An Oshkosh Corporation Company

Service and Maintenance Manual

Model
800AJ HC3

PVC 2001
PVC 2007

31215887

October 21, 2020 - Rev A

ANSI

CE

AS/NZS
MOL70

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. 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 MOBLIE 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.

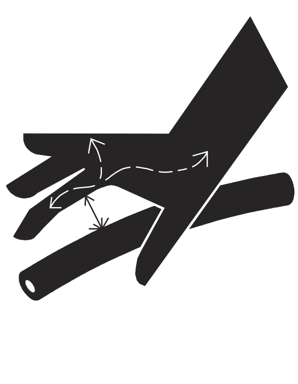
⚠ WARNING

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

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SECTION 1. SPECIFICATIONS

1.1 OPERATING SPECIFICATIONS

Maximum Work Load (Capacity) All Markets	 660 lb (300 kg) 750 lb (340 kg) 1000 lb (454 kg)
Travel Speed	3.0 MPH (4.83 Km/h.)
Maximum Operating Slope	5°
Maximum Travel Grade, stowed Position (Gradeability) 4WD	 45%
Maximum Travel Grade, stowed Position (Side Slope)	5°
Turning Radius (Outside) 2WS	 21 ft. 6.2 in. (6.56 m)
Turning Radius (Inside) 2WS	 10 ft. 2.9 in. (3.12 m)
Overall Width	8 ft. 1.5 in. (2.48 m)
Tailswing	2 ft. 5 in. (0.74 m)
Ground Clearance	11 in. (0.28 m)
Machine Height Stowed	9 ft. 9.1in. (2.97 m)
Machine Length (Stowed)	36 ft. 9.9 in. (11.22 m)
Wheel base	10 ft. (3.05 m)
Boom Elevation Above Grade Below Grade	 +80 ft. 4.4 in. (24.5 m) -13 ft. 7.2 in (-4.17 m)
Max. Ground Bearing Pressure	76 psi. (5.3 kg/cm^2)
Max. Tire Load	20,200 lb (9163 kg)
Manual Force	90 lb (400N)
Maximum Wind Speed	28 mph (12.5 m/s)
Gross Machine Weight ANSI/CSA/AUS CE	 37,530 lb (17,023 kg) 39,340 lb (17,844 kg)
Occupied Floor Area	108.7 sq. ft. (10.1 sq. m)

1.2 CAPACITIES

Fuel Tank	Approx. 40 Gallons (151.4L)
Hydraulic Tank	40 Gallons (151.42 L)
Hydraulic System (Including Tank)	Approx 46 Gallons (174.13 L)
Drive Hub	58 Ounces (1.7L)
Drive Brake	2.7 ounces (80 ml)
Engine Oil Capacity Deutz D2011L04 Deutz TD 2.9L4 Ford 2.5 L MSG425-DF	 11 Quarts (10.5 L) 9.4 Quarts (8.9 L) 7 Quarts (6.6 L)

1.3 TIRES

SIZE	TYPE	PLY RATING	LOAD RANGE	PRESSURE
18-625	foam-filled	16	H	N/A
18-625 (Non-Marking)	foam-filled	16	H	N/A
18-22.5 (Turf/Sand)	foam-filled	16	H	N/A

1.4 ENGINE DATA

Table 1-1. Deutz D2011L04 Specifications

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 Quartz (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

Table 1-2. Deutz TD2.9L4 T4F Specifications

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 Quartz (8.9 L)
Cooling System	3.3 Gallons (12.5 L)
Low RPM	1200 ± 50 rpm
High RPM	2600 ± 50 rpm
Alternator	12 V, 95 AMP
Battery	950 Cold Cranking Amps, 205 minutes Reserve Capacity, 12 VDC

Table 1-3. Deutz TD 2.9L4 T4F China III Specifications

Fuel	Low Sulfur Diesel (500 ppm)
Max Output (Power)	67 hp 50 kW @2600 rpm
Max Output (Torque)	173 ft. lbs. (234 Nm) @1800 rpm
Oil Capacity	9.4 Quartz (8.9 L)
Cooling System	3.3 Gallons (12.5 L)
Low RPM	1200 ± 50 rpm
High RPM	2600 ± 50 rpm
Alternator	12 V, 95 AMP
Battery	950 Cold Cranking Amps, 205 minutes Reserve Capacity, 12 VDC

Table 1-4. Ford 2.5L DF, MSG-425

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 Quartz (6.6 L)
Cooling System	2 Gallons (7.5 L)
Low RPM	1000 ± 50 rpm
High RPM	3200 ± 50 rpm
Alternator	12 V, 150 AMP
Battery	950 Cold Cranking Amps, 205 minutes Reserve Capacity, 12 VDC

Table 1-5. Deutz TD 2.9L4 Stage V Specifications

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 Quartz (8.9 L)
Cooling System	3.3 Gallons (12.5 L)
Low RPM	1200 ± 50 rpm
High RPM	2600 ± 50 rpm
Alternator	12 V, 95 AMP
Battery	950 Cold Cranking Amps, 205 minutes Reserve Capacity, 12 VDC

1.5 COMPONENT DATA

Drive System

Drive Motor Displacement 4WD	 2.13 cu. in. max. 0.63 cu. in. min. (35 cc max. 10.3 cc min.)
Drive Hub Ratio 4WD	 87- 86.74:1
Drive Brake	Spring applied, hydraulic released multi plate wet disc parking brake.

Swing System

Swing Motor Displacement	4.9 cu. in. (80 cm^3)
Swing Brake	Automatic spring applied hydraulically released disc brakes
Swing Hub Ratio	36-36.13:1

Auxiliary Power Pump

Pump Output	1.43 GPM (5.6 lpm) @ 1800 psi. (124 bar)
Pump Displacement	0.273 cu. in/rev (4.48 cc/rev)
Valving	Non-Adj. Unloader Preset to 230 psi Adjustable Relief Set at 1800 psi.
Motor	12 V.D.C. 2T Extended EMC Protected Intermittent Duty
Rotation	Counterclockwise

1.6 TORQUE REQUIREMENTS

DESCRIPTION	TORQUE VALUE (DRY)	INTERVAL HOURS
Wheel Bolts	300 ft. lbs. (407 Nm)	150
Support to Rotator Bolts	40 ft. lbs. (55 Nm)	150
Rotator Center Bolt	586 ft. lbs. (795 Nm)	150
Swing Bearing Bolts	190 ft. lbs. (260 Nm)	50/600*
Starter or Aux Pump Solenoid Contacts Coil	95 in. lbs. (10.5 Nm) 40 in. lbs. (4.5 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 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, 10W-30
+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 hydraulic oil, which has an SAE viscosity index of 152.*

NOTE: *When temperatures remain consistently below 20°F. (-7° 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. They may not contain required additives or be of comparable viscosities.*

Table 1-6. Standard UTTO Hydraulic Fluid Specs

Inspection Data	Recommended SHELL SPIRAX S4 TXM	Optional MOBILFLUID 424
ISO Viscosity Grade	68	68
Specific Gravity	0.882	0.880
Pour Point	-43.6°F (-42°C)	-45.4°F (-43°C)
Flash Point	428°F (220°C)	442.4°F (228°C)
Base Oil Type	HV	HV
Viscosity		
Brookfield, at -20°C	-	4300 cP
Brookfield, at -5°C	-	-
Viscosity at 40° C	66.93 cSt	60.21 cSt
Viscosity at 100° C	10.53 cSt	9.26 cSt
Viscosity Index	146	134

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

Inspection Data	Recommended SHELL TELLUS S2 VX 32	Optional MOBIL DTE 10 EXCEL 32
ISO Viscosity Grade	32	32
Specific Gravity	0.854	0.847
Pour Point	-38.2°F (-39°C)	-65.2°F (-54°C)
Flash Point	419°F (215°C)	482°F (250°C)
Base Oil Type	HV	HV
Viscosity		
Brookfield, at -30°C	-	3360 cP
Brookfield, at -20°C	-	1090 cP
Brookfield, at -5°C	-	-
Viscosity at 40° C	33.01 cSt	32.76 cSt
Viscosity at 100° C	6.26 cSt	6.58 cSt
Viscosity Index	142	161

Table 1-8. UCon Hydrolube HP-5046D Specs

Inspection Data	Required
ISO Viscosity Grade	46
Specific Gravity at 25°C	1.088
Flash Point, °F (°C)	None
Pour Point, °F (°C)	-81.4 (-63)
pH	9.0 - 10.
Base Oil Type	Diethylene Water-Glycol
Viscosity	
Viscosity at -20° C	-
Viscosity at 0° C	340 cST
Viscosity at 40° C	46 cST
Viscosity at 65° C	22 cST
Viscosity Index	192

Table 1-9. 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	-43.6°F (-42°C)	-49°F (-45°C)
Flash Point	611.6°F (322°C)	500°F (260°C)
Base Oil Type	POLYOL ESTER	FATTY ACID ESTER
	HEES	-
	HFDU	-
Auto Ignition Temperature	>752°F (>400°C)	-
Biodegradability (%28 Days)	76%	>60%
Viscosity		
Brookfield at -20°C	-	-
Brookfield at -5°C	-	-
Viscosity at 40° C	46.20 cSt	43.42 cSt
Viscosity at 100° C	9.41 cSt	7.69 cSt
Viscosity Index	193	147

Table 1-10. Premium Hydraulic Fluid (All Weather) Spec

Inspection Data	Recommended SHELL TELLUS S4 VX 32		Optional MOBIL UNIVIS HVI 26	
	UNSHEARED	SHEARED	UNSHEARED	SHEARED
ISO Viscosity Grade	32		26	
Specific Gravity	0.866	-	0.89	-
Pour Point	-76°F (-60°C)		-76°F (-60°C)	
Flash Point	>212°F (>100°C)		>201.2°F (>94°C)	
Base Oil Type	HV		HV	
Viscosity				
Brookfield at -40°C	-	-	-	-
Brookfield at -30°C	-	-	-	-
Brookfield at -20°C	-	-	-	-
Brookfield at -5°C	-	-	-	-
Viscosity at 40° C	31.41 cSt	21.64 cSt	25.78 cSt	15.28 cSt
Relative Viscosity Loss	31.1%		40.7%	
Viscosity at 100° C	9.17 cSt	6.10 cSt	8.74 cSt	5.02 cSt
Relative Viscosity Loss	33.5%		42.6 %	
Viscosity Index	296	258	352	304

1.8 MAJOR COMPONENT WEIGHTS

MAJOR COMPONENTS	LB	KG
Platform & Control Console	250	113
Main Boom Assembly	2285.6	1037.7
Main Lift Cylinder	493	224
Main Telescope Cylinder	505.7	229.4
Upright Weldment	1159.3	526.3
Upright Level Cylinder	557	253
Tower Boom Complete	2944	1335.4
Tower Lift Cylinder	597	271
Tower Telescope Cylinder	238.3	108.2
Turntable Counterweight	5169	2345
Turntable Complete (Including Engine)	10625	4820
Chassis Complete (Foam Filled Tires)	12220	5545
Machine Complete (GVW) w/ Foam Filled Tires	33100	15014
NOTE: *The above components are separate assemblies. Example: "TURNTABLE COMPLETE" does not include booms, upright, lift cylinders or platform. The weights of these components must be added for the total weight.*		

Critical Stability Weights

WARNING

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

COMPONENTS		LB	KG
Tire & Wheel Size (Foam Filled Only)	18-625	601	273
	18-22.5	724	328.4
Engine	Deutz T4i 2011 L04 (w/Muffler)	551	250
	Deutz T4f 2.9 L4	549	249.2
	Deutz China III 2.9L4	588	266.7
	Deutz Stage V 2.9L4	588	266.7
	Ford 2.5L MSG425-DF	289	131.1
Counterweight	Turntable	5169	2345
Wheel Hubs	Front/Rear 4WD	222	100.7
Platform	36x72	167.5	76
	36x96	199.5	90.5
	30x48	132	60
	30x72	154	70
	30x36	113.7	51.8

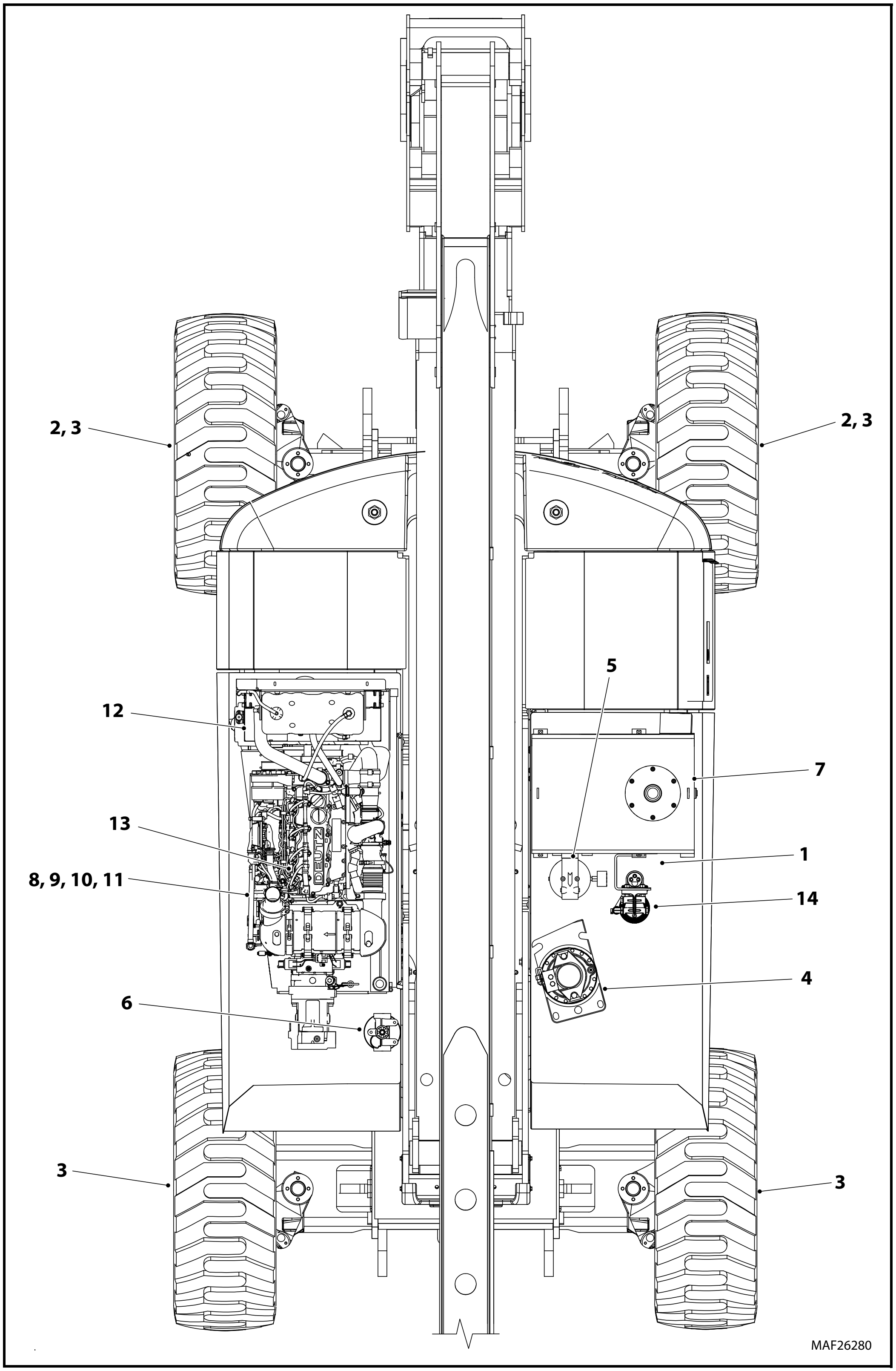


Figure 1-1. Maintenance and Lubrication Diagram

1.9 OPERATOR MAINTENANCE

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

Table 1-11. Lubrication Specifications.

KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350° F (177° C). Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec MIL-L-2105
HO	Hydraulic Oil. Refer Section 1.7, Hydraulic Oil.
EO	Engine (crankcase) Oil. Gas - API SF, SH, SG class, MIL-L-2104. Diesel - API CC/CD class, MIL-L-2104B/MIL-L-2104C
Super Lube®	Synthetic-Based Oil, Non-Flammable. Withstands temperatures within -45° to 450°F (-43° to 232° C). JLG PN 3020042.

NOTICE

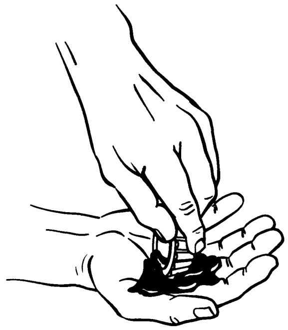
LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

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

1. Swing Bearing - Internal Ball Bearing

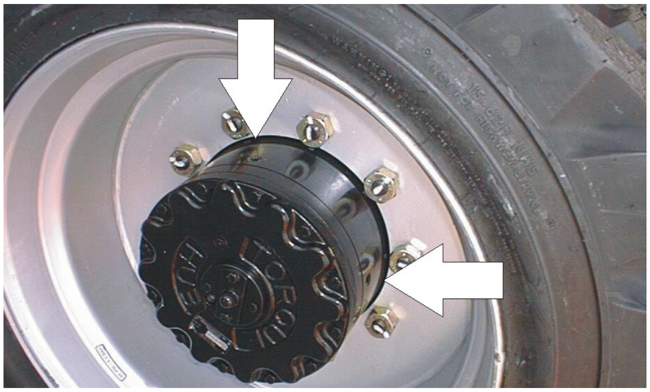
Lube Point(s) - 2 Grease Fittings
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hours of operation
Comments - Remote Access

2. Wheel Bearings



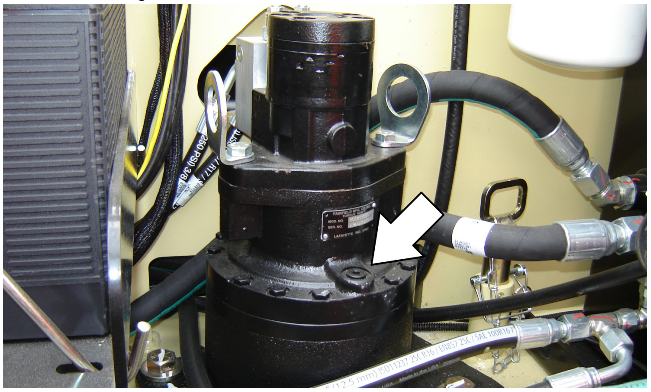
Lube Point(s) - Repack
Capacity - A/R
Lube - MPG
Interval - Every 2 years or 1200 hours of operation

3. Wheel Drive Hub



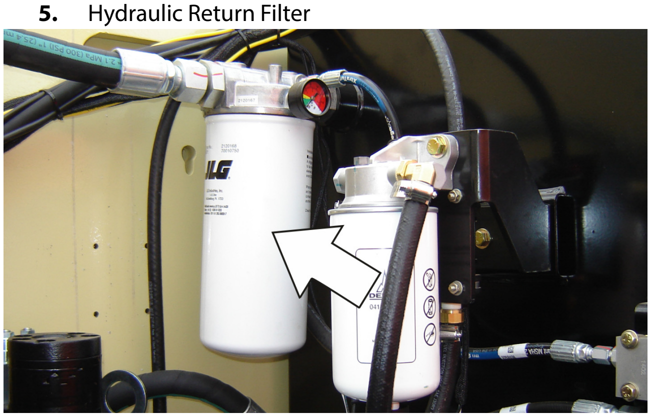
Lube Point(s) - Level/Fill Plug
Capacity - 17 oz. (0.5 L) - 1/2 Full
Lube - EPGL
Interval - Check level every 3 months or 150 hours of operation; change every 2 years or 1200 hours of operation.
Comments - Place Fill port at 12 o'clock position and Check port at 3 o'clock position. Pour lubricant into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

4. Swing Drive Hub



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

5. Hydraulic Return Filter

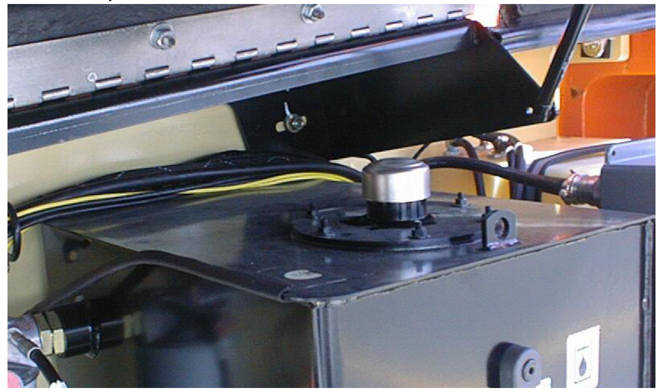


Interval - Change after first 50 hours and every 6 months or 300 hours thereafter or as indicated by Condition Indicator.

6. Hydraulic Charge Filter

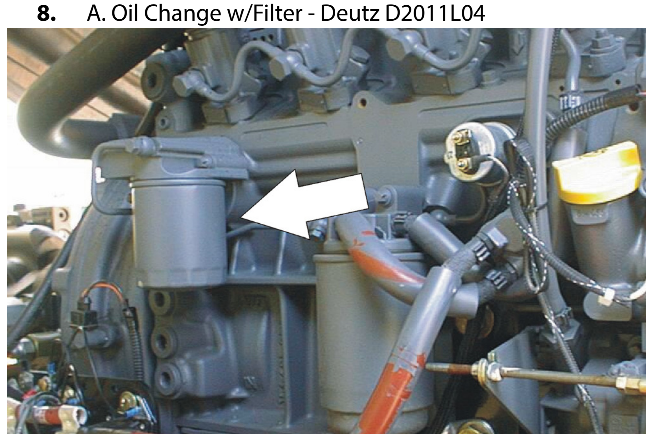
Interval - Change after first 50 hours and every 6 months or 300 hours thereafter or as indicated by Condition Indicator.

7. Hydraulic Tank



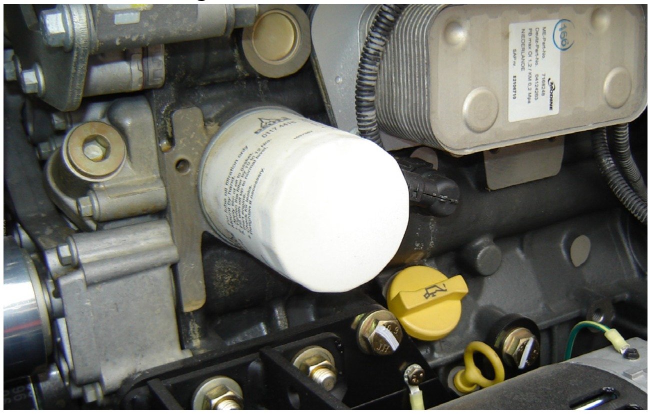
Lube Point(s) - Fill Cap
Capacity - 40 Gallons (151 L) Tank; 77 Gallons (291.4 L) System
Lube - HO
Interval - Check Level daily; Change every 2 years or 1200 hours of operation.

8. A. Oil Change w/Filter - Deutz D2011L04



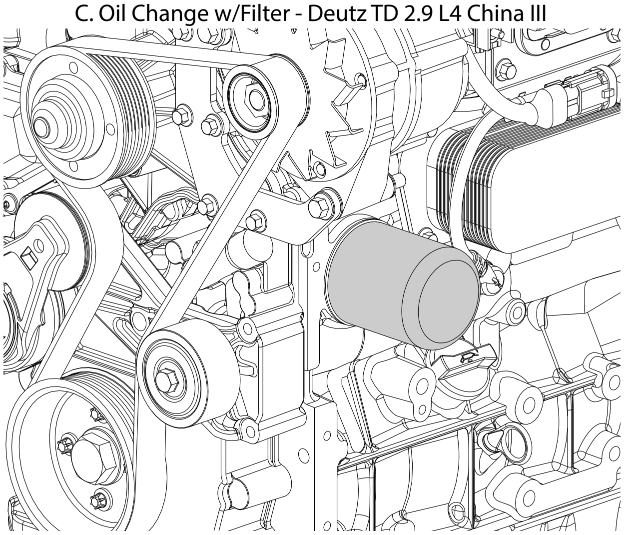
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 11 Quarts (10.5 L)
Interval - Every Year or 1200 hours of operation
Comments - Check level daily/Change in accordance with engine manual. Refer to Figure 1-1., Maintenance and Lubrication Diagram.

B. 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.

C. Oil Change w/Filter - Deutz TD 2.9 L4 China III



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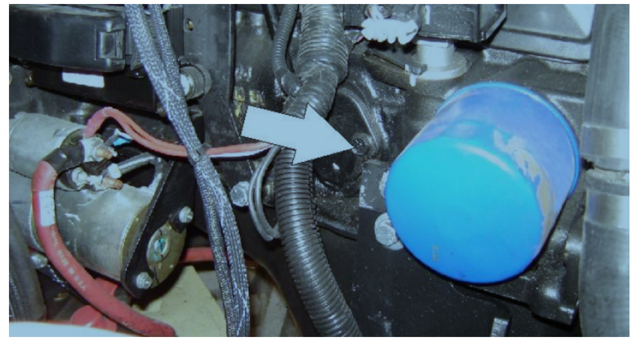
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 8.5 Quarts (8.0 L)
Interval - Every Year or 600 hours of operation
Comments - Check level daily/Change in accordance with engine manual. Use Deutz-approved engine oil.

9. Engine Coolant - Deutz TD2.9L4

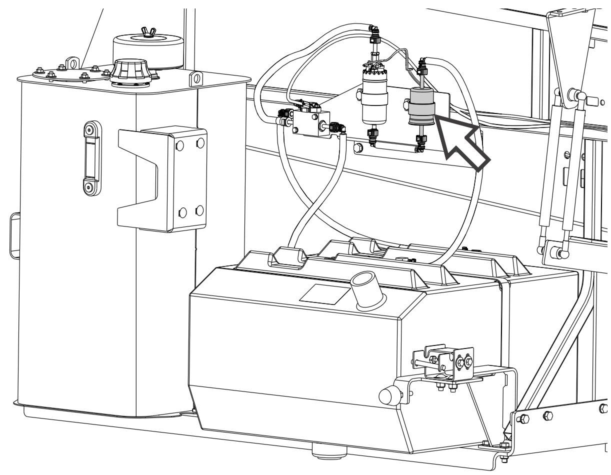
Lube Point(s) - Fill Cap
Capacity - 3.3 gal. (12.5 L)
Lube - Anti-Freeze
Interval - Check level daily; change every 1000 hours or two years, whichever comes first. Use Deutz approved engine coolant.

10. Oil Change w/Filter - Ford



Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 4.5 qt. (4.25 L) w/filter
Interval - Every year or 300 hours of operation
Comments - Check level daily/Change in accordance with engine manual.

11. Fuel Filter - Ford MSG425



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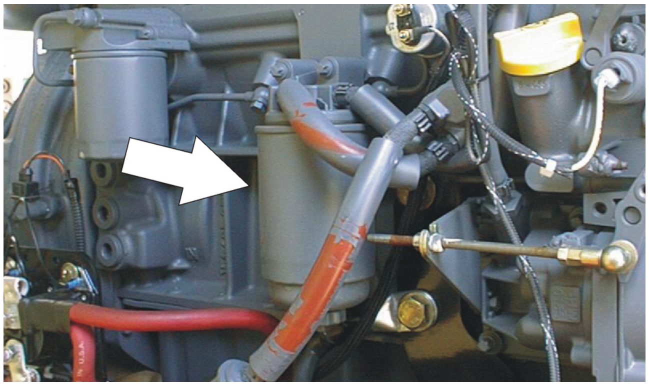
Lube Point(s) - Replaceable Element
Interval - Every Year or 600 hours of operation

12. Engine Coolant - Ford MSG425

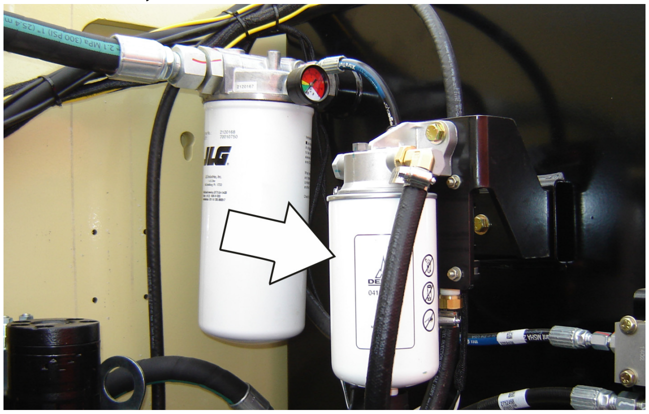
Lube Point(s) - Fill Cap
Capacity - 2 gal. (7.5 L)
Lube - Anti-Freeze
Interval - Check level daily; change every 1000 hours or two years, whichever comes first. Use Ford approved engine coolant.

13. A. Fuel Filter - Deutz D2011



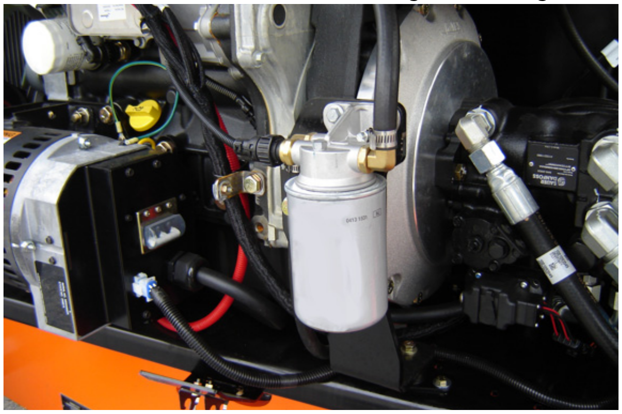
Lube Point(s) - Replaceable Element
Interval - Every Year or 600 hours of operation

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



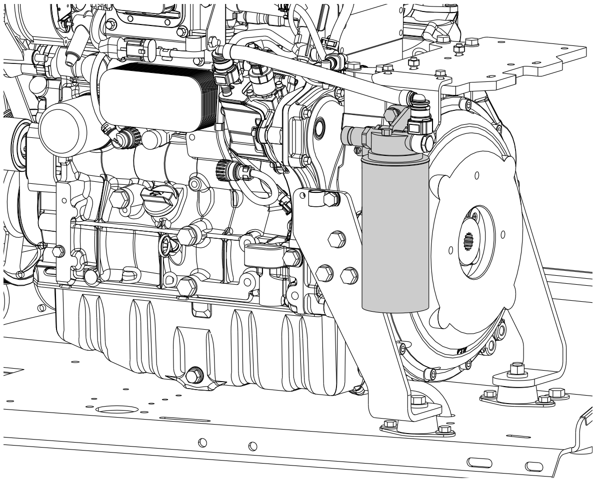
Lube Point(s) - Replaceable Element
Interval - Drain water daily; Filter must be replaced every year or 600 hours of operation (whichever comes first).

C. Fuel Filter - Deutz TD2.9T4f (Stage V) - On Engine



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

D. Fuel Filter - Deutz TD 2.9 L4 China III



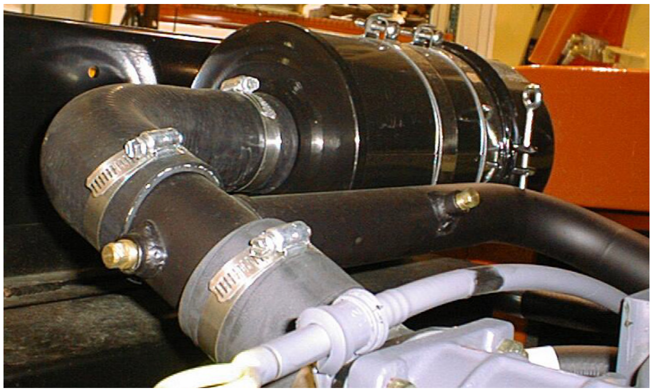
Lube Point(s) - Replaceable Element
Interval - Change in accordance with engine manual

14. Fuel Filter (Gasoline) - Ford

Lube Point(s) - Replaceable Element

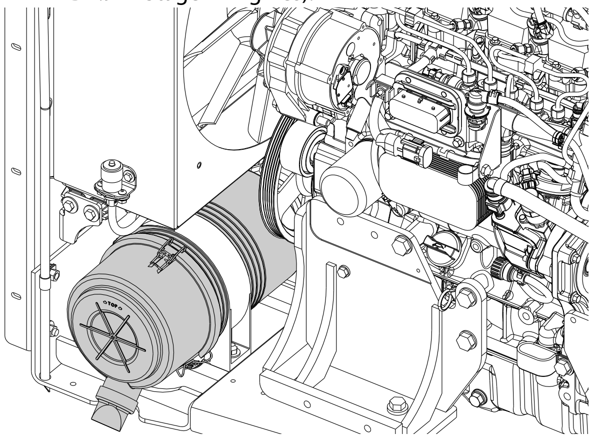
Interval - Drain water daily; Filter must be replaced every year or 600 hours of operation (whichever comes first).

15. A. Air Filter - Deutz D2011L04



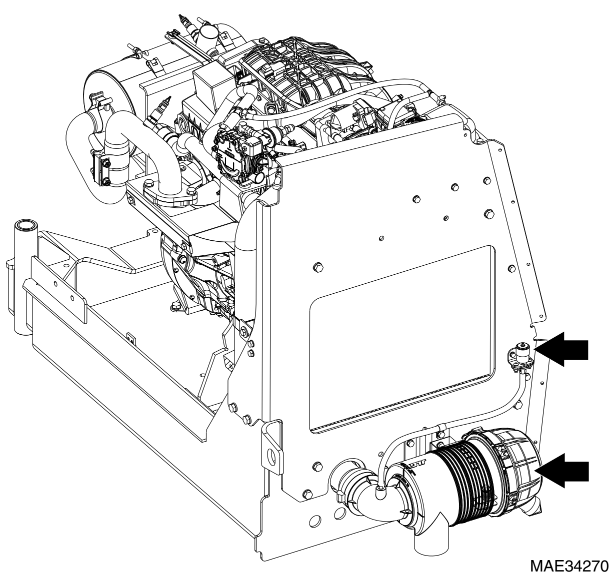
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator

B. Air Filter (Deutz TD2.9 T4F, TD2.9L4 China III and TD2.9L4 Stage V Engines).



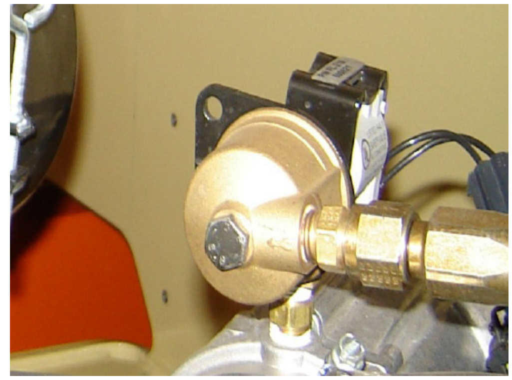
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator

C. Air Filter - Ford MSG425



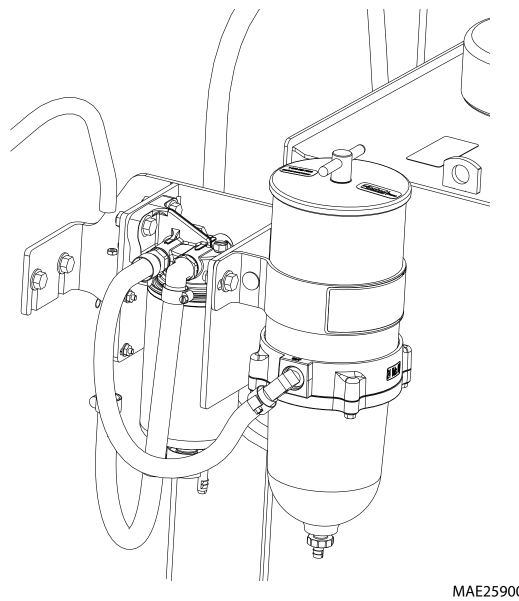
Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator.

16. Fuel Filter (Propane) - Ford Engine



Interval - 3 Months or 150 hours of operation
Comments - Replace filter.

17. Fuel/Water Separator - Deutz TD 2.9 L4 China III



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

1.10 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.*

1.11 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
13/8	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

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

5000059K

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

3. * ASSEMBLY USES HARDENED WASHER

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

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

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

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.

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

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

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:

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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.

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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:

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5000059K

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

Values for 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:
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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.

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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:

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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.

Preventative Maintenance

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

Reference the 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	Operator and Safety Manual
Pre-Delivery Inspection	Prior to each sale, lease, or rental delivery.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Frequent Inspection	In service for 3 months or 150 hours, whichever comes first; or Out of service for a period of more than 3 months; or purchased used.	Owner, Dealer, or User	Qualified JLG Mechanic	Service and Maintenance Manual and applicable JLG inspection form.
Annual Machine Inspection	Annually, no later than 13 months from the date of the prior inspection.	Owner, Dealer, or User	Factory-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 enter the system by hydraulic oil and through maintenance allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up or leaks in the pump supply (suction) lines.
2. The design and manufacturing tolerances of the component working parts are very close, therefore, even the smallest amount of dirt or foreign matter entering a system can cause wear or damage to the components and generally results in faulty operation. Every precaution must be taken to keep hydraulic oil clean, including reserve oil in storage. Hydraulic system filters should be checked, cleaned, and/or replaced as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.
3. Cloudy oils indicate a high moisture, 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.

2. JLG recommends Standard UTTO Fluid hydraulic oil, which has an SAE viscosity of 10W-30 and a viscosity index of 152.

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

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

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 “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: *The 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.).

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, Sheaves Pins	1, 2	1, 2
Bearings	1, 2	1, 2
Wear Pads	1, 2	1, 2
Covers or Shields	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], 2
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
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
Foot switch (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

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	Inspections	
	Pre-Delivery[1] or Frequent [2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
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, 3, 4	1, 3, 4
Hydraulic/Electric System		
Hydraulic Pumps	1, 2, 4	1, 2, 3, 4, 9
Hydraulic Cylinders	1, 2, 4, 5	1, 2, 3, 4, 5, 9
Cylinder Attachment Pins and Pin Retainers	1, 2	1, 2, 7, 9
Hydraulic Hoses, Lines, and Fittings	1, 2, 4	1,2,3,4
Hydraulic Reservoir, Cap, and Breather	1, 2, 3, 4, 5	1, 2, 3, 4, 5
Hydraulic Filter(s)	1, 4, 5	1, 2, 3, 4, 5
Hydraulic Fluid	4, 5	3, 4, 5
Electrical Connections	1, 2	1, 2
Instruments, Gauges, Switches, Lights, Horn	1, 2, 3	1, 2, 3
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

Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	Inspections	
	Pre-Delivery[1] or Frequent [2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
Grease and Lubricate to Specifications	9	3, 7, 9
Function Test of All Systems	9	3, 9
Paint and Appearance	5	2, 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

[50] Indicates a 50 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

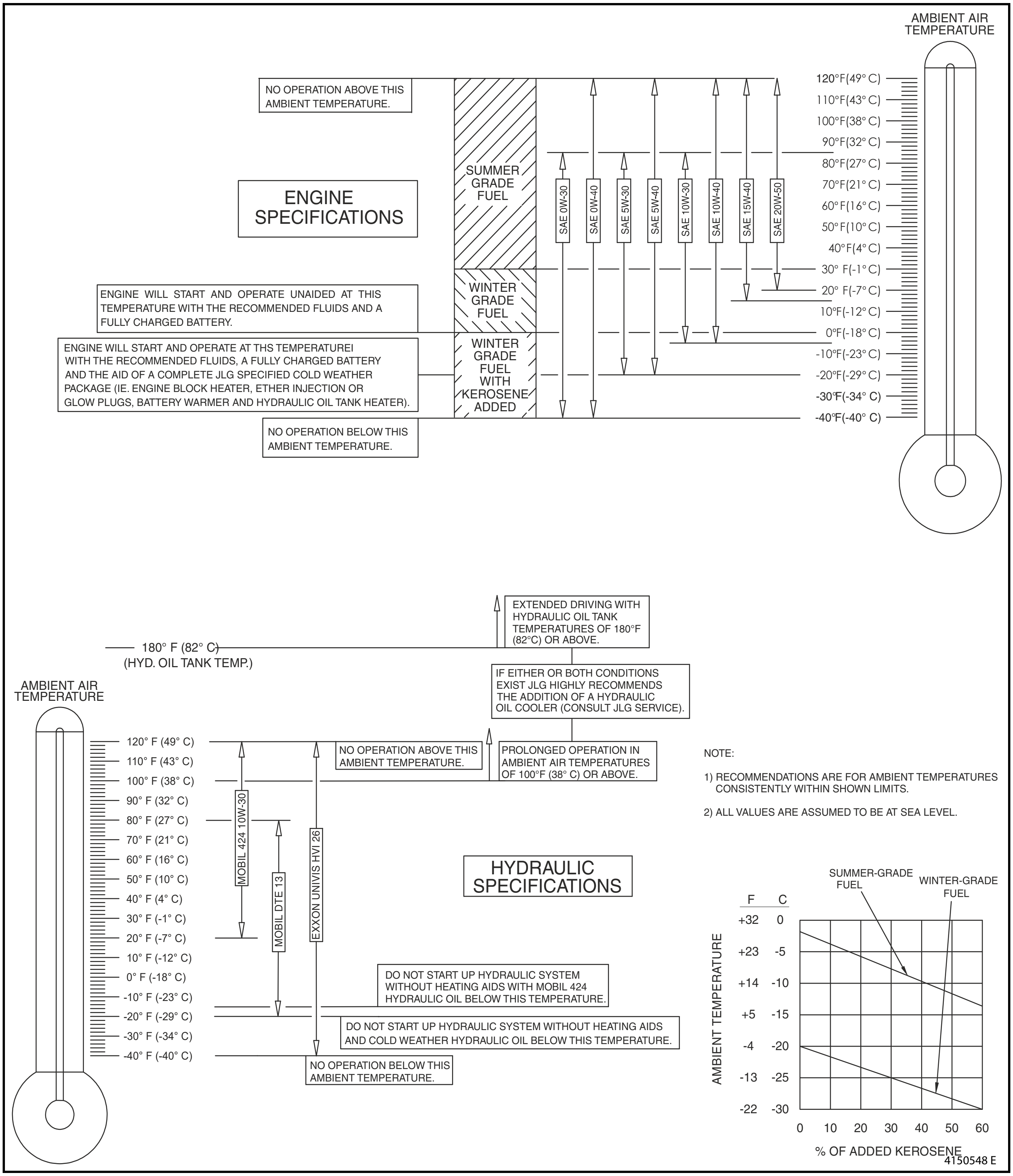


Figure 2-1. Engine and Hydraulic Operating Temperature Specifications - Deutz

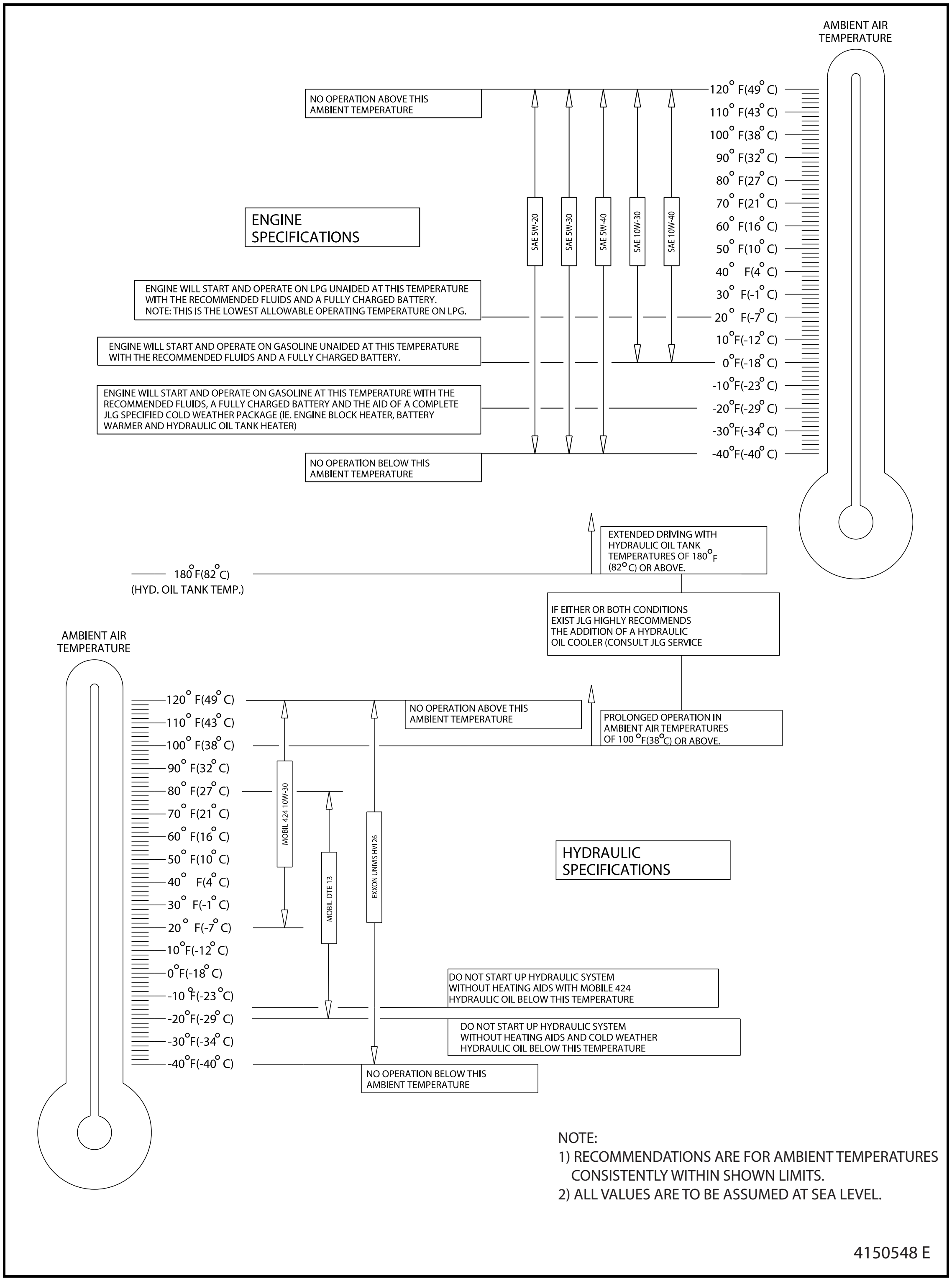


Figure 2-2. Engine and Hydraulic Operating Temperature Specifications - Ford MSG 425

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.

Tubes may be installed inside of tires that meet the criteria outlined above for usable tires, only to eliminate small air leaks (i.e., bead leaks, small nail puncture, etc.). Radial nail hole repairs up to 3/8 inch diameter may be made by using an industry approved commercial/industrial tire repair procedure, such as an internally applied plug and liner patch repair system, provided the nail hole is at least one inch inside the shoulder. Do not attempt any section repairs or repairs to the shoulder or sidewall areas.

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

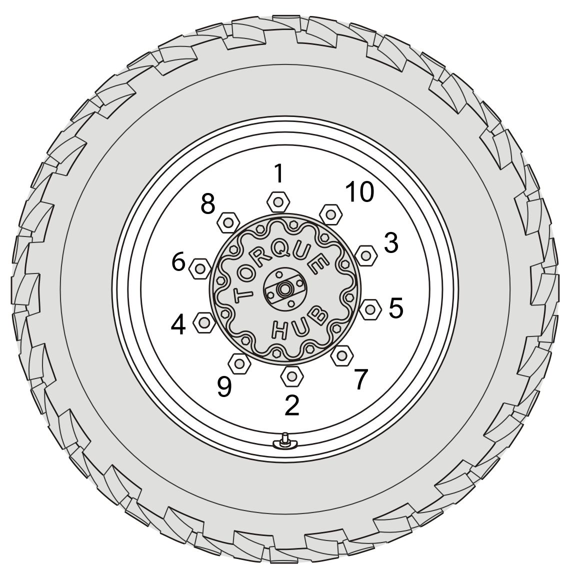
It is extremely important to apply and maintain proper wheel mounting torque.

⚠ 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.

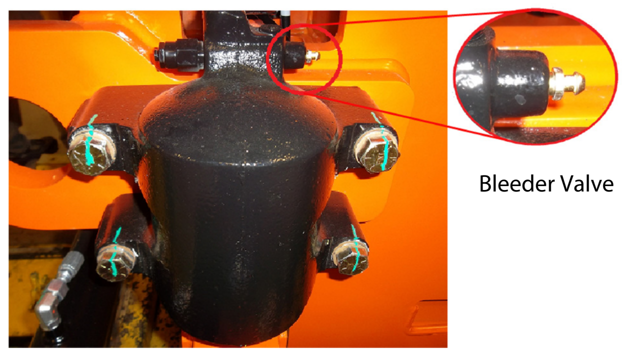
Table 3-1. Wheel Torque Chart

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

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

3.2 LOCKOUT CYLINDER BLEEDING

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



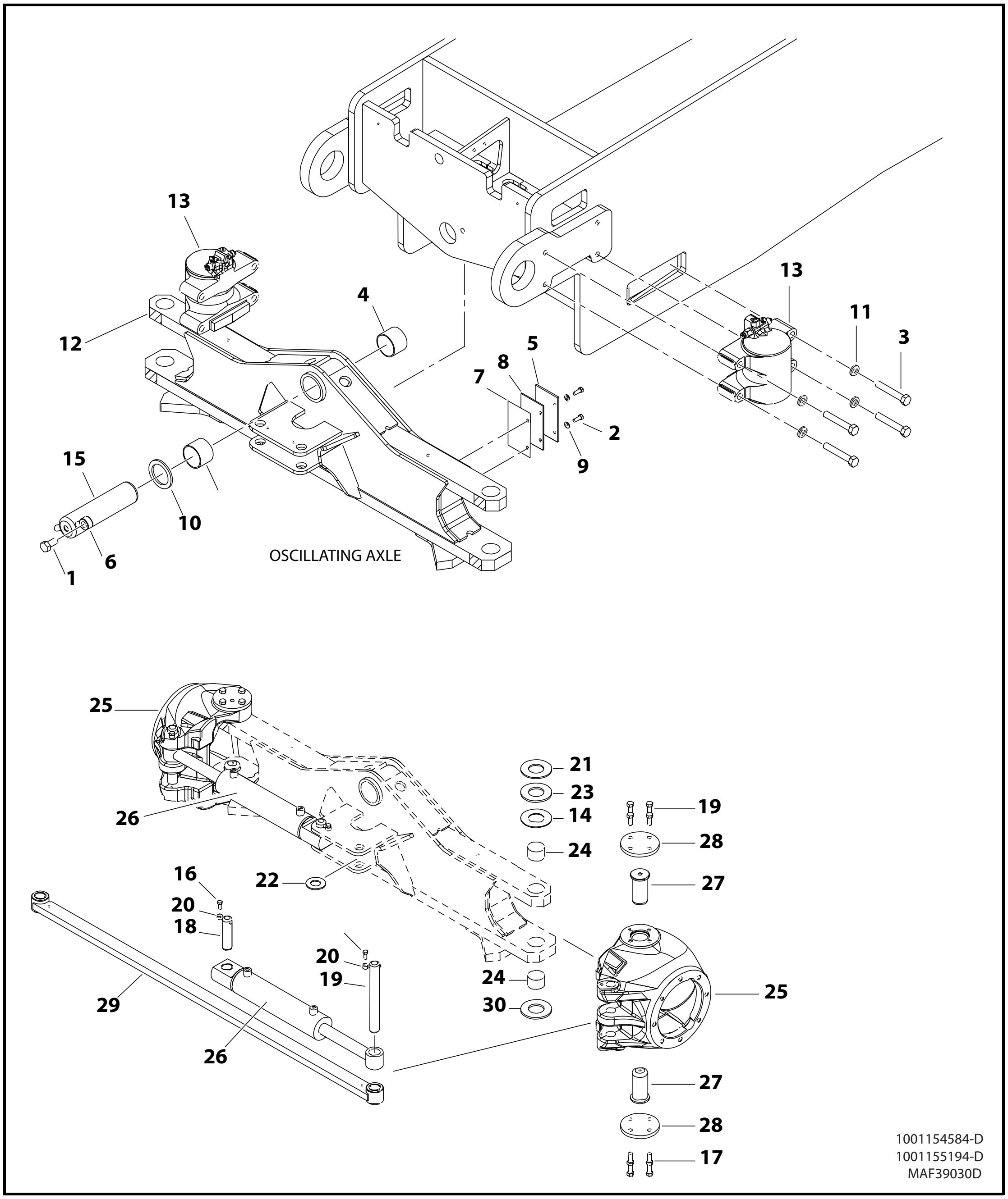


Figure 3-1. Axle and Steering Installation without Tow Package- Sheet 1 of 2

1. Bolt
2. Bolt
3. Bolt
4. Bushing
5. Wear Shim
6. Keeper Shaft
7. Wear Shim
8. Wear Shim
9. Flat Washer
10. Special Washer
11. Flat Washer
12. Axle
13. Axle Lockout Cylinder
14. Thrust Washer
15. Pin
16. Bolt
17. Bolt
18. Pin
19. Pin
20. Pin Keeper
21. Thrust Washer
22. Special Washer
23. Thrust Washer
24. Bearing
25. Spindle
26. Steer Cylinder Assembly
27. Kingpin
28. Plate
29. Tie-Rod
30. Thrust Washer

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

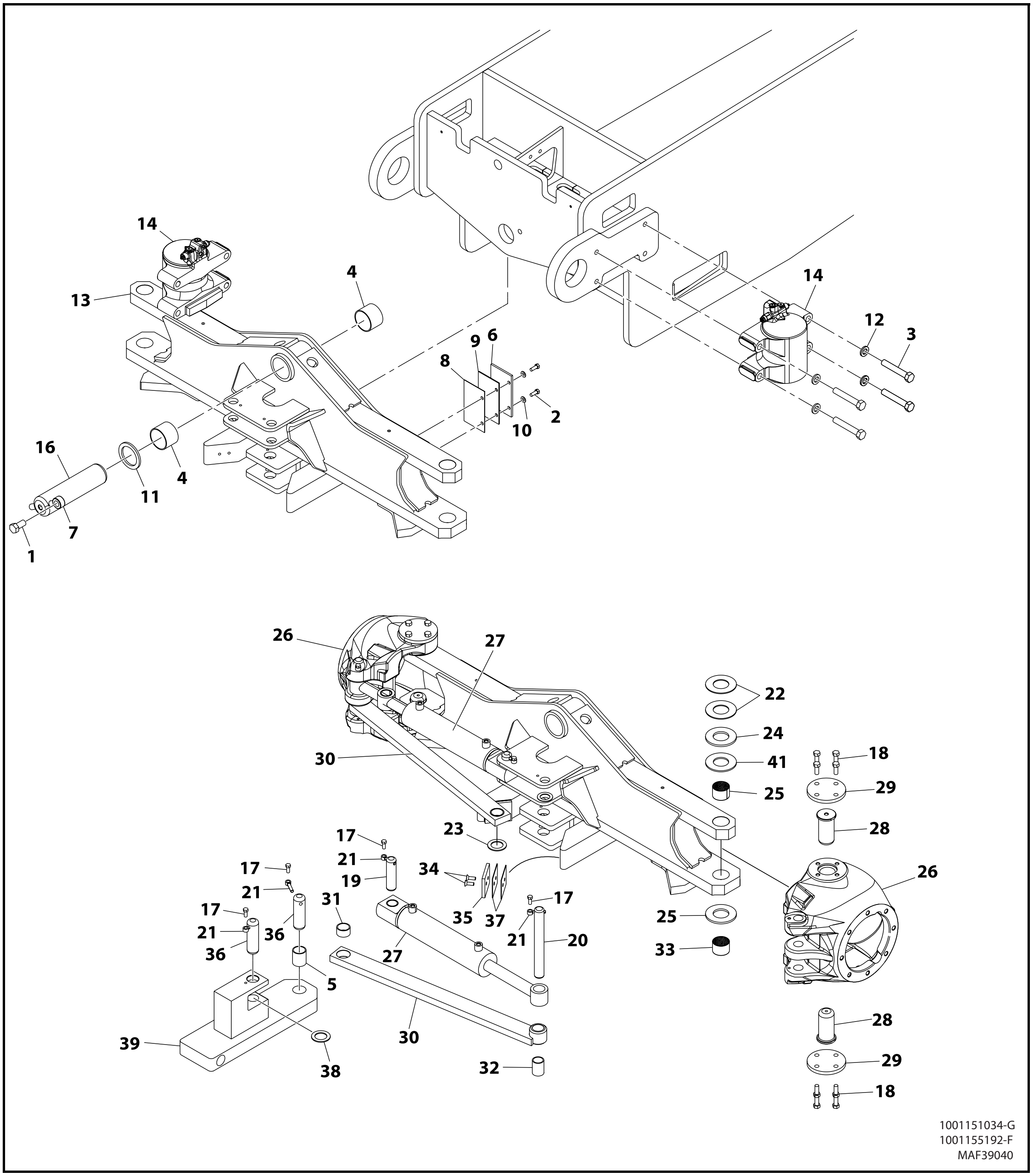


Figure 3-3. Axle and Steering Installation with Tow Package- Sheet 1 of 2

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

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

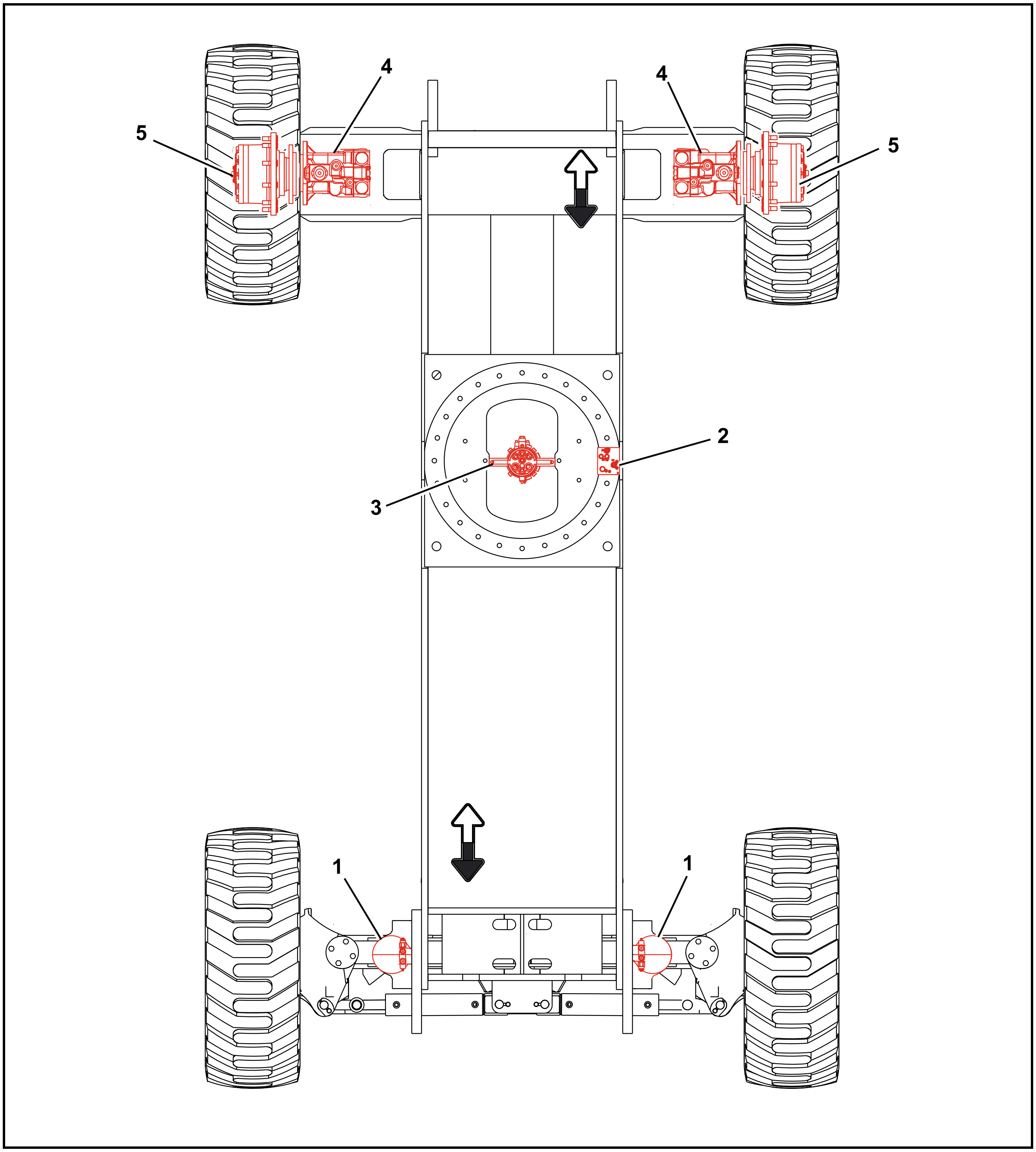
3.3 OSCILLATING AXLE LOCKOUT TEST

NOTICE

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

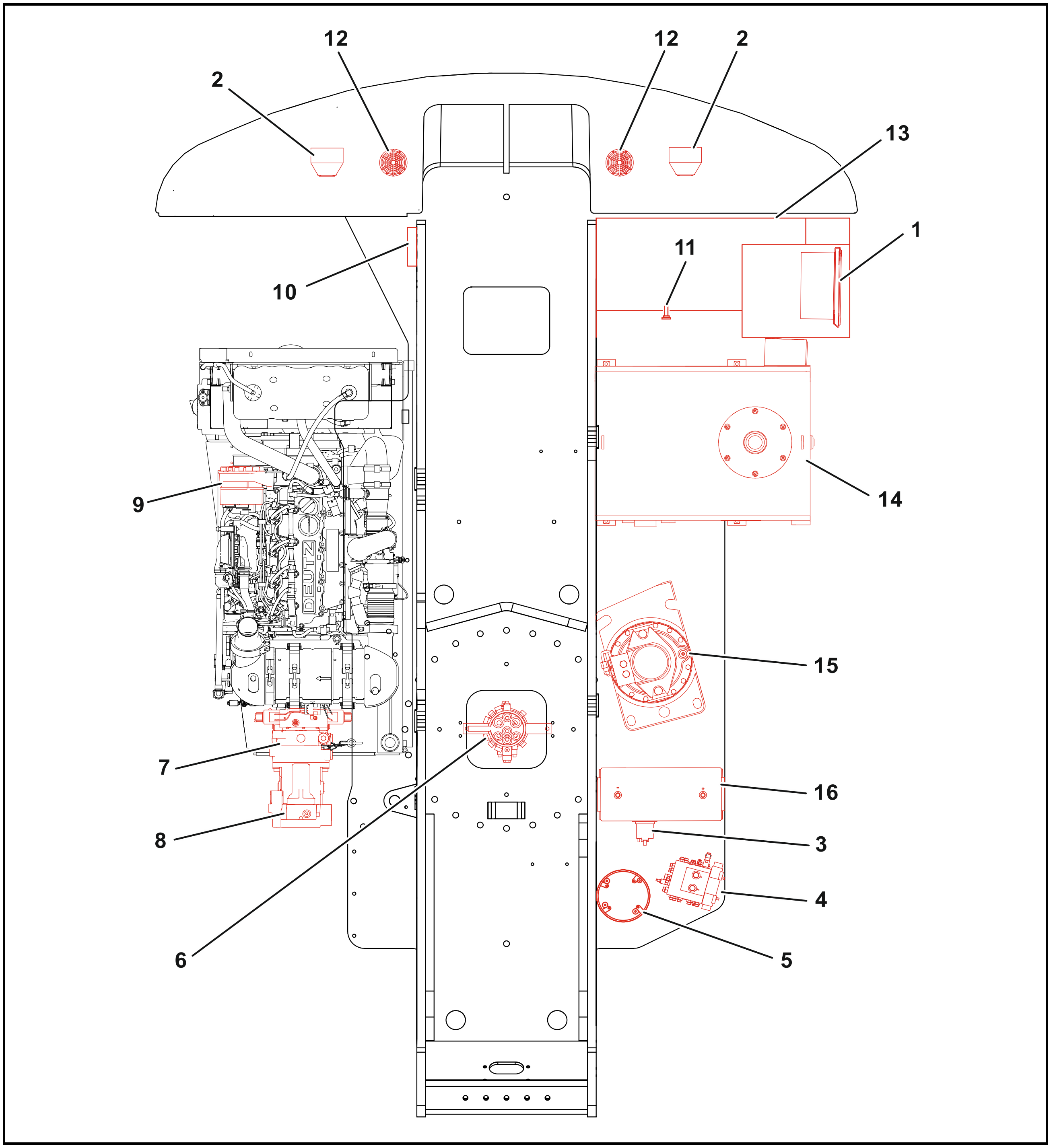
NOTE: *Ensure boom is fully retracted, lowered, and centered between drive wheels prior to beginning lockout cylinder test.*

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



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

Figure 3-5. Chassis Component Location



1. Ground Control Box
2. Headlight
3. Auxiliary Power Relay
4. Main Control Valve
5. Auxiliary Power Pump
6. Swivel
7. Drive Pumps
8. Function Pump
9. Alternator
10. Deutz Module & Diagnostic Connector
11. Fuel Level Sensor
12. Strobe
13. Fuel Tank
14. Hydraulic Oil Tank
15. Swing Drive
16. Battery

Figure 3-6. Turntable Component Location

3.4 CHASSIS TILT INDICATOR SYSTEM

The Chassis Tilt Indicator System measures the turntable angle with respect to level ground. The control system compares this measurement to a set turntable tilt angle value. By factory default, the tilt angle value is pre-set to 5.0°, but values of 5.0°, 4.0°, and 3.0° can be selected using the JLG handheld analyzer.

When the machine is in transport position (see Section 3.6, Transport Position Sensing System), it can travel at up to maximum speed until it tilts more than 8.0°. Then, the system will limit the drive speed to maximum displacement mode (slow drive speed).

By regulations, in all markets except Japan (MOL 70), when the machine is out of transport position and the turntable tilts more than the set valve, the boom functions and drive functions are disabled. The operator must return the machine into transport mode in order to continue.

For Japan (MOL 70), an option is available via the JLG handheld analyzer that allows the machine to drive in maximum displacement mode (slow drive speed) when out of transport position and tilted beyond the set turntable tilt angle value.

3.5 DRIVE ORIENTATION SYSTEM

The Drive Orientation System (DOS) is intended to indicate to the operator conditions that could make the direction of movement of the chassis different than the direction of movement of the drive/steer control handle.

The system indicates to the operator that it 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 swings +/- 45° off center of the normal driving position. This occurs roughly when the main boom swings 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 with the turntable swung past the switch point, the system is ignored until drive/steer is released. When drive is initiated with the turntable swung past the switch point, the DOS indicator will flash, and the drive/steer functions will be disabled. The operator must engage the DOS override switch to enable Drive/steer (high 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.

3.6 TRANSPORT POSITION SENSING SYSTEM

The transport position sensing system uses three sensors/switches together to sense when the boom is out of transport (nearly stowed) position.

1. Main Boom Angle Sensor: A rotary angle sensor mounted at the pivot point between the main boom and upright. This is a hall effect sensor with built-in redundancy.
2. A limit switch located inside the upright, activated by a cam on the upright level cylinder barrel bushing.
3. A proximity switch mounted near the pivot end of the main boom.

The tower boom is recognized as “out of transport position” when the tower boom angle switch senses the tower upright is raised 40” to 42” from stowed position, and resets to “within transport position” when lowered 25” to 30” from the activated position.

The main boom angle is recognized as “out of transport position” when one angular sensor signal from the main boom angle sensor reads more than 5° greater than horizontal (with respect to the turntable), and resets to “within transport position” when both angular sensor signals read less than 3° greater than horizontal (with respect to the turntable).

The main boom telescope length is recognized as “out of transport position” when the proximity switch near the pivot end of the main boom senses that the fly boom has extended 21”.

The articulated jib position of the 800AJ HC3 has no effect on transport position. This system is used to control the following systems:

1. Beyond Transport - Drive Speed Cutback System
2. Drive/Steer - Boom Function Interlock System

3.7 BEYOND TRANSPORT - DRIVE SPEED CUTBACK SYSTEM

When the boom is positioned beyond the transport position (see Section 3.6, Transport Position Sensing System), the drive motors are automatically restricted to their maximum displacement position (slow speed). See Section 3.4, Chassis Tilt Indicator System, for interaction with the tilt sensor.

3.8 DRIVE/STEER – BOOM FUNCTION INTERLOCK SYSTEM

The Drive/Steer - Boom Function Interlock System uses the Transport Position Sensing System (see Section 3.6, 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 inoperable. Likewise, while operating boom functions, drive/steer functions are inoperable.

3.9 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 incorporates two lockout cylinders connected between the frame and the axle. The lockout cylinders permit axle oscillation when pilot pressure allows flow through the axle cylinder holding valves.

When the turntable is moved off center, as recognized by a cam valve in the hydraulic swivel coupling, pilot pressure is removed from the axle cylinder holding valves and the cylinders are locked.

When the turntable is moved back to center after the cylinders have been locked, the cylinders may not fully release until drive is actuated.

3.10 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 Position - Drive Cut-back System (see Section 3.7, 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 3-2. 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	4.25
	Mid-Engine	–	Mid – 1800 RPM	3.00
	Max Torque	–	High – 2600 RPM	1.25
Out of Transport	Max Speed	–	High – 2600 RPM	0.75
	Mid-Engine	–	Mid – 1800 RPM	0.75
	Max Torque	–	High – 2600 RPM	0.75

3.11 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

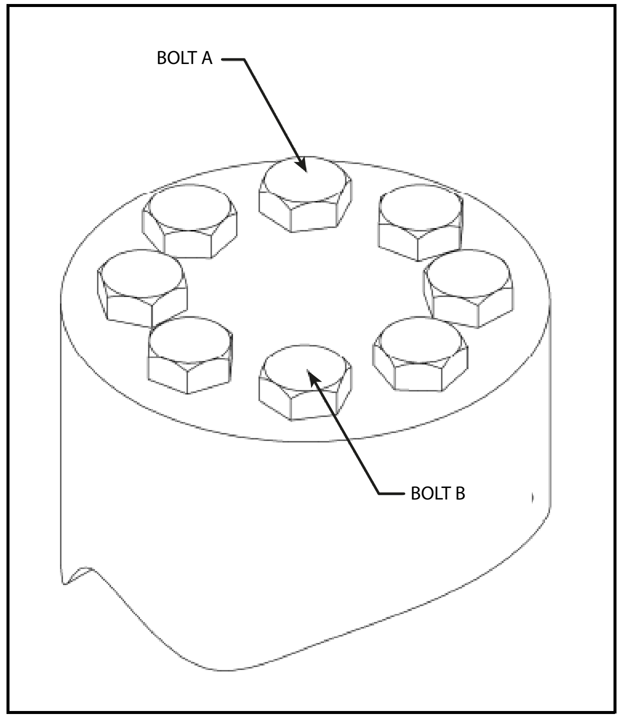
The purpose of the roll test is to determine if the unit's gears are rotating consistently, easily and properly. Release the brake by applying 400 psi (27.5 bar) to the brake port. To perform a roll test, use the recommended tool from table below (or something equivalent) to apply constant rotational 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

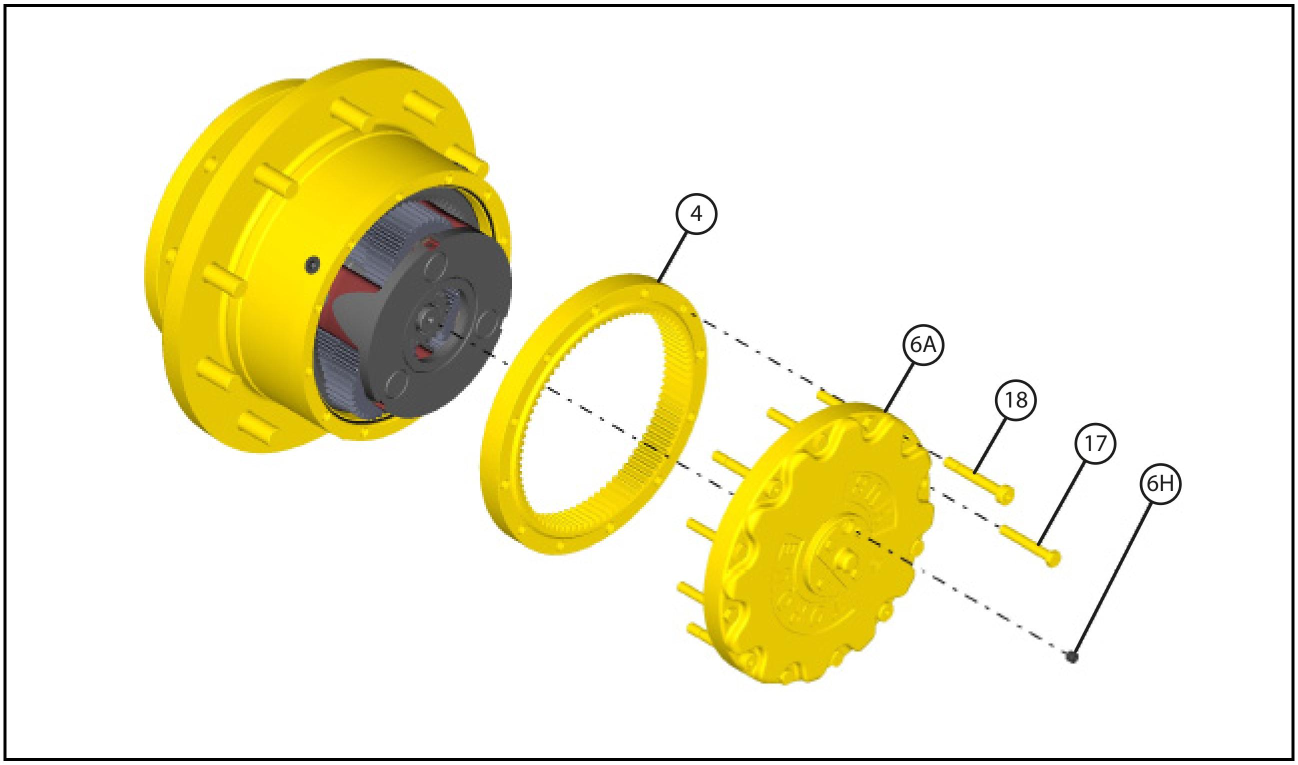
MAIN COVER PLATE DISASSEMBLY

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.*

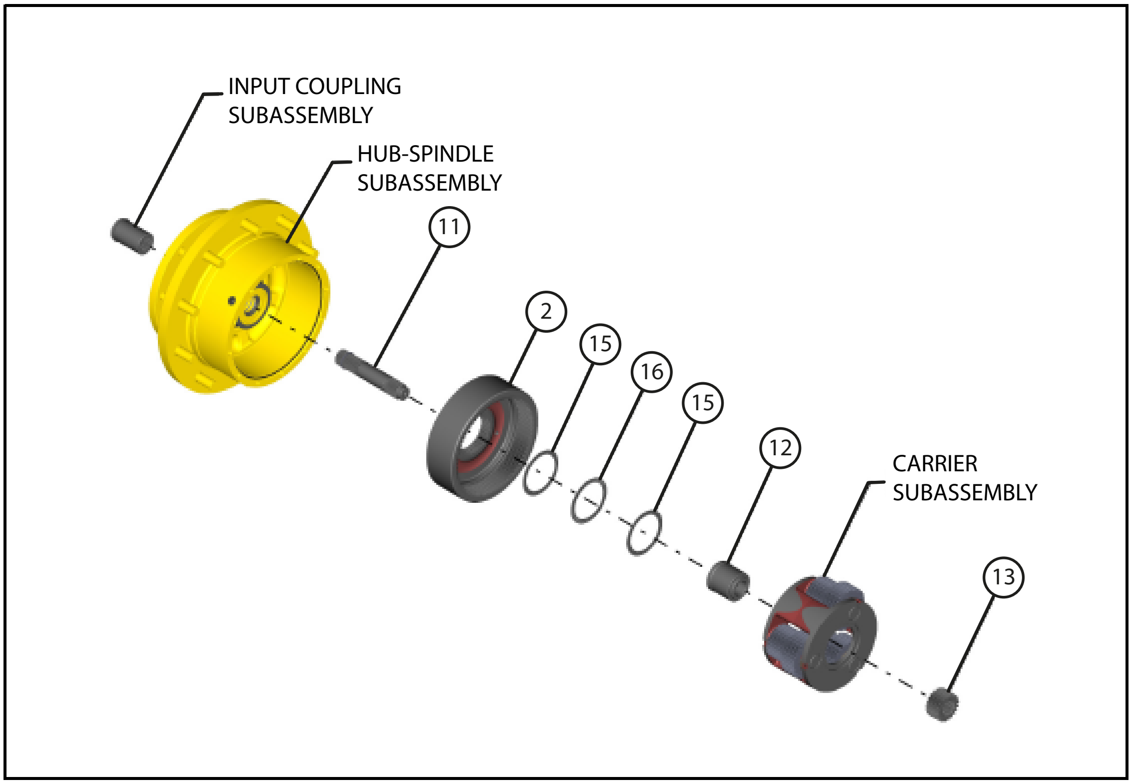
3. Remove eight bolts (17) followed by four special bolts (18) from cover subassembly.
4. Lift the cover subassembly off of the unit.
5. Lift ring gear (4) off the unit.



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

Figure 3-7. Main Cover Plate Disassembly

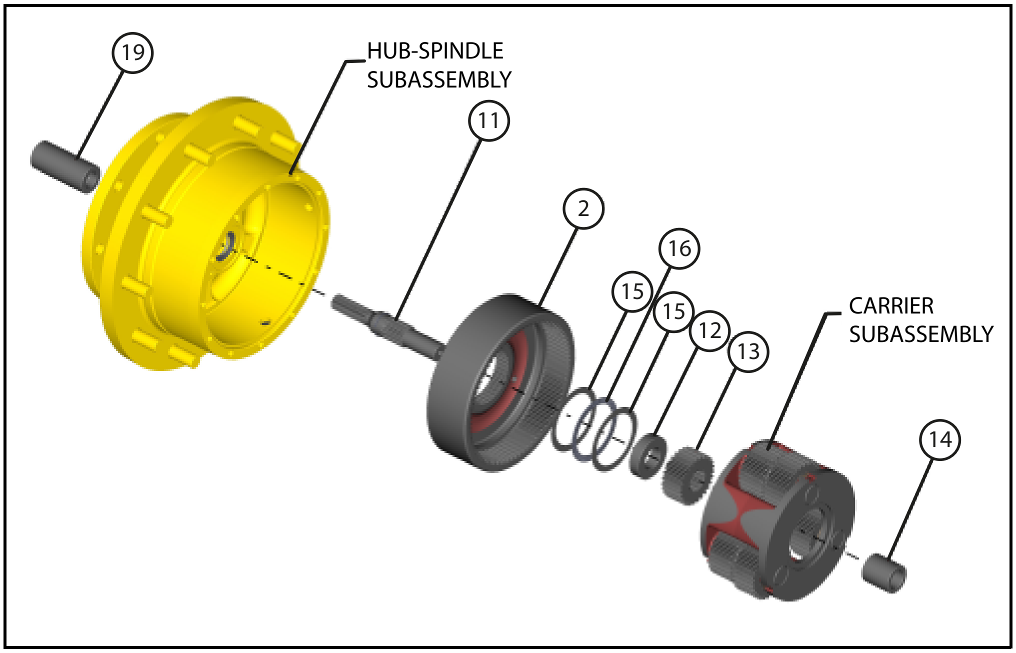
6. If applicable remove spacer (14) from the input shaft (11).
7. Remove the sun gear (13).
8. Lift out the Carrier subassembly from the unit.
9. Remove the input spacer (12) from the unit.
10. Remove two thrust spacers (15) and thrust bearing (16) from the internal gear (2).
11. Remove internal gear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

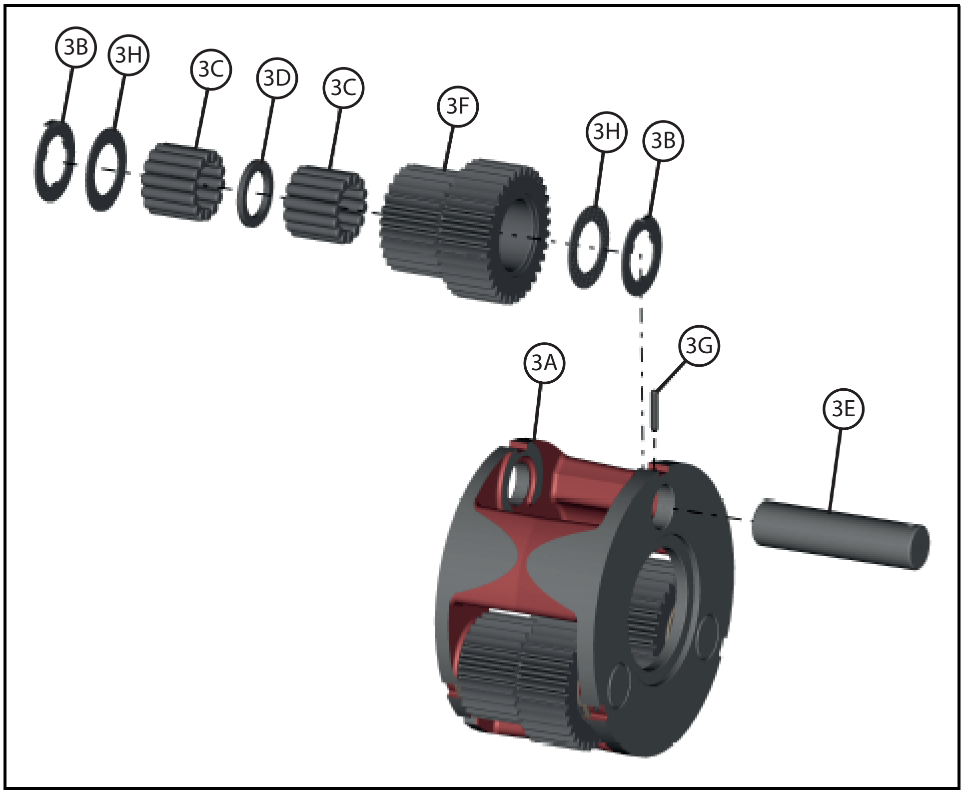
Figure 3-9. Carrier Subassembly Removal

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

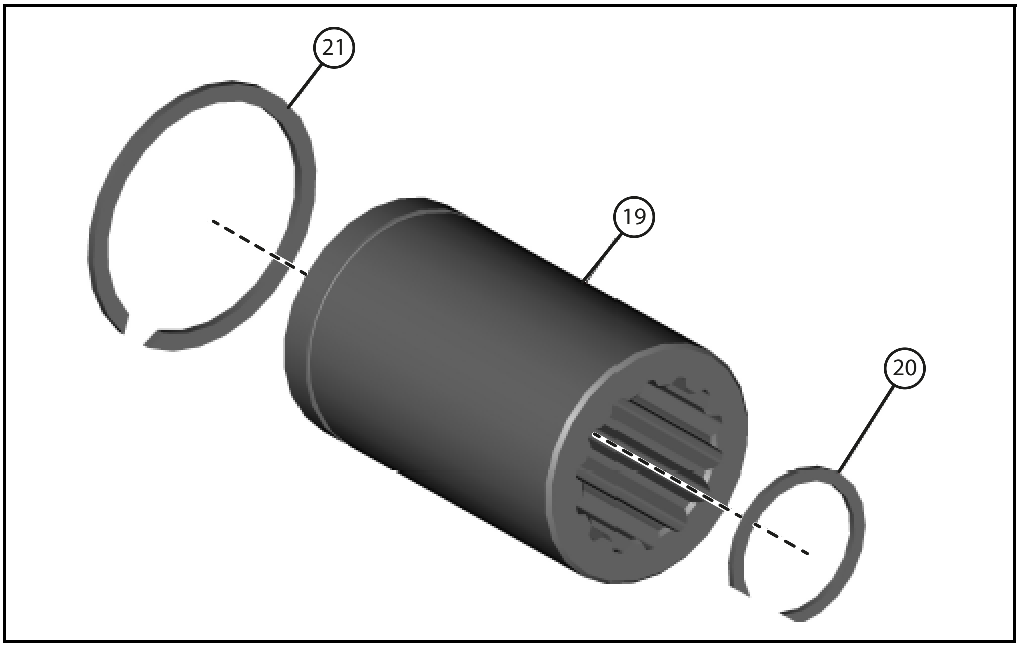
COUPLING DISASSEMBLY

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

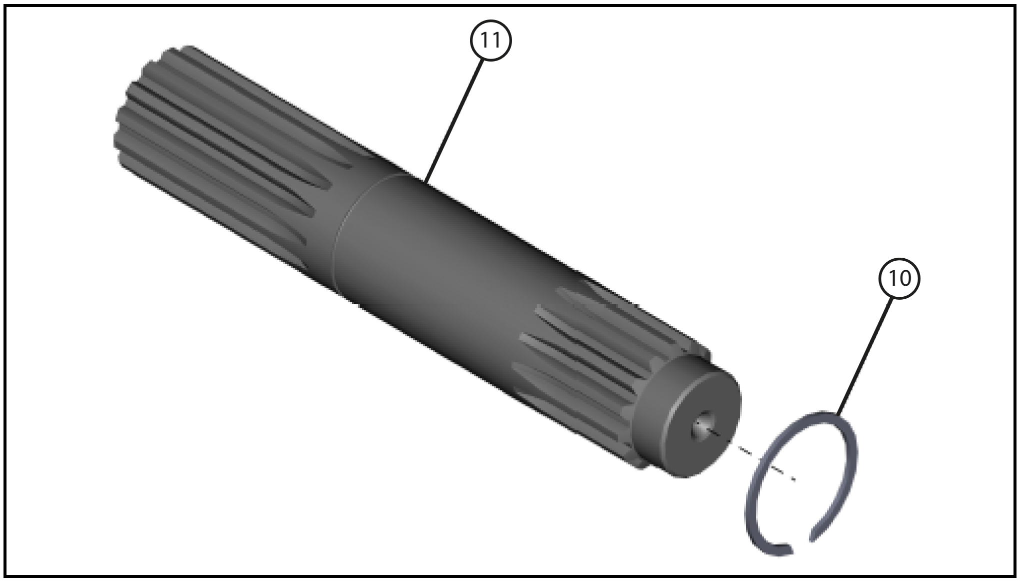
INPUT SHAFT DISASSEMBLY

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).



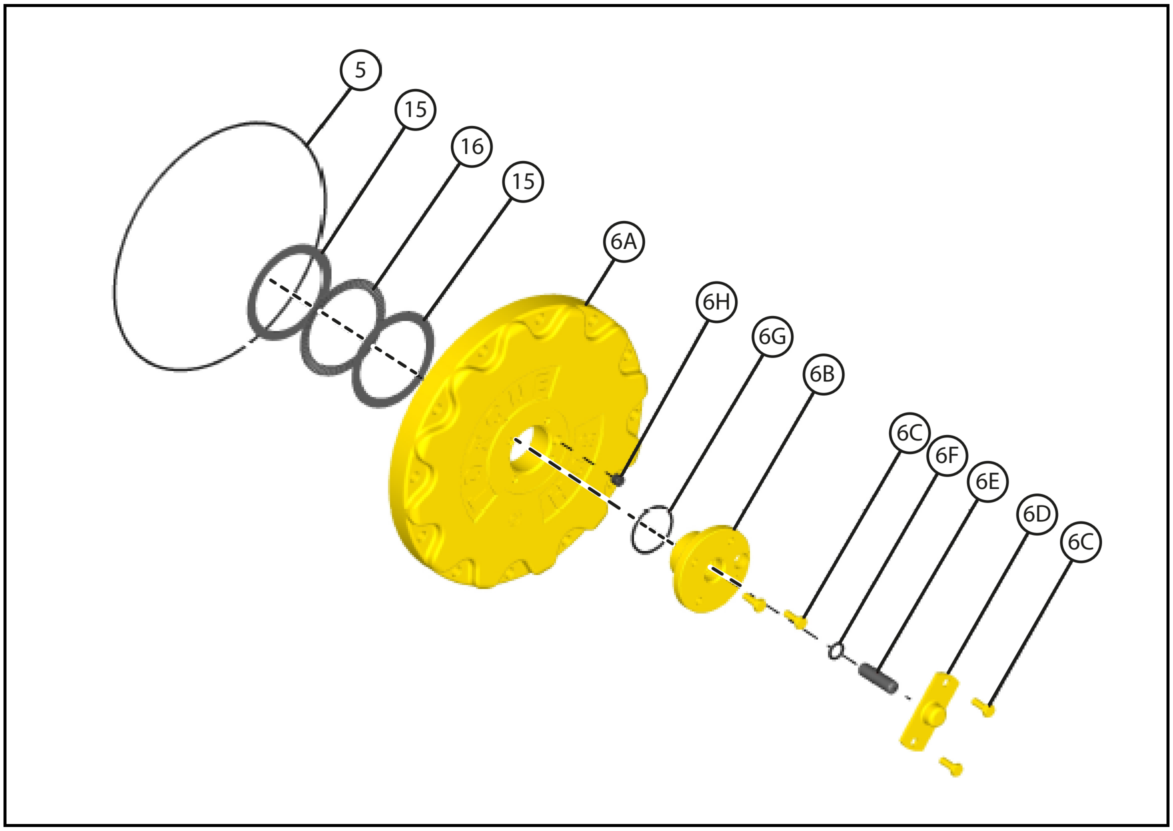
10. External Retaining Ring
11. Input Shaft

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

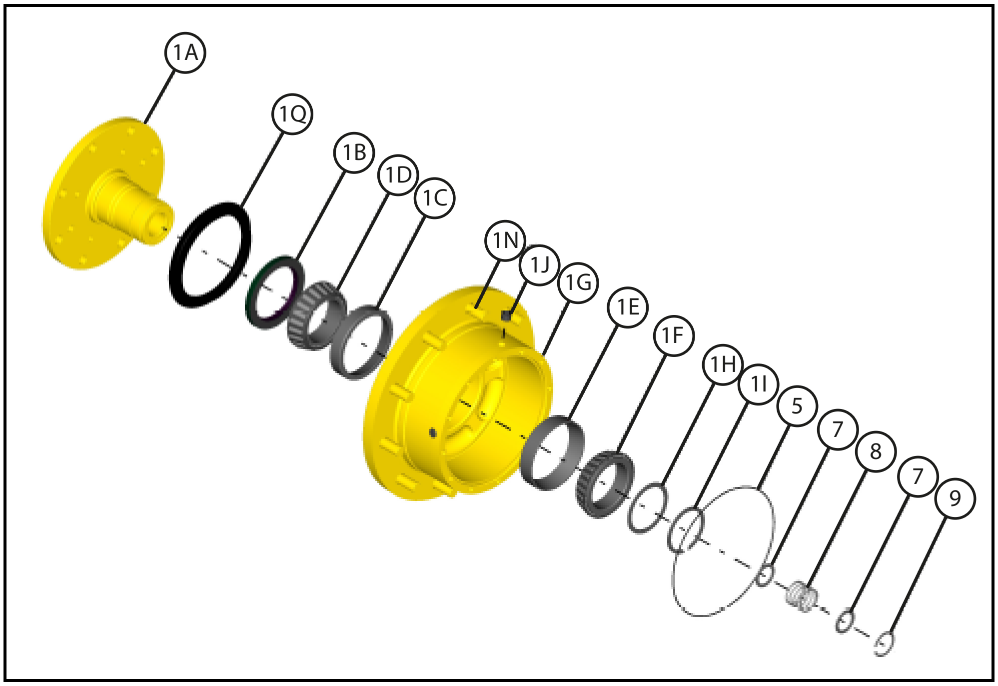
HOUSING-SPINDLE DISASSEMBLY

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

Figure 3-14. Housing Spindle Disassembly

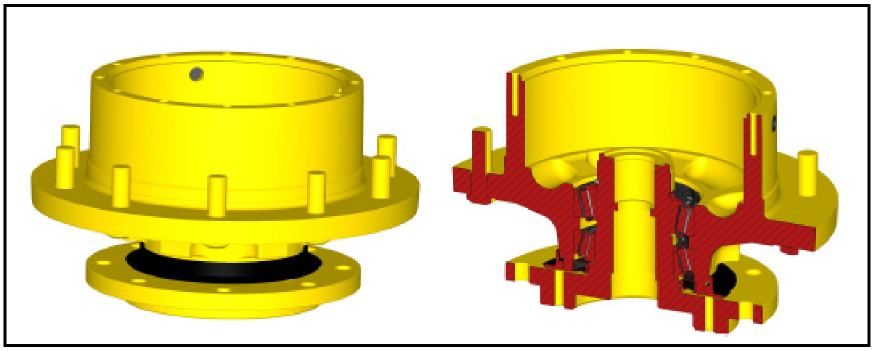


Figure 3-15. Housing Cross Section

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.

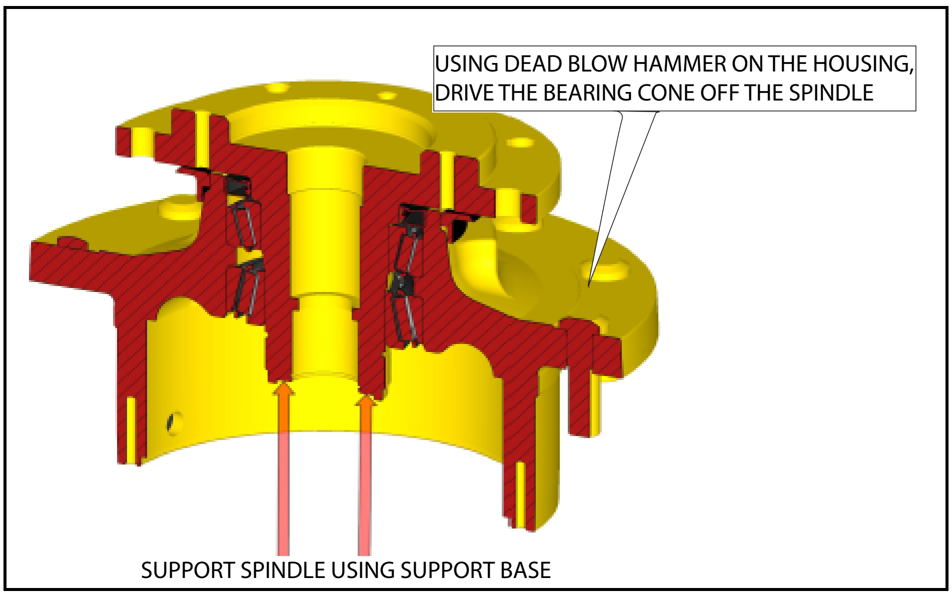


Figure 3-16. Housing Cross Section

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).

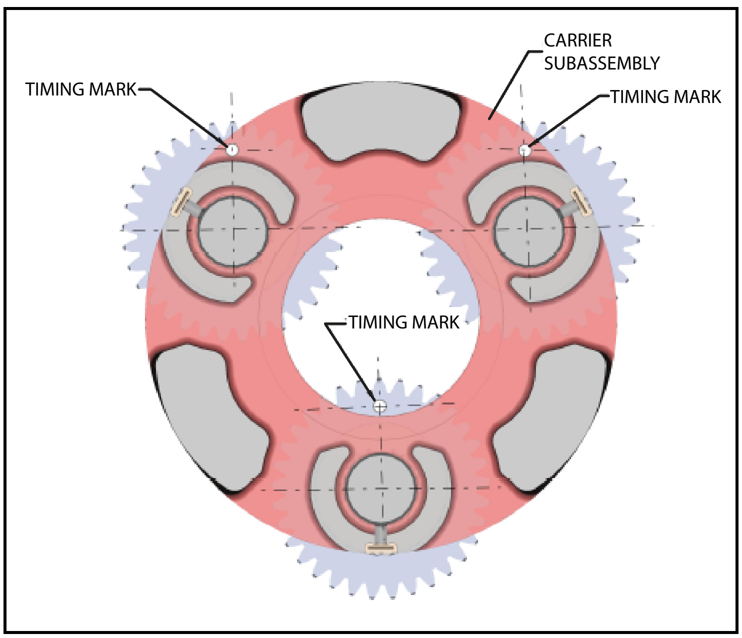


Figure 3-17. Timing Mark on Carrier Subassembly

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.

3.12 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.

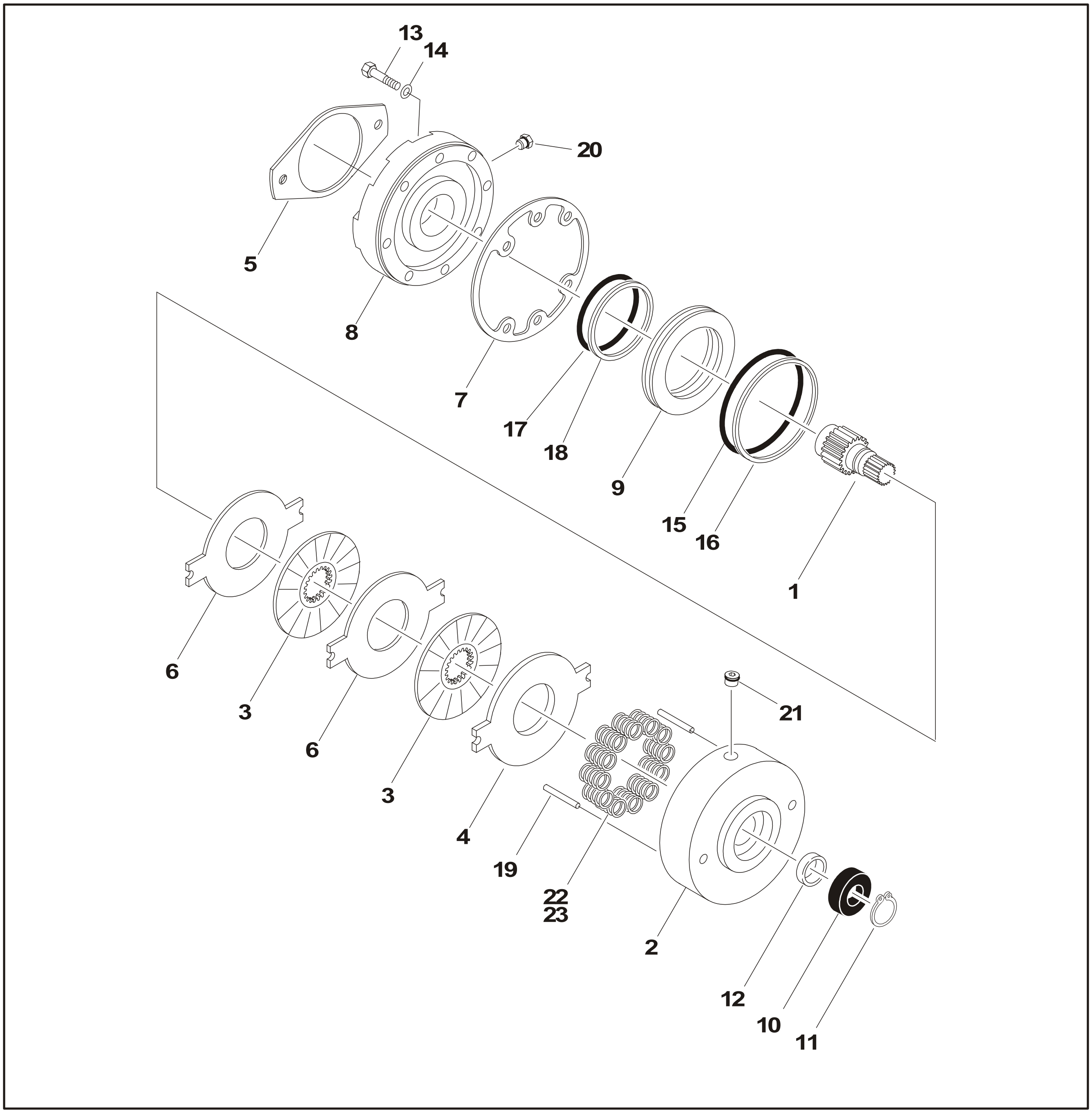
Assembly

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 Threadlocker or equivalent adhesive to full circumference of housing (2) bearing recess adjacent to shoulder.

   Apply complete coverage of Medium Strength Threadlocker 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

3.13 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.

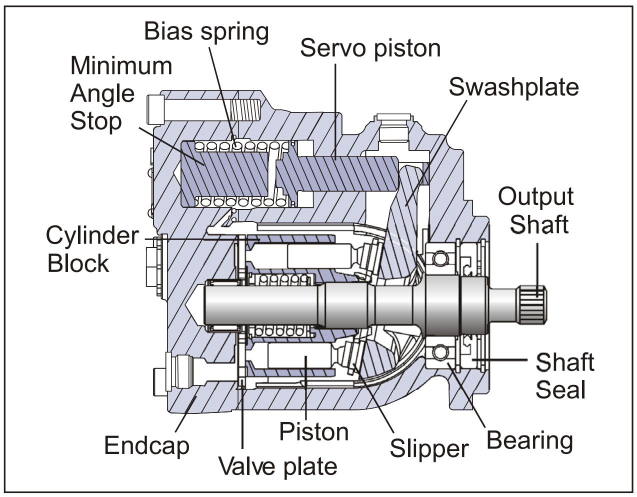
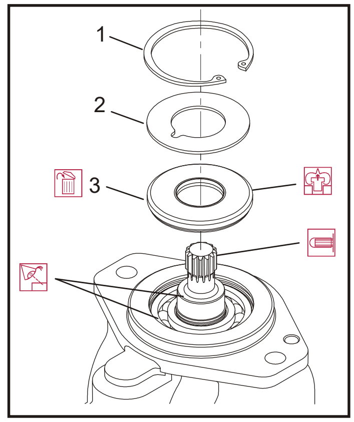


Figure 3-19. Drive Motor Cross Section

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).

   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.

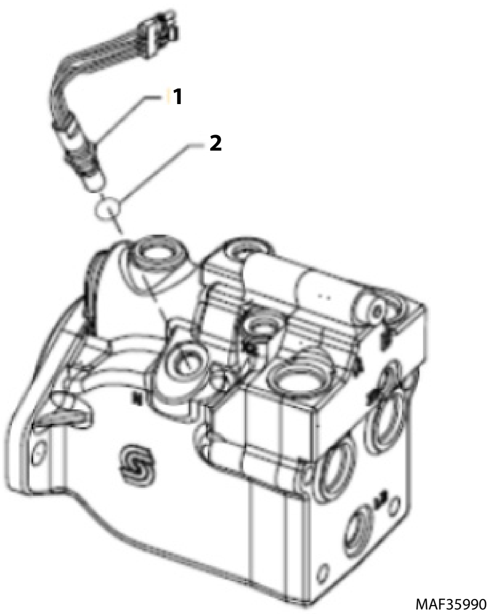
INSTALLATION

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

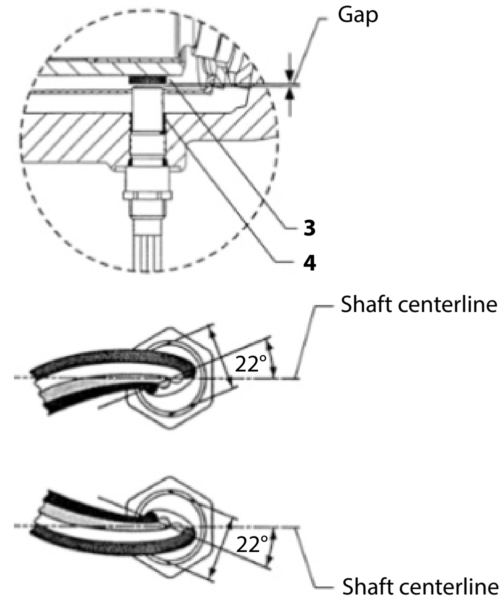
1. Disconnect the speed sensor electrical connector.
2. Using an 11/16 in. wrench, loosen the locknut.
3. Using a 1/2 in. wrench, remove the speed sensor and o-ring from the motor.



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

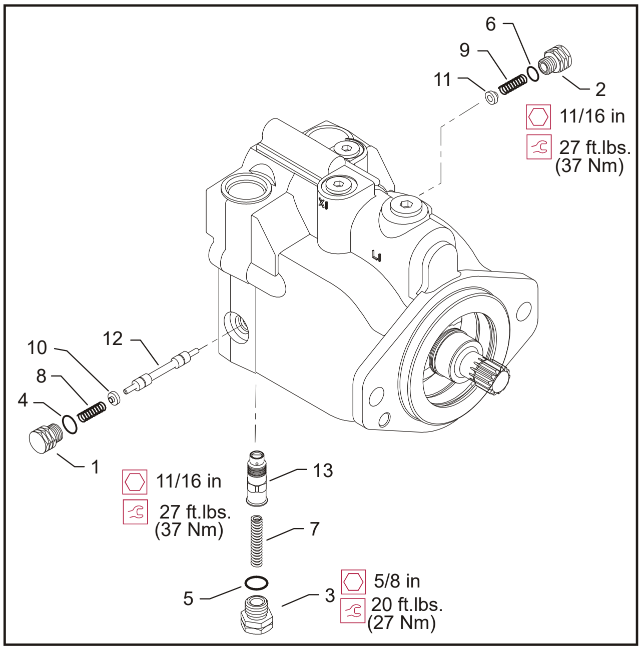
ADJUSTMENT AND TROUBLESHOOTING

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
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 3-21. Loop Flushing Spool

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).

INSPECT THE COMPONENTS

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

INSTALLATION

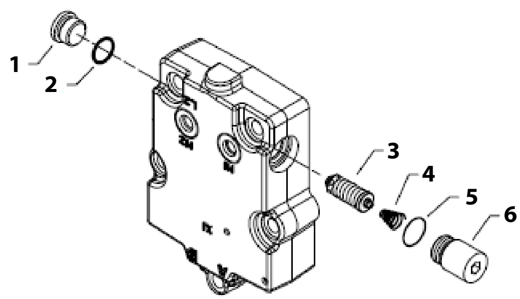
1. Install orifice poppet (13).
2. Install shift spool (12).
3. Install spring retaining washers onto springs (10 and 11).
4. Carefully install centering springs (7, 8, and 9).
5. Install new O-rings (6, 4, and 5).
6. Using a 5/8 in hex wrench torque plug (3) to 20 ft. lbs. (27 Nm).
7. Using a 11/16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

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

Table 3-4. System Operating Hot

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

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

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

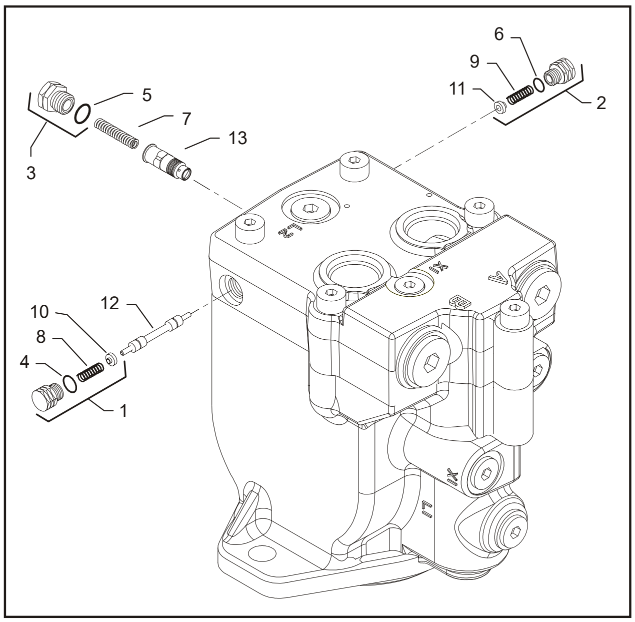
Disassembly

NOTE: *Removal of the endcap voids warranty.*

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

Replace all O-Rings and gaskets.

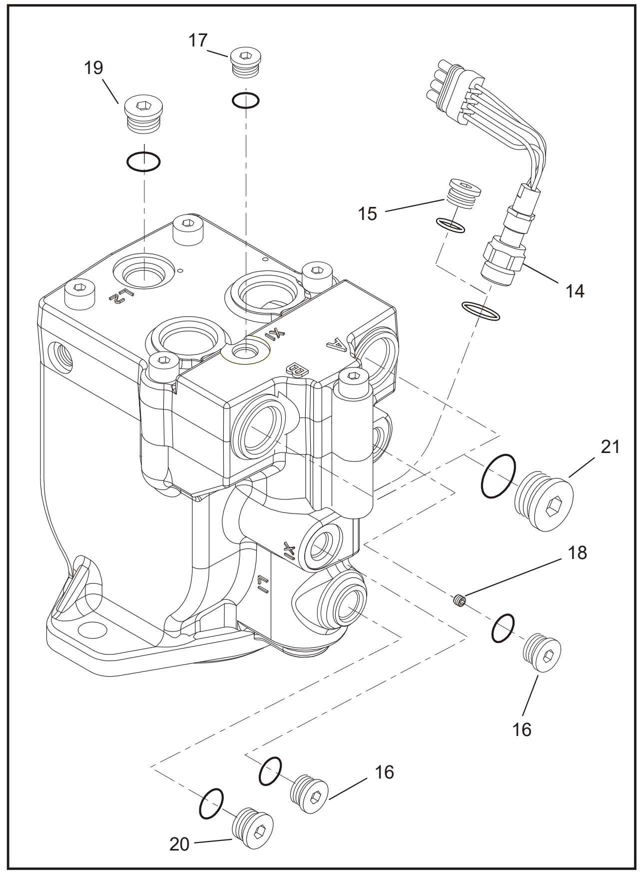
It is recommended that all O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.



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

Figure 3-22. Loop Flushing Spool

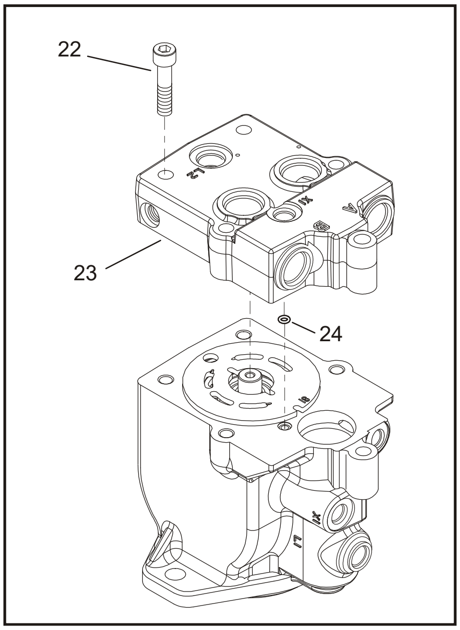
1. Using a 11/16 in wrench remove plug (1) and (2).
2. Using a 5/8 in hex wrench remove plug (3).
3. Remove O-rings (4, 5, and 6).
4. Using pliers, remove centering springs (7, 8, and 9).
5. Remove spring retaining washers (10 and 11).
6. Remove shift spool (12).
7. Remove orifice poppet (13).



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

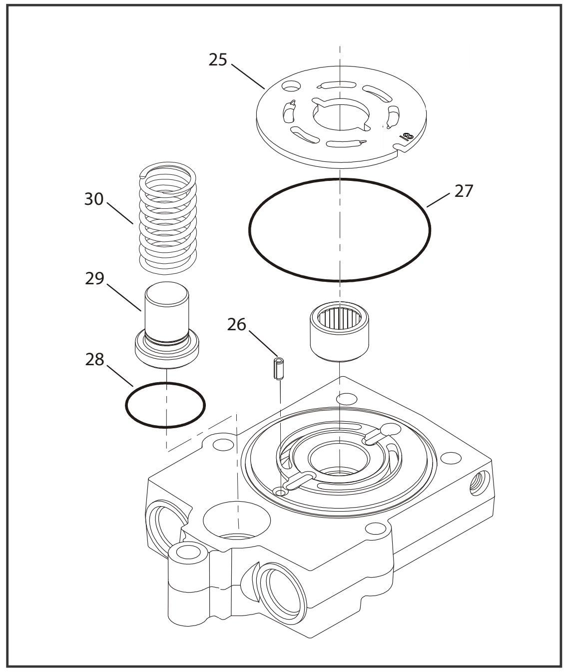


22. Screw
23. End Cap
24. O-ring

Figure 3-24. End Cap

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

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



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

Figure 3-25. Valve Plate & Rear Shaft Bearing

CAUTION

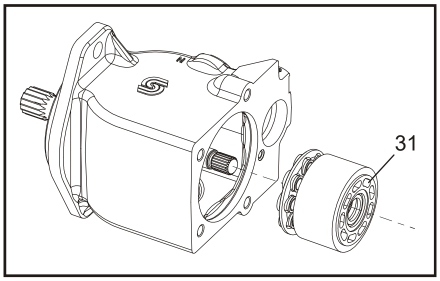
TAKE CARE NOT TO SCRATCH THE SURFACE OF THE VALVE PLATE.

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

    Each displacement has a unique valve plate. For identification, the last two digits of the valve plate part number are stamped on its surface.
16. Remove and discard the O-rings (27 and 28).
17. Remove the rear shaft bearing (29) from the endcap with a bearing puller.

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

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



31. Cylinder Kit Assembly

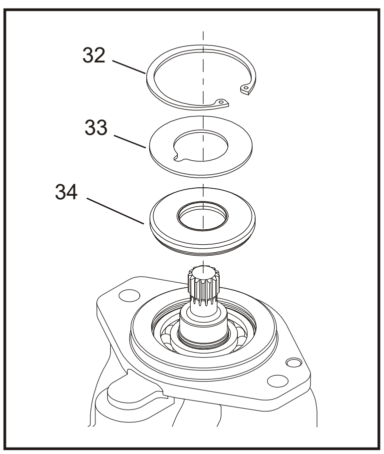
Figure 3-26. Cylinder Kit

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 3-6. Displacement Identifiers

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

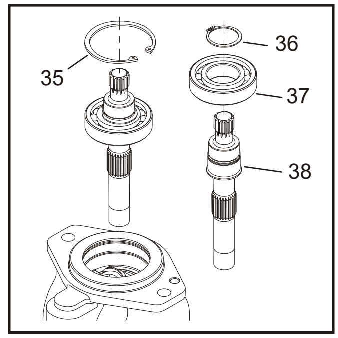


32. Snap Ring
33. Support Washer
34. Shaft Seal

Figure 3-27. 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.

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.

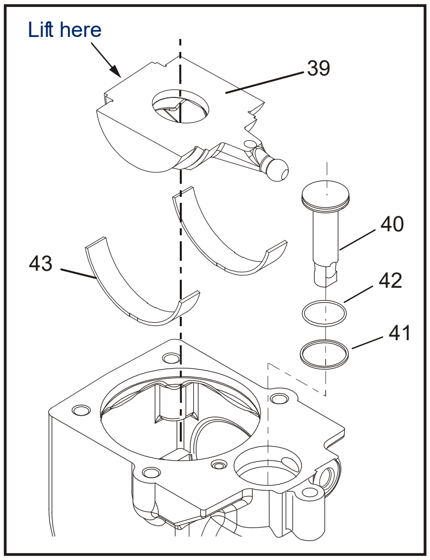


35. Inner Snap Ring
36. Snap Ring
37. Bearing
38. Shaft

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).



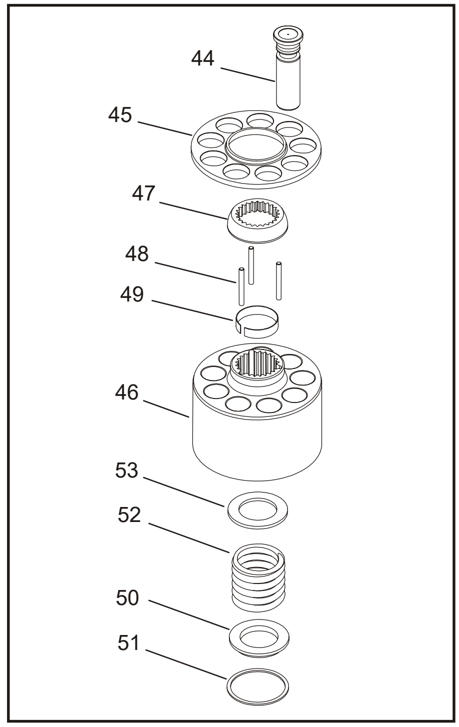
39. Swashplate
40. Servo Piston
41. Piston Seal
42. O-ring
43. Journal Bearings

Figure 3-29. Swash Plate & Servo Piston

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

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

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



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

Figure 3-30. Cylinder Kit Disassembly

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

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

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

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

⚠ WARNING

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

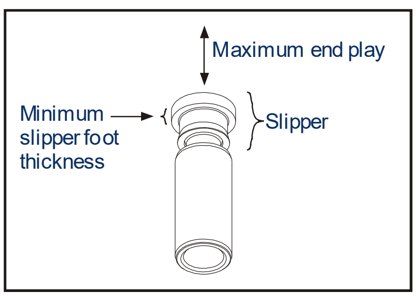
28. Turn the block over. Using a press, apply pressure on the block spring washer (50) to compress the block spring. Compress the spring enough to safely remove the spiral retaining ring (51). While maintaining pressure, unwind the spiral retaining ring (51). Carefully release the pressure and remove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

Inspection

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

PISTON

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



SLIPPERS

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

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

Table 3-7. Slipper Foot Thickness & End Play

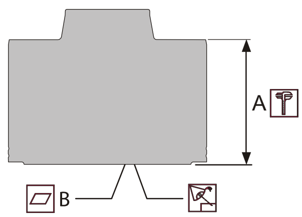
Measurement	L Frame mm (in.)	K Frame mm (in.)
Slipper Foot Thickness	2.71 (0.11)	4.07 (0.16)
Piston/Slipper End Play	0.15 (0.006)	

CYLINDER BLOCK

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

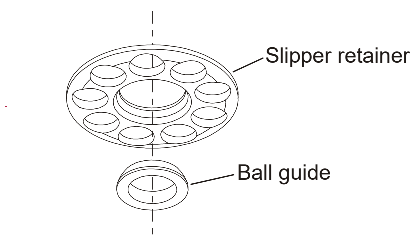
Table 3-8. Cylinder Block Measurements

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



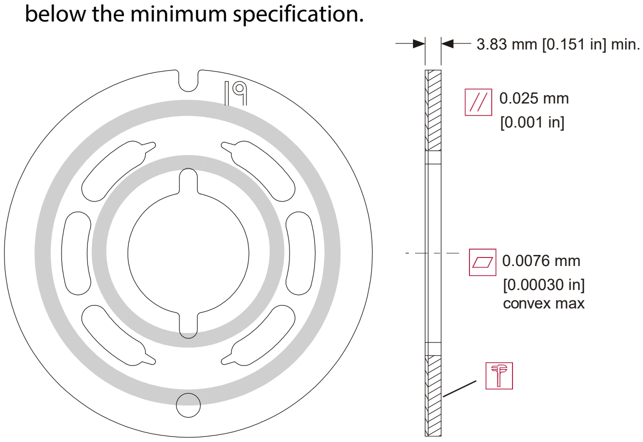
BALL GUIDE AND SLIPPER RETAINER

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



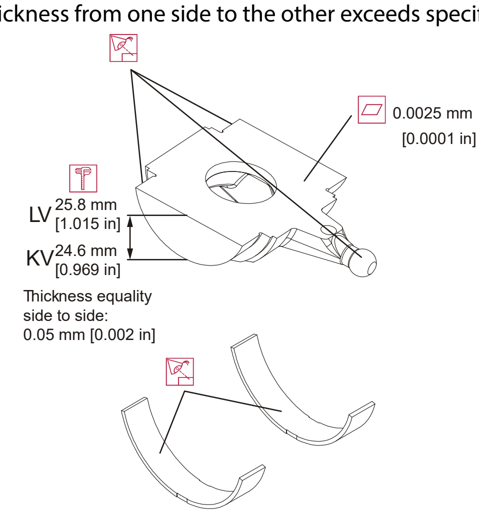
VALVE PLATE

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



SWASH PLATE AND JOURNAL BEARINGS

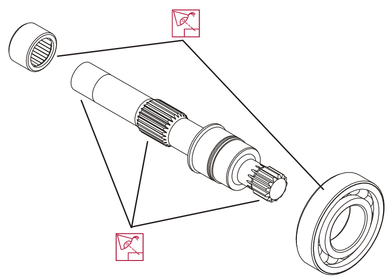
Inspect the running face, servo ball-joint, and swash plate journal surfaces for damage or excessive wear. Some material transfer may appear on these surfaces and is acceptable providing the surface condition meets specifications shown. Measure the swash plate thickness from the journals to the running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



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

SHAFT BEARINGS

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

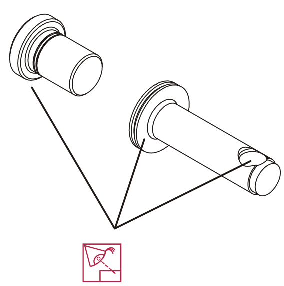


SHAFT

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

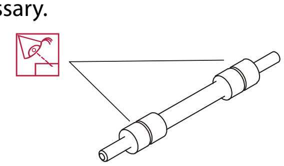
SERVO PISTON AND MINIMUM ANGLE STOP

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



LOOP FLUSHING SPOOL

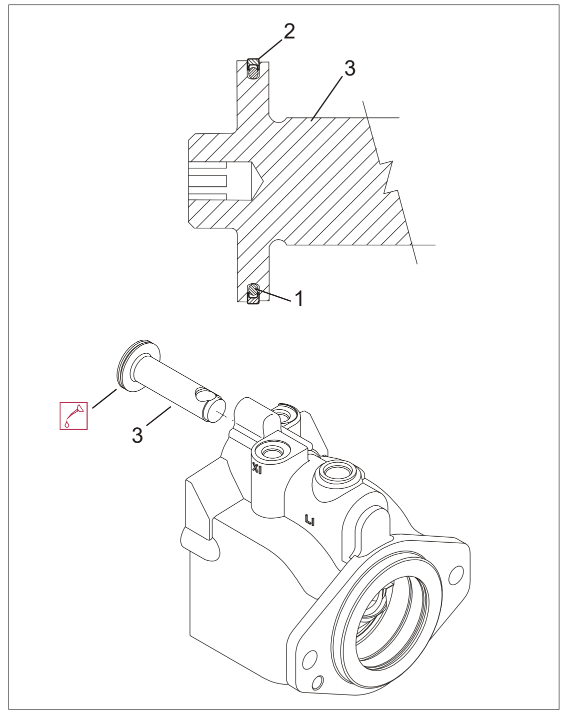
Inspect the loop flushing spool. Check for cracks or damage. Replace if necessary.



Assembly

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

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



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

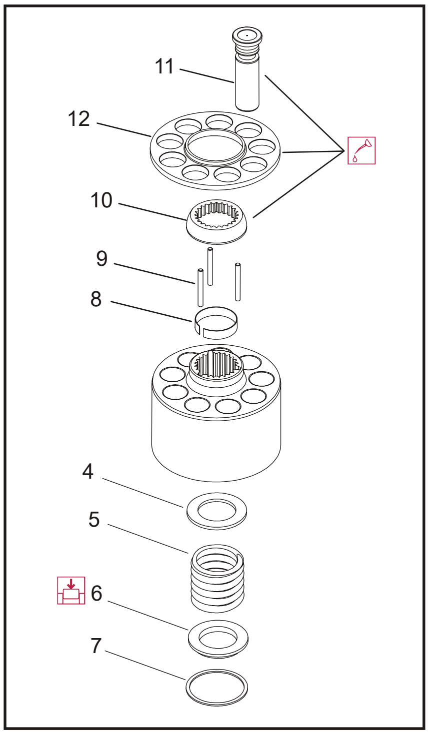
Figure 3-31. Servo Piston

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.



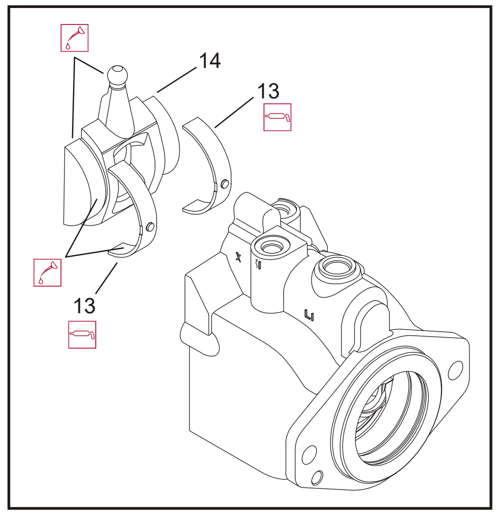
4. Block Spring Washer
5. Block Spring
6. Outer Washer
7. Spiral Retaining Ring
8. Retaining Ring
9. Holddown Pins
10. Ball Guide
11. Piston
12. Slipper Retainer

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.

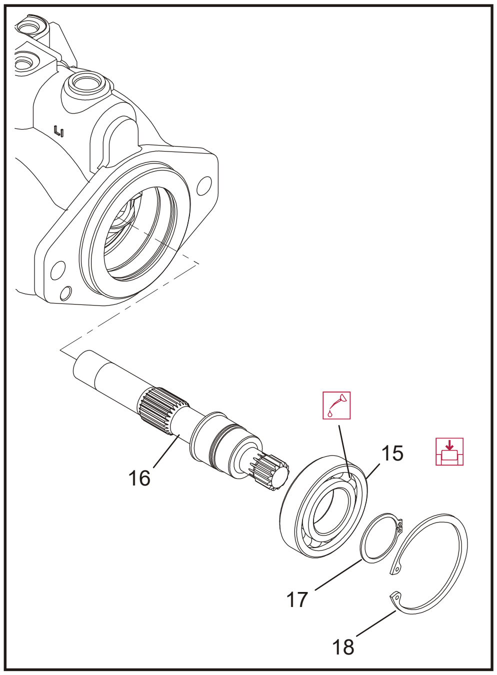


13. Journal Bearings
14. Swashplate

Figure 3-33. Swashplate and Journal Bearing

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

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.

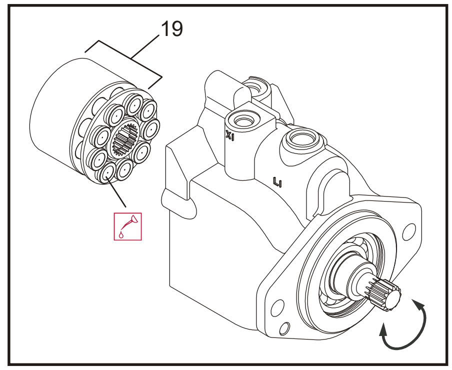


15. Front Shaft Bearing
16. Shaft
17. Snap Ring
18. Snap Ring

Figure 3-34. Shaft and Front Bearing

9. While holding the swash plate 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).

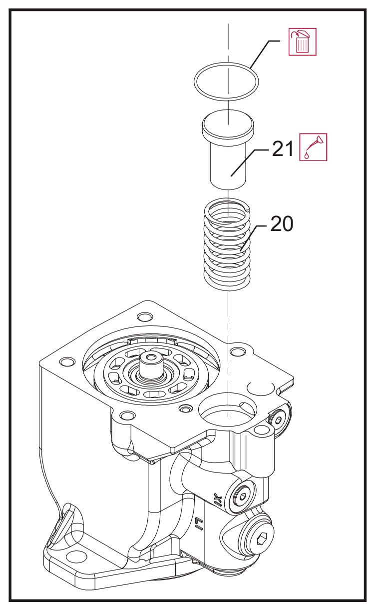
10. Verify swash plate and bearings are properly seated. Install the cylinder kit (19) onto the shaft. Install with the slippers facing the swash plate. Rock the shaft to align the block splines and slide the cylinder kit into place. Orient the motor with the shaft pointing downward and verify the cylinder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



19. Cylinder Kit

Figure 3-35. Cylinder Kit Installation

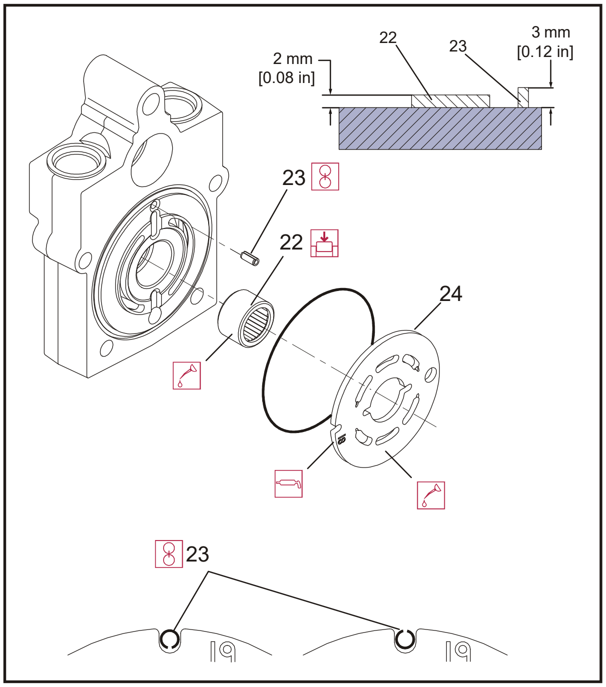
11. Lubricate and install the servo spring (20), and minimum angle stop (21) into the housing bore.



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



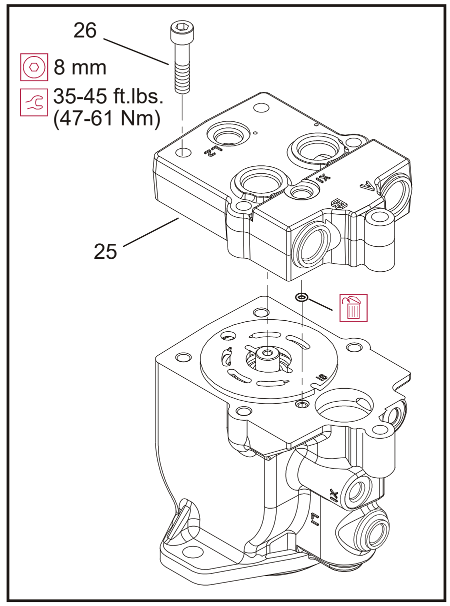
22. Rear Shaft Bearing
23. Timing Pin
24. Valve Plate

Figure 3-37. Valve Plate and Rear Bearing

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

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

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



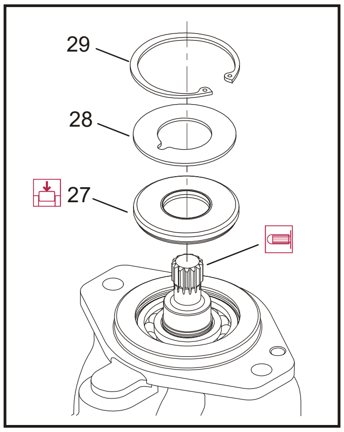
25. End Cap
26. Screw

Figure 3-38. 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 endcap. Torque end capscrews 35-45 ft.lbs. (47-61 Nm).

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

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



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

Figure 3-39. Shaft Seal

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

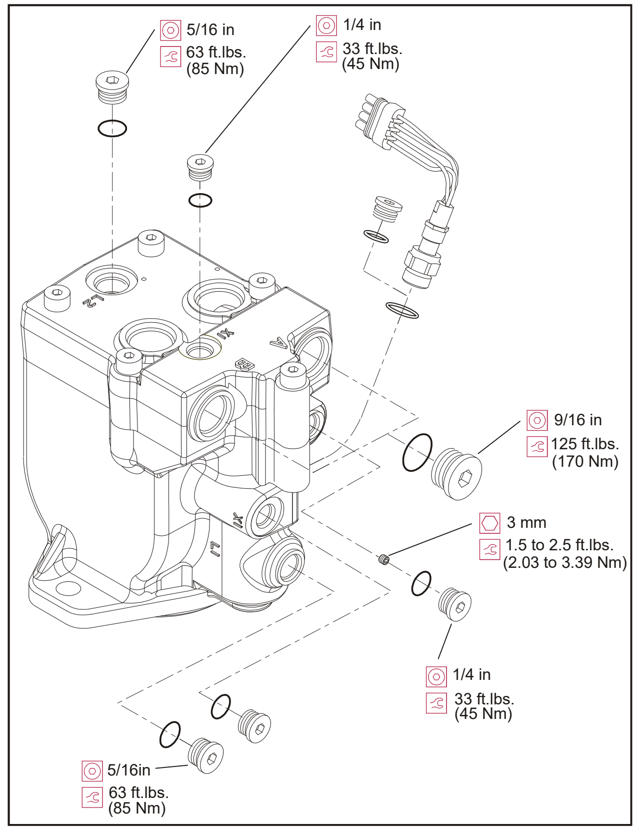
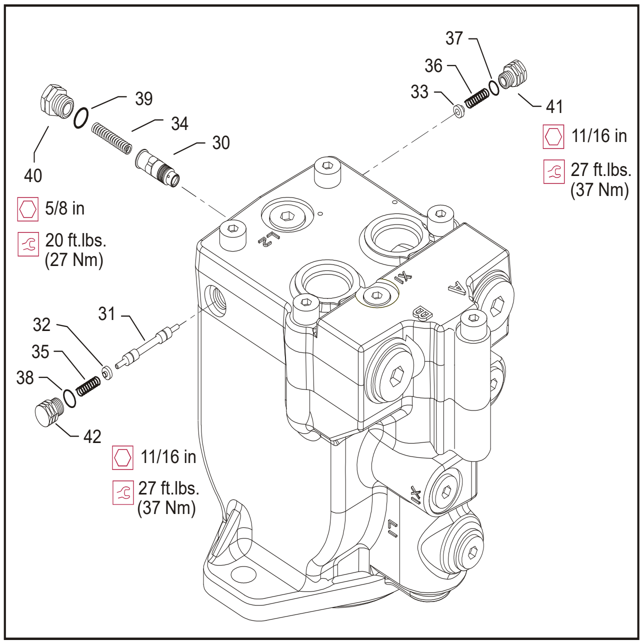


Figure 3-40. Plugs and Fittings Installation

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.*

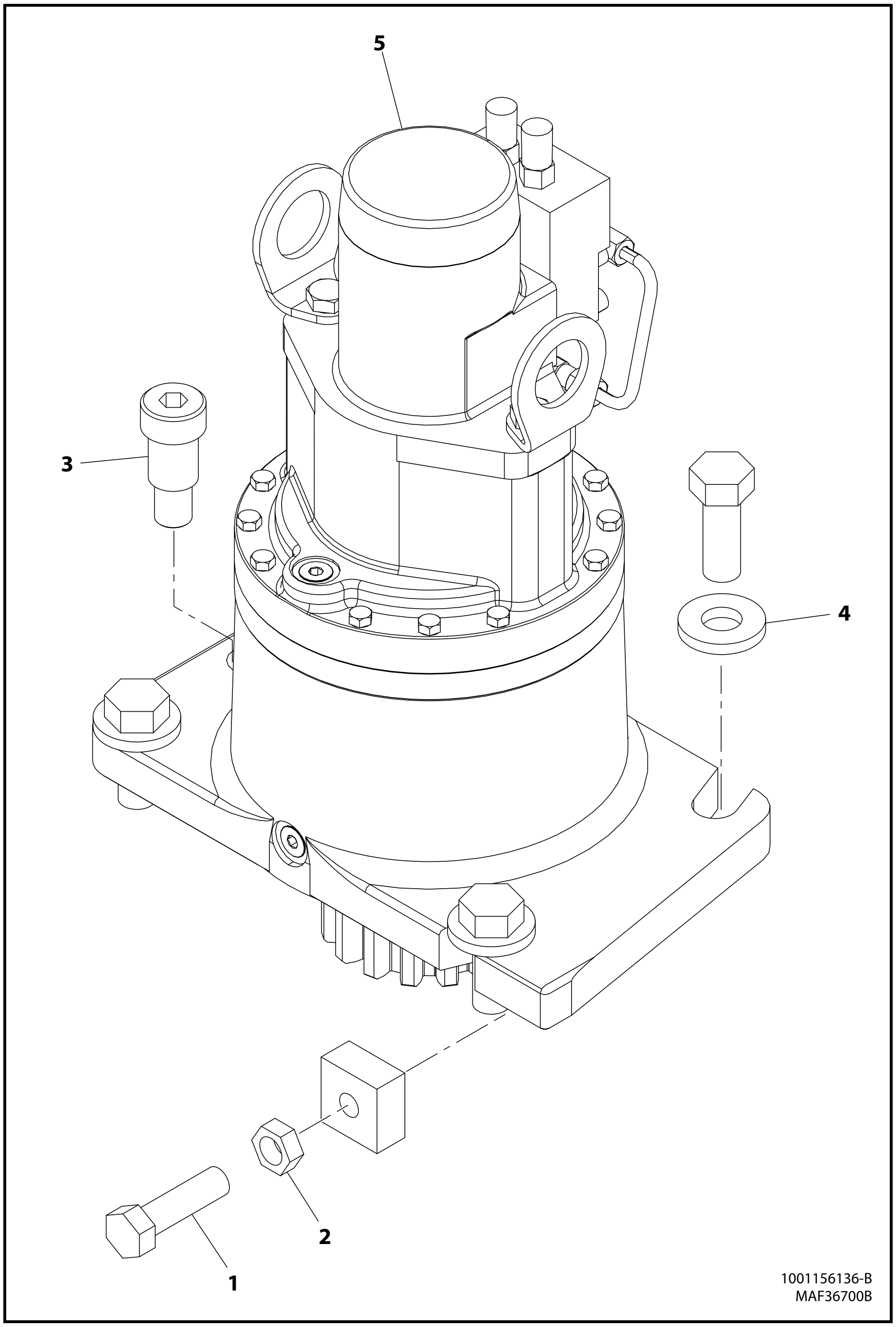
6. While watching the pressure gauge, run the engine at the lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shut down the prime mover, determine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



1. Bolt
2. Nut
3. Cap Screw
4. Washer
5. Swing Drive

Figure 3-42. Swing System

3.14 SWING DRIVE

Roll, Leak and Brake Testing

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

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

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

Roll Test

The purpose of the roll test is to determine if the unit's gears are rotating freely and properly. 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 3-58. 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" on page 48.

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.

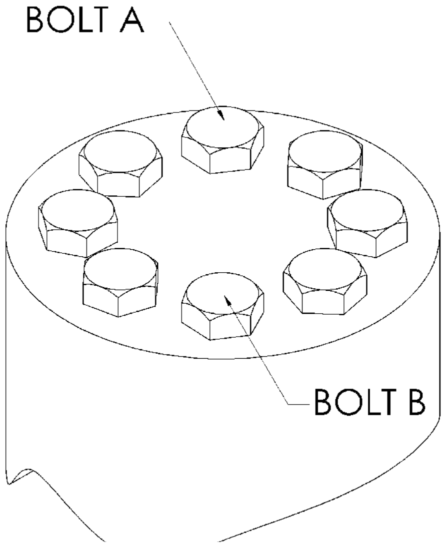
Carefully remove retaining ring from brake housing. Slowly remove bolts evenly from the input brake. Remove the pressure plate from the end of the input brake and count the number of springs in brake.

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.

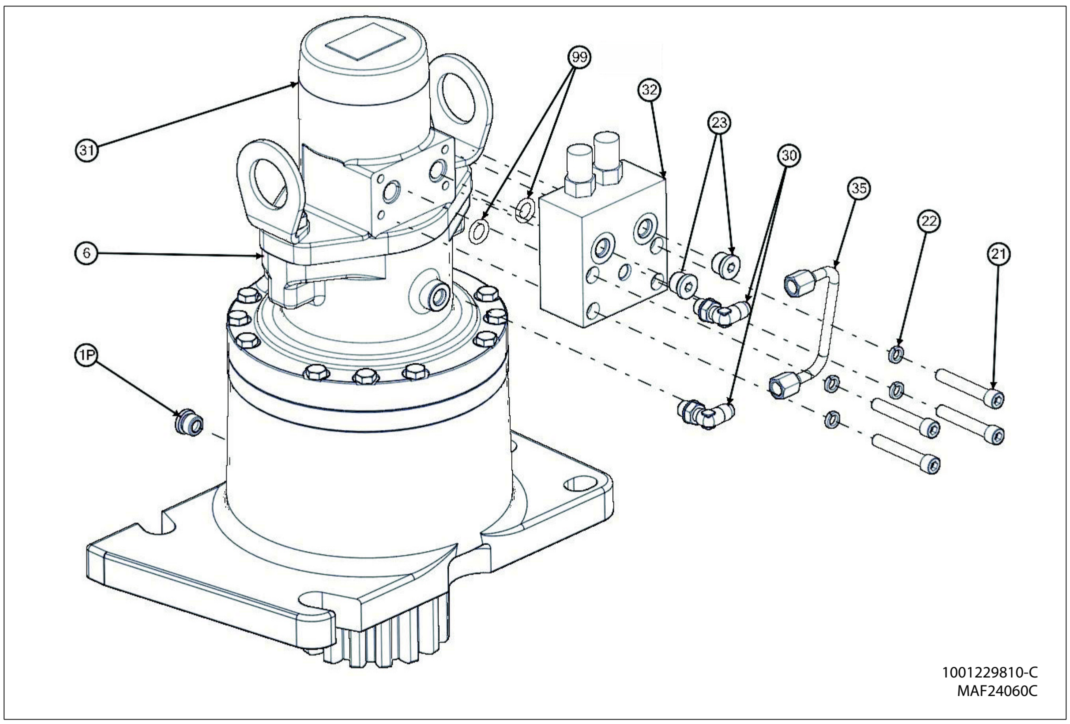
Motor Control Valve Disassembly

NOTE: *Refer to Figure 3-43.*

1. Place unit on bench with the motor end up.
2. Remove O-ring Plug (1P) and drain the oil from the gear-box.

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

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 3-43. Motor Control Valve

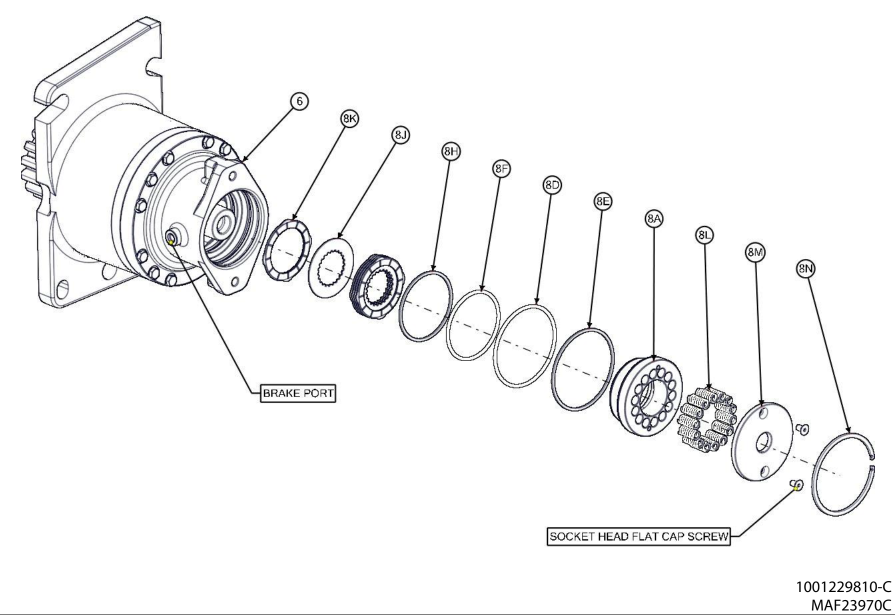
Motor and Brake Disassembly

NOTE: *Refer to Figure 3-44. and Figure 3-45.*

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).

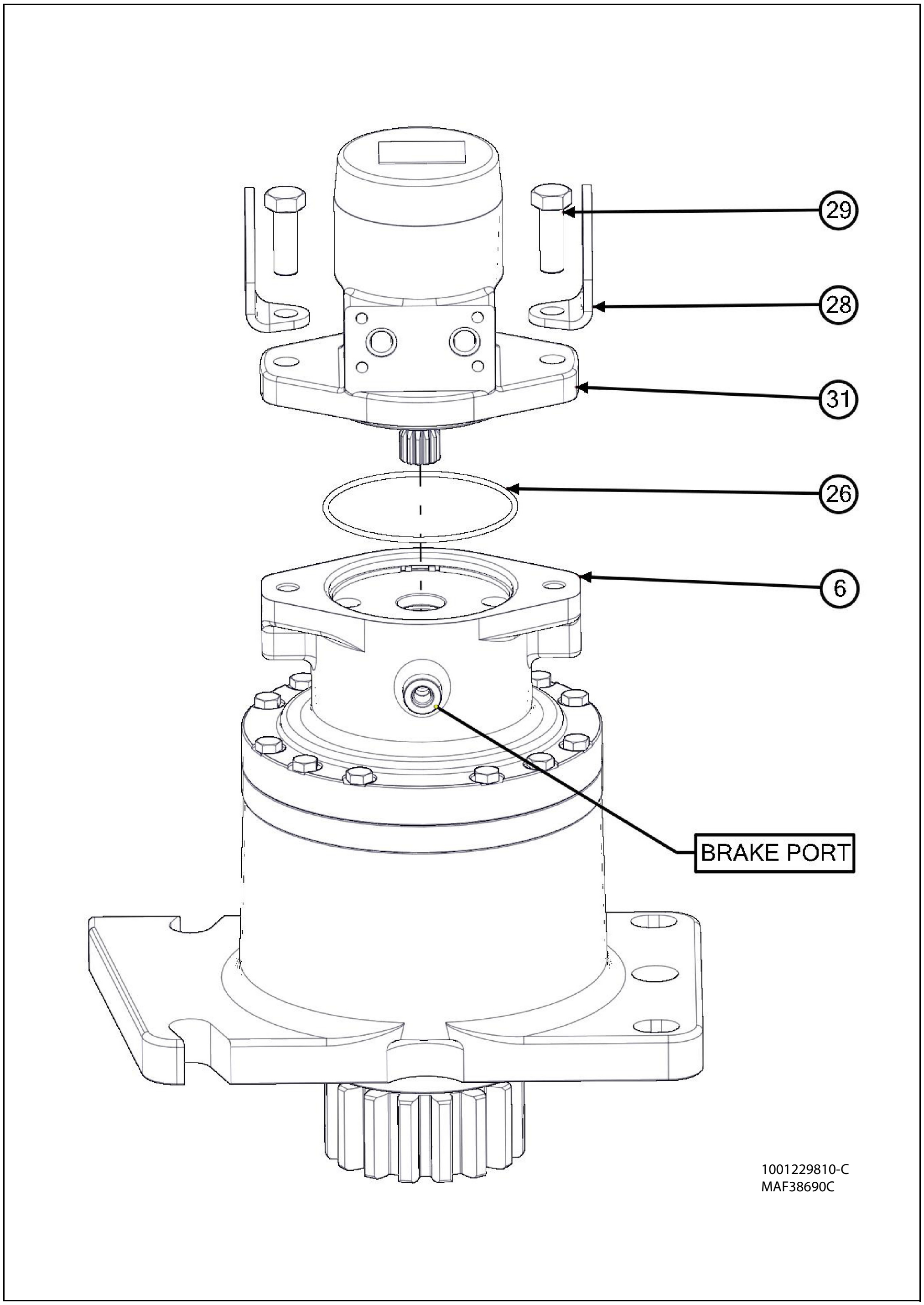
NOTE: *NOTE: Record the number of springs and mark their locations before removing them from brake piston.*

10. Remove Springs (8L) from the Brake Piston (8A).



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

Figure 3-44. Motor and Brake



6. Brake Housing
26. O-ring
28. Lift Lugs
29. Hex Bolts
31. Motor

Figure 3-45. Motor and Brake

Main Drive Disassembly

NOTE: *Refer to Figure 3-46.*

11. Remove Sun Gear (8) with Retaining Ring (44) inside.

12. With the unit resting on the Output Shaft (Pinion) (1A), remove the Bolts (12) from the Brake Housing (6).

13. Remove the Brake Housing (6) from the main assembly.

14. Remove O-ring (5A) from between Brake Housing (6) and Ring Gear (4).

15. Remove Thrust Washer (11) from between Brake Housing (6) and Carrier Subassembly.

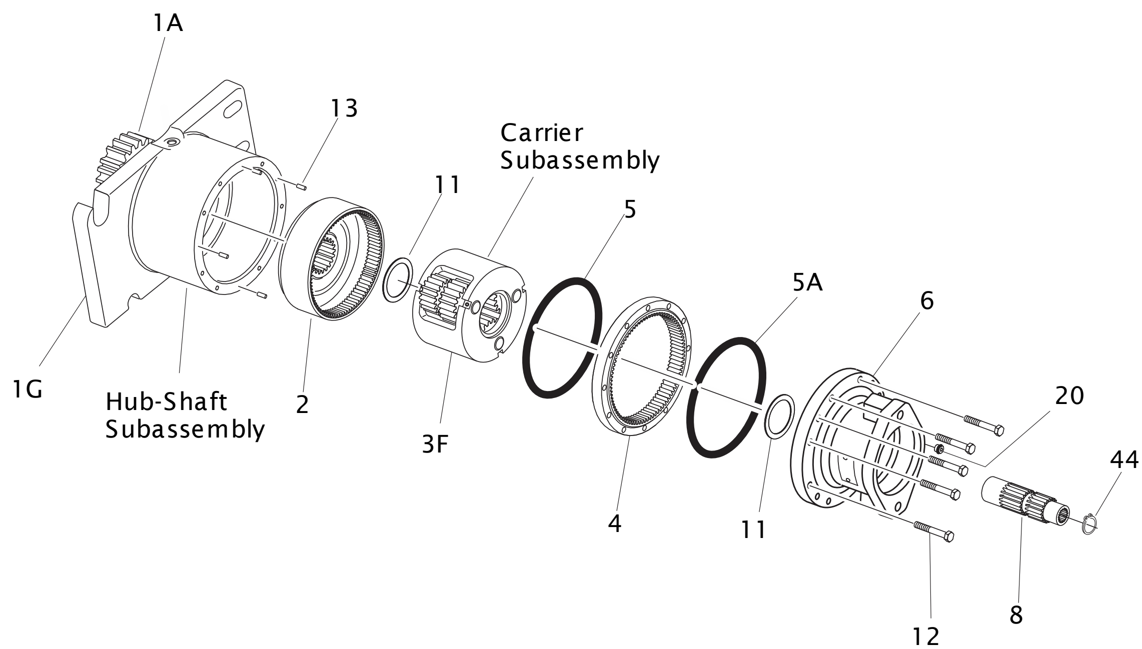
16. Remove Ring Gear (4) from Housing (1G).

17. Remove O-ring (5) from between Ring Gear (4) and Housing (1G).

18. Remove Carrier Sub-Assembly.

19. Remove Thrust Washer (11) from between Carrier Sub-Assembly and Internal Gear (2).

20. 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 3-46. Main Drive Disassembly

Hub-Shaft Disassembly

NOTE: *Refer to Figure 3-47.*

1. Set the unit on a bench so that the Housing (1G) flange is down.
2. Using retaining ring pliers remove Retaining Ring (1I) from groove in Output Shaft (1A) and discard.

CAUTION

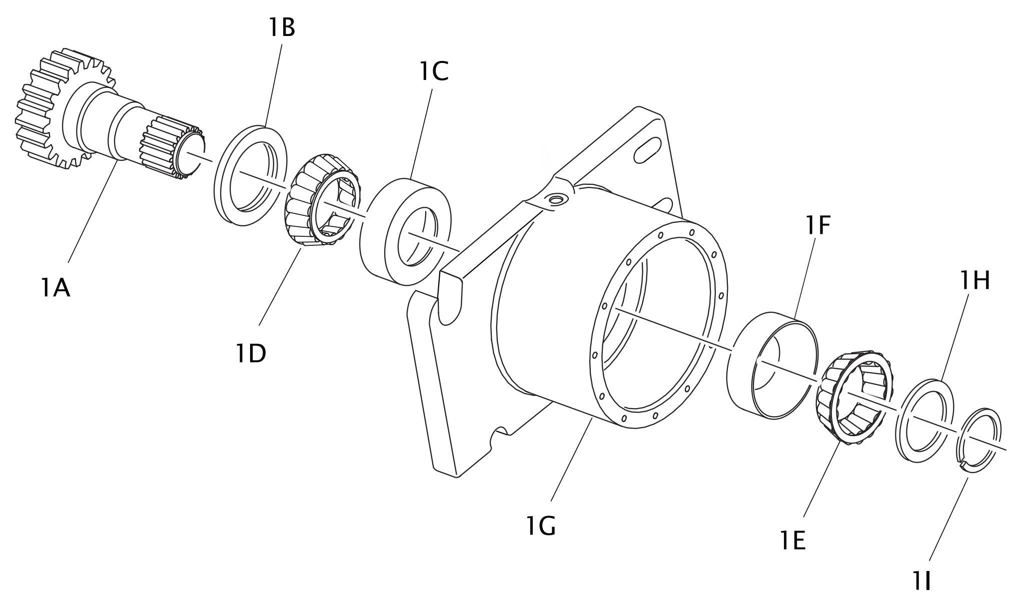
EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

3. Remove Thrust Washer (1H).
4. 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.*

5. Remove the Bearing Cone (1E) from the Housing (1G).
6. Use a bearing puller to remove the Bearing Cone (1D) from the Shaft (1A).
7. 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 3-47. Hub-Shaft

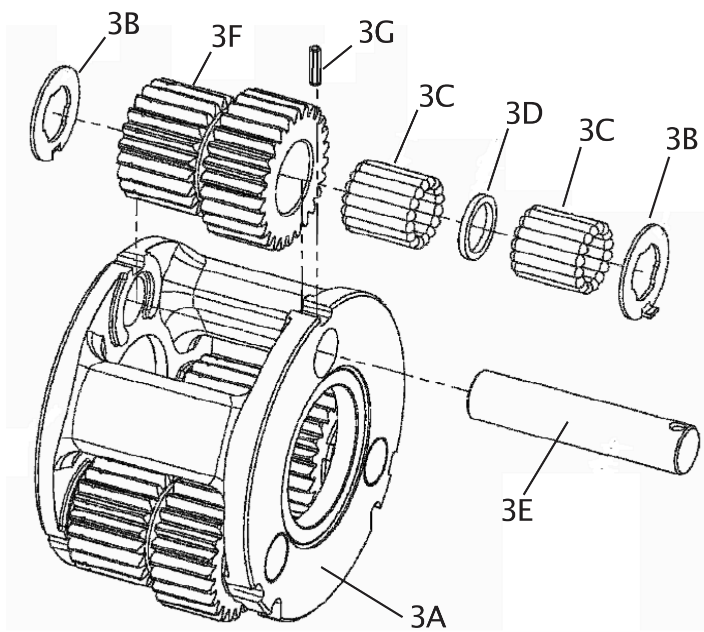
Carrier Disassembly

NOTE: *Refer to Figure 3-48.*

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

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

2. Remove the Planet Shaft (3E) from the Carrier (3A). Use a small punch to remove the Roll Pin (3G) 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 3-48. Carrier

Hub-Shaft Assembly

NOTE: *Refer to Figure 3-47.*

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

⚠ WARNING

EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

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

⚠ WARNING

EYE PROTECTION SHOULD BE WORN DURING THIS PROCEDURE.

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

Carrier Assembly

NOTE: *Refer to Figure 3-48.*

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

Main Drive Assembly

NOTE: *Refer to Figure 3-46.*

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 (1 G).
12. Install Bolts (12) through the Brake Housing (6) into the Hub (1G) and torque to 23-27 ft.lbs. (31-37 Nm).
13. With gearbox standing on the pinion end fill gearbox with 43 oz. of 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 to 24 ft·lbs. (31-32 Nm).

Motor and Brake Assembly

NOTE: *Refer to Figure 3-44., Motor and Brake*

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

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).

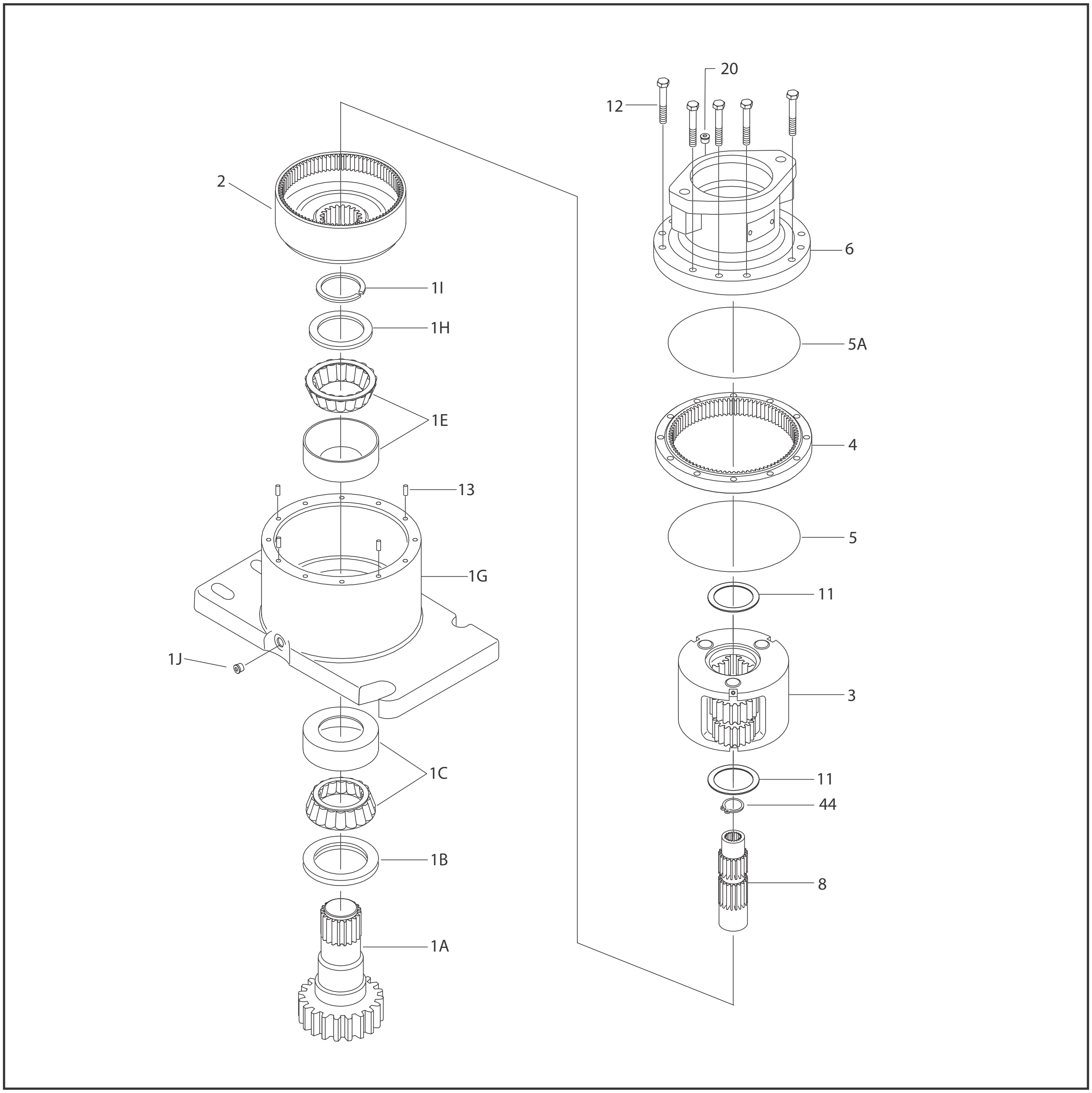
Motor Control Valve Assembly

NOTE: *Refer to Figure 3-43., Motor Control Valve*

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).

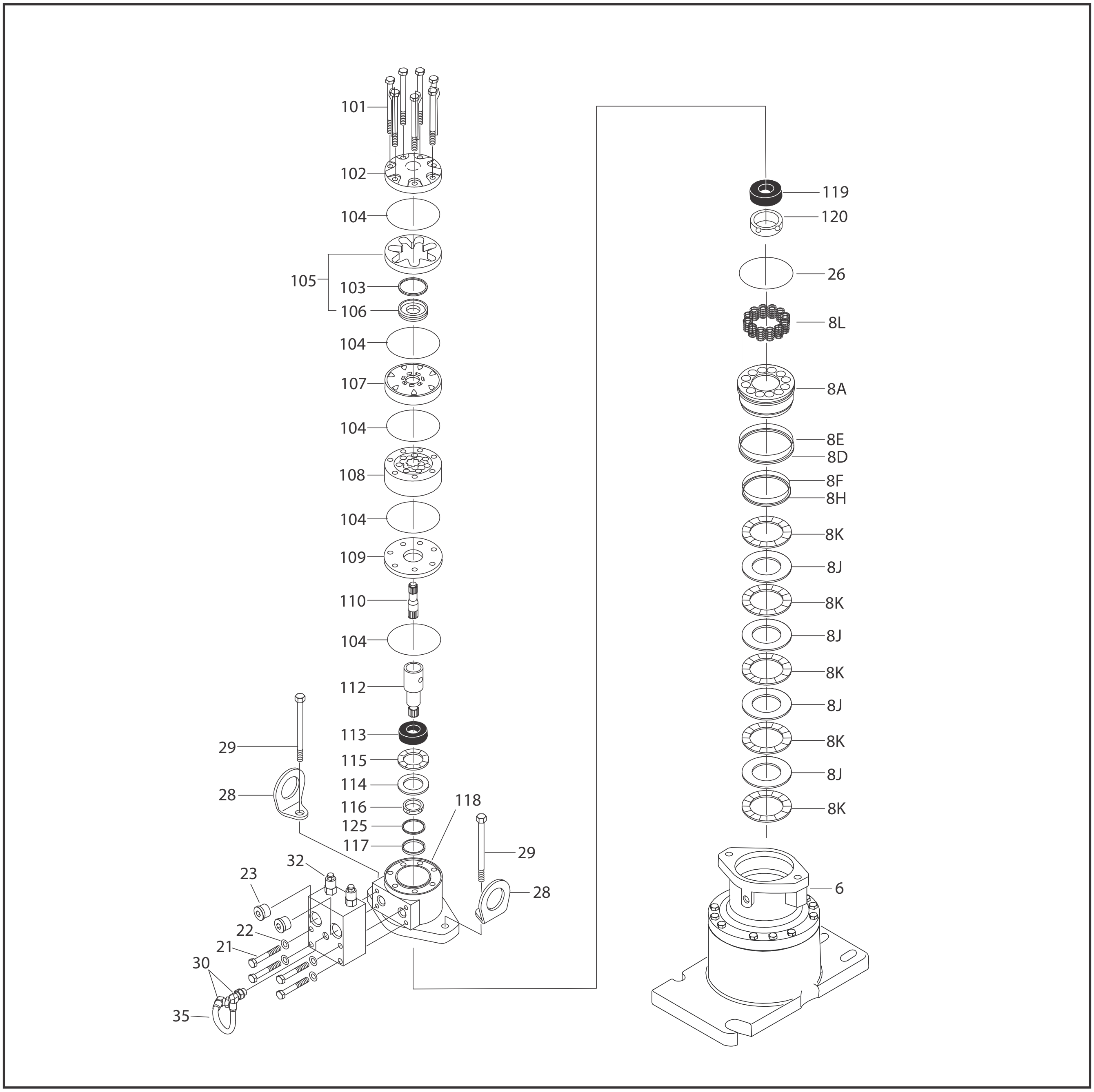
NOTE: *Be sure to align the holes in the control valve with the motor ports.*

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. Thrust Washer	3. Carrier Assembly	6. Brake Housing	13. Dowel Pin
1C. Bearing	1I. Retaining Ring	4. Ring Gear	8. Sun Gear	20. Pipe Plug
1D. Bearing	1J. Pipe Plug	5. O-Ring	11. Thrust washer	44. Internal Retaining Ring

Figure 3-49. Swing Drive Assembly



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

Figure 3-50. Swing Motor and Brake Assembly

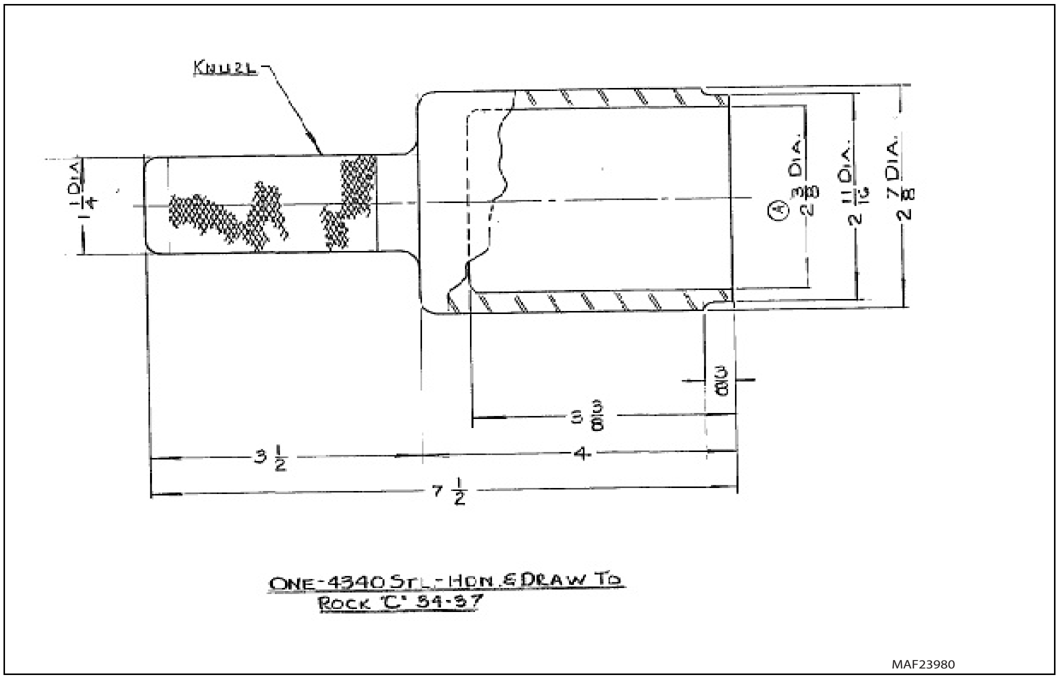


Figure 3-51. Bearing Cone Press Tool (T144566)

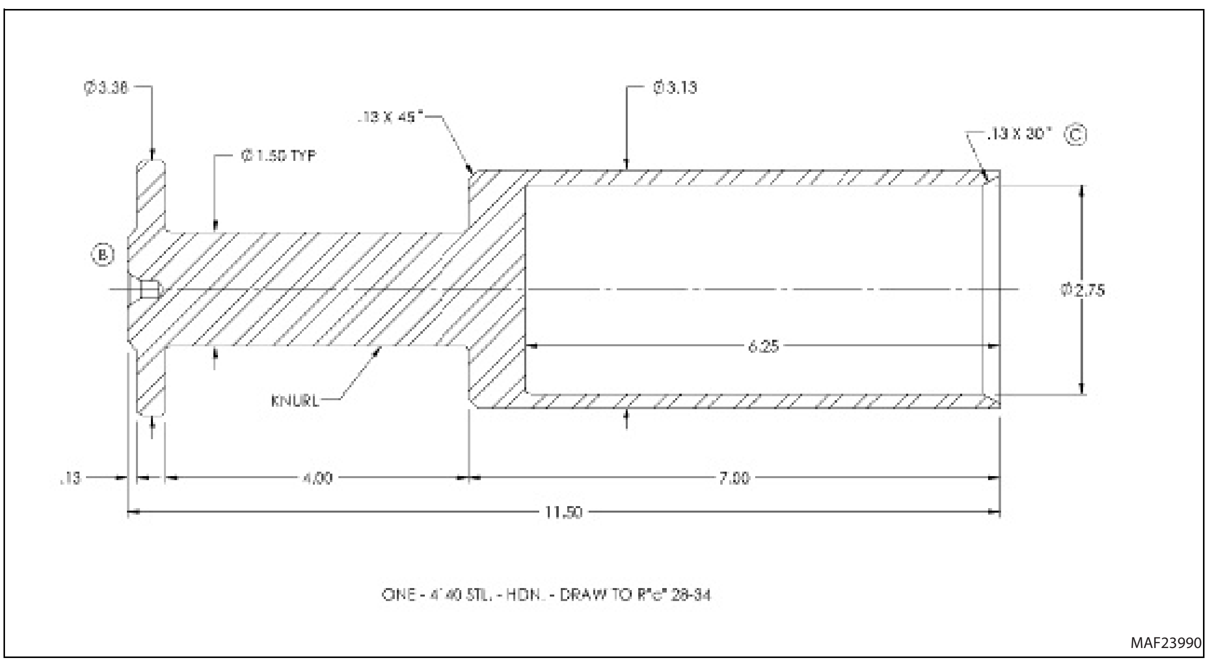


Figure 3-52. Bearing Cone Pressing Tool (T145741)

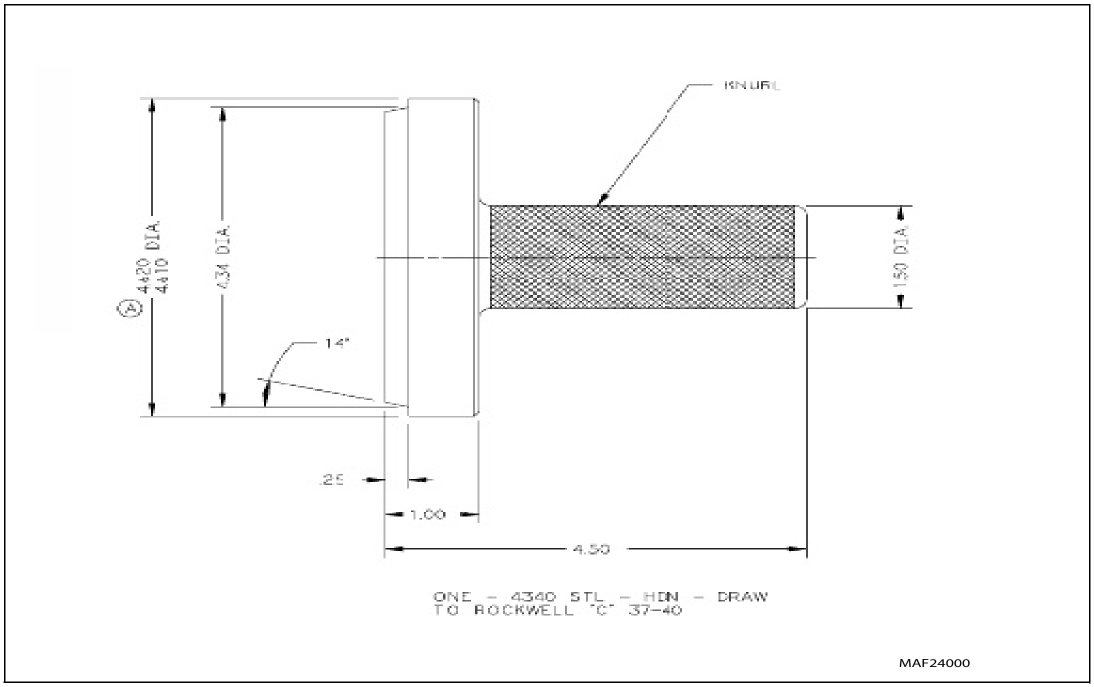


Figure 3-53. Bearing Cup Pressing Tool (T149013)

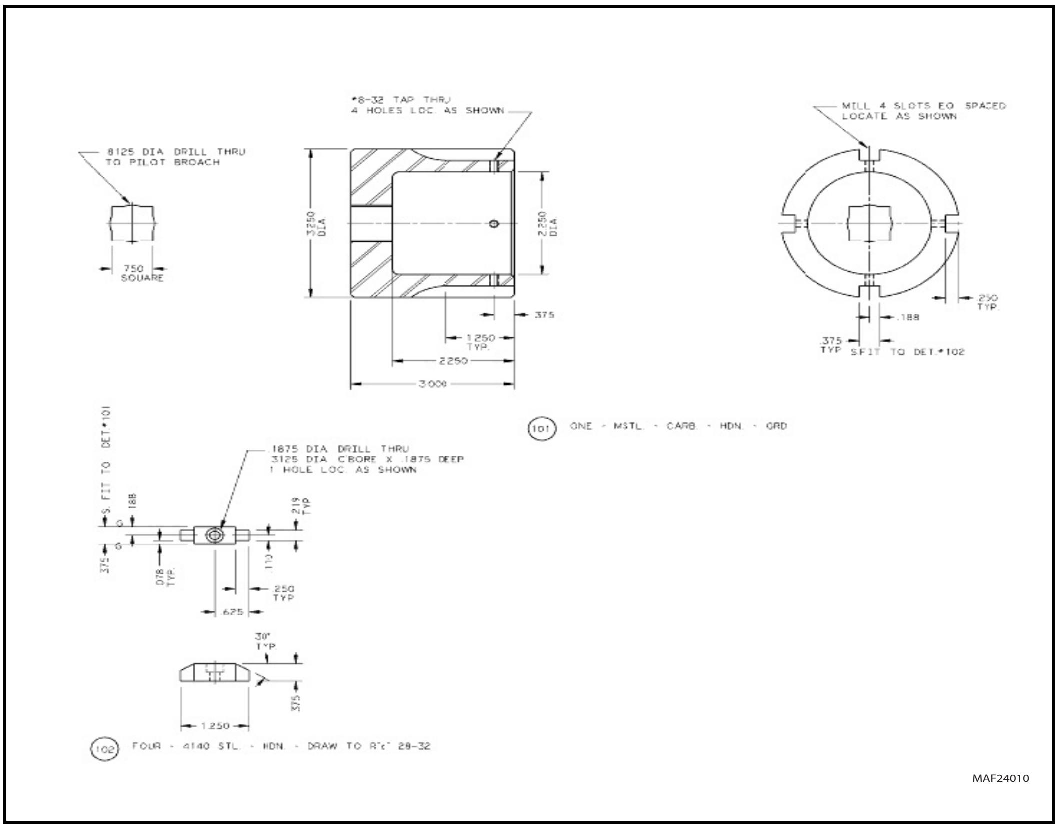


Figure 3-54. Locknut Wrench Tool (T151047)

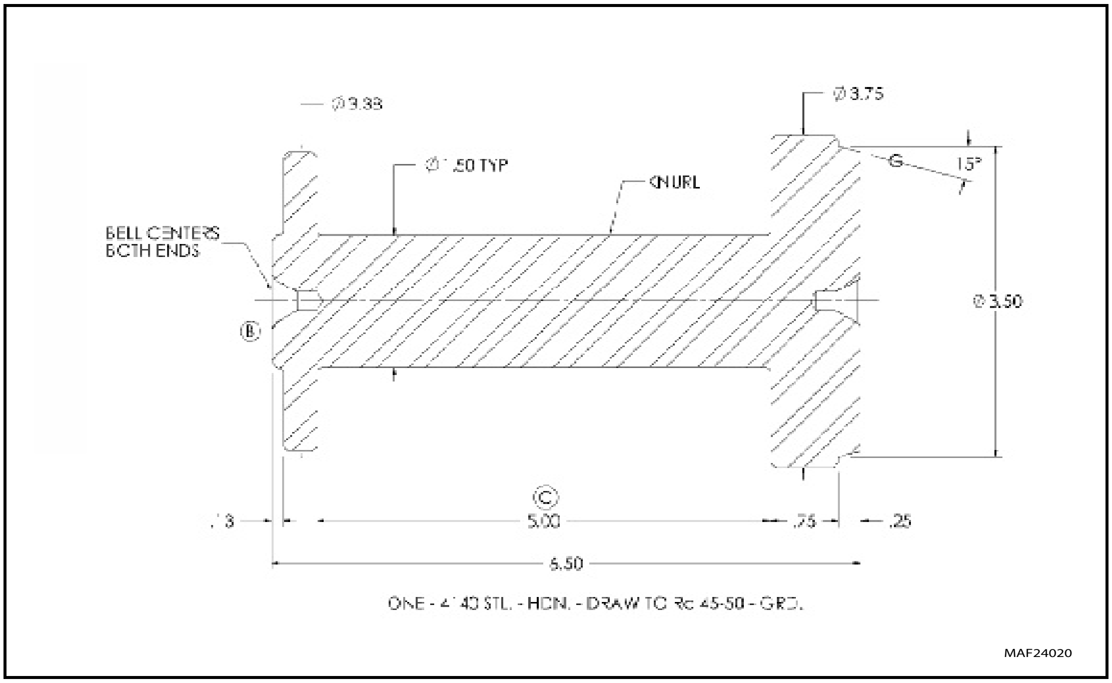


Figure 3-55. Bearing Cup Pressing Tool (T155291)

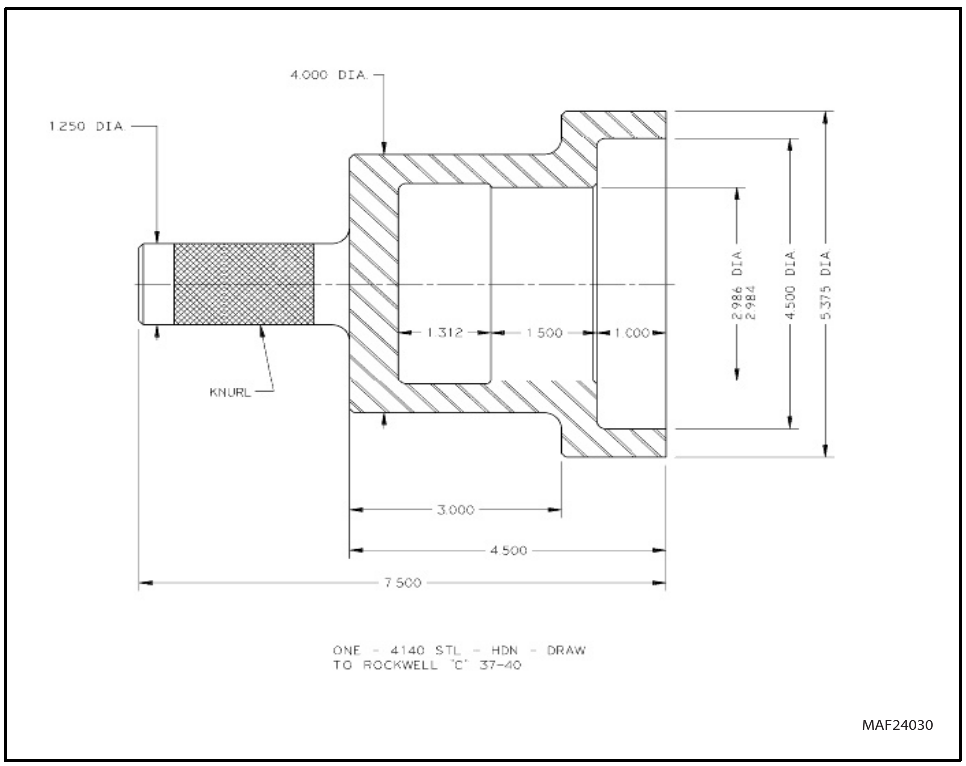


Figure 3-56. Seal Press Tool (T175741)

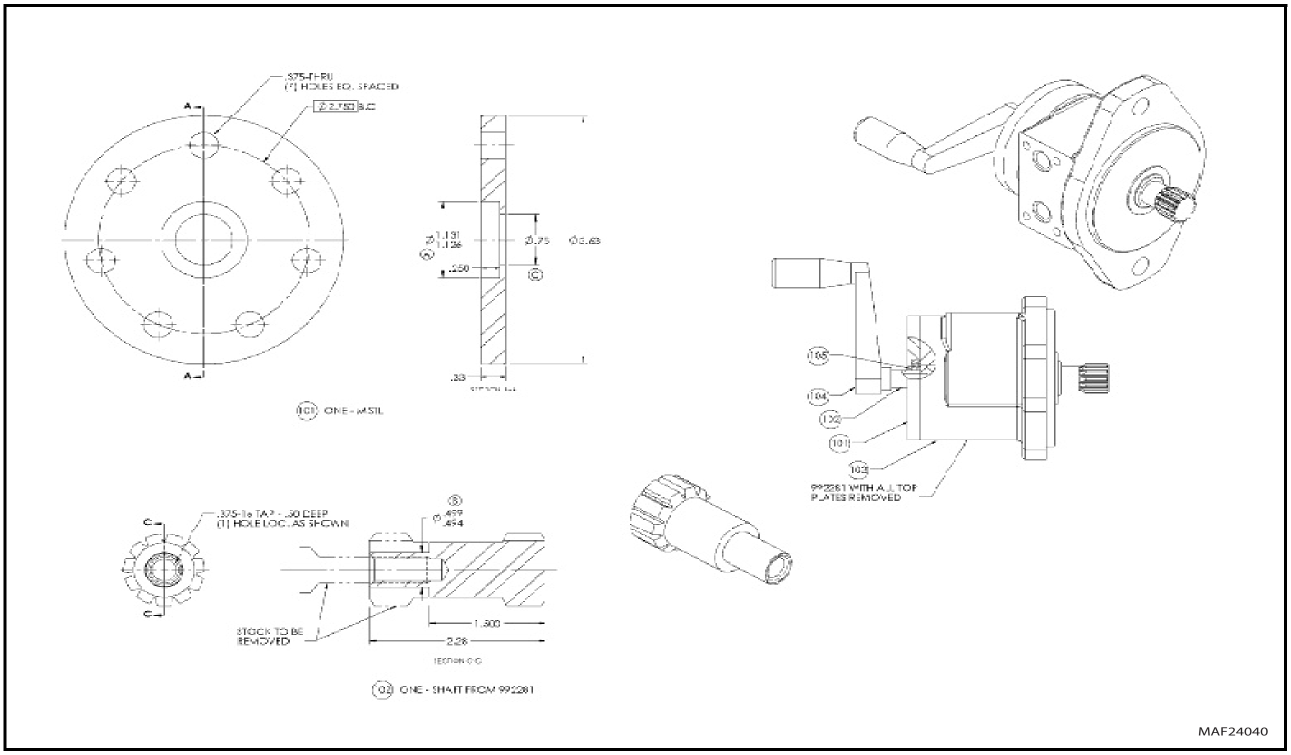


Figure 3-57. Swing Drive Test Plate (T187845)

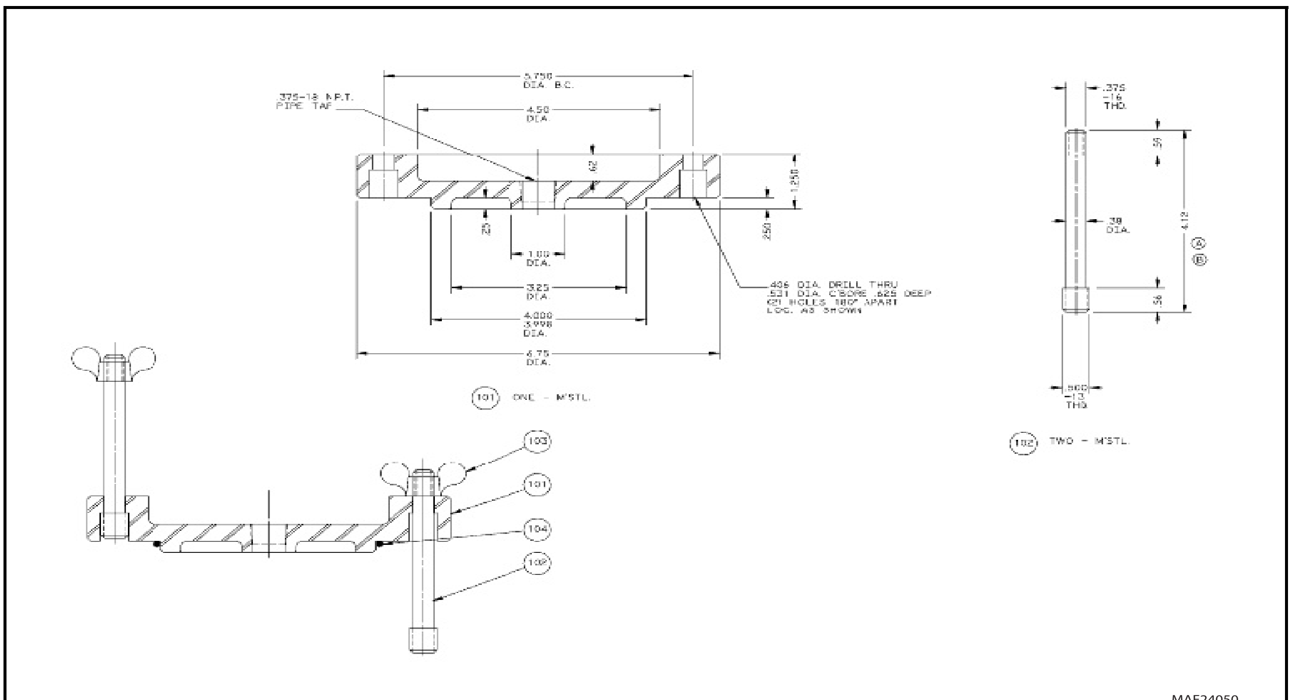
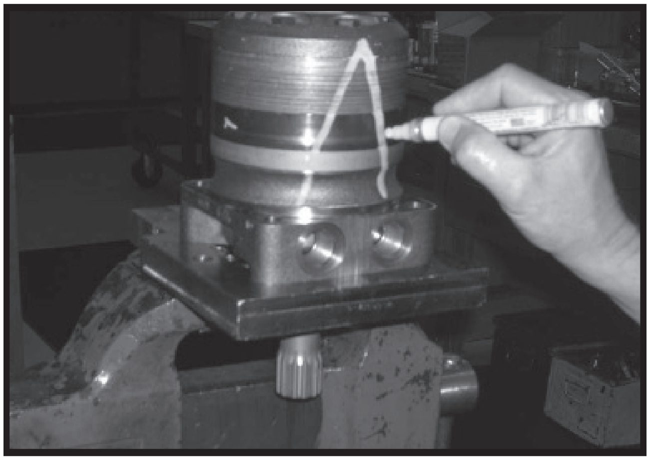


Figure 3-58. Leak Test Adapter Plate (T201476)

3.15 SWING MOTOR

Disassembly and Inspection

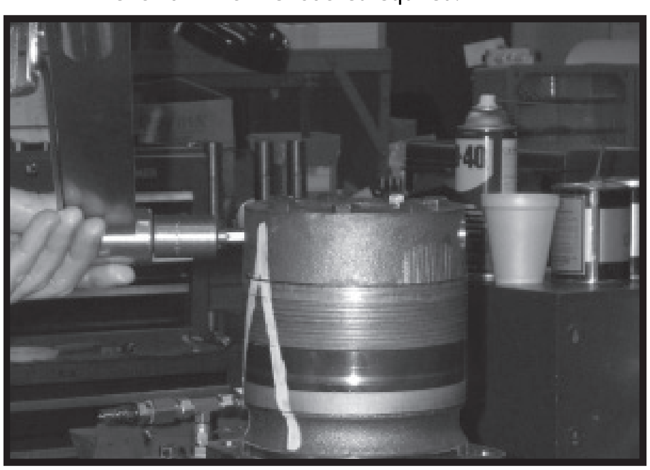
1. Place the Torqmotor™ in a soft jawed vice, with coupling shaft (12) pointed down and the vise jaws clamping firmly on the sides of the housing (18) mounting flange or port bosses. Remove manifold port O-Rings (18A) if applicable.

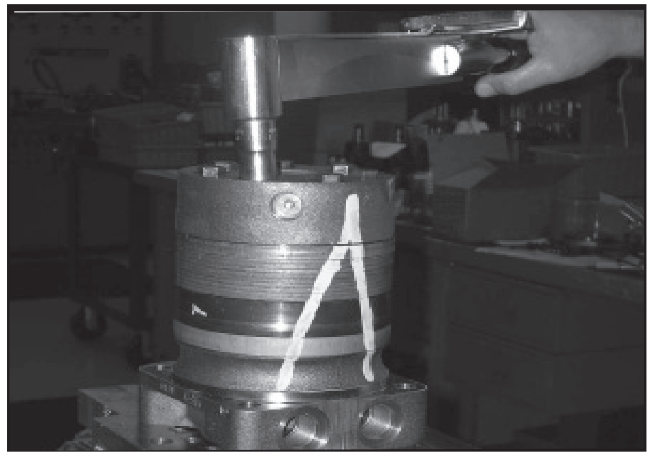


⚠ WARNING

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

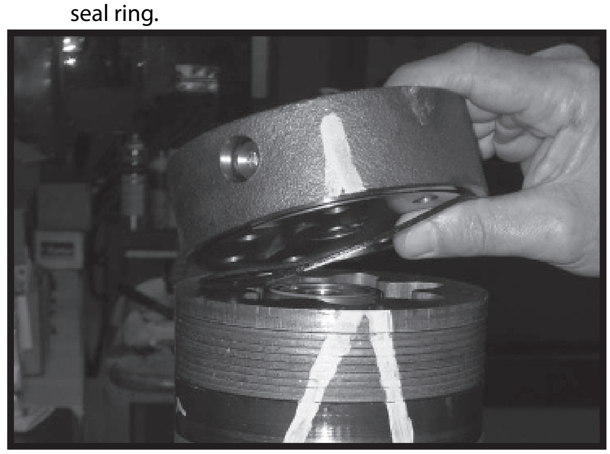
2. Scribe an alignment mark down and across the Torqmotor™ components from end cover (2) to housing (18) to facilitate reassembly orientation where required. Loosen two shuttle or relief valve plugs (21) for disassembly later if included in end cover. 3/16 or 3/8 inch Allen wrench or 1 inch hex socket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



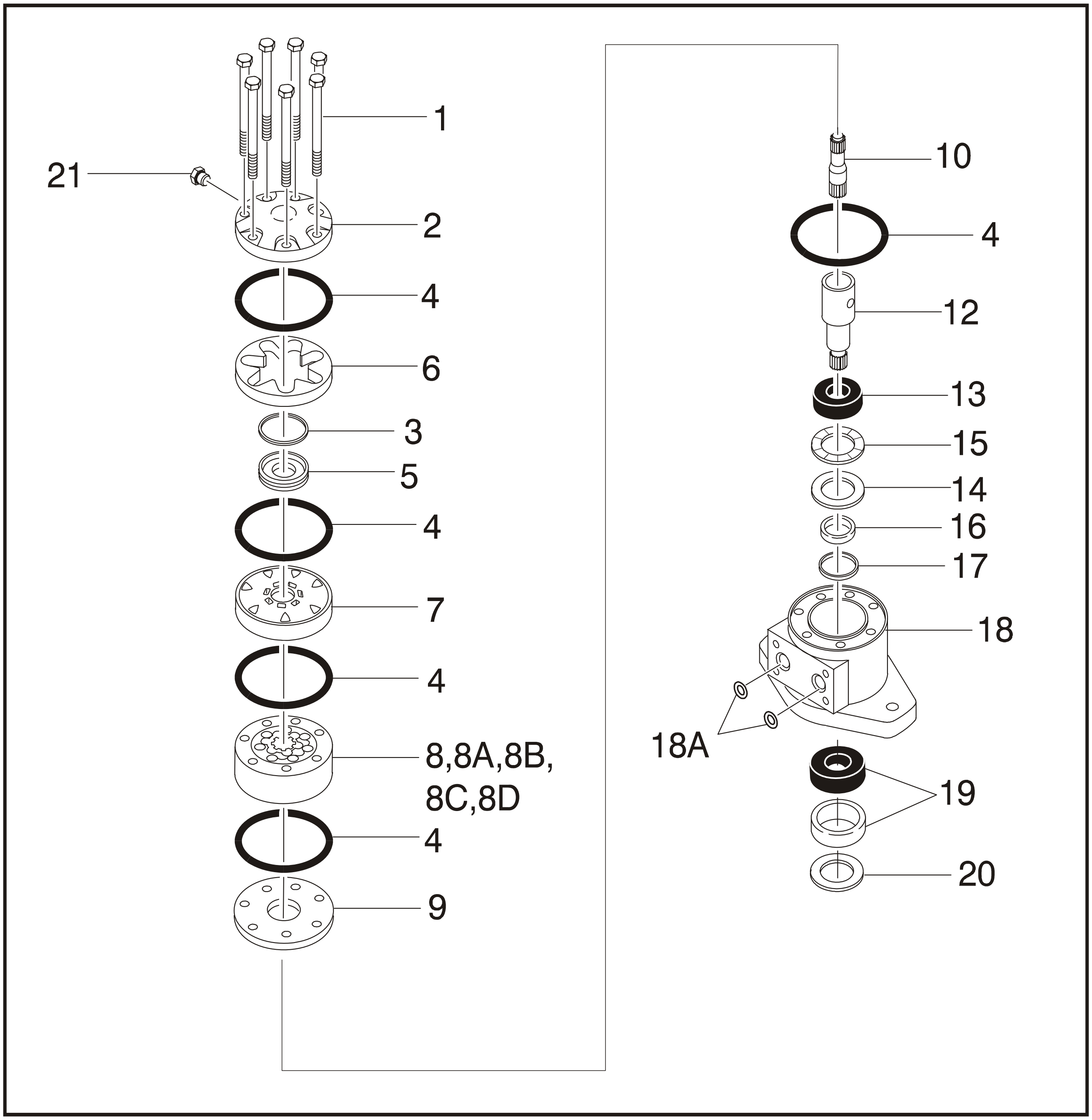


3. Remove the five, six, or seven special ring head bolts (1) using an appropriate 1/2 or 9/16 inch size socket. Inspect bolts for damaged threads, or sealing rings, under the bolt head. Replace damaged bolts.

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



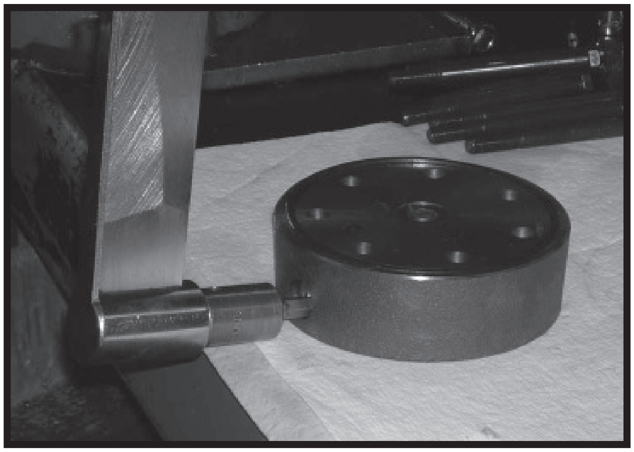
NOTE: *Refer to the appropriate "alternate cover construction" on the exploded view to determine the end cover construction being serviced.*



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

Figure 3-59. Swing Drive Motor

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



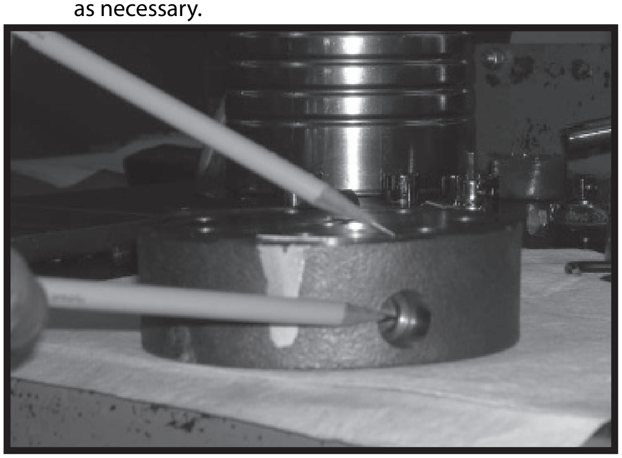
NOTICE

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

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

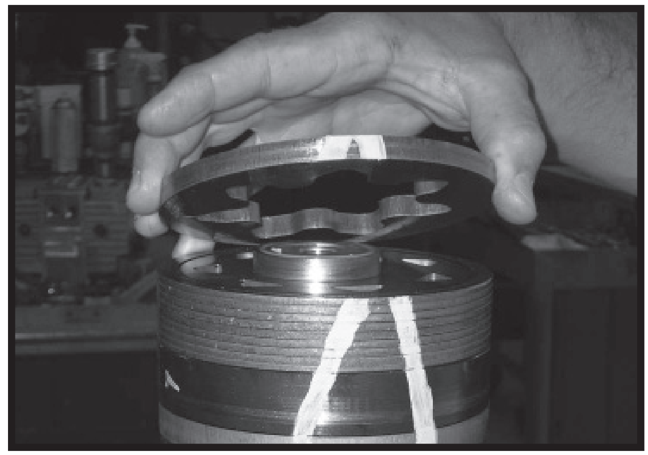
NOTE: *The insert and if included the orifice plug in the end cover (2) must not be removed as they are serviced as an integral part of the end cover.*

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

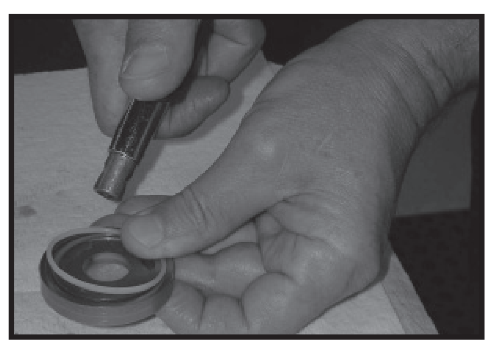


NOTE: *A polished pattern (not scratches) on the cover from rotation of the commutator (5) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.*

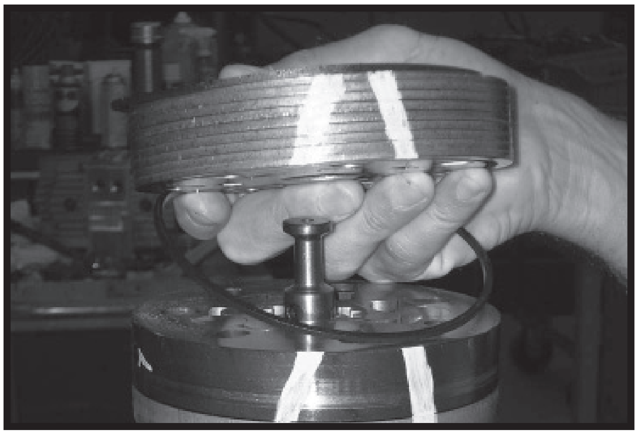
7. Remove commutator ring (6). Inspect commutator ring for cracks, or burrs.



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

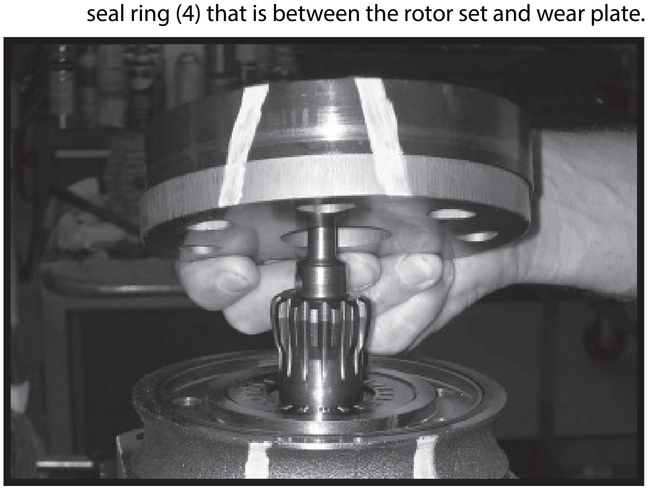


9. Remove manifold (7) and inspect for cracks surface scoring, brinelling or spalling. Replace manifold if any of these conditions exist. A polished pattern on the ground surface from commutator or rotor rotation is normal. Remove and discard the seal rings (4) that are on both sides of the manifold.

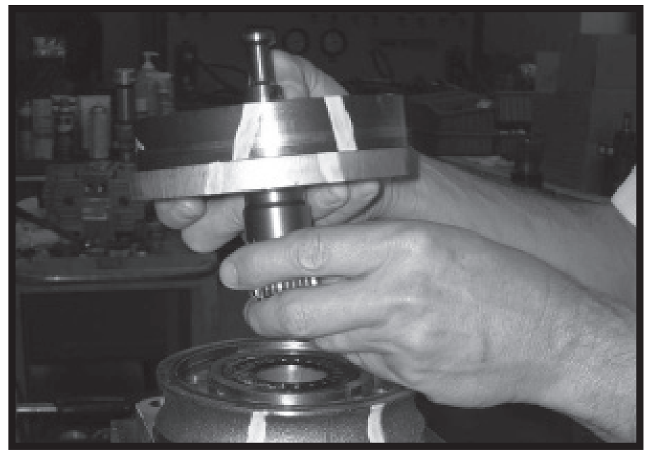


NOTE: *The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides oft hem an if old to ensure that same surface is reassembled against the rotor set.*

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



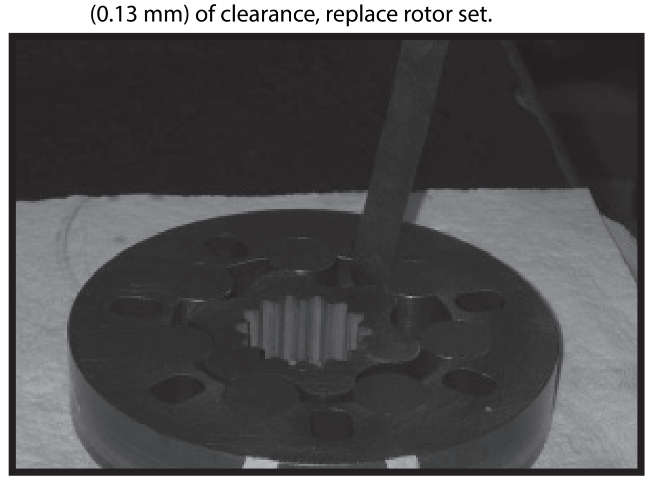
NOTE: *The rotor set (8) components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing UP, with etching ink or grease pencil before removal from Torqmotor™ will ensure correct reassembly of rotor into stator and rotor set intoTorqmotor™.Marking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



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

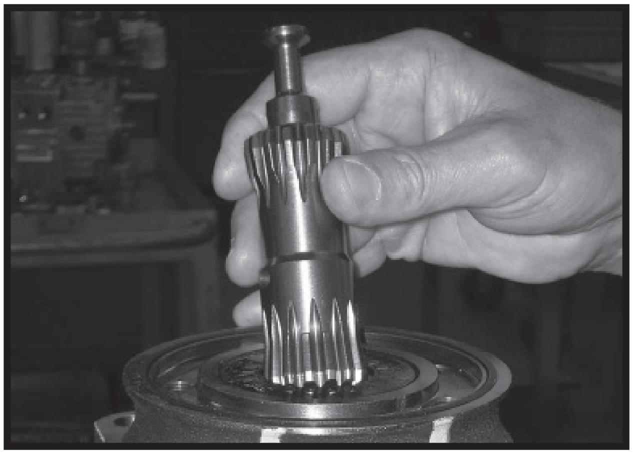
NOTE: *A polished pattern on the wear plate from rotor rotation is normal.*

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

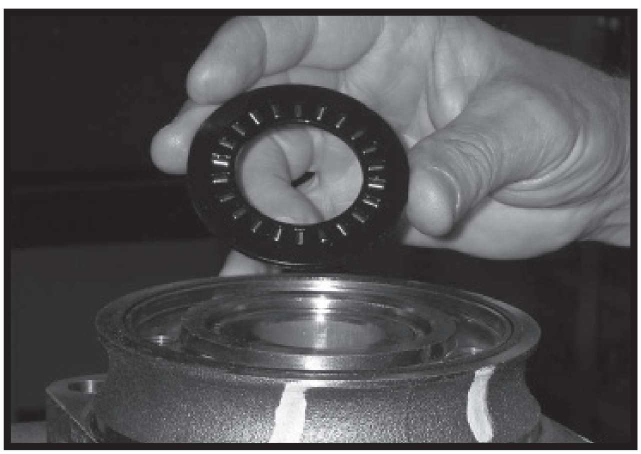


NOTE: *If rotor set (8) has two stator halves (8B & 8D) and two sets of seven vanes (8C & 8E) as shown in the alternate construction TG rotor set assembly view, check the rotor lobe to roller vane clearance at both ends of rotor.*

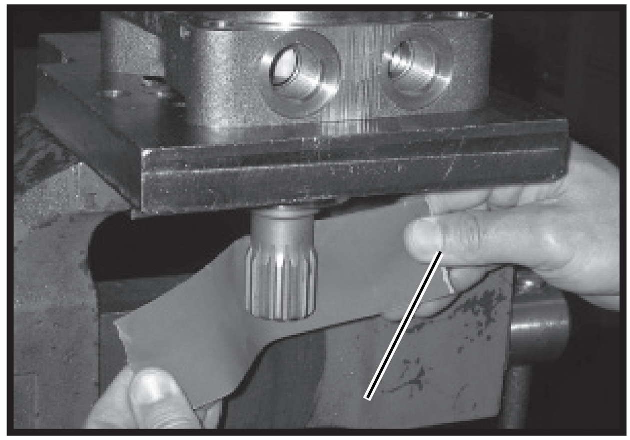
12. Remove drive link (10) from coupling shaft (12) if it was not removed with rotor set and wear plate. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts. Remove and discard seal ring (4) from housing (18).



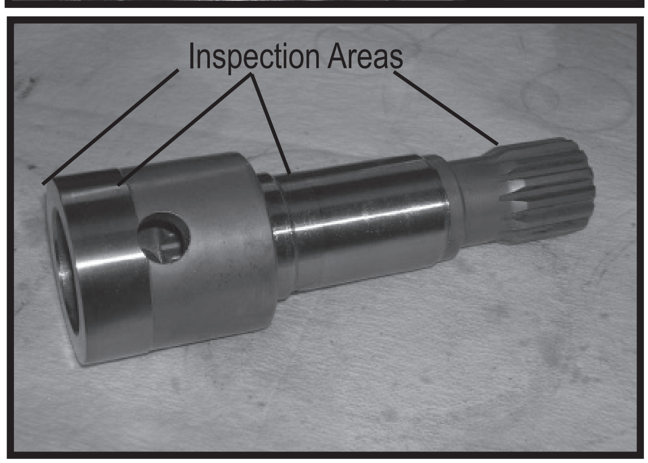
13. Remove thrust bearing (11) from top of coupling shaft (12). Inspect for wear, brinelling, corrosion and a full complement of retained rollers.



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



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

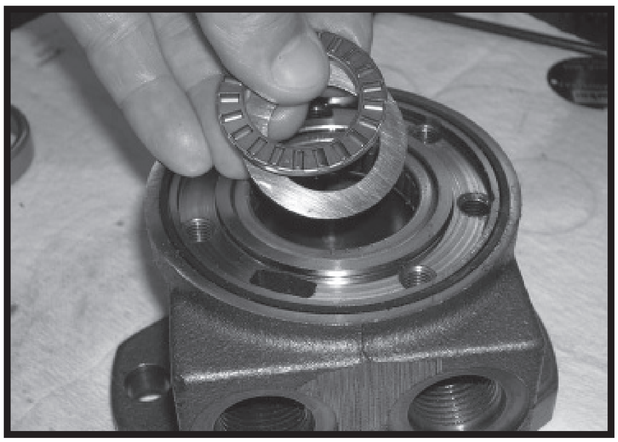


NOTE: *Minor shaft wear in seal area is permissible. If wear exceeds 0.020 inches (0.51 mm) diametrically, replace coupling shaft.*

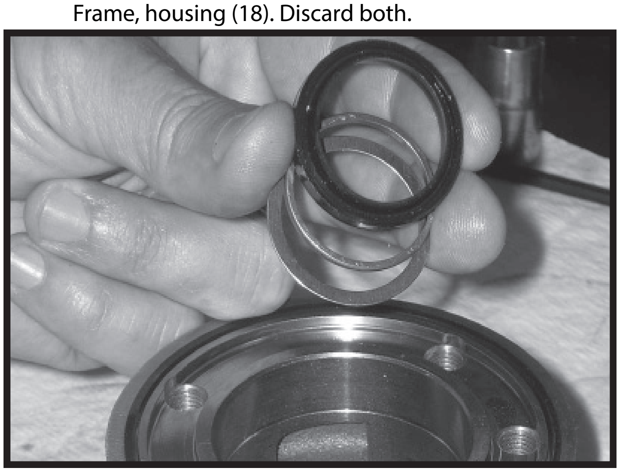
NOTE: *A slight "polish" is permissible in the shaft bearing areas. Anything more would require coupling shaft replacement.*

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

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



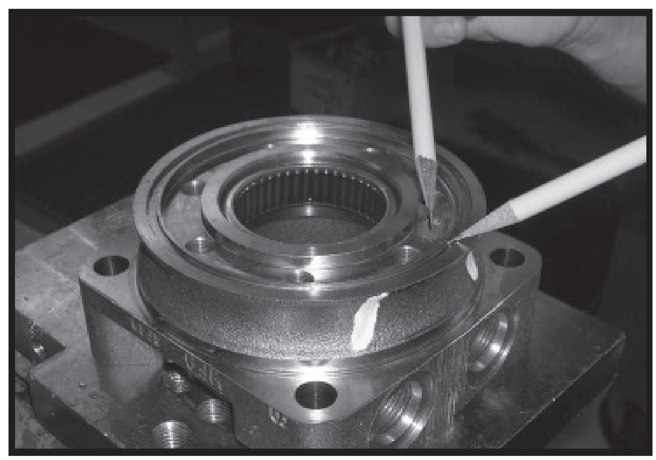
18. Remove seal (16) and back up washer (17) from Small Frame, housing (18). Discard both.



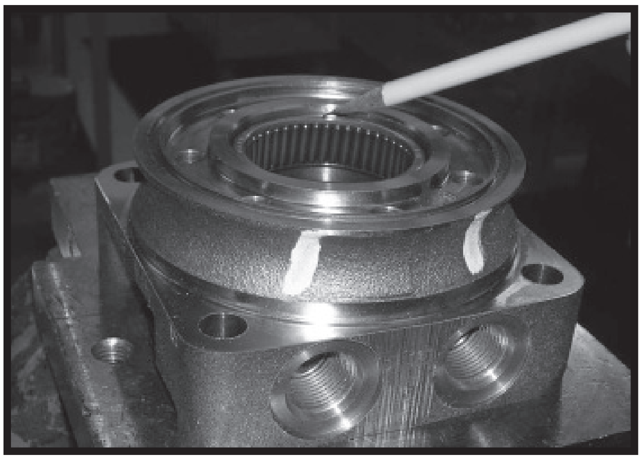
19. Remove housing (18) from vise, invert it and remove and discard seal

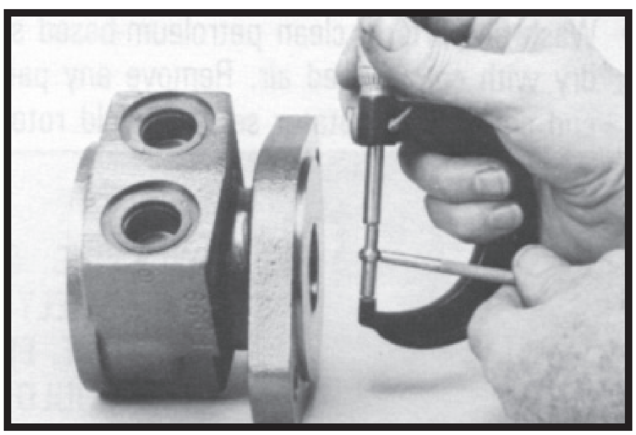
20. A blind hole bearing or seal puller is required.

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

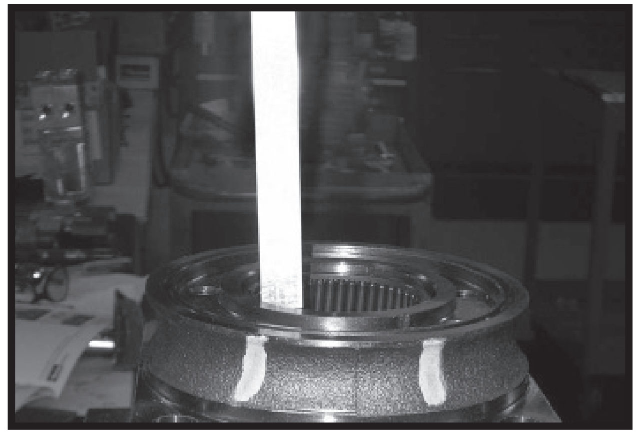


22. If the housing (18) assembly has passed inspection to this point, inspect the housing bearings/bushings (19) and (13) and if they are captured in the housing cavity the two thrust washers (14) and thrust bearing (15). The bearing rollers must be firmly retained in the bearing cages, but must rotate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

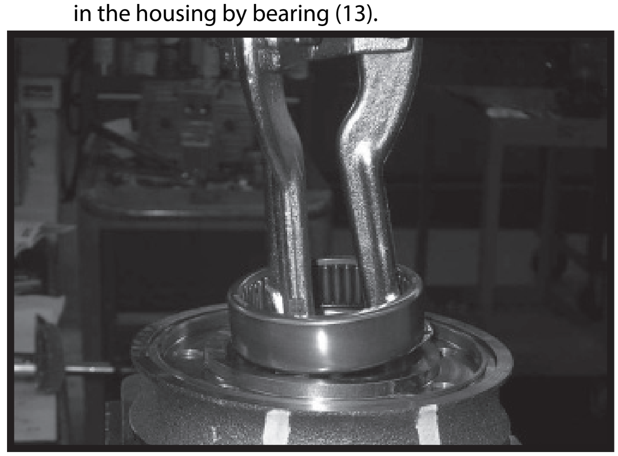


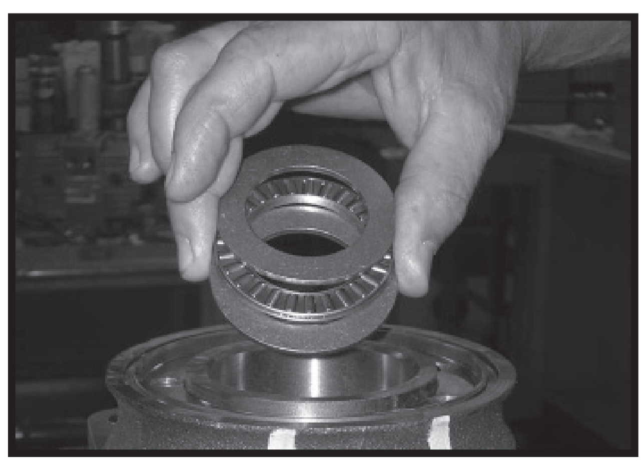


NOTE: *The depth or location of bearing/bushing (13) in relation to the housing wear plate surface and the depth or location of bearing/bushing (19) in relation to the beginning of bearing/bushing counterbore should be measured and noted before removing the bearings/ bushings. This will facilitate the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

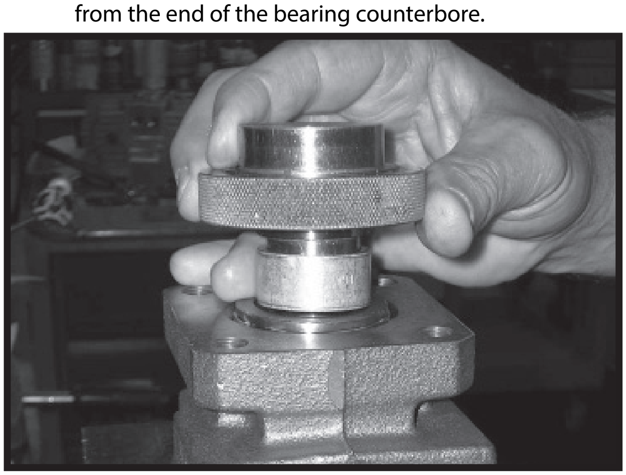
SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.

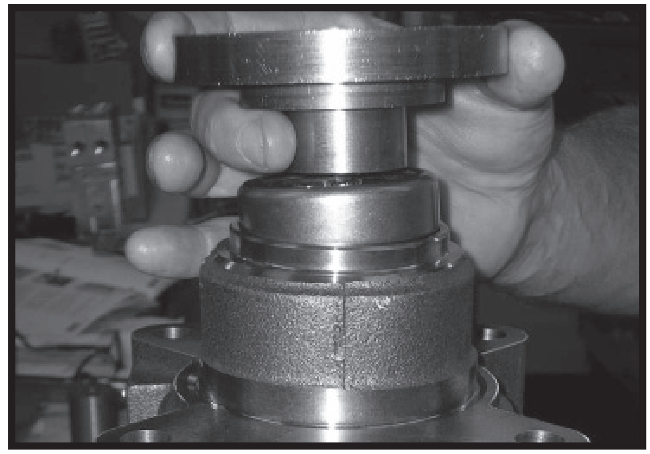
WARNING

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





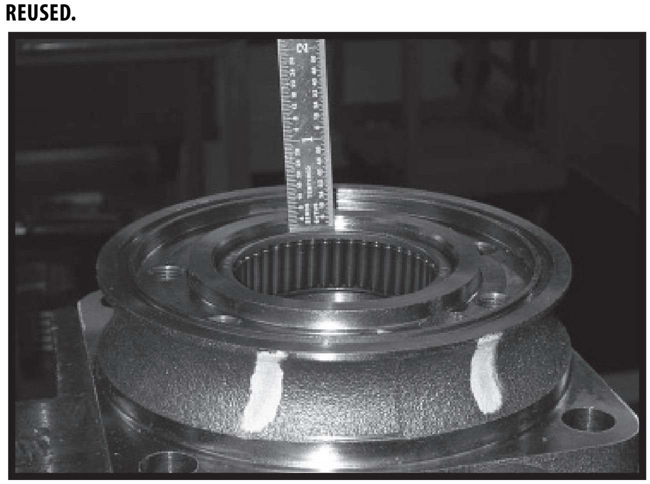
NOTE: *Bearing mandrel must be pressed against the lettered end of bearing shell. Take care that the housing bore is square with the press base and the bearing/bushing is not cocked when pressing a bearing/bushing into the housing.*

NOTICE

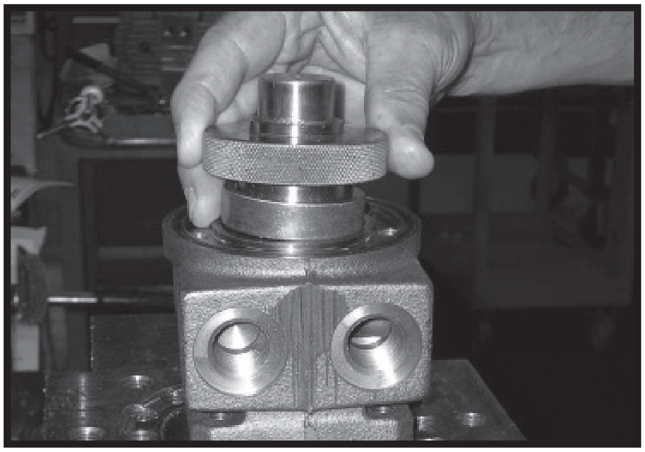
IF THE BEARING MANDREL SPECIFIED IN THE "TOOLS AND MATERIALS REQUIRED FOR SERVICING" SECTION IS NOT AVAILABLE AND ALTERNATE METHODS ARE USED TO PRESS IN BEARING/BUSHING (13) AND (19) THE BEARING/BUSHING DEPTHS SPECIFIED MUST BE ACHIEVED TO INSURE ADEQUATE BEARING SUPPORT AND CORRECT RELATIONSHIP TO ADJACENT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

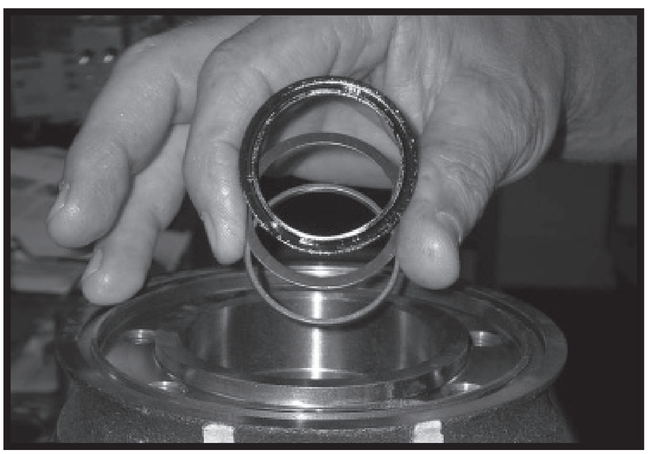
NOTICE

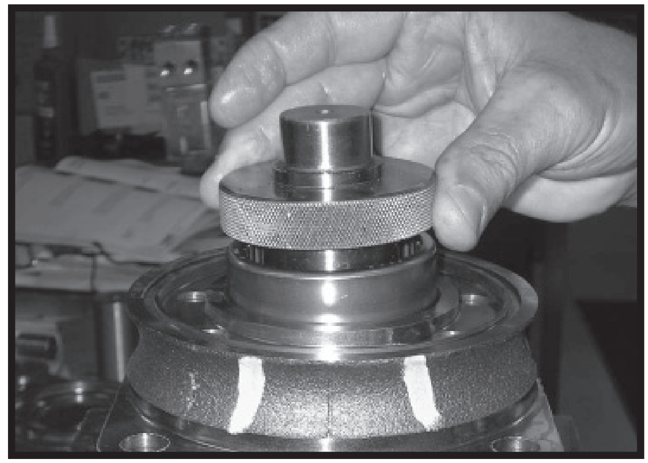
BECAUSE THE BEARING/BUSHINGS (13) AND (19) HAVE A PRESS FIT INTO THE HOUSING THEY MUST BE DISCARDED WHEN REMOVED. THEY MUST NOT BE REUSED.



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

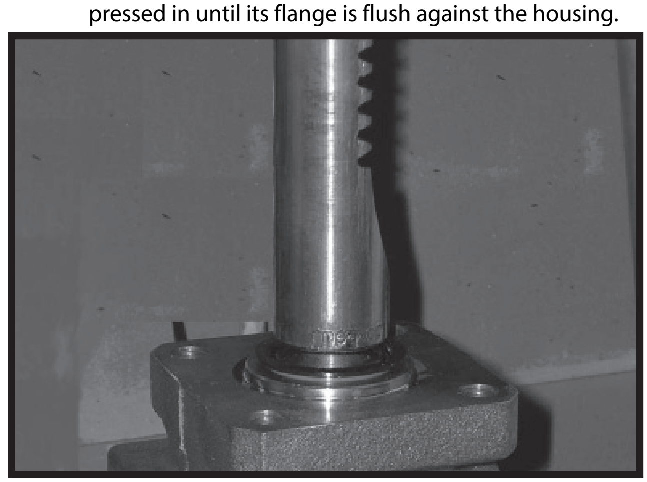


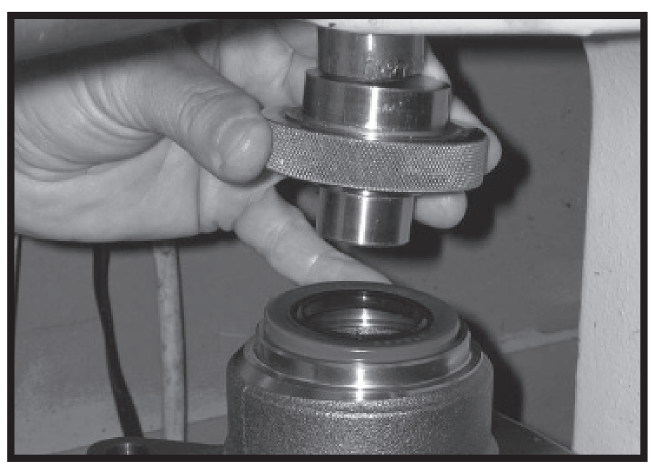




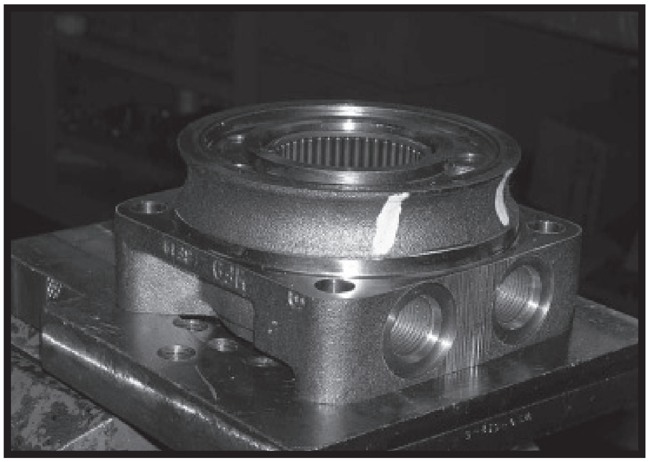
3. Press a new dirt and water seal (20) into the housing (18) outer bearing counterbore.

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

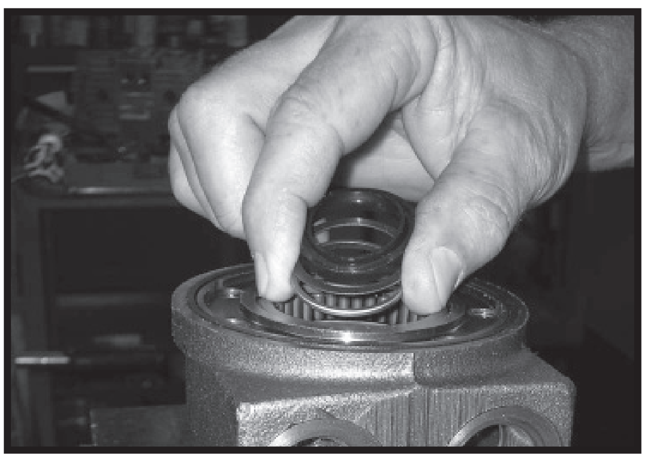


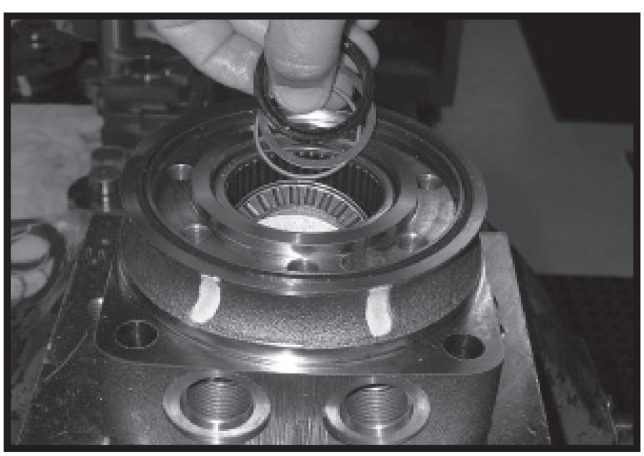


4. Place housing (18) assembly into a soft jawed vise with the coupling shaft bore down, clamping against the mounting flange.



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

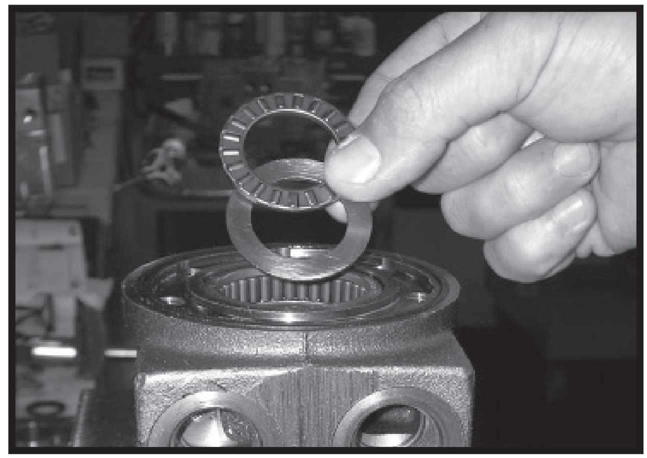




NOTICE

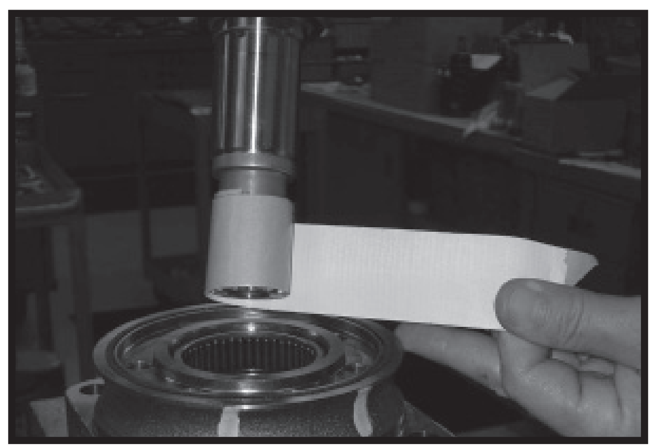
ORIGINAL DESIGN LARGE FRAME, TF & TG TORQMOTORS™ THAT DO NOT HAVE BACKUP WASHER (25) WHEN DISASSEMBLED MUST BE ASSEMBLED WITH A NEW BACKUP WASHER (17), NEW BACKUP WASHER (25), AND NEW SEAL (16).

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

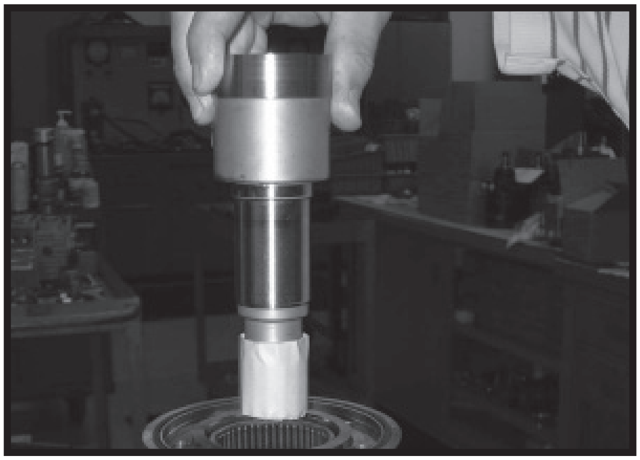


NOTE: *Torqmotors™ require one thrust washer (14) with thrust bearing (15).The coupling shaft will be seated directly against the thrust.*

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



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



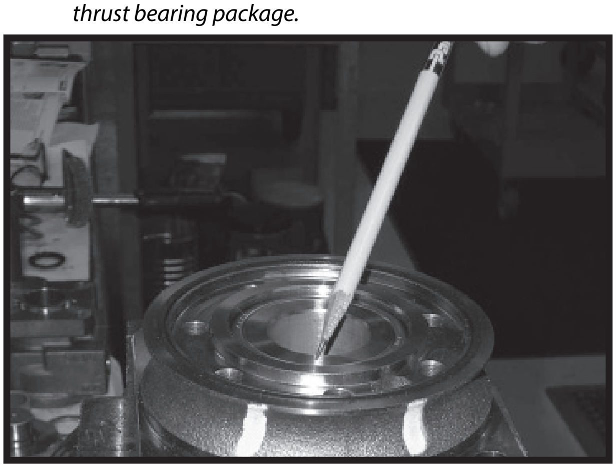
NOTICE

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

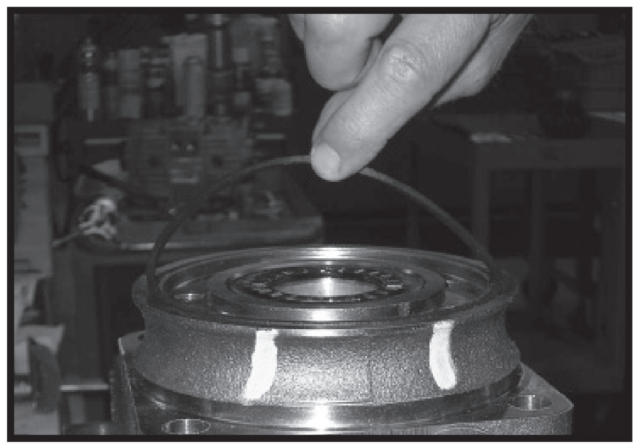
NOTE: *Mobil Mobilith SHC ® 460*

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.*

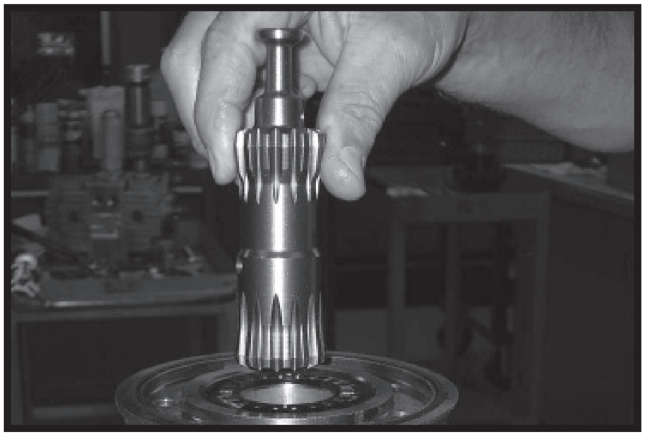


9. Apply a small amount of clean grease to a new seal ring (4) and insert it into the housing (18) seal ring groove.



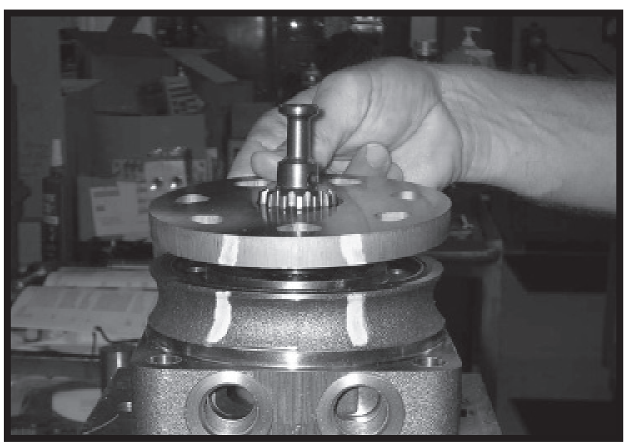
NOTE: *One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures.The studs can be made by cutting off the heads of either 3/8-24 UNF 2A or 5/16-24 UNF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

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

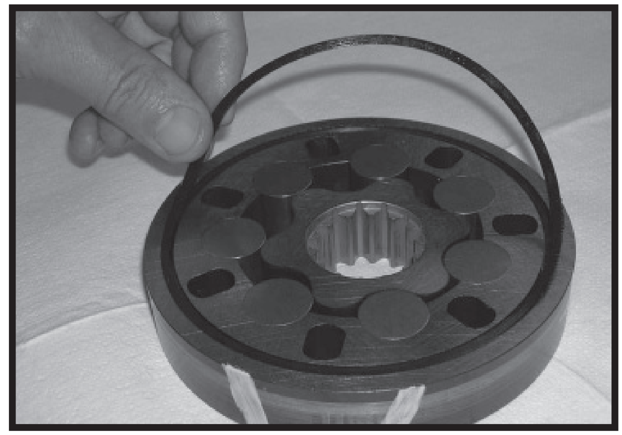


NOTE: *Use any alignment marks put on the coupling shaft and drive link before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.*

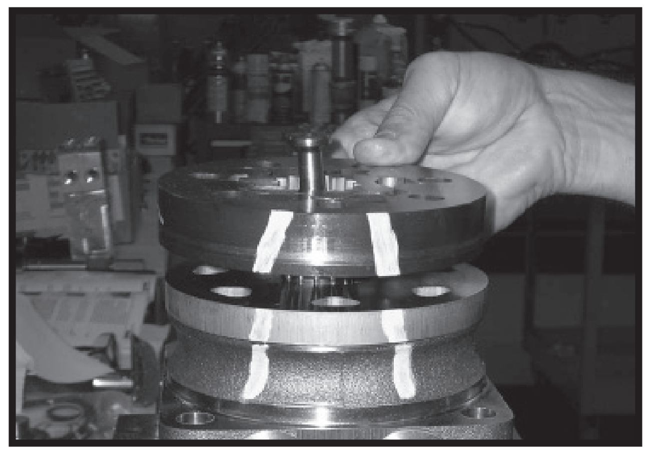
11. Assemble wear plate (9) over the drive link (10) and alignment studs onto the housing (18).



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



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

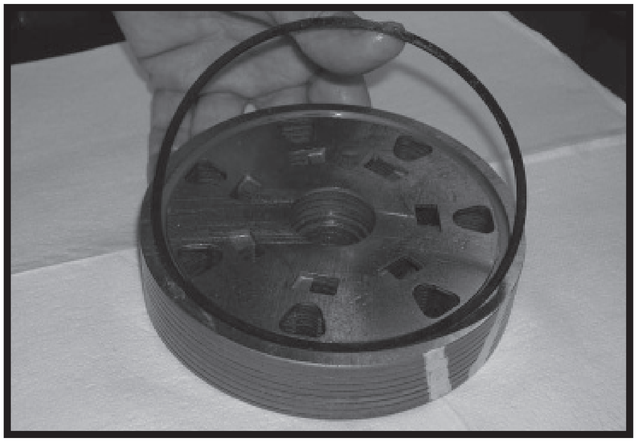


NOTE: *It may be necessary to turn one alignment stud out of the housing (18) temporarily to assemble rotor set (8) or manifold (7) over the drive link.*

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

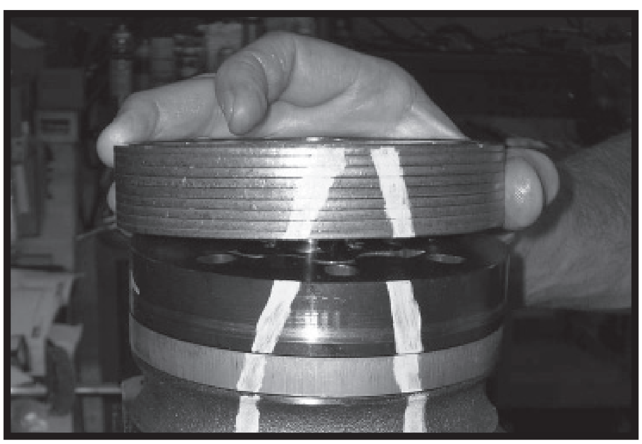
NOTE: *The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor-drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the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

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

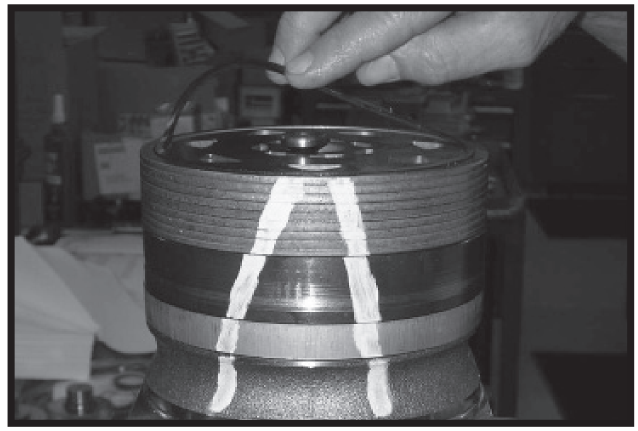


NOTE: *The manifold (7) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression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

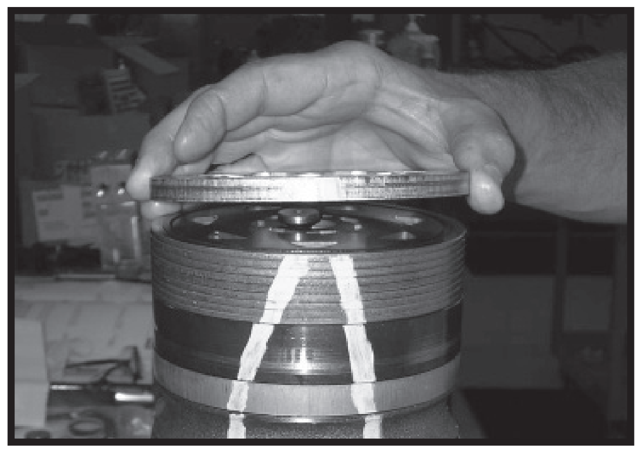
15. Assemble the manifold (7) over the alignment studs and drive link (10) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.



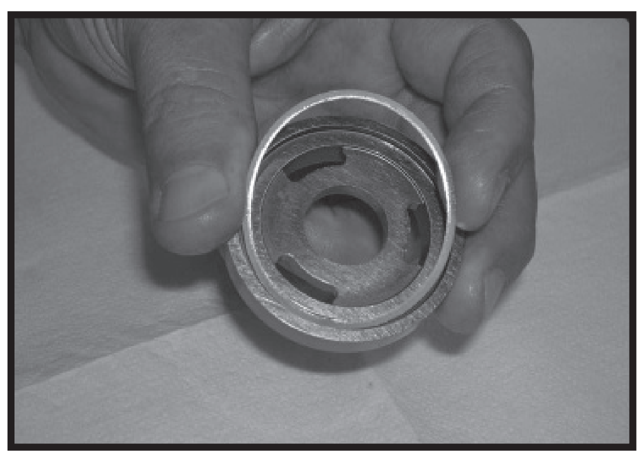
16. Apply grease to a new seal ring (4) and insert it in the seal ring groove exposed on the manifold.

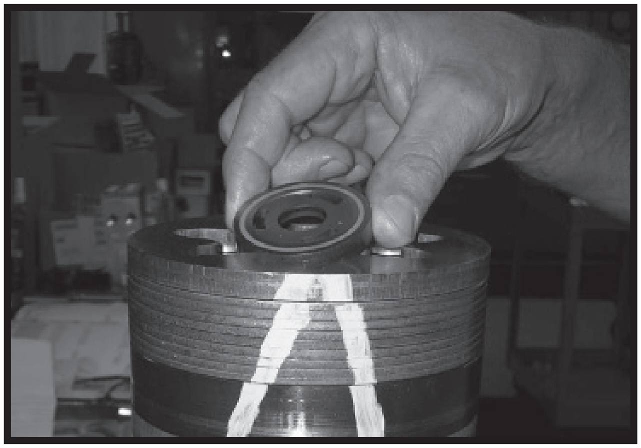


17. Assemble the commutator ring (6) over alignment studs onto the manifold.

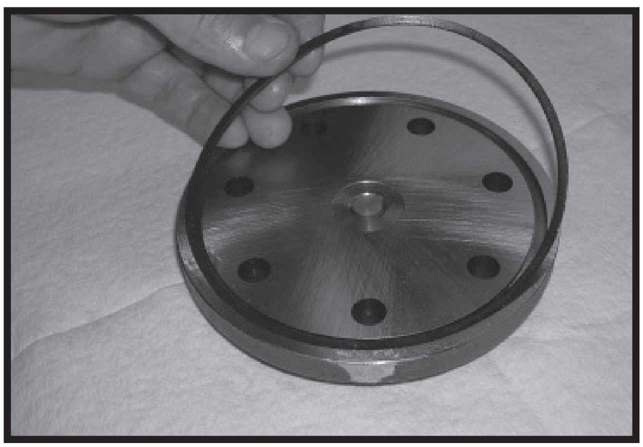


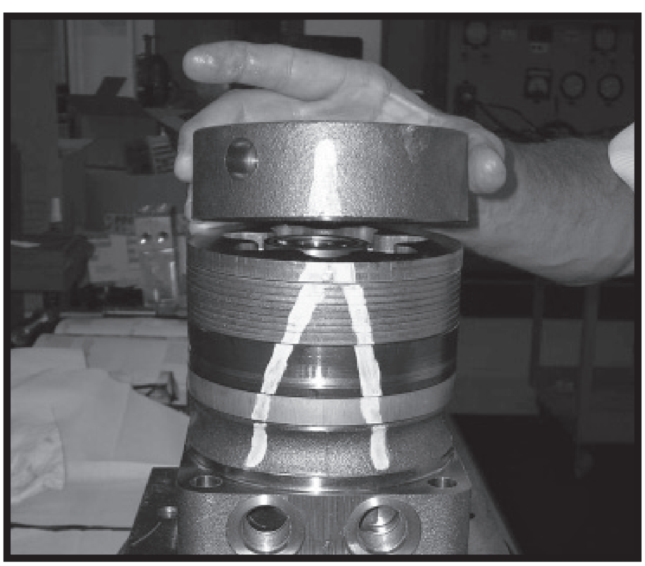
18. Assemble a new seal ring (3) flat side up, into commutator (5) and assemble commutator over the end of drive link (10) onto manifold (7) with seal ring side up.

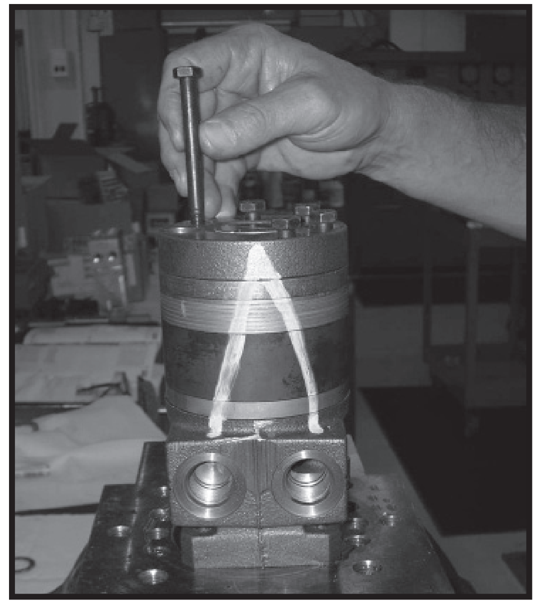




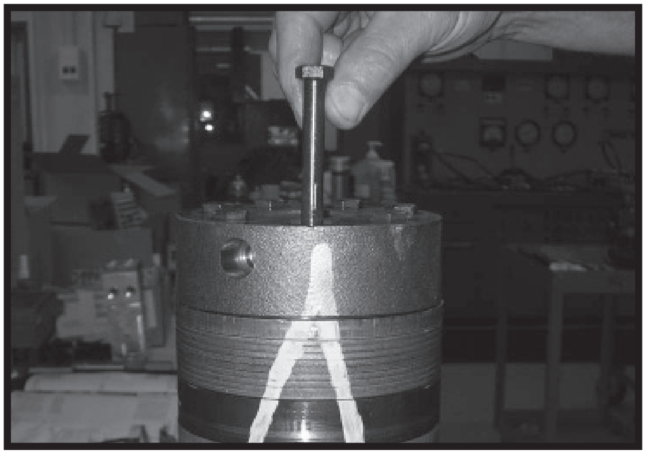
19. Assemble a new seal ring (4) into end cover (2) and assemble end cover over the alignment studs and onto the commutator set. If the end cover has only 5 bolt holes be sure the cover holes are aligned with the 5 threaded holes in housing (18).The correct 5 bolt end cover bolt hole relationship to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

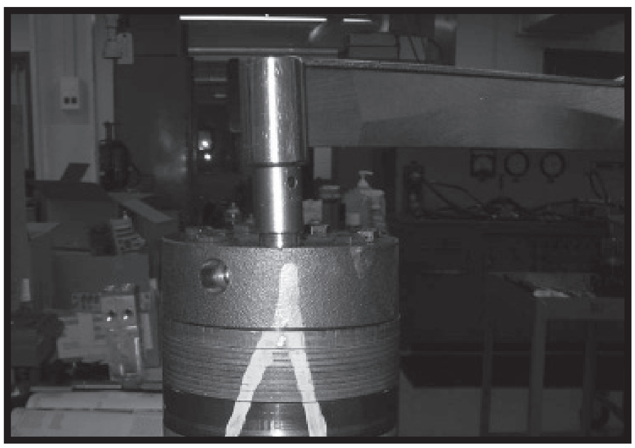


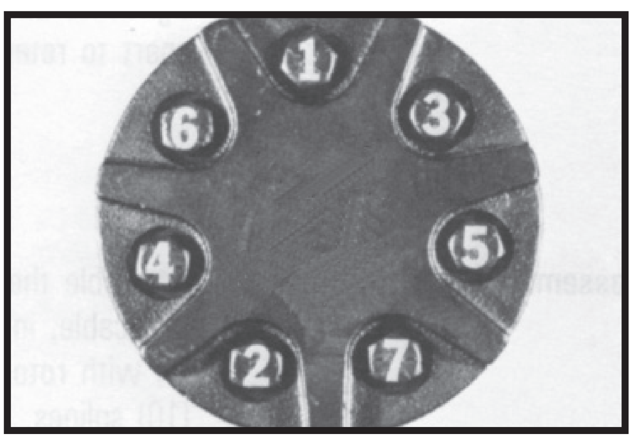




20. Assemble the 5 or 7 special bolts (1) and screw in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 50-55 ft. lbs.(68-75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



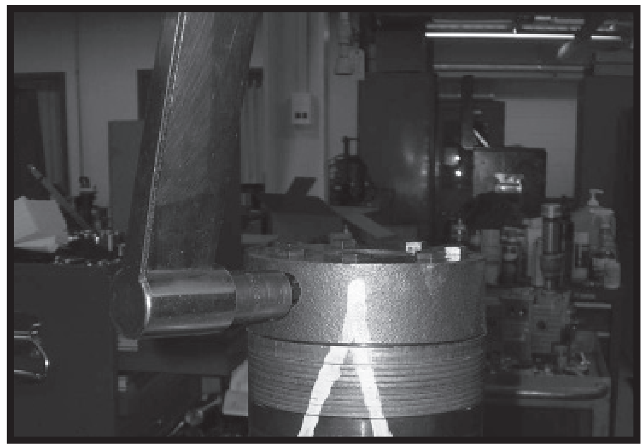


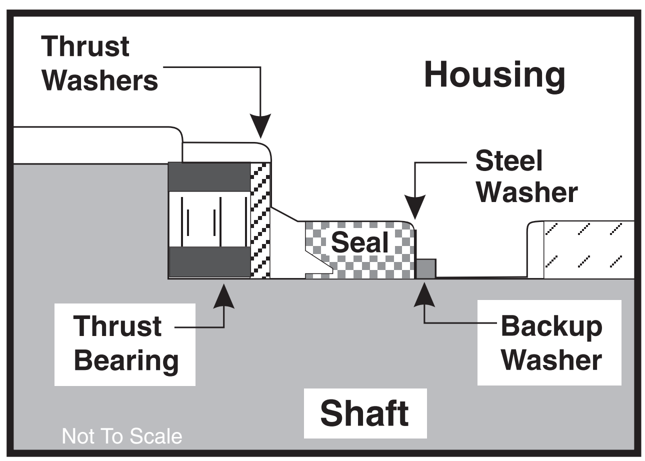


NOTE: *The special bolts required for use with the relief or shuttle valve (24) end cover assembly (2) are longer than the bolts required with standard and cover assembly. Refer to the individual service parts lists or parts list charts for correct service part number if replacement is required.*

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

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





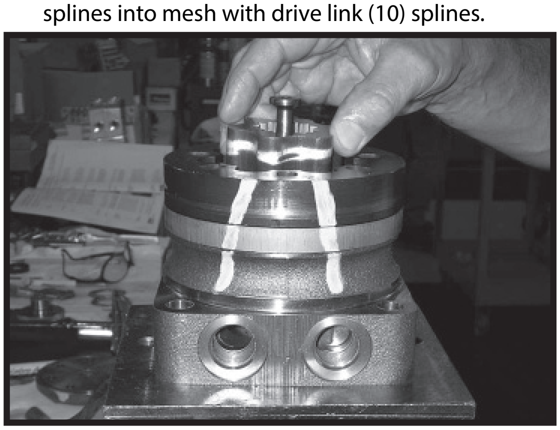
One Piece Stator Construction

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

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

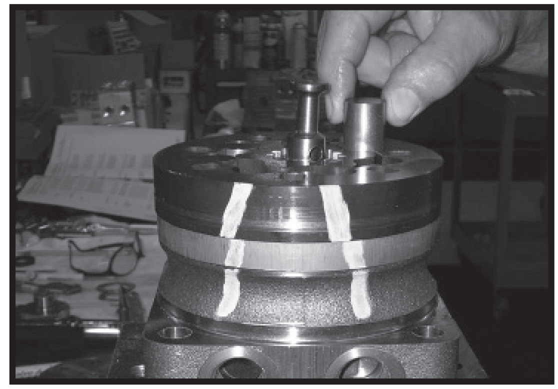
2. If assembly alignment studs are not being utilized, align stator bolt holes with wear plate and housing bolt holes and turn two bolts (1) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

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



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

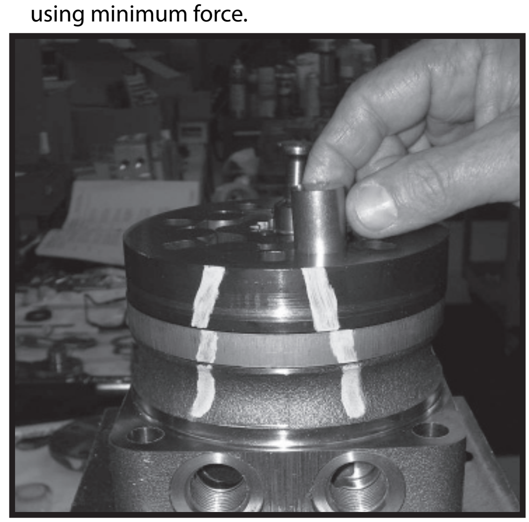
4. Assemble six vanes (8C), or as many vanes that will readily assemble into the stator vane pockets.



NOTICE

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

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



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

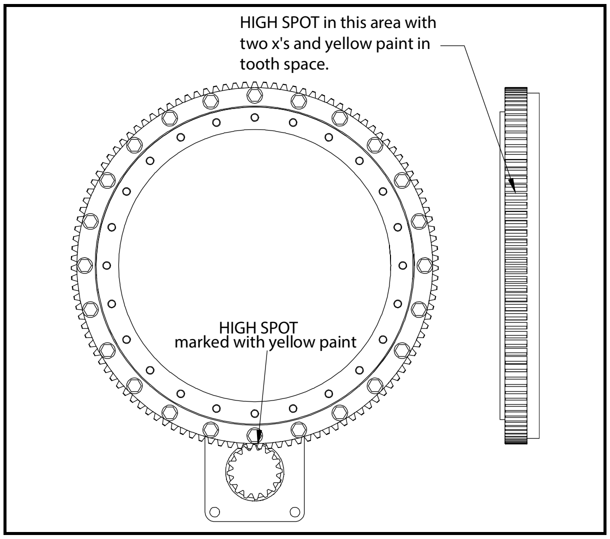
3.16 SWING HUB INSTALLATION

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

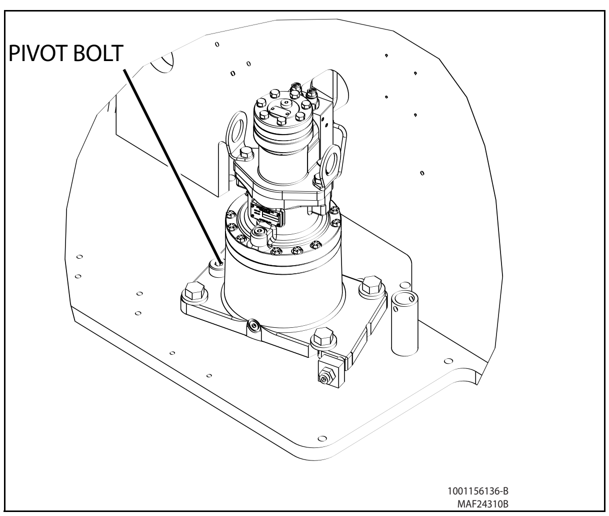
Procedure for Setting Swing Gear Backlash

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

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

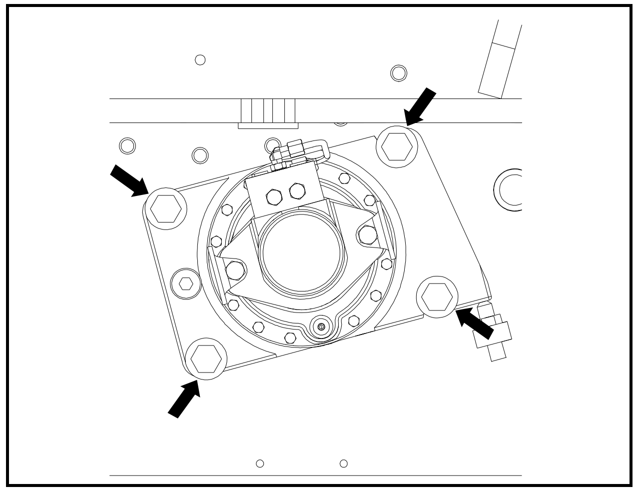


3. Apply High Strength Threadlocking Compound and torque pivot bolt to 205 ft. lbs. (280 Nm) (shown below).

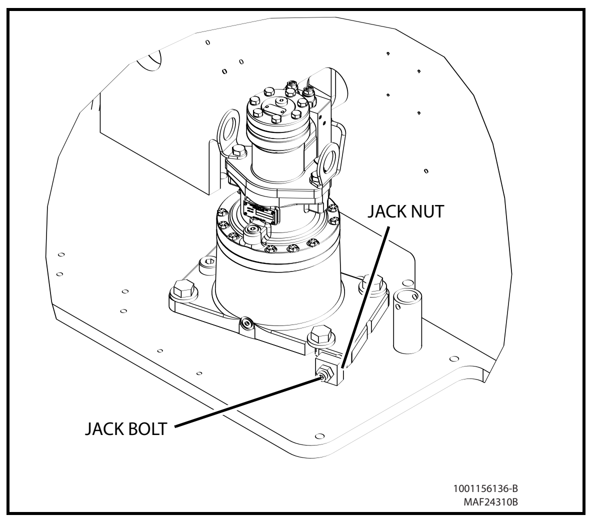


NOTE: *Make sure the turntable is properly supported during the following step. The turntable can swing a few degrees when the turntable lock is removed if the turntable is not balanced properly.*

4. Remove turntable lock pin.
5. Apply High Strength Threadlocking Compound and pre-torque swing drive mounting bolts to 30 ft. lbs. (40 Nm).

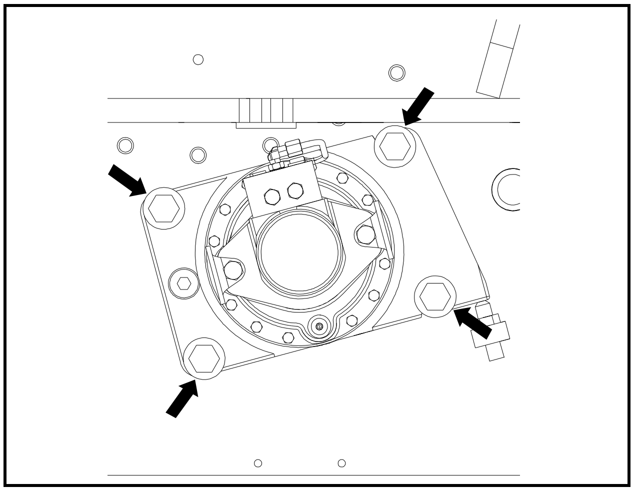


6. Tighten jack bolt until pinion is completely snug against shim and bearing then loosen jack bolt.

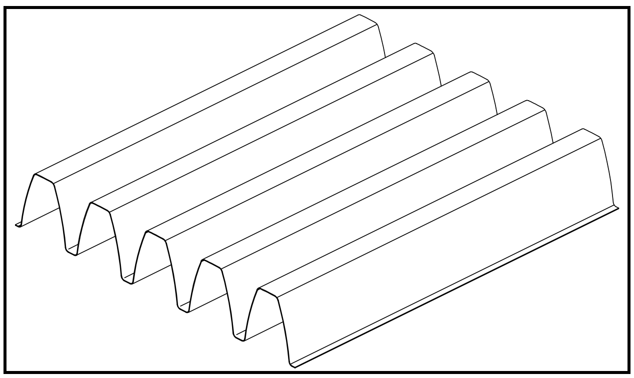


7. Apply High Strength Threadlocking Compound and torque jack bolt 50 ft. lbs. (68 Nm).
8. Apply High Strength Threadlocking Compound and tighten jam nut.

9. Torque mounting bolts to 340 ft. lbs. (460 Nm).

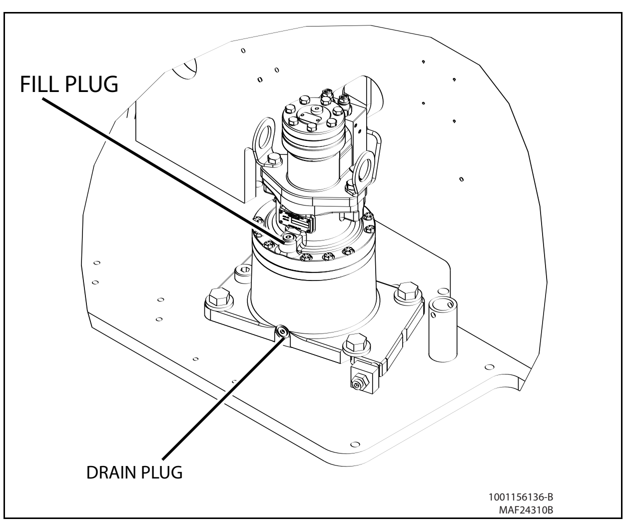


10. Remove shim and discard.



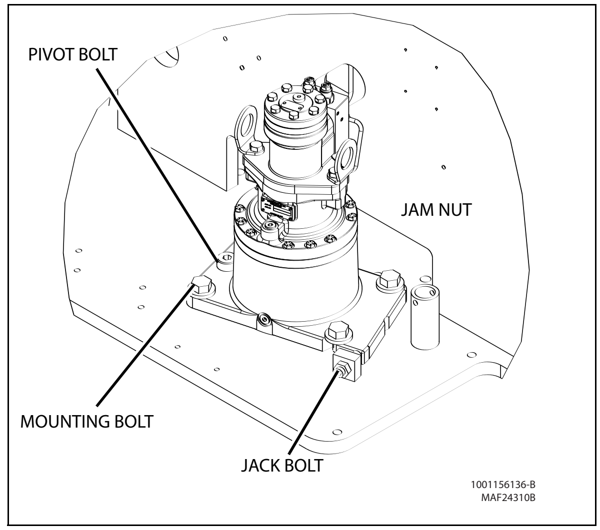
Swing Drive Lubrication

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



3.17 SWING HUB REMOVAL

1. Disconnect all wiring harness terminals connected to the swing motor.
2. Gently loosen the set screw. Do not remove.
3. Remove the pivot bolt using Allen Wrench.



4. Remove the mounting bolts securing swing drive hub to the turntable.
5. Using the suitable lifting device, remove the swing drive hub from mounting plate without damaging the swing gear.
6. Place swing drive hub in the clean area.
7. Refer to Section 3.14, Swing Drive for swing drive maintenance.

3.18 SWING BEARING

Turntable Bearing Mounting Bolt Condition Check

NOTICE

THE SWING BEARING IS ONE OF THE MOST CRITICAL POINTS ON 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 3-60.)
- **b.** At the positions indicated on Figure 3-62., try to insert the 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. (See Figure 3-61.)
- **b.** At the position indicated on Figure 3-62., 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.

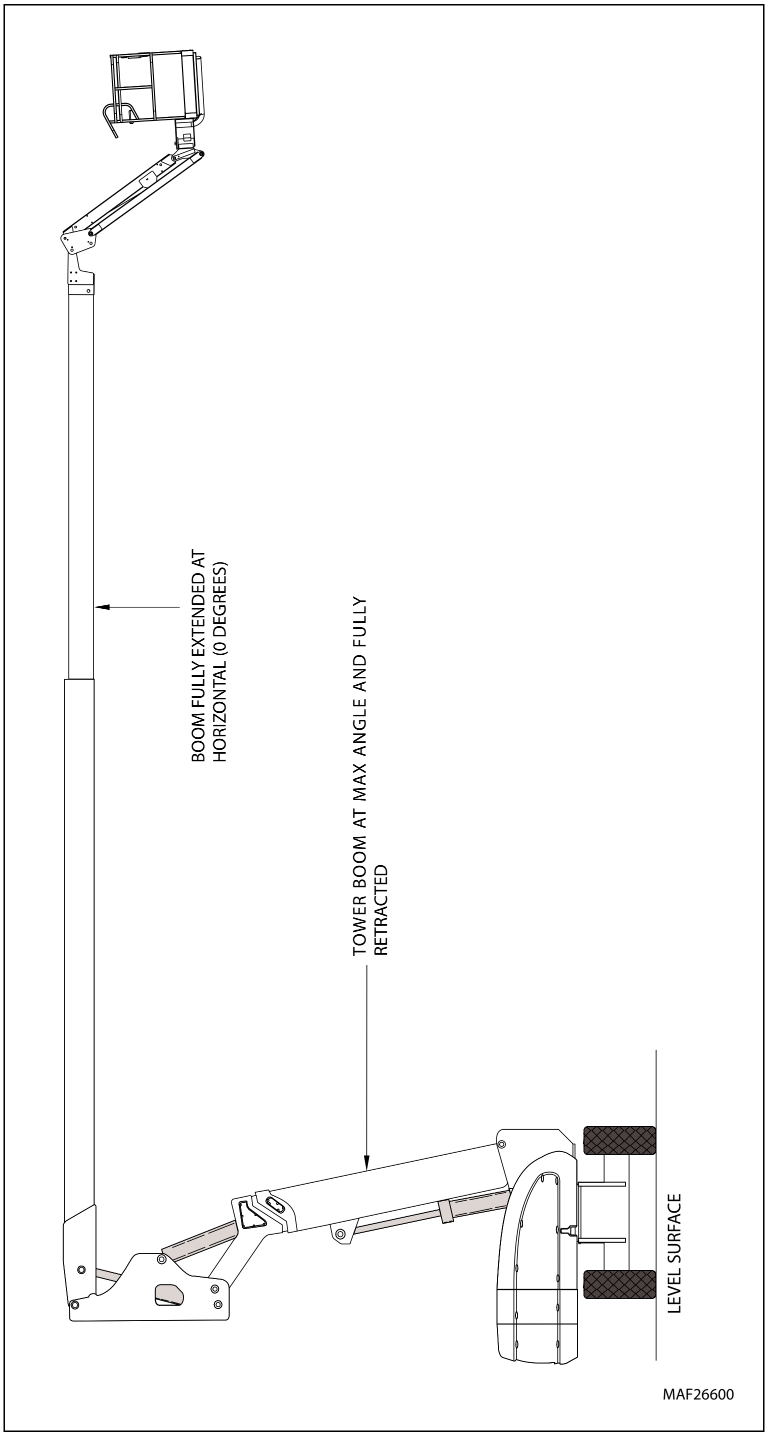


Figure 3-60. Swing Bearing Tolerance Boom Placement - Sheet 1 of 2

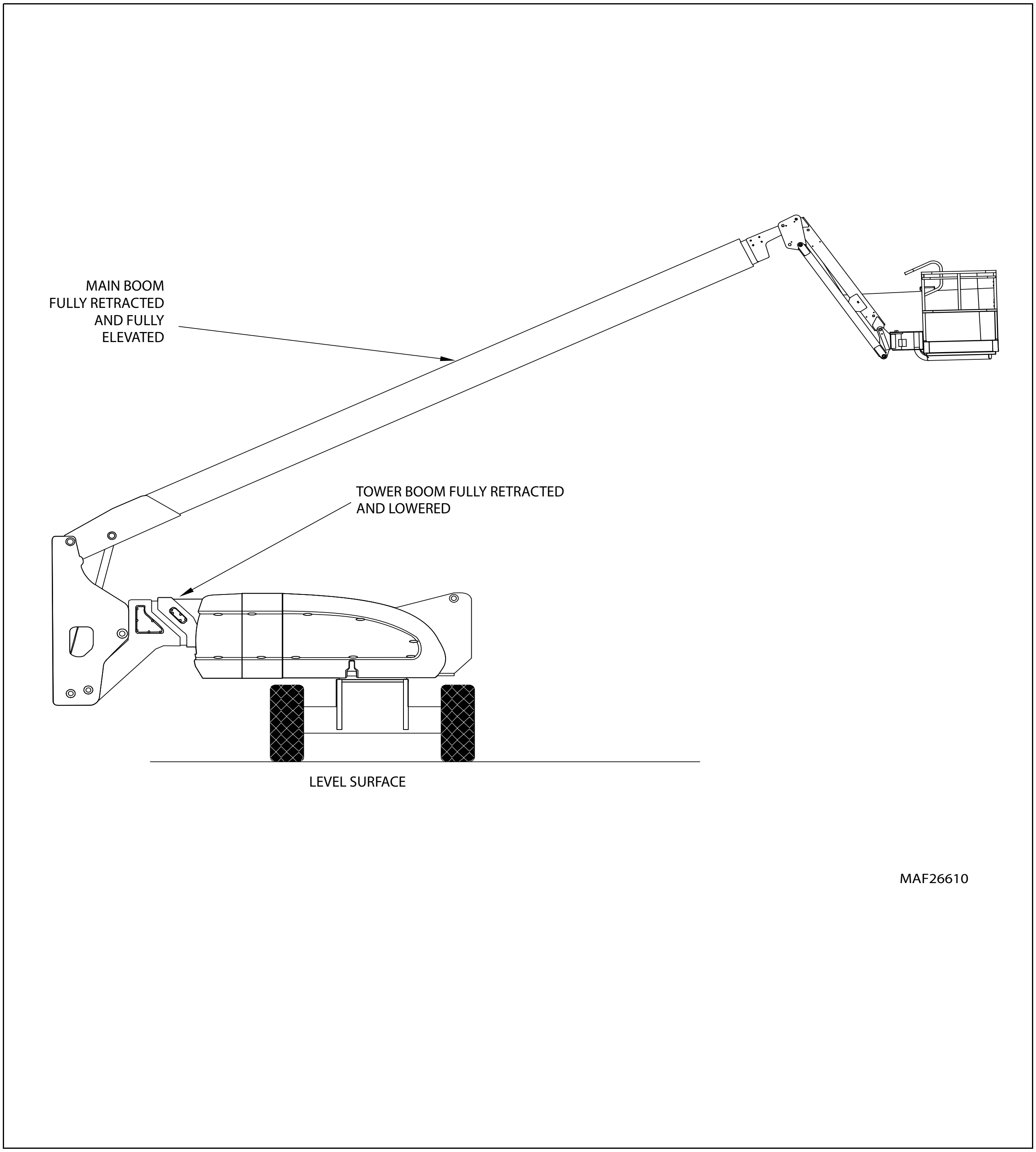


Figure 3-61. Swing Bearing Tolerance Boom Placement - Sheet 2 of 2

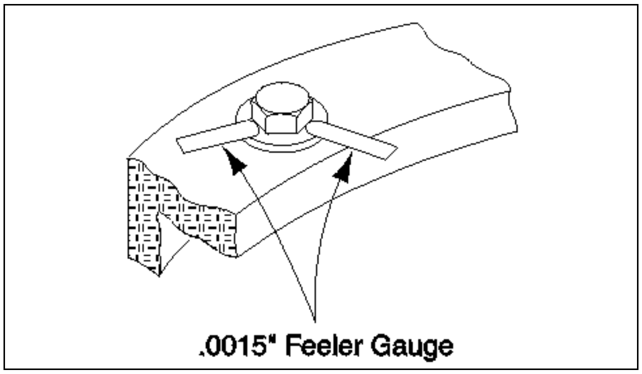


Figure 3-62. Swing Bolt Feeler Gauge Check

Wear Tolerance

1. From the underside of the machine, at rear center, with the main boom fully elevated and fully retracted, and tower boom stowed, 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, and the tower boom fully elevated and fully retracted 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.

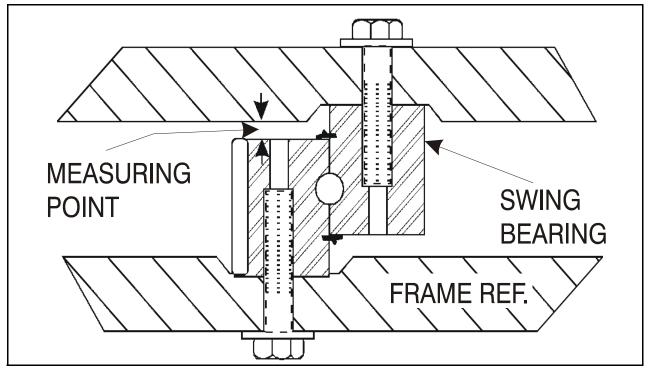


Figure 3-63. Swing Bearing Tolerance Measuring Point

Swing Bearing Replacement

REMOVAL

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

⚠ WARNING

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

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

NOTICE

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

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

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

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

INSTALLATION

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

CAUTION

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

2. Apply a light coating of 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 3-65., 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 3-65., Swing Bearing Torque Sequence, tighten the bolts to a torque of 190 ft. lbs. (260 Nm) w/Thread Locking Compound.

9. Remove the lifting equipment.

10. Install the rotary coupling retaining yoke brackets, apply a light coating of Medium 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. (260 Nm) w/High Strength Threadlocking Compound.

2. Inner Race - 190 ft. lbs. (260 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.

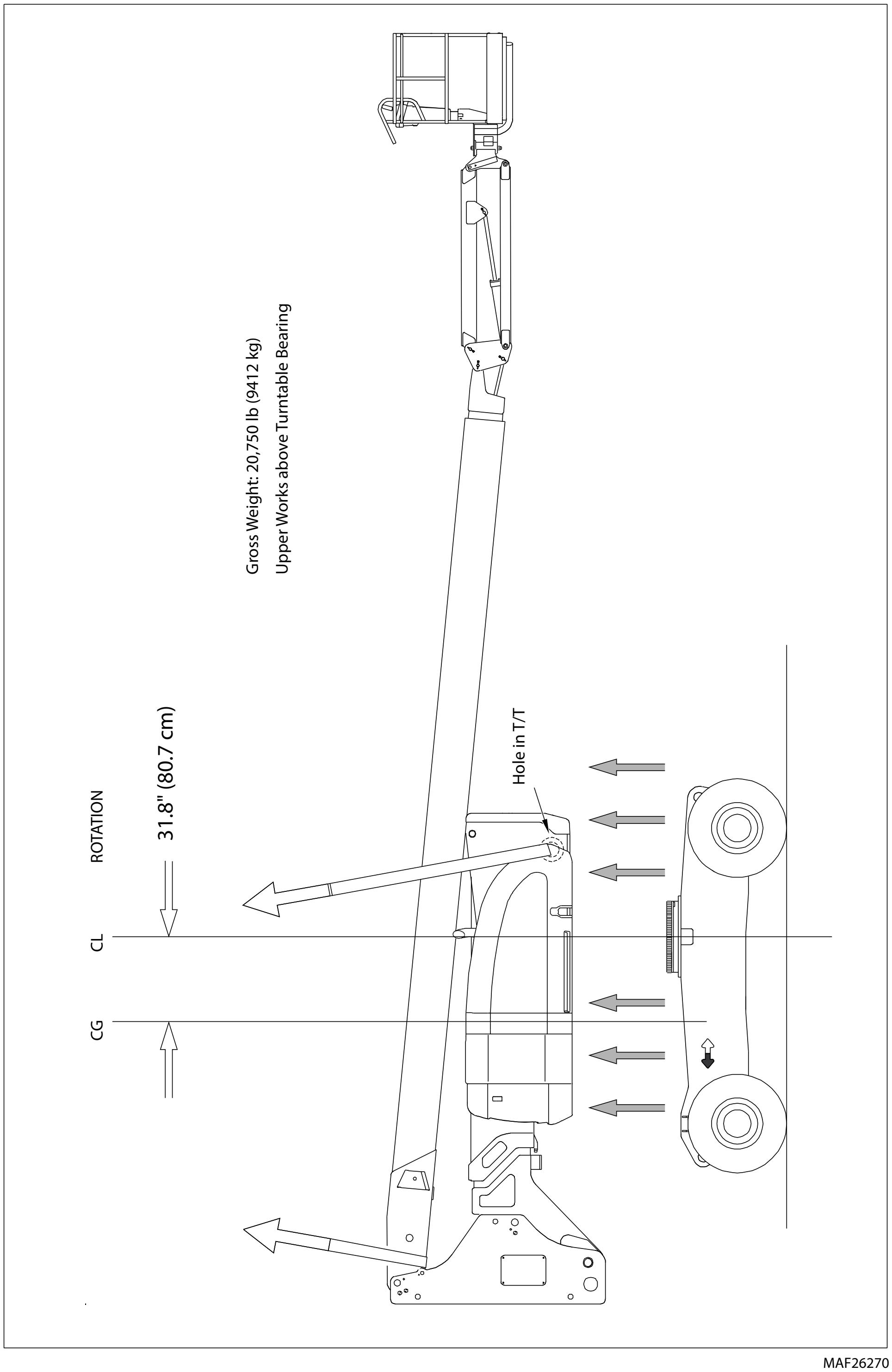
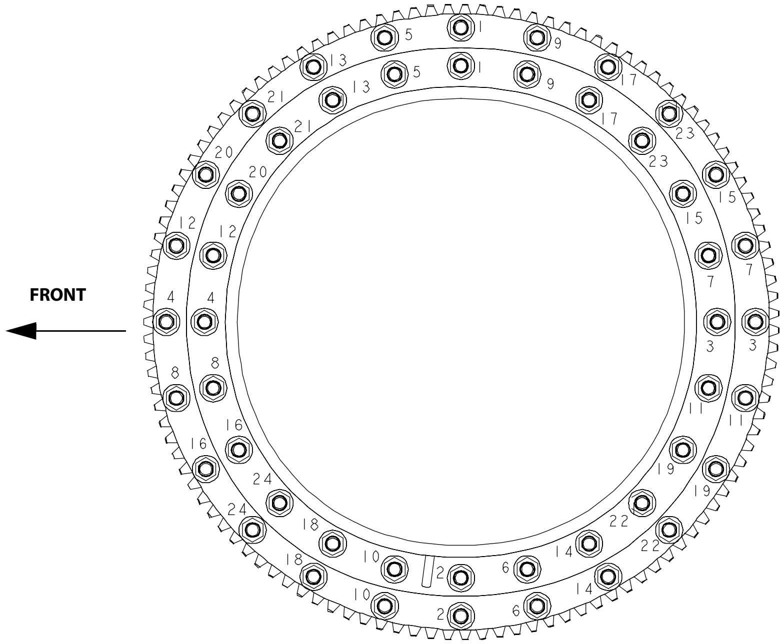


Figure 3-64. Swing Bearing Removal



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

Figure 3-65. Swing Bearing Torque Sequence

3.19 TILT INDICATOR SYSTEM

1. The tilt indicator system measures the turntable angle with respect to level ground. The tilt switch itself has two settings; 5 (or 4 degree dependent upon market) and 8.5 degrees. The tilt angle is dependent on market, Refer Table 6-2, Machine Configuration Programming Information (Software Version P6.33).

2. The smaller angle is used for the purpose of warning the operator by means of the tilt light in the platform display panel.

3. Additionally when used in conjunction with the "above elevation cutout system" or the "transport position interlock system", the tilt switch will cause an alarm to sound, and automatically put the machine in the creep speed mode. With the exception of the speed cutback, this is a warning system only.

4. The machine will continue to function. The operator is responsible to prevent the machine from attaining an unstable position. The 8.5 degree angle is used exclusively for the purpose of automatically shifting the drive motors to the maximum displacement position (slow speed).

3.20 SPARK ARRESTER CLEANING INSTRUCTIONS

1. Remove the cleanout plug in the bottom of spark arrester (muffler).

2. Without causing deformation (or any type of damage to the spark arrester) repeatedly tap on the arrester near the cleanout plug. This may be enough to begin drainage of the spark trap.

3. An industrial vacuum cleaner can do a complete job at this point.
   a. Or, IN A SAFE AREA, start the engine. Then alternate between low idle and high idle for two to three minutes.
   b. Or, operate the engine as required by the application for two to three minutes.
   c. Install the cleanout plug.

3.21 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.
13. Install proximity switch as shown in Figure 3-69.

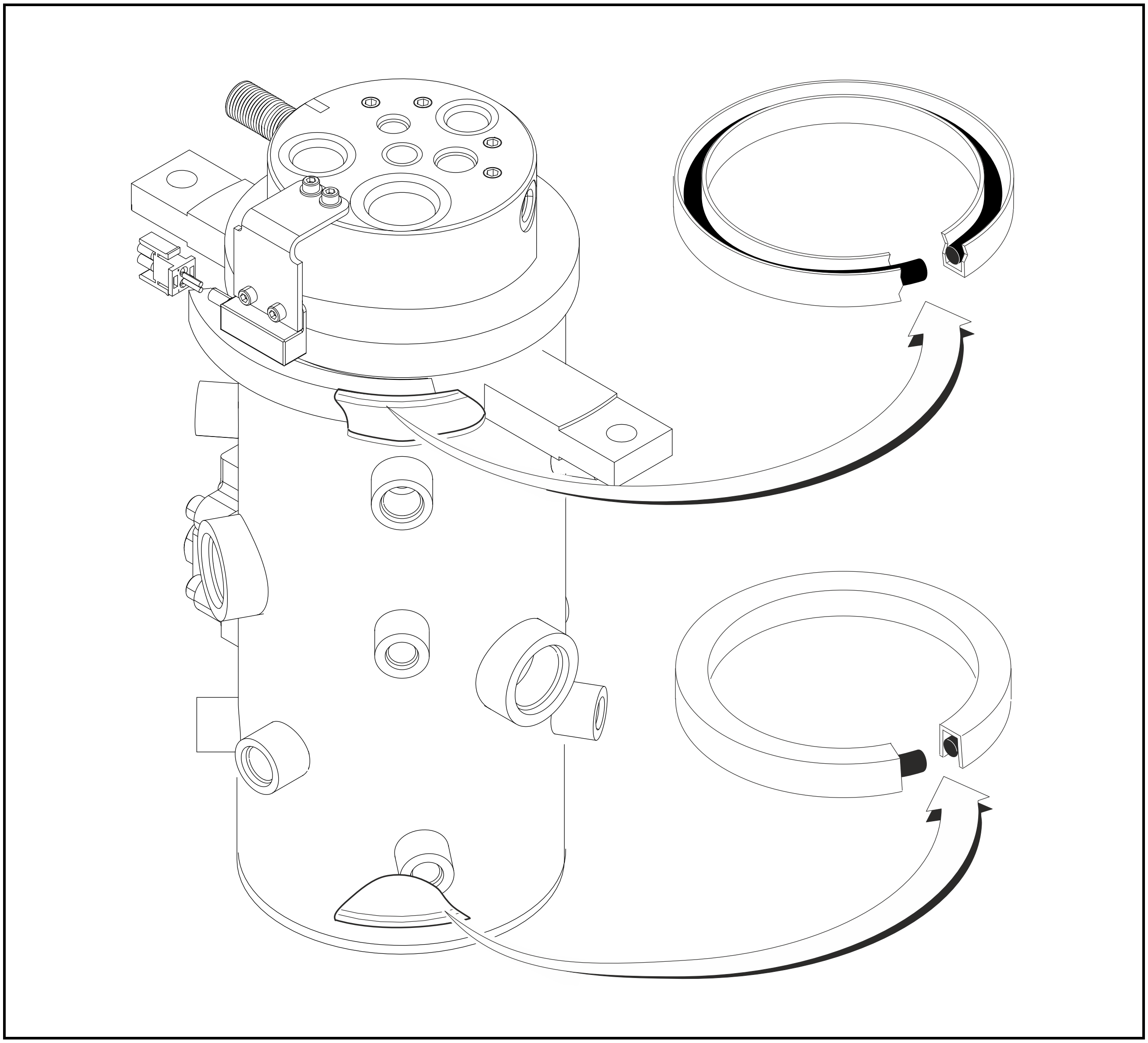
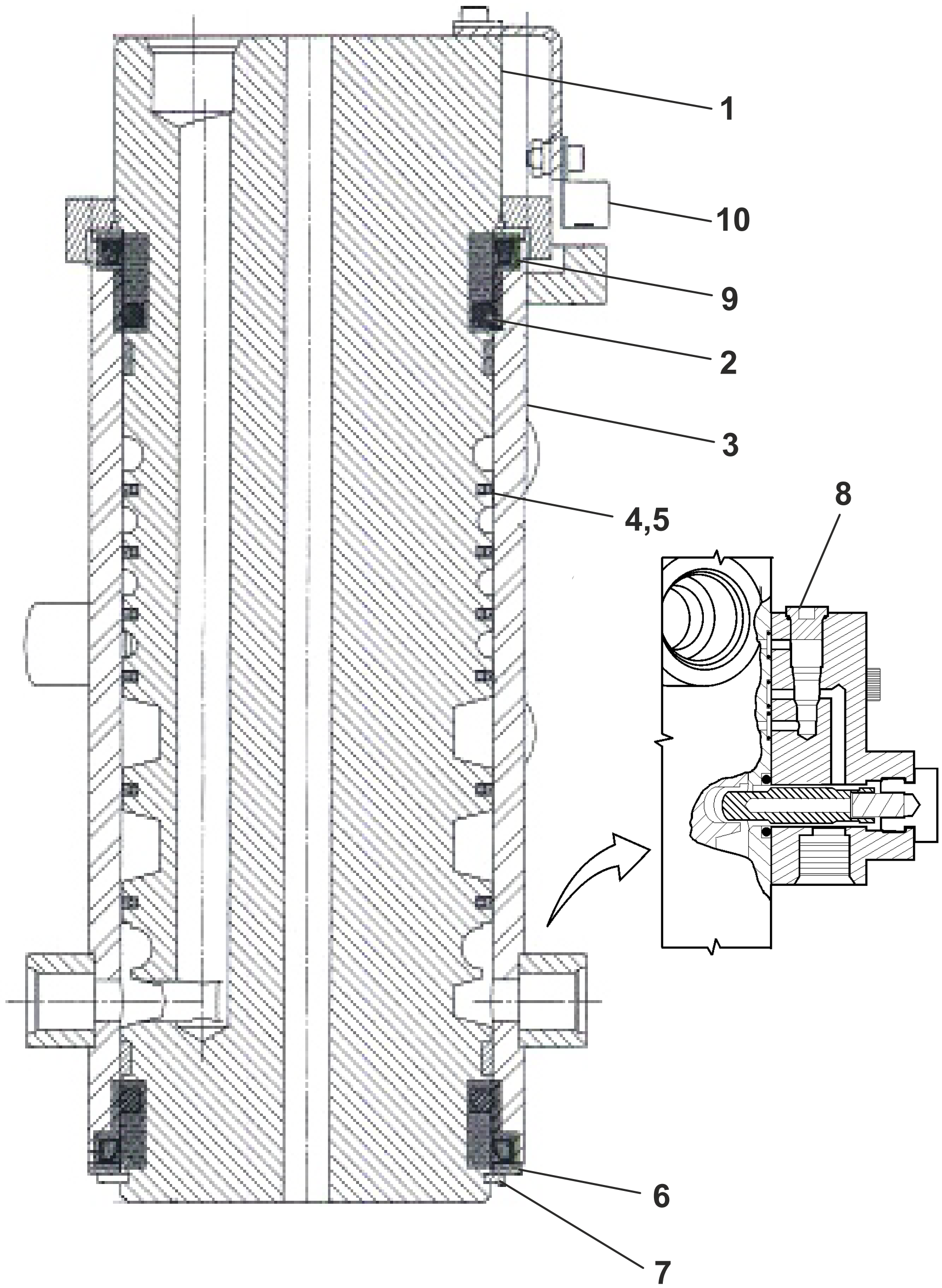


Figure 3-66. Rotary Coupling Seal Installation



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

Figure 3-67. Rotary Coupling Cutaway

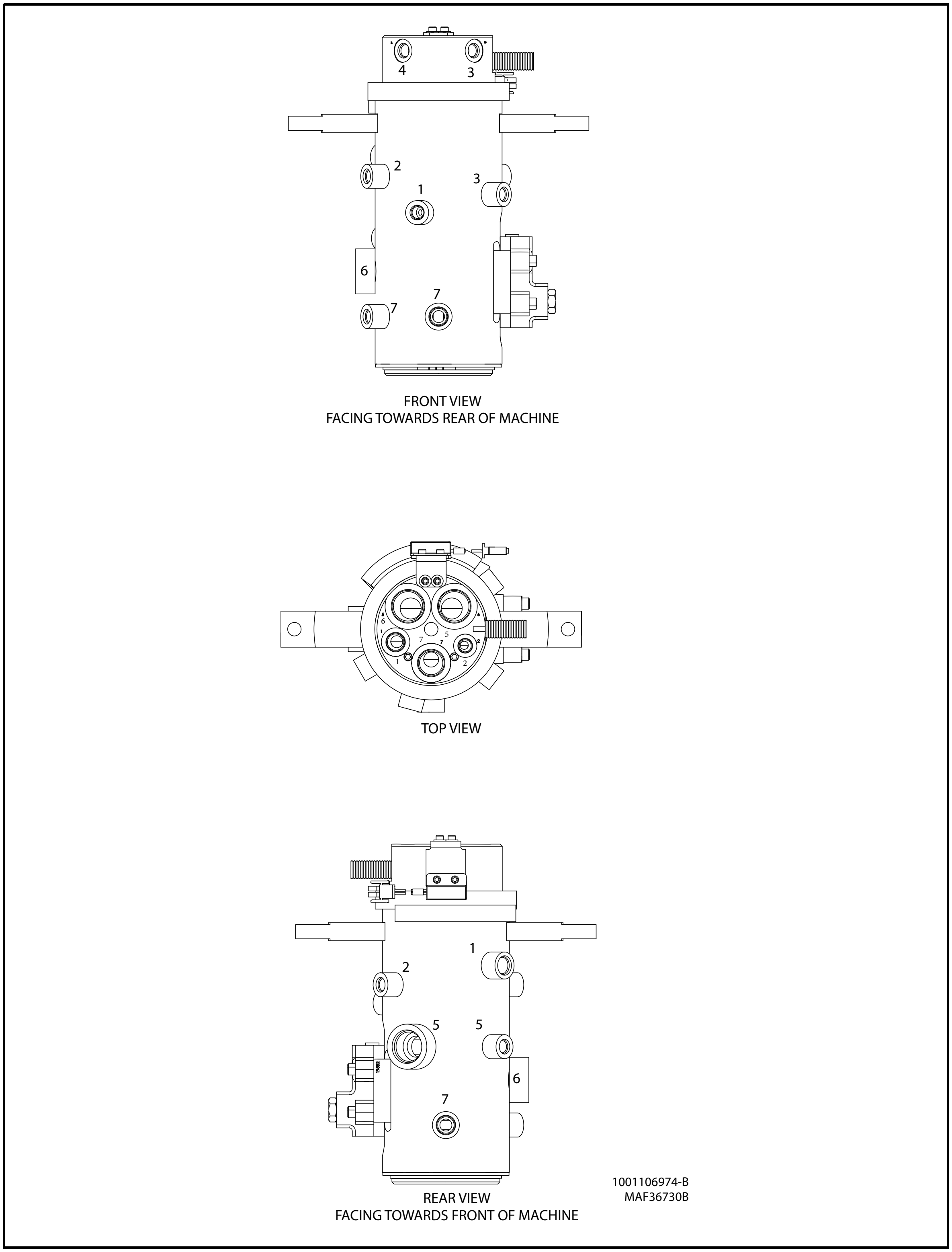
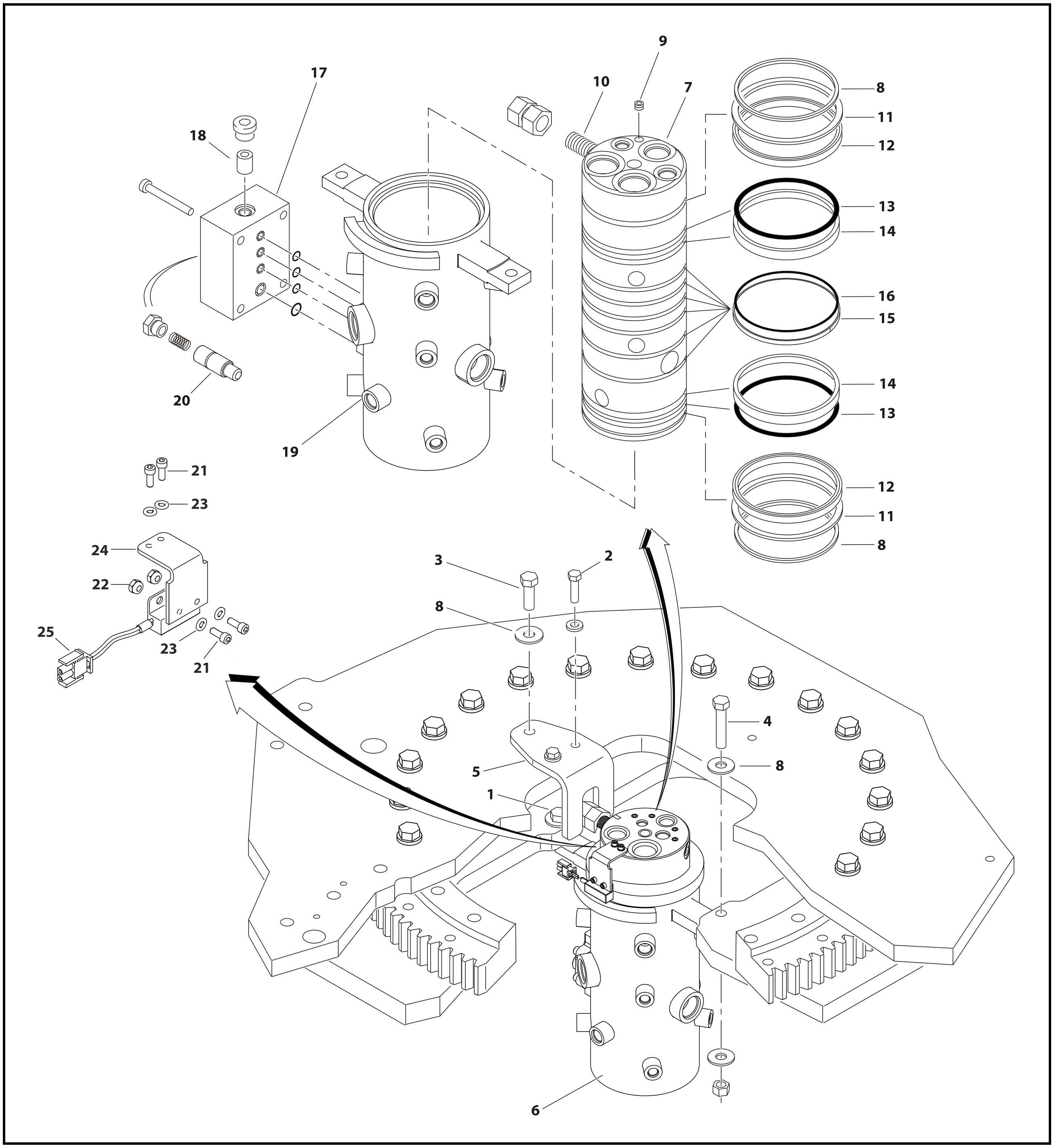


Figure 3-68. Rotary Coupling Port Location (7 Port)



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

Figure 3-69. Rotary Coupling Installation

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

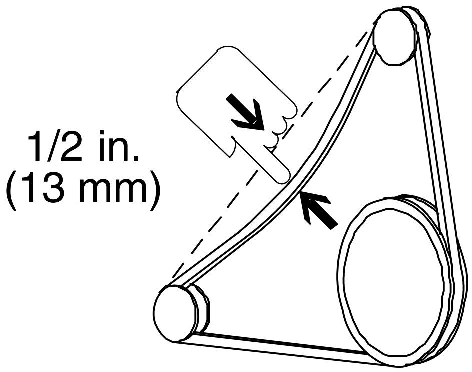
Port No.	Outlets	Port Size	Description	Operating Pressure PSI (Bar)	Proof Pressure PSI (Bar)
1	1	-8	Brake	450 (31)	675 (46.5)
2	2	-6	2 Speed	4500 (310)	6750 (465)
3	1	-6	Steer	2500 (172)	3750 (258.5)
4	1	-6	Steer	2500 (172)	3750 (258.5)
5	2	1-6, 1-16	Drive Reverse	4500 (310)	6750 (465)
6	1	-16	Drive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

3.22 GENERATOR

Maintenance Schedule

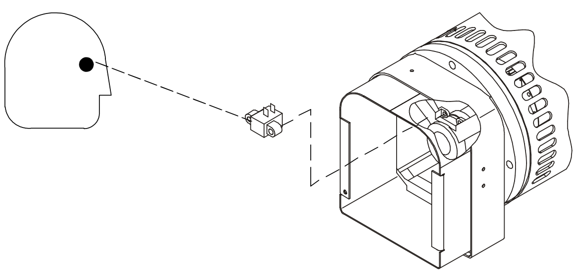
EVERY 250 HOURS

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

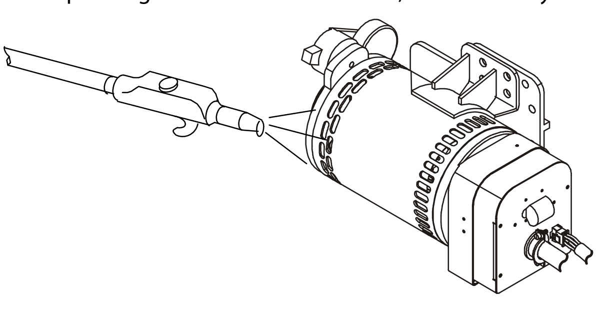


EVERY 500 HOURS

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.

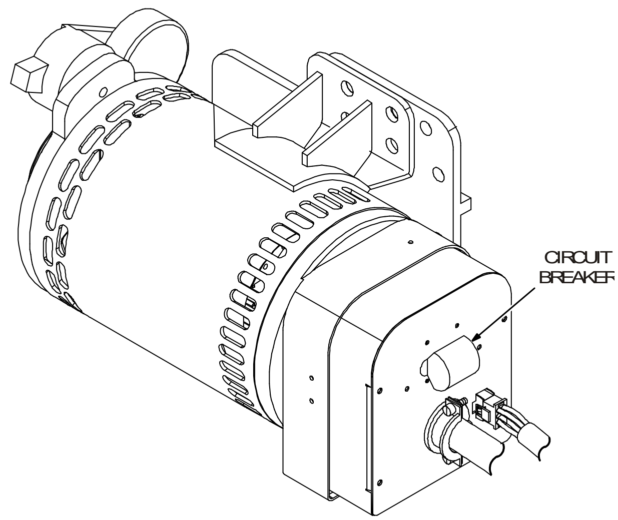


Overload Protection

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.

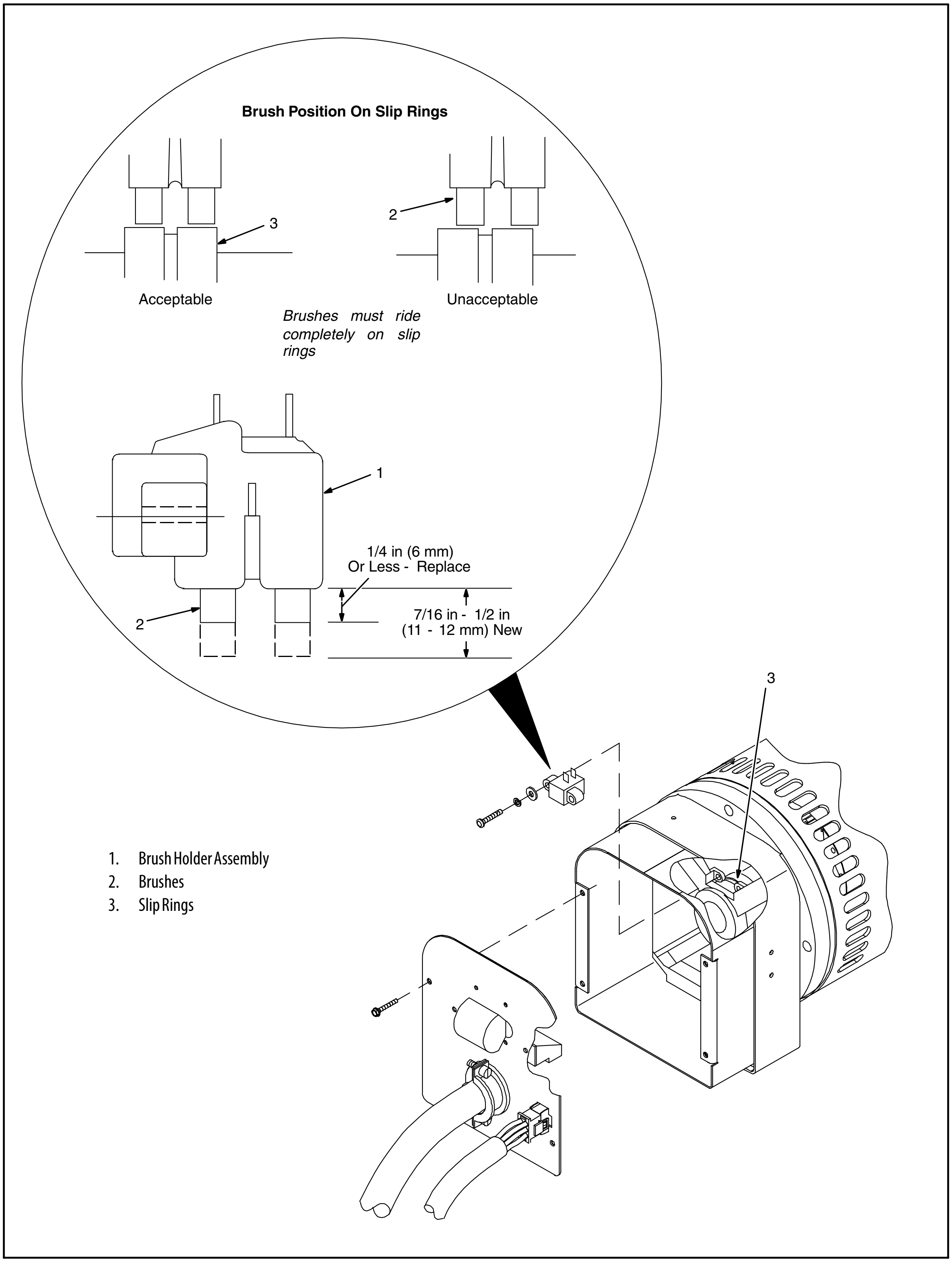


Figure 3-70. Inspecting Generator Brushes, Replacing Brushes, and Cleaning Slip Rings

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

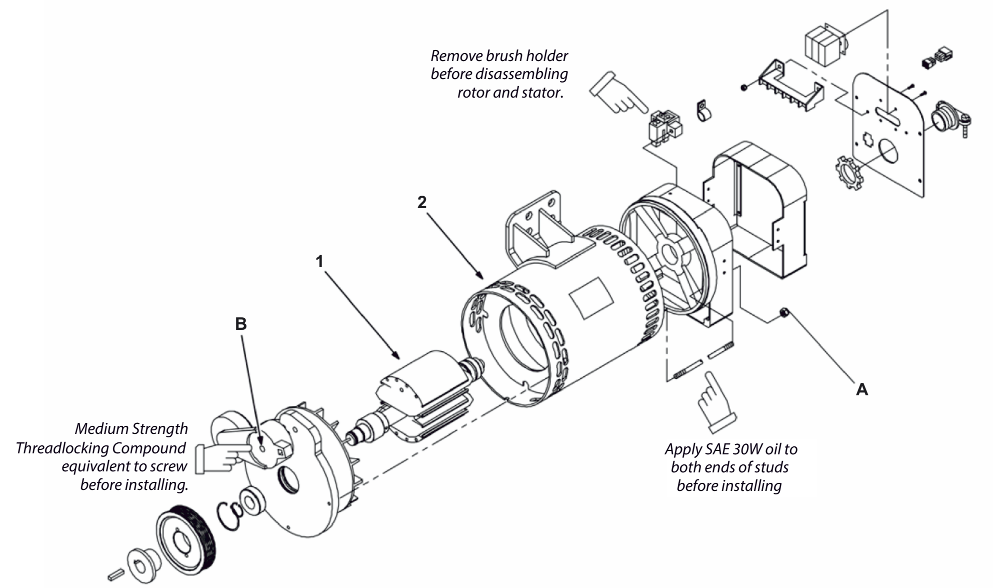
DO NOT DAMAGE ROTOR OR STATOR WINDINGS DURING DISASSEMBLY AND ASSEMBLY PROCEDURE.

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.



Tool Needed:

Torques:	
A	95 in lb (10.7 Nm.)
B	38 ft.lbs (52 Nm.) (Belt Tensioner)

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

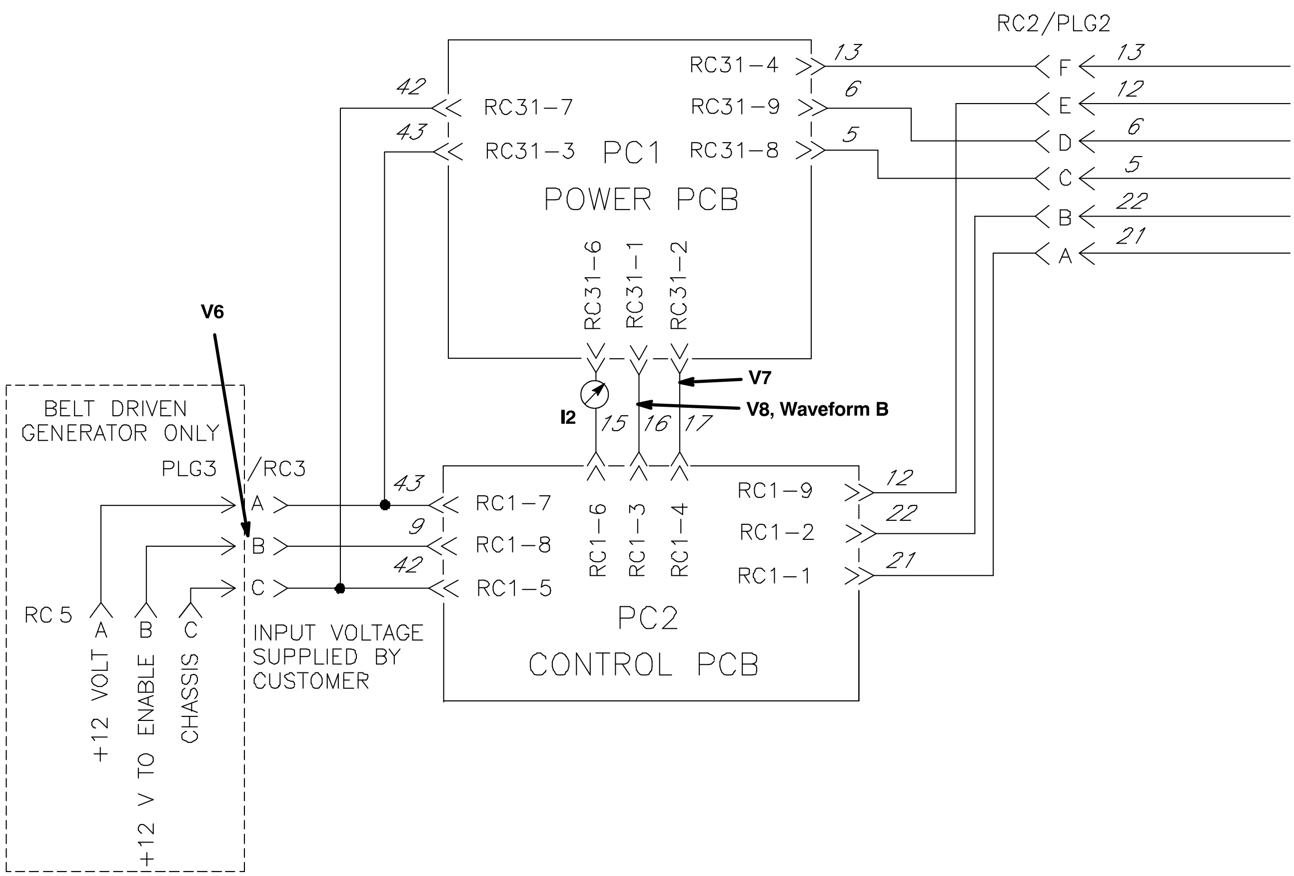
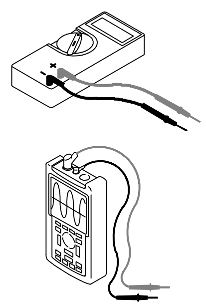


Figure 3-72. Generator Troubleshooting Circuit Diagram - Sheet 1 of 2

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

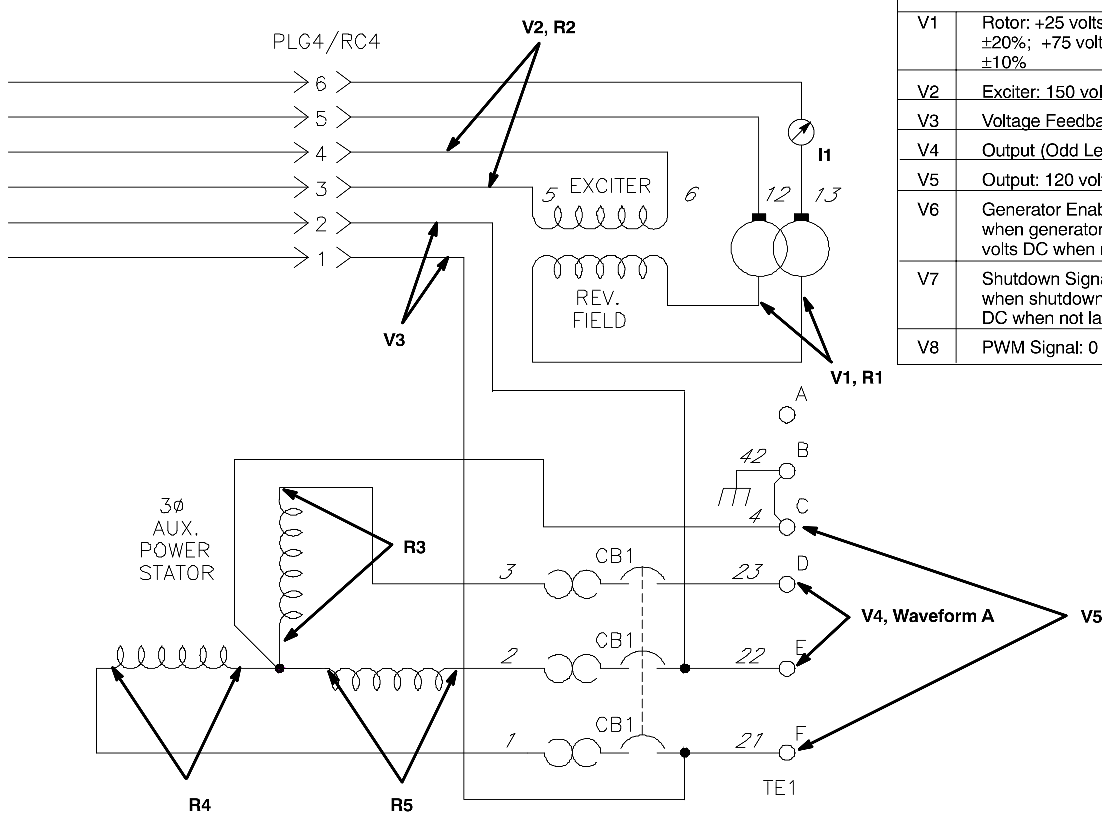


Figure 3-73. Generator Troubleshooting Circuit Diagram - Sheet 2 of 2

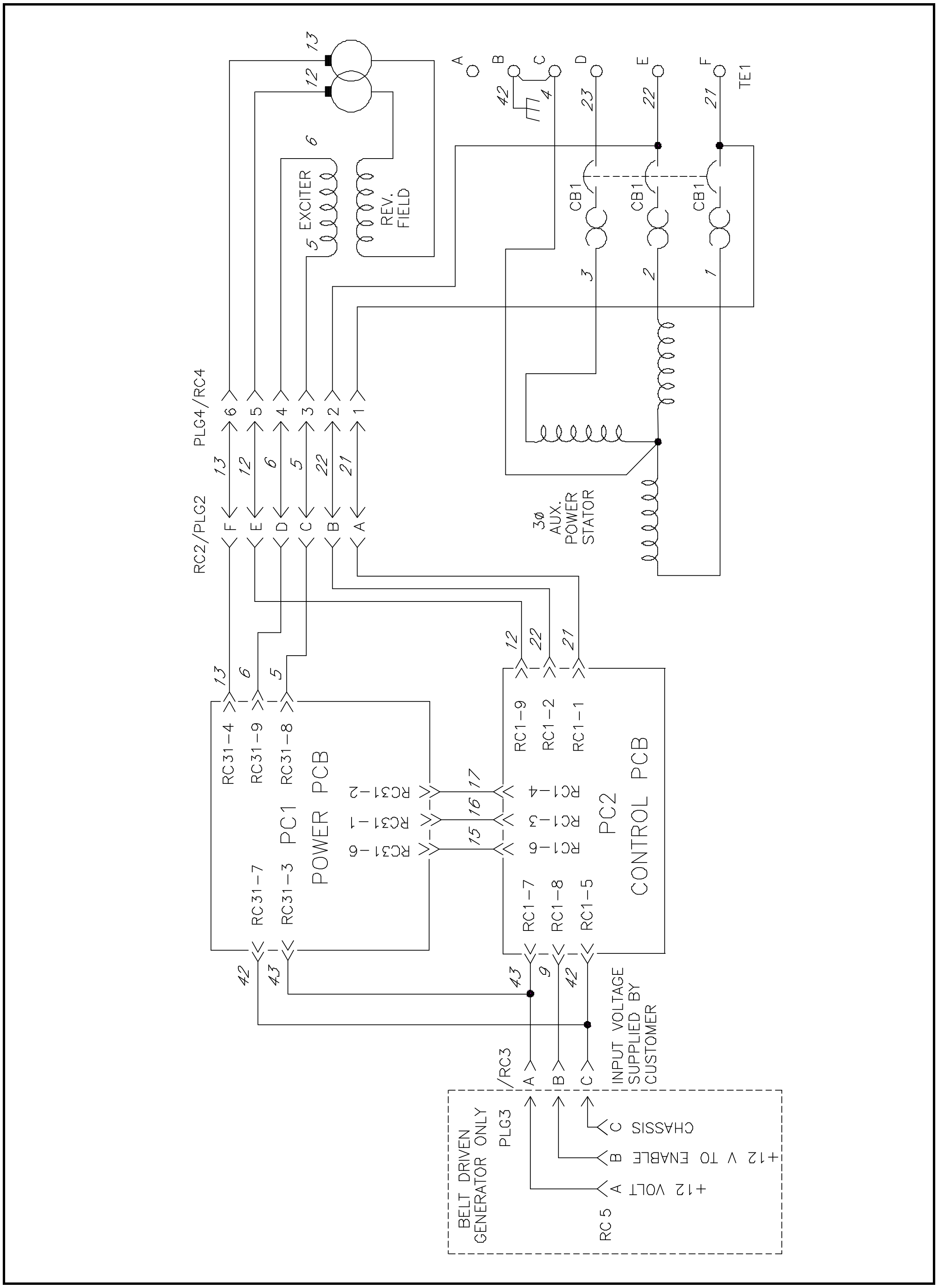


Figure 3-74. Generator Electrical Circuit Diagram

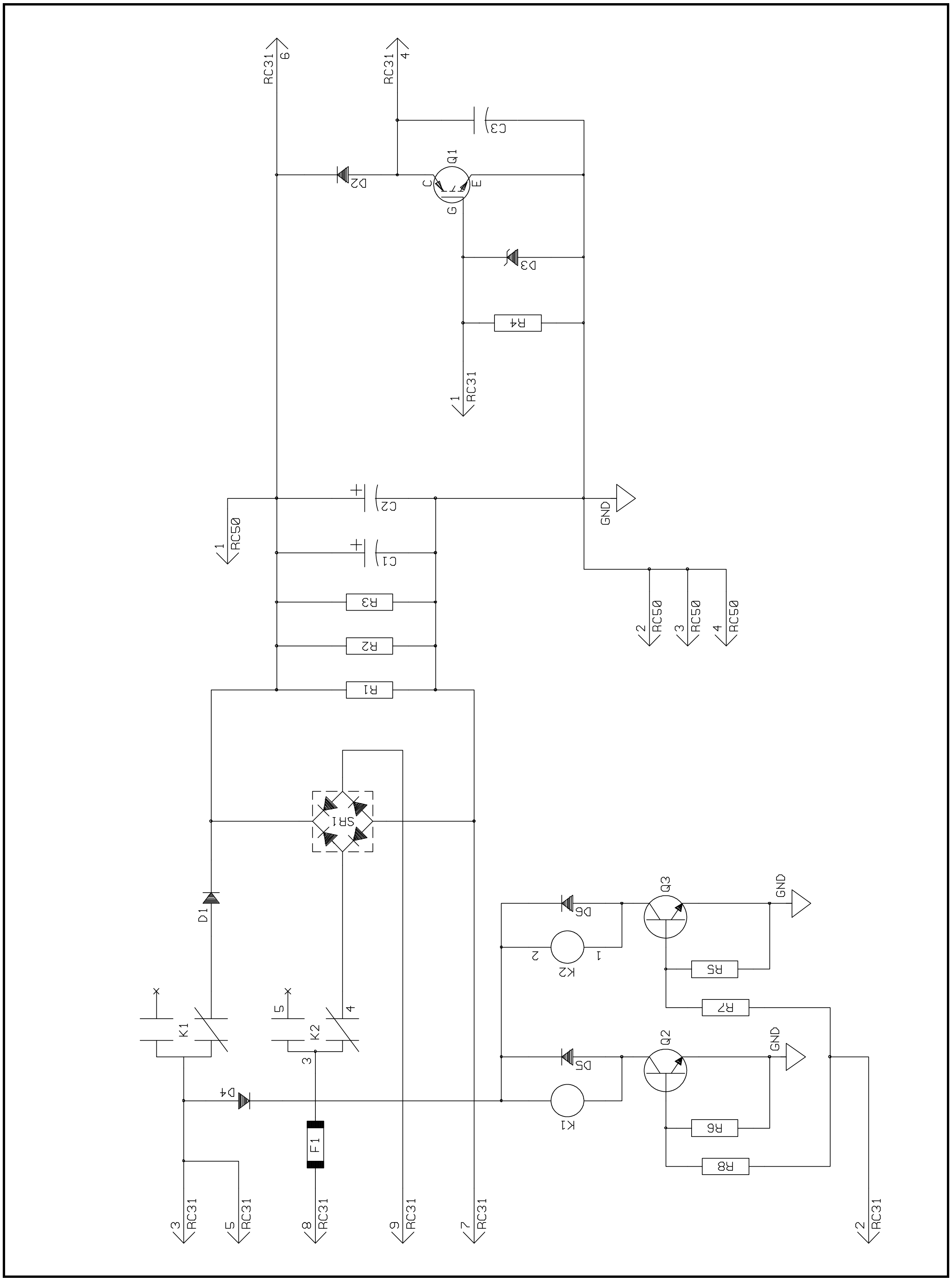
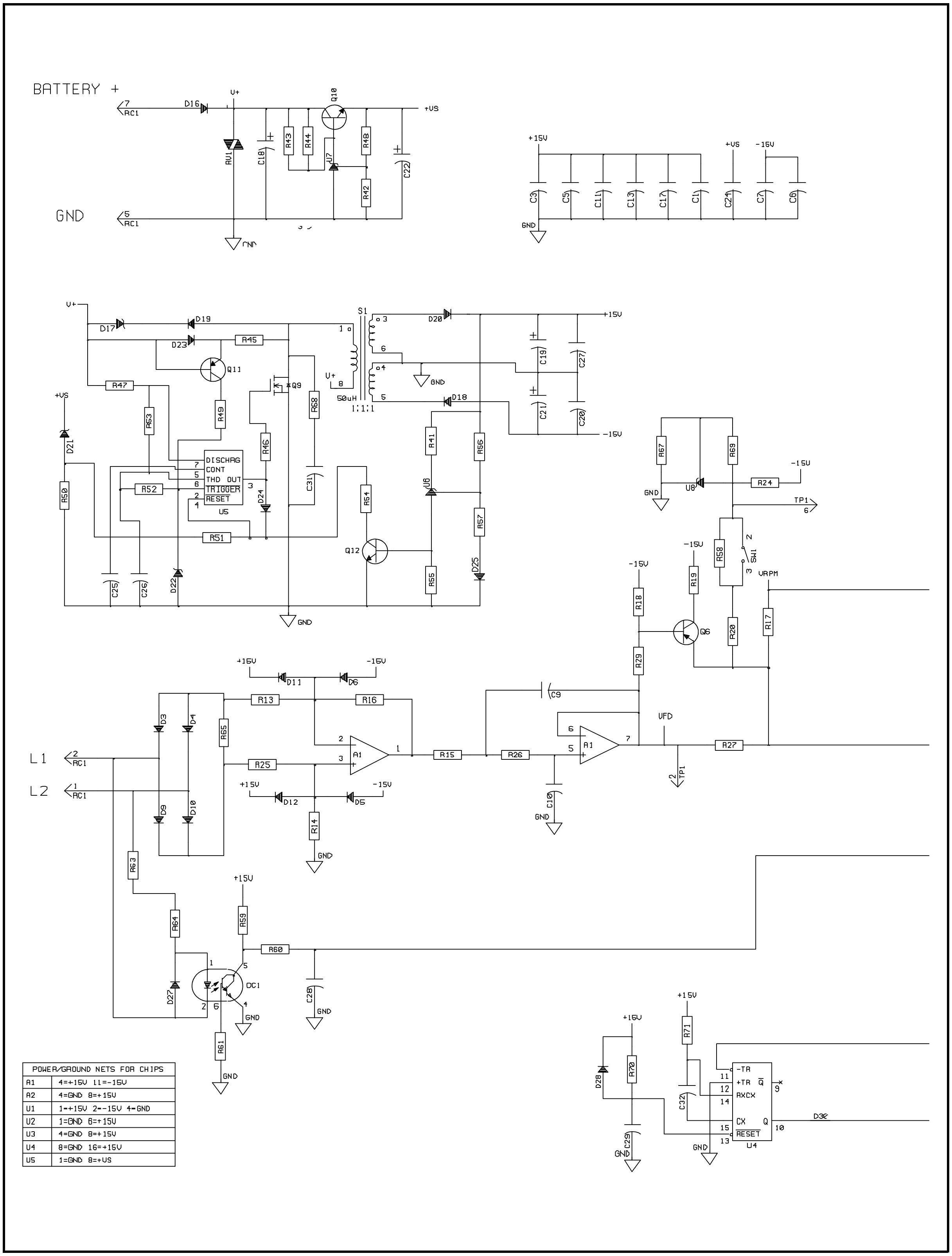


Figure 3-75. Power Board PC1 Electrical Circuit Diagram



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 8=+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

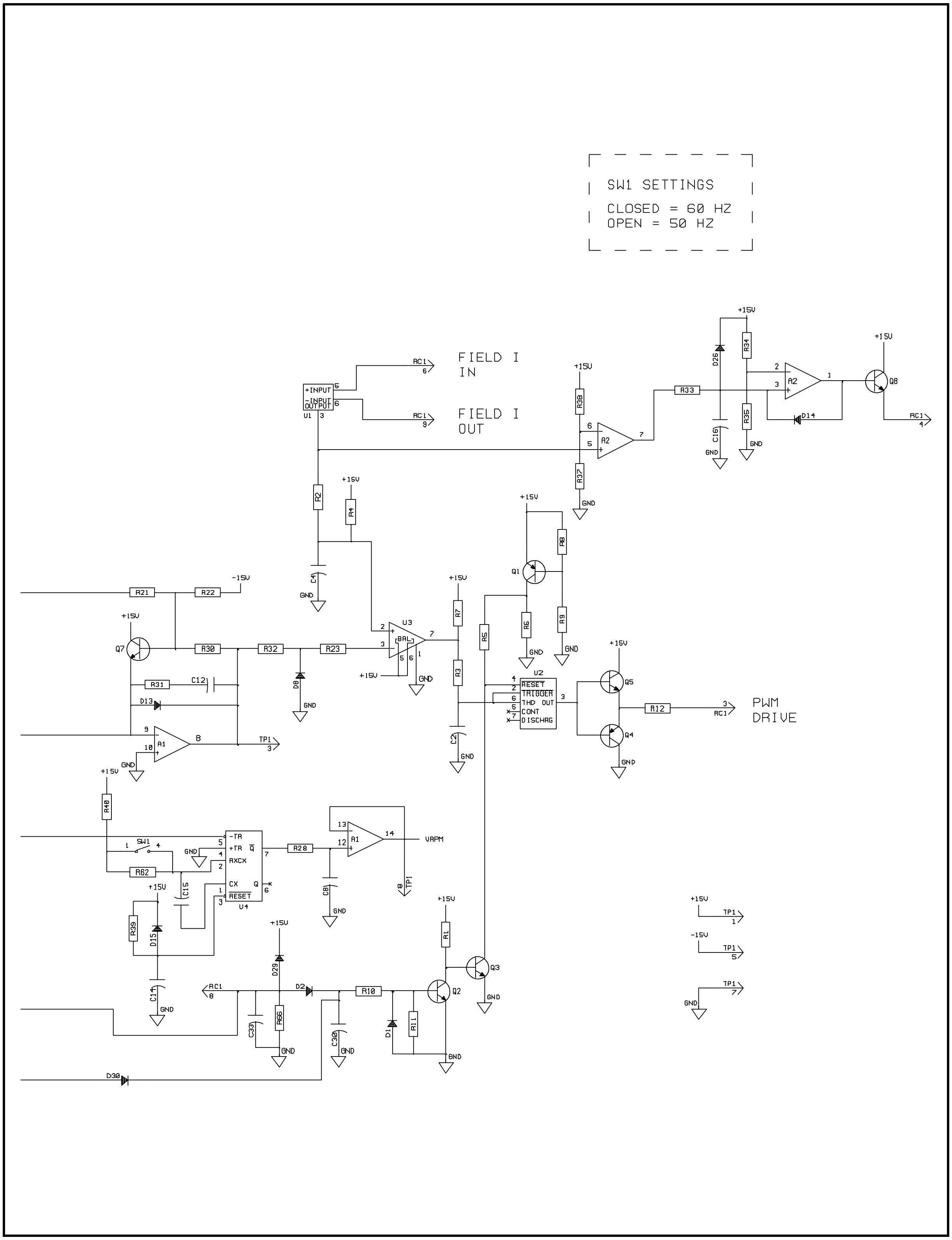


Figure 3-77. Power Board PC2 Electrical Circuit Diagram - Sheet 2 of 2

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.*

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

Generator Pulley

REMOVAL

1. Remove the hardware securing the pulley belt adjusting arm (1) to the generator (2) and remove adjusting arm.
2. Remove hardware attaching engine pulley (3) to engine shaft and remove engine pulley.
3. Using suitable lifting equipment, adequately support engine assembly weight along entire length.
4. Remove the hardware securing generator (2) to the engine and remove generator from engine assembly.

INSTALLATION

1. Install generator (2) to the engine and secure with hardware.
2. Install engine pulley (3) to the engine shaft and secure with hardware.

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

3. Install pulley belt adjusting arm (1) to generator (2) and secure with hardware.

NOTE: *Adjust the belt tension to 90 lbf (400N).*

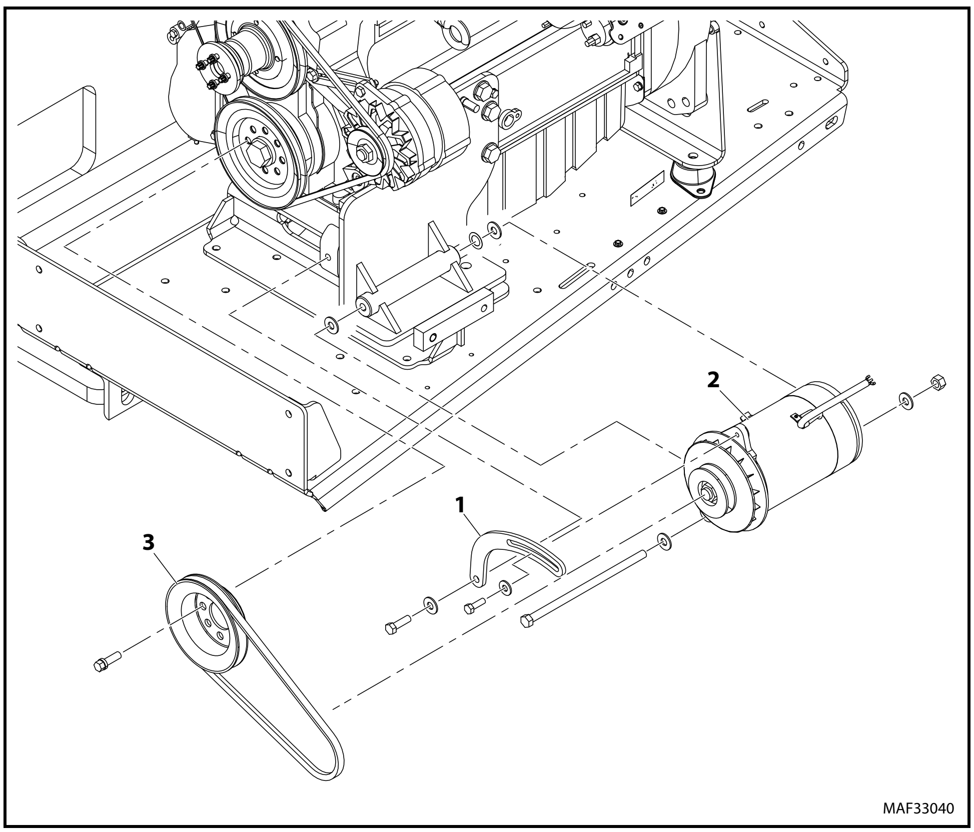


Figure 3-78. Generator Pulley (2500W) - Deutz D2011L04

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 generator pulley (3) and remove tapered bushing and pulley from the generator shaft.
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 hardwares.
2. Install generator pulley (3) and tapered bushing (2) on the generator shaft and secure with hardware.

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

3. Install pulley belt tensioner assembly (1) to generator (4) and secure with hardware.

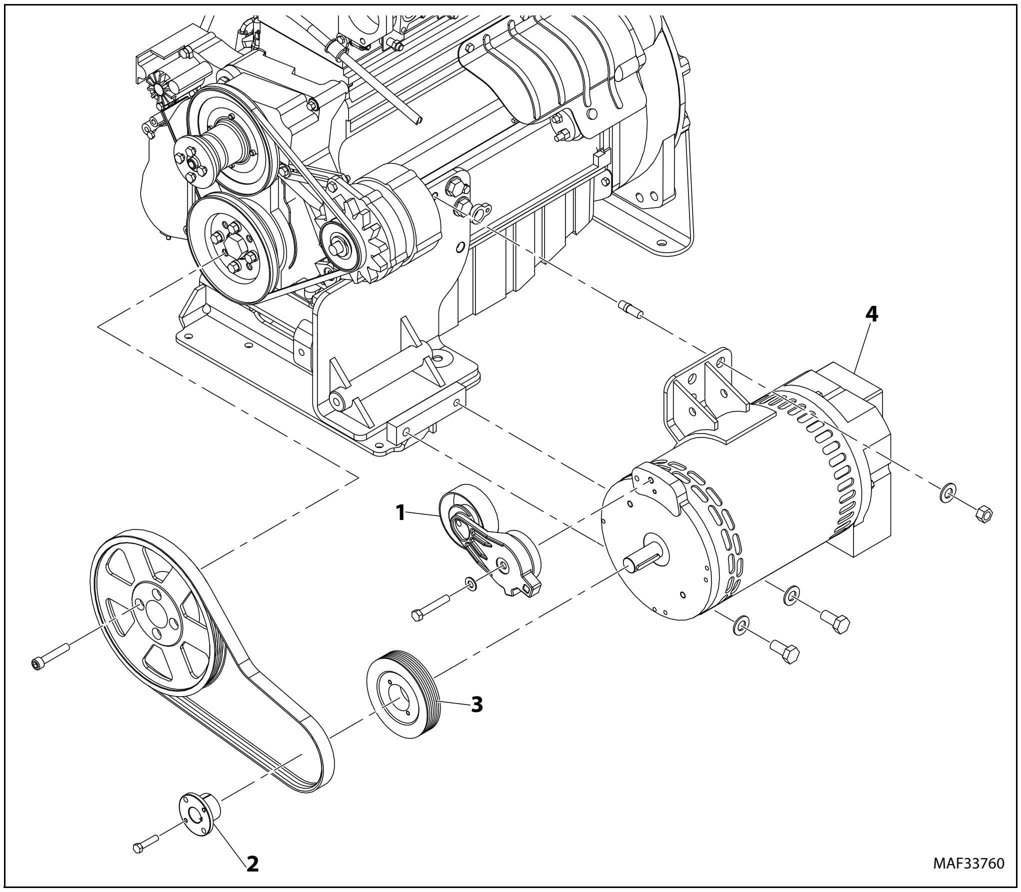


Figure 3-79. Generator and Pulley (7500W Skypower) - Deutz T4I

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 generator pulley (3) and remove tapered bushing and pulley from the generator shaft.
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.

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

3. Install pulley belt tensioner assembly (1) to generator (4) and secure with hardware.

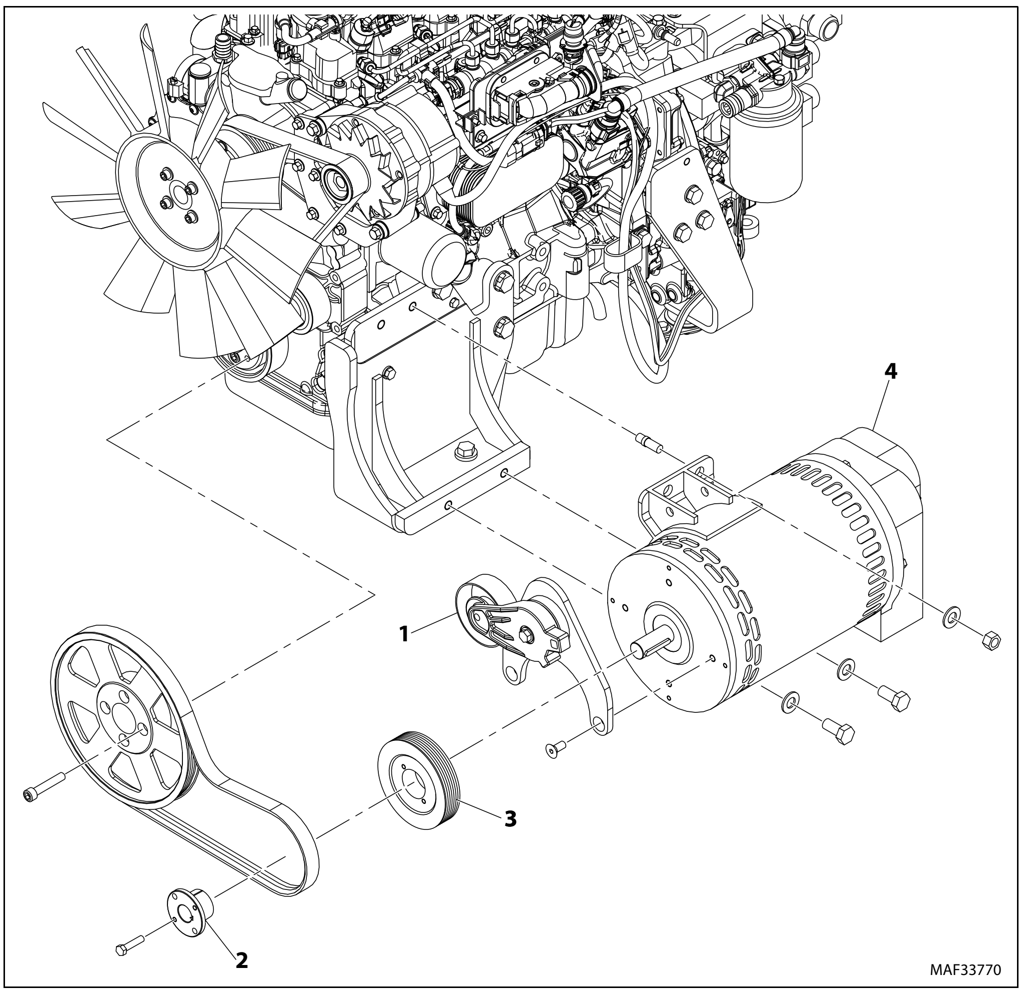


Figure 3-80. Generator and Pulley (7500W and 4000W) - Deutz TD2.9

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 generator pulley (3) and remove tapered bushing and pulley from the generator shaft.
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.

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

3. Install pulley belt tensioner assembly (1) to generator (4) and secure with hardware.

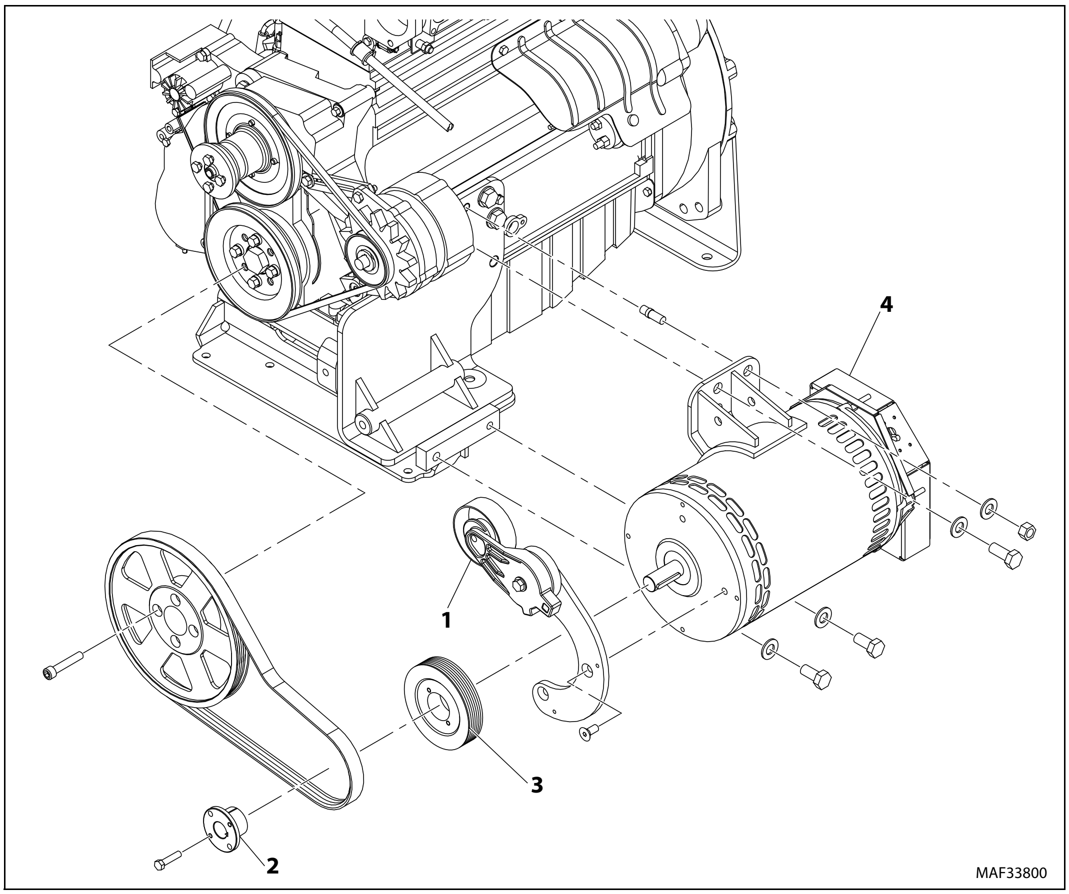


Figure 3-81. Generator and Pulley (4000W) - Deutz D2011L04

REMOVAL

1. Remove the hardware securing the pulley belt adjusting arm (1) to the generator (2) and remove pulley belt adjusting arm.
2. Remove hardware attaching engine pulley (3) to engine shaft and remove engine pulley.
3. Using suitable lifting equipment, adequately support engine assembly weight along entire length.
4. Remove the hardware securing generator (2) to the engine and remove generator from engine assembly.

INSTALLATION

1. Install generator (2) to the engine and secure with hardware.
2. Install engine pulley (3) to the engine shaft and secure with hardware.

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

3. Install pulley belt adjusting arm (1) to generator (2) and secure with hardware.

NOTE: *Adjust the belt tension to 90 lbf (400N)*

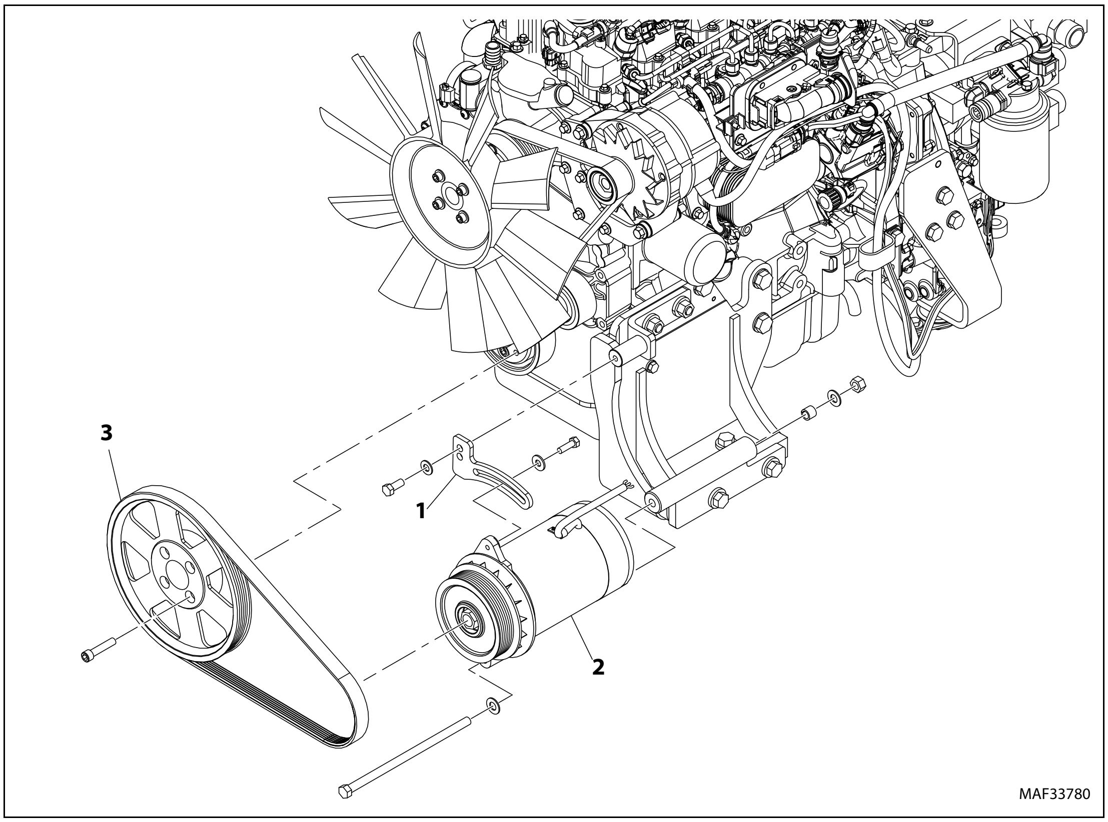


Figure 3-82. Generator and Pulley (2500W) - Deutz TD2.9

REMOVAL

1. Remove the hardware securing the pulley belt adjusting arm (1) to the generator (2) and remove pulley belt adjusting arm.
2. Remove hardware securing engine pulleys (3) to the engine shaft and remove the pulleys.
3. Using suitable lifting equipment, adequately support engine assembly weight along entire length.
4. Remove the hardware securing generator (2) to the engine and remove generator from engine assembly.

INSTALLATION

1. Install generator (2) to the engine and secure with hardware.
2. Install engine pulleys (3) on the engine shaft and secure with hardware.

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

3. Install pulley belt adjusting arm (1) to generator (2) and secure with hardwares. Torque hardware for adjuster to engine to 35 ft. lbs. (47.4 Nm).

NOTE: *Adjust the belt tension to 90 lbf (400N).*

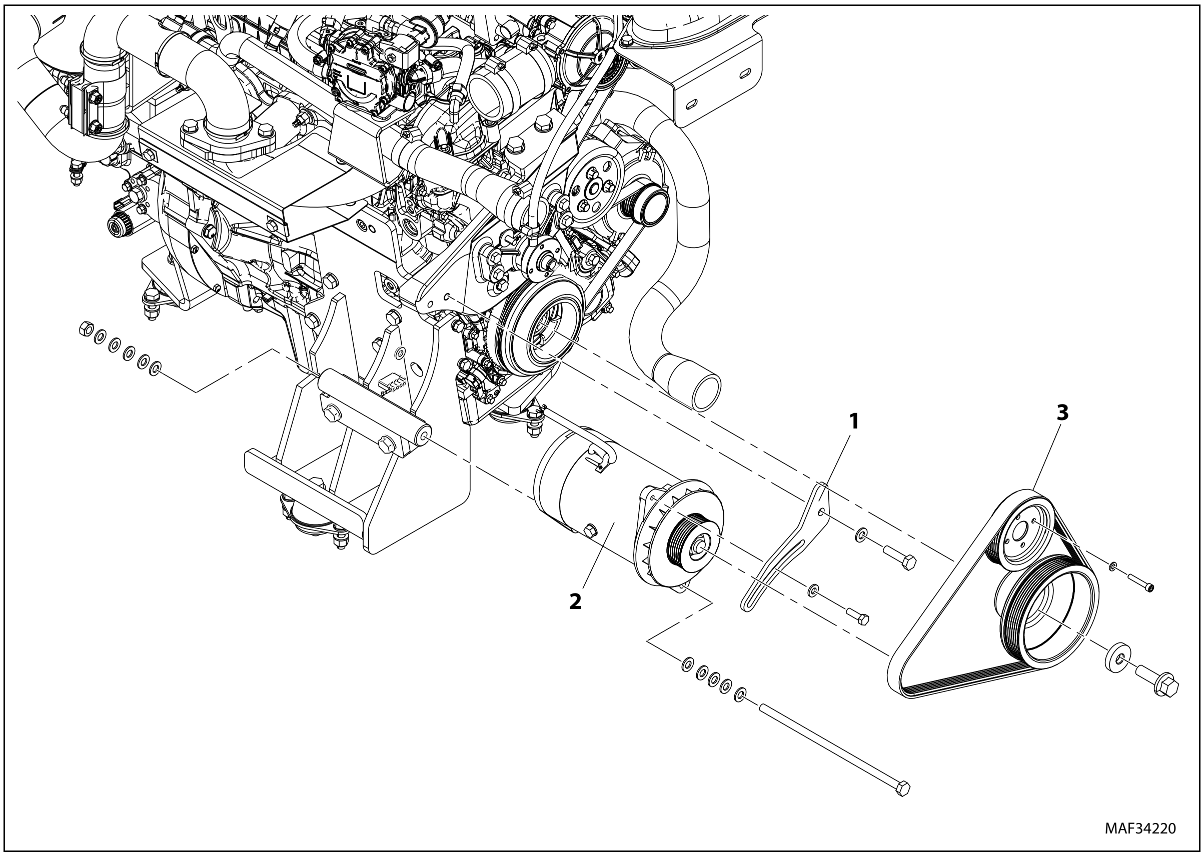


Figure 3-83. Generator and Pulley (2500W) - Ford DF 2.5L

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 generator pulley (3) and remove tapered bushing and pulley from the generator shaft.
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.

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

3. Install pulley belt tensioner assembly (1) to generator (4) and secure with hardware.

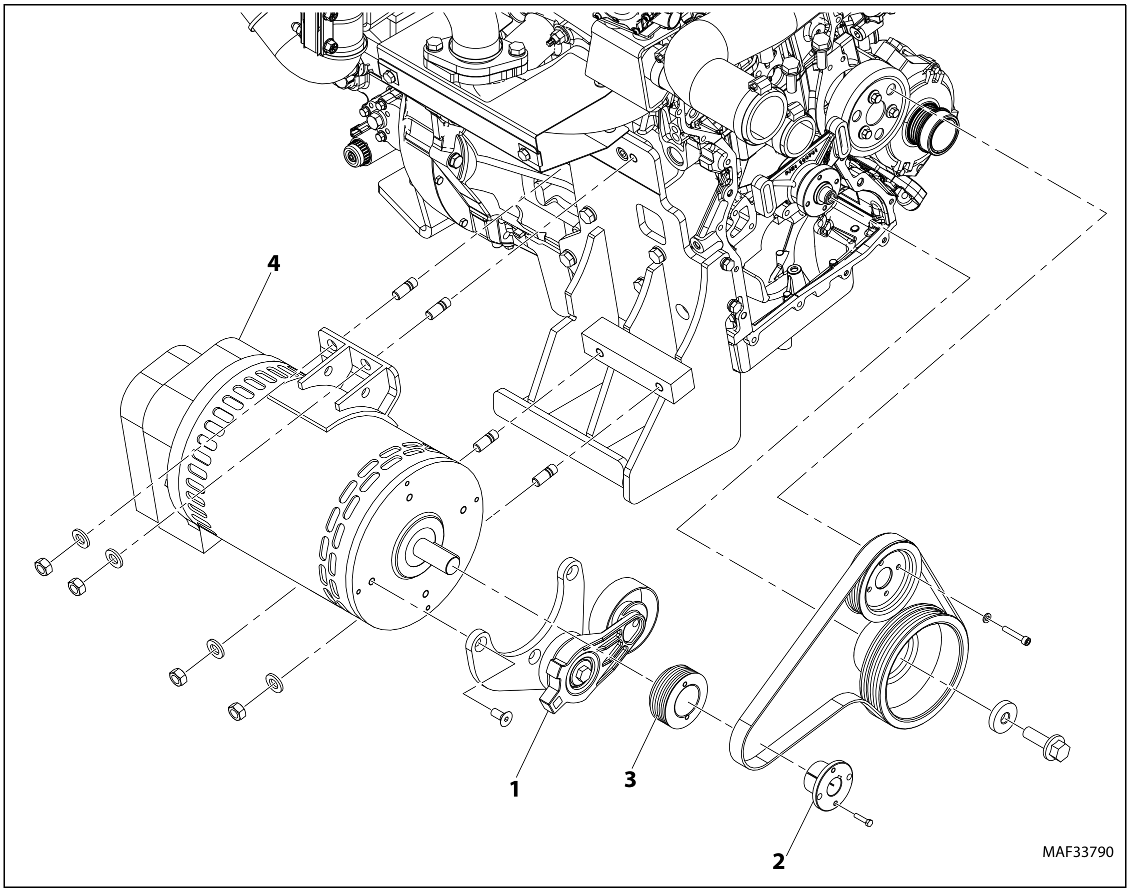


Figure 3-84. Generator and Pulley (7500W) - Ford DF 2.5L

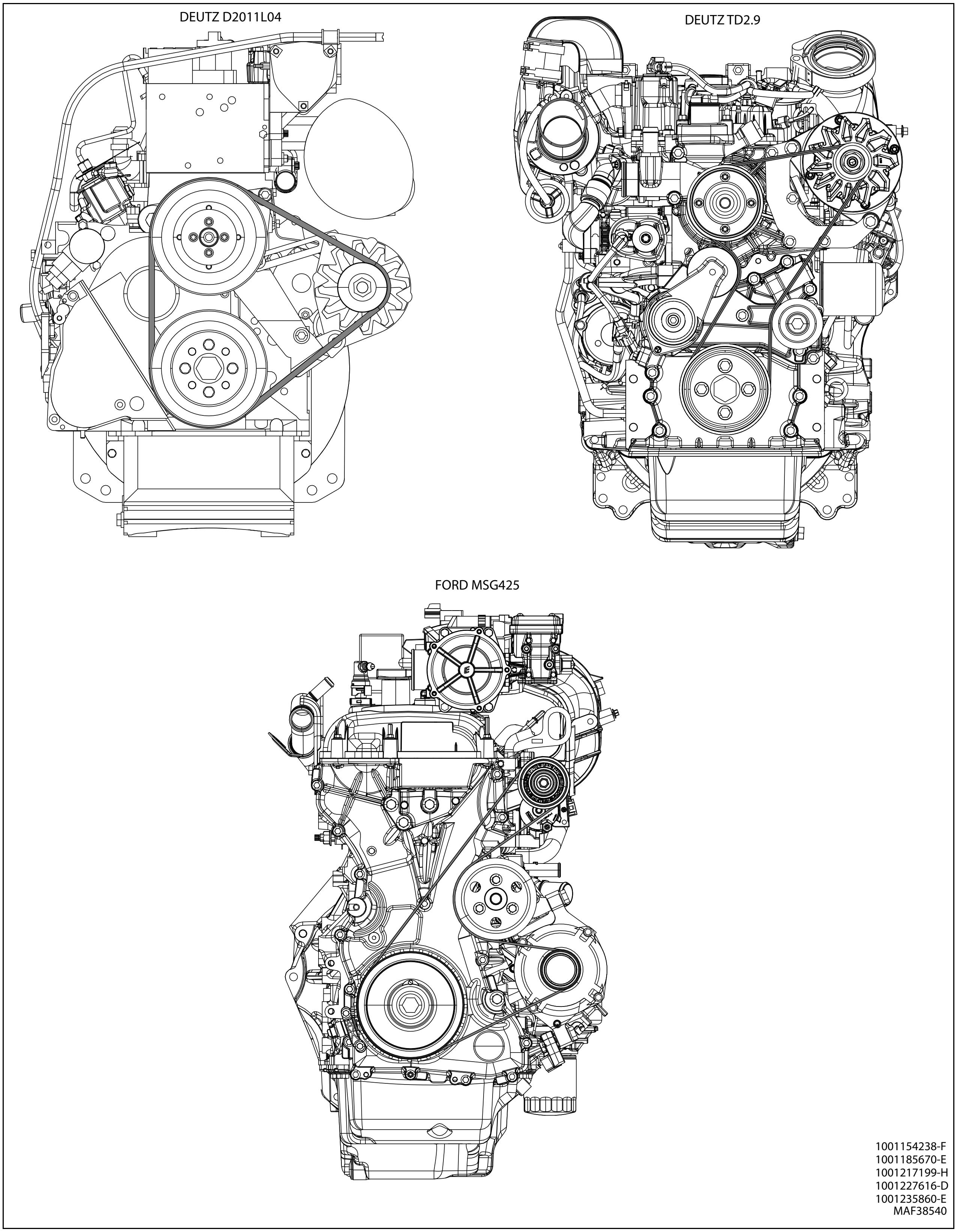
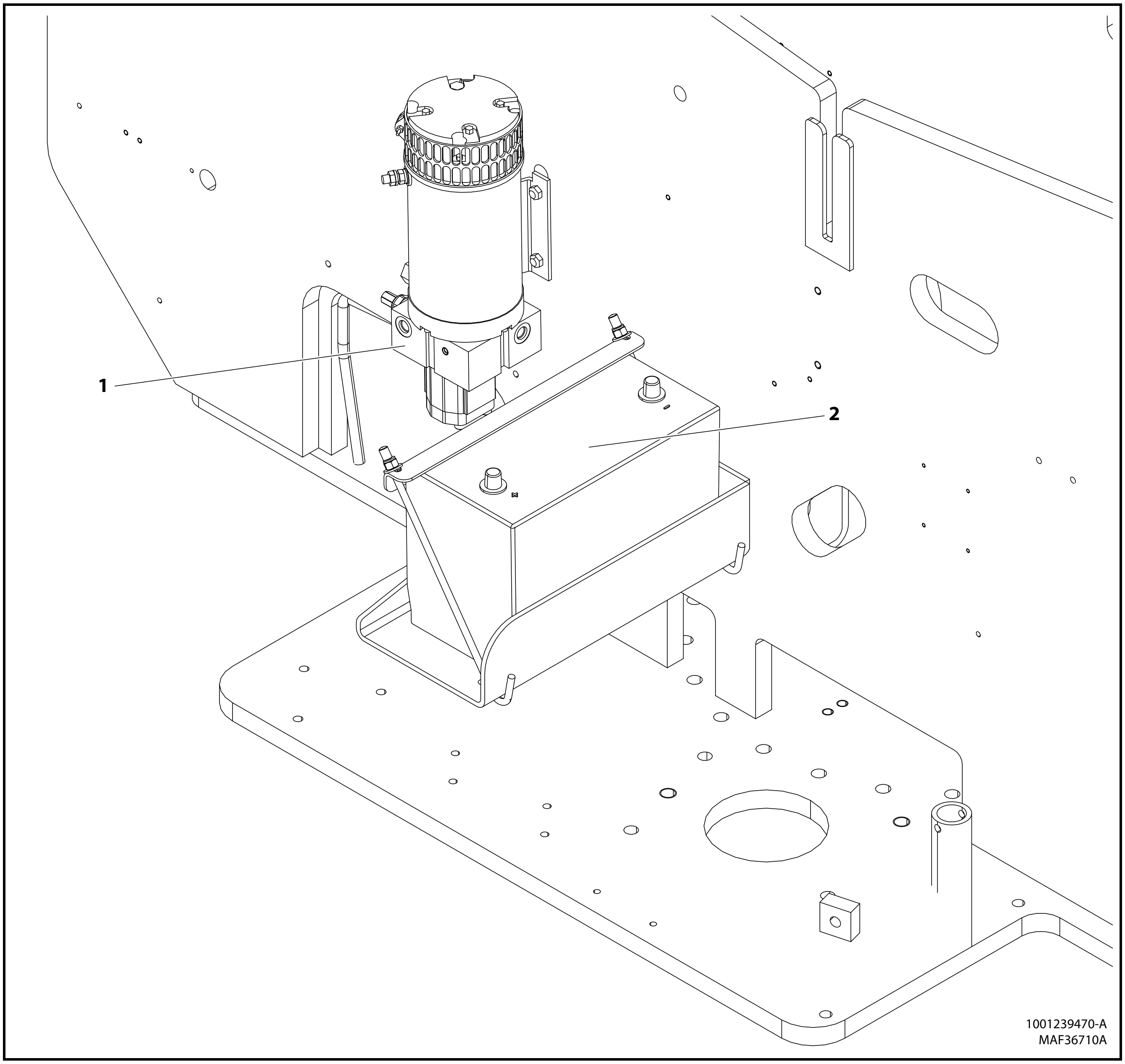


Figure 3-85. Belt Routing

3.23 AUXILIARY POWER SYSTEM

The auxiliary power system is intended as a secondary means of moving the boom in the event of primary power loss. This system uses an electric motor/pump unit powered by 12V.

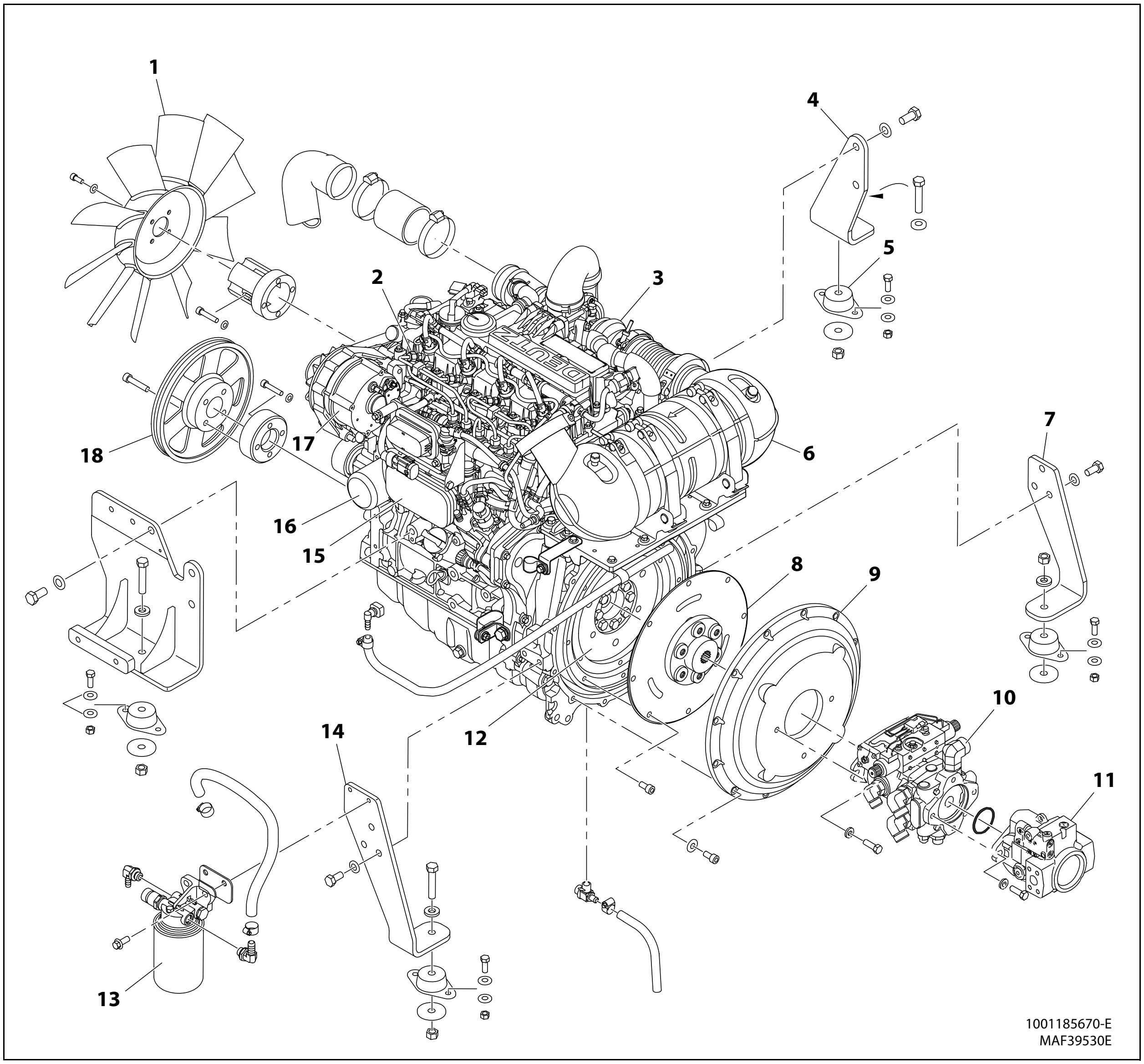
The auxiliary pump functions to provide sufficient oil flow to operate the basic machine functions should the main pump or engine fail. The auxiliary pump will operate tower boom lift, tower telescope, main boom lift, main telescope and swing. The Auxiliary Power control switch energizes the electrically operated hydraulic pump.



1. Auxiliary Pump
2. Battery

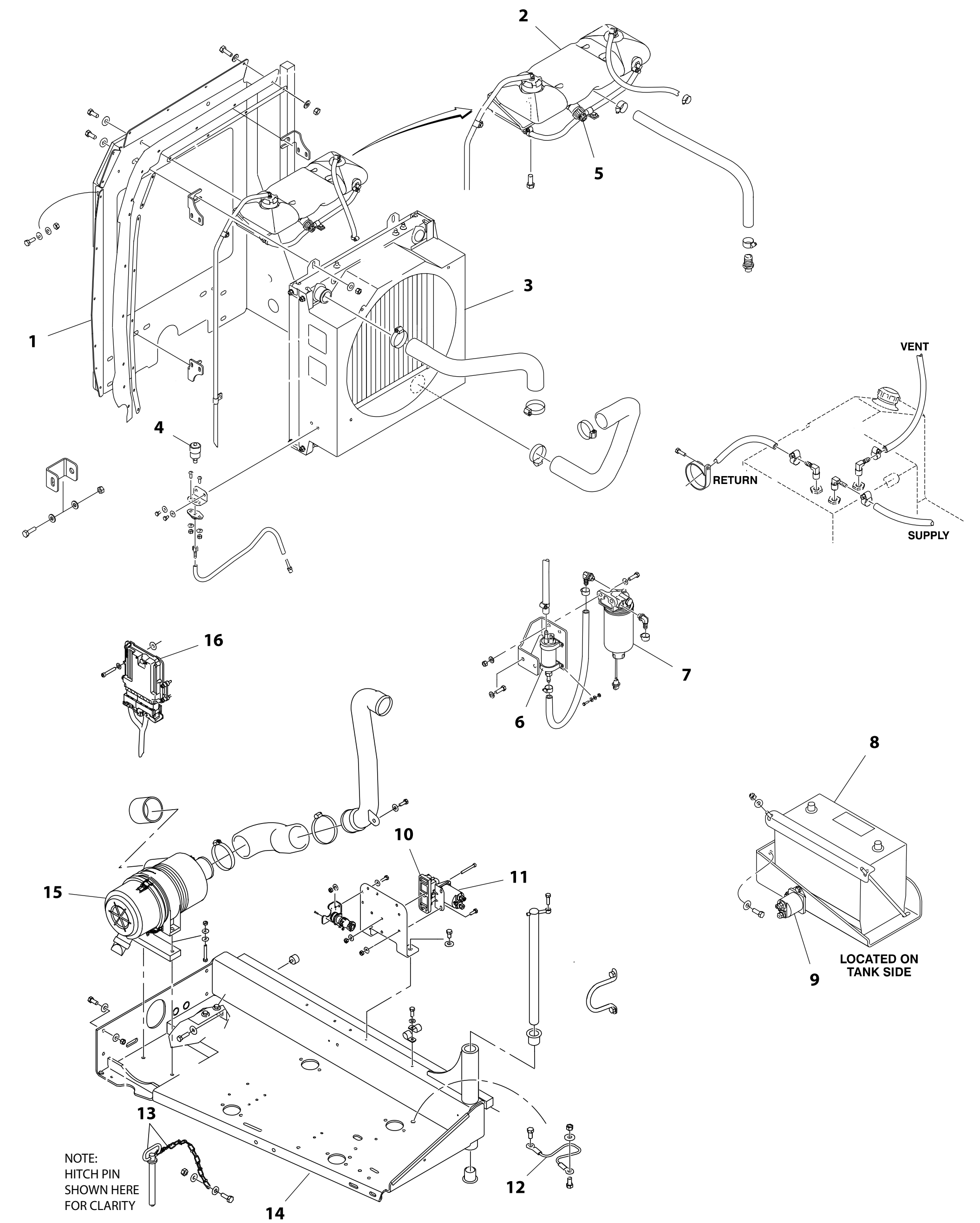
Figure 3-86. Auxiliary Power System

3.24 DEUTZ TD2.9L4 T4F ENGINE



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. Engine Isolator Mount	11. Gear Pump Assembly	17. Alternator
6. Diesel Oxidation Catalyst (DOC)	12. Flywheel	18. Pulley

Figure 3-87. Deutz TD2.9L4 T4F Engine Components - Sheet 1 of 2



1. Engine Cooler Support Assembly
2. Coolant Recovery Tank
3. Engine Cooler Assembly
4. Air Filter Service Indicator
5. Coolant Level Sensor
6. Fuel Pump
7. Fuel Pre-Filter
8. Battery
9. Battery Relay
10. Power Module Relay
11. Relay
12. Lanyard
13. Hitch Pin
14. Engine Tray
15. Air Filter Assembly
16. Engine Control Unit (ECU)

Figure 3-88. Deutz TD2.9L4 T4F Engine Components - Sheet 2 of 2

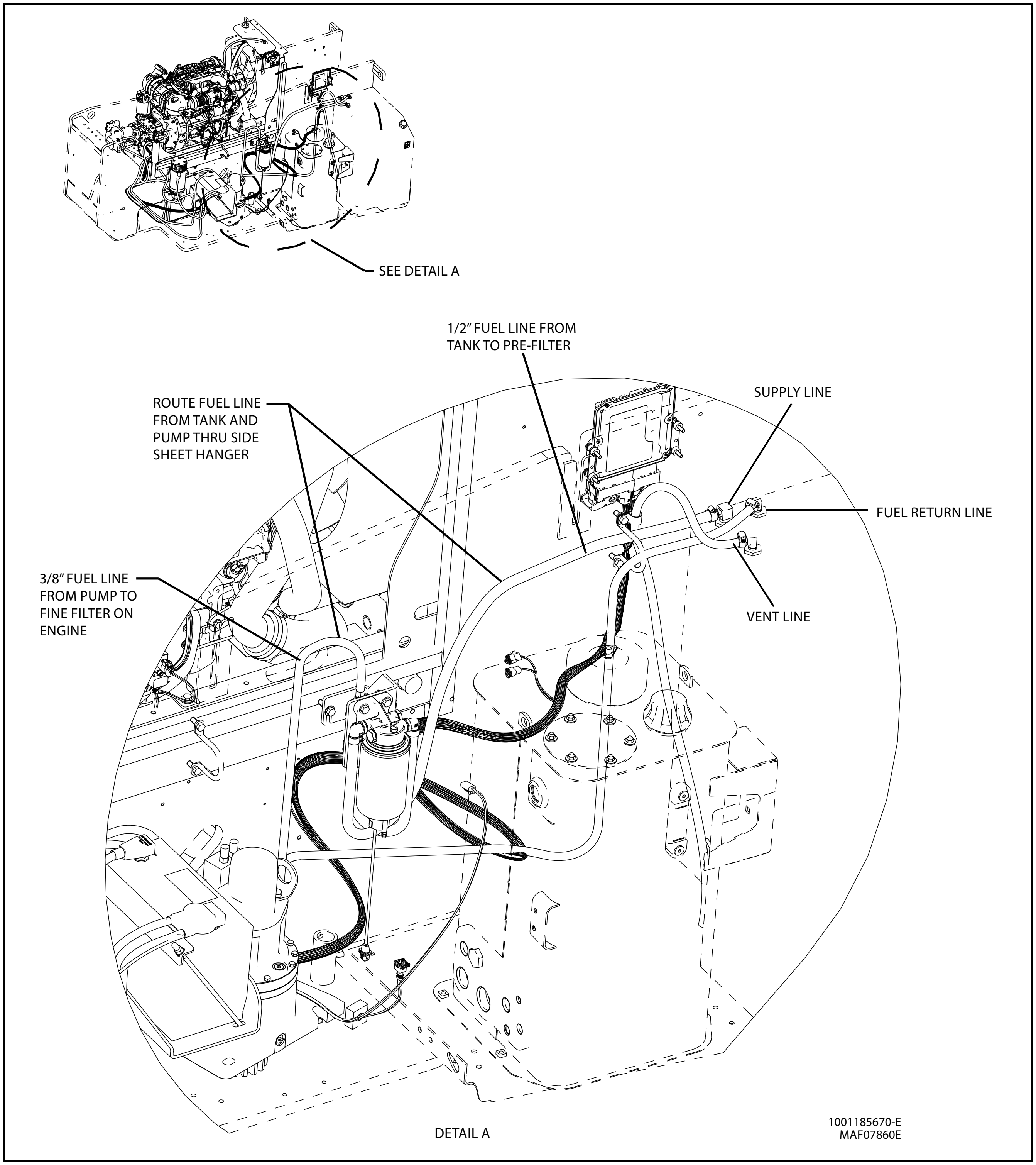


Figure 3-89. Deutz TD2.9L4 Engine Installation - Sheet 1 of 8

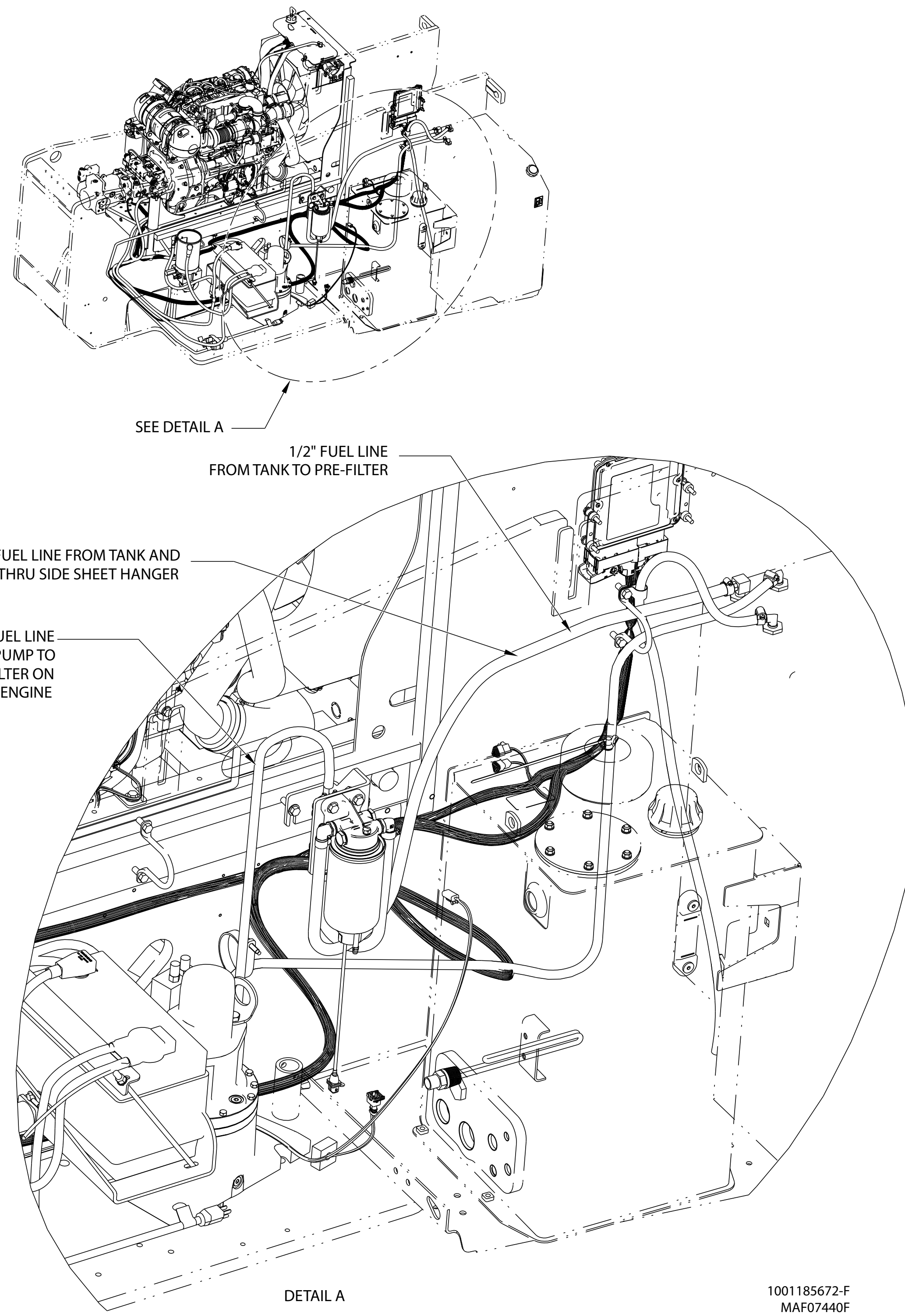


Figure 3-90. Deutz TD2.9L4 Engine Installation - Sheet 2 of 8

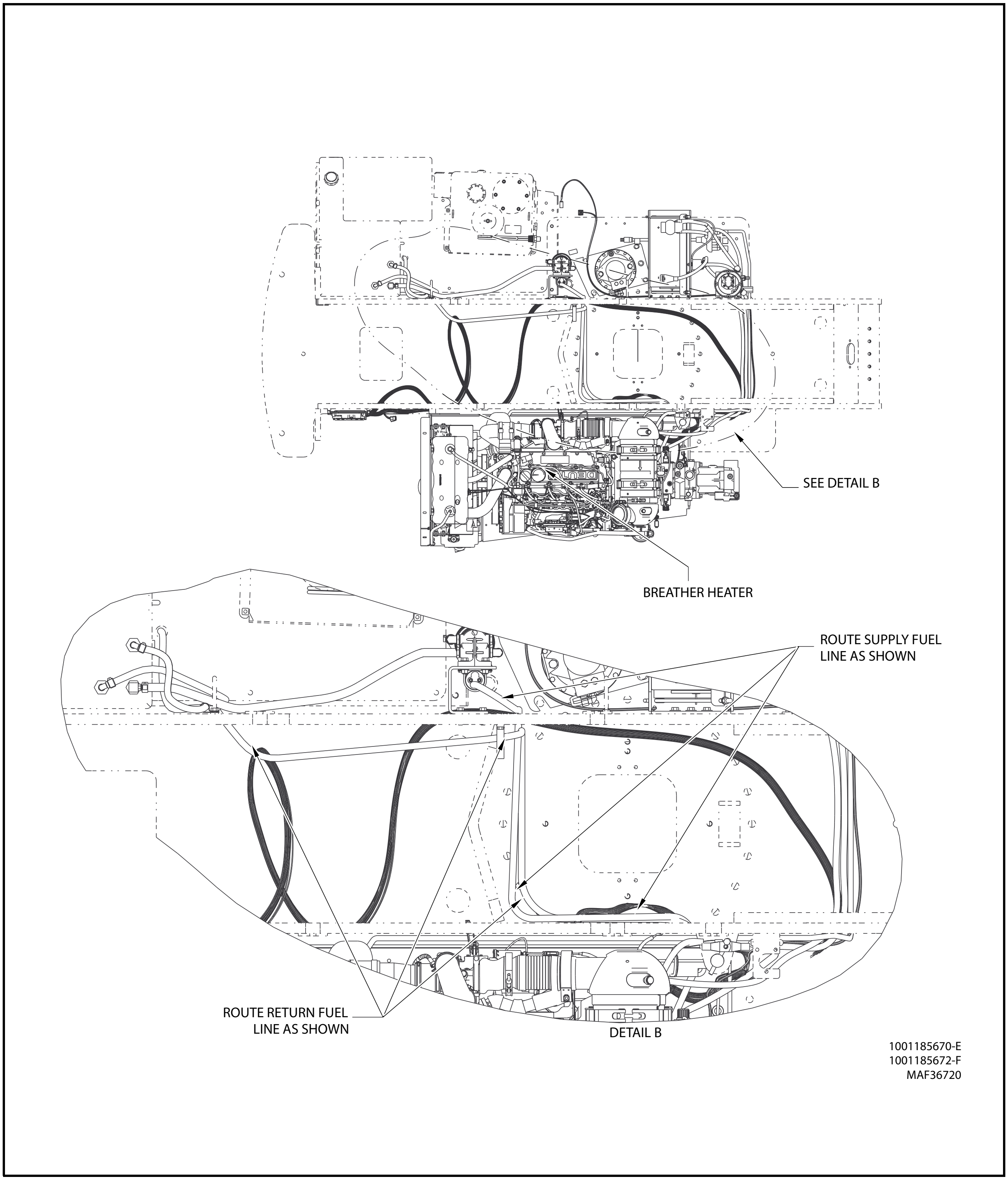


Figure 3-91. Deutz TD2.9L4 Engine Installation - Sheet 3 of 8

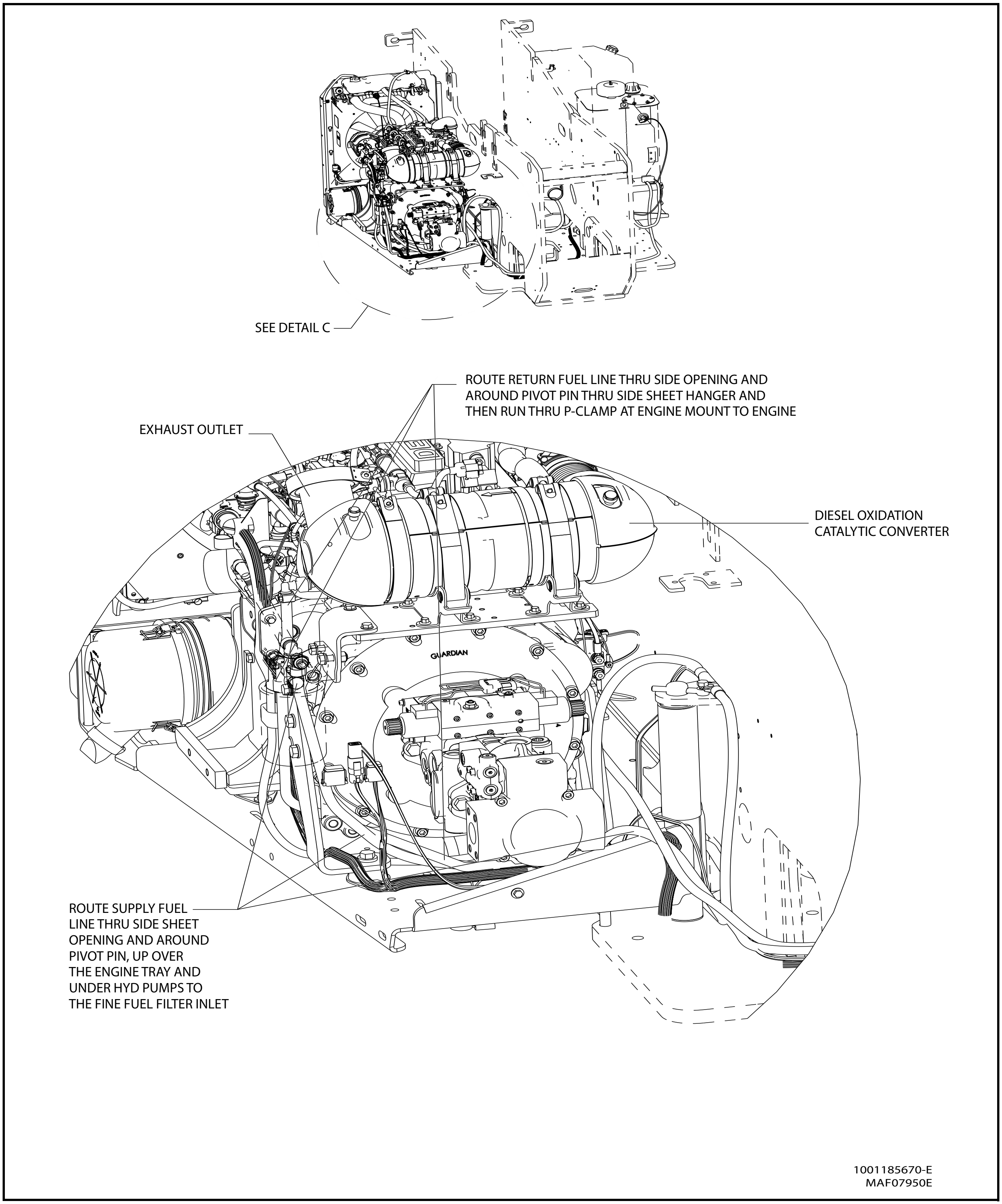


Figure 3-92. Deutz TD2.9L4 T4F Engine Installation - Sheet 4 of 8

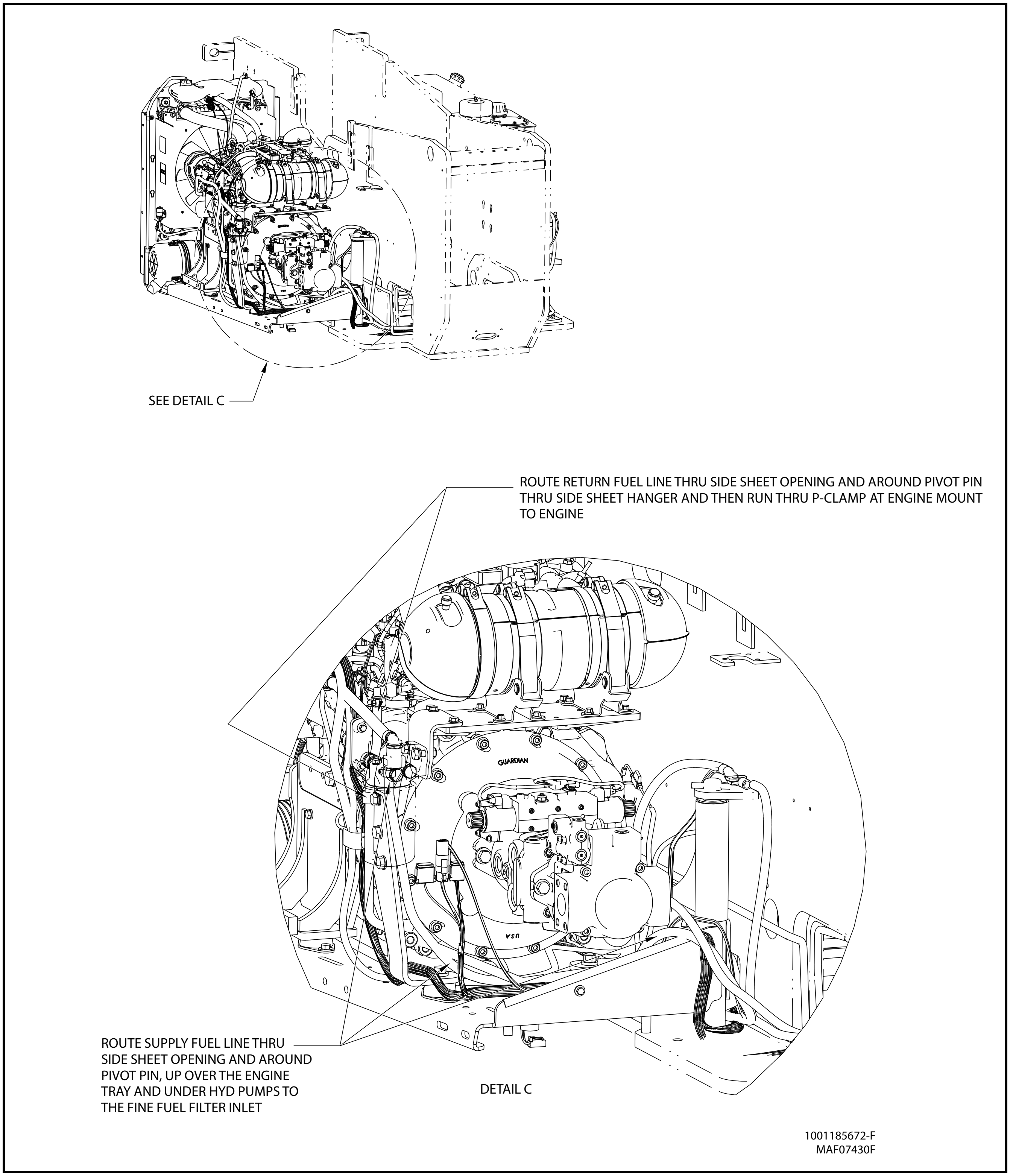


Figure 3-93. Deutz TD2.9L4 Engine Installation - Sheet 5 of 8

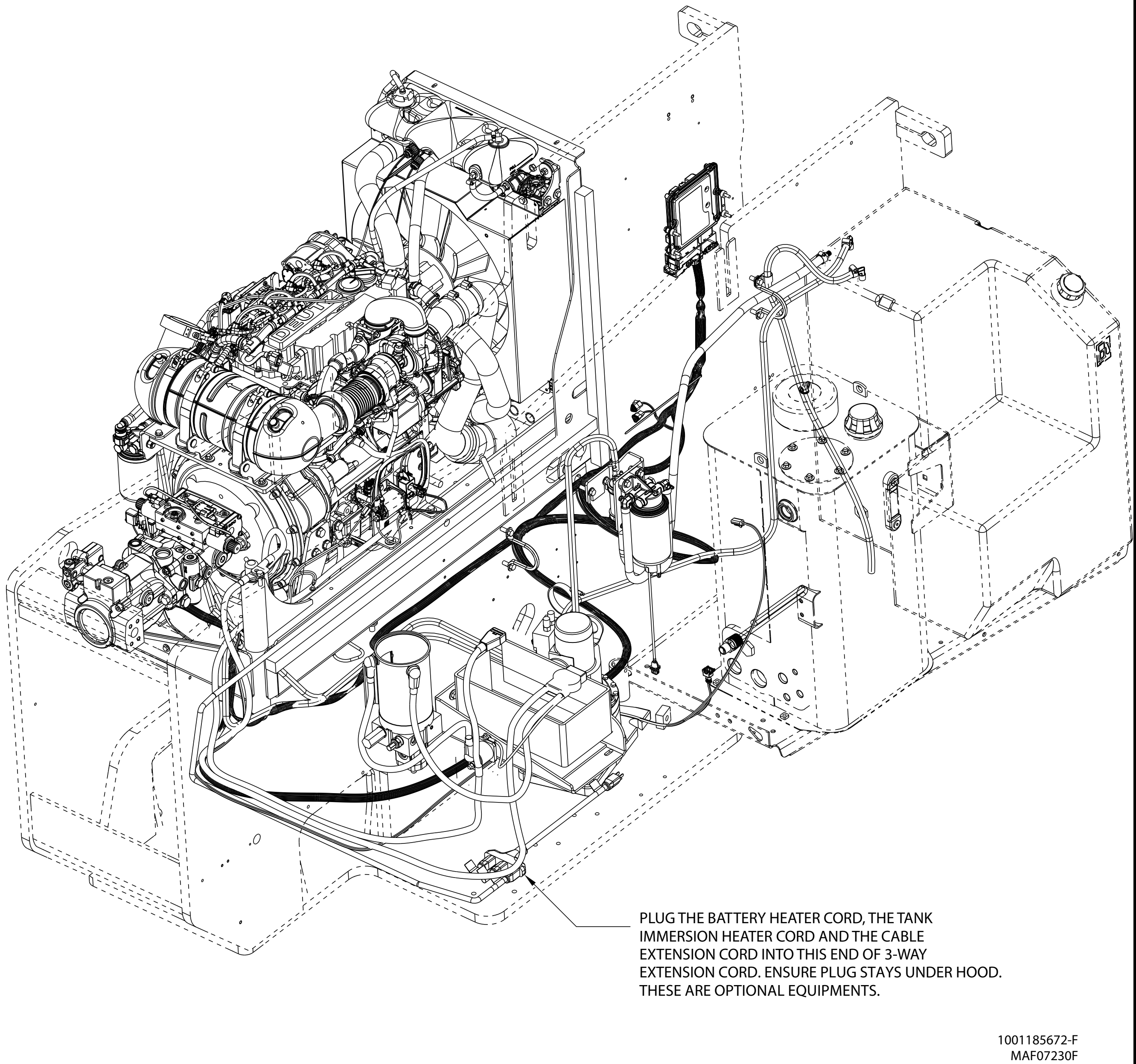


Figure 3-94. Deutz TD2.9L4 Engine Installation - Sheet 6 of 8

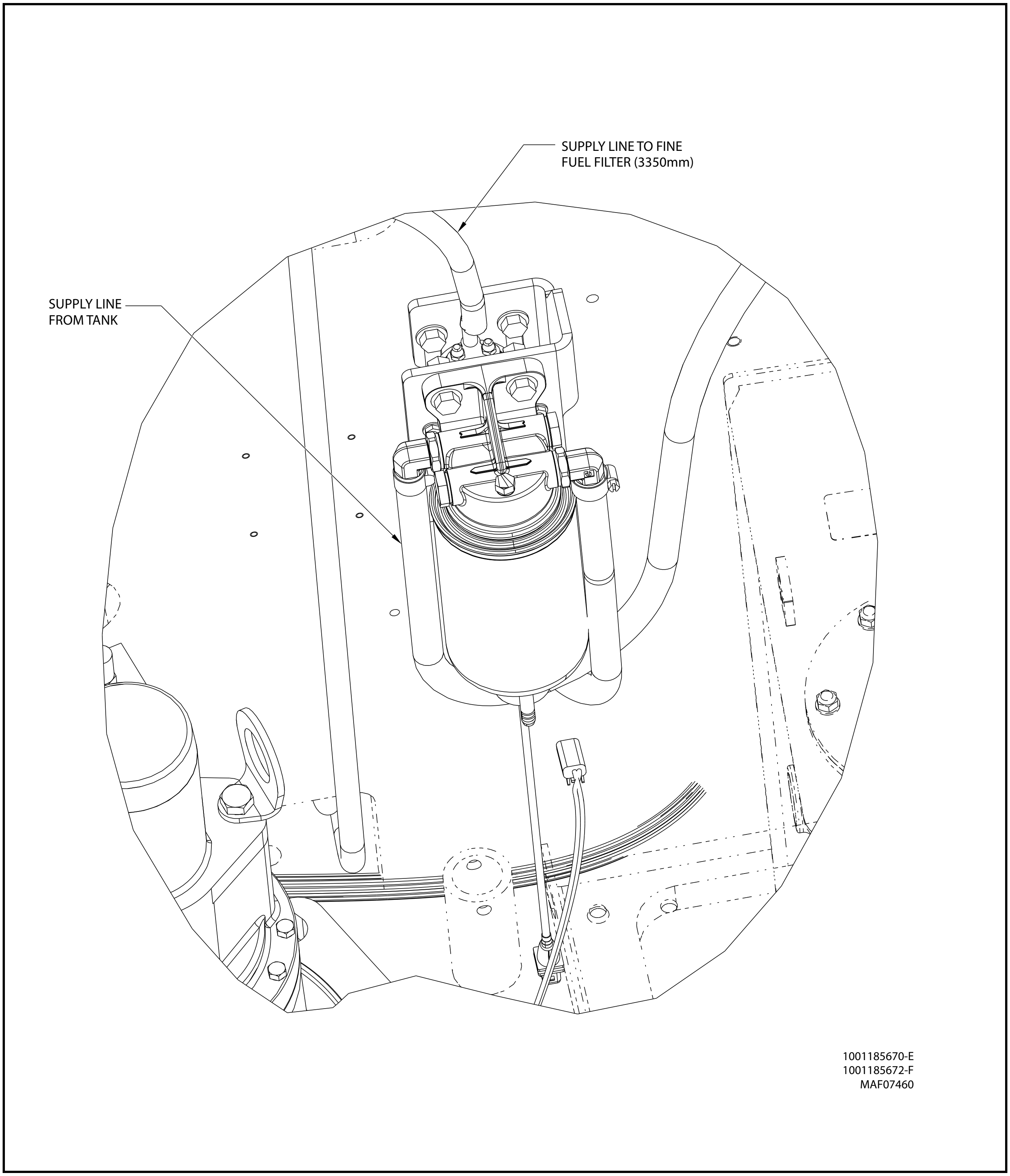


Figure 3-95. Deutz TD2.9L4 Engine Installation - Sheet 7 of 8

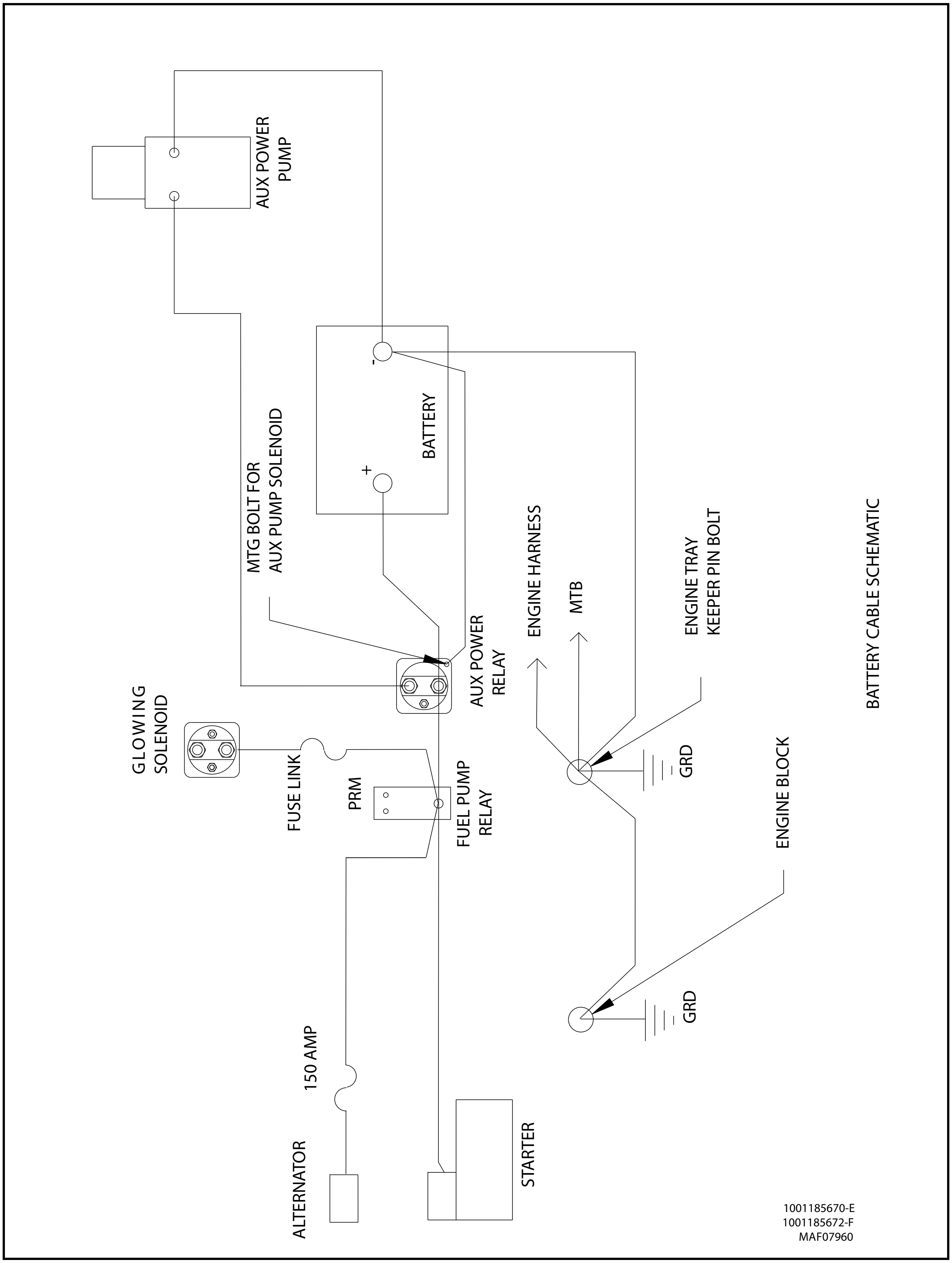


Figure 3-96. Deutz TD2.9L4 Engine Installation -Sheet 8 of 8

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.

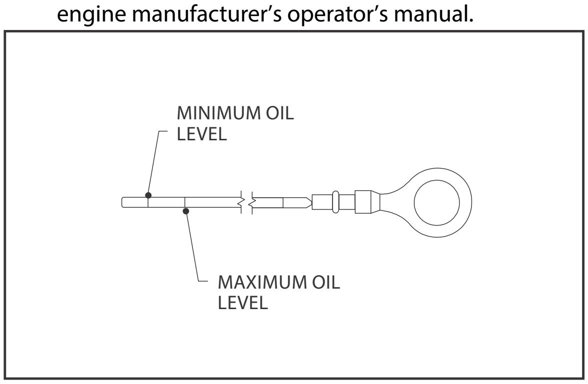


Figure 3-97. Deutz TD2.9L4 Dipstick Markings

5. Replace dipstick until fully seated.

Change Engine Oil

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

⚠ CAUTION

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

NOTICE

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

4. Open oil drain valve and drain oil.
5. Close oil drain valve.
6. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-98., Engine Oil Viscosity.

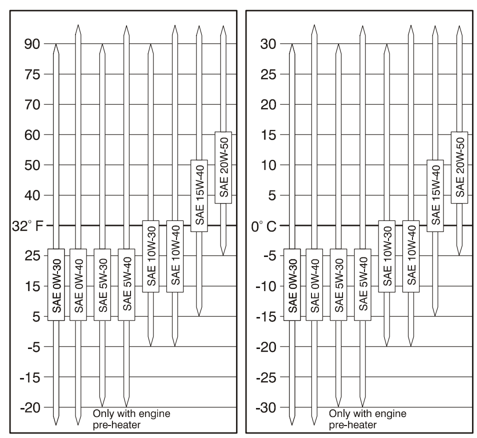
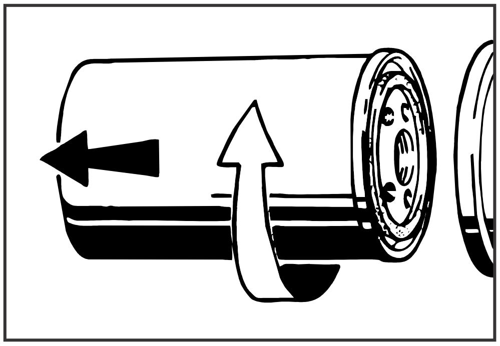


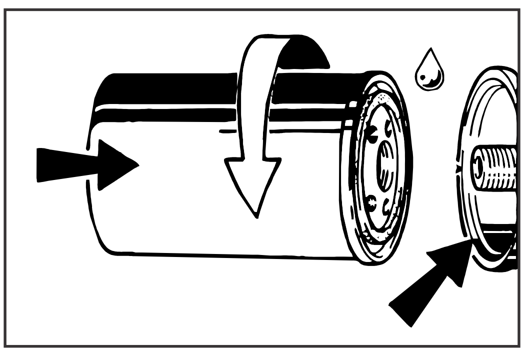
Figure 3-98. Engine Oil Viscosity

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.



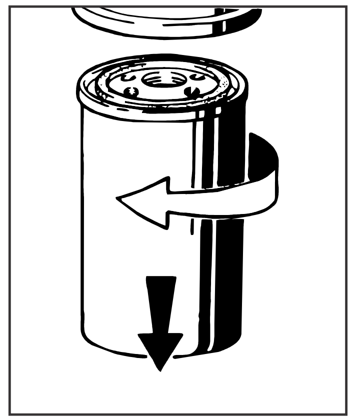
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

Change Fuel Filters

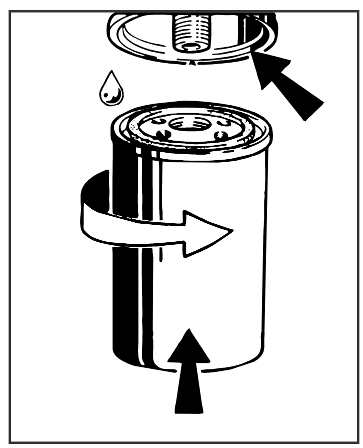
⚠ WARNING

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.

Replacing the Fuel Pre-Filter

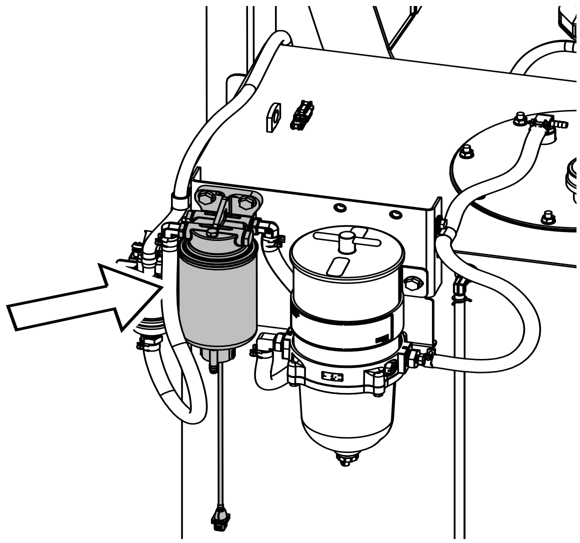
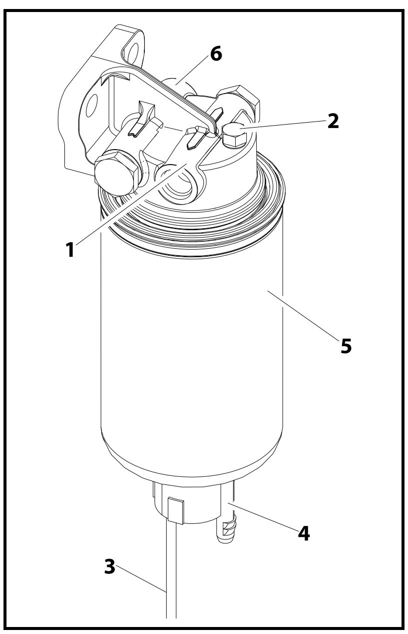


Figure 3-99. Location of Fuel Pre-Filter

NOTE: *Refer Figure 3-74., Components of Fuel Pre-Filter.*



1. Fuel Supply Flow to the Pump
2. Venting Screw
3. Electrical Connection for Water Level Sensor
4. Drain Plug
5. Filter Element
6. Fuel Inlet from the Fuel Tank

Figure 3-100. Components of Fuel Pre-Filter

⚠ WARNING

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

1. Switch off the engine.
2. Fuel supply from the fuel tank may need to be blocked to prevent fuel flow from the tank.
3. Place suitable collecting container under drain plug.
4. Disconnect electrical connections from water sensor.
5. Loosen drain plug and drain liquid.
6. Remove filter element.
7. Catch any escaping fuel.
8. Clean any dirt of the sealing surfaces of the new filter element and opposite side of filter head.
9. Wet the sealing surfaces of new filter element slightly with fuel.
10. Install new filter onto the filter head in clockwise direction. Torque to 12.5-13.3 ft. lbs. (17-18 Nm).
11. Install the drain plug and tighten to torque 1-1.4 ft. lbs. (1.3-1.9 Nm).
12. Connect electrical connection to water sensor.
13. Check for leaks after starting engine.

Water in Fuel Sensing System (Optional)

The Water in Fuel Sensing System detects when there is an excessive amount of water in the fuel and sets a DTC code in the JLG Control System to alert the operator and/or service technician.

When Water in Fuel condition occurs, the machine will respond in the following way:

- The engine will shut down automatically.
- The JLG Control System will set DTC 4375 - Water in Fuel.
- An alarm will sound from the active control station (ground or platform).
- If in platform mode, the Low Fuel Indicator will flash.
- Engine Restart will be permitted after the machine senses the Water in Fuel condition, but will only run for 2 minutes and the engine will shut down again. This restart process will continue until the Water in Fuel condition is corrected.

Draining Water

Frequency of water draining is determined by the contamination level of the fuel. Inspect or drain the collection bowl of water daily or as necessary. The collection bowl must be drained before contaminants reach the top of the turbine or

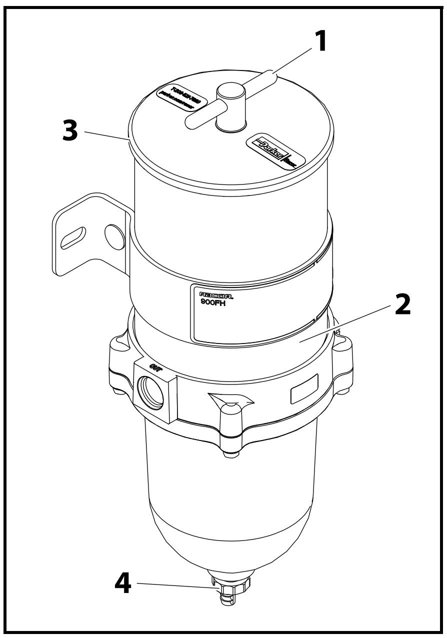
when the Water Detection Module (optional) indicates it's time to drain water.

Pressure Applications / Installations:

1. Open the drain plug on the bottom of the bowl to evacuate water and contaminants with a suitable collection container in place.
2. Close the drain after all the water and contaminants have been evacuated.

NOTE: *Do not leave the drain open too long as it may completely drain the entire filter assembly of water and fuel.*

Auxiliary Fuel Filter



1. T-handle
2. Filter Element
3. Lid
4. Drain Plug

Figure 3-101. Components of Auxiliary Fuel Filter

⚠ WARNING

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

ELEMENT REPLACEMENT

Frequency of element replacement is determined by the contamination level of the fuel. Replace the elements every 500 hours, if power loss is noticed or annually, which ever comes first.

1. Switch off the engine.
2. Fuel supply from the fuel tank may need to be blocked to prevent fuel flow from the tank.
3. Wipe the area around the filter to clean any dirt from the area.
4. Remove the T-handle and lid.
5. Remove the element by holding the bail handles and slowly pulling upward with a twisting motion. Dispose of properly.
6. Replace old lid gasket and T-handle O-ring with new seals (supplied with new element). Lubricate both seals with motor oil or diesel fuel before installation.
7. Refer to Priming of auxiliary fuel filter or fill the unit with clean fuel, then replace the lid and T-handle then tighten snugly by hand only.

NOTE: *Do not use any tool for removal and installation of T-handle.*

PRIMING OF AUXILIARY FUEL FILTER

1. Remove the T-handle and lid from the top of the filter assembly.
2. Fill the filter assembly with clean fuel.
3. Lubricate lid gasket and T-handle O-ring with clean fuel or motor oil.
4. Replace the lid and T-handle and tighten snugly by hand only.

NOTE: *Do not use any tool for removal and installation of T-handle.*

5. Start engine and check for fuel system leaks.
6. Correct as necessary with engine off and pressure relieved from filter assembly.

DRAINING WATER

Frequency of water draining is determined by the contamination level of the fuel. Inspect or drain the collection bowl of water daily or as necessary. The collection bowl must be drained before contaminants reach the top of the turbine or when the Water Detection Module (optional) indicates it's time to drain water.

Pressure Applications / Installations:

1. Open the self-venting drain plug on the bottom of the bowl to evacuate water and contaminants with a sui able collection container in place. Head pressure will push any water and contaminants out of the drain while keeping the filter primed.
2. Close the drain after all the water and contaminants have been evacuated.
3. If necessary, follow priming of auxiliary fuel filter.

NOTE: *Do not leave the drain open too long as it may completely drain the entire filter assembly of water and fuel.*

3.25 DEUTZ TD2.9L4 CHINA III ENGINE

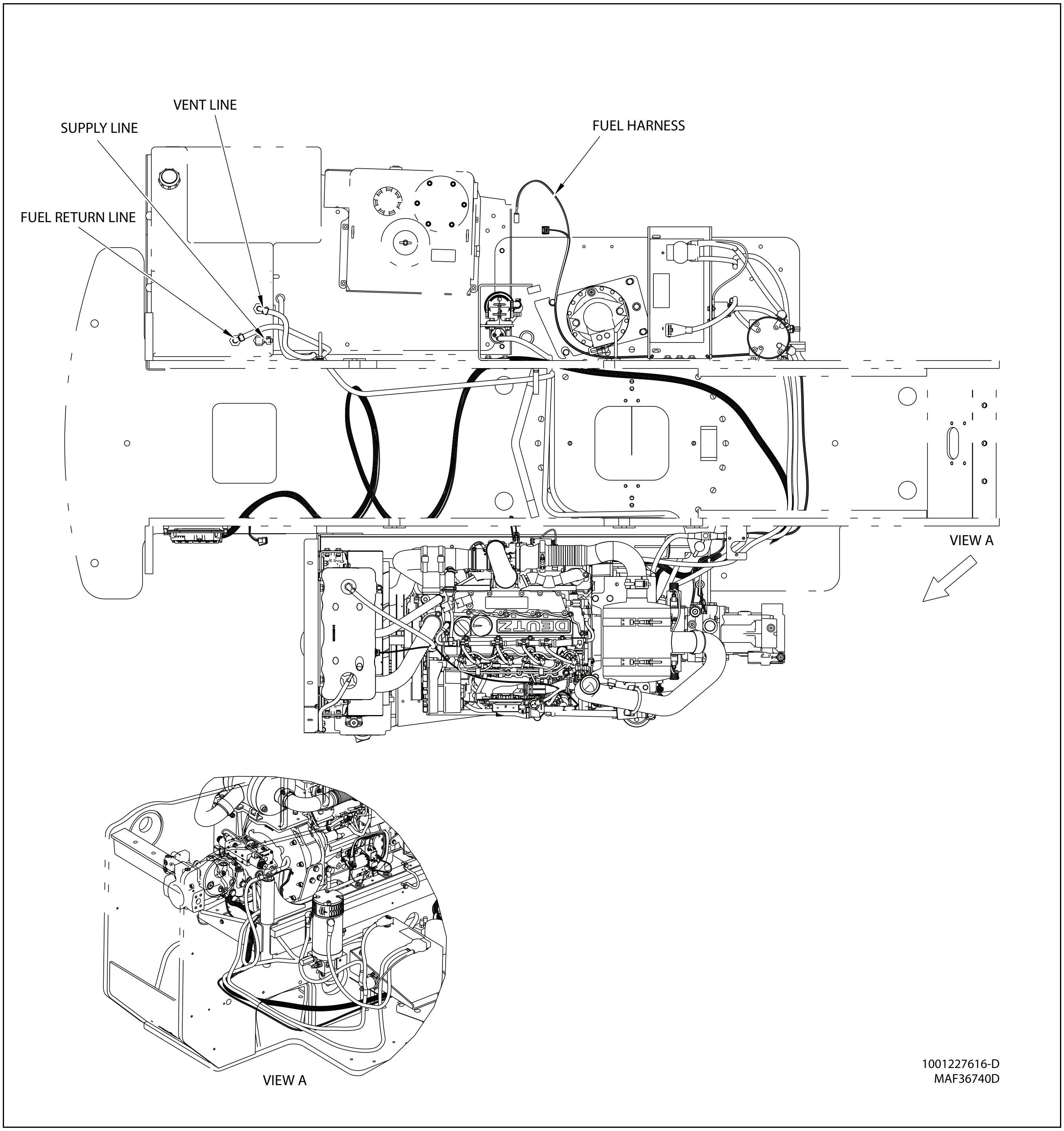


Figure 3-102. Deutz TD2.9L4 China III Engine Installation - Sheet 1 of 7

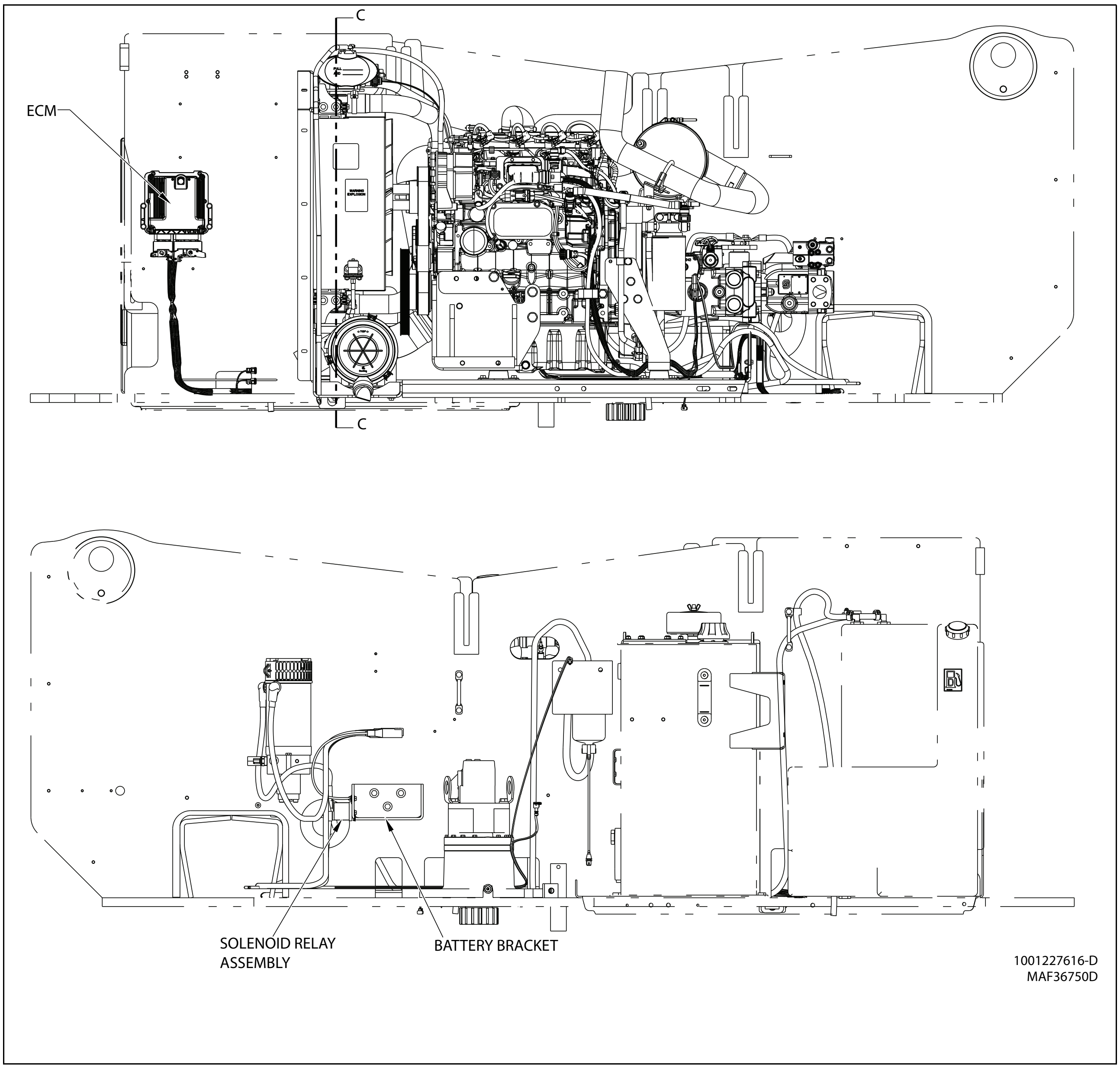
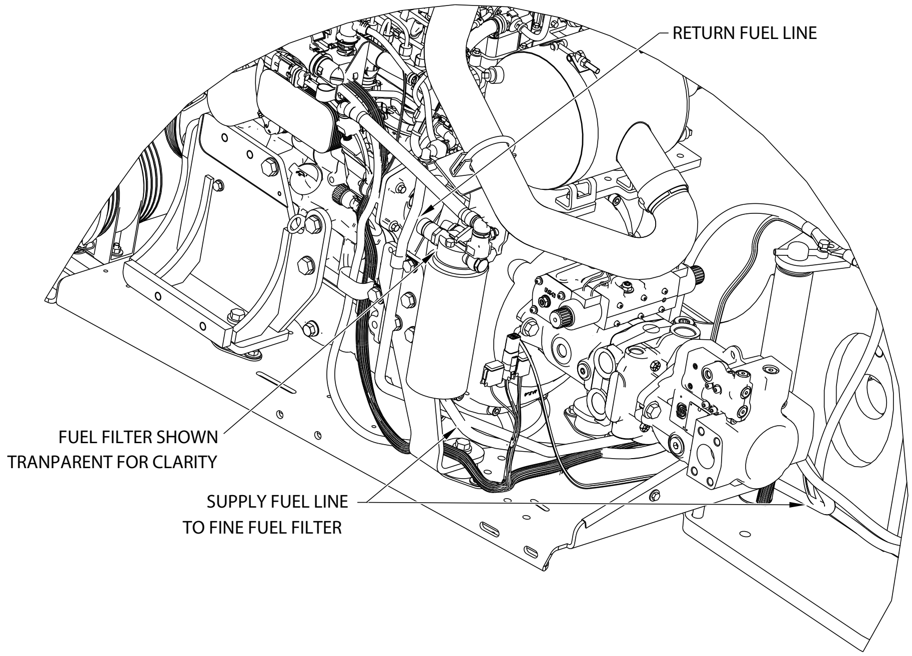


Figure 3-103. Deutz TD2.9L4 China III Engine Installation - Sheet 2 of 7



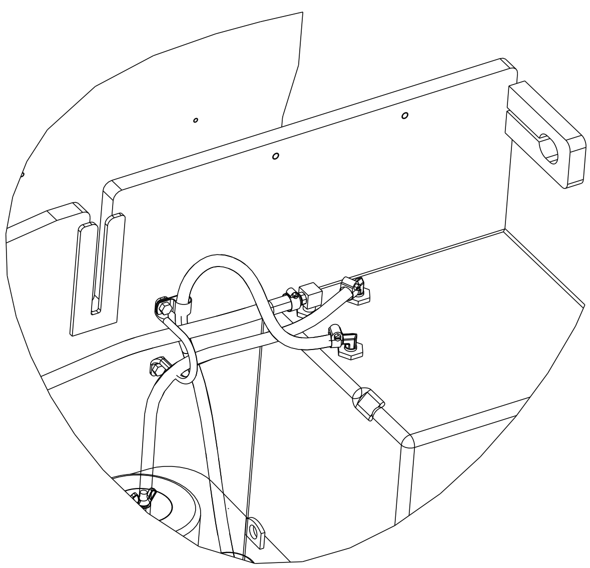


Figure 3-104. Deutz TD2.9L4 China III Engine Installation - Sheet 3 of 7

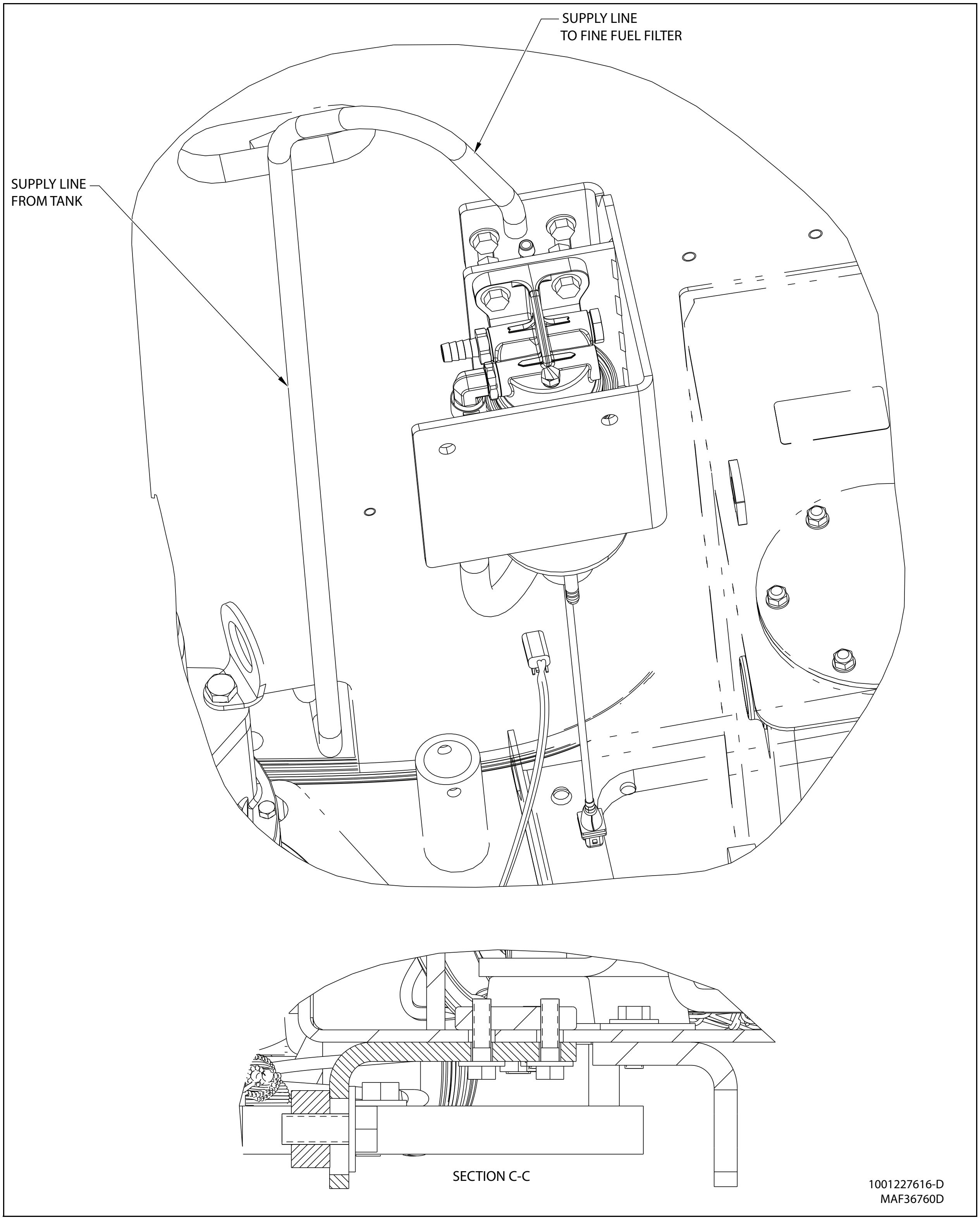


Figure 3-105. Deutz TD2.9L4 China III Engine Installation - Sheet 4 of 7

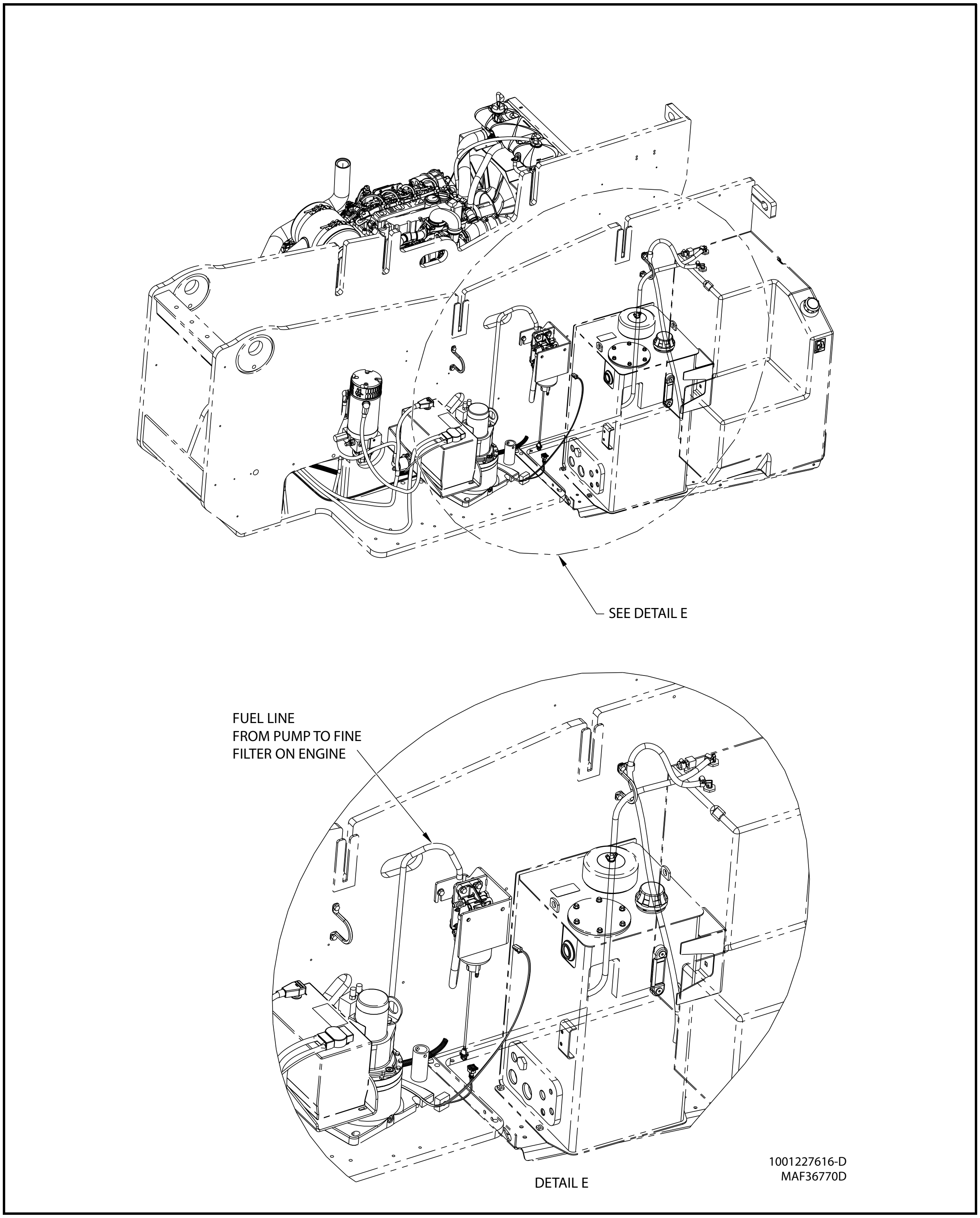


Figure 3-106. Deutz TD2.9L4 China III Engine Installation - Sheet 5 of 7

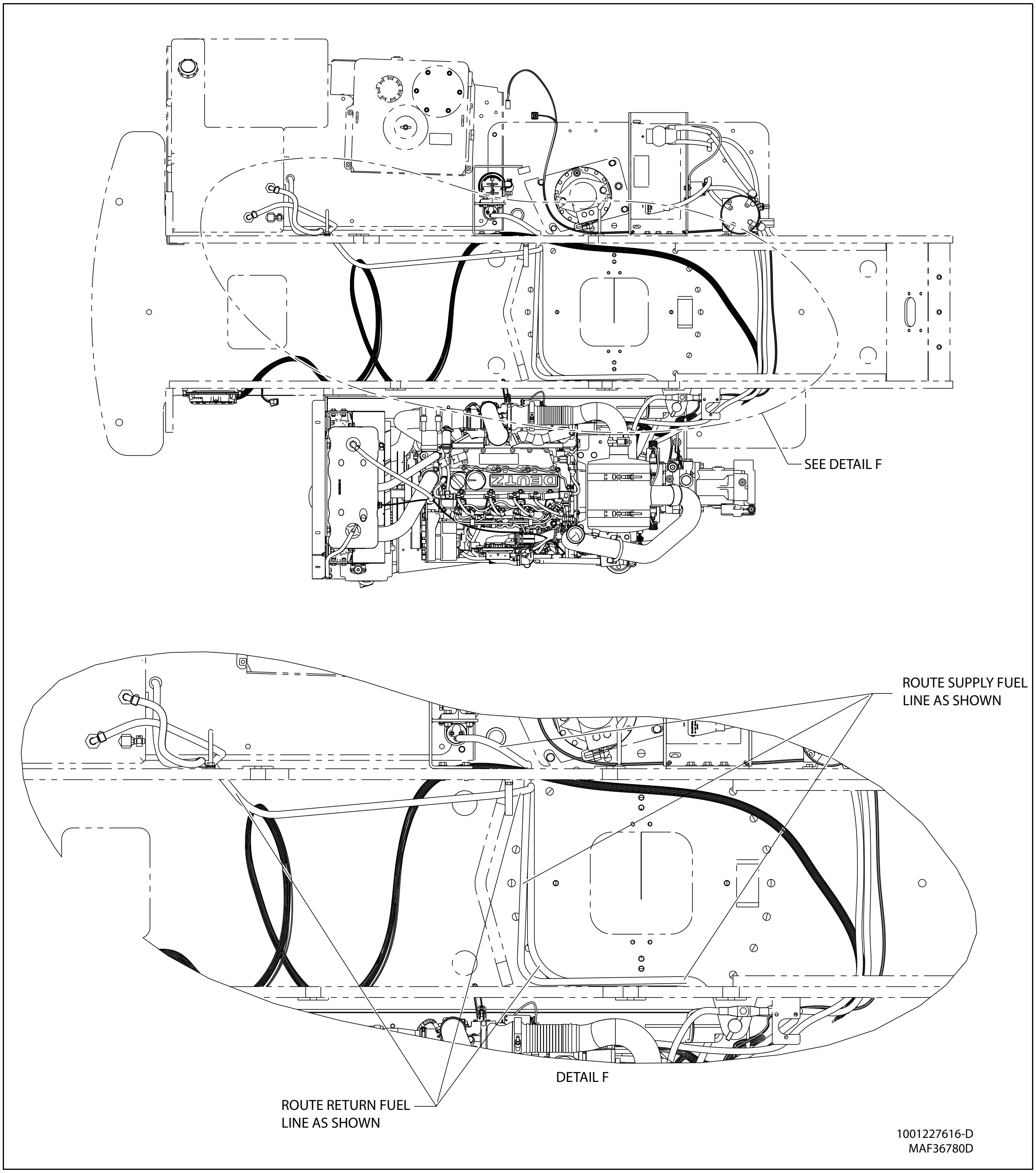


Figure 3-107. Deutz TD2.9L4 China III Engine Installation - Sheet 6 of 7

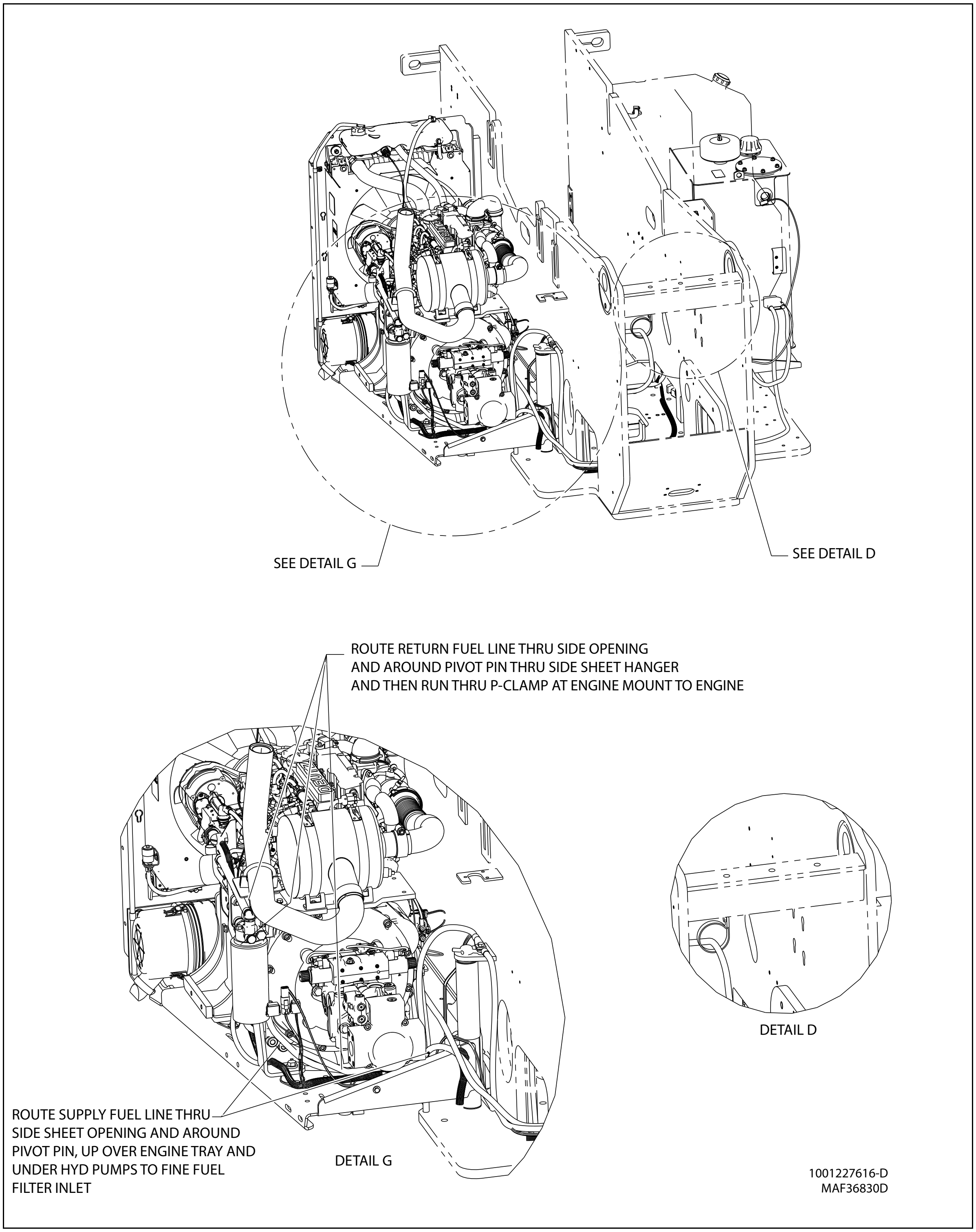


Figure 3-108. Deutz TD2.9L4 China III Engine Installation - Sheet 7 of 7

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.

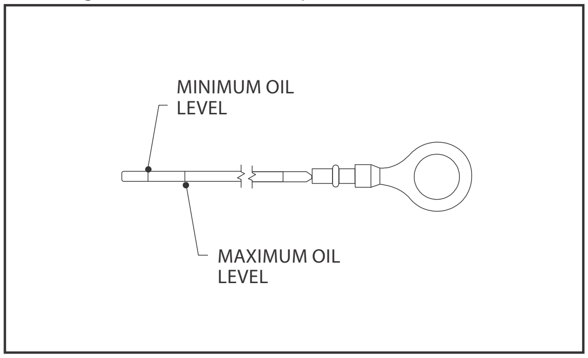


Figure 3-109. Deutz TD2.9L4 Dipstick Markings

5. Replace dipstick until fully seated.

Change Engine Oil

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

CAUTION

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

NOTICE

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

4. Open oil drain valve and drain oil.
5. Close oil drain valve.
6. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-98., Engine Oil Viscosity.

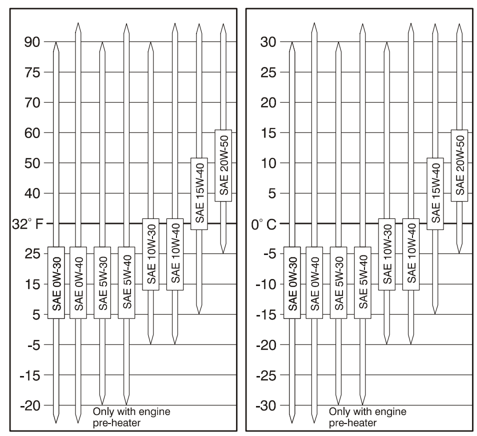
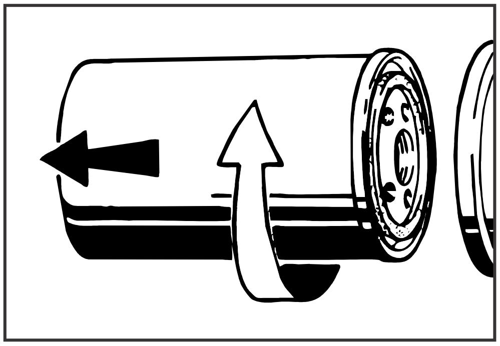


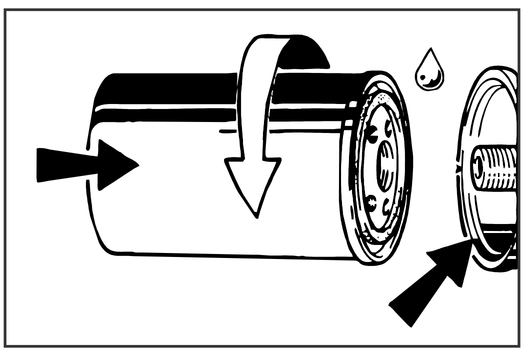
Figure 3-110. Engine Oil Viscosity

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.



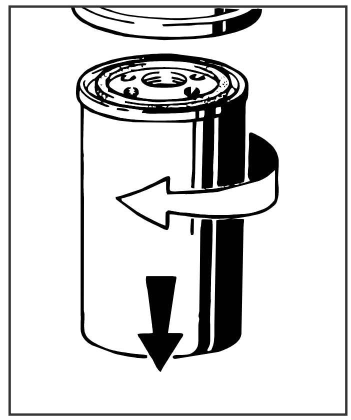
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

Change Fuel Filters

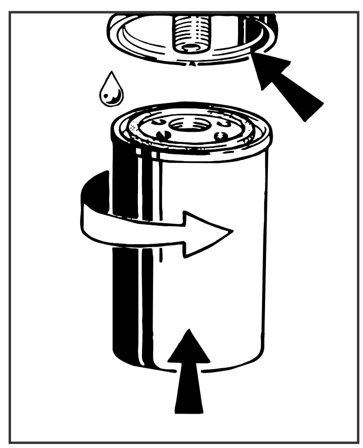
WARNING

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.

Replacing the Fuel Pre-Filter

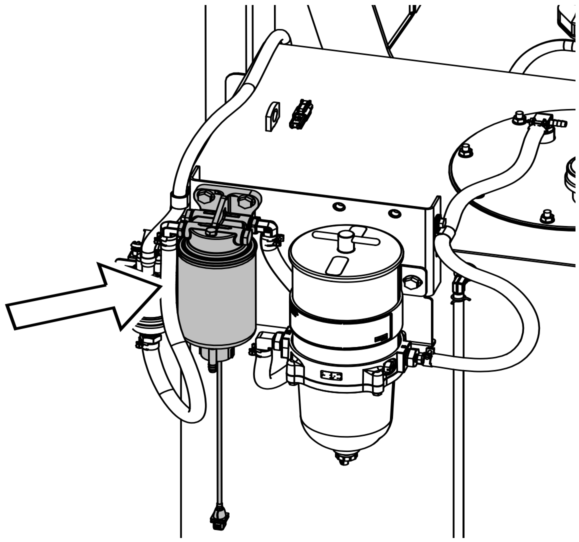
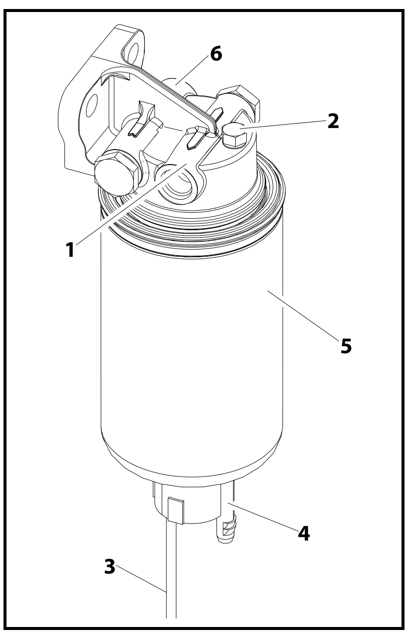


Figure 3-111. Location of Fuel Pre-Filter

NOTE: *Refer Figure 3-74., Components of Fuel Pre-Filter.*



1. Fuel Supply Flow to the Pump
2. Venting Screw
3. Electrical Connection for Water Level Sensor
4. Drain Plug
5. Filter Element
6. Fuel Inlet from the Fuel Tank

Figure 3-112. Components of Fuel Pre-Filter

⚠ WARNING

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

1. Switch off the engine.
2. Fuel supply from the fuel tank may need to be blocked to prevent fuel flow from the tank.
3. Place suitable collecting container under drain plug.
4. Disconnect electrical connections from water sensor.
5. Loosen drain plug and drain liquid.
6. Remove filter element.
7. Catch any escaping fuel.
8. Clean any dirt of the sealing surfaces of the new filter element and opposite side of filter head.
9. Wet the sealing surfaces of new filter element slightly with fuel.
10. Install new filter onto the filter head in clockwise direction. Torque to 12.5-13.3 ft. lbs. (17-18 Nm).
11. Install the drain plug and tighten to torque 1-1.4 ft. lbs. (1.3-1.9 Nm).
12. Connect electrical connection to water sensor.
13. Check for leaks after starting engine.

Water in Fuel Sensing System (Optional)

The Water in Fuel Sensing System detects when there is an excessive amount of water in the fuel and sets a DTC code in the JLG Control System to alert the operator and/or service technician.

When Water in Fuel condition occurs, the machine will respond in the following way:

- The engine will shut down automatically.
- The JLG Control System will set DTC 4375 - Water in Fuel.
- An alarm will sound from the active control station (ground or platform).
- If in platform mode, the Low Fuel Indicator will flash.
- Engine Restart will be permitted after the machine senses the Water in Fuel condition, but will only run for 2 minutes and the engine will shut down again. This restart process will continue until the Water in Fuel condition is corrected.

Draining Water

Frequency of water draining is determined by the contamination level of the fuel. Inspect or drain the collection bowl of water daily or as necessary. The collection bowl must be drained before contaminants reach the top of the turbine or

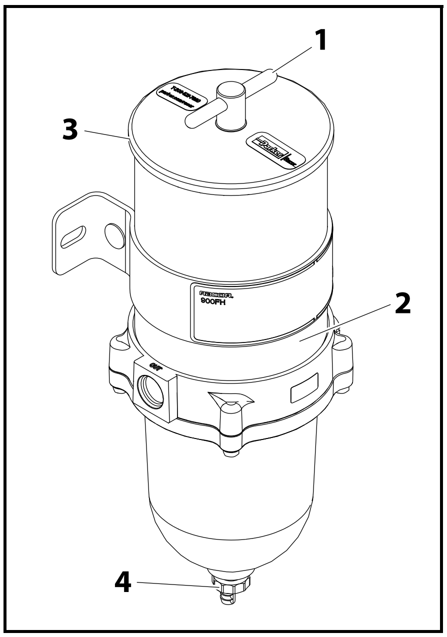
when the Water Detection Module (optional) indicates it's time to drain water.

Pressure Applications / Installations:

1. Open the drain plug on the bottom of the bowl to evacuate water and contaminants with a suitable collection container in place.
2. Close the drain after all the water and contaminants have been evacuated.

NOTE: *Do not leave the drain open too long as it may completely drain the entire filter assembly of water and fuel.*

Auxiliary Fuel Filter



1. T-handle	3. Lid
2. Filter Element	4. Drain Plug

Figure 3-113. Components of Auxiliary Fuel Filter

⚠ WARNING

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

ELEMENT REPLACEMENT

Frequency of element replacement is determined by the contamination level of the fuel. Replace the elements every 500 hours, if power loss is noticed or annually, which ever comes first.

1. Switch off the engine.
2. Fuel supply from the fuel tank may need to be blocked to prevent fuel flow from the tank.
3. Wipe the area around the filter to clean any dirt from the area.
4. Remove the T-handle and lid.
5. Remove the element by holding the bail handles and slowly pulling upward with a twisting motion. Dispose of properly.
6. Replace old lid gasket and T-handle O-ring with new seals (supplied with new element). Lubricate both seals with motor oil or diesel fuel before installation.
7. Refer to Priming of auxiliary fuel filter or fill the unit with clean fuel, then replace the lid and T-handle then tighten snugly by hand only.

NOTE: *Do not use any tool for removal and installation of T-handle.*

PRIMING OF AUXILIARY FUEL FILTER

1. Remove the T-handle and lid from the top of the filter assembly.
2. Fill the filter assembly with clean fuel.
3. Lubricate lid gasket and T-handle O-ring with clean fuel or motor oil.
4. Replace the lid and T-handle and tighten snugly by hand only.

NOTE: *Do not use any tool for removal and installation of T-handle.*

5. Start engine and check for fuel system leaks.
6. Correct as necessary with engine off and pressure relieved from filter assembly.

DRAINING WATER

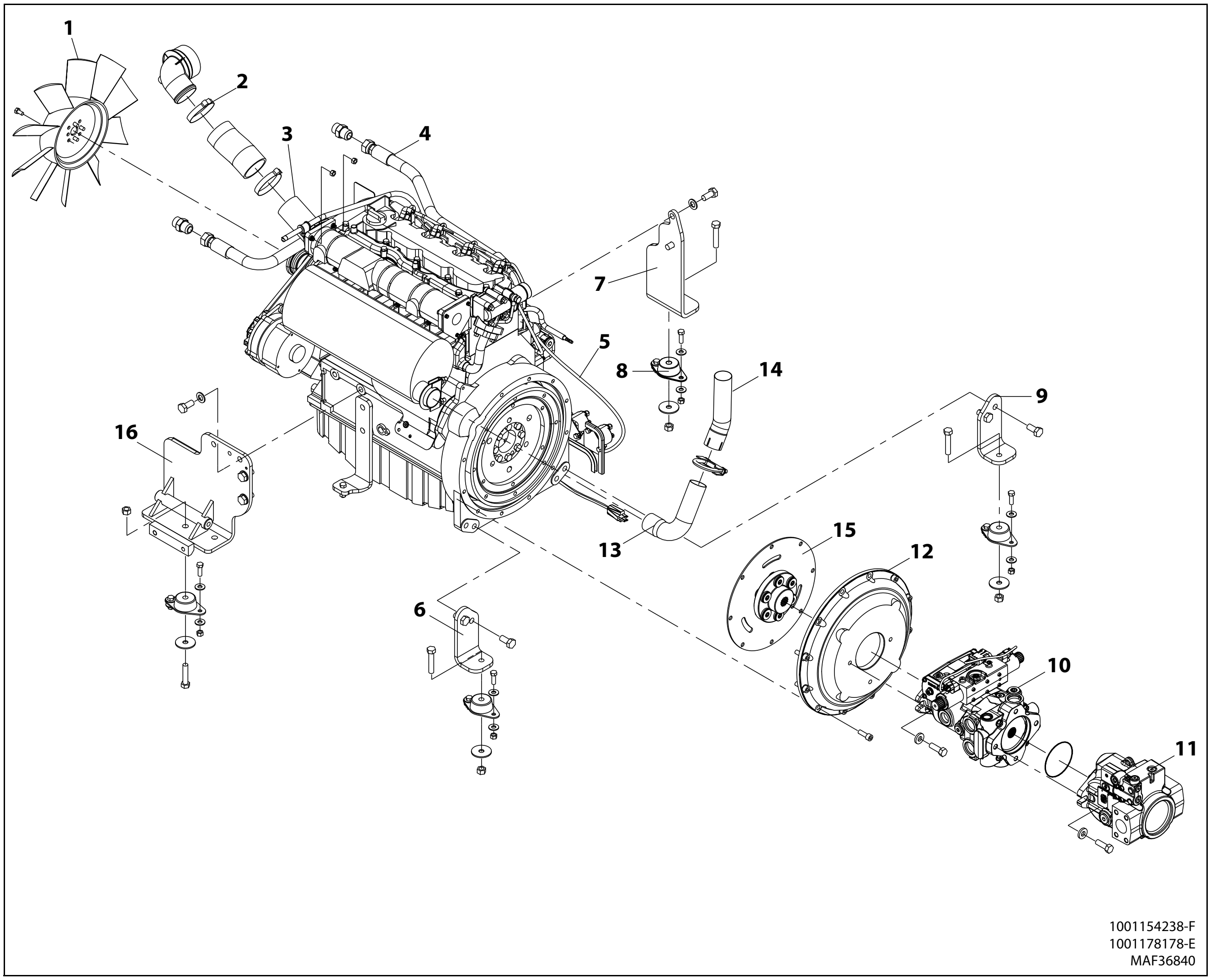
Frequency of water draining is determined by the contamination level of the fuel. Inspect or drain the collection bowl of water daily or as necessary. The collection bowl must be drained before contaminants reach the top of the turbine or when the Water Detection Module (optional) indicates it's time to drain water.

Pressure Applications / Installations:

1. Open the self-venting drain plug on the bottom of the bowl to evacuate water and contaminants with a sui able collection container in place. Head pressure will push any water and contaminants out of the drain while keeping the filter primed.
2. Close the drain after all the water and contaminants have been evacuated.
3. If necessary, follow priming of auxiliary fuel filter.

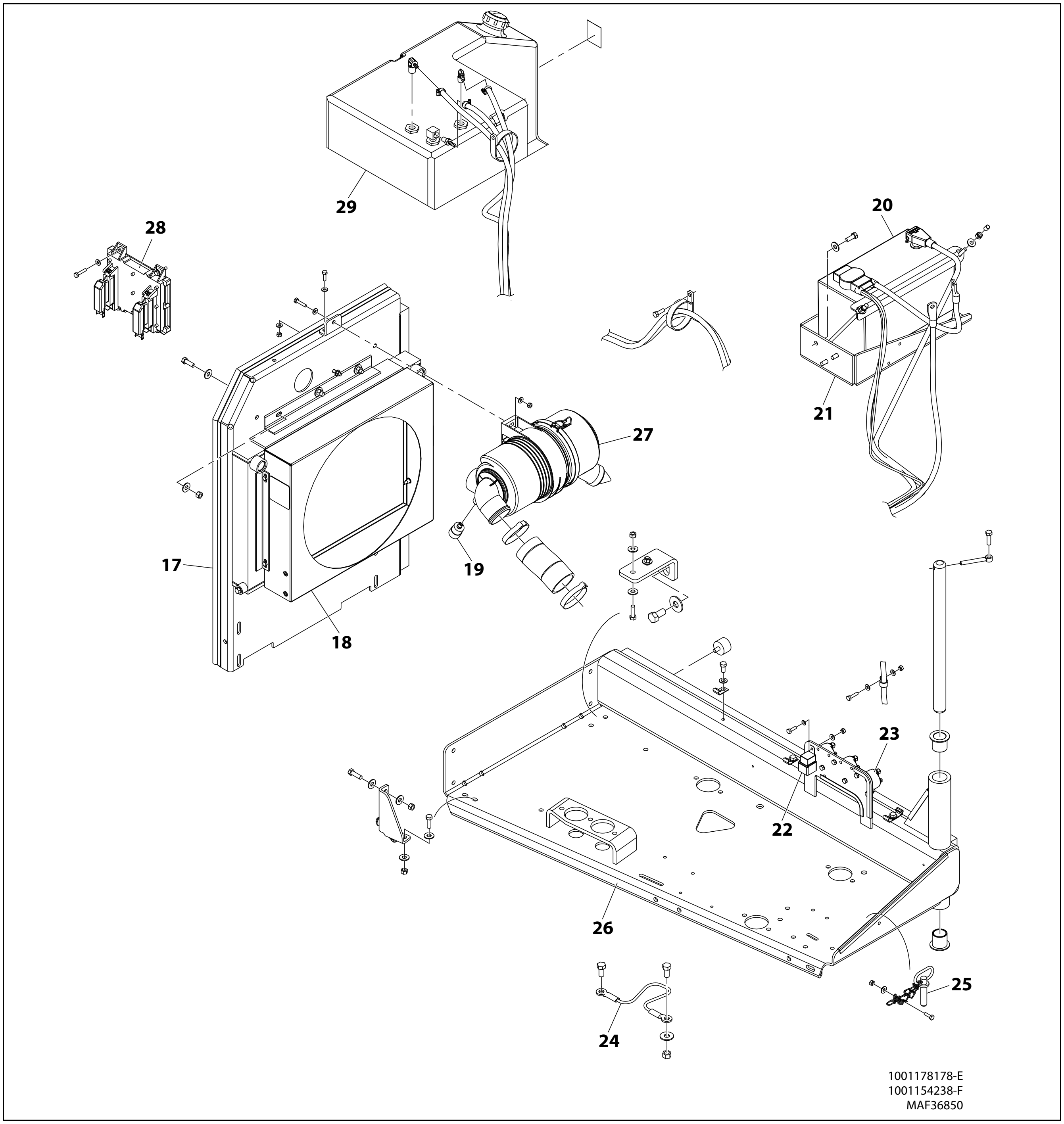
NOTE: *Do not leave the drain open too long as it may completely drain the entire filter assembly of water and fuel.*

3.26 DEUTZ D2011L04 ENGINE



1. Fan
2. Clamp
3. Air Intake Adapter
4. Oil Cooler Hose
5. Glow Plug Harness
6. Rear Engine Support
7. Front Engine Support
8. Engine Isolator Mount
9. Rear Engine Support
10. Pump Assembly
11. Gear Pump Assembly
12. Pump Adapter Plate
13. Exhaust Pipe
14. Exhaust Pipe
15. Coupling
16. Front Engine/Generator Support

Figure 3-114. Deutz D2011L04 Engine Components - Sheet 1 of 2



17. Engine Cooler Support Assembly
18. Engine Cooler
19. Air Intake Restriction Indicator
20. Battery
21. Bracket
22. Relay
23. Relay
24. Lanyard Cable
25. Hitch Pin
26. Tray
27. Air Cleaner assembly
28. Control Module
29. Fuel Tank

Figure 3-115. Deutz D2011L04 Engine Components - Sheet 2 of 2

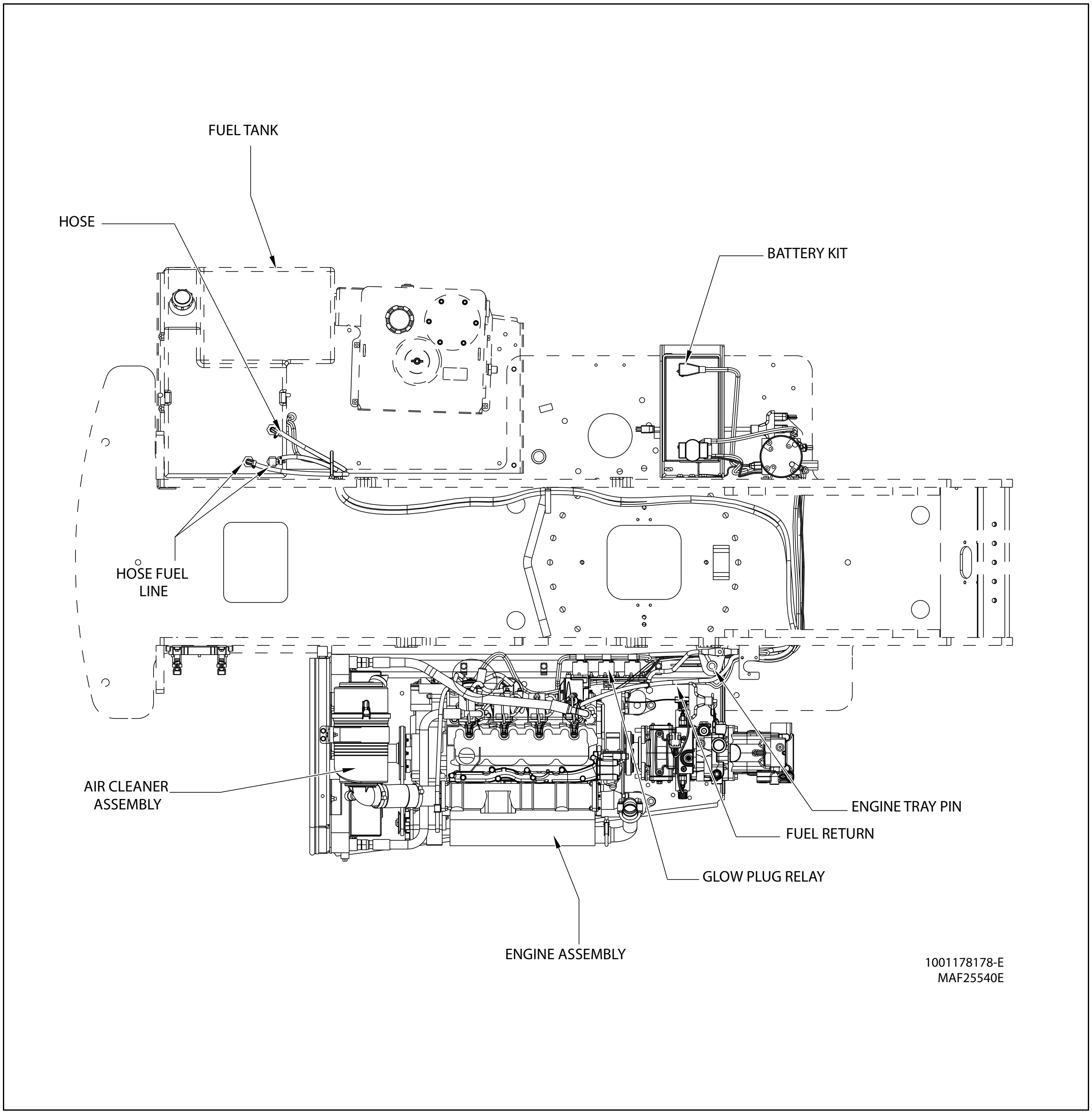


Figure 3-116. Deutz T4I (Arctic) Engine Installation - Sheet 1 of 2

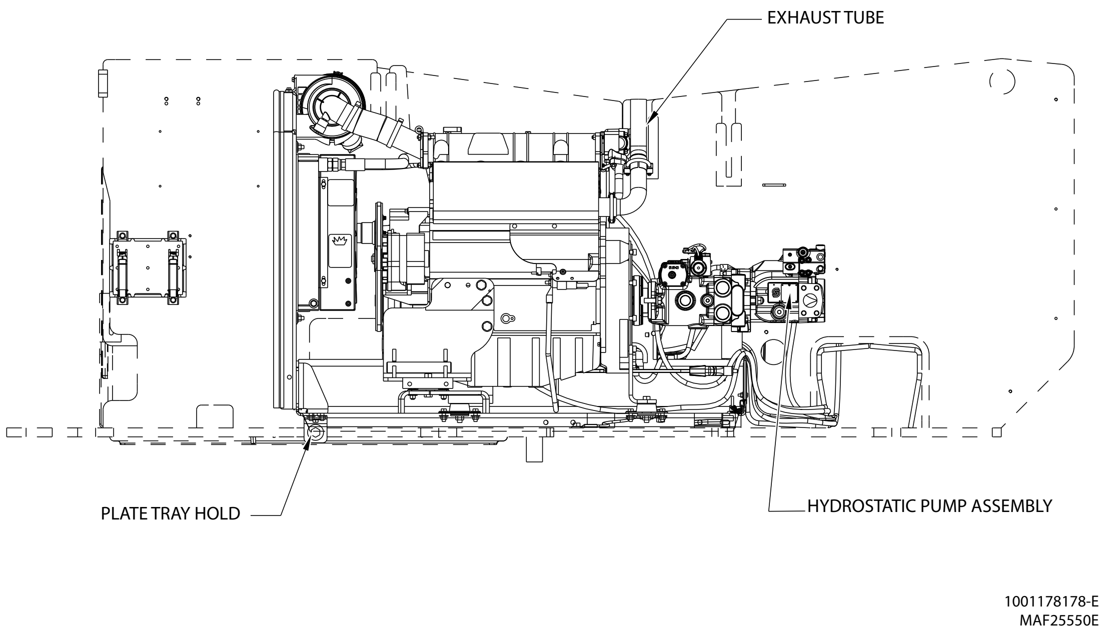


Figure 3-117. Deutz T4I (Arctic) Engine Installation - Sheet 2 of 2

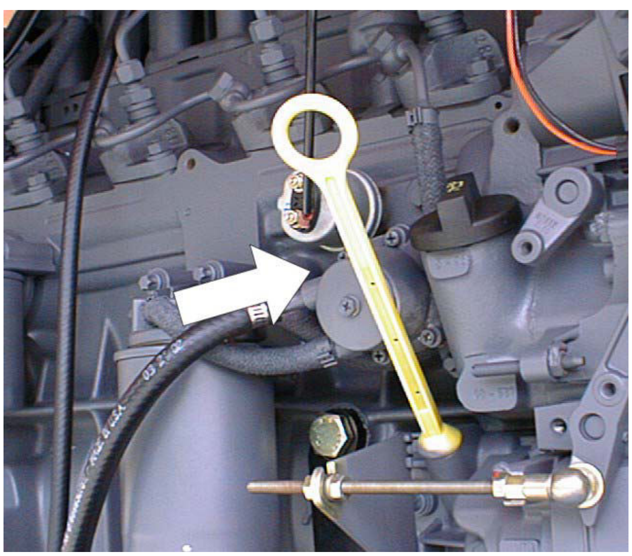
NOTE: *Refer to engine manufacturer's manual for detailed operating and maintenance instructions. Limited engine maintenance items are presented here for convenience but detailed engine maintenance items and schedule are included in the engine manufacturer's manual.*

Glow Plugs

If the glow plug option is enabled in the JLG Control System, the glow plug and indicator lamp will be energized when the Power/Emergency Stop switch is pulled on if the ambient air temperature is less than 50° F (10° C) and the engine coolant temperature is less than 140° F (60° C). This determination will occur one second after the Power/Emergency Stop switch has been pulled on. The lamp and glow plugs will remain energized for the period of time specified by the setting in the JLG Control System. Engine start shall be disabled during this period. On Deutz engines, the glow plugs will continue (post glow) after the engine has started for three times the machine digit setting.

Check Oil Level

1. Switch the engine off before checking oil level.
2. Make sure the machine and engine are level.
3. Remove the oil dipstick.
4. Wipe the dipstick with non-fibrous, clean cloth.
5. Insert the dipstick to the stop and remove again. Check the oil level, and if necessary, top the oil level up to the MAX mark with an approved grade and type of oil as outlined in the engine manufacturer's operator's manual. Refer to Figure 3-118., Deutz D2011LO4 Engine Dipstick.



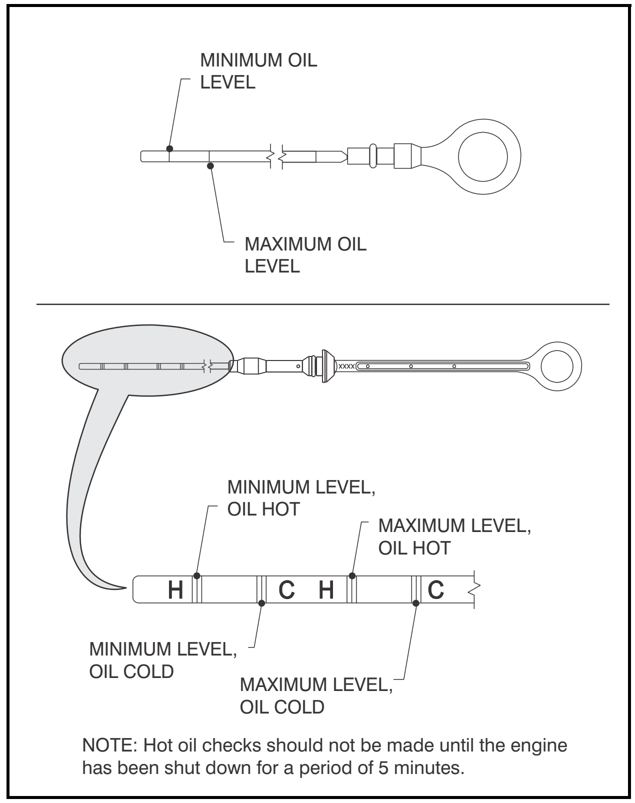


Figure 3-118. Deutz D2011LO4 Engine Dipstick

6. Replace the dipstick making sure that it is fully seated in the dipstick tube to seal off the crankcase.

Replacing Engine Oil

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

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 the oil drain valve.
6. Drain the oil.
7. Close the oil drain valve.
8. Pour in new engine oil. Refer to Section 1 for capacity and refer to Figure 3-119., Engine Oil Viscosity for the proper grade.

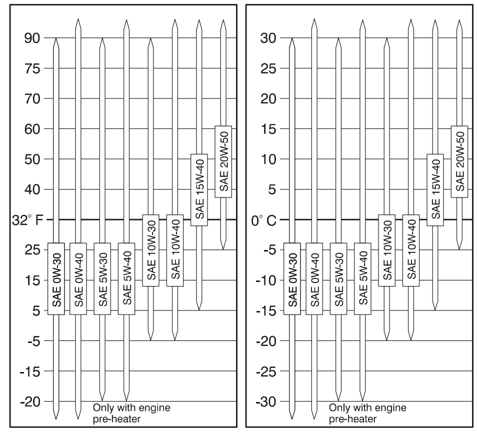
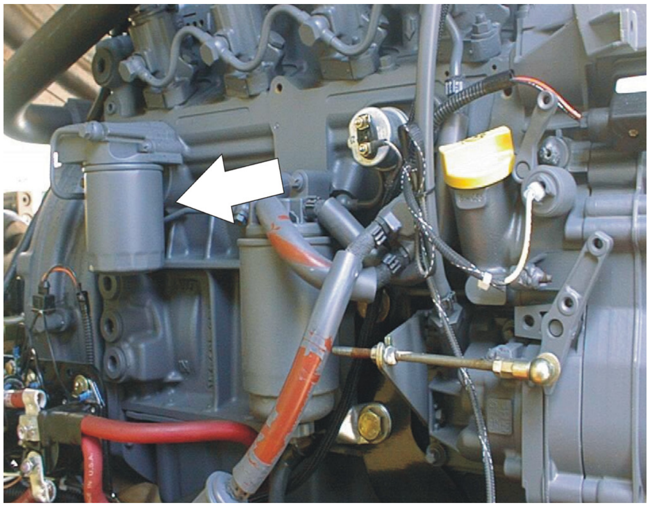
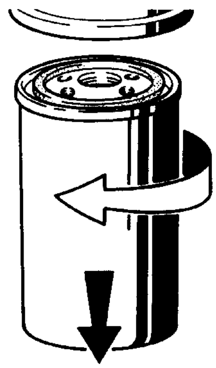


Figure 3-119. Engine Oil Viscosity

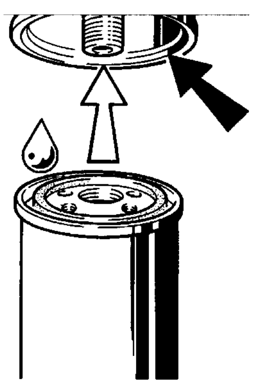
Replacing the Oil Filter



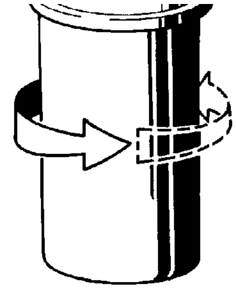
1. Wipe the area around the filter to clean any dirt from the area.
2. Using a suitable oil filter removal tool, loosen lube oil filter element and spin off.



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.

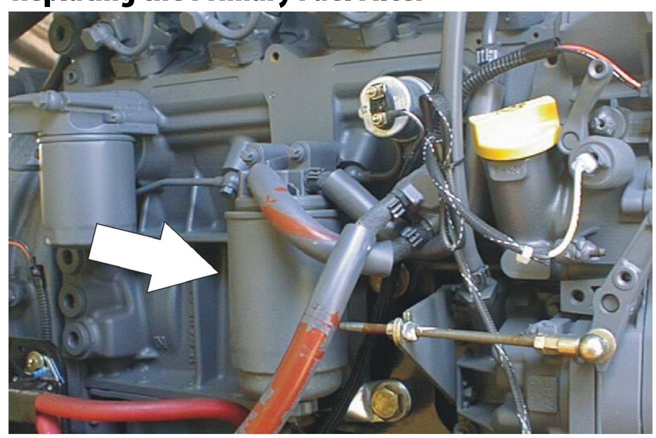


6. Manually screw in the new filter until the gasket is flush.



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

Replacing the Primary 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 THE FUEL SYSTEMS.

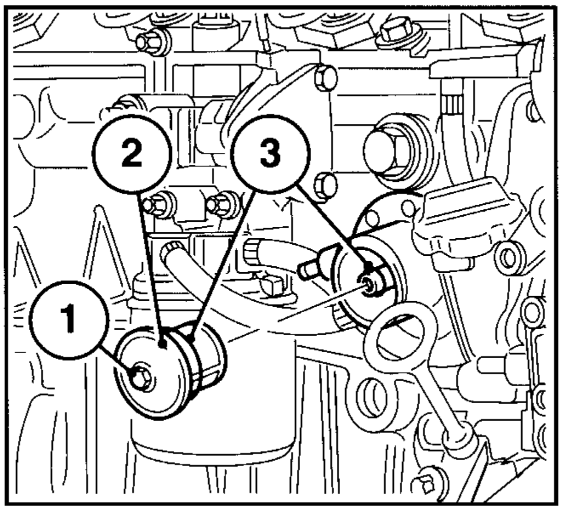
1. Wipe the area around the filter to clean any dirt from the area.
2. Fuel supply from the fuel tank may need to be blocked to prevent fuel flow from the tank.
3. Undo the fuel filter cartridge and spin off.
4. Catch any escaping fuel.
5. Clean any dirt from the filter carrier sealing surface.
6. Apply a light film of oil or diesel fuel to the rubber gasket of the new filter cartridge.
7. Manually screw in the new filter until the gasket is flush.
8. Tighten the fuel filter cartridge with a final half-turn.
9. 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.

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.

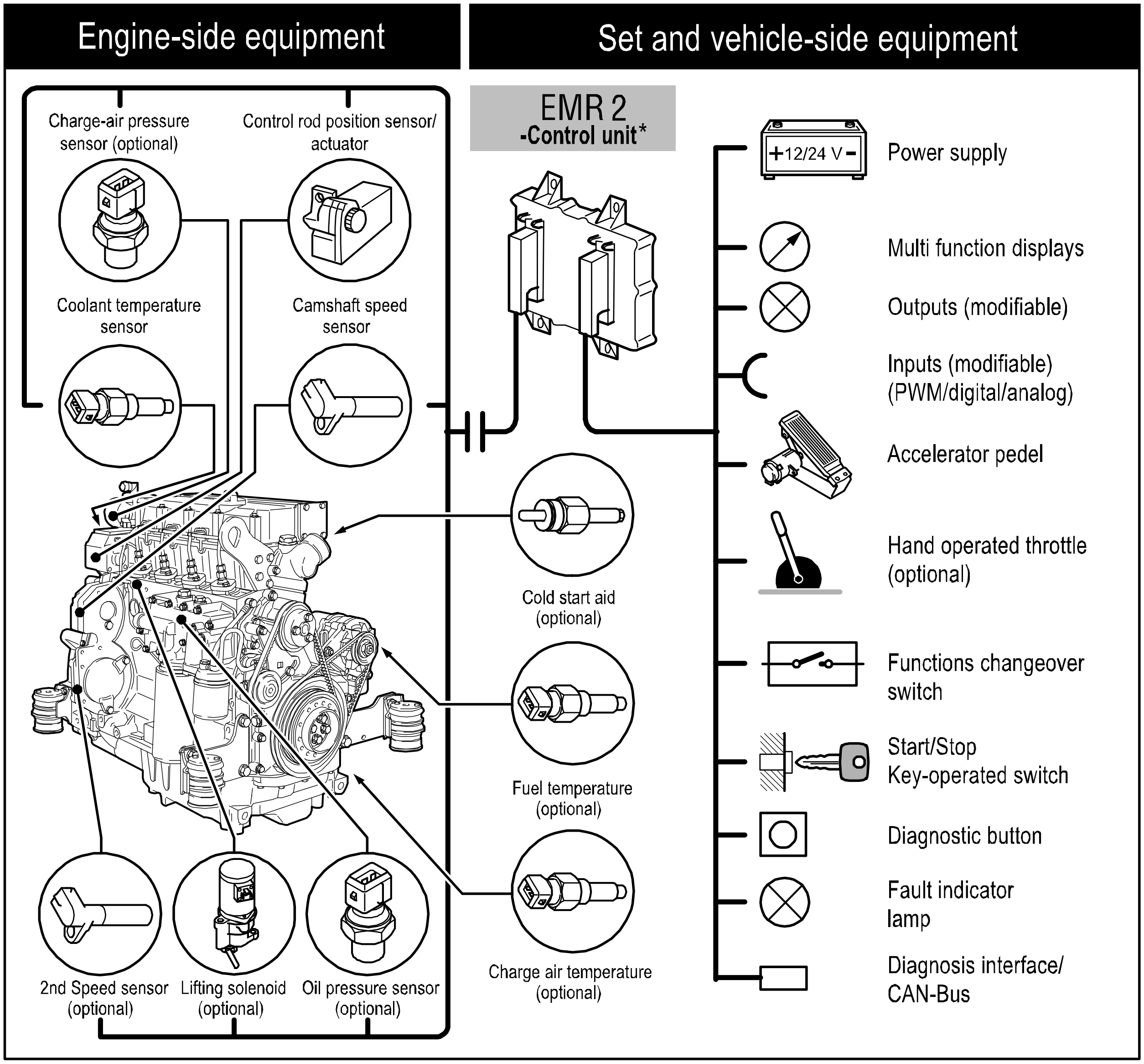


Figure 3-120. EMR 2 Engine Side Equipment

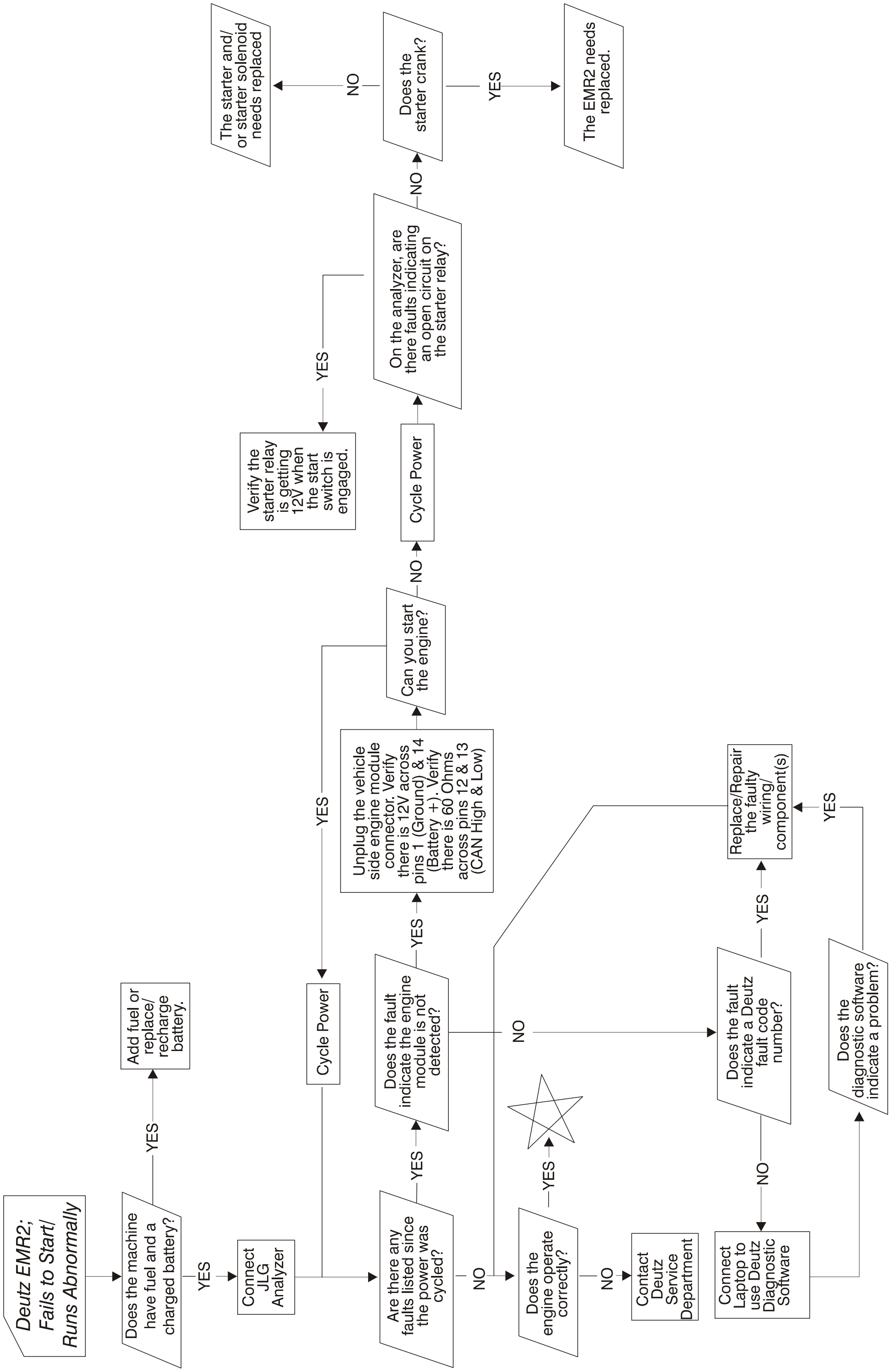


Figure 3-121. Deutz EMR 2 Troubleshooting Flow Chart

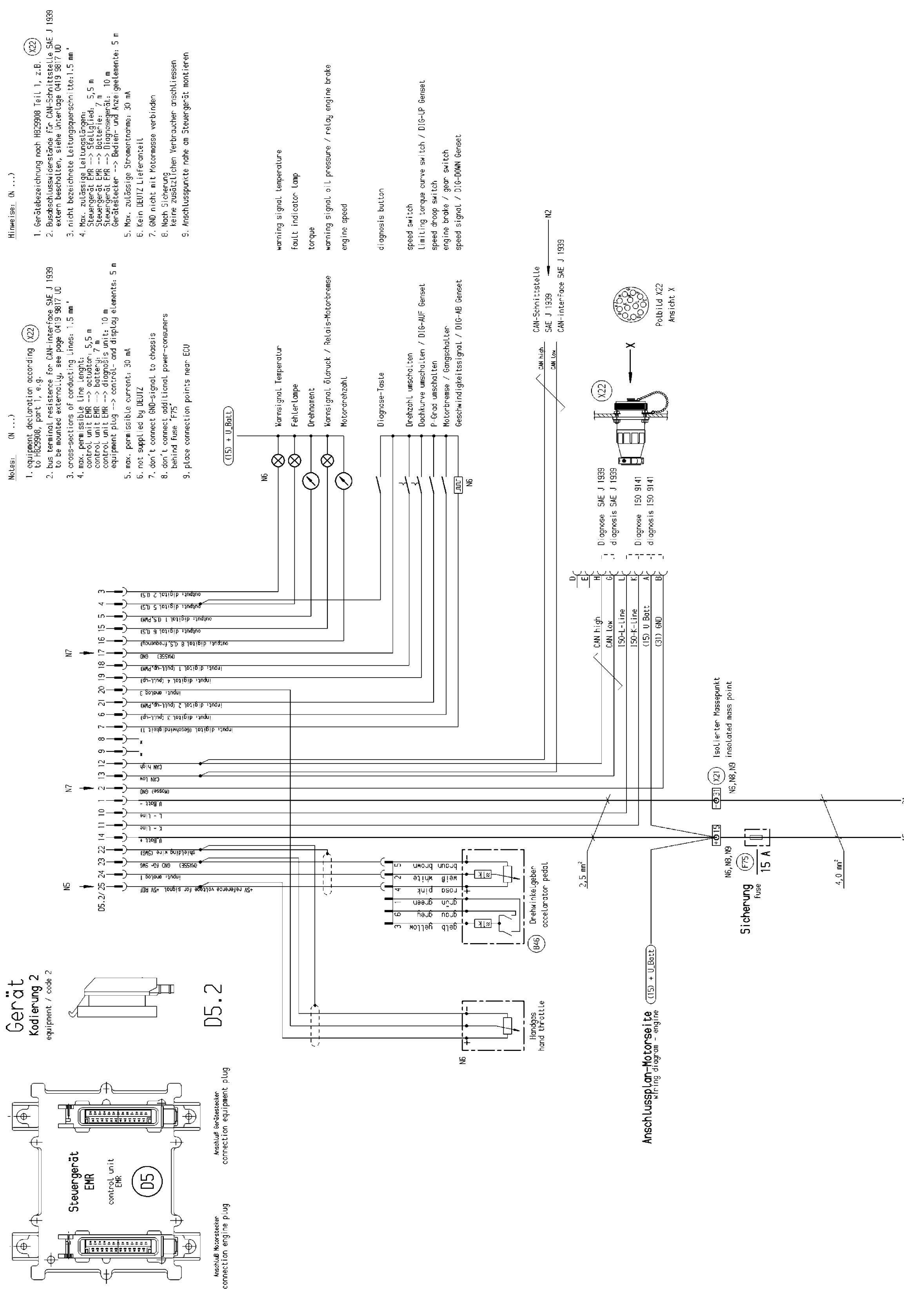


Figure 3-122. Deutz EMR 2 Vehicle Side Connection Diagram

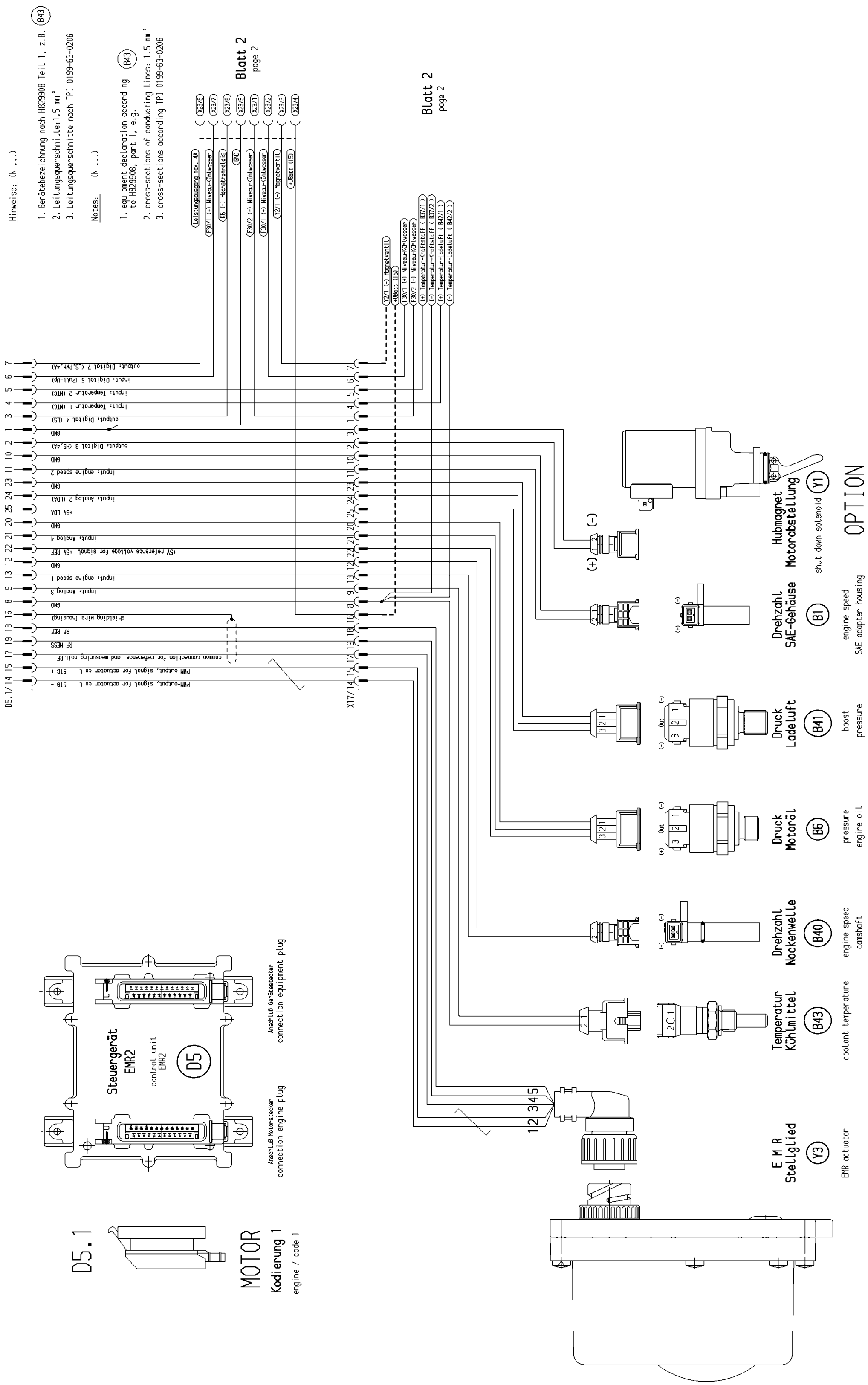


Figure 3-123. Deutz EMR 2 Engine Side Connection Diagram - Sheet 1 of 2

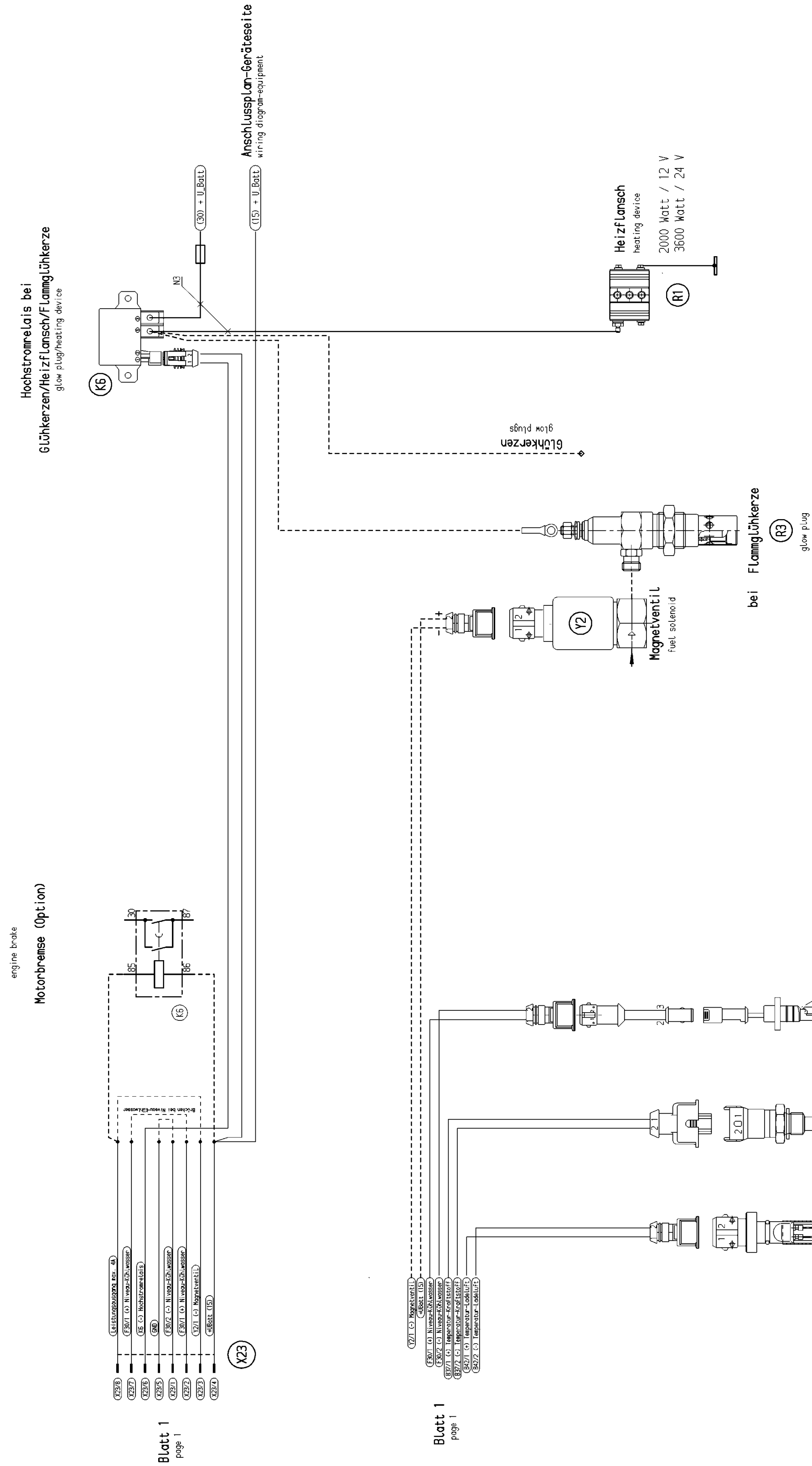
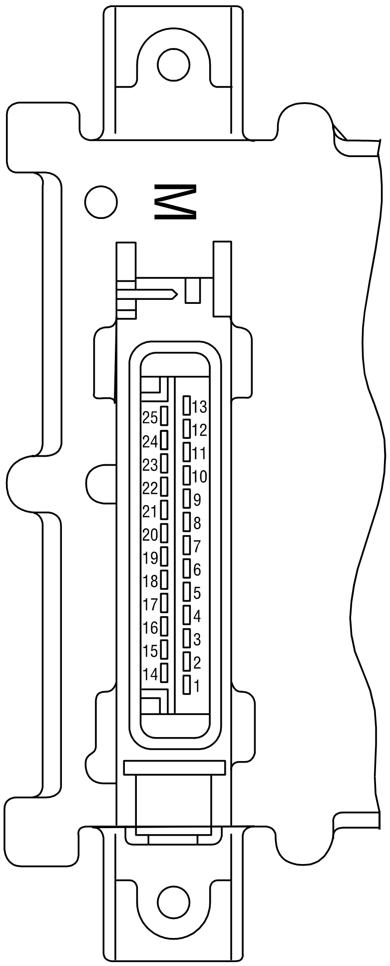


Figure 3-124. Deutz EMR 2 Engine Side Connection Diagram - Sheet 2 of 2

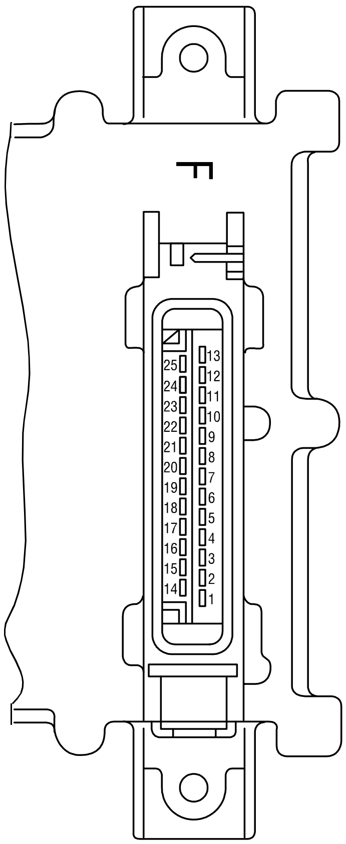


Pin No.	Designation	Description
1	Reserve	Reserve
2	Output: digital 3	Digital output for solenoid 1)
3	Output: digital 4	For heating flange (optional)/ glow plug (optional)
4	Input (optional) Temp 1	Fuel temperature 2)
5	Input (optional) Temp 2	Charge air temperature
6	Input (optional) DigIn 5	Coolant 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 3-125. 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 3-126. EMR 2 Vehicle Plug Pin Identification

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

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

Figure 3-127. 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 3-128. 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 3-129. 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 3-130. 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 3-131. EMR2 Fault Codes - Sheet 5 of 5

Table 3-11. DTC to SPN/FMI Cross Reference Chart - Deutz D2011L04

SPN Code	FMI Code	DTC	Description
51		2112	Unable to Reach Higher TPS
51	0	221	TPS 2 Signal Voltage Low
51	1	121	TPS 1 Lower Than TPS 2
51	3	123	TPS 1 Signal Voltage High
51	4	122	TPS 1 Signal Voltage Low
51	7	2111	Unable to Reach Lower TPS
51	31	2135	TPS 1/2 Simultaneous Voltages
94	3	92	Fuel Pump High Voltage
100	1	524	Oil Pressure Low
105	0	127	IAT Higher Than Expected 2
105	3	113	IAT High Voltage
105	4	112	IAT Low Voltage
105	15	111	IAT Higher Than Expected 1
106	4	107	MAP Low Voltage
106	16	108	MAP High Pressure
108	0	2229	BP Pressure High
108	1	129	BP Low Pressure
110	0	217	ECT Higher Than Expected 2
110	3	118	ECT High Voltage
110	4	117	ECT Low Voltage
110	15	116	ECT Higher Than Expected 1
168	15	563	System Voltage High
168	17	562	System Voltage Low
174	3	183	Fuel Temp Gasoline High Voltage
174	4	182	Fuel Temp Gasoline Low Voltage
515	0	1112	Spark Rev Limit
515	15	219	Max Govern Speed Override
515	16	1111	Fuel Rev Limit
628	13	601	Flash Checksum Invalid
629	31	606	COP Failure
629	31	1612	RTI 1 loss
629	31	1613	RTI 2 Loss
629	31	1614	RTI 3 Loss
629	31	1615	A/D Loss
629	31	1616	Invalid Interrupt
630	12	604	RAM Failure
636	2	336	Crank Sync Noise
636	4	337	Crank Loss
636	8	16	Crank Never Synced at Start
639	12	1626	CAN Tx Failure
639	12	1627	CAN Rx Failure

Table 3-11. DTC to SPN/FMI Cross Reference Chart - Deutz D2011L04

SPN Code	FMI Code	DTC	Description
639	13	1628	CAN Address Conflict Failure
639	31	1629	Loss of TSC 1
651	5	261	Injector Driver 1 Open
651	6	262	Injector Driver 1 Shorted
652	5	264	Injector Driver 2 Open
652	6	265	Injector Driver 2 Shorted
653	5	267	Injector Driver 3 Open
653	6	268	Injector Driver 3 Shorted
654	5	270	Injector Driver 4 Open
654	6	271	Injector Driver 4 Shorted
723	2	341	Cam Sync Noise
723	4	342	Cam Sensor Loss
724	10	134	EGO 1 Open/Inactive
1079	3	643	External 5V Reference High
1079	4	642	External 5V Reference Low
1384	31	1625	Shutdown Request
1485	3	687	Power Relay Short to Power
1485	4	686	Power Relay Shorted
1485	5	685	Power Relay Open
5294	4	91	Fuel Pump Low Voltage
520200	0	171	Adaptive Learn High Gasoline
520200	1	172	Adaptive Learn Low Gasoline
520202	0	1161	Adaptive Learn High LPG
520202	1	1162	Adaptive Learn Low LPG
520204	0	1155	Closed Loop Multiplier High Gasoline
520204	1	1156	Closed Loop Multiplier Low Gasoline
520206	0	1151	Closed Loop Multiplier High LPG
520206	1	1152	Closed Loop Multiplier Low LPG
520208	10	154	EGO 2 Open/Inactive
520211	10	420	Gasoline Cat Monitor
520213	10	1165	LPG Cat Monitor
520240	3	188	Fuel Temp LPG High Voltage
520240	4	187	Fuel Temp LPG Low Voltage
520251	3	223	TPS 2 Signal High Voltage
520251	4	222	TPS 2 Signal Low Voltage
520260	0	1171	LPG Pressure Higher Than Expected
520260	1	1172	LPG Pressure Lower Than Expected
520260	3	1174	EPR Voltage Supply High
520260	4	1175	EPR Voltage Supply Low
520260	12	1176	EPR Internal Actuator Fault
520260	12	1177	EPR Internal Circuitry Fault
520260	12	1178	EPR Internal Comm Fault
520260	31	1173	EPR Comm Lost

Table 3-12. Engine Fault Codes - Deutz D2011L04

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 applicable threshold; signal range violation	If the signal is below the applicable 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 applicable threshold; signal range violation	If the signal exceeds the applicable 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 applicable 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 applicable 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 3-12. Engine Fault Codes - Deutz D2011L04

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)	Oil pressure too low (pressure below warning threshold)	Threshold for error detection is an internal ECU threshold. Check oil level, check engine for oil leakage, measure oil pressure external to evaluate sensor value
100	1	737	231	Oil pressure is below the target range (shut off threshold)	Oil pressure too low (pressure below shut off threshold).	Threshold for error detection is an internal ECU threshold. Check oil level, check engine for oil leakage, 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 information!
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 pressure sensor.

Table 3-12. Engine Fault Codes - Deutz D2011L04

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
102	2	88	223	Charge air pressure measured 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 necessary.
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 performance 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 performance 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 3-12. Engine Fault Codes - Deutz D2011L04

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 Temperature 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 (About) > 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 3-12. Engine Fault Codes - Deutz D2011L04

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	Over speed monitoring during 1 level of FOC (Failure overrun condition) if engine speed was over Limit.	check powertrain settings regarding over speed
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 position. 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 position. 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 position. 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	Over speed monitoring during 2 level of FOC (Failure overrun condition) if engine speed was over limit.	check powertrain settings regarding over speed
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 position. Check Camshaft Sensor or wiring.

Table 3-12. Engine Fault Codes - Deutz D2011L04

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 position 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	Over speed monitoring during ORC (Override conditions) if engine speed was over 2900rpm	check powertrain settings regarding over speed
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 3-12. Engine Fault Codes - Deutz D2011L04

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 metal 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, reprogram 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, reprogram 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, reprogram 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 3-12. Engine Fault Codes - Deutz D2011L04

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.

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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 High Side-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 Low Side-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 High Side-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 Low Side-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 Low Side-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 period out of valid range.	PWM signal for temperature readout from supply module to the control unit is out of range. Supply module 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 3-12. Engine Fault Codes - Deutz D2011L04

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	Time out Error of CAN-Receive-Frame TSC1TE - active	Time out Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus scheduling, 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 / Oil Press / Low Fuel Press 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 / Oil Press / Low Fuel Press Pin K43: Reserve 5V Sensor Supply Pin A09: second foot pedal Suspected components EDC17cv56 Pin A21: Cam speed Pin K44: DEF press / Air Filter Diff Press Pin A24: LDF6T / Oil Press / Low Fuel Press 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 foot pedal 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 foot pedal Suspected components EDC17cv56 Pin A22: Fan Speed Sensor Pin K45: Position EGR or Intake throttle flap Pin K46: First foot pedal	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 3-12. Engine Fault Codes - Deutz D2011L04

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: the ECU receives a permanent signal.	Switch is blocked, taster locked, connection cable damaged plausibility 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 threshold	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 3-12. Engine Fault Codes - Deutz D2011L04

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_facVolP-er_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 actuator.
2791	3	1758	415	Overvoltage at EGR actuator.	High voltage from the battery	Check battery voltage.
2791	4	1759	415	Under voltage at EGR actuator.	Low voltage from the battery.	Check battery voltage.
2791	6	1757	415	Over current 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 occur.	Error detection during the learning process.	Threshold for error detection is an internal ECU threshold. Start Serdia Use case 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 Serried Use case 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 Serried Use case 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 3-12. Engine Fault Codes - Deutz D2011L04

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
2797	4	1337	565	Injector diagnosis: Time out of Injector 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: Time out of Injector 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 thresh-old	Sensed urea tank temperature > physical range high limit	Case "CANBUS sensor": Check urea tank temperature: really hot? Check CAN Bus-message of DEF sensor urea tank temperature Com_dRxSCR2Byt2 Compare it to Com_dRxSCR1Byt1 (urea tem-perature at quality sensor) identical? Tank heater permanently 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 permanently 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 tem-perature 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 3-12. Engine Fault Codes - Deutz D2011L04

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
3224	9	130	597	Time out 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	Time out Error of CAN-Receive-Frame AT1OG1Vol; NOX sensor (SCR-system down-stream 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 wiring Defect urea dosing injection valve	Check wiring Check the urea dosing injection valve
3519	3	1898	277	The integrated diagnostic of the tempera-ture sensor of the Urea Quality Sensor recog-nized 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 suc-tion unit. In case the communication is corrupt, exchange the suction unit.
3519	4	1899	277	The integrated diagnostic of the tempera-ture sensor of the Urea Quality Sensor recog-nized 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 3-12. Engine Fault Codes - Deutz D2011L04

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 3-12. Engine Fault Codes - Deutz D2011L04

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 quality	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 pressure 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 pressure sensor Clean the urea pump (filter)	Check the urea pump Check the supply module pressure sensor Clean the urea pump (filter)

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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 back flow 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 back flow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4345	4	1093	674	Urea back flow 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 back flow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element

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SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4345	5	1090	674	Urea back flow 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 emits too many Hydrocarbons => check injectors: is an injector got stuck? => Check EGR Valve If difference normal the exhaust out of the engine 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? Misdetection? Check wiring harness to UCatUsT-sensor Exchange UCatUsT-sensor
4360	2	1865	668	Error at static plausibility check: absolute 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: absolute 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 crystals? 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

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SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
4365	2	1137	6-6-9	Signal error in case of Urea tank temperature transmitted 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 components: DEF quality sensor Wiring harness	Check wiring harness and DEF quality sensor
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 components: DEF quality sensor Wiring harness	Check wiring harness and DEF quality sensor
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

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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 module
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 module
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 module
4765	0	1039	683	The exhaust temperature value from the sensor before 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 before 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

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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 before DOC and before SCR > Threshold 2 difference between temperature after DOC and before SCR < Threshold 3 difference between temperature after DOC and ambient temperature < Threshold 4 difference between temperature 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 => physically 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

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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 Throt-tle-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 batteries.	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 out-put 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 current 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

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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 misalignment 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 set point > 7%. Troubleshooting with SERDIA 2010 Use Case "EGR Diagnostic".
5763	11	1231	5-9-4	Power stage over temperature 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	Time out Error of CAN-Receive-Frame ComEngPrt; Engine Protection	Time out Error (Missing CAN Bus message)	Check wiring harness and customer devices
523240	9	179	527	Time out CAN-message FunModCtl; Function Mode Control	Time out Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus scheduling, 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 power stage 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.

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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 rail pressure 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 rail pressure.	Rail pressure 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 rail pressure, 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.	Start information 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 foot pedal 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.

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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 plausibility 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 post drive 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.

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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 under voltage 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 time out 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 energizing angles	Implausible start of energizing 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 energizing times of the zero fuel quantity calibration	The energizing 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.

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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 energizing time with maximum permitted energizing 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. Leakage 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 set point 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 set point 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 under voltage detection	The reason is that a slow dropping of the vehicle electrical system voltage (defective auto battery) should not lead the ECU OCWDA's diagnose to enter an error in the fault memory due to an under voltage 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 power stage 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 auto battery) should not lead the ECU OCWDA's diagnose to enter an error in the fault memory due to an under voltage 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 active replace ECU.

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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 Software resets 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 Software resets 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 Software Resets 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 back flow 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 back flow 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 back flow pressure (B) Check pressure relief valve and metering unit. (C) Change components if necessary

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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 back flow 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 back flow 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	power stage 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

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SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523698	11	122	591	Shut off request from supervisory monitor-ing function	Engine Shut Off due to supervisory function	Threshold for error detection is an internal ECU threshold. Check error memory for additional error code to find root cause. Depending on additional error follow the docu-mented "Take action for repair".
523718	3	1100	676	Urea heater relay: the current drain mea-sured 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 mea-sured 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 mea-sured 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 mod-ule
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 mod-ule
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 module defect, fault in the wir-ing.	When the received supply module heater tem-perature duty cycle SCR_rSMT is out of the failure range (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: Duty cycle timing over error threshold.	Duty cycle for temperature readout from supply module heater to the control unit is not valid. Supply module 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: Duty cycle timing over error threshold.	Duty cycle for temperature readout from supply module to the control unit is out of range. Supply module defect, fault in the wiring.	Supply module check and replace if necessary. Check the wiring.

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SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523721	8	931	689	Supply module heater: Duty cycle timing out of valid range.	Duty cycle for temperature readout from supply module to the control unit is not valid. Supply module 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 module 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 module 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 temperature signal for both information is received one after the other. Supply module check and replace if necessary. Check the wiring.
523776	9	291	119	Time out Error of CAN-Receive-Frame TSC1TE - active	Time out Error (Missing CAN Bus message)	Threshold for error detection is an internal ECU threshold. Check CAN Bus cabling (Bus scheduling, 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 time out 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 data set and flash correct injector adjustment 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 parametrization 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).

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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 actuator 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	Time out Error of CAN-Transmit-Frame EEC3VOL1; Engine send messages	Fault is detected if a Time Out of the EEC3VOL1 frame has occurred.	Check wiring harness and customer nodes
523936	12	169	764	Time out Error of CAN-Transmit-Frame EEC3VOL2; Engine send messages	Time out Error (Missing CAN Bus message)	Check wiring harness and customer nodes

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SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523938	9	133	766	Time out Error (BAM to packet) for CAN-Receive-Frame AT1IGCVol1 information; factors & Sensor calibration 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. Time out Error (BAM to BAM) for CAN-Receive-Frame AT1IGCVol1 information. factors & Sensor calibration 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	Time out Error (PCK2PCK) for CAN-Receive-Frame AT1IGCVol1 information; factors & Sensor calibration 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	Time out Error (BAM to packet) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensor calibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	Time out Error (Missing CAN Bus message)	NOX downstream sensor and sensor connection check
523942	9	141	767	Time out Error (BAM to BAM) for CAN-Receive-Frame AT1OGCVol2 information, Calibration message 1 of the after catalyst NOx sensor has failed. Factors & Sensor calibration 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	Time out Error (PCK2PCK) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensor calibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	The fault is detected when a time out 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

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SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
523982	0	360	737	Power stage diagnosis disabled; Indicating that battery voltage is not high.	Power stage 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	Power stage diagnosis disabled; Indicating that battery voltage is not low.	Power stage 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 main relay; 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 back flow 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

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SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
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
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 calibrated 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: Environment 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 relative pressure value of the exhaust gas from the urea cat upstream sensor is greater than an applicable maximum pressure threshold	sensed pressure upstream SCR catalyst > physical high range limit (exhaust volume flow) UCatUsP_pRelFlt_mp > UCatUsP_pMax_mp	Check for crystallization in exhaust line upstream SCR and downstream 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 heavily at engine low idle / high idle? => try to suppress the oscillating Exchange pressure sensor upstream SCR catalyst Check calculated exhaust volume flow of engine within EDC: SCR_dvolSCRUs plausible? 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 3-12. Engine Fault Codes - Deutz D2011L04

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524065	1	1566	892	The relative pressure value of the exhaust gas from the urea cat upstream sensor is less than an applicable minimum pressure threshold	sensed pressure upstream SCR catalyst > physical high range limit (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 environment 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 plausible? 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	absolute 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 environment 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 3-12. Engine Fault Codes - Deutz D2011L04

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 permanent 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 permanent 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 3-12. Engine Fault Codes - Deutz D2011L04

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524067	2	1867	894	absolute difference of sensed temperature of supply module heater temperature and ambient temperature UPmpT_tDiffP-mpHtrAmb_mp > threshold	absolute difference 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 difference of sensed temperature of supply module temperature and ambient temperature > threshold	absolute difference 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 3-12. Engine Fault Codes - Deutz D2011L04

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 3-12. Engine Fault Codes - Deutz D2011L04

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 3-12. Engine Fault Codes - Deutz D2011L04

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	Time out error of CAN-Transmit-Frame ComDPFHisDat.	Open load on CANBUS wiring.	Check wiring, component.
524104	9	1676	928	Time out error of CAN-Receive-Frame ComRxDPFCtl. CM1 Module Customer Receive 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 Receive Message.
524118	9	1672	9-4-2	Time out error of CAN-Receive-Frame ComRxCM1	If the frame CM1 message is not transmitted successfully	Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
524121	9	1683	9-4-5	Time out error of CAN-Receive-Frame ComRxTrbChActr	Time out Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
524125	9	1687	9-4-9	Time out error of CAN-Receive-Frame ComTxTrbChActr	Time out Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
524141	7	1827	192	DEF dosing valve is blocked with crystallized urea or other deposits.	While SCR system is starting up and after 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 crystallization 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 crystallized urea or other deposits.	While SCR system is starting up and after 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 crystallization 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 3-12. Engine Fault Codes - Deutz D2011L04

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 minutes	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 Power stage 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 continuously 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 (“Unit 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 continuously open Urea suction line, back flow line broken or connection swapped PWM Power stage 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 electrical connection if urea quality sensor Check engine CAN bus Check urea quality sensor itself Exchange urea quality sensor
524153	2	1875	997	CAN message is not received for a 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 electrical 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	Time out error of CAN-Receive-Frame ComRxEBC2 from wheel speed sensor.	Time out Error (Missing CAN Bus message) Defect on wheel speed sensor.	Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range. Replace the wheel speed sensor.

Table 3-12. Engine Fault Codes - Deutz D2011L04

SPN	FMI	Deutz Code	Blink Code	Description	Possible Cause	Action
524177	7	1863	995	The error shows up, if no proper urea pressure could be build up within the SCR system state “Fill Lines”=> SCRCo_stStatus_mp = 1.	This error shows up, if no proper urea pressure 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 positive. 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 there any leakage? Not only urea to the outside but also air into the lines, especially in the suction line! Perform SERDIA use case “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 Power stage 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 3-12. Engine Fault Codes - Deutz D2011L04

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 continuously open - Urea suction line, back flow line broken or connection swapped - PWM Power stage 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 use case "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 continuously open DEF suction line, back flow line broken or connection swapped PWM Power stage 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 3-12. Engine Fault Codes - Deutz D2011L04

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 regeneration.	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 system 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? Temperature 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 3-12. Engine Fault Codes - Deutz D2011L04

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 regeneration.	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 reach 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 system 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? Temperature 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 3-12. Engine Fault Codes - Deutz D2011L04

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 Crystallization Monitoring.	Back pressure upstream SCR catalyst has reached a level which indicates crystallization 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 crystallization 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 crystallization upstream of SCR catalyst: If crystallization 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 reason for crystallization. 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 thoroughly 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 crystallization 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 crystallization 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

3.27 FORD ENGINE

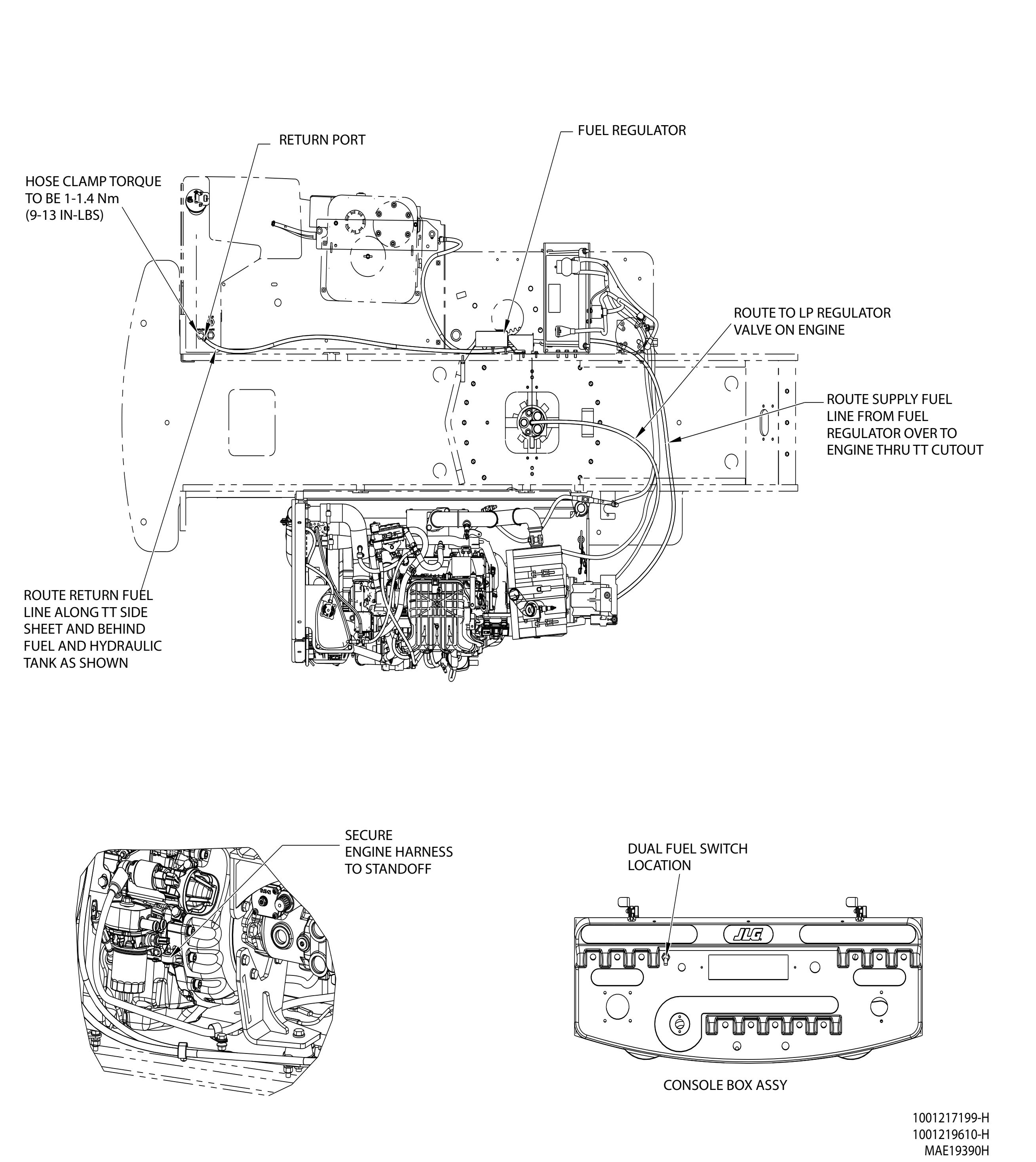


Figure 3-132. Ford Engine Installation - Sheet 1 of 5

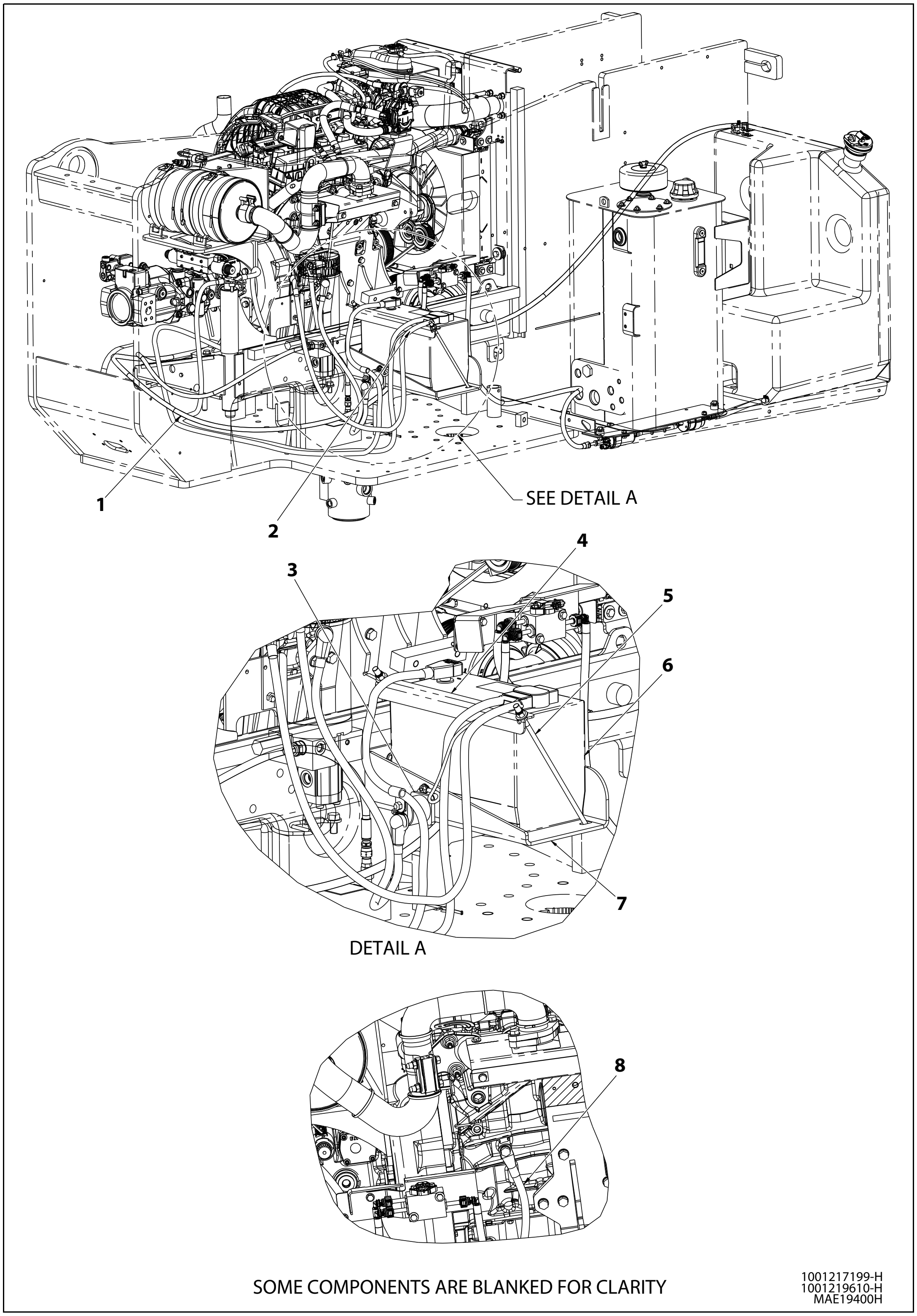


Figure 3-133. Ford Engine Installation - Sheet 2 of 5

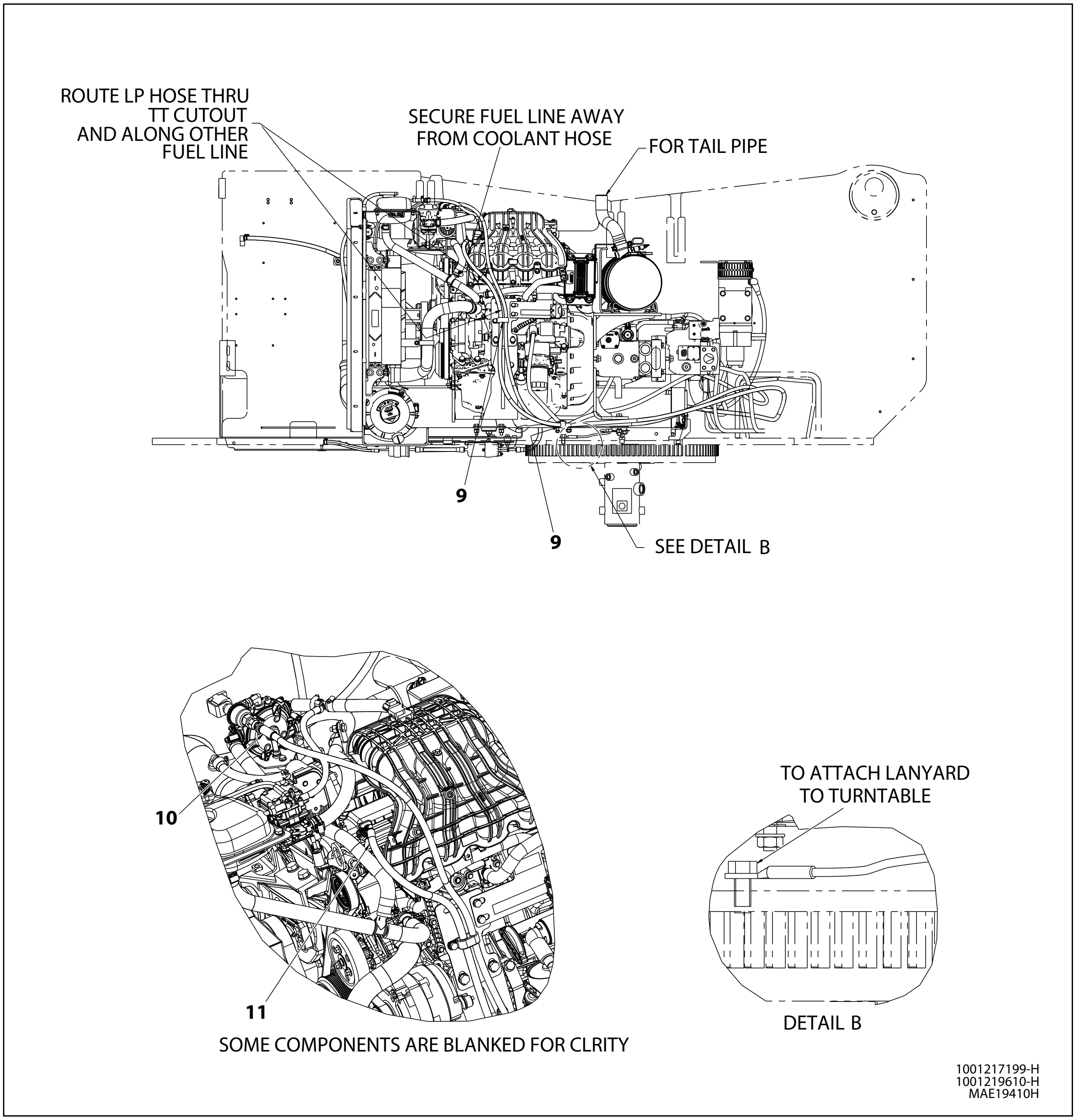
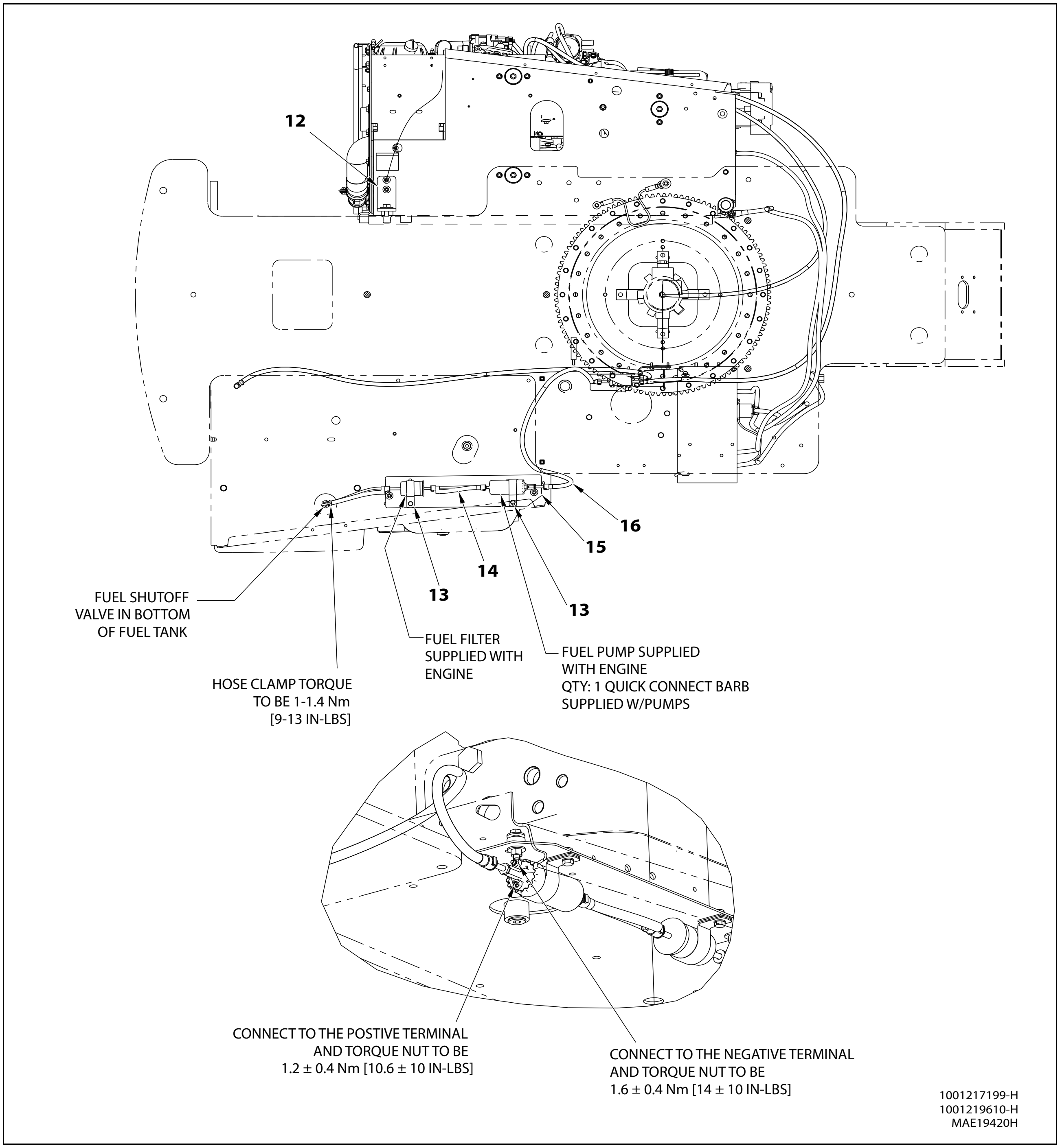


Figure 3-134. Ford Engine Installation - Sheet 3 of 5



1. High Pressure Fuel Hose	5. J-Bolt	9. Clamp	13. P-Clamp
2. Battery Cable Kit	6. Battery	10. LP Gas Hose	14. High Pressure Fuel Hose
3. Solenoid Assembly Relay	7. Battery Bracket	11. High Pressure Fuel Hose	15. Fuel Pump Filter Bracket
4. Battery Hold Down Bracket	8. Battery Cable Kit	12. Engine Tray Mount	16. High Pressure Fuel Hose

Figure 3-135. Ford Engine Installation - Sheet 4 of 5

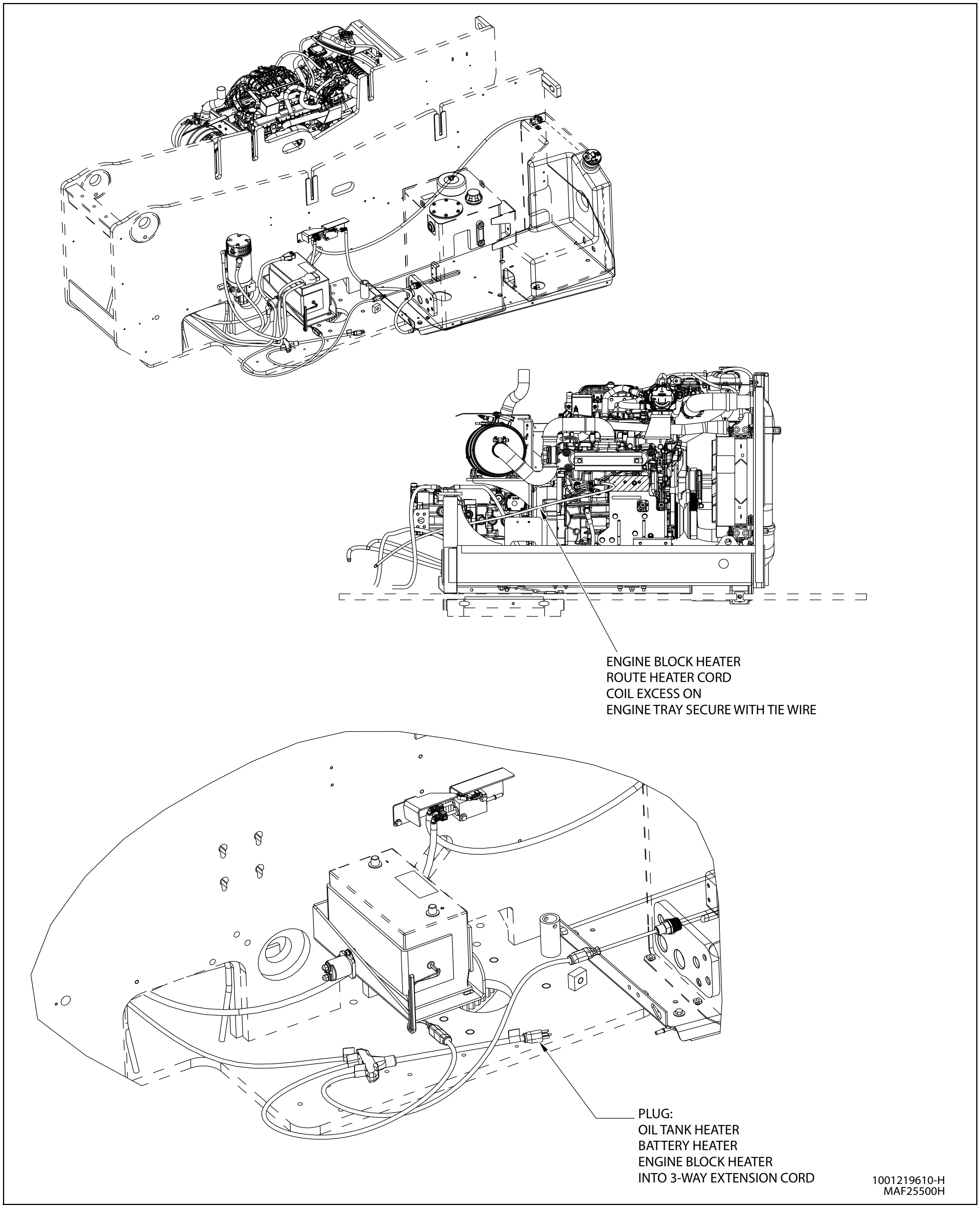


Figure 3-136. Ford Engine Installation (With Arctic Package) - Sheet 5 Of 5

Table 3-13. 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	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
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
105	3	113	IAT voltage high
105	4	112	IAT voltage low
105	15	111	IAT higher than expected stage 1

Table 3-13. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
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
639	12	1626	CAN-J1939 Tx fault
639	12	1627	CAN-J1939 Rx fault
639	13	1628	J1939 CAN address / engine-number conflict

Table 3-13. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
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
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

Table 3-13. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
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	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
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

Table 3-13. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
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
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

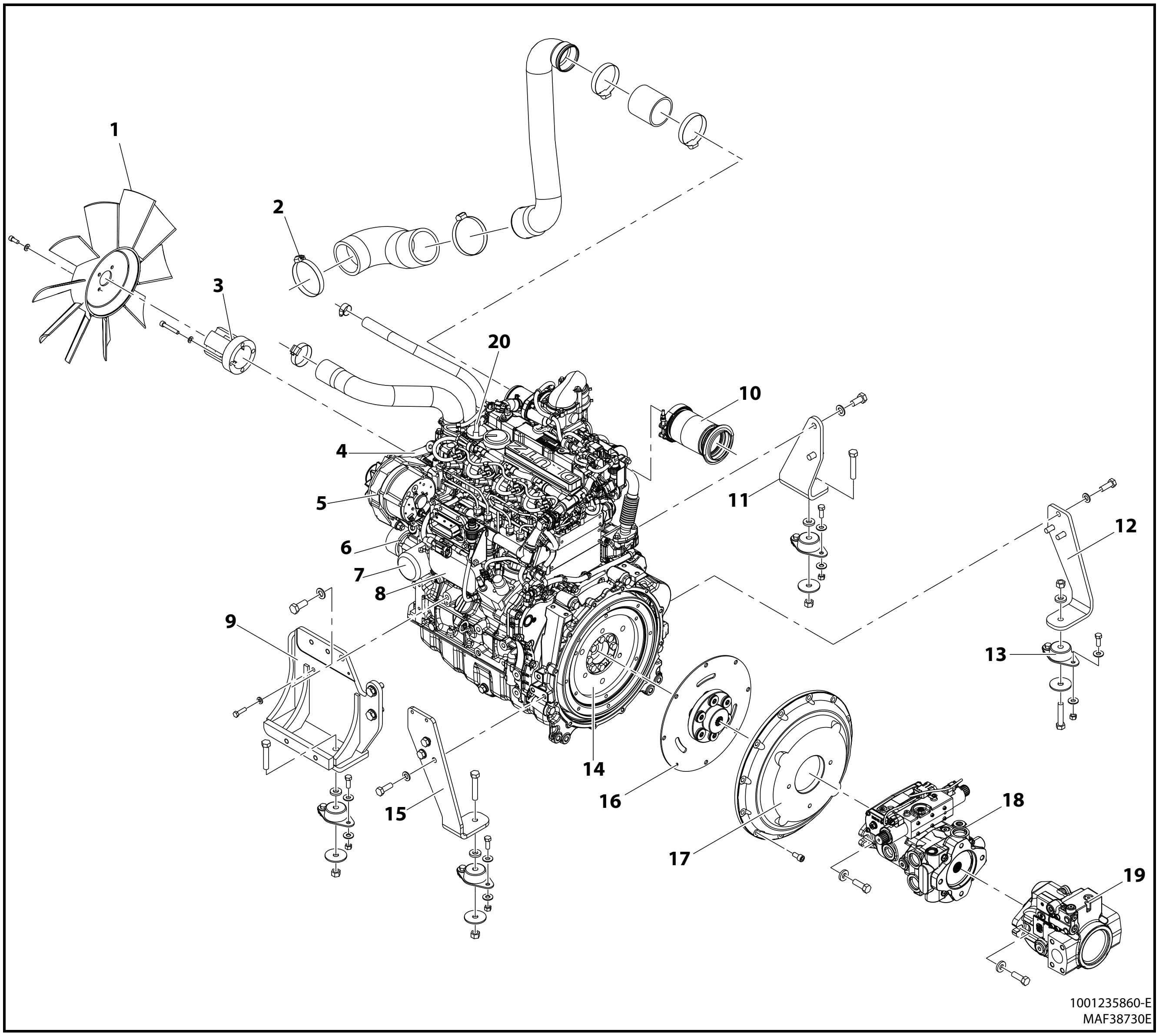
Table 3-13. CAN to DTC Cross Reference (Ford Engine)

SPN	FMI	DTC	DTC and Description
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
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

Table 3-13. CAN to DTC Cross Reference (Ford Engine)

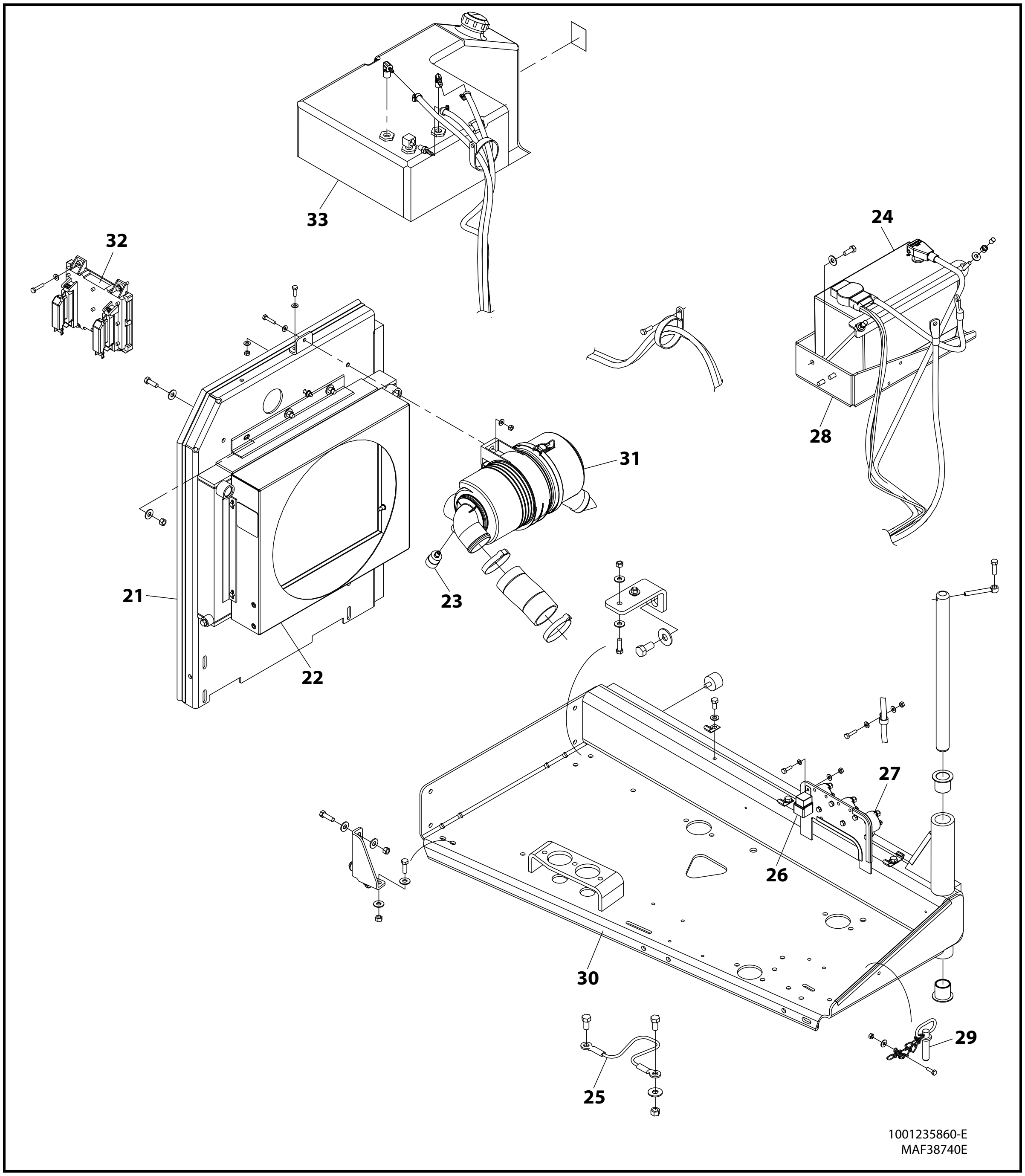
SPN	FMI	DTC	DTC and Description
4236	0	1155	Closed-loop gasoline bank1 high
4236	1	1152	Closed-loop LPG low
4236	1	1154	Closed-loop NG low
4236	1	1156	Closed-loop gasoline bank1 low
4237	0	171	Adaptive-learn gasoline bank1 high
4237	0	1161	Adaptive-learn LPG high
4237	0	1163	Adaptive-learn NG high
4237	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
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

3.28 DEUTZ ENGINE TD2.9L4 (STAGE V)



1. Fan	6. Belt Tensioner	11. Front Engine Mount	16. Coupling
2. Calmp	7. Oil Fitter	12. Rear Engine Mount	17. Pump Adapter Plate
3. Adapter	8. Oil Cooler	13. Engine Isolator Mount	18. Pump Assembly
4. Drive Belt	9. Front Engine/Generator Mount	14. Flywheel	19. Gear Pump Assembly
5. Alternator	10. Compensator	15. Rear Engine Mount	20. Oil Fill Cap

Figure 3-137. Deutz TD2.9L4 (Stage V) Engine Components - Sheet 1 of 2



21. Engine Coolant Support Assembly
22. Engine Cooler
23. Air Intake Restriction Indicator
24. Battery
25. Bracket
26. Relay
27. Relay
28. Lanyard Cable
29. Hitch Pin
30. Tray
31. Air Cleaner assembly
32. Control Module
33. Fuel Tank

Figure 3-138. Deutz TD2.9L4 (Stage V) Engine Components - Sheet 2 of 2

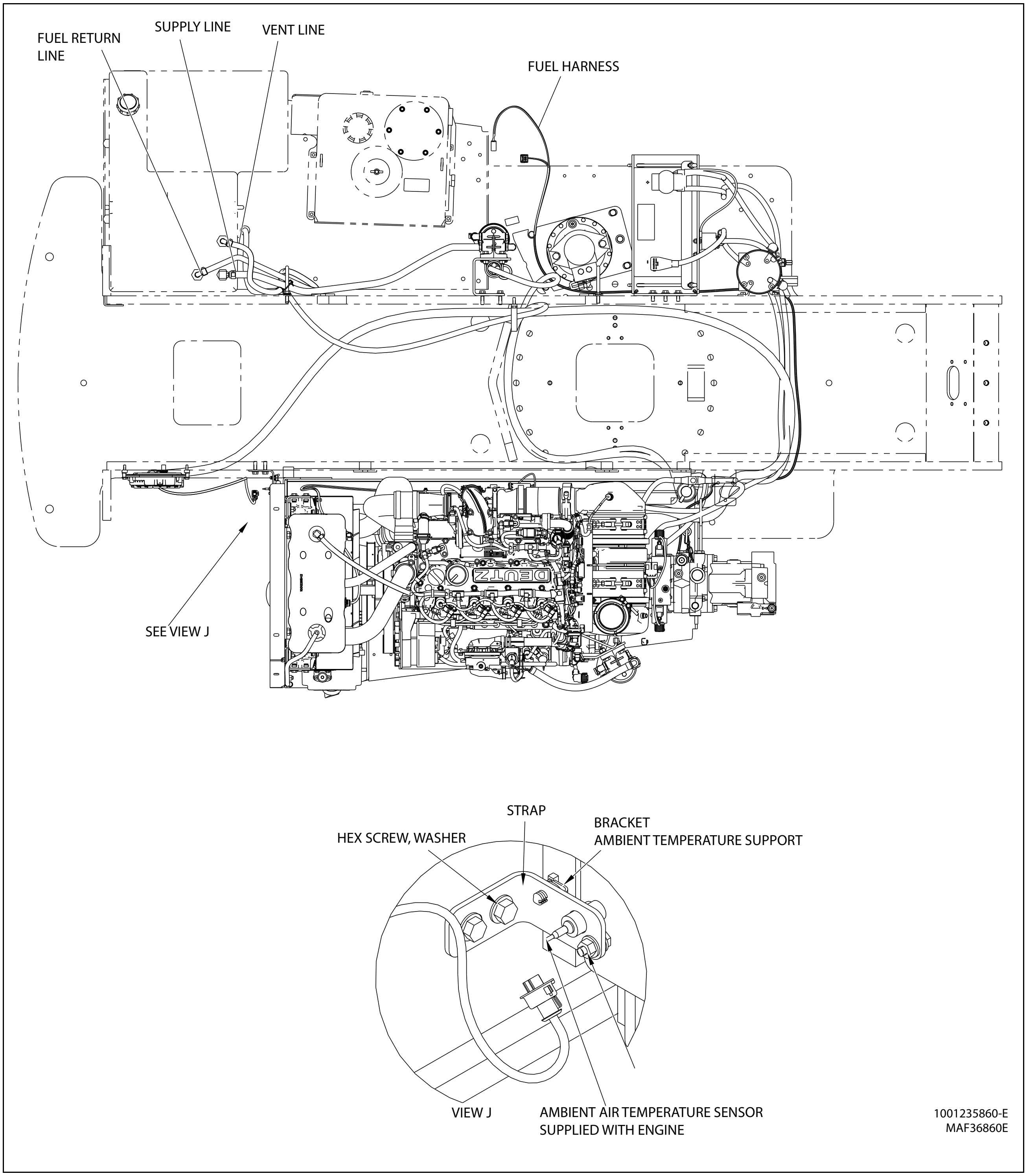


Figure 3-139. Deutz Engine TD2.9L4 (Stage V) Installation - Sheet 1 of 5

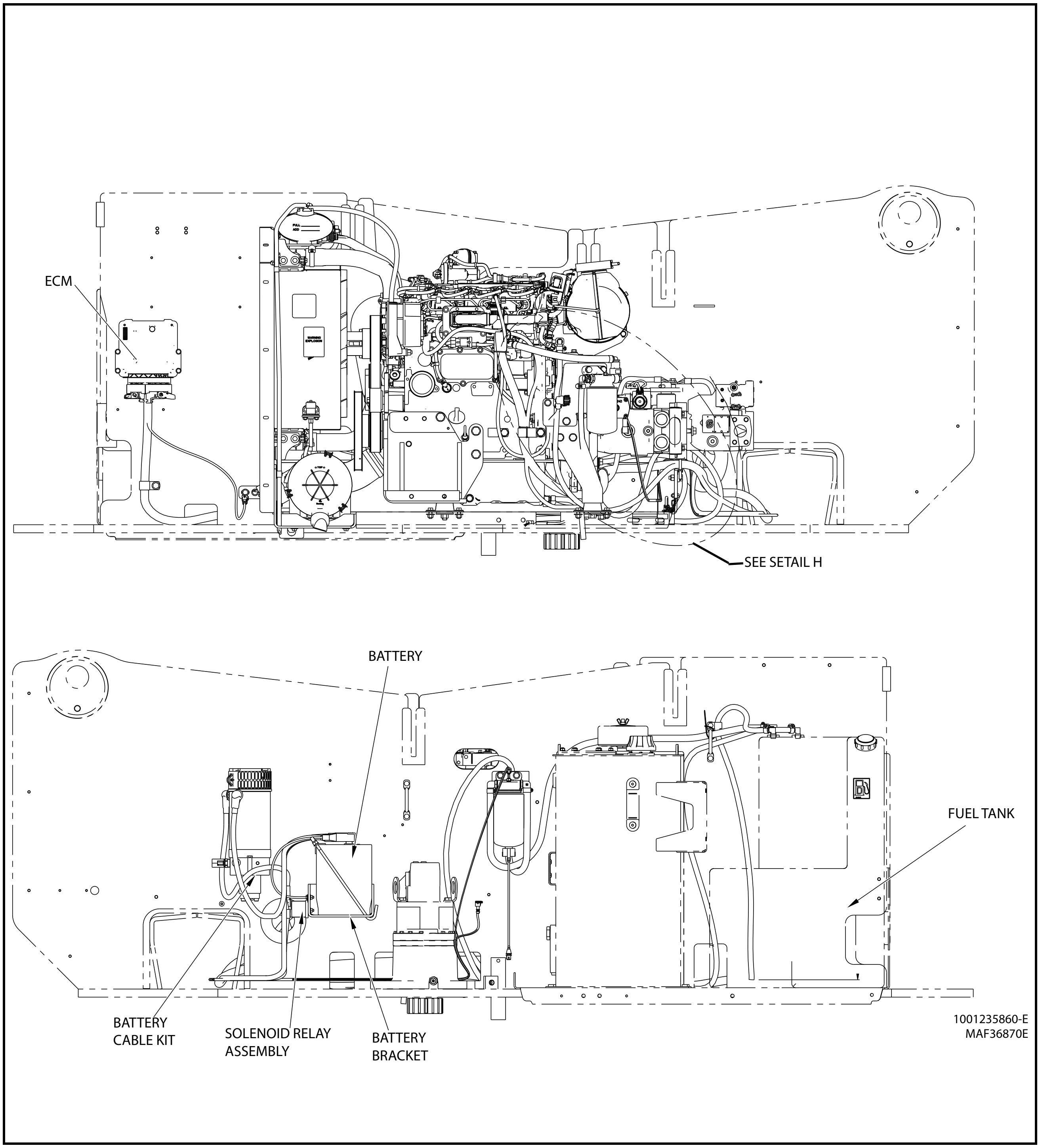


Figure 3-140. Deutz Engine TD2.9L4 (Stage V) Installation - Sheet 2 of 5

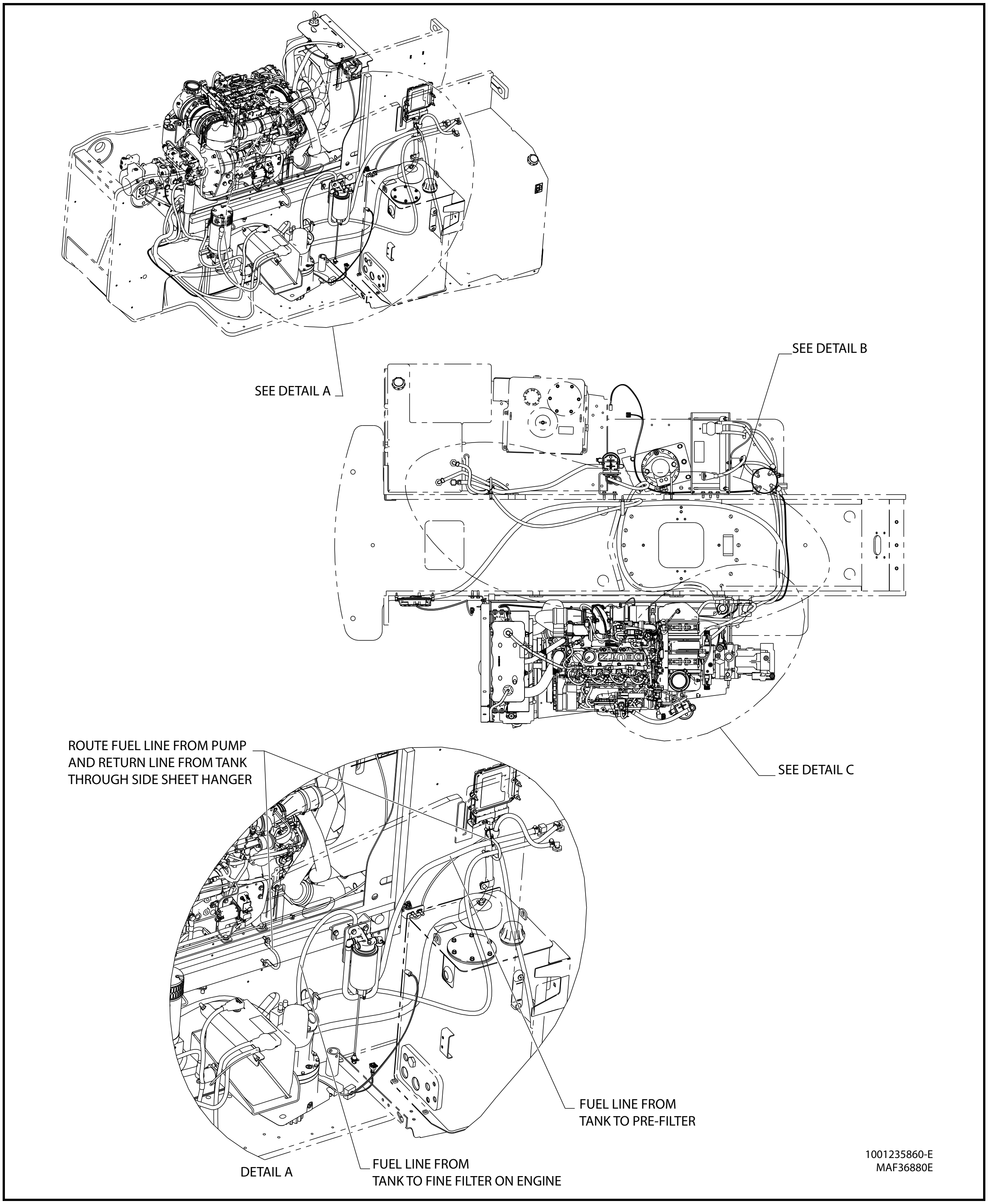


Figure 3-141. Deutz Engine TD2.9L4 (Stage V) Installation - Sheet 3 of 5

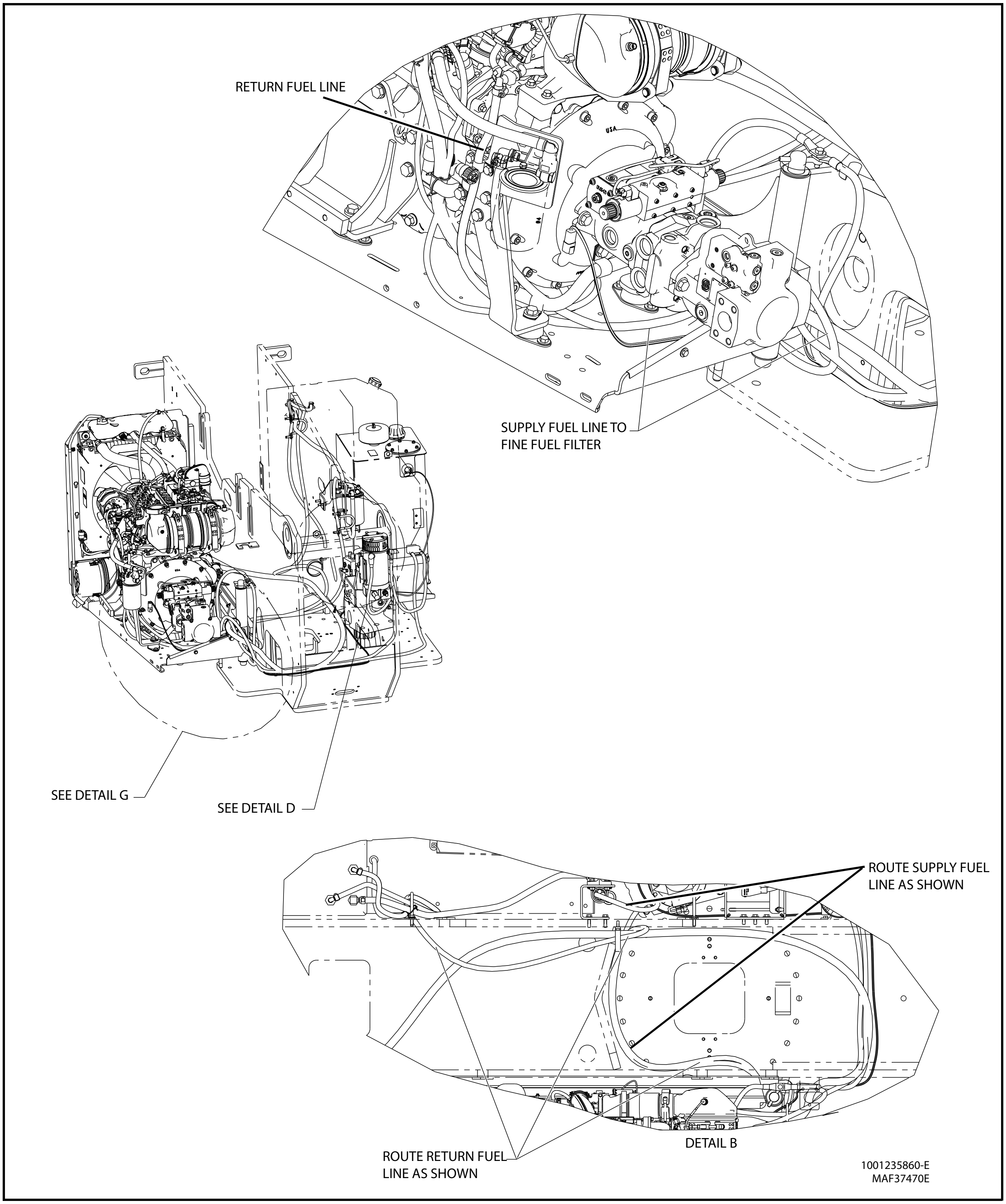


Figure 3-142. Deutz Engine TD2.9L4 (Stage V) Installation - Sheet 4 of 5

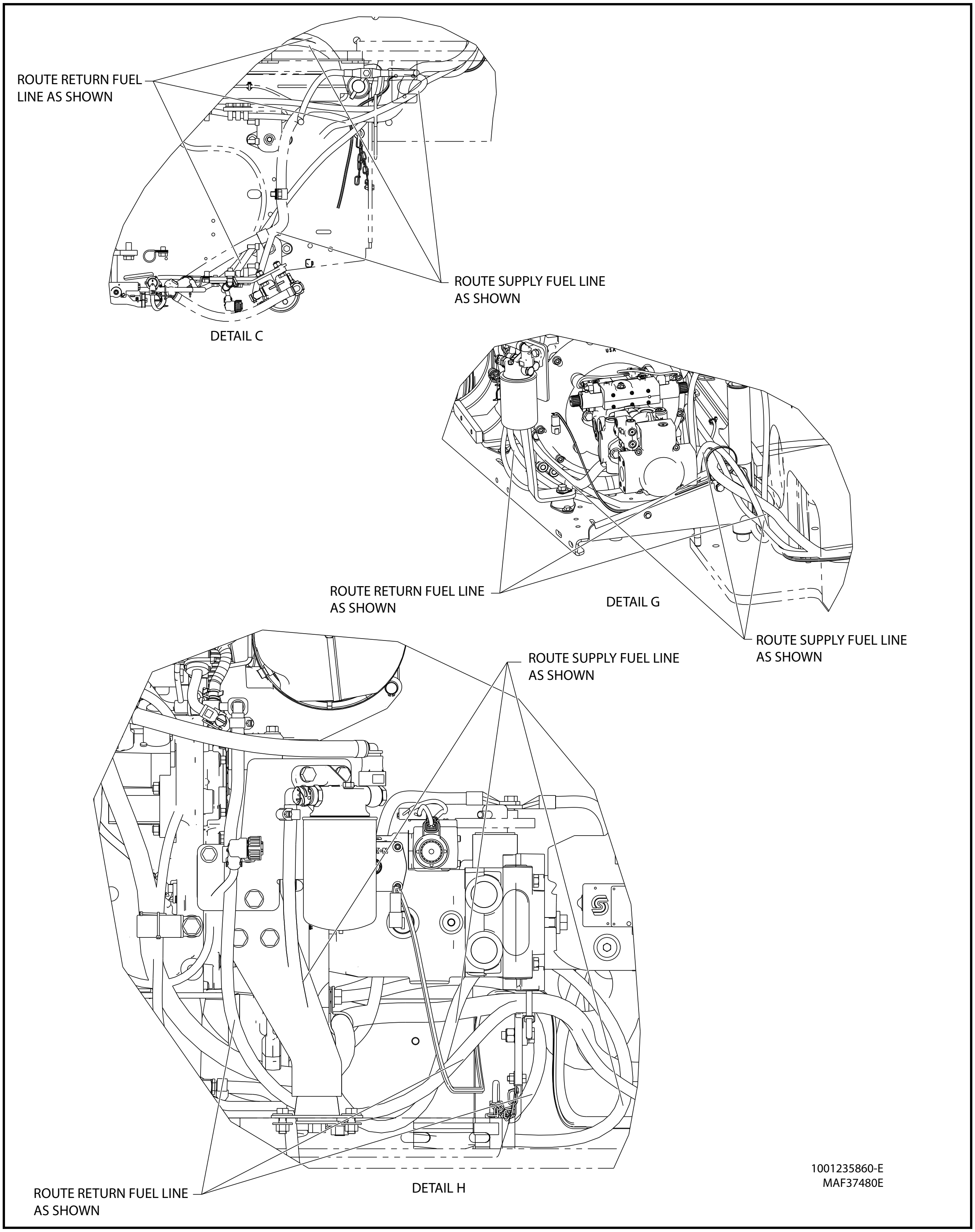


Figure 3-143. Deutz Engine TD2.9L4 (Stage V) Installation - Sheet 5 of 5

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.

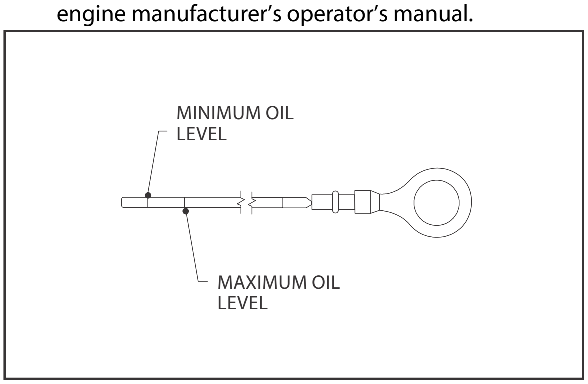


Figure 3-144. Deutz TD2.9L4 Dipstick Markings

5. Replace dipstick until fully seated.

Change Engine Oil

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

CAUTION

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

NOTICE

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

4. Open oil drain valve and drain oil.
5. Close oil drain valve.
6. Pour in new engine oil. Refer to Section 1 for capacity and Figure 3-145., Engine Oil Viscosity.

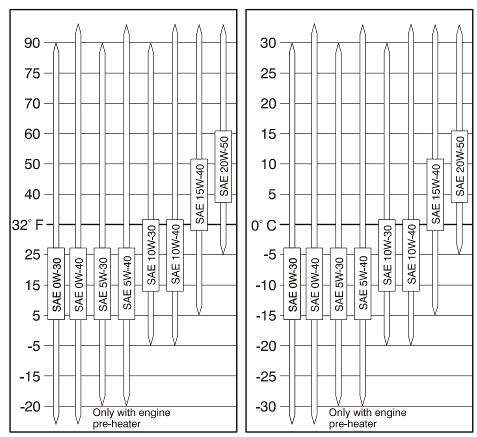
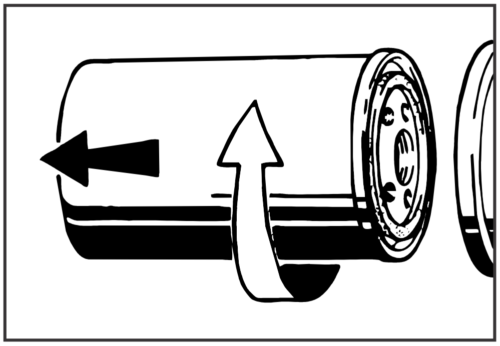


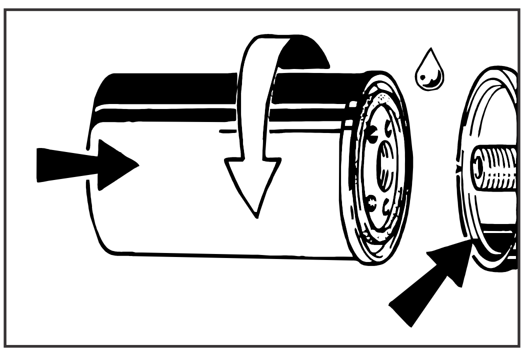
Figure 3-145. Engine Oil Viscosity

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.



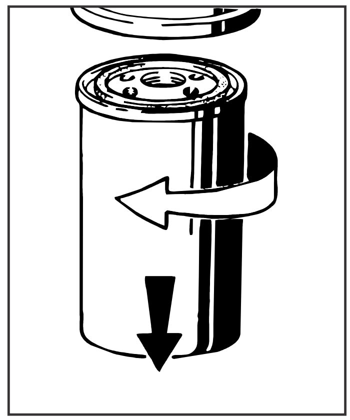
8. Check oil level.
9. Check oil pressure.
10. Check oil filter cartridge for leaks.

Change Fuel Filters

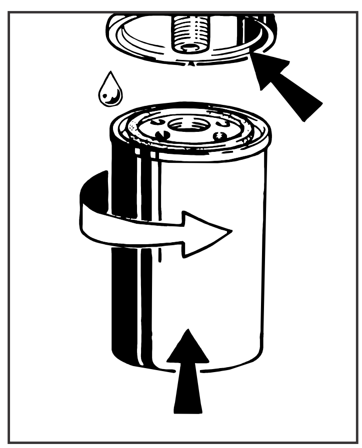
WARNING

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.

Replacing the Fuel Pre-Filter

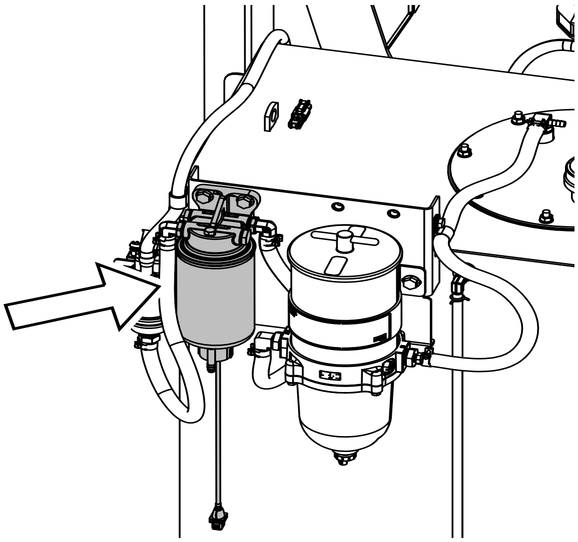
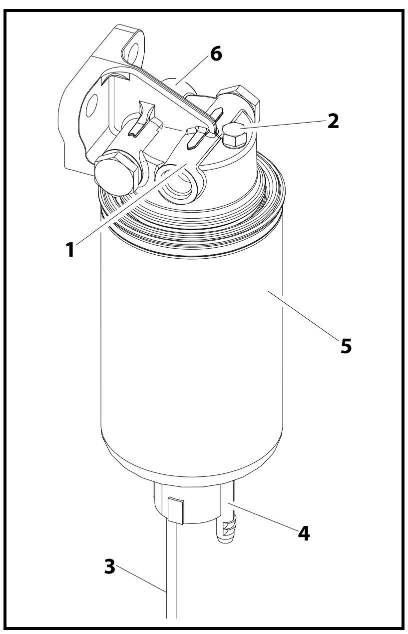


Figure 3-146. Location of Fuel Pre-Filter

NOTE: *Refer Figure 3-142., Components of Fuel Pre-Filter.*



1. Fuel Supply Flow to the Pump
2. Venting Screw
3. Electrical Connection for Water Level Sensor
4. Drain Plug
5. Filter Element
6. Fuel Inlet from the Fuel Tank

Figure 3-147. Components of Fuel Pre-Filter

⚠ WARNING

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

1. Switch off the engine.
2. Fuel supply from the fuel tank may need to be blocked to prevent fuel flow from the tank.
3. Place suitable collecting container under drain plug.
4. Disconnect electrical connections from water sensor.
5. Loosen drain plug and drain liquid.
6. Remove filter element.
7. Catch any escaping fuel.
8. Clean any dirt of the sealing surfaces of the new filter element and opposite side of filter head.
9. Wet the sealing surfaces of new filter element slightly with fuel.
10. Install new filter onto the filter head in clockwise direction. Torque to 12.5-13.3 ft. lbs. (17-18 Nm).
11. Install the drain plug and tighten to torque 1-1.4 ft. lbs. (1.3-1.9 Nm).
12. Connect electrical connection to water sensor.
13. Check for leaks after starting engine.

Water in Fuel Sensing System (Optional)

The Water in Fuel Sensing System detects when there is an excessive amount of water in the fuel and sets a DTC code in the JLG Control System to alert the operator and/or service technician.

When Water in Fuel condition occurs, the machine will respond in the following way:

- The engine will shut down automatically.
- The JLG Control System will set DTC 4375 - Water in Fuel.
- An alarm will sound from the active control station (ground or platform).
- If in platform mode, the Low Fuel Indicator will flash.
- Engine Restart will be permitted after the machine senses the Water in Fuel condition, but will only run for 2 minutes and the engine will shut down again. This restart process will continue until the Water in Fuel condition is corrected.

Draining Water

Frequency of water draining is determined by the contamination level of the fuel. Inspect or drain the collection bowl of water daily or as necessary. The collection bowl must be drained before contaminants reach the top of the turbine or

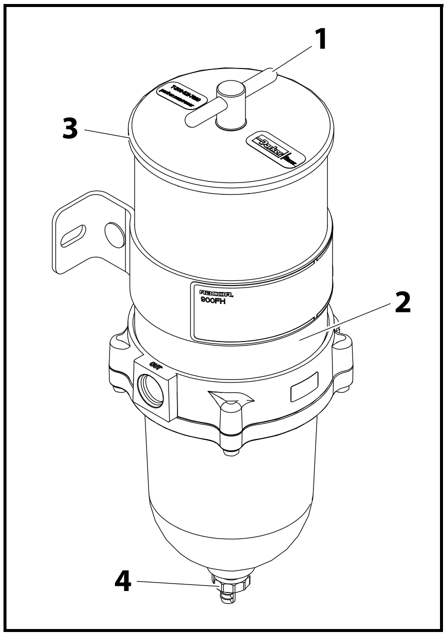
when the Water Detection Module (optional) indicates it's time to drain water.

Pressure Applications / Installations:

1. Open the drain plug on the bottom of the bowl to evacuate water and contaminants with a suitable collection container in place.
2. Close the drain after all the water and contaminants have been evacuated.

NOTE: *Do not leave the drain open too long as it may completely drain the entire filter assembly of water and fuel.*

Auxiliary Fuel Filter



1. T-handle
2. Filter Element
3. Lid
4. Drain Plug

Figure 3-148. Components of Auxiliary Fuel Filter

⚠ WARNING

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

ELEMENT REPLACEMENT

Frequency of element replacement is determined by the contamination level of the fuel. Replace the elements every 500 hours, if power loss is noticed or annually, which ever comes first.

1. Switch off the engine.
2. Fuel supply from the fuel tank may need to be blocked to prevent fuel flow from the tank.
3. Wipe the area around the filter to clean any dirt from the area.
4. Remove the T-handle and lid.
5. Remove the element by holding the bail handles and slowly pulling upward with a twisting motion. Dispose of properly.
6. Replace old lid gasket and T-handle O-ring with new seals (supplied with new element). Lubricate both seals with motor oil or diesel fuel before installation.
7. Refer to Priming of auxiliary fuel filter or fill the unit with clean fuel, then replace the lid and T-handle then tighten snugly by hand only.

NOTE: *Do not use any tool for removal and installation of T-handle.*

PRIMING OF AUXILIARY FUEL FILTER

1. Remove the T-handle and lid from the top of the filter assembly.
2. Fill the filter assembly with clean fuel.
3. Lubricate lid gasket and T-handle O-ring with clean fuel or motor oil.
4. Replace the lid and T-handle and tighten snugly by hand only.

NOTE: *Do not use any tool for removal and installation of T-handle.*

5. Start engine and check for fuel system leaks.
6. Correct as necessary with engine off and pressure relieved from filter assembly.

DRAINING WATER

Frequency of water draining is determined by the contamination level of the fuel. Inspect or drain the collection bowl of water daily or as necessary. The collection bowl must be drained before contaminants reach the top of the turbine or when the Water Detection Module (optional) indicates it's time to drain water.

Pressure Applications / Installations:

1. Open the self-venting drain plug on the bottom of the bowl to evacuate water and contaminants with a sui able collection container in place. Head pressure will push any water and contaminants out of the drain while keeping the filter primed.
2. Close the drain after all the water and contaminants have been evacuated.
3. If necessary, follow priming of auxiliary fuel filter.

NOTE: *Do not leave the drain open too long as it may completely drain the entire filter assembly of water and fuel.*

Deutz EMR5

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.

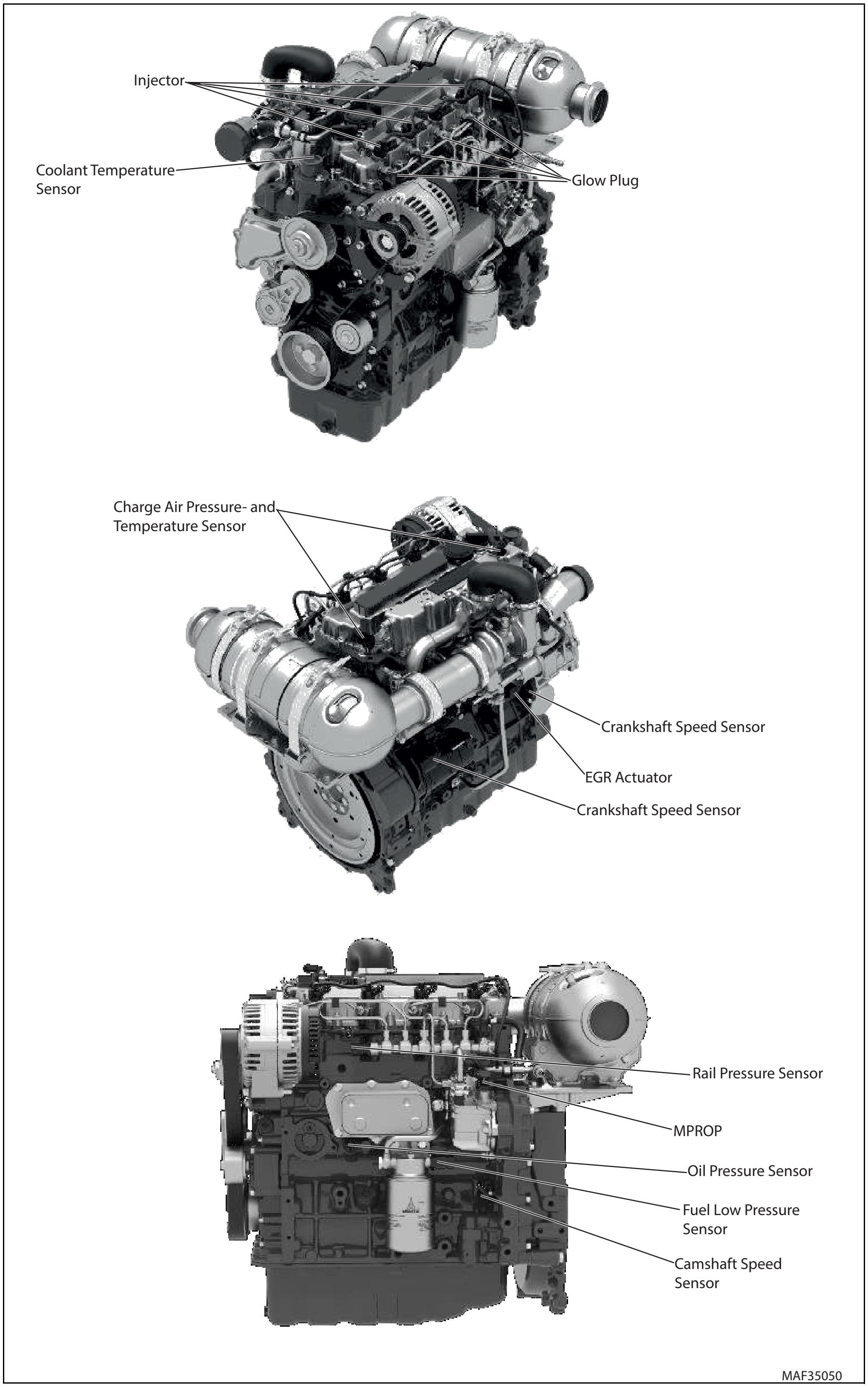


Figure 3-149. EMR5 Engine Side Equipment

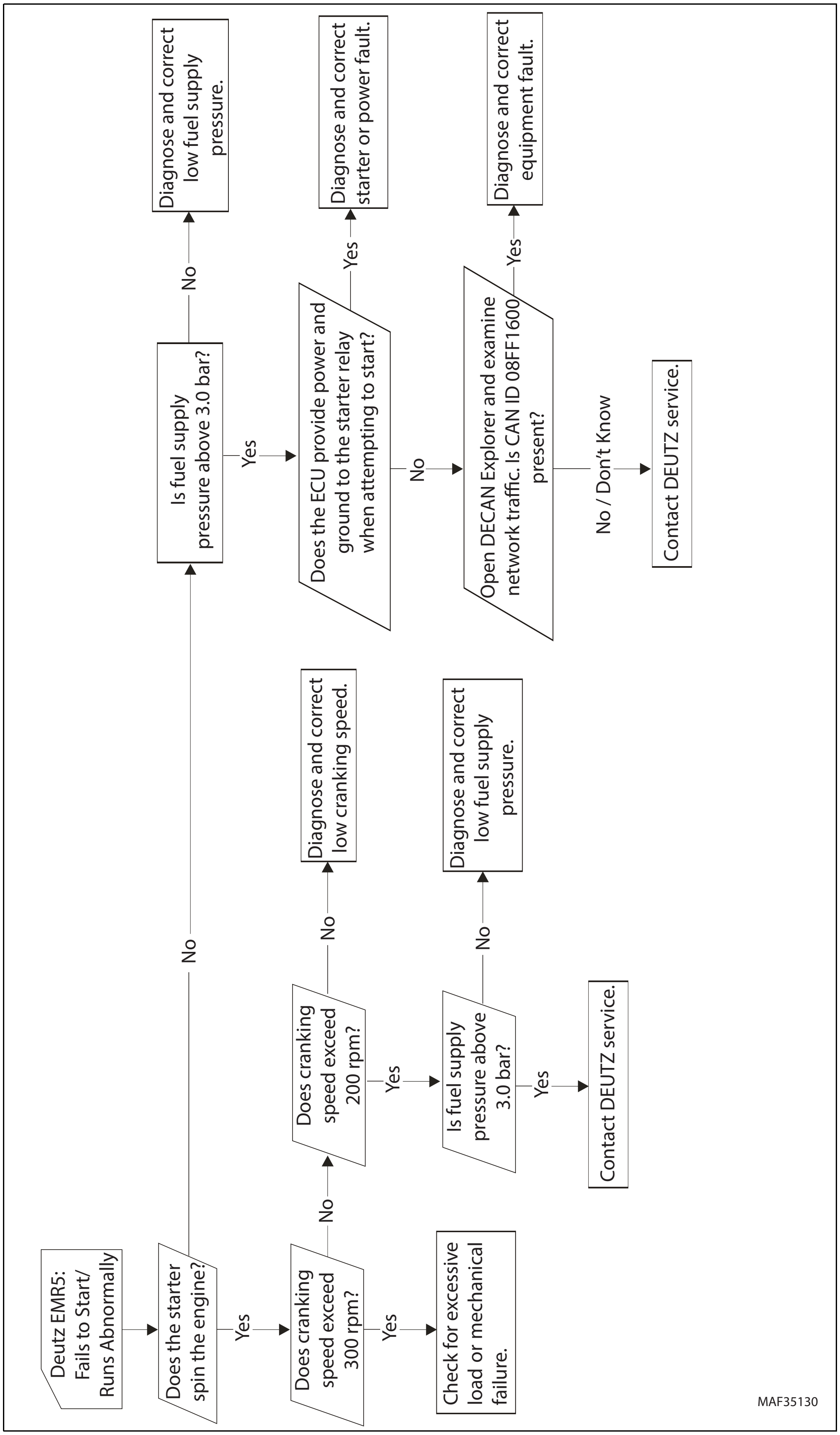


Figure 3-150. Deutz EMR5 Troubleshooting Flow Chart

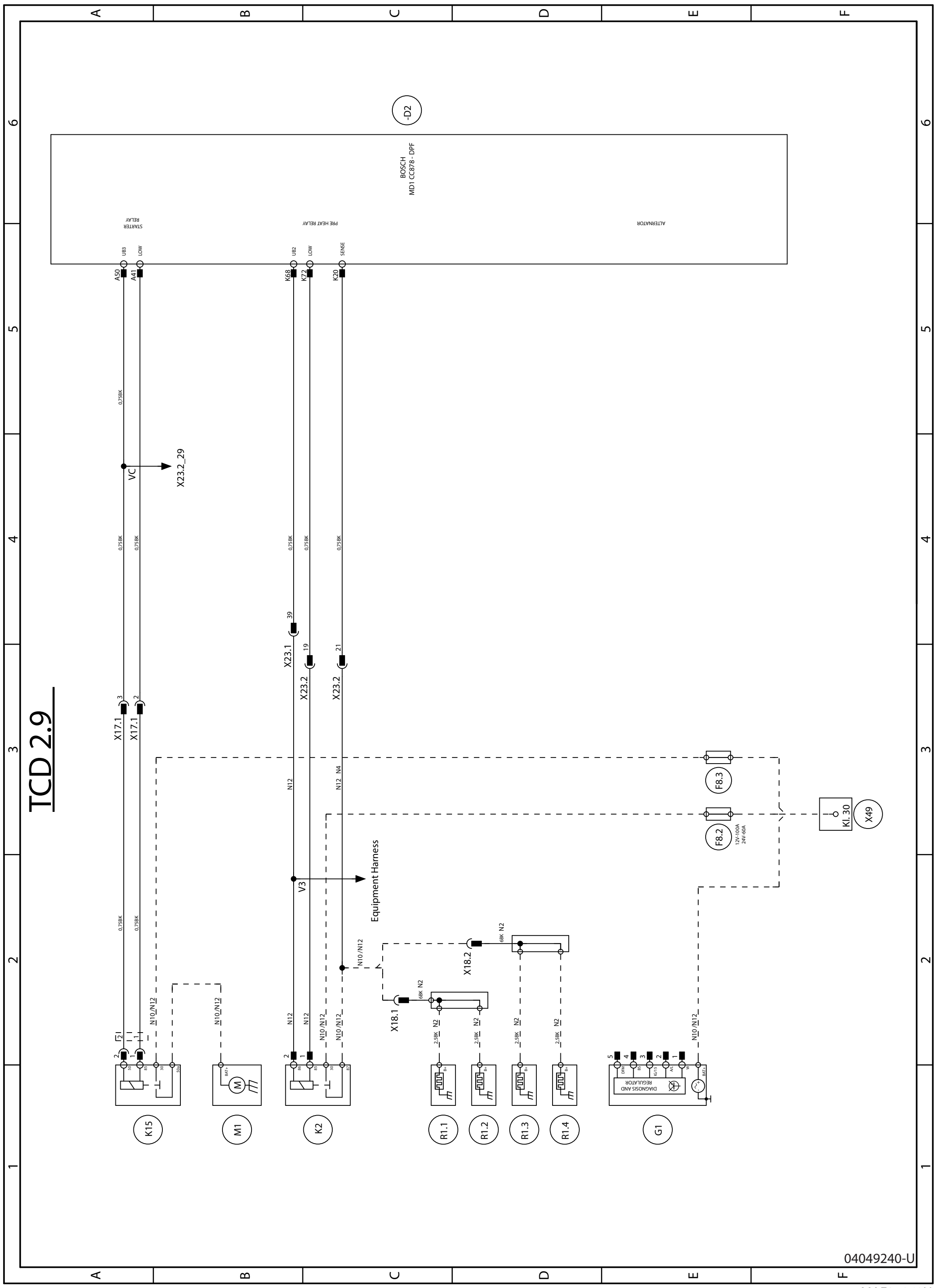


Figure 3-151. Deutz EMR5 Power Harness

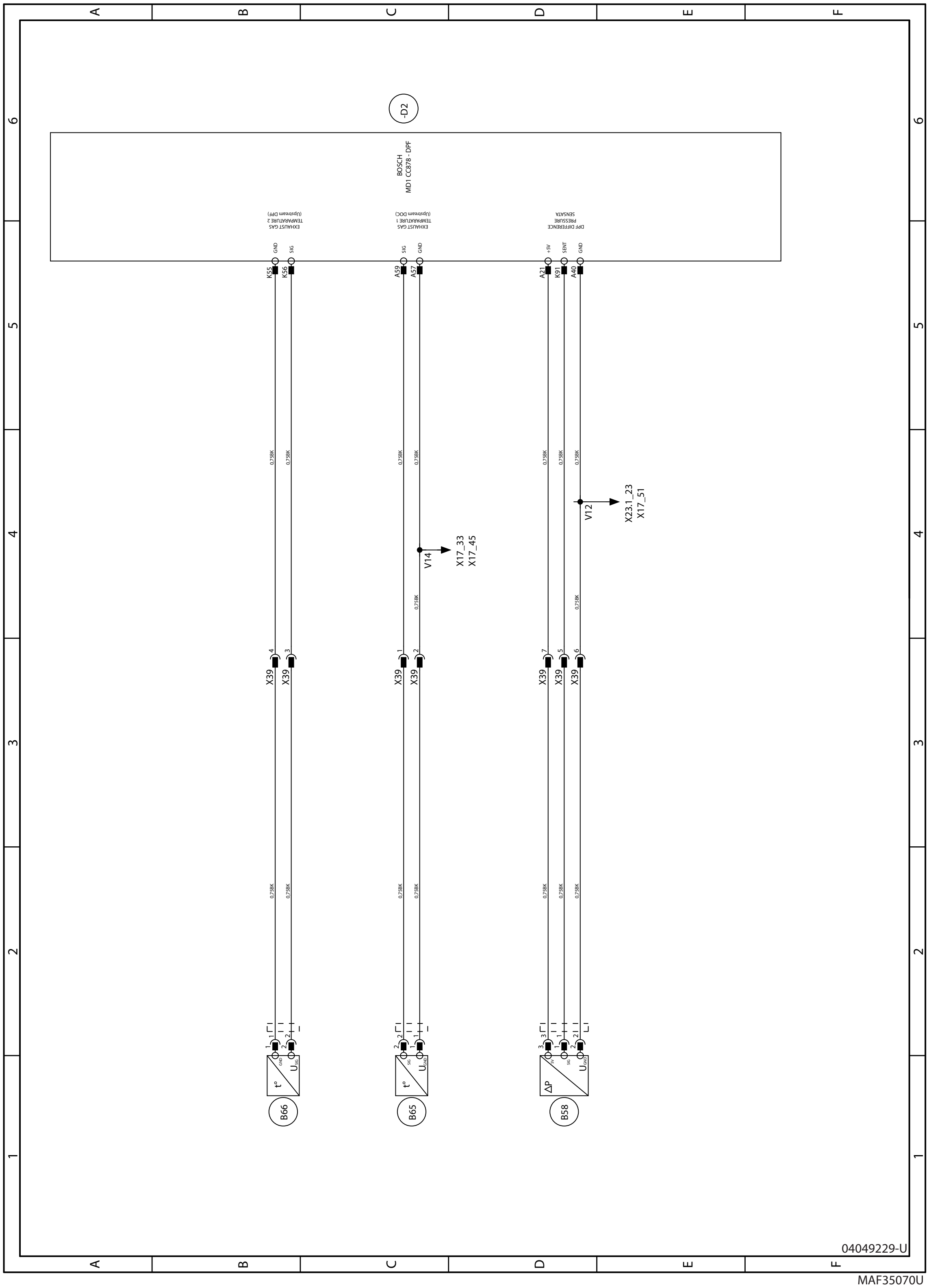


Figure 3-152. Deutz EMR5 Exhaust After Treatment Harness

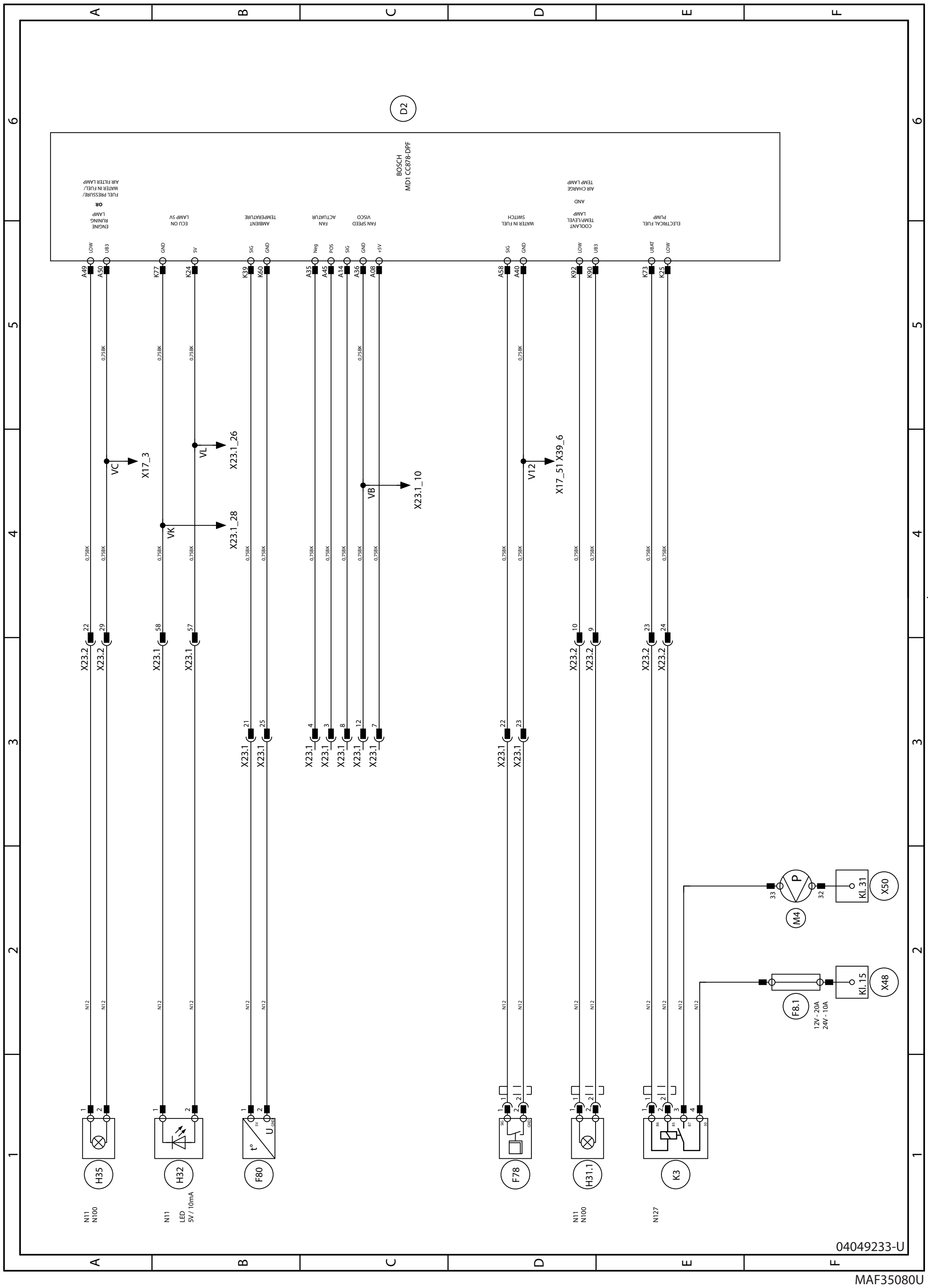
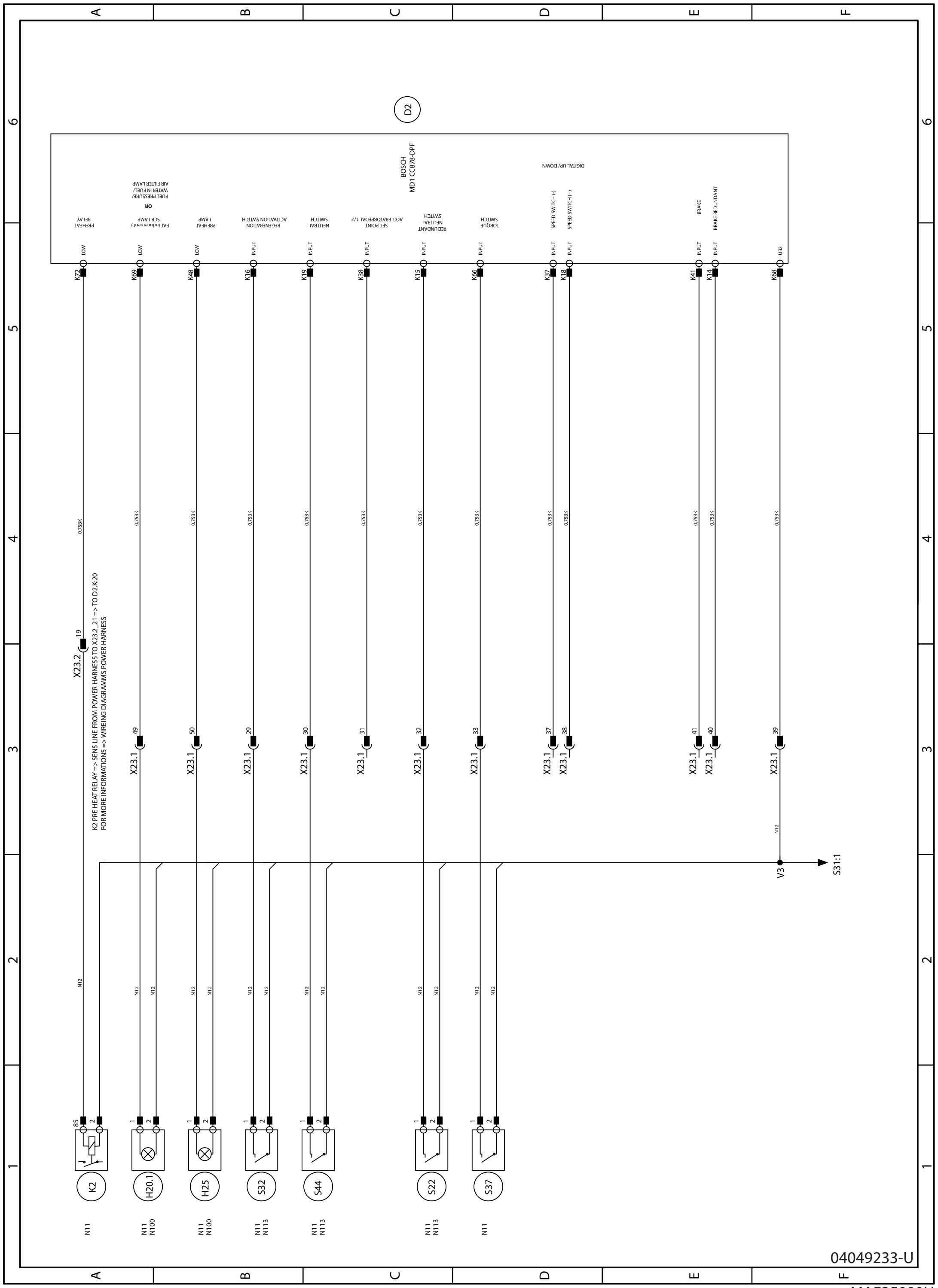


Figure 3-153. Deutz EMR5 Equipment Harness - Sheet 1 of 5



MAF35090U

Figure 3-154. Deutz EMR5 Equipment Harness - Sheet 2 of 5

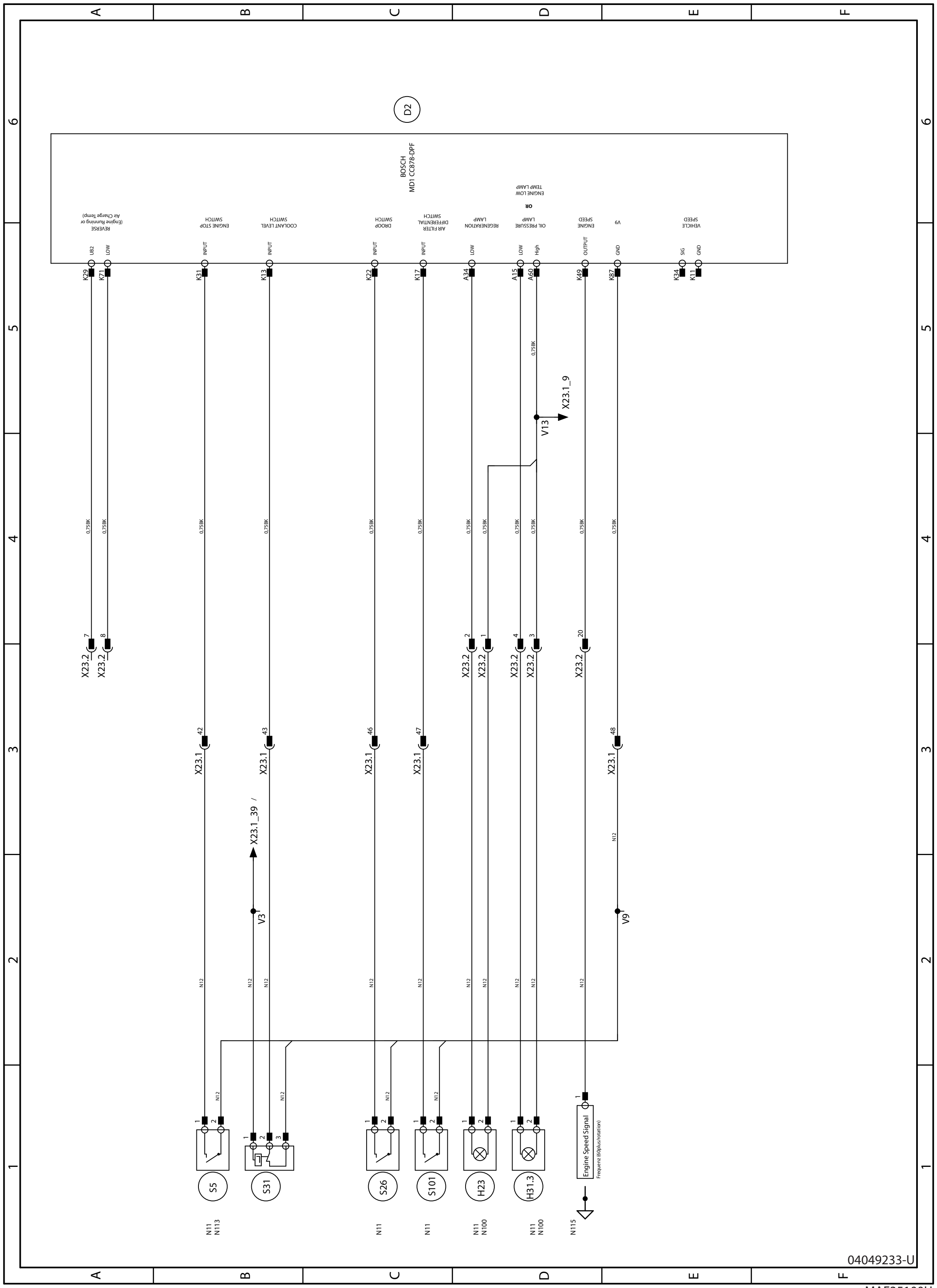


Figure 3-155. Deutz EMR5 Equipment Harness - Sheet 3 of 5

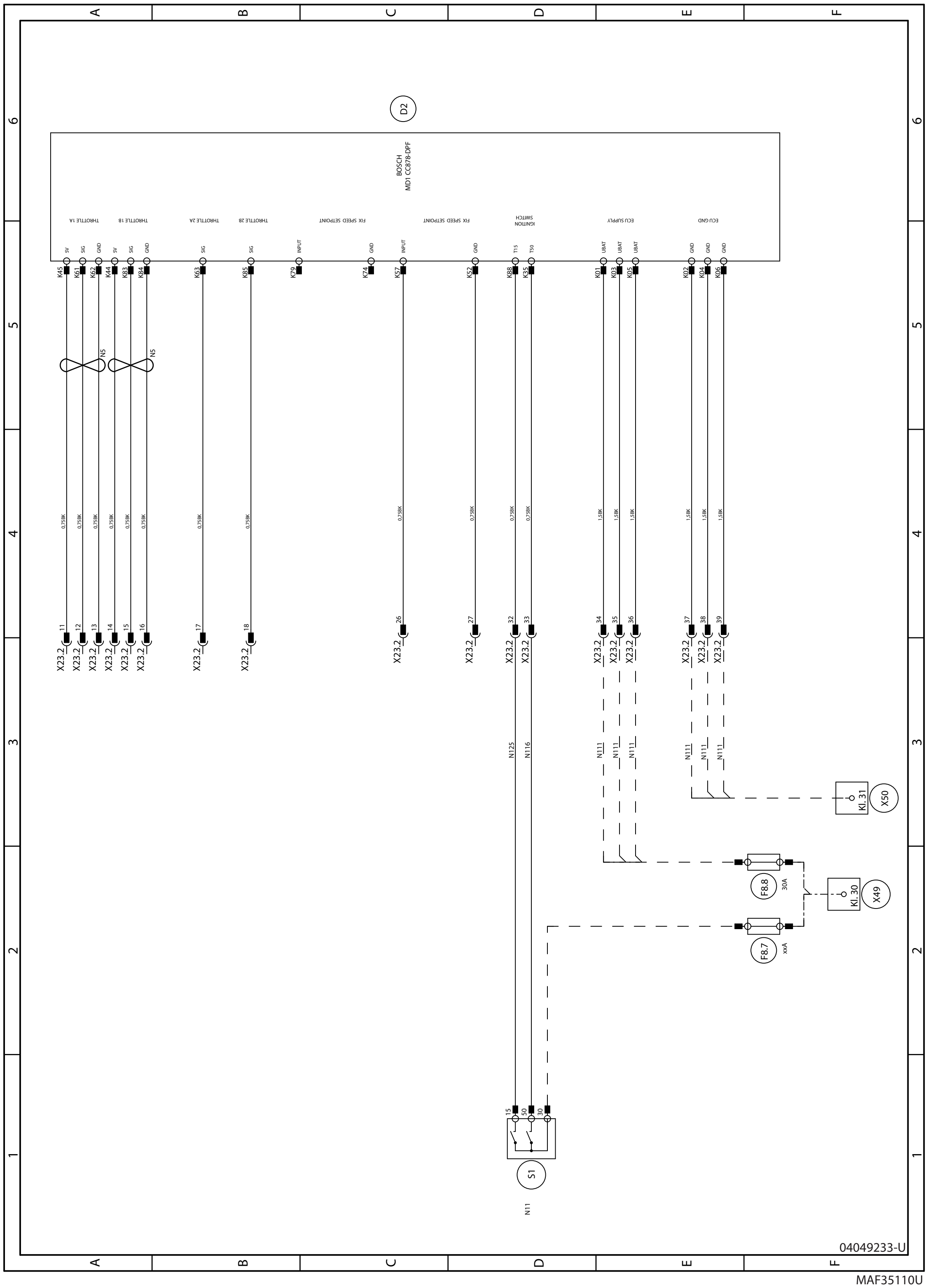


Figure 3-156. Deutz EMR5 Equipment Harness - Sheet 4 of 5

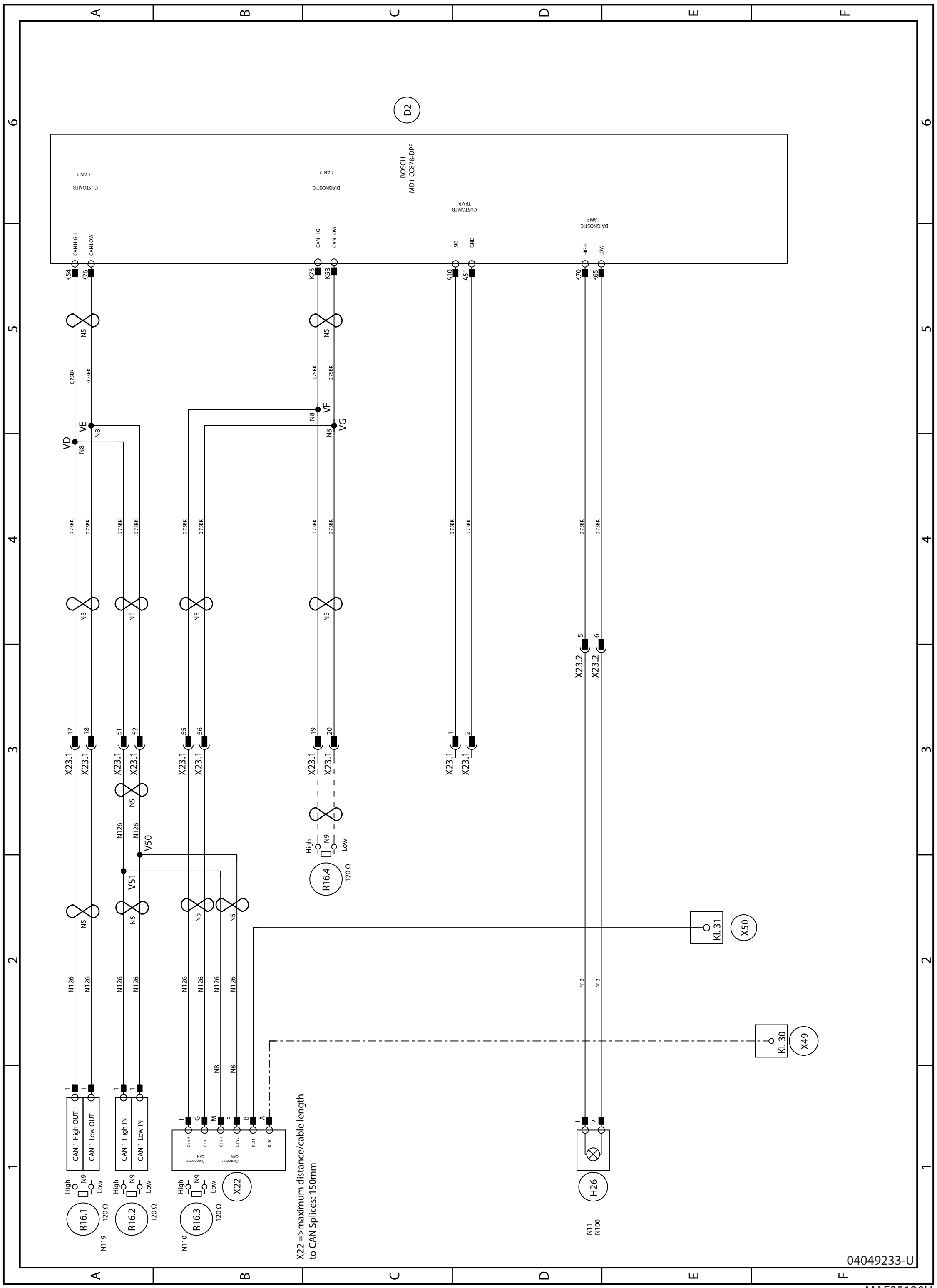
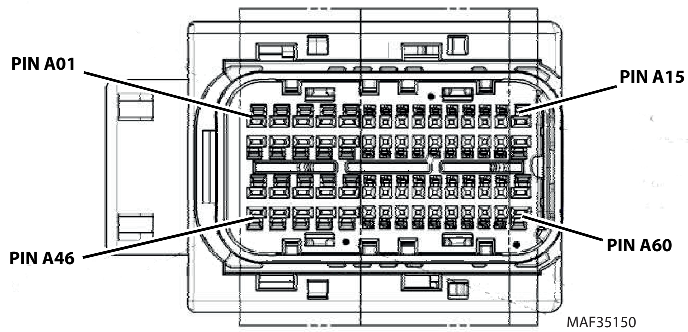


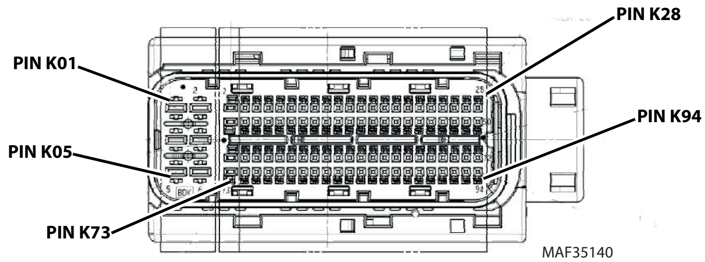
Figure 3-157. Deutz EMR5 Equipment Harness - Sheet 5 of 5



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 3-158. 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 3-159. 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

3.29 HRC ENGINE EMISSION CHARACTERISTICS

The Deutz engine uses multiple & different technologies in order to maintain engine emissions compliance in Highly Regulated Countries (HRC).

All HRC regions, except for CE, utilize an engine with Exhaust Gas Recirculation (EGR), & Diesel Oxidation Catalyst (DOC). These systems are passive, requiring no operator input or regular maintenance. This engine meets ANSI Tier 4F.

The CE market utilizes a similar engine, also incorporating EGR & DOC, but also includes a Diesel Particulate Filter (DPF). This engine meets CE Stage V. The DPF system requires monitoring & periodic maintenance. Failure to follow the DPF maintenance will cause the engine to de-rate & eventually shut down, if not addressed.

The DPF traps two kinds of contaminants: Soot & Ash. Soot can be burned off with heat. Ash is a byproduct of the burnt soot, & builds up over time, eventually necessitating filter replacement after thousands of hours of engine run-time.

Terminology for Removing Soot

AUTOMATIC BACKGROUND REGENERATION

During normal operation, if the DPF has accumulated a little too much soot, the system automatically engages a routine to increase the exhaust temperatures to burn out the soot. It operates in the background. It does not affect operation of the machine. Long periods of idle and/or low ambient temperatures may reduce the effectiveness of this type of regen.

STANDSTILL REGENERATION

This is supposed to be activated by the operator when the Automatic Background Regen fails to reduce the soot sufficiently. The machine must be made stationary and no functions may be operated. The system elevates the exhaust temperatures much higher to clean the DPF. Regen takes estimated 35 minutes every 500 hours (will vary). If the operator refuses to initiate a standstill regen when indicated, the engine will automatically be limited to lower power and/or idle lock.

The engine’s control unit also monitors the time elapsed since the last Standstill Regen. Even if soot loading doesn’t rise high enough to request a regen, the clock will eventually request the regen.

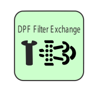
3.30 DIESEL PARTICULATE FILTER (IF EQUIPPED)

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

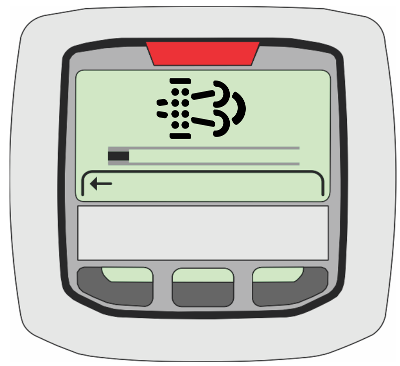
The following conditions must be met to perform Standstill Cleaning.

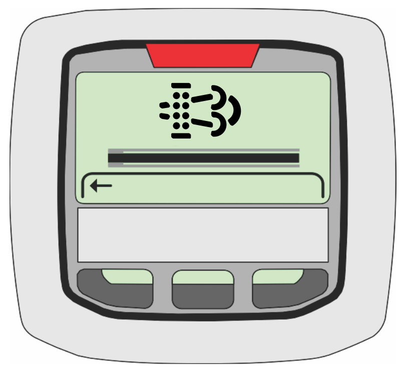
- Machine must be stationary
- Boom in the stowed position
- No personnel in platform
- Engine must be idling
- Coolant temperature must be above 104° F (40° C)
- Machine in Ground Station mode

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

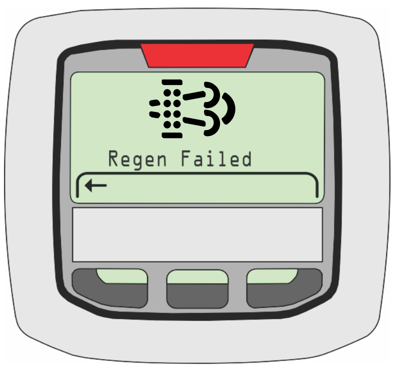
Maintenance Standstill Cleaning can be started by one of two methods, by using the Analyzer or the DPF button on the Ground Console. All the same conditions as outlined under Standstill Cleaning must be met.

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.

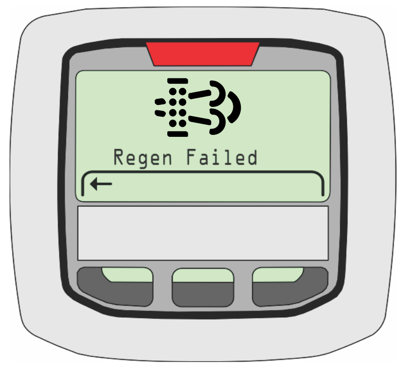


Unsuccessful Cleaning Event

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.

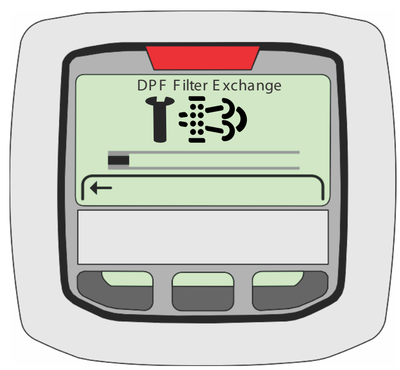


Table 3-16. Maintenance Standstill Cleaning

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

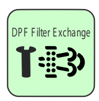
Table 3-17. Standstill Cleaning: DPF Filled with Soot

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%	-	-	-	-		None	
1	Heat Mode 1	62% to 78%	50						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 stand-still 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		xx0000xx - -	No Derating
Warning Level	≥105%	10	Blinking 	xx0000xx - -	No Derating
Warning Level	≥110%	11	Blinking 	xx0000xx On Continuous 	Derating Step 1Active.

3.31 DUAL FUEL SYSTEM

CAUTION

IT IS POSSIBLE TO SWITCH FROM ONE FUEL SOURCE TO THE OTHER WITHOUT ALLOWING THE ENGINE TO STOP. EXTREME CARE MUST BE TAKEN AND THE FOLLOWING INSTRUCTIONS MUST BE FOLLOWED.

Changing from Gasoline to LP Gas

1. Start the engine from the ground control station.
2. Open the hand valve on the LP gas supply tank by turning counterclockwise.

CAUTION

BE SURE ALL GASOLINE IS EXHAUSTED BEFORE SWITCHING TO LP GAS.

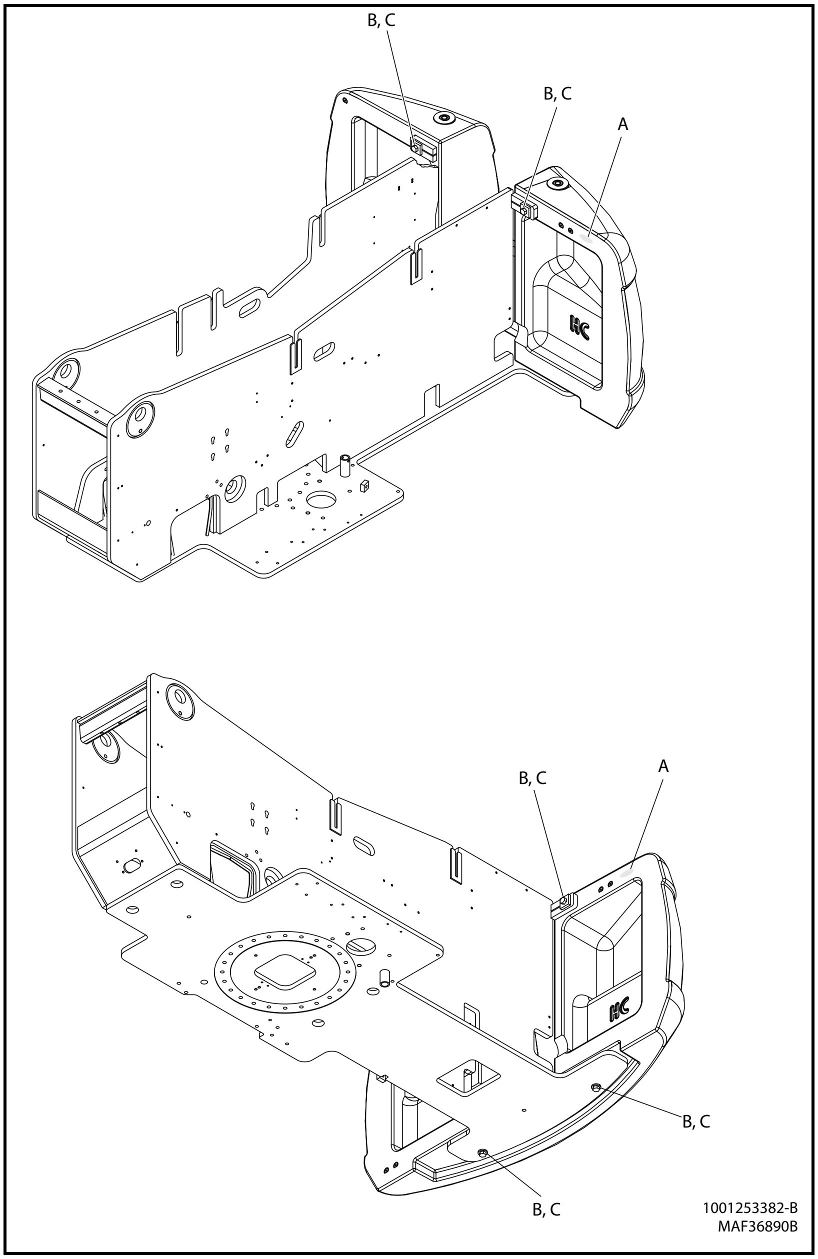
3. While the engine is operating, place the two position LPG/Gasoline switch at the platform control station to the LP position. Allow the engine to operate without load until the engine regains smoothness.

Changing from LP Gas to Gasoline

1. With engine operating on LP under a no load condition, throw the LPG/Gasoline switch at the platform control station to the “Gasoline” position. Allow the engine to operate with no load until the engine regains smoothness.
2. Close the hand valve on the LP gas supply tank by turn.

3.32 COUNTERWEIGHT

If the counterweight has been removed, ensure the retaining bolts are torqued to the proper value as shown in Figure 3-160.



A. Actual Weight Stamping

B. Apply Medium Strength Threadlocking Compound to Bolt Threads and to Threads in Counterweight.

C. Torque to 285 ft. lbs. (386 Nm). Typical Four Places.

Figure 3-160. Counterweight

SECTION 4. BOOM & PLATFORM

4.1 PLATFORM LOAD SENSING SYSTEM

The Platform Load Sensing System (LSS) consists of single load cell and two linkages mounted to the platform rotator and replaces the platform support on machines that get this installation. The load cell includes a sealed circuit and is connected directly to a CAN-based platform control panel within the platform box.

This system compares the capacity to the measured weight in the platform. When the capacity is exceeded, or when there is a fault in the system, the platform overload indicator will flash, the platform alarm will sound at the rate of 5 sec/min and all platform controls (except auxiliary power) will be disabled. The ground controls are unaffected.

4.2 MACHINE SAFETY SYSTEM OVERRIDE (MSSO) (CE ONLY)

The Machine Safety System Override (MSSO) 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.

4.3 TRANSPORT POSITION SENSING SYSTEM

The transport position sensing system uses three sensors/switches together to sense when the boom is out of transport (nearly stowed) position.

- Main Boom Angle Sensor: A rotary angle sensor mounted at the pivot point between the main boom and upright. This is a hall effect sensor with built-in redundancy.
- A limit switch located inside the upright, activated by a cam on the upright level cylinder barrel bushing.
- A proximity switch mounted near the pivot end of the main boom.

The tower boom is recognized as “out of transport position” when the tower boom angle switch senses the tower upright is raised 40” to 42” from stowed position, and resets to “within transport position” when lowered 25” to 30” from the activated position.

The main boom angle is recognized as “out of transport position” when one angular sensor signal from the main boom angle sensor reads more than 5° greater than horizontal (with respect to the turntable), and resets to “within transport position” when both angular sensor signals read less than 3° greater than horizontal (with respect to the turntable).

The main boom telescope length is recognized as “out of transport position” when the proximity switch near the pivot end of the main boom senses that the fly boom has extended 21”. The articulated jib position of the 800AJ HC3 has no effect on transport position.

This system is used to control the following systems:

- Beyond Transport - Drive Speed Cutback System.
- Drive/Steer – Boom Function Interlock System.

4.4 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 Tilt Indicator System for interaction with the tilt sensor.

4.5 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 inoperable. Likewise, while operating boom functions, drive/steer functions are inoperable.

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 4-30., Figure 4-31. & Figure 4-32.

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.*

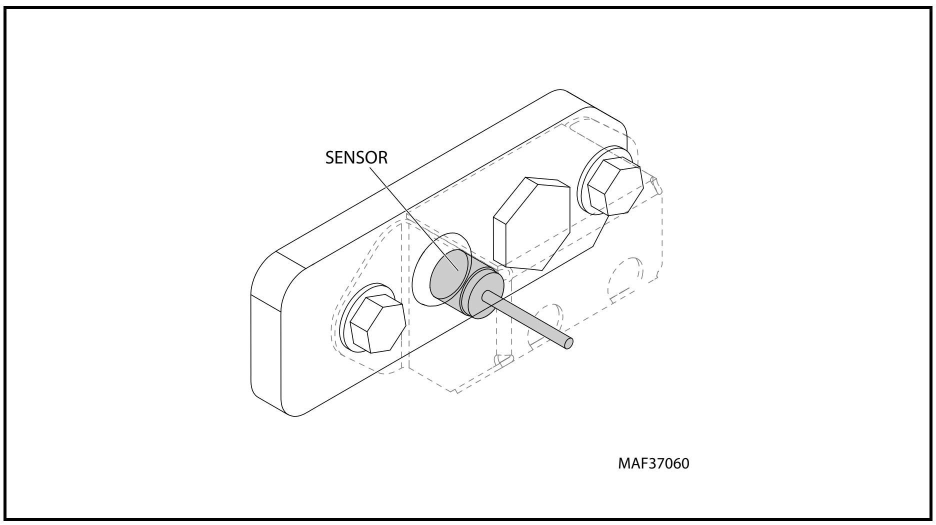


Figure 4-1. Telescope Retracted Sensor

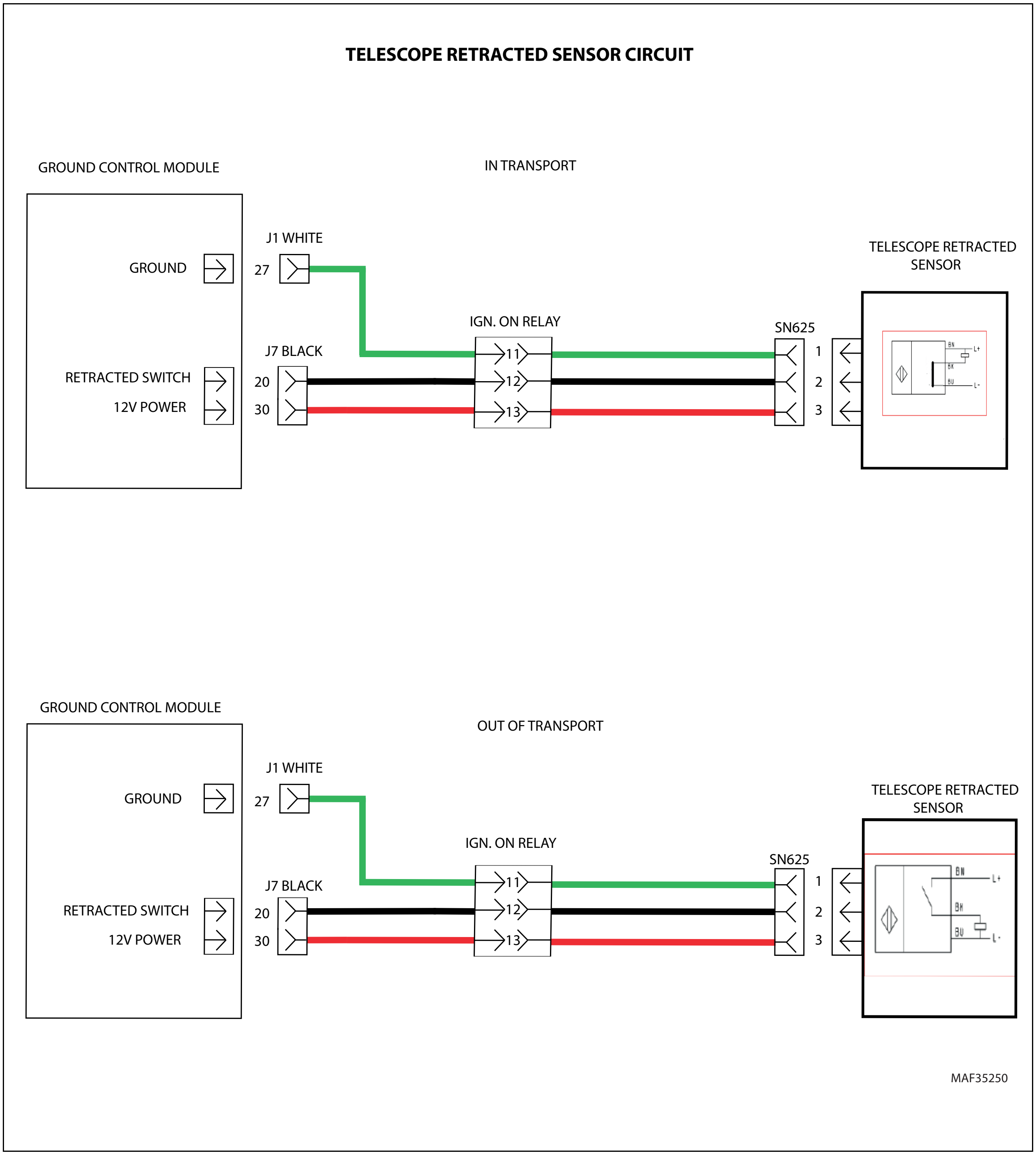


Figure 4-2. Telescope Retracted Sensor Circuit

TRIPLE CAPACITY SYSTEM

The 800AJ HC3 has three capacity zones: Unrestricted 660 lb/ 299 kg, Restricted 750 lb/340 kg, and Restricted 1000 lb/450 kg.

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 determines which capacity zone the platform can be operated in.

When the LSS system senses a platform load less than or equal to 660 lb / 299 kg, platform position is unrestricted within the envelope boundaries. When the LSS system senses a platform load greater than 660 lb / 299 kg, platform position is limited to one of the restricted zones.

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 lesser 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 will not enter the zone of lesser or no restriction. At this point, the control system will only allow the boom telescope function to retract and the boom lift function to lift up, since these actions will bring the platform towards an improved stability condition.

Unrestricted 660 lb (299 kg) - (Yellow)

Switch Set A & Switch Set B:

Sensor 1 (right proximity sensor, refer Figure 4-3.) is a normally open sensor which is open in the unrestricted 660 lb (299 kg) zone. LED for Sensor 1 is OFF in this mode.

Sensor 2 (left proximity sensor, refer Figure 4-3.) is a normally closed sensor which is closed in the unrestricted 660 lb (299 kg) zone. LED for Sensor 2 is ON in this mode.

- The Machine Control System will allow the platform to go anywhere in the working envelope. The unrestricted 660 lb (299 kg) working envelope is shown in Figure 4-3.

NOTE: *In unrestricted 660 lb (299 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.*

Restricted 750 lb (340 kg) - (Blue)

Switch Set A:

The Sensor 1 (right proximity sensor, refer Figure 4-3.) is a normally open sensor which is open in the restricted 750 lb (340 kg) zone. LED for Sensor 1 is OFF in this mode.

The Sensor 2 (left proximity sensor, refer Figure 4-3.) is a normally closed sensor which is closed in the restricted 750 lb (340 kg) zone. LED for Sensor 2 is ON in this mode.

Switch Set B:

The Sensor 1 (right proximity sensor, refer Figure 4-3.) is a normally open sensor which is closed in the restricted 750 lb (340 kg) zone. LED for Sensor 1 is ON in this mode.

The Sensor 2 (left proximity sensor, refer Figure 4-3.) is a normally closed sensor which is open in the restricted 750 lb (340 kg) zone. LED for Sensor 2 is OFF 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 4-3.

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

Restricted 1000 lb (454 kg) - (Green)

Switch set A & Switch Set B:

The Sensor 1 (right proximity sensor, refer Figure 4-3.) is a normally open sensor which is closed in the restricted 1000 lb (454 kg) zone. LED for Sensor 1 is ON in this mode.

The Sensor 2 (left proximity sensor, refer Figure 4-3.) is a normally closed sensor which is open in the restricted 1000 lb (454 kg) zone. LED for Sensor 2 is OFF 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 4-3.

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 CLOSED and CAPACITY SW 2 will read OPEN.*

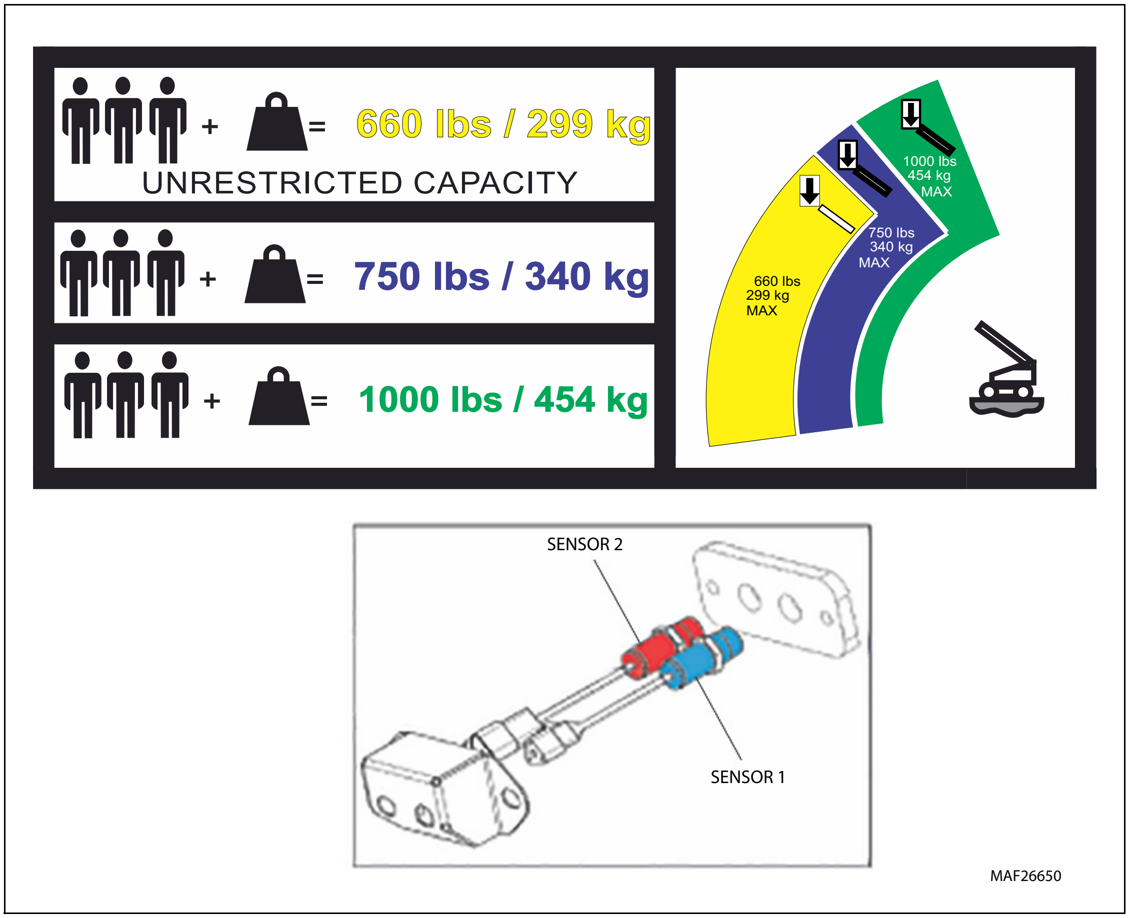


Figure 4-3. Capacity Sensors

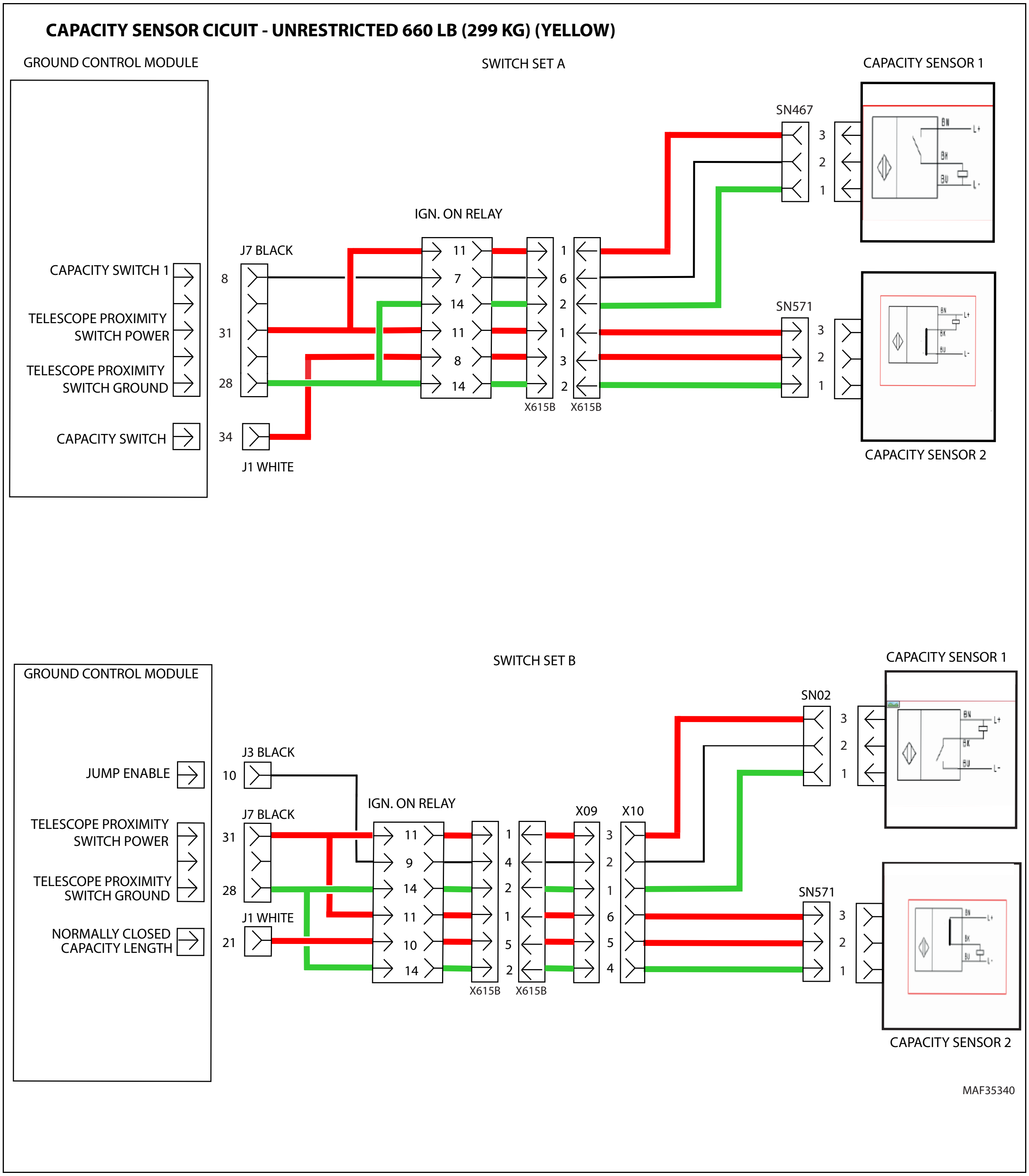


Figure 4-4. Capacity Sensors Circuit - Unrestricted 660 lb (299 kg) (Yellow)

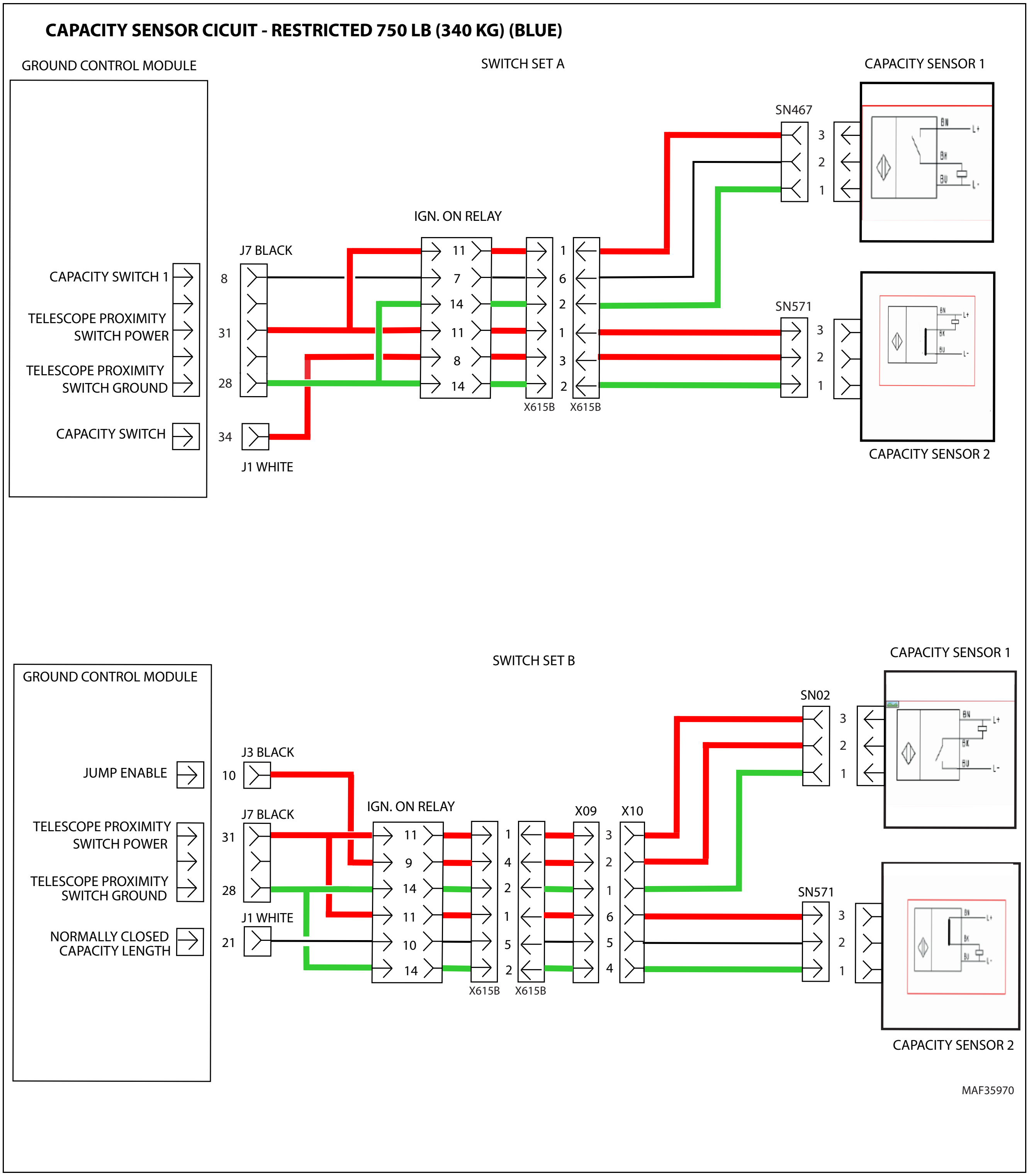


Figure 4-5. Capacity Sensors Circuit - Restricted 750 lb (340 kg) (Blue)

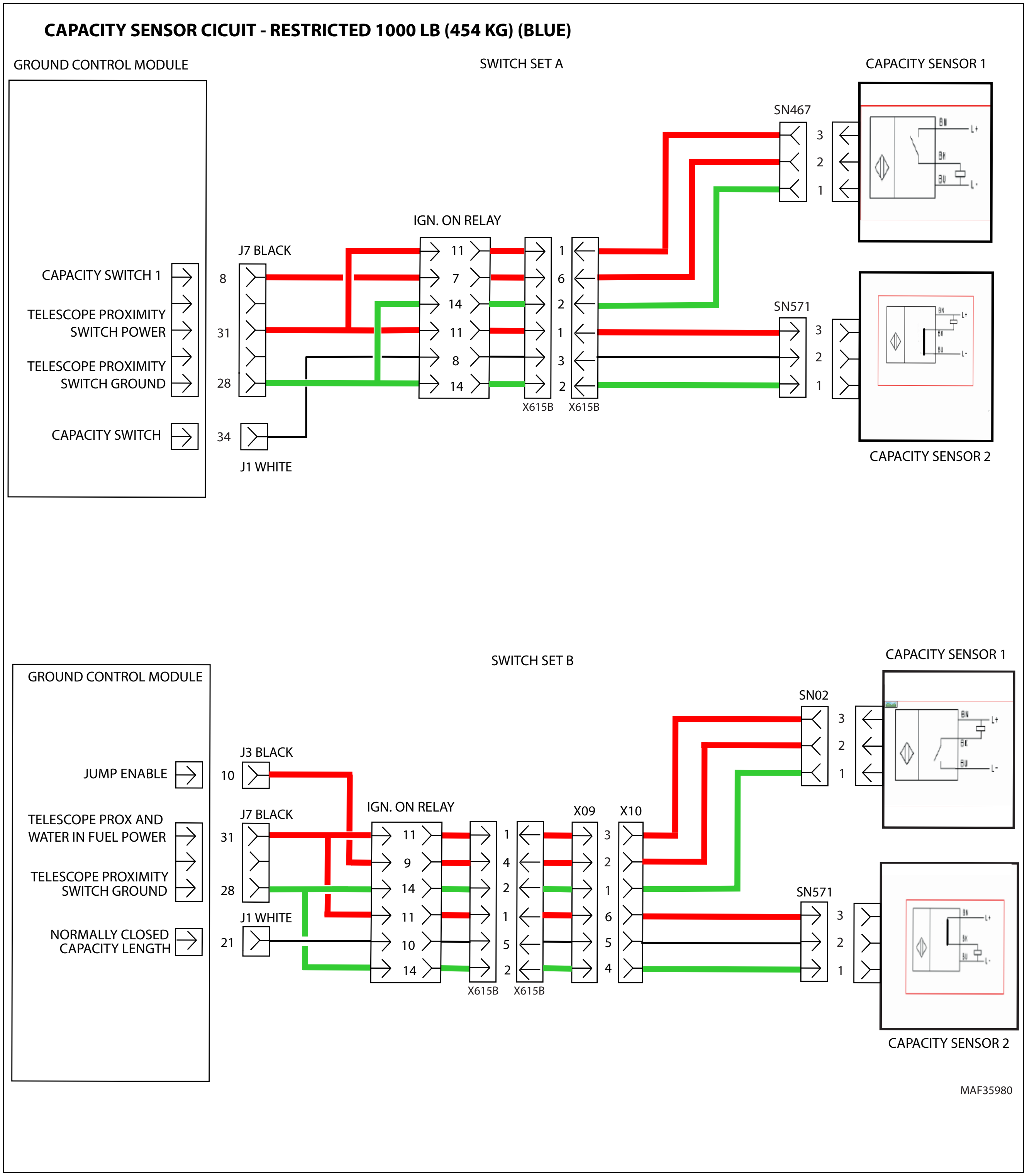


Figure 4-6. Capacity Sensors Circuit - Restricted 1000 lb (454 kg) (Blue)

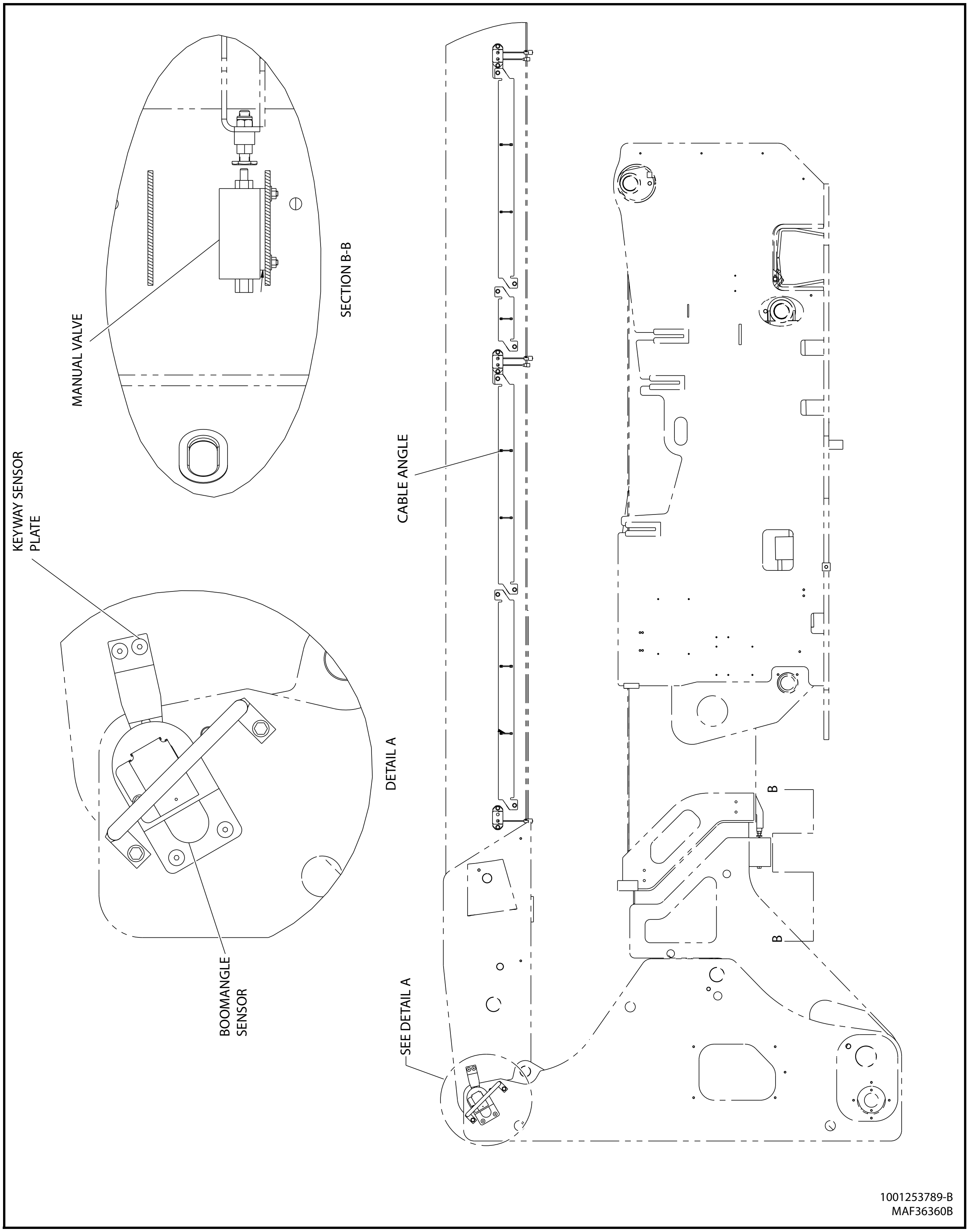


Figure 4-7. Capacity Switch Installation - Sheet 1 of 3

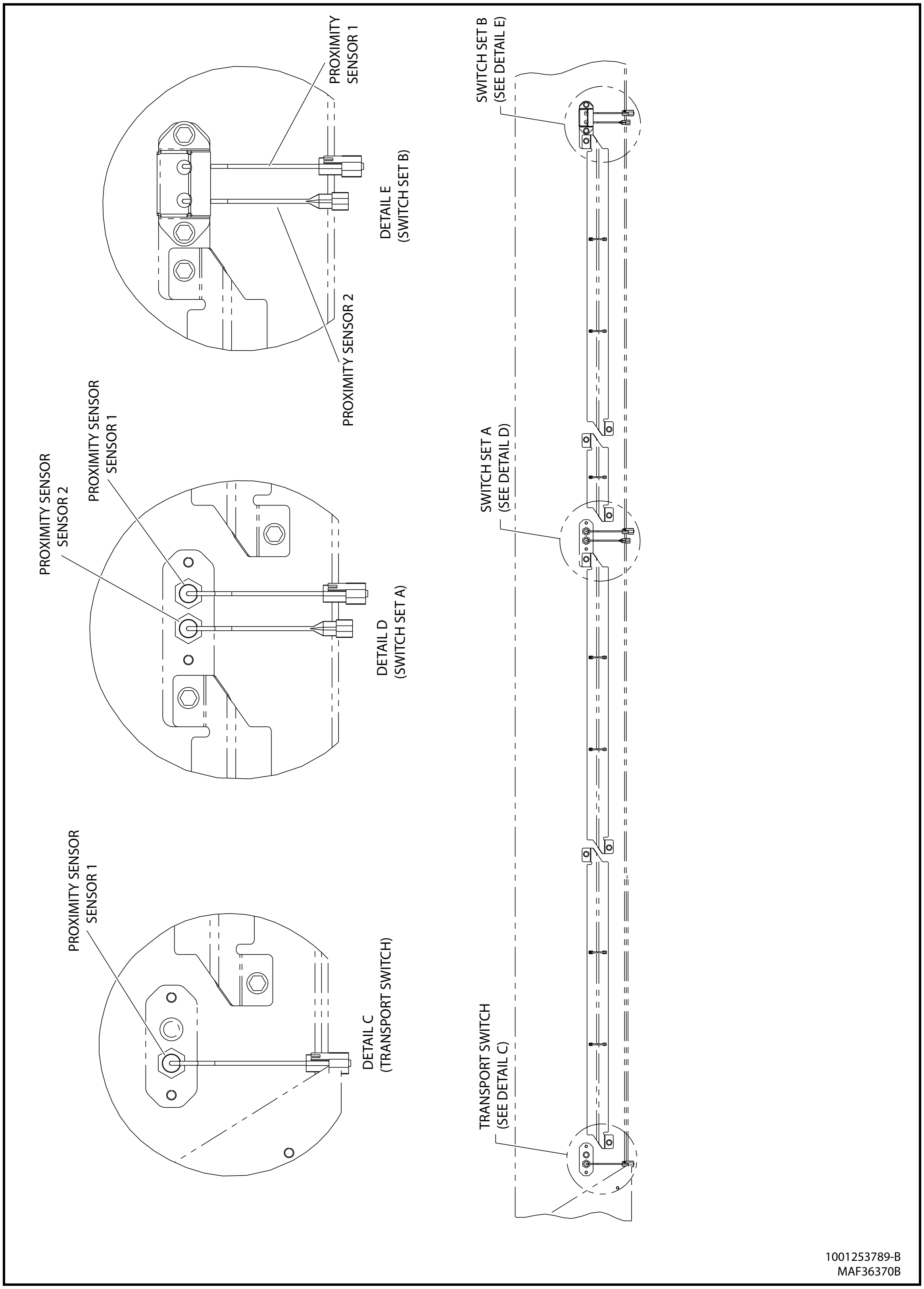


Figure 4-8. Capacity Switch Installation - Sheet 2 of 3

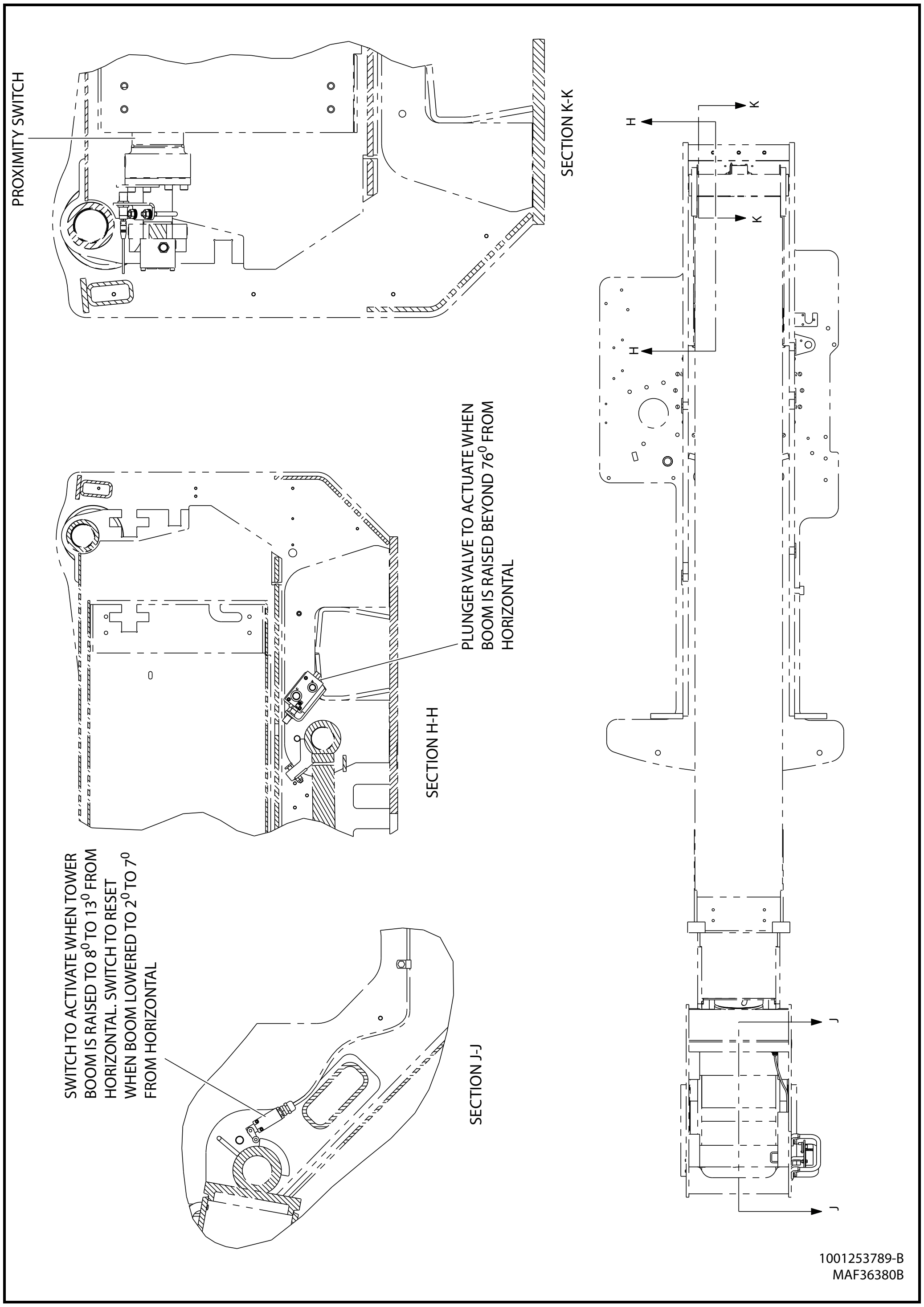
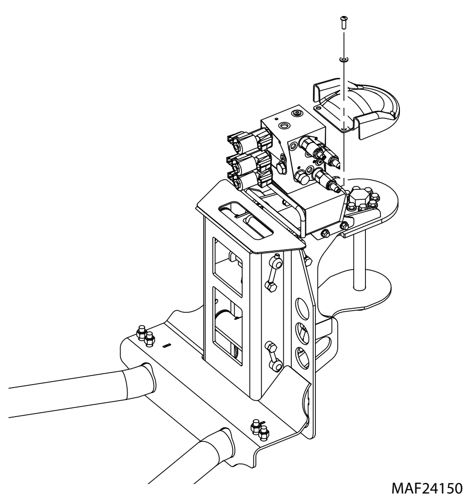


Figure 4-9. Capacity Switch Installation - Sheet 3 of 3

4.6 PLATFORM

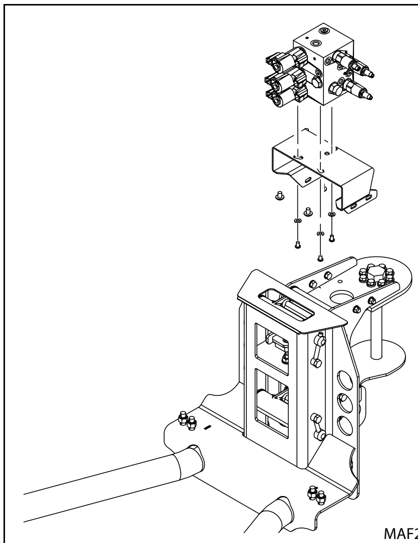
Platform Valve Removal

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



MAF24150

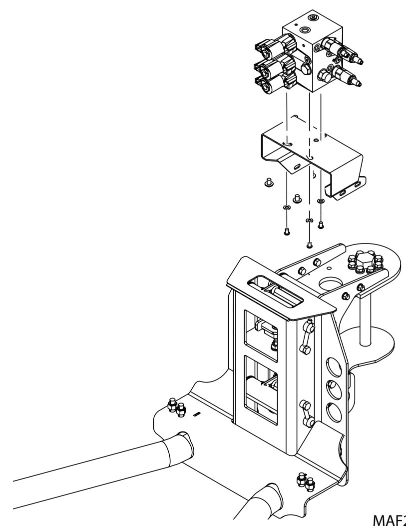
3. Remove hardware securing the mounting bracket to the platform support. Remove the mounting bracket along with platform control valve from platform support.
4. Remove hardware securing the platform control valve to the mounting bracket. Remove platform control valve.



MAF24320

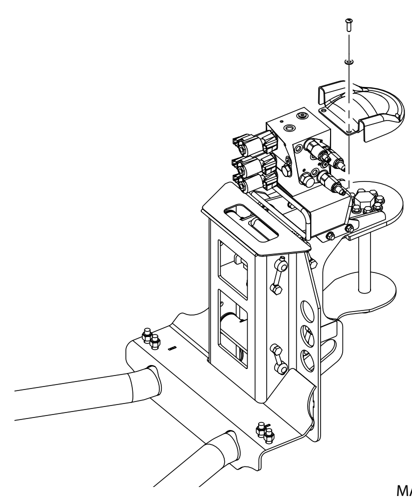
Platform Valve Installation

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.



MAF24320

3. Install cover onto the platform support securing hardware.



MAF24150

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

Platform Support Removal

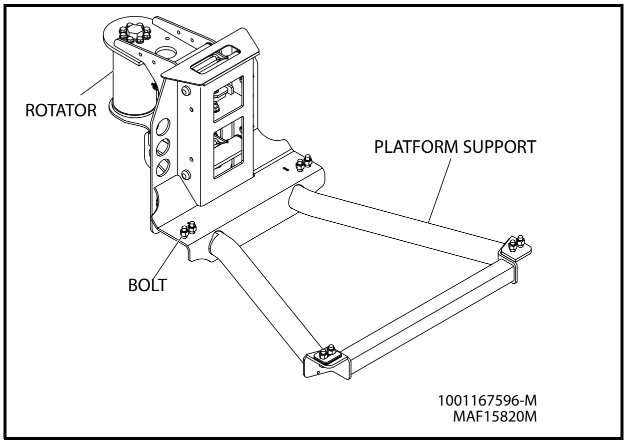
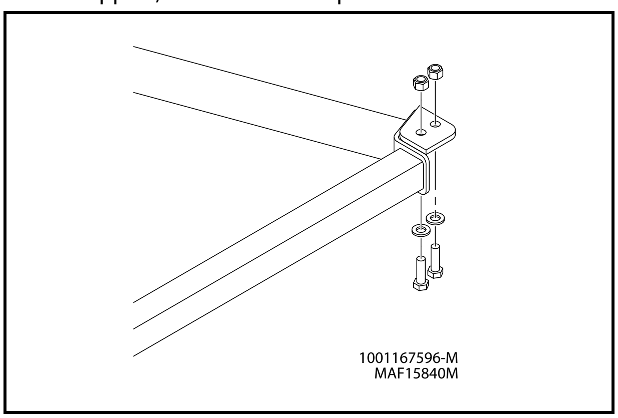


Figure 4-10. Location of Components Platform Support

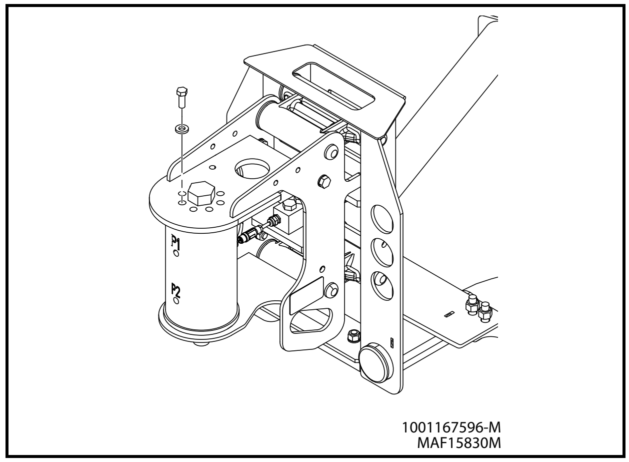
1. Disconnect electrical cables from control console.
2. Tag and disconnect the hydraulic lines from the rotator. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove the bolts securing the platform to the platform support, then remove the platform.



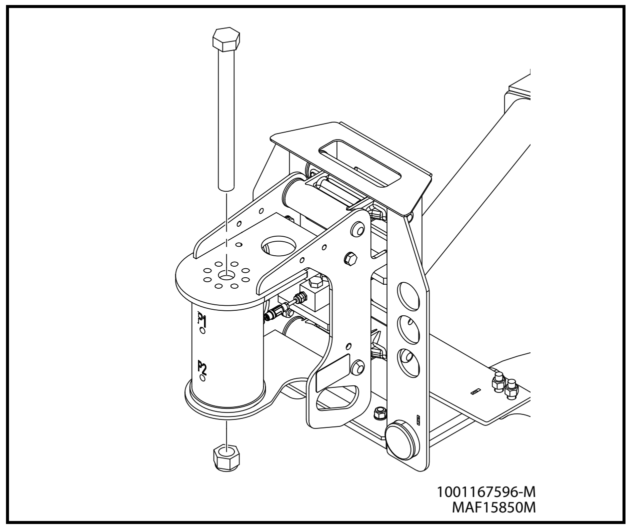
4. Using a suitable lifting device, support the platform support.

NOTE: *The platform support weighs approximately 132 lb (60kg).*

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



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

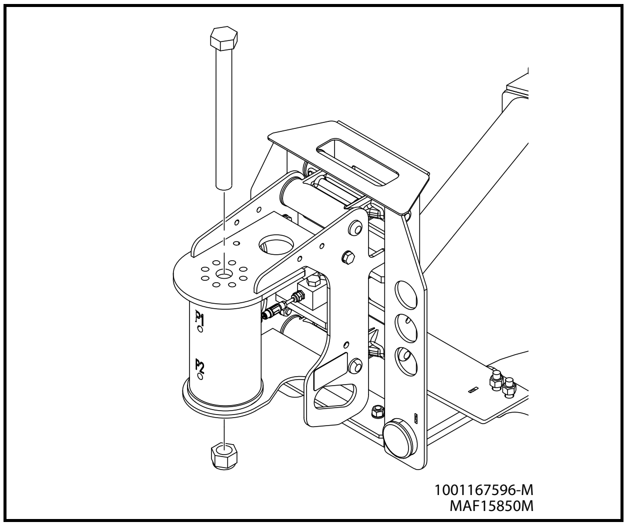


Platform Support Installation

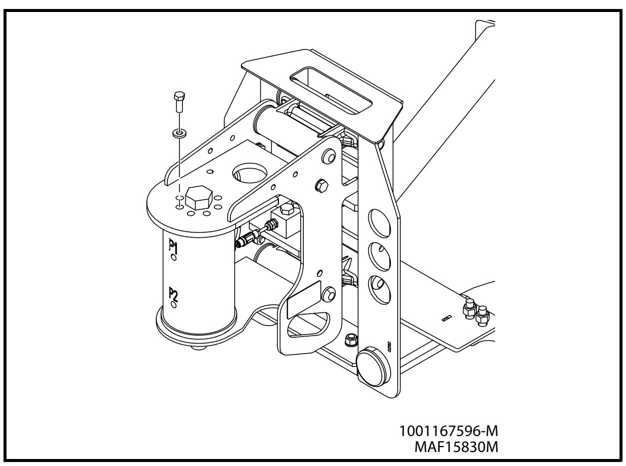
1. Using a suitable lifting device, support the platform support and position it on the rotator.

NOTE: *The platform support weighs approximately 132 lb (60 kg).*

2. Install the rotator center bolt.

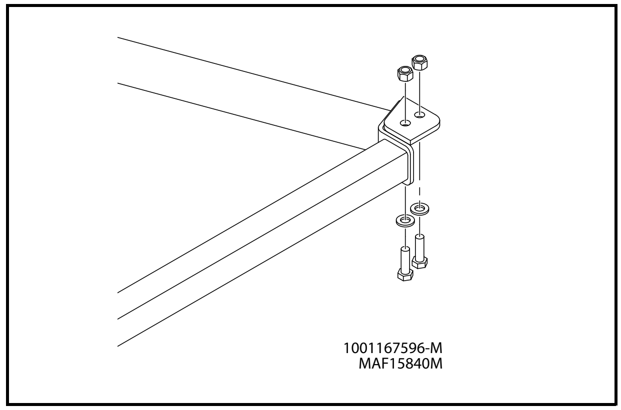


3. Apply Medium Strength Threadlocking Compound to the bolts and locknuts securing the support to the rotator and install the bolts and locknuts.

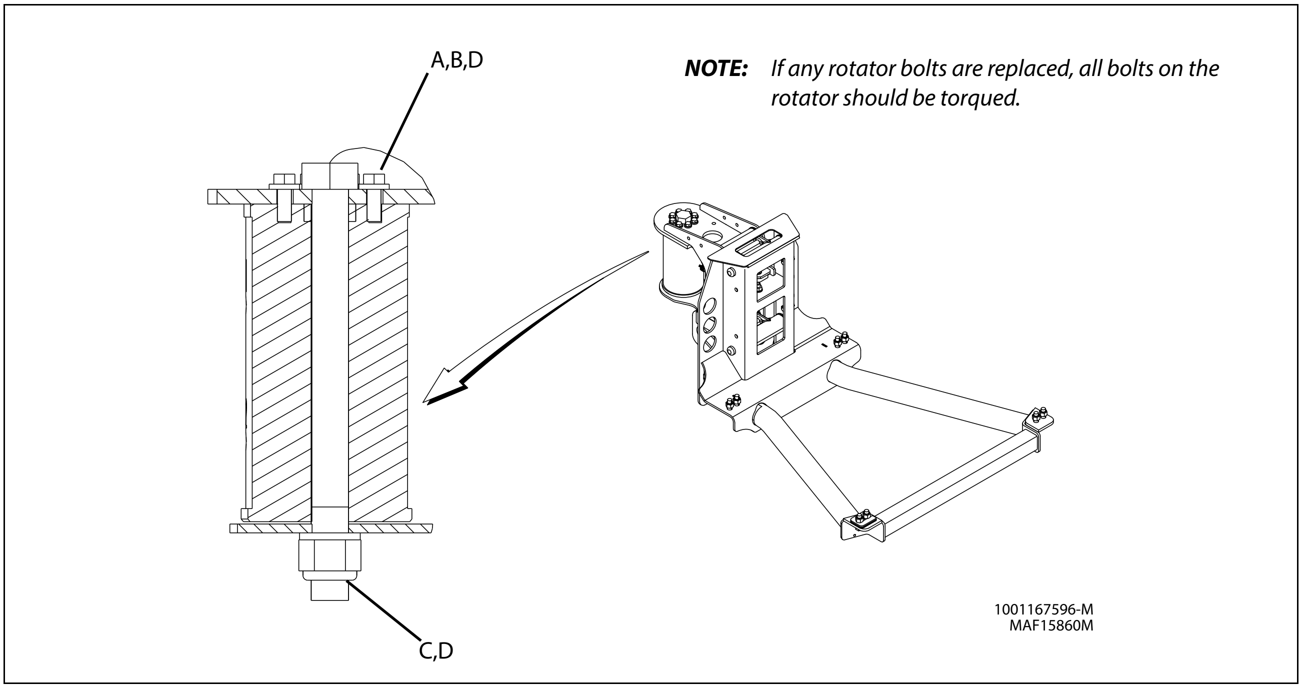


4. Torque the nut on the rotator center bolt to 586 ft. lbs (795 Nm). Torque the retaining bolts to 40 ft. lbs (55 Nm).

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

Figure 4-11. Platform Support Torque Values

4.7 ROTATOR AND PLATFORM LEVEL CYLINDER

Removal

1. Remove the Platform and Platform Support. See (Section 4.6, 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 64 lb (29 kg).*

NOTE: *The jib assembly weighs approximately 358 lb (162.5 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 91.3 lb (41.4 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.

Installation

NOTE: *The platform level cylinder weighs approximately 91.3 lb (41.4 kg).*

1. Support the platform level cylinder. Using a soft head mallet install pin #4 to the fly boom. Install hardware securing pin #4. Torque to 40.6 ft.lbs. (55 Nm).

NOTE: *The jib assembly weighs approximately 358 lb (162.5 kg).*

2. Support the jib assembly. Using a soft head mallet install pin #3 to jib assembly. Install hardware securing pin #3. Torque to 71.5 ft. lbs. (97 Nm).

NOTE: *The rotator weighs approximately 64 lb (29 kg).*

3. Support the rotator. Using a soft head mallet, install pin #2 to the jib assembly. Install hardware securing pin #2.
4. Using head mallet install pin #1 to jib assembly and install the rotator. Install hardware securing pin #1 and torque to 40.6 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.

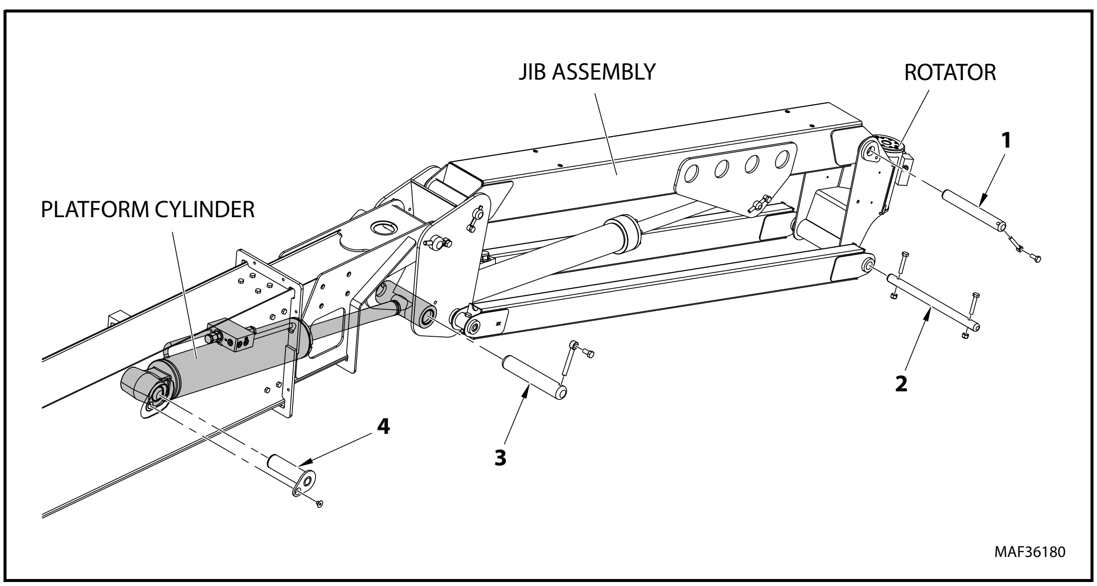


Figure 4-12. Removal/Installation of Components - Rotator and Platform Slave Level Cylinder

4.8 BOOM SYSTEM

Platform Control Enable System

The platform controls make use of a time dependent enable circuit to limit how long controls are “live” or enabled. 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. This is done by releasing all functions, then releasing and re-depressing the footswitch.

Function Speed Control System

The platform controls for platform rotate, jib lift, tower lift, tower telescope, and 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.

When the variable speed control knob is 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.

Platform

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

Main Lift End Stroke Dampening System

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

QuikStik® Lift System

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

Tower Boom Sequence Valve System

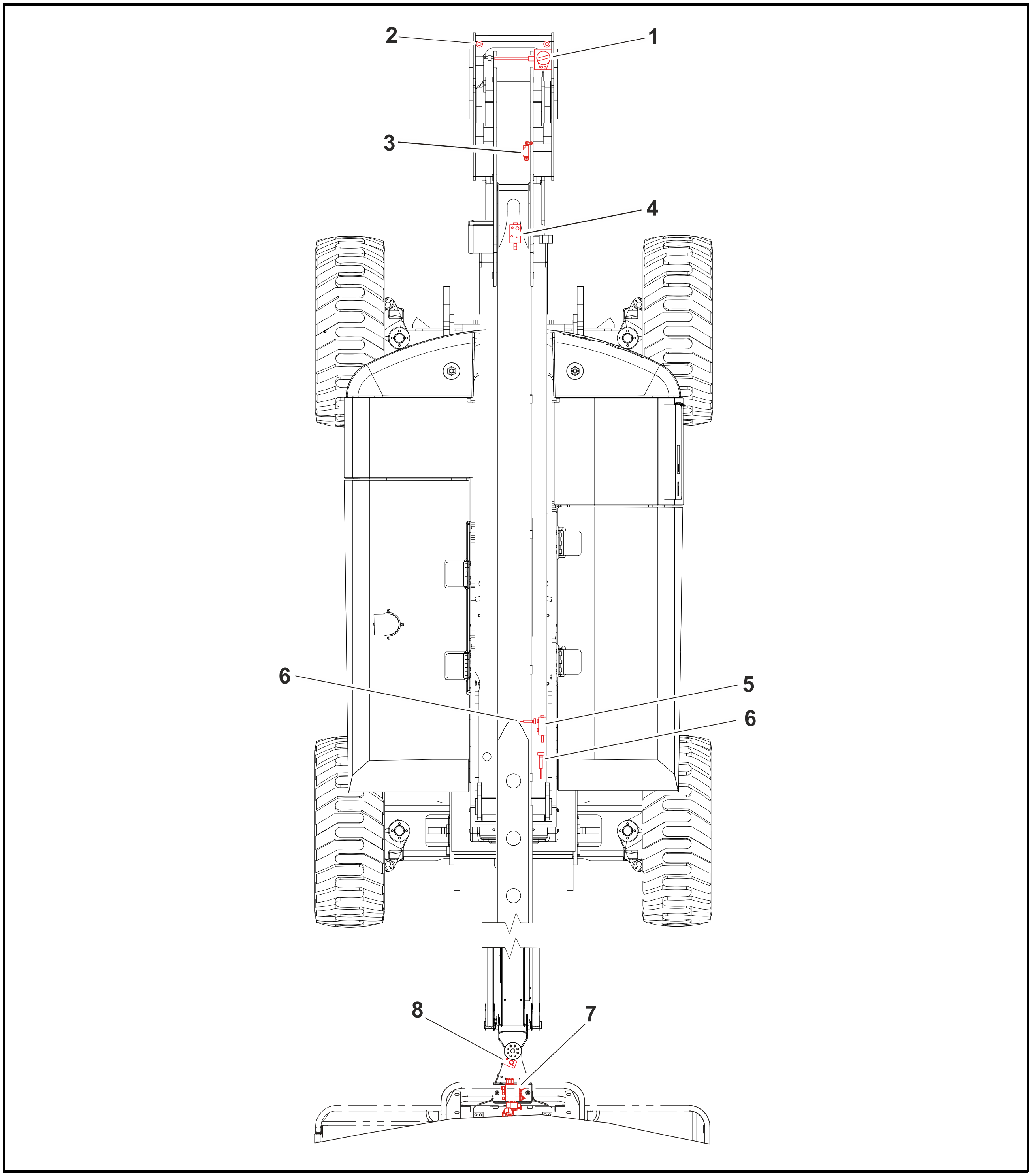
The two-section tower boom uses two hydraulic lockout valves to prevent the boom from being telescoped until the boom is fully raised, and to prevent the tower boom from being lowered until it is fully retracted. Until the valve mounted in the turntable is actuated by the cam on the tower lift cylinder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

Upright Level Override System

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

Ground Control Keyswitch System

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



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

Figure 4-13. Boom Component Location

4.9 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.

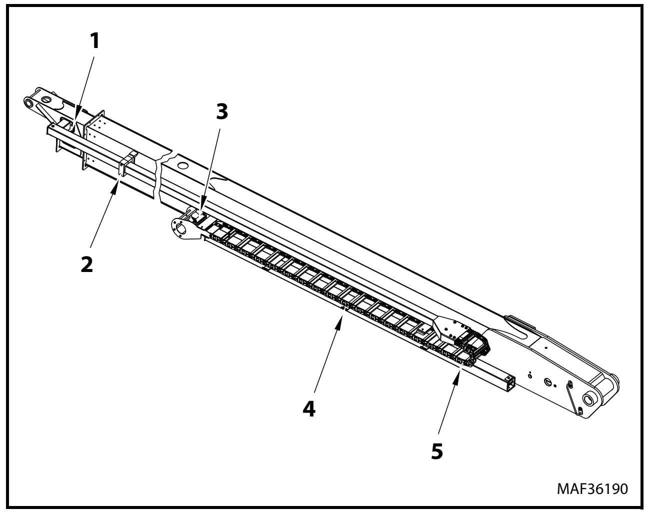
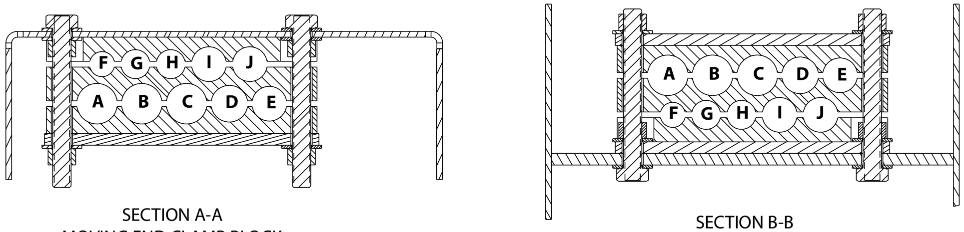


Figure 4-14. Main Boom Powertrack Components

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.



LETTER	CABLE/HOSE	SIZE/TYPE	USAGE
A	HOSE	1/2 in. (#8)	MASTER CYL EXTEND TO T
B	HOSE	1/2 in. (#8)	PLATFORM VALVE RETURN
C	CABLE	8/5	SKYPOWER
D	HOSE	1/2 in. (#8)	AIRLINE
E	HOSE	3/8 in. (#6)	MASTER CYL RETRACT TO T
F	CABLE	10/4	4000W 60HZ GEN
G	CABLE	10/3	PLATFORM WORK LIGHTS
H	CABLE	10/3	COURTESY CORD / 4000W 50HZ GEN / 2500W GEN
I	CABLE	12/4-18/8-18/2	BOOM CONTROL
J	HOSE	3/8 in. (#6)	PLATFORM VALVE SUPPLY

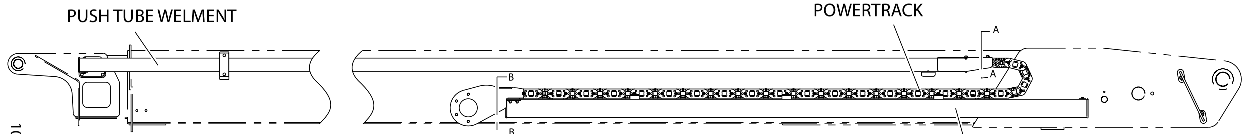


Figure 4-15. Powertrack Installation Main Boom - Sheet 1 of 3

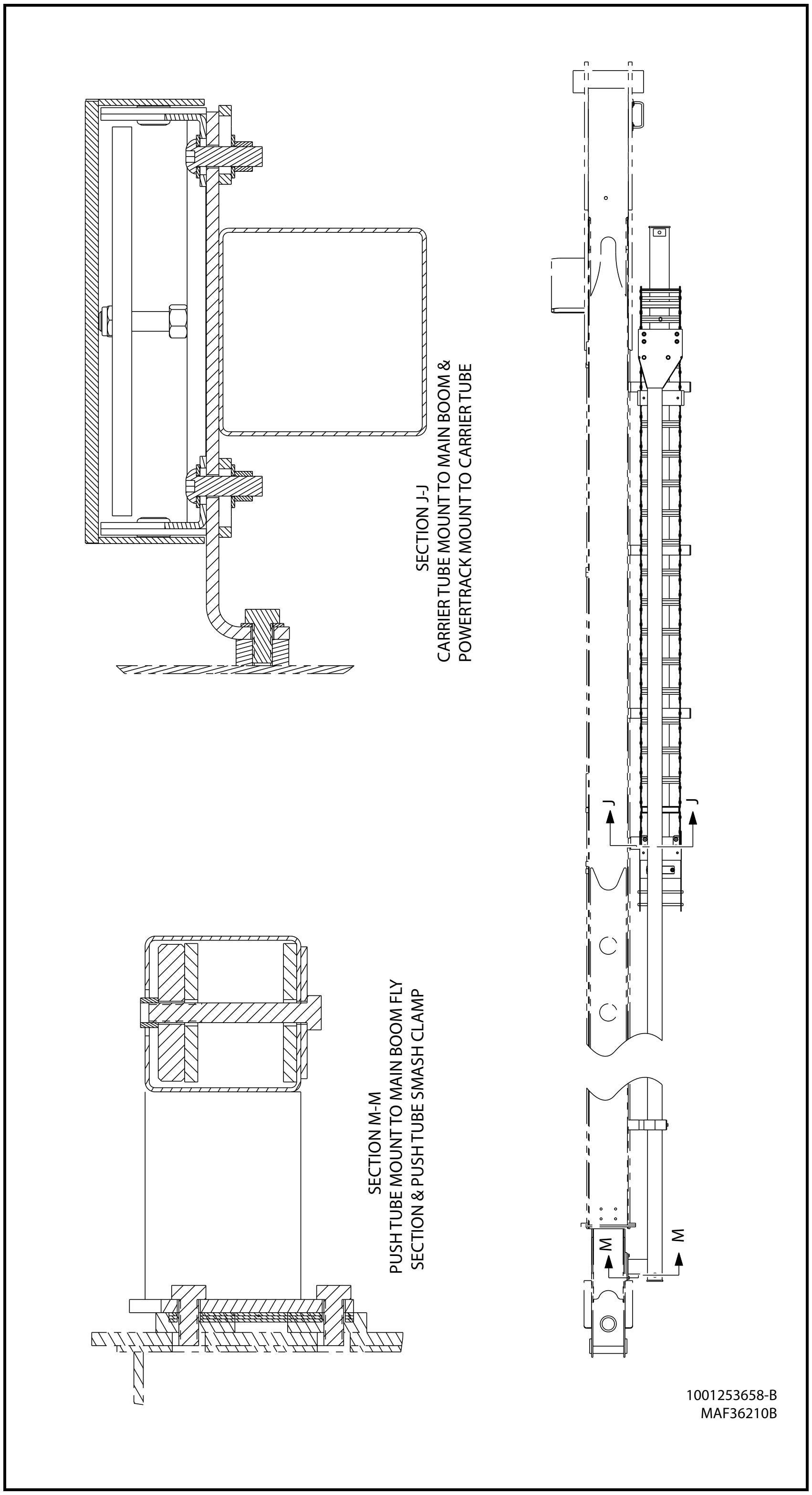


Figure 4-16. Powertrack Installation Main Boom - Sheet 2 of 3

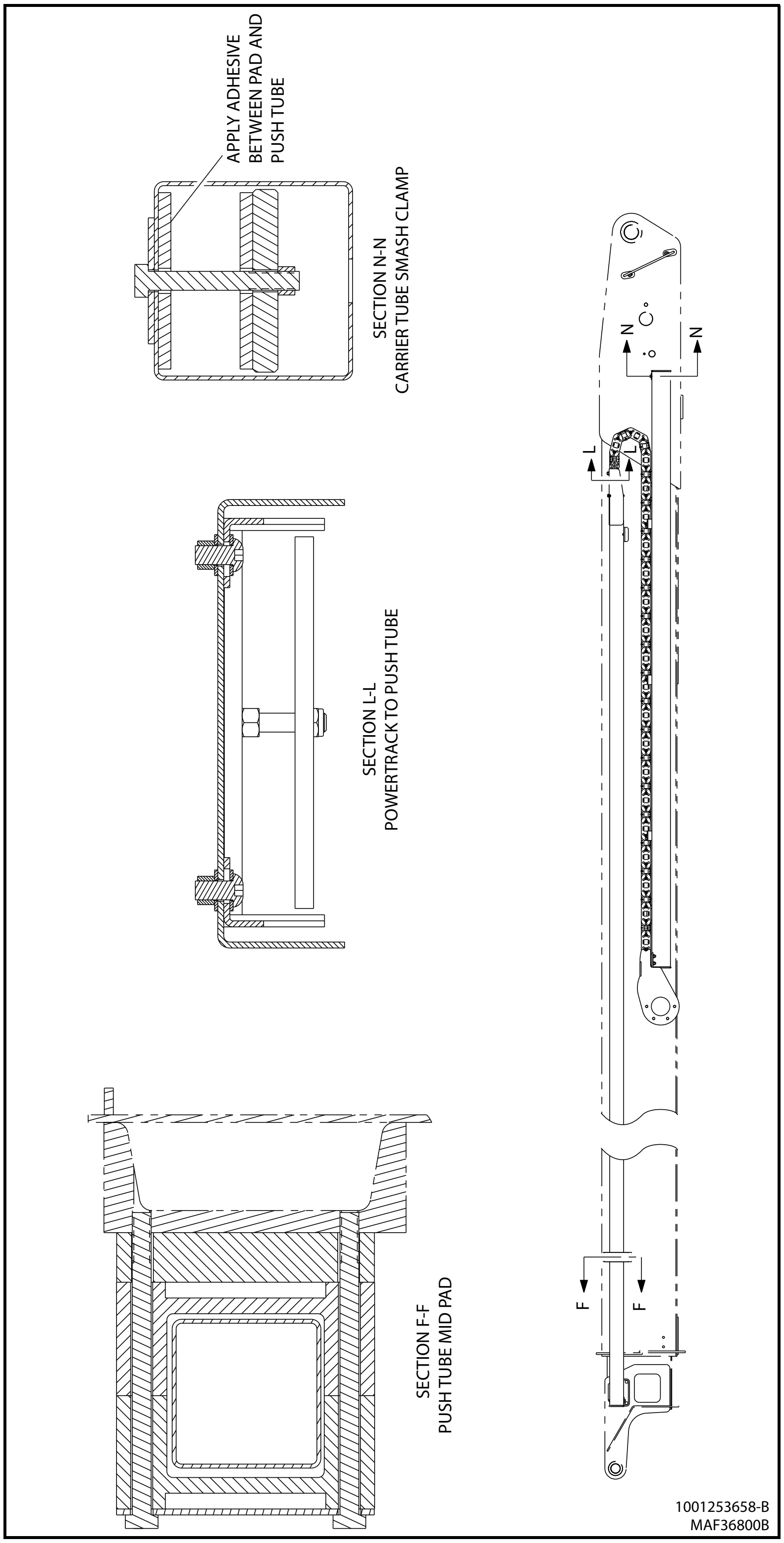


Figure 4-17. Powertrack Installation Main Boom - Sheet 3 of 3

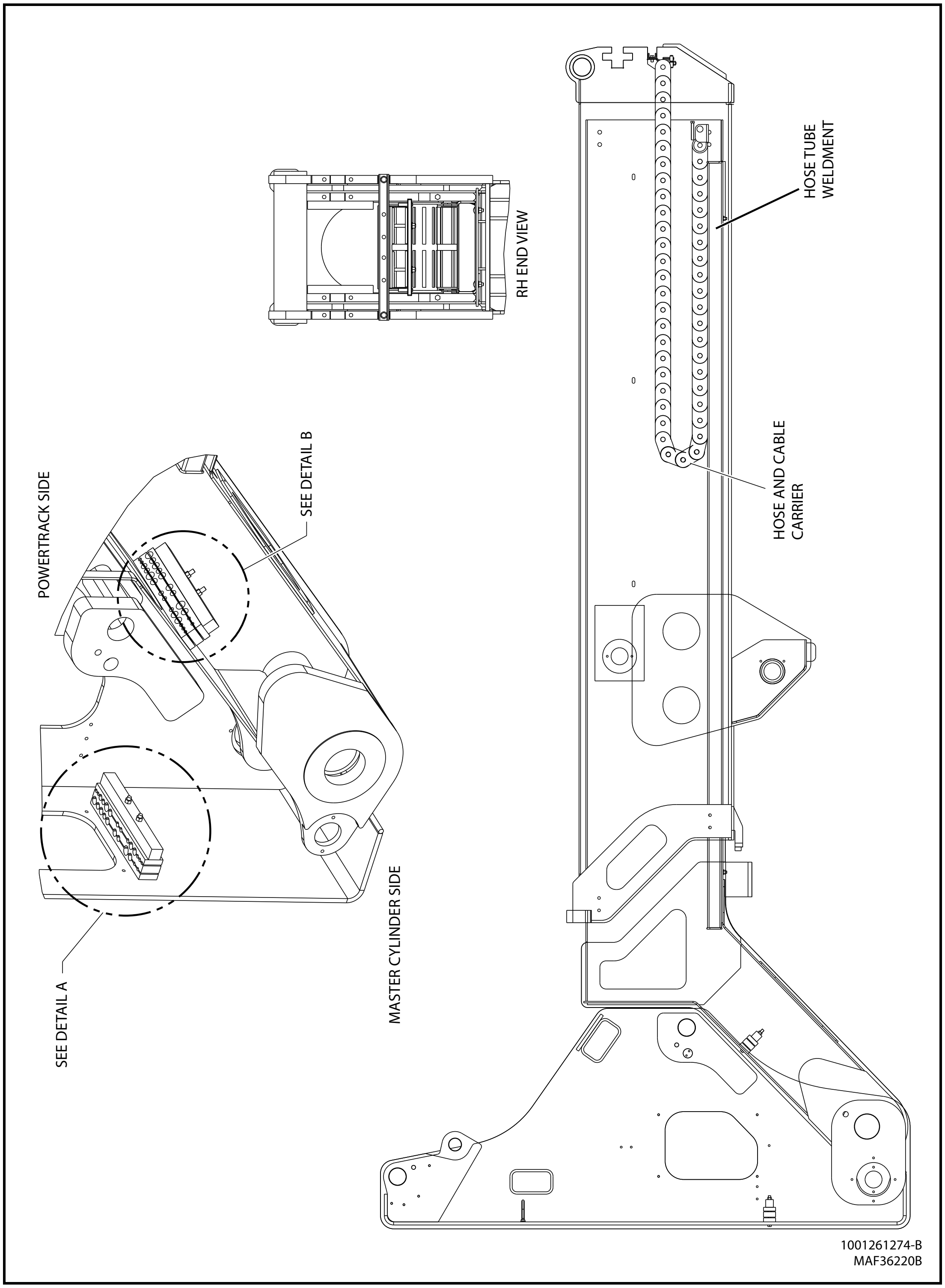


Figure 4-18. Powertrack Installation Tower Boom - Sheet 1 of 3

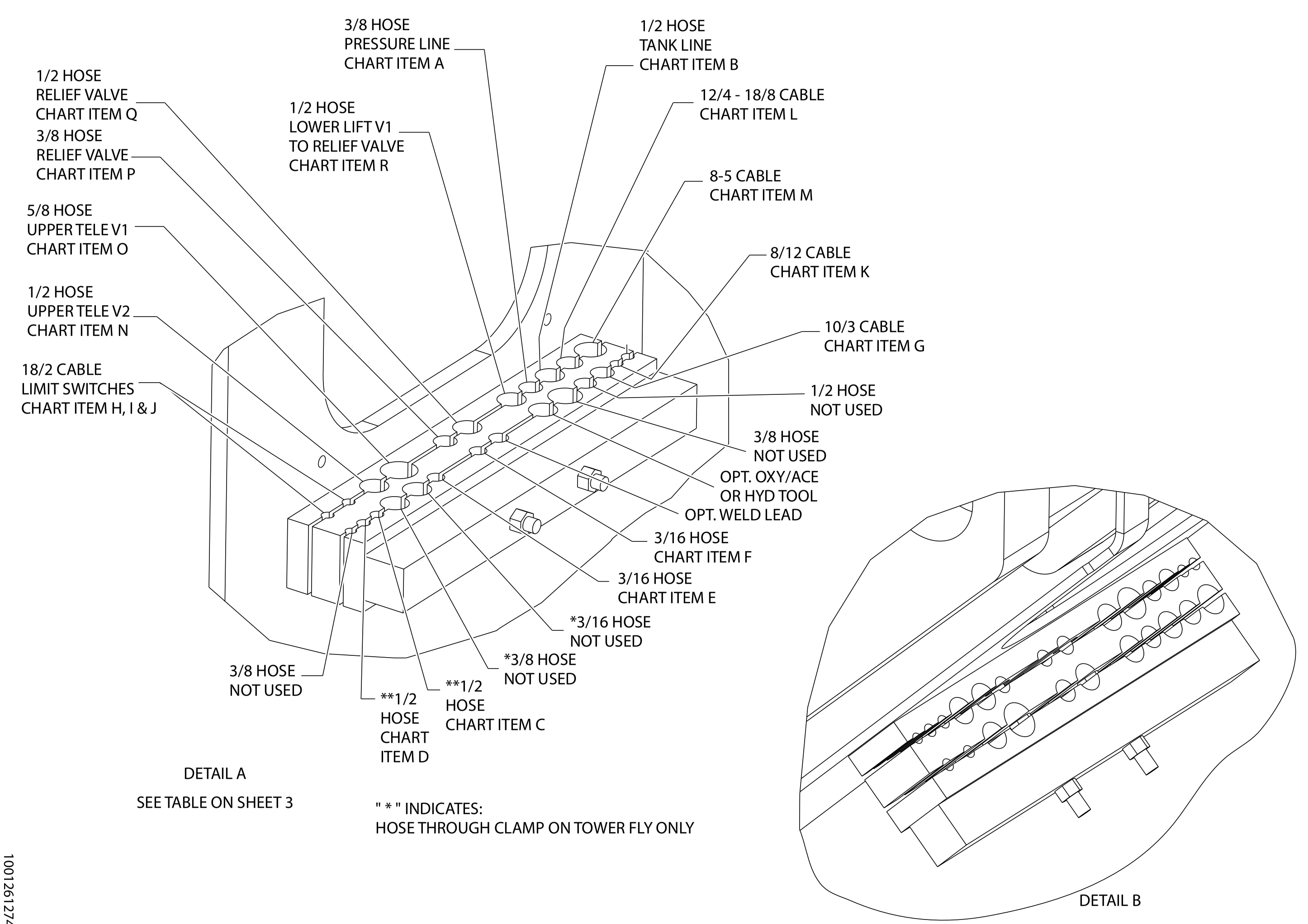
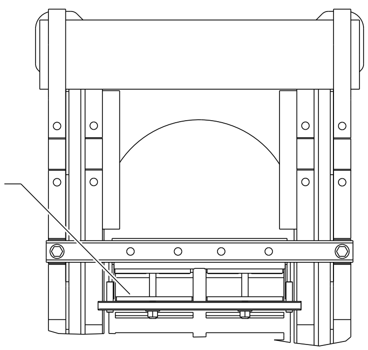
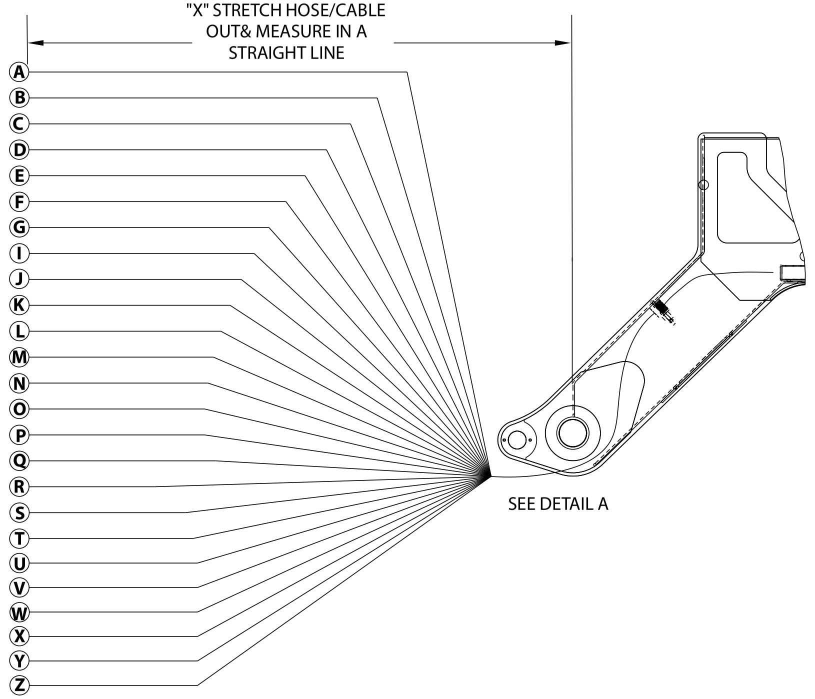


Figure 4-19. Powertrack Installation Tower Boom - Sheet 2 of 3

LETTER	TYPE	SIZE	USAGE	MODEL
A	HOSE	3/8" (#6)	PLATFORM VALVE SUPPLY	STANDARD & HC3
B	HOSE	1/2" (#8)	PLATFORM VALVE RETURN	STANDARD & HC3
C	HOSE	1/2" (#8)	MAIN (UPPER) LIFT CYL EXTEND (V1)	STANDARD & HC3
D	HOSE	1/2" (#8)	MAIN (UPPER) LIFT CYL RETRACT (V2)	STANDARD & HC3
E	HOSE	1/4" (#4)	UPRIGHT LEVEL CYL PILOT (P1) TO MAIN VALVE (M7)	STANDARD & HC3
F	HOSE	1/4" (#4)	RELIEF VALVE IN UPRIGHT (P3) TO TOWER (LOWER) LIFT CYL EXTEND PILOT (P2)	STANDARD & HC3
G	CABLE	10/3	COURTESY CORD / 4000W 50HZ GENERATOR / 2500W GENERATOR	STANDARD & HC3
I	CABLE	18/2	MAIN BOOM (UPPER) ELEVATION LIMIT SWITCH	STANDARD ONLY
J	CABLE	18/2	TOWER BOOM (LOWER) ELEV LIMIT SWITCH	STANDARD & HC3
K	CABLE	18/2	TRANSPORT LIMIT SWITCH	STANDARD ONLY
L	CABLE	12/4-18/8-18/2	BOOM CONTROL	STANDARD & HC3
M	CABLE	8/5	7500W GEN (SKYPOWER)	STANDARD & HC3
N	HOSE	1/2" (#8)	MAIN (UPPER) TELE RETRACT (V2)	STANDARD & HC3
O	HOSE	5/8" (#10)	MAIN (UPPER) TELE EXTEND (V1)	STANDARD & HC3
P	HOSE	3/8" (#6)	UPRIGHT LEVEL CYL (V1) TO MANUAL VALVE (2)	STANDARD & HC3
Q	HOSE	1/2" (#8)	RELIEF VALVE IN UPRIGHT (P2) TO TOWER (LOWER) BASE PLUNGER VALVE (C)	STANDARD & HC3
R	HOSE	1/2" (#8)	RELIEF VALVE IN UPRIGHT (V2) TO UPRIGHT LEVEL CYL RETRACT (V1)	STANDARD & HC3
S	HOSE	1/2" (#8)	AIRLINE - STANDARD	STANDARD & HC3
T	CABLE	18/3	UPRIGHT TILT SENSOR	STANDARD & HC3
U	CABLE	18/3	TRANSPORT PROX SWITCH	HC3 ONLY
V	CABLE	18/6	CAPACITY PROX SWITCHES	HC3 ONLY
W	CABLE	18/6	MAIN (UPPER) BOOM ROTARY ANGLE SENSOR	HC3 ONLY
X	CABLE	10/4	4000W 60HZ GENERATOR	STANDARD & HC3
Y	CABLE	10/3	PLATFORM WORK LIGHTS	STANDARD & HC3
Z	HOSE	1/2" (#8)	AIRLINE - ARCTIC	STANDARD & HC3

HOSES AND CABLES EXITING THIS END OF POWERTRACK SHOULD BE IN THE SAME APPROXIMATE ORDER AS IN THE FLY NOSE CLAMP BLOCK WHILE MAINTANING AND EVEN DISTRIBUTION ACCROSS THE BAR CLAMP. TIGHTEN THE BAR CLAMP UNTIL ALL HOSES AND CABLES ARE SECURE.





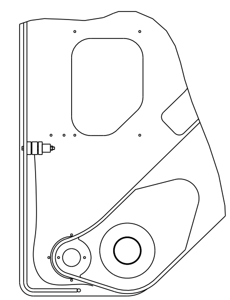


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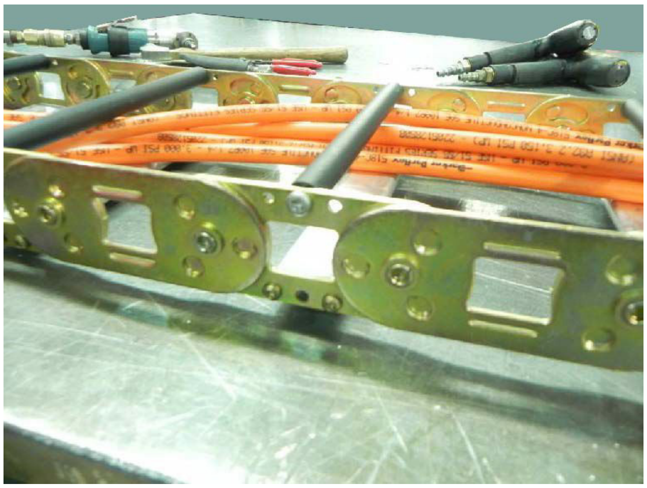
Figure 4-20. Powertrack Installation Tower Boom - Sheet 3 of 3

4.10 POWERTRACK MAINTENANCE

Flat Bar Removal

NOTE: *Hoses shown in the Powertrack are for example only. Actual hose and cable arrangements will be different.*



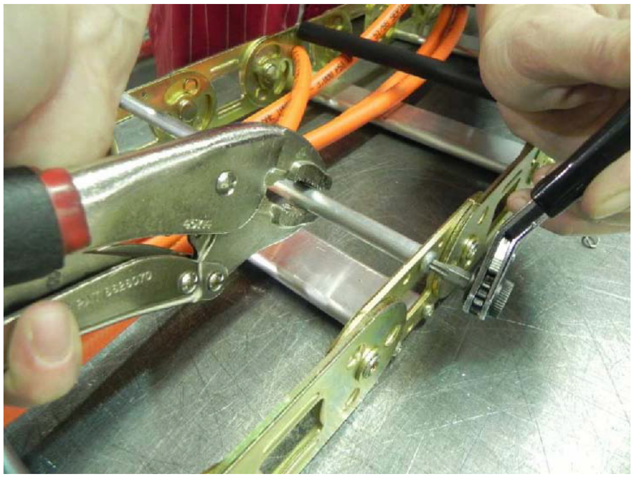
1. Use a small ¼" ratchet and a T-20 Torx bit. Remove the 8-32 x 0.500 screws from both sides. (If the track also has a flat bar on the inside of the track instead of round bar/ poly, perform the same step to remove it.)

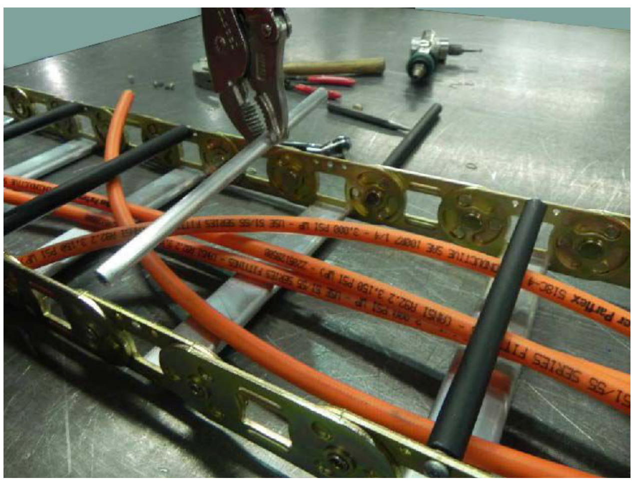
Round Bar/Poly Bar Removal

1. Use a small ¼" ratchet with a T-25 Torx bit. Remove the 10-24 x 0.812 screw. (If the bar spins then grip the bar and poly tightly with a vise-grip).

2. Lift up one end of the bar and slide the poly roller off.

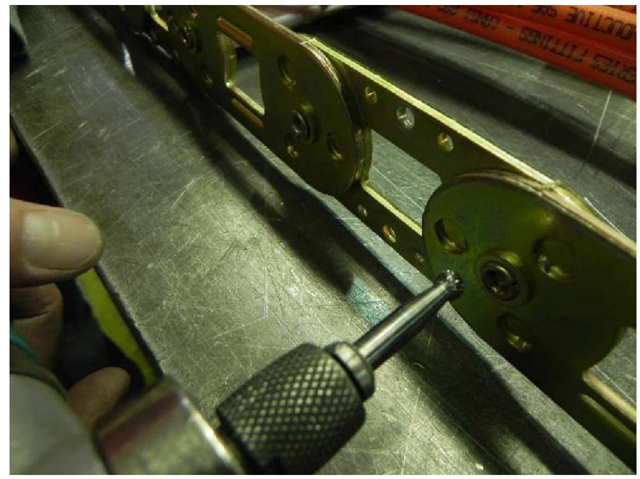
3. While gripping the bar tightly, remove the other 10-24 x 0.812 screw.



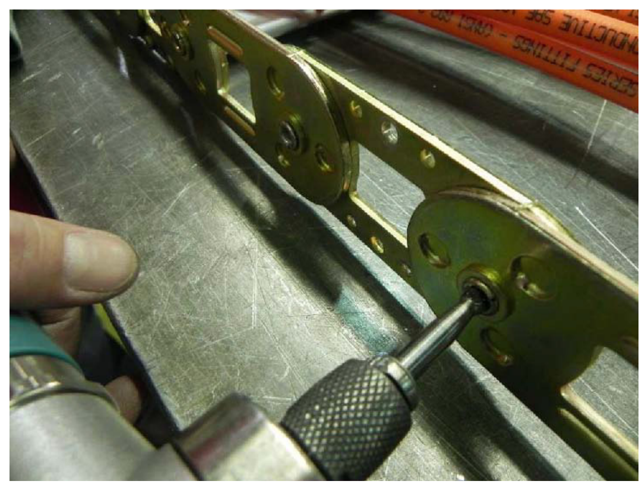


Removing and Installing Links

1. To remove the links, the rivets holding the links together must be removed. The following will show one way this can be done. Use a right angle die grinder with a ¼” ball double cut bur.

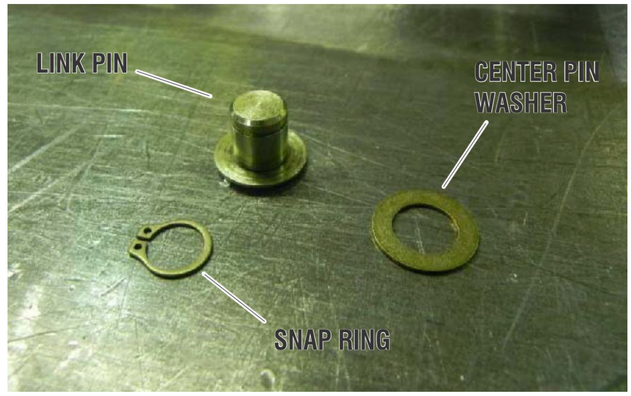


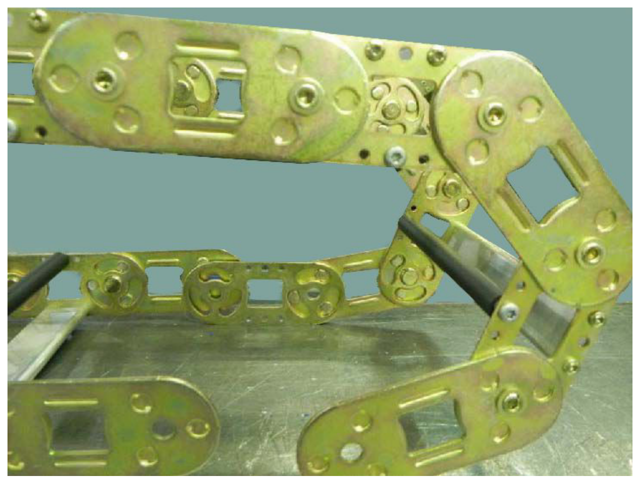
2. Insert the tool into the rolled over end of the rivet as shown. Grind out the middle of the rivet until the rolled over part of the rivet falls off. Repeat this step for all rivets that must be removed.



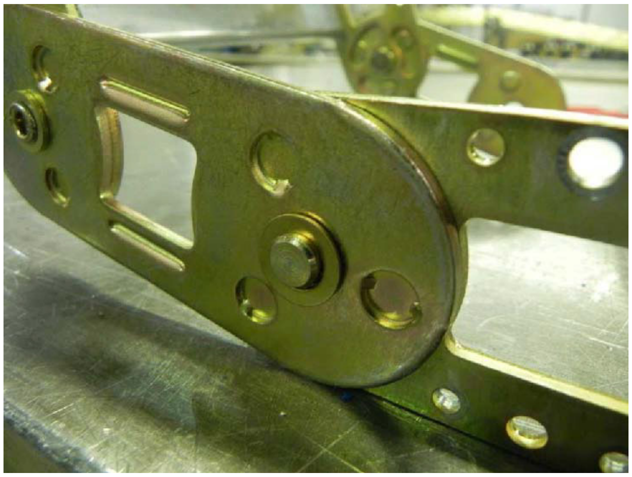
3. After grinding, it is sometimes necessary to use a center punch to punch out the rivet from the link.

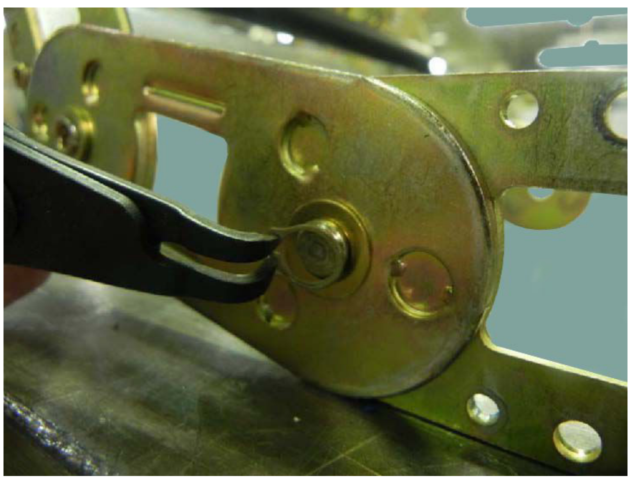
4. To install new links, extend the main moving end over the lower part of the track so the new connection point is in the curved part of the track. This will allow the round half-shears to be rotated in a way they will fit into the peanut-shaped cut-outs.



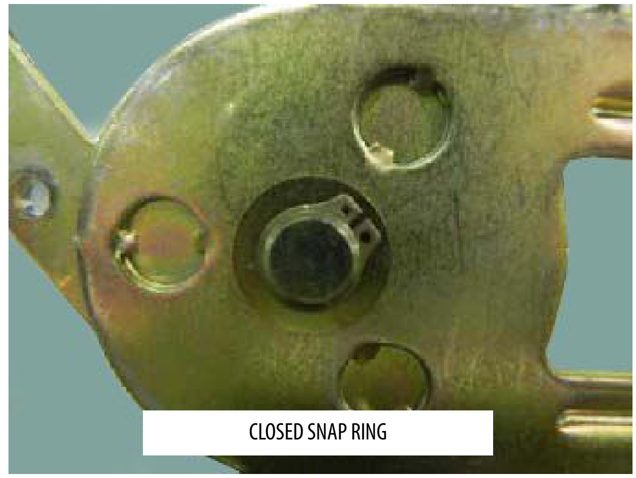


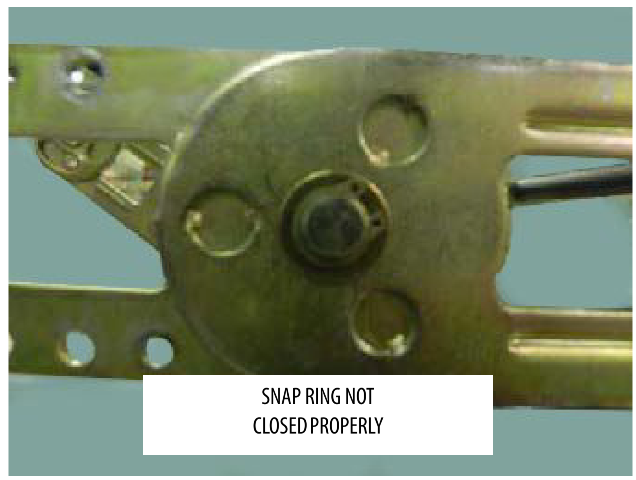
5. Install the pin into the center hole, then slide the washer over the pin. Install the snap ring into the groove in the pin.



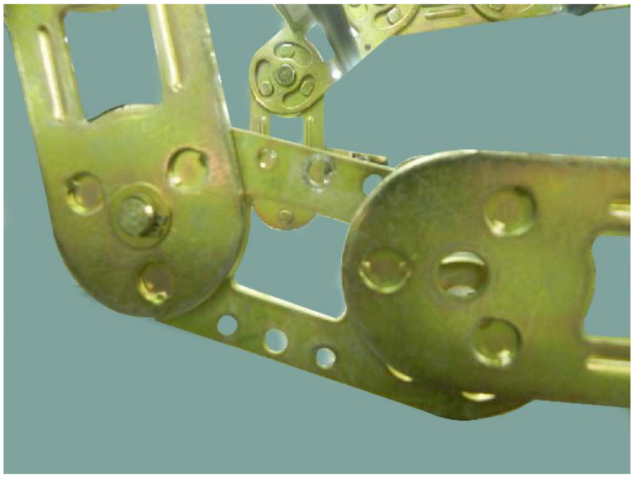


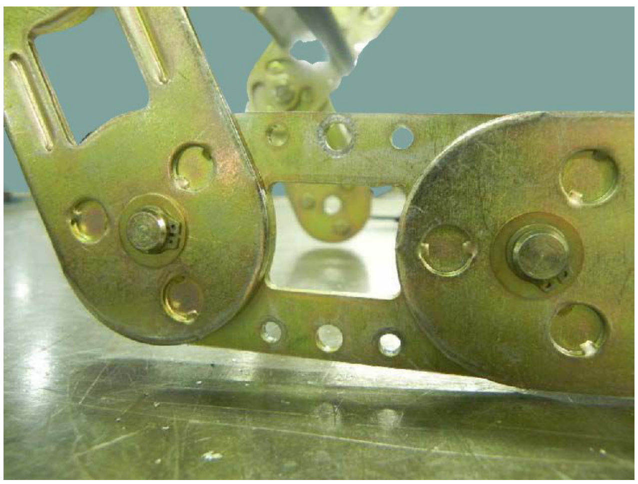
NOTE: *When installing snap rings make sure they are seated in the pin groove and closed properly.*





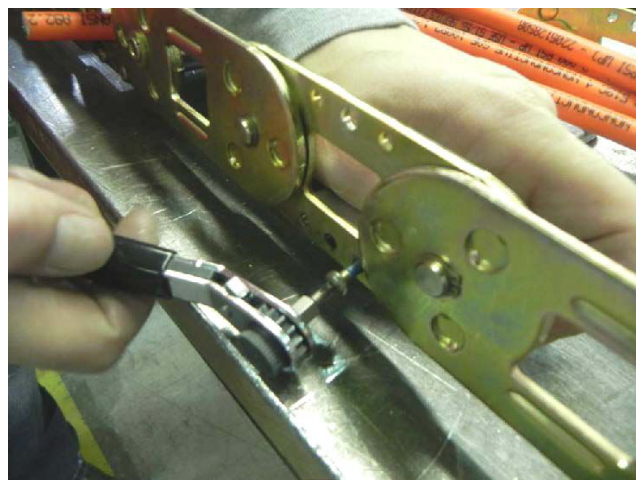
6. Install more pins, washers, and snap rings into all the links where a rivet was removed.





Installing a New Flat Bar

1. While holding the flat bar, install new 8-32 x 0.500 self threading torx screws into both holes on each side of track.



NOTE: *Maximum tightening torque for the 8-32 screw is 18-20 in-lbs (2-2.2 Nm).*

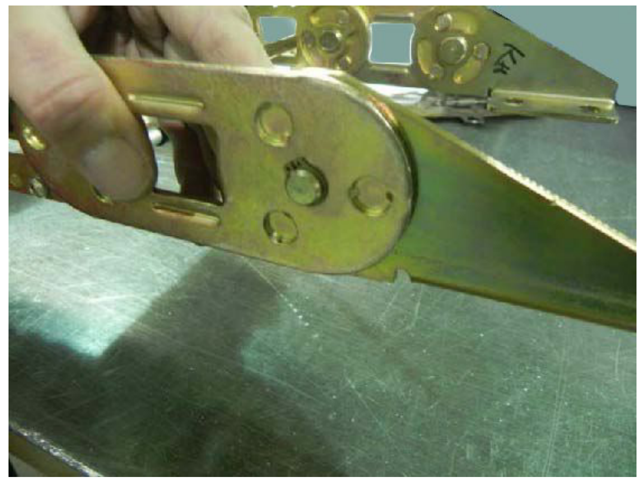
Installing a New Round Bar/Poly Roller

1. While tightly holding the round bar, install the new 10-24 x 0.812 self threading torx screw. Next lift up the other end and slide a new poly roller on. Install another 10-24 x 0.812 screw on the other side.

NOTE: *Maximum tightening torque for the 10-24 screw is 45-50 in-lbs (5-5.6 Nm).*

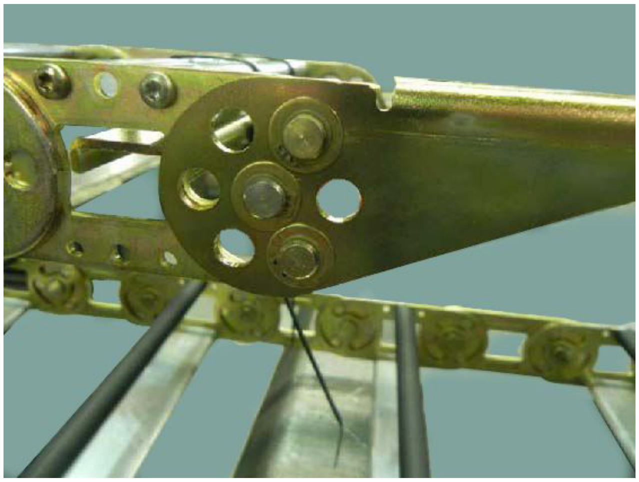
Replacing a Fixed End Bracket

1. Remove the bracket by removing the center pin, washer, and snap ring. Install a new bracket then reinstall the pin, washer, and new snap ring. After installing the new bracket make sure that it rotates correctly.



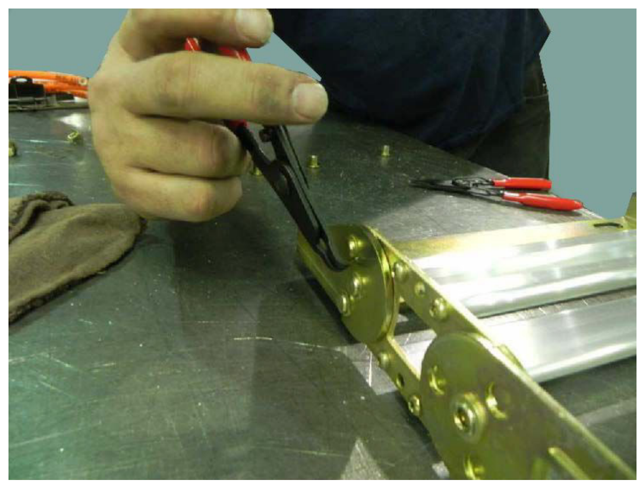
Replacing a Moving End Bracket

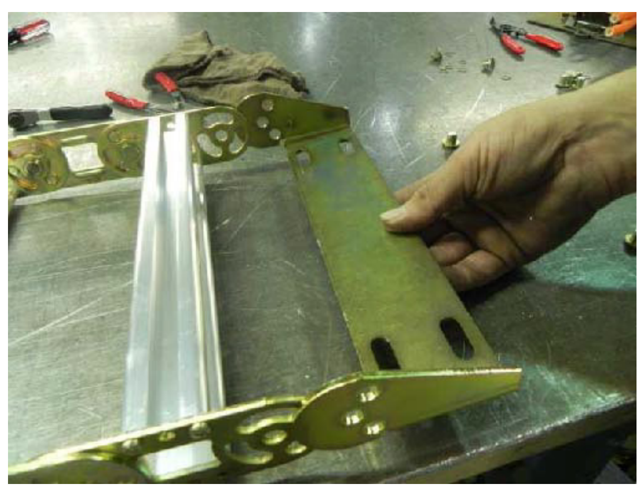
1. Remove bracket by removing all pins, washers, and snap rings. Replace with a new bracket and reinstall the pins, washers, and new snap rings. After installing a new bracket make sure that it rotates correctly.



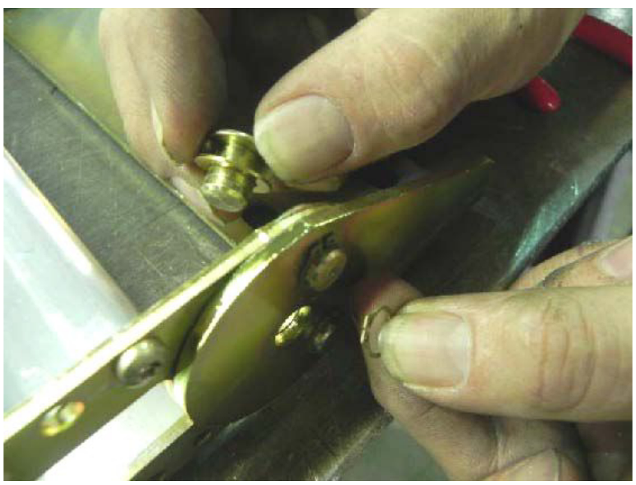
Replacing a One Piece Bracket

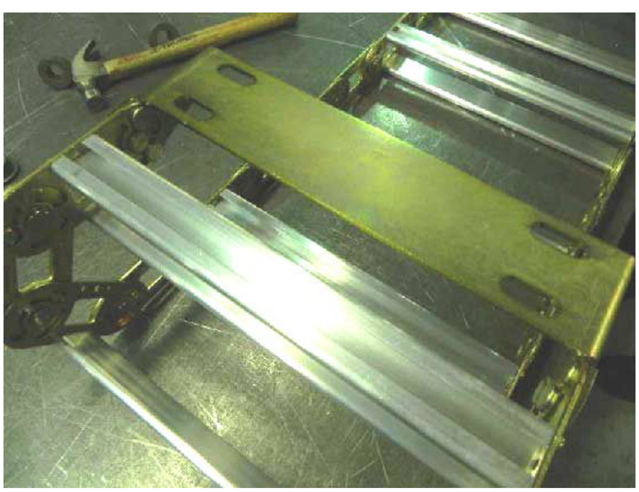
1. Remove all pins, washers, and snap rings and slide the bracket off of the links.





2. To install a new bracket, slide the bracket over the links and reinstall the pins, washers, and new snap rings. After installing the new bracket make sure that it rotates correctly.

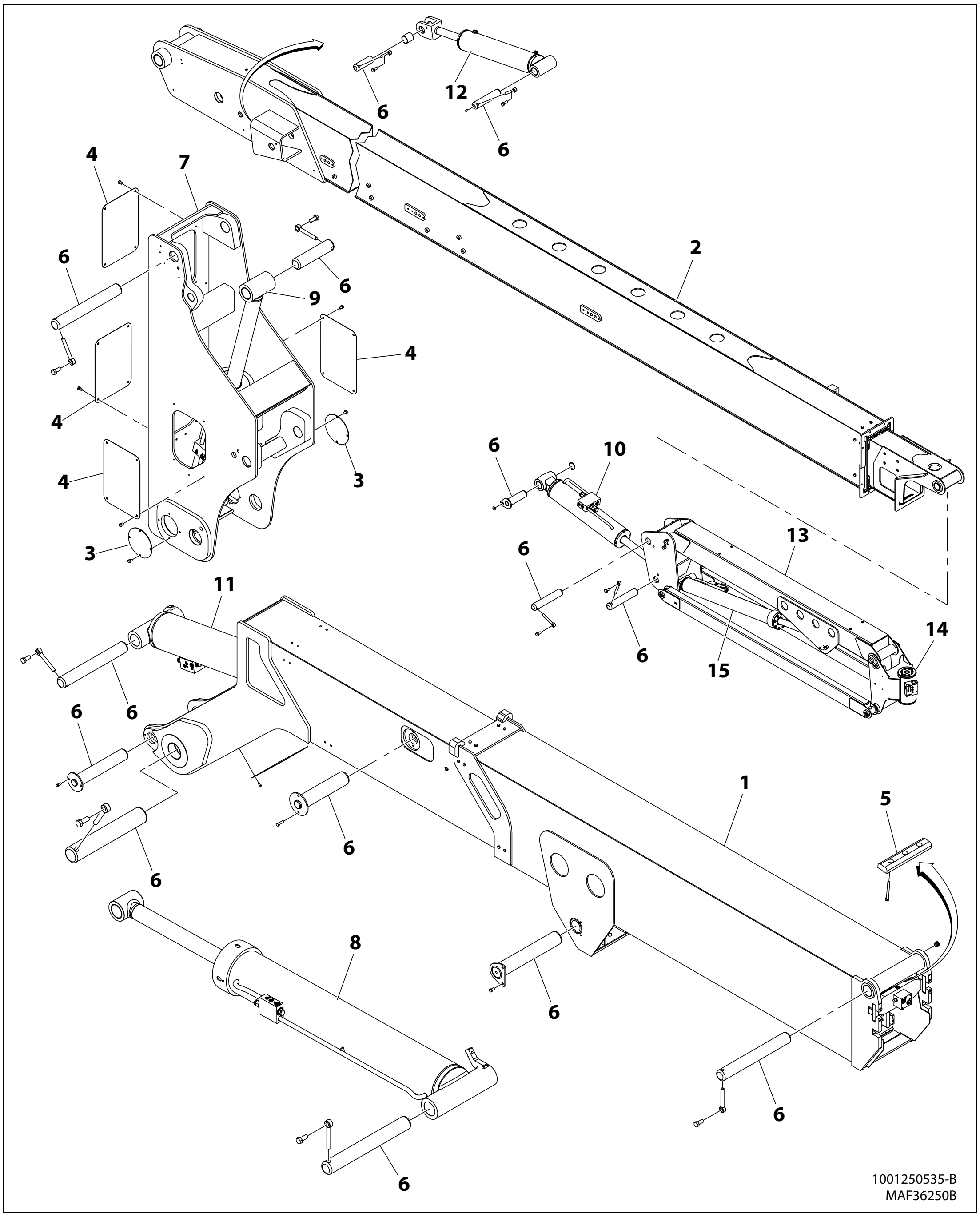




4.11 BOOM CLEANLINESS GUIDELINES

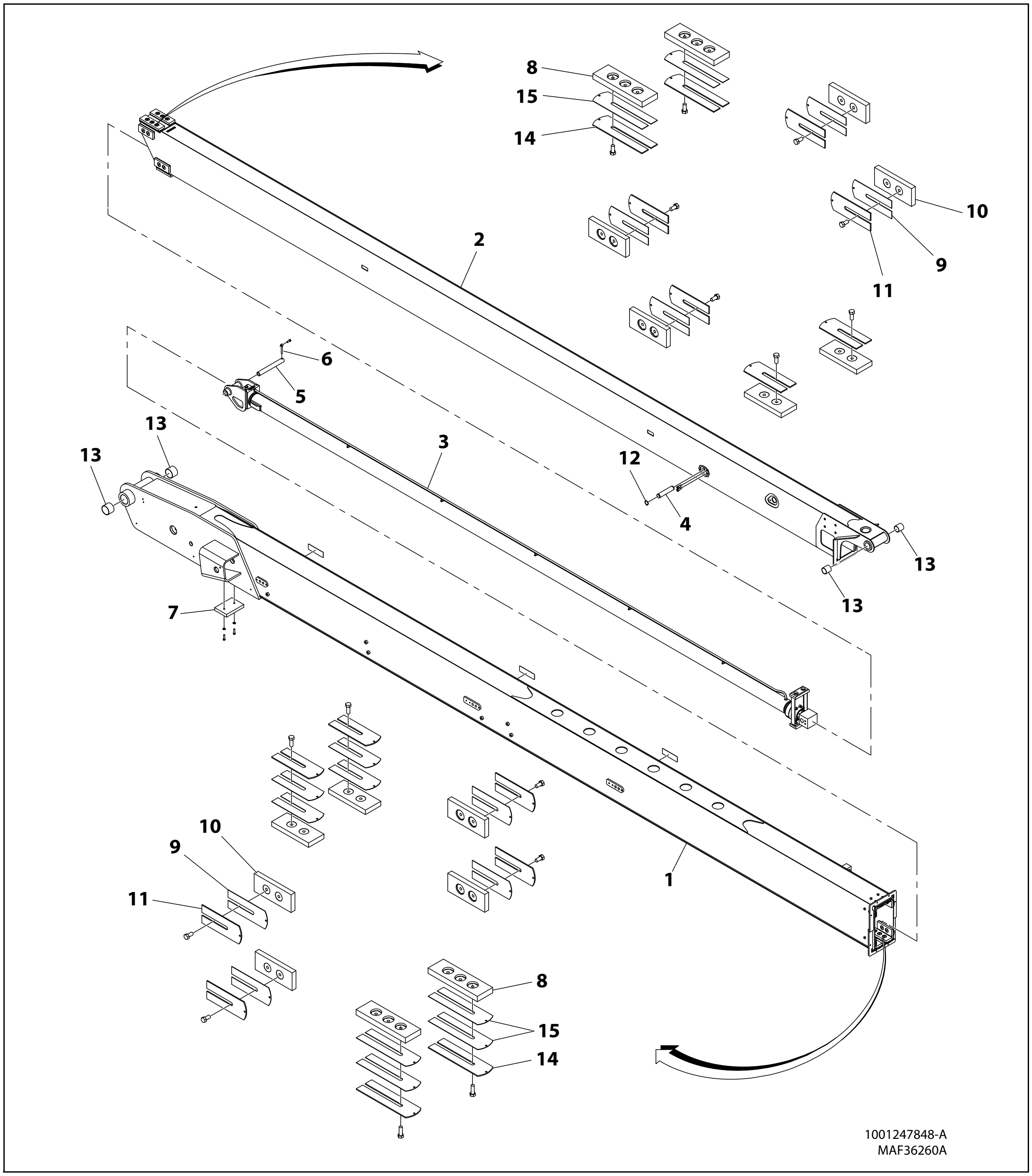
The following are guidelines for internal boom cleanliness for machines that are used in excessively dirty environments.

1. JLG recommends the use of the JLG Hostile Environment Package if available to keep the internal portions of a boom cleaner and to help prevent dirt and debris from entering the boom. This package reduces the amount of contamination which can enter the boom but does not eliminate the need for more frequent inspections and maintenance when used in these types of environments.
2. JLG recommends that you follow all guidelines for servicing your equipment in accordance with the instructions outlined in the JLG Service & Maintenance Manual for your machine. Periodic maintenance and inspection is vital to the proper operation of the machine. The frequency of service and maintenance must be increased as environment, severity and frequency of usage requires.
3. Debris and foreign matter inside of the boom can cause premature failure of components and should be removed. Methods to remove debris should always be done using all applicable safety precautions outlined in the JLG Service & Maintenance Manuals.
4. The first attempt to remove debris from inside the boom must be to utilize pressurized air to blow the debris toward the nearest exiting point from the boom. Make sure that all debris is removed before operating the machine.
5. If pressurized air cannot dislodge the debris, then water with mild solvents applied via a pressure washer can be used. Again the method is to wash the debris toward the nearest exiting point from the boom. Make sure that all debris is removed, that no “puddling” of water has occurred, and that the boom internal components are dry prior to operating the machine. Make sure you comply with all federal and local laws for disposing of the wash water and debris.
6. If neither pressurized air nor washing of the boom dislodges and removes the debris, then disassemble the boom in accordance to the instructions outlined in the JLG Service & Maintenance Manual to remove the debris.



1. Tower Boom Assembly
2. Main Boom Assembly
3. Upright Cover
4. Upright Cover
5. Pad Rest
6. Pin
7. Upright
8. Tower Boom Lift Cylinder Assembly
9. Main Boom Lift Cylinder Assembly
10. Platform Level Cylinder Assembly
11. Upright Level Cylinder Assembly
12. Master Cylinder Assembly
13. Jib Assembly
14. Rotator Assembly
15. Jib Lift Cylinder Assembly

Figure 4-21. Removal/Installation of Boom and Cylinder Assembly



1. Base Boom
2. Fly Boom
3. Telescope Cylinder Assembly
4. Pin
5. Pin
6. Pin Keeper
7. Boom Rest Block
8. Wear Pad
9. Shim
10. Wear Pad
11. Shim
12. Retaining Ring
13. Bushing
14. Shim
15. Shim

Figure 4-22. Disassembly/Assembly of Main Boom Components

4.12 MAIN BOOM ASSEMBLY

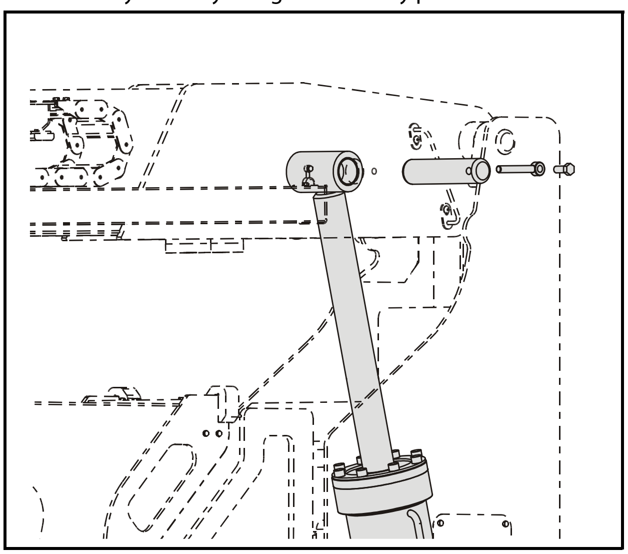
Removal

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

NOTICE

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

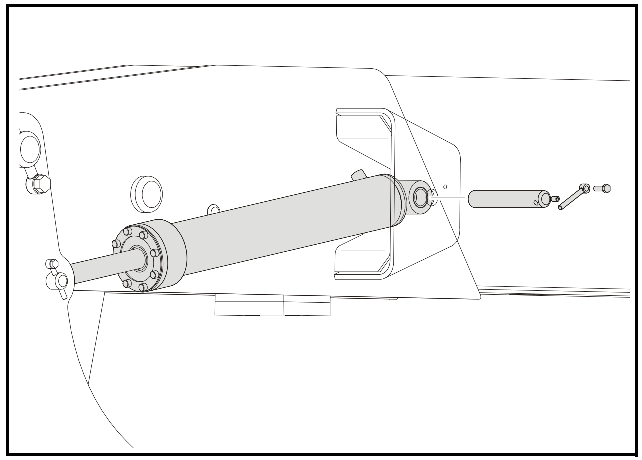
2. Tag and disconnect hydraulic lines from telescope cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Using a suitable brass drift and hammer, remove hardware securing the main boom lift cylinder rod end pin to the base boom section. Remove the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



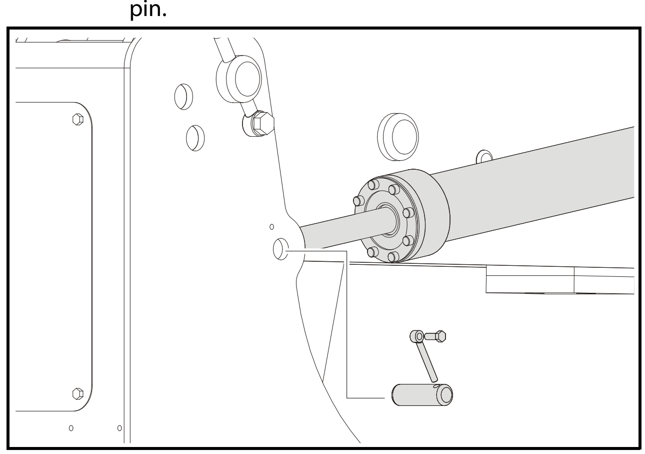
4. Remove the Master Cylinder as follows:
   a. Using an adequate supporting device, support the master cylinder so it doesn't fall when the retaining pins are removed.

NOTE: *The master cylinder weighs approximately 82.2 lb (37.3 kg).*

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

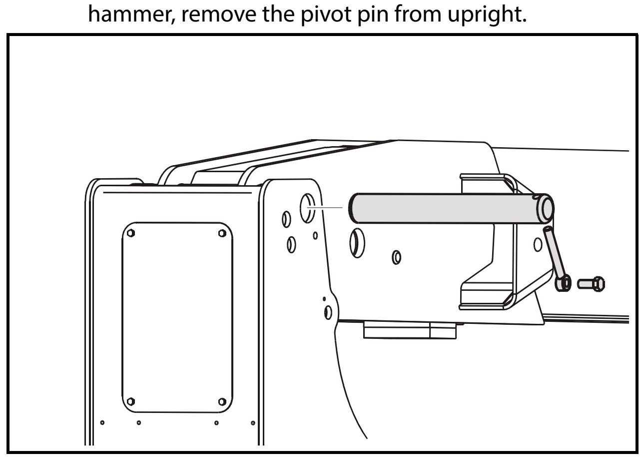


   d. Remove the bolt and keeper pin securing the master cylinder rod end pin to the upright. Remove the pin.



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

5. Remove the bolt and keeper pin securing the boom pivot pin to the upright. Using a suitable brass drift and hammer, remove the pivot pin from upright.



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

NOTE: *The main boom alone weighs approximately 2285.6 lb (1037.7 kg). Including the platform level cylinder, rotator, and platform support the assembly weighs approximately 3185 lb (1445 kg).*

Disassembly

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

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

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

Inspection

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

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

Assembly

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

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

NOTICE

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

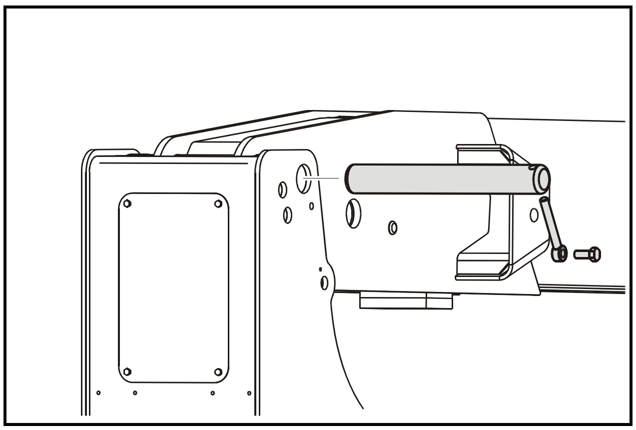
3. Secure the sling and lifting device at the telescope cylinder's approximate center of gravity, and lift the cylinder to the aft end of the fly boom section.
4. Slide telescope cylinder into the aft end of fly boom section. Align attachment holes in fly boom section with hole in rod end of telescope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

Installation

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

NOTE: *The main boom alone weighs approximately 2285.6 lb (1037.7 kg). Including the platform (slave) cylinder, rotator, and platform support the assembly weighs approximately 3185 lb (1445 kg).*

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

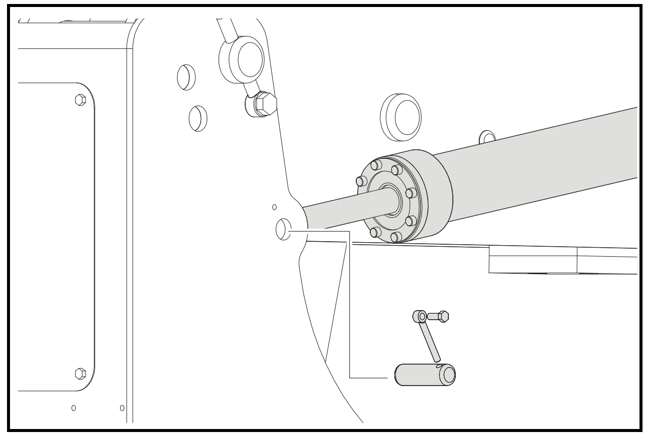


3. Install the Master Cylinder as follows:

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

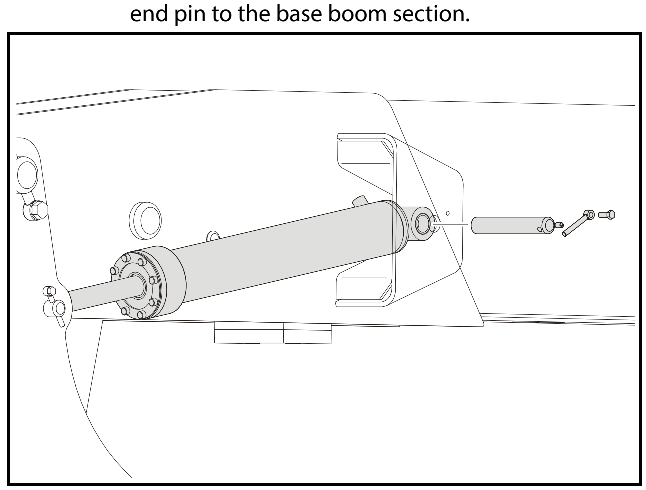
NOTE: *The master cylinder weighs approximately 82.2 lb (37.3 kg).*

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



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

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



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

4.13 UPRIGHT

Removal

NOTICE

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

1. Remove the main boom assembly. Refer to Section 4.12, Main Boom Assembly.
2. Tag and disconnect hydraulic lines to the main boom lift cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove mounting hardware from main boom lift Cylinder barrel end. Using a suitable brass drift and hammer, remove pin #1 from Upright and remove Main Boom Lift Cylinder.
4. Remove mounting hardware from master cylinder assembly barrel end. Using a suitable brass drift and hammer, remove pin #2 from upright and remove master cylinder assembly.

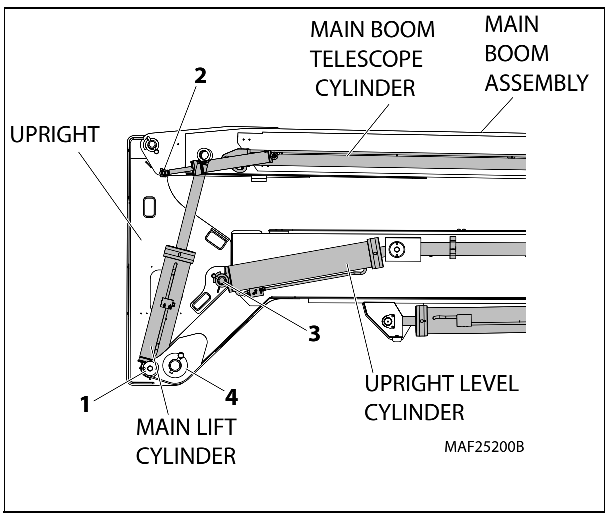


Figure 4-23. Location of Components - Upright

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

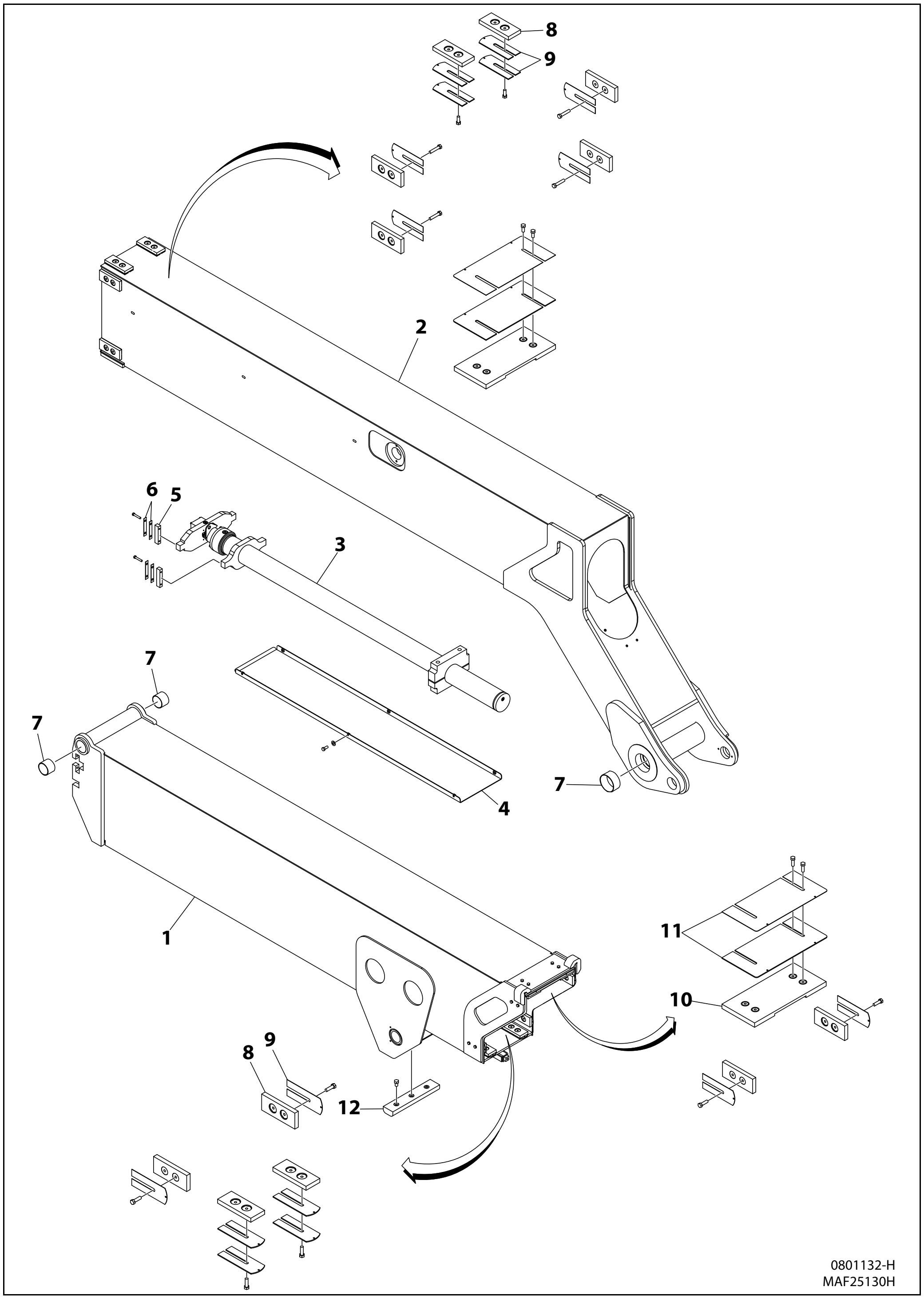
NOTE: *Steps 7 thru 10 are only necessary if the upright level cylinder is to be removed.*

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

Installation

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

1. Using a suitable lifting device, carefully install the upright lift cylinder into place in the tower boom.
2. Install the pin and mounting hardware at the barrel end of the upright lift cylinder.
3. Connect the hydraulic lines to the upright lift cylinder as tagged during removal.
4. Override the tower telescope limit switch and retract the tower boom.
5. Using an adequate lifting device, install the upright into position. Install pin # 4 into the tower boom assembly and secure it in place with the mounting hardware.
6. Connect the Upright Level Cylinder as follows:
   a. Align the holes in the cylinder and upright for pin #3, and install the pin into the upright and connect the upright level cylinder to the upright. Install the mounting hardware securing the pin.
   b. Install the hose bracket and secure in place with the mounting hardware.
7. Connect the wiring harness to horizontal limit switch.
8. Align the holes in the main boom lift cylinder and upright for pin #1 and install the pin. Secure the pin in place with the mounting hardware.
9. Align the holes in the master cylinder assembly and upright for pin #2 and install the pin. Secure the pin in place with the mounting hardware.
10. Connect the hydraulic lines to the main boom lift cylinder as tagged during removal.
11. Install the main boom. Refer to Section 4.12, Main Boom Assembly.



1. Base Boom	4. Support	7. Bushing	10. Wear Pad
2. Fly Boom	5. Attach Block	8. Wear Pad	11. Shim
3. Tower Telescope Cylinder Assembly	6. Shim	9. Shim	12. Boom Rest Pad

Figure 4-24. Disassembly/Assembly of Tower Boom Components

4.14 TOWER BOOM ASSEMBLY

Removal

NOTICE

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

1. Remove the main boom assembly. Refer to Section 4.12, Main Boom Assembly.
2. Using an overhead crane or suitable lifting device, support the entire Tower Boom Assembly and separately support the tower lift cylinder.
3. Remove mounting hardware from tower lift cylinder rod end. with a brass drift and hammer, remove the tower Lift cylinder Pin disconnecting the tower lift cylinder.
4. Remove mounting hardware from the tower boom pivot pin. Using a suitable brass drift and hammer, remove pin #2 from turntable assembly.
5. Using all applicable safety precautions, carefully lift the Tower Boom Assembly clear of turntable and lower to ground or a suitable supported work surface.
6. Remove mounting hardware from the upright leveling cylinder rod end. with a brass drift and hammer, remove the pin, disconnecting the upright cylinder. Remove with suitable lifting device.

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

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

Inspection

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

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

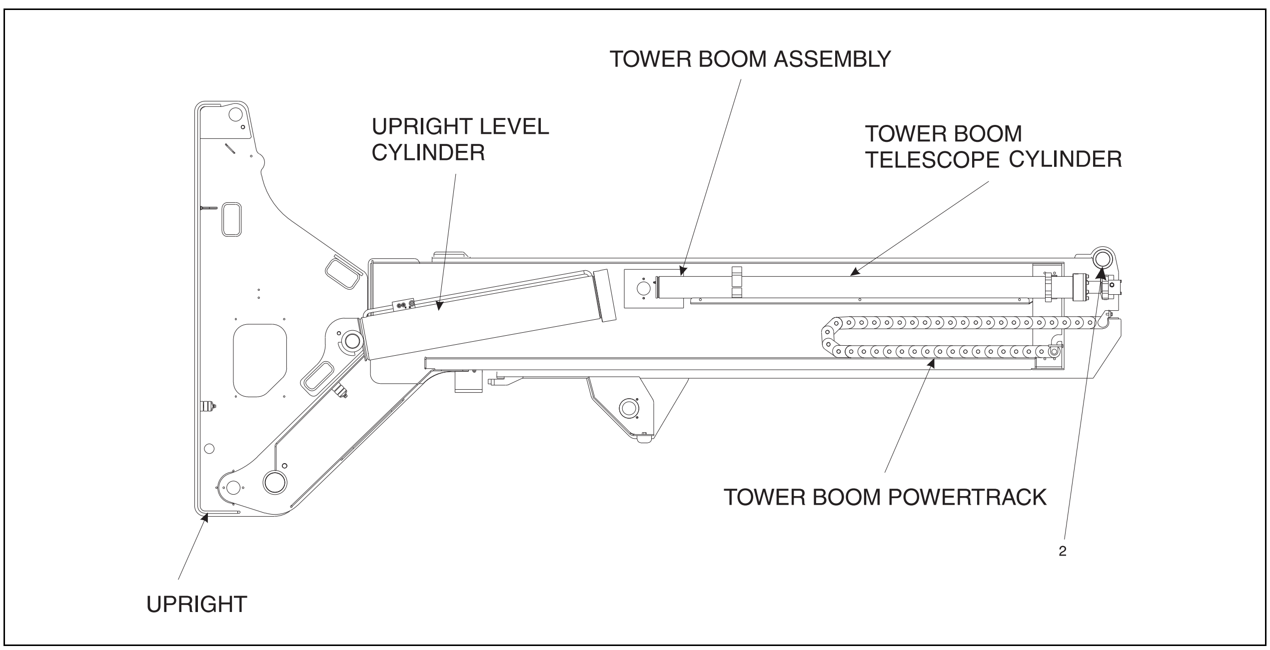


Figure 4-25. Location of Components - Tower Boom Powertrack

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

Assembly

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

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

NOTICE

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

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

Installation

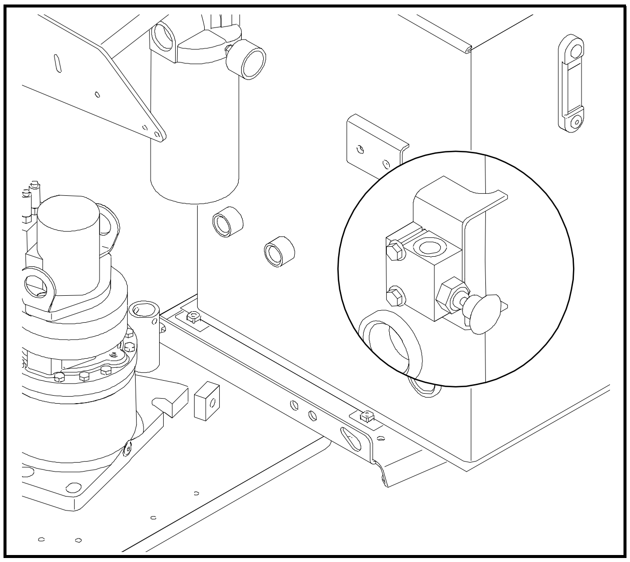
1. Using a suitable lifting device, position boom assembly on turntable so that the pivot holes in both boom and turntable are aligned.
2. Install boom pivot pin, ensuring that location of hole in pin is aligned with attach point on turntable.
3. If necessary, gently tap pin into position with soft headed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

Tower Out of Sync

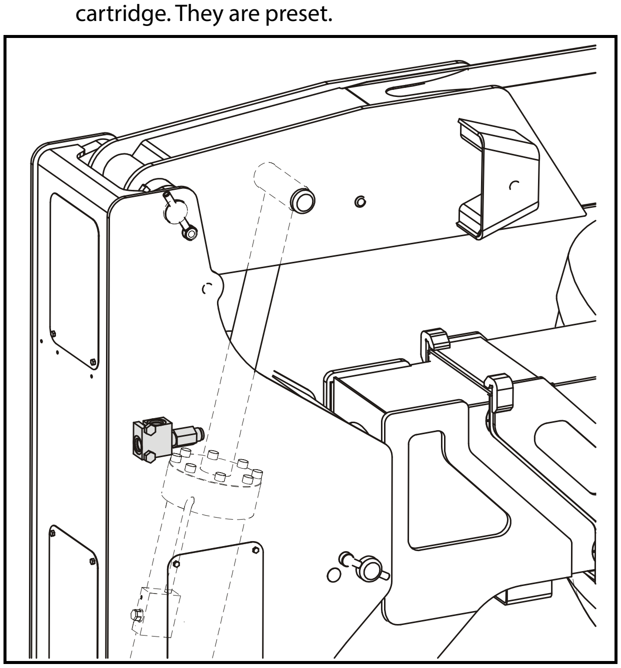
Tower is out of sync backwards, upright leaning toward the platform.

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

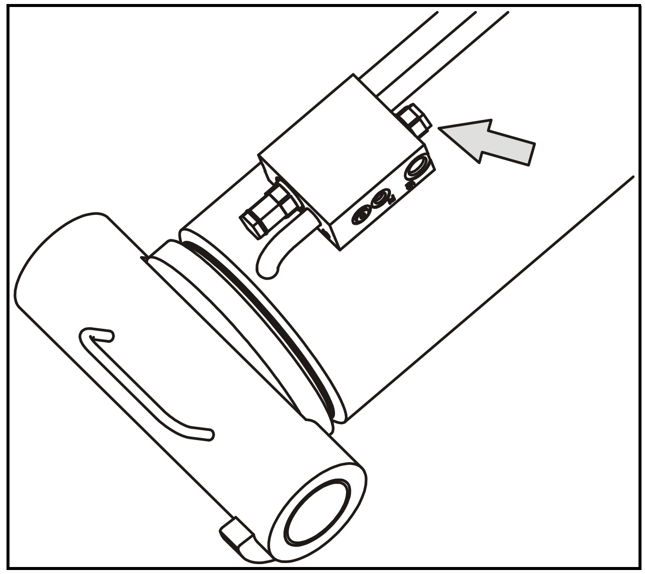
1. The releveling valve (red knob on the oil tank PN: 4640866), this is a poppet valve that could be leaking fluid out of the closed loop. Manually opening the valve and flushing it can eliminate any contaminate on the seat. The seat could also be damaged, so replacing the cartridge might be necessary.



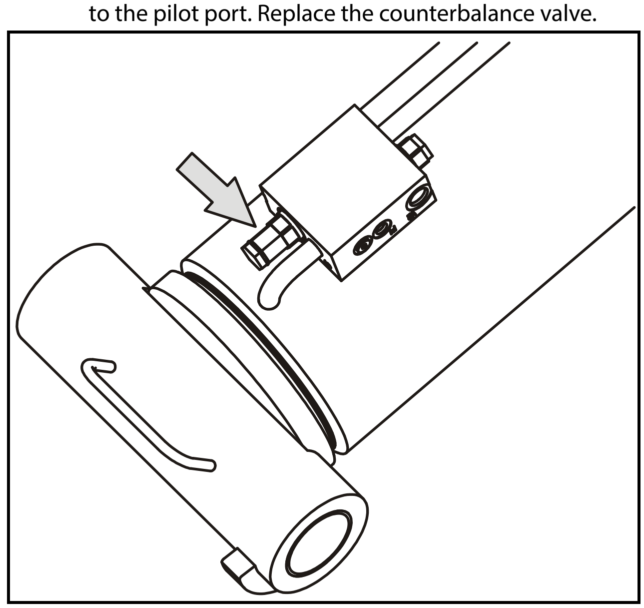
2. A relief valve is located in the upright. This relief valve could be leaking backwards out of the loop. Replace the cartridge. They are preset.



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



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

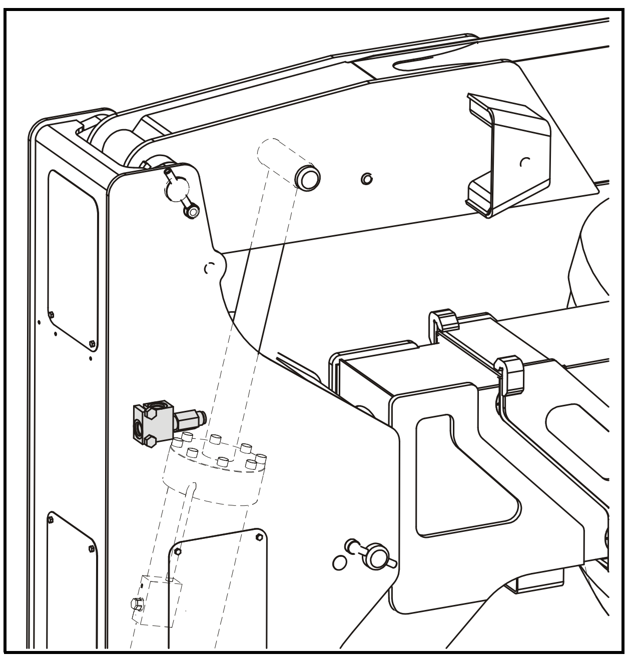


5. The packing on either the upright or lower cylinder can cause this. Do cylinder tests to determine if either cylinder needs new packing.

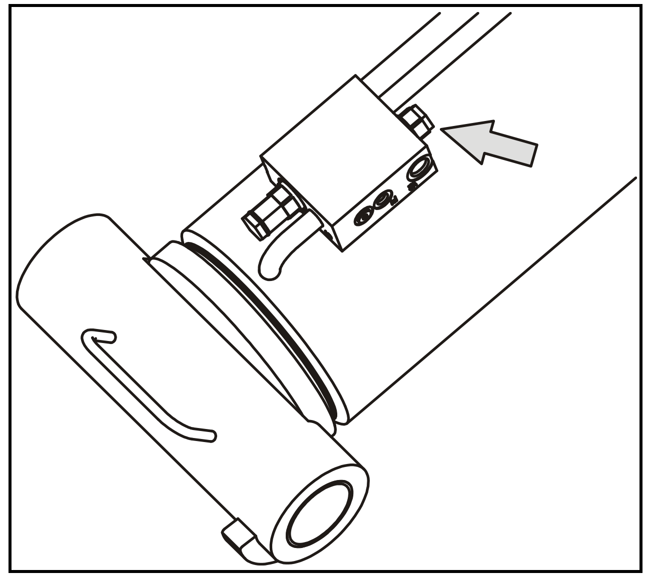
Tower is out of sync forwards, upright leaning away from the platform.

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

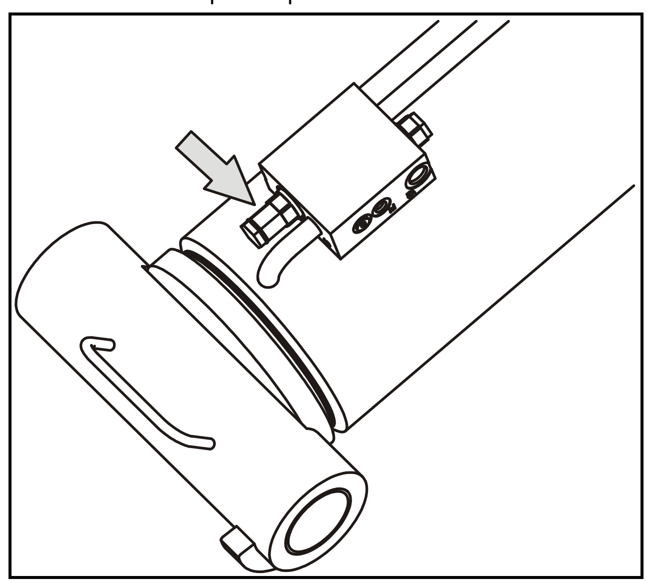
1. The relief valve located in the upright (PN: 4640929). If this valve is set too low or has contaminate in it causing it to leak prematurely, when lifting down oil can pass through it causing the volume to grow between the cylinders. Flush the valve out and reinstall it, or replace the cartridge. The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



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



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



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

4.15 UPRIGHT MONITORING SYSTEM (UMS)

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

Re-Synchronizing Upright

A pull type control valve allows the operator to adjust the upright level cylinder if the upright is not 90° (vertical) relative to the chassis (Refer to Figure 4-26.). This valve is located in the tank compartment area.

Referencing the corrective action listed on decal 1001096141 located on the oil tank, perform the following steps with the aid of an assistant:

1. Turn the key switch to the ground control position.
2. Start the engine.
3. Pull and hold the red relevel knob located next to the main control valve. Refer to Figure 4-26.
4. Raise the tower boom 6 feet (1.8 m).
5. Release the red relevel knob.
6. Lower the tower boom fully and continue to hold down the switch to Tower Down for an additional 20 seconds.
7. Repeat steps 3 thru 6 if necessary until the upright is 90° (vertical) relative to the chassis.

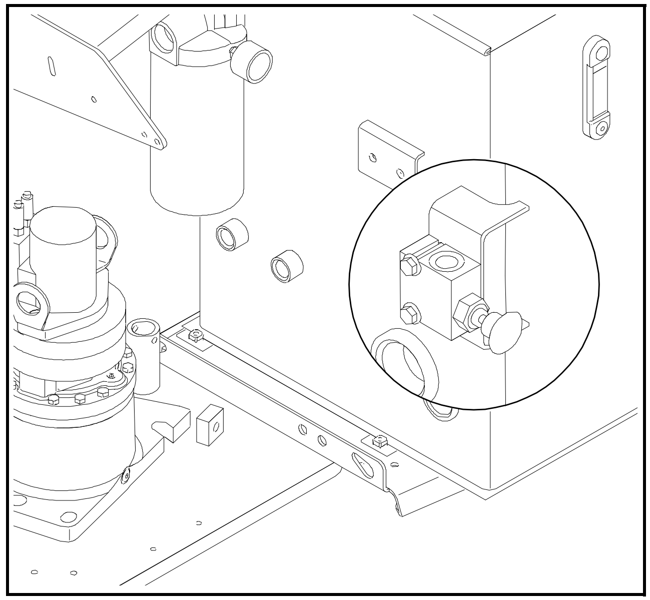


Figure 4-26. Releveling Valve

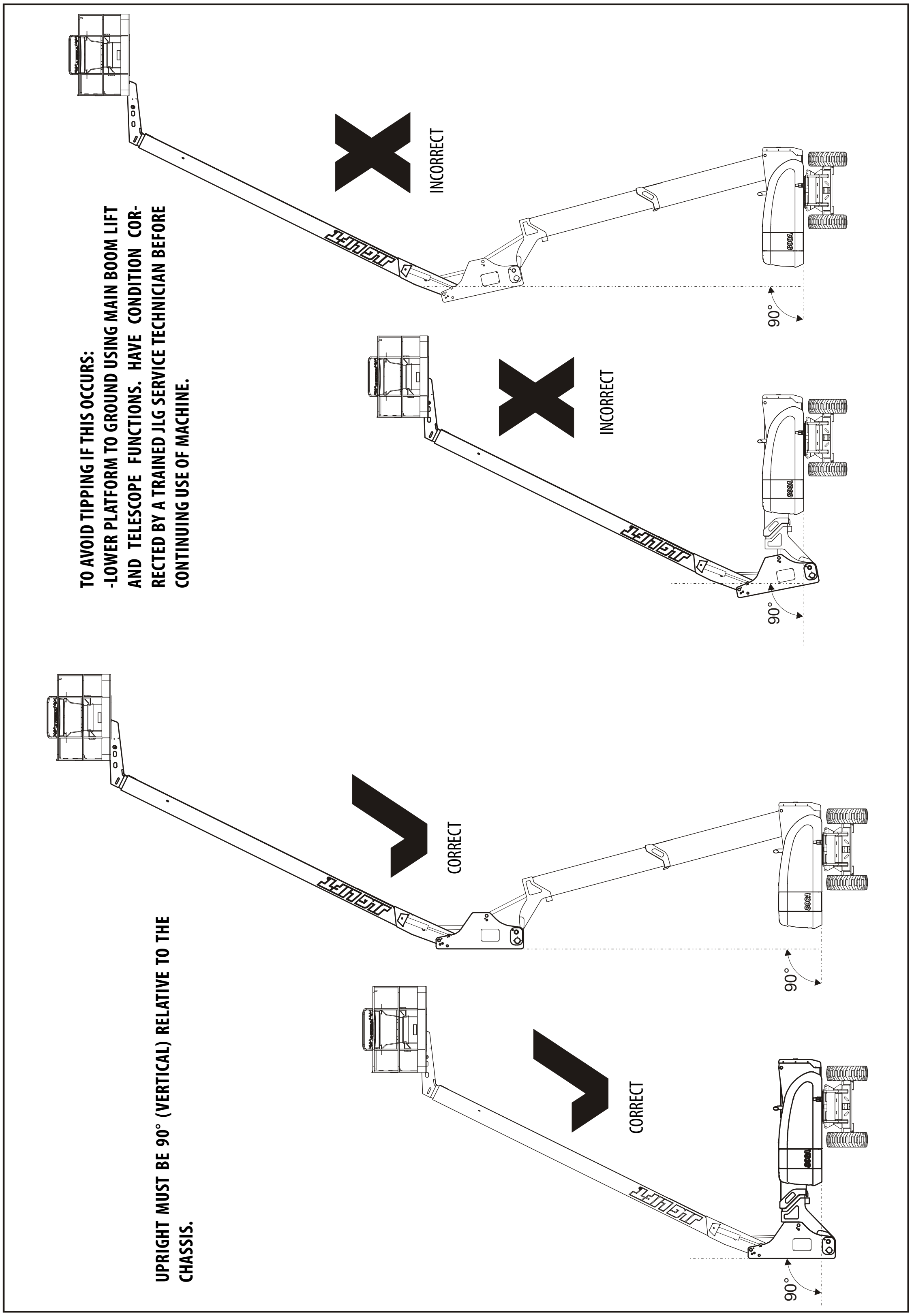


Figure 4-27. Boom Upright Positioning

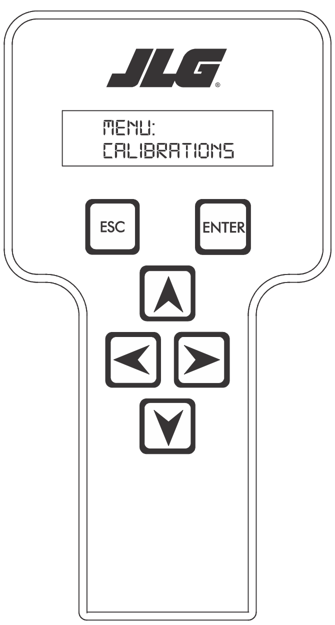
Calibration

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

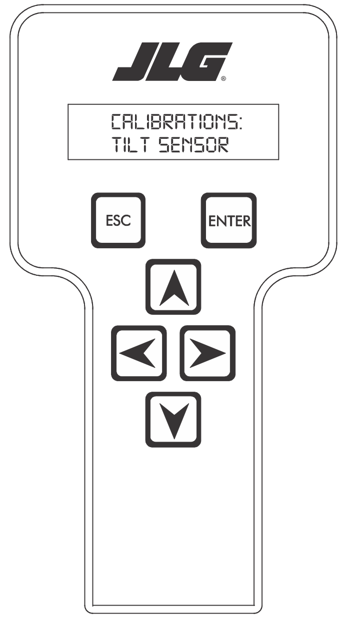
NOTICE

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

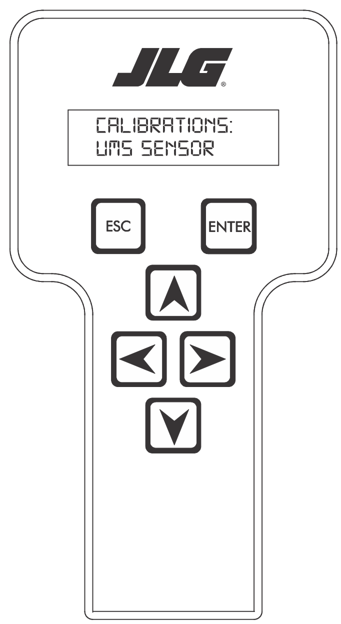
2. Pull out the emergency stop button at the ground control station and start the engine from the ground controls.
3. To calibrate the Upright Monitoring System through the hand-held analyzer, you must be in access level 1. To advance to access level 1, scroll to the ACCESS LEVEL menu and press "ENTER".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



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



Or

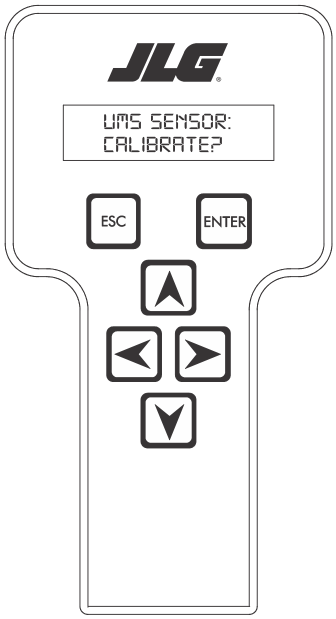


   c. Scroll left to right through the above menu items until "UMS SENSOR" sub menu appears on the bottom line of the analyzer display. Press the "ENTER" key.

NOTICE

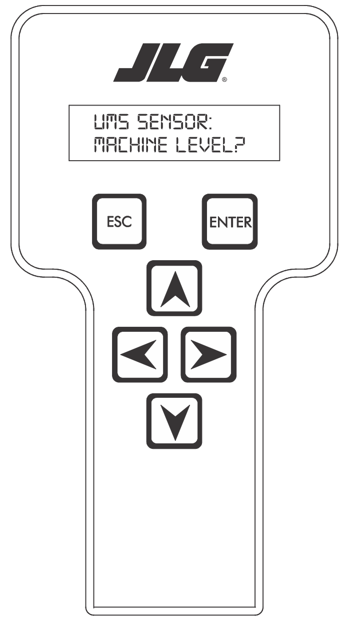
IT IS NOT NECESSARY TO CALIBRATE THE TILT SENSOR IN THE GROUND CONTROL MODULE AT THIS TIME. HOWEVER, WHEN THE TILT SENSOR IN THE GROUND CONTROL MODULE IS RECALIBRATED, THE UPRIGHT MONITORING SYSTEM TILT SENSOR MUST BE RECALIBRATED AS WELL.

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



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

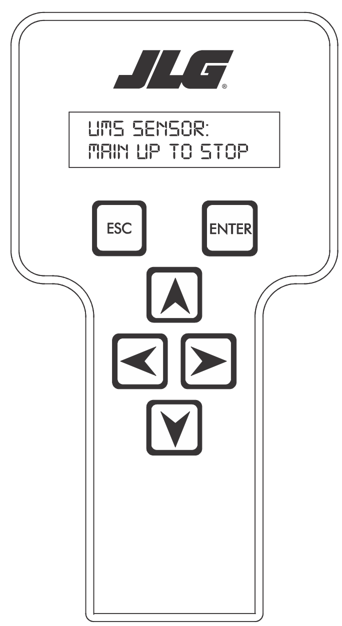
e. Press "ENTER" and the next screen will display the following, asking if the machine is on a level surface:



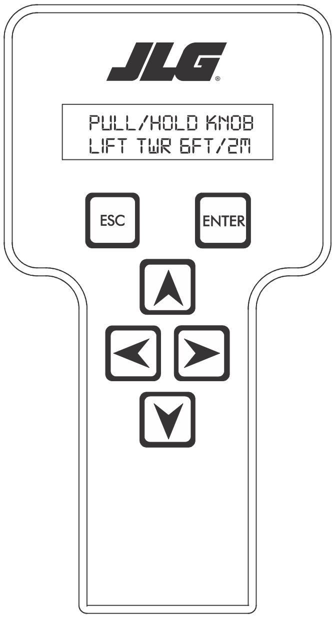
NOTICE

THE MACHINE MUST BE LEVEL FOR PROPER CALIBRATION.

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



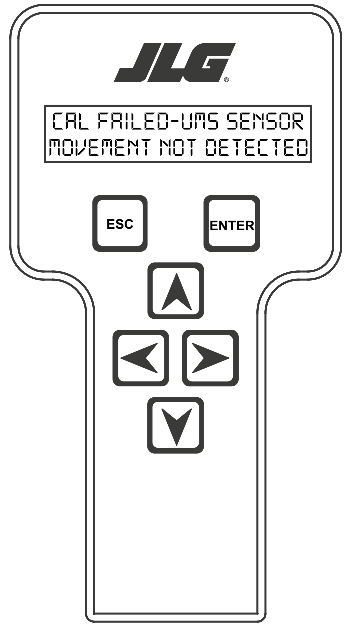
g. After the main boom has been fully elevated, press "ENTER" ENTER. The analyzer will display the following:



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

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

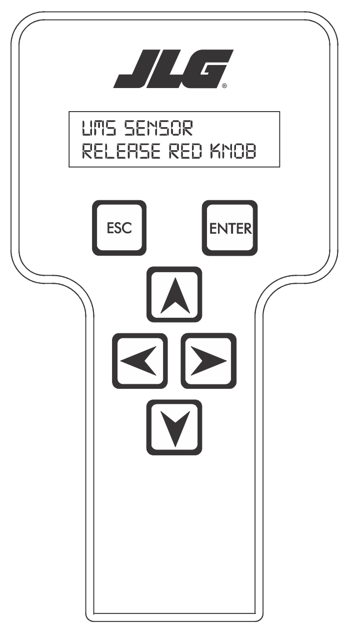
If the upright monitoring system did not detect adequate sensor activity, the screen will display:



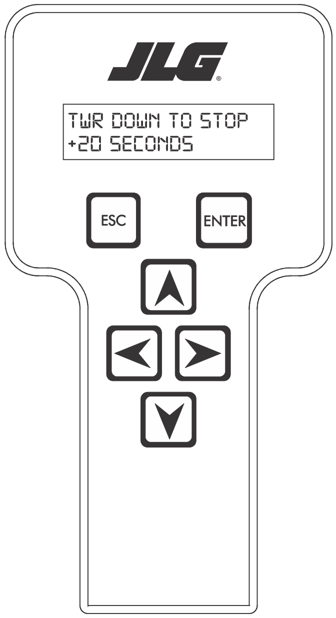
MAF14500

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

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

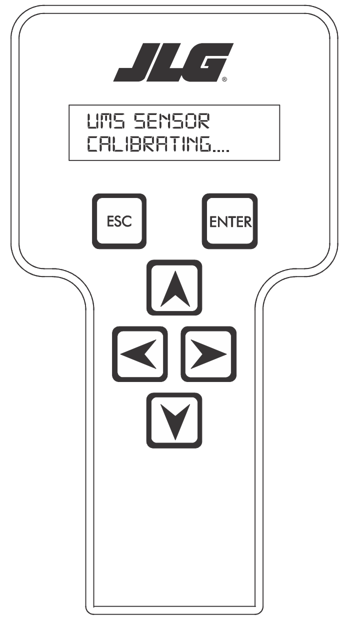


i. When viewing the above display, press "ENTER". The screen will display the following:

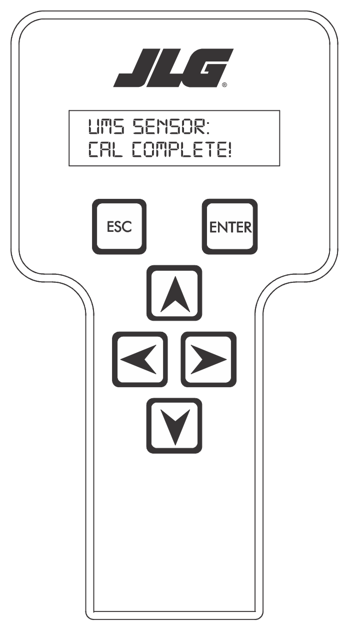


j. Lower the tower boom onto the boom stop. Continue to hold the tower boom down function for at least twenty (20) seconds **WITHOUT RELEASING THE FUNCTION SWITCH**. The calibration must recognize continuous activation of the tower down function switch for the required time.

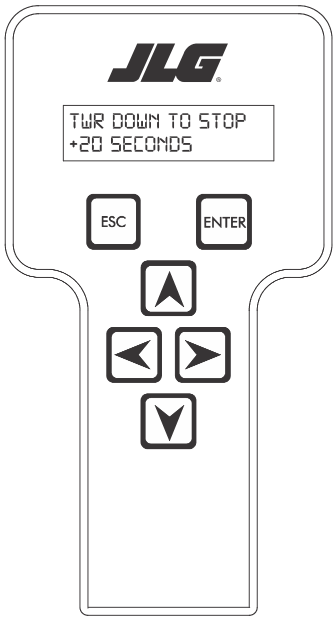
After the required activation time has passed, release the function switch and press "ENTER". The analyzer will display the following message:



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



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



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

WARNING

DO NOT RAISE THE TOWER BOOM AGAIN DURING CALIBRATION.

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

Calibration Faults

CAL Failed-Chassis Not Level

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

CAL Failed-UMS Sensor Raw Output Out Of Range

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

CAL Failed-Turntable Sensor Raw Output Out Of Range

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

CAL Failed-Calibration Disrupted

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

CAL Failed- UMS Sensor Movement Not Detected

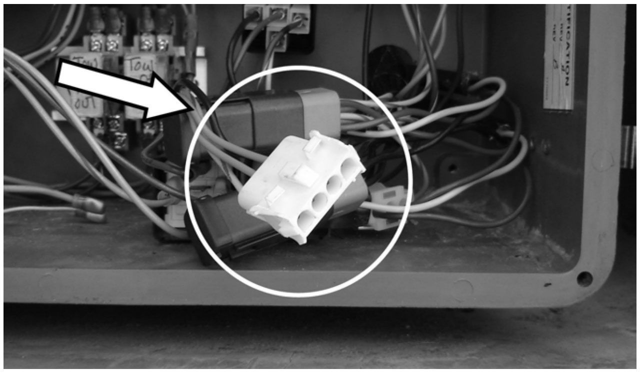
The UMS angle has not detected the required amount of movement during calibration.

Function Check

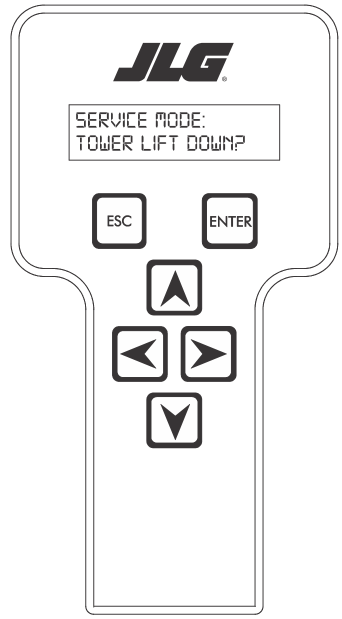
NOTICE

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

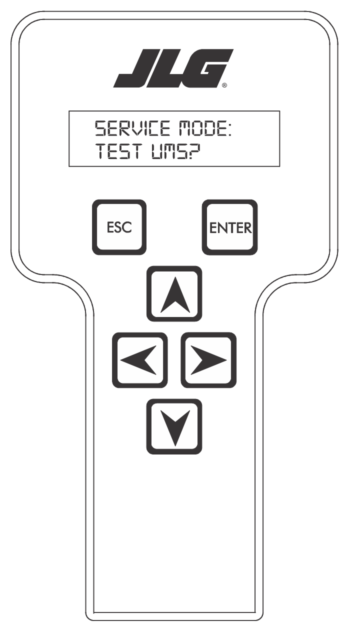
1. Connect the hand-held analyzer at the ground control station using the four-pin connector.



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

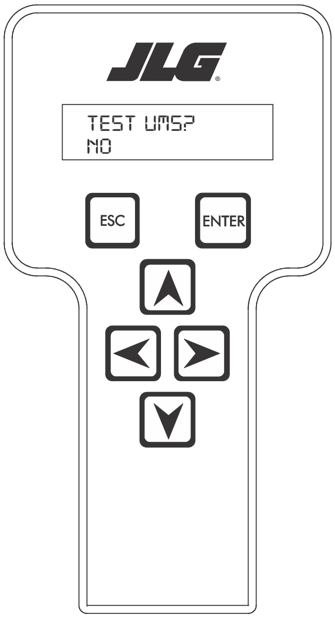


Or

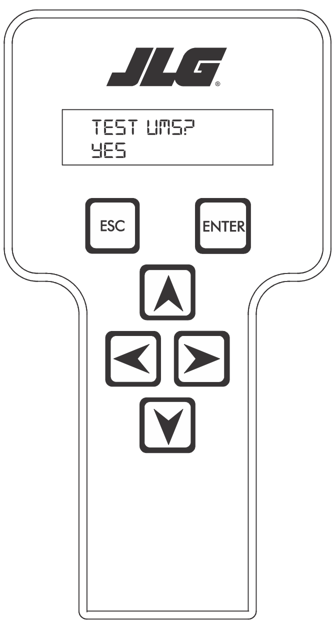


5. Scroll left to right through the above menu items until "TEST UMS?" sub menu appears on the bottom line of the analyzer display. Press the "ENTER" ENTER key.

6. The controller will now display the following:



or, by pressing the up and down arrow keys:



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

8. From the ground controls, raise the tower boom several feet. Verify that the tower boom will not lower.

9. To end the system test, press the Emergency Stop Switch (EMS) at the ground controls. Upon loss of power (pressing the EMS) to the system, the upright monitoring system will reset and all functionality will be restored to the machine.

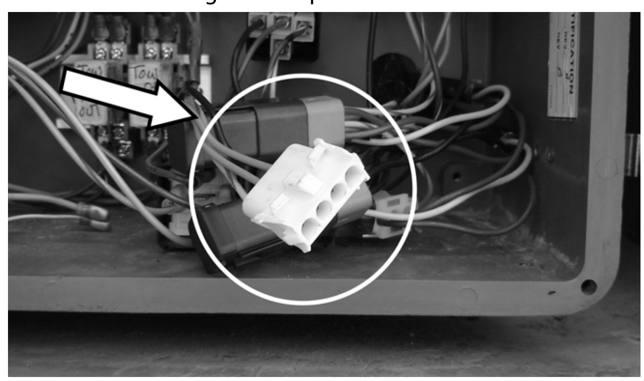
Service Mode/Tower Boom Retrieval

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

NOTICE

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

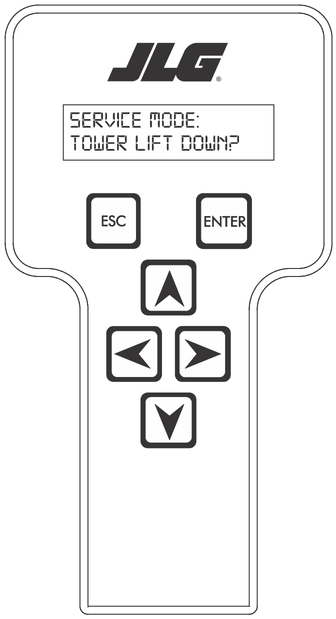
1. Connect the hand-held analyzer at the ground control station using the four-pin connector.



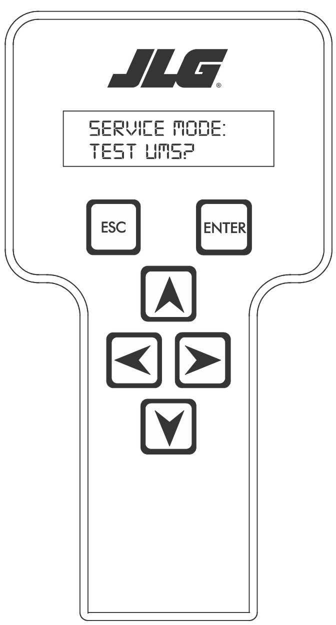
2. Pull out the emergency stop button at the ground control station and turn the key switch to ground controls. Start the engine.

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

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

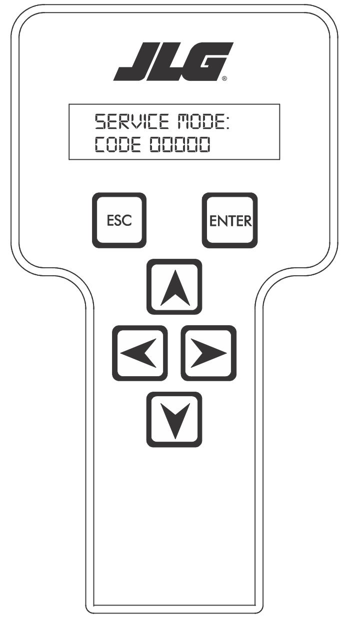


Or

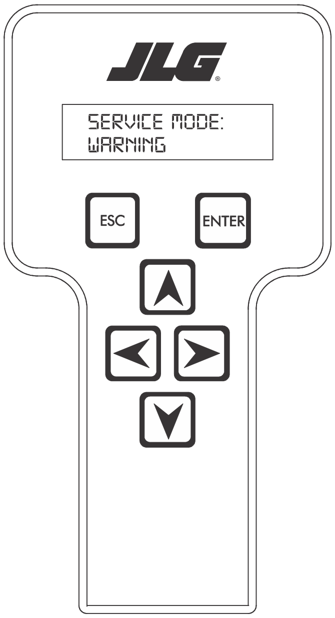


5. Scroll left to right through the above menu items until "TOWER LIFT DOWN?" sub menu appears on the bottom line of the analyzer display. Press the "ENTER" key.

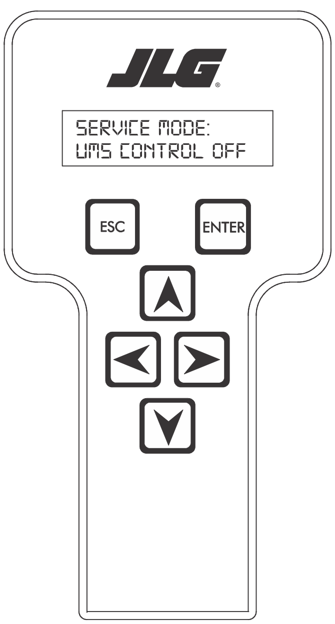
6. The controller will now display the following:



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

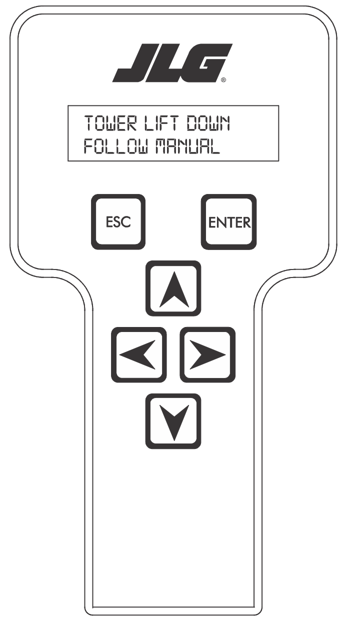


followed by:



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

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



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

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

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

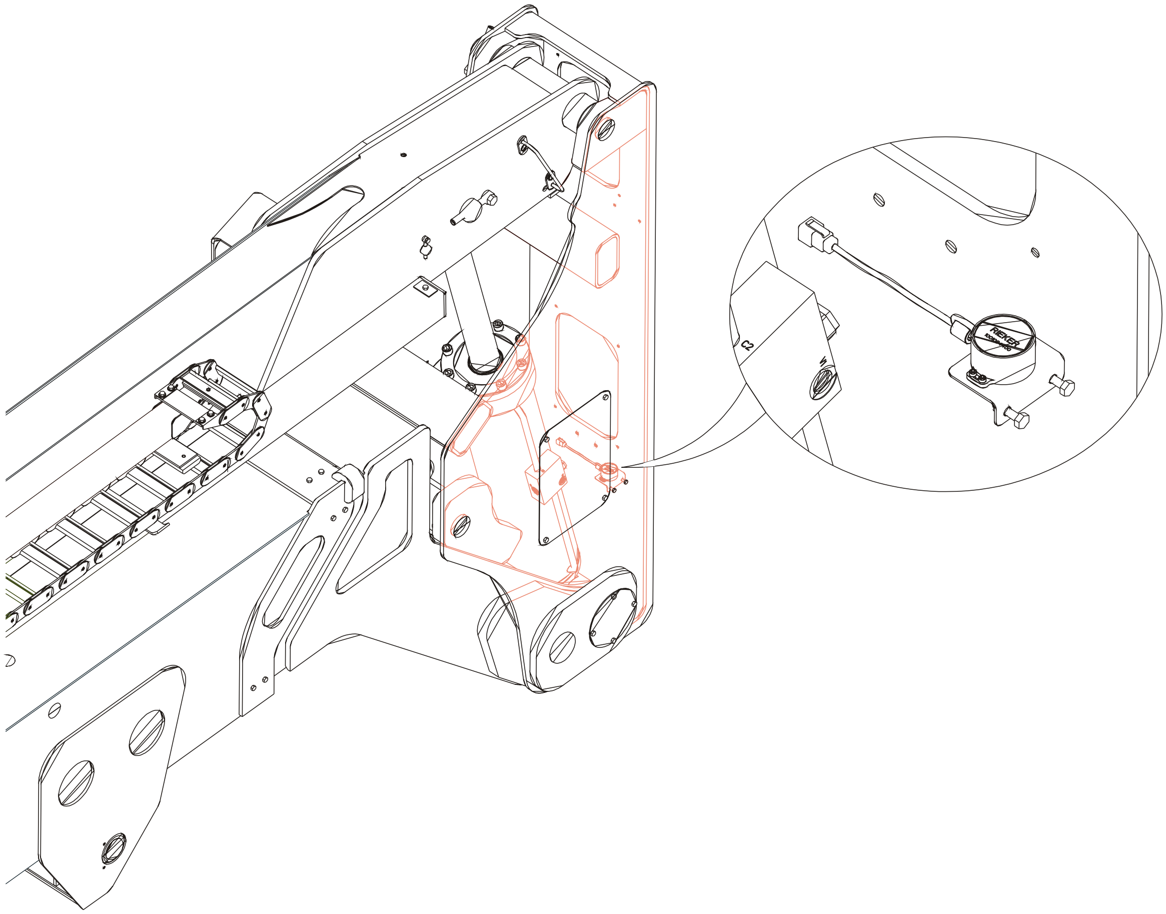


Figure 4-28. UMS Sensor Location

4.16 UMS TROUBLESHOOTING AND DIAGNOSTIC TROUBLE CODES (DTC)

Backward Stability Concern DTC (2532)

UMS SENSOR BACKWARD LIMIT REACHED

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

Solution:

- Inspect sensor mounting for obvious damage and excessive corrosion.
- Verify sensor calibration according to Section , Calibration.
- Follow the corrective action listed in Section , Re-Synchronizing Upright on decal 1001096141 located near the red knob of the machine.
- Inspect machine hydraulics. Refer to Holding Valve Checks in Section , Tower Out of Sync for other possible causes.

Forward Stability Concern DTC (2530)

UMS SENSOR FORWARD LIMIT REACHED

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

Solution:

- Inspect sensor mounting for obvious damage or excessive corrosion.
- Verify sensor calibration according to Section , Calibration.
- Command tower lift down function until fully stored.
- Inspect machine hydraulics. Refer to Holding Valve Checks in Section , Tower Out of Sync for other possible causes.

Out of Usable Range DTC (2531)

UMS SENSOR OUT OF USABLE RANGE

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

Solution:

- Verify the message clears when operating the machine on grade less than 10°.
- Inspect sensor mounting for obvious damage or excess corrosion.
- Verify sensor calibration according to Section , Calibration.

UMS Sensor Not Calibrated DTC (816)

UMS SENSOR NOT CALIBRATED

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

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

Solution:

- Calibrate sensor according to Section , Calibration.

UMS Sensor Faulted DTC (817)

UMS SENSOR FAULT

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

Solution:

- Inspect wire harness going to the sensor and UMS module for damage and proper continuity.
- Inspect sensor mounting for obvious dense and excessive corrosion.
- Replace sensor.

Calibration Faults

See Section , Calibration

4.17 ARTICULATING JIB AND JIB LIFT CYLINDER

NOTE: *Pin numbers listed in the following procedures are referenced in Figure 4-29., Location of Components-Articulating Jib.*

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

NOTE: *The Jib assembly weighs approximately 357.7 lb (162.4 kg).*

Removal

1. For platform/support removal see platform/support removal diagram. (See Section 4.6, Platform).
2. Position the articulating jib boom level with the ground.
3. Tag and disconnect hydraulic lines from platform 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 slave cylinder pin (1). Using a suitable brass drift and hammer, remove the cylinder pin from articulating jib boom.
5. Remove mounting hardware from articulating jib boom pivot pin (2). Using a suitable brass drift and hammer, remove the pivot pin from boom assembly. Remove the jib assembly from the machine.

Disassembly

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

Inspection

NOTE: *When inspecting pins and bearings Refer to Section 2.5, Pins and Composite Bearing Repair Guidelines*

1. Inspect articulating fly boom pivot pin for wear, scoring, tapering and ovality, or other damage. Replace pins as necessary.
2. Inspect articulating fly boom pivot attach points for scoring, tapering and ovality, or other damage. Replace pins as necessary.
3. Inspect inner diameter of articulating fly boom pivot bearings for scoring, distortion, wear, or other damage. Replace bearings as necessary.

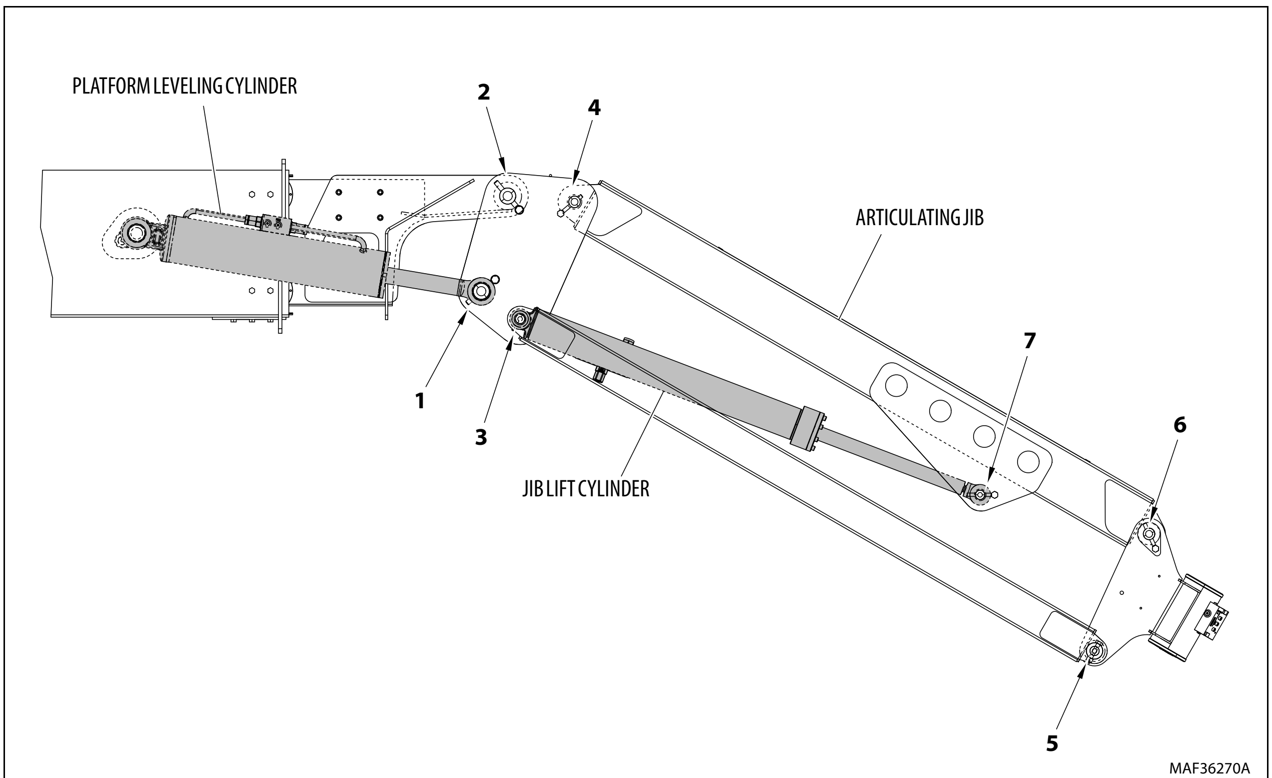


Figure 4-29. Location of Components-Articulating Jib

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 articulating jib boom assembly for bending, cracking, separation of welds, or other damage. Replace boom sections as necessary.

Assembly

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

Installation

NOTE: *The Jib assembly weighs approximately 357.7 lb (162.4 kg).*

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

1. Align articulating jib boom pivot weldment with attach holes in fly boom assembly. Using a soft head mallet, install pivot pin #2 into fly boom assembly and secure with mounting hardware.
2. Align the platform leveling cylinder with attach holes in articulating jib boom pivot weldment. Using a soft head mallet, install platform leveling cylinder pin #1 into articulating jib boom pivot weldment and secure with mounting hardware.
3. 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.

4.18 SEQUENCE FOR HOSE REPLACEMENT IN THE TOWER BOOM

1. Remove the tower boom front cover bolts, exposing the Powertrack.
2. Remove bolts to disconnect the top bar of the Powertrack
3. Pull the Powertrack out of base boom. (as far as hoses will allow)
4. At left side rear of upright, remove access cover plate, (4) bolts. (others if necessary)
5. Remove access cover plate, (4) bolts, from bottom front of fly boom.
6. Cut cable ties that attach hose to be replaced.
7. Disconnect hose that is to be replaced, and cap the male fitting.
8. Attach the new hose to the end of the hose to be replaced.
9. Pull these lines thru the upright and out the bottom, then feed back into the fly boom.
10. At the Powertrack, in front of the tower boom, open the Powertrack links to expose the hose to be replaced.
11. Pull hose to be replaced, attached to the new hose, thru the fly boom and thru the Powertrack links.
12. Disconnect new hose from the replaced hose and connect to fitting where the damaged hose was connected.
13. Roll Powertrack back into base, and attach the top bar of the Powertrack (2) bolts to the inside top of the fly boom section.
14. Check for leaks and hardware tightened securely.
15. Replace access cover plates and front cover.

4.19 LIMIT SWITCHES ADJUSTMENT

Main Boom Horizontal Limit Switch

1. Place machine on level surface.
2. Raise main boom 5 to 10 degrees above horizontal. limit switch should activate before this point.
3. Lower main boom until limit switch resets. This should be 1 degree above to 4 degrees below horizontal.

NOTE: *Angle indicator should be placed approx. 2 ft. from the main boom pivot pin and the attach point on the main boom. Tower angle switch must be reset before main boom angle switch can be activated.*

Tower Boom Horizontal Limit Switch

1. Place machine on level surface.
2. Raise Tower Boom 8 to 13 degrees above horizontal. The tower angle limit switch should activate at this point.
3. Lower the tower boom until the limit switch resets. This should be 2 to 7 degrees below where the switch was activated. (See Figure 4-30. and Figure 4-31. for adjustments).

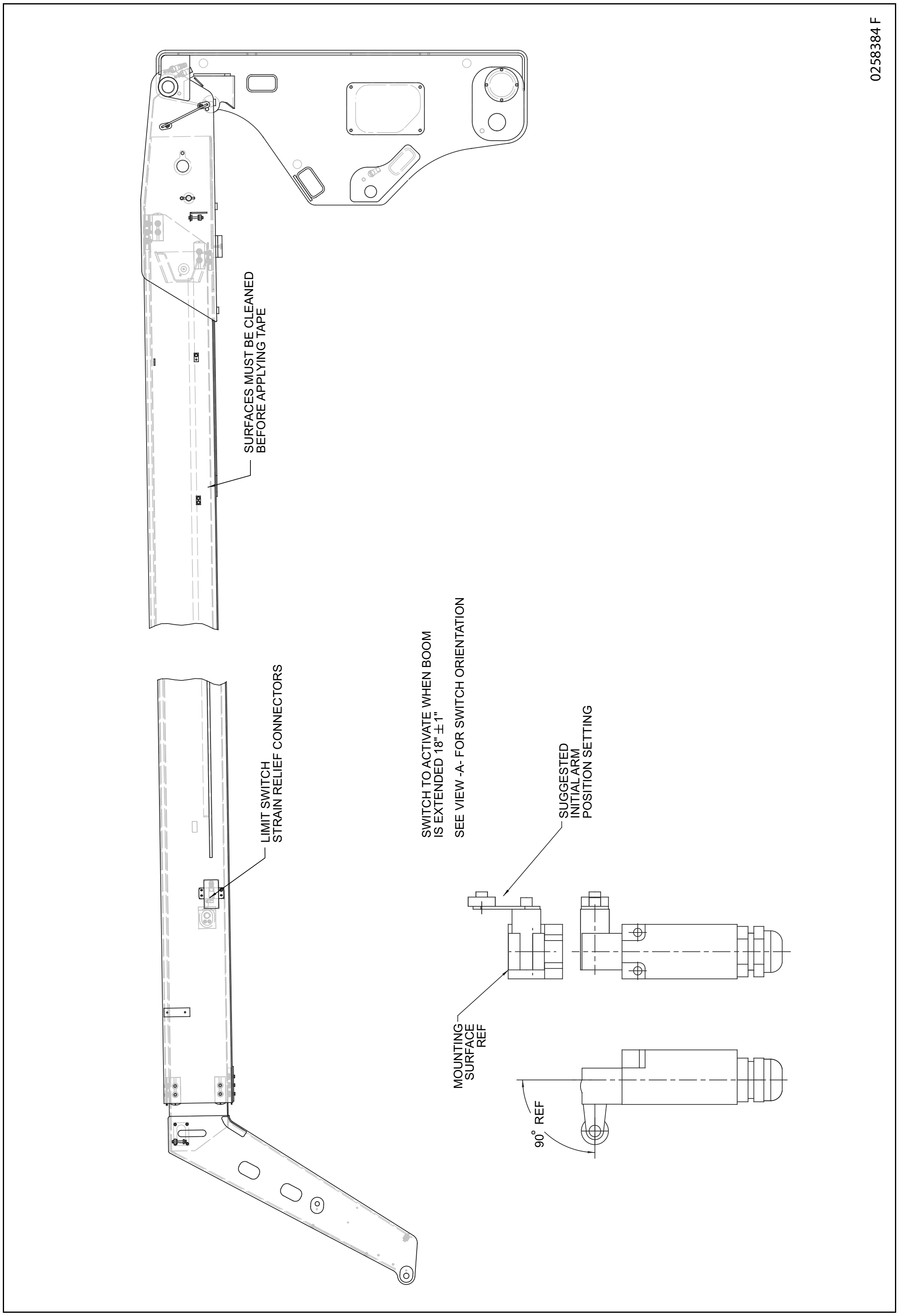


Figure 4-30. Transportation Switch Installation (CE only)

4.20 BOOM VALVE ADJUSTMENT

1. Adjust the screws so the plunger on the valves has 0.25 in. (6 mm) travel remaining when the lower boom is fully raised and retracted.
2. After the valves are adjusted, adjust the proximity switches to within 0.314 in. (8 mm) of their target. The LED’s on the proximity switches will illuminate when the power is on and the switch is within 0.314 in. (8 mm) of the target. There is a proximity switch to backup both valves.

NOTE: *The cam valve under the boom requires the tower boom to be completely lowered and the cam valve mounted on T/T requires the tower boom to be fully elevated prior to adjustment.*

Tower Boom

1. Shim up wear pads until 1/32 inch (0.8 mm) clearance to adjacent surface.
2. When adjusting wear pads, removing or adding shims, bolt length must also be changed.
   a. When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   b. When shims are removed, shorter bolts must be used so bolt does not protrude from insert and come into contact with boom surface.

Main Boom

1. Shim up wear pads to within 1/32 inch (0.8 mm) clearance between wear pad and adjacent surface.
2. Adjusting wear pads, removing or adding shims, bolt length must also be changed.
   a. When adding shims, longer bolts must be used to ensure proper thread engagement in insert.
   b. When shims are removed, shorter bolts must be used so bolt does not protrude from insert and Sheaves and wire rope must be replaced as sets.

4.21 ROTATOR ASSEMBLY

Theory of Operation

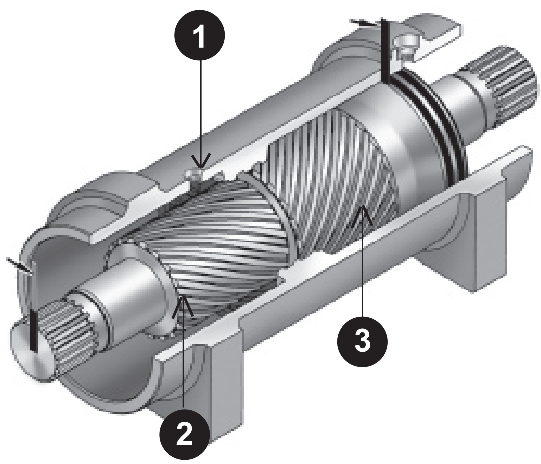
The rotary actuator is a simple mechanism that uses the sliding spline operating concept to convert axial piston motion into powerful shaft rotation. Each actuator is composed of a housing with integrated gear ring (1) and only two moving parts: the central shaft with integrated bearing tube and mounting 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 main radial bearing and the lower radial bearing. Axially, the shaft is separated from the housing by the main and lower thrust washers. The end cap is adjusted for axial clearance and locked in position by set screws or pins.

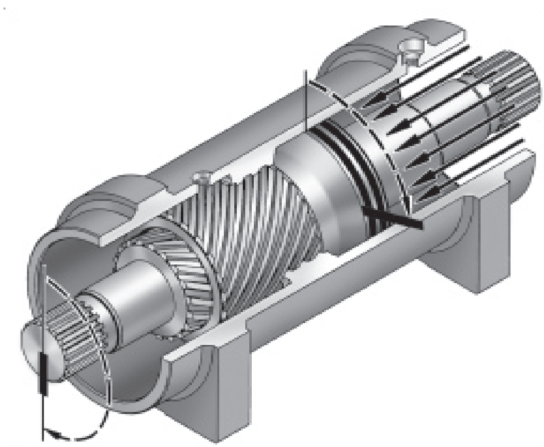
The actuators are equipped with factory installed counterbalance valves, which performs four major functions.

- 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 to their original starting positions.

Required Tools

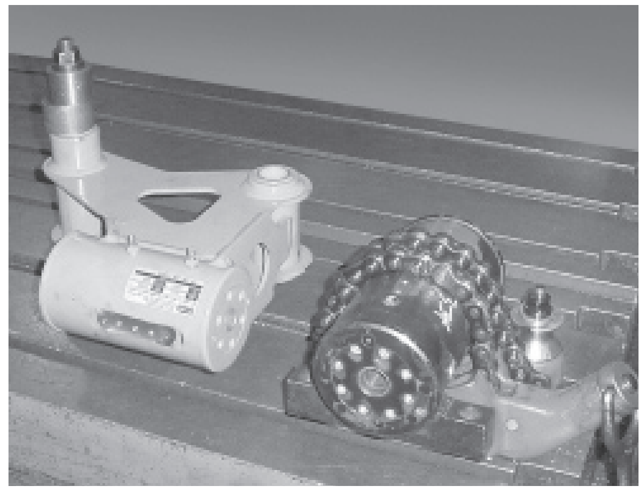
Upon assembly and disassembly of the actuator there are basic tools required. The tools and their intended functions are as follows:

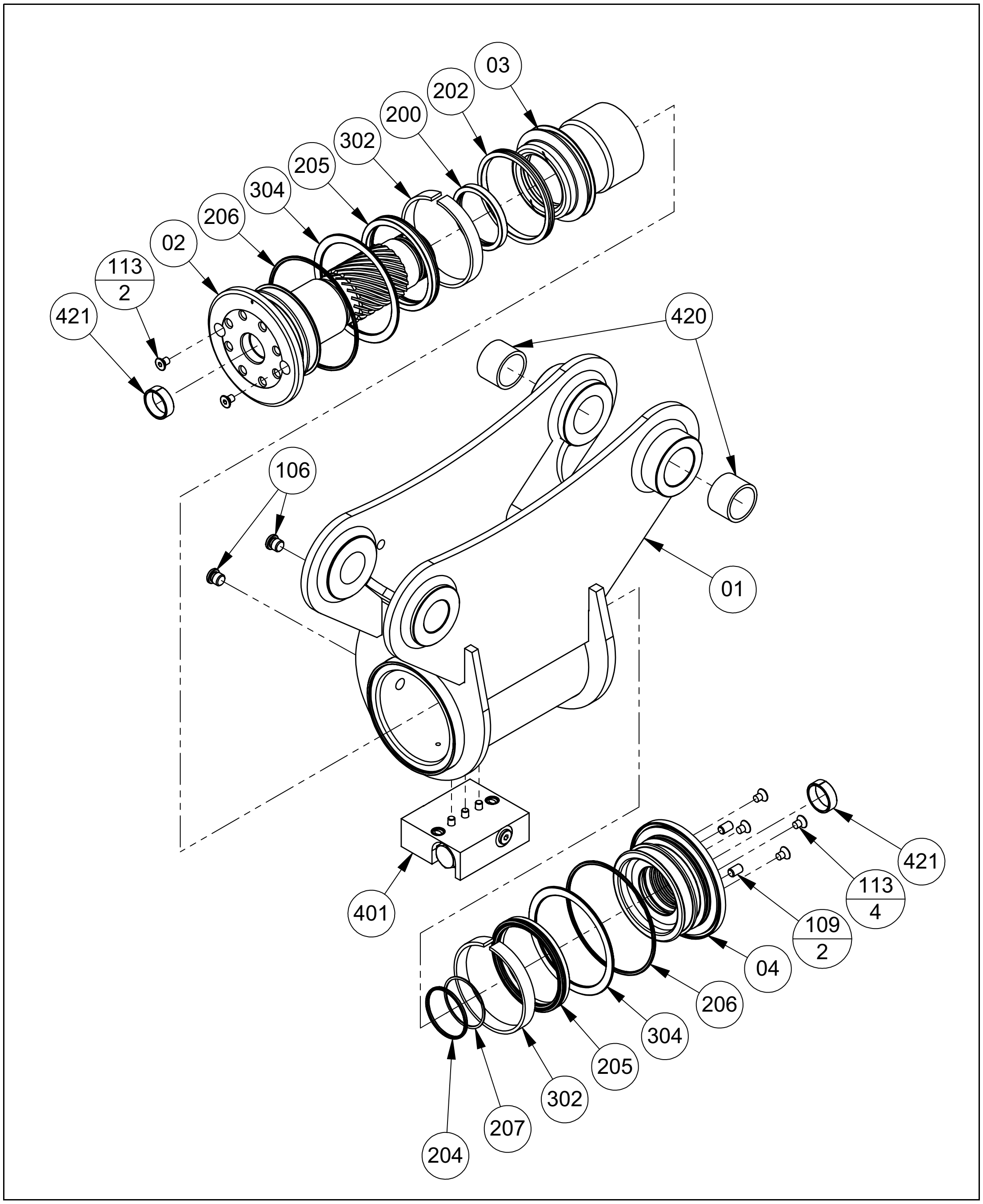
1. PIPE VISE
2. HEX WRENCH - Removal and replacement of port plugs and setscrews.
3. ASSORTED SCREWS
4. SAFETY GLASSES
5. END CAP REMOVAL TOOLS (provided with Helac seal kit).
6. DRILL
7. FLASHLIGHT - Helps to locate and examine timing marks, component failure and overall condition.
8. RUBBER MALLET - 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 the timing marks and outline troubled areas.
12. T-HANDLE SCREW EXTRACTOR
13. HEX WRENCH SET - Removal and replacement of port plugs and setscrews (106 &110).
14. SEAL TOOLS - Removal and installation of seals and wear guides. Directions to make a seal tool are provided below making a Seal Tool.
15. PUNCH
16. DOWEL PINS - Removal and installation of end cap.

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.

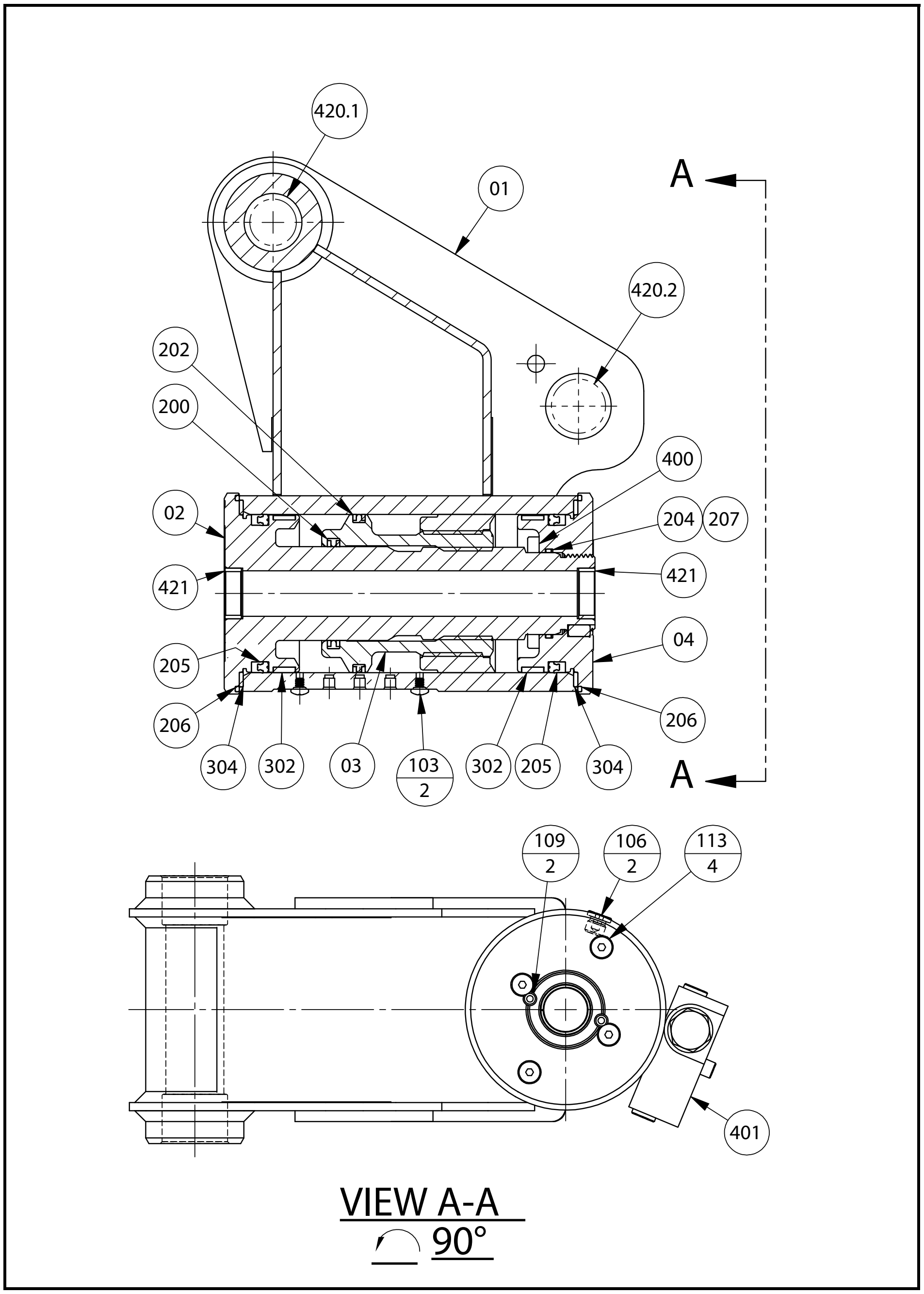
Disassembly is considerably easier if the actuator is firmly secured to the work bench. A pipe vise or mounting fixture work well.





PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
01. Housing	106. Port Plug	200. T-Seal	302. Wear Guide	401. Counterbalance Valve
02. Shaft	109. Lock Pin	202. T-Seal	304. Thrust Washer	420. Bushing
03. Piston Sleeve	113. Capscrew	204. O-ring		421 Bushing
04. End Cap		205. Cup Seal		
		206. Exclusion Seal		
		207. Backup Ring		

Figure 4-31. Rotator - Exploded View



PARTS	HARDWARE	SEALS	BEARINGS	ACCESSORIES
01. Housing	103. Screw	200. T-Seal	302. Wear Guide	400. Stop Tube
02. Shaft	106. Port Plug	202. T-Seal	304. Thrust Washer	401. Counterbalance Valve
03. Piston Sleeve	109. Lock Pin	204. O-ring		420.1 Bushing
04. End Cap	113. Capscrew	205. Cup Seal		420.2 Bushing
		206. Exclusion Seal		421 Bushing
		207. Backup Ring		

Figure 4-32. Rotator - Assembly Drawing

Disassembly

⚠ CAUTION

SECURE PRODUCT TO SLOTTED TABLE OR VISE.

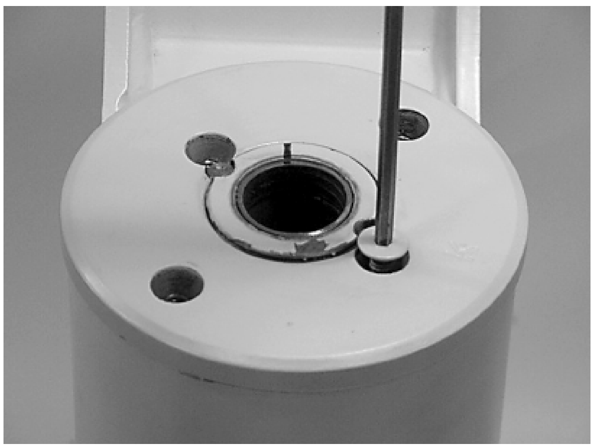
⚠ CAUTION

CONTENTS UNDER PRESSURE. WEAR APPROVED EYE PROTECTION. USE CAUTION WHEN REMOVING PORT PLUGS AND FITTINGS.

NOTICE

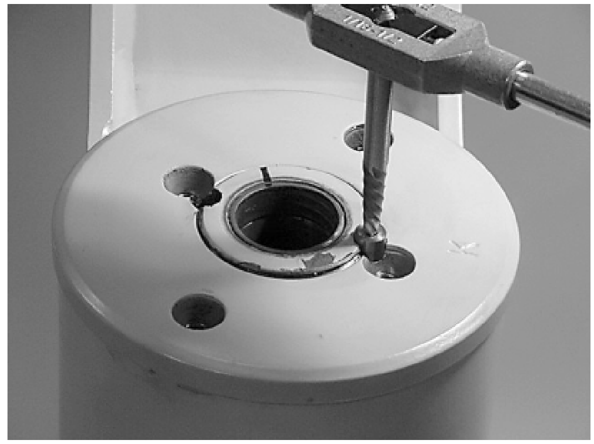
MAKE SURE WORK AREA IS CLEAN.

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

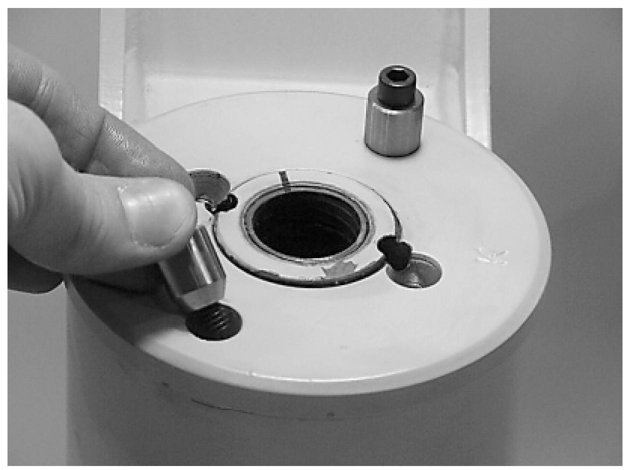


2. Using a 1/8 in. (3.18 mm) drill bit, drill a hole in the center of each lock pin to a depth of approximately 3/16 in. (4.76 mm).

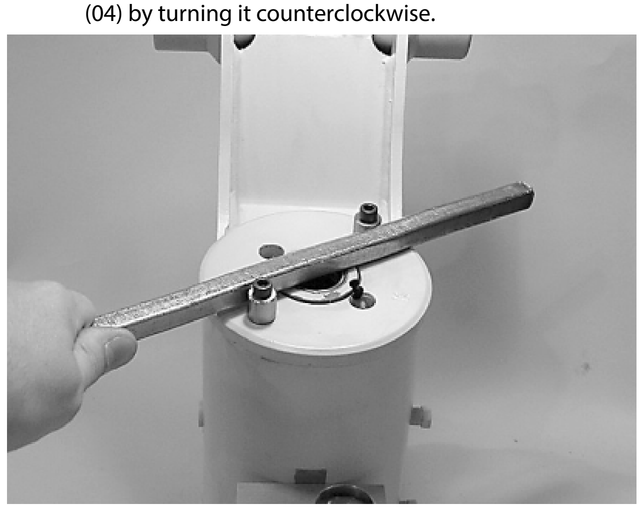
3. Remove the lock pins using an "Easy Out" (a size #2 is shown). If the pin will not come out with the" Easy Out", use 5/16 in. drill bit to a depth of 1/2 in. (12.7 mm) to drill out the entire pin.



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



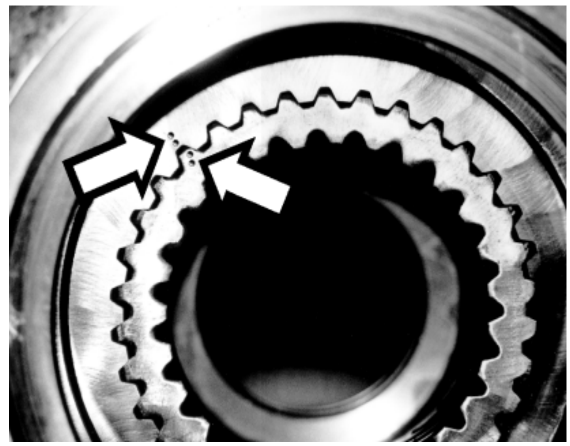
5. Using a metal bar, or similar tool, unscrew the end cap (04) by turning it counterclockwise.

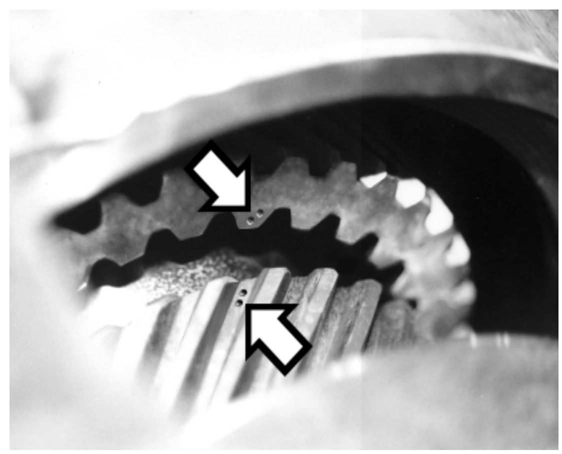


6. Remove the end cap (04) and set aside for later inspection.

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

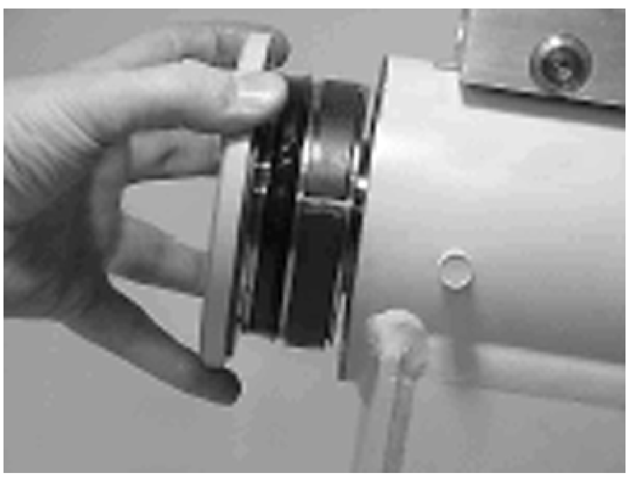
8. Some actuators have two sets of small punched timing marks that indicate timing between the gear sets. The location and appearance of the marks can vary slightly between models. One set indicates the timing between the piston sleeve (03) and the housing (01), the second set between the piston and the shaft (lower photo). To ensure correct rotation and accurate end positions, it is essential that the actuator be correctly timed when it is reassembled. If present, the punched timing marks can be used, but it is recommended to make timing marks with a marker before disassembly as outlined in steps 9 and 10 below .





9. Prior to removing the shaft, (02), use a felt marker to clearly indicate the timing marks between shaft and piston sleeve (03). This will greatly simplify timing during assembly.

10. Remove the shaft (02). It may be necessary to strike the threaded end of the shaft with a rubber mallet.



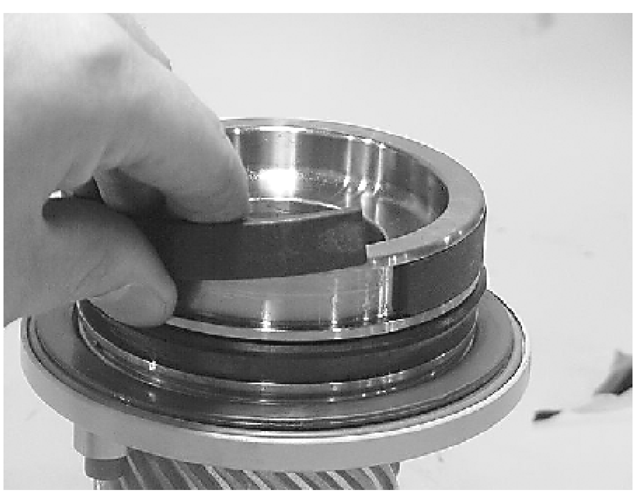
11. Before removing the piston (03), mark the housing (01) ring gear in relation to the piston O.D. gear. There should now be timing marks on the housing (01) ring gear, the piston (03) and the shaft (02).

12. To remove the piston (03) use a rubber mallet and a plastic mandrel so the piston is not damaged.

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

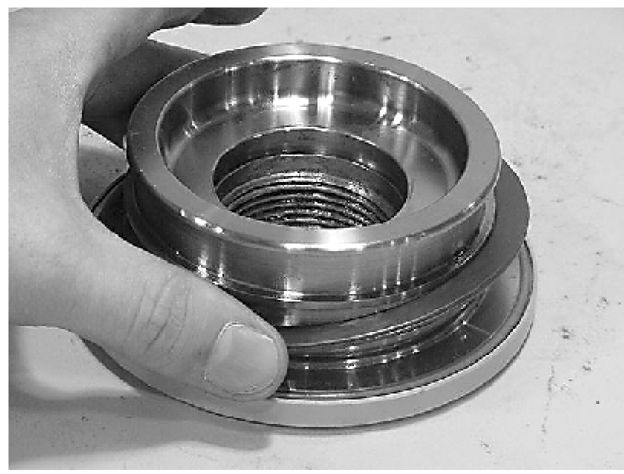
14. Remove the o-ring (204) and backup ring (207) from end cap (04) and set aside for inspection.

15. Remove the wear guides (302) from the end cap (04) and shaft (02).



16. Remove the main pressure seal (205).

17. Remove the thrust washers (304), from the end cap (04) and shaft (02).



18. Remove the wiper seal (304.1) from its groove in the end cap (04) and shaft (02).

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

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

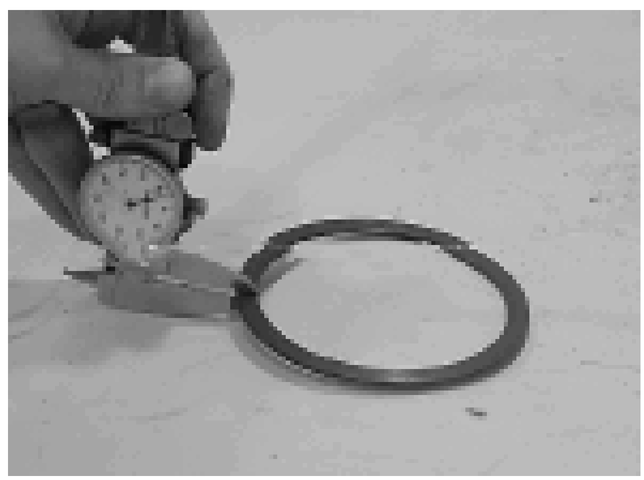
Inspection

NOTICE

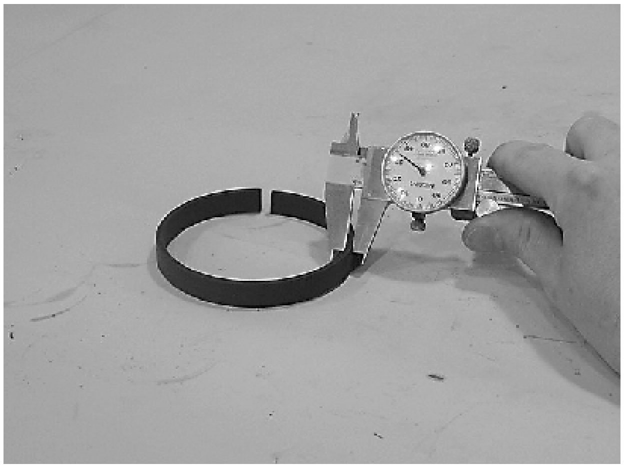
SMALL OR MINOR SURFACE SCRATCHES CAN BE CAREFULLY POLISHED.

1. Clean all parts in a solvent tank and dry with compressed air prior to inspecting. Carefully inspect all critical areas for any surface finish abnormalities: Seal grooves, bearing grooves, thrust surfaces, rod surface, housing bore and gear teeth.

2. Inspect the thrust washers (304) for rough or worn edges and surfaces. Measure it's thickness to make sure it is within specifications (Not less than 0.092 in. or 2.34 mm).

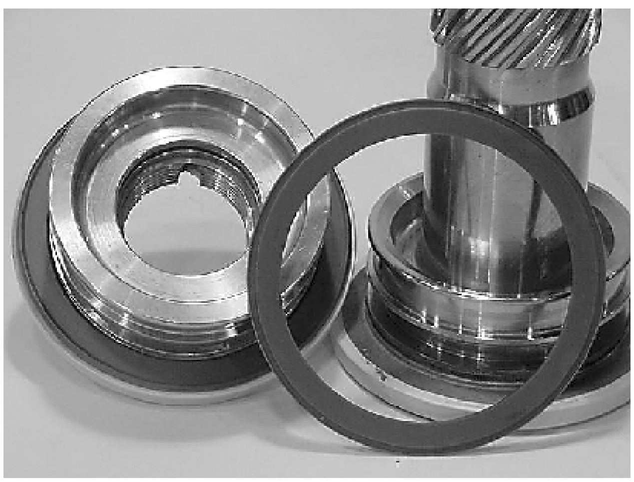


3. Inspect the wear guide condition and measure thickness (not less than 0.123 in. or 3.12 mm).

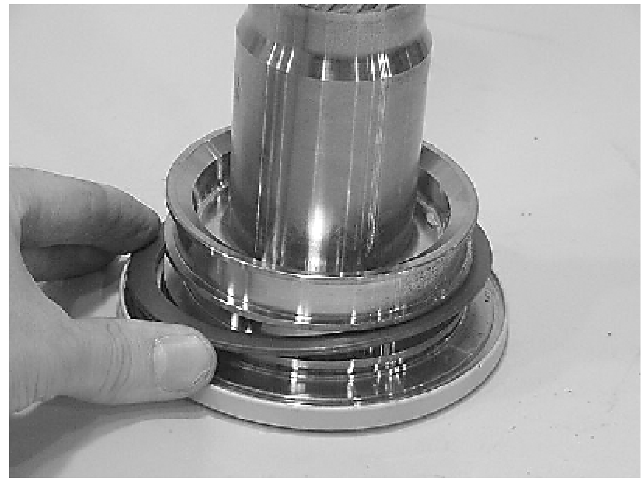


Assembly

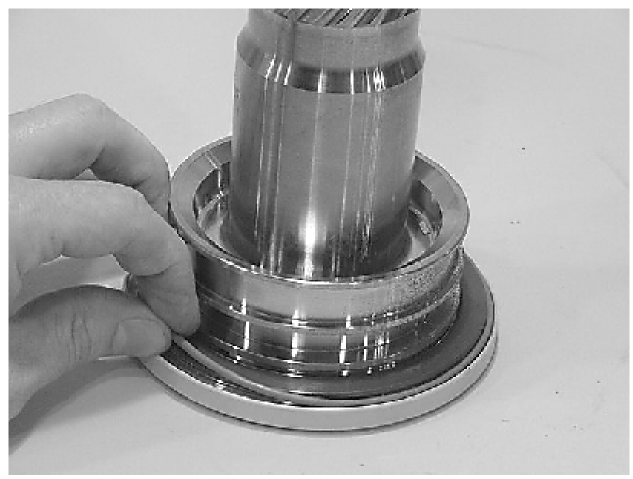
1. Gather all the components and tools into one location prior to re-assembly. Use the cut away drawing to reference the seal orientations.



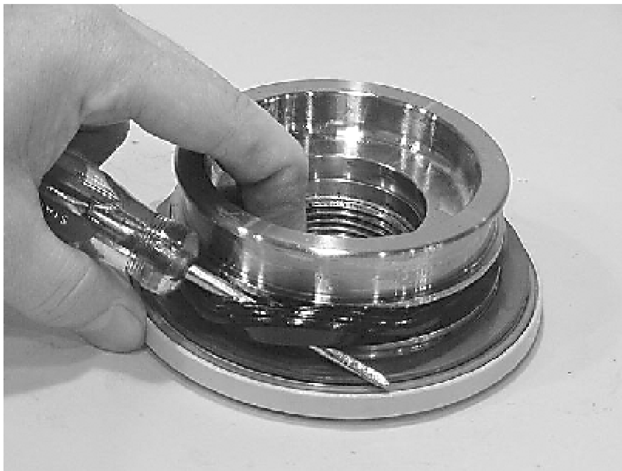
2. Install the thrust washer (304) onto shaft (02) and end cap (04).



3. Install the exclusion seal (206) into the groove on the shaft (02) and end cap (04) around the outside edge of the thrust washer (304).



4. Using a seal tool install the main pressure seal (205) onto shaft (02) and end cap (04). Use the seal tool in a circular motion.



5. Install the wear guide (302) on the end cap (04) and shaft (02).

6. Install the O-ring (204) and backup ring (207) into the inner seal groove on the end cap (04).

7. Install the inner T-seal (200) into the piston (03) using a circular motion.

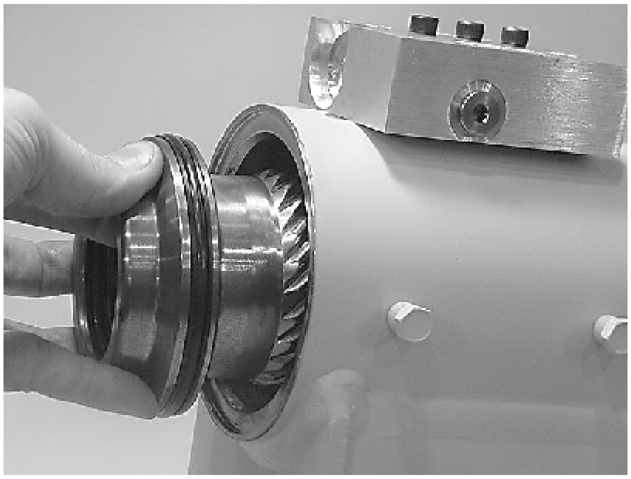
   Install the outer T-seal (202) by stretching it around the groove in a circular motion.

   Each T-seal has 2 backup rings (see drawing for orientation).

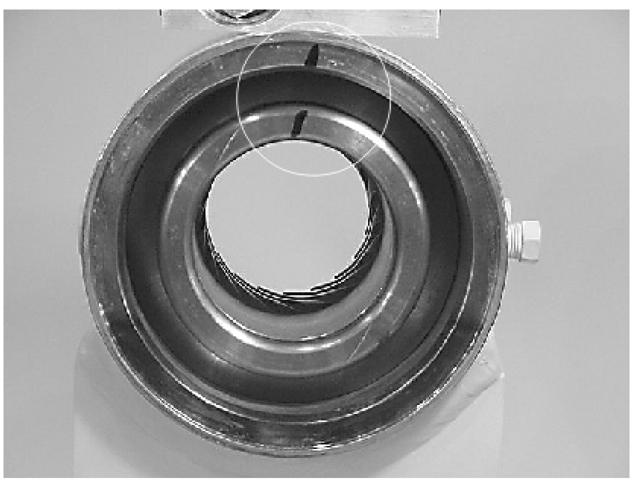
8. Beginning with the inner seal (200) insert one end of backup ring in the lower groove and feed the rest in using a circular motion. Make sure the wedged ends overlap correctly.

   Repeat this step for the outer seal (202).

9. Insert the piston (03) into the housing (01) as shown, until the outer piston seal (202) is touching inside the housing bore.

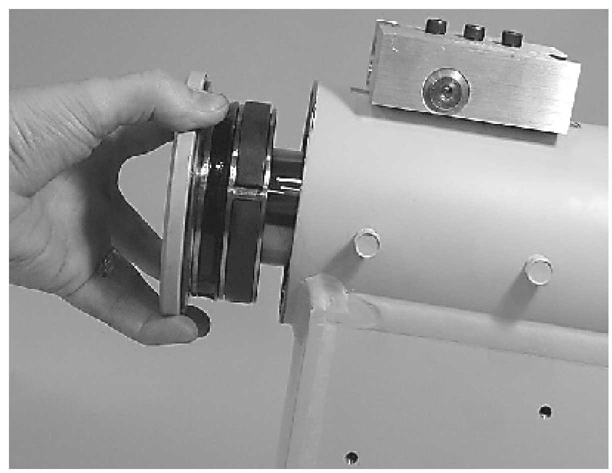


10. Looking from the angle shown, rotate the piston (03) until the marks you put on the piston and the housing (01) during disassembly line up as shown. Using a rubber mallet, tap the piston into the housing up to the point where the gear teeth meet.

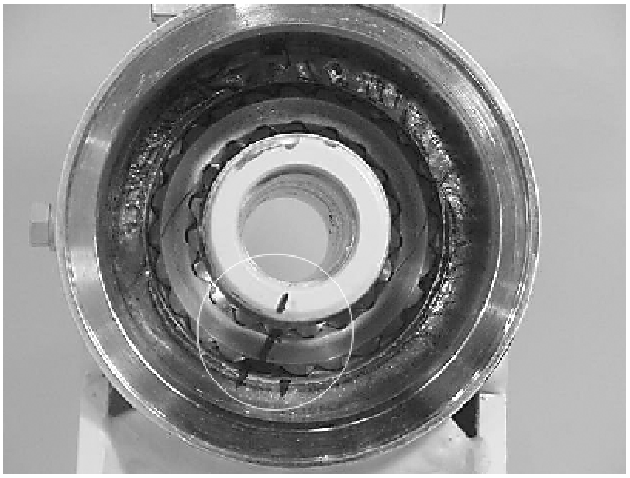


11. Looking from the opposite end of the housing (01) you can see if your timing marks are lining up. When they do, tap the piston (03) in until the gear teeth mesh together. Tap the piston into the housing the rest of the way until it bottoms out.

12. Install the shaft (02) into the piston (03). Be careful not to damage the seals. Do not engage the piston gear teeth yet.



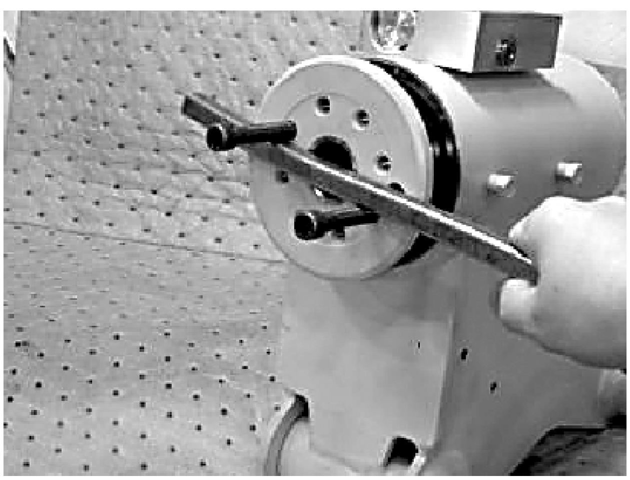
13. Looking from the view shown, use the existing timing marks to line up the gear teeth on the shaft (02) with the gear teeth on the inside of the piston (03). Now tap the flange end of the shaft with a rubber mallet until the gear teeth engage.



14. 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.

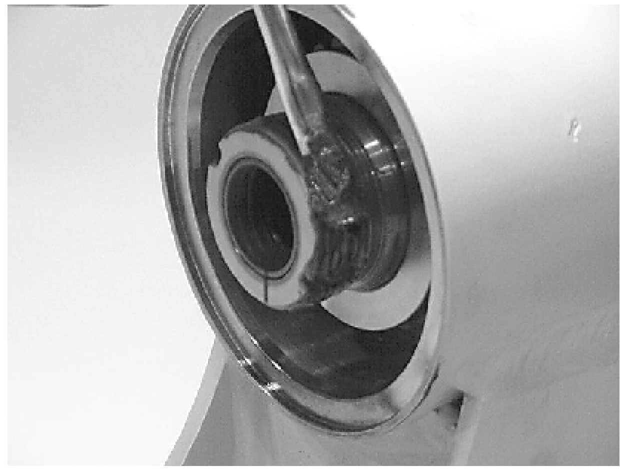
NOTICE

AS THE SHAFT IS ROTATED, BE CAREFUL NOT TO DISENGAGE THE PISTON AND HOUSE GEARING.

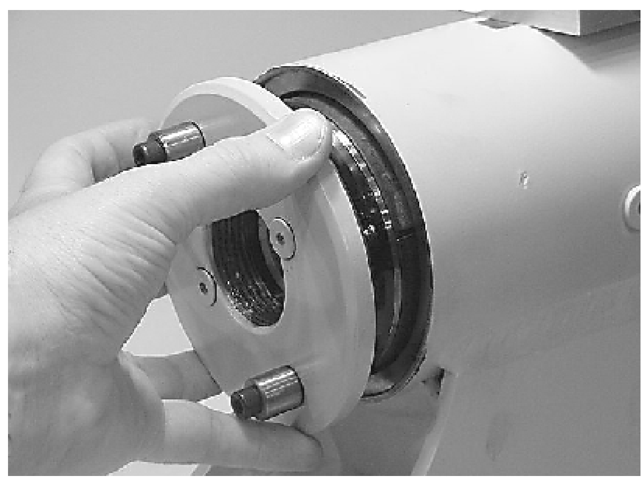


15. Install the stop tube onto the shaft end, if equipped. Stop tube is an available option to limit the rotation of an actuator.

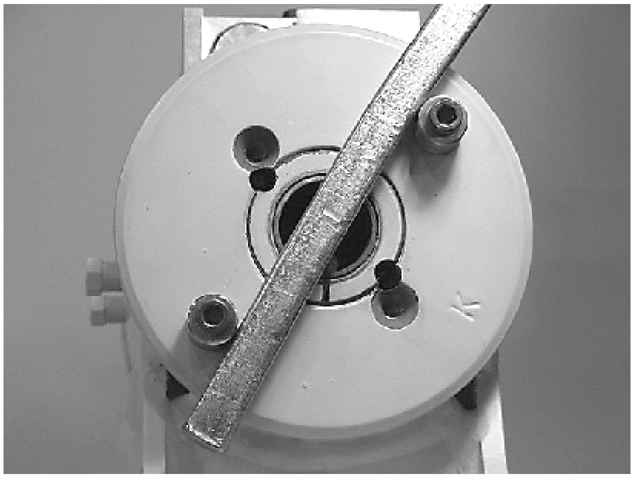
16. Coat the threads on the end of the shaft with anti-seize grease to prevent galling.



17. Thread the end cap (04) onto the shaft (02) end. Make sure the wear guide remains in place on the end cap as it is threaded into the housing (01).

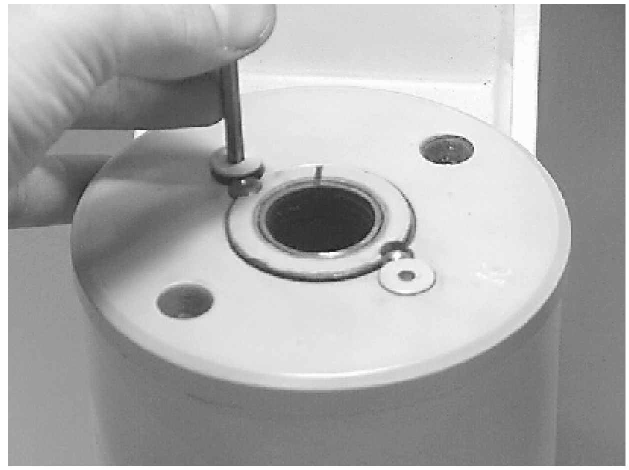


18. Tighten the end cap (04). In most cases the original holes for the lock pins will line up.



19. Place the lock pins (109) provided in the Helac seal kit in the holes with the dimple side up. Then, using a punch, tap the lock pins to the bottom of the hole.

20. Insert the set screws (113) over the lock pins. Tighten them to 25 in. lbs. (2.825 Nm).



Installing Counterbalance Valve

Refer to Figure 4-33., Rotator Counterbalance Valve.

1. Make sure the surface of the actuator is clean, free of any contamination and foreign debris including old Medium Strength Threadlocking Compound.
2. Make sure the new valve has the o-rings in the counter-bores 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.

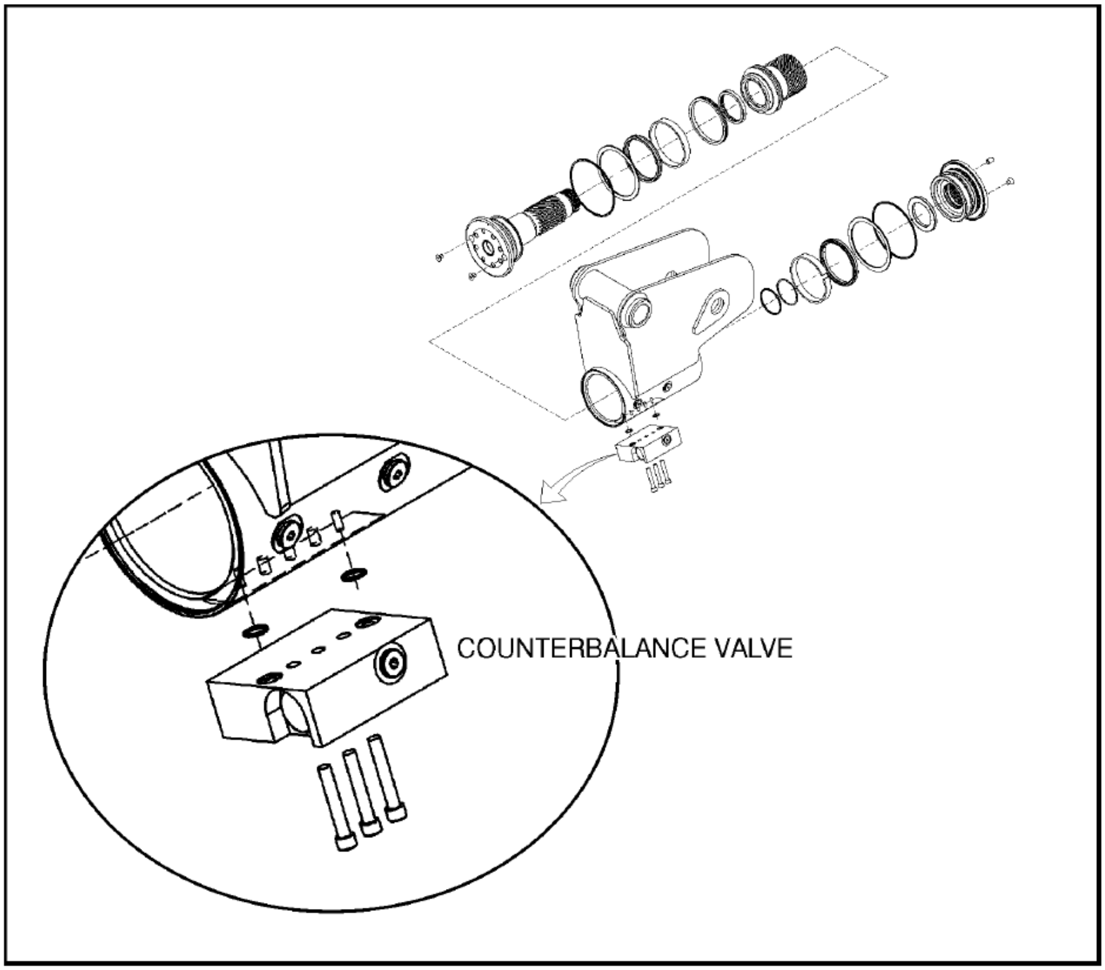


Figure 4-33. Rotator Counterbalance Valve

Greasing Thrust Washers

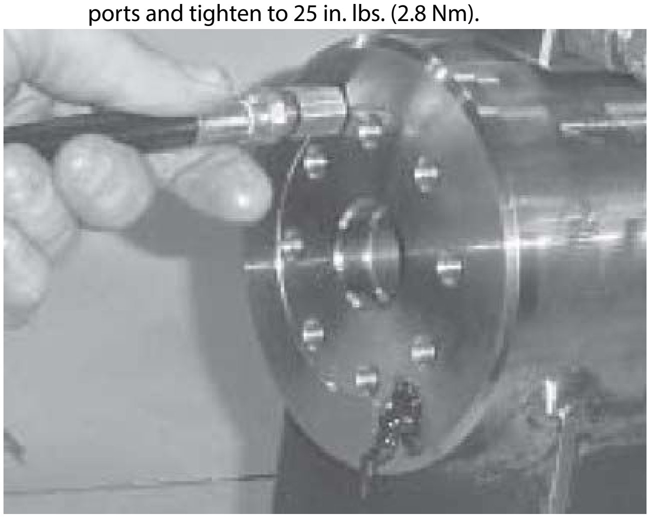
1. After the actuator is assembled but before it is put into service, the thrust washer area must be packed with Lithium grease.

2. There are two grease ports located on both the shaft flange and the end cap. They are plugged with capscrews (113) or set screws. Remove the grease port screws from the shaft flange and end cap. (See exploded view)

NOTICE

IF A HYDRAULIC TEST BENCH IS NOT AVAILABLE, THE ACTUATOR CAN BE ROTATED BY HAND, OPEN THE PRESSURE PORTS AND USE A PRY BAR WITH CAPSCREWS INSERTED INTO THE SHAFT FLANGE TO TURN THE SHAFT IN THE DESIRED DIRECTION.

3. Insert the tip of a grease gun into one port and apply grease to the shaft flange. Continue applying until grease flows from the opposite port. Cycle the actuator five times and apply grease again. Repeat this process on the end cap. Insert the capscrews into the grease ports and tighten to 25 in. lbs. (2.8 Nm).



Testing the Actuator

If the equipment is available, the actuator should be tested on a hydraulic test bench. The breakaway pressure — the pressure at which the shaft begins to rotate — should be approximately 500 psi (34 bar). Cycle the actuator at least 25 times at 3000 psi (207 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 (207 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.

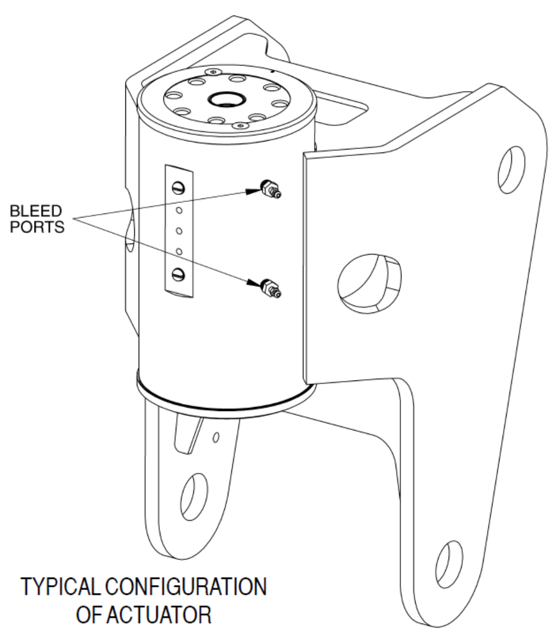
Installation and Bleeding

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 in. inside diameter x 5/16 in. outside diameter x 5 foot clear, vinyl drain tube to each of the two bleed nipples. Secure them with hose clamps. Place the vinyl tubes in a clean 5-gallon container to collect the purged oil. The oil can be returned to the reservoir after this procedure is completed.



TYPICAL CONFIGURATION
OF ACTUATOR

2. With an operator in the platform, open both bleed nipples 1/4 turn. Hydraulically rotate the platform to the end of rotation (either clockwise or counterclockwise), and maintain hydraulic pressure. Oil with small air bubbles will be seen flowing through the tubes. Allow a 1/2 gallon of fluid to be purged from the actuator.

3. Keep the fittings open and rotate the platform in the opposite direction to the end position. Maintain hydraulic pressure until an additional 1/4 gallon of fluid is pumped into the container.

4. Repeat steps 2 & 3. After the last 1/2 gallon is purged, close both bleed nipples before rotating away from the end position.

4.22 FOOT SWITCH ADJUSTMENT

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

Table 4-1. Troubleshooting

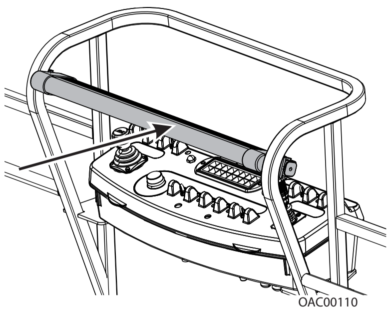
Problem	Cause	Solution
1. Shaft rotates slowly or not at all	a. Insufficient torque output	a. Verify correct operating pressure. Do not exceed OEM's pressure specifications. Load may be above maximum capacity of the actuator.
	b. Low rate of fluid flow	b. Inspect ports for obstructions and hydraulic 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 section Testing on page 79 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 on page 80 of this manual.
3. Shaft will not fully rotate	a. Twisted or chipped gear teeth	a. Check for gear binding. Actuator may not be able to be re-built and may need to be replaced. Damage could be a result of overload or shock.
	b. Port fittings are obstructing the piston	b. Check thread length of port fittings. Fittings should during stroke not reach inside the housing bore.
4. Selected position cannot be maintained	a. Control or counterbalance valve has internal leak	a. Disconnect hydraulic lines and bypass valve. Leave valve ports open and operate the actuator through housing ports (do not exceed OEM's operating pressure). The valve must be replaced if a steady flow of fluid is seen coming from the valve ports.
	b. Piston and/or shaft seal leak	b. Remove the plug and the housing's valve ports. Operate the actuator through the housing ports. Conduct the internal leakage test as described in the section Testing on page 79 of this manual.
	c. Air in actuator	c. Purge air from actuator. See bleeding procedures on page 80 of this manual

4.23 SKYGUARD®

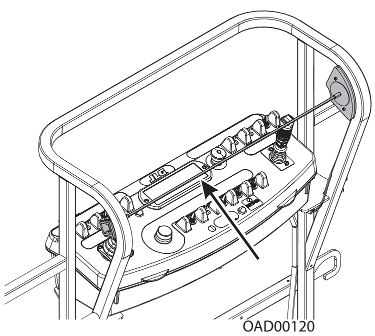
Operation

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.

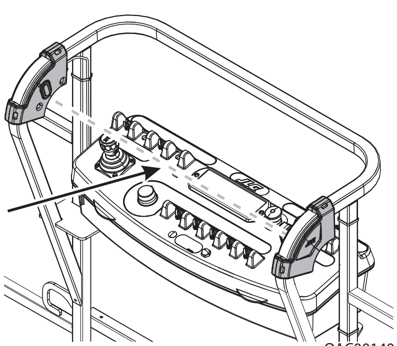
Consult the following illustrations to determine which type of SkyGuard the machine is equipped with. Regardless of the type, SkyGuard function according to the SkyGuard Function Table does not change.



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 6-13 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	Tower Lift Up	Tower Tele Out	Tower Lift Down	Boom Tele In	Boom Lift Up	Boom Lift Down	Boom Tele In	Boom Tele Out	Jib Lift	Basket Level	Basket Rotate
R*/C**	R	C	R	R	C	C	C	R	R	R	C	C	C	C
R = Indicates Reversal is Activated														
C = Indicates Cutout is Activated														
* 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 cutout instead of reversing.														

4.24 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.

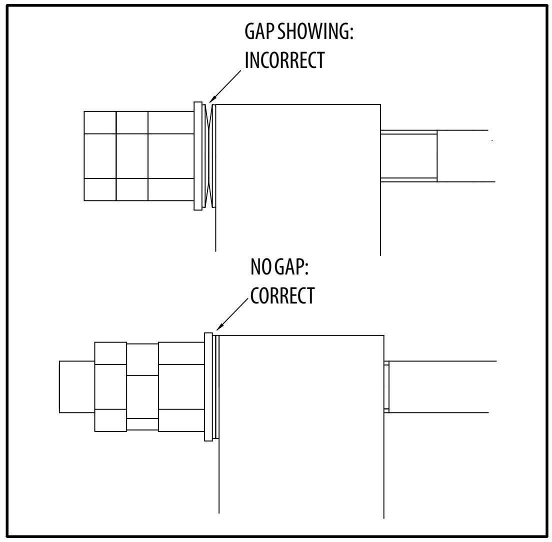
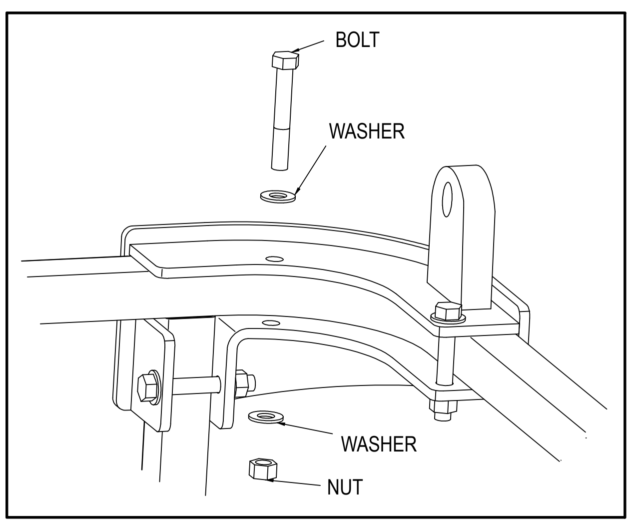


Figure 4-34. Bolt-On External Fall Arrest Cable Tension

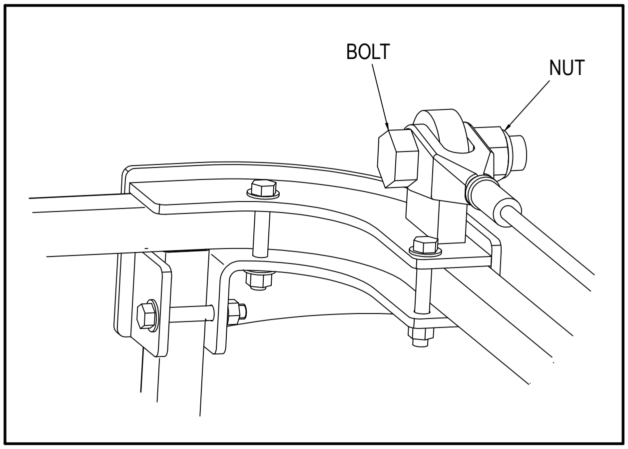
- Fittings & Brackets: Ensure all fittings are tight and there are no signs of fractures. Inspect brackets for any damage.
- Attachment Ring: No cracks or signs of wear are acceptable. Any signs of corrosion requires replacement.
- Attaching Hardware: Inspect all attaching hardware to ensure there are 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.

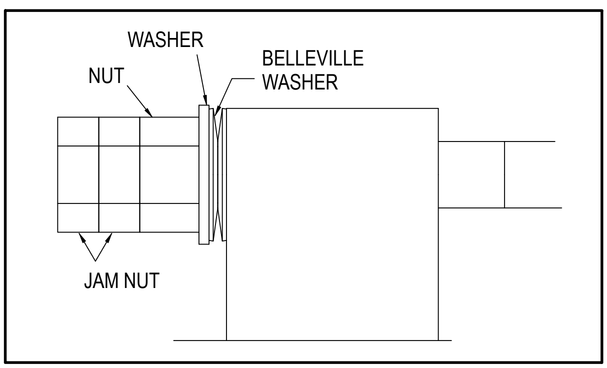


2. Attach the fall arrest cable to the right hand bracket Using the attaching bolt and nut. Orient the bolt as shown below. Do not tighten the nut so cable can still rotate.

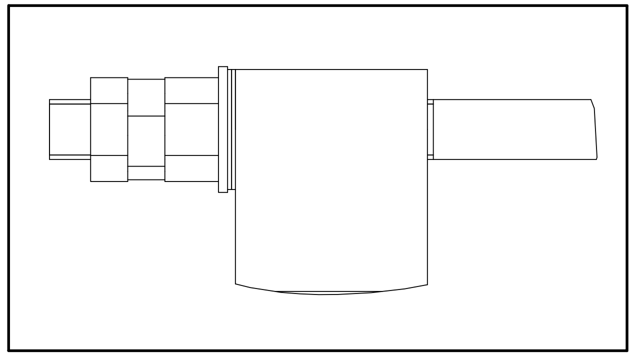


3. Install the Attachment Ring onto the cable.

4. Without twisting the fall arrest cable, pull it thru the left hand bracket and mark the top of the swaged cable end. Install the fall arrest cable through the left hand bracket and secure it using the belleville washers, washer, retaining nut, and jam nuts. Orient the hardware as shown below and with the belleville washers so the gap is present at the outside diameter of the washers. install the nuts onto the cable finger tight so the mark on the cable does not move.



5. Use the two jam nuts to prevent the cable from rotating while the nut is tightened. Tighten the nut until the belleville washers are fully compressed and no gap is present at the outside diameter of the washers. Ensure the cable has not rotated during tightening.



6. Tighten the first jam nut against the retaining nut to keep the nut from loosening. Tighten the remaining jam nut against the first jam nut.

7. Torque the nuts and bolts securing the brackets to 15 ft.lbs. (20 Nm).

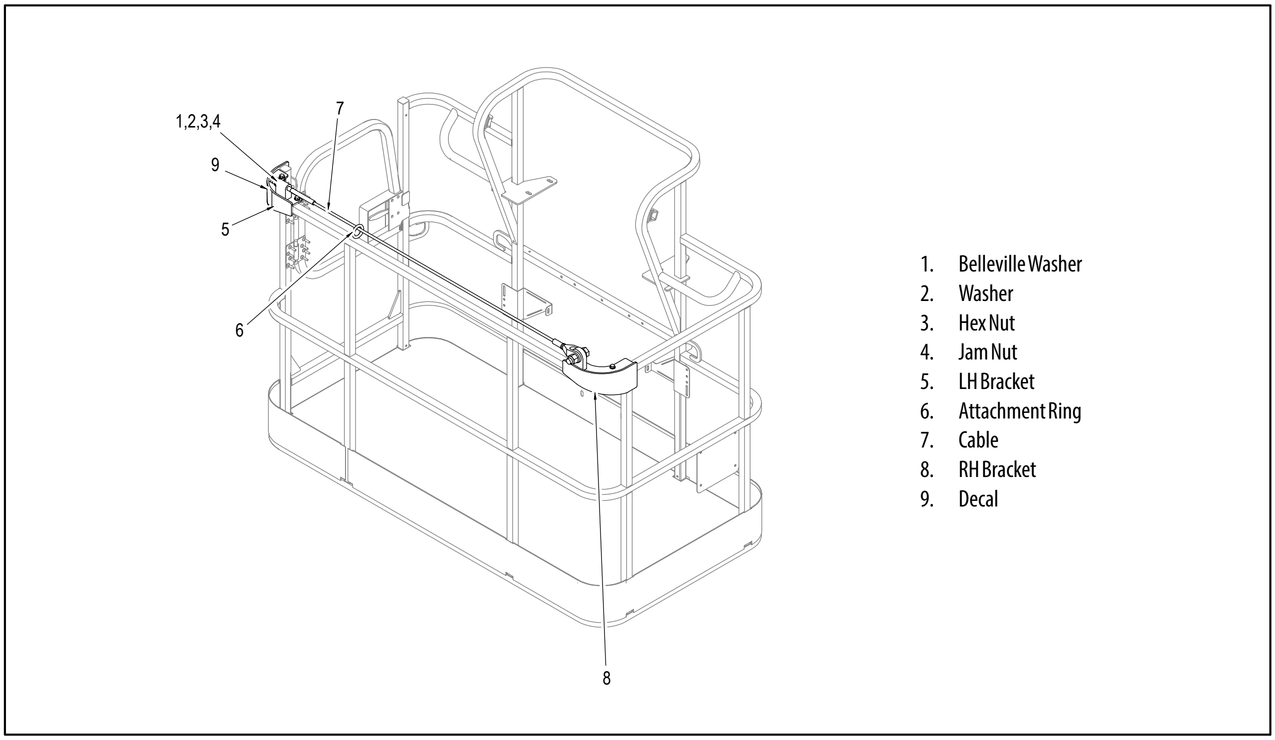


Figure 4-35. Bolt-On External Fall Arrest System

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

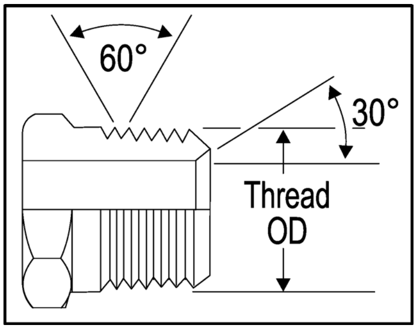


Figure 5-1. NPTF Thread

BSPT = British standard pipe tapered per ISO7-1

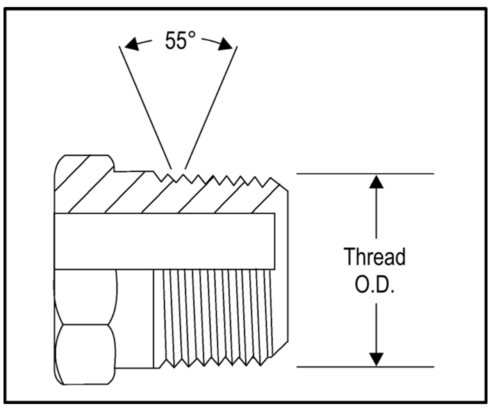


Figure 5-2. BSPT Thread

Straight Thread Types, Tube and Hose Connections

JIC = 37° flare per SAE J514

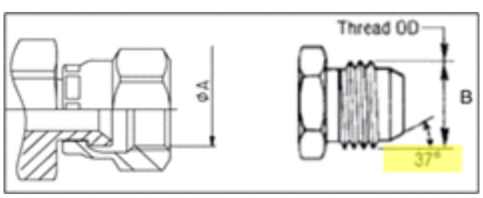


Figure 5-3. JIC Thread

SAE = 45° flare per SAE J512

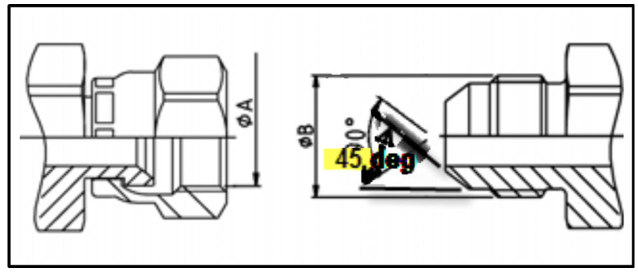


Figure 5-4. SAE Thread

ORFS = o-ring face seal per SAE J1453

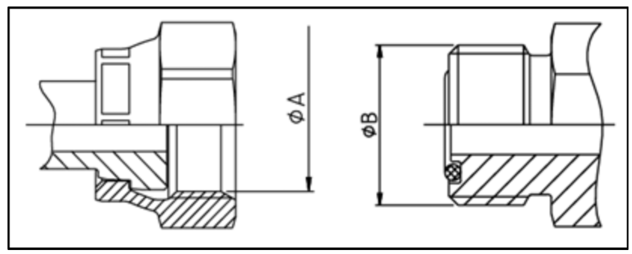


Figure 5-5. ORFS Thread

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

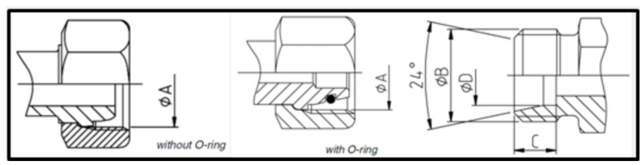


Figure 5-6. MTBL-MBTS Thread

BH = bulkhead connection – JIC, ORFS, MBTL, or MBTS types

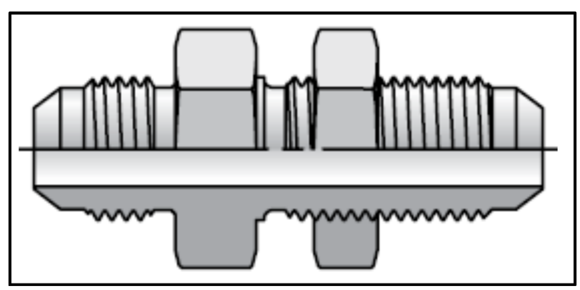


Figure 5-7. Bulkhead Thread

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

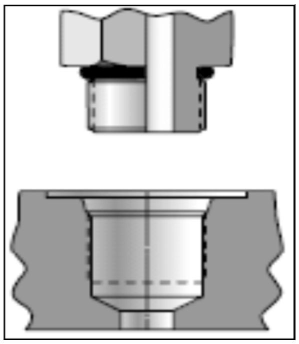


Figure 5-8. ORB-MPP Thread

MFF = metric flat face port per ISO 9974-1

BSPP = British standard parallel pipe per ISO 1179-1, DIN 3852-2

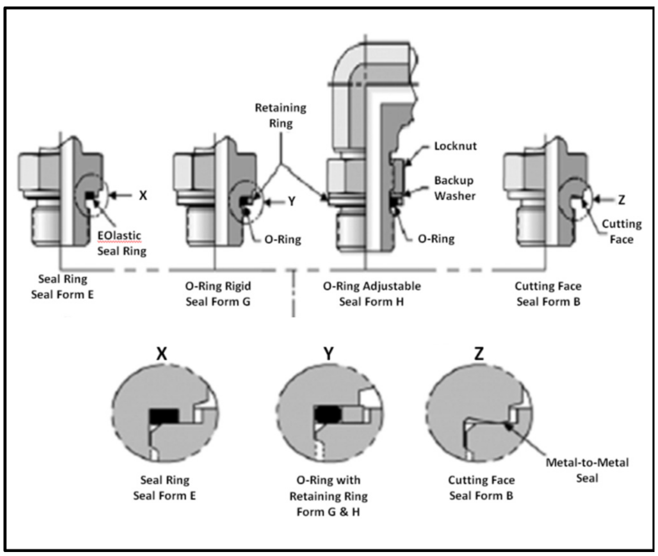


Figure 5-9. MFF-BSPP Thread

Flange Connection Types

FL61 = code 61 flange per SAE J518, ISO 6162

FL62 = code 62 flange per SAE J518, ISO 6162

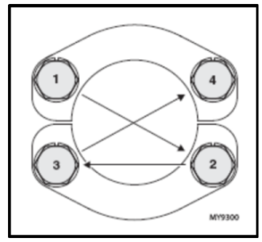


Figure 5-10. ORB-MPP Thread

Tightening Methods

Torque = Application of a twisting force to the applicable connection by use of a precise measurement instrument (i.e. torque wrench).

Finger Tight = The point where the connector will no longer thread onto the mating part when tightened by hand or fingers. Finger Tight is relative to user strength and will have some variance. The average torque applied by this method is 3 ft-lbs [4 N-m] Also referred to as 'Hand Tight.'

TFFT = Turns From Finger Tight; Application of a preload to a connection by first tightening the connection by hand (fingers) and applying an additional rotation counted by a defined number of turns by use of a tool.

FFWR = Flats from Wrench Resistance; Application of a preload to a connection by tightening to the point of initial wrench resistance and turning the nut a described number of 'flats'. A 'flat' is one side of the hexagonal tube nut and equates to 1/6 of a turn. Also referred to as the 'Flats Method.'

Assembly and Torque Specifications

Prior to selecting the appropriate torque from the tables within this section, it is necessary to properly identify the connector being installed. Refer to the Figures and Tables in this section.

GENERAL TUBE TYPE FITTING ASSEMBLY INSTRUCTIONS

1. Take precautions to ensure that fittings and mating components are not damaged during storage, handling or assembly. Nicks and scratches in sealing surfaces can create a path for leaks which could lead to component contamination and/or failure.
2. When making a connection to tubing, compression or flare, inspect the tube in the area of the fitting attachment to ensure that the tube has not been damaged.
3. The assembly process is one of the leading causes for contamination in air and hydraulic systems. Contamination can prevent proper tightening of fittings and adapters from occurring.
   a. Avoid using dirty or oily rags when handling fittings.
   b. If fittings are disassembled, they should be cleaned and inspected for damage. Replace fittings as necessary before re-installing.
   c. Sealing compounds should be applied where specified; however, care should be taken not to introduce sealant into the system.
   d. Avoid applying sealant to the area of the threads where the sealant will be forced into the system. This is generally the first two threads of a fitting.
   e. Sealant should only be applied to the male threads.
   f. Straight thread fittings do not require sealants. O-rings or washers are provided for sealing.
   g. When replacing or installing an O-ring, care is to be taken while transferring the O-ring over the threads as it may become nicked or torn. When replacing an O-ring on a fitting, the use of a thread protector is recommended.
   h. When installing fittings with O-rings, lubrication shall be used to prevent scuffing or tearing of the O-ring. See O-ring Installation (Replacement) in this section.
4. Take care to identify the material of parts to apply the correct torque values.
   a. Verify the material designation in the table headings.
   b. If specifications are given only for steel fittings and components, the values for alternate materials shall be as follows: Aluminum and Brass- reduce steel values by 35%; Stainless Steel- Use the main limit for steel.
5. To achieve the specified torque, the torque wrench is to be held perpendicular to the axis of rotation.

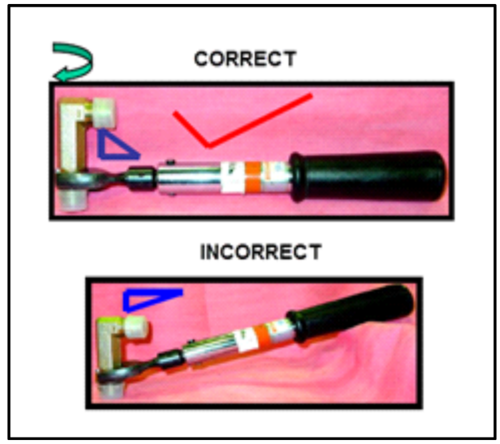


Figure 5-11. Torque Wrench Angle

6. Refer to the appropriate section in this manual for more specific instructions and procedures for each type of fitting connection

Assembly Instructions for American Standard Pipe Thread Tapered (NPTF) Connections.

1. Inspect components to ensure male and female port threads are free of rust, splits, dirt, foreign matter, or burrs.
2. Apply a suitable thread sealant, such as High Temperature High Thread Sealant with PTFE to the male pipe threads if not already applied. Ensure the first 1 to 2 threads are uncovered to prevent system contamination.
3. Assemble connection hand tight.
4. Mark fittings, male and female.

CAUTION

OVER TIGHTENING MAY CAUSE DEFORMATION OF THE PIPE FITTING AND DAMAGE TO THE JOINING FITTING, FLANGE OR COMPONENT MAY OCCUR.

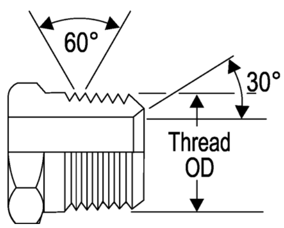
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

5. Rotate male fitting the number of turns per Table 5-1, NPTF Pipe Thread. See FFWR and TFFT Methods for TFFT procedure requirements.

NOTE: *TFFT values provided in Table 5-1, NPTF Pipe Thread are applicable for the following material configurations:*

- STEEL fittings with STEEL mating components
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-1. NPTF Pipe Thread



ØA dimension is measured on the 4th pitch of the thread

TYPE/FITTING IDENTIFICATION					Turns From Finger Tight (TFFT)**
Material	Dash Size	Thread Size	ØA*		
		(UNF)	(in)	(mm)	
STEEL, ALUMINUM, OR BRASS FITTINGS WITH STEEL, ALUMINUM, OR BRASS MATING C OMPONENTS	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 High Temperature High Thread Sealant with PTFE, 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.

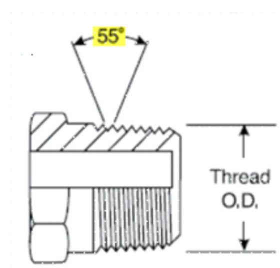
NEVER BACK OFF (LOOSEN) PIPE THREADED CONNECTORS TO ACHIEVE ALIGNMENT. MEET THE MINIMUM REQUIRED TURNS AND USE THE LAST TURN FOR ALIGNMENT.

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 FFWR and TFFT Methods for TFFT procedure requirements.

Assembly Instructions for 37° (JIC) Flare Fittings

1. Inspect the flare for obvious visual square ness and concentricity issues with the tube OD. Ensure surface is smooth, free of rust, weld and brazing splatter, splits, dirt, foreign matter, or burrs. If necessary replace fitting or adapter.

⚠ CAUTION

DO NOT FORCE A MISALIGNED OR SHORT HOSE/TUBE INTO ALIGNMENT. IT PUTS UNDESIRABLE STRAIN ONTO THE JOINT EVENTUALLY LEADING TO LEAKAGE.

2. Align tube to fitting and start threads by hand.

⚠ CAUTION

THE TORQUE METHOD SHOULD NOT BE USED ON LUBRICATED OR OILY FITTINGS. NO LUBRICATION OR SEALANT IS REQUIRED. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

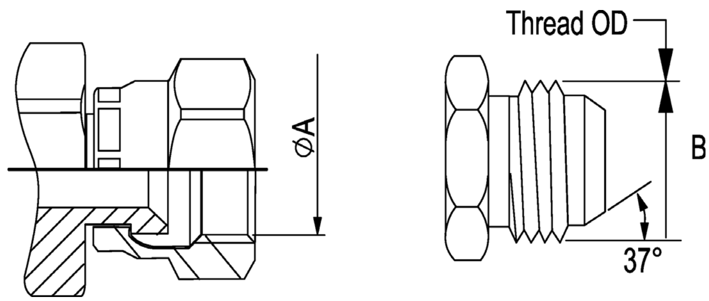
3. Torque assembly to value listed in Table Table 5-3, 37° Flare (JIC) Thread - Steel or Table 5-4, 37° Flare (JIC) Thread - Aluminum/Brass while using the Double Wrench Method per Double Wrench Method. Refer to FFWR and TFFT Methods for procedure requirements if using the FFWR method.

NOTE: *Torque values provided in Table Table 5-3, 37° Flare (JIC) Thread - Steel and Table 5-4, 37° Flare (JIC) Thread - Aluminum/Brass are segregated based on the material configuration of the connection.*

ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

Table 5-3. 37° Flare (JIC) Thread - Steel

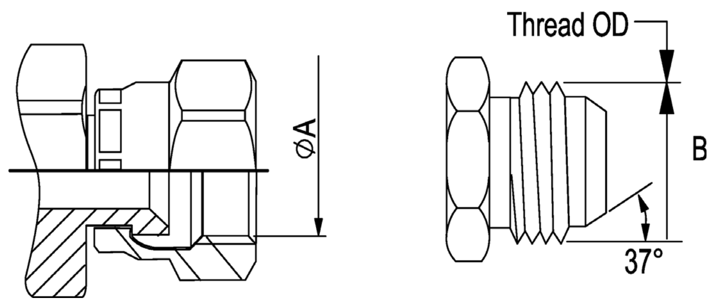


Type/Fitting Identification							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	6	7	7	8	9	10	--
	3	3/8-24	0.34	8.60	0.37	9.50	8	9	10	11	12	14	--
	4	7/16-20	0.39	10.00	0.44	11.10	13	14	14	18	19	19	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	14	15	15	19	20	21	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	22	23	24	30	31	33	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	42	44	46	57	60	63	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	60	63	66	81	85	89	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	84	88	92	114	120	125	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	100	105	110	136	142	149	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	118	124	130	160	168	176	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	168	176	185	228	239	251	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	195	205	215	264	278	291	3/4 to 1
	32	2 1/2-12	2.42	61.50	2.50	63.50	265	278	292	359	377	395	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

Table 5-4. 37° Flare (JIC) Thread - Aluminum/Brass



TYPE/FITTING IDENTIFICATION							Torque						Flats from Wrench Resistance (F.F.W.R)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.28	7.00	0.31	7.75	4	4	5	5	6	7	--
	3	3/8-24	0.34	8.60	0.37	9.50	5	6	7	7	8	9	--
	4	7/16-20	0.39	10.00	0.44	11.10	8	9	9	11	12	13	1-1/2 to 1-3/4
	5	1/2-20	0.46	11.60	0.50	12.70	9	10	10	12	13	14	1 to 1-1/2
	6	9/16-18	0.51	13.00	0.56	14.30	14	15	16	19	20	21	1 to 1-1/2
	8	3/4-16	0.69	17.60	0.75	19.10	27	29	30	37	39	41	1-1/2 to 1-3/4
	10	7/8-14	0.81	20.50	0.87	22.20	39	41	43	53	56	58	1 to 1-1/2
	12	1 1/16-12	0.97	24.60	1.06	27.00	55	57	60	74	78	81	1 to 1-1/2
	14	1 3/16-12	1.11	28.30	1.19	30.10	65	68	72	88	93	97	1 to 1-1/2
	16	1 5/16-12	1.23	31.30	1.31	33.30	77	81	84	104	109	114	3/4 to 1
	20	1 5/8-12	1.54	39.20	1.63	41.30	109	115	120	148	155	163	3/4 to 1
	24	1 7/8-12	1.80	45.60	1.87	47.60	127	133	139	172	180	189	3/4 to 1
	32	2 1/2-12	2.42	61.50	2.50	63.50	172	181	189	234	245	257	3/4 to 1

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

Assembly Instructions for 45° SAE Flare Fittings

1. Inspect the flare for obvious visual square ness 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.

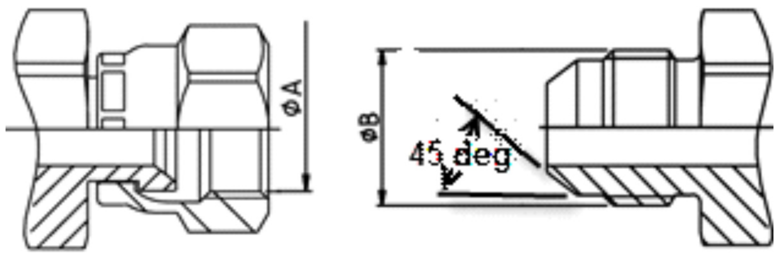
NOTE: *Torque values provided in Table 5-5, 45° Flare (SAE) - Steel and Table 5-6, 45° Flare (SAE) - Aluminum/Brass are segregated based on the material configuration of the connection.*

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

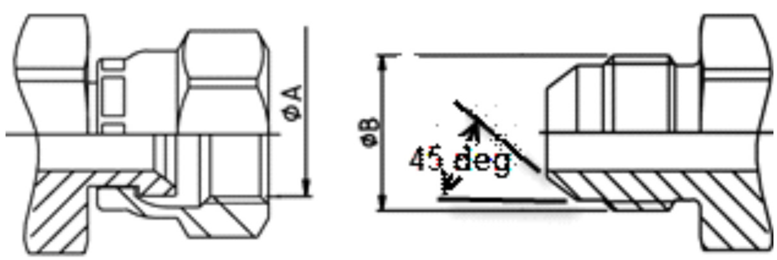


TYPE/FITTING IDENTIFICATION							Torque						Turns From Finger Tight (TFFT)**
MATERIAL	Dash Size	Thread Size	ØA*		ØB*		[Ft-Lb]			[N-m]			
		(UNF)	(in)	(mm)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max	
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	4	7/16-20	0.39	9.90	0.44	11.10	13	14	14	18	19	19	1/4 to 1/2
	6	5/8-18	0.56	14.30	0.63	15.90	22	23	24	30	31	33	1/4 to 1/2
	8	3/4-16	0.69	17.50	0.75	19.10	42	44	46	57	60	62	1/4 to 1/2
	10	7/8-14	0.81	20.60	0.87	22.20	60	63	66	81	85	89	1/4 to 1/2
	12	1 1/16-14	0.98	25.00	1.06	27.00	84	88	92	114	119	125	1/4 to 1/2

* 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						Turns From Finger Tight (TFFT)**
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	1/4 to 1/2
	6	5/8-18	0.56	14.30	0.63	15.90	14	15	15	19	20	20	1/4 to 1/2
	8	3/4-16	0.69	17.50	0.75	19.10	27	29	30	37	39	41	1/4 to 1/2
	10	7/8-14	0.81	20.60	0.87	22.20	39	41	43	53	56	58	1/4 to 1/2
	12	1 1/16-14	0.98	25.00	1.06	27.00	55	58	61	75	79	83	1/4 to 1/2

* 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.

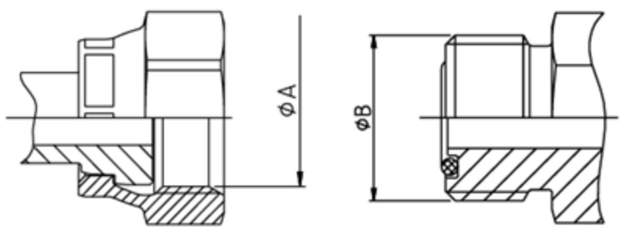
NOTE: *Torque values provided in Table 5-7, O-ring Face Seal (ORFS) - Steel and Table 5-8, O-ring Face Seal (ORFS) - Aluminum/Brass are segregated based on the material configuration of the connection.*

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

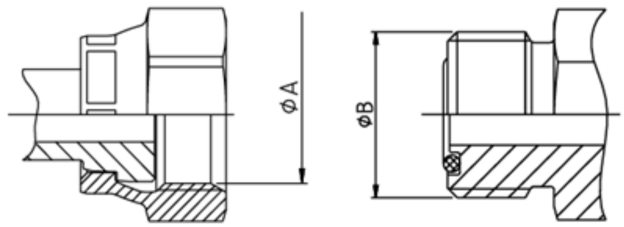


MATERIAL	Dash Size	Thread Size (UNF)	ØA* (in)	ØA* (mm)	ØB* (in)	ØB* (mm)	Torque [Ft-Lb] Min	Torque [Ft-Lb] Nom	Torque [Ft-Lb] Max	Torque [N-m] Min	Torque [N-m] Nom	Torque [N-m] Max	Flats from Wrench Resistance (F.F.W.R)** Tube Nuts	Flats from Wrench Resistance (F.F.W.R)** Swivel & Hose Ends
STEEL FITTINGS 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	1 3/16-12	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	1 7/16-12	1.34	34.15	1.44	36.50	110	116	121	149	157	164	1/4 to 1/2	1/2 to 3/4
	20	1 11/16-12	1.59	40.50	1.69	42.90	150	158	165	203	214	224	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	230	242	253	312	328	343	1/4 to 1/2	1/2 to 3/4
	32	2 1/2-12	2.43	61.67	2.50	63.50	375	394	413	508	534	560	1/4 to 1/2	1/2 to 3/4

* ØA and ØB thread dimensions for reference only.

** See FFWR and TFFT 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	1 11/16-12	1.59	40.50	1.69	42.90	98	103	108	133	140	146	1/4 to 1/2	1/2 to 3/4
	24	2-12	1.92	48.80	2.00	50.80	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.

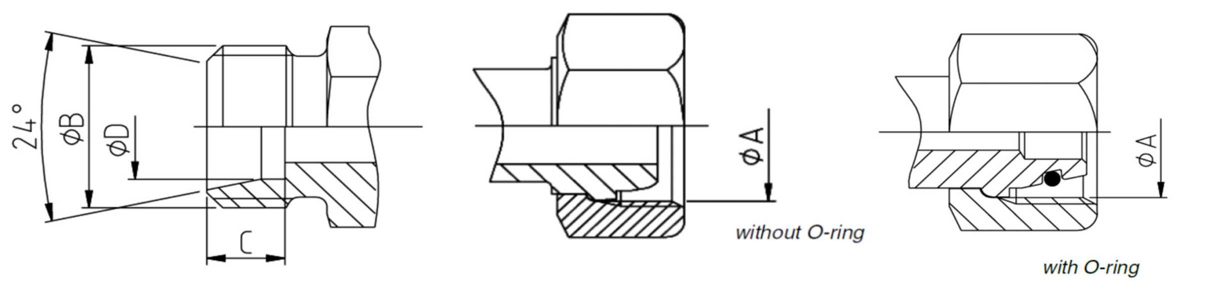
Assembly Instructions for DIN 24° Flare Bite Type Fittings (MBTL and MBTS)

⚠ 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 collect into position and tighten until finger tight. Mark nut and tube in the finger-tight position. Tighten nut to the number of flats listed in Table Table 5-9, DIN 24°Cone (MBTL & MBTS) while using the Double Wrench Method. The tube must not turn with the nut.

Table 5-9. DIN 24°Cone (MBTL & MBTS)



TYPE/FITTING IDENTIFICATION								DIN 24° CONE FLARELESS BITE FITTING (With or Without O-Ring)						
MATERIAL	TYPE	Tube O.D.	Thread M Size	ØA*	ØB*	C*	ØD*	Torque						Flats from Wrench Resistance
								[Ft-Lb]			[N-m]			
		(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						Flats from Wrench Resistance
								[Ft-Lb]			[N-m]			
		(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

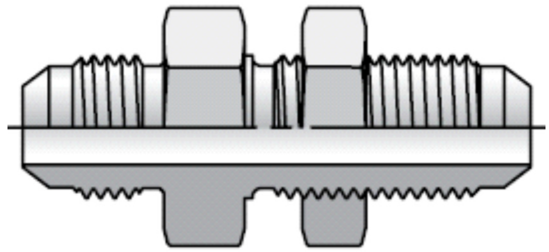
* ØA, ØB, C, & ØD thread dimensions for reference only.

** See FFWR and TFFT Methods for FFWR procedure requirements.

Assembly Instructions for Bulkhead (BH) Fittings

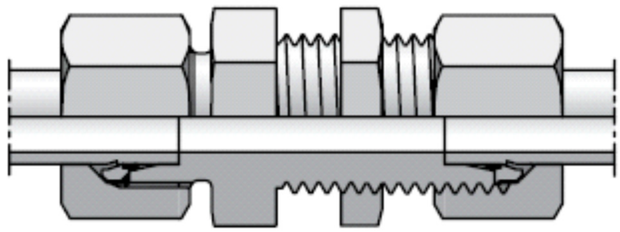
1. Ensure threads and surface are free of rust, weld and brazing splatter, splits, burrs or other foreign material. If necessary replace fitting or adapter.
2. Remove the locknut from the bulkhead assembly.
3. Insert the bulkhead side of the fitting into the panel or bulkhead bracket opening.
4. Hand 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

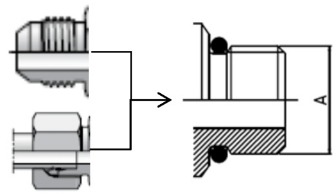
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

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 thru Table 5-17 while using the Double Wrench Method.
   a. The table headings identify the straight thread O-ring port and the type on the other side of the fitting. The torque will be applied to the straight thread O-ring port.
   b. Torque values provided in Table 5-12 thru Table 5-17 are segregated based on the material configuration of the connection. 'ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS' indicate either the following material configurations:

- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

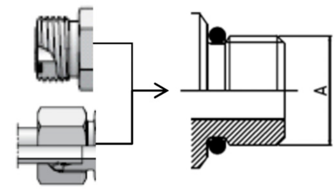
Table 5-12. O-ring Boss (ORB) - Table 1 of 6



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.

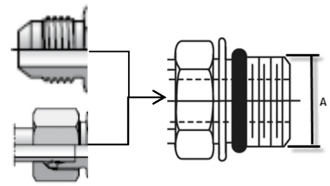
Table 5-13. O-ring Boss (ORB) - Table 2 of 6



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.

Table 5-14. O-ring Boss (ORB) - Table 3 of 6

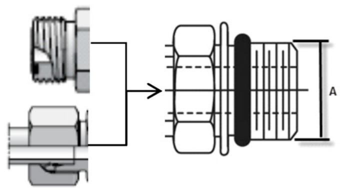


TYPE/FITTING IDENTIFICATION					ADJUSTABLE STUD END with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Dash Size	Thread Size	ØA*		Torque					
		(UNF)	(in)	(mm)	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	2	5/16-24	0.31	7.93	(60)	(63)	(66)	7	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.

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

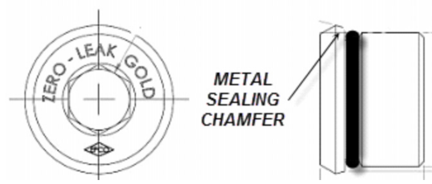
* ØA Thread OD dimension for reference only.

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.

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.

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

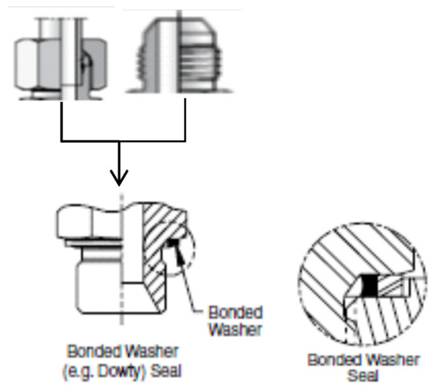
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

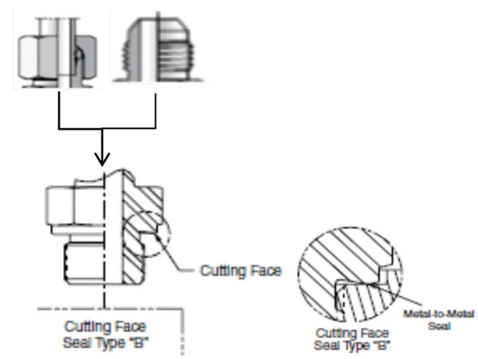
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-18, Table 5-19, Table 5-20, 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.

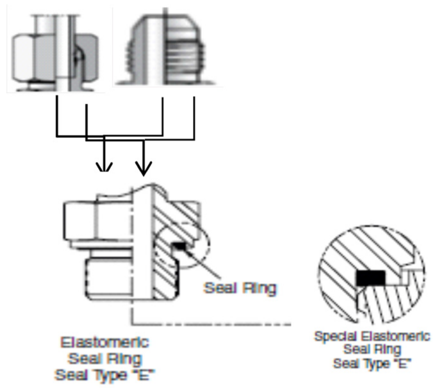
Table 5-18. Metric Flat Face Port (MFF) - L Series - Table 1 of 3

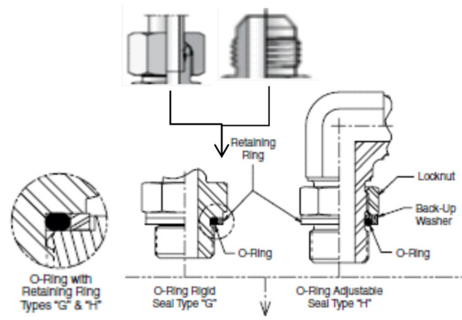




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[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

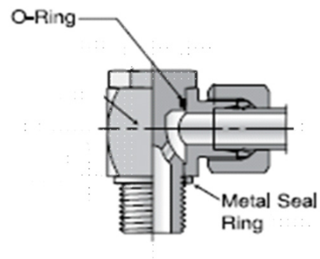
Table 5-19. Metric Flat Face Port (MFF) - L Series - Table 2 of 3

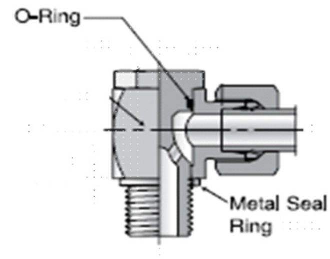


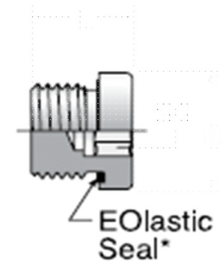


TYPE/FITTING IDENTIFICATION			FORM E (EOLASTIC SEALING RING) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM G/H (O-RING W/RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(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

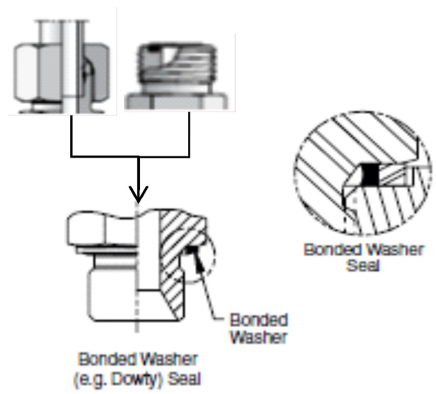


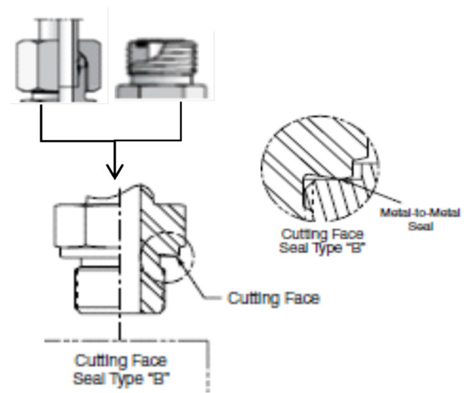




TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with L series DIN (MBTL) opposite end						HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end						FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[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

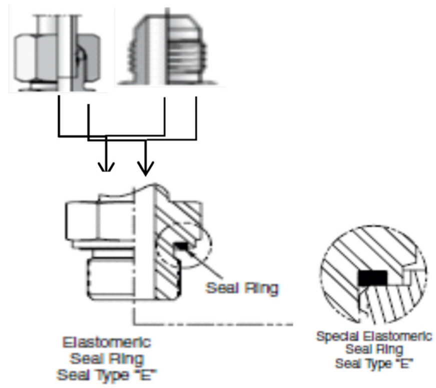
Table 5-21. Metric Flat Face Port (MFF) - S Series - Table 1 of 3

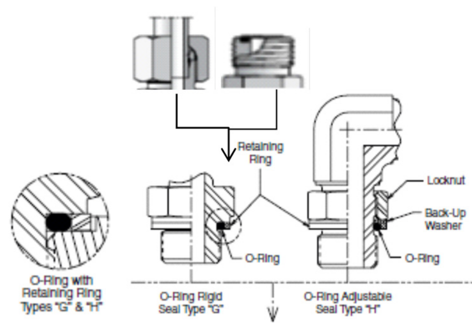




TYPE/FITTING IDENTIFICATION			FORM A (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	Thread M Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[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

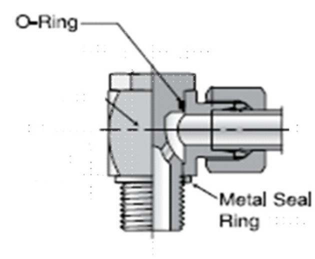
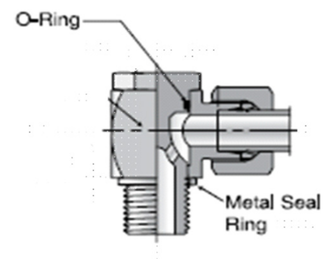
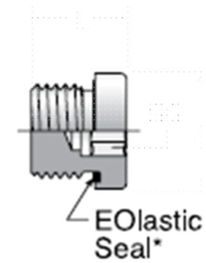
Table 5-22. Metric Flat Face Port (MFF) - S Series - Table 2 of 3





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

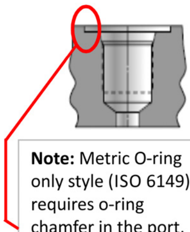
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

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:

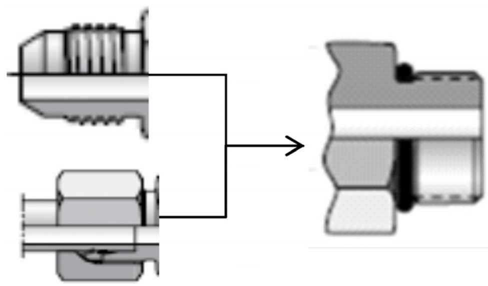
- STEEL fittings with ALUMINUM or BRASS mating components
- ALUMINUM or BRASS fittings with STEEL mating components
- ALUMINUM or BRASS fittings with ALUMINUM or BRASS mating components.

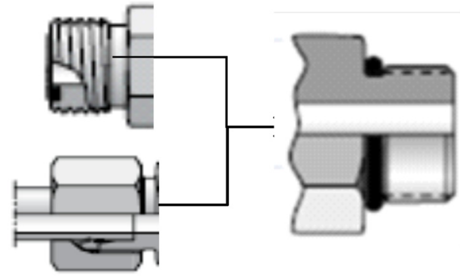
7. Inspect to ensure the O-ring is not pinched and the washer is seated flat on the counterbore of the port.

Table 5-24. Metric Pipe Parallel O-Ring Boss (MPP)



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	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

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

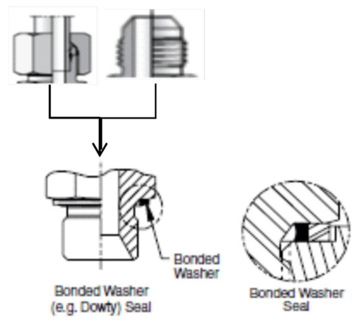
CARE TO BE TAKEN WHEN LUBRICATING O-RING. AVOID ADDING OIL TO THE THREADED CONNECTION OF THE FITTING. THE LUBRICATION WOULD CAUSE INCREASED CLAMPING FORCE AND CAUSE FITTING DAMAGE.

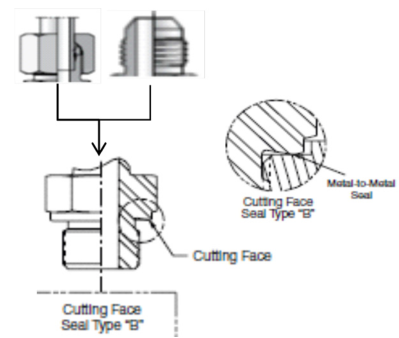
3. Pre-lubricate the O-ring with Hydraulic Oil.
4. For Non-Adjustable Fittings and Plugs, thread the fitting by hand until contact.
5. For Adjustable fittings, refer to Adjustable Stud End Assembly for proper assembly.
6. Torque the fitting or nut to value listed in Table 5-25, Table 5-26, Table 5-27, 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





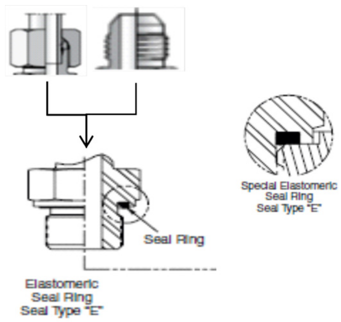
TYPE/FITTING IDENTIFICATION			FORM A**(SEALING WASHER) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end						FORM B** (CUTTING FACE) STUD ENDS with 37° (JIC) or L series DIN (MBTL) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[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

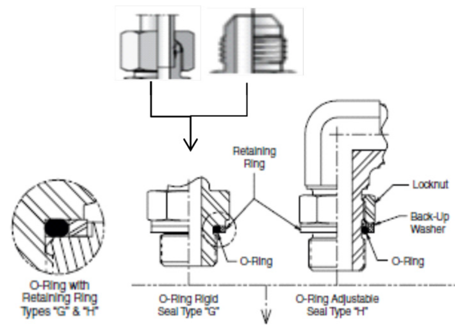
* Typical for JLG Straight Male Stud Fittings

** 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

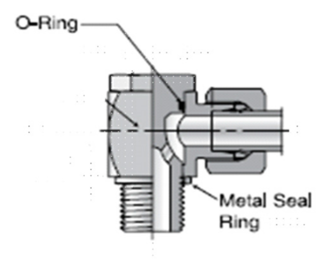
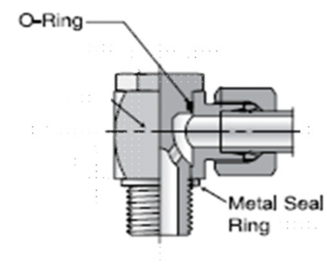
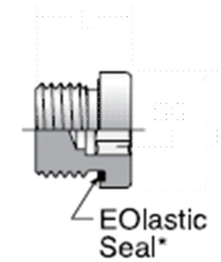
																				
TYPE/FITTING IDENTIFICATION			**BANJO FITTINGS with L series DIN (MBTL) opposite end**						**HIGH PRESSURE BANJO FITTINGS with L series DIN (MBTL) opposite end**						**FORM E (EOLASTIC SEALING RING) HOLLOW HEX PLUGS**					
MATERIAL	**BSPP Thread G Size**	**Connecting Tube O.D.**	**Torque**						**Torque**						**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

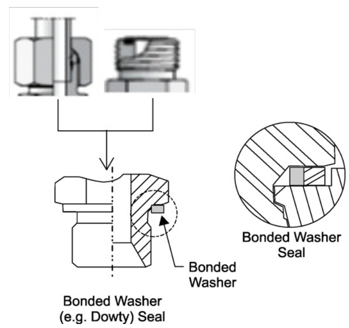
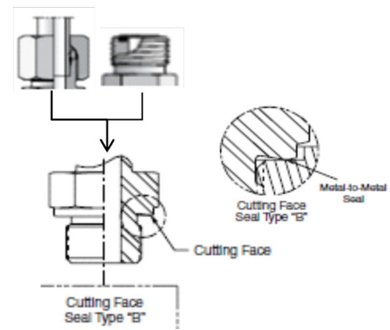
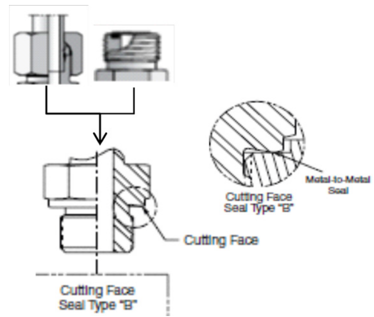
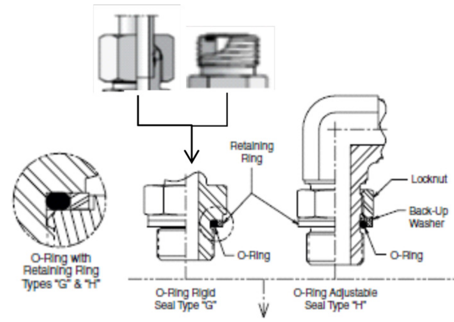
														
TYPE/FITTING IDENTIFICATION			FORM A** (SEALING WASHER) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end						FORM B** (CUTTING FACE) STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[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





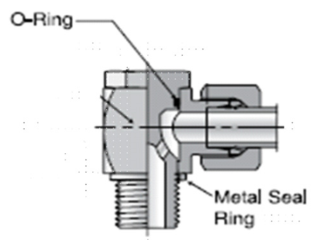
TYPE/FITTING IDENTIFICATION			FORM E* (EOLASTIC SEALING RING) STUD ENDS AND HEX TYPE PLUGS with (ORFS) or S series DIN (MBTS) opposite end						FORM G/H*** (O-RING W/ RETAINING RING) STUD ENDS & ADJUSTABLE STUD ENDS with (ORFS) or S series DIN (MBTS) opposite end					
MATERIAL	BSPP Thread G Size	Connecting 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

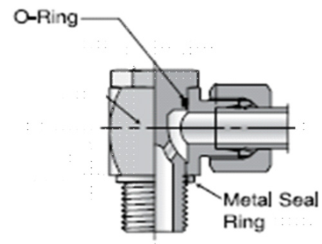
* Typical for JLG Straight Male Stud Fittings

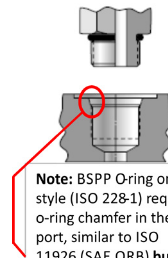
** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Table 5-30. British Standard Parallel Pipe Port (BSPP) - S Series - Table 3 of 3







Note: BSPP O-ring only style (ISO 228-1) requires o-ring chamfer in the port, similar to ISO 11926 (SAE ORB), **but is not interchangeable. Not typically used on JLG machines.**

TYPE/FITTING IDENTIFICATION			BANJO FITTINGS with S series DIN (MBTS) opposite end						HIGH PRESSURE BANJO FITTINGS with S series DIN (MBTS) opposite end						JIS/BSPP O-RING ONLY					
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
STEEL FITTINGS WITH STEEL MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	30	32	33	40	43	45	33	35	36	45	47	49	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	30	32	33	40	43	45	33	35	36	45	47	49						
	G 3/8A	10	48	51	53	65	69	72	52	55	57	70	75	77						
	G 3/8A	12	48	51	53	65	69	72	52	55	57	70	75	77						
	G 1/2A	14	66	70	73	90	95	99	89	94	98	120	127	133						
	G 1/2A	16	66	70	73	90	95	99	89	94	98	120	127	133						
	G 3/4A	20	92	97	101	125	132	137	170	179	187	230	243	254						
	G 1A	25	--	--	--	--	--	--	236	248	260	320	336	353						
	G 1-1/4A	30	--	--	--	--	--	--	398	418	438	540	567	594						
	G 1-1/2A	38	--	--	--	--	--	--	516	542	568	700	735	770						
MATERIAL	BSPP Thread G Size	Connecting Tube O.D.	Torque						Torque						Torque					
			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
	(metric)	(mm)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
ALUMINUM/BRASS FITTINGS OR ALUMINUM/BRASS MATING COMPONENTS; UN-LUBRICATED THREADS	G 1/4A	6	20	21	21	27	28	28	22	22	23	30	30	31	Fitting type not typically specified on JLG applications. Refer to the specific procedure in this Service Manual.					
	G 1/4A	8	20	21	21	27	28	28	22	22	23	30	30	31						
	G 3/8A	10	31	33	34	42	45	46	34	36	37	46	49	50						
	G 3/8A	12	31	33	34	42	45	46	34	36	37	46	49	50						
	G 1/2A	14	43	45	47	58	61	64	58	61	64	79	83	87						
	G 1/2A	16	43	45	47	58	61	64	58	61	64	79	83	87						
	G 3/4A	20	60	63	66	81	85	89	111	117	122	150	159	165						
	G 1A	25	--	--	--	--	--	--	153	161	169	207	218	229						
	G 1-1/4A	30	--	--	--	--	--	--	259	272	285	351	369	386						
	G 1-1/2A	38	--	--	--	--	--	--	335	352	368	454	477	499						

* Typical for JLG Straight Male Stud Fittings

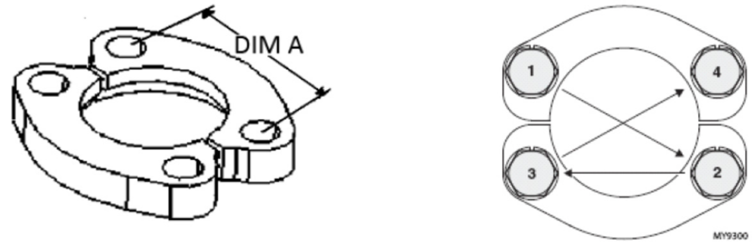
** Non typical for JLG Straight Male Stud Fittings, reference only.

*** Typical for JLG Adjustable Fittings

Assembly Instructions for Flange Connections: (FL61 and FL62)

1. Make sure sealing surfaces are free of rust, splits, scratches, dirt, foreign matter, or burrs.
2. See O-ring Installation (Replacement) for “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 Table 5-31and Table 5-32.

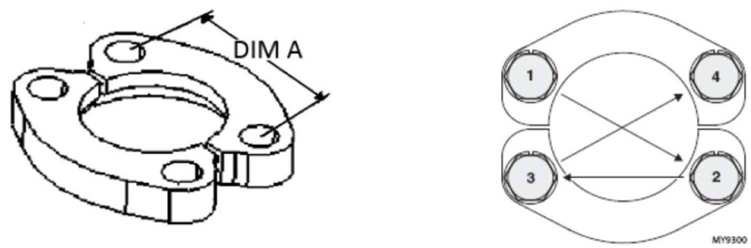
Table 5-31. Flange Code (FL61 & FL62) -Inch Fasteners



TYPE/FITTING IDENTIFICATION							STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)											
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	5/16-18	18	19	19	24	25	26	24	25	26	32	34	35
	12	0.75	19	1.88	47.75	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	16	1.00	25	2.06	52.32	3/8-16	32	33	35	43	45	47	44	46	49	60	63	66
	20	1.25	32	2.31	58.67	7/16-14	52	54	57	70	74	77	68	71	75	92	97	101
	24	1.50	38	2.75	69.85	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	32	2.00	51	3.06	77.72	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	40	2.50	64	3.50	88.90	1/2-13	77	81	85	105	110	116	111	116	122	150	158	165
	48	3.00	76	4.19	106.43	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	56	3.50	89	4.75	120.65	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	64	4.00	102	5.13	130.30	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
	80	5.00	127	6.00	152.40	5/8-11	155	163	170	210	221	231	218	228	239	295	310	325
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with GRADE 5 Screws						Fastener Torque for Flanges Equipped with GRADE 8 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(UNF)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 62 SPLIT FLANGE (FL62)	8	0.50	13	1.59	40.39	5/16-18	--	--	--	--	--	--	24	25	26	32	34	35
	12	0.75	19	2.00	50.80	3/8-16	--	--	--	--	--	--	44	46	49	60	63	66
	16	1.00	25	2.25	57.15	7/16-14	--	--	--	--	--	--	68	71	75	92	97	101
	20	1.25	32	2.62	66.55	1/2-13	--	--	--	--	--	--	111	116	122	150	158	165
	20	1.25	32	2.62	66.55	--	--	--	--	--	--	--	--	--	--	--	--	--
	24	1.50	38	3.12	79.25	5/8-11	--	--	--	--	--	--	218	228	239	295	310	325
	32	2.00	51	3.81	96.77	3/4-10	--	--	--	--	--	--	332	348	365	450	473	495

* A dimension for reference only.

Table 5-32. Flange Code (FL61 & FL62) - Metric Fasteners

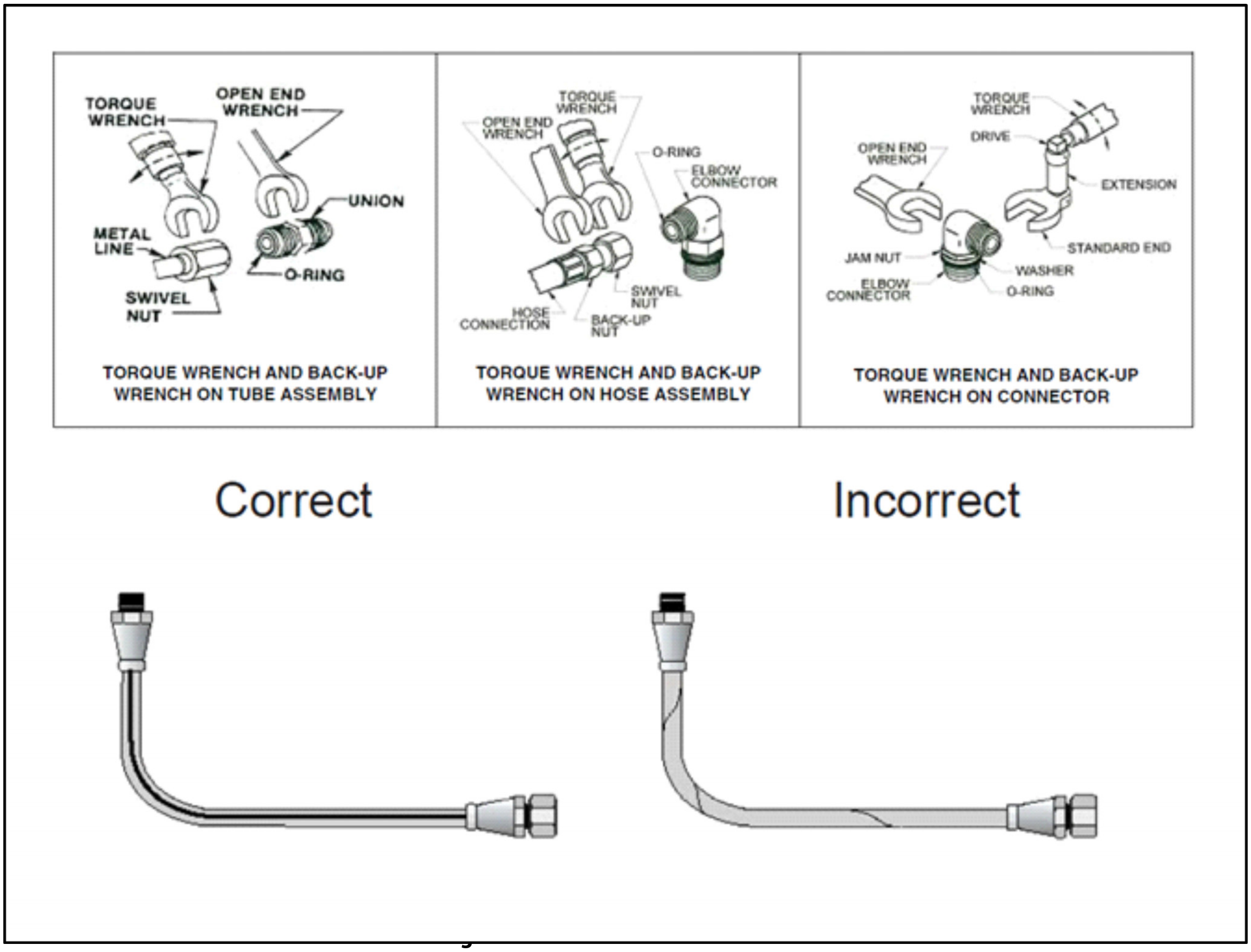


TYPE/FITTING IDENTIFICATION							STEEL 4-BOLT FLANGE SAE J518 (INCH FASTENERS)											
TYPE	Inch Flange SAE Dash Size	Flange Size		A*		Bolt Thread Size	Fastener Torque for Flanges Equipped with CLASS 8.8 Screws						Fastener Torque for Flanges Equipped with CLASS 10.9 Screws					
							[Ft-Lb]			[N-m]			[Ft-Lb]			[N-m]		
		(in)	(mm)	(in)	(mm)	(Metric)	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
CODE 61 SPLIT FLANGE (FL61)	8	0.50	13	1.50	38.10	M8 x 1.25	18	19	19	24	25	26	18	19	19	24	25	26
	12	0.75	19	1.88	47.75	M10 x 1.5	37	39	41	50	53	55	37	39	41	50	53	55
	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	M12 x 1.75	68	71	75	92	97	101	68	71	75	92	97	101
	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	M16 x 2	155	163	170	210	221	231	155	163	170	210	221	231
	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 'lay line' printed on the hose is a good indicator of proper hose installation. A twisted lay-line usually indicates the hose is twisted. See Figure 5-12. for double wrench method requirements.



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 5-13.
3. Use the double wrench method per Figure 5-12., turn the swivel nut to tighten as shown in Figure 5-13. The nut is to be rotated clockwise the number of hex flats as defined by the applicable Table in Section 5.0.
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened. See Figure 5-13.

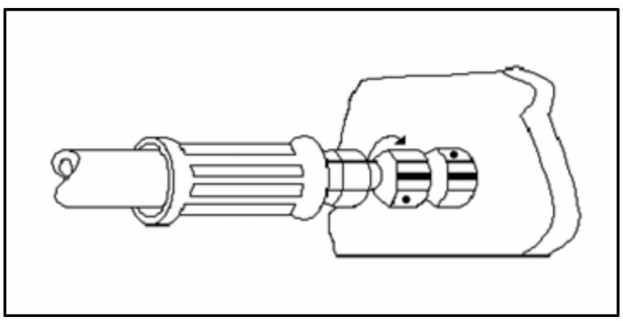


Figure 5-13. FFWR Method

TFFT (TURNS FROM FINGER TIGHT METHOD)

1. Tighten the swivel nut to the mating fitting until no lateral movement of the swivel nut can be detected; finger tight condition.
2. Mark a dot on one of the swivel hex nut flats and another dot in line on the connecting tube adapter.
3. Use the double wrench method per Appendix A, turn the swivel nut to tighten. The nut is to be rotated clockwise the number of turns as defined by the applicable Table in "BSPT Pipe Thread".
4. After the connection has been properly tightened, mark a straight line across the connecting parts, not covering the dots, to indicate the connection has been properly tightened.

Adjustable Stud End Assembly

For Adjustable Stud End Connections; the following assembly steps are to be performed:

1. Lubricate the o-ring with a light coat of hydraulic oil.
2. Position #1 – The o-ring should be located in the groove adjacent to the face of the backup washer. The washer and o-ring should be positioned at the extreme top end of the groove as shown.
3. Position #2 – Position the locknut to just touch the backup washer as shown. The locknut in this position will eliminate potential backup washer damage during the next step.
4. Position #3 – Install the connector into the straight thread box port until the metal backup washer contacts the face of the port as shown.
5. Position #4 – Adjust the connector to the proper position by turning out (counterclockwise) up to a maximum of one turn as shown to provide proper alignment with the mating connector, tube assembly, or hose assembly.
6. Position #5 – Using two wrenches, use the backup wrench to hold the connector in the desired position and then use the torque wrench to tighten the locknut to the appropriate torque.
7. Visually inspect, where possible, the joint to ensure the o-ring is not pinched or bulging out from under the washer and that the backup washer is properly seated flat against the face of the port.

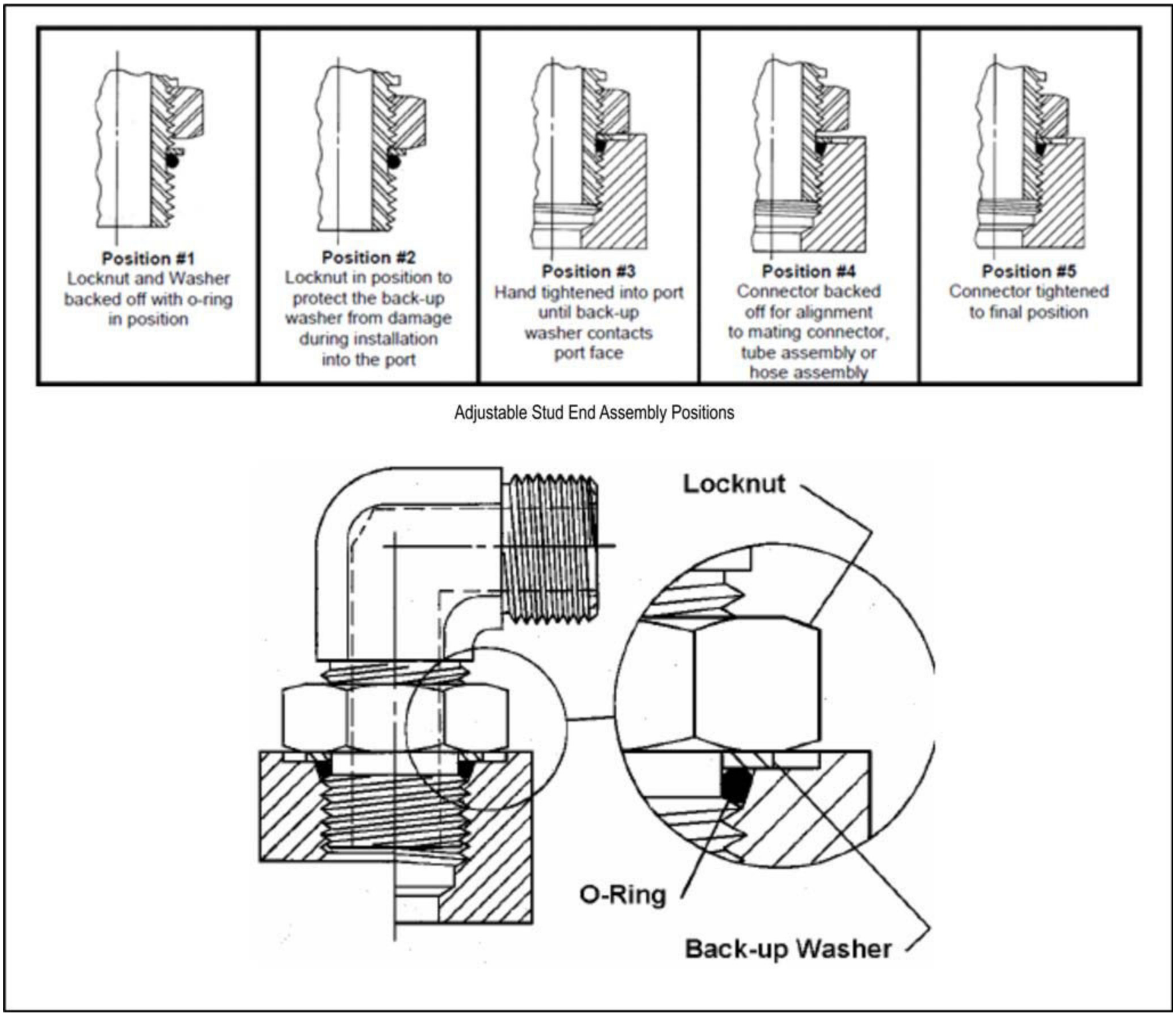


Figure 5-14. Adjustable Stud End Assembly

O-ring Installation (Replacement)

Care must be taken when installing O-rings over threads during replacement or installation. O-rings could become nicked or torn. A damaged O-ring could lead to leakage problems.

1. Inspect O-ring for tears or nicks. If any are found replace O-ring.
2. Ensure proper O-ring to be installed. Many O-rings look the same but are of different material, different hardness, or are slightly different diameters or widths.
3. Use a thread protector when replacing O-rings on fittings.
4. In ORB; ensure O-ring is properly seated in groove. On straight threads, ensure O-ring is seated all the way past the threads prior to installation.
5. Inspect O-ring for any visible nicks or tears. Replace if found.

5.3 HYDRAULIC CYLINDERS

Axle Lockout Cylinder

DISASSEMBLY

NOTICE

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

WARNING

ROD CAN FALL OUT OF BARREL AND CAUSE INJURY OR DAMAGE TO THE EQUIPMENT. BE CAREFUL WHEN REMOVING AXLE CYLINDER. OPENING BLEED VALVE CAN CAUSE ROD TO FALL OUT OF BARREL.

1. Open bleeder valve. Rotate rod and remove from barrel.
2. Remove wiper seal. 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

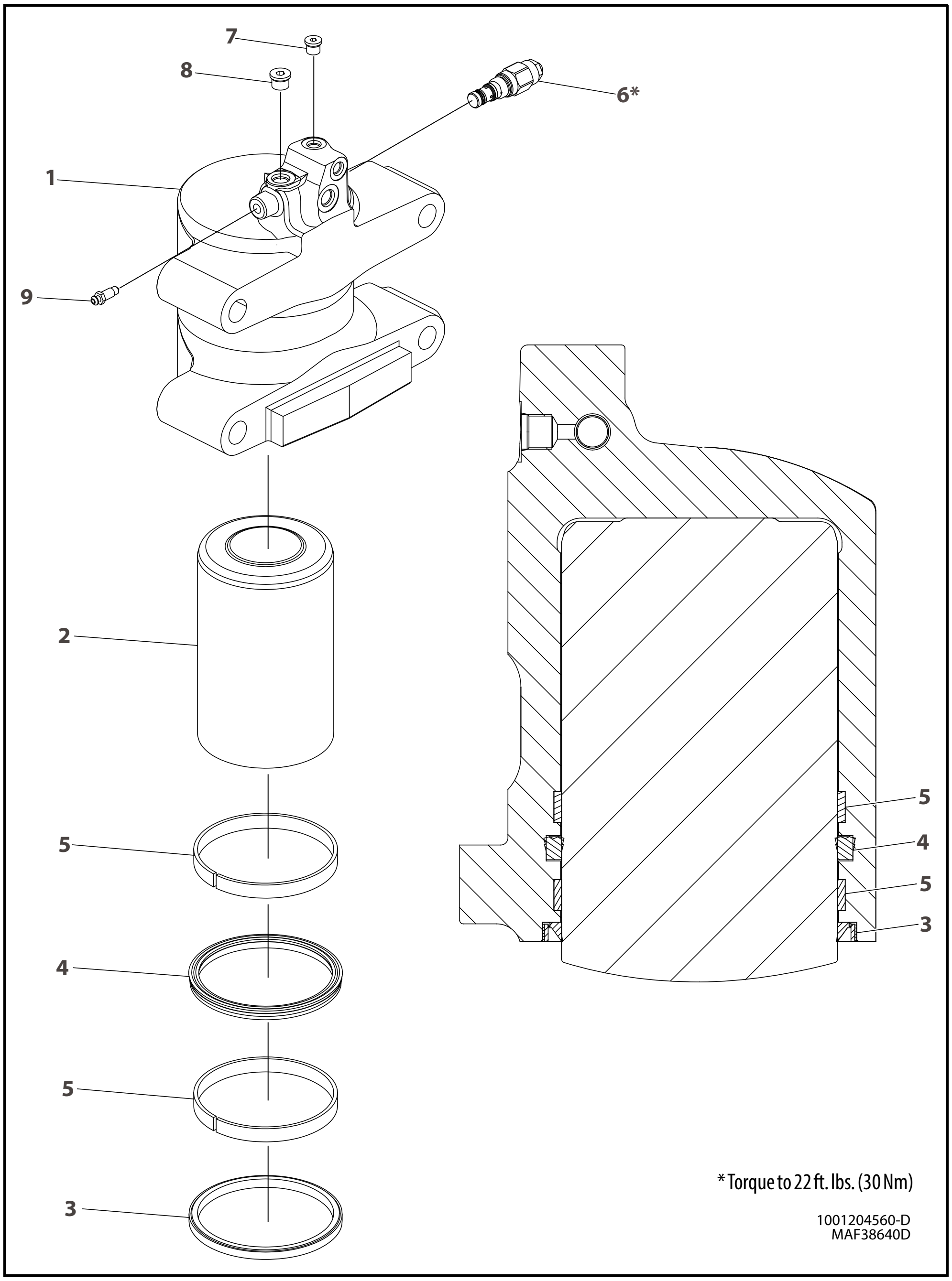
WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

1. Install two new wear rings and rod seal in rod bore grooves. Make sure they are not twisted.
2. Install new wiper seal 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. O-ring Plug
8. O-ring Plug
9. Bleeder Valve

Figure 5-15. Axle Lockout Cylinder

Disassembly and Assembly Instructions

7. Make sure the work area is large enough for the entire cylinder and clean and free of dirt. Ensure the cylinder can be secured firmly in place during disassembly.
8. Prepare all the necessary tools and replacement parts.

General Information

1. Clean any burrs or contamination from the surface of the cylinder before disassembly.
2. Handle every part with care. Each part is precision made and hitting parts together or letting them fall could damage the machined surfaces.
3. Do not twist or strike parts to get them apart. This will damage the part and/or threads, resulting in leakage and poor function.
4. Do not let the cylinder in a disassembled condition for a long period of time. It only takes a short period of time for the parts to rust.

Standard of Maintenance

Parts and seals should be replaced according to the conditions as follows.

1. Bushings - 1/4 of the bushing is worn off.
2. Seal and Slide Ring - Replace during disassembly.
3. Pin Bushing - When it is worn down.
4. Rod - Bent or warped more than 0.5mm/1m.

Inspection After Assembly

<table>
<tr><td>Operation Inspection Without Load</td><td colspan="7">There is no problem when fully extended 5 times without load</td></tr>
<tr><td>Dimension</td><td colspan="7">Check the retracted length and stroke</td></tr>
<tr><td>Inspection of the Surface</td><td colspan="7">When each of the cylinders are pressurized with test pressure on the piston end, it should not be loose and have no change in pressure or external
leakage</td></tr>
<tr><td>Inspection of external leakage</td><td colspan="7">Check the oil leakage at the rod area. Refer to Figure 5-16., Acceptable Oil Leakage on Cylinder Rod.</td></tr>
<tr><td rowspan="7">Inspection of internal leakage</td><td colspan="7">Leakage Unit: ml/ 10 minutes</td></tr>
<tr><th>Bore (mm)</th><th>Leakage (ml)</th><th>Bore (mm)</th><th>Leakage (ml)</th><th>Bore (mm)</th><th>Leakage (ml)</th><th>Remark</th></tr>
<tr><td>32</td><td>0.4</td><td>100</td><td>4</td><td>160</td><td>10</td><td></td></tr>
<tr><td>40</td><td>0.6</td><td>125</td><td>5.6</td><td>180</td><td>12.6</td><td></td></tr>
<tr><td>50</td><td>1</td><td>140</td><td>6</td><td>200</td><td>15.6</td><td></td></tr>
<tr><td>63</td><td>1.6</td><td></td><td></td><td>220</td><td>20</td><td></td></tr>
<tr><td>80</td><td>2.3</td><td></td><td></td><td>250</td><td>22</td><td></td></tr>
</table>

Value of Oil Leakage at Rod Area

NOTE: *Check the oil leakage status on the rod surface with a flow of 20cc - 40cc. Oil leakage in an amount as shown in example A is unacceptable. Examples B-G are acceptable.*

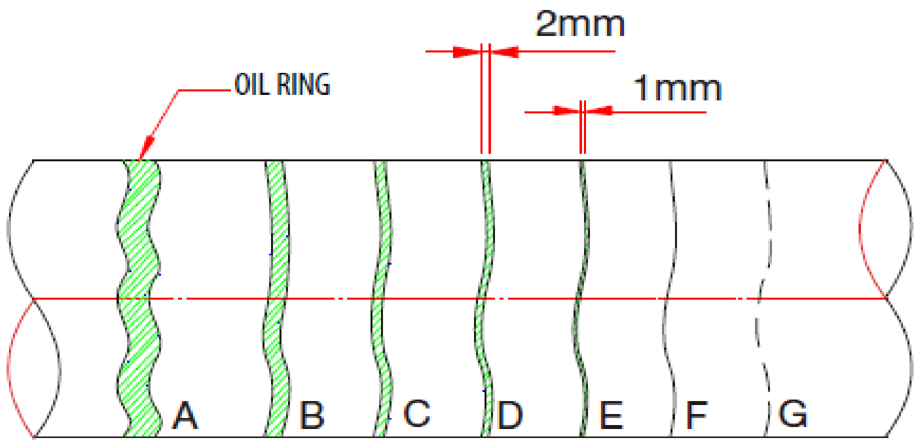


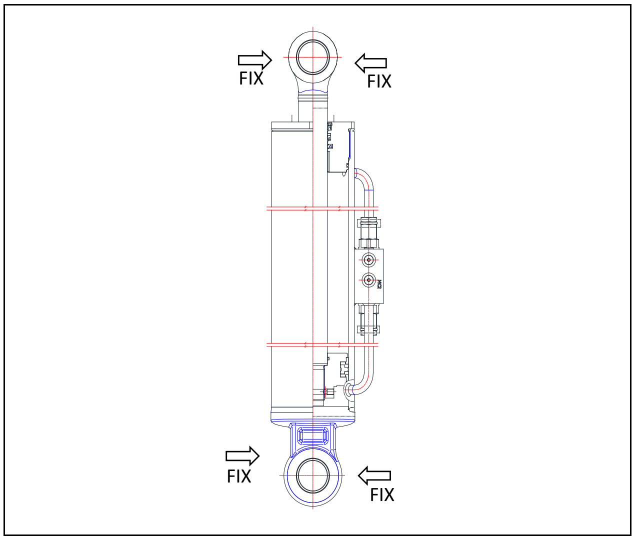
Figure 5-16. Acceptable Oil Leakage on Cylinder Rod

Platform Level Cylinder

DISASSEMBLY

1. Remove the oil from the cylinder.

2. Fix the cylinder in a vertical or horizontal position. Vertical position is convenient for disassembly and assembly. Fix the base by inserting the pin not to be rotated. Remove any hoses, valves, or fittings that may be in the way.



3. Unscrew the cylinder head.

   a. Caulking is used for locking when head is assembled with the barrel.

   b. Make the bent area flat and then take apart head from barrel with hook spanner.

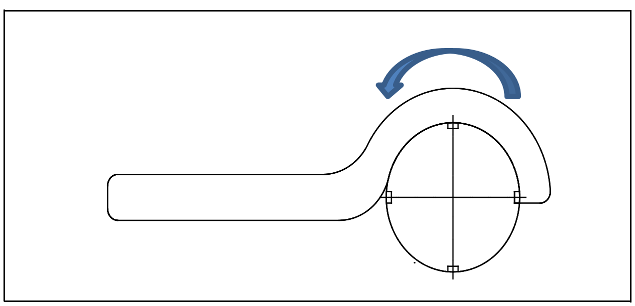


Figure 5-17. Cylinder Head Removal

4. Remove the Rod assembly.

   a. Check if the cap or plug has been removed from the cylinder ports.

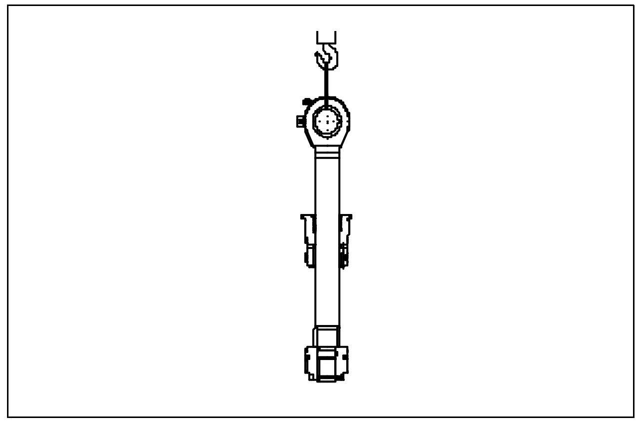
   b. Place a suitable container under the cylinder to catch any oil coming out of the cylinder.

   c. After the Rod assembly is pulled from the barrel, unscrew the head using a spanner wrench.

   d. After disassembling the rod assembly, place it on a support.

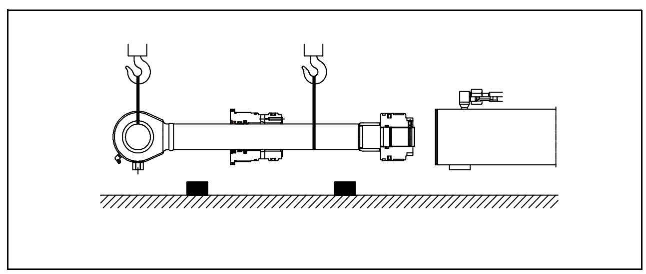
CAUTION

IF THE CYLINDER IS FIXED AT A VERTICAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; WHEN THE HEAD IS UNSCREWED AND THEN ROD ASSEMBLY IS PULLED FROM THE BARREL, THERE IS A SPACE BETWEEN THE HEAD AND PISTON. IT IS POSSIBLE FOR THE HEAD TO SUDDENLY SLIDE DOWN, POSSIBLY CAUSING INJURY. TO PREVENT THIS, THE HEAD SHOULD BE PUSHED AGAINST THE PISTON BEFORE PROCEEDING.



CAUTION

IF A CYLINDER IS AT A HORIZONTAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; IT IS POSSIBLE FOR THE ROD TO FALL AND BE DAMAGED WHEN REMOVED FROM THE BARREL IF NOT PROPERLY SUPPORTED. PLACE SUPPORT UNDER THE BARREL AS SHOWN BELOW.



5. Place the Rod assembly on blocking. Use the pin hole to keep it from rotating.

6. Unscrew the Piston Nut.

   a. Caulking is used to lock the setscrew so grind the caulking area and then unscrew the set screw.

   b. Remove the steel ball.

   c. Unscrew the piston. The piston is secured with a torque specified in Table 5-36, Piston Nut Torque. 1.5 x this torque is needed to remove the nut. If the stronger torque is needed, use a power wrench operated by a hydraulic unit.

NOTE: *If it is not a set screw type, continue with the disassembly of the piston nut.*

7. Remove the PISTON and HEAD in sequence.
8. Piston and Head disassembly.

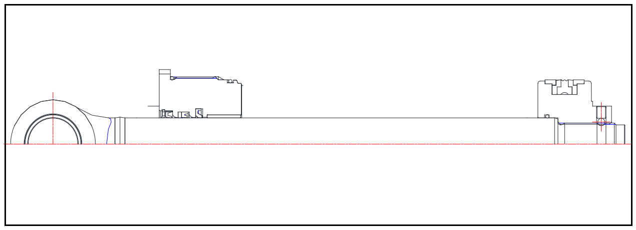


Figure 5-18. Piston and Head Disassembly

a. Unscrew the Piston Nut.
b. Take the piston apart by sliding off the rod in the direction of the rod threads.
c. Take the head apart by sliding off the rod in the direction of the rod threads. Be careful not to make the seal in the head damaged by the rods.

9. Take apart piston seal.

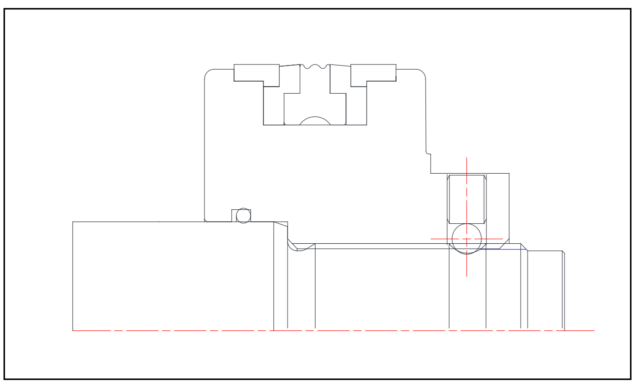


Figure 5-19. Piston Seal Removal

a. The wear ring is easily taken apart by hand.
b. The piston seal is a two piece seal; the ring at the outer side is easily removed. Remove the ring inside of the piston seal.
c. Remove the o-ring.

NOTE: *All seals must be discarded after removal. They cannot be reused.*

10. Remove the gland seal.

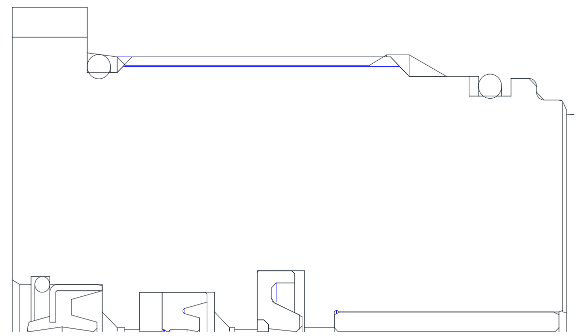


Figure 5-20. Head Seal Removal

a. Remove the rod seal and backup ring.
b. Remove the retaining ring with a flat-head screw-driver prior to removing the dust wiper and remove the dust wiper.
c. Remove the o-ring and backup ring.
d. The bushing is pressed in and must be removed by using a tool as shown below.

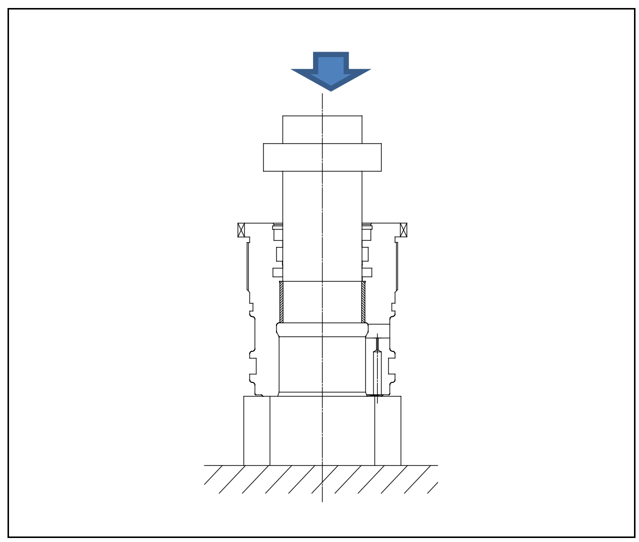


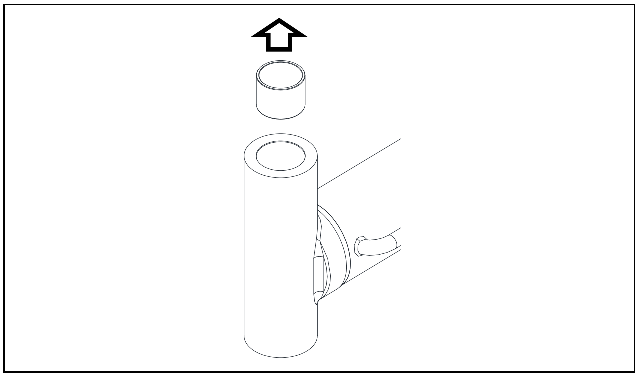
Figure 5-21. Bush Removal

NOTICE

DISCARD ALL SEALS AFTER REMOVAL AND REPLACE THEM WITH NEW ONES FOR ASSEMBLY.

11. MRP Bearing Disassembly

    To remove the MRP bearing, break it into pieces.



12. Washing And Storage

    All removed parts should be washed with cleaning solution and then coated with light oil to prevent rust. If the cylinder is not to be reassembled right away, store the parts and put a covering over them.

Assembly

CAUTION

TAKE CARE NOT TO LET ANY PAINT CHIPS OR DIRT FALL INSIDE THE CYLINDER. THIS COULD CAUSE LEAKAGE

1. Rod assembly

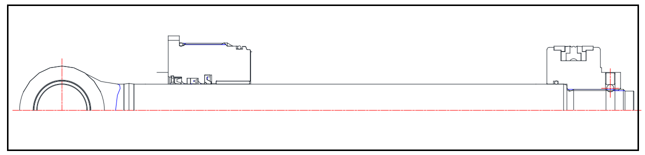


Figure 5-22. Fix Rod Assembly

   a. Secure the rod assembly.

   b. Install the Head with Rod Assembly onto the rod assembly. Take care as not to damage the lip of the dust wiper and rod seal.

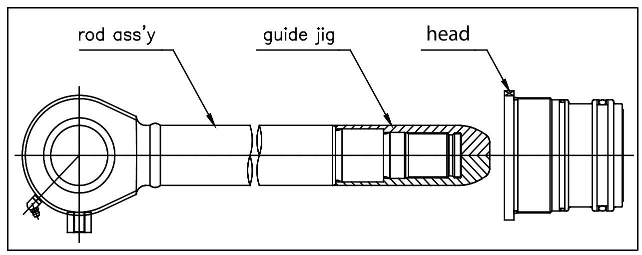


Figure 5-23. Install Cylinder Head

   a. Assemble piston.

   b. Torque the Piston nut as specified in Table 5-36, Piston Torque. Lack of the torque can result in internal leakage, the piston coming unscrewed, and thread damage. If over torqued, the piston surface which meets the rod will be damaged.

Table 5-33. Piston Nut Torque

Cylinder	Piston
Platform Level	233-285 lb. ft. (315.9 - 386.4 Nm)

2. Assemble the Rod Assembly.

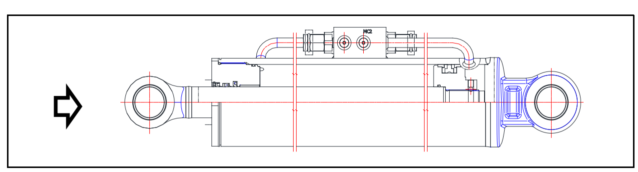


Figure 5-24. Rod Assembly Installation

a. Secure the barrel at a vertical or horizontal position.

b. Insert the assembly into the barrel.

c. When piston is inserted to the barrel take care as to not damage the seal rings.

3. Head and Bolt Assembly
Assemble using torque wrench with below torque.

Table 5-34. Gland and Tube End Assembly

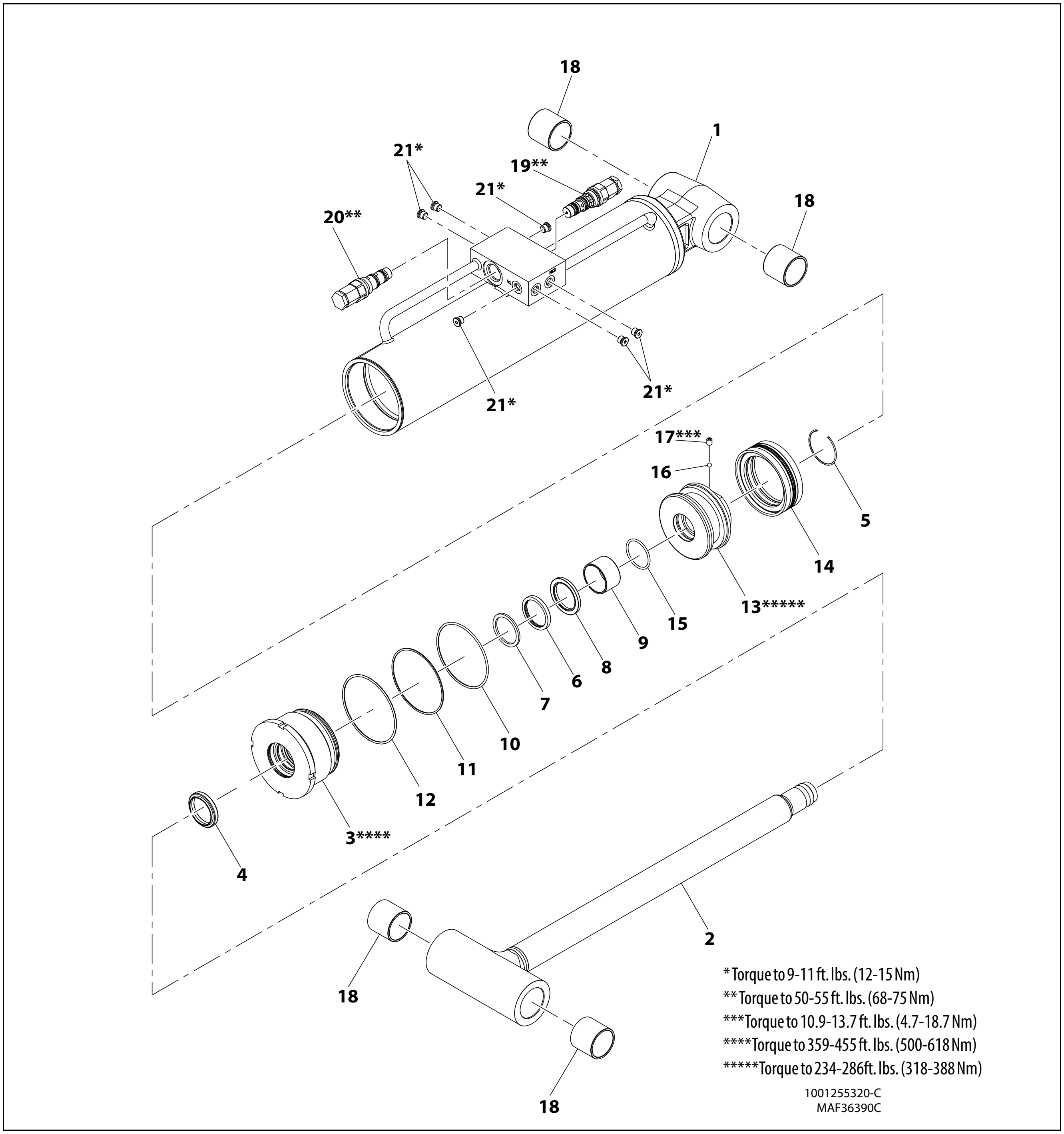
Cylinder	Head
Platform Level	369 - 451 lb.ft. (500.3 - 611.5 Nm)

4. Test Operation

a. Install the cylinder on a machine. Fill the cylinder with oil and then have the cylinder slowly operated a minimum of 8 cycles. If it is operated too fast in the beginning, cavitation will result.

b. It is important to make sure all air is cycled from the cylinder.

c. Grease the end of the pin.



1. Barrel
2. Rod
3. Head
4. Dust Wiper
5. Retain Ring
6. Rod Seal
7. Backup Ring
8. Buffer Ring
9. Dry Bearing
10. O-ring
11. Backup Ring
12. O-ring
13. Piston
14. Piston seal
15. O-ring
16. Steel Ball
17. Set screw
18. MRP Bearing
19. Counter Balance Valve
20. Counter Balance Valve
21. Plug

Figure 5-25. Platform Level Cylinder

Jib Lift Cylinder

Disassembly

1. Remove the oil from the cylinder.
2. Fix the cylinder in a vertical or horizontal position. Vertical position is convenient for disassembly and assembly. Fix the base by inserting the pin not to be rotated. Remove any hoses, valves, or fittings that may be in the way.

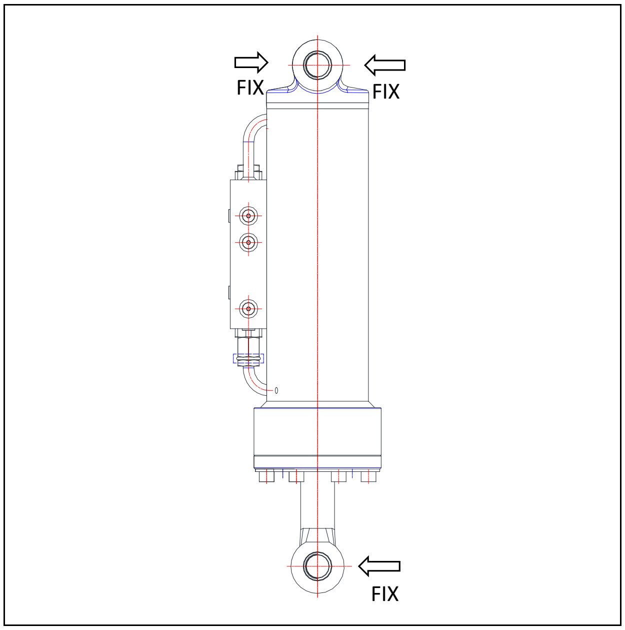


Figure 5-26. Fixing the Cylinder

3. Unscrew the cylinder head.
   a. Head that is threaded into the barrel are locked in place with caulking. Using a spanner wrench, unscrew the head from the barrel. (It is easier to do this with rod pulled out 5cm from the gland). If there is no caulking, continue with the disassembly process.

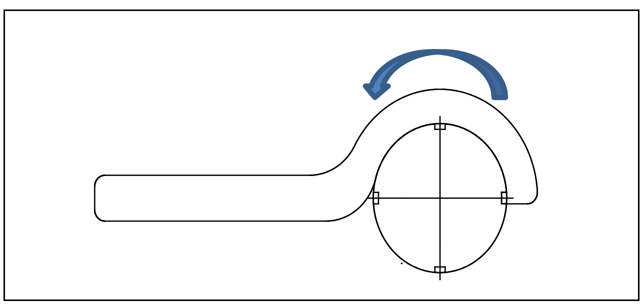
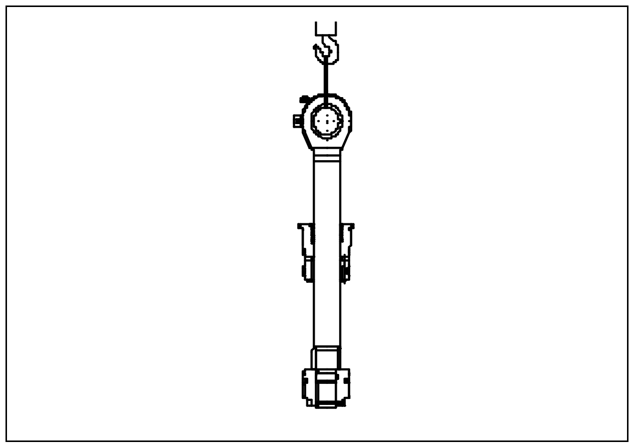


Figure 5-27. Cylinder Head Removal

4. Remove the Rod assembly.
   a. Check if the cap or plug has been removed from the cylinder ports.
   b. Place a suitable container under the cylinder to catch any oil coming out of the cylinder.
   c. After the Rod assembly is pulled from the barrel, unscrew the head using a spanner wrench.
   d. After disassembling the rod assembly, place it on a support.

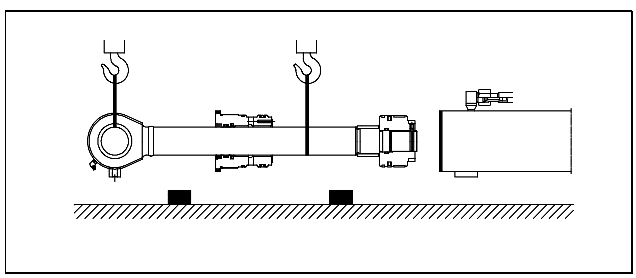
⚠ CAUTION

IF THE CYLINDER IS FIXED AT A VERTICAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; WHEN THE HEAD IS UNSCREWED AND THEN ROD ASSEMBLY IS PULLED FROM THE BARREL, THERE IS A SPACE BETWEEN THE HEAD AND PISTON. IT IS POSSIBLE FOR THE HEAD TO SUDDENLY SLIDE DOWN, POSSIBLY CAUSING INJURY. TO PREVENT THIS, THE HEAD SHOULD BE PUSHED AGAINST THE PISTON BEFORE PROCEEDING.



⚠ CAUTION

IF A CYLINDER IS AT A HORIZONTAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; IT IS POSSIBLE FOR THE ROD TO FALL AND BE DAMAGED WHEN REMOVED FROM THE BARREL IF NOT PROPERLY SUPPORTED. PLACE SUPPORT UNDER THE BARREL AS SHOWN BELOW.



5. Place the Rod assembly on blocking. Use the pin hole to keep it from rotating.

6. Unscrew the Piston Nut.

   a. Caulking is used to lock the setscrew so grind the caulking area and then unscrew the set screw.

   b. Remove the steel ball.

   c. Unscrew the piston. The piston is secured with a torque specified in Table 5-36 Piston Nut Torque. 1.5 x this torque is needed to remove the nut. If the stronger torque is needed, use a power wrench operated by a hydraulic unit.

NOTE: *If it is not a set screw type, continue with the disassembly of the piston nut.*

7. Remove the PISTON and HEAD in sequence.

8. Piston and Head disassembly.

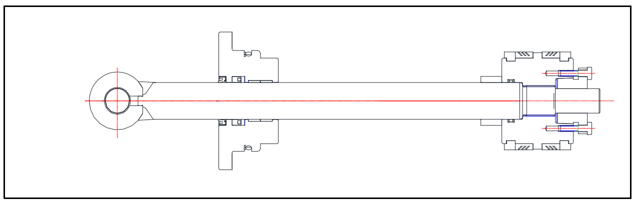


Figure 5-28. Piston and Gland Disassembly

   a. Unscrew the Piston Nut.

   b. Take the piston apart by sliding off the rod in the direction of the rod threads.

   c. Take the head apart by sliding off the rod in the direction of the rod threads. Be careful not to make the seal in the head damaged by the rods.

9. Take apart piston seals.

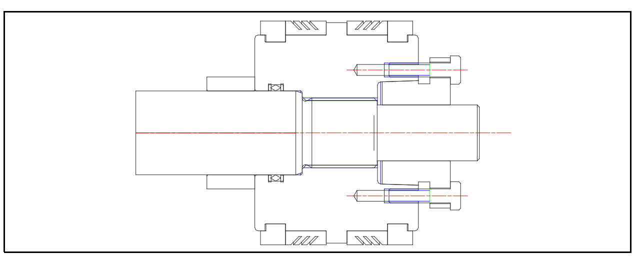


Figure 5-29. Piston Seal Removal

   a. The wear ring is easily taken apart by hand.

   b. The piston seal is a two piece seal; the ring at the outer side is easily removed. Remove the ring inside of the piston seal.

   c. Remove the o-ring.

NOTE: *All seals must be discarded after removal. They cannot be reused.*

10. Remove the head seal.

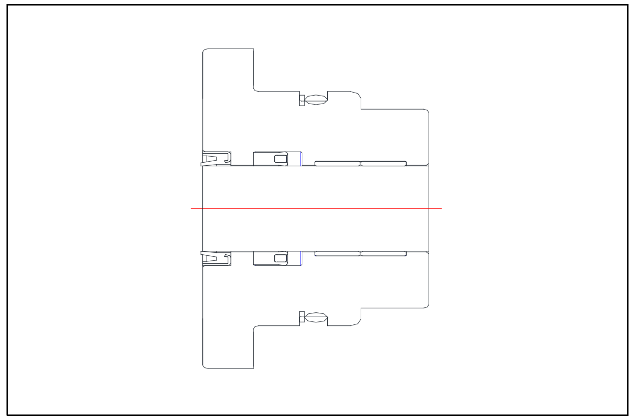


Figure 5-30. Head Seal Removal

   a. Remove the rod seal and backup ring.

   b. Remove the retaining ring with a flat-head screw-driver prior to removing the dust wiper and remove the dust wiper.

   c. Remove the o-ring and backup ring.

   d. The bushing is pressed in and must be removed by using a tool as shown below.

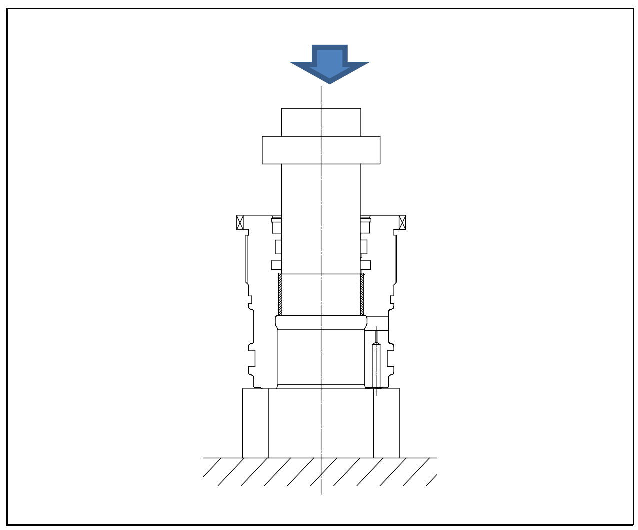


Figure 5-31. Bush Removal

NOTICE

DISCARD ALL SEALS AFTER REMOVAL AND REPLACE THEM WITH NEW ONES FOR ASSEMBLY.

11. MRP Bearing Disassembly

To remove the MRP bearing, break it into pieces.

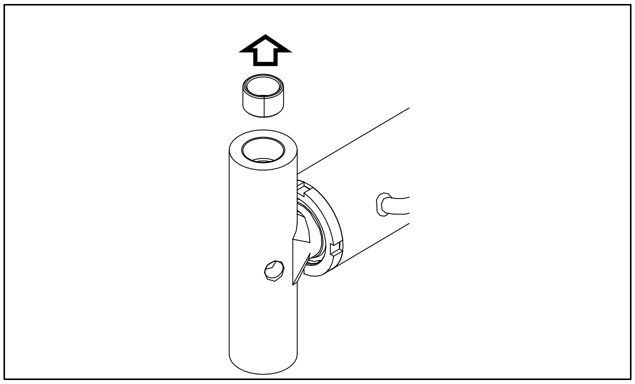


Figure 5-32. MRP Bearing Disassembly

12. Washing And Storage

All removed parts should be washed with cleaning solution and then coated with light oil to prevent rust. If the cylinder is not to be reassembled right away, store the parts and put a covering over them.

ASSEMBLY

CAUTION

TAKE CARE NOT TO LET ANY PAINT CHIPS OR DIRT FALL INSIDE THE CYLINDER. THIS COULD CAUSE LEAKAGE.

1. Rod assembly

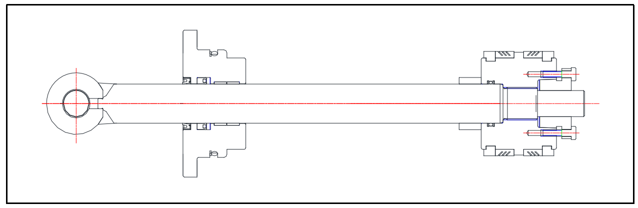


Figure 5-33. Fix Rod Installation

a. Secure the rod assembly.

b. Install the Tube cap and Gland onto the rod assembly. Take care as not to damage the lip of the dust wiper and rod seal.

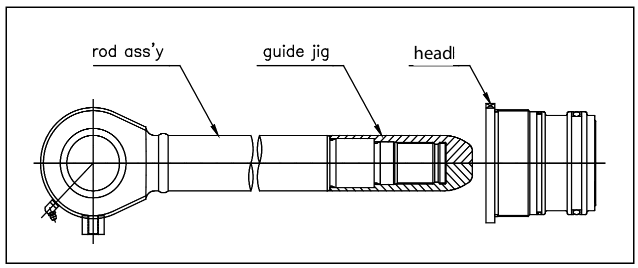


Figure 5-34. Cylinder Head Seal Installation

c. Assemble piston.

d. Torque the Piston nut as specified in Table 5-36, Piston Torque. Lack of the torque can result in internal leakage, the piston coming unscrewed, and thread damage. If over torqued, the piston surface which meets the rod will be damaged.

Cylinder	Piston
Jib Lift	69 - 84.4 lb ft (93.55 - 114.43 Nm)

2. Assemble the Rod Assembly.

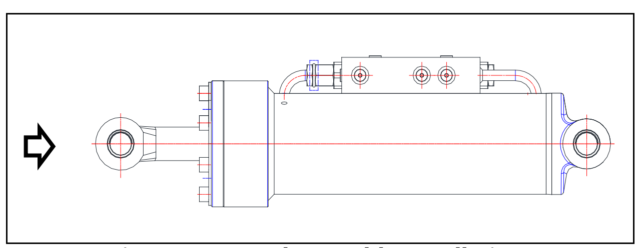


Figure 5-35. Rod Assembly Installation

a. Secure the barrel at a vertical or horizontal position.

b. Insert the assembly into the barrel.

c. When piston is inserted to the barrel take care as to not damage the seal rings.

3. Head and bolt assembly
Assemble using torque wrench with below torque.

Table 5-35. Head and Bolt Assembly

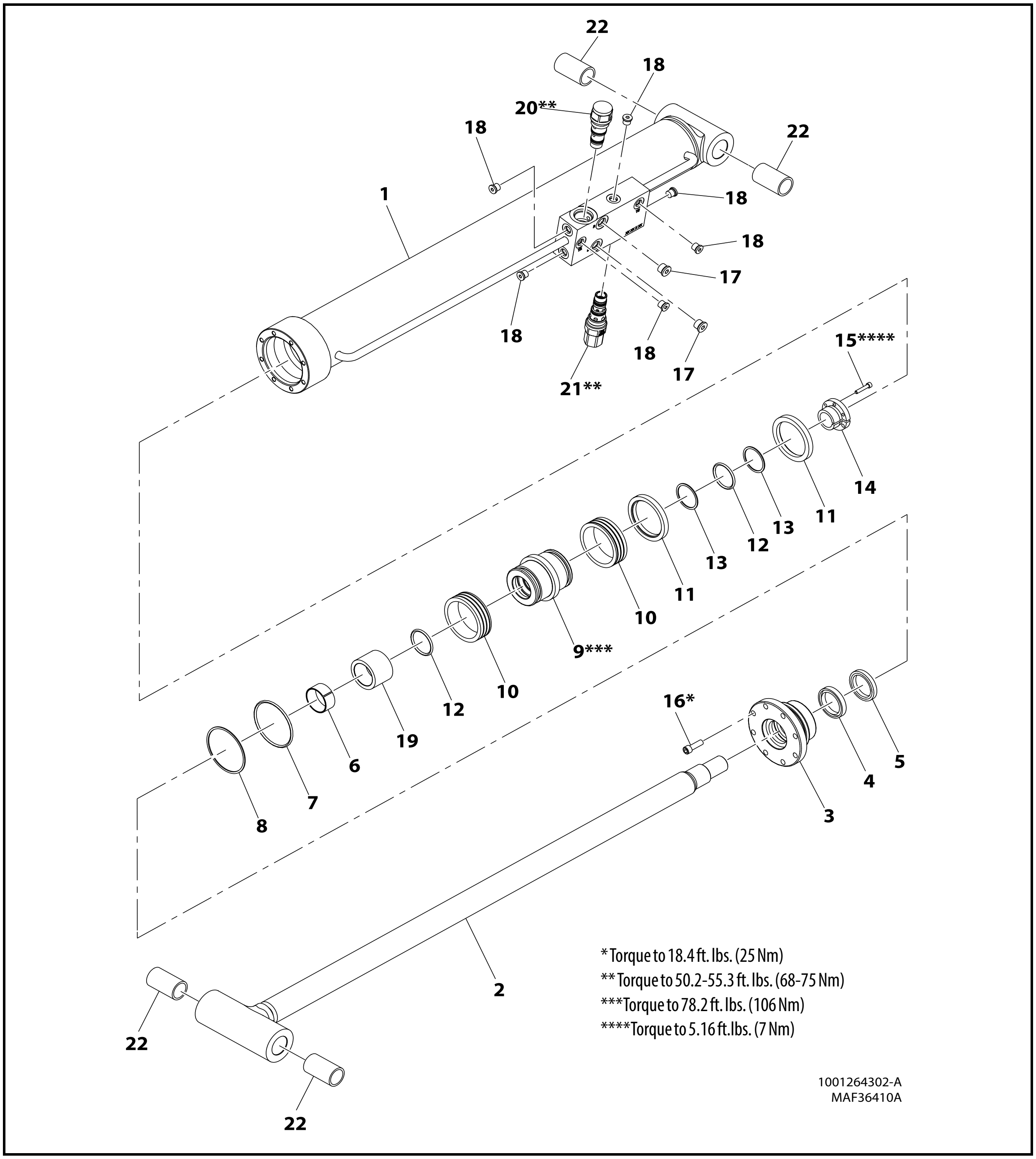
Cylinder	Head
Jib Lift	19.7 - 23.7 lb ft (26.7 - 32.1 Nm)

4. Test Operation

a. Install the cylinder on a machine. Fill the cylinder with oil and then have the cylinder slowly operated a minimum of 8 cycles. If it is operated too fast in the beginning, cavitation will result.

b. It is important to make sure all air is cycled from the cylinder.

c. Grease the end of the pin.



1. Barrel
2. Rod
3. Head
4. Dust Wiper
5. Rod Seal
6. Wear Ring
7. O-Ring
8. Backup Ring
9. Piston
10. Hydro Lock
11. Guide Lock
12. O-ring
13. Backup Ring
14. Tapered Bushing
15. Hex Bolt
16. Hex Bolt
17. Hex Plug
18. Hex Plug
19. Spacer
20. Counter Balance Valve
21. Counter Balance Valve
22. MRP Bearing

Figure 5-36. Jib Lift Cylinder

Main Boom Lift, Tower Lift and Upright Level Cylinder

Disassembly

1. Remove the oil from the cylinder.
2. Fix the cylinder in a vertical or horizontal position. Vertical position is convenient for disassembly and assembly. Fix the base by inserting the pin not to be rotated. Remove any hoses, valves, or fittings that may be in the way.

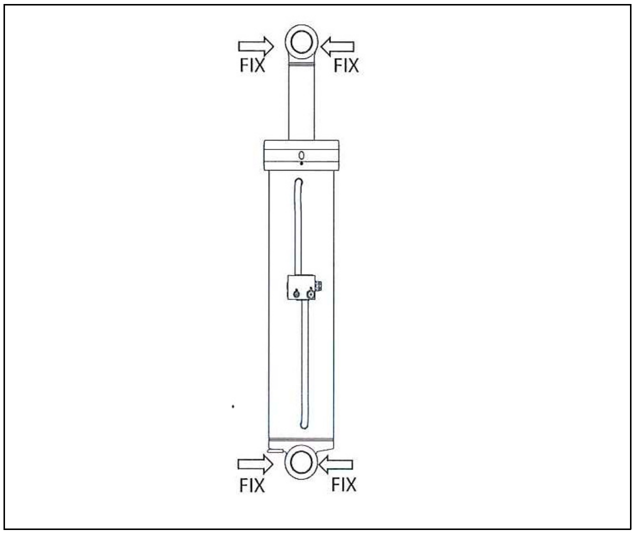


Figure 5-37. Fixing the Cylinder (Main Boom Lift Cylinder)

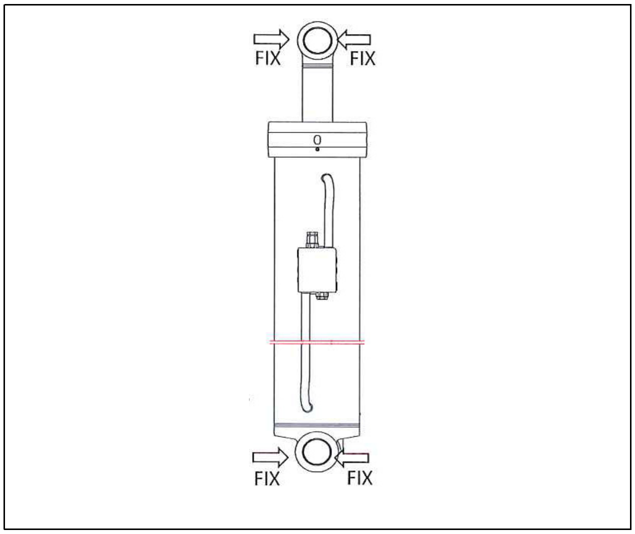


Figure 5-38. Fixing the Cylinder (Tower Lift Cylinder)

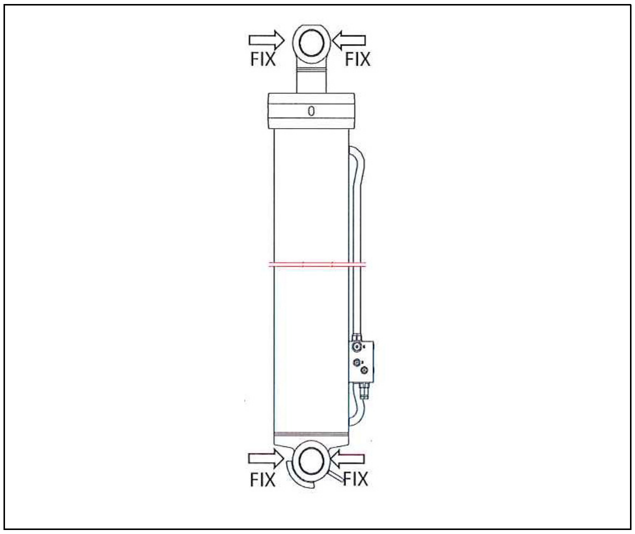


Figure 5-39. Fixing the Cylinder (Upright Level Cylinder)

3. Unscrew the cylinder head.
   a. Unscrew the set screw from the barrel cap first and then remove the locking insert.
   b. Take apart the barrel cap from the barrel with the hook spanner. (With the rod pulled out 5cm from the head it is much easier to work).

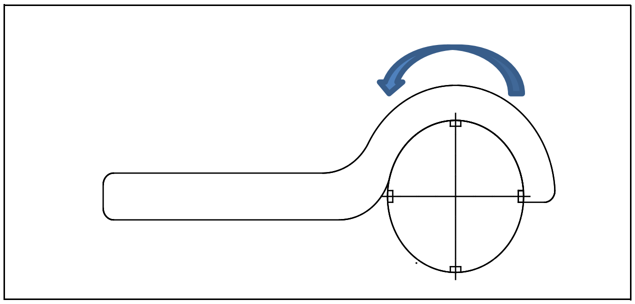
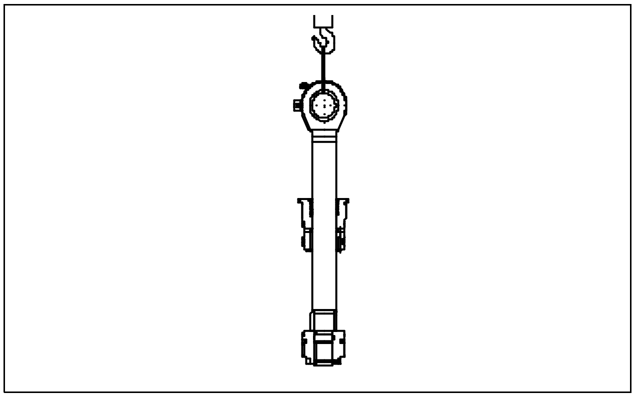


Figure 5-40. Cylinder Head Removal

4. Remove the Rod assembly.
   a. Check if the cap or plug has been removed from the cylinder ports.
   b. Place a suitable container under the cylinder to catch any oil coming out of the cylinder.
   c. After the Rod assembly is pulled from the barrel, unscrew the head using a spanner wrench.
   d. After disassembling the rod assembly, place it on a support.

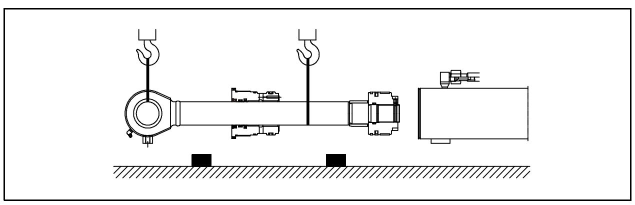
CAUTION

IF THE CYLINDER IS FIXED AT A VERTICAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; WHEN THE HEAD IS UNSCREWED AND THEN ROD ASSEMBLY IS PULLED FROM THE BARREL, THERE IS A SPACE BETWEEN THE HEAD AND PISTON. IT IS POSSIBLE FOR THE HEAD TO SUDDENLY SLIDE DOWN, POSSIBLY CAUSING INJURY. TO PREVENT THIS, THE HEAD SHOULD BE PUSHED AGAINST THE PISTON BEFORE PROCEEDING.



CAUTION

IF A CYLINDER IS AT A HORIZONTAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; IT IS POSSIBLE FOR THE ROD TO FALL AND BE DAMAGED WHEN REMOVED FROM THE BARREL IF NOT PROPERLY SUPPORTED. PLACE SUPPORT UNDER THE BARREL AS SHOWN BELOW.



5. Place the Rod assembly on blocking. Use the pin hole to keep it from rotating.

6. Unscrew the Piston Nut.

   a. Caulking is used to lock the setscrew so grind the caulking area and then unscrew the set screw.

   b. Remove the steel ball.

   c. Unscrew the piston. The piston is secured with a torque specified in Table 5-36, Piston Nut Torque. 1.5 x this torque is needed to remove the nut. If the stronger torque is needed, use a power wrench operated by a hydraulic unit.

NOTE: *If it is not a set screw type, continue with the disassembly of the piston nut.*

7. Remove the PISTON, HEAD and BARREL CAP in sequence.

8. Piston, Head and Barrel Cap disassembly.

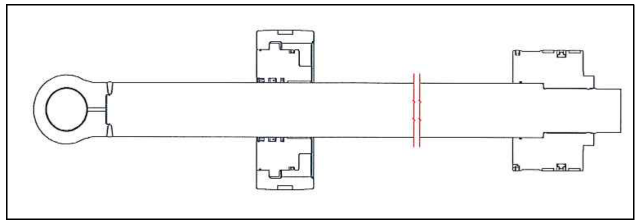


Figure 5-41. Piston, Head and Barrel Cap Disassembly (Main Boom Lift Cylinder)

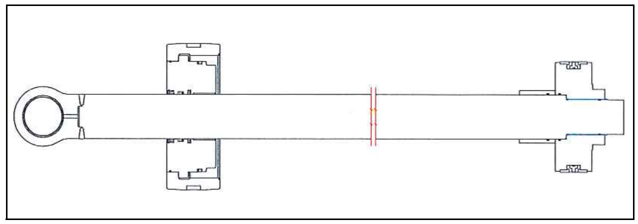


Figure 5-42. Piston, Head and Barrel Cap Disassembly (Tower Lift Cylinder)

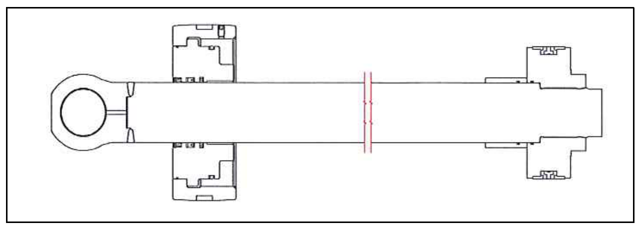


Figure 5-43. Piston, Head and Barrel Cap Disassembly (Upright Level Cylinder)

   a. Unscrew the Piston.

   b. Take the piston apart by sliding off the rod in the direction of the rod threads.

   c. Take the head apart by sliding off the rod in the direction of the rod threads. Be careful not to make the seal in the gland damaged by the rods.

   d. Take the barrel cap apart to the direction of the rod threads. Be careful not to make the rod damaged by barrel caps.

9. Take apart piston seals.

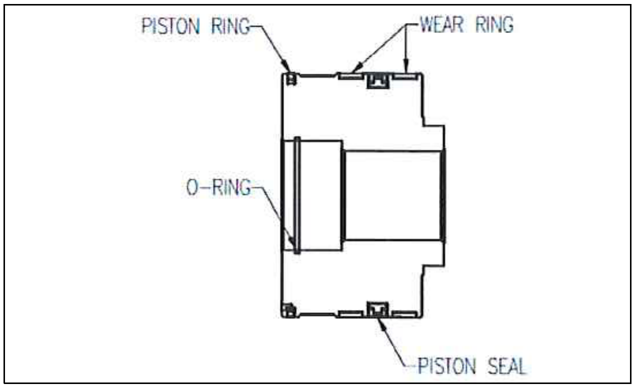


Figure 5-44. Piston Seal Removal (Main Boom Lift Cylinder)

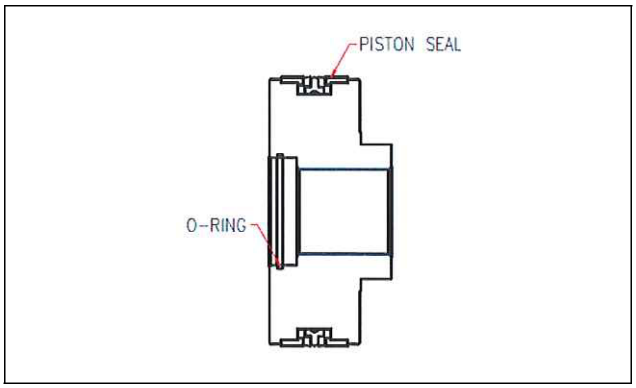


Figure 5-45. Piston Seal Removal (Tower Lift Cylinder)

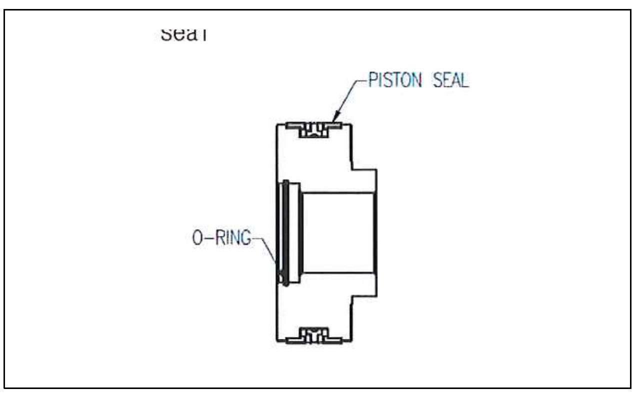


Figure 5-46. Piston Seal Removal (Upright Level Cylinder)

a. The wear ring is easily taken apart by hand.

b. The piston seal is a two piece seal; the ring at the outer side is easily removed. Remove the ring inside of the piston seal.

c. Remove the o-ring.

NOTE: *All seals must be discarded after removal. They cannot be reused.*

10. Remove the head seal.

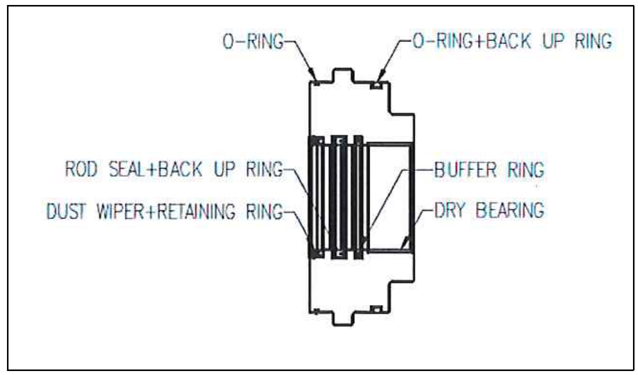


Figure 5-47. Head Seal Removal (Main Boom Lift Cylinder)

a. Remove the rod seal and backup ring.

b. Remove the retaining ring with a flat-head screw-driver prior to removing the dust wiper and remove the dust wiper.

c. Remove the o-ring and backup ring.

d. The bushing is pressed in and must be removed by using a tool as shown below.

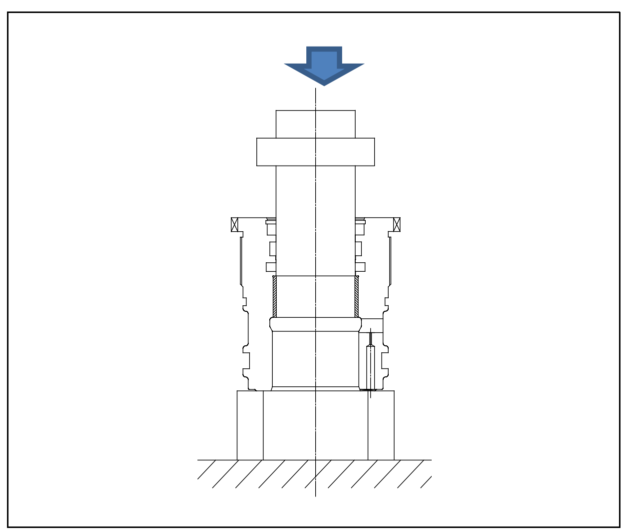


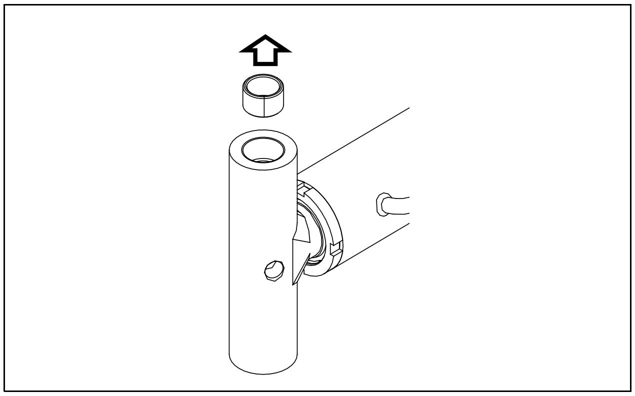
Figure 5-48. Bush Removal

NOTICE

DISCARD ALL SEALS AFTER REMOVAL AND REPLACE THEM WITH NEW ONES FOR ASSEMBLY.

11. MRP Bearing Disassembly

To remove the MRP bearing, break it into pieces.



12. Washing And Storage

All removed parts should be washed with cleaning solution and then coated with light oil to prevent rust. If the cylinder is not to be reassembled right away, store the parts and put a covering over them.

Assembly

CAUTION

TAKE CARE NOT TO LET ANY PAINT CHIPS OR DIRT FALL INSIDE THE CYLINDER. THIS COULD CAUSE LEAKAGE.

1. Rod assembly

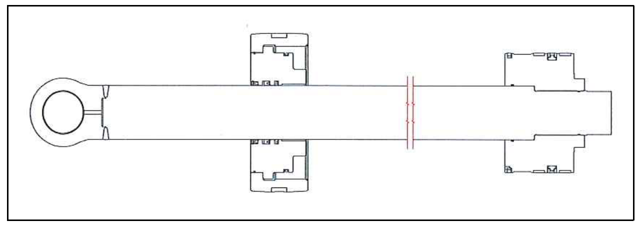


Figure 5-49. Fix Rod Assembly (Main Boom Lift Cylinder)

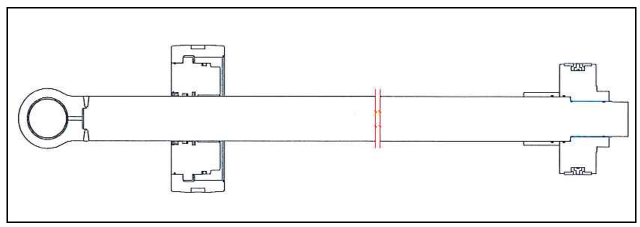


Figure 5-50. Fix Rod Assembly (Tower lift Cylinder)

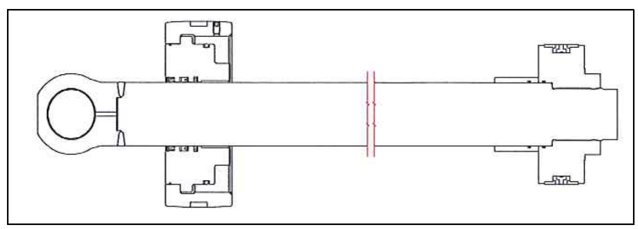


Figure 5-51. Fix Rod Assembly (Upper Lift Cylinder)

a. Secure the rod assembly.

b. Install the barrel cap and head onto the rod assembly. Take care as not to damage the lip of the dust wiper and rod seal.

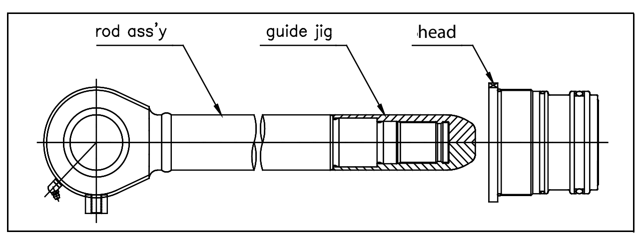


Figure 5-52. Install Cylinder Head

a. Assemble piston.

b. Torque the Piston nut as specified in Table 5-36, Piston Torque. Lack of the torque can result in internal leakage, the piston coming unscrewed, and thread damage. If over torqued, the piston surface which meets the rod will be damaged.

Table 5-36. Piston Torque

Cylinder	Piston
Main Lift	420.7 - 514.3 lb ft (570.4 - 697.3 Nm)
Tower Lift	1053 - 1287 ft. lbs. (1427.67 - 1744.9 Nm)
Upright Level	420.7 - 514.3 ft. lbs. (570.4 - 697.3 Nm)

2. Assemble the Rod Assembly.

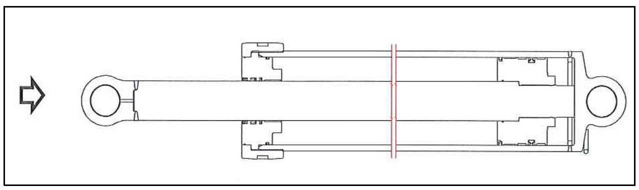


Figure 5-53. Rod Assembly Installation (Main Boom Lift Cylinder)

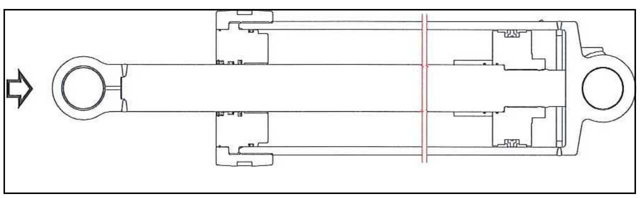


Figure 5-54. Rod Assembly Installation (Tower Lift Cylinder)

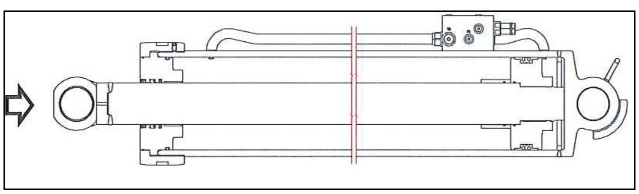


Figure 5-55. Rod Assembly Installation (Upright Level Cylinder)

a. Secure the barrel at a vertical or horizontal position.

b. Insert the assembly into the barrel.

c. When piston is inserted to the barrel take care as to not damage the seal rings.

Table 5-37. Tube Cap Assembly

Cylinder	Gland
Main Lift	712.8 - 871.2 ft. lbs. (966.4 - 1181.2 Nm)
Tower Lift	
Telescope	

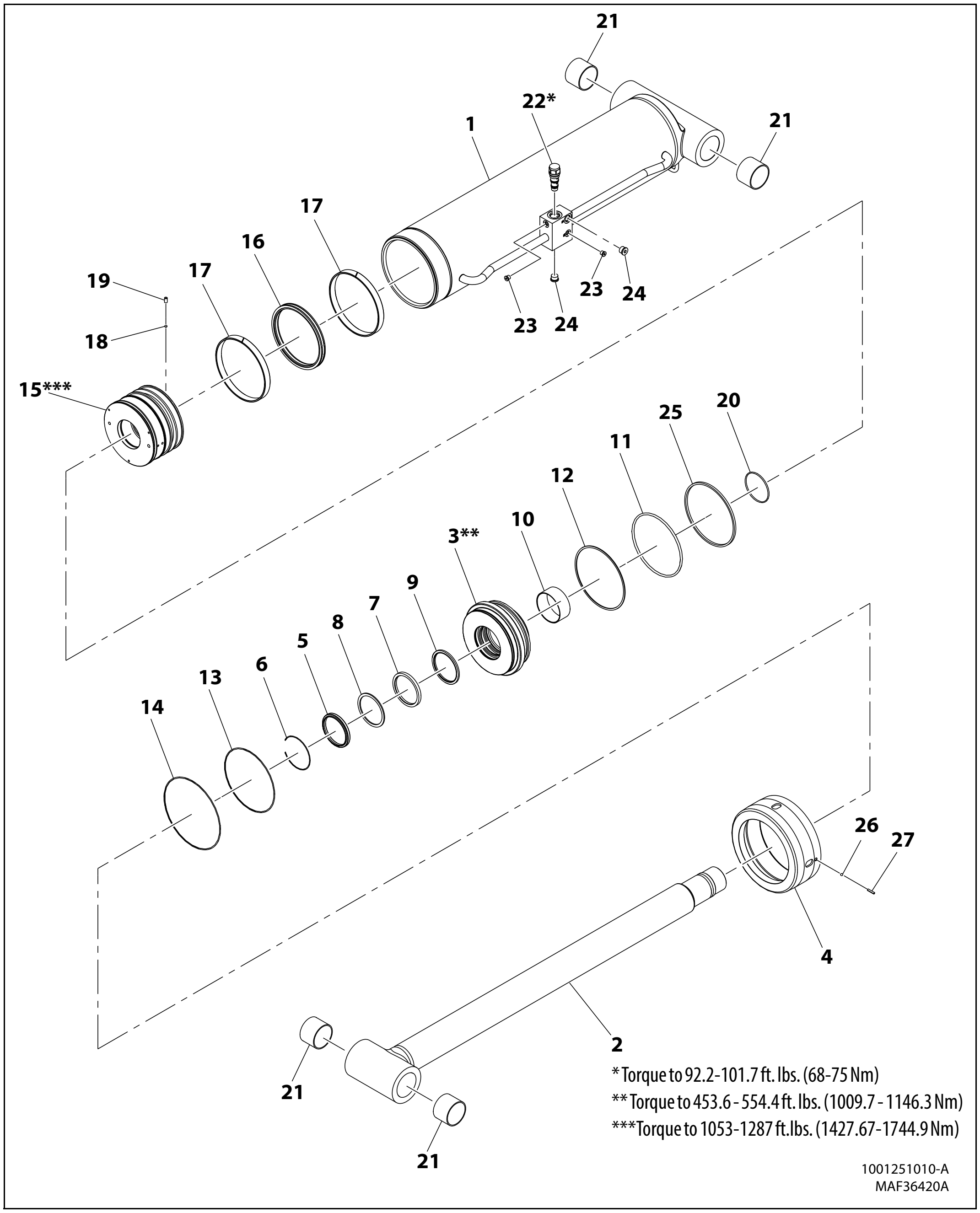
3. Test Operation

a. Install the cylinder on a machine. Fill the cylinder with oil and then have the cylinder slowly operated a minimum of 8 cycles. If it is operated too fast in the beginning, cavitation will result.

b. It is important to make sure all air is cycled from the cylinder.

c. Grease the end of the pin.

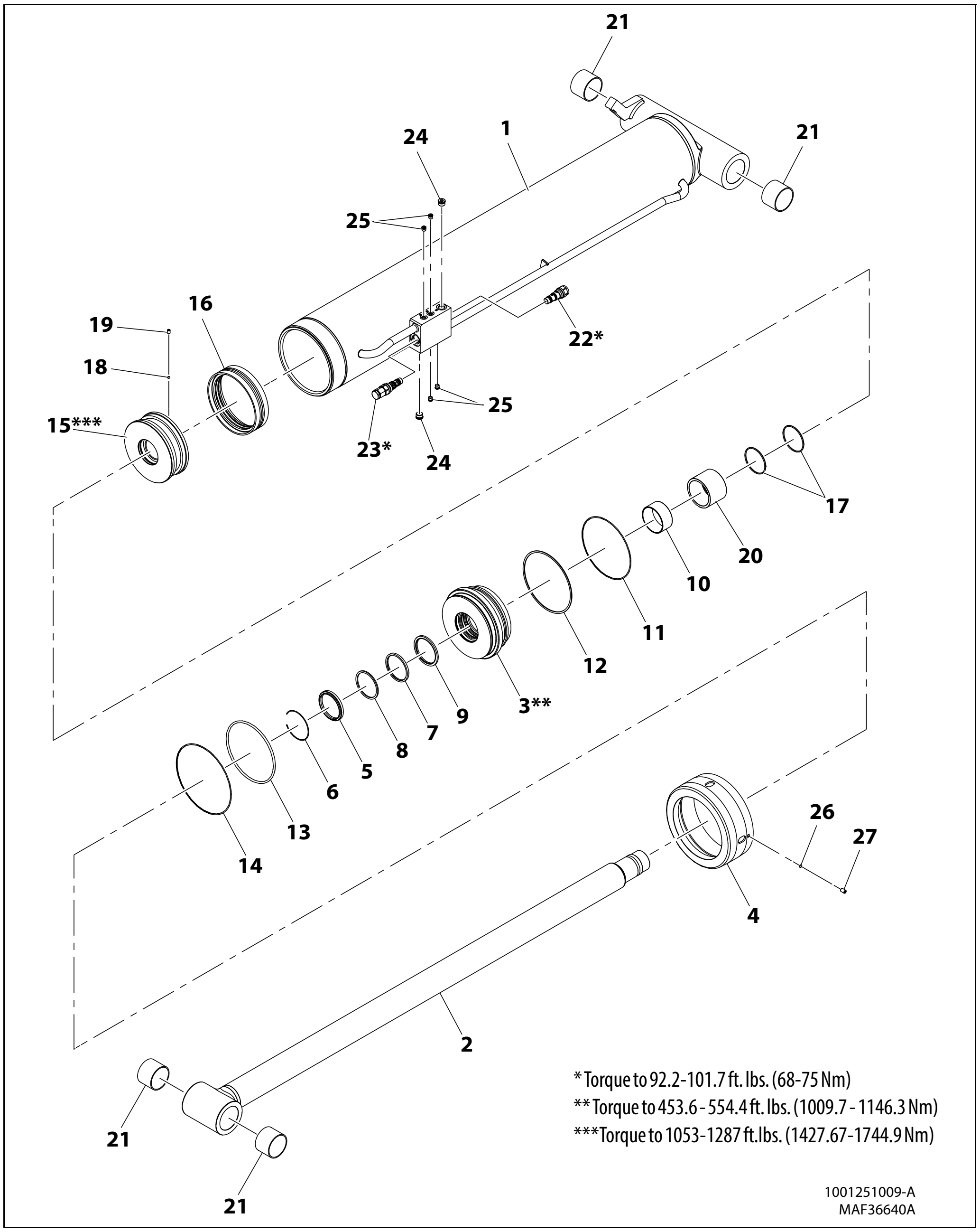
Main Boom Lift Cylinder



1. Barrel
2. Rod
3. Head
4. Barrel Cap
5. Dust Wiper
6. Retaining Ring
7. Rod Seal
8. Backup Ring
9. Buffer Ring
10. Dry Bearing
11. O-Ring
12. Backup ring
13. O-Ring
14. O-Ring
15. Piston
16. Piston Seal
17. Wear ring
18. Steel Ball
19. Set Screw
20. O-ring
21. MRP Bearing
22. Counter Balance Valve
23. Plug
24. Plug
25. Piston RIng
26. Locking insert
27. Screw

Figure 5-56. Main Boom Lift Cylinder

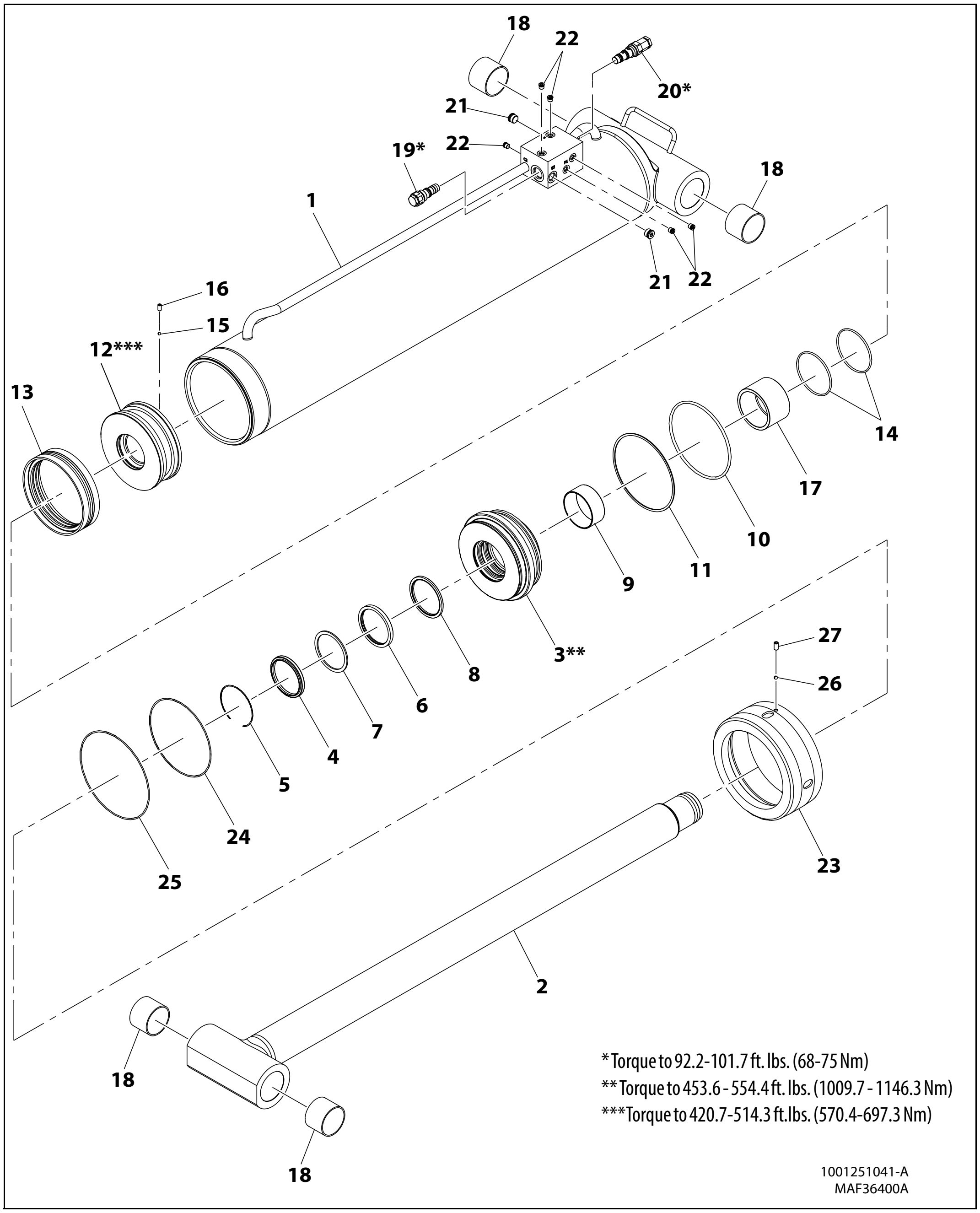
Tower Boom Lift Cylinder



1. Barrel
2. Rod
3. Head
4. Barrel Cap
5. Dust Wiper
6. Retaining Ring
7. Rod Seal
8. Backup Ring
9. Buffer Ring
10. Dry Bearing
11. O-Ring
12. Backup ring
13. O-Ring
14. O-Ring
15. Piston
16. Piston Seal
17. O-ring
18. Steel Ball
19. Set Screw
20. Spacer
21. MRP Bearing
22. Counter Balance Valve
23. Counter Balance Valve
24. Plug
25. Plug
26. Locking insert
27. Screw

Figure 5-57. Tower Boom Lift Cylinder

Upright Level Cylinder



1. Barrel	6. Rod Seal	11. Backup ring	16. Set Screw	21. Plug	26. Locking insert
2. Rod	7. Backup Ring	12. Piston	17. Spacer	22. Plug	27. Screw
3. Head	8. Buffer Ring	13. Piston Seal	18. MRP Bearing	23. Barrel Cap	
4. Dust Wiper	9. Dry Bearing	14. O-Ring	19. Counter Balance Valve	24. O-Ring	
5. Retaining Ring	10. O-Ring	15. Steel Ball	20. Counter Balance Valve	25. O-Ring	

Figure 5-58. Upright Level Cylinder

Master Cylinder

DISASSEMBLY

1. Remove the oil from the cylinder.
2. Fix the cylinder in a vertical or horizontal position. Vertical position is convenient for disassembly and assembly. Fix the base by inserting the pin not to be rotated. Remove any hoses, valves, or fittings that may be in the way.

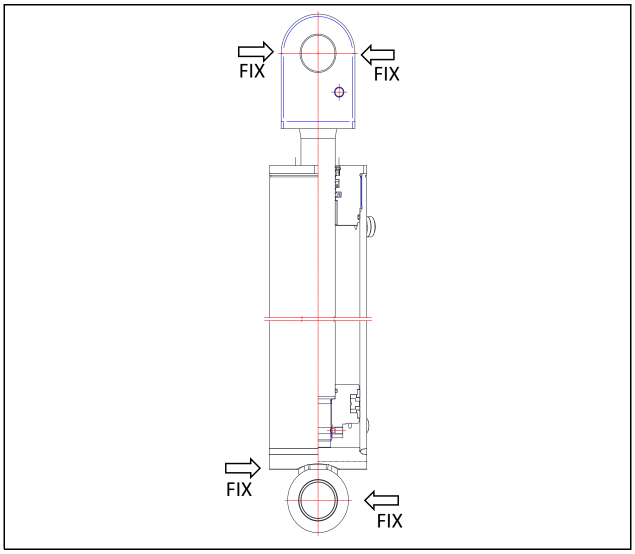


Figure 5-59. Fixing the Cylinder

3. Unscrew the cylinder head.
   - **a.** Caulking is used for locking when head is assembled with the barrel.
   - **b.** Make the bent area flat and then take apart head from barrel with hook spanner.

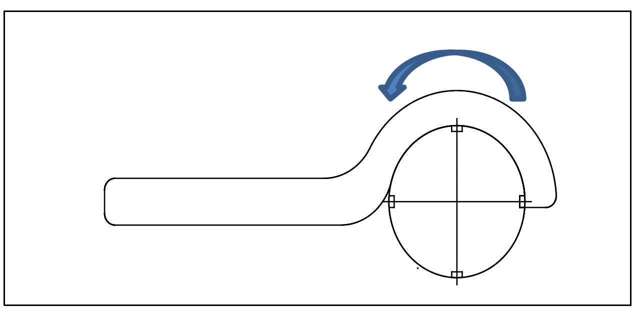
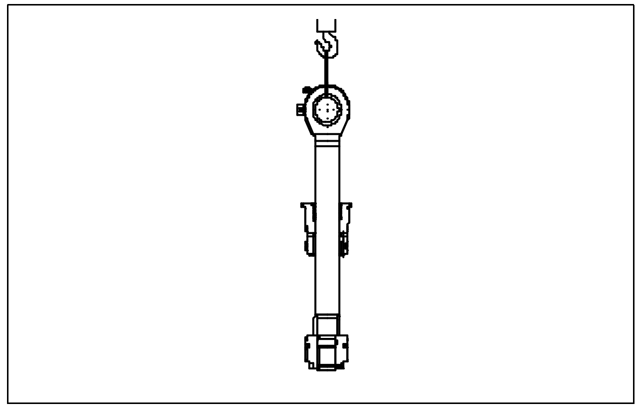


Figure 5-60. Cylinder Head Removal

4. Remove the Rod assembly.
   - **a.** Check if the cap or plug has been removed from the cylinder ports.
   - **b.** Place a suitable container under the cylinder to catch any oil coming out of the cylinder.
   - **c.** After the Rod assembly is pulled from the barrel, unscrew the head using a spanner wrench.
   - **d.** After disassembling the rod assembly, place it on a support.

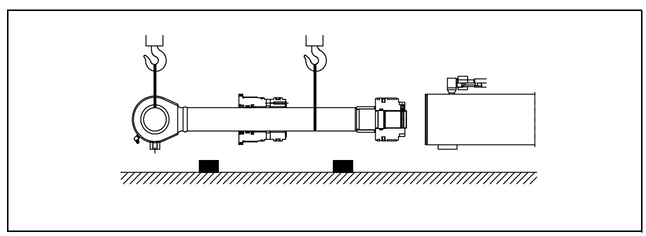
CAUTION

IF THE CYLINDER IS FIXED AT A VERTICAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; WHEN THE HEAD IS UNSCREWED AND THEN ROD ASSEMBLY IS PULLED FROM THE BARREL, THERE IS A SPACE BETWEEN THE HEAD AND PISTON. IT IS POSSIBLE FOR THE HEAD TO SUDDENLY SLIDE DOWN, POSSIBLY CAUSING INJURY. TO PREVENT THIS, THE HEAD SHOULD BE PUSHED AGAINST THE PISTON BEFORE PROCEEDING.



CAUTION

IF A CYLINDER IS AT A HORIZONTAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; IT IS POSSIBLE FOR THE ROD TO FALL AND BE DAMAGED WHEN REMOVED FROM THE BARREL IF NOT PROPERLY SUPPORTED. PLACE SUPPORT UNDER THE BARREL AS SHOWN BELOW.



5. Place the Rod assembly on blocking. Use the pin hole to keep it from rotating.
6. Unscrew the Piston Nut.
   - **a.** Caulking is used to lock the setscrew so grind the caulking area and then unscrew the set screw.
   - **b.** Remove the steel ball.
   - **c.** Unscrew the piston. The piston is secured with a torque specified in Table 5-36 Piston Nut Torque. 1.5 x this torque is needed to remove the nut. If the stronger torque is needed, use a power wrench operated by a hydraulic unit.

NOTE: *If it is not a set screw type, continue with the disassembly of the piston nut.*

7. Remove the PISTON and HEAD in sequence.

8. Piston and Head disassembly.

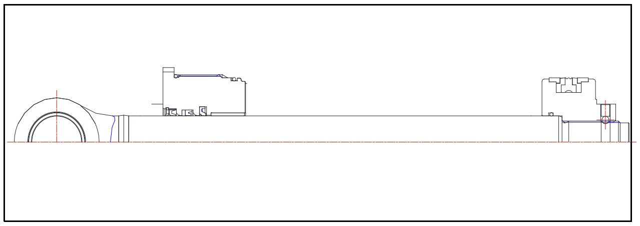


Figure 5-61. Piston and Head Disassembly

a. Unscrew the Piston Nut.
b. Take the piston apart by sliding off the rod in the direction of the rod threads.
c. Take the head apart by sliding off the rod in the direction of the rod threads. Be careful not to make the seal in the head damaged by the rods.

9. Take apart piston seal.

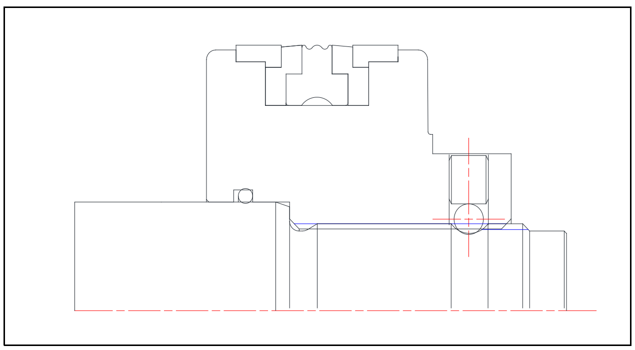


Figure 5-62. Piston Seal Removal

a. The wear ring is easily taken apart by hand.
b. The piston seal is a two piece seal; the ring at the outer side is easily removed. Remove the ring inside of the piston seal.
c. Remove the o-ring.

NOTE: *All seals must be discarded after removal. They cannot be reused.*

10. Remove the head seal.

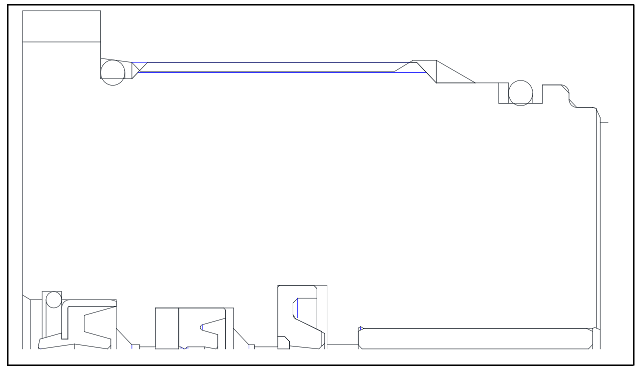


Figure 5-63. Head Seal Removal

a. Remove the rod seal and backup ring.
b. Remove the retaining ring with a flat-head screwdriver prior to removing the dust wiper and remove the dust wiper.
c. Remove the o-ring and backup ring.
d. The bushing is pressed in and must be removed by using a tool as shown below.

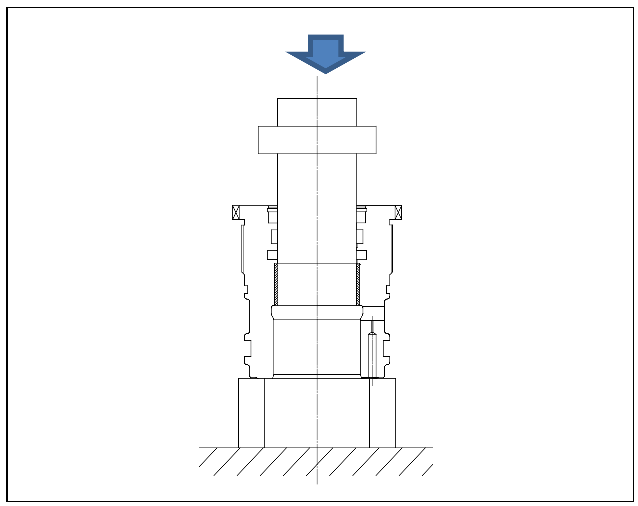


Figure 5-64. Bush Removal

NOTICE

DISCARD ALL SEALS AFTER REMOVAL AND REPLACE THEM WITH NEW ONES FOR ASSEMBLY.

11. MRP Bearing Disassembly

To remove the MRP bearing, break it into pieces.

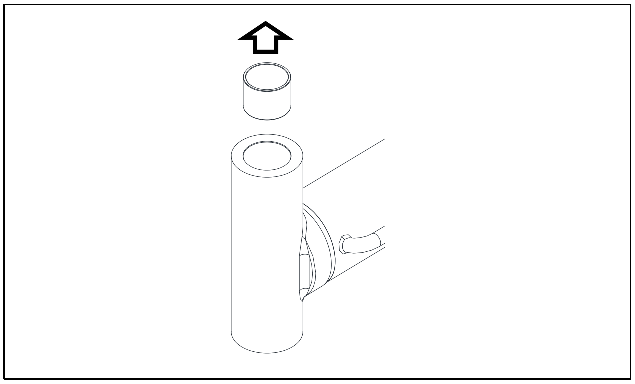


Figure 5-65. Remove Bearing.

12. Washing And Storage

All removed parts should be washed with cleaning solution and then coated with light oil to prevent rust. If the cylinder is not to be reassembled right away, store the parts and put a covering over them.

Assembly

CAUTION

TAKE CARE NOT TO LET ANY PAINT CHIPS OR DIRT FALL INSIDE THE CYLINDER. THIS COULD CAUSE LEAKAGE.

1. Rod assembly

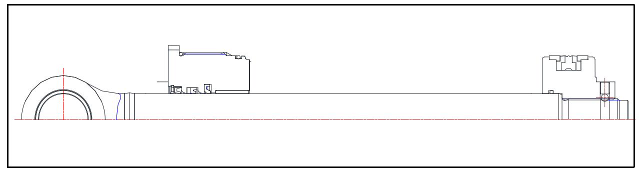


Figure 5-66. Fix Rod Assembly

a. Secure the rod assembly.

b. Install the Head with Rod Assembly onto the rod assembly. Take care as not to damage the lip of the dust wiper and rod seal.

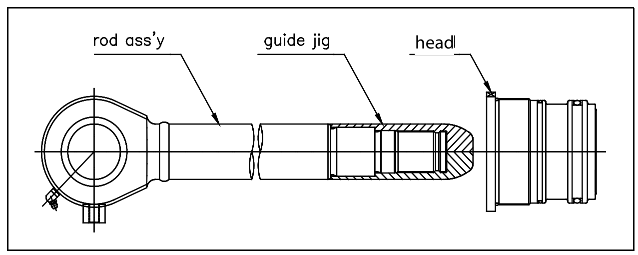


Figure 5-67. Install Cylinder Head

a. Assemble piston.

b. Torque the Piston nut as specified in Table 5-36, Piston Torque Piston Torque. Lack of the torque can result in internal leakage, the piston coming unscrewed, and thread damage. If over torqued, the piston surface which meets the rod will be damaged.

Table 5-38. Piston Nut Torque

Cylinder	Piston
Master	234-286 ft. lbs. (318-388 Nm)

2. Assemble the Rod Assembly.

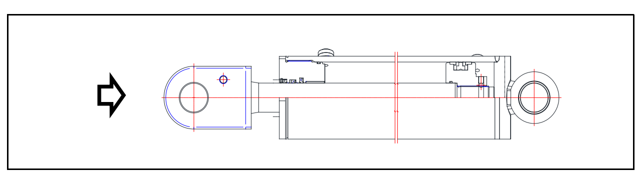


Figure 5-68. Rod Assembly Installation

a. Secure the barrel at a vertical or horizontal position.

b. Insert the assembly into the barrel.

c. When piston is inserted to the barrel take care as to not damage the seal rings.

Table 5-39. Gland and Tube End Assembly

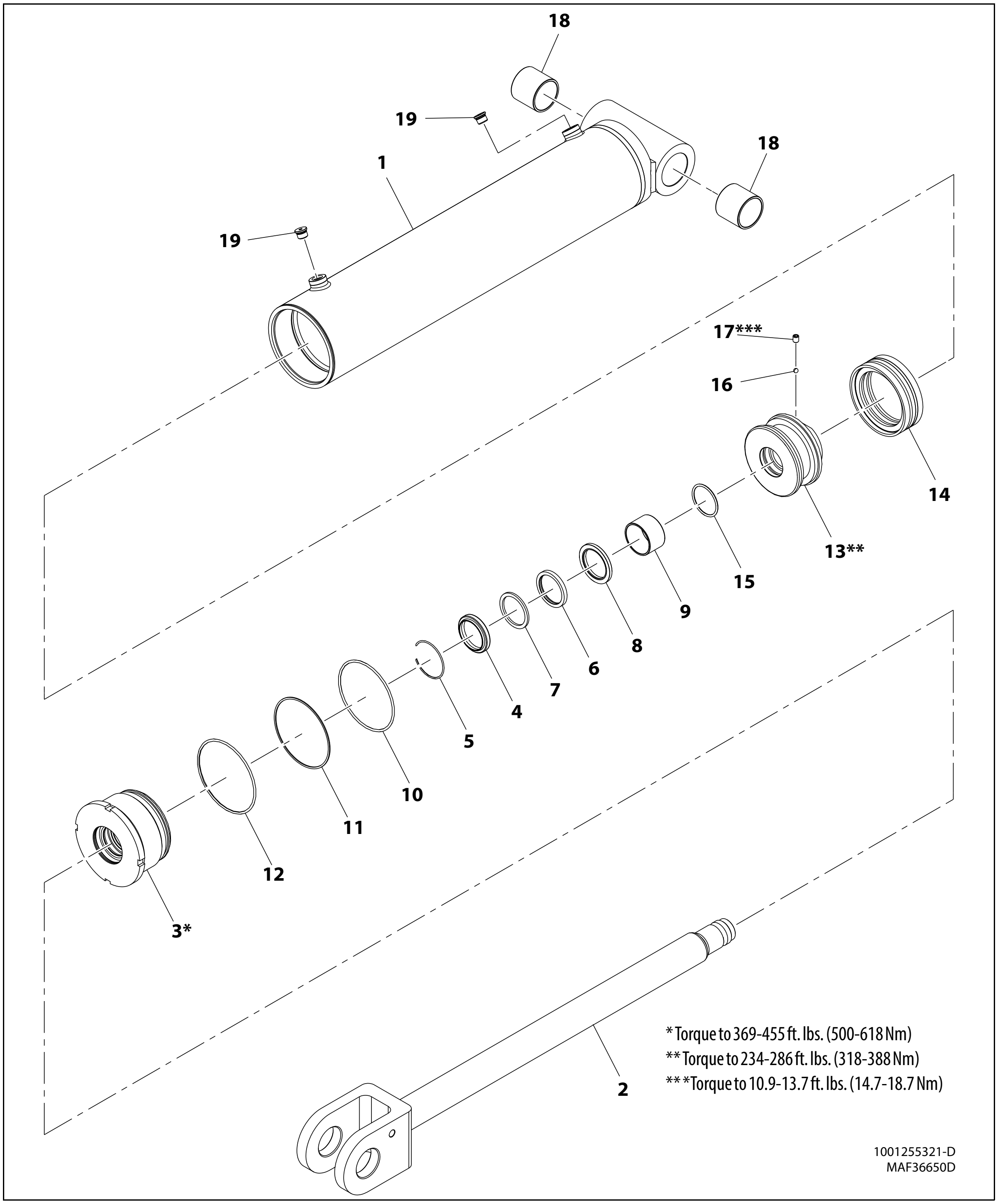
Cylinder	Gland
Master	611.5 - 500.3 Nm (451 - 369 lb ft)

3. Test Operation

a. Install the cylinder on a machine. Fill the cylinder with oil and then have the cylinder slowly operated a minimum of 8 cycles. If it is operated too fast in the beginning, cavitation will result.

b. It is important to make sure all air is cycled from the cylinder.

c. Grease the end of the pin.



1. Barrel	5. Retain Ring	9. Dry Bearing	13. Piston	17. Set Screw
2. Rod	6. Rod Seal	10. O-ring	14. Piston Seal	18. MRP Bearing
3. Head	7. Backup Ring	11. Backup Ring	15. O-ring	19. Plug
4. Dust Wiper	8. Buffer Ring	12. O-ring	16. Steel Ball	

Figure 5-69. Master Cylinder

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.

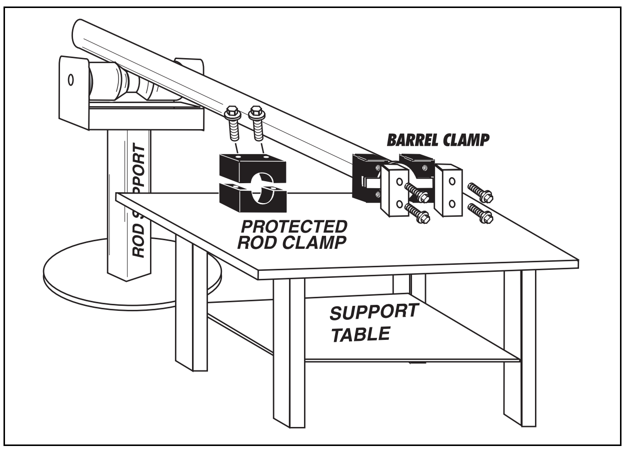


Figure 5-70. Cylinder Barrel Support

4. Using a hook spanner, loosen the spanner nut retainer and remove spanner nut from cylinder barrel.

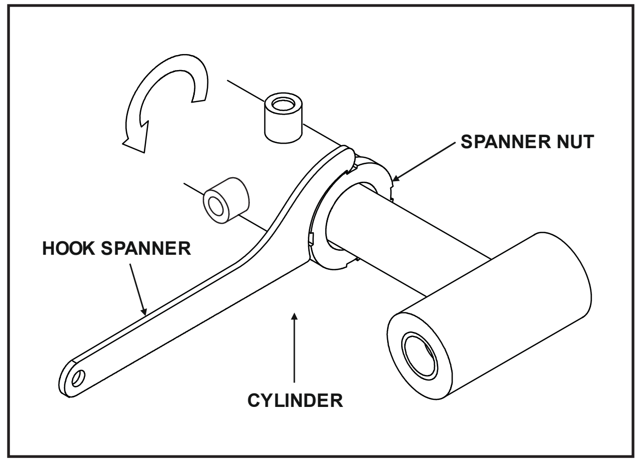


Figure 5-71. Spanner Nut Removal

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.

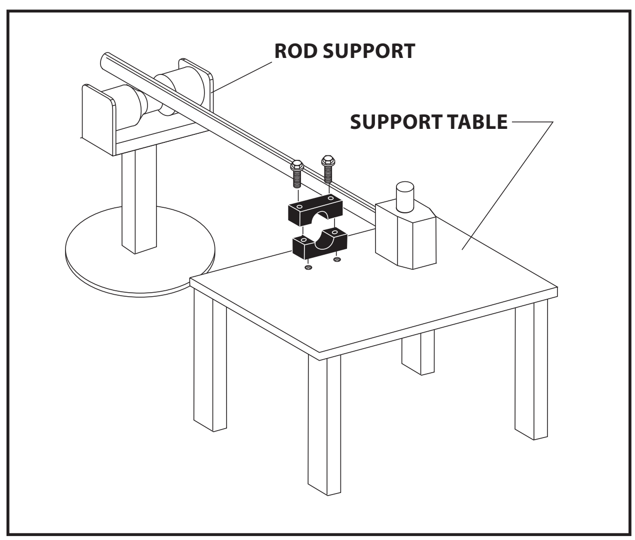
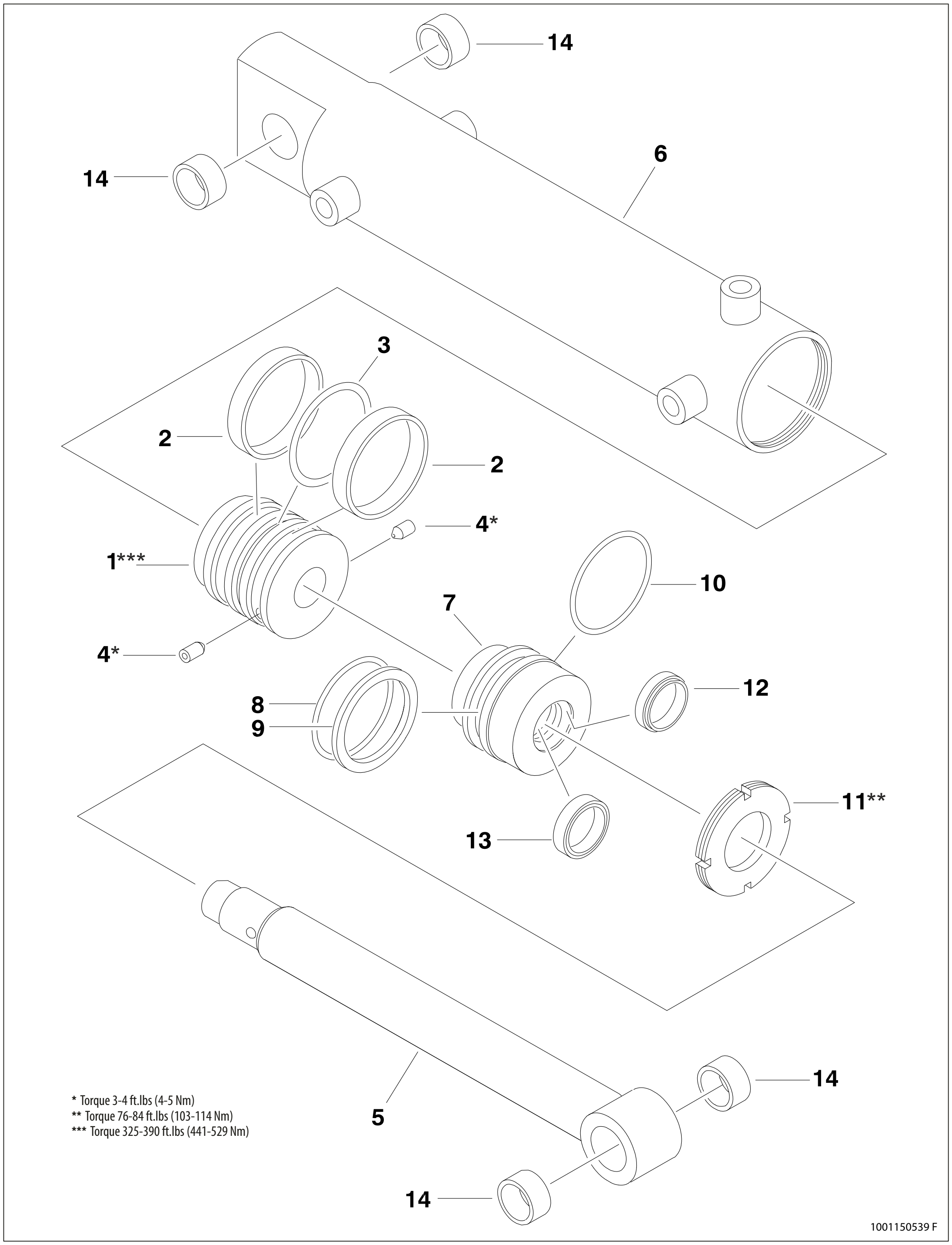


Figure 5-72. Cylinder Rod Support



1. Piston	6. Barrel	11. Spanner Nut
2. Wear Ring	7. Head	12. Wiper Seal
3. Seal	8. O-ring	13. Rod Seal
4. Setscrew	9. Backup Ring	14. Bushing
5. Rod	10. C-Ring	

Figure 5-73. Steer Cylinder

7. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
8. Remove the setscrews from the piston.
9. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
10. Remove and discard the piston seal and wear rings.
11. Remove the rod from the holding fixture. Remove the cylinder head gland. Discard the o-ring, backup ring, c-ring, rod seal, and wiper seal.

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of barrel for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

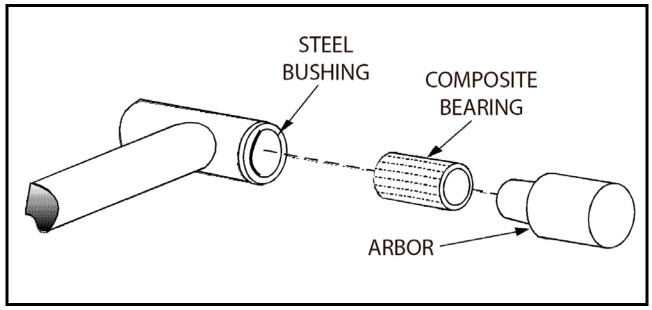


Figure 5-74. Composite Bearing Installation

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

ASSEMBLY

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

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

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

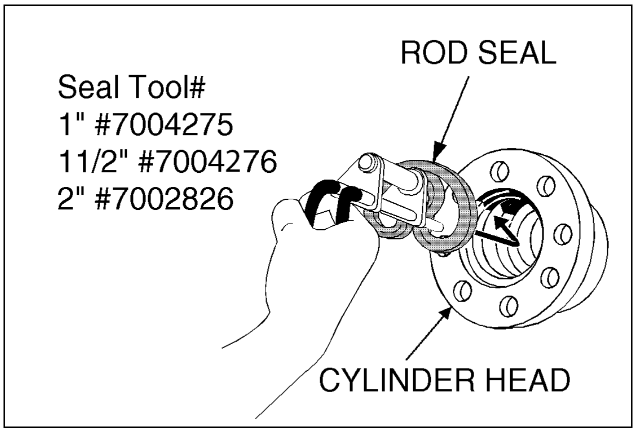


Figure 5-75. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

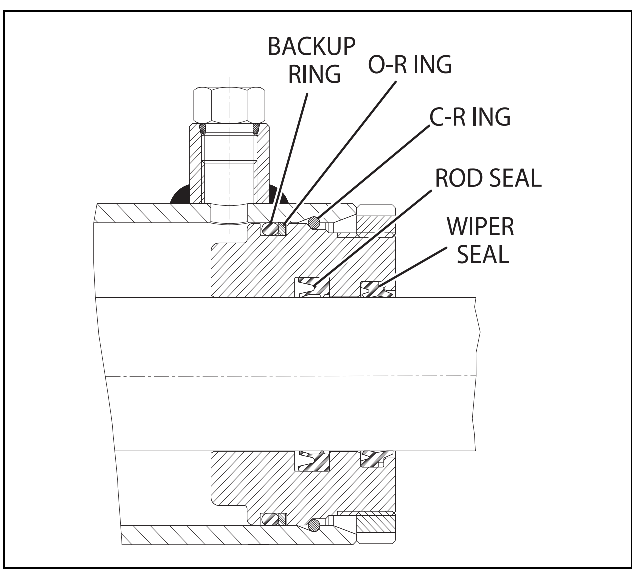
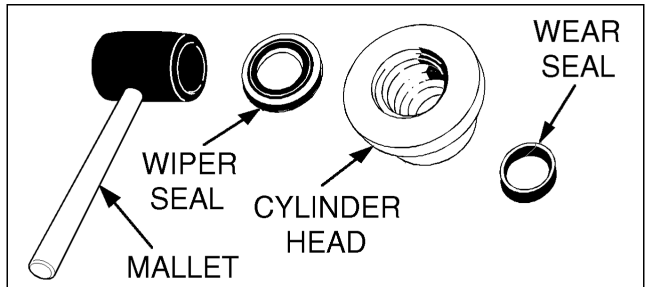


Figure 5-76. Cylinder Head Seal Installation

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 are installed properly. Install seal so that the flat part of seal is facing into head.

Figure 5-77. Wiper Seal Installation

3. Place a new o-ring, backup ring and c-ring in the applicable outside diameter groove of the cylinder head.

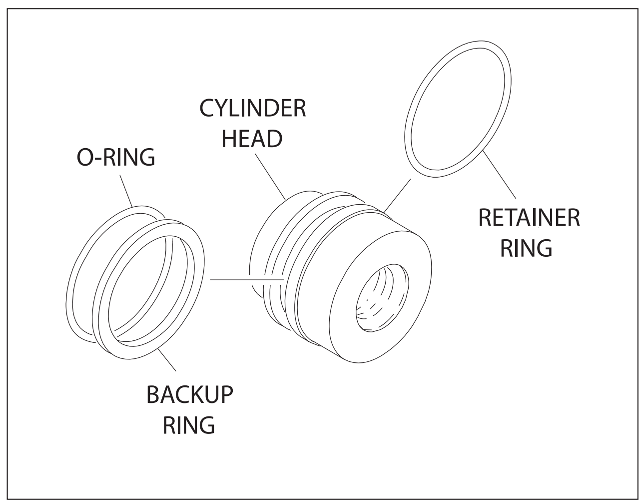


Figure 5-78. Installation of Head Seal Kit

4. Install spanner nut onto rod. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
5. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to piston as possible.
6. Carefully thread the piston on the cylinder rod hand tight, ensuring that the o-ring and backup rings are not damaged or dislodged.
7. Install the setscrews on the piston.
8. Remove the cylinder rod from the holding fixture.

9. Place new seal and wear ring in the outer piston diameter grooves. (A tube, with I.D. slightly larger than the O.D. of the piston is recommended to install the solid seal).

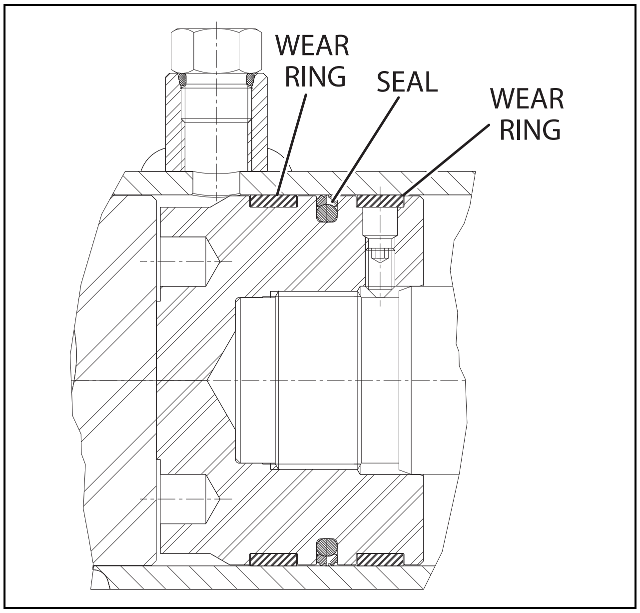


Figure 5-79. Piston Seal Kit Installation

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

NOTICE

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

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

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

13. Secure spanner nut into the cylinder barrel. Torque nut to 325-390 ft.lbs. (441-529 Nm).

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

Main Boom Telescope Cylinder

DISASSEMBLY

1. Remove the oil from the cylinder.
2. Fix the cylinder in a vertical or horizontal position. Vertical position is convenient for disassembly and assembly. Fix the base by inserting the pin not to be rotated. Remove any hoses, valves, or fittings that may be in the way.

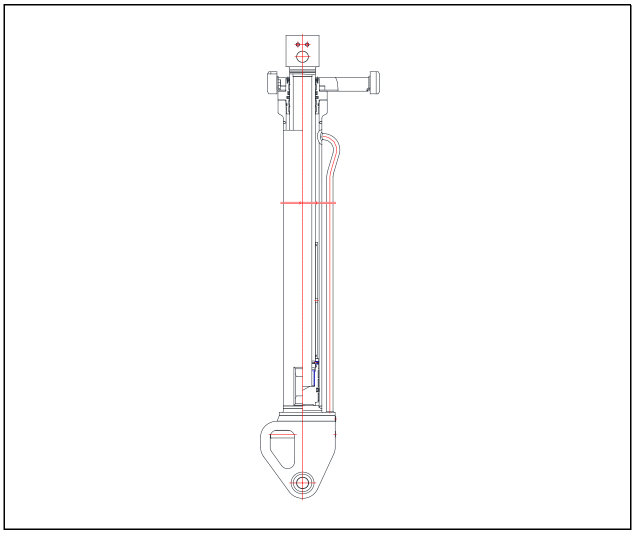


Figure 5-80. Fixing the Cylinder

3. Unscrew the cylinder head.
   a. Caulking is used for locking when land is assembled with the tube.
   b. Make the bent area flat and then take apart head from tube with hook spanner.

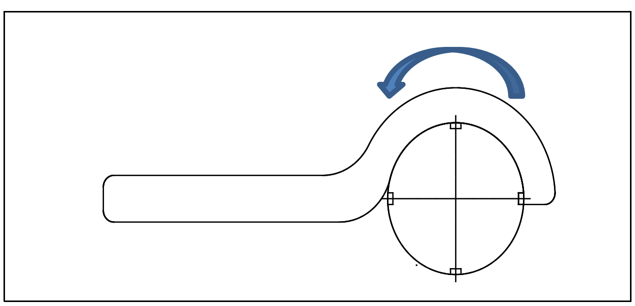
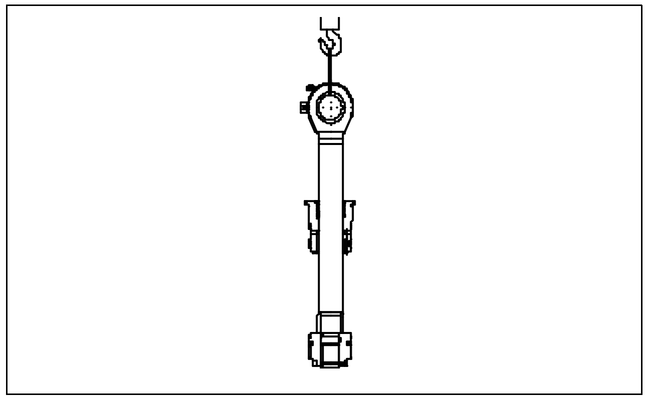


Figure 5-81. Cylinder Head Removal

4. Remove the Rod assembly.
   a. Check if the cap or plug has been removed from the cylinder ports.
   b. Place a suitable container under the cylinder to catch any oil coming out of the cylinder.
   c. After the Rod assembly is pulled from the barrel, unscrew the head using a spanner wrench.
   d. After disassembling the rod assembly, place it on a support.

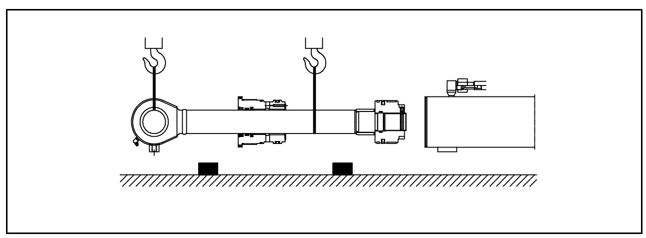
CAUTION

IF THE CYLINDER IS FIXED AT A VERTICAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; WHEN THE HEAD IS UNSCREWED AND THEN ROD ASSEMBLY IS PULLED FROM THE BARREL, THERE IS A SPACE BETWEEN THE HEAD AND PISTON. IT IS POSSIBLE FOR THE HEAD TO SUDDENLY SLIDE DOWN, POSSIBLY CAUSING INJURY. TO PREVENT THIS, THE HEAD SHOULD BE PUSHED AGAINST THE PISTON BEFORE PROCEEDING.



CAUTION

IF A CYLINDER IS AT A HORIZONTAL POSITION FOR DISASSEMBLY, GIVE ATTENTION TO THE FOLLOWING; IT IS POSSIBLE FOR THE ROD TO FALL AND BE DAMAGED WHEN REMOVED FROM THE BARREL IF NOT PROPERLY SUPPORTED. PLACE SUPPORT UNDER THE BARREL AS SHOWN BELOW.



5. Place the Rod assembly on blocking. Use the pin hole to keep it from rotating.
6. Unscrew the Piston Nut.
   a. Caulking is used to lock the setscrew so grind the caulking area and then unscrew the set screw.
   b. Remove the steel ball.
   c. Unscrew the piston nut. The piston is secured with a torque specified in Table 5-36 Piston Nut Torque. 1.5 x this torque is needed to remove the nut. If the stronger torque is needed, use a power wrench operated by a hydraulic unit.

NOTE: *If it is not a set screw type, continue with the disassembly of the piston nut.*

7. Remove the PISTON and HEAD in sequence.

8. Piston and Head disassembly.

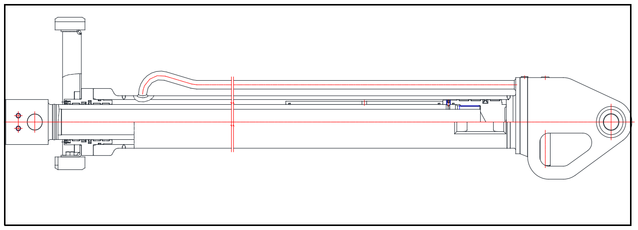


Figure 5-82. Piston and Head Disassembly

a. Unscrew the Piston Nut.

b. Take the piston apart by sliding off the rod in the direction of the rod threads.

c. Take the head apart by sliding off the rod in the direction of the rod threads. Be careful not to make the seal in the head damaged by the rods.

9. Take apart piston seal.

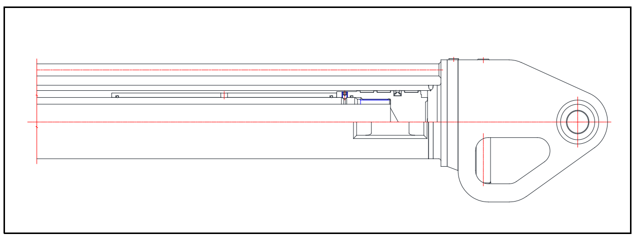


Figure 5-83. Piston Seal Removal

a. The wear ring is easily taken apart by hand.

b. The piston seal is a two piece seal; the ring at the outer side is easily removed. Remove the ring inside of the piston seal.

c. Remove the o-ring.

NOTE: *All seals must be discarded after removal. They cannot be reused.*

10. Remove the head seal.

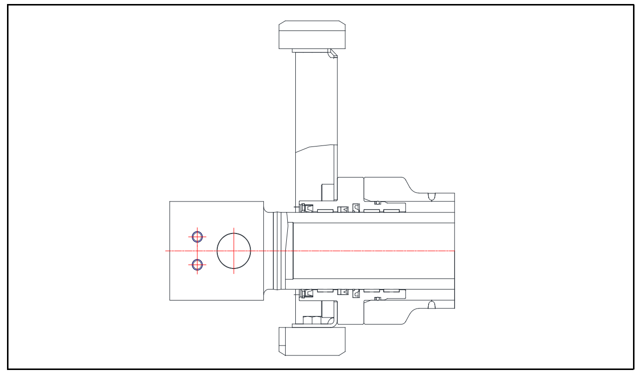


Figure 5-84. Head Seal Removal

a. Remove the rod seal and backup ring.

b. Remove the retaining ring with a flat-head screwdriver prior to removing the dust wiper and remove the dust wiper.

c. Remove the o-ring and backup ring.

d. The bushing is pressed in and must be removed by using a tool as shown below.

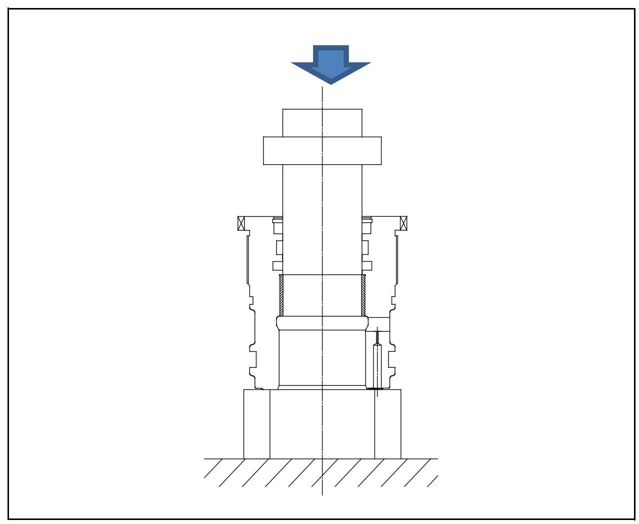


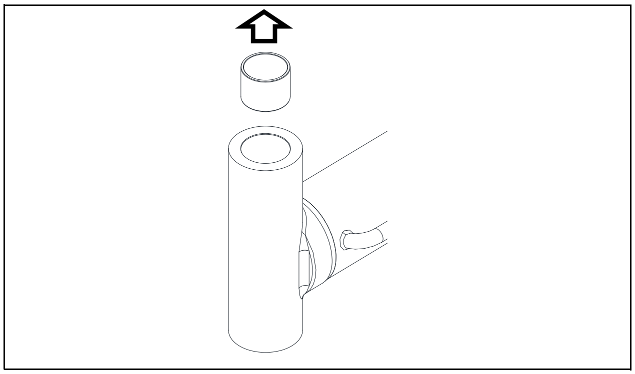
Figure 5-85. Bush Removal

NOTICE

DISCARD ALL SEALS AFTER REMOVAL AND REPLACE THEM WITH NEW ONES FOR ASSEMBLY.

11. MRP Bearing Disassembly

    To remove the MRP bearing, break it into pieces.



12. Washing And Storage

    All removed parts should be washed with cleaning solution and then coated with light oil to prevent rust. If the cylinder is not to be reassembled right away, store the parts and put a covering over them.

Assembly

CAUTION

TAKE CARE NOT TO LET ANY PAINT CHIPS OR DIRT FALL INSIDE THE CYLINDER. THIS COULD CAUSE LEAKAGE.

1. Rod assembly

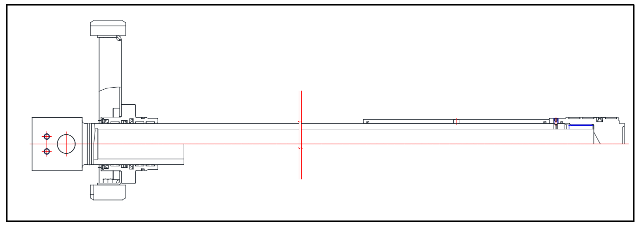


Figure 5-86. Fix Rod Assembly

   a. Secure the rod assembly.

   b. Install the Head with Rod Assembly onto the rod assembly. Take care as not to damage the lip of the dust wiper and rod seal.

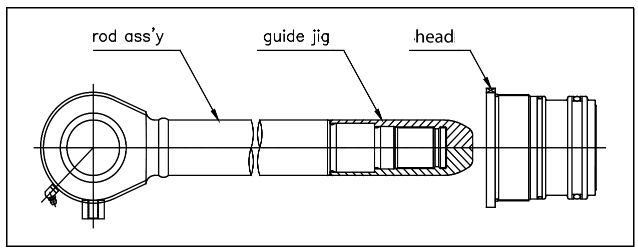


Figure 5-87. Install Cylinder Head

   a. Assemble piston.

   b. Torque the Piston nut as specified in Table 5-36, Piston Torque. Lack of the torque can result in internal leakage, the piston coming unscrewed, and thread damage. If over torqued, the piston surface which meets the rod will be damaged.

Cylinder	Piston
Main Boom Telescopic	420.3 - 513.7 ft.lbs. (569.85 - 696.48 Nm)

2. Assemble the Rod Assembly.

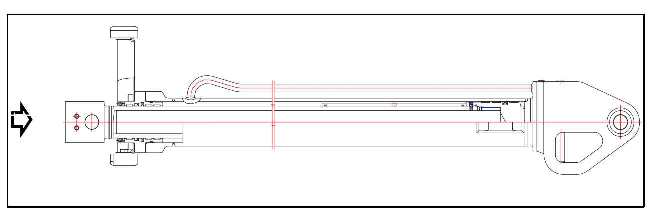


Figure 5-88. Rod Assembly Installation

a. Secure the barrel at a vertical or horizontal position.

b. Insert the assembly into the barrel.

c. When piston is inserted to the barrel take care as to not damage the seal rings.

Table 5-40. Head and Bolt Assembly

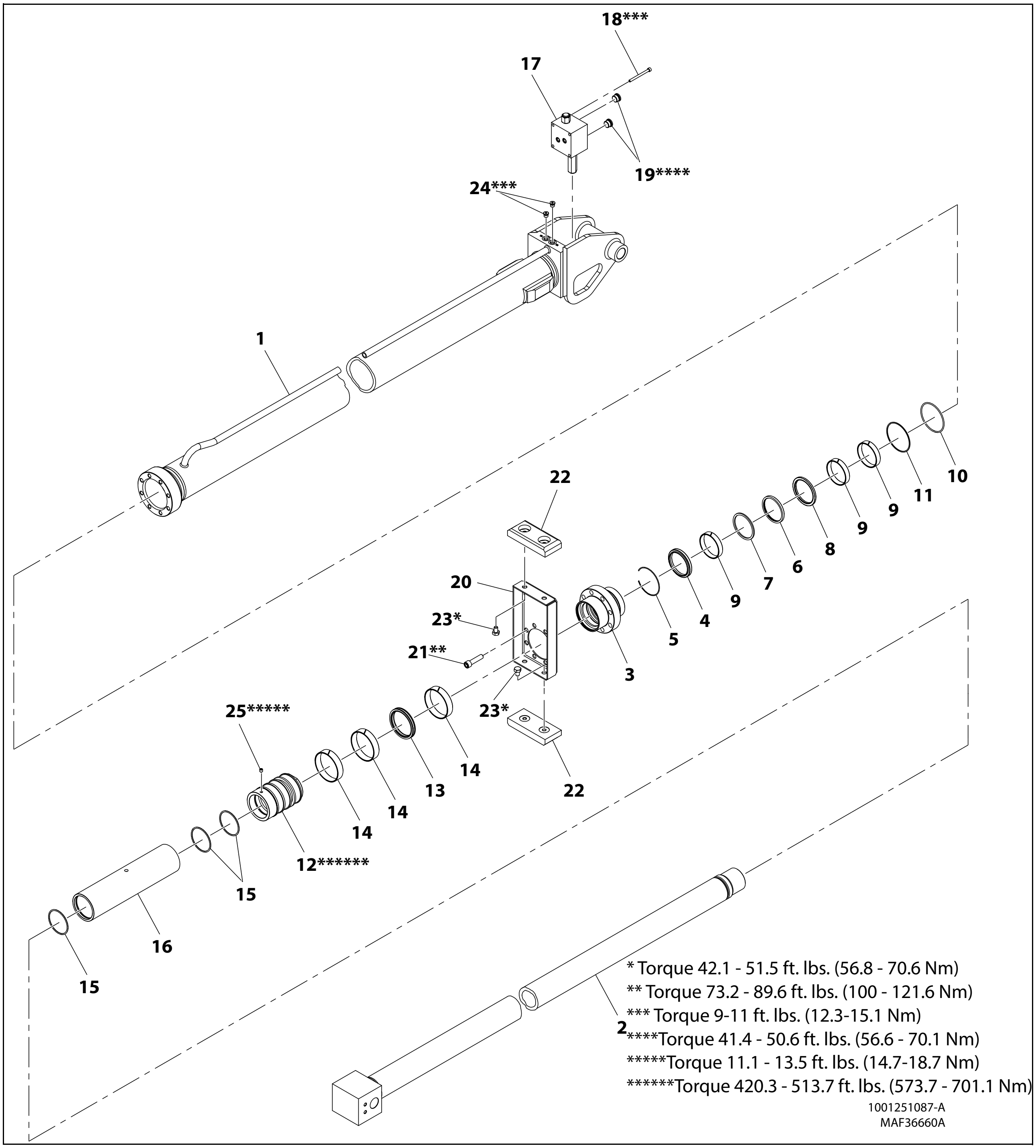
Cylinder	Gland
Main Boom Telescopic	73.2 - 89.6 lb ft (99.25 - 121.48 Nm)

3. Test Operation

a. Install the cylinder on a machine. Fill the cylinder with oil and then have the cylinder slowly operated a minimum of 8 cycles. If it is operated too fast in the beginning, cavitation will result.

b. It is important to make sure all air is cycled from the cylinder.

c. Grease the end of the pin.



1.	Barrel	6.	Rod Seal	11.	Backup Ring	16.	Spacer	21.	Socket Bolt
2.	Rod	7.	Backup Ring	12.	Piston	17.	Valve Assembly	22.	Wear pad assembly
3.	Head	8.	Buffer Ring	13.	Piston Seal	18.	Socket Bolt	23.	Bolt
4.	Dust Wiper	9.	Wear Ring	14.	Wear Ring	19.	Socket Plug	24.	Socket Plug
5.	Retain Ring	10.	O-ring	15.	O-ring	20.	Plate	25.	Screw

Figure 5-89. Main Boom Telescopic Cylinder

Tower Boom Telescope Cylinder

DISASSEMBLY

NOTICE

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

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

WARNING

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

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

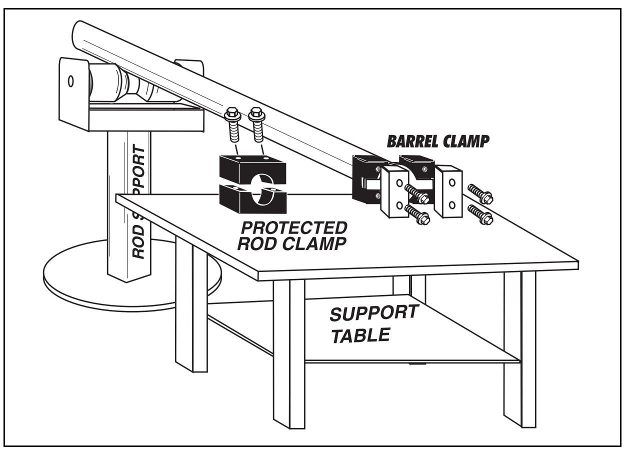


Figure 5-90. Cylinder Barrel Support

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

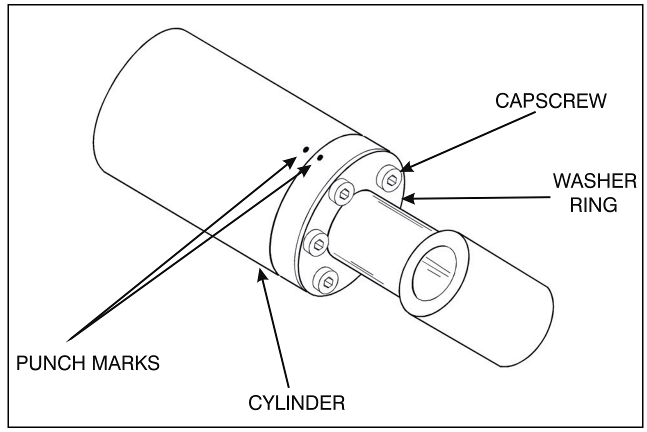


Figure 5-91. Capscrew Removal

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.

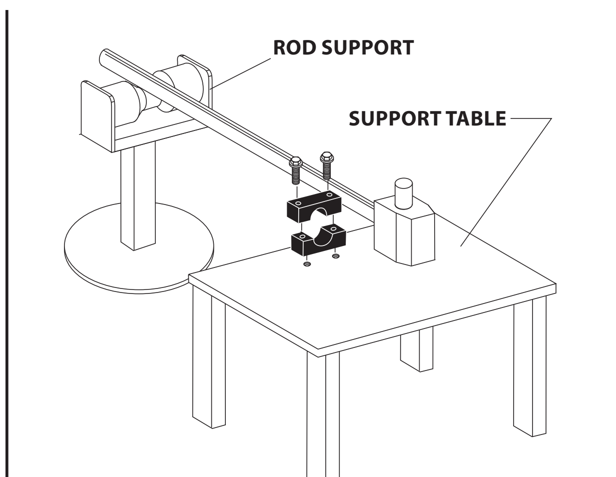
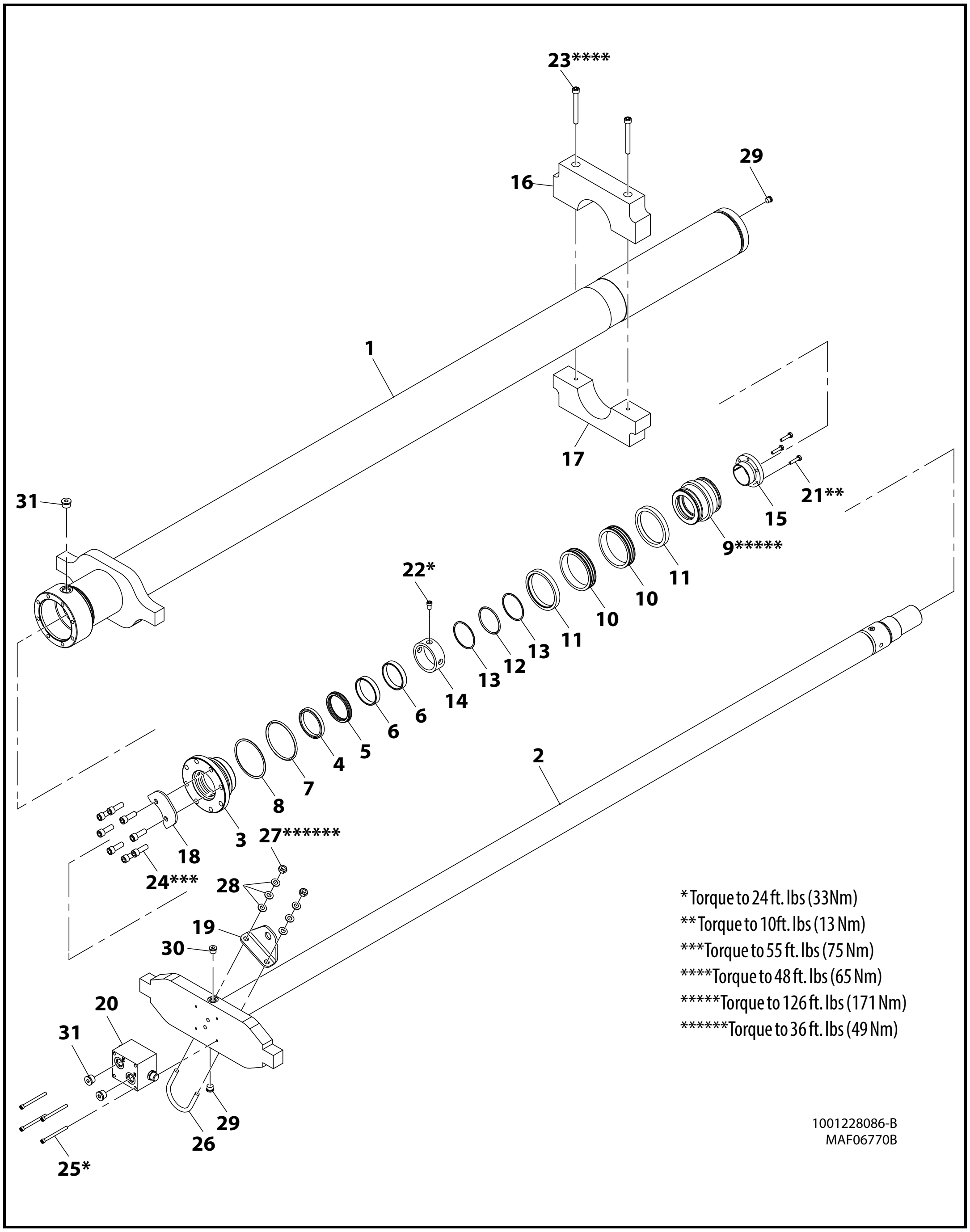


Figure 5-92. Cylinder Rod Support



1. Barrel	8. Backup Ring	15. Tapered Bushing	22. Setscrew	29. Plug
2. Rod	9. Piston	16. Support Pad	23. Bolt	30. Plug
3. Head	10. Seal	17. Support Pad	24. Capscrew	31. Plug
4. Wiper	11. Lock Ring	18. Target Plate	25. Capscrew	
5. Rod Seal	12. O-ring	19. Mount Plate	26. U Bolt	
6. Wear Ring	13. Backup Ring	20. Valve Assembly	27. Nut	
7. O-ring	14. Tube Spacer	21. Bolt	28. Flatwasher	

Figure 5-93. Tower Boom Telescopic Cylinder

8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.
9. Insert the capscrews in the threaded holes in the outer piece of the tapered bushing. Progressively tighten the capscrews until the bushing is loosen on the piston.
10. Remove the bushing from the piston.

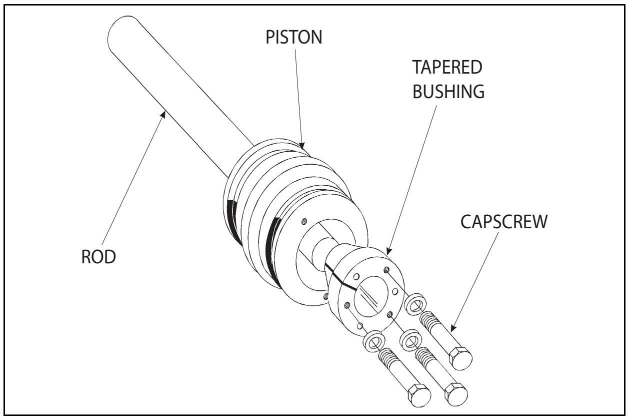


Figure 5-94. Tapered Bushing Removal

11. Screw the piston counterclockwise, by hand, and remove the piston from cylinder rod.
12. Remove and discard the piston o-rings, seal rings, and backup rings.
13. Remove setscrew from the piston spacer. Remove spacer from the rod.
14. Remove the rod from the holding fixture. Remove capscrews, target plate and washer ring if available. Remove the cylinder head gland. Discard the o-rings, backup rings, rod seals, and wiper seals.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
6. Inspect threaded portion of piston for damage. Dress threads as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
11. If applicable, inspect rod and barrel bearings for signs of correct excessive wear or damage. Replace as necessary.
    a. Thoroughly clean hole, (steel bushing) of burrs, dirt etc. to facilitate bearing installation.
    b. Inspect steel bushing for wear or other damage. If steel bushing is worn or damaged, rod/barrel must be replaced.
    c. Lubricate inside of steel bushing prior to bearing installation.
    d. Using an arbor of the correct size, carefully press the bearing into steel bushing.

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

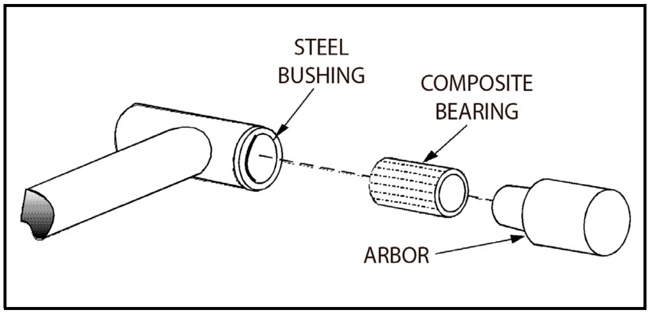


Figure 5-95. Composite Bearing Installation

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

ASSEMBLY

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

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

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

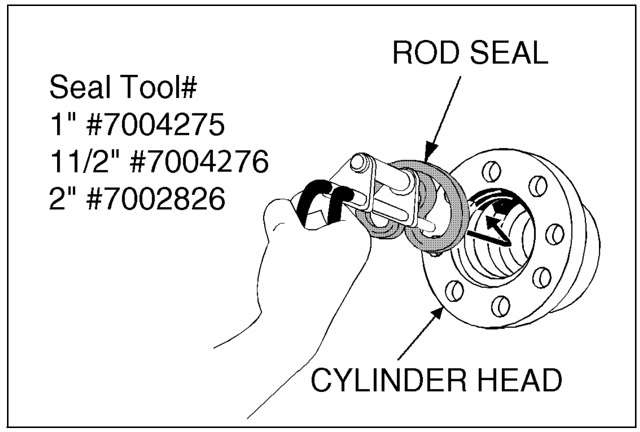


Figure 5-96. Rod Seal Installation

NOTICE

WHEN INSTALLING NEW SEALS, ENSURE SEALS ARE INSTALLED PROPERLY. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

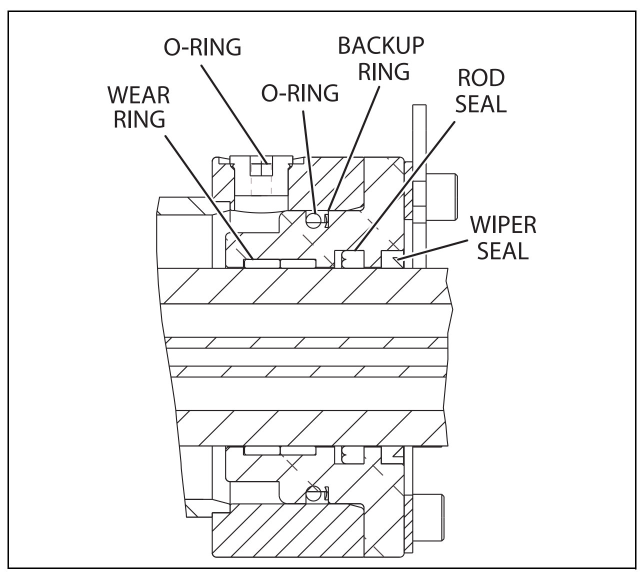
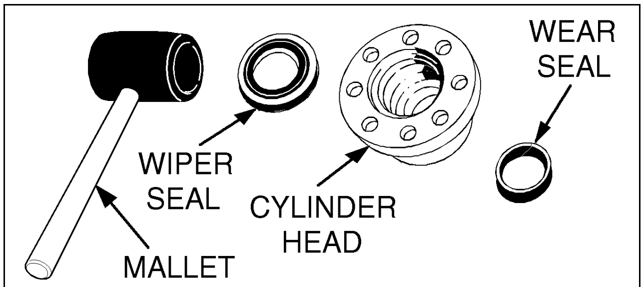


Figure 5-97. Cylinder Head Seal Installation

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 5-98. Wiper Seal Installation

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

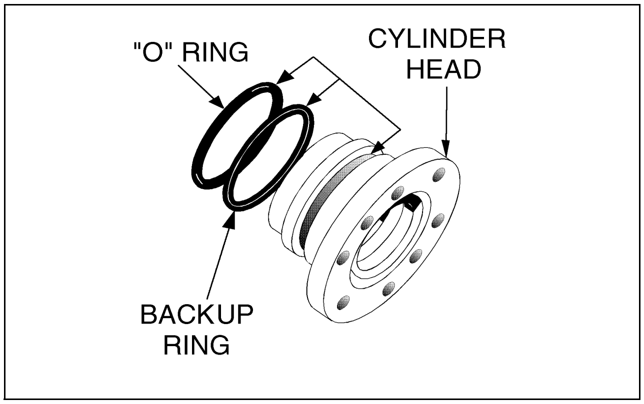


Figure 5-99. Installation of Head Seal Kit

4. Install washer ring onto rod if applicable, 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. Torque setscrew as shown in Figure 5-93.

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 torque piston as shown in Figure 5-103. and Figure 5-93. Install the tapered bushing.

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

10. Assemble the tapered bushing loosely into the piston and insert capscrews through the drilled holes in the bushing and into the tapped holes in the piston.

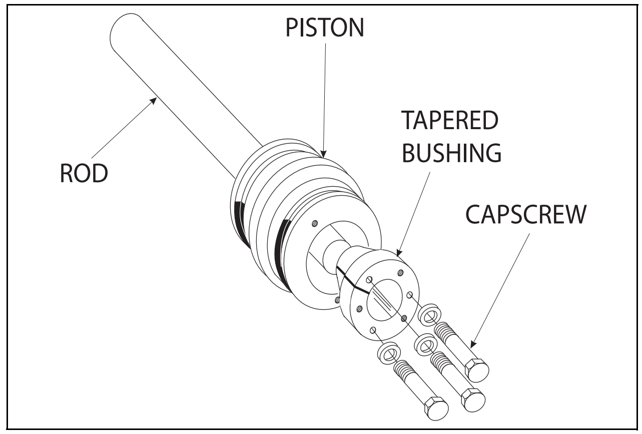


Figure 5-100. Tapered Bushing Installation

11. Tighten the capscrews evenly and progressively in rotation and torque capscrews as shown in Figure 5-93.

12. After the screws have been torqued, tap the tapered bushing with a hammer (16 to 24 oz.) and brass shaft (approximately 3/4" in diameter) as follows;

    a. Place the shaft against the cylinder rod and in contact with the bushing in the spaces between the capscrews.

    b. Tap each space once; this means the tapered bushing is tapped 3 times as there are 3 spaces between the capscrews.

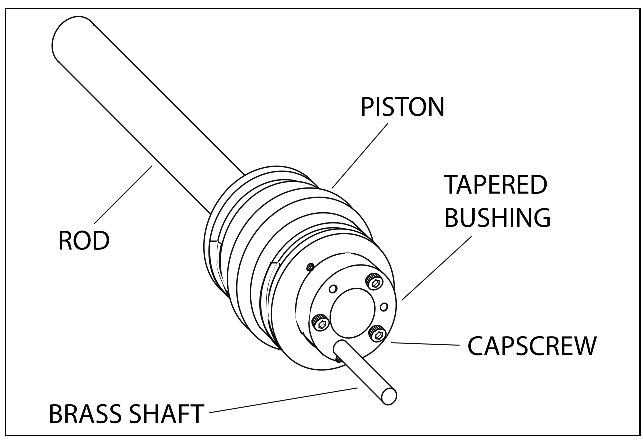


Figure 5-101. Seating the Tapered Bearing

13. Rotate the capscrews evenly and progressively in rotation and torque capscrews as shown in Figure 5-93.

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.

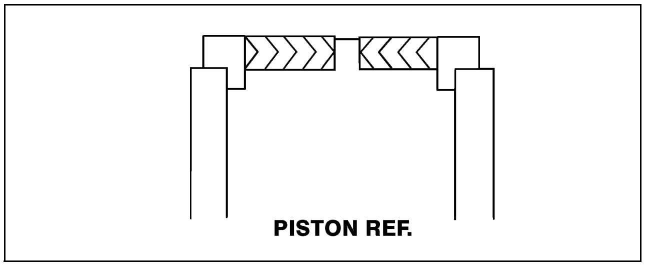


Figure 5-102. Hydrolock Piston Seal Installation

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).

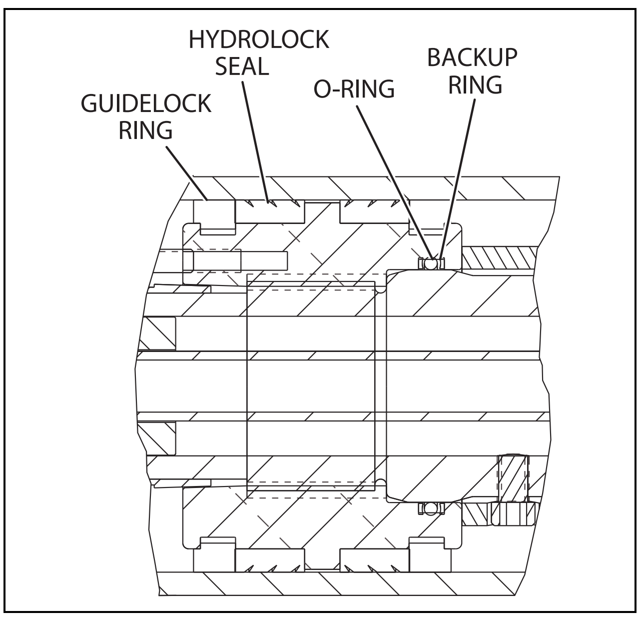


Figure 5-103. Piston Seal Kit Installation

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

NOTICE

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

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

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

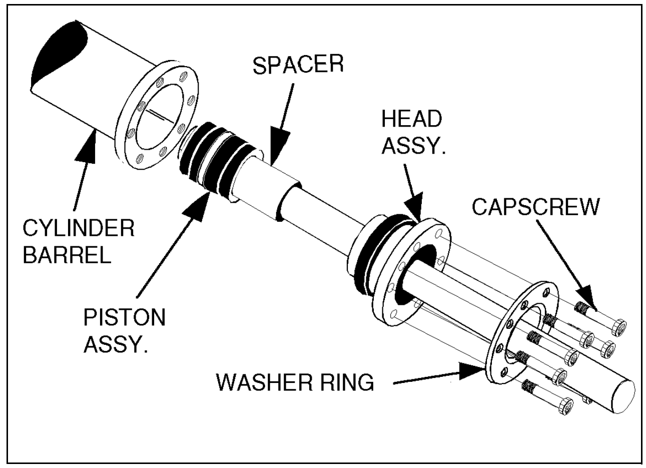


Figure 5-104. Rod Assembly Installation

19. Apply Medium Strength Threadlocking Compound to the socket head bolts and secure the cylinder head gland using the washer ring and bolts. Torque bolts to 55 ft.lbs. (75 Nm).

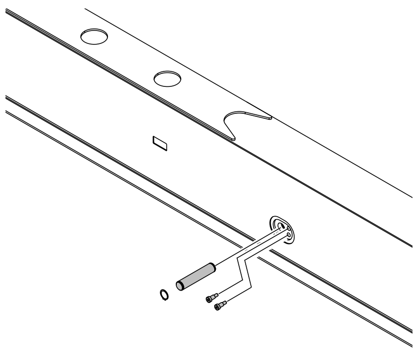
20. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.

21. Install the valve assembly. Torque capscrews to 24 ft.lbs. (33 Nm).

5.4 CYLINDER REMOVAL AND INSTALLATION

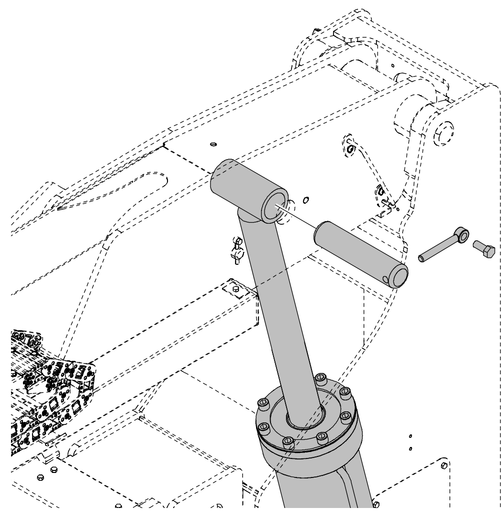
Main Boom Telescope Cylinder Removal

1. Place machine on a flat and level surface, with main boom in the horizontal position.
2. Extend the boom to gain access to main fly boom telescope cylinder rod end pin.
3. Remove the hardware securing the telescope cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.



NOTE: *The Main Boom weighs approximately 2285.6 lb (1037.7 kg).*

4. Using a suitable sling and lifting device, secure the platform end of the boom.
5. Place blocking under the main lift cylinder to prevent it from falling when the attaching hardware is removed.
6. Remove the hardware securing the main lift cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.



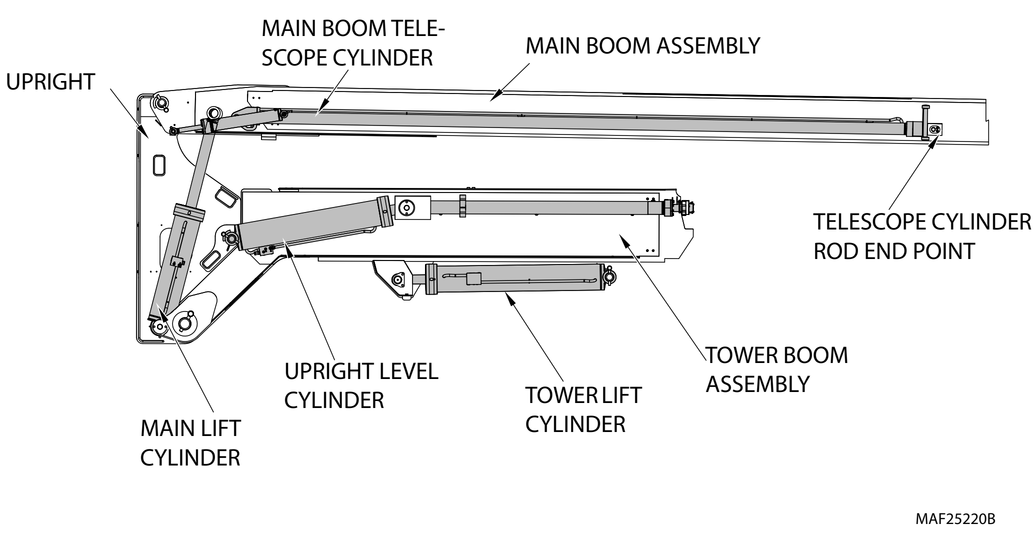
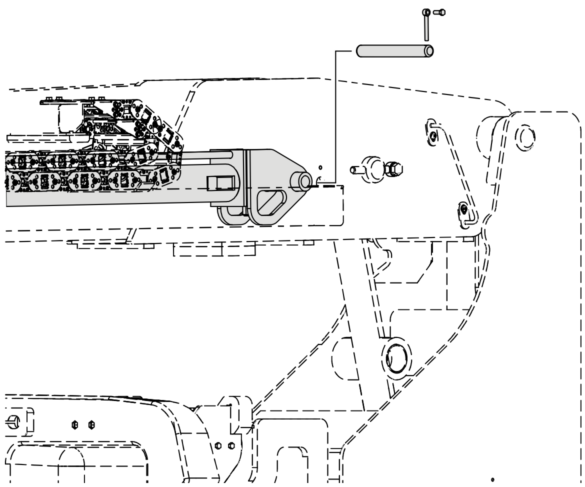


Figure 5-105. Components Main Boom and Tower Boom

7. Using auxiliary power from ground controls, retract the lift cylinder rod completely.
8. Remove hardware securing cover plate on the rear of the main boom. Remove cover plate.
9. Remove mounting hardware securing the telescope cylinder barrel to the main base boom.



10. Using an external pump, extend the cylinder as far as the hydraulic lines will allow to enable a lifting device to be attached to the telescope cylinder.

NOTICE

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

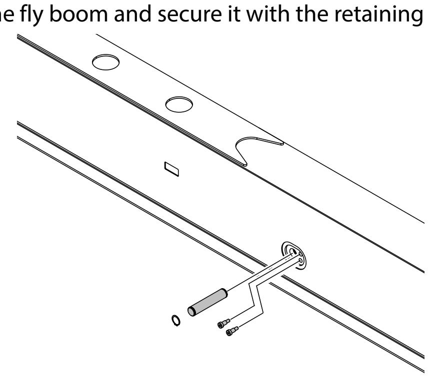
11. Tag and disconnect hydraulic lines from telescope cylinder. Use suitable container to retain any residual hydraulic fluid. Cap hydraulic lines and ports.

NOTE: *The Telescope Cylinder weighs approximately 505.7 lb (229.4 kg).*

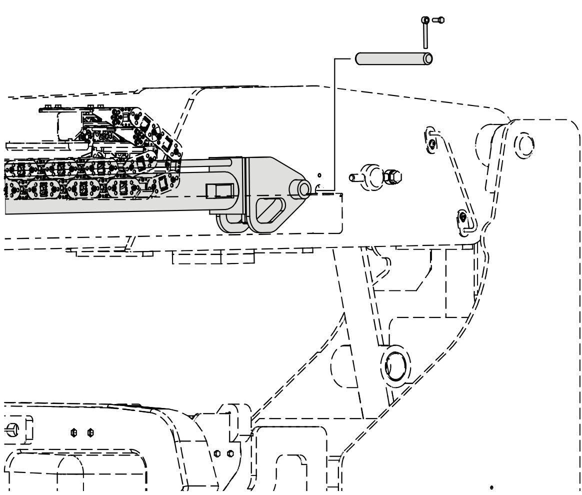
12. Secure the telescope cylinder with a suitable sling and lifting device.
13. Carefully remove the telescope cylinder from the main boom assembly and place in a suitable work area.

Main Boom Telescope Cylinder Installation

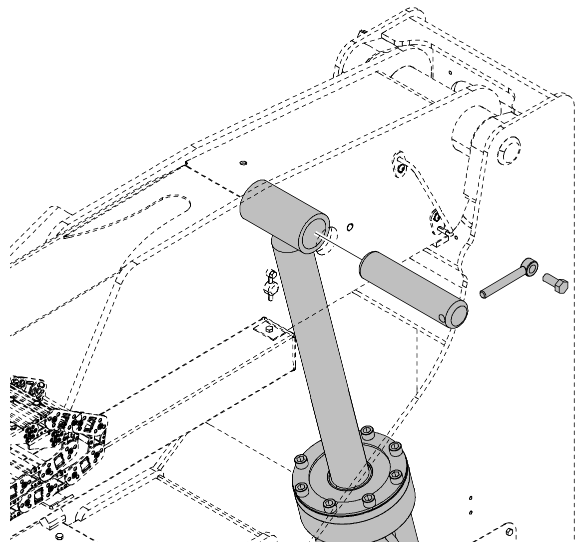
1. Using suitable lifting equipment, carefully insert the cylinder into the boom assembly.
2. Carefully install main telescope cylinder rod pin through the fly boom and secure it with the retaining rings.



3. Remove applicable hydraulic line and port caps and properly connect the hydraulic lines to the telescope cylinder. Ensure all hoses are correctly routed.
4. Carefully install the telescope cylinder barrel end support into mounting block in base boom and secure with blocks and torque the bolts to 35 ft.lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts. Shim as necessary.



5. Remove the lifting device from the main telescope cylinder and retract the main telescope cylinder.
6. Extend the main lift cylinder using the auxiliary control from the ground controls to align with rod end hole in main base boom.
7. Carefully insert the main lift cylinder rod end pin through the base boom and install the mounting hardware.

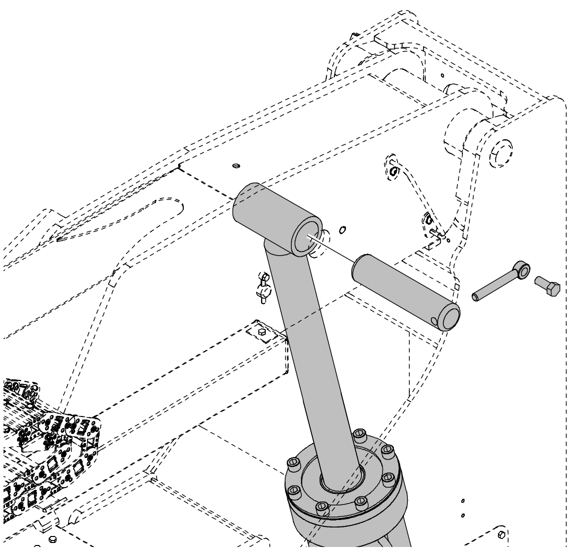


8. Using all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks. Secure as necessary.
9. Check fluid level of hydraulic tank and adjust as necessary.

Main Lift Cylinder Removal

NOTE: *The Main Boom weighs approximately 2285.6 lb (1037.7 kg).*

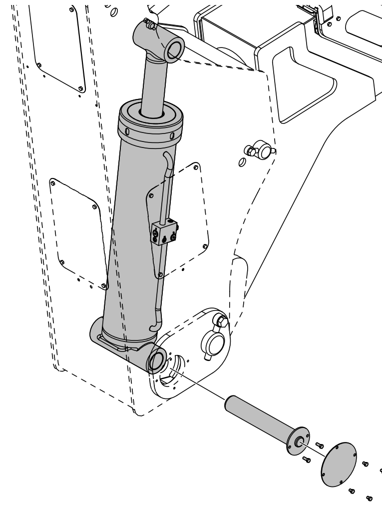
1. Place the machine on a flat and level surface. Attach a suitable lifting device and sling, sufficient to lift the main boom assembly, to the approximate center of the main boom assembly.
2. Place blocking under the cylinder to prevent it from falling when the attaching hardware is removed.
3. Remove the hardware securing the main lift cylinder rod attach pin to the boom. Using a suitable brass drift, drive out the cylinder rod attach pin.



4. Using auxiliary power from ground controls, retract the lift cylinder rod completely.
5. Disconnect, cap, and tag the main boom lift cylinder hydraulic lines and ports.
6. Attach a suitable lifting device and sling to the main lift cylinder.
7. Remove hardware securing cover plate on the bottom of the upright. Remove cover plate.

NOTE: *The Main Lift Cylinder weighs approximately 493 lb (224 kg).*

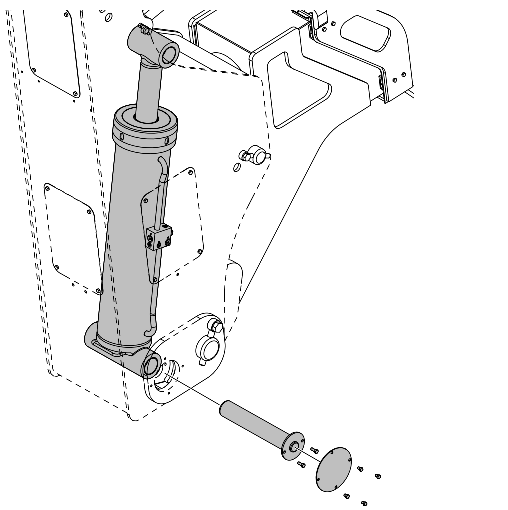
8. Use a suitable brass drift and hammer to remove main lift cylinder barrel end pin from Upright.



9. Using a suitable brass drift drive out the barrel end attach pin from the tower upright. Raise the main boom assembly with the lifting device and sling to allow enough space to remove the main lift cylinder from the upright top.
10. Carefully lift the cylinder clear of the boom assembly and lower to the ground or suitably supported work area.
11. Lower the boom assembly to the stowed position.

Main Lift Cylinder Installation

1. Lift the main boom to allow enough space to lower the main boom lift cylinder to align with pin mounting holes of the tower fly boom and barrel end of main lift cylinder.
2. Using a suitable brass drift, drive barrel end attach pin through the mounting holes in the lift cylinder and the tower fly boom. Secure in place with the pin and torque the bolts to 35 ft. lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts.



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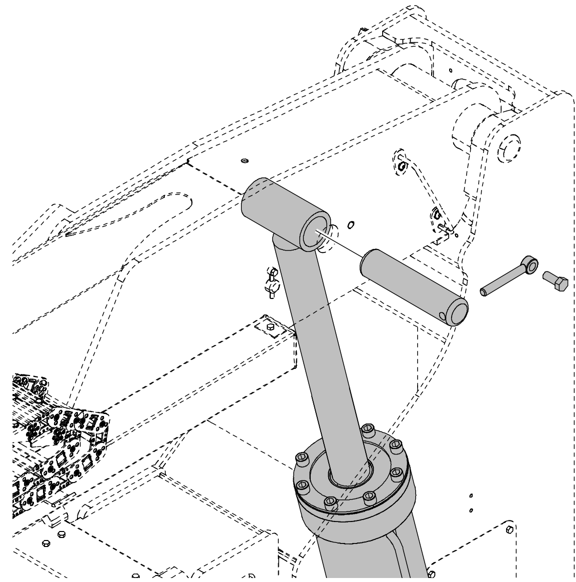
3. Remove cylinder port plugs and hydraulic line caps and attach lines to cylinder ports as tagged during removal.
4. Using auxiliary power extend the cylinder rod until the attach pin hole aligns with those in the main boom.
5. Using a suitable drift drive cylinder rod attach pin through the aligned holes, taking care to align the grooved pin holes. Secure the pin in place and torque the bolt to 285 ft. lbs. (388 Nm). Use JLG Medium Strength Threadlocking Compound on bolts.



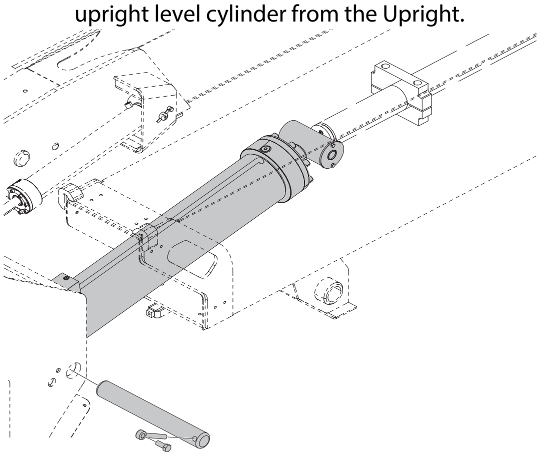
6. Remove lifting device and sling. Activate hydraulic system.
7. Using all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks. Secure as necessary.
8. Check fluid level of hydraulic tank and adjust as necessary.

Upright Level Cylinder Removal

NOTICE

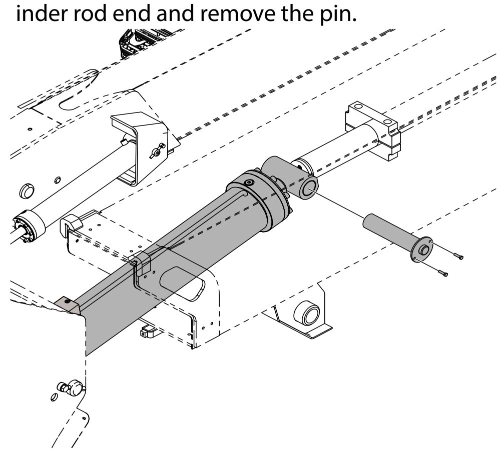
HYDRAULIC LINES AND PORTS SHOULD BE CAPPED IMMEDIATELY AFTER DISCONNECTING LINES TO AVOID ENTRY OF CONTAMINANTS INTO SYSTEM.

1. Remove the Main Boom. Refer to “Main Boom Telescope Cylinder Removal”.
2. Tag and disconnect hydraulic lines to the main lift cylinder. Use suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
3. Remove mounting hardware from the main boom lift cylinder barrel end. Use a suitable brass drift and hammer to remove main lift cylinder barrel end pin from Upright and remove main lift cylinder.
4. Disconnect the Upright Level Cylinder as follows:
   a. Use a suitable lifting device to support the Upright.
   b. Remove mounting hardware securing the Upright Level Cylinder to the upright. Use a suitable brass drift and hammer to remove upright level cylinder barrel end pin from upright and disconnect the upright level cylinder from the Upright.



NOTE: *The Upright weighs approximately 1159.3 lb (526.3 kg).*

5. Before extending the tower boom, support the tower boom from the bottom.
6. Extend the tower boom to get access to the Upright level cylinder rod end pin by using an external auxiliary pump.
7. Tag, disconnect and cap the hydraulic lines of the Upright level Cylinder barrel.
8. Attach a suitable lifting device to support the Upright Level Cylinder.
9. Remove mounting hardware from the upright level cylinder rod end and remove the pin.



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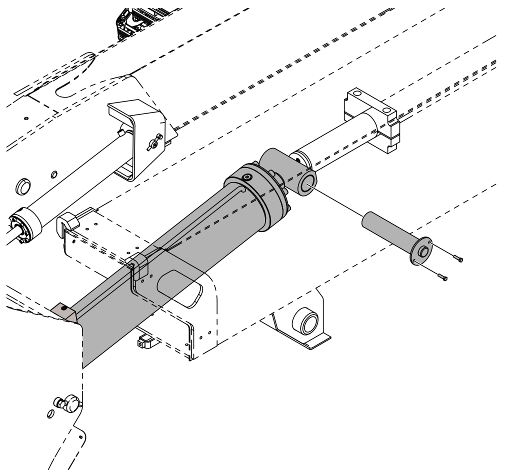
10. Remove the Upright Level Cylinder from the Tower Fly Boom. Place the Upright level Cylinder in a suitable work area.

Upright Level Cylinder Installation

1. Put the leveling cylinder in position in the tower boom, align holes in the tower boom and leveling cylinder rod end.
2. Secure the leveling cylinder rod end pin to tower boom and torque the bolts to 35 ft. lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts.



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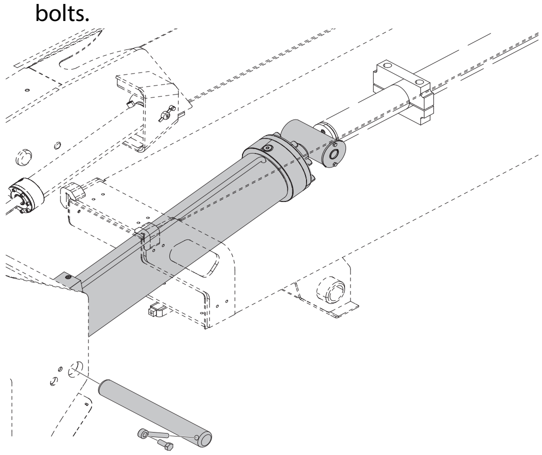
3. Remove Cylinder Port plugs and hydraulic line caps. Properly attach lines to Cylinder ports as tagged during removal.
4. Use all applicable safety precautions, operate the lifting device to move upright assembly into proper position.
5. Align holes in upright and barrel end of level cylinder. Use a suitable rubber mallet to install level barrel end pin. Secure pin and torque the bolt 285 ft. lbs. (388 Nm). Use Medium Strength Threadlocking Compound on bolts.



6. Install Main Lift Cylinder.
7. Install Main Boom. Refer to Main Boom installation.
8. Remove hydraulic line caps and attach all the hydraulic and electrical lines as tagged during removal.
9. Use all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks.
10. Check fluid level of hydraulic tank and add fluid, if required.

Tower Boom Lift Cylinder Removal

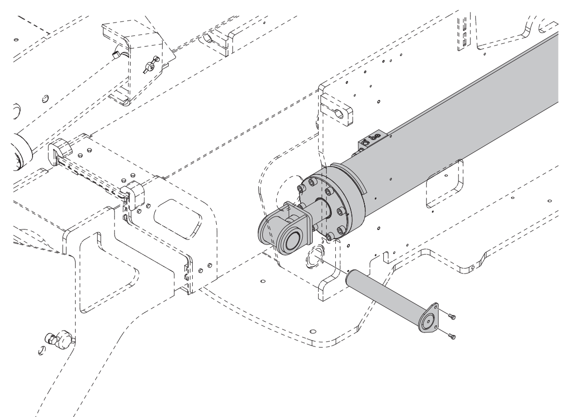
1. Place machine on a flat and level surface. Place the main boom in a horizontal position with the telescope cylinder fully retracted. Place the tower boom in a fully elevated and fully retracted position.

NOTE: *The Main Boom weighs approximately 2285.6 lb (1037.7kg), Upright weighs approximately 1159.3 lb (526.3 kg) & Tower Boom weighs approximately 2944 lb (1335 kg).*

2. Support the main boom, upright and tower boom with adequate overhead crane.

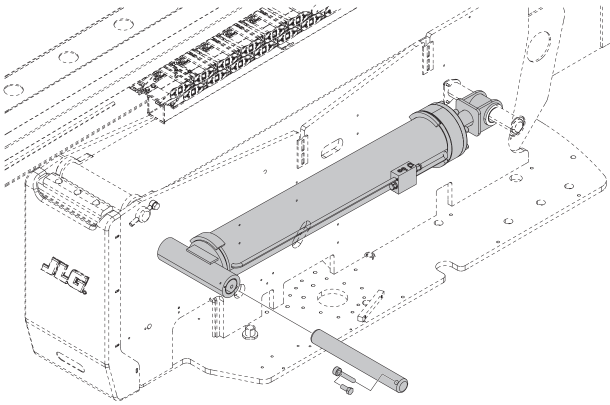
NOTE: *The Tower lift cylinder weighs approximately 597 lb (271 kg).*

3. Adequately support the tower lift cylinder.
4. Remove mounting hardware securing the lift cylinder rod pin to the tower boom. Using a suitable brass drift, drive out the tower lift cylinder rod attach pin.



5. Using all applicable safety precautions, operate auxiliary power, activate tower lift down and fully retract lift cylinder.
6. Tag, disconnect, and cap the tower lift cylinder hydraulic lines and ports.

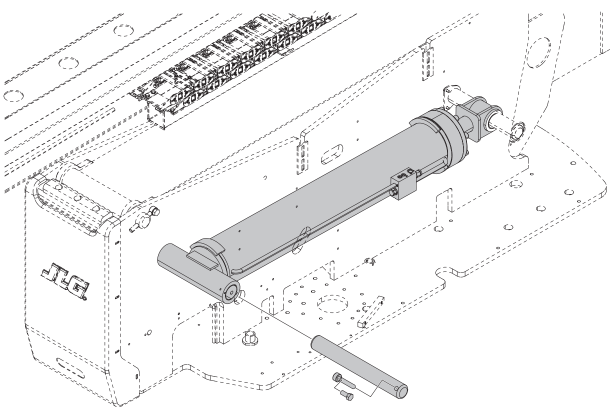
7. Remove mounting hardware securing the tower lift cylinder barrel pin to the turntable. Using a suitable brass drift, drive out the tower lift cylinder barrel pin.



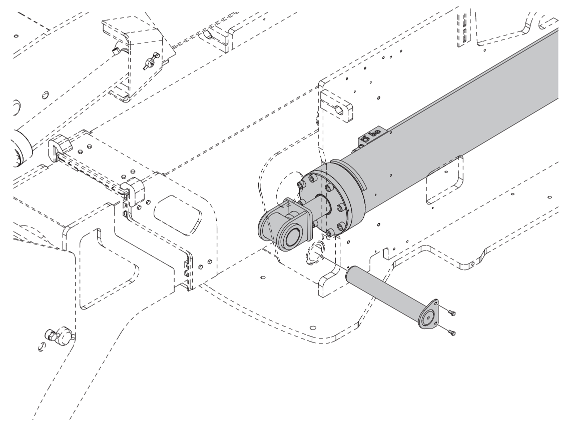
8. Carefully remove the tower lift cylinder from turntable. Place in a suitable work area.

Tower Boom Lift Cylinder Installation

1. Support the main boom and tower boom, place the tower lift cylinder on the turntable and align the holes. Install the cylinder barrel pin and torque the bolt to 285 ft. lbs. (388 Nm). Use Medium Strength Threadlocking Compound on bolts.



2. Remove caps from cylinder hydraulic lines properly and install lines to cylinder as previously tagged.
3. Using auxiliary power, activate tower lift function and extend cylinder rod until the cylinder rod bushing aligns with bushings on boom.
4. Using an appropriate brass drift, drive the tower lift cylinder rod end attach pin through the aligned bushings. Secure pin and torque the bolt 35 ft. lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts.



5. Remove main boom support and lifting device supporting the upright.
6. Using all applicable safety precautions, operate the boom functions. Check for proper operation and hydraulic leaks. Secure as necessary.
7. Check fluid level of hydraulic tank and add fluid, if required.

Tower Telescope Cylinder Removal

1. Place machine on flat and level surface.
2. Remove the tower telescope cylinder rod end trunion hardware.
3. Using an external pump, extend the tower telescope cylinder as far enough to attach the lifting device.
4. Tag, disconnect and cap hydraulic hoses to Tower Telescope Cylinder. Plug cylinder ports. Remove the hoses.

NOTE: *The Tower Telescope Cylinder weighs approximately 238.3 lb (108.1 kg).*

5. Properly secure the Tower Telescope Cylinder by using a suitable sling or support.
6. Remove the tower telescope cylinder barrel end trunion hardware.
7. Carefully remove the Tower Telescope Cylinder from the Boom. Place cylinder on a suitable work area.

Tower Telescope Cylinder Installation

1. Slide the telescope cylinder into the boom, aligning the cylinder port block end with slotted holes in Base Boom.
2. Secure the telescope cylinder barrel end to the fly boom by using retaining plate and torque the bolts 35 ft. lbs. (48Nm). Use Medium Strength Threadlocking Compound on bolts.
3. Secure telescope cylinder rod end and torque the bolts to 35 ft. lbs. (48 Nm). Use Medium Strength Threadlocking Compound on bolts.
4. Remove caps and plugs from hydraulic lines and ports. Properly connect hydraulic lines to cylinder. Reinstall cover plate.
5. Using all applicable safety precautions, operate the boom functions. Check for correct operation and hydraulic leaks. Secure as necessary.
6. Check fluid level of hydraulic tank and add fluid, if required.

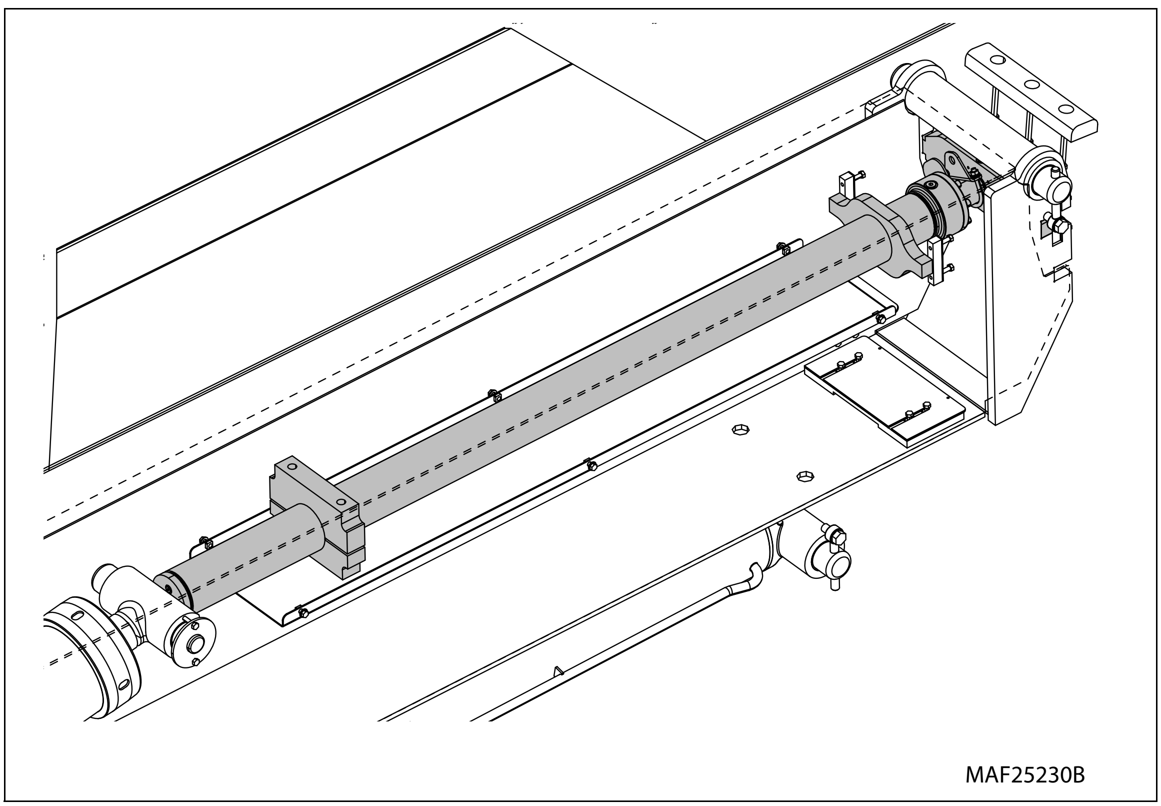


Figure 5-106. Removal/Installation of Tower Telescope Cylinder

Master Cylinder Removal

NOTE: *The Master Cylinder weighs approximately 82.2 lb (37.3 kg).*

1. Tag and disconnect hydraulic lines to the main boom lift cylinder. Use a suitable container to collect any residual hydraulic fluid. Cap hydraulic lines and ports.
2. Properly secure the master cylinder by using a suitable sling or support.
3. Remove the master cylinder pin retaining hardware. Using a suitable brass drift, remove the master cylinder pins from the rod and barrel ends.
4. Carefully remove the master cylinder.
5. Clean and inspect the cylinder pins and retaining hardware for reuse. Replace if necessary.

Master Cylinder Installation

1. Remove caps from the hydraulic hoses and attach hoses to the proper cylinder ports.

NOTE: *The Master Cylinder weighs approximately 82.2 lb (37.3 kg).*

2. Use suitable slings or support to position the master cylinder in place. Align barrel end mounting holes with the holes in main boom.
3. Use suitable mallet and keeper to install the barrel end attach pin and torque the bolts to 35 ft. lbs. (48 Nm).
4. Extend the master cylinder rod until the rod attach pin hole aligns with holes in the upright pivot. Use suitable mallet and keeper to install the rod end pin.
5. Remove any support or sling used to lift the master cylinder.
6. Use all applicable safety precautions, operate the boom functions.
7. Check for proper operation and hydraulic leaks.
8. Check the fluid level of hydraulic tank. Fill the tank, if required.

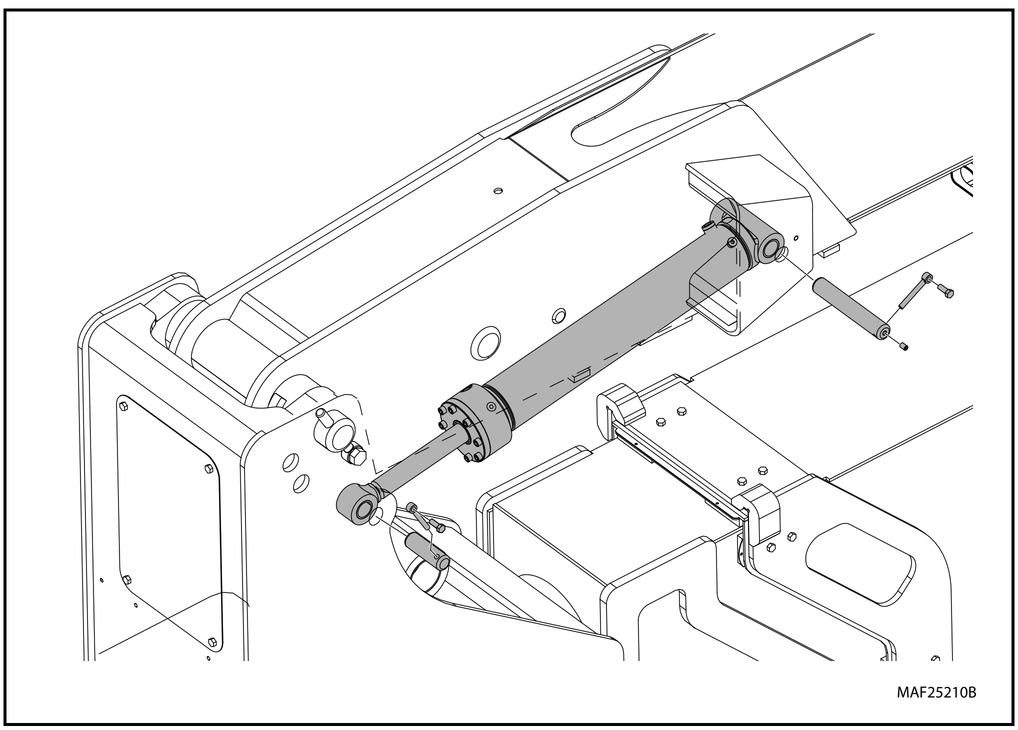


Figure 5-107. Removal/Installation of Master Cylinder

5.5 HYDRAULIC PUMP W/HAYES PUMP DRIVE COUPLING LUBRICATION

Any time pump or pump drive coupling is removed coat, pump and drive coupling splines with Lithium Soap Base Grease (TEXACO CODE 1912 OR EQUIVALENT) coupling is greased prior to assembly.

5.6 PRESSURE SETTING PROCEDURES

Cold temperatures have a significant impact on pressure readings. JLG Industries Inc. recommends operating the machine until the hydraulic system has warmed to normal operating temperatures prior to checking pressures. JLG Industries Inc. also recommends the use of a calibrated gauge. Pressure readings are acceptable if they are within ± 5% of specified pressures.

To ensure all pressures are set correctly, the following procedures must be followed in order.

1. All applicable steps must be followed.
2. Set up of the function pump.
3. Adjustments Made at the Main Valve Block.
4. Adjustments Made at the Platform Valve Block

Set Up the Function Pump

(the pump that is mounted on the back of the drive pump).

1. **Set Stand by pressure or load sense pressure**

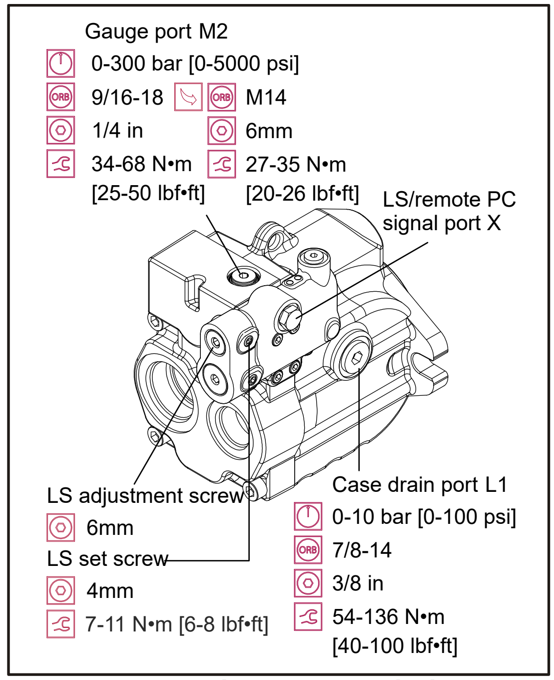


Figure 5-108. Load Sensing Control Adjustment

a. Install a low pressure gauge at port **"MP"** of the main valve block. A gauge capable of reading **400 psi (28 bar)**.

b. Start the engine and let it idle. The gauge should be reading between **400-440 psi (28-30 bar)**.

c. To make an adjustment to this pressure, go to the engine compartment, locate the function pump. There are (2) adjustments at the top of the pump. They are located on the pump compensator which has (4) bolts mounting it to the pump. The stand by adjustment is at the top.

d. To adjust this, a 4 mm and 6 mm Allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine. First, using the 4 mm wrench, loosen the setscrew on the side of the compensator which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it by 1 turn.

e. Using a 6 mm wrench adjust clockwise to increase or counterclockwise to decrease the pressure. The pressure should read between **400-440 psi (28-30 bar)**.

2. **Set High pressure relief**

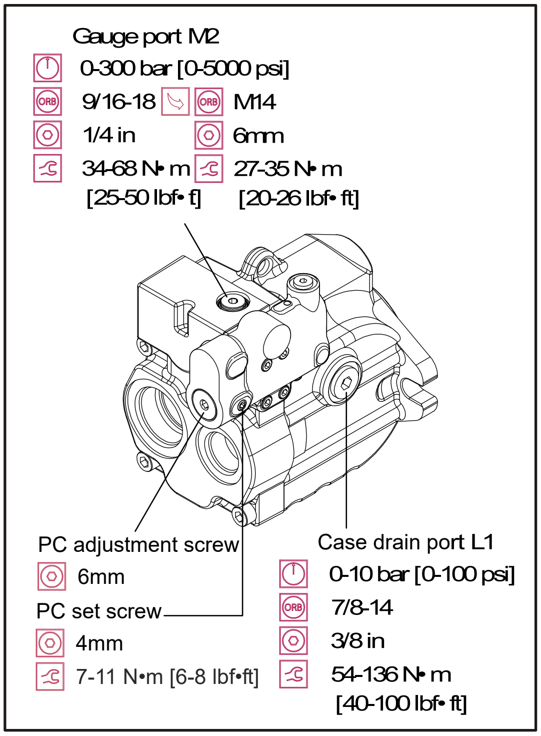


Figure 5-109. Pressure Compensation Control Adjustment

a. Install a high pressure gauge at the **"MP"** port of the main valve block.

b. Activate main boom telescope in. The gauge should read **2600-2700 psi (179-186 bar)**.

c. To make an adjustment to this pressure, go to the engine compartment to the function pump. The high pressure relief adjustment is the lower one of the (2) on the compensator. To adjust this, a 4 mm and 6 mm Allen wrench will be needed. The adjustment screw is facing the front of the pump, or toward the engine.

d. Using the 4 mm wrench, loosen the setscrew on the side of the compensator which is in line with the adjustment screw. This is a jam nut screw which holds the main adjustment from turning. Loosen it by 1 turn.

e. 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.

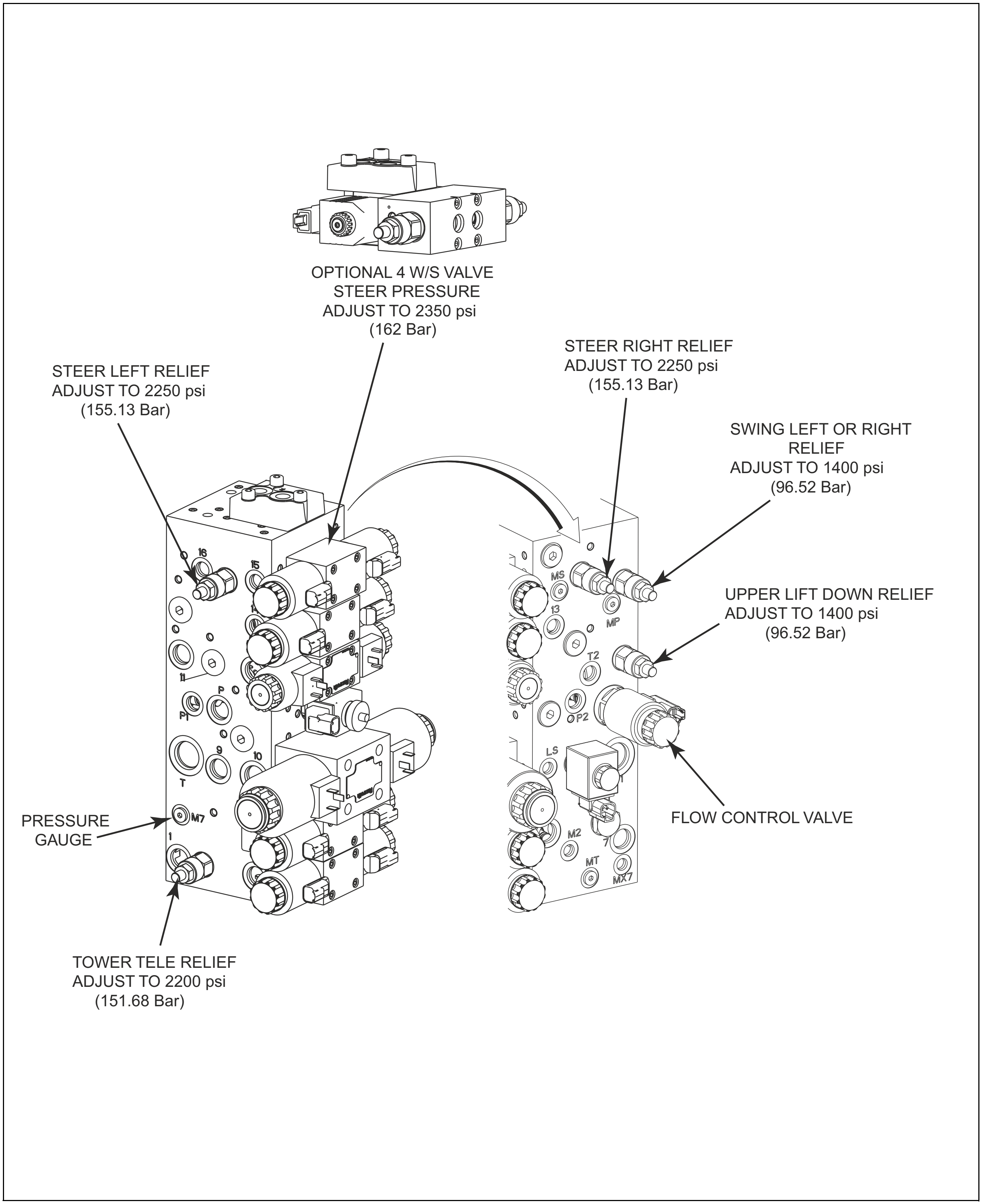


Figure 5-110. Main Control Valve Pressure Adjustments

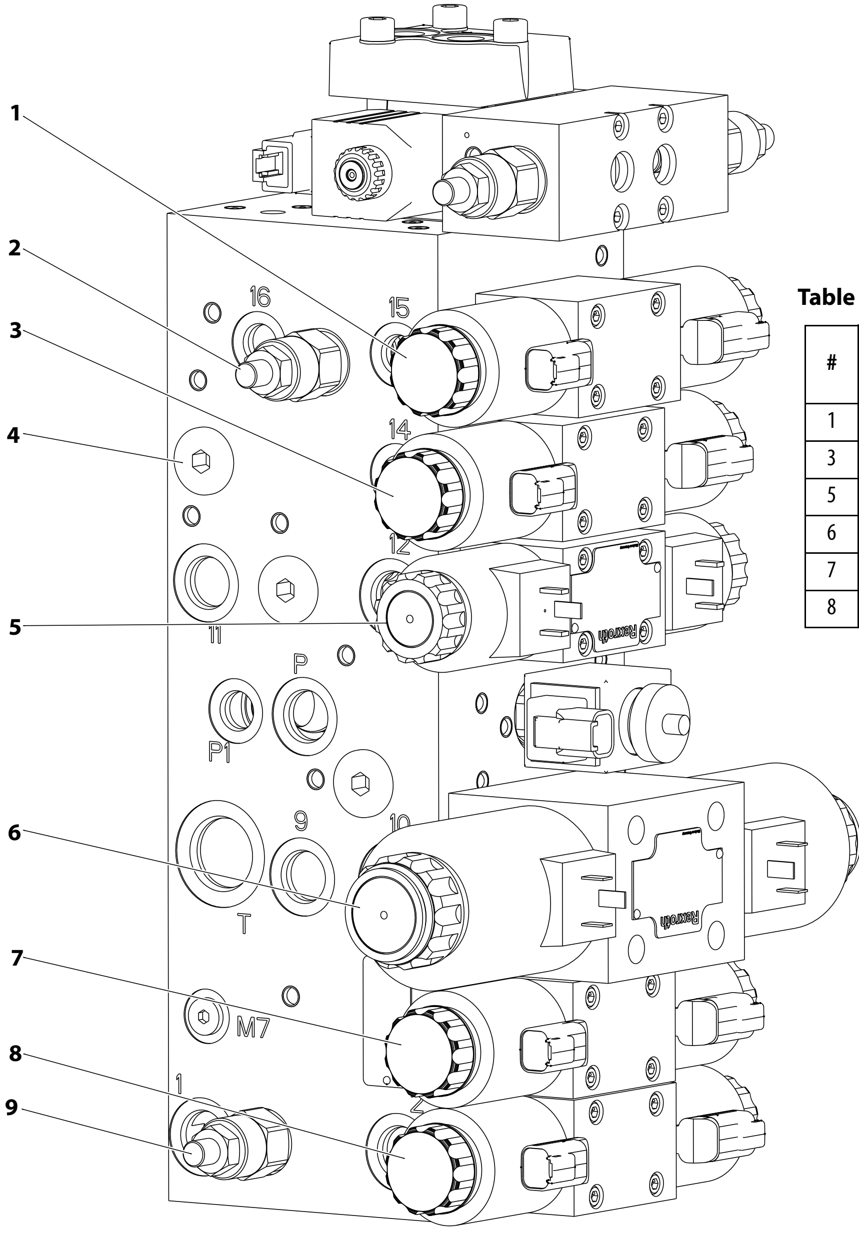
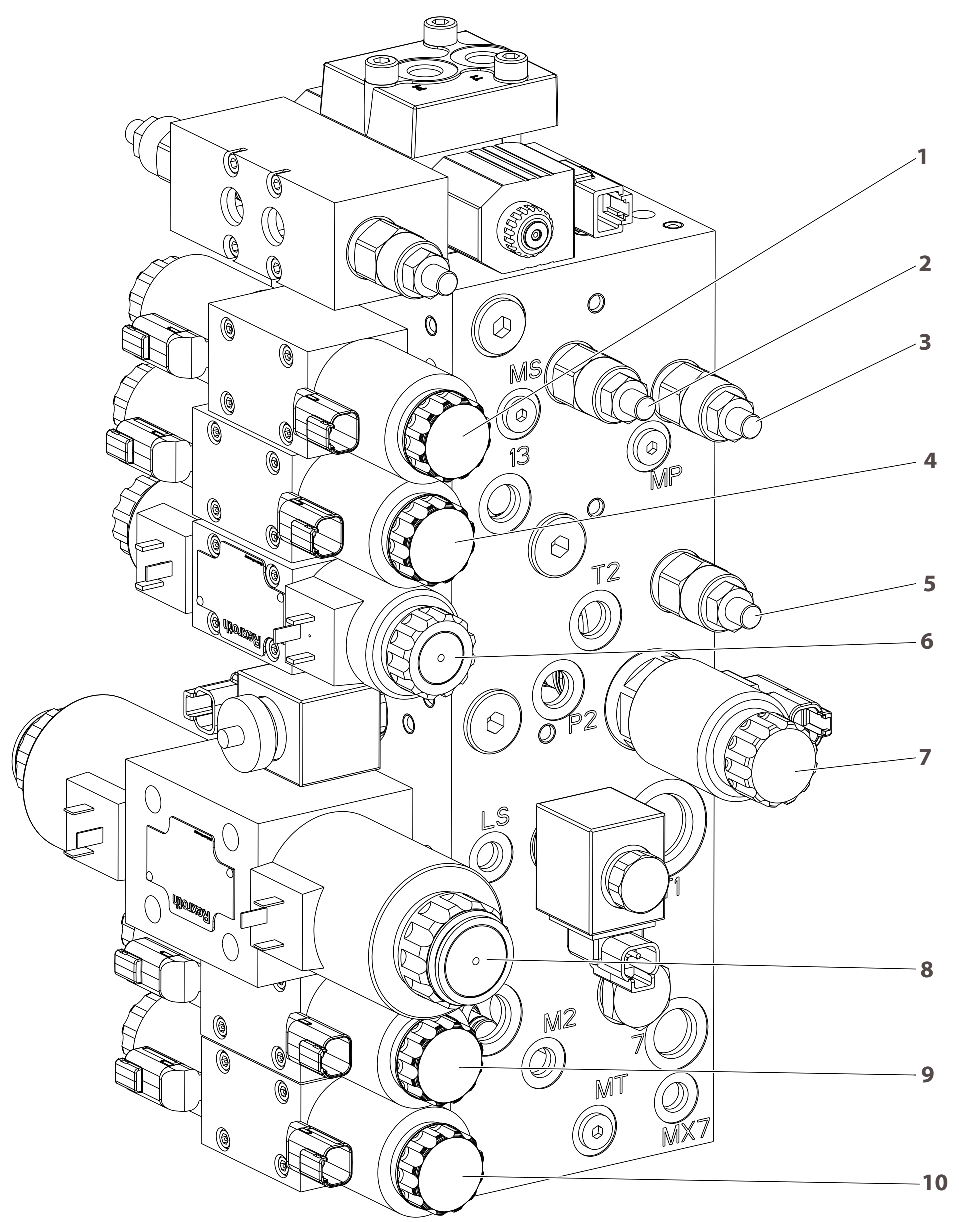


Table 5-41. Main Control Valve Coil Resistance

#	Item	Coil Resistance @20^{0}C (Ohms)
1	Front Steer Right Solenoid	5.3
3	Shuttle Valve	5.3
5	Main Lift Down Solenoid	2
6	Main Tele In Solenoid	3.23-3.75
7	Tower Lift Up Solenoid	4.1
8	Tower Tele In Solenoid	4.1

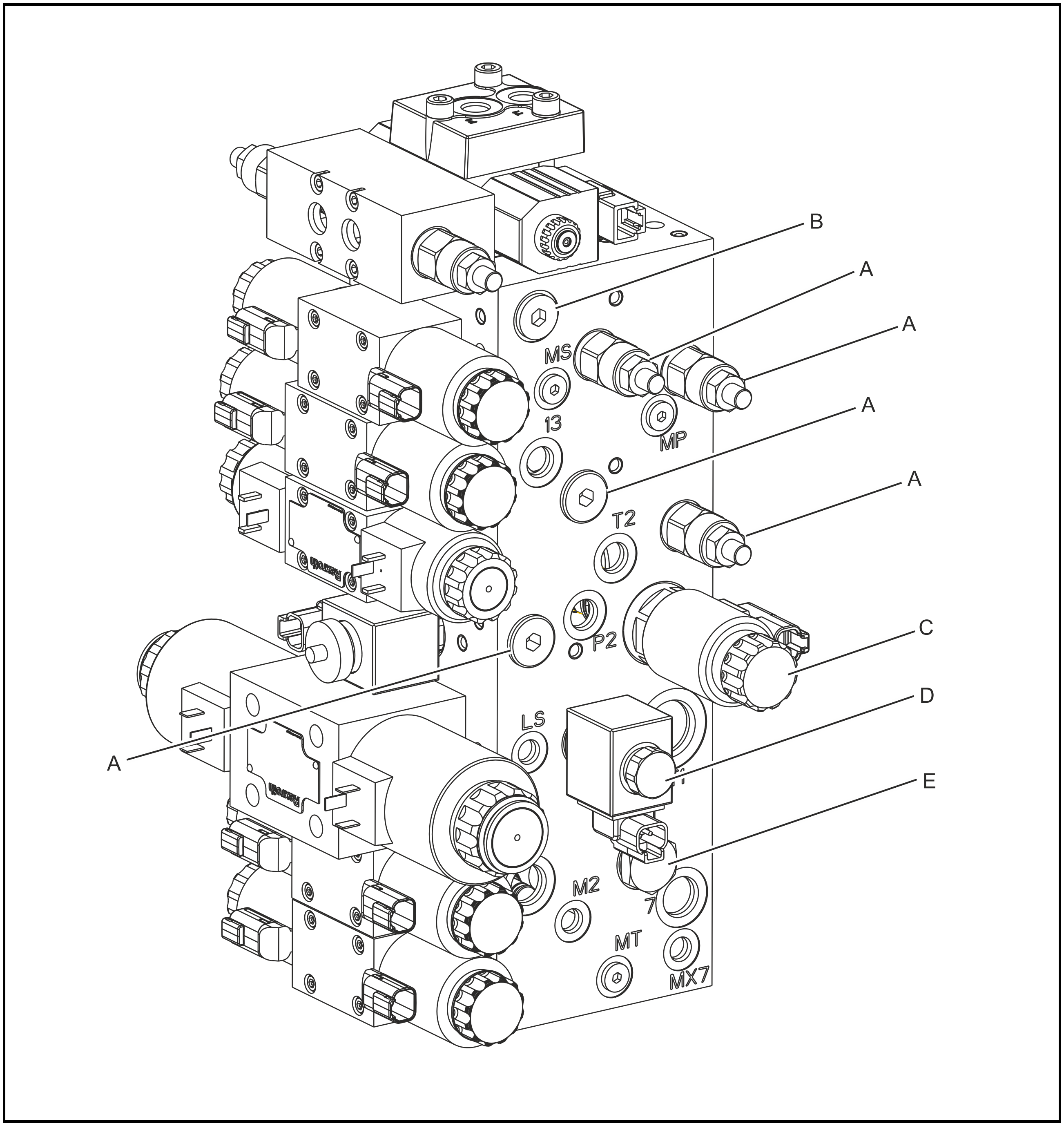
1. Front Steer Right Solenoid
2. Front Steer Left Solenoid
3. Shuttle Valve
4. Swing left Solenoid
5. Main Lift Down Solenoid
6. Main Tele In Solenoid
7. Tower Lift Up Solenoid
8. Tower Tele In Solenoid
9. Tower Tele Relief

Figure 5-111. Main Valve Components - Sheet 1 of 2



1. Front Steer Left Solenoid
2. Front Steer Right Relief
3. Relief Valve
4. Swing Left or Right Relief
5. Relief Valve
6. Main Lift Up Solenoid
7. Flow Control Valve
8. Main Tele Out Solenoid
9. Tower Lift Down Solenoid
10. Tower Tele Out Solenoid

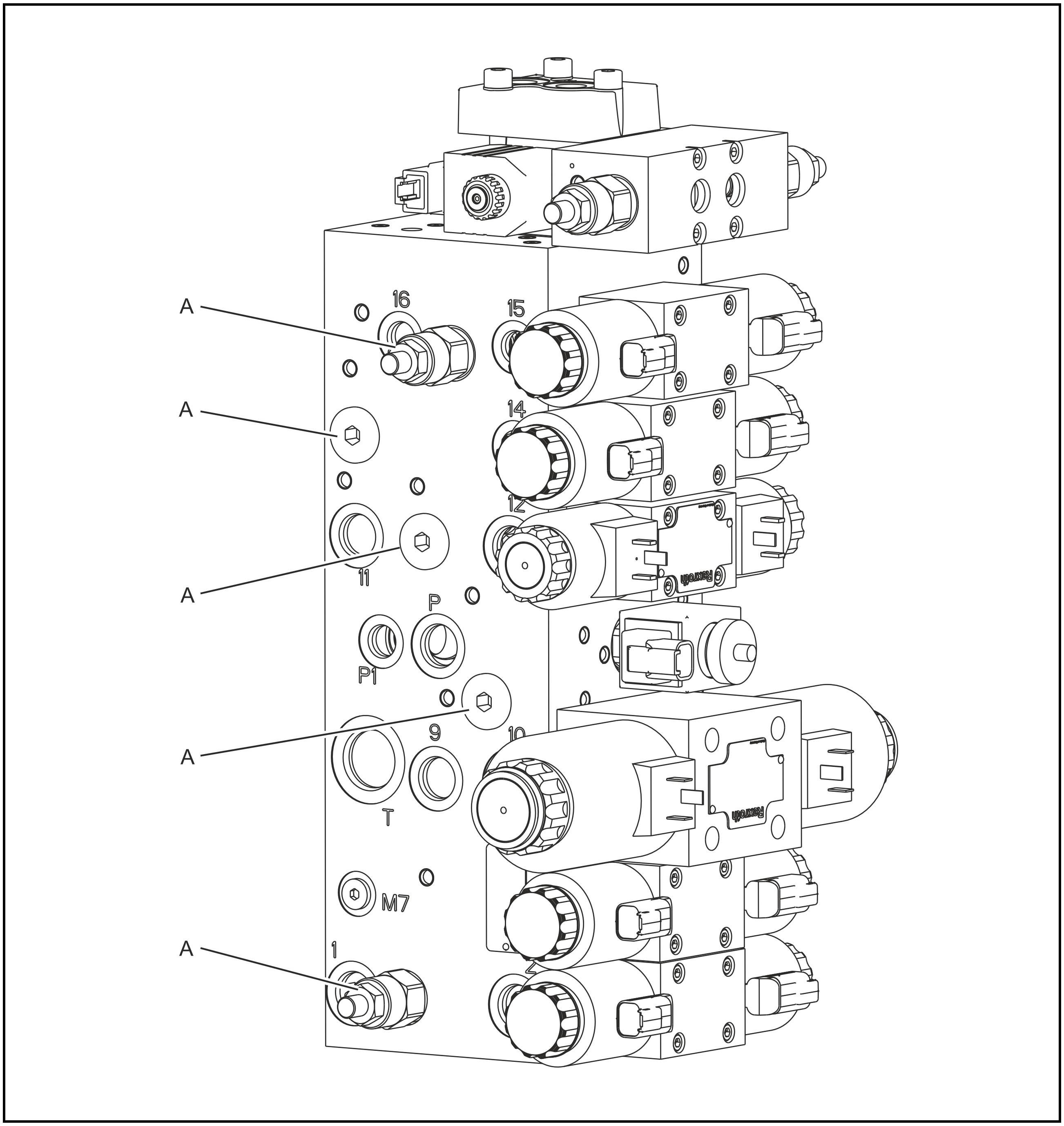
Figure 5-112. Main Valve Components - Sheet 2 of 2



	Ft. Lbs.	Nm
A	25-30	33.8-40.6
B	39	52.87
C	121.1-132.8	164.2-180
D	28.8-37.6	39-51
E	30-35	40.6-47.5

NOTE: *When removing control valves from the manifold, it is important to observe the tag on the face of the valve, as the new valve must be installed with the tag facing the same way as the tag on the valve that was removed. The bolt pattern on the control valves is not symmetrical, so if the bolts seem difficult to turn when installing, it would indicate the valve is upside down and forcing the bolts will result in cross-threading. Check the tag, and if necessary, rotate the valve 180 degrees.*

Figure 5-113. Valve Component Torque - Sheet 1 of 2



	Ft. Lbs.	Nm
A	25-30	33.8-40.6

NOTE: *When removing control valves from the manifold, it is important to observe the tag on the face of the valve, as the new valve must be installed with the tag facing the same way as the tag on the valve that was removed. The bolt pattern on the control valves is not symmetrical, so if the bolts seem difficult to turn when installing, it would indicate the valve is upside down and forcing the bolts will result in cross-threading. Check the tag, and if necessary, rotate the valve 180 degrees.*

Figure 5-114. Valve Component Torque - Sheet 2 of 2

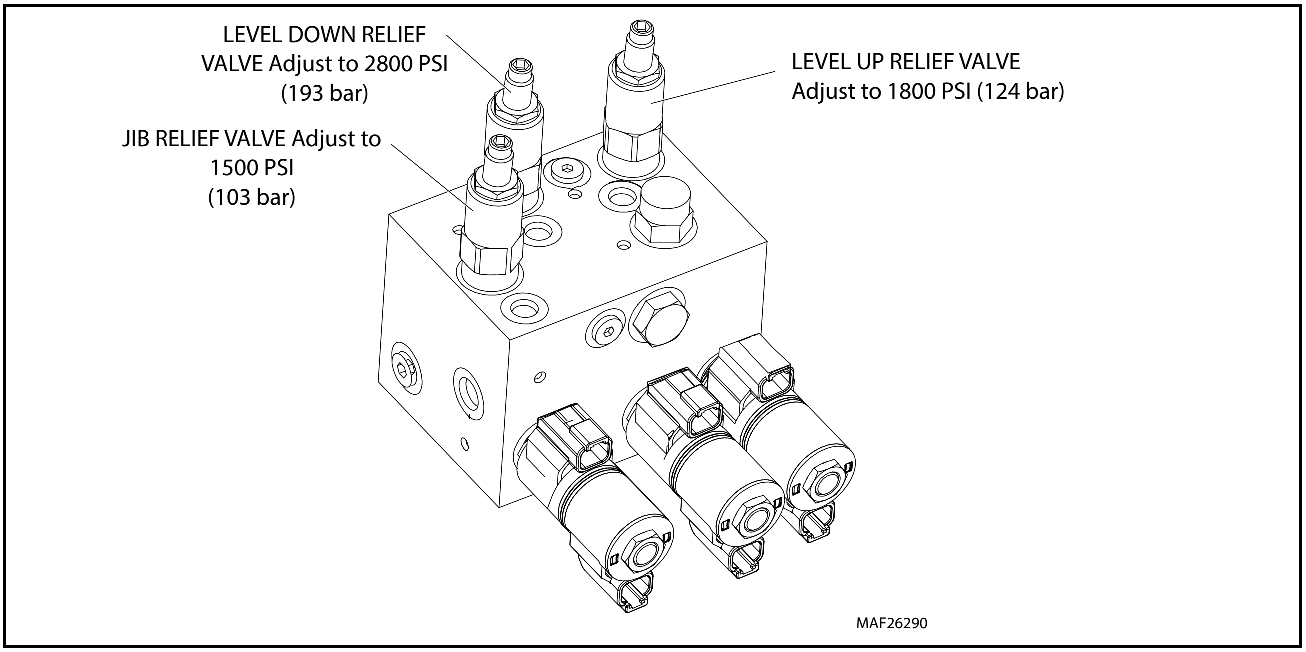


Figure 5-115. Platform Control Valve Pressure Adjustments

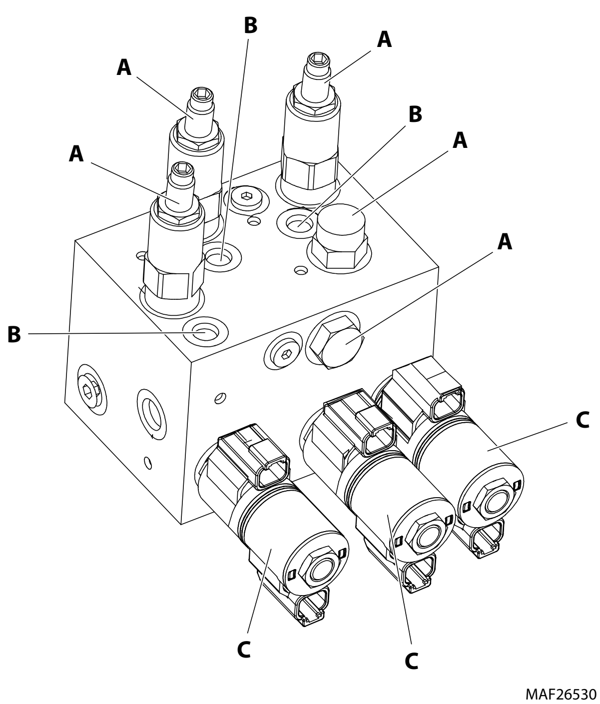


Table 5-42. Platform Control Valve Specification

#	Torque	Coil Resistance (Ohms)
A	20 ft.lbs (27 Nm)	-
B	13 ft.lbs (17 Nm)	-
C	5 ft.lbs (7 Nm)	8.8

Figure 5-116. Platform Control Valve Component Torque

Adjustments Made at the Main Valve Block

MAIN LIFT DOWN

1. Install a high pressure gauge capable of reading **3000 psi (206.84 bar)** into the external pressure tap at the tee fitting in port "**L.S**" of main control valve, right side of manifold.
2. Activate main boom lift down. The gauge should read **1400 psi (97 bar)**.
3. The adjustment cartridge is located to the right of port #T2. Turn clockwise to increase, counterclockwise to decrease.

SWING

NOTE: *left and right are done with one adjustment.*

4. Install a high pressure gauge at the "**MP**" port of the main valve block. Lock the turntable lock pin.
5. Activate swing, the gauge should read **1400 psi (97 bar)**. The adjustment cartridge is located on the right side of the block, right above port "**MP**".
6. Turn clockwise to increase, and counterclockwise to decrease.

2 WHEEL STEER

1. Install a high pressure gauge at the "**MS**" port of the main valve block. Activate steer left or right. The gauge should read **1800 psi (124 bar)** (2-wheel steer) both directions.
2. One relief cartridge is located on the right side of the block, above port "**MS**". The other one is located on the left side next to port #15.
3. Turn clockwise to increase, and counterclockwise to decrease.

TOWER TELESCOPE OUT

1. Install a high pressure gauge at gauge port **"M2"** located on the right side of the valve block, at the bottom.
2. Activate tower telescope out, the gauge should read **2200 psi (152 bar)**. This can be done with the tower lift down or up. If the tower lift is up, run the tower telescope out to the end of stroke.
3. The tower telescope out relief valve is located on the left side, at the bottom next to port #1. Turn clockwise to increase, counterclockwise to decrease.

Adjustments Made at the Platform Valve Block

PLATFORM LEVEL UP

1. Install a high pressure gauge at the gauge port **"M1"** of the platform valve. There is pressure trapped at this test port.
2. To release this Pressure, activate level down to the end of stroke (the pressure in the up side goes to 0). This will allow to snap a gauge on at this port.
3. First, adjust system pressure to **3400 psi (234.42 bar)** through adjusting the function pump PC pressure.
4. Activate level up to the end of stroke, the gauge should read **3250-3350 psi (224-231 bar)**. The level up relief valve is located next to the port **"M1"**.
5. Turn clockwise to increase, and counterclockwise to decrease.
6. After setup adjust the level up pressure to **3250 psi** (**224 bar**) and adjust the system pressure down to **2600 psi** (**179 bar**).

PLATFORM LEVEL DOWN

1. Install a high pressure gauge at the gauge port **"M2"** of the platform valve.
2. To get a gauge on this point activate level up to the end of stroke (the pressure in the down side will go to 0, allowing to snap a gauge on). Activate level down to the end of stroke, the gauge should read **1800 psi. (124 bar).**
3. The level down relief valve is located next to port "M2". Turn clockwise to increase and counterclockwise to decrease.

ARTICULATING JIB DOWN

1. Install a high pressure gauge on port "**M3**" of the platform valve.
2. Activate jib down, the gauge should read **1650 psi. (114 bar).**
3. The down relief valve is located next to port "**M3**". Turn clockwise to increase and counterclockwise to decrease.

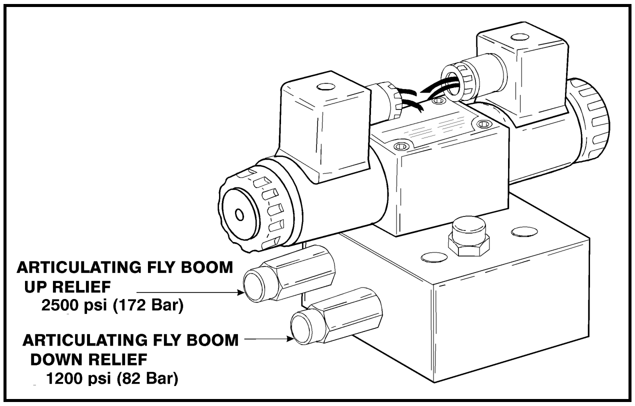


Figure 5-117. Articulating Jib Boom Pressure adjust.

5.7 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

From a hydrostatic component standpoint, the goal at system start up is to put into functional operation, the hydrostatic system in such a way as to preserve the designed life span of the system. The following start-up procedure should be adhered to whenever a new pump or motor is initially installed into a machine, or a system is restarted after either a pump or motor has been removed and/or replaced.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTIONS DISCONNECTED, ETC.). WHILE PERFORMING THE PROCEDURE IN ORDER TO PREVENT INJURY. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING THE VEHICLE/MACHINE.

Prior to installing the pump and/or motor, inspect the unit(s) for damage that may have been incurred during shipping and handling. Make certain that all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

NOTE: *If a pump or motor is being replaced due to internal damage, the remaining units (pump or motors) need to be inspected for damage and contamination, and the entire hydraulic system will need to be flushed and the fluid replaced. Failure to do so may cause considerable damage to the entire system.*

The inlet line leading from the reservoir to the pump must be filled prior to start-up. Check the inlet line for property tightened fittings and make sure it is free of restrictions and air leaks.

NOTE: *In most cases, the reservoir is above the pump inlet so that the pressure head created by the higher oil level helps to keep the inlet pressures within an acceptable range and prevent high vacuum levels. However, due to hose routing or low reservoir locations, there may be air trapped within this line. It is important to assure that the air is bled from this line. This can be accomplished by loosening the hose at the fitting closest the pump. When oil begins to flow, the line is full, the air has been purged, and the fitting can be retightened to its specified torque. If the tank needs to be pressurized in order to start the flow of oil, a vacuum reading should be taken at the inlet of the pump during operation in order to verify that the pump is not being asked to draw an inlet vacuum higher than it is capable of.*

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the main case drain port.

NOTE: *It is highly recommended to use the highest possible case drain port, this ensures that the housing contains as much oil as possible and offers the greatest amount of lubrication to the internal components.*

NOTE: *In initial start-up conditions, it may be convenient to fill the housing, just prior to installing the case drain line. Component, (especially motor), location may be such that access to the case drain port after installation is not realistic.*

NOTE: *Make certain that the oil being used to fill the component housing is as clean as possible, and store the fill container in such a way as to prevent it from becoming contaminated.*

Install a 60 bar (or 1000 psi) pressure gauge in the charge pressure gauge port in order to monitor the charge pressure during start-up.

It is recommended that the external control input signal, (electrical connections for EDC), be disconnected at the pump control until after initial start-up. This will ensure that the pump remains in its neutral position.

⚠ WARNING

DO NOT START THE ENGINE UNLESS PUMP IS IN THE NEUTRAL POSITION (0 DEGREES SWASHPLATE ANGLE). TAKE PRECAUTIONS TO PREVENT MACHINE MOVEMENT IN CASE PUMP IS ACTUATED DURING INITIAL START-UP.

"Jog" or slowly rotate the engine until charge pressure starts to rise. Start the engine and run at the lowest possible RPM until charge pressure has been established. Excess air should be bled from the system lines as close to the motors as possible.

NOTE: *With the engine on low idle, "crack", (loosen-don't remove), the system lines at the motor(s). Continue to run the engine at low idle and tighten the system lines as soon as oil is observed to leak from them. When oil is observed to "leak" at the motor the line is full, the air has been purged, and the system hoses should be retightened to their specified torque.*

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code. If charge pressure is inadequate, shut down and determine the cause for improper pressure.

⚠ WARNING

INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATOR'S ABILITY TO CONTROL THE MACHINE.

Shut down the engine and connect the external control input signal. Also reconnect the machine function(s), if disconnected earlier. Start the engine, checking to be certain the pump remains in neutral. With the engine at normal operating RPM, slowly check for forward and reverse machine operation.

Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

Shut down engine, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

The machine is now ready for operation.

5.8 HYDRAULIC DRIVE PUMP PRE-FILL PROCEDURE

CAUTION

HYDRAULIC DRIVE PUMP MUST BE PRE-FILLED BEFORE STARTING THE ENGINE. FAILURE TO DO SO CAN CAUSE PREMATURE FAILURE OF THE PUMP.

1. Fill the hydraulic reservoir.
2. Determine if the hydraulic oil tank sight level gauge is higher than other hydraulic components.
   a. Determine if the hydraulic oil tank sight level gauge is higher than the hydraulic drive pump assembly.
   b. Determine if the hydraulic oil tank sight level gauge is higher than all hydraulic hose loops and the routings between the hydraulic tanks and the hydraulic drive pump assembly.
   c. If sight level gauge is the highest hydraulic oil level point, proceed to step 3.
   d. If sight level gauge is NOT the highest oil level point, low pressure air may need to applied to the hydraulic oil tank (fill cap via air regulator) in conjunction with step 4 to get hydraulic oil to move over the air locks created by these high spots.
3. If the machine is to be equipped with a hydraulic oil cooler option.
   a. Determine if there is hydraulic “tee” fittings installed at the hydraulic drive pump that has a “cap” fittings attached to it. (this will generally be at or near the top of the hydraulic drive pump body). This “cap” fitting is to be used to manually fill the hydraulic drive pump case.
   b. Remove “cap” fitting.
   c. Fill hydraulic drive pump case with hydraulic oil.
   d. Attach and torque “cap” fitting.
   e. Pre-filling of hydraulic drive pump w/oil cooler option is complete. (Step #4 can be omitted at this point).
4. If machine is NOT equipped with a hydraulic oil cooler option.
   a. Locate a case access port on the hydraulic drive pump. Preferably one located on at or near the top or under sides of the pump.
   b. Using the proper wrench, remove the O-ring plug to allow air to escape from the hydraulic drive pump case.
   c. Hydraulic oil will flow by gravity from the hydraulic tank to the drive pump.
   d. The hydraulic oil starts to flow out of the port when the pump is full.
   e. Install the O-ring plug and torque.
5. Pre-filling of the hydraulic drive pump is complete.

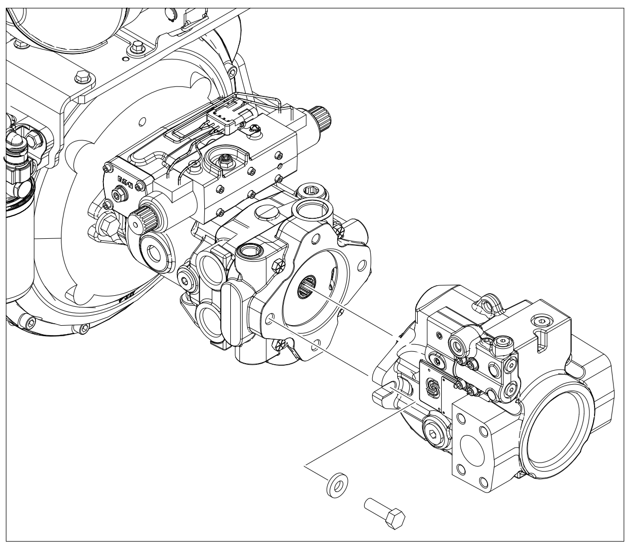
5.9 VARIABLE PUMP

Removal

1. Place machine on level surface and allow the engine and system fluids to cool.
2. Properly relieve any pressure in hydraulic system.
3. Tag and disconnect the hydraulic lines and fittings from the function pump. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

NOTE: *The function pump weighs approximately 35 lb (16 kg).*

4. Use a suitable device to support the function pump.
5. Remove two bolts and washers attaching the function pump to the drive pump. Remove function pump from the machine as shown.



6. Remove and discard o-ring, if applicable.
7. Place function pump in the clean work area.

Installation

NOTE: *The function pump weighs approximately 35 lb (16 kg).*

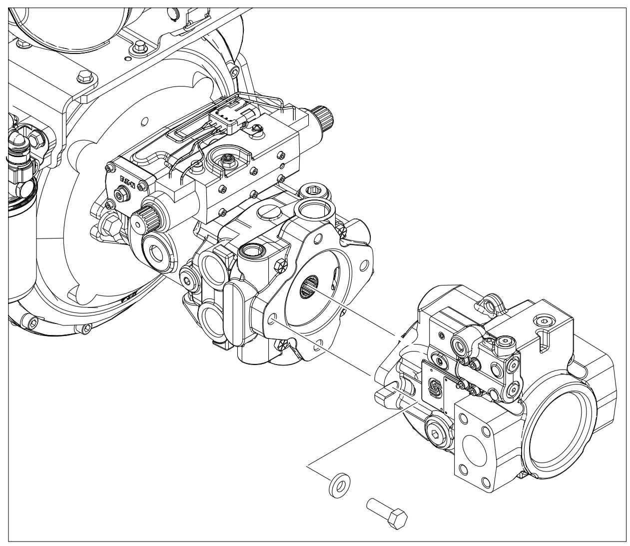
1. Use a suitable device to support the function pump.
2. If applicable, install the o-ring on to the function pump.
3. Align and install the function pump to the drive pump.

NOTE: *Make sure that the pump shaft is properly aligned.*

CAUTION

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

4. Secure function pump with two bolts and washers as shown. Apply Medium Strength Threadlocking Compound to the bolts before installation. Torque bolts to 85 ft. lbs. (116Nm).



5. Remove tag and reconnect the hydraulic lines to the function pump.
6. Reconnect the battery power and make sure for proper working of the function pump.

Table 5-43. Symbols Used

Symbol	Meaning	Symbol	Meaning
	Non-reusable part, use a new part		Inspect for wear or damage
	Option - either part may exist		Note correct orientation
	Internal hex head		Torque specification
ORB	O-ring boss port		Pull out with tool - press fit
	Lubricate with hydraulic fluid		Cover splines with installation sleeve
	Apply grease /petroleum jelly		Pressure measurement / gauge location or specification
The symbols above can be found in the pump illustrations. The legend above is provided to define each symbol and explain its purpose.			

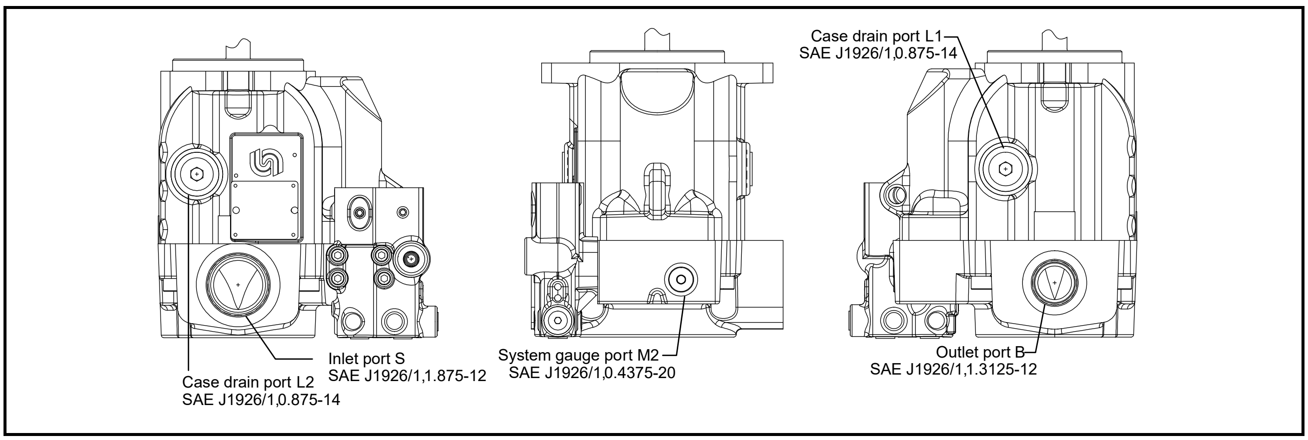


Figure 5-118. Gauge Port Locations

Table 5-44. Gauge and Port information

Port	Purpose	Range of Pump	Fitting
M2	System pressure	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting
M4	Servo pressure	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting
L1,L2	Case pressure	0-100 psi [0-10 bar]	7/8 - 14 o-ring fitting
X1	Load Sense signal	0-5000 psi [0-300 bar]	7/16 - 20 o-ring fitting (tee into Load Sense signal line)

Initial Start-up Procedures

Follow this procedure when starting-up a new pump or when the pump has been removed.

1. Install the pump on the engine. Ensure the pump shaft is properly aligned.

CAUTION

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

2. Fill the main pump housing with clean hydraulic fluid. Pour filtered oil directly into the main most case drain port.
3. Fill the inlet line leading from the pump to the reservoir. Check the inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
4. To ensure the pump stays filled with oil, install the case drain line in the main most case drain port.
5. Install a gauge at port M2 to monitor system pressure during start up.
6. While watching the pressure gauge installed at M2, jog the engine or run at the lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shutdown the engine, determine cause, and take corrective action. Refer to Troubleshooting.
7. Operate the hydraulic system for at least fifteen minutes under light load conditions.
8. Check and adjust control settings as necessary after installation. Refer to Adjustments.
9. Shut down the engine and remove the pressure gauge. Replace plug at port M2.
10. Check the fluid level in the reservoir; add clean filtered fluid if necessary. The pump is now ready for operation.

Troubleshooting

Table 5-45. Excessive Noise and/ or Vibration

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will cause cavitation.	Fill the reservoir to proper level.
Check for air in system.	Air in system will cause noisy, erratic control.	Purge air and tighten fittings. Check inlet for leaks.
Check pump inlet pressure / vacuum.	Improper inlet conditions will cause erratic behavior and low output flow.	Correct pump inlet pressure / vacuum conditions. Refer to Hydraulic parameters.
Inspect shaft couplings.	A loose or incorrect shaft coupling will cause excessive noise and/or vibration.	Repair or replace coupling and ensure that correct coupling is being used.
Check shaft alignment.	Misaligned shafts will create excessive noise and/or vibration.	Correct shaft misalignment.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.

Table 5-46. Actuator Response is Sluggish

Item	Description	Action
Check external system relief valve setting.	Low external relief valve setting will slow down system.	Adjust external relief valve setting per manufacturer's recommendations. External relief setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and LS control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check Load Sense control signal pressures.	Incorrect Load Sense signal will not allow pump to operate correctly.	Inspect system, ensure that proper Load Sense signal is transmitted to the pump.
Internal system leaks.	Worn internal parts will not allow the pump to operate properly.	Refer to Authorized Service Center for repairs as required.
Hydraulic fluid viscosity above acceptable limits.	Hydraulic fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system valving.	Malfunctioning valving may not allow system to respond properly.	Repair or replace system valving as required.
Check pump case pressure.	High case pressure will cause the system to be sluggish.	Correct case drain line restrictions.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.

Table 5-47. System Operating Hot

Item	Description	Action
Check fluid level in reservoir.	Insufficient volume of hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level. Verify proper size of reservoir.
Inspect heat exchanger. Check air flow and input air temperature for the heat exchanger.	Insufficient air flow, high input air temperature, or undersized heat exchanger will not meet cooling demands of the system.	Clean, repair, or replace heat exchanger as required. Verify proper size of heat exchanger.
Check external system relief valve setting.	Fluid passing through relief valve adds heat to system.	Adjust external system relief valve setting per manufacturer's recommendations. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check pump inlet pressure / vacuum.	High inlet vacuum adds heat to system.	Correct inlet pressure / vacuum conditions.

Table 5-48. Low Pump Output Flow

Item	Description	Action
Check fluid level in reservoir.	Insufficient hydraulic fluid will limit output flow and cause internal damage to pump.	Fill the reservoir to proper level.
Hydraulic fluid viscosity above acceptable limits.	Fluid viscosity above acceptable limits or low fluid temperature will not allow the pump to fill or control to operate properly.	Allow system to warm up before operation or use fluid with the appropriate viscosity grade for expected operating temperatures.
Check external system relief valve setting.	External relief valve set below Pressure Compensator setting will cause low output flow.	Adjust external relief valve per manufacturer's recommendation. External relief valve setting must be above Pressure Compensator setting for proper operation.
Check Pressure Compensator and Load Sense control setting.	Low Pressure Compensator setting will prevent the pump from achieving full stroke. Low Load Sense setting will limit output flow.	Adjust Pressure Compensator and Load Sense setting. Refer to Adjustments.
Check pump inlet pressure / vacuum.	High inlet vacuum will cause low output flow.	Correct inlet pressure conditions.
Check input speed.	Low input speeds decrease flow.	Adjust input speed.
Check pump rotation.	Incorrect rotational configuration will cause low flow.	Use pump with appropriate rotational configuration.

Table 5-49. Pressure or Flow Instability

Item	Description	Action
Check for air in system.	Air in system will cause erratic operation.	Activate Pressure Compensator, allowing system to bleed air. Check inlet line for leaks and eliminate source of air ingression.
Check control spools.	Sticking control spools will cause erratic operation.	Inspect spools for free movement in bore. Clean or replace as needed.
Check Load Sense setting.	Low Load Sense setting may cause instability.	Adjust Load Sense setting to proper level. See Adjustments.
Check Load Sense signal line.	Blocked Load Sense signal line will interfere with proper Load Sense operation.	Remove blockage.
Check external relief valve and Pressure Compensator setting.	Insufficient pressure differential between Pressure Compensator Pressure Compensator setting and external relief valve.	Adjust external relief valve or Pressure Compensator control settings to appropriate level. Relief valve setting must be above Pressure Compensator setting for proper operation.
Check external relief valve.	Chattering external relief valve may cause unstable feedback to pump control.	Adjust or replace relief valve.

Table 5-50. System Pressure Not Reaching Pressure Compensator Setting

Item	Description	Action
Check Pressure Compensator control setting.	System pressure will not rise above Pressure Compensator setting.	Adjust Pressure Compensator to appropriate setting.
Check external relief valve.	External relief valve setting below Pressure Compensator setting will prevent pressure compensation.	Adjust external relief valve per manufacturer's recommendations. External relief valve must be set above Pressure Compensator setting for proper operation.
Inspect Pressure Compensator control spring.	Broken, damaged, or missing spring will cause erratic operation.	Replace spring as required.
Inspect Pressure Compensator spool for wear.	Wear of the Pressure Compensator spool will cause internal leakage in the control.	Replace the spool as required.
Inspect Pressure Compensator spool for proper orientation.	Improper orientation will result in poor operation.	Correct orientation of spool.
Check Pressure Compensator control for contamination.	Contamination may interfere with movement of the Pressure Compensator Spool.	Clean Pressure Compensator control components, take appropriate action to eliminate contamination.

Table 5-51. High Inlet Vacuum

Item	Description	Action
CAUTION HIGH INLET VACUUM CAUSES CAVITATION WHICH CAN DAMAGE INTERNAL PUMP COMPONENTS.		
Check fluid temperature.	Low temperature increases viscosity. High fluid viscosity causes high inlet vacuum.	Allow system to warm up before operation.
Inspect inlet screen.	Blocked or restricted inlet screen will cause high inlet vacuum.	Clean screen / remove blockage.
Check inlet piping.	Too many fittings, bends, or long piping will cause high inlet vacuum.	Eliminate fittings to make path more direct.
Hydraulic fluid viscosity above acceptable limits.	High fluid viscosity causes high inlet vacuum.	Select fluid with appropriate viscosity for expected operating temperature.

Shaft Seal Replacement

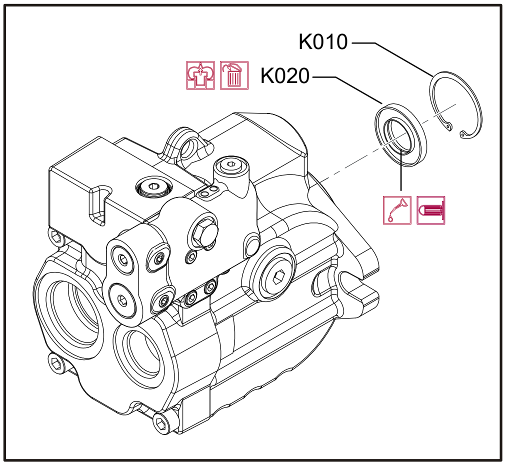


Figure 5-119. Shaft Seal and Retaining Ring

A lip type shaft seal is used in the pump and can be replaced without major disassembly of the unit. Replacement of the shaft seal requires removal of the pump from the machine.

REMOVAL

1. Using the appropriate snap-ring pliers, remove the retaining ring (K010) from the housing.
2. Remove the shaft seal (K020) from the bore in the pump housing and discard. Avoid damaging the pump housing or shaft. Puncture the face of the seal with a packing hook, or use a slide-hammer type puller to remove the seal.

INSTALLATION

1. Inspect the pump housing and new seal for damage. Inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.
2. Lubricate the lip of the new shaft seal with clean hydraulic fluid. Place a protective sleeve over the shaft end to prevent damage to the seal during installation.

⚠ CAUTION

PREMATURE BEARING FAILURE CAN RESULT IF THE SHAFT SEAL CONTACTS THE SHAFT BEARING. PRESS THE SEAL INTO THE HOUSING ONLY FAR ENOUGH TO CLEAR THE RETAINING RING GROOVE.

3. Keeping the seal perpendicular to the shaft, press the new seal into the housing just far enough to clear the retaining ring groove. Install seal with the cupped side toward the shaft bearing. Do not damage the seal during installation.
4. Using the appropriate snap ring pliers, install the seal retaining ring.
5. Remove the installation sleeve.

Control Assembly

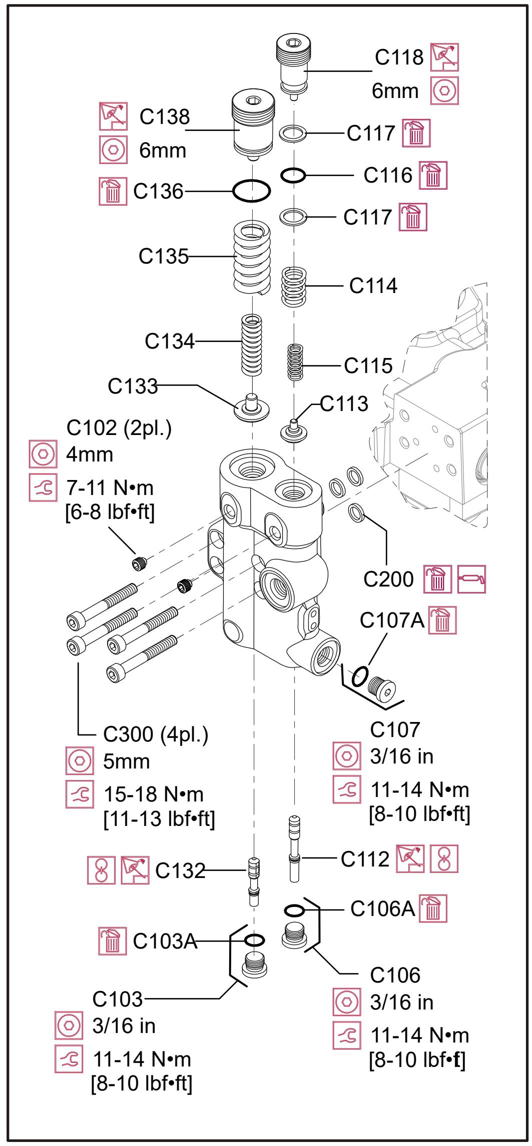


Figure 5-120. Control Assembly

DISASSEMBLY

1. Remove the four screws (C300) holding the control housing onto the end cap.
2. Remove the control and discard the three interface o-rings (C200).
3. Remove the Pressure Compensator set screw (C102), Pressure Compensator adjustment screw (C138), o-ring (C136), springs (C135, C134), and seat (C133). Discard the o-ring.
4. Remove the plug (C103), o-ring (C103A),and Pressure Compensator spool (C132) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.
5. Remove the plug (C107) and o-ring (C107A); discard the o-ring.

NOTE: *For Pressure Compensator only controls, skip steps 6 and 7.*

6. Remove the Load Sense set screw (C102), Load Sense adjustment screw (C118), o-ring (C116), backup rings (C117), springs (C114, C115), and seat (C113); discard the o-ring.
7. Remove the plug (C106), o-ring (C106A), and Load Sense spool (C112) from the control housing; discard the o-ring. Note orientation of the spool for reassembly.

INSPECTION

1. Inspect the adjustment screws for wear at the tips and where they contact the springs; replace as necessary.
2. Inspect the springs and spring guides for wear or damage; replace as necessary.
3. Carefully inspect the spools. Ensure the sealing lands are free of nicks and scratches. Check the ends that contact the spring guides for wear. Replace spools as necessary.
4. Inspect the control housing for damage. Check the spool bores for excessive wear.
5. Clean all parts and lubricate spools, springs, guides and new o-rings with clean hydraulic fluid.

REASSEMBLY

1. Install the Pressure Compensator spool, spherical end first, into the Pressure Compensator bore. The Pressure Compensator spool is the shorter of the two. Using a new o-ring, install the plug (C103). Torque to 8-10 ft.lbs. (11-14 Nm).
2. Place the two Pressure Compensator springs onto the spring guide and install into the Pressure Compensator bore. Place a new o-ring onto the Pressure Compensator adjustment screw and thread it into the Pressure Compensator bore until flush, then make another full turn. Install and torque the set screw to 6-8 ft.lbs. (7-11 Nm).

NOTE: *For Pressure Compensator only controls, skip steps 15 and 16.*

3. Install the Load Sense spool, spherical end first, into the Load Sense bore. The Load Sense spool is the longer of the two. Using a new o-ring, install the plug (C106). Torque to 8-10 ft.lbs. (11-14 Nm).
4. Place the two Load Sense springs onto the spring guide and install into the Load Sense bore. Place a new o-ring and backup rings onto the Load Sense adjustment screw and thread it into the Load Sense bore until flush, then make another full turn. Install and torque the set screw to 7-11 Nm (6-8 ft.lb.).
5. Using a new o-ring, install the plug (C107). Torque to 8-10 ft.lbs. (11-14 Nm).
6. Using petroleum jelly to retain them, install the three interface o-rings (C200) in the recesses on the control housing.
7. Install the control assembly onto the endcap using the four screws (C300). Torque to 11-13 ft.lb. (15-18 Nm). Torque screws in a criss-cross pattern and re-torque the first screw to ensure proper torque retention.

Plug and Fitting Sizes and Torques

If any plugs or fittings are removed from the unit during service, install and torque as indicated here. This drawing is a composite. Your configuration may differ but the appropriate wrench size and torque can be found here.

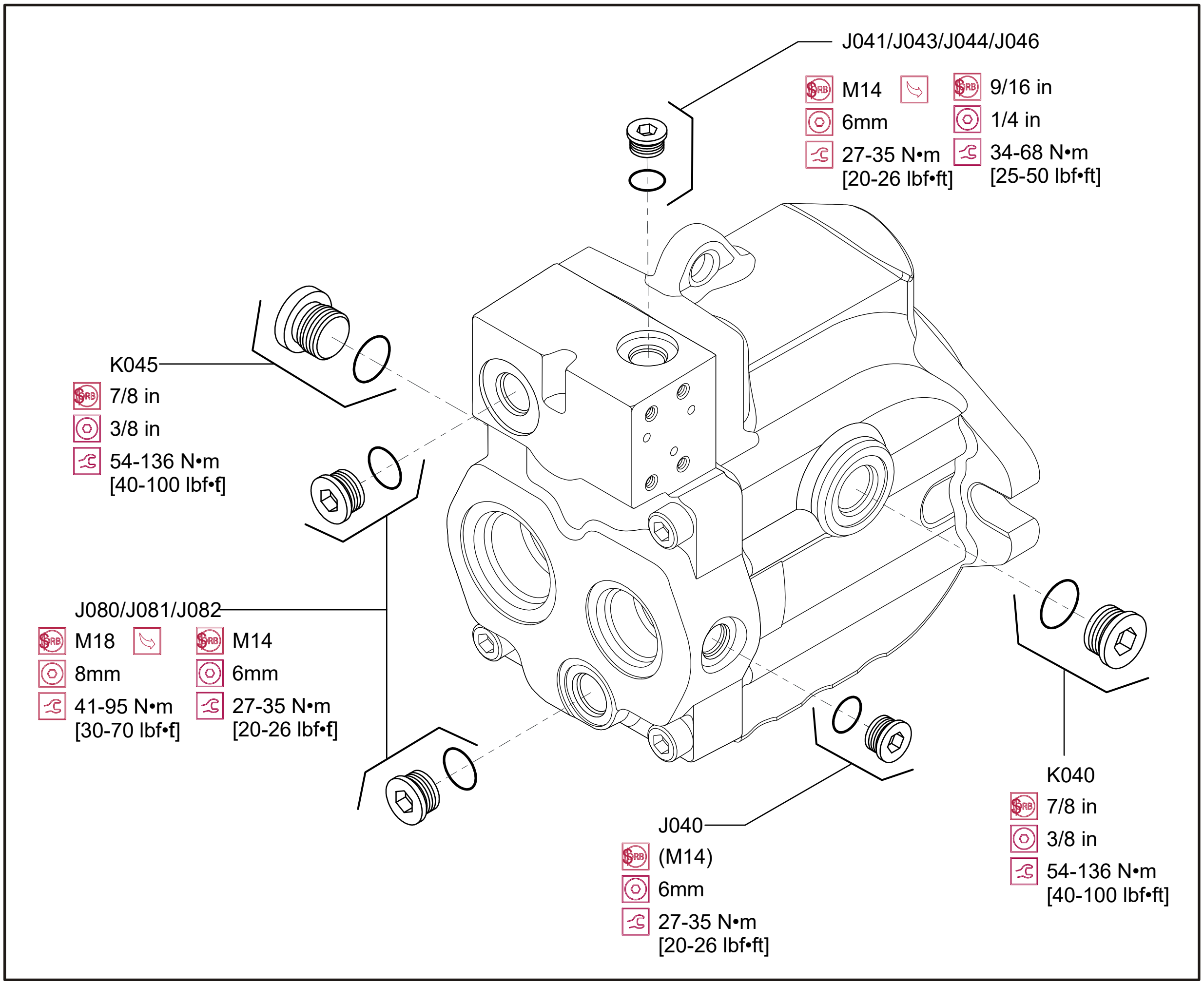


Figure 5-121. Plug Locations, Sizes, and Torques

5.10 DRIVE PUMP

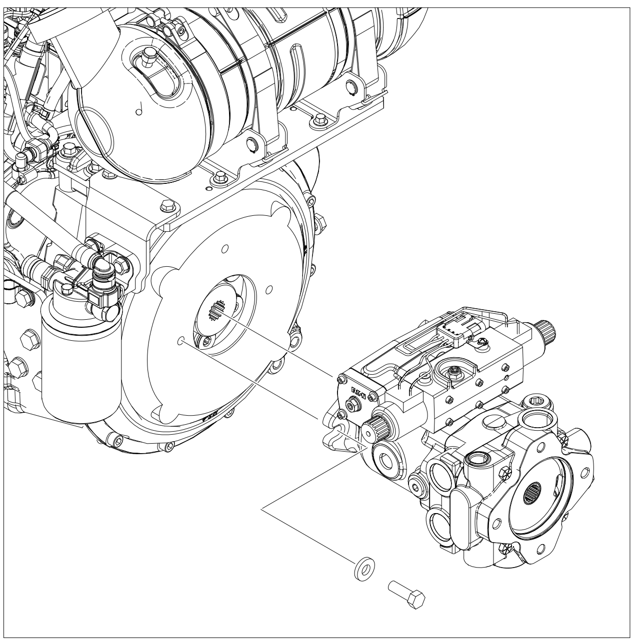
Removal

NOTE: *Remove the function pump from the machine first, refer Section 5.9, Variable Pump.*

1. Tag and disconnect the hydraulic lines and fittings from the drive pump. Use a suitable container to retain any residual hydraulic fluid. Immediately cap lines and ports.

NOTE: *The drive pump weighs approximately 62 lb (28 kg).*

2. Use a suitable device to support the drive pump.
3. Remove two bolts and washers attaching the drive pump to the engine assembly. Remove drive pump from the machine as shown.



4. Remove and discard o-ring from the drive pump groove.
5. Place drive pump in the clean work area.

Installation

NOTE: *The drive pump weighs approximately 62 lb (28 kg).*

1. Use a suitable device to support the drive pump.
2. Install the new o-ring in to the drive pump groove.
3. Align and install the drive pump to the engine assembly.

NOTE: *Make sure that the pump shaft is properly aligned.*

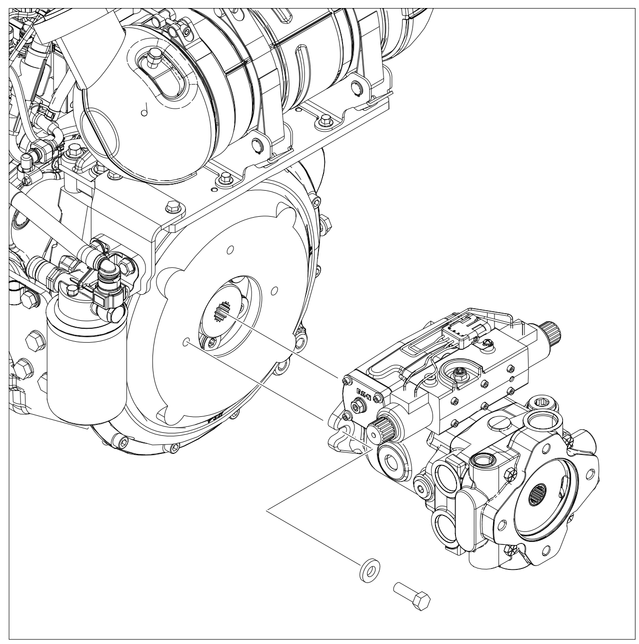
CAUTION

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

4. Secure drive pump with two bolts and washers as shown.

NOTE: *Apply Medium Strength Threadlocking Compound to the bolts before installation.*

5. Torque bolt to 50 ft. lbs. (68 Nm).



6. Remove tag and reconnect the hydraulic lines and fittings to the drive pump.

Servo Controlled Piston Pump

DISASSEMBLY

The following instructions apply to a single servo controlled piston pump with or without a gerotor charge pump. A tandem pump assembly should be separated into individual pumps before disassembly.

1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the capscrews up. Mark the relationship of the working ports (for assembly identification) to the servo control assembly with a scribe. Remove the four capscrews retaining endcover.

NOTE: *If there is no gerotor charge pump, jump to step 6.*

2. Lift the charge pump adapter assembly straight up off endcover, shaft and gerotor. Gerotor may stay in adapter or on endcover.
3. Remove o-ring from charge pump adapter.
4. Remove outer gerotor ring from either the charge pump adapter or the inner gerotor ring.

NOTE: *Refer to "Charge Pump Adapter Assembly" for disassembly and inspection of charge pump adapter assembly.*

5. Remove the inner gerotor ring and key from drive shaft or inner gerotor ring and coupler assembly from shaft.
6. Lift endcover straight up off shaft and housing. Remove valve plate from endcover or from rotating kit assembly, still in housing.
7. From endcover, remove bypass valve or plug, and relief valve assemblies. Note: Mark the relief valve in relationship to the cavity it was removed, for reassembly purposes.

Endcover Inspection

- Check the bearing (press fit) in endcover. If needles remain in cage, move freely, and setting is at the dimension shown in Figure 5-122. removal not required.
- Check roll pin in endcover. If tight and set to the dimension shown in Figure 5-122. removal not required.

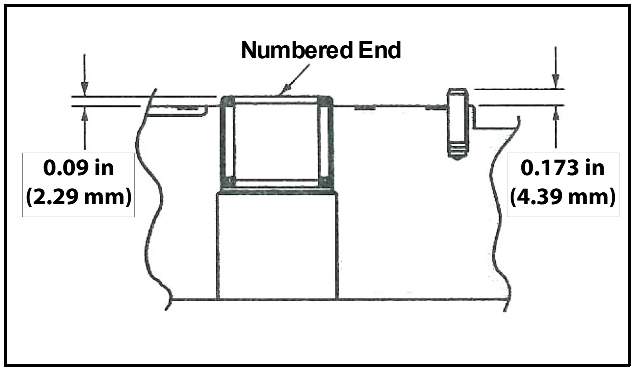


Figure 5-122. Endcover Inspection

1. Remove housing gasket from housing or endcover.
2. With pump still in vise, remove the six capscrews retaining the manual servo control assembly. Remove the control assembly and control housing gasket from the housing. Remove orifice plates, noting location for reassembly. Remove nut and lock washer from control arm, remove arm. Note position of control arm for reassembly.

NOTE: *Refer to "Manual Servo Control Basic Assembly" for disassembly and Inspection of control assembly.*

3. To remove rotating kit assembly from housing, first remove pump from vise holding the rotating kit assembly in position. Lower pump so that the shaft end (flange end) is up. Set the rear of housing onto table with housing flat and rotating kit assembly at rest on table. (Hole in table, for protruding shaft, is required.) Lift and remove the housing and shaft from rotating kit assembly, and swashplate.
4. Remove swashplate from rotating kit assembly and servo piston follower from swashplate.

NOTE: *Refer to "Rotating Kit Assembly" for disassembly and Inspection of rotating kit.*

Swashplate Inspection

- The finish on the piston shoe surfaces of the swashplate should show no signs of scoring.
- Inspect swashplate bushing surface for wear and surface for coating transfer from bushing.

1. To remove servo piston assembly from housing, start with the four each capscrews and washers retaining each cover plate.
2. In removing the cover plate from the servo piston bolt, remove jam nut, washer, and seal washer. Hold the servo piston bolt with hex key and unscrew cover plate off of bolt.
3. Remove servo piston assembly and seal sub-assemblies (two sets) from housing.

NOTE: *Disassembly of servo piston assembly is not required.*

4. Remove retaining ring from the front of housing. Press the shaft, shaft seal or spacer, and washer from housing. Remove retaining ring, thrust washer, thrust bearing, second thrust washer, and second retaining ring from shaft.

Housing Inspection

- Check the bearing (press fit) in housing. If needles remain in cage, move freely, and setting at the dimension shown in Figure 5-123., removal not required.

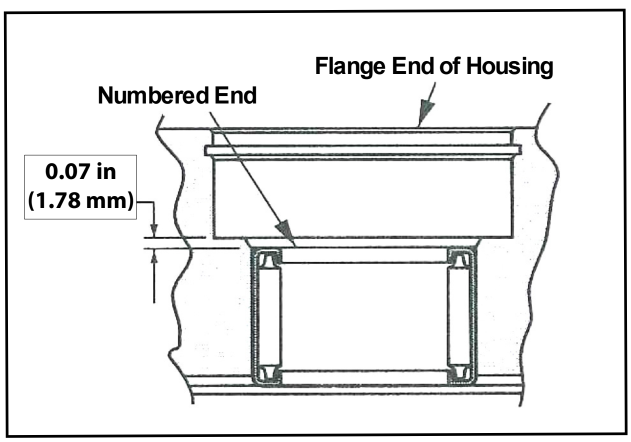


Figure 5-123. Housing Inspection

1. To remove cradle sub-assembly, remove the two capscrews retaining cradle inside housing. Removing cradle subassembly from housing.
2. Remove button head capscrews (2 Qty.) to remove bushing from cradle.

Bushing Inspection

- Inspect bushing for contamination embedment within coating of bushing surface coming in contact with swashplate.

1. Remove all plugs from housing.
2. Discard the shaft seal, gaskets, and o-rings from all assemblies. Replace with new seals upon reassembly.

ASSEMBLY

1. All parts should be cleaned and critical moving parts lubricated before reassembly.
2. If necessary, press new bearing in housing to dimension shown in Figure 5-123. with the numbered end of bearing outward.
3. Install the two new seal sub-assemblies into the servo piston cavity of housing.
4. Screw the cover plate onto the servo piston assembly. Install new cover plate gasket in place on housing. Install servo piston assembly and cover plate into servo piston bore in right side of housing (as shown in Figure 5-124. Retain cover plate with four each washers and capscrews. Torque capscrews 40 to 48 in.lbs. (4.5 to 5.4 Nm). To obtain neutral, centering the servo piston assembly is required. Measure in from the left side and set servo piston 0.5 in. (12.7 mm) from surface of housing servo bore as shown in Figure 5-124.

NOTE: *Re-adjustment may be required for neutral at unit start-up.*

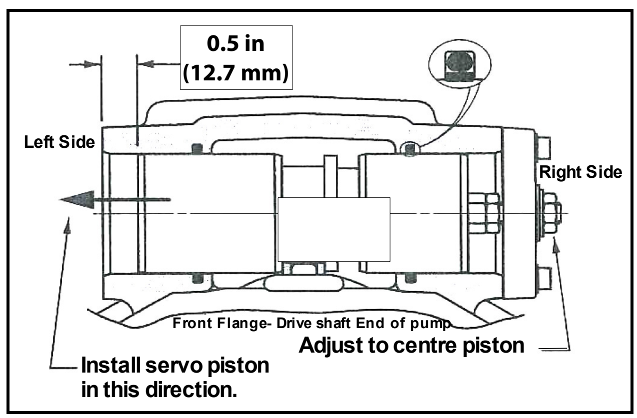


Figure 5-124. Servo Piston Installation

5. Install new seal washer, washer, and jam nut to servo piston bolt. Holding servo piston bolt with hex key wrench Torque jam nut 150 to 160 in.lbs. (17 to 18 Nm). Check the centering of servo piston assembly. Install new cover plate gasket and cover plate to left side of servo piston and retain with four each washers and #10-24 capscrews. Torque capscrews 40 to 48 in.lbs. (4.5 to 5.4 Nm).

6. To assemble cradle sub-assembly, install bushing onto cradle retaining with button head capscrews. Torque button head capscrew 14 to 16 in.lbs. (1.6 to 1.8 Nm).

7. Place cradle sub-assembly into housing making sure cradle is completely seated into housing. Retain cradle sub-assembly with two capscrews. Torque capscrews 20 to 24 ft.lbs. (27 to 33 Nm).

8. To install shaft, place exterior retaining ring, thrust race, thrust bearing, second thrust race, and second retaining ring onto shaft. Position washer and shaft seal or spacer onto shaft.

9. Install shaft assembly into front of housing for units with spacer, retain with interior retaining ring and go on to step 10. For units with shaft seal. seat seal into position with seal driver and retain with interior retaining ring.

10. Install servo piston follower onto swashplate dowel pin. Install swashplate carefully onto bushing (coat bushing surface with hydraulic oil), aligning servo piston follower with slot in servo piston assembly.

NOTE: *Refer to "Rotating Kit Assembly" for reassembly of rotating kit assembly.*

11. To install rotating kit assembly, leave housing and shaft in the horizontal position. Holding swashplate into position with screw driver thru controller linkage passageway at the top of housing. place rotating kit assembly over shaft and into housing until pistons are in against swashplate. Make sure all parts are in housing completely and properly positioned. Return the pump to the vise with open end of housing up. clamping housing on the outer portion of the flange.

12. Install gasket on to housing.

13. If necessary, press new bearing and roll pin in endcover to dimension shown in Table 5-122., Endcover Inspection. Bearing installed with the numbered end outward. Roll pin installed with split oriented away from bearing.

14. Install new o-ring on relief valves. Install relief valve in its original cavity in endcover that it was removed. Torque 100 to 110 ft.lbs. (136 to 149 Nm).

15. Install new o-ring on bypass valve or plug. Install bypass valve or plug into endcover. Note: Make sure paddle of bypass valve is perpendicular to relief valve axis prior to installing or damage could result.

16. Apply a small amount of petroleum jelly to the steel side of valve plate to hold in place for installation. Aligning the index pin, place the valve plate in position onto the endcover, with steel side against endcover.

17. Install endcover assembly onto housing assembly. Make sure ports are positioned correctly, valve plate and gasket stay in place.

18. Install key and inner ring gerotor onto shaft or coupler assembly. Lubricate inner ring gerotor.

NOTE: *Refer to "Charge Pump Adapter Assembly" for assembly of charge relief valve in adapter plate.*

19. Install o-ring and outer ring gerotor onto adapter plate. Lubricate both a-ring and outer ring to hold in position during assembly of adapter plate. Install adapter plate onto endcover. Make sure o-ring and gerotor ring stay in place.

20. Retain endcover and adapter plate (when used) with four capscrews, Torque 27 to 31 ft.lbs. (37 to 42 Nm).

NOTE: *Refer to "Manual Servo Control Basic Assembly" for reassembly of manual servo control assembly.*

21. Install control housing gasket onto housing. Install orifices into control assembly and retain in position with petroleum jelly. Position the feedback link at 90 degrees from control housing. Install manual servo control assembly onto housing making sure feedback link entered small groove in servo piston assembly.

22. Retain control assembly with six capscrews, torque 40 to 48 in.lbs. (4.5 to 5.4 Nm).

23. Install control arm onto control assembly input arm. Retain with lock washer and nut, torque 4 to 6 ft.lbs. (5 to 8 Nm).

24. Install new o-rings on all plugs. Install plugs into housing. Torque 3/4 in. plug 21 to 24 ft.lbs. (28 to 32 Nm). Torque 1-1/4 in. plug 40 to 45 ft.lbs. (54 to 61 Nm).

25. Refer to "Start-up Procedure".

Charge Pump Adapter Assembly

DISASSEMBLY

1. Remove plug, shims, spring, and poppet from adapter assembly as shown in Figure 5-126.

Inspection

- Inspect the charge pump relief valve seat inside the charge pump adapter. Check to insure that seat is smooth and free of burrs or other defects.
- Inspect the charge pump relief valve spring.
- Inspect the bearing or bushing inside the charge pump adapter. The bearing needles must remain in the bearing cage and bearing at dimension shown in Figure 5-125. The bushing must have no excessive scoring.
- Inspect the gerotor pocket inside the charge pump adapter assembly. It should not be scored excessively.

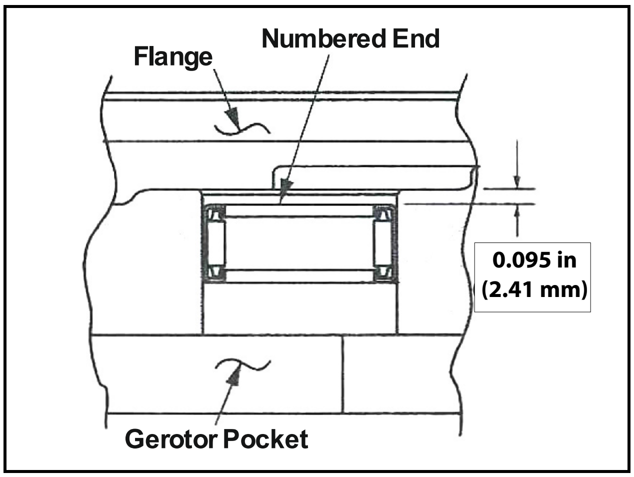
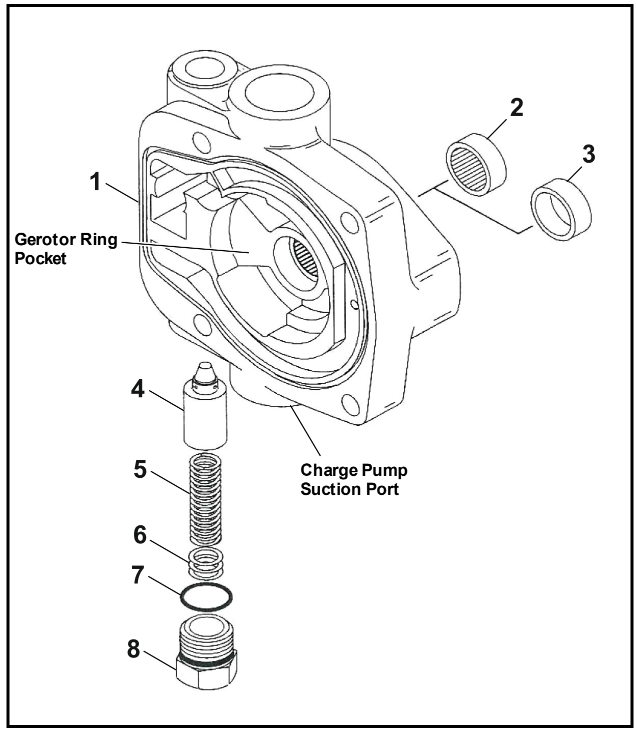


Figure 5-125. bearing or bushing Inspection

ASSEMBLY

1. If necessary, press new bearing or bushing in adapter assembly. The bearing to dimension shown in Figure 5-125. with the numbered end of bearing outward and closest to mounting flange. The bushing is to be pressed flush to 0.010 in. (0.254 mm) recessed.
2. Install poppet. spring, shims, new o-ring on plug, and plug into adapter assembly. Torque plug 30 to 27 ft.lbs. (40.7 to 36.6 Nm).



1. Charge Pump Adapter
2. Bearing
3. Bushing
4. Poppet
5. Spring
6. Shims
7. 0-ring
8. Plug

Figure 5-126. Charge Pump Adapter Assembly

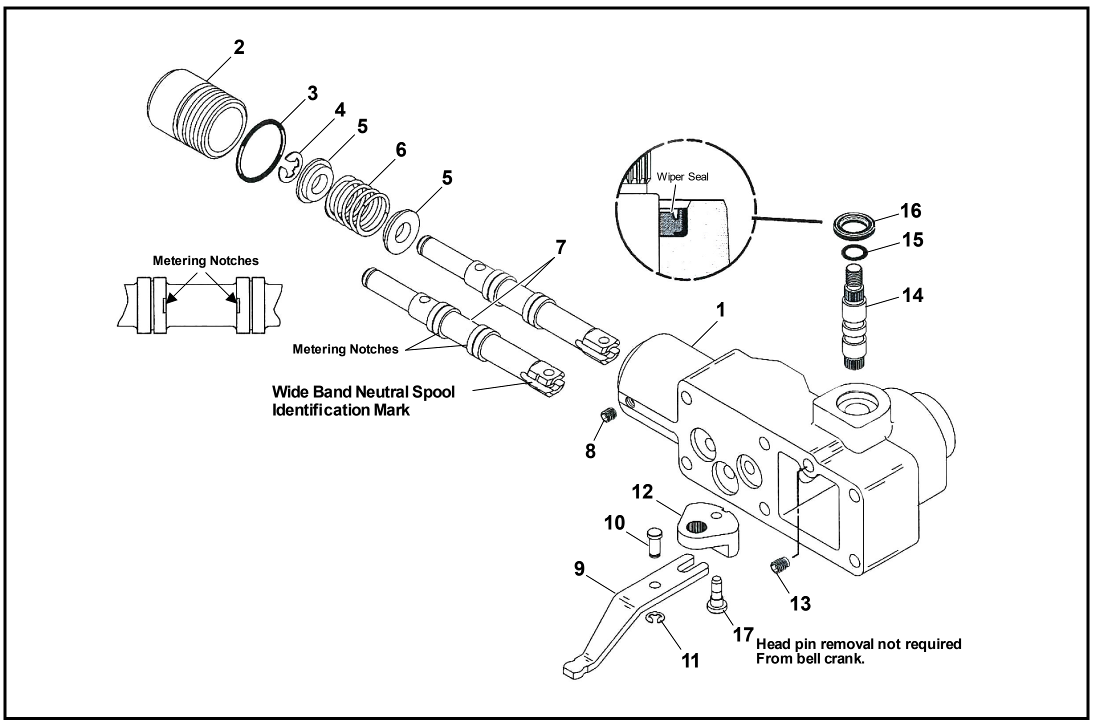
Manual Servo Control Basic Assembly

DISASSEMBLY

1. Remove wiper seal with screw driver. Remove set screw retaining input shaft and remove input shaft from control housing.
2. Remove set screw from plug retaining valve spool and remove plug.
3. Remove E-ring from pin retaining feedback link and valve spool. Remove pin, feedback link, valve spool and bell crank from control housing.
4. Compress spring and remove E-ring. spring retainer, spring and second spring retainer from valve spool.
5. Remove o-rings from plug and input shaft. Clean all parts and lubricate in prep for reassembly.

ASSEMBLY

1. Install spring retainer, spring. and second spring retainer onto spool. Compress spring with retainer and retain with E-ring onto valve spool.
2. Install valve spool into control housing making sure that metering notches on valve spool can be seen in the metering ports. Notches shown in Figure 5-127.
3. Position bell crank in housing. Slide feedback link into position between clevis on valve spool. aligning holes, and install dowel pin retaining with E-ring.
4. Install new o-ring onto input shaft. Hold bell crank in position with feedback link slot and align splined hole of bell crank with input shaft cavity. Install input shaft into control housing and bell crank.
5. Medium Strength Threadlocking Compound or equivalent to set screw and install, retaining input shaft. Adjust set screw until it bottoms out on input shaft and back out one-quarter turn.
6. Install wiper seal on input shaft as shown in Figure 5-127.
7. Install new o-ring onto plug. retaining valve spool, and install plug. Adjust plug until there is no play in the valve spool with input shaft held stationary. Lock in place with set screw. Torque set screw 17 to 25 in.lbs (2 to 3 Nm).



1. Control Housing	6. Spool Centering Spring	10. Dowel Pin	14. Input Shaft
2. Plug	7. Valve Spool	11. Retaining Ring	15. 0-ri ng
3. 0-ring	8. Set Screw	12. Bell Crank	16. Wiper Seal
4. Retaining Ring	9. Feedback Link	13. Set Screw	17. Head Pin
5. Spring Retainer			

Figure 5-127. Manual Servo Control Basic Assembly

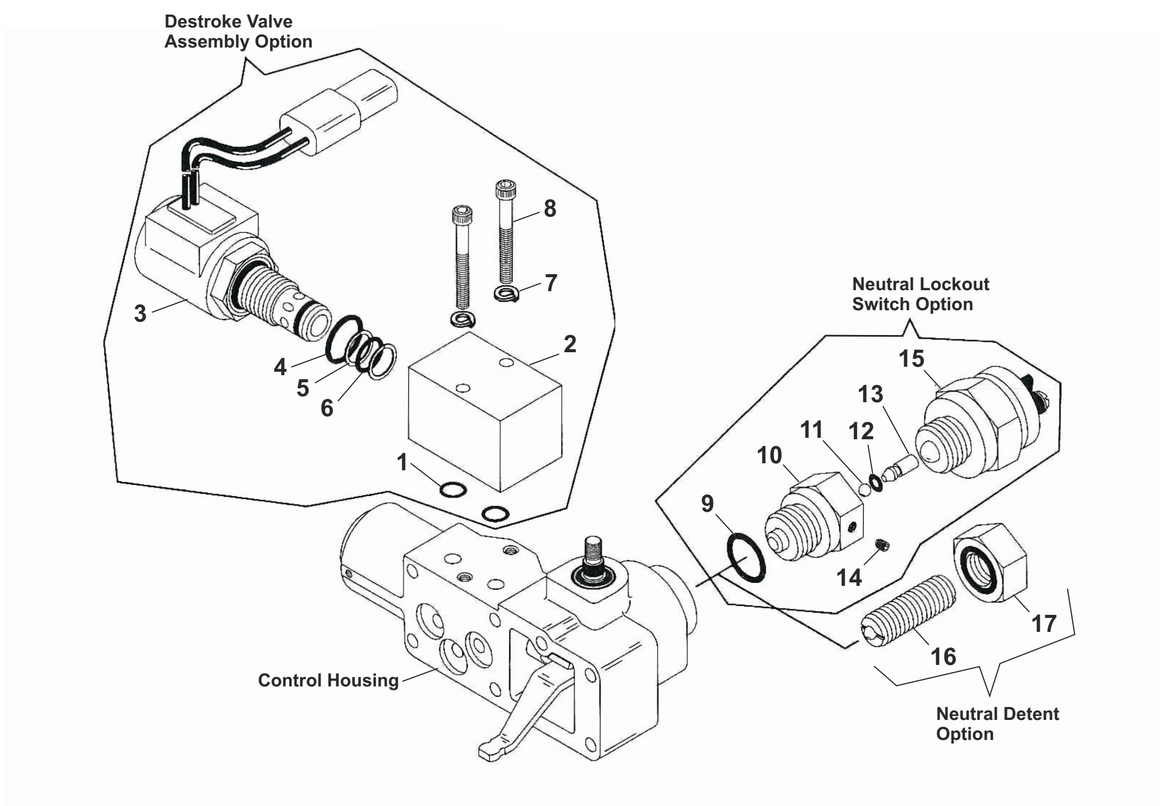
Manual Servo Control Assembly Options

DISASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Remove the two capscrews and lock washers from manifold. Removing destroke valve assembly and two o-rings.
2. Remove destroke valve from manifold in order to remove o-rings and backup washers. Note: in order to remove destroke valve the solenoid may need to be removed from core first (not shown).

ASSEMBLY - DESTROKE VALVE ASSEMBLY OPTION

1. Install new o-rings and backup washers onto destroke valve.
2. Install destroke valve into manifold by hand until top o-ring is met by manifold. Then wrench tighten to 25 ft.lbs. (34 Nm) max. Loosen Nut retaining coil to reposition if necessary and re-torque 4 to 5 ft.lbs. (5.4 to 7 Nm).
3. Lubricate the two o-rings and install onto manifold. Install destroke valve assembly onto control assembly. Retain with lock washers and capscrews. Torque 2.2 to 2.6 ft.lbs. (3 to 3.5 Nm).



1. O-ring	6. O-ring	10. Neutral Lockout Adapter	14. Set Screw
2. manifold	7. Lock Washer	11. Ball	15. Neutral Lockout Switch
3. Destroke Valve	8. Capscrew	12. O-ring	16. Ball Plunger
4. O-ring	9. O-ring	13. Pin	17. Seal Nut
5. Backup Washer			

Figure 5-128. Manual Servo Control Basic Assembly Option

DISASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION

1. Loosen set screw in adapter and remove neutral lockout switch from adapter.
2. Remove neutral lockout adapter from control assembly.
3. Remove pin, ball. and a-rings from adapter.

ASSEMBLY - NEUTRAL LOCKOUT SWITCH ASSEMBLY OPTION

1. Install new o-ring onto adapter and new o-ring onto pin.
2. Install ball and pin into adapter. Lubricate with petroleum jelly to hold in place during installation.
3. Install adapter into control assembly. Torque 44 to 53 ft.lbs. (60 to 70 Nm).
4. Apply Low strength threadlocking compound or equivalent to threads of switch and install neutral lockout switch into adapter. The adjustment procedures for the switch are as follows.
   a. Install switch, while moving control arm back and forth, until “detent” action is detected. Back out the switch until the “detent” action is very slight.
   b. Obtain a test light or use a multimeter. Attach the leads from the test light to the switch or the wiring connector.
   c. Move the control arm out of the detent position. The test light will go on. Screw in the switch until the light goes off. Mark this as position “A”. See Figure 5-129. Move the control arm to the detent position and the test light should come back on.
   d. Leaving the control arm in the detent position, the light will remain on. Screw in the switch until the light goes off. Mark this position "B".
   e. Unscrew the switch one third of the distance between "B" and "A". Install and tighten the hex socket head set screw in one of the main quadrants of the hex of the switch adapter. See Figure 5-129. Torque set screw 2.3 to 2.8 in.lbs. (3.2 to 3.8 Nm).
5. Test the switch by moving the control arm to the detent position, the light should be on. Move the control arm out of detent, the light should go off.
6. Remove test light and put servo control assembly into operation.

DISASSEMBLY - NEUTRAL DETENT OPTION

1. Loosen seal nut and remove ball plunger from control housing.

ASSEMBLY- NEUTRAL DETENT OPTION

1. Install ball plunger into control housing until contact with bell crank detent is detected. After contact screw in 1/2 turn and retain with seal nut. Torque nut 10 to 22 ft.lbs. (14 to 30 Nm).

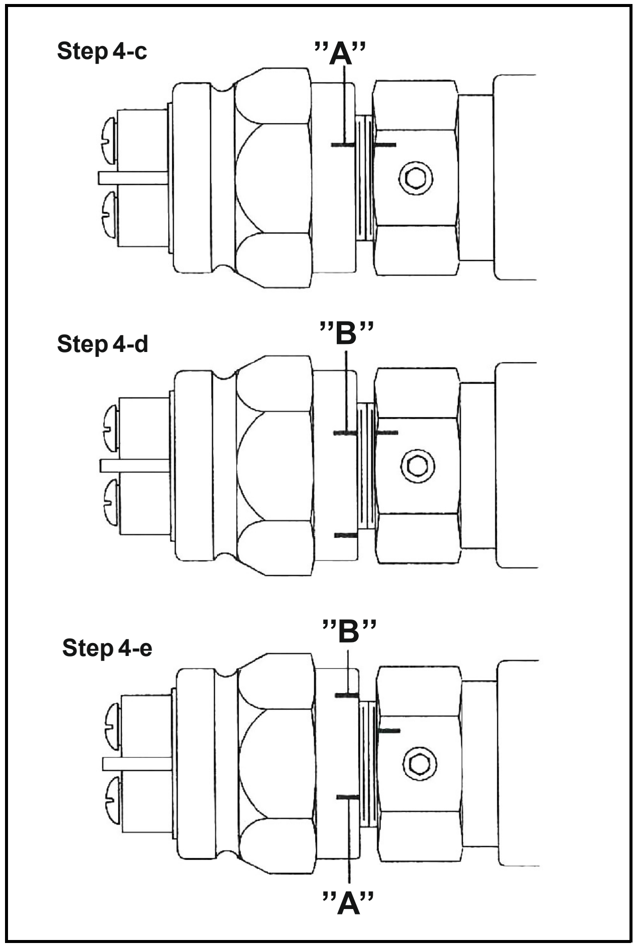


Figure 5-129. Neutral Lockout Switch Assembly

Rotating Kit Assembly

DISASSEMBLY

Disassembly of rotating assembly is required for inspection only.

1. Remove the nine piston assemblies, shoe retainer, and shoe retainer pivot from cylinder barrel.

Inspection

- Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the swashplate. **Do not lap piston shoes.**
- Examine the shoe retainer for wear in the pivot area.
- Examine the pivot to insure smoothness and no signs of wear.
- Inspect the cylinder barrel surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. Do not lap piston block.
- The pistons should move freely in the cylinder barrel bore. If they are sticky in the bore, examine the bore for scoring or contamination.

2. To inspect pins and spring caution should be taken in removing spring. The spring is highly compressed and the retaining ring should not be removed without compressing the spring safely.

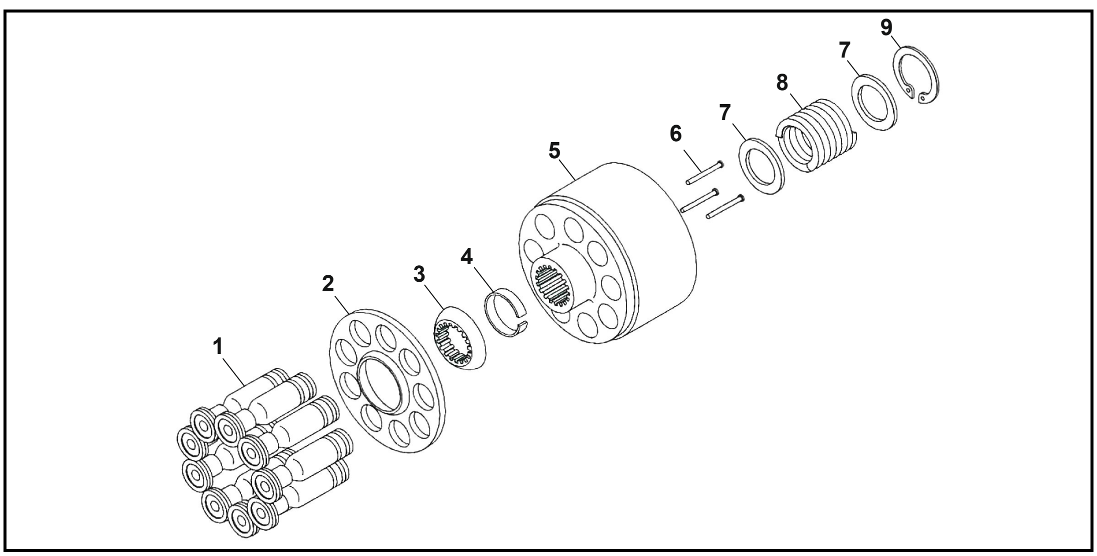
The following parts are required to disassemble the cylinder barrel:

2 ea.	3/8 in. I.D. x 1-1/8 in. O.D. flat washers
1 ea.	3/8 in. x 3-1/4 in. N.C. capscrew and
1 ea.	3/8 in. N.C. nut

To remove spring, place one of the flat washers over the 3/8 in. x 3-1/4 in. capscrew. Put capscrew through the center of the cylinder barrel and apply the second washer. Let washer rest on the three pins and retain with nut. Turning nut and compressing spring inside the barrel. Use a pair of retaining ring pliers and remove the internal retaining ring. Remove nut, bolt, and the two washers from barrel. Remove the washer, spring, second washer, three pins, and pin keeper at the same time.

ASSEMBLY

1. To reassemble the rotating kit assembly complete the following: Compress the pin keeper and install in the spline of the cylinder barrel. Install three pins with head end to the inside of the barrel and position in the special grooves of the cylinder barrel spline.
2. Install the washer, spring, and second washer into the cylinder barrel. Use the two 3/8 in. I. D. washers, nut, and 3/8 in. x 3-1/4 in. capscrew to compress the spring and retain with retaining ring. Remove the nut. capscrew, and the two washers.
3. Install the pivot onto the three pins, shoe retainer on the pivot, and piston assemblies thru the shoe retainer and into cylinder barrel. resting on shoe retainer.



1. Piston assemblies
2. Shoe Retainer
3. Shoe Retainer Pivot
4. Retainer
5. Cylinder Barrel
6. Pins
7. Washer
8. Spring
9. Retaining Ring

Figure 5-130. Rotating Kit Assembly

Fault- logic Troubleshooting

Match the transmission symptoms with the problem statements and follow the action steps shown in the box diagrams. This will give expedient aid in correcting minor problems eliminating unnecessary machine down time.

Following the fault - logic diagrams are diagram action comments of the action steps shown in the diagrams. Where applicable, the comment number of the statement appears in the action block of the diagrams.

RECOMMENDED GAUGE LOCATIONS

Gauges Recommended

Inlet vacuum gauge: 30 PSI to 14.8 PSI (2 bar to 1 bar)

System pressure gauge: 10,000 PSI (700 bar)

Charge pressure gauge: 0 to 600 PSI (0 to 50 bar)

Case pressure gauge: 0 to 300 PSI (0 to 25 bar)

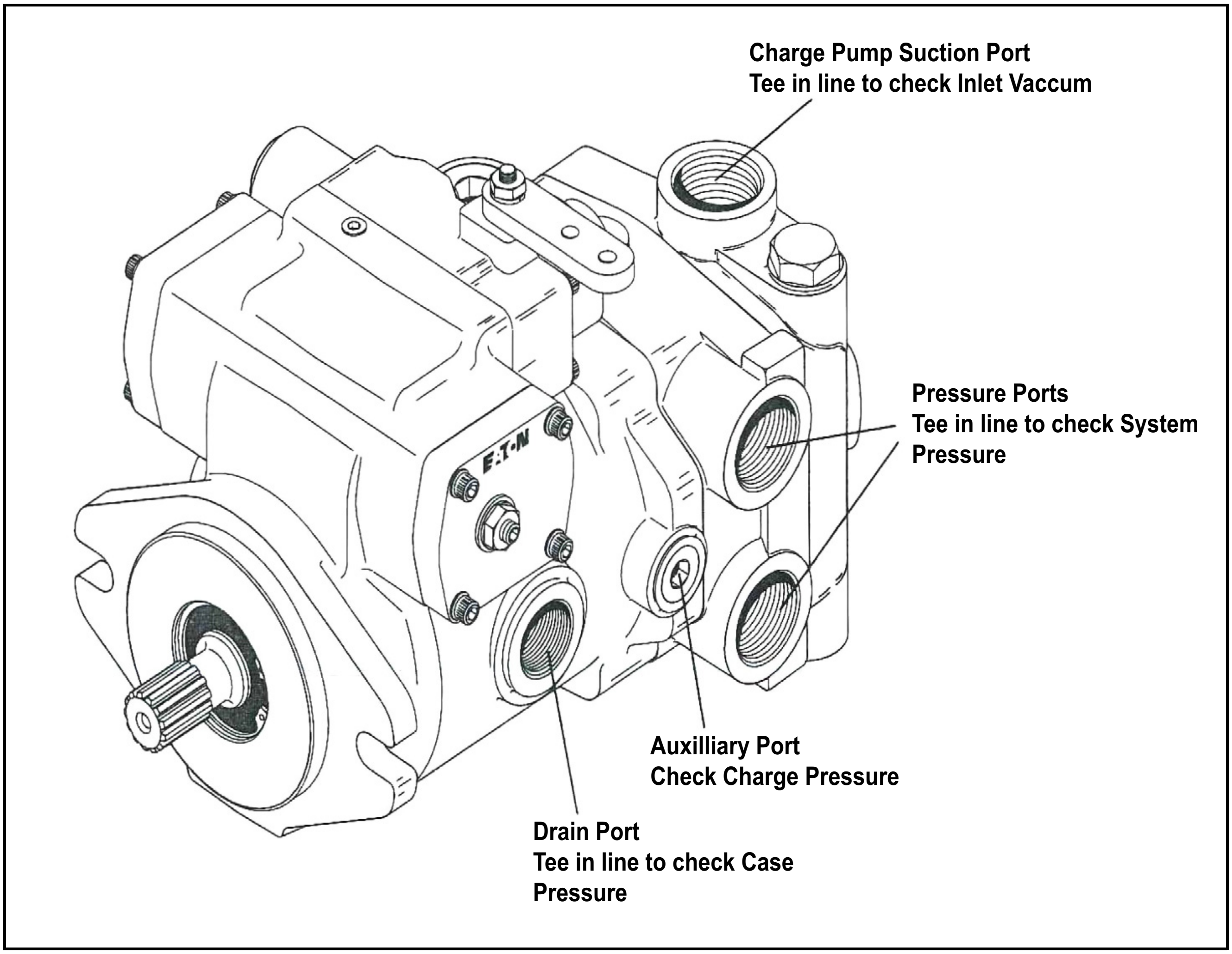


Figure 5-131. Gauge Locations

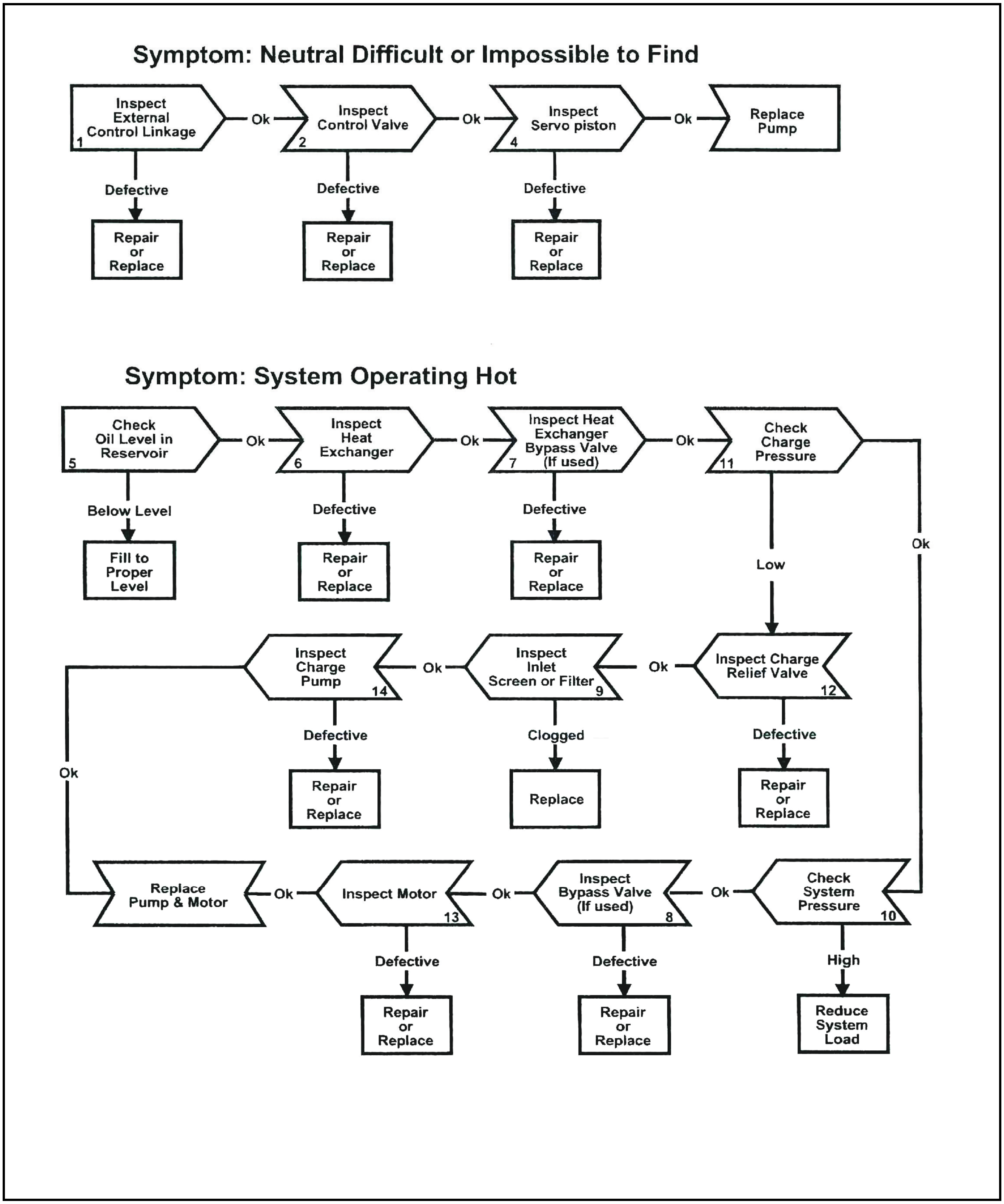


Figure 5-132. Fault- logic Troubleshooting

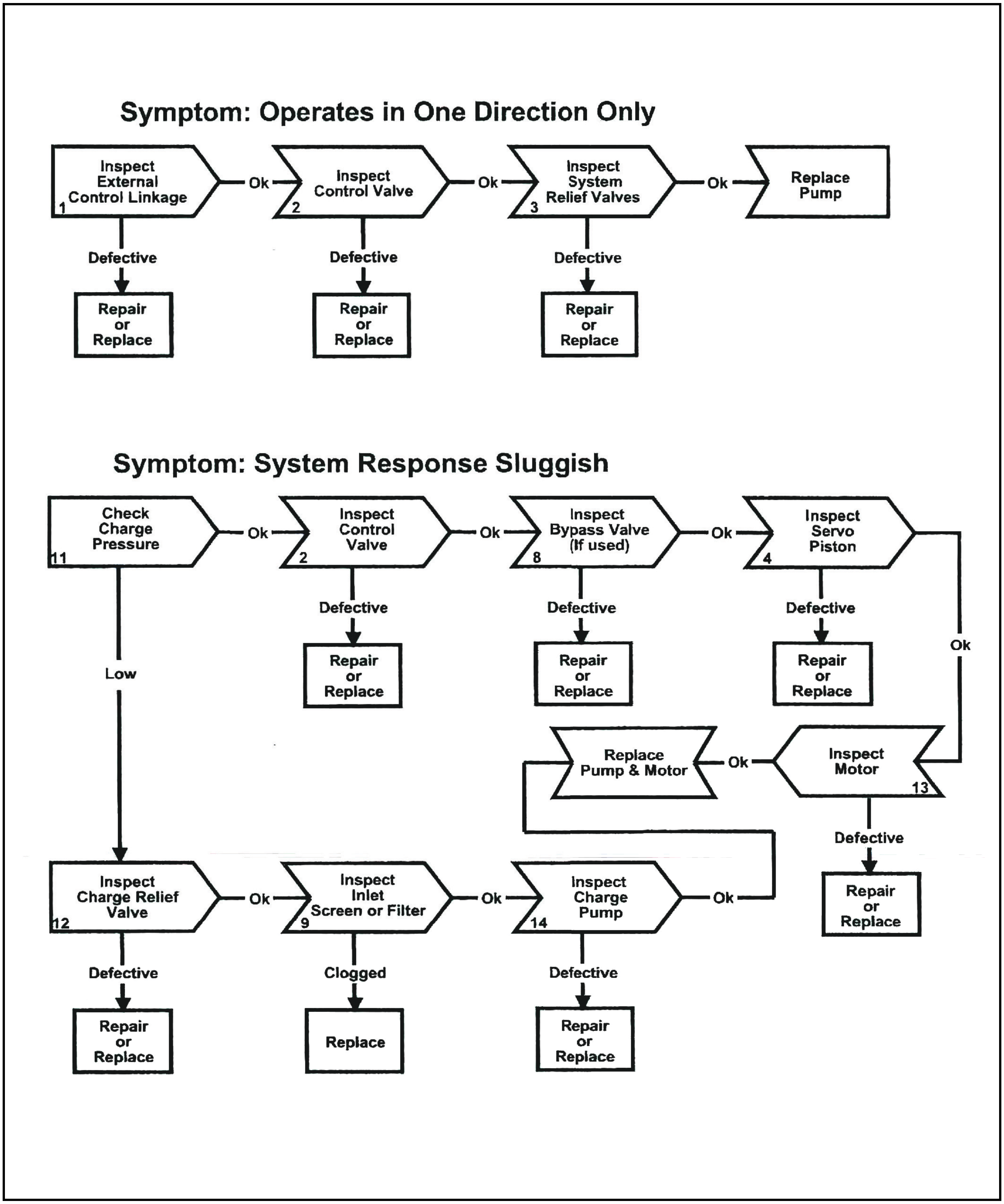


Figure 5-133. Fault- logic Troubleshooting

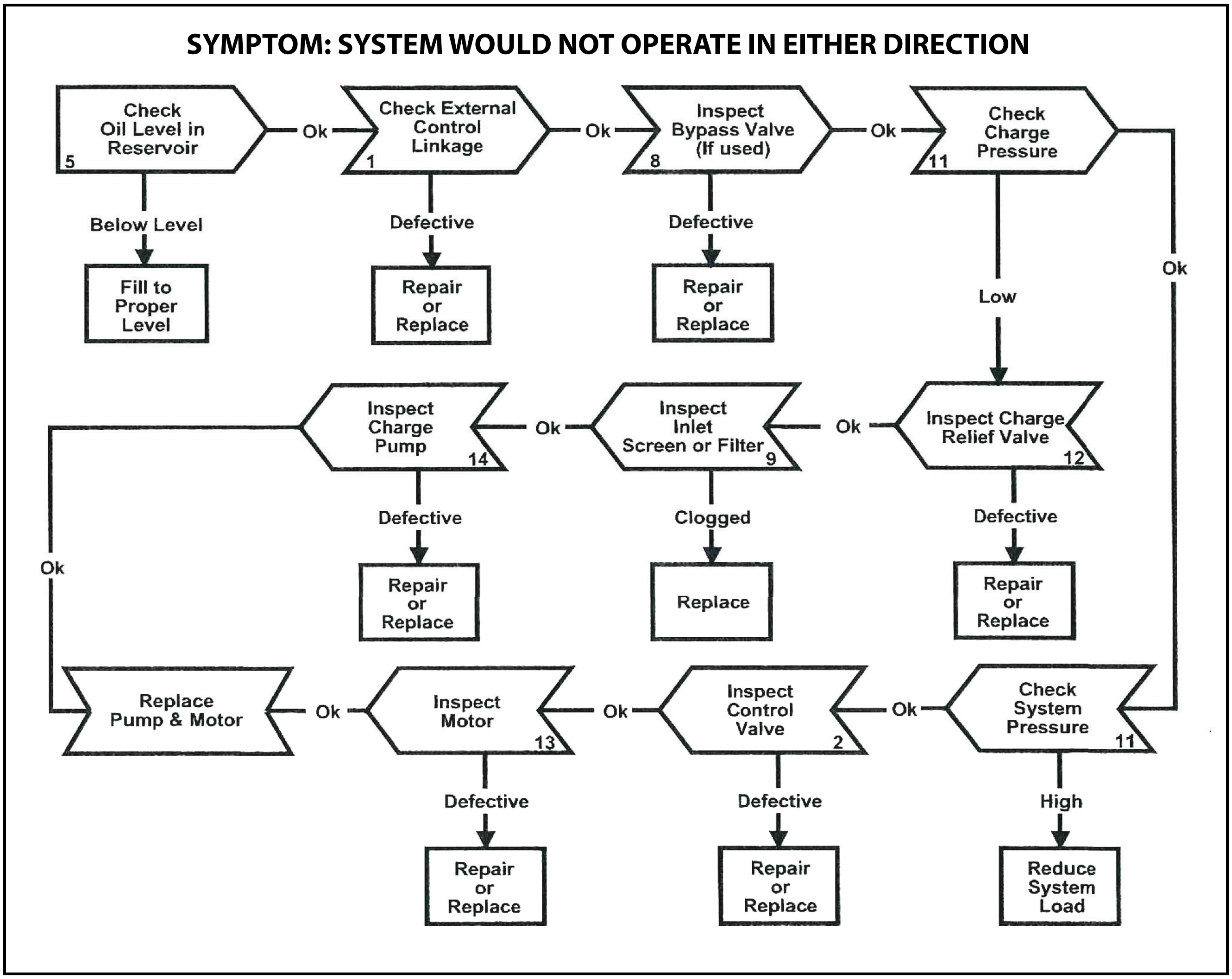


Figure 5-134. Fault- logic Troubleshooting

DIAGRAM ACTION STEP COMMENTS

1. **Inspect External Control Linkage for:**
   - **a.** Misadjusted or disconnected
   - **b.** Binding, bent or broken
2. **Inspect Control Valve for:**
   - **a.** Plugged control orifice(s)
   - **b.** Damaged mounting gasket
   - **c.** Misadjusted, damaged or broken neutral return spring
   - **d.** Broken control connector pin
   - **e.** Faulty destroke valve (if used)
   - **f.** Galled or stuck control spool
   - **g.** Neutral detent or lockout switch misadjusted (if used)
3. **Inspect System Relief Valves for:**
   - **a.** Improper pressure relief setting
   - **b.** Damaged or broken spring
   - **c.** Valve held off seat
   - **d.** Damaged valve seat
4. **Inspect Servo Piston for:**
   - **a.** Misadjusted, damaged or broken neutral return spring assembly
   - **b.** Galled or stuck servo piston
   - **c.** Damaged or missing o-ring and/or backup ring
5. **Check Oil Level in Reservoir:**
   - **a.** Consult owner/operators manual for the proper type fluid and level
6. **Inspect Heat Exchanger for:**
   - **a.** Obstructed air flow (air cooled)
   - **b.** Obstructed water flow (water cooled)
   - **c.** Improper plumbing (inlet to outlet)
   - **d.** Obstructed fluid flow
7. **Inspect Heat Exchanger Bypass Valve for:**
   - **a.** Improper pressure adjustment
   - **b.** Stuck or broken valve
8. **Inspect Bypass Valve for: {if used)**
   - **a.** Held in a partial or full open position
9. **Inspect Inlet Screen or Filter for:**
   - **a.** Plugged or clogged screen or filter element
   - **b.** Obstructed inlet or outlet
   - **c.** Open inlet to charge pump
10. **Check System Pressure:**
    - **a.** See Figure 5-118. for location of pressure gauge installation
    - **b.** Consult owner/operators manual for maximum system relief valve settings
11. **Check Charge Pressure:**
    - **a.** See Figure 5-118. for location of charge pressure gauge installation
    - **b.** Consult owner/operators manual for maximum charge relief valve settings
12. **Inspect Charge Relief Valve for:**
    - **a.** Improper charge relief pressure setting
    - **b.** Damaged or broken spring
    - **c.** Poppet valve held off seat
13. **Inspect Motor for:**
    - **a.** Consult owner/operator manual for motor operation and trouble shooting
14. **Inspect Charge Pump for:**
    - **a.** Broken or missing drive key
    - **b.** Damaged or missing o-ring
    - **c.** Excessive gerotor clearance
    - **d.** Galled or broken gerotor set

System/Charge Relief Valve Pressure Settings

Inlet Vacuum	2.94 PSI (0.203 bar) max.
Case Pressure	25 PSI (1.7 bar) maximum
Charge Pressure	250 to 300 PSI (17.24 to 20.68 bar)
System Pressure	5000 PSI (345 bar) maximum
	3000 PSI (207 bar) continuous

The high pressure relief valves are all factory preset and cannot be readjusted.

The pressure setting is stamped on each valve with a three digit number. To identify, multiply the noted number by 10 to get the valves pressure setting.

Example: 10 x 500 = 5000 PSI (345 bar)

Start-up Procedure

When initially starting a new or a rebuilt transmission system. it is extremely important that the start-up procedure be followed. It prevents the chance of damaging the unit which might occur if the system was not properly purged of air before start-up.

1. After the transmission components have been properly installed, fill the servo pump housing at least half full with filtered system oil. Connect all hydraulic lines and check to be sure they are tight.
2. Install and adjust all control linkage.
3. Fill the reservoir with an approved oil that has been filtered through a 10 micron filter. Refer to Eaton Hydraulics Technical Data sheet number 3-401 titled Hydraulic Fluid Recommendations.
4. Gasoline or L.P. engines: remove the coil wire and turn the engine over for 15 seconds. Diesel engines: shut off the fuel flow to the injectors and turn the engine over for 15 seconds.
5. Replace the coil wire or return the fuel flow to the injectors. Place the transmission unit in the neutral position, start the engine and run it at a low idle. The charge pump should immediately pick up oil and fill the system. If there is no indication of fill in 30 seconds, stop engine and determine the cause.
6. After the system starts to show signs of fill, slowly move pump swashplate to a slight cam angle. Continue to operate system slowly with no load on motors until system responds fully.
7. Check fluid level in the reservoir and refill if necessary to the proper level with an approved filtered oil.
8. Check all line connections for leaks and tighten if necessary.
9. The machine is now ready to be put into operation.
10. Frequent filter changes are recommended for the first two changes after placing the machine back into operation. Change the first filter in 3-5 hours and the second at approximately 50 hours. Routinely scheduled filter changes are recommended for maximum life of the hydraulic system.

5.11 UPRIGHT LEVEL SYSTEM HOLDING VALVE CHECKS

1. Start the machine and warm the hydraulic system to operating temperature.

NOTICE

PERFORM ALL HOLDING VALVE CHECKS FROM THE GROUND CONTROL STATION WITH AN EMPTY PLATFORM.

2. Check the Upright level cylinder rod side holding valve as follows:
   - **a.** Fully retract and fully lower the main boom and tower boom assemblies.
   - **b.** Power the main boom lift down function into the turntable boom rest by holding the function switch down between 10 and 20 seconds.
   - **c.** Verify the upright remains perpendicular to the turntable and that the Upright Monitoring System alarms have not been activated.
3. Check the Upright level cylinder barrel side holding valve function as follows:
   - **a.** Fully retract and fully lower the main boom and tower boom assemblies. Raise the tower boom between 2 ft. and 5 ft. (0.6 m and 1.5 m).
   - **b.** Pull and hold the re-leveling knob between 20 and 30 seconds.
   - **c.** Verify the upright remains perpendicular to the turntable and that the Upright Monitoring System alarms have not been activated.
4. Check the Tower lift cylinder barrel side holding valve function as follows:
   - **a.** Fully raise and fully retract the tower boom. Fully raise and fully extend the main boom.
   - **b.** Using auxiliary power, fully lower the tower boom.
   - **c.** Verify the upright remains perpendicular to the turntable and that the Upright Monitoring System alarms have not been activated.
5. Check the Tower lift up holding valve function as follows:
   - **a.** Fully retract and fully lower the main boom and tower boom assemblies.
   - **b.** Install a 5000 psi (345 bar) pressure gauge to the pressure tap connection installed on port #7 or port MX7 of the main control valve block. This pressure test connection was installed in earlier steps.
   - **c.** Hold the tower boom lift up function between 2 and 5 seconds, and then release the function.
   - **d.** Verify that the gauge reads and maintains the pressure above 1000 psi (68395 bar) for one minute.

NOTE: *If pressure does not remain above the stated pressure for one minute, replace the tower lift check valve (#7017474).*

   - **e.** Activate tower lift down to release any trapped pressure and remove pressure gauge from the test port.
6. Load the platform with the rated capacity and cycle all functions a minimum of five (5) times to confirm safe and proper operational characteristics.
7. The machine may be returned to service once proper operation is confirmed.

5.12 HYDRAULIC SCHEMATICS

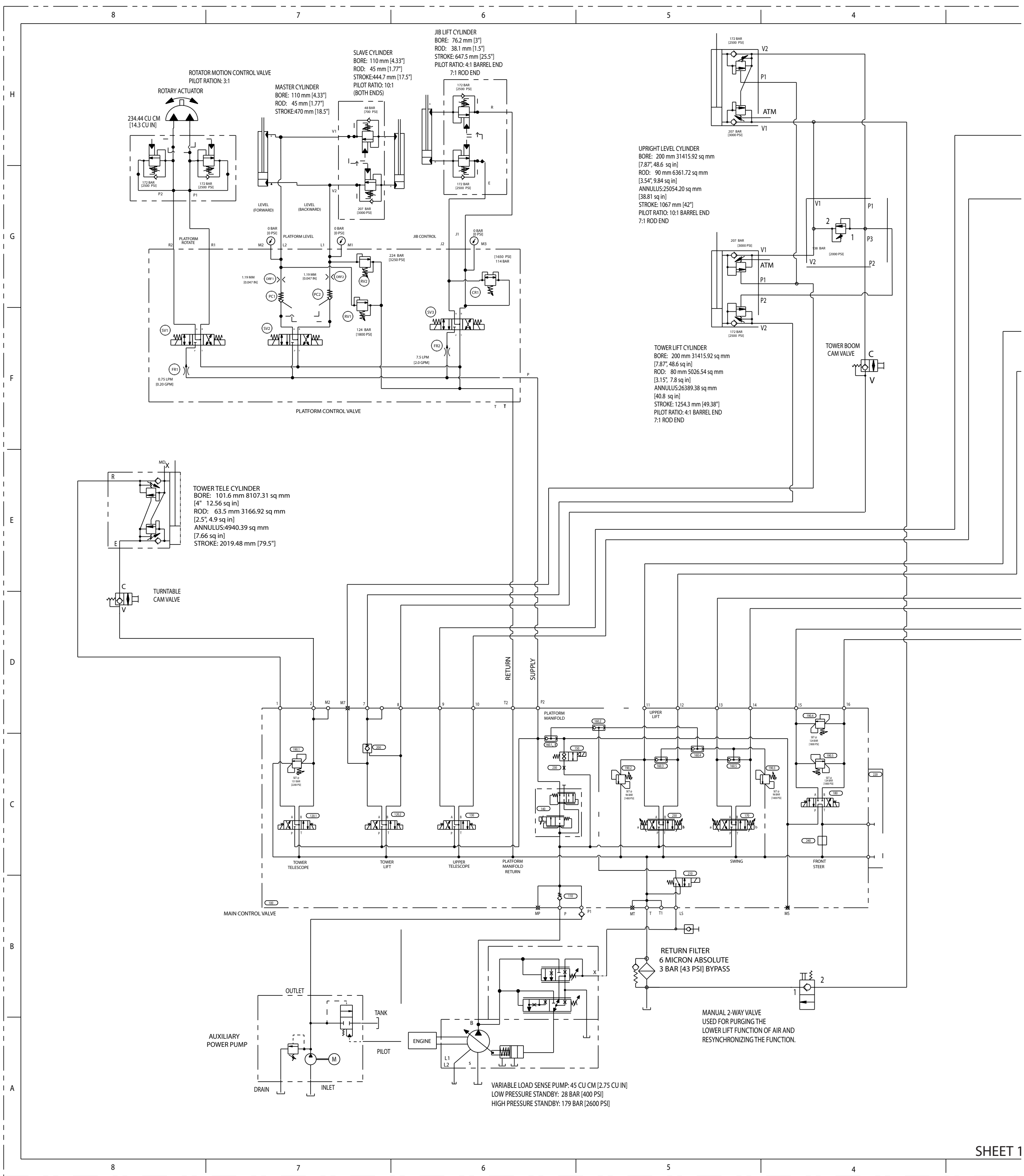


Figure 5-135. Hydraulic Schematic - Sheet 1 of 4

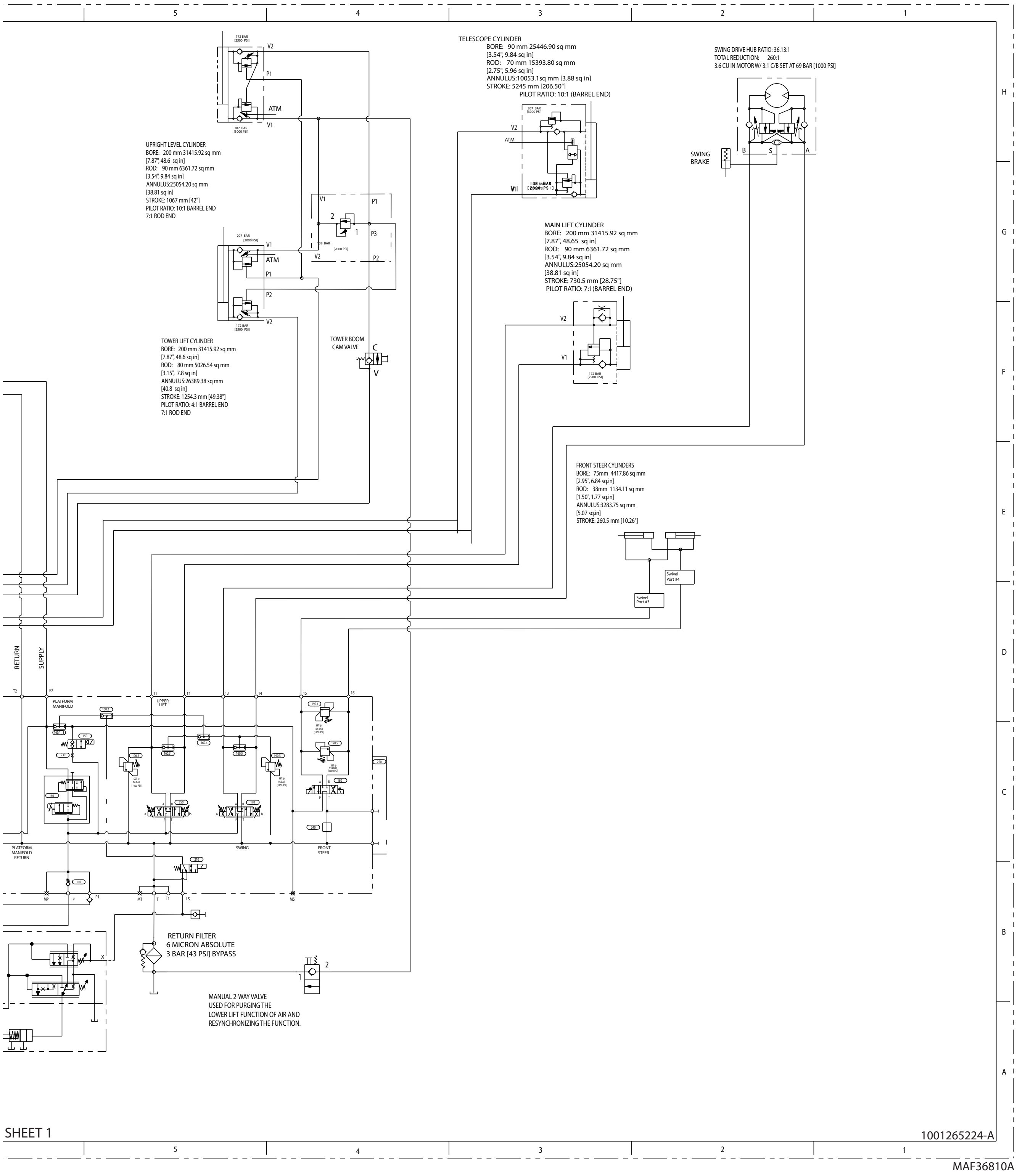


Figure 5-136. Hydraulic Schematic - Sheet 2 of 4

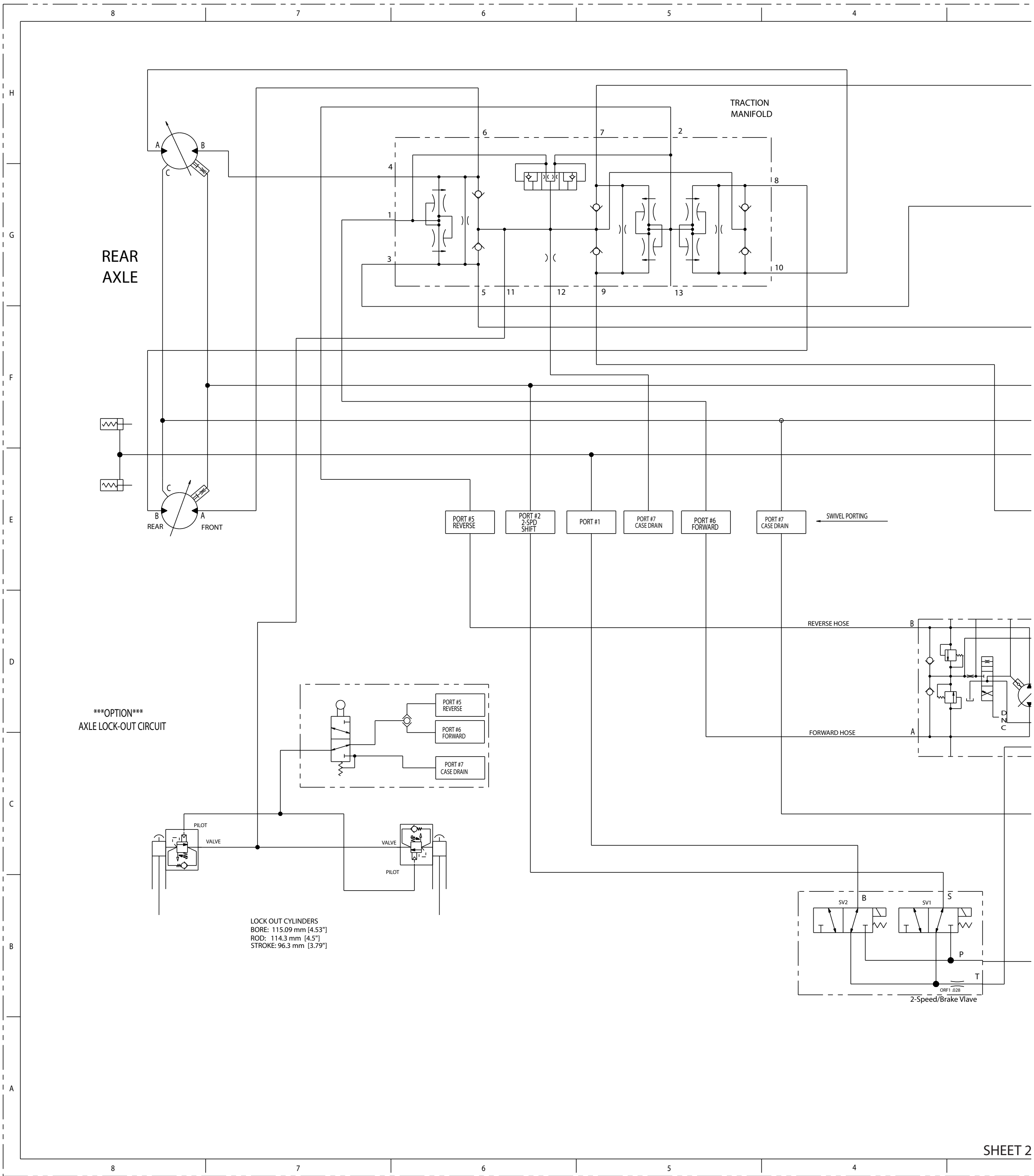


Figure 5-137. Hydraulic Schematic - Sheet 3 of 4

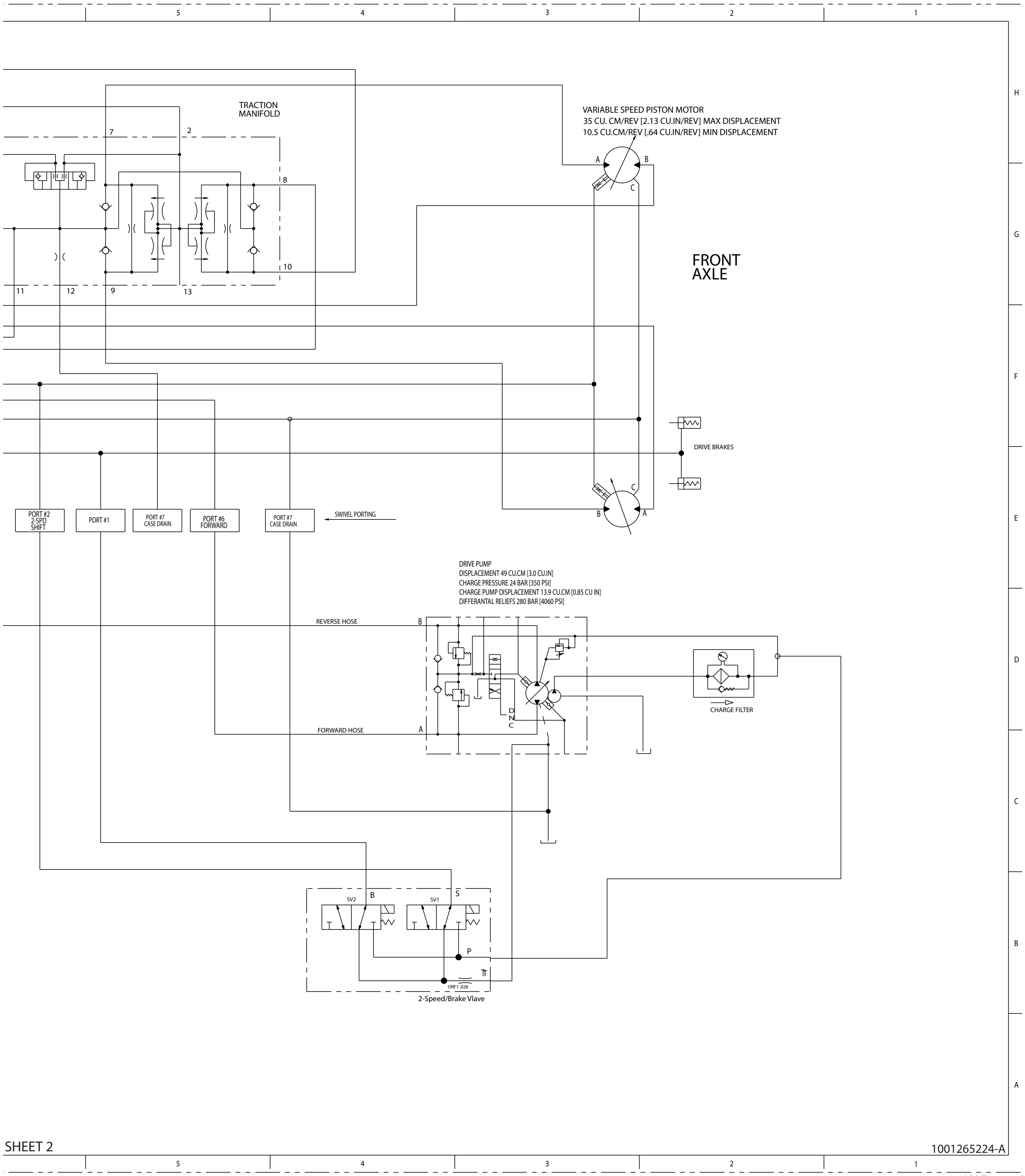


Figure 5-138. Hydraulic Schematic - Sheet 4 of 4

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 INCHES (30.5 CM) AWAY FROM THESE COMPONENTS. IF ELECTRICAL/ELECTRONIC COMPONENTS ARE SPRAYED, SPRAYING MUST NOT BE DIRECT AND BE FOR BRIEF TIME PERIODS TO AVOID HEAVY SATURATION.

The JLG designed Control System is a 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.

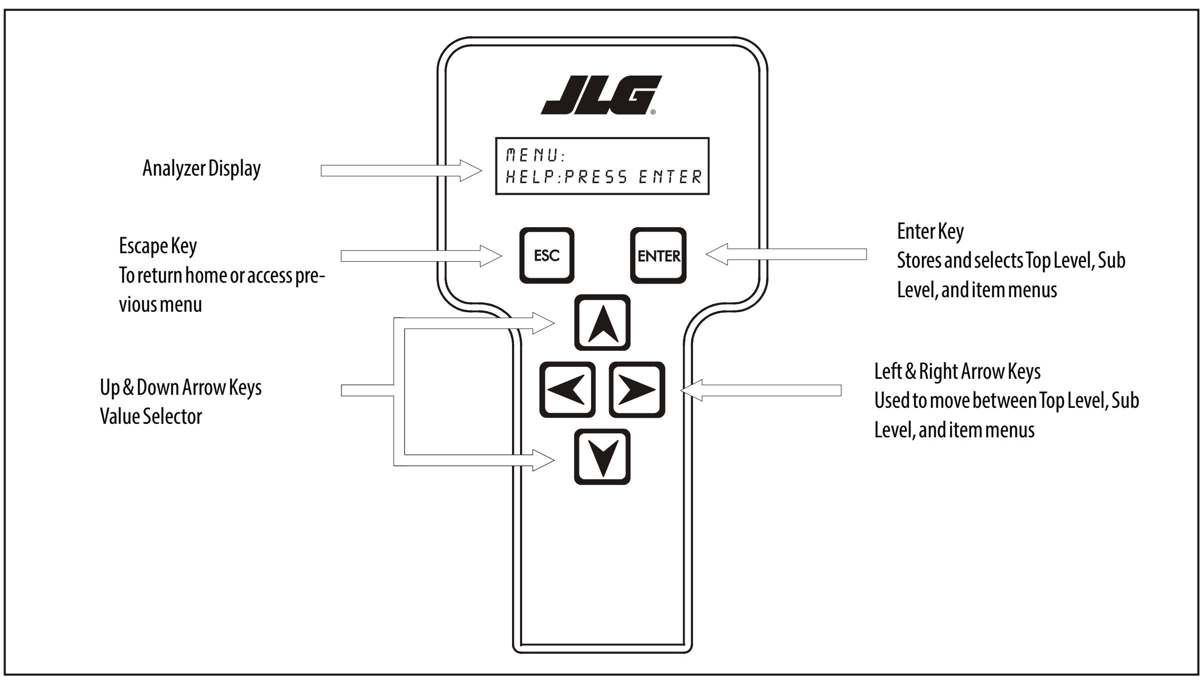


Figure 6-1. Hand Held Analyzer

To Connect the JLG Control System Analyzer

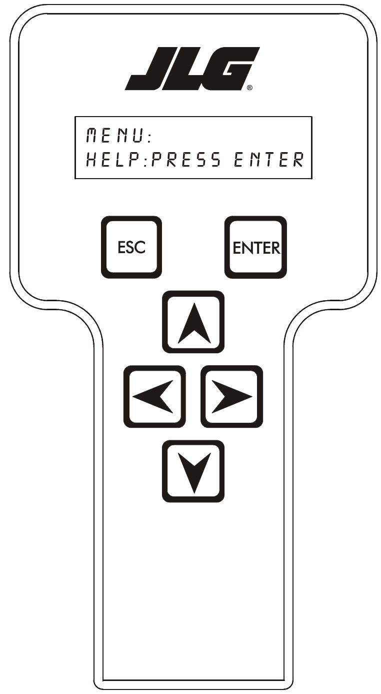
1. Connect the four pin end of the cable supplied with the analyzer, to the controller module located in the platform box or at the controller module in the ground control box and connect the remaining end of the cable to the analyzer.

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

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

Using the Analyzer

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



HELP:
PRESS ENTER

At this point, using the RIGHT  and LEFT  arrow keys, you can move between the top level menu items. To select a displayed menu item, press ENTER 

. To cancel a selected menu item, press Escape 

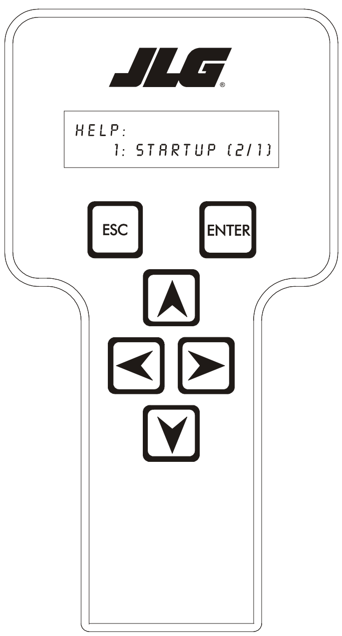
; then you will be able to scroll using the right and left arrow keys to select a different menu item.

The top level menus are as follows:

HELP
DIAGNOSTICS
ACTIVATE TEST
ACCESS LEVEL
PERSONALITIES
MACHINE SETUP
LEVEL VEHICLE (level 1 only)
CALIBRATIONS (view only)

If you press **ENTER** ENTER, at the **HELP: PRESS ENTER** display, and a fault is present, the analyzer display will scroll the fault across the screen. If there was no fault detected, the display will read: **HELP: EVERYTHING OK.** If powered up at the ground station, the display will read: **GROUND OK.**

If **ENTER** ENTER is pressed again, the display moves to the following display:



LOGGED HELP
1: STARTUP (2/1)

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

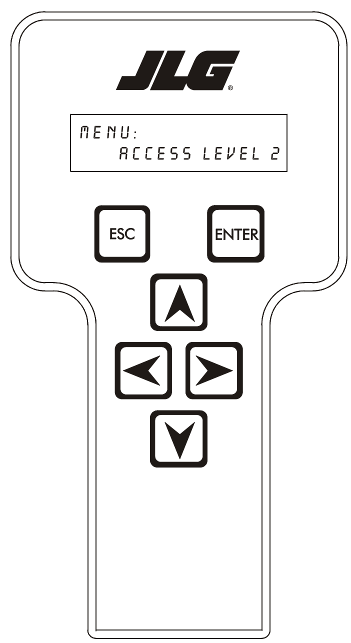
When a top level menu is selected, a new set of menu items may be offered: for example:

DRIVE
BOOM
SYSTEM
DATALOG
VERSIONS

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

Changing the Access Level of the Hand Held Analyzer

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



ACCESS LEVEL:
CODE 00000

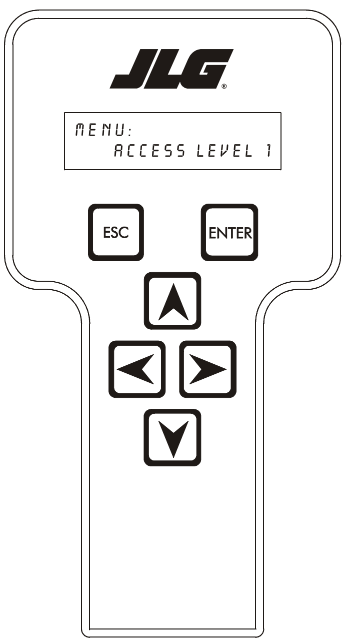
Press **ENTER** to select the **ACCESS LEVEL** menu.

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

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

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

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

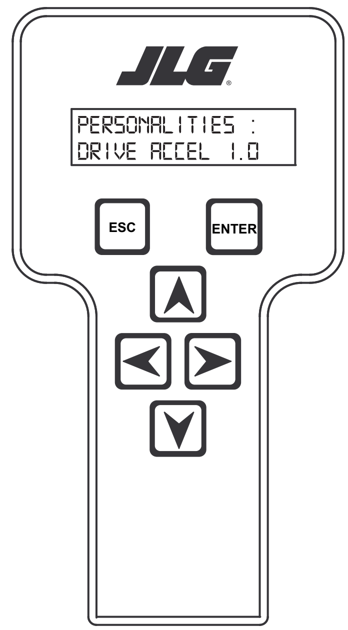


MENU:
ACCESS LEVEL 1

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

Adjusting Parameters Using the Hand Held Analyzer

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



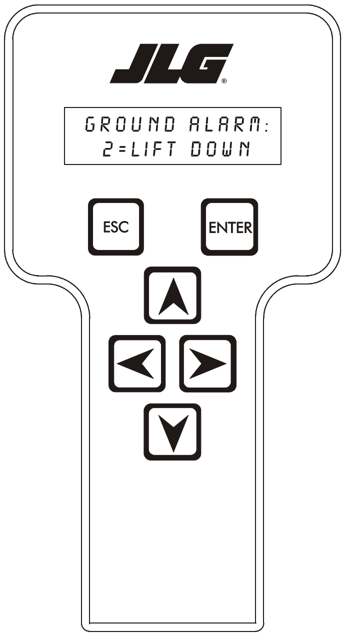
MAF14500

PERSONALITIES:
DRIVE ACCEL 1.0s

There will be a minimum and maximum for the value to ensure efficient operation. The Value will not increase if the **UP** arrow is pressed when at the maximum value nor will the value decrease if the **DOWN** arrow is pressed and the value is at the minimum value for any particular personality. If the value does not change when pressing the up and down arrows, check the access level to ensure you are at access level 1.

Machine Setup

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



GROUND ALARM:
2 = LIFT DOWN

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

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

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

NOTE: *Password 33271 will give you access to level 1, which will permit you to change all machine personality settings.*

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

ELEVATION CUTBACK

⚠ WARNING

CHANGING THIS SETTING MAY ADVERSELY AFFECT THE PERFORMANCE OF YOUR MACHINE.

NOTICE

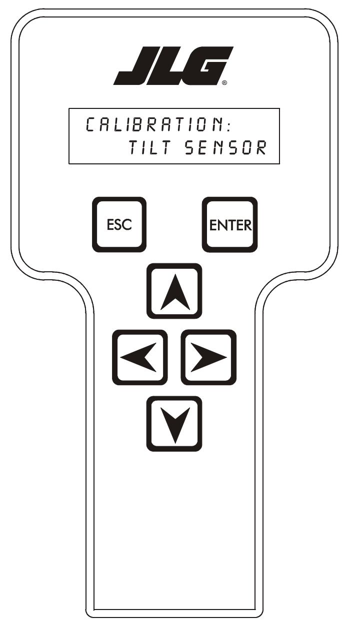
ITS IS A GOOD PRACTICE TO AVOID PRESSURE-WASHING ELECTRICAL/ELECTRONIC COMPONENTS. SHOULD PRESSURE-WASHING BE UTILIZED TO WASH AREAS CONTAINING ELECTRICAL/ELECTRONIC COMPONENTS, JLG INDUSTRIES INC. RECOMMENDS A MAXIMUM PRESSURE OF 750 PSI (52 BAR) AT A MINIMUM DISTANCE OF 12 INCHES (30.5CM) AWAY FROM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

Level Vehicle Description

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
G	GROUND

Table 6-1. Analyzer Abbreviations

ABBREVIATION	MEANING
GND	GROUND
GRN	GREEN
GM	GROUND MODULE
H	HOURS
HW	HARDWARE
HWFS	HARDWARE FAILSAFE
I	IN or CURRENT
JOY	JOYSTICK
L	LEFT
LB	POUND
LEN	LENGTH
LIM	LIMIT
LT	LEFT
LVL	LEVEL
M	MINUTES
MIN	MINIMUM
MAX	MAXIMUM
M	MAIN
MN	MAIN
NO	NORMALLY OPEN or NO
NC	NORMALLY CLOSED
O	OUT
O/C	OPEN CIRCUIT
OP	OPEN
O/R	OVERRIDE or OUTRIGGER
O//R	OVERRIDE
OSC	OSCILLATING
OVRD	OVERRIDE
P	PLATFORM
P	PRESSURE
PCV	PROPORTIONAL CONTROL VALVE
PLAT	PLATFORM
PLT	PLATFORM
PM	PLATFORM MODULE
POT	POTENTIOMETER
PRES	PRESSURE
PRS	PRESSURE
PT	POINT
R	REAR or RIGHT
REV	REVERSE or REVISION
RET	RETRACT
ROT.	ROTATE
RT	RIGHT

Table 6-1. Analyzer Abbreviations

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

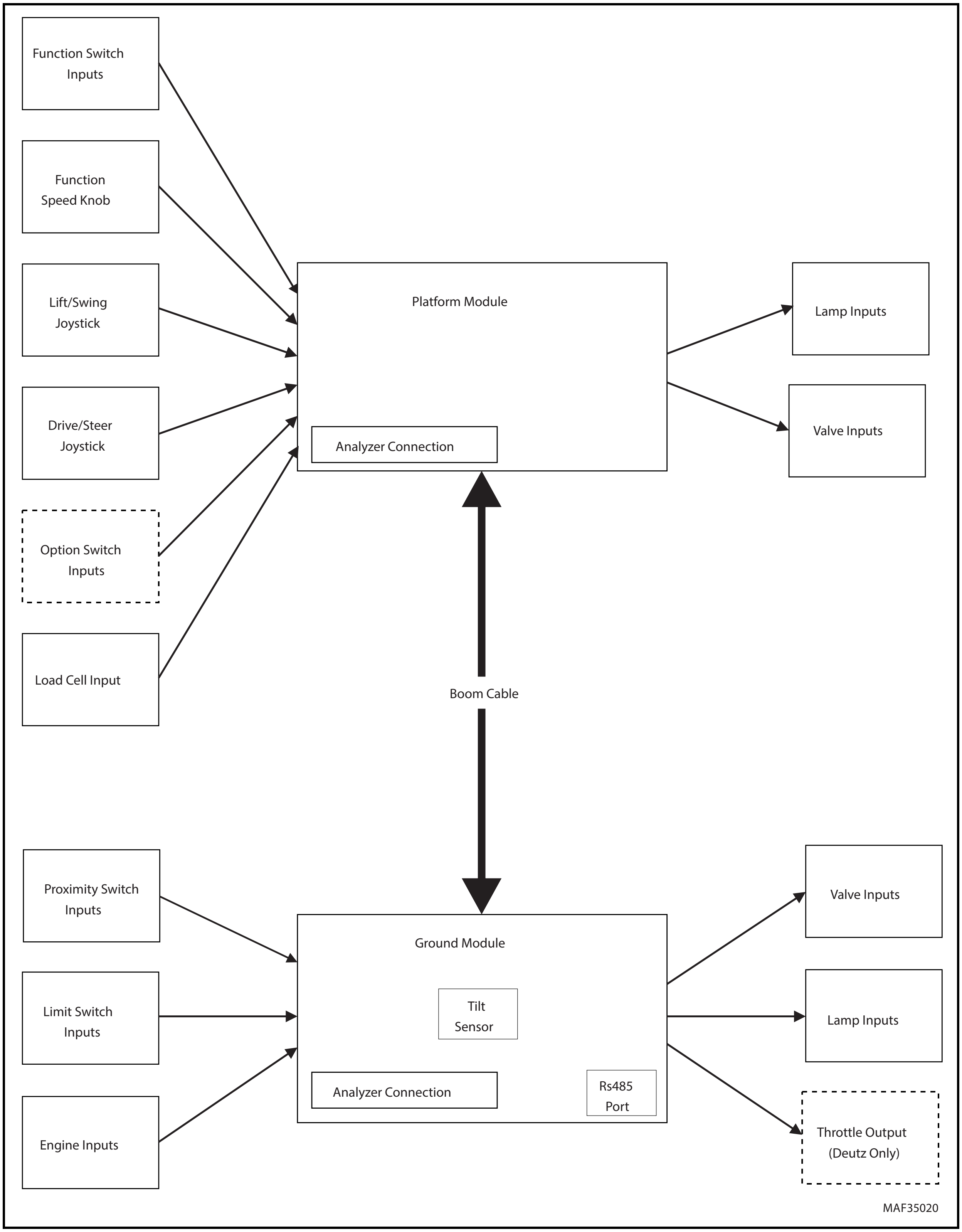


Figure 6-2. ADE Block Diagram

6.2 MACHINE CONFIGURATION PROGRAMMING INFORMATION

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Digit	Number	Description	Default Number
NOTE: *The machine configuration must be completed before any personality settings can be changed. Changing the personality settings first and then changing the model number of the machine configuration will cause the personality settings to return to default values.*			
MODEL NUMBER: 1	**1** 2 3 4	**600A** 800A 800S H800A	**1**
MARKET: 2*	**1** 2 3 4 5 6 7	**ANSI USA** ANSI EXPORT CSA CE AUSTRALIA JAPAN GB	**1**
* Certain model selections will limit market options.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration 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	DEUTZ F3 TIER1: Deutz F3M1011F Diesel (Tier 1)	
	5	CAT. 3024C: CAT 3024C Diesel (Tier 2)	
	6	CAT. 3044C: CAT 3044C Diesel (Tier 2)	
	7	PERKINS 404C: (Tier 2)	
	8	PERKINS 804C	
	9	DEUTZ F4 TIER2: Deutz F4M2011 Diesel (Tier 2)	
	10	DEUTZ F3 TIER2: Deutz F3M2011 Diesel (Tier 2)	
	11	FORD GAS TIER2: Ford LRG425 EFI Gas (Tier 2)	
	12	FORD D/F TIER2: Ford LRG425 EFI Dual Fuel (Tier 2)	
	13	**DEUTZ ECM: Engine Control Module - ECM (Tier 2 and Tier 3)**	**13**
	14	DUAL FUEL ECM: GM/PSI 3.0L Dual Fuel (Tier 2)	
	15	PERKINS ECM	
	16	CAT ECM T4I	
	17	CAT ECM T4F	
	18	DEUTZ EMR4: Deutz Engine Control Module (Tier 4 Final)	
	19	FORD DUAL FUEL	
	20	KUBOTA D1305	
* 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.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Digit	Number	Description	Default Number
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**
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 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	5	3 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 3 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	6	5 DEGREES + CUT: Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also disallows tower lift up, tower telescope out, drive, main telescope out and main lift up.	
	7	5 DEG + DRV CUT Reduces the maximum speed of all boom functions to creep when tilted more than 5 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.	
	8	**4 DEG + DRV CUT Reduces the maximum speed of all boom functions to creep when tilted more than 4 degrees and above elevation; also reduces drive speed to creep when drive reversal is allowed, drive is disallowed otherwise.**	**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.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Digit	Number	Description	Default Number
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.			
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.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Digit	Number	Description	Default Number
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**
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.			

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Digit	Number	Description	Default Number
DRIVE PUMP: 24*	**1**	**SAUER DANFOSS: Machine equipped with Sauer Danfoss drive pump.**	**1**
	2	EATON: Machine equipped with Eaton drive pump.	
	3	M46-XXXX: Machine equipped with M46-XXXX drive pump.	
	4	830XXXXX: Machine equipped 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.			
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	

Table 6-2. Machine Configuration Programming Information (Software Version P6.33)

Configuration Digit	Number	Description	Default Number
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-B

Table 6-3. Machine Configuration Programming Settings (Software Version P6.33)

800AJ HC3	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
Model Number	**2**	**2**	**2**	**2**	**2**	**2**	**2**
Market	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Engine	**13**	**13**	**13**	**13**	**13**	**13**	**13**
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
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	X	X
	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	4	4	4	4	4	4	4
	5	5	5	5	5	5	5
	X	X	X	X	X	X	X
	X	X	X	X	X	X	X
	8	**8**	**8**	**8**	**8**	**8**	**8**
	9	9	9	9	9	9	9
Jib	X	X	X	X	X	X	X
	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**
	X	X	X	X	X	X	X
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

Table 6-3. Machine Configuration Programming Settings (Software Version P6.33)

800AJ HC3	ANSI USA	ANSI Export	CSA	CE	Australia	Japan	GB
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
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**
	X	X	X	X	X	X	X
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**
	X	X	X	X	X	X	X
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**
	X	X	X	X	X	X	X
	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 a machine with a Jib. SHADED CELLS indicate hidden menu or selection.

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6.3 MACHINE PERSONALITY SETTINGS

NOTE: *Personality settings can be adjusted within the adjustment range for 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 6-4. Machine Personality Settings and Function Speed (Software Version P6.33)

FUNCTION		ADJUSTMENT RANGES	800AJ HC3 MODEL DEFAULTS		800AJ HC3 MODEL TIME RANGES (IN SECONDS)
DRIVE			**DANFOSS**	**EATON**	
	Accel	0.0 – 5.0 sec	2.0 sec		
	Decel	0.0 – 3.0 sec	2.0 sec		
Forward	Min	1 – 35 %	4%	15%	
	Max	1 – 100 %	30%	55%	2WD: 33 - 45 4WD: 33 - 45
REVERSE	Min	1 – 35 %	4%	15%	
	Max	1 – 100 %	34%	55%	
Elevation	Max	1 – 100 %	15%	28%	MIN 122
Creep	Max	1 – 90 %	15%	32%	
STEER					
	Max	1 - 100 %	100%		
SWING					
	Accel	0.0 – 5.0 sec	2.8 s		
	Decel	0.0 – 3.0 sec	2.5 s		
LEFT	Min	1 – 50 %	25%		
	Max	1 – 100 %	70%		79 - 101
	Creep	1 – 65 %	62%		
RIGHT	Min	1 – 50 %	25%		
	Max	1 – 100 %	73%		79 - 101
	Creep	1 – 65 %	62%		
TOWER LIFT					
	Accel	0.0 – 5.0 sec	2.8 s		
	Decel	0.0 – 3.0 sec	0.8 s		
UP	Min	1 – 60 %	53%		
	Max	1 – 100 %	90%		57 - 70
DOWN	Min	1 – 60 %	53%		
	Max	1 – 100 %	90%		44 - 53

Table 6-4. Machine Personality Settings and Function Speed (Software Version P6.33)

FUNCTION		ADJUSTMENT RANGES	800AJ HC3 MODEL DEFAULTS	800AJ HC3 MODEL TIME RANGES (IN SECONDS)
MAIN TELECOPE				
	Accel	0.0 – 5.0 sec	3.5 s	
	Decel	0.0 – 3.0 sec	0.8 s	
IN	Min	1 – 65 %	40%	
	Max	1 – 1000 %	75%	24 - 34
OUT	Min	1 – 65 %	40%	
	Max	1 – 100 %	70%	30 - 40
MAIN LIFT				
	Accel	0.0 – 5.0 sec	2.9 s	
	Decel	0.0 – 3.0 sec	1.0 s	
UP	Min	1 – 60%	26%	
	Max	1 – 100%	88%	45 -50
	Creep	1 – 65%	62%	
DOWN	Min	1 – 60%	25%	
	Max	1 – 100%	95%	45 -50
	Creep	1 – 75%	69%	
	Soft Up	1 – 75%	70%	
	Soft Down	1 – 75%	75%	
TOWER TELESCOPE				
	Accel	0.0 – 5.0 sec	1.0 s	
	Decel	0.0 – 3.0 sec	0.5 s	
IN	Min	1 – 65%	45%	
	Max	1 – 100%	90%	15 - 25
OUT	Min	1 – 65%	55%	
	Max	1 – 100%	90%	24 - 32
PLATFORM LEVEL				
	Accel	0.0 – 5.0 sec	2.5 s	
	Decel	0.0 – 3.0 sec	1.0 s	
UP	Min	1 – 65%	45%	
	Max	1 – 100%	55%	
DOWN	Min	1 – 65%	45%	
	Max	1 – 100%	55%	
PLATFORM ROTATE				
	Accel	0.0 – 5.0 sec	1.8 s	
	Decel	0.0 – 3.0 sec	0.5 s	
LEFT	Min	1 – 100%	25%	
	Max	1 – 100%	60%	19 - 30
RIGHT	Min	1 – 100%	25%	
	Max	1 – 100%	60%	19 - 30

Table 6-4. Machine Personality Settings and Function Speed (Software Version P6.33)

FUNCTION		ADJUSTMENT RANGES	800AJ HC3 MODEL DEFAULTS	800AJ HC3 MODEL TIME RANGES (IN SECONDS)
JIB LIFT				
	Accel	0.0 – 5.0 sec	2.5 s	
	Decel	0.0 – 3.0 sec	1.0 s	
UP	Min	1 – 65%	27%	
	Max	1 – 100%	50%	20 - 30
DOWN	Min	1 – 65%	26%	
	Max	1 – 100%	45%	20 - 30
GROUND MODE				
MAIN LIFT	Up	1 – 100%	87%	
	Down	1 – 100%	94%	
SWING		1 – 100%	65%	
MAIN TELE		1 – 100%	69%	
PLATFORM	Level	1 – 100%	54%	
	Rotate	1 – 100%	59%	
TOWER	Tele	1 – 100%	89%	
	Up	1 – 100%	89%	
	Down	1 – 100%		
JIB	Lift	1 – 100%	44%	

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6.4 MACHINE ORIENTATION WHEN SETTING FUNCTION SPEEDS

DRIVE (Below Elevation): Test should perform on a smooth, level surface. The Drive Select Switch should be in the "Max Speed" position. Start approximately 25 ft. (7.6 m) from starting point so the unit is at a maximum speed when starting the test. Results should be recorded for a 200 ft. (61 m) course. Drive forward, "High Speed", record time.

DRIVE (Above Elevation): Test should perform on a smooth, level surface. The Drive Select Switch should be in the “Max Speed” position, the boom should be > 10 degrees above horizontal to ensure the drive is working in Max Torque mode. Results should be recorded for a 50 ft. (15.2 m) 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.

SWING: Boom at full elevation, Telescope Retracted. Swing Right until over rear axle or end stop (if equipped). To eliminate effect of controller ramp up/down, record time starting, while swinging, as turntable is centered. Swing Left 360 degrees or end stop (if equipped), record time. Swing Right 360 degrees 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.

TOWER LIFT: Upper boom horizontal, Telescope Retracted. Tower Lift Up, record time. Tower 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 Tower Up and Down. Return Knob to fully clockwise.

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.

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.

TOWER TELESCOPE: Tower Lift fully elevated, upper boom horizontal, 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 Jib Lift Up and Down. Return Knob to fully clockwise.

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.

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 turned fully counterclockwise. The platform rotate may not work, this is acceptable.*

Test Notes

1. Personality settings can be adjusted anywhere within the adjustment range in order to achieve optimum machine performance.
2. Stop watch should be started with the function movement, not with actuation of the joystick or switch.
3. Drive speeds should be set to the values below regardless of the tire size.
4. All speed tests are run from the platform, these speeds do not reflect the ground control operation.
5. The Platform Speed Control knob must be at full speed (turned clockwise completely) unless noted.
6. Some flow control functions may not work with the Platform Speed Control knob clicked into the creep position.
7. Functional speeds may vary due to cold thick hydraulic oil. Test should be run with the oil temperature above 38° C (100° F).

6.5 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 set point 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.*

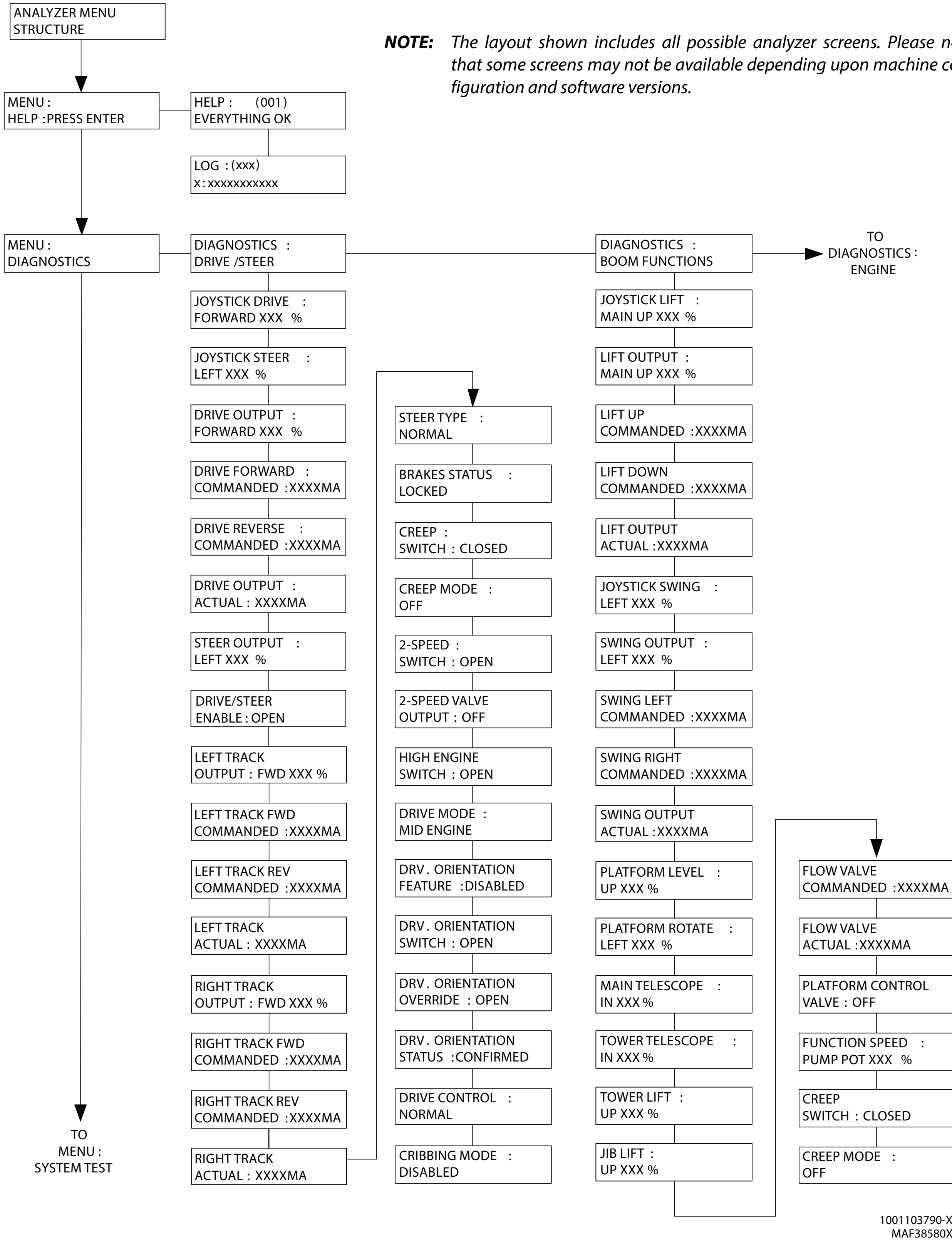
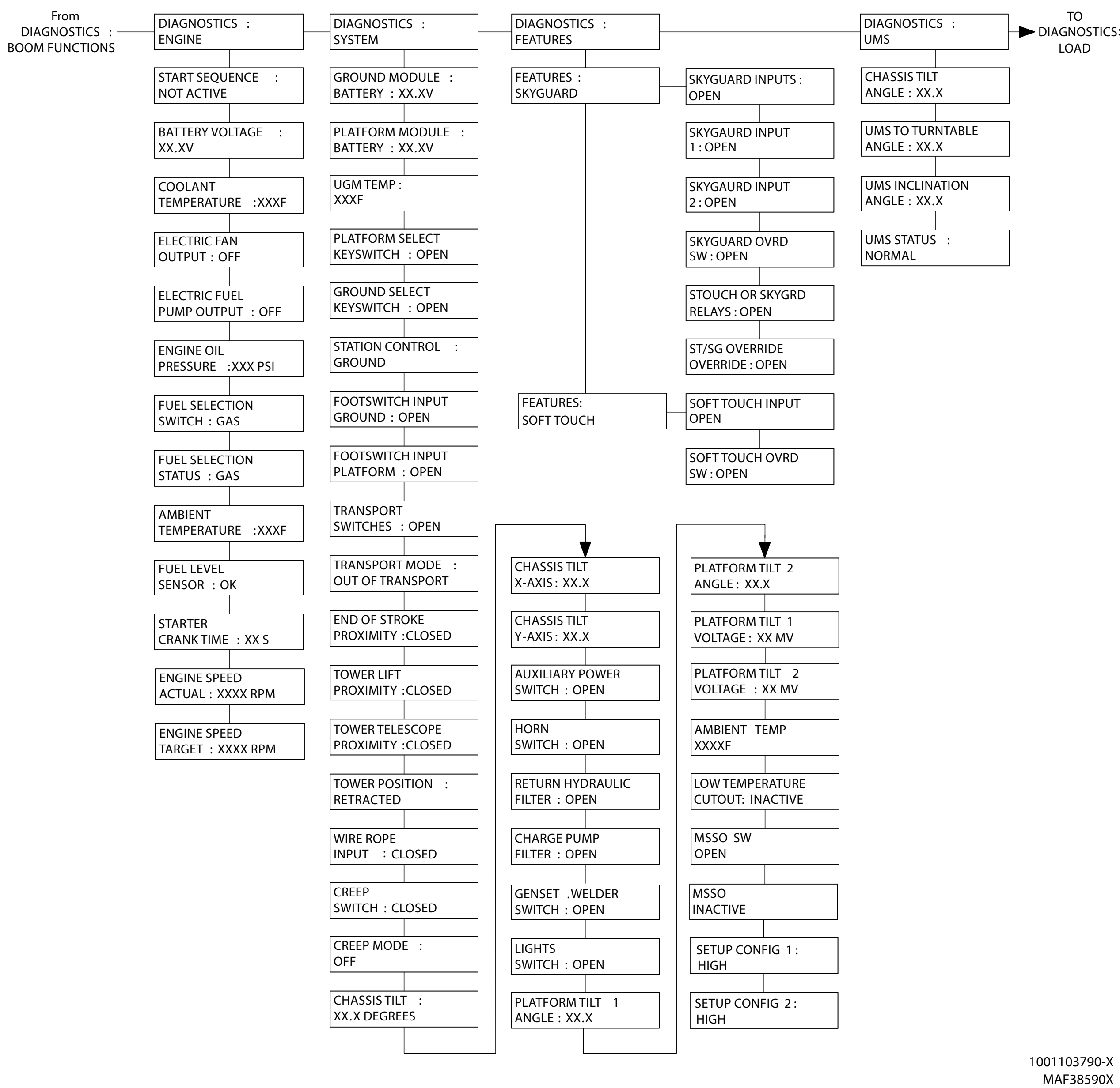
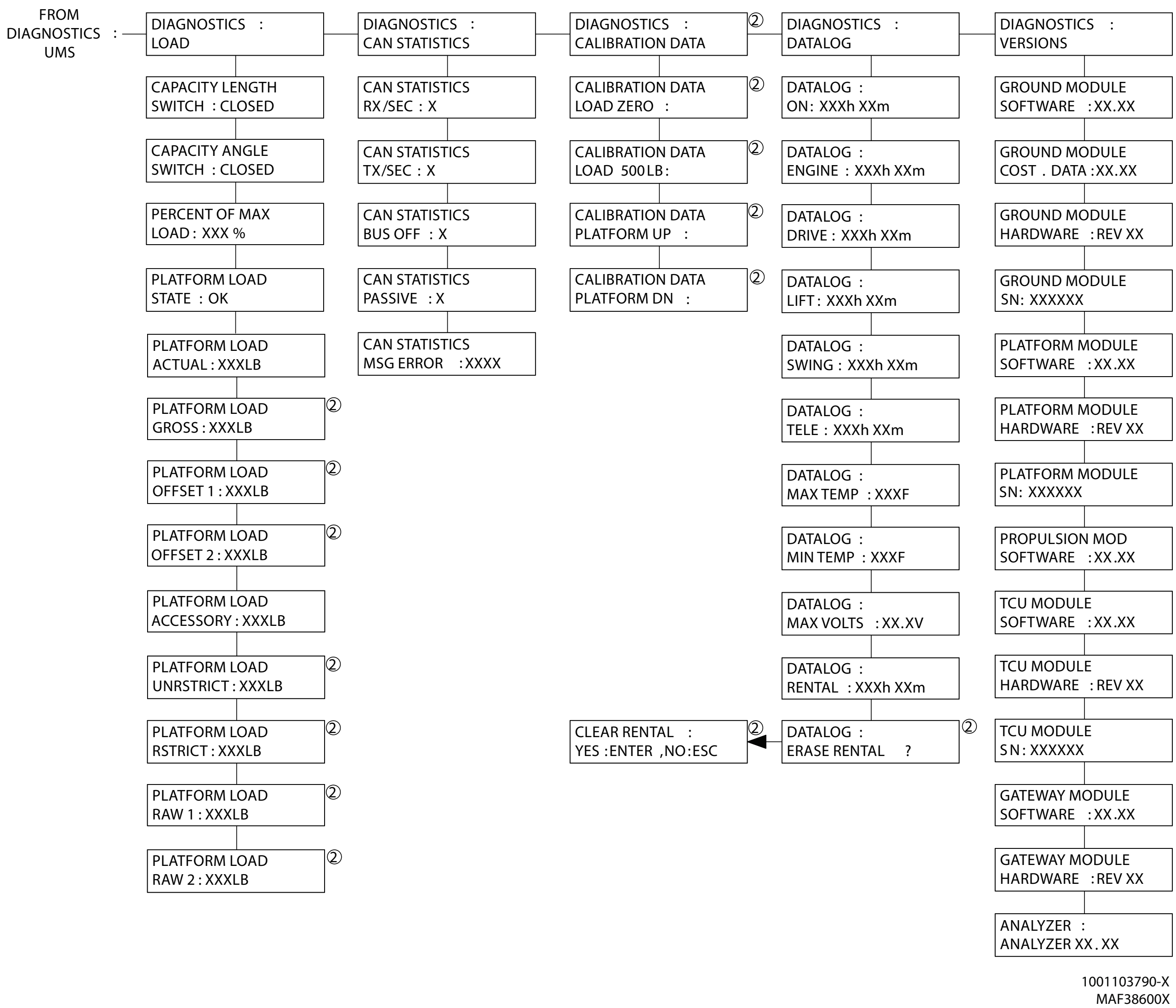


Figure 6-3. Analyzer Flow Chart (Software Version P6.33) -Sheet 1 of 7



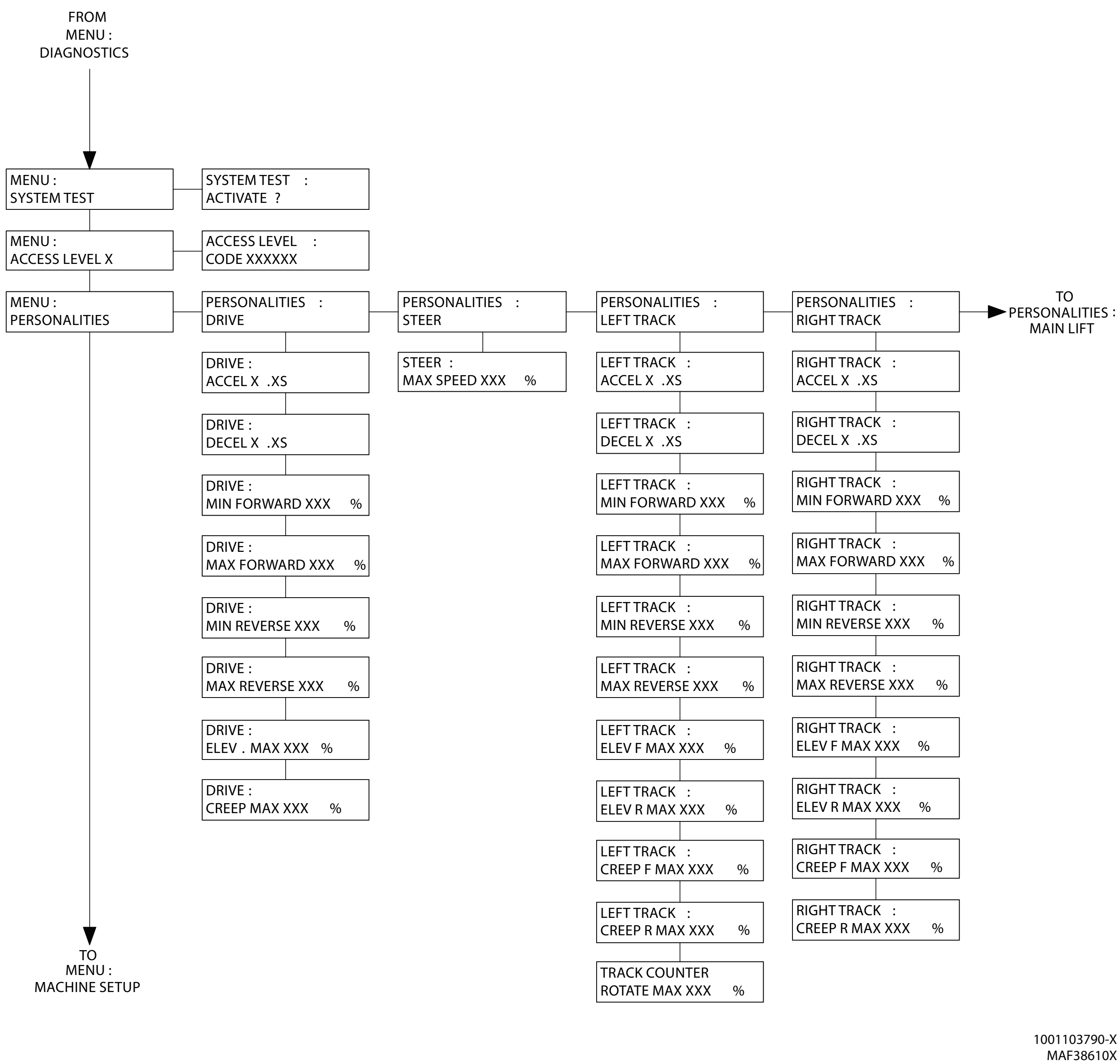
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-4. Analyzer Flow Chart (Software Version P6.33) -Sheet 2 of 7



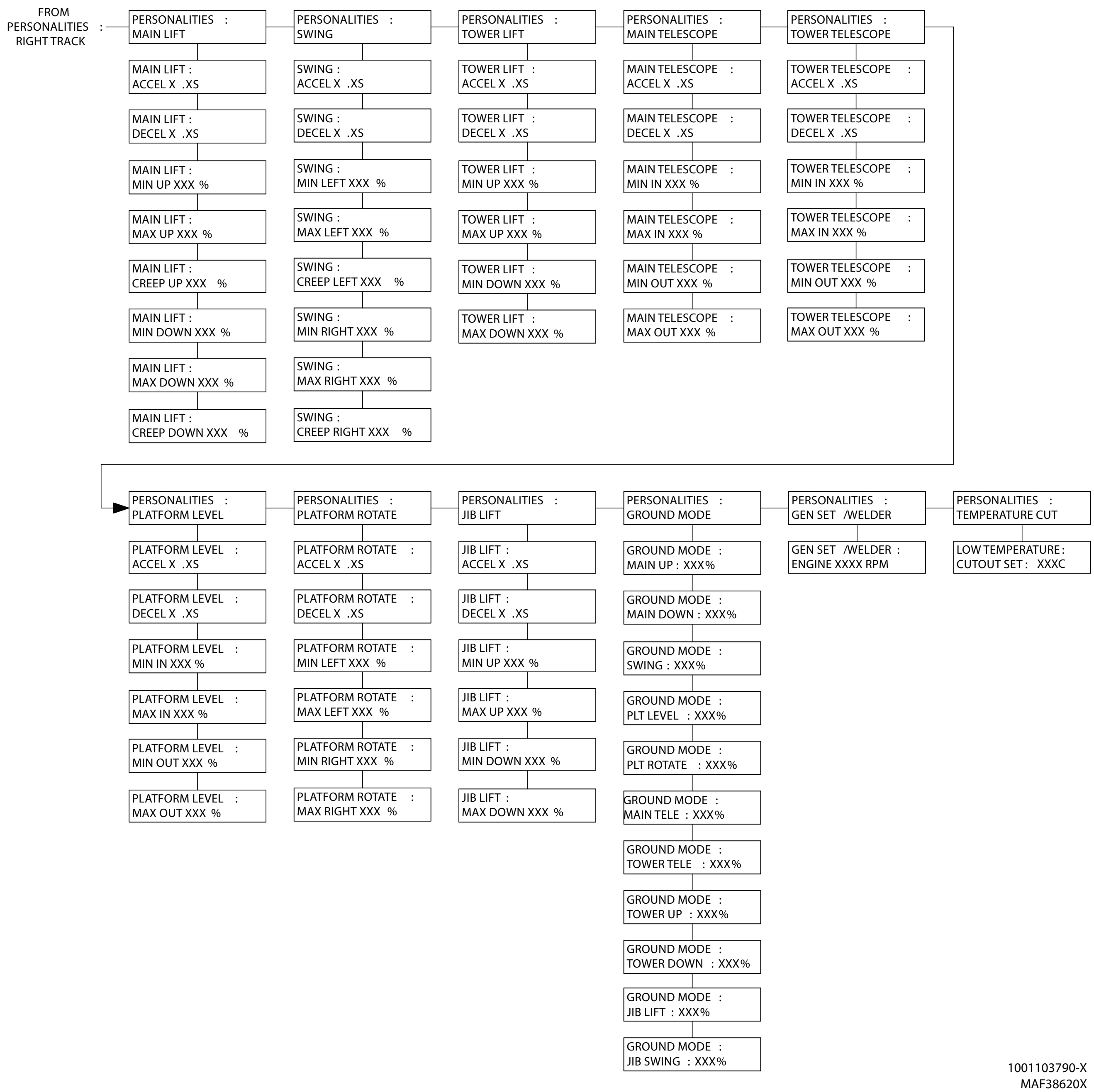
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-5. Analyzer Flow Chart (Software Version P6.33) -Sheet 3 of 7



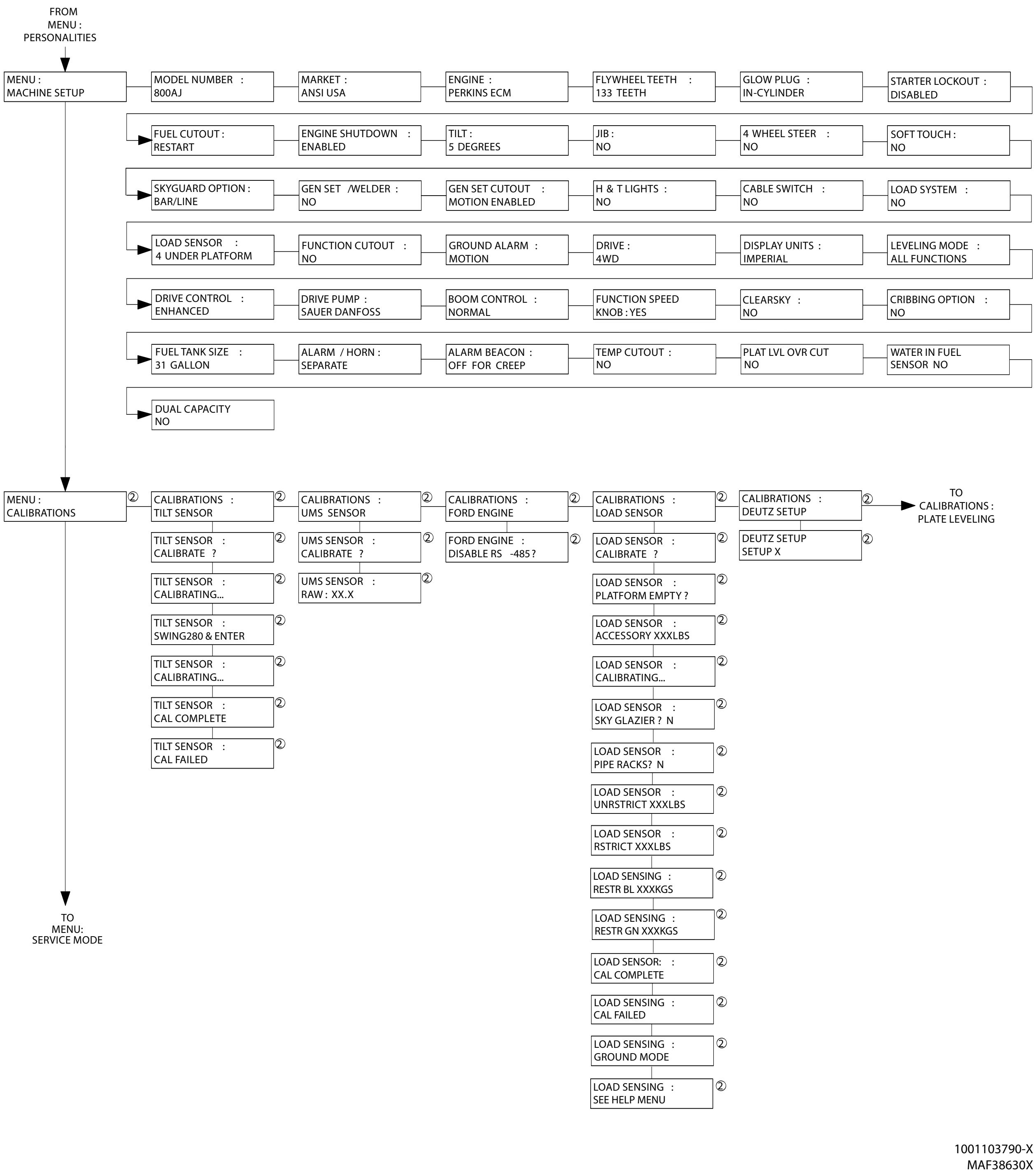
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-6. Analyzer Flow Chart (Software Version P6.33) -Sheet 4 of 7



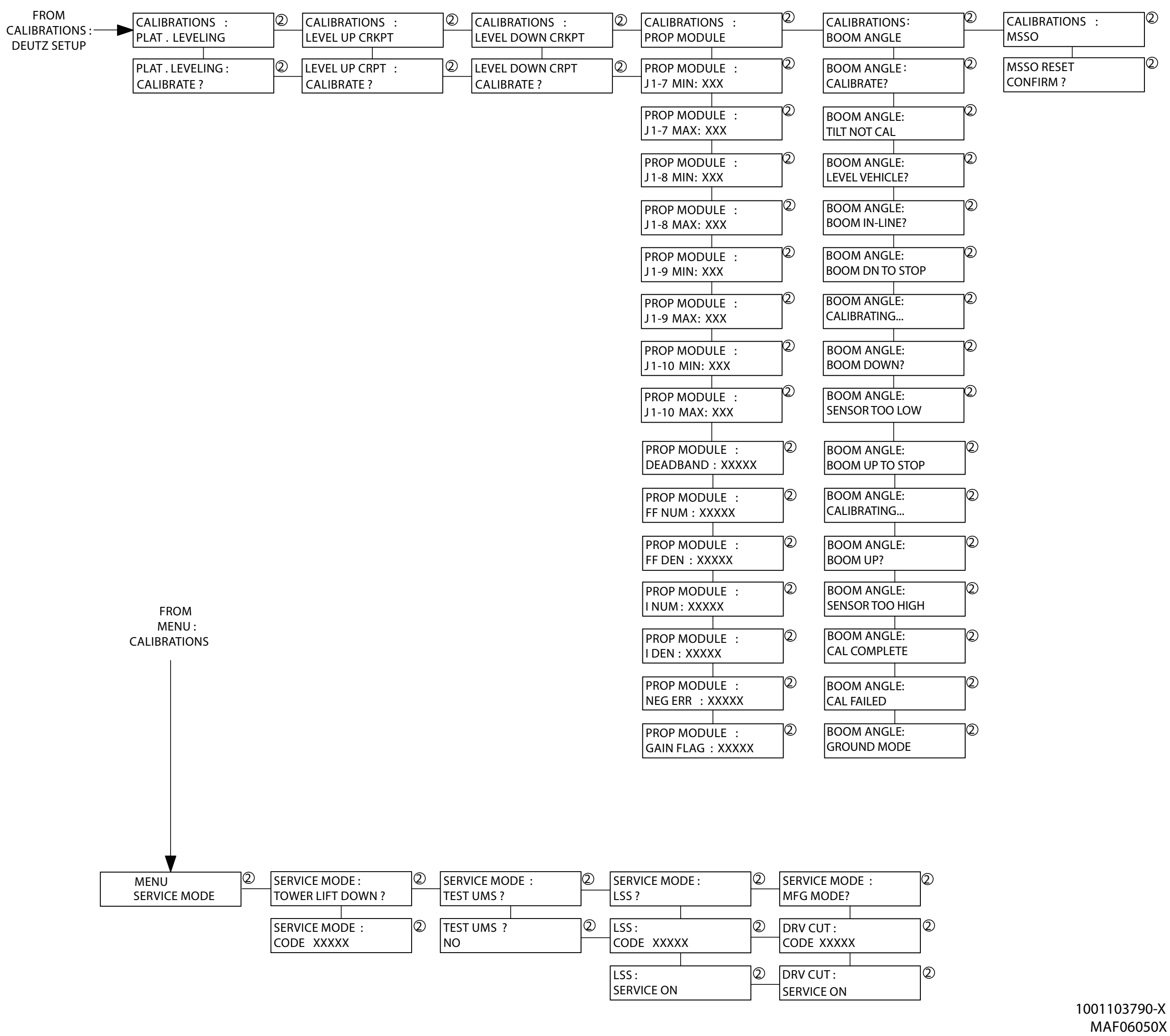
NOTE: *The layout shown includes all possible analyzer screens. Please note that some screens may not be available depending upon machine configuration and software versions.*

Figure 6-7. Analyzer Flow Chart (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 (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 (Software Version P6.33) -Sheet 7 of 7

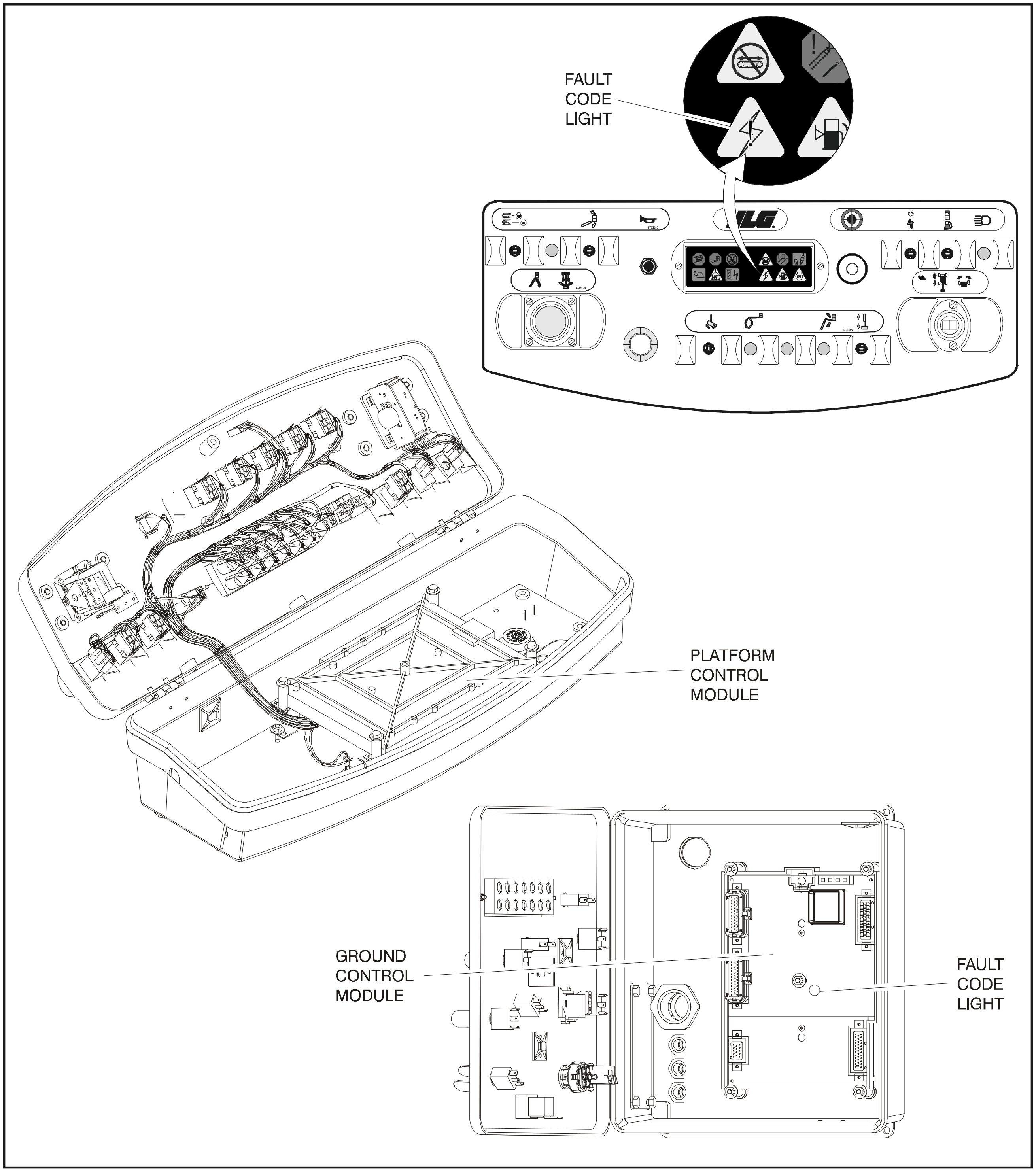
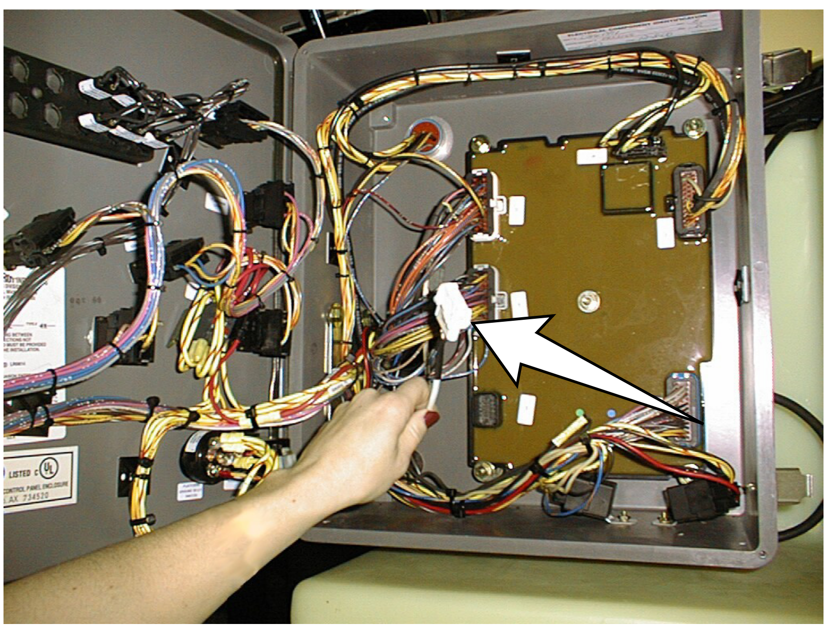


Figure 6-10. Fault Code Light Location

PLATFORM CONNECTION



GROUND CONTROL CONNECTION

Figure 6-11. Analyzer Connecting Points

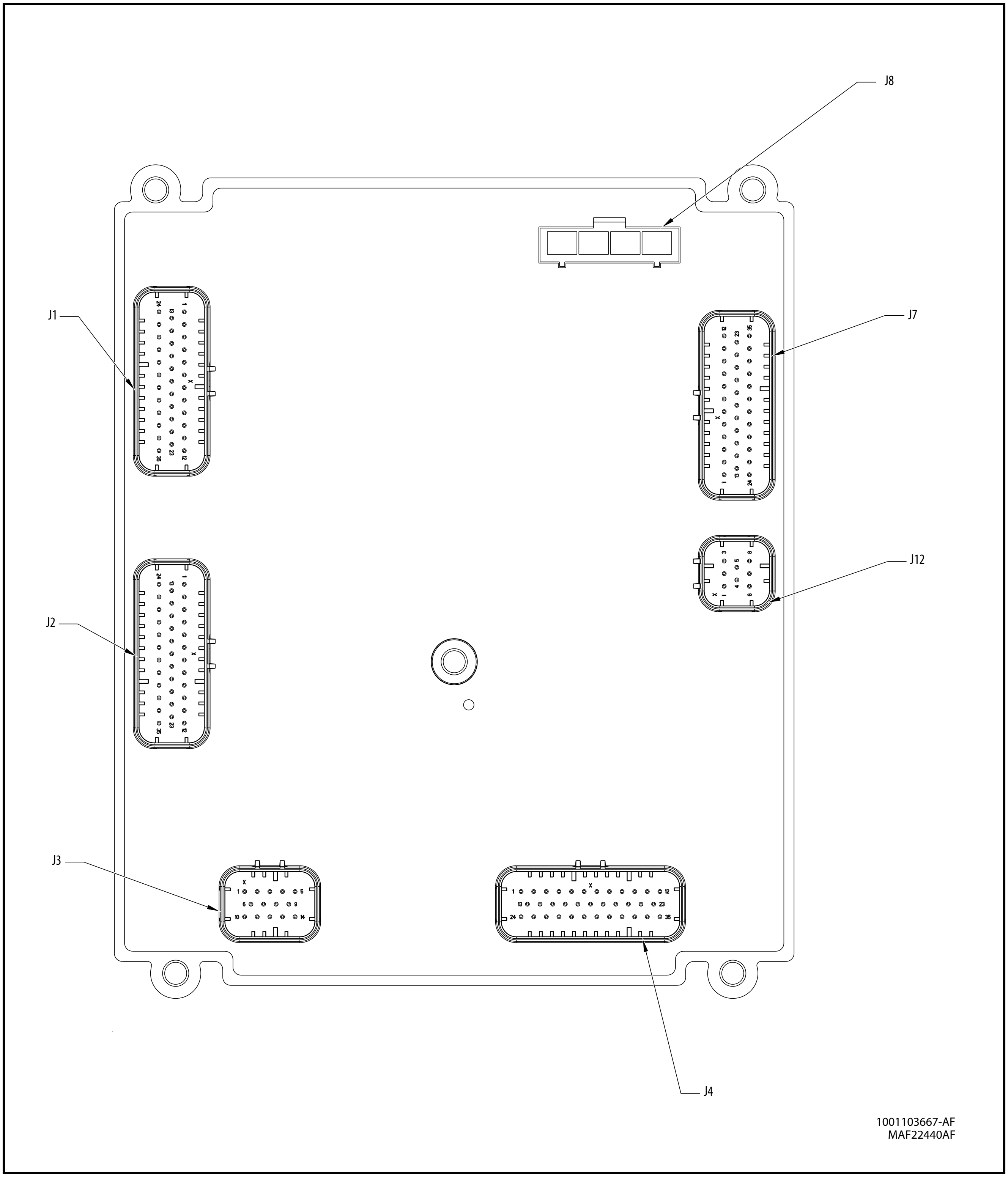


Figure 6-12. Ground Control Module Pin Connections

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

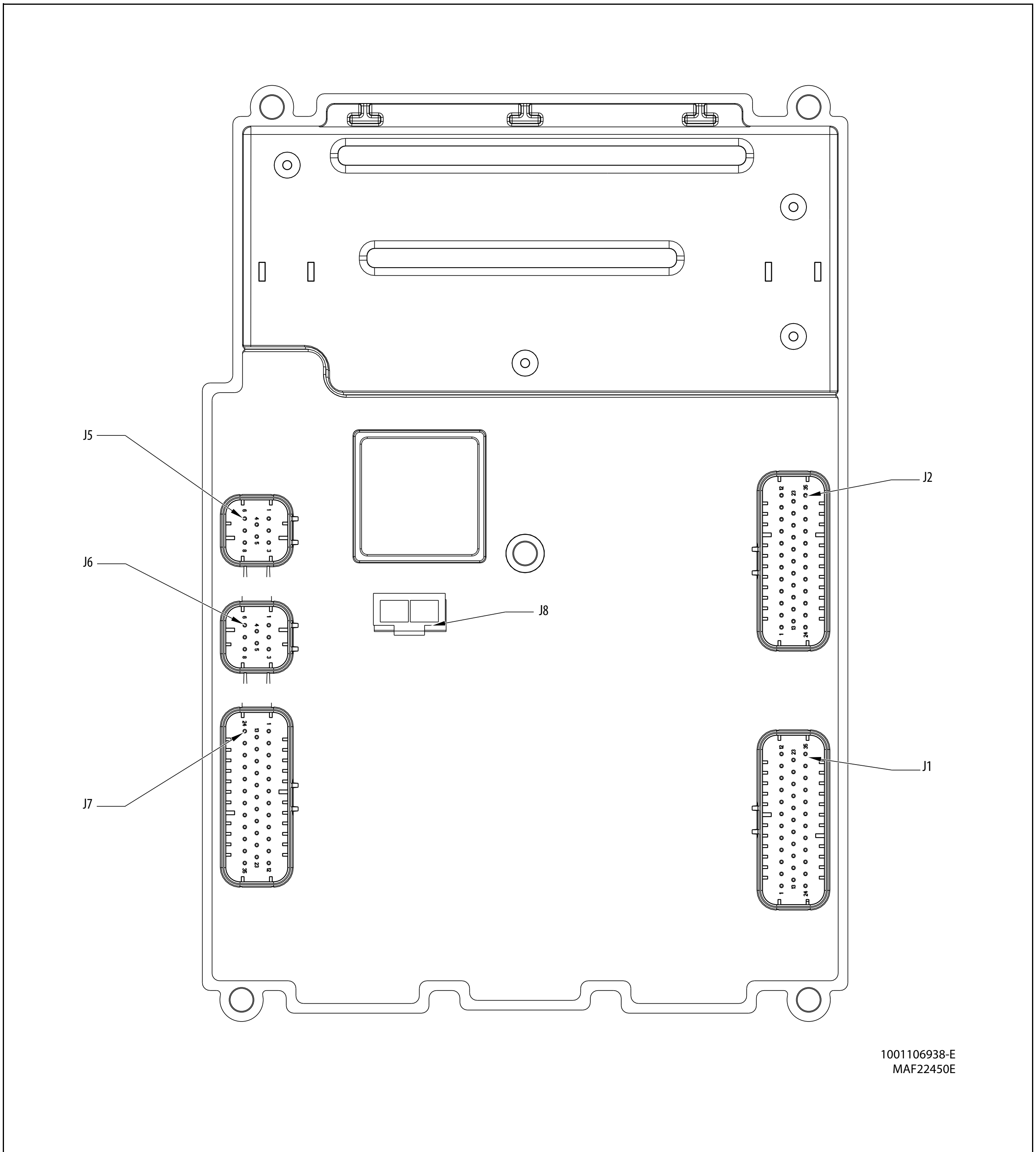


Figure 6-13. Platform Control Module Pin Connections

Connecto	Pin	Assignment	Function
J1 NATURAL	1	TOWER LIFT UP	DIGITAL INPUT
	2	TOWER LIFT DOWN	DIGITAL INPUT
	3	TOWER TELESCOPE IN	DIGITAL INPUT
	4	TOWER TELESCOPE OUT	DIGITAL INPUT
	5	MAIN TELESCOPE IN	DIGITAL INPUT
	6	MAIN TELESCOPE OUT	DIGITAL INPUT
	7	PLATFORM ROTATE RIGHT	DIGITAL INPUT
	8	PLATFORM ROTATE LEFT	DIGITAL INPUT
	9	PLATFORM LEVEL UP	DIGITAL INPUT
	10	PLATFORM LEVEL DOWN	DIGITAL INPUT
	11	JIB UP	DIGITAL INPUT
	12	JIB DOWN	DIGITAL INPUT
	13	SPEED PUMP POTENTIOMETER GROUND	GROUND
	14	ENGINE START	DIGITAL INPUT
	15	AUXILIARY POWER	DIGITAL INPUT
	16	CRAB STEER SELECT	DIGITAL INPUT
	17	COORDINATED STEER SELECT	DIGITAL INPUT
	18	SWITCH POWER	BATTERY
	19	UNALLOCATED	DIGITAL INPUT
	20	UNALLOCATED	DIGITAL INPUT
	21	UNALLOCATED	DIGITAL INPUT
	22	DRIVE ORIENTATION SYSTEM FEATURE	DIGITAL INPUT
	23	UNALLOCATED	DIGITAL INPUT
	24	UNALLOCATED	DIGITAL INPUT
	25	UNALLOCATED	DIGITAL INPUT
	26	UNALLOCATED	DIGITAL INPUT
	27	TWO SPEED VALVE (HIGH ENGINE)	DIGITAL INPUT
	28	TORQUE MODE	DIGITAL INPUT
	29	SOFT TOUCH OVERRIDE	DIGITAL INPUT
	30	HEAD/TAIL LIGHT	DIGITAL INPUT
	31	HORN	DIGITAL INPUT
	32	CREEP MODE	DIGITAL INPUT
	33	DUAL-FUEL SELECT	DIGITAL INPUT
	34	SPEED PUMP POTENTIOMETER REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	35	SPEED PUMP POTENTIOMETER	DIGITAL INPUT

Connector	Pin	Assignment	Function
J2 GRAY	1	UNALLOCATED	DIGITAL INPUT
	2	UNALLOCATED	DIGITAL INPUT
	3	BATTERY VOLTAGE	HS DIGITAL INPUT
	4	DRIVE ORIENTATION SYSTEM OVERRIDE SWITCH	HS DIGITAL INPUT
	5	UNALLOCATED	LAMP OUTPUT
	6	CHASSIS TILTED INDICATOR	LAMP OUTPUT
	7	FUNCTION ENABLE INDICATOR	LAMP OUTPUT
	8	VEHICLE SYSTEM DISTRESS INDICATOR	LAMP OUTPUT
	9	CREEP SPEED INDICATOR	LAMP OUTPUT
	10	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	DRIVE DISABLED INDICATOR	LAMP OUTPUT
	20	UPRIGHT TILTED INDICATOR	LAMP OUTPUT
	21	LOW FUEL INDICATOR	LAMP OUTPUT
	22	1/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	23	3/4 FUEL LEVEL INDICATOR	LAMP OUTPUT
	24	1/2 FUEL LEVEL INDICATOR	LAMP 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	BATTERY VOLTAGE	BATTERY VOLTAGE
	31	BATTERY VOLTAGE	BATTERY VOLTAGE
	32	BATTERY VOLTAGE	BATTERY VOLTAGE
	33	BATTERY VOLTAGE	BATTERY VOLTAGE
	34	SWITCH POWER	BATTERY VOLTAGE
	35	FULL FUEL LEVEL INDICATOR	LAMP OUTPUT

Connector	Pin	Assignment	Function
J7 BLACK	1	GROUND MODE	GROUND MODE
	2	PLATFORM EMS	PLATFORM EMS
	3	PLATFORM EMS TO GROUND MODULE	PLATFORM MODE
	4	FOOTSWITCH (FUNCTION ENABLE SWITCH) POWER	BATTERY VOLTAGE
	5	GENERATOR SWITCH POWER	BATTERY VOLTAGE
	6	JIB BLOCK LIMIT SWITCH POWER	BATTERY VOLTAGE
	7	SOFT TOUCH LIMIT SWITCH POWER	BATTERY VOLTAGE
	8	FOOTSWITCH SIGNAL	DIGITAL INPUT
	9	GENERATOR ON SIGNAL	DIGITAL INPUT
	10	+7 REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	11	LOAD CELL INPUT 1	ANALOG INPUT
	12	LOAD CELL INPUT 2	ANALOG INPUT
	13	UNALLOCATED	ANALOG INPUT
	14	GROUND RETURN	GROUND
	15	LOAD CELL REFERENCE VOLTAGE	+7 REFERENCE VOLTAGE
	16	LOAD CELL RETURN	GROUND
	17	JIB BLOCK LIMIT SWITCH	HS DIGITAL INPUT
	18	SOFT TOUCH LIMIT SWITCH	HS DIGITAL INPUT
	19	PLATFORM ALARM	LAMP OUTPUT
	20	ALARM RETURN	GROUND
	21	PLATFORM LEVEL UP	ME DIGITAL OUTPUT
	22	PLATFORM LEVEL DOWN	ME DIGITAL OUTPUT
	23	GROUND RETURN	GROUND
	24	GROUND RETURN	GROUND
	25	JIB UP	ME DIGITAL OUTPUT
	26	JIB DOWN	ME DIGITAL OUTPUT
	27	UNALLOCATED	ME DIGITAL OUTPUT
	28	UNALLOCATED	ME DIGITAL OUTPUT
	29	GROUND RETURN	GROUND
	30	CAN LOW	CAN LOW
	31	CAN HIGH	CAN HIGH
	32	CAN SHIELD	CAN SHIELD
	33	PLATFROM ROTATE LEFT	ME DIGITAL OUTPUT
	34	PLATFROM ROTATE RIGHT	ME DIGITAL OUTPUT
	35	GROUND RETURN	GROUND

Connector	Pin	Assignment	Function
J5 NATURAL	1	LIFT / SWING JOYSTICK SUPPLY VOLTAGE	SUPPLY
	2	LIFT CENTER TAP	INPUT
	3	LIFT SIGNAL	INPUT
	4	SWING SIGNAL	INPUT
	5	SWING CENTER TAP	INPUT
	6	NOT CONNECTED	INPUT
	7	LIFT / SWING JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND

Connector	Pin	Assignment	Function
J6 BLACK	1	DRIVE / STEER JOYSTICK SUPPLY VOLTAGE	SUPPLY
	2	DRIVE CENTER TAP	INPUT
	3	DRIVE SIGNAL	INPUT
	4	STEER SIGNAL	INPUT
	5	STEER LEFT	INPUT
	6	STEER RIGHT	INPUT
	7	DRIVE / STEER JOYSTICK RETURN	GROUND
	8	GROUND RETURN	GROUND

Connector	Pin	Assignment	Function
J8	1	MODULE GROUND	GROUND
	2	MODULE POWER	BATTERY

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 or DOWN arrow keys alter a value if allowed

Table 6-5. 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 main lift acceleration
DECEL	Displays/adjusts main lift deceleration
MIN UP	Displays/adjusts minimum main lift up speed
MAX UP	Displays/adjusts maximum main lift up speed
CREEP UP	Displays/adjusts maximum main lift up speed NOTE: used when creep switch on pump pot is active
MIN DOWN	Displays/adjusts minimum main lift down speed
MAX DOWN	Displays/adjusts maximum main lift down speed
CREEP DOWN	Displays/adjusts maximum main 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

Table 6-5. Adjustments - Personality Descriptions

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
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

Table 6-5. Adjustments - Personality Descriptions

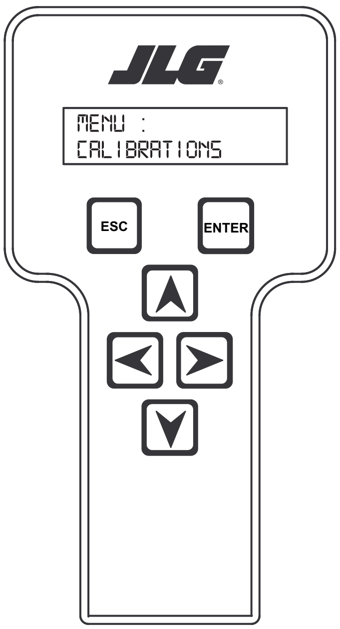
MAX DOWN	Displays/adjusts maximum jib down speed
MIN LEFT	Displays/adjusts minimum jib left speed
MAX LEFT	Displays/adjusts maximum jib left speed
MIN RIGHT	Displays/adjusts minimum jib right speed
MAX RIGHT	Displays/adjusts maximum jib right speed
STEER	
MAX SPEED	Displays/adjusts maximum steer speed, 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

6.6 TILT SENSOR CALIBRATION

WARNING

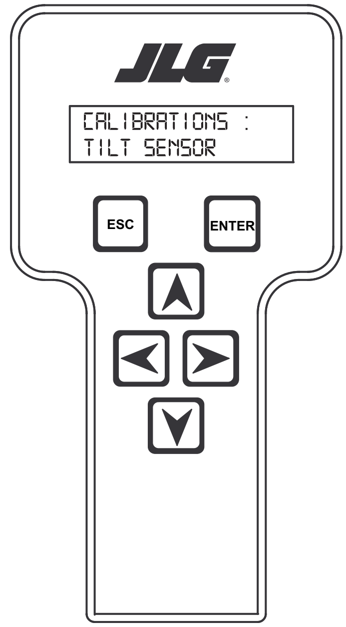
DO NOT CALIBRATE THE TILT SENSOR EXCEPT ON A LEVEL SURFACE.

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.



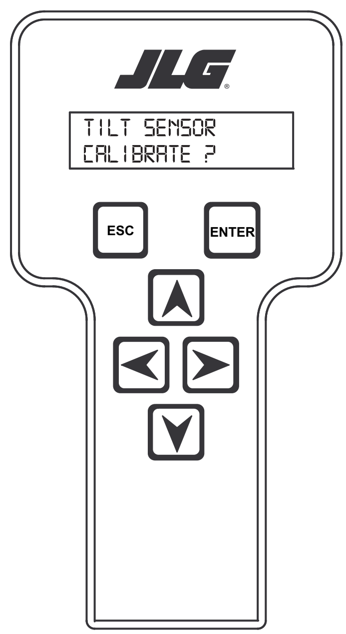
MAF14500

4. Using the arrow keys, navigate to the Tilt Sensor calibration as shown below and press ENTER.

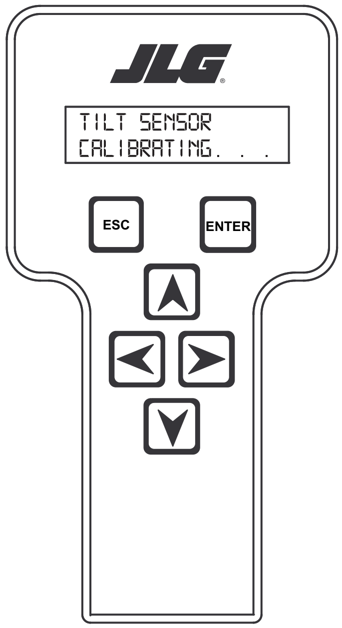


MAF14500

5. Hit Enter. The screen will read.

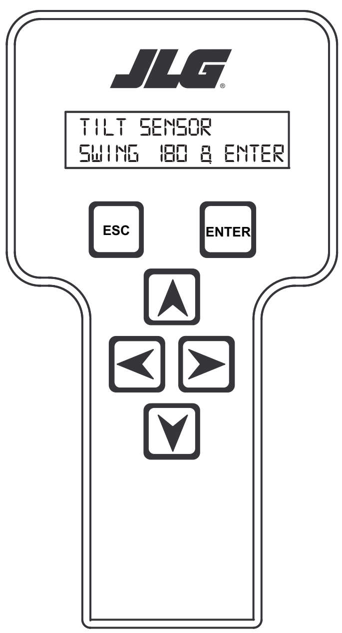


MAF14500



MAF14500

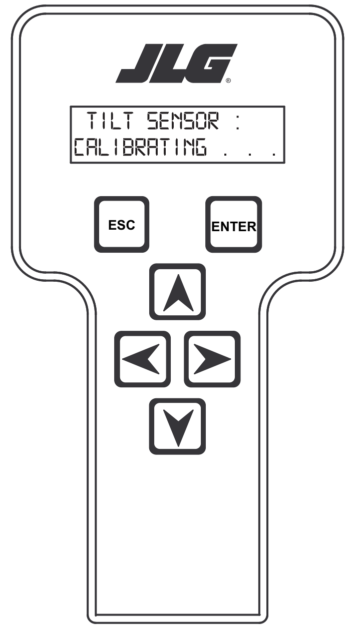
6. When the sensor is calibrated in that position, the screen will read:



MAF14500

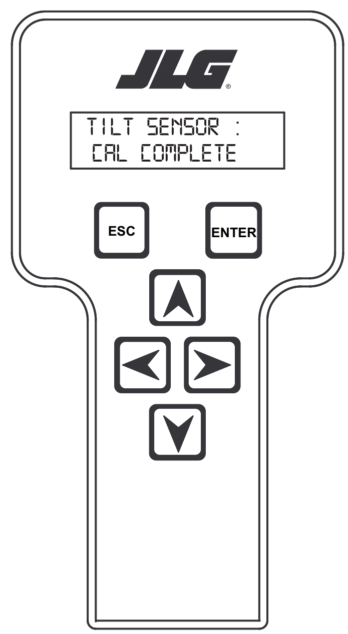
7. Swing the machine 180 degrees, making sure the boom is centered and in the transport position, and ENTER 

. The screen will read:



MAF14500

8. When the calibration is complete the screen will read as shown below. Return the machine to the travel position.

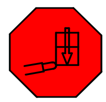


MAF14500

6.7 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.

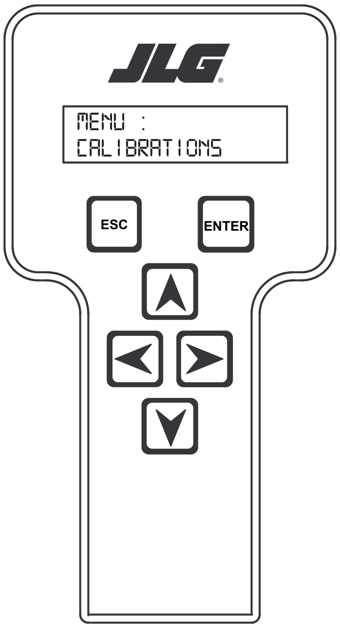
NOTICE

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.

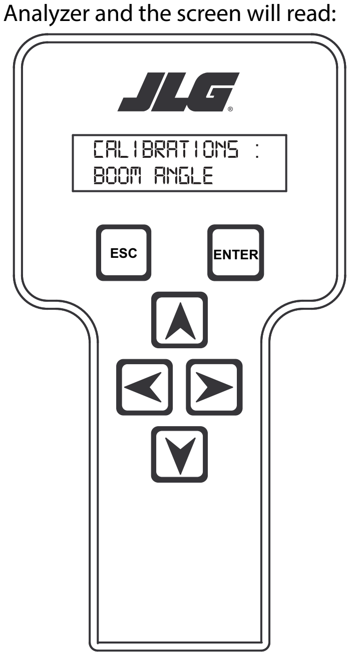
6.8 CALIBRATING BOOM ANGLE

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:



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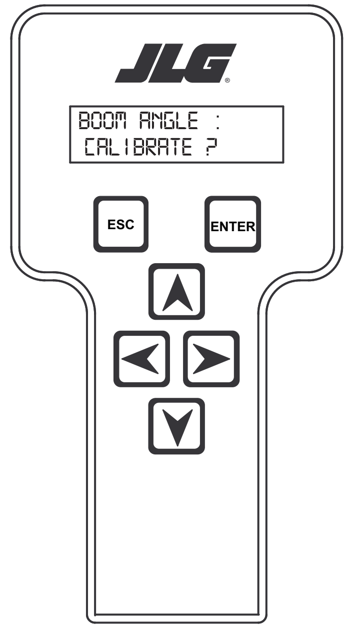
3. Hit Enter. The screen will read.



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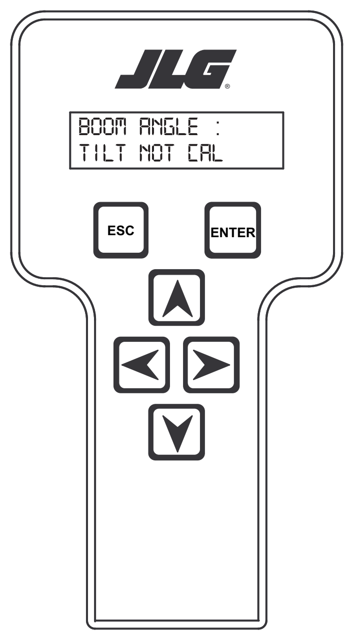
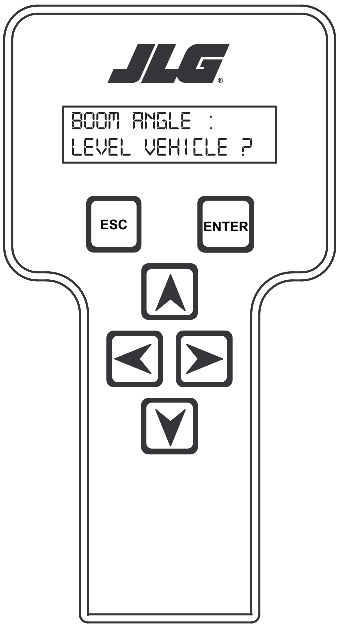
4. UGM will confirm the tilt sensor calibration. The screen will read.



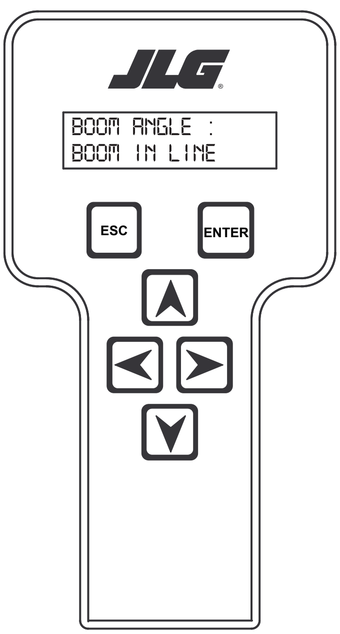
MAF14500

5. Hit Enter. The screen will read.



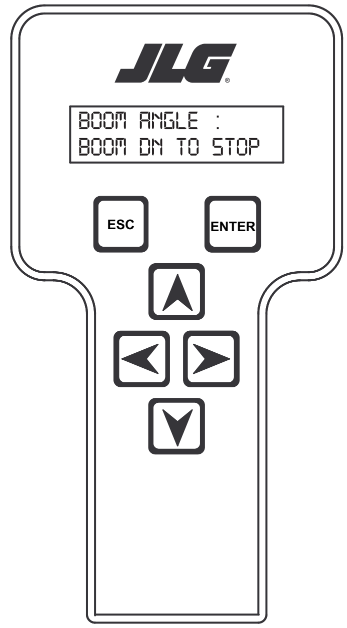
MAF14500

6. UGM will confirm the Boom In-Line position. The screen will read:



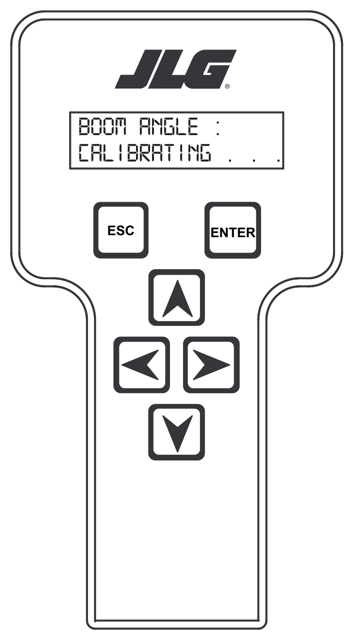
MAF14500

7. Hit Enter. The Screen will read:



MAF14500

8. When the sensor is calibrated at lower position of the boom. The screen will read:



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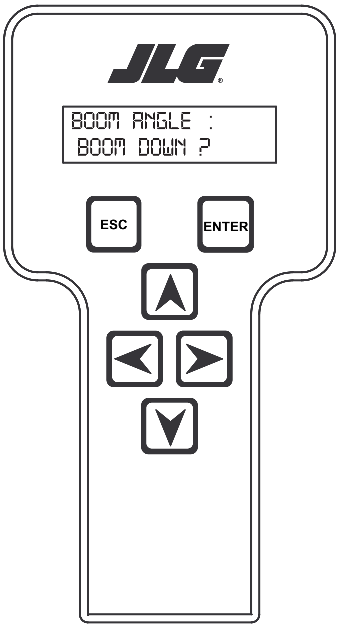
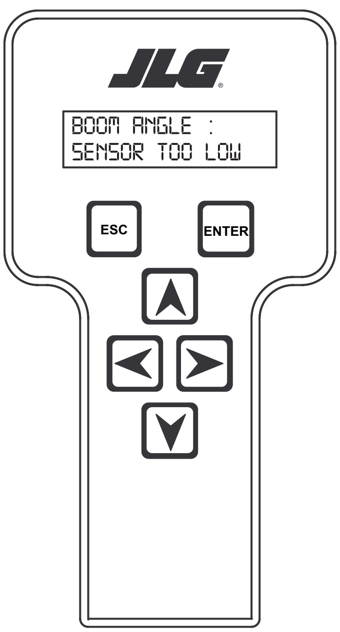
9. Hit Enter. The Screen will read:



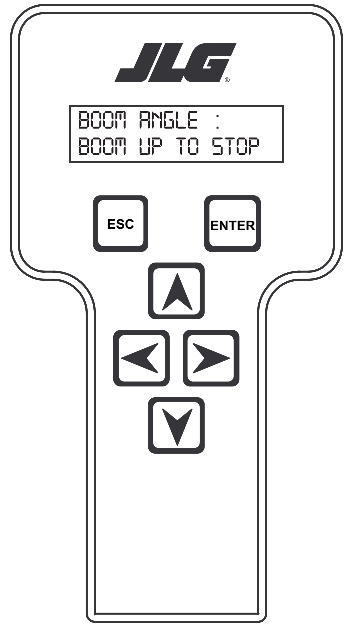
MAF14500

10. Hit Enter. The Screen will read:



MAF14500

11. UGM will confirm the position of the boom. Press Enter. The screen will read:



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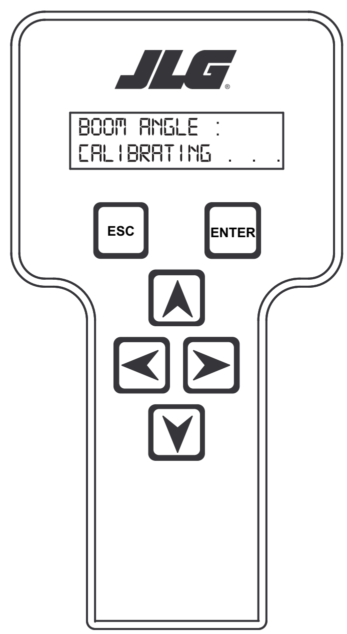
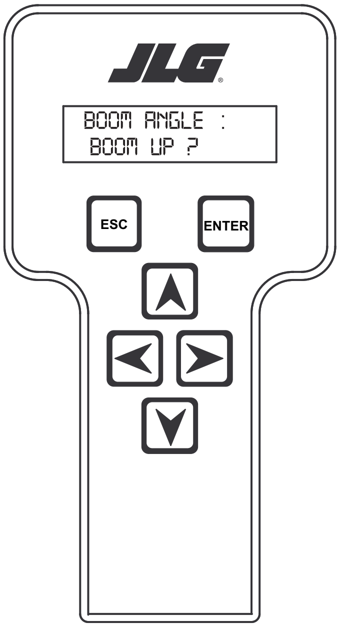
12. When the sensor is calibrated at upper position of the boom. The screen will read:



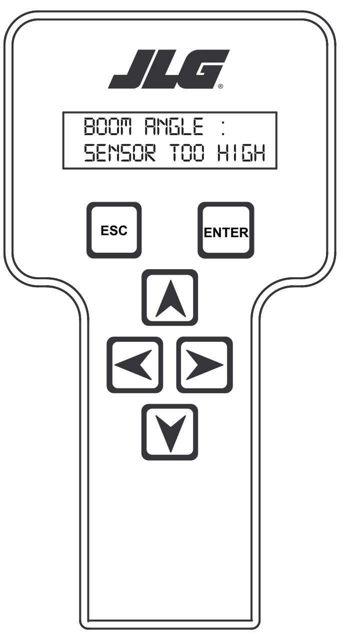
MAF14500

13. UGM will confirm the position of the boom. Press Enter. The screen will read:



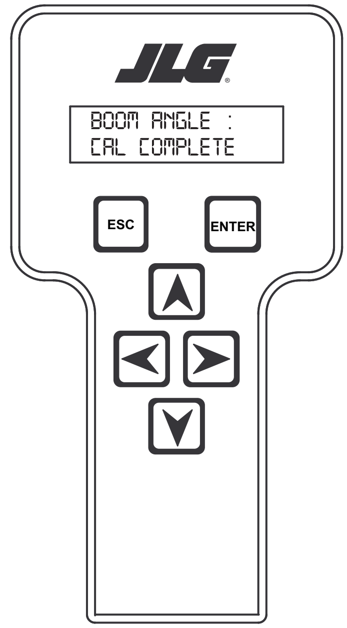
MAF14500

14. Hit Enter. The Screen will read:



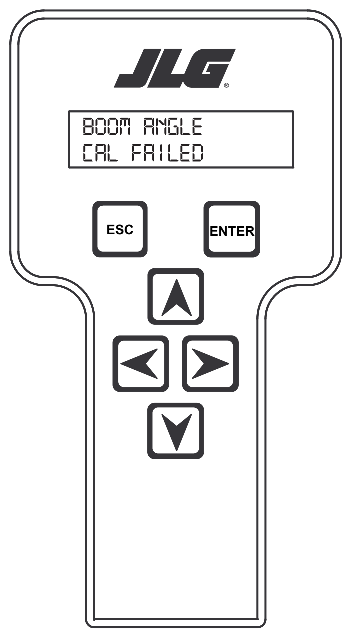
MAF14500

15. After few seconds. The screen will read:



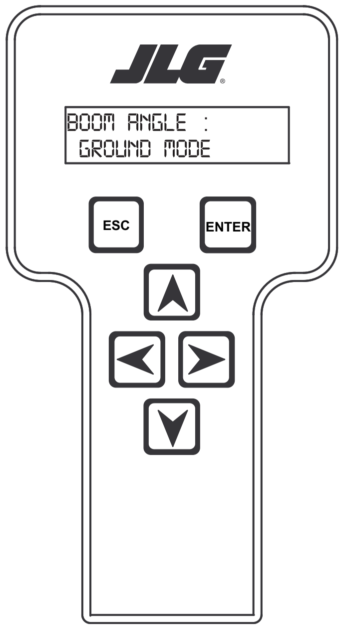
MAF14500

16. Press ENTER. If calibration is unsuccessful, the screen will read:



MAF14500

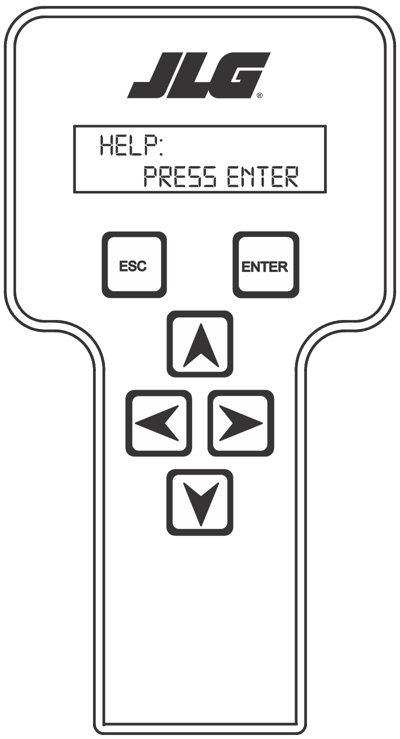
17. Press ENTER to reach Ground mode menu.



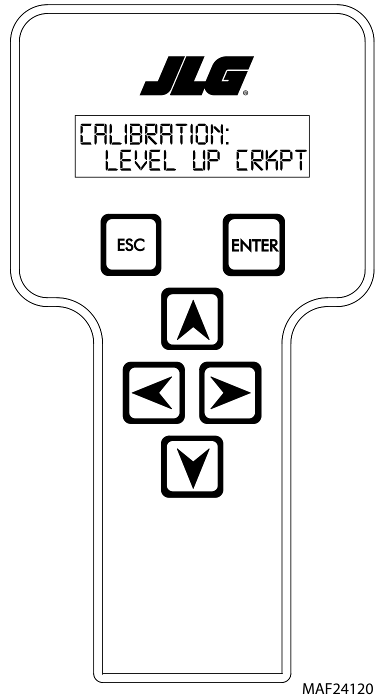
MAF14500

6.9 CALIBRATING LEVEL UP CRKPT

1. Position the Platform/Ground select switch to the Ground position.
2. Plug the analyzer into the connector inside the Ground control box.
3. Pull out the Emergency Stop switch and Start the engine.
4. The analyzer screen should read:

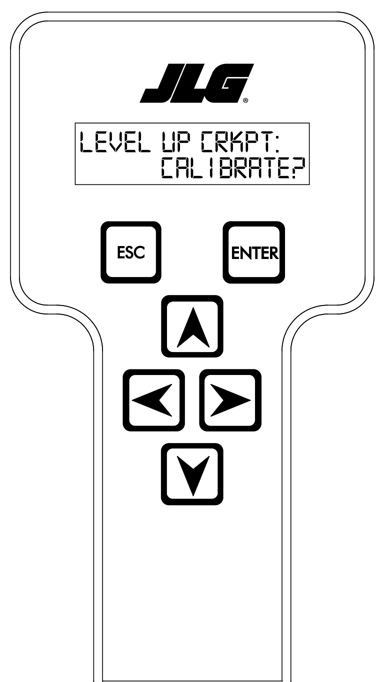


5. Use the arrow button to reach ACCESS LEVEL. Hit Enter.
6. Enter the Access Code, 33271.
7. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.
8. Use the arrow keys to reach LEVEL UP CRKPT. The screen will read.



MAF24120

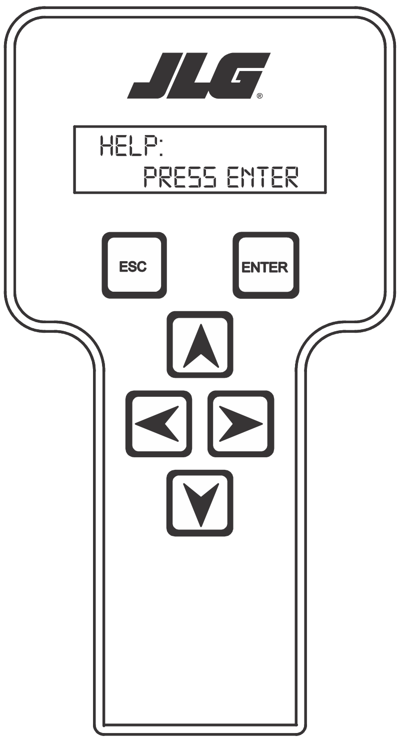
9. Hit Enter. The screen will read.



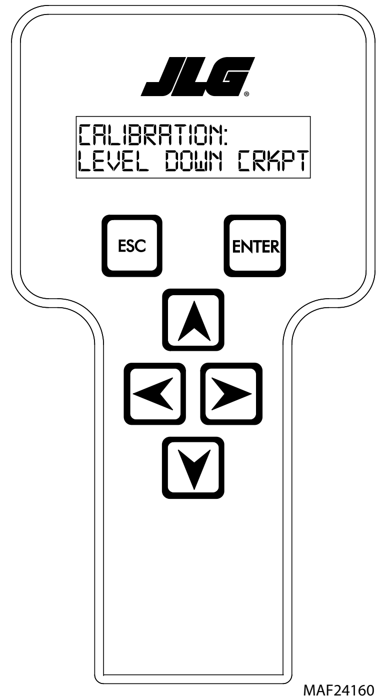
MAF24130

6.10 CALIBRATING LEVEL DOWN CRACKPOINT

1. Position the Platform/Ground select switch to the Ground position.
2. Plug the analyzer into the connector inside the Ground control box.
3. Pull out the Emergency Stop switch and Start the engine.
4. The analyzer screen should read:

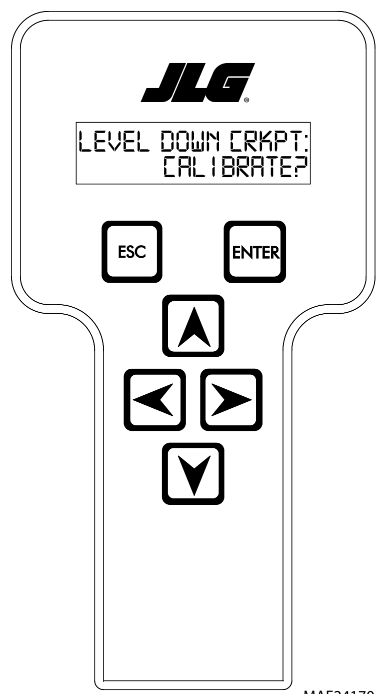


5. Use the arrow button to reach ACCESS LEVEL. Hit Enter.
6. Enter the Access Code, 33271.
7. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.
8. Use the arrow keys to reach LEVEL DOWN CRKPT. The screen will read.



MAF24160

9. Hit Enter. The screen will read.

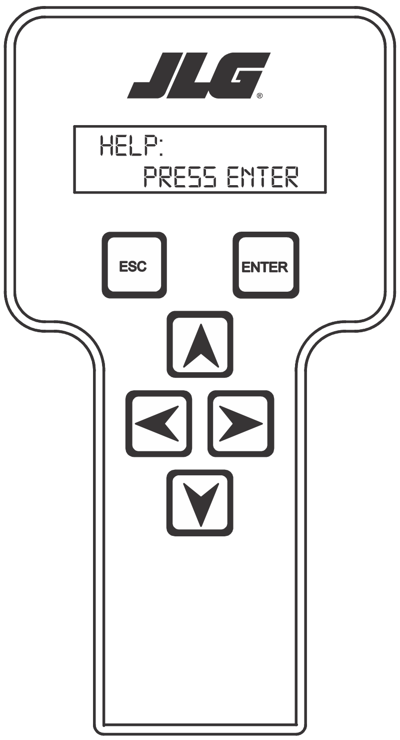


MAF24170

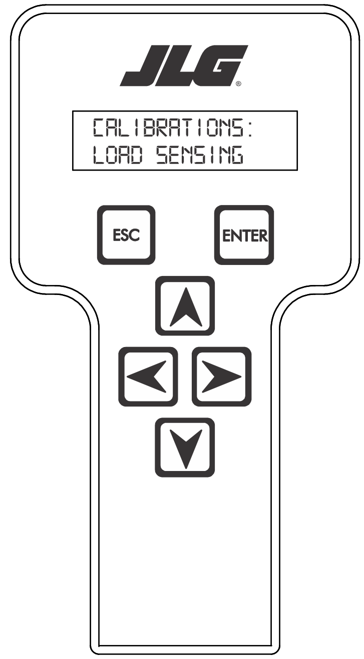
6.11 CALIBRATING LOAD SENSING

NOTE: *Calibration sub-menu LOAD SENSING is visible only if MACHINE SET-UP sub-menu LOAD SYSTEM is selected to YES.*

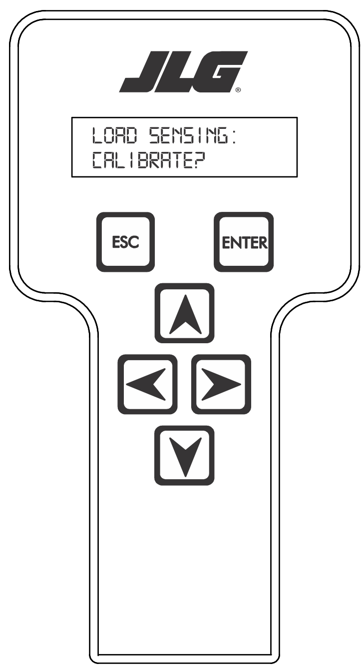
1. Position the Platform/Ground select switch to the Platform position.
2. Plug the analyzer into the connector at the base of the platform control box.
3. Pull out the Emergency Stop switch and Start the engine.
4. The analyzer screen should read:



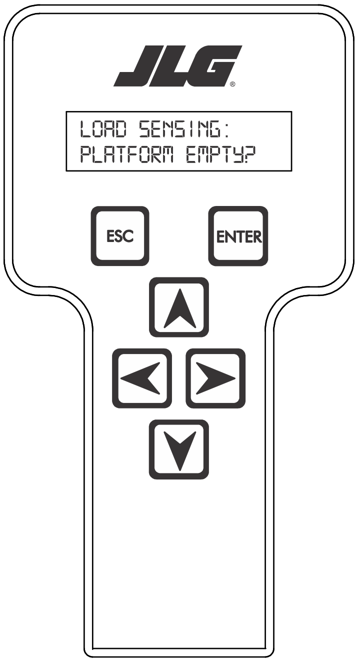
5. Use the arrow button to reach ACCESS LEVEL 2. Hit Enter.
6. Enter the Access Code, 33271.
7. Use the right Arrow key to reach CALIBRATIONS. Hit Enter.
8. Use the arrow keys to reach LOAD SENSING. The screen will read.



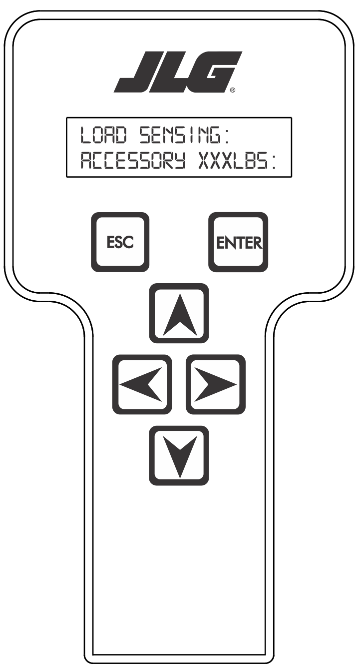
9. Hit Enter. The screen will read:



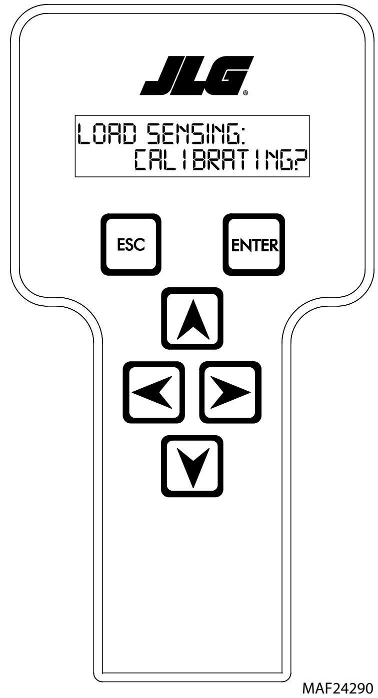
10. Hit Enter. The screen will read:



11. UGM will set the Accessary Weight default value. Press Enter. The screen will read.:

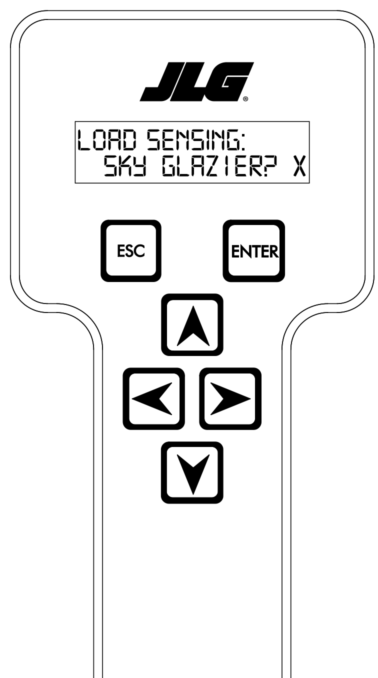


12. Hit Enter. The screen will read:



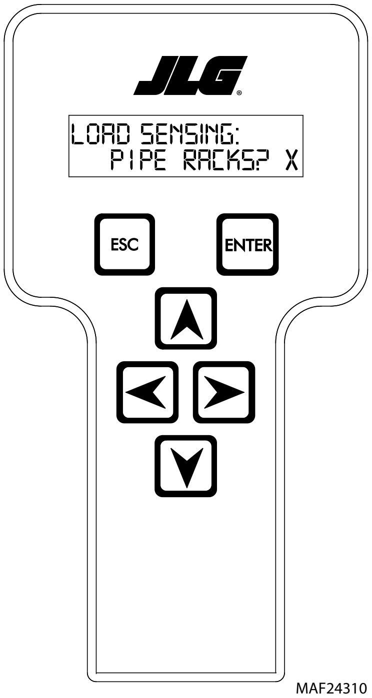
MAF24290

13. UGM will set the Glazier default value. Press Enter. The screen will read:



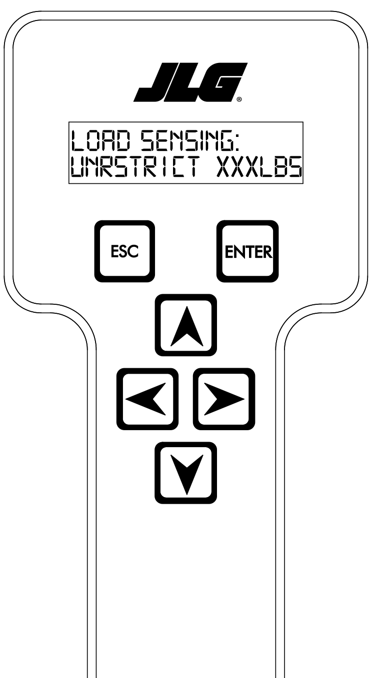
MAF24300

14. UGM will set the Pipe Racks default value. Press Enter. The screen will read:



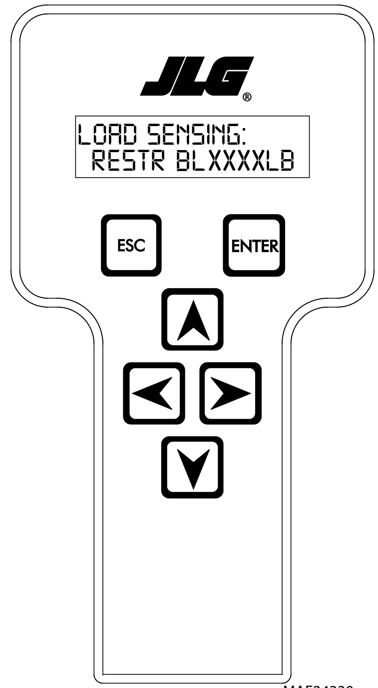
MAF24310

15. UGM will set the Unrestricted Rated Load. Press Enter. The screen will read:

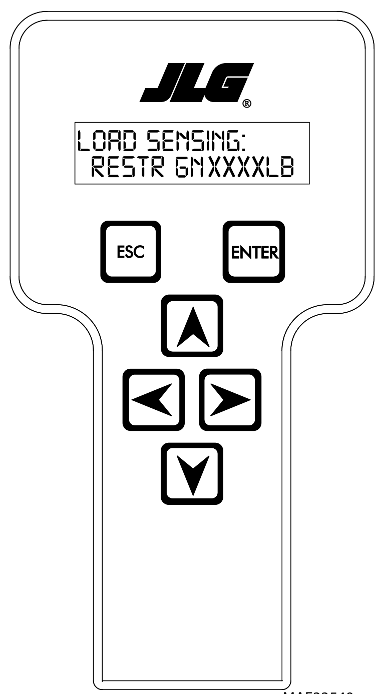


MAF24320

16. UGM will set the ”Restricted Blue Rate Load” and ”Restricted Green Rate Load”. Press Enter. The screen will read:

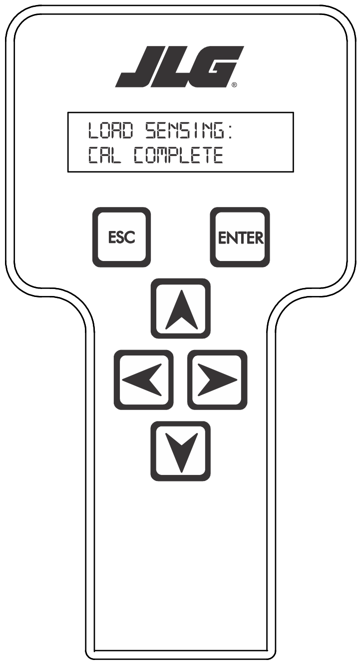


MAF24330



MAF33540

17. After few seconds, the screen will read:

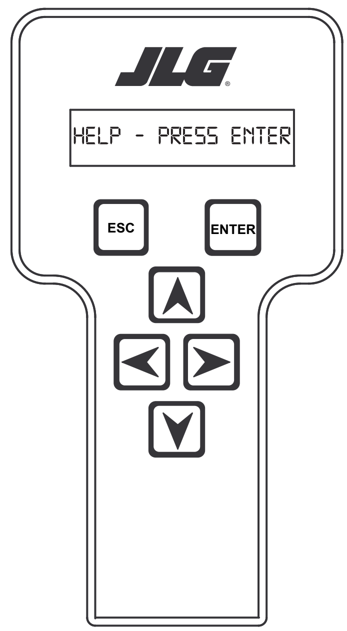


6.12 RESETTING THE MSSO SYSTEM (CE ONLY)

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:

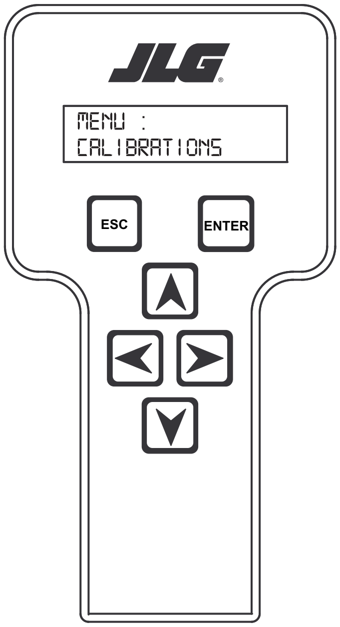


MAF14500

6. Use the arrow button to reach OPERATOR ACCESS. Press Enter .
7. Enter the Access Code, 33271.

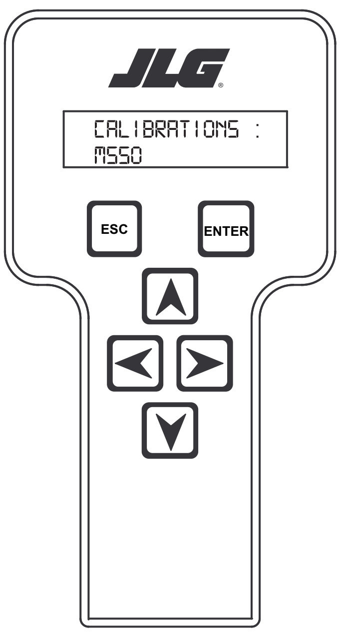
8. Use the right Arrow key to reach MENU: CALIBRATIONS.

Press Enter .



MAF14500

9. Use the arrow keys to reach the MSSO menu. The screen should read:

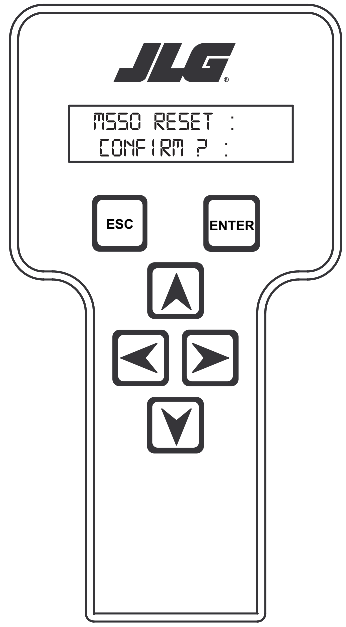


MAF14500

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.

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 .

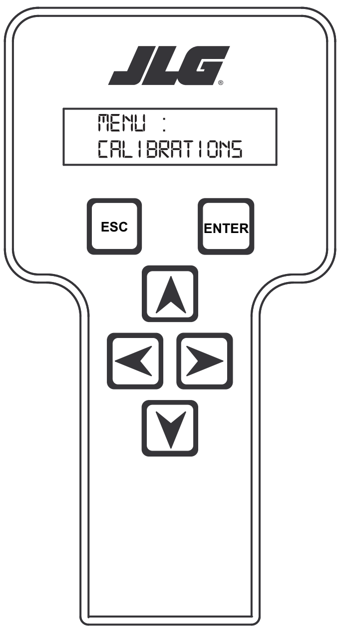
Table 6-6, Diagnostic Menu Descriptions details the structure of the Diagnostic Menu, and describes the meaning of each piece of information presented.

Table 6-6. Diagnostic Menu Descriptions

Diagnostics Menu (Displayed on Analyzer 1st Line)	Parameter (Displayed on Analyzer 2nd Line)	Parameter Value (Displayed on Analyzer 2nd Line)	Description
PLATFORM LOAD	STATE:	OK / OVERLOAD	LSS Status.
PLATFORM LOAD	ACTUAL:	XXX.X KG	Calibrated weight of the platform. ??? if Platform Load is Unhealthy**.
PLATFORM LOAD (service*)	GROSS:	XXX.X KG	Gross weight of the platform. ??? if both Cells are Unhealthy**.
PLATFORM LOAD (service*)	OFFSET 1:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	OFFSET 2:	XXX.X KG	Stored offset weight of Cell 1. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	ACCESSORY	XXX.X KG	Stored accessory weight. ??? if LSS is not calibrated.
PLATFORM LOAD (service*)	UNRESTRICT	XXX.X KG	UGM will set Unrestricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RESTRICT	XXX.X KG	UGM will set Restricted Rated Load as defined by Machine Configuration.
PLATFORM LOAD (service*)	RAW 1:	XXX.X KG	Gross value from Cell 1. ??? if Unhealthy**.
PLATFORM LOAD (service*)	RAW 2:	XXX.X KG	Gross value from Cell 2. ??? if Unhealthy**.
* Indicates only visible in service view mode ** Typically indicates a DTC is active			

Calibration Procedure

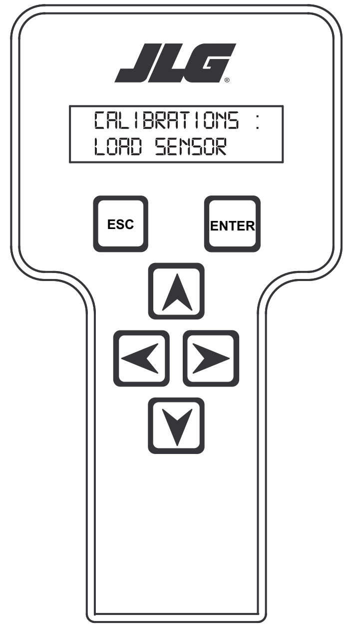
1. Remove everything from the platform, except permanently fixed JLG Accessories, to allow the Load Sensing System to record its' weight during calibration. This includes all tools, debris, and customer-installed devices.
2. Plug the JLG Analyzer into the Machine at the Ground Station and enter Service Access Password 33271.
3. The platform should be approximately level for calibration. Level the platform from ground control (if necessary) to within +/- 5°.
4. To access the Calibration Menu, use the LEFT and RIGHT Arrow keys to select CALIBRATION from the Top Level Menu. The screen will read:



MAF14500

NOTE: *The Calibration Menu is not available in OPERATOR ACCESS.*

5. Press the ENTER key ENTER to view the menu. Upon entry to the Calibration Menu, the JLG Control System will link to the Analyzer and the screen will read:



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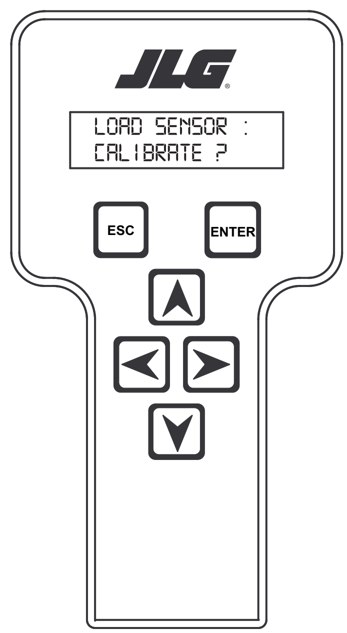
6. Press Enter ENTER. The Screen will read:

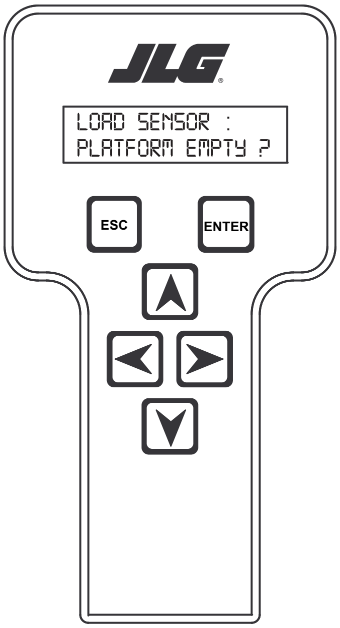


MAF14500

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).*

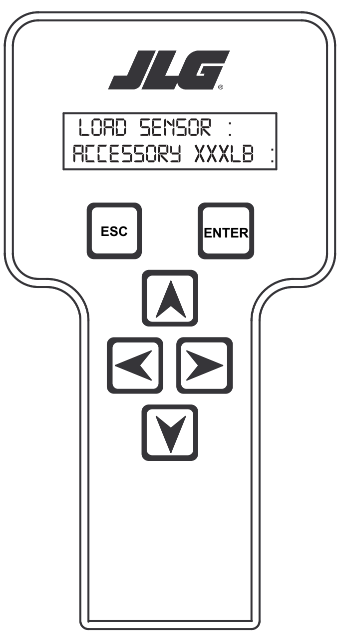
Pressing the ESC key after starting calibration and before calibration is complete will display the CAL FAILED message. This will not disturb the prior calibration information.

7. Press ENTER. The analyzer screen will read:



MAF14500

8. If the platform is empty, press ENTER. The screen will read:



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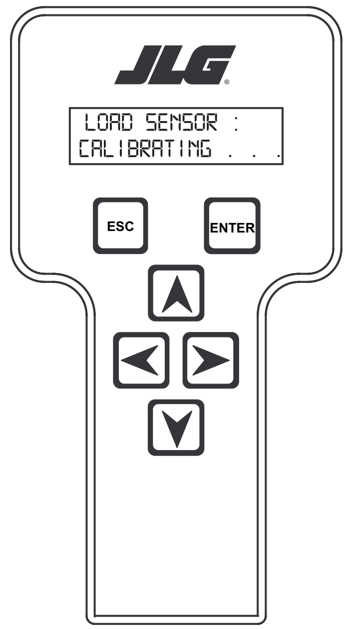
NOTE: *Accessory weight will reset to 0 lb each time the machine is re-calibrated and will need to be re-entered.*

NOTE: *The Accessory weight will be temporarily stored in the Control System until calibration has been completed successfully.*

Refer to Table 6-7, 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:



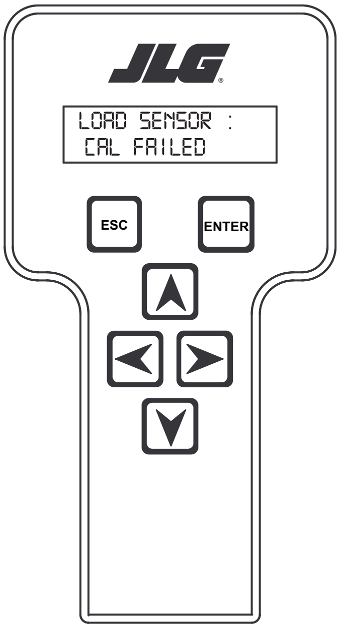
MAF14500

Table 6-7. 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.*	

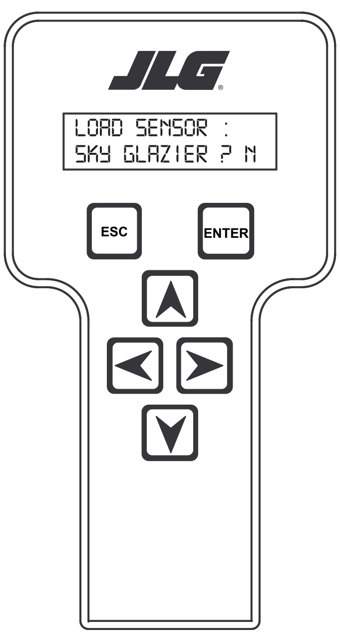
9. The control system will calculate the load cell readings and ensure it is greater than 130 lb (59 kg), but less than 575 lb (261 kg).

   If the platform weight is not within the allowed range, the calibration attempt will be unsuccessful and the Analyzer will show the following:



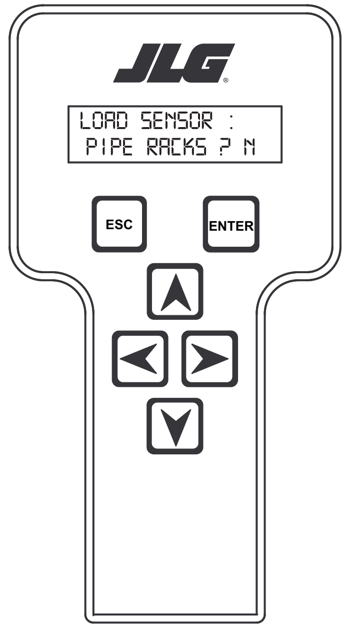
MAF14500

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 ENTER. The control system will default to an estimate of unrestricted capacity, which can be adjusted if necessary. Refer to Table 6-8, SkyGlazier Capacity Reductions and Table 6-9, Pipe Rack Capacity Reductions.

The screen will read:

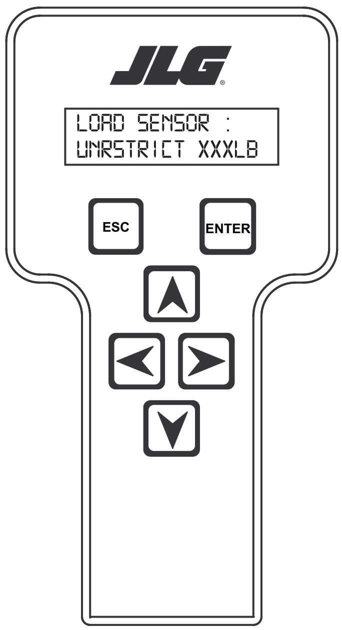


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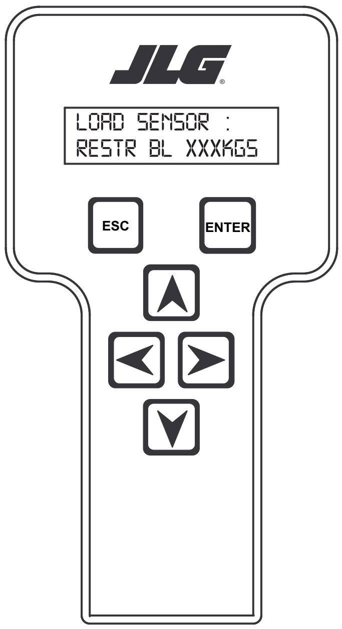
Table 6-8. SkyGlazier Capacity Reductions

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 6-9. Pipe Rack Capacity Reductions

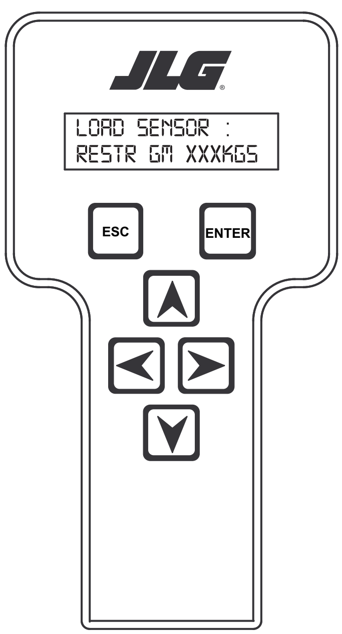
Capacity	PLATFORM OVRLD	PLATFORM OVRLD RESTRICT
500 lb (227 kg)	400 lb (181 kg)	N/A
550 lb (250 kg)	450 lb (204 kg)	N/A
600 lb (272 kg)	500 lb (227 kg)	N/A
660 lb (300 kg)	-	-
750 lb (340 kg)	N/A	650 lb (295 kg)
1000 lb (454 kg)	N/A	900 lb (408 kg)
Note: If both SkyGlazier and Pipe Racks are configured, capacity will be the lower of the two values.		

13. Press ENTER. The following screen will be displayed



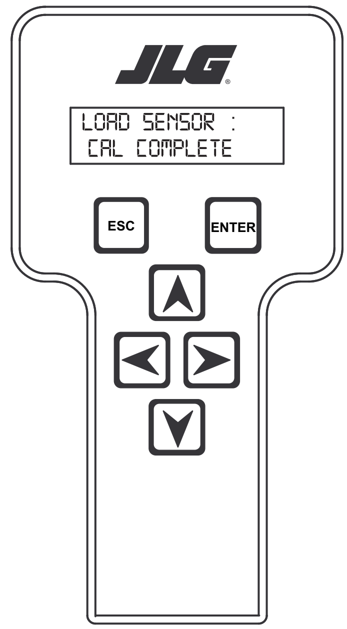
MAF14500

14. Press ENTER. The following screen will be displayed



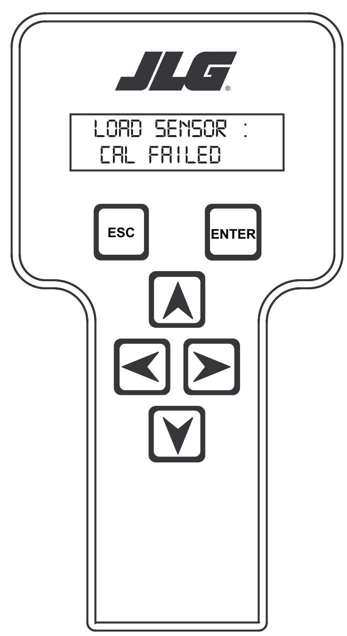
MAF14500

15. Press ENTER. If calibration is successful, the screen will read:



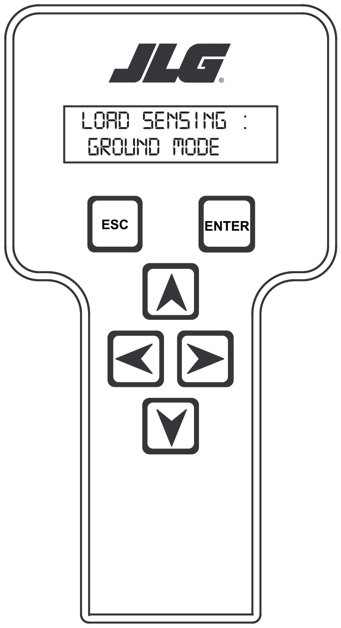
MAF14500

16. Press ENTER. If calibration is unsuccessful, the screen will read:



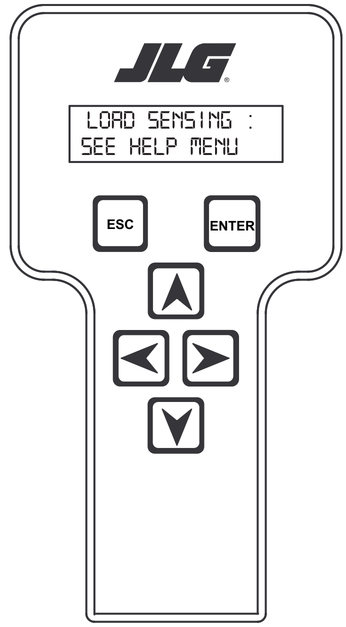
MAF14500

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 (± 7 kg). Further, the reading should be stable and should not vary by more than ±2 lb (±1 kg) (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 500lb (230 kg) 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 6-10. LSS Troubleshooting Chart

Difficulty	Possible Resolution
Empty Platform Weight (DIAGNOSTICS, PLATFORM LOAD) is not within ±15 lb (±7 kg) of zero. or Platform Load readings (DIAGNOTICS, PLTLOAD) are unstable by more than ±2 lb (±1 kg) (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 (±1 kg) (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 [>2722 kg]).
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.

6.13 DIAGNOSTIC TROUBLE CODES (DTC)

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
001	00	1	EVERYTHING OK	The normal help message in Platform Mode.	No response required for this DTC.
002	00	2	GROUND MODE OK	The normal help message in Platform Mode.	No response required for this DTC.
0010	00	10	RUNNING AT CUTBACK - OUT OF TRANSPORT POSITION	Drive speed is limited to "ELEVATED MAX" while the vehicle is out of transport position.The normal help message in Ground Mode.	Response described in Drive Modes section.
000	**00**	**0**	**<<<HELP COMMENT>>>**		
0011	00	11	FSW OPEN (Foot switch open)	A drive / boom function was selected with the Footswitch open.	The UGM shall not Enable the Machine.
0012	00	12	RUNNING AT CREEP - CREEP SWITCH OPEN	All functions at creep while the Creep Switch is open.	The UGM shall limit the machine to Creep speed.
0013	00	13	RUNNING AT CREEP - TILTED AND ABOVE ELEVATION	All functions at creep while the Platform is elevated and the Chassis is tilted.	
0014	00	14	CHASSIS TILT SENSOR OUT OF RANGE	The Chassis is tilted > 19 degrees for more then 4 seconds.	Not reported during power-up.
0015	00	15	LOAD SENSOR READING UNDER WEIGHT	The Load Sensing System indicates > 20% under calibrated zero point.	
0031	00	31	FUEL LEVEL LOW - ENGINE SHUTDOWN	Engine Shutdown has occurred due to Fuel Level = EMPTY condition.	Response described in Fuel Shutdown section.
0035	00	35	APU ACTIVE	Auxiliary Power/Emergency Descent Mode is active.	Response described in Auxiliary Power/Emergency Descent Mode section.
0039	00	39	SKYGUARD ACTIVE - FUNCTIONS CUTOUT	Response described in Auxiliary Power/ Emergency Descent Mode section.	Response described in SkyGuard section.
0040	00	40	RUNNING AT CREEP - CREEP SWITCH CLOSED	All Function speeds are limited to creep because the creep switch is closed.	
210	**21**	**0**	**<<<POWER-UP>>>**		
211	21	1	POWER CYCLE	The normal help message is issued at each power cycle.	
212	21	2	KEYSWITCH FAULTY	Both Platform and Ground modes are selected simultaneously.	The UGM shall assume a station selection of Ground.
213	21	3	FSW FAULTY	Both Footswitches are closed for more then one second.	The UGM shall not Enable the Machine.
220	**22**	**0**	**<<<PLATFORM CONTROLS>>>**		
227	22	7	STEER SWITCHES FAULTY	Both Steer Left and Steer Right inputs are closed simultaneously.	The UGM shall prohibit Steer; The UGM shall limit Drive to Creep The Steer Left switch input = Low; The Steer Right switch input = Low; Steer and full Drive speed permitted after controls are initialized

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
2211	22	11	FSW INTERLOCK TRIPPED	The Footswitch was closed for more then seven seconds.	Can be reported during power- up.
2212	22	12	DRIVE LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A drive function was selected with Footswitch open.	Can be reported during power- up.
2213	22	13	STEER LOCKED - SELECTED BEFORE FOOTSWITCH	A steer function was selected with Footswitch open.	The UGM shall not Enable the Machine.
2214	22	14	DRIVE/STEER LOCKED - JOYSTICK MOVED BEFORE ENABLE	Drive/Steer was selected before Enable switch activated.	
2216	22	16	D/S JOY. OUT OF RANGE HIGH	The D/S Joystick reference voltage is $>$ 8.1V.	Resistive joysticks. If the reference voltage is $>$ 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2217	22	17	D/S JOY. CENTER TAP BAD	The D/S Joystick center tap voltage is $<$ 3.08V or $>$ 3.83V.	Resistive joysticks. - There is a +/-.1V range. around these values due to resistor tolerances.
2219	22	19	L/S JOY. OUT OF RANGE HIGH	The L/S Joystick reference voltage is $>$ 8.1V.	Resistive joysticks. - If the reference voltage is $>$ 7.7V then the reference voltage is out of tolerance of a short to battery has occurred.
2220	22	20	L/S JOY. CENTER TAP BAD	The L/S Joystick center tap voltage is $<$ 3.08V or $>$ 3.83V.	Resistive joysticks. - There is a +/- .1V range. around these values due to resistor tolerances.
2221	22	21	LIFT/SWING LOCKED - JOYSTICK MOVED BEFORE FOOTSWITCH	A lift / swing function was selected with Footswitch open.	If triggered by the Lift and/or Swing joystick not being in the neutral position at Startup, the UGM shall pro-hibit Lift and Swing. If triggered by Lift and/or Swing joystick is not in the neutral position when Footswitch becomes active or while DTC 2212, 2213 or 2223 is active, the UGM shall not Enable the Machine.
2222	22	22	WAITING FOR FSW TO BE OPEN	The Footswitch was closed during Platform selection.	Can be reported during power- up.
2223	22	23	FUNCTION SWITCHES LOCKED - SELECTED BEFORE ENABLE	A boom function was selected with Footswitch open.	The UGM shall not Enable the Machine.
2224	22	24	FOOTSWITCH SELECTED BEFORE START	The Footswitch was closed during engine start.	The UGM shall prohibit Engine Start.
2269	22	69	FUNCTION PROBLEM - HIGH SPEED & CREEP ACTIVE TOGETHER		

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
234	23	4	FUNCTION SWITCHES FAULTY - CHECK DIAGNOSTICS/BOOM	A boom function has both directions selected together.	Disable whichever boom functions whose boom control inputs are triggering the fault. If Engine Start/Aux at fault, disable Engine Start but permit Auxiliary Power/ Emergency Descent.
235	23	5	FUNCTION SWITCHES LOCKED - SELECTED BEFORE AUX POWER	A boom function was selected before aux power.	
236	23	6	FUNCTION SWITCHES LOCKED - SELECTED BEFORE START SWITCH	A boom function was selected before engine start.	
237	23	7	START SWITCH LOCKED - SELECTED BEFORE KEYSWITCH	The Start Switch was closed during power-up.	The UGM shall prohibit Engine Start.
23163	23	163	FUNCTION PROBLEM - MSSO PERMANENTLY SELECTED	The MSSO switch input = Low at Startup.	No response required for this DTC Power Cycled.
240	**24**	**0**	**<<< OTHER CONTROLS >>>**		
241	24	1	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE LOW	MACHINE SETUP > TEMP CUTOUT = YES; Ambient Temperature sensor reading - 50C.	The UGM shall set Low Temperature Cutout state = Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; If the Machine is in Ground Mode; No response required for this DTC.
242	24	2	AMBIENT TEMPERATURE SENSOR - OUT OF RANGE HIGH	Ambient Temperature sensor reading ≥ 85C.	Check Ambient Temperature sensor reading < 85C.
250	**25**	**0**	**<<< FUNCTION PREVENTED >>>**		
259	25	9	MODEL CHANGED - HYDRAULICS SUSPENDED - CYCLE EMS	The model selection has been changed.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
2513	25	13	GENERATOR MOTION CUTOUT ACTIVE	Driving is not possible while the vehicle generator is running AND is configured to prevent drive.	The UGM shall not Enable the Machine.
2514	25	14	BOOM PREVENTED - DRIVE SELECTED	Boom functions are not possible while the vehicle is being driven AND is configured to not allow simultaneous drive & boom operation.	The UGM shall prohibit all boom functions.
2516	25	16	DRIVE PREVENTED - ABOVE ELEVATION	Driving is not possible while Boom functions are selected AND is configured to not allow simultaneous drive & boom operation.	The UGM shall prohibit Drive and Steer.
2517	25	17	DRIVE PREVENTED - TILTED & ABOVE ELEVATION	Driving is not possible while the vehicle is tilted and above elevation AND is configured to prevent drive while tilted and above elevation.	The UGM shall prohibit Drive and Steer.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
2518	25	18	DRIVE PREVENTED - BOOM SELECTED	MACHINE SETUP > FUNCTION CUTOUT = BOOM CUTOUT The boom is Above Elevation Any boom function is already active The operator attempts to activate Drive or Steer.	The UGM shall prohibit Drive and Steer.
2519	25	19	DRIVE PREVENTED - TILTED & EXTENDED OR HIGH ANGLE	Drive Selected while tilted and extended and tilt is configured to cutout drive.	
2520	25	20	FUNCTIONS LOCKED OUT - CONSTANT DATA VERSION IMPROPER		
2530	25	30	UMS SENSOR FORWARD LIMIT REACHED	The Upright angle relative to the turntable is less than -4.0 degree.	See Section 4.16 "UMS Troubleshooting and Diagnostic Trouble Codes (DTC)"
2531	25	31	UMS SENSOR OUT OF USABLE RANGE	Both the turntable tilt sensor and the UMS sensor read greater then +/-10 degree in the same direction.	See Section 4.16 "UMS Troubleshooting and Diagnostic Trouble Codes (DTC)"
2532	25	32	UMS SENSOR BACKWARD LIMIT REACHED	The Upright angle relative to the turntable is greater than +2.5 degree.	See Section 4.16 "UMS Troubleshooting and Diagnostic Trouble Codes (DTC)"
2563	25	63	SKYGUARD SWITCH - DISAGREEMENT	MACHINE SETUP > SKYGUARD = YES; Machine is in Platform Mode; [(SkyGuard input #1 Platform Module J7-18) ≠ (SkyGuard input #2 Platform Module J1-23)] > 160ms	Response detailed in SkyGuard section.
2568	25	68	TEMPERATURE CUTOUT ACTIVE - AMBIENT TEMPERATURE TOO LOW	Low Temperature Cutout = Active	If the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
2576	25	76	PLATFORM LEVEL PREVENTED - ABOVE ELEVATION	Platform Level Override Cutout = Enabled; The Platform Level Up or Down switch input = High; Footswitch is active.	The UGM shall suspend Platform Level Up and Down commands; The UGM shall prohibit Platform Level Up and Down
2577	25	77	DRIVE PREVENTED - START BATTERY CONNECTED	Start battery is connected	Check the battery.
330	**33**	**0**	**<<< GROUND OUTPUT DRIVER >>>**		
331	33	1	BRAKE - SHORT TO BATTERY	There is a Short to Battery to the Brake Valve.	Check Harness for damage.
332	33	2	BRAKE - OPEN CIRCUIT	There is an Open Circuit to the Brake Valve.	Check Harness for damage.
3311	33	11	GROUND ALARM - SHORT TO BATTERY	There is a Short to Battery to the Ground Alarm.	Ground Alarm equipped vehicles only.
3336	33	36	ALTERNATOR POWER - SHORT TO GROUND	There is a Short to Ground to the Alternator/ECM.	Check Harness for damage.
3340	33	40	AUX POWER - SHORT TO GROUND	There is a Short to Ground to the Auxiliary Power Pump Relay.	Check Harness for damage.
3341	33	41	AUX POWER - OPEN CIRCUIT	There is an Open Circuit to the Auxiliary Power Pump Relay.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3342	33	42	AUX POWER - SHORT TO BATTERY	There is a Short to Battery to the Auxiliary Power Pump Relay.	Check Harness for damage.
3346	33	46	ELECTRIC FAN - SHORT TO GROUND	There is a short to ground to the Electric Fan.	Check Harness for damage.
3347	33	47	ELECTRIC FAN - OPEN CIRCUIT	There is an Open Circuit to the Electric Fan.	Check Harness for damage.
3348	33	48	ELECTRIC FAN - SHORT TO BATTERY	There is a Short to Battery to the Electric Pump.	Check Harness for damage.
3349	33	49	ELECTRIC PUMP - SHORT TO GROUND	There is a Short to Ground to the Pump Relay.	Check Harness for damage.
3350	33	50	ELECTRIC PUMP - OPEN CIRCUIT	There is an Open Circuit to the Pump Relay.	Check Harness for damage.
3351	33	51	ELECTRIC PUMP - SHORT TO BATTERY	There is a Short to Battery to the Pump Relay.	Check Harness for damage.
3352	33	52	LP LOCK - SHORT TO GROUND	There is an Open Circuit to the LP Lock.	Check Harness for damage.
3353	33	53	LP LOCK - OPEN CIRCUIT	There is an Open Circuit to the LP Lock.	Check Harness for damage.
3354	33	54	LP LOCK - SHORT TO BATTERY	There is a short to Battery to the LP Lock.	Check Harness for damage.
3355	33	55	LP START ASSIST - SHORT TO GROUND	There is a short to ground to the LP Start Assist.	Check Harness for damage.
3356	33	56	LP START ASSIST - OPEN CIRCUIT	There is an Open Circuit to the LP Start Assist.	Check Harness for damage.
3357	33	57	LP START ASSIST - SHORT TO BATTERY	There is a short to battery to the LP Start Assist.	Check Harness for damage.
3358	33	58	MAIN DUMP VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Dump Valve.	Check Harness for damage.
3359	33	59	MAIN DUMP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Dump Valve.	Check Harness for damage.
3360	33	60	MAIN DUMP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Dump Valve.	Check Harness for damage.
3361	33	61	BRAKE - SHORT TO GROUND	There is a Short to Ground to the Brake Valve.	Check Harness for damage.
3362	33	62	START SOLENOID - SHORT TO GROUND	There is a Short to Ground to the Start Relay.	Check Harness for damage.
3363	33	63	START SOLENOID - OPEN CIRCUIT	There is an Open Circuit to the Start Relay.	Check Harness for damage.
3364	33	64	START SOLENOID - SHORT TO BATTERY	There is a Short to Battery to the Start Relay.	Check Harness for damage.
3365	33	65	STEER DUMP VALVE - SHORT TO GROUND	There is a Short to Ground to the Steer Dump Valve.	Check Harness for damage.
3366	33	66	STEER DUMP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Steer Dump Valve.	Check Harness for damage.
3367	33	67	STEER DUMP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Steer Dump Valve.	Check Harness for damage.
3368	33	68	TWO SPEED VALVE - SHORT TO GROUND	There is a Short to Ground to the Two Speed Valve.	Check Harness for damage.
3369	33	69	TWO SPEED VALVE - OPEN CIRCUIT	There is an Open Circuit to the Two Speed Valve.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3370	33	70	TWO SPEED VALVE - SHORT TO BATTERY	There is a Short to Battery to the Two Speed Valve.	Check Harness for damage.
3371	33	71	GROUND ALARM - SHORT TO GROUND	There is a Short to Ground to the Ground Alarm.	Check Harness for damage.
3372	33	72	GROUND ALARM - OPEN CIRCUIT	There is an Open Circuit to the Ground Alarm.	Check Harness for damage.
3373	33	73	GEN SET/WELDER - SHORT TO GROUND	There is a Short to Ground to the Generator Relay.	Check Harness for damage.
3374	33	74	GEN SET/WELDER - OPEN CIRCUIT	There is an Open Circuit to the Generator Relay.	Check Harness for damage.
3375	33	75	GEN SET/WELDER - SHORT TO BATTERY	There is a Short to Battery to the Generator Relay.	Check Harness for damage.
3376	33	76	HEAD TAIL LIGHT - SHORT TO GROUND	There is a Short to Ground to the Head Light Relay.	Check Harness for damage.
3377	33	77	HEAD TAIL LIGHT - OPEN CIRCUIT	There is an Open Circuit to the Head Light Relay.	Check Harness for damage.
3378	33	78	HEAD TAIL LIGHT - SHORT TO BATTERY	There is a Short to Battery to the Head Light Relay.	Check Harness for damage.
3379	33	79	HOUR METER - SHORT TO GROUND	There is a Short to Ground to the Hour Meter.	Check Harness for damage.
3382	33	82	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Valve	Check Harness for damage.
3383	33	83	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
3384	33	84	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Up Valve	Check Harness for damage.
3388	33	88	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Down Valve	Check Harness for damage.
3389	33	89	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
3390	33	90	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Down Valve	Check Harness for damage.
3394	33	94	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Left Valve.	Check Harness for damage.
3395	33	95	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Left Valve.	Check Harness for damage.
3396	33	96	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Left Valve.	Check Harness for damage.
3397	33	97	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Rotate Right Valve.	Check Harness for damage.
3398	33	98	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Right Valve.	Check Harness for damage.
3399	33	99	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Rotate Right Valve.	Check Harness for damage.
33100	33	100	JIB LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Up Valve.	Check Harness for damage.
33101	33	101	JIB LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Up Valve.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33102	33	102	JIB LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Up Valve.	Check Harness for damage.
33103	33	103	JIB LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Down Valve.	Check Harness for damage.
33104	33	104	JIB LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Down Valve.	Check Harness for damage.
33105	33	105	JIB LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Down Valve.	Check Harness for damage.
33106	33	106	TOWER LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift Up Valve.	Check Harness for damage.
33107	33	107	TOWER LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift Up Valve.	Check Harness for damage.
33108	33	108	TOWER LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift Up Valve.	Check Harness for damage.
33109	33	109	TOWER LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Lift Down Valve.	Check Harness for damage.
33110	33	110	TOWER LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Lift Down Valve.	Check Harness for damage.
33111	33	111	TOWER LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Lift Down Valve.	Check Harness for damage.
33112	33	112	TOWER TELESCOPE IN VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope In Valve.	Check Harness for damage.
33113	33	113	TOWER TELESCOPE IN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Tele-scope In Valve.	Check Harness for damage.
33114	33	114	TOWER TELESCOPE IN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope In Valve.	Check Harness for damage.
33115	33	115	TOWER TELESCOPE OUT VALVE - SHORT TO GROUND	There is a Short to Ground to the Tower Telescope Out Valve.	Check Harness for damage.
33116	33	116	TOWER TELESCOPE OUT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Tower Tele-scope Out Valve.	Check Harness for damage.
33117	33	117	TOWER TELESCOPE OUT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Tower Telescope Out Valve.	Check Harness for damage.
33118	33	118	SWING RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Right Valve.	Check Harness for damage.
33119	33	119	SWING RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Right Valve.	Check Harness for damage.
33120	33	120	TELESCOPE IN VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Tele-scope In Valve.	Check Harness for damage.
33121	33	121	SWING RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Swing Right Valve.	Check Harness for damage.
33122	33	122	SWING LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the Swing Left Valve.	Check Harness for damage.
33123	33	123	TELESCOPE OUT VALVE - SHORT TO BATTERY	There is a Short to Battery to the Main Tele-scope Out Valve.	Check Harness for damage.
33130	33	130	THROTTLE ACTUATOR - SHORT TO GROUND	There is a Short to Ground to the Throttle Actuator.	Check Harness for damage.
33131	33	131	THROTTLE ACTUATOR - OPEN CIRCUIT	There is an Open Circuit to the Throttle Actuator.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33132	33	132	THROTTLE ACTUATOR - SHORT TO BATTERY	There is a Short to Battery to the Throttle Actuator.	Check Harness for damage.
33170	33	170	LIFT DOWN VALVE - OPEN CIRCUIT	There is a Short to Ground to the Lift Down Valve.	Check Harness for damage.
33171	33	171	LIFT DOWN VALVE - SHORT TO BATTERY	There is an Open Circuit to the Lift Down Valve.	Check Harness for damage.
33172	33	172	LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Battery to the Lift Down Valve.	Check Harness for damage.
33175	33	175	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Left Valve.	Check Harness for damage.
33176	33	176	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Left Valve.	Check Harness for damage.
33177	33	177	JIB ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Left Valve.	Check Harness for damage.
33178	33	178	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Right Valve.	Check Harness for damage.
33179	33	179	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Right Valve.	Check Harness for damage.
33180	33	180	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Right Valve.	Check Harness for damage.
33182	33	182	LIFT VALVES - SHORT TO BATTERY	There is a Short to Battery to the Lift Valves.	Check Harness for damage.
33186	33	186	TELESCOPE OUT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope Out Valve.	Check Harness for damage.
33188	33	188	TELESCOPE OUT VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope Out Valve.	Check Harness for damage.
33189	33	189	TELESCOPE IN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Main Telescope In Valve.	Check Harness for damage.
33190	33	190	TELESCOPE IN VALVE - SHORT TO GROUND	There is a Short to Ground to the Main Telescope In Valve.	Check Harness for damage.
33207	33	207	HORN - OPEN CIRCUIT	There is an Open Circuit to the Horn.	Check Harness for damage.
33208	33	208	HORN - SHORT TO BATTERY	There is a Short to Battery to the Horn.	Check Harness for damage.
33209	33	209	HORN - SHORT TO GROUND	There is a Short to Ground to the Horn.	Check Harness for damage.
33279	33	279	GLOWPLUG - OPEN CIRCUIT	There is an Open Circuit to the Glow Plugs.	Check Harness for damage.
33280	33	280	GLOWPLUG - SHORT TO BATTERY	There is a Short to Battery to the Glow Plugs.	Check Harness for damage.
33281	33	281	GLOWPLUG - SHORT TO GROUND	There is a Short to Ground to the Glow Plugs.	Check Harness for damage.
33287	33	287	LIFT - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33295	33	295	SWING LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Swing Left Valve.	Check Harness for damage.
33306	33	306	SWING LEFT VALVE - SHORT TO BATTERY	There is short to Battery to the Swing Left Valve.	Check Harness for damage.
33314	33	314	FLOW CONTROL VALVE - OPEN CIRCUIT	There is an Open Circuit to the Flow Control Valve.	Check Harness for damage.
33315	33	315	FLOW CONTROL VALVE - SHORT TO BATTERY	There is short to Battery to the Flow Control Valve	Check Harness for damage.
33316	33	316	FLOW CONTROL VALVE - SHORT TO GROUND	There is short to Ground to the Flow Control Valve	Check Harness for damage.
33317	33	317	DRIVE FORWARD VALVE - OPEN CIRCUIT	There is an Open Circuit to the Drive Forward Valve.	Check Harness for damage.
33318	33	318	DRIVE FORWARD VALVE - SHORT TO BATTER	There is short to Battery to the Drive Forward Valve.	Check Harness for damage.
33319	33	319	DRIVE FORWARD VALVE - SHORT TO GROUND	There is short to Gropund to the Drive Forward Valve.	Check Harness for damage.
33320	33	320	DRIVE REVERSE VALVE - OPEN CIRCUIT	There is an Open Circuit to the Drive Reverse Valve.	Check Harness for damage.
33321	33	321	DRIVE REVERSE VALVE - SHORT TO BATTERY	There is a short to Battery to the Drive Reverse Valve.	Check Harness for damage.
33322	33	322	DRIVE REVERSE VALVE - SHORT TO GROUND	There is a short to Ground to the Drive Reverse Valve.	Check Harness for damage.
33323	33	323	LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Lift Up Valve.	Check Harness for damage.
33324	33	324	LIFT UP VALVE - SHORT TO BATTERY	There is a short to Battery to the Lift Up Valve.	Check Harness for damage.
33325	33	325	LIFT UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Lift Up Valve.	Check Harness for damage.
33331	33	331	DRIVE - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33410	33	410	DRIVE - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Drive Forward and Reverse command and revert to Open Current loop control for Drive; The UGM shall limit Drive Forward and Reverse to Creep speed after controls initialized
33412	33	412	SWING VALVES - SHORT TO BATTERY	There is a short to Battery to the Swing Valves.	Check Harness for damage.
33414	33	414	SWING - CURRENT FEEDBACK READING TOO LOW	Current feedback into controller is below threshold value.	Check wiring and coil.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
33415	33	415	FLOW CONTROL VALVE - CURRENT FEEDBACK READING TOO LOW	The Engine State = ENGINE RUNNING; The UGM commanded current > 250mA; The difference between the commanded current and the measured feedback current > [the larger of (125mA) or (15% of the commanded function Max)] for longer than 1 second.	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33417	33	417	LIFT - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output > 40% for a period of 100ms.	The UGM shall suspend Lift Up and Down command and revert to Open Loop Current control for Lift; The UGM shall limit Lift Up and Down to Creep speed after controls initialized.
33418	33	418	SWING - CURRENT FEEDBACK READING LOST	Current feedback into controller not detected.	Check wiring and coil.
33419	33	419	FLOW CONTROL VALVE - CURRENT FEEDBACK READING LOST	Measured feedback current < 225mA while PWM output >40% for a period of 100ms.	The UGM shall suspend Flow Control and revert to Open Current loop control for Flow Control.
33488	33	488	SWING FLOW CONTROL VALVE - SHORT TO GROUND	There is a short to the Ground to the Swing Flow Control Valve.	Check Harness for damage.
33575	33	575	ECM PULL DOWN RESISTOR - OPEN CIRCUIT	There is an Open Circuit to the ECM Pull Down Resistor.	Check Harness for damage.
340	**34**	**0**	**<<< PLATFORM OUTPUT DRIVER >>>**		
341	34	1	PLATFORM LEVEL UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
342	34	2	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the Platform Level Up Valve.	Check Harness for damage.
343	34	3	PLATFORM LEVEL UP VALVE - SHORT TO GROUND	There is a Short to Ground to the Platform Level Up Valve.	Check Harness for damage.
344	34	4	PLATFORM LEVEL UP VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Up Valve.	Check Harness for damage.
345	34	5	PLATFORM LEVEL DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
346	34	6	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Level Down Valve.	Check Harness for damage.
347	34	7	PLATFORM LEVEL DOWN VALVE - SHORT TO GROUND	There is a short to the Ground to the Platform Level Down Valve.	Check Harness for damage.
348	34	8	PLATFORM LEVEL DOWN VALVE - SHORT TO BATTERY OR OPEN CIRCUIT	There is a Short to Battery or an Open Circuit to the Platform Level Down Valve.	Check Harness for damage.
349	34	9	PLATFORM ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Left Valve.	Check Harness for damage.
3410	34	10	PLATFORM ROTATE LEFT VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Rotate Left Valve.	Check Harness for damage.
3411	34	11	PLATFORM ROTATE LEFT VALVE - SHORT TO GROUND	There is a short to Ground to the Platform Rotate Left Valve.	Check Harness for damage.
3412	34	12	PLATFORM ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the Platform Rotate Right Valve.	Check Harness for damage.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
3413	34	13	PLATFORM ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a short to Battery to the Platform Rotate Right Valve.	Check Harness for damage.
3414	34	14	PLATFORM ROTATE RIGHT VALVE - SHORT TO GROUND	There is a short to Ground to the Platform Rotate Right Valve.	Check Harness for damage.
3415	34	15	JIB LIFT UP VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Up Valve.	Check Harness for damage.
3416	34	16	JIB LIFT UP VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Up Valve.	Check Harness for damage.
3417	34	17	JIB LIFT UP VALVE - SHORT TO GROUND	There is a short to Ground to the JIB Lift Up Valve.	Check Harness for damage.
3418	34	18	JIB LIFT DOWN VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Lift Down Valve.	Check Harness for damage.
3419	34	19	JIB LIFT DOWN VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Lift Down Valve.	Check Harness for damage.
3420	34	20	JIB LIFT DOWN VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Lift Down Valve.	Check Harness for damage.
3421	34	21	JIB ROTATE LEFT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Left Valve.	Check Harness for damage.
3422	34	22	JIB ROTATE LEFT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Left Valve.	Check Harness for damage.
3423	34	23	JIB ROTATE LEFT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Left Valve.	Check Harness for damage.
3424	34	24	JIB ROTATE RIGHT VALVE - OPEN CIRCUIT	There is an Open Circuit to the JIB Rotate Right Valve.	Check Harness for damage.
3425	34	25	JIB ROTATE RIGHT VALVE - SHORT TO BATTERY	There is a Short to Battery to the JIB Rotate Right Valve.	Check Harness for damage.
3426	34	26	JIB ROTATE RIGHT VALVE - SHORT TO GROUND	There is a Short to Ground to the JIB Rotate Right Valve.	Check Harness for damage.
430	**43**	**0**	**<<< ENGINE >>>**		
431	43	1	FUEL SENSOR - SHORT TO BATTERY OR OPEN CIRCUIT	The Fuel Sensor reading is > 4.3V.	Energize fuel sensor per System Indicators
432	43	2	FUEL SENSOR - SHORT TO GROUND	The Fuel Sensor reading is < 0.2V.	Energize fuel sensor per System Indicators
433	43	3	OIL PRESSURE - SHORT TO BATTERY	The Oil Pressure Sensor reading is > 6.6V.	Deutz engine only.
434	43	4	OIL PRESSURE - SHORT TO GROUND	The Oil Pressure Sensor reading is < 0.1V for more then 5 seconds.	Deutz engine only. - Not reported during engine start.
435	43	5	COOLANT TEMPERATURE - SHORT TO GROUND	The Coolant Temperature Sensor reading is < 0.1V.	Deutz engine only.
436	43	6	FORD FAULT CODE ##	All ford fault codes except 63 are simply passed through from the Ford ECM. They only occur if a Ford Engine is selected in the machine configuration digits. Can be reported during power-up sequence.	

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
437	43	7	ENGINE TROUBLE CODE	Displays engine SPN FMI code.	Report and log in Help If [(MACHINE SETUP > DEUTZ EMR2) or (MACHINE SETUP > DEUTZ EMR4) and SPN:FMI = 535:7], prohibit engine cranking.
438	43	8	HIGH ENGINE TEMP	(Ford engine only) The engine temperature is > 117 C. (Deutz engine only) The engine temperature is > 130 C.	Ford / Deutz engine only.
439	43	9	AIR FILTER BYPASSED	The Air Filter is clogged.	Check Airfilter for clogging
4310	43	10	NO ALTERNATOR OUTPUT	Battery voltage is < 11.5 volts for more then 15 seconds after engine start.	Activate the No Charge indicator J4-26 per System Indicators.
4311	43	11	LOW OIL PRESSURE	(Ford engine only) The ECM has reported a low oil pressure fault. (Deutz engine only) Oil pressure is < 8 PSI for more then 10 seconds after engine start.	Ford / Deutz engine only.
4312	43	12	485 COMMUNICATIONS LOST	This fault only occurs with a Ford Engine. It occures when no response are received from the ECM for 2.5 seconds. Can be reported during power-up sequence.	
4313	43	13	THROTTLE ACTUATOR FAILURE	The engine RPM is > XXX for more then XX seconds.	
4314	43	14	WRONG ENGINE SELECTED - ECM DETECTED	A ECM was detected with a non- ECM type engine selected.	
4322	43	22	LOSS OF ENGINE SPEED SENSOR	The engine RPM sensor indicates 0 RPM AND the Oil Pressure Sensor indicates > 8 PSI for three seconds.	Diesel engine only.
4323	43	23	SPEED SENSOR READING INVALID SPEED	The engine RPM sensor indicates > 4000 RPM.	Diesel engine only.
4331	43	31	SOOT LOAD WARNING - LOW	SPN/FMI 3719 / 16 3703 / 31	Check Engine.
4332	43	32	SOOT LOAD WARNING - HIGH	SPN/FMI 3719 / 0 3714 / 31	Check Engine.
4333	43	33	SOOT LOAD WARNING - SEVERE	SPN/FMI 3715 / 31	Check Engine.
4334	43	34	ENGINE COOLANT - LOW LEVEL	MACHINE SETUP > ENGINE = DEUTZ EMR4; ECM transmits a J1939 DM1 message for an engine coolant low level fault (SPN:FMI 111:1) on CAN2 or uses the J1939 Transport Protocol every one second to send this information if multiple engine faults exist.	MACHINE SETUP > ENGINE SHUTDOWN = ENABLED then shutdown the engine; Activate High Engine Temperature indicator J4-28.
440	**44**	**0**	**<<< BATTERY SUPPLY >>>**		
441	44	1	BATTERY VOLTAGE TOO LOW - SYSTEM SHUTDOWN	Battery voltage is < 9V.	
442	44	2	BATTERY VOLTAGE TOO HIGH - SYSTEM SHUTDOWN	Battery voltage is > 16V.	
445	44	5	BATTERY VOLTAGE LOW	Battery voltage is < 11V for more then 5 seconds.	

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
660	**66**	**0**	**<<<COMMUNICATION>>>**		
662	66	2	CANBUS FAILURE - PLATFORM MODULE	Platform Module CAN communication lost.	
664	66	4	CANBUS FAILURE - ACCESSORY MODULE	The accessory module is not receiving CAN messages. This is probably due to wiring problem.	Check the Wiring.
666	66	6	CANBUS FAILURE - ENGINE CONTROLLER	Engine Control Module CAN	ECM equipped engine only.
6620	66	20	CANBUS FAILURE - UMS SENSOR	communication lost.	
6622	66	22	CANBUS FAILURE - TCU MODULE	Machine Setup/Telematics=YES, No device heartbeat for 30 sec	
6623	66	23	CANBUS FAILURE - GATEWAY MODULE	Machine Setup/Telematics=YES, No device heartbeat for 30 sec	
6629	66	29	CANBUS FAILURE - TELEMATICS CANBUS LOADING TOO HIGH		
6657	66	57	CANBUS FAILURE - TEMPERATURE SENSOR	MACHINE SETUP > TEMP CUTOUT=YES; UGM does not receive any CAN messages from the Ambient Temperature sensor in 250ms	The UGM shall set Low Temperature Cutout state= Faulty If the Machine is in Platform Mode and if the Boom is Above Elevation; The UGM shall suspend motion; The UGM shall limit the machine to Creep speed after controls initialized If the Machine is in Platform Mode and if the Boom is not Above Elevation.
671	67	1	ACCESSORY FAULT		
680	**68**	**0**	**<<<TELEMATICS>>>**		
681	68	1	REMOTE CONTRACT MANAGEMENT OVERRIDE - ALL FUNCTIONS IN CREEP		
810	**81**	**0**	**<<<TILT SENSOR>>>**		
813	81	3	CHASSIS TILT SENSOR NOT CALIBRATED	The Chassis Tilt Sensor has not been calibrated.	
815	81	5	CHASSIS TILT SENSOR DISAGREEMENT		
816	81	6	UMS SENSOR NOT CALIBRATED	The Control System detects a sensor out of range condition or a not calibrated fault with UMS angle sensor	
817	81	7	UMS SENSOR FAULT	The system detects that the UMS sensor frequency outside the 100Hz+/- 5Hz range or the duty cycle is outside 50% +/- 21% Range	
820	**82**	**0**	**<<<PLATFORM LOAD SENSE>>>**		
825	82	5	LSS HAS NOT BEEN CALIBRATED	The Load Sensing System Module has not been calibrated.	UGM to set Platform Load State=Overloaded

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
826	82	6	RUNNING AT CREEP - PLATFORM OVERLOADED	All functions at creep, the Load Sensing System indicates the Platform is overloaded AND is configured to warn only while the Platform is overloaded.	
827	82	7	DRIVE & BOOM PREVENTED - PLATFORM OVERLOADED	Driving and boom functions are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent drive and boom functions while the Platform is overloaded.	
828	82	8	LIFT UP & TELE OUT PREVENTED - PLATFORM OVERLOADED	Lift up and telescope out are not possible while the Load Sensing System indicates the Platform is overloaded AND is configured to prevent Lift up and telescope out while the Platform is overloaded.	
8639	86	39	FRONT LEFT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Front Left Steer Valve	Check Harness for damage.
8640	86	40	FRONT LEFT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Front Left Steer Valve	Check Harness for damage.
8641	86	41	FRONT LEFT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Front Left Steer Valve	Check Harness for damage.
8642	86	42	FRONT RIGHT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Front Right Steer Valve	Check Harness for damage.
8643	86	43	FRONT RIGHT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Front Right Steer Valve	Check Harness for damage.
8644	86	44	FRONT RIGHT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Front Right Steer Valve	Check Harness for damage.
8645	86	45	REAR LEFT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Rear Left Steer Valve	Check Harness for damage.
8646	86	46	REAR LEFT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Rear Left Steer Valve	Check Harness for damage.
8647	86	47	REAR LEFT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Rear Left Steer Valve	Check Harness for damage.
8648	86	48	REAR RIGHT STEER VALVE - OPEN CIRCUIT	There is an open circuit to the Rear Right Steer Valve	Check Harness for damage.
8649	86	49	REAR RIGHT STEER VALVE - SHORT TO BATTERY	There is a short to Battery to the Rear Right Steer Valve	Check Harness for damage.
8650	86	50	REAR RIGHT STEER VALVE - SHORT TO GROUND	There is a short to Ground to the Rear Right Steer Valve	Check Harness for damage.
871	87	1	RETURN FILTER BYPASSED	Hydraulic Return Filter Clogged	Check Hydraulic Return Filter.
872	87	2	CHARGE PUMP FILTER BYPASSED	Charge Pump Filter Clogged	Check Charge Pump Filter.
873	87	3	MACHINE SAFETY SYSTEM OVERRIDE OCCURRED	MSSO = Active	Response described in MSSO Influence on Machine Operation section.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
998	99	8	EEPROM FAILURE - CHECK ALL SETTINGS	The Ground Module has reported an EEPROM failure.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start); reset the section of EEPROM where the failure occurred to defaults.
9910	99	10	FUNCTIONS LOCKED OUT - PLATFORM MODULE SOFTWARE VERSION IMPROPER	The Platform Module software version is not compatible with the rest of the system.	Activate the platform alarm continuously Creep mode is active If Platform Mode is active, disable all Drive, Steer, and Boom functions and do not permit Machine Enable.
9914	99	14	PLATFORM MODULE SOFTWARE UPDATE REQUIRED	The Platform Module software requires an update.	
9915	99	15	CHASSIS TILT SENSOR NOT GAIN CALIBRATED	The Chassis Tilt Sensor gain calibration has been lost.	
9916	99	16	CHASSIS TILT SENSOR GAIN OUT OF RANGE	The Chassis Tilt Sensor gain calibration has become corrupted.	
9919	99	19	GROUND SENSOR REF VOLTAGE OUT OF RANGE	The Ground Module has reported that its sensor reference voltage is outside acceptable range.	Not reported during power-up.
9920	99	20	PLATFORM SENSOR REF VOLTAGE OUT OF RANGE	The Platform Module has reported that its sensor reference voltage is outside acceptable range.	Not reported during power-up.
9921	99	21	GROUND MODULE FAILURE - HIGH SIDE DRIVER CUTOUT FAULTY	The Ground Module has reported that its high side driver cutout failed.	
9922	99	22	PLATFORM MODULE FAILURE - HWFS CODE 1	The Platform Module has reported that the V(Low) FET has failed.	
9923	99	23	GROUND MODULE FAILURE - HWFS CODE 1	The Ground Module has reported that the V(Low) FET has failed.	
9924	99	24	FUNCTIONS LOCKED OUT - MACHINE NOT CONFIGURED	The machine is powered up and no model has been selected yet in the MACHINE SETUP menu	Display ??? or NO MODEL at Analyzer MACHINE SETUP menu MACHINE SETUP->MODEL NUMBER Do not report any other faults Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).
9944	99	44	CURRENT FEEDBACK GAINS OUT OF RANGE	The factory set current feedback gains are out of range.	A gain of 1 is used for the factory gain(s) that was out of range; all functions shall be placed in Creep mode.

Table 6-11. Diagnostic Trouble Code Chart

DTC	Flash Code	Sequence	Fault Message	Fault Description	Check
9945	99	45	CURRENT FEEDBACK CALIBRATION CHECKSUM INCORRECT	The factory set current feedback checksum is not correct.	
9979	99	79	FUNCTIONS LOCKED OUT - GROUND MODULE SOFTWARE VERSION IMPROPER	Temporary fault for the telematics project. The model needs to be a 600S or 1350S if not this fault will be generated and Platform controls will be prevented. This fault was to ensure that the software will only work for these two models.	Disable all machine and engine functions (i.e., command engine shutdown and do not permit start).

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.

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

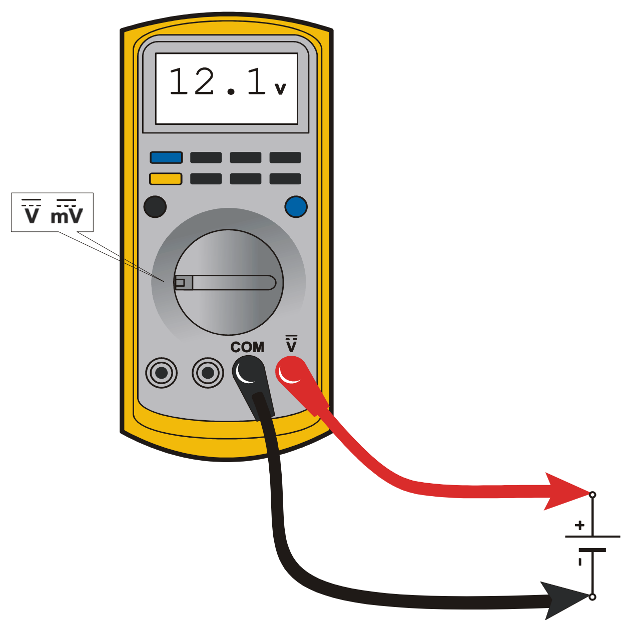


Figure 7-1. Voltage Measurement (DC)

- 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

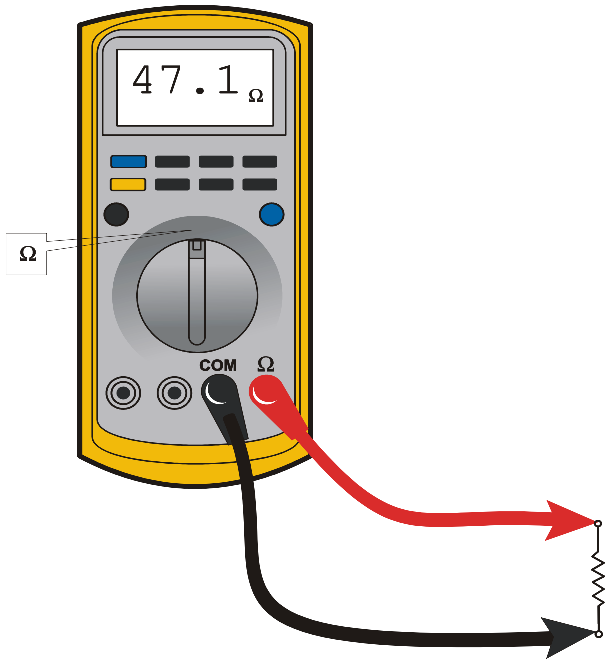


Figure 7-2. Resistance Measurement

- 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

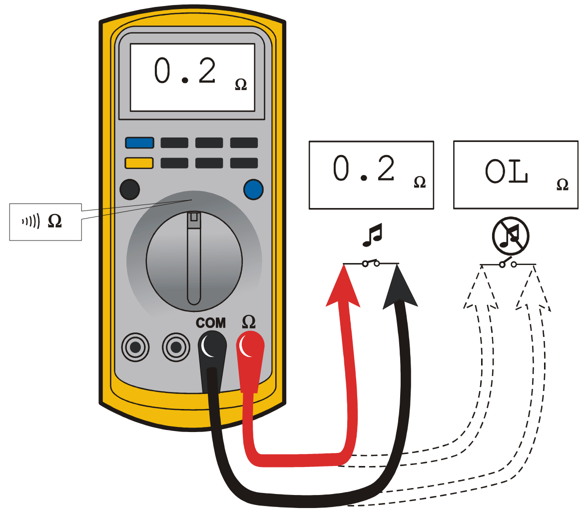


Figure 7-3. Continuity Measurement

- 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

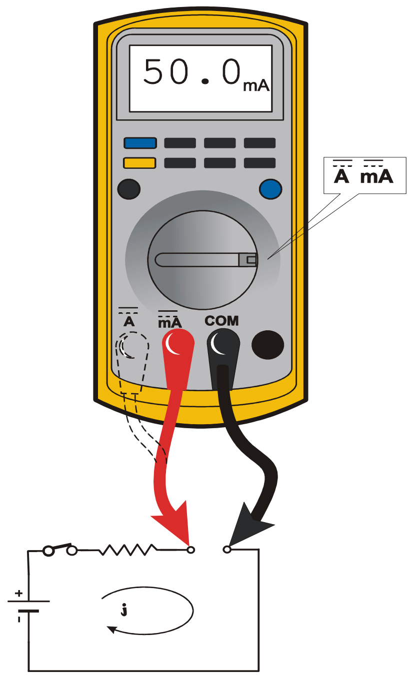


Figure 7-4. Current Measurement (DC)

- 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).

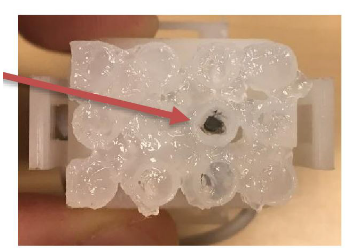
Installation of Dielectric Grease

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

1. Use dielectric grease in a tube for larger connection points or apply with a syringe for small connectors.
2. Apply dielectric grease to plug/male connector housing which typically contains sockets contact/female terminals (fill it approximately ½ full; see example below).
3. Leave a thin layer of dielectric grease on the face of the connector
4. Assemble the connector system immediately to prevent moisture ingress or dust contamination

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



Improper

Proper

AMP Faston

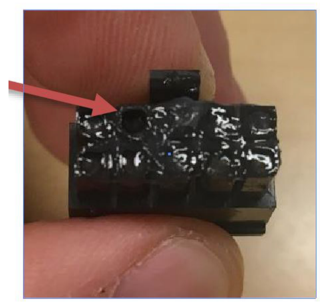
This connector system is typically used on operator switches at JLG. Follow the general guidance for installation.

Improper

Proper

AMP Micro-Fit

This connector system is typically used on control modules at JLG. Follow the general guidance for installation.

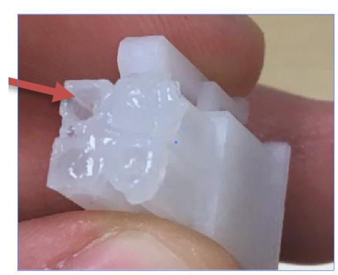


Improper

Proper

AMP Mini Fit Jr

This connector system is typically used on control modules at JLG. Follow the general guidance for installation.

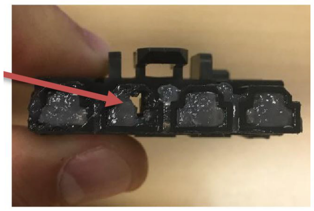


Improper

Proper

Mini Fit Sr

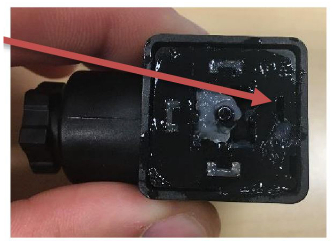
This connector system is typically used on control modules at JLG. Follow the general guidance for installation.


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

Applying Silicone Dielectric Compound to AMP Connectors

Silicone Dielectric Compound must be used on the AMP connections for the following reasons:

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

Use the following procedure to apply Silicone Dielectric Compound to the electrical connectors.

1. To prevent oxidation and low level conductivity, silicone dielectric grease must be packed completely around male and female pins on the inside of the connector after the mating of the housing to the header. This is easily achieved by using a syringe to fill the header with silicone dielectric compound, to a point just above the top of the male pins inside the header. When assembling the housing to the header, it is possible that the housing will become air locked, thus preventing the housing latch from engaging.
2. Pierce one of the unused wire seals to allow the trapped air inside the housing to escape.
3. Install a hole plug into this and/or any unused wire seal that has silicone dielectric compound escaping from it.

Assembly

Check to be sure the wedge lock is in the open, or as-shipped, position (See Figure 7-5.). Proceed as follows:

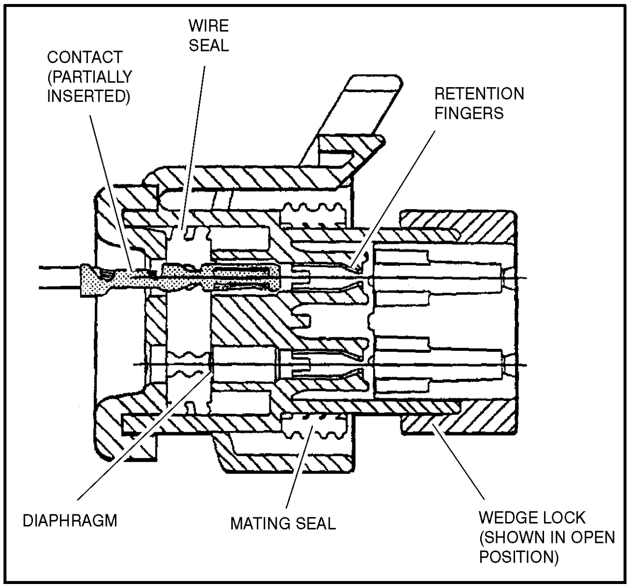


Figure 7-5. Connector Assembly Figure 1

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 lb to be sure the retention fingers are holding the contact (See Figure 7-7.).

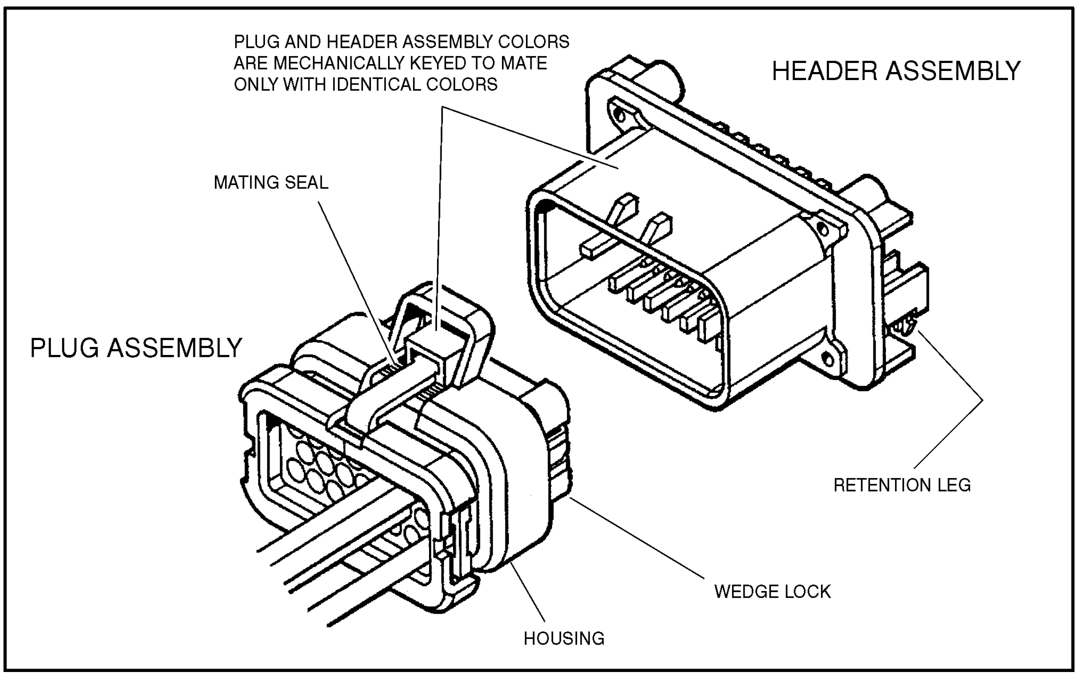


Figure 7-6. AMP Connector

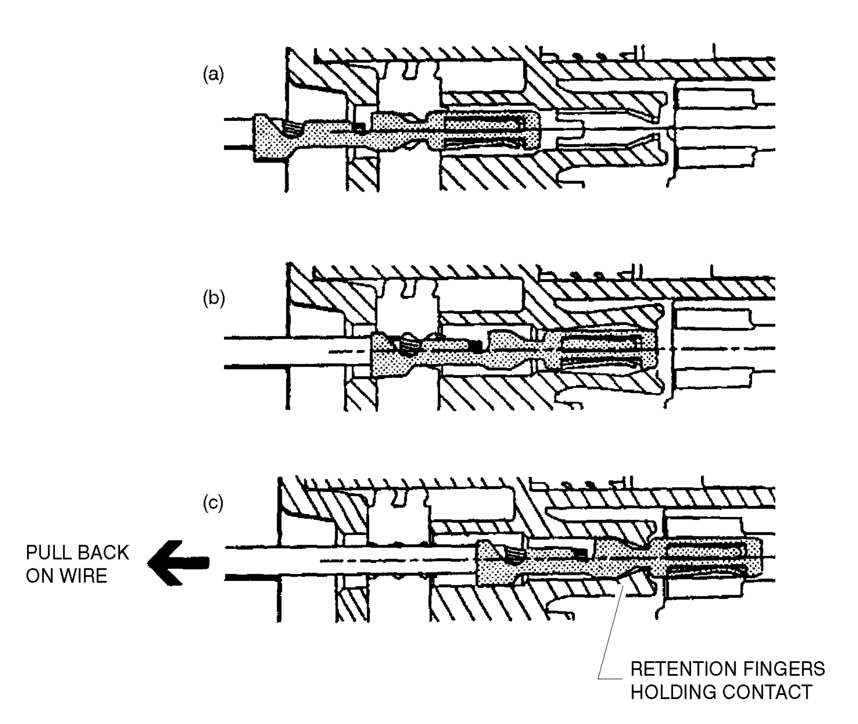


Figure 7-7. Connector Assembly Figure 2

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.).

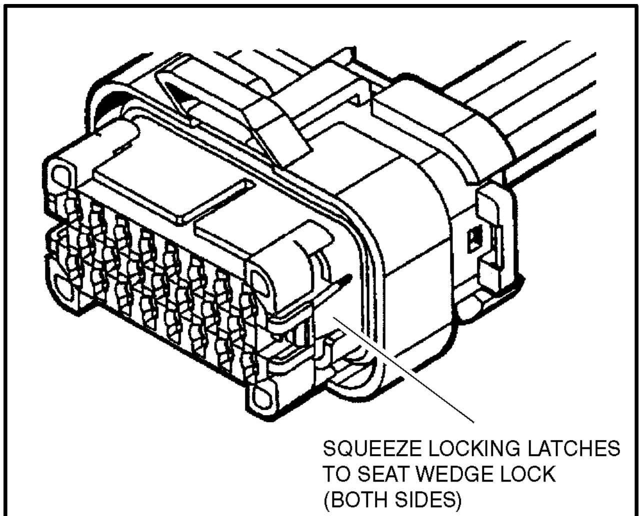


Figure 7-8. Connector Assembly Figure 3

4. Slide the wedge lock into the housing until it is flush with the housing (See Figure 7-9.).

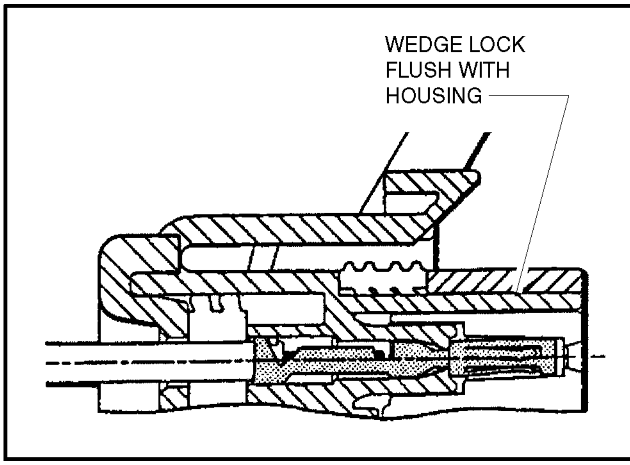


Figure 7-9. Connector Assembly Figure 4

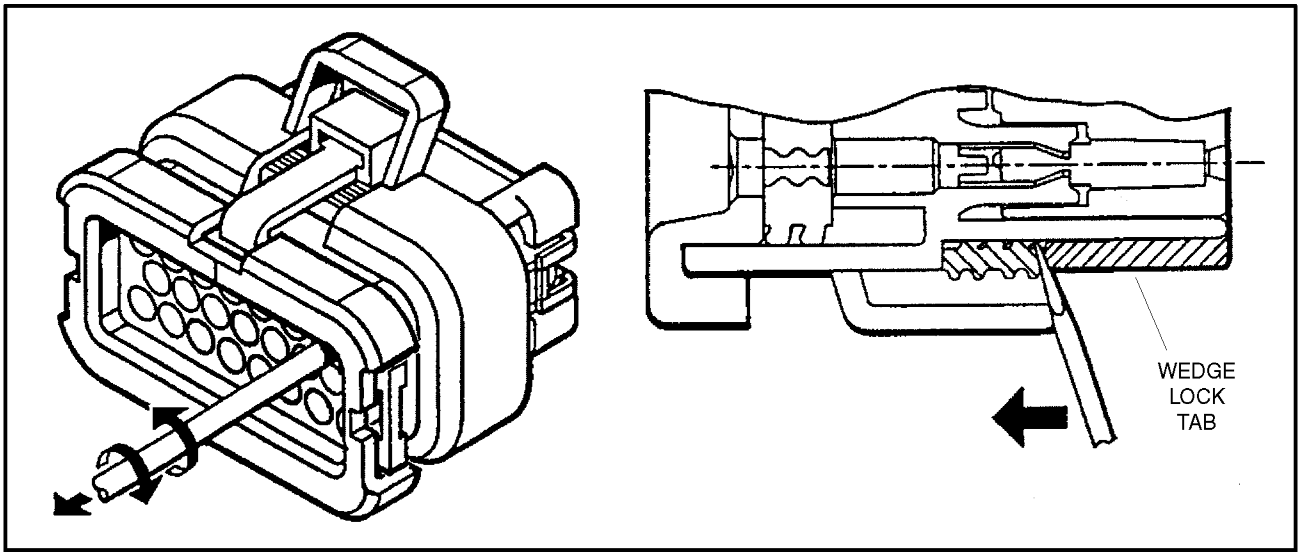


Figure 7-10. Connector Disassembly

Disassembly

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

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

Wedge Lock

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

Service - Voltage Reading

NOTICE

DO NOT PIERCE WIRE INSULATION TO TAKE VOLTAGE READINGS.

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice should be discouraged when dealing with the 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.

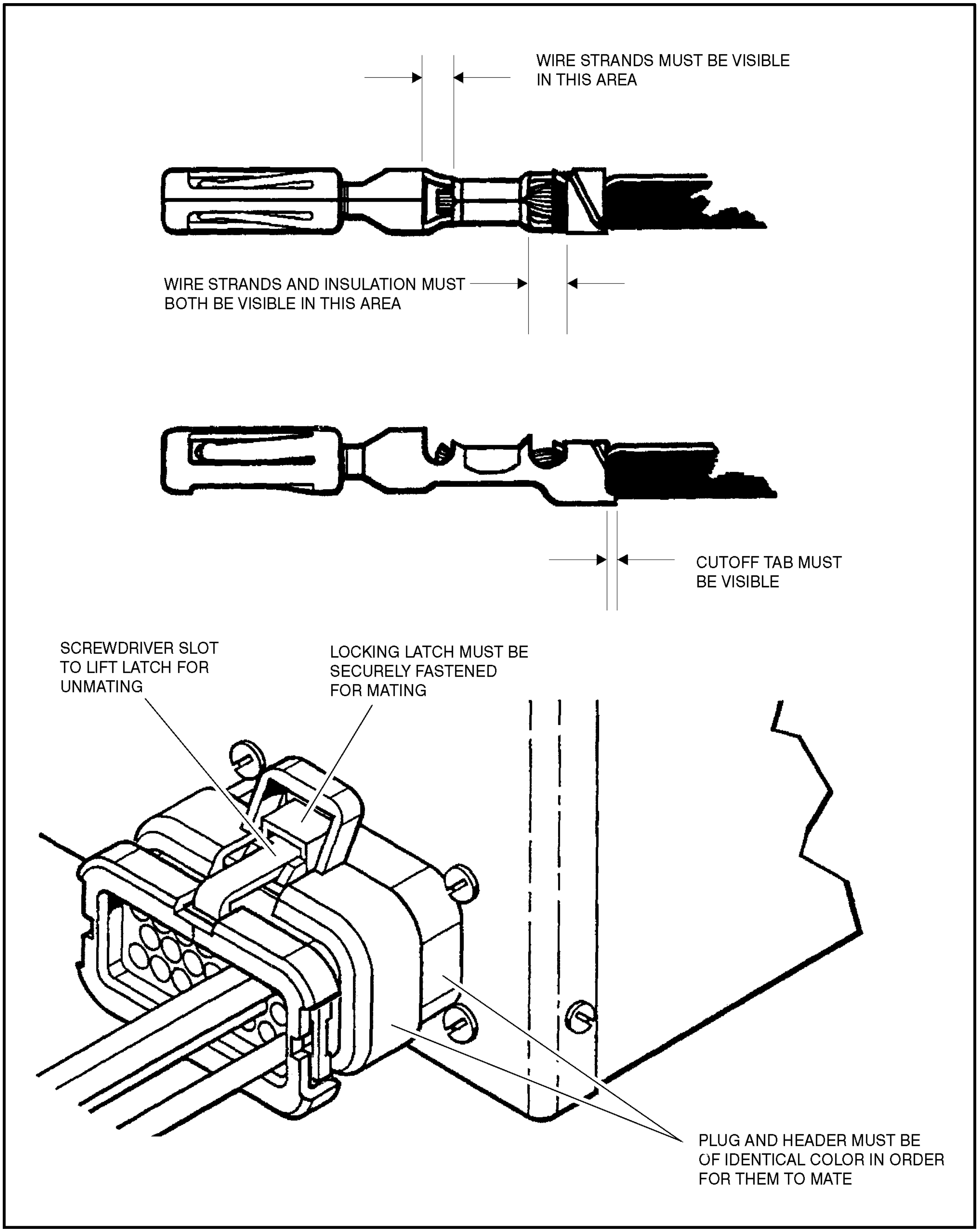
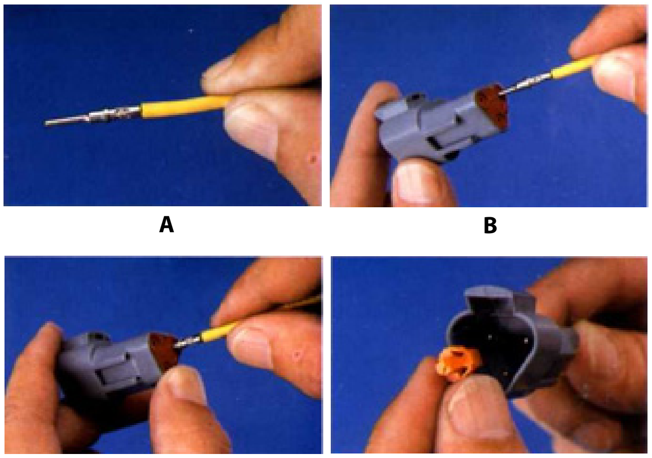


Figure 7-11. Connector Installation

7.5 DEUTSCH CONNECTORS

DT/DTP Series Assembly



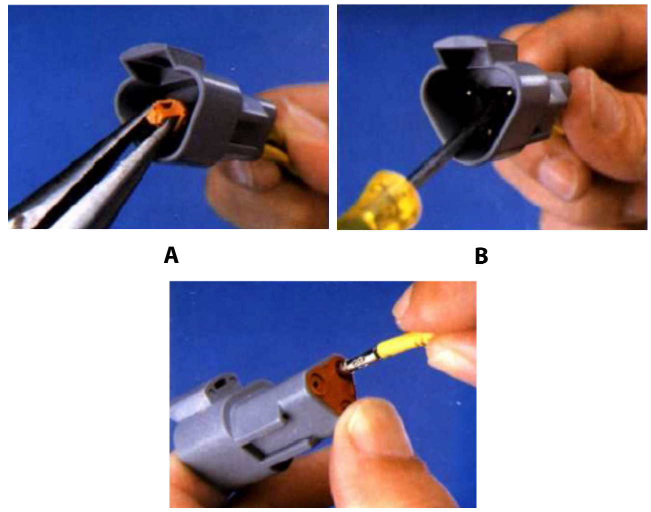
A B C D

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



A B C

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

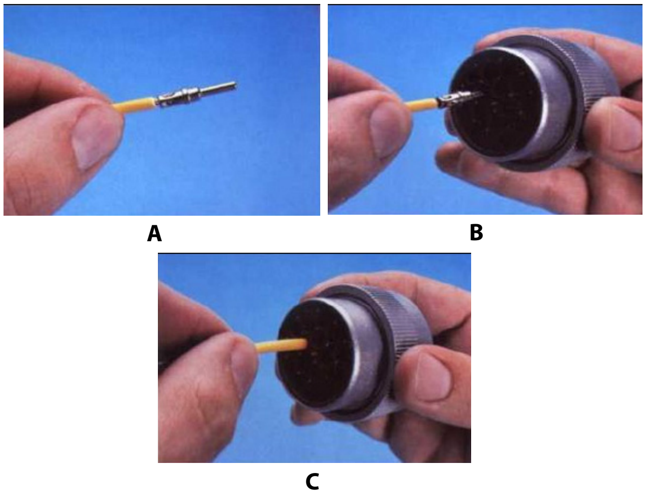


Figure 7-14. HD/HDP Contact Installation

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.

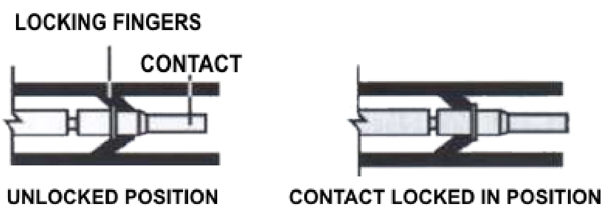


Figure 7-15. HD/HDP Locking Contacts into Position

NOTE: *For unused wire cavities, insert sealing plugs for full environmental sealing.*

HD30/HDP20 Series Disassembly

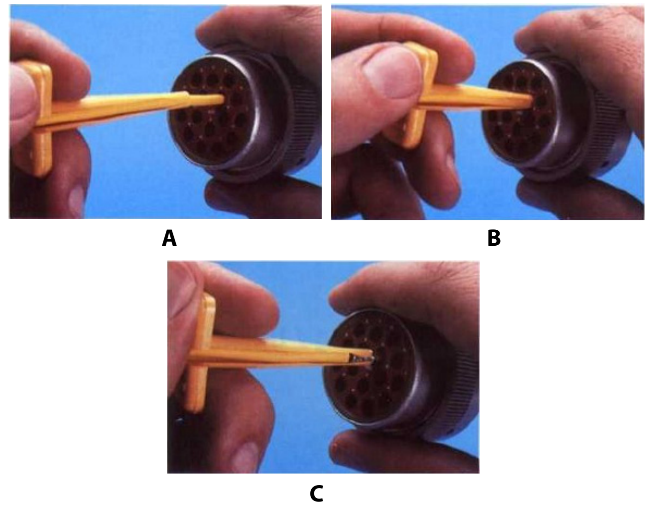


Figure 7-16. HD/HDP Contact Removal

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.

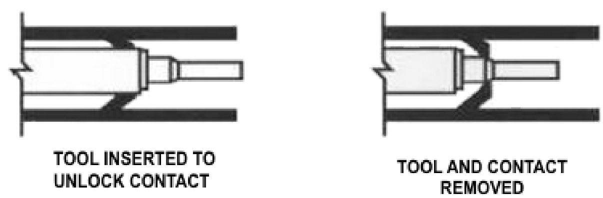


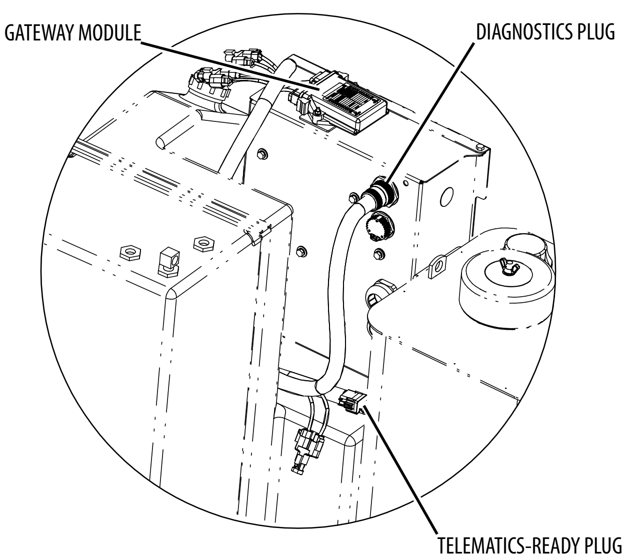
Figure 7-17. HD/HDP Unlocking Contacts

NOTE: *Do Not twist or insert tool at an angle.*

7.6 TELEMATICS GATEWAY

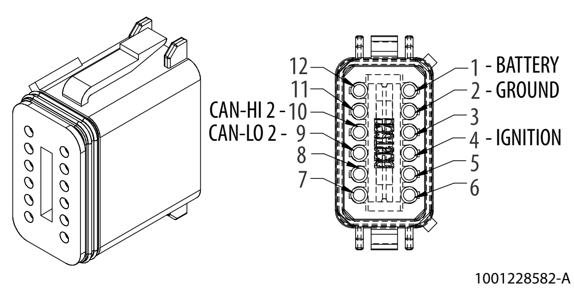
Personnel using machines equipped with an optional telematics gateway will be able to view the following data through their telematics device:

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:



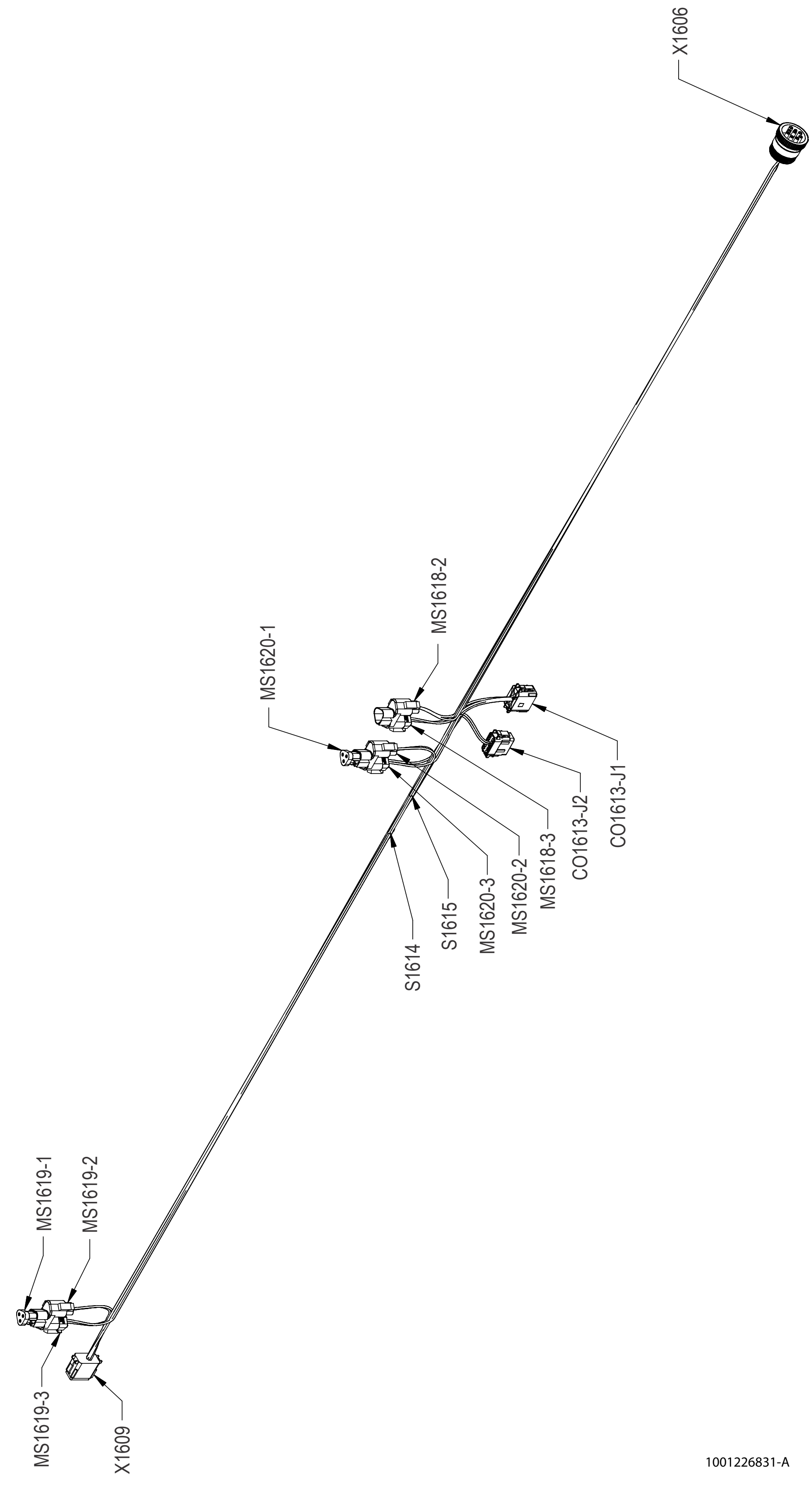


Figure 7-18. Telematics Gateway Harness - Sheet 1 of 3

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

Figure 7-21. Rotary Angle Sensor Cable

SN471 MAIN BOOM ANGLE SENSOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
A	BLK/RED	000-40-78 GND	18 AWG	TFFN	S295 (2)
B	ORN/BLK	4-106 PWR 5V	18 AWG	TFFN	S294 (2)
C	BLU/BLK	4-86 BM ANGLE SEN 1	18 AWG	TFFN	OPTI (10)
D	BLU/RED	4-87 BM ANGLE SEN 2	18 AWG	TFFN	OPT I (8)
E	BRN/BLK	000-40-79 GND	18 AWG	TFFN	S295 (2)
F	YEL/BLK	4-112 PWR 5V	18 AWG	TFFN	S294 (2)

S294					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
I	WHT	4-118 PWR 5V	18 AWG	GXL	OPTI (9)
2	ORN/BLK	4-106 PWR 5V	18 AWG	TFFN	SN471 (B)
2	YEL/BLK	4-112 PWR 5V	18 AWG	TFFN	SN471 (F)

S295					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
I	BLK	000-40-76 GND	18 AWG	GXL	OPTI (7)
2	BLK/RED	000-40-78 GND	18 AWG	TFFN	SN471 (A)
2	BRN/BLK	000-40-79 GND	18 AWG	TFFN	SN471 (E)

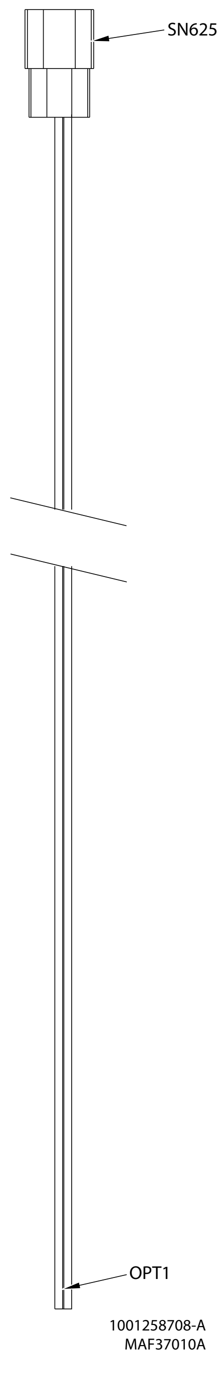


Figure 7-22. Transport Proximity Sensor Cable

X625 TRANSPORT PROX SENSOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	RED	1	18 AWG	TFFN	OPTI (13)
2	WHT	3	18 AWG	TFFN	OPTI (12)
3	BLK	2	18 AWG	TFFN	OPTI (11)

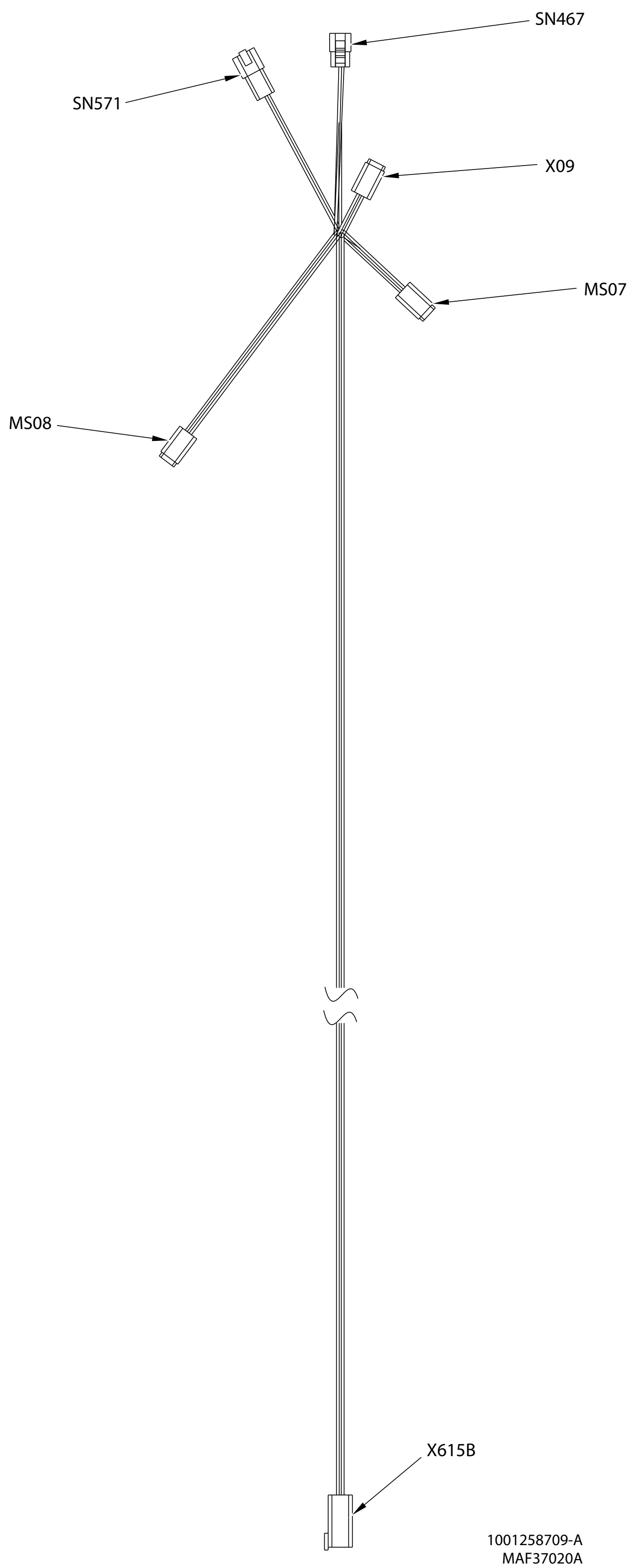


Figure 7-23. Mid Upper Boom Proximity Sensor Cable

X09 TO FULL EXTENSION					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	4	18 AWG	GXL	MS07 (2)
2	ORG-BL	110	18 AWG	TFFN	X615B (4)
3	BLK	2	18 AWG	GXL	MS08 (2)
4	YEL	3	18 AWG	GXL	MS07 (1)
5	BLK-RE	112	18 AWG	TFFN	X615B (5)
6	BLK	1	18 AWG	GXL	MS08 (1)

SN467 CAPACITY LENGTH NO 1					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	8	18 AWG	GXL	MS07 (5)
2	BLU-RED	111	18 AWG	TFFN	X615B (6)
3	BLK	6	18 AWG	GXL	MS08 (5)

SN571 CAPACITY LENGTH NO 2					
CONN POS	WIRECO LOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	7	18 AWG	GXL	MS07 (4)
2	BLU-BLK	114	18 AWG	TFFN	X615B (3)
3	BLK	5	18 AWG	GXL	MS08 (4)

MS07 PWR BUSS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL	3	18 AWG	GXL	X09 (4)
2	YEL	4	18 AWG	GXL	X09 (1)
3	YEL-BLK	113	18 AWG	TFFN	X615B (1)
4	YEL	7	18 AWG	GXL	SN571 (1)
5	YEL	8	18 AWG	GXL	SN467 (1)
6					

MS08 GND BUSS					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLK	1	18 AWG	GXL	X09 (6)
2	BLK	2	18 AWG	GXL	X09 (3)
3	BRN-BLK	115	18 AWG	TFFN	X615B (2)
4	BLK	5	18 AWG	GXL	SN571 (3)
5	BLK	6	18 AWG	GXL	SN467 (3)
6					

X615B CAP LENGTH PROX SENSOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL-BLK	113	18 AWG	TFFN	MS07 (3)
2	BRN-BLK	115	18 AWG	TFFN	MS08 (3)
3	BLU-BLK	114	18 AWG	TFFN	SN571 (2)
4	ORG-BLK	110	18 AWG	TFFN	X09 (2)
5	BLK-RED	112	18 AWG	TFFN	X09 (5)
6	BLU-RED	111	18 AWG	TFFN	SN467 (2)

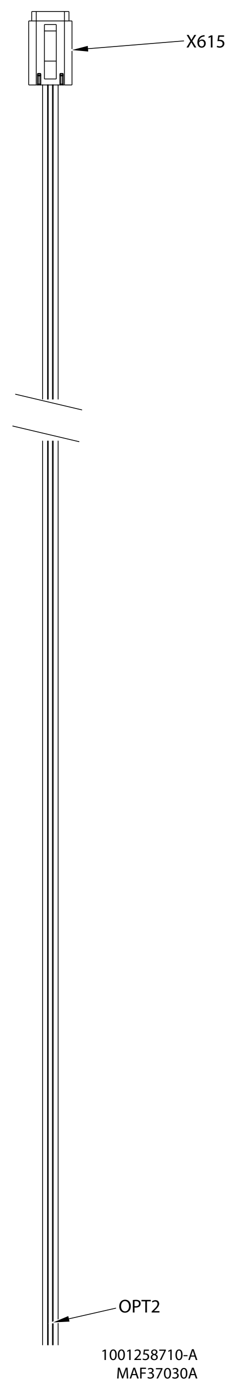


Figure 7-24. Mid Lower Boom Proximity Sensor Cable

X615B CAP LENGTH PROX SENSOR					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL-BLK	113	18 AWG	TFFN	OPT2 (11)
2	BRN-BLK	115	18 AWG	TFFN	OPT2 (14)
3	BLU-BLK	114	18 AWG	TFFN	OPT2 (8)
4	ORG-BLK	110	18 AWG	TFFN	OPT2 (9)
5	BLK-RED	112	18 AWG	TFFN	OPT2 (10)
6	BLU-RED	111	18 AWG	TFFN	OPT2 (7)

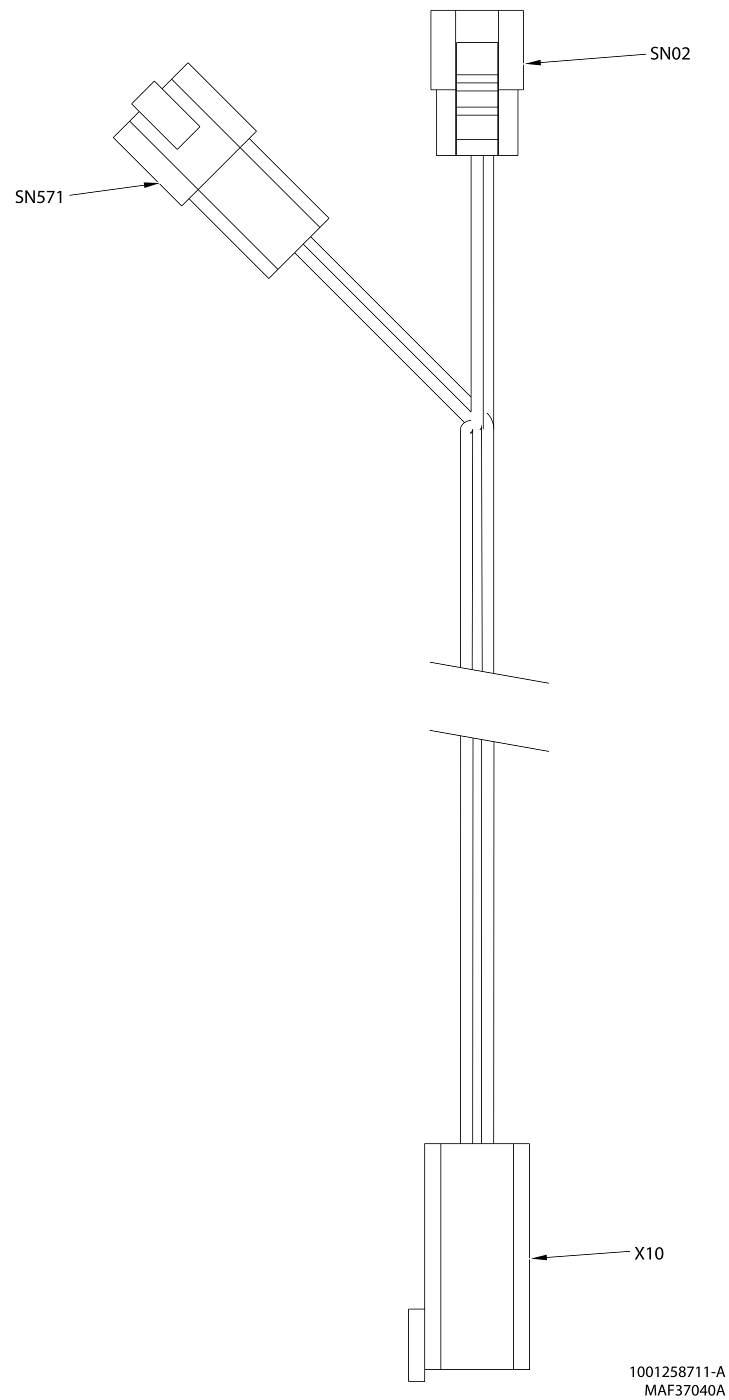


Figure 7-25. Full Extension Proximity Sensor Cable

SN02 CAPACITY LENGTH NO 1					
CONN POS	WIRE COLOR	WIRELABEL	GAUGE	JACKET	TO
1	YEL-BLK	1	18 AWG	TFFN	XIO (1)
2	ORG-BLK	2	18 AWG	TFFN	XIO (2)
3	BRN-BLK	3	18 AWG	TFFN	XIO (3)

SN571 CAPACITY LENGTH NO 2					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	BLU-RED	4	18 AWG	TFFN	XIO (4)
2	BLK-RED	5	18 AWG	TFFN	XIO (5)
3	BLU-BLK	6	18 AWG	TFFN	XIO (6)

X10 FULL EXTENSION					
CONN POS	WIRE COLOR	WIRE LABEL	GAUGE	JACKET	TO
1	YEL-BLK	1	18 AWG	TFFN	SN02 (1)
2	ORG-BLK	2	18 AWG	TFFN	SN02 (2)
3	BRN-BLK	3	18 AWG	TFFN	SN02 (3)
4	BLU-RED	4	18 AWG	TFFN	SN571 (1)
5	BLK-RED	5	18 AWG	TFFN	SN571 (2)
6	BLU-BLK	6	18 AWG	TFFN	SN571 (3)

7.7 ELECTRICAL SCHEMATICS

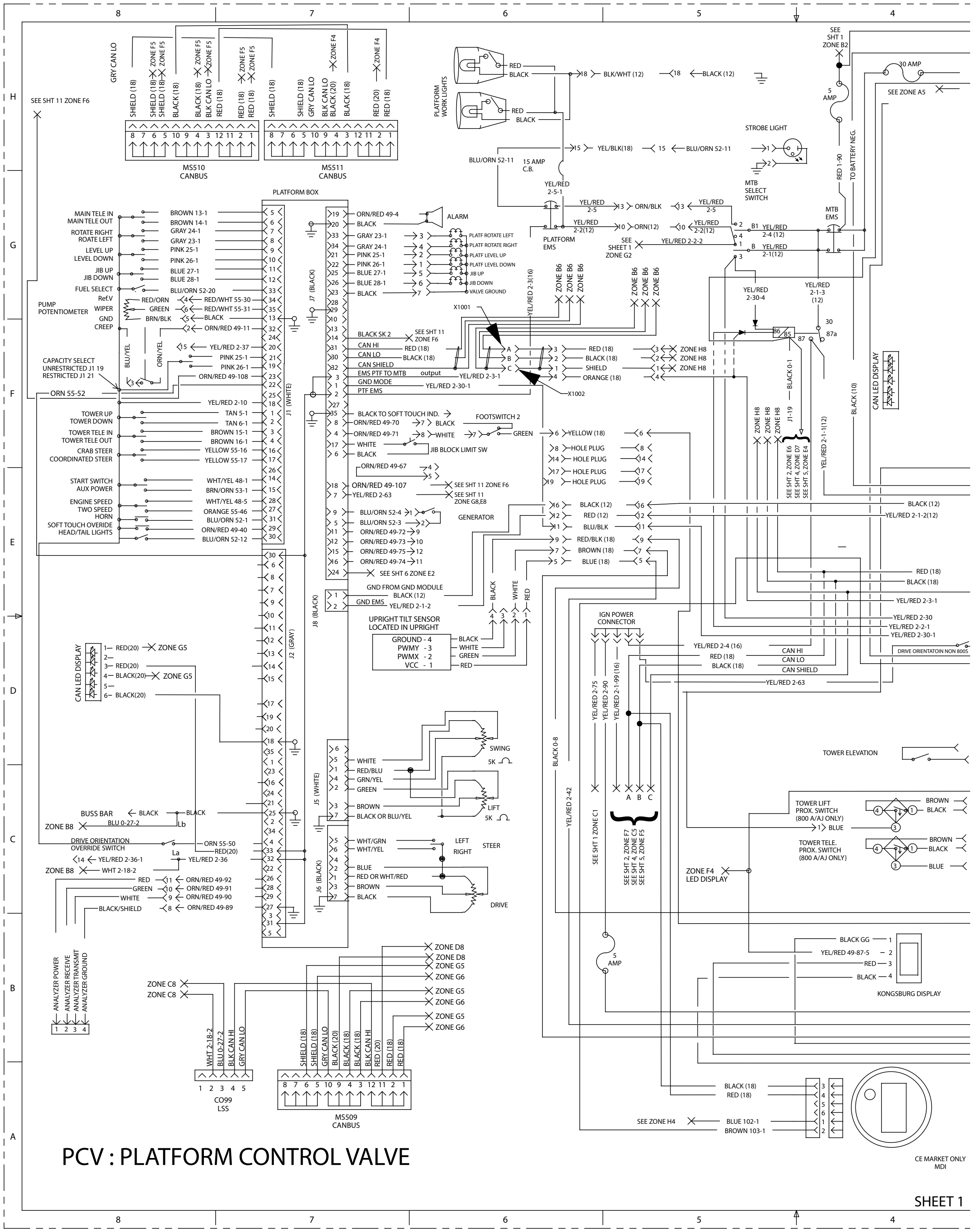


Figure 7-26. Electrical Schematic - Sheet 1 of 17

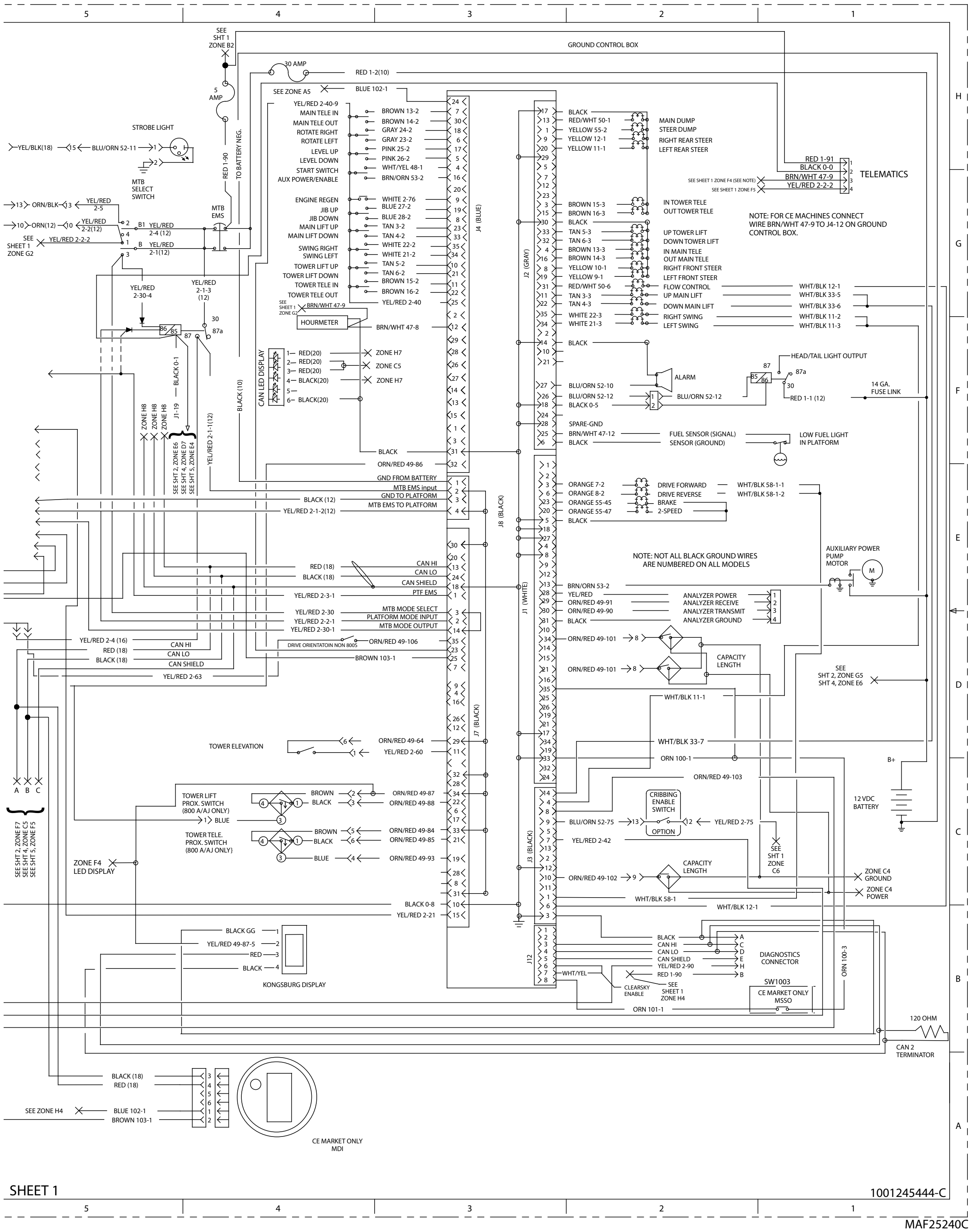
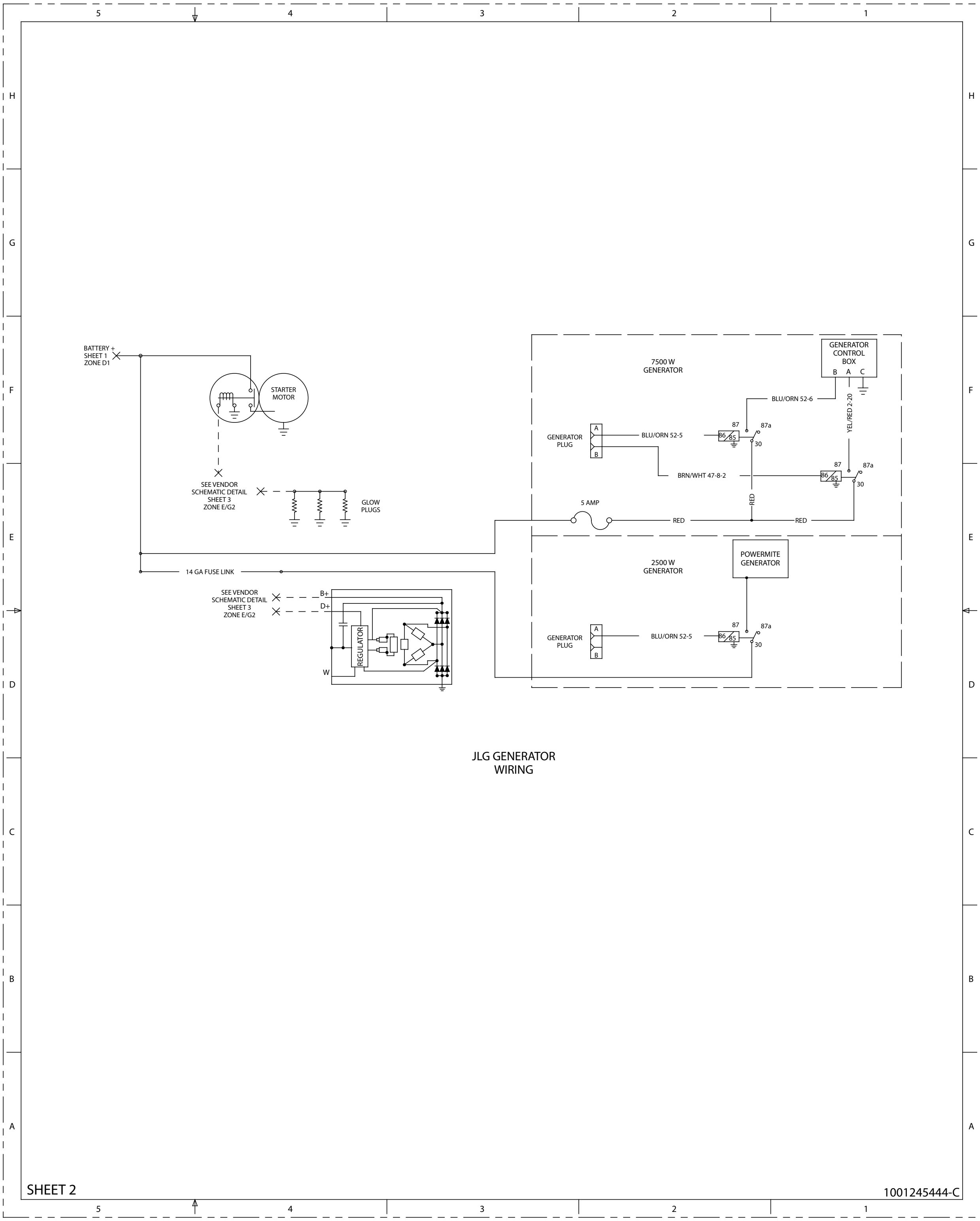


Figure 7-27. Electrical Schematic - Sheet 2 of 17



MAF25250C

Figure 7-28. Electrical Schematic - Sheet 3 of 17

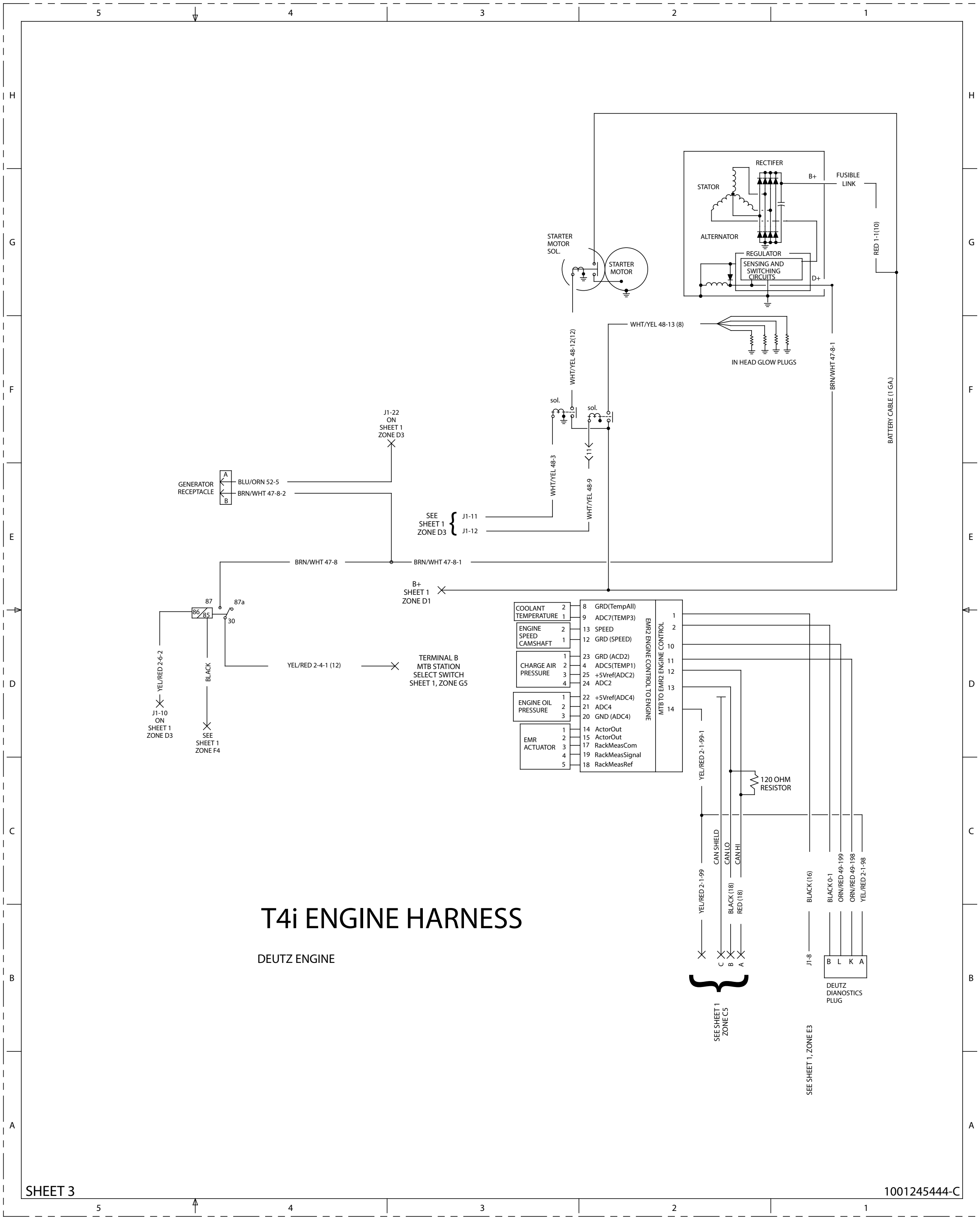


Figure 7-29. Electrical Schematic - Sheet 4 of 17

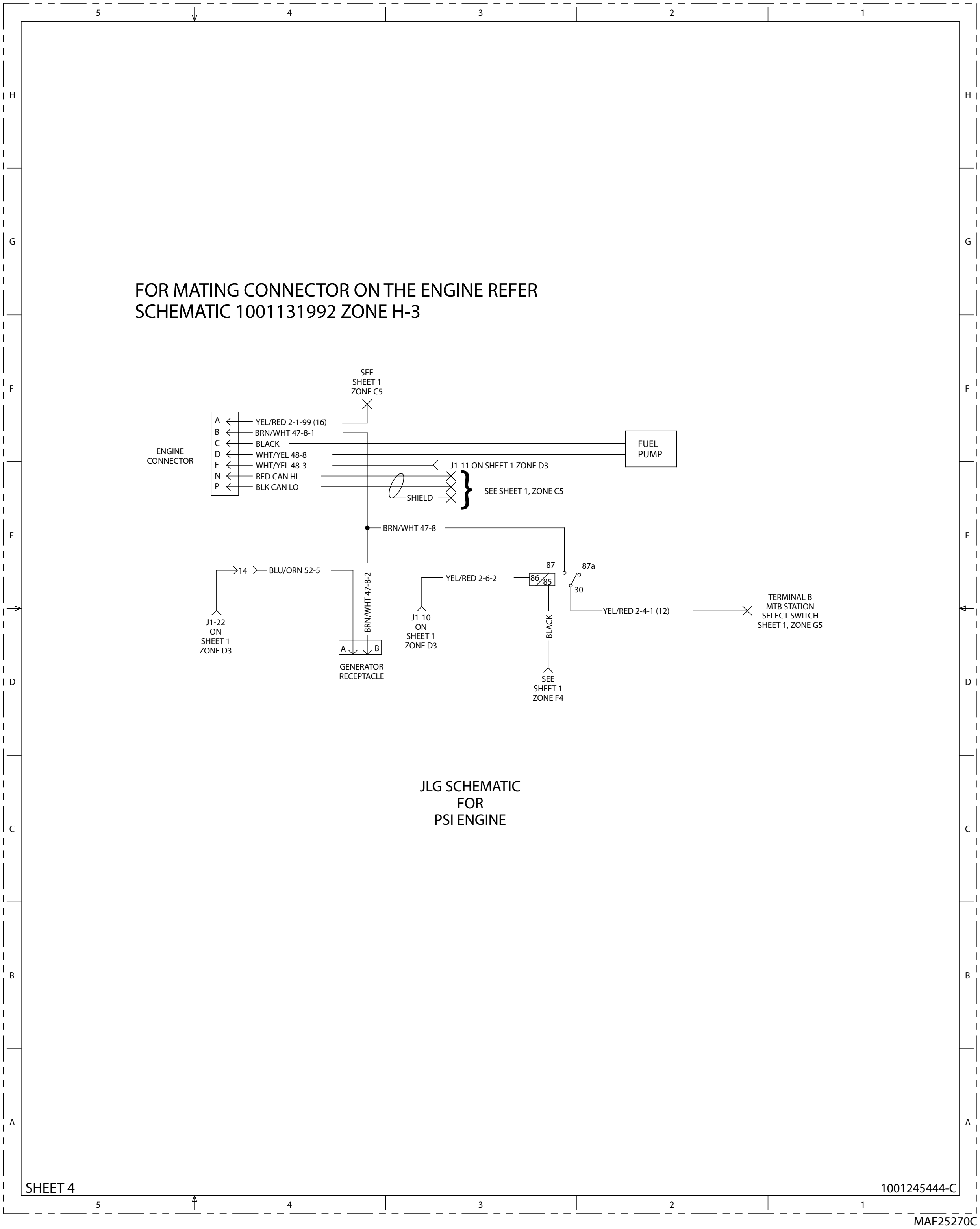


Figure 7-30. Electrical Schematic - Sheet 5 of 17

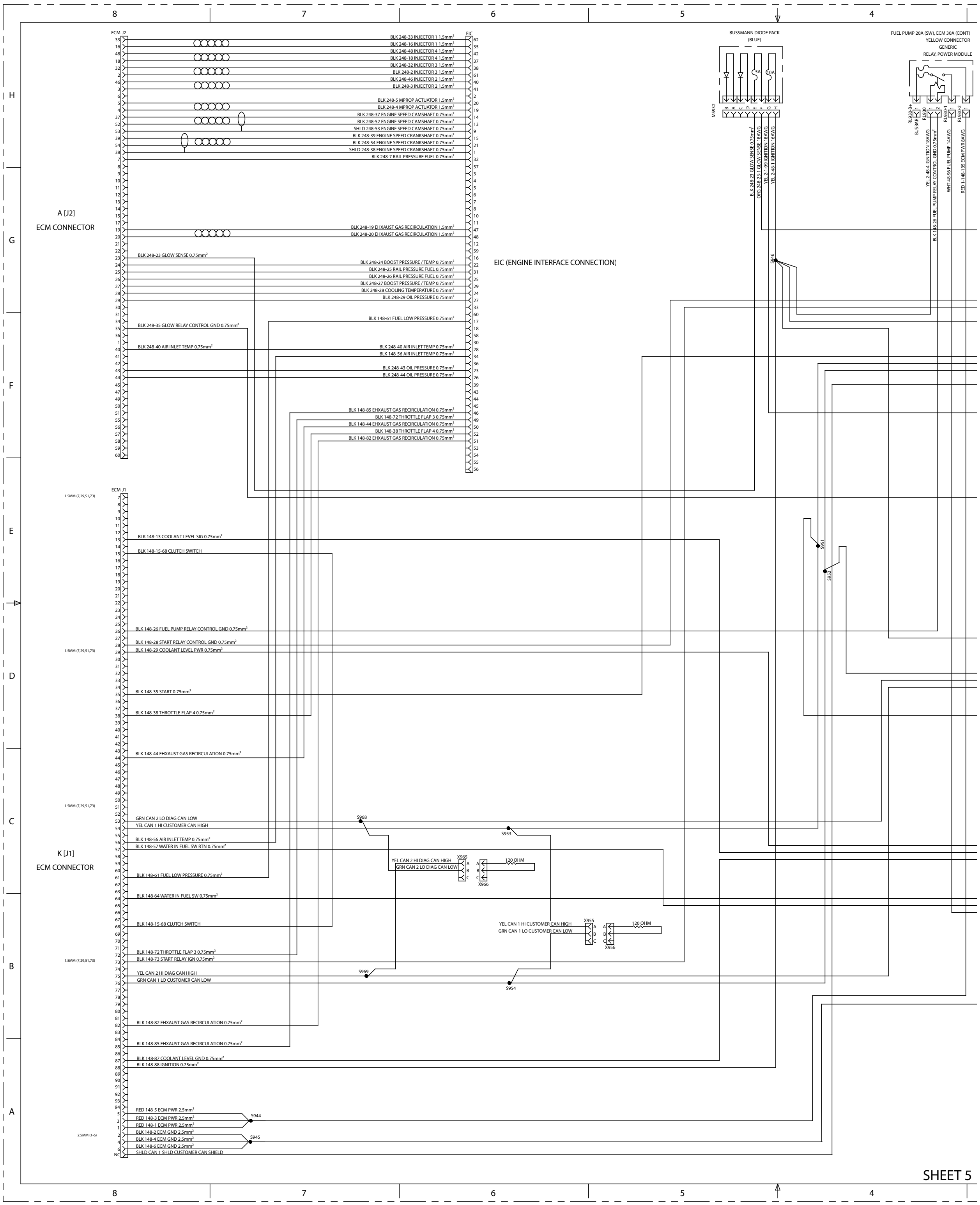


Figure 7-31. Electrical Schematic - Sheet 6 of 17

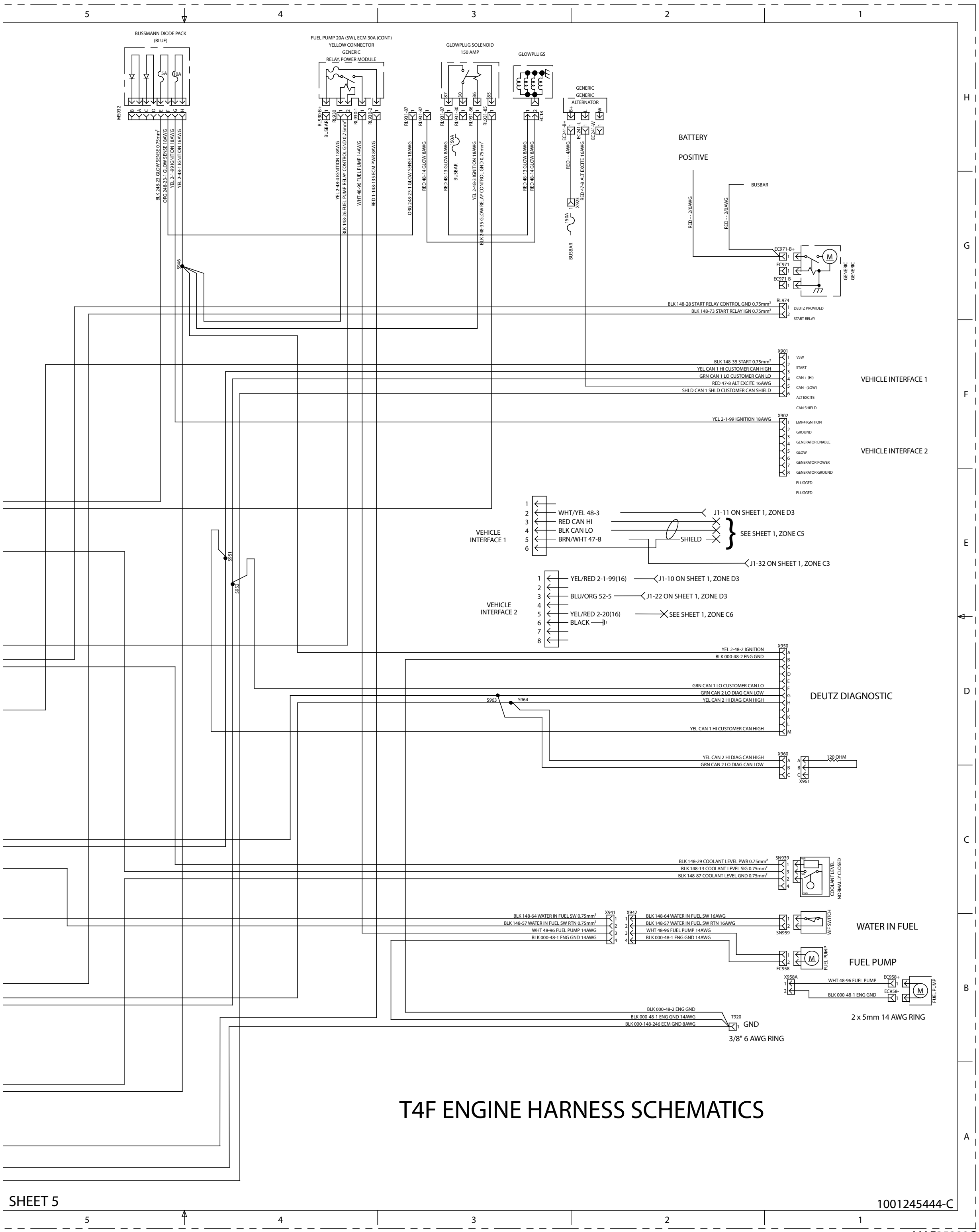


Figure 7-32. Electrical Schematic - Sheet 7 of 17

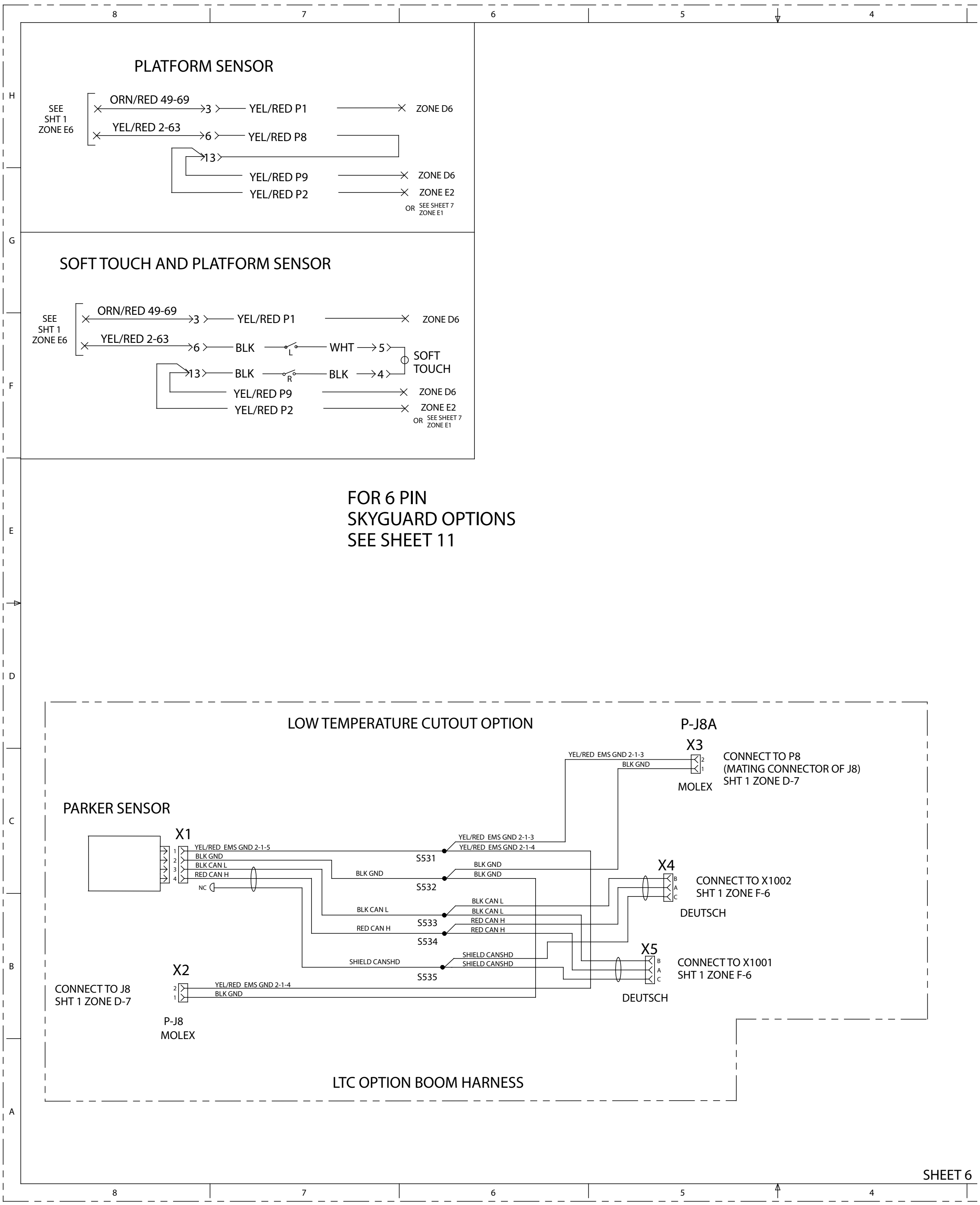


Figure 7-33. Electrical Schematic - Sheet 8 of 17

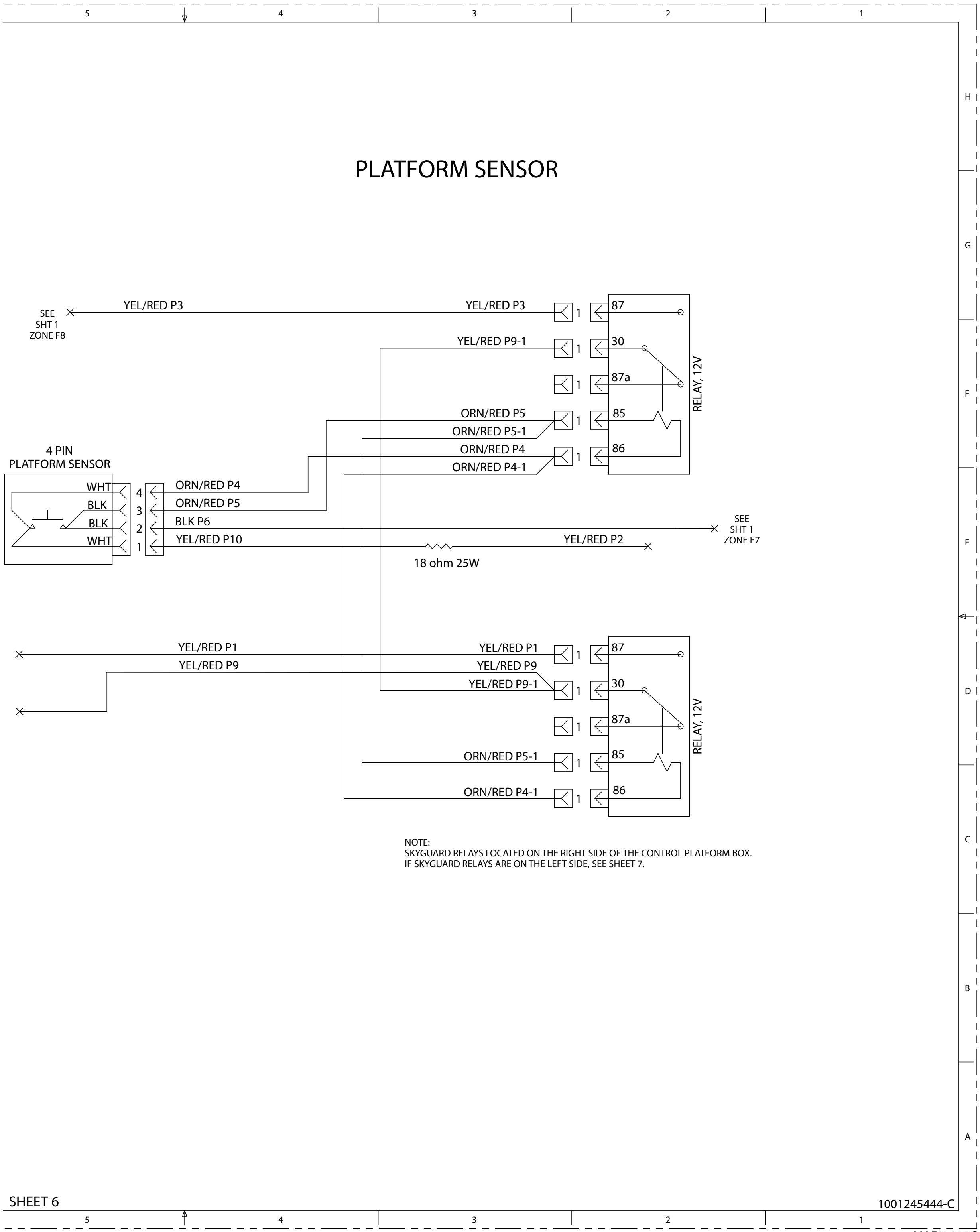


Figure 7-34. Electrical Schematic - Sheet 9 of 17

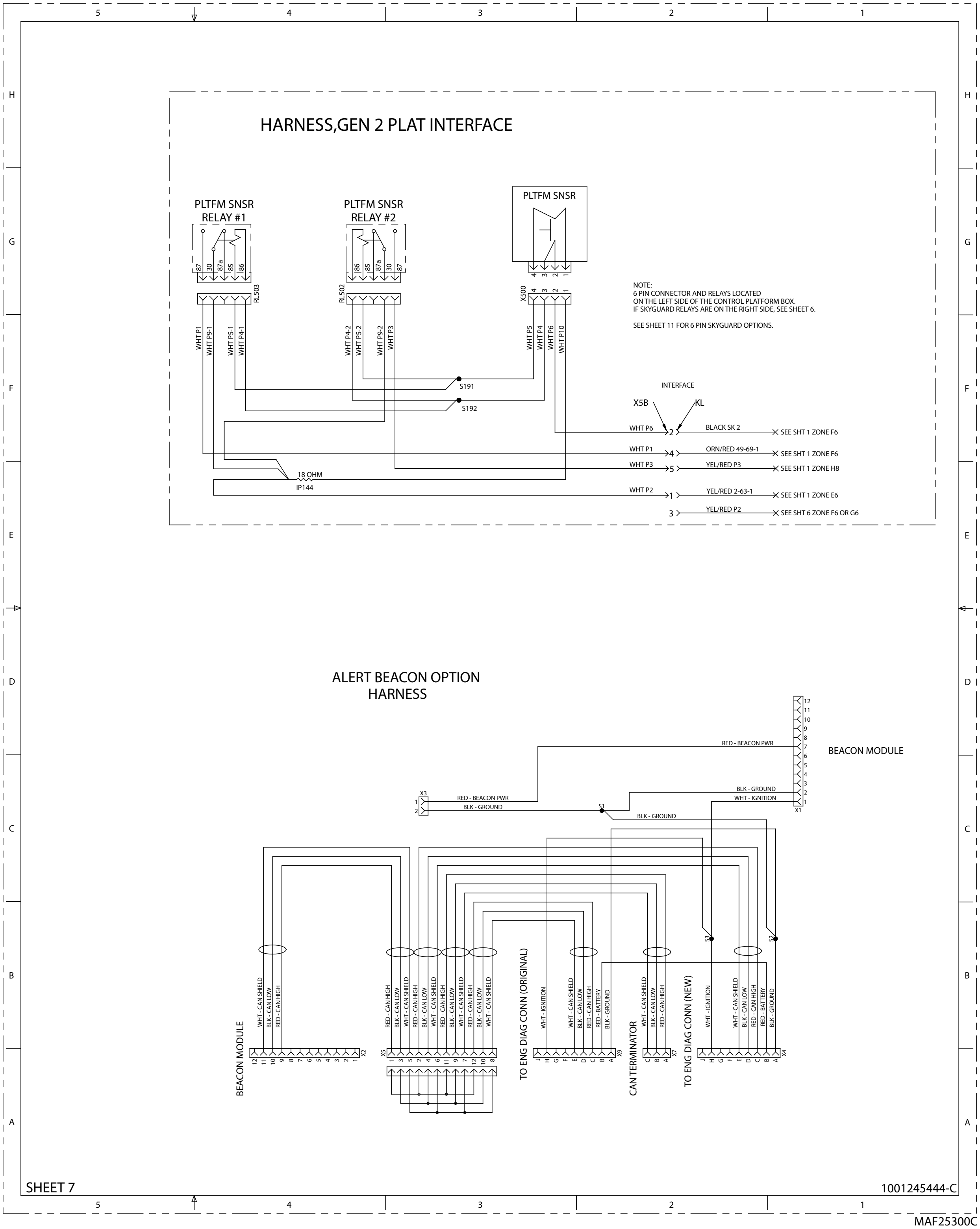


Figure 7-35. Electrical Schematic - Sheet 10 of 17

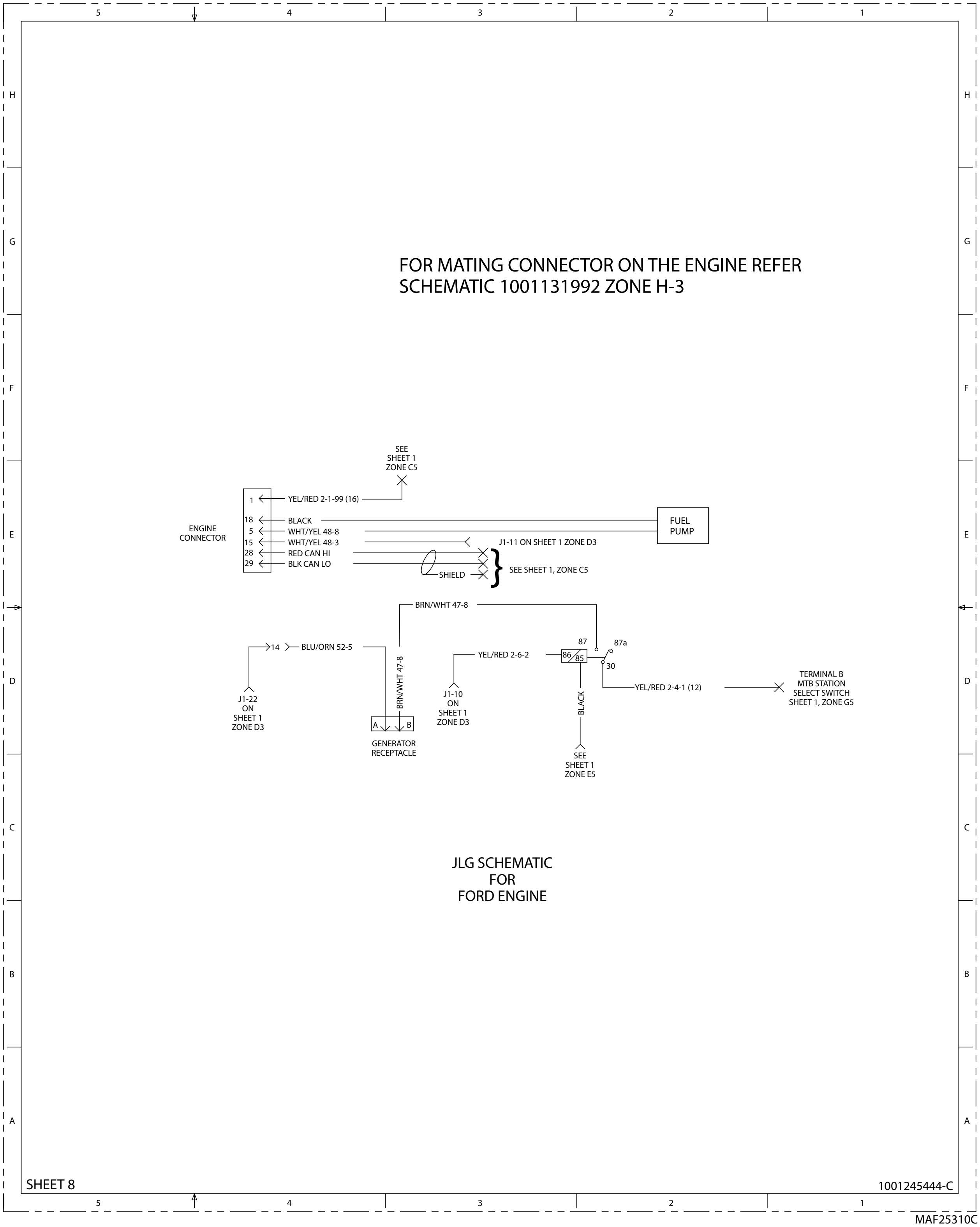


Figure 7-36. Electrical Schematic - Sheet 11 of 17

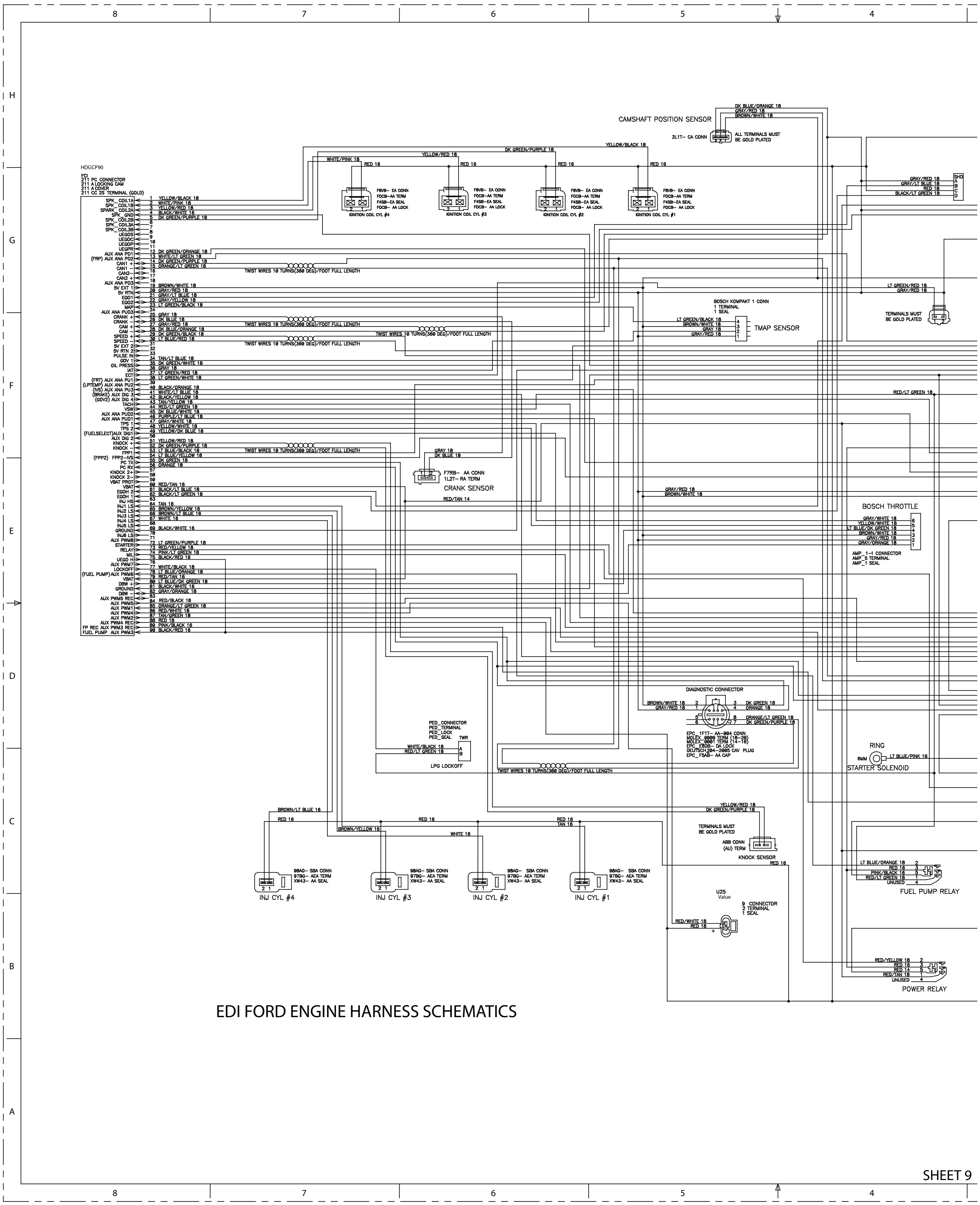


Figure 7-37. Electrical Schematic - Sheet 12 of 17

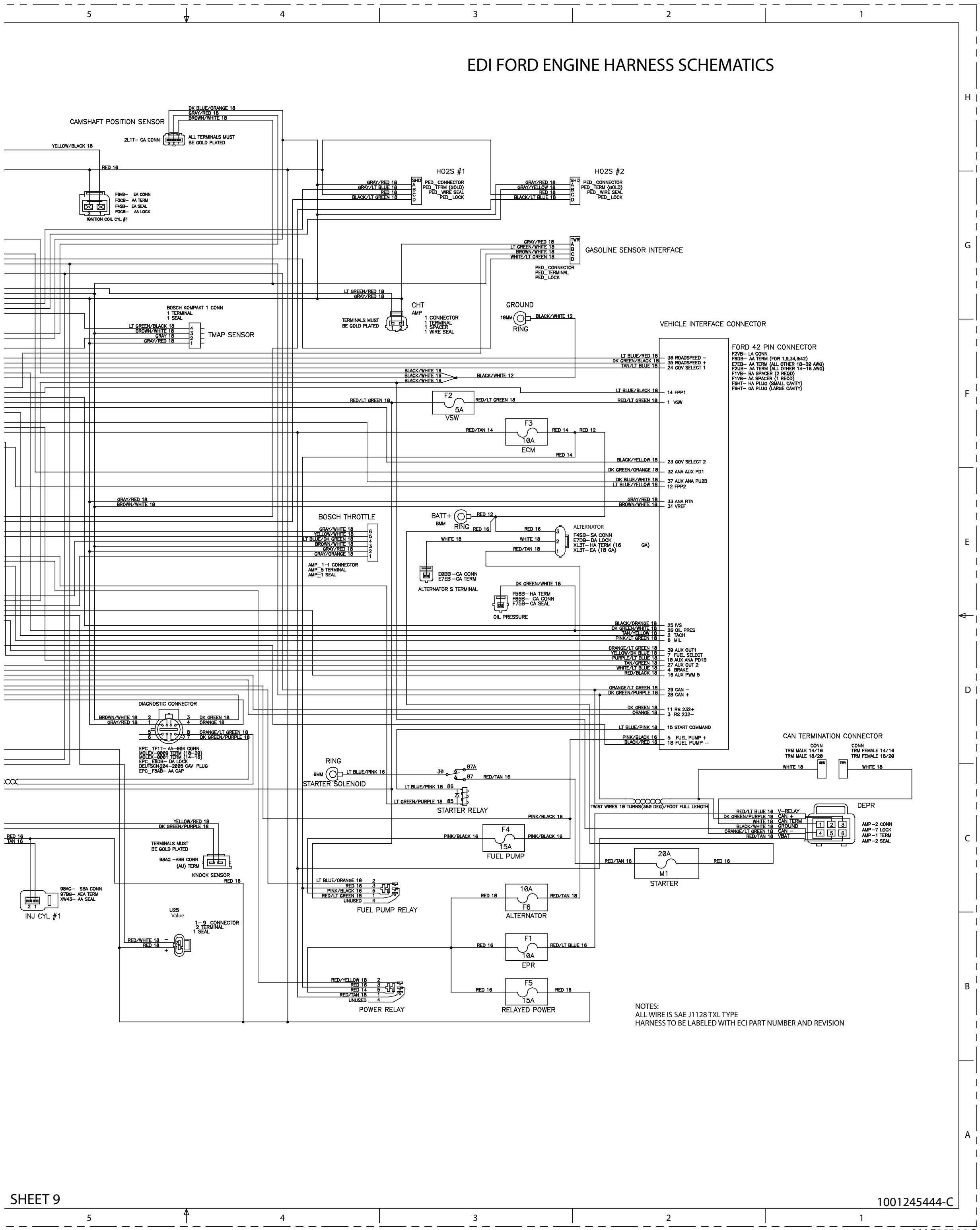


Figure 7-38. Electrical Schematic - Sheet 13 of 17

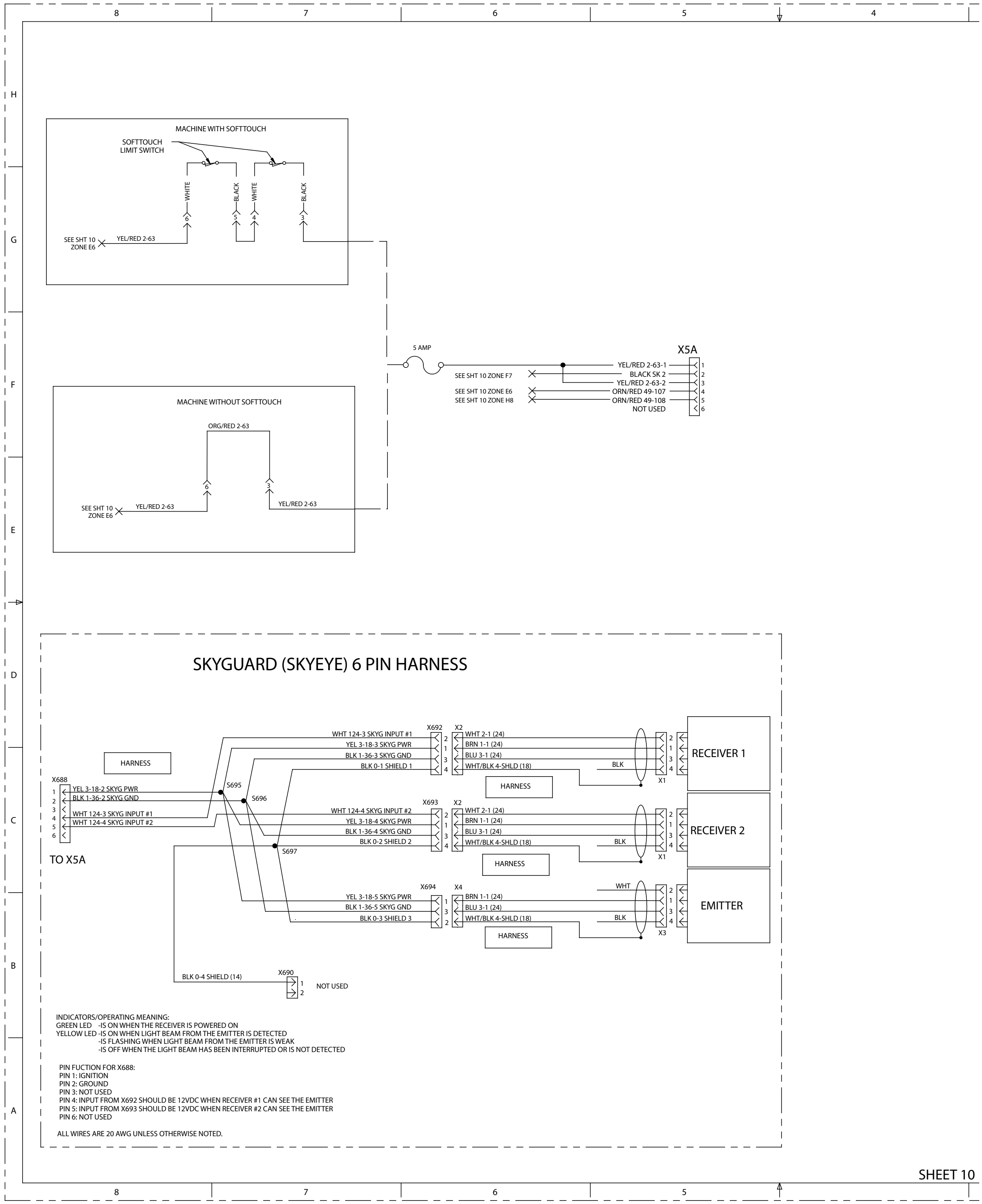


Figure 7-39. Electrical Schematic - Sheet 14 of 17

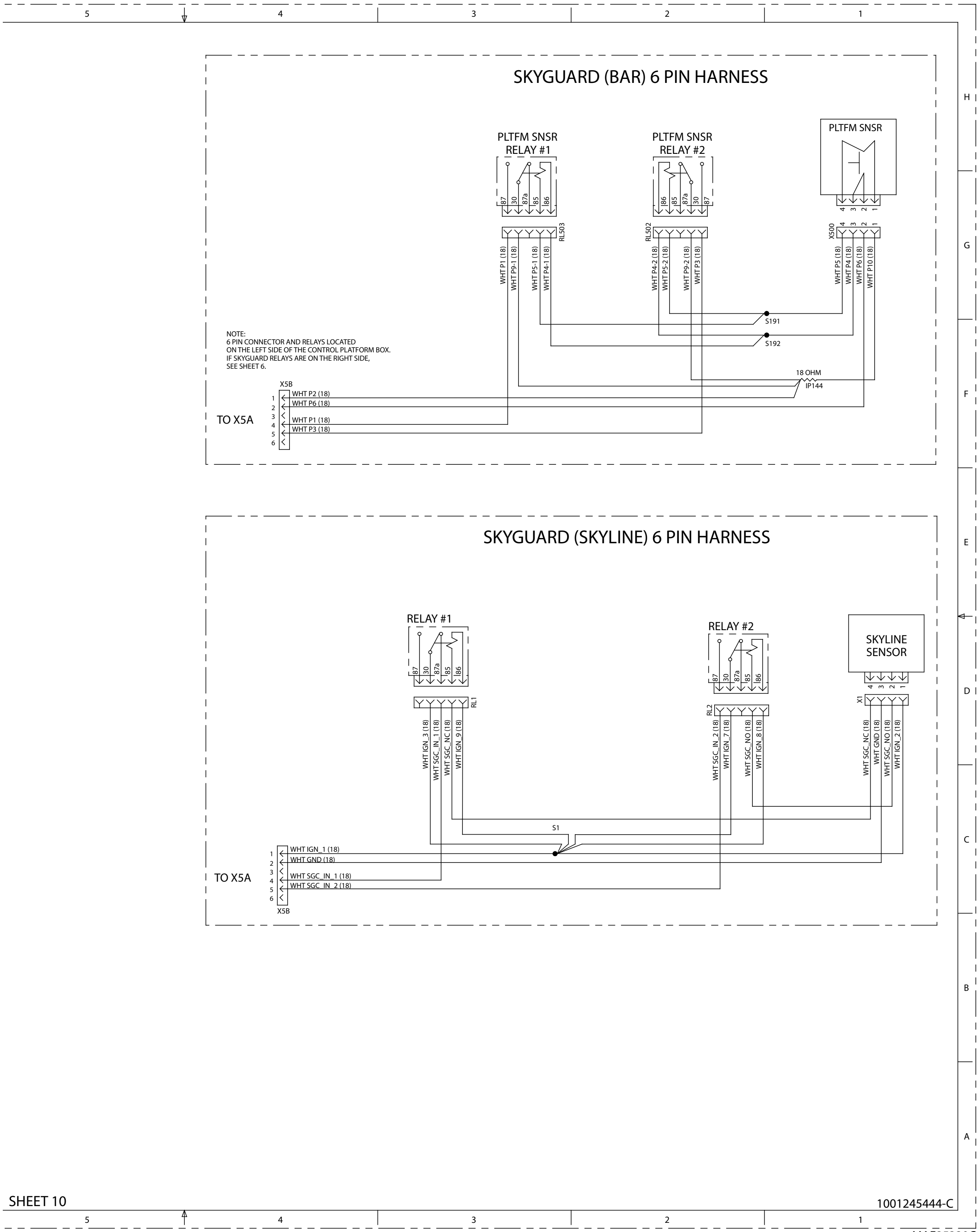


Figure 7-40. Electrical Schematic - Sheet 15 of 17

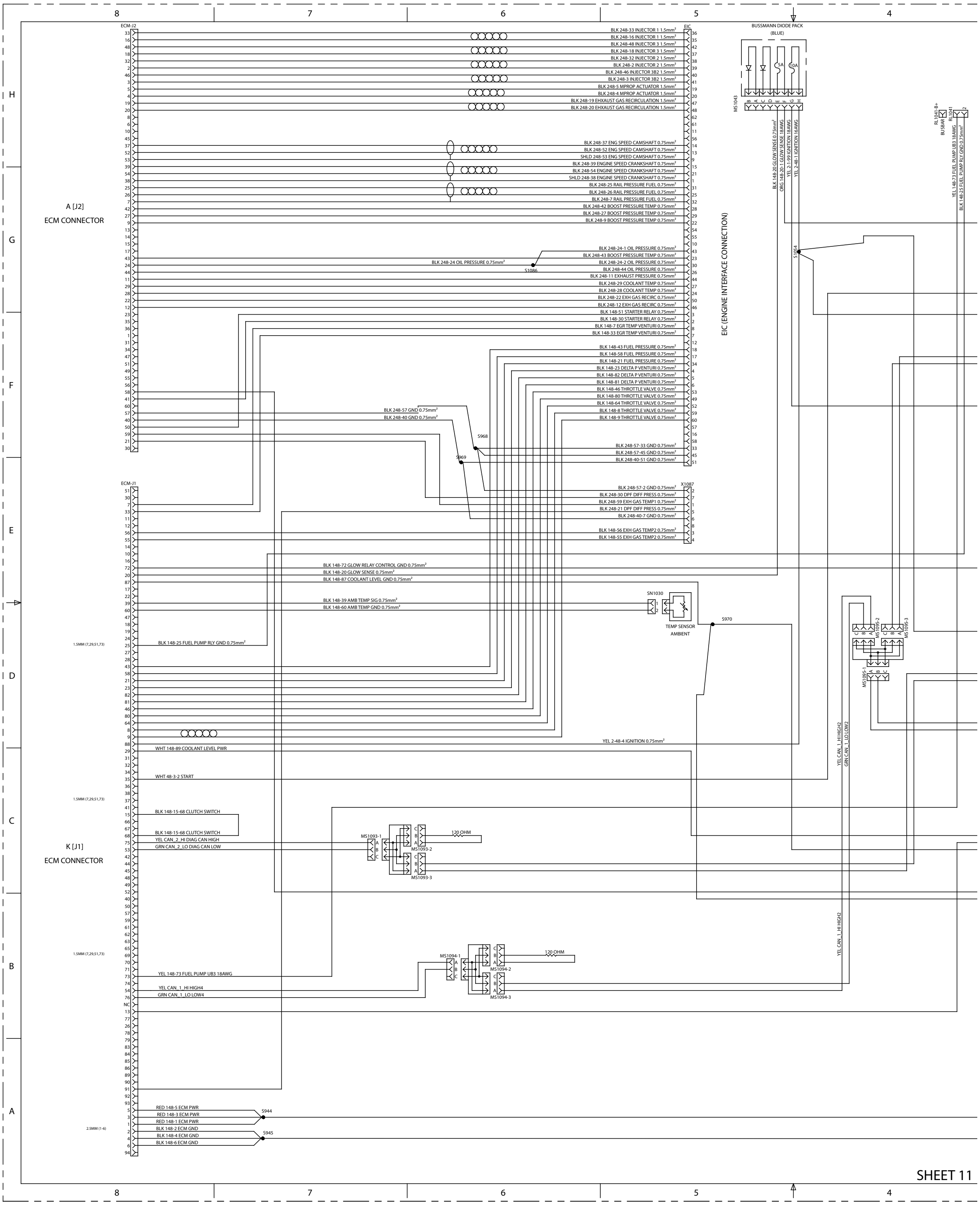


Figure 7-41. Electrical Schematic - Sheet 16 of 17

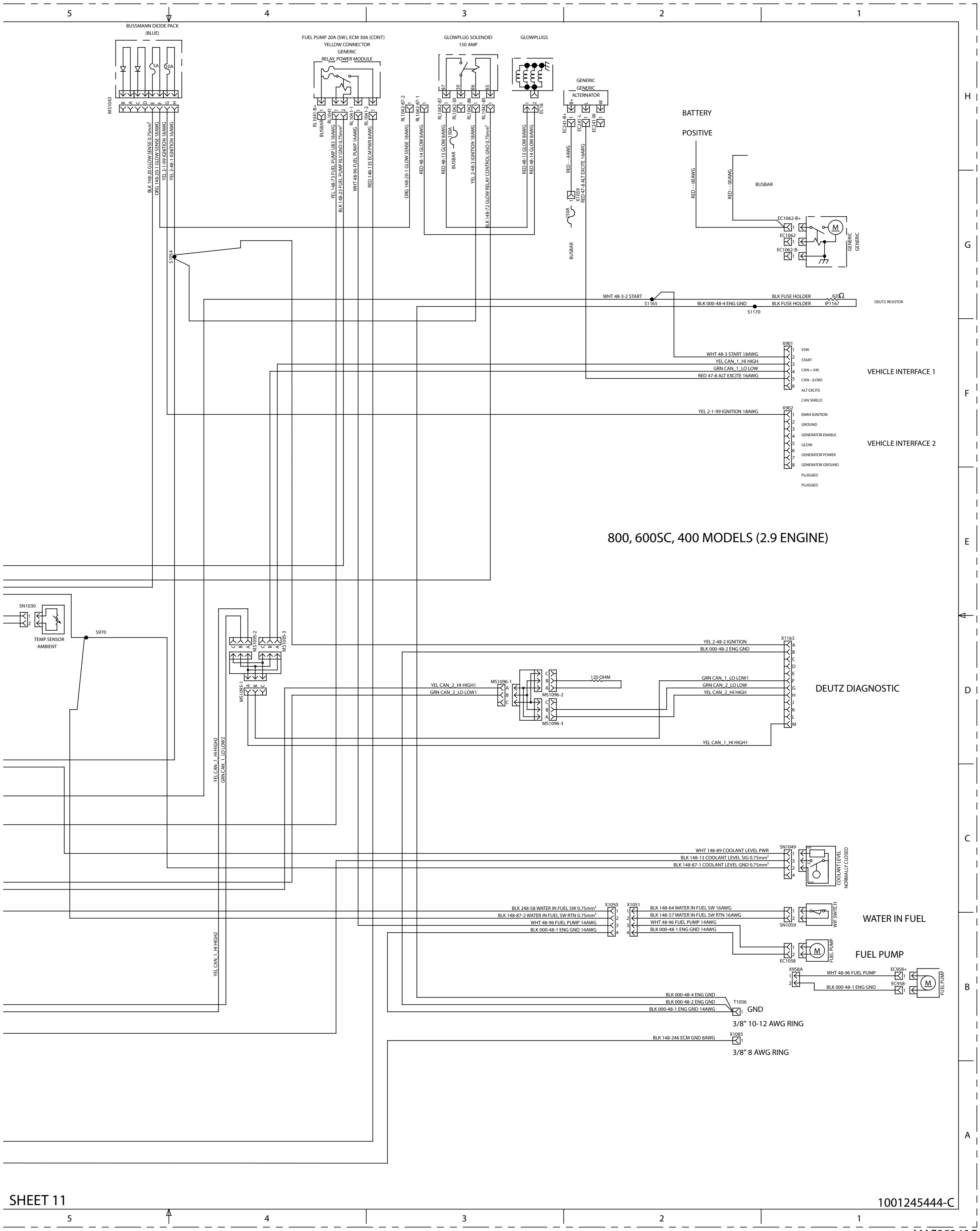


Figure 7-42. Electrical Schematic - Sheet 17 of 17

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