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Service and Maintenance Manual

Model 1500AJP

PVC 2001

31215061

November 26, 2019 - Rev A

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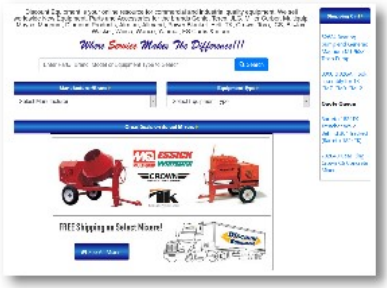

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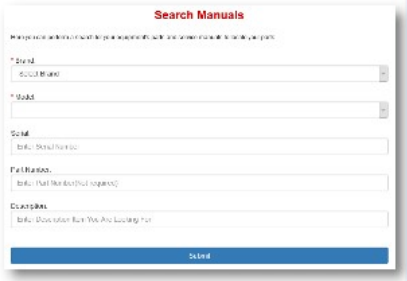

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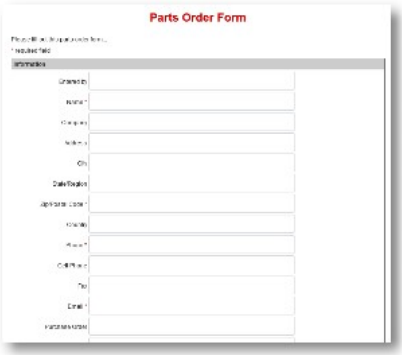

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SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

A GENERAL

This section contains the general safety precautions which must be observed during maintenance of the 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 MOBILE ELEVATING WORK PLATFORM SHALL BE MADE ONLY WITH WRITTEN PERMISSION FROM THE MANUFACTURER.

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

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

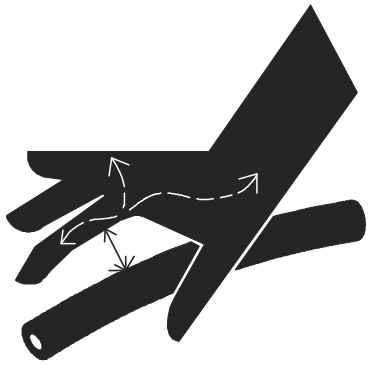
⚠ WARNING

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

B HYDRAULIC SYSTEM SAFETY

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

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



C MAINTENANCE

⚠ WARNING

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

- USE ONLY REPLACEMENT PARTS OR COMPONENTSTHAT ARE A P PR O V ED BY JLG . TO BE CO NS ID ER EDA P PR O V ED, REPLACEMENT PARTS OR COMPONENTSMUST BE IDENTICAL OR EQUIVALENT TO ORIGINALPARTS OR COMPONENTS.
- NO SMOKING IS MANDATORY. NEVER REFUEL DURING ELECTRICAL STORMS. ENSURE THAT FUEL CAP IS CLOSED AND SECURE AT ALL OTHER TIMES.
- REMOVE ALL RINGS, WATCHES AND JEWELRY WHEN PERFORMING ANY MAINTENANCE.
- DO NOT WEAR LONG HAIR UNRESTRAINED, OR LOOSE-FITTING CLOTHING AND NECKTIES WHICH ARE APT TO BECOME CAUGHT ON OR ENTANGLED IN EQUIPMENT.
- OBSERVE AND OBEY ALL WARNINGS AND CAUTIONS ON MACHINE AND IN SERVICE MANUAL.
- KEEP OIL, GREASE, WATER, ETC. WIPED FROM STANDING SURFACES AND HAND HOLDS.
- USE CAUTION WHEN CHECKING A HOT, PRESSURIZED COOLANT SYSTEM.
- NEVER WORK UNDER AN ELEVATED BOOM UNTIL BOOM HAS BEEN SAFELY RESTRAINED FROM ANY MOVEMENT BY BLOCKING OR OVERHEAD SLING, OR BOOM SAFETY PROP HAS BEEN ENGAGED.
- BEFORE MAKING ADJUSTMENTS, LUBRICATING OR PERFORMING ANY OTHER MAINTENANCE, SHUT OFF ALL POWER CONTROLS.
- BATTERY SHOULD ALWAYS BE DISCONNECTEDDURING REPLACEMENT OF ELECTRICAL COMPONENTS.
- KEEP ALL SUPPORT EQUIPMENT AND ATTACHMENTS STOWED IN THEIR PROPER PLACE.
- USE ONLY APPROVED, NONFLAMMABLE CLEANING SOLVENTS.

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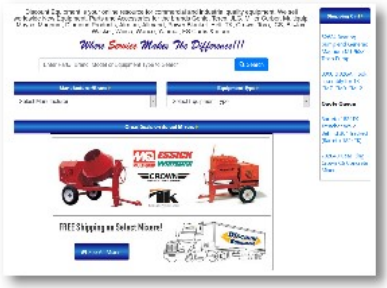

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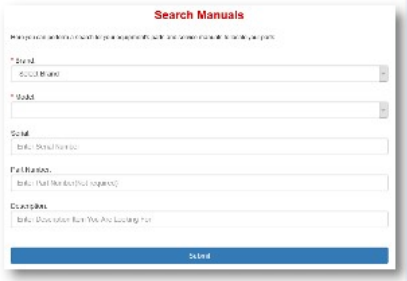

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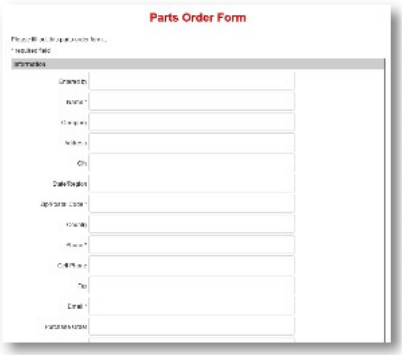

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SECTION 1. SPECIFICATIONS

1.1 OPERATING SPECIFICATIONS

Machine Specifications

Capacity - ANSI Unrestricted Restricted	 600 lb (272 kg) 1000 lb (454 kg)
Capacity - CE & Australia Unrestricted Restricted	 600 lb (270 kg) 1000 lb (450 kg)
Maximum Operating Slope	5°
Maximum Travel Grade, stowed Position (Gradeability)	40%
Maximum Travel Grade, stowed Position (Side Slope)	5°
Drive Speed	2.8 mph (4.5 kph)
Drive Speed at Elevation	0.3 mph (0.48 kph)
Gross Machine Weight - Approximate	56,630 lb (25687 kg)
Weight Distribution: Axles Deployed or Retracted (Front/Rear)	28,881 lb/27,749 lb (13,100 kg/12,587 kg)
Ground Bearing Pressure - Maximum	123 psi (8.65 kg/cm^2)
Maximum Wind Speed	28 mph (12.5 m/s)
Maximum Manual Force	90 lb (400N)
Maximum System Voltage	12 volts
Maximum Main Relief Hyd. Pressure	4600 psi (317 Bar)

1.2 DIMENSIONAL DATA

Machine Dimensional Data

Turning Radius (Axles Retracted) Outside Inside	 31 ft. 2.25 in. (9.5 m) 23 ft. 3.75 in. (7.1 m)
Turning Radius (Axles Extended) Inside Outside	 7 ft. 6.25 in. (2.3 m) 21 ft. 7.50 in. (6.6 m)
Machine Height (stowed)	10 ft. 2 in. (3.1 m)
Machine Length (stowed)	49 ft. 8 in. (15.1 m)
Machine Length (Transport Position)	39 ft. 8 in. (12.1 m)
Maximum Platform Height	150 ft. 0 in. (45.72 m)
Up and Over Height	60 ft. 4 in. (18.39 m)
Horizontal Reach from centerline of rotation Unrestricted Capacity Zone Restricted Capacity Zone	 85 ft. 0 in. (22.86 m) 67 ft. 0 in. (20.42 m)
Horizontal Reach over end Unrestricted Capacity Zone Restricted Capacity Zone	 65 ft. 8 in. (20.01 m) 57 ft. 8 in. (17.57 m)
Horizontal Reach over side Unrestricted Capacity Zone Restricted Capacity Zone	 67 ft. 10 in. (20.67 m) 59 ft. 10 in. (18.24 m)
Overall Width Axles Retracted Axles Extended	 8 ft. 1.5 in. (2.5 m) 16 ft. 6 in. (5.0 m)
Tailswing	2 ft. 5 in. (0.7 m)
Ground Clearance (Axle)	1 ft. 1.5 in. (0.3 m)
Ground Clearance (Chassis)	1 ft. 4 in. (0.4 m)

1.3 CAPACITIES

Hydraulic Oil Tank	93 Gal. (352 L)
Fuel Tank	45 Gal. (170 L)
Drive Hub	2.6 quarts (2.5 liters)
Swing Gearbox	3 qt. (2.8 L)

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1.4 TIRES

Type	Directional Lug
Size	445/50D710
Tire Width (Inflated)	16.81" (427mm)
Tire Diameter (Inflated)	46.45" (1180mm)
Load Rating	31000 lb (14,061 kg)

1.5 ENGINE DATA

Type	Turbo-charged Diesel
Number of Cylinders	4
Bore	3.9 in. (98 mm)
Stroke	4.7 in. (120 mm)
Total Displacement	221 cu.in. (3.6 L)
Firing Order	1-3-4-2
Output	99.8 hp (74.4 kW)
Low Idle Engine RPM	1000 ±50
High Engine RPM	2300±50

1.6 MAJOR COMPONENT WEIGHTS

⚠ WARNING

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

Components	LB	KG
Tire and Wheel Assembly	1193	541
Complete Engine Assembly	1625	737
Drive Hub and Motor	338	153
Swing Drive	225	102
Tower Boom Assembly	12089	5484
Main Boom Assembly (including Jib)	7059	3202
36x96 Platform Assembly	259	117.5

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 require anti-wear qualities at least API Service Classification GL-3, and sufficient chemical stability for mobile hydraulic system service.*

NOTE: *When temperatures remain 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, as they may not contain the same required additives or be of comparable viscosities.*

Table 1-1. Mobilfluid 424 Specs

SAE Grade	10W30
Gravity, API	29.0
Density, Lb/Gal. 60°F	7.35
Pour Point, Max	-46°F (-43°C)
Flash Point, Min.	442°F (228°C)
Viscosity	
Brookfield, at -18°C	2700 cP
at 40° C	55 cSt
at 100° C	9.3 cSt
Viscosity Index	152

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Table 1-2. Mobil DTE 10 Excel 32 Specs

ISO Viscosity Grade	#32
Specific Gravity	0.877
Pour Point, Max	-40°F (-40°C)
Flash Point, Min.	330°F (166°C)
Viscosity	
at 40° C	32.7 cSt
at 100° C	6.6 cSt
at 100° F	169 SUS
at 210° F	48 SUS
at -20° F	6,200 cP
Viscosity Index	140

Table 1-3. UCon Hydrolube HP-5046

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

Table 1-4. Mobil EAL H 46 Specs

Type	Synthetic Biodegradable
ISO Viscosity Grade	46
Density at 15° C	.874
Pour Point	-49°F (-45°C)
Flash Point	500°F (260°C)
Operating Temp.	-20 to 200°F (-29 to 93°C)
Weight	7.64 lb/gal (0.9 kg/L)
Viscosity	
at 40° C	48.8 cSt
at 100° C	7.8 cSt
Viscosity Index	145

Table 1-5. Mobil EAL 46 Specs

Type	Synthetic Biodegradable
ISO Viscosity Grade	46
Density at 15° C	.93
Pour Point	-27°F (-33°C)
Flash Point	568°F (298°C)
Operating Temp.	-20 to 200°F (-29 to 93°C)
Weight	7.64 lb/gal (0.9 kg/L)
Viscosity	
at 40° C	43.3 cSt
at 100° C	7.7 cSt
Viscosity Index	149

Table 1-6. Exxon Univis HVI 26 Specs

Specific Gravity	32.1
Pour Point	-76°F (-60°C)
Flash Point	217°F (103°C)
Viscosity	
at 40° C	25.8 cSt
at 100° C	9.3 cSt
Viscosity Index	376

NOTE: *Mobil/Exxon recommends that this oil be checked on a yearly basis for viscosity.*

Table 1-7. Quintolubric 888-46

Density	0.92 g/cm^3
Pour Point	<-30°C (<-22°F)
Flash Point	300°C (572°F)
Fire Point	360°C (680°F)
Autoignition Temperature	>450°C (842°F)
Viscosity	
at 0° C (32°F)	320 cSt
at 20° C (68°F)	109 cSt
at 40° C (104°F)	47.5 cSt
at 100° C (212°F)	9.5 cSt
Viscosity Index	190

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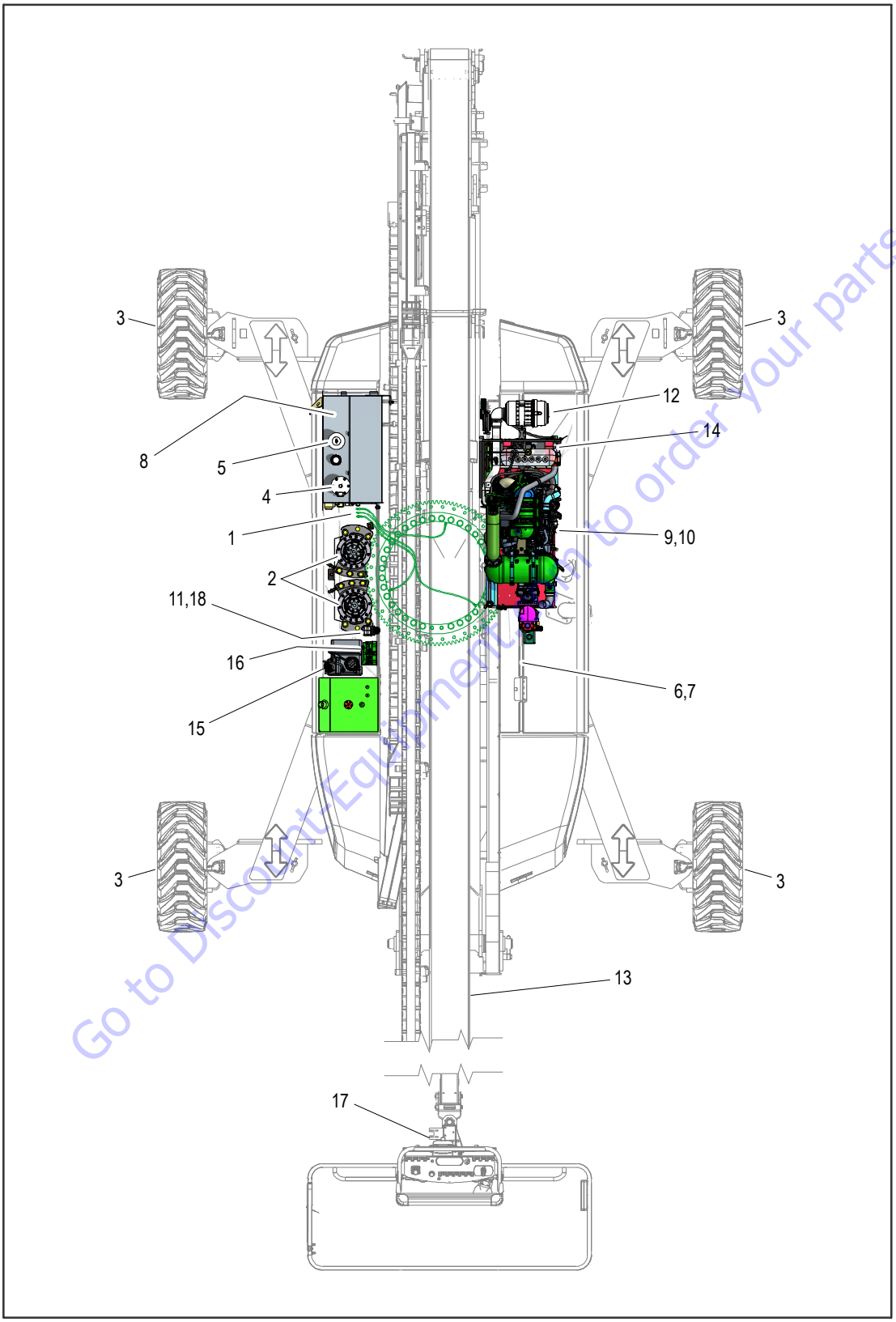

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Figure 1-1. Maintenance and Lubrication Diagram

1.8 MAINTENANCE AND LUBRICATION

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

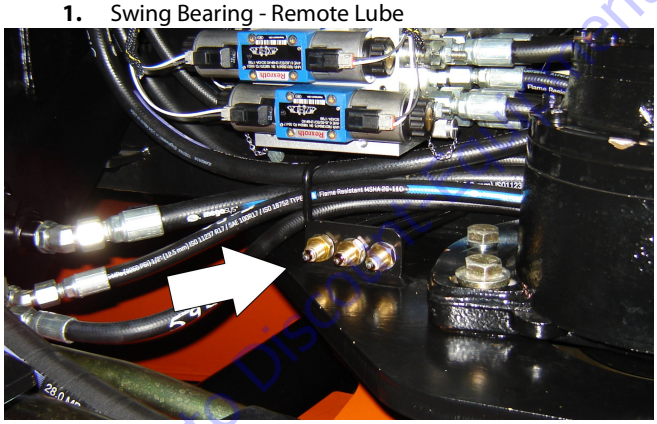
Table 1-8. Lubrication Specifications

KEY	SPECIFICATIONS
MPG	Multipurpose Grease having a minimum dripping point of 350°F (177°C). Excellent water resistance and adhesive qualities, and being of extreme pressure type. (Timken OK 40 pounds minimum.)
EPGL	Extreme Pressure Gear Lube (oil) meeting API service classification GL-5 or MIL-Spec MIL-L-2105
HO	Hydraulic Oil. API service classification GL-3, e.g. Mobilfluid 424
EO	Engine (crankcase) API CJ-4
Super Lube®	Synthetic-Based Oil, Non-Flammable. Withstands temperatures within -45° to 450°F (-43° to 232°C). JLG PN 3020042.

NOTICE

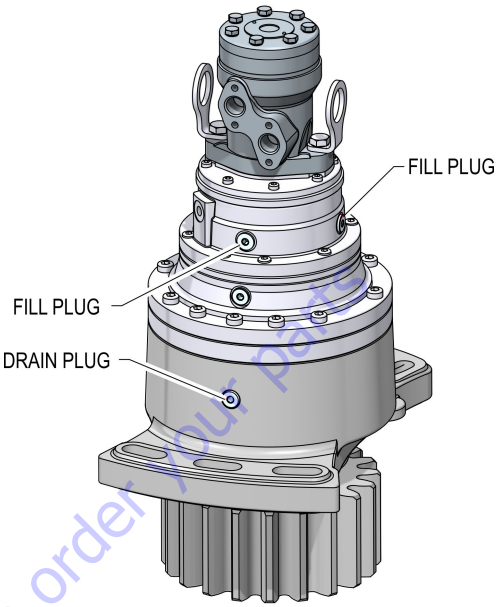
LUBRICATION INTERVALS ARE BASED ON MACHINE OPERATION UNDER NORMAL CONDITIONS. FOR MACHINES USED IN MULTI-SHIFT OPERATIONS AND/OR EXPOSED TO HOSTILE ENVIRONMENTS OR CONDITIONS, LUBRICATION FREQUENCIES MUST BE INCREASED ACCORDINGLY.

1. Swing Bearing - Remote Lube



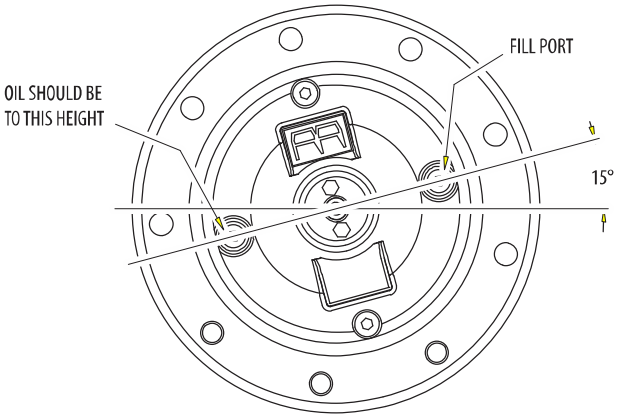
Lube Point(s) - 3 Grease Fitting
Capacity - A/R
Lube - MPG
Interval - Every 3 months or 150 hours of operation
Comments - Apply grease and rotate in 45 degree intervals until bearing is completely lubricated.

2. Swing Gearbox



Lube Point(s) - Fill Plug
Capacity - 3 qt. (2.8 L)
Lube - GL-5
Interval - Check level every 150 hrs/Change every 1200 hours of operation. Fill to cover ring gear.

3. Wheel Drive Hub



Lube Point(s) - Level/Fill Plug
Capacity - 2.6 quarts (2.5 liters) ± 10%
Interval - Check level every 3 months or 150 hrs of operation; change every 2 years or 1200 hours of operation.

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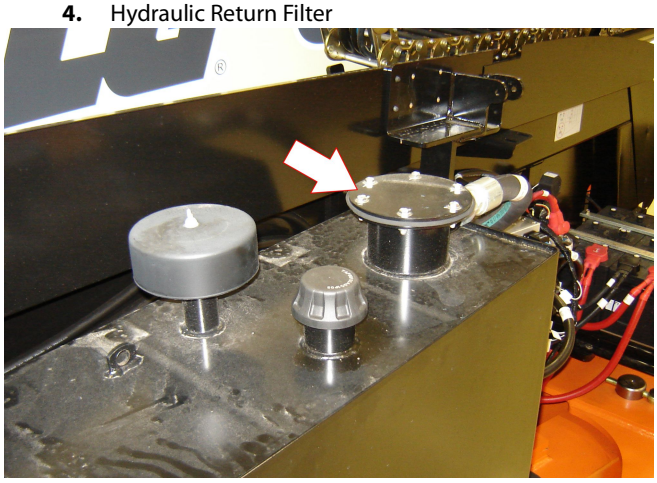
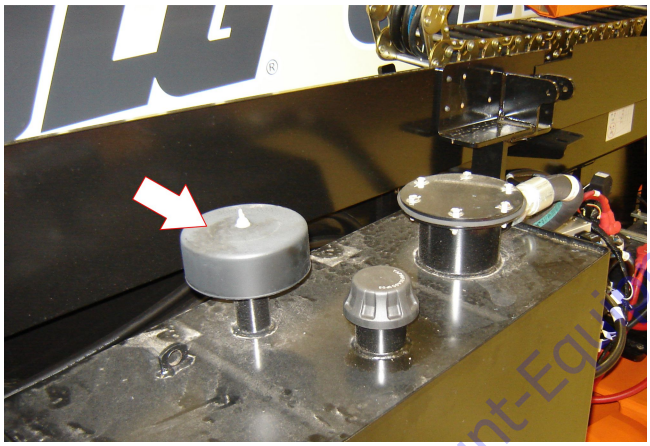
4. Hydraulic Return Filter



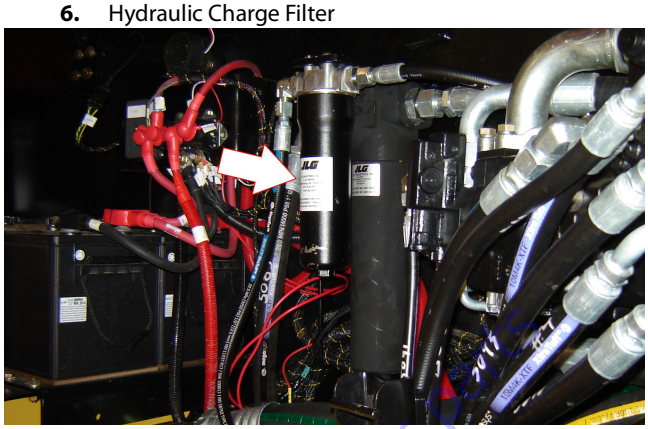
Lube Point(s) - Replaceable Element
Interval - Change after first 50 hours and every 6 months or 300 hours thereafter.

5. Hydraulic Tank Breather



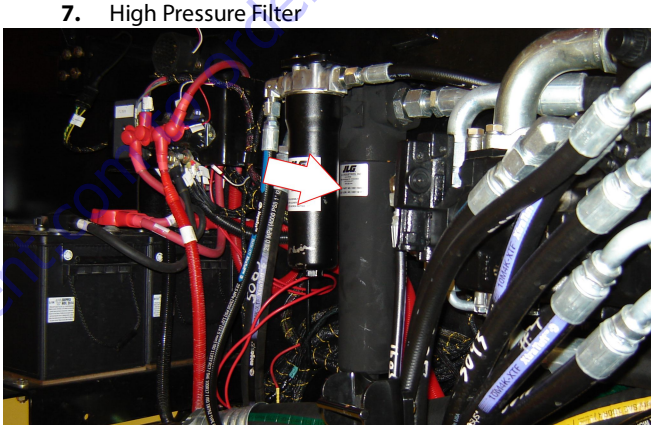
Interval - Change after first 50 hrs. and every 6 months or 300 hrs. thereafter.
Comments - Remove wing nut and cover to replace. Under certain conditions, it may be necessary to replace on a more frequent basis.

6. Hydraulic Charge Filter



Lube Point(s) - Replaceable Element
Interval - Change after first 50 hours and every 6 months or 300 hours thereafter.

7. High Pressure Filter



Lube Point(s) - Replaceable Element
Interval - Change after first 50 hours and every 6 months or 300 hours thereafter.

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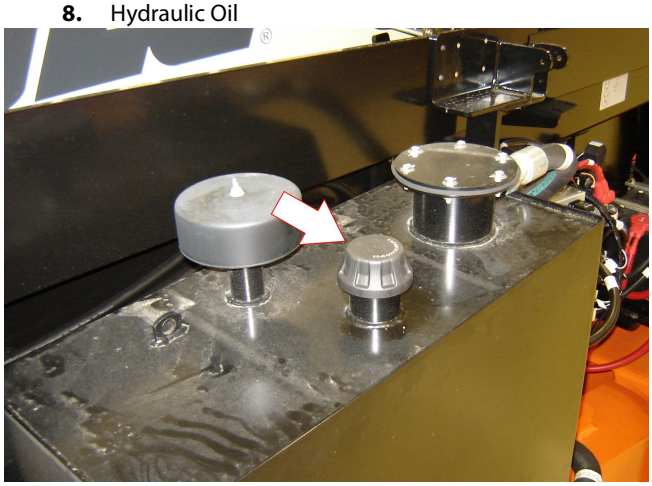
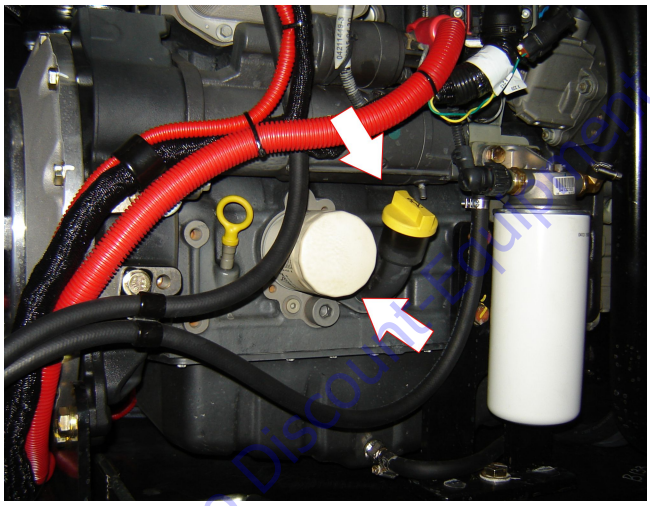
8. Hydraulic Oil



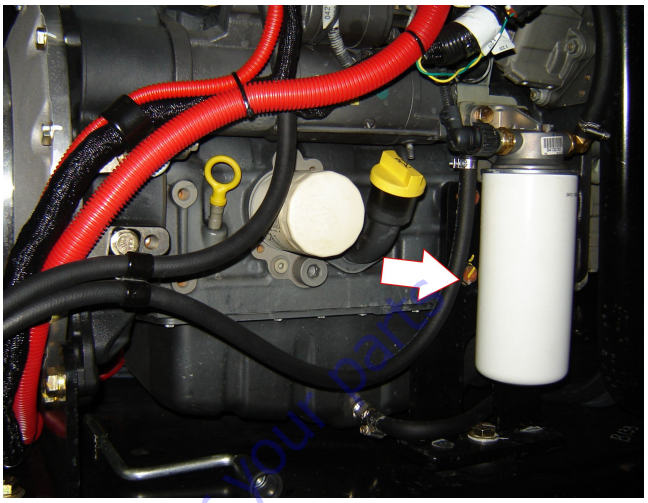
Lube Point(s) - Fill Cap
Capacity - 93 Gallons (352 liters) Tank to Full Mark
124 Gallons (469.3 L) System
Lube - HO
Interval - Check level daily. Change every 2 years or 1200 hours of operation.

9. Oil Change w/Filter - Deutz



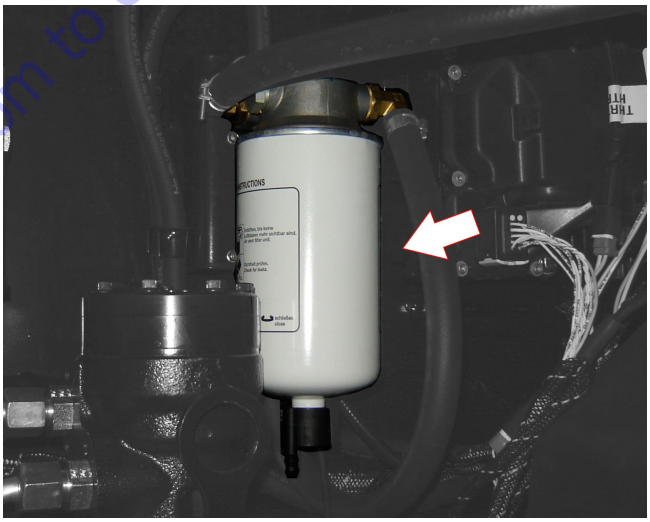
Lube Point(s) - Fill Cap/Spin-on Element
Capacity - 9.4 Quarts (8.9 L)
Lube - EO
Interval - Check level daily; change every 500 hours or yearly, whichever comes first. Adjust final oil level by mark on dipstick.

10. Fuel Filter - Deutz



Lube Point(s) - Replaceable Element
Interval - Every year or 500 hours of operation.

11. Fuel Pre-Filter



Lube Point(s) - Replaceable Element
Interval - Every year or 500 hours of operation.

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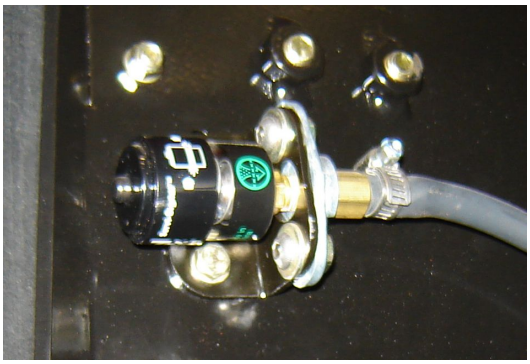
12. Air Filter



Lube Point(s) - Replaceable Element
Interval - Every 6 months or 300 hours of operation or as indicated by the condition indicator
Comments - Check dust valve for dirt daily.

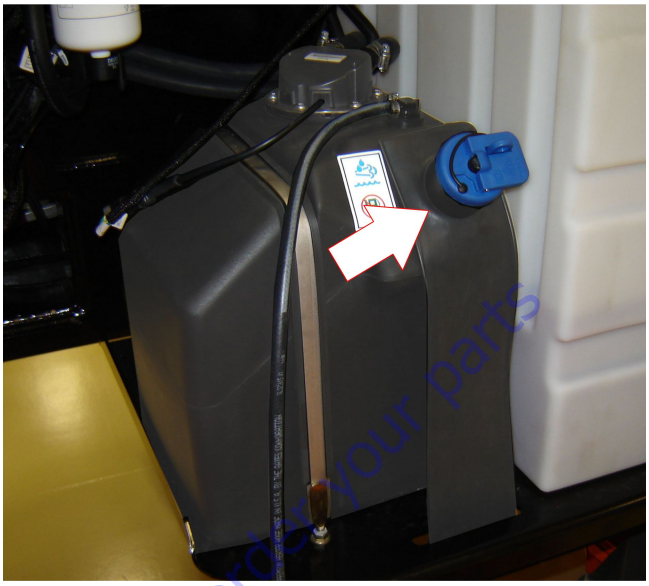
13. Boom

Lube Point(s) - Apply to wear pad contact paths
Lube - Super Lube®
Interval - As needed.

14. Radiator

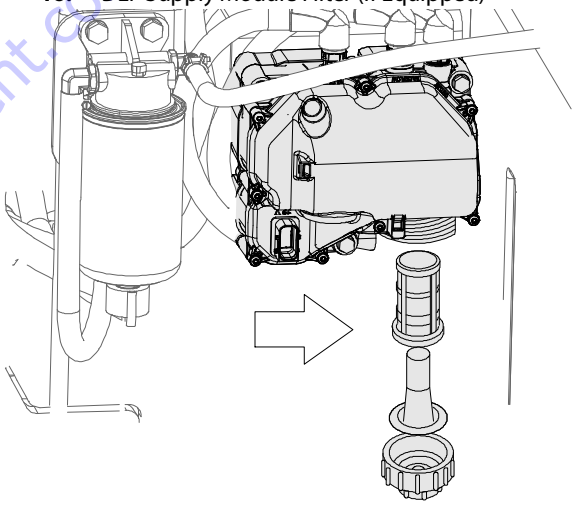
Lube Point(s) - Fill Cap
Lube - Anti-Freeze Coolant (Refer to Engine Manual for compatible coolants)
Capacity - Engines using DEF - 18.5 qt. (17.5 L).

15. Diesel Exhaust Fluid (DEF) (If Equipped)



Lube Point - Fill Cap
Lube - DEF
Capacity - 5.7 gal. (21.5 L).

16. DEF Supply Module Filter (If Equipped)



Interval - 500 hours or 2 years, whichever comes first.

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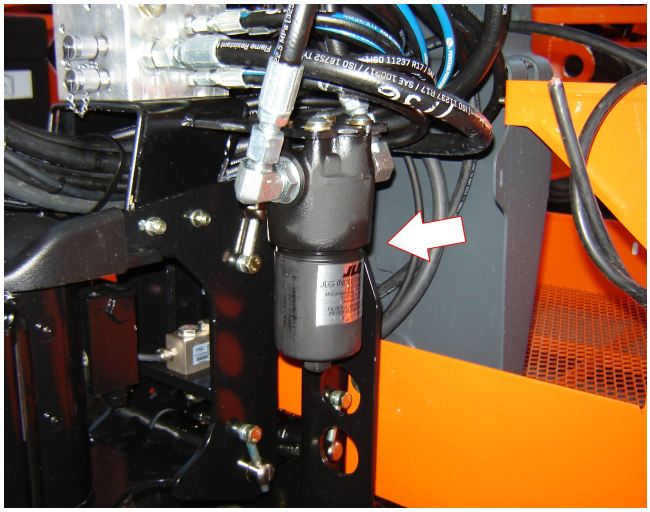
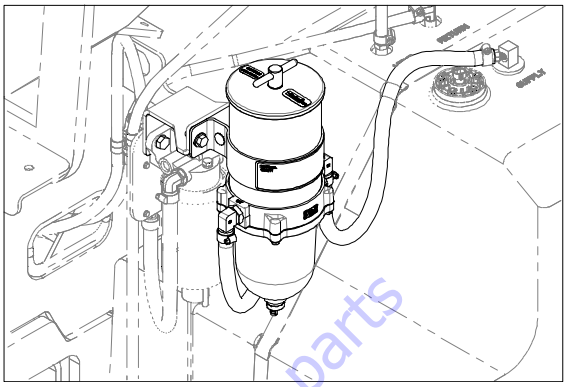
17. Platform Filter



Lube Point - Replaceable Element
Interval - Change after first 50 hours and then every year or 600 hours of operation, whichever comes first.

18. Optional Fuel Filter/Water Separator



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

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1.9 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.*

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1.10 TORQUE CHARTS

SAE Fastener Torque Chart

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)												
SAE GRADE 5 BOLTS & GRADE 2 NUTS												
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry)		Torque Lubricated		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140)		Torque (Loctite® 262™ or Vibra-TITE™ 111)	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	8	0.9	6	0.7				
	48	0.1120	0.00661	420	9	1.0	7	0.8				
6	32	0.1380	0.00909	580	16	1.8	12	1.4				
	40	0.1380	0.01015	610	18	2.0	13	1.5				
8	32	0.1640	0.01400	900	30	3.4	22	2.5				
	36	0.1640	0.01474	940	31	3.5	23	2.6				
10	24	0.1900	0.01750	1120	43	4.8	32	3.5				
	32	0.1900	0.02000	1285	49	5.5	36	4				
1/4	20	0.2500	0.0318	2020	96	10.8	75	9	105	12		
	28	0.2500	0.0364	2320	120	13.5	86	10	135	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	17	23	13	18	19	26	16	22
	24	0.3125	0.0580	3700	19	26	14	19	21	29	17	23
3/8	16	0.3750	0.0775	4940	30	41	23	31	35	48	28	38
	24	0.3750	0.0878	5600	35	47	25	34	40	54	32	43
7/16	14	0.4375	0.1063	6800	50	68	35	47	55	75	45	61
	20	0.4375	0.1187	7550	55	75	40	54	60	82	50	68
1/2	13	0.5000	0.1419	9050	75	102	55	75	85	116	68	92
	20	0.5000	0.1599	10700	90	122	65	88	100	136	80	108
9/16	12	0.5625	0.1820	11600	110	149	80	108	120	163	98	133
	18	0.5625	0.2030	12950	120	163	90	122	135	184	109	148
5/8	11	0.6250	0.2260	14400	150	203	110	149	165	224	135	183
	18	0.6250	0.2560	16300	170	230	130	176	190	258	153	207
3/4	10	0.7500	0.3340	21300	260	353	200	271	285	388	240	325
	16	0.7500	0.3730	23800	300	407	220	298	330	449	268	363
7/8	9	0.8750	0.4620	29400	430	583	320	434	475	646	386	523
	14	0.8750	0.5090	32400	470	637	350	475	520	707	425	576
1	8	1.0000	0.6060	38600	640	868	480	651	675	918	579	785
	12	1.0000	0.6630	42200	700	949	530	719	735	1000	633	858
1 1/8	7	1.1250	0.7630	42300	800	1085	600	813	840	1142	714	968
	12	1.1250	0.8560	47500	880	1193	660	895	925	1258	802	1087
1 1/4	7	1.2500	0.9690	53800	1120	1518	840	1139	1175	1598	1009	1368
	12	1.2500	1.0730	59600	1240	1681	920	1247	1300	1768	1118	1516
1 3/8	6	1.3750	1.1550	64100	1460	1979	1100	1491	1525	2074	1322	1792
	12	1.3750	1.3150	73000	1680	2278	1260	1708	1750	2380	1506	2042
1 1/2	6	1.5000	1.4050	78000	1940	2630	1460	1979	2025	2754	1755	2379
	12	1.5000	1.5800	87700	2200	2983	1640	2224	2300	3128	1974	2676

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

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

3. * ASSEMBLY USES HARDENED WASHER

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SAE Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) K=0.20		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.18		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474	1320	43	5				
10	24	0.1900	0.01750	1580	60	7				
	32	0.1900	0.02000	1800	68	8				
1/4	20	0.2500	0.0318	2860	143	16	129	15		
	28	0.2500	0.0364	3280	164	19	148	17		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	25	35	20	25	20	25
	24	0.3125	0.0580	5220	25	35	25	35	20	25
3/8	16	0.3750	0.0775	7000	45	60	40	55	35	50
	24	0.3750	0.0878	7900	50	70	45	60	35	50
7/16	14	0.4375	0.1063	9550	70	95	65	90	50	70
	20	0.4375	0.1187	10700	80	110	70	95	60	80
1/2	13	0.5000	0.1419	12750	105	145	95	130	80	110
	20	0.5000	0.1599	14400	120	165	110	150	90	120
9/16	12	0.5625	0.1820	16400	155	210	140	190	115	155
	18	0.5625	0.2030	18250	170	230	155	210	130	175
5/8	11	0.6250	0.2260	20350	210	285	190	260	160	220
	18	0.6250	0.2560	23000	240	325	215	290	180	245
3/4	10	0.7500	0.3340	30100	375	510	340	460	280	380
	16	0.7500	0.3730	33600	420	570	380	515	315	430
7/8	9	0.8750	0.4620	41600	605	825	545	740	455	620
	14	0.8750	0.5090	45800	670	910	600	815	500	680
1	8	1.0000	0.6060	51500	860	1170	770	1045	645	875
	12	1.0000	0.6630	59700	995	1355	895	1215	745	1015
11/8	7	1.1250	0.7630	68700	1290	1755	1160	1580	965	1310
	12	1.1250	0.8560	77000	1445	1965	1300	1770	1085	1475
11/4	7	1.2500	0.9690	87200	1815	2470	1635	2225	1365	1855
	12	1.2500	1.0730	96600	2015	2740	1810	2460	1510	2055
13/8	6	1.3750	1.1550	104000	2385	3245	2145	2915	1785	2430
	12	1.3750	1.3150	118100	2705	3680	2435	3310	2030	2760
11/2	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

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SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 5 BOLTS & GRADE 2 NUTS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604	380	7	0.8				
	48	0.1120	0.00661	420	8	0.9				
6	32	0.1380	0.00909	580	14	1.5				
	40	0.1380	0.01015	610	14	1.6				
8	32	0.1640	0.01400	900	25	2.8				
	36	0.1640	0.01474	940	26	2.9				
10	24	0.1900	0.01750	1120	36	4.1				
	32	0.1900	0.02000	1285	42	4.7				
1/4	20	0.2500	0.0318	2020	86	9.7	80	9		
	28	0.2500	0.0364	2320	99	11.1	95	11		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	3340	15	20	14	19	15	20
	24	0.3125	0.0580	3700	15	20	15	21	15	20
3/8	16	0.3750	0.0775	4940	25	35	25	34	25	34
	24	0.3750	0.0878	5600	30	40	28	38	25	34
7/16	14	0.4375	0.1063	6800	40	55	40	54	35	48
	20	0.4375	0.1187	7550	45	60	44	60	40	54
1/2	13	0.5000	0.1419	9050	65	90	60	82	55	75
	20	0.5000	0.1599	10700	75	100	71	97	65	88
9/16	12	0.5625	0.1820	11600	90	120	87	118	80	109
	18	0.5625	0.2030	12950	105	145	97	132	90	122
5/8	11	0.6250	0.2260	14400	130	175	120	163	115	156
	18	0.6250	0.2560	16300	145	195	136	185	125	170
3/4	10	0.7500	0.3340	21300	225	305	213	290	200	272
	16	0.7500	0.3730	23800	255	345	238	324	225	306
7/8	9	0.8750	0.4620	29400	365	495	343	466	320	435
	14	0.8750	0.5090	32400	400	545	378	514	355	483
1	8	1.0000	0.6060	38600	545	740	515	700	480	653
	12	1.0000	0.6630	42200	600	815	563	765	530	721
1 1/8	7	1.1250	0.7630	42300	675	920	635	863	595	809
	12	1.1250	0.8560	47500	755	1025	713	969	670	911
1 1/4	7	1.2500	0.9690	53800	955	1300	897	1219	840	1142
	12	1.2500	1.0730	59600	1055	1435	993	1351	930	1265
1 3/8	6	1.3750	1.1550	64100	1250	1700	1175	1598	1100	1496
	12	1.3750	1.3150	73000	1420	1930	1338	1820	1255	1707
1 1/2	6	1.5000	1.4050	78000	1660	2260	1560	2122	1465	1992
	12	1.5000	1.5800	87700	1865	2535	1754	2385	1645	2237

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

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

3. * ASSEMBLY USES HARDENED WASHER

5000059K

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SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SAE GRADE 8 (HEX HD) BOLTS & GRADE 8 NUTS*										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load	Torque (Dry or Loctite® 263) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474	1320	37	4				
10	24	0.1900	0.01750	1580	51	6				
	32	0.1900	0.02000	1800	58	7				
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	410	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625

NOTES: 1. THESE TORQUE VALUES DO NOT APPLY TO CADMIUM PLATED FASTENERS 5000059K

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

3. * ASSEMBLY USES HARDENED WASHER

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SAE Fastener Torque Chart (Continued)

Values for Magni Coating Fasteners (Ref 4150701)										
SOCKET HEAD CAPSCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) or Precoat® 85 K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474							
10	24	0.1900	0.01750							
	32	0.1900	0.02000							
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	415	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625

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

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SAE Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*										
SOCKET HEAD CAPSCREWS										
Size	TPI	Bolt Dia	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry) K=0.17		Torque (Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) or Precoat® 85 K=0.16		Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15	
		In	Sq In	LB	IN-LB	[N.m]	IN-LB	[N.m]	IN-LB	[N.m]
4	40	0.1120	0.00604							
	48	0.1120	0.00661							
6	32	0.1380	0.00909							
	40	0.1380	0.01015							
8	32	0.1640	0.01400							
	36	0.1640	0.01474							
10	24	0.1900	0.01750							
	32	0.1900	0.02000							
1/4	20	0.2500	0.0318	2860	122	14	114	13		
	28	0.2500	0.0364	3280	139	16	131	15		
		In	Sq In	LB	FT-LB	[N.m]	FT-LB	[N.m]	FT-LB	[N.m]
5/16	18	0.3125	0.0524	4720	20	25	20	25	20	25
	24	0.3125	0.0580	5220	25	35	20	25	20	25
3/8	16	0.3750	0.0775	7000	35	50	35	50	35	50
	24	0.3750	0.0878	7900	40	55	40	55	35	50
7/16	14	0.4375	0.1063	9550	60	80	55	75	50	70
	20	0.4375	0.1187	10700	65	90	60	80	60	80
1/2	13	0.5000	0.1419	12750	90	120	85	115	80	110
	20	0.5000	0.1599	14400	100	135	95	130	90	120
9/16	12	0.5625	0.1820	16400	130	175	125	170	115	155
	18	0.5625	0.2030	18250	145	195	135	185	130	175
5/8	11	0.6250	0.2260	20350	180	245	170	230	160	220
	18	0.6250	0.2560	23000	205	280	190	260	180	245
3/4	10	0.7500	0.3340	30100	320	435	300	415	280	380
	16	0.7500	0.3730	33600	355	485	335	455	315	430
7/8	9	0.8750	0.4620	41600	515	700	485	660	455	620
	14	0.8750	0.5090	45800	570	775	535	730	500	680
1	8	1.0000	0.6060	51500	730	995	685	930	645	875
	12	1.0000	0.6630	59700	845	1150	795	1080	745	1015
1 1/8	7	1.1250	0.7630	68700	1095	1490	1030	1400	965	1310
	12	1.1250	0.8560	77000	1225	1665	1155	1570	1085	1475
1 1/4	7	1.2500	0.9690	87200	1545	2100	1455	1980	1365	1855
	12	1.2500	1.0730	96600	1710	2325	1610	2190	1510	2055
1 3/8	6	1.3750	1.1550	104000	2025	2755	1905	2590	1785	2430
	12	1.3750	1.3150	118100	2300	3130	2165	2945	2030	2760
1 1/2	6	1.5000	1.4050	126500	2690	3660	2530	3440	2370	3225
	12	1.5000	1.5800	142200	3020	4105	2845	3870	2665	3625

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

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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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Metric Fastener Torque Chart (Continued)

Values for Zinc Yellow Chromate Fasteners (Ref 4150707)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS, CLASS 10 METRIC NUTS CLASS 12.9 SOCKET HEAD CAPSCREWS M3 - M5*						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.20	Torque (Lube or Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.18	Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	3.13			
3.5	0.6	6.78	4.22			
4	0.7	8.78	5.47			
5	0.8	14.20	8.85			
6	1	20.10	12.5			
7	1	28.90	18.0	25	23	19
8	1.25	36.60	22.8	37	33	27
10	1.5	58.00	36.1	70	65	55
12	1.75	84.30	52.5	125	115	95
14	2	115	71.6	200	180	150
16	2	157	97.8	315	280	235
18	2.5	192	119.5	430	385	325
20	2.5	245	152.5	610	550	460
22	2.5	303	189.0	830	750	625
24	3	353	222.0	1065	960	800
27	3	459	286.0	1545	1390	1160
30	3.5	561	349.5	2095	1885	1575
33	3.5	694	432.5	2855	2570	2140
36	4	817	509.0	3665	3300	2750
42	4.5	1120	698.0	5865	5275	4395

NOTES:

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Metric Fastener Torque Chart (Continued)

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 8.8 METRIC (HEX/SOCKET HEAD) BOLTS CLASS 8 METRIC NUTS						
Size	Pitch	Tensile Stress Area	Clamp Load See Note 4	Torque (Dry or Loctite® 263™) K=0.17	Torque (Lube or Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.16	Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15
		Sq mm	KN	[N.m]	[N.m]	[N.m]
3	0.5	5.03	2.19	1.1	1.1	1.0
3.5	0.6	6.78	2.95	1.8	1.7	1.5
4	0.7	8.78	3.82	2.6	2.4	2.3
5	0.8	14.20	6.18	5.3	4.9	4.6
6	1	20.10	8.74	9	8.4	7.9
7	1	28.90	12.6	15	14	13
8	1.25	36.60	15.9	22	20	19
10	1.5	58.00	25.2	43	40	38
12	1.75	84.30	36.7	75	70	66
14	2	115	50.0	119	110	105
16	2	157	68.3	186	175	165
18	2.5	192	83.5	256	240	225
20	2.5	245	106.5	362	340	320
22	2.5	303	132.0	494	465	435
24	3	353	153.5	627	590	555
27	3	459	199.5	916	860	810
30	3.5	561	244.0	1245	1170	1100
33	3.5	694	302.0	1694	1595	1495
36	4	817	355.5	2176	2050	1920
42	4.5	1120	487.0	3477	3275	3070

NOTES:

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Metric Fastener Torque Chart (Continued)

Values for Magni Coated Fasteners (Ref 4150701)*						
CLASS 10.9 METRIC (HEX HEAD) BOLTS CLASS 10 METRIC NUTS, CLASS 12.9 SOCKET HEAD CAPSCREWS M6 AND ABOVE*						
Size	**Pitch**	**Tensile Stress Area**	**Clamp Load See Note 4**	**Torque (Dry or Loctite® 263™) K=0.17**	**Torque (Lube or Loctite® 242™ or 271™ or Vibra-TITE™ 111 or 140) K=0.18**	**Torque (Loctite® 262™ or Vibra-TITE™ 131) K=0.15**
		Sq mm	**KN**	**[N.m]**	**[N.m]**	**[N.m]**
3	0.5	5.03	3.13			
3.5	0.6	6.78	4.22			
4	0.7	8.78	5.47			
5	0.8	14.20	8.85			
6	1	20.10	12.5	13	12	11
7	1	28.90	18.0	21	20	19
8	1.25	36.60	22.8	31	29	27
10	1.5	58.00	36.1	61	58	55
12	1.75	84.30	52.5	105	100	95
14	2	115	71.6	170	160	150
16	2	157	97.8	265	250	235
18	2.5	192	119.5	365	345	325
20	2.5	245	152.5	520	490	460
22	2.5	303	189.0	705	665	625
24	3	353	222.0	905	850	800
27	3	459	286.0	1315	1235	1160
30	3.5	561	349.5	1780	1680	1575
33	3.5	694	432.5	2425	2285	2140
36	4	817	509.0	3115	2930	2750
42	4.5	1120	698.0	4985	4690	4395

NOTES:

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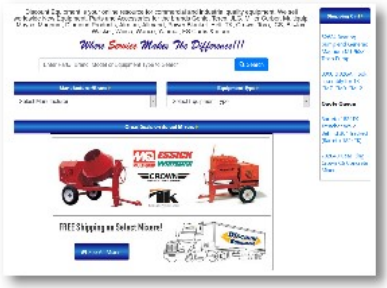

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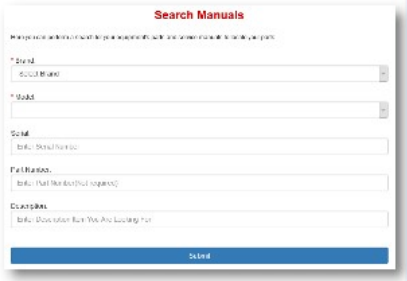

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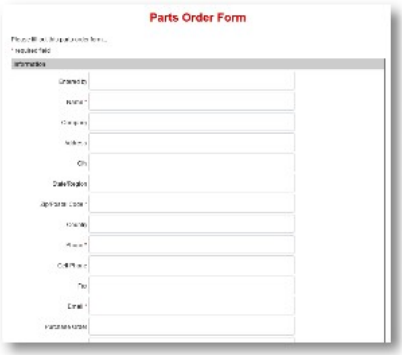

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SECTION 2. GENERAL

2.1 MACHINE PREPARATION, INSPECTION, AND MAINTENANCE

General

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

Preparation, Inspection, and Maintenance

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

Pre-Start Inspection

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

Pre-Delivery Inspection and Frequent Inspection

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

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

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

Annual Machine Inspection

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

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

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

Preventive Maintenance

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

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

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Table 2-1. Inspection and Maintenance

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

2.2 SERVICE AND GUIDELINES

General

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

Safety and Workmanship

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

Cleanliness

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

Components Removal and Installation

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

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Component Disassembly and Reassembly

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

Pressure-Fit Parts

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

Bearings

1. When a bearing is removed, cover it to keep out dirt and abrasives. Clean bearings in nonflammable cleaning solvent and allow to drip dry. Compressed air can be used but do not spin the bearing.
2. Discard bearings if the races and balls (or rollers) are pitted, scored, or burned.
3. If bearing is found to be serviceable, apply a light coat of oil and wrap it in clean (waxed) paper. Do not unwrap reusable or new bearings until they are ready to install.
4. Lubricate new or used serviceable bearings before installation. When pressing a bearing into a retainer or bore, apply pressure to the outer race. If the bearing is to be installed on a shaft, apply pressure to the inner race.

Gaskets

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

Bolt Usage and Torque Application

NOTICE

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

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

Hydraulic Lines and Electrical Wiring

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

Hydraulic System

1. Keep the system clean. If evidence of metal or rubber particles are found in the hydraulic system, drain and flush the entire system.
2. Disassemble and reassemble parts on clean work surface. Clean all metal parts with non-flammable cleaning solvent. Lubricate components, as required, to aid assembly.

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Lubrication

Service applicable components with the amount, type, and grade of lubricant recommended in this manual, at the specified intervals. When recommended lubricants are not available, consult your local supplier for an equivalent that meets or exceeds the specifications listed.

Battery

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

Lubrication and Servicing

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

2.3 LUBRICATION AND INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g., using inadequate hydraulic oil, allowing moisture, grease, filings, sealing components, sand, etc., to enter when performing maintenance, or by permitting the pump to cavitate due to insufficient system warm-up or leaks in the pump supply (suction) lines.

2. The design and manufacturing tolerances of the component working parts are very close, therefore, even the smallest amount of dirt or foreign matter entering a system can cause wear or damage to the components and generally results in faulty operation. Every precaution must be taken to keep hydraulic oil clean, including reserve oil in storage. Hydraulic system filters should be checked, cleaned, and/or replaced as necessary, at the specified intervals required in the Lubrication Chart in Section 1. Always examine filters for evidence of metal particles.

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

4. It is not advisable to mix oils of different brands or types, as they may not contain the same required additives or be of comparable viscosities. Good grade mineral oils, with viscosities suited to the ambient temperatures in which the machine is operating, are recommended for use.

NOTE: *Metal particles may appear in the oil or filters of new machines due to the wear-in of meshing components.*

Hydraulic Oil

1. Refer to Section 1 for recommendations for viscosity ranges.

2. JLG recommends Standard UTTO Fluid hydraulic oil, which has an SAE viscosity of 10W and a viscosity index of 140.

NOTE: *Start-up of hydraulic system with oil temperatures below -20 degrees F (-29 degrees C) is not recommended. If it is necessary to start the system in a sub-zero environment, it will be necessary to heat the oil with a low density, 100VAC heater to a minimum temperature of -20 degrees F (-29 degrees C).*

Changing Hydraulic Oil

1. Filter elements must be changed after the first 50 hours of operation and every 300 hours thereafter. If it is necessary to change the oil, use only those oils meeting or exceeding the specifications appearing in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils.

2. Use every precaution to keep the hydraulic oil clean. If the oil must be poured from the original container into another, be sure to clean all possible contaminants from the service container. Always clean the mesh element of the filter and replace the cartridge any time the system oil is changed.

3. While the unit is shut down, a good preventive maintenance measure is to make a thorough inspection of all hydraulic components, lines, fittings, etc., as well as a functional check of each system, before placing the machine back in service.

Lubrication Specifications

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

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2.4 CYLINDER DRIFT

Theory

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

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

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

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

Cylinder Leakage Test

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

Measure drift at cylinder rod with a calibrated dial indicator.

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

Cylinder leakage is acceptable if it passes this test.

Table 2-2. Cylinder Drift

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

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

Cylinder Thermal Drift

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

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2.5 PINS AND COMPOSITE BEARING REPAIR GUIDELINES

Filament wound bearings.

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

2.6 WELDING ON JLG EQUIPMENT

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

Do the Following When Welding on JLG Equipment

- Disconnect the battery.
- Ground only to structure being welded.
- Unplug all pressure transducers.

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.)

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Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL	
	Pre-Delivery[1] or Frequent[2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
Boom Assembly		
Boom Weldments	1,2	1,2
Hose/Cable Carrier Installations	1,2	1,2
Pivot Pins and Pin Retainers	1,2	1,2
Sheaves, Sheave Pins	1,2	1,2
Bearings	1,2	1,2
Wear Pads	1,2	1,2
Covers or Shields	1,2	1,2
Extend/Retract Chain or Cable Systems[4]	1,2	1,2
Platform Assembly		
Railing	2	2
Gate	1,2,3	1,2,3
Floor	2	2
Rotator	1,2,3,4	1,2,3,4
Lanyard Anchorage Point	1,2,6	1,2,6
Turntable Assembly		
Swing Bearing or Worm Gear	1[50],2	1[50],2
Oil Coupling	4	4
Swing Drive System	1,4	1,4
Turntable Lock	1,2,3	1,2,3
Hood, Hood Props, Hood Latches	3	3
Chassis Assembly		
Tires	1,2	1,2
Wheel Nuts/Bolts	1[50]	1[50]
Wheel Bearings	1,2,4,5	1,2,4,5
Extendable Axle Systems	3	3
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
Footswitch (shuts off function when released)	1,3,9	1,3,9

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Table 2-3. Inspection and Preventive Maintenance Schedule

AREA	INTERVAL	
	Pre-Delivery[1] or Frequent[2] (Quarterly) Inspection	Annual[3] (Yearly) Inspection
Emergency Stop Switches (Ground & Platform) arrest all platform movement	1,3,6	1,3,9
Function Limit or Cutout Switch Systems	1,3,9	1,3,9
Capacity Indicator	1,3,9	1,3,9
Drive Brakes	1,3,9	1,3,9
Swing Brakes	1,3,9	1,3,9
Auxiliary Power	1,3,9	1,3,9
Power System		
Engine Idle, Throttle, and RPM	1,3,7	1,3,7
Engine Fluids: Oil	4	4
Engine Fluids: Coolant	1,4,7	1,4,7
Air Filter	1,4	1,4
Fuel Filter(s)	1,5	1,5
Drain Oil Build Up in 2-Stage Vaporizer (LP Only)	1,4	1,4
Exhaust System	1,4	1,4
Batteries	1,4	1,4
Battery Fluid	4	4
Battery Charger	1,3	1,3
Intake System	1,2	1,2
Glow Plug (Diesel Only)	1,2,3	1,2,3
Serpentine Belt, Tensioner, Pulleys	1,2,3	1,2,3
Fuel Reservoir, Cap, and Breather	1,3,4	1,3,4
Hydraulic/Electric System		
Hydraulic Pumps	1,2,4	1,2,4
Hydraulic Cylinders	1,2,4,5	1,2,4,5
Cylinder Attachment Pins and Pin Retainers	1,2	1,2
Hydraulic Hoses, Lines, and Fittings	1,2,4	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	1,4,5
Hydraulic Fluid	4,5	4,5
Electrical Connections	1,2	1,2
Instruments, Gauges, Switches, Lights, Horn	1,3	1,3
General		
Operators and Safety Manuals in Storage Box	9	9
ANSI Manual of Responsibilities and AEM Safety Manual in Storage Box (ANSI and ANSI Export only)	2,1	2,1

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Table 2-3. Inspection and Preventive Maintenance Schedule

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

Footnotes:

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

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

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

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

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

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

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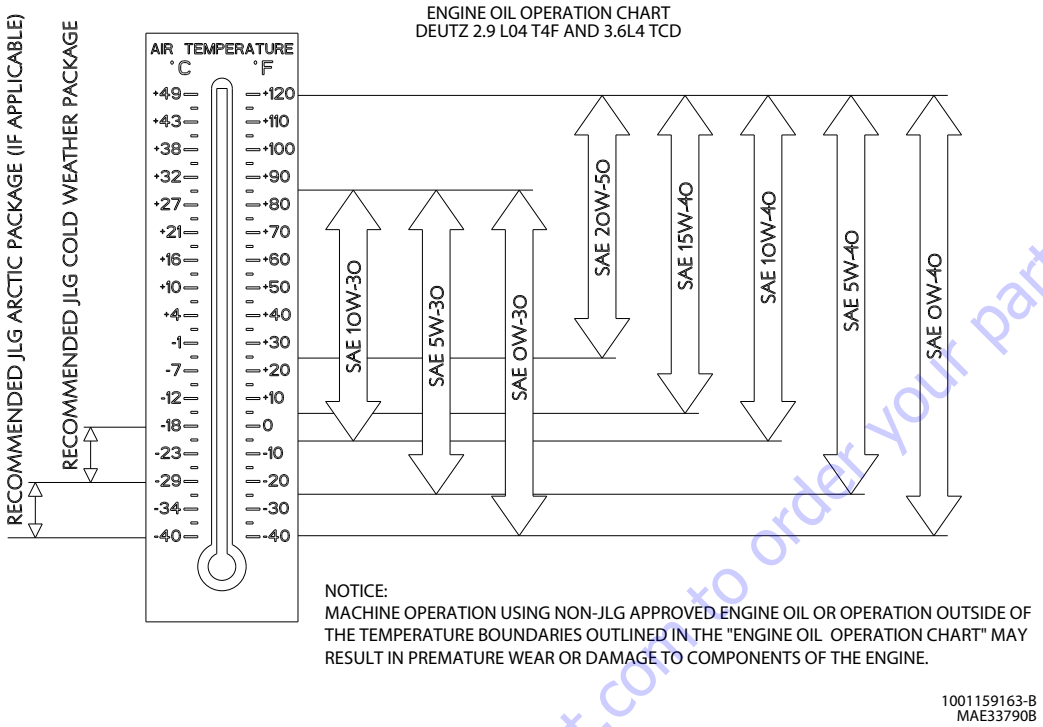

Figure 2-1. Engine Operating Temperature Specifications - Deutz

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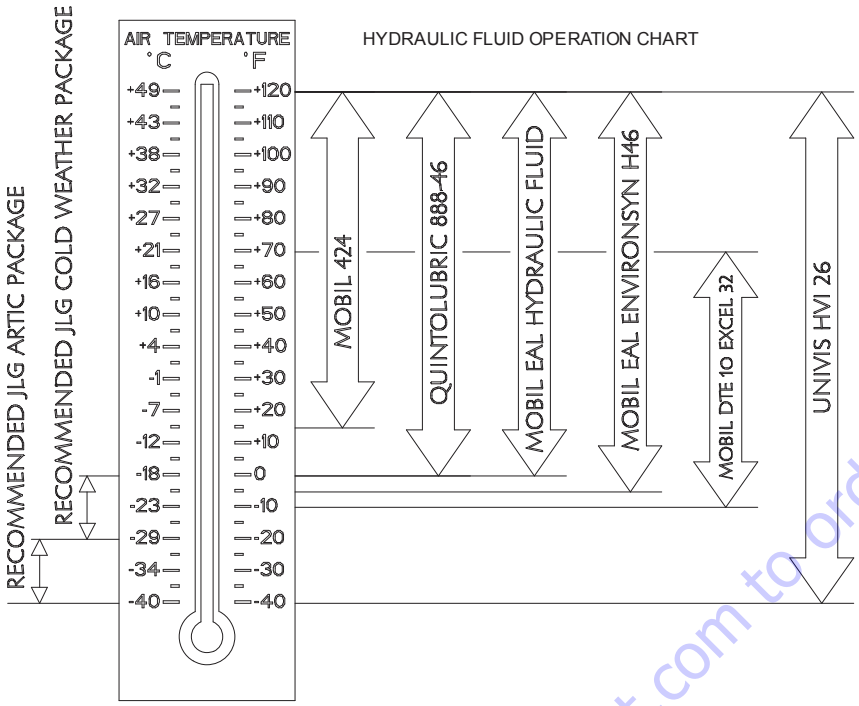

NOTICE:

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

Fluid	Properties		Base				Classifications		
Description	Viscosity at 40°C (cSt, Typical)	Viscosity Index	Mineral Oils	Vegetable Oils	Synthetic	Synthetic Polyol Esters	Readily Biodegradable*	Virtually Non-toxic**	Fire Resistant***
Mobilfluid 424	55	145	X						
Mobil DTE 10 Excel 32	32	164	X					X	
Univis HVI 26	26	376	X						
Mobil EAL Hydraulic Oil	47	176		X			X	X	
Mobil EAL Envirosyn H46	49	145			X		X	X	
Quintolubric 888-46	50	185				X	X	X	X

* Readily biodegradable classification indicates one of the following:
CO2 Conversion > 60% per EPA 560/6-82-003
CO2 Conversion > 80% per CEC-L-33-A-93

** Virtually Non-toxic classification indicates an LC50 > 5000 ppm per OECD 203

*** Fire Resistant classification indicates Factory Mutual Research Corp. (FMRC) Approval

4150740-B

Figure 2-2. Hydraulic Oil Operating Temperature Specifications

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SECTION 3. CHASSIS & TURNTABLE

3.1 TIRES AND WHEELS

Tire Damage

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

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

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

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.

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.

Wheel Installation

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

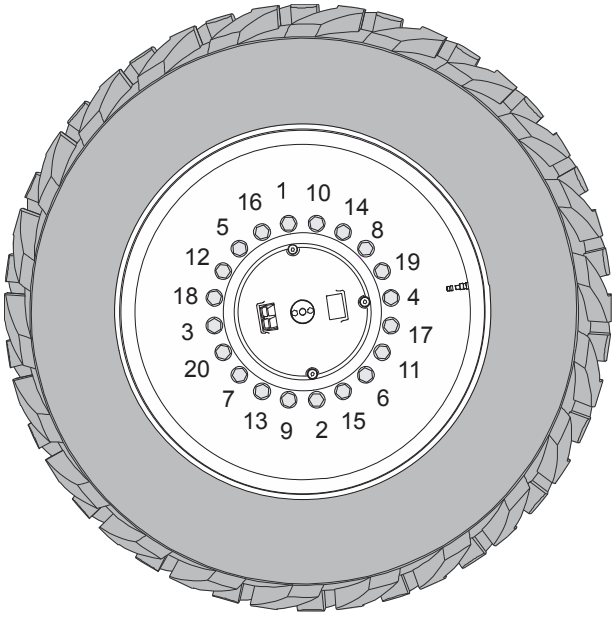
⚠ WARNING

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

Tighten the wheel bolts 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, the fasteners with a lug wrench, then immediately have a service garage or dealer tighten the wheel bolts to the proper torque. Overtightening will result in breaking the bolts or permanently deforming the mounting stud holes in the wheels.

The proper procedure for attaching wheels is as follows:

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



3. The tightening of the wheel bolts should be done in stages. Following the recommended sequence, tighten bolts per wheel torque chart.
4. Wheel bolts should be torqued before first road use and after each wheel removal. Check and torque every 3 months or 150 hours of operation.

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Table 3-1. Wheel Torque Chart

TORQUE SEQUENCE		
1st Stage	2nd Stage	3rd Stage
45 ft. lbs. (61 Nm)	100 ft. lbs. (136 Nm)	180 ft. lbs. (244 Nm)

3.2 AXLE EXTENSION SYSTEM

NOTE: *The boom must be oriented between the rear wheels to extend or retract the axles.*

The Axle Extension System allows each of the four axles to be extended and retracted together while maintaining full steering control as the machine is driven. The system allows the axles to extend or retract only while the boom is in the transport position (see Transport Position Sensing System in Section 4) and in order to minimize wheel scrubbing during axle movement, a minimum drive speed must be attained before axle extension/retraction will be permitted. The system uses four linear sensors (one at each axle) to sense when the axles are fully extended. If any of the linear sensors detect an out of range value for axle set, the control system considers the axles retracted. To extend/retract the axles, the user engages the axle extend/retract switch on the platform console and the drive control at the same time. The axle set indicator will be off when the axles are not fully extended and the axle extend/retract switch is not engaged. It will flash while the axles are extending or retracting and will be on constantly when the axles are fully extended. With the axles not fully extended, the boom is restricted to operation within the transport position (see Transport Position Sensing System in Section 4). If a signal from any axle linear sensor is lost when the boom is beyond the transport position, the axle set indicator will flash and drive/steer functions will be disabled until the boom is brought back into the transport position. The steering angle will be automatically limited to +/- 20 degrees anytime the axles are not fully extended. If the wheel angle is more than +/- 20 degrees when the axle retract command is engaged, the control system will automatically reduce the wheel angle to 20 degrees during axle retraction.

3.3 DRIVE ORIENTATION SYSTEM

The Drive Orientation System (DOS) indicates to the operator conditions that could make the direction of movement of the chassis different than the direction of movement of the drive/steer control handle. The system indicates to the operator the need to match the black and white directional arrows on the platform control panel to the directional arrows on the chassis. The system uses a proximity switch mounted on the hydraulic swivel, an indicator light and a spring return override switch on the platform display panel. The proximity switch trips when the turntable is swung ± 45 degrees off center of the normal driving position. When the turntable is in the normal drive position (the boom between the rear tires), no indications or interlocks are made. When the machine is actively driving when the turntable is swung past the switch point, the system is ignored until drive/steer is released. When drive is initiated with the boom swung past the switch point, the DOS indicator will flash and the drive/steer functions will be disabled. The operator must engage the DOS override switch on the console 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 the last drive/steer command. If the timer expires, the DOS override switch must be re-engaged to enable drive/steer.

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3.4 STEERING CONTROL SYSTEM

There are three different modes of steering selectable by the position of the steer select switch on the platform control panel: crab, coordinated, and conventional two wheel steering. These are shown below.

Figure 3-1. Crab Steer

Figure 3-2. Coordinated Steer

Figure 3-3. 2 Wheel Steer

Each wheel has its own steer cylinder, wheel angle sensor, axle extend linear sensor, and proportional valve, allowing the control system to position each wheel to the ideal angle for all steering modes and all steering commands. This is done whether the axle is retracted, extended, or somewhere in between. Changes in steering modes while drive is engaged causes the wheels to automatically adjust to the appropriate angle for the selected steering mode based on the position of the inside front wheel. If the steer select switch is changed without the footswitch depressed or the EMS is off, the wheels will not move until the footswitch is depressed and a steering or drive command has been initiated. The steering angles are limited to ± 20 degrees anytime the axles are not fully extended. See the Axle Extension System for interaction with the axle extension system. If a wheel cannot achieve its commanded angle within a specified time, it is considered jammed. When a wheel is considered jammed during steering, a fault is reported and the remaining wheels will continue to their commanded position. The fault is cleared when the footswitch is cycled. If a wheel is jammed making it significantly out of position, with regard to the other wheels, the drive motors are restricted to their maximum displacement (slow speed). Wheel angle sensor failures will result in an approximated steering control logic that will allow the operator to move the machine until it can be repaired. The wheel at the failed sensor will be driven based on the information available from the other sensors. This wheel will not track perfectly and will become farther out of position over time. When the wheel becomes prohibitively out of position, the wheels can be resynchronized by fully steering against the mechanical stops.

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Axle extend sensor failures will result in an approximated steering control logic that will allow the operator to move the machine until it can be repaired. The axle at the failed sensor will be driven based on the information available from the other sensors. This axle will not track perfectly and will become farther out of position over time. When the wheel becomes prohibitively out of position, the wheels can be resynchronized by fully steering against the mechanical stops.

3.5 DRIVE/STEERING SPEED CONTROL

The Drive/Steering Speed Control system uses the steering sensors from the steering control system to increase operator control and comfort by reducing the effect of turning the chassis on the resulting lateral platform speed. The system proportionally varies the drive speed based on the predicted turning radius of the chassis.

- For conventional two wheel steer mode, the tighter the turn the slower the allowable drive speed. In addition, when driving in reverse, two speed (high drive) is disabled.
- For coordinated steer or crab steer modes, the tighter the turn the slower the allowable drive speed. In addition two speed (high drive) is disabled anytime you are in these two steer modes.

3.6 DRIVE/STEER - BOOM FUNCTION INTERLOCK SYSTEM (CE ONLY)

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. 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. For example, while operating drive/steer functions the boom functions are inoperable or if operating boom functions, drive/steer functions are inoperable.

3.7 TRACTION CONTROL SYSTEM

The traction control system uses the steering sensors from the steering control system to optimize the performance of the drive system. This is especially important due to the disparity of wheel speeds generated between the inside and outside wheels of the extended axle chassis with large steering angle capability. The steering sensors are used to predict the rolling path and therefore the required wheel speed of each wheel as the steering angles change and steering modes change. The control system can then command the ideal flow from each of the two drive pumps, one for the right side of the machine and one for he left side. Two flow dividers, one for the right side, front to back and one for the left side, front to back absorb the variation in wheel speed, front to back.

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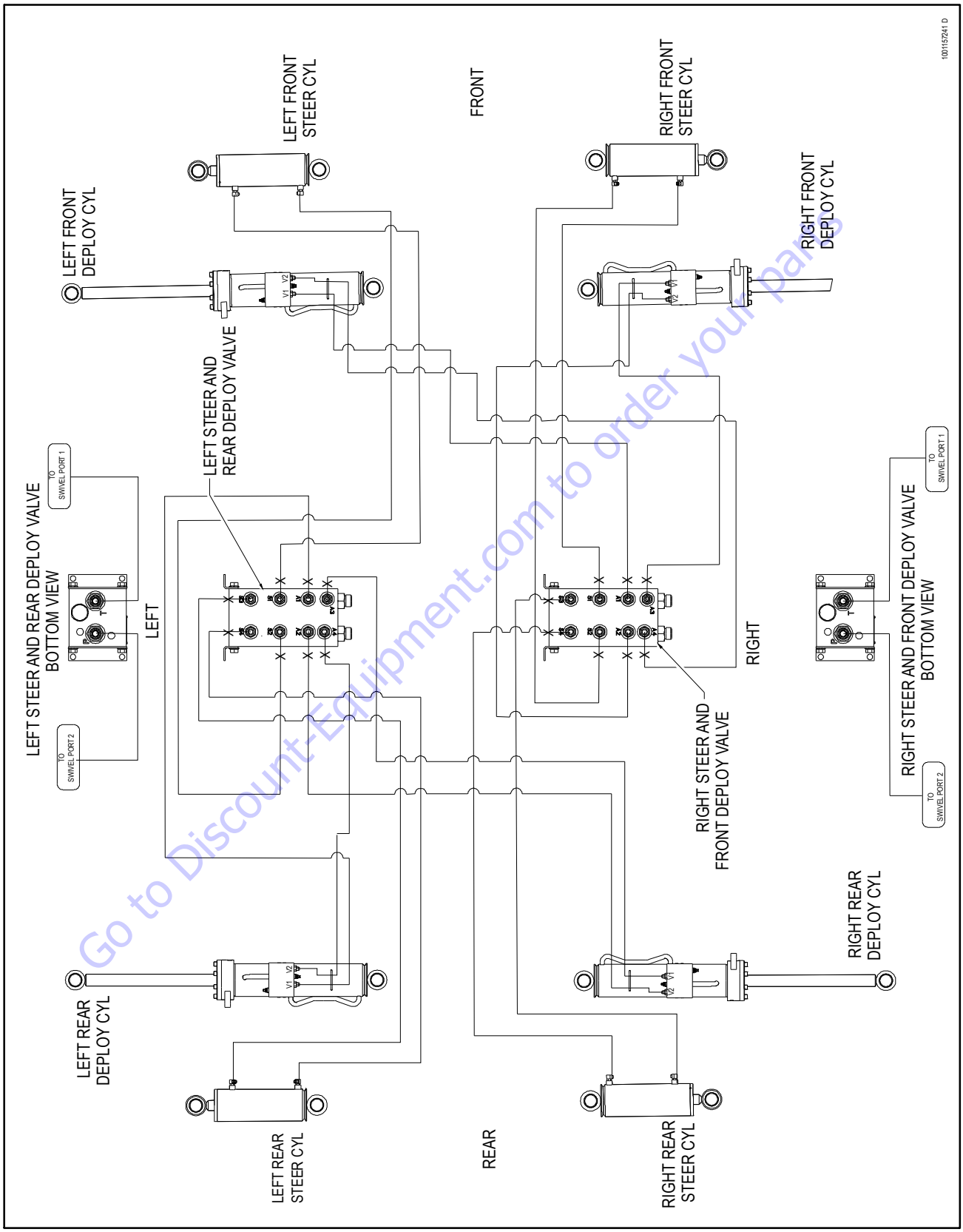

Figure 3-4. Steering/Axle Deploy Hydraulic Circuit

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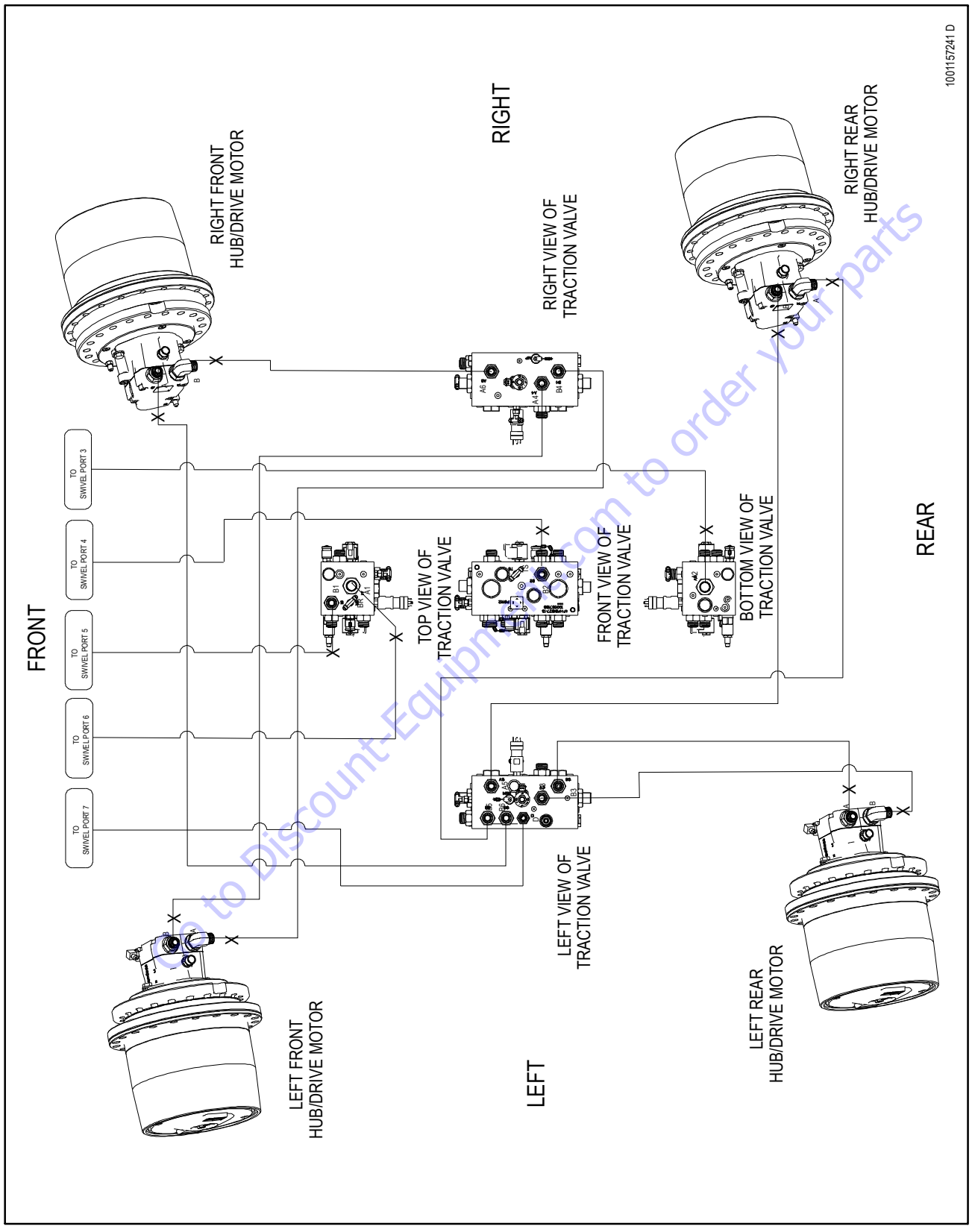

Figure 3-5. Drive System Hydraulic Circuit - Sheet 1 of 2

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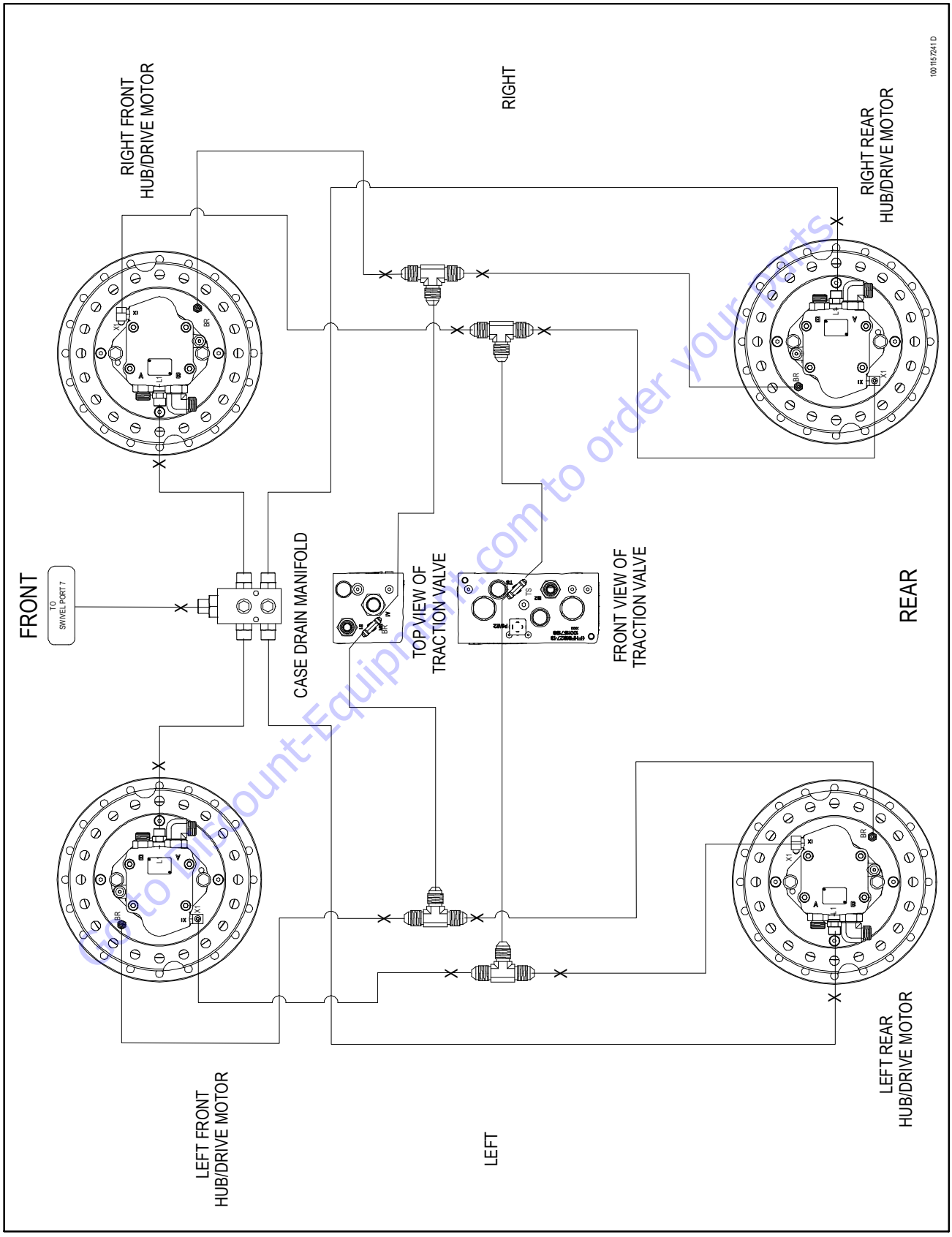

Figure 3-6. Drive System Hydraulic Circuit - Sheet 2 of 2

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3.8 CHASSIS TILT INDICATOR SYSTEM

The Chassis Tilt Indicator System measures the turntable angle with respect to level ground. There are three sensors. The primary sensor is mounted to a bracket above the batteries. This sensor is used by the machine control system to determine tilt angle. The second and third sensors (secondary sensors) are internal in the UGM. The average tilt value of these two sensors is used to compare against the primary sensor for accuracy. Differences between the primary and secondary sensors beyond a predetermined value will result in a machine fault.

Tilt Sensor Settings

The tilt sensors have four settings; 3.0 side tilt, 4.0 side tilt, 5.0 omni-directional tilt, and an 8.0 omni-directional tilt.

The 5.0 omni-directional angle setting is used for the purpose of warning the operator by means of the chassis tilt light in the platform display panel. Also, when used in conjunction with the Beyond Transport - Drive Speed Cutback System, the tilt sensor will cause an alarm to sound and automatically cuts out drive and puts all functions in the creep speed mode. With the exception of the drive cutout and speed cutback, this is a warning system only indicating to the operator the machine has reached the out of level limit.

The 3.0 and 4.0 side tilt settings are used in conjunction with boom position and when exceeded, imposes the same functionality as the 5.0° omni-directional setting. When 3.0 ° < Side Tilt ≤ 4.0° the main boom envelop is reduced in size providing less reach and platform height at certain main boom angles. When 4.0 ° < Side Tilt ≤ 5.0° the main boom envelop is reduced even further.

The 8.0° angle is used only for the purpose of automatically shifting the drive motors to the maximum displacement position (slow speed).

3.9 AUXILIARY POWER SYSTEM

The Auxiliary Power System is a secondary means of moving the tower boom and main boom in the event of primary power loss. The system consists of an electric motor/pump unit (powered by a 12V battery) capable of operating all functions except drive, tower lift up, main boom controlled arc, and main boom controlled boom angle.

When Commanding Tower Boom

No other functions are permitted and the control system will attempt to use the force of gravity to operate tower lift down, tower telescope in, and main lift down by supplying pilot pressure to the respective cylinders. If appropriate movement is not detected by the boom sensors, the auxiliary power system will supply the hydraulic flow to power the movement conventionally.

When Commanding Main Boom

The auxiliary power main lift down function supplies pilot pressure to the main lift cylinder. This allows gravity to lower the boom. The system redirects discharge oil from the main lift cylinder to retract the main telescope cylinder. At high main boom angles the envelope may be encroached during lift down requiring the operator to use main telescope in. When the main boom is retracted to the transport length, the main telescope in valve is dropped out and lift down is operated alone allowing the platform to reach the ground. This not only greatly reduces the power required for these functions but also lowers the boom within the envelope regardless of starting position. Jib lift down function may then be operated allowing the platform to reach ground level.

Envelope Control System Operation

The envelope control system remains active during auxiliary power operation, however, the functionality of tower lift or main lift only approximates the normal tower path control or main boom control functionality. Rather than the normal combined movements of tower lift, tower telescope, and main lift, these movements will automatically alternate during commands for tower lift or main lift to approximate the movements made under normal engine power.

3.10 SWING SPEED PROPORTIONING

Swing Speed Proportioning uses the envelope control sensors to improve the comfort, speed and control of the turntable swing function. Turntable swing speed is increased as the distance of the platform to the center of rotation is decreased and when the tower boom is lowered in angle. This results in approximately constant platform speeds regardless of boom position.

Swing speed proportioning is disabled with any envelope sensors fault. Disabling of swing speed proportioning will default to the slowest swing speed setting.

Go to Discount-Equipment.com to Order your Parts

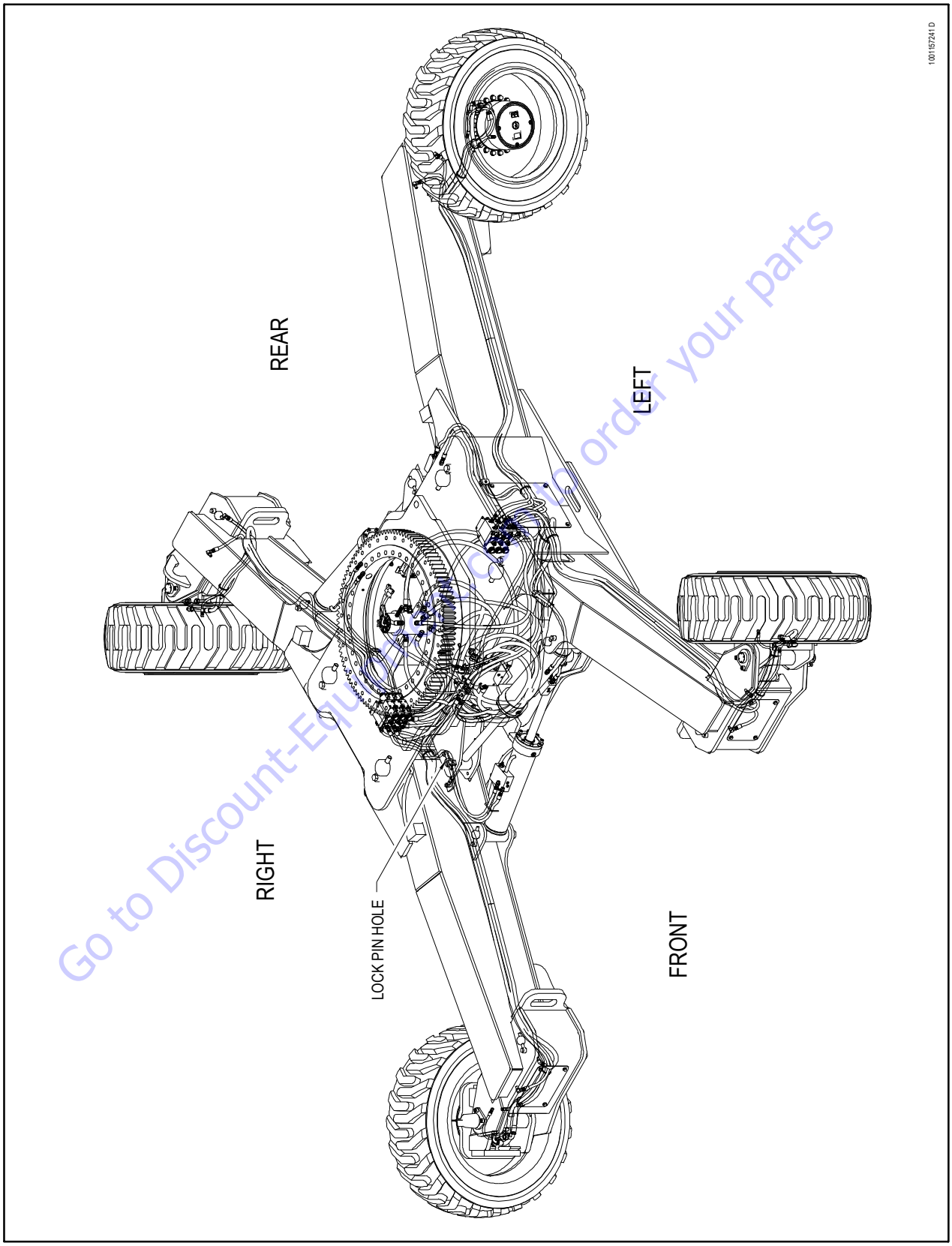

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Figure 3-7. Chassis Hose Routing - Sheet 1 of 7

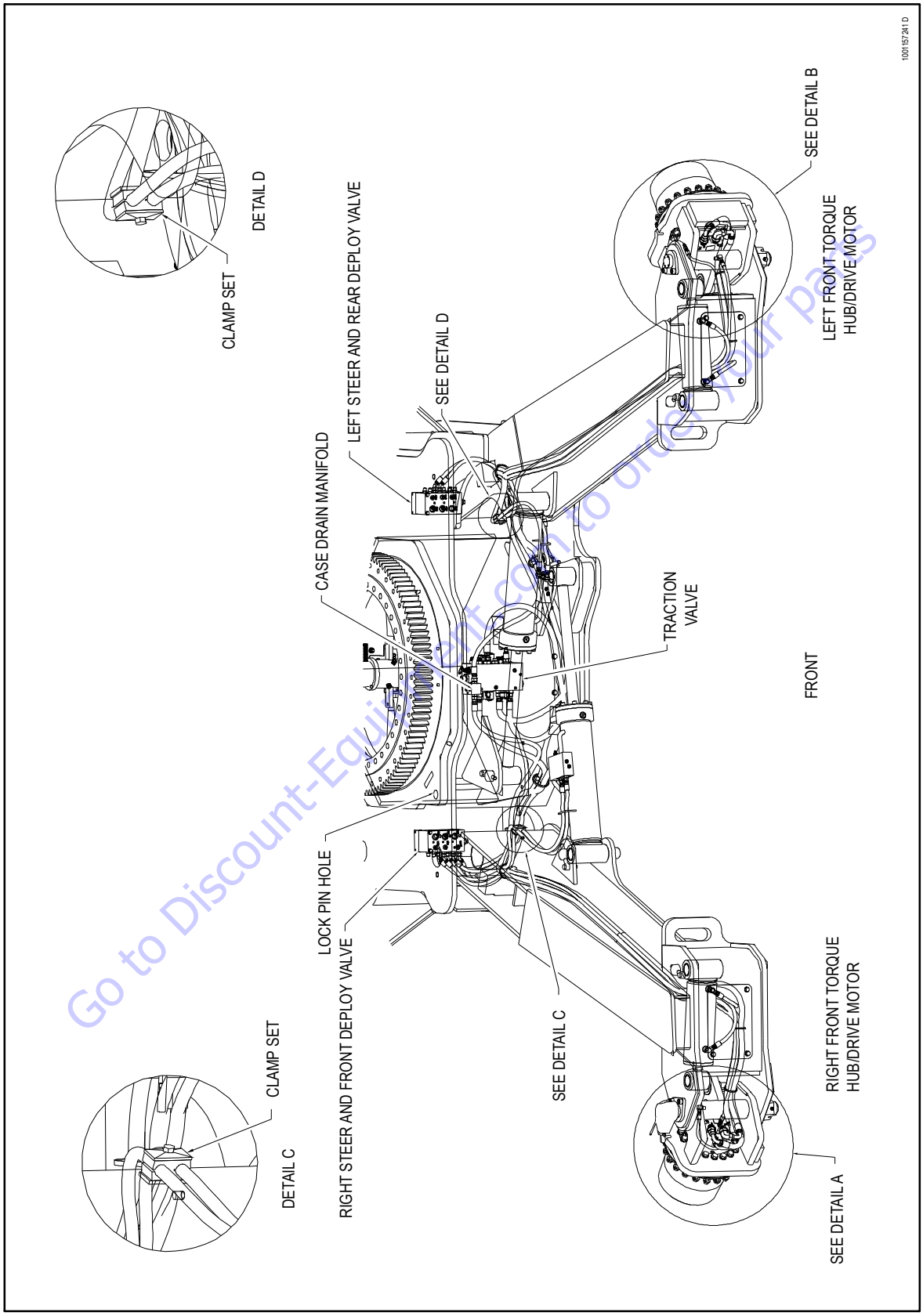

Figure 3-8. Chassis Hose Routing - Sheet 2 of 7

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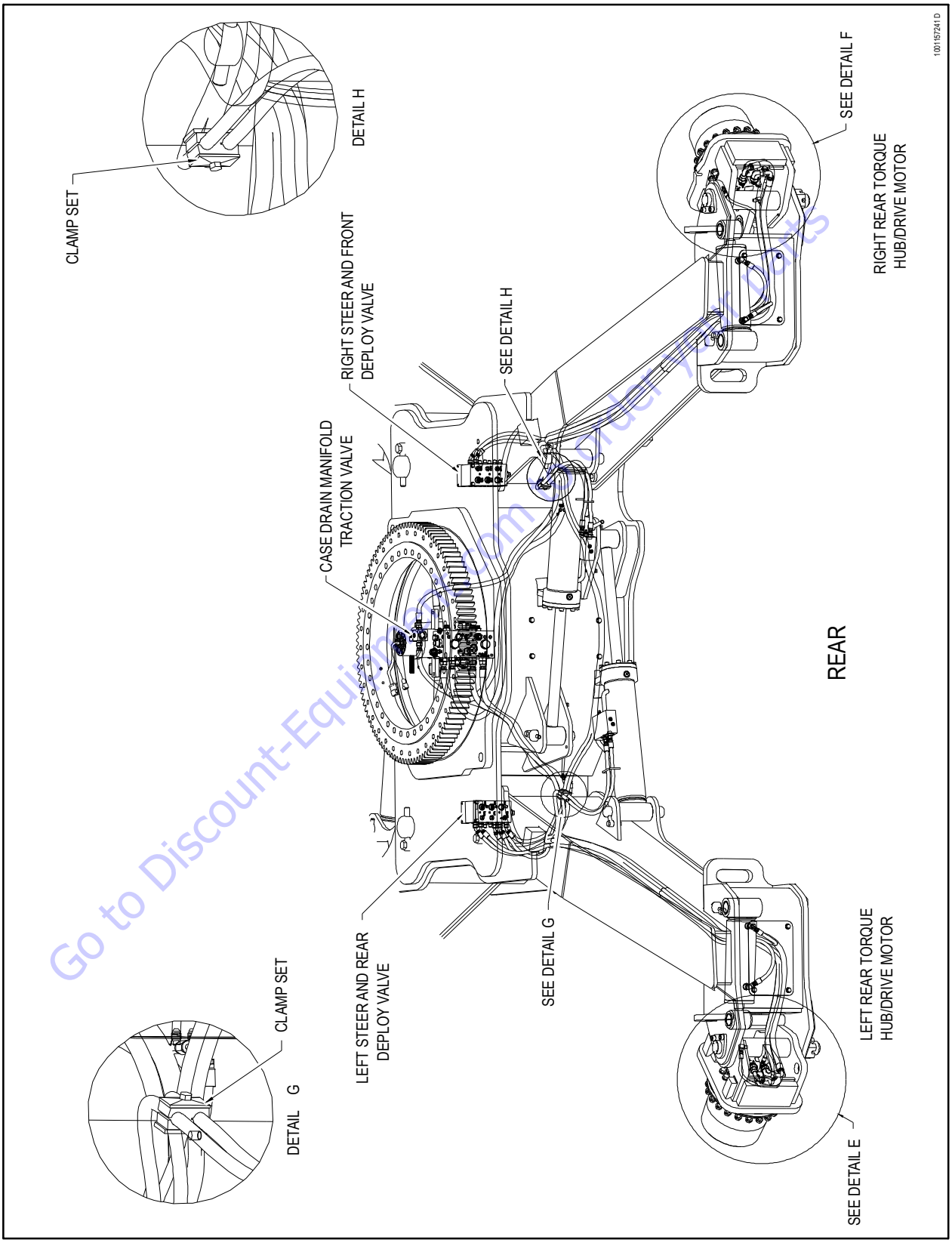

Figure 3-9. Chassis Hose Routing - Sheet 3 of 7

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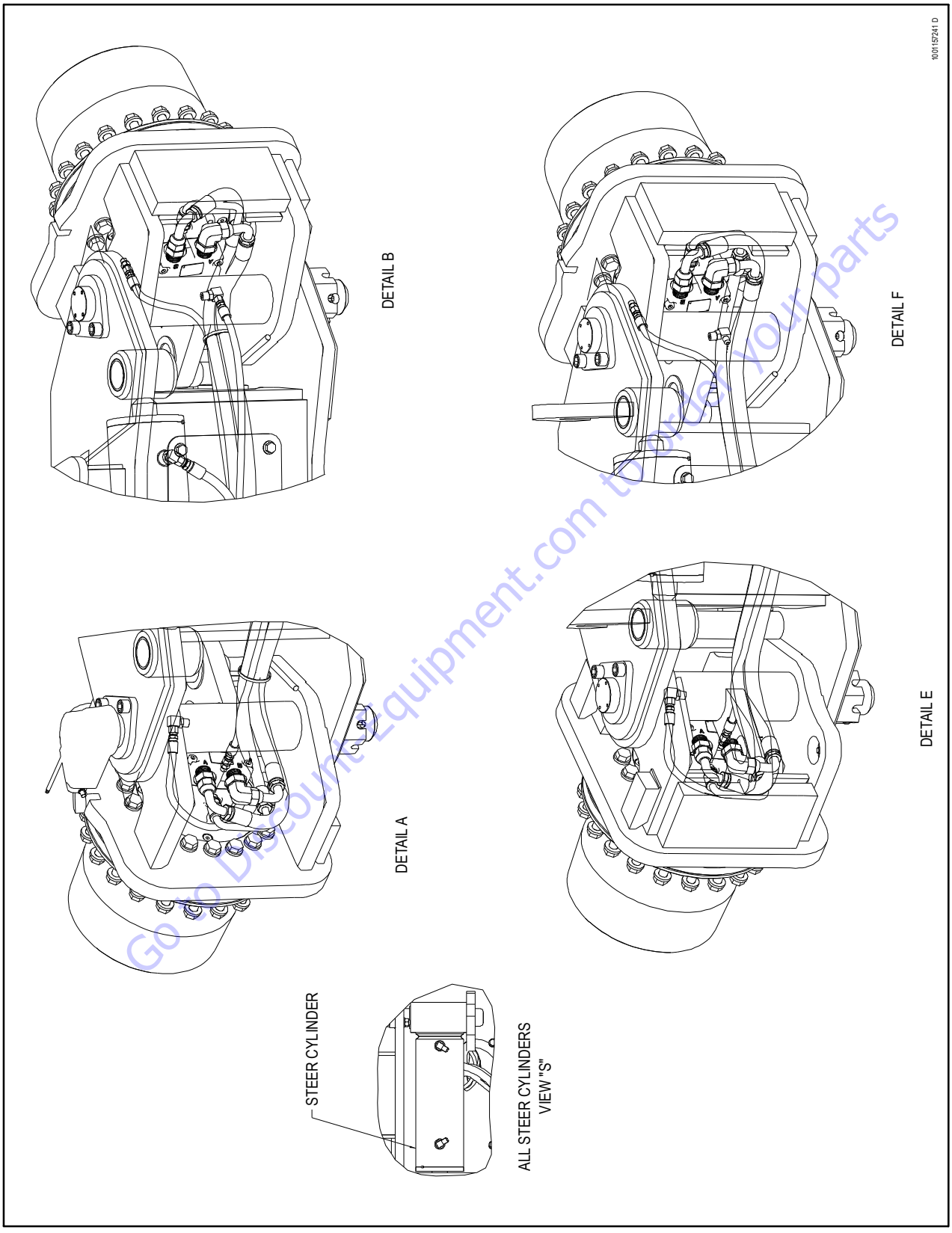

Figure 3-10. Chassis Hose Routing - Sheet 4 of 7

Go to Discount Equipment.com to order your parts

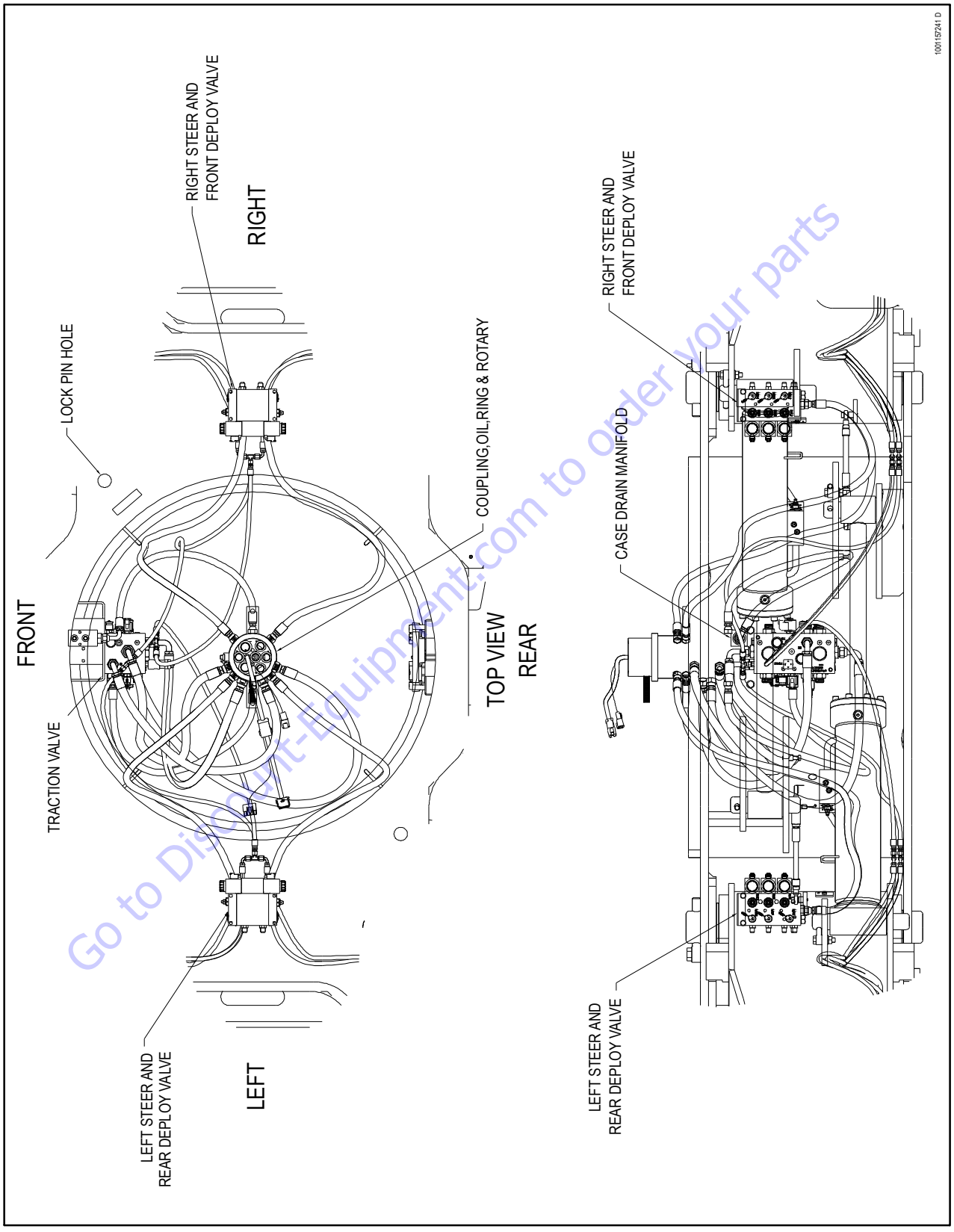

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Figure 3-11. Chassis Hose Routing - Sheet 5 of 7

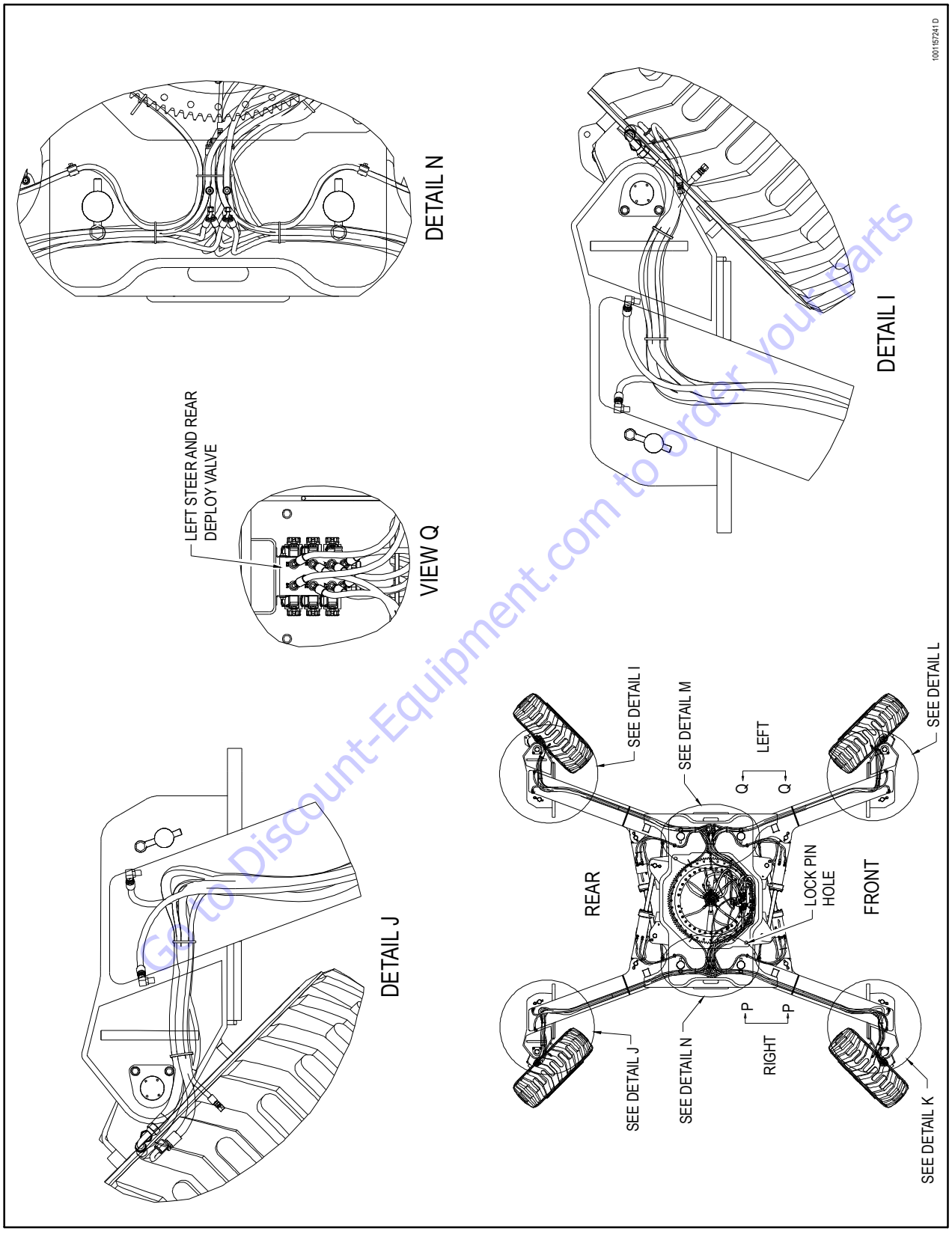

Figure 3-12. Chassis Hose Routing - Sheet 6 of 7

Go to Discount-Equipment.com to order your parts

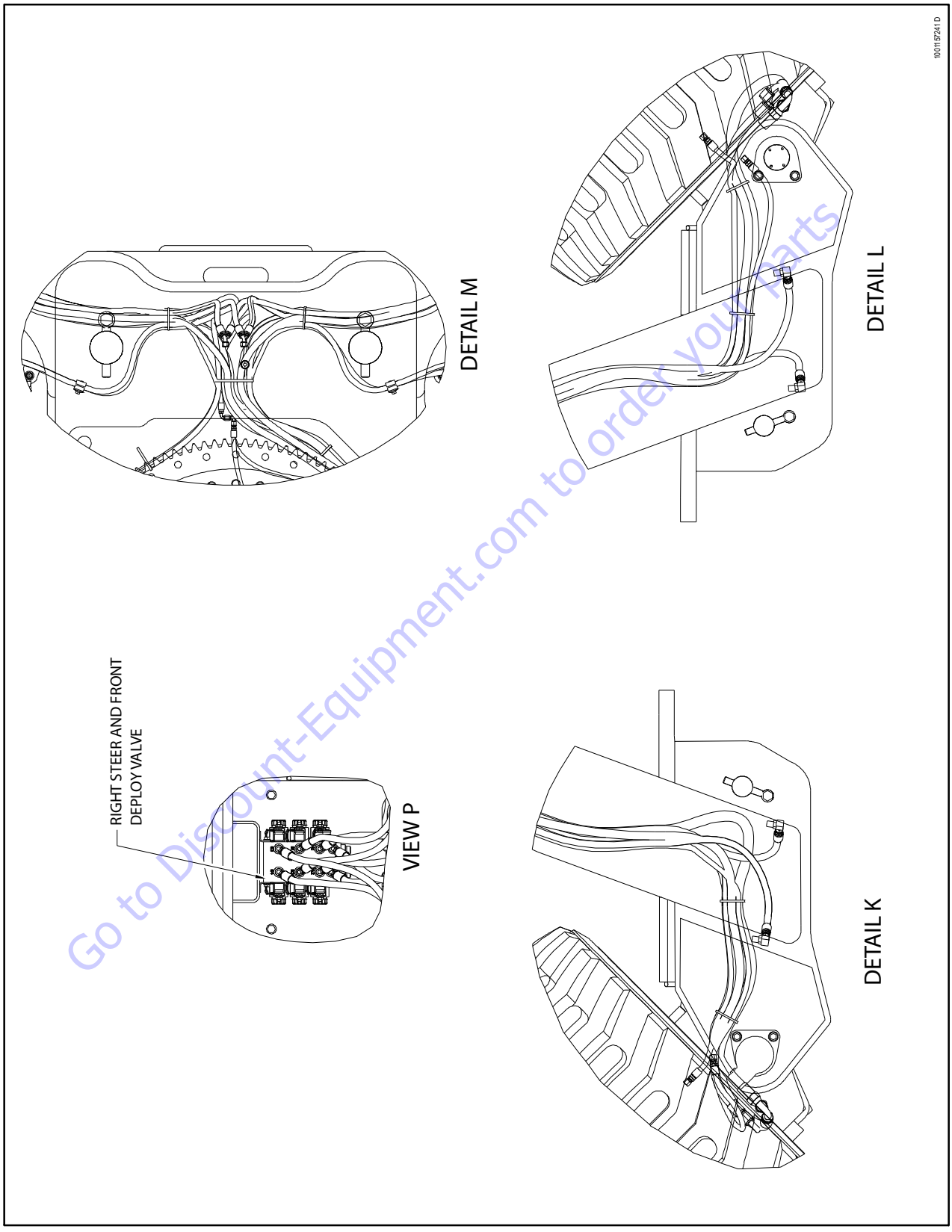

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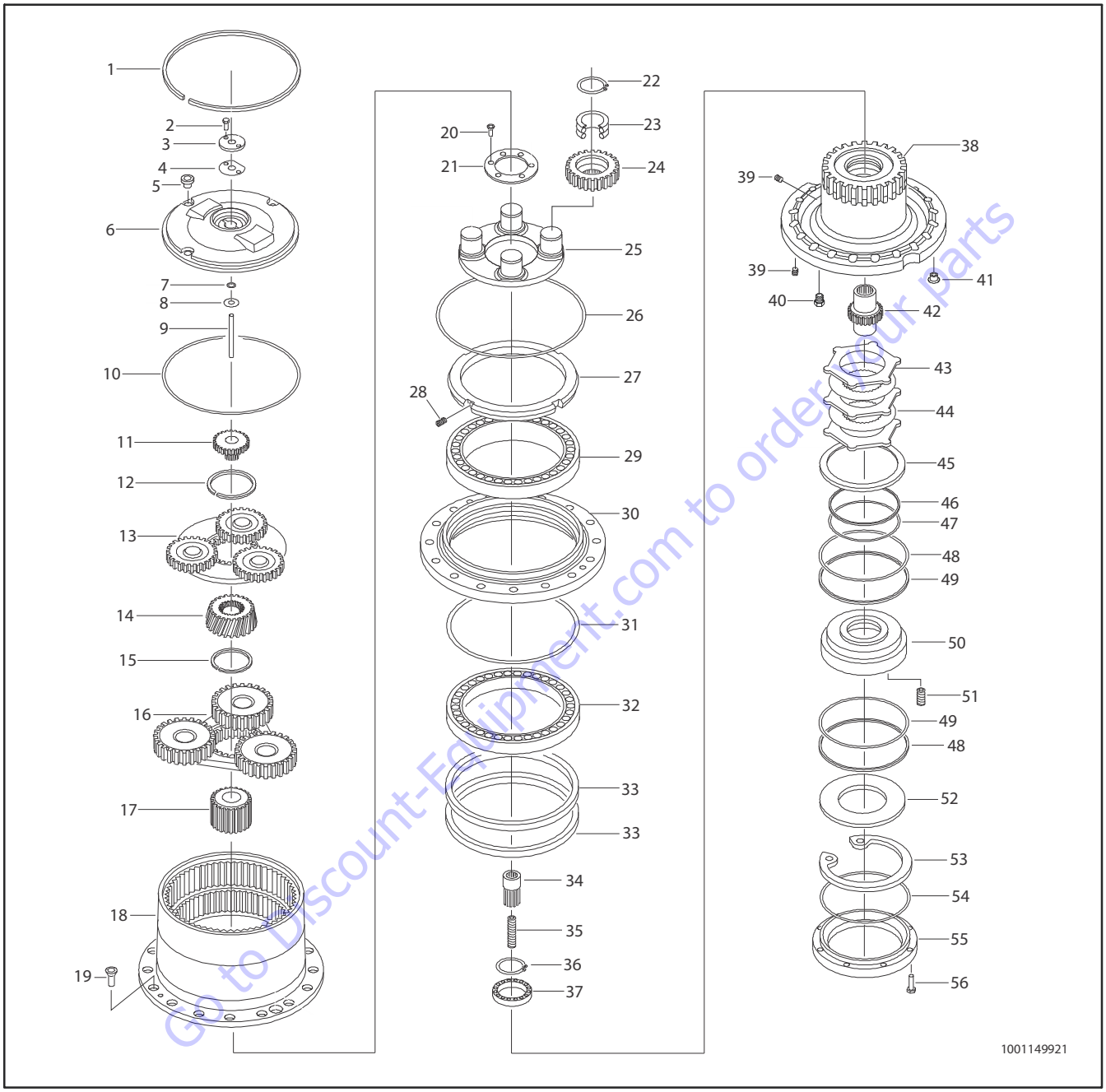
Figure 3-13. Chassis Hose Routing - Sheet 7 of 7

3.11 DRIVE HUB



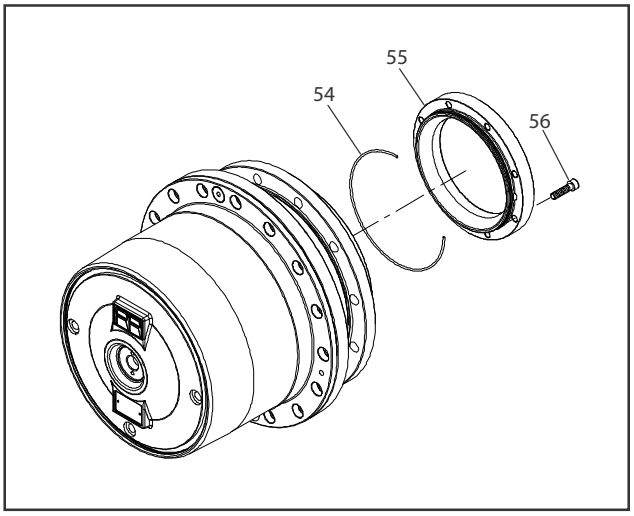
Go to Discount-Equipment.com to order your parts

1.	Ring	9.	Pin	17.	Pinion	25.	Flange	33.	Seal	41.	Plastic Plug	49.	O-Ring
2.	Screw	10.	O-Ring	18.	Hub Housing	26.	O-Ring	34.	Coupling	42.	Input Shaft	50.	Brake Piston
3.	Cover	11.	Pinion	19.	Screw	27.	Ring Nut	35.	Spring	43.	Iron Disc	51.	Brake Spring
4.	Gasket	12.	Retaining Ring	20.	Screw	28.	Set Screw	36.	Retaining Ring	44.	Brake Disc	52.	Spacer
5.	Plug	13.	Gear Reduction Assy	21.	Plug	29.	Bearing	37.	Bearing	45.	Spacer	53.	Retaining Ring
6.	Cover	14.	Pinion	22.	Retaining Ring	30.	Hub Support	38.	Axle	46.	Seal	54.	O-Ring
7.	O-Ring	15.	Ring	23.	Bearing	31.	O-Ring	39.	Plug	47.	O-Ring	55.	Motor Support
8.	Shim	16.	Gear Reduction Assy	24.	Planet Wheel	32.	Bearing	40.	Plug	48.	Seal	56.	Screw

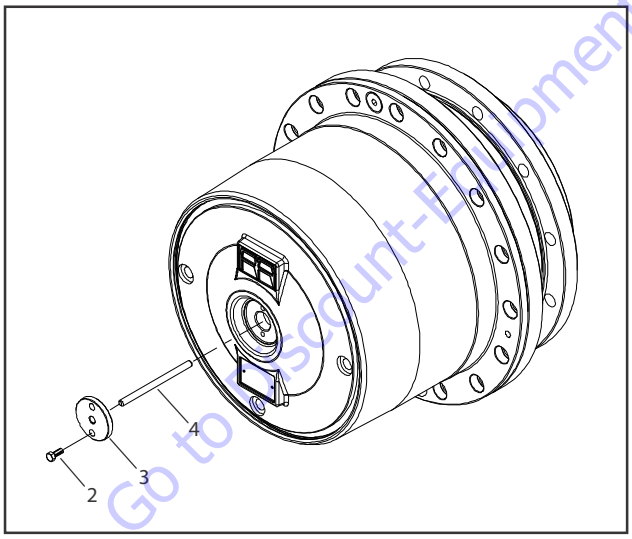
Figure 3-14. Drive Hub

Disassembly

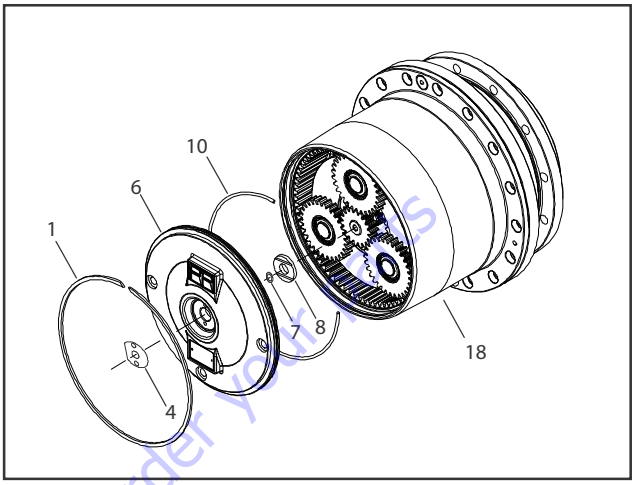
1. Remove plugs (5) and pour lubricant in a container. Reinstall plugs.
2. Remove six screws (56), motor flange(55), and O-Ring (54). Do not damage O-Ring.



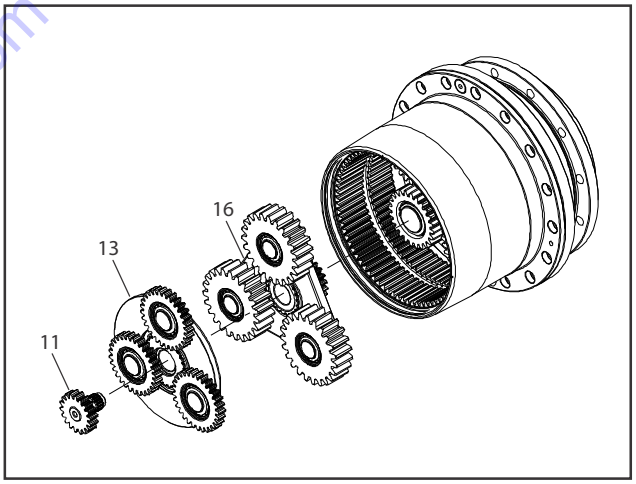
3. Remove two screws (2), cover (3), and pin (4).



4. Remove, Ring (1), Cover (6), O-Ring (7), Spacer (8) and O-Ring (10). Do not damage O-Rings. Check and remove Gasket (4) if damaged.



5. Remove Pinion (11), Gear Reduction Assembly (13), and Gear Reduction Assembly (16).



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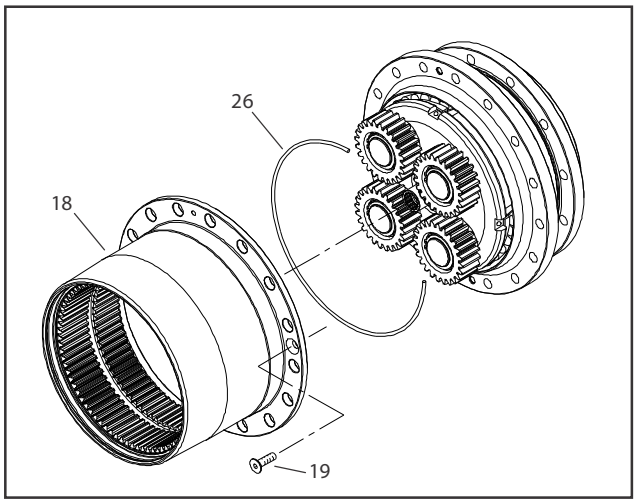
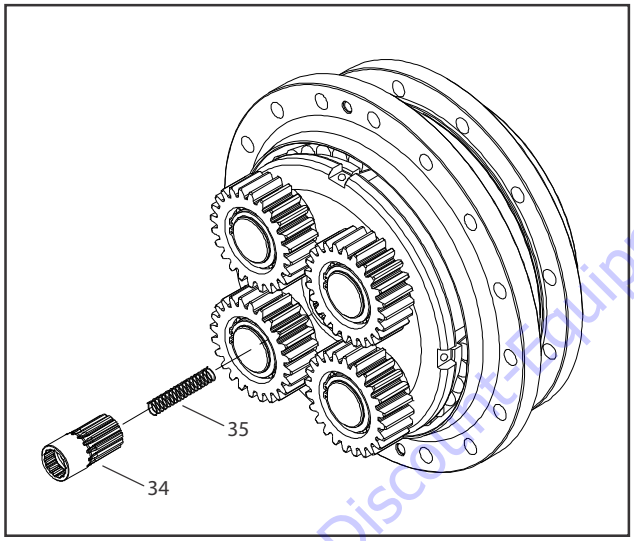
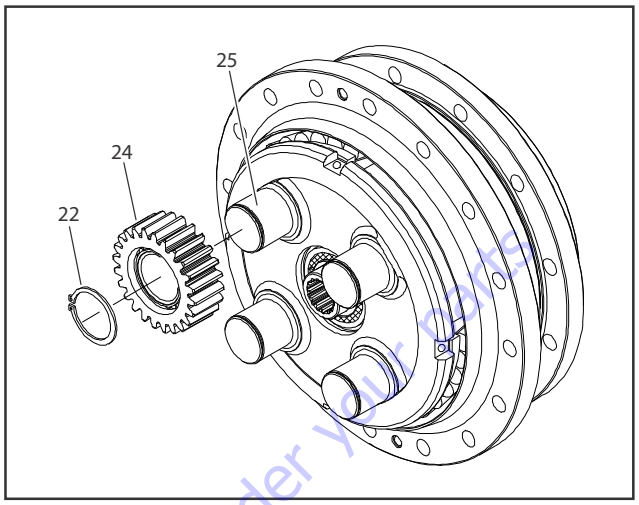
6. Remove two Screws (19), Planetary Ring (18) and O-Ring (26). Do not damage O-Ring.



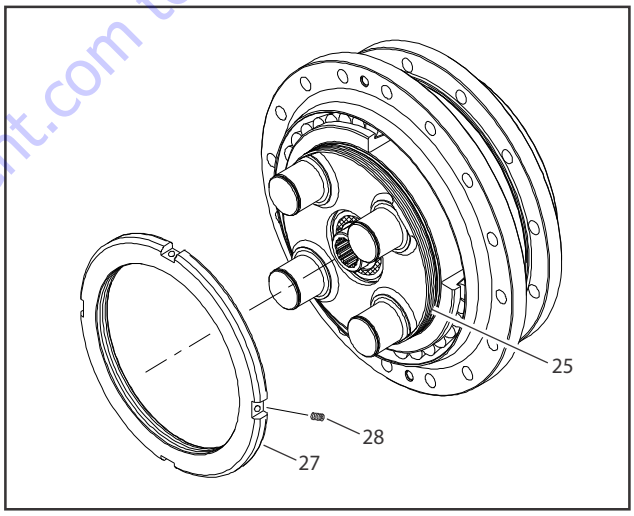
7. Remove Coupling (34) and Spring (35).



8. Remove three snap rings (22) and planetary gears (24) from spindles on Flange (25).



9. Remove two Set Screws (28) from Ring Nut (27). Remove Ring Nut from Flange (25).



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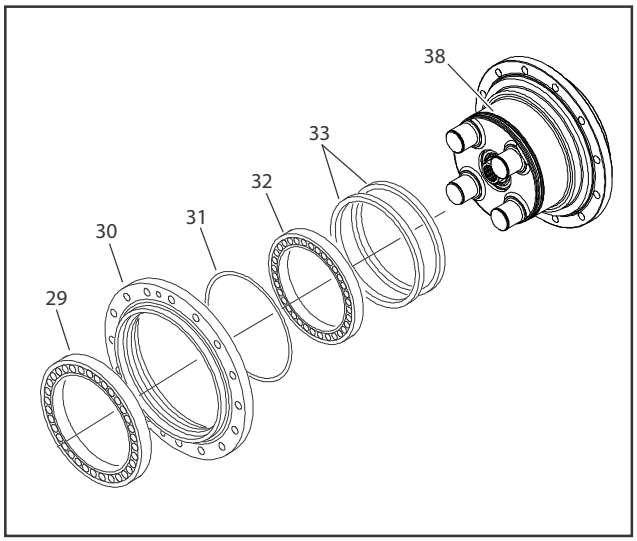
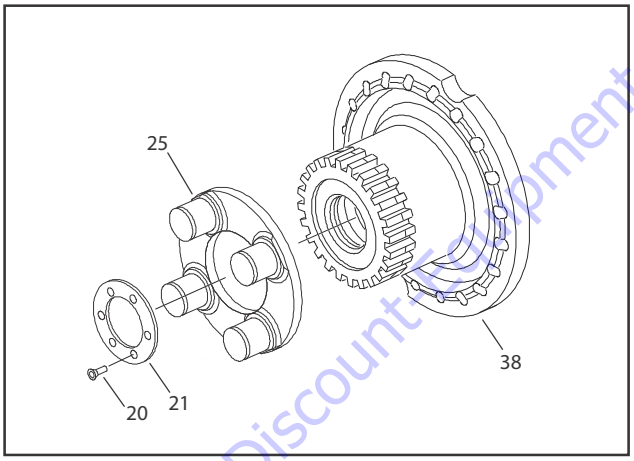
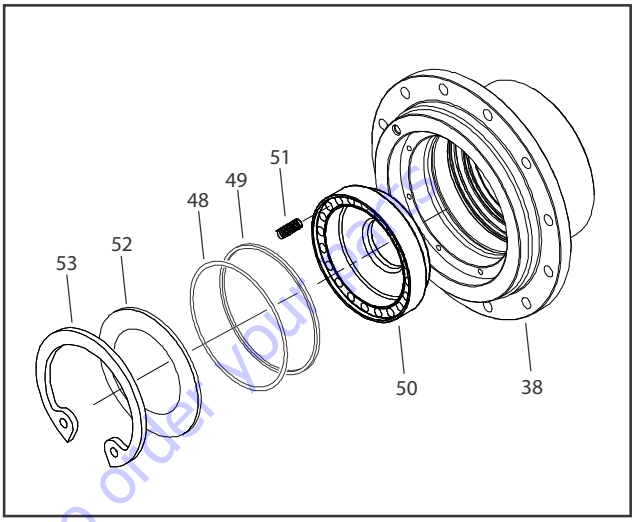
10. Remove Hub Support (30), Bearing (29), O-Ring (31), Bearing (32), and two Seals (33) from Axle (38).



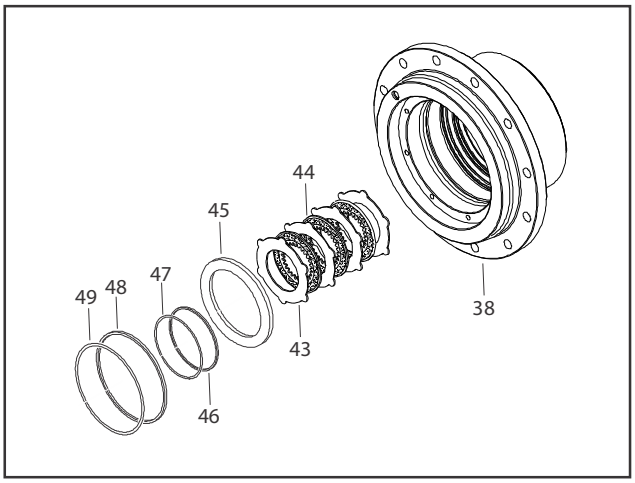
11. Remove six screws (20), Plug (21), and Flange (25) from Axle (38).,



12. Remove Snap Ring (53), Spacer (52), Seal (48), O-Ring (49), and Brake Piston (50) from Axle (38). Remove five Brake Springs (51) from Brake Piston (50). Use compressed air to remove Brake Piston from Axle.



13. Remove O-Ring (49), Seal (48), O-Ring (47), Seal (48), Spacer (45), nine Brake Discs (43) and eight Iron Discs (44) from Axle (38).



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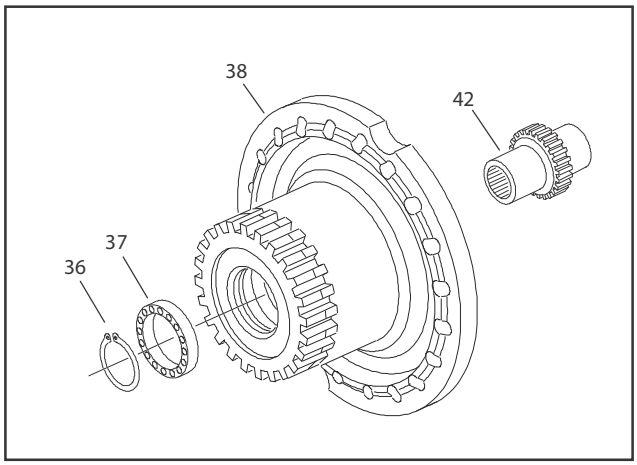
14. Remove Split Ring (36), Input Shaft (42), and Bearing (37) from Axle (38).

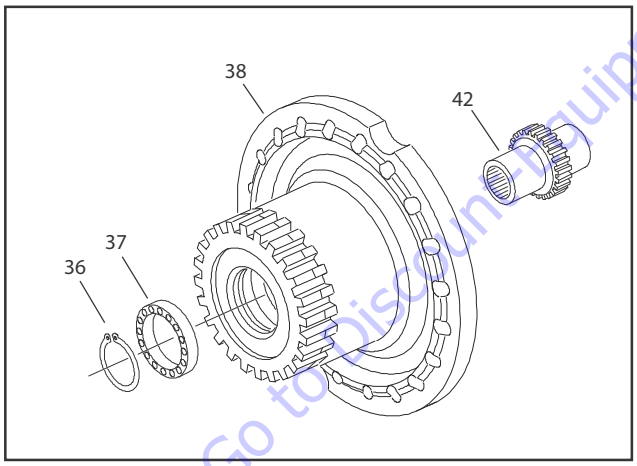


Assembly

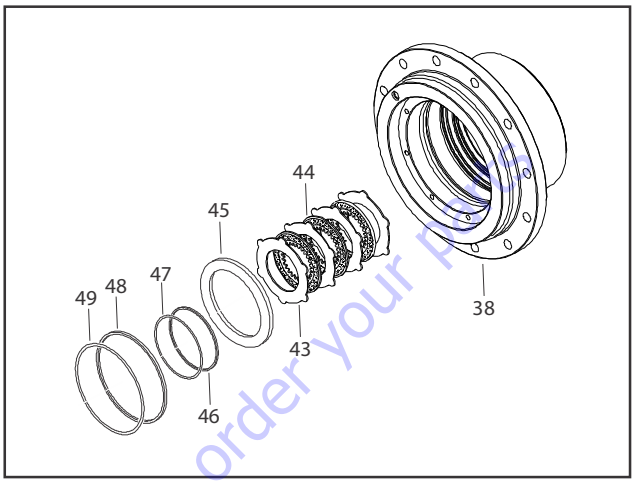
NOTE: *Thoroughly clean and coat all parts with grease before assembling.*

1. Check parts are free of damage, burrs, or other defects.

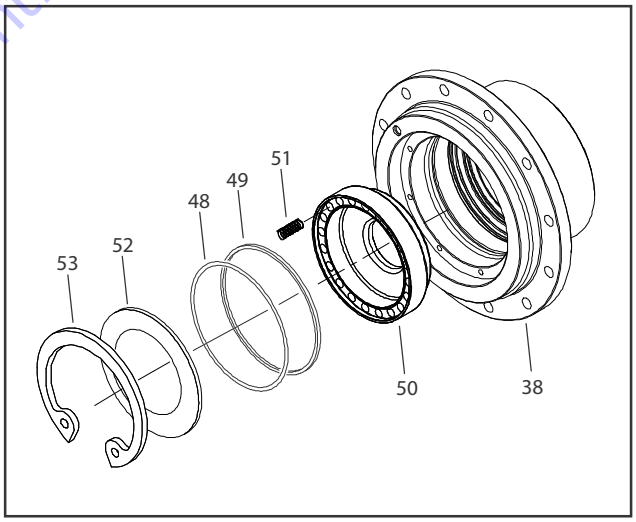
2. Install Bearing (37) in Axle (38). Install Input Shaft (42) in Axle and Bearing. Secure with Split Ring (36).



3. Install Seal (46), O-Ring (47), Seal (48), and O-Ring (49) in Axle (38). Starting with Brake Disk (43) alternate with Iron Disk (44) until a total of eight Brake Disks and nine Iron Discs are installed on Input Shaft (42 - not shown) in Axle.



4. Install Brake Piston (50) in Axle (38). Install five Brake Springs (51) Piston holes. Install O-Ring (49) and Seal (48) in Axle. Install Spacer (52) against Piston and secure with Split Ring (53).



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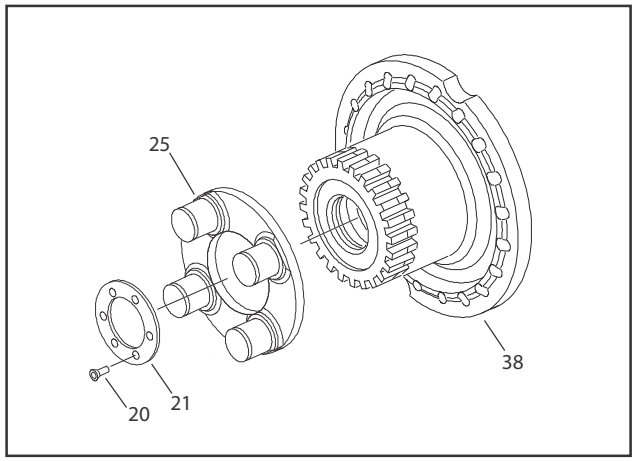
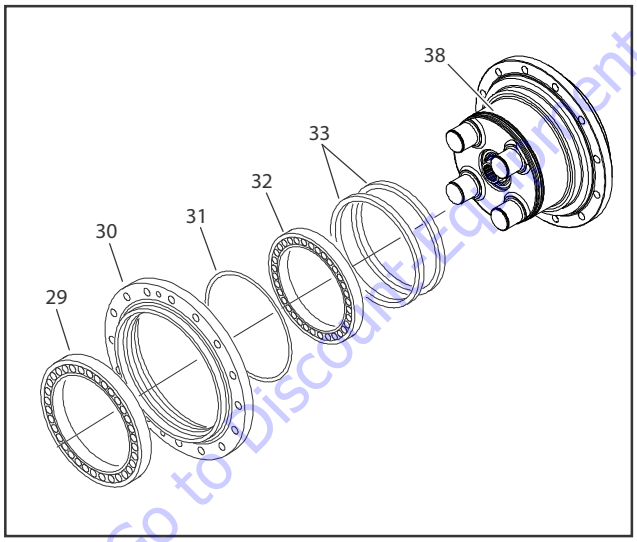
5. Install Flange (25) on Axle (38), with Plug (21) and six screws (20).



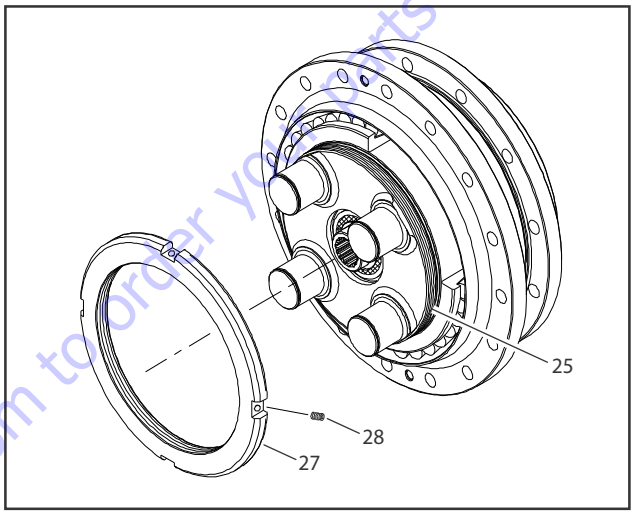
NOTE: *Flat surface of bearings face toward inside of Hub Support.*

6. Install two seals (33) on Axle (38). Install O-Ring (31) in Hub Support (30). Install Bearing (32) and Bearing (29) in Hub Support. Install assembled Hub Support on Axle as shown below.

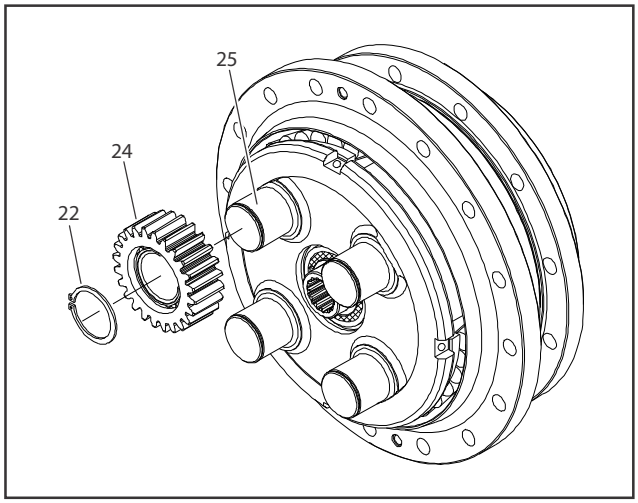


NOTE: *Install Ring Nut with convex part facing bearing.*

7. Install Ring Nut (27) on Flange (25). Prevent Flange from turning and torque Ring Nut to 295 ft-lb (400 Nm). Tighten and back off two times to completely seat bearings. Tighten to final torque of 221 ft-lb (300 Nm). Check roll torque with seal is within 7 - 11 ft-lb (10 - 15 Nm). Apply Medium Strength Threadlocking Compound or equivalent to two Setscrews (28). Install and torque Setscrews to 7.4 ft-lb (10 Nm) .



8. Install three planetary gears (24) on Flange spindles (25). Secure with Snap Rings (22). Lubricate planetary gear bearings.



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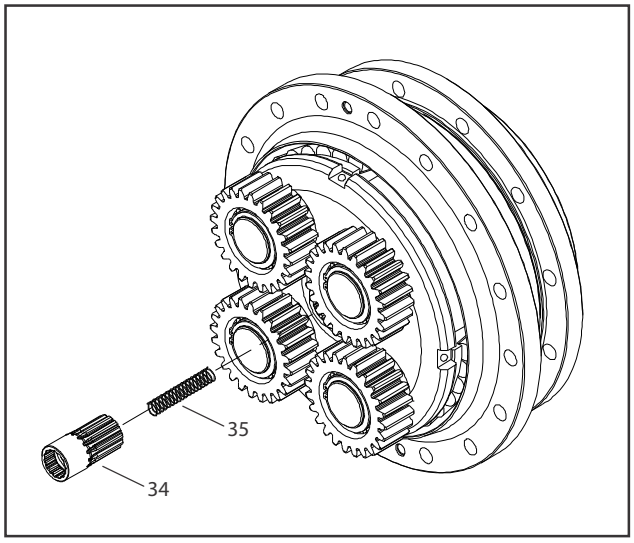
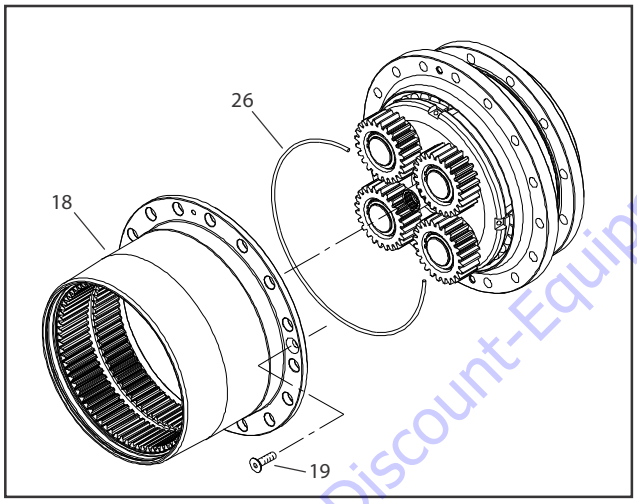
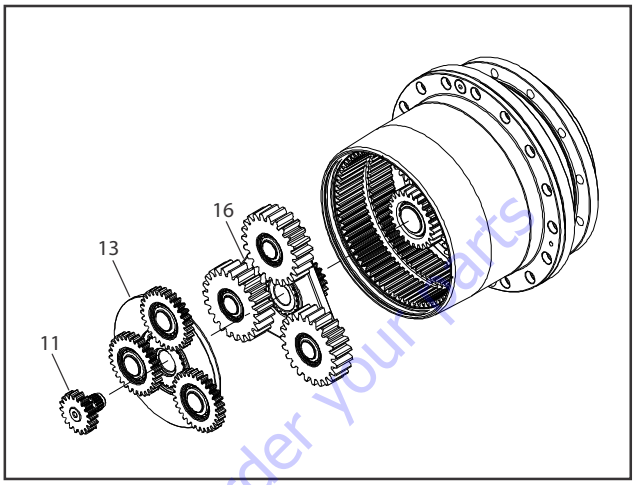
9. Install Spring (35) and Coupling (34).



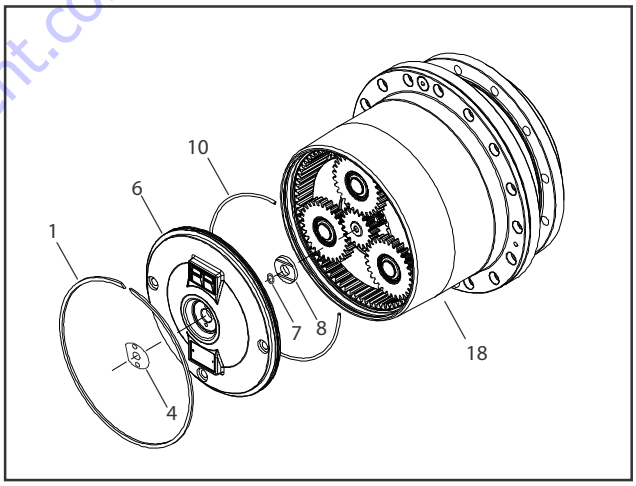
10. Install O-Ring (26). Install Planetary Ring (18) with two Screws (19). Torque Screws to 36.8 ft-lb (50 Nm).



11. Install Gear Reduction Assembly (16), Gear Reduction Assembly (13), and Pinion (11) in Planetary Housing. Lubricate all bearings.



12. Install O-Ring (7) and O-Ring (10) in Cover (6). Liberally coat Spacer (8) with grease and center on hole at center of Cover. Install Cover on Planetary Ring Assembly (18) and secure with Ring (1). Replace Gasket (4) as needed.



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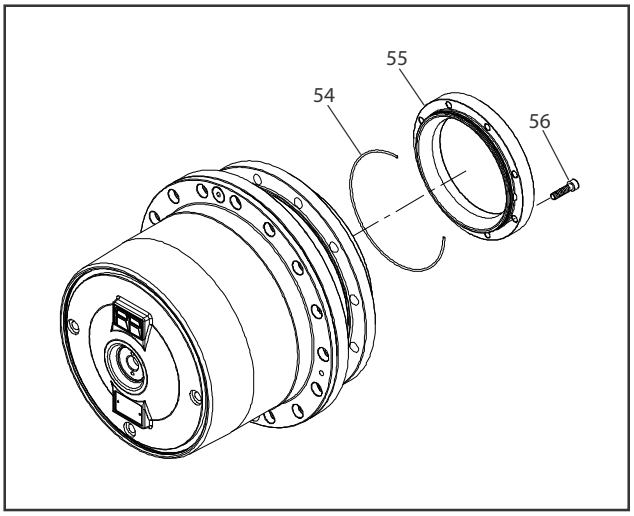
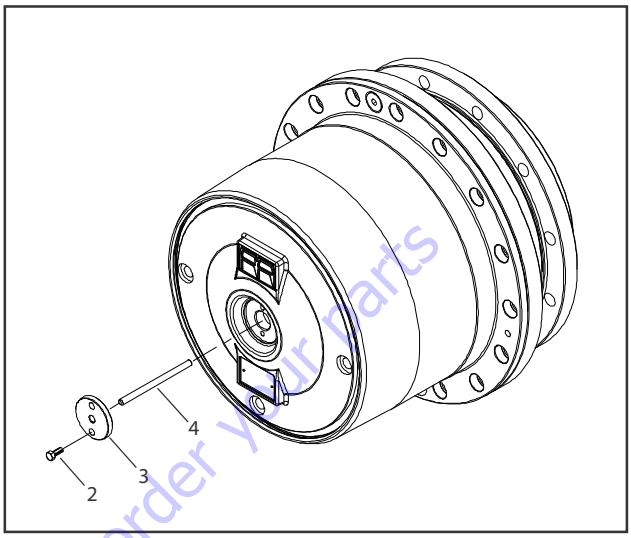
13. Install O-Ring (54) and Motor Flange (55). Apply Medium Strength Threadlocking Compound or equivalent to six Screws (56). Install and torque Screws to 177 ft-lb (240 Nm).



14. Check completed Drive Hub assembly rotates freely.

15. Install Pin (4) and Cover (3). Secure with two Screws (2). Torque to 7 ft-lb (10 Nm).



⚠ WARNING

FAILURE TO PROPERLY FILL DRIVE HUB WITH OIL BEFORE OPERATION WILL RESULT IN EQUIPMENT FAILURE AND COULD CAUSE DEATH, SERIOUS INJURY, OR DAMAGE TO PROPERTY AND EQUIPMENT.

16. Follow oil change procedures and refill Drive Hub before operating equipment.

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3.12 FREE WHEELING OPTION

Disengage Drive Motors & Brakes for Towing, etc. (Free Wheel)

1. Chock wheels.
2. Removing screws and invert cover so center tip presses on disengagement pin in hub. Reinstall screws.
3. Remove chocks.

Engage Drive Motors & Brakes (Normal Operation)

1. Chock wheels.
2. Removing screws and invert cover so center tip faces out. Reinstall screws.
3. Remove chocks.

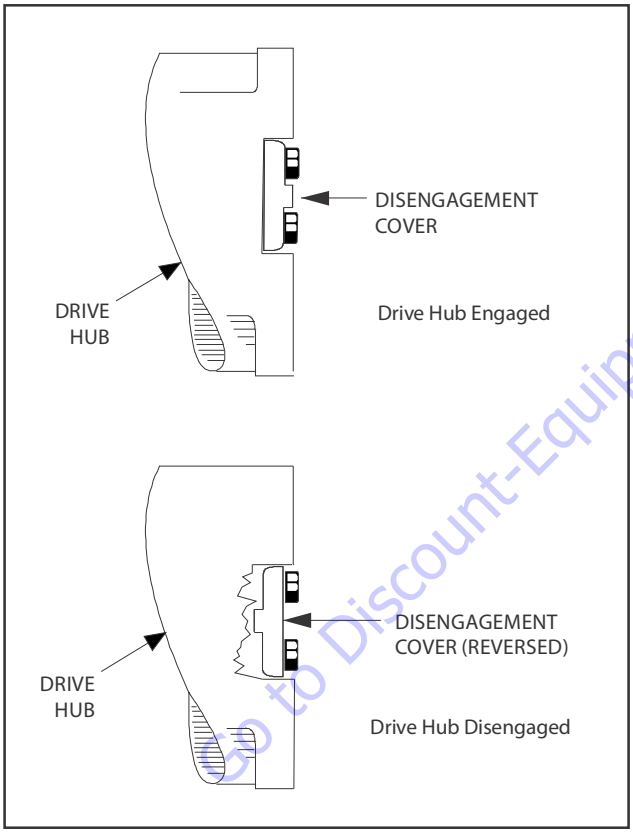

Figure 3-15. Disengaging Drive Hubs

3.13 GEAR HUB OIL SERVICE

Check Oil Level

1. Position hub as shown in Figure 3-16.
2. Remove Level Plug (3) and check oil is level with plug opening. Add oil as needed.
3. Reinstall plug.

Change Gear Hub Oil

NOTE: *Change oil when reduction gear is hot.*

1. Position hub as shown in Figure 3-16.
2. Place suitable tray underneath to collect waste oil.
3. Remove three plugs.
4. Flush gear hub with appropriate solvent.
5. Reinstall Drain Plug (2).
6. Fill with oil until level reaches level hole.
7. Reinstall Level Plug (3) and Fill Plug (1).l

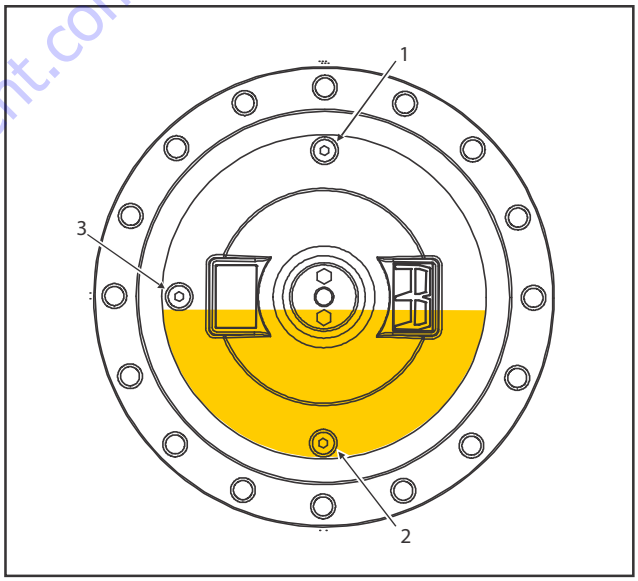

Figure 3-16. Gear Hub Oil Fill and Drain

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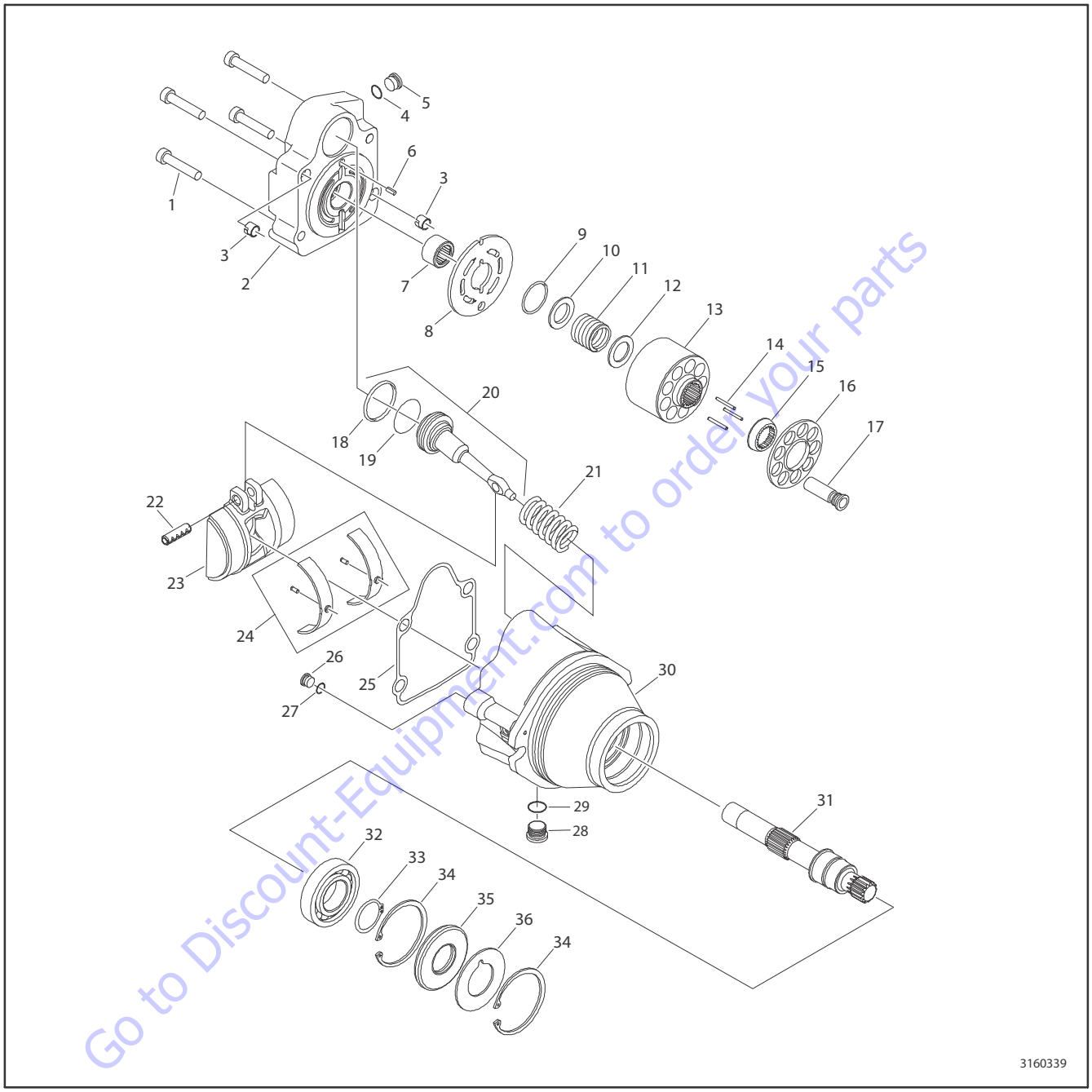

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1. Bolt
2. Motor End cap
3. Locating Pin
4. O-Ring
5. Plug
6. Dowel Pin
7. Needle Bearing
8. Valve Plate
9. Snap Ring
10. Spring Retainer
11. Spring
12. Washer
13. Cylinder Block
14. Slipper Pin
15. Guide
16. Slipper Retainer
17. Cylinder Piston
18. Piston Ring
19. O-Ring
20. Servo Piston
21. Spring
22. Pin
23. Swashplate
24. Bearing Kit
25. Gasket
26. Plug
27. O-Ring
28. Plug
29. O-Ring
30. Housing
31. Shaft
32. Bearing
33. Snap Ring
34. Snap Ring
35. Seal
36. Seal Support Washer

Figure 3-17. Drive Motor

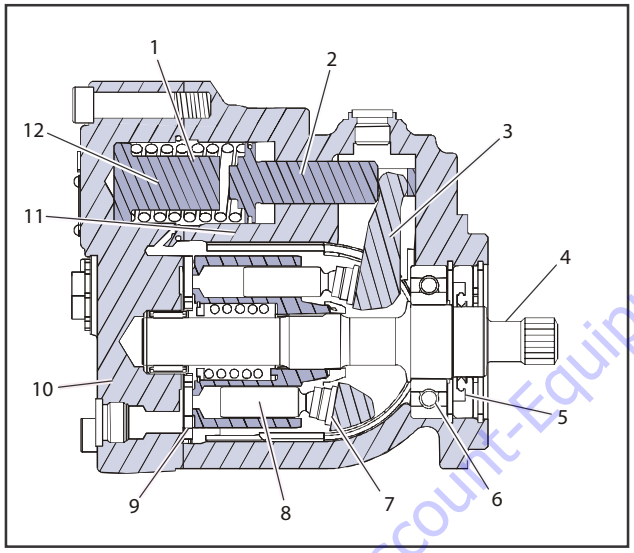
3.14 DRIVE MOTOR

NOTE: *Drive motor servicing is similar for all Series 45 hydraulic motors. The physical appearance of your motor may be slightly different than shown.*

Description

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

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



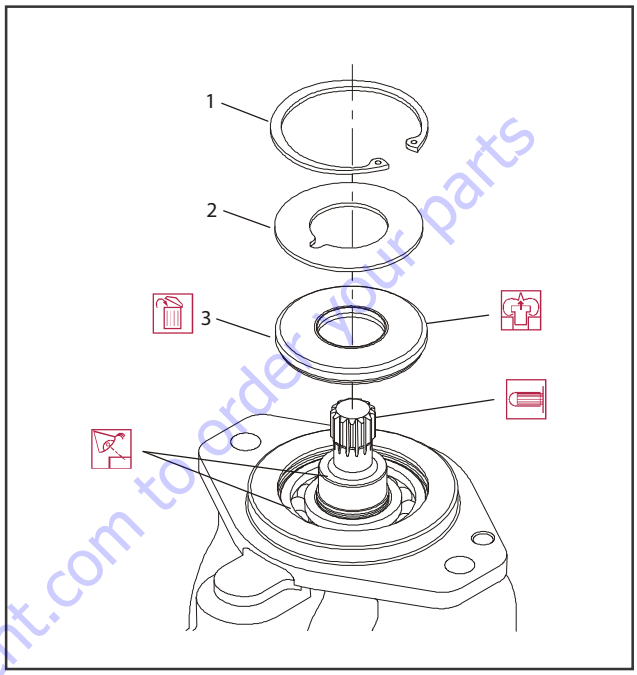
37. Bias Spring
38. Servo Piston
39. Swashplate
40. Output Shaft
41. Shaft Seal
42. Bearing
43. Slipper
44. Piston
45. Valve Plate
46. End Cap
47. Cylinder Block
48. Minimum Angle Stop

Figure 3-18. Drive Motor Cross Section

Shaft Seal Replacement

REMOVAL

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



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

Figure 3-19. Removing Shaft Seal

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

NOTE: *To avoid damaging shaft during removal, install a large sheet metal screw in chuck of a slide hammer. Drive screw in seal surface and use slide hammer to pull seal.*

4. Discard seal.

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INSPECTION

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

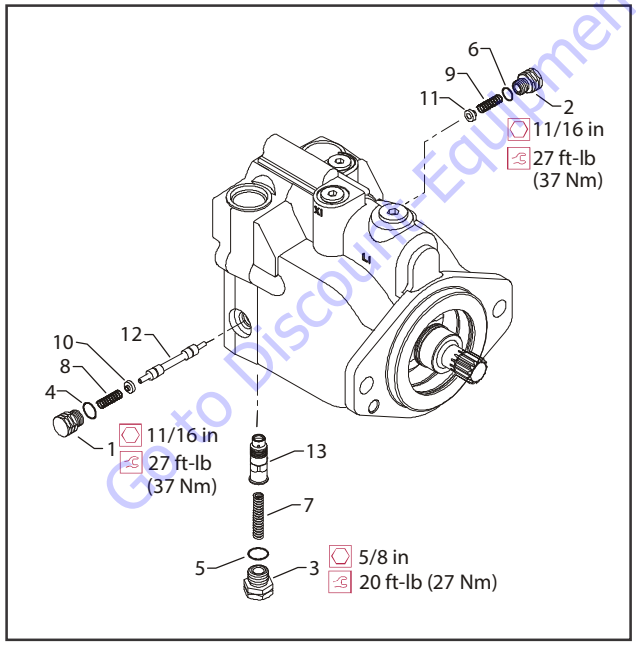
INSTALLATION

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

Loop Flushing Valve

REMOVAL

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



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

Figure 3-20. Loop Flushing Spool

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

INSPECTION

1. Inspect new O-rings and the sealing area for rust, wear, or contamination.
2. Check springs and poppet for wear.

INSTALLATION

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

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Troubleshooting

Table 3-2. Excessive Noise and/or Vibration

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

Table 3-3. System Operating Hot

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

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

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

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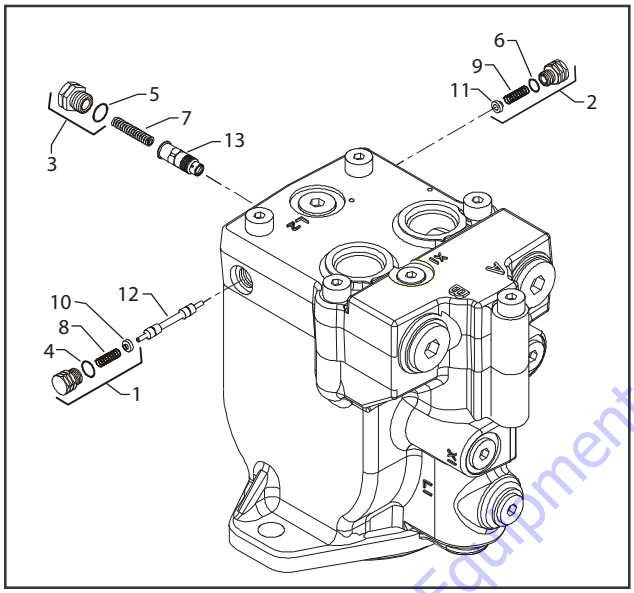
Disassembly

NOTE: *Removal of endcap voids warranty.*

During assembly, coat all moving parts with a film of clean hydraulic oil. This ensures 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 3-21. 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).

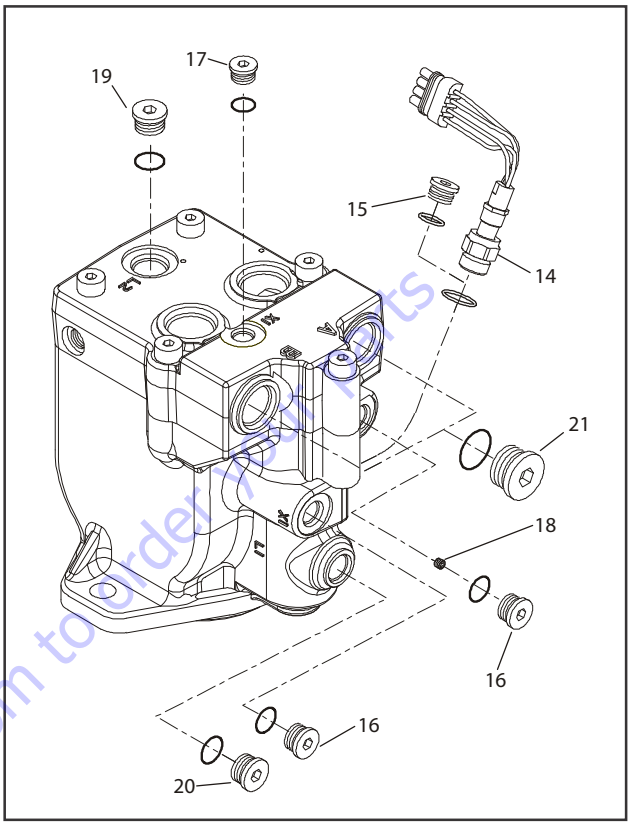
3. Remove O-rings (4, 5, and 6).

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 3-22. Plugs, Fittings, and Speed Sensor

8. Remove all fittings from unit. Discard any O-rings on fittings.

9. Using an 11/16 inch hex wrench, loosen speed sensor lock nut (14) if equipped. Remove 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.

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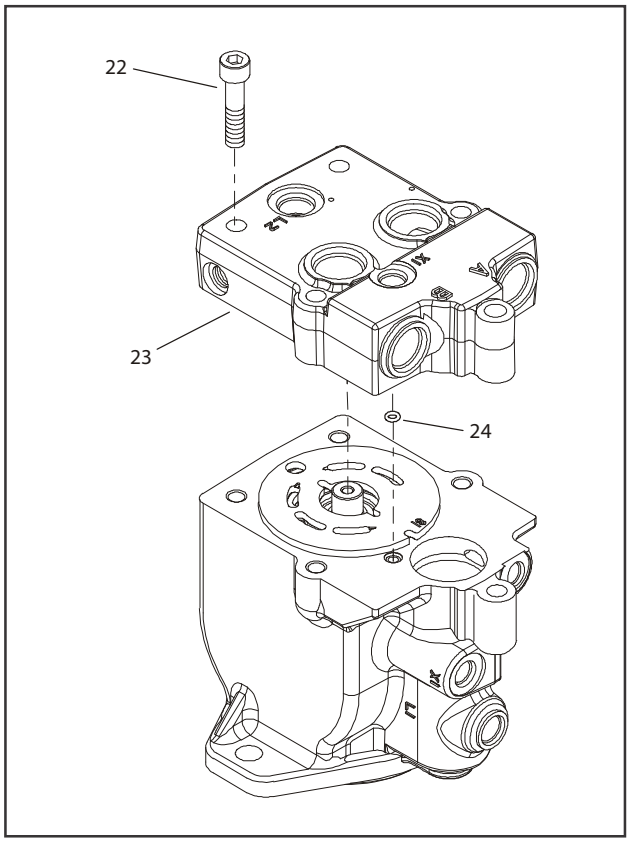
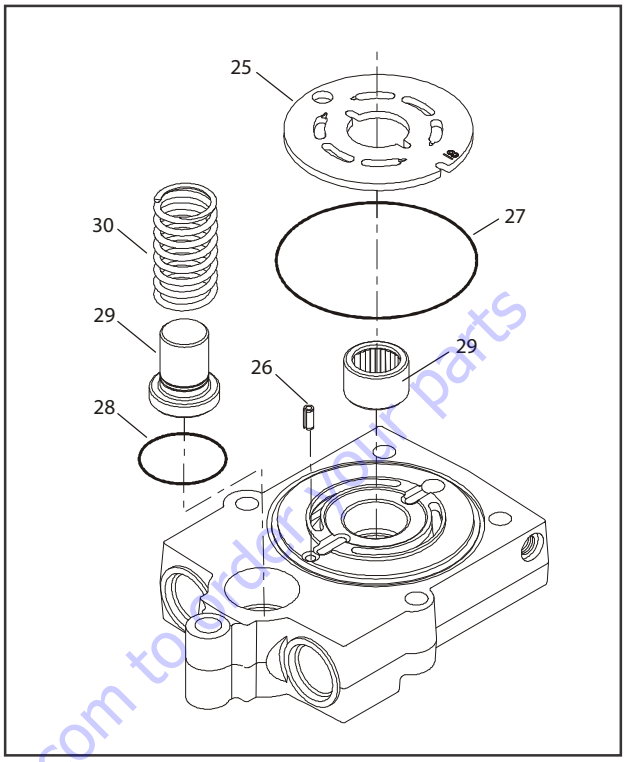


22. Screw
23. End Cap
24. O-ring

Figure 3-23. End Cap

13. Using an 8 mm internal hex wrench, remove endcap screws (22).

14. Remove endcap (23). Remove O-ring (24) from housing or endcap. When endcap screws are removed, pressure from servo spring will cause endcap to bind on shaft. Press down on portion of endcap covering servo piston and hold endcap level while removing.



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

Figure 3-24. Valve Plate & Rear Shaft Bearing

NOTICE

DO NOT SCRATCH VALVE PLATE SURFACE. DO NOT DRIVE BEARING PAST REAR SHAFT JOURNAL. BEARING MAY BECOME TRAPPED ON SHAFT AND DAMAGED.

15. Remove valve plate (25) and timing pin (26) from endcap. Each displacement has a unique valve plate. For identification, the last two digits of the valve plate part number are stamped on its surface.

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

17. Remove rear shaft bearing (29) from endcap with a bearing puller. Bearing may be difficult to remove with a puller. Try this as an alternative: Pack bearing cavity with heavy grease. After shaft is removed, insert it into bearing cavity and tap splined end lightly with a soft mallet. Grease will force the bearing out. Remove minimum angle stop (29) and servo spring (30) from housing.

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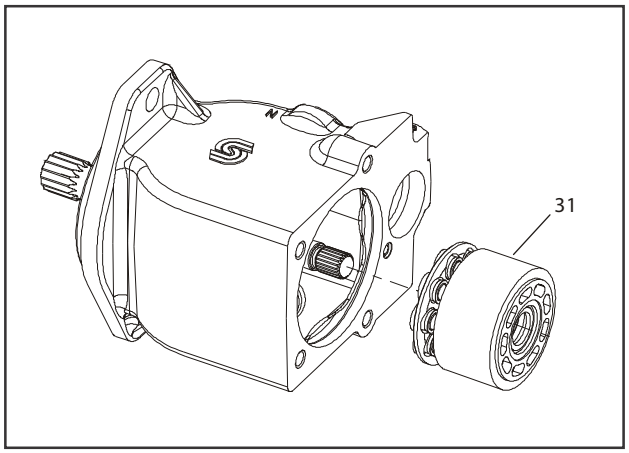


31. Cylinder Kit Assembly

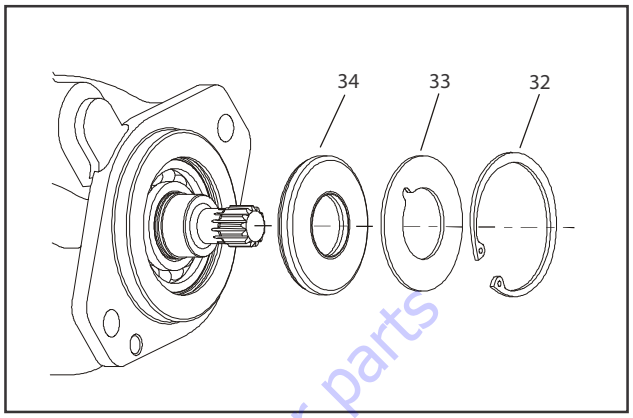
Figure 3-25. Cylinder Kit

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

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

Table 3-5. Displacement Identifiers

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



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

Figure 3-26. Shaft Seal

NOTICE

TO AVOID DAMAGING SHAFT DURING SEAL REMOVAL, INSTALL A LARGE SHEET METAL SCREW IN CHUCK OF SLIDE HAMMER. DRIVE SCREW INTO SEAL SURFACE AND USE SLIDE HAMMER TO PULL SEAL.

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

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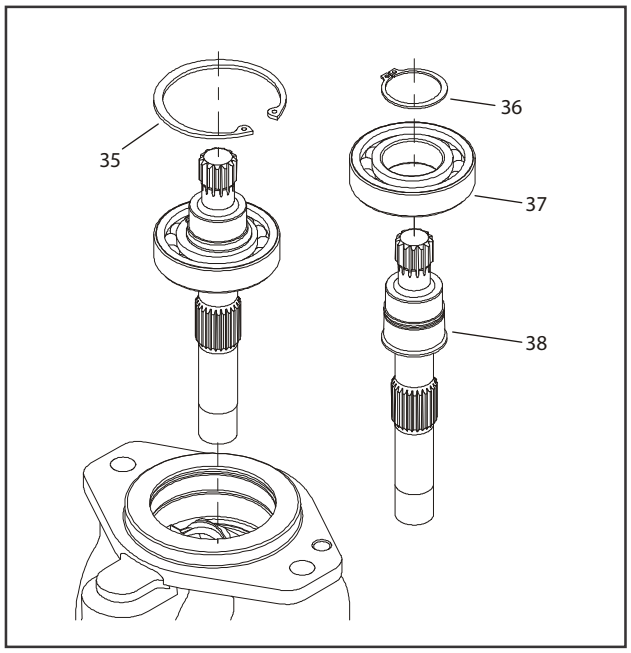
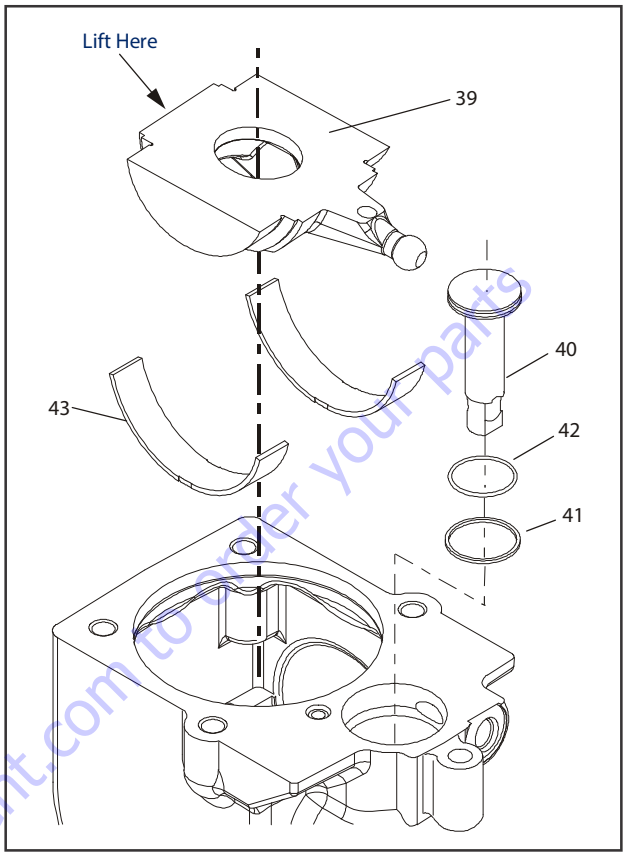


35. Inner Snap Ring
36. Snap Ring
37. Bearing
38. Shaft

Figure 3-27. Shaft & Front Bearing

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

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



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

Figure 3-28. Swash Plate & Servo Piston

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

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

24. Remove journal bearings (43) from housing. Note location and orientation of each bearing for reassembly.

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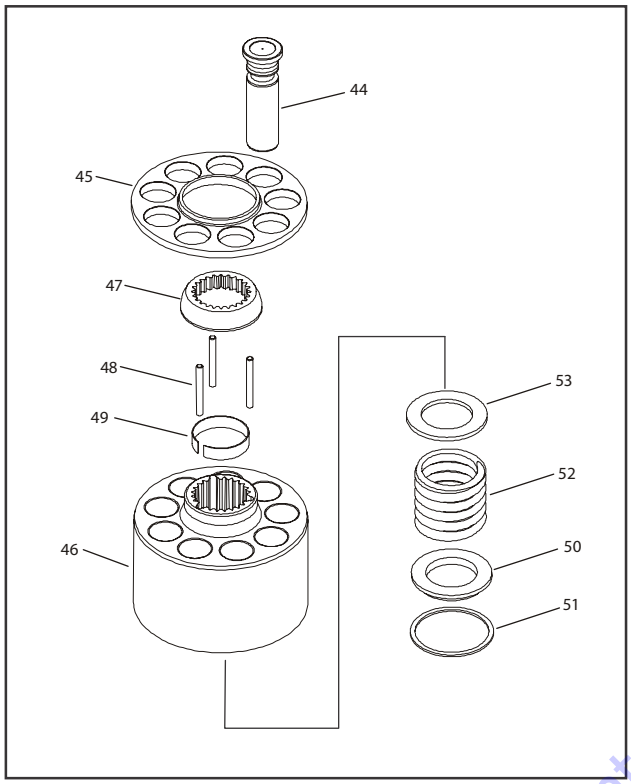


44. Piston
45. Slipper Retainer
46. Cylinder Block
47. Ball Guide
48. Holddown Pins
49. Retaining Ring
50. Block Spring Washer
51. Spiral Retaining Ring
52. Block Spring
53. Inner Block Spring Washer

Figure 3-29. Cylinder Kit Disassembly

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

NOTE: *Pistons are not selectively fitted. However, units with high hourly usage may develop wear patterns. Number pistons and bores for reassembly if they are to be reused.*

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

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

⚠ WARNING

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

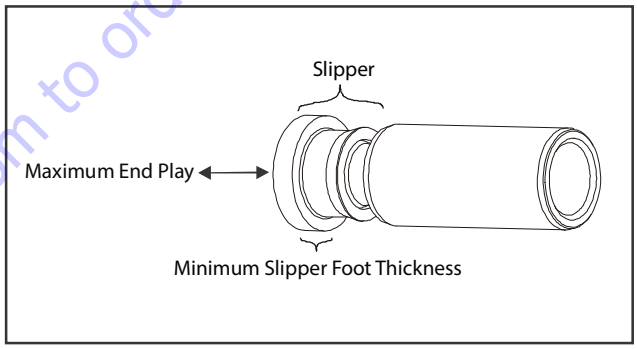
27. Turn block over. Using a press, apply pressure on block spring washer (50) to compress block spring. Compress spring enough to safely remove spiral retaining ring (51). While maintaining pressure, unwind spiral retaining ring (51). Carefully release pressure and remove outer block spring washer (50),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

Inspection

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



SLIPPERS

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

Table 3-6. Slipper Foot Thickness & End Play

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

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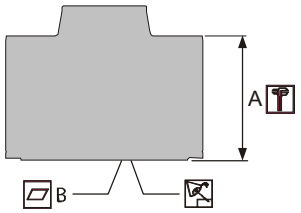
CYLINDER BLOCK

Measure cylinder block height. Replace blocks worn beyond minimum height specification. Inspect cylinder block running surface. Replace or resurface worn or scratched blocks. Blocks may be resurfaced to specifications shown in the drawing, provided resurfacing will not reduce block height below minimum specification. Table 3-7, Cylinder Block Measurements.

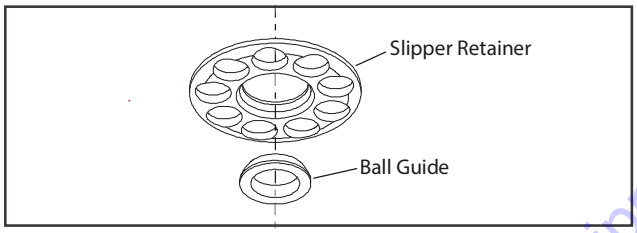
Table 3-7. Cylinder Block Measurements

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



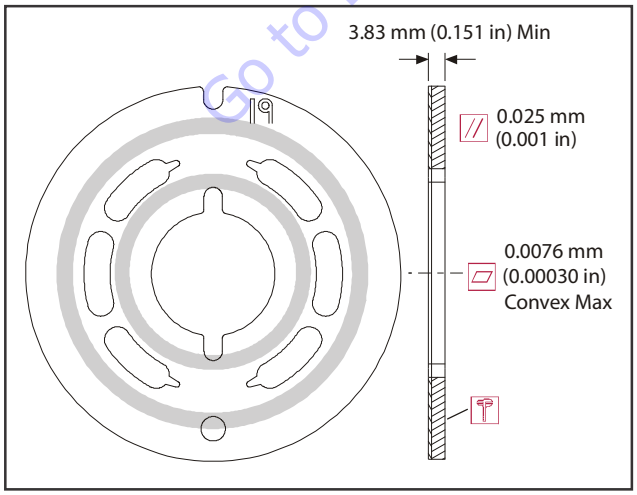
BALL GUIDE AND SLIPPER RETAINER

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



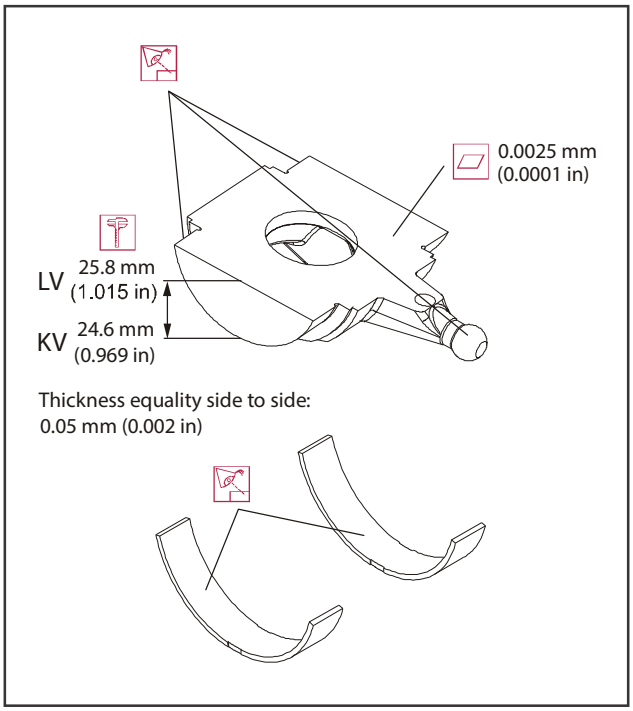
VALVE PLATE

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



SWASHPLATE AND JOURNAL BEARINGS

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



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

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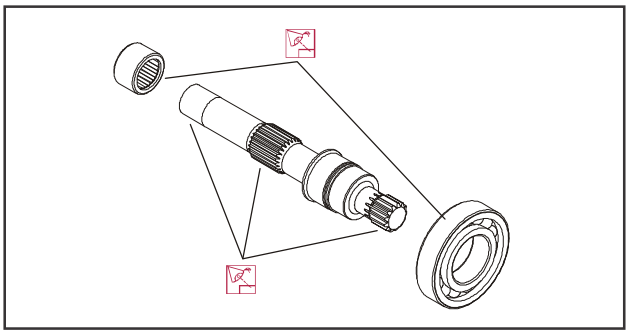
SHAFT BEARINGS

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

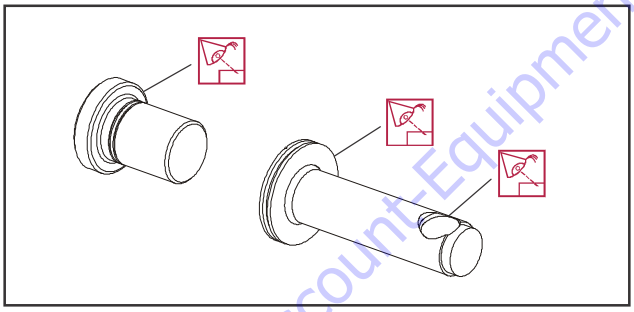


SHAFT

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

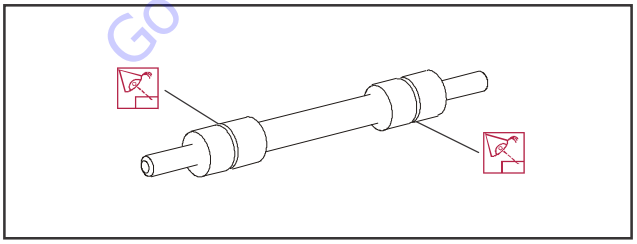
SERVO PISTON AND MINIMUM ANGLE STOP

Inspect minimum angle stop, servo piston head, and servo piston ball-socket for damage or excessive wear. Replace as required.



LOOP FLUSHING SPOOL

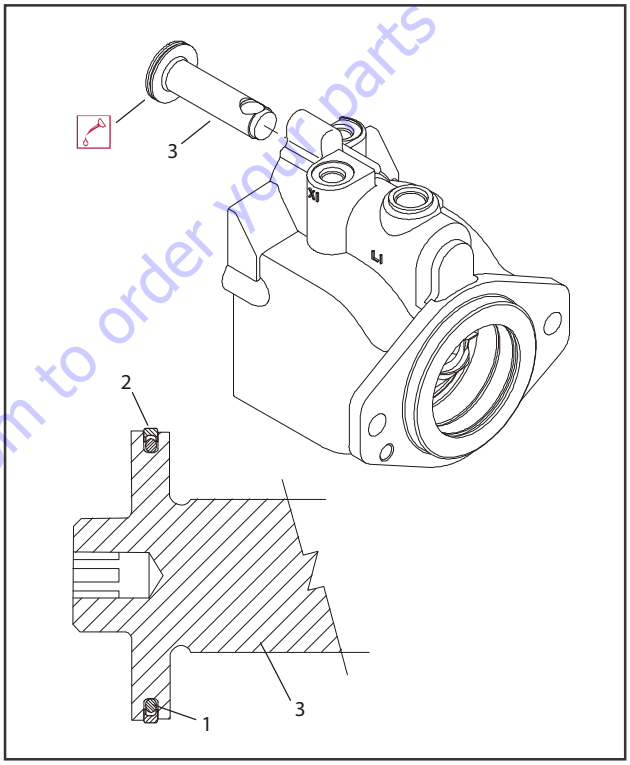
Inspect loop flushing spool for cracks or damage. Replace as required.



Assembly

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

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



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

Figure 3-30. Servo Piston

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

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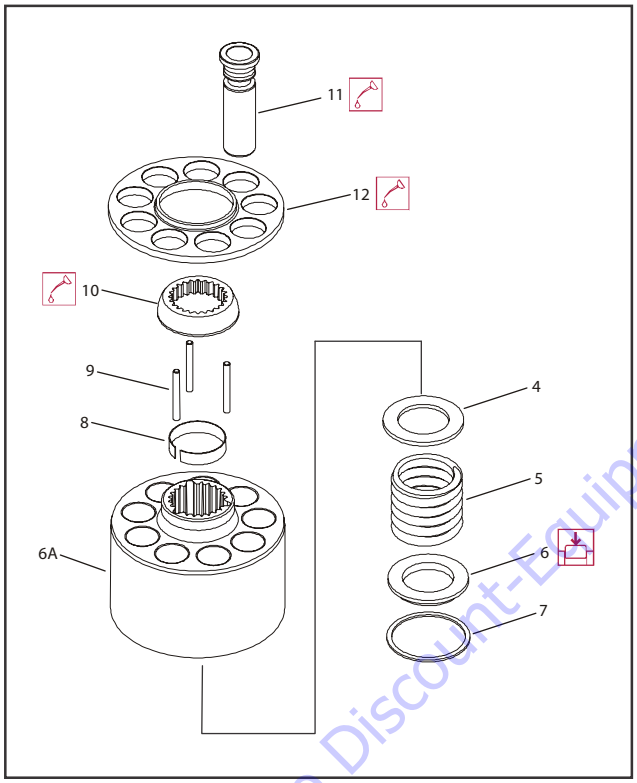
⚠ CAUTION

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 SPRING IS SECURE BEFORE ATTEMPTING TO INSTALL THE SPIRAL RETAINING RING. RELEASE PRESSURE SLOWLY AFTER RETAINING RING IS INSTALLED.

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

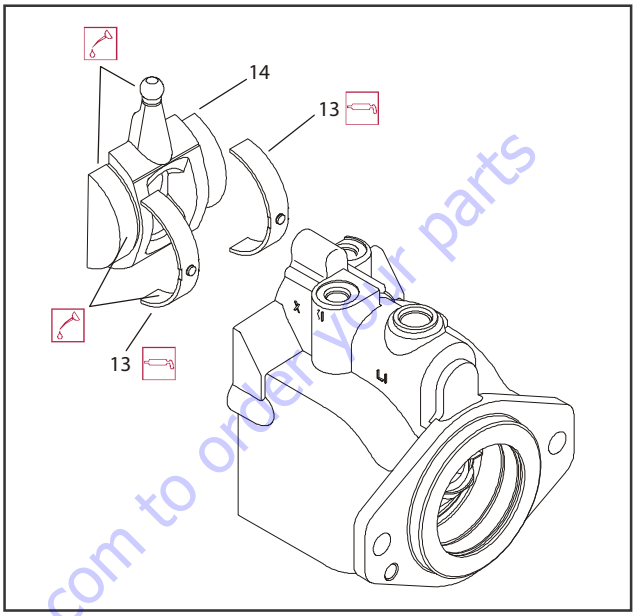


4. Block Spring Washer
5. Block Spring
6. Outer Washer
6A. Cylinder Block
7. Spiral Retaining Ring
8. Retaining Ring
9. Holddown Pins
10. Ball Guide
11. Piston
12. Slipper Retainer

4. Turn block over and install retaining ring (8), hold-down pins (9), and ball guide (10) to cylinder block.

5. Install pistons (11) to slipper retainer (12). Install piston/retainer assembly in cylinder block. Ensure concave surface of retainer seats on ball guide. If reusing pistons, install them in original block bores. Lubricate pistons, slippers, retainer, and ball guide before assembly. Set cylinder kit aside on a clean surface until needed.

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



13. Journal Bearings
14. Swash Plate

Figure 3-31. Swash Plate and Journal Bearing

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

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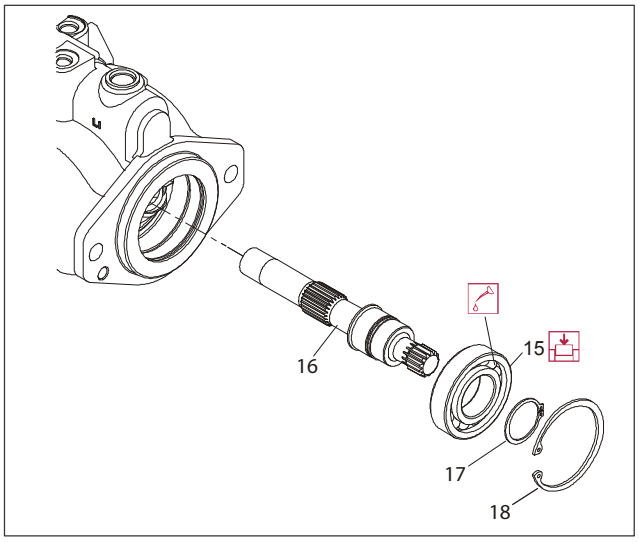
8. Press front shaft bearing (15) on shaft (16). Press bearing on shaft with lettering facing out. Lubricate bearing rollers. Install snap-ring (17) on shaft.

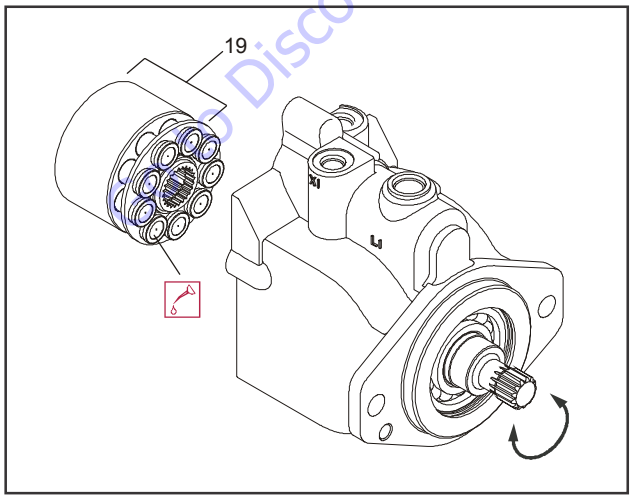


15. Front Shaft Bearing
16. Shaft
17. Snap Ring
18. Snap Ring

Figure 3-32. Shaft and Front Bearing

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

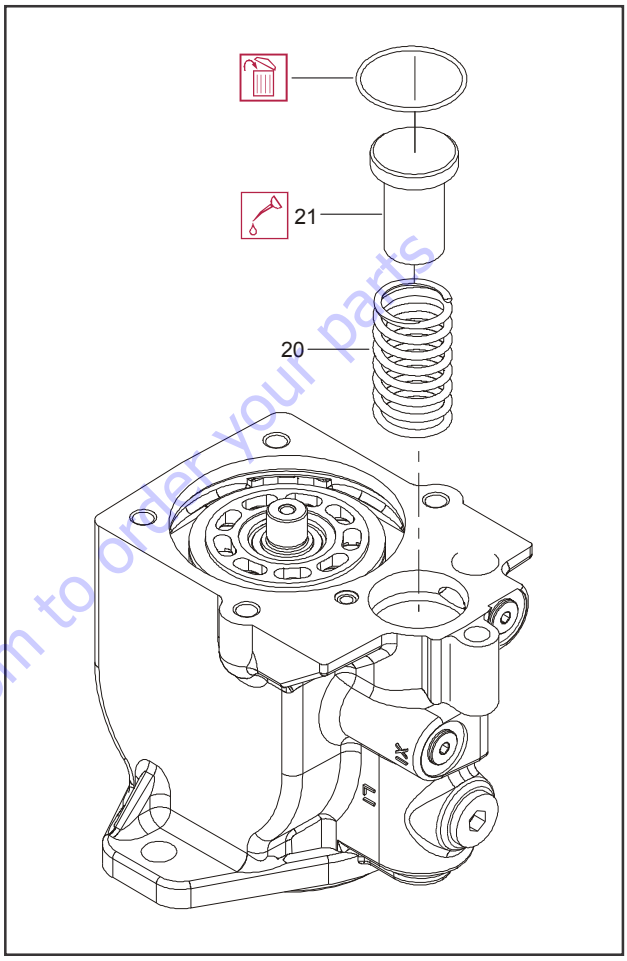
10. Verify swashplate and bearings are properly seated. Install cylinder kit (19) on shaft. Install with slippers facing swashplate. Rock the shaft to align block splines and slide cylinder kit into place. Orient motor with shaft pointing downward and verify cylinder kit, swashplate, journal bearings,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



19. Cylinder Kit

Figure 3-33. Cylinder Kit Installation

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



20. Servo Spring
21. Minimum Angle Stop

Figure 3-34. Servo Spring and Minimum Angle Stop

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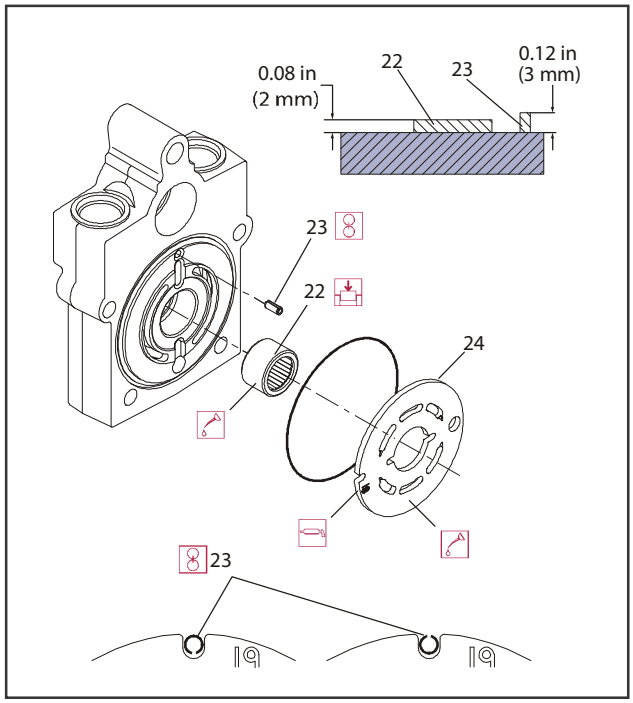
12. Press rear shaft bearing (22) in endcap. Install bearing with letters facing out. Press until bearing surface is 0.08 ±0.01 in (2 ±0.25 mm) above endcap surface.



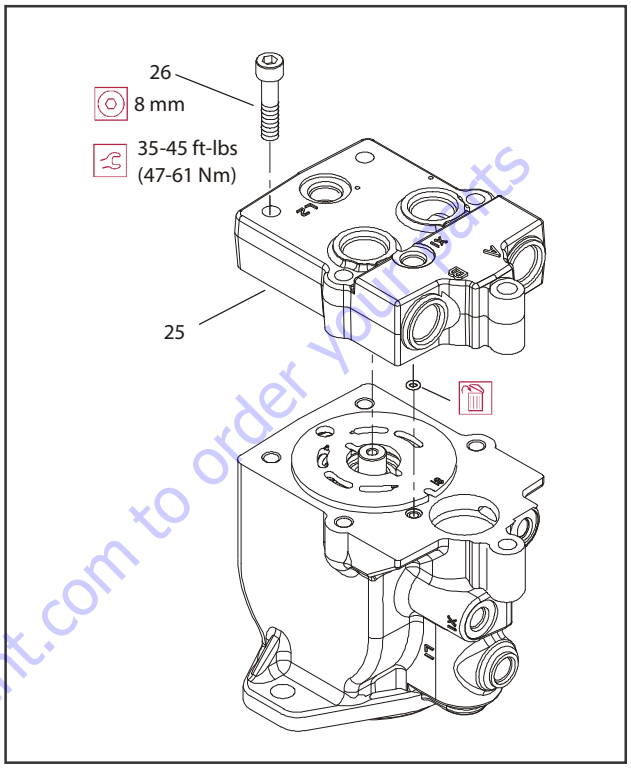
22. Rear Shaft Bearing
23. Timing Pin
24. Valve Plate

Figure 3-35. Valve Plate and Rear Bearing

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

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

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



25. End Cap
26. Screw

Figure 3-36. End Cap

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

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

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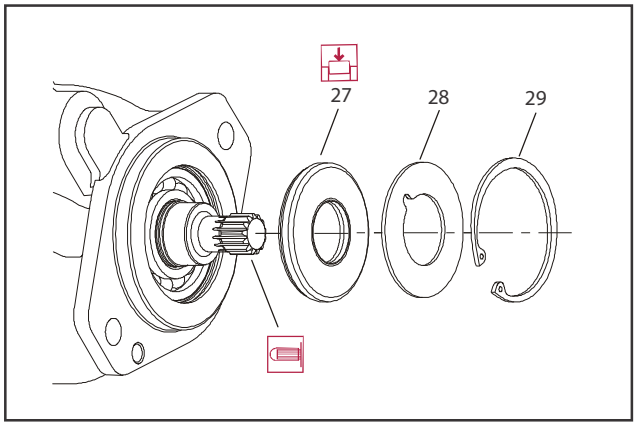
18. Cover shaft splines with an installation sleeve. Install a new shaft seal (27) with cup side facing motor. Press seal in housing until it bottoms out. Press evenly to avoid binding and damaging seal. Install seal support washer (28) and snap ring (29).



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

Figure 3-37. Shaft Seal

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

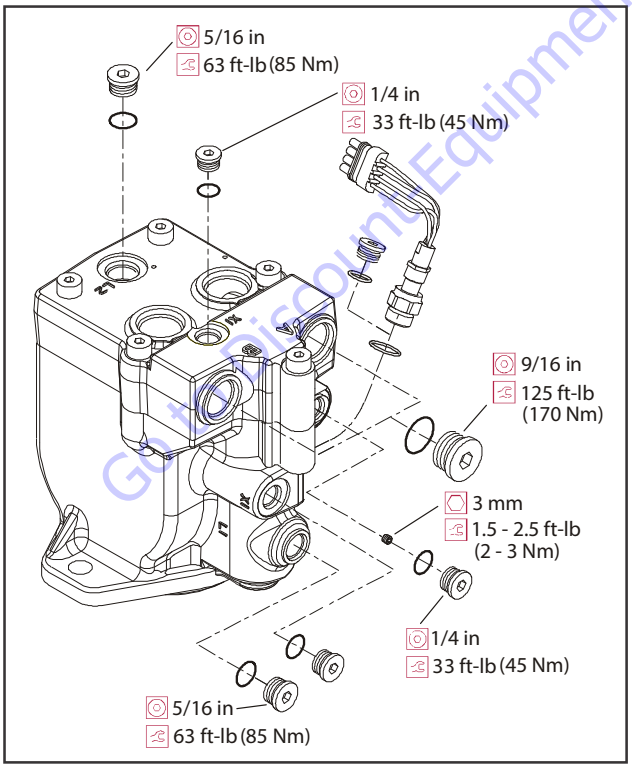
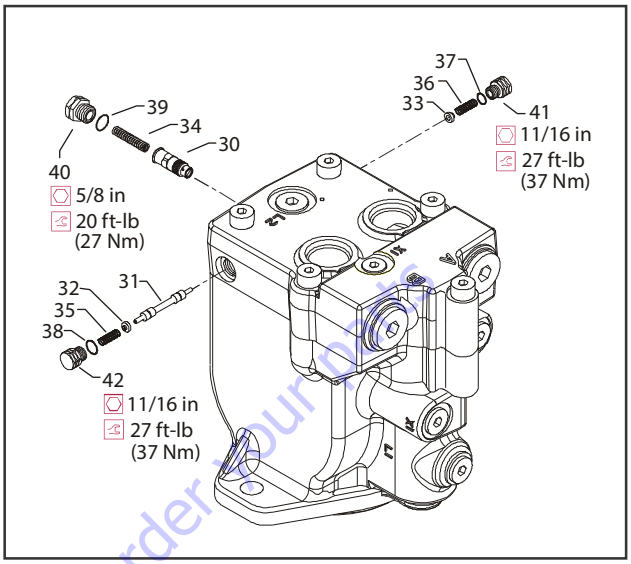


Figure 3-38. Plugs and Fittings Installation

20. Install orifice poppet (30).



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

Figure 3-39. Loop Flushing Spool

21. Install shift spool (31).

22. Install spring retaining washers on 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-lb (27 Nm).

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

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Initial Start-up

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

NOTICE

INSPECT MOTOR FOR DAMAGE BEFORE INSTALLATION. MAKE CERTAIN ALL SYSTEM COMPONENTS (RESERVOIR, HOSES, VALVES, FITTINGS, HEAT EXCHANGER, ETC.) ARE CLEAN BEFORE FILLING WITH FLUID.

1. Fill reservoir with recommended hydraulic fluid. Always filter fluid through a 10 micron filter when pouring into the reservoir. Never reuse hydraulic fluid.
2. Fill inlet line leading from pump to reservoir. Check inlet line for properly tightened fittings and be certain it is free of restrictions and air leaks.
3. Fill pump and motor housing with clean hydraulic fluid. Pour filtered oil directly in upper most case drain port.
4. To ensure pump and motor stay filled with oil, install case drain lines in upper most case drain ports.
5. Install a 0 to 500 psi (0 to 35 bar) gauge in charge pressure gauge port of pump to monitor system pressure during start up.
6. Watching pressure gauge and run engine at lowest possible speed until system pressure builds to normal levels (minimum 160 psi [11 bar]). Once system pressure is established, increase to full operating speed. If system pressure is not maintained, shut down engine, determine cause, and take corrective action.
7. Operate hydraulic system for at least fifteen minutes under light load conditions.
8. Check and adjust control settings as necessary after installation.
9. Shut down engine and remove pressure gauge. Replace plug at charge pressure gauge port.

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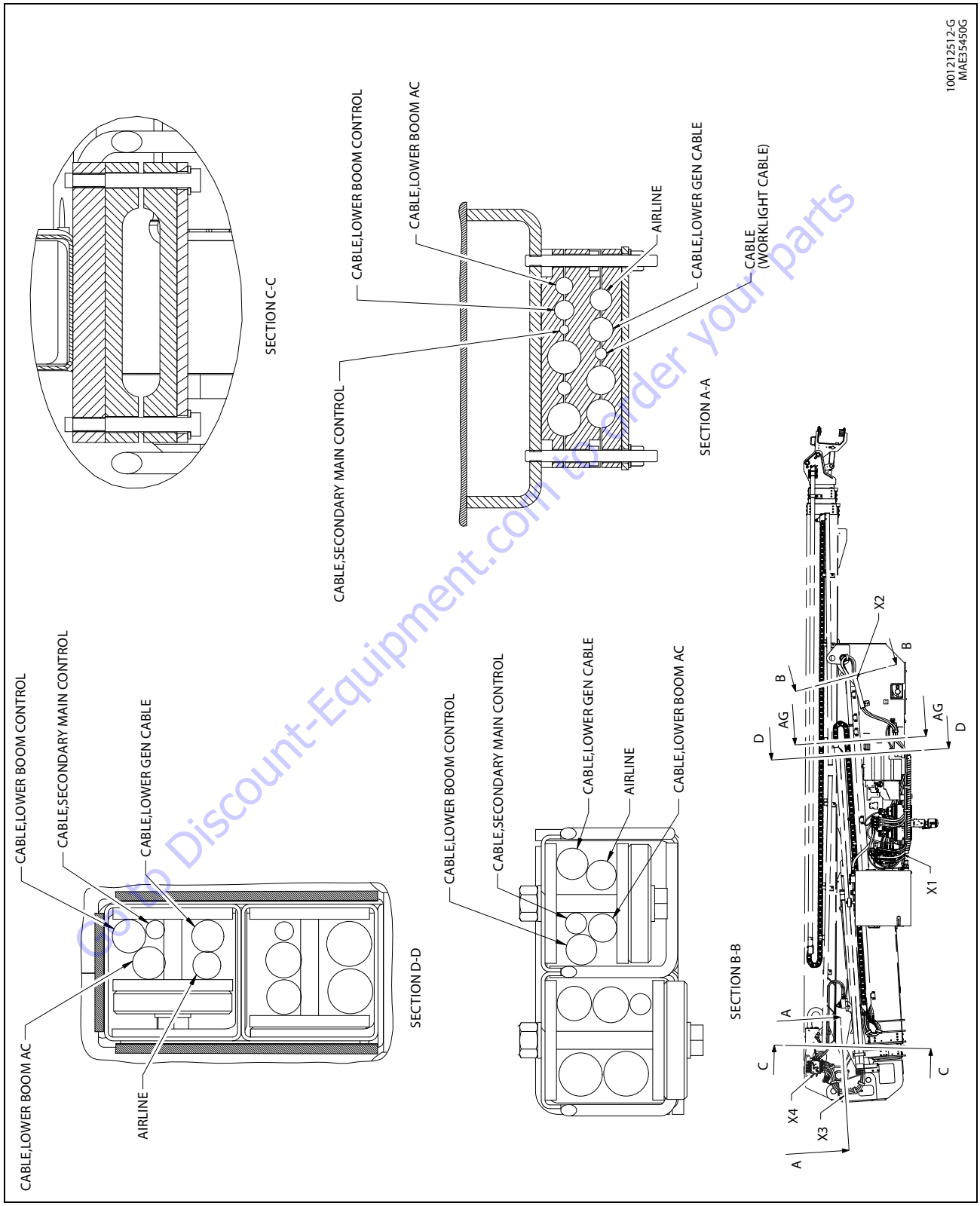

Figure 3-40. Turntable Hydraulic System - Sheet 1 of 12

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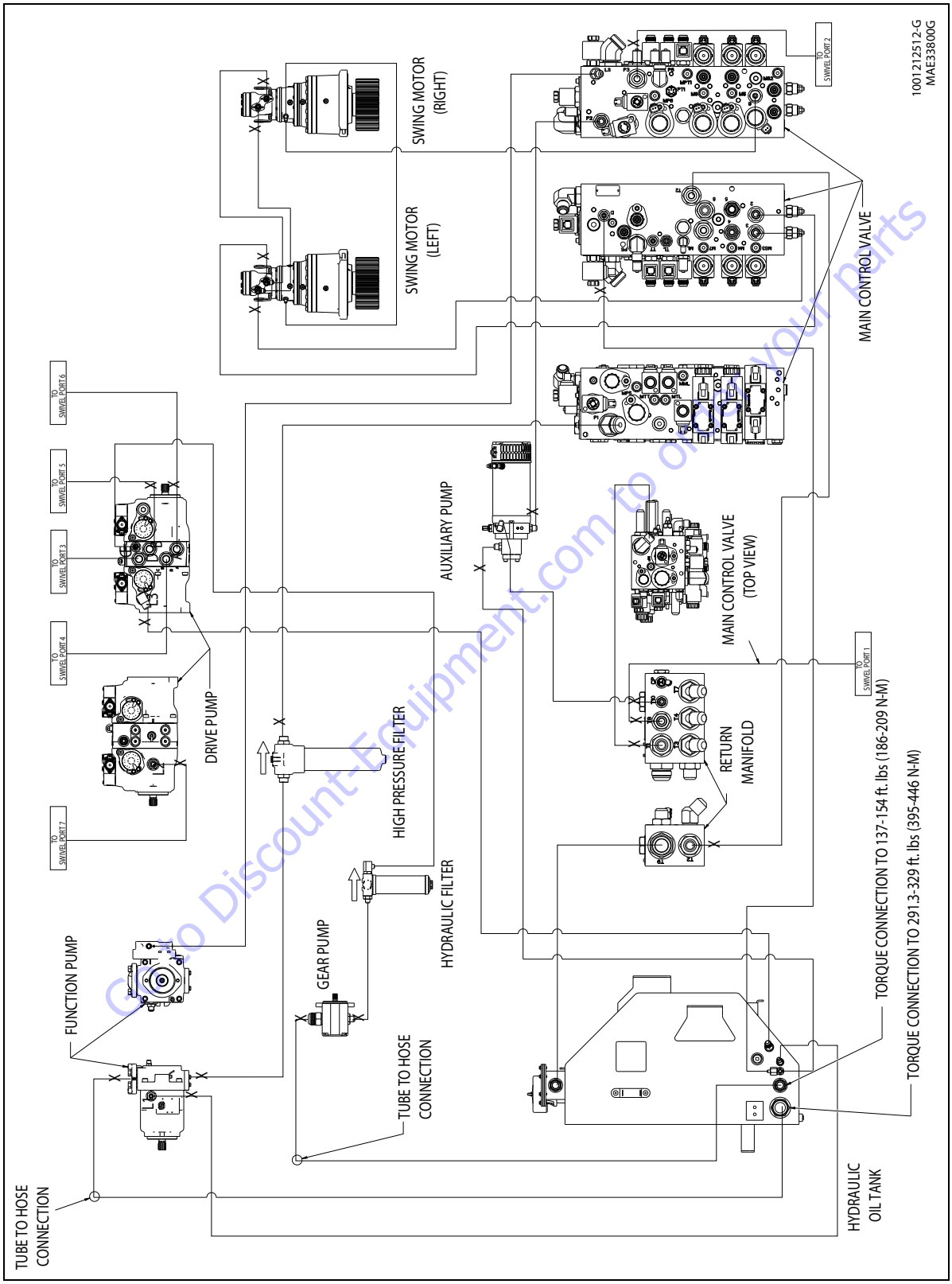

Figure 3-41. Turntable Hydraulic System - Sheet 2 of 12

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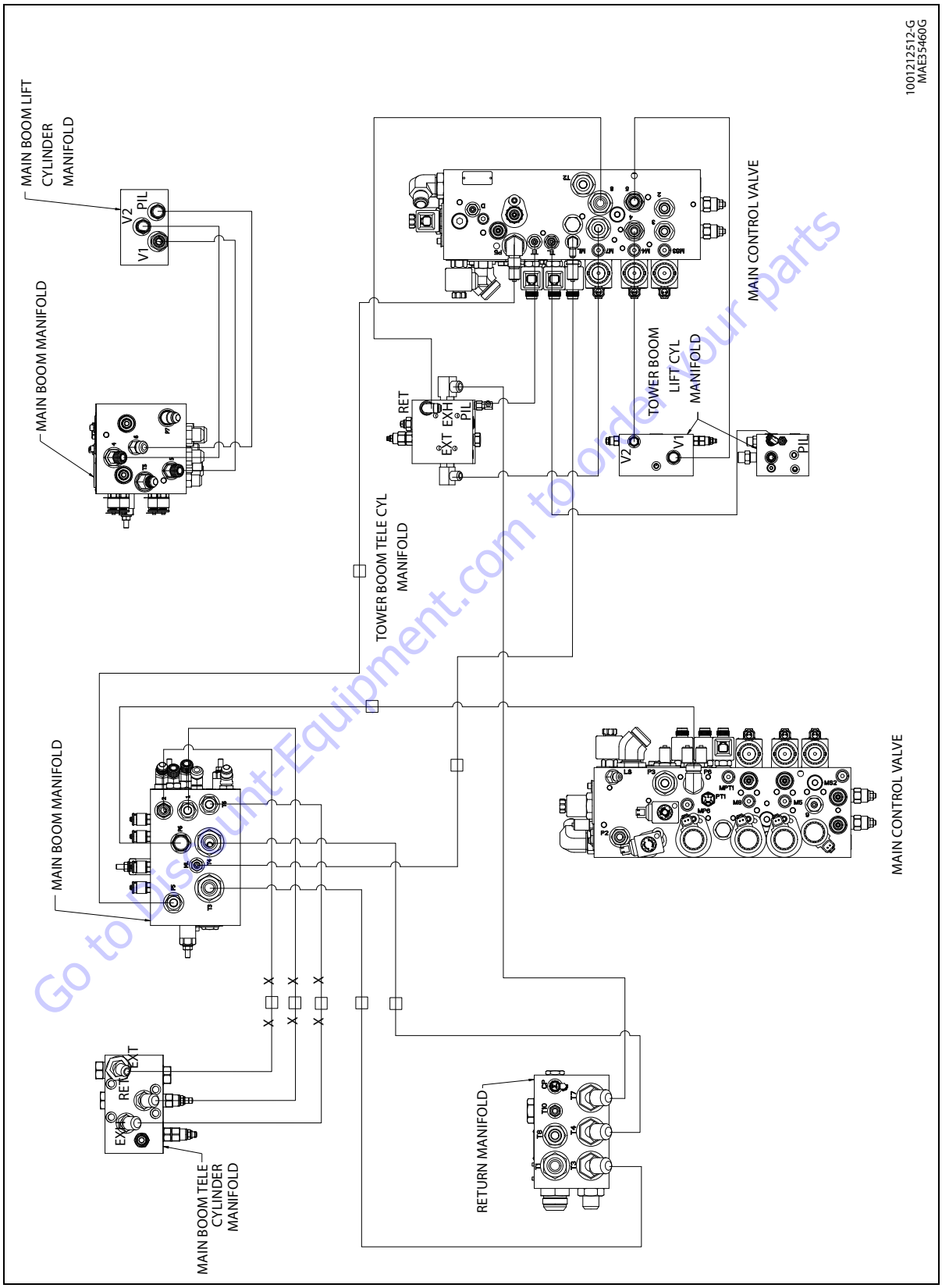

Figure 3-42. Turntable Hydraulic System - Sheet 3 of 12

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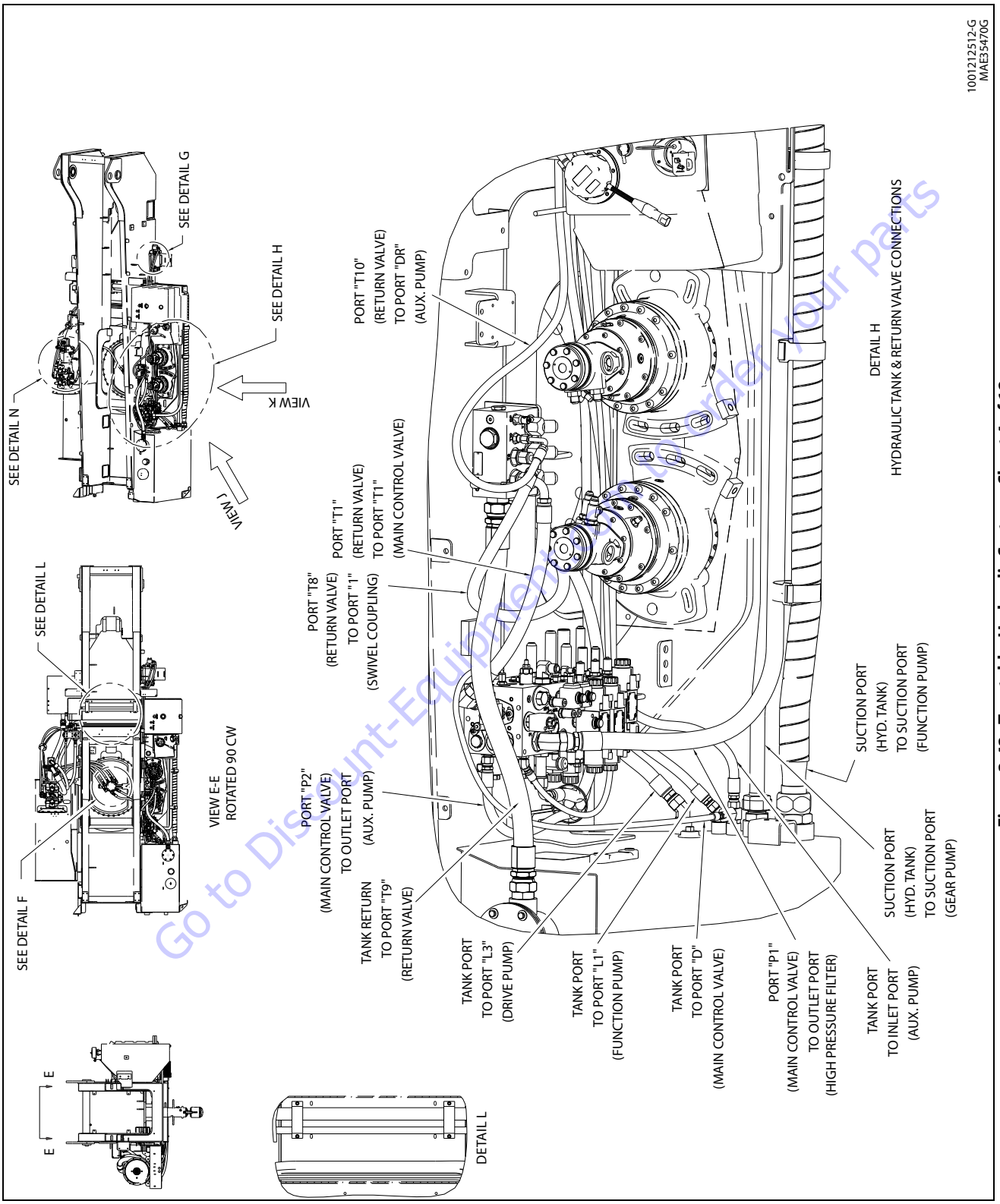

Figure 3-43. Turntable Hydraulic System - Sheet 4 of 12

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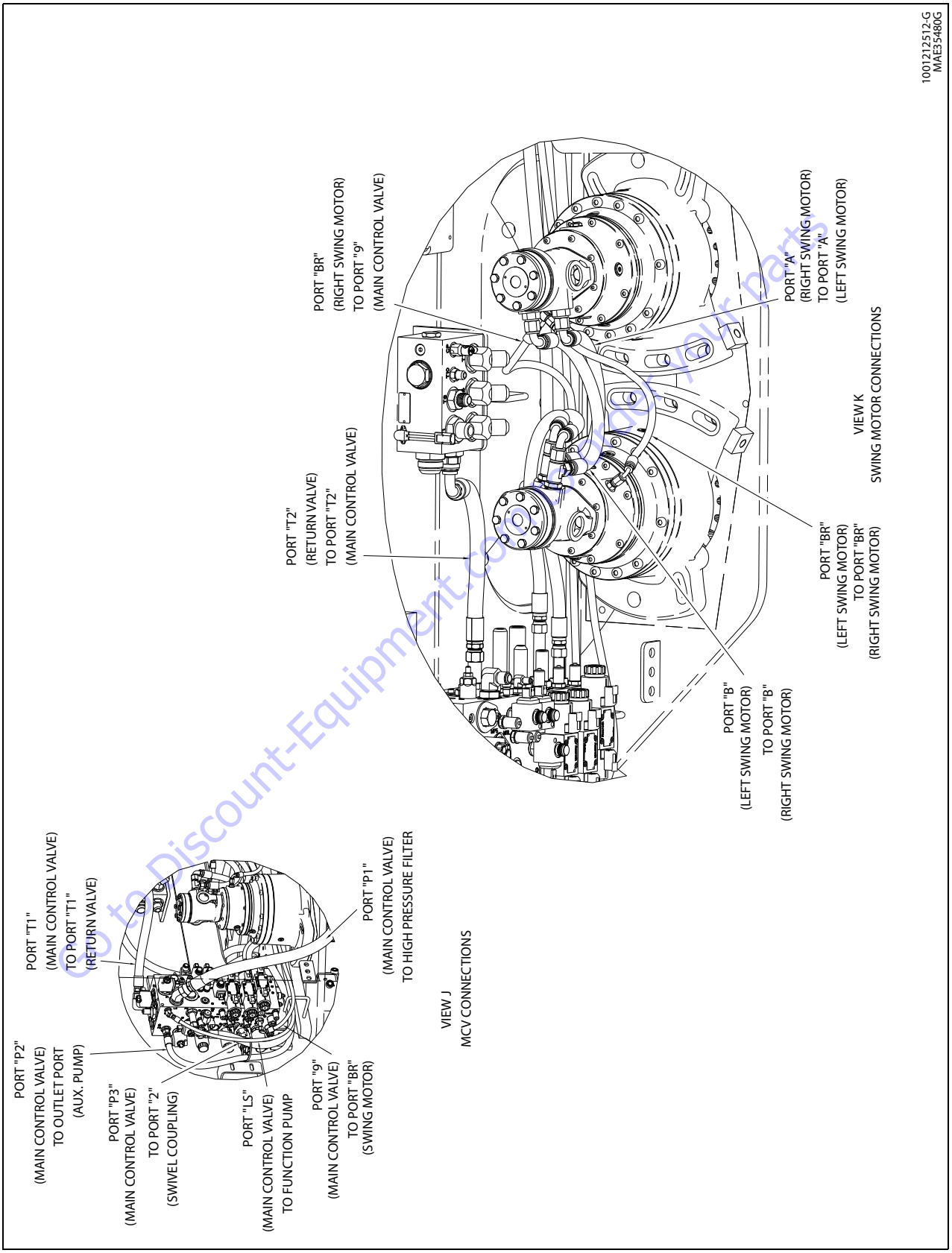

Figure 3-44. Turntable Hydraulic System - Sheet 5 of 12

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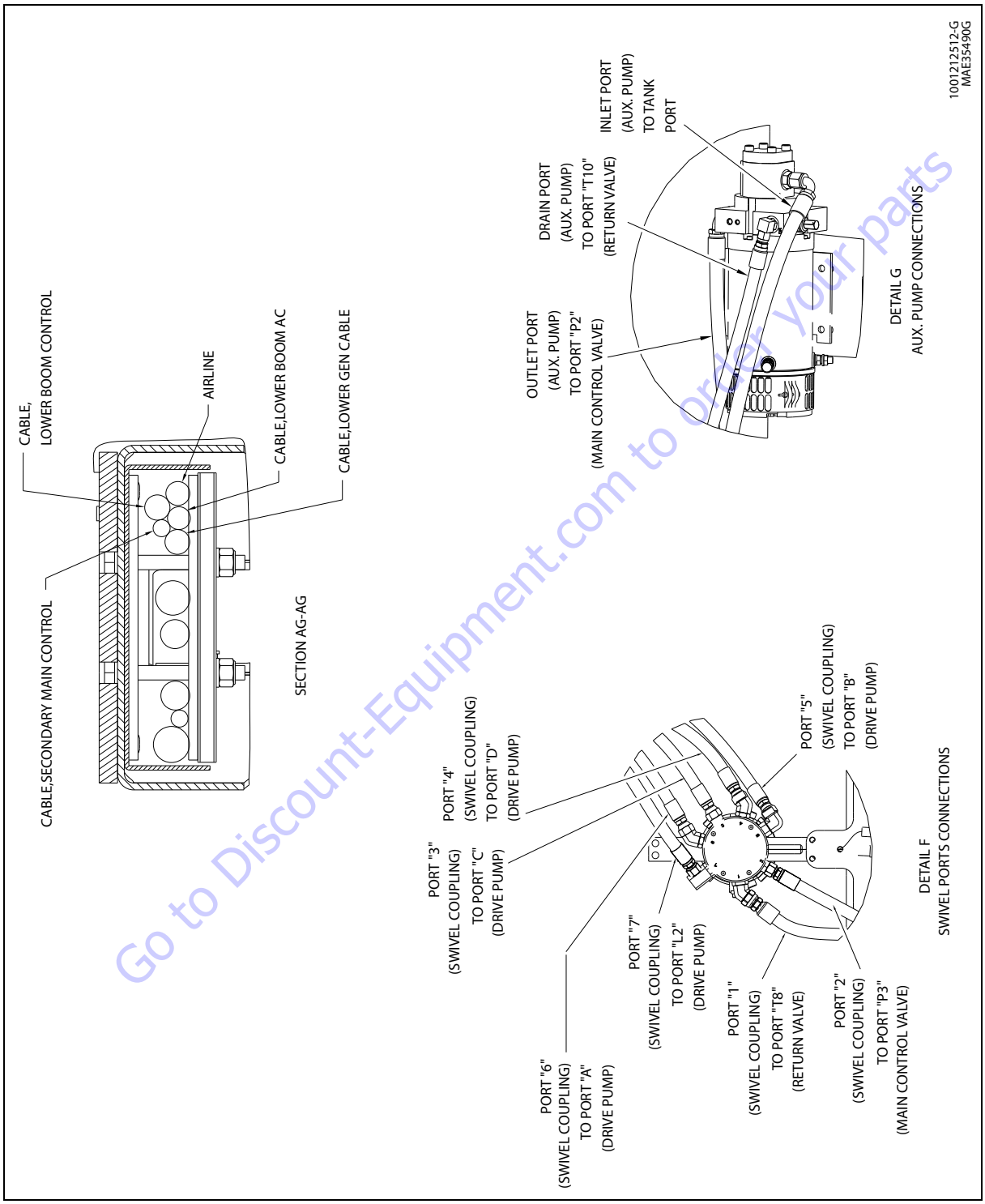

Figure 3-45. Turntable Hydraulic System - Sheet 6 of 12

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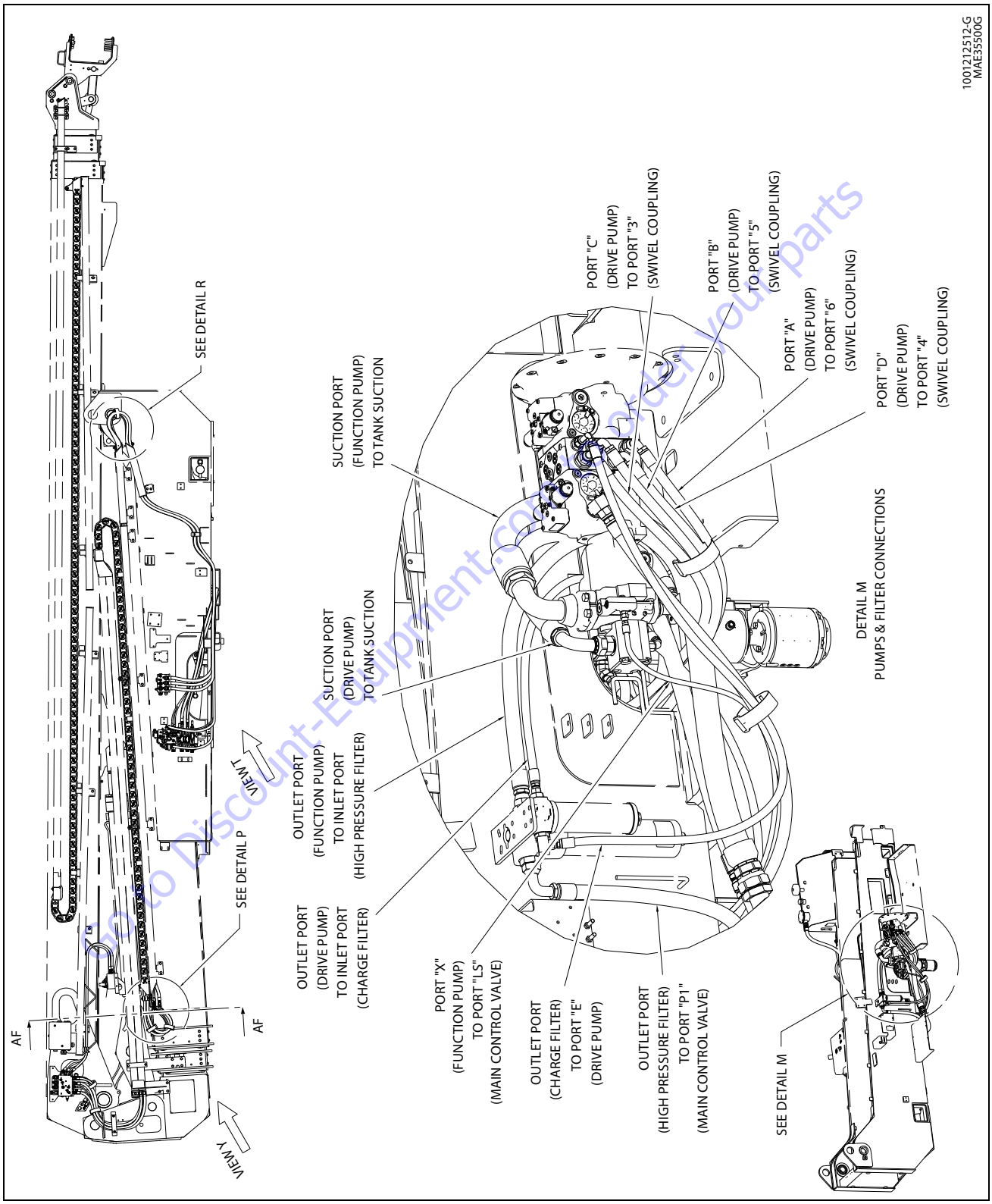

Figure 3-46. Turntable Hydraulic System - Sheet 7 of 12

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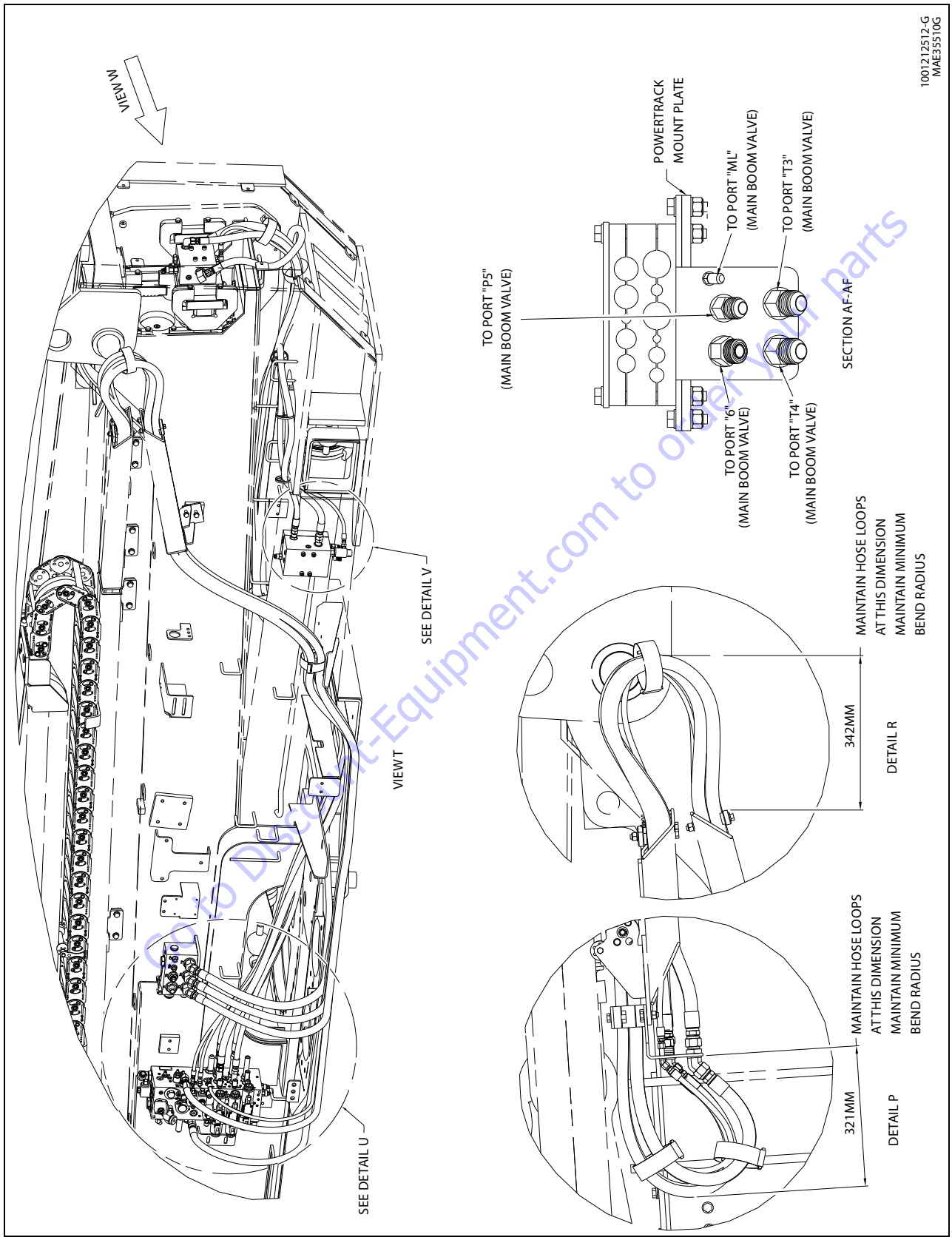

Figure 3-47. Turntable Hydraulic System - Sheet 8 of 12

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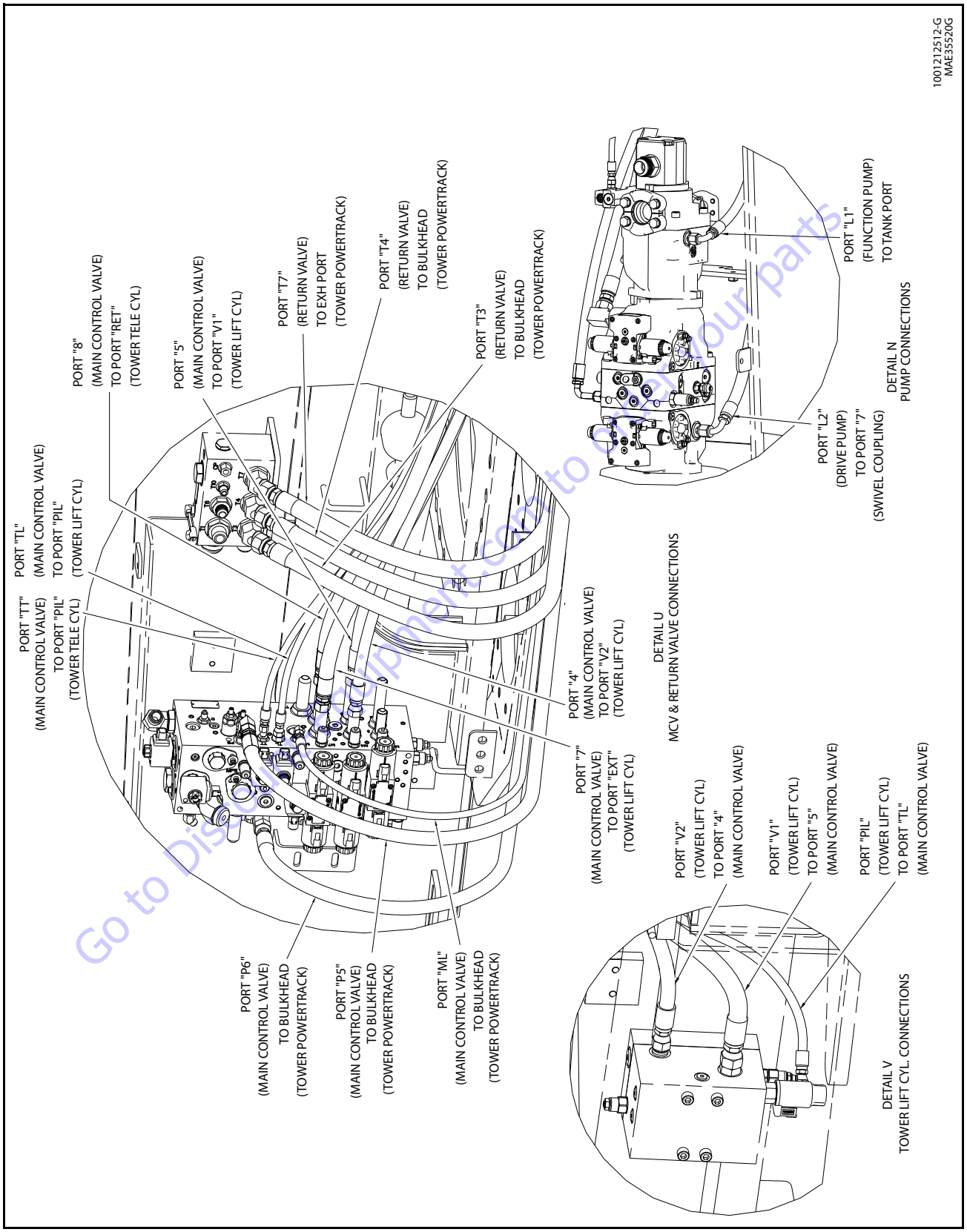

Figure 3-48. Turntable Hydraulic System - Sheet 9 of 12

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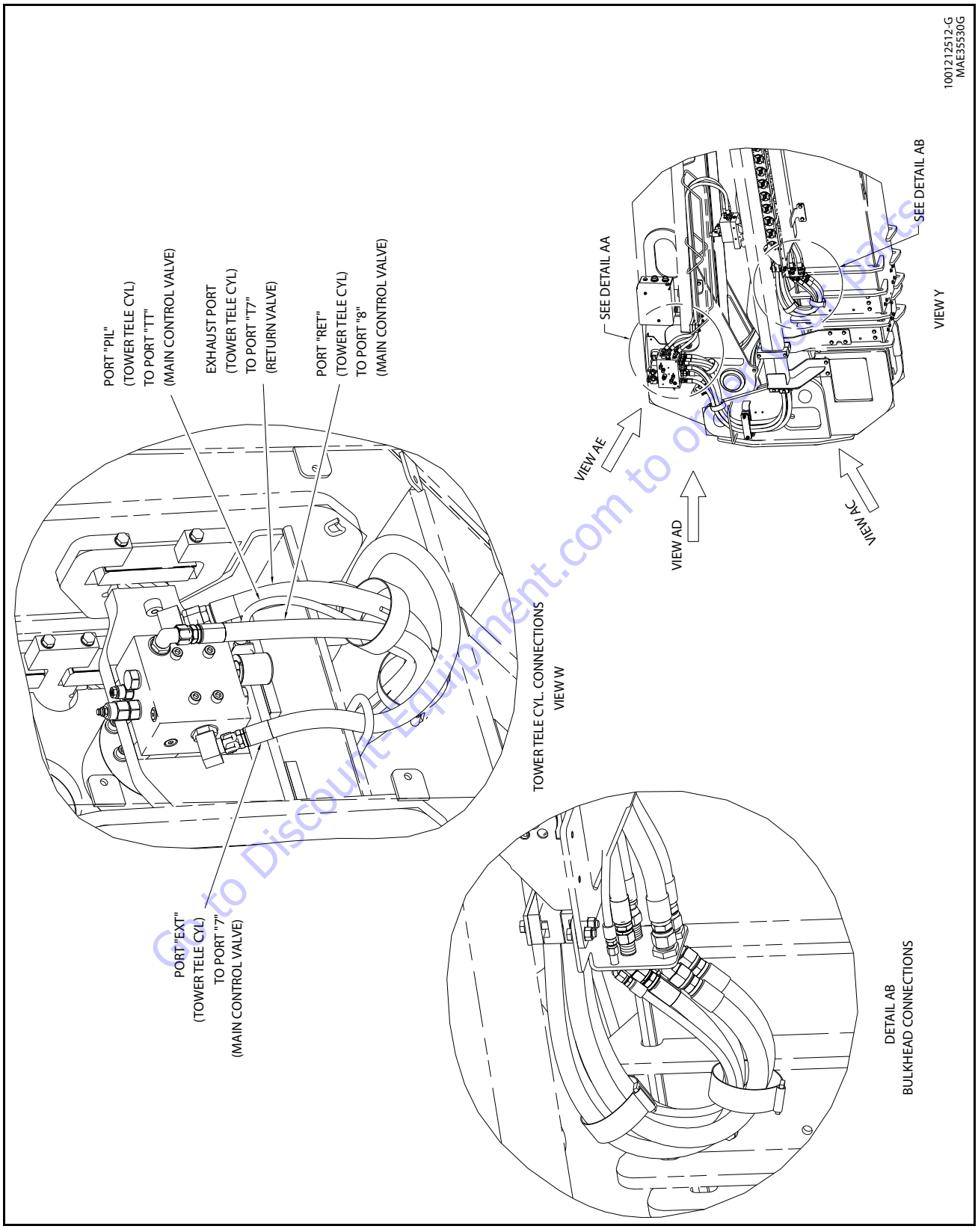

Figure 3-49. Turntable Hydraulic System - Sheet 10 of 12

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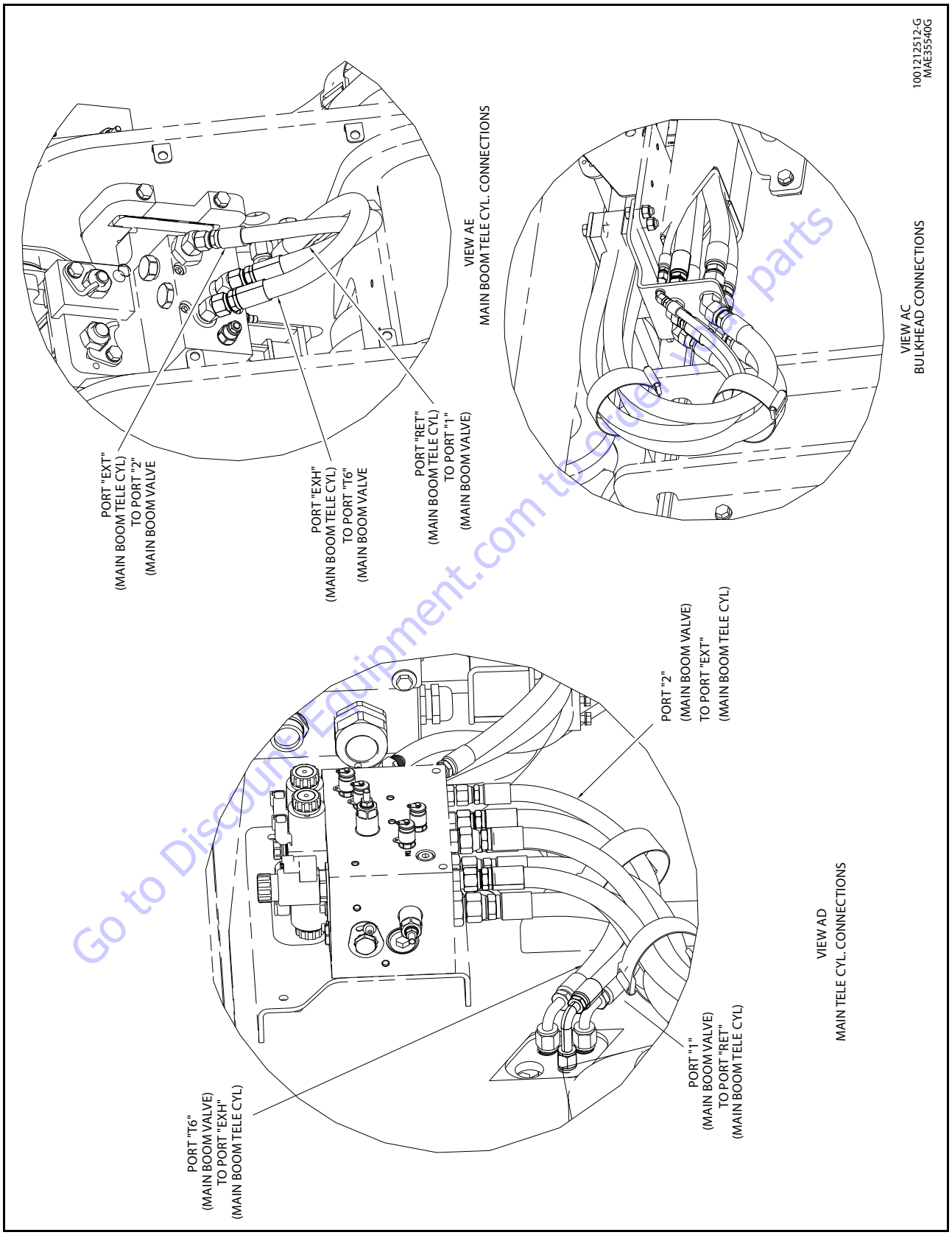

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Figure 3-50. Turntable Hydraulic System - Sheet 11 of 12

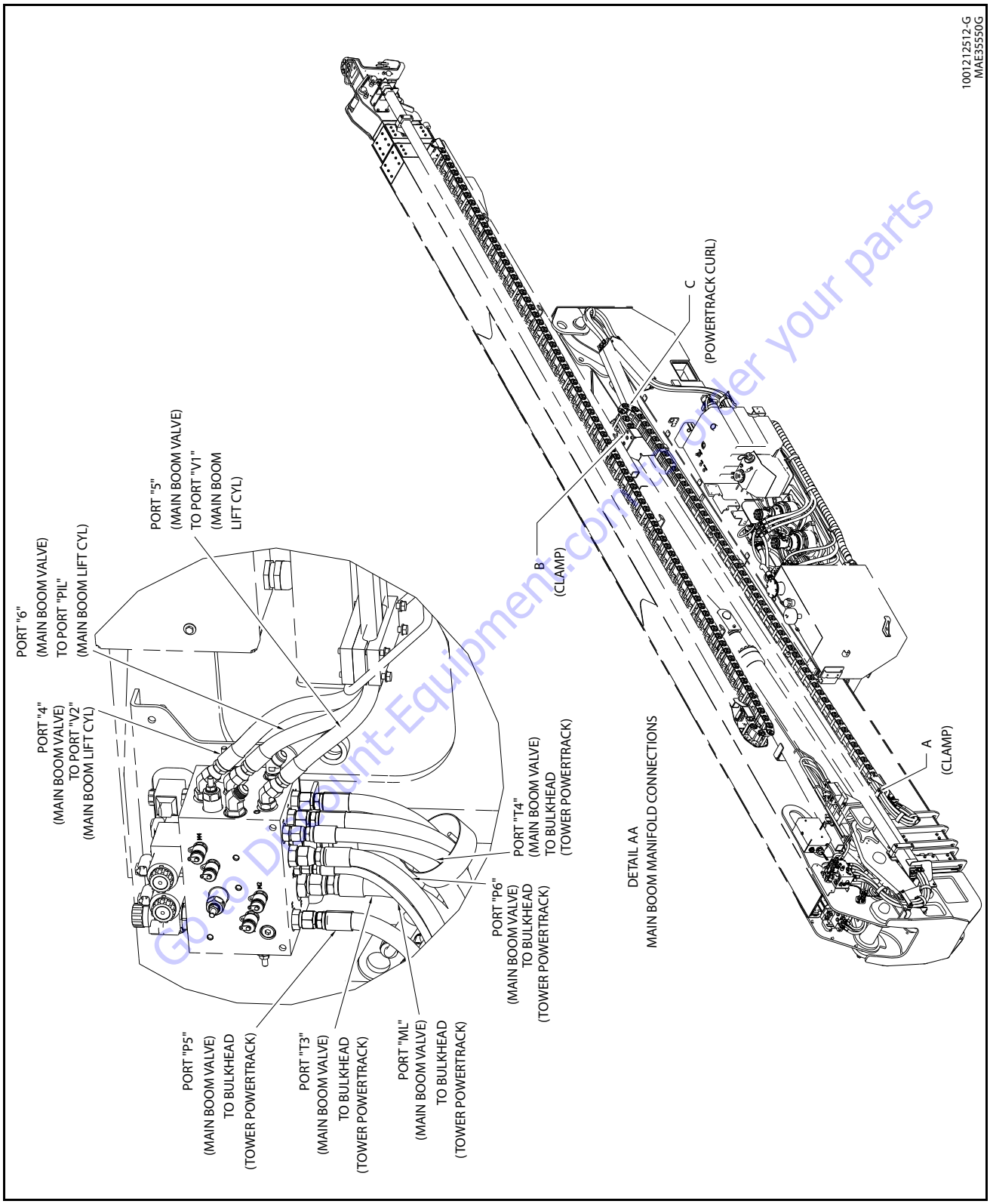

Figure 3-51. Turntable Hydraulic System - Sheet 12 of 12

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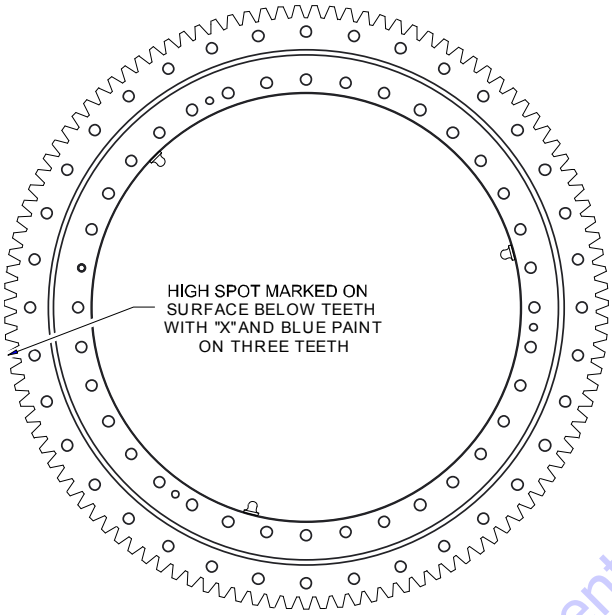
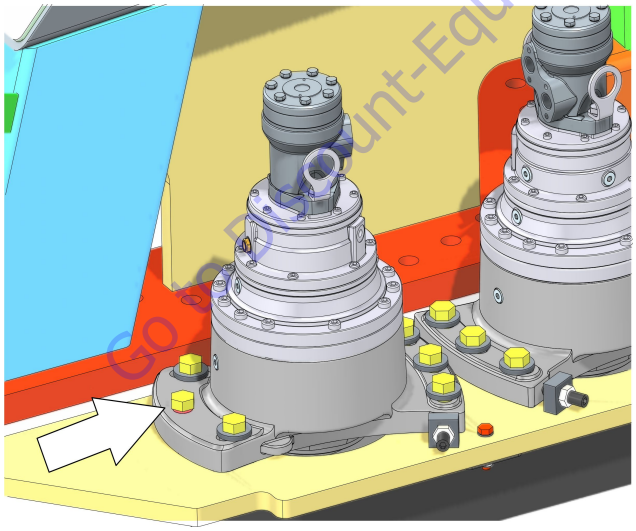
3.15 SETTING SWING GEAR BACKLASH

Set backlash 0.10 to 0.15" (0.254 to 0.381 mm) using the following procedure.

1. Place machine on firm, level ground.
2. Place shim between pinion and bearing on bearing high spot.

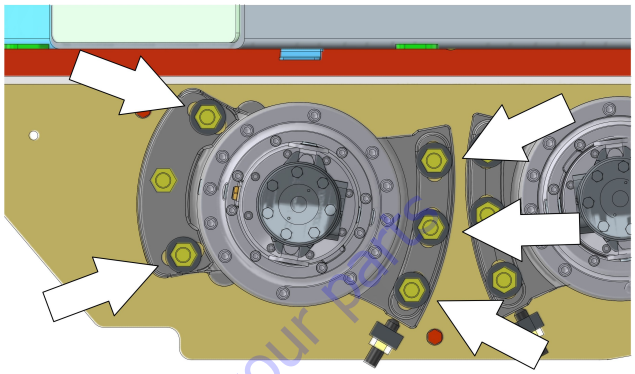


3. Apply High Strength Threadlocking Compound to bolt. Torque pivot spacer screw to 340 ft-lb (47 kgm).

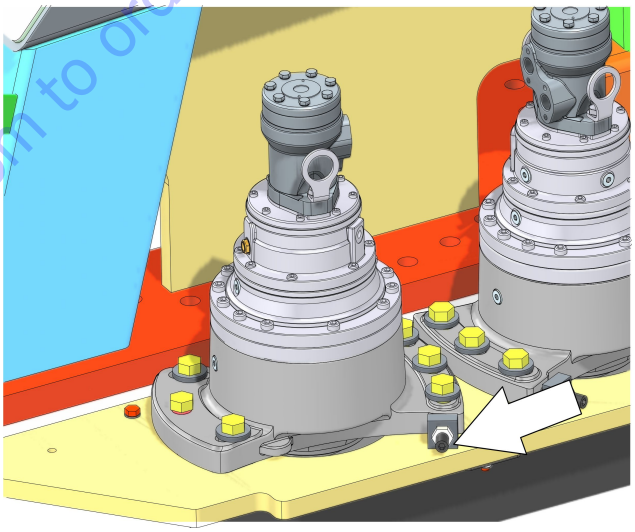


NOTE: *Make sure turntable is properly supported during the following step. The turntable can swing a few degrees when turntable lock is removed if turntable is not balanced.*

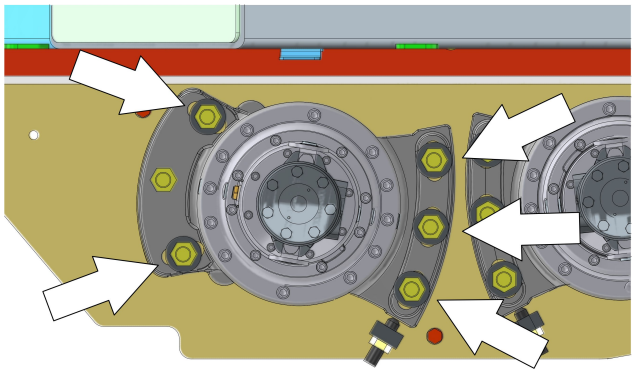
4. Remove turntable lock pin.
5. Apply High Strength Threadlocking Compound to the bolts. Pre-torque the five bolts to 45 ft-lb (6 kgm).



6. Tighten setscrew until pinion is completely snug against shim and bearing. Back off setscrew.



7. Torque setscrew to 50 ft-lb (7 kgm).
8. Apply High Strength Threadlocking Compound. Tighten jam nut.
9. Torque bolts to 340 ft-lb (47 kgm).



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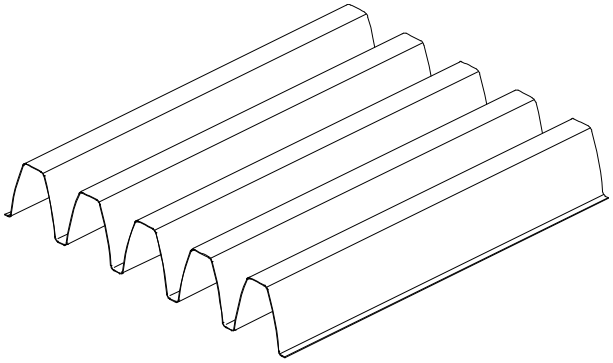
10. Discard shim.



11. Rotate bearing high spot 15° to the second drive hub. Repeat procedure.

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 applying High strength Threadlocking Compound to the bolt threads. After replacing and retorquing bolt or bolts recheck all existing bolts for looseness.*

1. Check the frame to bearing attach bolts as follows:

- **a.** Fully elevate the main boom. (Position 2, Figure 3-53.)
- **b.** At the position indicated on Figure 3-53., try to insert a 0.0015" feeler gauge between the bolt and hardened washer at the arrow indicated position.
- **c.** Ensure that the 0.0015" feeler gauge will not penetrate under the bolt head to the bolt shank.
- **d.** Swing the turntable 90 degrees, and check some selected bolts at the new position.
- **e.** Continue rotating the turntable at 90 degrees intervals until a sampling of bolts have been checked in all quadrants.

2. Check the turntable to bearing attach bolts as follows:

- **a.** Elevate the fully retracted main boom to full elevation.
- **b.** At the position indicated on Figure 3-52. try to insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.
- **c.** Lower the boom to horizontal and fully extend the boom.
- **d.** At the position indicated on Position 1 Figure 3-53., try and insert the 0.0015" feeler gauge between the bolt head and hardened washer at the arrow indicated position.

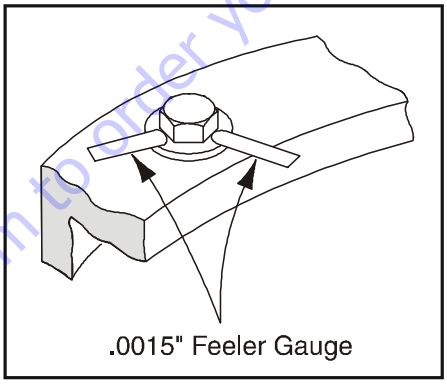


Figure 3-52. Swing Bolt Feeler Gauge Check

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3.16 SWING BEARING WEAR TOLERANCE

See Figure 3-53., Swing Bearing Wear Tolerance.

1. Position the machine as follows and as seen in Figure 3-53., Swing Bearing Wear Tolerance, Position 1:
   - **a.** Ensure the axles are extended
   - **b.** The turntable needs to be centered between the rear wheels
   - **c.** Fully elevate the tower boom
   - **d.** Lower the main boom to be horizontal
   - **e.** Extend the main boom until it stops
   - **f.** Lower the jib to horizontal
   - **g.** Keep the jib and platform centered and unloaded
2. Set up a dial indicator as follows:
   - **a.** The dial indicator location is to be at the front center of the machine, next to the bearing, opposite of the tower pivot pin.
   - **b.** The magnetic base of the indicator should be positioned on the frame

   - **c.** The indicator point needs positioned to measure the turntable base plate 2.5 inches from the root of the gear tooth. Refer to Figure 3-53., Swing Bearing Wear Tolerance.
3. Zero the dial indicator.
4. Check dial indicator accuracy once positioned, using a feeler gauge and ensure the dial indicator reading, is the same as the feeler gauge thickness.
5. Position the machine as follows and as seen in Figure 3-30., Swing Bearing Wear Tolerance, Position 2:
   - **a.** Do not rotate the turntable
   - **b.** The tower boom needs to be stowed
   - **c.** Raise the main boom to be fully elevated and retracted
   - **d.** Raise the jib to be fully elevated and centered
   - **e.** Center the platform and keep it unloaded
6. Verify the dial indicator has not shifted. Record the value for bearing play.
7. Return the machine to Figure 3-53., Swing Bearing Wear Tolerance, Position 1. The dial indicator should to return to zero. If the dial indicator does not return to zero, take corrective action and repeat the test.
8. If the measurement is more than 0.165 in. (4.2 mm), replace the bearing. If the measurement is less than 0.165 in. (4.2 mm), and any of the following conditions exist, the bearing should be removed, disassembled, and inspected.
   - **a.** Metal particles in the grease.
   - **b.** Increased drive power required.
   - **c.** Noise.
   - **d.** Rough rotation.
9. If bearing inspection shows no defects, reassemble and return to service.

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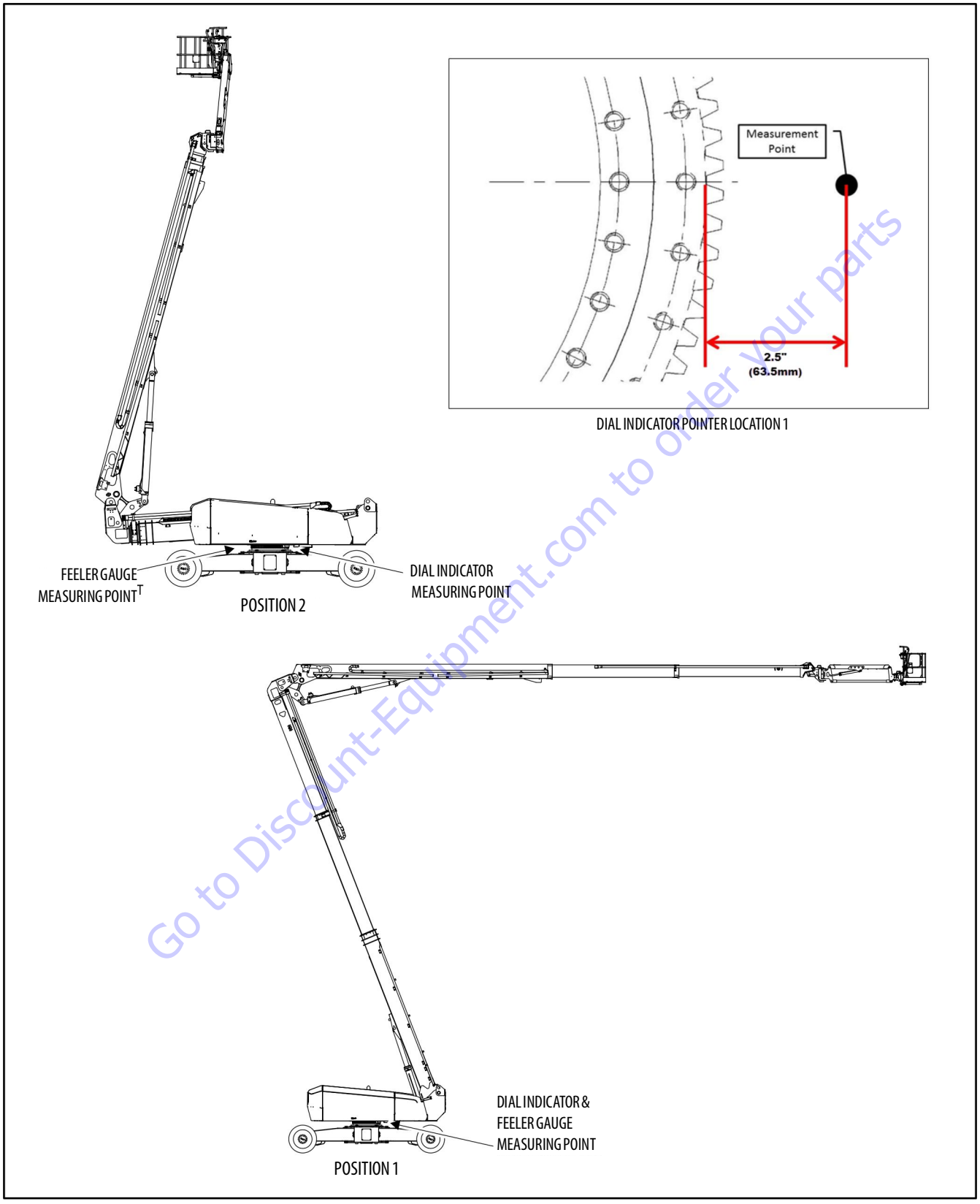

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Figure 3-53. Swing Bearing Wear Tolerance

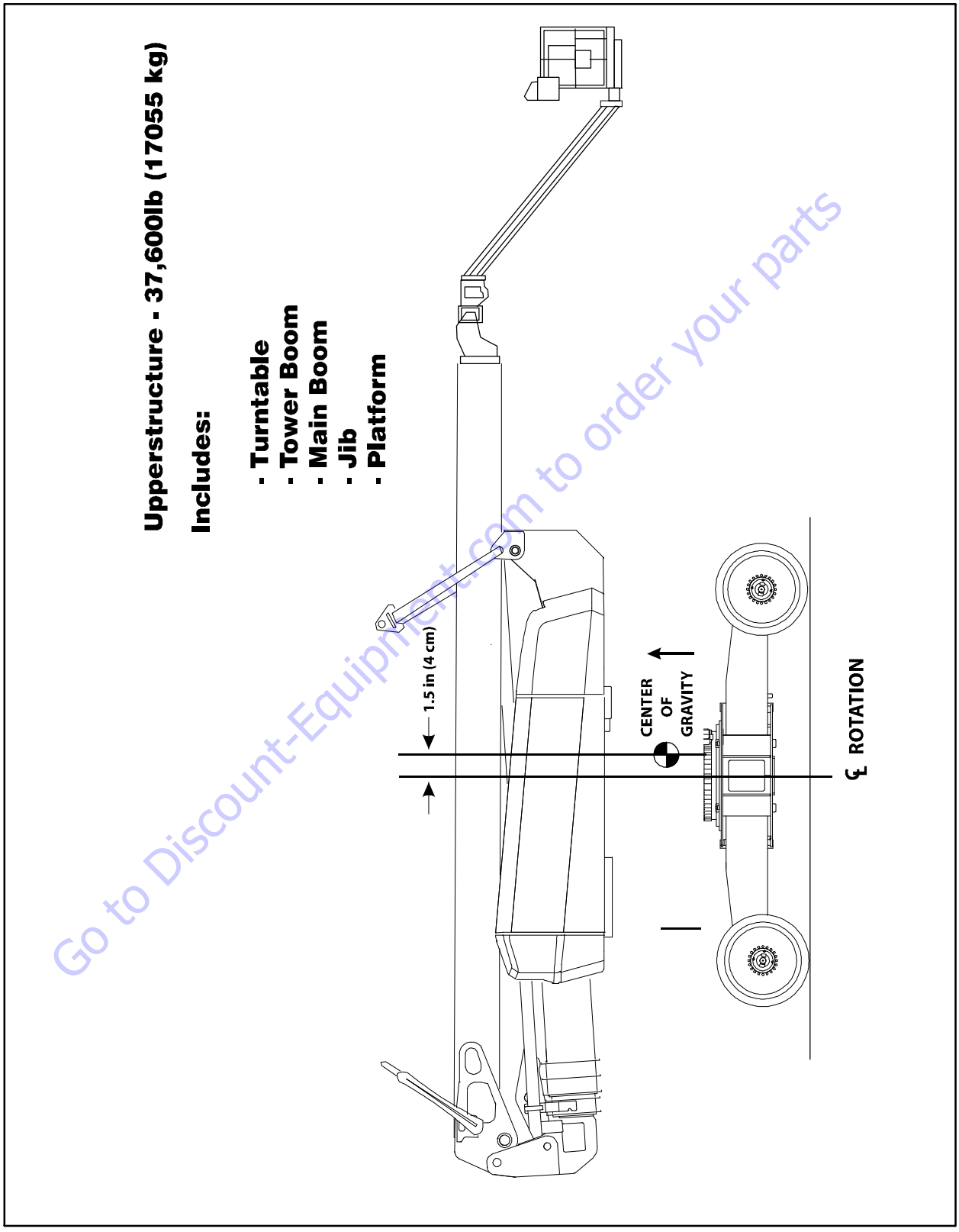

Figure 3-54. Swing Bearing Removal - Sheet 1 of 4

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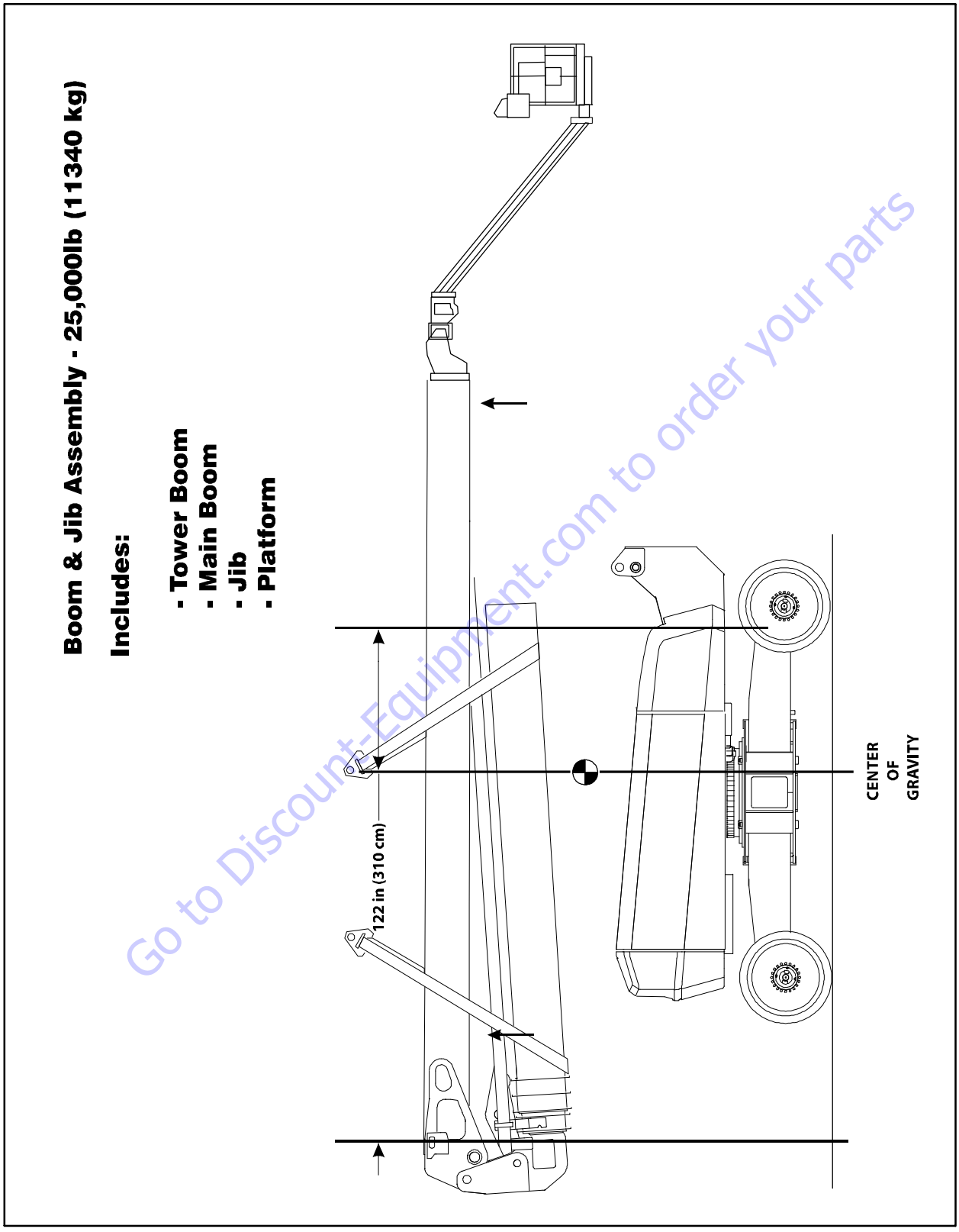

Figure 3-55. Swing Bearing Removal - Sheet 2 of 4

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Tower Boom Assembly - 14,200lb (6441 kg)

Includes:

- **Tower Base / Mid / Fly**
- **Links between tower & main boom**

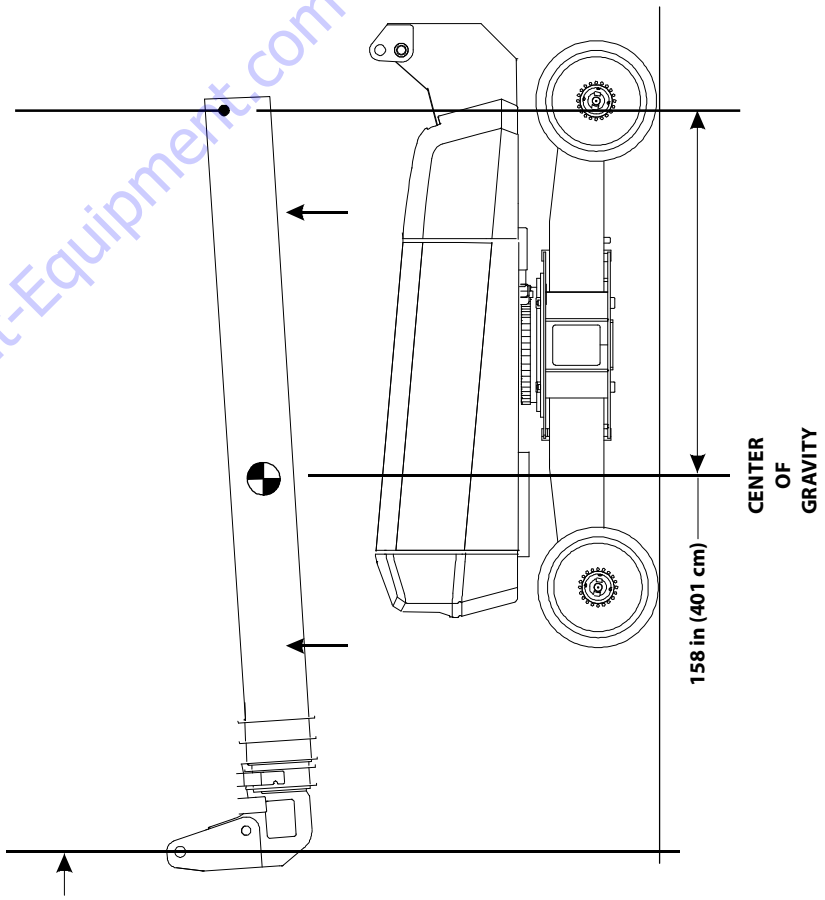

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Figure 3-56. Swing Bearing Removal - Sheet 3 of 4

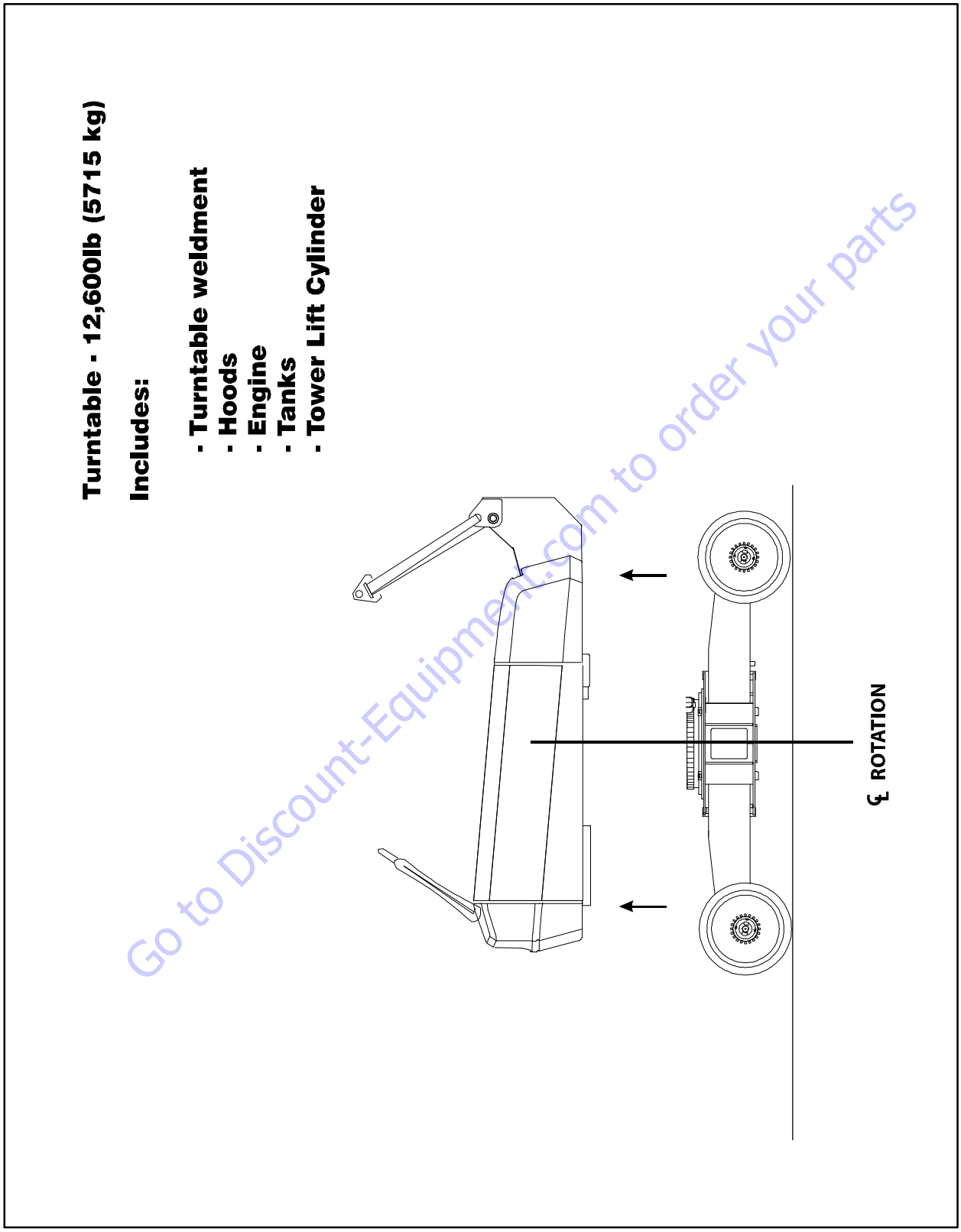

Figure 3-57. Swing Bearing Removal - Sheet 4 of 4

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3.17 GENERATOR

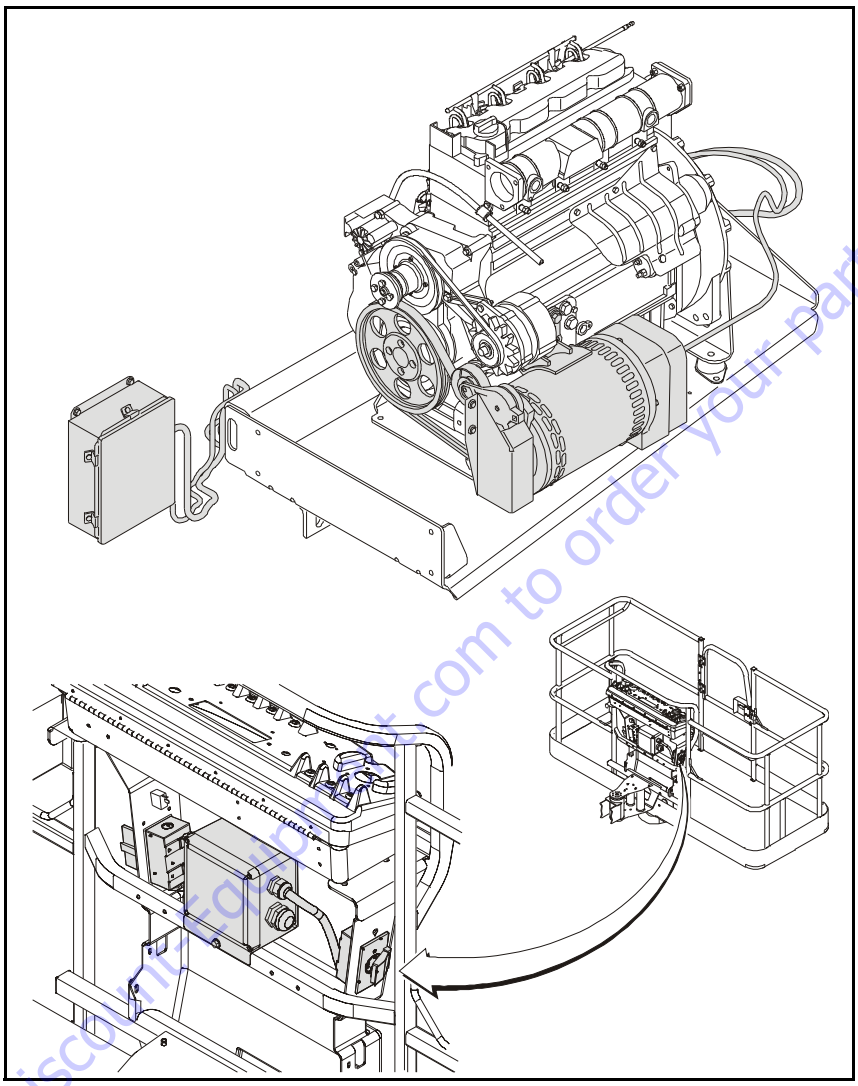

Figure 3-58. Generator Assembly

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NOTICE

INSTALLING OR REMOVING APPROVED ACCESSORIES OR CHANGING PLATFORM SIZE REQUIRES RECALIBRATION OF THE BOOM CONTROL SYSTEM.

Description

This belt-driven generator supplies AC power to the platform to run tools, lights, cutting and welding equipment through an AC receptacle. All power regulation components are located in a watertight box that is connected by cable to the generator. The generator supplies power when running at the specified speed with the power switch on (switch is located on platform). A three-pole, 30 Amp circuit breaker protects the generator from overload.

Generator Output

ANSI SPECS:

240V;60Hz; 3-Phase; 7.5kW and 240V/120V:60Hz; Single Phase:6kW.

CE SPECS:

3-phase, 240-volt, 7.5kw, 18.3-amps, 1.0-pf

1-phase, 240 volt, 6.0kw, 26-amps, 1.0-pf

1-phase, 120 volt, 6.0kw, 50-amps, 1.0-pf

PEAK:

3-phase 8.5kw

1-phase 6.0kw

Generator Rating

Drive -Type	Generator Speed
Belt-Drive/Pulley	3000rpm (50 Hz) 3600 rpm (60 Hz)

Safety Precautions

⚠ WARNING

DO NOT OVER LOAD PLATFORM.

1. Make sure no personnel are beneath platform.
2. This factory installed option is available only on models specified.
3. Keep lanyard attached at all times.
4. Do not use electrical tools in extremely wet conditions.
5. Use correct voltage for tool being used.
6. Do not over load circuit.

Preparation and Inspection

Ensure generator is secure, check condition of belt and wiring.

Operation

Start engine, turn on generator, begin using.

Service and Maintenance

Refer to Miller Generator Service and Maintenance Manual.

3.18 FUEL LEVEL CUTOUT SYSTEM

The Fuel Shutoff System, senses when the fuel level is getting low and shuts the engine down before the fuel tank is emptied. When the fuel level gets to the sensor end of stroke, empty level, the machine will shutdown (approx. < 5 Gal for 45 gallon tank). When this level is reached, the control system will flash the fuel level indication and report "FUEL LEVEL LOW - ENGINE SHUTDOWN" on the analyzer.

There is an analyzer personality setting (Machine setup' Fuel Cutout options) in the control system to control the machines response to this fault. There are three choices.

1. Restart (default) --shuts off engine when fuel low; allows restart and run for another 120s until shutdown and another restart
2. One Restart -- shuts off engine when fuel low; allows one restart to run for 120s; then fuel must be added
3. Engine Stop -- shuts off engine when fuel low; no restarts permitted; fuel must be added

3.19 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 a 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.

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3.20 DEUTZ TURBOCHARGER OPERATION

Good engine operating procedures are essential to prolong turbocharger life.

Particular attention to oil system and air system will eliminate the two main causes of turbocharger failure. To prevent this Operators/Owners must ensure that :-

1. Air and oil filters are checked regularly to the manufacturer's specifications.
2. Engine maintenance intervals are adhered to.
3. Engine and equipment are operated in such a way that is not harmful to the life of the turbocharger.

Operating Practices

Operators and owners can get maximum service life from their turbochargers if a few good practices are followed:

START UP

When starting the engine use minimum throttle and run in idle mode for approximately one minute. Full working oil pressure builds up within seconds but it is useful to allow the turbocharger moving parts to warm up under good lubricating conditions. Revving the engine within the first few seconds of start up causes the turbocharger to rotate at high speeds with marginal lubrication which can lead to early failure of the turbocharger.

AFTER SERVICING

After servicing the engine or turbocharger, ensure the turbocharger is pre-lubed by adding clean engine oil into the turbocharger oil inlet until full. After pre-lubing, crank the engine without firing (engine/fuel pump stop out) to allow oil to circulate through the full system under pressure. On starting the engine, run at idle for a few minutes to ensure the oil and bearing systems are operating satisfactorily.

LOW AIR TEMPERATURES & INACTIVE OPERATION

If the engine has been inactive for some time or the air temperature is very low, crank the engine first and then run at idle. This allows the oil to circulate throughout the full system before high loads and speeds are applied to engine and turbocharger.

SHUT DOWN

Before shutting the engine down, let the turbocharger cool down. When an engine runs at maximum power/high torque, the turbocharger is operating at very high temperatures and speeds. Hot shut down can cause reduced service life which is avoidable by a minute or two of idling. Most mobile equipment applications include an adequate cooling period during parking or mooring procedures.

Allow the engine to idle for 1-5 minutes to allow the high temperatures and speed to reduce and thus prolong the life of the turbocharger.

ENGINE IDLE

Avoid running the engine for long periods in idle mode (greater than 20-30 minutes). Under idling conditions low pressures are generated in the turbocharger which can cause oil mist to leak past seals into the two end housings. Although no real harm is done to the turbocharger, as load is applied temperatures increase and the oil will start to burn off and cause blue smoke emission problems.

If the engine is allowed to Idle for a period of time, lube oil will continue to flow cooling the turbine shaft.

You can also see spots on the turbo where grooves have been "worn" in to the turbine shaft at the point where the radial bearing sits. Dirty oil/contaminates in the oil can become trapped in between the radial bearing and the surface of the shaft becoming abrasive and ultimately grinding away the material.

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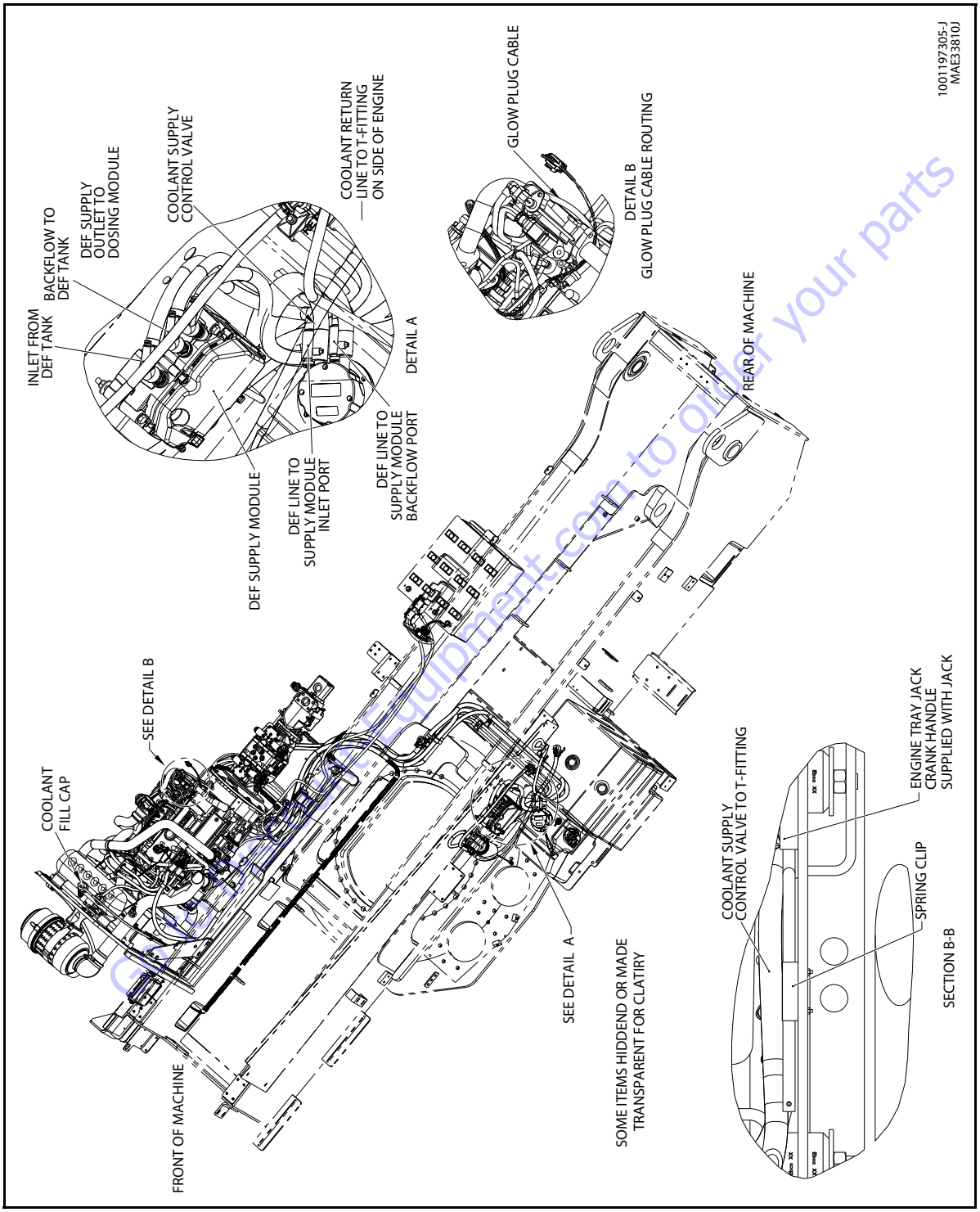

Figure 3-59. Engine Installation - Sheet 1 of 9

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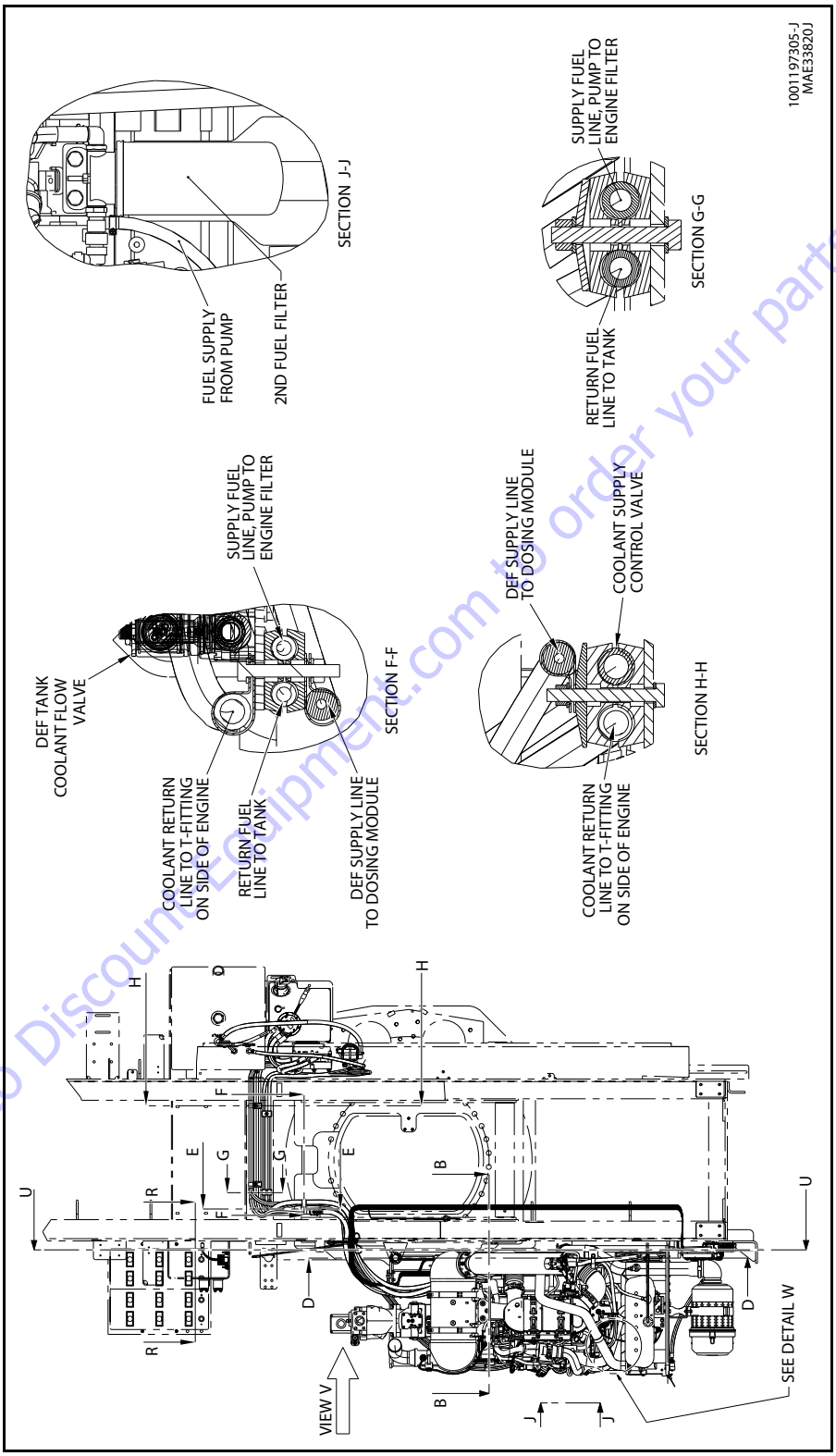

Figure 3-60. Engine Installation - Sheet 2 of 9

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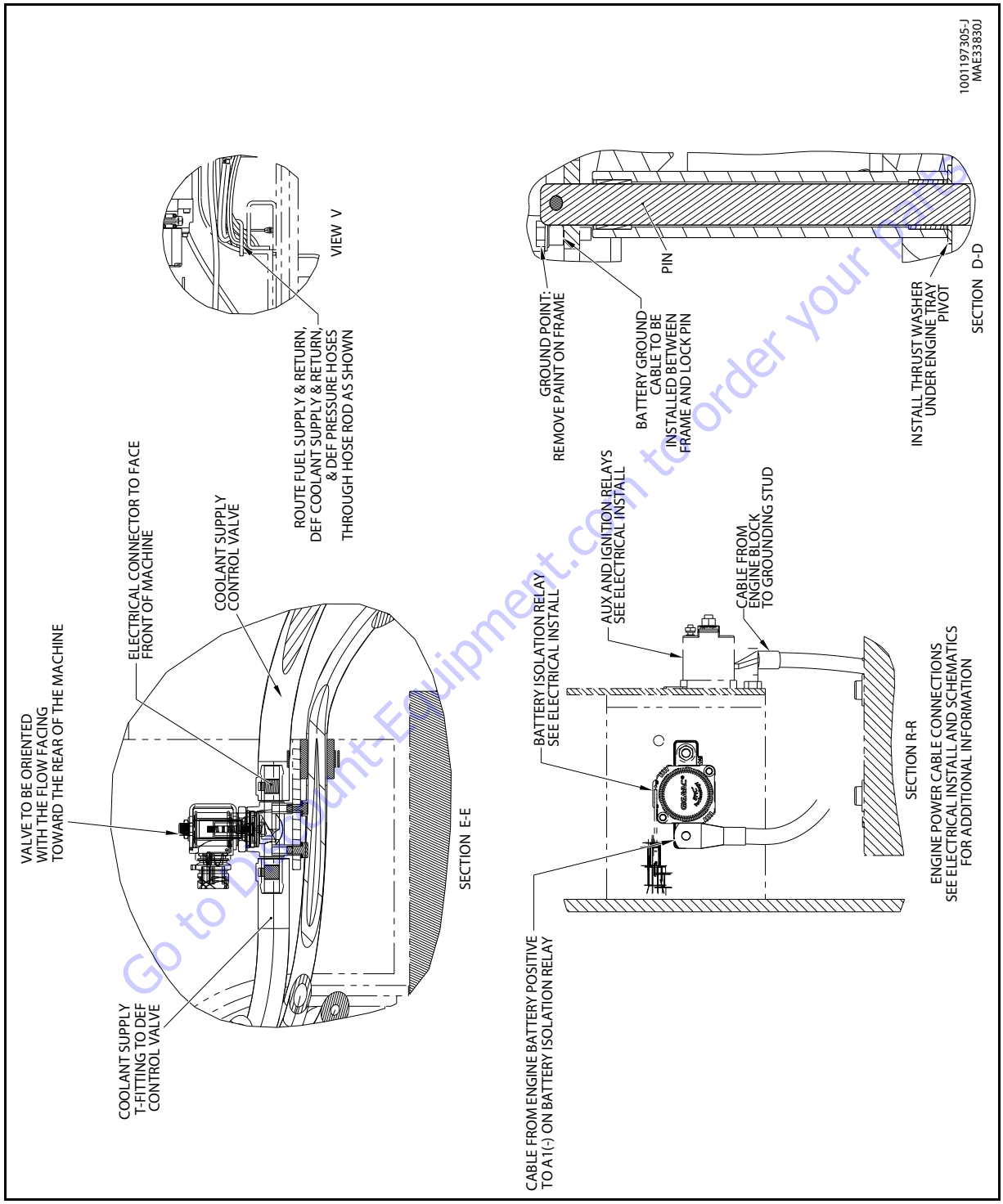

Figure 3-61. Engine Installation - Sheet 3 of 9

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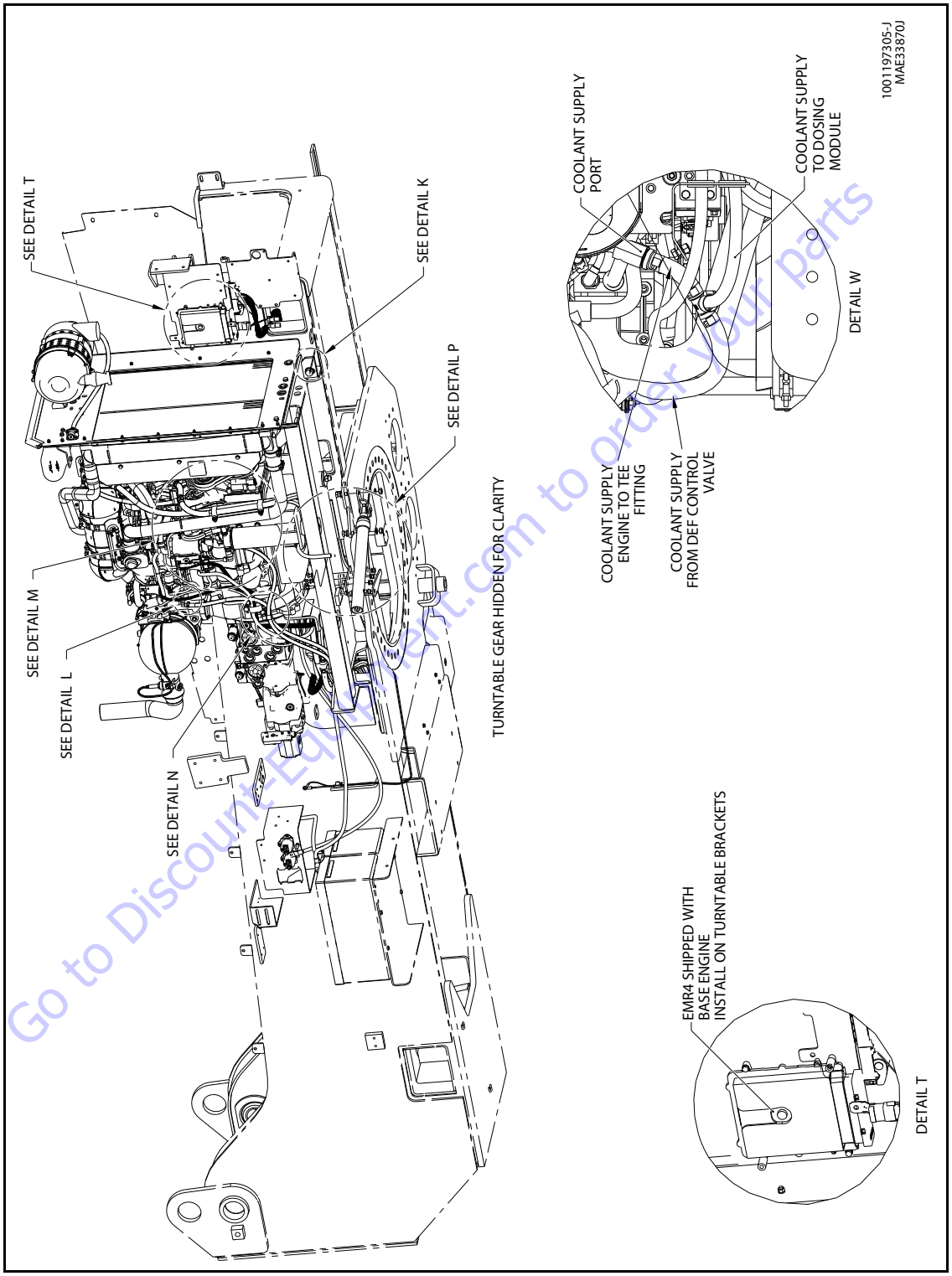

Figure 3-62. Engine Installation - Sheet 4 of 9

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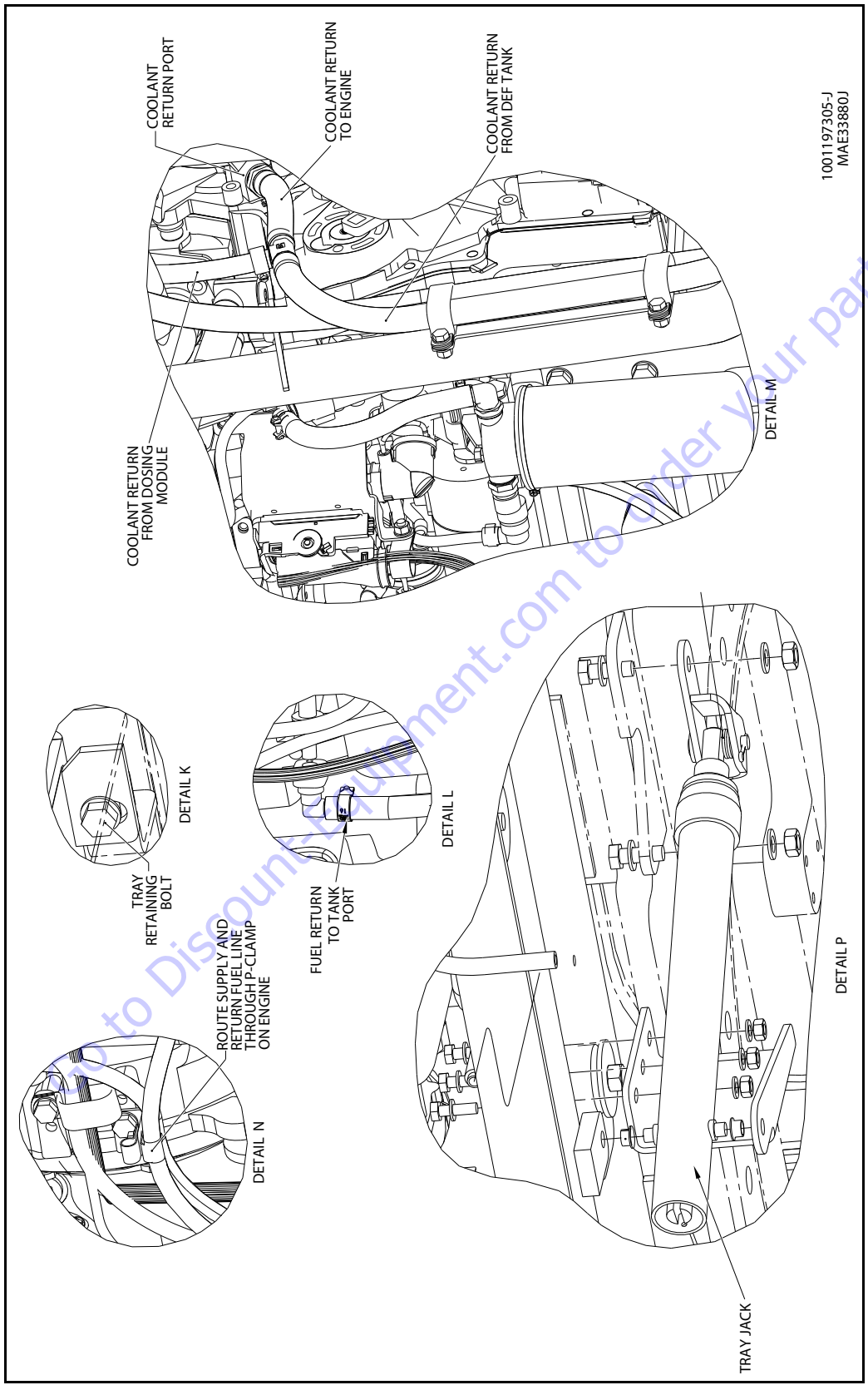

Figure 3-63. Engine Installation - Sheet 5 of 9

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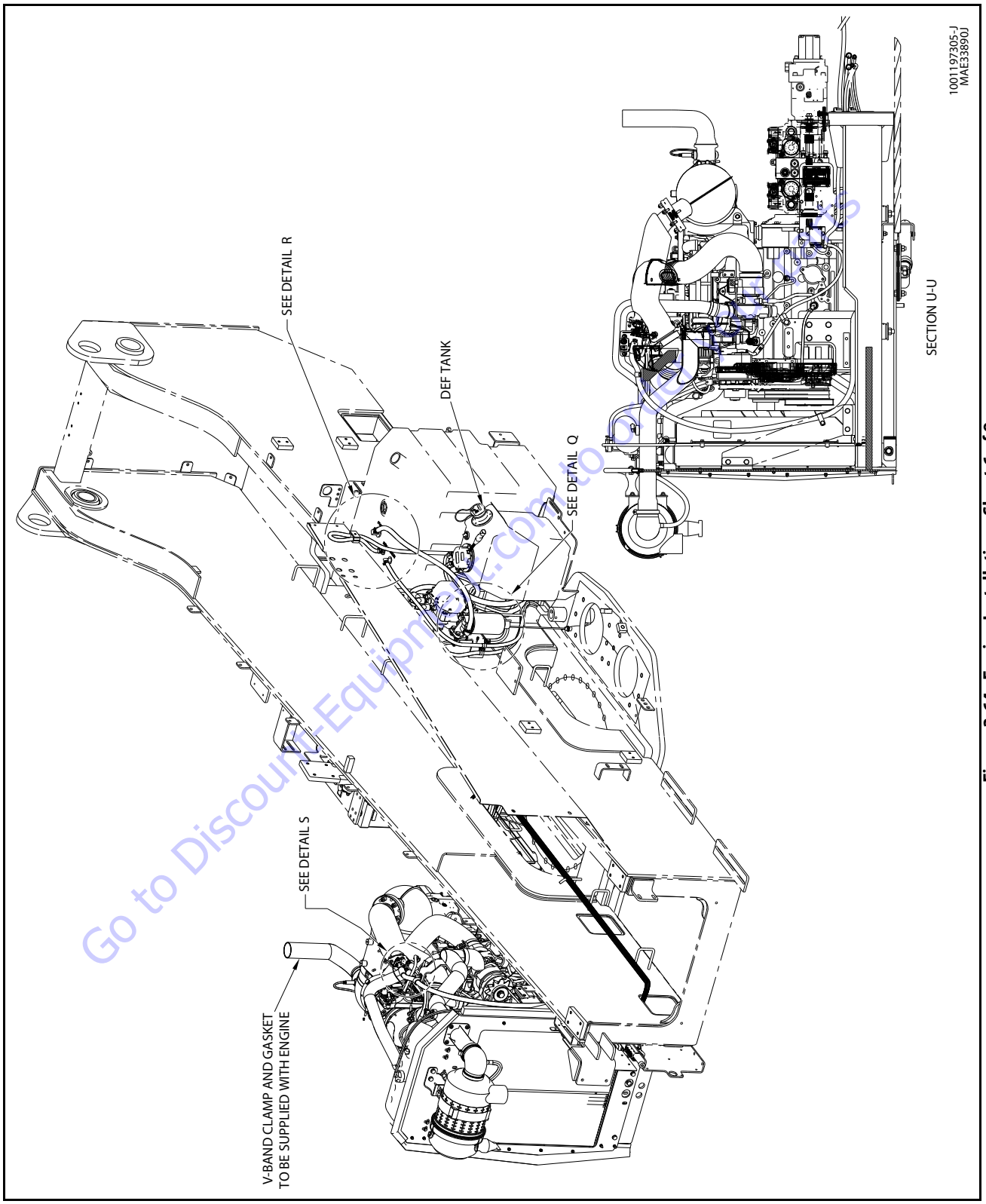

Figure 3-64. Engine Installation - Sheet 6 of 9

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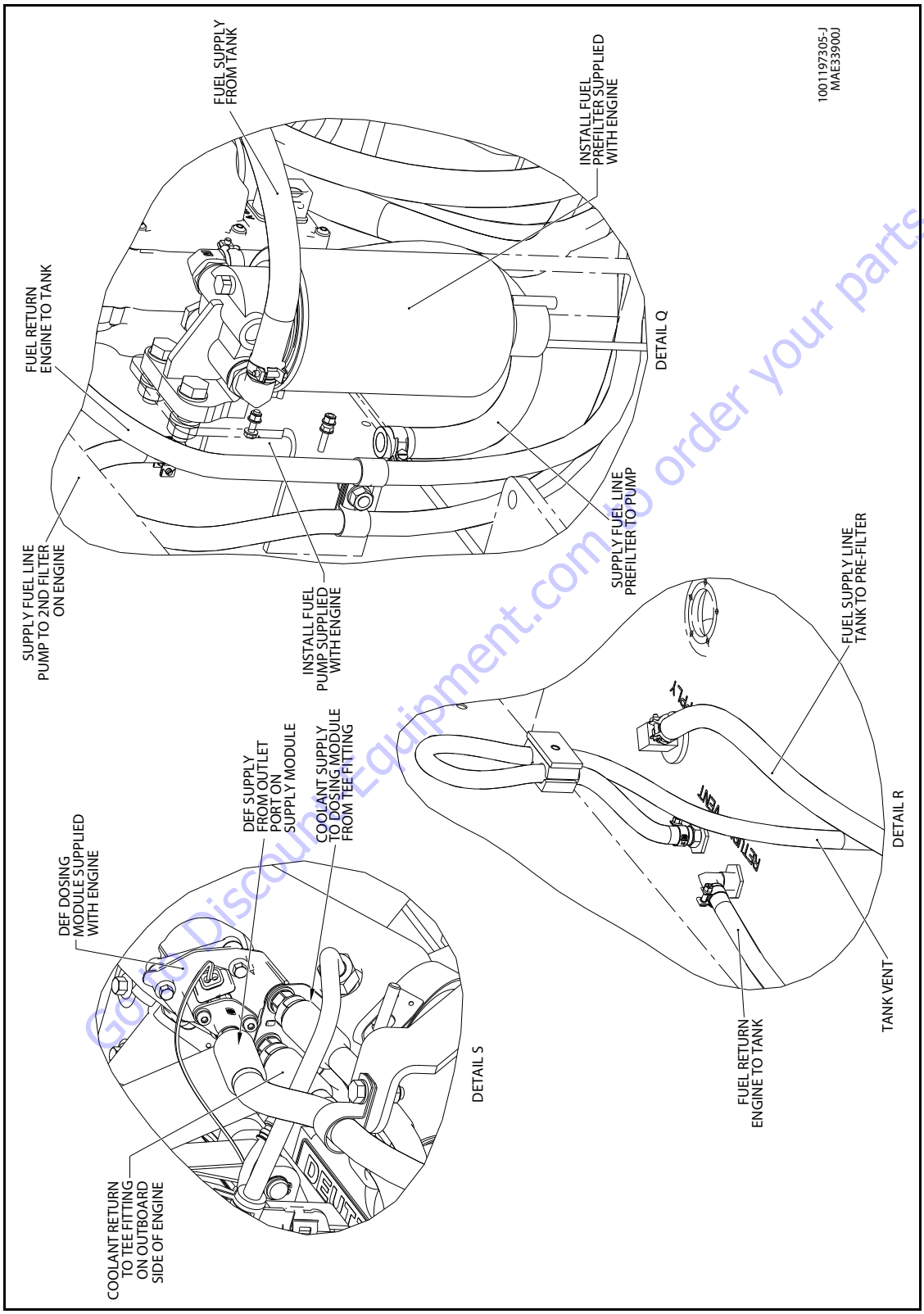

Figure 3-65. Engine Installation - Sheet 7 of 9

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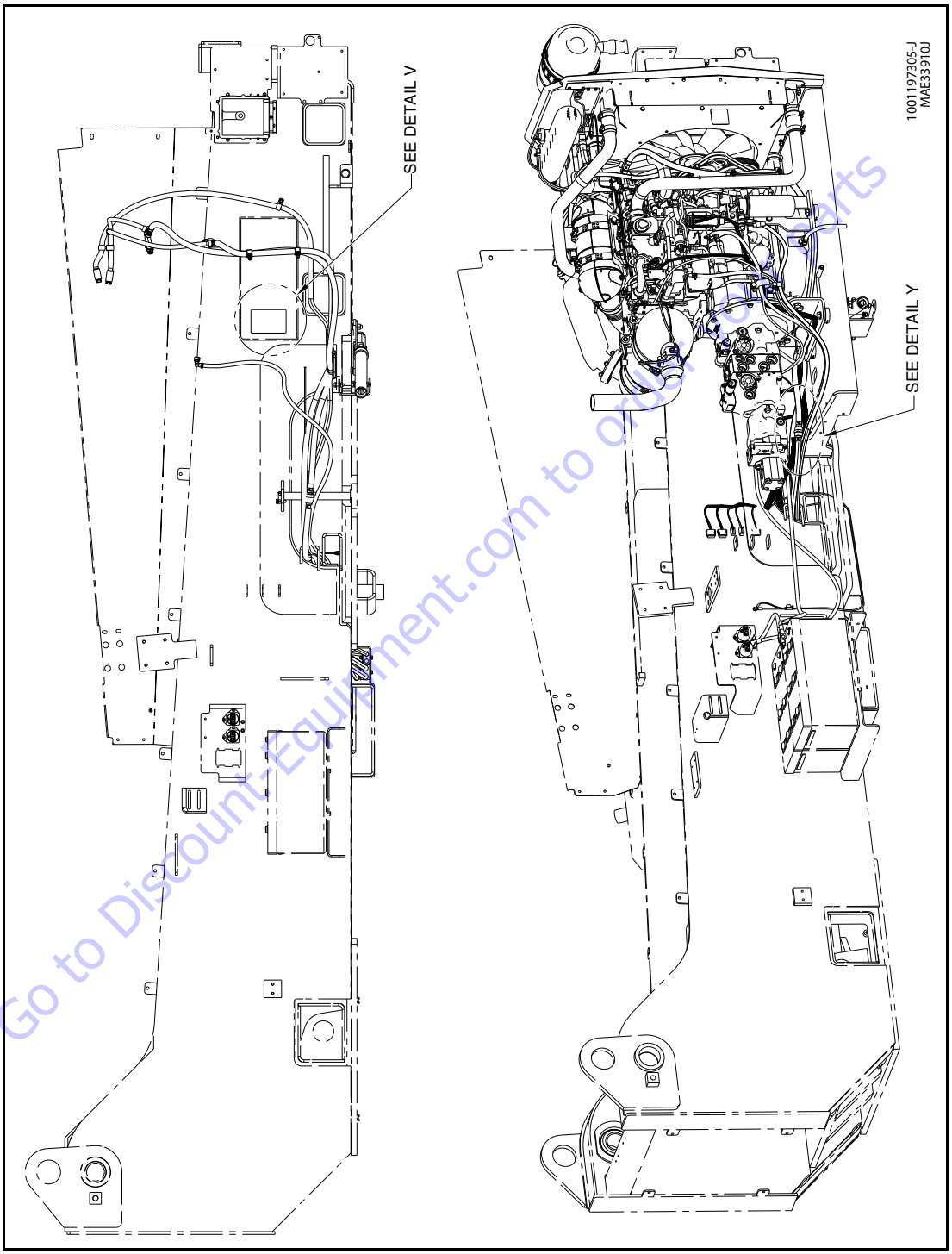

Figure 3-66. Engine Installation - Sheet 8 of 9

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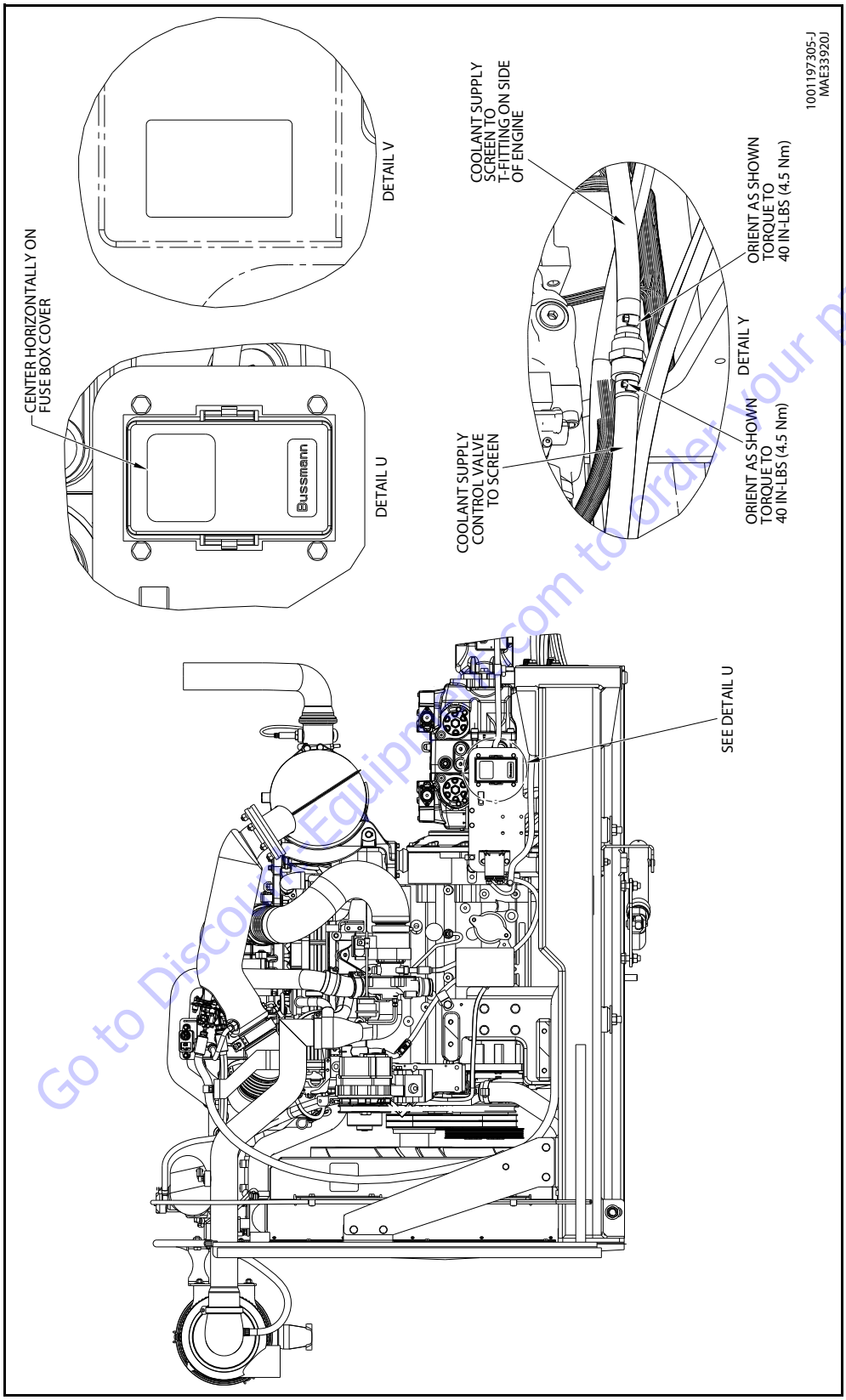

Figure 3-67. Engine Installation - Sheet 9 of 9

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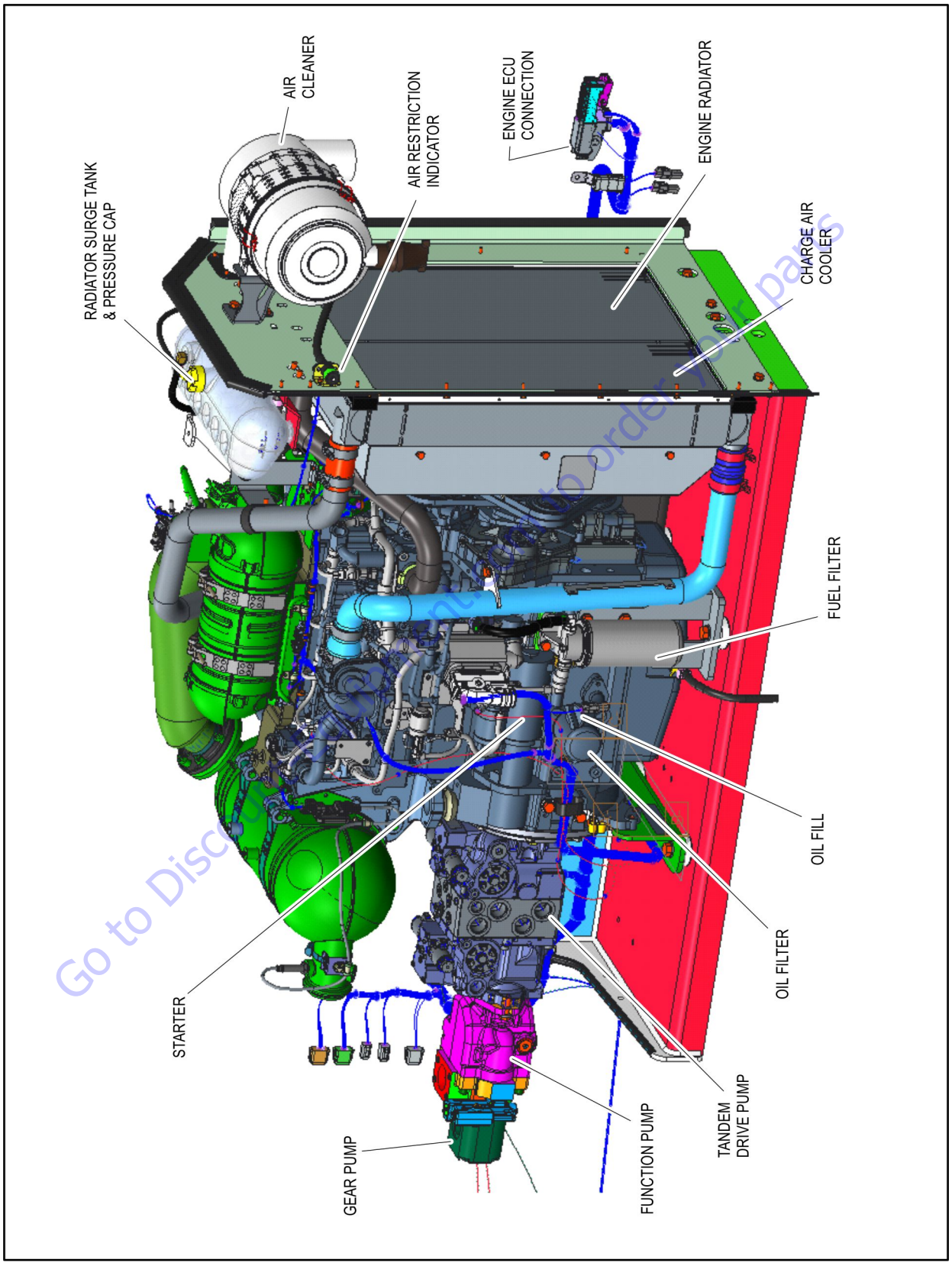

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Figure 3-68. Engine Components - Sheet 1 of 4

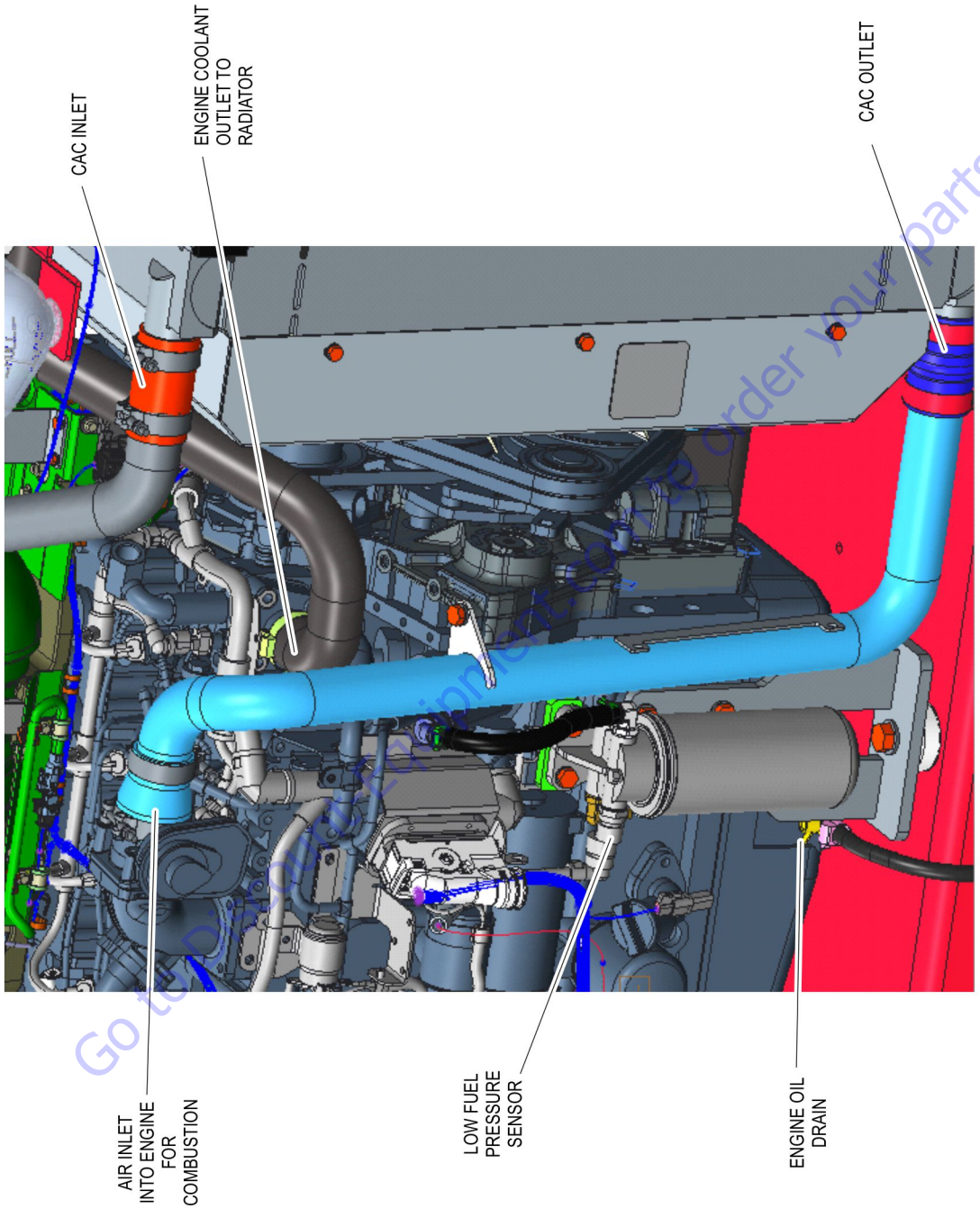

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Figure 3-69. Engine Components - Sheet 2 of 4

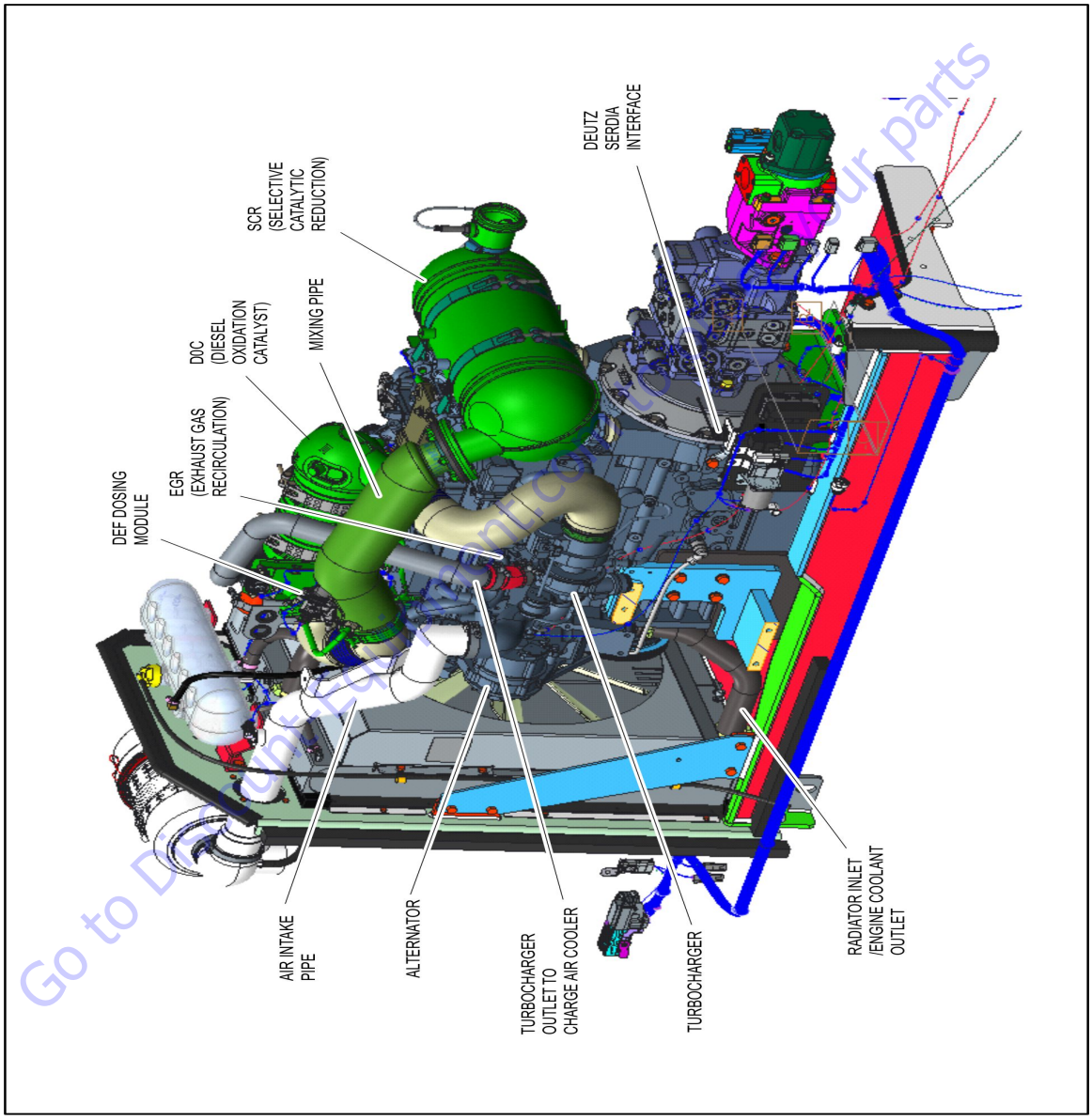

Figure 3-70. Engine Components - Sheet 3 of 4

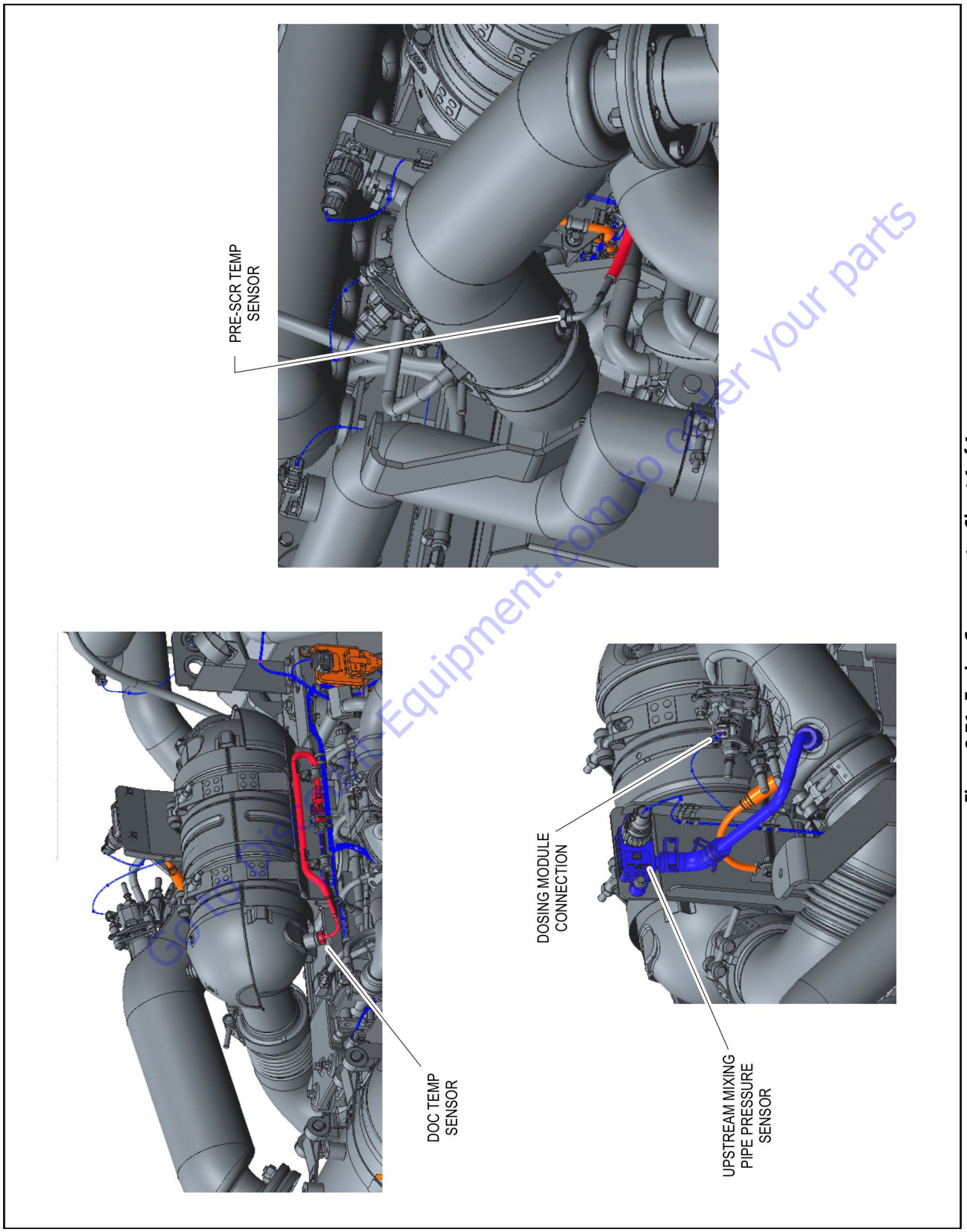

Figure 3-71. Engine Components - Sheet 4 of 4

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3.21 DIESEL EXHAUST FLUID (DEF) TANK

Refer to Figure 3-72. and Figure 3-73.

Diesel exhaust fluid (DEF) is a urea solution consisting of 32.5% urea and 67.5% deionized water. DEF is used in selective catalytic reduction (SCR) to lower nitrogen oxide (NOx) concentration in exhaust emissions.

DEF is temperature sensitive in storage. If stored between 75°F (24°C) and 12°F (-10°C), it can be stored for 2 years. In the machine's DEF tank, the storage life is 4 months. After 4 months, the DEF must be drained from the tank, properly disposed of, and the tank cleaned and flushed. If the machine has been idle in an extreme cold environment (-40° to 32°F [-40° to 0°C]), the interval is reduced to 2 months.

NOTE: *DEF freezes at 12°F (-11°C).*

Cleaning and Flushing the Tank

If contaminated fluid or foreign material is found in the tank, the tank must be cleaned. Use the following procedure for cleaning.

1. Remove the DEF tank drain plug, and drain any fluid into a suitable container. Dispose of fluid properly.
2. Clean the header with a mixture of warm water and a light petroleum based soap.
3. Clean DEF tank with a high pressure washer, or flush tank with hot water for five minutes and drain water.
4. If DEF fluid lines are contaminated, tag and remove the lines from the DEF pump module and flush with a mixture of warm water and a light petroleum based soap.
5. Refill DEF tank with water until it overflows. Completely flush tank with water.
6. Empty DEF tank, and dispose of contaminated water properly.
7. Rinse the tank and all soap residue with deionized or distilled water and allow to air dry.

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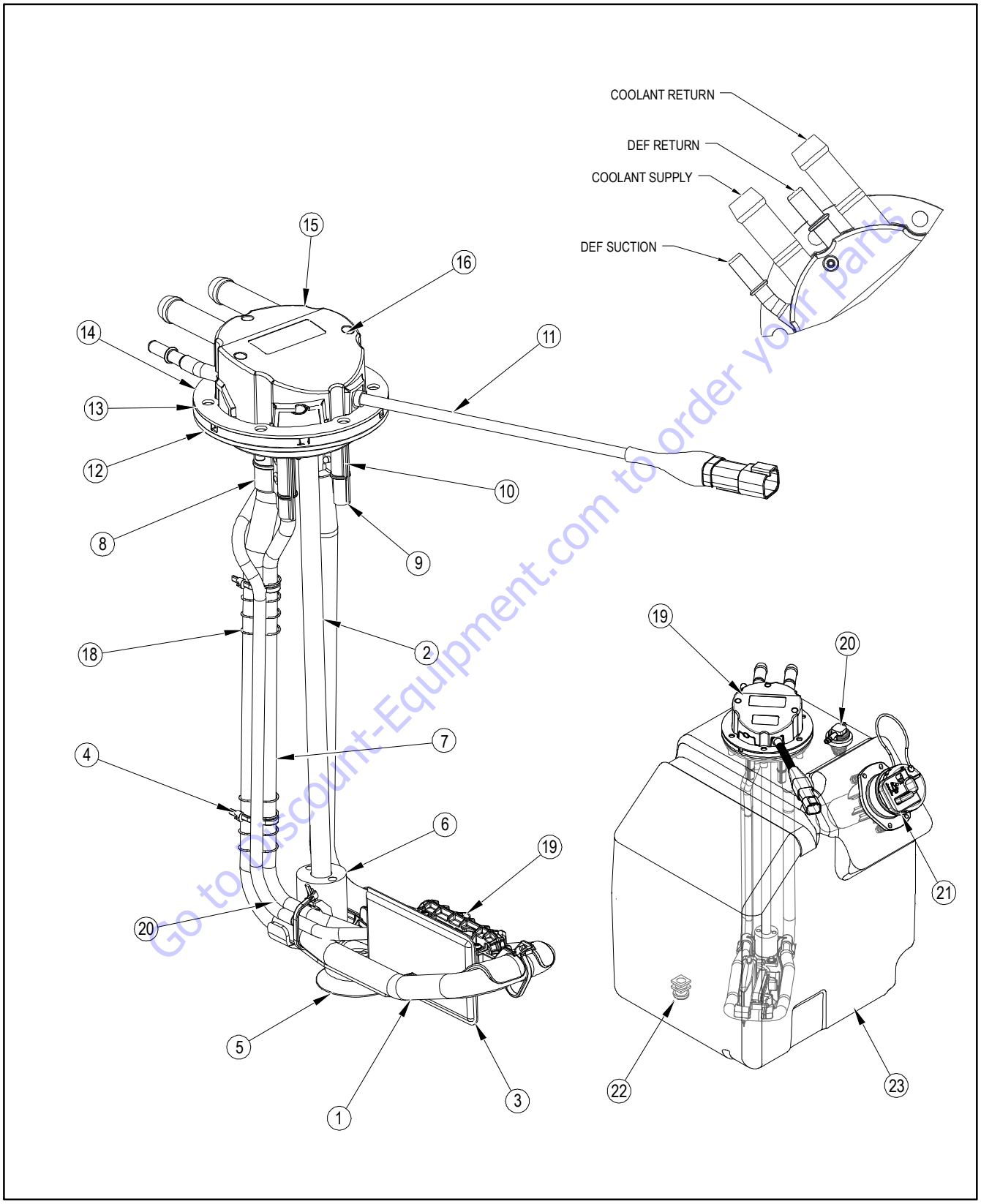

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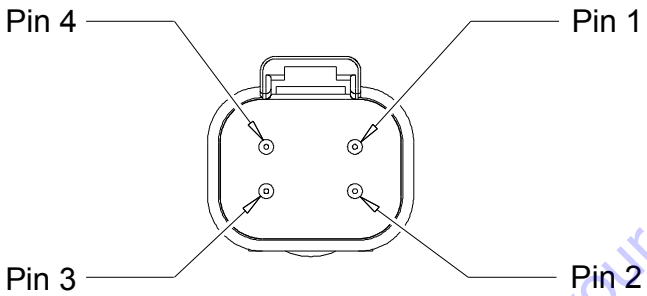
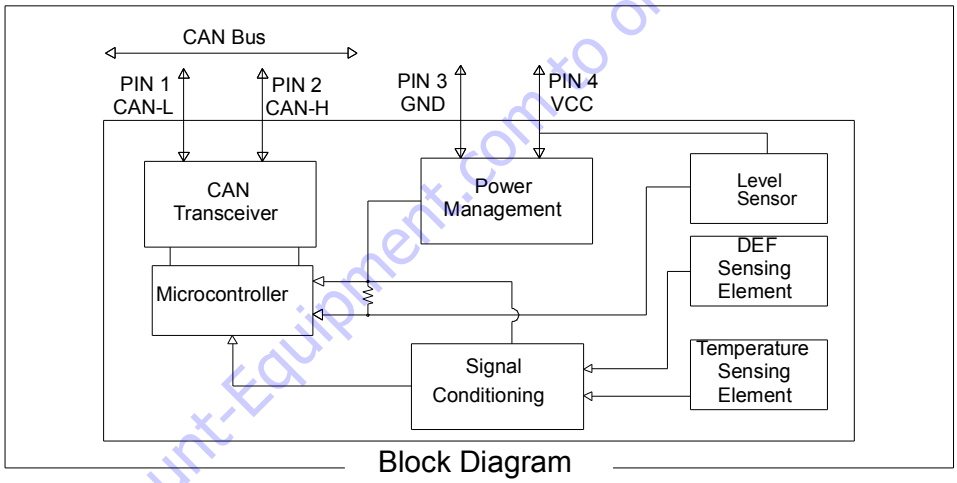
Figure 3-72. Diesel Exhaust Fluid (DEF) Tank - Sheet 1 of 2

CONNECTOR PIN OUT





Block Diagram

1. Coolant Tube
2. Level Tube
3. DEF Filter
4. Tie-Wrap
5. Rubber Bushing
6. Float Assembly
7. Suction Tube
8. Suction Strengthening Plate
9. Return Tube
10. Return Strengthening Plate
11. Connector
12. Rubber Header
13. Header
14. Metallic Flange
15. Cover
16. Screw
17. Spring Tube
18. Urea Quality Sensor
19. DEF Electric Assembly
20. Breather
21. Cap
22. Drain Plug
23. Tank

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Figure 3-73. Diesel Exhaust Fluid (DEF) Tank - Sheet 2 of 2

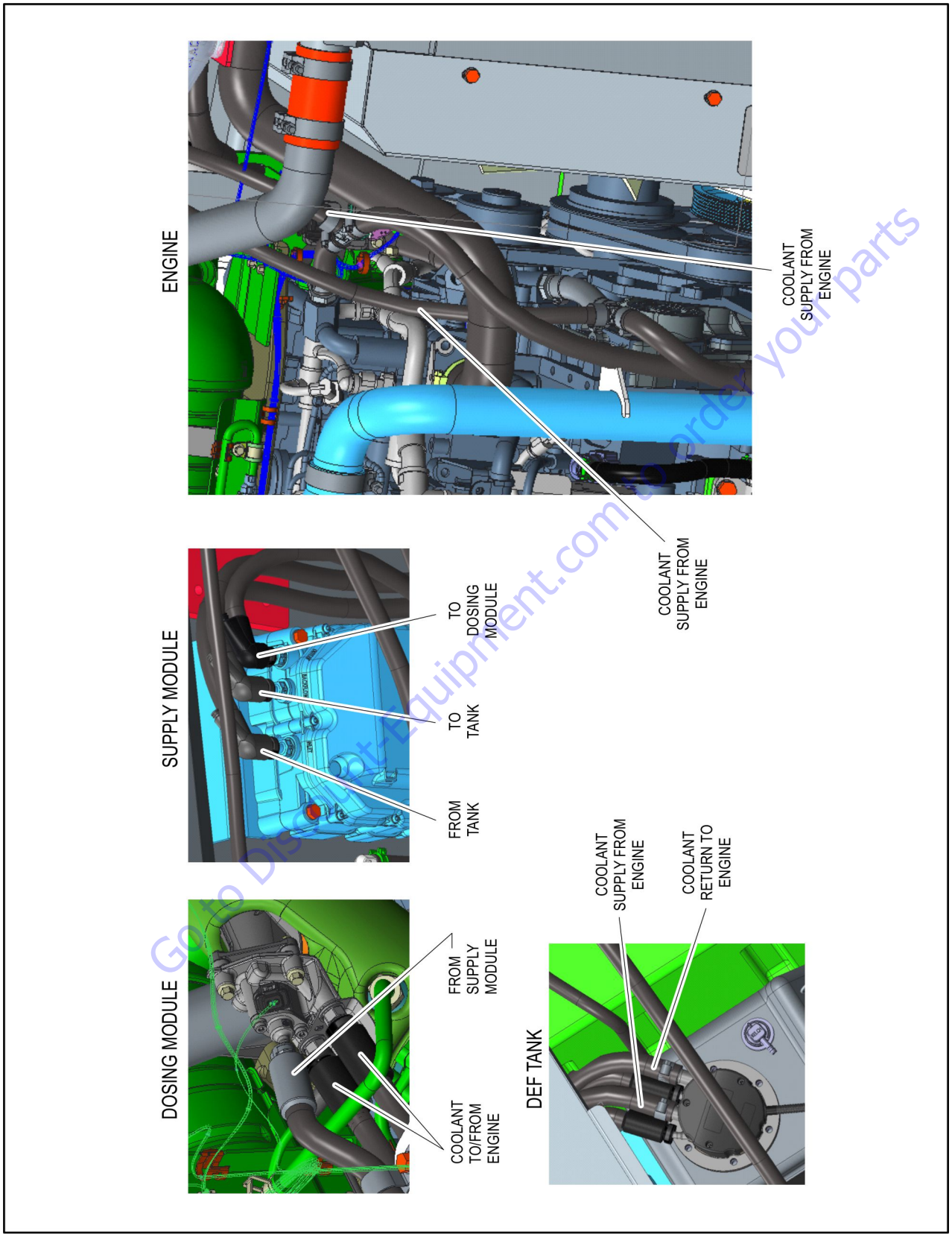

Figure 3-74. DEF-EAT Connections

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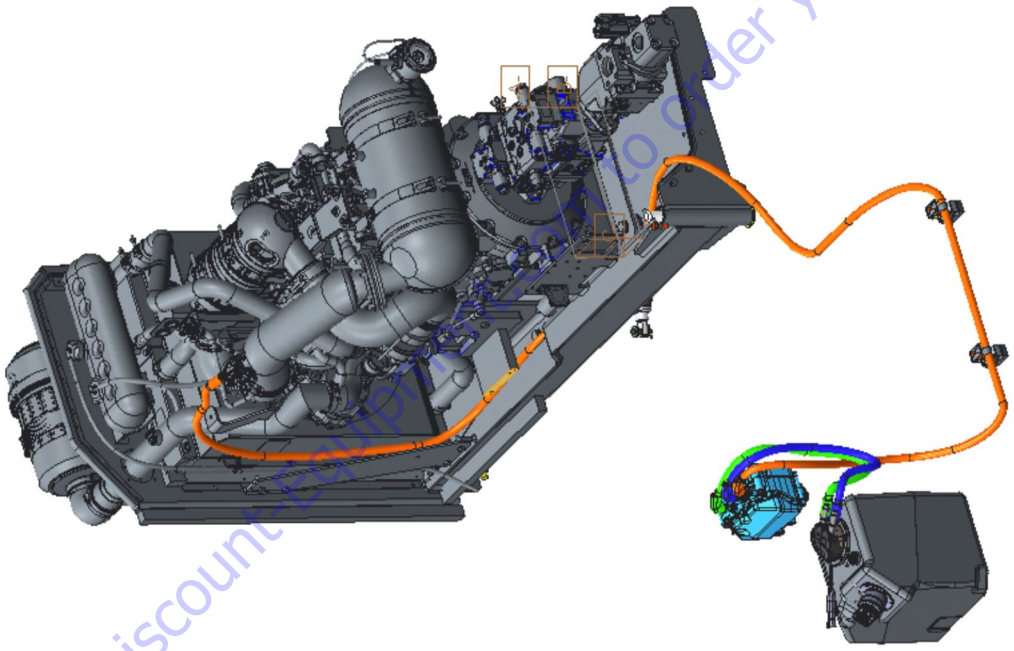

Green Line - Suction
Blue Line - Backflow
Orange Line - Pressure

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Figure 3-75. DEF System Heated Lines

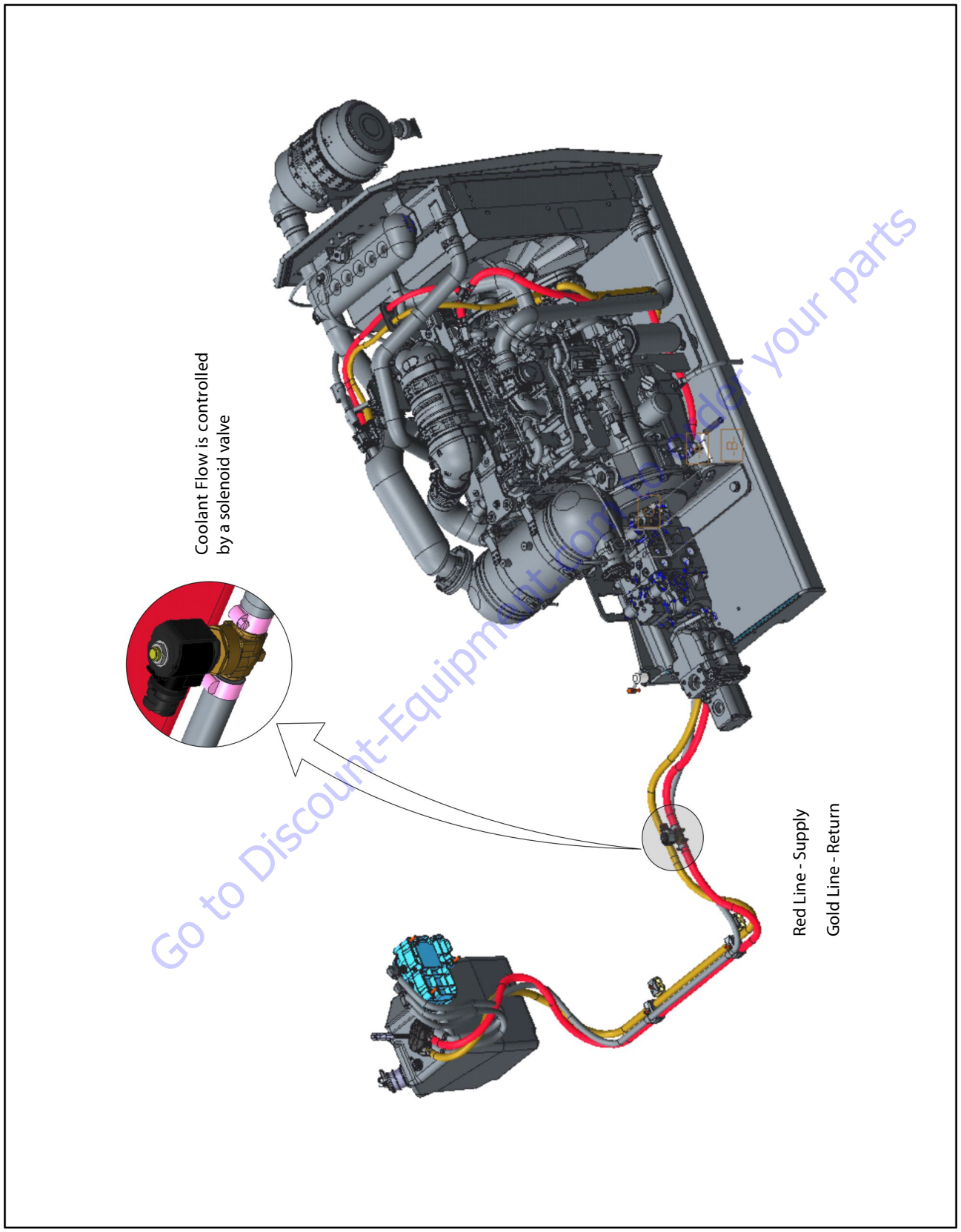

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Figure 3-76. DEF System Coolant Lines

3.22 DEUTZ ENGINE WITH DIESEL EXHAUST FLUID (DEF)

Engine Oil

Engines equipped with Exhaust After Treatment (EAT) systems require the use of low-ash engine lubricating oils.

Lubricating oil that is not "low-ash" rated can contain sulphate and oxide ashes from metal-organic additives which will significantly shorten the life span of diesel particle filters. Phosphor from wear-protection additives as well as sulphur and sulphur compounds negatively influence the catalyst activity in exhaust gas post-treatment systems.

NOTICE

LOW-ASH ENGINE LUBRICATING OILS ARE RECOMMENDED FOR SCR EXHAUST AFTER TREATMENT SYSTEMS.

NOTICE

USE OF NON-APPROVED LUBRICATING OIL WILL RESULT IN VOIDED WARRANTY COVERAGE.

Diesel Fuel

Engines equipped with an SCR system (Selective Catalytic Reduction) may only be operated with sulphur-free diesel fuels (EN 590, ASTM D975 Grade 2-D S15, ASTM D975 Grade 1-D S15 or heating oil in EN 590 quality). Otherwise compliance with the emission requirements and durability is not guaranteed.

In a warranty case the customer must prove by a certificate from the fuel supplier that a released fuel was used.

HIGH SULPHUR CONTENT IN THE FUEL

Fuels with a sulphur content > 0.5% (m/m) (5,000 mg/kg) demand a shorter lubricating oil change interval. Fuels with a high sulphur content may not be used in engines with exhaust gas after-treatment. Fuels with a sulphur content > 1.0% (m/m) are not permissible due to high corrosion and considerable shortening of the engine life. Low-ash / low SAPS engine lubricating oils (sulphate ash max. 1.0% (m/m)) may only be used in engines without exhaust after-treatment systems if the sulphur content in the fuel does not exceed 50 mg/kg. However, low-ash lubricating oils may be used in engines without exhaust gas after-treatment systems up to sulphur contents of 500 mg/kg if the base number (TBN) is at least 9 mg KOH/g.

WINTER OPERATION WITH DIESEL FUEL

Special demands are placed on the cold behavior (temperature limit value of the filtrability) for winter operation. Suitable fuels are available in winter.

Mixing with petrol is not permissible for safety and technical reasons (cavitation in the injection system).

Diesel fuels up to -44 °C are available for an Arctic climate. The addition of flow improvers to the diesel fuel is only allowed in exceptional cases. The choice of a suitable additive and the necessary dosing and mixing procedure must be discussed with the fuel supplier. If only summer diesel fuel is available, petroleum or kerosene can be added to the diesel fuel up to 30% (V/V) at low temperatures as shown in the diagram below.

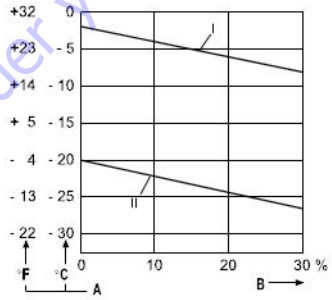

Figure 3-77. Mixing Petroleum With Summer Diesel Fuel

The mixing should take place in the engine tank. First pour in the necessary amount of petroleum or kerosene, and then add the diesel fuel.

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3.23 SELECTIVE CATALYTIC REDUCTION (SCR) - MACHINES USING DIESEL EXHAUST FLUID (DEF)

Selective Catalytic Reduction (SCR) is an emissions control used in diesel engines.

This system injects a liquid-reductant agent through a special catalyst into the exhaust stream of a diesel engine. The reductant source is usually automotive-grade urea known as Diesel Exhaust Fluid (DEF). DEF sets off a chemical reaction that converts nitrogen oxides into nitrogen, water, and tiny amounts of carbon dioxide (CO2), which is then expelled through the engine exhaust pipe.

For peak operation, the SCR 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 crystallization in the SCR system). Maintenance Standstill Cleaning is cleaning requested by the engine on the maintenance interval.

SCR technology is designed to permit nitrogen oxide (NOx) reduction reactions to take place in an oxidizing atmosphere. It is called "selective" because it reduces levels of NOx using ammonia as a reductant within a catalyst system. The chemical reaction is known as "reduction" where the DEF is the reducing agent that reacts with NOx to convert the pollutants into nitrogen, water and tiny amounts of CO2. The DEF can be rapidly broken down to produce the oxidizing ammonia in the exhaust stream. SCR technology alone can achieve NOx reductions up to 90 percent.

NOTE: *The system will reset the maintenance interval back to 0 hours after Standstill or Maintenance Standstill cleaning events are performed.*

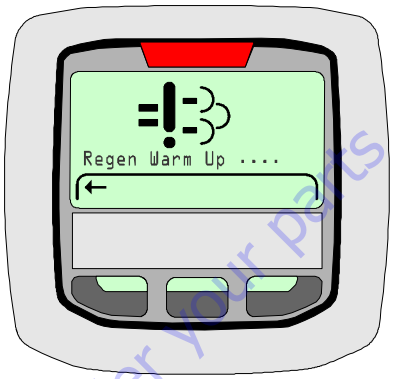
Standstill Cleaning

The following conditions must be met to perform Standstill Cleaning.

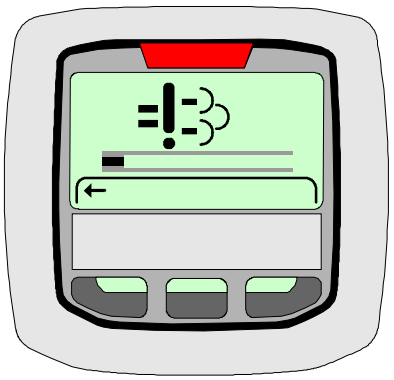
- Machine must be stationary
- Engine must be idling
- Coolant temperature must be above 104° F (40° C)
- Diesel Exhaust Fluid (DEF) tank must not be frozen
- Machine in Ground Station mode

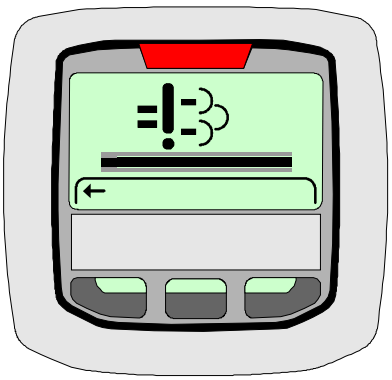
1. The Selective Catalytic Reduction Indicator will flash when standstill cleaning is required.

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



3. 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.





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4. 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 HEST 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 SCR button on the Ground Console. All the same conditions as outlined under Standstill Cleaning must be met.

Cancelling Maintenance Standstill

Maintenance Standstill Cleaning will be stopped immediately if:

- The Platform/Ground Select switch is switched from Ground to Platform mode
- 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.

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 SCR 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 Indicator Gauge will display the "Regen Failed" screen as shown. If the cleaning event has failed, it must be run again.

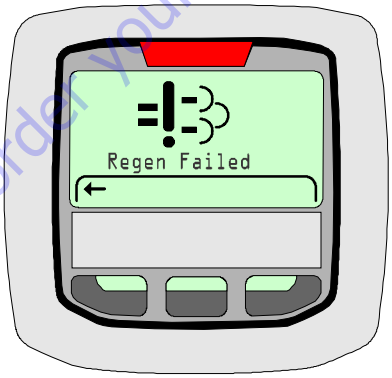

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Table 3-8. Maintenance Standstill Cleaning

Standstill Cleaning Levels		Machine Hours Since Last Cleaning	System Distress Light	SCR Cleaning Light	Derate	Comments
0	Normal Operation	0-500 500-1000	--	--	None	Between 500 and 1000 hours, cleaning cycle can be initiated with JLG analyzer.
1	Standstill Required	1000-1100	--	 0.5 Hz	None	Engine coolant temperature muxt be >40°C and DEF should be thawed before cleaning can be initiated.
2	Warning Level	1100-1125	 Continuous	 0.5 Hz	Machine placed in Creep and DTC active	
3	Shut Off Level	>1125	 Blinking	 3 Hz	Idle Lock. Boom Functions Locked Out and Trapped in Transport.	Contact Deutz Dealer.

Table 3-9. Cleaning When Crystallization is Detected During SCR

Crystallization Levels	Machine Hours after Crystallization	Cleaning Initiation Methods	System Distress Light	SCR Cleaning Light	Derate
Normal Operation	No Crystallization Detected	--	--	--	None
Crystallization Detected Standstill Required	0-5	SCR Switch or Analyzer	--	 0.5 Hz	None
Crystallization Detected Warning Level 1	5-600	SCR Switch or Analyzer	 Continuous	 0.5 Hz	Machine placed in Creep and DTC active
Crystallization Detected Shut Off Level	>600	Contact Deutz Dealer.	 Blinking	 3 Hz	Idle Lock. Boom Functions Locked Out and Trapped in Transport.

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3.24 ENGINE FAULT CODES

Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
29	2	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	Diagnostic fault check of short circuit to supply voltage (signal range check high) of acceleration pedal signal.	The signal exceeds the applicatable threshold; signal range violation	If the signal is below the applicatable threshold APP_uRawSRCHiHTLIS_C, the signal range violation is reset after the healing debouncing. In case when the CCP is active (CCP_stActive = 1) and the reading from the EEPROM memory is successful, the signal is below the threshold APP_uHTLISCCPHi[1], a signal range violation is reset after debouncing.
29	4	Diagnostic fault check of short circuit to ground (signal range check low) of acceleration pedal signal	The signal is below the applicatable threshold; signal range violation	If the signal exceeds the applicatable threshold APP_uRawSRCLoHTLIS_C, the signal range violation is reset after the healing debouncing. In case when the CCP is active (CCP_stActive = 1) and the reading from the EEPROM memory is successful, the signal exceeds the threshold APP_uHTLISCCPLo[1], a signal range violation is reset after debouncing.
91	3	Analog accelerator pedal sensor 1 or double accelerator pedal sensor: the voltage measured by ECU is out of the target range or the calculated pedal position is implausible compared with the position of the second pedal	Sensor defect. Short cut to battery or open loop.	Check cabling, check accelerator pedal sensor and if necessary replace it, check connection cable and if necessary repair or replace it. If the signal is below the applicatable threshold APP_uRaw1SRCHigh_C, the signal range violation is reset after the healing debouncing.
91	4	Analog accelerator pedal sensor 1 or double accelerator pedal sensor: the voltage measured by ECU is out of the target range or the calculated pedal position is implausible compared with the position of the second pedal	Short circuit to ground.	Check cabling, check accelerator pedal sensor and if necessary replace it, check connection cable and if necessary repair or replace it If the signal exceeds the applicatable threshold APP_uRaw1SRCLow_C, the signal range violation is reset after the healing
91	11	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
94	1	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	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	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	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	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	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	Oil pressure is below the target range (warning threshold)	Oilpressure too low (pressure below warning threshold)	Threshold for error detection is an internal ECU threshold. Check oil level, check engine for oil leckage, measure oil pressure external to evaluate sensor value
100	1	Oil pressure is below the target range (shut off threshold)	Oilpressure too low (pressure below shut off threshold).	Threshold for error detection is an internal ECU threshold. Check oil level, check engine for oil leckage, measure oil pressure external to evaluate sensor value.
100	3	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	Oil pressure sensor: the voltage of sensor measured by ECU is out of the target range	Short circuit to ground	The sensed raw voltage value Oil_uRawPSwmp is above Oil_SRCPSwmp.uMin_C Check cabling, if sensor not working, check sensor and if necessary replace it, check connection cable and if necessary repair or replace it No detail informationen!
102	1	charge air pressure below lower limit	measured charge air pressure below the threshold.	Check complete air system of engine for massive leakage, especially from compressor to intake air manifold. Check air filter. Exchange charge air presure sensor.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
102	2	Charge air pressure messured by sensor is above the shut off threshold.	Charged air cooler pressure below threshold.	Check waste gate system if necessary replace TC, check CAC if all channels are clean, check charge air piping if nececery.
102	2	Charge air pressure messured by sensor is above the warning threshold	Charge air pressure above shut off threshold	Check waste gate system if necessary replace TC, check CAC if all channels are clean, check charge air piping if necessery.
102	2	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	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	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	Charge air temperature downstream calculated by ECU is above the target range. The ECU activates a system reaction.	Charge air temperature (downstream) over warning threshold.	Check CAC system and clean it. Check fan functionality. Check cooling perfomance with temperature measurement.
105	0	Charge air temperature downstream calculated by ECU is under the shut down threshold. The ECU activates a system reaction.	Charge air temperature (downstream) over the low threshold.	Check CAC system and clean it. Check fan functionality. Check cooling perfomance with temperature measurement.
105	1	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	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	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	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	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

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
110	0	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	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	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	Coolant temperature sensor: the voltage of the sensor measured by ECU is out of the target range	Voltage Surveillance has found shortcut to Ground at Coolant Temperatur Sensor.	Check sensor and if necessary replace it, check connection cable and if necessary repair or replace it Measure Voltage at Coolant Temperature Sensor and renew harness if needed.
111	1	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	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	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	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	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	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	Battery voltage: the voltage measured by ECU is out of the target range, system reaction is initiated	If Battery voltage (Ubatt_U) > 17V or 31V for mor than =0.5sec a warning is generated Battery voltage above warning threshold	Check wiring harness and connected alternator.
168	3	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	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	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
171	4	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	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	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	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Overspeed monitoring during 1 level of FOC (Failure overrun condition) if engine speed was over Limit.	check powertrain settings regarding overspeed
190	2	ECU measures a deviation between camshaft and crankshaft angle to target.	Offset error between crankshaft and camshaft.	Threshold for error detection is an internal ECU threshold, occurs by offset between crankshaft and camshaft. Check increment wheel position, clean and adjust if necessary, check sensor postition. Check Camshaft and Crankshaft senor or wiring.
190	8	Camshaft speed sensor: the ECU receives no signal and uses the signal from crankshaft speed sensor as alternative to calculate the engine speed	When disturbed camshaft signal detected. Error in sensor or wiring.	Threshold for error detection is an internal ECU threshold, occurs by disturbed camshaft signal. Check increment wheel position, clean and adjust if necessary, check sensor postition. Check Camshaft Sensor or wiring.
190	8	Sensor crankshaft speed; disturbed signal	Error in sensor or wiring. Crankshaft sensor defect.	Threshold for error detection is an internal ECU threshold, occurs by disturbed crankshaft signal. Check increment wheel position, clean and adjust if necessary, check sensor postition. Check Crankshaft Sensor or wiring.
190	11	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Overspeed monitoring during 2 level of FOC (Failure overrun condition) if engine speed was over limit.	check powertrain settings regarding overspeed
190	12	Camshaft speed sensor: the ECU receives no signal and uses the signal from camshaft speed sensor as alternative to calculate the engine speed Threshold:	Error in sensor or wiring.	Threshold for error detection is an internal ECU threshold, occurs by disturbed or no camshaft signal. Check increment wheel position, clean and adjust if necessary, check sensor postition. Check Camshaft Sensor or wiring.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
190	12	Crankshaft speed sensor: the ECU receives no signal and uses the signal from camshaft speed sensor as alternative to calculate the engine speed.	Error in sensor or wiring.	Threshold for error detection is an internal ECU threshold, occurs by disturbed or no Crankshaft signal. Check increment wheel position, clean and adjust if necessary, check Crankshaft sensor postition or wiring.
190	14	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Overspeed monitoring during ORC (Override conditions) if engine speed was over 2900rpm	check powertrain settings regarding overspeed
190	14	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	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	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	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	Range check cannot be done or interrupted.	EGR or wiring defect	Check wiring harness and connected EGR.
411	4	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
411	11	DFC is stored in EEPROM and status kept until check is allowed to be carried out again DFC can be reset by service routine 216	deviation between desired O2 concentration in intake air manifold and the real O2-concentration within intake air manifold > limit	Threshold for error detection is an internal ECU threshold. EGR-Valve mechanically blocked open or closed EGR-pipe blocked with metall plate instead sealing downstream EGR-Valve EGR-Valve actuator defect EGR-cooler defect (check for coolant water) Reed Valve defect Intake throttle blocked in closed position => Check intake throttle Exhaust pressure too high => Check Exhaust pressure Check Nox-sensor upstream SCR catalyst dp venturi sensor defect
412	3	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	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	Internal hardware monitoring: the ECU finds an error during the access to its EEPROM memory or works with an alternative value	Section could not be erased	Threshold for error detection is an internal ECU threshold. There is no healing possible for the error. In the every new initialization phase, the debounce level is set to zero. If not programmed, EEPROM is defect --> ECU is defect, reprogramm ECU and if necessary replace it.
630	12	Internal hardware monitoring: the ECU finds an error during the access to its EEPROM memory or works with an alternative value	Minimum 3 blocks could not be readed, EEPROM has Checksum Error	There is no healing possible for the error. In the every new initialization phase, the debounce level is set to zero. If not programmed, EEPROM is defect -->ECU is defect, reprogramm ECU and if necessary replace it
630	12	Internal hardware monitoring: the ECU finds an error during the access to it's EEPROM memory or works with an alternative value	Block could not be written for minimum 3 times	Threshold for error detection is an internal ECU threshold. If not programmed, EEPROM is defect --> ECU is defect, reprogramm ECU and if necessary replace it.
639	14	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	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
651	5	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	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	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	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	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	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	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	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	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	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	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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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
676	11	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	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	Start relay (high side power stage): the current drop measured by ECU is above the target range.	Short cut HighSide-output to battery.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	3	Start relay (low side power stage): the current drain measured by ECU is above the target range.	Shortcut LowSide-Output to battery.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	4	Start relay (high side power stage): the current drain measured by ECU is above the target range.	Shortcut HighSide-output to ground.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	4	Start relay (low side power stage): the current drop measured by ECU is above the target range.	Shortcut LowSide-Output to ground.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable of terminal 50 and if necessary repair or replace it.
677	5	Start relay (low side power stage): the current drop measured by ECU is above the target range	Open circuit/disconnection LowSide-Output.	Threshold for error detection is an internal ECU threshold. Check cabling and start relay and if necessary replace it, check connection cable and if necessary repair or replace it.
677	12	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	Supply module heater: PWM time periode out of valid range.	PWM signal for temperature readout from supply module to the control unit is out of range. Supply modul defect, fault in the wiring.	The Time period of the received PWM signal SCR_tiSMPerPwm is within the specified range of 150ms to 250ms Supply module check and replace if necessary. Check the wiring.
729	3	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
729	4	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	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	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	Timeout Error of CAN-Receive-Frame TSC1TE - active	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
1079	13	Internal hardware monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 1.	Suspected components EDC17cv52 Pin A19: DEF press / Exh.PressBeforeTurb (P3) / Air Pump Press /BrnFuelPressAfterDV2 Pin K19: Fan Speed Sensor Pin A21: LDF6T / OilPress / LowFuelPress Pin A17: Rail Pressure Sensor Suspected components EDC17cv54 Pin A21: CAM speed Pin K44: Delta Press Venturi / Poti EGR or Inlet Throttle Pin A24: LDF6T / OilPress / LowFuelPressPin K43: Reserve 5V Sensor Supply Pin A09: second footpedal Suspected components EDC17cv56 Pin A21: Cam speed Pin K44: DEF press / Air FilterDiffPress Pin A24: LDF6T / OilPress / LowFuelPress Pin K43: second footpedal Pin A09: Delta Press Venturi	Check cabling of external components, check working voltage and if necessary correct it, check connection cable and if necessary repair or replace it, if error is not removable, change ECU.
1080	13	Internal hardware monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 2.	Suspected components EDC17cv52 Pin K16: second footpedal Pin A20: Exh.PressAfterTurb/DPFDiffPress/ BrnDV1Press/HClPressDV1DV2 Suspected components EDC17cv54 Pin K45: DPF Diff Press / Exh. Press After Turb / Fan Speed Sensor Pin A46: first footpedal Suspected components EDC17cv56 Pin A22: Fan Speed Sensor Pin K45: Position EGR or Intake throttle flap Pin K46: First footpedal	Check cabling of external components, check working voltage and if necessary correct it, check connection cable and if necessary repair or replace it, if error is not removable, change ECU.
1109	2	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	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

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
1231	14	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	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	Override switch 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	The urea tank level sensor detects a value higher than the maximum allowed thresh-old	Suspected components: Urea Quality Sensor defect mechanical defect at the float gauge	Check level sensor and float gauge
1761	1	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	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	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.

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Table 3-10. Engine Fault Codes

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

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
2797	4	Injector diagnosis: Timeout of Injetor detection cylinder bank 0	Short-Circuit to ground on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
2797	4	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	Injector diagnosis: Timeout of Injetor detection cylinder bank 1	Short-Circuit to ground on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Note: affected injector has to be evaluated according to firing order
2798	4	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	The urea tank temperature sensor detects a value above the maximum allowed threshold	Sensed urea tank temperature > physical range high limit	Case "CANBUS sensor": Check urea tank temperature: really hot? Check CANBus-message of DEF sensor urea tank temperature Com_dRxSCR2Byt2 Compare it to Com_dRxSCR1Byt1 (urea temperature at quality sensor) identical? Tank heater permantly on? Check wiring of DEF-quality sensor Case "analog DEFT & Level sensor": Check urea tank temperature: really hot? Check urea tank temperature SCR_tSensUTnkT Compare urea tank temperature to EnvT_t or to SCR_tSMT (the urea temperature inside the supply module) identical? Tank heater permantly on? Check wiring of analog DEFT & Level sensor
3031	1	The urea tank temperature sensor detects a value lower than the minimum allowed threshold.	sensed urea tank temperature < physical range low limit	Case "CANBUS sensor": Check ambient temperature EnvT_t => About -40 °C? If yes Error could be plausible Check CANBus-message of DEF sensor urea tank temperature Com_dRxSCR2Byt2 Compare it to Com_dRxSCR1Byt1 (urea temperature at quality sensor) identical? Check wiring of DEF-quality sensor Check quality sensor Case "analog DEFT & 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 DEFT & Level sensor Check analog DEFT & Level sensor
3224	2	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
3224	9	Timeout Error of CAN-Receive-Frame AT1IG-1Vol; NOX sensor (SCR-system upstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX sensor and sensor connection check
3234	2	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	Timeout Error of CAN-Receive-Frame AT1OG1Vol; NOX sensor (SCR-system downstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX downstream sensor and sensor connection check
3361	3	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	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	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	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	Urea dosing valve: the current measured value by ECU at the end of the injection is too high	Fault in the wiriing Defect urea dosing injection valve	Check wiring Check the urea dosing injection valve
3519	3	The integrated diagnostic of the temperature sensor of the Urea Quality Sensor recognized a short circuit to battery. The UQS Sensor is an combined sensor of tank temperature, filling grade and DEF quality and it is also an CAN sensor --> no PIN	Wrong diagnostic of the short circuits logic inside the temperature sensor of the UQS CAN Communication corrupted	Check the wiring to the suction unit in the DEF tank. Check the CAN bus communication of the suction unit. In case the communication is corrupt, exchange the suction unit.
3519	4	The integrated diagnostic of the temperature sensor of the Urea Quality Sensor recognized a short circuit to ground	DEF quality sensor in the suction unit of the DEF tank is defect CAN Communication corrupted	Check the wiring to the suction unit of the DEF tank. Check the CAN bus communication from the suction unit. In case the signal is corrupt, exchange the suction unit in the DEF tank.
3519	12	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
3519	13	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	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	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	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.
3520	13	Urea quality at UQS out of range the specified thresholds; invalid quality of the urea qualiy	Suspected components DEF quality sensor DEF	Check DEF quality and/or DEF quality sensor
3532	3	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	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
3711	12	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	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	The absolute pressure value of the urea pump is greater than an applicable maximal filtered pressure threshold	Suspected Components: Urea pump defect Supply module pressure sensor defect Pump contains dirty parts	Check the urea pump Check the supply module pressur sensor Clean the urea pump (filter)
4334	1	Urea supply module pressure sensor: The absolute pressure value of the urea pump is less than an applicable minimal filtered pressure threshold	Check the urea pump Check the supply module pressur sensor Clean the urea pump (filter)	Check the urea pump Check the supply module pressur sensor Clean the urea pump (filter)
4334	2	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

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
4341	3	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	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	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	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	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	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	Urea backflow line heater: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase is a result error: KWP 1089 Short cut to battery or broken wiring, broken heating element in backflow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4345	4	Urea backflow line heater: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase is a result error: KWP 1089 Short cut to ground or broken wiring, broken heating element in backflow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element
4345	5	Urea backflow line heater: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase is a result error: KWP 1089 Broken wiring, broken heating element in backflow line	Threshold for error detection is an internal ECU threshold Check wiring Check heating element

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
4360	0	The filtered urea cat upstream temperature is greater than an applicable maximum temperature threshold	Sensed temperature upstream SCR > physical high limit	Check temperature difference across DOC (Exh_tOxiCatDs-Exh_TOxiCatUs) at higher engine load => high difference > 100 K? If yes, the engine emitts too many Hydrocarbons => check injectors: is an injector got stuck? => Check EGR Valve If difference normal the exhaust out of the engie itself is too hot: => Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function If that error was set while stand-still operation the error source could be exothermal soot burn off in DPF (which should not happen) => Dismount DPF and check it visually exchange temperature sensor upstream SCR
4360	1	The filtered temperature before urea cat is less than an applicable minimum temperature threshold	Sensed temperature upstream SCR catalyst < than physical low limit	Cold start and ambient temperature < Threshold? Missdetection? Check wiring harness to UCatUsT-sensor Exchange UCatUsT-sensor
4360	2	Error at static plausibility check: absolut temperature difference of sensed temperature upstream SCR catalyst and ambient temperature > as static plausibility limit at engine cold start (engine was off for at least 8 h), temperature upstream of SCR catalyst is expected to be identical to ambient temperature => see enable conditions for details. Error at dynamic plausibility check: temperature difference of sensed temperature upstream SCR catalyst and ambient temperature < as dynamic plausibility limit dynamic check is blocked if static plausibility check is already faulty => Temperature upstream SCR catalyst must be by 40°C higher than ambient temperature if engine runs and a certain delay time has expired.	Error at static plausibility check: absolut temperature difference of sensed temperature upstream SCR catalyst and ambient temperature > as static plausibility limit at engine cold start (engine was off for at least 8 h), temperature upstream of SCR catalyst is expected to be identical to ambient temperature => see enable conditions for details. Error at dynamic plausibility check: temperature difference of sensed temperature upstream SCR catalyst and ambient temperature < as dynamic plausibility limit dynamic check is blocked if static plausibility check is already faulty => Temperature upstream SCR catalyst must be by 40°C higher than ambient temperature if engine runs and a certain delay time has expired.	Check whether temperature sensor upstream of SCR catalyst is physically mounted within exhaust pipe If cold start condition can be made sure (engine was off for at least 8 h) compare values of EnvT_t, EngDa_tEng, Exh_TOxiCatUs, Exh_tOxiCatDs and SCR_tSensUCatUsT at ignition on, without starting the engine. All identical? Compare values of Exh_TOxiCatUs, Exh_tOxiCatDs and SCR_tSensUCatUsT after 15 min in constant operation point: show all similar values (30 K tolerance width). Are ambient temperature and (EnvT_t), cooling water temperature (EngDa_tEng) plausible? Sensor coated with urea crystalls? Dismount urea injector and inspect temperature sensor upstream SCR catalyst visually Check wiring of sensor Replace sensor
4361	3	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	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
4365	2	Signal error in case of Urea tank temperature trnasmitted via CAN-signal Com_tUTnkT.	CAN message is not send properly.	Check sensor connector Check CANbus

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
4365	3	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	Internal error of DEF qualitysensor.	Suspected componentes: DEF qualitysensor Wiring harness	Check wiring harness and DEF qualitysensor
4365	4	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	Internal error of DEF qualitysensor.	Suspected componentes: DEF qualitysensor Wiring harness	Check wiring harness and DEF qualitysensor
4366	3	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	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	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	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	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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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
4375	5	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	Urea supply module reversal valve: the current drain measured by ECU is above the target range	Shortcut to battery Fault in the wiring Reversal valve in the urea supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea supply modul
4376	4	Urea supply module reversal valve: the current drain measured by ECU is above the target range	Shortcut to ground Fault in the wiring Reversal valve in the urea supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea supply modul
4376	5	Urea supply module reversal valve: the current drain measured by ECU is above the target range	Open load Fault in the wiring Reversal valve in the urea supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check urea supply modul
4765	0	The exhaust temperature value from the sensor befor DOC is above an applicable upper shutoff threshold TOxiCatUs_tShOffThresHiAds_C = Threshold 1 in Normal and Heatmodes (TOxiCatUs_tShOffThresHiRgn_C = Threshold 2 in stand-still)	sensed temperature upstream DOC > shut-off limit	Check air path of engine: EGR-Valve, Intake-Throttle, Check Turbocharger and Piping each for leakage and correct function Check injectors: is an injector got stuck? Exchange temperature sensor upstream DOC
4765	0	The exhaust temperature value from the sensor befor DOC is above an applicable upper warning threshold TOxiCatUs_tWarnThresHi_C = Threshold	Sensed temperature upstream DOC > warning limit	Check air path of engine: EGR-Valve, Intake-Throttle, Turbocharger and Piping each for leakage and correct function Check injectors: is an injector got stuck? Exchange temperature sensor upstream DOC

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
4768	2	Static plausibility check: The exhaust temperature value from the sensor before DOC, the exhaust temperature value from the sensor after DOC, the temperature value from the sensor before SCR-Cat, the environment temperature and the coolant engine temperature their ratios to each other exceed their related thresholds. Dynamic plausibility check with environment temperature sensor value: The exhaust temperature value from the sensor before DOC is lower than an applicable environment temperature threshold	Static plausibility check: The exhaust temperature value from the sensor before DOC, the exhaust temperature value from the sensor after DOC, the temperature value from the sensor before SCR-Cat, the environment temperature and the coolant engine temperature their ratios to each other exceed their related thresholds. (difference between temperature after DOC and temperature before DOC > Threshold 1 difference between temperature befor DOC and before SCR > Threshold 2 difference between temperature after DOC and before SCR < Threshold 3 difference between temperature after DOC and ambinet temperature < Threshold 4 differnece between temperatur ambient temperature and engine temperature < Threshold 5) Dynamic plausibility check with environment temperature sensor value: The exhaust temperature value from the sensor before DOC is lower than an applicable environment temperature threshold (< environmental temperature + Threshold 6)	Check ambient temperature => value plausible? upstream DOC sensor mounted within exhaust line? T upstream DOC sensor physically mounted in correct position upstream DOC? (not upstream SCR or downstream DOC?) Check T upstream DOC sensor Check other T-sensors within EAT-system (Exh_tOxiCatDs & UCatUsT_tFlt_mp show plausible values? No errors on them?
4768	2	At engine cold start conditions the sensed exhaust gas temperature downstream DOC (Exh_tSensTOxiCatDs) has exceeded the sum of ambient temperature (EnvT_t) + offset (40°C) earlier than the sensed exhaust gas temperature upstream of DOC (Exh_tSensTOxiCatUs). The check is only performed once each ignition cycle and only if the start is judged a cold start. Error status is frozen for that ignition cycle. No healing possible.	Difference temperature of exhaust gas temperature downstream DOC and fixed ambient temperature at ignition on exceeds a certain limit earlier than the difference temperature of exhaust gas temperature upstream DOC and fixed ambient temperature at ignition on.	Check whether all exhaust gas temperature sensors within the EAT system are mounted properly: Within the exhaust line and at correct positions. Check the position of the sensor upstream SCR which might be physically mounted in the wrong position. If cold start condition can be made sure (engine was off for at least 8 h) compare values of EnvT_t, EngDa_tEng, Exh_TOxiCatUs, Exh_tOxiCatDs and SCR_tSensUCatUsT at ignition on, without starting the engine. All identical? Then the sensors itself are okay. Check exhaust piping for leakage. Check wiring of sensors Replace sensors Check DOC => physicallly intact?
4768	3	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	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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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
5763	3	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	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	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	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	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	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	Actuator error EGR-Valve (2.9;3.6) or Throttle-Valve (4.1;6.1;7.8); Voltage below threshold 3.6) Drosselklappe (4.1;6.1;7.8); Voltage below threshold;	Monitoring for CY146 Under Voltage.	Threshold for error detection is an internal ECU threshold. Check wiring, component
5763	5	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	Actuator error EGR-Valve. Signal range check high.	Short cut to batterie.	Check wiring and repair or replace if necessary, check actuator with SERDIA test for EGR and if necessary replace it.
5763	6	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	Actuator EGR-Valve: Open load on ECU output is detected	Open circuit on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	6	Actuator EGR-valve: too high curent is going into the actuator. Output is switched off	Overload on component wiring	Threshold for error detection is an internal ECU threshold. Check wiring, component, ECU Check repair with SerDia 2010 use case
5763	6	Actuator error EGR-valve; Overload by short-circuit	Short Circuit over Load	Threshold for error detection is an internal ECU threshold. Check wiring, component

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
5763	7	Actuator position for EGR valve is not plausible, internal error, angular misalignement of the flap.	Position error of throttle flap (deviation > 7%).	Threshold for error detection is an internal ECU threshold. Threshold for error detection, deviation from setpoint > 7%. Troubleshooting with SERDIA 2010 Use Case "EGR Diagnostic".
5763	11	Power stage overtemperature due to high current.	Temperature dependent Over Current	Threshold for error detection is an internal ECU threshold. Check wiring, component
520521	5	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	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	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	Timeout Error of CAN-Receive-Frame ComEngPrt; Engine Protection	Timeout Error (Missing CAN Bus message)	Check wiring harness and customer devices
523240	9	Timeout CAN-message FunModCtl; Function Mode Control	Timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
523350	4	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	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	Internal hardware monitoring: the ECU detects an error of its injector high current output. Chip of CY33x defect power stage components	Defective powerstage in ECU	Threshold for error detection is an internal ECU threshold. If error is not removable, change ECU.
523450	4	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	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	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	7	Rail pressure is out of the expected average range.	Rail pressure is out of the expected average range. PRV can not be opened.	(A) Check railpressure relief valve and replace if necessary. (B) Check high pressure pumps, pressure relief valve and metering unit. (C) Change components if necessary

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523470	11	Rail pressure relief valve can not be opened due to the railpressure.	Railpressure out of tolerance range (PRV can not be opened by a pressure peak in this operating point)	Threshold for error detection is an internal ECU threshold. Check railpressure, check rail pressure sensor for plausibility, check FCU.
523470	11	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	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	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	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	Terminal 50 was operated for more than 2 minutes. This may happen due to short to battery or wrong usage of Terminal 50. Starter control is disabled until this error is healed.	Startinformation to Starter (T50-switch) erratic/defect.	Threshold for error detection is an internal ECU threshold. Check cabling, if sensor not working, check start switch and if necessary replace it, check connection cable and if necessary repair or replace it.
523601	13	Internal hardware monitoring: the ECU detects a deviation of the target range of the power supply voltage of sensor output 3.	Suspected components EDC17cv52 Pin A18: DeltaPressVenturi / Position intake throttle flap Pin K20: First footpedal Pin K21: Air FilterDiffPress Suspected components EDC17cv54 and cv56 Pin A07: Rail pressure	Check cabling of external components, check working voltage and if necessary correct it, check connection cable and if necessary repair or replace it, if error is not removable, change ECU.
523612	3	supply voltage too high	not used	Threshold for error detection is an internal ECU threshold.
523612	4	supply voltage too low	not used	Threshold for error detection is an internal ECU threshold.
523612	12	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523612	12	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	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	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	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error report due to an error in the plausbility of Function Coordination(FC) and Monitoring Modul(MM)(ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	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	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	multiple error in complete ROM-test during postdrive detected (ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	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	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	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	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.
523612	12	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in the check of the shut-off path test of the under voltage detection (ECU internal error). Diagnostic fault check to report the error in undervoltage monitoring	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	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.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523612	12	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	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error in time monitoring of the shut-off path test (ECU internal error). Diagnostic fault check to report the timeout in the shut off path test	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	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	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	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	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	Error in the plausibility of the start of energising angles	Implausible start of energising of either PiIx or MI1 or PoIx.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	Error in the plausibility of the energising times of the zero fuel quantity calibration	The energising times of the zero fuel quantity calibration ZFC is out of the target. (-> ECU internal error)	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	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	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	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.
523612	12	Engine speed: the engine speed calculated by ECU is above the target range; the ECU activates a system reaction	Error in the plausibility of current energising time with maximum permitted energising time. Diagnostic fault check to report the error due to Over Run	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	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	Plausibility error of the Rail pressure sensor	In case the gradient of rail pressure is larger than the max threshold or lesser than the min threshold. Rail metering unit defect. Leakge in the Rail System.	Threshold for error detection is an internal ECU threshold. Check metering unit or cable. Check Rail pressure. Check the Rail System of leakage.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523612	12	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	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	Diagnosis of lead path limitation forced by ECU monitoring level 2	The setpoint path of the air system is limited by the limitation torque of the functional control unit monitoring.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	Diagnosis of set path limitation forced by ECU monitoring level 2.	If the quantity setpoint is exceeds the limit of the torque function.	Threshold for error detection is an internal ECU threshold. If error is still present, exchange ECU.
523612	12	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	Error report "ABE wire is active" due to undervoltage detection	The reason is that a slow dropping of the vehicle electrical system voltage (defective autobattery) should not lead the ECU OCWDA's diagnose to enter an error in the fault memory due to an undervoltage recognition.	Threshold for error detection is an internal ECU threshold. Software reset.
523612	12	Error report "ABE wire is active" due to overvoltage detection	If the ABE/WDA powerstage shut-off is active due to an overvoltage detection.	Threshold for error detection is an internal ECU threshold. software reset.
523612	12	Error report "ABE/WDA active" due to an unknown reason	The reason is that a slow dropping of the vehicle electrical system voltage (defective autobattery) should not lead the ECU OCWDA's diagnose to enter an error in the fault memory due to an undervoltage recognition.	Threshold for error detection is an internal ECU threshold. Software reset.
523612	12	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Error during positive test (ECU internal error). Diagnostic fault check to report that the positive test failed	Threshold for error detection is an internal ECU threshold. Reflash ECU. If error is still activ replace ECU.
523612	12	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	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory.	Visibility of Softwareresets in DSM	Threshold for error detection is an internal ECU threshold.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523612	14	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory.	Visibility of Softwareresets in DSM	Threshold for error detection is an internal ECU threshold.
523612	14	Internal hardware monitoring: the CPU of the ECU is reset and the cause is logged internally; no item will be created in error memory	Visibility of SoftwareResets in DSM	Threshold for error detection is an internal ECU threshold. If possible the software update has to be done. Replace the ECU.
523613	0	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	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	Rail pressure: the fuel pressure in rail calculated by ECU is above the target range which is dependant on the engine speed.	leakage is detected based on fuel quantity balance.	Threshold for error detection is an internal ECU threshold. (A) Check backflow pressure (B) Check Injector function with SerDia (C) Change components (metering unit, injector) if necessary
523613	0	Rail pressure: the fuel pressure in rail calculated by ECU is above the target range which is dependant on the engine speed.	Maximum negative rail pressure deviation with metering unit on lower limit is exceeded.	Threshold for error detection is an internal ECU threshold. (A) Check backflow pressure (B) Check Injector function with SerDia (C) Change components (metering unit, injector) if necessary
523613	0	Rail pressure: the fuel pressure in rail calculated by ECU is above the target range.	Rail pressure exceeds the limiting value.	(A) Check backflow pressure (B) Check pressure relief valve and metering unit. (C) Change components if necessary
523613	1	Rail pressure: the fuel pressure in rail calculated by ECU is below the target range which is dependant on the engine speed.	Rail pressure falls below the limiting value based on the engine speed.	Threshold for error detection is an internal ECU threshold. (A) Check backflow pressure (B) Check Injector function with SerDia (C) Change components (metering unit, injector) if necessary
523613	2	Rail pressure metering unit, Setpoint of metering unit in overrun mode not plausible.	Pressure pump delivery quantity in overrun exceeds the threshold based on the pressure.	Threshold for detection is an internal ECU threshold. (A) Check backflow pressure (B) Check pressure relief valve and metering unit. (C) Change components if necessary

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523615	3	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	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	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	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	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	powerstage of metering unit is overheated	over temperature	Threshold for error detection is an internal ECU threshold. Check functionality of metering unit and replace it if needed. Check temperature of metering unit and improve the installation in case of overheating.
523632	3	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	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	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
523698	11	Shut off request from supervisory monitoring function	Engine Shut Off due to supervisory function	Threshold for error detection is an internal ECU threshold. Check error memory for additional errorcode to find root cause. Depending on additional error follow the documented "Take action for repair".
523718	3	Urea heater relay: the current drain measured by ECU is above the target range	Shortcut to battery If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring, broken relay	Threshold for error detection is an internal ECU threshold Check wiring Check SCR main relay

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523718	4	Urea heater relay: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring, broken relay	Threshold for error detection is an internal ECU threshold Check wiring Check SCR main relay
523718	5	Urea heater relay: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring broken relay	Threshold for error detection is an internal ECU threshold Test SCR main relay Check cabling, if necessary replace relay.
523719	4	Urea supply module heater: the current drain measured by ECU is above the target range	Shortcut to ground If this error detected during the heating phase it is a result error: KWP 1089 Broken wiring Heating element in supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check cabling, if necessary replace supply module
523719	5	Urea supply module heater: the current drain measured by ECU is above the target range	Open load If this error detected during the heating phase is a result error: KWP 1089 Broken wiring Heating element in supply module defect	Threshold for error detection is an internal ECU threshold Check wiring Check cabling, if necessary replace supply module
523720	8	Supply module heater: Duration of switch on is too long.	uty cycle for temperature readout from supply module heater to the control unit is out of range; Supply modul defect, fault in the wiring.	When the received supply module heater temperature duty cycle SCR_rSMT is out of the failurerange (SCR_rSMFailMax_C < SCR_rSMHtrT < SCR_rSMFailMin_C) Supply module check and replace if necessary. Check the wiring.
523720	8	Supply module heater: Dutycycle timing over error threshold.	Duty cycle for temperature readout from supply module heater to the control unit is not valid. Supply modul defect, fault in the wiring.	When the received supply module heater duty cycle SCR_rSMHtrT is in the valid range (SCR_r- Supply module check and replace if necessary. Check the wiring.
523721	8	Supply module heater: Dutycycle timing over error threshold.	Duty cycle for temperature readout from supply module to the control unit is out of range. Supply modul defect, fault in the wiring.	Supply module check and replace if necessary. Check the wiring.
523721	8	Supply module heater: Dutycycle timing out of valid range.	Duty cycle for temperature readout from supply module to the control unit is not valid. Supply modul defect, fault in the wiring.	When the received supply module duty cycle SCR_rSMT is in the valid range (SCR_rSMTVId-Min_C <= SCR_rSMT <= SCR_rSMTVIdMax_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	Supply module heater: temperature measurement not available.	Duty cycle for temperature readout from supply module heater to the control unit is not available. Supply modul defect, fault in the wiring.	Threshold for detection is an internal ECU threshold. No erasing in the current driving cycle. Supply module check and replace if necessary. Check the wiring.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523722	8	Supply module heater: Faulty PWM signal from supply module.	PWM Signal for temperature readout from supply module to the control unit is not valid. Supply modul defect, fault in the wiring.	Threshold for error detection is an internal ECU threshold. When valid Sync followed by temperature information signal is received AND valid sync and temperaturesignal for both information is received one after the other. Supply module check and replace if necessary. Check the wiring.
523776	9	Timeout Error of CAN-Receive-Frame TSC1TE - active	Timeout Error (Missing CAN Bus message)	Threshold for error detection is an internal ECU threshold. Check CAN Bus cabling (Bus sheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range.
523777	9	Message TSC1-TE has been missing (passive)	Passive timeout Error (Missing CAN Bus message)	Check CAN Bus cabling (Bus scheduling, polarity, short circuit, power interrupt), test protocol of receiver, check CAN functional range, check actuator
523895	13	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	Missing or wrong injector adjustment value programming (IMA) injector 2 (in firing order).	Missing or wrong injector adjustment value for cyl. 2	Threshold for error detection is an internal ECU threshold. check dataset and flash correct injector adjustement value (IMA). Use SERDIA UseCase to check it.
523897	13	Missing or wrong injector adjustment value programming (IMA) injector 3 (in firing order).	Missing or wrong parametrisation of injector adjustment cyl. 3.	Threshold for error detection is an internal ECU threshold. Check correct injector adjustment value (IMA).
523898	13	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	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).
523900	13	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	@ 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

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523924	4	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	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	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	Short circuit to ground aktuator relais 4. Overload at Pins O_V_PCV: A90	Suspected components:Fan, Wiring harness	Threshold for error detection is an internal ECU threshold. Check wiring harness and connected loads on pin A90. If error is still present, exchange ECU.
523927	3	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	Timeout Error of CAN-Transmit-Frame EEC3VOL1; Engine send messages	Fault is detected if a TimeOut of the EEC3VOL1 frame has occured.	Check wiring harness and customer nodes
523936	12	Timeout Error of CAN-Transmit-Frame EEC3VOL2; Engine send messages	Timeout Error (Missing CAN Bus message)	Check wiring harness and customer nodes
523938	9	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1IGCVol1 information; factors & Sensorcalibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX sensor and sensor connection check

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523939	9	Broadcast Announce Message of the calibration message of the upstream catalytic NOx sensor has failed. Timeout Error (BAM to BAM) for CAN-Receive-Frame AT1IGCVol1 information. factors & Sensorcalibration for NOX Sensor (SCR-system upstream cat, DPF-system downstream cat).	Defective Nox sensor, faulty parameterization	NOX sensor and sensor connection check
523940	9	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1IGCVol1 information; factors & Sensorcalibration for NOX Sensor (SCR-system upstream cat; DPF-system downstream cat)	Failure of the CAN Bus message	NOX sensor and sensor connection check
523941	9	Timeout Error (BAM to packet) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensorcalibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	Timeout Error (Missing CAN Bus message)	NOX downstream sensor and sensor connection check
523942	9	Timeout Error (BAM to BAM) for CAN-Receive-Frame AT1OGCVol2 information, Calibration message 1 of the after catalyst NOx sensor has failed. Factors & Sensorcalibration for NOX Sensor (SCR-system downstream cat, DPF-system downstream cat)	Defective Nox sensor, faulty parameterization.	NOX downstream sensor and sensor connection check.
523943	9	Timeout Error (PCK2PCK) for CAN-Receive-Frame AT1OGCVol2 information; factors & Sensorcalibration for NOX Sensor (SCR-system downstream cat; DPF-system downstream cat)	The fault is detected when a timeout error in packet 2 of NOxSenVol2Rx frame occurs.	NOX downstream sensor and sensor connection check
523960	0	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	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
523982	0	Powerstage diagnosis disabled; Indicating that battery voltage is not high.	Powerstage diagnostic can be deactivated due to too high battery voltage.	Check wiring, check alternator, check cables and repair or replace if necessary.
523982	1	Powerstage diagnosis disabled; Indicating that battery voltage is not low.	Powerstage diagnostic can be deactivated due to too low battery voltage.	Check wiring, check alternator, check cables and repair or replace if necessary.

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Table 3-10. Engine Fault Codes

SPN	FMI	Description	Possible Cause	Action
523984	3	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	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	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	CAN; not used	not used	not used
524051	11	CAN; not used	not used	not used
524057	2	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	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	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	Urea backflow line heater: broken wiring detected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Open Load on wiring to component	Check wiring, component
524063	5	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	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	SCR relay for suction line not connected Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	relay defect relay not connected wiring harness broken problems with supply voltage	Check wiring, component
524063	5	Open load on wiring to component Threshold 1 < SCRHtr_rUHtrMeasRatio_mp < Threshold 2	Open load on wiring to component	Check wiring, component
524063	5	SCR heater tank; open load	Open load on wiring to component	Check wiring, component

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Table 3-10. Engine Fault Codes

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

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Table 3-10. Engine Fault Codes

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

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Table 3-10. Engine Fault Codes

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

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