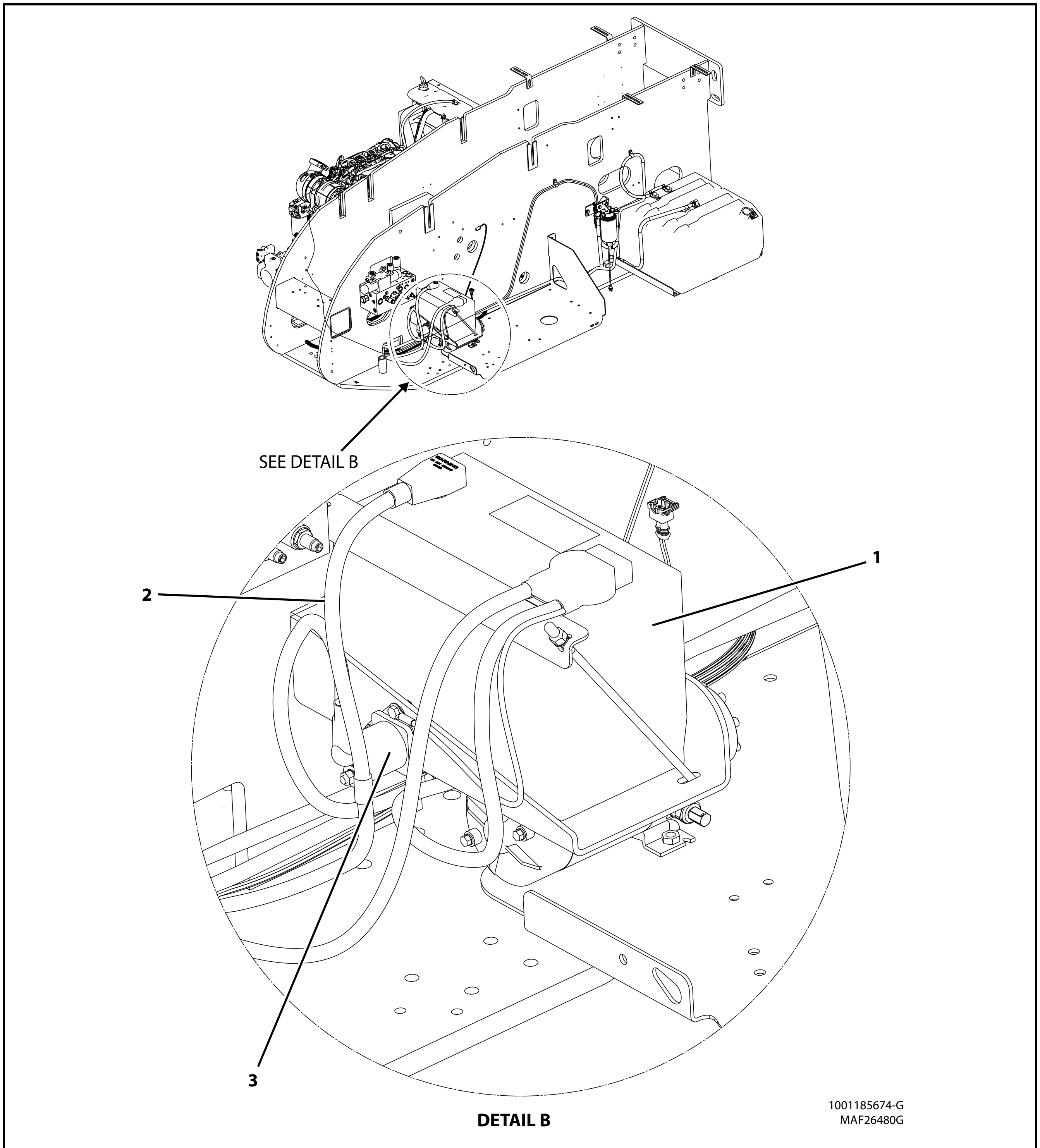
1. Fuel Pump
2. Fuel Filter
3. Supply Line

Figure 3-87. Deutz TD2.9L4 T4F Engine Installation - Sheet 2 of 7



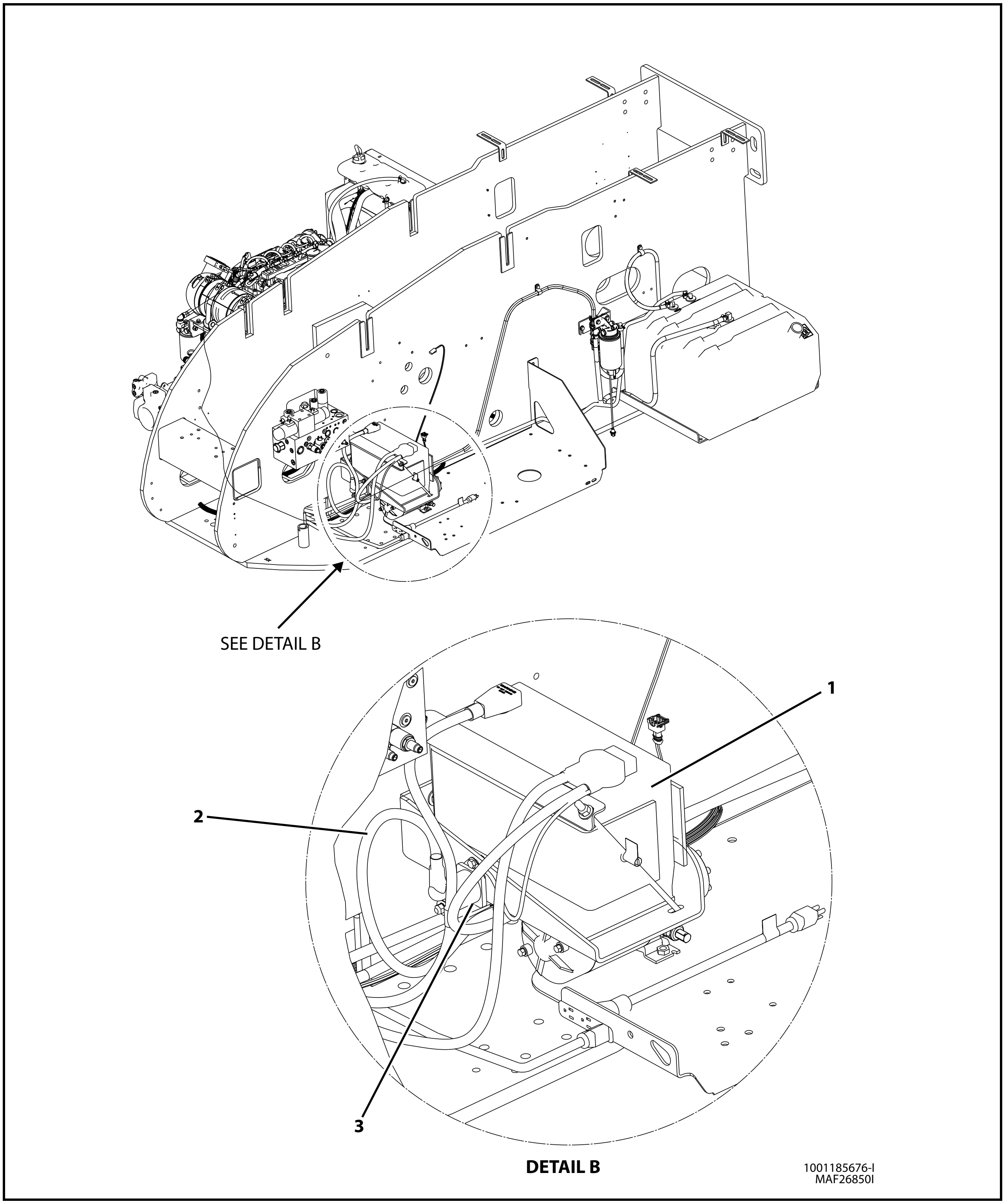
1. Fuel Filter
2. Fuel Tank
3. Supply Line

Figure 3-88. Deutz TD2.9L4 T4F Engine Installation - Sheet 3 of 7



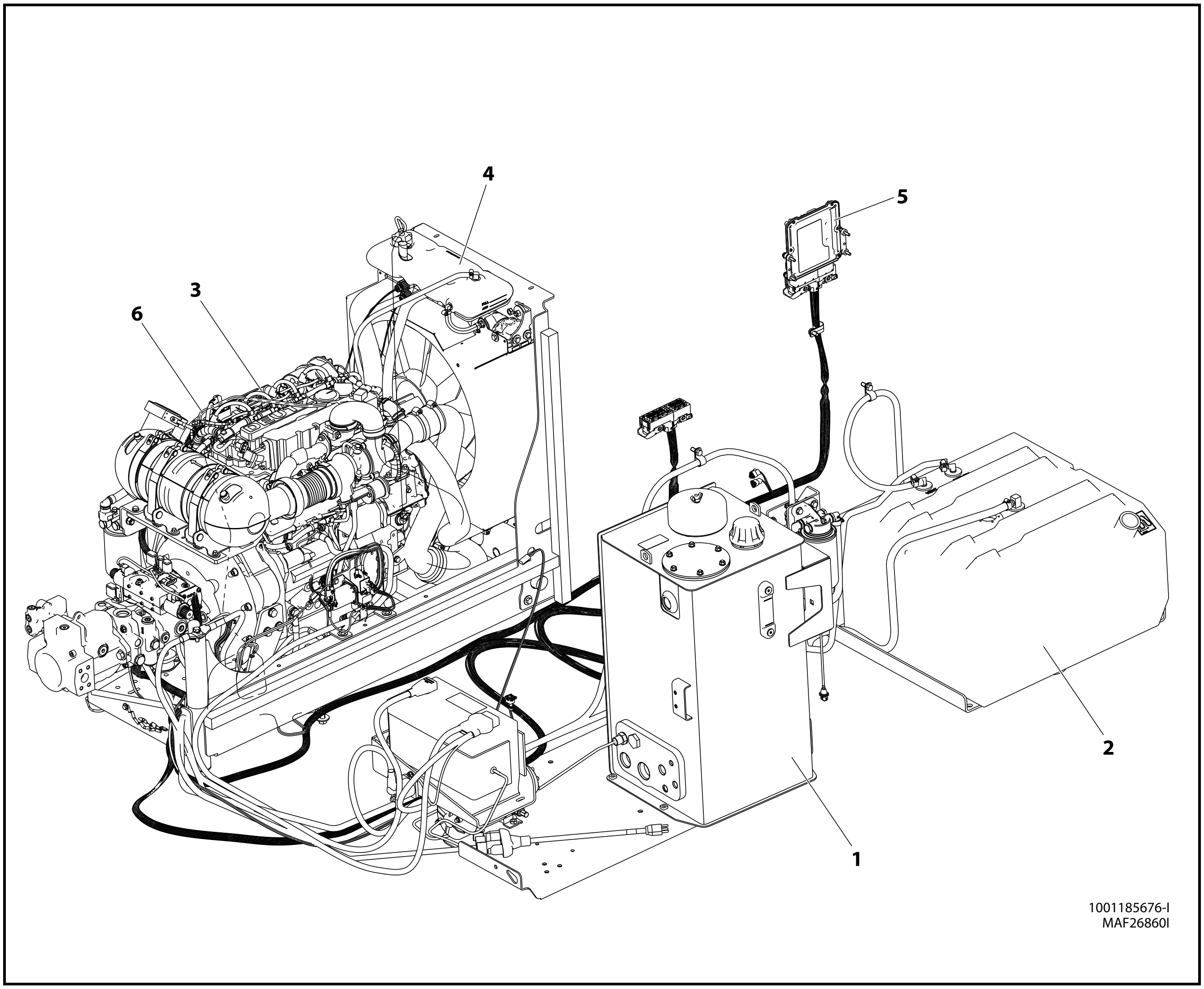
1. Battery
2. Battery Cable
3. Relay

Figure 3-89. Deutz TD2.9L4 T4F Engine Installation - Sheet 4 of 7



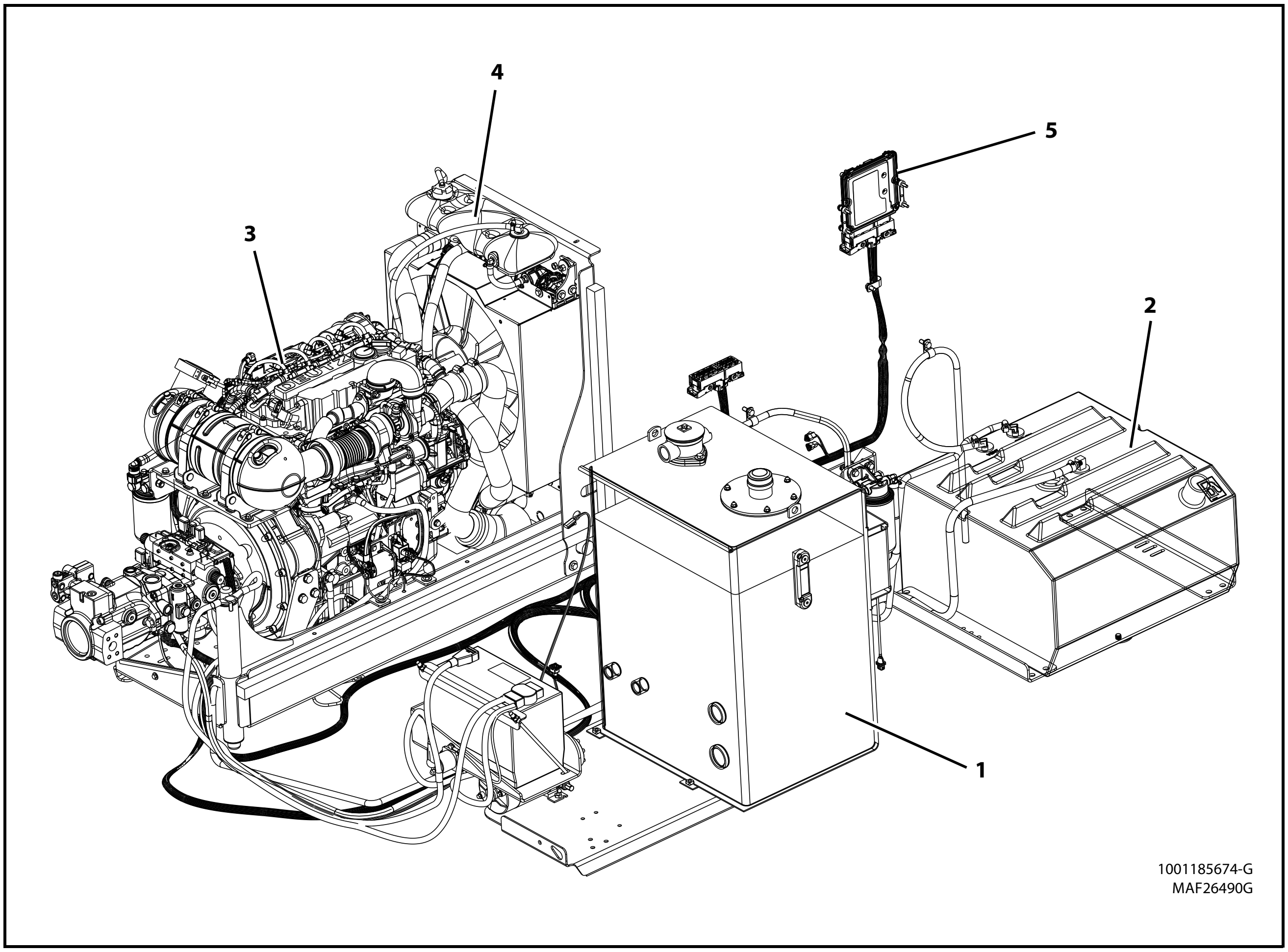
1. Battery
2. Battery Cable
3. Relay

Figure 3-90. Deutz TD2.9L4 T4F Engine Installation - Sheet 5 of 7



1. Hydraulic Tank
2. Fuel Tank
3. Engine
4. Tank Surge Assembly
5. Control Module
6. Breather Heater

Figure 3-91. Deutz TD2.9L4 T4F Engine Installation - Sheet 6 of 7



1. Hydraulic Tank
2. Fuel Tank
3. Engine
4. Tank Surge Assembly
5. Control Module

Figure 3-92. Deutz TD2.9L4 T4F Engine Installation - Sheet 7 of 7

3.22 DEUTZ TD 2.9 L4 STAGE V ENGINE

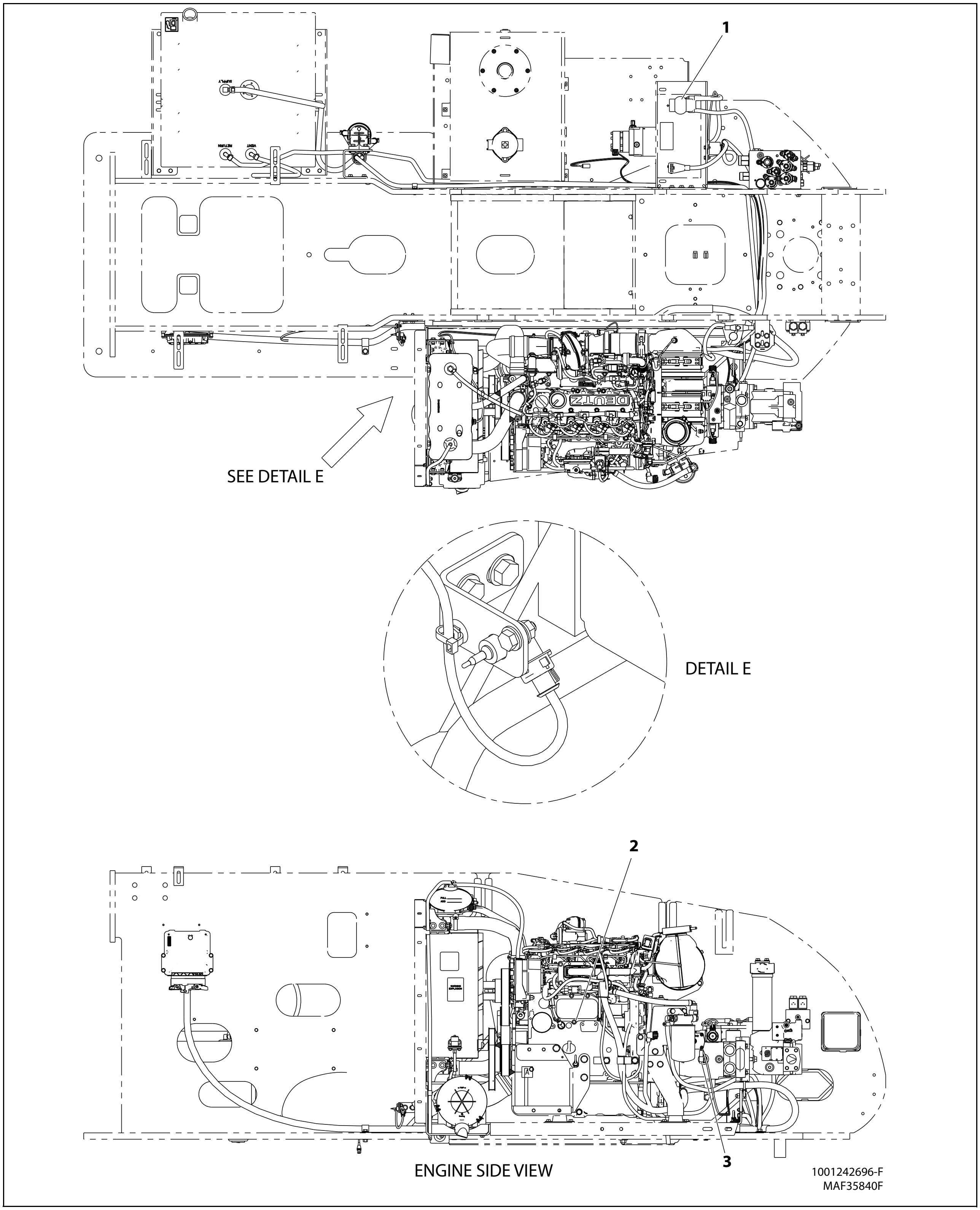


Figure 3-93. Deutz TD2.9 L4 Stage V Engine Installation - Sheet 1 of 5

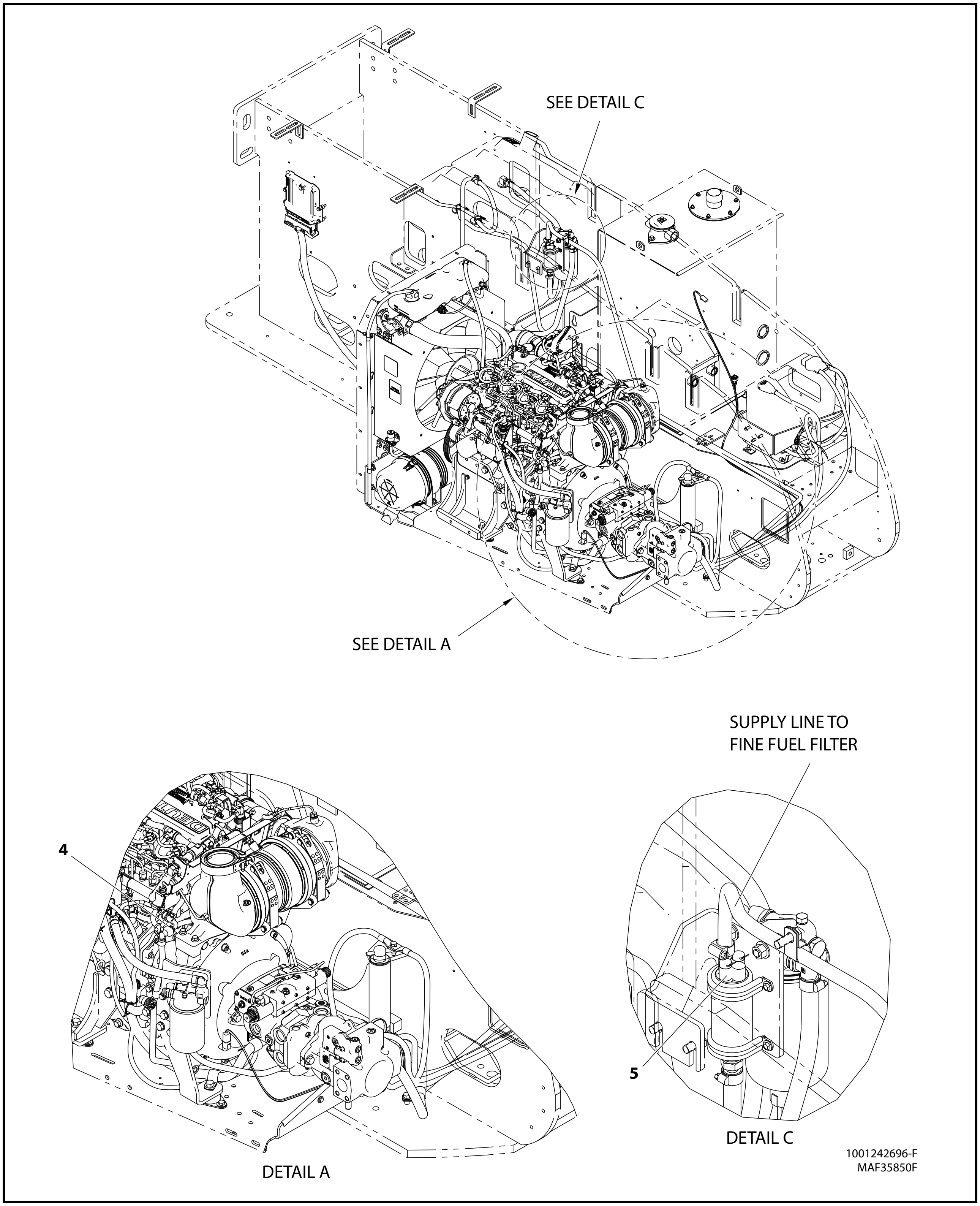


Figure 3-94. Deutz TD2.9 L4 Stage V Engine Installation - Sheet 2 of 5

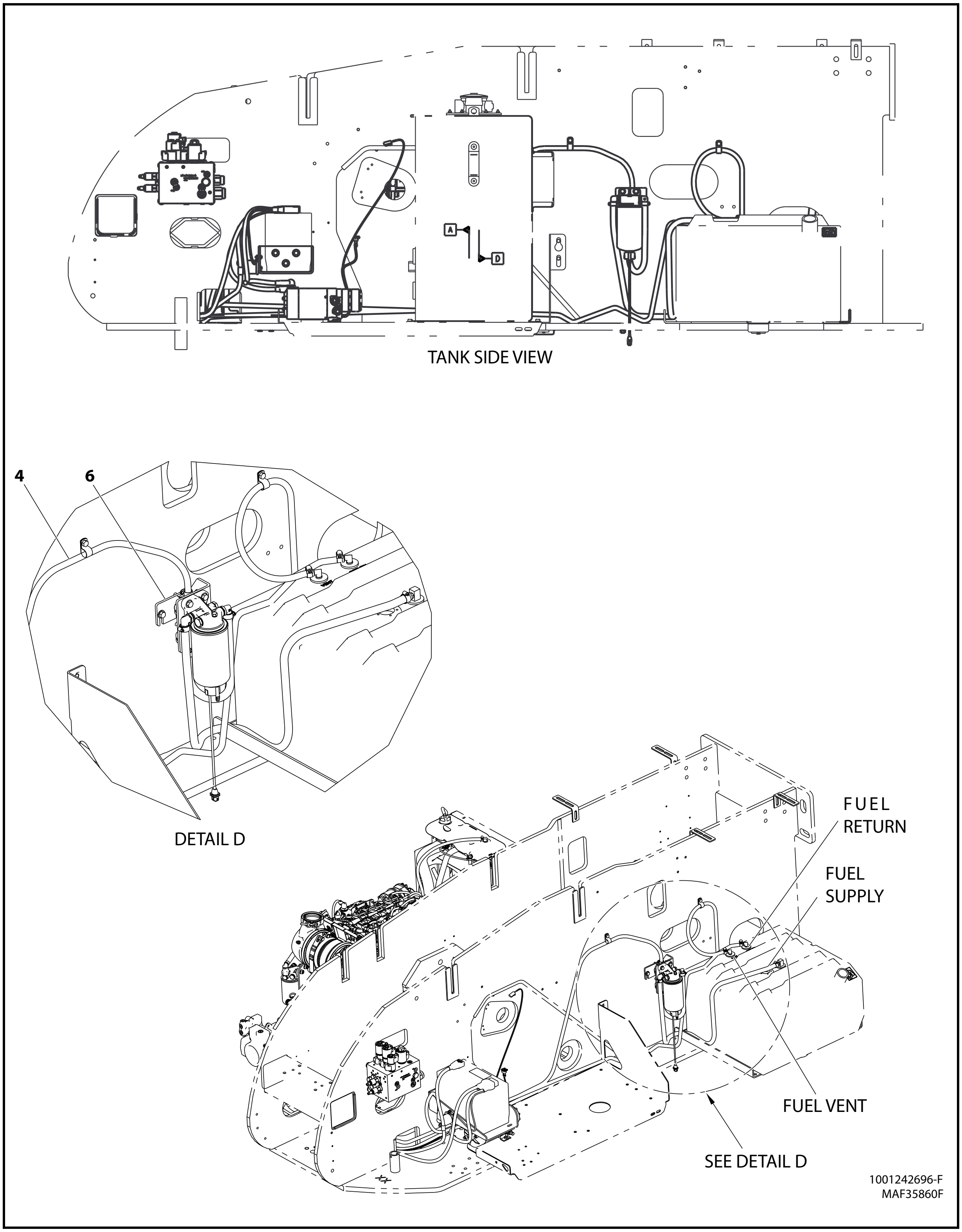


Figure 3-95. Deutz TD2.9 L4 Stage V Engine Installation - Sheet 3 of 5

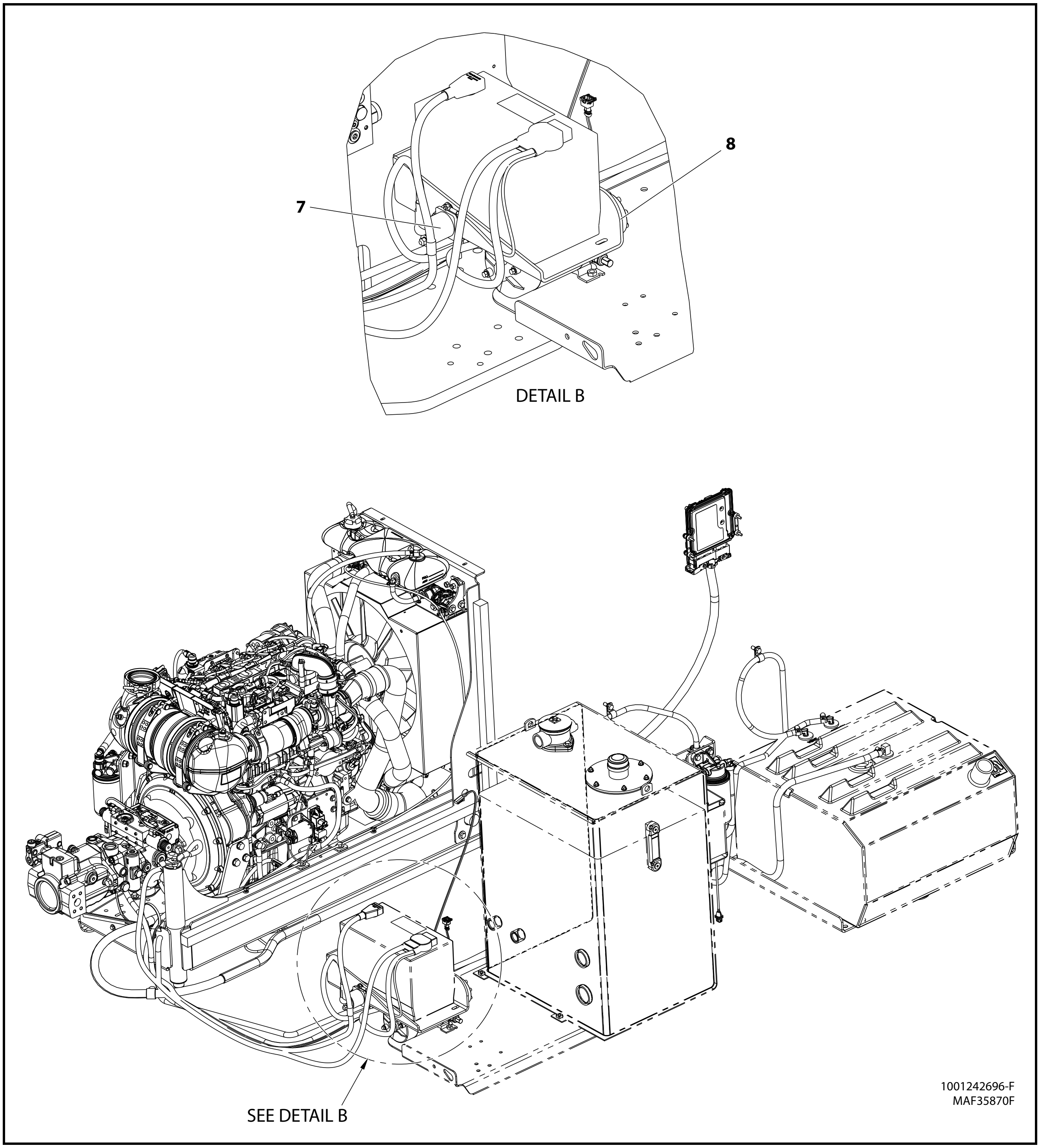
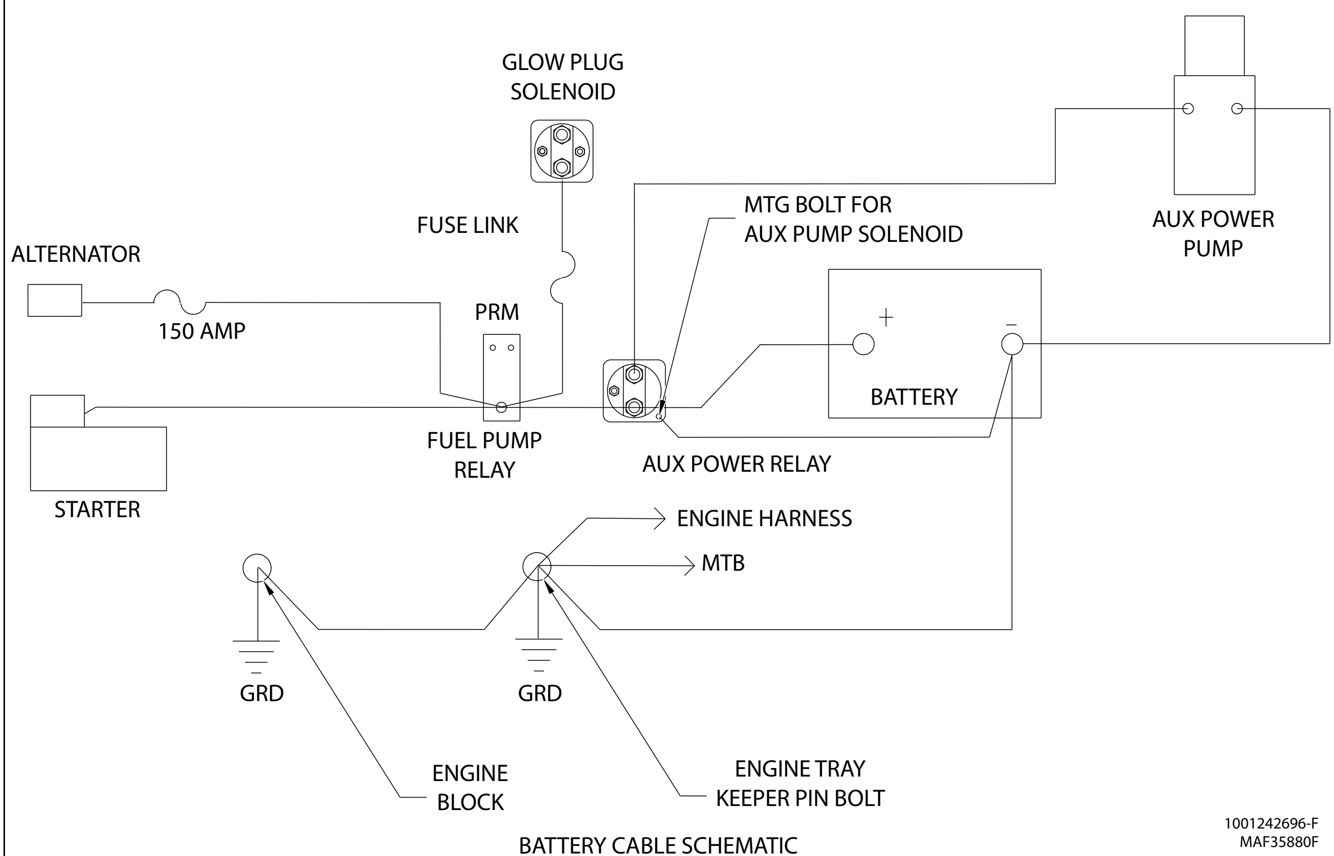


Figure 3-96. Deutz TD2.9 L4 Stage V Engine Installation - Sheet 4 of 5



1. Battery Cable Kit
2. Deutz Stage V Engine with Pumps
3. Deutz Engine Fuel Harness
4. Fuel Hose
5. Gear Clamp
6. Fuel Pump Bracket
7. Solenoid Assembly Relay
8. Battery Bracket

Figure 3-97. Deutz TD2.9 L4 Stage V Engine Installation - Sheet 5 of 5

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

Check Oil Level

1. Make sure machine and engine are level and switch engine OFF before checking oil level.
2. Remove oil dipstick and wipe with clean cloth.
3. Insert dipstick to the stop and remove again.
4. Check oil level. Top oil level as shown in figure below with an approved grade and type of oil outlined in engine manufacturer's operator's manual.

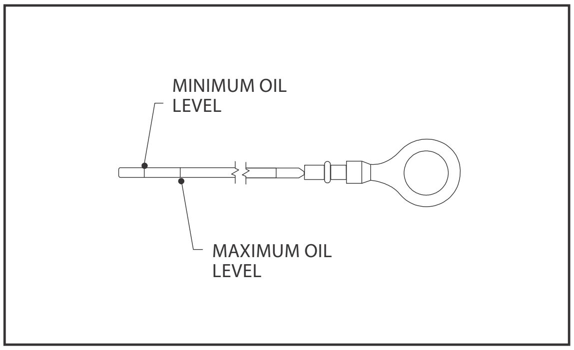


Figure 3-98. Deutz 2.9 Dipstick Markings

5. Replace dipstick until fully seated.

Change Engine Oil

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

CAUTION

HOT ENGINE OIL CAN CAUSE BURNS. AVOID CONTACT WITH HOT OIL WHEN DRAINING.

NOTICE

COLLECT USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.

5. Open oil drain valve and drain oil.
6. Close oil drain valve.
7. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-99., Engine Oil Viscosity.

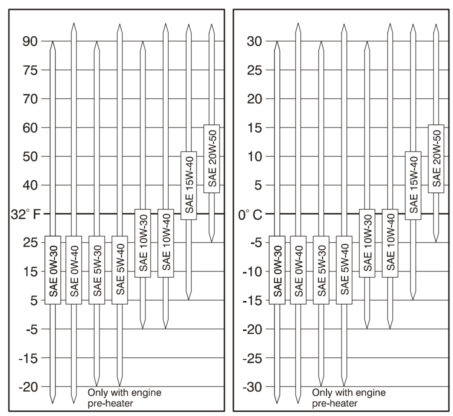
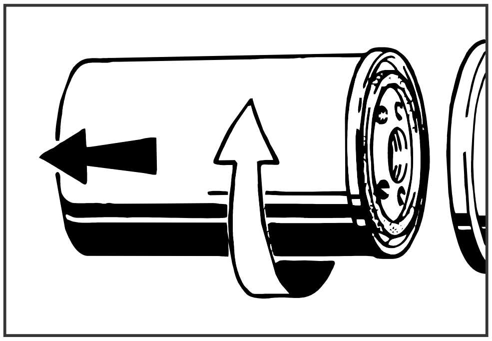


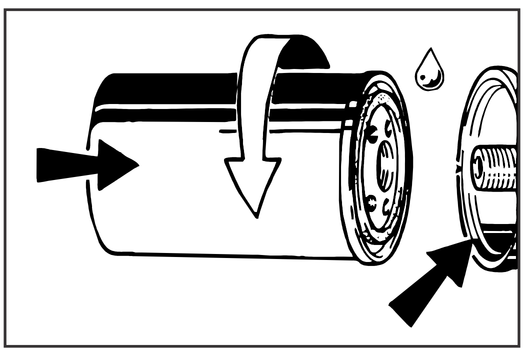
Figure 3-99. Engine Oil Viscosity

Change Oil Filter

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



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil
6. Screw in new filter by hand until gasket is flush.
7. Hand-tighten filter another half-turn.



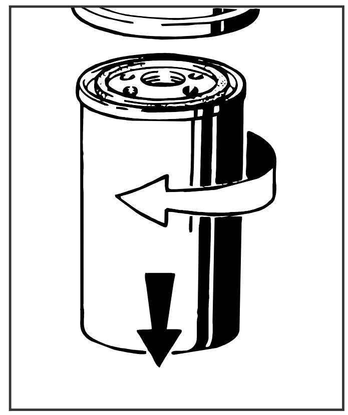
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

Change Fuel Filters

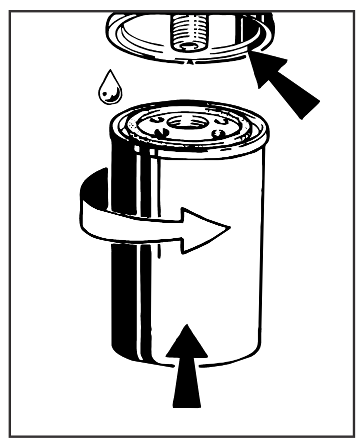
⚠ WARNING

FUEL IS FLAMMABLE AND CAN CAUSE DEATH OR SERIOUS INJURY. MAKE SURE NO OPEN FLAMES OR SPARKS ARE IN THE AREA WHEN WORKING ON FUEL SYSTEM. DO NOT SMOKE WHEN WORKING ON THE FUEL SYSTEMS.

1. Wipe area around filter to clean any dirt from area.
2. Disconnect water sensor connector (Pre-filter Only).
3. Remove fuel filter cartridge. Catch any escaping fuel.



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



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

3.23 DEUTZ D2011L04 ENGINE

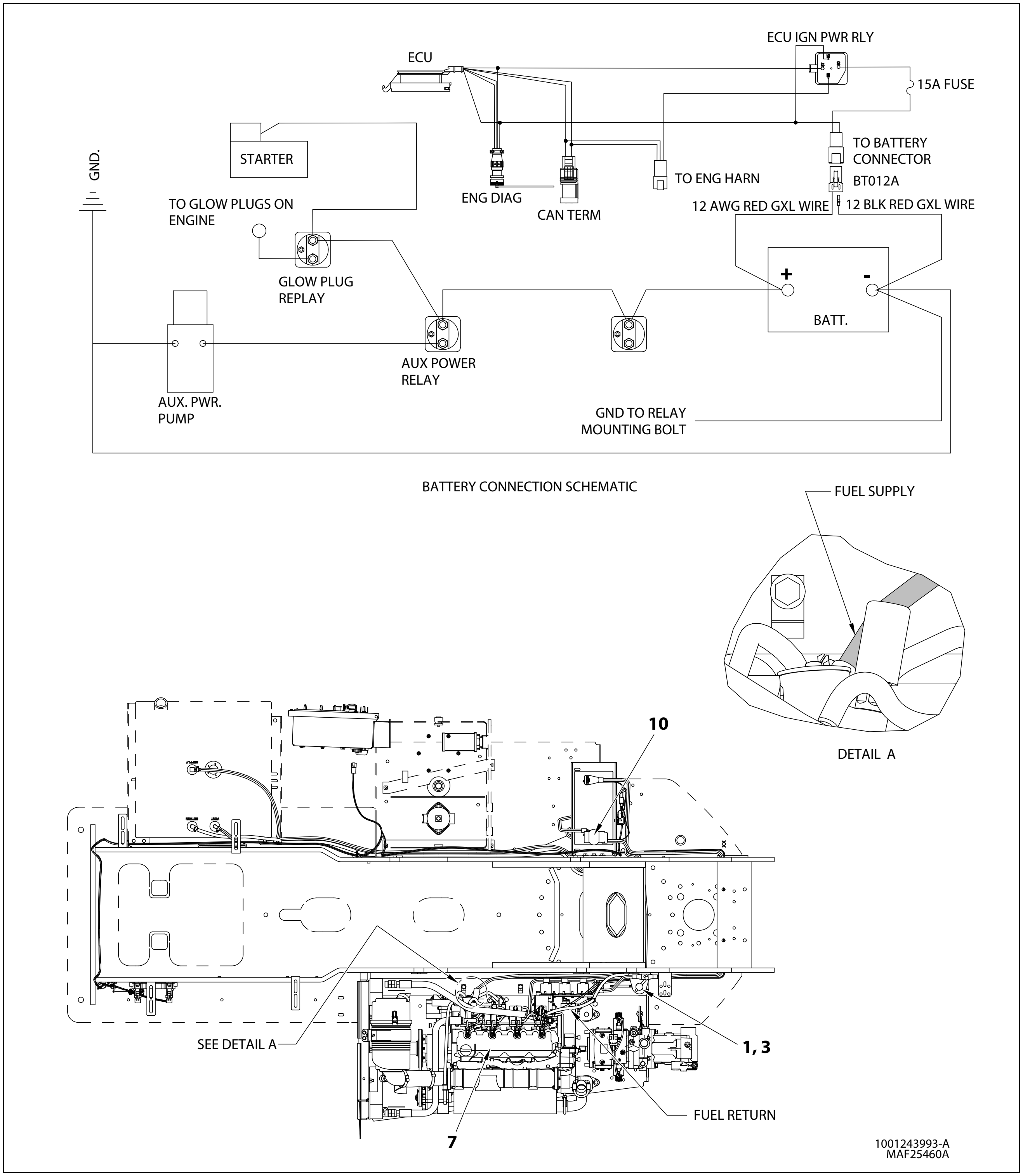


Figure 3-100. Deutz D2011LO4 Engine Installation (860SJ) - Sheet 1 of 4

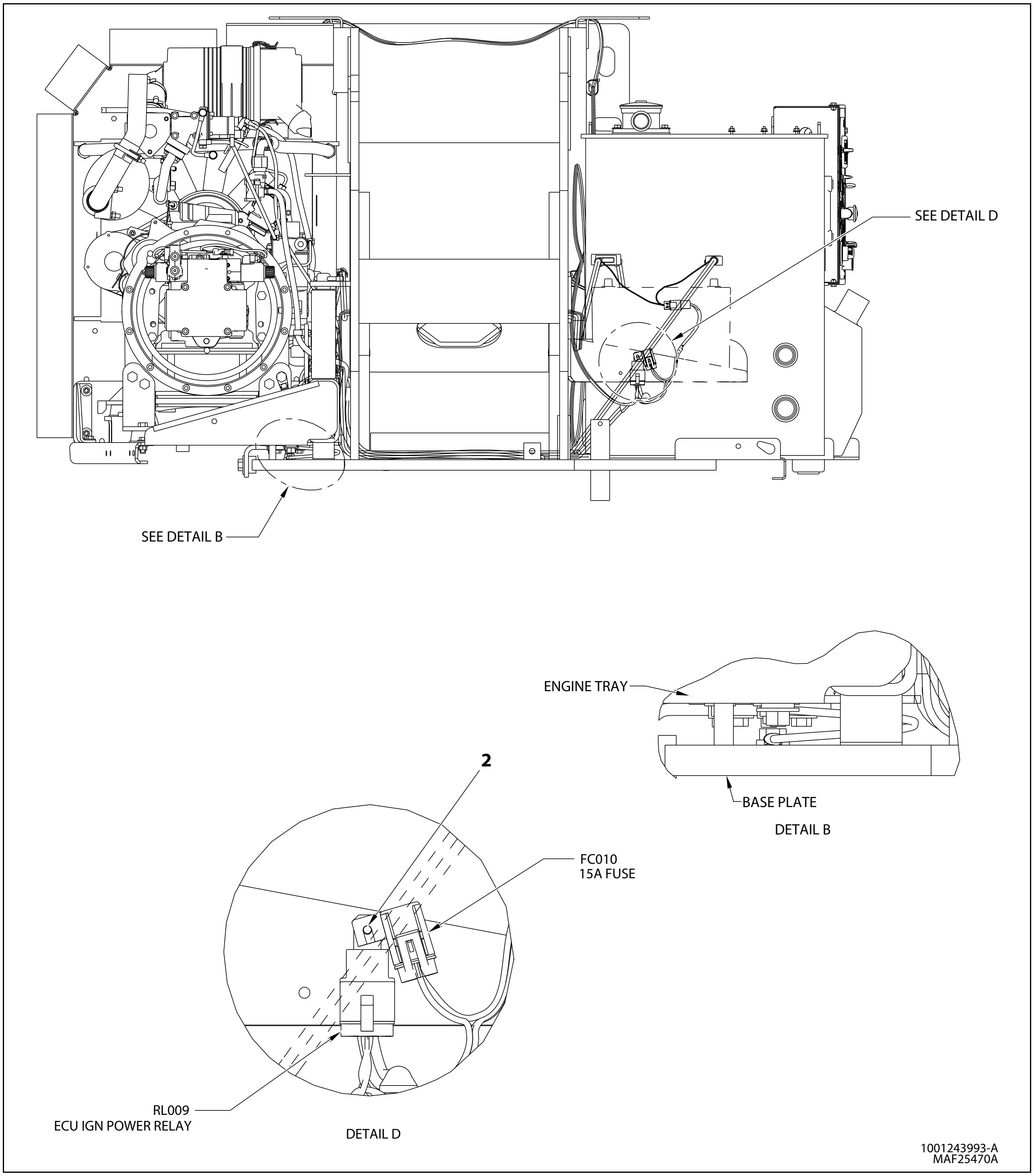


Figure 3-101. Deutz D2011LO4 Engine Installation (860SJ) - Sheet 2 of 4

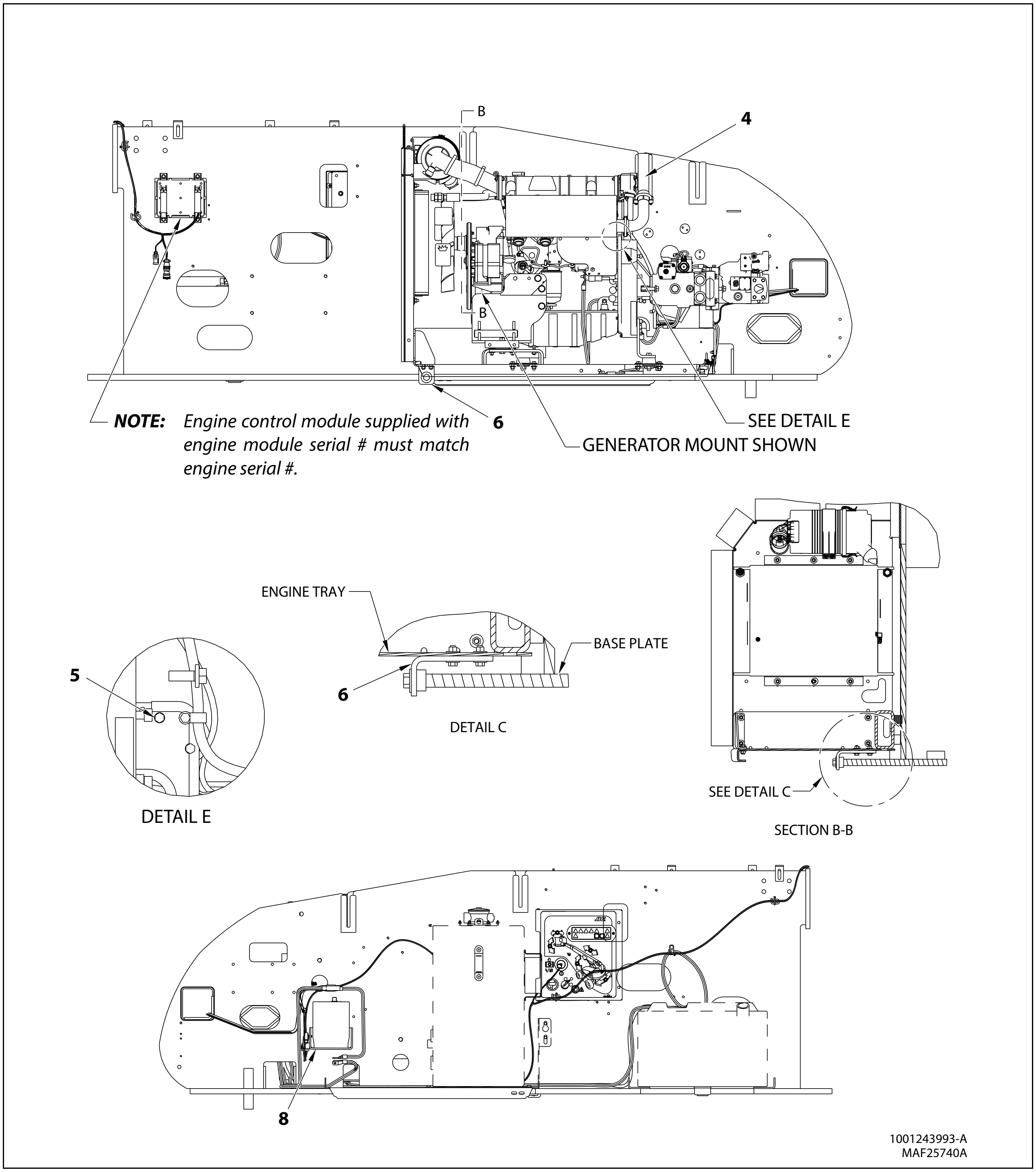
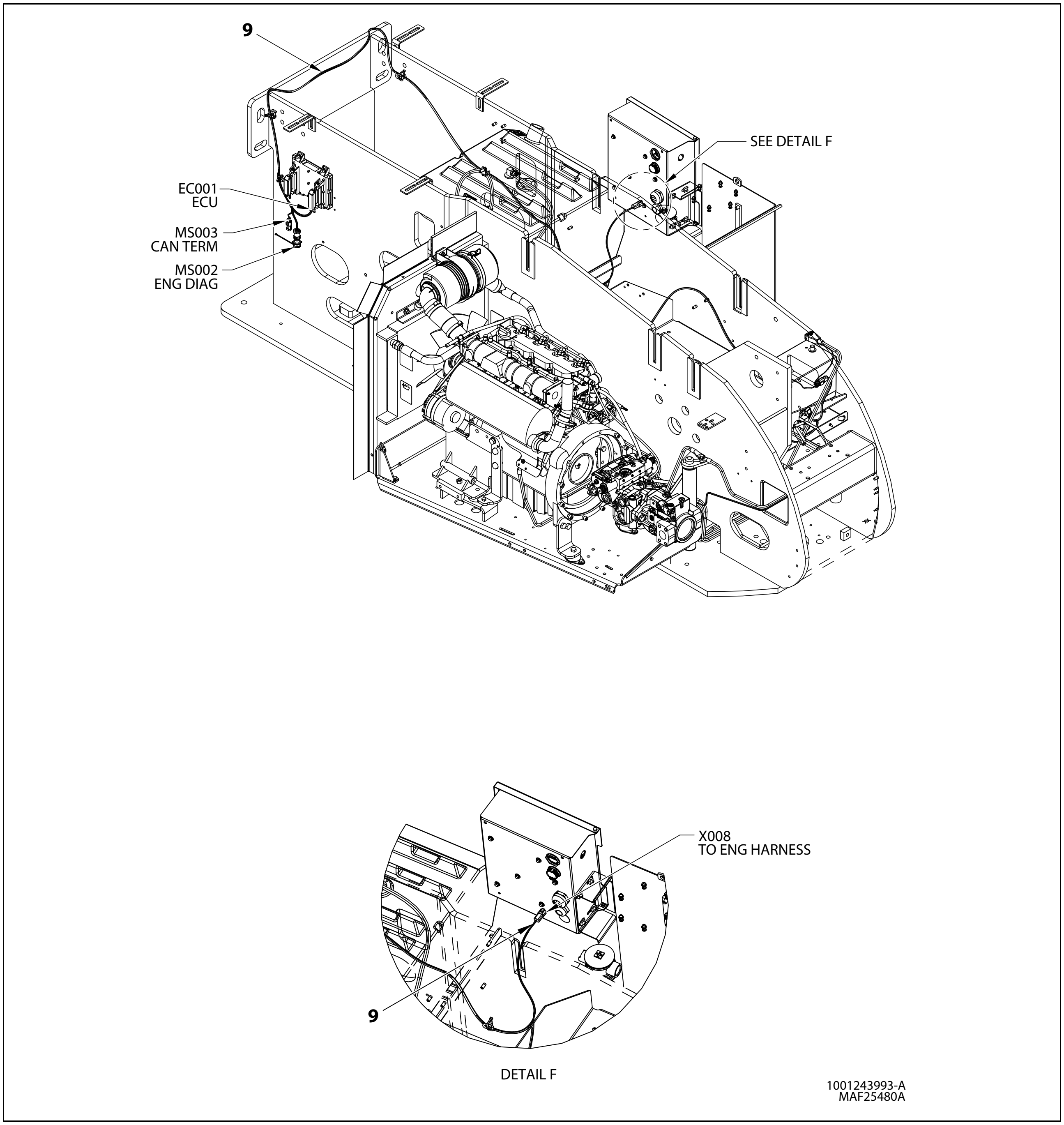


Figure 3-102. Deutz D2011LO4 Engine Installation (860SJ) - Sheet 3 of 4



1. Engine Tray Pin
2. Weather Proof Relay
3. Shaft Keeper
4. Exhaust Tube
5. Worklight Spacer
6. Tray Hold Plate
7. Deutz T4I Engine
8. Battery Bracket
9. ECU Jumper Harness
10. Battery Cable Kit

Figure 3-103. Deutz D2011LO4 Engine Installation (860SJ) - Sheet 4 of 4

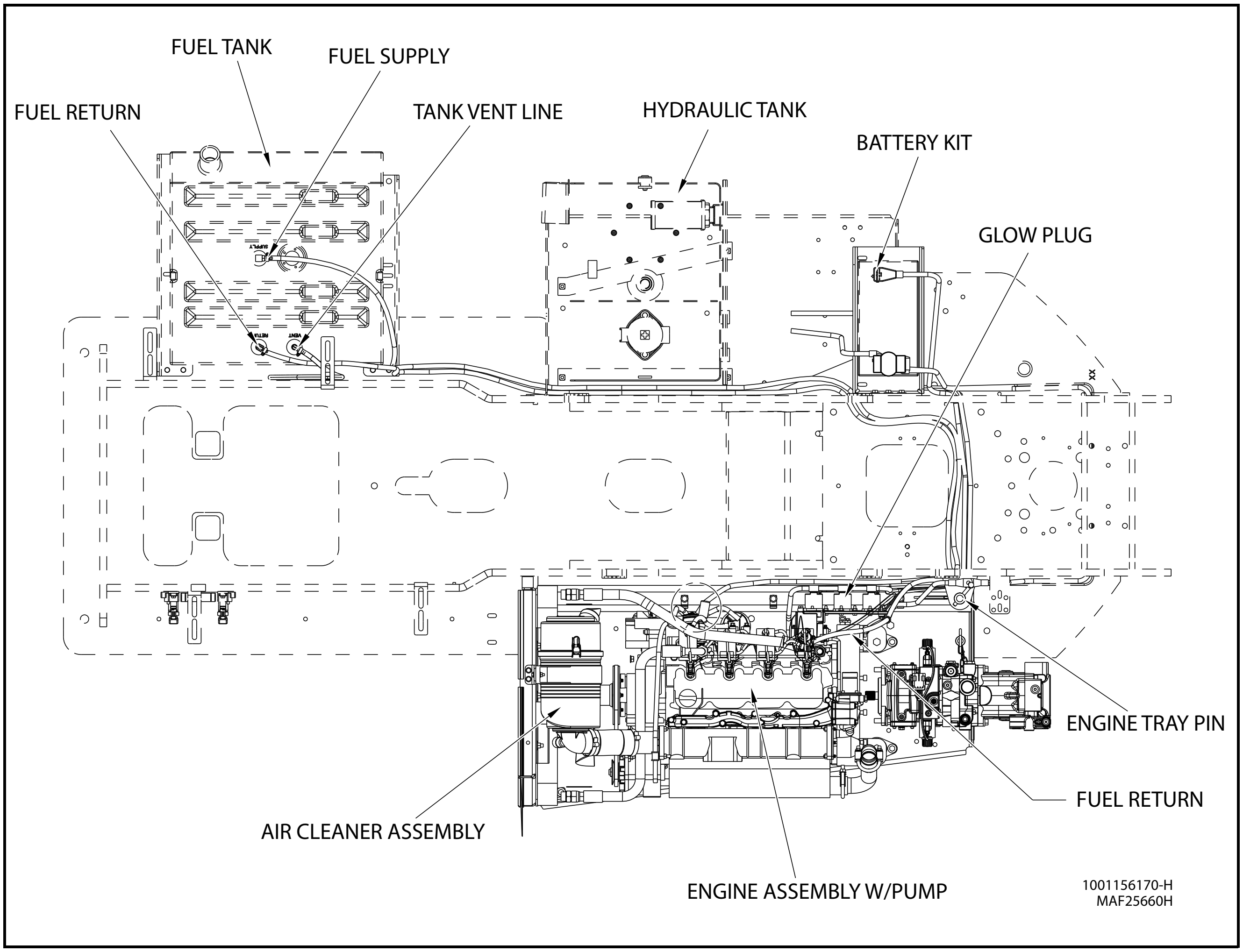


Figure 3-104. Deutz D2011 (T4I) Engine Installation (Without Arctic Package) - Sheet 1 of 2

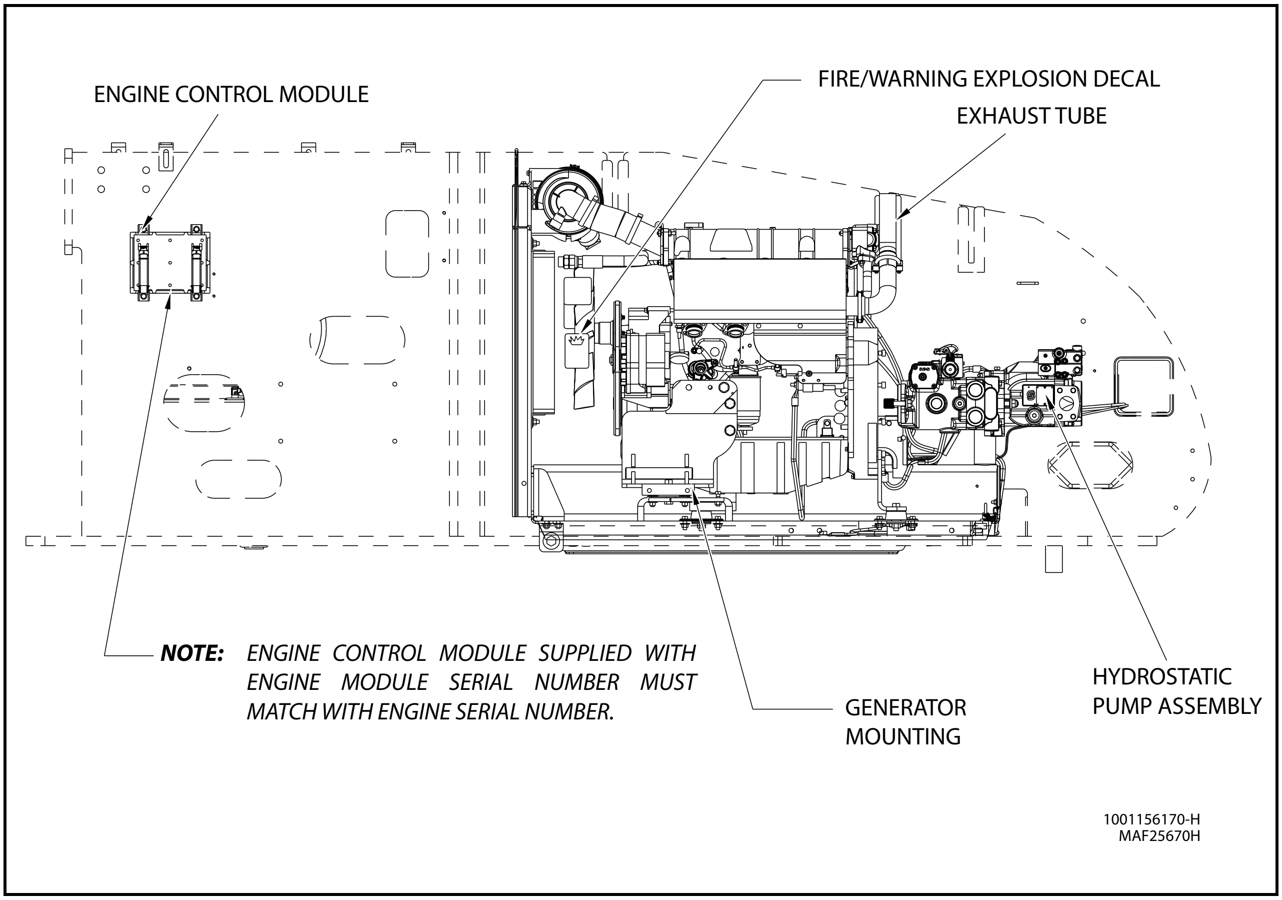


Figure 3-105. Deutz D2011 (T4I) Engine Installation (Without Arctic Package) - Sheet 2 of 2

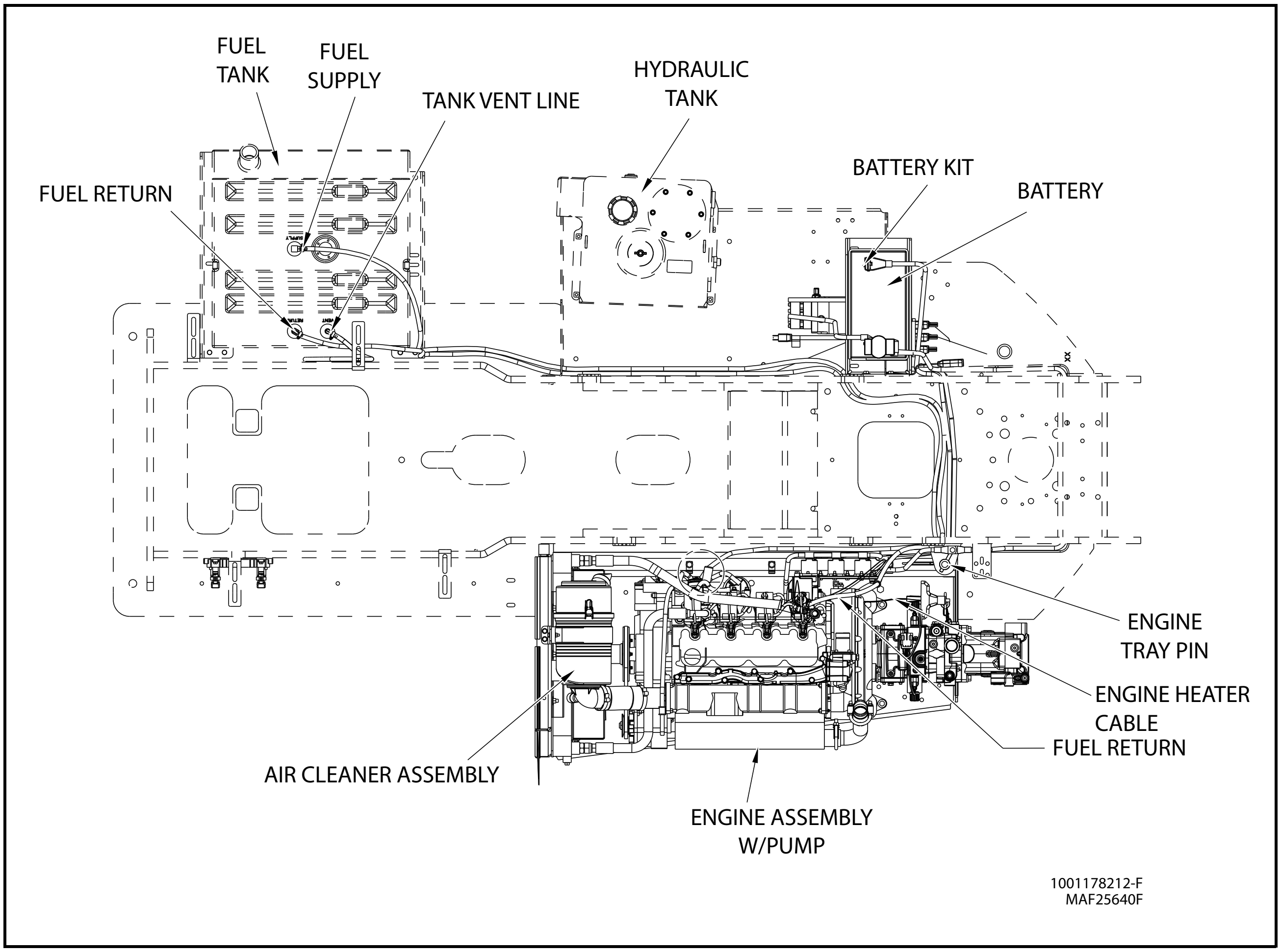


Figure 3-106. Deutz D2011 (T4I) Engine Installation (With Arctic Package) - Sheet 1 of 2

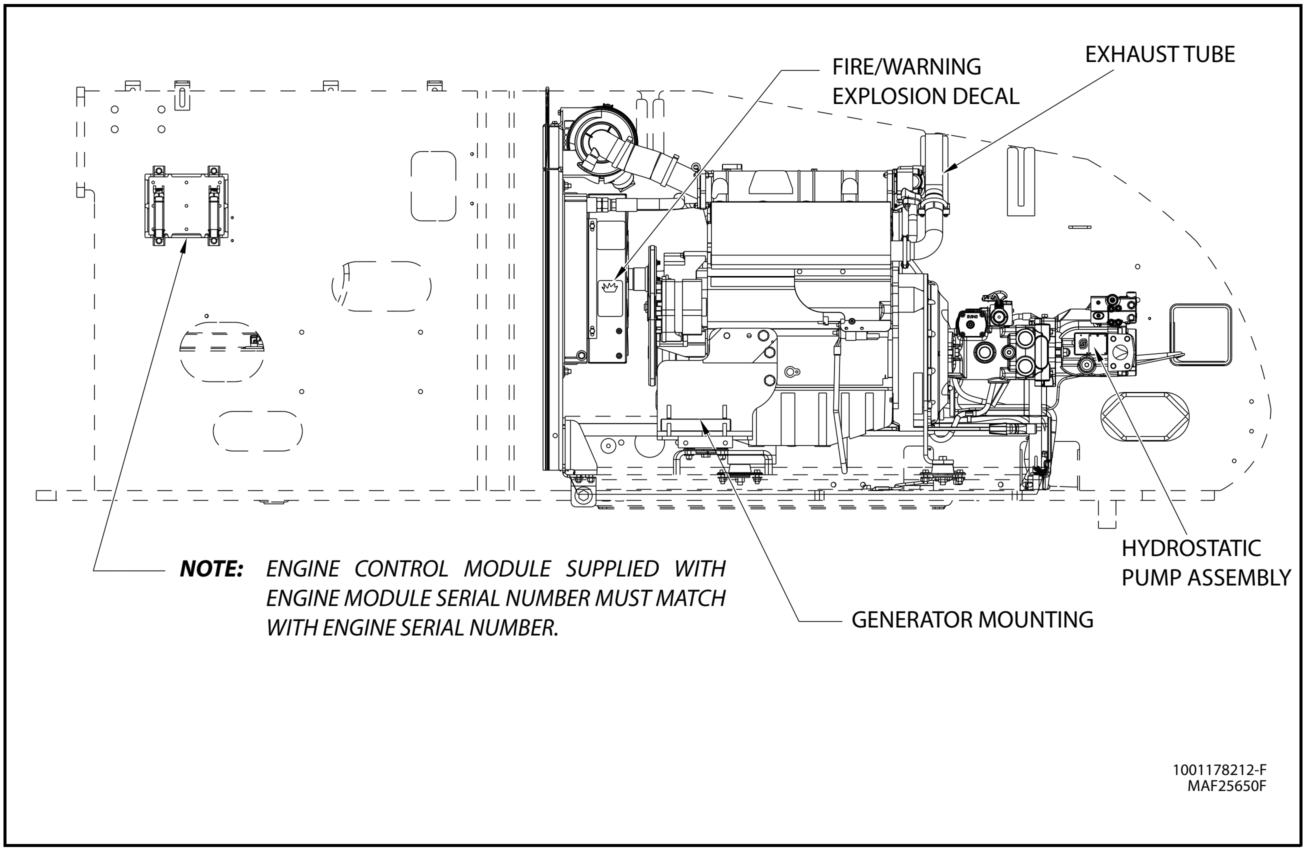


Figure 3-107. Deutz D2011 (T4I) Engine Installation (With Arctic Package) - Sheet 2 of 2

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

Checking Oil Level

1. Make sure machine and engine are level and switch engine OFF before checking oil level.
2. Remove oil dipstick and wipe with clean cloth.
3. Insert dipstick to the stop and remove again.
4. Check oil level. Top oil level as shown in figure below with an approved grade and type of oil outlined in engine manufacturer's operator's manual.

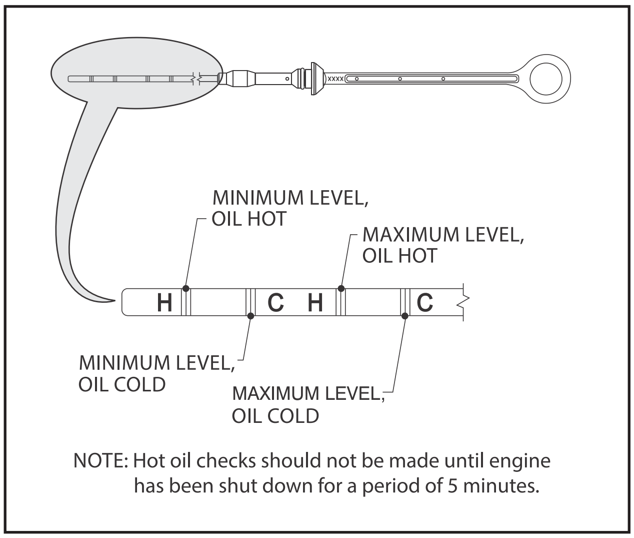


Figure 3-108. Deutz Dipstick Markings

5. Replace dipstick until fully seated.

Changing Engine Oil

1. Allow engine to warm up. Engine oil should reach approximately 176° F (80° C).
2. Make sure machine and engine are level and switch off engine.
3. Place oil tray under engine.

CAUTION

HOT ENGINE OIL CAN CAUSE BURNS. AVOID CONTACT WITH HOT OIL WHEN DRAINING.

NOTICE

COLLECT USED OIL IN A CONTAINER SUITABLE FOR DISPOSAL OR RECYCLING. DISPOSE OF USED ENGINE OIL IN ACCORDANCE WITH ENVIRONMENTAL REGULATIONS.

4. Open oil drain valve and drain oil.
5. Close oil drain valve.
6. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-109., Engine Oil Viscosity.

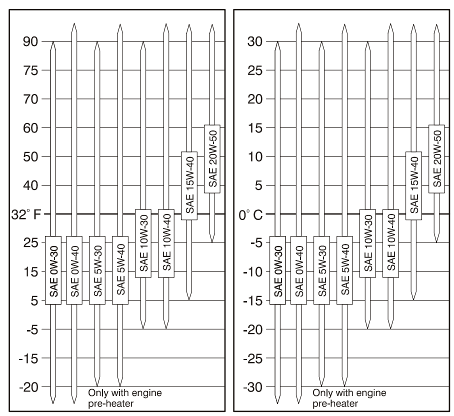
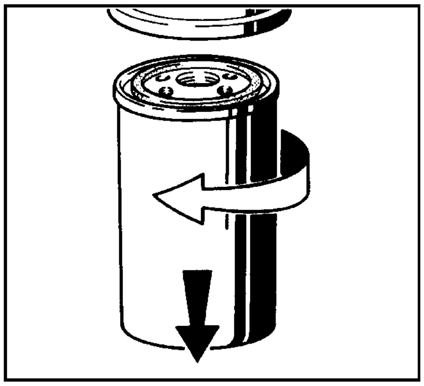


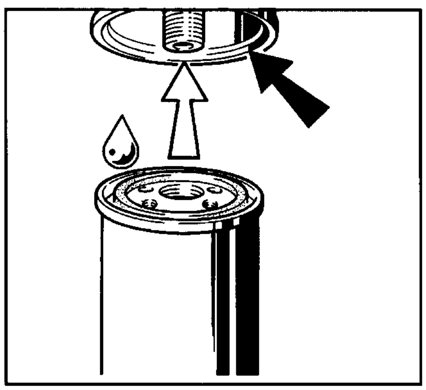
Figure 3-109. Engine Oil Viscosity

Changing Oil Filter

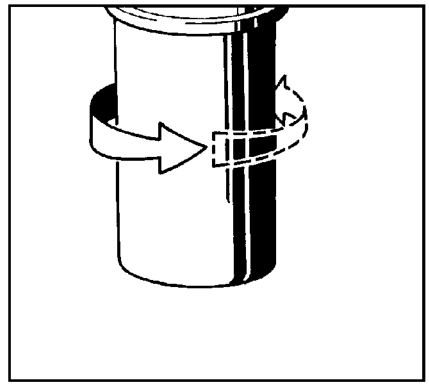
1. Wipe area around filter to clean any dirt from area.
2. Using a suitable oil filter removal tool, loosen lube oil filter cartridge and spin off.



3. Catch any escaping oil.
4. Clean any dirt from filter carrier sealing surface.
5. Lightly coat new oil filter rubber gasket with clean oil.



6. Screw in new filter by hand until gasket is flush.



7. Hand-tighten filter another half-turn.
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

Replace Fuel Filter

⚠ WARNING

FUEL IS FLAMMABLE AND CAN CAUSE DEATH OR SERIOUS INJURY. MAKE SURE NO OPEN FLAMES OR SPARKS ARE IN THE AREA WHEN WORKING ON FUEL SYSTEM. DO NOT SMOKE WHEN WORKING ON FUEL SYSTEM.

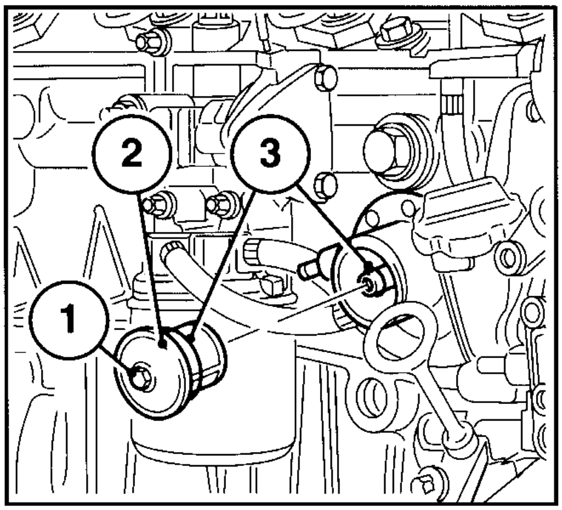
1. Wipe area around filter to clean any dirt from area.
2. Remove fuel filter cartridge. Catch any escaping fuel.
3. Clean dirt from filter carrier sealing surface.
4. Apply light film of oil or diesel fuel to rubber gasket of new filter cartridge.
5. Screw in new filter by hand until gasket is flush. Hand-tighten filter another half-turn.
6. Open fuel shut-off valve.
7. Check for leaks.

Clean Fuel Strainer

WARNING

FUEL IS FLAMMABLE AND CAN CAUSE DEATH OR SERIOUS INJURY. MAKE SURE NO OPEN FLAMES OR SPARKS ARE IN THE AREA WHEN WORKING ON FUEL SYSTEM. DO NOT SMOKE WHEN WORKING ON FUEL SYSTEM.

1. Unscrew hexagonal nut (1).



2. Remove fuel strainer cover (2).
3. Clean fuel strainer with diesel fuel and replace as needed.
4. Place seal (3) in position.
5. Install fuel strainer cover (2). Tighten screw (1).
6. Check for leaks.

Spark Arrester Cleaning Instructions

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

Glow Plugs

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

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

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

3.24 DEUTZ EMR 2

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

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

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

The EMR2 is equipped with safety devices and measures in the hardware and software in order to ensure emergency running (Limp home) functions.

In order to switch the engine off, the EMR2 is switched in a de-energized fashion over the ignition switch. A strong spring in the actuator presses the control rod in the de-energized condition into the zero position. As a redundancy measure, an additional solenoid serves for switching off and this, independently of the actuator, also moves the control rod in the de-energized condition into the zero position.

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

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

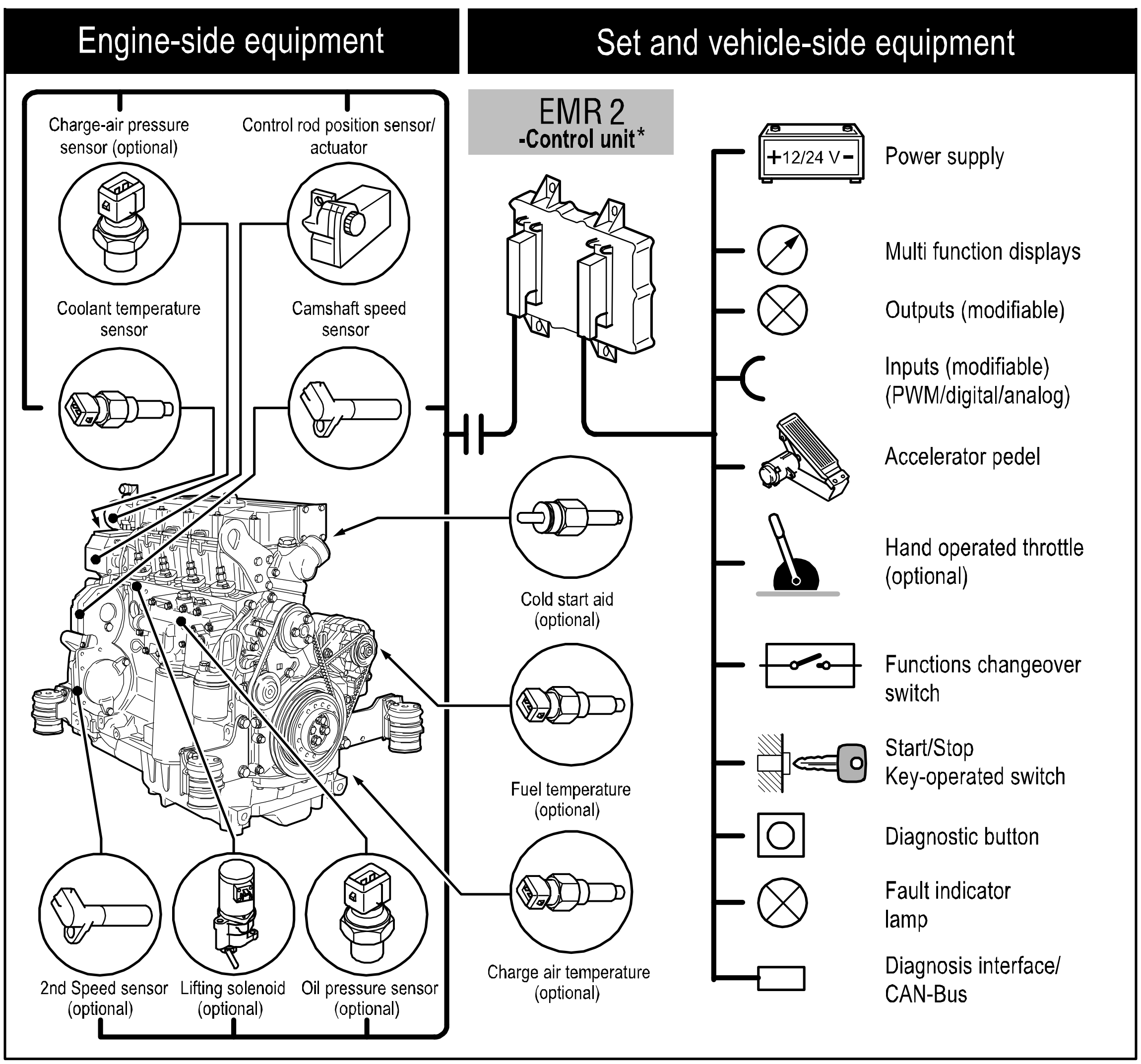


Figure 3-110. EMR 2 Engine Side Equipment

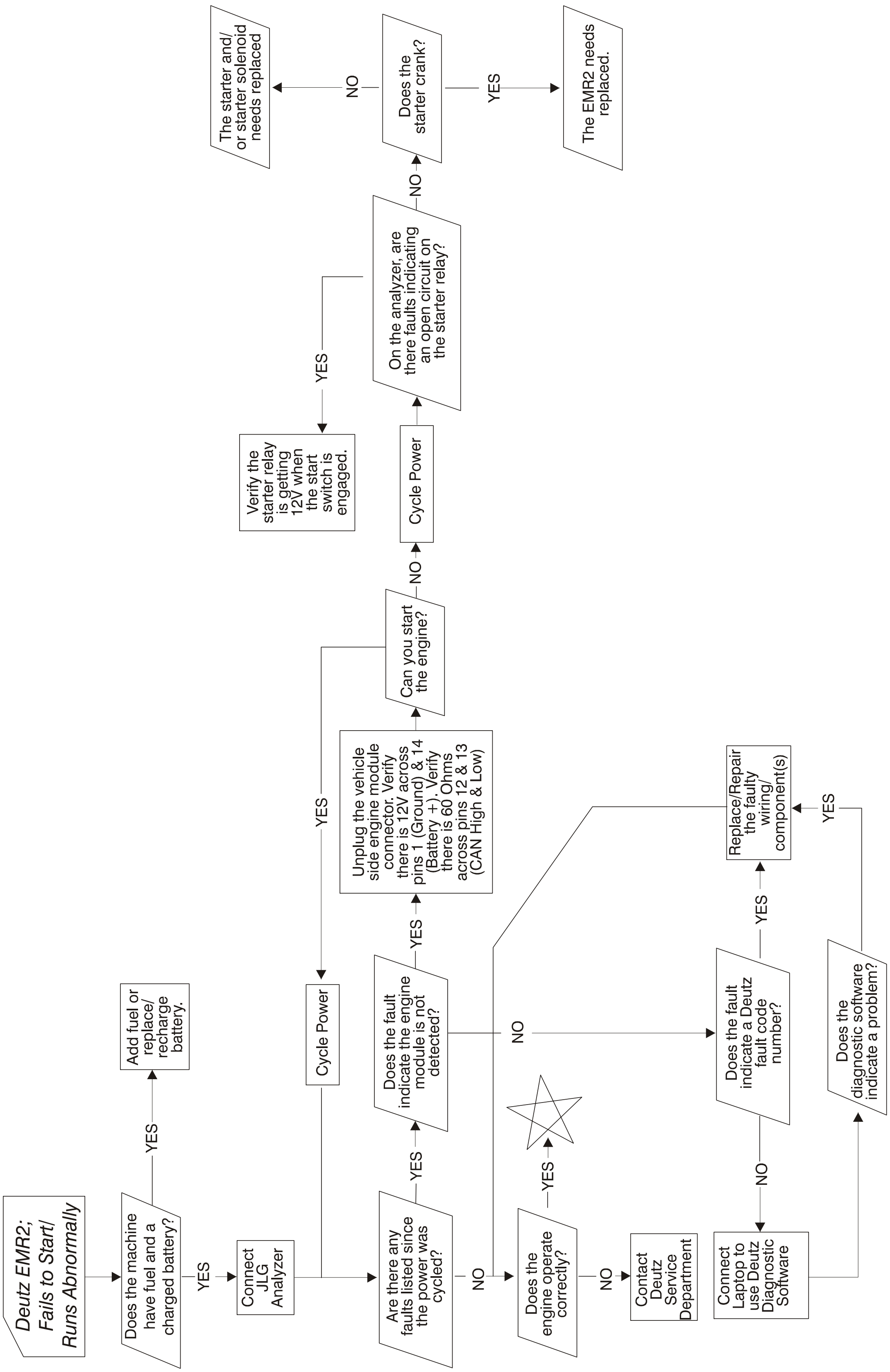


Figure 3-111. Deutz EMR 2 Troubleshooting Flow Chart

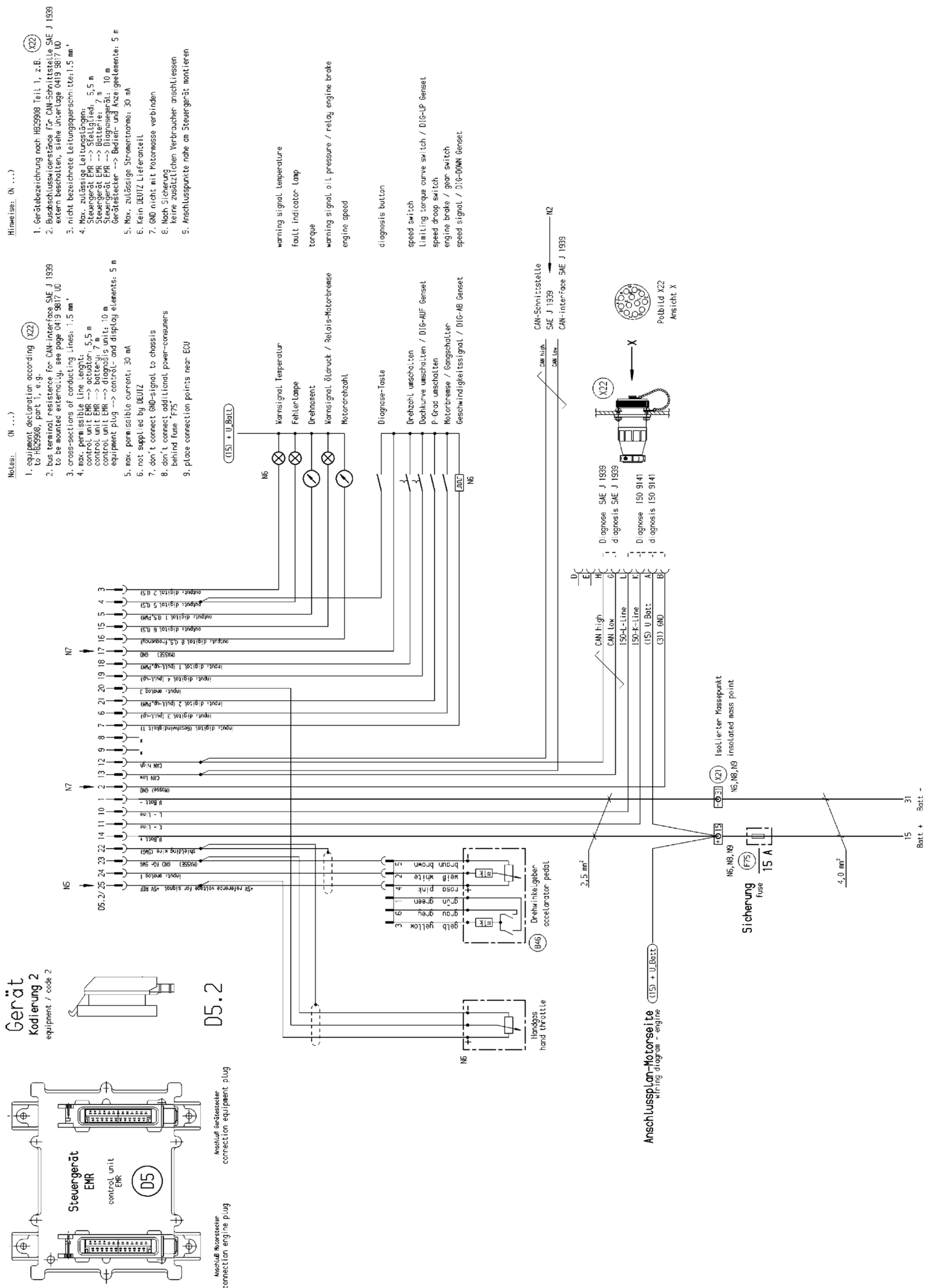


Figure 3-112. Deutz EMR 2 Vehicle Side Connection Diagram

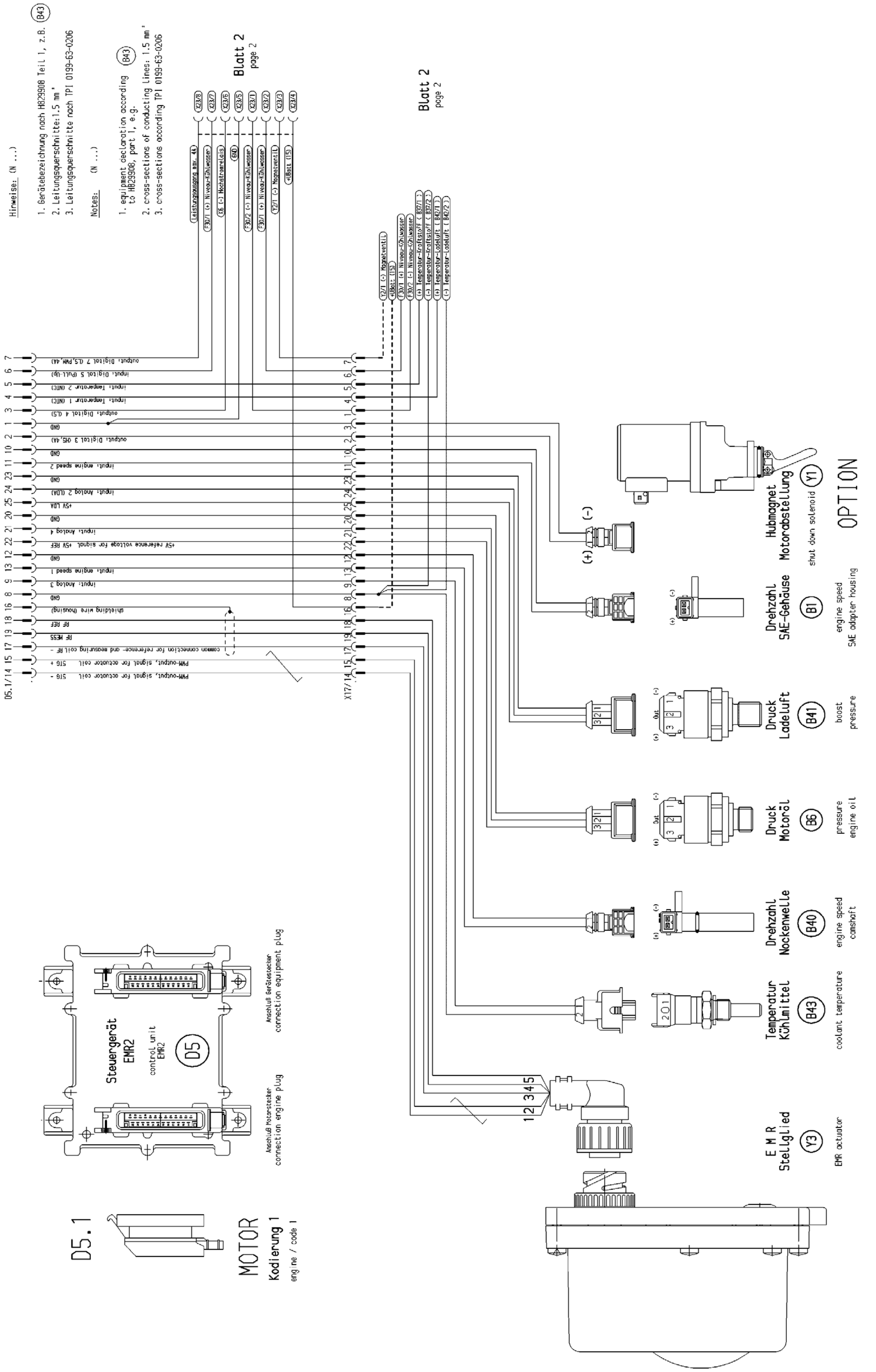


Figure 3-113. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

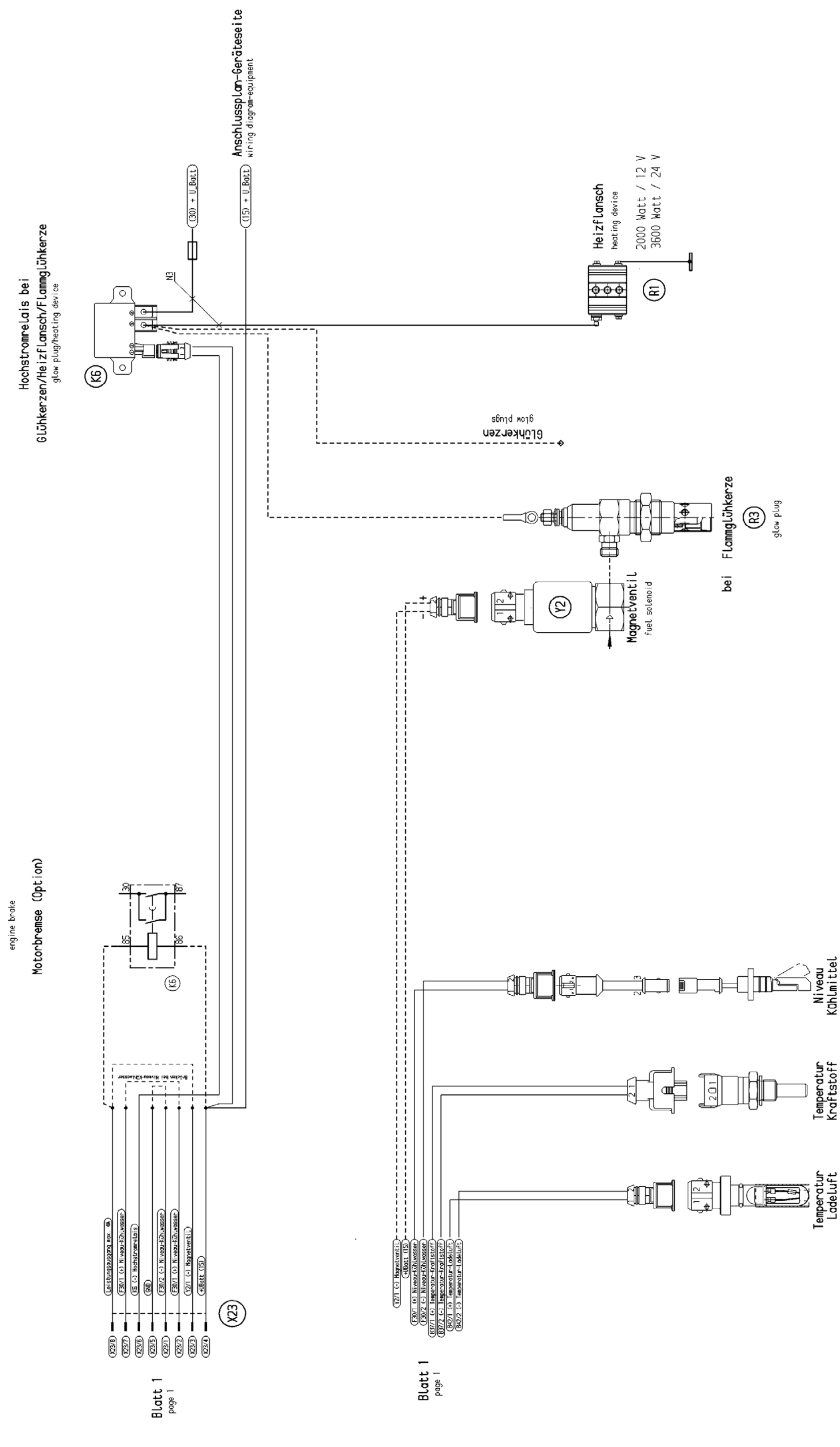
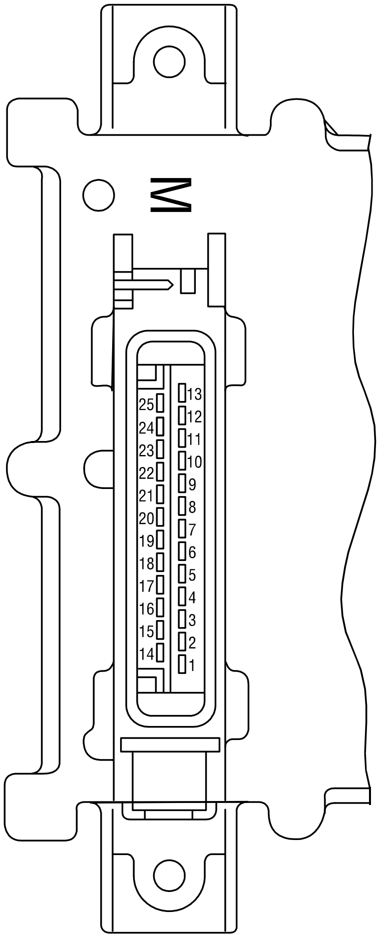


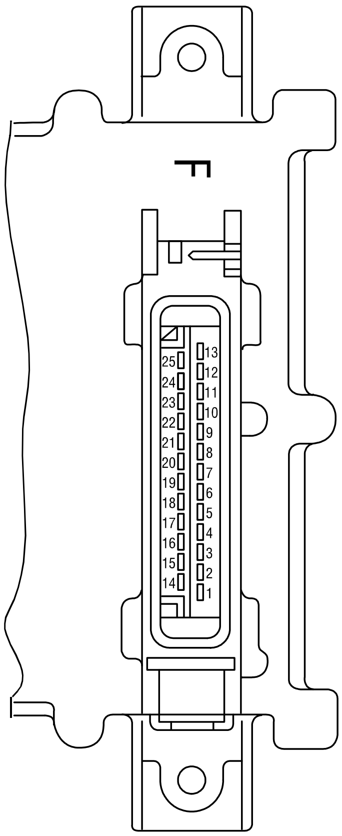
Figure 3-114. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2



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

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

Figure 3-115. EMR 2 Engine Plug Pin Identification



Pin-No.	Designation	Description
1	U Batt -	Negative pole at battery (clamp 31)
2	GND	Reference potential for signal
3	Output: digital 2	PWM or digital output, various functions
4	Input / output: DigInOut	Fault lamp and diagnostic button
5	Output: PWM 1/Dig 1	PWM or digital output, various functions
6	Multi-function input: DigIn 3	Genset applications/gear shift/motor brake
7	Input: digital 10/velocity	Speed signal (tacho input)
8	NC	Not occupied
9	NC	Not occupied
10	L-line	Serial ISO 9141 interface
11	K-line	Serial ISO 9141 interface
12	CAN high	Interface for CAN-Bus
13	CAN low	Interface for CAN-Bus
14	U Batt +	Positive pole for battery (clamp 15)
15	Output: digital 5	Digital output, various functions
16	Output: digital 7/Frequency	Frequency, PWM or digital output, various functions
17	Ground	Reference potential for signal at pins 18, 19 and 21
18	Input: digital 1 / PWM 1	PWM 1 or digital input 1, various functions
19	Multi-function input: DigIn 4	Performance curve switching/genset applications
20	Multi-function input: digital 8 / analog 3	Hand hand throttle/genset applications, Digital (8) or analog input (3)
21	Input: digital 2 / PWM 2	PWM 2 or digital input 2, various functions
22	Screen	Screening (e.g. for lines hand throttle or PWG)
23	GND	Reference potential for signal at pin 24
24	Input: analog 1 / digital 6	Analog input 1 (pedal value sensor, PWG) or digital input 6
25	+5 V REF	+5 V Reference voltage for signal at pin 24

Figure 3-116. EMR 2 Vehicle Plug Pin Identification

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Zero error display	-	No faults	524287	31	No **active** faults present		
Revolutions / speed acquisition	01	Speed sensor 1	190	8	Sensor failure. Distance from gear too far. Additional fault impulses. Cable joint interrupted.	Governor in emergency operation (if sensor 2 available). Emergency switch-off (if sensor 2 not available or failed). Governor in emergency operation (with sensor 1) Emergency switch-off (if sensor 1 not available or failed).	Check distance. Check cable connection. Check sensor and replace if required.
	03	Speed sensor	84	8	Tacho failed. Additional fault impulses. Cable connection interrupted.	Governor in emergency operation.	Check cable connection and Tacho. Replace if required.
	04	Excess speed switch-off	190	0	Speed was/is in excess of limit.e.	Engine stop.	Check parameter (21). Check speed settings.
					Check PID setting. Check rods. Check actuator and replace if required. Check cable to actuator (impulse on incorrect speed). Check No. of teeth. For vehicles check for possible thrust mode.		
Sensors	07	Charge air pressure	102	2	Fault at corresponding sensor entry (e.g. short circuit or cable break).	With failure of the sensor, the associated monitoring function is de-activated.	Check sensor cable. Check sensor and replace if required. Check fault limits for sensor.
	08	Oil pressure	100	2			
	09	Coolant temperature	110	2			
	10	Charge air temperature	105	2			
	11	Fuel temperature	174	2			

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

Figure 3-117. EMR2 Fault Codes - Sheet 1 of 5

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

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

Figure 3-118. EMR2 Fault Codes - Sheet 2 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Functional fault, switch-off	42	Charge air temperature switch-off	105	0	Charge air temperature has exceeded switch-off limit.	Emergency stop	Check charge air. Check charge air-temperature sensor and cable. Check switch-off limit.
	44	Coolant level switch-off	111	1	Switch input “Low coolant level” is active.	Emergency stop. Start lock.	Check coolant level. Check coolant level sensor and cable.
Actuator	50	Feedback	SID 24	12	Actuator not connected. Fault in actuator confirmation.	Emergency switch-off. Actuator cannot be operated.	Check actuator, replace if required. Check cable, check fault limits for “Confirmation”.
	52	Reference feedback	SID 24	13			Check actuator, replace if required. Check cable, check fault limits for “Rifeness confirmation”.
	53	Control travel difference	SID 23	7	Injection pump/actuator jammed or not connected. Difference between nominal/actual control travel is > 10 % of the overall control path.	Fault message (disappears when difference is < 10 %).	Check actuator/actuator rods / injection pump, replace if required. Check actuator cable.
	59	Auto calibration BOSCH-EDC pumps faulty operation	SID 23	13	No automatic actuator equalization possible. Incorrect input of the actuator reference values.	Engine stop / start lock. Governor cannot be taken into use. EDC actuator calibration required.	Check actuator and replaced if required. Check feedback cable. Check fault limits and reference values of the feedback. Program the fault limits for feedback, save values. Switch ignition off and on again.Check again. If faulty, inform DEUTZ-Service and carry out automatic equalization again. Set fault limits again.

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

Figure 3-119. EMR2 Fault Codes - Sheet 3 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Hardware inputs/ outputs	60	Digital output 3 (Switch-off solenoid, pin M 2)	SID 51	2	Fault (short circuit / cable break) at digital output.	Driver level is switched off.	Check cable of digital output (cable break or short circuit).
	62	Digital output 6, pin M 7	SID 60	2		Fault message.	
	63	Excess voltage switch-off solenoid	SID 51	6			
	67	Error Hand Setp1	91	11			
	68	Error CAN Setp1	898	2			
Communi-cation	70	CAN-Bus controller	SID 231	12	CAN-controller for CAN-bus is faulty. Fault removal despite re-initialising continuously not possible	Application-dependent.	Check CAN connection, terminating resistor (see Chapter 12.4), Check control unit.
	71	CAN interface SAE J 1939	SID 231	9	Overflow in input buffer or a transmission cannot be placed on the bus.		
	74	Cable break, short circuit or bus-error	SID 231	14			Check CAN connection, cable connection. Check sensor and replace if required.
Memory	76	Parameter programming (write EEPROM)	SID 253	12	Fault in parameter programming in the governor fixed value memory.	Emergency switch-off. engine cannot be started.	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service
	77	Cyclic program test	SID 240	12	Constant monitoring of program memory shows error (so-called "Flash-test").		
	78	Cyclic RAM test	SID 254	2	Constant monitoring of working memory shows error.		Note values of parameters (3895 and 3896). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.

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

Figure 3-120. EMR2 Fault Codes - Sheet 4 of 5

Fault group	Fault no. (in SERDIA)	Fault locality/ Fault description	SPN	FMI	Cause	Remarks	Help
Control unit hardware	80	Power supply (Actuator)	SID 254	2	Power supply for actuator not in the permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	83	Reference voltage 1	SID 254	2	Reference voltage for actuator not in the permissible range.	Fault message (disappears when power again in the normal range). Auxiliary value 5 V	Check voltage supply. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	84	Reference voltage 2	SID 254	2			
	85	Reference voltage 4	SID 254	2			
	86	Internal temperature	171	12	Internal temperature for control unit not in permissible range.	Fault message (disappears when power again in the normal range).	Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	87	Atmospheric pressure	108	12	Atmospheric pressure not in permissible range.	Fault message (disappears when power again in normal range). Atmospheric pressure monitoring function de-activated.	
Program logic	90	Parameter fault (EEPROM retrieval or checksum faulty).	SID 253	2	No data found or checksum of data is faulty (note: fault only occurs during setting of parameter / saving or reset.).	Engine cannot be started.	Check data for correct settings. Save parameters. Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	93	Stack overflow	SID 240	2	Internal calculation fault (so-called "Stack overflow" fault).	Emergency switch-off. Engine cannot be started.	Note parameters (3897 and 3898). Switch ignition off and on again. Check again. If faulty inform DEUTZ Service.
	94	Internal fault	SID 254	2			

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

Figure 3-121. EMR2 Fault Codes - Sheet 5 of 5

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
29	2	978	1-2-6	Diagnostic fault check of synchronism of hand throttle and Low idle switch(LIS).	Plausibility error between sensor and idle switch	Threshold for error detection is an internal ECU threshold. The accelerator pedal must have detected full load and idle plausibility at least once.
29	3	932	1-2-6	Diagnostic fault check of short circuit to supply voltage (signal range check high) of acceleration pedal signal.	The signal exceeds the applicatable threshold; signal range violation	If the signal is below the applicatable threshold APP_uRawSRCHiHTLIS_C, the signal range violation is reset after the healing debouncing. In case when the CCP is active (CCP_stActive = 1)and the reading from the EEPROM memory is successful, the signal is below the threshold APP_uHTLISC-CPHi[1], a signal range violation is reset after debouncing.
29	4	937	1-2-6	Diagnostic fault check of short circuit to ground (signal range check low) of acceleration pedal signal	The signal is below the applicatable threshold; signal range violation	If the signal exceeds the applicatable threshold APP_uRawSRCLoHTLIS_C, the signal range violation is reset after the healing debouncing. In case when the CCP is active (CCP_stActive = 1)and the reading from the EEPROM memory is successful, the signal exceeds the threshold APP_uHTLISC-CPLo[1], a signal range violation is reset after debouncing.
91	3	935	2-2-6	Analog accelerator pedal sensor 1 or double accelerator pedal sensor: the voltage measured by ECU is out of the target range or the calculated pedal position is implausible compared with the position of the second pedal	Sensor defect. Short cut to battery or open loop.	Check cabling, check accelerator pedal sensor and if necessary replace it, check connection cable and if necessary repair or replace it. If the signal is below the applicatable threshold APP_uRaw1SRCHigh_C, the signal range violation is reset after the healing debouncing.
91	4	940	2-2-6	Analog accelerator pedal sensor 1 or double accelerator pedal sensor: the voltage measured by ECU is out of the target range or the calculated pedal position is implausible compared with the position of the second pedal	Short circuit to ground.	Check cabling, check accelerator pedal sensor and if necessary replace it, check connection cable and if necessary repair or replace it If the signal exceeds the applicatable threshold APP_uRaw1SRCLow_C, the signal range violation is reset after the healing
91	11	976	2-2-6	Diagnostic fault check of synchronism of single potentiometer and Low idle switch(LIS).	Measured voltage of accelerator pedal 1 is out of plausible range.	Threshold for error detection is an internal ECU threshold. Check cabling, check accelerator pedal and pedal sensor and if necessary replace it, check connection cable and if necessary repair or replace it. When the PWM period APP_tiPWMPer is in between APP_tiSRCLoPWMPer_C and APP_tiSRCHiPWMPer_C.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
94	1	474	216	Low fuel pressure: the low fuel pressure calculated by ECU is underneath the target range; the ECU activates a system reaction	Fuel pressure below warning threshold	Check low fuel pressure system (fuel feed pump, relay , fuse, wiring, sensor) and if necessary repair or replace it.
94	3	472	216	Low fuel pressure sensor: the voltage of sensor measured by ECU is out of the target range	cable break or short circuit, sensor defective, connection cable damaged Short cut to battery or open loop	Check cabling, if sensor not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
94	4	473	216	Low fuel pressure sensor: the voltage of sensor measured by ECU is out of the target range	cable break or short circuit, sensor defective, connection cable damaged short cut to ground	Check cabling, if sensor not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
97	3	464	228	Fuel filter water level sensor: the voltage of sensor measured by ECU is out of the target range	Sensor not connected or sensor defect.	Check of wiring and water in fuel sensor. Check cabling, if charge Water in Fuel sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
97	4	465	228	Fuel filter water level sensor: the voltage of sensor measured by ECU is out of the target range.	cable break or short circuit, sensor defective, connection cable damaged. Short cut to ground.	Check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
97	12	1157	228	Fuel filter water level sensor: the maximum level is exceeded	Water level in fuel pre-filter reservoir over limit (bad fuel quality)	Measure Voltage at Water in Fuel Sensor and renew harness if needed.
100	1	736	231	Oil pressure is below the target range (warning threshold)	Oilpressure too low (pressure below warning threshold)	Threshold for error detection is an internal ECU threshold. Check oil level, check engine for oil leckage, measure oil pressure external to evaluate sensor value
100	1	737	231	Oil pressure is below the target range (shut off threshold)	Oilpressure too low (pressure below shut off threshold).	Threshold for error detection is an internal ECU threshold. Check oil level, check engine for oil leckage, measure oil pressure external to evaluate sensor value.
100	3	732	224	Oil pressure sensor: the voltage of sensor measured by ECU is out of the target range	short circuit to battery or cable break	check battery and wiring Check cabling. If sensor not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
100	4	733	224	Oil pressure sensor: the voltage of sensor measured by ECU is out of the target range	Short circuit to ground	The sensed raw voltage value Oil_uRawPSwmp is above Oil_SRCPSwmp.uMin_C Check cabling, if sensor not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it No detail informationen!
102	1	774	223	charge air pressure below lower limit	measured charge air pressure below the threshold.	Check complete air system of engine for massive leakage, especially from compressor to intake air manifold. Check air filter. Exchange charge air presure sensor.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
102	2	88	223	Charge air pressure messured by sensor is above the shut off threshold.	Charged air cooler pressure below threshold.	Check waste gate system if necessary replace TC, check CAC if all channels are clean,check charge air piping if nececery.
102	2	89	223	Charge air pressure messured by sensor is above the warning threshold	Charge air pressure above shut off threshold	Check waste gate system if necessary replace TC, check CAC if all channels are clean, check charge air piping if necessery.
102	2	772	223	Deviation between sensed intake manifold pressure is not plausible compared to environment pressure. Which sensor is not okay can not be said.	deviation between ambient pressure sensor and charge air pressure sensor at not running engine to high	1) Exchange boost pressure sensor 2) Exchange ECU
102	3	776	223	Charge air pressure sensor: the measured voltage of sensor by ECU is out of the target range	The Sensor Voltage is above the Threshold.	Check cabling, if charge air pressure/temperature sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
102	4	777	223	Charge air pressure sensor: the measured voltage of sensor by ECU is out of the target range	The Sensor Voltage is below the Threshold.	Check cabling, if charge air pressure/temperature sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
105	0	996	233	Charge air temperature downstream calculated by ECU is above the target range. The ECU activates a system reaction.	Charge air temperature (downstream) over warning threshold.	Check CAC system and clean it. Check fan functionality. Check cooling perfomance with temperature measurement.
105	0	997	233	Charge air temperature downstream calculated by ECU is under the shut down threshold. The ECU activates a system reaction.	Charge air temperature (downstream) over the low threshold.	Check CAC system and clean it. Check fan functionality. Check cooling perfomance with temperature measurement.
105	1	992	128	Charged Air cooler down stream temperature. Temperature below lower physical threshold.	Sensed temperature within intake air manifold < threshold.	actual temperature below -40°C? exchange sensor
105	3	994	128	Charge air temperature sensor: the voltage of sensor measured by ECU is out of the target range.	Short circuit to battery. sensor voltage > limit	The sensor raw signal Air_uRawTCACDs (voltage) > Air_SRCTCACDs.uMin_C. Check CAC-sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
105	4	995	128	Charge air temperature sensor: the voltage of sensor measured by ECU is out of the target range.	Short circuit to ground or open load. sensor voltage < limit.	The sensor raw signal Air_uRawTCACDs (voltage) is below Air_SRCTCACDs.uMin_C. Check CAC-sensor and if necessary replace it, check connection cable and if necessary repair or replace it
107	0	752	136	Air filter differential pressure: the pressure difference of the intake air between the filter inlet and outlet calculated by ECU is above the target range and the ECU activates a system reaction	Pressure loss above target range with system reaction, air filter clogged or defective, sensor not working, connection cable damaged Pressure value above warning threshold	Check airfilter and if necessary clean or renew it, check cabling, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
110	0	98	232	Coolant temperature: the coolant temperature calculated by ECU is above the target range; the ECU activates a system reaction	Cooling temperature too high. Coolant temperature above warning threshold	Clean radiator, check fan drive, check coolant level, check cooling system in general, check thermostat function, check water pump

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
110	0	99	232	Coolant temperature: the coolant temperature calculated by ECU is above the target range. The ECU activates a system reaction	Coolant temperature above shut off threshold.	Clean radiator, check fan drive, check coolant level, check cooling system in general, check thermostat function, check water pump
110	1	93	225	Coolant temperature sensor: the voltage of the sensor measured by ECU is out of the target range.	Suspected components:wiring harness, coolant temperature sensor.	Check wiring harness and connected Coolant Temp Sens.
110	3	96	225	Coolant temperature sensor: the voltage of the sensor measured by ECU is out of the target range	Short cut to battery or open load.	Check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
110	4	97	225	Coolant temperature sensor: the voltage of the sensor measured by ECU is out of the target range	Voltage Surveillance has found shortcut to Ground at Coolant Temperatur Sensor.	Check sensor and if necessary replace it, check connection cable and if necessary repair or replace it Measure Voltage at Coolant Temperature Sensor and renew harness if needed.
111	1	101	235	Coolant level: the coolant level calculated by ECU is underneath the allowed minimum.	Coolant level too low, leakage in cooling system, sensor defective, wiring damaged.	Check coolant level, inspect cooling system for leakage and if necessary repair it, check sensor and wiring
157	3	877	147	Rail pressure sensor: the voltage of sensor measured by ECU is out of the target range.	Short cut to battery. Damaged rail pressure sensor.	Check cabling, check rail pressure sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
157	4	878	147	Rail pressure sensor: the voltage of sensor measured by ECU is out of the target range.	Check cabling, check rail pressure sensor and if necessary replace it, check connection cable and if necessary repair or replace it.	Check cabling, check rail pressure sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
164	2	1381	839	Rail pressure safety function is not executed correctly	Rail pressure is still above threshold.	Threshold for error detection is an internal ECU threshold. Reset the fault and at reappearance check ECU and injection system
168	0	1180	318	Battery voltage: the voltage measured by ECU is out of the target range	Battery voltage over limit	Check alternator, regulator of alternator and if necessary replace it, check wiring and voltage of alternator
168	1	1181	318	Battery voltage: the voltage measured by ECU is out of the target range	Battery voltage below limit	Check alternator, cabling, contact resistance, safety fuses, too high load in energy system, check battery and if necessary replace it
168	2	47	318	Battery voltage: the voltage measured by ECU is out of the target range, system reaction is initiated	If Battery voltage (Ubatt_U) > 17V or 31V for mor than =0.5sec a warning is generated Battery voltage above warning threshold	Check wiring harness and connected alternator.
168	3	45	318	Battery voltage: the voltage measured by ECU is out of the target range, system reaction is initiated	Battery voltage above warning threshold (~38,9Volt), Short cut to battery possible.	Check wiring harness and connected alternator.
168	4	46	318	Battery voltage: the voltage measured by ECU is out of the target range, system reaction is initiated	Battery voltage below warning threshold, Short cut to ground	Check wiring harness and connected alternator.
171	3	417	312	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check high	open loop to sensor	Check cabling, if environment temperature sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
171	4	418	312	Sensor error SCR-System environment temperature; DPF-System air inlet temperature; signal range check low	short circuit to Ground	Check cabling, if environment temperature sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it
172	0	1425	226	sensed intake air temperature at air filter > physical high limit	sensed intake air temperature at air filter > physical high limit	Check outside conditions: Temperature > Threshold within the intake air system of the engine? E.G: engine sucks in air from hot asphalt out of paver bucket Sensor positioned within black air filter housing above engine lid at hot environmental conditions and idling or similar? => if yes check with application team to adapt limits if not check sensor and wiring harness exchange sensor
172	1	1183	226	sensed air temperature within air intake path of engine below physical low limit	sensed air temperature within air intake path of engine below physical low limit	Cold start and ambient temperature < threshold Check wiring harness to AFST-sensor Exchange AFST-sensor
190	0	389	214	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Overspeed monitoring during 1 level of FOC (Failure overrun condition) if engine speed was over Limit.	check powertrain settings regarding overspeed
190	2	421	213	ECU measures a deviation between camshaft and crankshaft angle to target.	Offset error between crankshaft and camshaft.	Threshold for error detection is an internal ECU threshold, occurs by offset between crankshaft and camshaft. Check increment wheel position, clean and adjust if necessary, check sensor postition. Check Camshaft and Crankshaft senor or wiring.
190	8	419	212	Camshaft speed sensor: the ECU receives no signal and uses the signal from crankshaft speed sensor as alternative to calculate the engine speed	When disturbed camshaft signal detected. Error in sensor or wiring.	Threshold for error detection is an internal ECU threshold, occurs by disturbed camshaft signal. Check increment wheel position, clean and adjust if necessary, check sensor postition. Check Camshaft Sensor or wiring.
190	8	422	212	Sensor crankshaft speed; disturbed signal	Error in sensor or wiring. Crankshaft sensor defect.	Threshold for error detection is an internal ECU threshold, occurs by disturbed crankshaft signal. Check increment wheel position, clean and adjust if necessary, check sensor postition. Check Crankshaft Sensor or wiring.
190	11	390	214	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Overspeed monitoring during 2 level of FOC (Failure overrun condition) if engine speed was over limit.	check powertrain settings regarding overspeed
190	12	420	212	Camshaft speed sensor: the ECU receives no signal and uses the signal from camshaft speed sensor as alternative to calculate the engine speed Threshold:	Error in sensor or wiring.	Threshold for error detection is an internal ECU threshold, occurs by disturbed or no camshaft signal. Check increment wheel position, clean and adjust if necessary, check sensor postition. Check Camshaft Sensor or wiring.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
190	12	423	212	Crankshaft speed sensor: the ECU receives no signal and uses the signal from camshaft speed sensor as alternative to calculate the engine speed.	Error in sensor or wiring.	Threshold for error detection is an internal ECU threshold, occurs by disturbed or no Crankshaft signal. Check increment wheel position, clean and adjust if necessary, check Crankshaft sensor postition or wiring.
190	14	391	214	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Overspeed monitoring during ORC (Override conditions) if engine speed was over 2900rpm	check powertrain settings regarding overspeed
190	14	1222	2-1-2	Camshaft- and Crankshaft speed sensor signal not available on CAN or defect.	Sensors for engine speed are defect.	Threshold for error detection is an internal ECU threshold. Check wiring, check cabels and repair or replace if necessary.
411	0	791	693	delta pressure across venturi in EGR line above physical high limit	sensed value of venturi difference pressure > high limit	Threshold for error detection is an internal ECU threshold. EGR-Valve blocked open EGR-Valve actuator defect EGR-cooler defect (check for coolant water) Reed Valve defect Intake throttle blocked in closed position => Check intake throttle Exhaust pressure too high => Check Exhaust pressure Check Nox-sensor upstream SCR catalyst dp venturi sensor defect
411	1	792	693	delta pressure across venturi in EGR line below physical low limit	sensed value of venturi difference pressure < low limit	Threshold for error detection is an internal ECU threshold. Check correct mounting of difference pressure sensor at venturi tube Exchange difference pressure sensor broken
411	3	795	693	The sensed raw voltage Air_uRawPEGRDeltaP is above the maximum threshold.	EGR Delta pressure Sensor defect	Check cabling, if charge EGR Delta pressure sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
411	4	381	693	Range check cannot be done or interrupted.	EGR or wiring defect	Check wiring harness and connected EGR.
411	4	796	693	The sensed raw voltage value Air_uRawPEGRDeltaP is above the minimum threshold.	EGR Delta pressure Sensor defect	Check cabling. If charge EGR Delta pressure sensor is not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
411	11	793	693	DFC is stored in EEPROM and status kept until check is allowed to be carried out again DFC can be reset by service routine 216	deviation between desired O2 concentration in intake air manifold and the real O2-concentration within intake air manifold > limit	Threshold for error detection is an internal ECU threshold. EGR-Valve mechanically blocked open or closed EGR-pipe blocked with metall plate instead sealing downstream EGR-Valve EGR-Valve actuator defect EGR-cooler defect (check for coolant water) Reed Valve defect Intake throttle blocked in closed position => Check intake throttle Exhaust pressure too high => Check Exhaust pressure Check Nox-sensor upstream SCR catalyst dp venturi sensor defect
412	3	1007	682	EGR downstream temperature sensor: the voltage of sensor measured by ECU is out of the target range.	Short circuit to battery. sensor voltage > limit	Check wiring harness to TEGR-sensor. Exchange TEGR-sensor.
412	4	1008	682	EGR downstream temperature sensor: the voltage of sensor measured by ECU is out of the target range.	Short circuit to ground or open load. sensor voltage < limit	Check wiring harness to TEGR-sensor. Exchange TEGR-sensor.
630	12	376	281	Internal hardware monitoring: the ECU finds an error during the access to its EEPROM memory or works with an alternative value	Section could not be erased	Threshold for error detection is an internal ECU threshold. There is no healing possible for the error. In the every new initialization phase, the debounce level is set to zero. If not programmed, EEPROM is defect --> ECU is defect, reprogramm ECU and if necessary replace it.
630	12	377	281	Internal hardware monitoring: the ECU finds an error during the access to its EEPROM memory or works with an alternative value	Minimum 3 blocks could not be readed, EEPROM has Checksum Error	There is no healing possible for the error. In the every new initialization phase, the debounce level is set to zero. If not programmed, EEPROM is defect -->ECU is defect, reprogramm ECU and if necessary replace it
630	12	378	281	Internal hardware monitoring: the ECU finds an error during the access to it's EEPROM memory or works with an alternative value	Block could not be written for minimum 3 times	Threshold for error detection is an internal ECU threshold. If not programmed, EEPROM is defect --> ECU is defect, reprogramm ECU and if necessary replace it.
639	14	84	271	CAN bus 0: the ECU is not allowed to send messages, because the status "BusOff" is detected.	CAN BusOff error; CAN 0 (Customer CAN)	Threshold for error detection is an internal ECU threshold. BusOff bit for CAN A node is set. Check wiring of CAN bus and if necessary repair it, check connection cable and if necessary repair or replace it, check resistance in CAN lines (120 Ohm)
651	3	580	154	Injector cyl. 1: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 1 wiring harness, cable break or short circuit, sensor defective, connection cable damaged	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
651	5	568	154	Injector cyl. 1: interruption of electrical connection	Interruption of electronic connection Injector cyl. 1	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
652	3	581	155	Injector cyl. 2: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 2 wiring harness, cable break or short circuit, sensor defective, connection cable damaged	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
652	5	569	155	Injector cyl. 2: interruption of electrical connection	Interruption of electronic connection Injector cyl. 2	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
653	3	582	156	Injector cyl. 3: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 3 wiring harness, cable break or short circuit, sensor defective, connection cable damaged	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
653	5	570	156	Injector cyl. 3: interruption of electrical connection	Interruption of electronic connection Injector cyl. 3	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
654	3	583	161	Injector cyl. 4: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 4 wiring harness, cable break or short circuit, sensor defective, connection cable	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
654	5	571	161	Injector cyl. 4: interruption of electrical connection	Interruption of electronic connection Injector cyl. 4	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
655	3	584	162	Injector cyl. 5: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 5 wiring harness, cable break or short circuit, sensor defective, connection cable	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
655	5	572	162	Injector cyl. 5: interruption of electrical connection	Interruption of electronic connection Injector cyl. 5	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
656	3	585	163	Injector cyl. 6: the current drop measured by ECU is above the target range	Suspected Components: injector cylinder 6 wiring harness, cable break or short circuit, sensor defective, connection cable	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it. Use SerDia Injector test for diagnosis.
656	5	573	163	Injector cyl. 6: interruption of electrical connection	Interruption of electronic connection Injector cyl. 6	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
676	11	543	263	Cold start aid relay error.	Relay defect or wire harness problem	Threshold for error detection is an internal ECU threshold. check wire harness, replace relay
676	11	544	263	Cold start aid relay open load	Relay or wire harness	Threshold for error detection is an internal threshold. check wire harness, replace relay
677	3	956	512	Start relay (high side power stage): the current drop measured by ECU is above the target range.	Short cut HighSide-output to battery.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	3	960	512	Start relay (low side power stage): the current drain measured by ECU is above the target range.	Shortcut LowSide-Output to battery.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	4	957	512	Start relay (high side power stage): the current drain measured by ECU is above the target range.	Shortcut HighSide-output to ground.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	4	961	512	Start relay (low side power stage): the current drop measured by ECU is above the target range.	Shortcut LowSide-Output to ground.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable of terminal 50 and if necessary repair or replace it.
677	5	958	512	Start relay (low side power stage): the current drop measured by ECU is above the target range	Open circuit/disconnection LowSide-Output.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	12	959	512	Start relay (low side power stage): the current drop measured by ECU is above the target range.	Temperature over limit.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
691	8	928	928	Supply module heater: PWM time periode out of valid range.	PWM signal for temperature readout from supply module to the control unit is out of range. Supply modul defect, fault in the wiring.	The Time period of the received PWM signal SCR_tiSMPerPwm is within the specified range of150ms to 250ms Supply module check and replace if necessary. Check the wiring.
729	3	549	263	wiring to the intake air heater device is faulty.	Intake Air Heater Device: overload, short-circuit	Threshold for error detection is an internal ECU threshold. Electrical error, Check wiring to the intake air heater device.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
729	4	551	263	wiring to the air intake heater is faulty	Relay (for cold start aid) cable break or short to ground:	Threshold for error detection is an internal ECU threshold. Electrical error, check wiring to the air intake heater.
729	5	545	263	The cold start aid relay is according to wiring faulty.	Relay defect or wire harness problem	Threshold for error detection is an internal ECU threshold. Electrical error, check wires
729	12	547	263	The cold start aid relay is overheated, which causes this error	High temperature around the cold start relay.	Check the functionality of relay and replace it if needed. Check the temperature around the cold start relay during worst case operation.
898	9	305	118	Timeout Error of CAN-Receive-Frame TSC1TE - active	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
1079	13	946	282	Internal hardware monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 1.	Suspected components EDC17cv52 Pin A19: DEF press / Exh.PressBeforeTurb (P3) / Air Pump Press /BrnFuelPressAfterDV2 Pin K19: Fan Speed Sensor Pin A21: LDF6T / OilPress / LowFuelPress Pin A17: Rail Pressure Sensor Suspected components EDC17cv54 Pin A21: CAM speed Pin K44: Delta Press Venturi / Poti EGR or Inlet Throttle Pin A24: LDF6T / OilPress / LowFuelPressPin K43: Reserve 5V Sensor Supply Pin A09: second footpedal Suspected components EDC17cv56 Pin A21: Cam speed Pin K44: DEF press / Air FilterDiffPress Pin A24: LDF6T / OilPress / LowFuelPress Pin K43: second footpedal Pin A09: Delta Press Venturi	Check cabling of external components, check working voltage and if necessary correct it, check connection cable and if necessary repair or replace it, if error is not removable, change ECU.
1080	13	947	282	Internal hardware monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 2.	Suspected components EDC17cv52 Pin K16: second footpedal Pin A20: Exh.PressAfterTurb/DPFDiffPress/BrnDV1Press/HCIPressDV1DV2 Suspected components EDC17cv54 Pin K45: DPF Diff Press / Exh. Press After Turb / Fan Speed Sensor Pin A46: first footpedal Suspected components EDC17cv56 Pin A22: Fan Speed Sensor Pin K45: Position EGR or Intake throttle flap Pin K46: First footpedal	Check cabling of external components, check working voltage and if necessary correct it, check connection cable and if necessary repair or replace it, if error is not removable, change ECU.
1109	2	121	341	Request of engine shut off: the operator ignores the engine shut off request within an allowed period.	Engine Shut Off demand has been ignored by the user	Depending on error requested a shut off.
1136	0	1398	681	ECU internal temperature; temperature measured by ECU is out of the target range	Short-Circuit in ECU, ECU heated by hot air	Close warm air circuits, replace ECU

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
1231	14	85	271	CAN bus 1: the ECU is not allowed to send messages, because the status "BusOff" is detected Warning, no diagnostic with SERDIA2010 possible	CAN BusOff error; CAN 1 (Diagnostic CAN)	Threshold for error detection is an internal ECU threshold. BusOff bit for CAN B node is set. Check wiring of CAN bus and if necessary repair it, check connection cable and if necessary repair or replace it, check resistance in CAN lines (120 Ohm)
1235	14	86	271	CAN bus 2: the ECU is not allowed to send messages, because the status "BusOff" is detected. Warning, depends on engine, EAT.	CAN BusOff error; CAN 2 (Engine CAN)	Threshold for error detection is an internal ECU threshold. BusOff bit for CAN C node is set. Check wiring of CAN bus and if necessary repair it, check connection cable and if necessary repair or replace it, check resistance in CAN lines (120 Ohm)
1237	2	747	145	Override switch switch: the ECU receives a permanent signal.	Switch is blocked, taster locked, connection cable damaged plausbility error "override switch > 250ms pressed".	If the Block Button is pressed shorter than the Maximum Plausible pressing Time. Check cabling, if sensor is not working, check switch and if necessary replace it, check connection cable and if necessary repair or replace it.
1761	0	1593	129	The urea tank level sensor detects a value higher than the maximum allowed thresh-old	Suspected components: Urea Quality Sensor defect mechanical defect at the float gauge	Check level sensor and float gauge
1761	1	1594	129	The DEF tank level sensor detects a value lower than the minimum allowed threshold	Suspected components: Urea Quality Sensor defect mechanical defect at the float gauge	Check level sensor and float gauge
1761	14	1655	138	The urea tank volume ratio is below the threshold of <5%	actual urea tank level SCRUTnk_rVol_mp [%] is below applicable threshold 5%	Check urea level => if empty, then fill in urea Check DEF level sensor. If there is urea in the tank, then move the floater of the level sensor. The floater must be free. If you lift the sensor body, then SCRUTnk_rVol_mp must change. Exchange DEF level sensor, if no change of value or it's implausible.
1761	14	1656	138	The urea tank volume ratio is below the threshold of <2.5%	actual urea tank level SCRUTnk_rVol_mp [%] is below 2.5%	Check urea level => if empty, then fill in urea Check DEF level sensor. If there is urea in the tank, then move the floater of the level sensor. The floater must be free. If you lift the sensor body, then SCRUTnk_rVol_mp must change. Exchange DEF level sensor, if no change of value or it's implausible.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
1761	14	1880	138	The DEF tank level is below the threshold.	actual DEF tank level SCRUTnk_rVol_mp [%] is below the threshold	Check DEF level => if empty, refill Check DEF level sensor. If there is urea in the tank loose the sensor and move it. The floater must be free and move if you lift the sensor body. SCRUTnk_rVol_mp must change. Compare SCRUTnk_rVol_mp to: 1 = SCR_rawUTnkLvl 2 = SCR_rAdapUtnkLvl 3 = SCRUTnk_rActTnkVol *SCRUTnk_facVolPer_mp In case of malfunction, exchange DEF level sensor.
2791	0	1763	415	Internal actuator temperature is above threshold.	Overheating of EGR actuator during operation.	Let EGR actuator cool down and check heat accumulation during worst case operation.
2791	2	1753	415	corrupted CAN communication with actuator.	CAN bus error or faulty EGR actuator.	Threshold for error detection is an internal ECU threshold. Check other CAN bus components. If no message is sent, fix the wiring. If o.k. exchange EGR actuaror.
2791	3	1758	415	Overvoltage at EGR actuator.	High voltage from the battery	Check battery voltage.
2791	4	1759	415	Undervoltage at EGR actuator.	Low voltage from the battery.	Check battery voltage.
2791	6	1757	415	Overcurrent to EGR actuator.	High voltage from battery. EGR actuator is blocked or moving very hard.	Check battery voltage. Check if EGR is blocked or not running smoothly. If everything is o.k. change EGR actuator.
2791	7	1752	415	EGR actuator is mechanically blocked.	EGR actuator faulty or blocked.	Threshold for error detection is an internal ECU threshold. Check the EGR actuator and EGR valve to mechanical blockage / clean. Check for free movement of the valve. If it'S blocked, then exchange the EGR valve.
2791	7	1761	415	EGR actuator spring broken.	mechanical damage of spring due to overstress.	Threshold for error detection is an internal ECU threshold. Exchange EGR actuator.
2791	12	1755	415	Internal electrical fault of EGR actuator.	Internal damage of EGR actuator due to high temperature or electrical wiring issue.	Threshold for error detection is an internal ECU threshold. Exchange EGR actuator.
2791	13	1754	415	EGR actuator can not learn stop positions. Possibly only second failure if other EGRTV failures occure.	Error detection during the learning process.	Threshold for error detection is an internal ECU threshold. Start Serdia Usecase to reset EGR actuator. Check EGR valve and mounting situation. If o.k. change EGR actuator.
2791	13	1756	415	EGR actuator can not learn stop positions because procedure was interrupted.	Interruption of learning process due to mechanical damage.	Threshold for error detection is an internal ECU threshold. Start Serdia Usecase to reset EGR actuator.
2791	13	1760	415	Stop positions of EGR valve not o.k.	Mechanical damage of EGR actuator. EGR valve is blocked or moving very hard.	Threshold for error detection is an internal ECU threshold. Start Serdia Usecase to reset EGR actuator.
2791	16	1762	415	Internal actuator temperature above threshold.	overheating of EGR actuator	Let EGR actuator cool down, check heat accumulation during worst case operation.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
2797	4	1337	565	Injector diagnosis: Timeout of Injetor detection cylinder bank 0	Short-Circuit to ground on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
2797	4	1339	565	Injector test: Short cut to ground on cylinder bank 0	Short-Circuit to ground on component wiring	Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
2798	4	1338	566	Injector diagnosis: Timeout of Injetor detection cylinder bank 1	Short-Circuit to ground on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
2798	4	1340	566	Injector test: Short cut to ground on cylinder bank 1	Short-Circuit to ground on component wiring	Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
3031	0	1135	669	The urea tank temperature sensor detects a value above the maximum allowed threshold	Sensed urea tank temperature > physical range high limit	Case "CANBUS sensor": Check urea tank temperature: really hot? Check CANBus-message of DEF sensor urea tank temperature Com_dRxSCR2Byt2 Compare it to Com_dRxSCR1Byt1 (urea temperature at quality sensor) identical? Tank heater permantly on? Check wiring of DEF-quality sensor Case "analog DEF T & Level sensor": Check urea tank temperature: really hot? Check urea tank temperature SCR_tSensUTnkT Compare urea tank temperature to EnvT_t or to SCR_tSMT (the urea temperature inside the supply module) identical? Tank heater permantly on? Check wiring of analog DEF T & Level sensor
3031	1	1136	669	The urea tank temperature sensor detects a value lower than the minimum allowed threshold.	sensed urea tank temperature < physical range low limit	Case "CANBUS sensor": Check ambient temperature EnvT_t => About -40 °C? If yes Error could be plausible Check CANBus-message of DEF sensor urea tank temperature Com_dRxSCR2Byt2 Compare it to Com_dRxSCR1Byt1 (urea temperature at quality sensor) identical? Check wiring of DEF-quality sensor Check quality sensor Case "analog DEF T & Level sensor": Check urea tank temperature: really that cold? Check ambient temperature EnvT_t => About -40 °C? If yes Error could be plausible Check urea tank temperature SCR_tSensUTnkT Check wiring of analog DEF T & Level sensor Check analog DEF T & Level sensor
3224	2	129	596	DLC Error of CAN-Receive-Frame AT1IG1Vol NOX Sensor (SCR-system upstream cat; DPF-system downstream cat); length of frame incorrect	Not Used	Threshold for error detection is an internal ECU threshold. Check Nox-Sensor and the wiring from CAN-BUS.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
3224	9	130	597	Timeout Error of CAN-Receive-Frame AT1IG-1Vol; NOX sensor (SCR-system upstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX sensor and sensor connection check
3234	2	138	114	DLC Error of CAN-Receive-Frame AT1O1Vol NOX Sensor (SCR-system downstream cat; DPF-system downstream cat); length of frame incorrect	Failure of the CAN Bus message	NOX downstream sensor and sensor connection check
3234	9	139	117	Timeout Error of CAN-Receive-Frame AT1OG1Vol; NOX sensor (SCR-system downstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX downstream sensor and sensor connection check
3361	3	1077	677	Urea dosing valve (low side power stage): the current drain measured by ECU is above the target range	Fault in the wiring	Threshold for error detection is an internal ECU threshold See substitute function Check the wiring
3361	3	1078	677	Urea dosing valve (high side power stage): the current drain measured by ECU is above the target range	Fault in the wiring	Threshold for error detection is an internal ECU threshold Check the wiring
3361	4	1079	677	Urea dosing valve (low side power stage): the current drain measured by ECU is above the target range	Fault in the wiring	Check the wiring
3361	4	1080	677	Urea dosing valve (high side power stage): the current drain measured by ECU is above the target range	Fault in the wiring	Threshold for error detection is an internal ECU threshold Check the wiring
3361	6	1075	677	Urea dosing valve: the current measured value by ECU at the end of the injection is too high	Fault in the wiriing Defect urea dosing injection valve	Check wiring Check the urea dosing injection valve
3519	3	1898	277	The integrated diagnostic of the temperature sensor of the Urea Quality Sensor recognized a short circuit to battery. The UQS Sensor is an combined sensor of tank temperature, filling grade and DEF quality and it is also an CAN sensor --> no PIN	Wrong diagnostic of the short circuits logic inside the temperature sensor of the UQS CAN Communication corrupted	Check the wiring to the suction unit in the DEF tank. Check the CAN bus communication of the suction unit. In case the communication is corrupt, exchange the suction unit.
3519	4	1899	277	The integrated diagnostic of the temperature sensor of the Urea Quality Sensor recognized a short circuit to ground	DEF quality sensor in the suction unit of the DEF tank is defect CAN Communication corrupted	Check the wiring to the suction unit of the DEF tank. Check the CAN bus communication from the suction unit. In case the signal is corrupt, exchange the suction unit in the DEF tank.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
3519	12	1895	277	The integrated temperature sensor of the Urea Quality Sensor measures higher temperature than threshold	Temperature sensor inside the UQS defect. CAN Communication corrupted. Overheating of the DEF tank due to malfunction of the heating valve. Flow direction is of coolant is wrong due to mixed up the hoses routed to the heating valve. Overheating of the DEF tank due to heat transfer from neighbor parts.	Check the temperature sensor signal for plausibility. In case of improper signal, exchange the suction unit in the tank. Check CAN bus communication for proper signal. In case of improper signal, exchange the suction unit in the tank. Check the function of heating valve and routing of the hoses. The coolant flow through the heating valve must be observed according to the shown arrow. In case all actions above are OK, check the real temperature in the DEF tank during worst case condition and improve the installation of the DEF tank.
3519	13	1908	277	Temperature at UQS out of range the specified thresholds; invalid quality of the temperature	Suspected Components Tank heater DEF sensor	Check temperature system and/or DEF quality sensor
3520	2	1904	2-7-8	Measured DEF Quality from UQS is too low. Quality value received from UQS is < 22 % for a certain time and a certain number or for measuring conditions not observed for a certain time.	Suspected components: Urea quality sensor defect Wrong installation (measuring air) Urea level sensor defect Non urea filled in tank CANBUS problems Evaluation conditions for new quality check not fulfilled after one previous mal detection	Check that there is liquid urea of known quality in the tank first Check urea tank level. Add urea until level is at least 10 cm above sensor. Ensure that urea is not frozen / sufficient urea is liquid Check Sensor: Are urea tank temperature and level displayed? Changes the level if you refill urea? Check electrical connection Check CANBus New quality detection is carried out if urea refill is detected or if an quality evaluation was triggered and was not finished successfully: To provoke a quality measurement: refill urea, at least 10 % of tank volume Wait until quality evaluation was carried out, can take up to 30 minutes => check value. It should be about 33 % Exchange quality sensor
3520	3	1896	278	The integrated diagnostic of the Urea Quality Sensor recognized a short circuit to battery	wiring harness of UQS corrupted CAN Communication corrupted	Threshold for error detection is an internal ECU threshold. Check the wiring harness from the ECU to the suction unit of the DEF tank Check the CAN bus communication. If the signal is corrupt, then exchange the suction unit.
3520	4	1897	278	The integrated diagnostic of the Urea Quality Sensor recognized a short circuit to ground.	wiring harness to the suction unit in the DEF tank is corrupted CAN Communication corrupted	Threshold for error detection is an internal ECU threshold. Check the wiring to the suction unit in the DEF tank. Check the CAN bus communication. In case the communication is corrupt, exchange the suction unit in the DEF tank.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
3520	13	1907	278	Urea quality at UQS out of range the specified thresholds; invalid quality of the urea qualiy	Suspected components DEF quality sensor DEF	Check DEF quality and/or DEF quality sensor
3532	3	1911	127	The urea quality value from the sensor is greater than the maximum physical range threshold Comment: tank temperature is measured by the UQS sensor	Suspected Components: UQS defect	Check DEF quality and/or sensor.
3532	4	1912	127	The urea quality value from the sensor is lower than the minimum physical range threshold.	Suspected Components: UQS defect	Check DEF quality and/or Sensor.
3711	12	1455	711	Temperature Phy_tPfWgh, the weighted DPF temperature < Threshold 1 Temperature Phy_tPfWgh, the weighted DPF temperature > Threshold 2 towards the end of the stand-still main phase.	temperature Phy_tPfWgh, the weighted DPF temperature, is below or above the target temperature towards the end of the stand-still main phase.	Check temperature upstream DOC Exh_tSensOxiCatUs within Stand-still: > 450 °C? If not: => Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check temperature difference across DOC by Exh_tSensOxiCatDs - Exh_tSensOxiCatUs within Stand-still: < 100°C? If not: Check exhaust pipe downstream turbo charger for oil? check injectors: is an injector got stuck? Too many hydrocarbons in exhaust? White smoke (at hot EAT system, not at cold start)? Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check exhaust gas temperature sensors within EAT-system: T upstream DOCC, T downstream DOC & T upstream SCR catalyst all three of them can influence Phy_tPfWgh
3936	14	1917	2-8-6	Standstill escalation by time. In case the standstill request will not be released within 50 h by the driver this fault code will be set.	Stand-still request ignored by the operator. Display / stand-still request lamp broken.	Perform Stand-still. If soot load level of DPF has increased too high already call service to perform stand-still. In case the DPF soot load level remove DPF => Exchange DPF.
4334	0	1122	665	The absolute pressure value of the urea pump is greater than an applicable maximal filtered pressure threshold	Suspected Components: Urea pump defect Supply module pressure sensor defect Pump contains dirty parts	Check the urea pump Check the supply module pressur sensor Clean the urea pump (filter)
4334	1	1123	665	Urea supply module pressure sensor: The absolute pressure value of the urea pump is less than an applicable minimal filtered pressure threshold	Check the urea pump Check the supply module pressur sensor Clean the urea pump (filter)	Check the urea pump Check the supply module pressur sensor Clean the urea pump (filter)

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4334	2	1866	665	absolute difference of sensed urea pump pressure (SCR_pAbsSensUPmpP) and ambient pressure (EnvP_p) > limit abs(UPmpP_pDiffPmpEnv_mp) > UPmpP_pDiffPmpEnv_C (250 hPa)	absolute difference of sensed urea pump pressure (SCR_pAbsSensUPmpP) and ambient pressure (EnvP_p) > limit abs(UPmpP_pDiffPmpEnv_mp) > UPmpP_pDiffPmpEnv_C	Check environment pressure sensor (EnvP_p) => plausible value? Engine shut-off and immediately re-started? => Shut-off again. Wait until afterun of ECU has finished, re-Start engine Back-flow line free? Does the urea pump pressure show values < 1000 hPa in SCR state emptying (64)? Check revision valve => Does the urea pump pressure show values < 1000 hPa in SCR state emptying (64)? => exchange supply module Supply module pressure sensor defect => exchange supply module
4341	3	1104	675	Urea heater supply line: the current drain measured by ECU is above the target range	Electrical error	Threshold for error detection is an internal ECU threshold Check wire harness Check supply line
4341	4	1105	675	Urea heater supply line: the current drain measured by ECU is above the target range	Electrical error	Threshold for error detection is an internal ECU threshold Check wire harness Check supply line
4341	5	1102	675	Urea heater supply line: the current drain measured by ECU is above the target range	Electrical error	Threshold for error detection is an internal ECU threshold Check wire harness Check supply line
4343	3	1096	673	Urea pressure line heater: the current drain measured by ECU is above the target range	shortcut to battery If this error detected during the heating phase is a result error: KWP 1089 broken heating element in pressure line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4343	4	1097	673	Urea pressure line heater: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase is a result error: KWP 1089 Short cut to ground or broken wiring, broken heating element in pressure line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4343	5	1094	673	Urea pressure line heater: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase is a result error: KWP 1089 Broken wiring, broken heating element in pressure line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4345	3	1092	674	Urea backflow line heater: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase is a result error: KWP 1089 Short cut to battery or broken wiring, broken heating element in backflow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4345	4	1093	674	Urea backflow line heater: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase is a result error: KWP 1089 Short cut to ground or broken wiring, broken heating element in backflow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4345	5	1090	674	Urea backflow line heater: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase is a result error: KWP 1089 Broken wiring, broken heating element in back-flow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4360	0	1069	668	The filtered urea cat upstream temperature is greater than an applicable maximum temperature threshold	Sensed temperature upstream SCR > physical high limit	Check temperature difference across DOC (Exh_tOxiCatDs-Exh_TOxiCatUs) at higher engine load => high difference > 100 K? If yes, the engine emitts too many Hydrocarbons => check injectors: is an injector got stuck? => Check EGR Valve If difference normal the exhaust out of the engie itself is too hot: => Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function If that error was set while stand-still operation the error source could be exothermal soot burn off in DPF (which should not happen) => Dismount DPF and check it visually exchange temperature sensor upstream SCR
4360	1	1070	668	The filtered temperature before urea cat is less than an applicable minimum temperature threshold	Sensed temperature upstream SCR catalyst < than physical low limit	Cold start and ambient temperature < Threshold? Missdetection? Check wiring harness to UCatUsT-sensor Exchange UCatUsT-sensor
4360	2	1865	668	Error at static plausibility check: absolut temperature difference of sensed temperature upstream SCR catalyst and ambient temperature > as static plausibility limit at engine cold start (engine was off for at least 8 h), temperature upstream of SCR catalyst is expected to be identical to ambient temperature => see enable conditions for details. Error at dynamic plausibility check: temperature difference of sensed temperature upstream SCR catalyst and ambient temperature < as dynamic plausibility limit dynamic check is blocked if static plausibility check is already faulty => Temperature upstream SCR catalyst must be by 40°C higher than ambient temperature if engine runs and a certain delay time has expired.	Error at static plausibility check: absolut temperature difference of sensed temperature upstream SCR catalyst and ambient temperature > as static plausibility limit at engine cold start (engine was off for at least 8 h), temperature upstream of SCR catalyst is expected to be identical to ambient temperature => see enable conditions for details. Error at dynamic plausibility check: temperature difference of sensed temperature upstream SCR catalyst and ambient temperature < as dynamic plausibility limit dynamic check is blocked if static plausibility check is already faulty => Temperature upstream SCR catalyst must be by 40°C higher than ambient temperature if engine runs and a certain delay time has expired.	Check whether temperature sensor upstream of SCR catalyst is physically mounted within exhaust pipe If cold start condition can be made sure (engine was off for at least 8 h) compare values of EnvT_t, EngDa_tEng, Exh_TOxiCatUs, Exh_tOxiCatDs and SCR_tSensUCatUsT at ignition on, without starting the engine. All identical? Compare values of Exh_TOxiCatUs, Exh_tOxiCatDs and SCR_tSensUCatUsT after 15 min in constant operation point: show all similar values (30 K tolerance width). Are ambient temperature and (EnvT_t), cooling water temperature (EngDa_tEng) plausible? Sensor coated with urea crystalls? Dismount urea injector and inspect temperature sensor upstream SCR catalyst visually Check wiring of sensor Replace sensor
4361	3	1072	668	Urea catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range	Voltage of temperature sensor upstream SCR catalyst > maximum limit Short circuit to battery	Check sensor Check wiring Replace UCatUsT-sensor
4361	4	1073	668	Urea catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range	Voltage of temperature sensor upstream SCR catalyst < minimum limit Short circuit to ground	Check sensor Check wiring Replace UCatUsT-sensor

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4365	2	1137	6-6-9	Signal error in case of Urea tank temperature trnasmitted via CAN-signal Com_tUTnkT.	CAN message is not send properly.	Check sensor connector Check CANbus
4365	3	1138	6-6-9	Urea tank temperature sensor: he current drain measured by ECU is above the target range.	Shortcut or open load.	Threshold for error detection is an internal ECU threshold. The Sensed raw voltage value SCR_uRawUTnkT is below SCR_SRCUTnkT.uMax_C. Check wiring.
4365	3	1914	669	Internal error of DEF quality sensor.	Suspected componentes: DEF quality sensor Wiring harness	Check wiring harness and DEF qualitysensor
4365	4	1139	6-6-9	Urea tank temperature sensor: he current drain measured by ECU is above the target range.	Shortcut or open load.	Threshold for error detection is an internal ECU threshold. The sensed raw voltage value SCR_uRawUTnkT is above SCR_SRCUTnkT.uMin_C. Check wiring.
4365	4	1915	6-6-9	Internal error of DEF quality sensor.	Suspected componentes: DEF quality sensor Wiring harness	Check wiring harness and DEF qualitysensor
4366	3	1112	671	Urea tank heating valve: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Urea tank heating valve defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea tank heating valve
4366	4	1113	671	Urea tank heating valve: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Urea tank heating valve defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea tank heating valve
4366	5	1110	671	Urea tank heating valve: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Urea tank heating valve defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea tank heating valve
4375	3	1120	666	Urea supply module pump: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Pump in urea supply module defect	Threshold for error detection is an internal ECU threshold The hardware detects absence of any short circuit to battery on the PWM output power stage for the urea pump module actuator Check wiring Check pump in the urea supply module
4375	4	1121	666	Urea supply module pump: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Pump in urea supply module defect	Threshold for error detection is an internal ECU threshold The hardware detects a short circuit to ground error on the PWM output power stage for the UreaPump Module Motor Actuator. The error is updated by setting bit 1 of measuring point UPmp-Mot_stPrevT-stRslt_mp Check wiring Check pump in the urea supply module

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4375	5	1118	666	Urea supply module pump: the ECU can not measure any reaction during pump control	Open load Broken wiring Pump in urea supply module defect	Threshold for error detection is an internal ECU threshold The hardware detects the presence of load on the PWM output power stage for the urea pump module actuator. Check wiring Check pump in the urea supply module
4376	3	1131	667	Urea supply module reversal valve: the current drain measured by ECU is above the target range	Shortcut to battery Fault in the wiring Reversal valve in the urea supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea supply modul
4376	4	1132	667	Urea supply module reversal valve: the current drain measured by ECU is above the target range	Shortcut to ground Fault in the wiring Reversal valve in the urea supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea supply modul
4376	5	1129	667	Urea supply module reversal valve: the current drain measured by ECU is above the target range	Open load Fault in the wiring Reversal valve in the urea supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea supply modul
4765	0	1039	683	The exhaust temperature value from the sensor befor DOC is above an applicable upper shutoff threshold TOxiCatUs_tShOffThresHiAds_C = Threshold 1 in Normal and Heatmodes (TOxiCatUs_tShOffThresHiRgn_C = Threshold 2 in stand-still)	sensed temperature upstream DOC > shut-off limit	Check air path of engine: EGR-Valve, Intake-Throttle, Check Turbocharger and Piping each for leakage and correct function Check injectors: is an injector got stuck? Exchange temperature sensor upstream DOC
4765	0	1040	683	The exhaust temperature value from the sensor befor DOC is above an applicable upper warning threshold TOxiCatUs_tWarnThresHi_C = Threshold	Sensed temperature upstream DOC > warning limit	Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check injectors: is an injector got stuck? Exchange temperature sensor upstream DOC

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4768	2	1036	683	Static plausibility check: The exhaust temperature value from the sensor before DOC, the exhaust temperature value from the sensor after DOC, the temperature value from the sensor before SCR-Cat, the environment temperature and the coolant engine temperature their ratios to each other exceed their related thresholds. Dynamic plausibility check with environment temperature sensor value: The exhaust temperature value from the sensor before DOC is lower than an applicable environment temperature threshold	Static plausibility check: The exhaust temperature value from the sensor before DOC, the exhaust temperature value from the sensor after DOC, the temperature value from the sensor before SCR-Cat, the environment temperature and the coolant engine temperature their ratios to each other exceed their related thresholds. (difference between temperature after DOC and temperature before DOC > Threshold 1 difference between temperature befor DOC and before SCR > Threshold 2 difference between temperature after DOC and before SCR < Threshold 3 difference between temperature after DOC and ambinet temperature < Threshold 4 differnece between temperatur ambient temperature and engine temperature < Threshold 5) Dynamic plausibility check with environment temperature sensor value: The exhaust temperature value from the sensor before DOC is lower than an applicable environment temperature threshold (< environmental temperature + Threshold 6)	Check ambient temperature => value plausible? upstream DOC sensor mounted within exhaust line? T upstream DOC sensor physically mounted in correct position upstream DOC? (not upstream SCR or downstream DOC?) Check T upstream DOC sensor Check other T-sensors within EAT-system (Exh_tOxiCatDs & UCatUsT_tFlt_mp show plausible values? No errors on them?
4768	2	1881	683	At engine cold start conditions the sensed exhaust gas temperature downstream DOC (Exh_tSensTOxiCatDs) has exceeded the sum of ambient temperature (EnvT_t) + offset (40°C) earlier than the sensed exhaust gas temperature upstream of DOC (Exh_tSensTOxiCatUs). The check is only performed once each ignition cycle and only if the start is judged a cold start. Error status is frozen for that ignition cycle. No healing possible.	Difference temperature of exhaust gas temperature downstream DOC and fixed ambient temperature at ignition on exceeds a certain limit earlier than the difference temperature of exhaust gas temperature upstream DOC and fixed ambient temperature at ignition on.	Check whether all exhaust gas temperature sensors within the EAT system are mounted properly: Within the exhaust line and at correct positions. Check the position of the sensor upstream SCR which might be physically mounted in the wrong position. If cold start condition can be made sure (engine was off for at least 8 h) compare values of EnvT_t, EngDa_tEng, Exh_TOxiCatUs, Exh_tOxiCatDs and SCR_tSensUCatUsT at ignition on, without starting the engine. All identical? Then the sensors itself are okay. Check exhaust piping for leakage. Check wiring of sensors Replace sensors Check DOC => physicallly intact?
4768	3	1044	683	Oxidation catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range	The sensed raw voltage value Exh_uRawTOxiCatUs is above Exh_SRCTOxiCatUs.uMax_C Shortcut to battery	Check wiring harness to temperature sensor upstream DOC Exchange temperature sensor upstream DOC
4768	4	1045	683	Oxidation catalyst upstream temperature sensor: the voltage of sensor measured by ECU is out of the target range	The sensed raw voltage value Exh_uRawTOxiCatUs is below Exh_SRCTOxiCatUs.uMin_C Shortcut to ground	Check wiring harness to temperature sensor upstream DOC Exchange temperature sensor upstream DOC

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
5763	3	1024	594	Actuator of the external EGR valve: the ECU detects a short circuit to battery or open load.	Short cut to battery or open loop.	Check cabling, actuator defect, check actuator and if necessary replace it, check connection cable and if necessary repair or replace it.
5763	3	1226	594	Actuator EGR-valve: short cut to battery is detected	Short-Circuit to battery on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	3	1227	594	Actuator EGR-valve: short cut to battery on ECU pin is detected	Short-Circuit to battery on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	4	1025	594	Actuator of the external EGR valve: the ECU detects a short circuit to ground.	Short cut to ground	Check cabling, actuator defect, check actuator and if necessary replace it, check connection cable and if necessary repair or replace it.
5763	4	1228	594	Actuator EGR-valve: short cut to ground on ECU pin is detected	Short-Circuit to ground on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	4	1229	594	Actuator EGR-valve: short cut to battery on ECU pin is detected	Short-Circuit to ground on component	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	4	1232	5-9-4	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); Voltage below threshold 3.6) Drosselklappe (4.1;6.1;7.8); Voltage below threshold;	Monitoring for CY146 Under Voltage.	Threshold for error detection is an internal ECU threshold. Check wiring, component
5763	5	1023	5-9-4	Actuator error EGR-Valve; signal range check low, measured current is below target	Short circuit to ground.	Check wiring, check cabels and repair or replace if necessary, check actuator with SERDIA 2010 test for EGR and if necessary replace it.
5763	6	1014	594	Actuator error EGR-Valve. Signal range check high.	Short cut to batterie.	Check wiring and repair or replace if necessary, check actuator with SERDIA test for EGR and if necessary replace it.
5763	6	1022	5-9-4	Actuator error EGR-Valve; signal range check high, measured current by ECU is over target	Short circuit to battery or open circuit.	Check cabling, actuator defect, check actuator and if necessary replace it, check connection cable and if necessary repair or replace it.
5763	6	1223	594	Actuator EGR-Valve: Open load on ECU output is detected	Open circuit on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	6	1224	594	Actuator EGR-valve: too high curent is going into the actuator. Output is switched off	Overload on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
5763	6	1230	5-9-4	Actuator error EGR-valve; Overload by short-circuit	Short Circuit over Load	Threshold for error detection is an internal ECU threshold. Check wiring, component
5763	7	1016	594	Actuator position for EGR valve is not plausible, internal error, angular misalignement of the flap.	Position error of throttle flap (deviation > 7%).	Threshold for error detection is an internal ECU threshold. Threshold for error detection, deviation from setpoint > 7%. Troubleshooting with SERDIA 2010 Use Case "EGR Diagnostic".
5763	11	1231	5-9-4	Power stage overtemperature due to high current.	Temperature dependent Over Current	Threshold for error detection is an internal ECU threshold. Check wiring, component
520521	5	1015	594	Actuator error EGR-Valve. Signal range check low.	Short cut to ground.	Check wiring and repair or replace if necessary, check actuator with SERDIA test for EGR and if necessary replace it.
523009	9	825	253	The pressure relief valve (PRV) has reached the number of allowed activations.	Rail pressure has exceeded the trigger threshold of the pressure limiting valve.	Replace pressure relief valve (PRV) and reset fault with Serdia.
523009	10	833	2-5-3	The pressure relief valve (PRV) has reached the allowed opening time.	Rail pressure has exceeded the trigger threshold of the pressure limiting valve.	Replace pressure relief valve (PRV) and reset fault with Serdia.
523212	9	171	3-3-3	Timeout Error of CAN-Receive-Frame ComEngPrt; Engine Protection	Timeout Error (Missing CAN Bus message)	Check wiring harness and customer devices
523240	9	179	527	Timeout CAN-message FunModCtl; Function Mode Control	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
523350	4	565	151	Injector cylinder bank 1: the current drop measured by ECU is above the target range	Short circuit injection bank 1 (all injectors of this bank can be affected)	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
523352	4	566	152	Injector cylinder bank 2: the current drop measured by ECU is above the target range	Short circuit injection bank 2 (all injectors of this bank can be affected)	Threshold for error detection is an internal ECU threshold. Check wiring harness, injectors and if necessary repair/replace it.
523354	12	567	153	Internal hardware monitoring: the ECU detects an error of its injector high current output. Chip of CY33x defect power stage components	Defective powerstage in ECU	Threshold for error detection is an internal ECU threshold. If error is not removable, change ECU.
523450	4	839	1-4-3	Diagnostic fault check for min error of COM message.	The sensed raw value is less than the threshold.	Check cabling, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it.
523470	2	826	146	The pressure relief valve (PRV) has been opened due to excessive pressure.	Rail pressure has exceeded the trigger threshold of the pressure limiting valve.	Threshold for error detection is an internal ECU threshold. Reset the fault and at reappearance check injection system.
523470	2	827	146	The pressure relief valve (PRV) has been opened due to excessive pressure.	Rail pressure has exceeded the trigger threshold of the pressure limiting valve.	Threshold for error detection is an internal ECU threshold. Reset the fault and at reappearance check injection system.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523470	7	876	146	Rail pressure is out of the expected average range.	Rail pressure is out of the expected average range. PRV can not be opened.	(A) Check railpressure relief valve and replace if necessary. (B) Check high pressure pumps, pressure relief valve and metering unit. (C) Change components if necessary
523470	11	831	146	Rail pressure relief valve can not be opened due to the railpressure.	Railpressure out of tolerance range (PRV can not be opened by a pressure peak in this operating point)	Threshold for error detection is an internal ECU threshold. Check railpressure, check rail pressure sensor for plausibility, check FCU.
523470	11	832	146	Rail pressure is out of the expected average range. The PRV can not be opened at this operating point with a pressure shock.	Averaged rail pressure is outside the expected tolerance range.	Threshold for error detection is an internal ECU threshold. Check PRV and replace if necessary.
523470	12	828	146	Rail pressure relief valve: is open. Shutoff conditions.	Shut Off after PRV Open	Threshold for error detection is an internal ECU threshold. Check PRV opening counter and if necessary replace PRV, check rail-pressure sensor for plausibility and if necessary replace it, check FCU and if necessary replace it.
523470	12	829	146	Rail pressure relief valve is open. Warning conditions.	Warning PRV open	Threshold for error detection is an internal ECU threshold. Check PRV opening counter and if necessary replace PRV, check rail-pressure sensor for plausibility and if necessary replace it, check FCU and if necessary replace it.
523470	14	830	146	Rail pressure relief valve is open. (PRV)	Open PRV	Threshold for error detection is an internal ECU threshold. Only after ECU reset. Check PRV opening counter and if necessary replace it, check rail-pressure sensor for plausibility and if necessary replace it, check FCU and if necessary replace it.
523550	12	980	515	Terminal 50 was operated for more than 2 minutes. This may happen due to short to battery or wrong usage of Terminal 50. Starter control is disabled until this error is healed.	Startinformation to Starter (T50-switch) erratic/defect.	Threshold for error detection is an internal ECU threshold. Check cabling, if sensor not working, check start switch and if necessary replace it, check connection cable and if necessary repair or replace it.
523601	13	948	282	Internal hardware monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 3.	Suspected components EDC17cv52 Pin A18: DeltaPressVenturi / Position intake throttle flap Pin K20: First footpedal Pin K21: Air FilterDiffPress Suspected components EDC17cv54 and cv56 Pin A07: Rail pressure	Check cabling of external components, check working voltage and if necessary correct it, check connection cable and if necessary repair or replace it, if error is not removable, change ECU.
523612	3	644	555	supply voltage too high	not used	Threshold for error detection is an internal ECU threshold.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523612	4	646	555	supply voltage too low	not used	Threshold for error detection is an internal ECU threshold.
523612	12	387	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Injector shut off demand for the ICO coordinator System responses: not	Threshold for error detection is an internal ECU threshold. Caution ! Sequence error, check error memory for other errors.
523612	12	612	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory.	Plausibility check failed (MoCADC_uNTP_mp is higher than MoCADC_uNTPMax_C).	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	613	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Analysis of test voltage (Value is out of the target -> ECU internal error)	Threshold for error detection is an internal ECU threshold. Check wiring, check connected sensors actuators. If error is still present, exchange ECU.
523612	12	614	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Analysis of the ratiometric correction (Value is out of the target -> ECU internal error)	Threshold for error detection is an internal ECU threshold. Check wiring, check connected sensors actuators. If error is still present, exchange ECU.
523612	12	615	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error report due to an error in the plausbility of Function Coordination(FC) and Monitoring Modul(MM)(ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	616	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error report due to an interrupted SPI communication (ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	617	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	multiple error in complete ROM-test during postdrive detected (ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	618	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Too less bytes received by monitoring memory from CPU as response (ECU internal error). Loss of synchronization sending bytes to the monitoring memory from CPU	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	619	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Suspected components: Injector ECU wiring harness/connector	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	620	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error trying to set MM Response time (ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	621	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error detected in the internal ECU communication, Too many SPI errors during MoCSOP execution	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523612	12	623	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in the check of the shut-off path test of the under voltage detection (ECU internal error). Diagnostic fault check to report the error in undervoltage monitoring	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	624	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in the check of the shut-off path of the monitoring module (ECU internal error).	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	625	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Time out error trying to set or cancelling the alarm task (ECU internal error). Failure setting the alarm task period	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	627	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in time monitoring of the shut-off path test (ECU internal error). Diagnostic fault check to report the timeout in the shut off path test	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	628	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in the check of the shut-off path test of the over voltage detection (ECU internal error). Diagnostic fault check to report the error in overvoltage monitoring	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	629	555	The two voltage values (ADC_VAL1, ADC_VAL2), detected by the accelerator pedal, are not plausible to each other.	Defect pedal or wiring	Threshold for error detection is an internal ECU threshold. Check Pedal, repair or exchange the Pedal. Check wiring. If error is still present, exchange ECU.
523612	12	630	555	Impermissible offset between the engine speed of level 2 and level 1	Calculated engine speed in level 1/2 implausible (-> ECU internal error).	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	631	555	Diagnostic fault check to report the plausibility error between level 1 energizing time and level 2 information	Implausible injection energizing time for either PiIx or MI1 or PoIx.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	632	555	Error in the plausibility of the start of energising angles	Implausible start of energising of either PiIx or MI1 or PoIx.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	633	555	Error in the plausibility of the energising times of the zero fuel quantity calibration	The energising times of the zero fuel quantity calibration ZFC is out of the target. (-> ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	634	555	Error in the plausibility of PoI2 efficiency.	Error in the plausibility of PoI2 efficiency.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	635	555	Error in the PoI2 shut-off.	Error in the PoI2 shut-off.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	636	555	Error in the plausibility of PoI3 efficiency.	Error in the plausibility of PoI3 efficiency.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523612	12	637	555	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Error in the plausibility of current energising time with maximum permitted energising time. Diagnostic fault check to report the error due to Over Run	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	638	555	Error in the plausibility of the wave correction parts	Error in the plausibility of the wave correction parts	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	639	555	Plausibility error of the Rail pressure sensor	In case the gradient of rail pressure is larger than the max threshold or lesser than the min threshold. Rail metering unit defect. Leakge in the Rail System.	Threshold for error detection is an internal ECU threshold. Check metering unit or cable. Check Rail pressure. Check the Rail System of leakage.
523612	12	640	555	Error in the torque comparison between permissible engine torque and current actual torque	Error in the torque comparison between the permissible inner engine torque and the current plausible actual torque.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	641	555	Diagnosis of curr path limitation forced by ECU monitoring level 2	The torque comparison is not plausible with the torque monitoring.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	642	555	Diagnosis of lead path limitation forced by ECU monitoring level 2	The setpoint path of the air system is limited by the limitation torque of the functional control unit monitoring.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	643	555	Diagnosis of set path limitation forced by ECU monitoring level 2.	If the quantity setpoint is exceeds the limit of the torque function.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	714	555	Error report "WDA wire is active" due to a defect query/response communication	Error detection by monitoring module	Threshold for error detection is an internal ECU threshold. Software reset.
523612	12	715	555	Error report "ABE wire is active" due to undervoltage detection	The reason is that a slow dropping of the vehicle electrical system voltage (defective autobattery) should not lead the ECU OCWDA's diagnose to enter an error in the fault memory due to an undervoltage recognition.	Threshold for error detection is an internal ECU threshold. Software reset.
523612	12	716	555	Error report "ABE wire is active" due to overvoltage detection	If the ABE/WDA powerstage shut-off is active due to an overvoltage detection.	Threshold for error detection is an internal ECU threshold. software reset.
523612	12	717	555	Error report "ABE/WDA active" due to an unknown reason	The reason is that a slow dropping of the vehicle electrical system voltage (defective autobattery) should not lead the ECU OCWDA's diagnose to enter an error in the fault memory due to an undervoltage recognition.	Threshold for error detection is an internal ECU threshold. Software reset.
523612	12	1170	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error during positive test (ECU internal error). Diagnostic fault check to report that the positive test failed	Threshold for error detection is an internal ECU threshold. Reflash ECU. If error is still activ replace ECU.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523612	12	1857	555	Fault in the monitoring during the engine start. Start requested in level 1, but not released in level 2 which leads to no fuel injection.	wiring is not according DEUTZ requirements engine start conditions are not observed low battery voltage during start malfunction of starter	Threshold for error detection is an internal ECU threshold. check other active errors and fix them. check all needed engine start conditions, e.g. neutral switch. check the engine speed during starting of the engine. If it's too low, then check the battery voltage and then check the starter for malfunction.
523612	14	973	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory.	Visibility of Softwareresets in DSM	Threshold for error detection is an internal ECU threshold.
523612	14	974	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory.	Visibility of Softwareresets in DSM	Threshold for error detection is an internal ECU threshold.
523612	14	975	555	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Visibility of SoftwareResets in DSM	Threshold for error detection is an internal ECU threshold. If possible the software update has to be done. Replace the ECU.
523613	0	856	134	Rail pressure: the fuel pressure in rail calculated by ECU is below the target range which is dependant on the engine speed.	Pressure governor deviation exceeds the limiting value based on the engine speed.	Threshold for error detection is an internal ECU threshold. (A) Check for leakage (B) Check fuel-primary pressure (C) Change components, check sensor and if necessary replace it, check fuel system and if necessary repair it
523613	0	857	134	Rail pressure: the fuel pressure in rail calculated by ECU is below the target range which is dependant on the engine speed.	maximum positive deviation of rail pressure exceeded concerning set flow of fuel.	Threshold for error detection is an internal ECU threshold. (A) Check for leakage (B) Check fuel-primary pressure (C) Change components, check sensor and if necessary replace it, check fuel system and if necessary repair it
523613	0	858	134	Rail pressure: the fuel pressure in rail calculated by ECU is above the target range which is dependant on the engine speed.	leakage is detected based on fuel quantity balance.	Threshold for error detection is an internal ECU threshold. (A) Check backflow pressure (B) Check Injector function with SerDia (C) Change components (metering unit, injector) if necessary
523613	0	859	134	Rail pressure: the fuel pressure in rail calculated by ECU is above the target range which is dependant on the engine speed.	Maximum negative rail pressure deviation with metering unit on lower limit is exceeded.	Threshold for error detection is an internal ECU threshold. (A) Check backflow pressure (B) Check Injector function with SerDia (C) Change components (metering unit, injector) if necessary
523613	0	862	134	Rail pressure: the fuel pressure in rail calculated by ECU is above the target range.	Rail pressure exceeds the limiting value.	(A) Check backflow pressure (B) Check pressure relief valve and metering unit. (C) Change components if necessary

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523613	1	861	134	Rail pressure: the fuel pressure in rail calculated by ECU is below the target range which is dependant on the engine speed.	Rail pressure falls below the limiting value based on the engine speed.	Threshold for error detection is an internal ECU threshold. (A) Check backflow pressure (B) Check Injector function with SerDia (C) Change components (metering unit, injector) if necessary
523613	2	864	134	Rail pressure metering unit, Setpoint of metering unit in overrun mode not plausible.	Pressure pump delivery quantity in overrun exceeds the threshold based on the pressure.	Threshold for detection is an internal ECU threshold. (A) Check backflow pressure (B) Check pressure relief valve and metering unit. (C) Change components if necessary
523615	3	594	135	Fuel metering unit: the current drain measured by ECU is above the target range	short circuit to battery high side	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	3	596	135	Fuel metering unit: the current drain measured by ECU is above the target range	short circuit to battery low side	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	4	595	135	Fuel metering unit: the current drain measured by ECU is above the target range	short circuit to ground high side	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	4	597	135	Fuel metering unit: the current drain measured by ECU is above the target range	short circuit to ground low side	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	5	592	135	Detecting an open load fault in the metering unit	wiring harness defective, cable break	Threshold for error detection is an internal ECU threshold. Check wiring harness and metering unit if necessary repair/replace it.
523615	12	593	135	powerstage of metering unit is overheated	over temperature	Threshold for error detection is an internal ECU threshold. Check functionality of metering unit and replace it if needed. Check temperature of metering unit and improve the installation in case of overheating.
523632	3	1127	665	Urea supply module pressure sensor: the current drain measured by ECU is above the target range	Shortcut to battery Broken wiring Pressure sensor in urea supply module defect	Check wiring Check pressure sensor in urea supply module
523632	4	1128	665	Urea supply module pressure sensor: the current drain measured by ECU is above the target range The sensed raw voltage value SCR_uRawUPmpP is above SCR_SRCUPmpP.uMin_C	Shortcut to ground Broken wiring Pressure sensor in urea supply module defect	Check wiring Check pressure sensor in urea supply module
523632	11	1117	666	Urea supply module pump: the current drain measured by ECU is above the target range	When the pump motor does not switch to pump actuation mode after temperature measurement has been carried out.	Threshold for error is an internal ECU threshold

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523698	11	122	591	Shut off request from supervisory monitoring function	Engine Shut Off due to supervisory function	Threshold for error detection is an internal ECU threshold. Check error memory for additional errorcode to find root cause. Depending on additional error follow the documented "Take action for repair".
523718	3	1100	676	Urea heater relay: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring, broken relay	Threshold for error detection is an internal ECU threshold Check wiring Check SCR main relay
523718	4	1101	676	Urea heater relay: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring, broken relay	Threshold for error detection is an internal ECU threshold Check wiring Check SCR main relay
523718	5	1098	676	Urea heater relay: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring broken relay	Threshold for error detection is an internal ECU threshold Test SCR main relay Check cabling, if necessary replace relay.
523719	4	1109	672	Urea supply module heater: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring Heating element in supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check cabling, if necessary replace supply module
523719	5	1106	672	Urea supply module heater: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Heating element in supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check cabling, if necessary replace supply module
523720	8	925	148	Supply module heater: Duration of switch on is too long.	uty cycle for temperature readout from supply module heater to the control unit is out of range; Supply modul defect, fault in the wiring.	When the received supply module heater temperature duty cycle SCR_rSMT is out of the failurerange (SCR_rSMFailMax_C < SCR_rSMHtrT < SCR_rSMFailMin_C) Supply module check and replace if necessary. Check the wiring.
523720	8	926	148	Supply module heater: Dutycycle timing over error threshold.	Duty cycle for temperature readout from supply module heater to the control unit is not valid. Supply modul defect, fault in the wiring.	When the received supply module heater duty cycle SCR_rSMHtrT is in the valid range (SCR_r- Supply module check and replace if necessary. Check the wiring.
523721	8	930	689	Supply module heater: Dutycycle timing over error threshold.	Duty cycle for temperature readout from supply module to the control unit is out of range. Supply modul defect, fault in the wiring.	Supply module check and replace if necessary. Check the wiring.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523721	8	931	689	Supply module heater: Dutycycle timing out of valid range.	Duty cycle for temperature readout from supply module to the control unit is not valid. Supply modul defect, fault in the wiring.	When the received supply module duty cycle SCR_rSMT is in the valid range (SCR_rSMTVld-Min_C <= SCR_rSMT <= SCR_rSMTVldMax_C), OR in the failure range (SCR_rSMFailMin_C <=SCR_rSMT <= SCR_rSMFailMax_C) Supply module check and replace if necessary. Check wiring.
523721	11	927	689	Supply module heater: temperature measurement not available.	Duty cycle for temperature readout from supply module heater to the control unit is not available. Supply modul defect, fault in the wiring.	Threshold for detection is an internal ECU threshold. No erasing in the current driving cycle. Supply module check and replace if necessary. Check the wiring.
523722	8	929	691	Supply module heater: Faulty PWM signal from supply module.	PWM Signal for temperature readout from supply module to the control unit is not valid. Supply modul defect, fault in the wiring.	Threshold for error detection is an internal ECU threshold. When valid Sync followed by temperature information signal is received AND valid sync and temperaturesignal for both information is received one after the other. Supply module check and replace if necessary. Check the wiring.
523776	9	291	119	Timeout Error of CAN-Receive-Frame TSC1TE - active	Timeout Error (Missing CAN Bus message)	Threshold for error detection is an internal ECU threshold. Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
523777	9	292	119	Message TSC1-TE has been missing (passive)	Passive timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range, check actuator
523895	13	559	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 1 (in firing order).	Missing or wrong injector adjustment value for cyl. 1.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA). Use SERDIA UseCase to check it.
523896	13	560	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 2 (in firing order).	Missing or wrong injector adjustment value for cyl. 2	Threshold for error detection is an internal ECU threshold. check dataset and flash correct injector adjustement value (IMA). Use SERDIA UseCase to check it.
523897	13	561	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 3 (in firing order).	Missing or wrong parametrisation of injector adjustment cyl. 3.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA).
523898	13	562	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 4 (in firing order).	Missing or wrong injector adjustment value for cyl. 4.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA).
523899	13	563	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 5 (in firing order).	Missing or wrong injector adjustment value for cyl. 5.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA).

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523900	13	564	1-5-8	Missing or wrong injector adjustment value programming (IMA) injector 6 (in firing order).	Missing or wrong injector adjustment value for cyl. 6.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA).
523912	4	73	7-2-2	@ engines < 4l: Throttle valve error, Open Load or Short cut to Battery, blocked valve or wrong control signal for valve. @ engines with Burner T4i: Pressure Sensor error after valve (DV2), lower limit reached	The sensed raw voltage value is below the minimum threshold.	The sensed raw voltage value DPM_uRawBrnDVDsP is above the minimum threshold DPM_SRCBrnDVDsP.uMin_C @ CRT < 4l: check throttle valve @ engines with Burner T4i: check back-pressure valve
523924	4	42	167	Overload at Pins O_V_RH2x: A01, K74, K91. Components on A01, K74, K91 cannot be activated. Internal ECU power stage switched off.	Suspected components: 1- Pin K91: Clutch switch, Brake switch, Engine brake demand, Regeneration activation, Parking brake, Gearbox N, Fan control 1 2- Pin K74: Boost air cooler bypass or electrical fuel pump relay, Fan control 2/fuel valve for flame star	Threshold for error detection is an internal ECU threshold. Check wiring harness and connected loads on pins A01, K74, K91 and/or reflash ECU. If error is still present, exchange ECU.
523925	3	38	731	Short circuit to battery error of actuator relay 2. Components on Pin A88, K57 cannot be activated. Internal ECU power stage switched off.	Suspected Components: 1- Lamps K57: Warn Ash Charge, Diagnostic, Warn Coolant Temp/Level, Warn Oil, Warn Boost Air, Warn Air Filter, Warn Water in Fuel, SCR, Regeneration, Engine Running. 2- Relay Preheat A88 3- Exhaust Flap A88	Check wiring harness and connected loads on pins A88, K57.
523925	4	43	731	Short circuit to ground actuator relais 3 Overload at Pins O_V_RH3x: A88, K57	Suspected components: 1- Pin A88: Preheat relay, Exhaust flap 2- Pin K 57: - control lamps: - OBD, preheat lamp, warning temp., warning oil, maintenance lamp, regeneration indicator, alternator management, engine running, diagnostic	Threshold for error detection is an internal ECU threshold. Check wiring harness and connected loads on pinsA88, K57. If error is still present, exchange ECU.
523926	4	44	732	Short circuit to ground aktuator relais 4. Overload at Pins O_V_PCV: A90	Suspected components: Fan, Wiring harness	Threshold for error detection is an internal ECU threshold. Check wiring harness and connected loads on pin A90. If error is still present, exchange ECU.
523927	3	40	733	Short circuit to battery error of actuator relay 2. Components on Pin A04, A05 cannot be activated. Internal ECU power stage switched off.	Suspected Components: 1- Urea Pump A04 2- SCR Heater A05	Check wiring harness and connected loads on pins A04, A05.
523935	12	168	763	Timeout Error of CAN-Transmit-Frame EEC3VOL1; Engine send messages	Fault is detected if a TimeOut of the EEC3VOL1 frame has occured.	Check wiring harness and customer nodes
523936	12	169	764	Timeout Error of CAN-Transmit-Frame EEC3VOL2; Engine send messages	Timeout Error (Missing CAN Bus message)	Check wiring harness and customer nodes

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523938	9	133	766	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1IGCVol1 information; factors & Sensorcalibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX sensor and sensor connection check
523939	9	134	766	Broadcast Announce Message of the calibration message of the upstream catalytic NOx sensor has failed. Timeout Error (BAM to BAM) for CAN-Receive-Frame AT1IGCVol1 information. factors & Sensorcalibration for NOX Sensor (SCR-system upstream cat, DPF-system downstream cat).	Defective Nox sensor, faulty parameterization	NOX sensor and sensor connection check
523940	9	135	766	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1IGCVol1 information; factors & Sensorcalibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX sensor and sensor connection check
523941	9	140	767	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensorcalibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	Timeout Error (Missing CAN Bus message)	NOX downstream sensor and sensor connection check
523942	9	141	767	Timeout Error (BAM to BAM) for CAN-Receive-Frame AT1OGCVol2 information, Calibration message 1 of the after catalyst NOx sensor has failed. Factors & Sensorcalibration for NOX Sensor (SCR-system downstream cat, DPF-system downstream cat)	Defective Nox sensor, faulty parameterization.	NOX downstream sensor and sensor connection check.
523943	9	142	767	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensorcalibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	The fault is detected when a timeout error in packet 2 of NOxSenVol2Rx frame occurs.	NOX downstream sensor and sensor connection check
523960	0	1011	771	Physical range check high for EGR cooler downstream temperature.	Sensed temperature downstream EGR-cooler > limit.	EGR-Valve blocked open EGR-Valve actuator defect EGR-cooler defect (check for coolant water) Reed Valve defect Intake throttle blocked in closed position Exhaust pressure too high Check Nox-sensor upstream SCR catalyst dp venturi sensor defect
523960	1	1012	771	Physical range check low for EGR cooler downstream temperature.	sensor voltage > lower limit	EGR-Valve blocked open EGR-Valve actuator defect EGR-cooler defect (check for coolant water) Reed Valve defect Intake throttle blocked in closed position Exhaust pressure too high Check Nox-sensor upstream SCR catalyst dp venturi sensor defect

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523982	0	360	737	Powerstage diagnosis disabled; Indicating that battery voltage is not high.	Powerstage diagnostic can be deactivated due to too high battery voltage.	Check wiring, check alternator, check cables and repair or replace if necessary.
523982	1	361	737	Powerstage diagnosis disabled; Indicating that battery voltage is not low.	Powerstage diagnostic can be deactivated due to too low battery voltage.	Check wiring, check alternator, check cables and repair or replace if necessary.
523984	3	1239	788	Actuator relay 5: the voltage measured by ECU is out of the target range	Short-Circuit to battery to component	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU
523986	4	1241	176	Actuator relay 4: the voltage measured by ECU is out of the target range	Short-Circuit to ground to component	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU
523987	4	1242	791	Actuator relay 5: the voltage measured by ECU is out of the target range	Short-Circuit to ground to component	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU
524050	11	1434	8-3-6	CAN; not used	not used	not used
524051	11	1435	8-3-7	CAN; not used	not used	not used
524057	2	1505	8-4-3	Low fuel pressure: the low fuel pressure calculated by ECU is underneath the target range; the ECU activates a system reaction	Fuel pressure below warning threshold	Threshold for error detection is an internal ECU threshold. Check low fuel pressure system (fuel feed pump, relay , fuse, wiring, sensor) and if necessary repair or replace it.
524063	3	1558	869	SCR heater mainrelay; short circuit to battery Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Short-Circuit to battery on wiring to component	Check wiring, component
524063	4	1559	869	Connection between heating valve (Y31) on the control unit Pin A:92 and Load side SCR heater main relay (K31) is a short cut to ground. Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Faulty wiring, faulty heater relay (K27-K31), defective heating valve (Y31), broken element in heating.	Disconnect plug from heating valve (Y31) and reset fault. If fault is still present you have to look in the wiring of Y31 to the control unit Pin A:92. If error is no longer present, you have to check the wiring of Y31 via relay K31 and possibly the heating cables and relay (K27-K30).
524063	5	1555	869	Urea backflow line heater: broken wiring detected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Open Load on wiring to component	Check wiring, component
524063	5	1556	869	Urea main relay: broken wiring detected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	relay defect relay not connected wiring harness broken problems with supply voltage	Check wiring, component
524063	5	1557	869	Urea pressure line heater: broken wiring detected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Open load on wiring to component	Check wiring, component
524063	5	1560	869	SCR relay for suction line not connected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	relay defect relay not connected wiring harness broken problems with supply voltage	Check wiring, component
524063	5	1561	869	Open load on wiring to component Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Open load on wiring to component	Check wiring, component

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524063	5	1562	869	SCR heater tank; open load	Open load on wiring to component	Check wiring, component
524063	12	1646	869	SCR supply module temperature is not reaching a threshold before a calibratable time is exceeded. Corresponding to the environmental Temperature a specific defrosting time is given. After starting the defrosting a clock counter is starting. Does the counter reach the given defrosting time limit, an error will be detected. Is the temperature reached in time the clock counter will be reset Example: by using the calibrated temperature/time curve --> environmental temperature 0°C --> defrosting time limit 6000s --> if the clock counter reaches 6000s the error will be detected	Suspected components: Enviroment temperature sensor defect SCR supply module temperature sensor defect SCR supply module electrical heater defect	Check Environment temperature sensor SCR supply module temperature sensor SCR supply module electrical heater
524065	0	1565	892	The relativ pressure value of the exhaust gas from the urea cat upstream sensor is greater than an applicable maximum pressure threshold	sensed presure upstream SCR catalyst > physical high range limit f(exhaust volume flow) UCatUsP_pRelFlt_mp > UCatUsP_pMax_mp	Check for crystallisation in exhaust line upstream SCR and dwnstream of urea injector Check correct connection from exhaust line to pressure sensor upstream SCR catalyst: syphons?, water in tube?, water in sensor? Check that exhaust pipe outlet is free (downstream SCR catalyst) Check wiring of pressure sensor upstream SCR catalyst Check pressure sensor upstream SCR catalyst: sensor has no connection to vehicle body? => Ensure that sensor is free Does sensor oscillate heavely at engine low idle / high idle? => try to supress the oscillating Exchange pressure sensor upstream SCR catalyst Check calculated exhaust volume flow of engine within EDC: SCR_dvolSCRUs pausible? If not: Check T sensor upstream SCR catalyst, check complete engine air path: EGR-Valve, Intake throttle, turbocharger, piping for leakage and function Check SCR catalyst: Broken? Exchange SCR-Catalyst

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524065	1	1566	892	The relativ pressure value of the exhaust gas from the urea cat upstream sensor is less than an applicable minimum pressure threshold	sensed presure upstream SCR catalyst > physical high range limit f(exhaust volume flow) UCatUsP_pRelFlt_mp < UCatUsP_pMin_mp	Check correct connection from exhaust line to pressure sensor upstream SCR catalyst: leakage? Check electric connector: 4h pin open / new connector type used? pressure exchange from inside electrical connector with the environemt possible Check exhaust line: any leakages upstream of SCR catalyst? Check wiring of pressure sensor upstream SCR catalyst Exchange pressure sensor upstream SCR catalyst Check calculated exhaust volume flow of engine within EDC: SCR_dvolSCRUs pausible? If not: Check T sensor upstream SCR catalyst, check complete engine air path: EGR-Valve, Intake throttle, turbocharger, piping for leakage and function Check SCR catalyst: Broken? Exchange SCR-Catalyst
524065	2	1598	892	Comparison of urea cat upstream exhaust gas- and environment pressure, the difference should not exceed a certain limit abs(UCatUsP_pDiffEnvCat_mp) > Threshold	absolut value of difference between sensed pressure upstream SCR catalyst and environmental pressure > limit abs(UCatUsP_pDiffEnvCat_mp) > Threshold	Check electric connector: 4h pin open / new connector type used? pressure exchange from inside electrical connector with the environemt possible? water in sensor? sensor frozen? Check wiring of pressure sensor upstream SCR catalyst Exchange pressure sensor upstream SCR catalyst Check intake manifold pressure sensor (Air_pCACDs) Check ambient pressure sensor (EnvP_p)
524065	3	1569	892	voltage of pressure sensor upstream SCR > voltage high limit	voltage of pressure sensor upstream SCR > voltage high limit	Check wiring of pressure sensor upstream SCR catalyst Check pressure sensor upstream SCR catalyst Exchange pressure sensor upstream SCR catalyst
524065	4	1570	892	voltage of pressure sensor upstream SCR < voltage low limit	voltage of pressure sensor upstream SCR < voltage low limit	Check wiring of pressure sensor upstream SCR catalyst. Check pressure sensor upstream SCR catalyst. Exchange pressure sensor upstream SCR catalyst

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524067	0	1581	894	Filtered urea supply module heater temperature value is above an applicable maximum heater temperature threshold of the supply module The temperature is read out via the PWM signal of the urea pump. That is only possible in status init of the SCR-system short after ignition was switched on. When that state is left the sensed temperature value is frozen.	sensed temperature of supply module heater > physical high range limit	Compare SCR_tSMT with SCR_tSMHtrT. Both show the same value? Check urea tank temperature (SCR_tAdapUTnkT). Very hot (> 70°C), urea tank heater permanet on? Does the pump never stop working? Check wiring to supply module Compare SCR_tSMT with SCR_tSMHtrT. Both show different values or urea tank temperature (SCR_tAdapUTnkT) is cold: exchange urea pump unit Supply module heater temperature sensor defect Supply module heater defect Supply module defect
524067	0	1585	894	Filtered urea supply module temperature value (SCR_tSMT) is above an applicable maximum temperature threshold of the supply module The temperature is read out via the PWM signal of the urea pump. That is only possible in status init of the SCR-system short after ignition was switched on. When that state is left the sensed temperature value is frozen.	sensed temperature of urea within supply module > physical high range limit	Compare SCR_tSMT with SCR_tSMHtrT. Both show the same value? Check urea tank temperature (SCR_tAdapUTnkT). Very hot (> 70°C), ure tank heater permanet on? Does the pump never stop working? Check wiring to supply module Compare SCR_tSMT with SCR_tSMHtrT. Both show different values or urea tank temperature (SCR_tAdapUTnkT) is cold: exchange urea pump unit Supply module temperature sensor defect Supply module heater defect Supply module defect
524067	1	1582	894	Filtered urea supply module heater temperature value is below an applicable minimum heater temperature threshold of the supply module The temperature is read out via the PWM signal of the urea pump. That is only possible in status init of the SCR-system short after ignition was switched on. When that state is left the sensed temperature value is frozen.	sensed temperature of supply module heater < threshold	Check ambient temperature EnvT_t < Threshold? Compare SCR_tSMT with SCR_tSMHtrT Check wiring with regard to supply modul heater exchange urea pump unit Supply module heater temperature sensor defect Supply module defect
524067	1	1586	894	Filtered urea supply module temperature (SCR_tSMT) value is below an applicable minimum temperature threshold of the supply module The temperature is read out via the PWM signal of the urea pump. That is only possible in status init of the SCR-system short after ignition was switched on. When that state is left the sensed temperature value is frozen.	sensed temperature of urea within supply module < physical low range limit	Check ambient temperature EnvT_t < threshold? Compare SCR_tSMT with SCR_tSMHtrT Check wiring with regard to supply modul heater exchange urea pump unit Supply module temperature sensor defect Supply module defect

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524067	2	1867	894	absolute diference of sensed temperature of supply module heater temperature and ambient temperature UPmpT_tDiffP-mpHtrAmb_mp > threshold	absolute diference of sensed temperature of supply module heater temperature and ambient temperature UPmpT_tDiffP-mpHtrAmb_mp > threshold	Compare SCR_tSMT with SCR_tSMHtrT, EnvT_t and CEngTds_t and SCR_tAdapUTnkT => All identical? If not: Has the machine been brought from cold environment into a warm one or vice versa without engine running, e.g. at workshop? Environment temperature sensor defect Coolant temperature sensor defect Supply module temperature sensor defect Problem at Supply module unit (broken?) => exchange supply module
524067	2	1868	894	absolute diference of sensed temperature of supply module temperature and ambient temperature > threshold	absolute diference of sensed temperature of supply module temperature and ambient temperature UPmpT_tDiffPmpAmb_mp > threshold	Compare SCR_tSMT with SCR_tSMHtrT, EnvT_t and CEngTds_t and SCR_tAdapUTnkT => All identical? If not: Has the machine been brought from cold environment into a warm one or vice versa without engine running, e.g. at workshop? Environment temperature sensor defect Coolant temperature sensor defect Supply module temperature sensor defect Problem at Supply module unit (broken?) => exchange supply module
524074	9	1533	246	Open load sensor internally at NOx-sensor downstream SCR	Open load sensor internally at NOx-sensor downstream SCR	Threshold for error detection is an internal ECU threshold. Check NOx-Sensor downstream SCR catalyst: water inside? Shake out sensor after dismounting. => If water inside, replace sensor. Check mounting position of sensor and judge it regarding condense water formation / agglomeration. Check wiring harness Exchange sensor
524075	11	1534	247	Short circuit sensor internally at NOx-sensor downstream SCR	Short circuit sensor internally at NOx-sensor downstream SCR	Threshold for error detection is an internal ECU threshold. Check NOx-Sensor downstream SCR catalyst: water inside? Shake out sensor after dismounting. => If water inside, replace sensor. Check mounting position of sensor and judge it regarding condense water formation / agglomeration? Rearrange if critical and possible Check wiring harness Exchange sensor

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524076	9	1535	248	Open line sensor internally at NOx-sensor downstream SCR NOx Sensors are CAN Sensors --> no HW Pin on the ECU	Open line sensor internally at NOx-sensor downstream SCR	Threshold for error detection is an internal ECU threshold. Check NOx-Sensor upstream SCR catalyst: water inside? Shake out sensor after dismounting. => If water inside, replace sensor. Check mounting position of sensor and judge it regarding condense water formation / agglomeration. Check wiring harness Exchange sensor
524077	11	1536	249	Short circuit sensor internally at NOx-sensor downstream SCR NOx Sensors are CAN Sensors --> no HW Pin on the ECU	Short circuit sensor internally at NOx-sensor downstream SCR	Threshold for error detection is an internal ECU threshold. Check NOx-Sensor upstream SCR catalyst: water inside? Shake out sensor after dismounting. => If water inside, replace sensor. Check mounting position of sensor and judge it regarding condense water formation / agglomeration. Check wiring harness Exchange sensor
524078	9	1537	255	Lambda value of NOx-Sensor downstream SCR is out of range. When the filtered Lambda concentration value at the sensor (ComRxSCR_rFltLamDs_mp) is greater than the physical range check max. lambda threshold	sensed lambda value of Nox-sensor downstream SCR catalyst is > physical high limit ComRxSCR_rCanLamDs_mp > threshold	Check whether NOx-sensor downstream SCR catalyst is physically mounted within the exhaust line Check Lambda values of NOx-sensor downstream SCR catalystat at idle conditions, ComRxSCR_rCanLamDs_mp > threshold? Compare to ComRxSCR_rCanLamUs_mp. Values must be almost identical Check CANBus of NOx-sensor downstream SCR catalyst Check NOx-sensor downstream SCR catalyst wiring Check NOx-sensor downstream SCR catalyst itself Replace NOx-sensor downstream SCR catalyst

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524079	9	1538	256	sensed lambda value of NOx-sensor downstream SCR catalyst is < physical low limit ComRxSCR_rCanLamDs_mp < threshold	sensed lambda value of NOx-sensor downstream SCR catalyst is < physical low limit ComRxSCR_rCanLamDs_mp < threshold	Compare to ComRxSCR_rCanLamUs_mp. ComRxSCR_rCanLamDs_mp must be almost identical! If almost identical, Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check injection system of engine. Injector stuck? if sensed lambda upstream SCR higher (ComRxSCR_rCanLamUs_mp) : Diesel in Urea-tank? Check CANBus of NOx-sensor downstream SCR catalyst Check NOx-sensor downstream SCR catalyst wiring Check NOx-sensor downstream SCR catalyst itself Replace NOx-sensor downstream SCR catalyst
524080	9	1539	257	sensed lambda value of Nox-sensor upstream SCR catalyst is > physical high limit ComRxSCR_rCanLamUs_mp > Threshold	sensed lambda value of Nox-sensor upstream SCR catalyst is > physical high limit ComRxSCR_rCanLamUs_mp > Threshold	Check whether NOx-sensor upstream SCR catalyst is physically mounted within the exhaust line Check Lambda values of NOx-sensor upstream SCR catalystat at idle conditions, ComRxSCR_rCanLamUs_mp < Threshold? Compare to ComRxSCR_rCanLamDs_mp. Must be almost identical Check CANBus of NOx-sensor upstream SCR catalyst Check NOx-sensor upstream SCR catalyst wiring Check NOx-sensor upstream SCR catalyst itself Replace NOx-sensor upstream SCR catalyst
524081	9	1540	258	sensed lambda value of Nox-sensor upstream SCR catalyst is < physical low limit ComRxSCR_rCanLamUs_mp < Threshold	sensed lambda value of Nox-sensor upstream SCR catalyst is < physical low limit ComRxSCR_rCanLamUs_mp < Threshold	Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check injection system of engine. Injector stuck? Check CANBus of NOx-sensor upstream SCR catalyst Check NOx-sensor upstream SCR catalyst wiring Check NOx-sensor upstream SCR catalyst itself Replace NOx-sensor upstream SCR catalyst
524083	9	1542	261	sensed NOx-value of NOx-sensor downstream SCR catalyst < Threshold	sensed Nox-value of Nox-sensor downstream SCR catalyst < physical low limit	Check CANBus of NOx-sensor downstream SCR catalyst Check NOx-sensor downstream SCR catalyst wiring Check NOx-sensor downstream SCR catalyst itself Replace NOx-sensor downstream SCR catalyst

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524085	9	1544	912	sensed Nox-value of Nox-sensor upstream SCR catalyst < Threshold	sensed Nox-value of Nox-sensor upstream SCR catalyst < physical low limit	Check CANBus of NOx-sensor upstream SCR catalyst Check NOx-sensor upstream SCR catalyst wiring Check NOx-sensor upstream SCR catalyst itself Replace NOx-sensor upstream SCR catalyst
524100	9	1666	924	Timeout error of CAN-Transmit-Frame Com-DPFHisDat.	Open load on CANBUS wiring.	Check wiring, component.
524104	9	1676	928	Timeout error of CAN-Receive-Frame Com-RxDPFCtl. CM1 Module Customer Recieve Message.	Time out of Check CANBUS EAT Control Receive Message, PGN65348. The message is not received.	Threshold for error detection is an internal ECU threshold. Check CANBUS EAT Control Receive Message, PGN65348. CM1 Module Customer Recieve Message.
524118	9	1672	9-4-2	Timeout error of CAN-Receive-Frame Com-RxCM1	If the frame CM1 message is not transmitted successfully	Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
524121	9	1683	9-4-5	Timeout error of CAN-Receive-Frame Com-RxTrbChActr	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
524125	9	1687	9-4-9	Timeout error of CAN-Receive-Frame ComTxTrbChActr	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
524141	7	1827	192	DEF dosing valve is blocked with crystalized urea or other deposits.	While SCR system is starting up and fter urea pressure reaches 10000 hPa, the DEF dosing module is tested. Expectation is that urea pressure drops below 1500 hPa if injector works properly. The test is repeated up to 3 times before an error is set. SCRSysPresMon_stPresDropDet_mp = 0 while SCRCo_stStatus_mp = 16. Suspected component: wiring harness DEF dosing valve The error is stored into the EEPROM of the ECU and status at ECU shut down is regained at ignition on.	Check electrical connection of urea injector: - wiring harness - connector Conduct SERDIA use-case "injection test". If it is faulty: - remove urea injector from exhaust line: - check for crystallisation direct on injector nozzle / plate - rinse it thoroughly in water - remount urea injector and conduct SERDIA use-case "injection test" If the error is still active, then exchange urea injector.
524141	7	1858	192	DEF dosing valve is blocked with crystalized urea or other deposits.	While SCR system is starting up and fter urea pressure reaches 10000 hPa, the DEF dosing module is tested. Expectation is that urea pressure drops below 1500 hPa if injector works properly. The test is repeated up to 3 times before an error is set. SCRSysPresMon_stPresDropDet_mp = 0 while SCRCo_stStatus_mp = 16. Suspected component: wiring harness DEF dosing valve The error is stored into the EEPROM of the ECU and status at ECU shut down is regained at ignition on.	Check electrical connection of urea injector: - wiring harness - connector Conduct SERDIA use-case "injection test". If it is faulty: - remove urea injector from exhaust line: - check for crystallisation direct on injector nozzle / plate - rinse it thoroughly in water - remount urea injector and conduct SERDIA use-case "injection test" If the error is still active, then exchange urea injector.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524147	13	1639	966	No proper urea pressure level could be build up within the SCR system state "Fill Lines" => SCRCo_stStatus_mp = 1 within some miuntes	This error shows up, if no proper urea pressure level could be build up within the SCR system state "Fill Lines" => SCRCo_stStatus_mp = 1 within some minutes Once the urea pump pressure has exceeded the threshold the error is declared as okay. Suspected components: Suction line blocked PWM Powerstage has a defect and a default value which leads not to a rising pressure Pump Pressure sensor defect pump filter contains dirty parts reverting valve continously open	Make sure that frozen lines, pump or tank can be excluded! Check whether there is urea in the urea tank Check urea lines: All lines connected? The right lines connected to the correct places? Suction line blocked? No leakage? Not also urea to the outside but also air into the lines, especially in the suction line! Perform service routine "pressure test": Does the urea pump work? => check wiring harness & PWM signal for pump Does the urea pressure rise? DFC already healed? If all unsuccessful so far: Check urea pressure sensor: At ignition on and SCR system state = 0 ("Init check"), SCR_pAbsAdapUPmpP shall be identical to EnvP_p. Fulfilled: Sensor okay! Check reverting valve => see DFC_SCRCoRevVlvBlk Check pump filter: dirt inside? Suspected components: Urea pump broken Reverting valve continously open Urea suction line, backflow line broken or connection swapped PWM Powerstage has a defect Pump Pressure sensor broken
524152	2	1874	971	CAN message is not received fora definite time => error is set. As soon as the message is received the error heals.	CAN message is not received for a definite time => error is set. As soon as the message is received the error heals.	Check eletrical connection oif urea quality sensor Check engine CAN bus Check urea quality sensor itself Exchange urea quality sensor
524153	2	1875	997	CAN message is not reseived for a definite time => error is set. As soon as the message is received the error heals.	CAN message is not reseived for a definite time => error is set. As soon as the message is received the error heals.	Check eletrical connection of suction unit sensor (combined sensor with tank level and tank temperature) Check engine CAN bus Check level sensor itself Exchange suction unit
524156	9	1705	972	Timeout error of CAN-Receive-Frame ComRxEBC2 from wheel speed sensor.	Timeout Error (Missing CAN Bus message) Defect on wheel speed sensor.	Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range. Replace the wheel speed sensor.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524177	7	1863	995	The error shows up, if no proper urea presure could be build up within the SCR system state "Fill Lines" => SCRCo_stStatus_mp = 1.	This error shows up, if no proper urea presure could be build up within the SCR system state "Fill Lines" => SCRCo_stStatus_mp = 1. 3 cases can lead to the error: Case A: increasing pressure is detected within 15s the check has passed => no error Case B: The pressure threshold was not reached within the 60s but case A was not positiv. Case C: The minimum pressure of 3000 hPa was not reached within the 60s.	Make sure that DEF lines, pump and tank are not frozen. Check for DEF level in the tank. Check DEF lines: Are all DEF lines connected? Is the suction line blocked? Is ther any leakage? Not only urea to the outside but also air into the lines, especially in the suction line! Perform SERDIA usecase "pressure test": Does the DEF pump work? => check wiring harness & PWM signal for pump. Does the urea pressure increase? All errors are already healed? If still unsuccessful so far: Check urea pressure sensor: At ignition on and SCR system state = 0 ("Init check"), SCR_pAbsAdapUPmpP shall be identical to EnvP_p. Fulfilled: Sensor okay! Check DEF pump filter: Is any dirt inside? Suspected components: Suction line PWM Powerstage has a defect and a default value which leads not to a rising pressure DEF pump pressure sensor defect DEF pump filter contains dirty parts

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524178	7	1864	996	The urea pump is not able to control the urea pressure between 9bar and 11 bar.	The urea pump controller is not able to control the urea pressure between 9bar and 11 bar due to malfunction in the SCR system. Suspected components: - DEF pump broken - Reverting valve continously open - Urea suction line, backflow line broken or connection swapped - PWM Powerstage has a defect - Pump Pressure sensor broken	Make sure that DEF lines, pump and tank are not frozen. Check for DEF level in the tank Check DEF lines: All lines connected? The right lines connected to the correct places? Suction line blocked? Is there any leakage? Not also urea to the outside but also air into the lines, especially in the suction line! Perform SERDIA usecase "pressure test": Does the DEF pump work properly? => check wiring harness & PWM signal for pump Does the DEF pressure rise? Is the error healed? If still unsuccessful so far: - Check DEF pressure sensor: At ignition on and SCR system state = 0 ("Init check"), SCR_pAbsAdapUPmpP shall be identical to EnvP_p. Fulfilled: Sensor okay! - Check reverting valve - Check DEF pump filter: dirt inside? Suspected components: DEF pump broken Reverting valve continously open DEF suction line, backflow line broken or connection swapped PWM Powerstage has a defect DEF pump pressure sensor broken
524190	14	1891	272	Not enough urea in tank or low urea quality or hardware tampering failure is detected or hardware failure is detected	Low DEF tank level Low DEF quality Hardware Tampering is active Hardware Failure is active	Check DEF level in tank. If there is no DEF, refill up to volume above the warning threshold. Check the DEF quality in the tank. If wrong fluid is filled, refill with proper DEF. Check other errors based on hardware malfunctions.
524191	14	1892	273	A low DEF tank level or a low DEF quality is detected or hardware tampering(system components are pinched off) or hardware failures as shortcut to battery, shortcut to ground etc. are detected.	Low DEF tank level Low DEF quality Hardware Tampering is active Hardware Failure is active	Threshold for error detection is an internal ECU threshold. Check the DEF level in tank. If there is no DEF, refill up above the warning level. Check DEF quality filled in the tank. Check other errors based on hardware tampering or failure.

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524193	8	1893	275	The total time in standstill-regeneration mode exceeds the long-limit threshold within last 500h total engine run time. The error is activated if the engine runs to many times in Standstill regeneartion.	Stand-still mode is very often aborted by the operator. Stand-still mode does not reach required temperature level and regeneration level is therefore reached after a short time again	Read out stand-still statistics => see service manual: Stand-still operation finished or often interrupted by driver / engine shut-off? => Run stand-still and instruct operator Stand-still operation required often by soot load => Check dp DPF pressure sensor Stand-still mode does not reach required temperature level: Check engine air path: Intake Trottle, EGR-Valve and turbocharger okay? Any leakage in engine air intake sytem or exhaust gas system? Check temperature sensors within exhaust system: upstream DOC, downstream DOC If soot load level of DPf allow it: Perform Stand-still and check reached temperature level upstream and downstream DOC: T upstream DOC in the range of 480-550°C? Downstream DOC after 25 min stand-still main phase 590°C are reached? Temerature traces are steady and even? Temperature downstream DOC higher than upstream DOC but difference does not exceed 100 K? Very small difference (< 10 K after 25 min stand-still main phase, 590 °C downstream DOC are not reached) => exchange DOC Very big difference (>100 K after 25 min stand-still main phase, 590 °C downstream DOC exceeded) => check injection system of engine & engine air path

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524194	8	1894	276	The total time in standstill-regeneration mode exceeds the long-limit threshold: 2,5h stand-still operation within 50h total motor run time. The error is activated if the engine runs to much time in short Standstill regeneartion.	Stand-still mode is aborted / interrupted too often by the operator Stand-still is required too often due to miscalculation in the soot model Stand-still mode does not reache temperature level and regeneration level is therefore reached after a short time again.	Read out stand-still statistics => see service manual: Stand-still operation finished or often interrupted by driver / engine shut-off? => Run stand-still and instruct operator Stand-still operation required often by soot load => Check dp DPF pressure sensor Stand-still mode does not reach required temperature level: Check engine air path: Intake Trottle, EGR-Valve and turbocharger okay? Any leakage in engine air intake sytem or exhaust gas system? Check temperature sensors within exhaust system: upstream DOC, downstream DOC If soot load level of DPF allows it: Perform Stand-still and check reached temperature level upstream and downstream DOC: T upstream DOC in the range of 480-550°C? Downstream DOC after 25 min stand-still main phase 590°C are reached? Temerature traces are steady and even? Temperature downstream DOC higher than upstream DOC but difference does not exceed 100 K? Very small difference (< 10 K after 25 min stand-still main phase, 590 °C downstream DOC are not reached) => exchange DOC Very big difference (>100 K after 25 min stand-still main phase, 590 °C downstream DOC exceeded) => check injection system of engine & engine air path

Table 3-13. Engine Fault Codes (Deutz EMR4 or T4F)

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524195	14	1900	279	The standstill request of detected crystallization is ignored for more than 5h(>300min) This will be activated if there is a standstill request activated by Crystalisation Monitoring.	Back pressure upstream SCR catalyst has reached a level which indicates crystallisation inside of exhaust line. The error detection depends on the sensed pressure upstream of the SCR catalyst and the calculated exhaust volume flow through the mixer pipe. In case of error is set, but no crystallisation can be found in the mixing pipe, a possible reason can be the defect sensors: - exhaust pressure & temperature upstream of the SCR catalyst, - the ambient pressure - the exhaust mass flow => Check air path system at the engine.	Dismount urea injector from exhaust line and inspect visually the injector and the exhaust line for urea crystallisation upstream of SCR catalyst: If crystallisation can be clearly seen, then standstill must be processed. Has the engine been operated in low load for longer time? If yes, then it could be the reaoson for crystallisation. Does the NOx-Sensors work properly? Compare ComRxSCR_rNOxUs to ComRxSCR_rNOxDs, when ComRxSCR_stNOxRdyUs = 1 & ComRxSCR_stNOxRdyDs = 1 (Warm engine and EAT-system, SCRT_tCatAvrgExhGs_mp > 250°C, SCR_stStatus = "Dosing" = 8): sensed NOx upstream of SCR catalyst must be higher than downstream of SCR catalyst. Go to idle and wait until SCR system enters status "stand-by" (no dosing), SCRT_tCatAvrgExhGs_mp < 225°C: ComRxSCR_rNOxUs = ComRxSCR_rNOxDs Clean urea injector: rinse it thourougly under water Check EGR-Path: difference pressure sensor at venturi tube, EGR cooler, EGR-Valve, Reed-Valve, Intake throttle regarding function and leakage. Does the EGR-cooler leak water in the exhaust? Check air path for leakage Check turbocharger No crystallisation can be seen in the mixing pipe: Check exhaust pressure sensor upstream of SCR catalyst (SCR_pSensUCatUsP): tube, water in sensor? Check environmental pressure sensor (EnvP_p): plausible? Check exhaust temperature sensor upstream of SCR-catalyst (SCR_tSensUCatUsT): plausible compared to Exh_tOxiCatUs & Exh_tOxiCatDs e.g. when engine has idled for 20 minutes? => Run stand-still to remove crystallisation and to reset the DFC
5232719	3	1108	672	Urea supply module heater: the current drain measured by ECU is above the target range	Short circuit to battery If this error detected during the heating phase it is a result error:KWP 1089 Broken wiring Heating element in supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check cabling, if necessary replace supply module

3.25 DEUTZ EMR 5

The EMR5 consists of the sensors, the control unit and the common rail injection system. Engine-side controls as well as the JLG Control System are connected by means of separate cable harnesses to the EMR control unit.

The sensors attached to the engine provide the electronics in the control unit with all the relevant physical parameters In accordance with the information of the current condition of the engine and the preconditions (throttle position etc.), the EMR5 controls the injection pump and thus doses the fuel quantity in accordance with the performance requirements.

The EMR5 is equipped with safety devices and measures in the hardware and software in order to ensure emergency running (Limp home) functions.

In order to switch the engine off, the EMR5 is switched in a de-energized fashion over the ignition switch.

After the programming, that is carried out over the interface, the EMR5 possesses a motor-specific data set and this is then fixedly assigned to the engine. Included in this are the various application cases as well as the customer's wishes regarding a particular scope of function.

Each EMR5 module is matched by serial number to the engine. Modules cannot be swapped between engines.

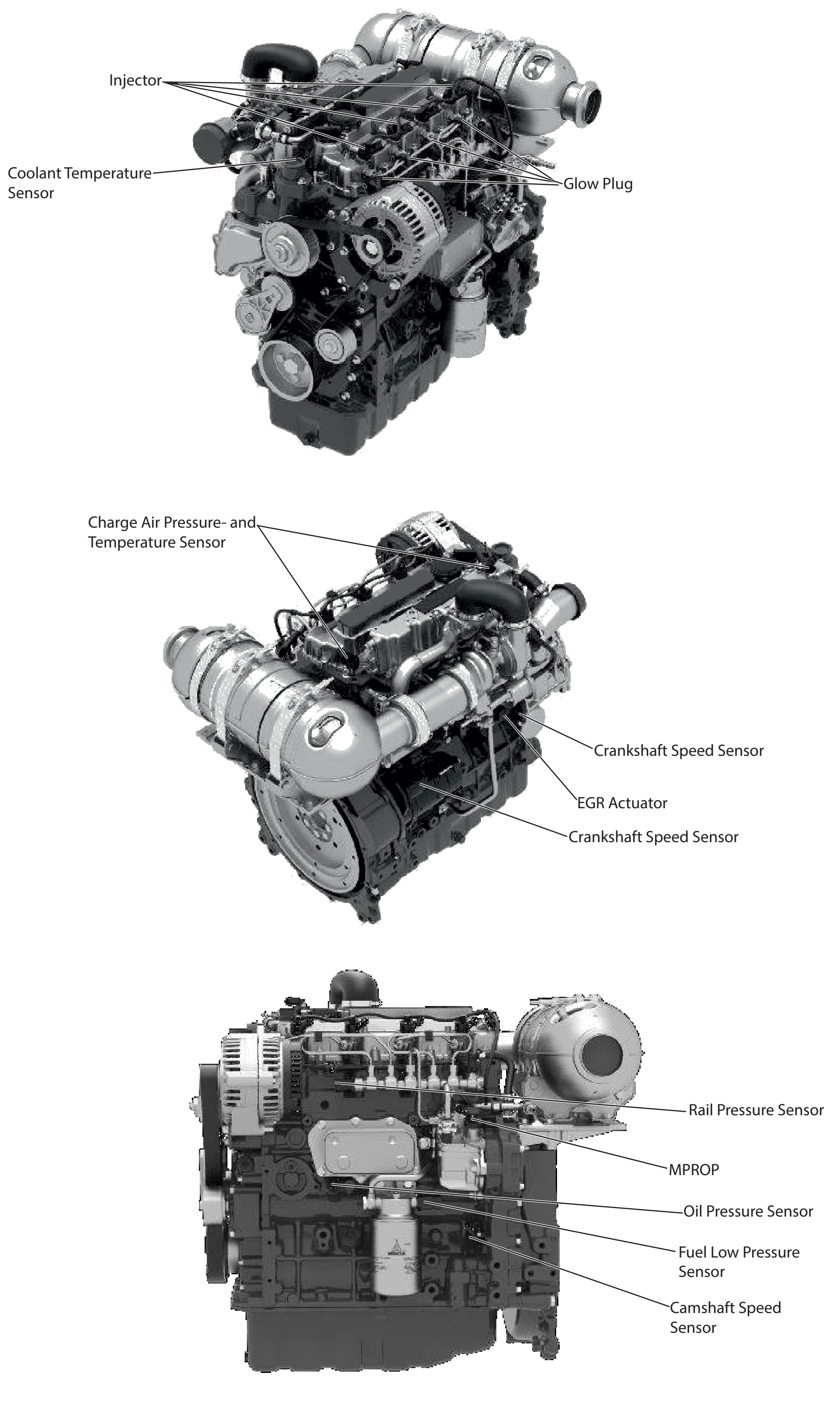


Figure 3-122. EMR5 Engine Side Equipment

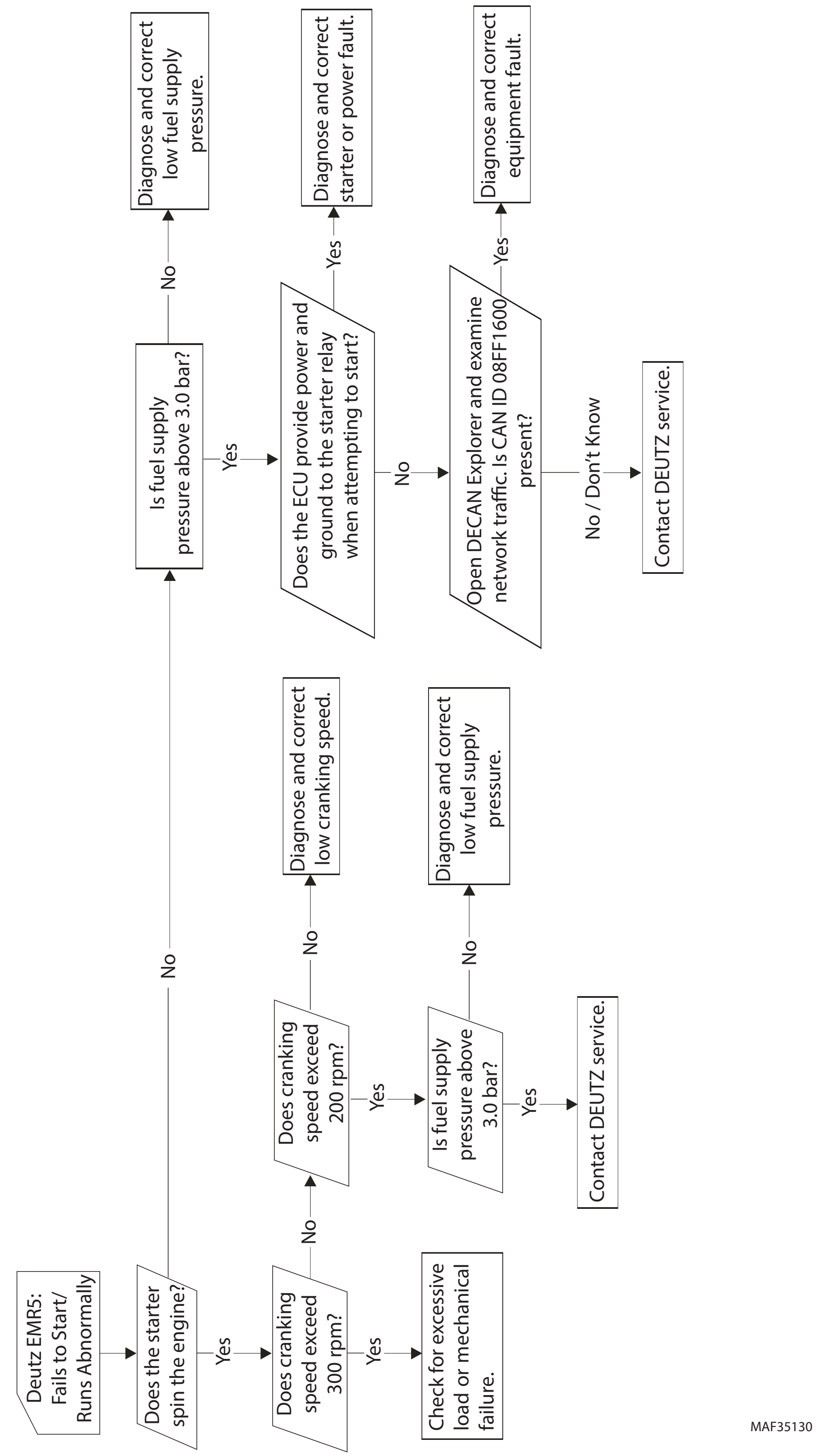
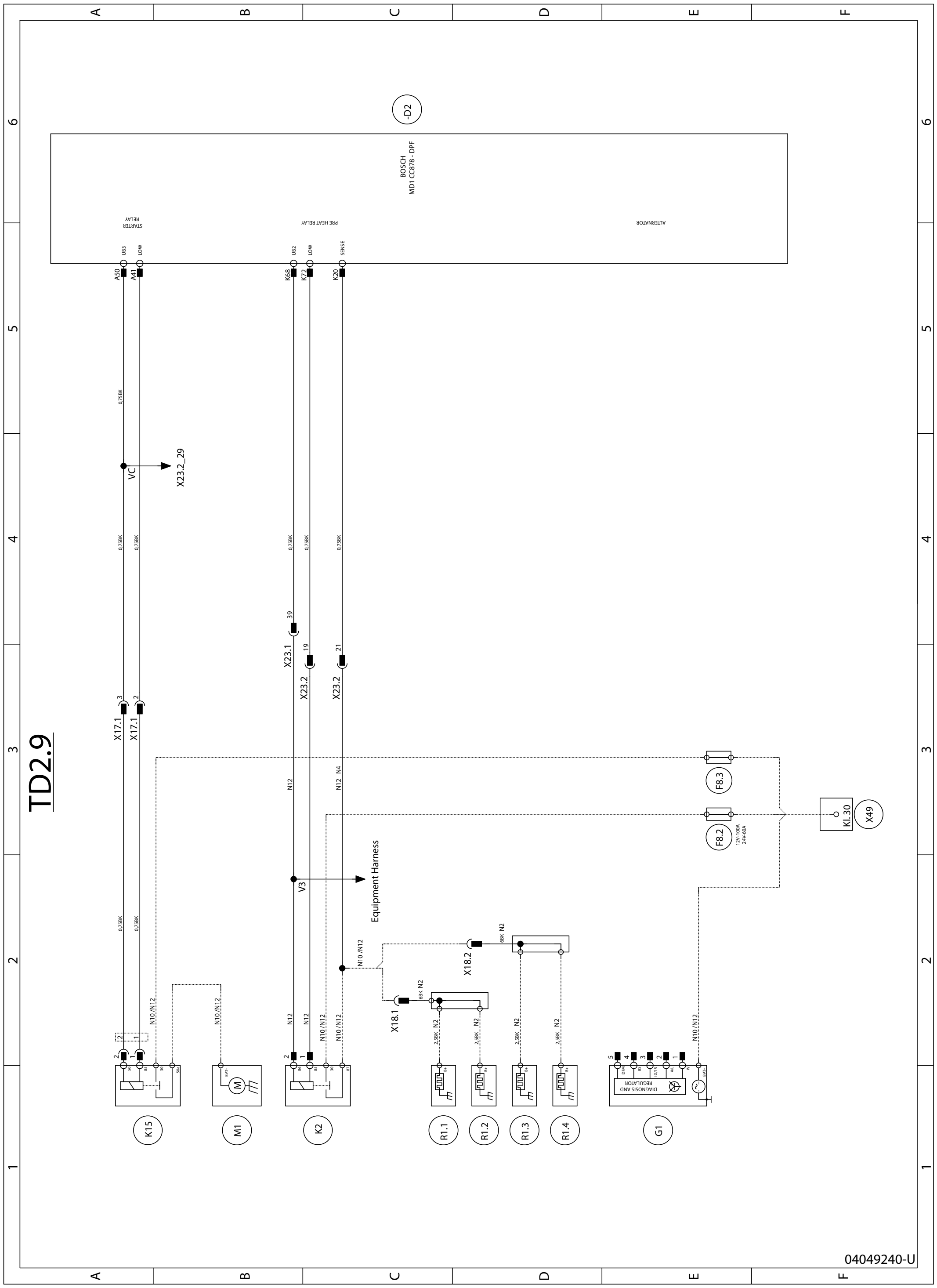
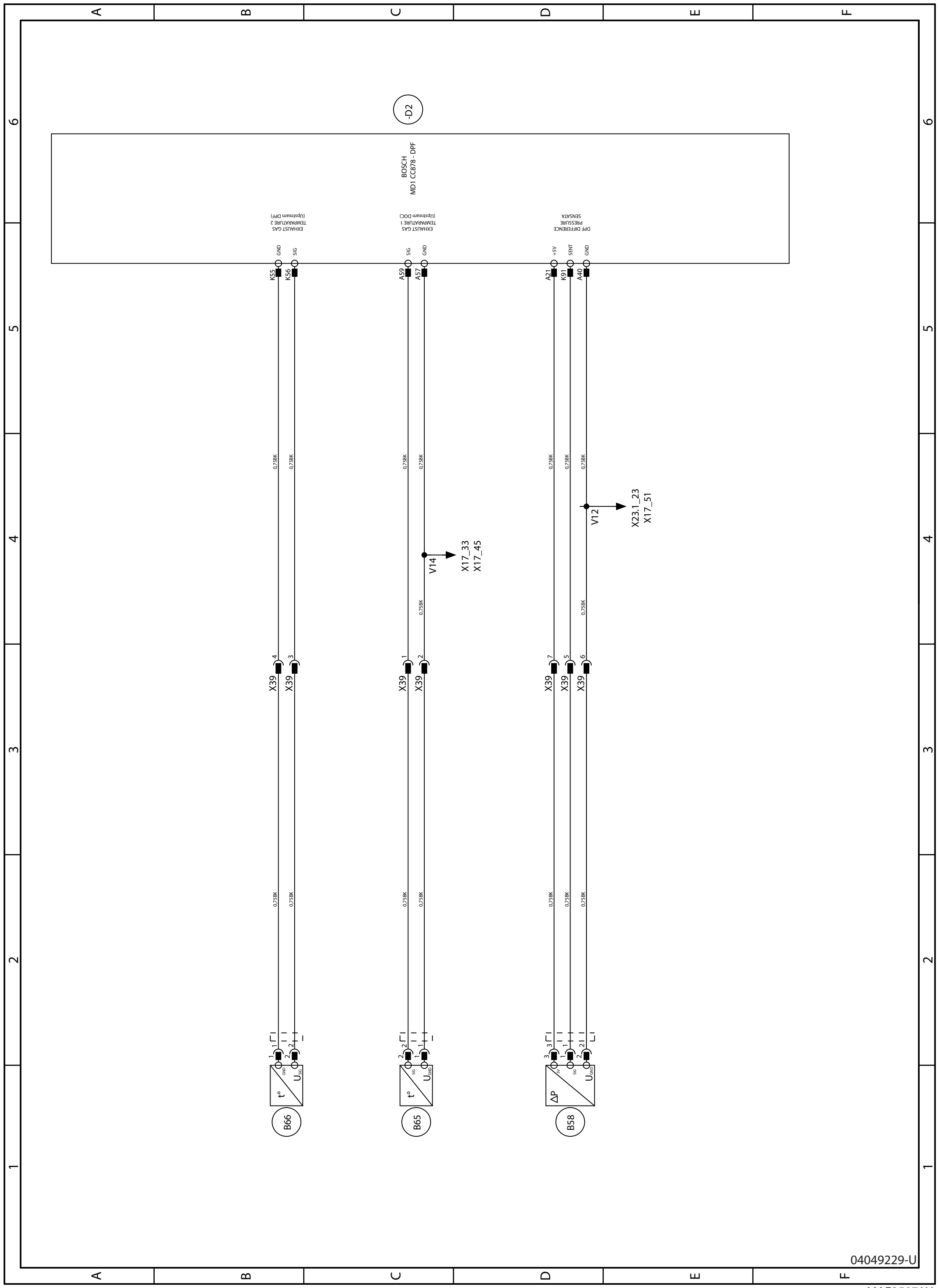


Figure 3-123. Deutz EMR5 Troubleshooting Flow Chart



MAF41840U

Figure 3-124. Deutz EMR5 Power Harness



MAF35070U

Figure 3-125. Deutz EMR5 Exhaust After Treatment Harness

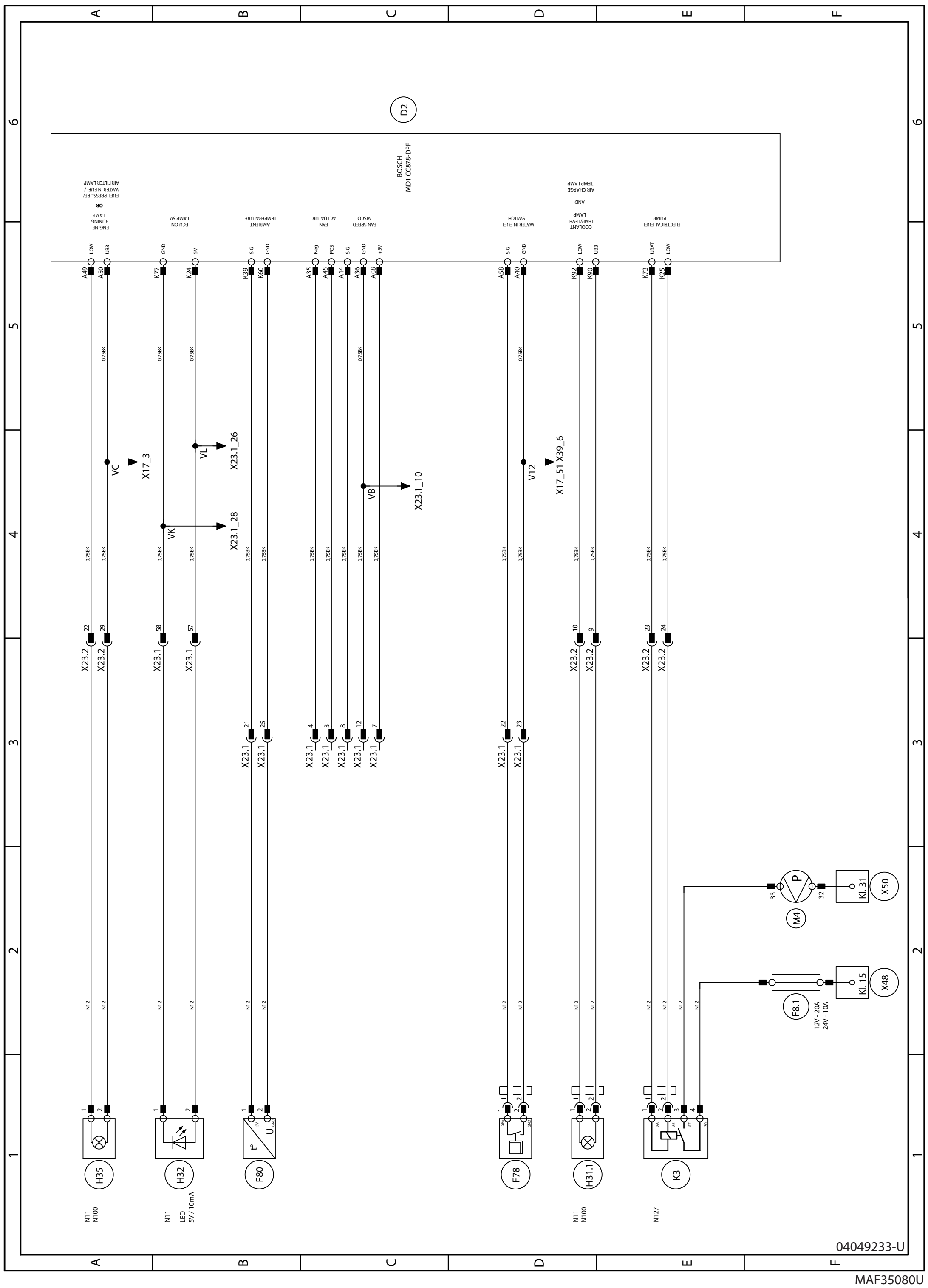


Figure 3-126. Deutz EMR5 Equipment Harness - Sheet 1 of 5

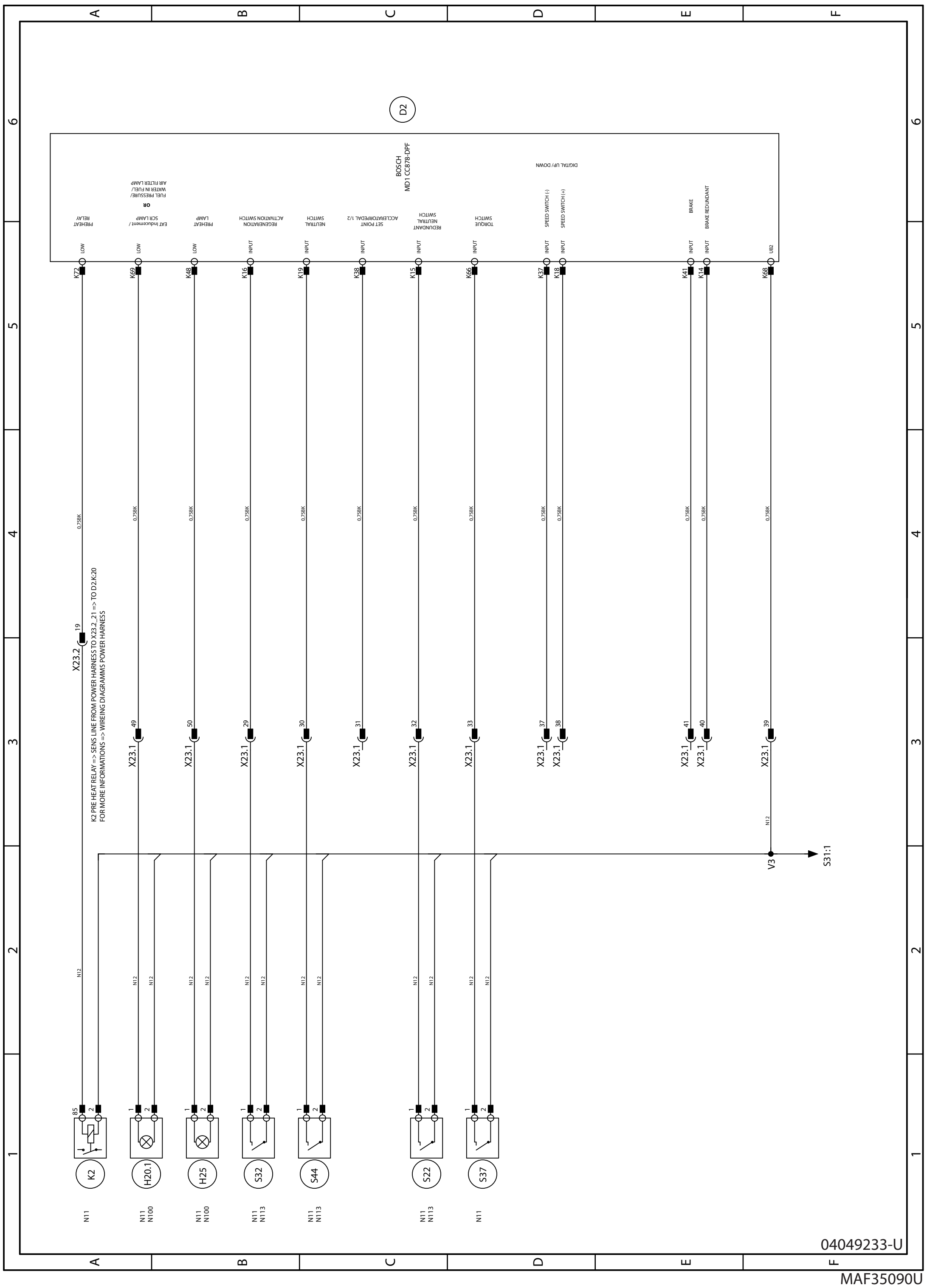


Figure 3-127. Deutz EMR5 Equipment Harness - Sheet 2 of 5

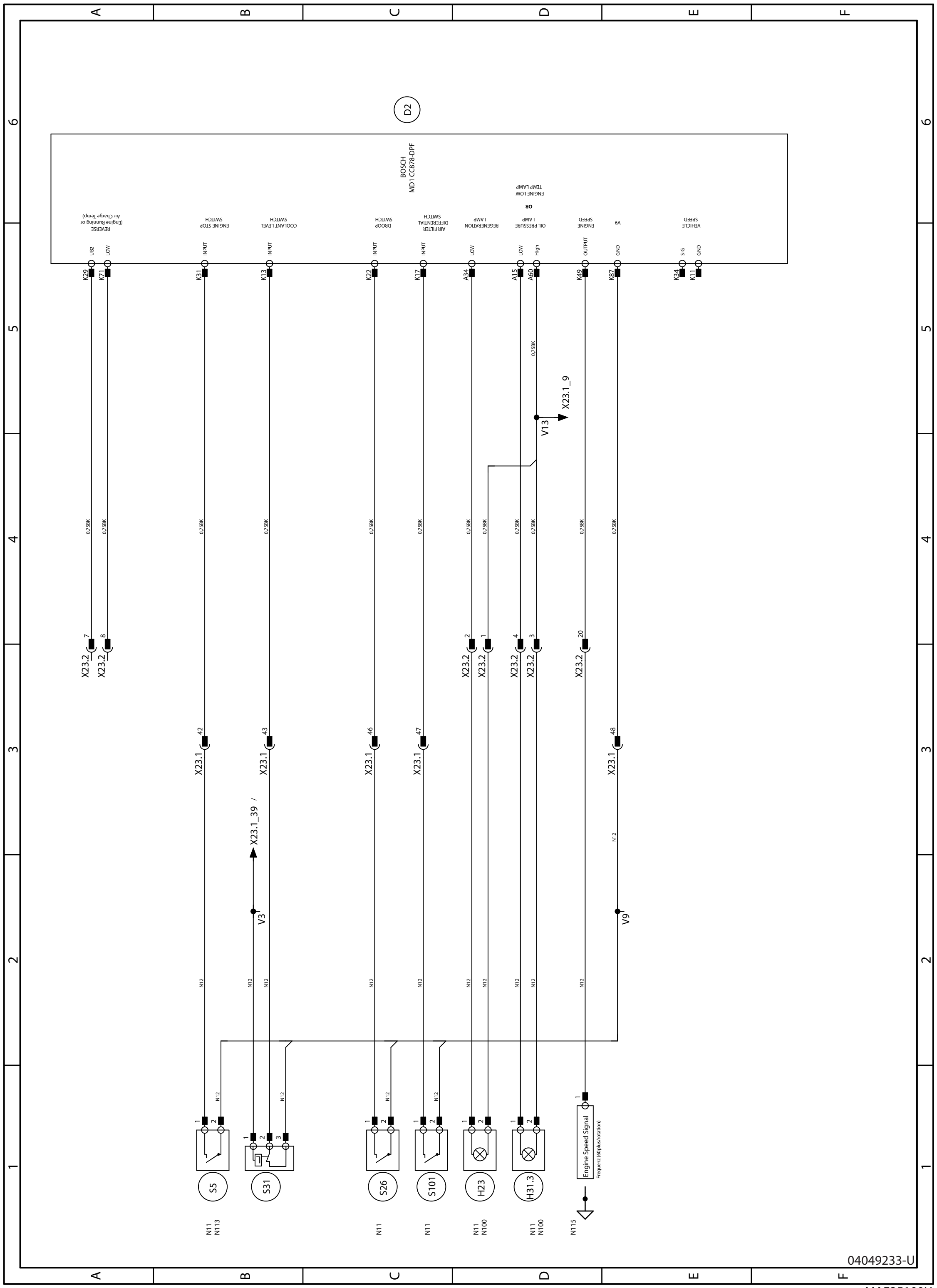


Figure 3-128. Deutz EMR5 Equipment Harness - Sheet 3 of 5

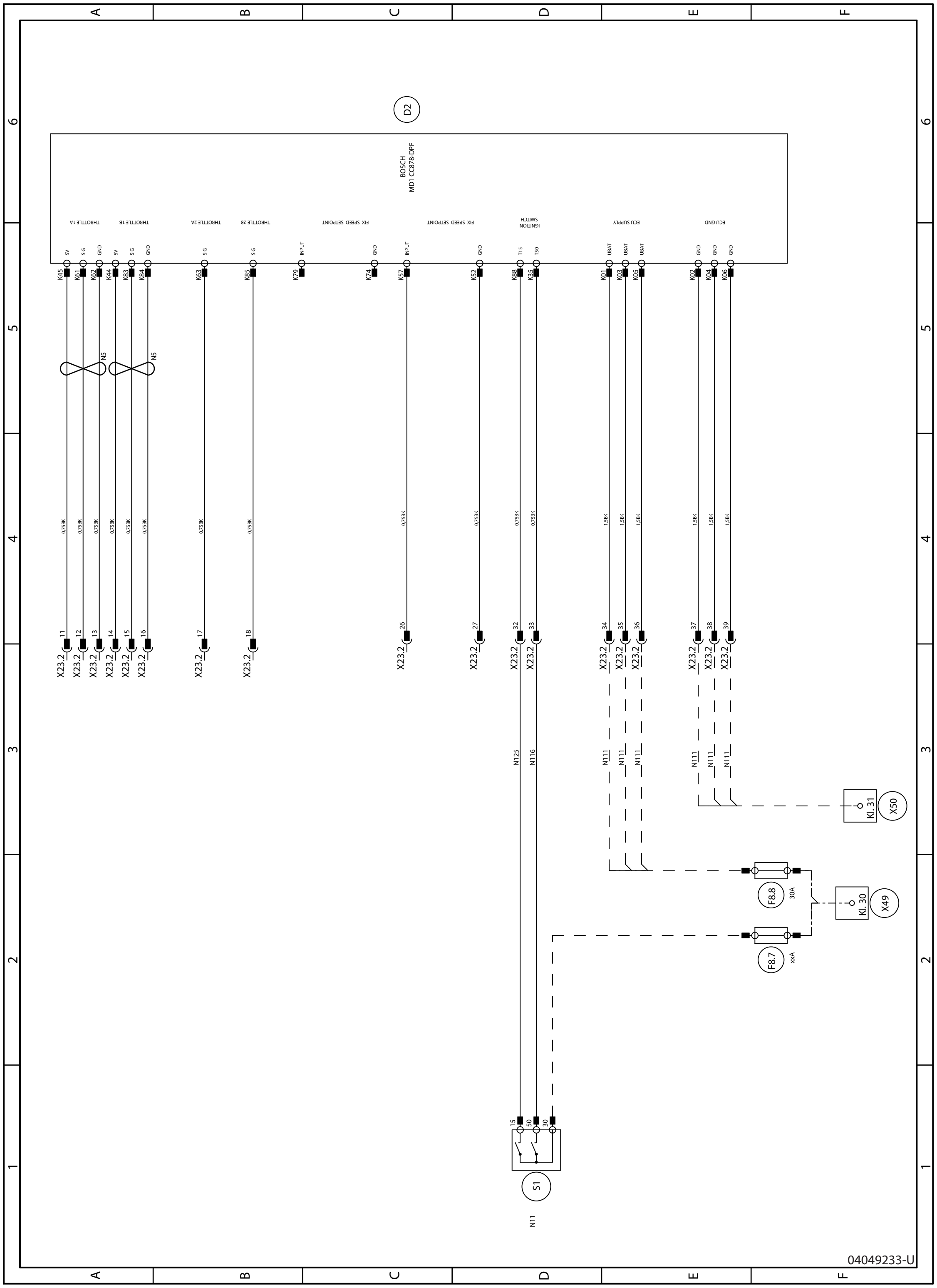


Figure 3-129. Deutz EMR5 Equipment Harness - Sheet 4 of 5

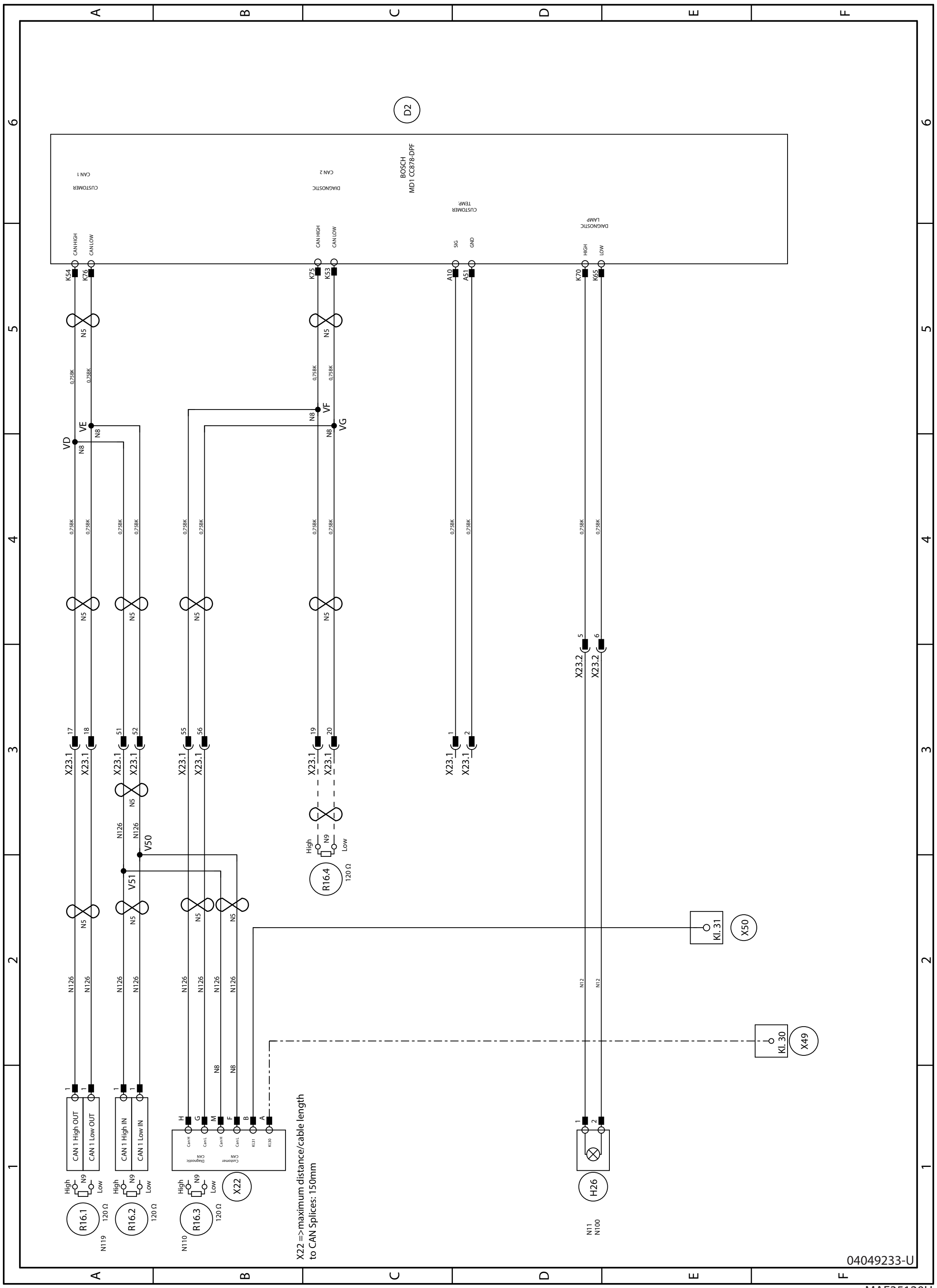
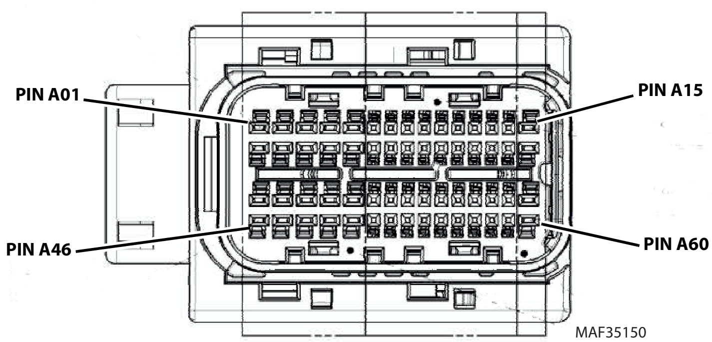


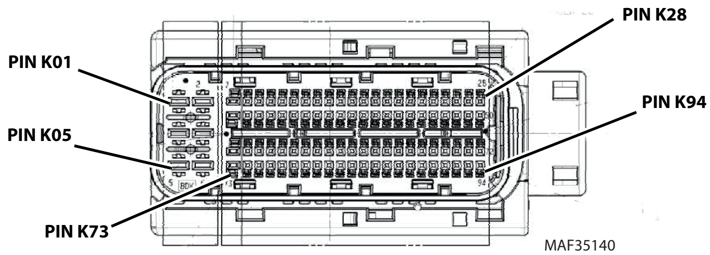
Figure 3-130. Deutz EMR5 Equipment Harness - Sheet 5 of 5



Pin No.	Description
A01	INJS3
A02	INJS4
A03	INJS5
A04	Fuel metering unit (BAT+)
A05	Fuel metering unit (low side)
A06	
A07	Rail fuel pressure supply
A08	Fan speed visco supply
A09	Boost pressure and temperature supply
A10	Customer Temperature
A11	Exhaust pressure P3
A12	EGR position sensor signal
A13	Air inlet temperature
A14	Fan speed visco
A15	Oil warning lamp
A16	INJS0
A17	INJS1
A18	INJS2
A19	EGR control pos
A20	EGR control neg
A21	DPF differential pressure sensor supply
A22	EGR feedback supply
A23	Oil level sensor (Hella)
A24	Oil pressure supply
A25	Rail fuel pressure ground
A26	Rail pressure sensor signal
A27	Boost temperature
A28	Coolant temperature
A29	Exhaust pressure P3 ground
A30	Differential pressure sensor
A30	Differential pressure sensor (see analog input)

Pin No.	Description
A31	INJS3
A32	INJS4
A33	INJS0
A34	Regeneration indication lamp
A35	Fan actuator
A36	Air inlet temperature ground
A37	Cam shaft speed sensor positive
A38	Crankshaft sensor shield
A39	Crank shaft speed sensor positive
A40	EGR feedback ground
A41	Starter low side
A42	Boost pressure and temperature ground
A43	Boost pressure sensor signal
A44	Oil pressure sensor input signal
A45	Switched Battery UB2
A46	INJS5
A47	INJS1
A48	INJS2
A49	After run active
A50	Switched Battery UB3
A51	Customer Temperature ground
A52	Cam shaft speed sensor negative
A53	Camshaft speed sensor shield
A54	Crank shaft speed sensor negative
A55	Reserve Ground
A56	Reserve Ground
A57	Oil pressure ground
A58	Water in fuel switch
A59	Exhaust gas temperature 1
A60	Switched Battery UB2

Figure 3-131. EMR5 Engine Plug Pin Identification



Pin No.	Description
K01	BATTERY PLUS
K02	BATTERY MINUS
K03	BATTERY PLUS
K04	BATTERY MINUS
K05	BATTERY PLUS
K06	BATTERY MINUS
K07	EGR temperature behind venturi ground
K08	ITV-H-bridge pos
K08	Intake air throttle pos
K09	Intake air throttle neg
K09	ITV-H-bridge neg
K10	Electrical connected with K9
K11	Vehicle speed sensor ground
K12	Speed switch on/off
K13	Coolant level
K14	Redundant brake switch
K15	Clutch switch
K16	Regeneration activation switch
K17	Air filter differential
K18	Speed switch (+)
K19	Gearbox neutral switch
K20	Preheat sense
K21	Low fuel pressure ground
K22	Controller parameter choise
K23	Delta P venturi supply
K24	Reserve pressure input supply
K25	Fuel pump relay
K26	Intake air throttle (PWM) low side switch
K27	Reserve
K28	Disk seperator
K29	Switched Battery UB2
K30	Reserve
K31	Engine stop switch
K32	Speed switch (hold/resume)

Pin No.	Description
K33	EGR Temperature behind venturi
K34	Vehicle speed sensor
K35	Terminal 50
K36	Reserve analog temperatur input
K37	Speed switch (-)
K38	Parking brake switch
K39	Ambient temperature
K40	Engine brake switch
K41	Brake main switch
K42	Override switch
K43	Low fuel pressure supply
K44	App2 supply
K45	App1 supply
K46	Air intake throttle feedback supply
K47	Exhaust flap
K48	Preheat lamp
K49	Engine speed output
K50	Reserve 2
K51	Switched Battery UB6
K52	Multiple state switch 2 ground
K53	CAN2 low
K54	CAN1 high
K55	Exhaust gas temperature 2 ground
K56	Exhaust gas temperature 2
K57	Multiple state switch 2
K58	Low fuel pressure
K59	LIN bus
K61	Throttle 1a
K62	APP1 ground
K63	Throttle 2a
K65	Diagnostic lamp ground
K66	Diagnostic switch
K67	Intake air throttle (PWM) status
K68	Switched Battery UB2

Pin No.	Description
K69	OBD lamp
K70	Diagnostic lamp
K71	Engine running lamp
K72	Prehead relay
K73	Switched Battery UB3
K74	Torque / droop Line ground
K75	CAN2 high
K76	CAN1 low
K77	Reserve pressure input ground
K78	Reserve analog pressure input
K79	Torque / droop Line
K80	Feedback intake air throttle
K81	Delta p venturi
K83	Throttle 1b
K84	APP2 ground
K85	Throttle 2b
K86	Controller mode
K87	Digital ground
K88	Terminal 15
K89	Switched Battery UB3
K90	Switched Battery UB3
K91	Sent1
K92	Warning temperature lamp
K93	Reserve 3
K94	Reserve 1

Figure 3-132. EMR5 Vehicle Plug Pin Identification

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
1000	0	98	2	Engine Oil Level - Data Erratic, Intermittent or Incorrect
1001	0	98	31	Engine Oil Level - Condition Exists
1002	0	98	31	Engine Oil Level - Condition Exists
1003	0	98	2	Engine Oil Level - Data Erratic, Intermittent or Incorrect
1004	0	98	31	Engine Oil Level - Condition Exists
1005	0	98	14	Engine Oil Level - Special Instructions
1021	0	100	3	Engine Oil Pressure 1 - Voltage Above Normal or Shorted To High Source
1022	0	100	4	Engine Oil Pressure 1 - Voltage Below Normal or Shorted To Low Source
1025	0	100	1	Engine Oil Pressure 1 - Data Below Normal Operational Range (Most Severe Level)
1026	0	100	1	Engine Oil Pressure 1 - Data Below Normal Operational Range (Most Severe Level)
1043	0	107	0	Engine Air Filter 1 Differential Pressure - Data Above Normal Operational Range (Most Severe Level)
1071	0	411	2	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Erratic, Intermittent or Incorrect
1072	0	411	0	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Above Normal Operational Range (Most Severe Level)
1073	0	411	1	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Below Normal Operational Range (Most Severe Level)
1074	0	411	2	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Erratic, Intermittent or Incorrect
1075	0	411	2	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Erratic, Intermittent or Incorrect
1077	0	411	3	Engine Exhaust Gas Recirculation 1 Differential Pressure - Voltage Above Normal or Shorted To High Source
1078	0	411	4	Engine Exhaust Gas Recirculation 1 Differential Pressure - Voltage Below Normal or Shorted To Low Source
1079	0	108	0	Barometric Pressure - Data Above Normal Operational Range (Most Severe Level)
080	0	108	1	Barometric Pressure - Data Below Normal Operational Range (Most Severe Level)
1081	0	108	15	Barometric Pressure - Data Above Normal Operational Range (Least Severe Level)

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
1082	0	108	17	Barometric Pressure - Data Above Normal Operational Range (Least Severe Level)
1083	0	108	2	Barometric Pressure - Data Erratic, Intermittent or Incorrect
1084	0	3720	0	Aftertreatment 1 Diesel Particulate Filter Ash Load Percent - Data Above Normal Operational Range (Most Severe Level)
1086	0	3734	0	Aftertreatment 1 Diesel Particulate Filter Trip Active Regeneration Time - Data Above Normal Operational Range (Most Severe Level)
1087	0	4781	14	Aftertreatment 1 Diesel Particulate Filter Soot Mass - Special Instructions
1088	0	4781	0	Aftertreatment 1 Diesel Particulate Filter Soot Mass - Data Above Normal Operational Range (Most Severe Level)
1089	0	4781	16	Aftertreatment 1 Diesel Particulate Filter Soot Mass - Data Above Normal Operational Range (Moderately Sever Level)
1090	0	10156	0	DPF Active Regeneration Time Remaining - Data Above Normal Operational Range (Most Severe Level)
1091	0	3735	16	Aftertreatment 1 Diesel Particulate Filter Trip Disabled Time - Data Above Normal Operational Range (Moderately Sever Level)
1092	0	3735	0	Aftertreatment 1 Diesel Particulate Filter Trip Disabled Time - Data Above Normal Operational Range (Most Severe Level)
1093	0	4766	1	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Data Below Normal Operational Range (Most Severe Level)
1102	0	171	2	Ambient Air Temperature - Data Erratic, Intermittent or Incorrect
1113	0	102	0	Engine Intake Manifold 1 Pressure - Data Above Normal Operational Range (Most Severe Level)
1114	0	102	1	Engine Intake Manifold 1 Pressure - Data Below Normal Operational Range (Most Severe Level)
1115	0	102	3	Engine Intake Manifold 1 Pressure - Voltage Above Normal or Shorted To High Source
1116	0	102	4	Engine Intake Manifold 1 Pressure - Voltage Below Normal or Shorted To Low Source
1118	0	102	1	Engine Intake Manifold 1 Pressure - Data Below Normal Operational Range (Most Severe Level)
1121	0	102	2	Engine Intake Manifold 1 Pressure - Data Erratic, Intermittent or Incorrect
1122	0	102	0	Engine Intake Manifold 1 Pressure - Data Above Normal Operational Range (Most Severe Level)
1123	0	102	1	Engine Intake Manifold 1 Pressure - Data Below Normal Operational Range (Most Severe Level)
1124	0	1209	2	Engine Exhaust Pressure 1 - Data Erratic, Intermittent or Incorrect
1125	0	1209	15	Engine Exhaust Pressure 1 - Data Above Normal Operational Range (Least Severe Level)
1126	0	1176	1	Engine Turbocharger 1 Compressor Intake Pressure - Data Below Normal Operational Range (Most Severe Level)
1127	0	1209	2	Engine Exhaust Pressure 1 - Data Erratic, Intermittent or Incorrect

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
1130	0	1209	3	Engine Exhaust Pressure 1 - Voltage Above Normal or Shorted To High Source
1131	0	1209	4	Engine Exhaust Pressure 1 - Voltage Below Normal or Shorted To Low Source
1134	0	3251	3	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Voltage Above Normal or Shorted To High Source
1135	0	3251	4	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Voltage Below Normal or Shorted To Low Source
1136	0	3251	14	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Special Instructions
1137	0	3251	14	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Special Instructions
1138	0	3251	14	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Special Instructions
1139	0	3251	14	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Special Instructions
1149	0	3251	2	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Erratic, Intermittent or Incorrect
1150	0	3251	0	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Above Normal Operational Range (Most Severe Level)
1151	0	3251	16	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Above Normal Operational Range (Moderately Sever Level)
1152	0	3251	1	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Below Normal Operational Range (Most Severe Level)
1153	0	3251	18	Aftertreatment 1 Diesel Particulate Filter Differential Pressure - Data Below Normal Operational Range (Moderately Severe Level)
1161	0	5571	16	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Moderately Sever Level)
1162	0	5571	2	High Pressure Common Rail Fuel Pressure Relief Valve - Data Erratic, Intermittent or Incorrect
1163	0	5571	2	High Pressure Common Rail Fuel Pressure Relief Valve - Data Erratic, Intermittent or Incorrect
1164	0	5571	16	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Moderately Sever Level)
1165	0	5571	15	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Least Severe Level)
1166	0	5571	0	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Most Severe Level)
1167	0	5571	2	High Pressure Common Rail Fuel Pressure Relief Valve - Data Erratic, Intermittent or Incorrect
1168	0	5571	2	High Pressure Common Rail Fuel Pressure Relief Valve - Data Erratic, Intermittent or Incorrect
1169	0	5571	13	High Pressure Common Rail Fuel Pressure Relief Valve - Out of Calibration
1170	0	5571	16	High Pressure Common Rail Fuel Pressure Relief Valve - Data Above Normal Operational Range (Moderately Sever Level)
1171	0	94	1	Engine Fuel Delivery Pressure - Data Below Normal Operational Range (Most Severe Level)

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
1172	0	1347	5	Engine Fuel Pump Pressurizing Assembly 1 - Current Below Normal or Open Circuit
1174	0	1347	3	Engine Fuel Pump Pressurizing Assembly 1 - Voltage Above Normal or Shorted To High Source
1175	0	1347	4	Engine Fuel Pump Pressurizing Assembly 1 - Voltage Below Normal or Shorted To Low Source
119	0	1231	14	CAN Bus 2 / Engine/Diagnose CAN - Special Instructions
1190	0	7103	13	Engine Fuel Metering Rail Pump - Out of Calibration
1191	0	7103	13	Engine Fuel Metering Rail Pump - Out of Calibration
1194	0	7103	13	Engine Fuel Metering Rail Pump - Out of Calibration
1195	0	7103	1	Engine Fuel Metering Rail Pump - Data Below Normal Operational Range (Most Severe Level)
1197	0	7103	0	Engine Fuel Metering Rail Pump - Data Above Normal Operational Range (Most Severe Level)
1198	0	7103	2	Engine Fuel Metering Rail Pump - Data Erratic, Intermittent or Incorrect
120	0	639	14	CAN 1 / Customer CAN (J1939) - Special Instructions
1200	0	5357	14	Engine Fuel Injection Quantity Error for Multiple Cylinders - Special Instructions
1202	0	157	0	Engine Fuel 1 Injector Metering Rail 1 Pressure - Data Above Normal Operational Range (Most Severe Level)
1208	0	157	3	Engine Fuel 1 Injector Metering Rail 1 Pressure - Voltage Above Normal or Shorted To High Source
1209	0	157	4	Engine Fuel 1 Injector Metering Rail 1 Pressure - Voltage Below Normal or Shorted To Low Source
121	0	520252	2	CAN-Receive-Message EAT Control Checksum - Data Erratic, Intermittent or Incorrect
1212	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1213	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1215	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1216	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1218	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
1219	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
122	0	4207	2	TSC1 Message Checksum - Data Erratic, Intermittent or Incorrect
123	0	4207	2	TSC1 Message Checksum - Data Erratic, Intermittent or Incorrect

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
1233	0	5826	15	Emission Control System Operator Inducement Severity (NCD Inducement) - Data Above Normal Operational Range (Least Severe Level)
1235	0	5826	0	Emission Control System Operator Inducement Severity (NCD Inducement) - Data Above Normal Operational Range (Most Severe Level)
1236	0	5826	14	Emission Control System Operator Inducement Severity (NCD Inducement) - Special Instructions
124	0	4207	2	TSC1 Message Checksum - Data Erratic, Intermittent or Incorrect
125	0	4207	2	TSC1 Message Checksum - Data Erratic, Intermittent or Incorrect
1274	0	91	3	Accelerator Pedal Position 1 - Voltage Above Normal or Shorted To High Source
1275	0	2623	3	Accelerator Pedal 1 Channel 2 - Voltage Above Normal or Shorted To High Source
1276	0	29	3	Accelerator Pedal 2 Position - Voltage Above Normal or Shorted To High Source
1277	0	2625	3	Accelerator Pedal 2 Channel 2 - Voltage Above Normal or Shorted To High Source
1280	0	91	4	Accelerator Pedal Position 1 - Voltage Below Normal or Shorted To Low Source
1281	0	2623	4	Accelerator Pedal 1 Channel 2 - Voltage Below Normal or Shorted To Low Source
1282	0	29	4	Accelerator Pedal 2 Position - Voltage Below Normal or Shorted To Low Source
1283	0	2625	4	Accelerator Pedal 2 Channel 2 - Voltage Below Normal or Shorted To Low Source
1289	0	3509	14	Sensor supply voltage 1 from ECU - Special Instructions
1290	0	3509	0	Sensor supply voltage 1 from ECU - Data Above Normal Operational Range (Most Severe Level)
1291	0	3509	6	Sensor supply voltage 1 from ECU - Current Above Normal or Grounded Circuit
1292	0	3509	1	Sensor supply voltage 1 from ECU - Data Below Normal Operational Range (Most Severe Level)
1293	0	3510	14	Sensor supply voltage 2 from ECU - Special Instructions
1294	0	3510	0	Sensor supply voltage 2 from ECU - Data Above Normal Operational Range (Most Severe Level)
1295	0	3510	6	Sensor supply voltage 2 from ECU - Current Above Normal or Grounded Circuit
1296	0	3510	1	Sensor supply voltage 2 from ECU - Data Below Normal Operational Range (Most Severe Level)
1306	0	677	3	Engine Starter Motor Relay - Voltage Above Normal or Shorted To High Source
1307	0	677	4	Engine Starter Motor Relay - Voltage Below Normal or Shorted To Low Source
1308	0	677	5	Engine Starter Motor Relay - Current Below Normal or Open Circuit

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
1310	0	677	3	Engine Starter Motor Relay - Voltage Above Normal or Shorted To High Source
1311	0	677	4	Engine Starter Motor Relay - Voltage Below Normal or Shorted To Low Source
1323	0	91	11	Accelerator Pedal Position 1 - Root Cause Not Known
1326	0	29	11	Accelerator Pedal 2 Position - Root Cause Not Known
1346	0	1041	14	Start Signal Indicator - Special Instructions
1354	0	105	0	Engine Intake Manifold 1 Temperature - Data Above Normal Operational Range (Most Severe Level)
1355	0	105	0	Engine Intake Manifold 1 Temperature - Data Above Normal Operational Range (Most Severe Level)
1357	0	1136	0	Engine ECU Temperature - Data Above Normal Operational Range (Most Severe Level)
1358	0	1136	1	Engine ECU Temperature - Data Below Normal Operational Range (Most Severe Level)
1359	0	1136	15	Engine ECU Temperature - Data Above Normal Operational Range (Least Severe Level)
1360	0	1136	17	Engine ECU Temperature - Data Above Normal Operational Range (Least Severe Level)
1361	0	1136	2	Engine ECU Temperature - Data Erratic, Intermittent or Incorrect
1362	0	412	15	Engine Exhaust Gas Recirculation 1 Temperature - Data Above Normal Operational Range (Least Severe Level)
1363	0	412	17	Engine Exhaust Gas Recirculation 1 Temperature - Data Above Normal Operational Range (Least Severe Level)
1364	0	412	3	Engine Exhaust Gas Recirculation 1 Temperature - Voltage Above Normal or Shorted To High Source
1365	0	412	4	Engine Exhaust Gas Recirculation 1 Temperature - Voltage Below Normal or Shorted To Low Source
1372	0	51	5	Engine Throttle Valve 1 Position 1 - Current Below Normal or Open Circuit
1375	0	51	3	Engine Throttle Valve 1 Position 1 - Voltage Above Normal or Shorted To High Source
1376	0	51	3	Engine Throttle Valve 1 Position 1 - Voltage Above Normal or Shorted To High Source
1377	0	51	4	Engine Throttle Valve 1 Position 1 - Voltage Below Normal or Shorted To Low Source
1378	0	51	4	Engine Throttle Valve 1 Position 1 - Voltage Below Normal or Shorted To Low Source
1379	0	51	6	Engine Throttle Valve 1 Position 1 - Current Above Normal or Grounded Circuit
1382	0	51	7	Engine Throttle Valve 1 Position 1 - Mechanical System not Responding or Out of Adjustment
1383	0	51	7	Engine Throttle Valve 1 Position 1 - Mechanical System not Responding or Out of Adjustment

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
1391	0	51	3	Engine Throttle Valve 1 Position 1 - Voltage Above Normal or Shorted To High Source
1392	0	51	4	Engine Throttle Valve 1 Position 1 - Voltage Below Normal or Shorted To Low Source
1397	0	105	0	Engine Intake Manifold 1 Temperature - Data Above Normal Operational Range (Most Severe Level)
1398	0	105	1	Engine Intake Manifold 1 Temperature - Data Below Normal Operational Range (Most Severe Level)
1399	0	4766	2	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Data Erratic, Intermittent or Incorrect
1400	0	4766	2	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Data Erratic, Intermittent or Incorrect
1401	0	4766	15	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Data Above Normal Operational Range (Least Severe Level)
1402	0	4766	3	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Voltage Above Normal or Shorted To High Source
1403	0	4766	4	Aftertreatment 1 Diesel Oxidation Catalyst Outlet Temperature - Voltage Below Normal or Shorted To Low Source
1404	0	4765	2	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Data Erratic, Intermittent or Incorrect
1405	0	4765	15	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Data Above Normal Operational Range (Least Severe Level)
1406	0	4765	3	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Voltage Above Normal or Shorted To High Source
1407	0	4765	4	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Voltage Below Normal or Shorted To Low Source
1408	0	4765	2	Aftertreatment 1 Diesel Oxidation Catalyst Intake Temperature - Data Erratic, Intermittent or Incorrect
142	0	520256	9	CAN-Receive-Message EAT Control - Abnormal Update Rate / Timeout
144	0	523211	9	CAN-Receive-Message EBC1 - Abnormal Update Rate / Timeout
154	0	523212	9	CAN-Receive-Message Engine Protection - Abnormal Update Rate / Timeout
1540	0	520254	8	Time in Standstill Mode - Abnormal Frequency or Pulse Width or Period
1541	0	520255	2	Hoses Connected to dp DPF SENT Sensor Inverted - Data Erratic, Intermittent or Incorrect
155	0	523741	14	Engine Shutdown Request via CAN - Special Instructions
1587	0	97	0	Water In Fuel Indicator 1 - Data Above Normal Operational Range (Most Severe Level)
188	0	523240	9	CAN-Receive-Message Function Mode Control - Abnormal Update Rate / Timeout
219	0	520253	2	CAN-Receive-Message EAT Control Message Counter - Data Erratic, Intermittent or Incorrect
220	0	4206	2	TSC1 Message Counter - Data Erratic, Intermittent or Incorrect

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
221	0	4206	2	TSC1 Message Counter - Data Erratic, Intermittent or Incorrect
222	0	4206	2	TSC1 Message Counter - Data Erratic, Intermittent or Incorrect
223	0	4206	2	TSC1 Message Counter - Data Erratic, Intermittent or Incorrect
349	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
350	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
351	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
352	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
353	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
354	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
355	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
356	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
361	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
363	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
365	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
367	0	3349	0	TSC1 Receive Timeout-Error - Data Above Normal Operational Range (Most Severe Level)
38	0	1485	3	ECM Main Relay - Voltage Above Normal or Shorted To High Source
39	0	1485	3	ECM Main Relay - Voltage Above Normal or Shorted To High Source
40	0	1485	3	ECM Main Relay - Voltage Above Normal or Shorted To High Source
41	0	1485	4	ECM Main Relay - Voltage Below Normal or Shorted To Low Source
42	0	1485	4	ECM Main Relay - Voltage Below Normal or Shorted To Low Source
43	0	1485	4	ECM Main Relay - Voltage Below Normal or Shorted To Low Source
48	0	168	0	Battery voltage - Data Above Normal Operational Range (Most Severe Level)
49	0	168	1	Battery voltage - Data Below Normal Operational Range (Most Severe Level)
50	0	168	3	Battery voltage - Voltage Above Normal or Shorted To High Source

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
51	0	168	4	Battery voltage - Voltage Below Normal or Shorted To Low Source
516	0	523982	0	Powerstage Diagnosis disabled, Battery Potential - Data Above Normal Operational Range (Most Severe Level)
517	0	523982	1	Powerstage Diagnosis disabled, Battery Potential - Data Below Normal Operational Range (Most Severe Level)
52	0	168	0	Battery voltage - Data Above Normal Operational Range (Most Severe Level)
567	0	27	5	Engine Exhaust Gas Recirculation 1 Valve Position - Current Below Normal or Open Circuit
570	0	27	3	Engine Exhaust Gas Recirculation 1 Valve Position - Voltage Above Normal or Shorted To High Source
571	0	27	3	Engine Exhaust Gas Recirculation 1 Valve Position - Voltage Above Normal or Shorted To High Source
572	0	27	4	Engine Exhaust Gas Recirculation 1 Valve Position - Voltage Below Normal or Shorted To Low Source
573	0	27	4	Engine Exhaust Gas Recirculation 1 Valve Position - Voltage Below Normal or Shorted To Low Source
574	0	27	6	Engine Exhaust Gas Recirculation 1 Valve Position - Current Above Normal or Grounded Circuit
577	0	27	7	Engine Exhaust Gas Recirculation 1 Valve Position - Mechanical System not Responding or Out of Adjustment
578	0	27	7	Engine Exhaust Gas Recirculation 1 Valve Position - Mechanical System not Responding or Out of Adjustment
582	0	5763	3	Engine Exhaust Gas Recirculation 1 Actuator 1 - Voltage Above Normal or Shorted To High Source
583	0	5763	4	Engine Exhaust Gas Recirculation 1 Actuator 1 - Voltage Below Normal or Shorted To Low Source
586	0	3055	14	Engine Fuel System Monitor (ECU Internal Error) - Special Instructions
587	0	190	0	Engine Speed - Data Above Normal Operational Range (Most Severe Level)
588	0	190	0	Engine Speed - Data Above Normal Operational Range (Most Severe Level)
589	0	190	0	Engine Speed - Data Above Normal Operational Range (Most Severe Level)
590	0	190	0	Engine Speed - Data Above Normal Operational Range (Most Severe Level)
610	0	171	15	Ambient Air Temperature - Data Above Normal Operational Range (Least Severe Level)
613	0	171	3	Ambient Air Temperature - Voltage Above Normal or Shorted To High Source
614	0	171	4	Ambient Air Temperature - Voltage Below Normal or Shorted To Low Source
615	0	723	8	Camshaft Speed Sensor - Abnormal Frequency or Pulse Width or Period
616	0	723	14	Camshaft Speed Sensor - Special Instructions

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
617	0	723	13	Camshaft Speed Sensor - Out of Calibration
618	0	4201	8	Crankshaft Speed Sensor - Abnormal Frequency or Pulse Width or Period
619	0	4201	14	Crankshaft Speed Sensor - Special Instructions
68	0	1669	14	CAN Bus ID-5 - Special Instructions
70	0	110	2	Engine Coolant Temperature - Data Erratic, Intermittent or Incorrect
709	0	97	3	Water In Fuel Indicator 1 - Voltage Above Normal or Shorted To High Source
710	0	97	4	Water In Fuel Indicator 1 - Voltage Below Normal or Shorted To Low Source
721	0	94	15	Engine Fuel Delivery Pressure - Data Above Normal Operational Range (Least Severe Level)
723	0	94	3	Engine Fuel Delivery Pressure - Voltage Above Normal or Shorted To High Source
724	0	94	4	Engine Fuel Delivery Pressure - Voltage Below Normal or Shorted To Low Source
725	0	94	1	Engine Fuel Delivery Pressure - Data Below Normal Operational Range (Most Severe Level)
726	0	94	1	Engine Fuel Delivery Pressure - Data Below Normal Operational Range (Most Severe Level)
75	0	110	3	Engine Coolant Temperature - Voltage Above Normal or Shorted To High Source
76	0	110	4	Engine Coolant Temperature - Voltage Below Normal or Shorted To Low Source
77	0	110	0	Engine Coolant Temperature - Data Above Normal Operational Range (Most Severe Level)
78	0	110	0	Engine Coolant Temperature - Data Above Normal Operational Range (Most Severe Level)
797	0	676	12	Engine Cold Start Aid Relay - Bad Intelligent Device or Component
798	0	676	5	Engine Cold Start Aid Relay - Current Below Normal or Open Circuit
799	0	676	5	Engine Cold Start Aid Relay - Current Below Normal or Open Circuit
80	0	411	2	Engine Exhaust Gas Recirculation 1 Differential Pressure - Data Erratic, Intermittent or Incorrect
803	0	676	3	Engine Cold Start Aid Relay - Voltage Above Normal or Shorted To High Source
805	0	676	4	Engine Cold Start Aid Relay - Voltage Below Normal or Shorted To Low Source
807	0	2797	14	Engine Fuel 1 Injector Group 1 - Special Instructions
815	0	2797	4	Engine Fuel 1 Injector Group 1 - Voltage Below Normal or Shorted To Low Source

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
816	0	5358	5	Engine Cylinder 1 Fuel Injection Quantity - Current Below Normal or Open Circuit
817	0	5359	5	Engine Cylinder 2 Fuel Injection Quantity - Current Below Normal or Open Circuit
818	0	5360	5	Engine Cylinder 3 Fuel Injection Quantity - Current Below Normal or Open Circuit
819	0	5361	5	Engine Cylinder 4 Fuel Injection Quantity - Current Below Normal or Open Circuit
820	0	5362	5	Engine Cylinder 5 Fuel Injection Quantity - Current Below Normal or Open Circuit
821	0	5363	5	Engine Cylinder 6 Fuel Injection Quantity - Current Below Normal or Open Circuit
822	0	2797	6	Engine Fuel 1 Injector Group 1 - Current Above Normal or Grounded Circuit
823	0	2798	6	Engine Fuel 1 Injector Group 2 - Current Above Normal or Grounded Circuit
824	0	5358	6	Engine Cylinder 1 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
825	0	5359	6	Engine Cylinder 2 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
826	0	5360	6	Engine Cylinder 3 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
827	0	5361	6	Engine Cylinder 4 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
828	0	5362	6	Engine Cylinder 5 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
829	0	5363	6	Engine Cylinder 6 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
83	0	111	1	Engine Coolant Level 1 - Data Below Normal Operational Range (Most Severe Level)
830	0	5358	6	Engine Cylinder 1 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
831	0	5359	6	Engine Cylinder 2 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
832	0	5360	6	Engine Cylinder 3 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
833	0	5361	6	Engine Cylinder 4 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
834	0	5362	6	Engine Cylinder 5 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
835	0	5363	6	Engine Cylinder 6 Fuel Injection Quantity - Current Above Normal or Grounded Circuit
836	0	105	3	Engine Intake Manifold 1 Temperature - Voltage Above Normal or Shorted To High Source
837	0	105	4	Engine Intake Manifold 1 Temperature - Voltage Below Normal or Shorted To Low Source
838	0	2797	14	Engine Fuel 1 Injector Group 1 - Special Instructions

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
839	0	2798	14	Engine Fuel 1 Injector Group 2 - Special Instructions
840	0	4257	14	Engine Fuel 1 Injector Group 3 - Special Instructions
841	0	4258	14	Engine Fuel 1 Injector Group 4 - Special Instructions
853	0	0	0	Not defined - Data Above Normal Operational Range (Most Severe Level)
854	0	7103	5	Engine Fuel Metering Rail Pump - Current Below Normal or Open Circuit
855	0	7103	3	Engine Fuel Metering Rail Pump - Voltage Above Normal or Shorted To High Source
856	0	7103	3	Engine Fuel Metering Rail Pump - Voltage Above Normal or Shorted To High Source
857	0	7103	4	Engine Fuel Metering Rail Pump - Voltage Below Normal or Shorted To Low Source
858	0	7103	4	Engine Fuel Metering Rail Pump - Voltage Below Normal or Shorted To Low Source
859	0	7103	6	Engine Fuel Metering Rail Pump - Current Above Normal or Grounded Circuit
868	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
869	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
870	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
871	0	91	14	Accelerator Pedal Position 1 - Special Instructions
875	0	190	2	Engine Speed - Data Erratic, Intermittent or Incorrect
876	0	5357	2	Engine Fuel Injection Quantity Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
877	0	5441	2	Engine Fuel Injection Timing Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
878	0	5357	2	Engine Fuel Injection Quantity Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
879	0	523612	12	Internal Recovery - Bad Intelligent Device or Component
88	0	598	10	Clutch Switch - Abnormal Rate of Change
880	0	523612	12	Internal Recovery - Bad Intelligent Device or Component
881	0	523612	12	Internal Recovery - Bad Intelligent Device or Component
882	0	5357	2	Engine Fuel Injection Quantity Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
883	0	5357	2	Engine Fuel Injection Quantity Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
884	0	5442	2	Engine Fuel Injection Pressure Error for Multiple Cylinders - Data Erratic, Intermittent or Incorrect
885	0	29	2	Accelerator Pedal 2 Position - Data Erratic, Intermittent or Incorrect
886	0	677	2	Engine Starter Motor Relay - Data Erratic, Intermittent or Incorrect
887	0	513	2	Actual Engine Percent Torque - Data Erratic, Intermittent or Incorrect
888	0	513	2	Actual Engine Percent Torque - Data Erratic, Intermittent or Incorrect
889	0	520250	2	Function Monitoring: Error During Subsequent Selectable Monitoring - Data Erratic, Intermittent or Incorrect
890	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
891	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
893	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
894	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
895	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
896	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
897	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
898	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
899	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
900	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
901	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
902	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
903	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
904	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
905	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
906	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
907	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
908	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component

Table 3-14. EMR5 Trouble Codes

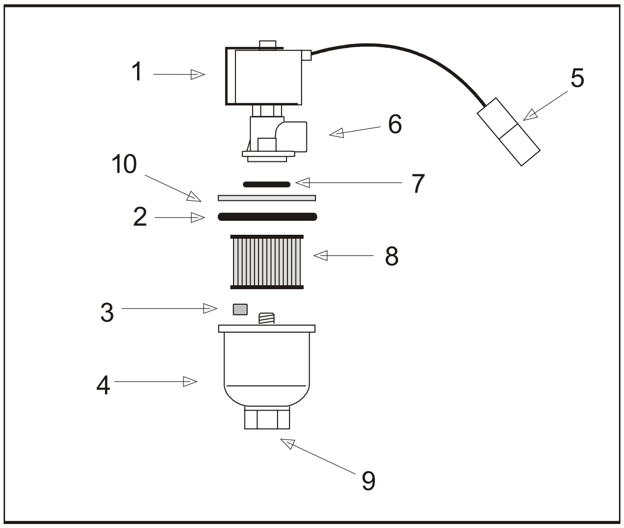
DTC-Code	FTB	SPN	FMI	Error Identification
909	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
91	0	1109	2	Engine Protection System Approaching Shutdown - Data Erratic, Intermittent or Incorrect
910	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
911	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
912	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
913	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
914	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
915	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
916	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
917	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
918	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
919	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
92	0	1109	14	Engine Protection System Approaching Shutdown - Special Instructions
920	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
921	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
922	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
923	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
924	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
925	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
926	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
927	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
928	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
929	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
930	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component

Table 3-14. EMR5 Trouble Codes

DTC-Code	FTB	SPN	FMI	Error Identification
931	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
932	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
933	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
935	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
936	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
937	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
938	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
939	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
940	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
941	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
942	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
943	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
944	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
945	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
996	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
997	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
998	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component
999	0	629	12	Engine Control Unit (Controller 1) - Bad Intelligent Device or Component

3.26 FORD 2.5L ENGINE FUEL SYSTEM REPAIR

Propane Fuel Filter Replacement



1.	Electric Lock off Solenoid	6.	Fuel Outlet
2.	Housing Seal	7.	O-ring
3.	Filter Magnet	8.	Filter
4.	Filter Housing	9.	Fuel Inlet
5.	Electrical Connector	10.	Ring

Figure 3-133. Filter Lock Assembly

REMOVAL

1. Relieve the propane fuel system pressure. Refer to Propane Fuel System Pressure Relief.
2. Disconnect the negative battery cable.
3. Slowly loosen the Filter housing and remove it.
4. Pull the filter housing from the Electric lock off assembly.
5. Remove the filter from the housing.
6. Locate Filter magnet and remove it.
7. Remove and discard the housing seal.
8. If equipped, remove and discard the retaining bolt seal.
9. Remove and discard mounting plate to lock off O-ring seal.

INSTALLATION

NOTICE

BE SURE TO REINSTALL THE FILTER MAGNET INTO THE HOUSING BEFORE INSTALLING NEW SEAL

1. Install the mounting plate to lock off O-ring seal.
2. If equipped, install the retaining bolt seal.
3. Install the housing seal.
4. Drop the magnet into the bottom of the filter housing.
5. Install the filter into the housing.
6. If equipped, install the retaining bolt into the filter housing.
7. Install the filter up to the bottom of the electric lock off.
8. Tighten the filter bowl retainer to 106 in lbs (12 Nm).
9. Open manual shut-off valve. Start the vehicle and leak check the propane fuel system at each serviced fitting. Refer to Propane Fuel System Leak Test.

Propane Fuel System Pressure Relief

CAUTION

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

To relieve propane fuel system pressure:

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

CAUTION

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

Propane Fuel System Leak Test

CAUTION

NEVER USE AN OPEN FLAME OF ANY TYPE TO CHECK FOR PROPANE FUEL SYSTEM LEAKS.

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

3.27 DIESEL PARTICULATE FILTER (IF EQUIPPED)

Diesel Particulate Filter (DPF) is an emissions control system used in diesel engines and requires operator interaction to make sure proper operation of the system.

For peak operation, the DPF system must be cleaned using one of two methods, Standstill Cleaning and Maintenance Standstill Cleaning. Standstill Cleaning is any cleaning requested by the engine outside of the regular maintenance window (for example, if the system detects excessive soot in the DPF canister). Maintenance Standstill Cleaning is cleaning requested by the engine on the regular maintenance interval.

NOTE: *The system will reset the maintenance interval back to zero hours after Standstill or Maintenance Standstill Cleaning events are performed.*

Table 3-15. DPF Operational Indicators

Indicator / Switch	Meaning / Use	Platform Control LED Module	Ground Control LED Module	Ground Control LCD
Regen Required	The DPF Time-Since-Last-Regen Clock, or Soot Loading, is calling for a Standstill Regeneration.		-	
Emission Temperature Indicator	The engine is producing High Exhaust System Temperatures.			-
Ash Overload	The DPF Ash Loading has reached levels that require DPF Replacement.	-	-	
Engine Distress	The Engine's monitoring systems have detected an issue requiring service. Fault Codes will be displayed on the LCD.			Fault Codes
Emission System Malfunction	The Emission Controls' monitoring systems have detected an issue requiring service. Fault Codes will be displayed on the LCD.		-	Fault Codes
Standstill Regen Initiation Switch	Actuated by the Operator to initiate a Standstill Regeneration.	-	 Switch	-

Standstill Cleaning

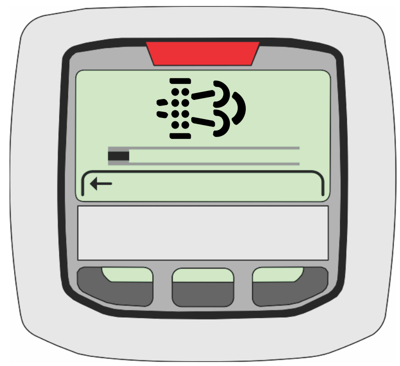
The following conditions must be met to perform Standstill Cleaning.

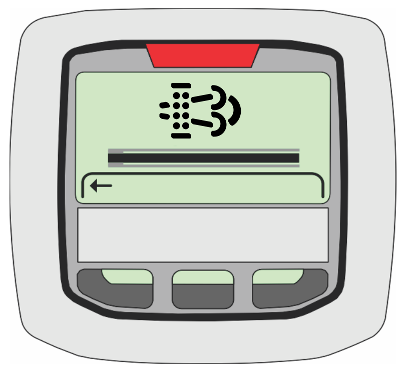
- Machine must be stationary
- Boom in the stowed position
- No personnel in platform
- Engine must be idling
- Coolant temperature must be above 104° F (40° C)
- Machine in Ground Station mode

1. The Diesel Particulate Filter (DPF) Indicator on the Platform Control Panel will flash when standstill cleaning is required.

2. Move the machine to an suitable area free of flammables and personnel that could be exposed to hot exhaust.
3. Launch the cleaning process by pressing the DPF button on the Ground Console for 3 seconds. The Indicator Gauge will display the following screen.

4. The Main Cleaning process will begin and last for approximately 30 to 60 minutes. The following screen will show that the process has begun and includes a status bar that indicates the progress of the cleaning process.





5. After the cleaning process is complete, the engine will run for approximately 5 minutes to allow the Engine and Exhaust After Treatment (EAT) to cool down. The Indicator Gauge will display the "Regen Complete" screen as shown and the Emissions Temperature indicator will no longer be illuminated.

Maintenance Standstill Cleaning Initiation Methods

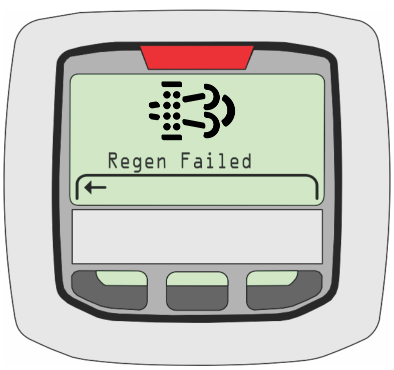
Maintenance Standstill Cleaning can be started by one of two methods, by using the Analyzer or the DPF button on the Ground Console. All the same conditions as outlined under Standstill Cleaning must be met.

Canceling Maintenance Standstill

Maintenance Standstill Cleaning will be stopped immediately if:

- The Platform/Ground Select switch is switched from Ground to Platform mode
- Any function switch is enabled to perform a boom function
- The Engine is powered down

If Maintenance Standstill Cleaning is interrupted, it must be re-initiated and the Indicator Gauge will display the "Regen Failed" screen as shown.

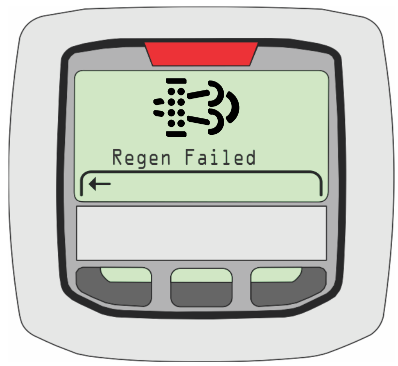


Unsuccessful Cleaning Event

If there is an unsuccessful cleaning event, the DPF icon will show on the display gauge. Possible causes of an Unsuccessful Cleaning Event are:

- Engine is not warmed up
- DEF tank is frozen
- Machine functions operated during cleaning event in progress
- Other engine faults are active

The Gauge will display "Regen Failed" screen as shown. If the cleaning event has failed, the process must be repeated.



DPF Filter Replacement due to Ash Load

The DPF collects non-burnable particulates which cannot be removed by the Standstill Cleaning process. Build up of the ash load requires filter maintenance and/or exchange. DPF filter maintenance or exchange requirement is indicated by the DPF Exchange icon shown on the display gauge.

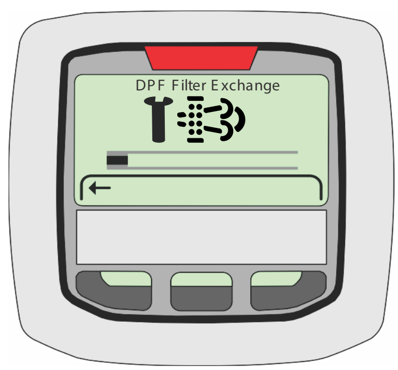


Table 3-16. Maintenance Standstill Cleaning

Standstill Cleaning Levels		Machine Hours Since Last Cleaning	DPF Regeneration Initiation Methods	Engine Error Indicator	DPF Indicator	Emissions Temperature Indicator*	Derate	Comments
0	Normal Operation	0-500	Serdia Tool (Level 2) + (Switch in JLG machine or JLG Analyzer)	-	-		None	Between 500 and 650 hours, cleaning cycle can be initiated with a JLG analyzer or Switch in machine. (Deutz ECM will generate DPF cleaning required lamp at 500 hours. JLG will mask this lamp until 650 hours.)
		500-650	Switch in JLG Machine OR JLG Analyzer					
1	Standstill Required	650-750	Switch in JLG Machine OR JLG Analyzer	-			None	Exhaust gas temperature will be around 600°C during standstill DPF regeneration.
2	Warning Level	750-775	Switch in JLG Machine OR JLG Analyzer	Continuous 			Derating Step 1 (25% Power derate)	Machine placed in Creep and DTC active
3	Shut Off Level	>775	Must have Serdia Level 3 access + (switch in JLG machine or JLG analyzer)	Blinking 			Derating Step 2 (Idle Lock)	Idle Lock. Boom Functions Locked Out and trapped in Transport.
4	Filter Exchange	DPF Regeneration NOT POSSIBLE DPF Filter exchange required		Blinking 			Derating Step 2 (Idle Lock)	Idle Lock. Boom Functions Locked Out and trapped in Transport.

*Emissions Temperature indicator continuously ON during Standstill Cleaning

Table 3-17. Standstill Cleaning: DPF Filled with Soot

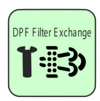
Standstill Escalation Steps		Soot Load	Time in Heat Mode (Hours)	DPF Regeneration Initiation Methods	Check Engine Lamp	DPF Cleaning Lamp	HEST Lamp (Possible), Continuously on during standstill cleaning	Derate	Comments
0	Normal Operation	<62%	-						
1	Heat Mode 1	62% to 78%	50	-	-	-		None	If soot load reaches 56% in 50 hours of Heat Mode 1, System will automatically take it to normal operation.
2	Heat Mode 2	78% to 100%	250						If soot load reaches 56% in 250 hours of Heat Mode 2, System will automatically take it to normal operation.
3	Standstill Required	100% to 109%	100	Switch in JLG Machine or JLG Analyzer	-	0.5 Hz		None	Will remain in Standstill mode for 100 hours or until the soot load reaches 109%
4	Warning Level	109% to 125%	25	Switch in JLG Machine or JLG Analyzer	Continuous	0.5 Hz		Derating Step 1 (25% Power derate)	Will remain in Warning level (Derate) for 25 hours or until the soot load reaches 125%. Machine placed in Creep and DTC active
5	Shut Off Level	125% to 161%		Must have Serdia Level 3 access + (switch in JLG machine or JLG analyzer)	Blinking	3 Hz		Derating Step 2 (Idle Lock)	Idle Lock. Boom Functions Locked Out and Trapped in Transport.
6	Filter Exchange	>161%		DPF Regeneration NOT POSSIBLE. DPF Filter exchange required	Blinking	3 Hz		Derating Step 2 (Idle Lock)	Idle Lock. Boom Functions Locked Out and Trapped in Transport.

*Emissions Temperature indicator continuously ON during Standstill Cleaning

Ash Load

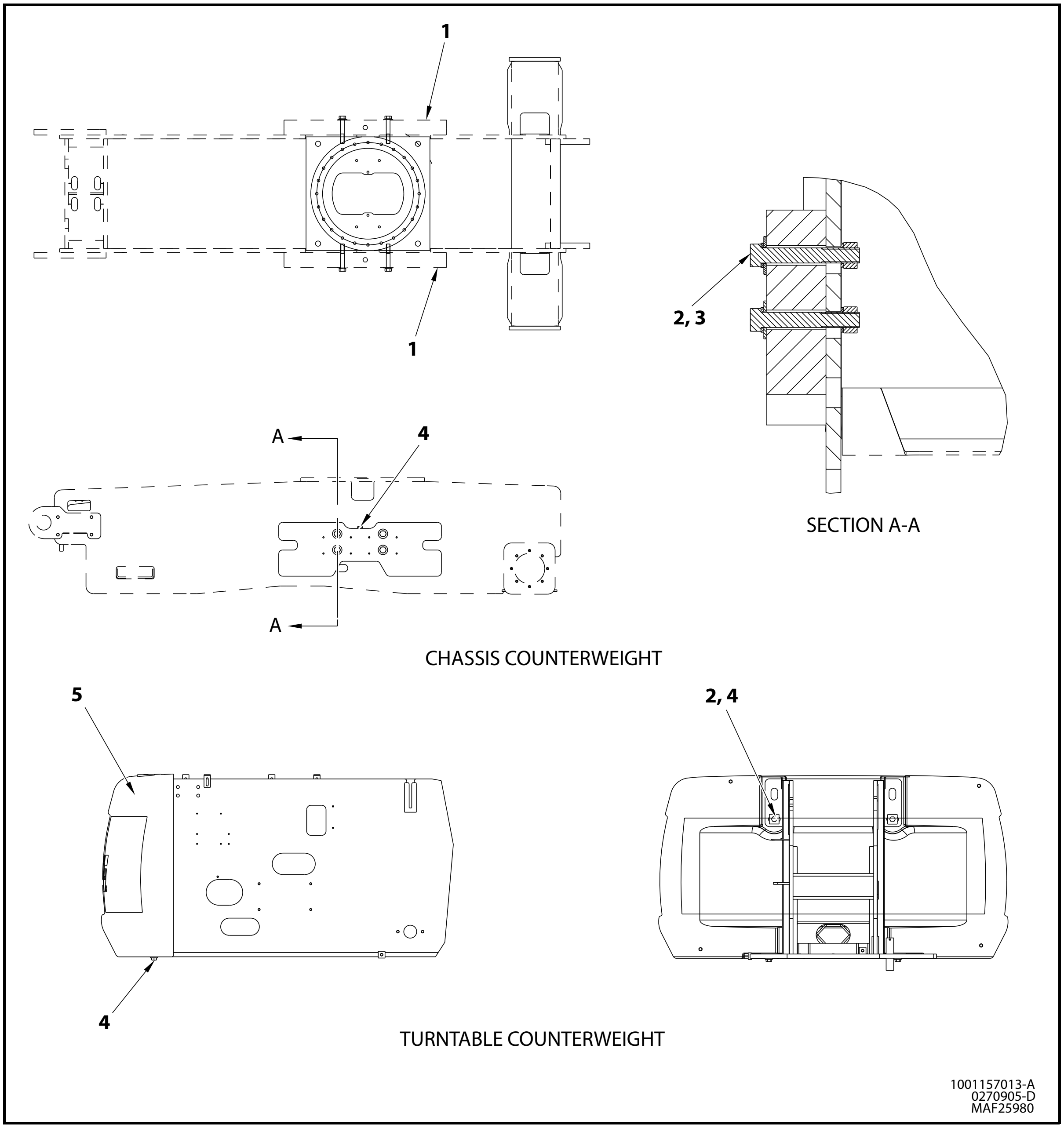
- During the lifetime of the EAT system the DPF collects also particulates that cannot be removed by regeneration process. All non-burnable particles stored in the filter are here summarized as ash load. This ash load leads to shortened regeneration intervals and finally a filter maintenance or exchange is required.
- When 100'% of the rated ash load is reached, a filter exchange is required. The maintenance request is indicated by the ash lamp (solid on) and/or by the respective CAN-message.
- In case of continuously ignored maintenance requests the available filter volume is reduced and the need for standstill regenerations becomes more probable.
- Therefore, at higher ash loads an error paths is set and engine protection functionalities are activated. At this state the ash lamp is flashing with 1 Hz.
- After exchanging the filter, the soot and ash load stored in the ECU must be reset with the Service Tool (SERDIA).

Table 3-18. Ash Load DPF Filter Replacement

Ash Load	AT1S Byte 2 [%]	DPF Test Monitor Byte 3.3-4	Ash Lamp	DM1 Byte 1.3-6 Warning Lamp Symbol	System reaction EU and EPA
Normal Operation	<100%	00	Off	xx0000xx - -	No Derating
Filter Exchange Required	≥100%	01	On 	xx0000xx - -	No Derating
Warning Level	≥105%	10	Blinking 	xx0000xx - -	No Derating
Warning Level	≥110%	11	Blinking 	xx0000xx On Continuous 	Derating Step 1Active.

3.28 COUNTERWEIGHT

If the counterweight has been removed, ensure the retaining bolts are torqued to the proper value as shown in Figure 3-134., Counterweight Bolt Torque.



1. Counterweight Plate
2. Apply High Strength Threadlocking Compound to Bolt Threads and to Threads in Counterweight
3. Torque bolts to 480 ft. lbs. (651 Nm)
4. Torque bolts to 285 ft. lbs. (388 Nm)
5. Counterweight Casting

Figure 3-134. Counterweight Bolt Torque

SECTION 4. BOOM & PLATFORM

4.1 PLATFORM AND BOOM SYSTEM

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.

To operate any directional function, the footswitch must be depressed before activation of the function. When the footswitch is depressed, the controls are enabled, and the operator has 7 seconds to operate any function.

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. Do this by releasing all functions, then releasing and re-depressing the footswitch. Releasing the foot switch during function commands will stop the function movement.

Platform Load Sensing System

The Platform Load Sensing System consists of a single load cell mounted within the platform support. This system provides the platform load to the Dual Capacity System or the Triple Capacity System. The control system will light the applicable capacity light in both the platform control box and the ground control station based on the value observed by the LSS system.

When there is a fault in the system, the platform and ground overload indicator will flash, the platform alarm will sound at the rate of 5 sec on / 2 sec off and all platform function controls (except auxiliary power) will be disabled. The ground controls are unaffected unless configured otherwise in the machine setup selection.

If the LSS system senses an overload condition, boom functions will be disabled, the overload alarm will sound at the platform. If power is cycled under this condition, the machine will only allow the boom telescope function to retract and will only allow the boom lift function to lift up, since these actions will bring the platform towards a condition improved stability.

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.

The key is removable only in the off position, which allows the ground control station to have ultimate priority over the platform control.

Function Speed Control System

The platform controls for the jib, lift, and main telescope functions are controlled through a common variable speed control knob.

This knob feeds the valve driver of each control circuit allowing a smooth ramp up, controlled maximum output speed, and ramp down.

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.

The variable speed control knob when turned counterclockwise and into the detent position (shown with a snail on the control panel decal), will place all functions, including proportional functions, in creep.

Main Boom End of Stroke Damping

When main boom lift is activated, end of stroke damping is achieved through the electronic control system. This system slows the main boom speed within the last 5 degree before minimum and maximum main boom elevations. This reduction in speed occurs only while approaching the end of stroke limits. Speeds in the opposite direction are not altered.

Transport Position Sensing System

The transport position sensing system consists of a boom angle sensor (this sensor is a hall effect sensor) mounted at the pivot point between the main boom and upright and two proximity switches mounted at the bottom of the base boom.

The system uses these sensor/switches in combination to sense if the boom is in the position associated with high speed travel. The control circuit reads two redundant angular sensor signals from the boom angle sensor.

Above transport angle is recognized when one angular sensor signal from the boom angle sensor reads more than 12 degree greater than horizontal (with respect to the turntable), and resets to within transport position when both angular sensor signals read less than 2 degree greater than horizontal (with respect to the turntable).

Transport length is recognized when any one of two length switches reads more than 18 in. extension of fly boom.

During failures of either of two length switches, the system will sense a disagreement. It will presume the boom is extended out past the limit. The position of the articulated jib is not considered.

This system is used to control the following systems:

1. Beyond Transport Position - Drive Speed Cutback System
2. Drive/Steer - Boom Function Interlock System
3. Oscillating Axle System

Beyond Transport - Drive Speed Cutback System

When the boom is positioned beyond the transport position as described in "Transport Position Sensing System", the drive motors are automatically restricted to their maximum displacement position (slow speed).

See the "Chassis Tilt Indicator System" for interaction with the tilt sensor.

Drive/Steer - Boom Function Interlock System

The Drive/Steer - Boom Function Interlock System uses the "Transport Position Sensing System" to sense when the boom is out of the transport 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 while in this mode, becomes the master function set. In other words, while operating drive/steer functions the boom functions are disable. Similarly, while operating boom functions drive/steer.

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 “Transport Position Sensing System” and when the boom is oriented between the rear tires as described in the “Drive Orientation System”.

Platform Capacity System

The control system obtains the platform load from the Platform Load Sensing System (LSS).

The main boom angle from the main boom angle sensor and the fly boom position from the fly boom position proximity sensors and then determines which capacity zone (Unrestricted 500 lb/230 kg or Restricted 750 lb/340kg or Restricted 1000 lb/450 kg) the platform can be operated in.

If the control system determines that the platform position is in one of the restricted zones and the machine operator attempts to cross the boundary of the current zone and enter the next zone of lessor or no restriction with more weight in the platform than what is allowed, the machine will stop at the boundary of the current zone and not enter the zone of lessor or no restriction. At this point, the control system will only allow the boom telescope function to retract and will only allow the boom lift function to lift up, since these actions will bring the platform towards an improved stability condition.

When the LSS system senses a platform load equal to or less than 500 lb/227 kg, platform position is unrestricted within the envelope boundaries.

Machine Safety System Override (CE only)

The MSSO (Machine Safety System Override) is fitted to the ground console and is standard only for the CE market.

The MSSO is only used to retrieve an operator who is pinned, trapped, or unable to operate the machine from the platform controls and function controls are locked out from platform due to a platform overload situation.

Platform overload fault is logged like any other fault, it remains active and is displayed until it is removed using the JLG Analyzer. No functional checks of the MSSO system are necessary. The JLG control system will set a Diagnostic Code if the MSSO enable switch is faulty.

Telescope Retracted Sensor

The Telescope Retracted Sensor measures boom length to control drive speed and the oscillating axle. The telescope retracted sensor is mounted on the left side of main boom as shown in Figure 4-7. to Figure 4-15.

In transport:

The Sensor is a normally open sensor which is closed in transport condition. LED for Sensor is ON in transport condition.

- The telescope retracted sensor measures the fly boom extension. When less than 24 in. (61 cm), drive speed and oscillating axle are not affected.

NOTE: *In Transport condition, Using Analyzer under DIAGNOSTICS/SYSTEM, TELE RETRAC SW will read CLOSED.*

Out of transport:

The Sensor is a normally open sensor in out of transport condition. LED for Sensor is OFF when out of transport condition.

- The telescope retracted sensor measures the fly boom extension. When more than 24 in. (61 cm), drive speed is reduced and oscillating axle is locked.

NOTE: *In Out Of Transport condition, Using Analyzer under DIAGNOSTICS/SYSTEM, TELE RETRAC SW will read OPEN.*

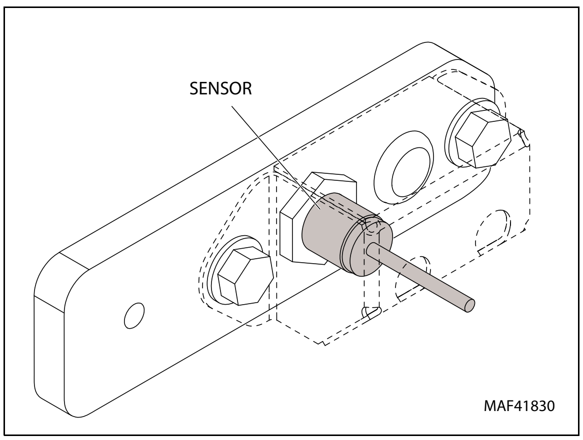


Figure 4-1. Telescope Retracted Sensor

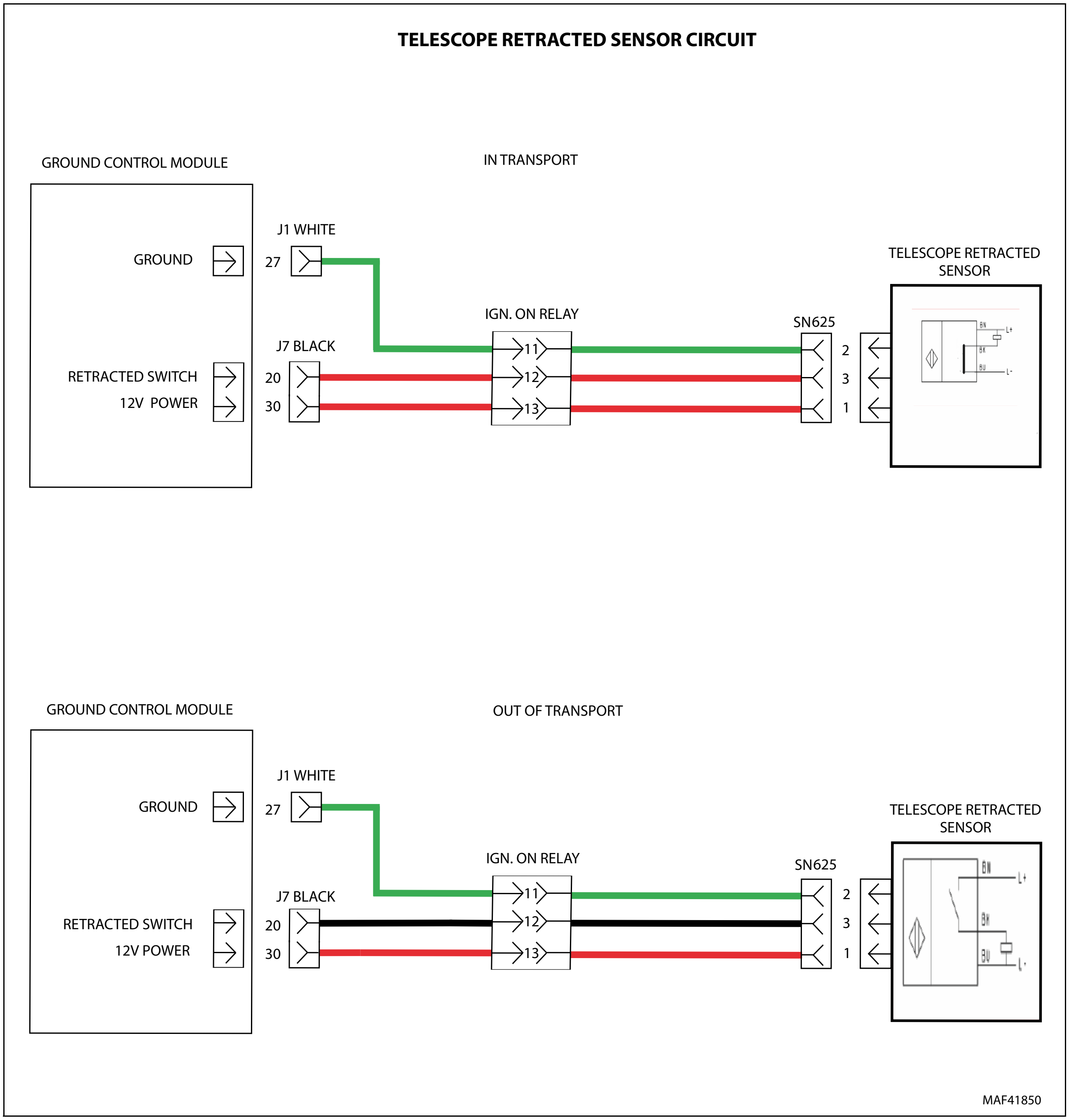


Figure 4-2. Telescope Retracted Sensor Circuit

TRIPLE CAPACITY SYSTEM

The control system obtains the platform load from the Platform Load Sensing System (LSS), the main boom angle from the main boom angle sensor, and the fly boom position from the fly boom position proximity sensors, and then determines which capacity zone (Unrestricted 500 lb/227 kg or Restricted 750 lb/340 kg or Restricted 1000 lb/450 kg) the platform can be operated in.

If the control system determines that the platform position is in one of lesser or no zones and the machine operator attempts to cross the boundary of the current zone and enter the next zone of greater restriction with more weight in the platform than what is allowed, the machine will stop at the boundary of the current zone and not enter the zone of greater restriction. At this point, the control system will only allow the boom telescope function to retract and will only allow the boom lift function to lift up, since these actions will bring the platform towards an improved stability condition.

When the LSS system senses a platform load equal to or less than 500 lb/227 kg, platform position is unrestricted within the envelope boundaries.

The capacity sensors are located on the main boom as shown in Figure 4-7. to Figure 4-8.

Unrestricted 500 lb (227 kg) - (Yellow)

Switch Set A & Switch Set B:

Sensor 1 (left proximity sensor, refer Figure 4-7. to Figure 4-8.) is a normally closed sensor which is closed in the unrestricted 500 lb (227 kg) zone. LED for Sensor 1 is ON in this mode.

Sensor 2 (right proximity sensor, refer Figure 4-7. to Figure 4-8.) is a normally open sensor which is open in the unrestricted 500 lb (227 kg) zone. LED for Sensor 2 is OFF in this mode.

- The Machine Control System will allow the platform to go anywhere in the working envelope. The unrestricted 500 lb (227 kg) working envelope is shown in Figure 4-7. to Figure 4-8.

NOTE: *In unrestricted 500 lb (227 kg) zone with analyzer under DIAGNOSTICS/SYSTEM, for both switch set A & B, CAPACITY SW 1 will read CLOSED and CAPACITY SW 2 will read OPEN.*

Restricted 750 lb (340 kg) - (Blue)

Switch Set A:

The Sensor 1 (left proximity sensor, refer Figure 4-7. to Figure 4-8.) is a normally closed sensor which is closed in the restricted 750 lb (340 kg) zone. LED for Sensor 1 is ON in this mode.

The Sensor 2 (right proximity sensor, refer Figure 4-7. to Figure 4-8.) is a normally open sensor which is open in the restricted 750 lb (340 kg) zone. LED for Sensor 2 is OFF in this mode.

Switch Set B:

The Sensor 1 (left proximity sensor, refer Figure 4-7. to Figure 4-8.) is a normally closed sensor which is open in the restricted 750 lb (340 kg) zone. LED for Sensor 1 is OFF in this mode.

The Sensor 2 (right proximity sensor, refer Figure 4-7. to Figure 4-8.) is a normally open sensor which is closed in the restricted 750 lb (340 kg) zone. LED for Sensor 2 is ON in this mode.

- The Machine Control System will not allow the platform to go beyond the boundaries of the restricted 750 lb (340 kg) zone. It will allow retraction of the boom or lifting of the boom. The restricted 750 lb (340 kg) working envelope is shown in Figure 4-7. to Figure 4-8.

NOTE: *In the restricted 750 lb (340 kg) zone with analyzer under DIAGNOSTICS/SYSTEM, for switch set A, CAPACITY SW 1 will read CLOSED and CAPACITY SW 2 will read OPEN. For switch set B, CAPACITY SW 1 will read OPEN and CAPACITY SW 2 will read CLOSED.*

Restricted 1000 lb (454 kg) - (Green)

Switch set A & Switch Set B:

The Sensor 1 (left proximity sensor, refer Figure 4-7. to Figure 4-8.) is a normally closed sensor which is open in the restricted 1000 lb (454 kg) zone. LED for Sensor 1 is OFF in this mode.

The Sensor 2 (right proximity sensor, refer Figure 4-7. to Figure 4-8.) is a normally open sensor which is closed in the restricted 1000 lb (454 kg) zone. LED for Sensor 2 is ON in this mode.

- The Machine Control System will not allow the platform to go beyond the boundaries of the restricted 1000 lb (454 kg) zone. It will allow retraction of the boom or lifting of the boom. The restricted 1000 lb (454 kg) working envelope is shown in Figure 4-7. to Figure 4-8.

NOTE: *In the restricted 1000 lb (454 kg) zone, with analyzer under DIAGNOSTICS/SYSTEM, for both switch set A & B, CAPACITY SW 1 will read OPEN and CAPACITY SW 2 will read CLOSED.*

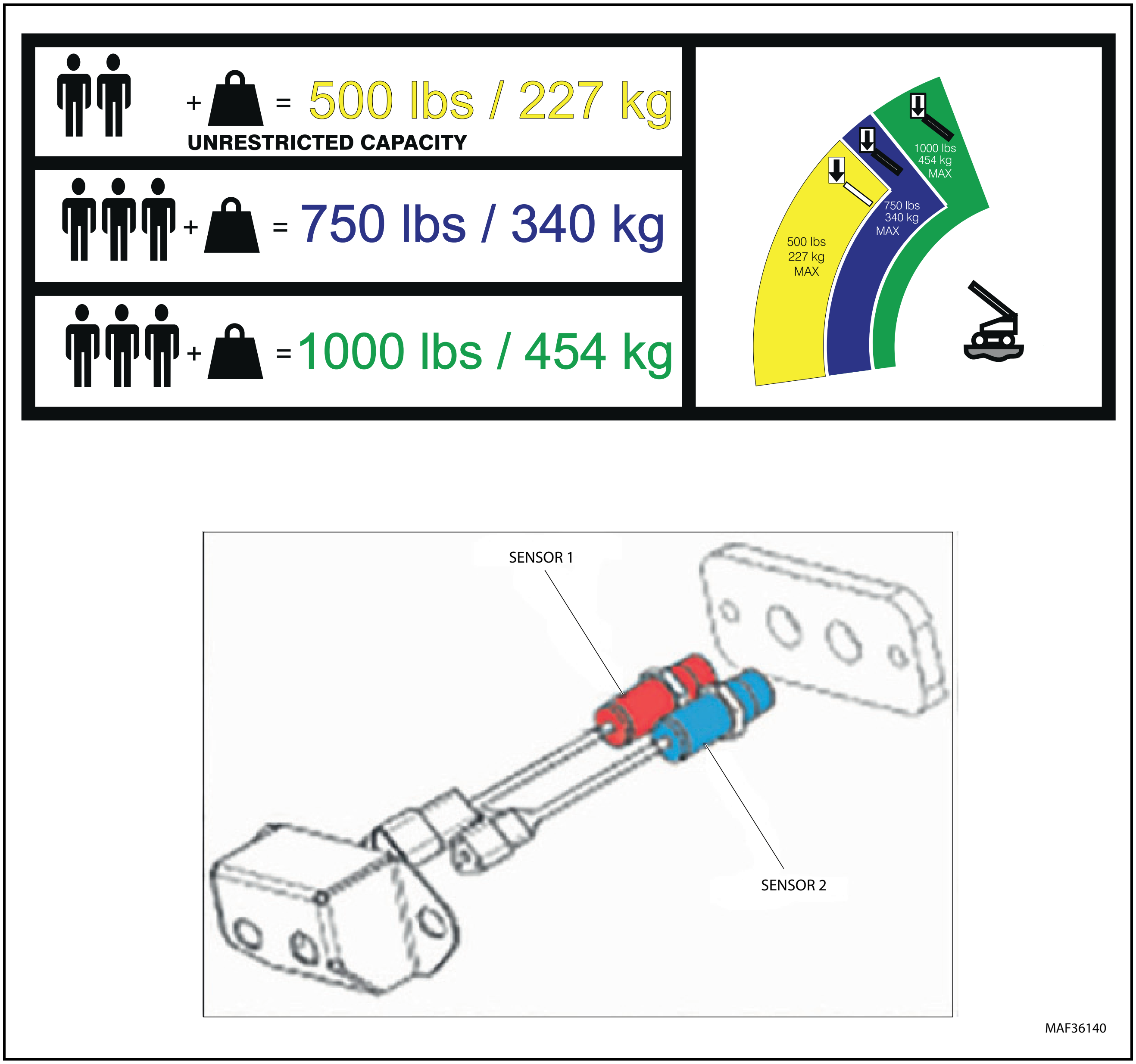


Figure 4-3. Capacity Sensors

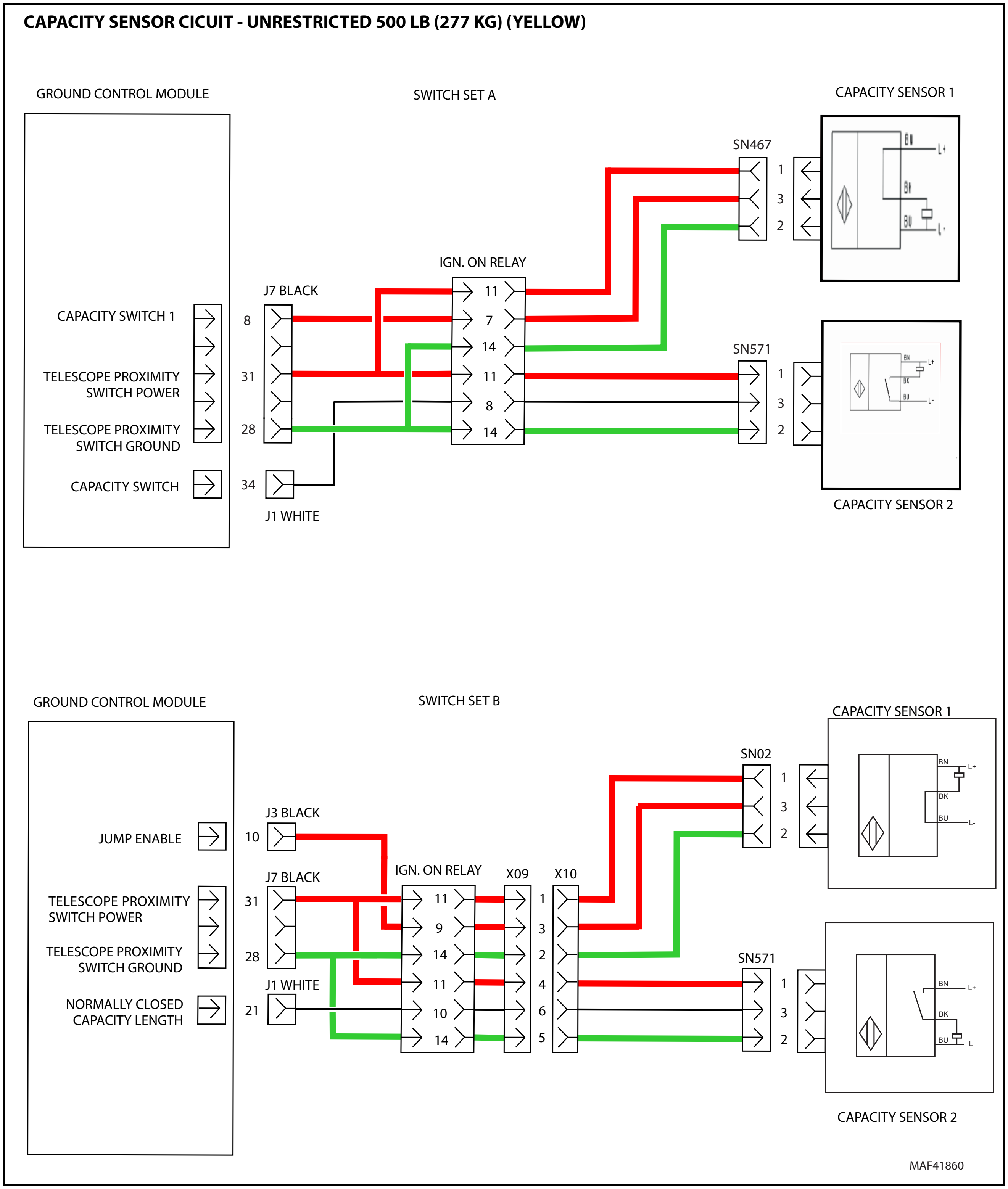


Figure 4-4. Capacity Sensors Circuit - Unrestricted 500 lb (277 kg) (Yellow)

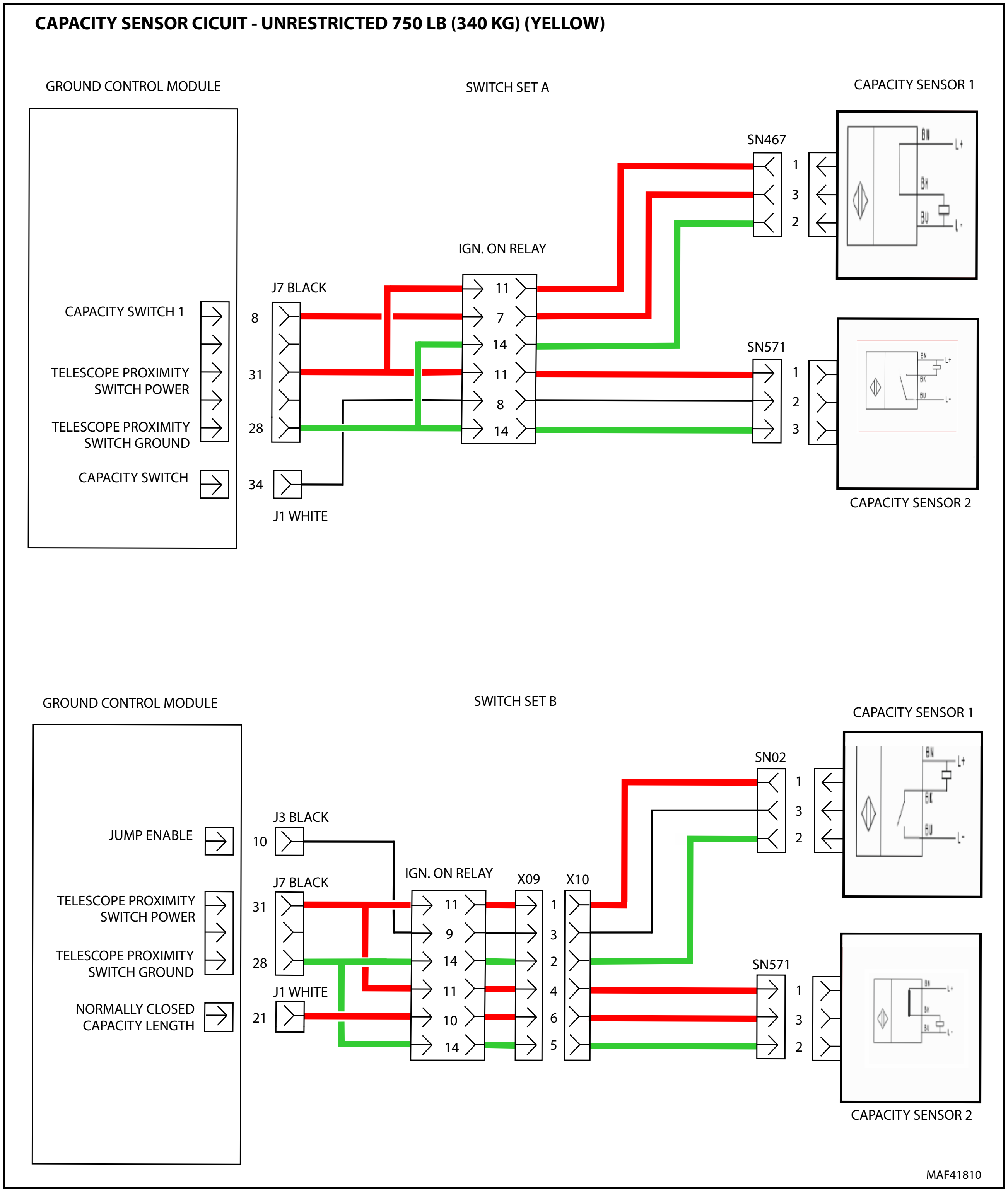


Figure 4-5. Capacity Sensors Circuit - Restricted 750 lb (340 kg) (Blue)

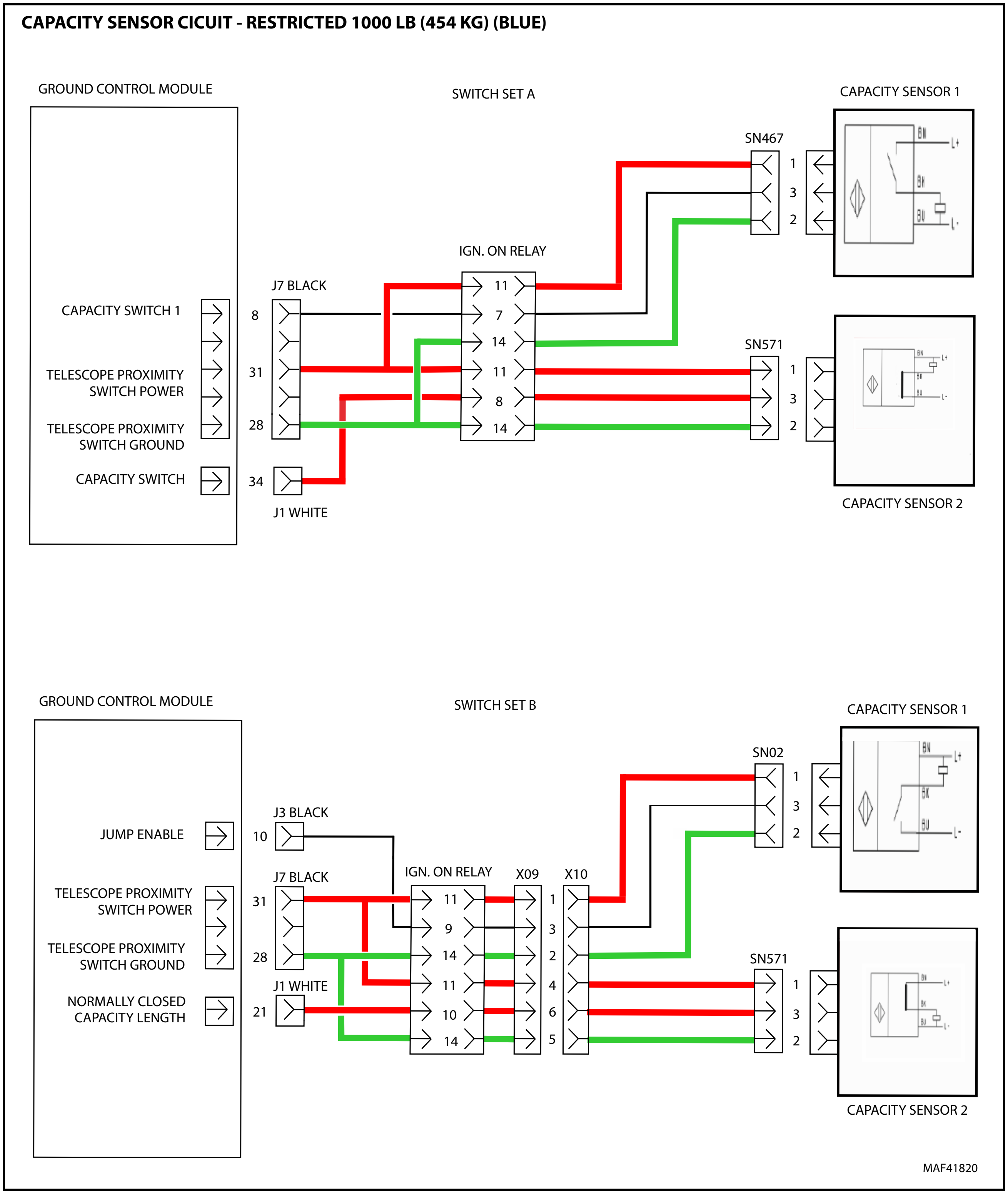


Figure 4-6. Capacity Sensors Circuit - Restricted 1000 lb (454 kg) (Blue)

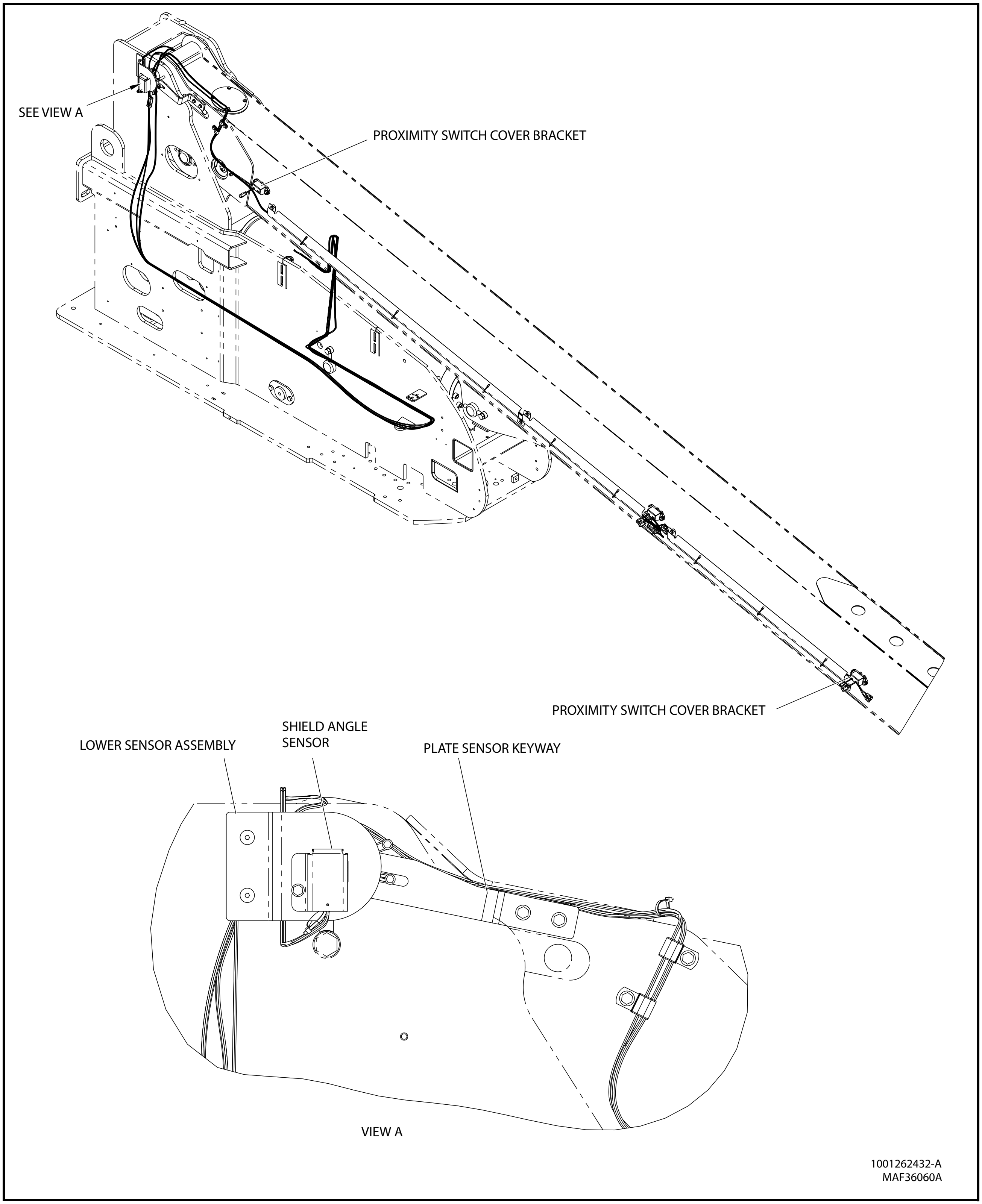
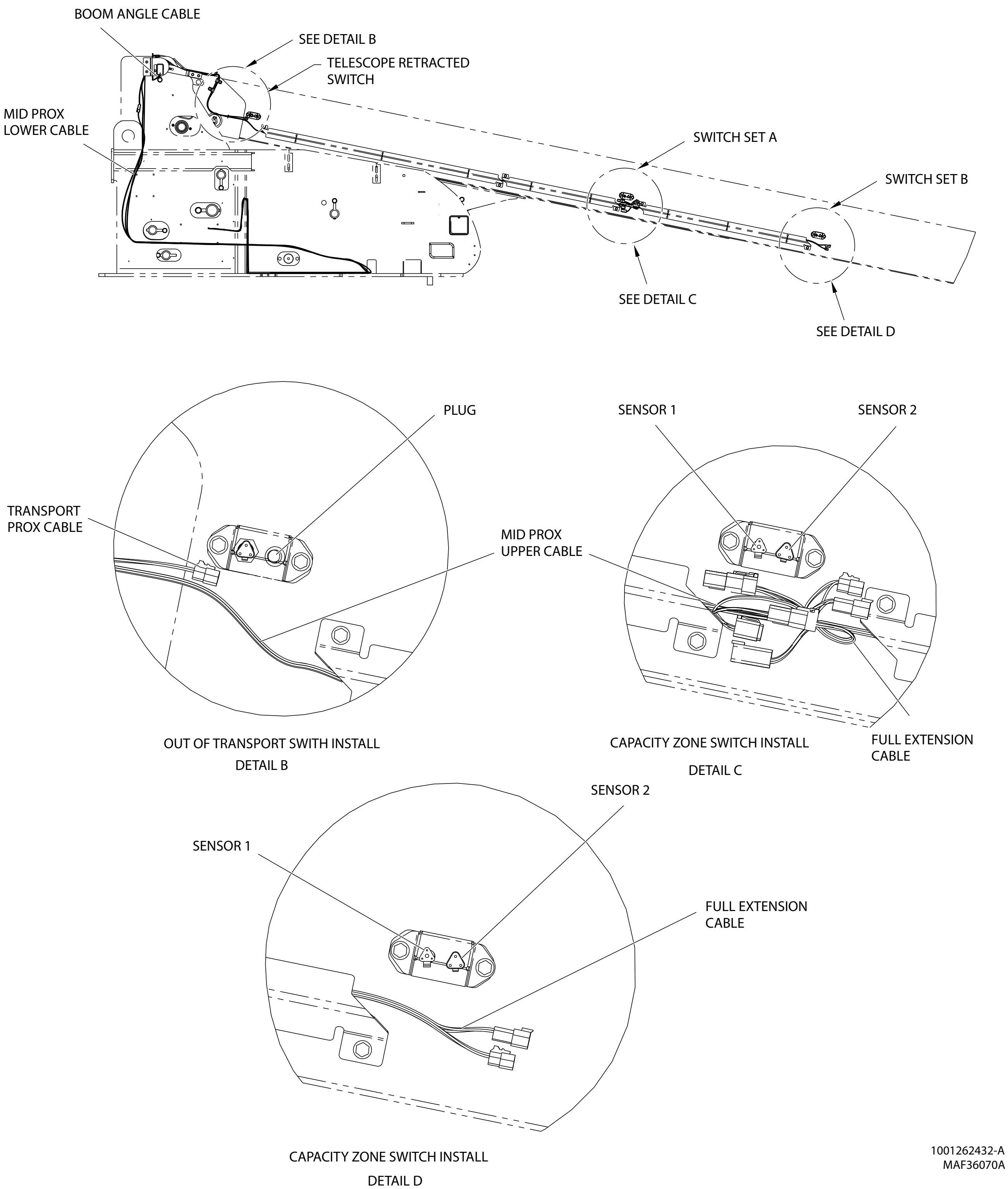


Figure 4-7. Capacity Switch Installation - Sheet 1 of 2



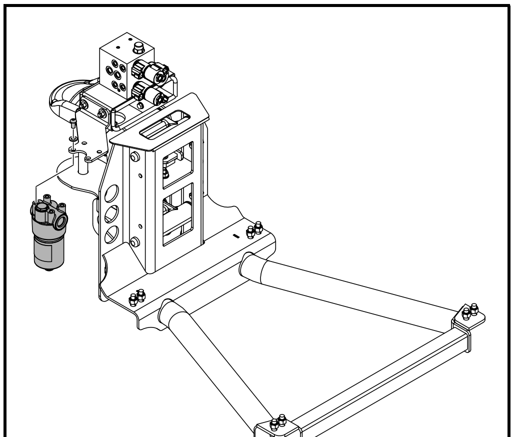
NOTE: *TO INSTALL PROX SWITCHES THREAD SENSORS UNTIL THEY BOTTOM OUT ON THE MID BOOM. THEN BACK THEM OUT A TOTAL OF SIX FULL TURNS. INSTALL BACKUP NUTS PROVIDED WITH THE SENSORS TO PREVENT MOVEMENT.*

Figure 4-8. Capacity Switch Installation - Sheet 2 of 2

4.2 PLATFORM

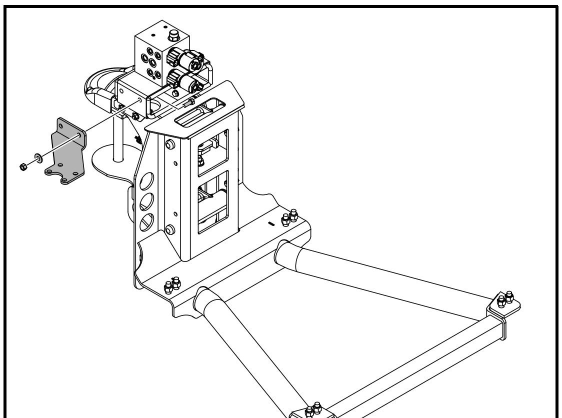
Platform Valve Removal

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 high pressure filter to filter mounting bracket. Remove high pressure filter.



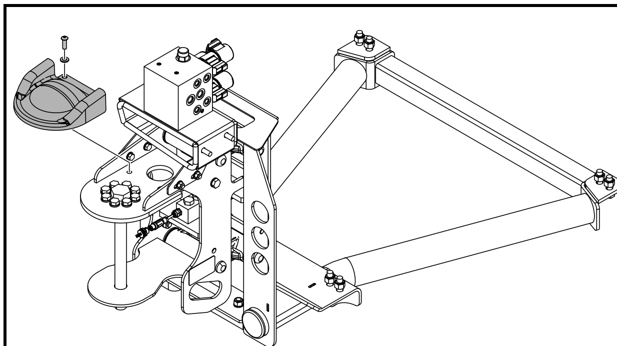
MAF26200

3. Remove hardware securing filter mounting bracket to valve mount. Remove filter mounting bracket.



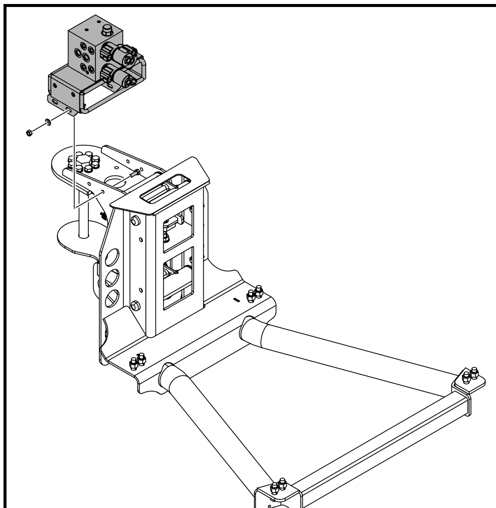
MAF26210

4. Remove hardware securing cover to the platform support. Remove cover.



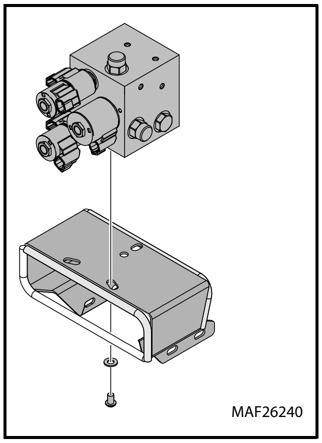
MAF26220

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



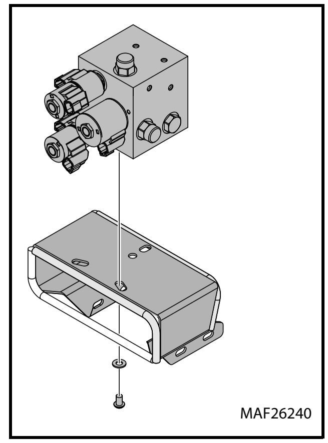
MAF26230

6. Remove hardware securing the platform control valve to the mounting bracket. Remove platform control valve.

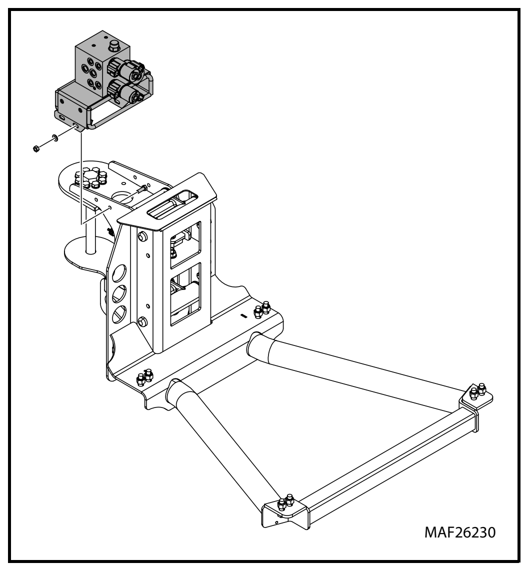


Platform Valve Installation

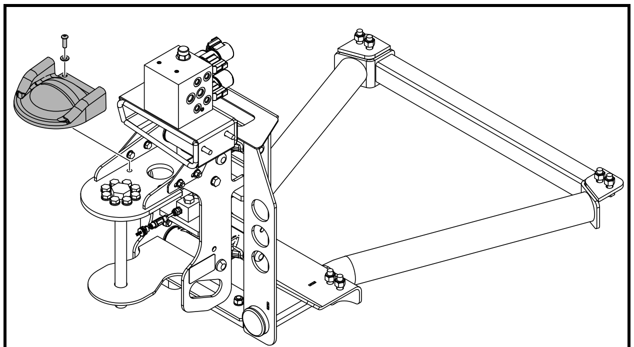
1. Install platform control valve onto the mounting bracket and secure using hardware.



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

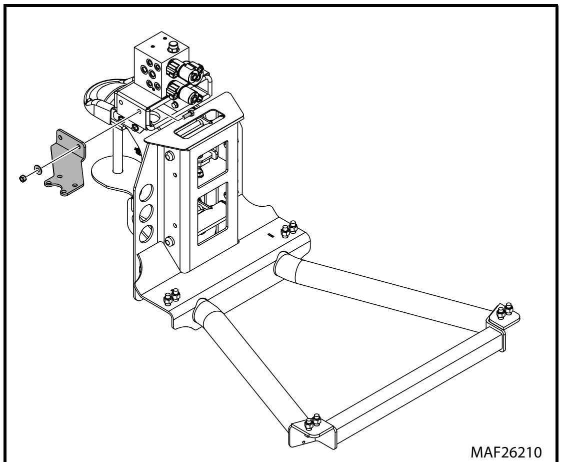


3. Install cover onto the platform support and secure with mounting hardware.



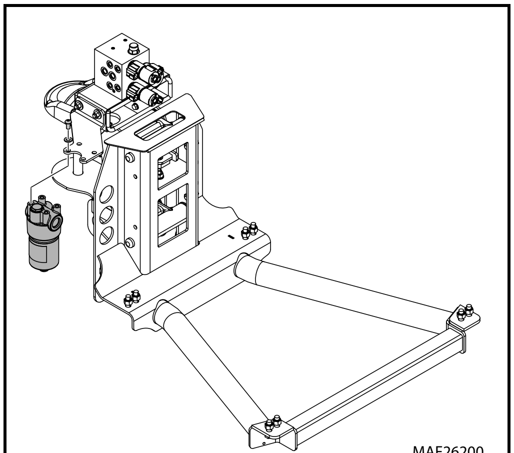
MAF26220

4. Install filter mounting bracket on side of valve mount and secure with mounting hardware.



MAF26210

5. Install high pressure filter onto filter mounting bracket and secure with mounting hardware.



MAF26200

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

Platform Support Removal

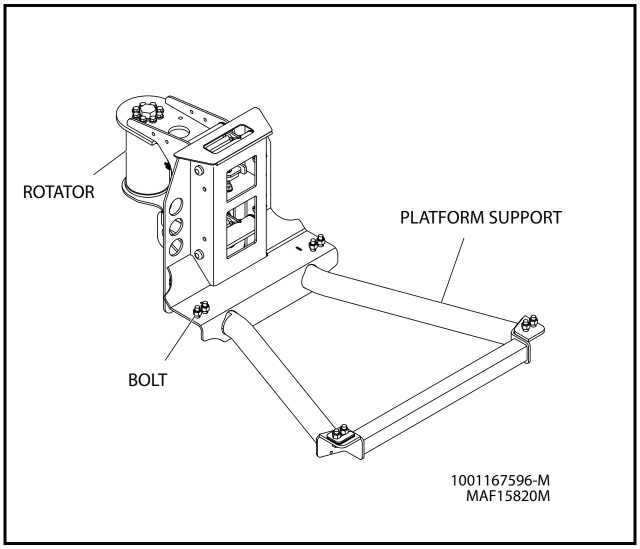
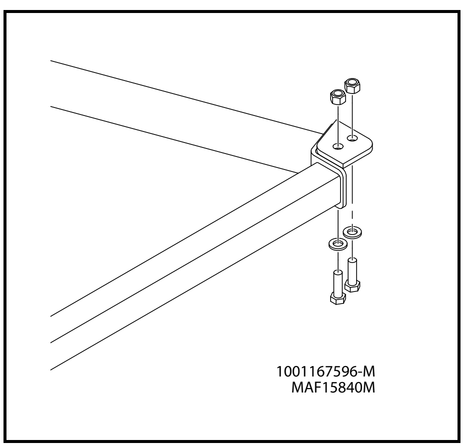


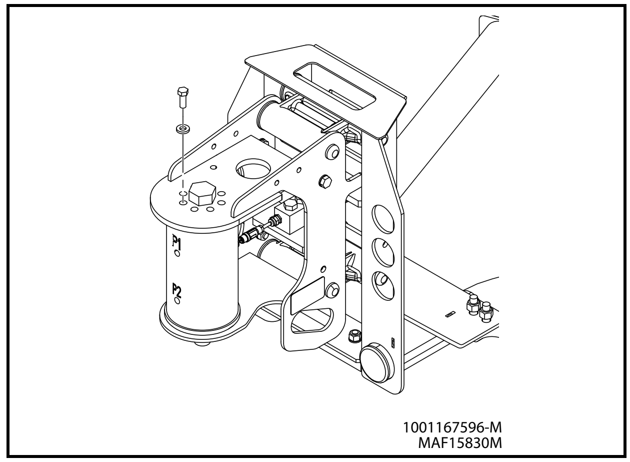
Figure 4-9. Location of Components Platform Support

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, then remove the platform.

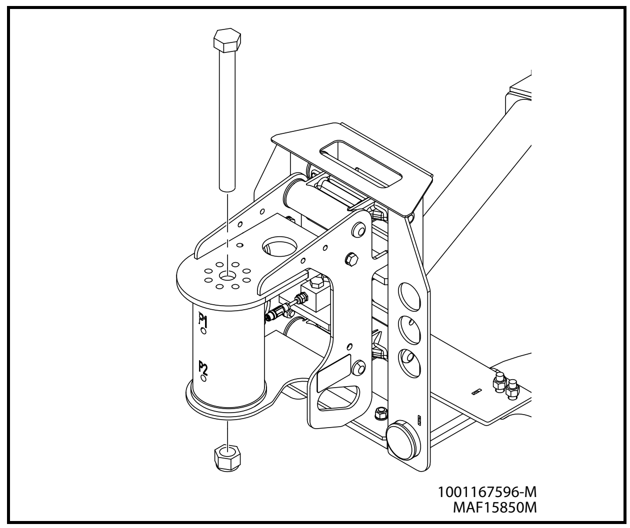
NOTE: *The platform support weighs approximately 125 lb (56.8 kg).*



4. Using a suitable lifting device, support the platform support.
5. Remove the bolts and locknuts securing the support to the rotator.



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

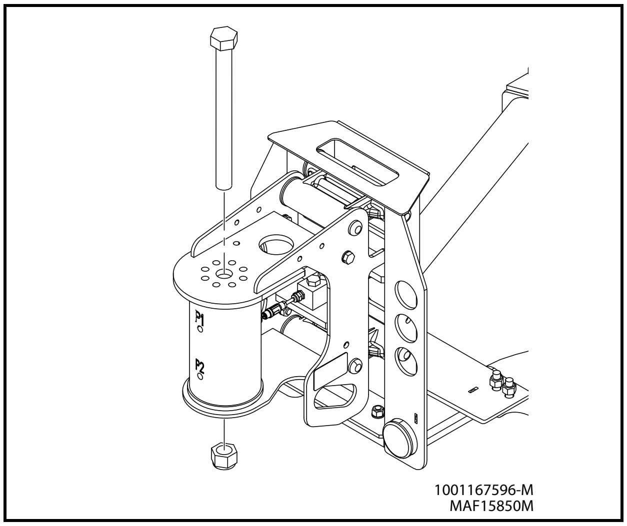


Platform Support Installation

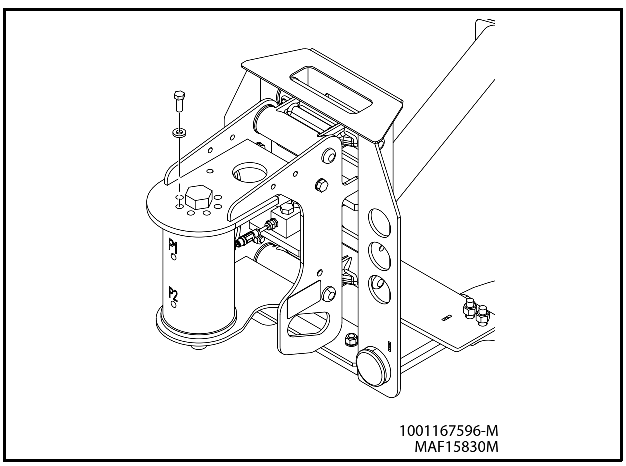
1. Using a suitable device, support the platform support and position it on the rotator.

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

2. Install the rotator center bolt.

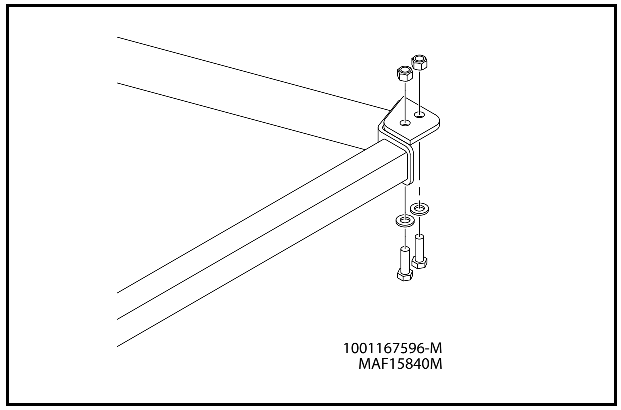


3. Apply Medium Strength Threadlocking Compound to the bolts and locknuts securing the support to the rotator and install the bolts and locknuts.

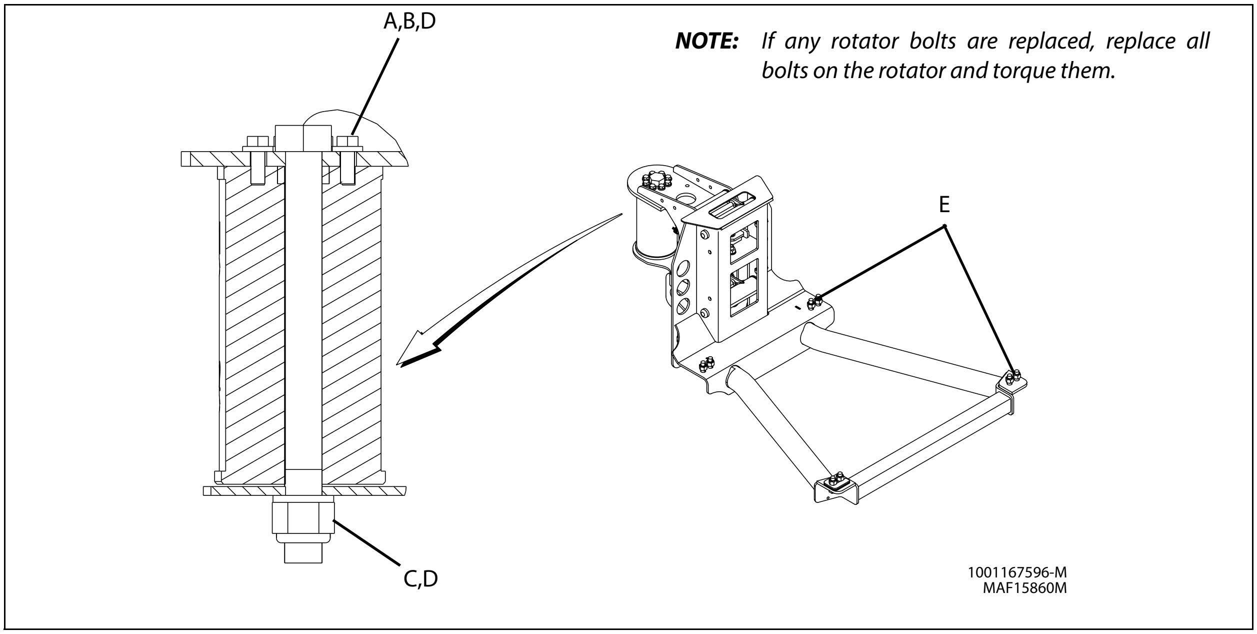


4. Torque the nut on the rotator center bolt to 586 ft. lbs. (795 Nm). Torque the retaining bolts to 40 ft. lbs. (55 Nm).

5. Position the platform on the platform support and install the bolts securing the platform to the platform support.



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



A	Torque to 40 ft. lbs. (55 Nm)
B	Medium Strength Threadlocking Compound
C	Torque to 586 ft. lbs. (795 Nm)
D	Check torque every 150 hours of operation
E	Torque to 75.5 ft. lbs. (97 Nm)

Figure 4-10. Platform Support Torque Values

4.3 ROTATOR AND LEVEL CYLINDER

Removal

NOTE: *Refer Figure 4-11., Removal/Installation of Components - Rotator and Level Cylinder*

800S

1. Remove the Platform and Platform Support. Refer Section 4.2 - Platform.
2. Extend the fly boom section out to gain access to the platform level cylinder pin.
3. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap or plug all openings of hydraulic lines and ports.

NOTE: *The rotator weighs approximately 54 lb (25 kg).*

4. Supporting the rotator, remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1.

NOTE: *The platform level cylinder weighs approximately 63.3 lb (28.7 kg).*

5. Supporting the platform level cylinder, remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 from the rotator and remove the rotator.
6. Tag and disconnect hydraulic lines to platform level cylinder. Use suitable container to retain any residual hydraulic fluid. Cap or plug all openings of hydraulic lines and ports.
7. Remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the fly boom and remove platform level cylinder.

860SJ

1. Remove the Platform and Platform Support. Refer Section 4.2 - Platform.
2. Extend the fly boom section out to gain access to the platform level cylinder pin.
3. Tag and disconnect hydraulic lines to rotator. Use suitable container to retain any residual hydraulic fluid. Cap or plug all openings of hydraulic lines and ports.

NOTE: *The rotator weighs approximately 58 lb (26 kg).*

NOTE: *The jib assembly weighs approximately 302 lb (137.1 kg).*

4. Supporting the rotator and jib assembly, remove hardware from pin #1. Using a suitable brass drift and hammer remove pin #1 from the jib assembly.
5. Remove the hardware from pin #2. Using a suitable brass drift and hammer, remove pin #2 from the jib assembly and remove the rotator.

NOTE: *The platform level cylinder weighs approximately 99.7 lb (45.3 kg).*

6. Supporting the platform level cylinder, remove the hardware from pin #3. Using a suitable brass drift and hammer remove pin #3 from the jib assembly.
7. Remove the hardware from pin #4. Using a suitable brass drift and hammer remove pin #4 from the fly boom. Remove the platform level cylinder.

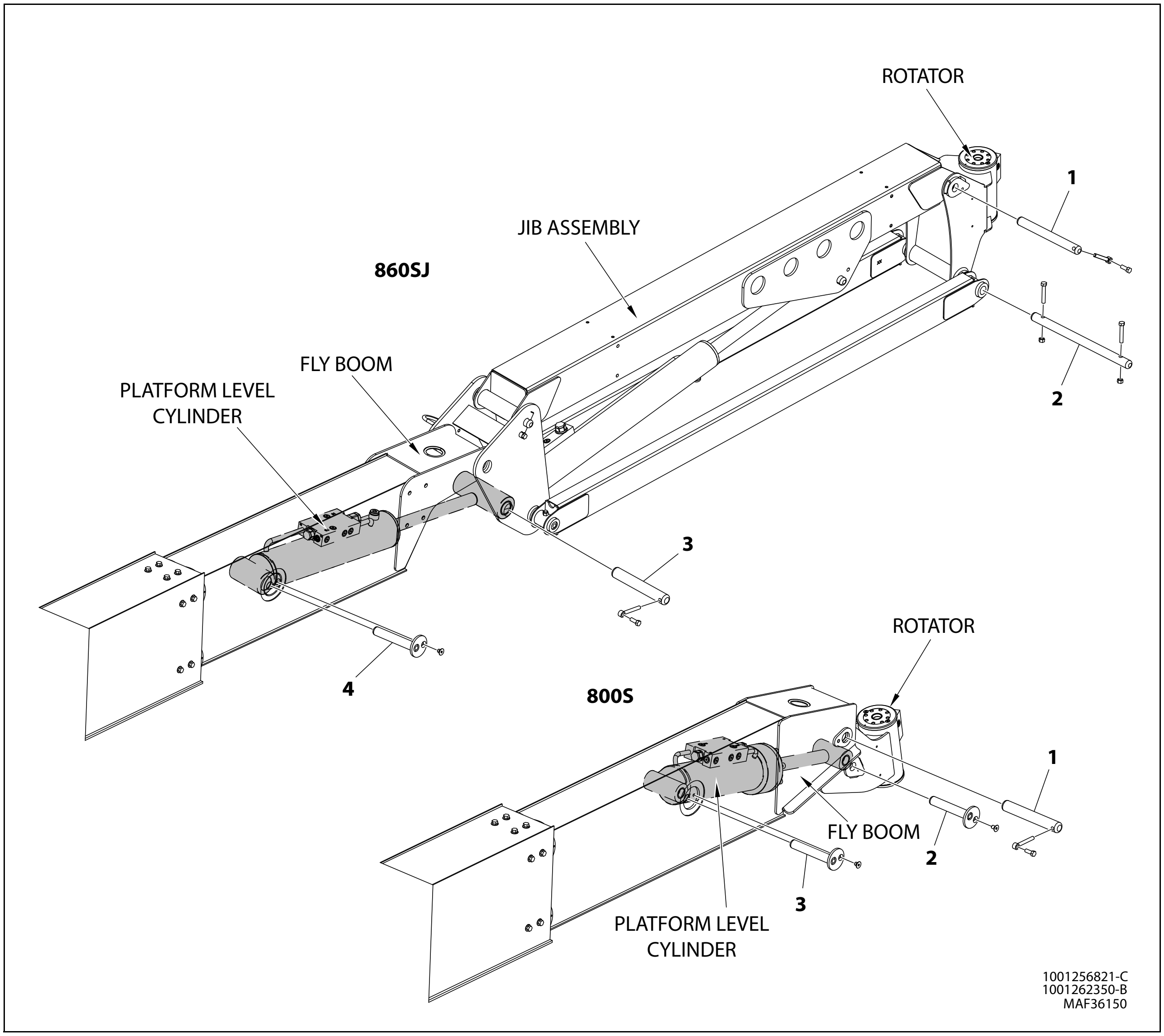


Figure 4-11. Removal/Installation of Components - Rotator and Level Cylinder

Installation

NOTE: *Refer Figure 4-11., Removal/Installation of Components - Rotator and Level Cylinder.*

800S

NOTE: *The platform level cylinder weighs approximately 63.3 lb (28.7 kg).*

1. Support the platform level cylinder. Using a suitable brass drift and hammer, install pin #3 to the fly boom. Install hardware securing pin #3.

NOTE: *The rotator weighs approximately 54 lb (25 kg).*

2. Support the rotator, using a suitable brass drift and hammer, install pin #2 to the rotator. Install hardware securing pin #2.
3. Using a suitable brass drift and hammer, install pin #1 to the rotator. Install hardware securing pin #1 and torque to 35 ft. lbs. (48 Nm).
4. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to rotator and platform level cylinder as tagged during removal.

860SJ

NOTE: *The platform level cylinder weighs approximately 99.7 lb (45.3 kg).*

1. Support the platform level cylinder. Using a soft head mallet, install pin #4 to the fly boom. Install hardware securing pin #4.

NOTE: *The jib assembly weighs approximately 302 lb (137.1 kg).*

2. Support the jib assembly. Using a soft head mallet install pin #3 to jib assembly. Install hardware securing pin #3.

NOTE: *The rotator weighs approximately 58 lb (26 kg).*

3. Support the rotator, using a soft head mallet, install pin #2 to the jib assembly. Install hardware securing pin #2 and torque to 41 ft. lbs. (55 Nm).
4. Using head mallet install pin #1 to jib assembly and install the rotator. Install hardware securing pin #1 and torque to 41 ft. lbs. (55 Nm).
5. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to rotator and platform level cylinder as tagged during removal.

4.4 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. Remove hydraulic lines and electrical cables from Powertrack.
4. Using suitable lifting equipment, adequately support Powertrack weight along entire length.
5. Remove bolt #1 securing the push tube on the fly boom section.

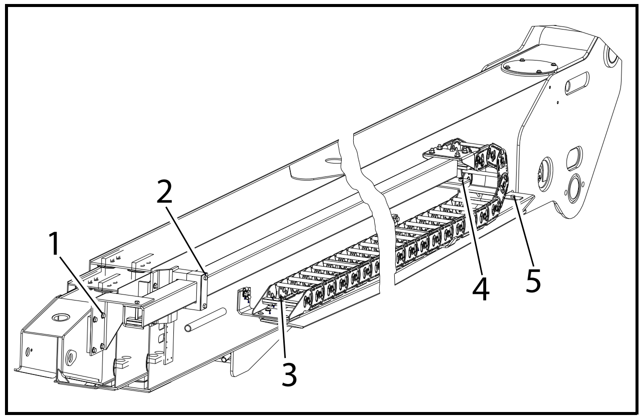


Figure 4-12. Main Boom Powertrack Components

6. Remove bolt #2 securing the push tube on the mid boom section.
7. With Powertrack supported and using all applicable safety precautions, remove bolts #3, #4 and #5 securing rail to the base boom section. Remove Powertrack from boom section.

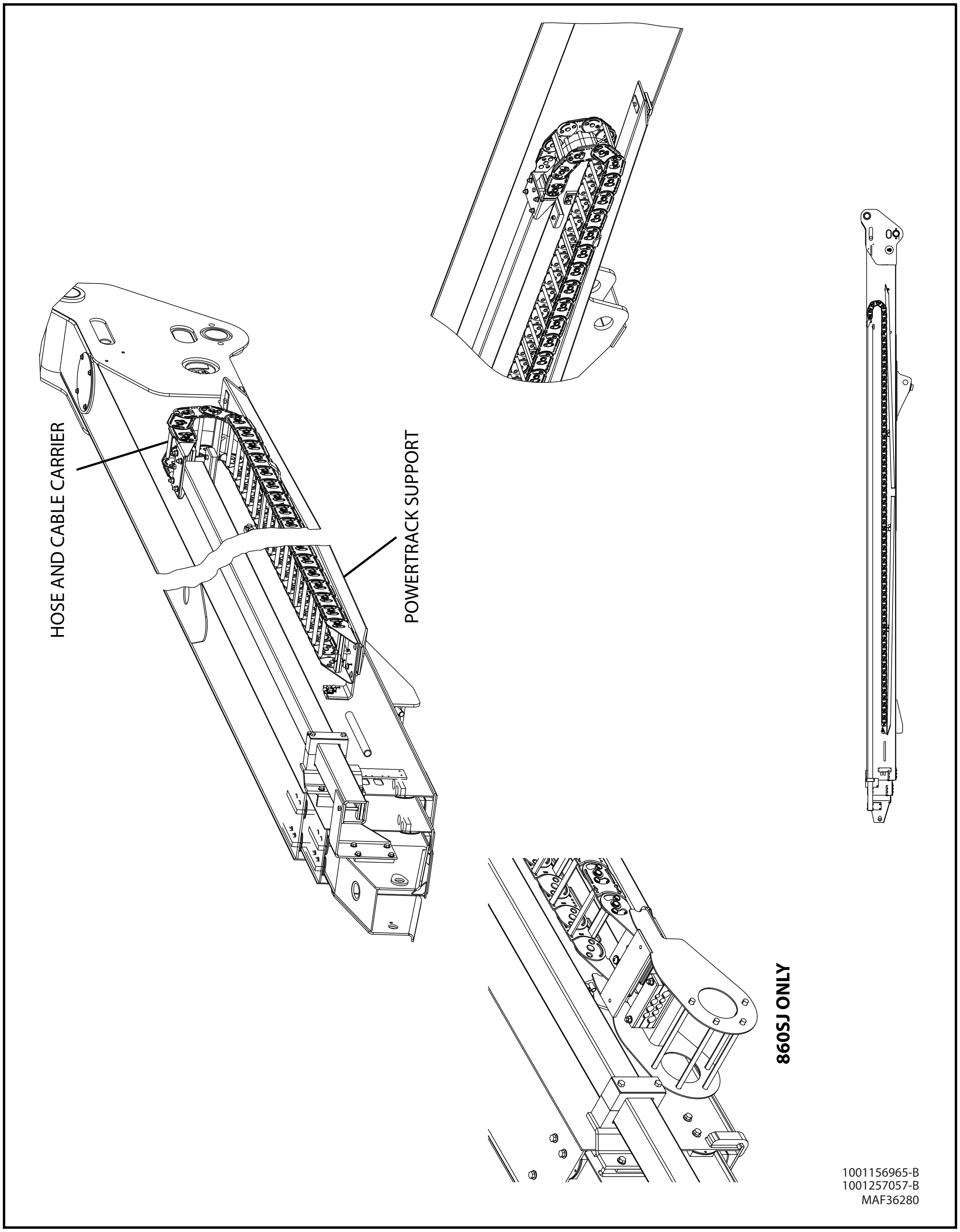
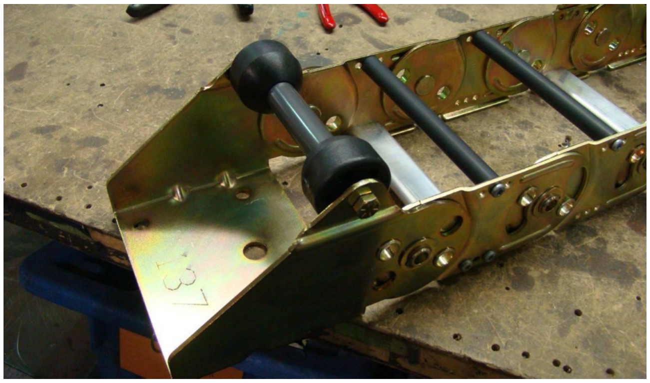


Figure 4-13. Powertrack Installation Main Boom

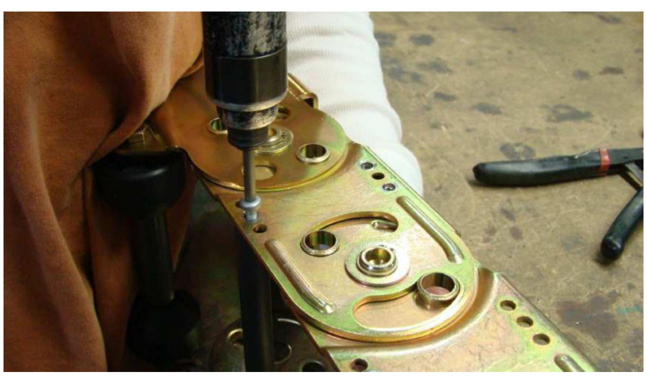
4.5 POWERTRACK MAINTENANCE

One Piece Bracket Maintenance

1. Place the powertrack on a workbench.



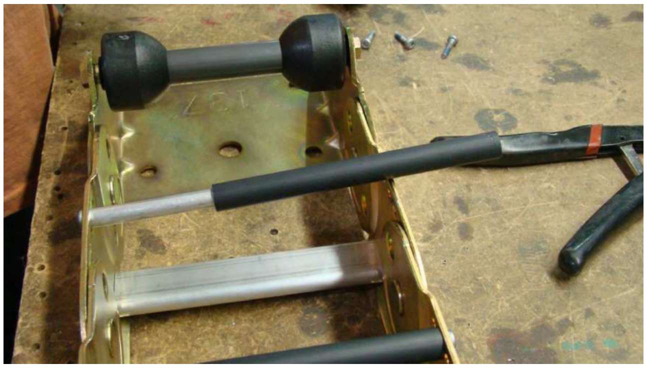
2. Remove the screws from the bars on one side of the powertrack on the first link.

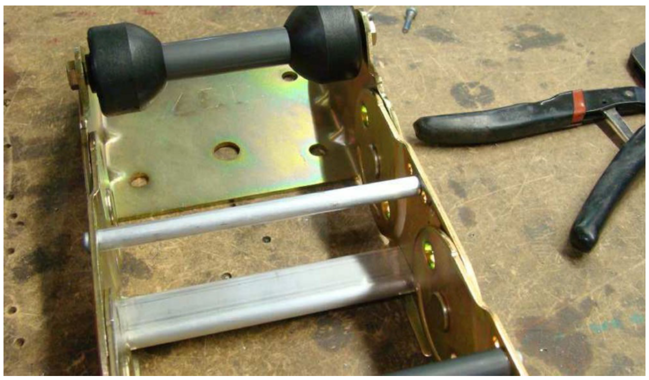


3. Remove the screws from the flat bar on the other side of the powertrack.

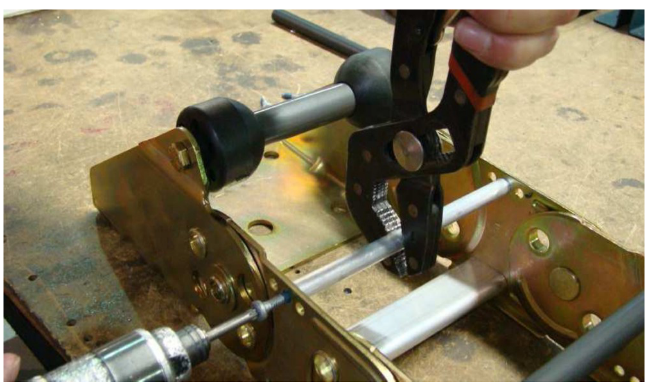
4. Pull up on the loose side of the round bar to allow the poly roller to slide off.

5. Slide the poly roller off of the round bar.

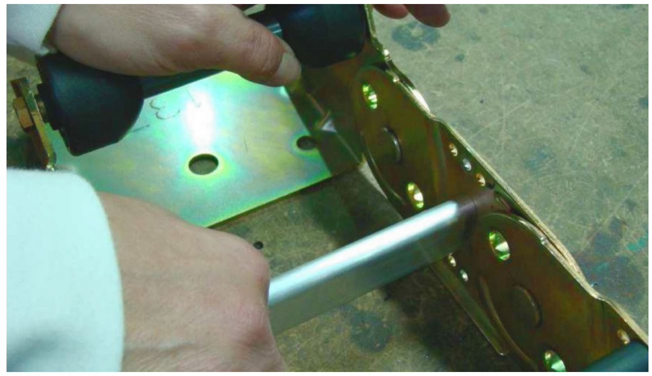


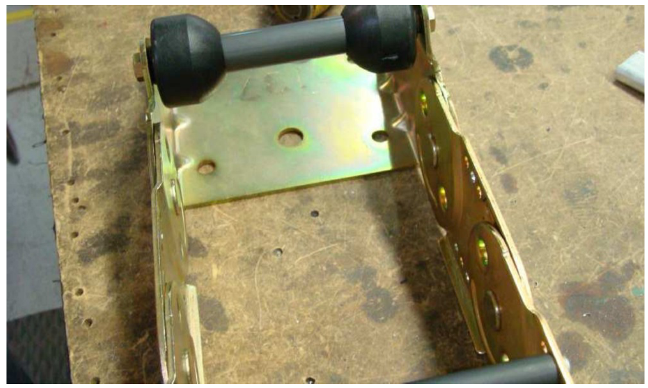


6. Hold the round bar to remove the other screw.

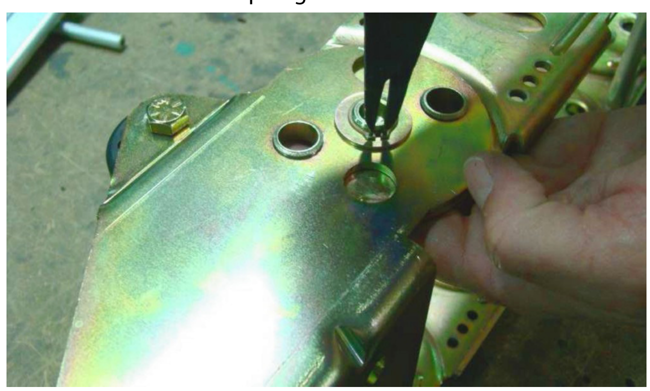


7. Slide the flat bar out.



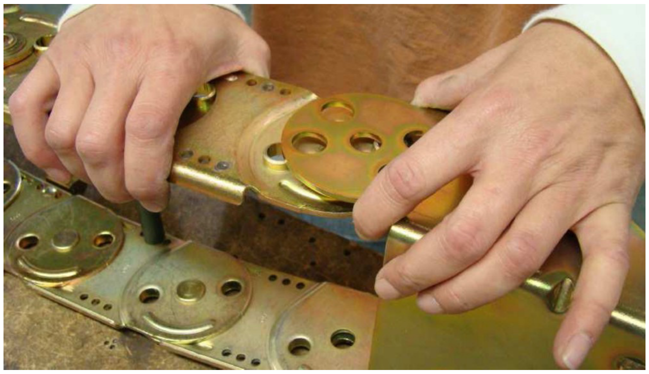


8. Remove the snap ring from one side of the bracket.



9. Remove the snap ring from the other side of the bracket.

10. Push down with slight pressure on the link and slide the bracket side up and over the extrusion on the link.

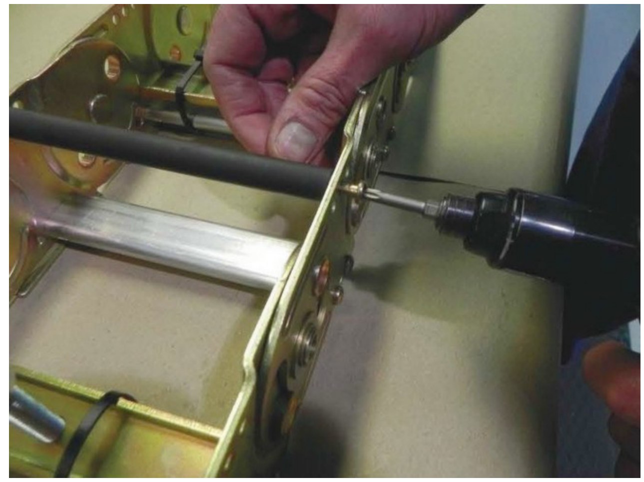


11. Repeat the previous step on the other side.

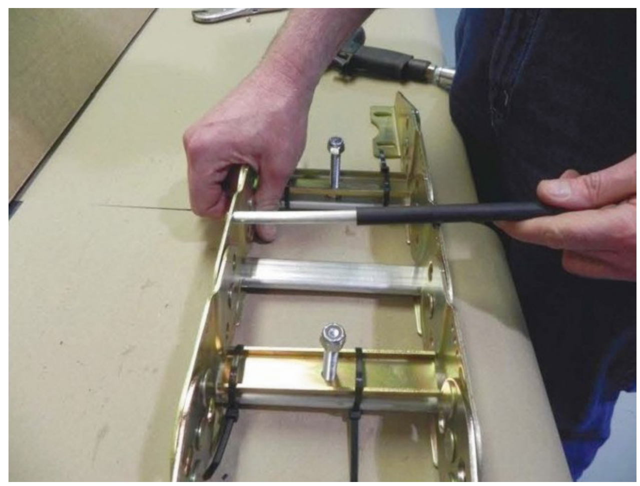
12. Slide the bracket off of the powertrack.

Two Piece Bracket Maintenance

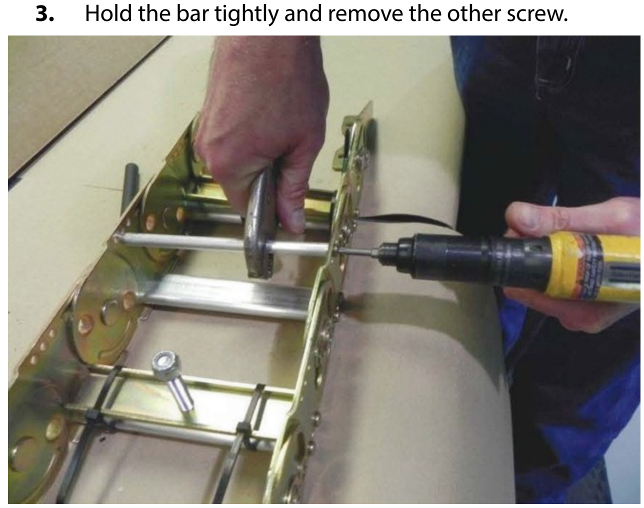
1. Loosen the screw.



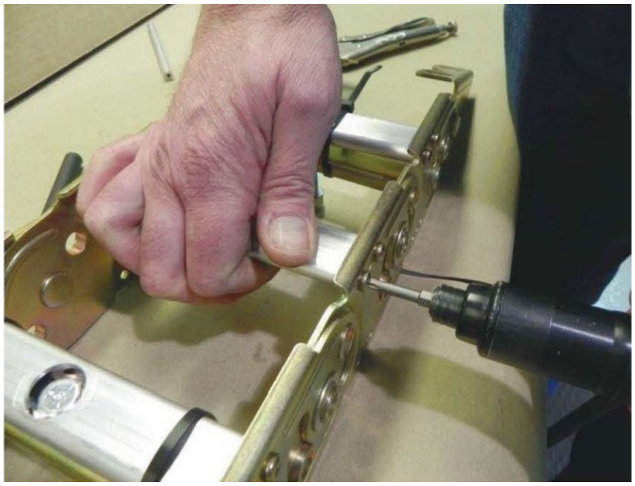
2. Slide the roller off the bar.



3. Hold the bar tightly and remove the other screw.

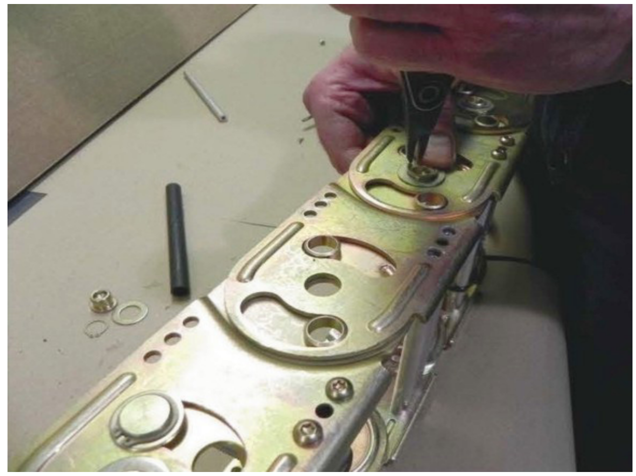


4. Hold the flat bar and remove the screws.

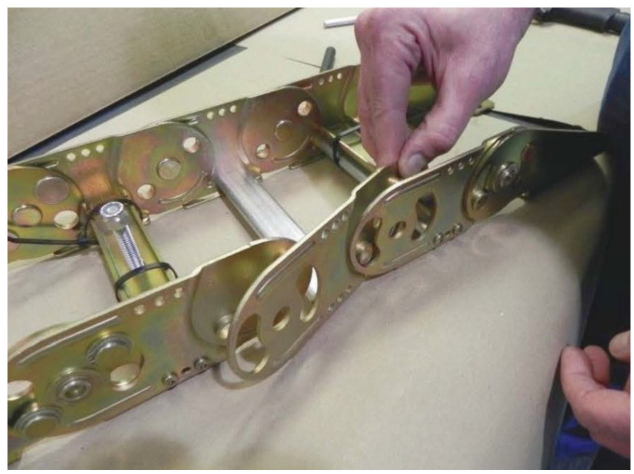


5. Remove the snap rings and pins.

6. Remove the screws from the bar. Remove the snap ring and pin.



7. Slide the link out.

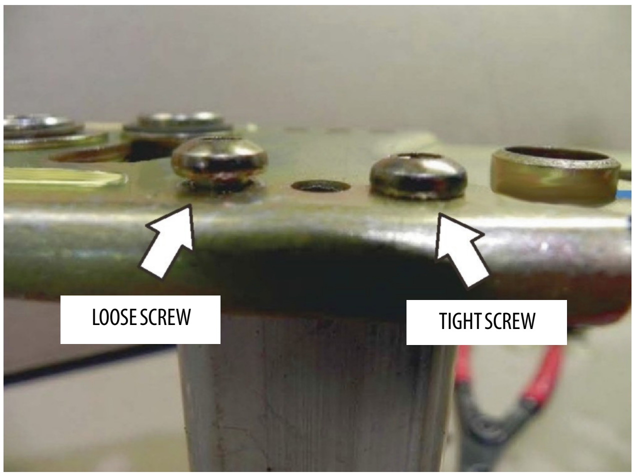


Snap Rings and Screws

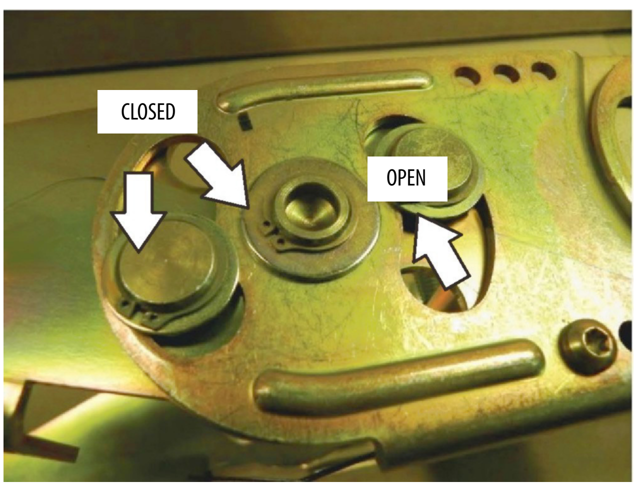
NOTICE

WHEN PERFORMING MAINTENANCE ON THE POWERTRACK, MAKE SURE TO DISCARD AND REPLACE ALL OLD SCREWS.

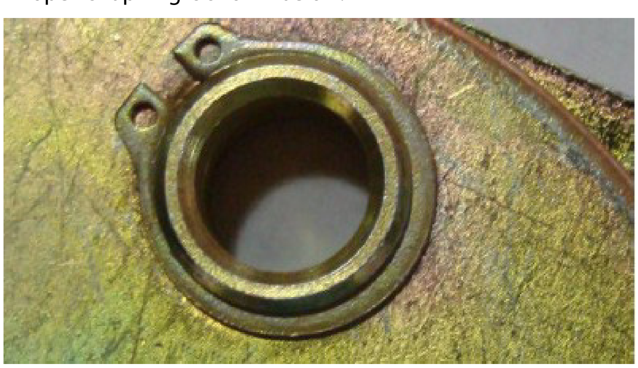
Make sure screws are tight and installed properly.



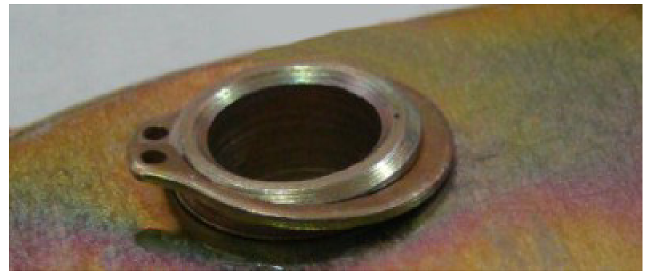
Make sure that all snap rings are closed and seated.



An open snap ring is shown below.



A snap ring that is not seated is shown below.



A seated and closed snap ring is shown below.

10-24 x 0.812 button torx socket head with blue locking patch:

- Tighten to 45-50 in. lbs. (5-5.6 Nm).
- Use T-25 torx bit.
- Do not reuse this screw. After removing replace with a new one.

4.6 MAIN BOOM ASSEMBLY

Removal

1. Using 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.

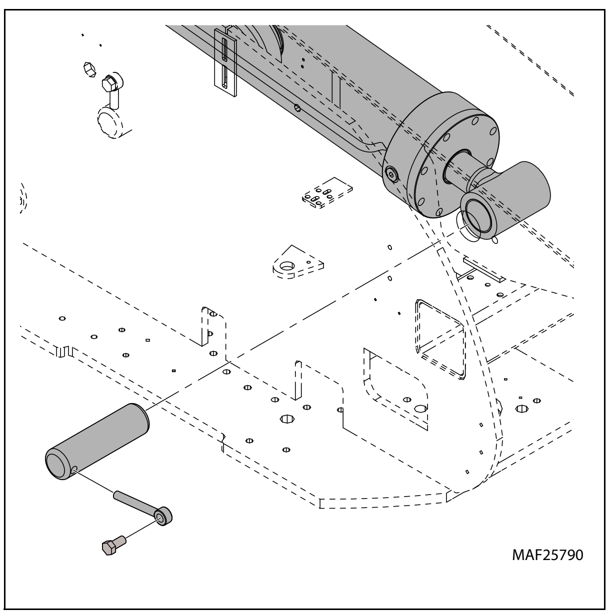
2. Tag and disconnect hydraulic lines from telescope cylinder. Use a suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.

3. Use an adequate support for the main boom lift cylinder. Extend main boom cylinder with auxiliary power switch to gain access to remove rod end pin.

NOTE: *The main boom lift cylinder weighs approximately 600 lb to 692 lb (271 kg to 314 kg).*

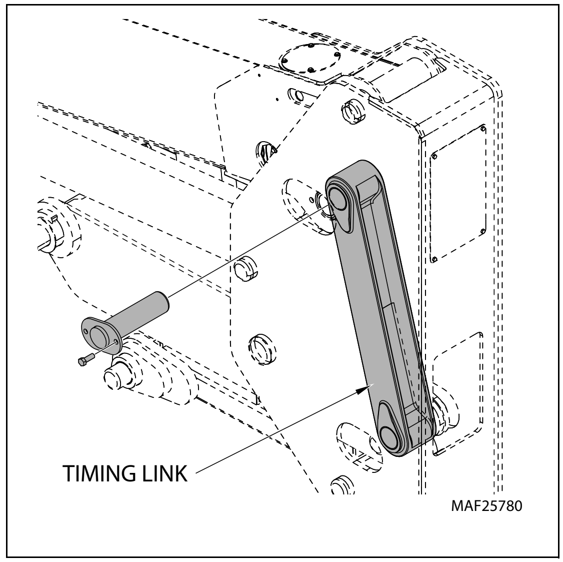
4. Using a suitable brass drift and hammer, remove hardware securing the main boom lift cylinder rod end pin to the base boom section.

5. Remove the main boom lift cylinder pin from base boom. Retract the main boom lift cylinder by using the auxiliary power switch.

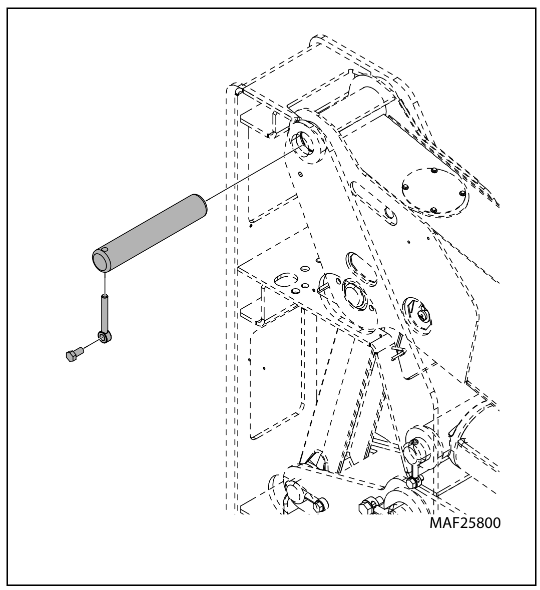


6. Using an adequate supporting device, support the timing link so it doesn't fall when the pin is removed.

7. Remove hardware securing timing link to boom assembly. Remove pin from boom assembly.



8. Using a suitable brass drift and hammer, remove hardware securing the main boom section to the upright.

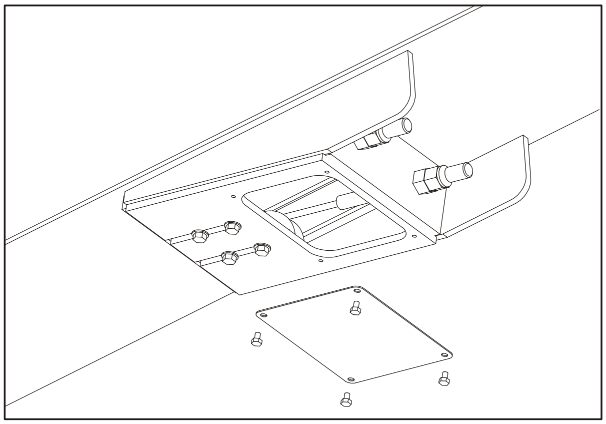


9. Using all applicable safety precautions, carefully lift boom assembly clear of upright and lower to ground or suitably supported work surface.

Boom Disassembly

NOTE: *The following procedure assumes the boom is removed from the machine.*

1. Extend the boom approximately 2 ft. (0.6 m). This will enable access to the bolts that secure the cable mount block to the boom fly section.
2. Remove hardware securing the telescope cylinder.
3. Remove hardware securing the cover plate on the bottom front of the base boom section.

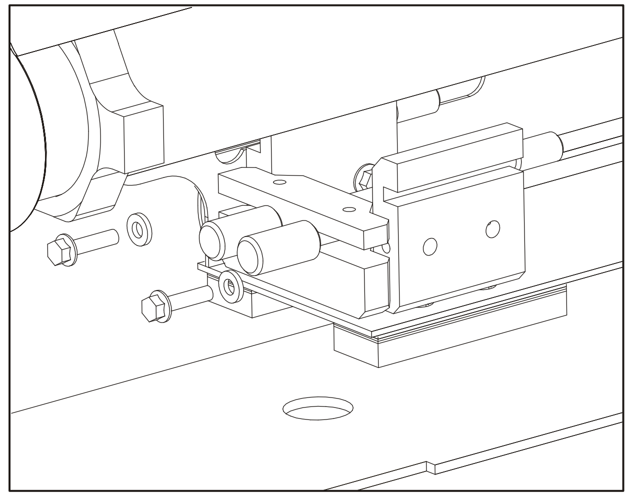


NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

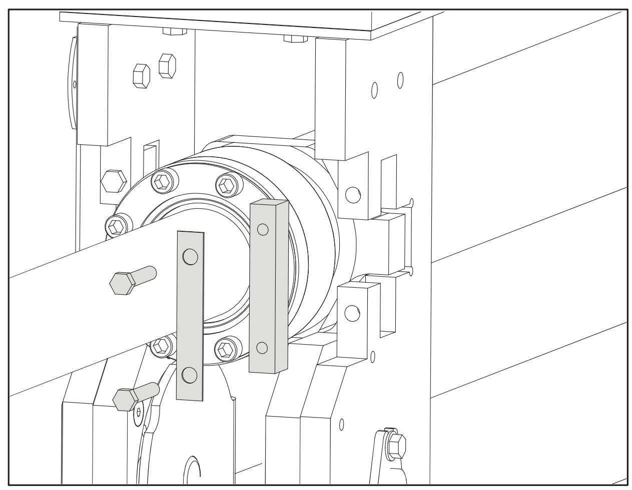
4. Clamp both threaded ends of wire rope to prevent rotation. Remove jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.

NOTE: *Do not clamp on threads.*

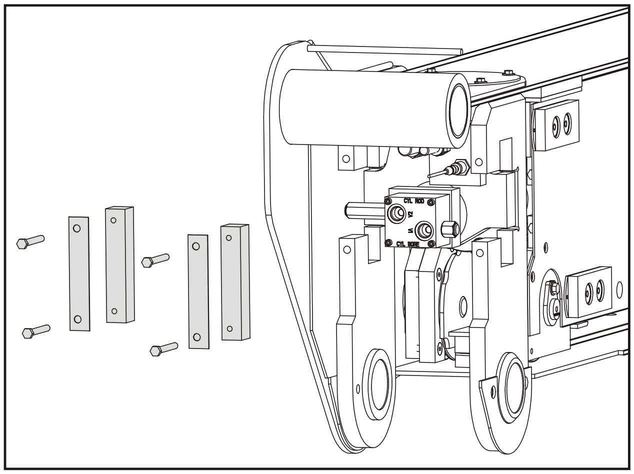
5. Remove jam nuts and nuts which secure the wire rope adjustments to the bottom front of the base boom section.
6. Using a 3/8 drive extension approximately 4 ft. (1.2 m) long, remove the bolts and washers securing the cable mount block to the boom fly section.



7. Remove the four bolts, shims, and attachment blocks that secure the telescope cylinder barrel to the boom mid section.



8. Remove the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the boom base section.

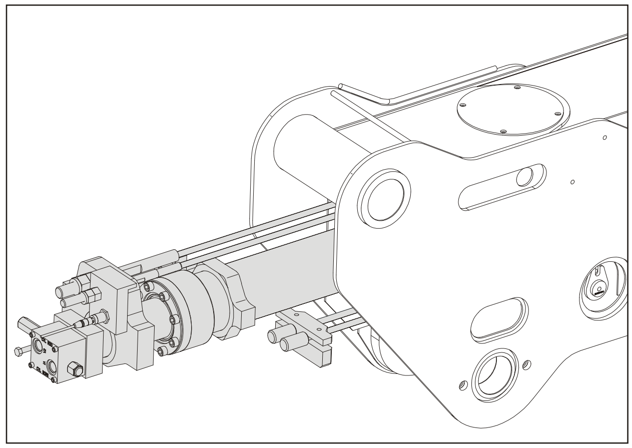


NOTICE

WHEN REMOVING THE TELESCOPE CYLINDER FROM THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY FROM THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

NOTE: *The 800S telescope cylinder weighs approximately 606.4 lb (275.4 kg). The 860SJ telescope cylinder weighs approximately 589.2 lb (267.2 kg).*

9. Using overhead cranes or other suitable lifting/supporting devices, carefully pull the telescope cylinder out from the back of the boom. At the same time, also pull the cable mount block out so the extension cables come out with the telescope cylinder and do not bind. The lifting/supporting devices will have to be repositioned to support the weight of the cylinder as it is drawn out of the boom.



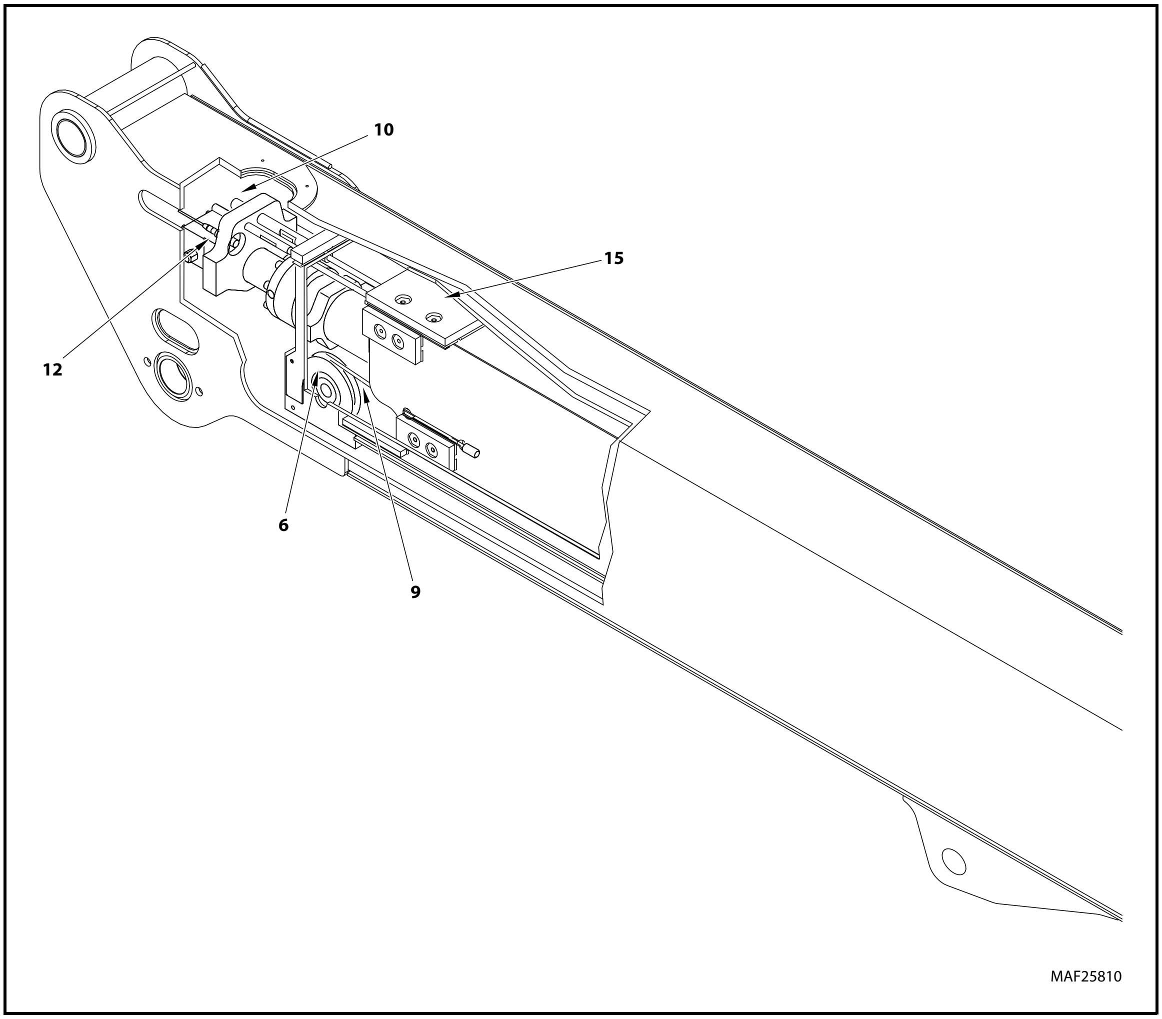
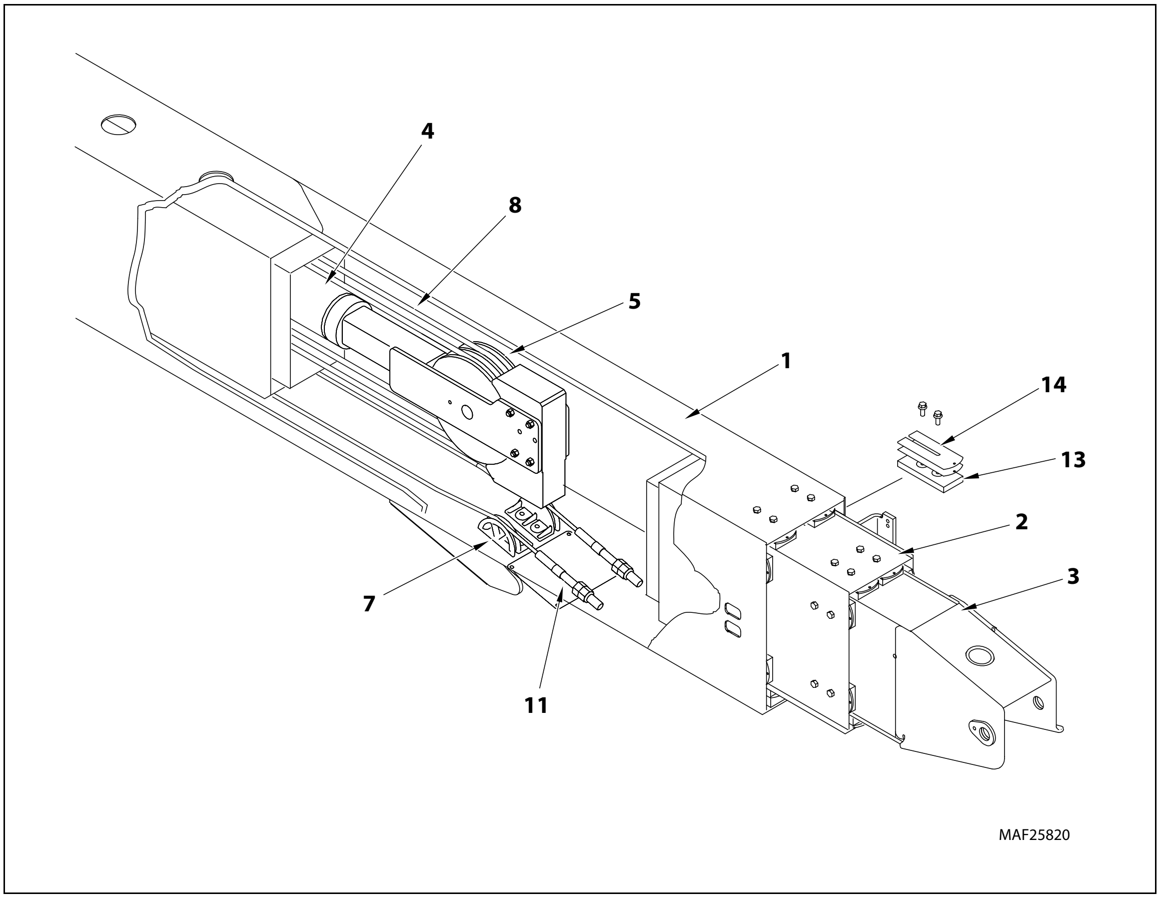
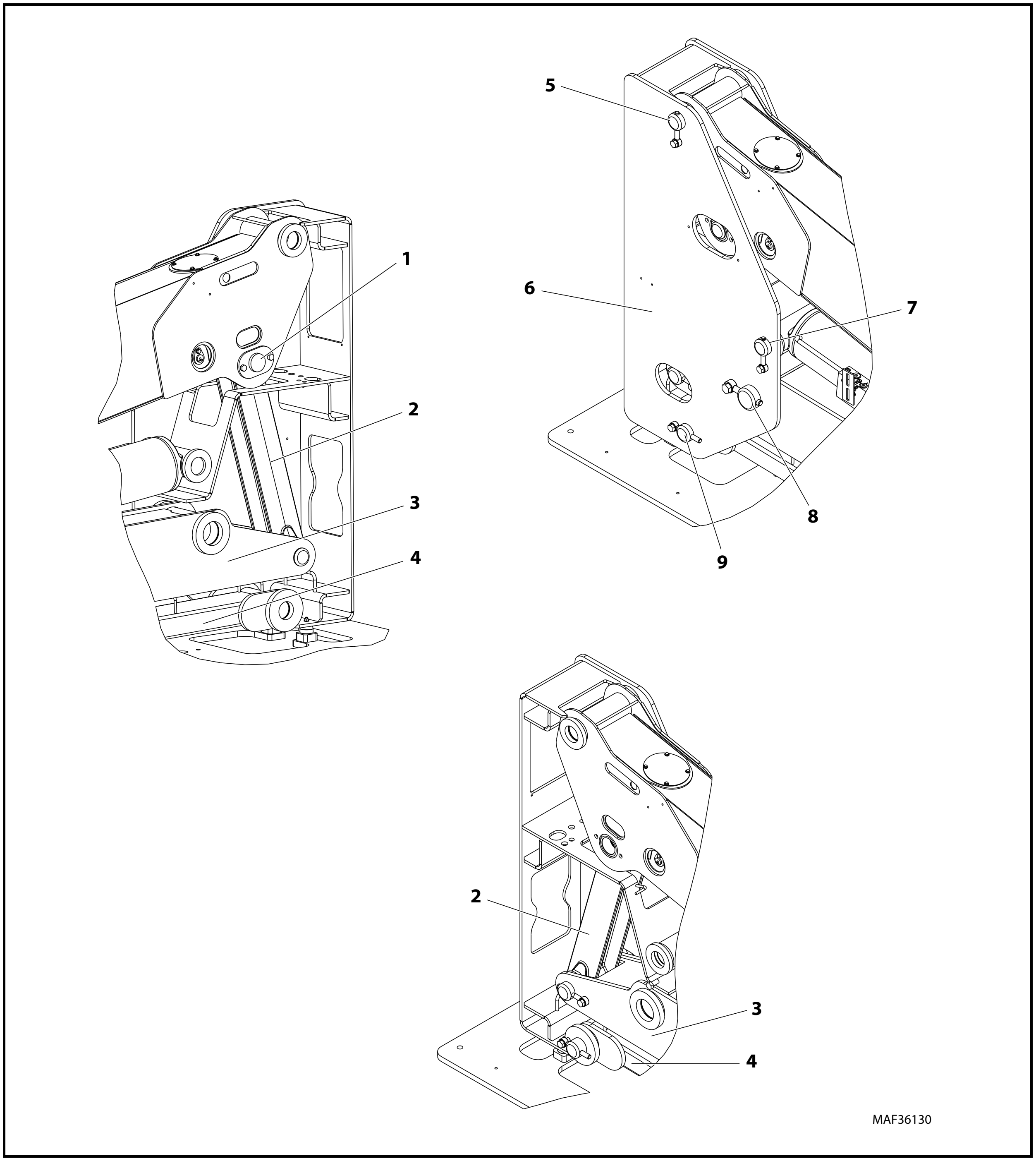


Figure 4-14. Boom Assembly Cutaway - Sheet 1 of 2



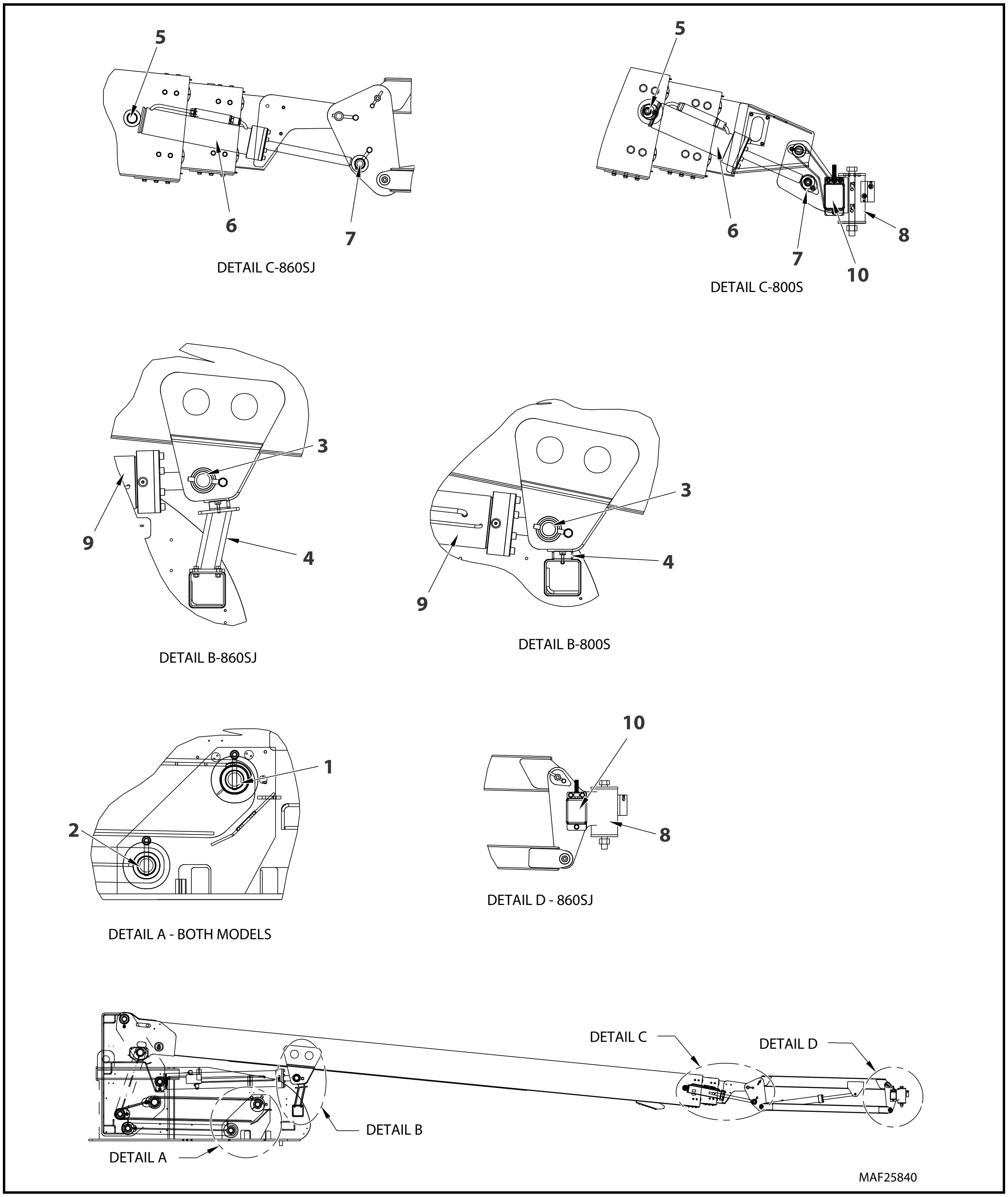
1. Base Boom
2. Mid Boom
3. Fly Boom
4. Telescope Cylinder
5. Extend Sheave
6. Retract Sheave
7. Sheave Block
8. Extend Cable
9. Retract Cable
10. Extend Cable Adjustment
11. Retract Cable Adjustment
12. Proximity Switch
13. Wear Pad
14. Shims
15. Wear Pad

Figure 4-15. Boom Assembly Cutaway - Sheet 2 of 2



1. Pivot Pin
2. Power Link
3. Tower
4. Level Link
5. Boom Pivot Pin
6. Upright
7. Lift Cylinder Pivot Pin
8. Tower Pin
9. Level Link Pin

Figure 4-16. Boom Components - Sheet 1 of 2



1. Pivot Pin
2. Level Link Pivot Pin
3. Lift Cylinder Pivot Pin
4. Boom Rest
5. Level Cylinder Attach Pin
6. Level Cylinder
7. Level Cylinder Pivot Pin
8. Rotator
9. Lift Cylinder
10. Level Switch

Figure 4-17. Boom Components - Sheet 2 of 2

10. Carefully remove the telescope cylinder and sheave assembly. Place telescope cylinder on a suitable trestle.
    a. Remove hardware from the wear pads; remove wear pads from cylinder.
    b. Remove hardware from the wire rope guard; remove guard from cylinder.
    c. Remove hardware from the sheave pin; remove pin and sheave from cylinder.

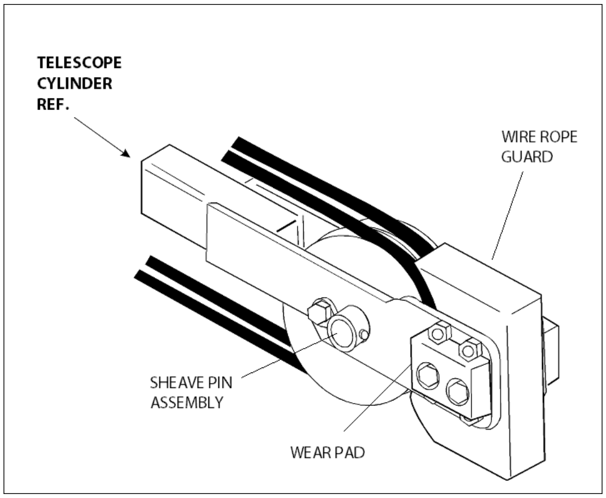


Figure 4-18. Disassembly of Sheave Assembly

9. Remove hardware which secures the wear pads to the front of base boom section; remove wear pads from the top, sides and bottom of the base boom section.
10. Using an overhead crane or suitable lifting device, remove mid and fly boom sections from base section. Note: When removing mid and fly boom sections from base boom section, retract wire rope must be dragged along with boom sections.
11. Remove hardware which secures the wear pads to the rear end of mid boom section; remove the wear pads from the top, sides and bottom of the mid boom section.
12. Remove hardware which secures the sheave guards and sheave assemblies to mid boom section, remove sheave assemblies from mid boom section.
13. Remove hardware which secures the wear pads to the front of mid boom section; remove wear pads from the top, sides and bottom of the mid boom section.
14. Using an overhead crane or suitable lifting device, remove fly boom section from mid section. Note: When removing fly boom section from mid boom section, retract wire rope must be dragged along with fly boom section.
15. Remove hardware which secures the wear pads to the rear end of fly boom section; remove wear pads from the top, sides and bottom of the fly boom section.
16. When removing wire rope from fly boom section, push the cable into fly boom. Route wire rope back through holes in the side of the fly boom section.

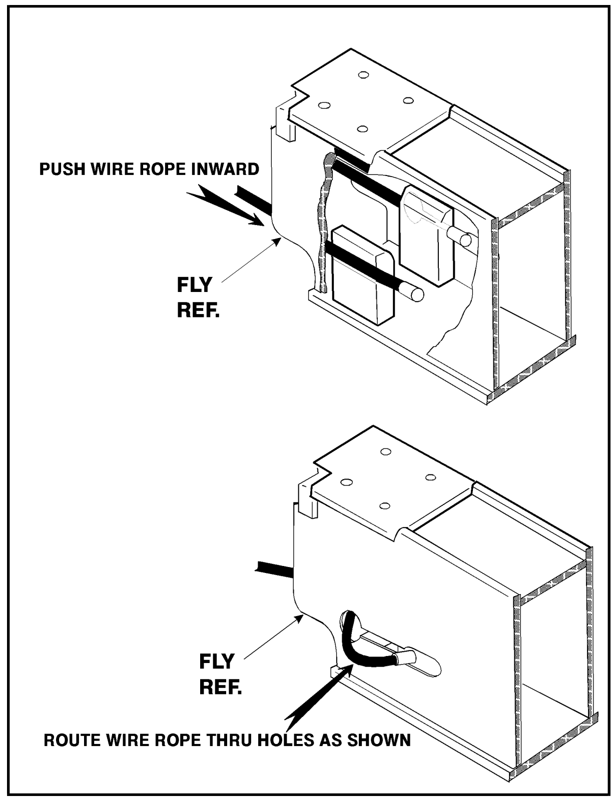


Figure 4-19. Disassembly Wire Rope Routing Procedure

Inspection

NOTE: *When inspecting pins and bearings Refer to the guidelines established in Section 2.5, Pins and Composite Bearing Repair Guidelines.*

1. Inspect all sheaves (extend and retract wire ropes and telescope cylinder) for excessive groove wear, burrs or other damage. Replace sheaves as necessary.

NOTE: *To check the size, contour and amount of wear, a groove gauge is used. Replace the sheave if worn as shown in the following drawing.*

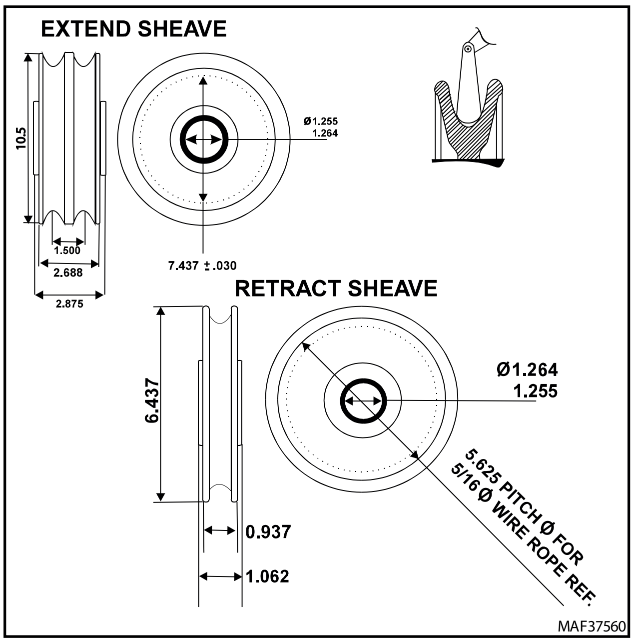


Figure 4-20. Dimension of Sheaves When New

2. Inspect extend and retract wire rope sheave bearings for wear, scoring, or other damage, and for ovality.
3. Inspect extend wire rope and retract wire rope sheave pins for scoring, tapering and ovality. Replace pins as necessary.
4. Inspect telescope cylinder sheave pin for scoring, tapering and ovality. Replace pins as necessary.
5. Inspect boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
6. Inspect telescope cylinder attach point for scoring, tapering and ovality. Replace pins as necessary.
7. Inspect main 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.
8. Inspect inner diameter of boom pivot bushing for scoring, distortion, wear, or other damage. Replace bearing as necessary.
9. Inspect all wear pads for excessive wear or other damage. Replace pads when worn to within 1/8 in. (3.2 mm) of threaded insert.
10. Inspect extend and retract wire rope attach point components for cracks, stretching, distortion, or other damage. Replace components as necessary.
11. Inspect all threaded components for damage such as stretching, thread deformation, or twisting. Replace as necessary.
12. Inspect structural units of boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Boom 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 and mid sections to determine the number of shims required for proper lift.
2. Measure inside dimensions of the mid section to determine the number of shims required for proper lift.
3. Install side, top and bottom wear pads to the rear end of fly section; shim evenly to the measurements of the inside of mid section.

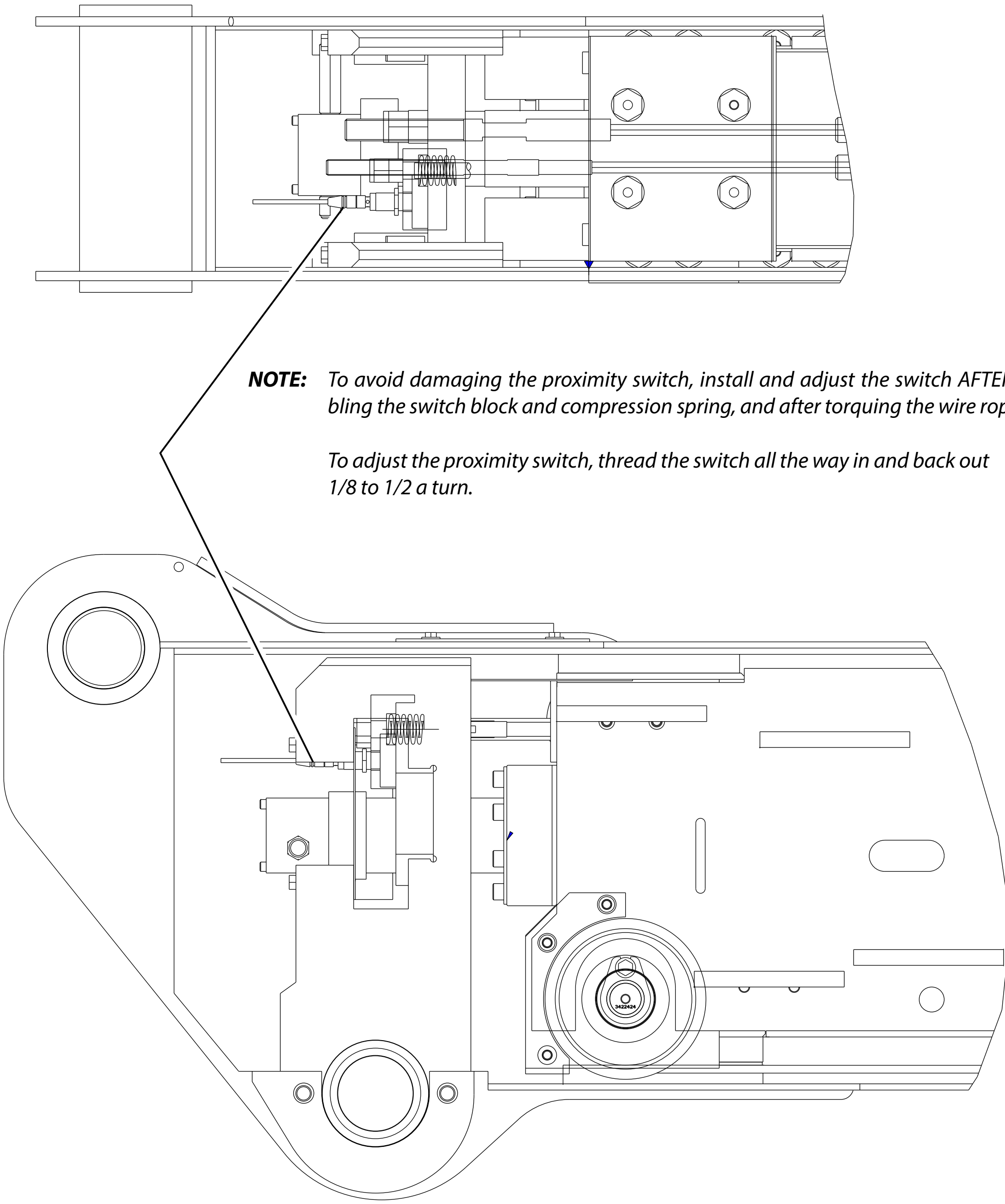


Figure 4-21. Proximity Switch Adjustment

4. Install retract wire ropes into rear end of fly section, route wire ropes through holes in side of fly boom section and pull into slot.

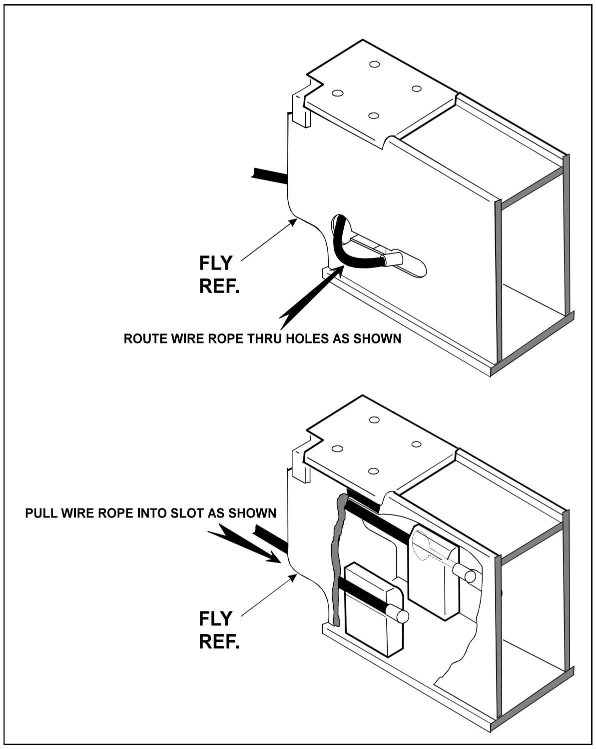


Figure 4-22. Routing Installation of Retract Wire Ropes

5. Install side, top and bottom wear pads to the rear end of mid section; shim evenly to the measurements of the inside of mid section.

NOTICE

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

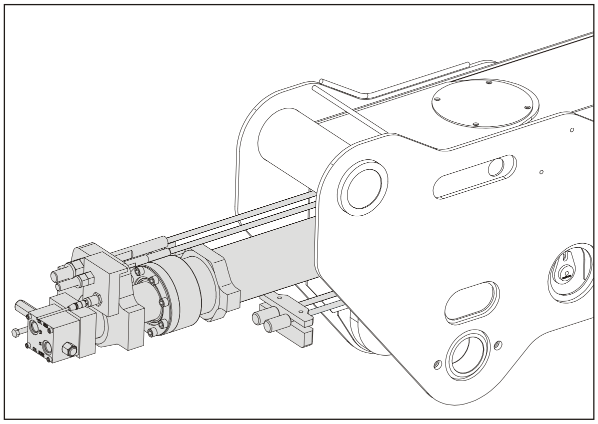
6. Shim the insides of the boom sections for a total of 1/16 in. (0.062) clearance (if the action is centered, there will be 1/32 clearance on each side).
7. Slide fly boom section into the mid boom section. Shim boom, if necessary, for a total of 1/16 in. (0.062) clearance.
8. Install wear pads into the forward position of the mid boom section. Shim boom, if necessary, for a total of 2/10 in. (0.20) clearance.
9. Properly position the retraction wire rope sheaves assemblies at the rear end of the mid boom section; ensure all sheave-to-mounting block attachment holes align. Install the sheave pins and secure them with mounting hardware. Position retract wire ropes onto the sheaves.
10. Install sheave guards to rear end of mid boom section and secure with mounting hardware.
11. Slide mid boom section into the base boom section. Allow the retraction wire ropes to trail between the bottom surfaces of boom sections. Shim boom, if necessary, for a total of 1/16 in. (0.062) clearance.
12. Install wear pads into the forward position of the base boom section. Shim boom, if necessary, for a total of 2/10 in. (0.20) clearance.
13. Install sheave block to bottom of base boom section and adjust block so that retract wire ropes do not come into contact with boom surfaces.
14. Install wire rope threaded ends through attachment holes in the bottom of base boom section. Loosely install nuts and jam nuts onto the threaded ends of wire ropes.
15. Pull the boom sections out to approximately where they were extended to for telescope cylinder removal.
16. Install a new extend sheave on the end of the telescope cylinder.
17. Route new extend cables around the telescope cylinder. Loosely fasten the threaded end of the cables to the rod end of the telescope cylinder with the adjusting nuts and lock nuts. Install the opposite end of the cables in the cable mount block.
18. Use tape or tie straps to fasten the cables to the telescope cylinder assembly. It is important that the tape or straps be strong enough to hold the cable in place yet weak enough to break and fall away when the cables are adjusted.

NOTICE

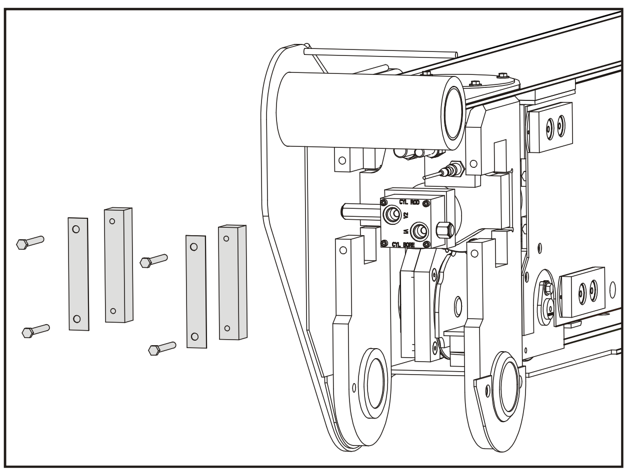
WHEN PUSHING THE TELESCOPE CYLINDER INTO THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

NOTE: *The 800S telescope cylinder weighs approximately 606.4 lb (275.4 kg). The 860SJ telescope cylinder weighs approximately 589.2 lb (267.2 kg).*

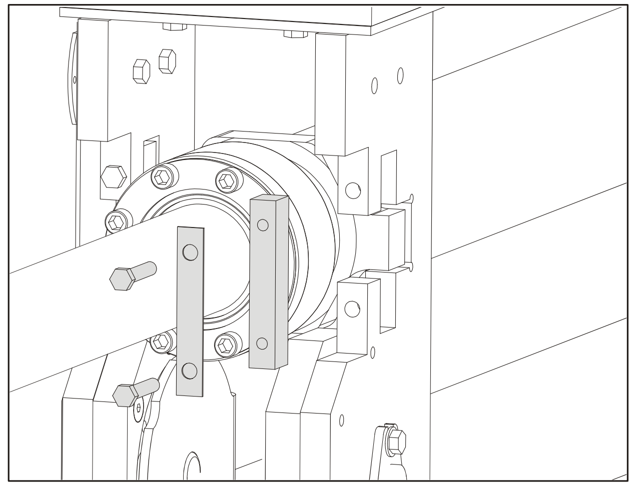
19. Using adequate lifting equipment, carefully push the telescope cylinder assembly and cables back into the boom.



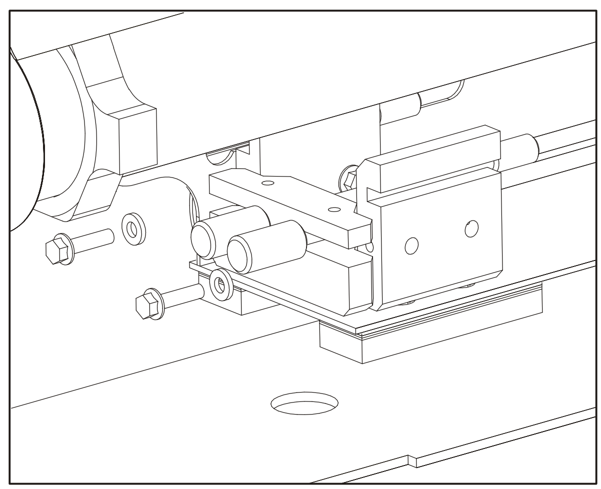
20. Apply Medium Strength Threadlocking Compound to the bolts and fasten the telescope cylinder rod to the boom base section with the bolts, shims, mounting blocks.



21. Apply Medium Strength Threadlocking Compound to the bolts and fasten the telescope cylinder barrel to the boom mid section with the bolts, shims, mounting blocks.



22. Using a 3/8 drive extension approximately 4 ft. (1.2 m) long, install the bolts and washers securing the cable mount block to the boom fly section. Tape the bolts to the socket at the end of the extension to prevent it from coming out of the socket before it engages the mounting threads.

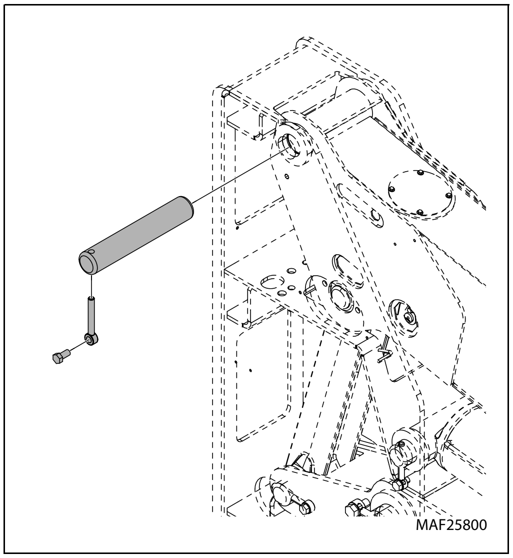


23. Connect all the hydraulic lines to the cylinder as tagged during the removal procedure.

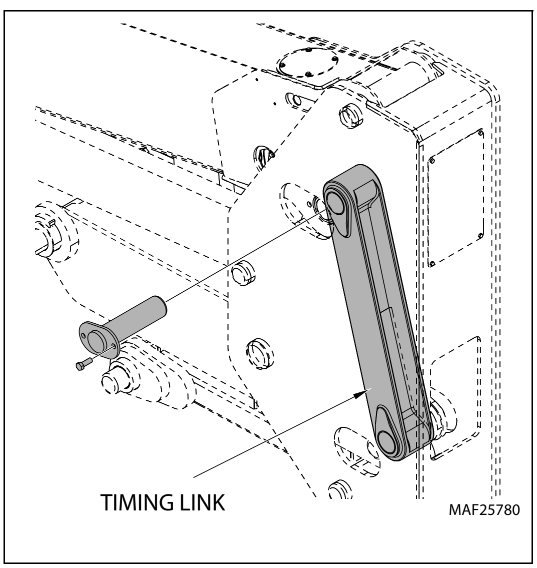
24. Adjust the boom cables as outlined under Section 4.9, Boom Rope Torquing Procedures.

Installation

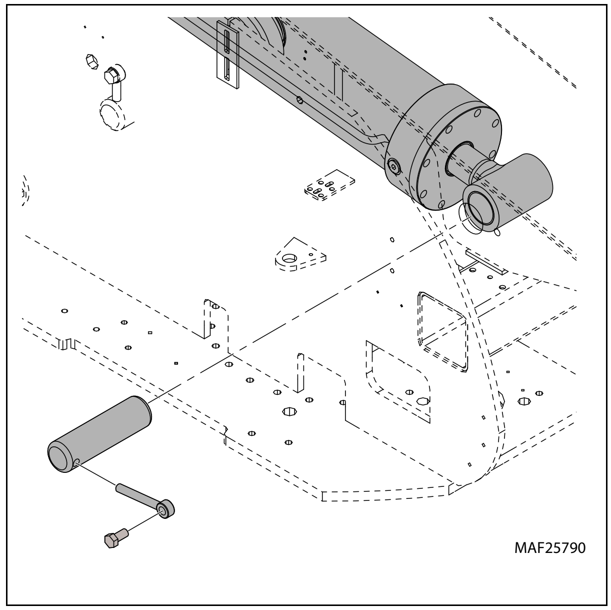
1. Using a suitable lifting device, position boom assembly on upright so that the pivot holes in both boom and upright are aligned.
2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on upright.
3. If necessary, gently tap pin into position with soft headed mallet. Secure pin mounting hardware.



4. Align holes of boom assembly and timing link, install pivot pin, ensuring that location of hole in pin is aligned with attach point of timing link.



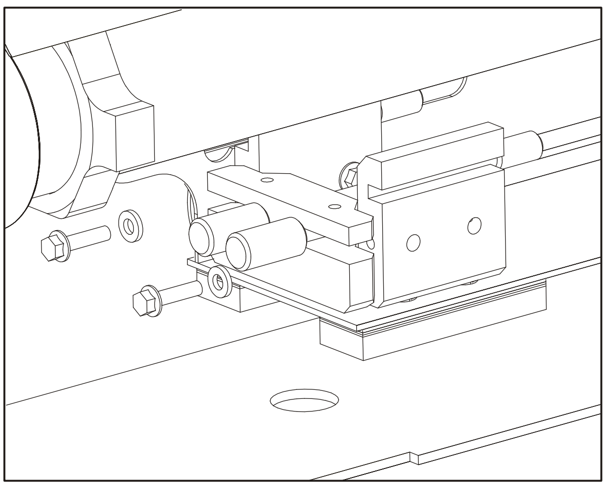
5. Using suitable lifting device, align main lift cylinder rod end with mounting holes on boom assembly.
6. Extend the main lift cylinder by using the auxiliary power switch. Using a suitable brass drift and hammer, install hardware secured to the main lift cylinder rod end pin into the base boom section.



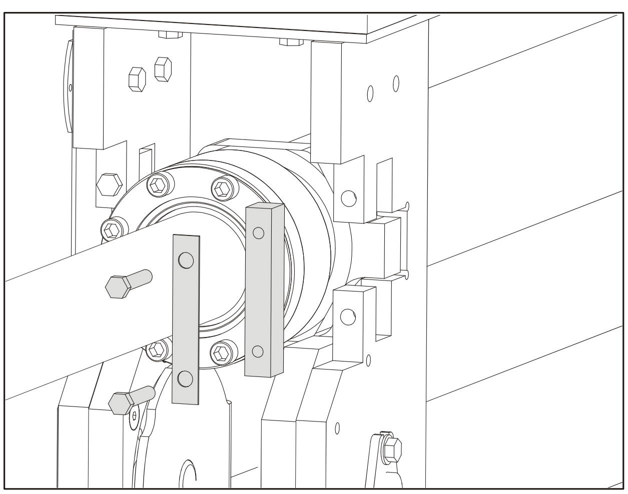
7. Connect all wiring to the ground control box.
8. Connect all hydraulic lines running along side of boom assembly.
9. Adjust retract and extend cables to the proper torque. Refer to Section 4.9, Boom Rope Torquing Procedures.
10. Using all applicable safety precautions, operate machine systems and raise and extend boom fully, noting the performance of the extension cycle.
11. Retract and lower boom, noting the performance of the retraction cycle.

Telescope Cylinder/Boom Cable Removal

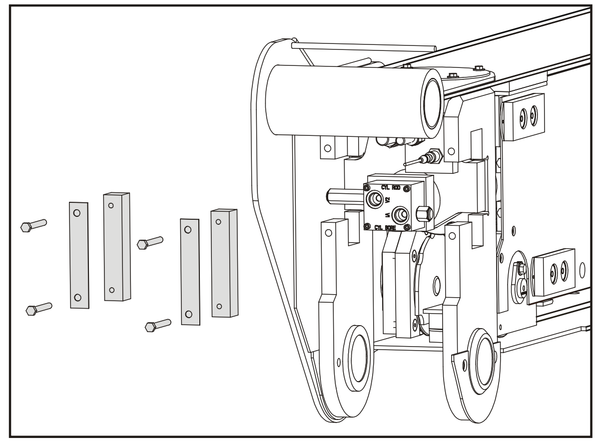
1. Make sure the machine is on a firm, level surface.
2. Raise the boom to a horizontal position.
3. Extend the boom approximately 2 ft. (0.6 m). This will enable access to the bolts that secure the cable mount block to the boom fly section.
4. Tag and disconnect all hydraulic hoses running to the telescope cylinder. Cap or plug all openings to prevent any foreign matter from entering the hydraulic system.
5. Using a 3/8 drive extension approximately 4 ft. (1.2 m) long, remove the bolts and washers securing the cable mount block to the boom fly section.



6. Remove the four bolts, shims, and attachment blocks that secure the telescope cylinder barrel to the boom mid section.



7. Remove the four bolts, shims, and mounting blocks that secure the telescope cylinder rod to the boom base section.

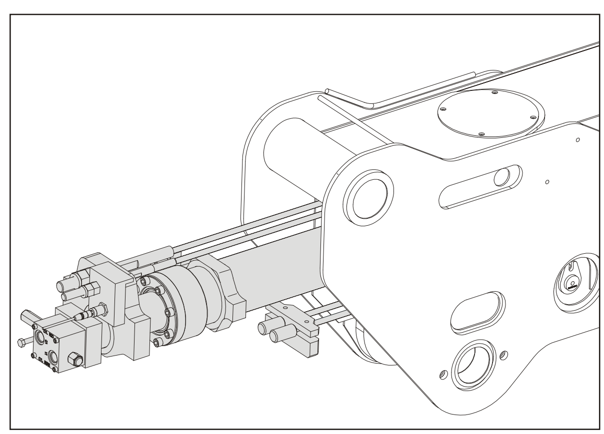


NOTICE

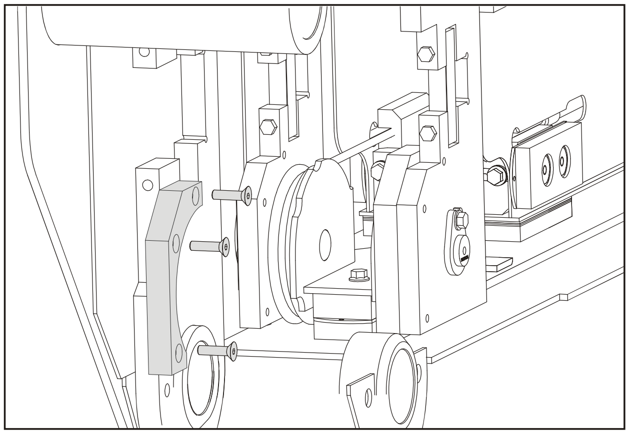
WHEN REMOVING THE TELESCOPE CYLINDER FROM THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY FROM THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

NOTE: *The 800S telescope cylinder weighs approximately 606.4 lb (275.4 kg). The 860SJ telescope cylinder weighs approximately 589.2 lb (267.2 kg).*

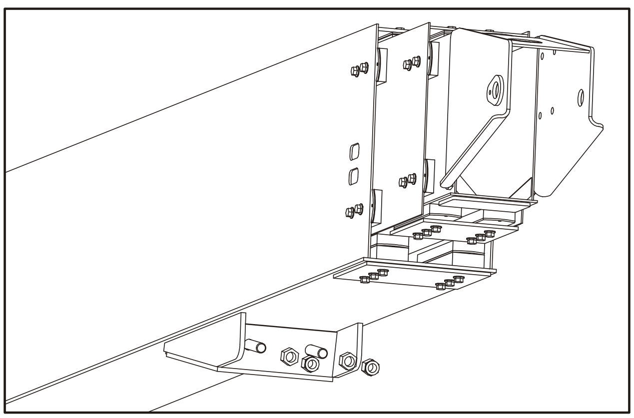
8. Using overhead cranes or other suitable lifting/supporting devices, carefully pull the telescope cylinder out from the back of the boom. At the same time, also pull the cable mount block out so the extension cables come out with the telescope cylinder and do not bind. The lifting/supporting devices will have to be repositioned to support the weight of the cylinder as it is drawn out of the boom.



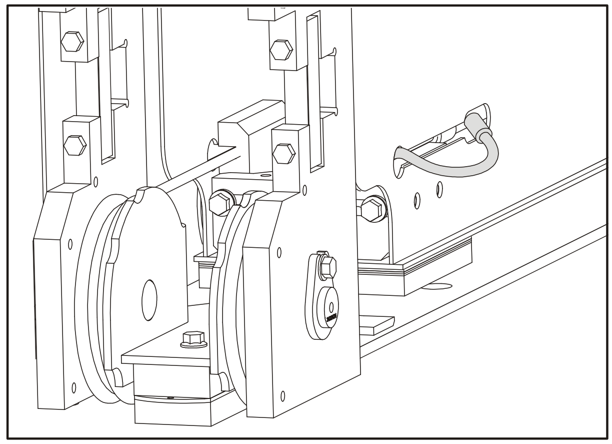
9. Push the boom fly sections back in to gain access to the boom retraction cable.
10. Remove the screws securing the sheave guards to the boom mid section and remove the sheave guards.



11. Remove the adjusting nuts and lock nuts from the opposite end of the retraction cables at the front of the boom base section. To aid in installing new retraction cables, fasten a length of tie wire as long as the retraction cables to the ends of the cables.



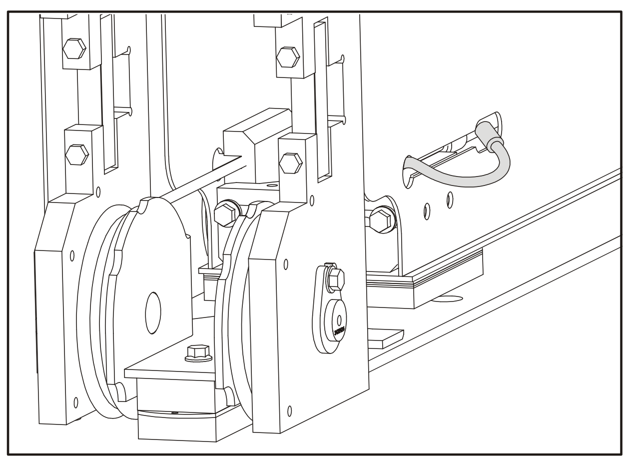
12. Twist the ends of the retraction cables to remove the ends of the cables from the slots in the side of the boom fly section.



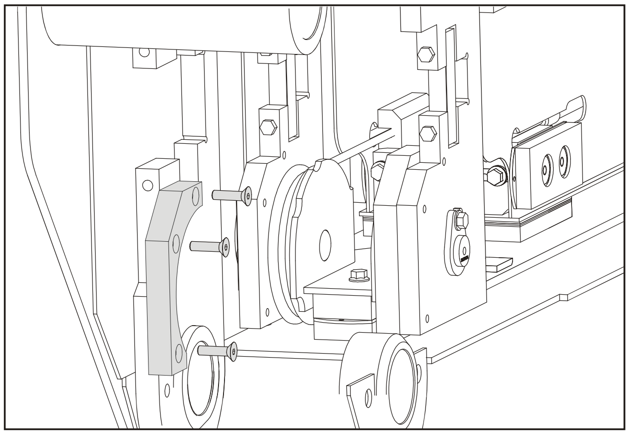
13. From the rear of the boom, pull out the boom retraction cables.

Telescope Cylinder/Boom Cable Installation

1. Attach the threaded end of the new retraction cables to the tie wires used in the removal procedure.
2. From the front of the boom, pull the retraction cables through the boom and through the attachment holes in the bottom of the boom base section. Loosely install the adjustment nuts and jam nuts.
3. Install new retract sheaves, then route the opposite end of the retraction cables around the sheaves. Push the ends of the cables through the slots in the side of the boom fly section.



4. Install the sheave guards and secure them in place with the retaining screws.



5. Pull the boom sections out to approximately where they were extended to for telescope cylinder removal.

6. Install a new extend sheave on the end of the telescope cylinder.

7. Route new extend cables around the telescope cylinder. Loosely fasten the threaded end of the cables to the rod end of the telescope cylinder with the adjusting nuts and lock nuts. Install the opposite end of the cables in the cable mount block.

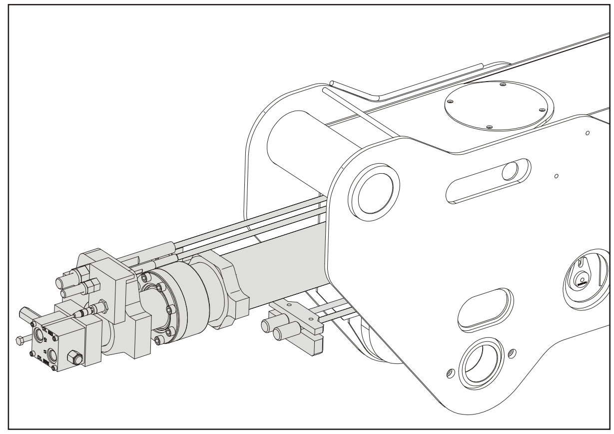
8. Use tape or tie straps to fasten the cables to the telescope cylinder assembly. It is important that the tape or straps be strong enough to hold the cable in place yet weak enough to break and fall away when the cables are adjusted.

NOTICE

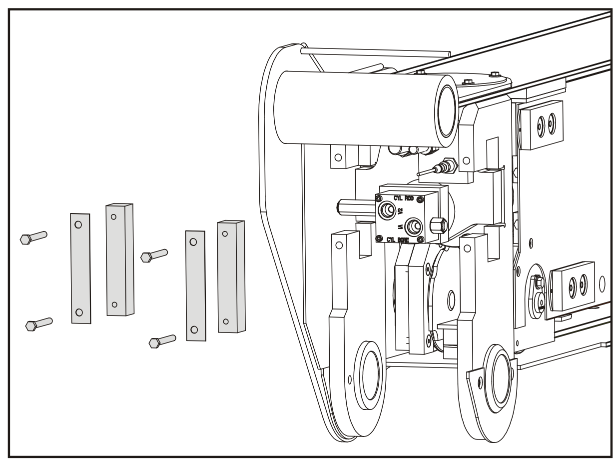
WHEN PUSHING THE TELESCOPE CYLINDER INTO THE BOOM, IT MAY BE NECESSARY AT SOME POINT TO TURN THE CYLINDER SLIGHTLY IN ORDER TO CLEAR ASSEMBLIES MOUNTED WITHIN THE BOOM. CARE MUST BE TAKEN TO MOVE THE CYLINDER SLOWLY INTO THE BOOM. DAMAGE TO COMPONENTS MAY RESULT FROM FORCIBLE IMPACT WITH THESE ASSEMBLIES.

NOTE: *The 800S telescope cylinder weighs approximately 606.4 lb (275.4 kg). The 860SJ telescope cylinder weighs approximately 589.2 lb (267.2 kg).*

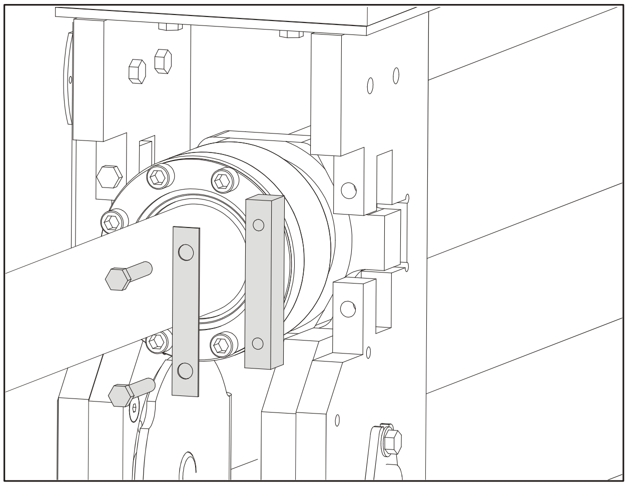
9. Using adequate lifting equipment, carefully push the telescope cylinder assembly and cables back into the boom.



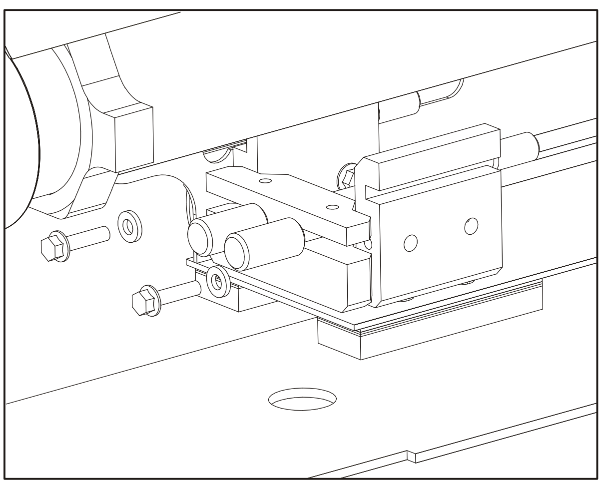
10. Apply Medium Strength Threadlocking Compound to the bolts and fasten the telescope cylinder rod to the boom base section with the bolts, shims, mounting blocks.



11. Apply Medium Strength Threadlocking Compound to the bolts and fasten the telescope cylinder barrel to the boom mid section with the bolts, shims, mounting blocks.



12. Using a 3/8 drive extension approximately 4 ft. (1.2 m) long, install the bolts and washers securing the cable mount block to the boom fly section. Tape the bolts to the socket at the end of the extension to prevent it from coming out of the socket before it engages the mounting threads.



13. Connect all the hydraulic lines to the cylinder as tagged during the removal procedure.

14. Adjust the boom cables as outlined under Section 4.9, Boom Rope Torquing Procedures.

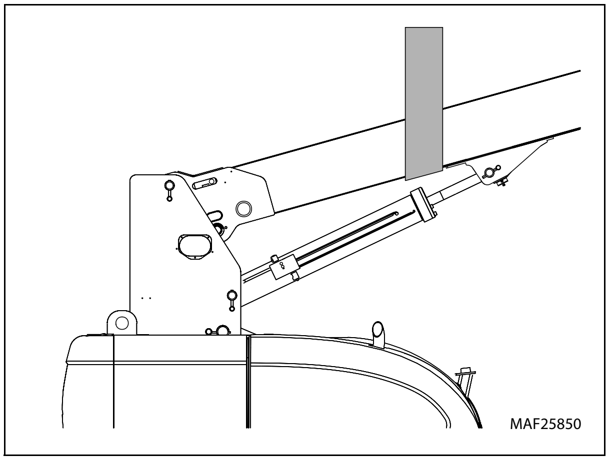
15. Run the boom through all lift and telescope functions and check for proper operation or any leakage.

Lift Cylinder Removal

1. Elevate the boom enough to gain access to the lift cylinder lower pivot pin.

2. Use an adequate lifting device to support the weight of the boom and associated components as shown below.

NOTE: *The* lifting *device must be able to support approximately 5350 lb (2430 kg).*

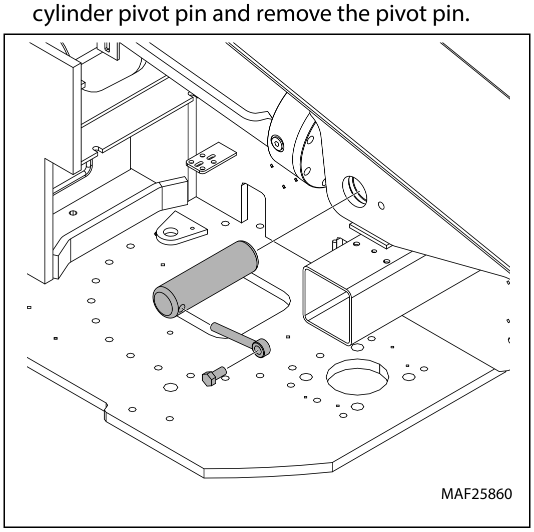


3. Tag and disconnect the hydraulic hoses from the lift cylinder.

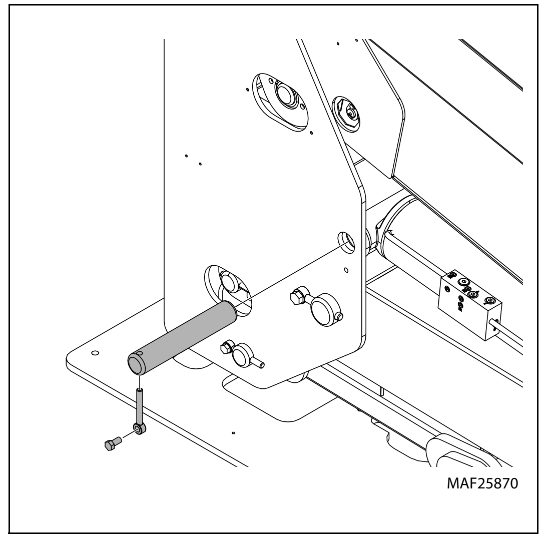
4. Use an adequate lifting device to support the lift cylinder.

NOTE: *The 800S lift cylinder weighs approximately 691.8 lb (313.8 kg). The 860SJ lift cylinder weighs approximately 620 lb (281 kg).*

5. Remove the bolt and keeper pin securing the main lift cylinder pivot pin and remove the pivot pin.



6. Remove the bolt and keeper pin securing the lower lift cylinder pivot pin and remove the pivot pin.



7. Using the lifting device, slide the lift cylinder back enough to allow the cylinder end to clear the attachment point on the boom.

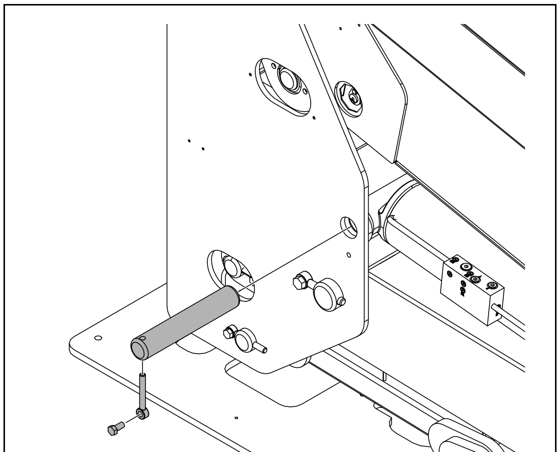
8. Slide the lift cylinder sideways enough to remove it from the machine.

Lift Cylinder Installation

1. Using an adequate lifting device, position the lift cylinder in the machine in the same manner that it was removed.

NOTE: *The 800S lift cylinder weighs approximately 691.8 lb (313.8 kg). The 860SJ lift cylinder weighs approximately 620 lb (281 kg).*

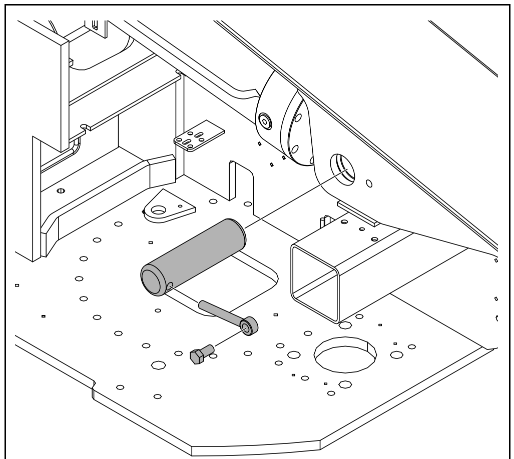
2. Using a suitable brass drift and hammer, install the barrel end pivot pin. Secure pivot pin with mounting hardware.



MAF25870

3. Extend the cylinder rod until it aligns with the attachment point on the boom. Take care not to extend the cylinder rod too far.

4. Using a suitable brass drift and hammer, install the rod end pivot pin. Secure pivot pin with mounting hardware.



MAF25860

4.7 JIB (860SJ ONLY)

Removal

1. For platform and support removal see Section 4.2, Platform.

NOTE: *The jib assembly weighs approximately 302 lb (137.1 kg).*

2. Using a suitable lifting device to support the jib assembly and position the assembly level with ground.

NOTICE

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

3. Tag and disconnect hydraulic lines from platform level cylinder and jib lift cylinder. Use suitable container to retain any residual hydraulic fluid. Cap or plug all openings of hydraulic lines and ports.
4. Remove mounting hardware from platform level cylinder pin #1. Using a suitable brass drift and hammer, remove the cylinder pin from jib assembly.
5. Remove mounting hardware from jib assembly boom pivot pin #2. Using a suitable brass drift and hammer, remove the pivot pin from boom assembly. Remove the jib assembly from the machine.

Disassembly

1. Remove mounting hardware from jib pivot pins #3 and #4. Using a suitable brass drift and hammer, remove the pins from jib 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 jib boom.

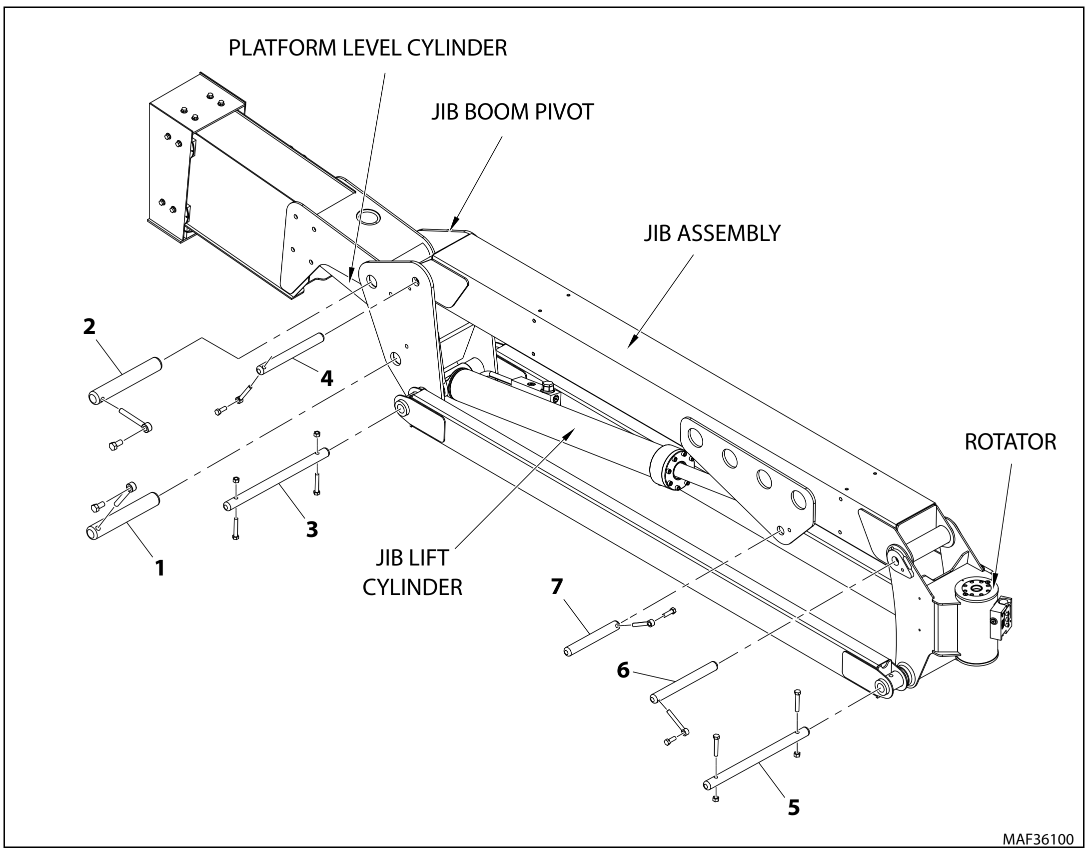


Figure 4-23. Jib Assembly - Removal/Installation

Inspection

NOTE: *When inspecting pins and bearings Refer to Section 2.5, Pins and Composite Bearing Repair Guidelines.*

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

Assembly

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

Installation

NOTE: *The jib assembly weighs approximately 302 lb (137.1 kg).*

1. Using a suitable lifting device to support the jib assembly and position the assembly level with ground.
2. Align jib boom pivot weldment with attach holes in fly boom assembly. Using a soft head mallet, install pivot pin #2 into fly boom assembly and secure with mounting hardware.
3. Align the platform level cylinder with attach holes in jib boom pivot weldment. Using a soft head mallet, install platform level cylinder pin #1 into jib pivot weldment and secure with mounting hardware.
4. Remove cap or plugs from openings of hydraulic lines and ports and connect hydraulic lines to platform level cylinder and jib lift cylinder as tagged during removal.

4.8 WIRE ROPE

CAUTION

WIRE ROPE CAN HAVE SHARP EDGES AND CAUSE SERIOUS INJURY. NEVER HANDLE WIRE ROPE WITH BARE HANDS.

Each day before using machine:

1. Raise main boom approximately horizontal.
2. Extend and retract the boom sections.
3. Check for delayed movement of fly section which indicates loose wire ropes.

WARNING

IF DELAYED MOVEMENT IS DETECTED IN WIRE ROPE OPERATION, LOWER PLATFORM TO STOWED POSITION, SHUT DOWN MACHINE, AND HAVE WIRE ROPES INSPECTED/SERVICED BY A QUALIFIED JLG MECHANIC. LOOSE OR MIS-ADJUSTED WIRE ROPES COULD RESULT IN SERIOUS INJURY OR DEATH.

Inspection

NOTE: *The pictures in this paragraph are just samples to show the replacement criteria of the rope.*

1. Inspect ropes for broken wires, particularly valley wire breaks and breaks at end terminations.

NOTE: *Flexing a wire rope can often expose broken wires hidden in valleys between strands.*

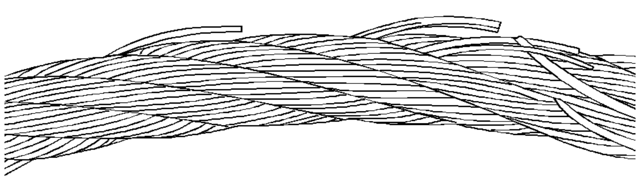


Figure 4-24. Wire Rope Wire Breaks

2. Inspect ropes for corrosion.
3. Inspect ropes for kinks or abuse.

NOTE: *A kink is caused by pulling down a loop in a slack line during improper handling, installation, or operation.*

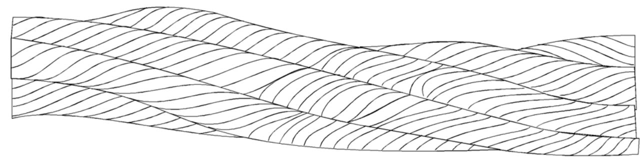


Figure 4-25. Wire Rope Kink

4. Inspect sheaves for condition of bearings/pins. (See Dimension Of Sheaves for proper dimension.)
5. Inspect sheaves for condition of flanges. (See Dimension Of Sheaves for proper dimension.)
6. Inspect sheaves with a groove wearout gauge for excessive wear.

NOTE: *Check groove so that it may be clearly seen if gauge contour matches sheave groove contour.*

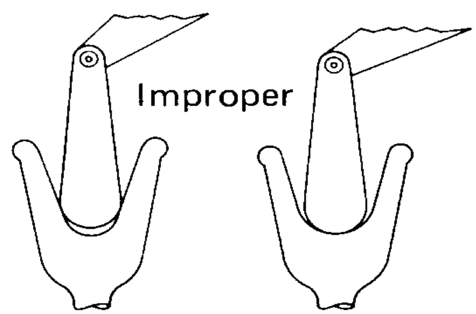


Figure 4-26. Sheave Groove Wear

7. Ropes passing inspection should be lubricated with wire rope lubricant before reassembly.

Three Month Inspection

1. Remove boom covers and visually (with flashlight) inspect the ropes for rust, broken wires, frays, abuse, or any signs of abnormalities.
2. Check rope tension by deflecting the ropes by hand. Properly tensioned ropes should have little or no movement.

NOTE: *Delayed movement of the fly boom indicates loose wire ropes.*

Additional Inspection Required If:

1. Machine is exposed to hostile environment or conditions.
2. Erratic boom operation or unusual noise exists.
3. Machine is idle for an extended period.
4. Boom is overloaded or sustained a shock load.
5. Boom exposed to electrical arc. Wires may be fused internally.

12 Year or 7000 Hour Replacement

1. Mandatory wire rope and sheave replacement.

Additional Replacement Criteria

NOTE: *Sheaves and wire rope must be replaced as sets.*

1. Rusted or corroded wire ropes.
2. Kinked, "bird caged", or crushed ropes.
3. Ropes at end of adjustment range.
4. Sheaves failing wearout gage inspection.
5. Ropes with 6 total broken wires in one rope lay, 3 in one strand in one rope lay, 1 valley break, or 1 break at any end termination.

4.9 BOOM ROPE TORQUING PROCEDURES

Torque Procedures

1. Position boom in fully down and fully retracted position.
2. Clamp both threaded ends of wire rope to prevent rotation.

NOTE: *Do not clamp on threads.*

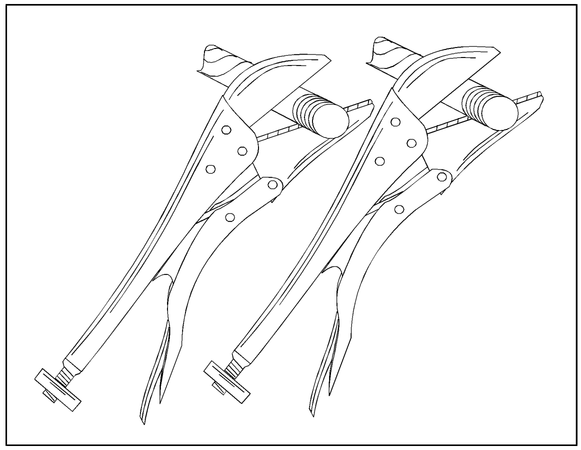


Figure 4-27. Clamping Wire Ropes

3. Install adjusting nuts (or remove nylon collar locknuts if re-adjusting) to both retract and extend wire ropes.
4. Torque retract adjusting nuts (platform end) to 15 ft. lbs. (20 Nm) alternating between the two wire ropes and keeping approximately the same amount of thread beyond the adjusting nut.

NOTE: *Do not allow wire rope to rotate. This may damage the wire rope.*

5. Repeat the torque procedure in step #3 to the extend wire ropes (turntable end).
6. Extend the boom 2 - 3 ft. using the telescope function. Repeat step #3.
7. Retract the boom 1 - 2 ft. using the telescope function. Do not bottom out telescope cylinder. Repeat step #6.
8. Extend the boom approximately 2 - 3 ft. again and check torque on the retract wire ropes.
9. Retract the boom without bottoming out telescope cylinder and check torque on the extend wire ropes.

NOTE: *Step #7 and #8 may need to be repeated to equalize the torque on all 4 wire ropes.*

10. After all wire ropes have been properly torqued, install nylon collar locknuts. Remove all clamping devices and install all covers and guards. Check the boom for proper function.

4.10 WIRE ROPE SERVICE INDICATOR

On booms that use a wire rope system to drive boom sections during telescope function, each wire rope must be redundant. Rope failures that cannot be seen by the operator require the addition of a Broken Wire Rope Indicator Systems.

This system uses two proximity sensors (One for extend wire ropes and one for retract wire ropes) to detect excessive movement of the sensed wire rope as would be expected with a wire rope failure. A loose wire rope detection results in illuminating the Wire Rope Service indicator on the light panel on the platform control box or on a display if applicable. When a loose wire rope is detected, telescope out is prevented.

4.11 ELECTRONIC PLATFORM LEVELING

Description

Electronic platform leveling replaces the conventional hydraulic method of platform leveling. The term “platform leveling” does not refer to the system maintaining the platform at level (or 0°) with respect to gravity, but instead refers to the controls automatically maintaining the platform within several degrees of a preset angle.

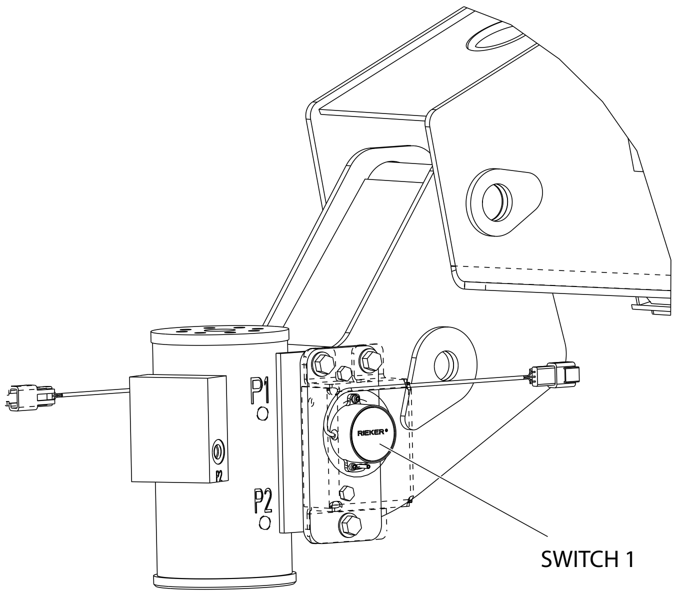
To control electronic platform leveling the platform is equipped with a pair of tilt sensors, one primary and one secondary, mounted to the non-rotating portion of the platform rotator, level up and level down valves that are used to provide proportional hydraulic flow for each directional function, and a control module that interprets the sensor readings and actuates the leveling valves.

PRIMARY AND SECONDARY TILT SENSOR INTERACTION

Two tilt sensors, mounted on each side of the platform support, are used to measure the incline of the platform with respect to gravity and control the automatic platform angle control function. The right one (as viewed from standing in the platform) is used as the primary sensor and the left one as a secondary backup sensor.

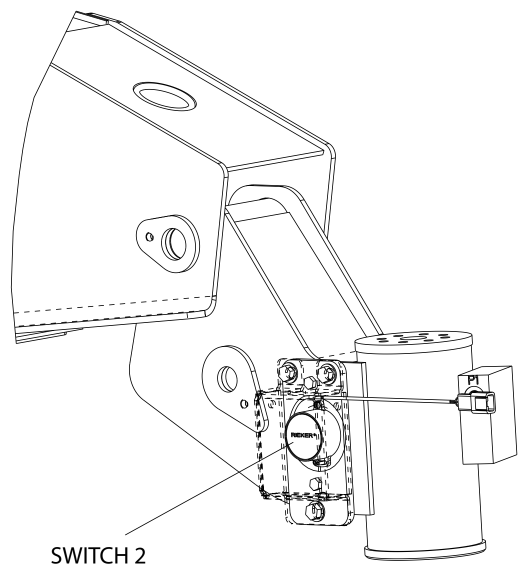
If a fault occurs with the primary sensor, control will revert to the secondary sensor. (This is discussed in more detail in the error response section.)

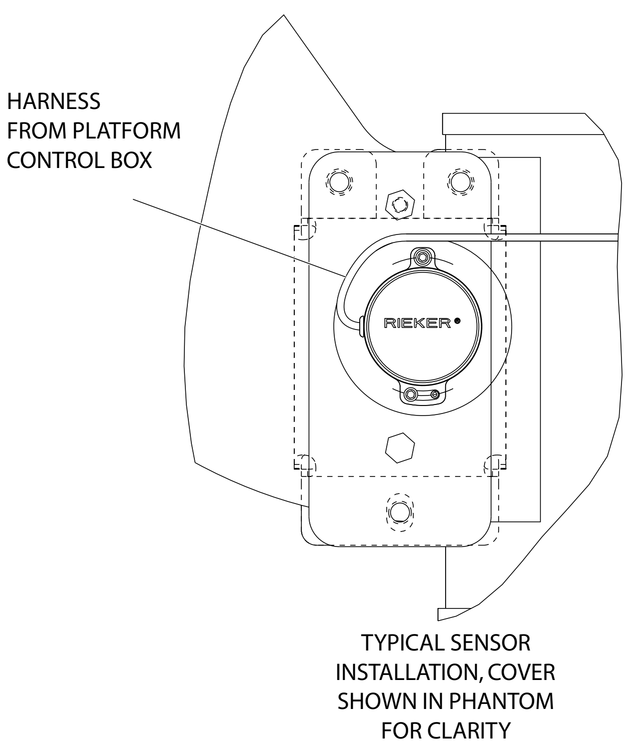
Because of the mounting orientation of the tilt sensors, the primary tilt sensor will output ascending voltage values with increases in positive platform tilt angle. The backup or secondary tilt sensor will output descending voltage values with increases in positive platform angle.



SWITCH #1			
PIN #	DESCRIPTION	SWITCH	HARNESS
PIN #1	POWER	RED	RED
PIN#2	PWM OUT	GREEN	BLUE
PIN#3	GROUND	BLACK	BLACK

SWITCH #2			
PIN #	DESCRIPTION	SWITCH	HARNESS
PIN #1	POWER	RED	ORANGE
PIN#2	PWM OUT	GREEN	YELLOW
PIN#3	GROUND	BLACK	BLACK



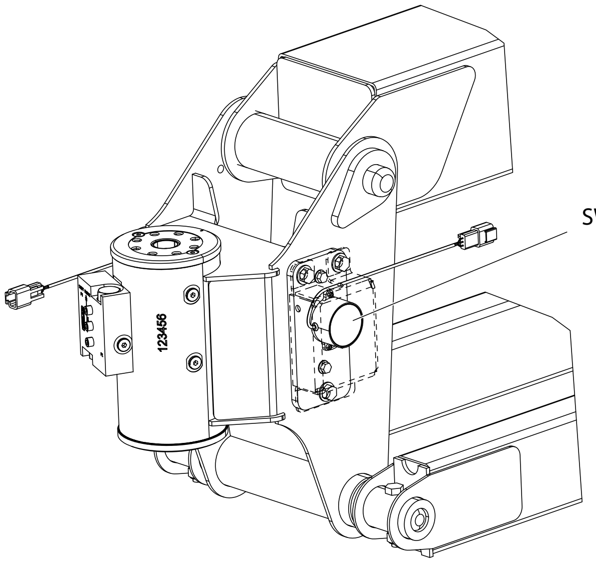


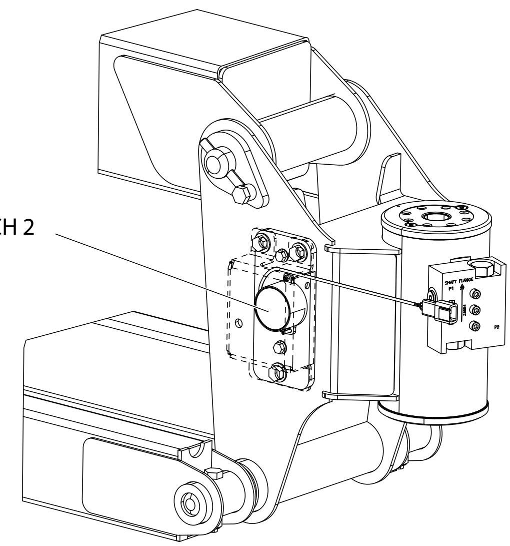
0273695-D
MAF36110D

Figure 4-28. Level Switches - 800S

SWITCH #1			
PIN #	DESCRIPTION	SWITCH	HARNESS
PIN #1	POWER	RED	RED
PIN#2	PWM OUT	GREEN	BLUE
PIN#3	GROUND	BLACK	BLACK

SWITCH #2			
PIN #	DESCRIPTION	SWITCH	HARNESS
PIN #1	POWER	RED	ORANGE
PIN#2	PWM OUT	GREEN	YELLOW
PIN#3	GROUND	BLACK	BLACK





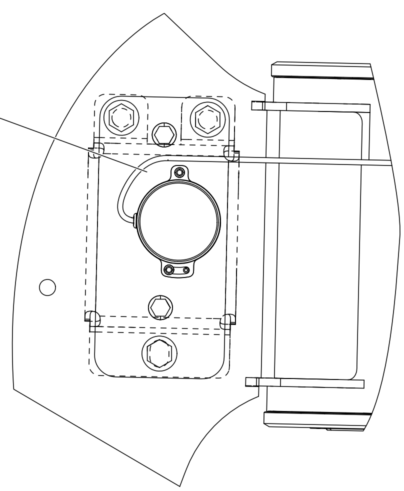


Figure 4-29. Level Switches - 860SJ

PLATFORM VALVES

The platform specific valves are located in a manifold at the platform.

There are six valves that control various platform functions. Two control Platform Level up and down for the leveling function, two are used to rotate the platform, and two to control jib up and down.

All platform valves are Pulse Width Modulated (PWM'd). PWM is a method of setting the voltage across a valve, and therefore the flow through it, by varying the On/Off duty cycle of the control module output. PWM permits proportional flow control.

There is also a Platform Dump Valve, located in the platform valve manifold, which is used to hydraulically isolate the control valves and to improve hydraulic response.

The Ground Module controls this valve to enable automatic platform leveling and to provide manual platform leveling in the event that the Platform Module is inoperable.

In ground mode, the platform dump valve is turned on whenever any platform or jib valve output is turned on. Whenever all platform and jib valves are turned off, the platform dump valve is turned off.

In platform mode, the platform dump valve is turned on whenever the footswitch is depressed.

Normal Operation

AUTOMATIC PLATFORM ANGLE CONTROL

The level system will assume a new fixed set point (fixed incline of the platform with respect to gravity) each time the control system is powered up (cycling of the EMS) and each time the footswitch is engaged.

Automatic platform angle control only functions while operating drive, telescope, lift or swing. It does not adjust the platform angle while operating any other function (e.g. rotate, jib, or steer). Furthermore, machines equipped with control system software P5.0 and later, automatic platform angle control for drive and swing may be disabled by using the analyzer. For this case, the platform angle setpoint is taken when the joystick moves from a non-leveling function (drive/swing) to a leveling function (lift/tele).

The machine controls attempt to maintain the angle of the platform to setpoint by providing a command proportional to the angular error from setpoint. Since the sensors used to measure the platform angle are fluid-filled, gravity-based sensors, reading the sensors in real time would cause constant correction of the platform position due to machine vibration and inertial changes of the boom. Therefore, the sensor readings are averaged over time, or filtered, in order to achieve a more uniform reading. This filtering has the advantage of providing smoother operation, but has the disadvantage of causing a lag (or sluggishness) in the system response. This lag may cause the platform to be several degrees from setpoint.

In order to provide a better system response, the controls also compute the rate of angular change of the platform position and set the leveling valve positions to achieve a matching velocity. The measured velocity is the average platform speed over the last 0.5 seconds. The desired valve command is computed by comparing the measured velocity to the desired velocity and setting the valve opening to correspond to the required amount of make-up angle. The amount the valve opens when making an automatic correction is proportional to and directly affected by:

- Crackpoint setting
- Velocity error (proportional factor)
- Sum of velocity errors over time (integral factor)

These three factors are summed together with appropriate gain factors to compute the resulting current to the valves. The operator does not have control over the latter two factors, but can affect the resulting current by adjusting the crackpoint. Increasing the crackpoint makes the valve current higher, resulting in quicker more aggressive control and larger amounts of overshoot. Decreasing the crackpoint will result in smoother operation but may not permit enough platform velocity to keep up with the boom (i.e., may get platform timeout alarms) in some multi-function operations. The platform controls are set up to provide smooth leveling operations for the majority of conditions and will perform best for steady operator command, as opposed to command values for function, that change frequently.

In order to obtain acceptable performance while performing all hydraulic functions, five sets of parameters are used. These "zones" allow compensation for differences in how the basket level changes when doing different functions. These zones are as follows:

1. Lift up
2. Lift down
3. Other boom functions
4. Drive
5. Auxiliary

The other boom functions zone includes Swing, Telescope, Jib swing (It is not necessary to level with jib lift, since the mechanical linkage keeps the basket level).

These zones are prioritized when multiple functions are active. The priorities are as follows.

1. Auxiliary power and any other function, zone = auxiliary power
2. Drive and any other function, zone = Drive
3. Lift up and any other function, zone = Lift up
4. Lift down and any other function, zone = Lift down
5. Other boom functions, zone = Other boom functions

During the power-up procedure, function enable, in both Platform and Ground Mode, is delayed during the 1.5 second startup lamp test. During this 1.5 second startup period, the basket level up valve will be energized at 100% duty cycle for 0.5 second, and then the basket level down valve energized at 100% duty cycle for 0.5 second. This will help to keep the valves from sticking.

PLATFORM LEVEL MANUAL OVERRIDE

In addition to automatic platform angle control, the operator is able to manually adjust the platform level position by means of the level override switches located at the platform and ground control positions (similar to a Master/Slave hydraulic system).

If a command from the Platform Level Up and Down toggle switch on either the platform or the ground is received, automatic platform angle control will cease and the appropriate output will be commanded to turn on.

The duty cycle of the output shall be scaled from the pump potentiometer. When the toggle switch is released, after one second, the current filtered value of tilt angle will be taken as the new set point.

In other words the operator can chose a platform level incline other than level with gravity and the system will maintain the chosen platform angle within several degrees of setpoint.

Platform Leveling Fault

The JLG Control System takes a snapshot of the two sensor values and records the difference once on each power up. The Control system allows a ±5 degrees difference from those values. For example, if Sensor 1 is at 5 degrees and Sensor 2 is at 11 degrees, the difference is 6 degrees and the DTC is triggered when the sensors are 1 degree (or less) apart or 11 degrees (or more) apart.

If a fault occurs in the platform leveling system the following will occur:

1. Automatic platform angle control will stop and the platform dump valve will be disabled (level, rotate, and jib functions disabled). The exception is when there is a fault in only one sensor automatic platform angle control will remain active as the control system will use the other sensor to control leveling.
2. The level system fault lamp will flash (to indicate that the leveling function has been lost).
3. The platform alarm will sound.
4. A system fault will be logged.
5. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position see below).

To reset the fault the emergency stop switch should be recycled.

NOTICE

IF THE LEVEL SYSTEM FAULT INDICATOR REMAINS ILLUMINATED, RETURN THE PLATFORM TO THE STOWED POSITION, SHUT DOWN THE MACHINE, AND REPAIR THE LEVELING SYSTEM.

ERROR RESPONSE

If basket level varies from the current **setpoint** by ± 5.5° for more than 2 seconds for large variations from setpoint when the platform is not in the transport position, the controls assume the system is not properly set up or has degraded and initiate a fault.

When the unit is in the transport position and driving and the current setpoint varies by ± 5.5° for more than 10 seconds the events 1,2,3 & 4 above will occur. (note function speeds will operate normally). Since the control system can not anticipate all conditions under which a machine is to be operated, these parameters have been chosen to provide reasonable performance and safe operation. If an error occurs, cycling the EMS will clear the fault. The operator should evaluate the operating situation and assess his machine to determine the source of the fault.

VALVE DRIVER ERRORS

There are three possible level valve driver errors, short to battery, short to ground, and open circuit.

1. In the case of a **short to ground or an open circuit**, the platform valve cannot be turned on and the following will occur:
    a. All interactions with platform leveling shall cease
    b. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
    c. The platform alarm will sound.
    d. A system fault will be logged.
    e. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position).
2. In the case of a **short to battery** on one of the platform leveling valves, the valve cannot be turned off and the following will occur:
    a. The platform dump valve will be turned off to prevent unintended tilting of the platform.
    b. All interactions with platform leveling shall cease.
    c. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
    d. The platform alarm will sound.
    e. A system fault will be logged.
    f. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position)
3. In the case of a **short to battery on the platform dump valve**, the valve cannot be turned off. The controllability of the platform leveling function will be impaired and the following will occur:
    a. All interactions with platform leveling shall cease.
    b. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
    c. The platform alarm will sound.
    d. A system fault will be logged.
    e. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position).

Lift, swing, drive and telescope will continue to operate

In each of the cases above it shall be necessary to re-cycle the EMS to clear the fault. Operable functions shall be in the creep mode except while below elevation.

TILT SENSOR ERRORS

If the secondary tilt sensor is faulty, the control system will continue to utilize information from the primary sensor.

If the primary sensor is faulty, the control system will switch to the backup sensor for control.

In both cases above the following will occur:

1. The Electronic Leveling System Fault Lamp will flash (to indicate that there is a leveling fault).
2. The platform alarm will sound.
3. A system fault will be logged.
4. All function speeds (lift, swing, telescope, jib and drive) will be placed in creep mode (except when the platform is in the transport position).
5. Automatic platform angle control remains active.

Lift, swing, drive and telescope will continue to operate.

In each of the cases above it will be necessary to re-cycle the EMS to clear the fault. Operable functions shall be in the creep mode except while below elevation.

When both sensors appear to be working but have measurements that disagree by ±5.5° The following will occur:

1. All interactions with platform leveling shall cease.
2. The Electronic Leveling System Fault Lamp shall flash (to indicate that the leveling function has been lost).
3. The platform alarm will sound.
4. A system fault will be logged.
5. All function speeds (lift, swing, telescope and drive) will be placed in creep mode (except when the platform is in the transport position)

At this point, the operator must use the level up and down toggle switch to manually level during descent. It shall be necessary to re-cycle the EMS to clear the fault.

CAN Errors

The Ground Module has two direct outputs dedicated to overriding the Platform Module's control of the leveling valves. The EPBC Ground Module "Platform Level Up/Down" outputs are used to control the platform level up and down valves.

When in ground mode, if the Ground Module reads a platform leveling switch command, the switch command is communicated over CAN to the Platform Module where it is handled normally.

If Ground Module determines that CAN communication is inoperable, it turns on the platform control valve and the appropriate platform leveling override outputs while the switch is engaged.

If the Platform Module is still running when CAN is down nothing will operate when in platform mode. When the operator switches to ground mode, the platform will not control any of its valve outputs and a CAN error message is signaled.

Replacing the Level Sensors

Earlier generations of this machine had three different generations of level sensors that were used on this machine. JLG PN 4360503, PN 4360528, and PN 4360544. PN 4360528 and 4360544 supersede PN 4360503. If one of the 4360503 sensors fail, BOTH sensors must be replaced with two PN 4360544 sensors. 4360503 Sensors can be identified by the code SSY0185-13 which is printed on the sensor. Otherwise, single 4360528 or 4360544 9999 sensors may be replaced.

Additional Platform and Jib Valves

The high side drivers for the platform left and right and the jib up and down valves are be located in the Platform Module and are PWM'd. The control for these functions are the same as currently implemented for the EPBC except that the flow through the valves is individually controllable instead of controlled by single the flow control valve. The individually controlled duty cycle will be the same as would otherwise have been commanded to the flow control valve.

Only one platform or jib function is allowed at one time to limit the amount of current draw, minimizing the voltage drop on the supply to the PM.

The function is enabled first shall remain active until it is released. Any other function commanded while another function is active is ignored.

If only one other function is commanded when the active function is released, the other function will be activated.

If more than one function is commanded when the active function is released, only one function shall be activated.

Platform Leveling Calibration Procedure

STEP 1: SETTING THE PLATFORM VALVE MINIMUMS

1. Put machine into "Ground Mode".
2. Start machine and plug in Analyzer.
3. Go to the "Access Level 2" screen.
4. Enter "33271" to get into Access Level 1 mode.
5. Go to the "Personalities" menu and adjust the following personalities. Refer to the Personality Ranges/Defaults table in Section 6 - JLG Control System for proper setting values.

   Basket Level Up Min
   Basket Level Up Max
   Basket Level Down Max
   Jib Up Min
   Jib Down Min
6. Recycle EMS.

STEP 2: CALIBRATING THE PLATFORM LEVEL SENSORS (FOR PLATFORM SOFTWARE PRIOR TO VERSION P3.4)

1. Put machine into "Ground Mode".
2. Start machine and plug in Analyzer.
3. Manually level the platform with the switch on the MTB.
4. Go to the "Access Level 2" screen.
5. Enter "33271" to get into Access Level 1 mode.
6. Go to the "Calibrations" menu and hit ENTER.

7. Use RIGHT ARROW go to “Plat. Leveling” screen.
8. Hit ENTER. “Calibrate?” prompt should appear.
9. Hit ENTER again to calibrate level sensors.
10. When calibration has been successful “Cal Complete” should appear.
11. Cycle power to the machine.

STEP 3: BLEEDING THE PLATFORM VALVES

Start up the machine and exercise the following platform functions (from the ground) eight (8) to ten (10) times for 5 seconds in each direction.

Basket Rotate
Basket Level
Jib U/D (if configured)

STEP 4: CALIBRATING THE PLATFORM LEVEL UP AND DOWN VALVE CRACKPOINTS

NOTE: *Since the valve position which allows minimum oil flow (crackpoint) is dependent on the oil pressure, verify the proper stand-by pressure as outlined in Section 5.4, Pressure Setting Procedure prior to setting the crackpoints.*

1. Put machine into “Ground Mode”.
2. Start machine and plug in Analyzer.
3. Go to the “Access Level 2” screen.
4. Enter “33271” to get into Access Level 1 mode.
5. Go to the “Calibrations” menu and hit ENTER.
6. Go to the “Basket U Crkpt” Screen. Hit ENTER.
7. “Calibrate?” prompt should appear. Hit ENTER again.
8. You will hear engine go to 1800 rpm.
9. Using UP ARROW, increase the value until you see the basket up movement. (Typically from 275 – 425).
10. Hit ENTER again. “Cal Complete” message should appear
11. Engine should again return to idle.
12. Hit ESC should return to “Basket U Crkpt” screen.
13. Hit RIGHT ARROW to get to the “Basket D Crkpt” screen. Hit ENTER.
14. “Calibrate?” prompt should appear. Hit ENTER again.
15. You will hear engine go to 1800 rpm.
16. Using UP ARROW, increase the value until you see the basket down movement. (Typically from 275 – 425).
17. Hit ENTER again. “Cal Complete” message should appear.
18. Engine should again return to idle.
19. Hit ESC to exit.
20. Cycle power to the machine.
21. The preceding steps will provide acceptable crackpoint settings for the majority of machines. However, there exists the possibility certain machines could still have too high or too low a crackpoint setting.

    If the operator can feel small jolts in the platform from the valve opening during a leveling operation, the crackpoint is likely too high. A high crackpoint may also lead to over-leveling, causing the platform to drift beyond the set point. An example of this would be the platform tilting too far backwards during a Lift Up operation. Use the following guidelines to evaluate whether further crackpoint adjustment is required.

    a. Telescope the boom halfway.
    b. Perform a continued Lift Up command (do not cycle the joystick on/off repeatedly). If the basket leans backward (over compensates), the Level Down crackpoint is too high. If the basket leans forward or a BASKET LEVELING SYSTEM TIMEOUT fault occurs, the Level Down crackpoint is too low.
    c. Perform a continued Lift Down command (do not cycle the joystick on/off repeatedly). If the basket leans forward (over compensates), the Level Up crackpoint is too high. If the basket leans backwards or the Tilt Cutout Alarm comes on, the Level Up crackpoint is too low.

    If Platform Level is slow to respond during Lift commands, causing PLATFORM LEVEL TIMED OUT faults, it may be necessary to increase the crackpoint settings. Use the following guidelines to evaluate whether further crackpoint adjustment is required.

    a. Perform a continued Lift Up command (do not cycle the joystick on/off repeatedly). If the PLATFORM LEVEL TIMED OUT fault sets or if Platform Level Down seems slow to respond, an increase in the Platform Level Down crackpoint may be necessary.
    b. Perform a continued Lift Down command (do not cycle the joystick on/off repeatedly). If the PLATFORM LEVEL TIMED OUT fault sets or if Platform Level Up seems slow to respond an increase in the Platform Level Up crackpoint may be necessary.

4.12 HELAC ROTARY ACTUATOR

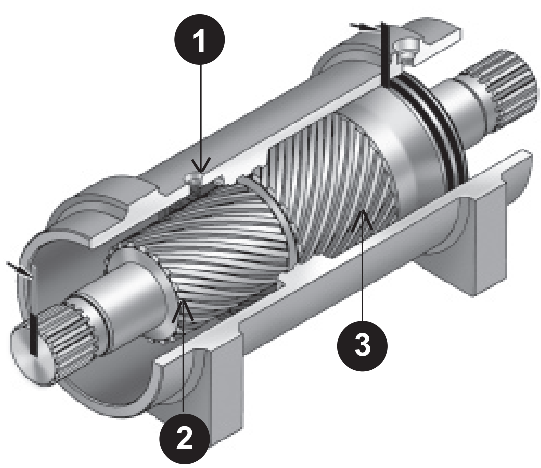
Theory of Operation

The rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert axial piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear ring (1) and only two moving parts: the central shaft with integrated bearing tube and mounting flange (2), and the annular piston sleeve (3). Helical spline teeth machined on the shaft engage matching splines on the inside 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 housing, preventing piston movement and locking the shaft in position.

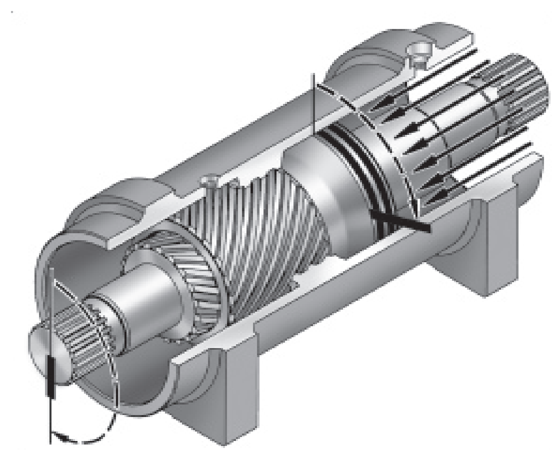
The shaft is supported radially by the large upper radial bearing and the lower radial bearing. Axially, the shaft is separated from the housing by the upper and lower thrust washers. The end cap is adjusted for axial clearance and locked in position by set screws or pins.

The actuators are equipped with factory installed counterbalance valves, which performs four major functions.

- Protects the actuator in the event of overload
- Enables the actuator to hold position without drifting when external loads are applied
- Reduces hydraulic backlash by pressuring the hydraulic fluid
- Provides a constant controlled rate of rotation in over-center load conditions

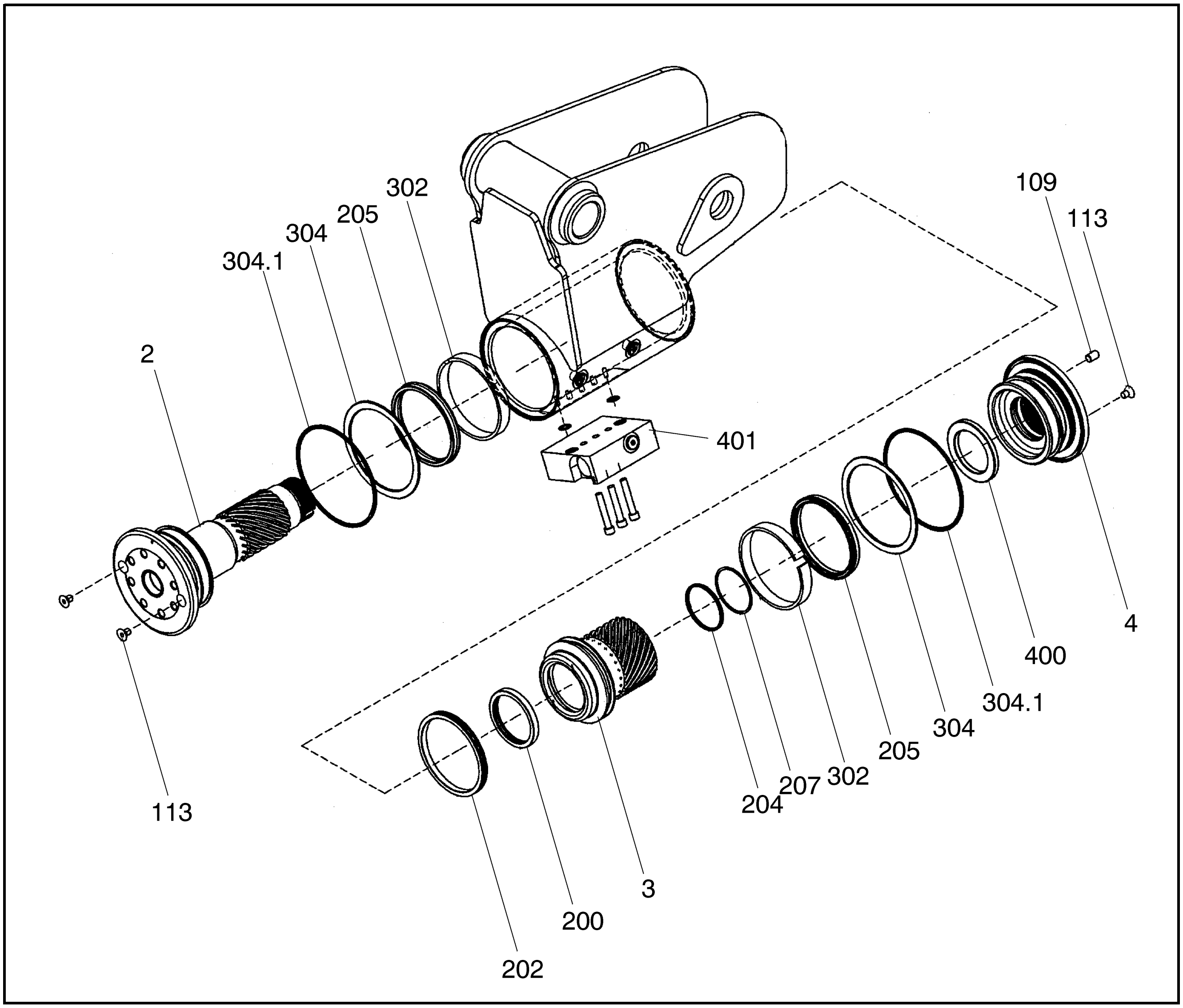


Bars indicate starting positions of piston and shaft. Arrows indicate direction they will rotate. The housing with integral ring gear remains stationary.



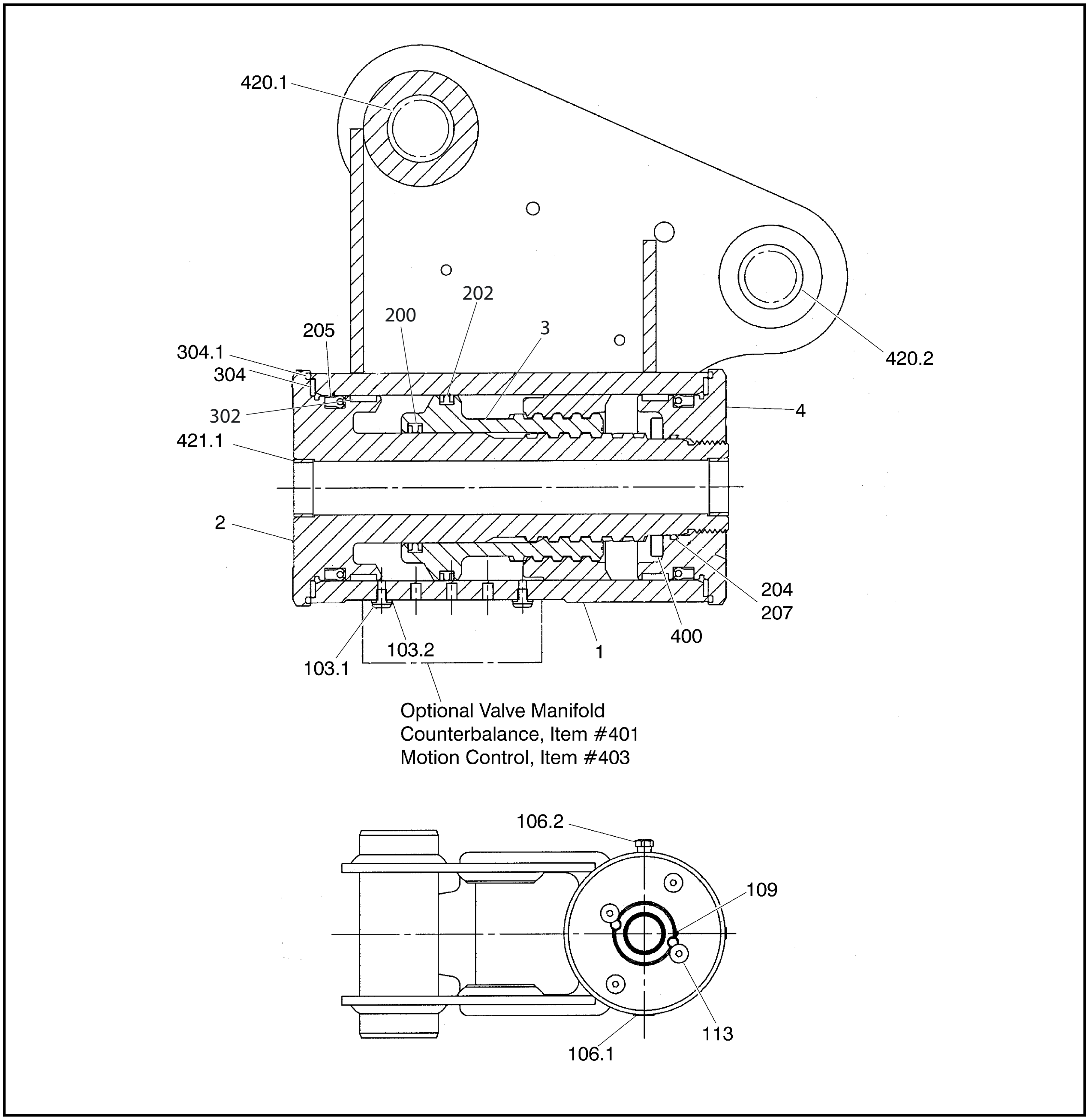
Applying fluid pressure will displace the piston axially while the helical gearing causes the piston and shaft to rotate simultaneously.

The double helix design compounds rotation: shaft rotation is about twice that of the piston. Applying pressure to the opposite port will return the piston and shaft.



1. Housing
2. Shaft
3. Piston Sleeve
4. End Cap
109. Lock Pin
113. Capscrew
200. T-Seal
202. T-Seal
204. O-ring
205. Cup Seal
207. Backup Ring
302. Wear Guide
304. Thrust Washer
304.1. Wiper Seal
400. Counterbalance Valve
401. Counterbalance Valve

Figure 4-30. Rotary Actuator (Exploded View)



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

Figure 4-31. Rotary Actuator (Cutaway View)

Tools Required for Assembly/Disassembly

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

1. Pipe Vise
2. Hex Wrench - Removal and replacement of port plugs and set screws.
3. Assorted Screws
4. Safety Glasses
5. End Cap Removal Tools
6. Drill
7. Flashlight- Helps in locating and examining timing marks, component failure and overall condition.
8. Rubber mallet- removal and installation of shaft and piston sleeve assembly.
9. Plastic Mandrel
10. Pry bar- removal of end cap and manual rotation of shaft.
11. Felt Marker- Highlights timing marks and outlines troubled areas. Permanent ink is recommended.
12. T - Handle Screw Extractor
13. Hex Wrench Set - Removal and replacement of port plugs and set screws (106,110).
14. Seal tools - Removal and installation of seals and wear guides.
15. Punch
16. Dowel Pins - Removal and installation of end cap.

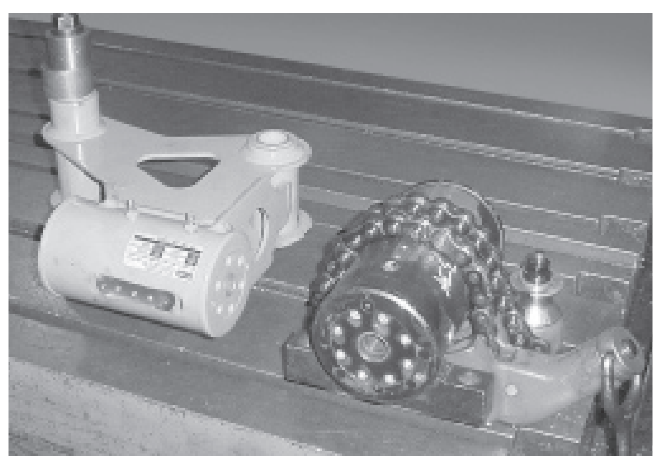
CAUTION

TO AVOID INJURY: BE CAREFUL WHEN HANDLING THE SCREWDRIVER WHEN HOT.

Before Disassembly

Inspect the actuator for corrosion prior to disassembly. Severe corrosion can make it difficult to remove the lock pins (109) and unthread the end cap (04). If corrosion is evident, soak the lock pins and end cap with penetrating oil for several hours before disassembly.

Disassembly is considerably easier if the actuator is firmly secured to the work bench. A pipe vise or mounting fixture work well.

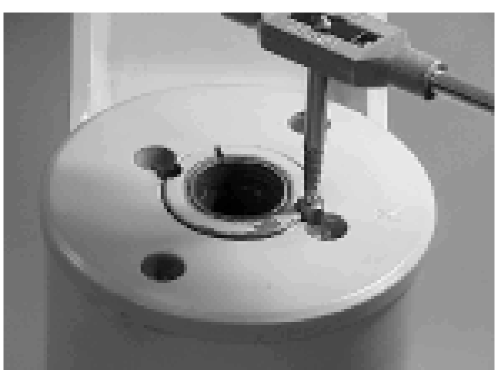


Disassembly

1. Remove port plugs (106.1) (106.2) and drain oil. Inspect oil for signs of contamination, i.e. water, metal shavings.

2. Remove the capscrews (113) over end caplock pins (109).

3. Using a 1/8" (3 mm) drill bit, drill a hole in the center of each lock pin to a depth of approximately 3/ 16" (5 mm).



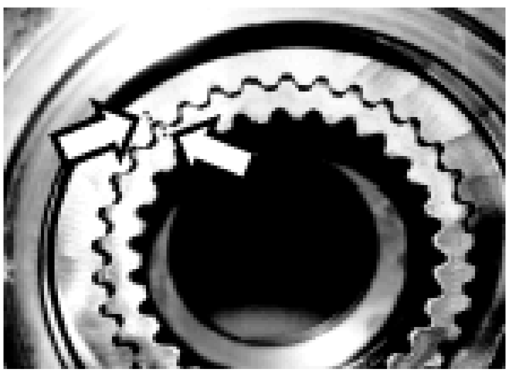
4. Remove the lock pins using an "Easy Out" (a size #2 is shown). If the pin will not come out with the "Easy Out", use 5/16" drill bit to a depth of 1/2" (12.7mm) to drill out the entire pin.

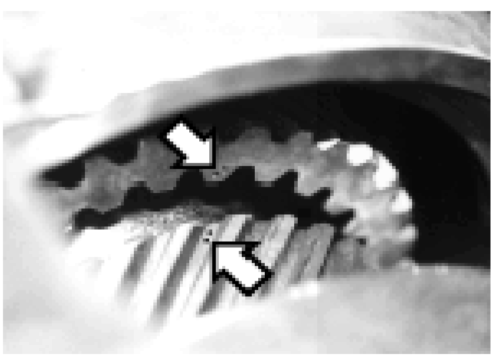
5. Install the end cap removal tools provided with the Helac seal kit.

6. Using a metal bar, or something similar, unscrew the end cap (4) by turning it counterclockwise.

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

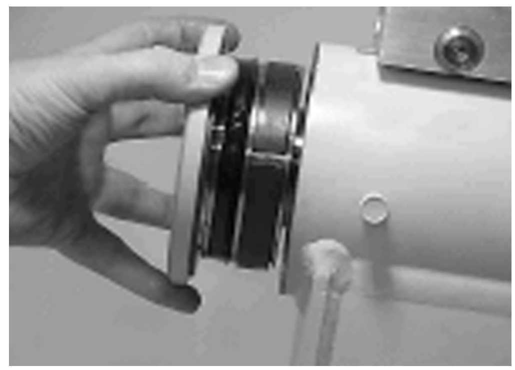
8. Remove the stop tube (400) if included. The stop tube is an available option to limit the rotation of the actuator.



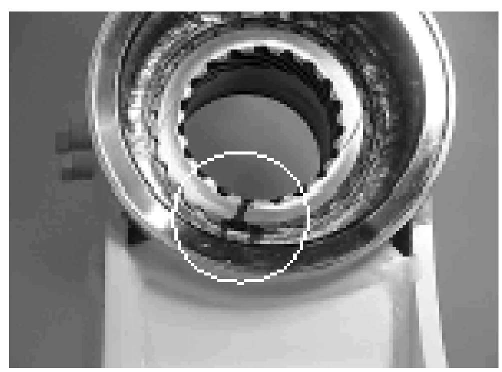


9. Every actuator has timing marks for proper engagement.

10. 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.



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



12. 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).

13. To remove the piston (3) use a rubber mallet and a plastic mandrel so the piston is no damaged.

14. 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.

15. Remove the o-ring (204) and backup ring (207) from end cap (4) and set aside for inspection.

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

17. Remove the main pressure seal (205).

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

19. Remove the O-ring (304.1) from its groove in the end cap (4) and shaft (2).

20. Remove the piston O.D. piston seal (202).

21. Remove the piston I.D. seal (200).

Inspection

NOTICE

PRIOR TO ASSEMBLY OF ACTUATOR, THESE STEPS MUST BE CLOSELY FOLLOWED TO INSURE PROPER OPERATION OF THE ACTUATOR.

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

NOTICE

SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.

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. Coat the thrust washers (304) with a generous amount of Lithium grease. Install the thrust washer (304) onto shaft (2) and end cap (4).

3. Install the exclusion (304.1) into it's 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).

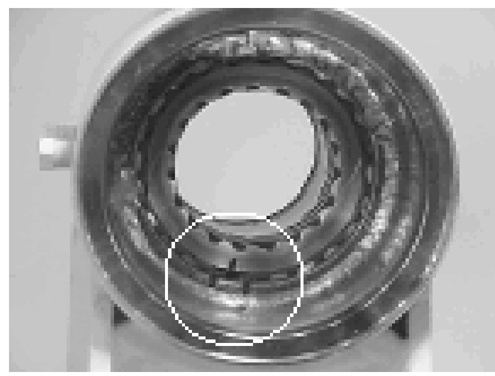
6. Install the O-ring (204) and backup ring (207) into the inner seal groove on the end cap (4).

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).

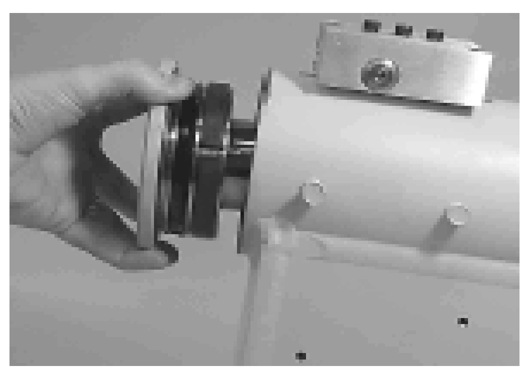
Beginning with the inner seal (200) insert one end of backup ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly. Repeat this step for the outer seal (202).

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 into the housing bore from the shaft flange end, rotate the piston (3) until the marks you put on the piston and the housing (1) during disassembly align as shown. Using a rubber mallet, tap the piston into the housing until the gear teeth contact.

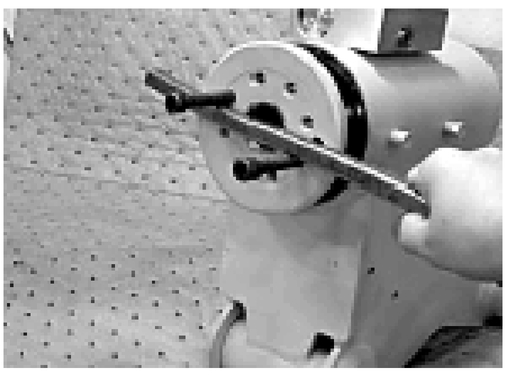


10. Looking into the bore from the opposite end of the housing (1) be sure the timing marks align correctly. Rotate the piston as necessary until aligned, then gently tap the piston (3) into the housing until the gear teeth mesh together. Tap the piston into the housing until it completely bottoms out against the ring gear.



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 at the actuator from the end opposite the shaft flange, use the exisitng timing marks to align the gear teeth on the shaft (2) with the gear teeth on the inside of the piston (3). When the marks align, gently tap the flange end of the shaft with a rubber mallet until the gear teeth engage.



13. Install two 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.

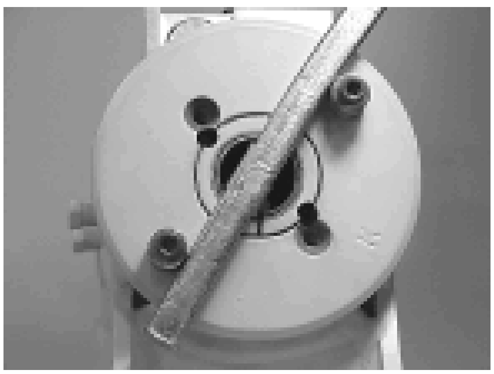
NOTICE

AS THE SHAFT IS ROTATED, BE CAREFUL NOT TO DISENGAGE THE PISTON AND HOUSING GEARING.

14. Install the stop tube (400) onto the shaft end if necessary. Stop tubes are an available option to limit the rotation of an actuator.

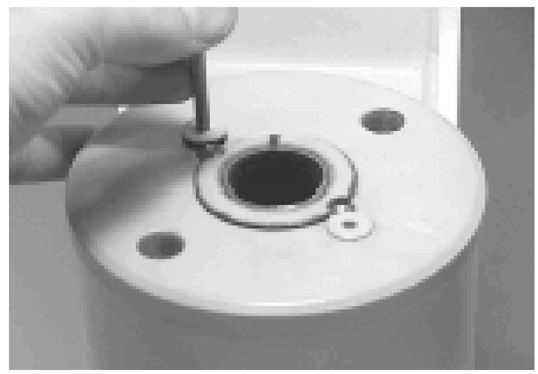
15. Coat the threads on the end of the shaft with antiseize grease to prevent galling.

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



17. Tighten the end cap (4) using a metal bar. In most cases the original holes for the lock pins will align.

18. 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.



19. Insert the set screws (113) over the lock pins. Tighten them to 25 in. lbs. (2.8 Nm).

Installing Counterbalance Valve

Refer to Figure 4-32., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old Threadlocking compound.
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. Medium Strength Threadlocking Compound should be applied to the shank of the three bolts at the time of installation.
4. Torque the 1/4 in. 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 in. 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.

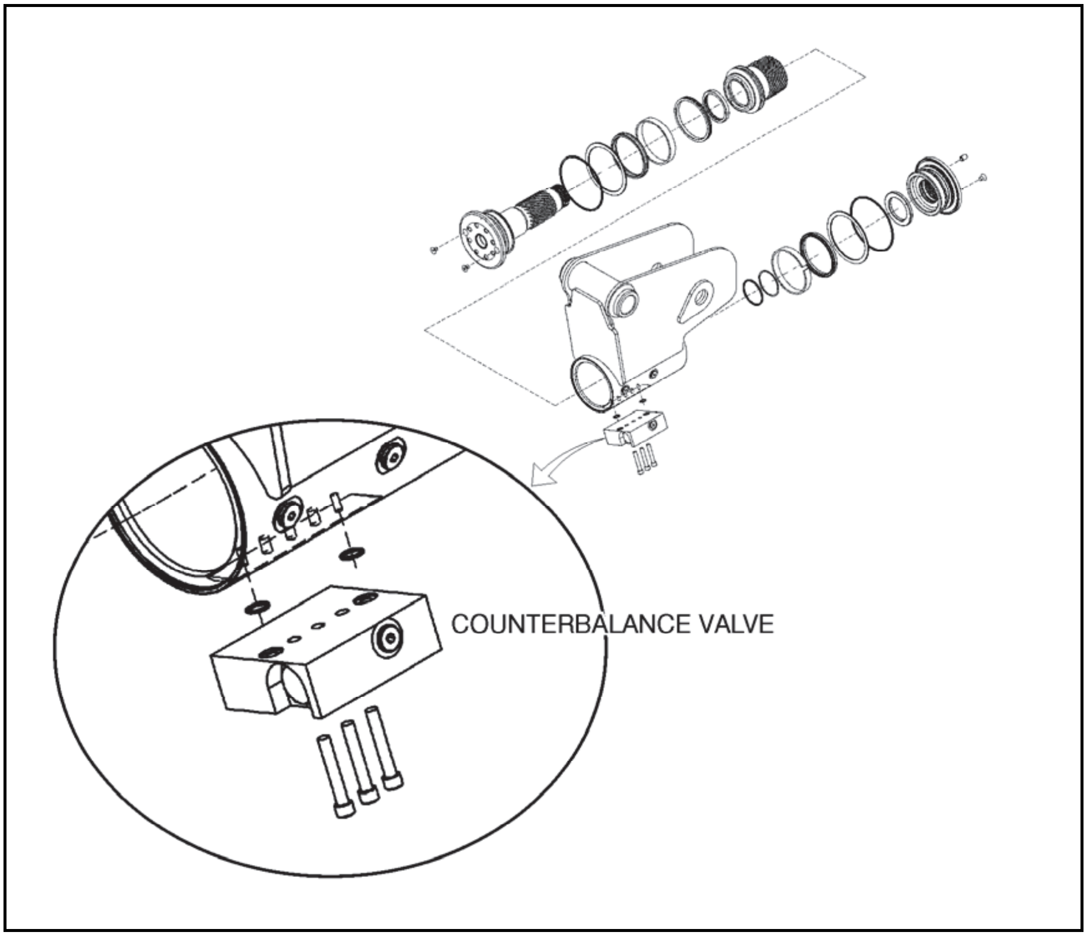


Figure 4-32. Rotator Counterbalance Valve

Greasing Thrust Washers

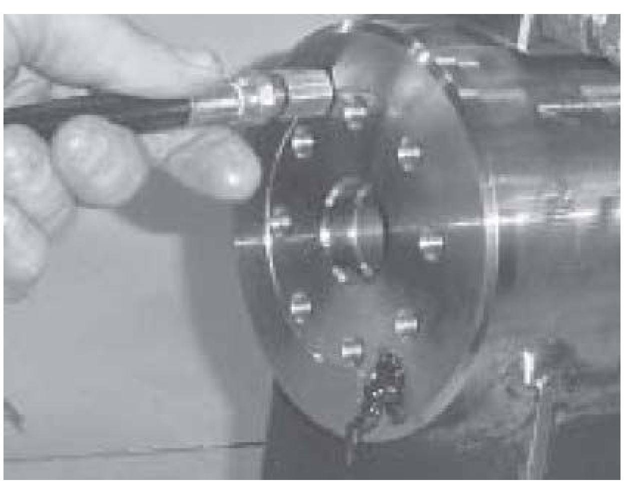
1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.

2. There are two grease ports located on both the shaft flange and the end cap. They are plugged with capscrews (6) 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.

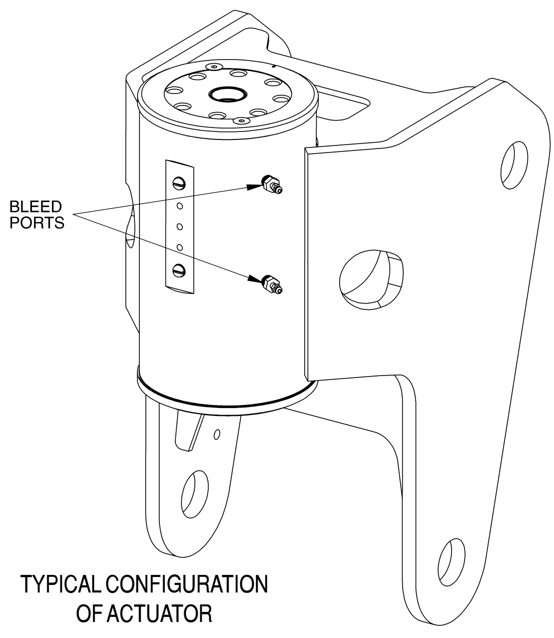
Installation and Bleeding

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 1/2 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.

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 as described in the Testing section on page 73 of this manual.
	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 overload conditions	a. Check for gear binding. Actuator may not be able to be re-built and may need to be replaced.
	b. Port fittings are obstructing the piston during stroke	b. Check thread length of port fittings. Fittings should 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 as described in the Testing section on page 73 of this manual.
	c. Air in actuator	c. Purge air from actuator. See bleeding procedures

4.13 LOAD SENSING DEVICE

Calibrating the Load Sensor

NOTE: *Refer to Section 6 - JLG Control System.*

1. Place the boom in the following position.
   a. Boom - Stowed
   b. Telescope - In
   c. Jib - 0 Degrees
   d. Swing - 0 Degrees
   e. Basket Level - 0 Degrees
   f. Basket Rotate - 0 Degrees
   g. Weight in Basket - 0
   h. Machine parked on firm, level surface
2. Activate both emergency stop switches and turn the key switch to the platform position.
3. Remove all loads from the platform, including the operator.
4. Turn P1 clockwise (in) until the potentiometer begins to click.
5. Plug the analyzer into the port in the platform.
6. Select Access Level from Main Menu.
7. Enter 33271.
8. Select Machine Set-Up>Load Cell>1 Warn Only.
9. Select Machine Diagnostics>System Load Cell on the Analyzer.
10. Adjust P2 until the Load = 0%.
11. Place 525 lb (238 kg) in the center of the basket.
12. Adjust P1 until the Load = 100%.
13. Verify that the overload indicator lights continuously and the alarm sounds continuously during an overload condition.
14. Remove the weight from the platform.
15. Adjust P2 until the Load = 0%.
16. Place 525 lb (238 kg) in the center of the basket.
17. Adjust P1 until the Load = 100%.
18. Remove the weight from the basket.
19. Seal the potentiometers with fingernail polish.

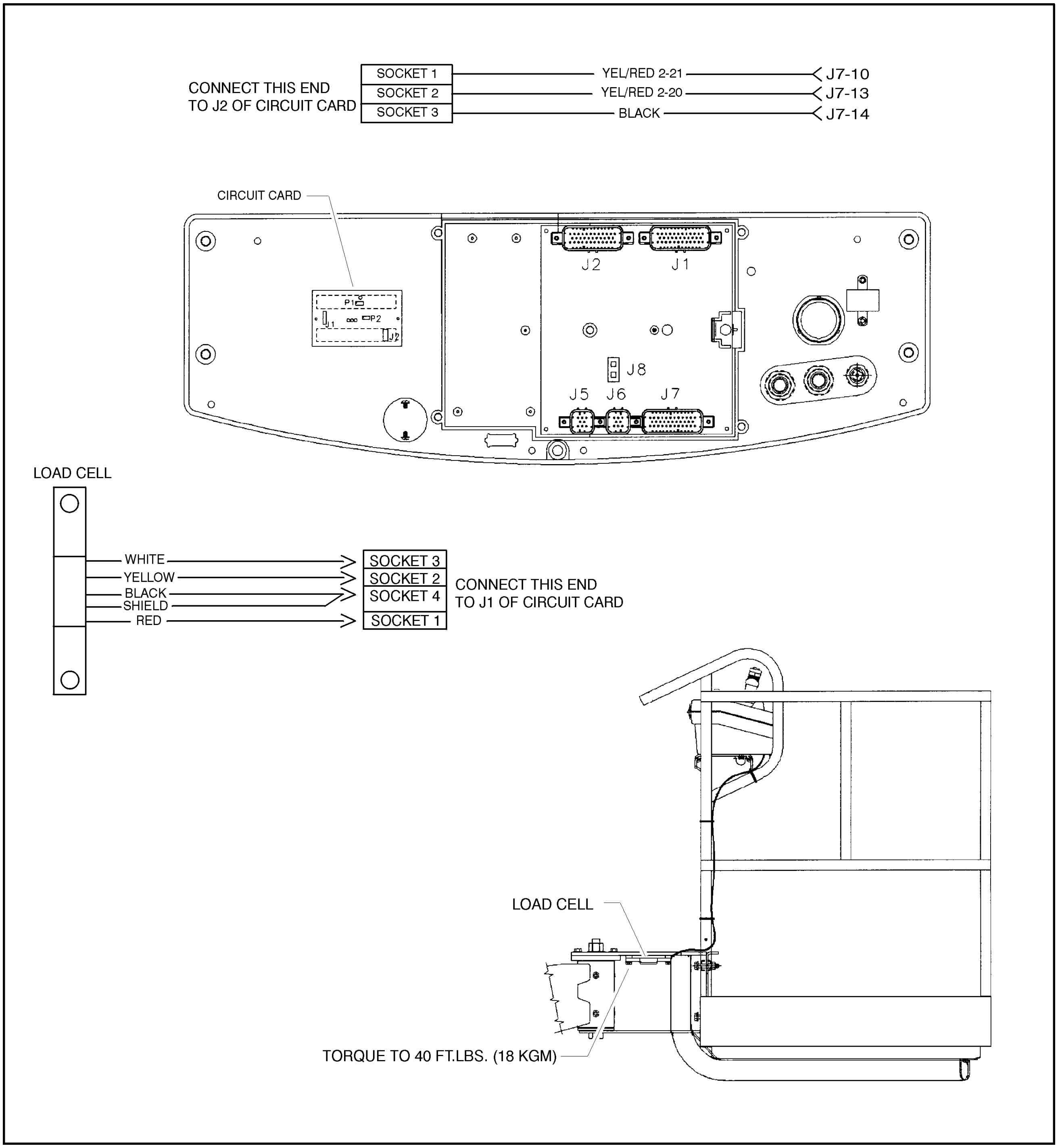


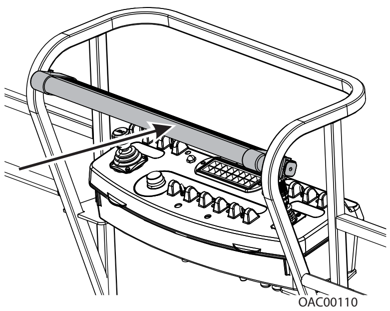
Figure 4-33. Load Sensing Device

4.14 SKYGUARD®

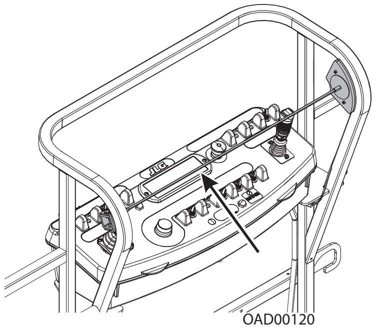
Operation

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.

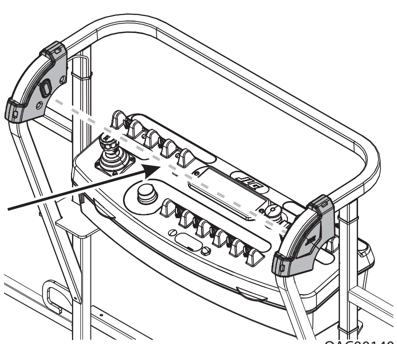
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



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:

1. Operation is allowed regardless of SkyGuard activation.

BOTH SKYGUARD AND SOFT TOUCH

Perform this procedure if both SkyGuard and Soft Touch are selected in machine setup (refer to Table 6-2).

From the Platform Control Console in an area free from obstructions:

NOTE: *Machine will treat Soft Touch/SkyGuard override switch as if it is a Soft Touch and SkyGuard switch.*

1. Operate the telescope out function, then activate SkyGuard sensor.
2. Once sensor has been activated, ensure telescope out function stops. 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 sure normal operation is available.

In Ground Mode:

1. 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 6-9 for more fault code information

- **0039 -** SkyGuard switch activation fault
- **2563 -** switch disagreement fault

Table 4-2. SkyGuard Function Table

Drive Forward	Drive Reverse	Steer	Swing	Boom Lift Up	Boom Lift Down	Boom Tele Out	Boom Tele In	Jib Lift	Basket Level	Basket Rotate
R*/C**	R	C	R	R	R	R	C	C	C	C
R = Indicates Reversal is Activated										
C = Indicates Cutout is Activated										
* DOS (Drive Orientation System) Enabled										
** DOS Not Enabled, machine is driving straight without steering, and any other hydraulic function is active										
Note: If SkyGuard is enabled with the Soft Touch system, functions will cut out instead of reversing.										

4.15 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 lb (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 BE PERFORMED 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 mobile elevating 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.

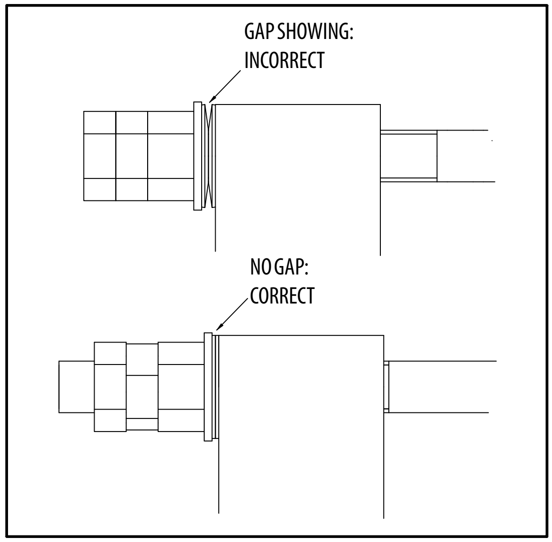
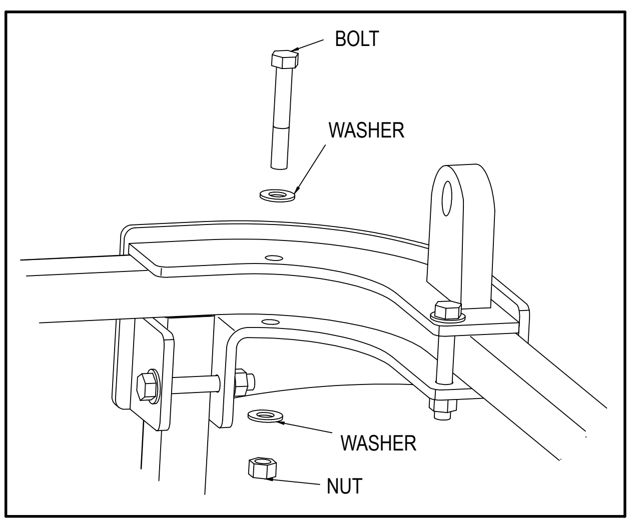


Figure 4-34. Bolt-On External Fall Arrest Cable Tension

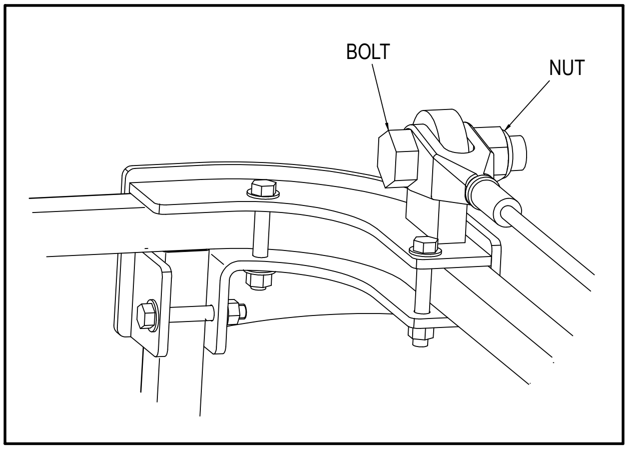
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are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

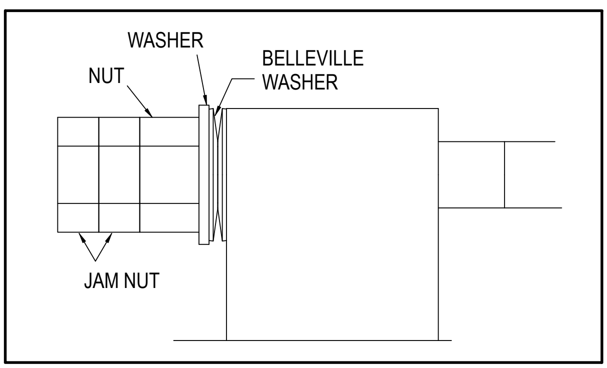


2. Attach the fall arrest cable to the right hand bracket Using the attaching bolt and nut. Orient the bolt as shown below. Do not tighten the nut so cable can still rotate.

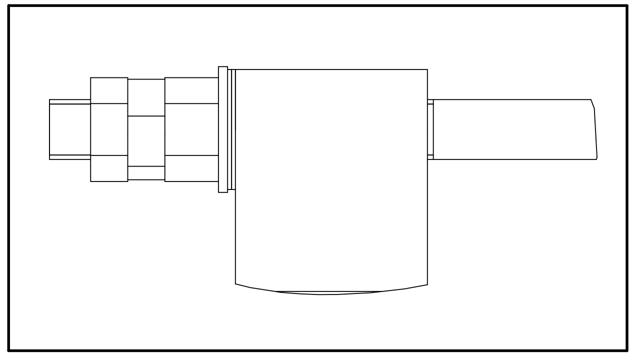


3. Install the Attachment Ring onto the cable.

4. Without twisting the fall arrest cable, pull it through 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.

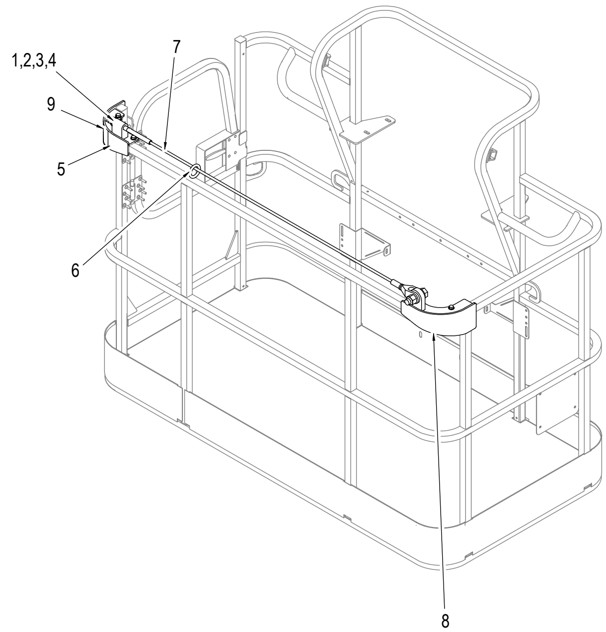


5. Use the two jam nuts to prevent the cable from rotating while the nut is tightened. Tighten the nut until the belleville washers are fully compressed and no gap is present at the outside diameter of the washers. Ensure the cable has not rotated during tightening.



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).



1. Belleville Washer
2. Washer
3. Hex Nut
4. Jam Nut
5. LH Bracket
6. Attachment Ring
7. Cable
8. RH Bracket
9. Decal

Figure 4-35. Bolt-On External Fall Arrest System

SECTION 5. BASIC HYDRAULICS INFORMATION & SCHEMATICS

5.1 LUBRICATING O-RINGS IN THE HYDRAULIC SYSTEM

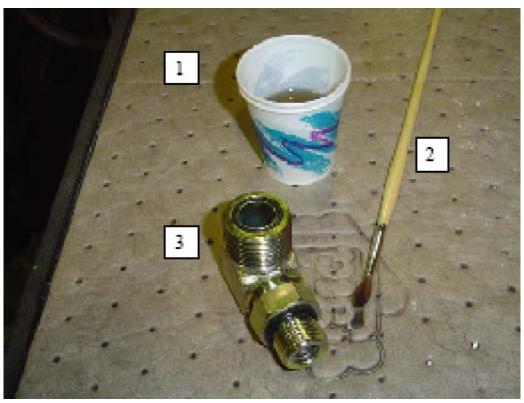
When assembling connectors in the hydraulic that use o-ring fittings, it is necessary to lubricate all fittings with hydraulic oil prior to assembly. To lubricate the fittings, use one of the following procedures.

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

Cup and Brush

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

- 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

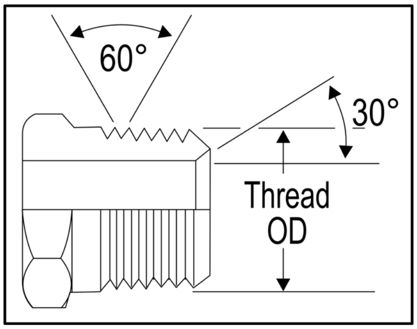


Figure 5-1. NPTF thread

BSPT = British standard pipe tapered per ISO7-1

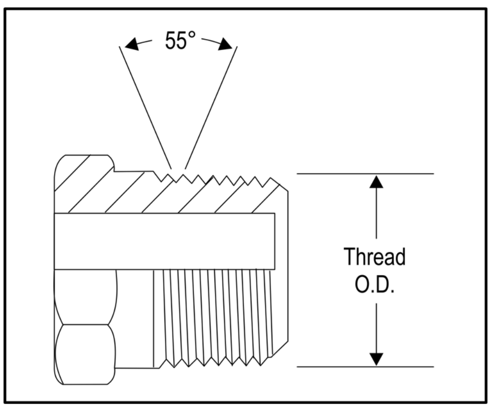


Figure 5-2. BSPT thread

Straight Thread Types, Tube and Hose Connections

JIC = 37° flare per SAE J514

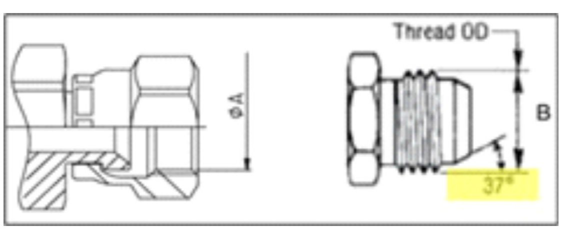


Figure 5-3. JIC Thread

SAE = 45° flare per SAE J512

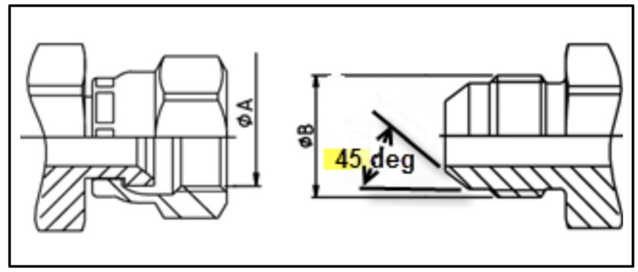


Figure 5-4. SAE Thread

ORFS = o-ring face seal per SAE J1453

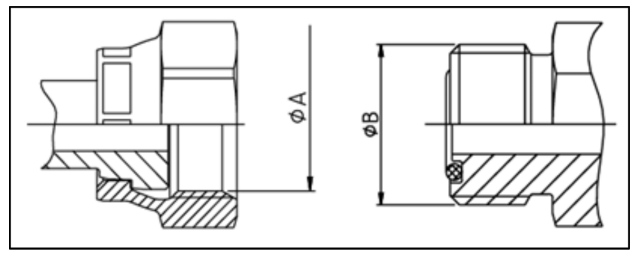


Figure 5-5. ORFS Thread

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

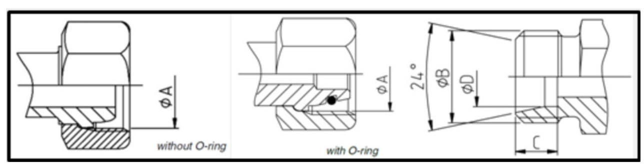


Figure 5-6. MTBL-MBTS Thread

BH = bulkhead connection – JIC, ORFS, MBTL, or MBTS types

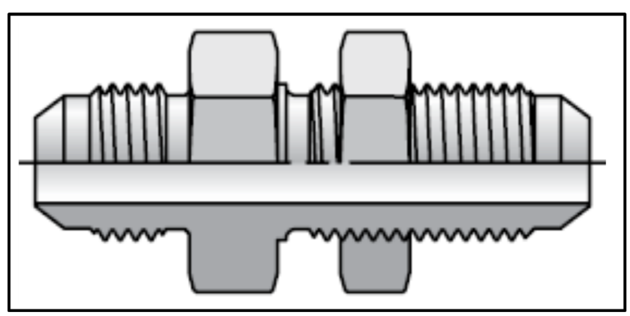
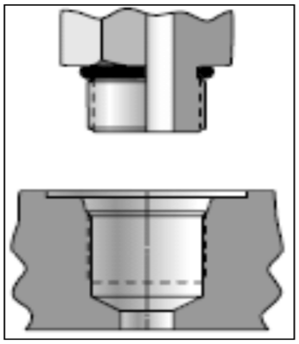


Figure 5-7. Bulkhead Thread

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



MFF = metric flat face port per ISO 9974-1

BSPP = British standard parallel pipe per ISO 1179-1, DIN 3852-2

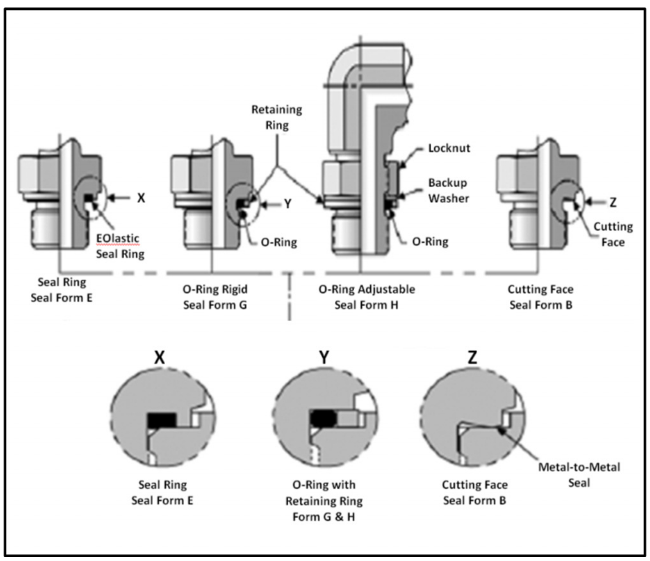


Figure 5-8. MFF-BSPP Thread

Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

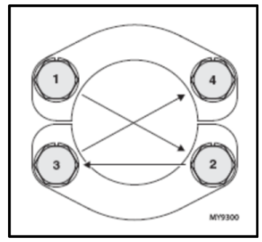


Figure 5-9. FL61/FL62

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 Nm). 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.

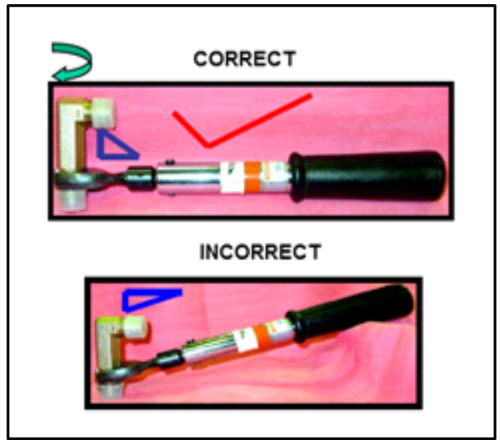


Figure 5-10. Torque Wrench Angle

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 Low Strength Threadlocking Compound, 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.

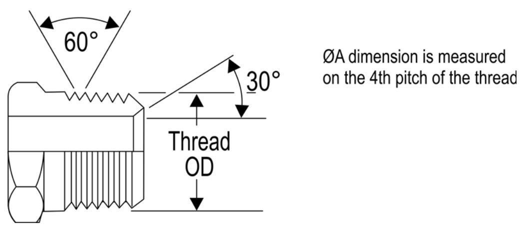
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

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



TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
Material	Dash Size	Thread Size (UNF)	ØA* (in)	ØA* (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 Low Strength Threadlocking Compound, 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.

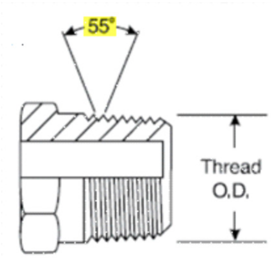
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

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.

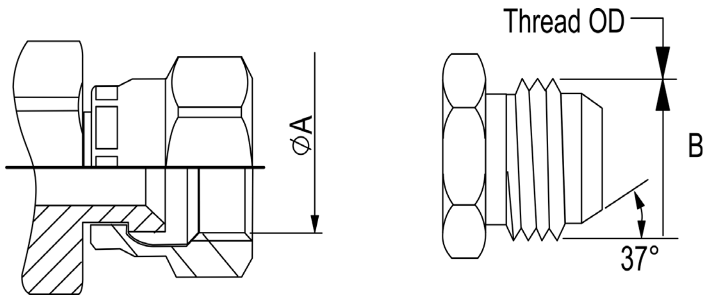
3. Torque assembly to value listed in Table 5-3, 37° Flare (JIC) Thread - Steel or Table 5-4, 37° Flare (JIC) Thread - Aluminum/Brass while using the Double Wrench Method per Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

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

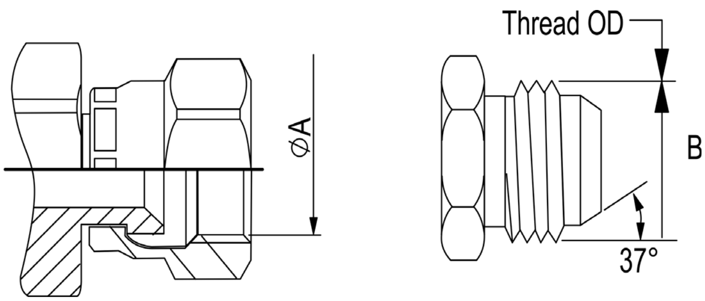


Type/Fitting Identification							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	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	11/16-12	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	15/8-12	1.54	39.20	1.63	41.30	109	115	120	148	155	163	3/4 to 1
	24	17/8-12	1.80	45.60	1.87	47.60	127	133	139	172	180	189	3/4 to 1
	32	21/2-12	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.

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.

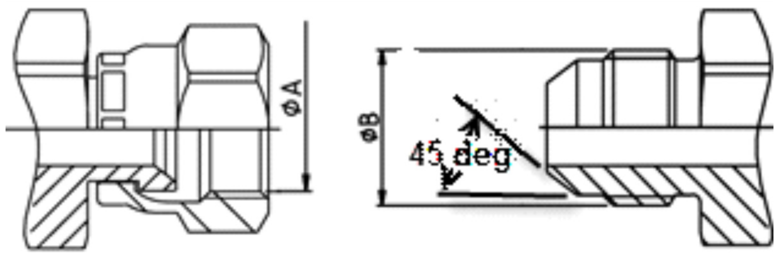
NOTE: *Torque values provided in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass are segregated based on the material configuration of the connection.*

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

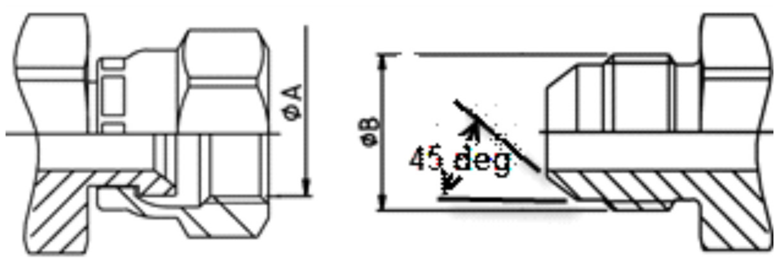
mating components.

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	1 1/16-14	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 Methods for 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	1 1/16-14	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.

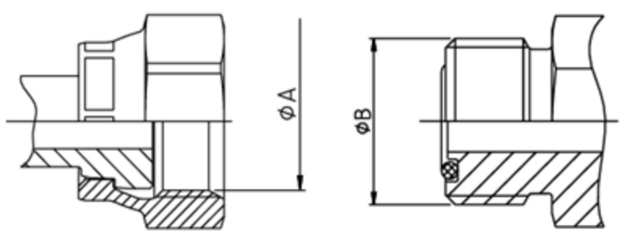
NOTE: *Torque values provided in Table 5-7, O-ring Face Seal (ORFS) - Steel and Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass are segregated based on the material configuration of the connection.*

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

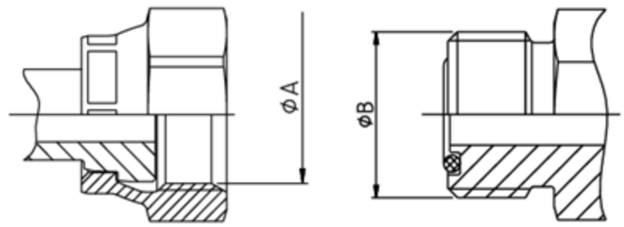


TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**	
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			Tube Nuts	Swivel & Hose Ends
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max		
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	9/16-18	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	111/16-12	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	21/2-12	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 Methods for 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	111/16-12	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	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	244	257	269	331	348	365	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.

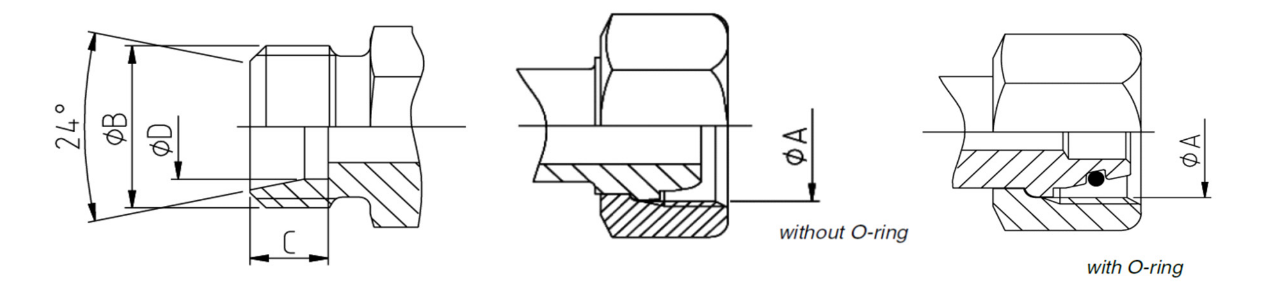
Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

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 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]			Torque [N-m]			Flats from Wrench Resistance
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	Min	Nom	Max	Min	Nom	Max	(F.F.W.R)**
STEEL FITTINGS WITH STEEL MATING COMPONENTS	DIN 24° CONE FLARELESS BITE (MBTL) FITTING	6	M12 x 1.5	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	M14 x 1.5	12.50	14.00	7.00	8.20							1.5 to 1.75
		10	M16 x 1.5	14.50	16.00	7.00	10.20							1.5 to 1.75
		12	M18 x 1.5	16.50	18.00	7.00	12.20							1.5 to 1.75
		15	M22 x 1.5	20.50	22.00	7.00	15.20							1.5 to 1.75
		18	M26 x 1.5	24.50	26.00	7.50	18.20							1.5 to 1.75
		22	M30 x 2	27.90	30.00	7.50	22.20							1.5 to 1.75
		28	M36 x 2	33.90	36.00	7.50	28.20							1.5 to 1.75
		35	M45 x 2	42.90	45.00	10.50	35.30							1.5 to 1.75
		42	M52 x 2	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]			Torque [N-m]			Flats from Wrench Resistance
		(mm)	(Metric)	(mm)	(mm)	(mm)	(mm)	Min	Nom	Max	Min	Nom	Max	(F.F.W.R)**
	DIN 24° CONE FLARELESS BITE (MBTS) FITTING	6	M14 x 1.5	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	M16 x 1.5	14.50	16.00	7.00	8.20							1.5 to 1.75
		10	M18 x 1.5	16.50	18.00	7.50	10.20							1.5 to 1.75
		12	M20 x 1.5	18.50	20.00	7.50	12.20							1.5 to 1.75
		14	M22 x 1.5	20.50	22.00	8.00	14.20							1.5 to 1.75
		16	M24 x 1.5	22.50	24.00	8.50	16.20							1.5 to 1.75
		20	M30 x 2	27.90	30.00	10.50	20.20							1.5 to 1.75
		25	M36 x 2	33.90	36.00	12.00	25.20							1.5 to 1.75
		30	M42 x 2	39.90	42.00	13.50	30.20							1.5 to 1.75
		38	M52 x 2	49.90	52.00	16.00	38.30							1.5 to 1.75

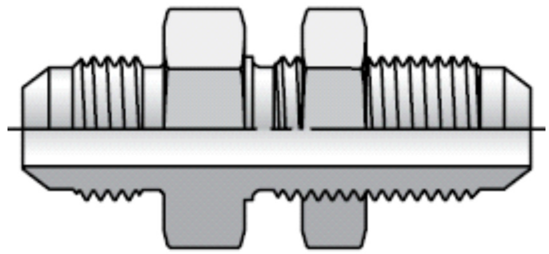
* ØA, ØB, C, & ØD thread dimensions for reference only.

** See Appendix B for FFWR procedure requirements.

Assembly Instructions for Bulkhead (BH) Fittings

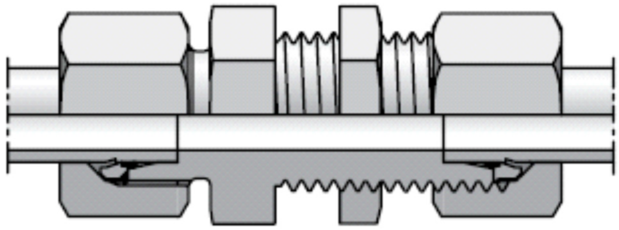
1. Ensure threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary replace fitting or adapter.
2. Remove the locknut from the bulkhead assembly.
3. Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
4. Hand 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	1 3/16-12	135	142	149	183	193	202
		14	1 5/16-12	170	179	187	230	243	254
		16	1 7/16-12	200	210	220	271	285	298
		20	1 11/16-12	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	1 1/16-12	135	142	149	183	193	202
		14	1 3/16-12	170	179	187	230	243	254
		16	1 5/16-12	200	210	220	271	285	298
		20	1 5/8-12	245	258	270	332	350	366
		24	1 7/8-12	270	284	297	366	385	403
		32	2 1/2-12	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	M12 x 1.5	14	15	16	19	20	22
		8	M14 x 1.5	17	18	19	23	24	26
		10	M16 x 1.5	22	23	24	30	31	33
		12	M18 x 1.5	35	37	39	47	50	53
		15	M22 x 1.5	44	47	50	60	64	68
		18	M26 x 1.5	70	75	80	95	102	108
		22	M30 x 2	115	120	125	156	163	169
		28	M36 x 2	150	157	164	203	213	222
		35	M45 x 2	155	162	169	210	220	229
		42	M52 x 2	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	M14 x 1.5	17	15	16	23	20	22
		8	M16 x 1.5	22	18	19	30	24	26
		10	M18 x 1.5	35	23	24	47	31	33
		12	M20 x 1.5	40	35	37	54	47	50
		14	M22 x 1.5	44	47	50	60	64	68
		16	M24 x 1.5	70	75	80	95	102	108
		20	M30 x 2	115	120	125	156	163	169
		25	M36 x 2	150	157	164	203	213	222
		30	M42 x 2	155	162	169	210	220	229
		38	M52 x 2	220	230	240	298	312	325

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

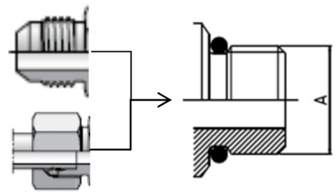
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

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 through 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 through 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 counterbore of the port.

Table 5-12. O-ring Boss (ORB) - Table 1 of 6



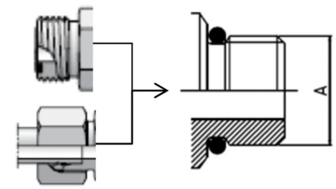
TYPE/FITTING IDENTIFICATION					HEX TYPE PLUGS & STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(85)	(90)	(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	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					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	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.

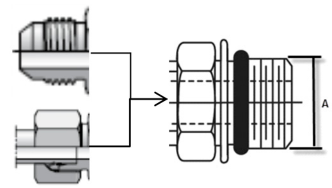
**Removal Torque for Zero Leak Gold® Hollow Hex Plugs is significantly higher than install torque, typically 1.5-3.5X install torque.

Table 5-13. 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	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 5-14. O-ring Boss (ORB) - Table 3 of 6

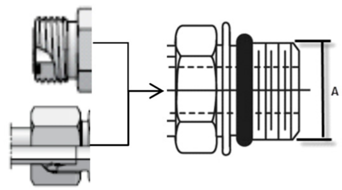


TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	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	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 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	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 5-15. 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	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.

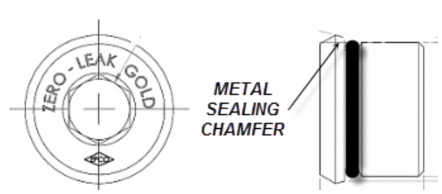
Table 5-16. O-ring Boss (ORB) - Table 5 of 6

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	1 3/16-12	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	1 3/16-12	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.										

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

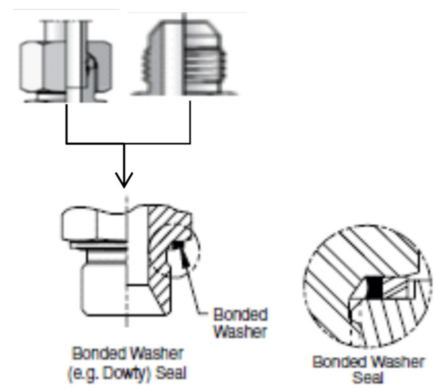
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

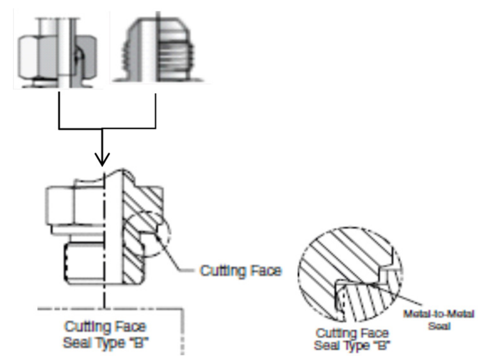
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-18, Table 5-19, Table 5-20, 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 counterbore of the port.

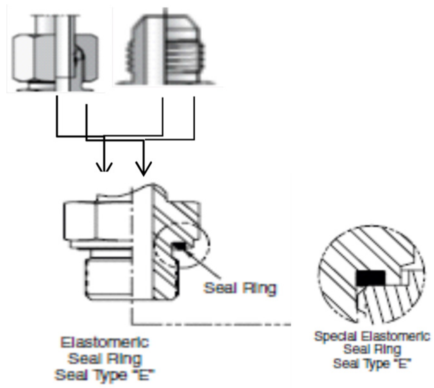
Table 5-18. Metric Flat Face Port (MFF) - L Series - Table 1 of 3

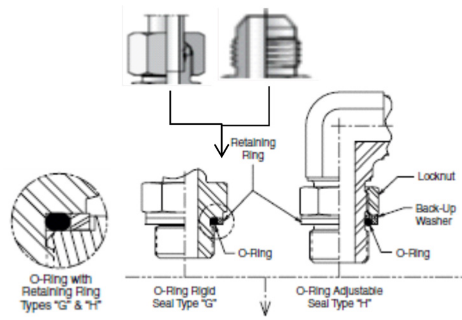




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[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

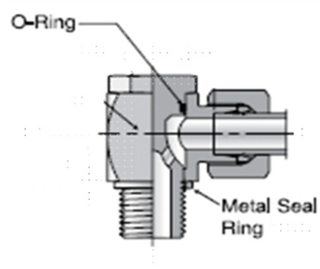
Table 5-19. Metric Flat Face Port (MFF) - L Series - Table 2 of 3

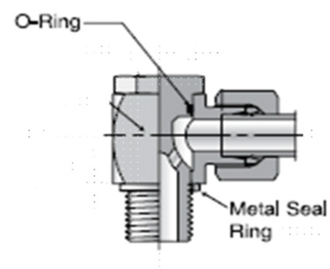


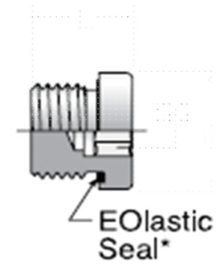


TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END						FORM G/H (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS WITH 37° (JIC) OR L SERIES DIN (MBTL) OPPOSITE END					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						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

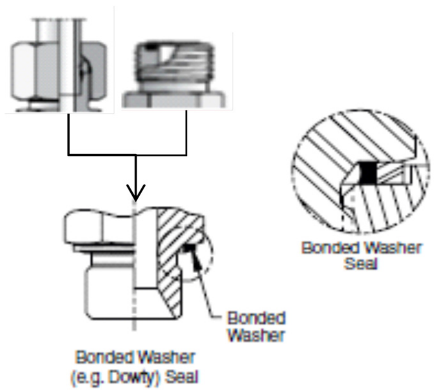


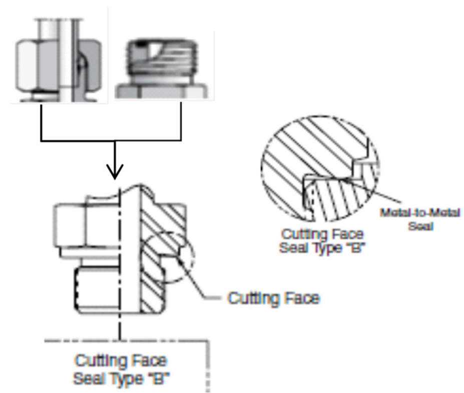




TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end						HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[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

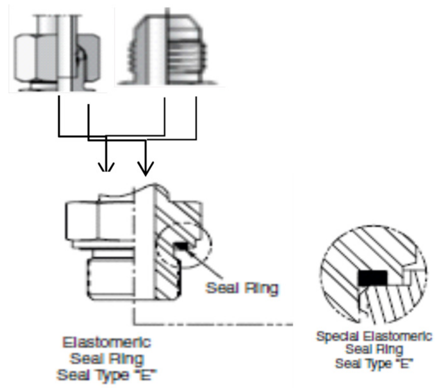
Table 5-21. Metric Flat Face Port (MFF) - S Series - Table 1 of 3

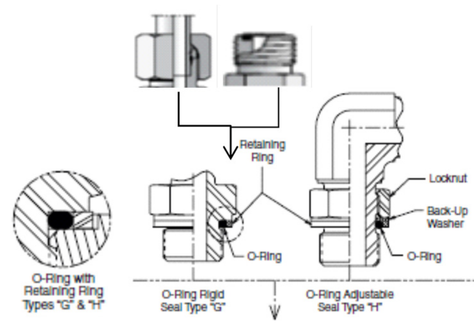




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[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

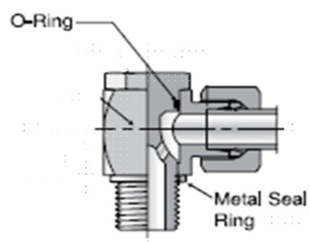
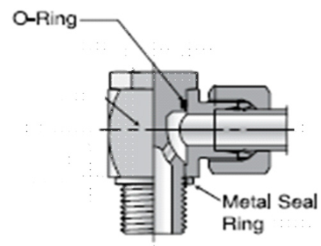
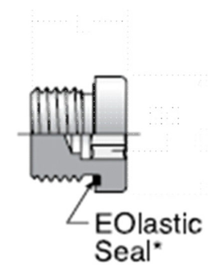
Table 5-22. Metric Flat Face Port (MFF) - S Series - Table 2 of 3





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) - S 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	--	--	--	--	--	--

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 pre-installed, install proper size, taking care not to damage it. See O-ring Installation (Replacement) for instructions.

CAUTION

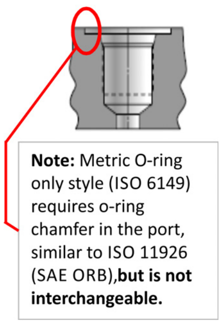
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

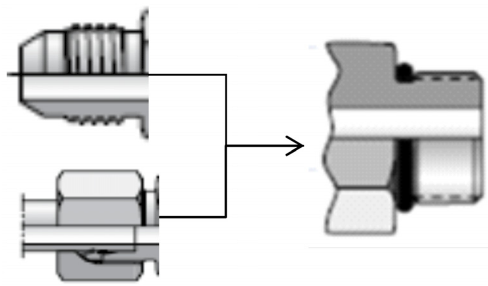
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-24 while using the Double 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:

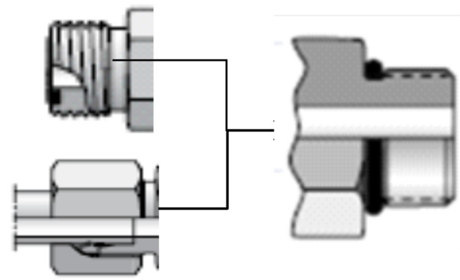
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)

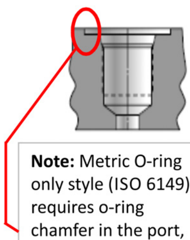




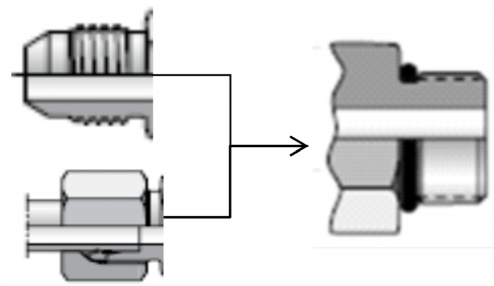


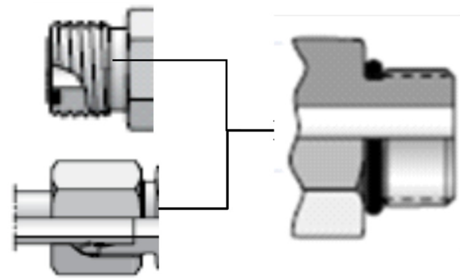
TYPE/FITTING IDENTIFICATION			STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	M8 x 1	4	6	7	7	8	9	9	8	9	9	10	12	12
	M10 x 1	6	11	12	12	15	16	16	15	16	17	20	22	23
	M12 x 1.5	8	18	19	20	25	26	27	26	28	29	35	38	39
	M14 x 1.5	10	26	28	29	35	38	39	33	35	36	45	47	49
	M16 x 1.5	12	30	32	33	40	43	45	41	43	45	55	58	61
	M18 x 1.5	15	33	35	36	45	47	49	52	55	57	70	75	77
	M20 x 1.5	--	--	--	--	--	--	--	59	62	65	80	84	88
	M22 x 1.5	18	44	46	48	60	62	65	74	78	81	100	106	110
	M27 x 2	22	74	78	81	100	106	110	125	132	138	170	179	187
	M30 x 2	--	95	100	105	130	136	142	175	184	193	237	249	262
	M33 x 2	25	120	126	132	160	171	179	230	242	253	310	328	343
	M38 x 2	--	135	142	149	183	193	202	235	247	259	319	335	351
	M42 x 2	30	155	163	171	210	221	232	245	258	270	330	350	366
	M48 x 2	38	190	200	209	260	271	283	310	326	341	420	442	462
	M60 x 2	50	230	242	253	315	328	343	370	389	407	500	527	552

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
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	M8 x 1	4	4	5	5	5	7	7	5	6	6	7	8	8
	M10 x 1	6	7	8	8	9	11	11	10	11	11	14	15	15
	M12 x 1.5	8	12	13	13	16	18	18	17	18	19	23	24	26
	M14 x 1.5	10	17	18	19	23	24	26	21	22	23	28	30	31
	M16 x 1.5	12	20	21	21	27	28	28	27	28	29	37	38	39
	M18 x 1.5	15	21	22	23	28	30	31	34	36	37	46	49	50
	M20 x 1.5	--	--	--	--	--	--	--	30	40	42	41	54	57
	M22 x 1.5	18	29	30	31	39	41	42	48	51	53	65	69	72
	M27 x 2	22	48	51	53	65	69	72	81	86	90	110	117	122
	M30 x 2	--	62	65	68	84	88	92	114	120	125	155	163	169
	M33 x 2	25	78	82	86	106	111	117	150	157	164	203	213	222
	M38 x 2	--	88	93	97	119	126	132	153	161	168	207	218	228
	M42 x 2	30	101	106	111	137	144	150	159	168	176	216	228	239
	M48 x 2	38	124	130	136	168	176	184	202	212	222	274	287	301
	M60 x 2	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 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 5-25, 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 counterbore of the port.

Table 5-25. British Standard Parallel Pipe Port (BSPP) - L Series - Table 1 of 3

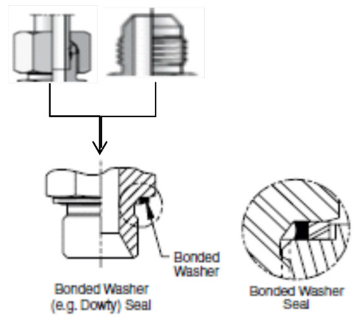
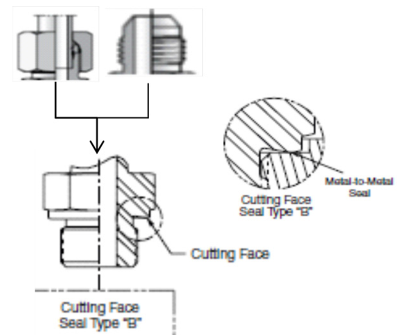
														
TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B** (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[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

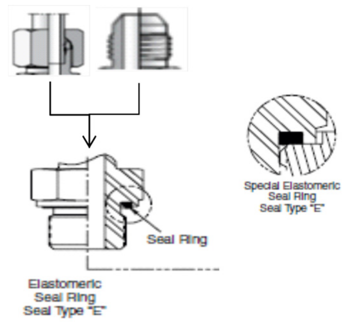
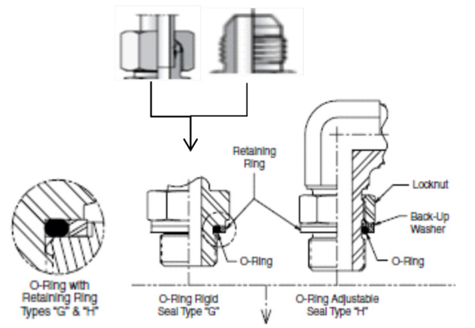
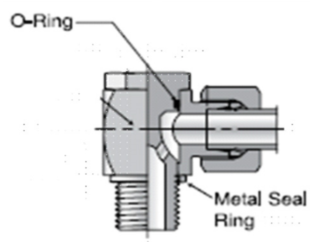
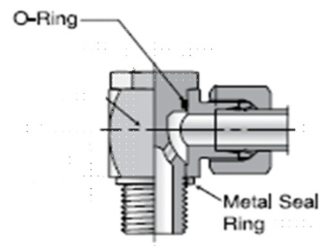
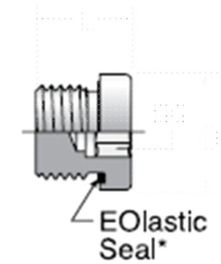
														
TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	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	G 1/8A	6	13	14	14	18	19	19	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	52	55	57	70	75	77	52	55	57	70	75	77
	G 1/2A	15	66	70	73	90	95	99	66	70	73	90	95	99
	G 1/2A	18	66	70	73	90	95	99	66	70	73	90	95	99
	G 3/4A	22	133	140	146	180	190	198	133	140	146	180	190	198
	G 1A	28	229	241	252	310	327	342	229	241	252	310	327	342
	G 1-1/4A	35	332	349	365	450	473	495	332	349	365	450	473	495
	G 1-1/2A	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	G 1/8A	6	8	9	9	11	12	12	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	34	36	37	46	49	50	34	36	37	46	49	50
	G 1/2A	15	43	45	47	58	61	64	43	45	47	58	61	64
	G 1/2A	18	43	45	47	58	61	64	43	45	47	58	61	64
	G 3/4A	22	86	91	95	117	123	129	86	91	95	117	123	129
	G 1A	28	149	157	164	202	213	222	149	157	164	202	213	222
	G 1-1/4A	35	216	227	237	293	308	321	216	227	237	293	308	321
	G 1-1/2A	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	G 1/8A	6	13	14	14	18	19	19	13	14	14	18	19	19	10	11	11	13	15	15
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G 1/4A	10	30	32	33	40	43	45	33	35	36	45	47	49	22	23	24	30	31	33
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77	44	46	48	60	62	65
	G 1/2A	15	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G 1/2A	18	66	70	73	90	95	99	89	94	98	120	127	133	59	62	65	80	84	88
	G 3/4A	22	92	97	101	125	132	137	170	179	187	230	243	254	103	108	113	140	146	153
	G 1A	28	--	--	--	--	--	--	236	248	260	320	336	353	148	156	163	200	212	221
	G 1-1/4A	35	--	--	--	--	--	--	398	418	438	540	567	594	295	313.5	332	400	425	450
	G 1-1/2A	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	G 1/8A	6	8	9	9	11	12	12	8	9	9	11	12	12	6	7	7	8	9	9
	G 1/4A	8	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G 1/4A	10	20	21	21	27	28	28	21	22	23	28	30	31	14	15	16	19	20	22
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50	29	30	31	39	41	42
	G 1/2A	15	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G 1/2A	18	43	45	47	58	61	64	58	61	64	79	83	87	38	40	42	52	54	57
	G 3/4A	22	60	63	66	81	85	89	111	117	122	150	159	165	67	70	73	91	95	99
	G 1A	28	--	--	--	--	--	--	153	161	169	207	218	229	96	101	106	130	137	144
	G 1-1/4A	35	--	--	--	--	--	--	259	272	285	351	369	386	216	227	237	293	308	321
	G 1-1/2A	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

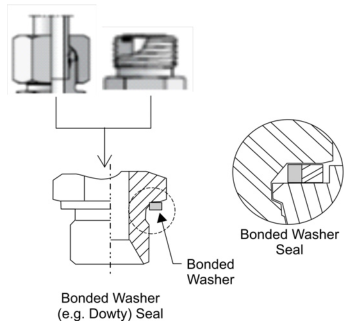
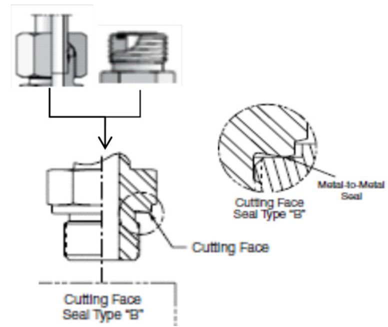
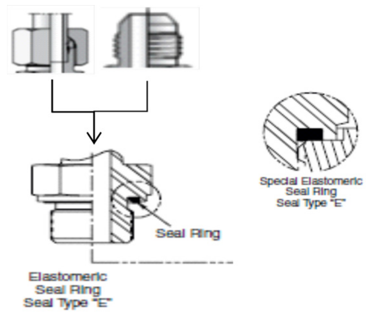
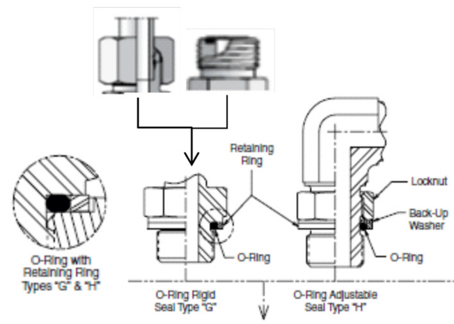
														
TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[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														

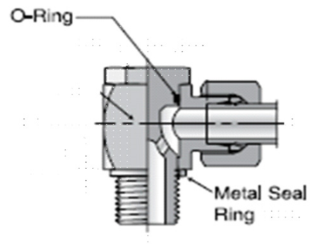
Table 5-29. British Standard Parallel Pipe Port (BSPP) - S Series - Table 2 of 3

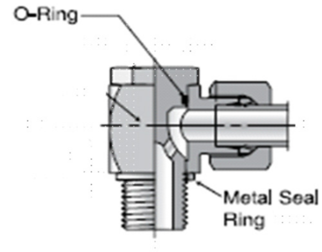


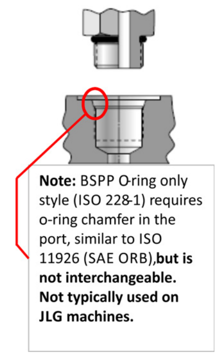


TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting 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







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

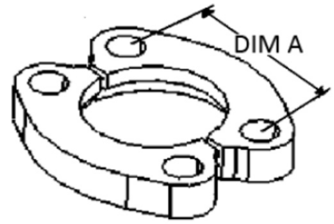
** Non typical for JLG Straight Male Stud Fittings, reference only.

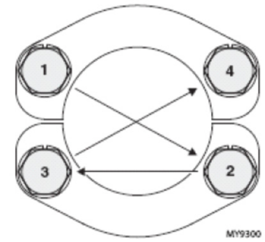
*** Typical for JLG Adjustable Fittings

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. Install O-ring as per "O-ring Installation (Replacement)" .
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 5-31and Table 5-32.

Table 5-31. Flange Code (FL61 & FL62) - Inch Fasteners

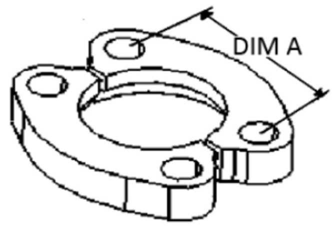


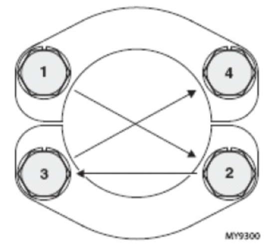


TYPE/FITTING IDENTIFICATION							STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)												
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws						
							[Ft-Lb]			[N-m]			[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 ISO 6162 (METRIC 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	M8 x 1.25	18	19	19	24	25	26	18	19	19	24	25	26
	16	1.00	25	2.06	52.32	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	20	1.25	32	2.31	58.67	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	24	1.50	38	2.75	69.85	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	32	2.00	51	3.06	77.72	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	40	2.50	64	3.50	88.90	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	48	3.00	76	4.19	106.43	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	56	3.50	89	4.75	120.65	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231
	64	4.00	102	5.13	130.30	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231
	80	5.00	127	6.00	152.40	M16 x 2	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	M8 x 1.25	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	M10 x 1.5	--	--	--	--	--	--	52	54	57	70	74	77
	16	1.00	25	2.25	57.15	M12 x 1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M12 x 1.75	--	--	--	--	--	--	96	101	105	130	137	143
	20	1.25	32	2.62	66.55	M14 x 2	--	--	--	--	--	--	133	139	146	180	189	198
	24	1.50	38	3.12	79.25	M16 x 2	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	M20 x 2.5	--	--	--	--	--	--	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 5-11. for double wrench method requirements.

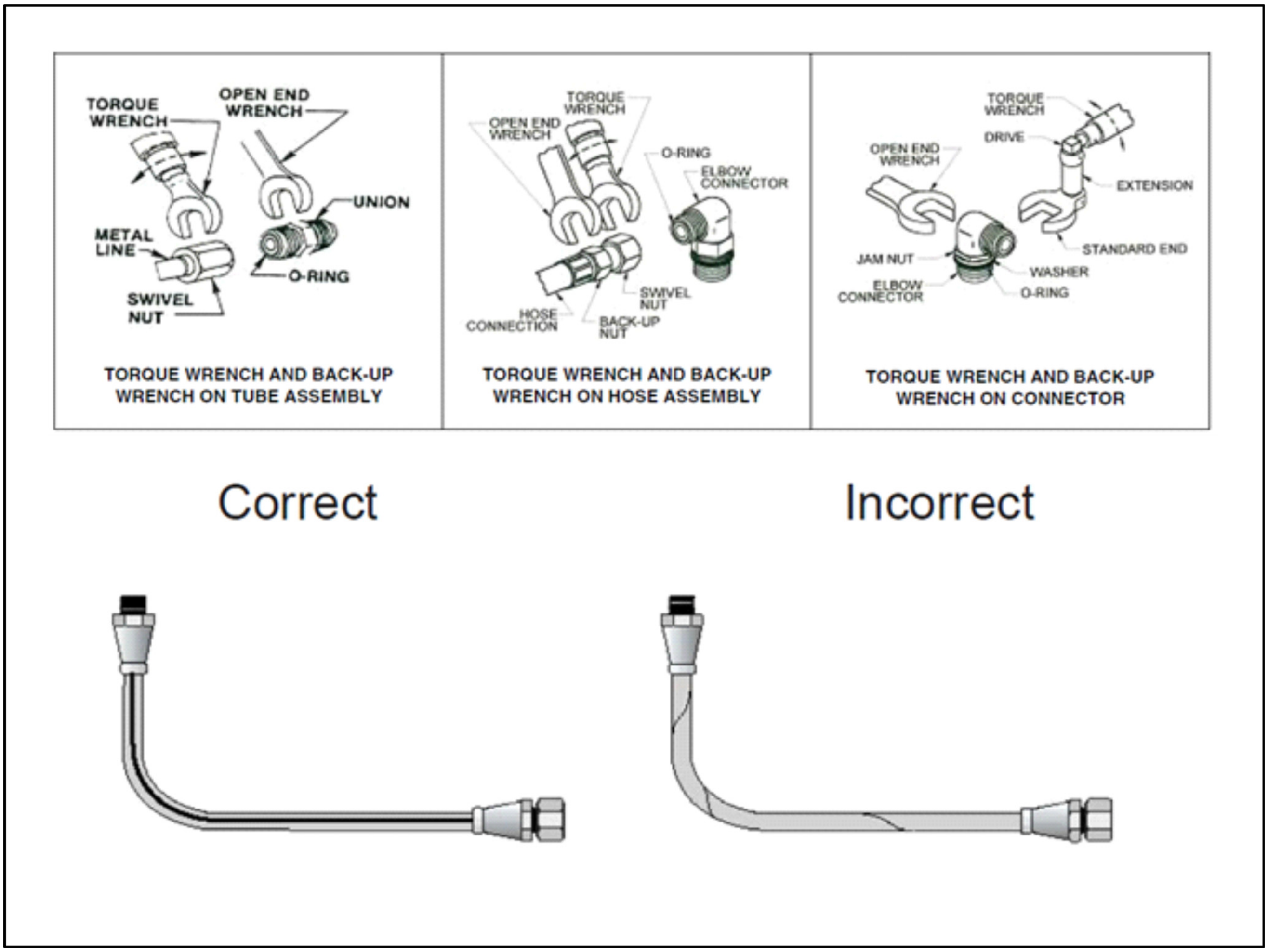


Figure 5-11. Double Wrench Method

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 5-11. 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 5-12.

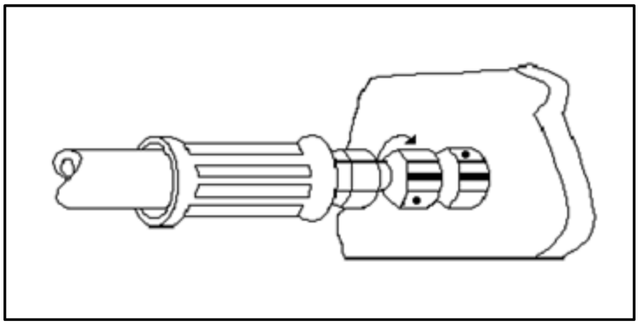


Figure 5-12. FFWR Method

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.

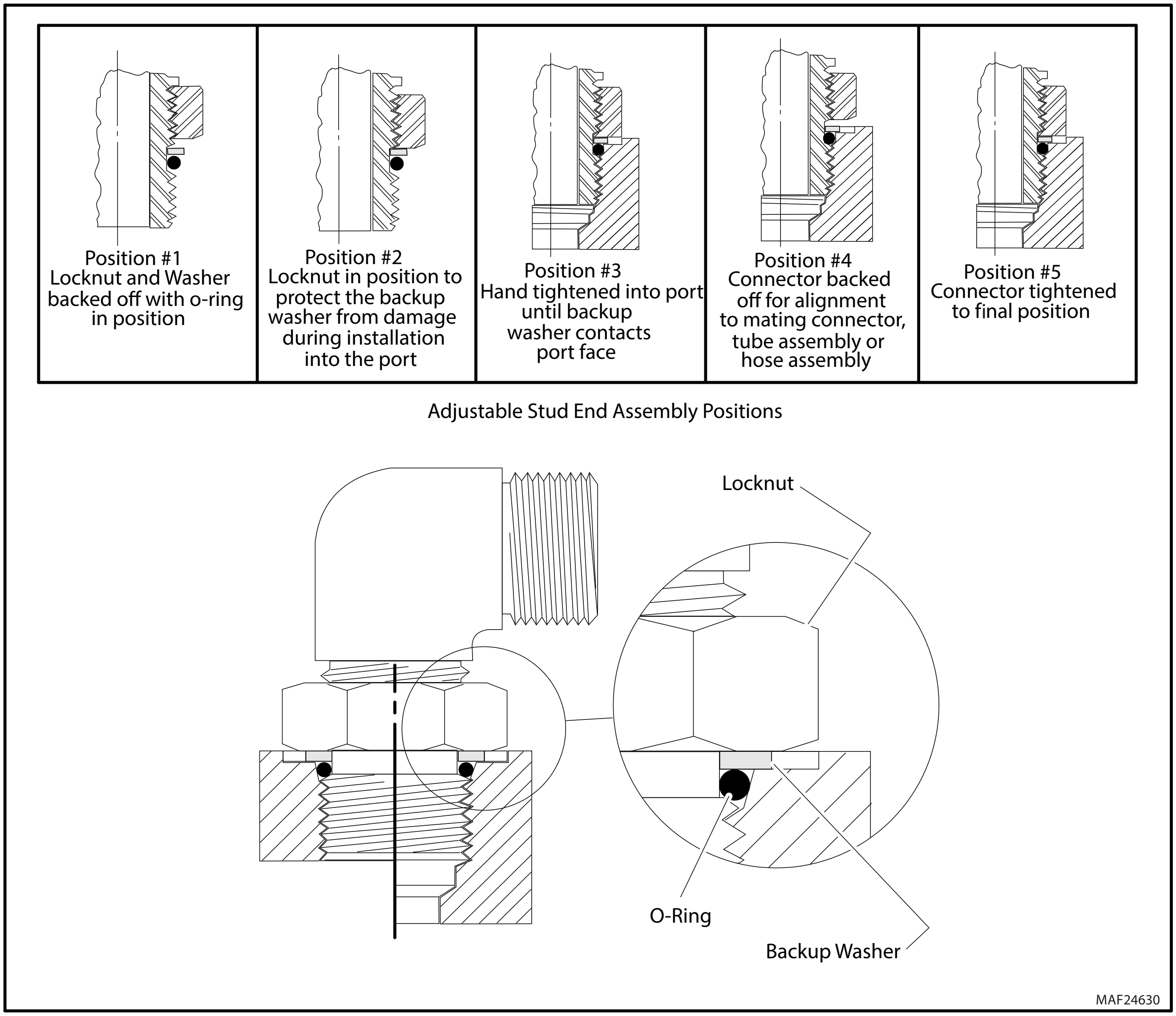


Figure 5-13. Adjustable Stud End Assembly

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

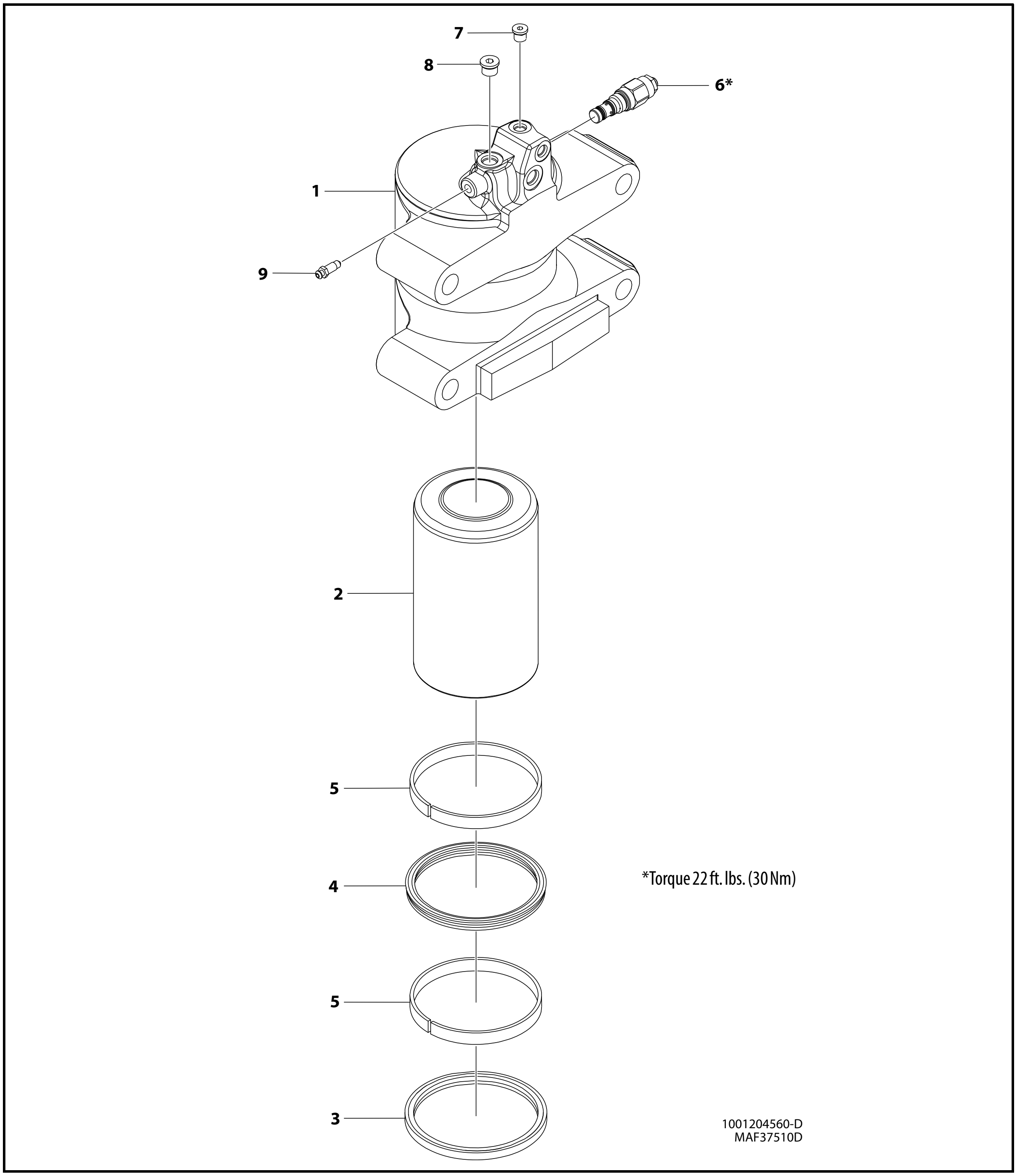
WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

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 Seal
4. Rod Seal
5. Wear Ring
6. Counterbalance Valve
7. Plug
8. Plug
9. Bleeder Valve

Figure 5-14. Axle Lockout Cylinder

Jib Lift Cylinder (860SJ)

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 valves and plugs from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

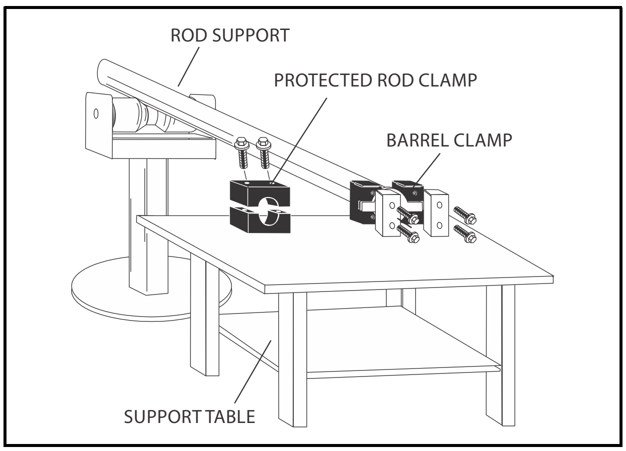


Figure 5-15. Cylinder Barrel Support

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

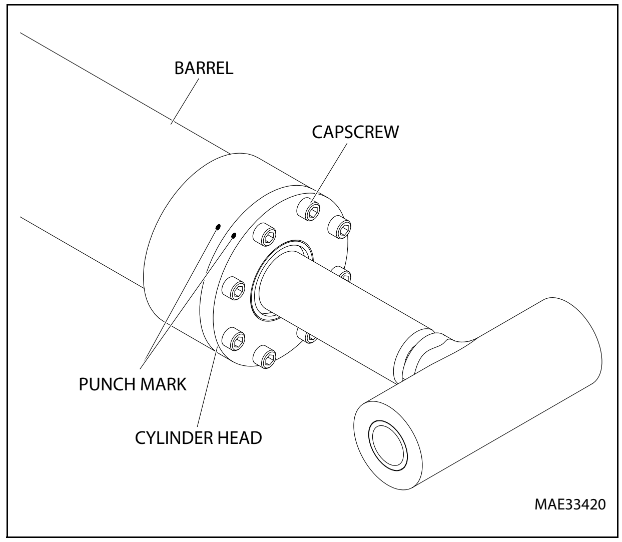


Figure 5-16. Capscrew Removal

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.

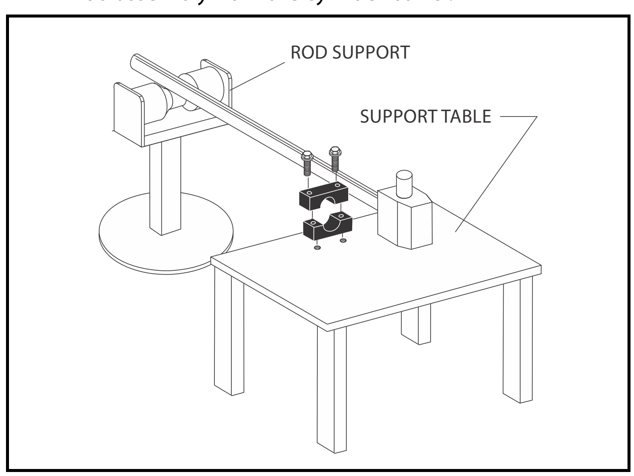
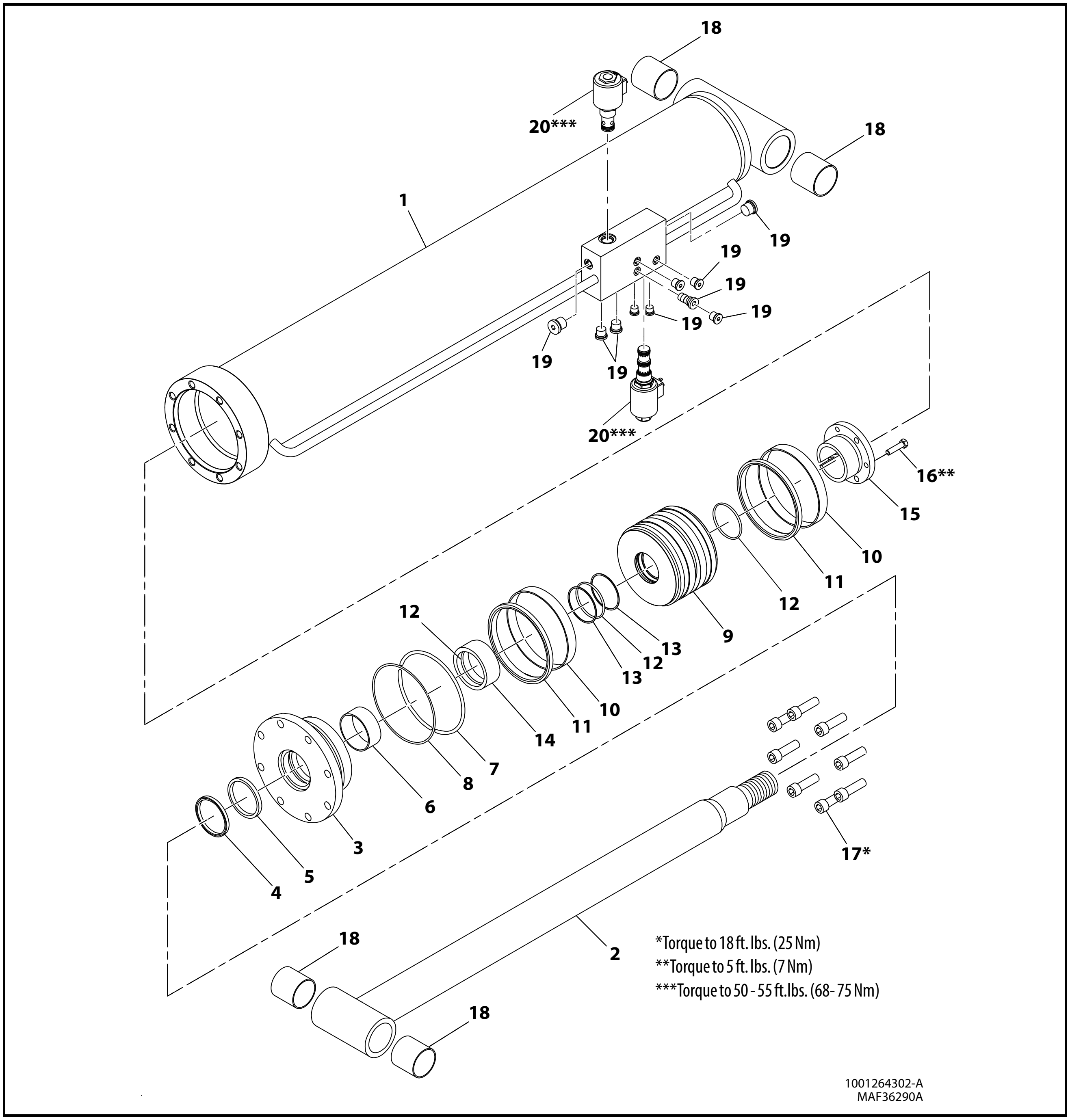


Figure 5-17. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Dust Wiper
5. Rod Seal
6. Wear Ring
7. O-ring
8. Backup Ring
9. Piston
10. Hydrolock Seal
11. Guidelock Ring
12. O-ring
13. Backup Ring
14. Spacer
15. Tapered Bushing
16. Capscrew
17. Capscrew
18. Bushing
19. Plug
20. Counterbalance Valve

Figure 5-18. Jib Lift Cylinder (860SJ)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrew from drilled holes.
10. Insert the capscrew in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrew until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

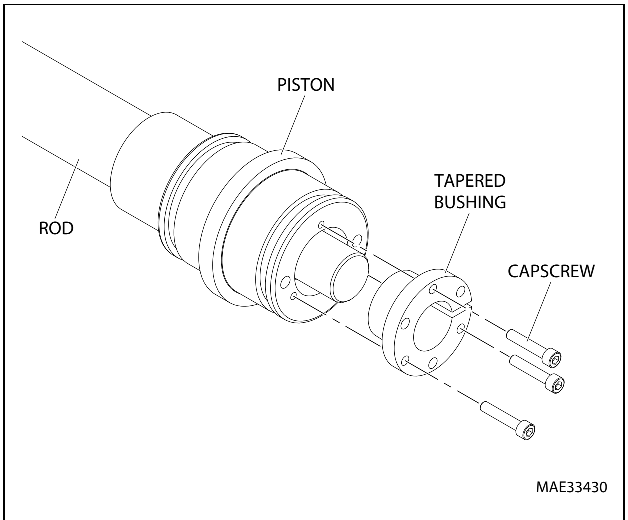


Figure 5-19. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston o-rings, seal rings and backup rings.
14. Remove piston spacer from the rod.
15. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, wear rings 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, tapering, ovality or other damage. Replace if 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, tapering, ovality or other damage. Replace if necessary.
11. Inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

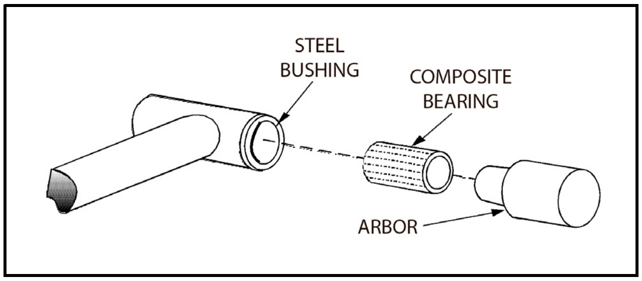


Figure 5-20. Composite Bearing Installation

12. If applicable, inspect port block fittings and holding valve. Replace if necessary.

13. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair if necessary.

14. If applicable, inspect piston rings for cracks or other damage. Replace if 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.

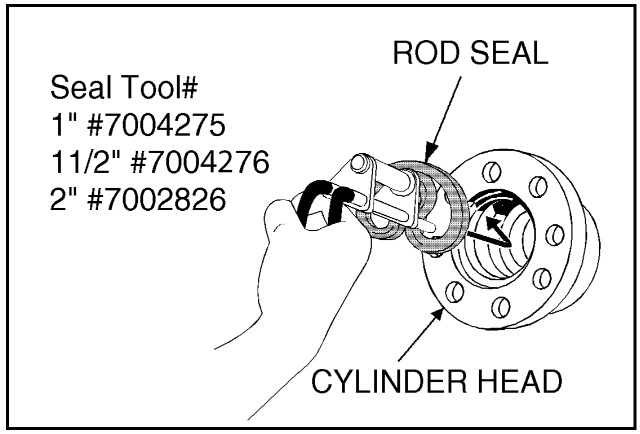


Figure 5-21. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

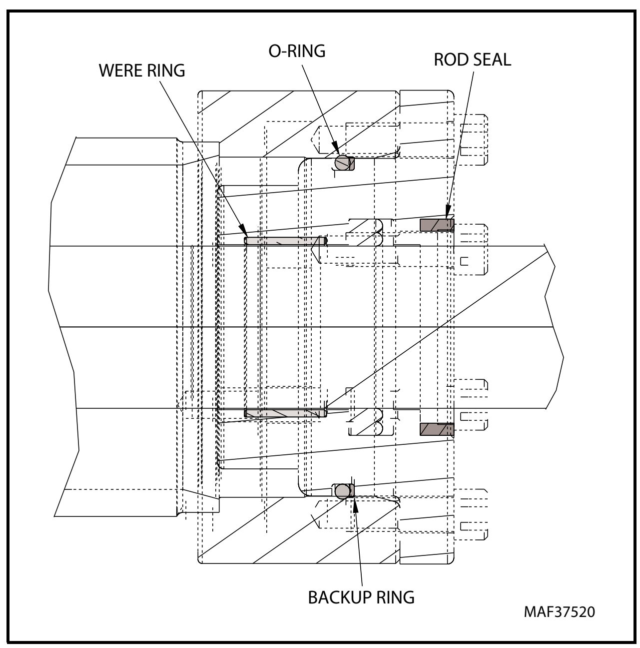
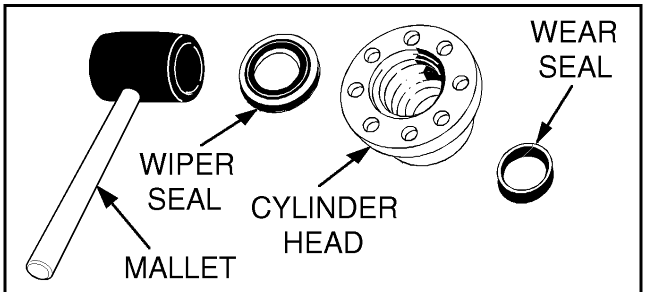


Figure 5-22. Cylinder Head Seal Installation

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.



Note: When installing wiper seal ensure seal is installed properly. Install seal so that the flat part of seal is facing into head.

Figure 5-23. Wiper Seal Installation

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

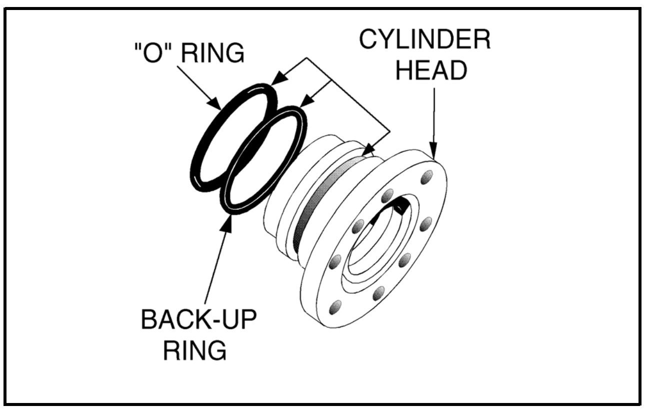


Figure 5-24. Installation of Head Seal Kit

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. 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 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 capscrew through the drilled holes in the bushing and into the tapped holes in the piston.

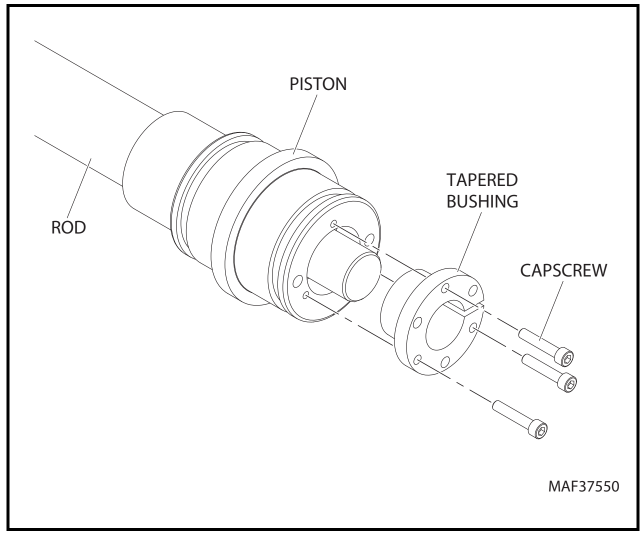


Figure 5-25. Tapered Bushing Installation

11. Tighten the capscrew evenly and progressively in rotation to 5 ft. lbs. (7 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 capscrew.

    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrew.

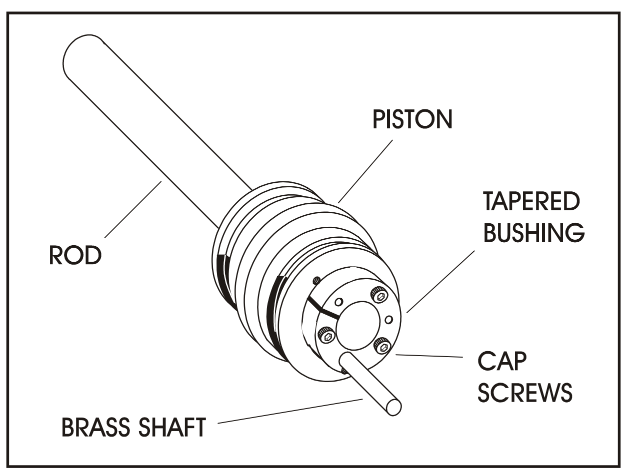


Figure 5-26. Seating the Tapered Bearing

13. Rotate the capscrew evenly and progressively in rotation to 5 ft. lbs. (7 Nm).

14. Remove the cylinder rod from the holding fixture.

NOTICE

WHEN INSTALLING HYDROLOCK PISTON SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO HYDROLOCKK PISTON SEAL INSTALLATION FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

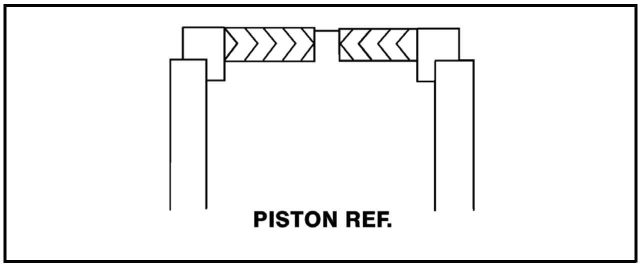


Figure 5-27. Hydrolock Piston Seal Installation

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).

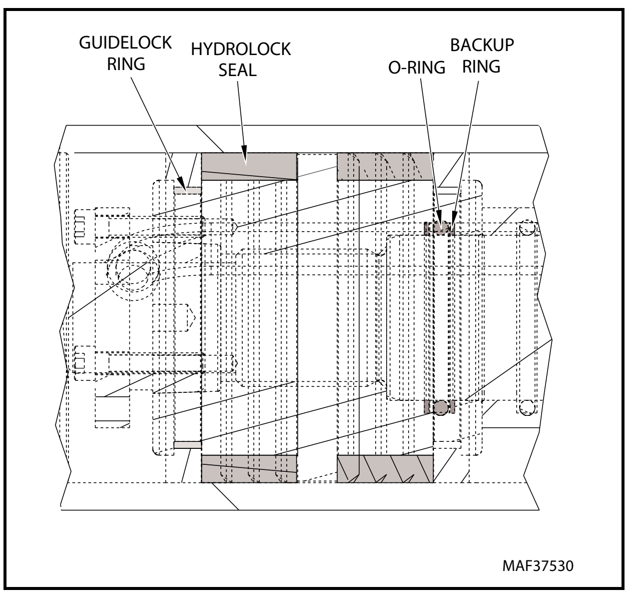


Figure 5-28. Piston Seal Kit Installation

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 secured and 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.

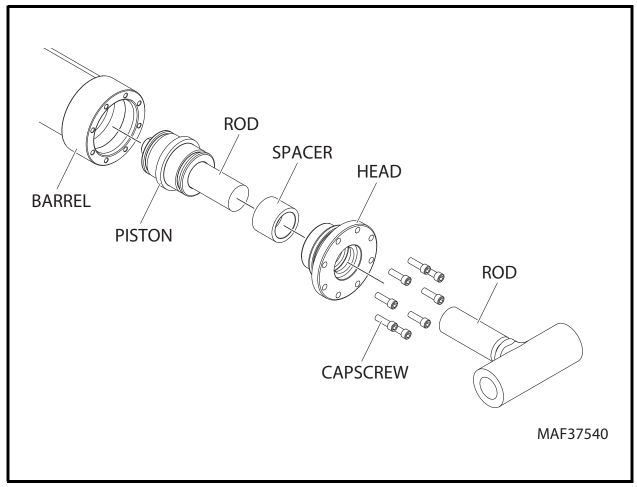


Figure 5-29. Rod Assembly Installation

19. Secure the cylinder head gland using the capscrew. Torque capscrew to 18 ft. lbs. (25 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. 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 (800S)

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 proportional valve, lift holding valve, relief valve, check valve and plugs. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

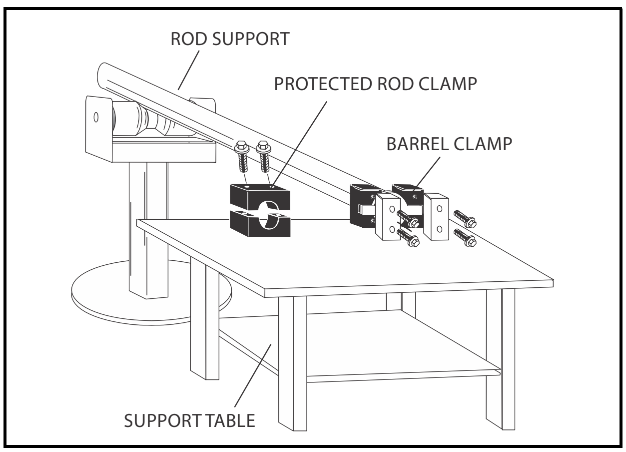


Figure 5-30. Cylinder Barrel Support

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

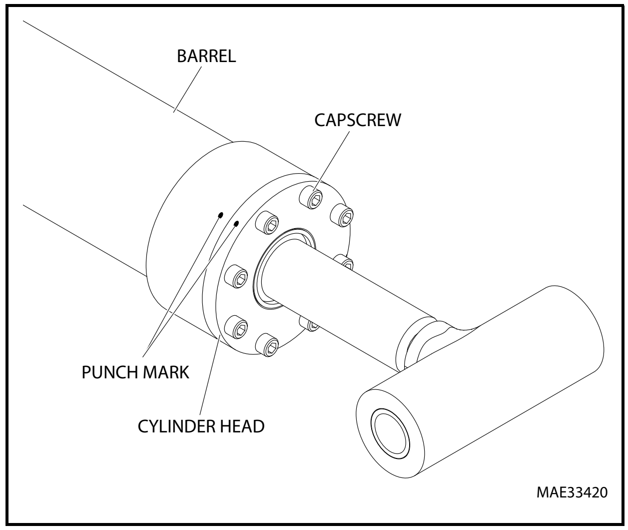


Figure 5-31. Capscrew Removal

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.

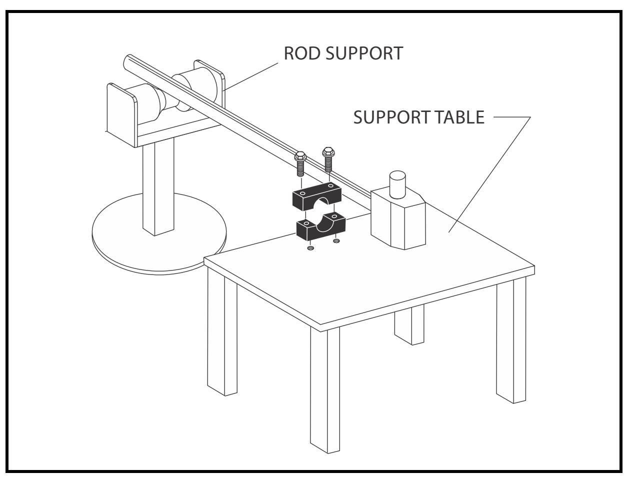
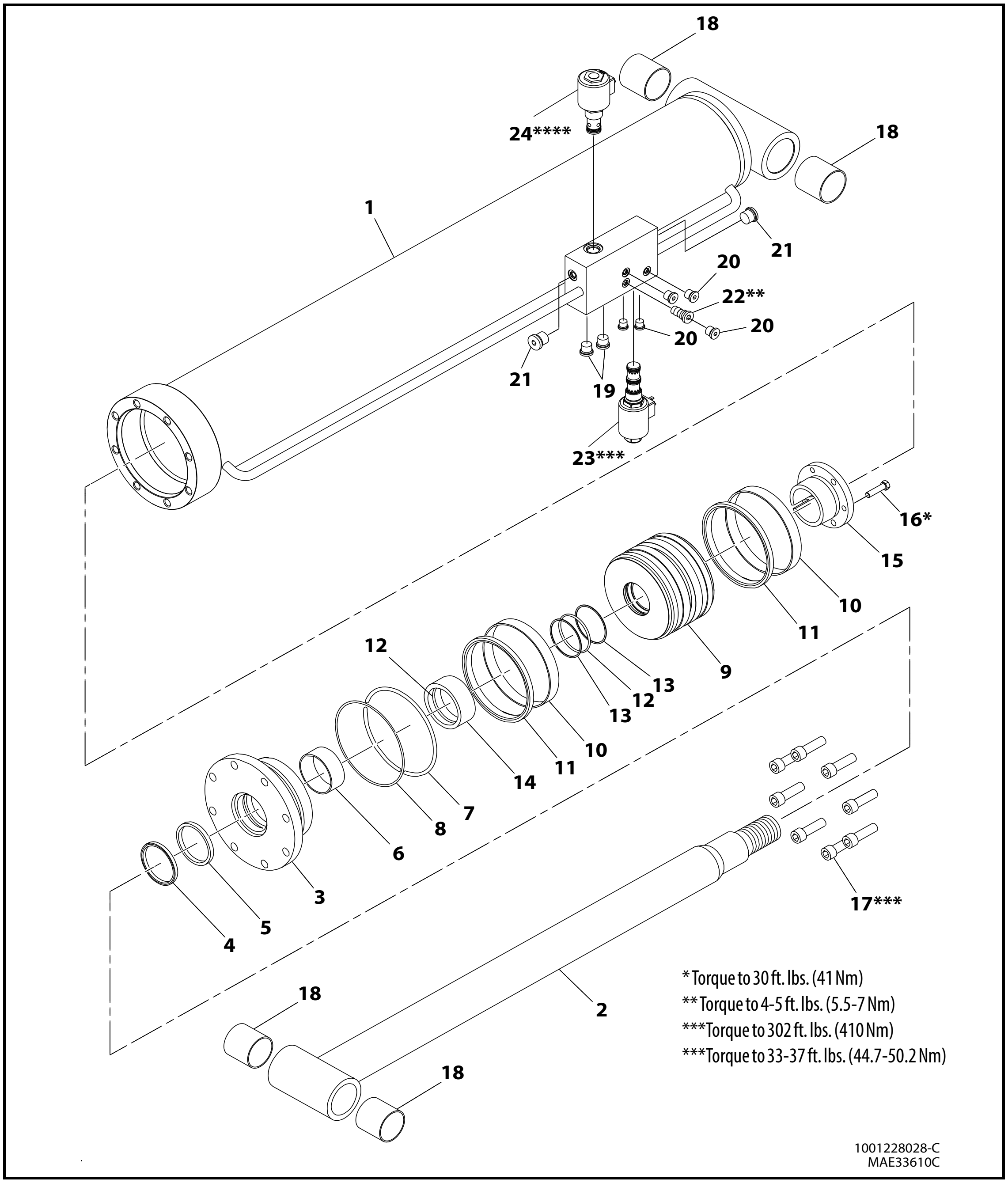


Figure 5-32. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Wiper Seal
5. Rod Seal
6. Wear Ring
7. O-ring
8. Backup Ring
9. Piston
10. Guidelock Ring
11. Guidelock Ring
12. O-ring
13. Backup Ring
14. Spacer
15. Tapered Bushing
16. Capscrew
17. Capscrew
18. Bushing
19. Plug
20. Plug
21. Plug
22. Cartridge, Relief Valve
23. Cartridge, Lift Holding Solenoid
24. Cartridge, Lift Relief Proportional Solenoid

Figure 5-33. Main Boom Lift Cylinder (800S)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrew from drilled holes.
10. Insert the capscrew in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrew until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

.

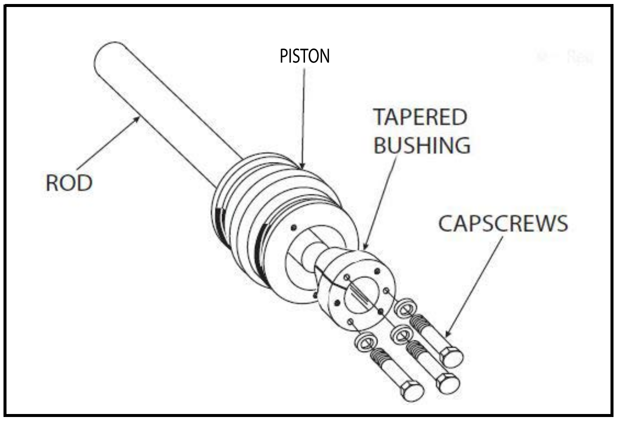


Figure 5-34. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston o-rings, seal rings, wear rings and backup rings.
14. Remove piston spacer from the rod.
15. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, wear rings 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, tapering, ovality or other damage. Replace if 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, tapering, ovality or other damage. Replace if necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

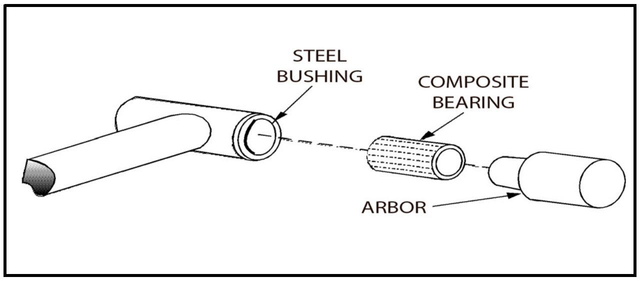


Figure 5-35. Composite Bearing Installation

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 if necessary.

14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair if necessary.

15. If applicable, inspect piston rings for cracks or other damage. Replace if 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.

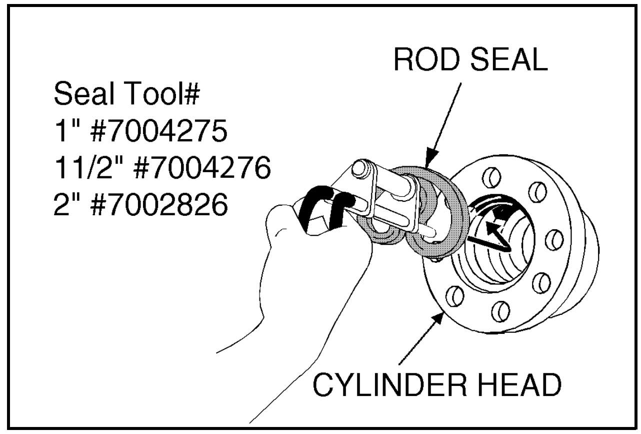


Figure 5-36. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

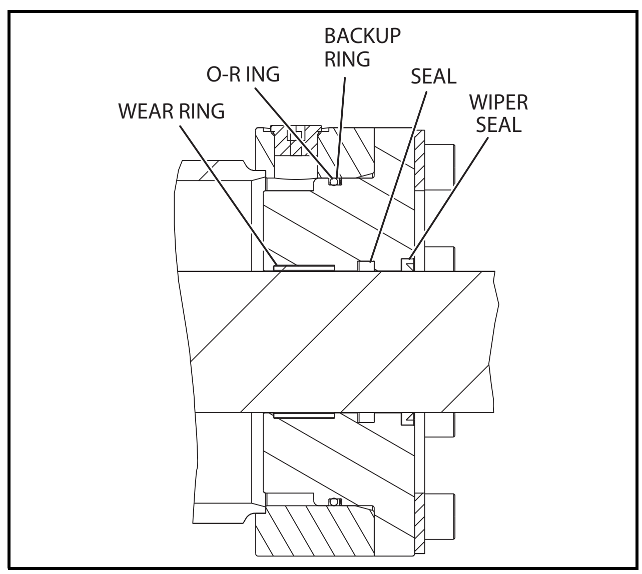
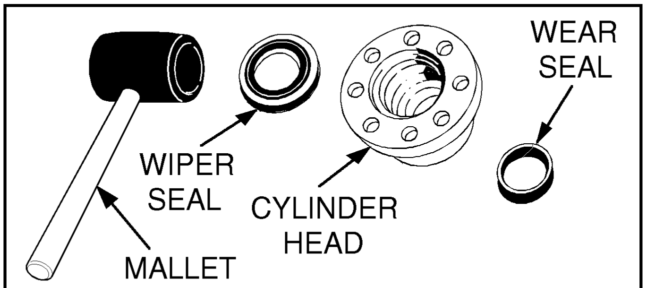


Figure 5-37. Cylinder Head Seal Installation

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.



Note: When installing wiper seal ensure seal is installed properly. Install seal so that the flat part of seal is facing into head.

Figure 5-38. Wiper Seal Installation

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

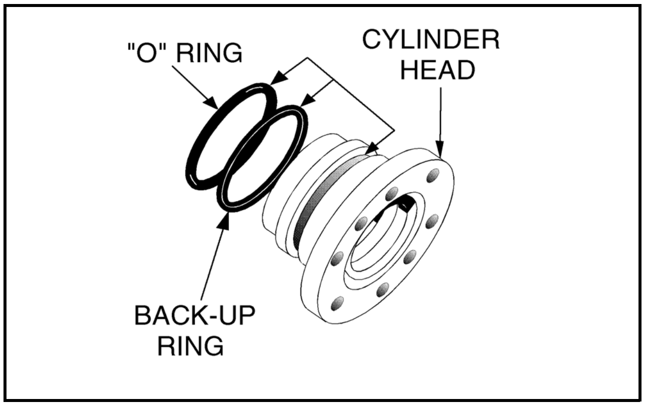


Figure 5-39. Installation of Head Seal Kit

4. 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 onto 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 hand tight 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 capscrew through the drilled holes in the bushing and into the tapped holes in the piston.

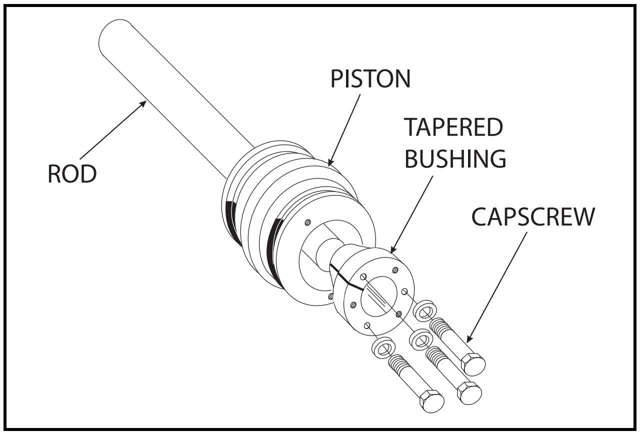


Figure 5-40. Tapered Bushing Installation

11. Tighten the capscrew evenly and progressively in rotation to 30 ft. lbs. (41 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 capscrew.

    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrew.

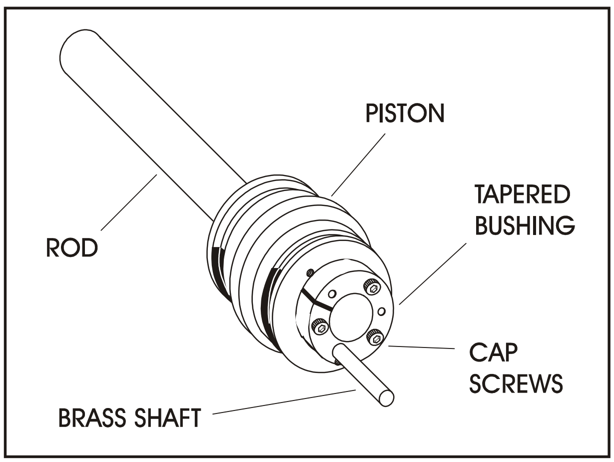


Figure 5-41. Seating the Tapered Bearing

13. Rotate the capscrew evenly and progressively in rotation to 30 ft. lbs. (41 Nm).

14. Remove the cylinder rod from the holding fixture.

15. Place new 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).

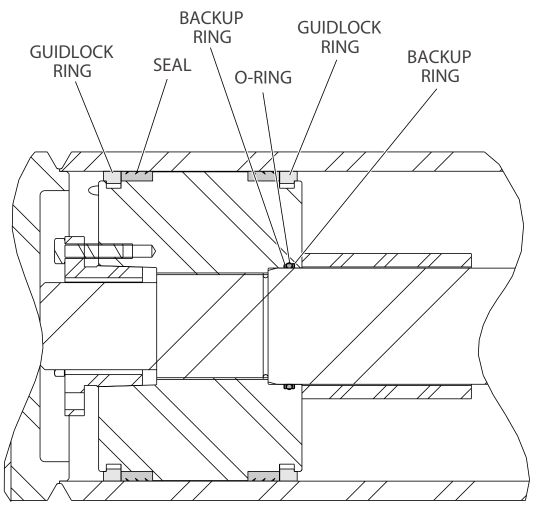


Figure 5-42. Piston Seal Kit Installation

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 secured and 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.

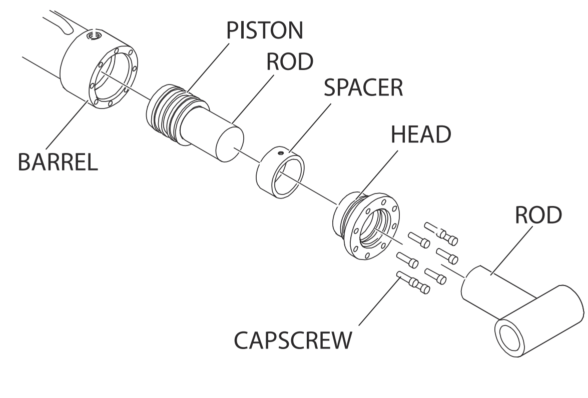


Figure 5-43. Rod Assembly Installation

19. Secure the cylinder head gland using the capscrew. Torque capscrew to 302 ft. lbs. (410 Nm).

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. Install the relief valve before installing the plug. Torque the relief valve as shown Figure 5-33., Main Boom Lift Cylinder (800S). Install the remaining plugs, using new o-rings as applicable.

22. Install the proportional valve, lift holding valve, relief valve, check valve and plugs, using new O-rings as applicable.

Main Boom Lift Cylinder (860SJ)

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 proportional valve, lift holding valve, relief valve, check valve and plugs. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

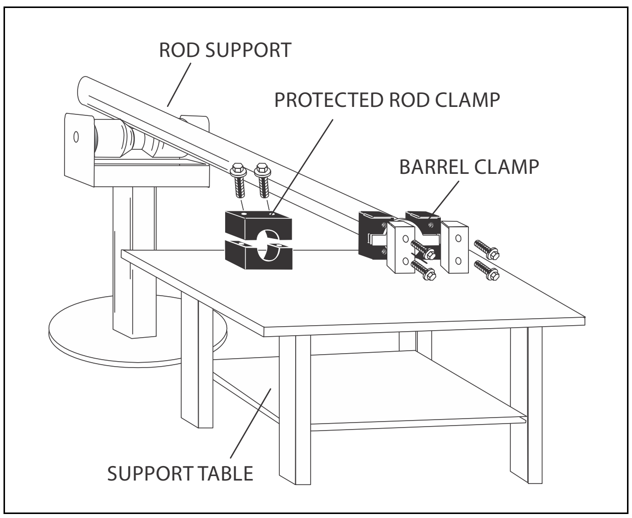


Figure 5-44. Cylinder Barrel Support

5. Mark cylinder head and barrel with center punch marks for later realignment. Using a hook spanner wrench, unscrew the cylinder head cap from the barrel.

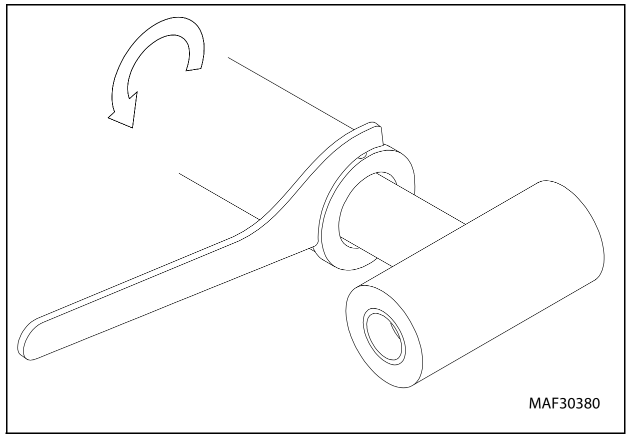


Figure 5-45. Cylinder Head Removal

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.

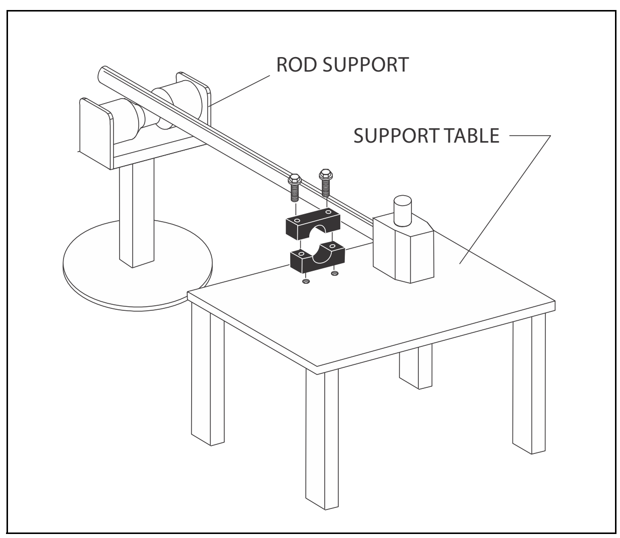
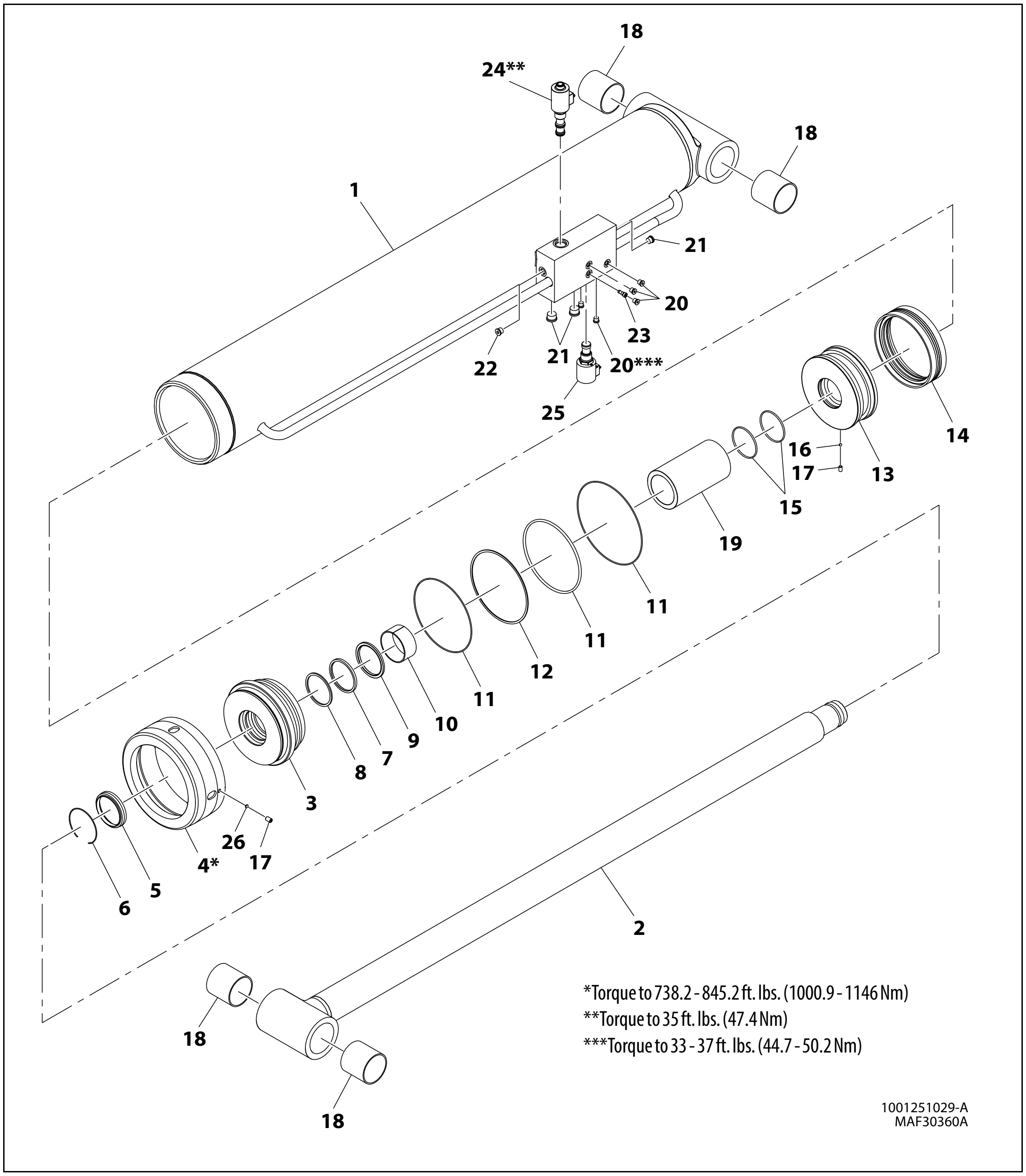


Figure 5-46. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Tube Spacer
5. Wiper
6. Retaining Ring
7. Rod Seal
8. Backup ring
9. Buffer ring
10. Bearing Ring
11. O-ring
12. Backup Ring
13. Piston
14. Piston Seal
15. O-ring
16. Steel Ball
17. Set Screw
18. Bushing
19. Spacer
20. Plug
21. Plug
22. Plug
23. Relief Valve
24. Proportional Valve
25. Poppet valve
26. Locking Insert

Figure 5-47. Main Boom Lift Cylinder (860SJ)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.

9. Loosen and remove the setscrew and steel ball which attaches the piston to the rod.

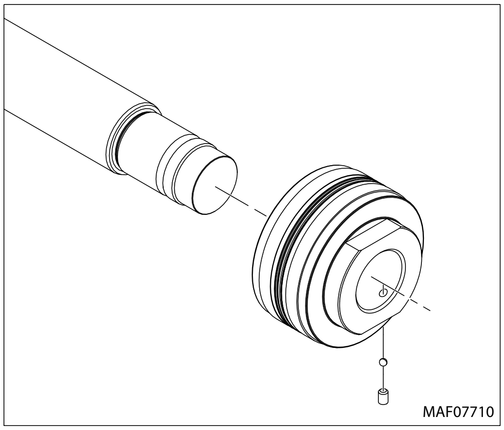


Figure 5-48. Piston Removal

10. Screw the piston counterclockwise and remove the piston from cylinder rod.

NOTICE

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

11. Remove and discard the piston seal from outside grooves of piston.

12. Remove and discard the o-rings from inside groove of the piston.

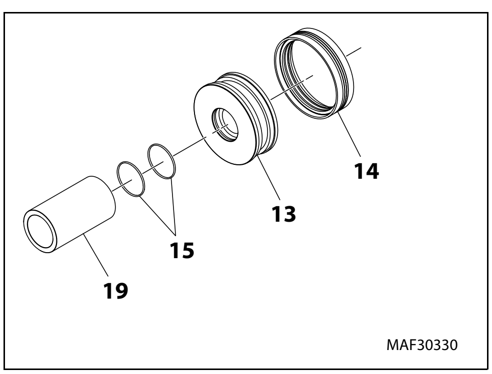


Figure 5-49. Piston Seal Disassembly

13. Remove piston spacer from the rod.

14. Remove the rod from the holding fixture. Remove the cylinder head gland.

15. Remove and discard Retaining ring, rod seal, wiper, backup ring, buffer ring and Bearing ring from inside groove of the head.

16. Remove and discard o-ring and backup ring from outside groove of the head.

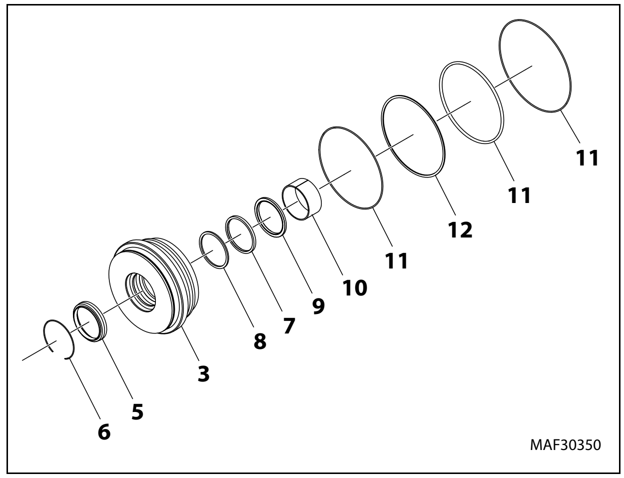


Figure 5-50. Cylinder Head Disassembly

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, tapering, ovality or other damage. Replace if 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, tapering, ovality or other damage. Replace if necessary.

11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

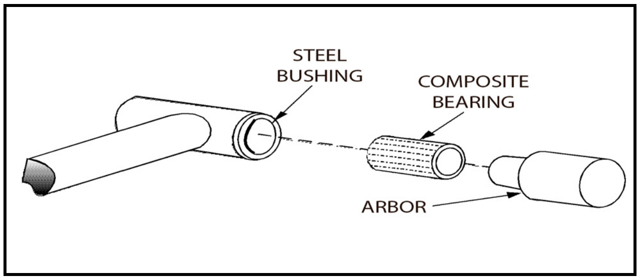


Figure 5-51. Composite Bearing Installation

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 if necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair if necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace if necessary.

ASSEMBLY

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

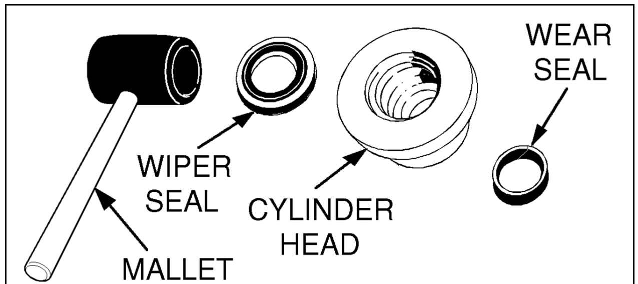
NOTE: *Apply a light film of hydraulic oil to all components prior to assembly.*

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

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

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



Note: When installing wiper seal ensure seal are installed properly. Install seal so that the flat part of seal is facing into head.

Figure 5-52. Wiper Seal Installation

3. Install backup ring and o-ring in outside groove of the cylinder head.
4. Install Retaining ring, Rod seal, Wiper, Backup ring, Buffer ring and Bearing ring in inside groove of the head.

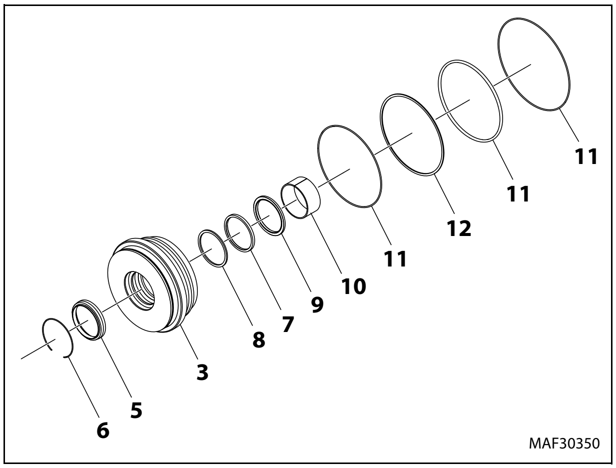


Figure 5-53. Cylinder Head Assembly

5. Carefully install the cylinder head 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. Carefully slide the piston 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. Install new o-ring in inside groove of the piston.
9. Install setscrew and steel ball on the piston and attach the piston on the rod.

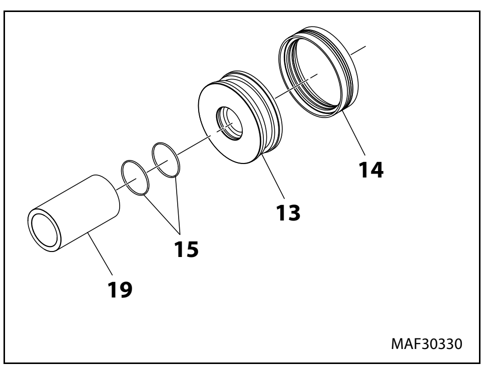


Figure 5-54. Piston Seal Installation

10. Remove the cylinder rod from the holding fixture.
11. Place new piston seal in the outer diameter of piston groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).
12. 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.

13. With barrel clamped secured and 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.
14. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

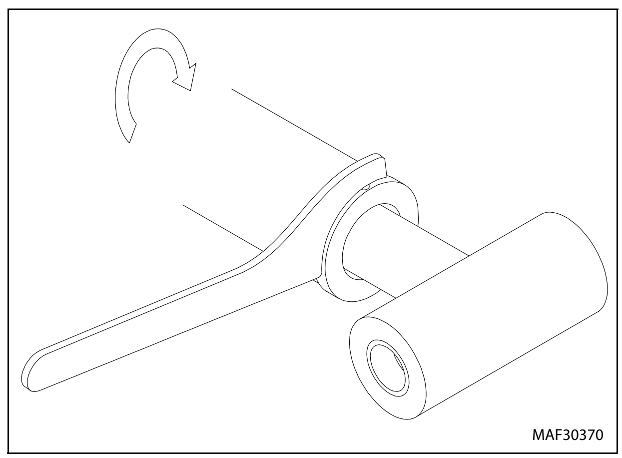


Figure 5-55. Cylinder Head Tightening

15. Screw the cylinder head into the barrel using a hook-spanner wrench and torque cylinder head to 554.4 - 453.6 ft. lbs. (1146 - 1000.9 Nm).
16. 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.
17. Install the new o-rings and plugs into the cylinder port-block and torque plug as shown in Figure 5-47., Main Boom Lift Cylinder (860SJ).
18. Install the Proportional valve, Poppet valve, Relief valve and plugs, using new o-rings as applicable.

Platform Level Cylinder (800S)

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 valves and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture.

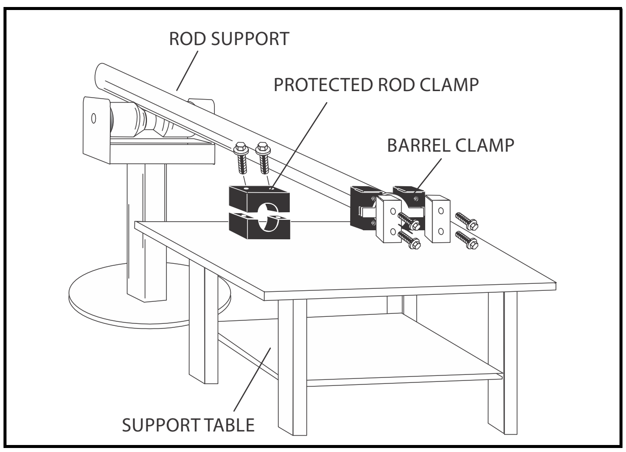


Figure 5-56. Cylinder Barrel Support

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

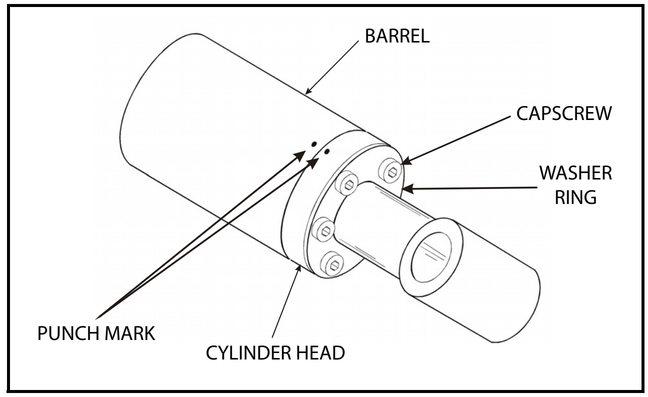


Figure 5-57. Capscrew Removal

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.

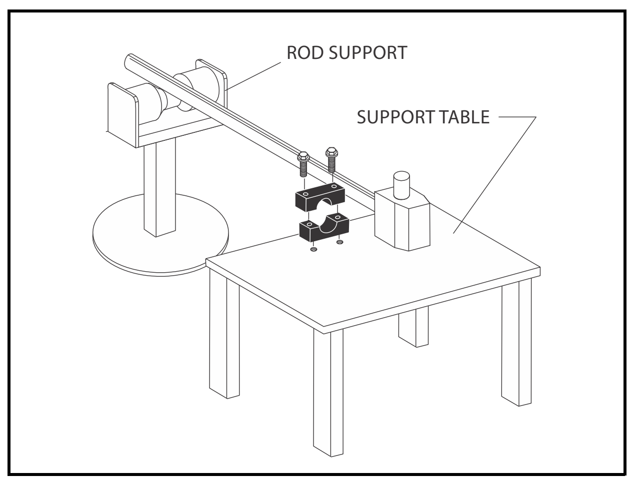
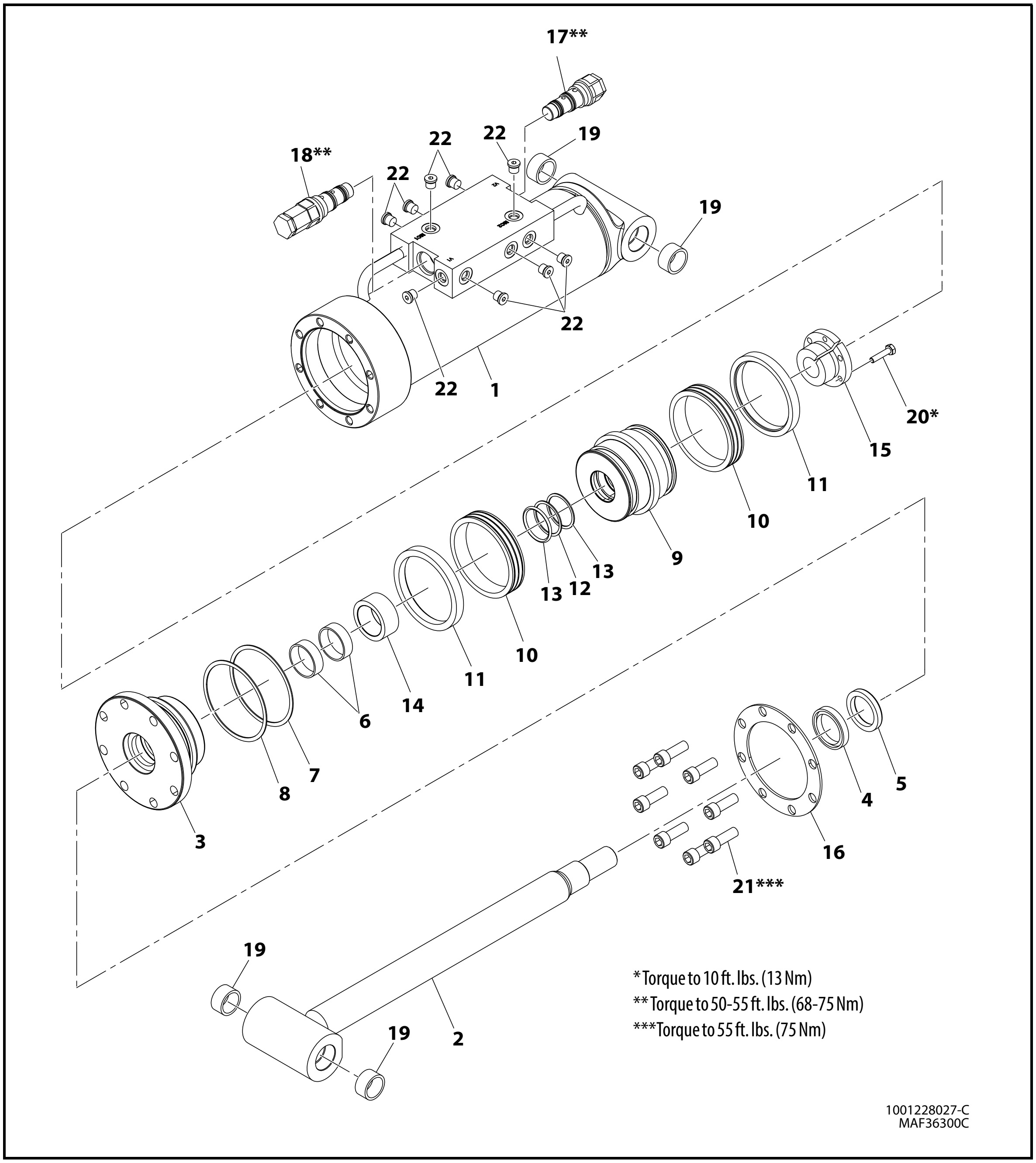


Figure 5-58. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Wiper Seal
5. Rod Seal
6. Wear Ring
7. O-ring
8. Backup Ring
9. Piston
10. T-Seal
11. Wear Ring
12. O-ring
13. Backup Ring
14. Tube Spacer
15. Tapered Bushing
16. Washer Ring
17. Counterbalance Valve (Barrel End)
18. Counterbalance Valve (Rod End)
19. Bushing
20. Capscrew
21. Capscrew
22. Plug

Figure 5-59. Platform Level Cylinder (800S)

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Remove capscrew from drilled holes.
10. Insert the capscrew in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrew until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

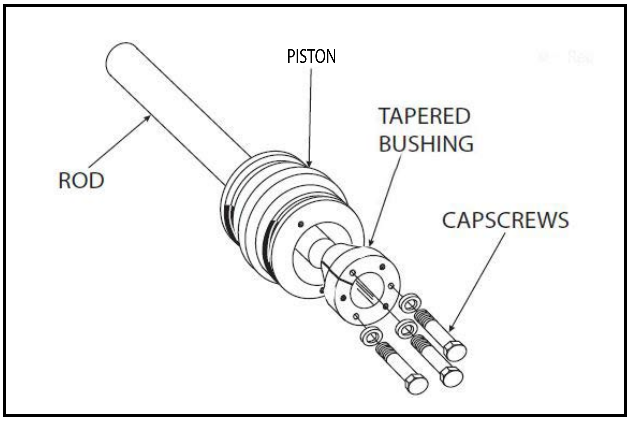


Figure 5-60. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston hydrolock seals, guidelock rings.
14. Remove piston spacer from the rod.
15. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, wear rings 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, tapering, ovality or other damage. Replace if 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, tapering, ovality or other damage. Replace if necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

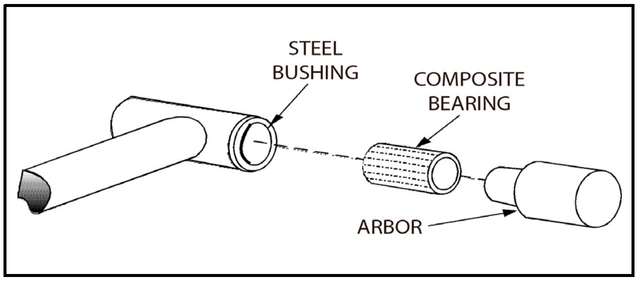


Figure 5-61. Composite Bearing Installation

12. If applicable, inspect port block fittings and holding valve. Replace if necessary.

13. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair if necessary.

14. If applicable, inspect piston rings for cracks or other damage. Replace if 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.

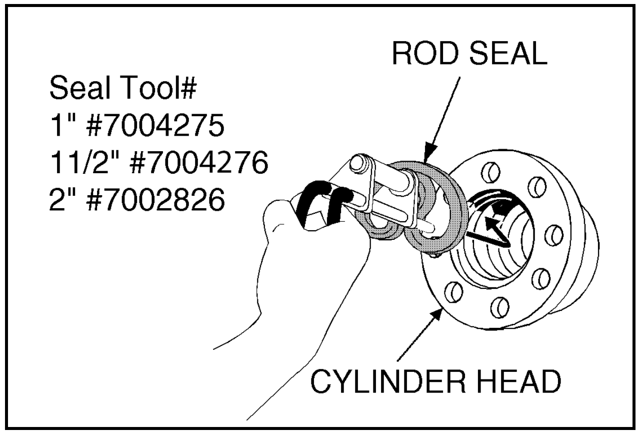


Figure 5-62. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

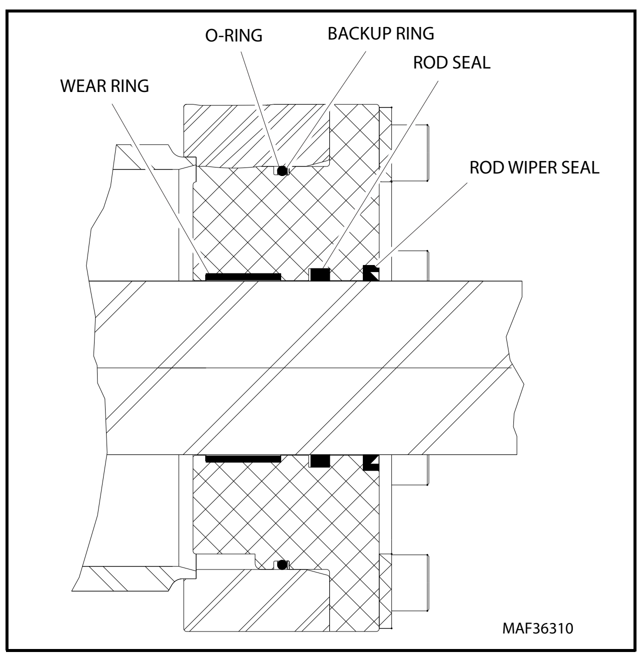


Figure 5-63. Cylinder Head Seal Installation

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

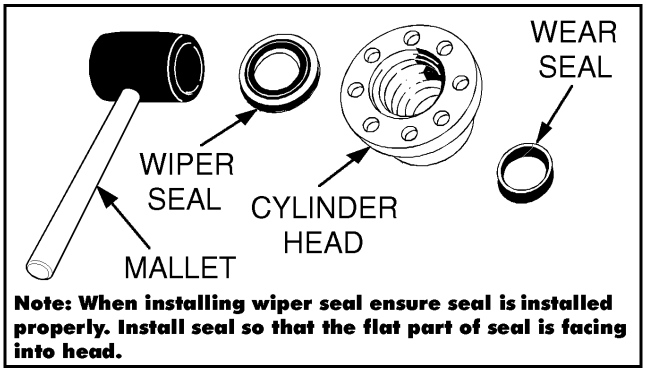


Figure 5-64. Wiper Seal Installation

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

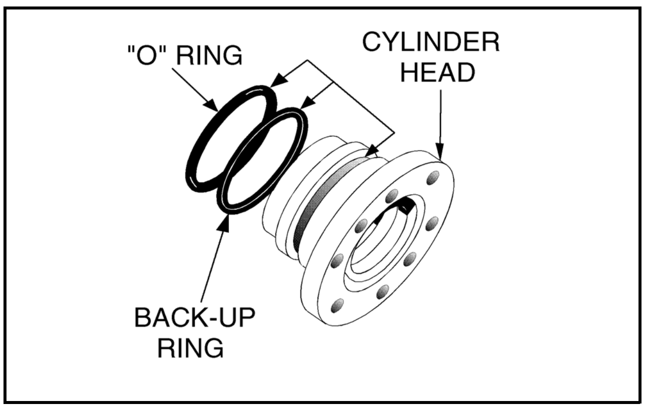


Figure 5-65. Installation of Head Seal Kit

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 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 capscrew through the drilled holes in the bushing and into the tapped holes in the piston.

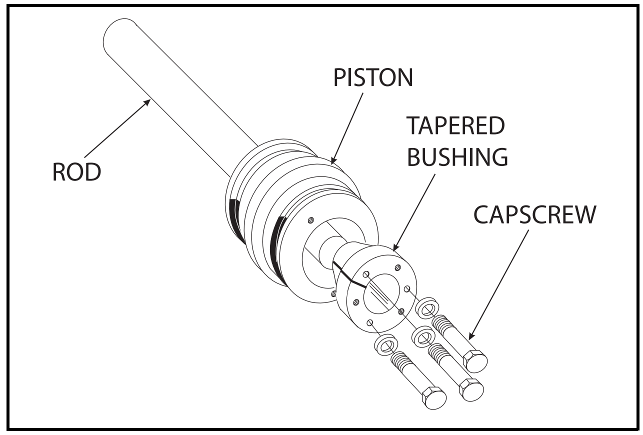


Figure 5-66. Tapered Bushing Installation

11. Tighten the capscrew evenly and progressively in rotation to 10 ft. lbs (13 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 capscrew.

    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrew.

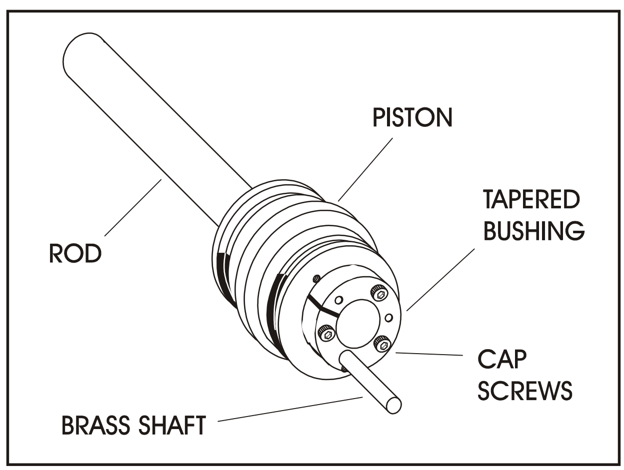


Figure 5-67. Seating the Tapered Bearing

13. Tighten the capscrew evenly and progressively in rotation to 10 ft. lbs (13 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.

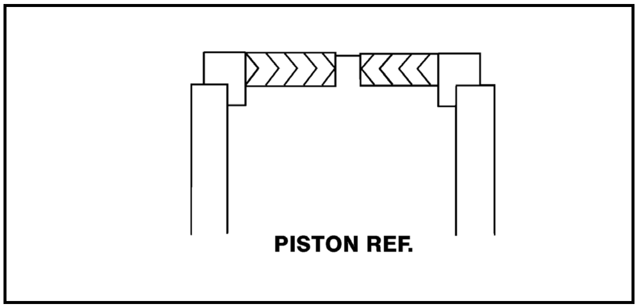


Figure 5-68. Hydrolock Piston Seal Installation

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).

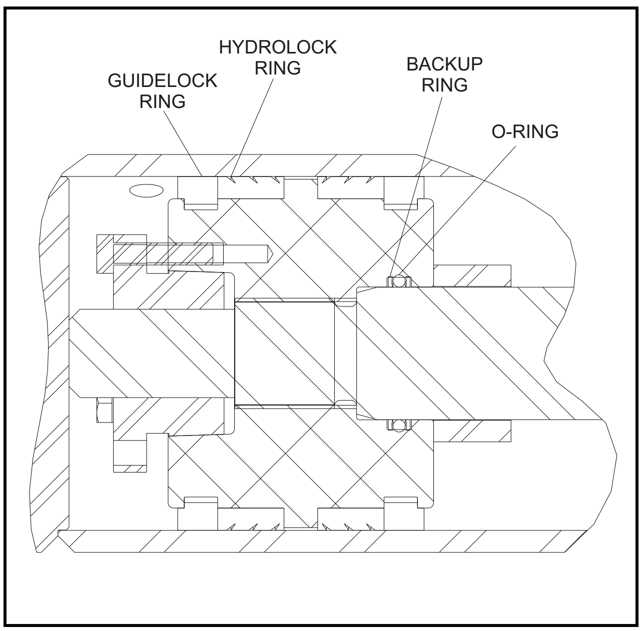


Figure 5-69. Piston Seal Kit Installation

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 secured and adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading hydrolock seals, guidelock rings 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.

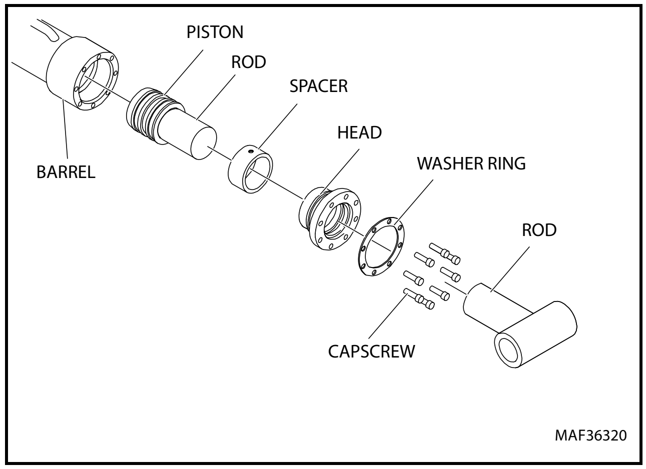


Figure 5-70. Rod Assembly Installation

18. Secure the cylinder head gland using the washer ring and capscrew. Torque capscrew to 55 ft. lbs. (75 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. Install the cartridge-type holding valves and fittings in the rod port block, using new o-rings as applicable. Torque valves to 50-55 ft. lbs. (68-75 Nm).

Platform Level Cylinder (860SJ)

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 valves and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to break thread-locking compound.

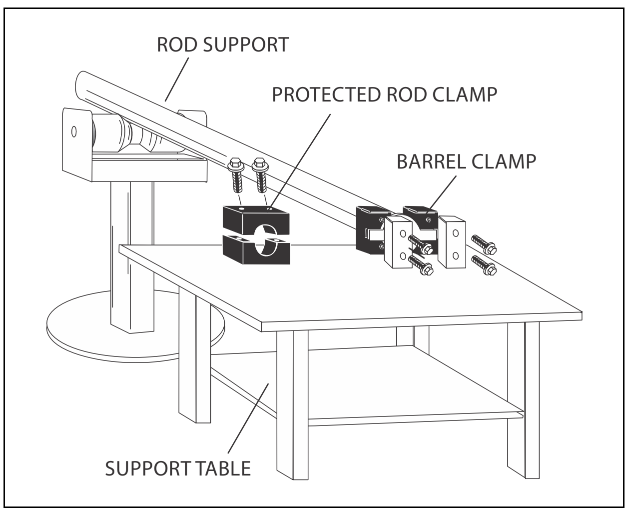


Figure 5-71. Cylinder Barrel Support

5. Unscrew cylinder head with hook spanner wrench.

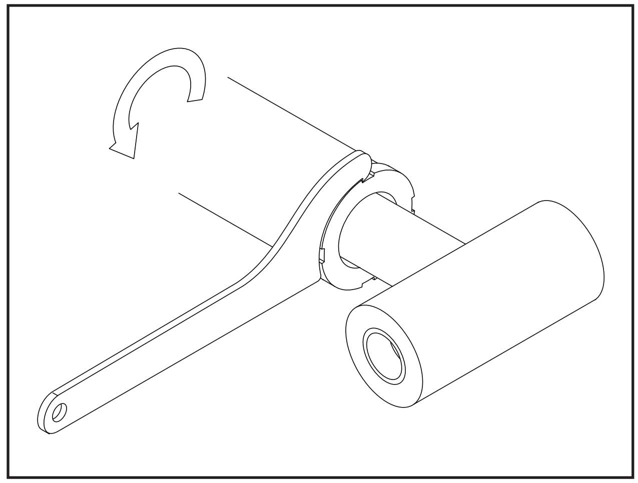


Figure 5-72. Cylinder Head Removal

NOTICE

PULLING ROD OFF-CENTER CAN DAMAGE PISTON AND CYLINDER BARREL SURFACES. USE EXTREME CARE WHEN REMOVING CYLINDER ROD, HEAD, AND PISTON.

6. Clamp barrel securely. Pull rod assembly and cylinder head from barrel.
7. Protect cylinder rod from damage and clamp in a vise or holding fixture as close to piston as possible.

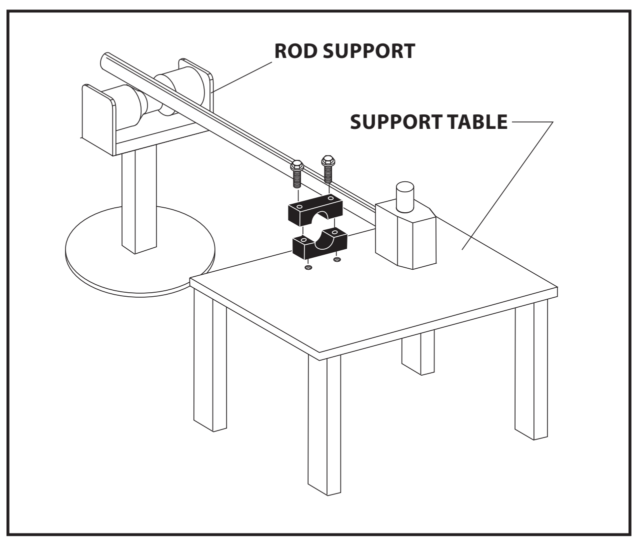
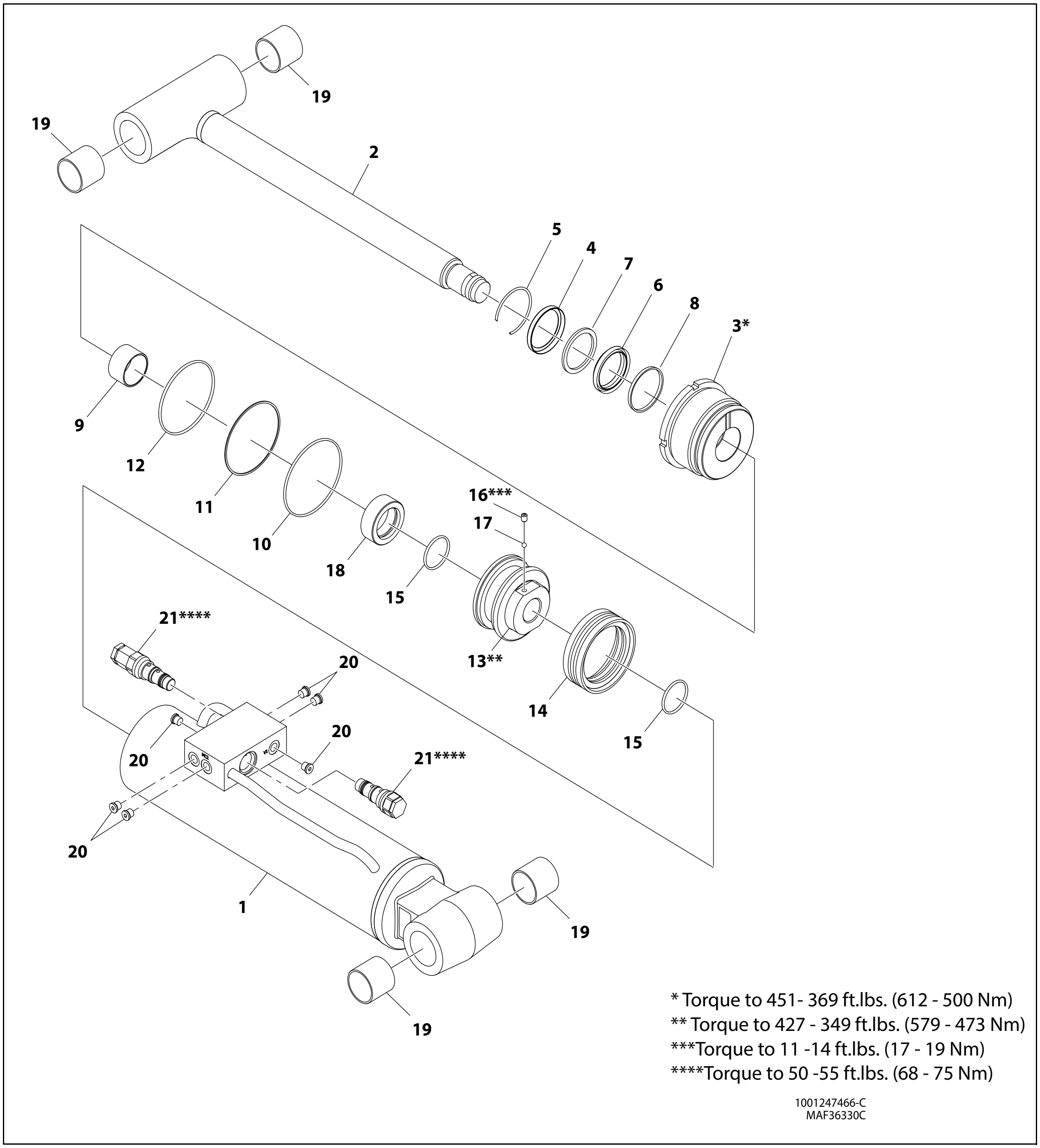


Figure 5-73. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Wiper
5. Retaining Ring
6. Rod Seal
7. Backup Ring
8. Bearing
9. Dry Bearing
10. O-Ring
11. Backup Ring
12. O-Ring
13. Piston
14. Piston Seal
15. O-Ring
16. Setscrew
17. Ball
18. Spacer
19. Bushing
20. Plug
21. Counterbalance Valve

Figure 5-74. Platform Level Cylinder (860SJ)

8. Loosen and remove the setscrew and steel ball which attaches the piston to the rod.

9. Screw the piston counterclockwise and remove the piston from cylinder rod.

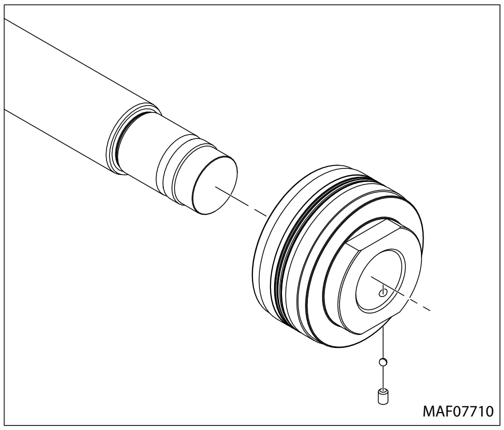


Figure 5-75. Piston Removal

NOTICE

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

10. Remove and discard the piston seal from outside grooves of piston.

11. Remove and discard the o-rings from inside groove of the piston.

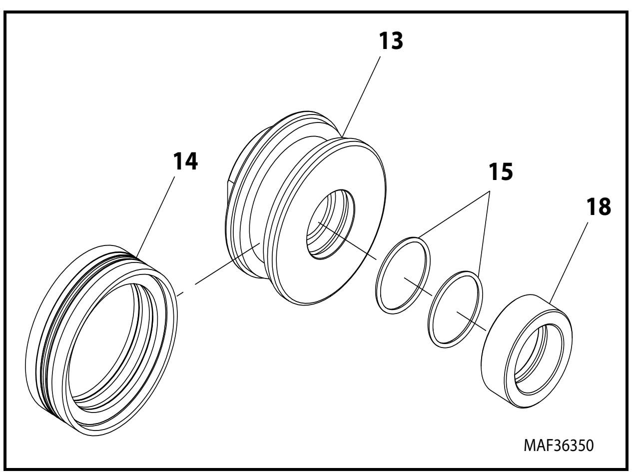


Figure 5-76. Piston Seal Disassembly

12. Remove piston spacer from the rod.

13. Remove the rod from the holding fixture. Remove the cylinder head gland.

14. Remove and discard Retaining ring, rod seal, wiper, backup ring, buffer ring and Bearing ring from inside groove of the head.

15. Remove and discard o-ring and backup ring from outside groove of the head.

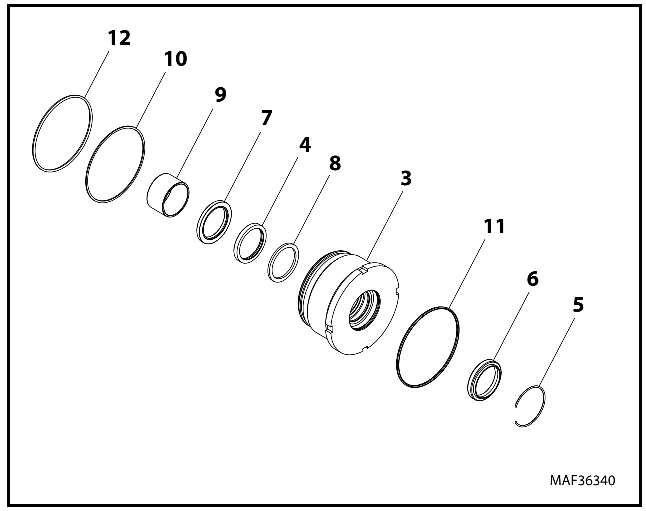


Figure 5-77. Cylinder Head Disassembly

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, tapering, ovality or other damage. Replace if 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, tapering or ovality other damage. Replace if necessary.

11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

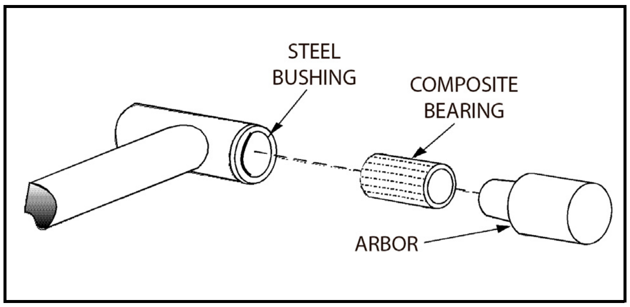


Figure 5-78. Composite Bearing Installation

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 if necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair if necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace if 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.

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

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

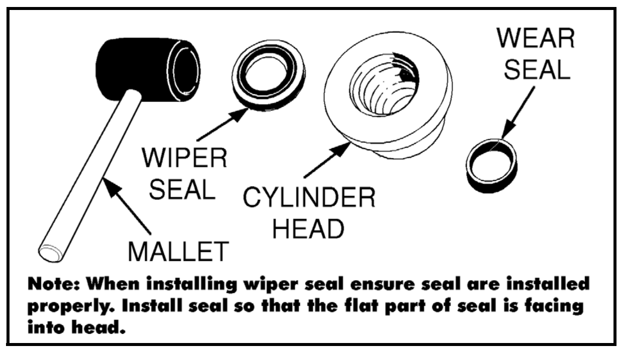


Figure 5-79. Wiper Seal Installation

3. Install backup ring and o-ring in outside groove of the cylinder head.
4. Install Retaining ring, Rod seal, Wiper, Backup ring, Buffer ring and Bearing ring in inside groove of the head.

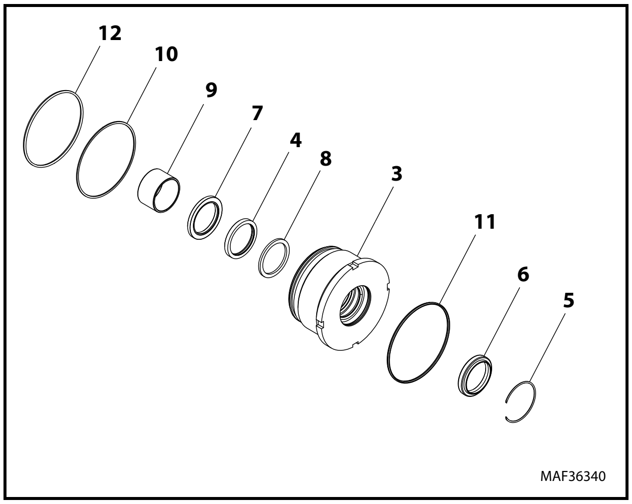


Figure 5-80. Cylinder Head Assembly

5. Carefully install the cylinder head 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. Carefully slide the piston 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. Install new o-ring in inside groove of the piston.
9. Install setscrew and steel ball on the piston and attach the piston on the rod.

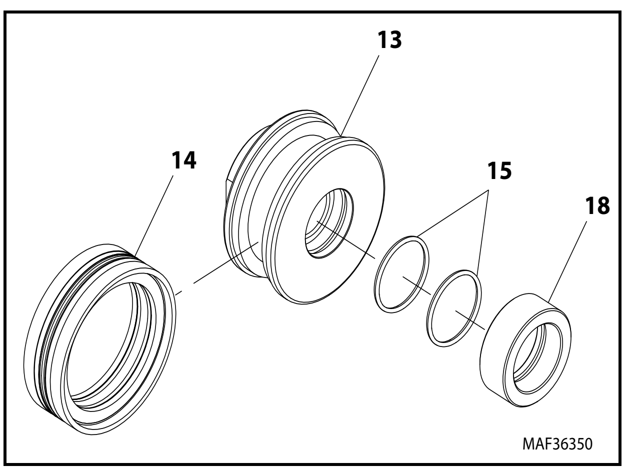


Figure 5-81. Piston Seal Installation

10. Remove the cylinder rod from the holding fixture.
11. Place new piston seal in the outer diameter of piston groove. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).
12. 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.

13. With barrel clamped secured and 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.
14. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.

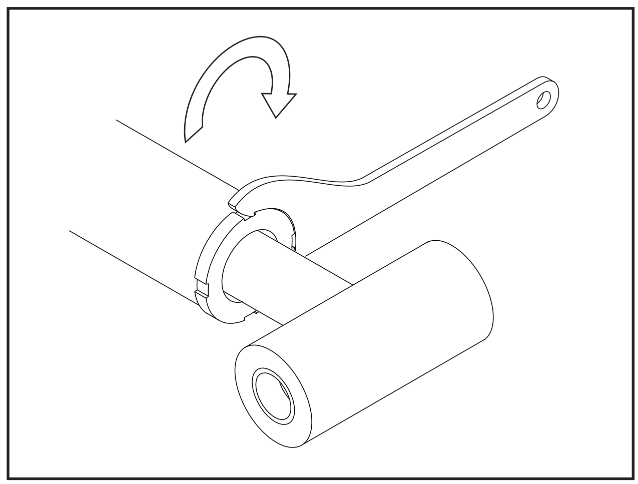


Figure 5-82. Cylinder Head Tightening

15. Screw the cylinder head into the barrel using a hook-spanner wrench and torque cylinder head to 451 - 369 ft. lbs. (612 - 500 Nm).
16. 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.
17. Install the new o-rings and plugs into the cylinder port-block.

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.

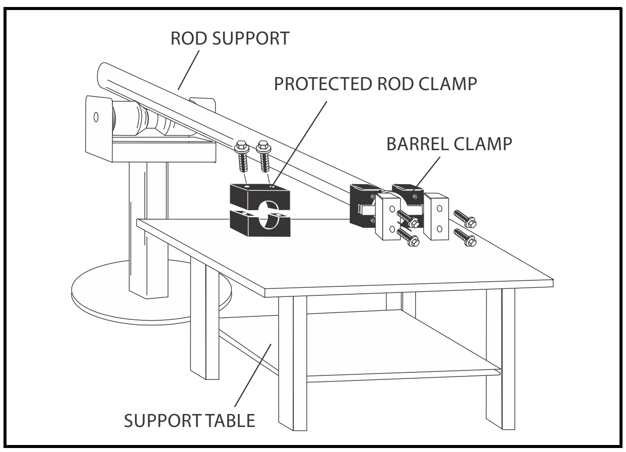


Figure 5-83. Cylinder Barrel Support

4. Using a hook Spanner, loosen the spanner nut retainer and remove spanner nut from cylinder barrel.

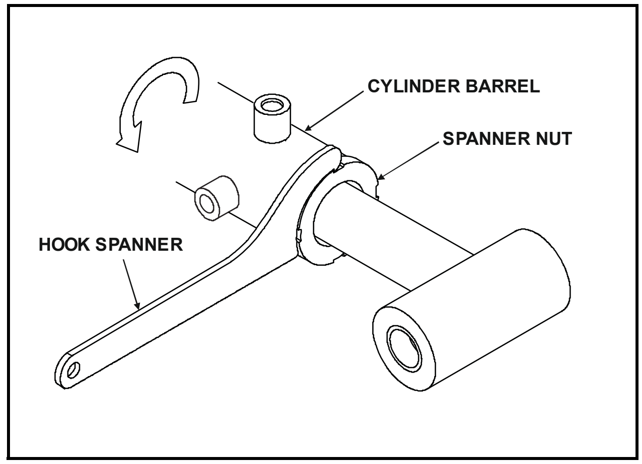


Figure 5-84. Spanner Nut Removal

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.

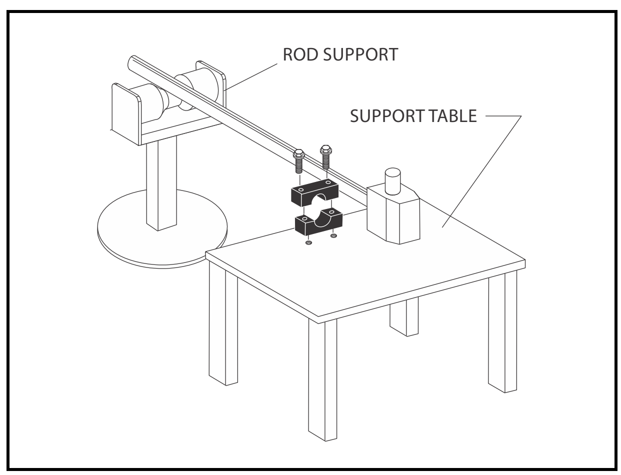
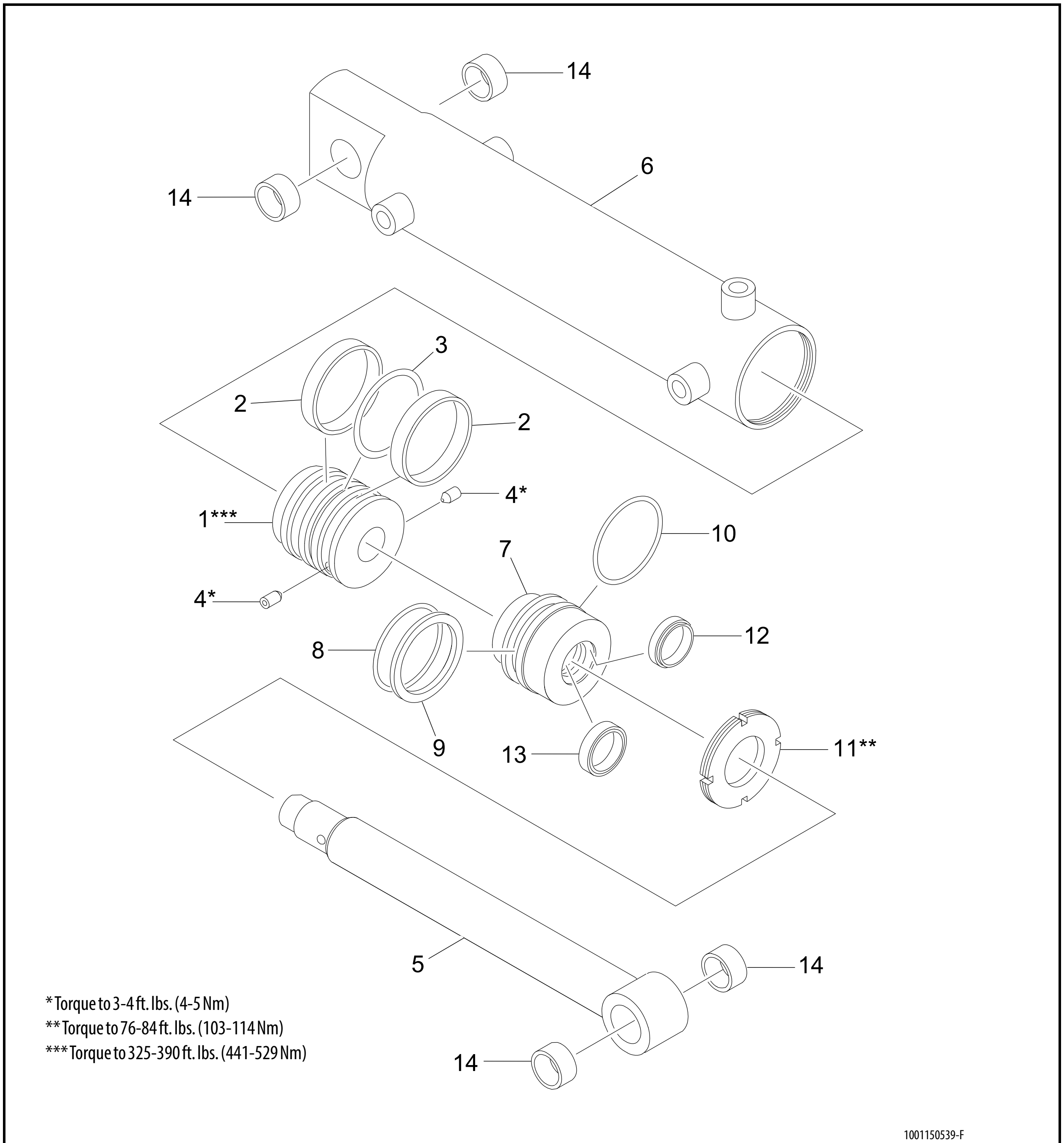


Figure 5-85. Cylinder Rod Support



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 5-86. 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. Loosen and remove setscrew which attaches the piston to the rod.
9. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
10. Remove and discard the piston o-rings, seal rings.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, c-ring 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 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, tapering, ovality or other damage. Replace if 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, tapering or ovality other damage. Replace if necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace if 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 inner side 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.*

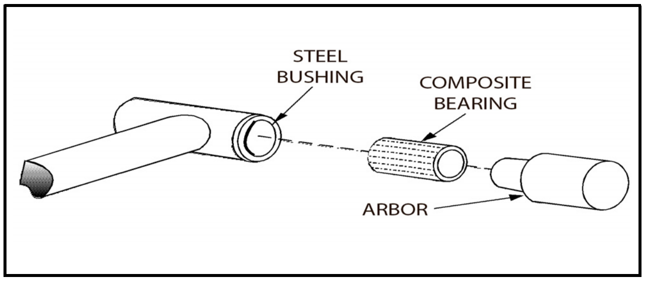


Figure 5-87. Composite Bearing Installation

12. Inspect piston rings for cracks or other damage. Replace if 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.

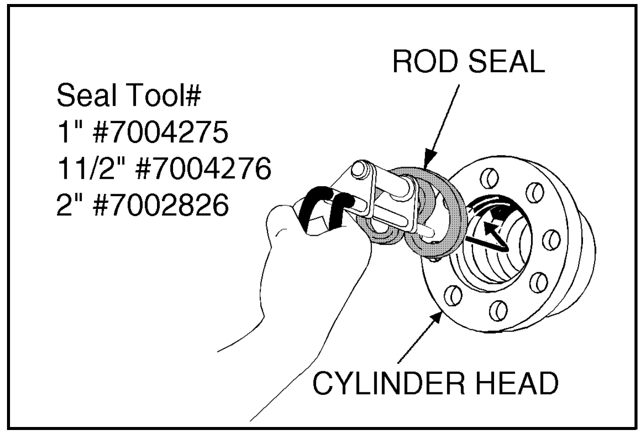


Figure 5-88. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

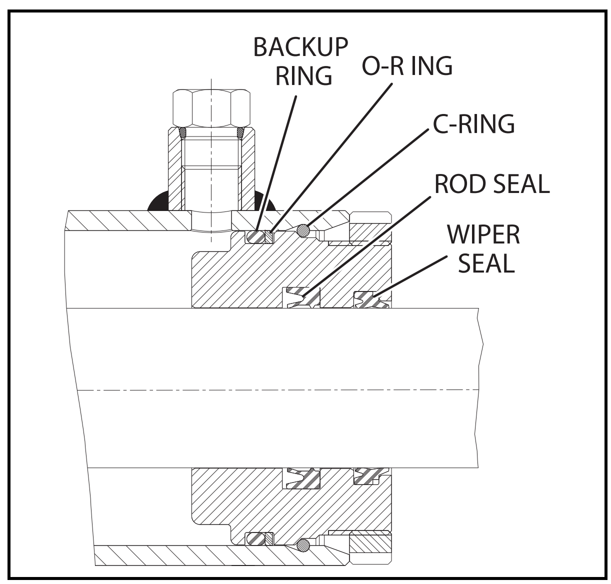


Figure 5-89. Cylinder Head Seal Installation

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

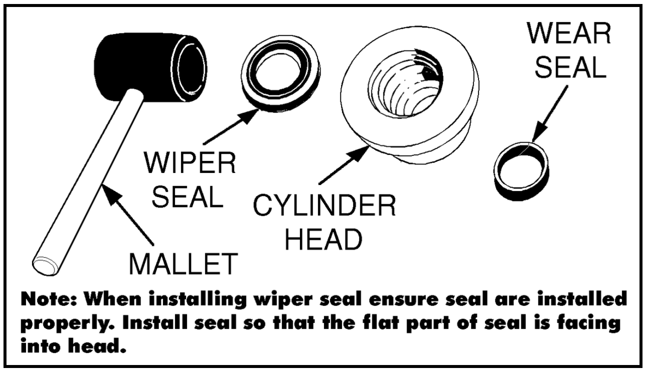


Figure 5-90. Wiper Seal Installation

3. Place a new o-ring backup ring and c-ring in the applicable outside diameter groove of the cylinder head.

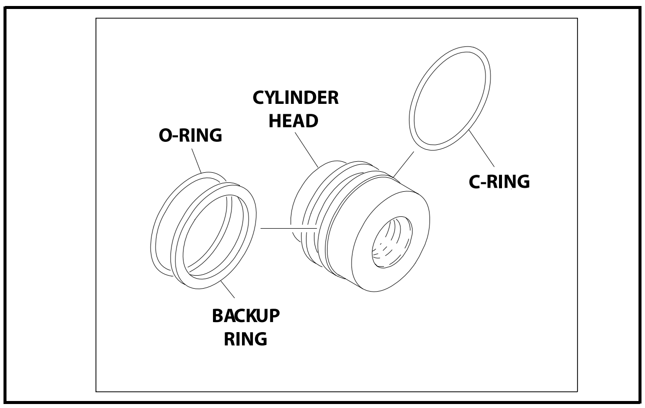


Figure 5-91. Installation of Head Seal Kit

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. Torque piston to 325-390 ft. lbs. (441-529 Nm).

7. Install the setscrews on the piston. Torque the setscrews to 3-4 ft. lbs (4-5 Nm) and attached the piston onto the rod.

NOTE: *Apply Medium Strength Threadlocking Compound to setscrew thread of 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).

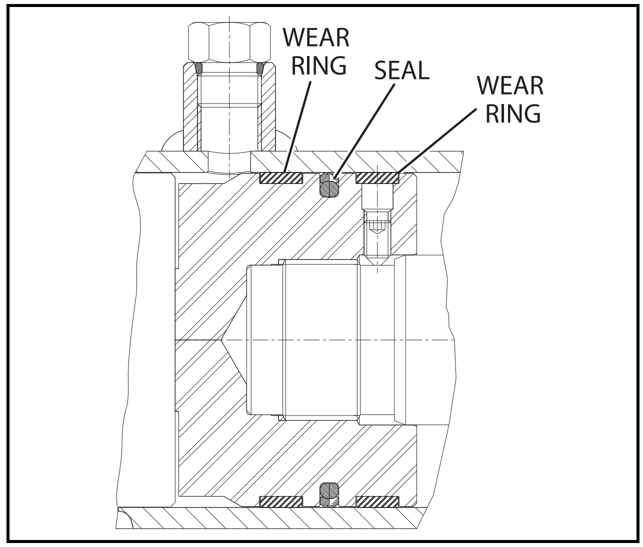


Figure 5-92. Installation of Piston Seal Kit

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 secured and 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. Screw the cylinder head gland into the barrel using a spanner nut and torque gland to 76-84 ft. lbs. (103-114 Nm).

NOTE: *Apply Medium Strength Threadlocking Compound to spanner nut thread.*

14. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted).

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

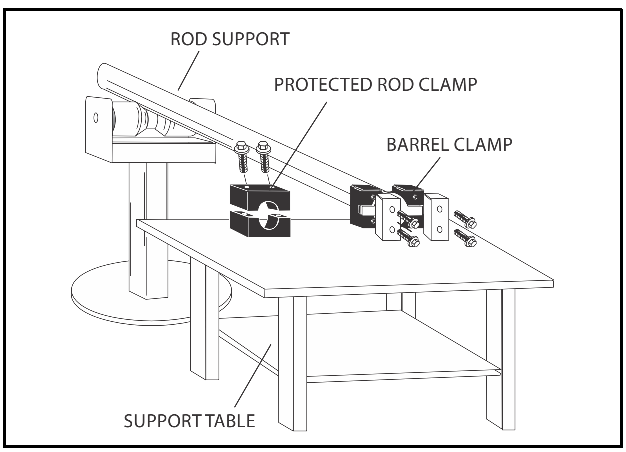


Figure 5-93. Cylinder Barrel Support

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

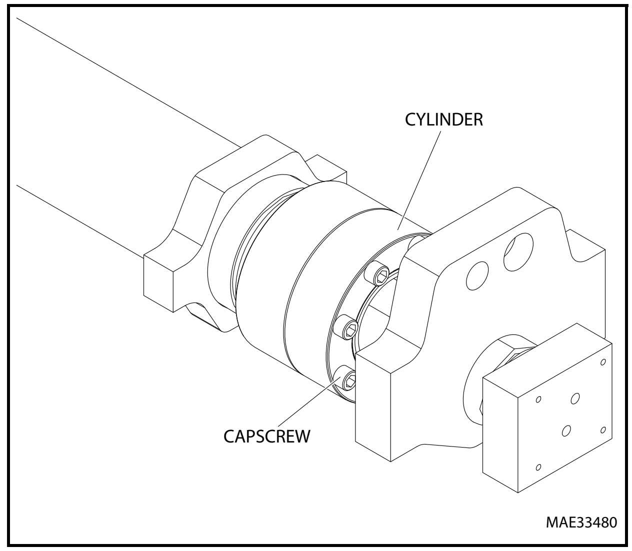


Figure 5-94. Capscrew Removal

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.

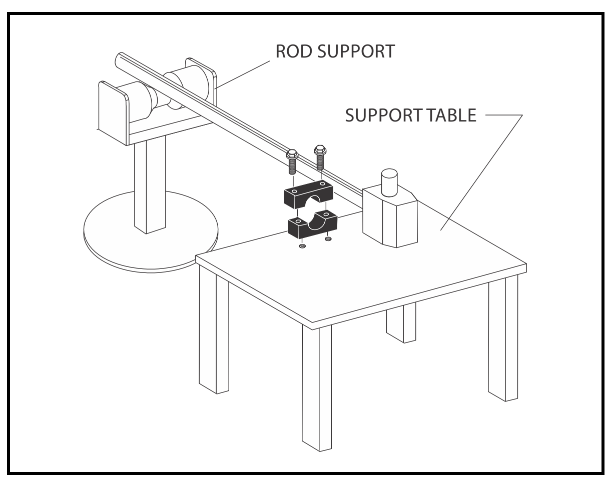
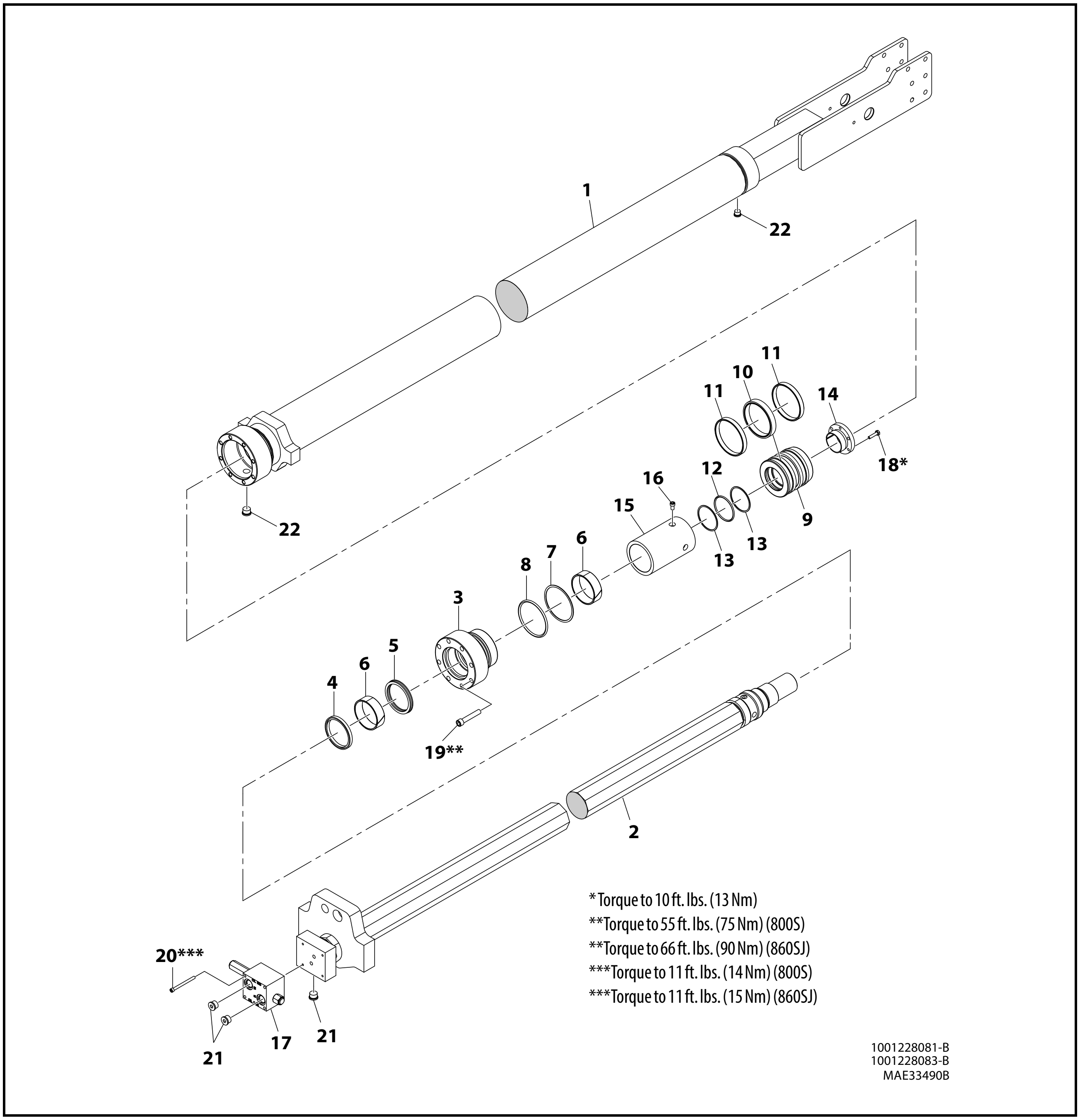


Figure 5-95. Cylinder Rod Support



1. Barrel
2. Rod
3. Head
4. Wiper
5. Rod Seal
6. Wear Ring
7. O- ring
8. Backup Ring
9. Piston
10. T-Seal
11. Wear Ring
12. O- ring
13. Backup Ring
14. Tapered Bushing
15. Tube Spacer
16. Capscrew
17. Valve assembly
18. Capscrew
19. Capscrew
20. Capscrew
21. Plug
22. Plug

Figure 5-96. 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. Remove capscrew from drilled holes
10. Insert the capscrew in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrew until the bushing is loosen on the piston.
11. Remove the bushing from the piston.

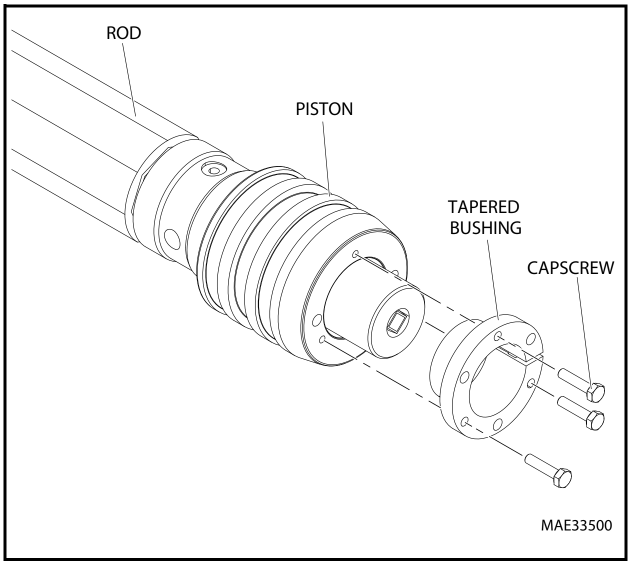


Figure 5-97. Tapered Bushing Removal

12. Screw the piston counterclockwise by hand and remove the piston from cylinder rod.
13. Remove and discard the piston o-rings, seal rings, wear rings and backup rings.
14. Remove setscrew from the piston spacer. Remove spacer from the rod.
15. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, wear rings 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, tapering, ovality or other damage. Replace if 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, tapering, ovality or other damage. Replace if 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 inner side 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.*

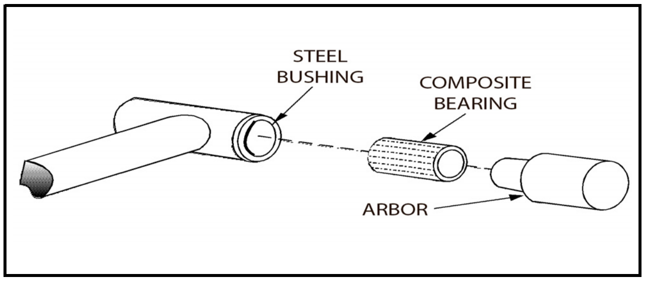


Figure 5-98. Composite Bearing Installation

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 if necessary.
14. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair if necessary.
15. If applicable, inspect piston rings for cracks or other damage. Replace if 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.

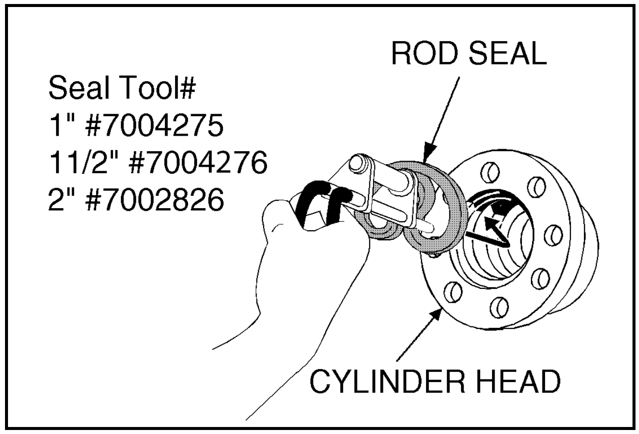


Figure 5-99. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

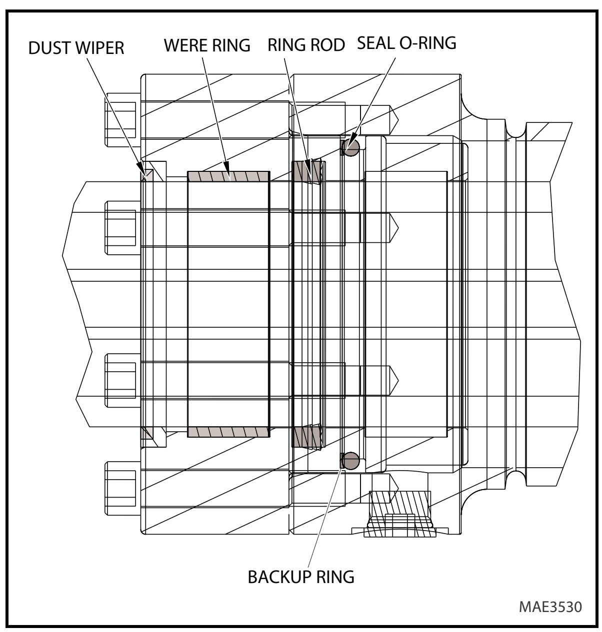
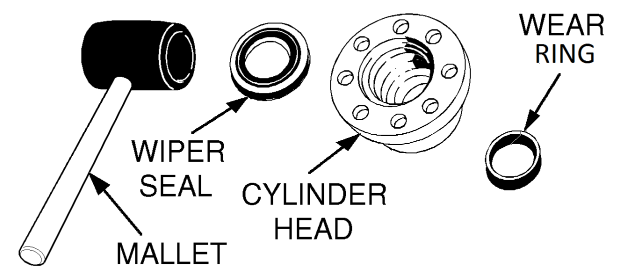


Figure 5-100. Cylinder Head Seal Installation

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



Note: When installing wiper seal ensure seal is installed properly. Install seal so that the flat part of seal is facing into head.

Figure 5-101. Wiper Seal Installation

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

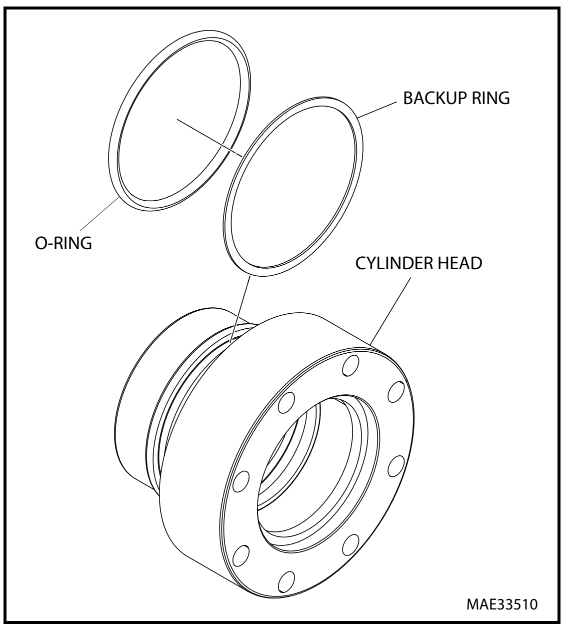


Figure 5-102. Installation of Head Seal Kit

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. 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 capscrew through the drilled holes in the bushing and into the tapped holes in the piston.

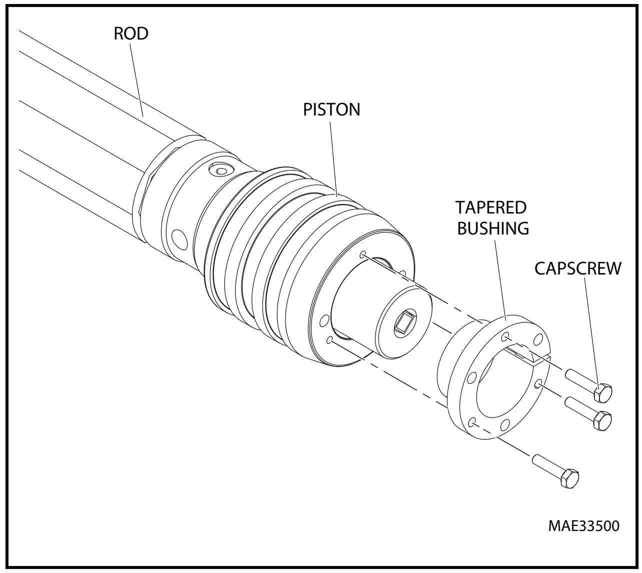


Figure 5-103. Tapered Bushing Installation

11. Tighten the capscrew evenly and progressively in rotation to 10 ft. lbs. (13 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 capscrew.

    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrew.

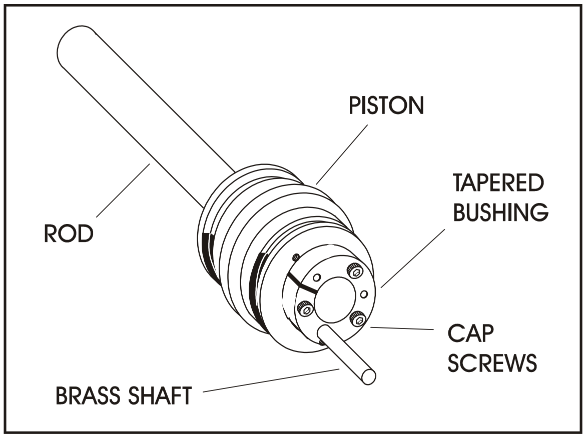


Figure 5-104. Seating the Tapered Bearing

13. Tighten the capscrew evenly and progressively in rotation to 10 ft. lbs. (13 Nm).

14. Remove the cylinder rod from the holding fixture.

15. 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).

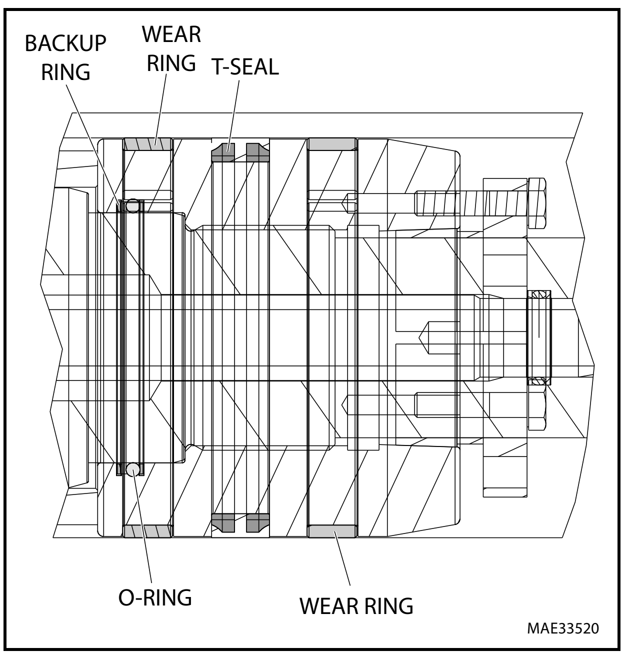


Figure 5-105. Piston Seal Kit Installation

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 secured, and 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.

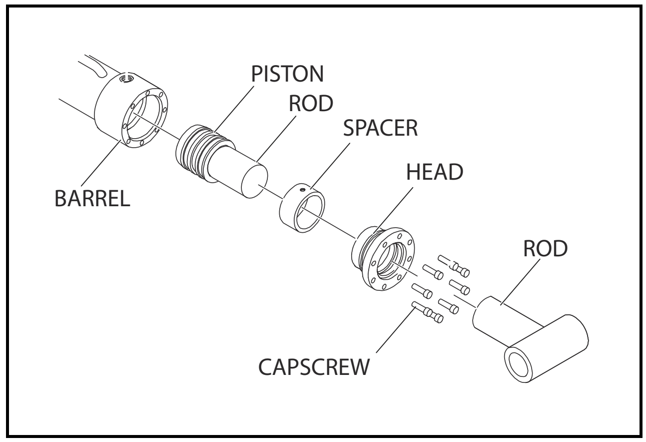
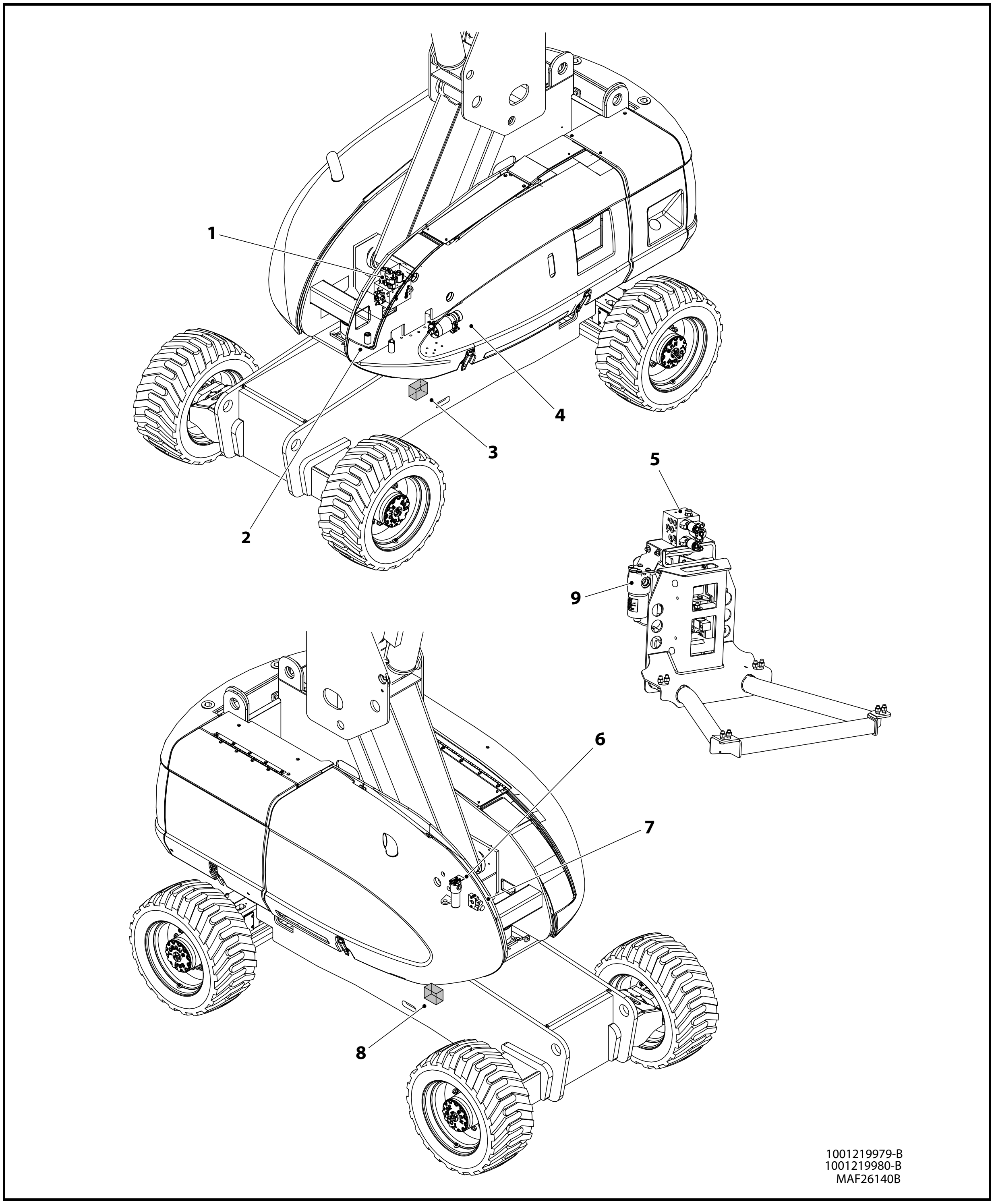


Figure 5-106. Rod Assembly Installation

19. Secure the cylinder head gland using the capscrew. For Torque capscrew Refer Figure 5-96., Telescopic Cylinder.

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. Install the valve assembly. For Torque capscrew Refer Figure 5-96., Telescopic Cylinder.



1. Main Valve
2. Platform Valve Filter
3. Dual Flow Divider (4WD)
4. Auxiliary Pump
5. Platform Valve
6. Hydraulic Filter
7. Dual Select Valve
8. Flow Divider (2WD)
9. High Pressure Filter

Figure 5-107. Control Valve Installation

5.4 PRESSURE SETTING PROCEDURE

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within ± 5% of specified pressures.

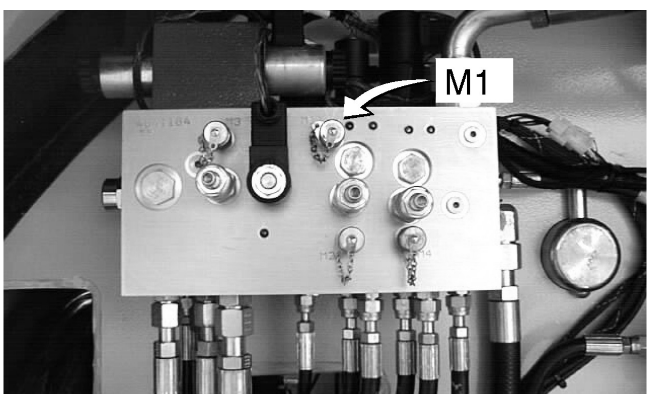
To ensure all pressures are set correctly, the following procedures must be followed in order.

1. All applicable steps in Section 5.5, Start Up Procedures 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.

Set Up of the Function Pump

STAND BY PRESSURE OR LOAD SENSE PRESSURE

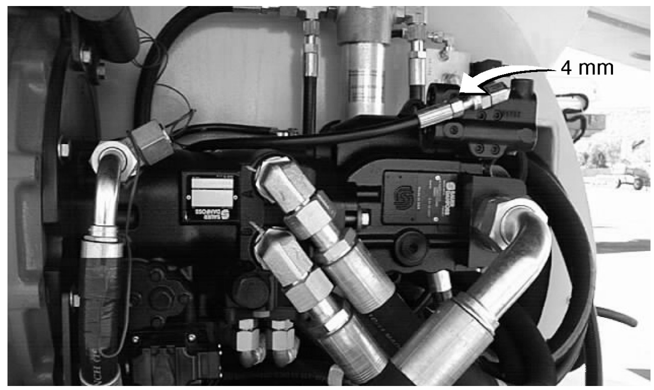
1. Install a low pressure gauge at port "M1" of the main valve block. A low pressure gauge capable of reading 500 psi.



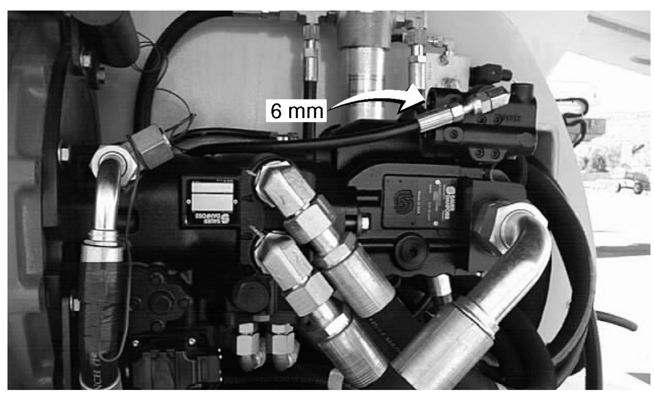
2. Start the engine from the ground control. The gauge should read between 400-440 psi (27.5 to 30 Bar). To make an adjustment to this pressure, go to the engine compartment and locate the function pump.

3. 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. 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.

   a. 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.

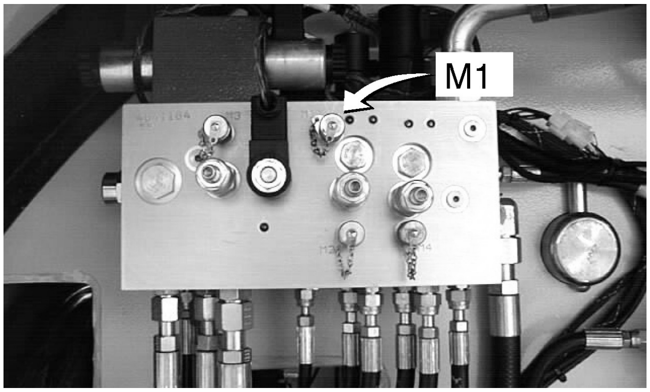


   b. Using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. The pressure should read between 400-440 psi (27.5 to 30 Bar).



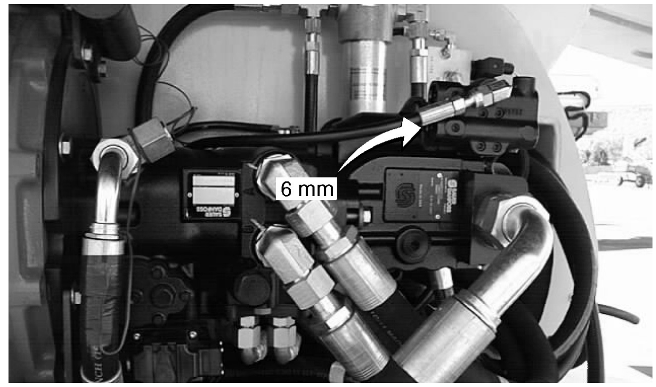
HIGH PRESSURE RELIEF

1. Install a high pressure gauge at the “M1” port of the main valve block.



2. Activate telescope in and hold. The gauge should read 2600 psi.
3. 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 shaft end of the pump, or toward the engine.
   a. 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.

   b. Using the 6 mm wrench adjust the main adjustment clockwise to increase or counterclockwise to decrease. This is the **maximum** relief pressure for all functions governed by this pump.



Adjustments Made at the Main Valve Block

SWING LEFT AND RIGHT

1. Lock the Turntable lock pin.
2. Install the hi-pressure gauge at port M2.
3. From the ground control, activate swing RIGHT. the gauge should read 1700 psi (117 Bar).
4. The adjustment cartridge is located on the left face of the valve block. There are two adjustable relief valves on this face and the swing relief is toward the top of the block. Turn clockwise to increase, counterclockwise to decrease.

NOTE: *Swing left is not used to set the relief valve. The swing left pressure will default to approximately 1575 psi.*

STEER

1. Install a hi-pressure gauge at port M3. Activate steer left or right. The gauge should read 2500 psi (172 Bar).
2. The adjustment cartridge is located on the left face of the valve block. There are two adjustable relief valves on this face and the steer relief is the lower one. Turn clockwise to increase, counterclockwise to decrease.

Adjustments Made at the Platform Valve Assembly

PLATFORM JIB UP AND DOWN

1. Install a high pressure gauge at port M of the platform valve. Activate jib down, you should read 1700 psi (117 Bar).
2. The jib down relief valve is located on the front face of the platform valve. Turn clockwise to increase, counterclockwise to decrease.

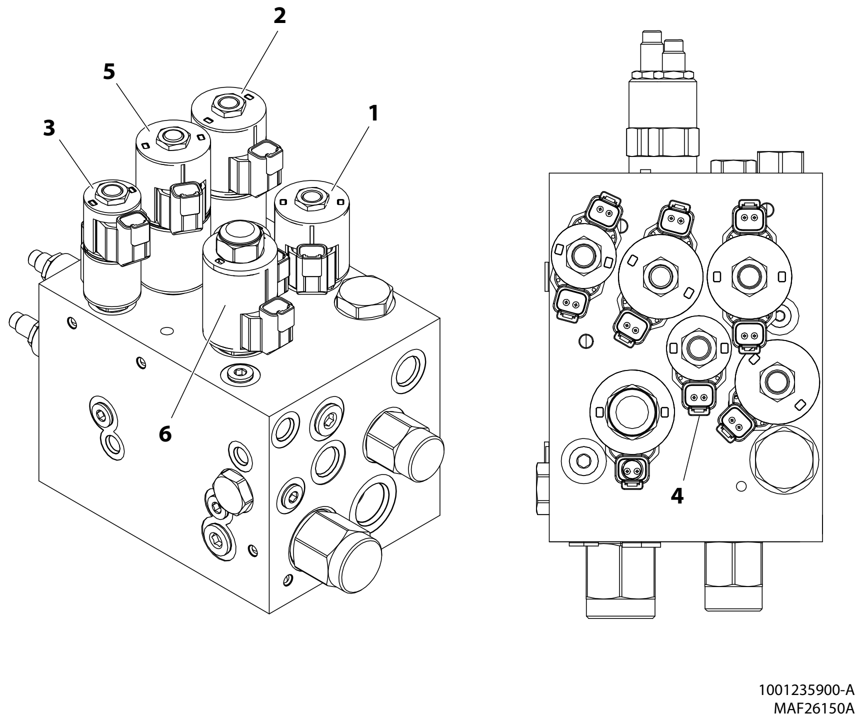


Table 5-33. Main Valve Coil Resistance

#	Coil Resistance @ 20°C (Ohms)
1	7.1
2	7.1
3	8.8
4	8.8
5	7.1
6	4.5

1. Main Dump Valve (Coil Resistance 7.1 Ohms @ 20oC) (50-55 ft. lb. (68-75 Nm))
2. Steer Valve (Coil Resistance 7.1 Ohms @ 20oC) (24-26 ft. lb. (33-36 Nm))
3. Tele Solenoid Valve (Coil resistance 8.8 Ohms @ 20oC) (19-21 ft. lb. (26-29 Nm))
4. Lift Valve (Coil resistance 8.8 Ohms @ 20oC) (19-21 ft. lb. (26-29 Nm))
5. Swing Valve (Coil Resistance 7.1 Ohms @ 20oC) (24-26 ft. lb. (33-36 Nm))
6. Telescope Flow Valve (Coil resistance 4.5 Ohms @ 20oC) (50-55 ft. lb. (68-75 Nm))

Figure 5-108. Main Valve Identification

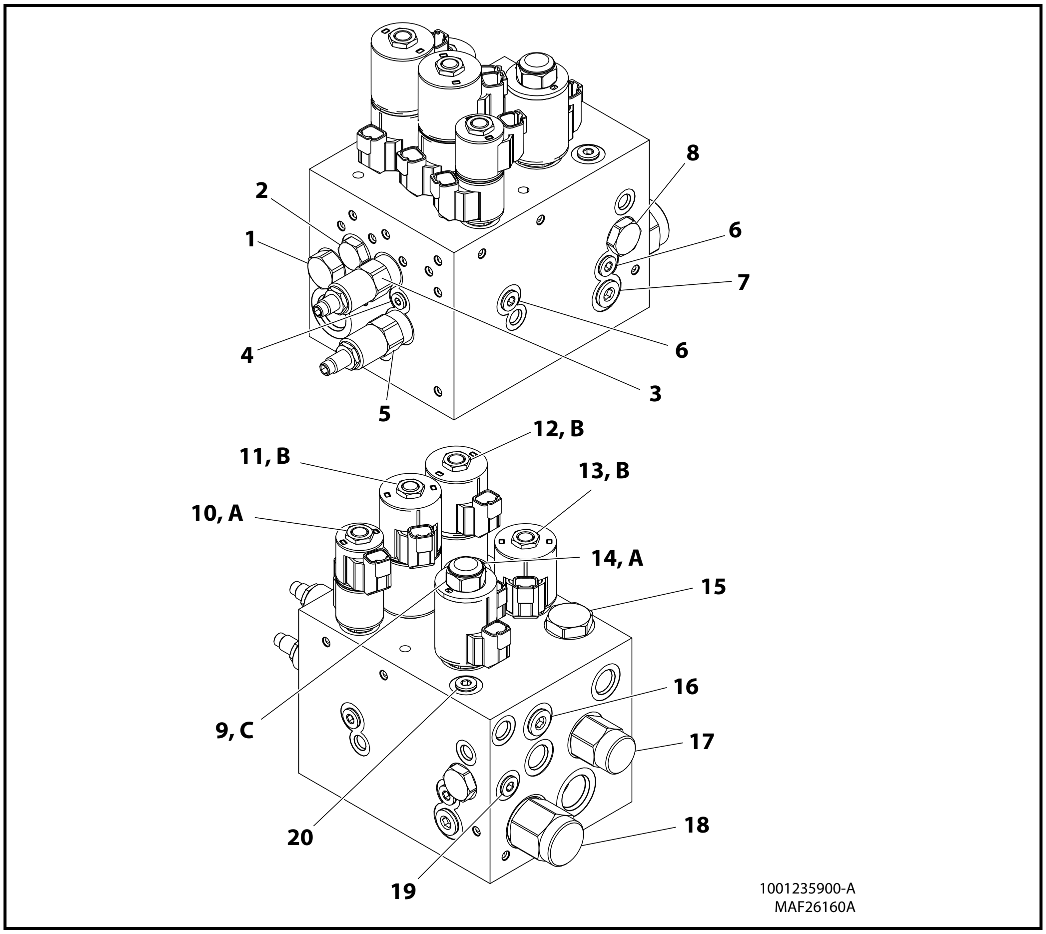


Table 5-34. Cartridge Torque Values

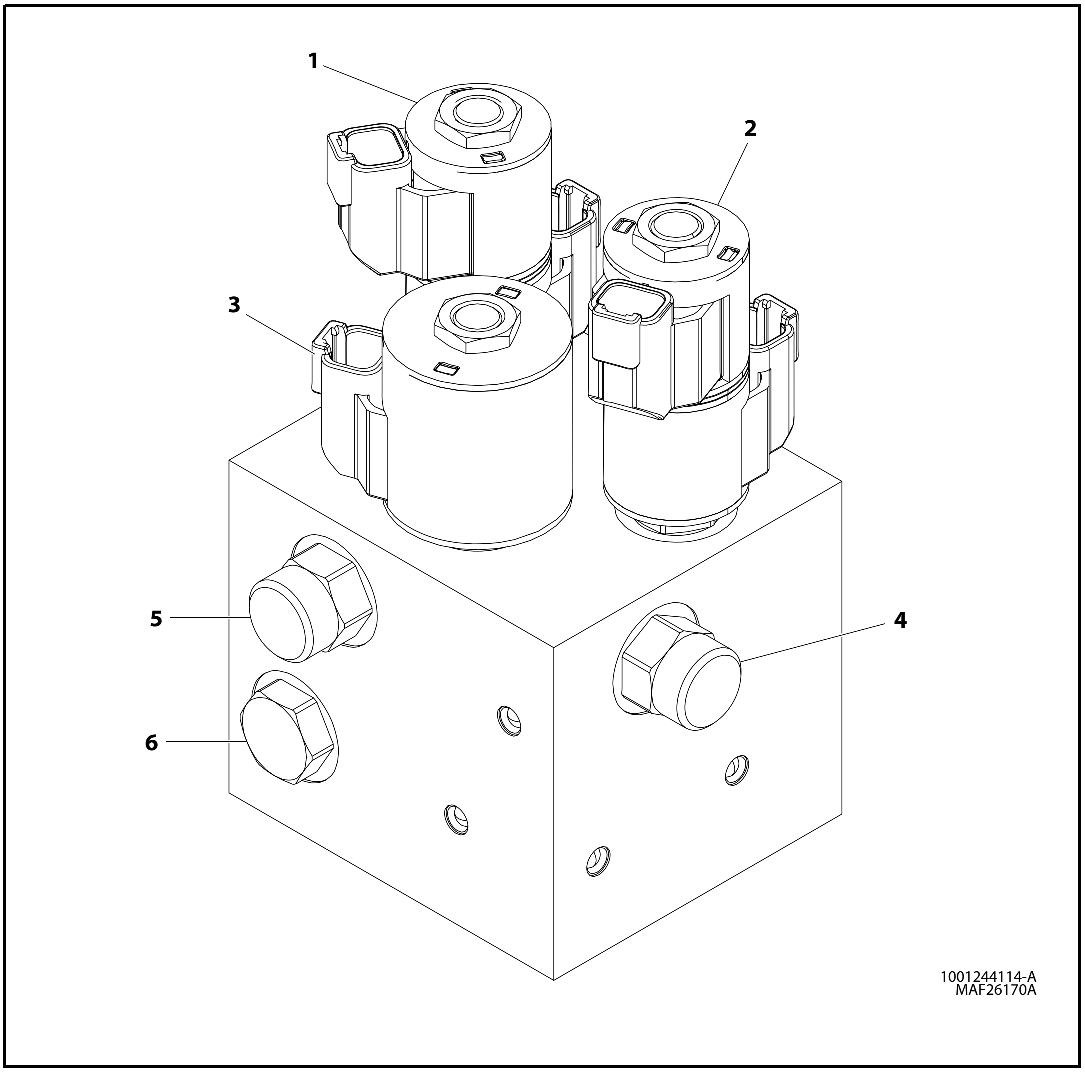
	Ft-Lbs.	Nm
1	33-37	45-50
2	19-21	26-29
3	19-21	26-29
4	14-16	19-22
5	19-21	26-29
6	23-27	31-37
7	33-37	45-50
8	24-26	33-36
9	50-55	68-75
10	19-21	26-29

	Ft-Lbs.	Nm
11	24-26	33-36
12	24-26	33-36
13	50-55	68-75
14	19-21	26-29
15	70-80	95-108
16	33-37	45-50
17	50-55	68-75
18	95-100	129-136
19	23-27	31-37
20	23-27	31-37

Table 5-35. Coil Torque Values

	Ft-Lbs.	Nm
A	5-7	7-10
B	5-7	7-10
C	5-7	7-10

Figure 5-109. Main Valve Cartridge Torque Values



1. Level Up and Down
2. Platform Rotate Valve
3. Platform Dump Valve
4. Rotate Orifice
5. Platform Level Orifice
6. Check Valve

Figure 5-110. Platform Valve Identification (800S)

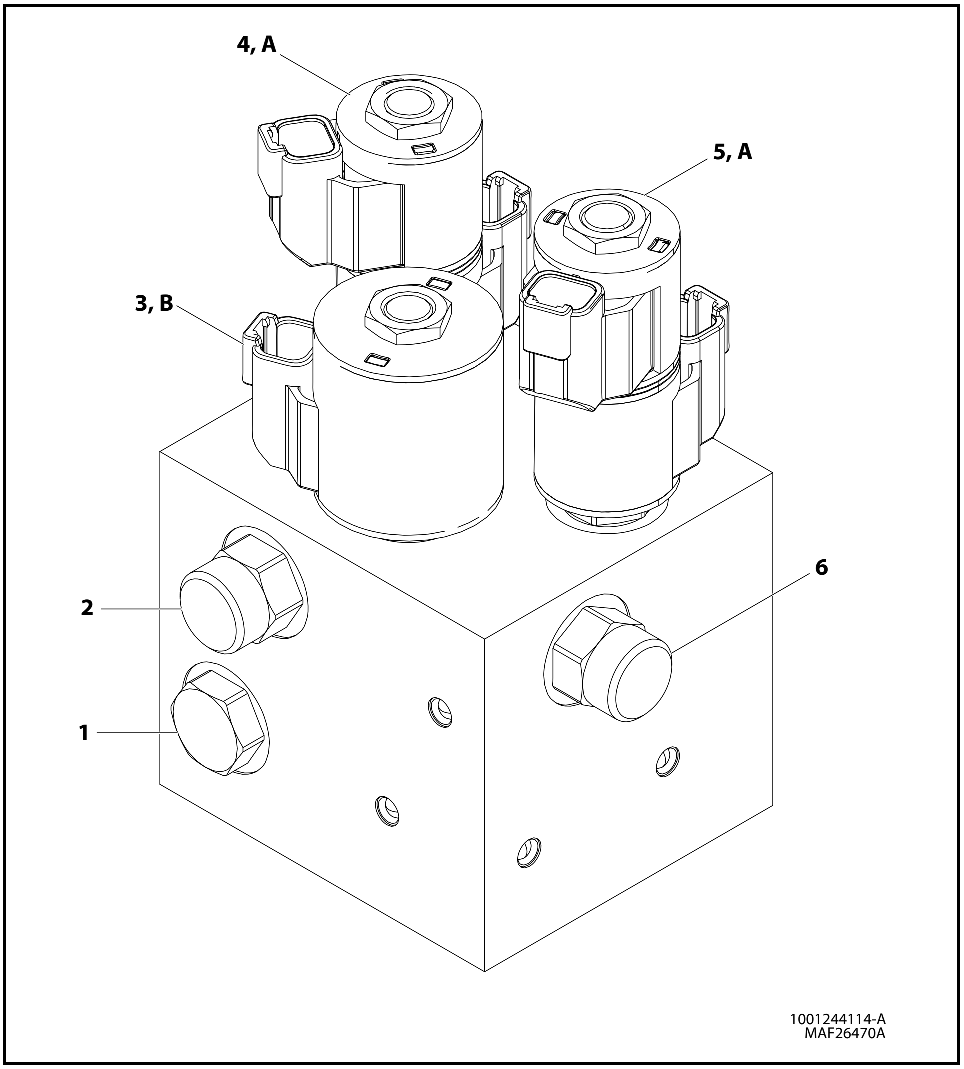


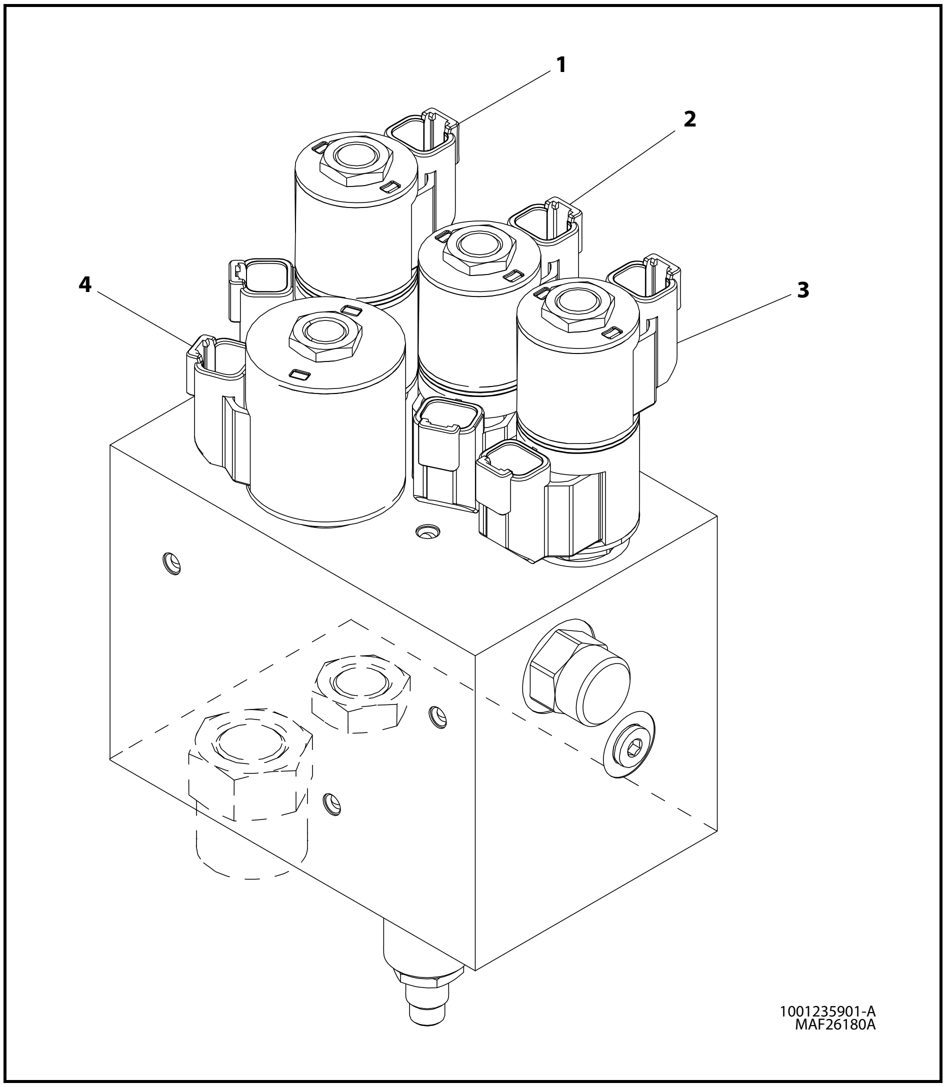
Table 5-36. Cartridge Torque Values

	Ft-Lbs.	Nm
1	NA	NA
2	20	27.1
3	25	33.9
4	20	27.1
5	20	27.1
6	20	27.1

Table 5-37. Coil Torque Values

	Ft-Lbs.	Nm
A	5	6.7
B	6	8

Figure 5-111. Platform Valve Cartridge Torque Values (800S)



1. Platform Level Solenoid Valve
2. Platform Jib Solenoid Valve
3. Platform Rotator Solenoid Valve
4. Platform Dump Valve

Figure 5-112. Platform Valve Identification (860SJ)

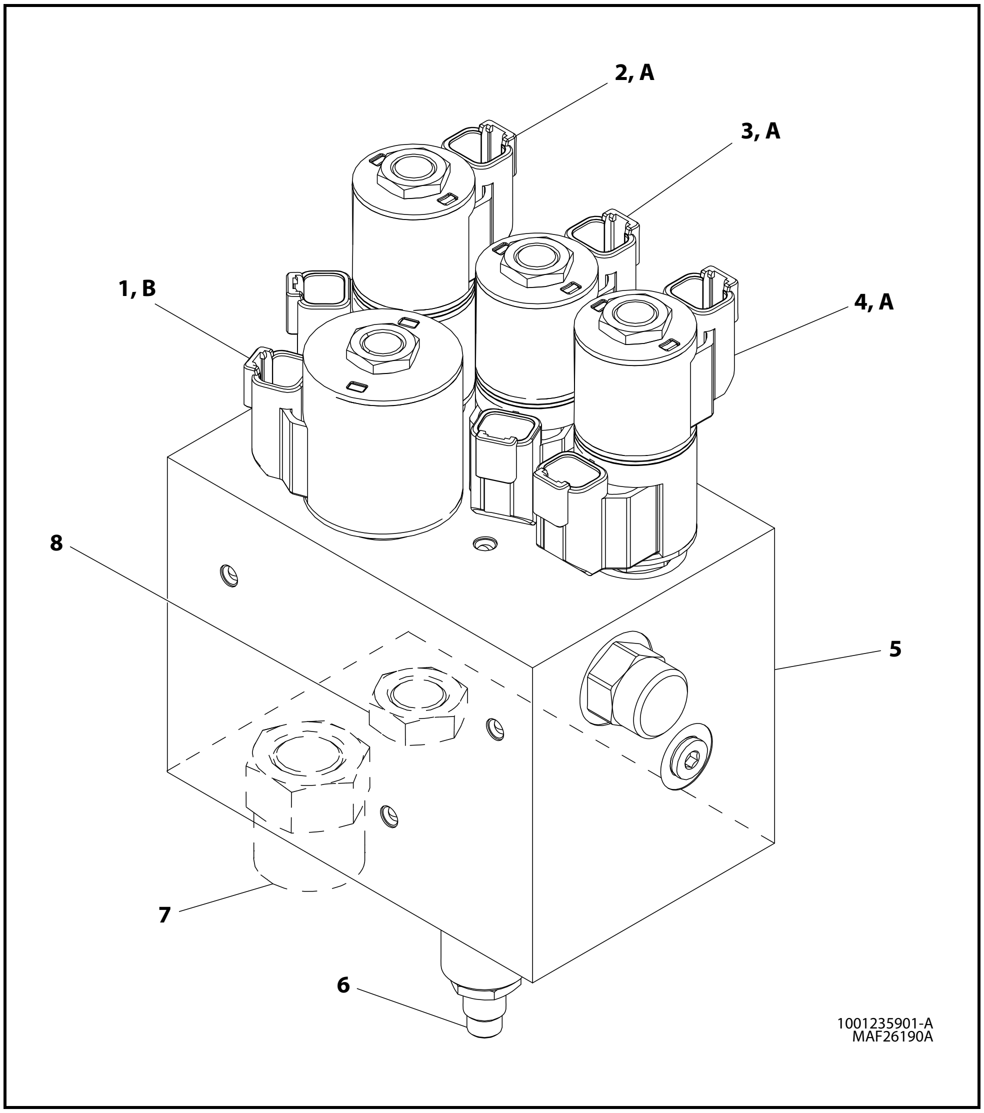


Table 5-38. Cartridge Torque Values

	Ft-Lbs.	Nm
1	25	33.9
2	20	27.1
3	20	27.1
4	20	27.1
5	20	27.1
6	20	27.1
7	20	27.1
8	20	27.1

Table 5-39. Coil Torque Values

	Ft-Lbs.	Nm
A	5	6.7
B	6	8

Figure 5-113. Platform Valve Cartridge Torque Values (860SJ)

5.5 START UP PROCEDURES

Start Up After Overhaul or Replacement of Components

PRE-FILL OF BOTH THE DRIVE AND FUNCTION PUMP

Machine without oil cooler: When filling the oil tank, fill it to the very top of the tank. This will give you enough head pressure from the tank to gravity fill the case on both pumps. The excess oil will be used to fill the cylinders during start up. The top case port on the outside of the drive pump has a 3/4" tee fitting. Remove the cap from the end of the tee. You should see oil in 1-2 minutes, tighten up the cap. The drive pump case is done. Next, go the function pump, using a 3/8" allen wrench remove the plug on the inside of the pump next to the turn-table side sheet. When oil flows out of the pump, 2-3 minutes, re-install the plug. Both pumps are pre-filled. Not doing this causes the pumps to start dry, and reduces the efficiency of the pump and can cause premature failure.

Machine with oil cooler: When filling the oil tank, fill it to the very top of the tank. This will help give you enough head pressure from the tank to gravity fill the case on both pumps. The top case port on the outside of the pump has a 3/4" tee fitting. Remove the cap from the center of the tee. You should see oil in 1-2 minutes. If not, depending on hose routing, the drive pump may not gravity feed. Oil has to flow through the oil cooler to get to the pump. Hose up an external hand pump to this tee fitting, and give it about six pumps after it has started pumping oil. This should be sufficient. Install the cap back onto the tee fitting. The drive pump is done. Next, go the function pump, using a 3/8" allen wrench remove the plug on the inside of the pump next to the turn-table side sheet. When oil flows out of the pump, 2-3 minutes, re-install the plug. Both pumps are pre-filled. Not doing this causes the pumps to start dry, and reduces the efficiency of the pump and can cause premature failure.

PURGING OF THE FUNCTION PUMP SUCTION HOSE.

Large pockets of air get trapped in this line and must be removed at low pressure. Head pressure from the tank is not enough. Here are three methods of purging the air from the hose at low pressure.

1. At the main control valve, remove the 3/4 in. hose from port "P1" and remove the 1 in. hose from port "T" by using a 12-16 connector, connect them together. Start the machine and let it run for approx. 10 seconds. Shut off the machine, remove the 12-16 adapter and re-hose.
2. Remove the 3/4" hose from port "P1" and hold it into a 5 gallon bucket and start the machine. The air should purge very quickly, (seconds). Shut off the machine and re-hose.
3. Remove the 3/4" hose from port "P1", using a #12 male union add approx. 30" of 3/4" hose to it. Remove the return filter cap at the top of the tank, lift out the element making sure the canister stays in the tank. Hold the hose end down in the canister and start the machine and let it run approx. 10 seconds. Re-install the filter and re-hose the machine.

NOTE: ***If using a shop vac to create suction on the oil tank while doing maintenance, both steps "1" and "2" will need done.*

NOTE: ***If installing a new drive pump, step "1" will need done.*

NOTE: ***If installing a new function pump, step "1" and "2" will need done.*

NOTE: ***If installing a new function pump and the suction hose is capped without draining a lot of oil out of the hose, which creates a large air void, step "2" will not need to be done.*

NOTE: ***When operating a function such as Lift Up, if the function pump makes a loud noise and the lift up stops and starts, that is a sign of cavitation, air going through the pump at high pressure. This will in a short time destroy the pump and contaminate the entire system. Make sure all suction hoses are tight and free of leaks at the tank and pump. A suction hose does not leak when the engine is running, it will allow air to be drawn into the pump causing cavitation. After the machine is shut down, then you will see a very slow leak.*

5.6 HYDRAULIC SCHEMATICS

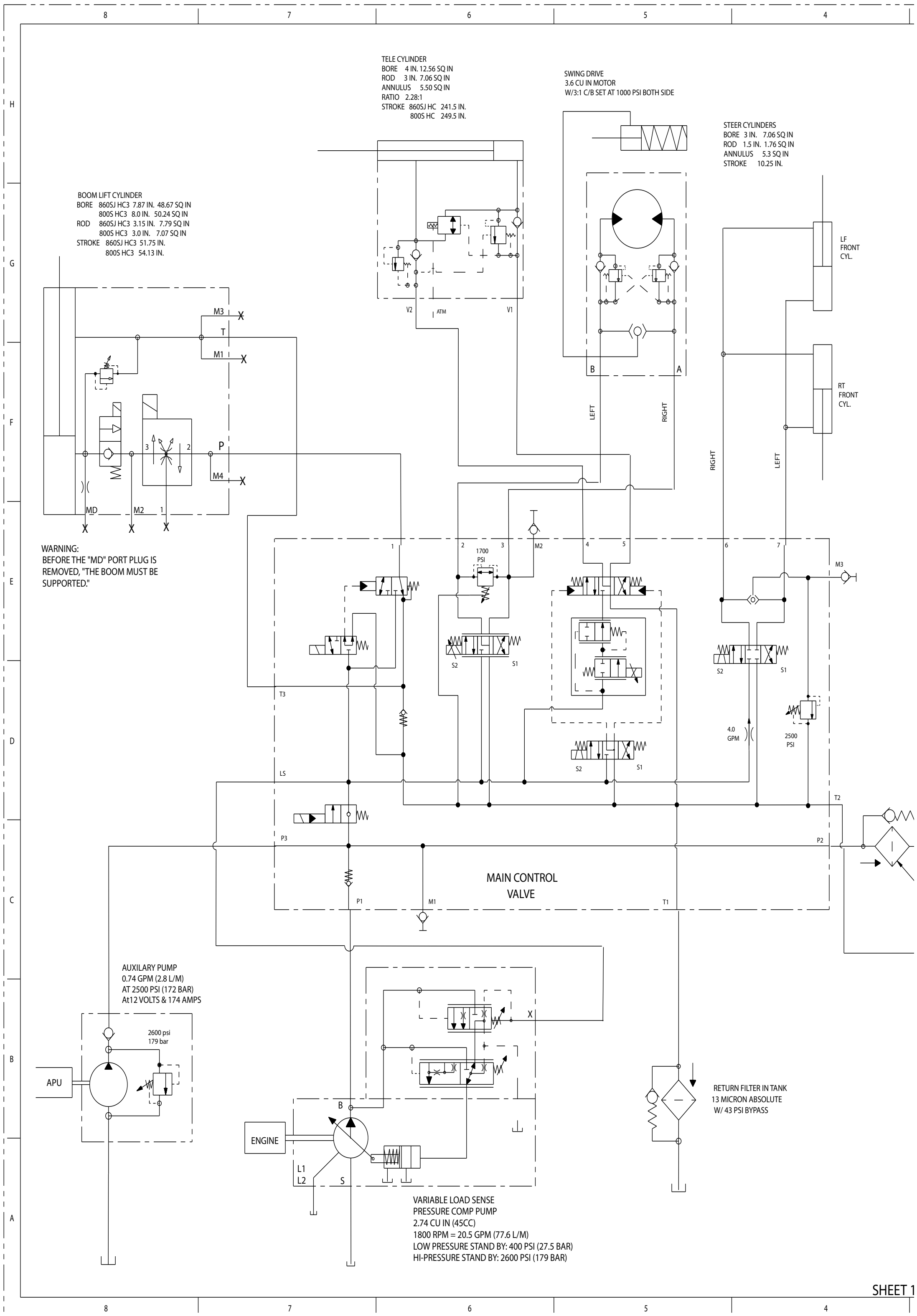


Figure 5-114. Hydraulic Schematic - Sheet 1 of 4

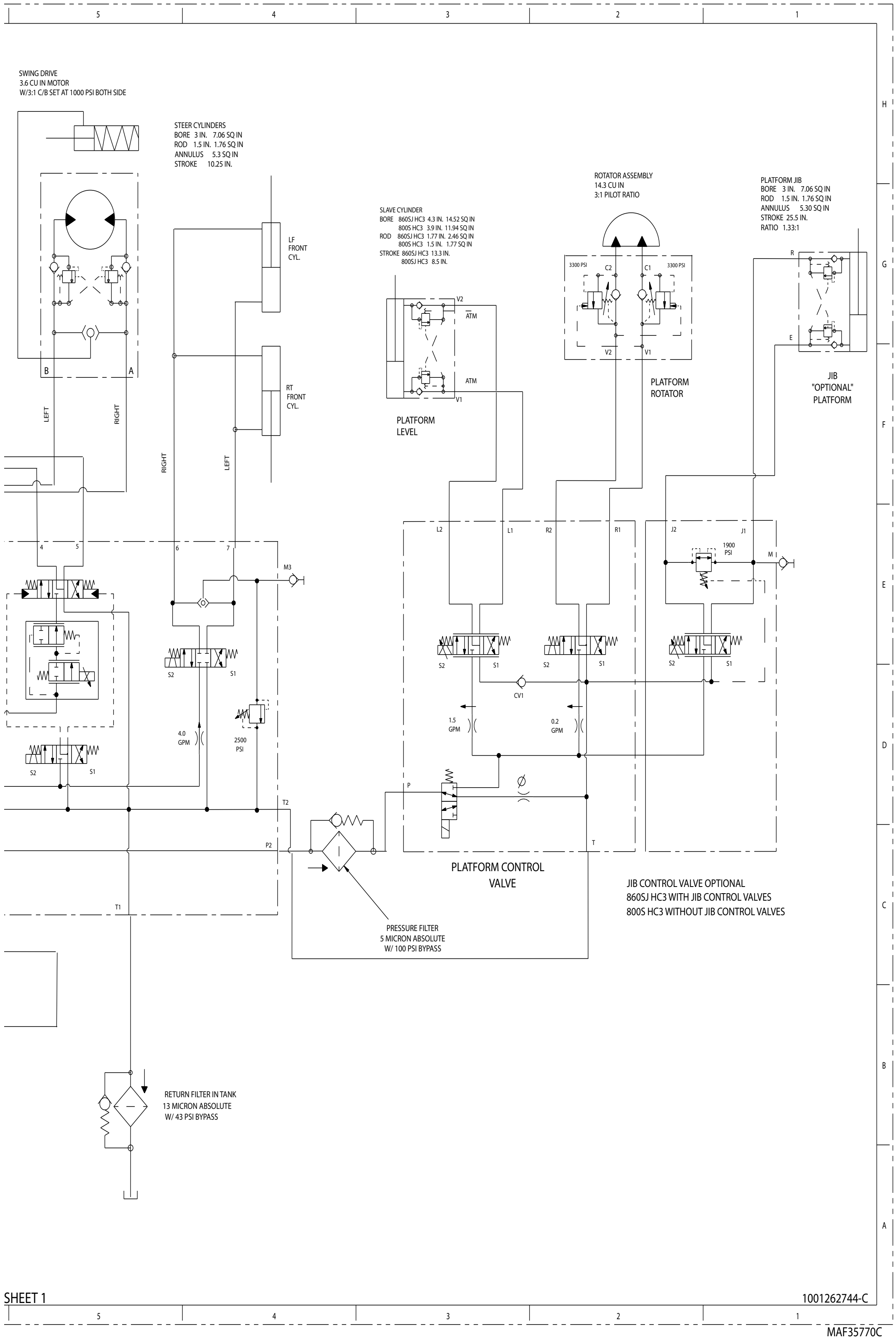


Figure 5-115. Hydraulic Schematic - Sheet 2 of 4

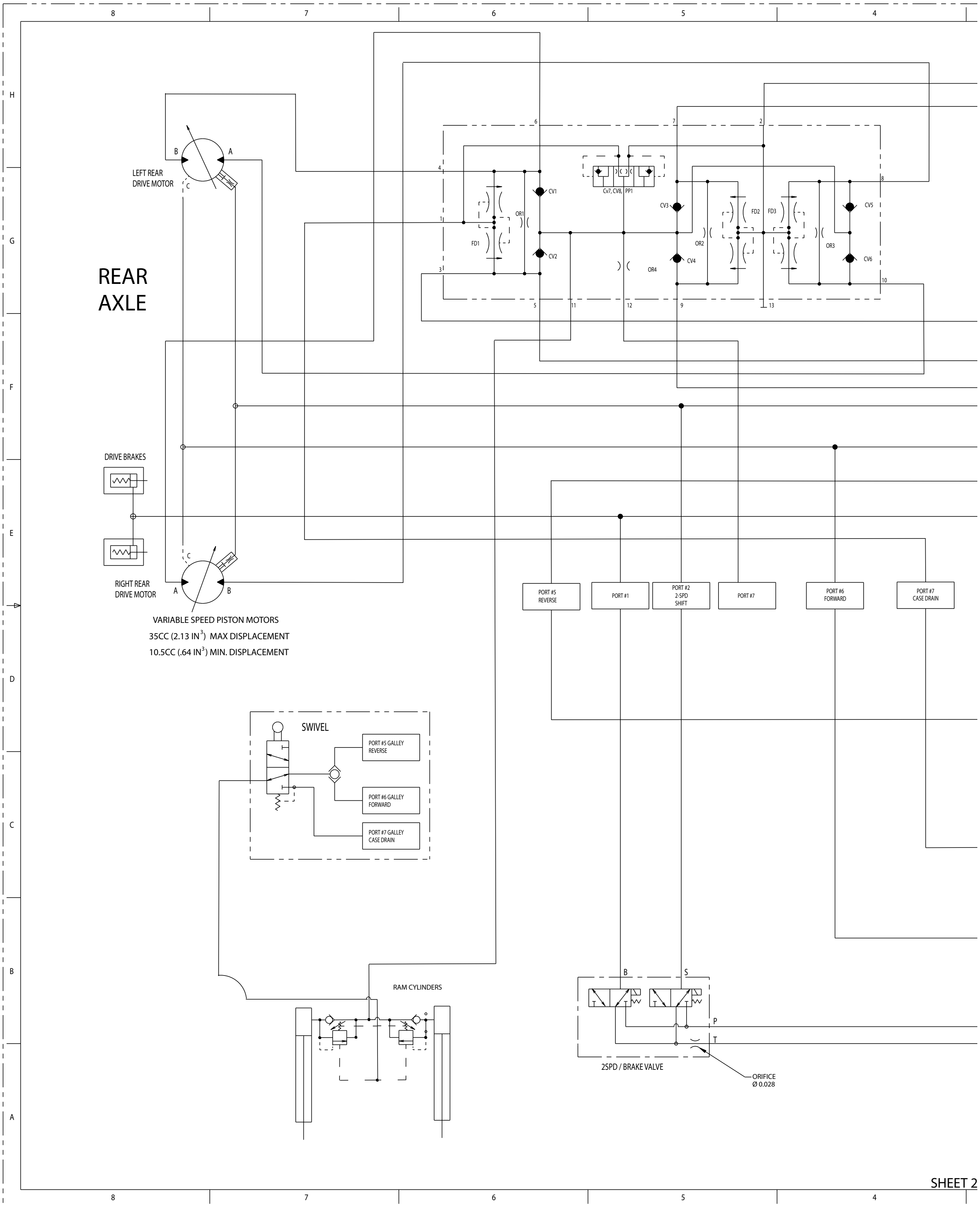


Figure 5-116. Hydraulic Schematic - Sheet 3 of 4

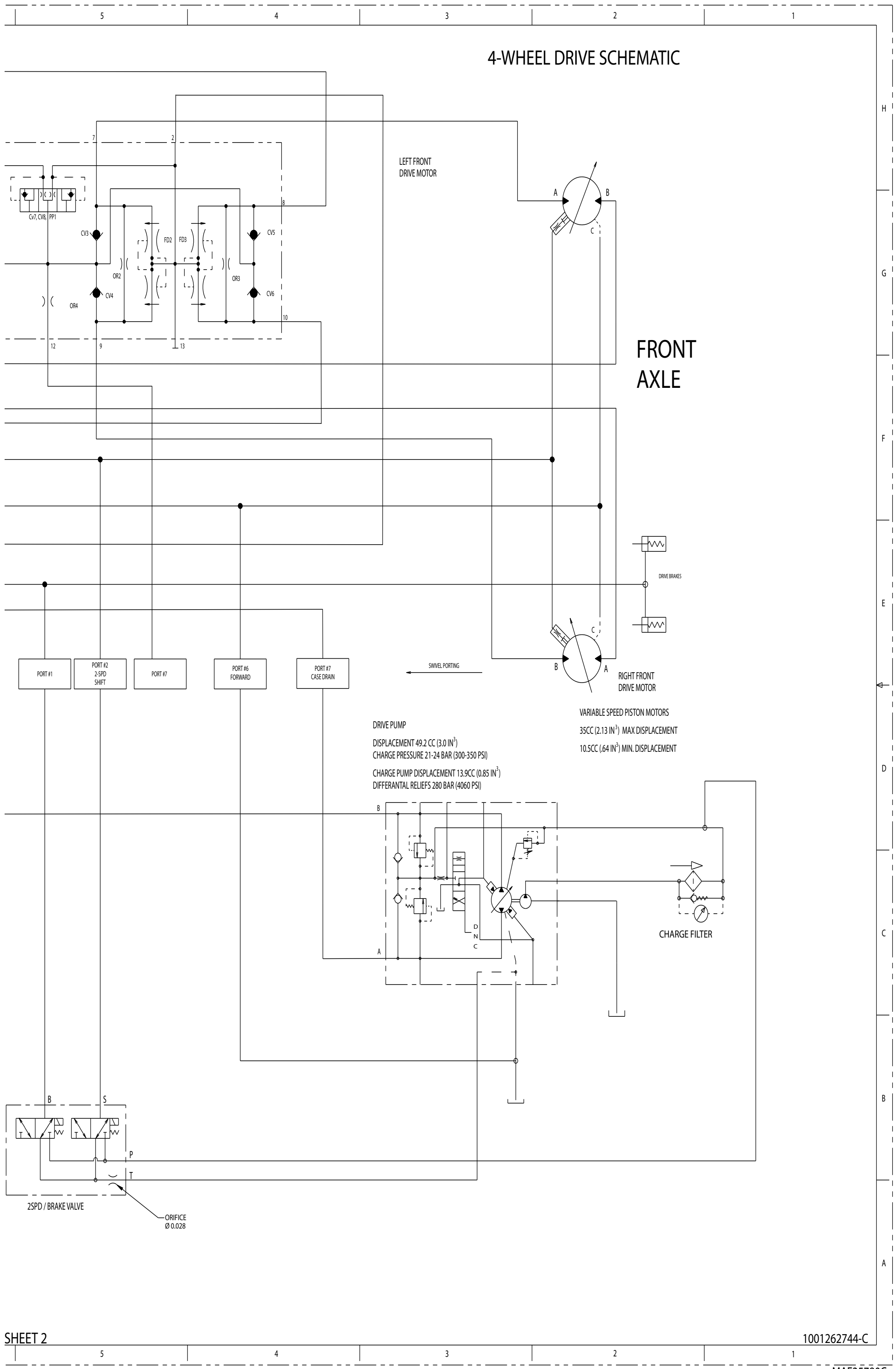


Figure 5-117. Hydraulic Schematic - Sheet 4 of 4

SECTION 6. JLG CONTROL SYSTEM

6.1 JLG CONTROL SYSTEM ANALYZER KIT INSTRUCTIONS

Introduction

NOTICE

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

NOTICE

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

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

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

The main lift, swing, and drive are controlled by individual joysticks, 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 controller has a built in LED to indicate any faults. The system stores recent faults which may be accessed for troubleshooting. Optional equipment includes a soft touch system, head and tail lights, and ground alarm. These options may be added later but must be programmed into the control system when installed.

The Control System may be accessed utilizing a custom designed, hand held analyzer (Analyzer Kit, JLG part no. 1001249695) which will display two lines of information at a time, by scrolling through the program.

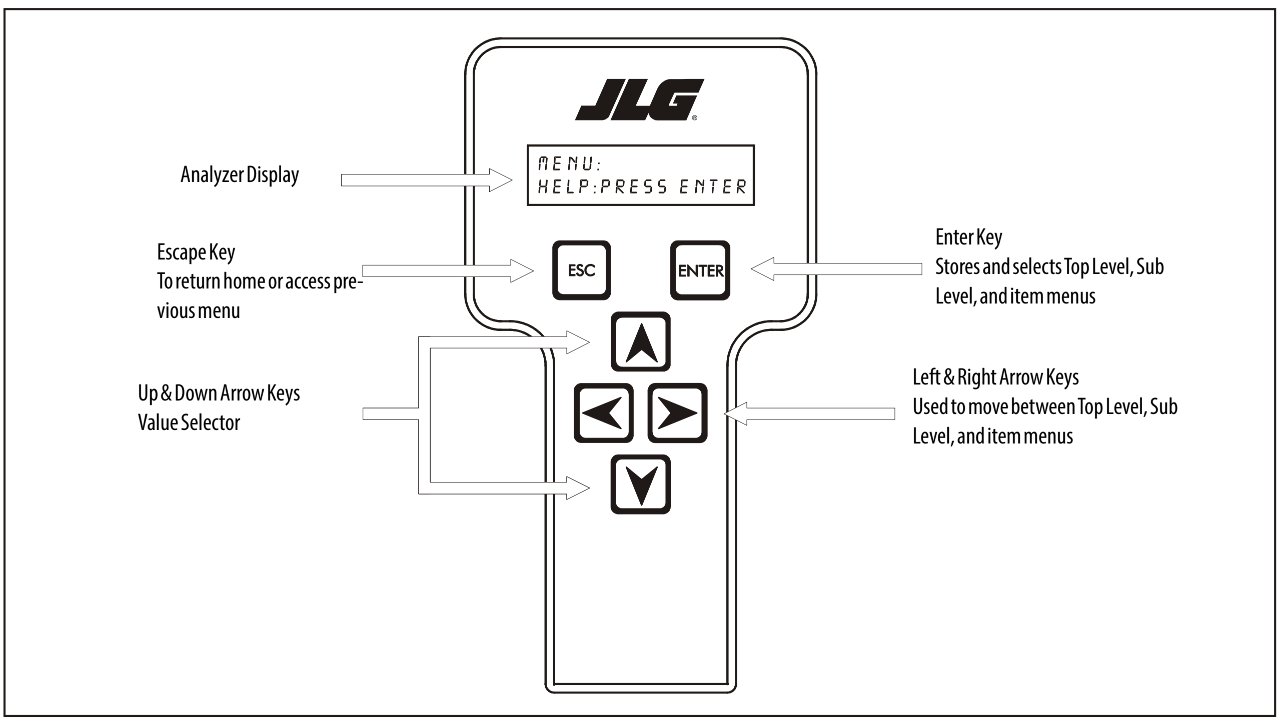


Figure 6-1. Hand Held Analyzer

To Connect the JLG Control System Analyzer

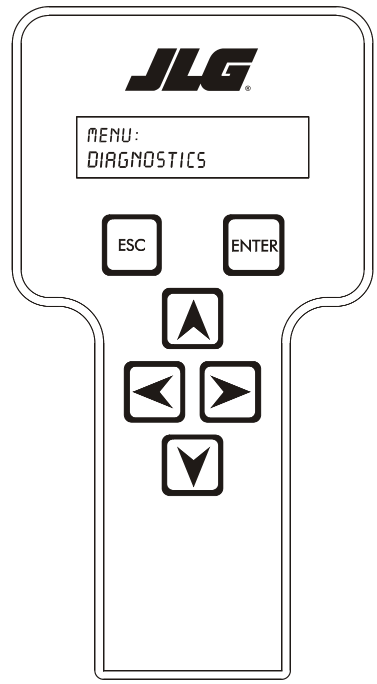
1. Connect one end of the cable, supplied with the analyzer, to the correct four pin connector on the motor control unit; there will be only one connector which correctly fits the cable.
2. Connect the other end of the cable to the analyzer.

NOTE: *The ends of the cable are identical and can be reversed; the cable end can only be inserted one way into the matching connector.*

3. Power up the vehicle by turning the key to the platform or ground position and pulling the emergency stop buttons on; this will power the SMART System and the analyzer.

Using the Analyzer

The analyzer will display the current top level menu item, for example:



MENU:
DIAGNOSTICS

Press LEFT & RIGHT (g, e) to move between menu items; press ENTER to select the displayed menu item.

When a top level menu item is selected, a new set of menu items may be offered; press **LEFT** & **RIGHT** arrows then **ENTER** again to select the required item.

To cancel a selected menu item, press **ESCAPE**; then a different menu item can be chosen.

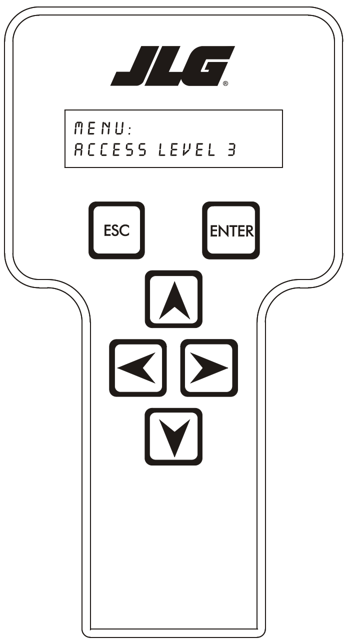
The available menu items will vary depending on the vehicle; check the vehicle manual for more information.

Changing the Access Level of the Hand Held Analyzer

When the analyzer is first connected, its access level ensures that most configurations cannot be changed; this ensures that a setting cannot be accidentally altered.

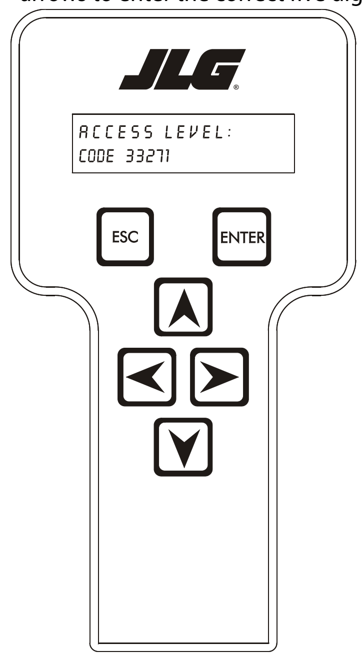
To change the access level, a PASSWORD must be entered; the password must be known.

To enter a password, first find the appropriate top level menu item:



MENU:
ACCESS LEVEL 3

Press **ENTER** to select the ACCESS LEVEL item; then press **UP** & **DOWN** arrows and **LEFT** & **RIGHT** arrows to enter the correct five digit password:



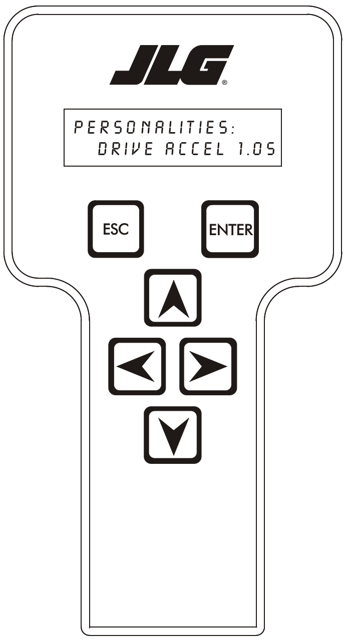
ACCESS LEVEL:
CODE 33271

When the correct password is displayed, press **ENTER** to confirm it; the access level will change to match the password (if not, press **ENTER** to check and correct the password).

The correct passwords will vary depending on the vehicle; check the vehicle manual for more information.

Adjusting Configuration Using the Hand Held Analyzer

When a personality item is selected, press **UP** & **DOWN** arrows to adjust its value, for example:



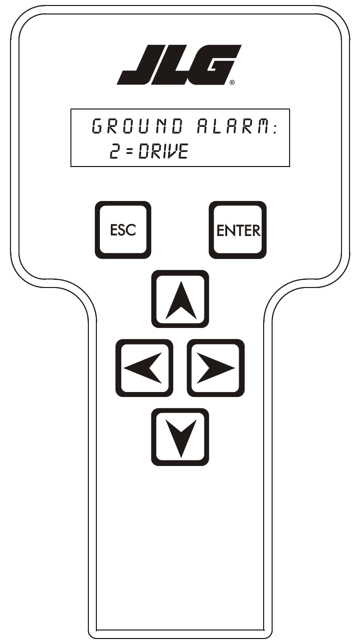
PERSONALITIES:
DRIVE ACCEL 1.0s

There will be a maximum and minimum for the value to ensure safe, operation; the value will not increase if **UP** is pressed when at the maximum, or if DOWN is pressed when at the minimum.

If the value does not change when **UP** or **DOWN** is pressed, check the access level.

Machine Setup

When a machine digit item is selected, press **UP** & **DOWN** (e, e) to adjust its value, for example:



GROUND ALARM:
2 = DRIVE

The effect of the machine digit value is displayed along with its value; there will only be certain settings allowed to ensure safe operation.

If the value does not change when **UP** or **DOWN** is pressed, check the access level.

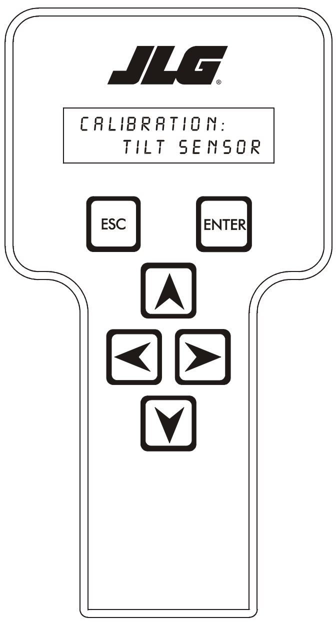
The available personality and machine digit items will vary depending on the vehicle; check the vehicle manual for more information.

Level Vehicle Description

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

⚠ WARNING

DO NOT CALIBRATE THE LEVEL SENSOR EXCEPT ON A LEVEL SURFACE.



Place machine in stowed position with the boom between the rear wheels.

To level machine chose:

CALIBRATION:
TILT SENSOR

Press ENTER.

When prompted, swing machine 180°

Press ENTER.

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

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
G	GROUND
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

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
RT	RIGHT
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	main or UP
V	VOLT
VER	VERSION
VLV	VALVE
WIT	WITNESS
YEL	YELLOW

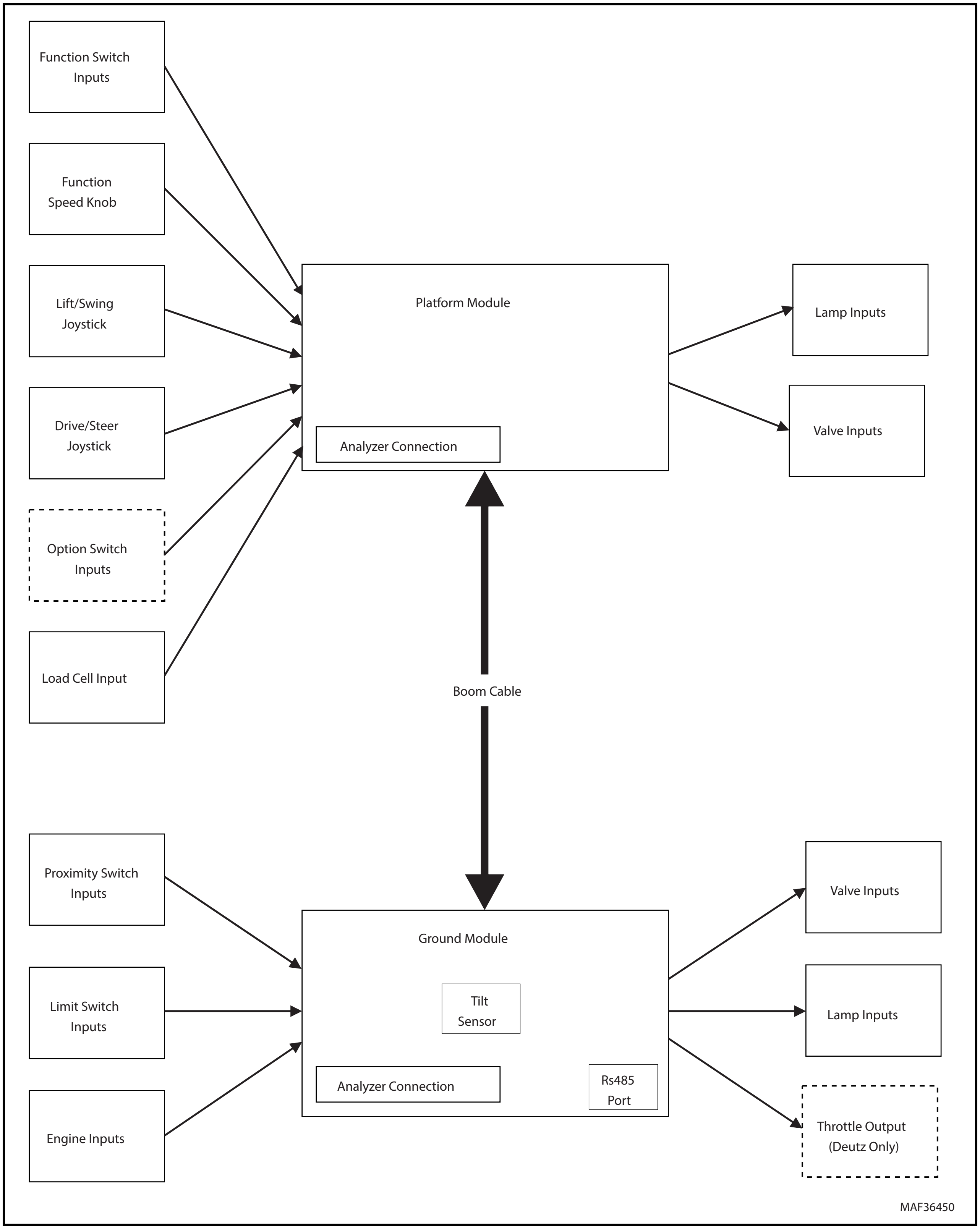


Figure 6-2. ADE Block Diagram

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Label/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**	**600A**	**1**
	2	800A	
	3	800S	
	4	H800A	
MARKET: 2*	**1**	**ANSI USA**	**1**
	2	ANSI EXPORT	
	3	CSA	
	4	CE	
	5	AUSTRALIA	
	6	MOL70	
	7	GB	
* Certain model selections will limit market options.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Label/Digit	Number	Description	Default Number
ENGINE: 3*	1	FORD EFI GAS: Ford LRG425 EFI Gas (Tier 1)	
	2	FORD EFI D/F: Ford LRG425 EFI dual fuel (Tier 1)	
	3	DEUTZ F4 TIER1: Deutz F4M1011F Diesel (Tier 1)	
	4	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	5	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	6	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	7	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	8	**DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)**	**8**
	9	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	10	CAT ECM T4I	
	11	DEUTZ EMR4: Deutz Engine Control Module (Tier 4 Final)	
	12	FORD DUAL FUEL	
	13	KUBOTA D1305	
	14	DZTD22 E5 X-36: Deutz TD22 Stage V 36 KW	
	15	DZTD29 E5 X-50: Deutz TD29 Stage V 50 KW	
* Certain model selections will limit engine options. * Certain market selections will limit engine options.			
GLOW PLUG: 4*	1	NO GLOW PLUGS: No glow plugs installed.	
	2	AIR INTAKE: Glow plugs installed in the air intake on the manifold.	
	3	**IN-CYLINDER: Glow plugs installed in each cylinder.**	**3**
* Only visible for diesel engine selections.			
STARTER LOCKOUT: 5*	**1**	**DISABLED: Automatic pre-glow time determined by ambient air temperature; engine start can be attempted at any time during pre-glow.**	**1**
	2	ENABLED: Automatic pre-glow time determined by ambient air temperature; engine start is NOT permitted until pre-glow is finished.	
* Only visible for diesel engine selections.			
ENGINE SHUTDOWN: 6	1	DISABLED: No engine shutdown.	
	2	**ENABLED: Shutdown engine when coolant temperature is greater than 110 deg. C or the oil pressure is less than 8 PSI.**	**2**

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Label/Digit	Number	Description	Default Number
FUEL CUTOUT: 7*	**1**	**RESTART: Engine allowed to be restarted multiple times when very low fuel level is reached**	**1**
	2	ONE RESTART: Engine allowed to be restarted once for 2 minutes when very low fuel level is reached	
	3	ENGINE STOP: Engine not able to restart when very low fuel level is reached	
* Only visible for diesel engine selections.			
TILT: 8*	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.	
	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 DEG + 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 DEG + 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 DEG + 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.**	**8**
	9	3 DEG + DRV CUT 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 when drive reversal is allowed, drive is disallowed otherwise.	
* Certain market selections will limit tilt options and alter default setting.			
JIB: 9*	**1**	**NO: No jib installed.**	**1**
	2	YES: Jib installed which has up and down movements only.	
* Only visible under certain model selections.			
4 WHEEL STEER: 10*	**1**	**NO: No four-wheel steer installed.**	**1**
	2	YES: Four-wheel steer installed.	
* Only visible under certain model selections.			
SOFT TOUCH: 11*	**1**	**NO: No soft touch installed.**	**1**
	2	YES: Soft touch installed	
* Only visible under certain model selections.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Label/Digit	Number	Description	Default Number
SKYGUARD: 12	1	NO: No SkyGuard installed.	
	2	**BAR/SKYLINE: SkyGuard system installed.**	**2**
	3	SKYEYE: SkyGuard system installed.	
GEN SET/WELDER: 13	**1**	**NO: No generator installed.**	**1**
	2	BELT DRIVE: Belt driven setup.	
GEN SET CUTOUT: 14*	**1**	**MOTION ENABLED: Motion enabled when generator is ON.**	**1**
	2	MOTION CUTOUT: Motion cutout in platform mode only.	
* Only visible if gen set / welder selection is not NO.			
H & T LIGHTS: 15	**1**	**NO: No head and tail lights installed.**	**1**
	2	YES: Head and tail lights installed.	
CABLE SWITCH: 16*	**1**	**NO: No broken cable switch installed.**	**1**
	2	YES: Broken cable switch installed.	
* Only visible under certain model selections.			
LOAD SYSTEM: 17*	1	NO: No load sensor installed.	
	2	WARN ONLY: Functions in creep, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).	
	3	**CUTOUT PLATFORM: All functions cutout, overload lamp lit, platform alarm beeps (5 sec ON, 2 sec OFF).**	**3**
	4	CUTOUT ALL: All functions cutout, flash overload light (500mS on, 500mS off), platform alarm beeps (5 sec ON, 2 sec OFF).	
* Certain market selections will limit load system options or alter default setting.			
FUNCTION CUTOUT: 18*	**1**	**NO: No drive cutout.**	**1**
	2	BOOM CUTOUT: Boom function cutout while driving above elevation.	
	3	DRIVE CUTOUT: Drive & steer cutout above elevation.	
* Certain market selections will limit function cutout options or alter default setting.			
GROUND ALARM: 19	1	NO: No ground alarm installed.	
	2	DRIVE: Travel alarm sounds when the drive function is active (Option).	
	3	DESCENT: Descent alarm sounds when lift down is active (Option).	
	4	**MOTION: Motion alarm sounds when any function is active (Option).**	**4**

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Label/Digit	Number	Description	Default Number
DRIVE: 20	**1**	**4WD: Four wheel drive.**	**1**
	2	2WD: Two wheel drive	
	3	2WD W/ 2-SPEED: Two wheel drive with 2-speed valve.	
DISPLAY UNITS: 21*	**1**	**IMPERIAL: DEG F, PSI, LB**	**1**
	2	METRIC: DEG C, KPA, KGS	
* Certain market selections will alter default setting.			
LEVELING MODE: 22*	**1**	**ALL FUNCTIONS: Platform level with all functions.**	**1**
	2	LEVEL LIFT/TELESCOPE: Platform level on lift and telescope only.	
* Only visible under certain model selections.			
DRIVE CONTROL: 23*	1	NORMAL: Drive coils are energized from the Ground Module.	
	2	PROPULSION: Drive coils are energized from the Propulsion Module.	
	3	**ENHANCED: Drive coils are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns.**	**3**
* Only visible under certain model selections.			
DRIVE PUMP: 24*	**1**	**SAUER DANFOSS: Machine equiped with Sauer Danfoss drive pump**.	**1**
	2	EATON: Machine equipped with Eaton drive pump .	
	3	M46-XXXX: Machine equiped with M46-XXXX drive pump.	
	4	830XXXXX: Machine equiped with 830XXXXX: drive pump.	
* Only visible under certain model selections.			
BOOM CONTROL: 25*	1	NORMAL: Boom function coils are energized from the Ground Module	
	2	**ENHANCED: Boom function are energized from the Ground Module and the ground side of the drive coils are brought back to current feedback returns**	**2**
* Only visible under certain model selections.			
CLEARSKY: 26	**1**	**NO: ClearSky (telematics) options is disabled.**	**1**
	2	YES: ClearSky (telematics) option is enabled.	
CRIBBING OPTION: 27*	**1**	**NO: Cribbing Option is disabled.**	**1**
	2	YES: Cribbing Option is enabled.	
* Only visible under certain model selections.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Label/Digit	Number	Description	Default Number
FUEL TANK SIZE: 28*	**1**	**31 Gallon Tank**	**1**
	2	52 Gallon Tank	
* Only visible under certain model selections.			
ALARM / HORN: 29	1	SEPARATE: Separate alarm and horn.	
	2	**COMBINED: Combination alarm / horn.**	**2**
ALERT BEACON: 30	**1**	**OFF FOR CREEP: Alert beacon will not flash while in Creep**	**1**
	2	20FPS FOR CREEP: Alert beacon will flash at 20FPS while in Creep	
TEMP CUTOUT: 31*	**1**	**NO: Temp Cutout is Disabled**	**1**
	2	YES: Temp Cutout is Enabled	
* Certain model selections will limit temp cutout options.			
PLAT LVL OVR CUT 32	**1**	**NO: Platform Level Override will always be functional**	**1**
	2	YES: Platform Level Override will only be functional when In Transport	
WATER IN FUEL SENSOR: 33*	**1**	**NO: Water in Fuel Sensor Disabled**	**1**
	2	YES: Water in Fuel Sensor Enabled	
* Only visible if engine selection is Deutz EMR4.			
CAPACITY 34*	**1**	**SINGLE: Single Capacity system installed**	**1**
	2	DUAL: Dual Capacity system installed	
	3	TRIPLE: Triple Capacity system installed	
* Only visible under certain model selections.			

1001249237-C

Table 6-3. 800S HC3 Machine Configuration Programming Settings (Software Version P6.33)

800 S	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB
Model Number	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Market	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Engine	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	6	6	6	6	6	6	6
	7	7	7	7	7	7	7
	8	**8**	**8**	**8**	**8**	**8**	**8**
	9	9	9	9	9	9	9
	10	10	10	10	10	10	10
	11	11	11	11	11	11	11
	12	12	12	12	12	12	12
	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	X	X	X	15	X	X	X
Glow Plug	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	**3**	**3**	**3**	**3**	**3**	**3**
Starter Lockout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Engine Shutdown	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
Fuel Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Tilt	X	X	X	X	X	1	X
	X	X	X	X	X	2	X
	X	X	X	X	X	3	X
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	6	6	6	6	6	6	6
	7	7	7	7	7	7	7
	8	**8**	**8**	**8**	**8**	**8**	**8**
	9	9	9	9	9	9	9
Jib	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
4 Wheel Steer	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Soft Touch	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
SkyGuard	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
	3	3	3	3	3	3	3
Gen Set / Welder	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Gen Set Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Head & Tail-lights	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Cable Switch	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
Load System	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	3	**3**	**3**	X	**3**	**3**	**3**
	4	4	4	**4**	X	4	4
Function Cut-out	**1**	**1**	**1**	1	**1**	**1**	**1**
	X	2	2	**2**	2	2	2
	3	3	3	X	3	3	3
Ground Alarm	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
	4	**4**	**4**	**4**	**4**	**4**	**4**
Drive	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Display Units	**1**	**1**	1	1	1	1	1
	2	2	**2**	**2**	**2**	**2**	**2**
Leveling Mode	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Drive Control	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	3	**3**	**3**	**3**	**3**	**3**	**3**
Drive Pump	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
Boom Control	X	X	X	X	X	X	X
	2	**2**	**2**	**2**	**2**	**2**	**2**
ClearSky	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Cribbing Option	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Fuel Tank Size	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2

Table 6-3. 800S HC3 Machine Configuration Programming Settings (Software Version P6.33)

800 S	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB
Alarm / Horn	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
Alert Beacon	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Temp Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	X	2	X	2	X	X	2
Plat Lvl Ovr Cut	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Water In Fuel Sensor	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Capacity	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	***3***	***3***	***3***	***3***	***3***	***3***
BOLD TEXT indicates the default setting. Plain text indicates another available selection. ***RED ITALIC*** text indicates the required selection for machine model. SHADED CELLS indicate hidden menus or selections.							

1001249237-C

Table 6-4. 860SJ HC3 Machine Configuration Programming Settings (Software Version P6.33)

860 SJ	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB
Model Number	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Market	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Engine	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	6	6	6	6	6	6	6
	7	7	7	7	7	7	7
	8	**8**	**8**	**8**	**8**	**8**	**8**
	9	9	9	9	9	9	9
	10	10	10	10	10	10	10
	11	11	11	11	11	11	11
	12	12	12	12	12	12	12
	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	X	X	X	15	X	X	X
Glow Plugs	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	**3**	**3**	**3**	**3**	**3**	**3**
Starter Lockout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2

Table 6-4. 860SJ HC3 Machine Configuration Programming Settings (Software Version P6.33)

860 SJ	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB
Engine Shutdown	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
Fuel Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
Tilt	X	X	X	X	X	1	X
	X	X	X	X	X	2	X
	X	X	X	X	X	3	X
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	6	6	6	6	6	6	6
	7	7	7	7	7	7	7
	8	**8**	**8**	**8**	**8**	**8**	**8**
	9	9	9	9	9	9	9
Jib	1	1	1	1	1	1	1
	2	***2***	***2***	***2***	***2***	***2***	***2***
4 Wheel Steer	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Soft Touch	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
SkyGuard	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
	3	3	3	3	3	3	3
Gen Set / Welder	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Gen Set Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Head & Taillights	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Cable Switch	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
Load System	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	3	**3**	**3**	X	**3**	**3**	**3**
	4	4	4	**4**	X	4	4
Function Cutout	**1**	**1**	**1**	1	**1**	**1**	**1**
	X	2	2	**2**	2	2	2
	3	3	3	X	3	3	3
Ground Alarm	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3
	4	**4**	**4**	**4**	**4**	**4**	**4**
Drive	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
	3	3	3	3	3	3	3

Table 6-4. 860SJ HC3 Machine Configuration Programming Settings (Software Version P6.33)

860 SJ	ANSI USA	ANSI Export	CSA	CE	Australia	MOL70	GB
Display Units	**1**	**1**	1	1	1	1	1
	2	2	**2**	**2**	**2**	**2**	**2**
Leveling Mode	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Drive Control	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	3	**3**	**3**	**3**	**3**	**3**	**3**
Drive Pump	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
Boom Control	X	X	X	X	X	X	X
	2	**2**	**2**	**2**	**2**	**2**	**2**
ClearSky	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Cribbing Option	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Fuel Tank Size	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Alarm / Horn	1	1	1	1	1	1	1
	2	**2**	**2**	**2**	**2**	**2**	**2**
Alert Beacon	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Temp Cutout	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	X	2	X	2	X	X	2
Plat Lvl Ovr Cut	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Water In Fuel Sensor	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	2	2	2	2	2	2	2
Capacity	1	1	1	1	1	1	1
	2	2	2	2	2	2	2
	3	*3*	*3*	*3*	*3*	*3*	*3*

BOLD TEXT indicates the default setting. Plain text indicates another available selection. ***RED ITALIC*** text indicates the required selection for machine model. SHADED CELLS indicate hidden menus or selections.

1001249237-C

6.2 MACHINE PERSONALITY SETTINGS AND FUNCTION SPEEDS

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

NOTE: *GROUND MODE speeds are automatically limited to being lower than platform speed for a given function.*

NOTE: *Set personalities in the following order: creep speeds, platform speeds, and then ground speeds.*

Table 6-5. Machine Personality Settings and Function Speeds (Software Version P6.33)

FUNCTION	PERSONALITY	RANGE	800S HC3 / 860SJ HC3 DEFAULTS	
			DANFOSS	EATON
DRIVE	Acceleration	0.0-5.0 sec	2.0	
	Deceleration	0.0-3.0 sec	2.0	
	Forward Minimum speed	1-35%	4	15
	Forward Maximum speed	1-100%	30	53
	Reverse Minimum speed	1-35%	4	15
	Reverse Maximum speed	1-100%	30	53
	Elevated Maximum speed	1-100%	20	28
	Creep Maximum speed	1-90%	20	30
STEER	Maximum speed	1 to 100%	100	
MAIN LIFT	Acceleration	0.0-5.0 sec	2.5	
	Deceleration	0.0-3.0 sec	1.5	
	Minimum Up speed	1-60%	15	
	Maximum Up speed	1-100%	80	
	Creep maximum Up speed	1-65%	30	
	Minimum Down speed	1-60%	15	
	Maximum down speed	1-100%	80	
	Creep Maximum down speed	1-75%	30	
	Soft Up	1-75%	35	
	Soft Down	1-75%	30	
SWING	Acceleration	0.0-5.0 sec	2.8	
	Deceleration	0.0-3.0 sec	1.7	
	Minimum Left speed	1-50%	14	
	Maximum Left speed	1-100%	65	
	Creep Maximum Left speed	1-65%	43	
	Minimum Right speed	1-50%	14	
	Maximum Right speed	1-100%	68	
	Creep Maximum Right speed	1-65%	49	
MAIN TELESCOPE	Acceleration	0.0-5.0 sec	3.5	
	Deceleration	0.0-3.0 sec	1.0	
	Minimum IN speed	1-65%	24	
	Maximum IN speed	1-100%	63	
	Minimum OUT speed	1-65%	26	
	Maximum OUT speed	1-100%	65	

Table 6-5. Machine Personality Settings and Function Speeds (Software Version P6.33)

FUNCTION	PERSONALITY	RANGE	800S HC3 / 860SJ HC3 DEFAULTS	
			DANFOSS	EATON
PLATFORM LEVEL	Acceleration	0.0-5.0 sec	0.1	
	Deceleration	0.0-3.0 sec	0.1	
	Minimum Up speed	1-65%	48	
	Maximum Up speed	1-100%	100	
	Minimum Down speed	1-65%	48	
	Maximum Down speed	1-100%	100	
PLATFORM ROTATE	Acceleration	0.0-5.0 sec	0.1	
	Deceleration	0.0-3.0 sec	0.1	
	Minimum Left speed	1-100%	69	
	Maximum Left speed	1-100%	90	
	Minimum Right speed	1-100%	69	
	Maximum Right speed	1-100%	90	
JIB LIFT	Acceleration	0.0-5.0 sec	3.3	
	Deceleration	0.0-3.0 sec	0.8	
	Minimum Up speed	1-65%	43	
	Maximum Up speed	1-100%	80	
	Minimum Down	1-65%	40	
	Maximum Down	1-100%	75	
GROUND MODE	Main Lift Up speed	1-100%	63	
	Main Lift down speed	1-100%	63	
	Swing Left speed	1-100%	64	
	Platform Level speed	1-100%	99	
	Platform Rotate speed	1-100%	89	
	Main Telescope speed	1-100%	62	
	Tower Telescope speed	1-100%	N/A	
	Tower Lift Up speed	1-100%	N/A	
	Tower Lift Down speed	1-100%	N/A	
	Jib Lift speed	1-100%	79	

1001245447-C

6.3 MACHINE ORIENTATION WHEN DOING SPEED TESTS

Main Lift: Tower lift fully elevated, tower telescope fully extended, Main Telescope fully retracted. Main Lift Up, record time. Main Lift Down, record time. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode; Creep light on Panel must be energized. Verify that machine will Lift Up and Down. Return Knob to fully clockwise.

Swing: Boom at full elevation, Telescope retracted. Swing Right until over rear axle or end stop (if equipped). To eliminate effect of controller rampup/down, record time starting, while swinging, as turntable is centered. Swing Left 360° or end stop (if equipped), record time. Swing Right 360° or end stop (if equipped), record time. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode; Creep light on Panel must be energized. Verify that machine will swing left and right. Return Knob to fully clockwise.

Main Telescope: Main Lift at full elevation, Telescope Retracted. Telescope Out, record time. Telescope In, record time. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode; Creep light on Panel must be energized. Verify that machine will Telescope In and Out. Return Knob to fully clockwise.

Drive (Below Elevation): Test should be done on a smooth, level surface. The Drive Select Switch should be in the "Max Speed" position. Start approximately 7.6m (25 ft) from starting point so the unit is at a maximum speed when starting the test. Results should be recorded for a 61m (200ft) course. Drive forward, "High Speed", record time.

Drive (Above Elevation): Test should be done on a smooth, level surface. The Drive Select Switch should be in the "Max Speed" position, the boom should be > 10° above horizontal to ensure the drive is operating in Max Torque mode. Results should be recorded for a 15.2m (50ft) course. Drive forward, record time. Drive reverse, record time. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode; Creep light on Panel must be energized. Verify that machine will Drive Forward and Reverse. Return Knob to fully clockwise.

Platform Rotate: Platform level, Rotate Platform Right until stop. Platform Left, record time. Platform Right, record time. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode; Creep light on Panel must be energized. Verify that machine will Platform Rotate Left and Right. Return Knob to fully clockwise.

NOTE: *When the platform speed control knob is turned fully counterclockwise. The platform rotate may not work, this is acceptable.*

Jib Lift: Platform level and centered with the boom. Jib Lift Down until stop. Jib Lift Up, record time. Jib Lift Down, record time. Turn Platform Speed Control Knob fully counterclockwise to enter Creep mode; Creep light on Panel must be energized. Verify that machine will Jib Lift Up and Down. Return Knob to fully clockwise.

Test Notes

1. Stop watch should be started with the function movement, not with actuation of joystick or switch.
2. All speed tests are run from the platform. These speeds do not reflect the ground control operation.
3. The platform speed knob control must be at full speed (turned clockwise completely) unless noted.
4. Function speeds may vary due to cold, thick hydraulic oil. Test should be run with the oil temperature above 100° F (38° C).
5. Some flow control functions may not work with the platform speed control knob clicked into the creep position.
6. Drive speeds should be set to the values below regardless of the tire size.

Table 6-6. Function Speeds (In Seconds)

Function	800S	860SJ
Lift Up	59-75	56-73
Lift Down	57-75	56-75
Swing Right & Left*	110-135	110-135
NOTE: *No more than 10% difference between swing left and swing right.*		
Telescope Out	59-65	56-65
Telescope In	45-57	44-60
Platform Rotate Right & Left**	18-30	18-30
NOTE: *No more than 15% difference between rotate left and rotate right.*		
Jib Up	N/A	33-47
Jib Down	N/A	29-39
Drive (Forward)	33-45	33-45
Drive (Elevated)	46-75	46-75

6.4 CANBUS COMMUNICATIONS

CANbus: CAN (Control Area Network) is a two wire differential serial link between the Platform Module, Jib Module, Ground Module, Boom Length Angle Module and the Chassis Module providing bi-directional communications.

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

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

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

A complete CANbus circuit is approximately 60 ohms, which can be verified at the "T" fitting inside the ground station or below the BLAM. Each individual circuit from the modules is approximately 120 ohms.

The GROUND MODULE (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 GROUND MODULE 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 setpoint sent from the GROUND MODULE.

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

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

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

NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

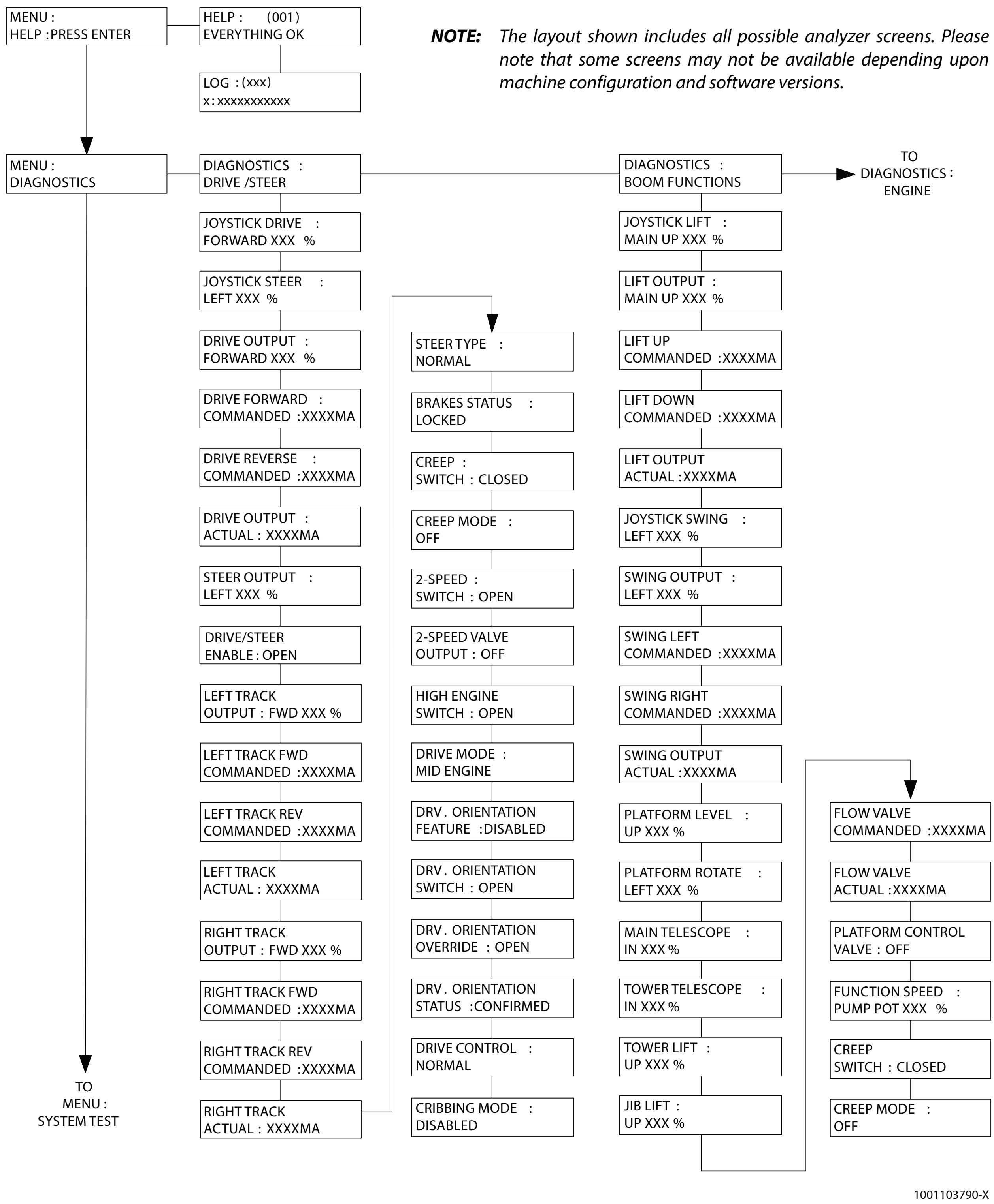
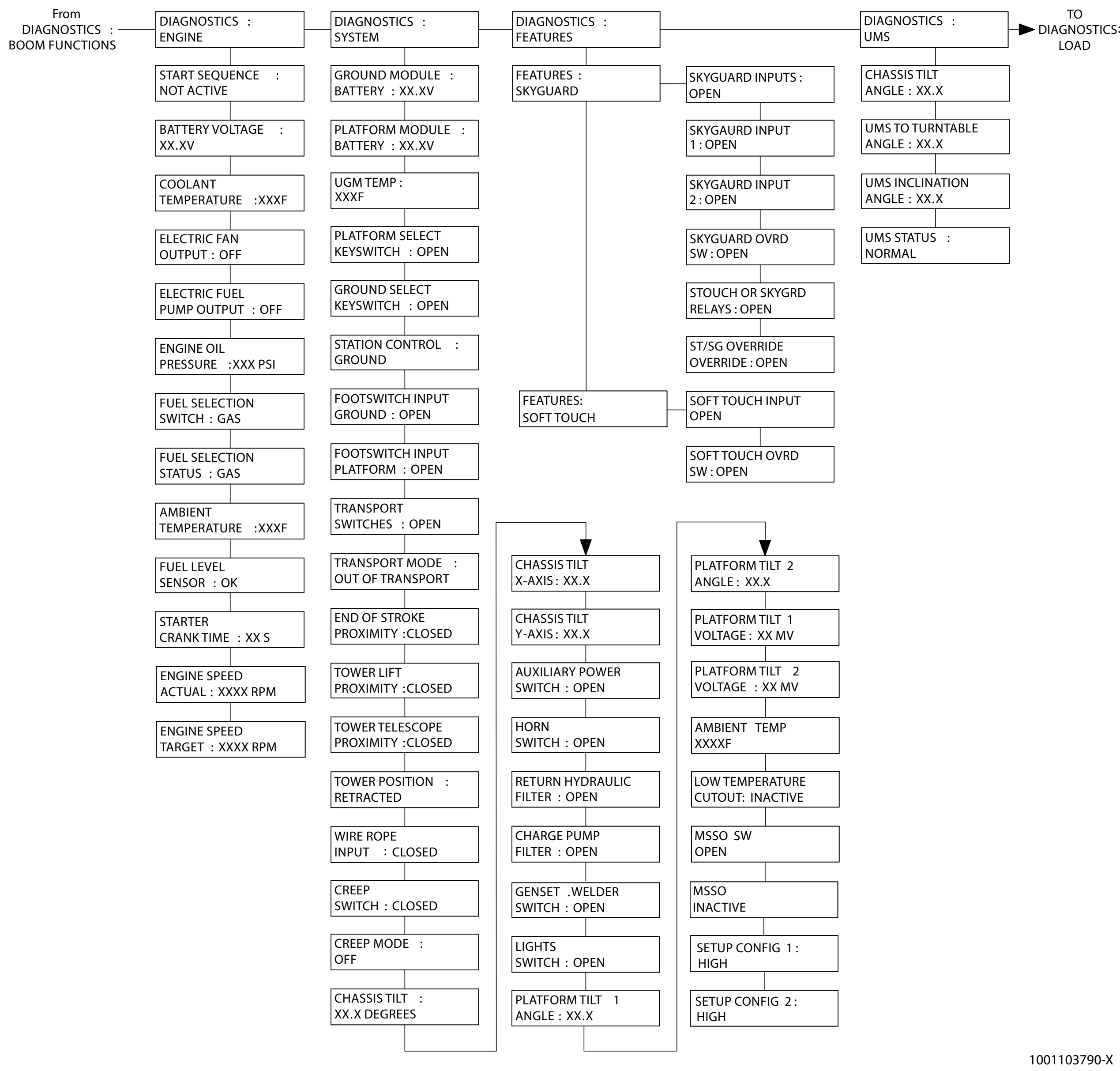
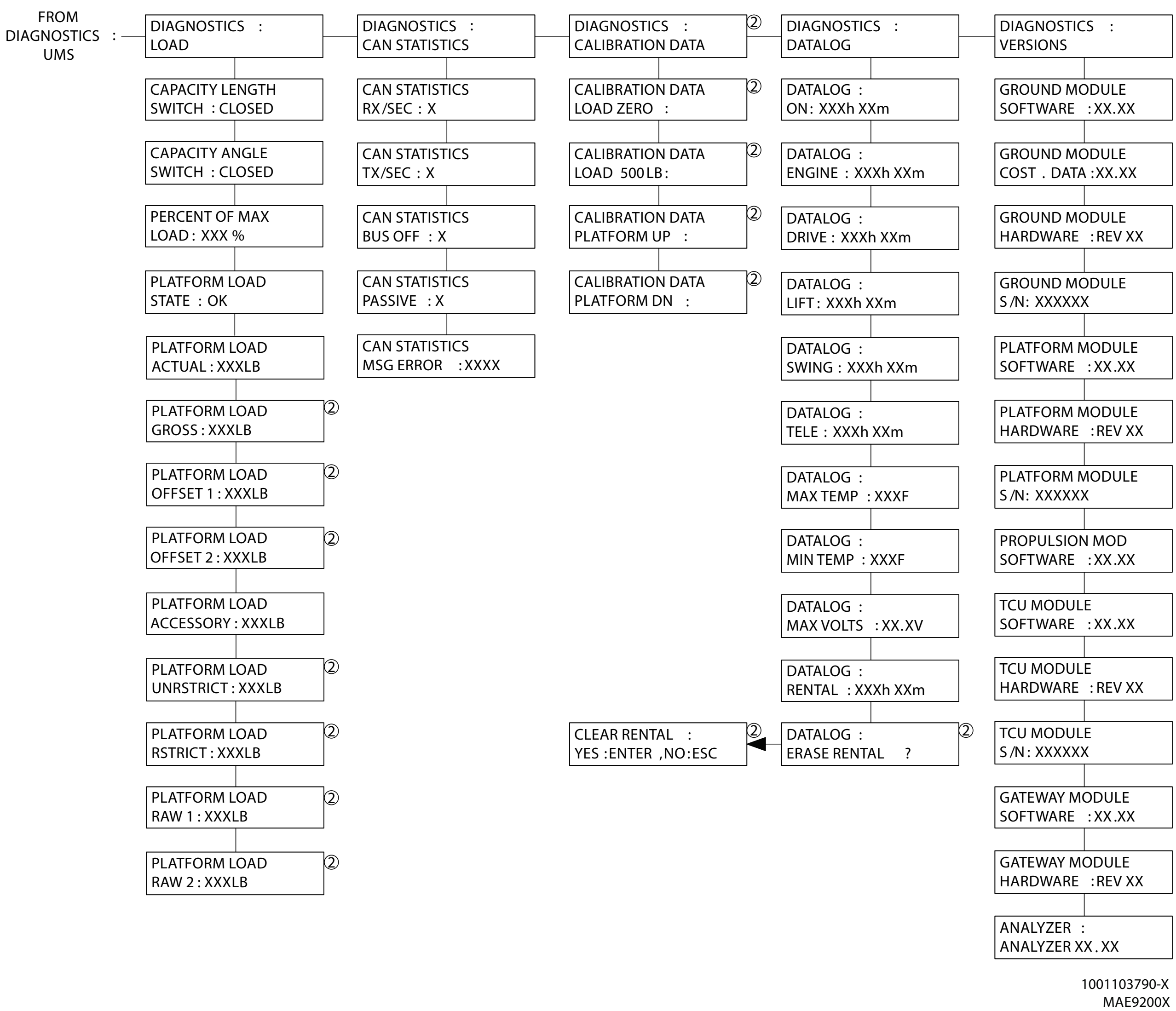


Figure 6-3. Analyzer Flow Chart - Diagnostics (Software Version P6.33) - Sheet 1 of 7



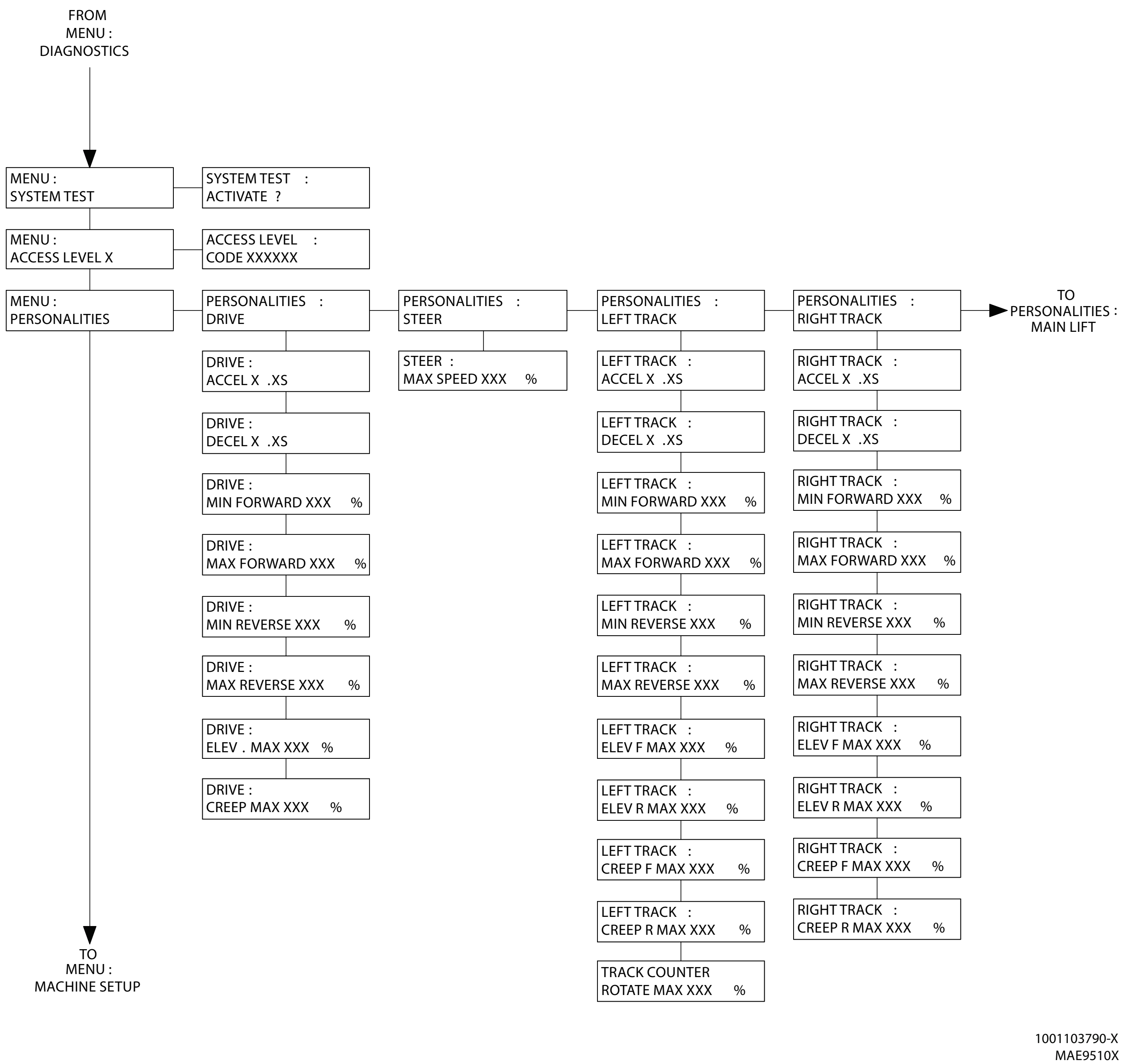
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-4. Analyzer Flow Chart - Diagnostics (Software Version P6.33) - Sheet 2 of 7



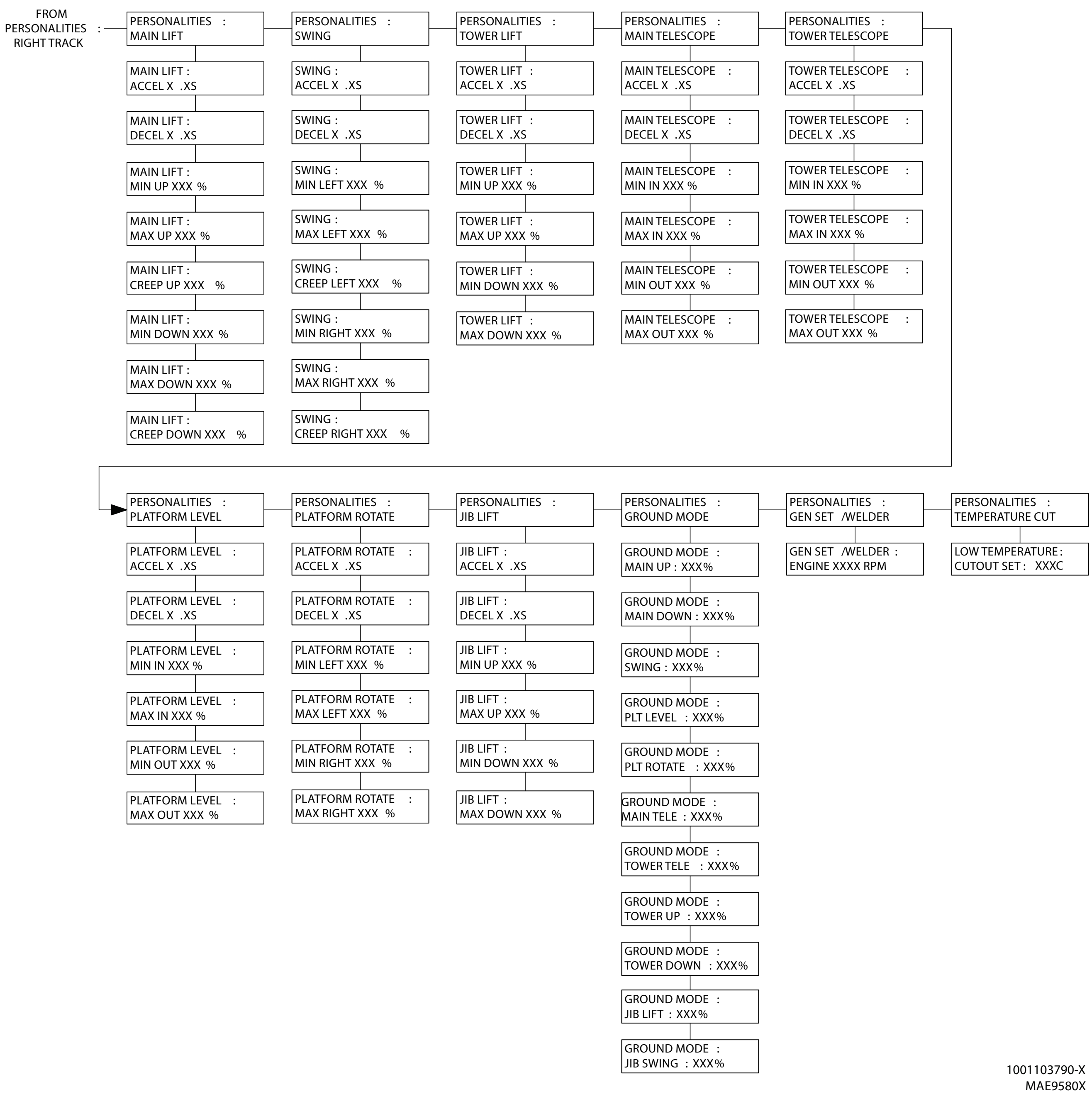
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-5. Analyzer Flow Chart - Diagnostics (Software Version P6.33) - Sheet 3 of 7



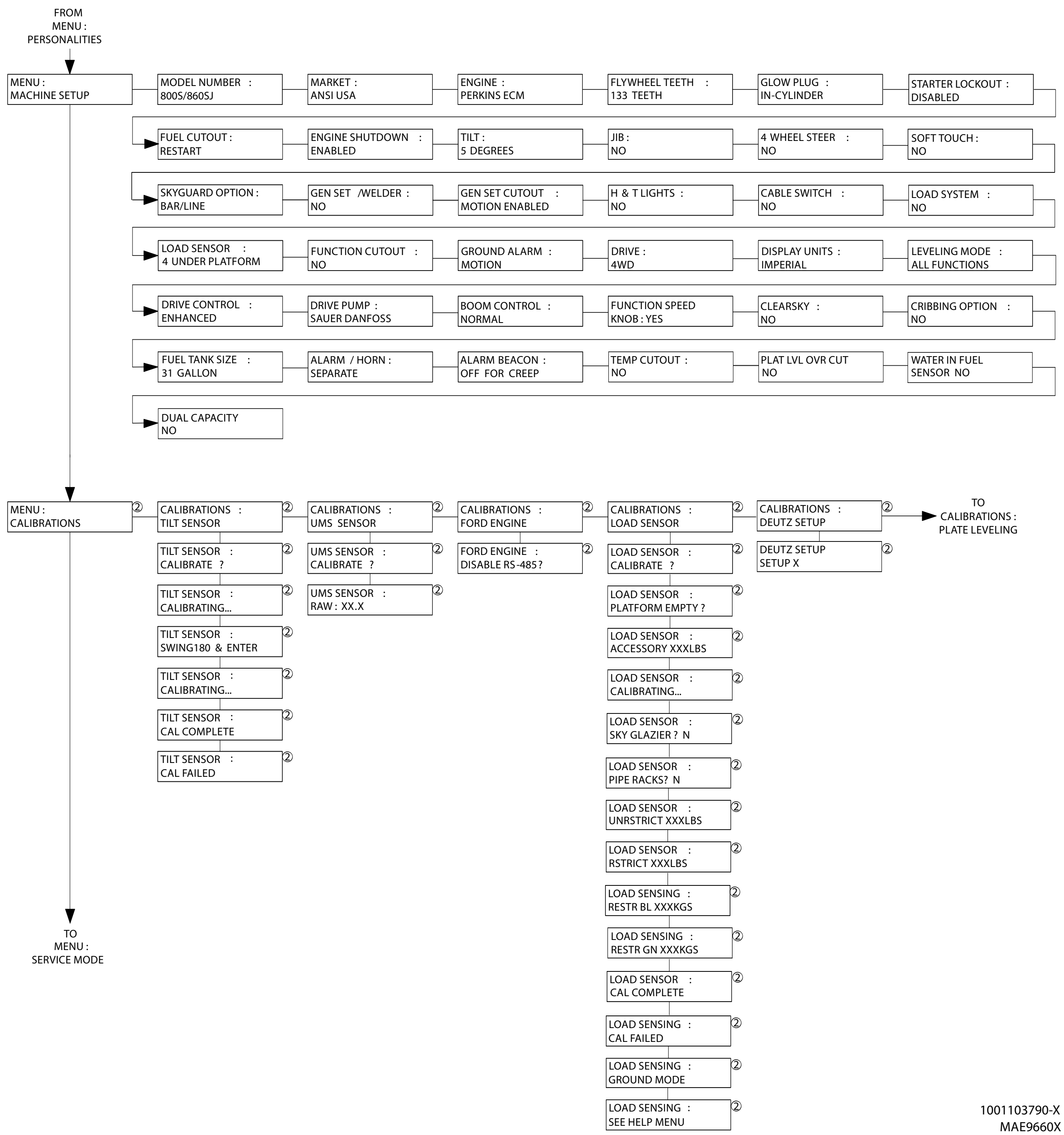
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-6. Analyzer Flow Chart - Diagnostics (Software Version P6.33) - Sheet 4 of 7



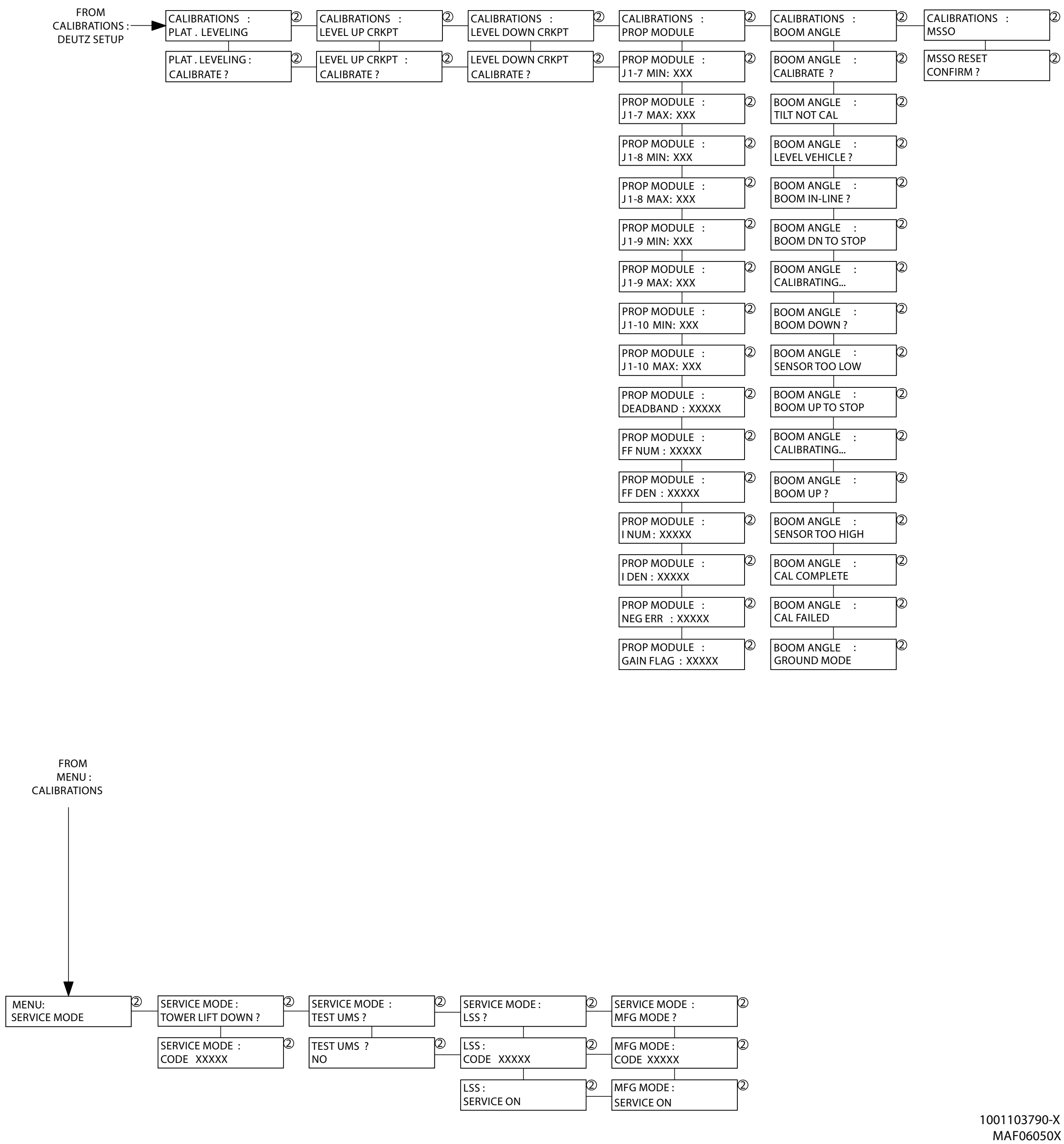
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-7. Analyzer Flow Chart - Diagnostics (Software Version P6.33) - Sheet 5 of 7



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-8. Analyzer Flow Chart - Diagnostics (Software Version P6.33) - Sheet 6 of 7



NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-9. Analyzer Flow Chart - Diagnostics (Software Version P6.33) - Sheet 7 of 7

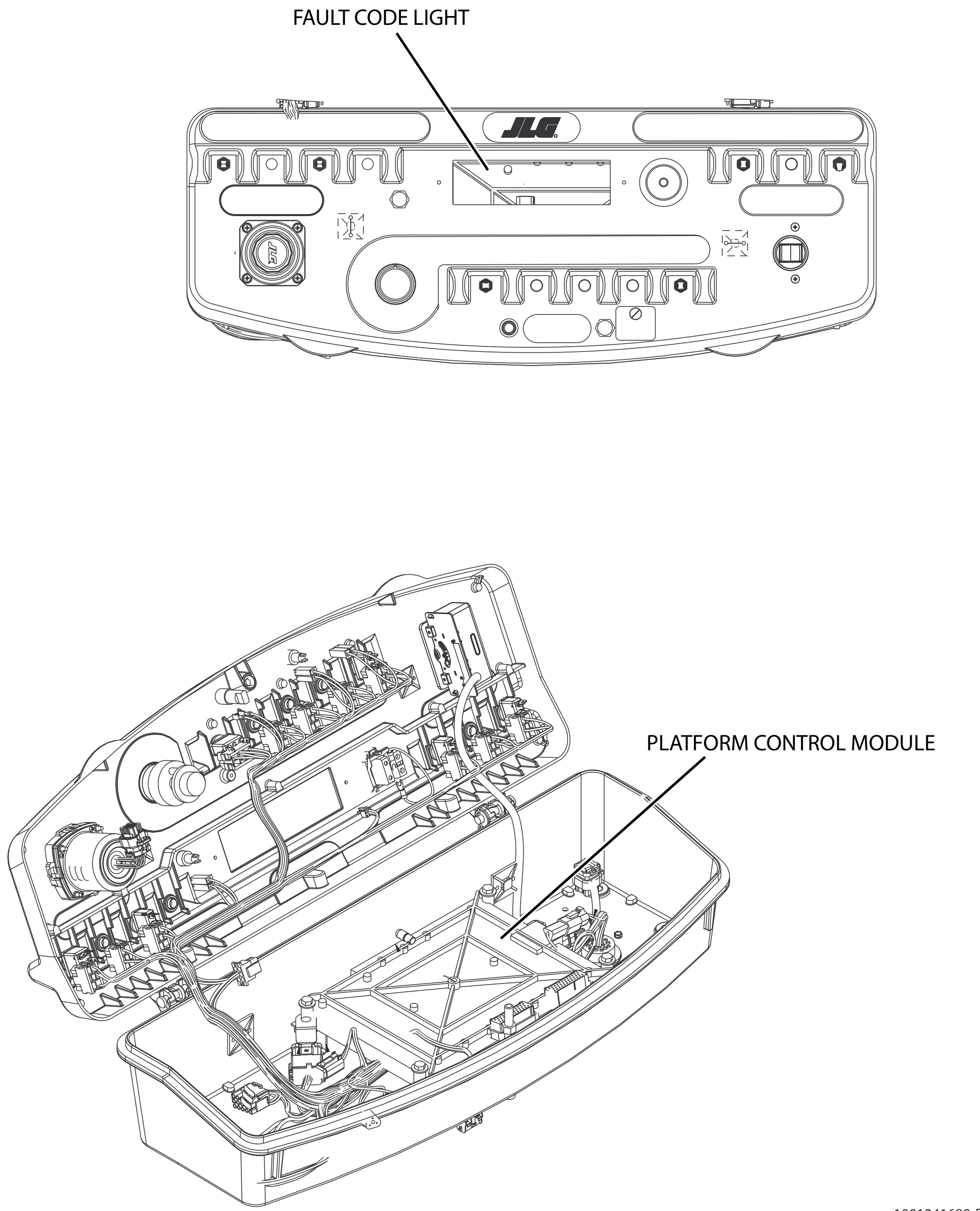
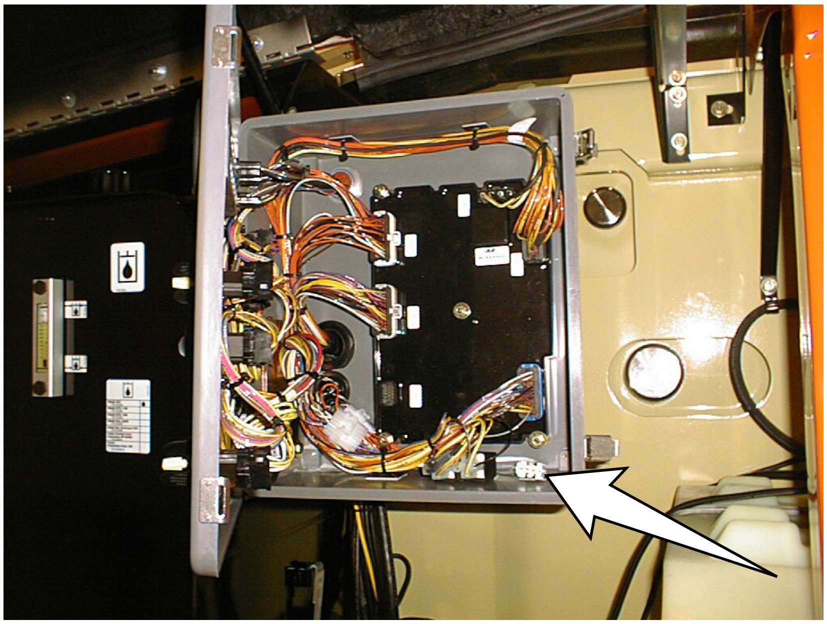


Figure 6-10. Fault Code Light and module Location

PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 6-11. Analyzer Connecting Points

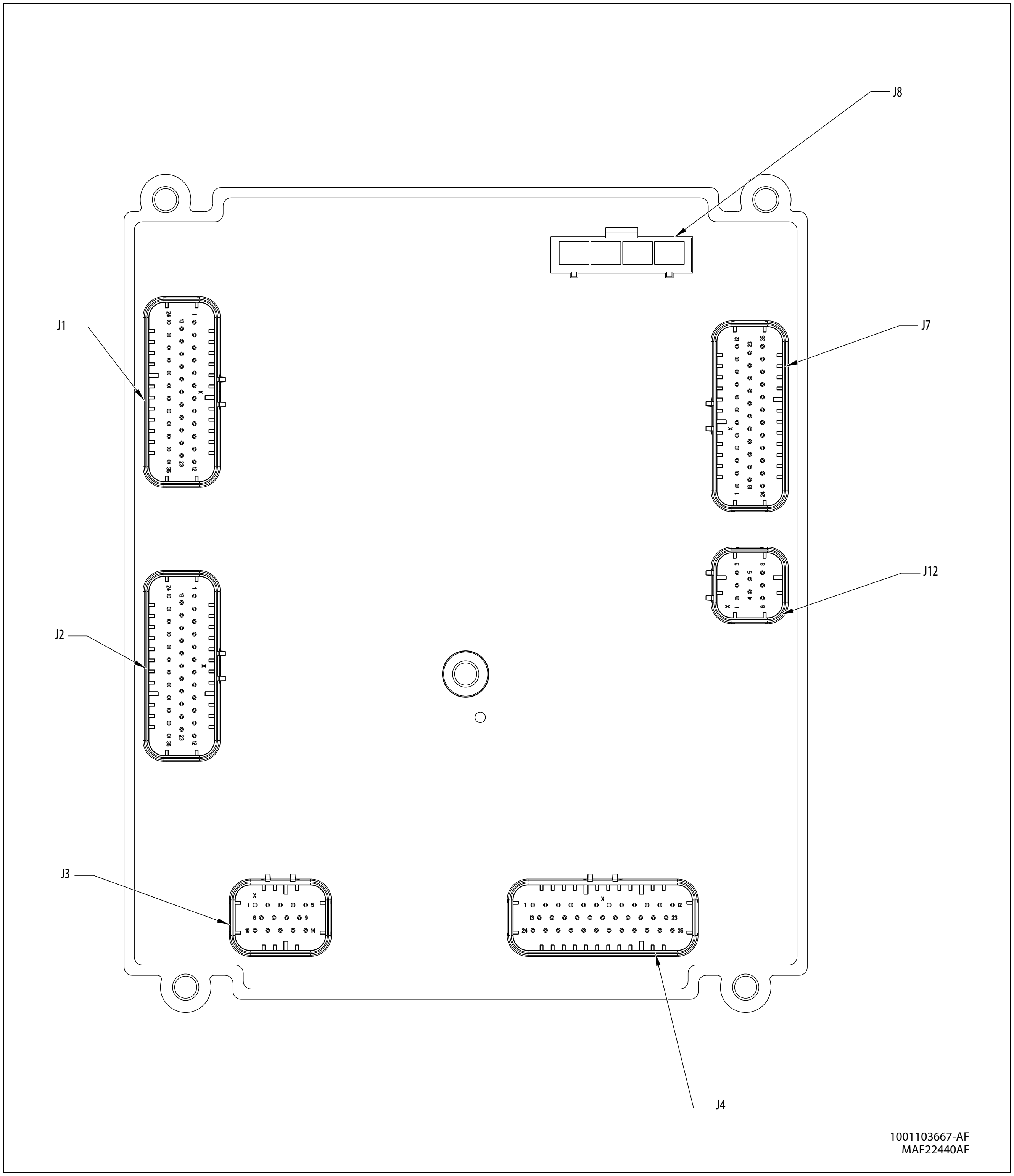


Figure 6-12. Ground Control Module Pin Connections

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

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

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

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

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

Connector	Pin	Function	Type	
J8 BLACK	1	MODULE GROUND FEEDBACK	GROUND	OUTPUT
	2	MODULE POWER	VBAT	INPUT
	3	GROUND TO PLATFORM MODULE	GROUND	INPUT
	4	POWER TO PLATFORM MODULE	VBAT	OUTPUT

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

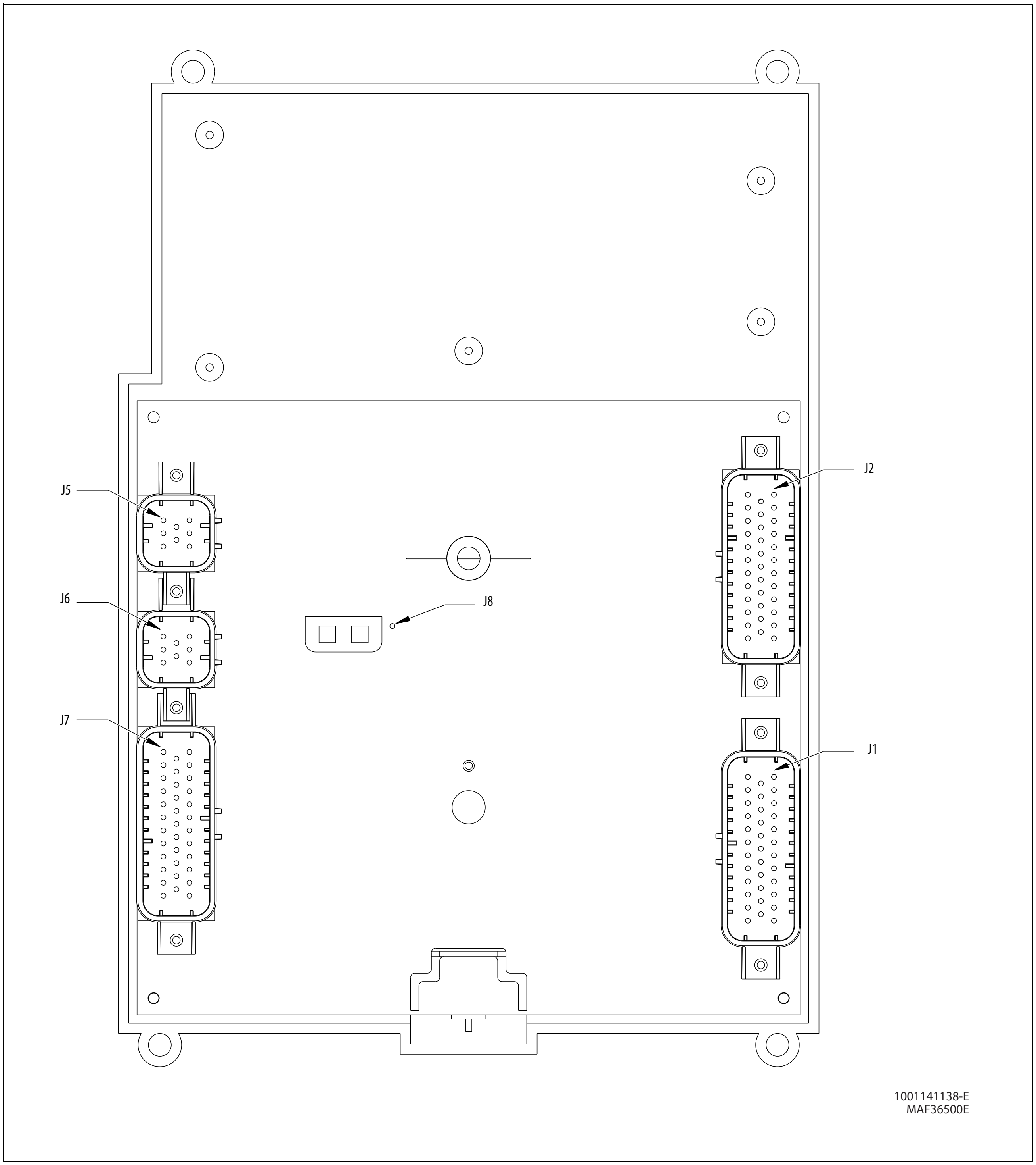


Figure 6-13. Platform Control Module Pin Connections

Connector	Pin	Assignment	Function
J1 NATURAL	1	TOWER LIFT UP	HS DIGITAL INPUT
	2	TOWER LIFT DOWN	HS DIGITAL INPUT
	3	TOWER TELESCOPE IN	HS DIGITAL INPUT
	4	TOWER TELESCOPE OUT	HS DIGITAL INPUT
	5	MAIN TELESCOPE IN	HS DIGITAL INPUT
	6	MAIN TELESCOPE OUT	HS DIGITAL INPUT
	7	PLATFORM ROTATE RIGHT	HS DIGITAL INPUT
	8	PLATFORM ROTATE LEFT	HS DIGITAL INPUT
	9	PLATFORM LEVEL UP	HS DIGITAL INPUT
	10	PLATFORM LEVEL DOWN	HS DIGITAL INPUT
	11	JIB UP	HS DIGITAL INPUT
	12	JIB DOWN	HS DIGITAL INPUT
	13	SPEED PUMP POTENTIOMETER GROUND	GROUND
	14	ENGINE START	HS DIGITAL INPUT
	15	AUXILIARY POWER	HS DIGITAL INPUT
	16	CRAB STEER SELECT	HS DIGITAL INPUT
	17	COORDINATED STEER SELECT	HS DIGITAL INPUT
	18	SWITCH POWER	BATTERY VOLTAGE
	19	JIB 1000 LB ENABLE	HS DIGITAL INPUT
	20	EIM PLATFORM OVERLOAD	HS DIGITAL INPUT
	21	500/1000 LB CAPACITY SELECT	HS DIGITAL INPUT
	22	DRIVE ORIENTATION SYSTEM FEATURE ENABLE	HS DIGITAL INPUT
	23	SPARE PIN	HS DIGITAL INPUT
	24	SPARE PIN	HS DIGITAL INPUT
	25	LEVEL SENSOR 1 SIGNAL	HS DIGITAL INPUT
	26	LEVEL SENSOR 2 SIGNAL	HS DIGITAL INPUT
	27	TWO SPEED VALVE (HIGH ENGINE)	HS DIGITAL INPUT
	28	TORQUE MODE	HS DIGITAL INPUT
	29	SOFT TOUCH OVERRIDE	HS DIGITAL INPUT
	30	HEAD/TAIL LIGHT	HS DIGITAL INPUT
	31	HORN	HS DIGITAL INPUT
	32	CREEP MODE	HS DIGITAL INPUT
	33	DUAL-FUEL SELECT	HS DIGITAL INPUT
	34	SPEED PUMP POTENTIOMETER REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	35	SPEED PUMP POTENTIOMETER	ANALOG INPUT

Connector	Pin	Assignment	Function
J2 BLUE	1	SPARE PIN	HS DIGITAL INPUT
	2	SPARE PIN	HS DIGITAL INPUT
	3	BATTERY VOLTAGE	BATTERY VOLTAGE
	4	DRIVE ORIENTATION SYSTEM OVERRIDE SWITCH	HS DIGITAL INPUT
	5	PLATFORM STOWED	HS DIGITAL INPUT
	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	BROKEN CABLE INDICATOR	LAMP OUTPUT
	11	PLATFORM OVERLOADED INDICATOR	LAMP OUTPUT
	12	500 LB CAPACITY INDICATOR	LAMP OUTPUT
	13	1000 LB CAPACITY INDICATOR	LAMP OUTPUT
	14	DRIVE ORIENTATION SYSTEM INDICATOR	LAMP OUTPUT
	15	GENERATOR ON INDICATOR	LAMP OUTPUT
	16	SOFT TOUCH TRIGGERED INDICATOR	LAMP OUTPUT
	17	GLOW PLUG ENGAGED INDICATOR	LAMP OUTPUT
	18	LAMP RETURN	GROUND
	19	SPARE PIN	LAMP OUTPUT
	20	UPRIGHT TILTED INDICATOR	LAMP OUTPUT
	21	LOW FUEL INDICATOR	LAMP OUTPUT
	22	1/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	23	3/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	24	1/2 FUEL LEVEL INDICATOR	LAMP OUTPUT
	25	FUEL 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	SPARE PIN	LAMP OUTPUT
	31	SPARE PIN	DIGITAL OUTPUT
	32	BATTERY VOLTAGE	BATTERY VOLTAGE
	33	BATTERY VOLTAGE	BATTERY VOLTAGE
	34	SWITCH POWER	BATTERY VOLTAGE
	35	FULL FUEL LEVEL INDICATOR	LAMP OUTPUT

Connector	Pin	Assignment	Function
J7 BLACK	1	GROUND MODE	GROUND MODE
	2	PLATFORM EMS	PLATFORM EMS
	3	PLATFORM EMS TO GROUND	PLATFORM MODE
	4	FOOTSWITCH (FUNCTION ENABLE SWITCH) POWER	BATTERY VOLTAGE
	5	PLATFORM ROTATE LEFT	ME DIGITAL OUTPUT
	6	PLATFORM ROTATE RIGHT	ME DIGITAL OUTPUT
	7	SOFT TOUCH LIMIT SWITCH	BATTERY VOLTAGE
	8	FOOTSWITCH SIGNAL	DIGITAL INPUT
	9	GENERATOR ON SIGNAL	DIGITAL INPUT
	10	+7 REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	11	SPARE PIN	+5V REFERENCE VOLTAGE
	12	SPARE PIN	+5V REFERENCE VOLTAGE
	13	SPARE PIN	ANALOG INPUT
	14	GROUND RETURN	GROUND
	15	PLATFORM LEVEL UP	HS DIGITAL OUTPUT
	16	PLATFORM LEVEL DOWN	HS DIGITAL OUTPUT
	17	JIB BLOCK LIMIT SWITCH	HS DIGITAL OUTPUT
	18	SOFT TOUCH LIMIT SWITCH	HS DIGITAL OUTPUT
	19	PLATFORM ALARM	LAMP OUTPUT
	20	ALARM RETURN	GROUND
	21	SPARE PIN	GROUND
	22	SPARE PIN	GROUND
	23	SPARE PIN	ANALOG INPUT
	24	SPARE PIN	DIGITAL OUTPUT
	25	JIB UP	ME DIGITAL OUTPUT
	26	JIB DOWN	ME DIGITAL OUTPUT
	27	JIB RIGHT	ME DIGITAL OUTPUT
	28	JIB LEFT	ME DIGITAL OUTPUT
	29	GROUND RETURN	GROUND
	30	CAN LOW	CAN LOW
	31	CAN HIGH	CAN HIGH
	32	CAN SHIELD	CAN SHIELD
	33	SPARE PIN	GROUND
	34	SPARE PIN	GROUND
	35	SPARE PIN	ANALOG INPUT

Connector	Pin	Assignment	Function
J5 NATURAL	1	LIFT / SWING JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	LIFT CENTER TAP	ANALOG INPUT
	3	LIFT SIGNAL	ANALOG INPUT
	4	SWING SIGNAL	ANALOG INPUT
	5	SWING CENTER TAP	ANALOG INPUT
	6	NOT CONNECTED	ANALOG INPUT
	7	LIFT / SWING JOYSTICK RETURN	GROUND
	8	SPARE PIN	BLANK

Connector	Pin	Assignment	Function
J6 BLACK	1	DRIVE / STEER JOYSTICK SUPPLY VOLTAGE	SUPPLY VOLTAGE
	2	DRIVE CENTER TAP	ANALOG INPUT
	3	DRIVE SIGNAL	ANALOG INPUT
	4	STEER SIGNAL	ANALOG INPUT
	5	STEER LEFT	ANALOG INPUT
	6	STEER RIGHT	ANALOG INPUT
	7	DRIVE / STEER JOYSTICK RETURN	GROUND
	8	SPARE PIN	BLANK

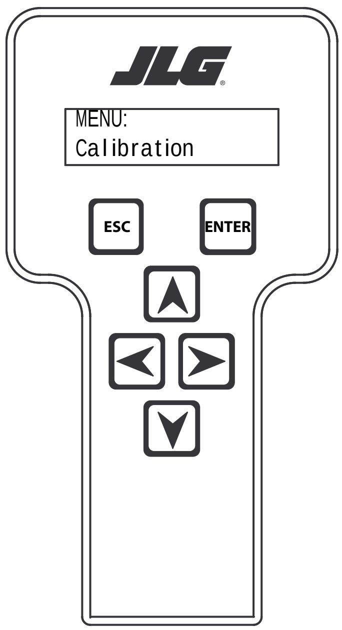
Connector	Pin	Assignment	Function
J8	1	MODULE GROUND	GROUND
	2	MODULE POWER	BATTERY VOLTAGE

6.5 TILT SENSOR CALIBRATION

WARNING

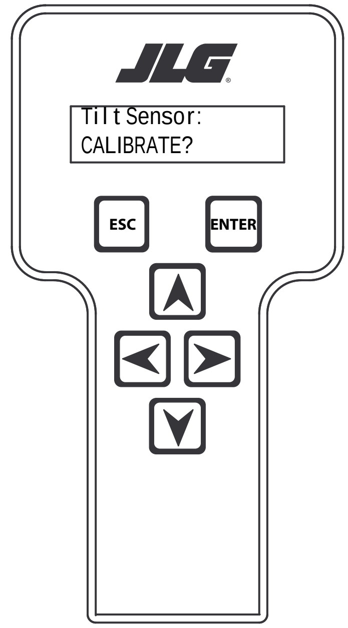
DO NOT CALIBRATE THE TILT SENSOR EXCEPT ON A LEVEL SURFACE.

1. Place the machine on a firm, level surface.
2. Using the analyzer, go to Service Access level. Refer to Changing the Access Level of the Hand Held Analyzer in this section.
3. Using the arrow keys, navigate to Calibrations Menu as shown below and press ENTER.



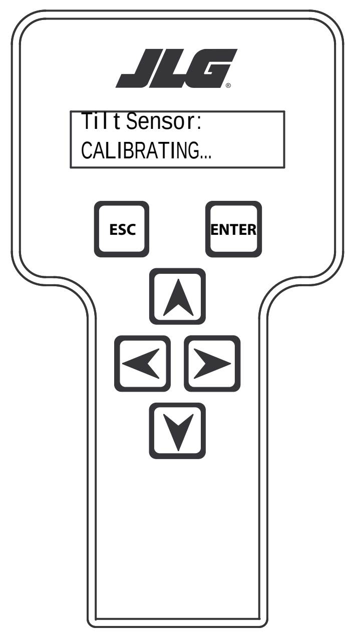
MAF14500

4. Using the arrow keys, navigate to Calibrations Menu as shown below and press ENTER.



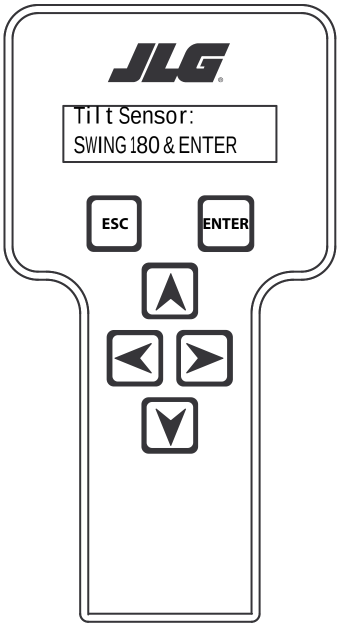
MAF14500

the screen will then read:



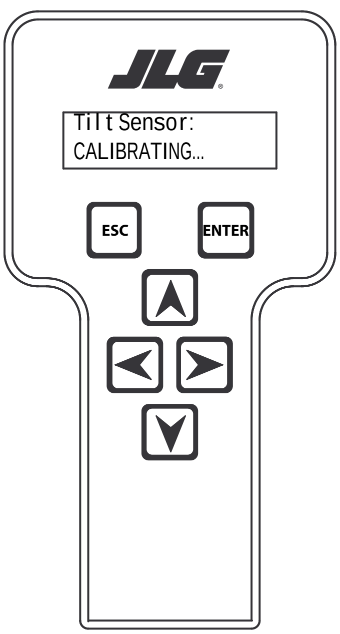
MAF14500

5. When the sensor is calibrated in that position, the screen will read:



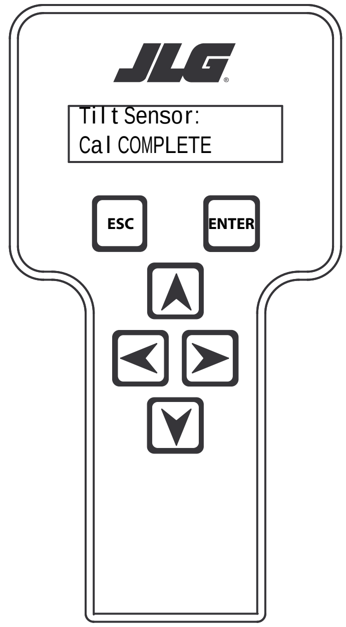
MAF14500

6. Swing the machine 180 degrees, making sure the boom is centered and in the transport position, and ENTER. The screen will read:



MAF14500

7. When the calibration is complete the screen will read as shown below. Return the machine to the travel position.

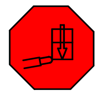


MAF14500

6.6 LSS SYSTEM

The JLG-designed Load Sensing System (LSS) measures platform load via a sensor mounted in the platform support structure. If the actual platform load exceeds the selected Rated Load, the following will occur:

1. The Overload Visual Warning Indicator will flash at the selected control position (platform or ground).



2. The Platform and Ground Alarms will sound 5 seconds On, and 2 seconds Off.
3. All normal movement will be prevented from the platform control position (optional - ground control functions may be prevented).
4. Further movement is permitted by:
   a. Removing the excess platform load until actual platform load is less than Rated Load.
   b. Operation of the overriding emergency system (Auxiliary Power Unit).
   c. By an authorized person at the ground control position (optional - ground control functions may be prevented).
5. 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 6-7, Diagnostic Menu Descriptions details the structure of the Diagnostic Menu, and describes the meaning of each piece of information presented.

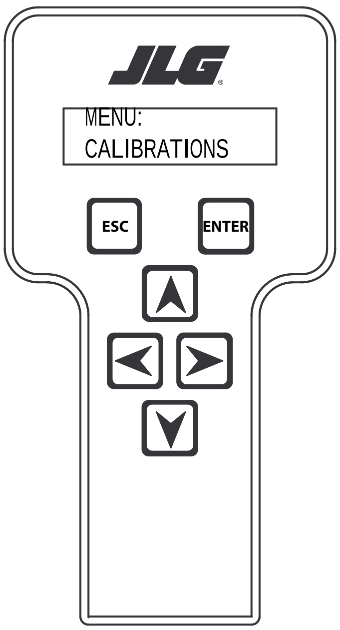
Table 6-7. Diagnostic Menu Descriptions

Diagnostics Menu (Displayed on Analyzer 1^{st} Line)	Parameter (Displayed on Analyzer 2^{nd} Line)	Parameter Value (Displayed on Analyzer 2^{nd} 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

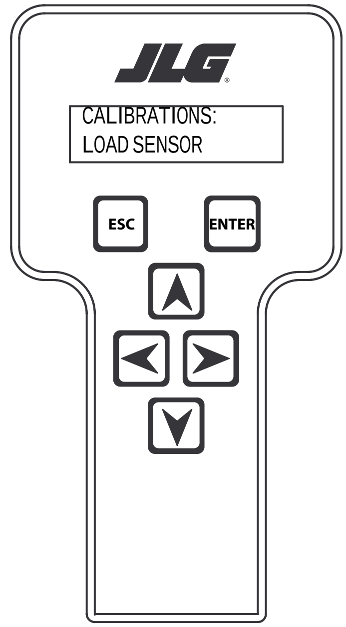
1. Remove everything from the platform, except permanently fixed JLG Accessories, to allow the Load Sensing System to record its' weight during calibration. This includes all tools, debris, and customer-installed devices.
2. Plug the JLG Analyzer into the Machine at the Ground Station and enter Service 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:



MAF14500

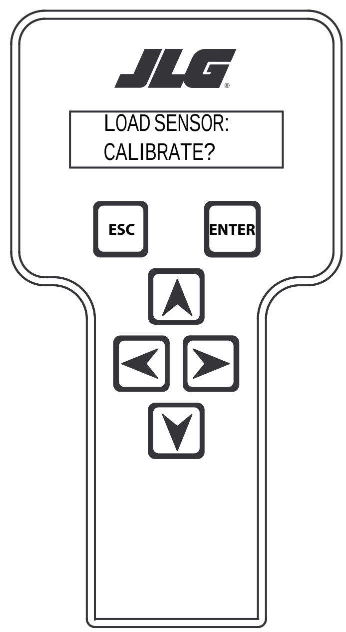
NOTE: *The Calibration Menu is not available in OPERATOR ACCESS.*

5. Press the ENTER key  to view the menu. Upon entry to the Calibration Menu, the JLG Control System will link to the Analyzer and the screen will read:



MAF14500

6. Press Enter . The Screen will read:

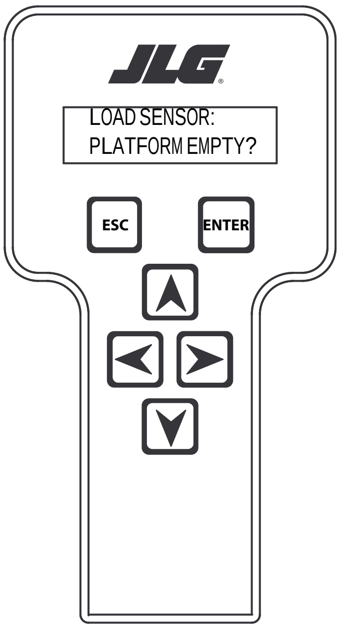


MAF14500

NOTE: *Calibration will auto fail if LSS DTC's are active (443, 444, 4479, 4480, 663, 821, 822, 823, 824, 8218, 8222 -> 8238, 991, 992, 993, 994 or 99285).*

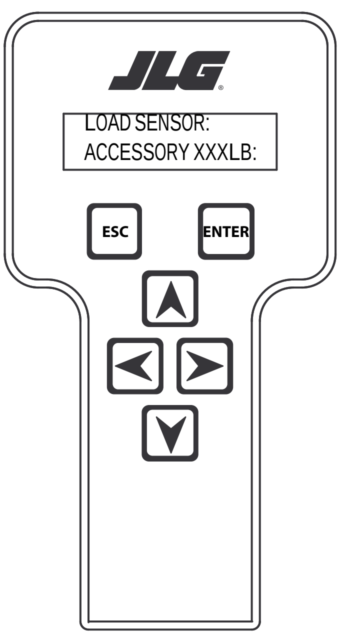
Pressing the ESC key after starting calibration and before calibration is complete will display the CAL FAILED message. This will not disturb the prior calibration information.

7. Press ENTER. The analyzer screen will read:



MAF14500

8. If the platform is empty, press ENTER. The screen will read:

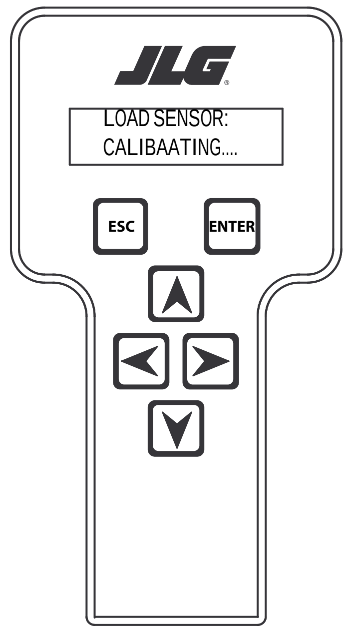


MAF14500

NOTE: *Accessory weight will reset to 0 lb 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 6-8, Accessory Weights. Use the up and down analyzer keys to enter the accessory weight(s) (in lb). When all the accessory weights are entered, press ENTER. The screen will read:



MAF14500

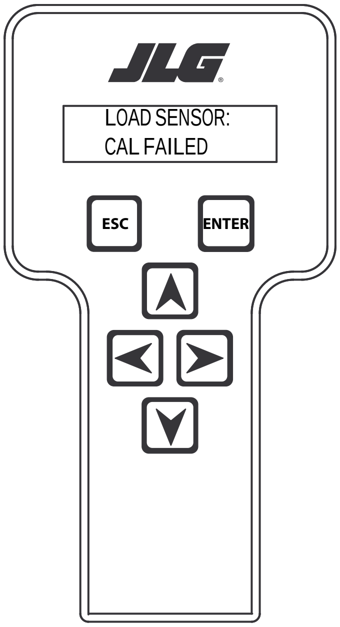
Table 6-8. Accessory Weights

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.*

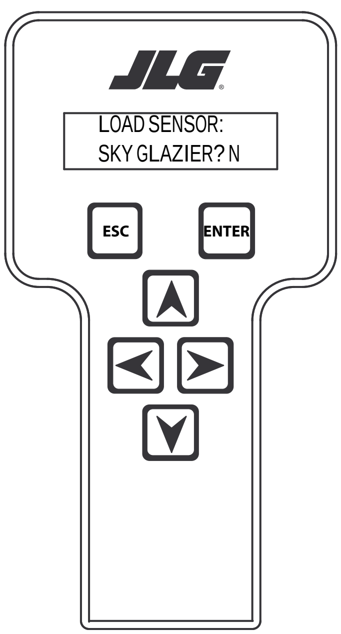
9. The control system will calculate the load cell readings and ensure it is greater than 130 lb (59 kg), but less than 575 lb (261 kg).

   If the platform weight is not within the allowed range, the calibration attempt will be unsuccessful and the Analyzer will show the following:



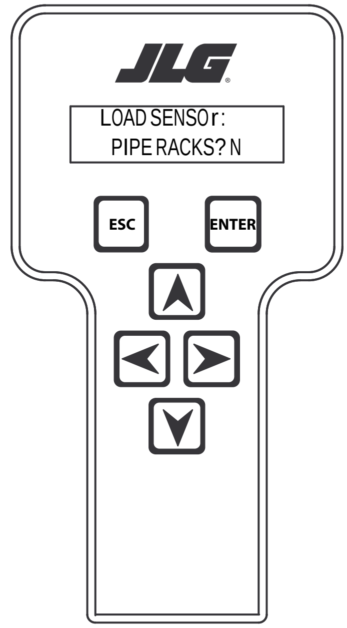
MAF14500

10. Press ENTER. The control system will ask for installed accessories. The screen will show the following:



MAF14500

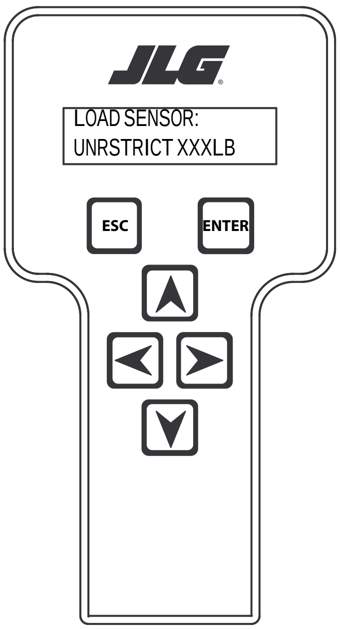
11. Use the analyzer keys to select N for no or Y for yes. Press ENTER. The screen will read:



MAF14500

12. Use the analyzer keys to select N for no or Y for yes. Press ENTER. The control system will default to an estimate of unrestricted capacity, which can be adjusted if necessary. Refer to Table 6-9, SkyGlazier Capacity Reductions and Table 6-10, Pipe Rack Capacity Reductions.

The screen will read:



MAF14500

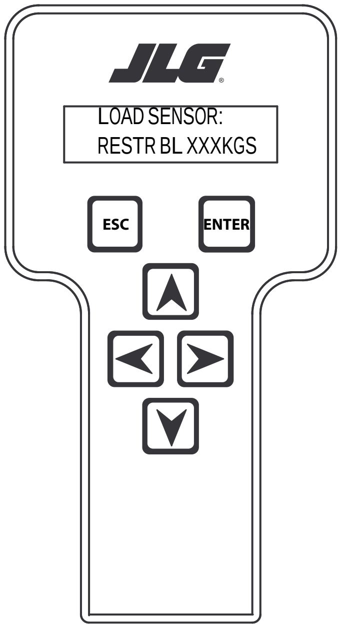
Table 6-9. SkyGlazier Capacity Reductions

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
660 lb (300 kg)	-	-
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 6-10. Pipe Rack Capacity Reductions

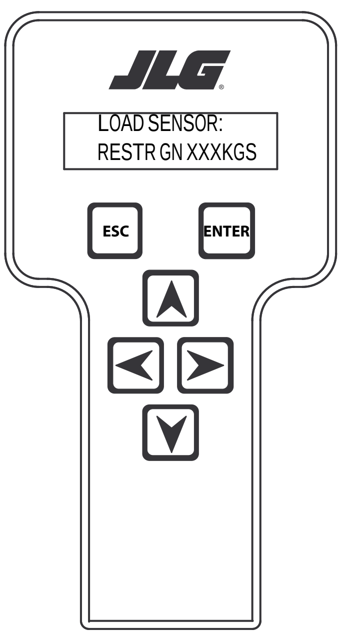
Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	N/A
550 lb (250 kg)	450 lb (204 kg)	N/A
600 lb (272 kg)	500 lb (227 kg)	N/A
660 lb (300 kg)	-	-
750 lb (340 kg)	N/A	650 lb (295 kg)
1000 lb (454 kg)	N/A	900 lb (408 kg)
Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.		

13. Press ENTER . The following screen will be displayed



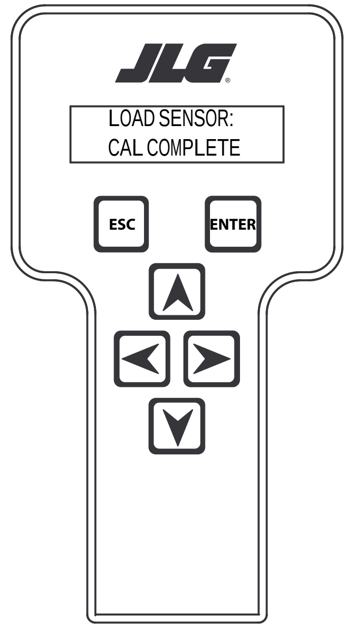
MAF14500

14. Press ENTER . The following screen will be displayed



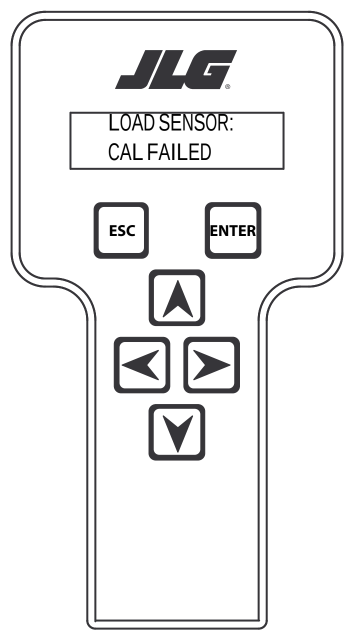
MAF14500

15. Press ENTER . If calibration is successful, the screen will read:



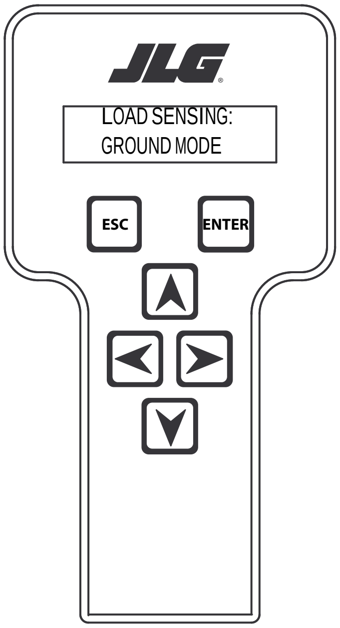
MAF14500

16. Press ENTER . If calibration is unsuccessful, the screen will read:



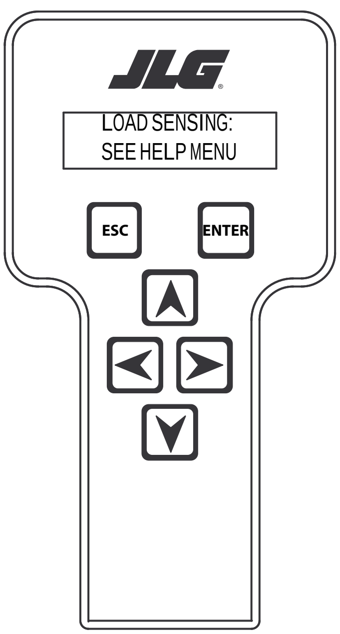
MAF14500

17. Press ENTER  to reach Ground mode menu.



MAF14500

18. To access the Help Menu, use the LEFT and RIGHT Arrow keys to select Help. The screen will read:



MAF14500

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 ±15 lb (± 7kg). Further, the reading should be stable and should not vary by more than ±2 lb (±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 500 lb (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

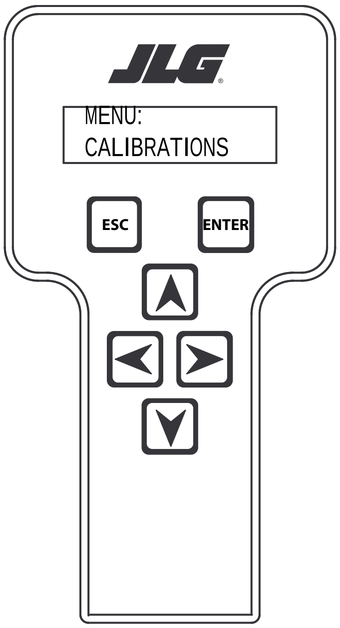
The following tables are furnished to provide possible resolutions for common difficulties. Difficulties are classified as General, Calibration, Measurement Performance, and Host System Functionality.

Table 6-11. LSS Troubleshooting Chart

Difficulty	Possible Resolution
Empty Platform Weight (DIAGNOSTICS, PLATFORM LOAD) is not within ±15lb (±7kg) of zero. or Platform Load readings (DIAGNOTICS, PLTLOAD) are unstable by more than ±2 lb (±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 20 lb 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 ±2 lb (±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 (>6000 lb [>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.

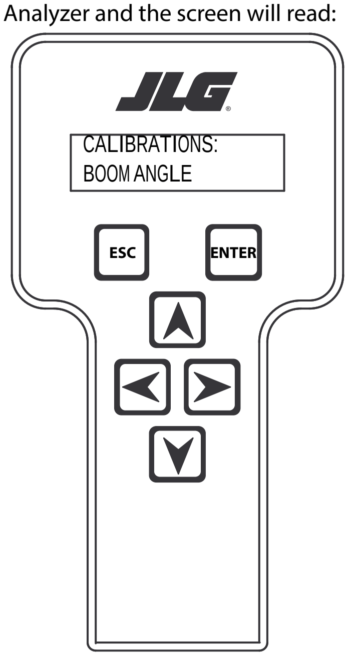
6.7 BOOM ANGLE CALIBRATION

1. To access the Calibration Menu, use the LEFT and RIGHT Arrow keys to select CALIBRATION from the Top Level Menu. The screen will read:



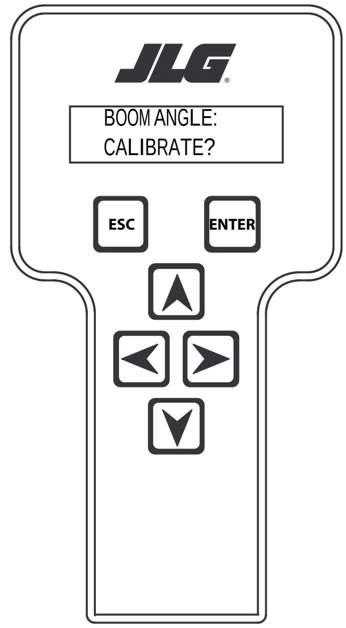
MAF14500

2. Press the ENTER  key to view the menu. Upon entry to the Calibration Menu, the JLG Control System will link to the Analyzer and the screen will read:



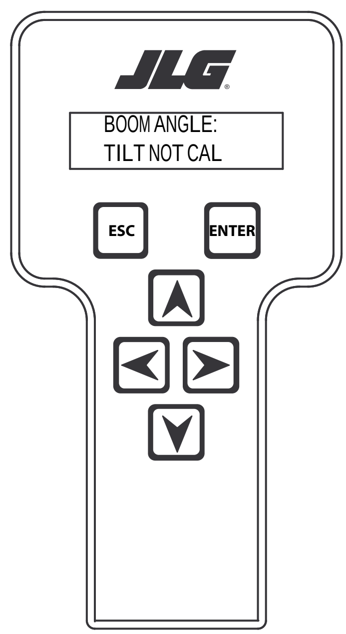
MAF14500

3. Hit Enter. The screen will read.



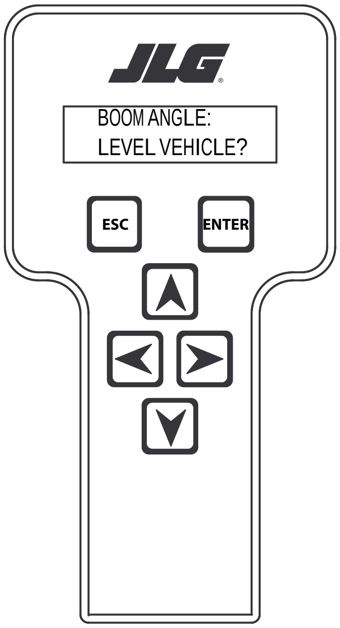
MAF14500

4. UGM will confirm the tilt sensor calibration. The screen will read.



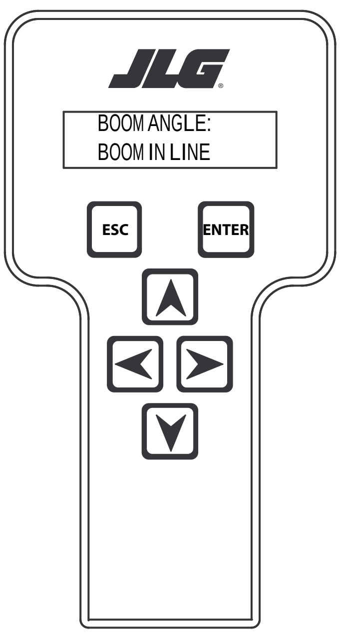
MAF14500

5. Hit Enter. The screen will read.



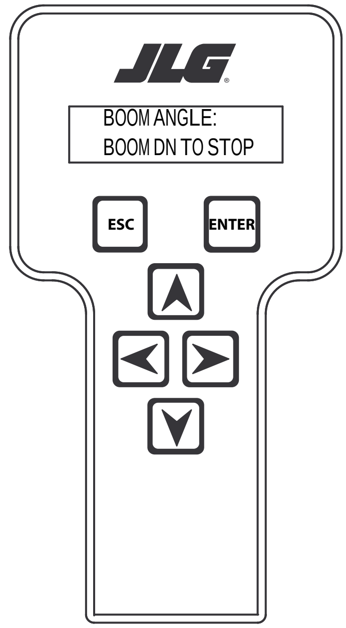
MAF14500

6. UGM will confirm the Boom In-Line position. The screen will read:



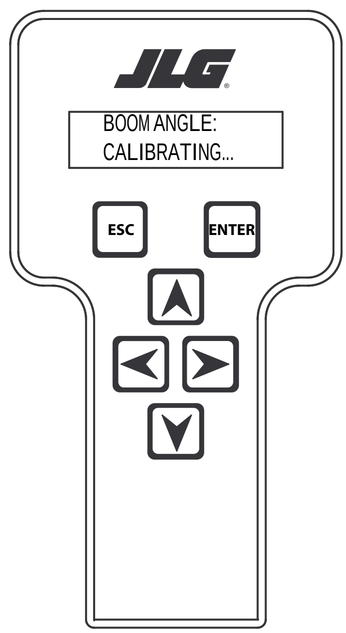
MAF14500

7. Hit Enter. The Screen will read:



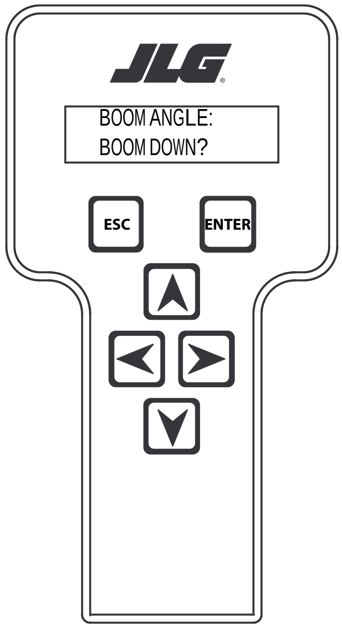
MAF14500

8. When the sensor is calibrated at lower position of the boom. The screen will read:



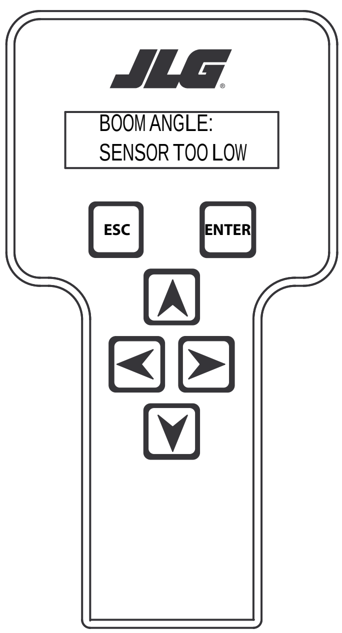
MAF14500

9. Hit Enter. The Screen will read:



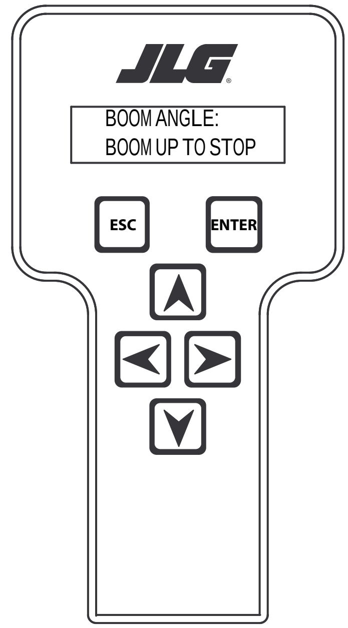
MAF14500

10. Hit Enter. The Screen will read:



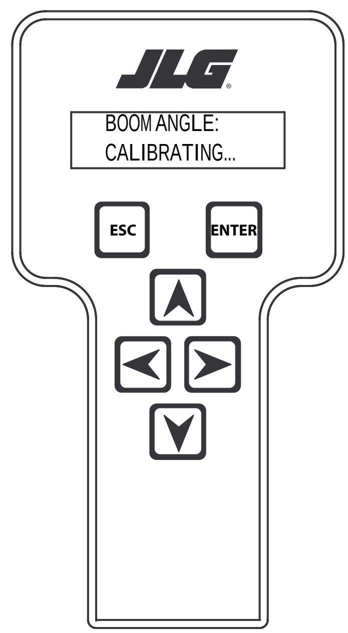
MAF14500

11. UGM will confirm the position of the boom. Press Enter. The screen will read:



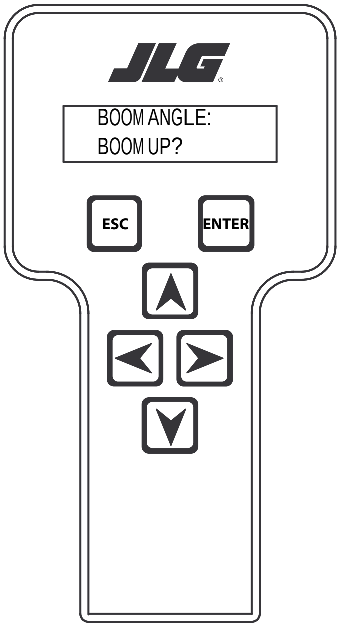
MAF14500

12. When the sensor is calibrated at upper position of the boom. The screen will read:



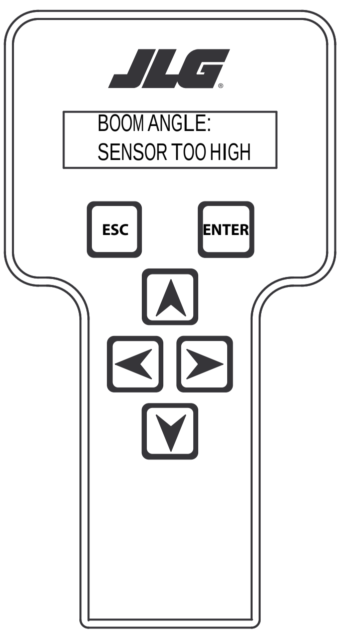
MAF14500

13. UGM will confirm the position of the boom. Press Enter. The screen will read:



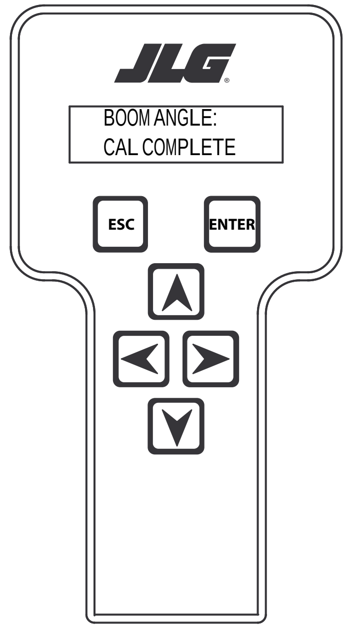
MAF14500

14. Hit Enter. The Screen will read:



MAF14500

15. After few seconds. The screen will read:



MAF14500

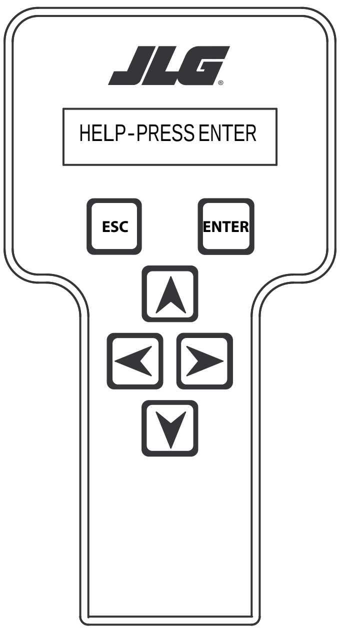
16. Hit ESC twice to go back to CALIBRATIONS.

6.8 RESETTING THE MSSO SYSTEM (CE ONLY)

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:

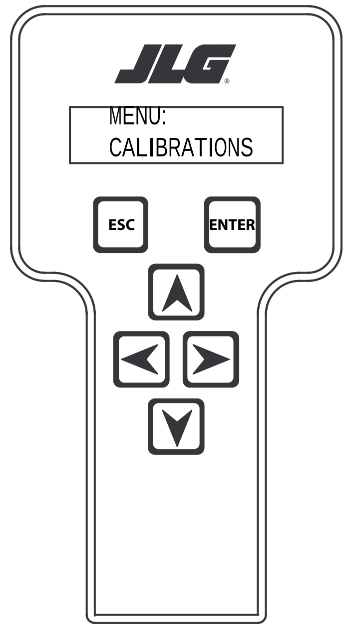


MAF14500

6. Use the arrow button to reach OPERATOR ACCESS. Press Enter 

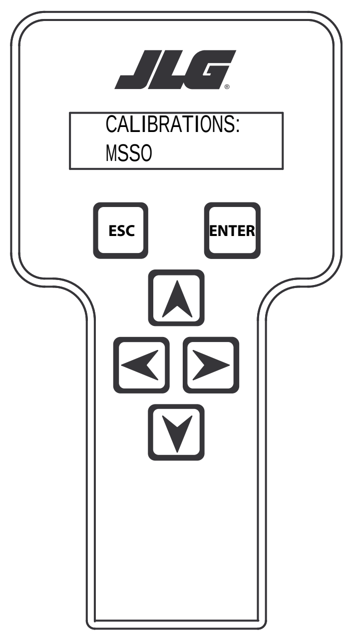
.
7. Enter the Access Code, 33271.
8. Use the right Arrow key to reach MENU: CALIBRATIONS. Press Enter 

.



MAF14500

9. Use the arrow keys to reach the MSSO menu. The screen should read:

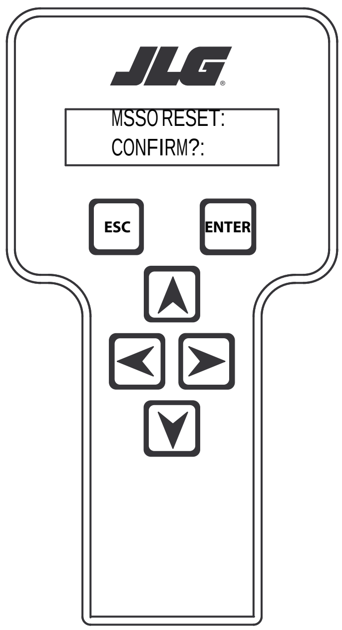


MAF14500

10. Press ENTER .

11. Use the Down arrow to reach MSSO RESET.

12. Press Enter . The screen will read:



MAF14500

13. Press Enter . The JLG Control System will reset an active 873 DTC and the MSSO System will be reset. Press Escape to return to the CALIBRATIONS menu.

Analyzer Diagnostics Menu Structure

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

Table 6-12. Adjustments - Personality Descriptions

DRIVE	
ACCEL	Displays/adjusts drive acceleration
DECEL	Displays/adjusts drive deceleration
MIN FORWARD	Displays/adjusts minimum forward drive speed
MAX FORWARD	Displays/adjusts maximum forward drive speed
MIN REVERSE	Displays/adjusts minimum reverse drive speed
MAX REVERSE	Displays/adjusts maximum reverse drive speed
ELEVATED MAX	Displays/adjusts maximum drive speed NOTE: used when elevation cutout switches are limiting maximum speed
CREEP MAX	Displays/adjusts maximum drive speed NOTE: used when creep switch on pump pot is active
STEER MAX	Displays/adjusts the maximum steer speed
LIFT	
ACCEL	Displays/adjusts upper lift acceleration
DECEL	Displays/adjusts upper lift deceleration
MIN UP	Displays/adjusts minimum upper lift up speed
MAX UP	Displays/adjusts maximum upper lift up speed
CREEP UP	Displays/adjusts maximum upper lift up speed NOTE: used when creep switch on pump pot is active
MIN DOWN	Displays/adjusts minimum upper lift down speed
MAX DOWN	Displays/adjusts maximum upper lift down speed
CREEP DOWN	Displays/adjusts maximum upper lift down speed NOTE: used when creep switch on pump pot is active
SWING	
ACCEL	Displays/adjusts swing acceleration
DECEL	Displays/adjusts swing deceleration
MIN LEFT	Displays/adjusts minimum swing left speed
MAX LEFT	Displays/adjusts maximum swing left speed
CREEP LEFT	Displays/adjusts maximum swing left speed NOTE: used when creep switch on pump pot is active
MIN RIGHT	Displays/adjusts minimum swing right speed
MAX RIGHT	Displays/adjusts maximum swing right speed
CREEP RIGHT	Displays/adjusts maximum swing right speed NOTE: used when creep switch on pump pot is active
MAIN TELESCOPE	
ACCEL	Displays/adjusts telescope acceleration
DECEL	Displays/adjusts telescope deceleration
MIN IN	Displays/adjusts minimum telescope in speed

Table 6-12. Adjustments - Personality Descriptions

MAX IN	Displays/adjusts maximum telescope in speed
MIN OUT	Displays/adjusts minimum telescope out speed
MAX OUT	Displays/adjusts maximum telescope out speed
BASKET LEVEL	
ACCEL	Displays/adjusts basket level acceleration
DECEL	Displays/adjusts basket level deceleration
MIN UP	Displays/adjusts minimum basket level up speed
MAX UP	Displays/adjusts maximum basket level up speed
MIN DOWN	Displays/adjusts minimum basket level down speed
MAX DOWN	Displays/adjusts maximum basket level down speed
BASKET ROTATE	
ACCEL	Displays/adjusts basket rotate acceleration
DECEL	Displays/adjusts basket rotate deceleration
MIN LEFT	Displays/adjusts minimum basket rotate left speed
MAX LEFT	Displays/adjusts maximum basket rotate left speed
MIN RIGHT	Displays/adjusts minimum basket rotate right speed
MAX RIGHT	Displays/adjusts maximum basket rotate right speed
JIB LIFT	Not displayed if JIB = NO
ACCEL	Displays/adjusts jib acceleration
DECEL	Displays/adjusts jib deceleration
MIN UP	Displays/adjusts minimum jib up speed
MAX UP	Displays/adjusts maximum jib up speed
MIN DOWN	Displays/adjusts minimum jib down speed
MAX DOWN	Displays/adjusts maximum jib down speed
MIN LEFT	Displays/adjusts minimum jib left speed
MAX LEFT	Displays/adjusts maximum jib left speed
MIN RIGHT	Displays/adjusts minimum jib right speed
MAX RIGHT	Displays/adjusts maximum jib right speed
STEER	
MAX SPEED	Displays/adjusts maximum steer speed, which applies when vehicle speed is at minimum
GROUND MODE	
LIFT UP	Displays/adjusts fixed lift up speed
LIFT DOWN	Displays/adjusts fixed lift down speed
SWING	Displays/adjusts fixed swing speed
TELE	Displays/adjusts fixed telescope speed
BASKETLEVEL	Displays/adjusts fixed basket level speed
BASKETROTATE	Displays/adjusts fixed basket rotate speed
JIB (U/D)	Displays/adjusts jib lift speed Not displayed if JIB = NO
JIB (L/R)	Displays/adjusts jib swing speed Not displayed if JIB = NO

Table 6-13. Diagnostic Menu Descriptions

DRIVE	
DRIVE FOR . . .	Displays drive joystick direction & demand
STEER . . .	Displays steer switch direction & demand NOTE: steer demand is inversely proportional to vehicle speed
BRAKES . . .	Displays brake control system status
CREEP . . .	Displays pump pot creep switch status
TWO SPEED...	Displays two speed switch status
2 SPEED MODE	Displays status of two speed valve
HIGH ENGINE	Displays high engine switch status
BOOM	
U LIFT UP . . .	Displays lift joystick direction & demand
SWING LEFT . . .	Displays swing joystick direction & demand
LEVEL UP . . .	Displays basket level switch direction & demand NOTE: demand is controlled by the pump pot
ROT. LEFT . . .	Displays basket rotate switch direction & demand NOTE: demand is controlled by the pump pot
U TELE IN . . .	Displays telescope switch direction & demand NOTE: demand is controlled by the pump pot
JIB UP . . .	Displays jib lift switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
JIB LEFT . . .	Displays jib swing switch direction & demand NOTE: demand is controlled by the pump pot Not displayed if JIB = NO
PUMP POT . . .	Displays pump pot demand
ENGINE	
START . . .	Displays start switch status
AIR FILTER . . .	Displays air filter status
BATTERY . . .	Displays measured battery voltage
COOLANT . . .	Displays coolant temperature
OIL PRS . . .	Displays oil pressure status
FUEL SELECT . . .	Displays selected fuel (Dual Fuel only)
FUEL LEVEL . . .	Displays fuel level status
RPM	Displays Engine RPM
GM BATTERY	Displays battery voltage at ground module
PM BATTERY . . .	Displays battery voltage at platform module
TEMP...	Displays ground module temperature
ELEV. CUTOUT . . .	Displays elevation cutout switch status
FUNC. CUTOUT . . .	Displays function cutout switch status
CREEP . . .	Displays creep switch status
TILT . . .	Displays measured vehicle tilt
AUX POWER . . .	Displays status of auxiliary power switch
HORN . . .	Displays status of horn switch
R FILTER . . .	Displays status of return filter switch
C FILTER . . .	Displays status of charge pump filter
LOAD LENGTH . . .	Displays length switch status

Table 6-13. Diagnostic Menu Descriptions

ANGLE . . .	Displays angle switch status
LOAD . . .	Displays load sensor value NOTE: Not displayed if load = 0.
DATALOG	
ON . . .	Displays total controller on (EMS) time
ENGINE . . .	Displays engine run time
DRIVE . . .	Displays total controller drive operation time
LIFT . . .	Displays total controller lift operation time
SWING . . .	Displays total controller swing operation time
TELE . . .	Displays total controller tele operation time
MAX.TEMP . . .	Displays maximum measured heatsink temp.
MIN.TEMP . . .	Displays minimum measured heatsink temp.
MAX.VOLTS . . .	Displays maximum measured battery voltage
RENTAL . . .	Displays total controller operation time NOTE: can be reset
ERASE RENTAL	Not available at password level 2
YES:ENTER, NO:ESC	ENTER resets rental datalog time to zero
VERSIONS	
GROUND . . .	Displays ground module software version
PLATFORM . . .	Displays platform module software version
ANALYSER . . .	Displays Analyzer software version

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
001	00	EVERYTHING OK	No response required for this DTC.
002	00	GROUND MODE OK	No response required for this DTC.
0010	00	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION	Response described in Drive Modes section.
000	00	<<< HELP COMMENT >>>	
0011	00	FSW OPEN (Foot switch open)	The UGM shall not Enable the Machine.
0012	00	RUNNING AT CREEP - CREEP SWITCH OPEN	The UGM shall limit the machine to Creep speed.
0013	00	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	
0014	00	CHASSIS TILT SENSOR OUT OF RANGE	Not reported during power-up.
0015	00	LOAD SENSOR READING UNDER WEIGHT	
0031	00	FUEL LEVEL LOW - ENGINE SHUTDOWN	Response described in Fuel Shutdown section.
0035	00	APU ACTIVE	Response described in Auxiliary Power/Emergency Descent Mode section.
0039	00	SKYGUARD ACTIVE - FUNCTIONS CUTOUT	Response described in Sky-Guard section.
0040	00	RUNNING AT CREEP - CREEP SWITCH CLOSED	
210	21	<<< POWER-UP >>>	
211	21	POWER CYCLE	
212	21	KEYSWITCH FAULTY	The UGM shall assume a station selection of Ground.
213	21	FSW FAULTY	The UGM shall not Enable the Machine.
220	22	<<< PLATFORM CONTROLS >>>	
227	22	STEER SWITCHES FAULTY	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
2211	22	FSW INTERLOCK TRIPPED	Can be reported during power- up.
2212	22	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	Can be reported during power- up.
2213	22	STEER LOCKED - SELECTED BEFORE FOOTSWITCH	The UGM shall not Enable the Machine.
2214	22	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE	
2216	22	D/S JOY. OUT OF RANGE HIGH	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	D/S JOY. CENTER TAP BAD	Resistive joysticks. - There is a +/-.1V range. around these values due to resistor tolerances.
2219	22	L/S JOY. OUT OF RANGE HIGH	Resistive joysticks. - If the reference voltage is > 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
2220	22	L/S JOY. CENTER TAP BAD	Resistive joysticks. - There is a +/- .1V range. around these values due to resistor tolerances.
2221	22	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	If triggered by the Lift and/or Swing joystick not being in the neutral position at Startup, the UGM shall prohibit Lift and Swing. If triggered by Lift and/or Swing joystick is not in the neutral position when Footswitch becomes active or while DTC 2212, 2213 or 2223 is active, the UGM shall not Enable the Machine.
2222	22	WAITING FOR FSW TO BE OPEN	Can be reported during power- up.
2223	22	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE	The UGM shall not Enable the Machine.
2224	22	FOOTSWITCH SELECTED BEFORE START	The UGM shall prohibit Engine Start.
2269	22	FUNCTION PROBLEM - HIGH SPEED & CREEP ACTIVE TOGETHER	
234	23	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 Engine Start but permit Auxiliary Power/Emergency Descent.
235	23	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER	
236	23	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH	
237	23	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH	The UGM shall prohibit Engine Start.
23163	23	FUNCTION PROBLEM - MSSO PERMANENTLY SELECTED	No response required for this DTC Power Cycled.
240	24	<<< OTHER CONTROLS >>>	
241	24	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE LOW	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	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE HIGH	Check Ambient Temperature sensor reading < 85C.
250	25	<<< FUNCTION PREVENTED >>>	
259	25	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
2513	25	GENERATOR MOTION CUTOUT ACTIVE	The UGM shall not Enable the Machine.
2514	25	BOOM PREVENTED - DRIVE SELECTED	The UGM shall prohibit all boom functions.

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
2516	25	DRIVE PREVENTED - ABOVE ELEVATION	The UGM shall prohibit Drive and Steer.
2517	25	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	The UGM shall prohibit Drive and Steer.
2518	25	DRIVE PREVENTED - BOOM SELECTED	The UGM shall prohibit Drive and Steer.
2519	25	DRIVE PREVENTED - TILTED & EXTENDED OR HIGH ANGLE	
2520	25	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER	
2530	25	UMS SENSOR FORWARD LIMIT REACHED	
2531	25	UMS SENSOR OUT OF USABLE RANGE	
2532	25	UMS SENSOR BACKWARD LIMIT REACHED	
2563	25	SKYGUARD SWITCH - DISAGREEMENT	Response detailed in Sky-Guard section.
2568	25	TEMPERATURE CUTOUT ACTIVE - AMBIENT TEMPERATURE TOO LOW	If the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initial-ized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
2576	25	PLATFORM LEVEL PREVENTED - ABOVE ELEVATION	The UGM shall suspend Platform Level Up and Down commands; The UGM shall prohibit Platform Level Up and Down
2577	25	DRIVE PREVENTED - START BATTERY CONNECTED	Check the battery.
330	33	<<< GROUND OUTPUT DRIVER >>>	
331	33	BRAKE - SHORT TO BATTERY	Check Harness for damage.
332	33	BRAKE - OPEN CIRCUIT	Check Harness for damage.
3311	33	GROUND ALARM - SHORT TO BATTERY	Ground Alarm equipped vehicles only.
3336	33	ALTERNATOR POWER - SHORT TO GROUND	Check Harness for damage.
3340	33	AUX POWER - SHORT TO GROUND	Check Harness for damage.
3341	33	AUX POWER - OPEN CIRCUIT	Check Harness for damage.
3342	33	AUX POWER - SHORT TO BATTERY	Check Harness for damage.
3346	33	ELECTRIC FAN - SHORT TO GROUND	Check Harness for damage.
3347	33	ELECTRIC FAN - OPEN CIRCUIT	Check Harness for damage.
3348	33	ELECTRIC FAN - SHORT TO BATTERY	Check Harness for damage.
3349	33	ELECTRIC PUMP - SHORT TO GROUND	Check Harness for damage.
3350	33	ELECTRIC PUMP - OPEN CIRCUIT	Check Harness for damage.
3351	33	ELECTRIC PUMP - SHORT TO BATTERY	Check Harness for damage.
3352	33	LP LOCK - SHORT TO GROUND	Check Harness for damage.
3353	33	LP LOCK - OPEN CIRCUIT	Check Harness for damage.
3354	33	LP LOCK - SHORT TO BATTERY	Check Harness for damage.
3355	33	LP START ASSIST - SHORT TO GROUND	Check Harness for damage.
3356	33	LP START ASSIST - OPEN CIRCUIT	Check Harness for damage.
3357	33	LP START ASSIST - SHORT TO BATTERY	Check Harness for damage.
3358	33	MAIN DUMP VALVE - SHORT TO GROUND	Check Harness for damage.

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
3359	33	MAIN DUMP VALVE - OPEN CIRCUIT	Check Harness for damage.
3360	33	MAIN DUMP VALVE - SHORT TO BATTERY	Check Harness for damage.
3361	33	BRAKE - SHORT TO GROUND	Check Harness for damage.
3362	33	START SOLENOID - SHORT TO GROUND	Check Harness for damage.
3363	33	START SOLENOID - OPEN CIRCUIT	Check Harness for damage.
3364	33	START SOLENOID - SHORT TO BATTERY	Check Harness for damage.
3365	33	STEER DUMP VALVE - SHORT TO GROUND	Check Harness for damage.
3366	33	STEER DUMP VALVE - OPEN CIRCUIT	Check Harness for damage.
3367	33	STEER DUMP VALVE - SHORT TO BATTERY	Check Harness for damage.
3368	33	TWO SPEED VALVE - SHORT TO GROUND	Check Harness for damage.
3369	33	TWO SPEED VALVE - OPEN CIRCUIT	Check Harness for damage.
3370	33	TWO SPEED VALVE - SHORT TO BATTERY	Check Harness for damage.
3371	33	GROUND ALARM - SHORT TO GROUND	Check Harness for damage.
3372	33	GROUND ALARM - OPEN CIRCUIT	Check Harness for damage.
3373	33	GEN SET/WELDER - SHORT TO GROUND	Check Harness for damage.
3374	33	GEN SET/WELDER - OPEN CIRCUIT	Check Harness for damage.
3375	33	GEN SET/WELDER - SHORT TO BATTERY	Check Harness for damage.
3376	33	HEAD TAIL LIGHT - SHORT TO GROUND	Check Harness for damage.
3377	33	HEAD TAIL LIGHT - OPEN CIRCUIT	Check Harness for damage.
3378	33	HEAD TAIL LIGHT - SHORT TO BATTERY	Check Harness for damage.
3379	33	HOUR METER - SHORT TO GROUND	Check Harness for damage.
3382	33	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	Check Harness for damage.
3383	33	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	Check Harness for damage.
3384	33	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	Check Harness for damage.
3388	33	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
3389	33	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
3390	33	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
3394	33	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
3395	33	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
3396	33	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
3397	33	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
3398	33	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
3399	33	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
33100	33	JIB LIFT UP VALVE - SHORT TO GROUND	Check Harness for damage.
33101	33	JIB LIFT UP VALVE - OPEN CIRCUIT	Check Harness for damage.
33102	33	JIB LIFT UP VALVE - SHORT TO BATTERY	Check Harness for damage.
33103	33	JIB LIFT DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
33104	33	JIB LIFT DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
33105	33	JIB LIFT DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
33106	33	TOWER LIFT UP VALVE - SHORT TO GROUND	Check Harness for damage.
33107	33	TOWER LIFT UP VALVE - OPEN CIRCUIT	Check Harness for damage.
33108	33	TOWER LIFT UP VALVE - SHORT TO BATTERY	Check Harness for damage.
33109	33	TOWER LIFT DOWN VALVE - SHORT TO GROUND	Check Harness for damage.

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
33110	33	TOWER LIFT DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
33111	33	TOWER LIFT DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
33112	33	TOWER TELESCOPE IN VALVE - SHORT TO GROUND	Check Harness for damage.
33113	33	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT	Check Harness for damage.
33114	33	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY	Check Harness for damage.
33115	33	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND	Check Harness for damage.
33116	33	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT	Check Harness for damage.
33117	33	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY	Check Harness for damage.
33118	33	SWING RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
33119	33	SWING RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
33120	33	TELESCOPE IN VALVE - SHORT TO BATTERY	Check Harness for damage.
33121	33	SWING RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
33122	33	SWING LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
33123	33	TELESCOPE OUT VALVE - SHORT TO BATTERY	Check Harness for damage.
33130	33	THROTTLE ACTUATOR - SHORT TO GROUND	Check Harness for damage.
33131	33	THROTTLE ACTUATOR - OPEN CIRCUIT	Check Harness for damage.
33132	33	THROTTLE ACTUATOR - SHORT TO BATTERY	Check Harness for damage.
33170	33	LIFT DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
33171	33	LIFT DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
33172	33	LIFT DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
33175	33	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
33176	33	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
33177	33	JIB ROTATE LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
33178	33	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
33179	33	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
33180	33	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
33182	33	LIFT VALVES - SHORT TO BATTERY	Check Harness for damage.
33186	33	TELESCOPE OUT VALVE - OPEN CIRCUIT	Check Harness for damage.
33188	33	TELESCOPE OUT VALVE - SHORT TO GROUND	Check Harness for damage.
33189	33	TELESCOPE IN VALVE - OPEN CIRCUIT	Check Harness for damage.
33190	33	TELESCOPE IN VALVE - SHORT TO GROUND	Check Harness for damage.
33207	33	HORN - OPEN CIRCUIT	Check Harness for damage.
33208	33	HORN - SHORT TO BATTERY	Check Harness for damage.
33209	33	HORN - SHORT TO GROUND	Check Harness for damage.
33279	33	GLOWPLUG - OPEN CIRCUIT	Check Harness for damage.
33280	33	GLOWPLUG - SHORT TO BATTERY	Check Harness for damage.
33281	33	GLOWPLUG - SHORT TO GROUND	Check Harness for damage.

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
33287	33	LIFT - CURRENT FEEDBACK READING TOO LOW	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	SWING LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
33306	33	SWING LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
33314	33	FLOW CONTROL VALVE - OPEN CIRCUIT	Check Harness for damage.
33315	33	FLOW CONTROL VALVE - SHORT TO BATTERY	Check Harness for damage.
33316	33	FLOW CONTROL VALVE - SHORT TO GROUND	Check Harness for damage.
33317	33	DRIVE FORWARD VALVE - OPEN CIRCUIT	Check Harness for damage.
33318	33	DRIVE FORWARD VALVE - SHORT TO BATTER	Check Harness for damage.
33319	33	DRIVE FORWARD VALVE - SHORT TO GROUND	Check Harness for damage.
33320	33	DRIVE REVERSE VALVE - OPEN CIRCUIT	Check Harness for damage.
33321	33	DRIVE REVERSE VALVE - SHORT TO BATTERY	Check Harness for damage.
33322	33	DRIVE REVERSE VALVE - SHORT TO GROUND	Check Harness for damage.
33323	33	LIFT UP VALVE - OPEN CIRCUIT	Check Harness for damage.
33324	33	LIFT UP VALVE - SHORT TO BATTERY	Check Harness for damage.
33325	33	LIFT UP VALVE - SHORT TO GROUND	Check Harness for damage.
33331	33	DRIVE - CURRENT FEEDBACK READING TOO LOW	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	DRIVE - CURRENT FEEDBACK READING LOST	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	SWING VALVES - SHORT TO BATTERY	Check Harness for damage.
33414	33	SWING - CURRENT FEEDBACK READING TOO LOW	Check wiring and coil.
33415	33	FLOW CONTROL VALVE - CURRENT FEEDBACK READING TOO LOW	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33417	33	LIFT - CURRENT FEEDBACK READING LOST	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	SWING - CURRENT FEEDBACK READING LOST	Check wiring and coil.

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
33419	33	FLOW CONTROL VALVE - CURRENT FEEDBACK READING LOST	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33488	33	SWING FLOW CONTROL VALVE - SHORT TO GROUND	Check Harness for damage.
33575	33	ECM PULL DOWN RESISTOR - OPEN CIRCUIT	Check Harness for damage.
340	34	<<< PLATFORM OUTPUT DRIVER >>>	
341	34	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	Check Harness for damage.
342	34	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	Check Harness for damage.
343	34	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	Check Harness for damage.
344	34	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	Check Harness for damage.
345	34	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
346	34	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
347	34	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
348	34	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	Check Harness for damage.
349	34	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
3410	34	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
3411	34	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
3412	34	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
3413	34	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
3414	34	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
3415	34	JIB LIFT UP VALVE - OPEN CIRCUIT	Check Harness for damage.
3416	34	JIB LIFT UP VALVE - SHORT TO BATTERY	Check Harness for damage.
3417	34	JIB LIFT UP VALVE - SHORT TO GROUND	Check Harness for damage.
3418	34	JIB LIFT DOWN VALVE - OPEN CIRCUIT	Check Harness for damage.
3419	34	JIB LIFT DOWN VALVE - SHORT TO BATTERY	Check Harness for damage.
3420	34	JIB LIFT DOWN VALVE - SHORT TO GROUND	Check Harness for damage.
3421	34	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	Check Harness for damage.
3422	34	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	Check Harness for damage.
3423	34	JIB ROTATE LEFT VALVE - SHORT TO GROUND	Check Harness for damage.
3424	34	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	Check Harness for damage.
3425	34	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	Check Harness for damage.
3426	34	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	Check Harness for damage.
430	43	<<< ENGINE >>>	
431	43	FUEL SENSOR - SHORT TO BATTERY OR OPEN CIRCUIT	Energize fuel sensor per System Indicators
432	43	FUEL SENSOR - SHORT TO GROUND	Energize fuel sensor per System Indicators
433	43	OIL PRESSURE - SHORT TO BATTERY	Deutz engine only.
434	43	OIL PRESSURE - SHORT TO GROUND	Deutz engine only. - Not reported during engine start.
435	43	COOLANT TEMPERATURE - SHORT TO GROUND	Deutz engine only.
436	43	FORD FAULT CODE ##	

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
437	43	ENGINE TROUBLE 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	HIGH ENGINE TEMP	Ford / Deutz engine only.
439	43	AIR FILTER BYPASSED	Check Airfilter for clogging
4310	43	NO ALTERNATOR OUTPUT	Activate the No Charge indicator J4-26 per System Indicators.
4311	43	LOW OIL PRESSURE	Ford / Deutz engine only.
4312	43	485 COMMUNICATIONS LOST	
4313	43	THROTTLE ACTUATOR FAILURE	
4314	43	WRONG ENGINE SELECTED - ECM DETECTED	
4322	43	LOSS OF ENGINE SPEED SENSOR	Diesel engine only.
4323	43	SPEED SENSOR READING INVALID SPEED	Diesel engine only.
4331	43	SOOT LOAD WARNING - LOW	Check Engine.
4332	43	SOOT LOAD WARNING - HIGH	Check Engine.
4333	43	SOOT LOAD WARNING - SEVERE	Check Engine.
4334	43	ENGINE COOLANT - LOW LEVEL	MACHINE SETUP > ENGINE SHUTDOWN = ENABLED then shutdown the engine; Activate High Engine Temperature indicator J4-28.
440	44	<<< BATTERY SUPPLY >>>	
441	44	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN	
442	44	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN	
445	44	BATTERY VOLTAGE LOW	
660	66	<<< COMMUNICATION >>>	
662	66	CANBUS FAILURE - PLATFORM MODULE	
664	66	CANBUS FAILURE - ACCESSORY MODULE	Check the Wiring.
666	66	CANBUS FAILURE - ENGINE CONTROLLER	ECM equipped engine only.
6620	66	CANBUS FAILURE - UMS SENSOR	
6622	66	CANBUS FAILURE - TCU MODULE	
6623	66	CANBUS FAILURE - GATEWAY MODULE	
6629	66	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH	

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
6657	66	CANBUS FAILURE - TEMPERATURE SENSOR	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	ACCESSORY FAULT	
680	68	<<< TELEMATICS >>>	
681	68	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP	
810	81	<<< TILT SENSOR >>>	
813	81	CHASSIS TILT SENSOR NOT CALIBRATED	
815	81	CHASSIS TILT SENSOR DISAGREEMENT	
816	81	UMS SENSOR NOT CALIBRATED	
817	81	UMS SENSOR FAULT	
820	82	<<< PLATFORM LOAD SENSE >>>	
825	82	LSS HAS NOT BEEN CALIBRATED	UGM to set Platform Load State = Overloaded
826	82	RUNNING AT CREEP - PLATFORM OVERLOADED	
827	82	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED	
828	82	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED	
8639	86	FRONT LEFT STEER VALVE - OPEN CIRCUIT	Check Harness for damage.
8640	86	FRONT LEFT STEER VALVE - SHORT TO BATTERY	Check Harness for damage.
8641	86	FRONT LEFT STEER VALVE - SHORT TO GROUND	Check Harness for damage.
8642	86	FRONT RIGHT STEER VALVE - OPEN CIRCUIT	Check Harness for damage.
8643	86	FRONT RIGHT STEER VALVE - SHORT TO BATTERY	Check Harness for damage.
8644	86	FRONT RIGHT STEER VALVE - SHORT TO GROUND	Check Harness for damage.
8645	86	REAR LEFT STEER VALVE - OPEN CIRCUIT	Check Harness for damage.
8646	86	REAR LEFT STEER VALVE - SHORT TO BATTERY	Check Harness for damage.
8647	86	REAR LEFT STEER VALVE - SHORT TO GROUND	Check Harness for damage.
8648	86	REAR RIGHT STEER VALVE - OPEN CIRCUIT	Check Harness for damage.
8649	86	REAR RIGHT STEER VALVE - SHORT TO BATTERY	Check Harness for damage.
8650	86	REAR RIGHT STEER VALVE - SHORT TO GROUND	Check Harness for damage.

Table 6-14. Diagnostic Trouble Code Chart (DTC)

DTC	Flash Code	Fault Message	Check
871	87	RETURN FILTER BYPASSED	Check Hydraulic Return Filter.
872	87	CHARGE PUMP FILTER BYPASSED	Check Charge Pump Filter.
873	87	MACHINE SAFETY SYSTEM OVERRIDE OCCURRED	Response described in MSSO Influence on Machine Operation section.
998	99	EEPROM FAILURE - CHECK ALL SETTINGS	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	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	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	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	
9915	99	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	
9916	99	CHASSIS TILT SENSOR GAIN OUT OF RANGE	
9919	99	GROUND SENSOR REF VOLTAGE OUT OF RANGE	Not reported during power-up.
9920	99	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	Not reported during power-up.
9921	99	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY	
9922	99	PLATFORM MODULE FAILURE - HWFS CODE 1	
9923	99	GROUND MODULE FAILURE - HWFS CODE 1	
9924	99	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED	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	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.
9945	99	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	
9979	99	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).

SECTION 7. BASIC ELECTRICAL INFORMATION & 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.

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

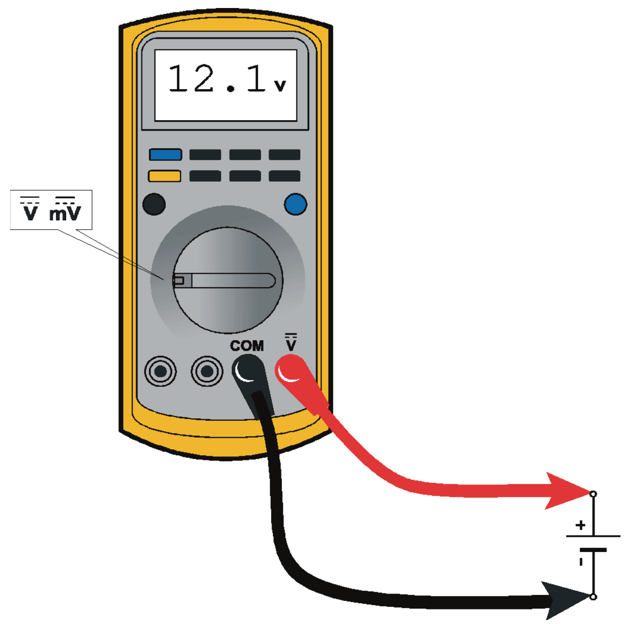


Figure 7-1. Voltage Measurement (DC)

- 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

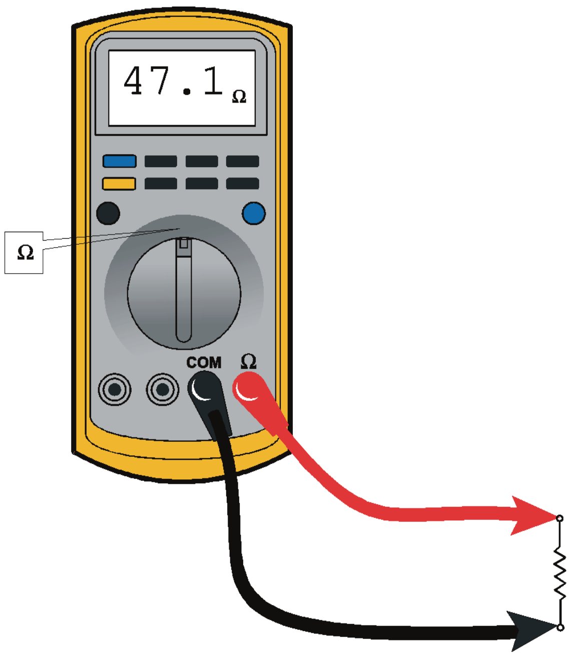


Figure 7-2. Resistance Measurement

- 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

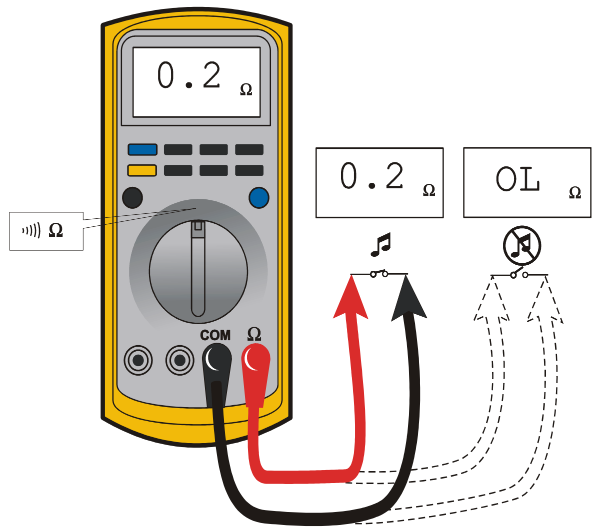


Figure 7-3. Continuity Measurement

- 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

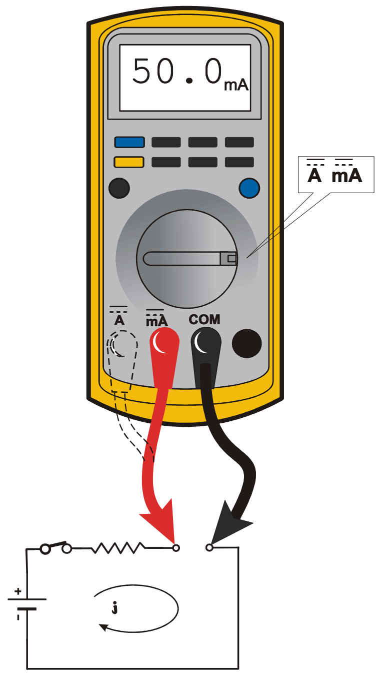


Figure 7-4. Current Measurement (DC)

- 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 PN 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 could be applied to all electrical connectors at the time of connection (except those noted under Exclusions).

Installation of Dielectric Grease

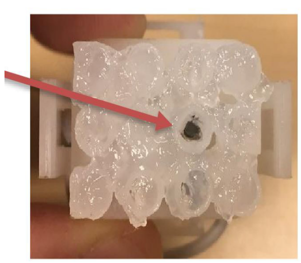
The following is general guidance for the installation of dielectric grease in a connector system.

- Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
- Apply dielectric grease to plug/male connector housing which typically contains sockets contact/female terminals.
- Leave a layer of dielectric grease on the mating face of the connector, completely covering each connector terminal hole. Refer the pictures shown below.
- Assemble the connector system immediately to prevent moisture ingress or dust contamination.

The following connector systems are specifically addressed because of their widespread use at JLG. However, this guidance may be applied to similar devices.

AMP Mate-N-Lok

This connector system is widely used inside enclosures for general-purpose interconnect. Follow the general guidance for installation.



Improper

Proper

AMP Faston

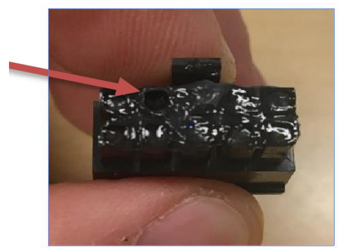
This connector system is typically used on operator switches at JLG. Follow the general guidance for installation.

Improper

Proper

AMP Micro-Fit

This connector system is typically used on control modules at JLG. Follow the general guidance for installation.

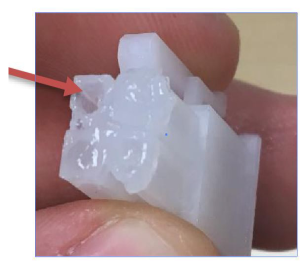


Improper

Proper

AMP Mini Fit Jr

This connector system is typically used on control modules at JLG. Follow the general guidance for installation.

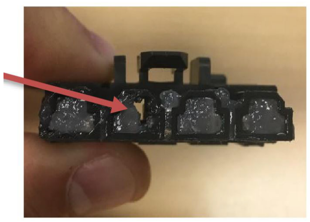


Improper

Proper

Mini Fit Sr

This connector system is typically used on control modules at JLG. Follow the general guidance for installation.

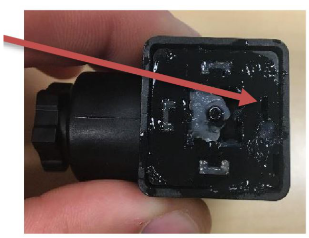


Improper

Proper

DIN Connectors

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



Improper

Proper

Exceptions

Some waterproof connector applications do benefit from dielectric grease, and some non waterproof connectors do not benefit from dielectric grease.

In the exceptions below, we have found dielectric grease is not needed for some applications, and in some cases can interfere with the intended connection. Dielectric grease shall be used as an exception in other applications.

Enclosures

Application of dielectric grease is not required in properly sealed enclosures. To meet criteria, the enclosure must be rated to at least IP56 (dust protected; protected from powerful jets of water).

Carling Switch Connectors

Carling switches may experience high impedance, or discontinuity, due to silicone dielectric grease ingress when switching inductive loads. Therefore, dielectric grease shall not be applied to Carling switch mating connectors unless specifically noted.

7.4 AMP CONNECTOR

Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 7-5.). Proceed as follows:

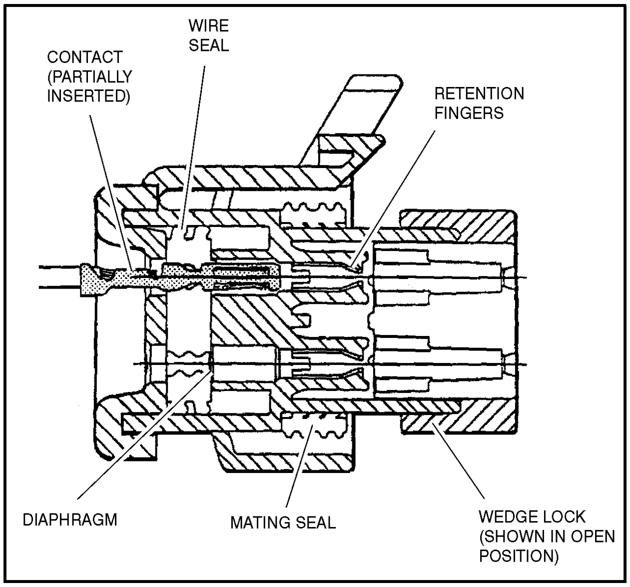


Figure 7-5. Connector Assembly Figure 1

1. To insert a contact, push it straight into the appropriate circuit cavity as far as it will go (See Figure 7-7.).

2. Pull 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 7-7.).

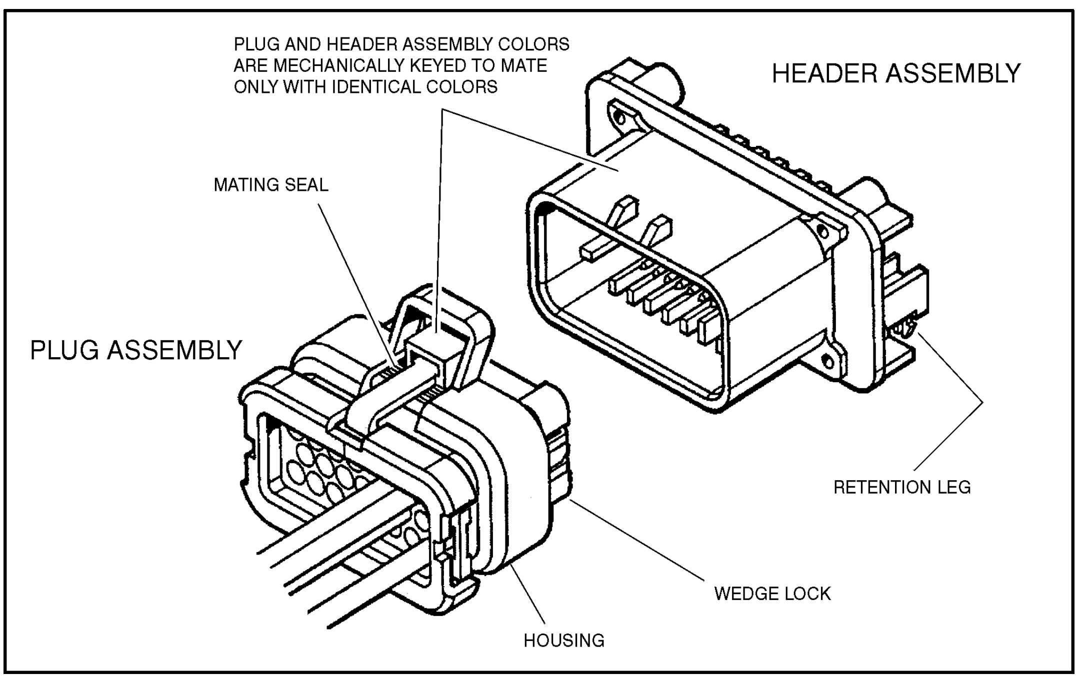


Figure 7-6. AMP Connector

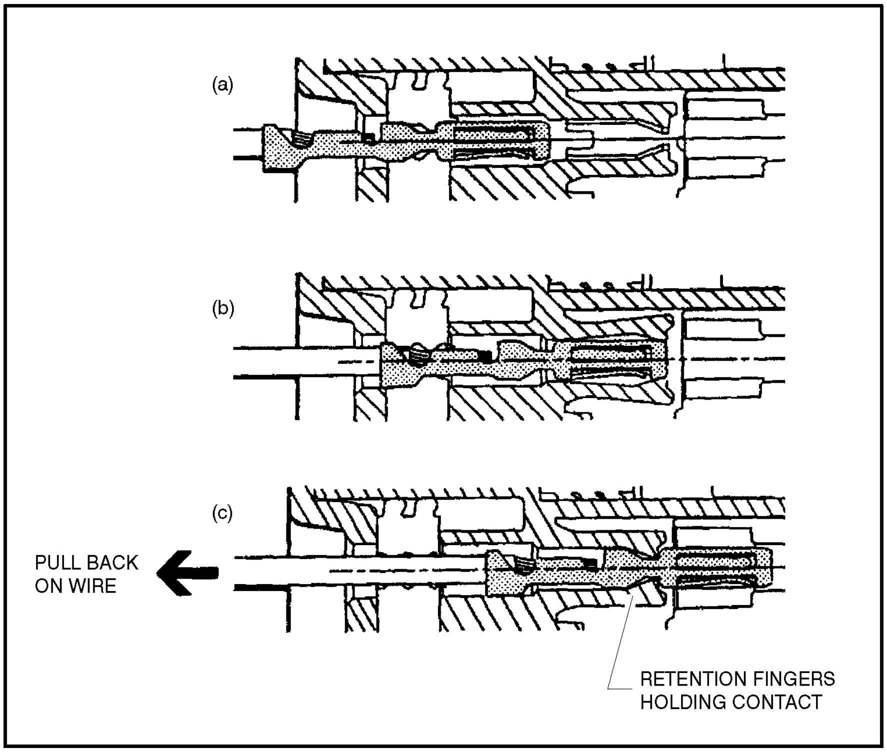


Figure 7-7. Connector Assembly Figure 2

3. After all required contacts have been inserted, the wedge lock must be closed to its locked position. Release the locking latches by squeezing them inward (See Figure 7-8.).

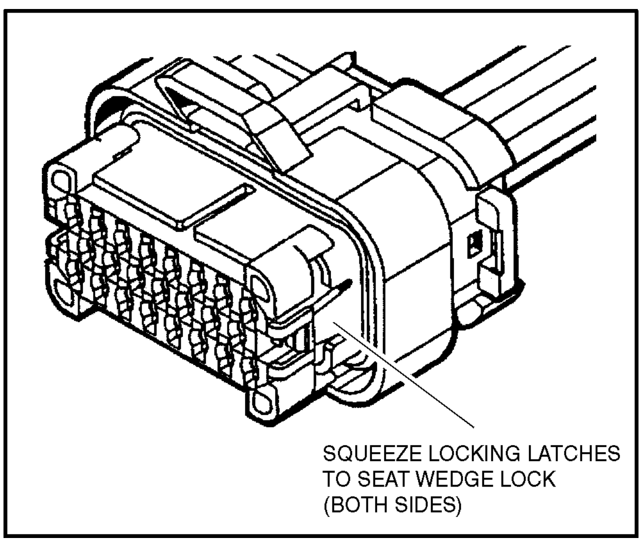


Figure 7-8. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-9.).

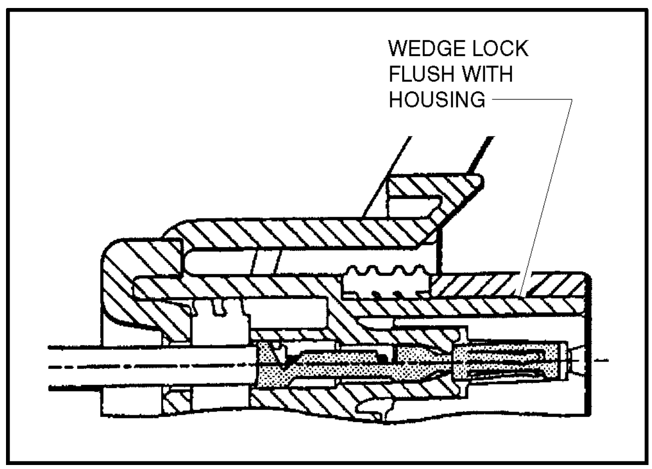


Figure 7-9. Connector Assembly Figure 4

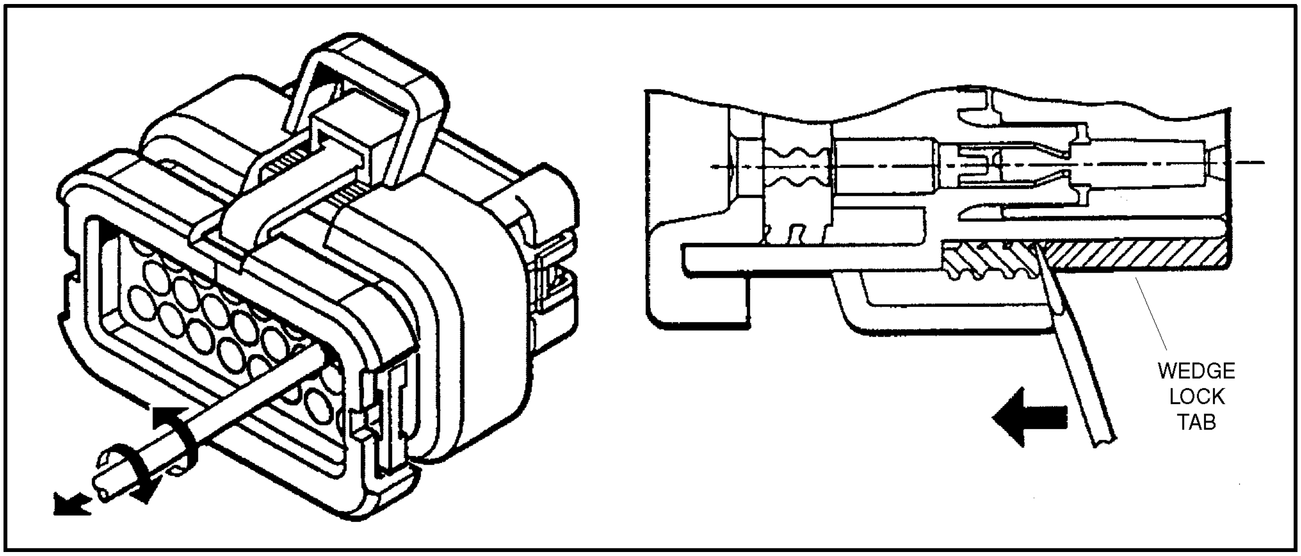


Figure 7-10. Connector Disassembly

Disassembly

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

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

Wedge Lock

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

Service - Voltage Reading

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 AMP-SEAL plug assembly, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and could result in system failure.

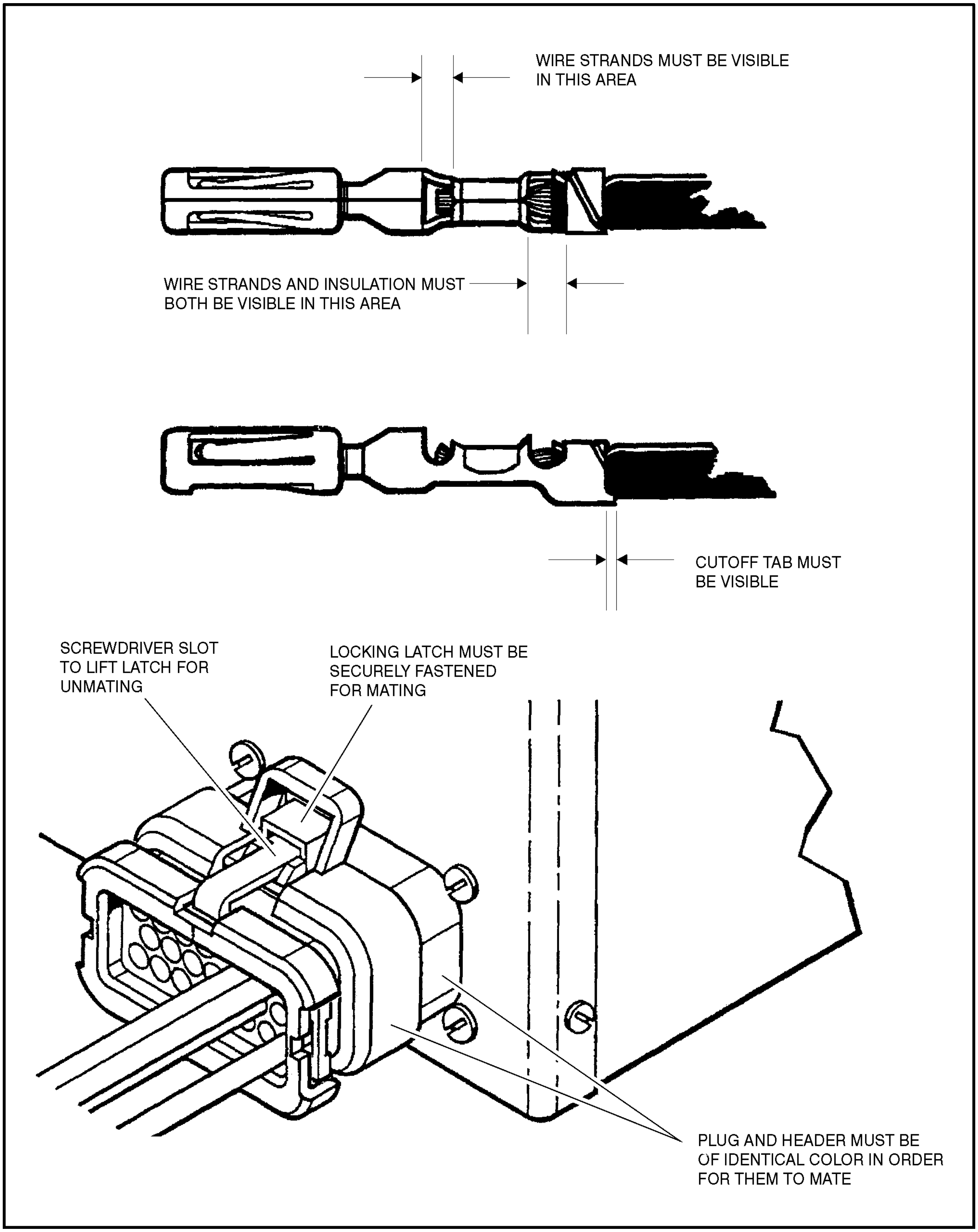


Figure 7-11. Connector Installation

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly

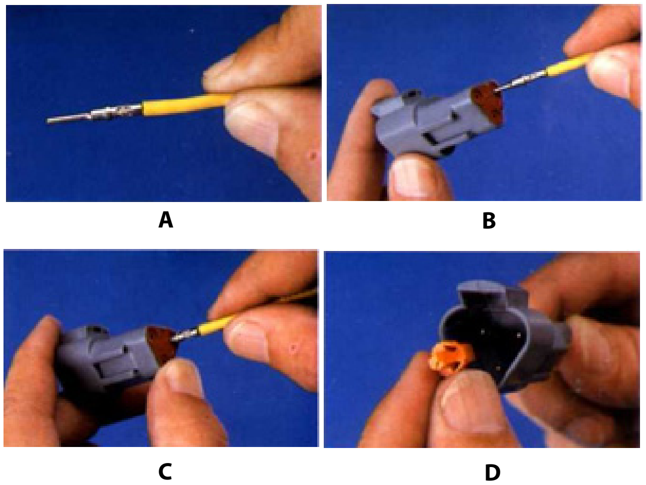


Figure 7-12. DT/DTP Contact Installation

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

NOTE: *The receptacle is shown - use the same procedure for plug.*

DT/DTP Series Disassembly

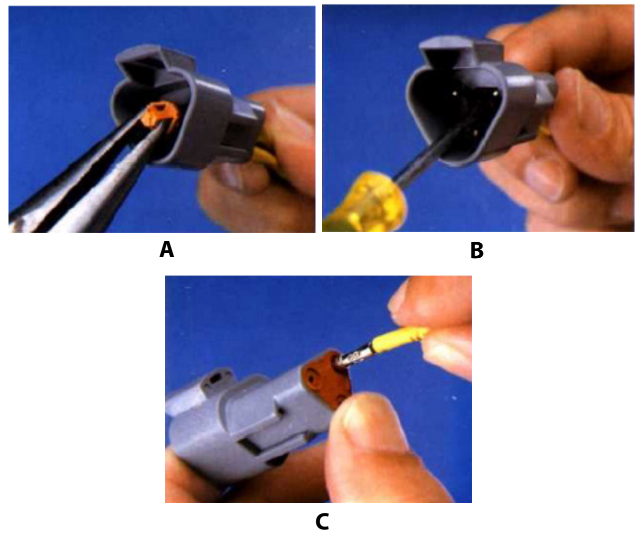


Figure 7-13. DT/DTP Contact Removal

5. Remove wedgelock using needle nose 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

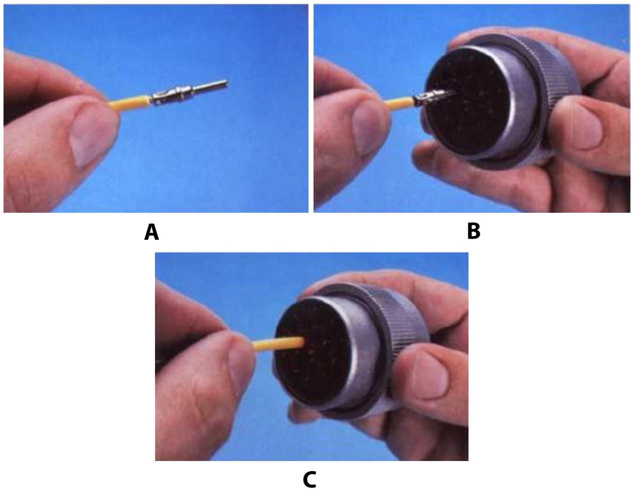


Figure 7-14. HD/HDP Contact Installation

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.

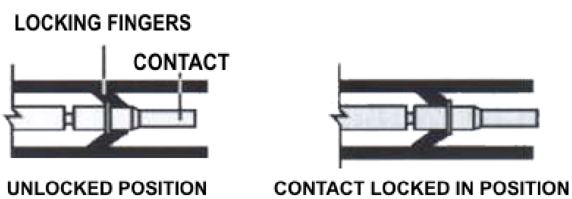


Figure 7-15. HD/HDP Locking Contacts Into Position

NOTE: *For unused wire cavities, insert sealing plugs for full environmental sealing.*

HD30/HDP20 Series Disassembly

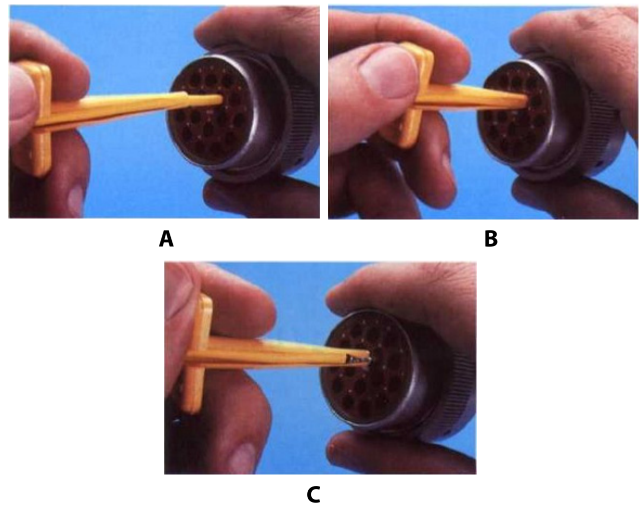


Figure 7-16. HD/HDP Contact Removal

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.

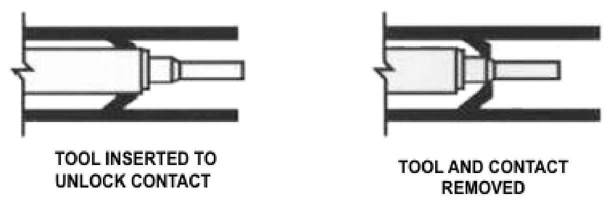


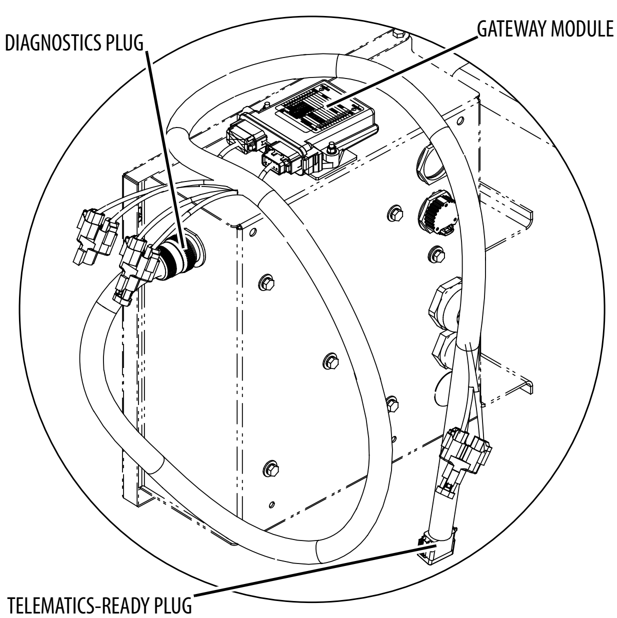
Figure 7-17. HD/HDP Unlocking Contacts

NOTE: *Do Not twist or insert tool at an angle.*

7.6 TELEMATICS GATEWAY

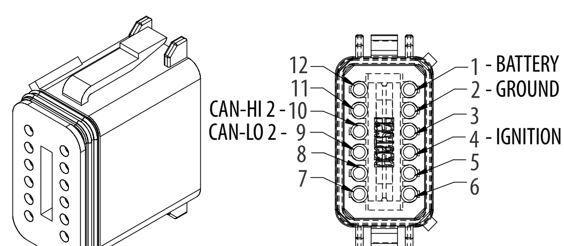
Personnel using machines equipped with an optional telematics gateway will be able to view the following data through their telematics device:

JLG LABEL	DESCRIPTION	UNIT
Engine Speed	Actual engine speed.	RPM
DEF Tank Level (If Equipped)	Indicates the level of DEF (diesel exhaust fluid) within the DEF tank if the machine is equipped with DEF tank. • 0% = Empty • 100% = Full	Percentage (%)
JLG Machine Faults: Active / Not-Active	• 00 - No Machine Faults • 01 - Active Machine Fault • 10 - Error • 11 - Not available	Bit
Total Idle Fuel Used	Total amount of fuel used during vehicle operation during idle conditions.	Liters
Total Idle Hours	Total time of engine operation during idle conditions.	Seconds
Total Engine Hours	Total time of engine operation.	Seconds
Total Fuel Used	Total amount of fuel used during vehicle operation.	Liters
Fuel Rate	Amount of fuel consumed by engine per unit of time.	Liters/Hour
Fuel Level	Ratio of fuel volume to the total volume of the fuel storage container. When a low fuel limit switch is present, the fuel level will indicate "full" until the switch opens, which will then indicate 10% fuel remaining. When Fuel Level 2 (SPN 38) is not used, Fuel Level 1 represents the total fuel in all fuel storage containers. When Fuel Level 2 is used, Fuel Level 1 represents the fuel level in the primary or left side fuel storage container.	Percentage (%)
DM1 Engine Faults	Shows actual engine fault codes.	N/A



Telematics-Ready (TCU) Plug

The telematics-ready (TCU) plug is a standard 12-pin Deutsch connector. Pin-out locations are shown below:



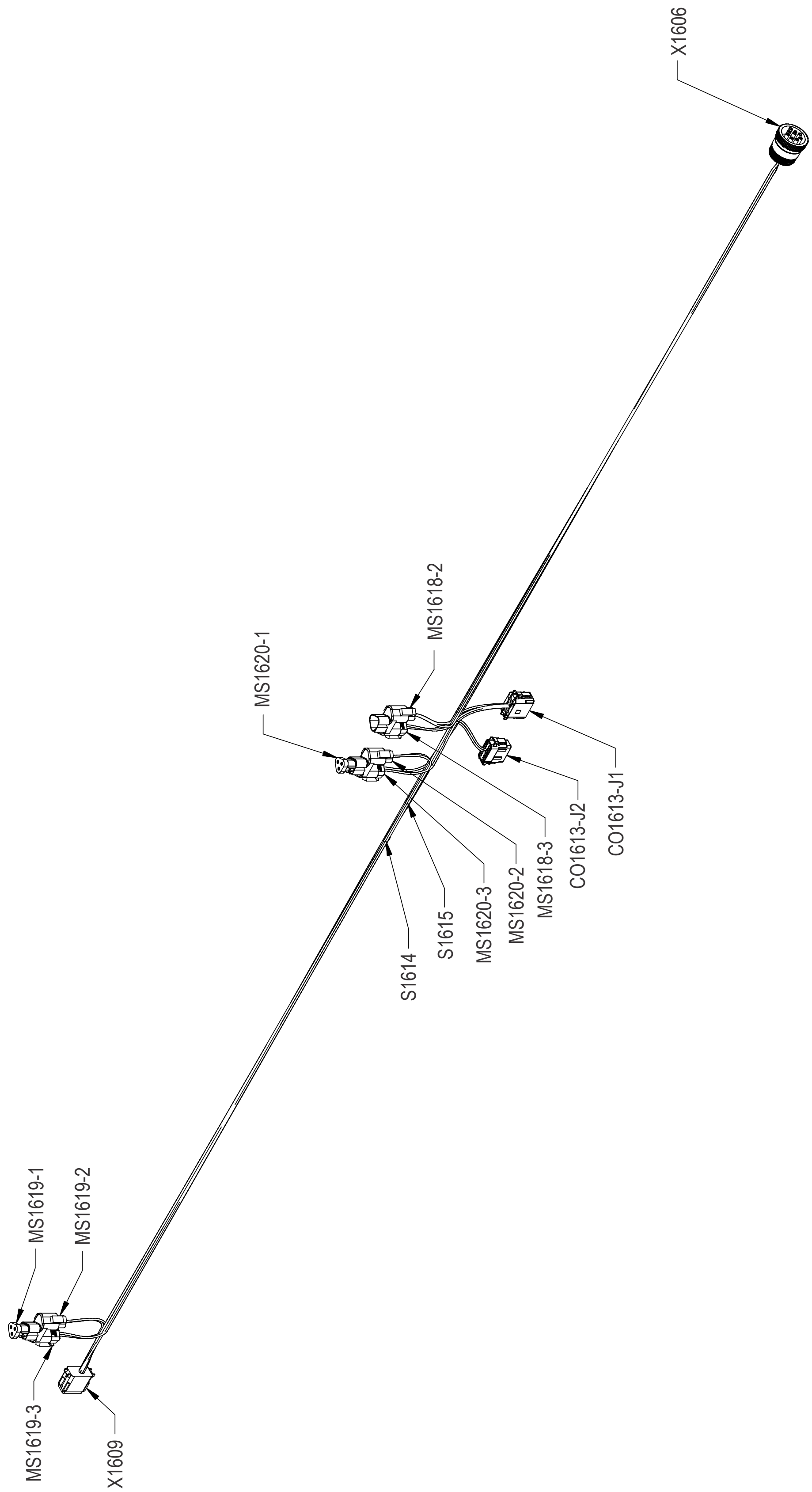


Figure 7-18. Telematics Gateway Harness - Sheet 1 of 3

X1609 (TCU)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1-0 BAT	16 AWG	GXL	X1606 (B)
2	BLK	0-0 GND	16 AWG	GXL	S1615 (1)
4	ORN	2-0 IGN	16 AWG	GXL	S1614 (1)
9	GRN	CANL2	18 AWG	GXL	MS1619-2 (B)
10	YEL	CANH2	18 AWG	GXL	MS1619-2 (A)

MS1619-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	X1609 (10)
B	GRN	CANL2	18 AWG	GXL	X1609 (9)

MS1619-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1620-2 (A)
B	GRN	CANL2	18 AWG	GXL	MS1620-2 (B)

CO1613-J1 (GATEWAY 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CAN1	18 AWG	GXL	MS1618-2 (B)
10	YEL	CANH1	18 AWG	GXL	MS1618-2 (A)
11	BLK	0-2 GND	16 AWG	GXL	S1615 (2)
12	ORN	2-2 IGN	16 AWG	GXL	S1614 (2)

CO1613-J2 (GATEWAY 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
9	GRN	CANL2	18 AWG	GXL	MS1620-3 (B)
10	YEL	CANH2	18 AWG	GXL	MS1620-3 (A)

MS1620-2 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	MS1619-3 (A)
B	GRN	CANL2	18 AWG	GXL	MS1619-3 (B)

MS1620-3 (CAN-T 2)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH2	18 AWG	GXL	CO1613-J2 (10)
B	GRN	CANL2	18 AWG	GXL	CO1613-J2 (9)

S1614					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	ORN	2-0 IGN	16 AWG	GXL	X1609 (4)
2	ORN	2-1 IGN	16 AWG	GXL	X1606 (H)
2	ORN	2-2 IGN	16 AWG	GXL	CO1613-J1 (12)

S1615					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	0-0 GND	16 AWG	GXL	X1609 (2)
2	BLK	0-1 GND	16 AWG	GXL	X1606 (A)
2	BLK	0-2 GND	16 AWG	GXL	CO1613-J1 (11)

MS1618-2 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	CO1613-J1 (10)
B	GRN	CANL1	18 AWG	GXL	CO1613-J1 (9)

MS1618-3 (CAN-T 1)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	YEL	CANH1	18 AWG	GXL	X1606 (C)
B	GRN	CANL1	18 AWG	GXL	X1606 (D)

X1606 (DIAG)					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK	0-1 GND	16 AWG	GXL	S1615 (2)
B	RED	1-0 BAT	16 AWG	GXL	X1609 (1)
C	YEL	CANH1	18 AWG	GXL	MS1618-3 (A)
D	GRN	CANL1	18 AWG	GXL	MS1618-3 (B)
H	ORN	2-1 IGN	16 AWG	GXL	S1614 (2)

Figure 7-19. Telematics Gateway Harness - Sheet 2 of 3

					FROM		TO	
WIRE NO.	COLOR	WIRE GAUGE	LENGTH (mm)	JACKET	REFERENCE	PIN	REFERENCE	PIN
CAN L2	GRN	18 AWG	1151	GXL	MS1619-3	B	MS1620-2	B
CAN L2	GRN	18 AWG	151	GXL	X1609	9	MS1619-2	B
CAN L1	GRN	18 AWG	157	GXL	MS1618-2	B	CO1613-J1	9
CAN L2	GRN	18 AWG	225	GXL	MS1620-3	B	CO1613-J2	9
CAN L1	GRN	18 AWG	1076	GXL	MS1618-3	B	X1606	D
CAN H2	YEL	18 AWG	155	GXL	X1609	10	MS1619-2	A
CAN H2	YEL	18 AWG	233	GXL	MS1620-3	A	CO1613-J2	10
CAN H1	YEL	18 AWG	157	GXL	MS1618-2	A	CO1613-J1	10
CAN H2	YEL	18 AWG	1150	GXL	MS1619-3	A	MS1620-2	A
CAN H1	YEL	18 AWG	1079	GXL	MS1618-3	A	X1606	C
0-0 GND	BLK	16 AWG	1006	GXL	X1609	2	S1615	1
0-1 GND	BLK	16 AWG	1145	GXL	X1606	A	S1615	2
0-2 GND	BLK	16 AWG	223	GXL	CO1613-J1	11	S1615	2
1-0 BAT	RED	16 AWG	2150	GXL	X1609	1	X1606	B
2-0 IGN	ORN	16 AWG	939	GXL	X1609	4	S1614	1
2-1 IGN	ORN	16 AWG	1212	GXL	S1614	2	X1606	H
2-2 IGN	ORN	16 AWG	287	GXL	CO1613-J1	12	S1614	2

Figure 7-20. Telematics Gateway Harness - Sheet 3 of 3

7.7 ELECTRICAL SCHEMATICS

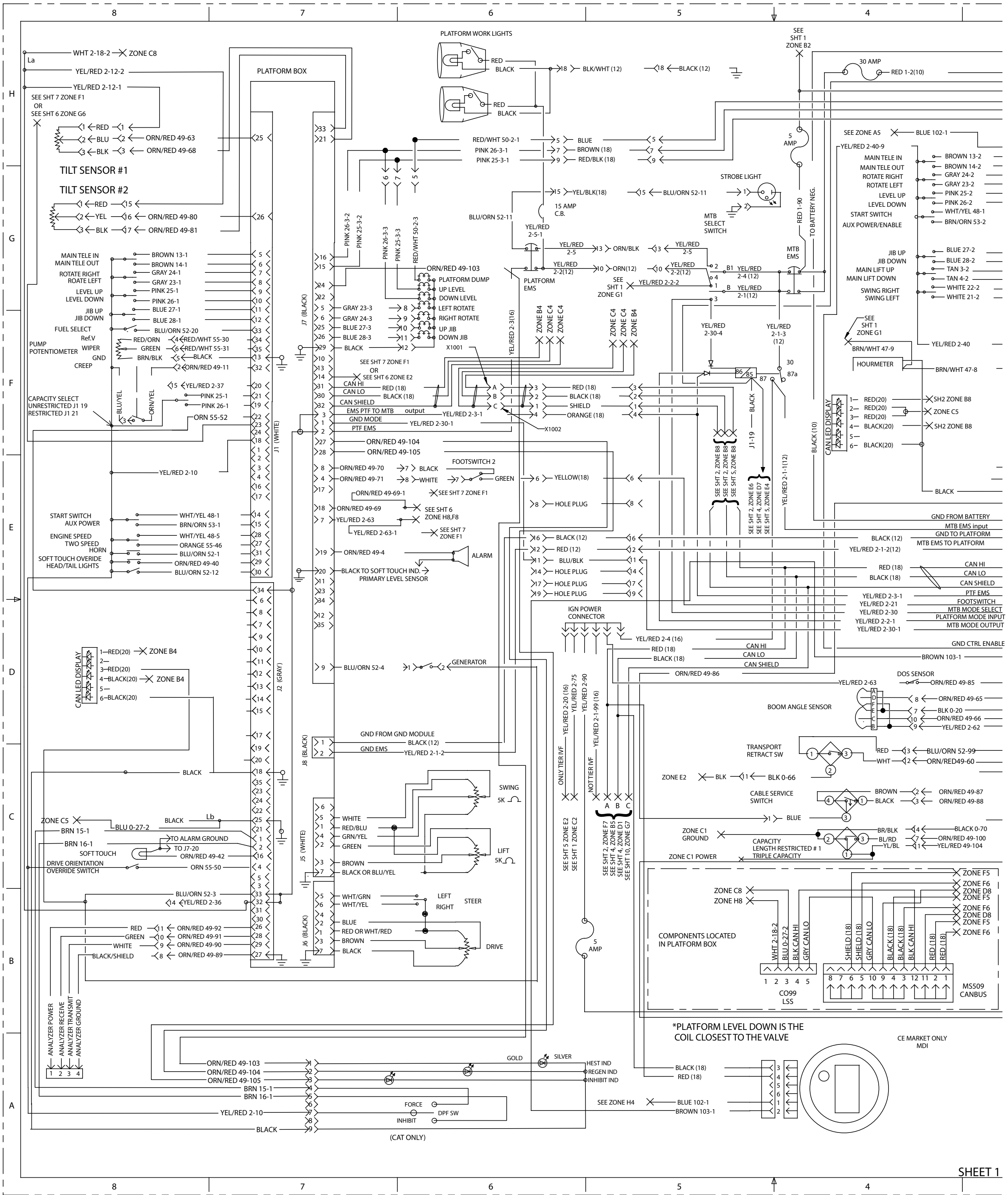


Figure 7-21. Electrical Schematic - Sheet 1 of 21

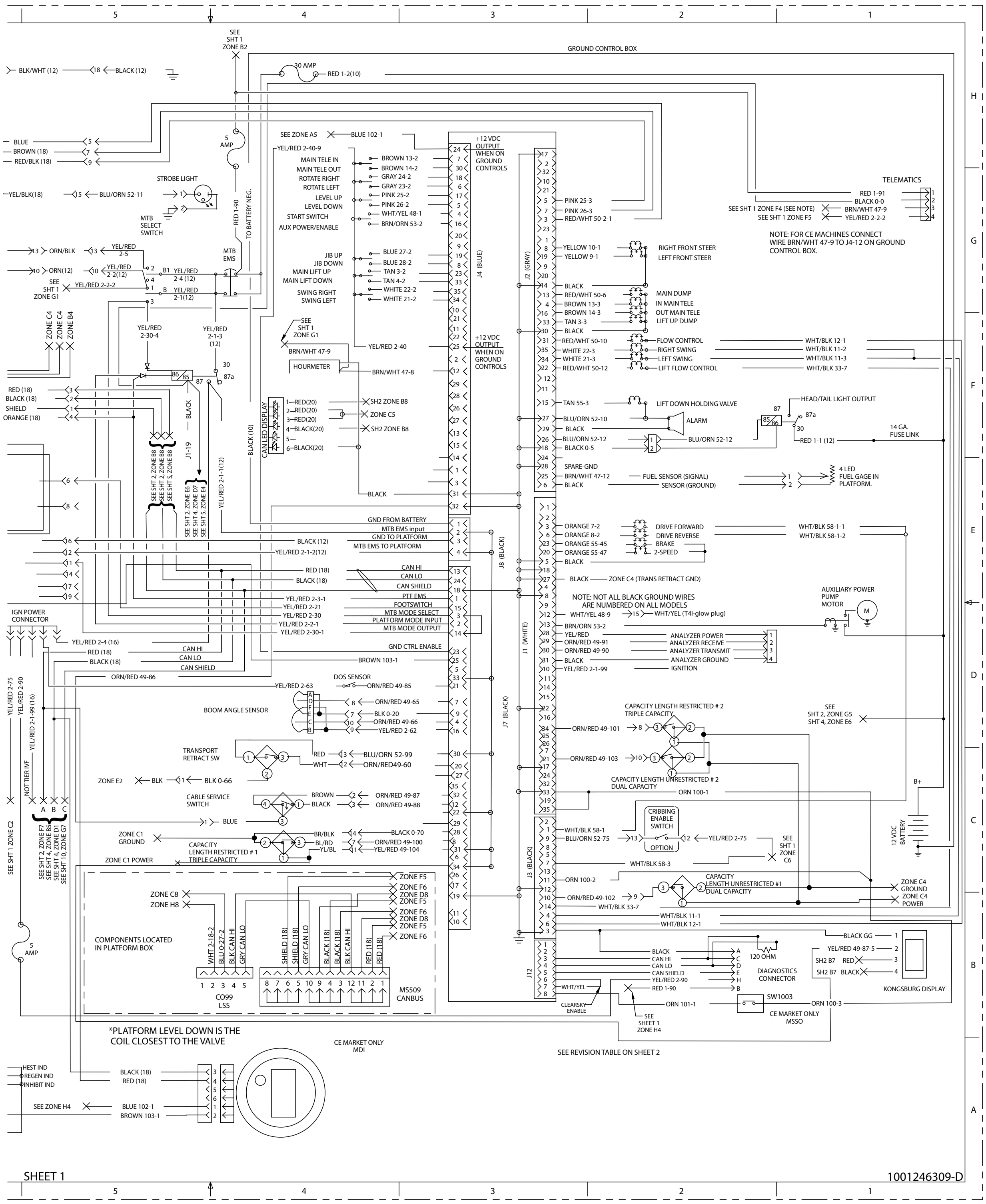


Figure 7-22. Electrical Schematic - Sheet 2 of 21

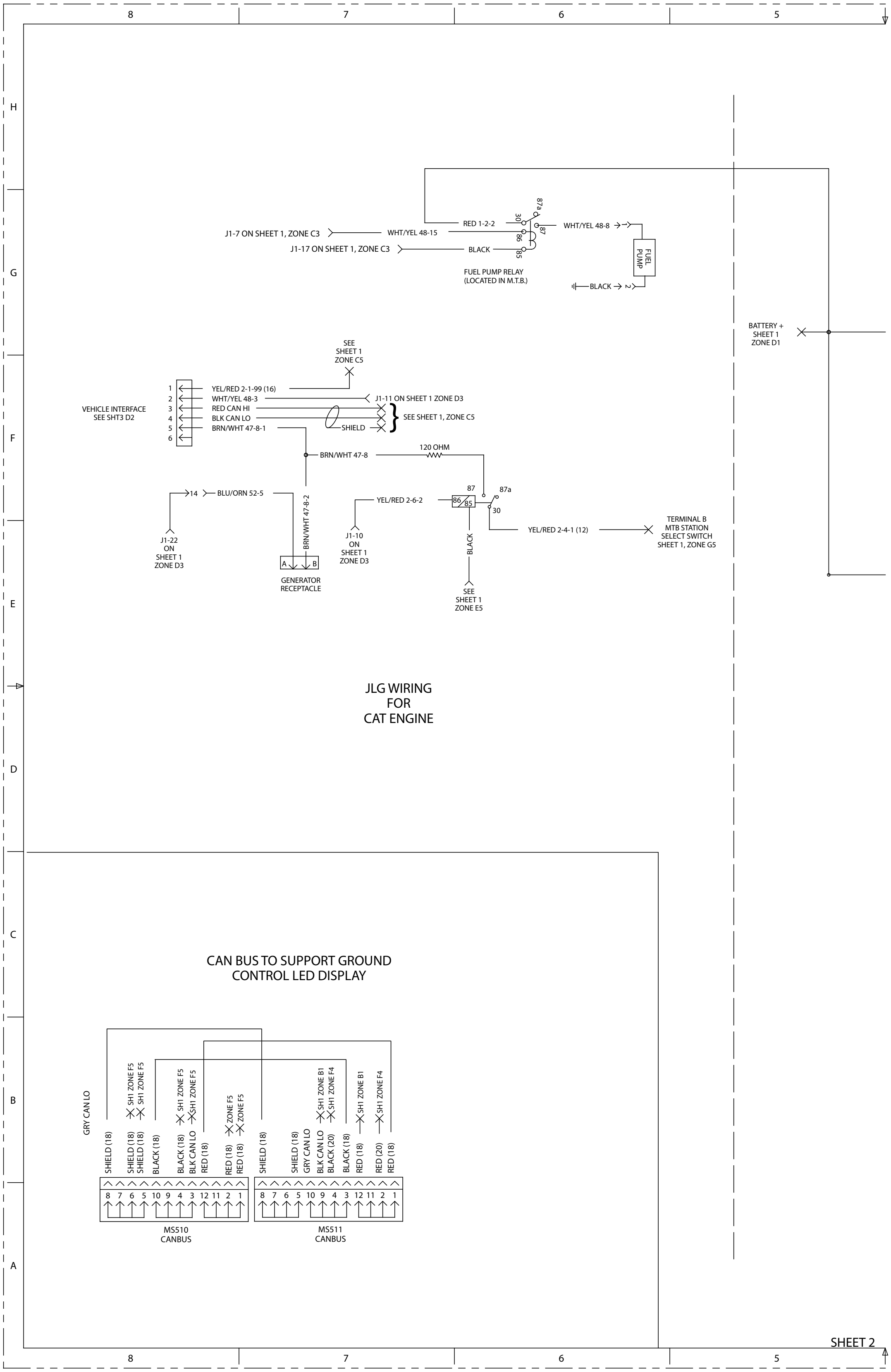


Figure 7-23. Electrical Schematic - Sheet 3 of 21

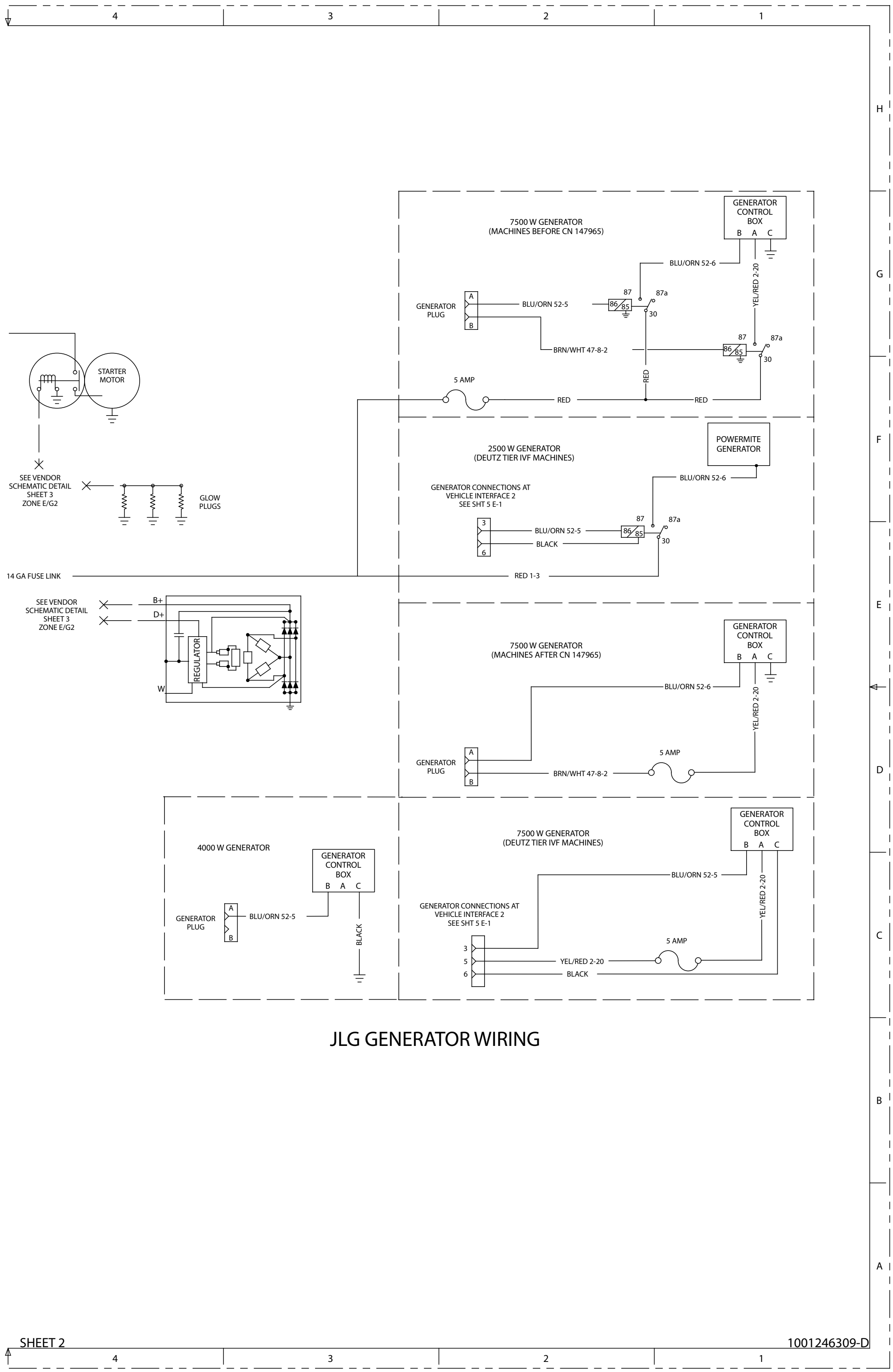


Figure 7-24. Electrical Schematic - Sheet 4 of 21

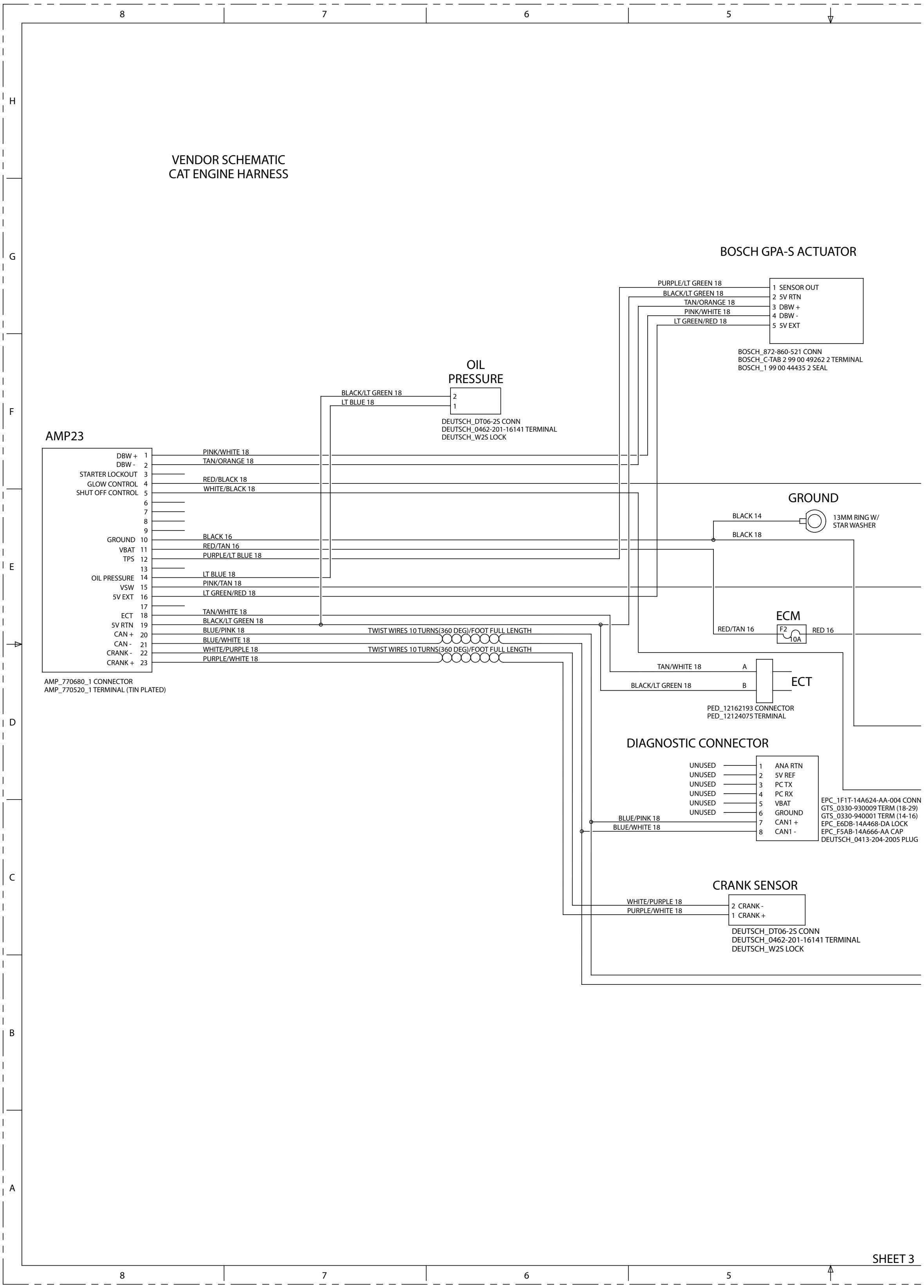


Figure 7-25. Electrical Schematic - Sheet 5 of 21

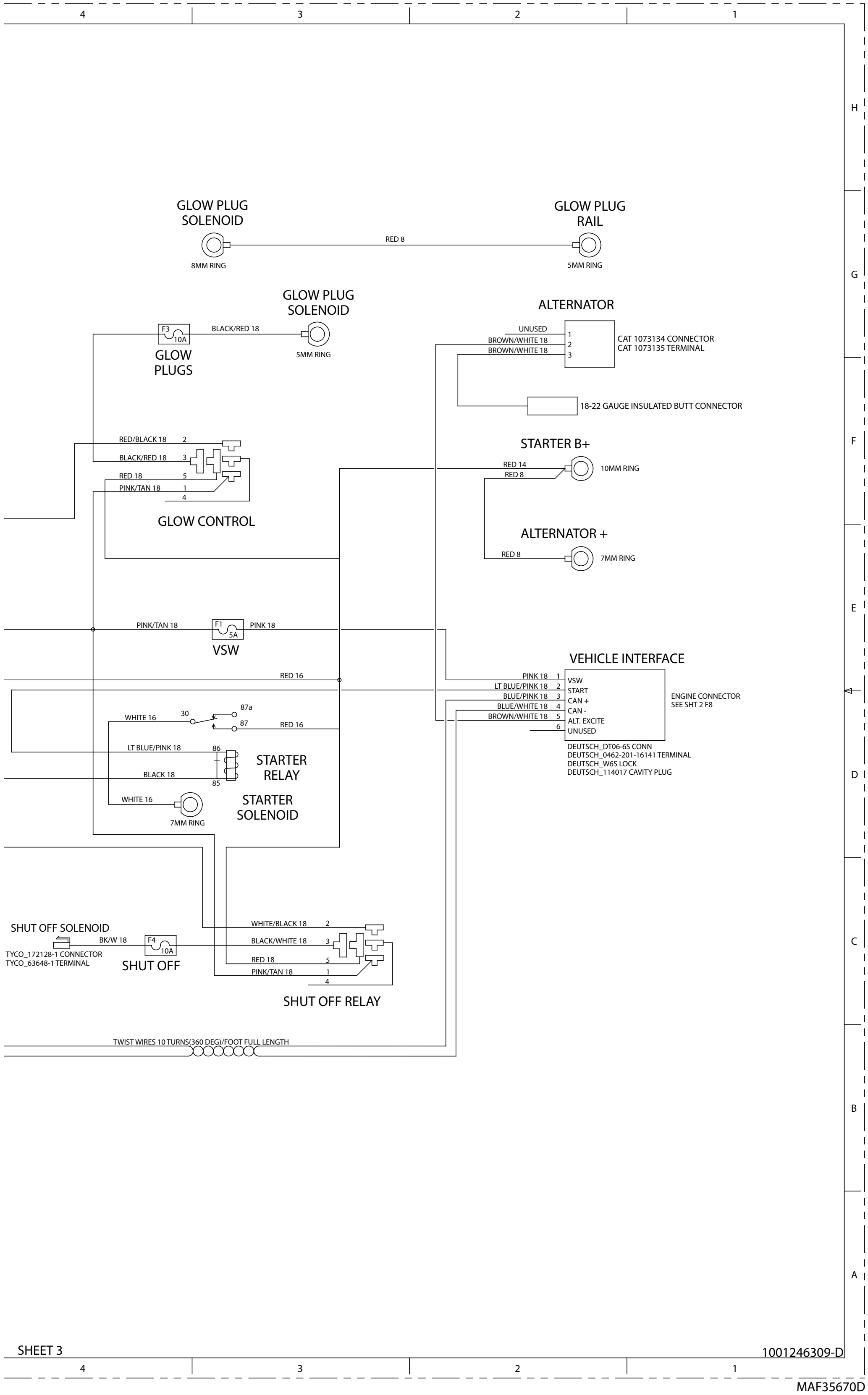


Figure 7-26. Electrical Schematic - Sheet 6 of 21

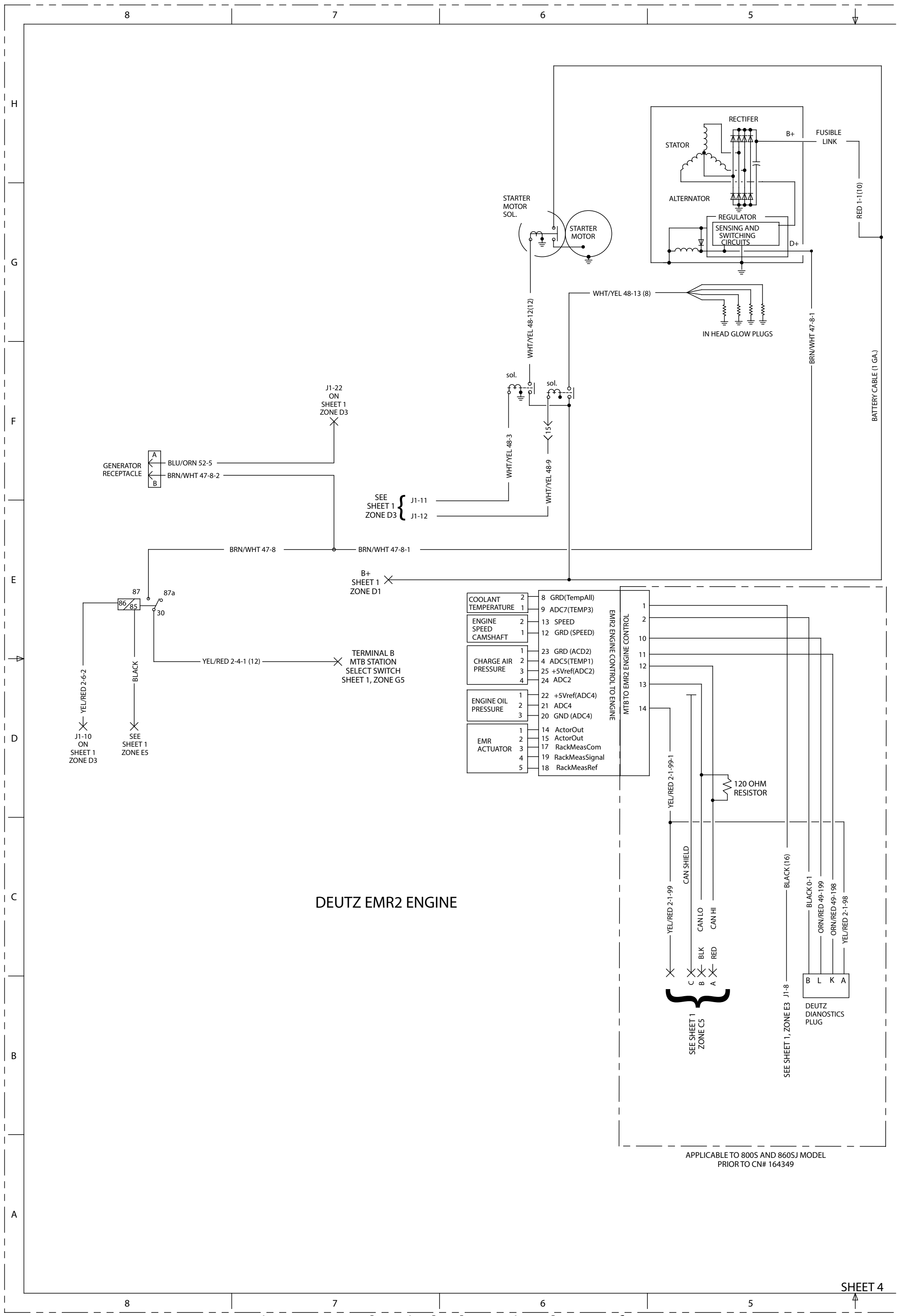


Figure 7-27. Electrical Schematic - Sheet 7 of 21

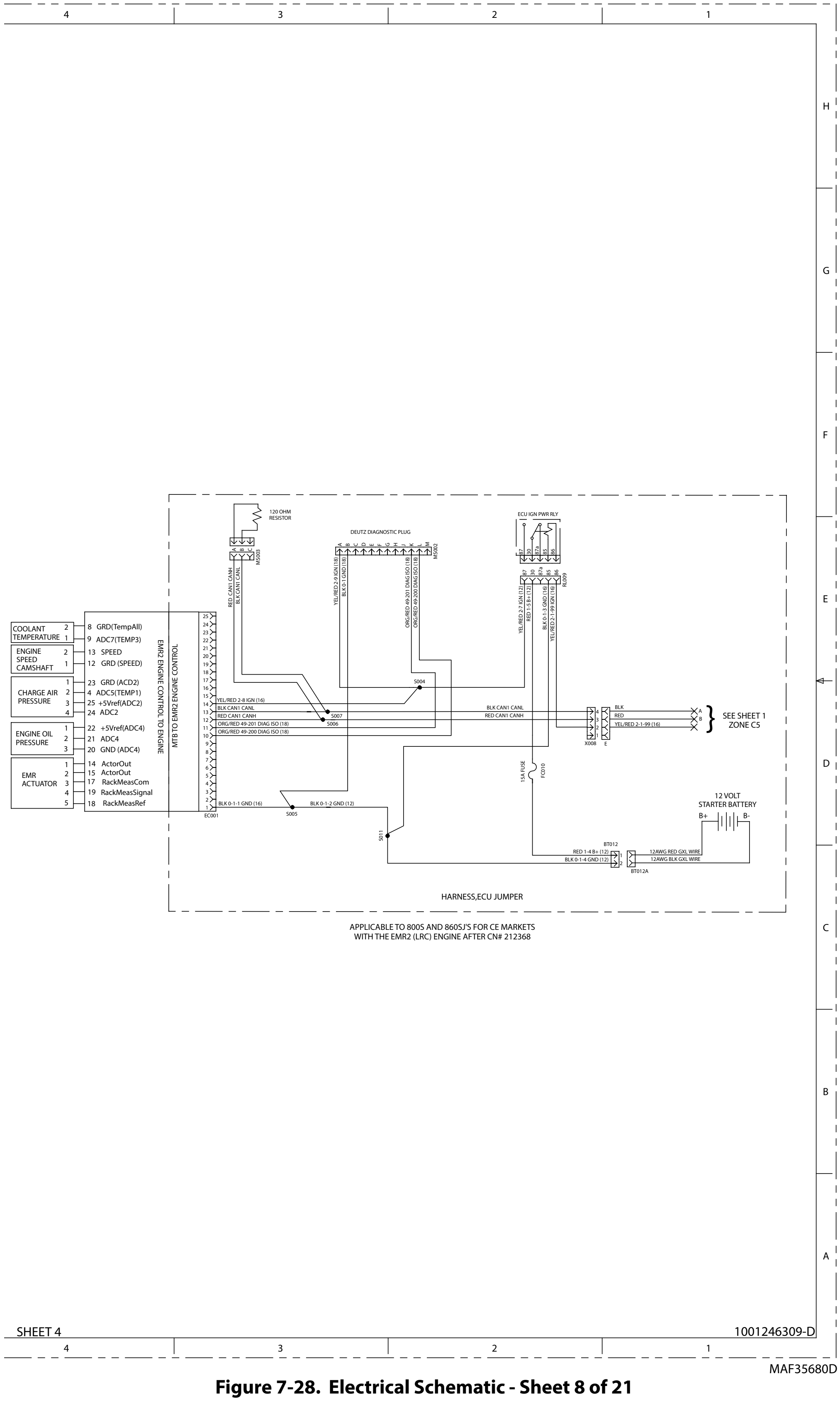


Figure 7-28. Electrical Schematic - Sheet 8 of 21

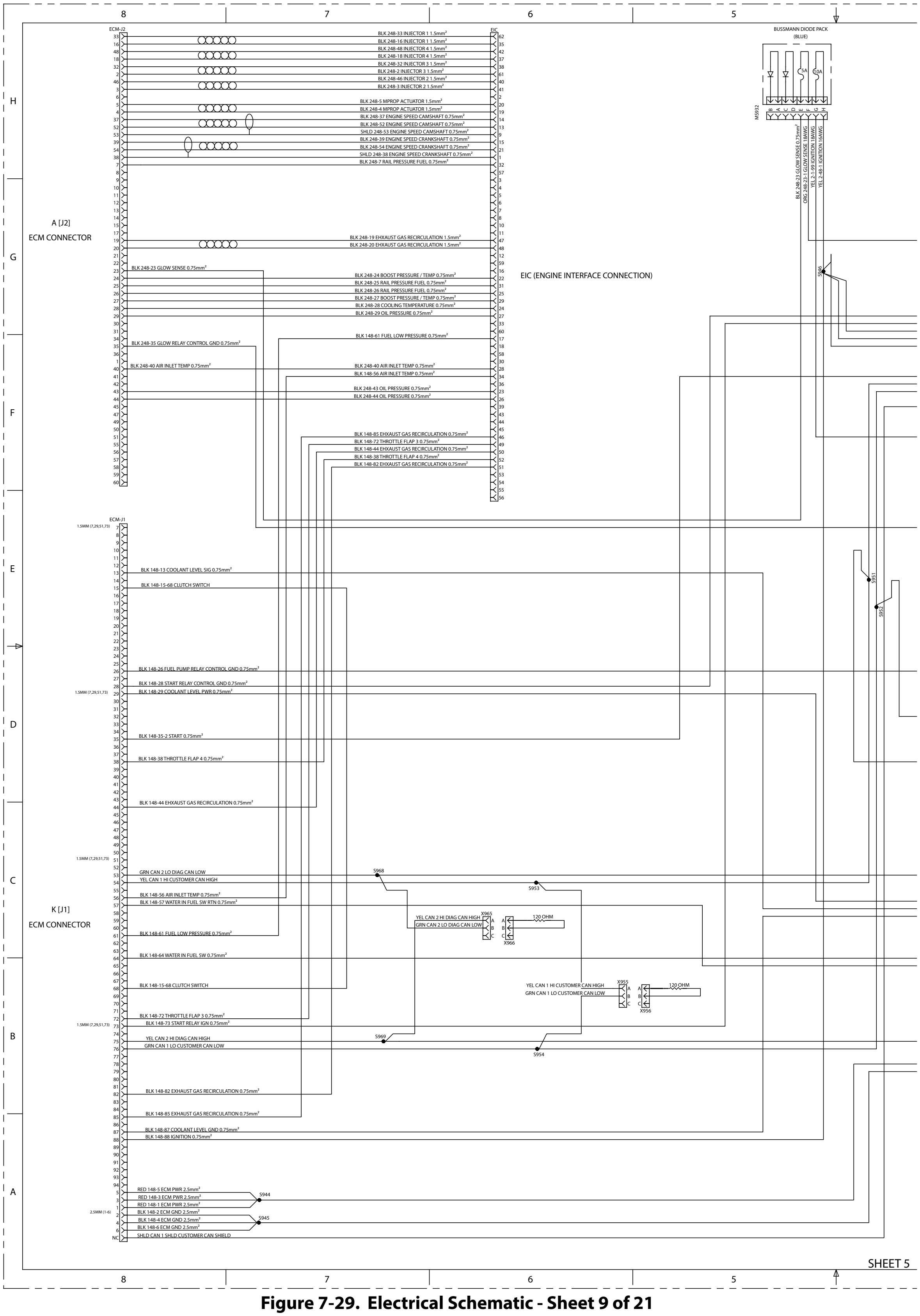


Figure 7-29. Electrical Schematic - Sheet 9 of 21

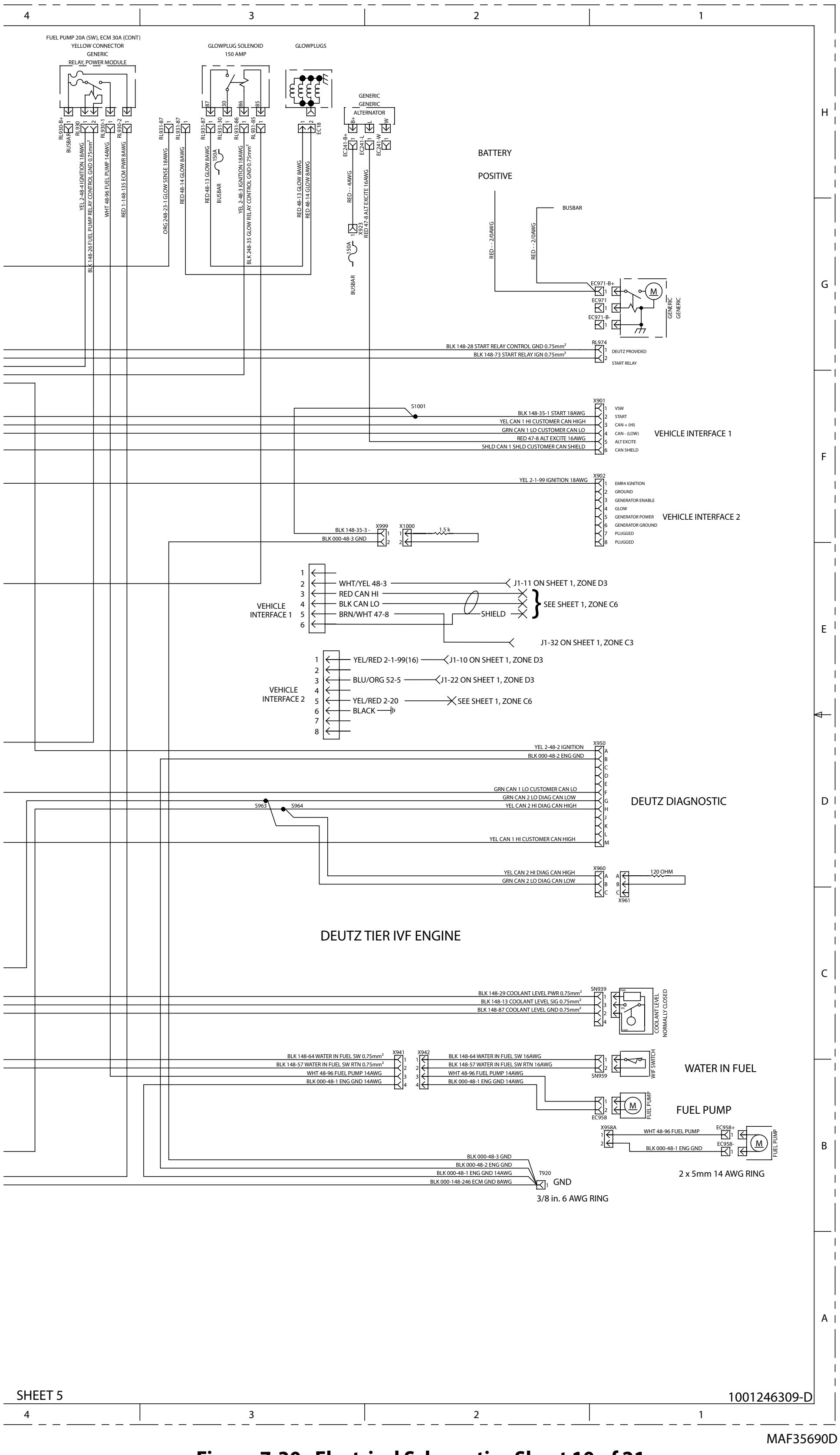


Figure 7-30. Electrical Schematic - Sheet 10 of 21

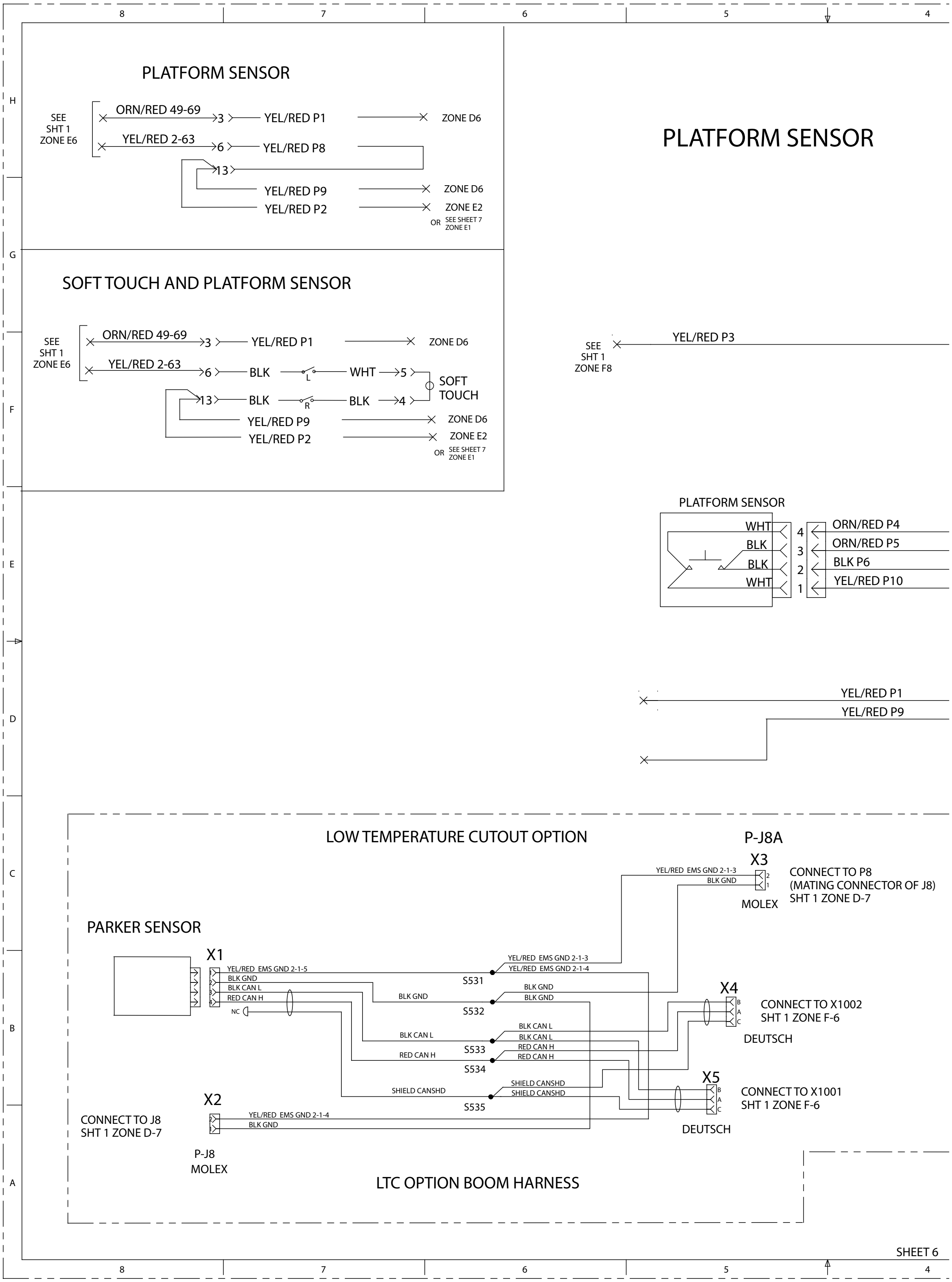


Figure 7-31. Electrical Schematic - Sheet 11 of 21

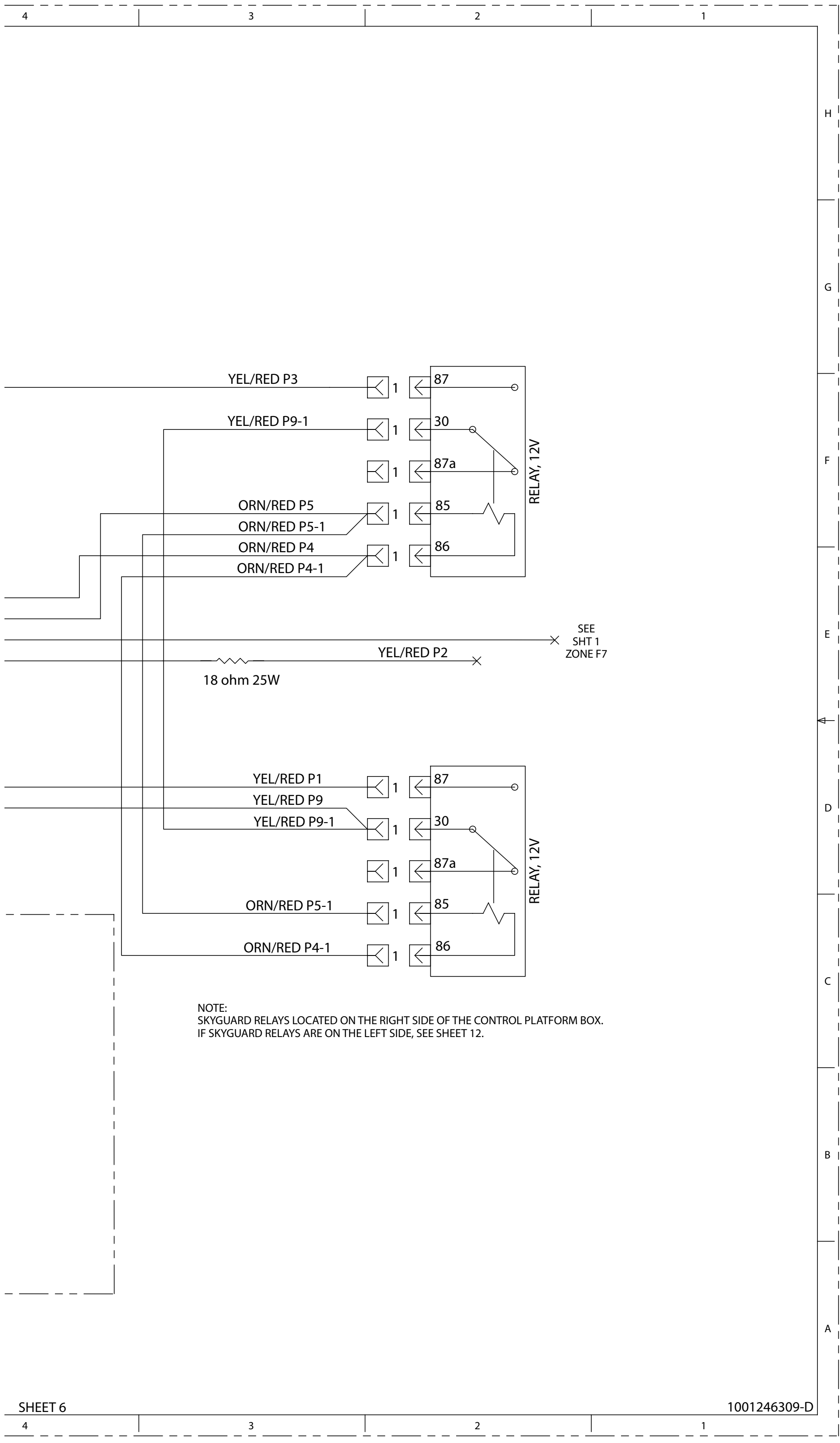


Figure 7-32. Electrical Schematic - Sheet 12 of 21

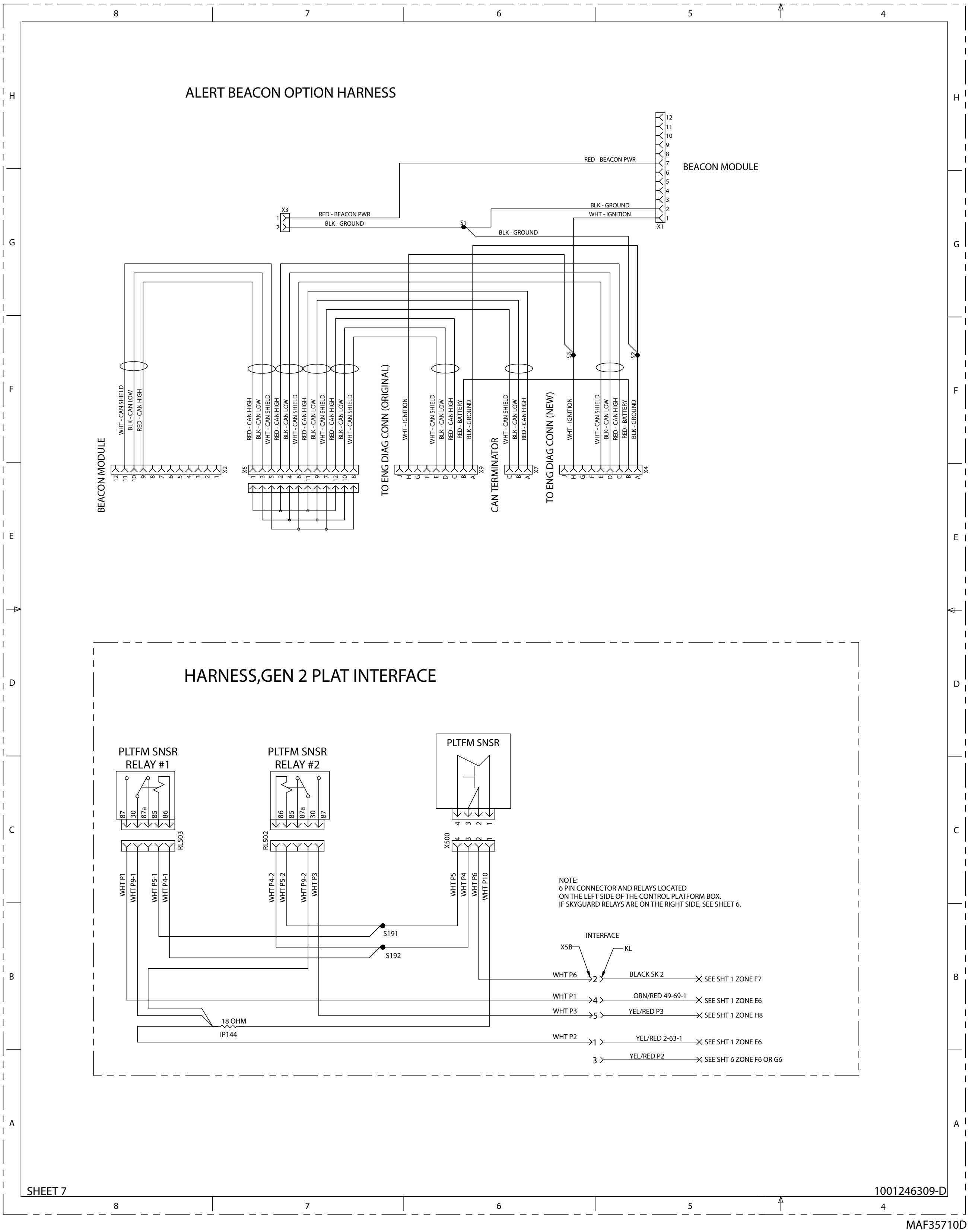
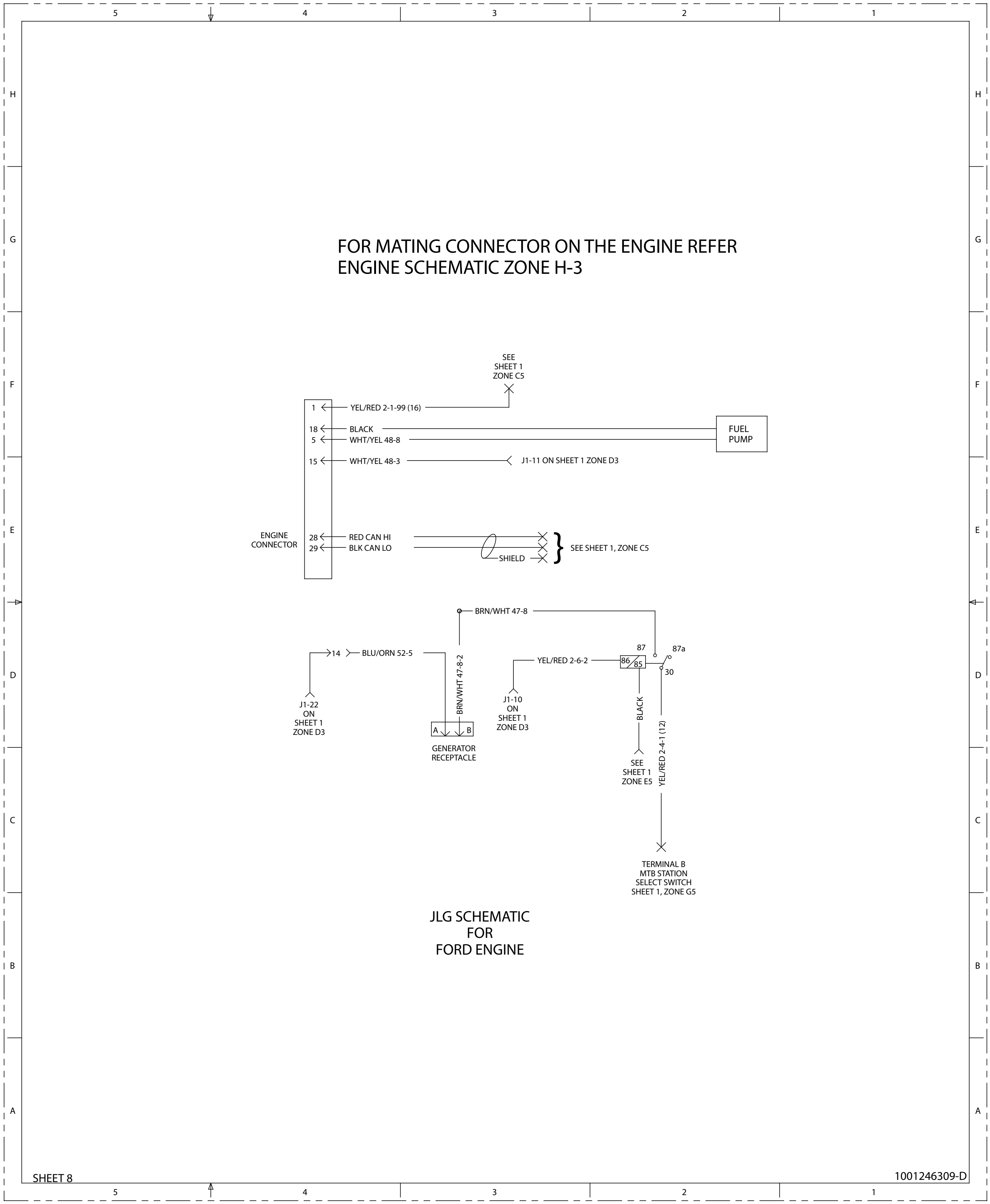


Figure 7-33. Electrical Schematic - Sheet 13 of 21



MAF35720D

Figure 7-34. Electrical Schematic - Sheet 14 of 21

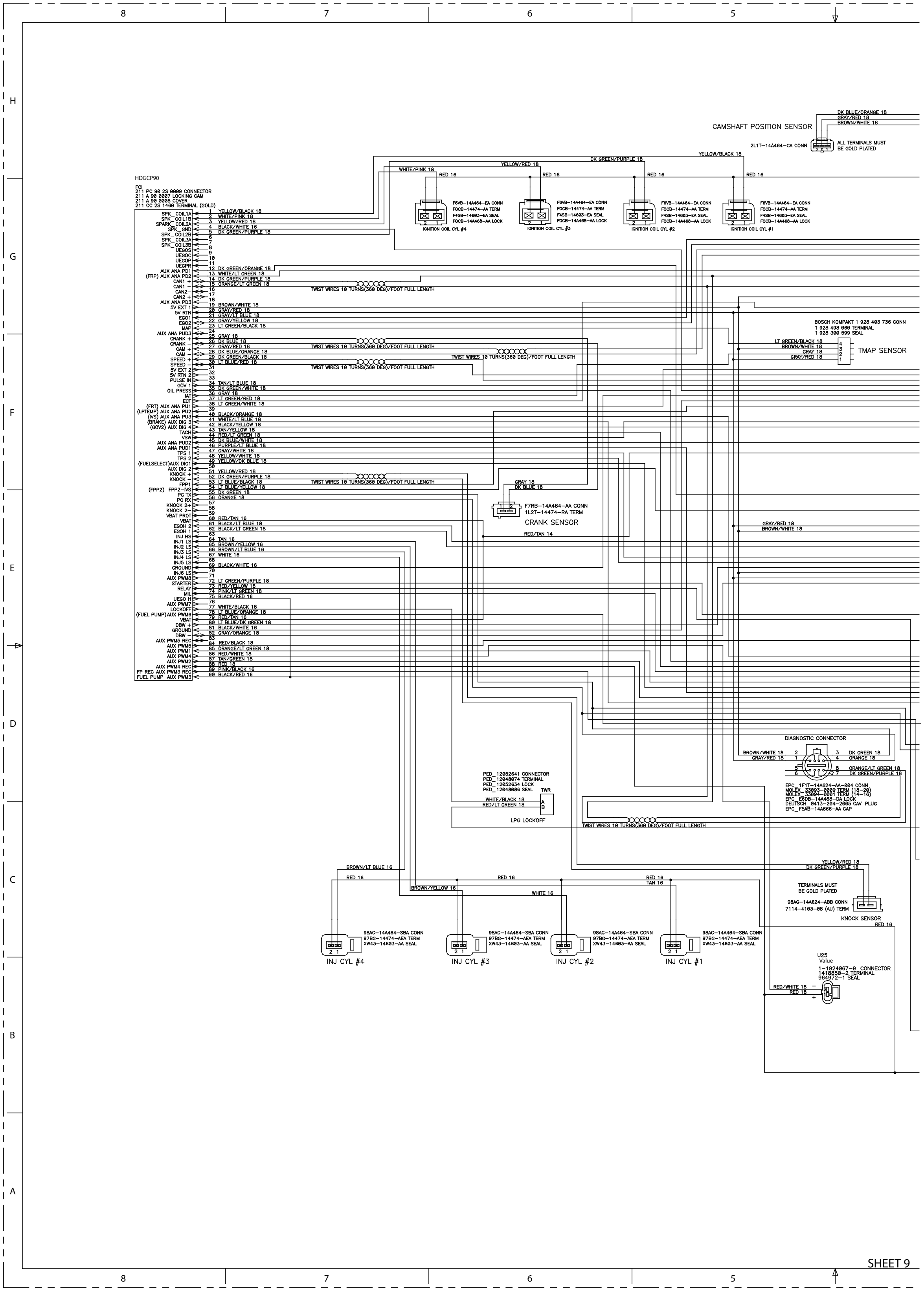


Figure 7-35. Electrical Schematic - Sheet 15 of 21

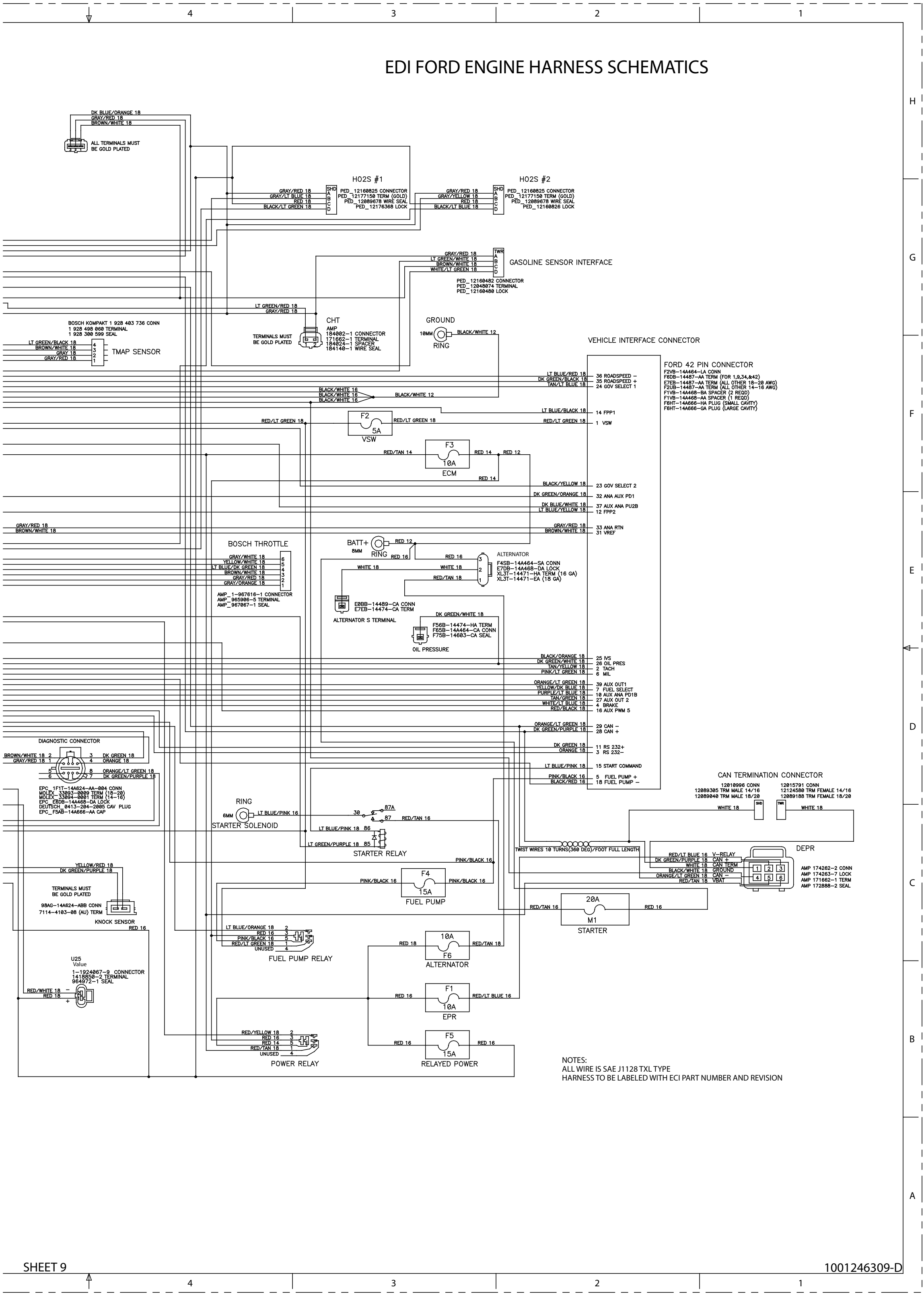


Figure 7-36. Electrical Schematic - Sheet 16 of 21

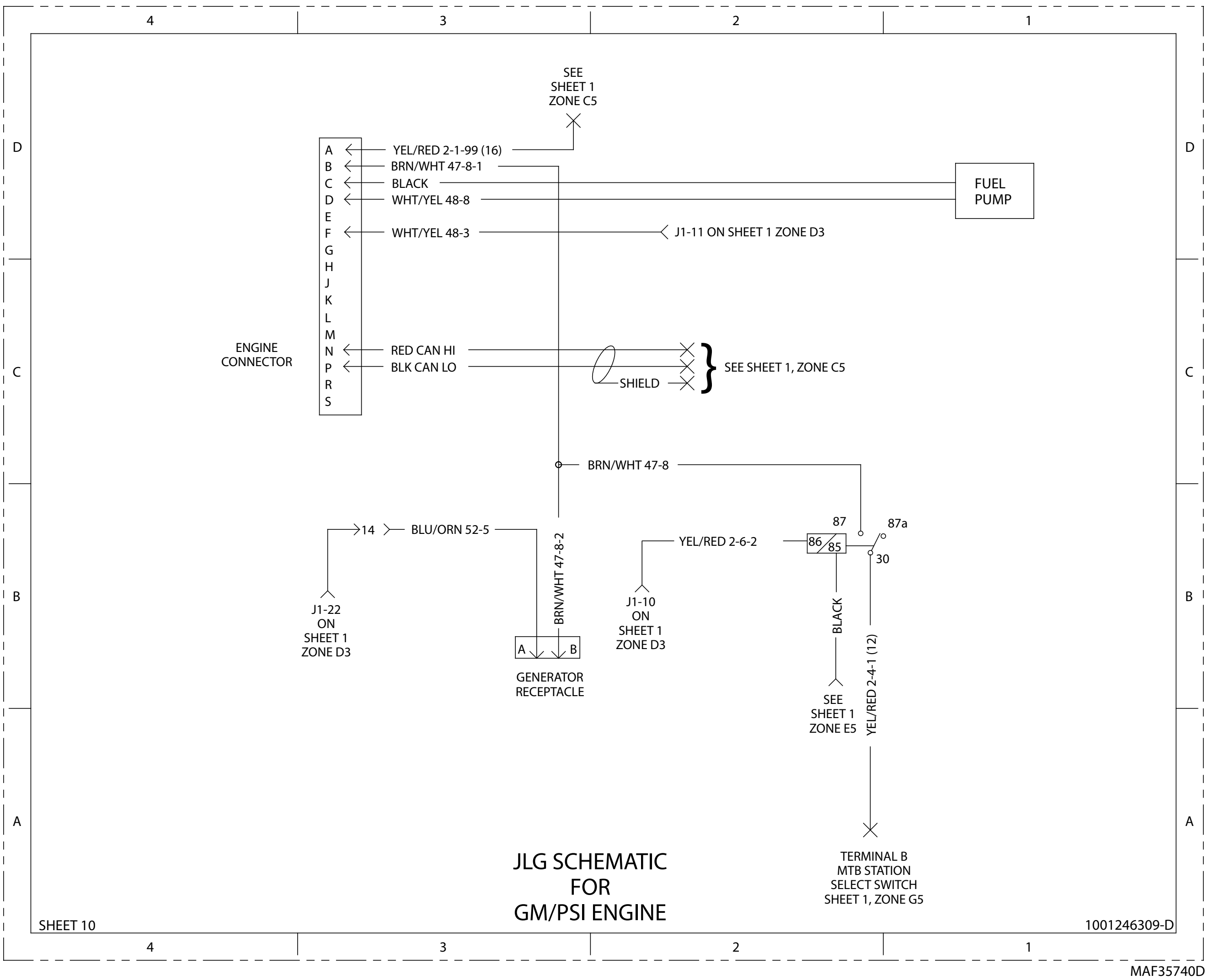
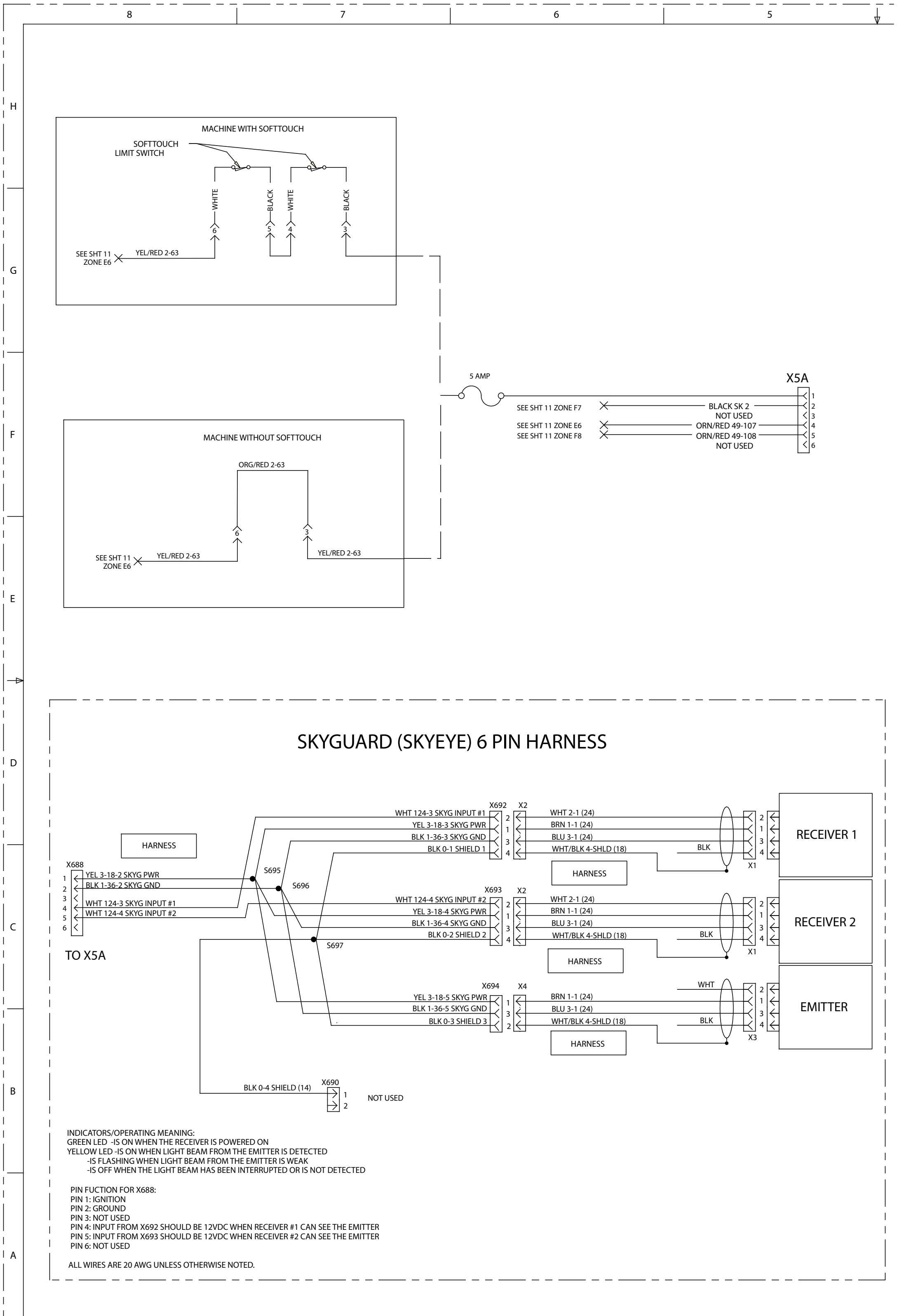


Figure 7-37. Electrical Schematic - Sheet 17 of 21

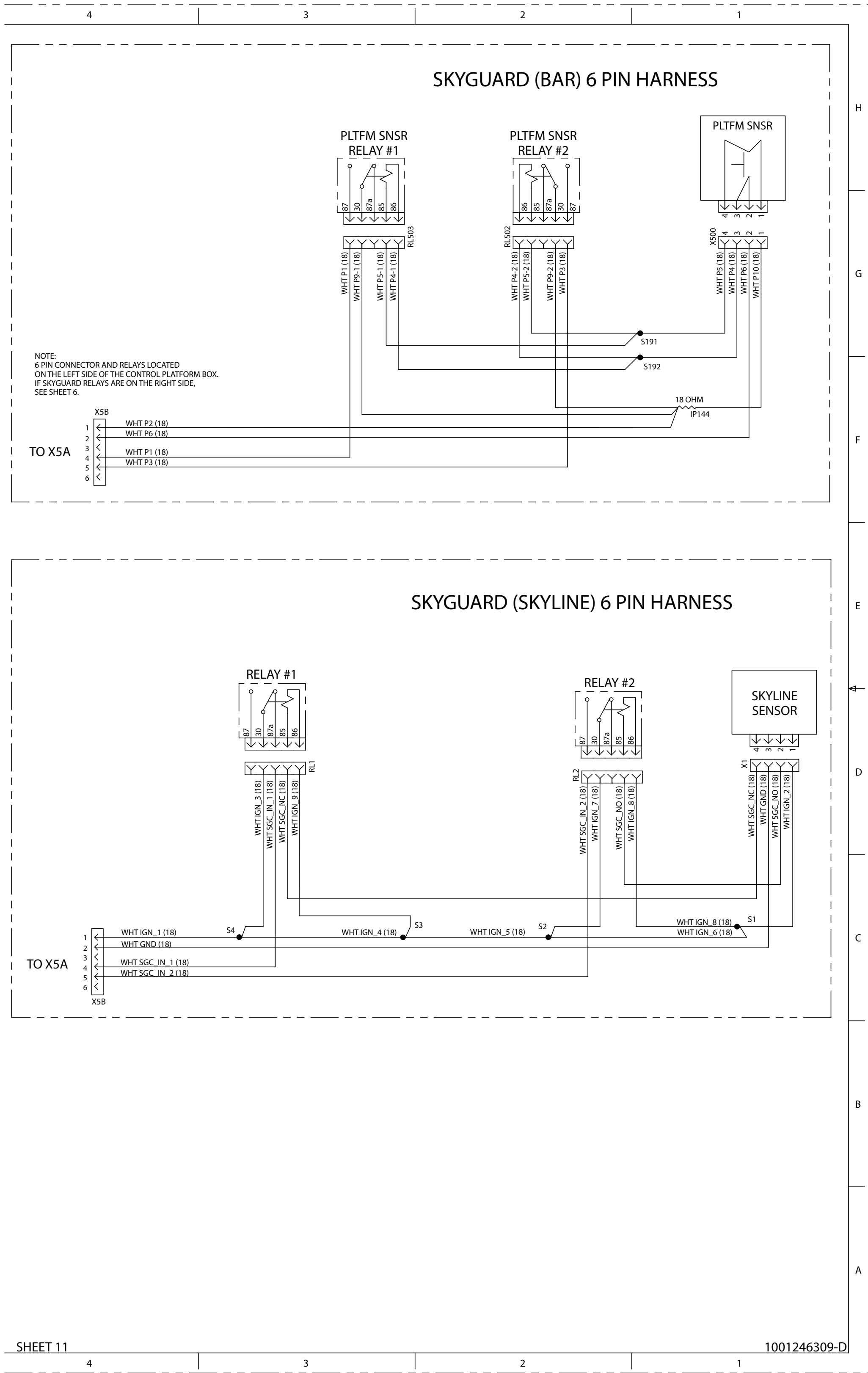


INDICATORS/OPERATING MEANING:
GREEN LED -IS ON WHEN THE RECEIVER IS POWERED ON
YELLOW LED -IS ON WHEN LIGHT BEAM FROM THE EMITTER IS DETECTED
-IS FLASHING WHEN LIGHT BEAM FROM THE EMITTER IS WEAK
-IS OFF WHEN THE LIGHT BEAM HAS BEEN INTERRUPTED OR IS NOT DETECTED

PIN FUCTION FOR X688:
PIN 1: IGNITION
PIN 2: GROUND
PIN 3: NOT USED
PIN 4: INPUT FROM X692 SHOULD BE 12VDC WHEN RECEIVER #1 CAN SEE THE EMITTER
PIN 5: INPUT FROM X693 SHOULD BE 12VDC WHEN RECEIVER #2 CAN SEE THE EMITTER
PIN 6: NOT USED

ALL WIRES ARE 20 AWG UNLESS OTHERWISE NOTED.

Figure 7-38. Electrical Schematic - Sheet 18 of 21



MAF35750D

Figure 7-39. Electrical Schematic - Sheet 19 of 21

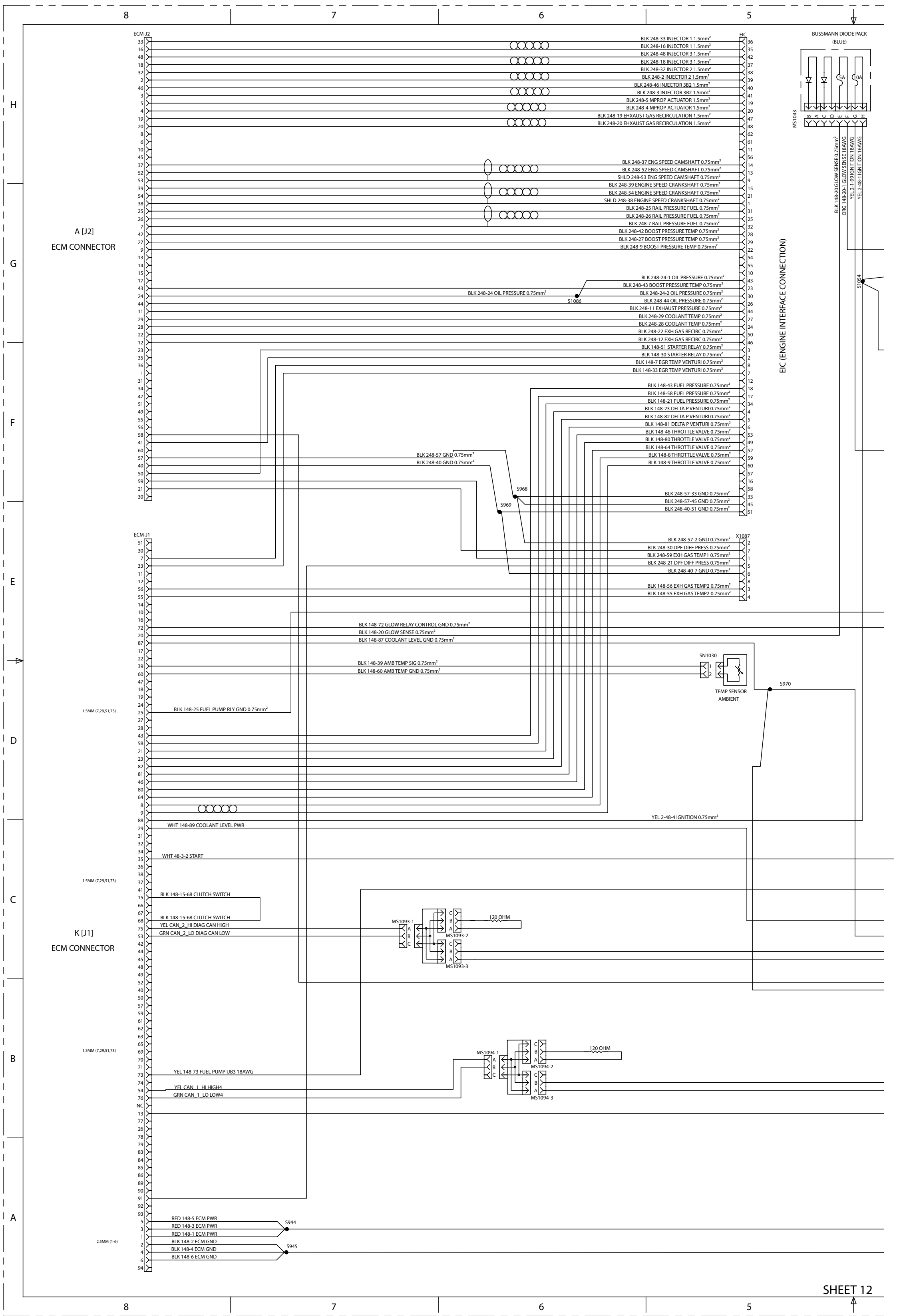
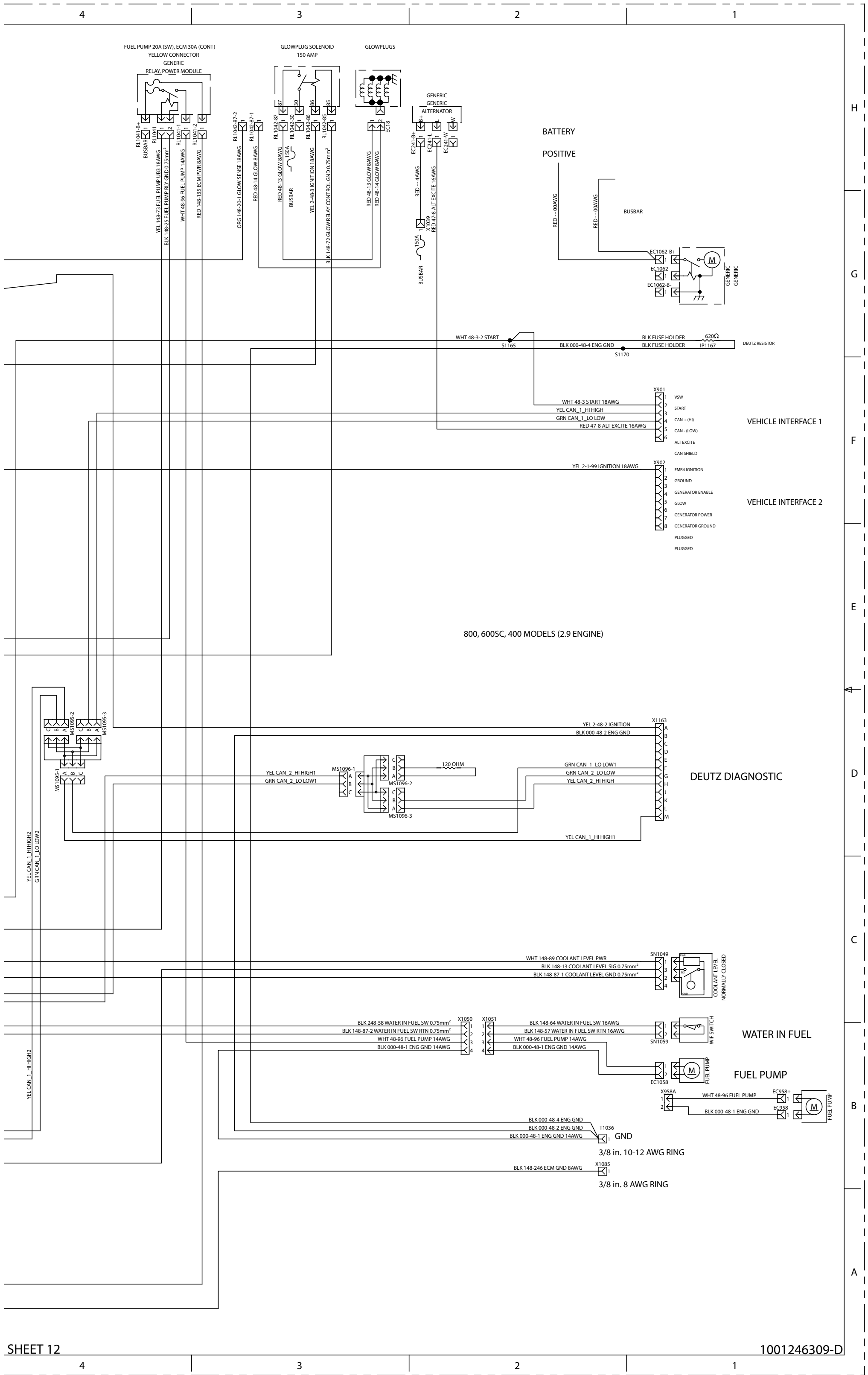


Figure 7-40. Electrical Schematic - Sheet 20 of 21



MAF35760D

Figure 7-41. Electrical Schematic - Sheet 21 of 21

An Oshkosh Corporation Company

Corporate Office
JLG Industries, Inc.
1 JLG Drive
McConnellsburg, PA 17233-9533 USA
(717) 485-5161 (Corporate)
(877) 554-5438 (Customer Support)
(717) 485-6417

Visit our website for JLG Worldwide Locations.
www.jlg.com