An Oshkosh Truck Corporation Company

Service & Maintenance Manual

Models
400RTS
500RTS

3120829

November 12, 2007

CE

NQA ISO9001 REGISTERED COMPANY UKAS QUALITY MANAGEMENT 015

An Oshkosh Truck Corporation Company

SECTION A. INTRODUCTION - MAINTENANCE SAFETY PRECAUTIONS

A.A GENERAL

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

⚠ WARNING

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

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

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

⚠ WARNING

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

A.B HYDRAULIC SYSTEM SAFETY

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

Relieve system pressure by cycling the applicable control several times with the engine stopped and ignition on, to direct any line pressure back into the reservoir. Pressure feed lines to system components can then be disconnected with minimal fluid loss.

A.C MAINTENANCE

⚠ WARNING

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

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

REVISION LOG

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August 4, 2004 - Revised

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SECTION 1. SPECIFICATIONS

1.1 CAPACITIES

Hydraulic Oil Tank

Approximately 138.17 liters (36.5 U.S. gallons) w/10% air space.

Hydraulic System (Including Tank)

Approximately 166.56 liters (44 U.S. gallons).

Fuel Tank

Approximately 56.8 liters (15 U.S. gallons)

Engine Crankcase

Gasoline Engine

3.2 liters (3.4 quarts) w/filter

2.7 liters (2.9 quarts) w/o filter

Diesel Engine

6.0 liters (6.34 quarts) w/filter

5.5 liters (5.8 quarts) w/o filter

Coolant Capacity (Gasoline Engine)

13.2 liters (3.5 U.S. gallons)

1.2 COMPONENT DATA

Gasoline Engine

Displacement - 4.5 liter

Manufacturer/Model - Ford LRG-425

Oil Capacity

4.3 liters (4.5 quarts) w/ filter
3.8 liters (4.0 quarts) w/o filter

Low RPM - 750

Mid RPM - 2200

High RPM - 3000

Alternator - 55 Amp external

Battery - 85 Amphour, 550 Cold Cranking Amps

Fuel Consumption

Low RPM - 6.7 lph (1.8 gph)

High RPM - 11.4 lph (3.0 gph)

Horsepower - 70 @ 2800 RPM

Coolant Capacity - 13.2 liters (3.5 U.S. gallons)

Diesel Engine

Manufacturer/Model - Deutz F3L-1011

Oil Capacity

6.0 liters (6.34 quarts) w/filter

5.5 liters (5.8 quarts) w/o filter

Mid RPM - 2000

High RPM - 3000

Alternator - 60 Amphour

Battery - 60 Amphour, 1000 Cold Cranking Amps

Fuel Consumption

Low RPM - 7.19 lph (1.9 gph)

High RPM - 9.46 lph (2.5 gph)

Horsepower - 42 @ 3000 RPM

Drive/Steer System

Tires 400RTS

Standard - 31 - 15.5 x 15 NHS, 8 ply, pneumatic, inflate to 2.4 bar (35 PSI)

Optional - 12 - 16.5 NHS, 6 ply, foam filled

Tires 500RTS

Standard - 12 x 16.5 NHS, 8 ply, pneumatic, inflate to 3.1 bar (45 PSI)

Optional - 31 - 15.5 x 15 NHS, 8 ply, pneumatic, inflate to 2.4 bar (35 PSI)

Optional - 12 - 16.5 NHS, 6 ply, foam filled

Steer System

Toe-In - Adjust to 6.4 mm (1/4 in) overall

Drive Motors/Hubs/Brakes

Drive Motor - 6.3 cm^3 (2.48 $in.^3$) displacement

Drive Hub (2WD Gasoline and Diesel Engine - Rear) - Hub ratio 35:1

Drive Hub (4WD Rear) - Hub ratio 24:1

Drive Hub/Brake (4WD Front) - Hub ratio 24:1; brake - spring applied, hydraulic release, release pressure - 11 bar (160 psi) initial, 13 bar (190 psi) full

Drive Brake (2WD/4WD Rear) - Spring applied, hydraulic release, release pressure - 10 bar (150 psi) initial, 12 bar (170 psi) full

NOTE: *Wheel lugs should be torqued to 109 Nm (80 ft lb) at 50 hour intervals.*

When maintenance becomes necessary or a fastener has loosened, refer to Figure 1-3., Torque Chart, to determine proper torque value.

Hydraulic Filter - Inline

Return - Bypass Type

25 Micron Nominal

1.3 PERFORMANCE DATA

Travel Speed

2 Wheel Drive - 5.6 kmh (3.5 mph)

4 Wheel Drive - 4.5 kmh (2.8 mph)

Gradeability

2 Wheel Drive - 25% (14°)

4 Wheel Drive - 45% (24°)

Turning Radius (Outside)

2 Wheel Steer - 4.0 m (13 ft 2 in)

4 Wheel Steer - 2.0 m (6 ft 6 in)

Lift Speed - 400RTS

Up - 42 - 50 seconds

Down - 60 - 70 seconds

Lift Speed - 500RTS

Up - 65 - 80 seconds

Down - 70 - 80 seconds

Platform Capacity - Fixed Platform

400RTS - 905 kg (2,000 lb)

500RTS - 1135 kg (2,500 lb)

Platform Capacity - Traversing Platform Extension (If Equipped)

400RTS (With Deck Extended)

Machine Capacity - 680 kg (1,500 lb)

Extension - 265 kg (500 lb)

500RTS (With Deck Extended)

Machine Capacity - 905 kg (2000 lb)

Extension - 265 kg (500 lb)

With Deck Retracted

400RTS - 680 kg (1,500 lb)

500RTS - 900 kg (2,000 lb)

Platform Capacity - Dual Extensions

400RTS - 680 kg (1,500 lb)

500RTS - 900 kg (1,984 lb)

Platform Capacity - Wide Deck, Dual Extensions (500RTS Only)

500RTS - 680 kg (1,500 lb)

Machine Weight

400RTS - Approx. 6,797kg (14,985 lb)

500RTS - Approx. 6,940 kg (15,300 lb)

Machine Height (Platform Lowered)

400RTS - 2.9 m (116 in)

500RTS - 3.15 m (126 in)

Machine Length

4.72 m (15 ft 5 in)

Machine Width

Standard Tires - 2.3 m (7 ft 6 in)

Foam Filled Tires - 2.3 m (7 ft 7 in)

1.4 LUBRICATION

Table 1-1. Hydraulic Oil

HYDRAULIC SYSTEM OPERATING TEMPERATURE RANGE	SAE VISCOSITY GRADE
0 to +23 degrees F (-18 to -5 degrees C)	10W
0 to +210 degrees F (-18 to +100 degrees C)	10W-20,10W-30
+50 to +210 degrees F (+10 to +100 degrees C)	20W-20

NOTE: *Hydraulic oils must have anti-wear qualities at least to API Service Classification GL-3, and sufficienthemical stability for mobile hydraulic system service. JLG Industries recommends Mobil 424 hydraulic oil, which has an SAE viscosity of 10W-20 and viscosity index of 152.*

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. If use of hydraulic oil other than Mobil 424 is desired, contact JLG Industries for proper recommendations.*

1.5 LUBRICATION SPECIFICATIONS

Table 1-2. Lubrication Specifications

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

NOTE: *Refer to Figure 1-1., Lubrication Diagram for specific lubrication procedures.*

1.6 PRESSURE SETTINGS

400RTS

Rexroth/Hydraforce Valve

Main Relief - 156 bar (2250 psi)

Steer Relief - 103 bar (1500 psi)

Steer Relief 4-W/S (If Equipped) - 103 bar (1500 psi)

Platform Extension (If Equipped) - 34 bar (500 psi)

500RTS

Rexroth/Hydraforce Valve

Main Relief - 193 bar (2800 psi)

Steer Relief - 103 bar (1500 psi)

Steer Relief 4-W/S (If Equipped) - 103 bar(1500 psi)

Platform Extension (If Equipped) -83 bar (1200 psi)

1.7 LIMIT SWITCHES

The machine is equipped with the following limit switches:

High Drive Speed Cut-Out

High drive speed is cut out when platform is raised above stowed (fully lowered) position.

Lift Cut-Out (If Equipped)

Lift is cut out at 6.8 m (22 ft) when leveling jacks are in the stowed position.

Drive Cut-Out (If Equipped)

Drive is cut out when platform is at 6.8 m (22 ft) above stow position, or when leveling jacks are in the set position.400RTS Tilt Alarm - 5° (If Equipped)

A horn is sounded and a warning light is illuminated when the machine is operated on a slope that exceeds 5° with the platform raised. If the machine is operated on a 5° slope with the platform completely lowered, only the warning light is illuminated.

500RTS - Tilt Alarm - 3°

A horn is sounded and a warning light is illuminated when the machine is operated on a slope that exceeds 3° with the platform raised. If the machine is operated on a 3° slope with the platform completely lowered, only the warning light is illuminated.

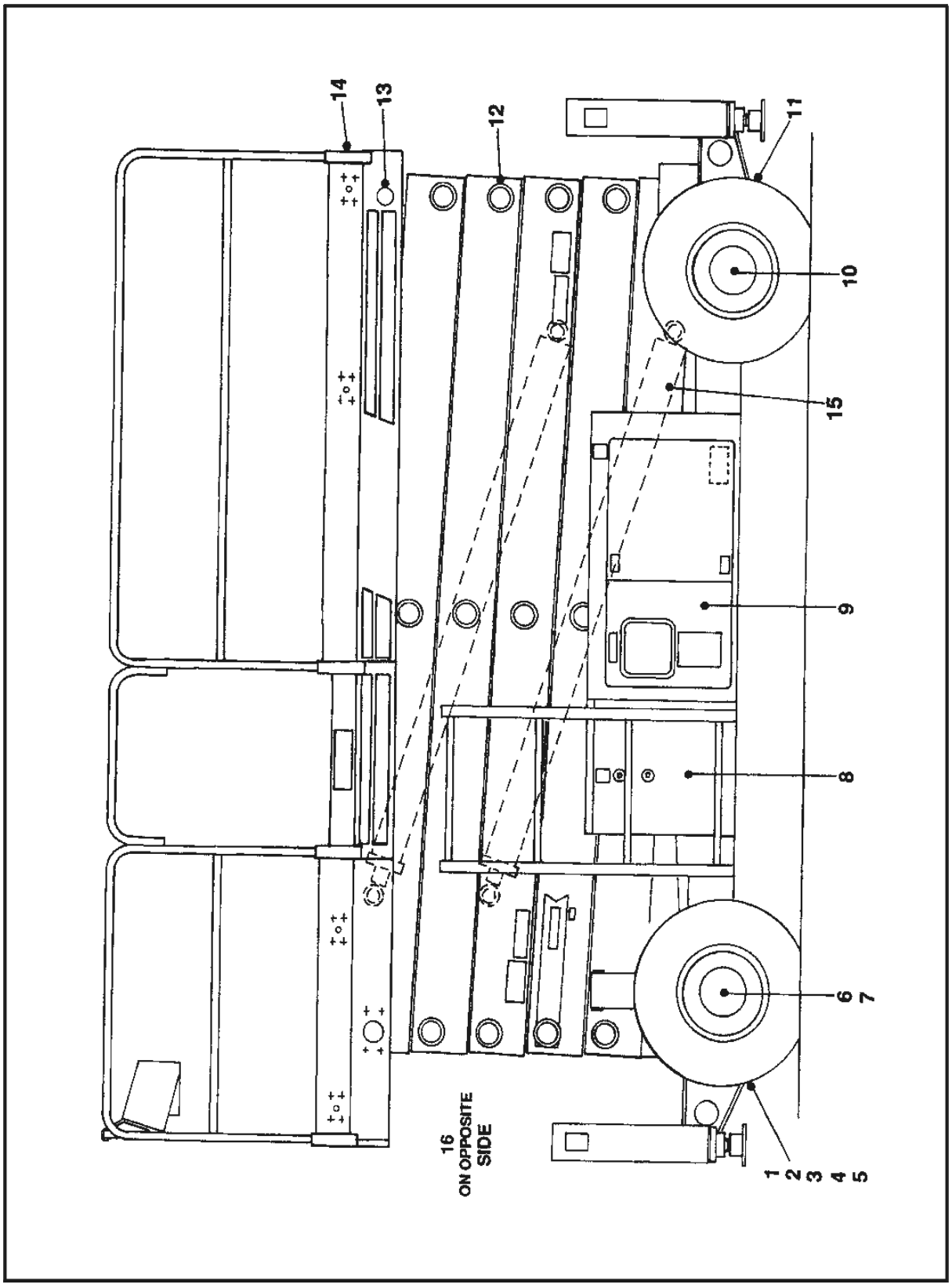


Figure 1-1. Lubrication Diagram

Table 1-3. Lubrication Chart

INDEX NO	COMPONENT	NUMBER/TYPE LUBE POINTS	LUBE METHOD	INTERVAL HOURS
1	Oscillating Axle Pivot Point (Optional)	1 Grease Fitting	MPG - Pressure Gun	100
2	Lockout Cylinders (Optional)	2 Grease Fittings (1 each cylinder)	MPG - Pressure Gun	100
3	Front Steering Spindles (2-W/D)	2 Grease Fittings	MPG - Pressure Gun	100
4	Front Steering Spindles (4-W/D) (Optional)	2 Grease Fittings	MPG - Pressure Gun	100
5	Tow Bar Hitch (Optional)	1 Grease Fitting	MPG - Pressure Gun	100
6	Wheel Bearings (2-W/D)	N/A	MPG - Repack	2000
7	*Wheel Drive Hub (4-W/D) (Optional)	Fill Plug	EPGL (SAE 90)	500
8	Hydraulic Oil Reservoir	Fill Cap/Drain Plug	HO - Check HO Level (See note 4)/ HO - Change HO	10/500
9	** Hydraulic Filter Element	N/A	Initial Change - 40 Hours	250
10	*Wheel Drive Hub	Fill Plug	EPGL (SAE 90)	500
11	Rear Steering Spindles (4-W/S) (Optional)	2 Grease Fittings	MPG - Pressure Gun	100
12	400 RTS Sizzor Arm Pivot Pins 500 RTS Sizzor Arm Pivot Pins	30 Grease Fittings (400 RTS) 38 Grease Fittings (500RTS)	MPG - Pressure Gun MPG - Pressure Gun	100
13	Rail Slides	N/A	MPG - Brush	100
14	Platform Extension Slides (Optional)	N/A	MPG - Brush	100
15	Lift Cylinder	4 Grease Fittings	MPG - Pressure Gun	100
16	Engine Crankcase	Fill Cap/Drain Plug	Check Engine Oil Level	10/100

KEY TO LUBRICANTS:

MPG - Multi-purpose Grease

EPGL - Extreme Pressure Gear Lube

HO - Hydraulic Oil (Mobil 424)

*Torque Hubs should be 1/2 full of lubricant

** JLG Industries recommends replacing the hydraulic filter after the first 40 hours of operation and every 250 hours thereafter.

⚠ WARNING

TO AVOID PERSONAL INJURY, USE SAFETY PROP FOR ALL MAINTENANCE REQUIRING PLATFORM TO BE ELEVATED.

NOTE: ***1.*** *Be sure to lubricate like items on each side*

2. *Recommended lubricating intervals are based on machine operations under normal conditions. For machines used in multi-shift operations and/ or exposed to hostile environments or conditions, lubrication frequencies must be increased accordingly.*

3. *Operate hydraulic functions through one complete cycle before checking hydraulic oil level in tank. Oil should be visible in ADD sight window on hydraulic tank. If oil is not visible, add oil until oil is visible in both ADD and FULL sight windows on tank. Do not overfill tank.*

4. *Any time the pump coupling is removed, coat splines of coupling with Texaco Code 1912 grease prior to assembly. (gasoline or diesel engine only).*

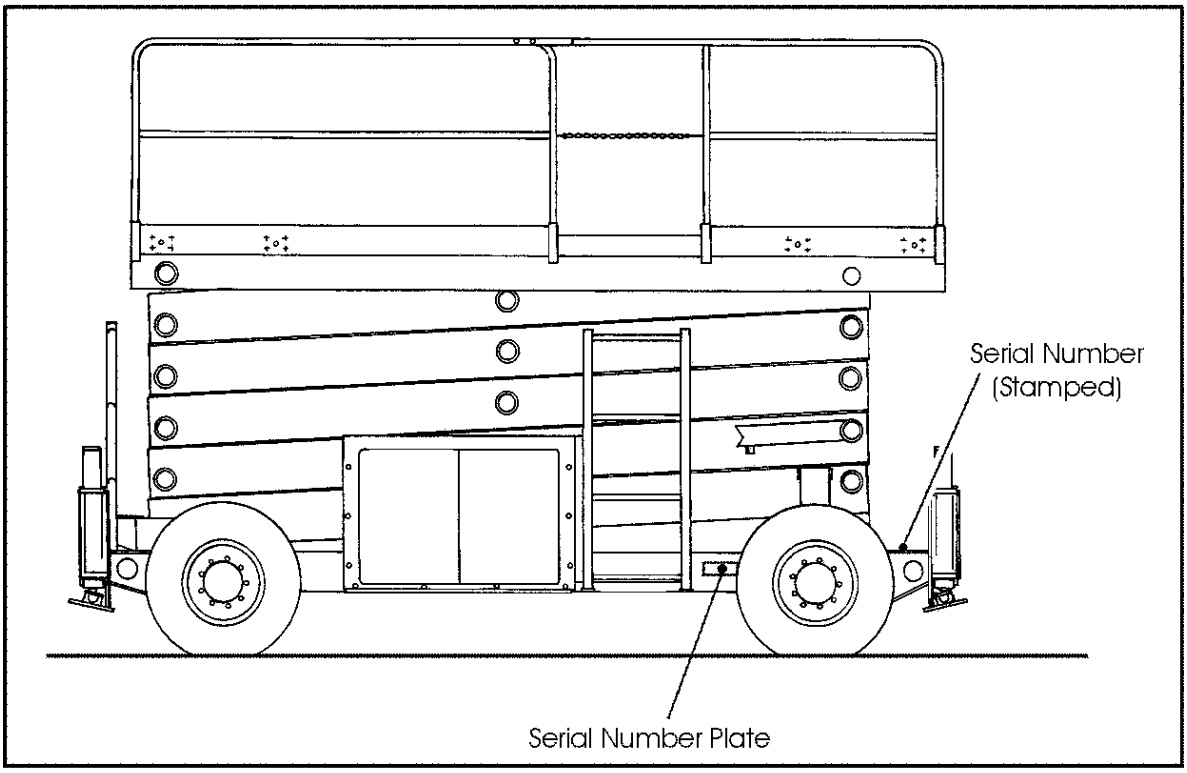


Figure 1-2. Serial Number Location

1.8 SERIAL NUMBER LOCATIONS

For machine identification, a serial number plate is affixed to the machine. On gasoline or diesel powered machines, the plate is located on the right front side of the frame rail. In addition, should the serial number plate be damaged or missing, the machine serial number is stamped on the top of frame between the front wheels.

1.9 CYLINDER SPECIFICATIONS

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

Table 1-4. Cylinder Specifications

Description	Bore	Stroke	Rod Dia
Lift Cylinder (400RTS/500RTS)	5.0 (12.7)	78.5 (199)	3.5 (8.9)
Steer Cylinder	3.0 (7.6)	7.5 (19.05)	1.5 (3.8)
Lockout Cylinder (Oscillating Axle)	3.0 (7.6)	3.75 (9.5)	1.25 (3.2)
Leveling Jack Cylinder	3.0 (7.6)	18.75 (47.6)	2.0 (5.0)
Traversing Platform Cylinder	1.5 (3.8)	48 (121)	1.00 (2.5)

1.10 MAJOR COMPONENT WEIGHTS

Table 1-5. Major Component Weights

Component	Lb	Kg
Fixed Platform (180 cm x 426 cm).	1235	560
Platform Extension.	275	125
Arm Assembly - 400RTS - Includes Lift Cylinder.	7750	3515
Arm Assembly - 500RTS - Includes Lift Cylinder.	8699	3946
400RTS		
Chassis - Includes Pneumatic Tires.	5450	2472
Chassis - Includes Foam-Filled Tires.	6154	2791
500RTS		
Chassis - Includes Outriggers, and Pneumatic Tires.	6052	2745
Chassis - Includes Outriggers, and Foam-Filled Tires.	6756	3065

1.11 CRITICAL STABILITY WEIGHTS

⚠ WARNING

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

Table 1-6. Critical Stability Weights

Component	Lb	Kg
Tires (Balasted Only) 12X16.5	295	134
Engine (Ford)	525	238
Engine (Deutz)	600	272

SIZE	THD	BOLT DIA. (IN.)	THREAD STRESS AREA (SQ. IN.)	VALUES FOR ZINC PLATED BOLTS ONLY									UNPLATED CAP SCREWS		
				SAE GRADE 5 BOLTS & GRADE 2 NUTS					SAE GRADE 8 BOLTS & GRADE 8 NUTS					UNBRAKO 1960 SERIES SOCKET HEAD CAP SCREW	
				CLAMP LOAD (LB.)	TORQUE (DRY OR LOC. 263) NM	TORQUE (LUB.) NM	TORQUE (LOCTITE 262) NM	TORQUE (LOCTITE 242 OR 271) NM	CLAMP LOAD (LB.)	TORQUE (DRY OR LOC. 263) NM	TORQUE (LUB.) NM	TORQUE (LOCTITE 262) NM	TORQUE (LOCTITE 242 OR 271) NM	CLAMP LOAD (LB.)	TORQUE (as received) WITHOUT LOC-WEL PATCH NM	TORQUE (as received) WITH LOC-WEL PATCH NM
4	40	0.1120	0.00604	380	.8	.8	—	—	540	1.4	1.0	—	—	—	—	—
	48		0.00661	420	1.0	.8	—	—	600	1.5	1.0	—	—	—	—	—
6	32	0.1380	0.00909	580	1.8	1.4	—	—	820	2.6	2.0	—	—	—	—	—
	40		0.01015	610	2.0	1.6	—	—	920	2.8	2.2	—	—	—	—	—
8	32	0.1640	0.01400	900	3.4	2.4	—	—	1260	4.6	3.4	—	—	—	—	—
	36		0.01474	940	3.4	2.6	—	—	1320	5	3.6	—	—	—	—	—
10	24	0.1900	0.01750	1120	5	3.6	—	—	1580	7	5	—	—	—	—	—
	32		0.02000	1285	6	4	—	—	1800	8	6	—	—	—	—	—
1/4	20	0.2500	0.0318	2020	11	8	—	12	2860	16	12	—	18	3180	18	19
	28		0.0364	2320	14	10	—	15	3280	19	14	—	21	3640	19	20
5/16	18	0.3125	0.0524	3340	23	18	22	26	4720	34	24	30	41	5240	34	38
	24		0.0580	3700	26	19	23	28	5220	34	27	34	41	5800	37	41
3/8	16	0.3750	0.0775	4940	41	31	38	47	7000	61	47	54	68	7750	61	68
	24		0.0878	5600	47	34	43	54	7900	68	47	61	75	8780	68	75
7/16	14	0.4375	0.1063	6800	68	47	61	75	9550	95	75	85	108	10630	95	104
	20		0.1187	7550	75	54	68	81	10700	108	81	95	122	11870	102	111
1/2	13	0.5000	0.1419	9050	102	75	92	115	12750	149	108	130	163	14190	149	163
	20		0.1599	10700	122	88	108	136	14400	163	122	146	183	15990	156	172
9/16	12	0.5625	0.1820	11600	149	108	133	163	16400	203	149	188	224	18200	210	230
	18		0.2030	12950	163	122	148	183	18250	230	176	209	258	20300	224	247
5/8	11	0.6250	0.2260	14400	203	149	183	224	20350	298	230	244	325	22600	285	313
	18		0.2560	16300	230	176	207	258	23000	325	244	277	359	25600	298	328
3/4	10	0.7500	0.3340	21300	353	271	325	386	30100	515	380	408	569	33400	495	542
	16		0.3730	23800	407	298	363	447	33600	569	434	456	630	37300	542	597
7/8	9	0.8750	0.4620	29400	583	434	523	644	41600	813	624	658	895	46200	793	874
	14		0.5090	32400	637	475	576	705	45800	895	678	724	983	50900	861	949
1	8	1.000	0.6060	38600	868	651	785	915	51500	1220	922	931	1342	60600	1173	1288
	12		0.6630	42200	949	719	858	997	59700	1356	1003	1079	1491	66300	1241	1356
1-1/8	7	1.1250	0.7630	42300	1085	813	968	1139	68700	1735	1302	1396	1898	76300	1681	1851
	12		0.8560	47500	1193	895	1087	1254	77000	1952	1464	1566	2135	85600	1871	2061
1-1/4	7	1.2500	0.9690	53800	1518	1139	1368	1593	87200	2468	1844	1970	2712	96900	2373	2610
	12		1.0730	59600	1681	1247	1516	1763	96600	2712	2034	2183	2983	107300	2549	2807
1-1/2	6	1.500	1.1550	64100	1979	1491	1792	2068	104000	3227	2413	2586	3559	115500	3145	3457
	12		1.3150	73000	2278	1708	2042	2373	118100	3688	2766	2935	4067	131500	3308	3640
1-1/2	6	1.500	1.4050	78000	2630	1979	2379	2745	126500	4284	3200	3430	4711	140500	4122	4535
	12		1.5800	87700	2983	2224	2676	3118	142200	4827	3606	3856	5322	158000	4433	4881

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

SAE GRADE 5

SAE GRADE 8

Figure 1-3. Torque Chart

SECTION 2. PROCEDURES

2.1 GENERAL

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

⚠ CAUTION

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

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

2.2 SERVICING AND MAINTENANCE GUIDELINES

General

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

Safety and Workmanship

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

Cleanliness

1. The most important single item in preserving the long service life of a machine is to keep dirt and foreign materials out of the vital components. Precautions have been taken to safeguard against this. Shields, covers, seals, and filters are provided to keep 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°.
3. If a part resists removal, check to see whether all nuts, bolts, cables, brackets, wiring, etc., have been removed and that no adjacent parts are interfering.

Component Disassembly and Reassembly

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

Pressure-Fit Parts

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

Bearings

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

4. Lubricate new or used serviceable bearings before installation. When pressing a bearing into a retainer or bore, apply pressure to the outer race. If the bearing is to be installed on a shaft, apply pressure to the inner race.

Gaskets

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

Bolt Usage and Torque Application

1. Use bolts of proper length. A bolt which is too long will bottom before the head is tight against its related part. If a bolt is too short, there will not be enough thread area to engage and hold the part properly. When replacing bolts, use only those having the same specifications of the original, or one which is equivalent.

2. Unless specific torque requirements are given within the text, standard torque values should be used on heat-treated bolts, studs, and steel nuts, in accordance with recommended shop practices.

Hydraulic Lines and Electrical Wiring

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

Hydraulic System

1. Disassemble and reassemble parts on clean work surface. Clean all metal parts with non-flammable cleaning solvent. Lubricate components, as required, to aid assembly.

2. Disassemble and reassemble parts on clean work surface. Clean all metal parts with non-flammable cleaning solvent. Lubricate components, as required, to aid assembly.

Lubrication

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

Batteries

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

Lubrication and Servicing

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

2.3 LUBRICATION INFORMATION

Hydraulic System

1. The primary enemy of a hydraulic system is contamination. Contaminants enter the system by various means, e.g., 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. Always examine filters for evidence of metal particles.

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

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

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

Hydraulic Oil

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

2. JLG recommends Mobil 424 hydraulic oil, which has an SAE viscosity of 10W-20 and a viscosity index of 152.

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

3. The only exception to the above is to drain and fill the system with Mobil DTE 11 oil or its equivalent. This will allow start up at temperatures down to-29 ° C (-20 ° F). However, use of this oil will give poor performance at temperatures above 49° C (120° F). Systems using DTE 11 oil should not be operated at temperatures above 94° C (200° F). under any condition.

Changing Hydraulic Oil

1. Use of any of the recommended crankcase or hydraulic oils eliminates the need for changing the oil on a regular basis. However, filter elements must be changed after the first 40 hours of operation and every 250 hours thereafter. If it is necessary to change the oil, use only those oils meeting or exceeding the specifications appearing in this manual. If unable to obtain the same type of oil supplied with the machine, consult local supplier for assistance in selecting the proper equivalent. Avoid mixing petroleum and synthetic base oils. JLG Industries recommends changing the hydraulic oil annually.

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

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

Lubrication Specifications

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

2.4 CYLINDERS - THEORY OF OPERATION

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

NOTE: *The Lift cylinder is a single acting cylinder which take hydraulic pressure to extend and gravity to retract.*

A holding valve is used in the Lift, and Leveling Jack circuit to prevent retraction of the cylinder rod should a hydraulic line rupture or a leak develop between the cylinder and its related control valve.

2.5 VALVES - THEORY OF OPERATION

Solenoid Control Valves(Bang Bang)

Control valves used are four-way three-position solenoid valves of the sliding spool design. When a circuit is activated and the control valve solenoid energizes, the spool is shifted and the corresponding work port opens to permit oil flow to the component in the selected circuit, with the opposite work port opening to reservoir. Once the circuit is deactivated (control returned to neutral), the valve spool returns to neutral (center) and oil flow is then directed through the valve body and returns to reservoir. A typical control valve consists of the valve body, sliding spool, and two solenoid assemblies. The spool is machine fitted in the bore of the valve body. Lands on the spool divide the bore into various chambers, which, when the spool is shifted, align with corresponding ports in the valve body open to common flow. At the same time other ports would be blocked to flow. The spool is spring-loaded to center position, therefore when the control is released, the spool automatically returns to neutral, prohibiting any flow through the circuit.

Relief Valves

Main relief valves are installed at various points within the hydraulic system to protect associated systems and components against excessive pressure. Excessive pressure can be developed when a cylinder reaches its limit of travel and the flow of pressurized fluid continues from the system control. The relief valve provides an alternate path for the continuing flow from the pump, thus preventing rupture of the cylinder, hydraulic line or fitting. Complete failure of the system pump is also avoided by relieving circuit pressure. The relief valve is installed in the circuit

between the pump outlet (pressure line) and the cylinder of the circuit, generally as an integral part of the system valve bank. Relief pressures are set slightly higher than the load requirement, with the valve diverting excess pump delivery back to the reservoir when operating pressure of the component is reached.

Crossover Relief Valves

Crossover relief valves are used in circuits where the actuator requires an operating pressure lower than that supplied to the system. When the circuit is activated and the required pressure at the actuator is developed, the crossover relief diverts excess pump flow to the reservoir. Individual, integral reliefs are provided for each side of the circuit.

2.6 COMPONENT FUNCTIONAL DESCRIPTION

Piston Hydraulic Pump

The Sundstrand piston hydraulic pump is attached to and driven by the gasoline or diesel engine. The pump is a 45.9 cm^3 (2.8 in^3) displacement piston pump that powers the drive motors.

Gear Hydraulic Pump

The John Barnes gear pump is piggy-backed to the piston pump, and operates all machine functions except drive. The gear pump has a displacement of10.5 cm^3 (0.6 in^3).

Manual Descent Valve (If Equipped)

The manual descent valve is located on top of the holding valve on the lift cylinder. The holding valve is a normally closed solenoid valve, and holds the platform in place when raised. When activated, the valve opens to permit lift down. The holding valve is connected to the manual descent valve, which is connected to a cable which, when pulled, manually opens the lift down port of the valve and allows the platform to be lowered in the event hydraulic power is lost.

2.7 SLIDING WEAR PADS

The original thickness of the sliding pads is 15.2 cm (6.0 in). Replace sliding pads when worn to 14.5 cm (5.7 in).

2.8 PUMP COUPLING LUBRICATION

To insure proper operation and a long service life for the Hayes pump coupling, it is necessary to lubricate the splines of the coupling any time the coupling is disassembled or replaced. Lubricate the splines with Texaco Code 1912 Pump Coupling Grease ONLY. No other lubricant is recommended.

2.9 CYLINDER CHECKING PROCEDURES

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

Cylinder w/o Counterbalance Valves - Steer Cylinder, Platform Ext. Cylinder, Axle Lockout Cylinder (If Equipped)

NOTICE

OPERATE FUNCTIONS FROM GROUND CONTROL STATION ONLY.

1. Using all applicable safety precautions, activate hydraulic system and fully extend cylinder to be checked. Shut down hydraulic system.
2. Carefully disconnect hydraulic hose from retract port of cylinder. There will be initial weeping of hydraulic fluid which can be caught in a suitable container. After the initial discharge, there should be no further leakage from the retract port.
3. Activate hydraulic system and activate cylinder extend function. Check retract port for leakage.
4. If cylinder leakage is 6-8 drops per minute or more, piston seals are defective and must be replaced. If cylinder retract port leakage is less than 6-8 drops per minute, carefully reconnect hose to retract port and retract cylinder.
5. With cylinder fully retracted, shut down hydraulic system and carefully disconnect hydraulic hose from cylinder extend port.
6. Activate motor and activate cylinder retract function. Check extend port for leakage.
7. If cylinder leakage is 6-8 drops per minute or more, piston seals are defective and must be replaced. If extend port leakage is less than 6-8 drops per minute, carefully reconnect hose to extend port, then activate cylinder through one complete cycle and check for leaks.

Cylinders w/Single Counterbalance Valves - Lift Cylinder, Leveling Jacks (If Equipped)

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

⚠ WARNING

WHEN WORKING ON THE LIFT CYLINDER, RAISE THE PLATFORM COMPLETELY AND SUPPORT THE PLATFORM USING A SUITABLE OVERHEAD LIFTING DEVICE.

2. Raise platform completely and place a suitable overhead lifting device or prop approximately 2.5 cm (1 in) below the platform.

NOTE: *Step (3) applies to the leveling jacks only.*

3. Fully extend leveling jacks to check.
4. Shut down hydraulic system and allow machine to sit for 10-15 minutes. Carefully remove hydraulic hoses from cylinder port block.
5. There will be initial weeping of hydraulic fluid, which can be caught in a suitable container. After the initial discharge, there should not be any further leakage from the ports. If leakage continues at a rate of 6-8 drops per minute or more, cylinder repairs must be made. If the retract port is leaking, the piston seals are defective and must be replaced. If the extend port is leaking, the counterbalance valve is defective and must be replaced.
6. If no repairs are necessary or when repairs have been made, carefully reconnect hydraulic hoses to the appropriate ports.
7. Remove lifting device from platform, activate hydraulic system and run cylinder through one complete cycle to check for leaks.

2.10 CYLINDER REMOVAL AND INSTALLATION

Lift Cylinder Removal

1. Place the machine on a flat and level surface. Start the engine/motor and raise the platform. Shut down the engine/motor and attach a suitable support device to the platform.
2. Remove the locknut, bolts, flatwashers and keeper shaft securing the cylinder rod attach pin to the upper inner arm assembly. Using a suitable brass drift, drive out the rod end attach pin from the arm assembly.
3. Retract the lift cylinder rod completely.
4. Tag and disconnect, then cap the lift cylinder hydraulic lines and ports.
5. Remove the bolts, lockwashers, and flatwashers securing the barrel end attach pin to the lower arm assembly. Using a suitable brass drift, drive out the barrel end attach pin from the arm assembly.
6. Carefully remove the cylinder from the Sizzor lift and place in a suitable work area.

Lift Cylinder Installation

1. Install lift cylinder in place using suitable slings or supports, aligning barrel end attach pin mounting holes on lower arm assembly.
2. Using a suitable drift, drive the barrel end attach pin through the mounting holes in the lift cylinder and the lower arm assembly. Secure in place with the bolts, flatwashers, and lockwashers.
3. Remove cylinder port plugs and hydraulic line caps and correctly attach lines to cylinder ports.
4. Extend the cylinder rod until the attach pin hole aligns with those in the upper arm assembly. Using a suitable drift, drive the cylinder rod attach pin through the aligned holes. Secure the pin in place with the bolts, lockwashers, and flatwashers.
5. Lower platform to stowed position and shut down motor/engine. Check hydraulic fluid level and adjust accordingly.

2.11 CYLINDER REPAIR

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

Disassembly

NOTICE

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

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

⚠ WARNING

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

2. Operate the hydraulic power source and extend the cylinder. Shut down and disconnect the power source. Adequately support the cylinder rod, if applicable.

⚠ WARNING

CYLINDERS WITH DOUBLE HOLDING VALVES. BEFORE REMOVING HOLDING VALVES CRACK BLEEDER TO RELEASE PRESSURE.

3. If applicable, remove the cartridge-type holding valve and fittings from the cylinder port block. Discard o-rings.
4. Place the cylinder barrel into a suitable holding fixture. Tap around outside of cylinder head retainer with a suitable hammer to shatter loctite.
5. Using a suitable spanner wrench, loosen the cylinder head retainer, if applicable, and/or cylinder head gland, and remove from cylinder barrel.

NOTE: *Steer Cylinder has two head retainers at each end of cylinder.*

Platform Ext. Cylinder has a snap ring in barrel end of cylinder. Remove snap ring before withdraw of the rod.

6. Attach a suitable pulling device to the cylinder rod port block end or cylinder rod end, as applicable.

⚠ WARNING

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

7. With the barrel clamped securely, apply pressure to the rod pulling device and carefully withdraw the complete rod assembly from the cylinder barrel.
8. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.

NOTE: *On the Steer Cylinder, the rod and piston are all one unit.*

9. Remove the setscrew(s), if applicable, and nut which attach the piston to the rod, and remove the piston. Discard nylon point set screws.
10. Remove the piston rings.
11. Remove and discard the piston o-rings, seal rings, and backup rings.
12. Remove the set screw, if applicable, piston spacer, and wear ring, if applicable, from the rod.
13. Remove the rod from the holding fixture. Remove the cylinder head gland and retainer, if applicable. Discard the o-rings, back-up rings, rod seals, and wiper seals.

Cleaning and Inspection

1. Clean all parts thoroughly in an approved cleaning solvent.
2. Inspect the cylinder rod for scoring, tapering, ovality, or other damage. If necessary, dress rod with Scotch Brite or equivalent. Replace rod if necessary.
3. Inspect threaded portion of rod for excessive damage. Dress threads as necessary.
4. Inspect inner surface of cylinder barrel tube for scoring or other damage. Check inside diameter for tapering or ovality. Replace if necessary.
5. Inspect threaded portion of barrel for damage. Dress threads as necessary.
6. Inspect piston surface for damage and scoring and for distortion. Dress piston surface or replace piston as necessary.
7. Inspect seal and o-ring grooves in piston for burrs and sharp edges. Dress applicable surfaces as necessary.
8. Inspect cylinder head inside diameter for scoring or other damage and for ovality and tapering. Replace as necessary.
9. Inspect seal and o-ring grooves in head for burrs and sharp edges. Dress applicable surfaces as necessary.
10. If applicable, inspect cylinder head retainer or end cap for surface or thread damage. Repair or replace as necessary.
11. Inspect cylinder head outside diameter for scoring or other damage and ovality and tapering. Replace as necessary.
12. If applicable, inspect thread ring for scoring or other damage. Dress threads or applicable surfaces as necessary.
13. If applicable, inspect rod and barrel bushings for signs of correct lubrication and excessive wear. Replace as necessary.
14. Inspect travel limiting collar or spacer for burrs and sharp edges. If necessary, dress inside diameter surface with Scotch Brite or equivalent.
15. If applicable, inspect port block fittings and holding valve. Replace as necessary.
16. Inspect the oil ports for blockage or the presence of dirt or other foreign material. Repair as necessary.

17. If applicable, inspect piston rings for cracks or other damage. Replace as necessary.

Assembly

NOTE: *Prior to cylinder assembly, ensure that the proper cylinder seal kit is used. Refer to the Illustrated Parts manual.*

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

NOTICE

WHEN INSTALLING NEW POLY-PAK TYPE PISTON SEALS (AXLE LOCKOUT CYLINDER), ENSURE SEALS ARE INSTALLED PROPERLY. REFER TO FIGURE 2-1 FOR CORRECT SEAL ORIENTATION. IMPROPER SEAL INSTALLATION COULD RESULT IN CYLINDER LEAKAGE AND IMPROPER CYLINDER OPERATION.

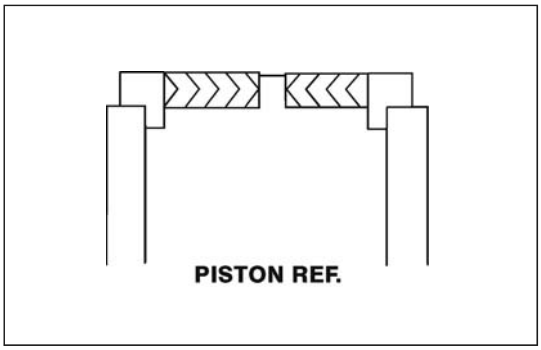


Figure 2-1. Poly-Pak Seal Installation

1. Place a new wiper seal and rod seal into the applicable cylinder head gland grooves.
2. Carefully install the head gland on the rod, ensuring that the wiper and rod seals are not damaged or dislodged. Push the head along the rod to the rod end, as applicable.
3. Carefully slide the piston spacer on the rod. If applicable, align the oil holes in the rod and the spacer. Secure the spacer, if applicable.
4. If applicable, correctly place a new o-ring and back-up rings in the inner piston diameter groove.
5. Carefully place the piston on the cylinder rod, ensuring that the o-ring and back-up rings are not damaged or dislodged.
6. Using suitable protection, clamp the cylinder rod in a vise or similar holding fixture as close to the piston as possible.

Table 2-1. Cylinder Piston Nut Torque Specifications

Description	Nut Torque Value	Setscrew torque Value
Lift Cylinder	400 ft lb (542 Nm)	100 in lb (12 Nm)
Lockout Cylinder	N/A	N/A
Level Cylinder	400 ft lb (542 Nm)	100 in lb (12 Nm)
Platform Ext. Cylinder	N/A	N/A
Steer Cylinder	N/A	N/A

Table 2-2. Holding Valve Torque Specifications

Description	Torque Value	
Sun - 7/8 hex M20 x 1.5 thds	30 - 35 ft lb	41 - 48 Nm
Sun - 1-1/8 hex 1 - 14 UNS thds	45 - 50 ft lb	61 - 68 Nm
Sun - 1-1/4 hex M36 x 2 thds	150 - 153 ft lb	204 - 207 Nm
Racine - 1-1/8 hex 1-1/16 - 12 thds	50 - 55 ft lb	68 - 75 Nm
Racine - 1-3/8 hex 1-3/16 - 12 thds	75 - 80 ft lb	102 - 109 Nm
Racine - 1-7/8 hex 1-5/8 - 12 thds	100 - 110 ft lb	136 - 149 Nm

7. Push the piston onto the rod until it abuts the spacer end, apply locktite # 242 and install the attaching nut. Refer to Table 2-1, Cylinder Piston Nut Torque Specifications.

NOTE: *On the Steer Cylinder, the rod and piston are all one unit.*

8. Prior to setscrew installation spot drill rod before installing the setscrew(s) which secure the piston attaching nut to the diameter groove.
9. Remove the cylinder rod from the holding fixture.
10. Place new o-rings and seals in the applicable outside diameter grooves of both the piston and the cylinder head.

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

NOTICE

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

12. With barrel clamped securely, and while adequately supporting the rod, insert the piston end into the barrel cylinder. Ensure that the piston loading o-ring and seal ring are not damaged or dislodged.
13. Continue pushing the rod into the barrel until the cylinder head gland can be inserted into the barrel cylinder.
14. If applicable, secure the cylinder head retainer using a suitable spanner type wrench.
15. After the cylinder has been reassembled, the rod should be pushed all the way in (fully retracted) prior to the reinstallation of any holding valve or valves.
16. If applicable, install the cartridge-type holding valve and fittings in the port block using new o-rings as applicable. Refer to Table 2-2, Holding Valve Torque Specifications.

2.12 TILT ALARM SWITCH

NOTE: *The machine may be equipped with a tilt alarm switch (sensor), optional on 400RTS, which is factory set to activate at 5° on the 400RTS and 3° on the 500RTS that will sound an alarm and illuminate a warning light on the platform control console. Consult factory for tilt sensor adjustment. The only field adjustment necessary is leveling the switch on the spring loaded studs.*

⚠ CAUTION

PERFORM TILT ALARM SWITCH LEVELING PROCEDURE A MINIMUM OF EVERY SIX MONTHS TO ENSURE PROPER OPERATION AND ADJUSTMENT OF SWITCH.

Manual Adjustment

1. Park the machine on a flat, level surface and ensure machine is level.

NOTE: *Ensure switch mounting bracket is level and securely attached.*

2. Level the base of the indicator by tightening the three flange nuts. Tighten each nut until bubble in the indicator is in the center of indicator.
3. Individually push down on one corner at a time; there should be enough travel to cause the switch to trip. If the switch does not trip in all three tests, the flange nuts have been tightened too far. Loosen the nuts and repeat steps (2) and (3).

2.13 PRESSURE SETTING PROCEDURES - (400RTS)

Rexroth/Hydraforce Valve

1. Install pressure gauge at port G on Rexroth/ Hydraforce Valve.
2. Adjust both steer section crossover reliefs all the way in.
3. Adjust main relief cartridge out several turns.
4. Activate engine and allow hydraulic system to come up to operating temperature.
5. Bottom out steer function. Adjust main relief to 156 bar (2250 psi).
6. Bottom out Front Steer Right and Steer Left functions and adjust each Steer Crossover Relief to 103 bar (1500 psi).
7. Bottom out rear steer right and steer left functions and adjust each steer crossover relief to 103 bar (1500 psi).
8. Bottom out platform ext. extended functions and adjust each ext. crossover relief to 83 bar (1200 psi).
9. De-energize platform ext. function, shut down motor, and disconnect pressure gauge.

2.14 PRESSURE SETTING PROCEDURES - (500RTS)

Rexroth/Hydraforce Valve

1. Install pressure gauge at port G on Rexroth/ Hydraforce Valve.
2. Adjust both steer section crossover reliefs all the way in.
3. Adjust main relief cartridge out several turns.
4. Activate engine and allow hydraulic system to come up to operating temperature.
5. Bottom out steer function. Adjust main relief to 193 bar (2800 psi).
6. Bottom out front steer right and steer left functions and adjust each steer crossover relief to 103 bar (1500 psi).

7. Bottom out Rear Steer Right and Steer Left functions and adjust each Steer Crossover Relief to 103 bar (1500 psi).
8. Bottom out Platform Ext. Extended functions and adjust each Ext. Crossover Relief to 83 bar (1200 psi).
9. De-energize Platform Ext. function, shut down motor, and disconnect pressure gauge.

2.15 DRIVE PUMP START-UP PROCEDURE

NOTICE

THE FOLLOWING PROCEDURE SHOULD ALWAYS BE PERFORMED WHEN STARTING A NEW PUMP OR WHEN RESTARTING AN INSTALLATION IN WHICH EITHER THE PUMP OR MOTOR HAVE BEEN REMOVED FROM THE SYSTEM.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, DRIVE FUNCTION DISCONNECTED, ETC.) WHILE PERFORMING THE PROCEDURE IN ORDER TO PREVENT INJURY TO TECHNICIAN AND OTHER PERSONNEL. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING THE MACHINE.

1. Prior to installing pump and/or motor, inspect unit(s) for damage incurred during shipping and handling. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with hydraulic fluid.
2. Fill reservoir with recommended hydraulic fluid, which should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to components, which may result in unexpected machine movement.
3. The inlet line leading from the reservoir to the pump should be filled prior to start-up. Check inlet line for properly tightened fittings and make sure it is free of restrictions and air leaks.
4. Be certain to fill pump and/or motor housing with clean hydraulic fluid prior to start-up. Fill housing by pouring filtered oil into upper case drain port.
5. Install a 0 to 50 psi (0 to 35 bar) pressure gauge in the charge pressure gauge port to monitor charge pressure during start-up.
6. It is recommended that the external control input signal electrical connections be disconnected at the pump control until after initial start-up. This will allow the pump to remain in its neutral position.
7. Jog or slowly rotate prime mover until charge pressure starts to rise. Start prime mover and run at the lowest possible RPM until charge pressure has been established. Excess air may be bled from high pressure lines through high pressure gauge ports

⚠ WARNING

DO NOT START PRIME MOVER UNLESS PUMP IS IN NEUTRAL POSITION (0 DEGREES SWASHPLATE ANGLE). TAKE PRECAUTIONS TO PREVENT MACHINE MOVEMENT IN CASE PUMP IS ACTUATED DURING INITIAL START-UP.

8. Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be approximately 15.5 bar (22 psi) minimum. If charge pressure is incorrect, shut down and determine cause for improper pressure.

⚠ WARNING

INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATORS ABILITY TO CONTROL THE MACHINE.

9. Shut down prime mover and connect external control input signal. start prime mover, checking to be certain pump remains in neutral. with prime mover at normal operating speed, slowly check for forward and reverse machine operation.
10. Charge pressure should remain at 15.5 bar - 16.9 bar (22 psi - 24 psi) minimum during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.
11. Shut down prime mover, remove gauges, and plug ports. Check reservoir level and add fluid if necessary.

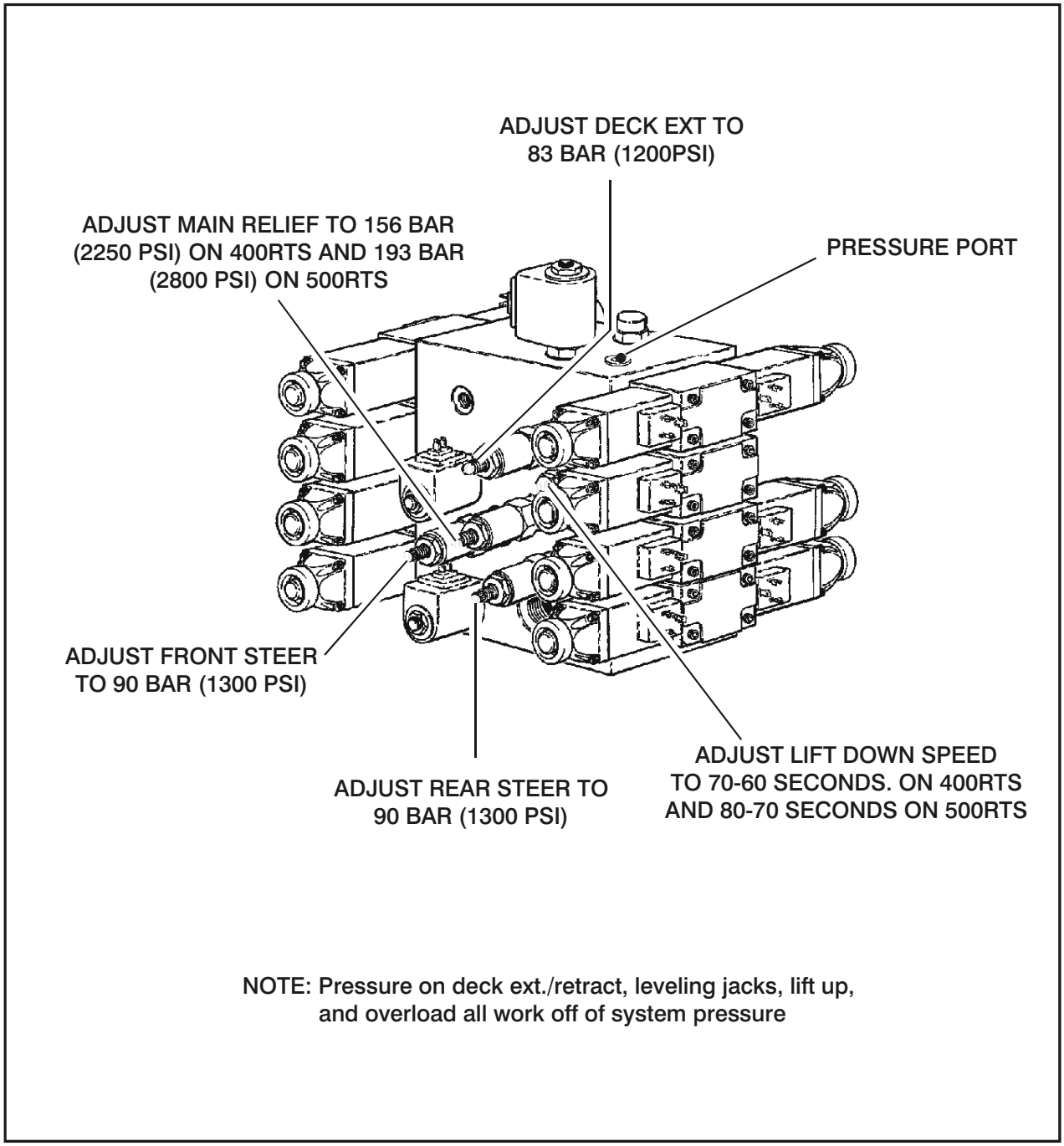


Figure 2-2. Pressure Adjustment Locations

2.16 THROTTLE CHECKS AND ADJUSTMENTS - FORD ENGINE

Throttle Checks

1. Check that anti-dieseling solenoid is operating. If solenoid is operating, an audible click should be heard when the ignition is switched ON and OFF.
2. Check throttle linkage for smooth operation by rotating throttle lever by hand to full throttle position, then slowly back to idle position, feeling closely for sticking or binding.

Throttle Adjustments - In Sequence

NOTE: *Steps (1) and (2) are preliminary settings.*

1. Remove cover from controller. With engine shut down, turn gain CCW as far as it will go, then turn screw slot CW until vertical. Gain may need fine tuning.
2. Turn droop CCW as far as it will go. Then turn screw slot CW until vertical. Droop should not need further adjustment.
3. Turn idle adjusting screw on carburetor CCW all the way out CCW until there is a gap between the screw and stop plate.
4. Start engine and allow it to come up to operating temperature.
5. Remove wire from no. 7 connector on controller, which will switch engine speed to HIGH. Adjust speed screw until engine runs at 3000 rpm.

NOTE: *If engine surges, turn gain screw one or two degrees CCW until surging stops, no more.*

6. Replace wire no. 7 connector on controller, which will return engine to LOW speed. Adjust remote until engine runs at 2200 rpm.
7. Recheck speeds. When satisfied, apply a drop of fingernail polish to all trimpot screws. Replace cover.

NOTE: *Start with large end of hub facing up, large end of spindle facing down*

2.17 THROTTLE CHECKS AND ADJUSTMENTS - DEUTZ F3L1011

NOTE: *Never run fuel tank dry. Diesel engines cannot be restarted after running out of fuel until fuel system has been air-vented or bled of air. (See Deutz Operators Manual for procedure).*

1. Disconnect actuator cable from the throttle lever. With the aid of an assistant, start the engine and allow it to come up to operating temperature. Adjust throttle lever stop until engine runs at 2000 rpm. Shut down engine. Reattach actuator cable to throttle lever, making sure that low engine setting remains the same. Restart engine and check settings. If necessary, adjust slide pin to contact low engine limit switch at 2000 rpm. Shut down engine.
2. With the aid of an assistant, start engine from platform and allow it to come up to operating temperature. Disconnect modular dump valve wire. Activate HIGH ENGINE switch. Activate and Drive Controller and hold it in full drive position. Adjust slide pin to contact high engine limit switch at 3000 rpm. Shut off all switches and controllers. Reconnect modular control dump valve wire.

NOTE: *Actuator cable travel must stop slightly before lever makes contact with throttle lever stop. Failure to do so will burn out actuator.*

⚠ CAUTION

WEAR SAFETY GLASSES WHEN PERFORMING THE FOLLOWINGSTEP . BE AWARE THAT SPRING AND SPACERS COMPRESSED BY RETAINING RING MAY POP SUDDENLY OFF SHAFT WHEN RETAINING RING IS REMOVED.USING RETAINING RING PLIERS, REMOVE RETAINING RING FROM GROOVE ON INPUT SHAFT.

1. Remove one spacer, one spring, and other spacer from input shaft.
2. Remove thrust washer from around spindle.
3. Lift internal gear out of hub.

⚠ CAUTION

BEWARE OF SHARP EDGES IN COUNTERBORE WHEN REMOVING O-RING.

4. Remove o-ring from counterbore in hub. Discard o-ring.
5. If necessary, disassemble hub-spindle assembly as follows:

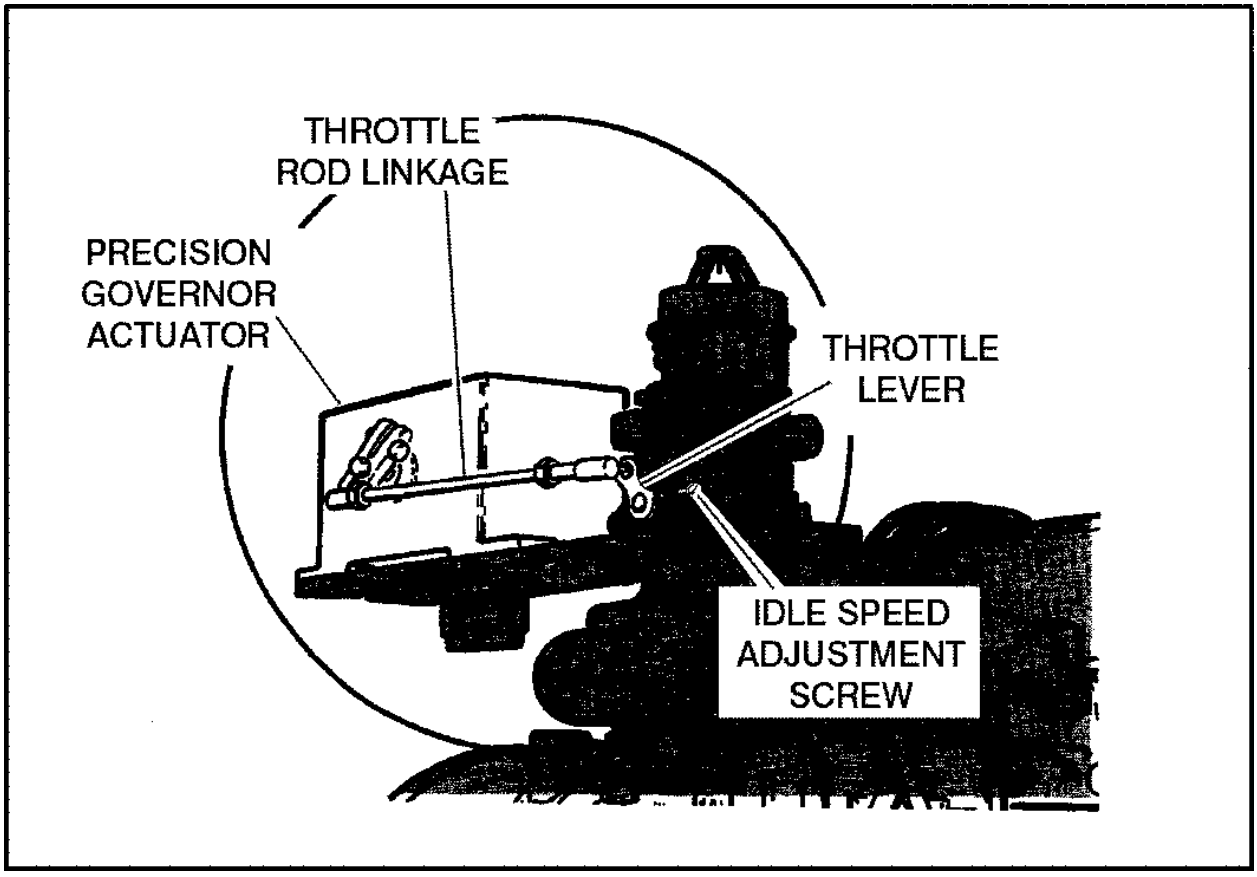


Figure 2-3. Throttle Checks and Adjustments - Ford VSG 413

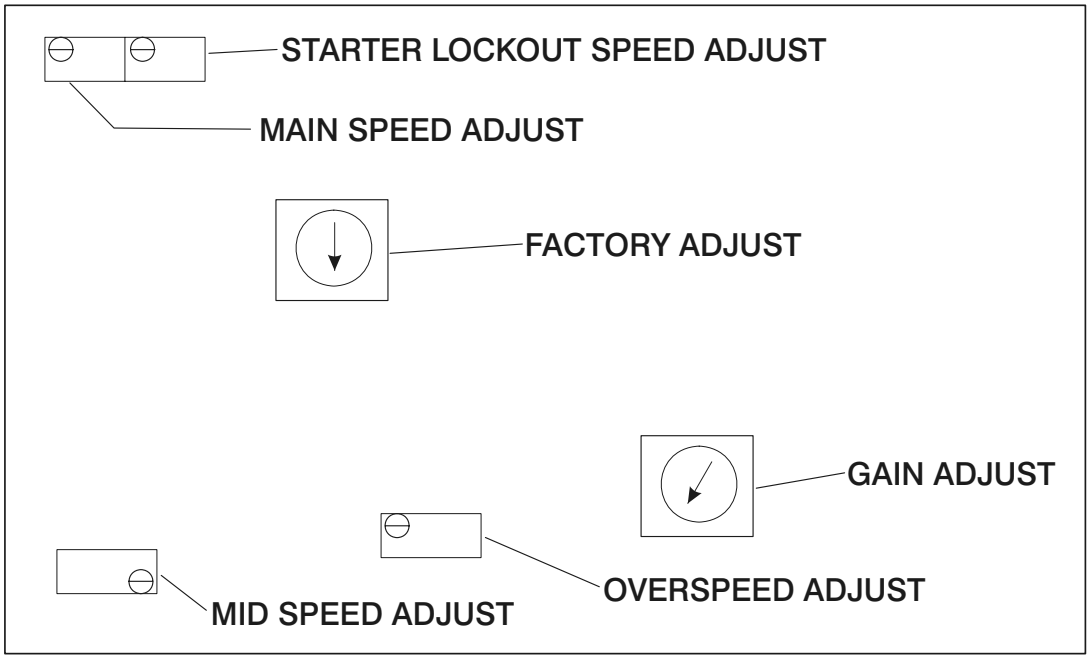


Figure 2-4. Precision Governor Adjustments

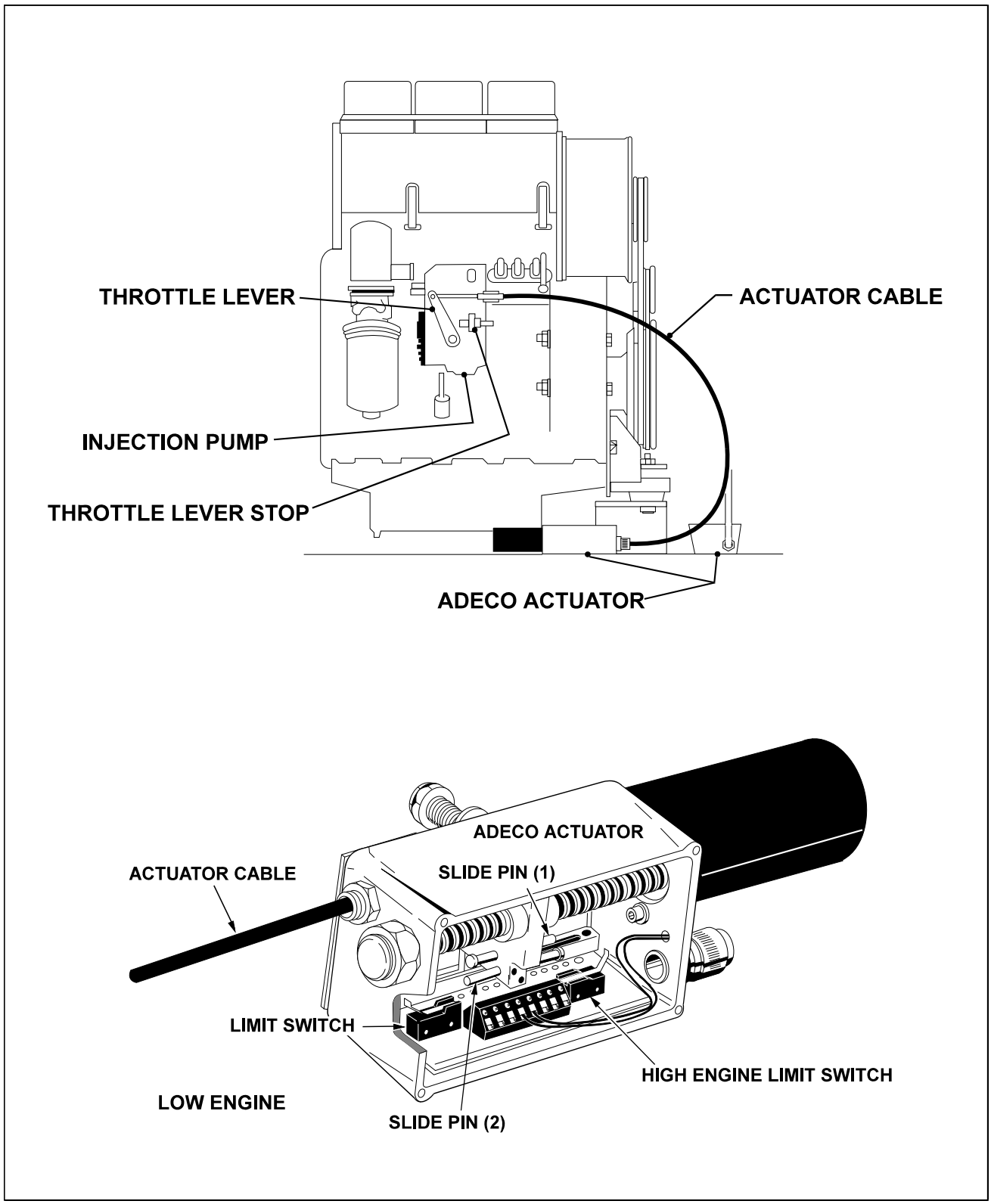


Figure 2-5. Throttle Adjustments, Deutz F3L1011

2.18 HYDRAULIC COMPONENT START-UP PROCEDURES AND RECOMMENDATIONS

From a hydrostatic component standpoint, the goal at system start up is to put into functional operation, the hydrostatic system in such a way as to preserve the designed life span of the system. The following start-up procedure should be adhered to whenever a new pump or motor is initially installed into a machine, or a system is restarted after either a pump or motor has been removed and/or replaced.

⚠ WARNING

THE FOLLOWING PROCEDURE MAY REQUIRE THE MACHINE TO BE DISABLED (WHEELS RAISED OFF THE GROUND, WORK FUNCTIONS DISCONNECTED, ETC.) WHILE PERFORMING THE PROCEDURE IN ORDER TO PREVENT INJURY. TAKE NECESSARY SAFETY PRECAUTIONS BEFORE MOVING THE VEHICLE/MACHINE.

Prior to installing the pump and/or motor, inspect the unit(s) for damage that may have been incurred during shipping and handling. Make certain that all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

NOTE: *If a pump or motor is being replaced due to internal damage, the remaining units (pump or motors) need to be inspected for damage and contamination, and the entire hydraulic system will need to be flushed and the fluid replaced. Failure to do so may cause considerable damage to the entire system.*

The inlet line leading from the reservoir to the pump must be filled prior to start-up. Check the inlet line for property tightened fittings and make sure it is free of restrictions and air leaks.

NOTE: *In most cases, the reservoir is above the pump inlet so that the pressure head created by the higher oil level helps to keep the inlet pressures within an acceptable range and prevent high vacuum levels. However, due to hose routing or low reservoir locations, there may be air trapped within this line. It is important to assure that the air is bled from this line. This can be accomplished by loosening the hose at the fitting closest the pump. When oil begins to flow, the line is full, the air has been purged, and the fitting can be retightened to its specified torque. If the tank needs to be pressurized in order to start the flow of oil, a vacuum reading should be taken at the inlet of the pump during operation in order to verify that the pump is not being asked to draw an inlet vacuum higher than it is capable of.*

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the upper case drain port.

NOTE: *It is highly recommended to use the highest possible case drain port, this ensures that the housing contains as much oil as possible and offers the greatest amount of lubrication to the internal components.*

NOTE: *In initial start-up conditions, it may be convenient to fill the housing, just prior to installing the case drain line. Component, (especially motor), location may be such that access to the case drain port after installation is not realistic.*

NOTE: *Make certain that the oil being used to fill the component housing is as clean as possible, and store the fill container in such a way as to prevent it from becoming contaminated.*

Install a 60 bar (or 1000 psi) pressure gauge in the charge pressure gauge port in order to monitor the charge pressure during start-up.

It is recommended that the external control input signal, (electrical connections for EDC), be disconnected at the pump control until after initial start-up. This will ensure that the pump remains in its neutral position.

⚠ WARNING

DO NOT START THE ENGINE UNLESS PUMP IS IN THE NEUTRAL POSITION (0 DEGREES SWASHPLATE ANGLE). TAKE PRECAUTIONS TO PREVENT MACHINE MOVEMENT IN CASE PUMP IS ACTUATED DURING INITIAL START-UP.

"Jog" or slowly rotate the engine until charge pressure starts to rise. Start the engine and run at the lowest possible RPM until charge pressure has been established. Excess air should be bled from the system lines as close to the motors as possible.

NOTE: *With the engine on low idle, "crack", (loosen-don't remove), the system lines at the motor(s). Continue to run the engine at low idle and tighten the system lines as soon as oil is observed to leak from them. When oil is observed to "leak" at the motor the line is full, the air has been purged, and the system hoses should be retightened to their specified torque.*

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code. If charge pressure is inadequate, shut down and determine the cause for improper pressure.

⚠ WARNING

INADEQUATE CHARGE PRESSURE WILL AFFECT THE OPERATOR' S ABILITY TO CONTROL THE MACHINE.

Shut down the engine and connect the external control input signal. Also reconnect the machine function(s), if disconnected earlier. Start the engine, checking to be certain the pump remains in neutral. With the engine at normal operating RPM, slowly check for forward and reverse machine operation.

Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

Shut down engine, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

The machine is now ready for operation.

2.19 OSCILLATING AXLE LOCKOUT CYLINDER BLEEDING PROCEDURE - (IF EQUIPPED)

NOTE: *Ensure platform is fully lowered to open the cam valve prior to beginning oscillating axle lockout cylinder bleeding procedure.*

NOTE: *Making sure that machine is on a level surface and rear wheels are blocked then disengage drive hubs. Optional 4WD all drive hubs must be unlocked.*

1. Making sure that machine is on a level surface and rear wheels are blocked then disengage drive hubs. Optional 4WD all drive hubs must be disengaged.
2. Activate machine hydraulic system from platform control station.
3. Start the engine and place engine speed and drive speed control switches to their respective low positions.
4. Depress the enable switch and activate drive controller to forward position.
5. Using a suitable lifting equipment lift front of machine up and place a 20 cm (8 in) high block under left front wheel.
6. With the drive controller activated and engine at idle, crack open both fittings at lockout cylinder, one at a time, and close when all air is dissipated (bled).
7. Using a suitable lifting equipment lift front of machine and remove the 20 cm (8 in) block.
8. Transfer the 20 cm (8 in) high block to right front wheel and repeat steps 1 through 6, substituting the word right for left in step 5.

NOTE: *After lockout cylinders are bled be sure to engage drive hubs before removing stop block from rear wheels.*

9. To check lockout cylinder after bleeding, perform the LOCKOUT CYLINDER CHECK in paragraph 2-19.

2.20 LOCKOUT CYLINDER CHECK

NOTE: *Ensure platform is completely lowered prior to beginning lockout cylinder check.*

1. Place a 20 cm (8 in) high block with ascension ramp in front of left front wheel.
2. Activate machine hydraulic system from platform control station.
3. Place engine speed and drive speed control switches to their respective low positions.
4. Place drive controller to forward position and carefully drive machine up ascension ramp until left front wheel is on top of the 20 cm (8 in) high block.
5. Raise machine platform approximately 0.6 m (2 ft); ensure lockout cylinder cam valve is free of sizzor arm trip bar.
6. Place drive controller to reverse position and carefully drive machine off block and ramp.
7. Have an assistant check to see that left front wheel remains locked in position off the ground.
8. Lower machine platform; lockout cylinder should then release the wheel and allow it to rest on the ground.
9. Transfer the 20 cm (8 in) high block to front of right front wheel and repeat steps 1 through 8, substituting the word right for left in steps 1, 4 and 7.
10. If lockout cylinder does not function properly, have qualified personnel correct the malfunction prior to any further operation.

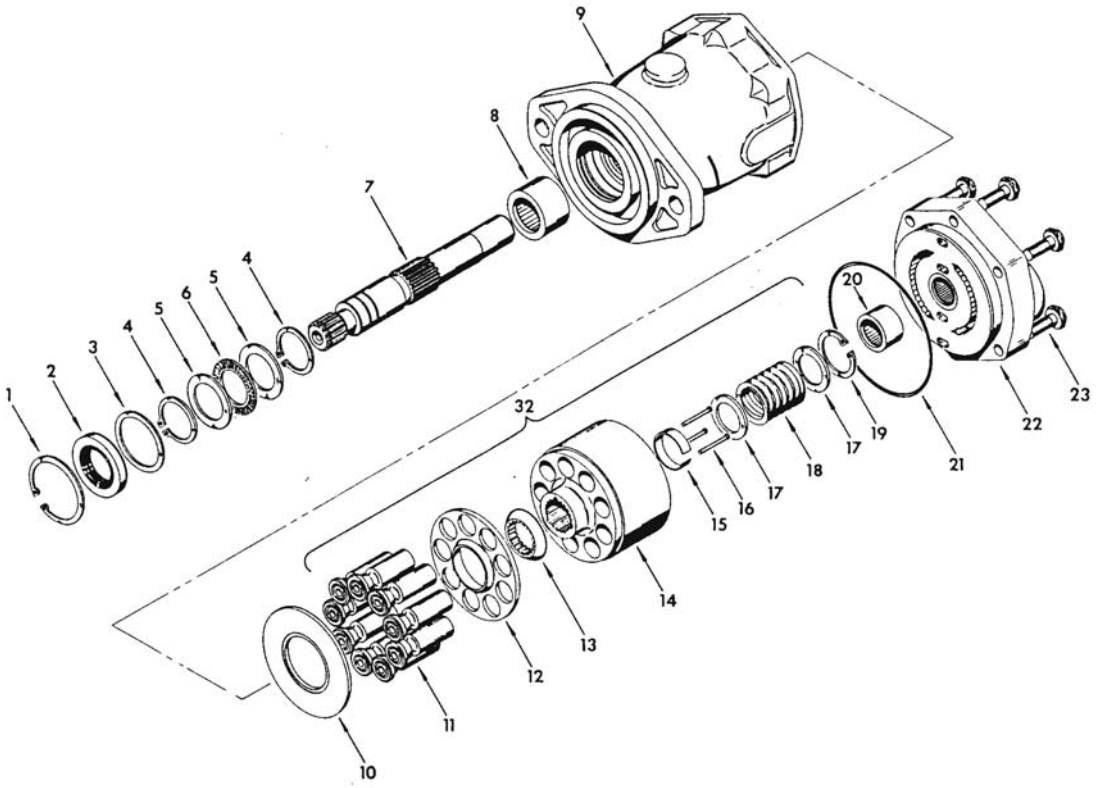
2.21 PISTON DRIVE MOTOR - 2WD & 4WD

Disassembly

1. Clean outside of unit thoroughly.
2. Clamp drive shaft in a protected jaw vise with backplate end up.
3. Remove six cap screws from backplate.
4. Use a plastic mallet and tap the backplate to loosen it.
5. Remove o-ring from backplate.
6. Remove complete piston block assembly from housing assembly.
7. Remove piston assemblies, spider, and pivot from piston block assembly.
8. The piston block assembly need not be disassembled unless pins or spring are damaged.

⚠ CAUTION

THE FOLLOWING PROCEDURE SHOULD BE USED IF THE SPRING IS TO BE REMOVED FROM THE PISTON BLOCK. THE SPRING IS HIGHLY COMPRESSED AND THE SNAP RING SHOULD NOT BE REMOVED WITHOUT COMPRESSING THE SPRING.



1.Snap Ring
2. Shaft Seal
3.Washer
4. Snap Ring
5. Thrust Washer
6. Thrust Bearing
7. Drive Shaft
8. Needle Bearing
9. Housing Assembly
10. Thrust Face
11. Piston Assembly
12. Spider
13. Pivot
14. Piston Block
15. Pin Keeper
16. Pin
17. Washer
18. Spring
19. Snap Ring
20. Needle Bearing
21. O-Ring
22. Backplate
23. Cap Screw

Figure 2-6. Piston Drive Motor

DISASSEMBLE THE PISTON BLOCK AS FOLLOWS:

NOTE: *The following parts will be needed to disassemble the piston block:*
2 ea. 3/8 I.D. x 1-1/8 O.D. flat washers
1 ea. 3/8 x 3-1/4 N.C. capscrew
1 ea. 3/8 N.C. nut

a. Place one of the flatwashers over the 3/8 x 3-1/4 capscrew and place this through the center of the piston block.
b. Place the other washer over the capscrew and let it rest on the three pins.
c. Screw nut on capscrew and compress the spring inside the piston block.
d. Using a pair of snap ring pliers, remove internal snap ring.
e. Remove bolt, nut, and two washers.
f. Remove two washers, spring, three pins, and pin keeper.

1. Remove thrust race, shaft seal, washer, and drive shaft from housing.
2. Remove two snap rings, thrust washers, and thrust bearing from drive shaft.

Inspection

1. Wash all parts thoroughly in a suitable solvent.
2. Examine needle bearings in housing and backplate. If needles are free of excessive play and remain in bearing cage, there is no need to replace bearing.
3. Inspect thrust washers and thrust bearing. All surfaces should be free of any signs of wear or fretting.
4. Inspect spider and pivot. Conical surfaces should be free of wear and score marks.
5. Inspect pistons. The O.D. surface should be smooth and free of scoring. Shoes should be snug fit to piston. Face of shoes should be flat and free of scoring and flaking. **Do not lap piston shoes.**
6. Inspect piston block; bores should be free of scoring. Surface that contacts backplate should be smooth and free of grooves or metal build-up. **Do not lap piston block.**
7. Inspect thrust race; surface should show no signs of scoring or grooves.
8. Inspect flat surface on backplate; it should be free of excessive scoring or metal build-up. **Do not lap backplate.**
9. Inspect drive shaft for fretting in bearing areas. Check spline area for twisted or broken teeth. If keyed shaft, check for cracked or chipped keyway.

Assembly

NOTE: *Use filtered system oil to lubricate all critical moving parts before assembly.*

1. Install one snap ring in rear groove of drive shaft. Install one thrust washer, thrust bearing, and second thrust washer on drive shaft. Install second snap ring in front groove on drive shaft.
2. Replace needle bearing in housing if necessary. Install shaft in housing assembly and install washer. Oil I.D. of new shaft seal and press into position. Retain with snap ring.
3. Compress pin keeper and install in spline area of piston block.
4. Install three pins in special grooves of spline with head end of pin toward inside of block.
5. Install one washer, spring, and second washer. Use two 3/8 I.D. washers, 3/8 N.C. nut and 3/8 x 3-1/4 capscrew to compress spring and retain with snap ring. Remove 3/8 N.C. nut, 3/8 x 3-1/4 capscrew and two washers.
6. Install pivot, spider, and piston assemblies in piston block assembly.
7. Lubricate thrust race and install in housing assembly.
8. Install piston block assembly in housing assembly. Piston shoes must contact thrust race. Be sure all parts are in their proper position.
9. Install new needle bearing in backplate if necessary.
10. Install new o-ring on backplate.
11. Install backplate on housing.
12. Install six capscrews and torque to 20 - 24 Nm (15 - 18 ft lbs).

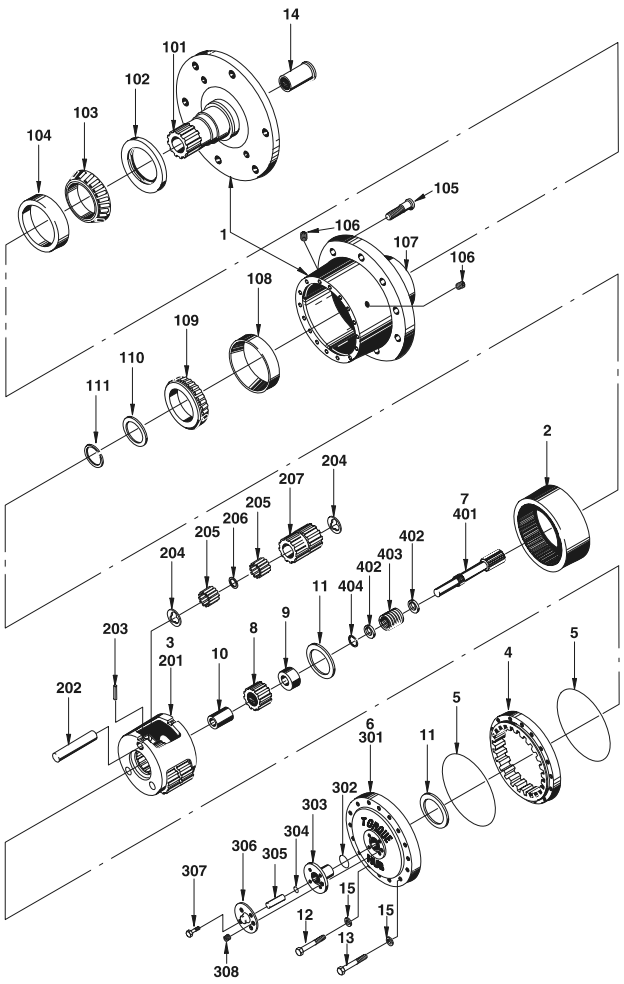
2.22 DRIVE TORQUE HUB - 2WD/4WD REAR

NOTICE

TORQUE HUB UNITS SHOULD ALWAYS BE ROLL AND LEAK TESTED BEFORE DISASSEMBLY AND AFTER ASSEMBLY TO MAKE SURE THAT THE UNITS GEARS AND SEALANTS ARE WORKING PROPERLY.

NOTICE

WHEN REBUILDING A UNIT, USE NEW SEALS AND O-RINGS. NEVER RE-USE SEALS AND O-RINGS, AS THIS WOULD CAUSE UNIT TO LEAK.



1. Hub/Spindle Assembly
   - 101. Spindle
   - 102. Seal
   - 103. Bearing Cone
   - 104. Bearing Cup
   - 105. Wheel Bolt
   - 106. Pipe Plug
   - 107. Hub
   - 108. Bearing Cup
   - 109. Bearing Cone
   - 110. Spacer
   - 111. Retaining Ring
2. Internal Gear
3. Carrier Assembly
   - 201. Carrier
   - 202. Planet Shaft
   - 203. Roll Pin
   - 204. Thrust Washer
   - 205. Needle Roller
   - 206. Spacer
   - 207. Cluster Gear
4. Ring Gear
5. O-Ring
6. Cover Assembly
   - 301. Cover
   - 302. O-Ring
   - 303. Cover Cap
   - 304. O-RIng
   - 305. Disconnect Rod
   - 306. Disconnect Cap
   - 307. Bolt
   - 308. Pipe Plug
7. Input Shaft
   - 401. Shaft
   - 402. Spacer
   - 403. Spring
   - 404. Retaining Ring
8. Input Gear
9. Thrust Spacer
10. Thrust Spacer
11. Thrust Washer
12. Bolt
13. Shoulder Bolt
14. Coupling
15. Flatwasher

Figure 2-7. Drive Torque Hub - (2WD/4WD rear)

Disassembly

1. Turn hub over on to its side. Remove coupling from wide end of spindle.
2. Mark location of shoulder bolt holes on outside of ring gear and hub for easy re-alignment when rebuilding. Remove four shoulder bolts and twelve bolts from cover.
3. Remove sixteen flat washers from cover assembly.
4. Lift cover assembly off of ring gear, and set cover on table, interior side facing up.

⚠ CAUTION

BEWARE OF SHARP EDGES IN COUNTERBORE WHEN REMOVING O-RING.

5. Remove o-ring from counterbore around edge of cover. Discard o-ring.

NOTE: *If o-ring is not in cover counterbore, it is in ring gear counterbore. Remove o-ring from hub and discard it.*

6. If necessary, disassemble cover as follows:
   a. Remove two bolts holding disconnect cap to cover.
   b. Remove disconnect cap from on top of cover cap and cover.
   c. Remove two bolts securing cover cap to cover. Remove cover cap.
   d. Remove disconnect rod from cover cap.
   e. Pry o-ring from groove inside cover cap. Discard o-ring.
   f. Remove o-ring from flange of cover cap. Discard o-ring.
   g. Remove pipe plug from cover.
7. Remove thrust washer from counterbore in top of carrier assembly.
8. Remove input gear from middle of carrier assembly.
9. Lift ring gear off of hub.
10. Lift carrier assembly out of hub.
11. If necessary, disassemble carrier assembly as follows:

NOTE: *When removing needle rollers from cluster gears, discard old needle rollers and use new ones during re-assembly.*

   a. Using a punch and hammer, drive roll pin into planet shaft.

NOTE: *If roll pin isn't driven all the way into the planet shaft, carrier could be damaged when planet shaft is removed from carrier.*

   b. Using a punch and hammer, drive planet shaft from carrier housing; one thrust washer, one cluster gear, and one more thrust washer will come off planet shaft and come to rest inside carrier. Remove these parts from inside carrier.
   c. Remove sixteen needle rollers from inside one end of cluster gear. Discard needle rollers.
   d. Repeat steps (a) through (c) to remove and disassemble two remaining cluster gears.
12. Remove thrust spacer from input shaft assembly in middle of spindle.
13. Lift input shaft assembly out of middle of spindle, and stand input shaft on its splined end.

⚠ CAUTION

WEAR SAFETY GLASSES WHEN PERFORMING THE FOLLOWINGSTEP . BE AWARE THAT SPRING AND SPACERS COMPRESSED BY RETAINING RING MAY POP SUDDENLY OFF SHAFT WHEN RETAINING RING IS REMOVED.USING RETAINING RING PLIERS, REMOVE RETAINING RING FROM GROOVE ON INPUT SHAFT.

14. Remove one spacer, one spring, and other spacer from input shaft.
15. Remove thrust washer from around spindle.
16. Lift internal gear out of hub.

⚠ CAUTION

BEWARE OF SHARP EDGES IN COUNTERBORE WHEN REMOVING O-RING.

17. Remove o-ring from counterbore in hub. Discard o-ring.
18. If necessary, disassemble hub-spindle assembly as follows:

NOTE: *Start with large end of hub facing up, large end of spindle facing down.*

⚠ CAUTION

WEAR SAFETY GLASSES WHILE PERFORMING THE FOLLOWING STEP

   a. Remove retaining ring from around spindle in hub.
   b. Remove spacer from around spindle in hub.

c. Remove retaining ring from around spindle in hub.Remove spacer from around spindle in hub. Set hub, small end/spindle facing down, up on something that will support hubs flange while it lifts hub up so spindle is not resting on anything. Carefully press or hammer spindle down out of hub. If seal and bearing cone come out of hub and rest on spindle, remove these parts from spindle and set them aside. Discard seal.

d. If seal and bearing cone did not come out of small end of hub when spindle was pressed out of hub, remove seal and bearing cone from small end of hub. Discard seal.

e. Bearing cone should be lying loose in wide end of hub. Remove bearing cone from inside hub.

NOTE: *If hammer and punch are used to remove bearing cups, make sure counterbore is not struck with punch when removing bearing cup.*

f. Remove bearing cup from counterbore in small end of hub.

g. Turn hub over and lift it out of flange-support. Remove bearing cup from wide end of hub.

h. Press nine studs out of stud holes in hub.

Roll Test

The purpose of a roll test is to determine if the units gears are rotating freely and properly. Gears should be able to be rotated by applying a *constant* force to the roll checker. If *more* drag is felt in the gears only at certain points, then the gears are not rolling freely and should be examined for proper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if gears seem to roll hard as long as they roll with *consistency*.

Leak Test

The purpose of the leak test is to make sure the unit is air tight. The unit has a leak if the pressure gauge reading on the air checker starts to fall once the unit has been pressurized. Leaks will most likely occur at main seal or wherever o-rings or gaskets are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where o-rings or gaskets meet the exterior of the unit, then checking for air bubbles. If a leak is detected in a seal, o-ring, or gasket, the part must be replaced.

Assembly

⚠ CAUTION

BEWARE OF SHARP EDGES IN COUNTERBORE WHEN INSTALLING O-RING.

1. Assemble hub-spindle assembly as follows:

NOTE: *Make sure cup sits square with counterbore before pressing.*

a. Set hub onto its large end. Press bearing cup into counterbore in small end of hub.

b. Press nine studs into stud holes in hub.

c. Apply a light coat of Never-Seize to two pipe plugs and tighten them into two pipe plug holes in side of hub.

NOTE: *Make sure cup sits square with counterbore before pressing.*

d. Turn hub over onto its small end. Press bearing cup down into counterbore in deep end of hub.

e. Set hub onto its large end. Place bearing cone into bearing cup.

f. Press seal into small end of hub.

g. Oil spindle, then lower hub, small end down, onto spindle.

h. Press bearing cone onto spindle in hub.

i. Place spacer onto spindle in hub.

NOTE: *Make sure the retaining ring is securely seated in groove in spindle.*

j. Place retaining ring over spacer onto spindle in hub.

2. Grease o-ring and place it into counterbore in hub.

NOTE: *O-ring may be stretched or pinched together to make it fit counterbore exactly.*

3. Oil all exposed surfaces inside hub.

4. Place internal gear into hub so that its internal splines mesh with external splines of spindle. Oil internal gear.

5. Place thrust washer around spindle so that it rests on bottom of internal gear.

6. Stand input shaft on its splined end. Place one spacer onto smooth end of input shaft.

7. Place one spring onto smooth end of input shaft.

8. Place other spacer onto smooth end of input shaft.

⚠ CAUTION

SAFETY GLASSES MUST BE WORN DURING THE FOLLOWING STEP. BE AWARE THAT SPRING AND SPACERS, COMPRESSED BY RETAINING RING, MAY POP SUDDENLY OFF SHAFT IF RING IS RELEASED BEFORE IT IS PROPERLY IN PLACE.

9. Using retaining ring pliers, insert retaining ring into groove on input shaft by compressing spring and spacers together.
10. With large, splined end down, place input shaft assembly into spindle.
11. Place thrust spacer onto input shaft.
12. Set carrier assembly on work surface so that large ends of cluster gears face up. Locate punch marks on face of each cluster gear and position them at 12 o'clock. Refer to Figure 2-8., Torque Hub Carrier Timing
13. With X-marked side facing up, place ring gear around cluster gears. NOTE: This will hold punch marks in position while installing carrier into hub.
14. Place carrier assembly and ring gear together into mesh with internal gear, aligning X-marked shoulder bolt in ring gear over one of the shoulder bolt holes in hub. Mark location of shoulder bolt holes on outside of ring gear and hub.

NOTE: *Ring gear may be lifted off hub to align shoulder bolt holes. Ring gear and carrier were installed together only to keep punch marks on carrier in place*

15. With internal splines facing up, counterbore end facing down, place input gear into mesh with carrier assembly.
16. Oil all exposed surfaces inside hub. Place thrust washer into counterbore in top of carrier assembly.
17. Assemble cover as follows:
    a. Using disconnect rod, push o-ring into groove inside cover cap.
    b. Place o-ring onto cover cap so it rests against flange of cover cap.
    c. Insert disconnect rod into cover cap.
    d. Set cover on table, exterior side up. Place cover cap onto cover, aligning pipe plug hole in cover cap over pipe plug hole in cover.
    e. Place two cover cap bolts into any two bolt holes 180 degrees apart on cover cap, then tighten bolts.
    f. Torque both bolts to 4 - 5 Nm (36 - 49 in lbs).
    g. With large end down, place disconnect cap onto cover cap, aligning pipe plug hole in disconnect cap over pipe plug hole in cover cap.
    h. Place two remaining bolts into bolt holes in disconnect cap, and tighten bolts.
    i. Torque both bolts to 4 - 5 Nm (36 - 49 in lbs).
    j. Apply a light coat of Never-Seize to pipe plug and tighten it into pipe plug hole in cover.

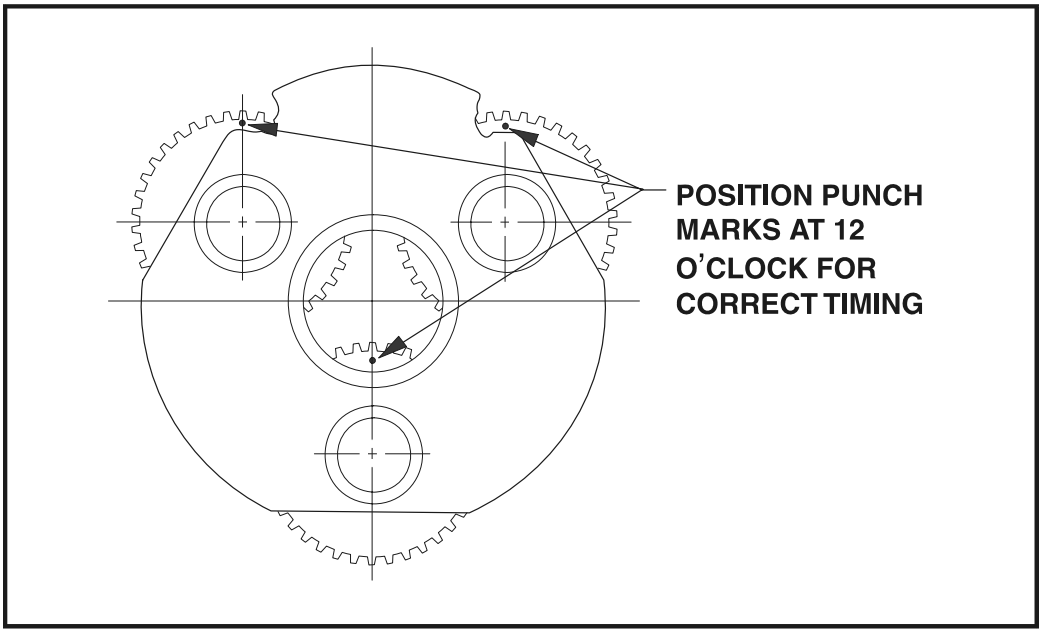


Figure 2-8. Torque Hub Carrier Timing

⚠ CAUTION

BEWARE OF SHARP EDGES IN COUNTERBORE WHEN INSTALLING O-RING.

18. Set cover assembly on table, interior side up. Grease o-ring and place it into counterbore around edge of cover.

NOTE: *O-ring may be stretched or pinched together to make it fit counterbore exactly.*

19. Place cover assembly onto ring gear, aligning pipe plug holes in cover and hub according to applicable assembly print. Also, make sure shoulder bolt holes in cover and ring gear are aligned.
20. Place four flat washers on top of bolt holes in cover assembly.
21. Place shoulder bolts into four shoulder bolt holes in cover and tighten by hand.
22. Place remaining twelve flat washers) onto remaining bolt holes in cover.
23. Place twelve bolts into remaining bolt holes in cover and tighten.
24. Torque shoulder bolts to 25 - 34 Nm (18 - 25 ft lb). Torque bolts to 25 - 34 Nm (18 - 25 ft lb).
25. Turn hub over on to its side. Insert coupling into end of spindle.
26. Roll test unit in both clockwise and counter clockwise directions. Perform same number of turns in each direction as ratio of unit. Ratio is last two digits of model number on units ID tag. For example, if model number is W1BFF0335, then roll unit 35 times in each direction.
27. Leak test unit at a pressure of 0.4 bar (5 psi) for 2-3 minutes.

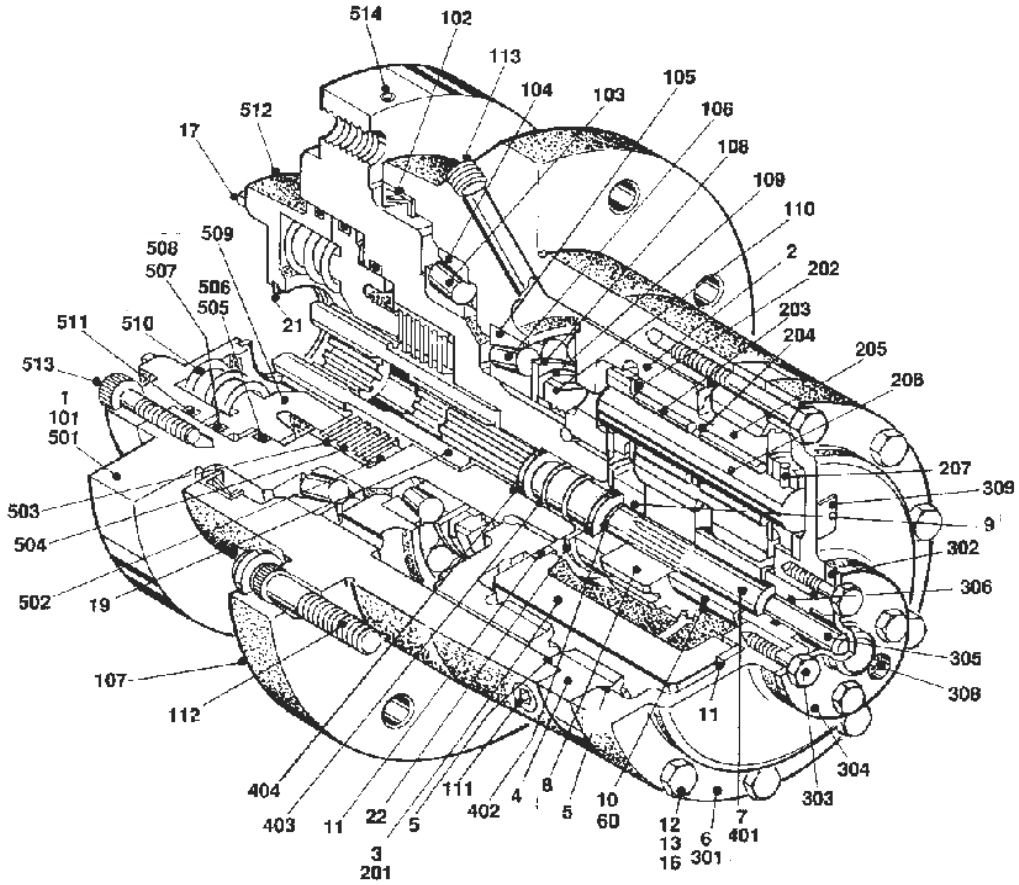
2.23 DRIVE TORQUE HUB/BRAKE - 4WD FRONT

NOTICE

TORQUE HUB UNITS SHOULD ALWAYS BE ROLL AND LEAK TESTED BEFORE DISASSEMBLY AND AFTER ASSEMBLY TO MAKE SURE THAT THE UNITS GEARS AND SEALANTS ARE WORKING PROPERLY.

Disassembly

1. Remove pipe plug from cover and drain oil from unit.
2. Inspect spindle/brake as follows:
   a. Examine two brake ports on bottom of spindle/brake. Bottom of one is tapered and bottom of other one is flat. Install hydraulic line of a hand pump into flat brake port.
   b. Install a bleeder valve into tapered brake port.
   c. Insert roll checker into spindle/brake. If brake is not working properly, roll checker should *not* turn.
   d. Set hand pump to PUMP.
   e. Increase hydraulic pressure in brake by pumping gradually. At the same time, try to turn roll checker. If brake is set correctly, roll checker should turn when pump pressure reaches 10-11 bar (140 - 160 psi).
   f. Roll test brake in both clockwise and counterclockwise directions. Perform same number of turns in each direction as ratio of unit. This number is the same as the last two digits of the model number found on the units ID tag. For example, if units model number is W1BJ4U318, then it should be rolled 18 times in both directions.
   g. Set hand pump to RELEASE and check to see if brake has reset itself. If brake has reset roll checker should not be able to turn.
   h. Remove roll checker from spindle/brake.
   i. Remove hydraulic line from its brake port.
   j. Remove bleeder valve from its brake port.
3. Leak test unit at a pressure of 0.4 bar(5 psi) for 2 to 3 minutes.
4. Remove the twelve grade 8 bolts and four shoulder bolts from cover.
5. Remove flat washers from cover.
6. Remove cover from hub.
7. If necessary, disassemble cover as follows:
   a. Remove pipe plug from cover if it has not already been removed.
   b. Set cover down so that its open end faces up. Remove o-ring from counterbore in cover. Discard o-ring.
   c. Turn cover over. Remove two bolts that hold disconnect cap in place.
   d. Remove disconnect cap from cover.
   e. Remove two remaining bolts that hold cover cap in place.
   f. Remove cover cap from cover.
   g. Remove disconnect rod from cover cap.
   h. Remove o-ring from groove inside cover cap. Discard o-ring.
   i. Remove o-ring from outside of cover cap.



1. Hub/Spindle/Brake Assy
   - 101. Brake Assembly
   - 501. Spindle
   - 502. Spacer
   - 503. Stationary Disc
   - 504. Rotating Disc
   - 505. Back-Up Ring
   - 506. O-Ring
   - 507. Back-Up Ring
   - 508. O-Ring
   - 509. Piston
   - 510. Spring
   - 511. O-Ring
   - 512. Cover
   - 513. Socket Head Bolt
   - 514. Expander
   - 102. Lip Seal
   - 103. Bearing Cone
   - 104. Bearing Cup
   - 105. Bearing Cup
   - 106. Bearing Cone
   - 107. Hub
   - 108. Tongued Flatwasher
   - 109. Tongued Lockwasher
   - 110. Lock Nut
   - 111. Pipe Plug
   - 112. Wheel Stud
   - 113. Pipe Plug
2. Internal Gear
3. Carrier Assembly
   - 201. Carrier Housing
   - 202. Tongued Thrust Washer
   - 203. Needle Roller
   - 204. Thrust Spacer
   - 205. Cluster Gear
   - 206. Planet Shaft
   - 207. Roll Pin
4. Internal Gear
5. O-Ring
6. Cover Assembly
   - 301. Cover
   - 302. Cover Cap
   - 303. Bolt
   - 304. Disconnect Cap
   - 305. Disconnect Rod
   - 306. O-Ring
   - 307. O-Ring
   - 308. Pipe Plug
   - 309. I.D. Plate
7. Input Shaft Assembly
   - 401. Shaft
   - 402. Retaining Ring
   - 403. Spring
   - 404. Thrust Spacer
8. Input Gear
9. Thrust Spacer
10. Thrust Spacer
11. Thrust Washer
12. Bolt
13. Shoulder Bolt
14. Flatwasher (16)
15. Gasket (17)
16. Coupling (19)
17. Retainer Ring (21)
18. Thrust Washer (22)

Figure 2-9. Drive Torque Hub/Brake - 4WD Front

8. Remove thrust washer from carrier assembly.
9. Remove thrust spacer from input shaft assembly.
10. Remove ring gear from mesh with carrier assembly.
11. Remove carrier assembly from hub.
12. If necessary, disassemble carrier assembly as follows:
    a. Locate roll pin in carrier housing. Drive roll pin down into planet shaft until it bottoms against carrier housing. If roll pin is not completely driven into planet shaft, damage to carrier could occur when shaft is removed.
    b. Drive roll pin out of planet shaft. Roll pin must come out through side of planet shaft that it originally went into.
    c. Remove planet shaft from carrier housing. Two tongued thrust washers and cluster gear will slide off.
    d. Remove needle rollers and spacer from inside cluster gear.
    e. Repeat steps (a) through (d) to remove two remaining cluster gears.
13. Remove input gear from input shaft assembly.
14. Remove thrust spacer from input shaft assembly.
15. Remove input shaft assembly from spindle/brake.
16. If necessary, disassemble input shaft as follows:
    a. Remove retaining ring from input shaft. Discard retaining ring.
    b. Slide thrust spacer, spring, and other thrust spacer off of input shaft.
17. Remove thrust washer from bottom of internal gear.
18. Remove internal gear from hub.
19. Remove o-ring from counterbore in hub. Discard o-ring.
20. Using a screwdriver or chisel and hammer, straighten out tang on lock washer which has been bent into notch in locknut.
21. Using an N-13 locknut wrench (tool no. T-141863), loosen locknut. Remove locknut from spindle/brake and discard.
22. Remove lock washer from spindle/brake and discard.
23. Remove tongued washer from spindle/brake.
24. Lift bearing cone out of hub.
25. Lift hub off of spindle/brake.
26. Using a slide hammer, remove seal from small end of hub. Discard seal.
27. Lift bearing cone off of spindle/brake.
28. Using a soft punch and hammer, remove bearing cup from deep end of hub.

NOTE: *When using punch, be very careful not to strike counterbore of hub where cup is located.*

29. Using a soft punch and hammer, remove bearing cup from shallow end of hub.

NOTE: *This cup can be reached by putting punch into small access hole in bottom of hubs deep end.*

30. Remove two pipe plugs from pipe plug holes in side of hub.
31. Remove two magnetic pipe plugs from pipe plug holes in flange of hub.
32. Hammer out nine wheel studs.

Roll Test

The purpose of a roll test is to determine if the units gears are rotating freely and properly. Gears should be able to be rotated by applying a *constant force to the roll checker. If more drag is felt in the gears only at certain points, then the gears are not rolling freely and should be examined for proper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if gears seem to roll hard as long as they roll with consistency.*

Leak Test

The purpose of the leak test is to make sure the unit is air tight. The unit has a leak if the pressure gauge reading on the air checker starts to fall once the unit has been pressurized. Leaks will most likely occur at main seal or wherever o-rings or gaskets are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where o-rings or gaskets meet the exterior of the unit, then checking for air bubbles. If a leak is detected in a seal, o-ring, or gasket, the part must be replaced.

Assembly

1. Grease o-ring.
2. Place o-ring into counterbore in hub.

⚠ CAUTION

BEWARE OF SHARP EDGES AND BURRS IN COUNTERBORE WHEN INSTALLING O-RING.

NOTE: *O-rings may be stretched to fit counterbore. If an o-ring has been stretched too much, simply squeeze o-ring together bit by bit while placing it around counterbore. It can be made to fit exactly.*

3. Oil exposed surfaces inside hub.
4. Mark four shoulder bolt holes on hub so for alignment with shoulder bolt holes in ring gear and cover.
5. Place internal gear into hub so its internal splines mesh with external splines of spindle/brake.
6. Oil internal gear.
7. Place thrust washer onto spindle/brake so it rests on bottom of internal gear.
8. Assemble input shaft as follows:
   a. Place one thrust spacer, spring, and other spacer, **IN THAT ORDER**, onto smooth end of shaft.

⚠ CAUTION

SAFETY GLASSES SHOULD BE WORN DURING FOLLOWING PROCEDURE.

   b. Place retaining ring onto input shaft. Using retaining ring pliers, insert retaining ring into groove on input shaft by compressing spring and spacers together.
9. With large, splined end down, place input shaft assembly into spindle/brake.
10. Place thrust spacer onto input shaft.
11. With internal splines facing up, place input gear into mesh with input shaft assembly.
12. Assemble carrier as follows:
   a. Apply grease to inside of one cluster gear.
   b. Line one half of cluster gear with 16 needle rollers.
   c. Place one thrust spacer inside cluster gear so it rests on top of needle rollers.
   d. Line remaining half of cluster gear with 16 needle rollers.
   e. Insert a planet shaft into one of the planet shaft holes in the carrier housing which has a roll pin hole. End of planet shaft that does not have a roll pin hole should be inserted into carrier housing first.
   f. Place one thrust washer onto end of planet shaft which has been inserted through planet shaft hole. Notice that thrust washer has a tang on it. Tang should point straight so as to fit in slot on inside edge of planet shaft hole.
   g. Following thrust washer, place cluster gear, with needle rollers, onto planet shaft. Large end of cluster gear should go onto shaft first.
   h. Following cluster gear, place one more thrust washer onto planet shaft. Align thrust washer in same manner as described in step (f).
   i. Insert planet shaft through opposite planet shaft hole in carrier housing. Use an alignment punch or similar tool to align roll pin holes in carrier housing and planet shaft.
   j. Drive roll pin down into aligned roll pin holes.
   k. Repeat steps (a) through (j) to install two remaining cluster gears.
13. Set carrier assembly on work surface so that large end of cluster gears face up. Locate punch marks on face of each cluster gear and position them at 12 o'clock.
14. With squared shoulder side down, place ring gear into mesh with cluster gears in carrier. If ring gear is on correctly, the X marking a shoulder bolt hole should face up.

NOTE: *Make sure punch marks on cluster gears remain in their correct positions when installing ring gear.*

15. Place carrier assembly and ring gear together into mesh with internal gear. Align shoulder bolt hole in ring gear marked with an X over one of the shoulder bolt holes in the hub.

NOTE: *Ring gear may be lifted off hub to align shoulder bolt holes. Ring gear and carrier need to be installed together initially only so that punch marks on carrier remain aligned.*

16. Oil all exposed surfaces inside hub.
17. Place thrust spacer onto input shaft assembly.
18. Place thrust washer into counterbore in carrier.
19. Assemble cover as follows:
   a. Place o-ring onto cover cap so it rests against flange of cover cap.
   b. Insert o-ring into groove inside cover cap.
   c. Insert disconnect rod into cover cap.
   d. Place cover cap into cover. Align pipe plug hole in cover cap over pipe plug hole in cover.
   e. Place two cover cap bolts into any two bolt holes 180° apart on cover cap and tighten.
   f. Using a torque wrench, apply 4 - 5 Nm (36 - 49 in lb) torque to both bolts.
   g. With large end down, place disconnect cap onto cover. Align pipe plug hole in disconnect cap over pipe plug hole in cover cap.

h. Place two remaining bolts into bolt holes in disconnect cap and tighten.

i. Using a torque wrench, apply 4 - 5 Nm (36 - 49 in lbs) torque to both bolts.

j. Grease o-ring.

k. Place o-ring into counterbore around edge of cover.

⚠ CAUTION

BEWARE OF BURRS AND SHARP EDGES AROUND COUNTERBORE WHEN INSTALLING O-RING.

NOTE: *O-rings may be stretched to fit counterbore. If an o-ring has been stretched too much, simply squeeze o-ring together bit by bit while placing it around counterbore. It can be made to fit exactly.*

l. Apply a light coat of never-seize to pipe plug.

m. Tighten pipe plug into pipe plug hole in cover.

20. Place cover assembly onto ring gear. Align pipe plug holes in cover and hub as shown in Figure 2-10. Make sure shoulder bolt holes in cover and ring gear are aligned.

21. Place sixteen flatwashers on top of bolt holes in cover assembly.

22. Place shoulder bolts into four shoulder bolt holes in cover and tighten *by hand*.

23. Place grade 8 bolts into twelve bolt holes in cover and tighten.

24. Apply 25 - 35 Nm (18 - 25 ft lbs) of torque to all bolts.

25. Leak test unit at a pressure of 0.4 bar (5 psi) for 2-3 minutes.

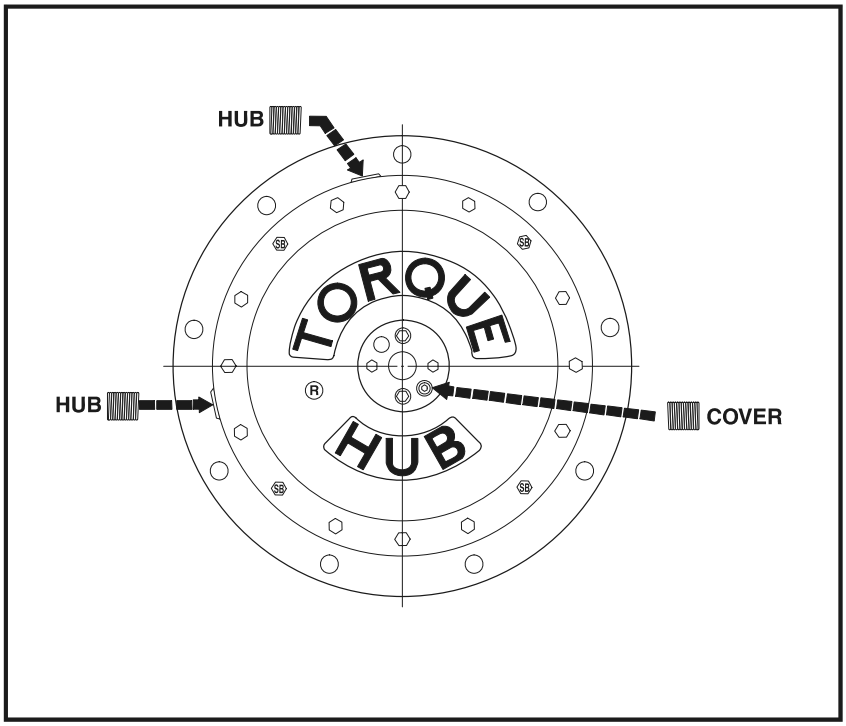


Figure 2-10. Torque Hub Cover Pipe Plug Alignment

2.24 DRIVE BRAKE - 2WD/4WD REAR

Disassembly

1. Remove end cover from housing by removing washer head cap screws.

⚠ CAUTION

END COVER IS UNDER SPRING TENSION OF APPROXIMATELY 907 KG (2000 LB). THE FOUR WASHER HEAD CAP SCREWS SHOULD BE LOOSENED EVENLY TO RELIEVE THIS FORCE. IF A HYDRAULIC PRESS IS AVAILABLE 1361 KG MINIMUM (3000 LB MINIMUM) , COVER CAN BE HELD IN POSITION WHILE REMOVING WASHER HEAD CAP SCREWS.

2. Remove case seal from housing, then remove bleeder screw from end cover.
3. Remove piston from end cover.
4. Remove o-ring, back-up ring, o-ring and back-up ring from piston.
5. Remove separators from housing.
6. Remove stack assembly, consisting of stator friction discs, return plate, and rotor discs from housing.
7. Remove dowel pins, springs, and spring retainer from housing.

NOTE: *Not all models use the same number of springs or spring pattern. Record this information for assembly purposes.*

8. Remove retaining ring from housing.
9. Remove shaft by pressing or using a soft mallet on male end of shaft.
10. Remove retaining ring and bearing from shaft.
11. Press rotary oil seal from housing.

Assembly

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

1. Clean all parts thoroughly before assembly.
2. Press new rotary oil seal into housing. Note direction of seal.
3. Install new bearing and retaining ring on shaft.
4. Insert shaft assembly and retaining ring in housing.
5. Insert dowel pins, guide retainer, and springs in housing.

NOTE: *Be sure to use the same number of springs and same spring pattern as recorded during disassembly.*

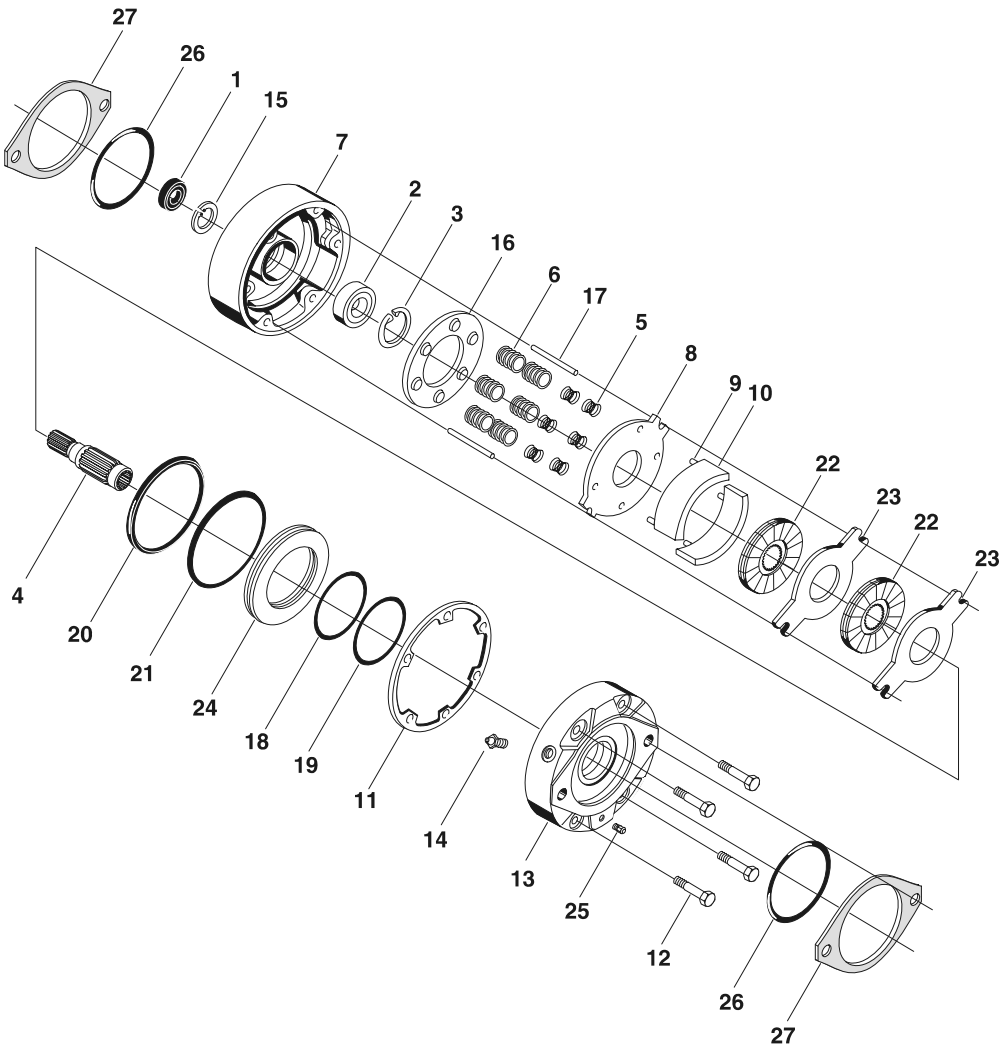
6. Position new large diameter return plate in housing with tabs guided by dowel pins until disc rests on springs.

NOTE: *Rotor discs and stator friction discs should remain dry during installation. No oil residue should be allowed to contaminate disc surfaces.*

7. Place a new rotor disc on shaft until it contacts return plate.
8. Add additional new stator discs and new rotor discs as required to complete assembly.
9. Insert separators in holes of return plate.
10. Install new o-ring, new back-up ring, new o-ring, and new back-up ring on piston. Note order of o-rings and back-up rings. Insert piston into end cover, being careful not to shear o-rings or back-up rings.
11. Install case seal in housing, then install bleeder screw in end cover.
12. Position end cover on housing, aligning dowel pins with holes in end cover.
13. Install washer head cap screws and tighten evenly to draw end cover to housing. Torque washer head cap screws to 75 Nm (55 ft lbs).

NOTE: *If available, a hydraulic press will simplify installation of end cover on housing. Clamp cover in position while tightening washer head cap screws.*

14. If hydrostatic bench testing is done on brake assembly, release pressure should not exceed 138 bar (2000 psi) unless two additional bolts are used for supplemental clamping.



1. Oil Seal
2. Bearing
3. Retaining Ring
4. Shaft
5. Inner Spring
6. Outer Spring
7. Housing
8. Return Plate
9. Pin
10. Separator
11. Case Seal
12. Washer Head Cap Screw
13. Cover
14. Bleeder Screw
15. Retainer Ring
16. Guide Spring
17. Dowel Pin
18. Back-Up Ring
19. O-Ring
20. Back-Up Ring
21. O-Ring
22. Disc (Rotor)
23. Friction Disc (Stator)
24. Piston
25. Pipe Plug
26. O-Ring
27. Gasket

Figure 2-11. Drive Brake - (2WD/4WD Rear)

2.25 SPARK ARRESTOR MUFFLER

The multiple discs on these mufflers will require frequent cleaning if used with oily or sooty exhaust, such as a diesel engine, or on malfunctioning engines, as evidenced by visible exhaust.

2.26 DUAL FUEL/LPG SYSTEM

⚠ CAUTION

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

Changing From Gasoline to LP Gas

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

⚠ CAUTION

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

3. While engine is operating, place the three position LPG/GASOLINE switch at ground control station to center OFF position. Allow engine to operate, without load, until engine begins to stumble from lack of gasoline.
4. As engine begins to stumble, place switch to LPG position, allowing LP fuel to be sent to the fuel regulator.

Changing From LP Gas to Gasoline

1. With engine operating on LP under a no-load condition, throw LPG/GASOLINE switch at ground control station to GASOLINE position.
2. If engine stumbles because of lack of gasoline, place switch to LPG position until engine regains smoothness, then return switch to GASOLINE position.
3. Close hand valve on LP gas supply by turning clockwise.

Using Liquid Petroleum (LP) Gas

⚠ WARNING

CLOSE FUEL VALVE ON TANK WHEN PARKING SIZZOR LIFT MORE THAN MOMENTARILY.

WHEN REFUELING LPG POWERED SIZZOR LIFTS, ALWAYS FOLLOW MANUFACTURERS SPECIFICATIONS AND/OR APPLICABLE REGULATIONS.

1. If machine is to be left overnight or longer, it must be parked outside or the LPG tank removed and stored outside.
2. LPG is extremely flammable. No smoking.
3. Only trained and authorized personnel are permitted to operate filling equipment.
4. Fill LPG tanks outdoors. Stay at least 15 m (50 ft) from buildings, motor vehicles, electrical equipment or other ignition sources. Stay at least 4.5 m (15 ft) from LPG storage tanks.
5. During transfer of LPG, metal components can become very cold. Always wear gloves when refilling or changing tanks to prevent freeze burns to skin.
6. Do not store LPG tanks near heat or open flame. For complete instructions on the storage of LPG fuels, refer to ANSI/NEPA 58 & 505.

⚠ WARNING

DO NOT USE AN LPG TANK THAT IS DAMAGED. A DAMAGED TANK MUST BE REMOVED FROM SERVICE. FROST ON THE SURFACE OF A TANK, VALVES, OR FITTINGS INDICATES LEAKAGE. A STRONG ODOR OF LPG FUEL CAN INDICATE A LEAK.

2.27 FREEWHEELING FEATURE

To Disengage Torque Hubs (Freewheel)

1. Chock wheels securely.
2. Disengage (reverse) disconnect caps on drive torque hubs by removing two attaching capscrews, turning cap around, then reinstalling and tightening capscrews.
3. If desired, remove chocks and using suitable equipment for assistance, move machine to an appropriate maintenance area. Again chock wheels securely.

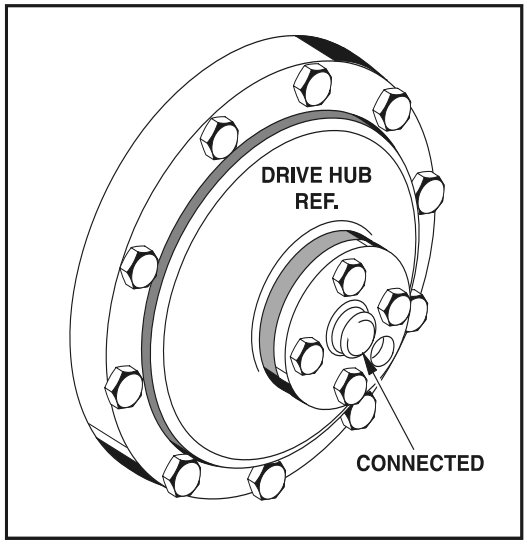


Figure 2-12. Drive Hub Engaged

To Engage Torque Hubs

Engage (reverse) disconnect cap on both drive torque hubs by removing two attaching capscrews, turning cap around, then reinstalling and tightening capscrews.

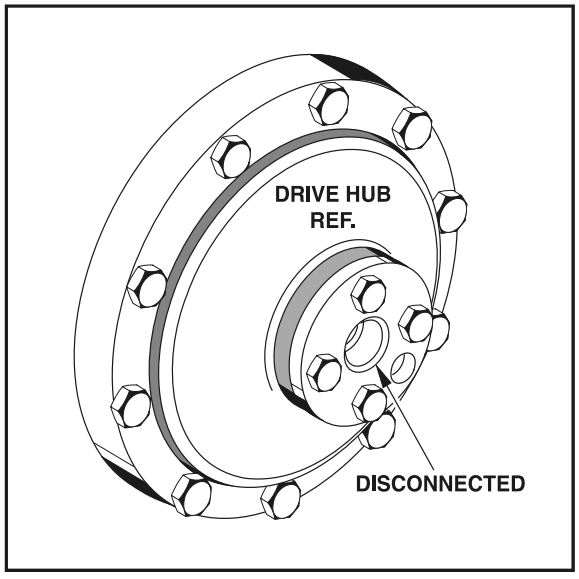


Figure 2-13. Drive Hub Disengaged

2.28 LIMIT SWITCH ADJUSTMENT PROCEDURE

Drive Cut-Out Switch

The drive cut-out switch is set at the following heights.

Table 2-3. Drive Cutout Heights

Model	Cut-Out
400 RTS	Not Required
400 RTS w/31 x 15.5 - 15 Tires	32 ft (9.8 m)
500RTS	22 ft (6.7 m)

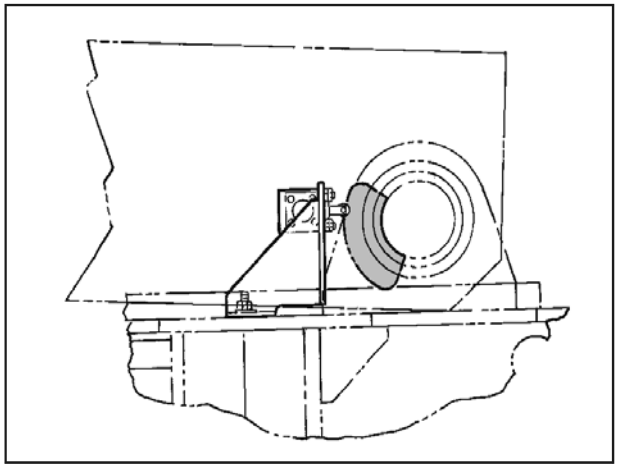


Figure 2-14. Drive Cut-out Switch

Drive Speed Cutout

Drive speed limit switch set to actuate as soon as possible after the platform lifts beyond the stowed position and begins to elevate. Switch must activate prior to a maximum platform height of 4.2 m (14 ft).

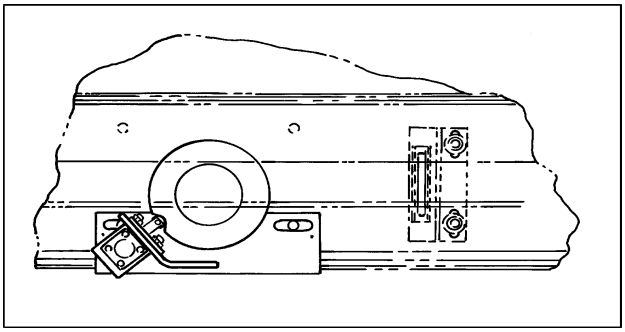


Figure 2-15. Drive Speed Cutout Switch

2.29 PREVENTIVE MAINTENANCE AND INSPECTION SCHEDULE

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

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

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

NOTICE

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

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

The inspection and maintenance code numbers are as follows:

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

Table 2-4. Preventive Maintenance and Safety Inspection

AREA	INTERVAL				
	10Hours (Daily)	50 Hours (Weekly)	200 Hours (Monthly)	500 Hours (3 Month)	1000 Hours (6 Month)
PLATFORM					
1. Controller	1,11				
2. Switches	1,11				
3. Placards and Decals	1,2				
4. Control Tags	1,2				
5. Hoses and Cables		4,8			
6. Wear Pads			8		
7. Handrails and Chains	1,4				
CHASSIS					
1. Engine Oil	3	5			
2. Battery	3	5			
3. Air Cleaner	1	14			
4. Exhaust System	1		1,5		
5. Engine Mounts			1		
6. Hydraulic Pump	1	5			
7. Valves	1	5			
8. Hydraulic Filter (See Lubrication Chart)		5,14	14		
9. Hydraulic Hoses and Tubing	1	5			
10. Hydraulic Oil Tank*	3	5	4		
11. Hydraulic Tank Breather		6,14			
12. Fuel Tank	3,5		4		
13. Lift Cylinder	1,12	5,6,13	4		
14. Limit Switch	1,7				
15. Tilt Alarm Switch					1,7
16. Placards and Decals	1,2				
17. Wheel and Tire Assemblies	1	8,9			
18. Drive Motors		1,5,6			
19. Drive Brakes		1,6	8		
20. Drive Torque Hubs		1,3,5,6			
21. Steer Cylinder	1	5,6,13	4		
22. Steer Components	1	4,6	8		
23. Wheel Bearings (2 Wheel Drive)			8	12	
24. Sizzor Arms	1,4				
25. Safety Props	1,4				
26. Sliding Wear Pads			8		
27. Pivot Pins/Bolts	1,4		7,8		
28. Switches, Ground Control	1,11				
29. Control Tags	1,2				

*Inspection and Maintenance Code 10 to be performed annually.

NOTES:

SECTION 3. TROUBLESHOOTING

3.1 GENERAL

This section contains troubleshooting information to be used for locating and correcting most of the operating problems which may develop in the aerial platform. If a problem should develop which is not presented in this section or which is not corrected by listed corrective actions, technically qualified guidance should be obtained before proceeding with any maintenance.

Troubleshooting and maintenance information pertaining to the prime mover (engine/motor) that are not contained in this manual are contained in the applicable engine maintenance manual.

3.2 TROUBLESHOOTING INFORMATION

The troubleshooting procedures applicable to the aerial platform are listed and defined in Tables 3-1 through 3-4. As an aid to table use, the platform sizzor is divided into 4 major groups, each covered separately within this section. These groups are as follows: Platform, chassis, hydraulic system and electrical system.

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

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

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

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

3.3 HYDRAULIC CIRCUIT CHECKS

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

Table 3-1. Platform Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
No response to control switch		
	Enable switch not activated	Activate enable switch
	Function not activated within the 3 seconds after enable switch was depressed	Reactivate enable switch
	Enable switch not functioning properly	Replace enable switch circuit card
	Lift control switch inoperative	Repair or replace lift control switch
	Hydraulic system oil low	Replenish oil as necessary
	No power supply	See wiring diagram
	Restricted or broken supply line on valve bank or hydraulic pump	Clean, repair or replace line
	Control valve not functioning properly	Repair or replace valve
	Defective dump valve on cylinder	Repair or replace dump valve
	Lift cylinder not functioning properly	Repair or replace lift cylinder
	Hydraulic pump not functioning properly	Repair or replace hydraulic pump
Platform will not raise		
	Enable switch not activated	Activate enable switch
	Function not activated within the 3 seconds after enable switch was depressed	Reactivate enable switch
	Enable switch not functioning properly	Replace enable switch circuit card
	Load capacity exceeded. (Personnel and/or equipment.)	Reduce load. (Refer to capacity placard.)
	Hydraulic system oil low	Replenish oil as necessary
	Broken or binding pivot pin	Repair or replace pivot pin
	Restricted or broken hydraulic line or fitting	Clean, repair or replace line or fitting
	Control valve not functioning properly	Repair or replace control valve
	Lift cylinder not functioning properly	Repair or replace lift cylinder
	Pump does not respond when lift control switch is moved to the up position	Refer to electrical troubleshooting table
	No electrical signal being sent to lift up control valve cartridge	Refer to electrical troubleshooting table
Platform will not raise above 7.6 m (25 ft)		
	Leveling jacks not in contact with the ground to set limit switches	Set leveling jacks
	Leveling jack limit switches not functioning properly	Repair or replace limit switch
	Machine is on an unlevel surface	Lower platform and level machine
	No power supply	See wiring diagram
Platform will not lower		
	Enable switch not activated	Activate enable switch
	Function not activated within the 3 seconds after enable switch was depressed	Reactivate enable switch
	Enable switch not functioning properly	Replace enable switch circuit card
	Pump does not respond when lift control switch is moved to the down position	Refer to electrical troubleshooting table

Table 3-1. Platform Assembly - Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	No electrical signal being sent to lift down control valve cartridge	Refer to electrical troubleshooting table
	Lift down control valve cartridge not functioning properly	Repair or replace lift down control valve cartridge
	Lift cylinder not functioning properly	Repair or replace lift cylinder
Platform raises and lowers erratically		
	Hydraulic system low	Replenish hydraulic oil as required
	Restricted or broken hydraulic line or fitting	Clean, repair or replace line or fitting
	Lack of lubricant on lift cylinder attach pins	Lubricate as required (Refer to lubrication chart)
	Counterbalance valve on lift cylinder improperly adjusted or not functioning properly	Replace valve
	Control valve not functioning properly	Repair or replace valve
	Sizzor arm pins not properly lubricated	Lubricate as necessary
	Worn seals in lift cylinder	Replace seals
	Cylinder not functioning properly	Repair or replace lift cylinder
Platform drifts down		
	Manual lowering valve not functioning properly	Repair or replace valve
	Worn seals in lift cylinder	Replace seals
	Holding valve on lift cylinder not functioning properly	Repair or replace holding valve
High drive does not operate below set height		
	Damaged wiring on limit switch	Repair or replace wiring
	Damage limit switch	Replace limit switch

Table 3-2. Chassis Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	DRIVE SYSTEM	
No response to control		
	Enable switch not activated	Activate enable switch
	Function not activated within the 3 seconds after enable switch was depressed	Reactivate enable switch
	Enable switch not functioning properly	Replace enable switch circuit card
	Hydraulic system oil low	Replenish oil as necessary
	Drive hubs disengaged	Engage hubs
	Controller not properly adjusted	Correctly adjust controller
	Hydraulic pump not functioning properly	Repair or replace pump
	Restricted or broken pump supply line	Clean, repair or replace line
	Restricted or broken line on valve bank	Clean, repair or replace line
	Drive motor(s) not functioning properly	Repair or replace motor(s)
	Damaged wiring on controller	Repair or replace wiring
	Controller not functioning properly	Repair or replace controller
	Drive brake not releasing	Determine cause and repair or replace brake
Machine drives erratically		
	Microswitch on controller improperly adjusted	Adjust microswitch on controller for proper operation
Machine will not travel forward		
	Enable switch not activated	Activate enable switch
	Function not activated within the 3 seconds after enable switch was depressed	Reactivate enable switch
	Enable switch not functioning properly	Replace enable switch circuit card
	Hydraulic system oil low	Replenish oil as necessary
	Restricted or broken hydraulic line or fitting	Clean, repair or replace line or fitting
	Controller not adjusted properly	Correctly adjust controller
	Control valve not functioning properly	Repair or replace valve
	Drive motor(s) not functioning properly	Repair or replace motor(s)
	Defective controller	Repair or replace controller
Machine will not travel in reverse		
	See: Machine will not travel forward	
High speed function does not operate		
	Loose or damaged wiring between controller and high speed switch	Ensure proper connection of wires. Using suitable test meter, perform continuity test on wiring between controller and switches. Repair or replace wires as necessary.
	Defective high speed control switch	Replace switch
	Loose or damaged wire in control box wire harness	Ensure proper connection of wire at the control switch. Using suitable test meter, perform continuity test on wire. repair or replace harness as necessary.

Table 3-2. Chassis Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	Loose or damaged wire between platform and high speed solenoid	Ensure proper connection of wire at the platform and at the high speed solenoid. Using suitable test meter, perform continuity test on wire. repair or replace harness as necessary.
	High speed solenoid not functioning properly	Replace e solenoid
	Loose or damaged wires between high sped relay and high speed limit switch	Ensure proper connection of wires between high speed relay and high speed limit switch. Using suitable test meter, perform continuity test on wire. repair or replace harness as necessary.
	High speed limit switch not functioning properly	Repair or replace limit switch
	Loose or damaged wire in valve wiring harness	Ensure proper connection of wires at the terminal strip. Using suitable test meter, perform continuity test on wire. repair or replace harness as necessary.
STEERING SYSTEM		
No response to control		
	Enable switch not activated	Activate enable switch
	Function not activated within the 3 seconds after enable switch was depressed	Reactivate enable switch
	Enable switch not functioning properly	Replace enable switch circuit card
	Hydraulic system oil low	Replenish oil as necessary
	Damaged wiring on control switch or solenoid valve	See proper wiring diagram
	Controller not functioning properly	Replace controller
	Restricted or broken hydraulic line on valve bank or hydraulic pump	Clean repair or replace line
	Control valve not functioning properly	Repair or replace valve
	Steer cylinder not functioning properly	Repair or replace steer cylinder
Machine hard to steer or steering is erratic		
	Hydraulic system oil low	Replenish oil as necessary
	Restricted hydraulic line or fitting	Clean, repair or replace line or fitting
	Lack of lubrication	Lubricate as required (refer to lubrication chart)
	Restricted crossover relief valve (pressure low)	Clean or replace valve
	Steer system pressure low	Adjust pressure
	Bent steering linkage	Repair or replace linkage as required
	Hydraulic pump not functioning properly	Repair or replace pump
	Steer cylinder not functioning properly	Repair or replace cylinder
	Tire pressure low	Correct tire pressure
	Bent or seized spindle	Replace spindle
Steering inoperative		
	Damaged wiring on controller or solenoid valve	See proper wiring diagram
	Solenoid valve not functioning properly	Repair or replace valve
	Controller not functioning properly	Replace controller
	Relief valve improperly set or not functioning properly	Reset, repair or replace valves as required
	Steer cylinder not functioning properly	Repair or replace steer cylinder

Table 3-2. Chassis Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Machine will not steer left or right		
	Enable switch not activated	Activate enable switch
	Function not activated within the 3 seconds after enable switch was depressed	Reactivate enable switch
	Enable switch not functioning properly	Replace enable switch circuit card
	Wiring on controller is damaged	Repair or replace wiring
	Wiring on solenoid valve is damaged	Repair or replace wiring
	Coil in solenoid is damaged	Replace coil
	Bent cylinder rod	Repair or replace cylinder
	Damaged steer linkage	Repair or replace steer linkage
	Crossover relief valve stuck	Repair or replace crossover relief valve
	Pressure setting incorrect	Reset pressure setting
Machine wanders; steering not firm		
	Crossover relief valve set too low or not functioning properly	Reset, repair or replace valve as required
	Steer linkages loose	Tighten linkage
	Steer wheel toe-in not set properly	Adjust toe-in for 1/4 inch overall
	Spindle bushings badly worn	Replace bushings
	Spindle bushings to tight	Replace bushings
OSCILLATING AXLE (IF EQUIPPED)		
Axle will not oscillate		
	Defective lockout cylinder	Repair or replace cylinder
	Lockout valve sticking	Repair or replace valve
	Lack of lubrication on axle pin	Lubricate pin
	Lockout valve defective	Repair or replace valve
Axle will not lock		
	Air in lockout system	Bleed lockout system
	Defective lockout valve	Repair or replace valve
	Defective pressure reducing valve feeding lockout system	Repair or replace valve

Table 3-3. Chassis Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	ENGINE	
Engine will not start		
	Station power selector switch is not in required position	Actuate switch as required
	Circuit breaker open	Determine and correct cause. Reset circuit breaker
	Start lockout solenoid not working	Replace solenoid
	Start switch defective	Replace start switch
	Defective anti-dieseling solenoid on carburetor	Replace solenoid or carburetor
	Damaged wiring in ignition circuit (broken wire on starter	repair or replace wiring
	Ignition switch not functioning properly	Replace switch
	Defective ignition module	Replace ignition module
	Ignition circuit shorted to ground	Repair circuit card as required
	Battery cable(s) not making contact	Clean and tighten cables
Engine will not star (Ignition O.K.)		
	No fuel	Replenish fuel as necessary
	Restricted or broken fuel line	Clean or replace line
	Battery defective or requires charging	Charge or replace battery as required
Engine will not accelerate above low speed		
	Damaged wiring on speed control switch on governor solenoid	Repair or replace wiring
	Speed control switch not functioning properly	Replace switch
	Defective precision governor (Ford)	Repair or replace governor
	Defective Adeco throttle actuator (Deutz)	Repair or replace actuator
	Governor not functioning properly	Repair or replace governor
	Defective electronic governor	Replace governor
Engine will not decelerate below high speed		
	See engine will not accelerate above low speed	

Table 3-4. Hydraulic System Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
Hydraulic pump noisy		
	Air entering system through broken line or fitting	Repair or replace line or fitting
	Air bubbles in oil	Replenish oil as required
	Faulty pump coupler	Replace coupler
	Defective pump bearing	Repair or replace pump
	Oil filter(s) dirty	Clean and/or replace filter(s) as necessary
Pump cavitating (Vacuum in pump due to oil starvation		
	Restricted suction line	Clean, repair, or replace line
	OIl in reserve low	Replenish oil to proper level
	Restricted reservoir air vent	Clean vent
	Oil viscosity to high	Drain system and replace with recommended oil (Refer to hydraulic oils)
	Leak in suction line or manifold	Repair or replace line or manifold as necessary
System overheating		
	Oil viscosity to high	Drain system and replace with recommended oil (Refer to hydraulic oils)
	Restricted or blocked hydraulic line	Repair or replace line
	Machine overloaded	Check weight in platform
	Main relief valve set too high	Reset valve as required
	Hydraulic system oil low	Replenish oil as necessary
Pump not delivering oil		
	Restricted suction line	Clean repair or replace line
	Air entering system through broken line or fitting (suction side)	Replace or repair line or fitting
	Oil level too low	Replenish oil to proper level
	Plugged strainer in tank	Clean strainer
	Pump coupling defective	Replace pump coupling
	Broken pump drive shaft	Repair or replace pump
System pressure too low		
	Main relief valve set too low	Reset valve as required
	Main relief valve stuck in open position	Clean, repair or replace valve (Check system oil for contamination)
	Hydraulic pump not functioning properly	Repair or replace pump
	Leak in component, line or fitting	Repair or replace component, line or fitting
	Scored valve spool; Scored cylinder	Replace valve; Replace cylinder
System(s) operate erratically		
	Sticking or binding valve spools, piston rod, etc	Clean, repair or replace components as required
	Hydraulic oil not a t optimum operating temperature	Allow oil sufficient time to warm up
	Pump drive slipping	Repair or replace drive

Table 3-5. Electrical System Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
HAND CONTROLLER		
Regardless of which way handle is moved, only one function occurs		
	Improper or loose wiring to the solenoid(s)	Check all wiring for proper connections
	Directional valve stuck in one direction	Repair or replace valve
Valve will not function when handle is moved in either direction		
	Enable switch not activated	Activate enable switch
	Function not activated within the 3 seconds after enable switch was depressed	Reactivate enable switch
	Enable switch not functioning properly	Replace enable switch circuit card
	No electrical power to handle	Check electrical input to hand controller (12V)
	No electrical power to valve	Check electrical output of printed circuit board and electrical signal at the valve
	Improper ground	Check for proper grounding of handle
	Defective controller	Repair or replace controller
	Microswitches on controller bad or need adjustment	Adjust or replace switches
CONTROL SWITCHES		
No response to a function control switch		
	Emergency stop switch not positioned properly	Place emergency stop switch to on
	Platform/Ground select switch not positioned properly	Place switch to platform or ground, as necessary
	Circuit breaker open	Determine and correct cause. Reset circuit breaker
	No voltage present at emergency stop switch	Check battery cable from battery to emergency stop switch for proper connection or damage. Repair or replace cable as necessary
	Emergency stop switch not functioning properly	Replace switch
	No voltage supplied to start relay from emergency stop switch	Check battery cable from switch to relay for proper connection or damage. Repair or replace cable as necessary
	No voltage input at terminal strip	Check wire from battery to terminal strip for proper connection or damage. Repair or replace cable as necessary
	No voltage present at circuit breaker	Check wire from terminal strip to battery for proper connection or damage. Repair or replace cable as necessary
	Defective circuit breaker	Replace circuit breaker
	No voltage present at Platform/Ground select switch	Unplug ground control box harness from platform receptacle. check wire from applicable pin in plug to control box power switch for proper connection. Using suitable test meter, perform continuity test on wire. Repair or replace harness as necessary

Table 3-5. Electrical System Troubleshooting

TROUBLE	PROBABLE CAUSE	REMEDY
	Defective Platform/Ground select switch	Replace Platform/Ground select switch
	No voltage e present at function control switch	Check wiring from power switch to function control switch for proper connection or damage. Repair or replace wiring as necessary
	Defective function control switch	Replace function control switch
	No voltage present at applicable control valve coil	Check applicable wire for proper connection at terminal strip, valve harness plug pin, valve harness receptacle pin and valve coil. Using suitable test meter, perform continuity test on wire. Repair or replace harness as necessary
	No voltage supplied to motor from start relay	Check battery cable from relay to motor for proper connection or damage. Repair or replace cable as necessary
	Defective motor/pump assembly	Replace motor/pump assembly
ENGINE STARTER SYSTEM		
Engine will not crank		
	Discharged battery or loose battery terminals	Check and charge battery or replace battery as necessary. Clean and secure battery terminals
	Starter relay faulty or faulty relay connections	Using a test meter, check relay coil terminals for presence of electrical power and for energization of relay coil. Also check relay terminals for correct switching of contacts. Replace relay as necessary
	Malfunctioning starter solenoid or motor	Replace solenoid or motor in accordance with applicable manufacturer's manual
	Defective start lockout solenoid	Replace start lockout solenoid
	Malfunctioning ignition switch	Using a test meter, check ignition switch for correct switching of contacts. replace switch as necessary
	Faulty ignition and/or starter circuit wiring	Check wiring continuity. refer to wiring diagram
	Defective ring gear or flywheel	Replace ring gear
INSTRUMENTS AND INDICATORS		
Ammeter inoperative		
	Damaged wiring in circuits	Repair or replace wiring
	Ammeter not functioning properly	Replace ammeter
	Alternator not charging	Repair or replace alternator
Travel warning horn inoperative		
	Circuit breaker open	Determine and correct cause
	Damaged wiring in horn circuit	Replace horn
	Damaged wiring in hourmeter circuit	Repair or replace wiring
	Inoperative hourmeter	Replace hourmeter

NOTES:

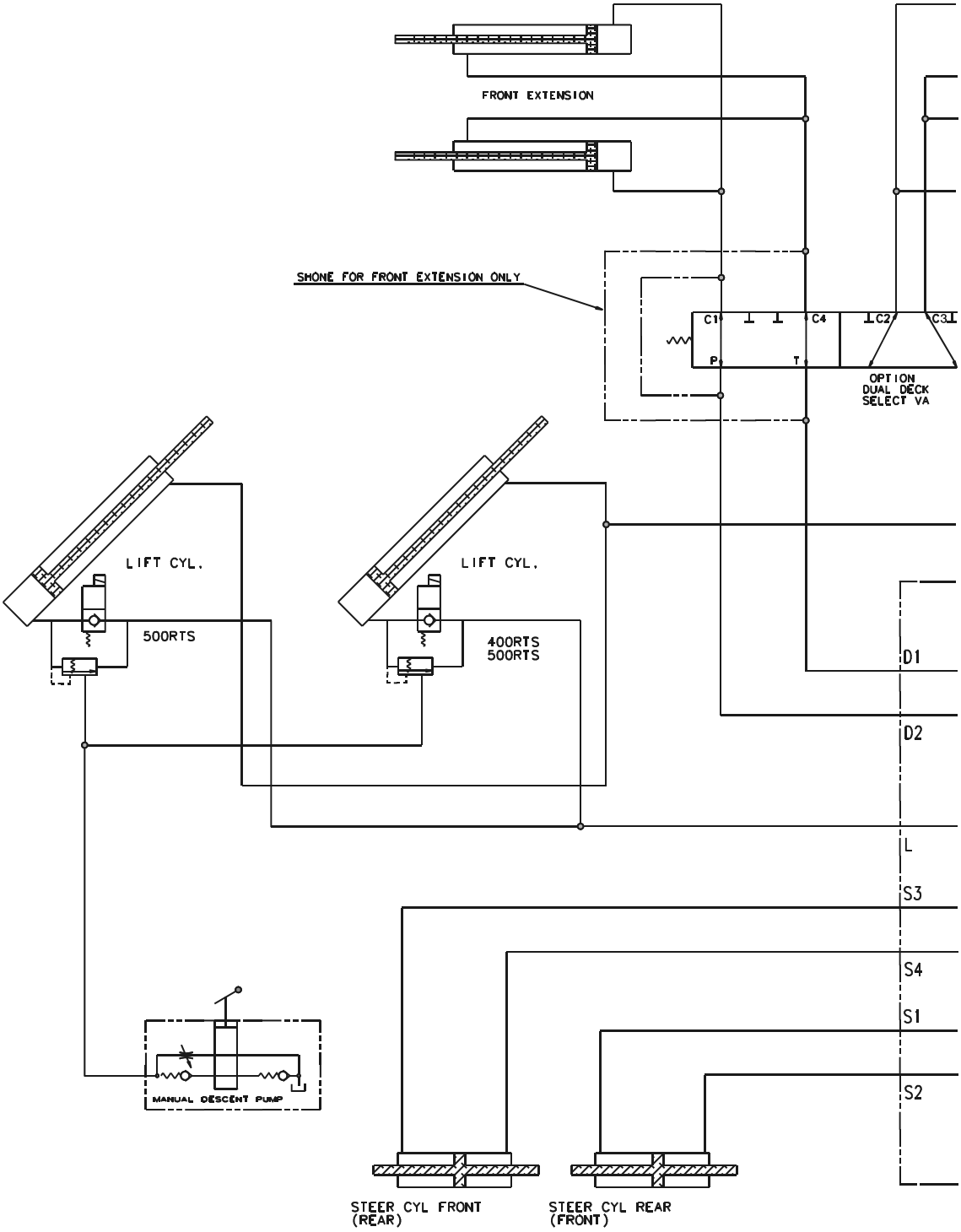


Figure 3-1. Hydraulic Schematic (Sheet 1 of 6)

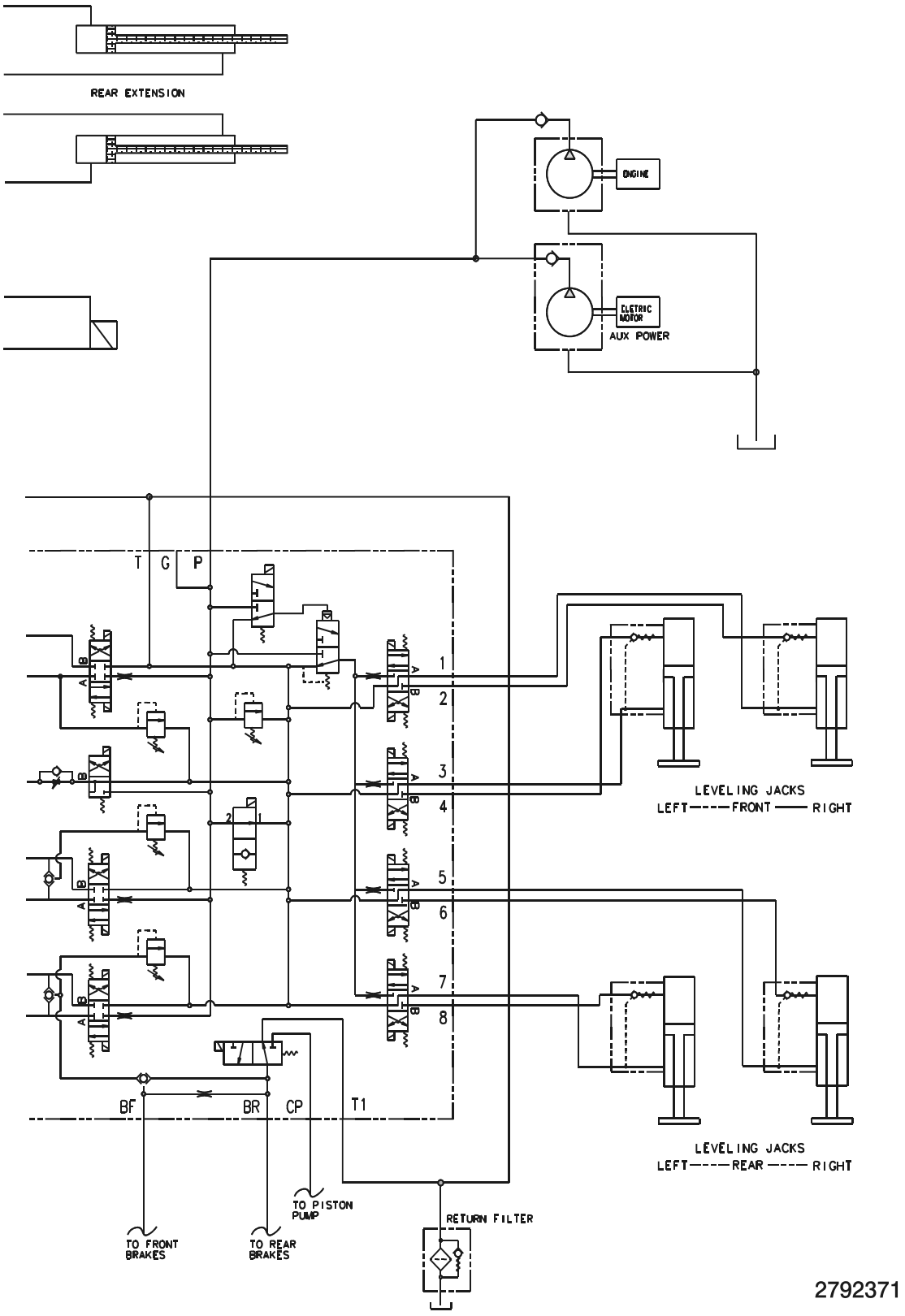


Figure 3-2. Hydraulic Schematic (Sheet 2 of 6)

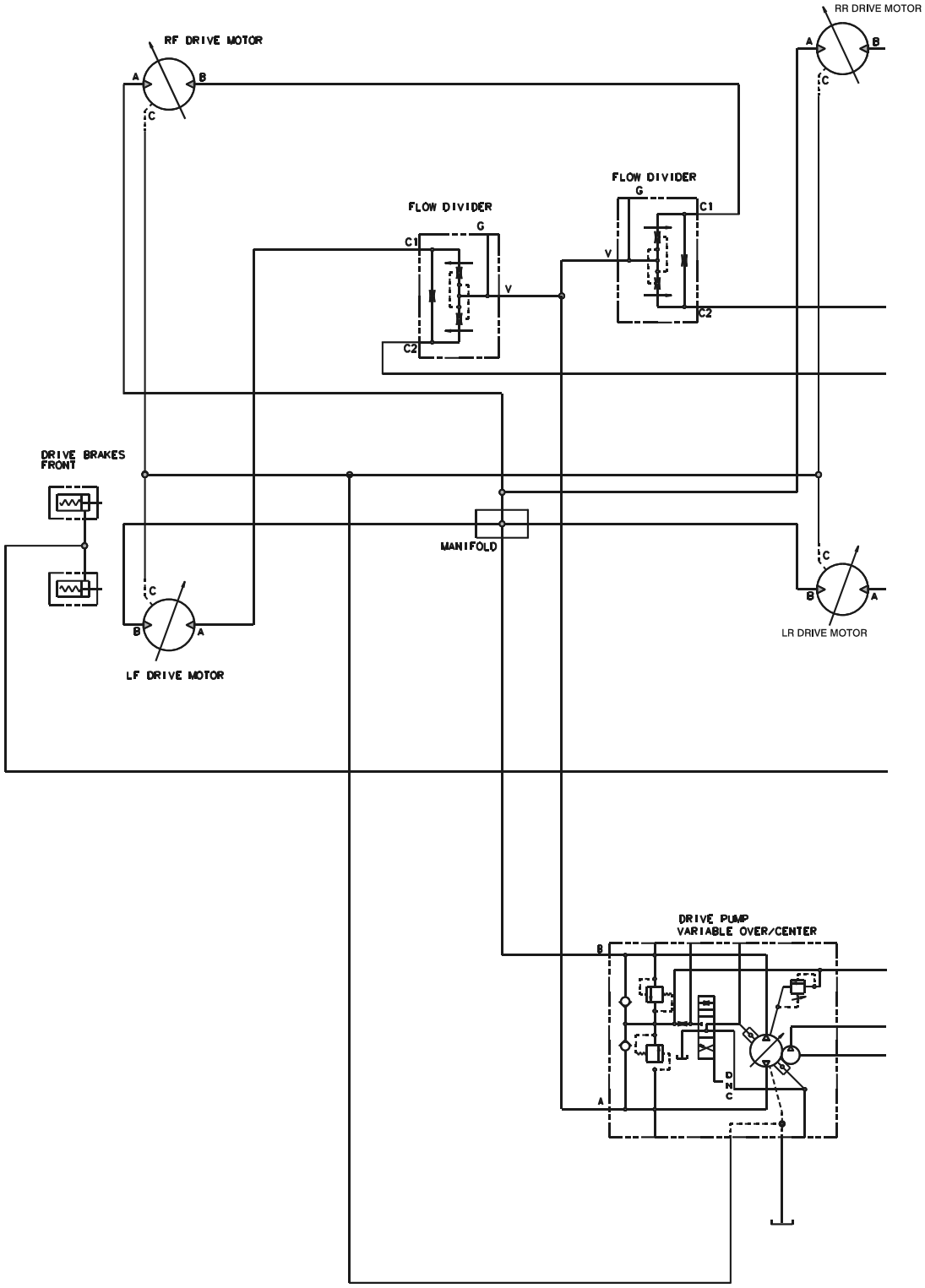


Figure 3-3. Hydraulic Schematic (Sheet 3 of 6)

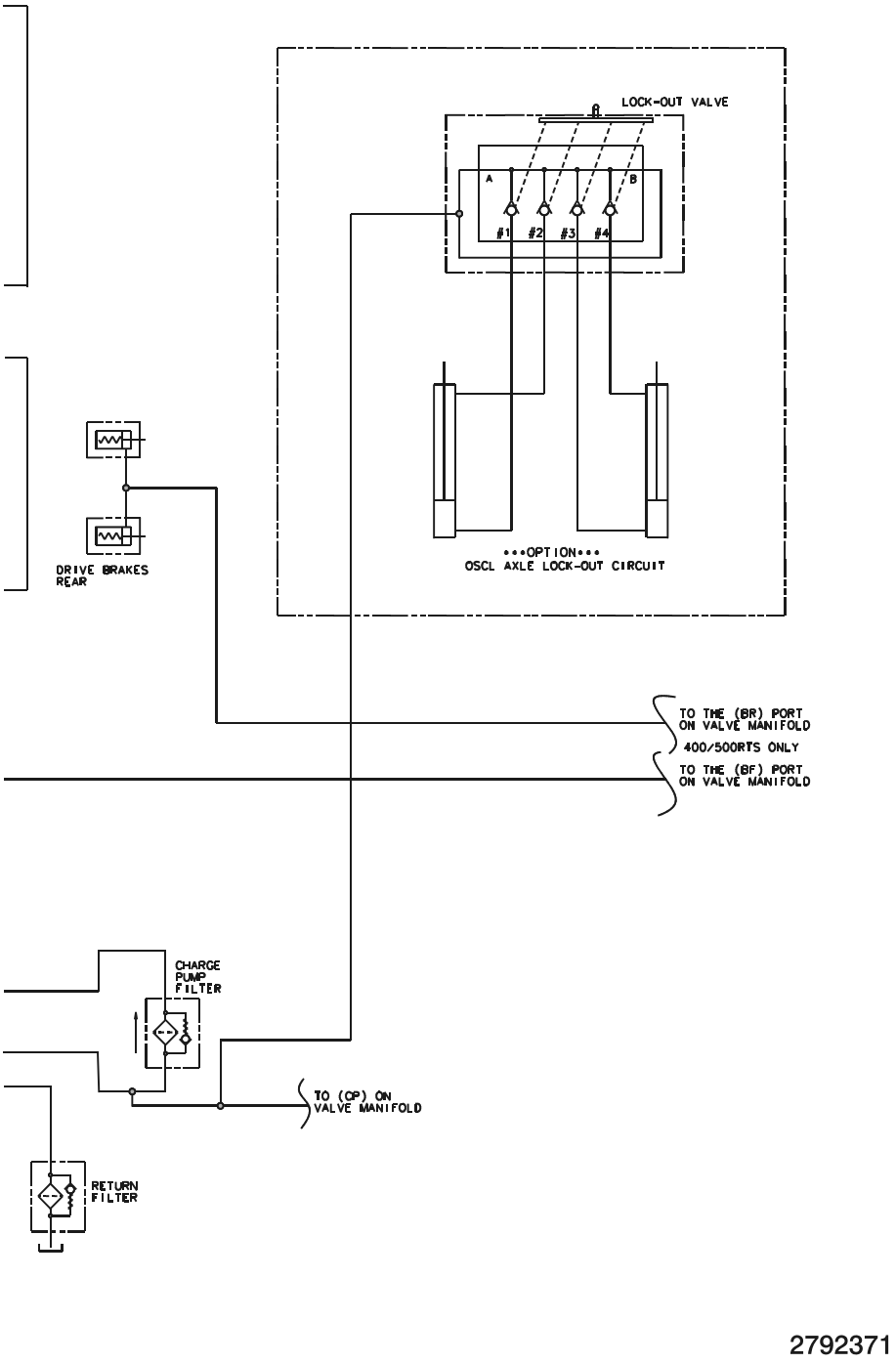


Figure 3-4. Hydraulic Schematic (Sheet 4 of 6)

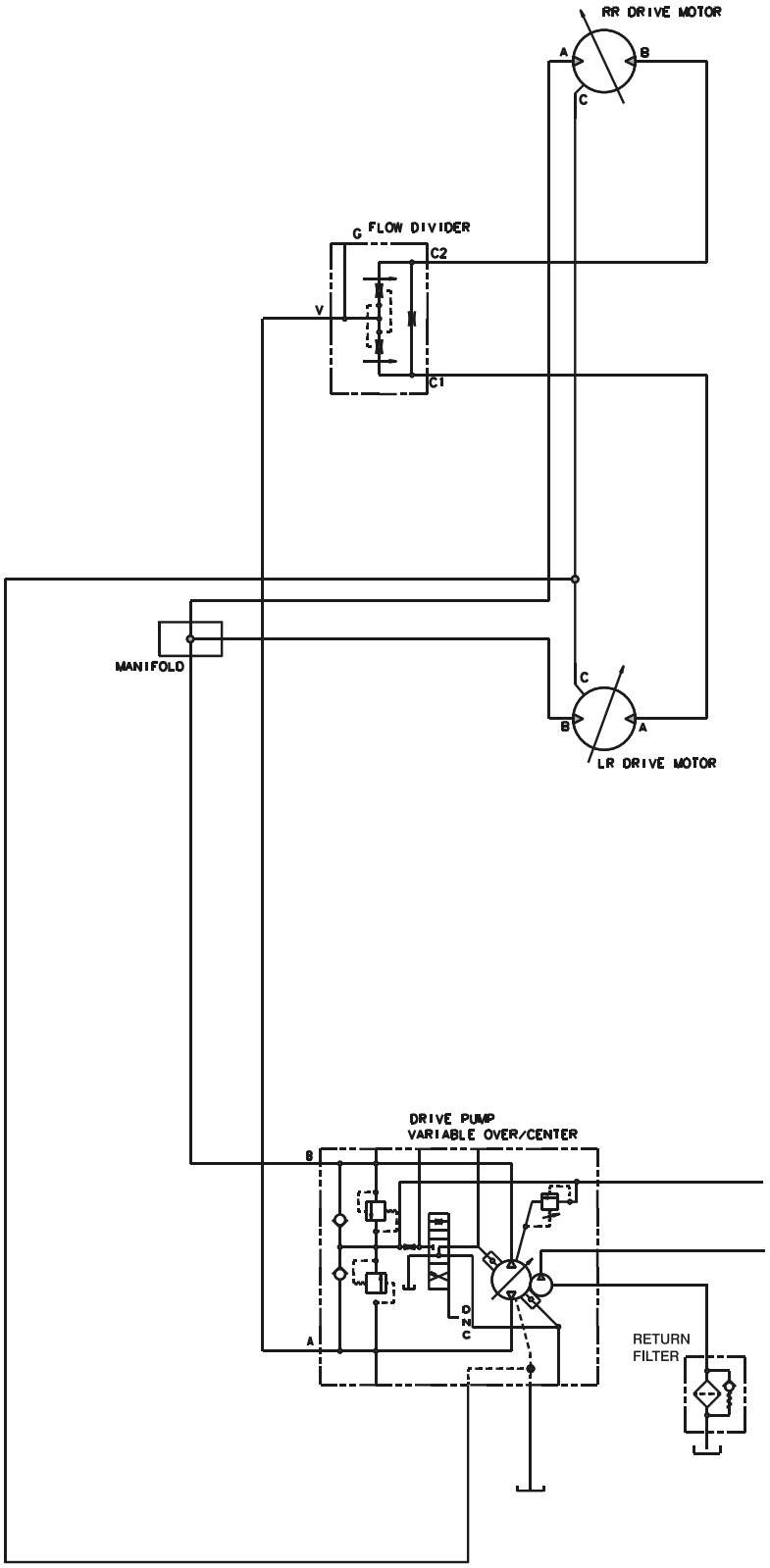


Figure 3-5. Hydraulic Schematic (Sheet 5 of 6)

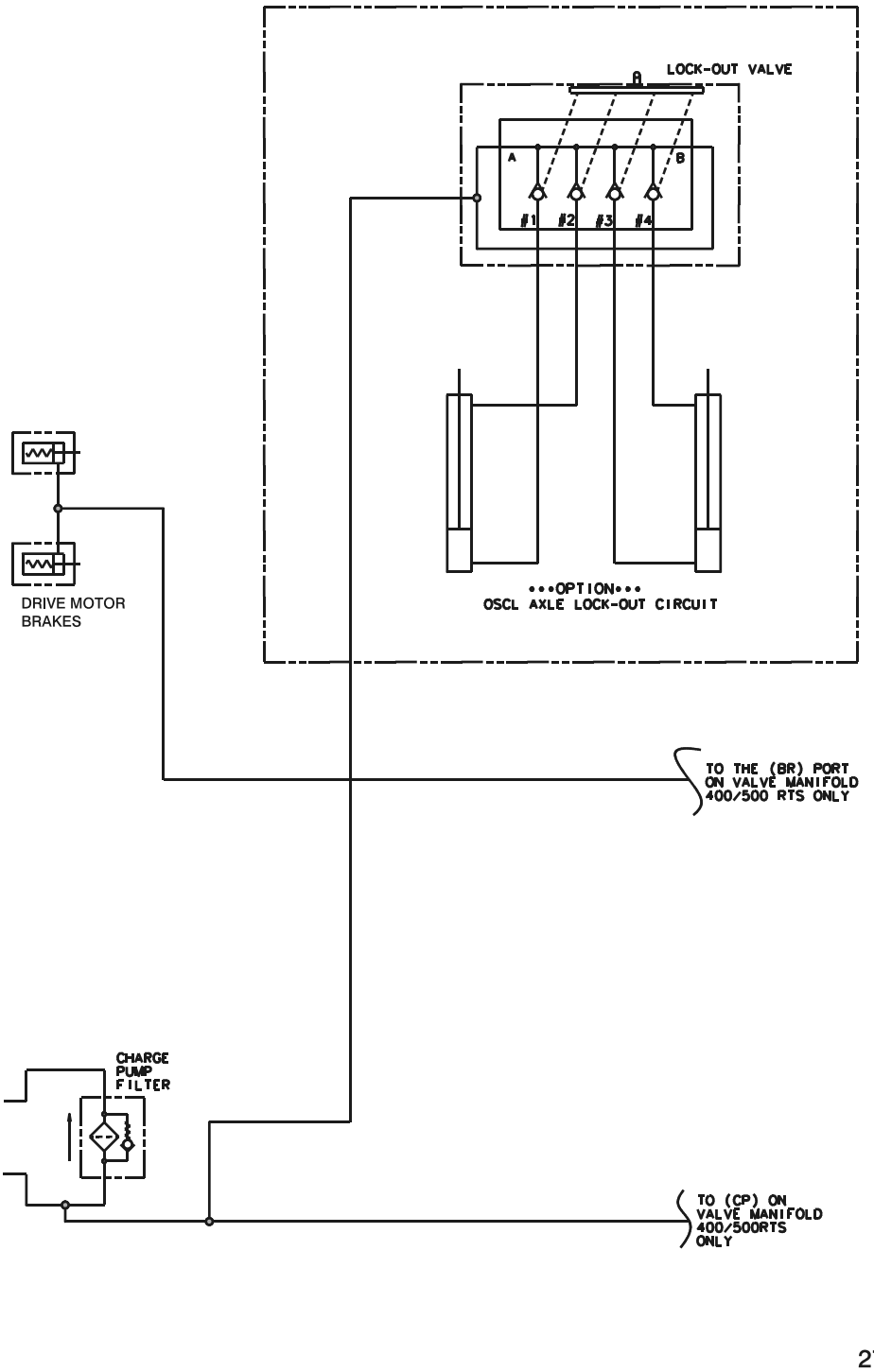


Figure 3-6. Hydraulic Schematic (Sheet 6 of 6)

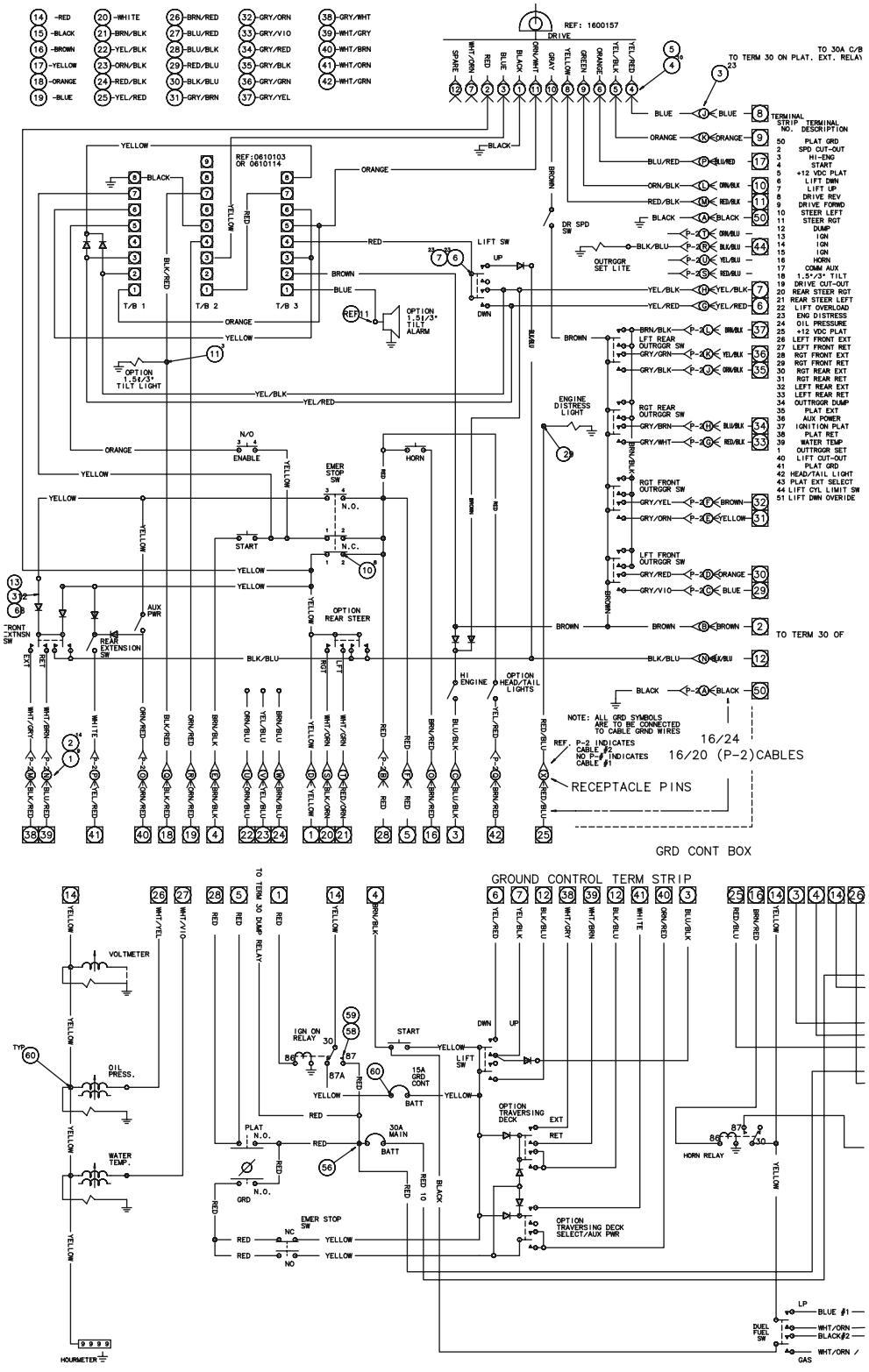


Figure 3-7. Electrical Schematic - 400 RTS - Ford LRG (Sheet 1 of 4)

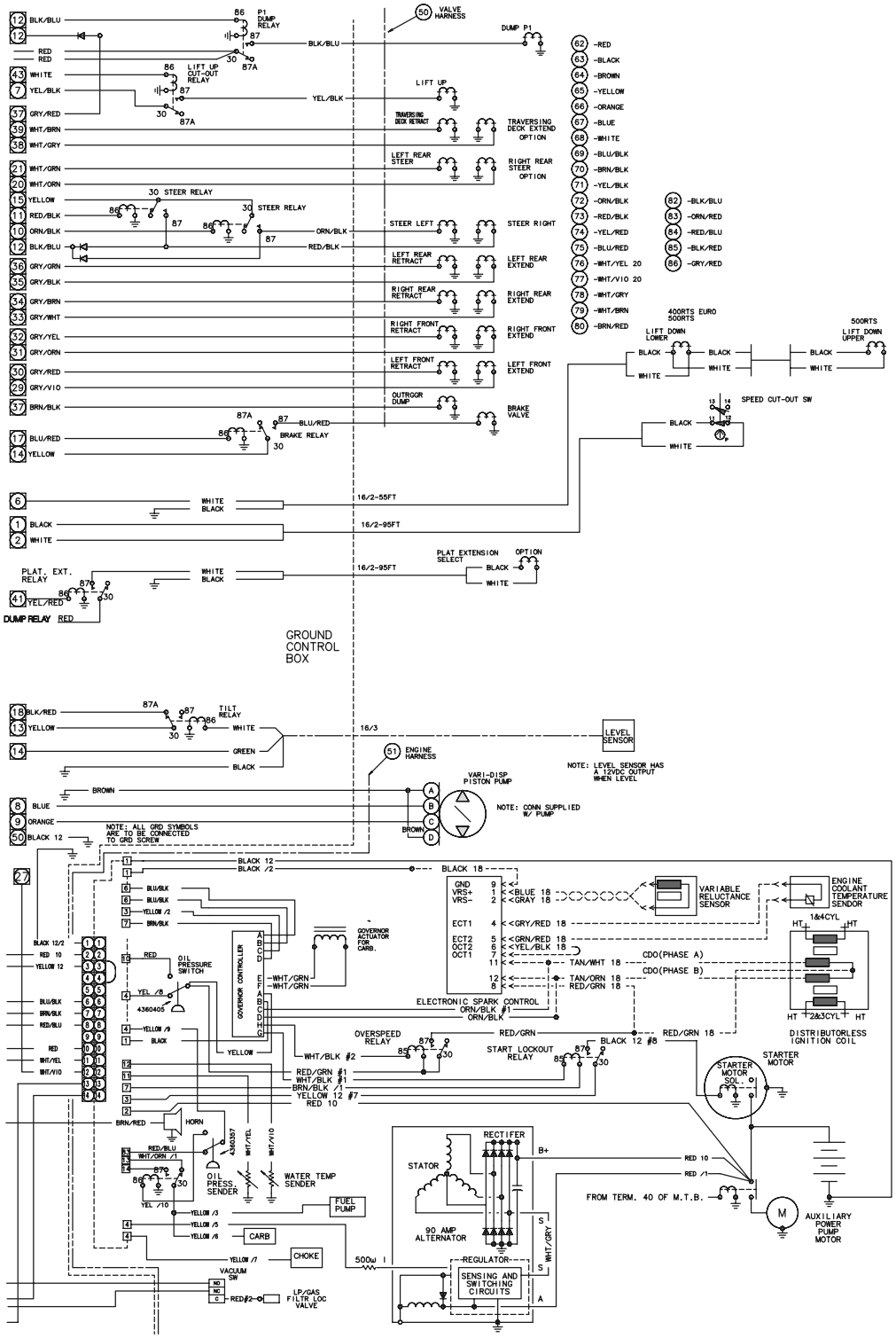


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Figure 3-8. Electrical Schematic - 400 RTS - Ford LRG (Sheet 2 of 4)

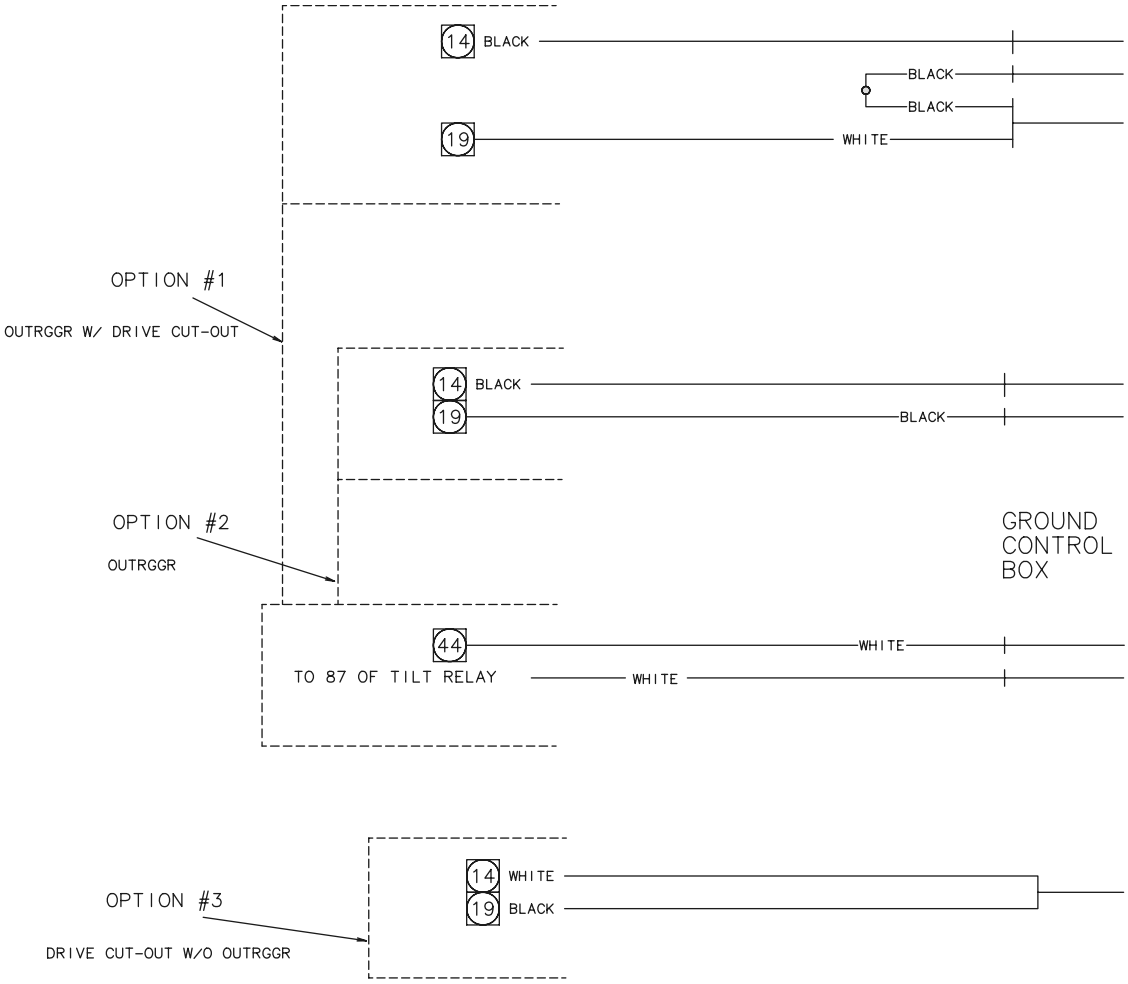

Figure 3-9. Electrical Schematic - 400 RTS - Ford LRG (Sheet 3 of 4)

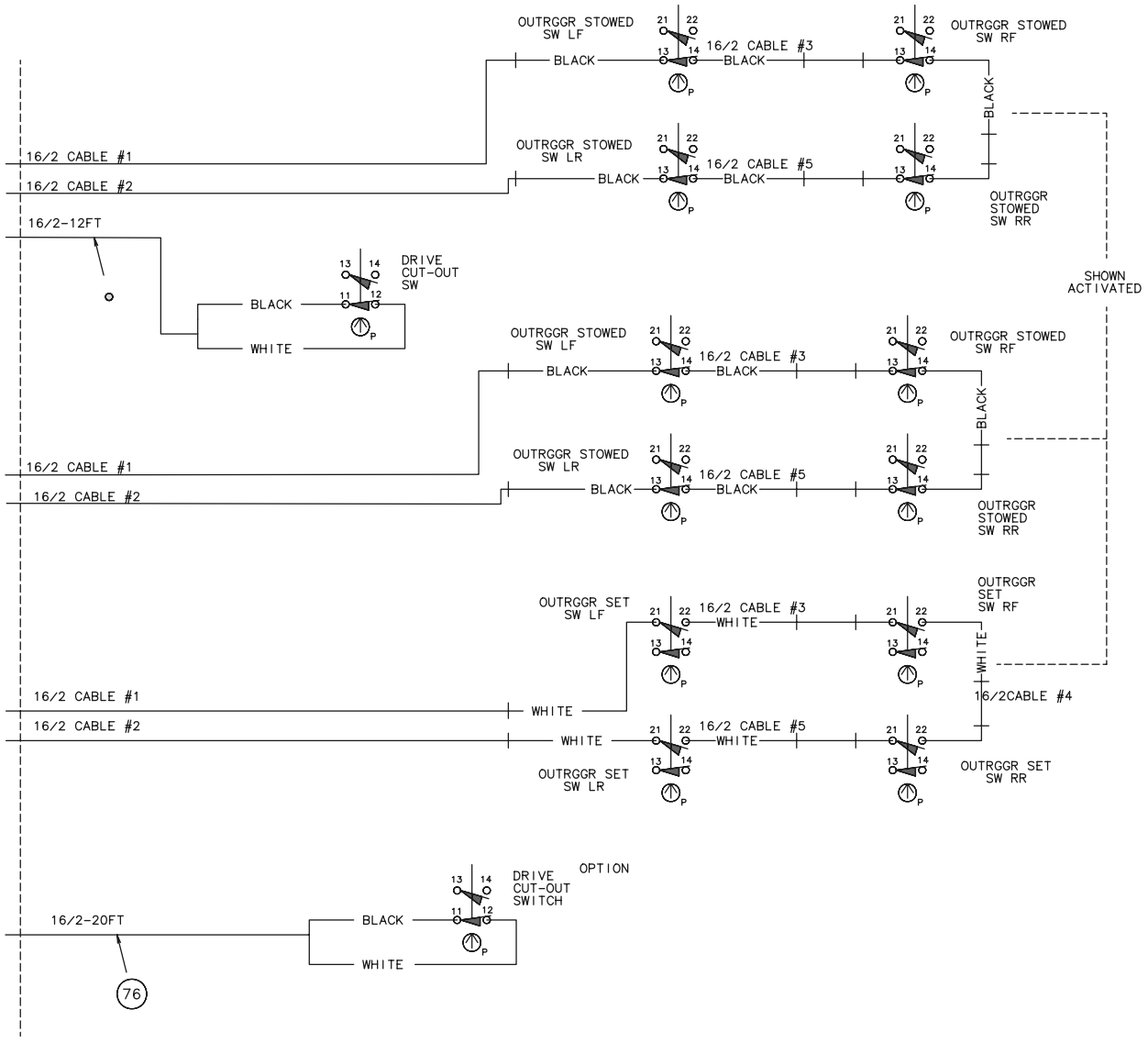

Figure 3-10. Electrical Schematic - 400 RTS - Ford LRG (Sheet 4 of 4)

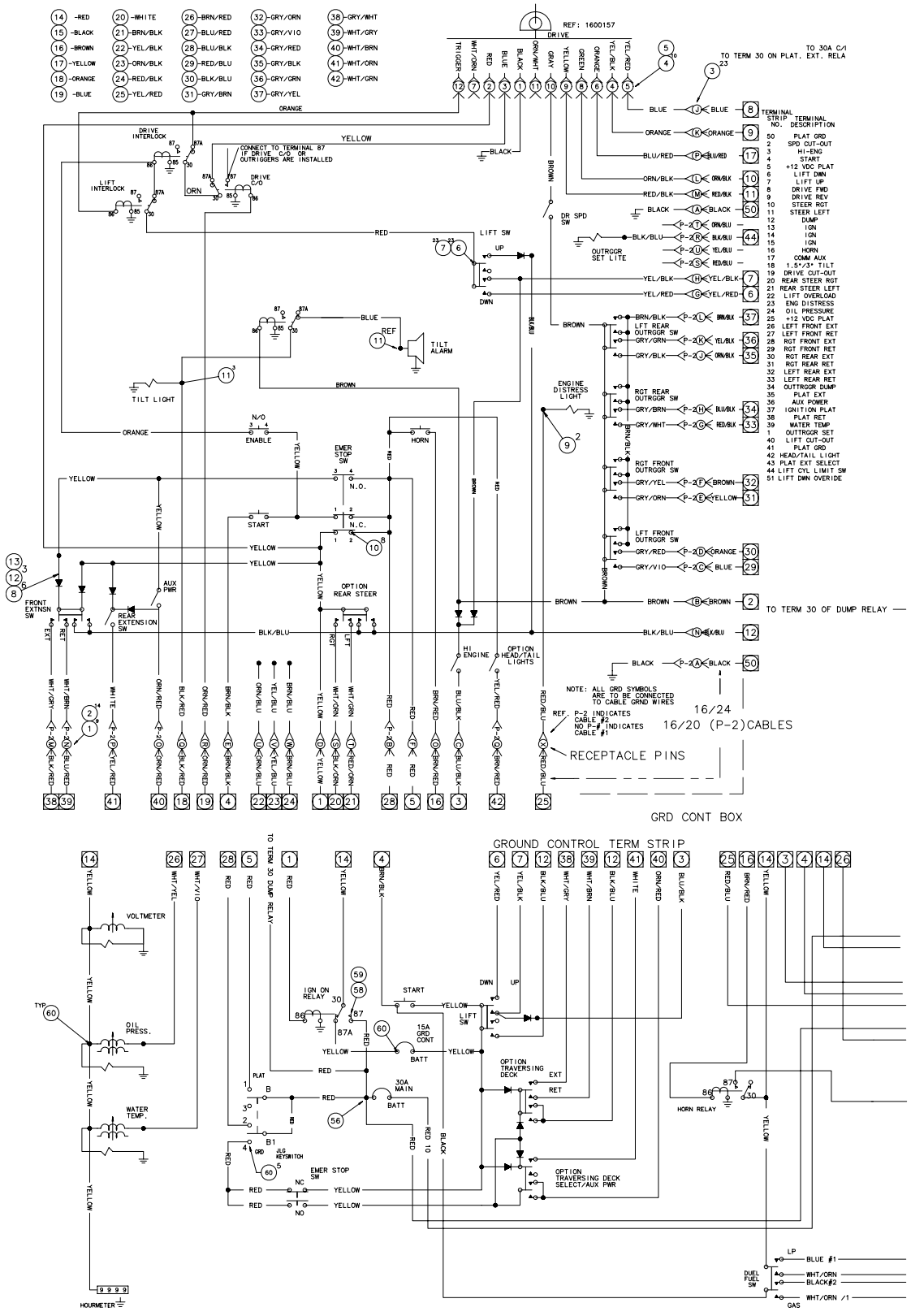

Figure 3-11. Electrical Schematic - 400RTS - Ford LRG (Sheet 1 of 3)

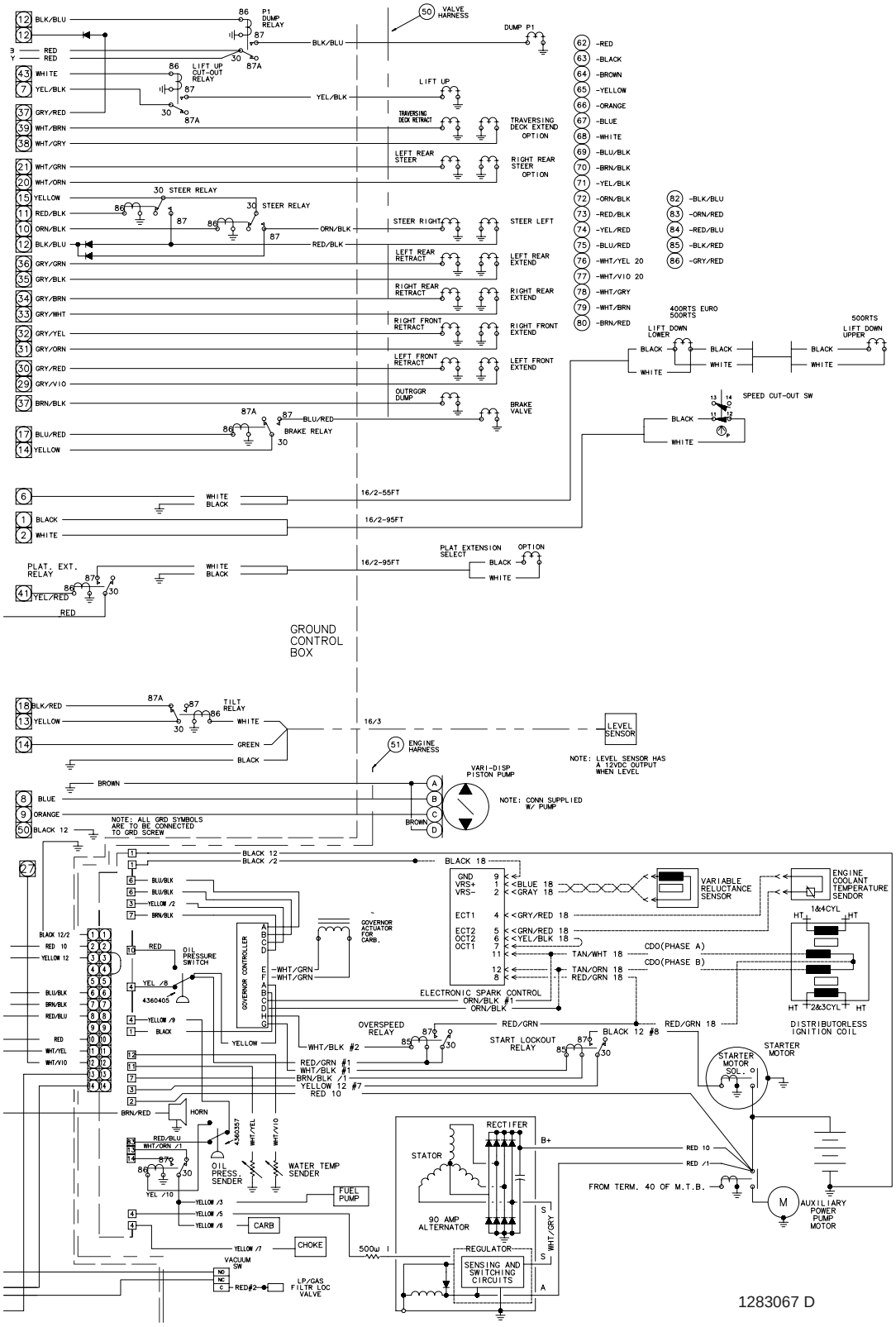

Figure 3-12. Electrical Schematic - 400RTS - Ford LRG (Sheet 2 of 3)

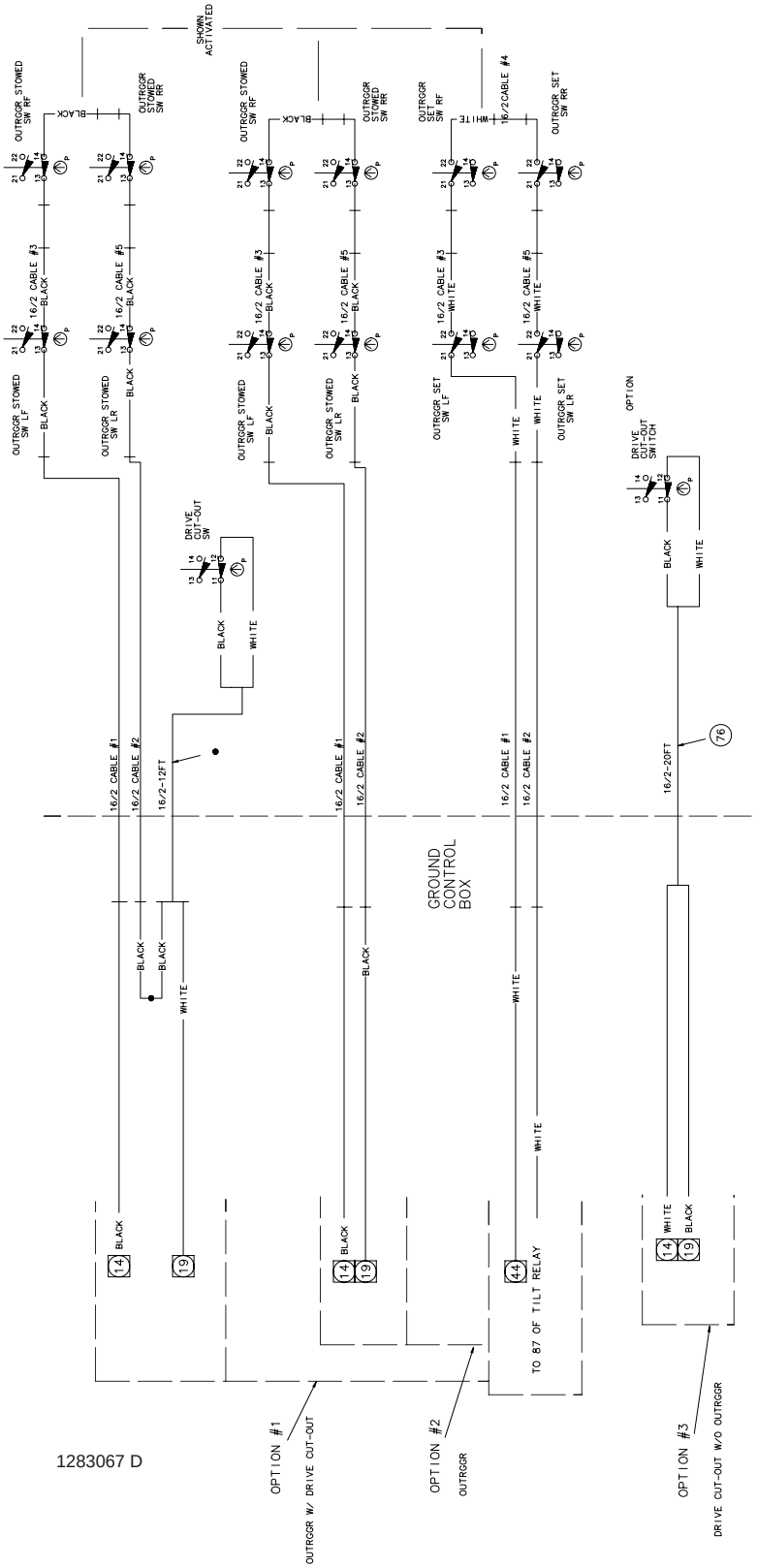

Figure 3-13. Electrical Schematic - 400RTS - Ford LRG (Sheet 3 of 3)

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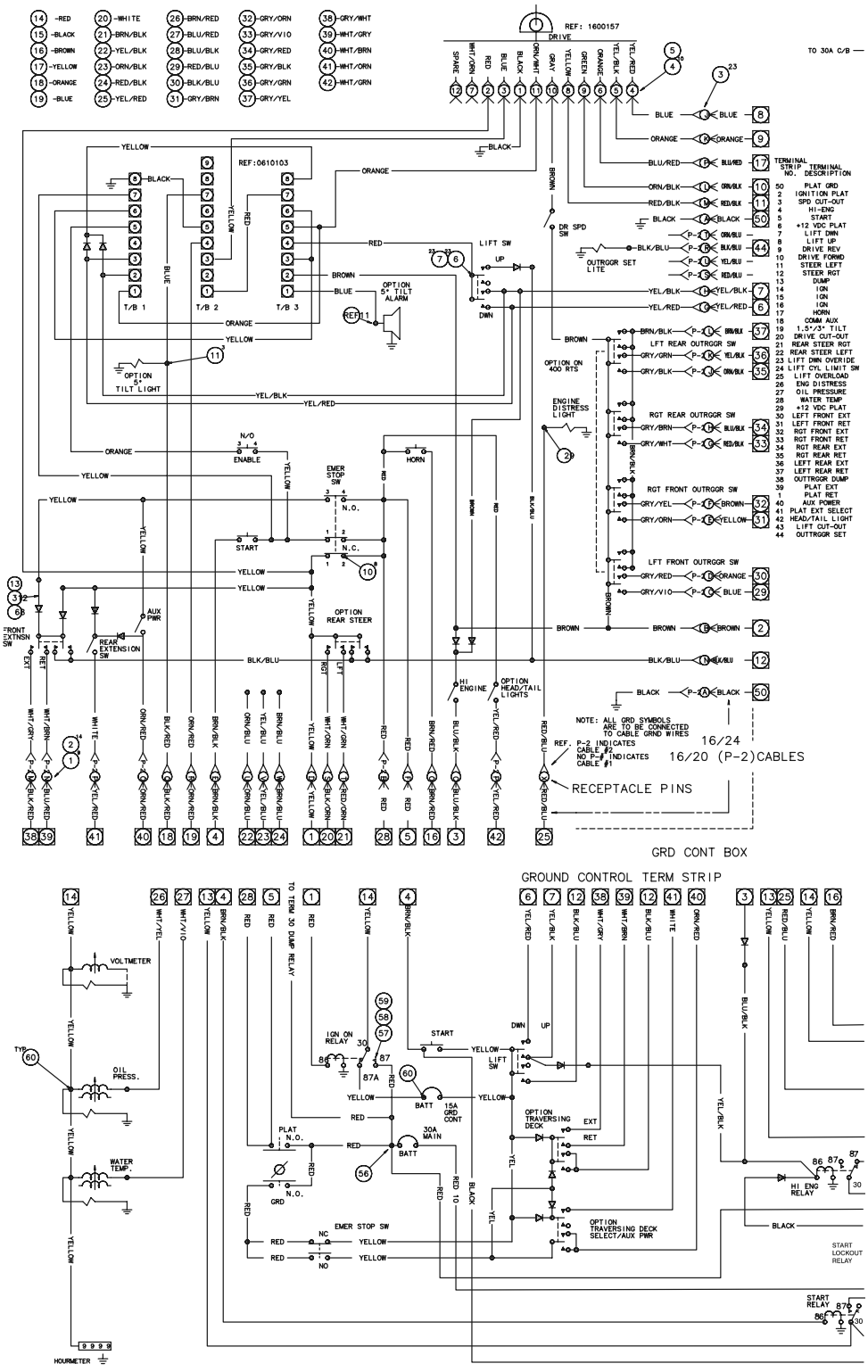

Figure 3-14. Electrical Schematic - 400 RTS - Ford VSG (Sheet 1 of 4)

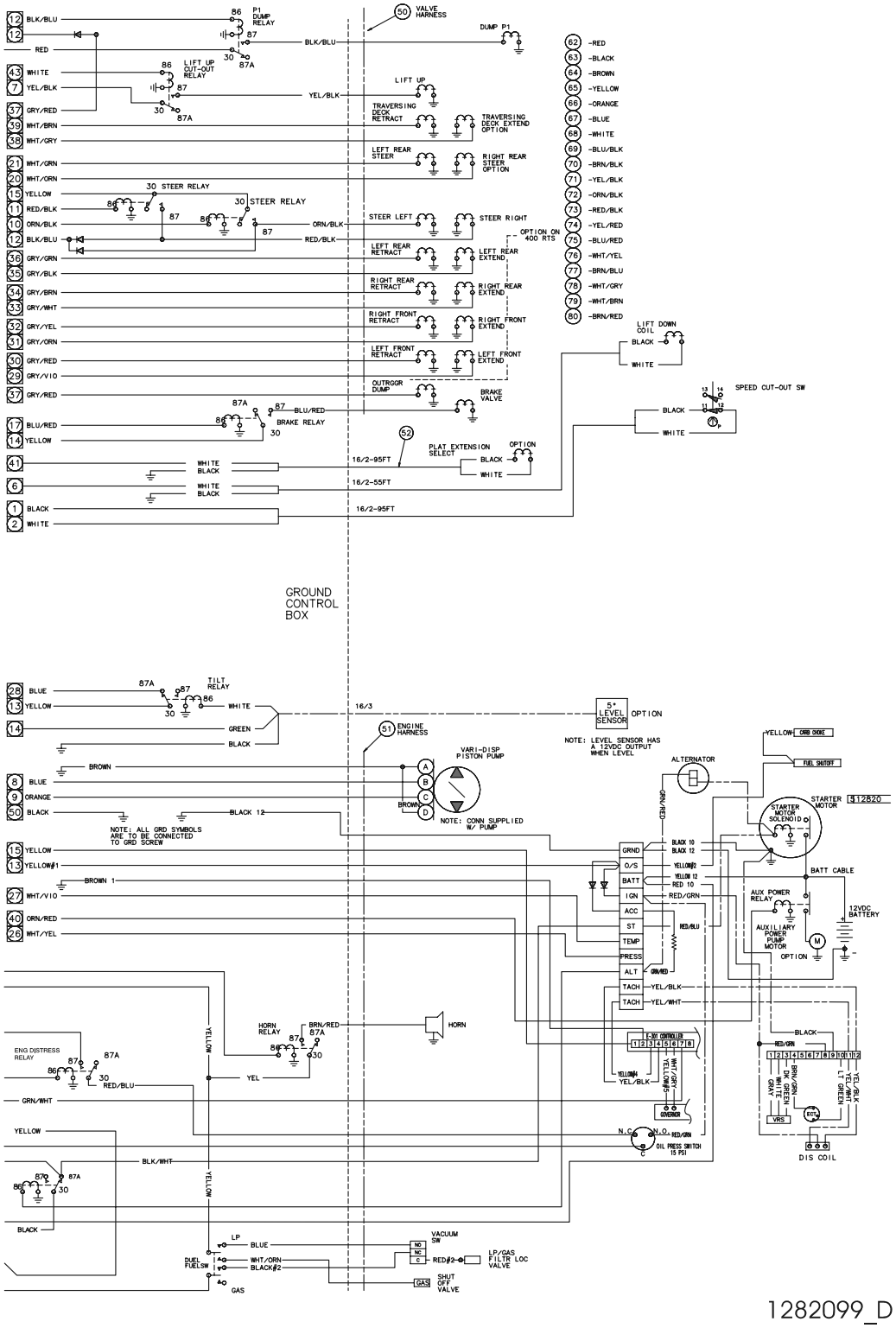

Figure 3-15. Electrical Schematic - 400 RTS - Ford VSG (Sheet 2 of 4)

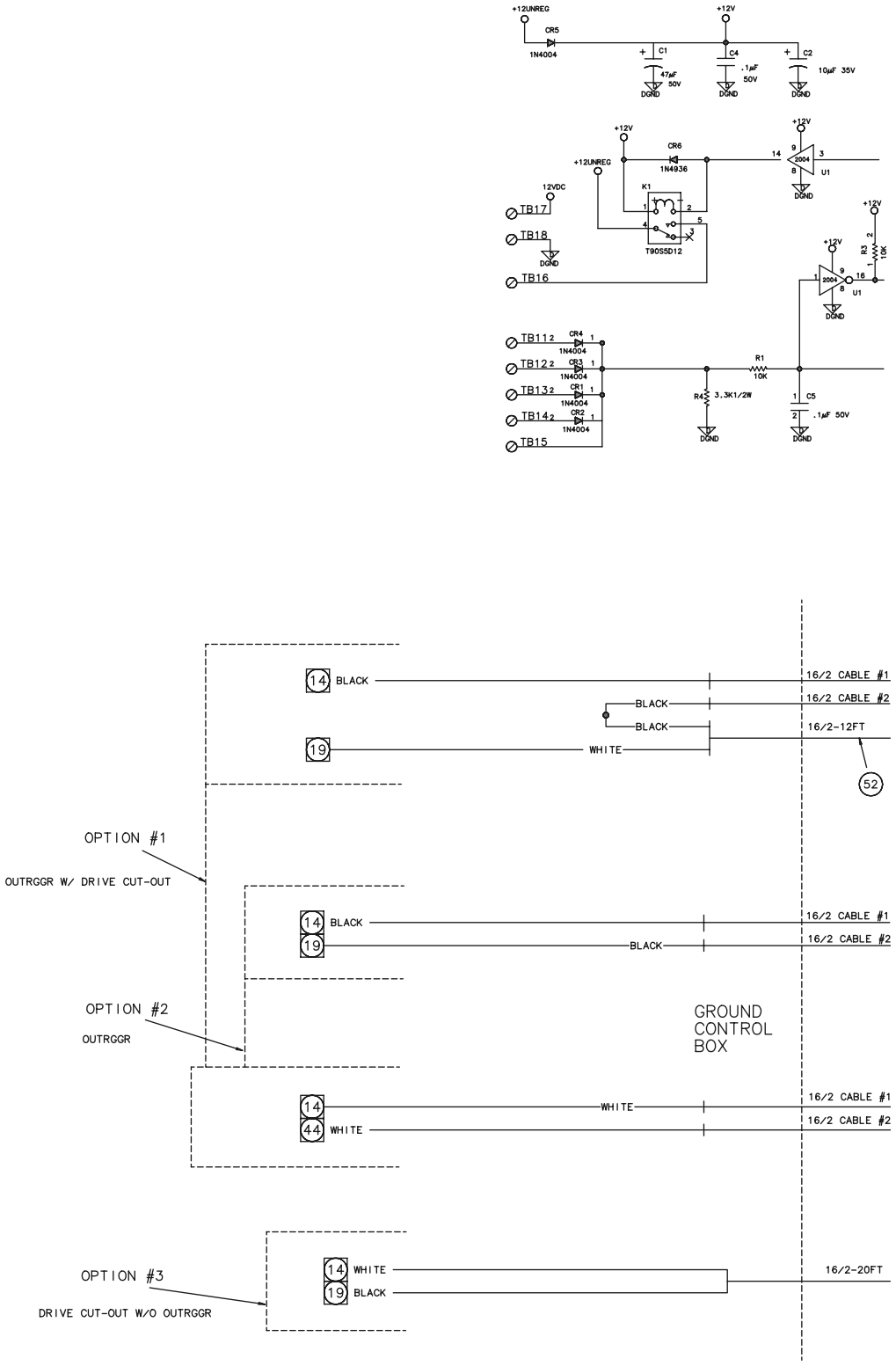

Figure 3-16. Electrical Schematic - 400 RTS - Ford VSG (Sheet 3 of 4)

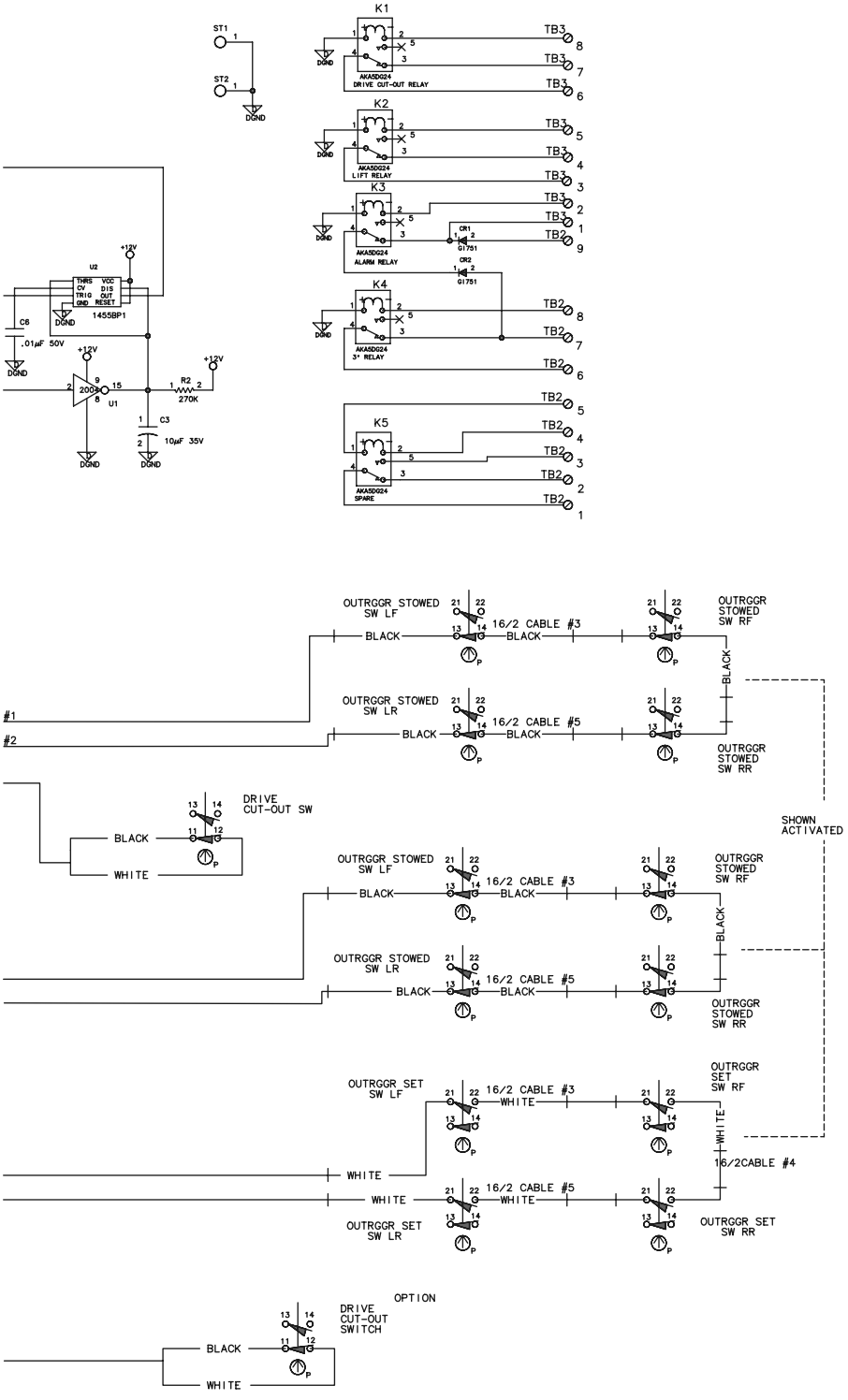

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Figure 3-17. Electrical Schematic - 400 RTS - Ford VSG (Sheet 4 of 4)

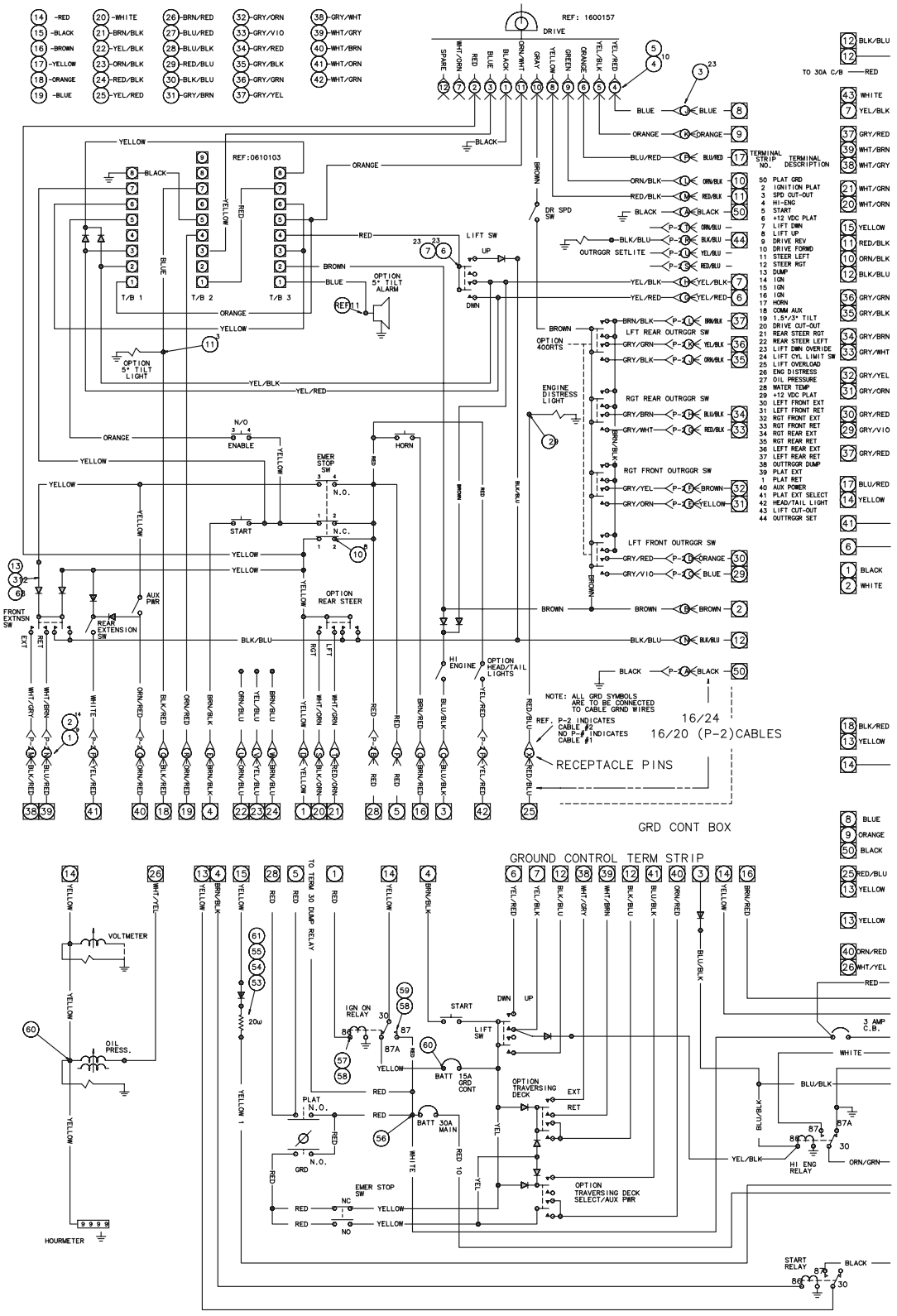

Figure 3-18. Electrical Schematic - 400RTS - Deutz (Sheet 1 of 4)

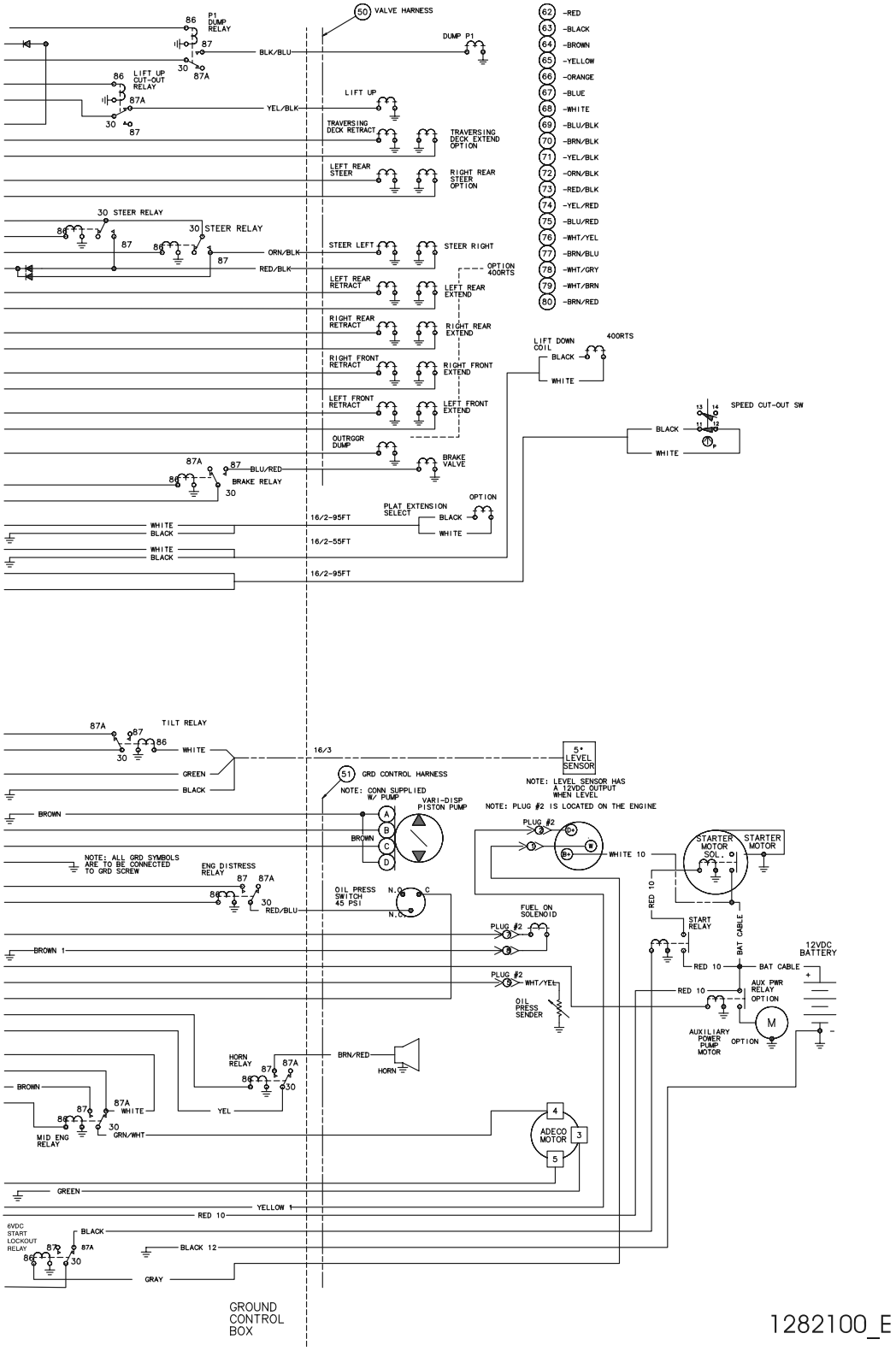

Figure 3-19. Electrical Schematic - 400RTS - Deutz (Sheet 2 of 4)

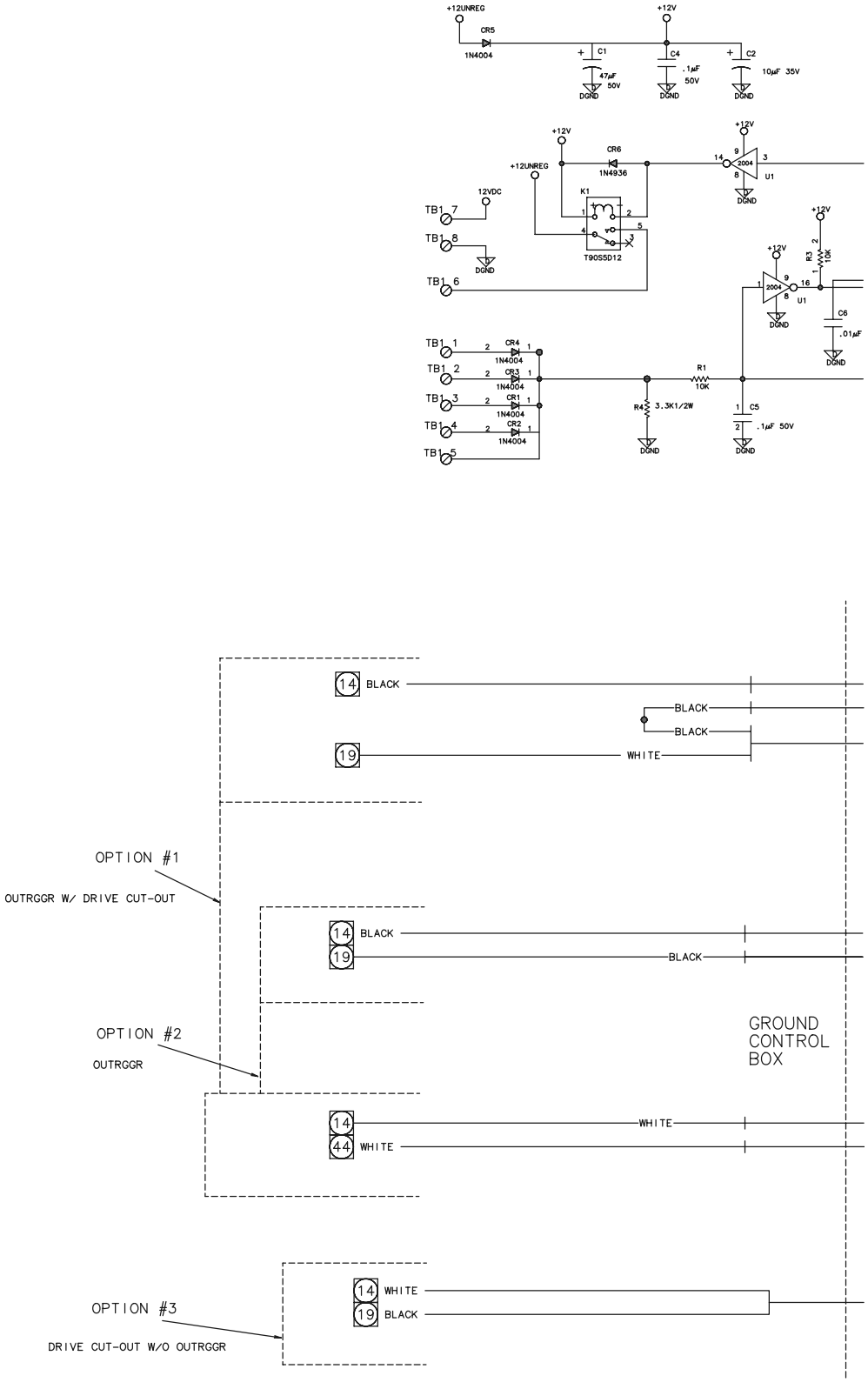

Figure 3-20. Electrical Schematic - 400RTS - Deutz (Sheet 3 of 4)

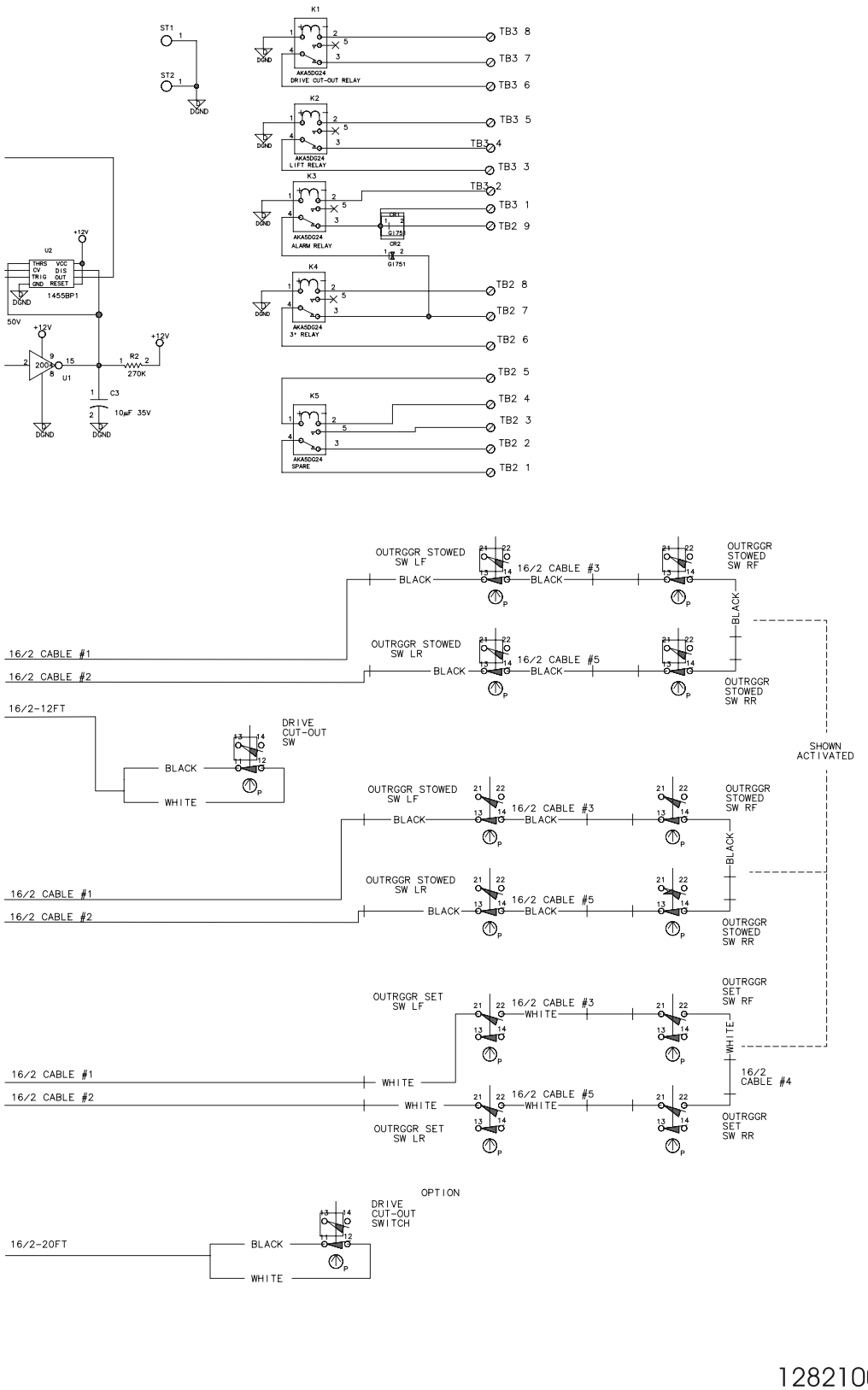

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Figure 3-21. Electrical Schematic - 400RTS - Deutz (Sheet 4 of 4)

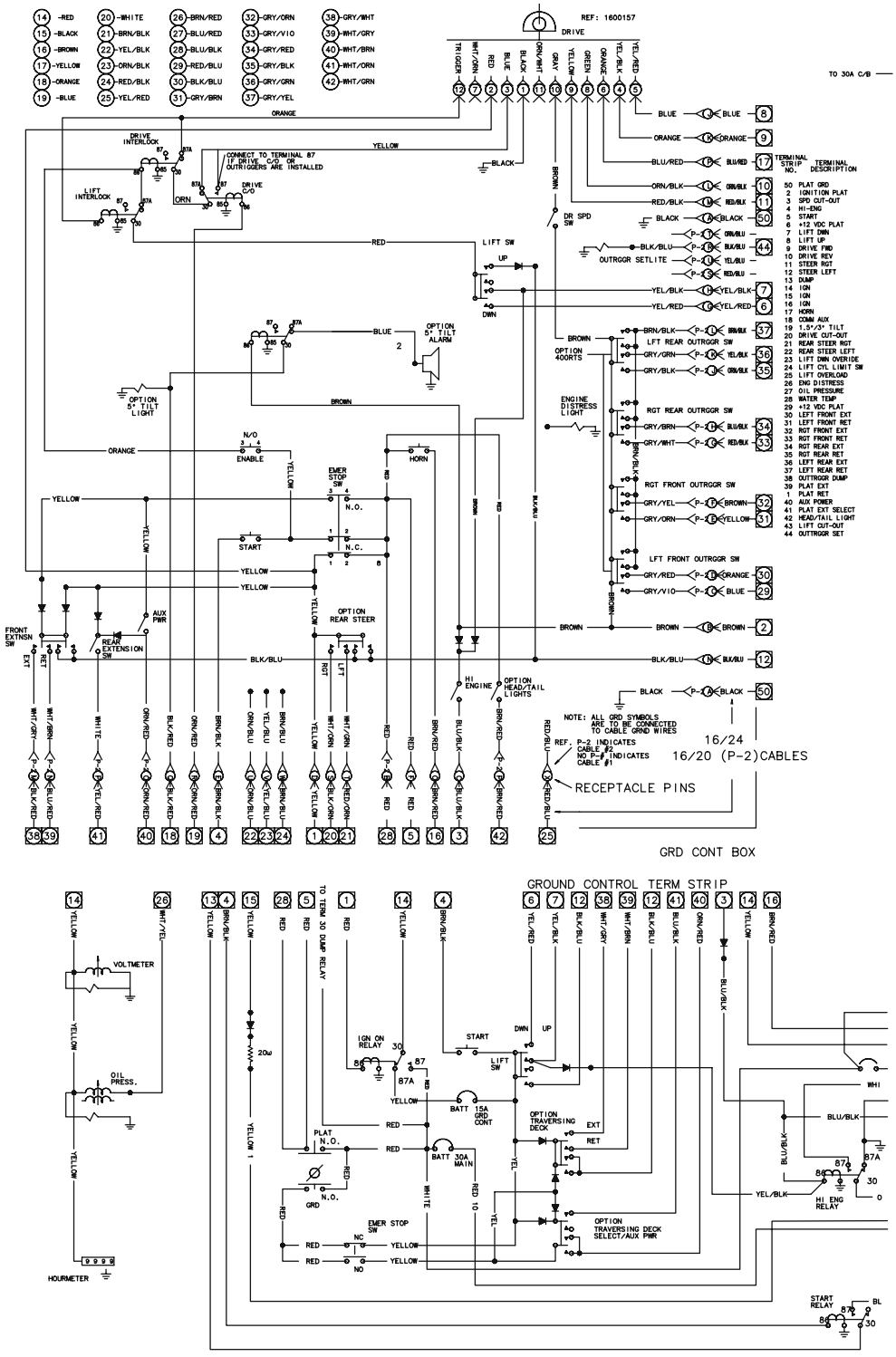

Figure 3-22. Electrical Schematic - 400RTS - Deutz (Sheet 1 of 4)

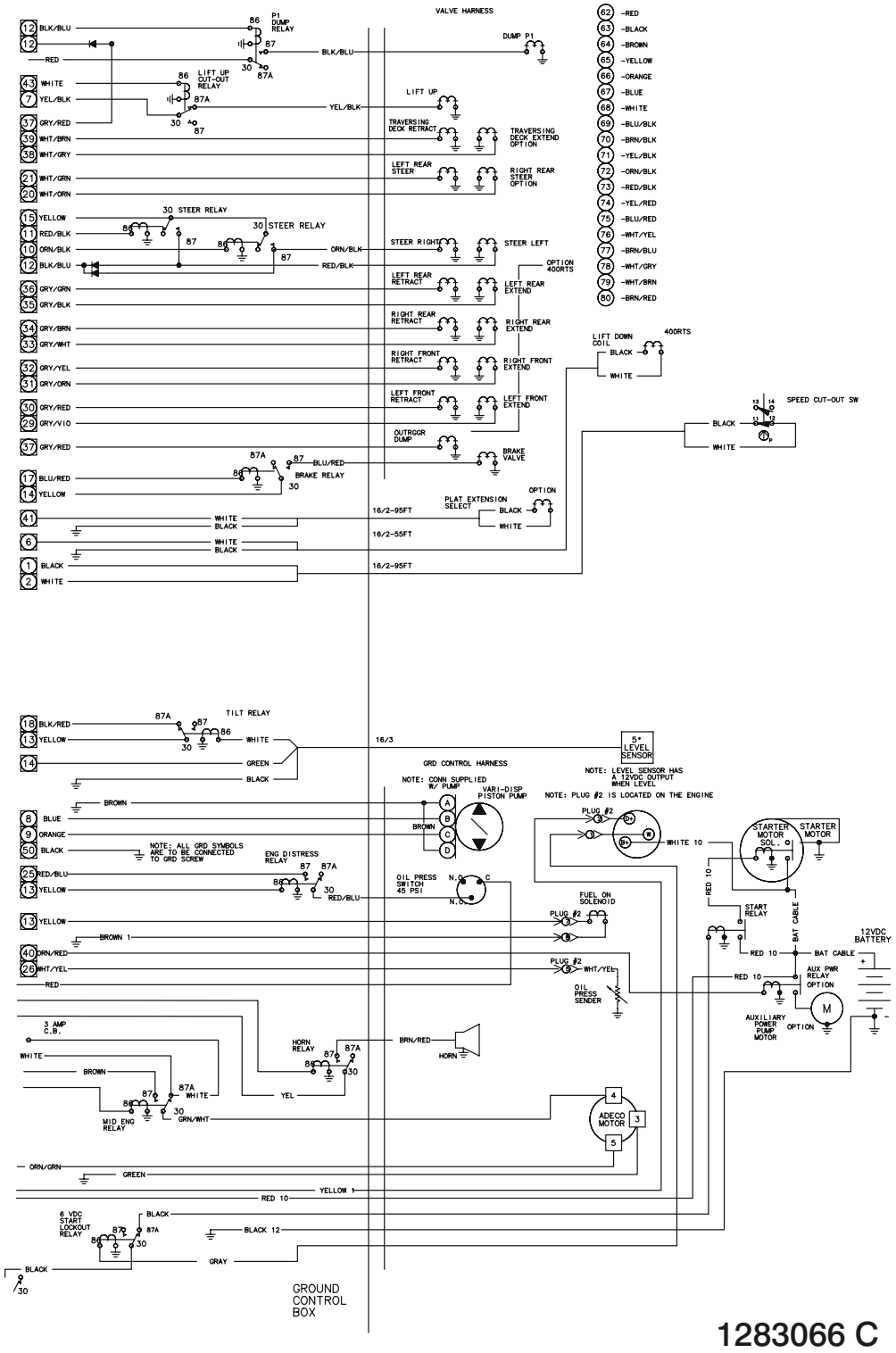

Figure 3-23. Electrical Schematic - 400RTS - Deutz (Sheet 2 of 4)

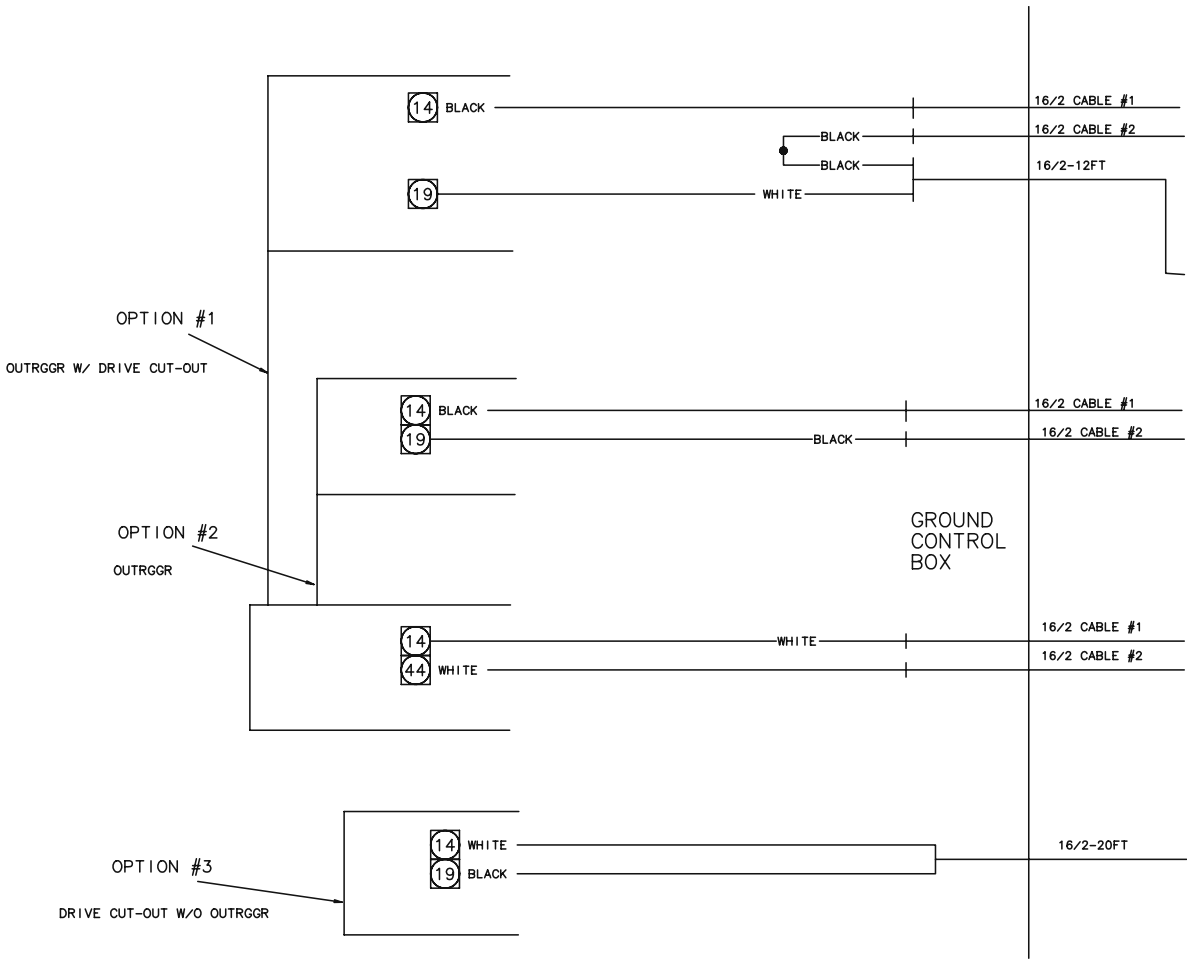

Figure 3-24. Electrical Schematic - 400RTS - Deutz (Sheet 3 of 4)

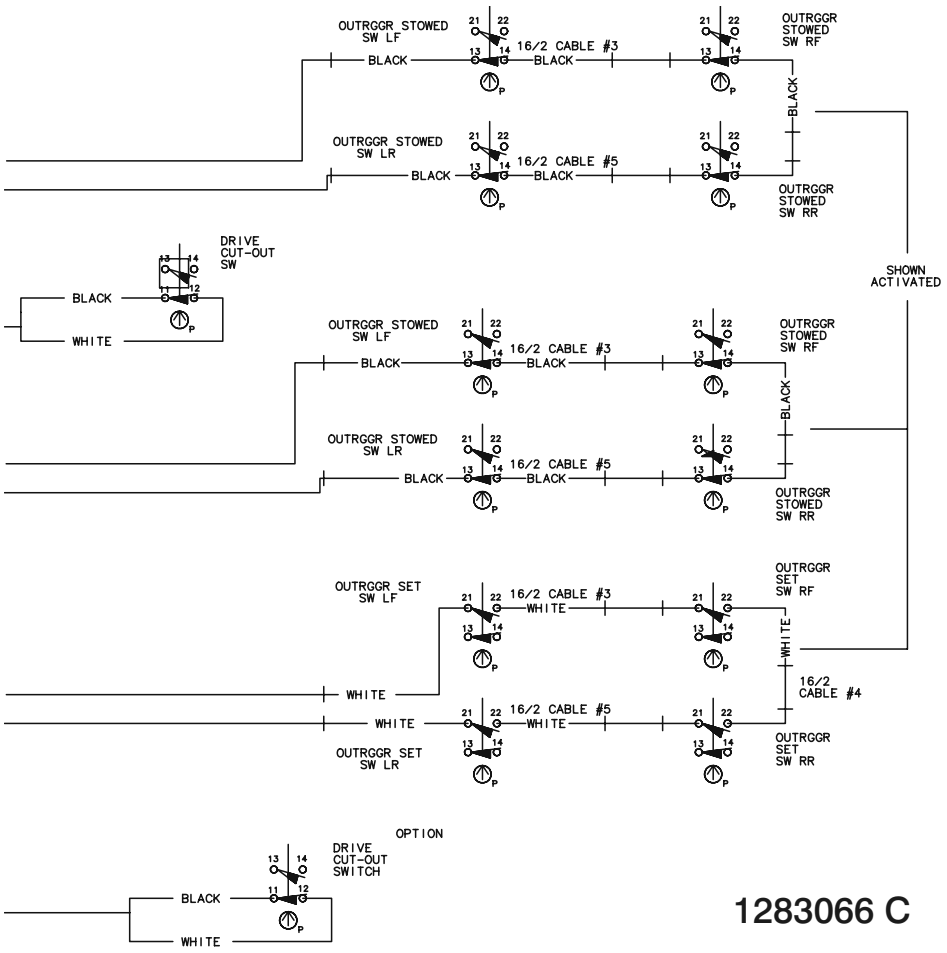

Figure 3-25. Electrical Schematic - 400RTS - Deutz (Sheet 4 of 4)

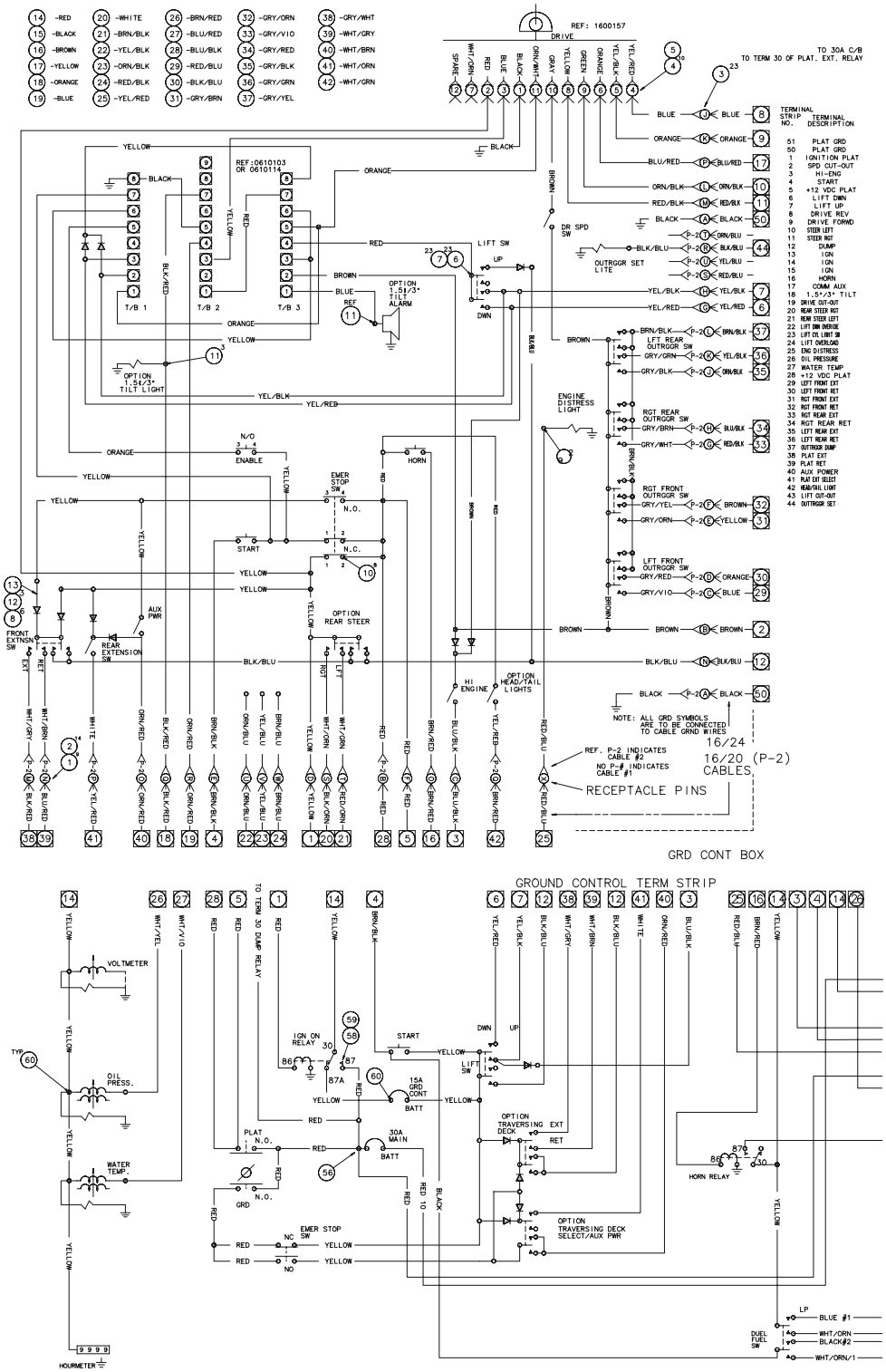

Figure 3-26. Electrical Schematic - 500 RTS Ford LRG (Sheet 1 of 2)

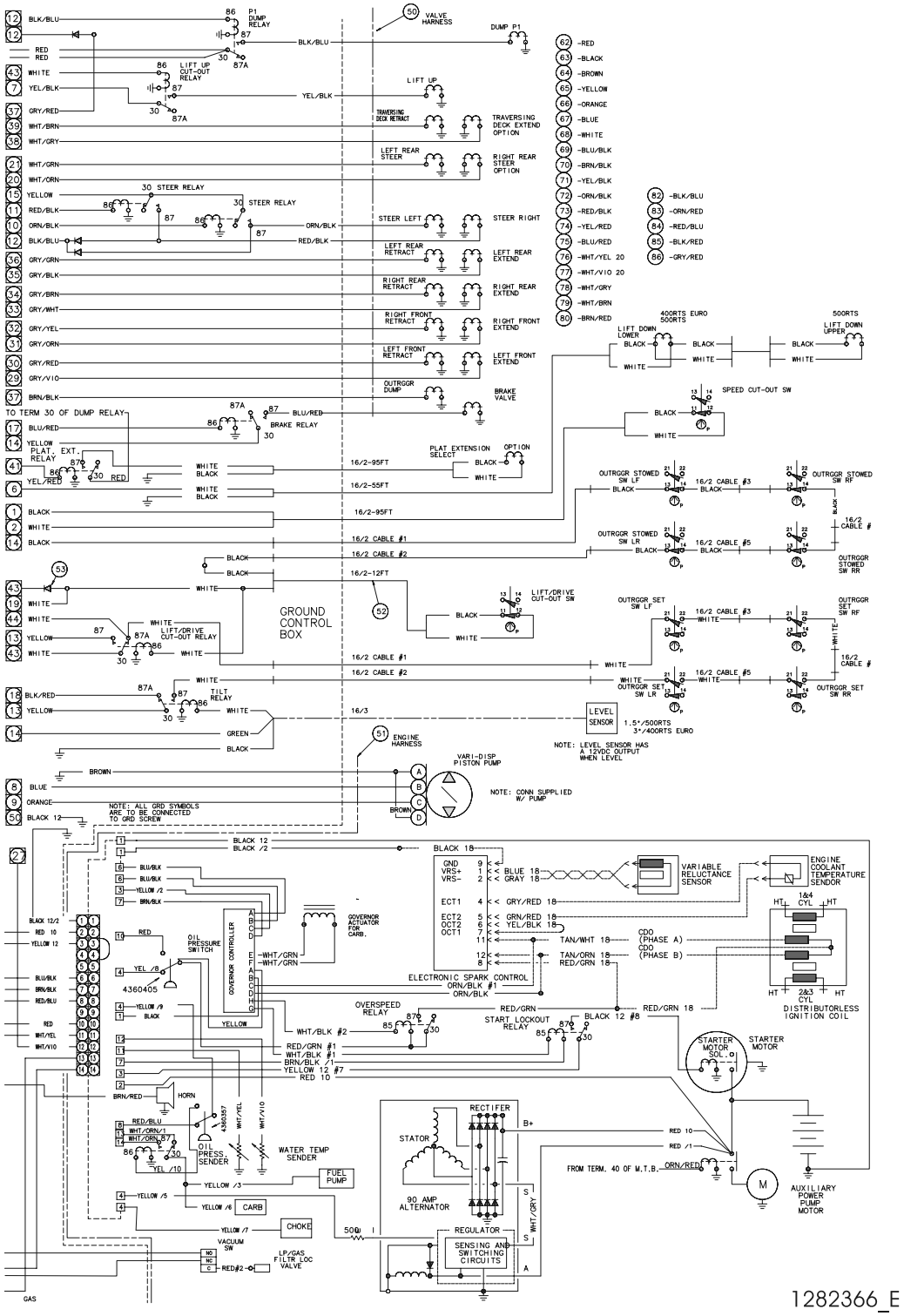

Figure 3-27. Electrical Schematic - 500 RTS Ford LRG (Sheet 2 of 2)

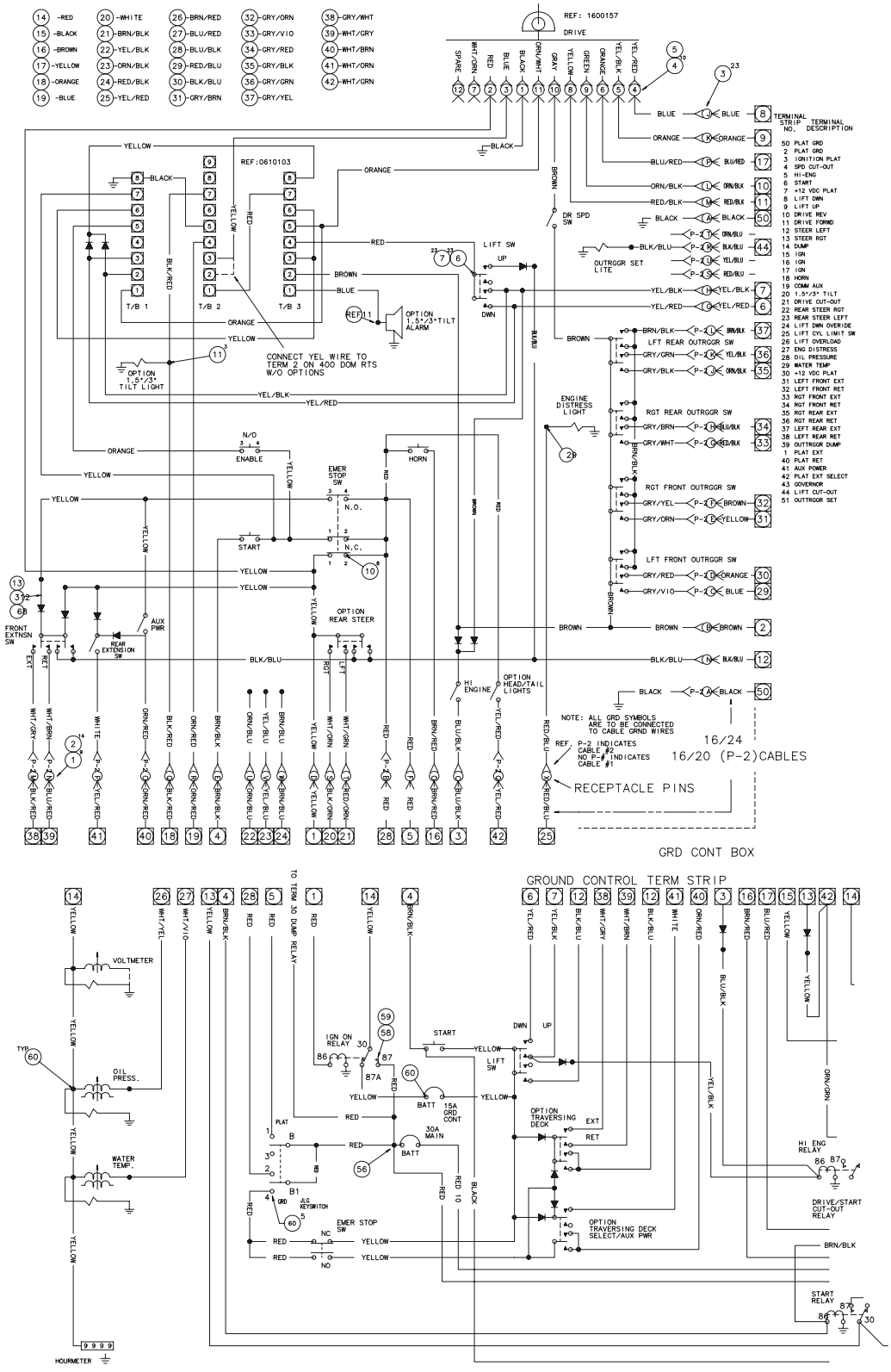

Figure 3-28. Electrical Schematic - 500 RTS Ford LSG (Sheet 1 of 2)

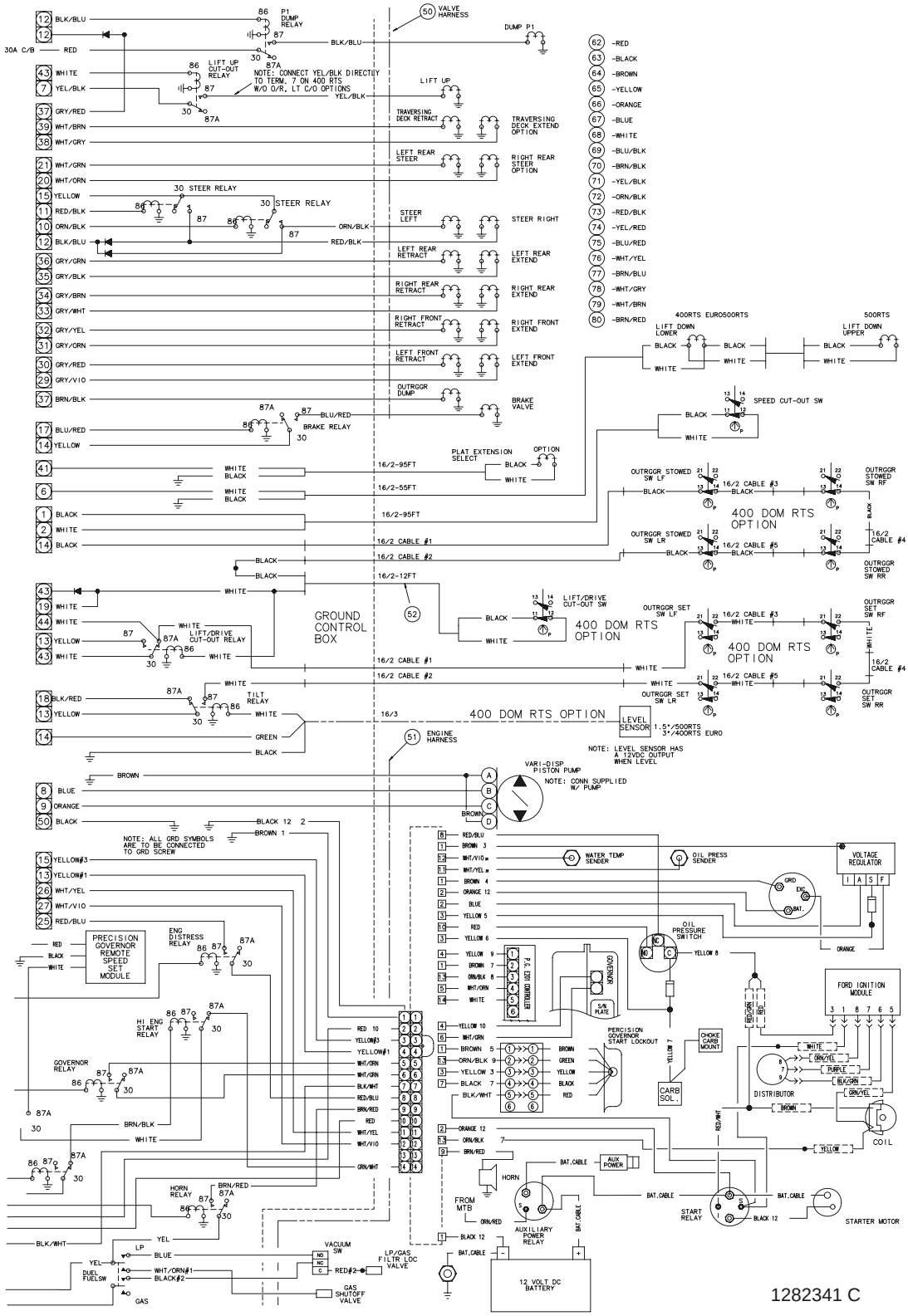

Figure 3-29. Electrical Schematic - 500 RTS Ford LSG (Sheet 2 of 2)

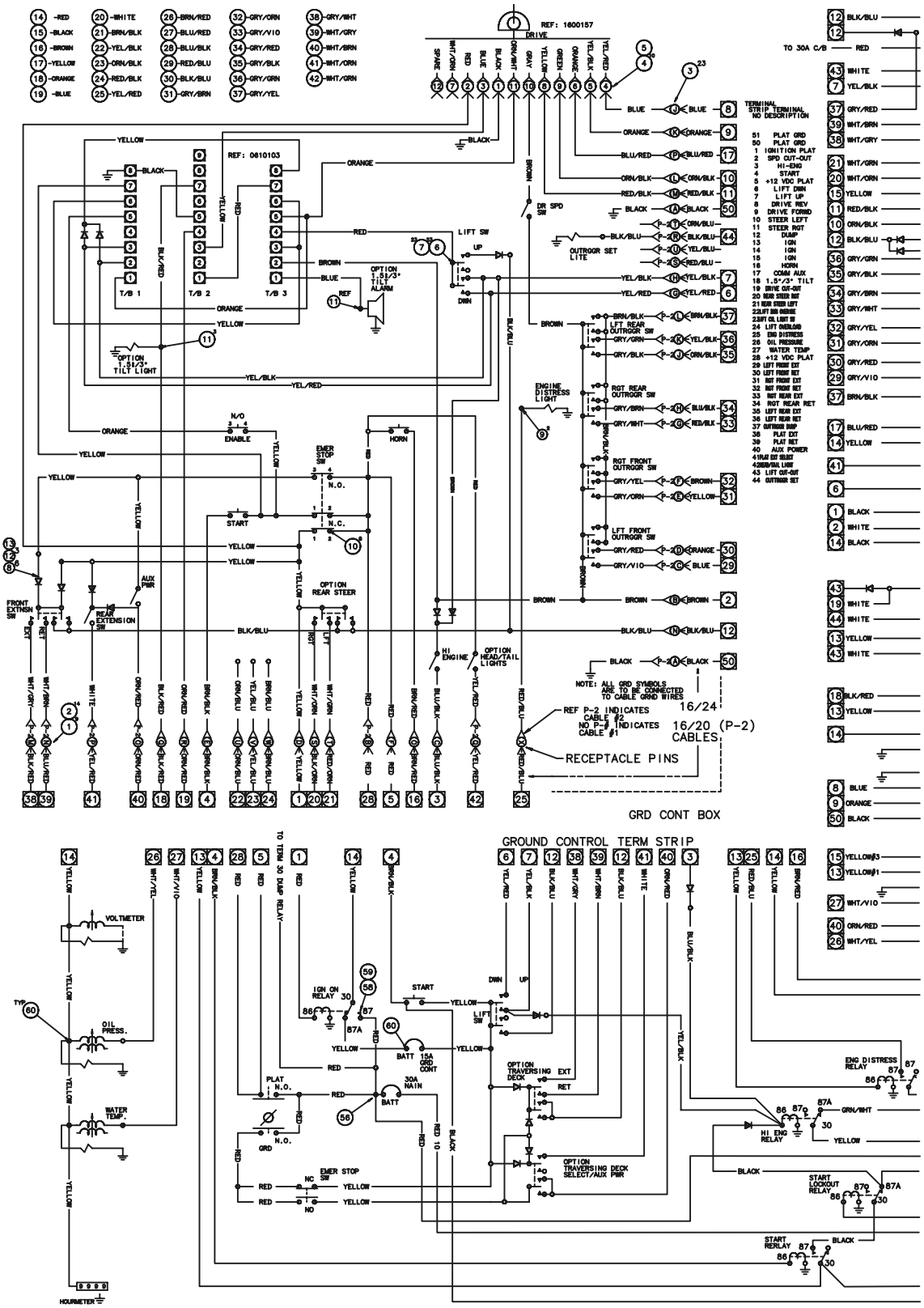

Figure 3-30. Electrical Schematic - 500 RTS Ford VSG (Sheet 1 of 2)

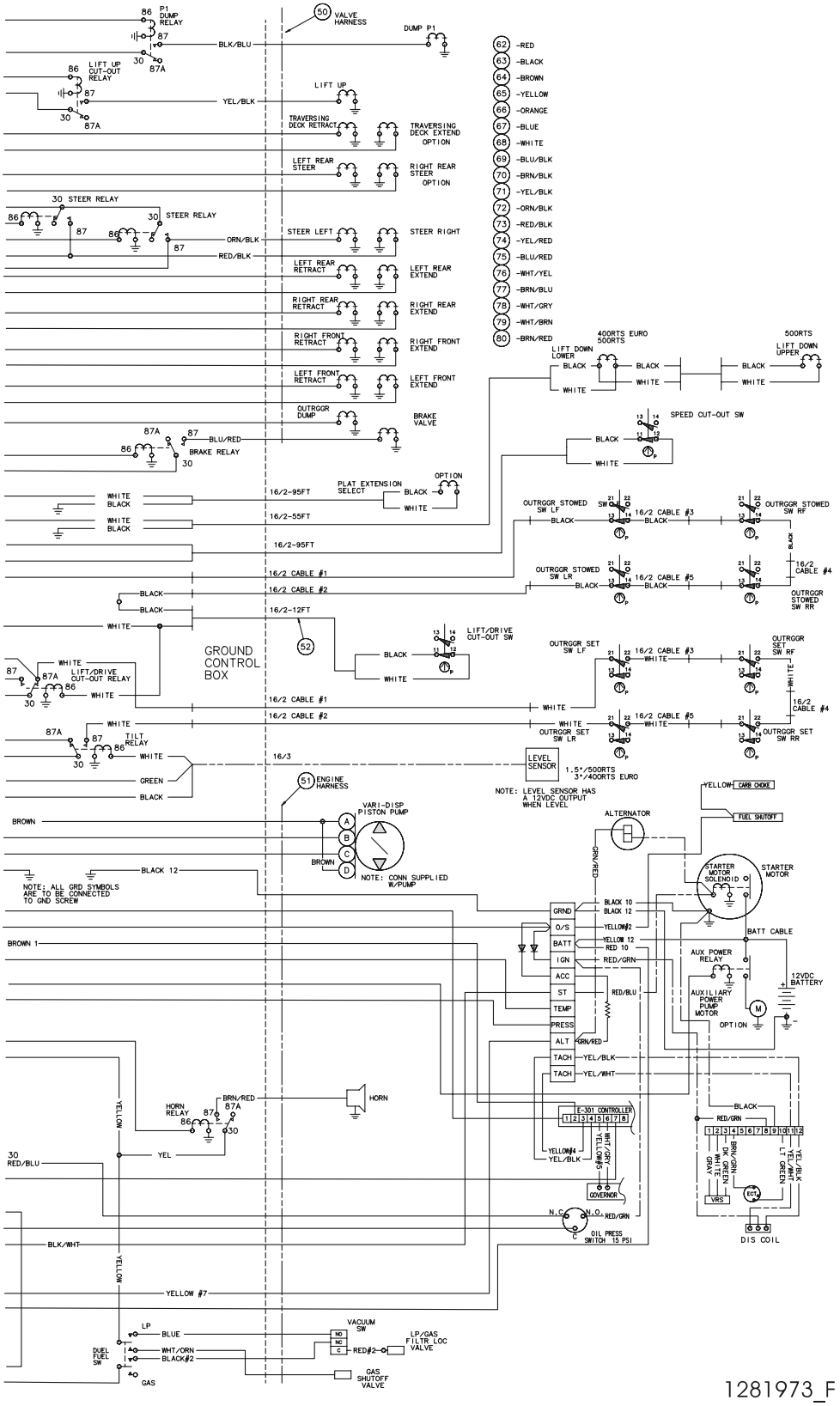

Figure 3-31. Electrical Schematic - 500 RTS Ford VSG (Sheet 2 of 2)

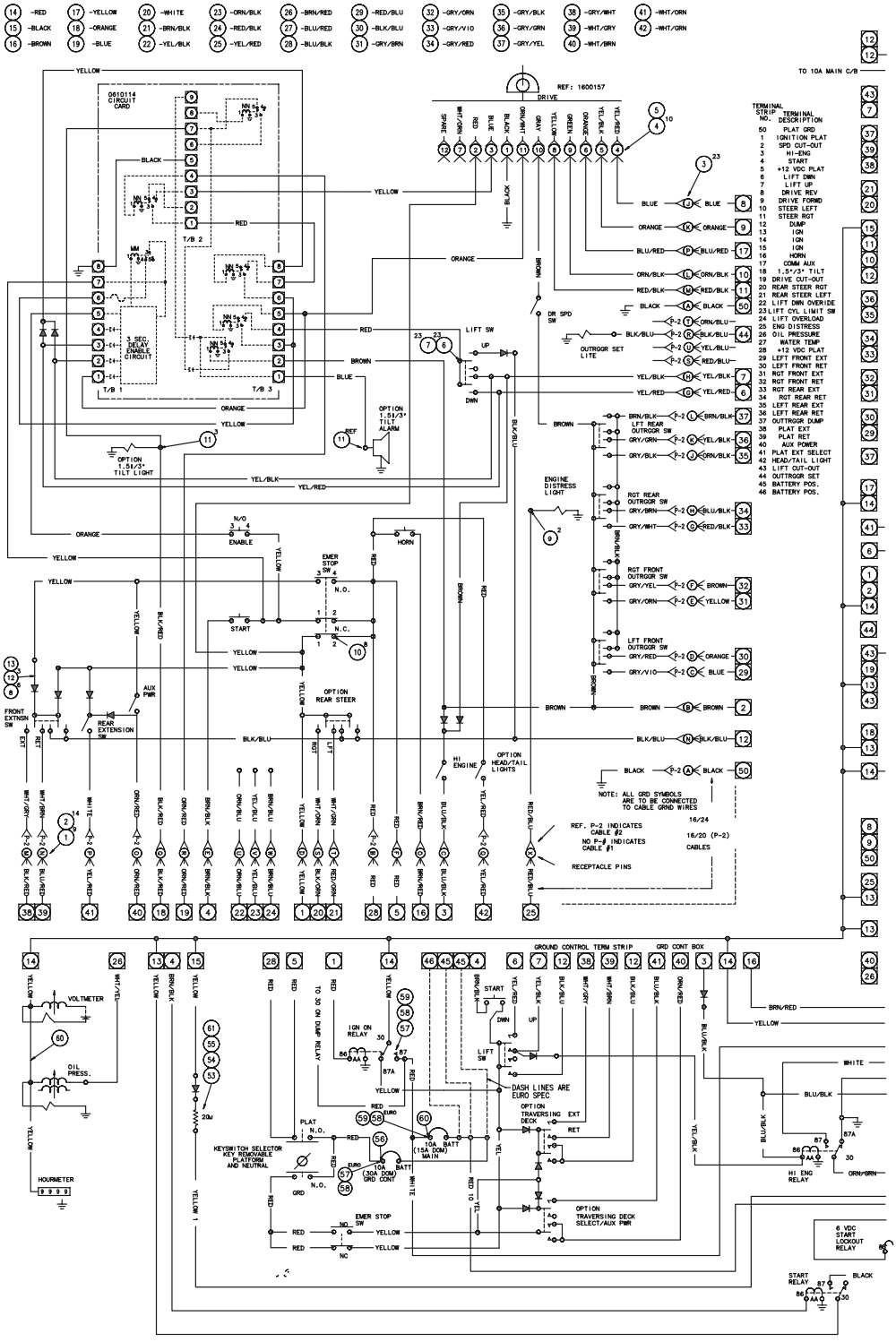

Figure 3-32. Electrical Schematic - 500RTS Deutz (Sheet 1 of 2)

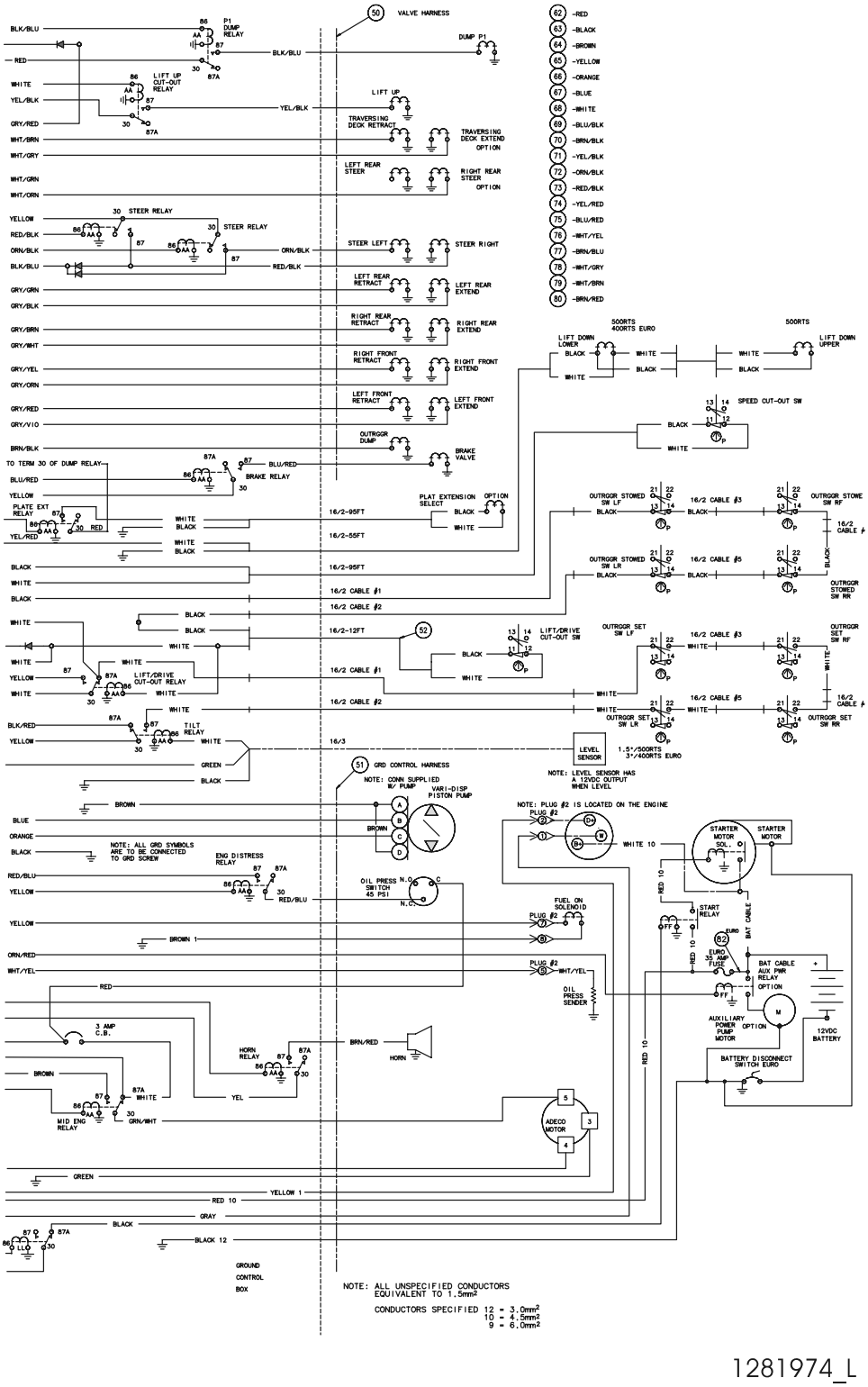

Figure 3-33. Electrical Schematic - 500RTS Deutz (Sheet 2 of 2)

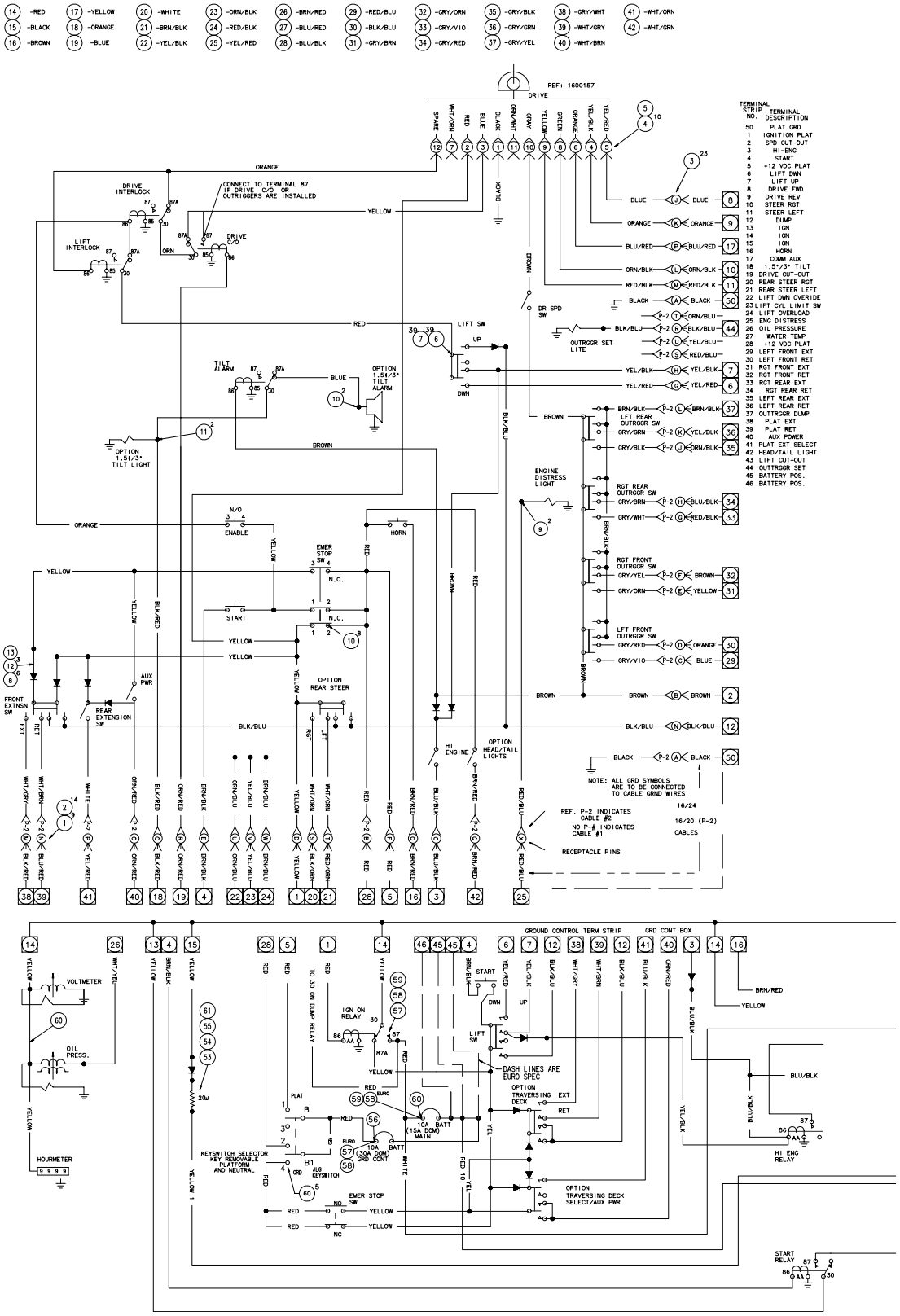

Figure 3-34. Electrical Schematic - 500RTS Duetz (Sheet 1 of 2)

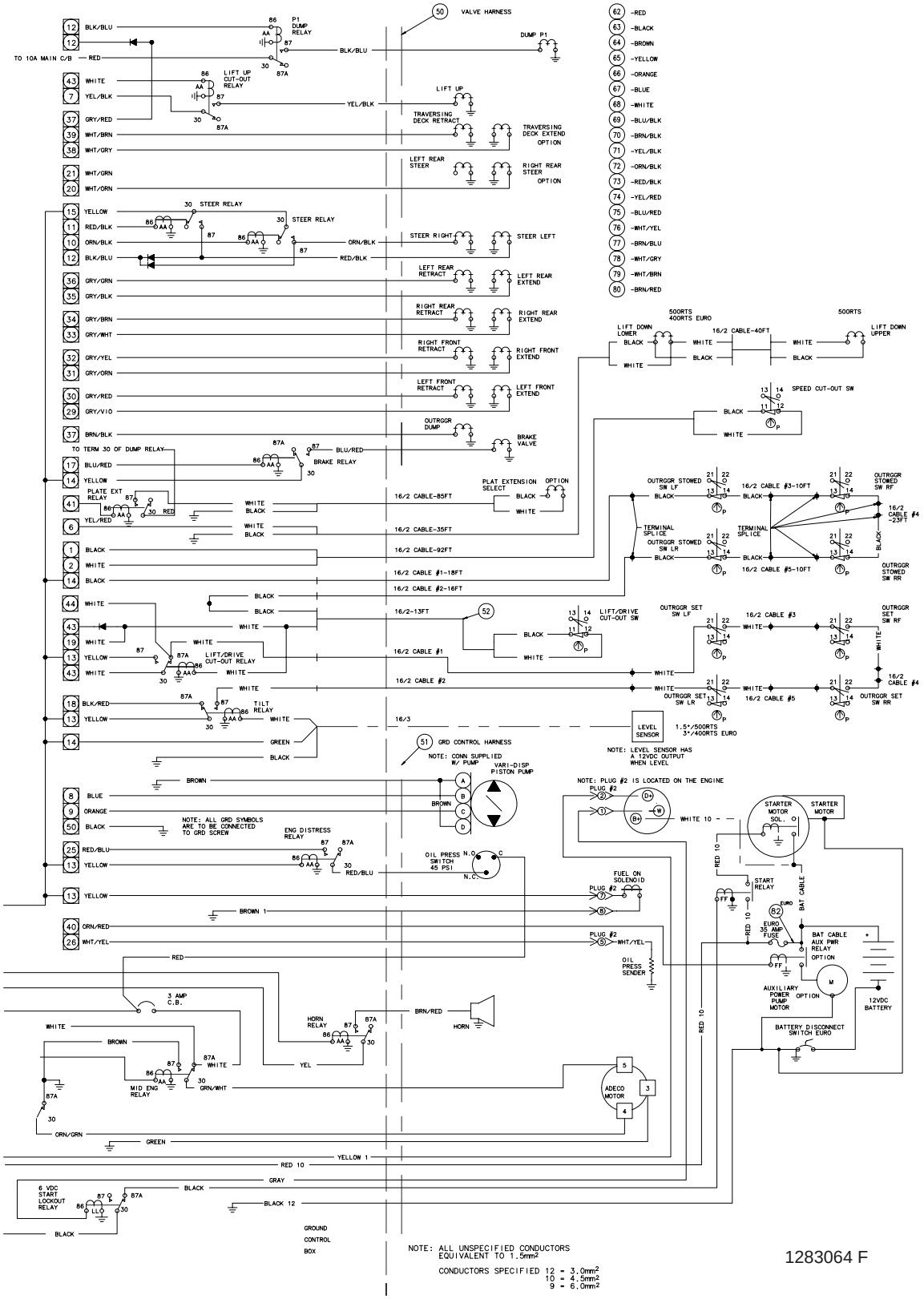

Figure 3-35. Electrical Schematic - 500RTS Duetz (Sheet 2 of 2)

NOTES:

CALIFORNIAN PROPOSITION 65

BATTERY WARNING

Battery posts, terminals and related accessories contain lead and lead compounds, chemical known to the State of Califormia to cause cancer and reproductive harm.

WASH HANDS AFTER HANDLING!

⚠ WARNING: ⚠

The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

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