

CAPACITY TRUCKS

TRUCK SERVICE MANUAL

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INTRODUCTION

This manual provides information and procedures for maintaining and repairing the TJ and Sabre Series trucks. For Engine, Transmission and Rear Axle overhaul procedures, refer to the manufacturer's manual for the specific model.

Use of this information and application of these procedures will enable the technician to be more efficient, better organized and capable of performing the various tasks properly. These skills will ensure that the service and/or repair is thorough and complete, and results in maximum service life of the vehicle, and personal safety.

Every effort has been made to ensure the accuracy and completeness of this manual. We reserve the right to change, alter and/or improve the product and this document at any time without prior notice.

All information in this manual is subject to production variations. Dimensions and weights are approximate, and illustrations do not necessarily show vehicles in standard condition.

ASSISTANCE

Capacity Trucks, Inc. is available to assist you with any service and parts questions you may have.

Call 1-800-458-3238 to contact our service and parts support team.

PRECAUTIONARY SYMBOLS

The following precautionary symbols are used in this manual to identify items of importance.

These precautionary symbols and corresponding information reinforce safe and correct maintenance of the vehicle.

DANGER

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

WARNING INDICATORS

Indicators for the following components and conditions are located in the cab dash panel.

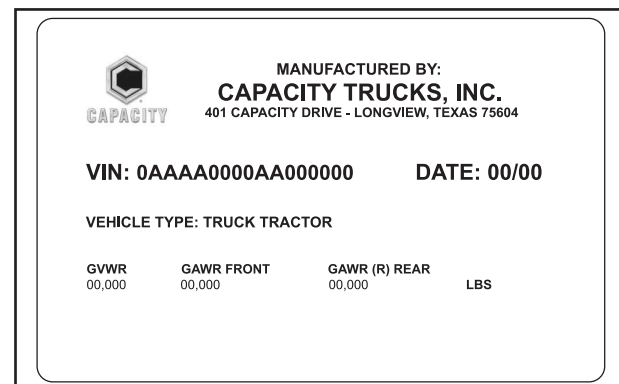
Component / Condition	Indicator Type
Air Pressure	Light and Alarm
Charging System	Light
Check Transmission	Light
DEF	Light
Engine Coolant Level	Light
Engine Coolant Temperature	Light
Engine Oil Pressure	Light
Engine Stop	Light
Engine Warning	Light
Fuel Level	Light
HEST	Light
PTO	Light
Regeneration Request	Light
Trailer ABS	Light
Transmission Temperature	Light
Truck ABS/ATC	Light
WTS	Light

VEHICLE, ENGINE AND TRANSMISSION IDENTIFICATION

Vehicle Serial Number Decal

The vehicle serial number decal is located at the front of the cab ceiling, above the sun visor.

The vehicle serial number is needed for parts ordering and service needs.

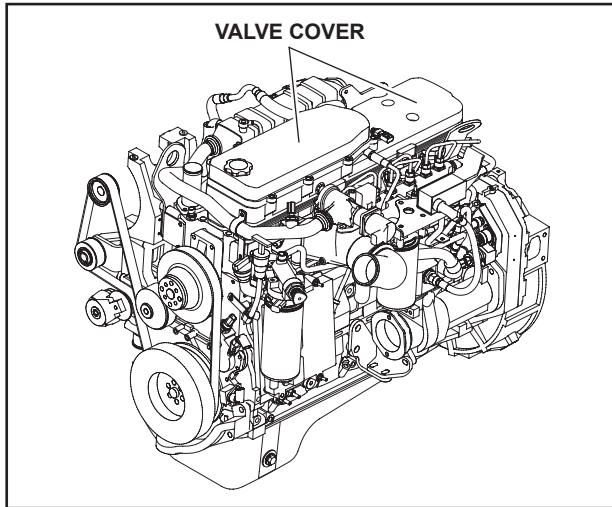


GENERAL INFORMATION

Engine Dataplate

The engine dataplate is located on the engine valve cover; specific location varies by model.

The engine serial number and Control Parts List (CPL) number are needed for parts ordering and service needs.

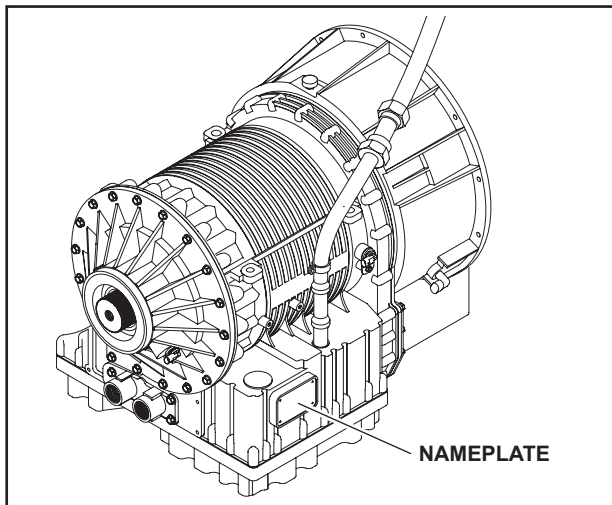


NOTE: The engine dataplate must not be changed unless approved by Cummins Engine Company, Inc.

Transmission Nameplate

The transmission nameplate is located at the lower rear, RH side of the transmission.

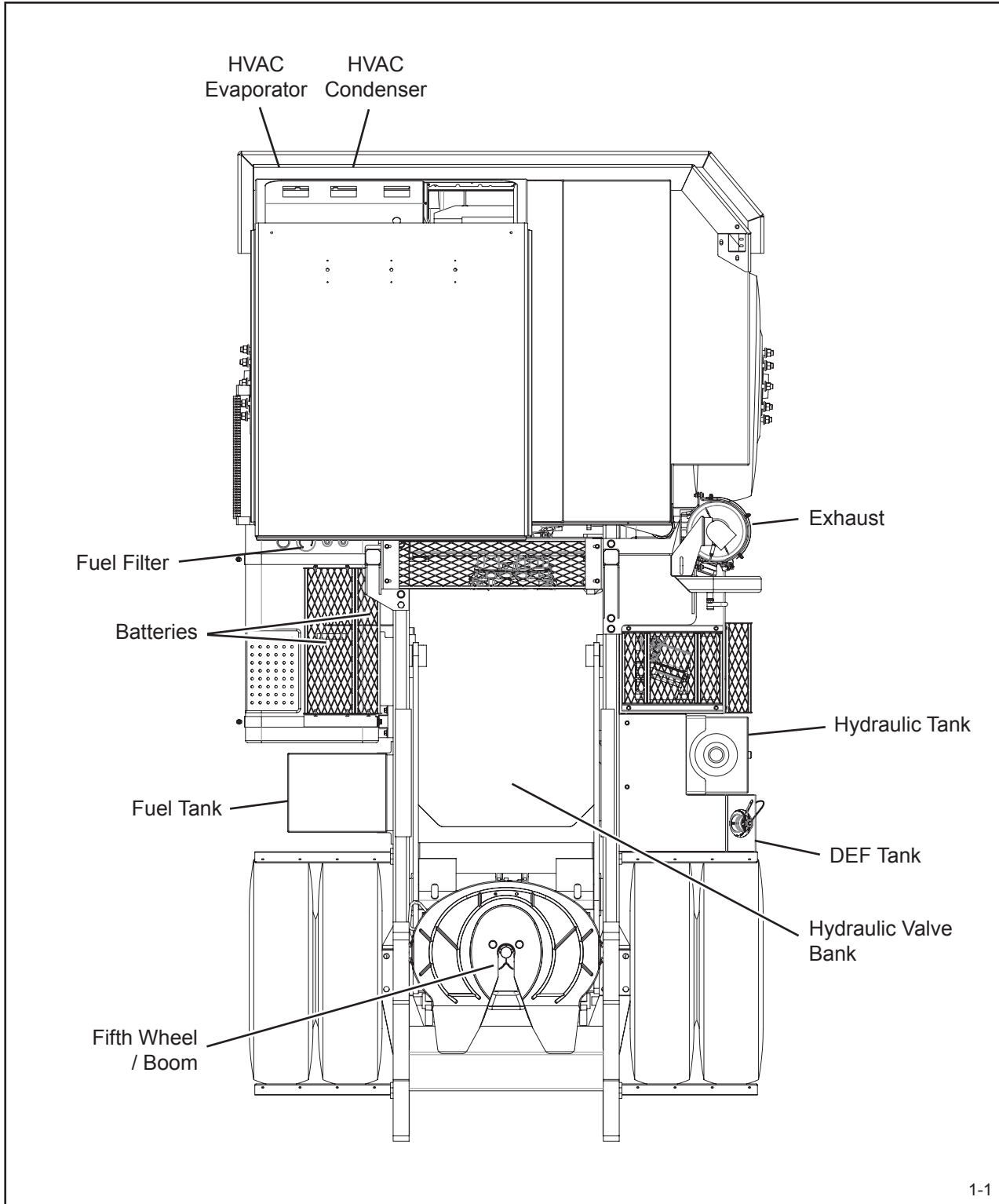
The transmission serial number, part/assembly number and model number are needed for parts ordering and service needs.



MAJOR COMPONENTS

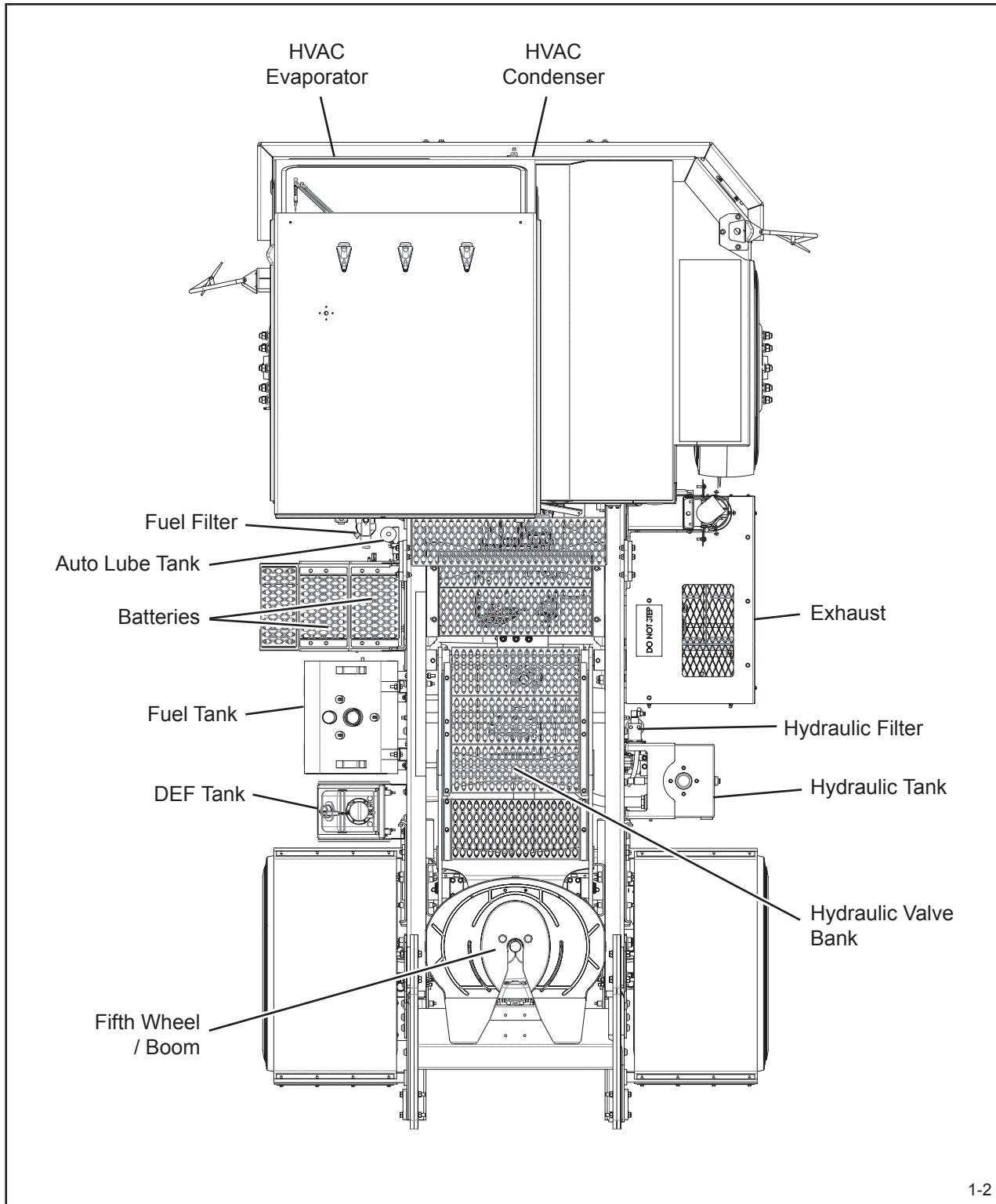
1

TJ Series



GENERAL INFORMATION

Sabre Series



FASTENERS

All threaded fasteners used on the vehicle are SAE, Grade 8. Do not attempt to install metric fasteners or fasteners with different dimensions or grades.

Follow these guidelines when working with threaded fasteners:

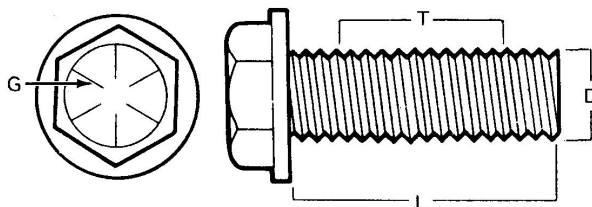
- Only install fasteners that are clean and straight, with undamaged threads and drive heads.
- Apply penetrating fluid to rusted and corroded fasteners to ease removal and prevent breakage.
- Replace all damaged fasteners, using new fasteners of the same type, dimension and grade.
- Replace special lock nuts that have nylon or fiber locking mechanisms after the first time they are removed; locking-fasteners of this type are one-time use fasteners.
- Reinstall flat washers in the same orientation in which they were removed.
- Replace all damaged washers, using new washers of the same type, dimension and material.
- Tighten fasteners to the recommended torque values, and use a sequence when tightening or removing multiple fasteners that are used to clamp a component.

Dimensions and Grade Marks

Bolts are specified by their drive head type, diameter, length, thread pitch and grade.

Nuts are specified by their type, diameter, thread pitch and grade.

Refer to the diagram below to determine the dimensions and grade of an SAE fastener:



D - Diameter (in.) G - Grade marks
L - Length (in.) T - Pitch (threads per inch)

Installation and Removal Procedures

Depending on the application, most threaded fasteners should be tightened to specific torque values, and tightened and removed in specific sequences.

- Over- or under-tightening can weaken the fastener and lead to fastener breakage, or cause the fastener to loosen, and lead to component damage and personal injury.
- Failure to follow a sequence when tightening or removing multiple fasteners that are used to clamp a component can lead to component warpage or breakage.

Follow these guidelines when installing or removing threaded fasteners:

- Use the torque chart that follows when a torque value is not specified on the assembly print or manual procedure.
- Use a calibrated torque wrench to tighten fasteners.
- The frame on the Sabre Series is assembled using the BobTail® HuckBolt®, which are permanent-type fasteners; use the proper installation tool when installing BobTail HuckBolts, and replace both the pin and the collar after the first time they are removed.
- When tightening a bolt with a castellated nut, first tighten the fasteners to the torque value listed in the chart, and then continue to tighten the fasteners until the through hole in the bolt and the nearest slot in the nut are aligned.
- Follow this procedure when a tightening sequence is not specified on the assembly print or manual procedure for multiple fasteners that are used to clamp a component:
 1. Install all the fasteners finger-tight.
 2. Tighten each fastener one full turn in a crisscross pattern; for elongated components, begin the crisscross pattern at the center of the component.
 3. Tighten each fastener a half turn in the same crisscross pattern.
 4. Tighten each fastener a quarter turn at a time in the same crisscross pattern until all fasteners are tightened to the proper torque value.
- Reverse the tightening procedure when removing multiple fasteners that are used to clamp a component.

GENERAL INFORMATION

Torque Chart

Use this chart as a general guide for tightening nuts, bolts, studs, and cap screws when a torque value is not specified in the manual procedure. This chart is not intended for use in seating a stud in a housing.

- Torque values are listed in lb-ft (N•m) with the exception of values for 1/4 in and 5/16 in fasteners, which are listed in lb-in (N•m), as indicated.
- Torque values apply to non-lubricated fasteners threaded into steel or cast iron only.
- Nuts must be of the same SAE grade as the bolts on the chart. When nuts and bolts are of different grades, use the torque value for the lower grade of the two fasteners.

Dimension: Diameter - Threads/Inch	Steel Hex Nuts and Locknuts: lb-ft (N•m)	Steel Hex Flange Nuts and Locknuts: lb-ft (N•m)
Coarse Thread Series		
1/4 - 20*	115* (7.1)	142* (8.7)
5/16 - 18*	180* (11.1)	228* (14.0)
3/8 - 16	29 (21.4)	30 (22.1)
7/16 - 14	46 (33.9)	48 (35.4)
1/2 - 13	68 (50.2)	71 (52.4)
9/16 - 12	95 (70.1)	110 (81.1)
5/8 - 11	130 (95.9)	136 (100.3)
3/4 - 10	230 (169.6)	236 (174.1)
7/8 - 9	370 (272.9)	-
1 - 8	555 (409.3)	-
1 1/8 - 7	780 (575.3)	-
1 1/4 - 7	1,100 (811.3)	-
Fine Thread Series		
1/4 - 28*	120* (7.4)	152* (9.3)
5/16 - 24*	190* (11.7)	218* (13.4)
3/8 - 24	31 (22.9)	31 (22.9)
7/16 - 20	51 (37.6)	57 (42.0)
1/2 - 20	75 (55.3)	85 (62.7)
9/16 - 18	105 (77.4)	125 (92.2)
5/8 - 18	142 (104.7)	166 (122.4)
3/4 - 16	255 (188.1)	256 (188.8)
7/8 - 14	400 (295.0)	-
1 - 14	600 (442.5)	-
1 1/8 - 12	880 (649.1)	-
1 1/4 - 12	1,250 (921.9)	-

* Torque values for 1/4 in and 5/16 in fasteners are listed in lb-in (N•m).

GENERAL INFORMATION

SPECIFICATIONS

1

Component	Item	Description
General	Vehicle load capacity (at 15 mph (24.1 km/h))	GVW: 32,200 lb (14,606 kg) GCVW: 81,000 lb (36,741 kg)
	Overall weight	TJ Series: 13,500 lb (6,124 kg) Sabre Series: 13,780 lb (6,251 kg)
	Length	192 in (487.7 cm)
	Width	TJ Series: 98.8 in (251.0 cm) Sabre Series: 99.0 in (251.5 cm)
	Height	TJ Series: 120 in (304.8 cm) Sabre Series: 130 in (330.2 cm)
	Wheelbase	116 in (294.6 cm)
	Turning radius	20 ft 6 in (62.5 m)
	Gradeability at capacity	16.9%
	Drawbar load capacity	15,015 lb (6,813 kg)
Brake System	Type	ABS / ATC, air powered with 18.7 CFM compressor and triple-tank reservoir system
	Parking brake	Spring, rear axle-mounted
	Emergency brake	Automatic, applies parking brake
Cab	Width	51 in (129.5 cm)
	Depth	64 in (162.6 cm)
	Height	66 in (167.6 cm) (standard)
	Mounts	Front: Rubber cushion pivots Rear: Air ride; safety-type latch
	Tilt	45 degrees hydraulically
	HVAC system	45,000 BTU fresh air with electric blower and integrated defroster
	Door(s)	Heavy duty, with key lock
Electrical System	Dash panel	Removable; volt meter, hour meter, oil pressure gauge, air filter restriction indicator, water temperature gauge, air system pressure gauge and fuel level gauge
	Type	Negative ground
	Battery capacity (standard)	12 V, 750 CCA; optional 24 V
	Starter motor Manufacturer / Model	Denso / PA90L
	Starter motor	12 V, 3.0 Kw
	Alternator Manufacturer / Model	Delco / 24SI
	Alternator	12 V, 130 A
Engine	Manufacturer	Cummins
	Model	(various)
	Type	Four stroke, water-cooled diesel
	Power	(varies by model)
	Number of cylinders	6

GENERAL INFORMATION

Component	Item	Description
Engine (cont.)	Displacement	409 cu in (6.7 L)
	Cooling system	Rubber shock pad-mounted, heavy duty radiator with integrated transmission cooler
	Exhaust system	EPA-approved
Fifth Wheel / Boom	Type	Hydraulic, dual 5 in (12.7 cm) double-acting cylinders with self-aligning replaceable cylinder bushings, transmission-mounted PTO with directly-mounted gear pump
	Controls	Cab-controlled air unlatch and automatic relatch
	Fifth wheel size	36 in (91.4 cm) diameter
	King pin size	2 in (5.08 cm) diameter
	Lift capacity	70,000 lb (31,752 kg)
	Lift height	16 in (40.6 cm)
	Filters	Engine air
Engine oil		Spin-on, paper element
Fuel system		Externally-mounted fuel / water separator
Hydraulic system		Full-flow, spin-on element with intake strainer
Power steering reservoir		Internally-mounted, replaceable element
Front Axle	Manufacturer / Model	(various)
	Type	Straight axle
	Suspension type	Leaf spring
	Suspension rating (standard)	11,000 lb (4,990 kg)
Rear Axle	Manufacturer / Model	(various)
	Type	Ring and pinion gears
	Ratio	(varies by manufacturer and model)
	Suspension types	<ul style="list-style-type: none"> • Dura-Ride trailing arm • Solid mount
	Suspension rating	30,000 lb (13,608 kg)
Steering System	Type	Hydraulic power steering with engine-mounted, gear-driven pump
Tires	Size (front / rear)	11 x R22.5 / 11 x 22.5
	Type (front / rear)	Tubeless, single, 16 ply LRG highway tread / Tubeless, dual, 16 ply LRG highway tread
Trailer Equipment	Air system	Dual-line, with glad hand receivers
	Electrical system	7-wire female receptacle on cab rear
Transmission	Manufacturer	Allison
	Model	(various)
	Type	Automatic
	Number of speeds	6 maximum
Wheels	Type	Hub-piloted, 5 hole
	Size	22.5 x 8.35 in

ACRONYMS

Acronym	Definition
ABS	Anti-Lock Brake System
ASR	Automatic Slip Regulation
ATC	Automatic Traction Control
CAN	Controller Area Network
CMN	Common
DEF	Diesel Exhaust Fluid
DLS	Differential Lock Solenoid
DMD	Display Mode/Diagnostic
DOC	Diagnostic Optimized Connection
DTC	Diagnostic Trouble Code
DVEC	Dual Vehicle Electrical Center
ECU	Electronic Control Unit
EMI	Electromagnetic Interference
EPDM	Ethylene Propylene Diene Monomer
FM	Filter Life Monitor
GCVW	Gross Combined Vehicle Weight
GRND	Ground
GUI	Graphical User Interface
GVW	Gross Vehicle Weight
HEST	High Exhaust System Temperature
HLD	Hold
HVAC	Heating, Ventilation and Cooling
ID	Inside Diameter
I/O	Input/Output
IR	Independent Regulation
MIR	Modified Independent Regulation
OEM	Original Equipment Manufacturer
OD	Outside Diameter
OLS	Oil Level Sensor
OM	Oil Life Monitor
PLC	Power Line Carrier
PMV	Pressure Modulator Valve
PTO	Power Take Off
PWM	Pulse Width Modulation
QR	Quick-Release
RDS	Rugged Duty Series

Acronym	Definition
REL	Release
RFI	Radio Frequency Interference
RMR	Retarder Modulation Request
TAN	Total Acid Number
TCM	Transmission Control Module
TCS	Traction Control System
TM	Transmission Health Monitor
TPS	Throttle Position Sensor
TXV	Thermostatic Expansion Valve
UNL	Unloader
WTEC	World Transmission Electronic Control
WTS	Wait-to-Start



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INTRODUCTION

Regular service and an established preventive maintenance program will keep all components operating at maximum efficiency and promote a longer and safer service life.

For Engine, Transmission and Rear Axle maintenance procedures, refer to the manufacturer's manual for the specific model.

2

Pre-Operation and Safety Inspection

Use the Pre-Operation and Safety Inspection Checklist on page 2-2 to help ensure safe operation after servicing or repairing the vehicle.

Make copies of the checklist, and use the checklist prior to putting a unit back into service.

Maintenance Intervals

Use the Maintenance Schedule, which starts on page 2-3, as a guide under normal operating conditions. Maintenance may be more frequent in severe conditions.

Repeat hourly maintenance tasks at the intervals specified in the Maintenance Schedule.

Lubricants, Fluids and Fuel

Use the lubricants, fluids and fuel specified in Lubricant, Fluid and Fuel Types and Capacities on page 2-6, or the following conditions may result:

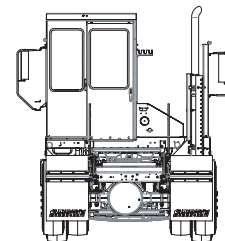
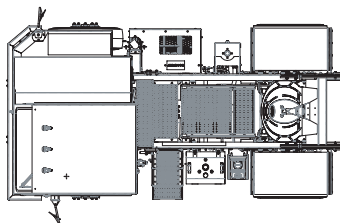
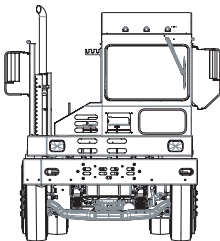
- More frequent replacement intervals
- Decreased component service life
- Component damage
- Personal injury

Lubricants showing signs of excessive heat, oxidation or dirt should be changed often enough to prevent these conditions from occurring.

PREVENTATIVE MAINTENANCE

PRE-OPERATION AND SAFETY INSPECTION CHECKLIST

- Check engine oil level
 - Check engine coolant level
 - Check power steering fluid level
 - Check charge air cooler connections for security and leaks
 - Check hydraulic fluid level (with boom in fully-lowered position)
 - Drain moisture from air tanks
 - Check tire condition and inflation pressure
 - Check cab hold-down latches for proper operation
 - Make sure cab tilt pump selector is in cab lower position
 - Check cab door(s) for proper operation, and make sure door latches operate properly
 - Check windshield wipers and washer for proper operation
 - Check accelerator for proper operation (accelerator must move freely through range of operation)
 - Check rear view mirrors, and make adjustments as necessary
 - Check trailer hoses and electrical cable for security and condition
 - Check neutral lockout system for proper operation
 - Check fifth wheel control lever for proper operation
 - Make sure fifth wheel secondary lock is disengaged
 - Check fifth wheel plate for adequate lubrication
 - Check horn for proper operation
 - Check steering system for proper operation
 - Check parking and service brakes for proper operation
 - Check lube lever in autolube system; if less than half full, refill reservoir
 - Check fuel tank and DEF levels; fill as necessary
 - Adjust operator's seat as necessary
 - Check air compressor for proper operation:
 - Cut-out pressure: 120 psi
 - Cut-in pressure: 90 to 110 psi
 - Check electrical system for proper operation
 - Check lighting system for proper operation:
 - Headlights; high and low beams
 - Turn signals; LH and RH sides
 - Parking and clearance lights
 - Brake lights
 - Hazard and reverse lights
 - Check transmission fluid level (with engine running at idle)
 - Check all safety items:
 - Seat belt operation
 - Fire extinguisher
 - Mud flaps
 - Fan/defroster
 - Gauges and indicators operation
 - Perform final walk-around inspection; check for the following:
 - Fluid leaks at engine, transmission, axles and hydraulic system
 - Air leaks
 - Exhaust system damage and leakage
 - Cab and frame damage
- Circle all damaged areas on the diagrams below.
- Report all discrepancies to your supervisor.



MAINTENANCE SCHEDULE



Intervals apply to operation under normal conditions. Maintenance may be more frequent in severe conditions.

Component/Task	Daily	Hourly Intervals								Overhaul	Comments			
		50	500	1000	2000	2500	3000	5000	6000			6500		
Chassis														
Air drier cartridge				○								●		If equipped
Autolube system operation		○												
Batteries, cables and connections			○											
Brake cams			○											
Brake linings			○											
Cab lift oil						●								
Dura-Ride suspension						○								Check suspension and height adjustment
Fifth wheel	○ ¹							○ ²						¹ Apply grease to wheel jaws, locks, etc. ² Check and adjust jaws
Hydraulic filter								●						
Hydraulic fluid		○						●						
Hydraulic strainer								●						
Lighting system operation		○												
Mirrors operation		○												
Oil sampling			○											Recommended to maximize service life
Power steering filter								●						
Power steering fluid		○						●						
Rear axle oil		○											●	

○ Check, Fill or Adjust ● Replace ▲ Clean, Flush or Drain

PREVENTATIVE MAINTENANCE

○ Check, Fill or Adjust ● Replace ▲ Clean, Flush or Drain

Component/Task	Daily	Hourly Intervals								Overhaul	Comments	
		50	500	1000	2000	2500	3000	5000	6000			6500
Wet air tank				○ ▲								Inspect and clean automatic drain
Wheel bearing fluid			○									
Wheel nut torque			○								●	
Leaks and broken/damaged parts	○											
Engine												
Air compressor discharge lines					▲							Steam clean
Air filter						○ ³	○ ⁴					Interval based on engine installed
Air filter dust ejection valve ¹	○		○									QSB6.7 Engine only
Air intake piping			○ ▲									Check condition of piping and clamps; clean as necessary
Air tanks	▲											Drain
After-treatment exhaust piping	○											
Charge air cooling			○									
Charge air piping			○									
Coolant condition			○									
Coolant level	○		○									
Coolant system									▲			Flush
Cooling fan			○									Check condition of blades and fan shroud
Cooling fan drive belt and belt tensioner				○								
Crankcase breather tube			○									

³ QSB6.7 Engine ⁴ ISB6.7 Engine

PREVENTATIVE MAINTENANCE

Component/Task	Daily	Hourly Intervals										Overhaul	Comments	
		50	500	1000	2000	2500	3000	5000	6000	6500				
					○ ³	○ ⁴								
Crankcase ventilation filter														Interval based on engine installed
DEF dosing unit filter ⁴													●	ISB6.7 Engine only
DEF level ⁴	○													ISB6.7 Engine only
Diesel particulate filter ⁴													▲	ISB6.7 Engine only
Engine oil	○	●												
Engine oil filter		●												
Fuel filter		●												
Fuel / water separator	▲	●												Drain daily
Overhead set										○				
Radiator ³		○												QSB6.7 Engine only
Radiator cap		○								●				
Radiator hoses		○												
Vibration dampener							○							
Transmission														
Fluid	○												●	Reset filter and fluid monitors after service
Main and lube filters													●	
Suction filter													●	

³ QSB6.7 Engine ⁴ ISB6.7 Engine

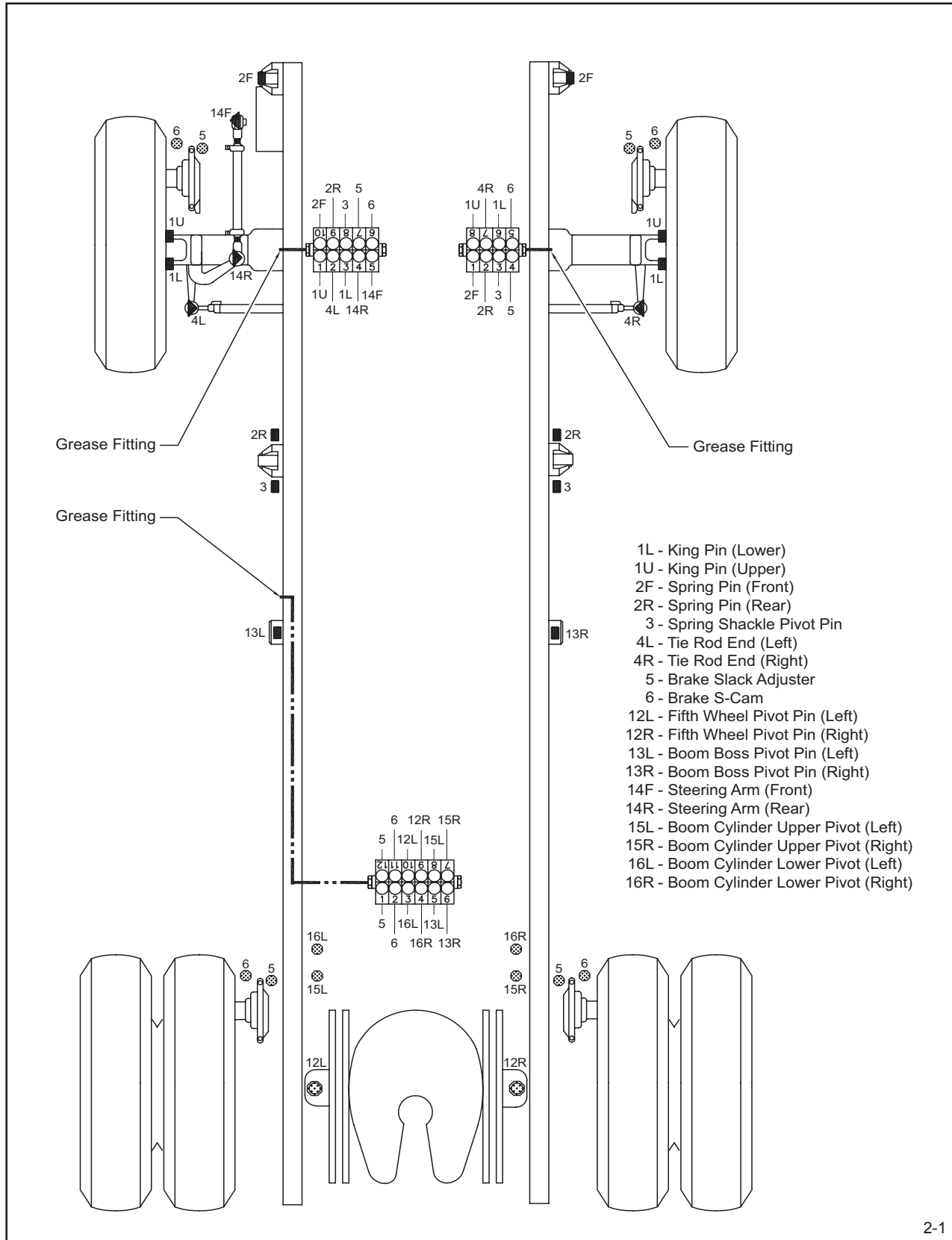
PREVENTATIVE MAINTENANCE

LUBRICANT, FLUID AND FUEL TYPES AND CAPACITIES

Filling Point	Type	Quantity
Autolube Pump Reservoir	(Per Autolube System Manufacturer)	6 lb (2.7 kg)
Cab Tilt Pump	Dextron III ATF	2 qt (1.9 L)
Chassis Fittings	NLGI-00 Grease	(as required)
DEF Tank	Diesel Exhaust Fluid (ISO 22241-1)	TJ Series: 10 gal (37.9 L) Sabre Series: 5 gal (18.9 L)
Drive Axle	Chevron RPM 75W-90 Synthetic Gear Lube	41 pt (19.4 L)
Engine Cooling System	50/50 Solution of Ethylene Glycol Extended-Life Antifreeze and Clean Water	10.25 gal (38.8 L)
Engine Lubrication System	SAE 15W40 Heavy Duty Motor Oil (API C1-4)	17.6 qt (16.7 L)
Front Wheel Bearings	Chevron RPM 75W-90 Synthetic Gear Lube	(as required)
Fuel Tank	Diesel; Sulphur Content: 0.0015 (15 ppm) • No. 1 (On-Road) • No. 2 (Off-Road)	50 gal (189.3 L)
HVAC System	R-134A Refrigerant	1.8 lb (0.8 kg)
Hydraulic System	Anti-Wear, Anti-Foam Hydraulic Fluid (AW46)	16 gal (60.6 L)
Power Steering System	Dextron ATF	4 qt (3.8 L)
Transmission	Allison Transynd or TES295 Approved ATF NOTE: Using a non-approved fluid will require the fluid replacement interval to be much more frequent.	29.75 qt (28.2 L)

LUBRICATION DIAGRAM

2



2-1

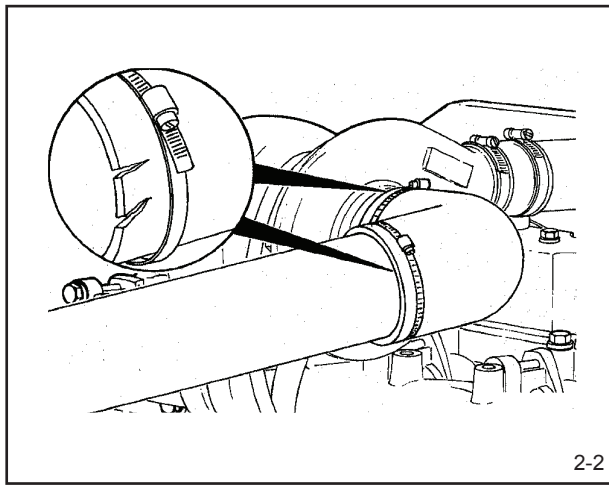
PREVENTATIVE MAINTENANCE

GENERAL ENGINE MAINTENANCE PROCEDURES

For complete Engine maintenance procedures, refer to the manufacturer's manual for the specific model.

Air Intake System Inspection

Inspect the air intake system for cracked hoses, loose clamps or punctures that can allow dirt and debris to enter the engine. See figure 2-2.



Tighten or replace parts as necessary to make sure the air intake system does not leak.

Coolant Level Check

⚠ CAUTION

Do not remove the radiator cap when the engine is hot. Wait until engine temperature has decreased to below 120° F (66.7° C) before removing the radiator cap. Failure to do so can result in minor or moderate injury from heated coolant spray or steam.

1. Remove the radiator cap slowly to relieve cooling system pressure.

IMPORTANT: Do not add cold coolant to a hot engine or engine castings can be damaged. Allow the engine to cool to below 120° F (66.7° C) prior to adding coolant.

2. Add coolant as necessary to bring the coolant level to 1 in (25.4 mm) below the bottom of the fill neck.
3. Reinstall the radiator cap

IMPORTANT: Never use a sealing additive to repair

leaks in the cooling system. Doing so can clog the cooling system and result in inadequate coolant flow and engine overheating.

Cooling System Draining and Flushing

⚠ CAUTION

Keep antifreeze out of reach of children.

Avoid prolonged and repeated skin contact with used antifreeze, and wash skin thoroughly after contact. Prolonged and/or repeated contact with antifreeze can cause skin disorders or other bodily injury.

IMPORTANT: Protect the environment; handling and disposal of used antifreeze can be subject to federal, state, and local regulations. Use authorized waste disposal facilities, including civic amenity sites and garages providing authorized facilities for the receipt of used antifreeze. If in doubt, contact your local authorities or the EPA for guidance as to proper handling of used antifreeze.

Draining

1. Place a suitable container with a capacity of 10 gal (37.9 L) under the radiator drain valve.
2. Open the radiator drain valve and remove the plug in the bottom of the water inlet.
3. Allow the coolant to drain from the system.

Inspection

- Check for damaged hoses and loose or damaged hose clamps. Replace components as required.
- Check the radiator for leaks, damage and buildup of dirt. Clean and repair components as required.

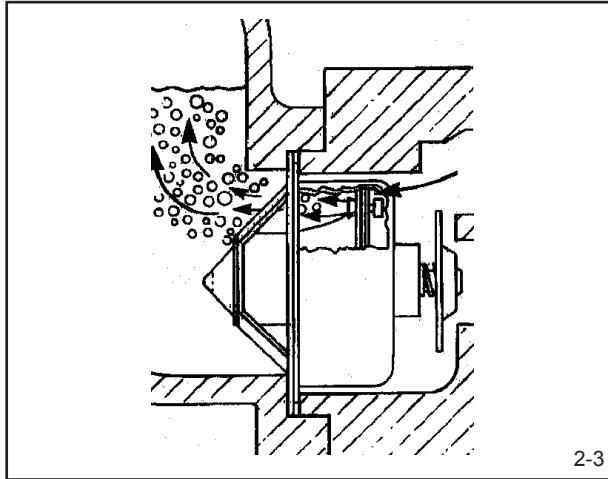
Flushing

1. Drain the cooling system.
2. Close the radiator drain valve and install the plug in the bottom of the water inlet.
3. Remove the radiator cap.
4. Fill the cooling system with a mixture of sodium carbonate and water (or a commercially available equivalent); use 1 lb (0.45 kg) of sodium carbonate for each 6 gal (23 L) of water used.

NOTE: During filling, air must be vented from the engine coolant passages. This is achieved through

PREVENTATIVE MAINTENANCE

the 'jiggle pin' openings to the top radiator hose and out the fill opening. See figure 2-3. Adequate venting is provided for a fill rate of 5 gal/min (18.9 L/min).



5. Turn the heater to high and, with the radiator cap removed, start up the engine.
6. Allow the engine to idle for ten minutes, topping up the system with the sodium carbonate and water mixture.
7. Shut down the engine.
8. Drain the cooling system.

Filling

1. Close the radiator drain valve and install the plug in the bottom of the water inlet.
2. Remove the radiator cap.
3. Fill the cooling system with a mixture of 50 percent water and 50 percent propylene glycol antifreeze.

NOTE: During filling, air must be vented from the engine coolant passages. This is achieved through the 'jiggle pin' openings to the top radiator hose and out the fill opening. See figure 2-3. Adequate venting is provided for a fill rate of 5 gal/min (18.9 L/min).

4. Install the radiator cap.
5. Start up the engine, and allow the engine to idle until the engine temperature reaches 180° F (82.2° C).
6. Check the system for leaks.

CAUTION

Do not remove the radiator cap when the engine is hot. Wait until engine temperature has decreased to below 120° F (66.7° C) before removing the radiator cap. Failure to do so can result in minor or moderate injury from heated coolant spray or steam.

7. Remove the radiator cap and add coolant as necessary to bring the coolant level to 1 in (25.4 mm) below the bottom of the fill neck.
8. Reinstall the radiator cap

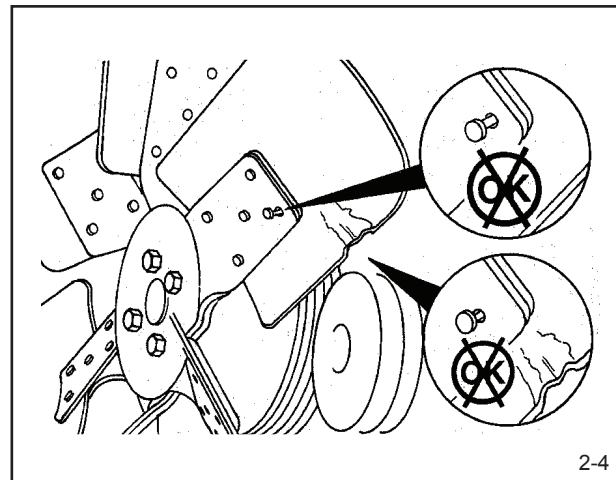
Cooling Fan Inspection

WARNING

Cooling fan failure can result in serious injury.

IMPORTANT: Never pull or pry on the cooling fan, or fan blade damage and fan failure can occur. Use the engine barring gear to rotate the crankshaft.

- Check for cracks, loose rivets, and bent or loose blades. See figure 2-4.



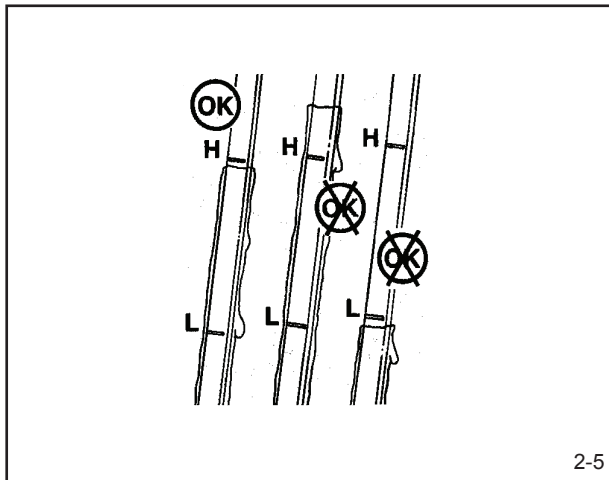
- Replace the cooling fan as necessary.
- Make sure that the cooling fan is securely mounted, and tighten the cap screws as necessary.

PREVENTATIVE MAINTENANCE

Oil Level Check

IMPORTANT: Never operate the engine with a low oil level, or internal engine damage can occur.

1. Park the vehicle on a flat, level surface.
2. Allow the oil to settle in the pan for approximately 15 minutes after the engine is shut down.
3. Remove the oil level gauge, and wipe the oil from the end of the gauge.
4. Reinsert and remove the oil level gauge.
5. Determine the oil level (see figure 2-5):



- If the oil level is below the 'L' (low) mark on the level gauge or between the marks but closer to the 'L' (low) mark, add oil as necessary to raise the oil level to the 'H' (high) mark.
- If the oil level is above the 'H' (high) mark, drain oil to lower the oil level to the 'H' (high) mark.

Oil Change

1. Park the vehicle on a flat, level surface.
2. Allow the oil to settle in the pan for 15 minutes after the engine is shut down.
3. Place a suitable container with a capacity of 18 gal (68.1 L) under the engine oil drain plug.
4. Remove the engine oil drain plug and allow the oil to drain.
5. Replace the engine oil filter.
6. Clean the area around the engine oil drain plug and reinstall the drain plug.
7. Fill the engine with the oil and quantity specified

in Lubricant, Fluid and Fuel Types and Capacities on page 2-6.

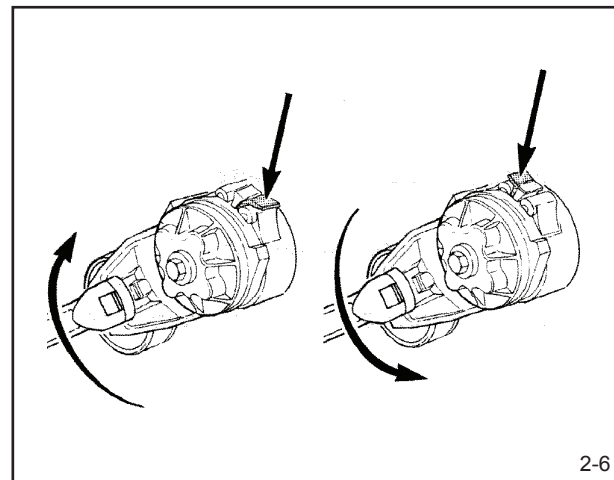
8. Start up the engine and allow the engine to idle for a few minutes while inspecting the filter and drain plug for leaks.
9. Shut down the engine.
10. Allow the oil to settle in the pan for 15 minutes, and then recheck the oil level.

Serpentine Belt Maintenance

Removal

IMPORTANT: The automatic belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting the belt tensioner in the opposite direction of windup or in the correct direction after the tensioner has been wound up to the positive stop can cause damage to the belt tensioner.

1. Pivot the automatic belt tensioner in the direction that the spring tang is bent over the housing. See figure 2-6.



2. Remove the serpentine belt.
3. Release the automatic belt tensioner.

Inspection

- Serpentine Belt:

A new Ethylene Propylene Diene Monomer (EPDM) engine serpentine belt will have a traditional v-shaped profile in the ribs however, material loss results in a u-shaped rib profile.

Once the rib profile has changed, there is less material (surface area) coming into contact with the pulleys. This material loss can cause slippage that will affect the performance of the accessories and may result in a noisy belt.

PREVENTATIVE MAINTENANCE

Use the following criteria to inspect an engine serpentine belt for wear:

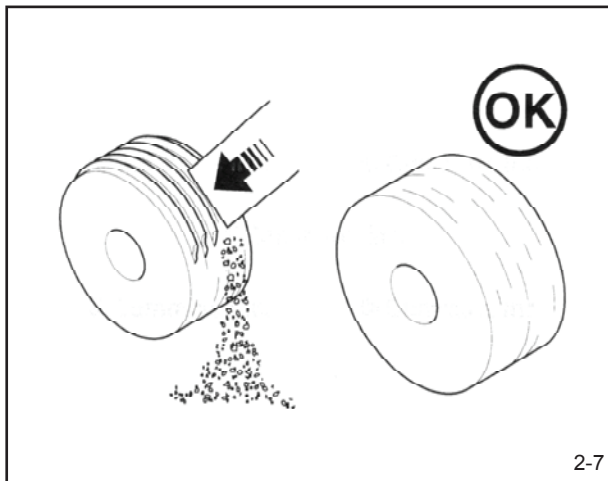
- Rib height
- Rib profile
- Cracking: no more than 4 cracks in a 1 in length of the belt

NOTE: Gauges are available to assist in inspecting the rib height and profile.

- Idler Pulleys:

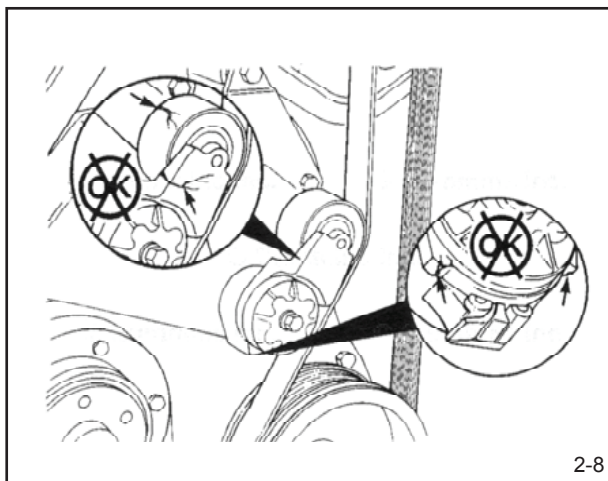
Inspect the idler pulleys for wear and cracks, and replace the pulley if necessary.

Plastic pulleys often have a build up of road dirt and belt material; such build up should not be considered wear. Remove any build up with a suitable tool, and then check the pulley for wear. See figure 2-7.



- Drive Belt Pulley and Idlers:

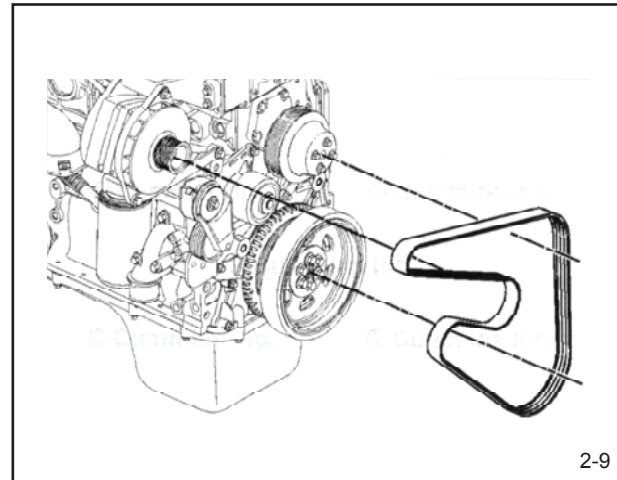
Inspect the drive belt pulley and idlers for cracks and broken grooves, and replace components as necessary. See figure 2-8.



Installation

IMPORTANT: The automatic belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting the belt tensioner in the opposite direction of windup or in the correct direction after the tensioner has been wound up to the positive stop can cause damage to the belt tensioner.

1. Route the serpentine belt over all pulleys except the water pump pulley. See figure 2-9.



2. Pivot the tensioner to put slack into the belt and place the belt over the water pump pulley.
3. Release the tensioner.
4. Make sure that the belt is aligned with all pulleys.

Tension Chart

NOTE: This chart does not apply to systems with an automatic belt tensioner.

SAE Belt Size	Tension (New)	Tension (Used*)
0.38 in	140 lb-ft (620 N•m)	60 to 110 lb-ft (270 to 490 N•m)
0.44 in	140 lb-ft (620 N•m)	60 to 110 lb-ft (270 to 490 N•m)
1/2 in	140 lb-ft (620 N•m)	60 to 110 lb-ft (270 to 490 N•m)
1 1/16 in	140 lb-ft (620 N•m)	60 to 110 lb-ft (270 to 490 N•m)
3/4 in	140 lb-ft (620 N•m)	60 to 110 lb-ft (270 to 490 N•m)
7/8 in	140 lb-ft (620 N•m)	60 to 110 lb-ft (270 to 490 N•m)
4 rib	140 lb-ft (620 N•m)	60 to 110 lb-ft (270 to 490 N•m)

PREVENTATIVE MAINTENANCE

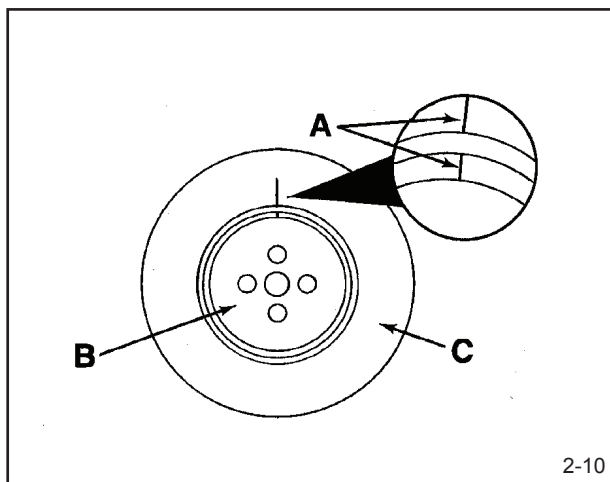
SAE Belt Size	Tension (New)	Tension (Used*)
5 rib	150 lb-ft (670 N•m)	60 to 120 lb-ft (270 to 530 N•m)
6 rib	160 lb-ft (710 N•m)	65 to 130 lb-ft (290 to 580 N•m)
8 rib	200 lb-ft (890 N•m)	80 to 160 lb-ft (360 to 710 N•m)
10 rib	250 lb-ft (1110 N•m)	100 to 200 lb-ft (440 to 890 N•m)
12 rib	300 lb-ft (1330 N•m)	120 to 240 lb-ft (530 to 1070 N•m)
12 rib (K section)	300 lb-ft (1330 N•m)	200 to 240 lb-ft (890 to 1070 N•m)

* A belt that has been in service for ten minutes or longer is considered used. If the tension of a used belt is less than the minimum value listed, tighten the belt to the maximum value listed for a used belt.

Vibration Dampener Inspection

Inspect the vibration dampener as follows:

- If the index lines (A) on the damper hub (B) and the dampener ring (C) are more than 1/16 in (1.59 mm) out of alignment, replace the dampener. See figure 2-10.



- If the surface of the dampener ring is not flush with the surface of the dampener hub, replace the dampener.
- If the rubber isolator is deteriorated, pieces of rubber are missing or if the isolator is more than 1/8 in (3.18 mm) below the surfaces of the dampener hub and ring, replace the dampener.

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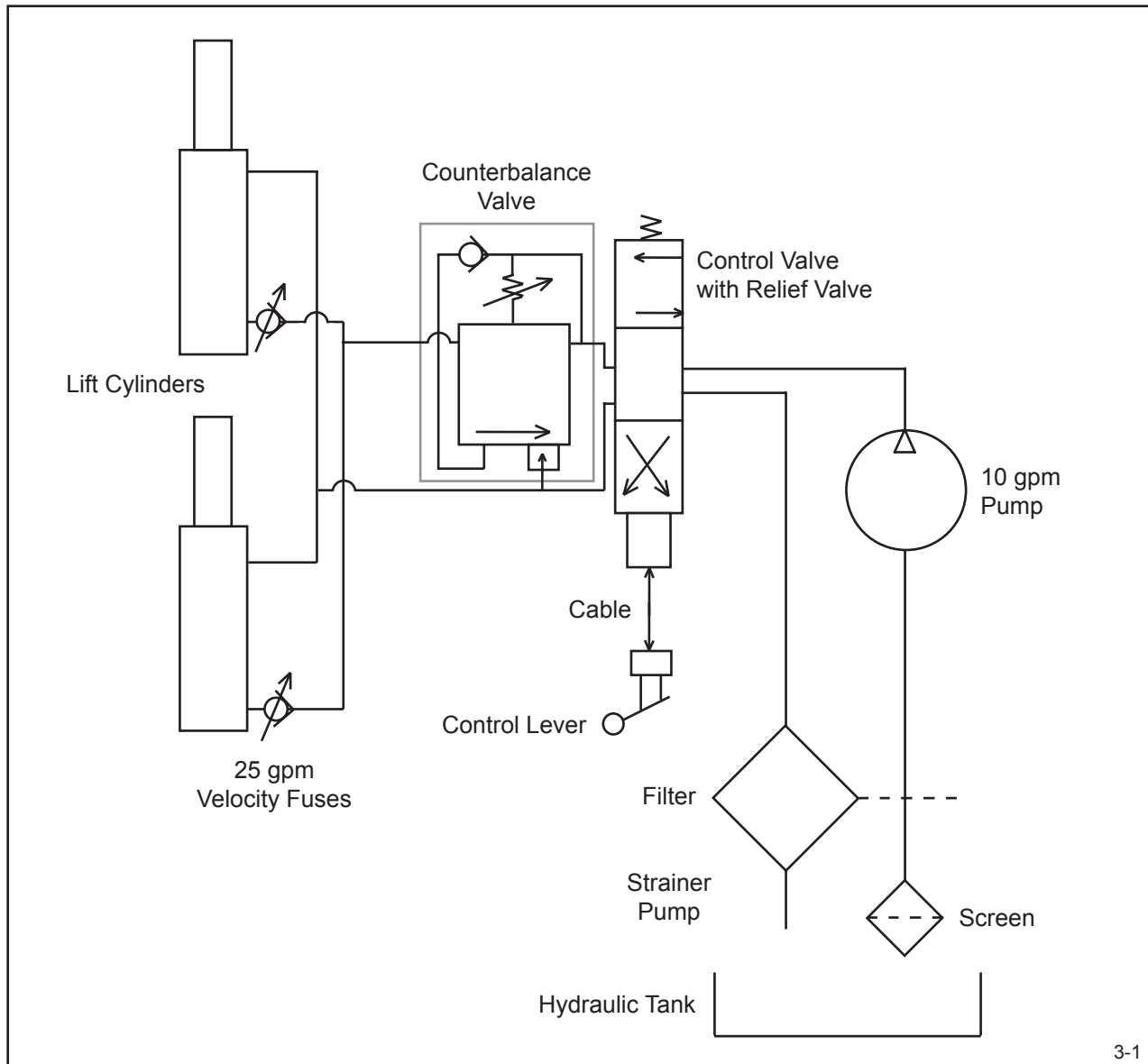
COMPONENTS AND THEORY OF OPERATION

The hydraulic system consists of the following major components (see figure 3-1):

- Hydraulic reservoir
- Hydraulic pump
- Control valve
- Actuating cylinders
- Filter
- Hoses
- Fittings
- Pilot check valve

Fluid is drawn from the reservoir by the transmission-mounted pump and sent to the control valve.

The pressurized fluid can be directed to the boom cylinders or, when not needed, the fluid returns to the tank via the return filter.



HYDRAULIC SYSTEM

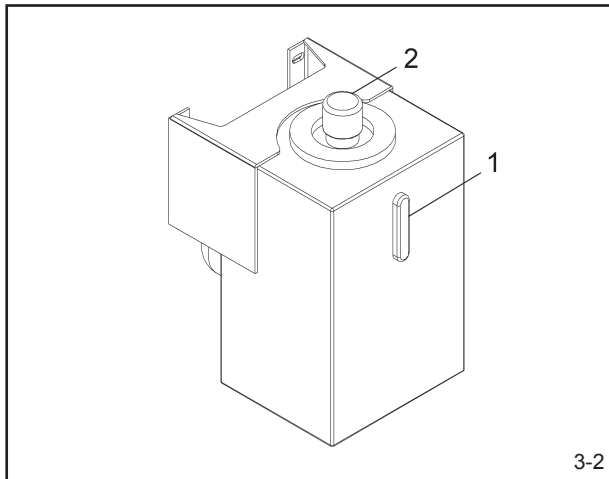
MAINTENANCE

Checking the Fluid Level

WARNING

Fully lower the boom and remove power from the system prior to checking the fluid level, or death or serious injury could result.

Observe the fluid level at the level sight gauge (1) on the hydraulic reservoir. See figure 3-2.



If the fluid level is below the lower (red) mark, remove the breather cap (2) and add fluid until the level is between the lower and the upper (black) marks.

Replacing the Filter

The hydraulic filter is a spin-on type filter, located at the inside of the frame rail from the hydraulic reservoir (TJ Series), or at the outside of the frame rail, between the reservoir and the exhaust (Sabre Series).

NOTE: The strainer is a cleanable filter, located inside the hydraulic reservoir; see the procedures for changing the fluid for strainer service.

Replace the hydraulic filter as follows:

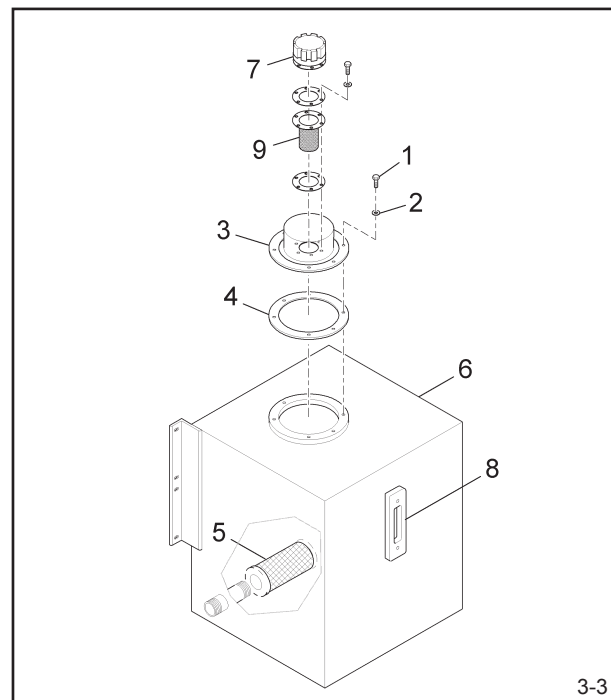
1. Place a suitable container under the filter to catch fluid.
2. Spin the filter counterclockwise to remove the filter.
3. Clean the filter housing mating surface of residual fluid.
4. Apply a thin coat of new fluid to the filter gasket surface.

5. Spin the filter clockwise onto the filter housing until the gasket contacts the filter housing mating surface.
6. Turn the filter an additional 1/2 to 3/4 turn by hand to tighten the filter.
7. Operate the hydraulic system to check for leaks at the filter.
8. Dispose of used fluid in accordance with federal and local regulations.

Changing the Fluid

NOTE: Change the hydraulic fluid when the fluid is warm.

1. Raise the boom to its maximum height and then allow the boom to lower under its own weight.
2. Place a suitable container under the reservoir to catch fluid.
3. Remove the drain plug from the bottom of the reservoir and allow the fluid to drain.
4. Reinstall the drain plug.
5. Remove the six bolts (1) and lock washers (2) that secure the cover (3), remove the cover and the gasket (4) and discard the gasket. See figure 3-3.



6. Unscrew the strainer (5) from strainer housing and remove the strainer from the reservoir (6).
7. Use solvent to clean the strainer.

CAUTION

Use eye protection when using compressed air to dry the strainer, or eye injury could result.

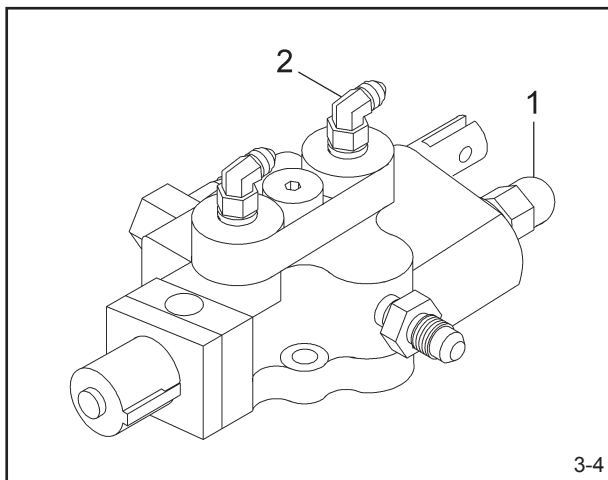
8. Use compressed air to dry the strainer.
9. Clean the interior of the reservoir if necessary.
10. Reinstall the strainer.
11. Install the new gasket between the cover and the reservoir, and re-install the cover using the six bolts and lock washers.
12. Remove the breather cap (7) and refill the reservoir with the specified fluid to the upper (black) line on the level sight gauge (8).
13. Ensure that the filler screen (9) is clean, and reinstall the breather cap.
14. Start up the engine and operate the hydraulic system until the fluid reaches the normal operating temperature.
15. Add fluid to the reservoir, as necessary, to bring the fluid level to the upper (black) mark on the level sight gauge.
16. Check the hydraulic system for leaks.

Adjusting the Relief Valve

Adjust the hydraulic relief valve when the boom will not lift under pressure, or when the hydraulic control valve is replaced.

Adjust the relief valve as follows:

1. Use an assistant who is trained to operate the boom control.
2. Remove the acorn nut (1) to expose the control valve adjusting screw. See figure 3-4.



3. Remove the hydraulic line from the elbow fitting (2).
4. Plug or clamp the removed hydraulic line.
5. Install a pressure gauge onto the fitting.
6. Start up the engine and allow the hydraulic fluid to reach normal operating temperature.

NOTE: Do not hold the boom at its lowest limit of travel for more than 30 seconds at a time or the fluid will overheat. If more than 30 seconds is needed, allow the fluid to cool between adjustments.

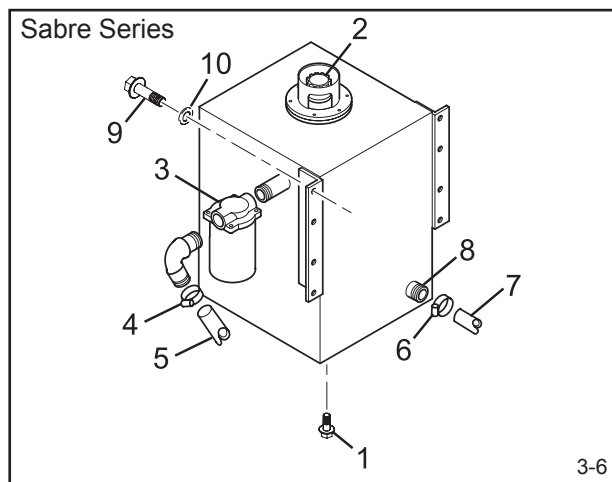
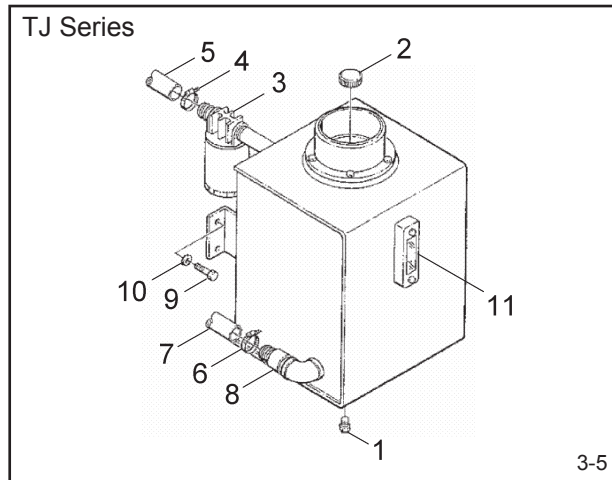
7. Press the accelerator pedal to approximately 1/4 throttle, and observe the pressure gauge reading while lowering the boom to its limit of travel.
8. Loosen the adjusting screw jam nut, and use the adjusting screw to obtain a reading of 2,500 psi (172.4 bar) on the pressure gauge:
 - Turn the adjusting screw inwards to increase system pressure.
 - Turn the adjusting screw outwards to decrease system pressure.
9. Tighten the adjusting screw jam nut.
10. Shut down the engine.
11. Remove the pressure gauge from the elbow fitting, and remove the plug or the clamp from the hydraulic line.
12. Reinstall the hydraulic line on the elbow fitting and reinstall the acorn nut.

HYDRAULIC SYSTEM

REPAIR

Reservoir

NOTE: All serviceable components of the hydraulic reservoir can be removed without removing the reservoir.



Removal

1. Place a suitable container under the reservoir to catch fluid.
2. Remove the drain plug (1) and the breather cap (2), and allow the fluid to drain. See figures 3-5 and 3-6.
3. Reinstall the drain plug and the breather cap.
4. Disconnect filter housing (3):
 - TJ Series: Loosen the clamp (4), unscrew the filter housing from the reservoir and plug the exposed end of the filter housing to prevent contamination. Removal of the hose (5) is not necessary.

- Sabre Series: Loosen the clamp (4) and remove the hose (5) from the filter housing.
5. Remove the clamp (6), and disconnect the hose (7) from the adapter (8).
 6. Remove the reservoir mounting bolts (9) and lock washers (10), and remove the reservoir.
 7. Remove components from the reservoir:
 - TJ Series: Remove the adapter.
 - Sabre Series: Remove the filter housing mounting bracket from the reservoir and the filter housing, and unscrew the filter housing from the reservoir.
 8. Dispose of used fluid in accordance with federal and local regulations.

Installation

1. Install components on the reservoir:
 - TJ Series: Install the adapter (8). See figure 3-5.
 - Sabre Series: Thread the filter housing (3) onto the reservoir, and install the filter housing mounting bracket to the reservoir and the filter housing. See figure 3-6.
2. Position the reservoir on the vehicle frame, and install the reservoir with the mounting bolts (9) and lock washers (10).
3. Install the adapter (8), connect the hose (7) and tighten the clamp (6).
4. Connect the filter housing:
 - TJ Series: Thread the filter housing (3) onto the reservoir, and tighten the clamp (4).
 - Sabre Series: Connect the hose (5) to the filter housing, and tighten the clamp (4).
5. Make sure that the drain plug (1) is tight, remove the breather cap (2) and fill the reservoir to the upper (black) mark on the level sight gauge (11).
6. Start up the engine and raise and lower the boom several times to expel trapped air, and check for leaks.
7. Power down the boom and add fluid as necessary so that the fluid level is between the lower (red) and upper marks on the level sight gauge.

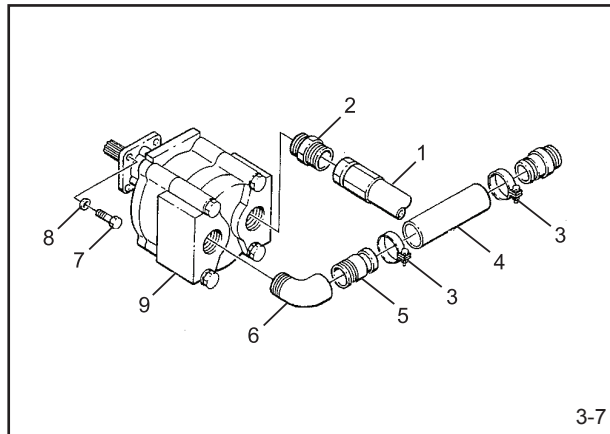
Boom Lift Pump

Removal

1. Remove the two walkways behind the cab.
2. Drain the hydraulic tank.

NOTE: The hydraulic pump is mounted on the PTO, on the RH side of the transmission.

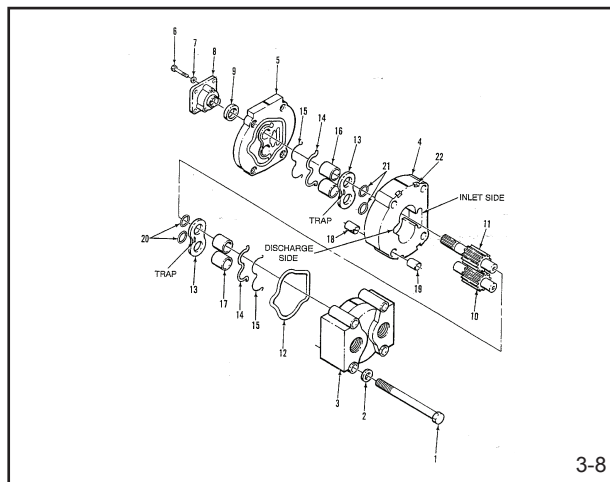
3. Disconnect the hydraulic hose (1) from the straight fitting (2). See figure 3-7.



4. Remove the clamps (3) and the hose (4).
5. Remove the bolts (7) and the lock washers (8), and remove the pump (9).
6. Remove the adapter (5), the elbow (6) and the straight fitting (2).

Shaft Seal Replacement

1. Clean the pump body with a brush and solvent, and compressed air to clean the shaft seal.
2. Remove the socket screws (6) and the lock washers (7). See figure 3-8.



3. Remove the mounting adapter (8).

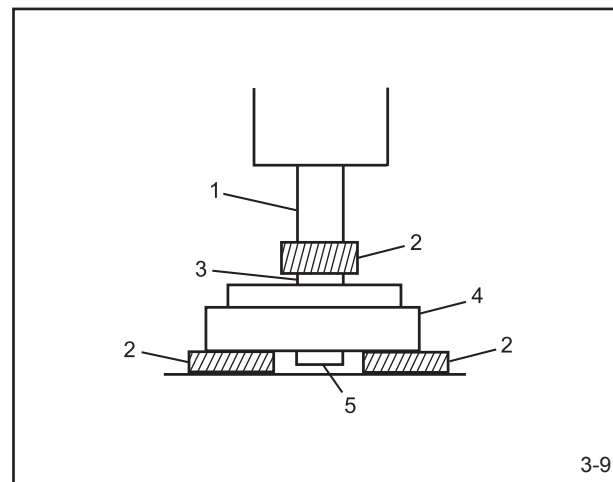
4. Remove the cap screws (1) and the lock washers (2).
5. Hold the gear housing (4) and the rear cover (3) together, and tap the front flange (5) with a plastic hammer to loosen the flange.
6. Slide the front flange (5) off of the gear shafts and remove the o-ring (12), the seal (14) and the backup seal (15).
7. Place the front flange (5) in a machinist's vise, using cardboard between the jaws of the vise and the flange to protect the flange surfaces.

NOTE: Do not allow the punch to touch the seal bore or the bearing while driving the seal (9) out.

8. Slide a punch of appropriate size through the bearing and against the seal's metal casing.
9. Hold the punch away from the bearing and, while moving the punch around the seal, drive the seal (9) out without damaging the seal bore or the bearing.
10. Check around the seal bore for scratches, and use 400 grit or finer sandpaper to clean up light scratches.

If the bore is badly scratched, replace the front flange.

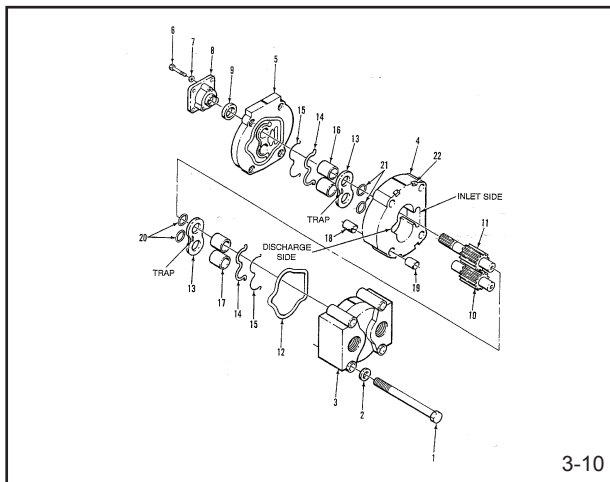
11. Wash the front flange in clean solvent and use compressed air to dry.
12. Using a press (1) and wood blocks (2), press the new seal (3) into the front flange (4), making sure not to press against the protruding end of the shaft bearing (5). See figure 3-9.



13. When the upper wood block contacts the front flange, release the press and replace the upper wood block with the appropriate size seal driver, or a socket with an OD slightly smaller than the seal bore.

HYDRAULIC SYSTEM

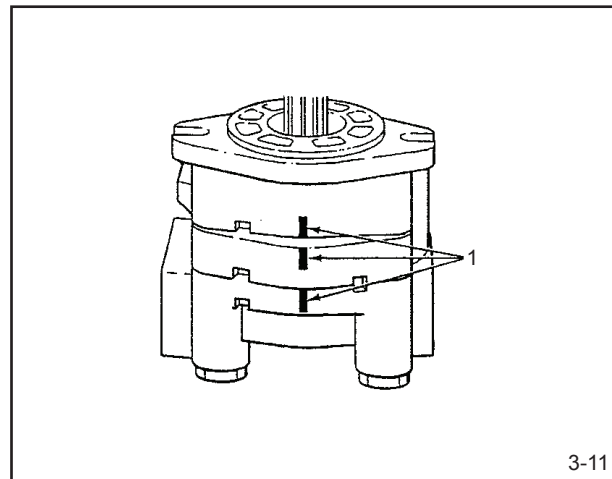
14. Continue to press the seal into the front flange until the seal just passes the snap ring groove in the seal bore.
15. Apply two or three drops of Loctite 290 against the seal bore and the outside of seal. Allow the Loctite to flow entirely around the OD of the seal.
16. Wipe any excess Loctite from the seal bore and the seal lip.
17. Apply a clean, heavy grease to the seals (14 and 15) and the o-ring (12), and install the o-ring, the backup seal (15) and the seal (14). See figure 3-10.



18. Coat the spline end of the drive shaft with clean grease to protect the shaft seal (9).
19. Install the front flange (5) on the pump, using the cap screws (1) and the lock washers (2).
20. Tighten the cap screws to 75 lb-ft (101.7 N•m) torque.
21. Install the mounting adapter (8), the socket screws (6) and the lock washers (7).

Disassembly

1. Clean the pump body with a brush and solvent.
2. Use an ink marker to make alignment marks (1) on the housings nearest to the drive shaft extension side for reference during assembly. See figure 3-11.



3. Remove the socket screws (6) and the lock washers (7), and remove the mounting adapter (8). See figure 3-10.
4. Remove the cap screws (1) and the lock washers (2).
5. Use a wood mallet or a plastic hammer to tap the rear cover (3) loose, and remove the rear cover.
6. Remove the o-ring (12), the seal (14) and the backup seal (15) from the rear cover (3).
7. Remove the thrust plate (13) and the o-rings (20) from the thrust plate.
8. Mark the tooth and valley with layout dye for reference during assembly.
9. Remove the drive gear (11) and the idler gear (10) from the gear housing (4).
10. Tap the edges of the gear housing (4) with a wooden mallet or a plastic hammer to loosen the housing, and remove the gear housing and the front flange (5).
11. If the gear housing (4) will be replaced, use a suitable drift to remove the dowels (18 and 19) from the gear housing. Tap alternate sides of the dowels to remove the dowels.
12. Remove the o-ring (12), the seal (14) and the backup seal (15) from the front flange (5).
13. Remove the thrust plate (13) from the gear housing (4), and remove the o-rings (21) from the thrust plate.

Inspection

- Visually inspect all parts:
It is not necessary to set up gauges to check the amount of wear on the pump parts. After

a visual inspection, those parts that are in questionable condition should be replaced.

- Note the bores in the gear plate:

A milled groove is present on the discharge side, in the center of the plate. During initial break-in at the factory, the gears cut into the suction side. Nominal depth of this cut is 0.008 in (0.203 mm) and should not exceed 0.015 in (0.381 mm). Small bits of metal are sometimes pulled out of the surface during break-in, which is not detrimental. If the cut is deeper than 0.015 in (0.381 mm) or the plate is cracked or damaged, it should be replaced.

- Examine the gears:

If excessive wear is visible on the journals, the sides or the faces of the gears, or at the point where the drive gear shaft rotates in the lip seal, replace these components. If the splines are excessively worn, replace the drive gear.

- Examine the thrust plates:

The thrust plates should not show excessive wear on the bronze side. If deep, curved wear marks are visible, replace the thrust plate.

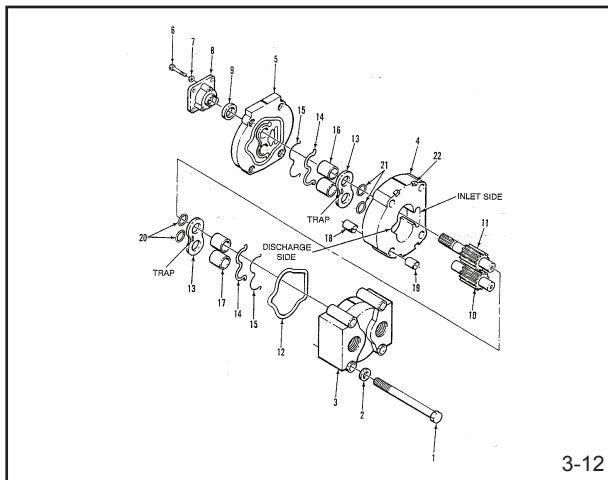
- Bearings:

Bearing IDs should have a gray coating. If bronze can be seen through the Teflon coating on the suction side, replace the bearings and the applicable plate.

- Replace the shaft seals, all o-ring seals and backup rings or strips as standard procedure.

Assembly

1. Apply a clean, heavy grease to the o-ring (12), and install the o-ring in the rear cover (3). See figure 3-12.



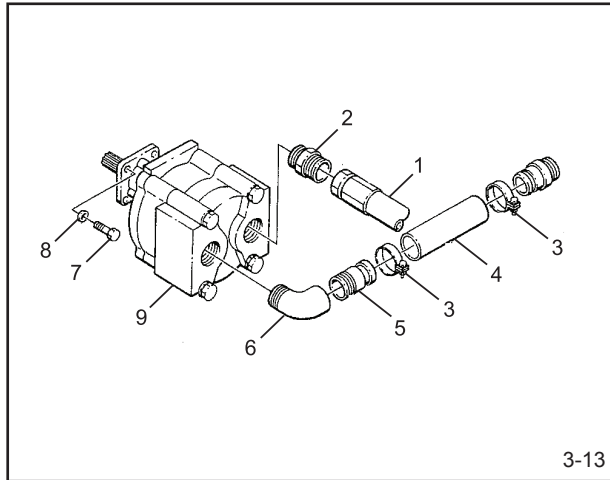
3-12

2. If the gear housing (4) has been replaced, press the dowels (18 and 19) into the new gear housing. Make sure the dowels are straight and fully-seated.
3. Align the marks on the gear housing (4) and the rear cover (3) that were made during disassembly.
4. Position the cast in the recesses on the gear housing (4) towards the rear cover (3), and lightly tap the gear housing with a plastic hammer until the housing contacts the o-ring (12).
5. Install the backup seal (15) and the seal (14) in the rear cover (3).
6. Install the o-rings (20) in the thrust plate (13) and, with trap positioned toward the discharge side of the gear housing (4) and the bronze side facing upwards, slide the thrust plate down the gear bores in the rear cover (3).
7. Align the tooth and valley marked with layout dye and install the drive gear (11) in the gear bore nearest the alignment mark, and install the idler gear (10) in the opposite bore.
8. Install the o-rings (21) in the remaining thrust plate (13).
9. With trap positioned toward the discharge side of the gear housing (4) and the bronze side facing downwards (facing the gears) install the remaining thrust plate (13) against the gears.
10. Apply a clean, heavy grease to the seals (14 and 15) and the o-ring (12), and install the o-ring, the backup seal (15) and the seal (14) into the front flange (5).
11. Coat the splines with clean heavy grease to protect the shaft seal (9).
12. Install the front flange (5) with the marks aligned to the gear shafts, until the front flange contacts the dowels (18).
13. Use a plastic hammer to tap the front flange (5) onto the dowels (18 and 19) while making sure that the seals and the o-rings remain in place.
14. Coat the threads of the cap screws (1) with clean hydraulic oil and install the cap screws and the lock washers (2).
15. Tighten the cap screws to 80 lb-ft (108.5 N•m).
16. Use a 12 in wrench on the shaft to make sure that the shaft turns with 15 lb (6.8 kg) of force.

HYDRAULIC SYSTEM

Installation

1. Position the pump (9) on the PTO flange and secure the pump with the bolts (7) and the lock washers (8). See figure 3-13.



2. Install the elbow (6) and the adapter (5).
3. Attach the hose (4) and secure the hose with the clamps (3).
4. Install the straight fitting (2) and connect the hydraulic hose (1).
5. Fill the hydraulic tank to the full mark on the level gauge. See Lubricant, Fluid and Fuel Types and Capacities on page 2-6 for the specified lubricant.
6. Start up the engine and operate the boom through the entire range of travel several times to expel air and check for leaks.
7. Add fluid to the hydraulic tank, as necessary, so that the fluid level is at the full mark on the level gauge.

Boom Cylinder (TJ Series)

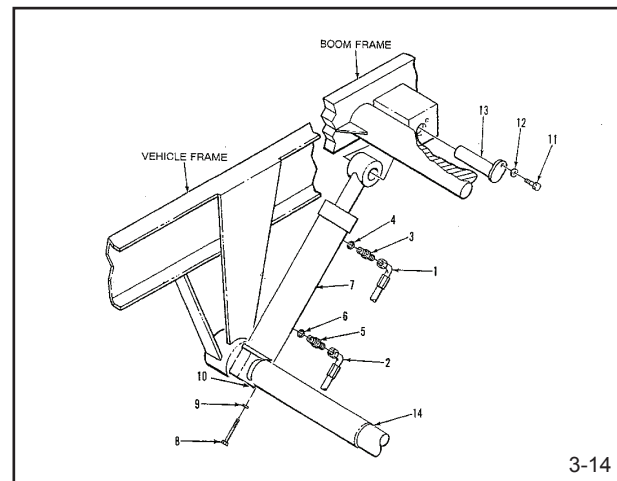
Removal

⚠ WARNING

Relieve pressure in the hydraulic system prior to disconnecting the hydraulic hoses or death or serious injury could result.

1. Park the vehicle on a flat, level surface, set the parking brake and chock the wheels.
2. Raise the fifth wheel boom frame to the upper limit of travel, and block the boom in this position.
3. Place a suitable container under the connection point of the boom lift cylinders.

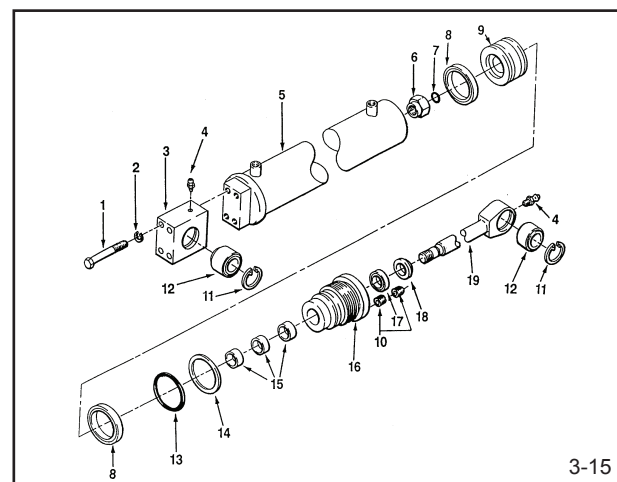
4. Disconnect the hydraulic hoses (1 and 2). See figure 3-14.



5. Attach a suitable sling and a hoist to the lift cylinder and take up all slack in the sling.
6. Remove the cap screws (8), and the lock washers (9).
7. Remove the cap screw (11), the lock washer (12) and the cylinder pin (13).
8. Remove the boom lift cylinder.
9. Remove the adapters (3 and 5) and the o-rings (4 and 6).
10. Repeat steps 4 through 9 to remove the second boom cylinder.
11. Dispose of used oil in accordance with federal and local regulations.

Disassembly, Inspection and Assembly

1. Remove the two setscrews (10) and remove the head (16) from the tube assembly (5). See figure 3-15.



2. Remove all the components from the tube assembly.
3. Clamp the end of the rod assembly (19) in a vise, and remove the self-locking nut (6), the u-cups (8) and the piston (9) from the rod assembly.
4. Slide the head (16) off the rod assembly (19).
5. Remove the o-ring (13), the backup ring (14), the wiper (18) and the u-cup (17) from the head.
6. If the bushing (12) is to be replaced, press the bushing out of the rod assembly (19) and press in the new bushing.
7. Remove the wear rings (15) if the rings exhibit excessive wear.
8. Check the inside surface of the tube assembly (5) for scoring or scratches.
 - Smooth out light scratches with crocus cloth.
 - Replace the tube assembly if the inside surface exhibits excessive wear.
9. Check the sliding surfaces of the piston (9) and rod assembly (19).
 - Smooth out light scratches with crocus cloth.
 - Replace any parts that exhibit excessive wear.
10. Install the u-cups (8 and 17), the o-rings (7 and 13) and the wiper (18) from the seal kit.
11. Install the head (16), the piston (9) and the o-ring (7) onto the rod assembly (19) and tighten the self-locking nut (6).
12. Lubricate the u-cups (8 and 17) and the seals (7 and 13) with clean hydraulic fluid and slide the complete rod assembly (19) into the tube assembly (5).
13. Install the head (16) into the tube assembly (5), tighten the head with a spanner wrench and install the setscrews (10).

Installation

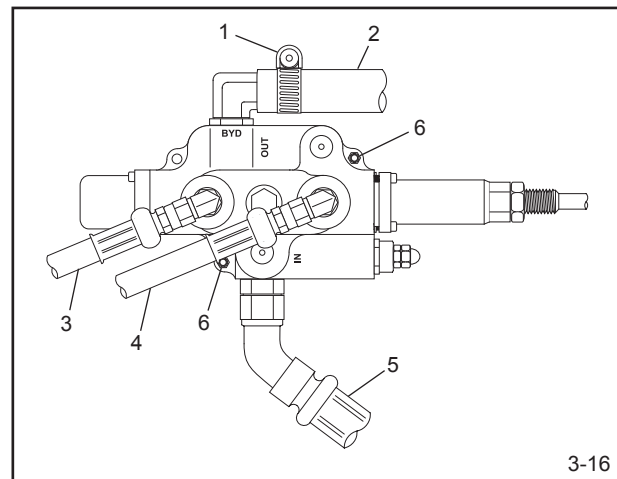
1. Install the hydraulic boom cylinders, rod end first using the cylinder pins (13), the lock washers (12) and the cap screws (11). See figure 3-14.
2. Position the lower end of the cylinders (7) over the bearing block (10), and install the cap screws (8) and the lock washers (9).

3. Install the o-rings (4 and 6) and the adapters (3 and 5), and connect the hose assemblies (1 and 2).
4. Service the grease fittings (4). See figure 3-15.
5. Start up the engine and allow the hydraulic fluid to warm to normal operating temperature.
6. Operate the boom through its full range of travel ten times to remove trapped air, and check for leaks.

Control Valve

Removal

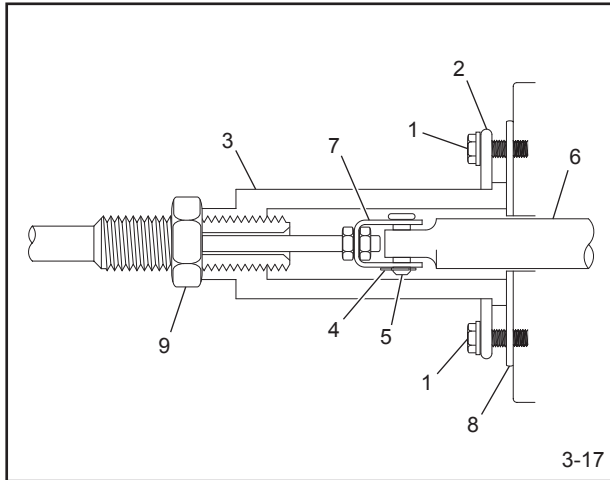
1. Park the vehicle on a flat, level surface, set the parking brakes, chock the wheels and shut down the engine.
2. Remove the walkway behind the cab to gain access to the control valve.
3. Tilt the cab forward to its maximum height and make sure the safety latch is engaged.
4. Place a suitable container under the hydraulic filter to catch fluid.
5. To release hydraulic pressure, remove the hydraulic filter and then move the hydraulic control lever.
6. Loosen the hose clamp (1) at the BYD port fitting and remove the hydraulic return hose (2) from the fitting. See figure 3-16.



7. Loosen and remove the hose (3) from the B port fitting, and drain the hydraulic fluid into a suitable container.
8. Loosen and remove the hose (4) from the A port fitting, and drain the hydraulic fluid into a suitable container.

HYDRAULIC SYSTEM

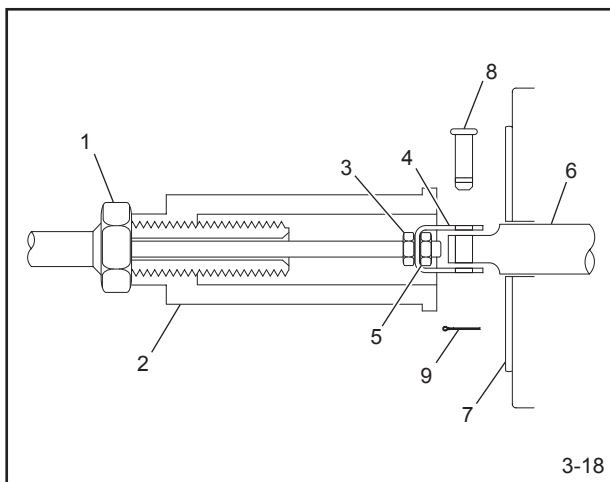
9. Loosen and remove the hose (5) from the inlet port fitting.
10. Loosen and remove the two flange bolts (1). See figure 3-17.



11. Slide the cable mounting flange (2) and the sleeve (3) away from the control valve.
12. Remove the cotter pin (4) and the clevis pin (5) to disconnect the valve spool (6) from the clevis (7) at the end of the cable.
13. Loosen and remove the two control valve mounting bolts (6). See figure 3-16.
14. Remove the control valve from the valve mounting plate.

Installation

1. Loosen the sleeve jam nut (1) and turn the nut away from the cable end until the nut is at the end of the threads. See figure 3-18.

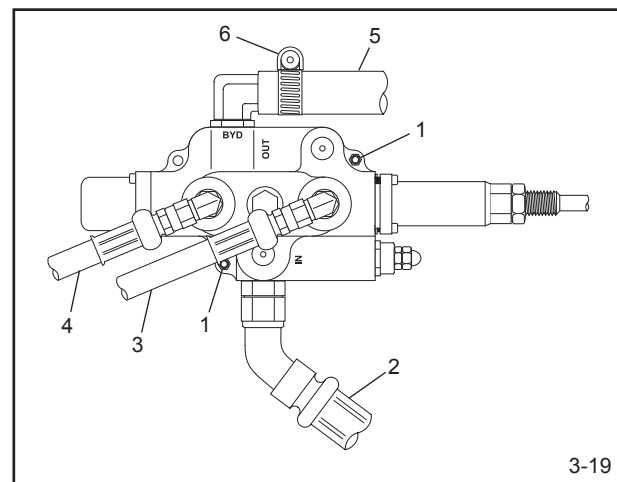


2. Turn the sleeve (2) in the same direction as the jam nut until the sleeve contacts the nut.

3. Apply thread locking compound to the clevis jam nut (3) and fully install the jam nut.
4. Install the clevis (4).
5. Apply thread locking compound to the clevis mounting nut (5) and install the mounting nut until it contacts the clevis.
6. Rotate the clevis (4) so that the holes in the clevis are aligned with the holes in the valve spool (6).
7. Tighten the clevis jam nut (3).
8. Making sure that the retainer plate (7) is installed on the valve, align the holes in the clevis (4) with the holes in the valve spool (6).
9. Install the clevis pin (8) and the cotter pin (9) to attach the clevis to the valve spool.
10. Make sure that the hydraulic control lever is in the neutral position and remains in this position when performing steps 11 through 14.
11. Turn the sleeve (3) towards the control valve until the sleeve contacts the retainer plate (8). See figure 3-17.
12. Turn the sleeve jam nut (9) towards the sleeve, and tighten the nut against the sleeve.
13. Align the mounting holes in the flange (2) with the threaded holes in the control valve.
14. Install and tighten the two flange bolts (1) until the lock washers are flattened.

NOTE: Do not continue to tighten the flange bolts after the lock washers are flattened or the flange will become distorted.

15. Position the control valve on the mounting plate.
16. Install and tighten the two control valve mounting bolts (1). See figure 3-19.



HYDRAULIC SYSTEM

17. Install and tighten the hose (2) to the inlet port fitting.
18. Install and tighten the hose (3) to the A port fitting.
19. Install and tighten the hose (4) to the B port fitting.
20. Install the hydraulic return hose (5) to the BYD port fitting and tighten the hose clamp (6).
21. Install a new hydraulic filter.
22. Tilt the cab down to the operating position.
23. Start up the engine and raise and lower the boom several times to expel trapped air and check for leaks.
24. Power down the boom and add fluid to the reservoir, as necessary, so that the fluid level is between the lower (red) and upper marks on the level sight gauge.
25. Reinstall the walkway behind the cab.

3

HYDRAULIC SYSTEM

TROUBLESHOOTING

Symptom	Cause	Solution
Hydraulic pump excessively noisy during operation	Low fluid level	Fill reservoir with specified fluid to correct level
	Restricted suction filter	Clean or replace suction filter
	Restricted or collapsed suction line	Replace suction line
	Incorrect fluid (high viscosity)	Replace fluid with correct viscosity
Excessive fluid temperature	Low fluid level	Fill reservoir with specified fluid to correct level
	Malfunctioning relief valve	Clean, adjust and/or replace relief valve
	Overloaded machine	Remove excessive load
	Incorrect fluid (low viscosity)	Replace fluid with correct viscosity
Lift speed abnormally slow	Low fluid level	Fill reservoir with specified fluid to correct level
	Malfunctioning relief valve	Clean, adjust and/or replace relief valve
	Worn out pump	Inspect, repair and/or replace pump
Boom leaks down	Leaking cylinder piston packing	Rebuild or replace cylinder
	Control valve not centering valve spool	Replace centering spring, or clean or replace valve spool, cable or lever
	Internal control valve leak	Replace control valve
Lift cylinder leaks externally	Damaged or worn rod seal and wiper	Rebuild or replace lift cylinder
Pump leaks at shaft	Worn or damaged shaft seal	Replace shaft seal or pump
	Worn or damaged pump bearings	Replace pump
Fluid is foamy	Suction leak between reservoir and pump	Inspect and tighten all connections, and replace any defective pads
	Low fluid level	Fill reservoir with specified fluid to correct level
	Incorrect fluid	Drain system and refill with specified fluid to correct level

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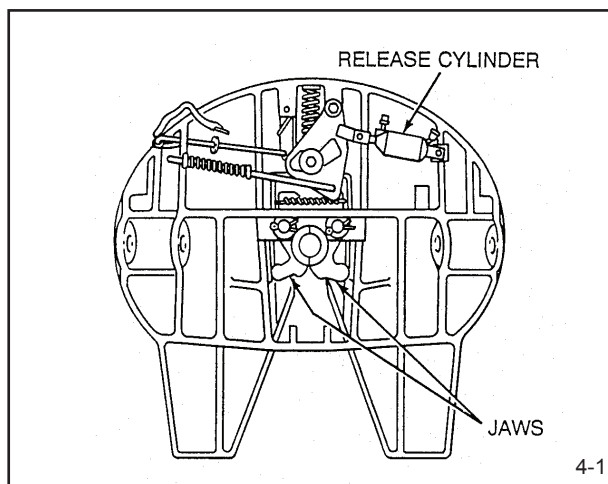


MAINTENANCE

Maintaining the fifth wheel consists of lubricating the pivot shaft and the fifth wheel surface plate with multipurpose grease. There are no adjustments on the fifth wheel plate.

Jaw Release Air Cylinder Inspection

1. Have the operator in the cab depress and hold the release button.
2. Apply soapy water to the release cylinder shaft seal area to determine if leaks exist. See figure 4-1.



3. Have the operator allow the release button to return to the 'out' position.
4. Disconnect the air hose from the release cylinder.
5. Remove the air cylinder from the fifth wheel.
6. Collapse and extend the release cylinder to check for stroke binding, and replace the cylinder if binding occurs.
7. Install the cylinder on the fifth wheel and connect the air hose.

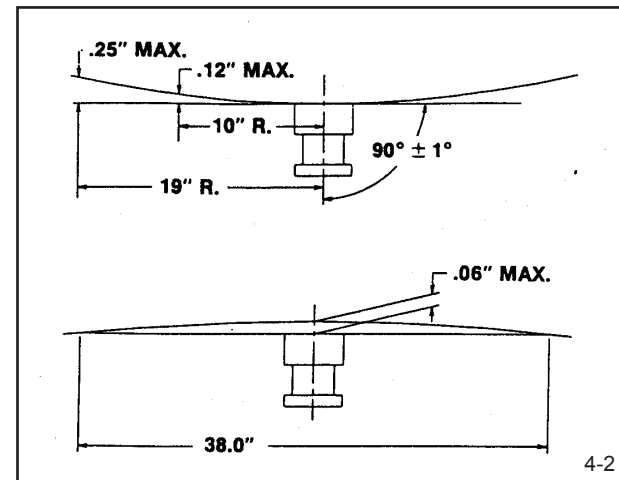
IMPORTANT: Do not overtighten the cylinder mount bolts. The cylinder should swing freely on either mount.

8. Use the appropriate tool to push forward on the locking jaws until the jaws lock.
9. Make sure that the air system is pressurized to 80 to 120 psi (5.5 to 8.3 bar), and have the operator in the cab depress and hold the release button.
10. Make sure that the jaws separate and open fully.

Trailer Upper Coupler / Bolster Plate Inspection

Any bumps, valleys or warping will result in uneven loading, a cracked fifth wheel, poor lubricant retention, galling of the fifth wheel and the trailer upper coupler and poor lock life.

1. Check the flatness of the upper coupler or bolster plate (see figure 4-2):

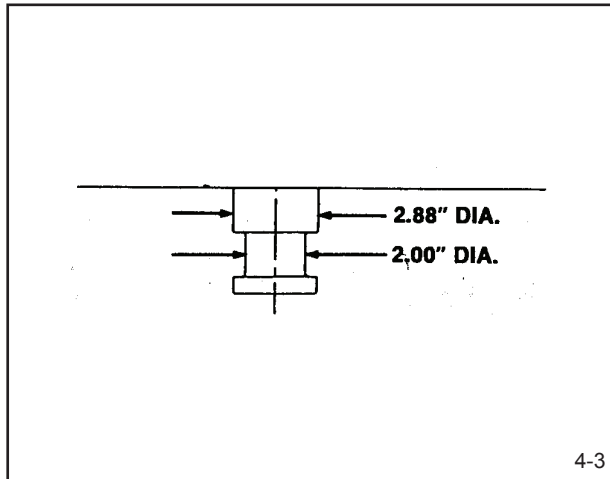


Use a 48 in straight edge, and replace the bolster plate if the plate is deformed more than any of the following specifications:

- 0.12 in (3.05 mm) away from the kingpin 10 in (25.4 cm) from the kingpin center
 - 0.25 in (6.35 mm) away from the kingpin 19 in (48.3 cm) from the kingpin center
 - 0.06 in (1.53 mm) towards the kingpin within a 38 in (96.5 cm) diameter from the kingpin center
2. Inspect the kingpin using a kingpin gauge:
 - Bent kingpin: A bent kingpin can result from excessive coupling speed or impacting the trailer into a dock. The kingpin may be bent or pulled down in the center, deforming the bolster plate. If this condition exists, replace the kingpin.
 - Kingpin length: The kingpin must be of the proper length to couple properly with a fifth wheel. If a lube plate is used during operation, the kingpin must be sized to compensate for the thickness of the lube plate to maintain the proper dimensions.
 - Long kingpin: A long kingpin will result in excessive wear in the locks, and coupling difficulty. If this condition exists, replace the kingpin.

BOOM AND FIFTH WHEEL

- Short kingpin: A short kingpin will accelerate lock wear and may interfere with proper fifth wheel coupling. If this condition exists, replace the kingpin.
- Worn kingpin: If the kingpin is worn 0.125 in (3.18 mm) or more on either the 2 in (5.1 cm) or the 2.88 in (7.32 cm) diameter portions in either direction, replace the kingpin. See figure 4-3.



REPAIR

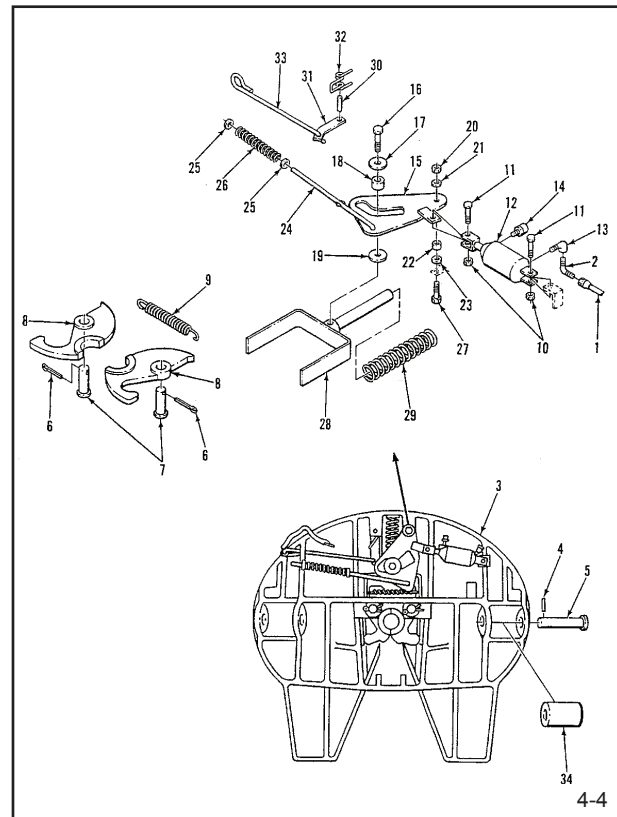
Perform only those steps necessary to effect the desired repair.

Fifth Wheel (Holland)

Removal

NOTE: All serviceable parts of the fifth wheel may be removed without removing the entire fifth wheel.

1. Park the vehicle on a flat, level surface, set the parking brake and chock the wheels to prevent vehicle movement.
2. Raise the boom approximately 6 in (15.2 cm) to provide adequate access to the underside of the fifth wheel.
3. Shut down the engine.
4. Press and release the brake pedal approximately thirty times to decrease air brake system pressure to 0 psi (0 bar).
5. Disconnect the air hose (1) from the elbow (2). See figure 4-4.



6. Attach a suitable hoist and a sling to the fifth wheel (3) and drive out the roll pins (4) and the bracket pins (5).
7. Hoist the fifth wheel (3) to a prepared work area.

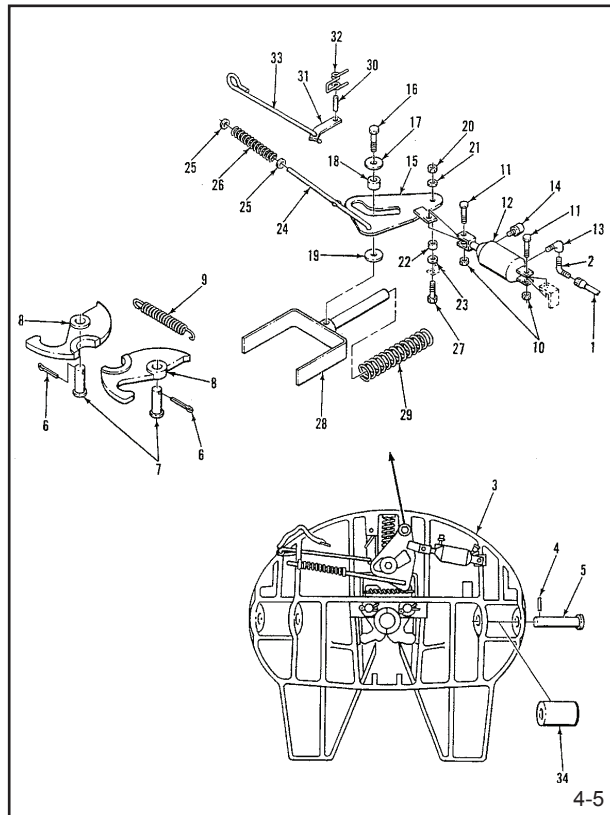
Disassembly

1. Remove the cotter pins (6) and the lock pins (7), and slide out the locks (8) with the spring (9). See figure 4-4.
2. Remove the locknuts (10) and the bolts (11), and remove the air cylinder (12).
3. Remove the elbows (2 and 13) and the air filter (14) from the air cylinder.
4. Remove the bolt (16), the outer washer (17), the roller (18) and the inner washer (19).
5. Remove the locknut (20) and the washer (21), and remove the cam (15), lifting the cam and the spring rod (24) out together.
6. Retain the roller (22), the bolt (27), the washers (23 and 25) and the spring (26).
7. Slide the yoke (28) and the spring (29) out of fifth wheel (3) through the opening left by the locks (8).

- Drive out the roll pin (30) and remove the secondary lock (31) and the spring (32), leaving the secondary lock handle (33) installed on the secondary lock.

Cleaning, Inspection and Repair

- Clean all metal parts except the air cylinder (12) in solvent and dry the parts with compressed air. See figure 4-5.



- Replace components exhibiting the following conditions:
 - Check the locks (8) and the lock pins (7) for cracks and excessive wear (replace the locks as a set if either of the locks require replacement).
 - Check the cam (15), the rollers (18 and 22), the yoke (28) and the secondary lock (31) for excessive wear, cracks or damage.
 - Check the springs (9, 26, 29 and 32) for cracks, fatigue or excessive wear.
 - Check the bracket pins (5) for cracks and excessive wear.
 - Inspect the fifth wheel plate (3) for cracks, wear or damage of any kind.
 - Check the rubber bushings (34) for cracks or signs of deterioration.

Assembly and Installation

- Attach the secondary lock (31) to the secondary lock handle (33). See figure 4-5.
- Install the spring (32) and the secondary lock (31) in the fifth wheel (3) with the roll pin (30).
- Place the spring (29) over the shaft in the yoke (28) and install the yoke on the fifth wheel (3).
- Install the spring rod (24) in the cam (15), and install the inner washer (25), the spring (26) and the outer washer (25).
- Insert the spring end of the spring rod (24) through the tab on the fifth wheel (3) and position the cam (15) over the yoke (28).
- Install the cam (15) onto yoke (28) using the inner washer (19), the roller (18), outer washer (17) and the bolt (16).
- Secure the cam (15) to the fifth wheel (3) using the washers (21 and 23), the roller (22) and the bolt (20).
- Install the spring (9) onto the locks (8) and slide the lock assembly into the fifth wheel (3) so that the holes for the lock pins (7) are aligned.
- Install the lock pins (7) and the cotter pins (6).
- Install the air filter (14) and the street elbow onto the air cylinder (12).
- Install the elbow (2) onto the street elbow (13).
- Install the complete air cylinder (12) onto the cam (15) and the fifth wheel (3) using the bolts (11) and the locknuts (10).
- Install the rubber bushings (34).
- Attach a suitable hoist and a sling to the fifth wheel assembly and position the assembly onto the boom assembly.
- Install the bracket pins (5) and the roll pins (4).
- Connect the air hose (1) to the elbow (2).
- Start up the engine and allow the pressure in the air system to reach normal operating pressure.
- Test the operation of the fifth wheel release cylinder.
- Check the air hose connections for leaks using soapy water.
- Lubricate the fifth wheel.

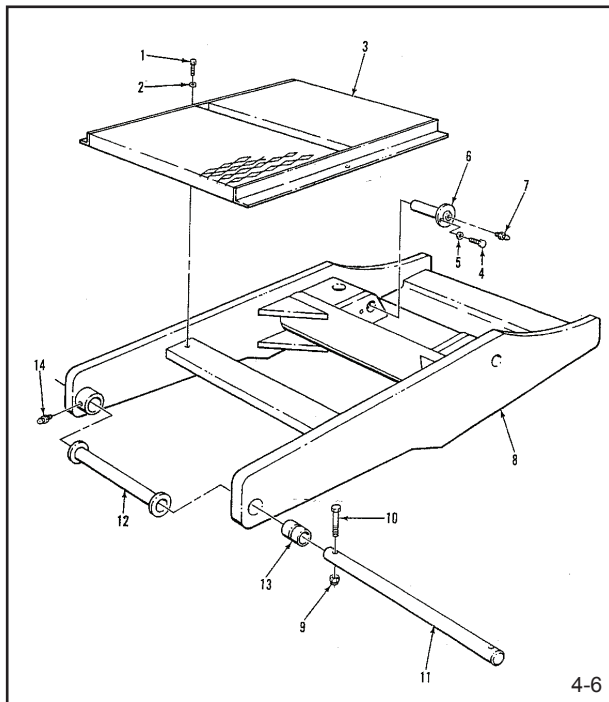
BOOM AND FIFTH WHEEL

Boom (TJ Series)

Removal

NOTE: The boom can be removed with the fifth wheel still installed however, removing the fifth wheel will ease handling the boom.

1. Follow the fifth wheel Removal procedures on page 4-2 to remove the fifth wheel or, if the fifth wheel is not to be removed, disconnect the air hose (1) from the elbow (2). See figure 4-5 on page 4-3.
2. Remove the boom step bolts (1) and lock washers (2). See figure 4-6.



3. Remove the boom step (3).
4. Remove the boom cylinder pin bolts (4) and lock washers (5).
5. Remove the boom cylinder pins (6).

NOTE: As the boom is removed, allow the boom cylinders to lean back and rest against the drive axle.

6. Attach a suitable hoist and a sling to the boom (8) and apply a lifting force that is sufficient to support the weight of the boom.
7. Release any clamps that are securing the release cylinder air hose to the boom.
8. Remove the pivot pin locknuts (9) and bolts (10).

9. Support the spacer (12) and drive out the boom pivot pin (11).
10. Hoist the boom (8) clear of the vehicle.

Inspection

- Check all welds for cracks and reweld any cracks.
- Check the cylinder pins (6) for excessive wear, and replace cylinder pins as necessary. See figure 4-6.
- Check the pivot pin bushings (13) for wear, and press out any worn bushings.

Installation

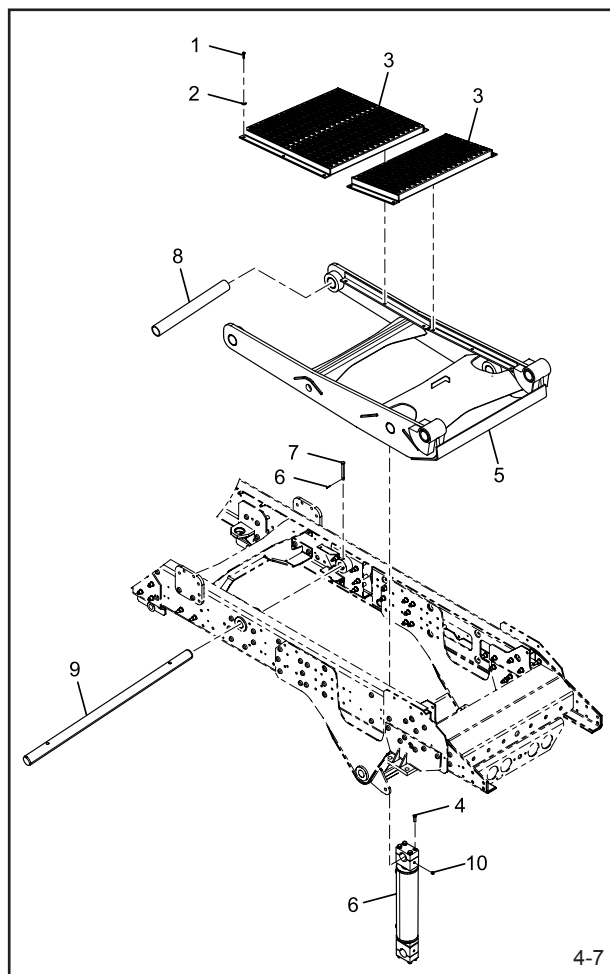
1. If the pivot pin bushings (13) were removed, align the grease hole in the new bushings with the grease fittings (14) on the boom, and press the bushings into the boom. See figure 4-6.
2. Hoist the boom (8) into position on the frame.
3. Support the spacer (12) in position and install the boom pivot pin (11).
4. Install and tighten the pivot pin bolts (10) and locknuts (9).
5. Move the boom cylinders into position and install the boom cylinder pins (6), bolts (4) and lock washers (5).
6. Connect the air hose for the release cylinder to the boom using the removed clamps.
7. Install the boom step (3) and install and tighten the boom step bolts (1) and lock washers (2).
8. Follow steps 14 through 16 of the fifth wheel Assembly and Installation procedures on page 4-3 to install the fifth wheel or, if the fifth wheel was not removed, connect the air hose (1) to the elbow (2). See figure 4-5 on page 4-3.
9. Service the grease fittings (7 and 14). See figure 4-6.
10. Lubricate the fifth wheel.
11. Start up the engine and allow the pressure in the air system to reach normal operating pressure.
12. Test the operation of the boom and the fifth wheel.
13. Check the air hose connections for leaks using soapy water.

Boom (Sabre Series)

Removal

NOTE: The boom can be removed with the fifth wheel still installed however, removing the fifth wheel will ease handling the boom.

1. Follow the fifth wheel Removal procedures on page 4-2 to remove the fifth wheel or, if the fifth wheel is not to be removed, disconnect the air hose (1) from the elbow (2). See figure 4-5 on page 4-3.
2. Remove the boom step bolts (1) and washers (2). See figure 4-7.



3. Remove the boom steps (3).
 4. Remove the upper boom cylinder bolts (4).
- NOTE:** As the boom is removed, allow the boom cylinders to lean back and rest against the drive axle.
5. Attach a suitable hoist and a sling to the boom (5) and apply a lifting force that is sufficient to support the weight of the boom.

6. Release any clamps that are securing the release cylinder air hose to the boom.
7. Remove the pivot pin spring pins (6) and clevis pins (7).
8. Support the spacer (8) and drive out the boom pivot pin (9).
9. Hoist the boom (5) clear of the vehicle.

Inspection

- Check all welds for cracks and reweld any cracks.
- Check the pivot pin bushings for wear, and replace any worn bushings.

Installation

1. Hoist the boom (5) into position on the frame.
2. Support the spacer (8) in position and install the boom pivot pin (9).
3. Install the pivot pin clevis pins (7) and spring pins (6).
4. Move the boom cylinders into position and install the upper boom cylinder bolts (4).
5. Connect the air hose for the release cylinder to the boom using the removed clamps.
6. Install the boom steps (3) and install and tighten the boom step bolts (1) and lock washers (2).
7. Follow steps 14 through 16 of the fifth wheel Assembly and Installation procedures on page 4-3 to install the fifth wheel or, if the fifth wheel was not removed, connect the air hose (1) to the elbow (2). See figure 4-5 on page 4-3.
8. Service the grease fittings (10). See figure 4-7.
9. Lubricate the fifth wheel.
10. Start up the engine and allow the pressure in the air system to reach normal operating pressure.
11. Test the operation of the boom and the fifth wheel.
12. Check the air hose connections for leaks using soapy water.

BOOM AND FIFTH WHEEL

TROUBLESHOOTING

Symptom	Cause	Solution
Boom doesn't lift	Low fluid level	Add fluid to upper (black) mark on reservoir.
	Broken hose or loose fittings	Examine all hoses and fittings for leaks. Replace damaged components, and tighten loose fittings.
	Low oil pressure	Check operation of control valve and control linkage, and make adjustment as needed.
		Check output from pump for proper flow and pressure.
		Check pump to PTO mounting for secure connection.
Cylinder piston packing worn or leaking	Check all hoses for restrictions, and remove any restrictions. Install cylinder seal kit	

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COMPONENTS AND THEORY OF OPERATION

The cab lift system consists of the following major components:

- Pump
- Reservoir
- Pump level
- Hydraulic cylinder
- Hydraulic hoses
- Safety lock bar
- Safety lock bar release cable

Hydraulic fluid is pumped to the cab lift cylinder by a self-contained electric/hydraulic pump with reservoir. Moving the lever clockwise opens a valve that allows hydraulic fluid to return to the reservoir.

MAINTENANCE

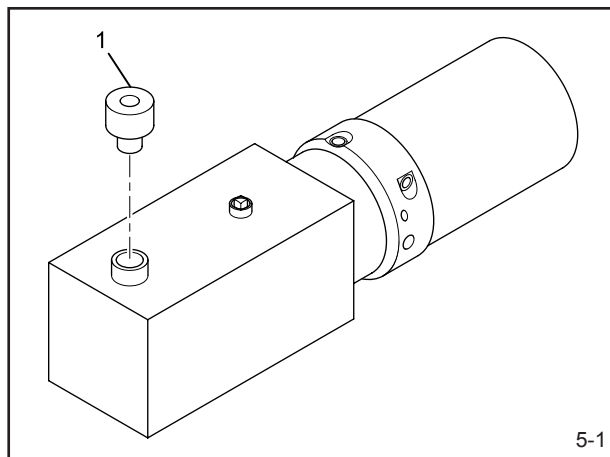
Maintenance procedures that are in addition to the procedures that follow include:

- Periodic inspection of the hoses, lines, fittings and hydraulic cylinder for leaks
- Inspection of the safety lock bar for cracks, broken teeth (TJ Series) and freedom of movement.

Refer to Lubricant, Fluid and Fuel Types and Capacities on page 2-6 for the specified lubricant for the cab tilt system.

Checking the Fluid Level (TJ Series)

1. Lower the cab to the fully lowered position.
2. Remove the reservoir filler plug (1) and check the fluid level. See figure 5-1.



3. Add the specified fluid through the filler plug hole, as necessary, to maintain a full reservoir.
4. Reinstall the reservoir filler plug (1).

Checking the Fluid Level (Sabre Series)

The cab lift pump is integrated with the main hydraulic tank. Perform the Checking the Fluid Level procedures on page 3-2 to check the fluid level for the cab lift system.

Cab Cushion

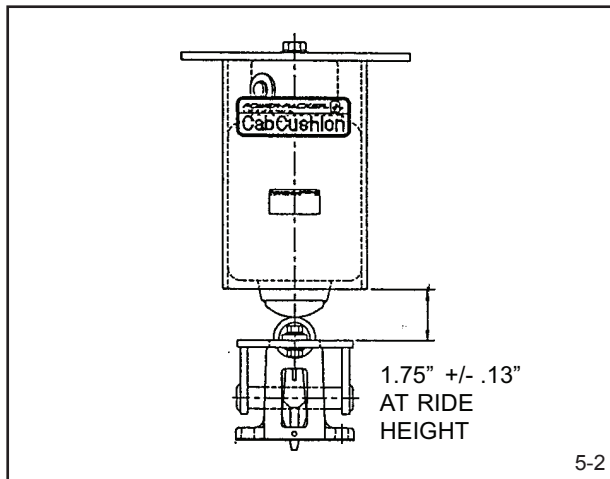
Alignment

1. Visually check that the shock absorber is centered radially within the restraining cylinder from each side of the tractor and from the rear.
2. If the shock absorber is misaligned, realign the shock absorber as follows:
 - a. Tilt the cab forwards and loosen the bolts that secure the can weldment to the cab.
 - b. Remove the lower cap screw that secures the linkage between the leveling valve and the catch weldment.
 - c. Push the leveling valve arm upwards to fill the air bags with air until flow stops, to force the shock into alignment while the cab is tilted.
 - d. Lower the cab slowly, to force the can weldment into alignment.
 - e. If the can weldment is not in place, tap the can weldment into place.
 - f. Use the Ride Height procedures that follow to set the ride height to 1.75 +/- 0.13 in (44.45 +/- 3.30 mm).
 - g. Visually check alignment.
 - h. Tighten the can weldment bolts and reattach the leveling valve linkage.

Ride Height

1. Measure the clearance between the bottom of the can weldment and the top surface of the catch weldment. See figure 5-2.

CAB LIFT SYSTEM



2. If the clearance is not 1.75 +/- 0.13 in (44.45 +/- 3.30 mm), adjust the ride height as follows:
 - a. Make sure that the vehicle air system is pressurized to a minimum of 100 psi (6.90 bar).
 - b. Loosen the 1/4-20NC nuts that secure the suspension to the vehicle approximately a half of a turn.
 - c. Rotate the height control valve to obtain a ride height of 1.75 +/- 0.13 in (44.45 +/- 3.30 mm).
 - d. Tighten the 1/4-20NC nuts to 66 lb-in (7.46 N•m) torque.
 - e. Recheck the ride height.

Leveling Valve Operation

1. Pull downwards and hold the cab handle and count how long it takes for the air bags to raise the cab to the specified ride height.
2. If it takes longer than 10 seconds or less than 2 seconds to raise the cab to the specified ride height, replace the valve as the valve may be broken or the filter is clogged.

REPAIR

Perform only those steps necessary to effect the desired repairs.

NOTE: Components may be removed and serviced individually.

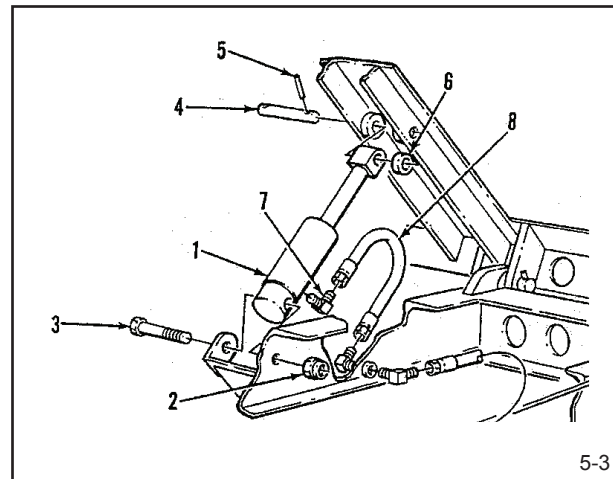
Cab Tilt Cylinder

Removal

1. Park the vehicle on a flat, level surface, set the

parking brake, chock wheels and shut down the engine.

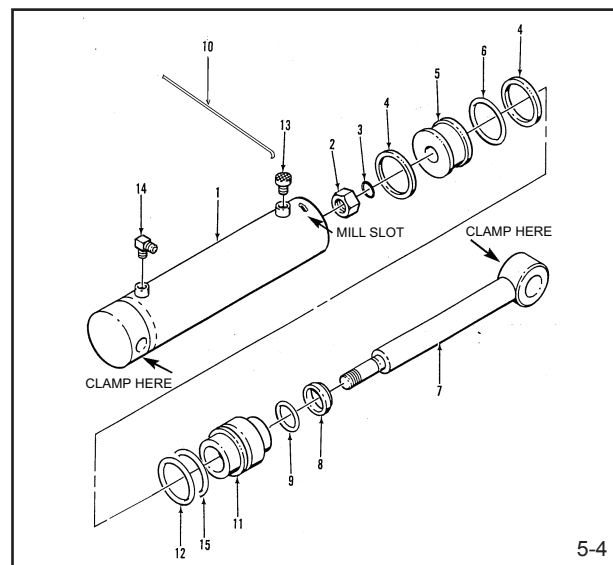
2. Raise the cab to the upper limit of travel, and then allow the cab to settle back until the first notch in the safety lock bar is engaged (TJ Series) or the lock bar is engaged (Sabre Series).
3. Disconnect hydraulic hose (8) from the cylinder fitting (7). See figure 5-3.



4. Drive out the roll pin (5) and remove the cylinder pin (4) and the spacer (6).
5. Remove the locknut (2) and the bolt (3) and remove the cylinder (1).

Disassembly

1. Rotate the stuffing box using a spanner wrench, and remove the retaining ring (10) from the milled slot in the tube assembly (1). See figure 5-4.



- Remove the rod assembly (7) from the tube assembly (1) with all attached parts.

NOTE: Do not clamp the chrome rod surface.

- Remove the locknut (2), the piston (5), the stuffing box (11) and the snap ring (10) from the rod assembly (7).
- Remove the stuffing box o-ring (12), the rod u-cup (9) and the wiper (8) from the stuffing box (11).
- Remove the backup rings (4), the piston seal (6) and the rod o-ring (3) from the piston (5).
- Discard all seals, o-rings and the wiper.
- Remove the breather (13).

Inspection and Repair

- Clean all metal parts in solvent and allow the parts to air dry.
- Check the inner surface of the tube assembly (1) and the stuffing box (11) for scratches, scoring and excessive wear. See figure 5-4.
- Check the mill slot at the inner surface of the tube assembly (1) for burrs, and remove light scratches with crocus cloth.
Replace parts as necessary.
- Check the bearing surfaces of the piston (5) and the rod assembly (7) for scratches, and remove light scratches with crocus cloth.
Replace parts as necessary.

Assembly and Installation

- Lubricate all seals, o-rings and the wiper with fresh hydraulic fluid.
- Install the rod u-cup (9), the wiper (8) and the stuffing box o-ring (12) onto the stuffing box (11) and the backup (15). See figure 5-4.
- Lubricate the rod assembly (7) and install the stuffing box assembly onto the rod assembly.
- Install the piston seal (6), the back-up rings (4) and the rod o-ring (3) onto the piston (5).
- Install the piston assembly and the locknut (2) onto the rod assembly and tighten the locknut to 175 to 200 lb-ft (237.3 to 271.2 N•m) torque.
- Lubricate the piston assembly and install the assembly into the tube assembly (1).
- Slide the stuffing box assembly into the tube assembly and align the hole in the mill slot.
- Install the retaining ring (10), rotating the head

to fully engage the ring in the mill slot.

- Install the breather (13) and hand tighten.
- Fully compress the cylinder, place the cylinder in position under the cab and install the bolt (3) and the locknut (2). See figure 5-3.
- Connect the hydraulic hose (8) to the fitting (7) and pump the cylinder full of hydraulic fluid so that the cylinder is extended to the cab mount.
- Install the cylinder pin (4), the spacer (6) and the roll pin (5).
- Raise and lower the cab several times to expel trapped air, and check all hose connections and the stuffing box for leaks.
- Fully lower the cab, and use the Checking the Fluid Level (TJ Series) procedures on page 5-1 or the Checking the Fluid Level (Sabre Series) procedures on page 5-1 to check the fluid level in the reservoir.

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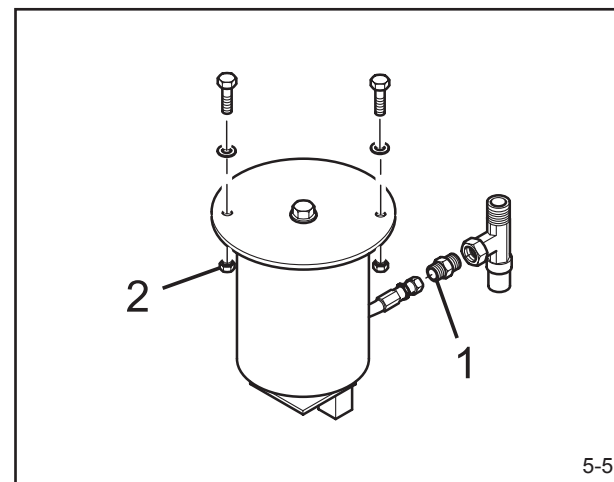
Cab Cushion

Air Bag

A leaking air bag can be caused by misalignment or operation with low pressure.

If an air bag is leaking, replace the air bag as follows:

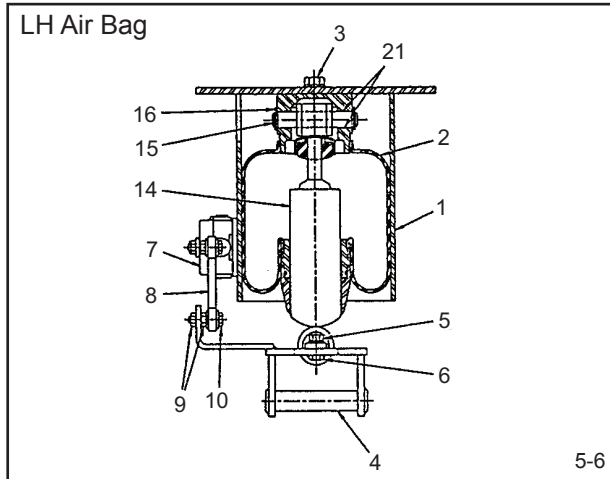
- Close the air supply valve to the suspension.
- Tilt and lock the cab.
- Remove the pipe fitting (1). See figure 5-5.



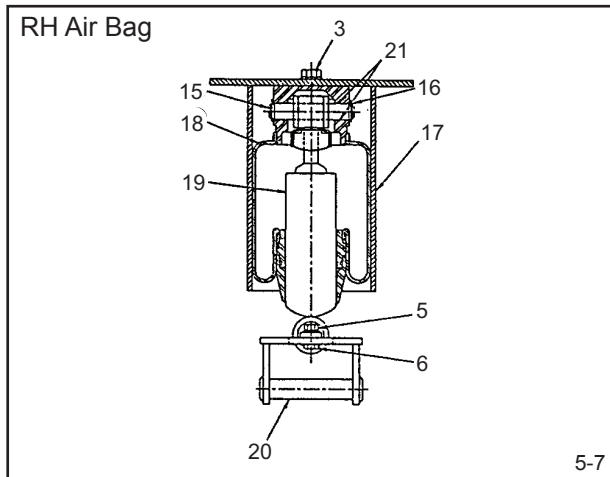
- Remove the flange nuts (2) while supporting the air bag/shock assembly.
- Remove the air bag/shock assembly from the restraining cylinder.

CAB LIFT SYSTEM

- Remove the two snap rings (16) and drive out the pin (15) that holds the shock (14 or 19) inside of the air bag (2 or 18). See figure 5-6 or 5-7.



5-6



5-7

- Remove the shock and inspect the shock for damage or leaking oil.
- Replace the shock and air bag in reverse order of removal, making sure to grease the o-ring locations on the air bag and at the pin, and extending the shock before installation.

NOTE: A soapy water solution can be applied to the inside edge of the air bag to ease installation.

- Tighten the flange nuts (2) to 28 to 34 lb-ft (37.9 to 46.1 N•m) torque. See figure 5-5.
- Reconnect the pipe fitting (1).

Shock Absorber

The shock absorber may require replacement if the suspension has been operated with a blown air bag, on low pressure or after a few years of service.

If a shock absorber requires replacement, replace the shock absorber as follows:

- Perform step 1 through 7 of the air bag replacement procedure on page 5-3.
- Remove the catch weldment (4 or 20). See figure 5-6 or 5-7.
- Install the catch weldment (4 or 20) on the new shock absorber.
- Continue with steps 8 through 10 of the air bag replacement procedures.

Hydraulic Rotary Latch Assembly

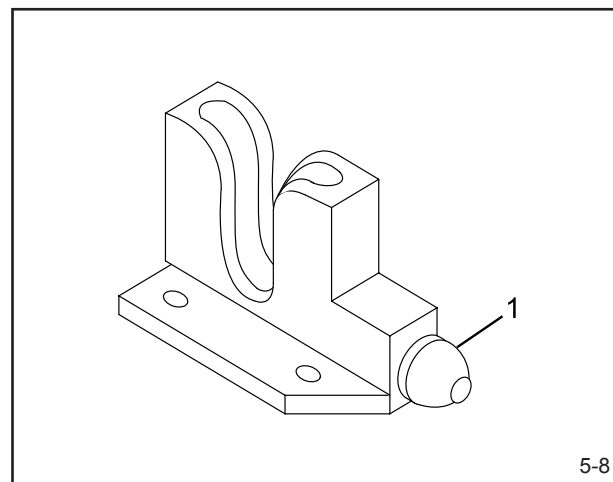
The hydraulic rotary latch is a non-serviceable component. If operational problems occur, replace the complete assembly.

The latch, the catch weldment and the shock absorber can be damaged if the latch fails to disengage before the cab is tilted. This damage can occur if the pump is not operational and the cab is tilted by other means.

IMPORTANT: Disassembling the latch will void the latch warranty. Perform the procedure that follows only when absolutely necessary.

To manually disengage the latches:

- Remove the stop cap (1). See figure 5-8.



5-8

- Remove the internal pin and allow the plunger to retract so that the catch weldment disengages from the hook.

IMPORTANT: Make sure that the internal pin is below the surface to assure that it is engaged.

TROUBLESHOOTING

Symptom	Cause	Solution
Tilt cylinder will not retract or advance	Damaged or broke line.	Replace hydraulic hose
	Pressure builds up in both directions, due to plugged orifice in the pump.	Replace pump
	Oil reservoir not filled on pump.	Fill pump reservoir
	Worn or faulty seal in cylinder.	Replace cylinder and/or replace seals.
	Crossed hoses	Replumb and bleed
Pump handle kicks up	Outlet ball leaking	Replace or rebuild pump
Pump functions only on last portion of stroke	Reservoir low on oil	Fill reservoir
	Inlet ball leaking	Replace pump
	Dirt on inlet screen	Clean screen and reservoir
Pump will not build pressure	Reservoir empty or low	Fill reservoir
	Inlet ball leaking	Replace or rebuild pump
	Bad o-ring on selector valve spool	
	Relief valve improperly set or blocked open	
Pump leaks between pump base and reservoir	Bad o-ring on reservoir	Replace or rebuild pump
Cab latch inoperable	Damaged or broken hydraulic hose	Replace hose
	Binding piston	Replace latch
Cab stops moving when in free-fall	Plugged orifice in pump	Replace pump
Cab fails to tilt	Cab latch binding. Fails to unlatch	Replace cab latch cylinder
	Pump does not build pressure	Replace pump
Hydraulic fluid forced out of breather	Reservoir overfilled.	Drain oil out and properly fill
Oil leak at hand pump plunger	Damaged seal	Rebuild or replace pump
No flow with air pump running	Reservoir low or empty	Fill reservoir
	Inlet ball leaking	Check ball and seat for chips, clean and reseal ball to seat
	Relief valve improperly set or blocked open	Replace relief valve assembly

5

CAB LIFT SYSTEM

Symptom	Cause	Solution
Air pump will not pump	Air pump poppet stem stuck	Replace air motor assembly
	Bad seal on large air piston	
	Push button ball will not unseat	Replace air button assembly
	Low inlet air pressure	Increase air supply
Air leak, air pump will not run	Bad seal on poppet stem	Replace air motor assembly
	Bad o-ring on poppet stem	
	Bad seal on main air pump piston	Replace air inlet assembly
	Bad o-ring on air inlet swivel	
Air pump will not stop running	Bad seat in push button	Replace air button assembly
Air leak at push button	Bad o-ring on push button stem	Replace air button assembly
	Bad o-ring on air valve body	

CHASSIS LUBRICATION SYSTEM

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CHASSIS LUBRICATION SYSTEM

COMPONENTS AND THEORY OF OPERATION

The Grease Jockey® auto lube system consists of the following major components (see figure 6-1):

- Timer
- Solenoid
- Air-operated pump
- Modules
- Meters
- Tubing
- Grease

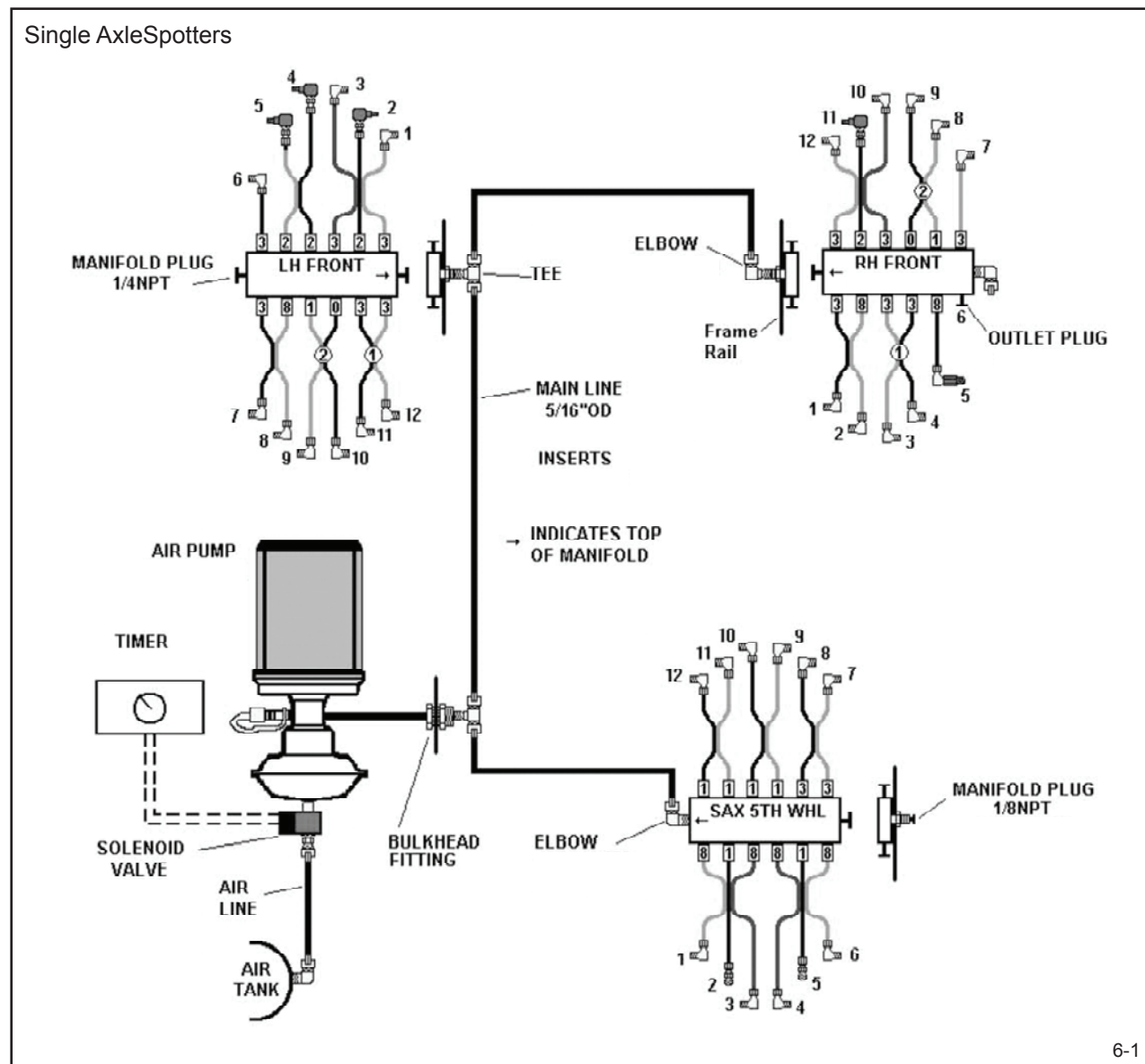
The auto lube system is controlled by a timer, which activates either an air solenoid valve or an electric motor to drive a pump.

The pump supplies grease into the main supply line for delivery to localized distribution modules.

These modules are made up of manifolds with metering valves and distribution lines for each lube point in that localized area.

The meters are designed to dispense a precise amount of grease at each lube cycle. Meter size is chosen by a ratio of the smallest to the largest lube point requirements in the system.

The pump must pressurize the system, then vent the pressure to allow the metering valves to reset for the next cycle. A fluid grease is required to achieve proper flow and lubrication characteristics.



CHASSIS LUBRICATION SYSTEM

Timer

The timer, on an air-operated pump system, is a compact, solid-state device housed in a high-impact resistant plastic enclosure.

The timer has seven lube-cycle interval settings from 0.5 to 6 hours, with a test position and a manual run button.

The timer operates the system only while the vehicle's ignition is turned on. A memory function keeps track of elapsed cycle-time even if the ignition switch is turned off. When the predetermined cycle time has elapsed, the timer signals the pump to initiate a lubrication cycle. If the vehicle's ignition is turned off before the interval is complete, the timer's memory saves the time count until the vehicle is restarted.

When the cycle-time dial is switched from one range to another, the manual run button should be pressed to initiate the new cycle time setting. Otherwise, the new time is added to any time that remains from the previous lube cycle.

When rapid, repetitive cycles are needed, set the cycle time dial to the 'TEST' position and press the manual run button. In this mode, the timer signals the pump to cycle approximately once every minute (45 seconds on and 15 seconds off). This rapid cycling continues as long as the timer remains in the 'TEST' position.

Always reset the timer dial to the proper setting:

Timer Setting	Driving Conditions
0.5 to 1 hr	Off-highway
1.5 to 2 hrs	<ul style="list-style-type: none"> • Start and stop in the city • Heavy salt • Snow and ice • Rough pavement • Wet climate • Heavy loads • Dusty roads
3 hrs	<ul style="list-style-type: none"> • Normal city or highway driving • Normal climate • Moderate loads

Solenoid

The air valve used with the air-operated pump threads into the port on the bottom of the pump.

The air valve is a 3-way, normally closed, free-venting valve available with either a 12 or 24 VDC, 9 watt continuous-duty rated coil.

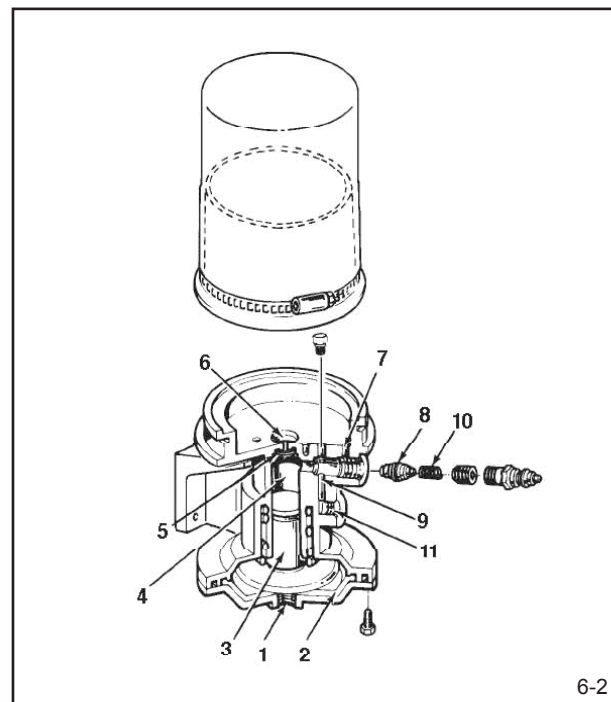
The coil is molded and potted with a 6 in (15.2 cm) lead of 16 AWG wire and a weather-tight, male connector.

The air valve has a 1/8 in NPT inlet port and a 1/4 in NPT male thread outlet port, with a maximum operating pressure of 150 psi (10.3 bar). The barbed connector is the exhaust port and should not be blocked. There is a manual test button located on the end, above the electrical lead. A 22 in (55.9 cm) wire harness with a weather-tight, female connector to mate with the solenoid is available (included with kits).

Air-Operated Pump

General order of operation:

1. The air pump operates when the 3-way air solenoid valve is actuated by the timer and air pressure is applied to the air chamber port (1) and diaphragm (2). See figure 6-2.



2. The spring-loaded pump piston (3) is then forced upward, compressing the grease in the chamber (4).
3. This pressure seats the flapper valve (5) against the reservoir opening (6), and grease flows toward the port (9).

Simultaneously, pressure is applied behind the spring-loaded check valve poppet (8) through the port (9), sealing off the passage way (7).

CHASSIS LUBRICATION SYSTEM

4. Grease flows into the main lines through the outlet (11).
5. After completion of an on-time cycle, the 3-way air valve exhausts the air in the pump. The pump piston spring forces the pump piston (3) down, allowing the flapper valve (5) to unseat from the reservoir opening (6).
6. Grease from the reservoir is drawn into the chamber (4), just vacated by the pump piston (3).
7. System pressure is relieved through the port (9) to the port (7) back to the reservoir as the check valve (8) is returned by the spring (10).

Modules

A module is an assembly that distributes the grease from the main line to a group of lube points.

A module is comprised of a manifold, a mounting stem, meters (metering valves), 3/16 in OD tubing and fittings.

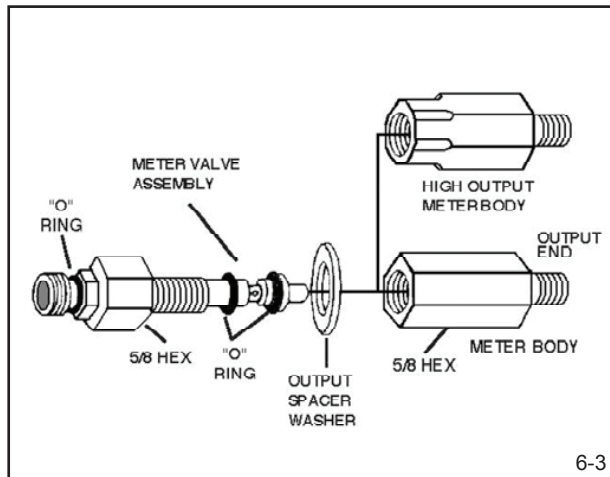
One manifold can hold as many as twelve meters. Plugs are available to close off any manifold port that is not required.

The manifold mounts with the ported stud through a 5/8 in hole.

Main lines may be connected at either end of the manifold or at the end of the mounting stud.

Meters

Meters are positive displacement, spring-reloaded dispensing devices designed for use in Grease Jockey systems operating at 900 to 1,200 psi (62.1 to 82.7 bar). See figure 6-3.



6-3

These meters are available in six sizes (based on output volume) to meet various lube requirements.

- Request Lubriquip® document GJ-00003 for additional meter information, and document GJ-00006 for instructions on changing meter volume.

Meter Size	Qty of Washers in Meter Body	Turned Hex	Output (cu in)
0	0	No	0.002
1	1	No	0.005
2	2	No	0.009
3	3	No	0.012
4	4	No	0.020
8	4	Yes	0.026

Tubing

Only Grease Jockey heavy-wall, nylon tubing should be used in the auto lube system.

- Use 3/16 in OD lines for lube point distribution.
- Use 5/16 in OD lines for main lines with brass fittings.

IMPORTANT: Tube inserts are required on all 5/16 in OD line connections.

- Other adapters, fittings, connectors, and mounting hardware are available from Lubriquip.

IMPORTANT: Do not substitute air brake tubing for lube lines. The pressure rating of air brake tubing is not adequate for the Grease Jockey lubrication system use.

Grease

Grease should not contain suspended lubricating agents such as graphite or molydisulfide.

Refer to the auto lube system manufacturer for the specified lubricant for the system, and page 2-6 for system capacity.

CHASSIS LUBRICATION SYSTEM

MAINTENANCE

Purging Air From the Main Line

1. Check the vehicle air supply for a minimum of 100 psi (6.89 bar), and make sure that all the air is removed from the main line and the manifolds.
2. Remove all of the 1/4 in NPT end port and 1/8 in NPT stud plugs on the module manifolds.
3. Turn the ignition switch to the 'ON' position, set the timer to the 'TEST' position and press the manual run button.
4. As the pump cycles, check the open module ports for flow of grease with no air.
5. Check the open port closest to the pump first proceeding to the port furthest from the pump last:
When the flow of grease from a port is free of air, close the port.

NOTE: *The 3/16 in OD distribution lines are pre-filled and should not require purging.*

6. Let the system run in the test position for a few minutes, while checking all line connections to make sure the connections are holding pressure, and checking the lube points to make sure lubricant is being delivered to each point in the system.
7. Reset the timer to the desired setting for your application.

NOTE: *Timer settings are dependent upon vehicle application; refer to the Timer Settings table on page 6-2.*

CHASSIS LUBRICATION SYSTEM

TROUBLESHOOTING

Symptom	Cause	Solution
Excessive amount of grease at all lubrication points	Timer cycle is too frequent	Adjust the timer one click to a higher time cycle (ex: from 2 to 3 hours)
Excessive amount of grease at one lubrication point	Meter is leaking	Replace meter
Insufficient grease at all lube points	Timer cycle is too infrequent	Adjust the timer one click to a lower time cycle (ex: from 3 to 2 hours)
No grease at any lubrication point	Reservoir is empty	Fill lubrication reservoir
	Reservoir is filled with incorrect (heavy) grease	(refer to procedures for Cause on page 6-6)
	Fuse is blown fuse or wiring has open circuit	Check for broken wire or short circuit in wiring and repair fault
	Air line is damaged (air pump only)	Repair or replace air line
	Solenoid air valve is inoperative (air pump only)	(refer to procedures for Cause on page 6-6)
	Air pump is inoperative	
	Electric pump is inoperative	
Timer is inoperative		
Main line is damaged		
(other)	(refer to procedures for Symptom and Cause on page 6-6)	
No grease at some lubrication points	Main line is damaged	(refer to procedures for Cause on page 6-6)
	Air lock in main line	Purge air from the main line (refer to prior Maintenance procedure on page 6-4)
No grease at one lubrication point	Secondary line is damaged	(refer to procedures for Cause on page 6-6)
	Meter is inoperative	Replace meter
	Broken fitting at lubrication point	Replace broken fitting

6

CHASSIS LUBRICATION SYSTEM

Procedures

Air pump is inoperative

- Solenoid air valve is inoperative: refer to the following procedures for this Cause.
- Air line is damaged: Repair or replace air line.
- Air pressure is low: Build up pressure in vehicle system.
- Electrical circuit to timer or solenoid is damaged: Check connections; repair or replace circuit components as necessary.
- Timer is inoperative: refer to the following procedures for this Cause.

Electric pump is inoperative

- Electrical circuit is damaged: Check electrical circuit to confirm voltage to motor.
- Motor is inoperative: Repair or replace motor.

Main line is damaged

- Main line is trapped and/or damaged:
 1. Repair or replace main line.
 - Re-route line and/or add protection to the line to prevent reoccurring damage.
 - Install new tube inserts at all main line connections.
 2. Purge air from main line; refer to the Purging Air From the Main Line procedures on page 6-4.
- Main line is disconnected from fitting: Reconnect the main line to the fitting, installing a new compression sleeve and a new tube insert.

No grease at any lubrication point (other)

1. Use a 2,500 psi (172 bar) pressure gauge to check system pressure at the last module in the system.
2. If the minimum gauge reading is less than 500 psi (34.5 bar), check the pressure at the pump.
 - If the pump 'dead-headed' pressure does not reach 1,000 psi (69.0 bar), repair or replace pump.
 - If the pump 'dead-headed' pressure reaches 1,000 psi (69.0 bar), check for a blocked, broken or collapsed main line; repair or replace the main line as necessary.

Reservoir is filled with incorrect (heavy) grease

1. Remove and clean the reservoir, and refill the reservoir with the specified lubricant. Refer to the auto lube system manufacturer for the specified lubricant for the system, and page 2-6 for system capacity.
2. Remove the main line plugs from the meter blocks, and cycle the pump until the incorrect lubricant is removed from the lines.
3. Reinstall the main line plugs.

Secondary line is damaged

- Secondary line is trapped and/or damaged: Repair or replace the secondary line, and re-route the line and/or add protection to the line to prevent reoccurring damage.
- Secondary line is disconnected from fitting: Reconnect the secondary line to the fitting, installing a new compression sleeve.
- Broken fitting at lubrication point: Replace the broken fitting.

Solenoid air valve is inoperative (air pump only)

1. Check the electrical circuit for voltage at the solenoid coil from the timer:
2. Connect a meter from the supply (black) wire to the return (white) wire at the solenoid connector. Do not connect directly to ground.
3. Repair or replace wiring as necessary.
4. Check coil resistance: Resistance should be approximately 20 ohms; replace coil if necessary.
5. Check valve operation; repair or replace components as necessary.
6. Check barbed connector for blockage; clear blockage if necessary.

Timer is inoperative

1. With the ignition switch on, check the input voltage of both the memory (orange) and the switch (red) wires.
2. If the meter reading is less than 12 VDC, repair the electric supply.
3. Set the timer to the 'TEST' position.
4. Check the output signal to the solenoid: Connect a meter from the timer supply to the return, not a ground. (At the timer connector, the supply may be a black wire and the return a white wire.)

CHASSIS LUBRICATION SYSTEM

The meter readings should be as follows:

- 12 VDC during the ON cycle (approximately 45 sec)
 - A maximum of 2 VDC during the OFF period (approximately 15 sec)
5. If the meter readings do not meet these specifications, or if there is no voltage or a constant 12 VDC output, check the wiring from the timer to the solenoid for grounding or breakage.
 6. Repair or replace timer wiring as necessary.



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COMPONENTS AND THEORY OF OPERATION

The air system consist of the following major components (see figure 7-1):

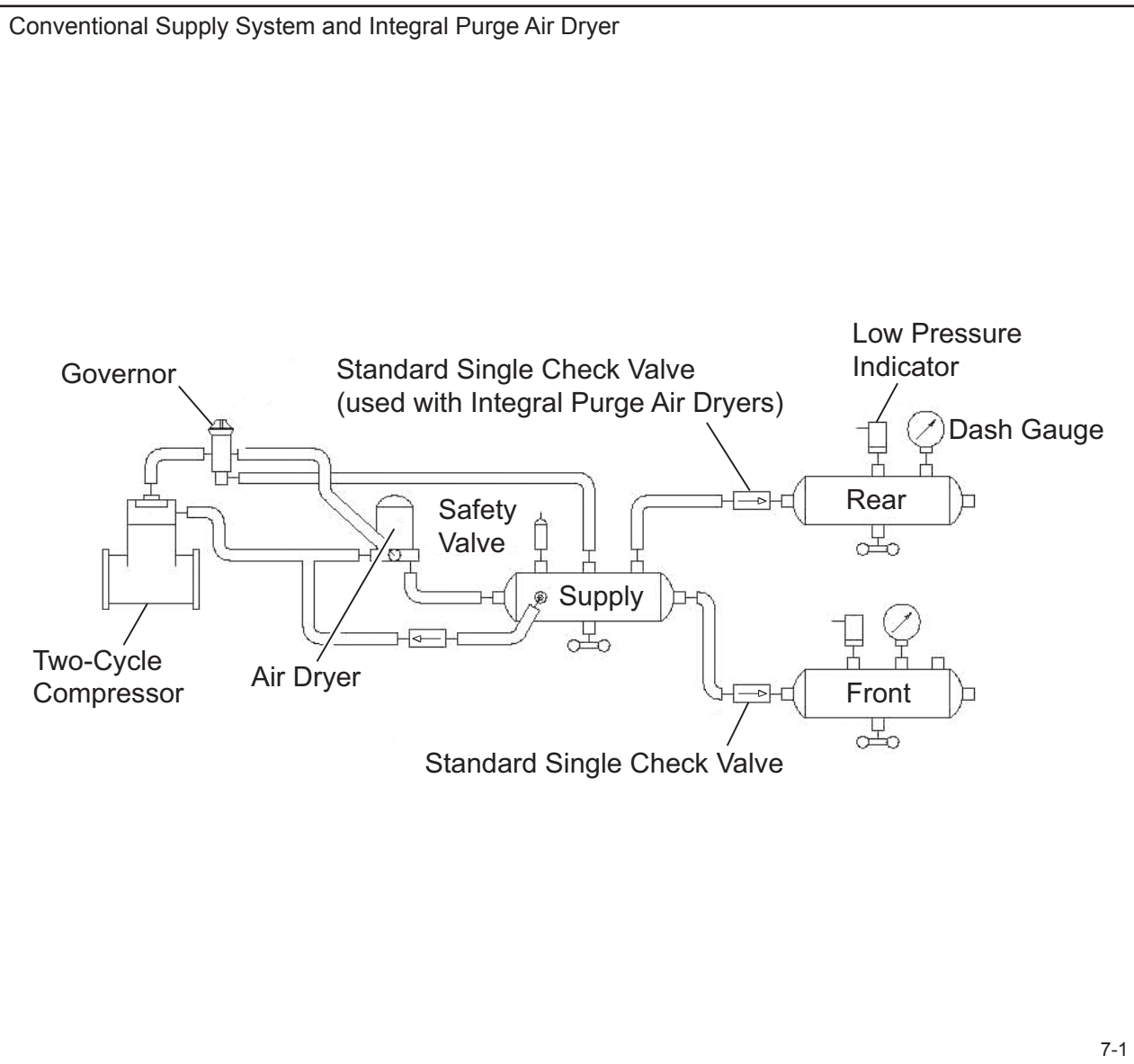
- Compressor
- Governor
- Brake system
- Air suspension
- Air tanks
- Automatic drain
- Air dryer

The air system generates pressure for operation of the tractor brakes, trailer brakes, fifth wheel latch and optional equipment such as Dura-Ride air suspension.

The compressor is gear-driven by the engine.

A pressure-regulating governor and safety valves are provided to control the pressurization of the brake system.

Conventional Supply System and Integral Purge Air Dryer



AIR SYSTEM

Brake System

The compressor sends air through a check valve to the wet tank. The check valve prevents air pressure from escaping due to a faulty compressor.

The pressure in the wet tank is used to operate the compressor governor, which regulates compressor operation so that the proper system pressure is maintained. The compressed air passes through two check valves to the primary and the secondary reservoirs.

The primary reservoir supplies air pressure to the primary section of the treadle valve and to the parking brake/trailer supply valve. When the treadle valve is depressed, the primary section supplies air to activate the rear vehicle brakes and, through the vehicle protection valve, activates the trailer service brakes. The air pressure sent to the parking brake/trailer supply valve is used to release the vehicle and trailer parking brakes as well as fill the trailer air system reservoir(s).

The parking brake section of the valve is used to supply air pressure to the parking brake chambers to release the parking brakes. When the parking brake valve is moved outwards, air pressure is released, which allows the springs to apply the parking brake.

Quick-release valves are installed in the brake chamber supply lines to make sure that air pressure is released instantly when the brake pedal or the treadle valve is released.

The vehicle protection valve isolates the vehicle air system from the trailer air system in the event of a pressure loss in the trailer system. This valve maintains air pressure to keep the tractor brakes functioning.

The parking brake quick-release valve incorporates a compensator valve, which allows service brake pressure to release the parking brakes as the service brakes are applied. This function reduces the load on the brake actuating mechanisms.

Air Suspension

For vehicles that are equipped with optional air suspension, air pressure is routed through the brake pressure protection valve to the air suspension reservoir. The brake pressure protection valve assures that the brake system is fully pressurized before pressure is supplied to the air suspension system.

The leveling valve controls the flow of air pressure to and from the air springs. A mechanical linkage is used to connect the leveling valve to the rear suspension trailing arm. As weight on the fifth wheel increases, the tractor frame settles causing the linkage to open the valve and supply the air springs with additional pressure for compensation.

Air Tanks

All compressors pass a certain amount of oil in order to lubricate the cylinder walls and the piston rings.

Depending on humidity, air entering the compressor contains a certain amount of water. This oil and water normally enters the air tanks in the form of vapor because of the heat generated during compression. After reaching the air tanks the water and the oil condense to form a water emulsion that must be drained off before entering the brake system.

Automatic Drain

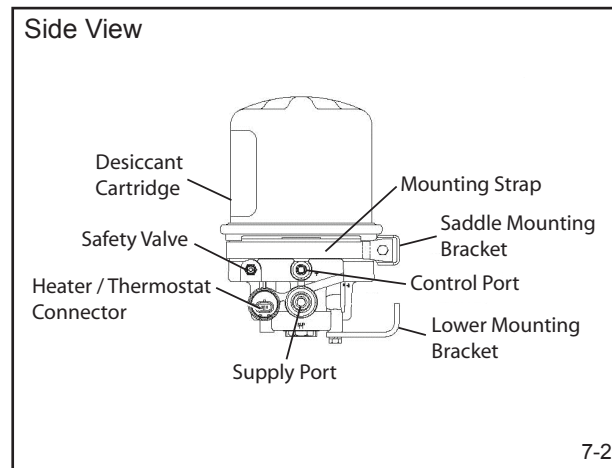
The air tanks are equipped with an automatic drain valve. When the brakes are applied and the pressure in the air tank drops approximately 2 psi (0.14 bar), the automatic drain valve opens momentarily to allow a small amount of air and any collection of oil and water emulsion to escape.

- To manually drain the automatic drain valve, press the plunger in the drain exhaust port.
- To check the operation of the automatic drain valve:
 1. Start up the engine and allow the engine to idle.
 2. Allow the brake system to reach normal operating pressure.
 3. Place an operator in the cab, and have the operator apply the brakes.
 4. Observe the automatic drain valve: a small amount of air should escape from the valve when the brakes are applied.
- If the automatic drain valves are not operating properly and are not checked, water accumulation in the tanks can rise to a level that renders the brake system inoperative.
- Check all hoses, lines, and fittings periodically for leaks and condition.
- Check any abnormal operation of the brakes or the brake system immediately.

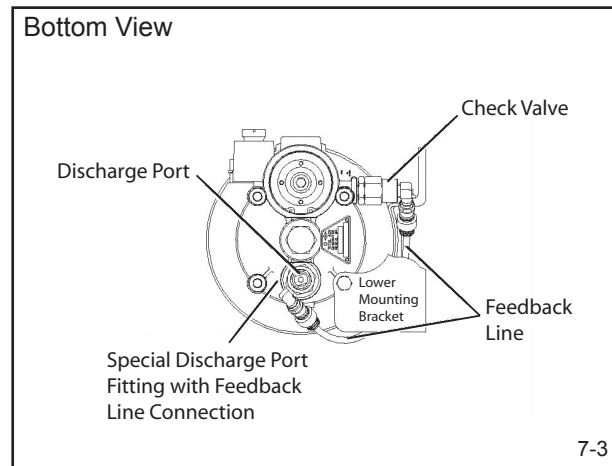
Air Dryer

The function of the integral purge air dryer is to collect and remove solid, liquid and vapor contaminants from the air system before they enter the brake system. The air dryer provides clean, dry air to the components of the brake system, which increases the service life of the system and reduces maintenance costs; daily manual draining of the reservoirs is not necessary.

The air dryer consists of the following major components (see figures 7-2 and 7-3):



7-2



7-3

- A desiccant cartridge that is attached to a die-cast aluminum end cover with a single, centrally-located bolt.
 - An end cover that houses a check valve assembly, a safety valve, a heater and thermostat assembly, three pipe-thread air connections and a purge valve assembly.
- The removable purge valve assembly includes a purge valve mechanism and a turbo charger cutoff feature that prevents loss of engine boost pressure during the air dryer purge cycle.

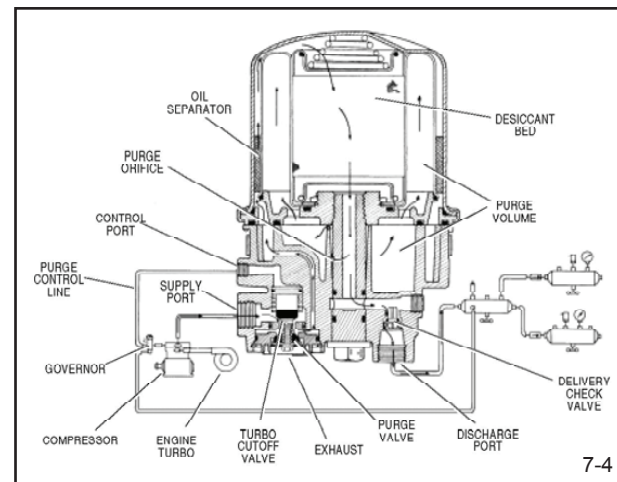
NOTE: For ease of serviceability, all replaceable assemblies can be replaced without removal of the air dryer from the vehicle.

The air dryer has three female pipe-thread air connections, identified as follows:

Air Connection Port ID	Function/Connection
CON 4	Control Port (purge valve control and turbo cutoff)
SUP 11	Supply Port (air in)
DEL 2	Delivery Port (air out)

The air dryer alternates between two operational modes (or 'cycles') during operation: the Charge Cycle and the Purge Cycle.

Charge Cycle



7-4

When the compressor is loaded (compressing air), compressed air, along with oil vapor, water and water vapor flows through the compressor discharge line to the supply port of the air dryer body.

As air travels through the end cover assembly, the direction of flow changes several times, reducing the temperature and causing contaminants to condense and drop to the bottom (or 'sump') of the air dryer end cover.

After exiting the end cover, air flows into the desiccant cartridge. Once in the desiccant cartridge, air flows through an oil separator, which is located between the outer and the inner shells of the cartridge. The separator removes water in liquid form as well as liquid oil and solid contaminants.

AIR SYSTEM

Air, along with the remaining water vapor, is further cooled as it exits the oil separator and continues to flow upwards, between the outer and inner shells.

When air reaches the top of the cartridge, the direction of flow is reversed, and air then enters the desiccant drying bed. Air that flows down through the column of desiccant becomes progressively drier as water vapor is absorbed by the desiccant material. The desiccant cartridge typically removes most of the water vapor from the pressurized air.

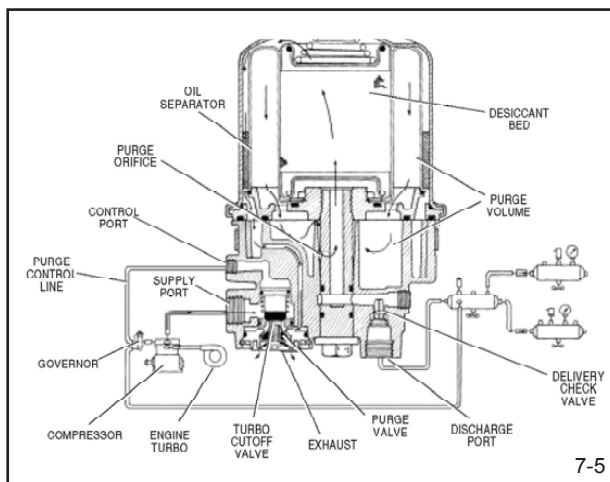
Dry air exits the bottom of the desiccant cartridge and flows through the center of the bolt that is used to attach the cartridge to the end cover. Air flows down through the center of the desiccant cartridge bolt, through a cross-drilled passage and exits the air dryer delivery port through the delivery check valve.

IMPORTANT: The early end cover designs use a vertical (black) delivery check valve in the delivery port, and the newer versions use a horizontal (white) check valve behind the pipe plug above the delivery port. Both check valves perform the same function, but the components are not interchangeable.

Dry air flowing through the center of the desiccant cartridge bolt also flows out the cross-drilled purge orifice and into the purge area.

The air dryer will remain in the charge cycle until air brake system pressure rises to the governor cutout setting.

Purge Cycle



As air brake system pressure reaches the cutout setting of the governor, the governor unloads the compressor (air compression is stopped) and the purge cycle of the air dryer begins.

When the governor unloads the compressor, the compressor unloader mechanism and the line connecting the governor unloader port to the air dryer end cover control port are pressurized.

The purge piston moves in response to the air pressure, which causes the purge valve to open to the atmosphere and the turbo cutoff valve to close off the supply of air from the compressor (additional details about this process is provided in the description of the Turbo Cutoff Feature on page 7-5).

Water and contaminants in the end cover sump are expelled immediately when the purge valve opens, and air that was flowing through the desiccant cartridge changes direction and begins to flow toward the open purge valve.

Liquid oil and solid contaminants that are collected by the oil separator are removed by air flowing from the purge area through the desiccant drying bed to the open purge valve. The initial purge and desiccant cartridge decompression lasts only a few seconds and can be identified by an audible burst of air at the air dryer exhaust.

NOTE: Purging of air should not occur for more than thirty seconds.

Reactivation of the desiccant drying bed begins as dry air flows from the purge volume through the purge orifice in the desiccant cartridge bolt and through the center of the bolt and into the desiccant bed.

Pressurized air from the purge volume expands after passing through the purge orifice; pressure is lowered as volume is increased. The flow of dry air through the drying bed reactivates the desiccant material by removing the water vapor adhering to the material.

Generally, thirty seconds are required for the entire purge volume of a standard air dryer to flow through the desiccant drying bed. The delivery check valve assembly prevents air pressure in the brake system from returning to the air dryer during the purge cycle.

After the thirty-second purge cycle is complete, the desiccant has been reactivated or dried and the air dryer is ready for the next charge cycle to begin.

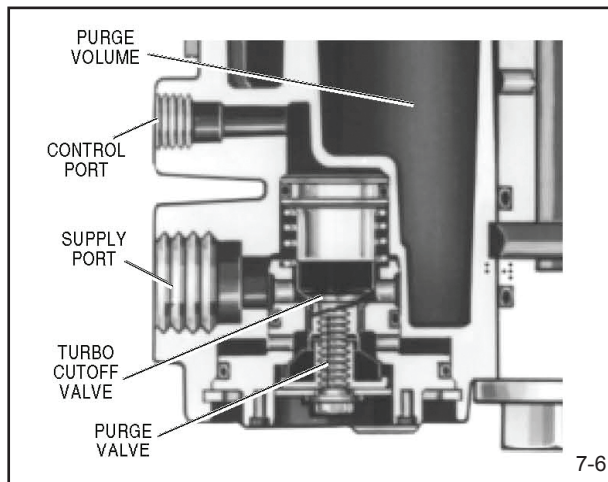
The purge valve will remain open and will not close until air brake system pressure is reduced and the governor signals the compressor to charge the system.

Turbo Cutoff Feature

The primary function of the turbo cutoff valve is to prevent loss of engine turbocharger air pressure through the air dryer in systems where the compressor intake is connected to the engine turbocharger.

The turbo cutoff valve also removes the 'puffing' of air out the open purge exhaust when a naturally aspirated, single-cylinder compressor equipped with an inlet check valve is in use.

At the onset of the purge cycle, the downward travel of the purge piston is stopped when the turbo cutoff valve (the tapered portion of the purge piston) contacts the metal seat in the purge valve housing. See figure 7-6.



When the turbo cutoff valve is seated (in the 'closed' position), air in the compressor discharge line and the air dryer inlet port cannot enter the air dryer.

This function allows the turbo cutoff feature to maintain turbo charger boost pressure to the engine.

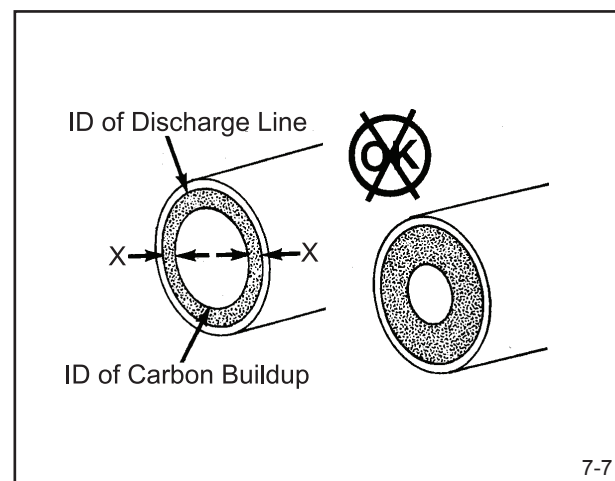
MAINTENANCE

Air Compressor Discharge Inspection

All air compressors have a small amount of lubrication oil carryover that lubricates the piston rings and other moving parts. When this lubricating oil is exposed to normal air compressor operating temperatures over a period of time, the lubricating oil will form varnish or carbon deposits.

If the air compressor discharge inspection is not performed, the air compressor piston rings will be adversely affected by high operating temperatures and pressures, which can cause the rings to not seal correctly.

1. Drain the air system wet tank to release the system air pressure.
2. Remove the air discharge line from the air compressor.
3. Measure the total carbon deposit thickness inside the air discharge line. See figure 7-7.



4. If the total carbon deposit ($X+X$) exceeds 1/16 in (1.59 mm), clean and inspect the cylinder head, the valve assembly, and the discharge line. Replace components as necessary.

Air Brake System

Checking Pressure Buildup, Low Pressure Warning Cutoff, and Governor Cutout

1. Open the reservoir drain valves and drain the system of all pressure.
2. Start up the engine and operate the engine at a fast idle.

NOTE: The low pressure warning should occur.

AIR SYSTEM

3. Begin timing the pressure buildup when system pressure reaches 50 psi (3.45 bar), being ready to note the pressure at which the low pressure warning ceases.

The low pressure warning should cease at approximately 60 psi (4.14 bar).

4. Note the period of time it takes for the pressure to reach 90 psi (6.21 bar).

The period of time for the pressure to increase from 50 psi (3.45 bar) to 90 psi (6.21 bar) should not exceed five minutes.

5. Continue observing the gauge and note the pressure at which the governor cuts off.

Governor cutoff should occur at approximately 120 psi (8.28 bar).

Checking Reservoir Air Supply Leakage

1. Run the engine until the system reaches full pressure, and then shut down the engine.
2. Wait one minute for system pressure to stabilize.
3. Observe the pressure reading for a period of two minutes.

The decrease in pressure should not exceed:

- 2 psi (0.14 bar) per minute for a disconnected vehicle
- 3 psi (0.21 bar) per minute for a vehicle connected to a trailer

Checking Service Air Delivery Leakage

1. Run the engine until the system reaches full pressure, and then shut down the engine.
2. Apply and hold the foot brake.
3. Wait one minute for system pressure to stabilize.
4. With the foot brake applied, observe the pressure reading for a period of two minutes.

The decrease in pressure should not exceed:

- 3 psi (0.21 bar) per minute for a disconnected vehicle
- 4 psi (0.28 bar) per minute for a vehicle connected to a trailer

Checking Automatic Parking System

1. Run the engine until system pressure is greater than 85 psi (5.87 bar), and then shut down the engine.

2. Apply and release the service brake until the low pressure indicator illuminates; this should occur at approximately 65 psi (4.48 bar).

NOTE: *The low pressure indicator should illuminate before the automatic emergency brakes are applied.*

3. Continue applying and releasing the service brake until the automatic parking brakes apply, and note system pressure.

Automatic application of the parking brakes should occur below 60 psi (4.14 bar).

Brake Adjustment

A schedule for the periodic cleaning, inspection and lubrication of brake equipment should be established by the operator on the basis of past experience and the severity of operation.

Linings and drums are particularly subject to wear degradation. To compensate for this wear, the brakes are equipped with automatic slack adjusters to maintain satisfactory operation and maximum safety. The adjusters should be routinely checked to provide uniform lining clearance, correct lever travel and proper equalization.

Clean, inspect, lubricate and adjust the brakes each time the hubs are removed.

Air Pressure Adjustment

1. Start up the engine and allow air brake system pressure to increase, while noting the pressure indicated by the dash gauge or a test gauge at the moment that the governor cuts off.

Governor cutoff pressure should be 120 psi (8.28 bar).

2. With the engine still running, apply and release the brakes a number of times, and note the pressure at which the governor cuts in the compressor.

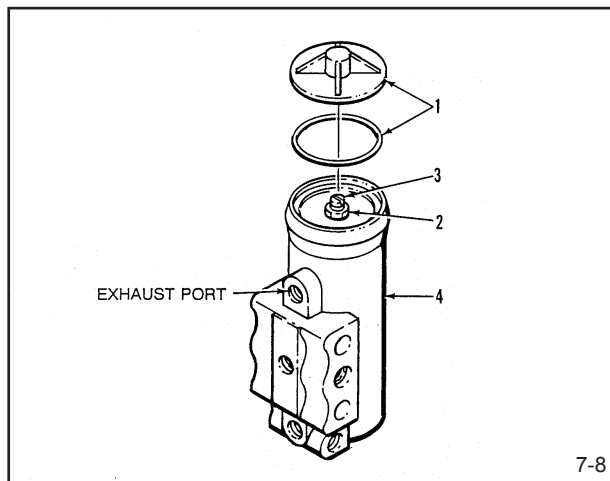
Governor cut in pressure should be 90 to 105 psi (6.21 to 7.24 bar).

NOTE: *Never condemn or adjust the governor pressure settings unless they are checked with an accurate test gauge or a dash gauge that is registering accurately.*

3. If pressure adjustment is required, perform the following:

NOTE: *If the governor cover is marked non-adjustable and the adjusting stem has been sheared off, the governor must be replaced with a new or remanufactured unit.*

- a. Remove the top cover and o-ring (1) from the governor (4). See figure 7-8.



- b. Loosen adjusting screw locknut (2).
c. Adjust the pressure setting:

IMPORTANT: Do not over-adjust the governor.

- Turn the adjusting screw (3) counter-clockwise to raise the pressure setting.
- Turn the adjusting screw (3) clockwise to lower the pressure setting.

NOTE: A 1/4 turn of the adjusting screw changes the pressure setting by approximately 4 psi (0.28 bar).

- d. Tighten the adjusting screw locknut (2) and replace the cover and o-ring (1).

NOTE: The pressure range between the cut in and cutout is not adjustable.

Air Dryer

Check for Moisture in the Air Brake System

IMPORTANT: The air dryer is intended to remove moisture and other contaminants normally found in the air brake system. Do not inject alcohol, antifreeze or other de-icing substances into or upstream of the air dryer. Alcohol is removed by the dryer, but reduces the effectiveness of the device to dry the air. Use of other substances can damage the air dryer and may void the warranty.

Open all reservoirs, drain cocks, or drain valves and check for the presence of moisture. If moisture is present, the desiccant cartridge may require replacement however, the following conditions can also cause water accumulation and should be considered prior to desiccant replacement:

- An outside air source has been used to charge the system; this air does not pass through the drying bed.
- Air usage is exceptionally high and not normal for a highway vehicle:

This can be caused by accessory air demands or some unusual air requirement that does not allow the compressor to load and unload (compressing and non-compressing cycle) in a normal fashion.

Check for high air system leakage.

If vehicle usage has changed, it may be necessary to increase the compressor size.

- The air dryer has been installed in a system that has been previously used without an air dryer:

The system will be saturated with moisture; several weeks of operation may be required to dry out the system.

NOTE: A small amount of oil in the system is normal and should not be considered a reason to replace the desiccant cartridge; oil-stained desiccant can function adequately.

- Location of the air dryer is too close to the air compressor.
- In areas where more than a 30 degree range of temperature occurs in one day, small amounts of water can temporarily accumulate in the air brake system due to condensation. Under these conditions, the presence of small amounts of moisture is normal and should not be considered an indication that the dryer is not performing properly.

Check for Visible Damage

Visually check for physical damage to the air dryer, such as: chaffed or broken air and electrical lines and broken or missing parts.

Check Mounting Bolt Tightness

Check the mounting bolts for tightness, and retighten the bolts to 270 to 385 lb-in (30.5 to 43.5 N•m) torque.

Operation and Leakage Tests

1. Attach a pressure gauge in the number 1 reservoir.
2. Check all lines and fittings leading to and from the air dryer for leakage and integrity.
3. Test the delivery port check valve assembly:

AIR SYSTEM

- a. Raise the pressure in the air system to the level where the governor cuts off, and note the pressure reading when the governor cutoff occurs,
 - If a rapid loss of pressure occurs, continue with step b to confirm a failed delivery port check valve.
 - If a rapid loss of pressure does not occur, skip to step 4.
 - b. Shut down the engine.
 - c. Release system pressure through the compressor discharge line until system pressure is less than governor cut in pressure (usually not less than 95 psi (6.55 bar)).
 - d. Remove the discharge line at the supply port of the dryer.
 - e. Remove the line from the control port to the governor UNL port to make sure that there is no air pressure at the control port.
- NOTE:** The reservoir needs to have at least 50 psi (3.45 bar) of pressure when performing step f.
- f. Use soapy water to determine if air is flowing out of the supply port.

If a 1 in (25.4 mm) bubble forms within one second, repair the delivery check valve.
4. Check for excessive leakage around the purge valve:
 - a. With the compressor in loaded mode (compressing air), apply a soap solution to the purge valve exhaust port and note if the leakage exceeds formation of 1 in (25.4 mm) bubble in one second.
 - If the leakage exceeds this specification, repair the purge valve assembly.
 - If the leakage does not exceed this specification, continue with step b.
 - b. Close all of the reservoir drain cocks.
 - c. Increase system pressure to the governor cutout pressure and note that the air dryer purges with an audible escape of air.
 - d. 'Fan' the service brakes to reduce system air pressure to the governor cut in.
 - e. Note that the system once again increase to full pressure and is followed by an air dryer purge cycle.
 5. Check the operation of the end cover heater and thermostat assembly during cold weather operation:
 - Electric Power to the Dryer:
 1. Turn the ignition or engine kill switch to the 'ON' position.
 2. Check for voltage to the heater and thermostat assembly using a voltmeter or a test light:

Unplug the electrical connector at the air dryer and place the test leads on each of the pins of the connector with the locking latch.
 3. If no voltage is present, check for a blown fuse, broken wires, corrosion in the vehicle wiring harness and poor grounding.
 - Thermostat and Heater Operation:

NOTE: These tests are not required except in cold weather operation.

 1. Turn the ignition switch to the 'OFF' position.
 2. Cool the thermostat and heater assembly to below 40° F (4.4° C).
 3. Using an ohmmeter, check the resistance between the electrical pins in the air dryer connector half.

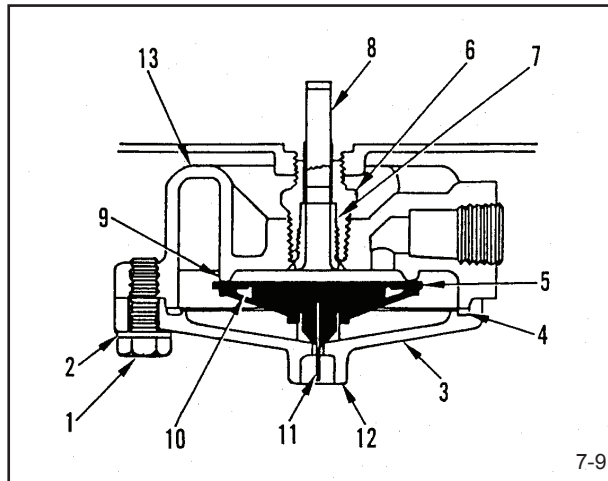
Resistance should be:

 - 1.5 to 3.0 ohms for a 12 volt heater assembly
 - 6.0 to 9.0 ohms for a 24 volt heater assembly
 4. Warm the thermostat and heater assembly to over 90° F (32.2° C).
 5. Recheck the resistance.

Resistance should exceed 1000 ohms.
 6. Make a determination:
 - If the resistance readings are within specifications, the thermostat and heater assembly is operating properly.
 - If the resistance are outside the specification, replace the heater and thermostat assembly.

REPAIR

Automatic Drain



Removal

1. Set the parking brake.
2. Apply and release the service brakes to bleed the air pressure from the brake system.
3. Depress the plunger in the automatic drain valve to ensure that all pressure is released.
4. Remove the four cap screws (1) and the lock washers (2). See figure 7-9.

Disassembly

1. Remove the cover (3) and the sealing ring (4). See figure 7-9.
2. Remove the inlet and exhaust valve (5).
3. Remove the adapter and filter assembly (6).
4. Remove the filter retainer (7) and the filter (8).
5. Clean and inspect the filter, and replace the filter if the filter is clogged.
6. Wipe all rubber parts clean, and clean metal parts with a cleaning solvent.

Reassembly

1. Apply a light film of grease to the inlet valve seat (9). See figure 7-9.

IMPORTANT: Do not apply oil or grease to the inlet and exhaust valve.

2. Place the sealing ring (4) into the groove in the cover (3).
3. Place the valve guide (10) over the inlet and exhaust valve (5).

4. Place the valve guide (10) and the inlet and exhaust valve assembly (5) into the cover (3) so that the wire stem (11) projects through the exhaust port (12).
5. Place the cover (3) on the body (13) and install the lock washers (2) and the cap screw (1).
6. Install the filter (8) into the adapter and screw in the filter retainer (7).
7. Install the adapter and filter assembly (6) into the body (13) and tighten the assembly.

Installation

1. Place the automatic drain valve at its mounting location in the air tank.
2. Install the four cap screws (1) and the lock washers (2), and tighten the cap screws. See figure 7-9.

AIR SYSTEM

TROUBLESHOOTING (AIR DRYER)

Symptom	Cause	Solution
Dryer is constantly cycling or purging; dryer purges frequently (every 4 minutes or less while vehicle is idling)	Excessive system leakage / Leakage indicated on gauges NOTE: Pressure loss shown on gauges is caused by service brake system or component leakage.	Determine if leakage is within allowable limits; if leakage is not within allowable limits, service or repair reservoir and retest. Allowable Limits: <ul style="list-style-type: none"> • Single vehicle: 1 psi/min • Tractor trailer: 3 psi/min
	Excessive system leakage / Leakage NOT indicated on gauges NOTE: Pressure loss not shown on gauges is caused by supply system or component leakage.	(refer to procedures for Cause on page 7-15)
Water and/or oil in supply or service reservoir (continued on next page)	Improper discharge line length or improper line material / Maximum air dryer inlet temperature is exceeded.	Check line size and length: <ul style="list-style-type: none"> • Standard discharge line: 1/2 in ID; 12 ft length • For oil carryover control: 5/8 in ID; 15 ft length
	Air system charged from outside air source (outside air not passing through air dryer)	If system must have outside air fill provision, outside air should pass through air dryer. This practice should be minimized.
	Air dryer not purging	(refer to Symptom: Constant exhaust of air at air dryer purge valve exhaust (Charge mode) on page 7-12)
	Purge (air exhaust) time insufficient due to excessive system leakage	(refer to Symptom: Dryer is constantly cycling or purging; dryer purges frequently (every 4 minutes or less while vehicle is idling))
	Excessive air usage / duty cycle too high	Air dryer not compatible with vehicle air system requirement (Improper air dryer/vehicle application); upgrade compressor
	Air compressor discharge and/or air dryer inlet temperature too high	(refer to procedures for Cause on page 7-15)

Symptom	Cause	Solution
Water and/or oil in supply or service reservoir	Compressor malfunction	Test the compressor using the BASIC cup method as described in the OEM compressor service manual. Replace compressor, if necessary. If still under warranty, follow normal warranty process.
	Air by-passes desiccant cartridge assembly	If installed, inspect feedback check valve for proper installation and operation. When replacing the desiccant cartridge, make sure desiccant cartridge assembly is properly installed and sealing rings are in place on mounting surface of desiccant cartridge.
	Desiccant requires replacement	Replace desiccant cartridge assembly
Oil present at air dryer purge exhaust or cartridge during maintenance	Air brake charging system is functioning normally	NOTE: A small amount of oil is normal. Check that regular maintenance is being performed and that the amount of oil in the air tanks (reservoirs) is within the acceptable range as indicated with the BASIC cup test: 5 oil units/month Replace the air dryer cartridge as needed and return the vehicle to service.
Safety valve on air dryer 'popping off' or exhausting air (continued on next page)	Restriction between air dryer and supply (first) reservoir	Check to determine if air is reaching supply reservoir. Inspect for kinked tubing or hose. Check for non-drilled or restricted hose or tubing fittings and repair or replace as needed
	Air dryer safety valve malfunction	Verify relief pressure is at vehicle or component manufacturer specifications. Replace relief valve, if valve is malfunctioning
	Desiccant cartridge maintenance required (recommended every 2 years)	Check compressor for excessive oil passing and/or correct compressor installation. Repair or replace as necessary. Replace desiccant cartridge.

AIR SYSTEM

Symptom	Cause	Solution
Safety valve on air dryer 'popping off' or exhausting air	Malfunctioning discharge check valve in end cover of the air dryer	Test to determine if air is passing through check valve. Repair or replace check valve as necessary.
	Excessive pressure pulsations from compressor (Typical single cylinder type)	<ul style="list-style-type: none"> Increase volume in discharge line by increasing length or diameter. Add a ping tank (small reservoir).
	Governor malfunction; missing or restricted governor control line installation.	Test governor operation and/or inspect the control line leading from the governor unloader (UNL) port to the air dryer control port.
Constant exhaust of air at air dryer purge valve exhaust (Charge mode)	Air dryer purge valve leaking excessively	Test for excessive leakage: With compressor loaded, apply soap solution on purge valve exhaust. Repair purge valve as necessary
	Compressor fails to unload (stop compressing air) and air dryer purge exhaust makes 'sputtering' or 'popping' sound	Confirm failure to unload: Increase and decrease engine RPM and note change in the rate of leakage and intensity of accompanying leakage sound. Repair or replace compressor unloaders.
	Purge control line connected to reservoir or exhaust port of governor	Connect purge control line to unloader port of governor.
	Purge valve frozen open; malfunctioning heater and thermostat wiring	Test heater and thermostat.
	Excessive system leakage	(refer to Symptom: Dryer is constantly cycling or purging; dryer purges frequently (every 4 minutes or less while vehicle is idling) on page 7-10)
	Purge valve stays open; supply air leaks to control side	Repair purge valve and housing.
Cannot build system air pressure (continued on next page)	Inlet and outlet air connections reversed	Connect compressor discharge to air dryer supply port; reconnect lines properly.
	Check valve between air dryer and first reservoir	Test check valve for proper operation. Repair or replace check valve as necessary

Symptom	Cause	Solution
Cannot build system air pressure	Kinked or blocked (plugged) discharge line	Check to determine if air passes through discharge line; check for kinks, bends, excessive carbon deposits or ice blockage.
	Excessive bends in discharge line (water collects and freezes)	Make sure discharge line is at a constant slope from compressor to air dryer with as few bends as possible.
	Excessive pressure pulsations from compressor (Typical single cylinder type)	<ul style="list-style-type: none"> • Increase volume in discharge line by increasing length or diameter. • Add a ping tank (small reservoir).
	Governor malfunction; missing or restricted governor control line installation.	Test governor operation and/or inspect the control line leading from the governor unloader (UNL) port to the air dryer control port.
Air dryer does not purge or exhaust air	Missing, broken, kinked, frozen, plugged or disconnected purge control line	<ul style="list-style-type: none"> • Inspect control line from governor UNL port to control port of air dryer. Test to determine that air flows through purge control line when compressor is unloaded. • Check for non-drilled fittings. • Check compressor for excessive oil passing and/or correct compressor installation. Repair or replace as necessary. • Replace desiccant cartridge.
	Faulty air dryer purge valve	After determining that air reaches purge valve (perform prior solution above), repair purge valve
	Air dryer safety valve malfunction	<p>Verify relief pressure is at vehicle or component manufacturer specifications.</p> <p>Replace relief valve, if valve is malfunctioning</p>
	Excessive pressure pulsations from compressor (Typical single cylinder type)	<ul style="list-style-type: none"> • Increase volume in discharge line by increasing length or diameter. • Add a ping tank (small reservoir).

AIR SYSTEM

Symptom	Cause	Solution
Desiccant material is expelled from air dryer purge valve exhaust (may look like whitish liquid, paste or small beads) OR Unsatisfactory desiccant life	This symptom is almost always accompanied by one or more of the first five symptoms.	See related causes and solutions for the first five symptoms from page 7-10 through page 7-12.
	Air dryer not securely mounted (excessive vibration)	Vibration should be held to a minimum: Add bracket supports or change air dryer mounting location as necessary
	Malfunctioning or saturated desiccant cartridge	Replace desiccant cartridge assembly
	Compressor passing excessive oil	Check for proper compressor installation; if symptoms persist, replace compressor.
	Desiccant cartridge not assembled properly to end cover (loose attachment)	Check the torque on the desiccant cartridge to end cover attachment.
'Pinging' noise excessive during compressor loaded cycle	Single cylinder compressor with high pulse cycles	A slight 'pinging' sound may be heard during system build up when a single cylinder compressor is used. If this sound is deemed objectionable, it can be reduced substantially by increasing the discharge line volume. This can be accomplished by adding an additional four feet of discharge line or adding a 90 cu in reservoir between the compressor and the air dryer. NOTE: Do not exceed the line lengths requirements specified in this manual.
Constant seepage of air at air dryer purge valve exhaust (non-charging mode)	Defective check valve assembly in air dryer end cover	Repair or replace check valve.
	Leaking turbo cutoff valve	Repair or replace purge valve assembly.
	Leaking purge valve control piston o-ring	
The air dryer purge piston cycles rapidly in the compressor unloaded (non-compressing) mode	Compressor fails to 'unload'	Faulty governor installation; no air line from governor to compressor or line is kinked or restricted. Install or repair air line.

Procedures

Air compressor discharge and/or air dryer inlet temperature too high

1. Restricted discharge line:
If the discharge line is restricted or more than 1/16 in (1.6 mm) carbon build up is found, replace the discharge line.
 - Standard discharge line: 1/2 in ID; 12 ft length
 - For oil carryover control: 5/8 in ID; 15 ft length
2. Discharge Line Freeze-Up:
 - If ice blockages occur at the air dryer inlet, add insulation at that location.
 - If the inlet fitting is a typical 90 degree fitting, change the fitting to a straight or 45 degree fitting.
 - Shorter discharge line lengths or insulation may be required in cold climates.
3. Insufficient coolant flow through compressor:
 - a. Inspect coolant line, and replace the line if necessary (minimum ID is 1/2 in).
 - b. Inspect the coolant lines for kinks and restrictions, and the fittings for restrictions. Replace component as necessary.
 - c. Verify coolant line routing from the engine block to the compressor and back to the water pump. Repair components as necessary.
4. Restricted air inlet (not enough air to compressor).
 - Check the compressor air inlet line for restrictions, brittleness, soft or sagging hose conditions, etc. Repair the line if necessary (inlet line ID is 3/4 in; maximum restriction requirement for compressors is 25 in (63.5 cm) of water).
 - Check the engine air filter, and service the filter if necessary (if possible, check the air filter usage indicator).
5. Poorly filtered inlet air (poor air quality to compressor):
Check for leaking, damaged or malfunctioning compressor air inlet components (i.e. induction line, fittings, gaskets, filter bodies, etc.). Repair inlet components as needed.

NOTE: Dirt ingestion will damage the compressor and is not covered under warranty

6. If excessive oil is present in the service reservoir and none of the prior issues exist, the compressor may be passing oil:
Replace the compressor. If still under warranty, follow the normal warranty process.

Excessive system leakage / Leakage NOT indicated on gauges

Test for excessive supply system leakage as follows:

1. Remove the drain cock or the valve in the supply reservoir (wet tank) and install an air gauge.
2. Build up system pressure, allow the air dryer to purge and observe the air gauge reading in the supply reservoir.
3. If system pressure drop exceeds 1 psi/min (0.07 bar/min), continue with step 4.
4. Test the fittings, the hoses, the lines and the connections; apply soapy water to detect excessive leakage.
5. Tighten or replace components as needed.
6. Repeat the air dryer charge/purge cycle and observe the gauge installed in the supply reservoir.
 - If leakage is within allowable limits, remove the gauge from the reservoir and replace the drain cock or the valve.
Allowable Limits:
 - Single vehicle: 1 psi/min (0.07 bar/min)
 - Tractor trailer: 3 psi/min (0.21 bar/min)
 - If leakage is outside the allowable limits, continue with step 7.
7. Test the accessories connected to the supply reservoir:
 - a. Drain all air pressure from the system.
 - b. Disconnect all the air lines leading to the accessories (fan clutch, wipers, air seats, etc.).
 - c. Plug in the reservoir at the disconnection point.
 - d. Build air system pressure until the air dryer purges and observe the supply reservoir gauge:

AIR SYSTEM

- If leakage is now within allowable limits, repair or replace the leaking accessory.
 - If leakage is outside allowable limits, continue with step 8.
8. Test governor leakage:
- High system pressure test:
- a. Build system pressure to governor cut-out.
 - b. Shut down the engine.
 - c. Apply soapy water to the governor exhaust port and around the cap.
Leakage should not exceed a 1 in (25.4 mm) bubble in 5 seconds.
- Low system pressure test:
- a. Reduce system pressure to 80 psi (5.52 bar) or less.
 - b. Re-apply the soapy water.
Leakage should not exceed a 1 in (25.4 mm) bubble in 5 seconds.
- If excessive leakage is detected in either test, repair or replace the governor.
9. Test compressor unloader leakage:
- a. Drain all air pressure from the system.
 - b. Remove the governor from the compressor.
 - c. Temporarily plug the governor unloader port or air line that mated with, or connected to, the compressor.
 - d. Build air system pressure until the air dryer purges then immediately shut down the engine.
 - e. Observe the air gauge in the supply reservoir:
 - If leakage is within limits, replace the compressor unloaders, reconnect the governor to the compressor (after removing the plug installed in the governor) and retest while observing the supply reservoir gauge.
 - If excessive leakage is detected, continue with step 10.
10. Test air dryer purge valve and outlet (delivery) check valve:
- a. Drain all air pressure from the system.
 - b. Remove the control line connection at the air dryer and plug the end of the air line leading to the governor (not the air dryer control port).
- c. Build system pressure to governor cutout and observe the air gauge.
 - If little or no pressure drop is observed, replace the air dryer check valve.
 - If pressure drop continues, apply soapy water to the air dryer purge exhaust and purge control port (where the control line was removed).
Leakage should not exceed a 1 in (25.4 mm) bubble in 5 seconds. If leakage is excessive, repair or replace the purge valve assembly.
11. Connect the gauge to the RES port of the governor.
If pressure drops below 'Cut-In' pressure at the onset of the compressor 'Unloaded' cycle, check for kinks or restrictions in the line connected to RES port.
- NOTE:** *The line connected to the RES port on the governor must be the same diameter as, or preferably larger than, lines connected to the UNL port(s) on the governor.*

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COMPONENTS AND THEORY OF OPERATION

The ABS/ATC system consist of the following major components:

- Controller/Electronic control unit (ECU)
- Exciter ring
- Pressure modulator valves (PMV)
- Traction control valves (TCV)
- Wheel speed sensors (WSS)

ABS Operation

WSS, ABS modulator valves and an ECU are used to control either four or six wheels of a vehicle. By monitoring individual wheel rotation speeds during braking, and adjusting or pulsing the brake pressure at each wheel, the ECU is able to optimize slip between the tire and the road surface.

When excessive wheel slip, or wheel lockup, is detected, the ECU will activate the PMVs to simulate a driver pumping the brakes. However, the ECU is able to pump the brakes on individual wheels (or pairs of wheels) independently and with greater speed and accuracy than a driver.

Single Drive Axle Control (4x2 Vehicle)

For vehicles with a single rear drive axle (4x2), the brakes are operated independently by the ECU, based on the individual wheel behavior.

Normal Braking

During normal braking, brake pressure is delivered through the ABS PMV and into the brake chamber. If the ECU does not detect excessive wheel slip, it will not activate ABS control, and the vehicle stops with normal braking.

ATC Operation

Just as ABS improves vehicle stability during braking, ATC improves vehicle stability and traction during vehicle acceleration. The ATC function uses the same wheel speed information and modulator control as the ABS function. The ECU detects excessive drive wheel speed, compares the speed of the front, non-driven wheels, and reacts to help bring the wheel spin under control. The ECU can be configured to use engine torque limiting and/or differential braking to control wheel spin. For optimal ATC performance, both methods are recommended.

ATC can improve vehicle traction during acceleration, and lateral stability while driving through curves. ATC utilizes Engine Torque Limiting (ETL) where the ECU communicates with the engine's controller and/or Differential Braking (DB) where individual wheel brake applications are used to improve vehicle traction.

ABS/ATC ECUs have a drag torque control feature which reduces driven-axle wheel slip (due to driveline inertia) by communicating with the engine's controller and increasing the engine torque.

Indicator Operation

ABS Indicator

The ABS indicator will illuminate in the following cases:

- When ignition power is applied, the indicator will illuminate for approximately three seconds, and then extinguish if no diagnostic trouble codes are detected.
- When full ABS operation is not available due to a diagnostic trouble code. In most cases, partial ABS is still available.

ATC Status Indicator

The ATC status indicator will illuminate in the following cases:

- When ignition power is applied the status indicator will illuminate for approximately 2.5 seconds, and then extinguish if no diagnostic trouble codes are detected.
- When ATC is disabled due to a diagnostic trouble code.
- During an ATC event, the lamp will flash rapidly. When ATC is no longer active, the ATC status indicator will extinguish.

Trailer ABS Indicator

Certain models of the ECU will control the trailer ABS indicator when a PLC signal (SAE J2497) from a trailer ABS ECU is detected.

ABS/ATC SYSTEM

REPAIR

Safe Maintenance Practices

WARNING

Read and make sure you follow these general precautions prior to servicing the ABS system, or death or serious injury could result.

When working on or around the truck, observe the following general precautions at all times:

- Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.
- Always wear safety glasses.
- Stop the engine and remove ignition key when working under or around the vehicle.
- When working in the engine compartment, the engine should be shut off and the ignition key should be removed.
- Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
- Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures.
- Use only the proper tools and observe all precautions pertaining to use of those tools.
- If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
- Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
- Never exceed manufacturer's recommended pressures.
- Never connect or disconnect a hose or line containing pressure; it may whip.
- Never remove a component or plug unless you are certain all system pressure has been depleted.

- Use only genuine OEM replacement parts, components and kits.
- Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
- Components with stripped threads or damaged parts should be replaced rather than repaired.
- Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component OEM.
- Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
- For vehicles with ATC, the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

Controller/ECU

Removal

1. Turn vehicle ignition switch to the OFF position.
2. Remove as much contamination as possible prior to disconnecting air lines and electrical connections.
3. Note the controller assembly mounting orientation on the vehicle.
4. Disconnect the electrical connectors from the controller.
5. Remove and retain the controller mounting bolts, and remove the controller.

Installation

WARNING

When replacing the controller, verify that the unit you are installing has the correct default settings. Failure to do so could result in a loss of features, such as ATC and PLC and cause death or serious injury, and noncompliance with U.S. regulations such as FMVSS 121.

1. Position and secure the controller in the original mounting orientation using the mounting bolts retained during removal.
 - For cab-mount controllers, use no more torque than is necessary to firmly secure the controller into position.

- For frame-mount controllers, tighten the mounting bolts to 66 to 80 lb-in (7.5 to 9 N•m) torque.

NOTE: Over-tightening the mounting hardware can cause damage to the controller.

2. Reconnect the electrical connectors to the controller.

WARNING

Verify correct operation of the controller, the system and indicators prior to putting the vehicle back into service. Towing vehicles manufactured after March 1, 2001 must support the trailer ABS indicator lamp located on the dash.

For further information, contact the vehicle OEM, controller OEM or your local authorized controller OEM dealer.

3. Apply power and monitor the controller power up sequence to verify proper system operation.

TROUBLESHOOTING

Blink Codes and Diagnostic Modes

The controller contains self-testing diagnostic circuitry that continuously checks for the normal operation of internal components and circuitry, as well as external ABS components and wiring.

Active Diagnostic Trouble Codes (DTC)

When an erroneous system condition is detected, the controller does the following:

- Illuminates the appropriate indicator lamp(s) and disengages part or all of the ABS and ATC functions.
- Places the appropriate trouble code information in the ECU memory.
- Communicates the appropriate trouble code information over the serial communications diagnostic link as required.

NOTE: *Handheld or PC-based diagnostic tools attach to the vehicle diagnostic connector, typically located on or under the dash.*

Blink Codes

Blink codes allow a technician to troubleshoot ABS problems without using a hand-held or PC-based diagnostic tool. Instead, information about the ABS system is communicated by the ECU using the ABS indicator lamp to display sequences of blinks.

The ECU will not enter the diagnostic blink code mode if the WSS show that the vehicle is in motion. If the ECU is in the diagnostic blink code mode and then detects vehicle motion, it will exit the blink code mode. In addition, by operating the blink code switch as described below, one of several diagnostic modes can be entered. Refer to Diagnostic Modes on page 8-4.

Blink Code Switch Activation

When activating the blink code switch:

1. Wait at least two seconds after 'ignition on', except when entering Reconfiguration Mode.
2. Press the switch for between 0.1 and 5 seconds for the ECU to recognize that the switch is activated.

NOTE: *If the switch is held for more than 5 seconds, the ECU will register a malfunctioning switch.*

ABS/ATC SYSTEM

- When a sequence is required (i.e. when changing modes) do not pause between pressing the switch longer than 2 seconds.
After a pause of 3.5 seconds, the ECU will begin responding with output information blinks.

Blink Code Timing

The ECU responds with a sequence of blink codes which, when combined, is called a 'message'.

Each message includes, depending on the mode selected, a sequence of one or more groups of blinks.

Record the number of blinks for each sequence of an active or inactive trouble code, and use the DTC Reference Table on page 8-6 to be directed to the page that provides specific troubleshooting information.

General blink code timing (see figure 8-1):

- Sequences of blinks illuminate the ABS indicator for 0.5 seconds, with 0.5 second pauses between them.
- Pauses between blink code digits are 1.5 seconds.
- Pauses between blink code messages are 2.5 seconds.
- The lamp remains on for 5 seconds at the end of messages.

The ABS indicator will display sequences of codes until all blink code messages are displayed, and then return to the normal operating mode. During this time, the ECU will ignore any additional blink code switch activation.

All trouble codes, with the exception of voltage and J1939 trouble codes, will remain in an active state for the remainder of the power cycle:

- Voltage trouble codes will clear automatically when the voltage returns within the required limits. All ABS functions will be re-engaged.
- J1939 trouble codes will clear automatically when communications are re-established.

Diagnostic Modes

In order to communicate with the ECU, there are several modes that can be selected, allowing information to be retrieved, or other ECU functions to be accessed.

To enter the various diagnostic modes:

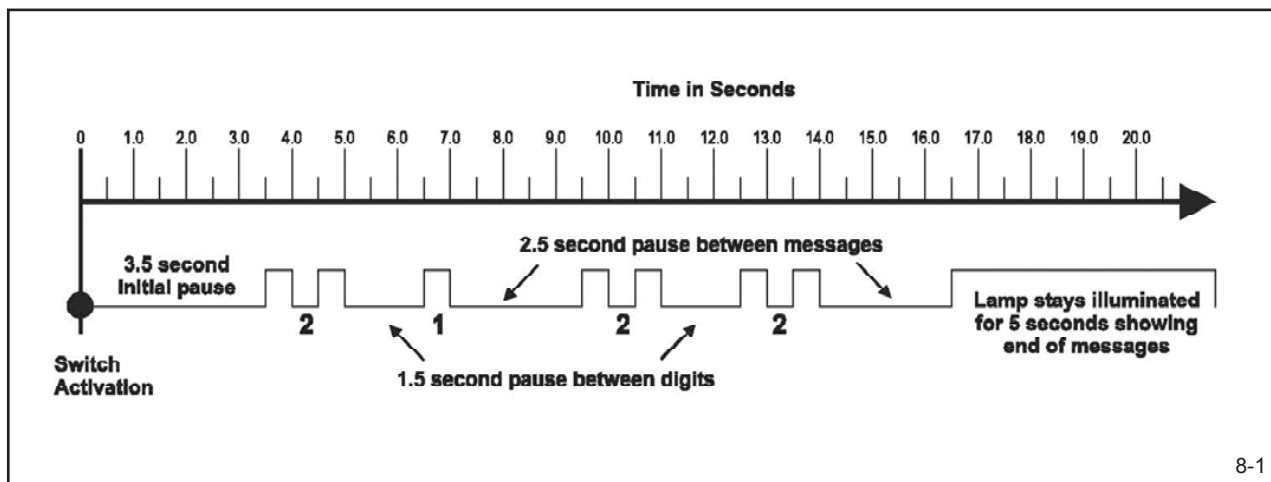
No. of Times to Press Blink Code Switch	System Mode Entered
1	Active DTC retrieval
2	Inactive DTC retrieval
3	Clear active DTC
4	System configuration check
5	Dynamometer test mode
7	Reconfigure ECU

Active DTC Mode

For troubleshooting, typically the Active and Inactive Diagnostic Trouble Retrieval Modes are used.

The technician presses the blink code switch once and the ABS indicator lamp flashes a first group of two codes, and if there are more trouble codes recorded, this is followed by a second set of codes, etc.

All active trouble codes may also be retrieved using a hand-held or PC-based diagnostic tool.



To clear active DTC (as problems are fixed), simply clear (or 'self-heal') by removing and re-applying ignition power. The only exception is for WSS trouble codes, which clear when power is removed, re-applied, and the ECU detects valid wheel speed from all WSS.

Alternately, codes may be cleared by pressing the diagnostic blink code switch 3 times (to enter the Clear Active DTC Mode) or by using a hand-held or PC-based diagnostic tool. Handheld or PC-based diagnostic tools are able to clear WSS trouble codes without the vehicle being driven.

Inactive DTC Mode

The ECU stores past trouble codes and comments (such as configuration changes) in its memory. This record is commonly referred to as 'event history'.

When an active trouble code is cleared, the ECU stores it in the event history memory as an inactive trouble code.

Using blink codes, the technician may review all inactive trouble codes stored on the ECU.

The ABS indicator lamp will display inactive diagnostic blink codes when the diagnostic blink code switch is depressed and released two times. Inactive trouble codes and event history may be retrieved and cleared using a hand-held or PC-based diagnostic tool.

Clearing Active DTC

The ECU will clear active trouble codes when the diagnostic blink code switch is depressed and released three times.

System Configuration Check Mode

The ABS indicator lamp will display system configuration information when the diagnostic blink code switch is depressed and released four times. The lamp will blink out configuration information codes using the following patterns.

1st Number	System Power
1	12 V
2	24 V
2nd Number	WSS
4	4 Sensors (S)
6	6 Sensors (S)

3rd Number	PMV
4	4 Modulators (M)
5	5 Modulators (M)
6	6 Modulators (M)
4th Number	ABS Configuration
1	4S/4M or 6S/6M
2	6S/4M
3	6S/5M
5th Number	Traction Control Configuration
2	No ATC
3	ATC Engine Control Only
4	ATC Brake Control Only
5	Full ATC (both Engine and Brake Control)
6th Number	Retarder Configuration
1	No Retarder
2	J1939 Retarder
3	Retarder Relay
4	J1939 Retarder and Retarder Relay

In this mode the ECU tells the technician, by means of a series of six blink codes, the type of ABS system that the ECU has been set up to expect. For example, if the fourth blink code is a three, the technician knows that a 6S/5M sensor/modulator configuration has been set.

Reconfigure ECU Mode

Vehicle reconfiguration is carried out by using the Reconfigure ECU Mode.

To enter the Reconfiguration Mode, press and hold the blink code switch before applying ignition power. Once ignition power is supplied, release the switch and then press the switch seven times.

ABS/ATC SYSTEM

DTC Reference Table

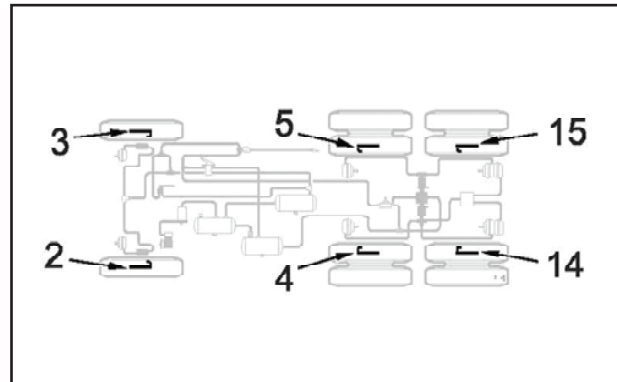
Use the table that follows to determine the component referenced by the first blink code, and then go to the DTC section for that component on pages 8-7 through 8-15:

1st Blink Code	Component	Page
2	WSS	8-7
3	WSS	8-7
4	WSS	8-7
5	WSS	8-7
6	Power Supply	8-12
7	PMV	8-9
8	PMV	8-9
9	PMV	8-9
10	PMV	8-9
11	J1939	8-13
12	Miscellaneous	8-15
13	ECU	8-14
14	WSS	8-7
15	WSS	8-7
16	PMV	8-9
17	PMV	8-9
18	TCV	8-11

DTC: WSS

1st Blink Code Locations

1st Blink Code	Location
2	LH Steering Axle
3	RH Steering Axle
4	LH Drive Axle
5	RH Drive Axle
14	LH Additional Axle
15	RH Additional Axle



2nd Blink Code Descriptions and Procedures

2nd Blink Code	Description	Procedure
1	Excessive Air Gap	<ol style="list-style-type: none"> 1. Adjust WSS to contact exciter ring. 2. Rotate wheel and verify a minimum of 0.25 VAC WSS output at ~0.5 RPS. 3. Verify condition of WSS head.
2	Output Low at Drive Off	<ol style="list-style-type: none"> 4. Verify mounting of exciter ring and condition of teeth. 5. Verify proper bearing end play. 6. Verify condition and retention of clamping sleeve. 7. Verify WSS lead routing and clamping.
3	Open or Shorted	<ol style="list-style-type: none"> 1. Verify 1,500 to 2,500 ohms across WSS leads. 2. Verify no continuity between WSS leads and GRND or voltage. 3. Verify no continuity between WSS leads and other sensors. 4. Check for corroded/damaged wiring or connectors between the ECU and the WSS.
4	Loss of WSS Signal	<ol style="list-style-type: none"> 1. Adjust WSS to contact exciter ring. 2. Rotate wheel and verify a minimum of 0.25 VAC WSS output at ~0.5 RPS. 3. Verify condition of WSS head. 4. Verify mounting of exciter ring and condition of teeth. 5. Verify proper bearing end play. 6. Verify condition and retention of clamping sleeve. 7. Verify WSS lead routing and clamping. 8. Check for corroded/damaged wiring or connectors between the ECU and the WSS.

ABS/ATC SYSTEM

2nd Blink Code	Description	Procedure
5	Wheel End	<ol style="list-style-type: none"> 1. Verify mounting of exciter ring and condition of teeth. 2. Verify proper bearing end play. 3. Verify condition and retention of clamping sleeve. 4. Verify WSS lead routing and clamping. 5. Check mechanical function of brake. 6. Check for kinked or restricted air lines.
6	Erratic WSS Signal	<ol style="list-style-type: none"> 1. Adjust WSS to contact exciter ring. 2. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~0.5 RPS. 3. Verify condition of WSS head. 4. Verify mounting of exciter ring and condition of teeth. 5. Verify proper bearing end play. 6. Verify condition and retention of clamping sleeve. 7. Verify WSS lead routing and clamping. 8. Check for corroded/damaged wiring or connectors between the ECU and the WSS.
7	Tire Size Calibration	<ol style="list-style-type: none"> 1. Verify correct tire size, as desired. 2. Verify proper tire inflation. 3. Verify correct number of exciter ring teeth.
8	Configuration Error (ECU is configured for four WSS, but has detected the presence of additional WSS)	Verify WSS wiring and ECU configuration.

Testing

1. Take all measurements at ECU harness connector pins in order to check wire harness and WSS. Probe the connector carefully so that the terminals are not damaged.
2. WSS measurements should be as follows:

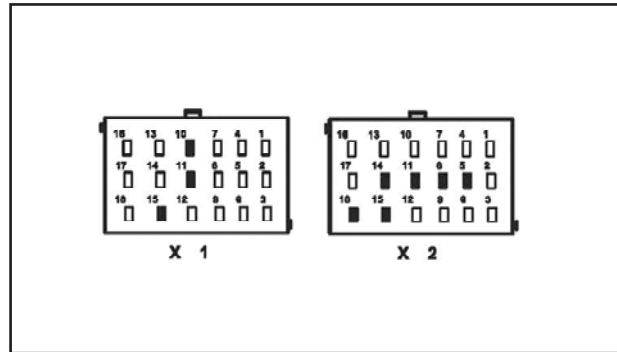
Measurement	Specification
WSS	1,500 to 2,000 ohms
WSS to Voltage or GRND	Open Circuit (no continuity)
WSS Output Voltage	> 0.25 of VAC WSS Output at ~ 0.5 RPS

3. Clear the DTCs after the issues are corrected. The DTC will remain on until the power is cycled to the ABS ECU and the vehicle is driven above 15 mph (24.1 km/h) or the DTC was cleared using either the diagnostic blink code switch or a diagnostic tool.

ABS/ATC SYSTEM

Cab-Mounted ECU Wire Harness Connector

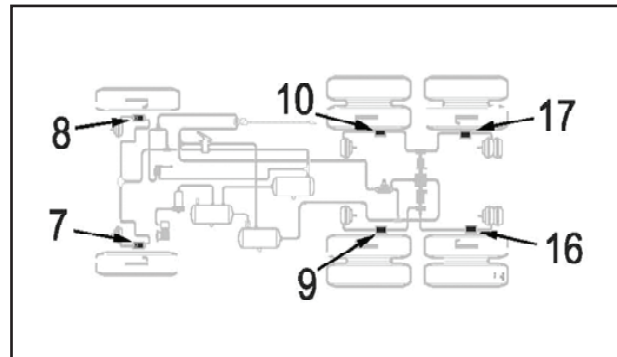
Connector	Pin	WSS Location/Test
X1 18-way	10	RH Drive Axle (+)
	11	RH Drive Axle (-)
X2 18-way	5	LH Steering Axle (+)
	8	LH Steering Axle (-)
	11	RH Steering Axle (+)
	14	RH Steering Axle (-)
	15	LH Drive Axle (+)
	18	LH Drive Axle (-)



DTC: PMV

1st Blink Code Locations

1st Blink Code	Location
7	LH Steering Axle
8	RH Steering Axle
9	LH Drive Axle
10	RH Drive Axle
16	LH Additional Axle
17	RH Additional Axle



8

2nd Blink Code Descriptions and Procedures

2nd Blink Code	Description	Procedure
1	Release Solenoid Shorted to GRND	1. Verify no continuity between PMV leads and GRND. 2. Verify 4.9 to 5.5 ohms from REL to CMN and HLD to CMN, and 9.8 to 11.0 ohms from REL to HLD.
2	Release Solenoid Shorted to Voltage	3. Check for corroded/damaged wiring or connectors between ECU and PMV.
3	Release Solenoid Open Circuit	1. Verify 4.9 to 5.5 ohms from REL to CMN and HLD to CMN, and 9.8 to 11.0 ohms from REL to HLD. 2. Check for corroded/damaged wiring or connectors between ECU and PMV.
4	Hold Solenoid Shorted to GRND	(follow prior procedures for Release Solenoid Shorted to GRND)
5	Hold Solenoid Shorted to Voltage	(follow prior procedures for Release Solenoid Shorted to GRND)
6	Hold Solenoid Open Circuit	(follow prior procedures for Release Solenoid Open Circuit)
7	CMN Open Circuit	(follow prior procedures for Release Solenoid Open Circuit)

ABS/ATC SYSTEM

2nd Blink Code	Description	Procedure
8	Configuration Error (ECU configuration does not match PMV configuration)	Verify PMV wiring and installation, and ECU configuration

Testing

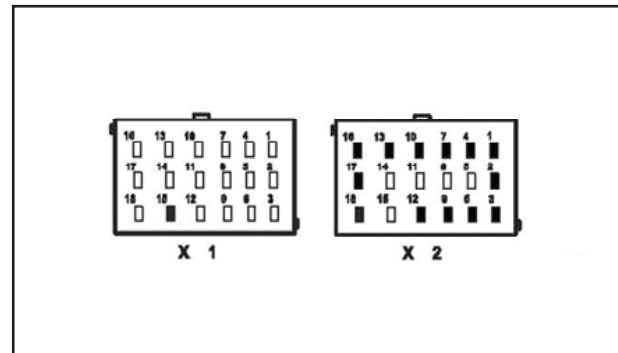
- Take all measurements at ECU harness connector pins in order to check wire harness and PMV. Probe the connector carefully so that the terminals are not damaged.
- PMV resistance should be as follows:

Measurement	Specification	Measurement	Specification
REL to CMN	4.9 to 5.5 ohms	REL to HLD	9.8 to 11.0 ohms
HLD to CMN	4.9 to 5.5 ohms	REL, HLD or CMN to Voltage or GRND	Open Circuit (no continuity)

NOTE: When troubleshooting PMV DTC, check inactive DTC and event history for over-voltage or excessive noise DTC. If one of these inactive DTC exist, troubleshoot those DTC prior to troubleshooting.

Cab-Mounted ECU Wire Harness Connector

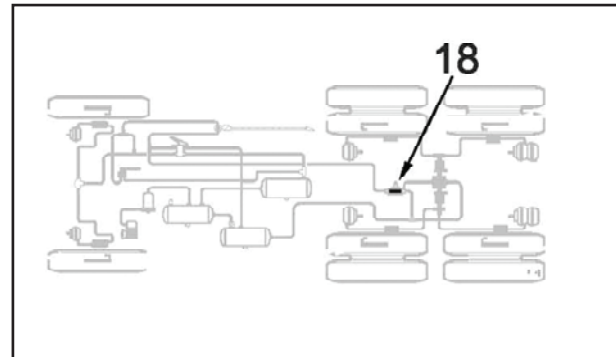
Connector	Pin	PMV Location/Test
X2 18-way	1	LH Steering Axle HLD
	2	LH Steering Axle REL
	3	LH Steering Axle CMN
	4	RH Steering Axle HLD
	6	RH Steering Axle CMN
	7	RH Steering Axle REL
	9	RH Drive Axle CMN
	10	RH Drive Axle HLD
	12	LH Drive Axle CMN
	13	RH Drive Axle REL
	16	LH Drive Axle HLD
	17	LH Drive Axle REL



DTC: TCV

1st Blink Code Location

1st Blink Code	Location
18	TCV



2nd Blink Code Descriptions and Procedures

2nd Blink Code	Description	Procedure
1	TCV Solenoid Shorted to GRND	1. Verify 7 to 19 ohms between TCV and TCV CMN. 2. Verify no continuity between TCV leads and GRND.
2	TCV Solenoid Shorted to Voltage	3. Check for corroded/damaged wiring or connectors between ECU and TCV.
3	TCV Solenoid Open Circuit	1. Verify 7 to 19 ohms between TCV and TCV CMN. 2. Check for corroded/damaged wiring or connectors between ECU and TCV.
4	TCV Configuration Error (ECU is not configured for ATC, but has detected the presence of a TCV)	1. Verify TCV wiring. 2. Inspect for presence of a TCV. 3. Verify ECU configuration.

8

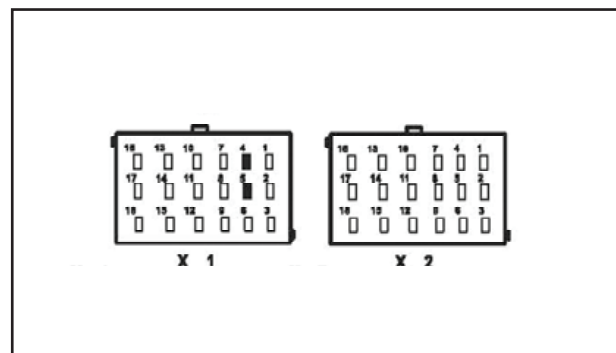
Testing

1. Take all measurements at ECU harness connector pins in order to check wire harness and TCV. Probe the connector carefully so that the terminals are not damaged.
2. TCV resistance should be as follows:

Measurement	Specification
TCV to TCV CMN	7 to 9 ohms
REL, HLD or CMN to Voltage or GRND	Open Circuit (no continuity)

Cab-Mounted ECU Wire Harness Connector

Connector	Pin	TCV Test
X1	4	TCV CMN
18-way	5	TCV



ABS/ATC SYSTEM

DTC: Power Supply

1st Blink Code Location

1st Blink Code	Location
6	Power Supply

2nd Blink Code Descriptions and Procedures

2nd Blink Code	Description	Procedure
1	Battery Voltage Too Low	<ol style="list-style-type: none"> 1. Measure battery voltage under load. 2. Check vehicle battery and associated components. 3. Check for damaged wiring. 4. Check for corroded/damaged connectors and connections.
2	Battery Voltage Too High	<ol style="list-style-type: none"> 1. Measure battery voltage under load: Make sure that battery voltage is correct for the model of ECU installed. 2. Check vehicle battery and associated components. 3. Check for damaged wiring. 4. Check for corroded/damaged connectors and connections.
3	Battery Voltage Too Low During ABS	(follow prior procedures for Battery Voltage Too Low)
4	Battery Voltage Open Circuit	<ol style="list-style-type: none"> 1. Measure battery voltage under load. 2. Check condition of fuse. 3. Check vehicle battery and associated components. 4. Check for damaged wiring. 5. Check for corroded/damaged connectors and connections.
5	Ignition Voltage Too Low	<ol style="list-style-type: none"> 1. Measure ignition voltage under load. 2. Check vehicle battery and associated components. 3. Check for damaged wiring. 4. Check for corroded/damaged connectors and connections. 5. Check condition of fuse.
6	Ignition Voltage Too High	<ol style="list-style-type: none"> 1. Measure ignition voltage: Make sure that ignition voltage is correct for the model of ECU installed. 2. Check vehicle battery and associated components. 3. Check for damaged wiring. 4. Check for corroded/damaged connectors and connections.
7	Ignition Voltage Too Low During ABS	<ol style="list-style-type: none"> 1. Measure ignition voltage under load. 2. Check vehicle battery and associated components. 3. Check for damaged wiring. 4. Check for corroded/damaged connectors and connections.

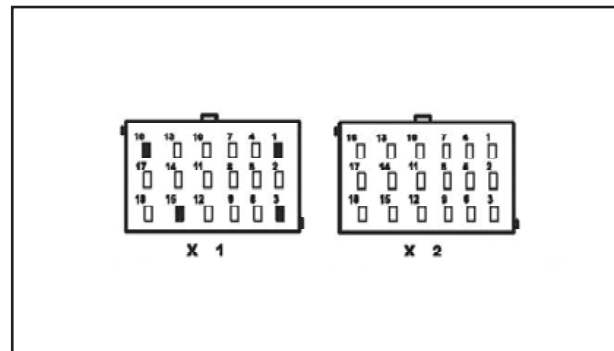
2nd Blink Code	Description	Procedure
8	Input Voltage Has Excessive Noise (temporarily)	<ol style="list-style-type: none"> 1. Check alternator output for excessive noise. 2. Check for other devices causing excessive noise.
9	Input Voltage Has Excessive Noise	

Testing

1. Take all measurements at ECU harness connector.
2. Place a load (i.e. a number 1157 stop lamp) across battery or ignition and GRND connection, and measure ignition and battery voltage with the load:
Ignition to GRND and battery to GRND measurements should be 9 to 17 VDC.
3. Check for damaged wiring, and corroded/damaged connectors and connections.
4. Check condition of vehicle battery and associated components, and that all GRND connections are secure.
5. Check alternator output for excessive noise.

Cab-Mounted ECU Wire Harness Connector

Connector	Pin	TCV Test
X1 18-way	1	GRND
	3	Ignition
	16	Battery



8

DTC: J1939

1st Blink Code Location

1st Blink Code	Location
11	J1939

2nd Blink Code Descriptions and Procedures

2nd Blink Code	Description	Procedures
1	J1939 Serial Link (loss of communications between ECU and devices connected to J1939 link)	<ol style="list-style-type: none"> 1. Check for damaged or reversed J1939 wiring. 2. Check for corroded/damaged connectors. 3. Verify ECU configuration. 4. Check for other devices that are inhibiting J1939 communications.

ABS/ATC SYSTEM

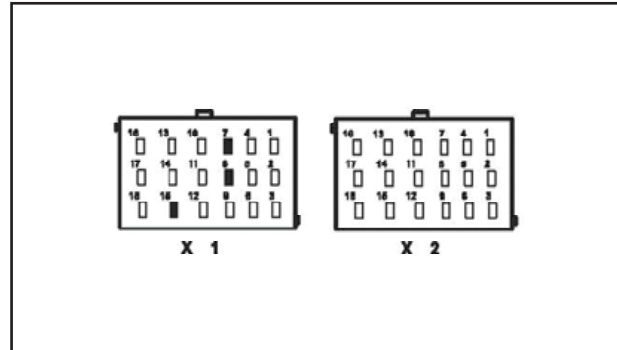
2nd Blink Code	Description	Procedures
3	J1939 Engine Communications (loss of communications between ECU and engine ECU over J1939 link)	<ol style="list-style-type: none"> 1. Check for damaged or reversed J1939 wiring. 2. Check for corroded/damaged connectors. 3. Verify presence of engine ECU on the J1939 link. 4. Verify ECU configuration. 5. Check for other devices that are inhibiting J1939 communications.

Testing

1. Take all measurements at ECU harness connector.
2. Check for damaged or reversed J1939 wiring.
3. Check for corroded/damaged wiring connector problems, such as opens or shorts to voltage or GRND.
4. Check for other J1939 devices that may be loading down (inhibiting) J1939 communications.

Cab-Mounted ECU Wire Harness Connector

Connector	Pin	J1939 Test
X1	7	J1939 Low
18-way	8	J1939 High



DTC: ECU

1st Blink Code Location

1st Blink Code	Location
13	ECU

2nd Blink Code Descriptions and Procedures

2nd Blink Code	Description	Procedure
2	ECU (10)	
3	ECU (11)	
4	ECU (12)	
5	ECU (13)	
6	ECU (14)	1. Check for corroded/damaged connectors.
7	ECU (15)	2. Check for damaged wiring.
8	ECU (16)	3. Clear DTCs.
9	ECU (17)	4. If DTCs return, replace ECU.
10	ECU (18)	
11	ECU (1A)	
12	ECU (1B)	
13	ECU (80)	

DTC: Miscellaneous

1st Blink Code Location

1st Blink Code	Location
12	Miscellaneous

2nd Blink Code Descriptions and Procedures

2nd Blink Code	Description	Procedure
1	<p>Stop Lamp Switch Not Detected (ECU has not detected the presence of the stop lamp switch since ignition power was applied)</p> <p>NOTE: The stop lamp switch input may be applied to the ECU using either hardware input of the J1939 serial connection.</p>	<ol style="list-style-type: none"> 1. Apply and release the service brake. 2. Check for brake switch input into ECU. 3. With service brake released, check for presence of the stop lamp bulb. 4. With service brake applied, verify system voltage is not present at the stop lamp switch input to the ECU. 5. Check for damaged wiring between ECU, stop lamp and bulb. 6. Check for corroded/damaged connectors. 7. Check for damaged or reversed J1939 wiring. 8. Check for corroded/damaged connectors on the J1939 link.
2	Stop Lamp Switch Defective	<ol style="list-style-type: none"> 9. Verify presence of engine ECU on the J1939 link. 10. Verify ECU configuration.
3	Dynamometer Test Mode	N/A: ECU has been placed in the Dynamometer Test Mode by either the diagnostic blink code switch or a hand-held or PC-based diagnostic tool; ATC is disabled.
4	Retarder Relay Open Circuit or Shorted to GRND	<ol style="list-style-type: none"> 1. Verify that vehicle is equipped with a retarder relay. 2. Verify ECU configuration. 3. Check wiring between ECU and retarder relay. 4. Verify no continuity between retarder disable output of ECU and GRND. 5. Verify condition and wiring of retarder relay.
5	Retarder Relay Circuit Shorted to Voltage	<ol style="list-style-type: none"> 1. Check wiring between ECU and retarder relay. 2. Verify no continuity between retarder disable output of ECU and voltage. 3. Verify condition and wiring of retarder relay.
6	ABS Indicator Lamp Circuit Fault	<ol style="list-style-type: none"> 1. Check operation of diagnostic blink code switch. 2. Check wiring of diagnostic blink code switch, ABS WL and ABS WL relay (frame-mounted ECUs only). 3. Verify ABS WL GRND input (cab-mounted ECUs only).

ABS/ATC SYSTEM

2nd Blink Code	Description	Procedure
7	PMV/TCV/DLS CMN Shorted to GRND	<ol style="list-style-type: none"> 1. Verify no continuity between CMN of all PMV, TCV and Differential Lock Solenoid (DLS) and GRND. 2. Check for corroded/damaged wiring and connectors between the ECU and the CMN of all PMV, TCV and DLS.
8	PMV/TCV/DLS CMN Shorted to Voltage	<ol style="list-style-type: none"> 1. Verify no continuity between CMN of all PMV, TCV and DLS and voltage. 2. Check for corroded/damaged wiring and connectors between the ECU and the CMN of all PMV, TCV and DLS.
9	ATC Disabled to Prevent Brake Fade	N/A: ATC is temporarily disabled to prevent excessive heating of the foundation brakes.
10	Tire Size Out of Range (front to rear)	<ol style="list-style-type: none"> 1. Verify correct tire size, as desired. 2. Verify proper tire inflation. 3. Verify correct number of exciter ring teeth. 4. Verify that ECU has the proper tire size settings.
11	WSS Reversed on an Axle (LH to RH sides)	Verify proper installation, connection and wiring of WSS.
12	DLS Shorted to GRND or Open Circuit	<ol style="list-style-type: none"> 1. Verify no continuity between DLS and GRND. 2. Check for corroded/damaged wiring and connectors between the ECU and DLS.
13	DLS Shorted to Voltage	<ol style="list-style-type: none"> 1. Verify no continuity between DLS and voltage. 2. Check for corroded/damaged wiring and connectors between the ECU and DLS.

Testing

- Take all measurements at ECU harness connector pins in order to check wire harness and sensor.
- Probe the connector carefully so that the terminals are not damaged.

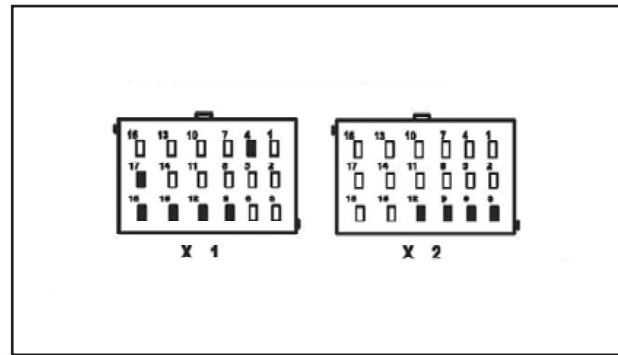
Component	Procedure
Stop Lamp Switch	<ol style="list-style-type: none"> 1. With the service brake applied, measure the system voltage stop lamp switch input to ECU: 9 to 17 VDC 2. Apply and release the service brake: Does the stop lamp extinguish? 3. Verify brake lamp switch is connected to ECU via hard wire or J1939 connection. 4. With service brake released, check for presence of stop lamp bulb.
Dynamometer Test Mode (ATC indicator continuously illuminated)	Press and release the blink code switch three times, or use an off-board diagnostic tool, to clear the dynamometer test mode.
ABS Indicator Lamp	Verify diagnostic blink code switch is open when not activated.

ABS/ATC SYSTEM

Component	Procedure
Retarder Relay	<ol style="list-style-type: none"> 1. Measure resistance between retarder disable output of ECU and voltage/GRND: Open Circuit (no continuity). 2. Verify vehicle has retarder relay. 3. Verify proper wiring from ECU to retarder relay.
PMV CMN	Measure resistance between any CMN (PMV, TCV and DLS) and voltage or GRND: Open Circuit (no continuity).
DLS	Measure resistance between DLS and voltage or GRND: Open Circuit (no continuity).

Cab-Mounted ECU Wire Harness Connector

Connector	Pin	PMV Location
X1 18-way	4	TCV CMN
	9	Stop Lamp Switch
	12	ABS WL GRND
	15	ABS WL Interlock
	17	Retarder
X2 18-way	18	ABS WL
	3	PMV LH Steering Axle CMN
	6	PMV RH Steering Axle CMN
	9	PMV RH Drive Axle CMN
	12	PMV LH Drive Axle CMN



ABS/ATC SYSTEM

Premium Cab Controller/ECU Connector Pin Assignments

Premium cab models utilize three AMP connectors for wire harness connections.

Connector Designation	Number of Contacts
X1	17
X2	18
X3	15

X1 Connector Pin Assignments

X1 Pin	Designation
1	GRND
2	Trailer ABS WL
3	Ignition
4	TCV CMN
5	TCV
6	ATC Lamp/ATC ORS
7	J1939 Low
8	J1939 High
9	SLS
10	WSS DA RH (+)
11	WSS DA RH (-)
12	ABS WL GRND
13	J1587 (B)
14	J1587 (A)
15	ABS WL Interlock
16	Battery
17	Retarder
18	ABS WL

X2 Connector Pin Assignments

X2 Pin	Designation
1	PMV SA LH HLD
2	PMV SA LH REL
3	PMV SA LH CMN
4	PMV SA RH HLD
5	WSS SA LH (+)
6	PMV SA RH CMN
7	PMV SA RH REL
8	WSS SA LH (-)
9	PMV DA RH CMN
10	PMV DA RH HLD
11	WSS SA RH (+)

X2 Pin	Designation
12	PMV DA LH CMN
13	PMV DA RH REL
14	WSS SA RH (-)
15	WSS DA LH (+)
16	PMV DA LH HLD
17	PMV DA LH REL
18	WSS DA LH (-)

Wiring

Cab-Mounted Controller/ECU Wiring Harness Connectors

Cab-mounted controllers/ECUs are designed to interface with AMP MCP 2.8 connectors. Follow all AMP requirements for the repair of wire harnesses.

All wire harness connectors must be properly seated. The use of secondary locks is strongly advised.

All unused ECU connectors must be covered and receive proper environmental protection.

Frame-Mounted Controller/ECU Wiring Harness Connectors

Frame-mount controllers/ECUs are designed to interface with Deutsch connectors.

The frame wire harness connectors must be properly seated with the seals intact (undamaged).

All unused connector terminals must be plugged with the appropriate sealing plugs. Failure to properly seat or seal the connectors could result in moisture or corrosion damage to the connector terminals. ECUs damaged by moisture and/or corrosion are not covered under OEM warranty.

Secondary locks must be snapped securely in place. Follow all Deutsch requirements for the repair of wire harnesses.

All unused connector terminals must be plugged with the appropriate sealing plugs.

Frame-Mounted ECU Connector Covers

Frame-mounted ECUs are provided with covers that must be removed to permit connection of the vehicle wiring harness.

The cover can be removed by sliding the slide lock mechanism to the unlock position.

The covers provide strain relief and connector protection of the vehicle wire harness and will accept round convoluted conduit with a 19 mm ID.

ABS Wiring Requirements

As a matter of good practice and to ensure maximum system robustness, always use the maximum size wire supported by the wire harness connectors for battery, ignition, GRND, PMV, TCV, Inter-axle Differential Lock and indicator lamp circuits.

All sensor and serial communications circuits (J1587 and J1939) must use twisted pair wiring with one to two twists every 1 in (2.5 cm).

See the applicable SAE document for additional details.

All wires must be carefully routed to avoid contact with rotating elements. Wiring must be properly secured approximately every 6 to 12 in (15.2 to 30.5 cm) using UV stabilized, non-metallic hose clamps or bow-tie cable ties to prevent pinching, binding or fraying.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend. Battery and ground wires should be kept to a minimum length.

If convoluted tubing is used, its ID must match the size of the wire bundle as closely as possible.

Wire harness lengths must be carefully selected for the vehicle. Harnesses that are too long increase the possibility of electrical interference and wire damage. Excess lengths of wire are not to be wound to form coils, instead re-route, repair or replace wire harness. Do not attempt to stretch harnesses that are too short, since mechanical strain can result in wire breakage.

WSS Wiring

Route sensor wiring coming out of the wheel ends away from moving brake components. Sensor wiring needs to be secured to the axle to prevent excess cable length and wiring damage. It is required that cable ties be installed to the sensor wire within 3 in (76.2 mm) of the sensor head to provide strain relief.

Following the axle, the sensor wires must be attached along the length of the service brake hoses using cable ties with ultraviolet protection and secured every 6 to 8 in (152 to 203 mm). Sufficient, but not excessive, cable length must be provided to permit full suspension travel and steering axle movement. Install wires so that they cannot touch rotating elements such as wheels, brake discs or drive shafts. Radiation protection may be necessary in the area of brake discs.

The controller/ECU OEM does not recommend using standard tie-wraps to secure wiring harnesses directly to rubber air lines. This may cause premature wiring failure from the pressure exerted on the wiring when air pressure is applied through the air line. Non-metallic hose clamps or bow-tie tie-wraps are preferred.

The use of grommets or other suitable protection is required whenever the cable must pass through metallic frame members.

All sensor wiring must utilize twisted pair wire, with approximately one to two twists per inch.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend.

ABS/ATC SYSTEM

J1587 Blink Code Cross-Reference

J1587			Blink Code Equivalent		
SID	FMI	Location	1st Digit	2nd Digit	DTC Description
1	1	Wheel Speed Sensor	2	1	SA LH WSS Excessive Air Gap
1	2	Wheel Speed Sensor	2	3	SA LH WSS Open or Shorted
1	7	Wheel Speed Sensor	2	5	SA LH WSS Wheel End
1	8	Wheel Speed Sensor	2	6	SA LH WSS Erratic WSS Signal
1	10	Wheel Speed Sensor	2	4	SA LH WSS Loss of WSS Signal
1	13	Wheel Speed Sensor	2	7	SA LH WSS Tire Size Calibration
1	14	Wheel Speed Sensor	2	2	SA LH WSS Output Low at Drive Off
2	1	Wheel Speed Sensor	3	1	SA RH WSS Excessive Air Gap
2	2	Wheel Speed Sensor	3	3	SA RH WSS Open or Shorted
2	7	Wheel Speed Sensor	3	5	SA RH WSS Wheel End
2	8	Wheel Speed Sensor	3	6	SA RH WSS Erratic WSS Signal
2	10	Wheel Speed Sensor	3	4	SA RH WSS Loss of WSS Signal
2	13	Wheel Speed Sensor	3	7	SA RH WSS Tire Size Calibration
2	14	Wheel Speed Sensor	3	2	SA RH WSS Output Low at Drive Off
3	1	Wheel Speed Sensor	4	1	DA LH WSS Excessive Air Gap
3	2	Wheel Speed Sensor	4	3	DA LH WSS Open or Shorted
3	7	Wheel Speed Sensor	4	5	DA LH WSS Wheel End
3	8	Wheel Speed Sensor	4	6	DA LH WSS Erratic WSS Signal
3	10	Wheel Speed Sensor	4	4	DA LH WSS Loss of WSS Signal
3	13	Wheel Speed Sensor	4	7	DA LH WSS Tire Size Calibration
3	14	Wheel Speed Sensor	4	2	DA LH WSS Output Low at Drive Off
4	1	Wheel Speed Sensor	5	1	DA RH WSS Excessive Air Gap
4	2	Wheel Speed Sensor	5	3	DA RH WSS Open or Shorted
4	7	Wheel Speed Sensor	5	5	DA RH WSS Wheel End
4	8	Wheel Speed Sensor	5	6	DA RH WSS Erratic WSS Signal
4	10	Wheel Speed Sensor	5	4	DA RH WSS Loss of WSS Signal
4	13	Wheel Speed Sensor	5	7	DA RH WSS Tire Size Calibration
4	14	Wheel Speed Sensor	5	2	DA RH WSS Output Low at Drive Off
5	1	Wheel Speed Sensor	14	1	AA LH WSS Excessive Air Gap
5	2	Wheel Speed Sensor	14	3	AA LH WSS Open or Shorted
5	7	Wheel Speed Sensor	14	5	AA LH WSS Wheel End
5	8	Wheel Speed Sensor	14	6	AA LH WSS Erratic WSS Signal
5	10	Wheel Speed Sensor	14	4	AA LH WSS Loss of WSS Signal
5	13	Wheel Speed Sensor	14	7	AA LH WSS Tire Size Calibration
5	13	Wheel Speed Sensor	14	8	AA LH WSS Configuration Error
5	14	Wheel Speed Sensor	14	2	AA LH WSS Output Low at Drive Off
6	1	Wheel Speed Sensor	15	1	AA RH WSS Excessive Air Gap
6	2	Wheel Speed Sensor	15	3	AA RH WSS Open or Shorted

ABS/ATC SYSTEM

J1587			Blink Code Equivalent		
SID	FMI	Location	1st Digit	2nd Digit	DTC Description
6	7	Wheel Speed Sensor	15	5	AA RH WSS Wheel End
6	8	Wheel Speed Sensor	15	6	AA RH WSS Erratic WSS Signal
6	10	Wheel Speed Sensor	15	4	AA RH WSS Loss of WSS Signal
6	13	Wheel Speed Sensor	15	7	AA RH WSS Tire Size Calibration
6	13	Wheel Speed Sensor	15	8	AA RH WSS Configuration Error
6	14	Wheel Speed Sensor	15	2	AA RH WSS Output Low at Drive Off
7	5	Pressure Modulator Valve	7	7	SA LH PMV CMN Open Circuit
7	13	Pressure Modulator Valve	7	8	SA LH PMV Configuration Error
8	5	Pressure Modulator Valve	8	7	SA RH PMV CMN Open Circuit
8	13	Pressure Modulator Valve	8	8	SA RH PMV Configuration Error
9	5	Pressure Modulator Valve	9	7	DA LH PMV CMN Open Circuit
9	13	Pressure Modulator Valve	9	8	DA LH PMV Configuration Error
10	5	Pressure Modulator Valve	10	7	DA RH PMV CMN Open Circuit
10	13	Pressure Modulator Valve	10	8	DA RH PMV Configuration Error
11	5	Pressure Modulator Valve	16	7	AA LH PMV CMN Open Circuit
11	13	Pressure Modulator Valve	16	8	AA LH PMV Configuration Error
12	5	Pressure Modulator Valve	17	7	AA RH PMV CMN Open Circuit
12	13	Pressure Modulator Valve	17	8	AA RH PMV Configuration Error
13	2	Miscellaneous	12	4	Retarder Relay Open Circuit or Shorted to GRND
13	3	Miscellaneous	12	5	Retarder Relay Circuit Shorted to Voltage
17	14	Miscellaneous	12	3	Dynamometer Test Mode
17	14	Miscellaneous	12	9	ATC Disabled to Prevent Brake Fade
18	13	TCV	18	4	TCV Configuration Error
18	3	TCV	18	2	TCV Solenoid Shorted to Voltage
18	4	TCV	18	1	TCV Solenoid Shorted to GRND
18	5	TCV	18	3	TCV Solenoid Open Circuit
22	7	Miscellaneous	12	11	WSS Reversed on an Axle
23	2	Miscellaneous	12	6	ABS Indicator Lamp Circuit Fault
42	3	Pressure Modulator Valve	7	5	SA LH PMV Hold Solenoid Shorted to Voltage
42	4	Pressure Modulator Valve	7	4	SA LH PMV Hold Solenoid Shorted to GRND
42	5	Pressure Modulator Valve	7	6	SA LH PMV Hold Solenoid Open Circuit
43	3	Pressure Modulator Valve	8	5	SA RH PMV Hold Solenoid Shorted to Voltage
43	4	Pressure Modulator Valve	8	4	SA RH PMV Hold Solenoid Shorted to GRND
43	5	Pressure Modulator Valve	8	6	SA RH PMV Hold Solenoid Open Circuit
44	3	Pressure Modulator Valve	9	5	DA LH PMV Hold Solenoid Shorted to Voltage
44	4	Pressure Modulator Valve	9	4	DA LH PMV Hold Solenoid Shorted to GRND
44	5	Pressure Modulator Valve	9	6	DA LH PMV Hold Solenoid Open Circuit
45	3	Pressure Modulator Valve	10	5	DA RH PMV Hold Solenoid Shorted to Voltage
45	4	Pressure Modulator Valve	10	4	DA RH PMV Hold Solenoid Shorted to GRND

ABS/ATC SYSTEM

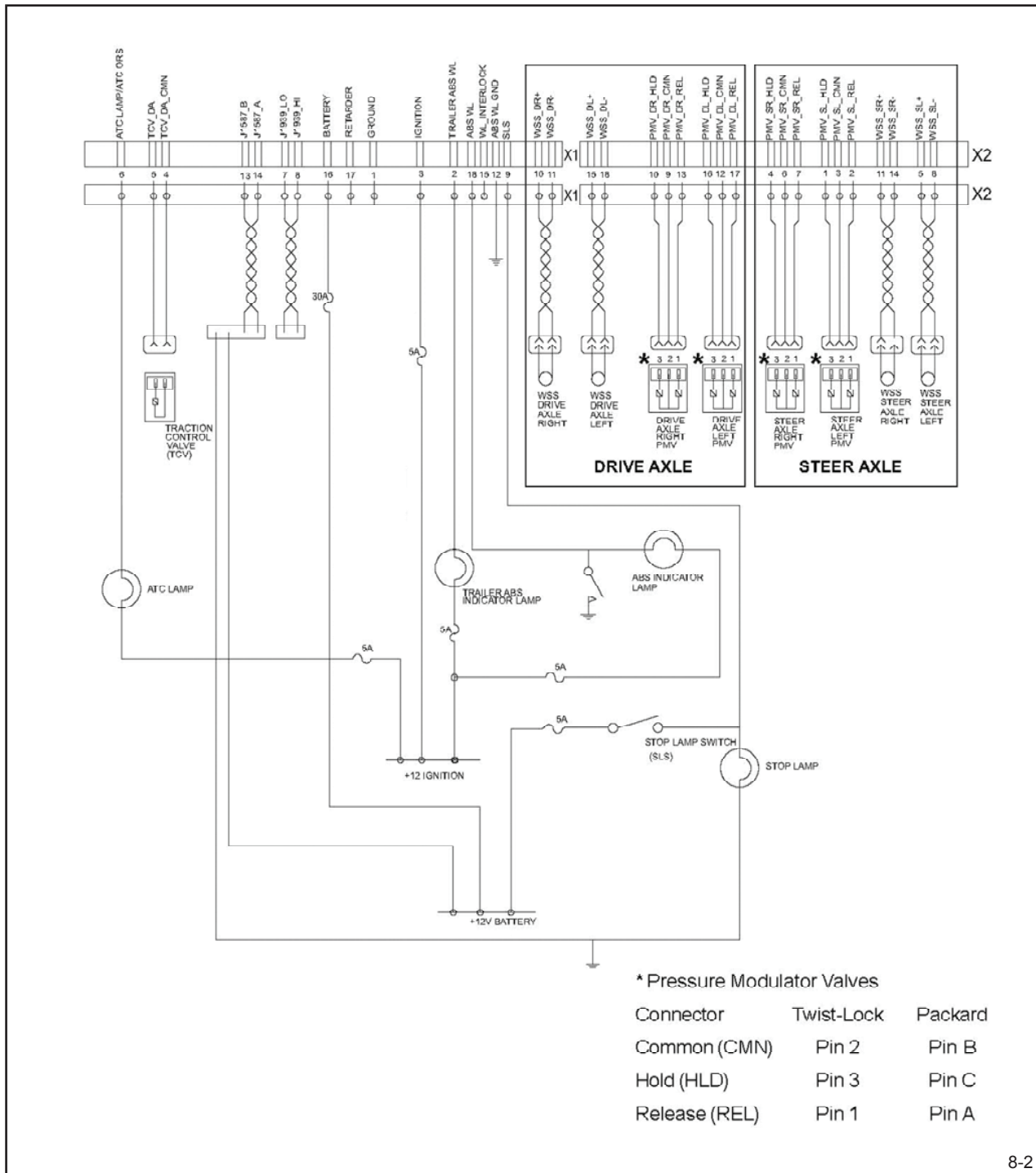
J1587			Blink Code Equivalent		
SID	FMI	Location	1st Digit	2nd Digit	DTC Description
45	5	Pressure Modulator Valve	10	6	DA RH PMV Hold Solenoid Open Circuit
46	3	Pressure Modulator Valve	16	5	AA LH PMV Hold Solenoid Shorted to Voltage
46	4	Pressure Modulator Valve	16	4	AA LH PMV Hold Solenoid Shorted to GRND
46	5	Pressure Modulator Valve	16	6	AA LH PMV Hold Solenoid Open Circuit
47	3	Pressure Modulator Valve	17	5	AA RH PMV Hold Solenoid Shorted to Voltage
47	4	Pressure Modulator Valve	17	4	AA RH PMV Hold Solenoid Shorted to GRND
47	5	Pressure Modulator Valve	17	6	AA RH PMV Hold Solenoid Open Circuit
48	3	Pressure Modulator Valve	7	2	SA LH PMV Release Solenoid Shorted to Voltage
48	4	Pressure Modulator Valve	7	1	SA LH PMV Release Solenoid Shorted to GRND
48	5	Pressure Modulator Valve	7	3	SA LH PMV Release Solenoid Open Circuit
49	3	Pressure Modulator Valve	8	2	SA RH PMV Release Solenoid Shorted to Voltage
49	4	Pressure Modulator Valve	8	1	SA RH PMV Release Solenoid Shorted to GRND
49	5	Pressure Modulator Valve	8	3	SA RH PMV Release Solenoid Open Circuit
50	3	Pressure Modulator Valve	9	2	DA LH PMV Release Solenoid Shorted to Voltage
50	4	Pressure Modulator Valve	9	1	DA LH PMV Release Solenoid Shorted to GRND
50	5	Pressure Modulator Valve	9	3	DA LH PMV Release Solenoid Open Circuit
51	3	Pressure Modulator Valve	10	2	DA RH PMV Release Solenoid Shorted to Voltage
51	4	Pressure Modulator Valve	10	1	DA RH PMV Release Solenoid Shorted to GRND
51	5	Pressure Modulator Valve	10	3	DA RH PMV Release Solenoid Open Circuit
52	3	Pressure Modulator Valve	16	2	AA LH PMV Release Solenoid Shorted to Voltage
52	4	Pressure Modulator Valve	16	1	AA LH PMV Release Solenoid Shorted to GRND
52	5	Pressure Modulator Valve	16	3	AA LH PMV Release Solenoid Open Circuit
53	3	Pressure Modulator Valve	17	2	AA RH PMV Release Solenoid Shorted to Voltage
53	4	Pressure Modulator Valve	17	1	AA RH PMV Release Solenoid Shorted to GRND
53	5	Pressure Modulator Valve	17	3	AA RH PMV Release Solenoid Open Circuit
55	2	Miscellaneous	12	2	Stop Lamp Switch Defective
55	7	Miscellaneous	12	1	Stop Lamp Switch Not Detected
79	13	Miscellaneous	12	10	Tire Size Out of Range (front to rear)
93	4	Miscellaneous	12	8	PMV/TCV/DLS CMN Shorted to Voltage
93	4	Miscellaneous	12	7	PMV/TCV/DLS CMN Shorted to GRND
102	3	Miscellaneous	12	13	DLS Shorted to Voltage
102	5	Miscellaneous	12	12	DLS Shorted to GRND or Open Circuit
231	2	J1939	11	3	J1939 Engine Communications
231	12	J1939	11	1	J1939 Serial Link
231	14	J1939	11	2	J1939 Retarder
251	2	Power Supply	6	8	Input Voltage Has Excessive Noise (temporarily)
251	3	Power Supply	6	2	Battery Voltage Too High
251	3	Power Supply	6	6	Ignition Voltage Too High
251	4	Power Supply	6	1	Battery Voltage Too Low

ABS/ATC SYSTEM

J1587			Blink Code Equivalent		
SID	FMI	Location	1st Digit	2nd Digit	DTC Description
251	4	Power Supply	6	3	Battery Voltage Too Low During ABS
251	4	Power Supply	6	5	Ignition Voltage Too Low
251	4	Power Supply	6	7	Ignition Voltage Too Low During ABS
251	5	Power Supply	6	4	Battery Voltage Open Circuit
251	14	Power Supply	6	9	Input Voltage Has Excessive Noise
254	2	ECU	13	4	ECU (12)
254	2	ECU	13	5	ECU (13)
254	12	ECU	13	2	ECU (10)
254	12	ECU	13	3	ECU (11)
254	12	ECU	13	6	ECU (14)
254	12	ECU	13	7	ECU (15)
254	12	ECU	13	10	ECU (18)
254	12	ECU	13	11	ECU (1A)
254	12	ECU	13	12	ECU (1B)
254	12	ECU	13	13	ECU (80)
254	13	ECU	13	8	ECU (16)
254	14	ECU	13	9	ECU (17)

ABS/ATC SYSTEM

ABS/ATC SYSTEM SCHEMATIC



8-2

FRONT SUSPENSION AND STEERING

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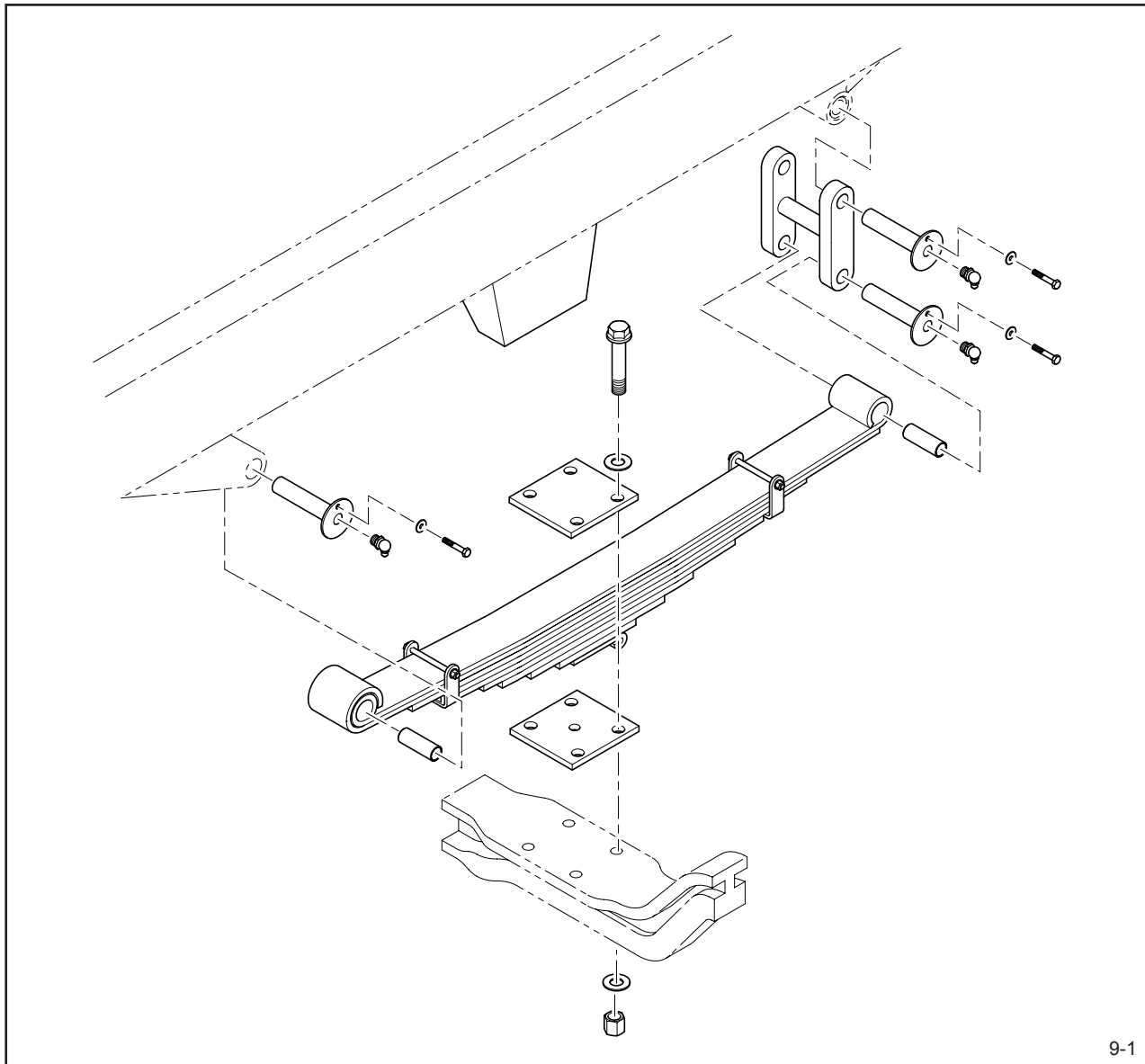
FRONT SUSPENSION AND STEERING

COMPONENTS AND THEORY OF OPERATION

Suspension System

The front suspension system consists of the following major components (see figure 9-1):

- Two multi-leaf, semi-elliptical springs
- Rubber bumpers
- Shackles
- Shock absorbers
- Related hardware



9-1

FRONT SUSPENSION AND STEERING

Steering System

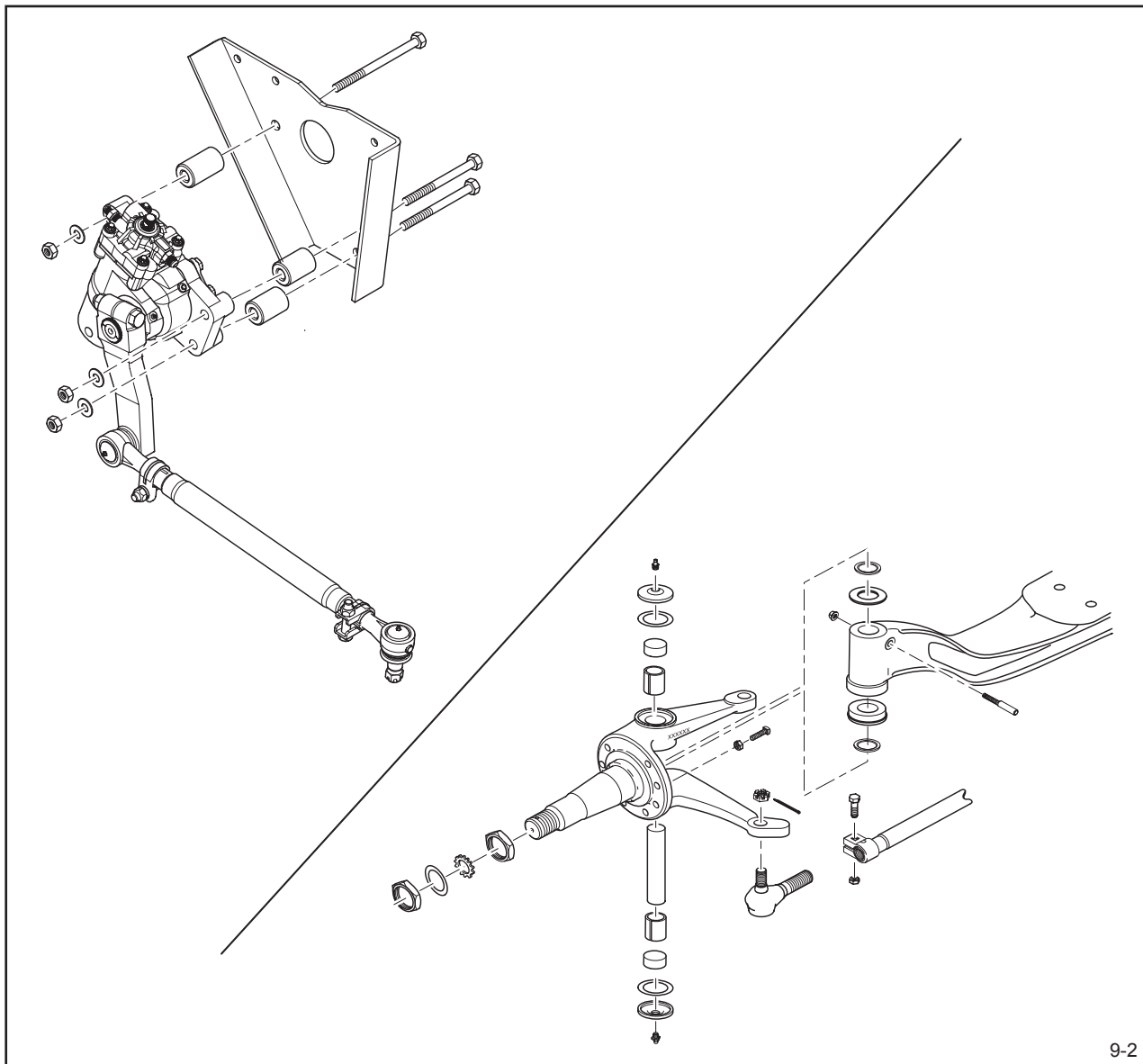
The steering system consists of the following major components (see figure 9-2):

- Steering wheel
- Torsion bar
- Power steering gearbox
- Power steering reservoir
- Steering knuckles
- Kingpins
- Tie rods

When the driver turns the steering wheel, force is transmitted from the steering wheel to the steering gear input shaft. A torsion bar, pinned at one

end to the input shaft and at its other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force, the worm shaft, acting through the recirculating ball mechanism, tries to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.



FRONT SUSPENSION AND STEERING

5. Place a jack under the end of the axle with the spring that is to be serviced.
6. Remove the locknuts (20) and the bolts (11) that secure the spring (13) to the axle.
7. Lower the axle away from the spring.
8. Remove the bolts (8) and the lock washers (9) that secure the front spring pin (7), and drive out the front spring pin to release the spring (13) and the bushing (6).
9. Remove the bolts (8) and the lock washers (9) that secure the rear shackle pins (7), and drive out the shackle pins to release the spring (13), the shackles (3) and the bushing (6).
10. Remove the bumper bolts (5) and washers (4), and remove the bumpers (2).

Inspection

- Check the spring (13) for cracked or broken leaves.
- Check the end bushings (6) for deterioration.

Installation

Reverse the order of the Removal procedures on page 9-3.

STEERING SYSTEM

Front End Alignment

Alignment is the proper positioning or state of adjustment of parts in relation to each other.

Proper alignment of front wheels must be maintained to ensure efficient steering and satisfactory tire life. The most important factors of front end alignment are wheel toe-in, wheel camber, and axle caster. King-pin inclination is designed into the axle end. Front end alignment should be checked at regular intervals, and particularly after the front axle has been subjected to heavy impacts such as a collision.

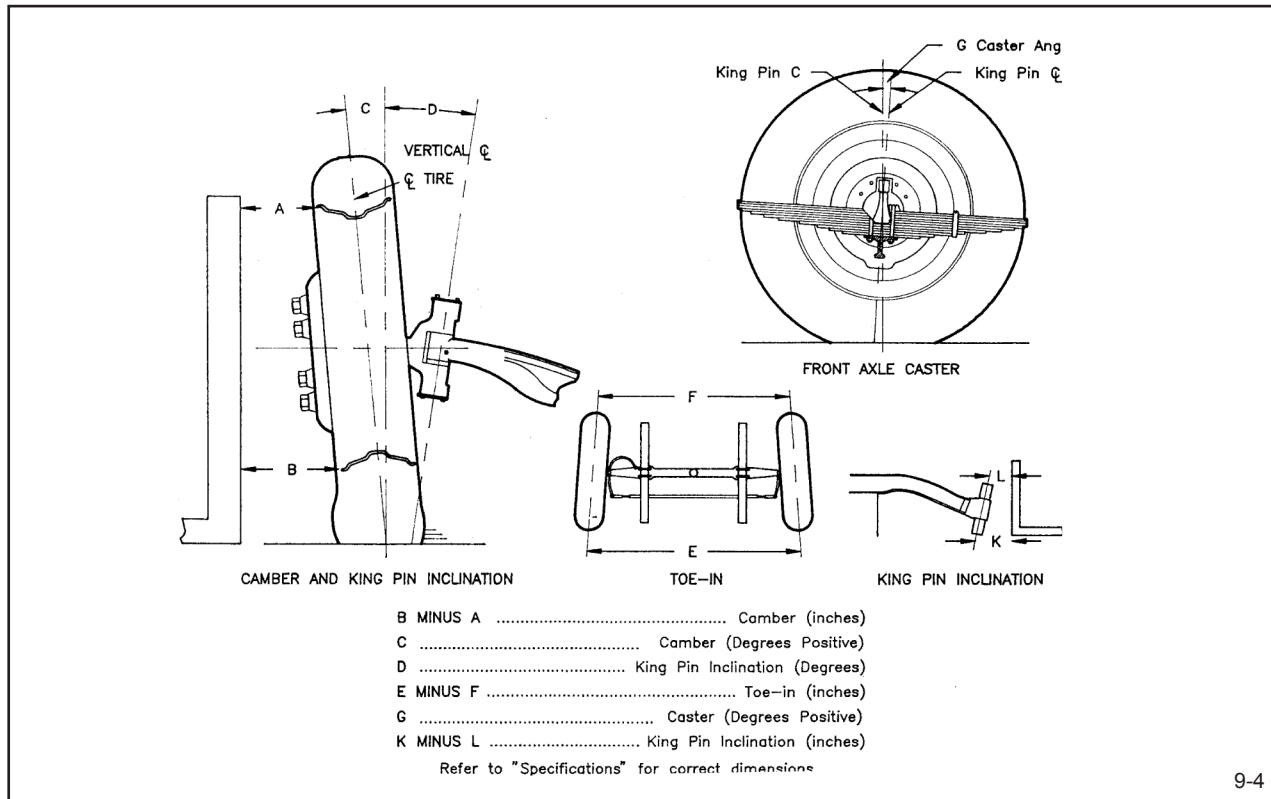
Before checking alignment, ensure that front wheel bearings are properly adjusted. The wheel bearings will affect the instrument readings when checking the wheel toe-in, wheel camber, and axle caster.

When checking the alignment, the instructions outlined in this section should be followed carefully, as well as instructions covering related units such as brakes, and wheels and tires, which are given in other sections of this manual.

See figure 9-4 on page 9-5 as reference for the points at which the alignment dimensions are taken.

FRONT SUSPENSION AND STEERING

Terminology



Toe:

The distance between the front wheels is different at the front of the wheels than at the rear of the wheels.

- Toe-in is when the distance is less at the front of the wheels.
- Toe-out is when the distance is greater at the front of the wheels.

Incorrect toe results in excessive tire wear due to slide slippage and unstable steering with a tendency to wander. Toe may be measured from the center of the tire treads or from the inside of the tires. Measure at both the front and rear of the axle.

NOTE: The toe-in measurements must be made at the horizontal axis of the wheel.

Camber:

The amount in degrees that the top of the front wheels are tilted from a vertical position.

- Positive camber is when the top of the wheel is tilted outwards.
- Negative (or Reverse) camber is when the top of the wheel is tilted inwards.

Camber offsets wheel deflection, due to wear of front axle parts, and positive camber prevents a

reverse or negative camber condition under load.

If camber is not equal between the front wheels, improper steering and excessive tire wear can result.

Caster:

Caster is the forward or reverse tilt (toward the front or rear of vehicle) of the steering kingpin as viewed from the side of the vehicle.

- Positive caster is the tilt of the kingpin towards the rear of the vehicle.
A caster angle more positive than specified may result in excessive steering effort and/or shimmy.
- Negative caster is the tilt of the kingpin towards the front of the vehicle.

A caster angle less positive may result in vehicle wander or poor steering return to center.

Caster angle is determined by the installed position of the steering axle, and is adjusted by adding or removing taper wedges between the springs and axle beam mounting pad.

The caster angle is generally more positive with power steering, since the power-assist overcomes

FRONT SUSPENSION AND STEERING

excessive steering effort. This enables the vehicle to exhibit maximum straight ahead steering stability (common range for power steering units is and additional 1 to 2 degrees).

King Pin Inclination:

King pin inclination is designed into the axle end and is the amount that the top of the king pin is inclined toward the center of vehicle.

King pins are inclined to assist front return to center after a turn is executed.

Frame Angle:

Frame angle is the degrees of tilt in the frame from the level position.

The caster, camber, and toe dimensions apply to the vehicle when at design load (with frame level). If the frame is not level on alignment equipment, the frame angle must be considered. This is especially important when making the caster angle check and adjustment to obtain an accurate setting.

Specifications

Adjustment	Specification
Camber (truck on ground)	<ul style="list-style-type: none"> • Positive • 15 degrees or 1/4 in (6.35 mm) or less • 3/32 in (2.38 mm) or less difference between wheels
King pin inclination (included angle of steering knuckle)	<ul style="list-style-type: none"> • Negative • 30 degrees or 1/2 in (12.70 mm)
Toe (applies to unloaded trucks; a truck without a trailer or a straight truck with no load)	1/16 in (1.59 mm)
Turning angle (clearance between tire and any chassis component)	5/8 in (15.88 mm) or greater
Wheel runout (both lateral and radial)	3/32 in (2.38 mm) or less

Inspection

WARNING

Front end alignment fasteners are important in that they could affect the performance of vital parts and systems, and/or could result in major repair expense. Replace each fastener with the same part number or with an equivalent part if the part number is not available. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of all parts.

Before making any front end alignment checks, perform the following procedures:

1. Check the tires for proper inflation pressure.

NOTE: *The rim-to-floor distance needs to be the same at each wheel.*
2. Check for proper wheel installation.
3. Check wheel runout; refer to procedure on page 9-6.
4. Check the steering tie rod and drag link ends for tightness.
5. Check king pin condition and wheel bearing adjustment; refer to procedure on page 9-7.

Wheel Runout Check

1. Raise and support the axle at the side to be checked.
2. Make a tool for checking runout:
 - a. Obtain a 6x6x14 in block of wood or material with a suitable base so it will remain in a vertical position.
 - b. Obtain a thin piece of 10 in (25.4 cm) long wood or a suitable material (ruler or yardstick), and fasten the thin piece of wood to the block in a horizontal position, at a height relative to the rim surface.
 - c. Tighten the screw so the pointer will hold its position when adjusted.
3. Position the pointer at the crown of the rim.
4. Slowly turn the wheel and move the pointer until it touches the wheel at the nearest point.
5. Continue to turn the wheel and measure the amount of lateral runout (the amount of wheel side wobble).
6. Place the point of the marker at the inside of the wheel.

FRONT SUSPENSION AND STEERING

7. Slowly turn the wheel and move the pointer until it touches the wheel at the nearest point.
 8. Continue to turn the wheel and measure the radial runout (out of round condition).
 9. Compare the two measurements to the specification of 3/32 in (2.38 mm) or less.
 - If either measurement is outside this specification, proceed with step 10 to determine whether the wheel or the hub is the cause.
 - If both measurements are within this specification, no further action is necessary.
 10. Replace the existing wheel with a known true wheel, and repeat steps 3 through 8.
 11. Compare the two measurements to the specification of 3/32 in (2.38 mm) or less.
 - If either measurement is outside this specification, replace the damaged hub.
 - If both measurements are within this specification, replace the damaged wheel.
2. Chock the rear wheels.
 3. Place a 5 in (127 mm) long piece of masking tape parallel to the center tread rib at the rear of both tires, half way up the tire height.
 4. Position a trammel bar behind the front tires.
 5. Position the pointers so they are at the hub's center line height.
 6. Place the pointers at the outside edges of the masking tape and secure the pointer set screws.
 7. Mark the location of one of the pointers with a horizontal mark on the masking tape.
 8. Remove the trammel bars from behind the wheels.
 9. Roll the truck forward until the mark on the tape travels 180 degrees of wheel rotation.
 10. Position the trammel bar at the front of the tires, to the edge of the tape on the side that has the horizontal mark so that the pointer and the mark are at the same height.
 11. Measure the toe between the pointer and the edge of the tape on the opposite tire to obtain the total toe measurement.

King Pin and Wheel Bearing Check

1. Raise the front of the vehicle.
2. Pull the bottom of the wheel outward and measure the camber.
3. Pull the top of the wheel outward and measure the camber.
4. Compare the two measurements to the specification of 15 degrees or 1/4 in (6.35 mm) or less:
 - If either measurement is outside this specification, proceed with step 5.
 - If both measurements are within this specification, no further action is necessary.
5. Adjust the wheel bearings, and repeat steps 2 and 3.
6. Compare the two measurements to the specification of 15 degrees or 1/4 in (6.35 mm) or less:
 - If either measurement is outside this specification, replace the steering knuckle/king pin bushings and, if necessary, the king pins.
 - If both measurements are within this specification, no further action is necessary.

Toe Adjustment

1. Park the vehicle on a flat, level surface slowly

- and with the wheels pointed straight ahead; try to roll to a stop without the use of brakes.
2. Chock the rear wheels.
 3. Place a 5 in (127 mm) long piece of masking tape parallel to the center tread rib at the rear of both tires, half way up the tire height.
 4. Position a trammel bar behind the front tires.
 5. Position the pointers so they are at the hub's center line height.
 6. Place the pointers at the outside edges of the masking tape and secure the pointer set screws.
 7. Mark the location of one of the pointers with a horizontal mark on the masking tape.
 8. Remove the trammel bars from behind the wheels.
 9. Roll the truck forward until the mark on the tape travels 180 degrees of wheel rotation.
 10. Position the trammel bar at the front of the tires, to the edge of the tape on the side that has the horizontal mark so that the pointer and the mark are at the same height.
 11. Measure the toe between the pointer and the edge of the tape on the opposite tire to obtain the total toe measurement.
- NOTE:** Toe-in specification is 1/16 in (1.59 mm) for unloaded trucks. This applies to a truck without a trailer or straight truck with no load.
12. If the toe measurement is not at the specification, loosen the tube clamp and bolt on the end of each of the cross tubes, and turn the cross tubes until the specification is obtained.
 13. Make sure the threaded portion of the tie ends are inserted completely and are visible in the complete cross tube slot.
 14. Tighten the bolt and nut on the ends of the cross tube to the specified torque.
 15. Confirm toe measurement.

Camber Check

NOTE: Camber variations can be caused by wear at wheel bearings and steering knuckle/king pin bushings, or by a bent steering knuckle or axle. Ensure that the Inspection procedures on page 9-6 are performed prior to performing a camber check.

1. Place the vehicle on a flat, level surface with the normal weight of the vehicle on the wheels.

FRONT SUSPENSION AND STEERING

2. Measure camber; if a camber gauge is not available, refer to the figure on page 9-5, and measure the A and B dimensions on both front wheels.
3. Compare the measurements to the specifications of positive camber (B should be greater than A), and the camber measurement (B minus A) should be $\frac{3}{32}$ in (2.38 mm) or less between the right and the left wheels:
 - If any measurement is outside these specifications, proceed with step 4 to determine whether the steering knuckle or the axle center is bent.
 - If all measurements are within these specifications, no further action is necessary.
4. Measure the king pin inclination.

NOTE: *Camber plug king pin inclination is the included angle of the steering knuckle.*

5. Compare the measurement to the specification of 30 degrees or $\frac{1}{2}$ in (12.70 mm) or less
 - If the measurement is outside this specification, replace the bent steering knuckle.
 - If the measurement is within this specification, replace the bent axle.

Caster Adjustment

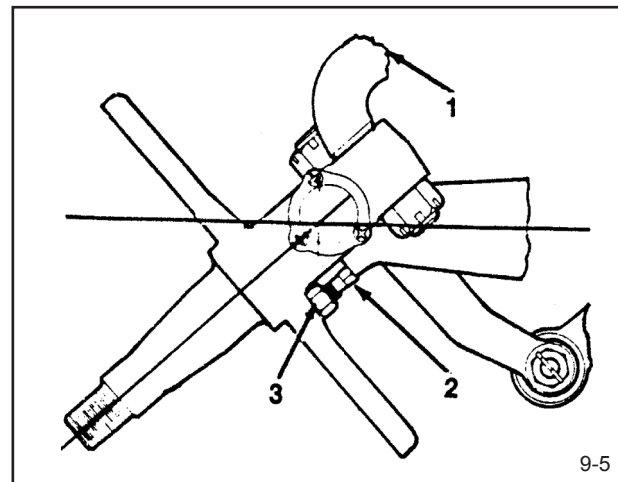
Caster dimensions are for a vehicle carrying its design load. Design load is the load equal to the capacity of the vehicle's suspension, whereby the frame in most cases would be level. If an alignment check is to be made with the frame not level, the frame angle must be determined and added to the caster angle to obtain a true caster reading. To determine frame angle proceed as follows:

1. Park the vehicle on a flat, level surface.
2. Using a bubble protractor or inclinometer, measure the frame angle.
3. Determine whether the frame angle is up in rear or down in rear.
4. Determine the caster angle for the left wheel not.
5. To determine an actual (corrected) caster reading with various frame angles and caster readings, one of the following rules applies:
A Down-In-Rear frame angle is:
 - SUBTRACTED from a POSITIVE caster reading
 - ADDED to a NEGATIVE caster readingAn Up-In-Rear frame angle is:
 - ADDED to a POSITIVE caster reading
 - SUBTRACTED from a NEGATIVE caster reading

6. Repeat steps 2 through 5 for the right wheel.
7. If the caster is not within specifications, install the appropriate caster shims between the axle and the spring.

Turning Angle (Stop Screw) Adjustment

Turning angle, or toe-out on turns, is determined by the angle of the steering arms (1). Regardless of maximum turning angles, a minimum of $\frac{5}{8}$ in (15.88 mm) clearance between the tire and any chassis component must be maintained. See figure 9-5.



- If front wheel stop screw adjustments are made, steering gear poppet valve adjustment must be performed.
 - When installing oversized tires, check the turning angle and perform the Turning Angle Adjustment if necessary.
1. Loosen the jam nut (2).
 2. Turn in the RH steering arm stop screw (3).
 3. Turn the wheels to the right to the position where a $\frac{5}{8}$ in (15.88 mm) clearance exists between the tire and any chassis component.
 4. Turn out the stop screw until it contacts firmly against its stop.
 5. Check the position of the tire, and adjust the stop screw as necessary if the tire has less than a $\frac{5}{8}$ in (15.88 mm) clearance between the tire and any chassis component.

FRONT SUSPENSION AND STEERING

6. Tighten the jam nut.
7. Repeat steps 1 through 6 on the LH side of the truck, adjusting the LH steering arm stop screw and turning the wheels to the left.

Maintenance

General Maintenance

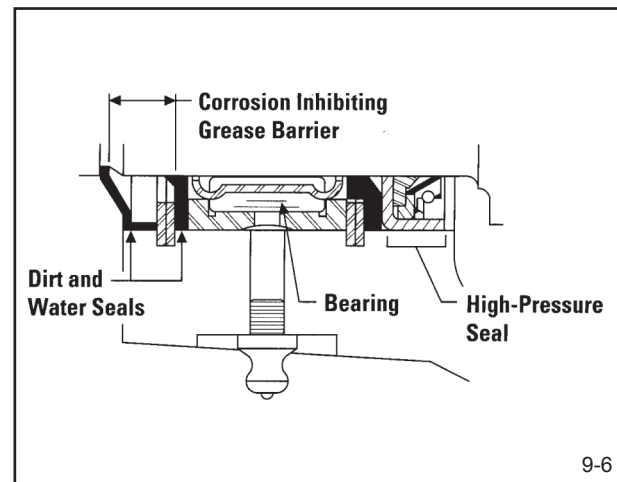
- Maintain the proper level of fluid in the reservoir.

⚠ WARNING

Fill and flush the power steering system with the specified fluid only; do not mix fluids. Any mixture or unapproved fluid could lead to seal deterioration and leaks, which could result in a loss of power steering and cause death or serious injury.

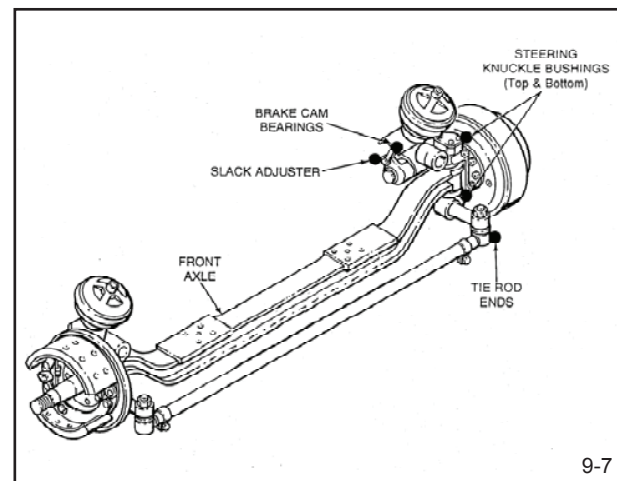
- Check all hoses and fittings for sign of leakage.
- Never high-pressure wash or steam clean a power steering gear while on or off the vehicle. Doing so could force contaminants inside the gear and cause it to malfunction.
- Make sure vehicle wheel cut or clearances meet manufacturer's specifications, and make sure the pitman arm timing marks are aligned properly to prevent internal bottoming of the steering gear.
- Keep tires inflated to the correct pressure.
- Never use a torch to remove the pitman arm.
- Investigate and immediately correct the cause of any play, rattle, or shimmy in any part of the steering system.
- Make sure the steering column is aligned properly.
- Encourage drivers to report any malfunctions or accidents that could have damaged steering components.
- Do not attempt to weld any broken steering component. Replace the component with original equipment only.
- Do not cold straighten, hot straighten, or bend any steering system component.
- Always clean off around the reservoir filler cap before removing the cap to prevent dirt or other foreign matter from entering the power steering system.
- Investigate and correct any external leaks, no matter how minor.

- Replace reservoir filters according to requirements.
- If you feel the vehicle is developing excessively high hydraulic fluid temperatures, determine the cause immediately.
- Maintain a grease pack behind the dirt and water seals of the output shaft as a general maintenance procedure at least twice a year, in the Spring and the Fall. The grease fitting is located in the housing trunnion. Use only NLGI Grade 2 or 3 multipurpose chassis lube, and use only a hand operated grease gun to add grease through the fitting. Add grease until the grease begins to extrude past the dirt and water seals of the sector shaft. See figure 9-6.



General Lubrication

General lubrication is provided by the automatic lubrication system. Check for proper lubrication by turning the front wheels to the right and then the left, inspecting the lubrication points on either side of the axle. See figure 9-7.



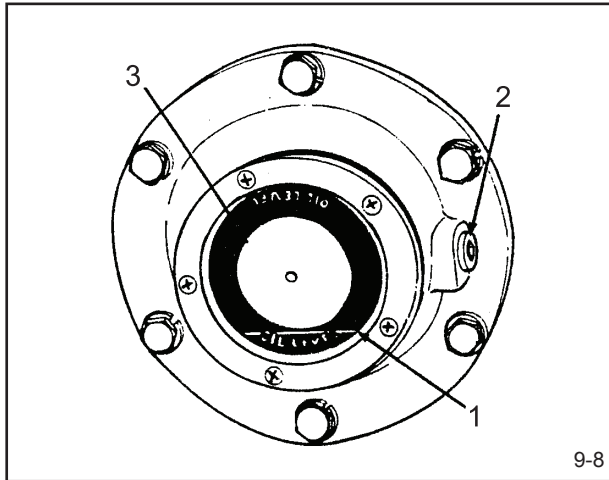
FRONT SUSPENSION AND STEERING

Refer to Lubricant, Fluid and Fuel Types and Capacities on page 2-6 for the specified lubricant. If the vehicle is subject to a heavy work schedule under extreme, dusty conditions, more frequent lubrication may be necessary.

Wheel Bearing Lubrication (Oil-Lubricated)

NOTE: Hub caps on systems with oil-lubricated wheel bearings can be removed in the same manner as conventional hub caps. However, care must be taken to correctly install the gasket on oil-lubricated systems or oil leakage can occur. Tighten the hub cap bolts in a crisscross pattern to 24 lb-ft (32.5 N•m) torque.

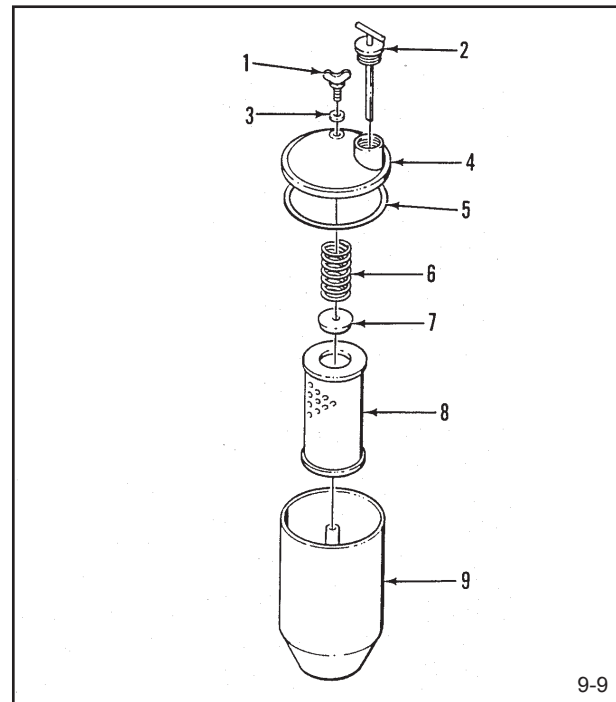
1. Park the vehicle on a flat, level surface.
2. Check the oil level, as indicated by the oil level mark (1) on the hub. See figure 9-8.



3. If the oil level is below the oil level mark, remove the filler plug (2) or the window plug (3), and add oil until the oil level is no higher than 1/4 in (6.35 mm) above the oil level mark.
4. Reinstall the filler plug or the window plug.

Changing the Power Steering System Filter

1. Remove the wing nut (1) and the wing nut gasket (3). See figure 9-9.



2. Remove the reservoir cover (4) and the cover gasket (5).
3. Remove the spring (6) and the filter cap (7), and remove the filter element (8) from the reservoir (9).
4. Position the new filter element in the reservoir, and reinstall the filter cap and the spring.
5. Reinstall the cover gasket, the reservoir cover, wing nut gasket and the wing nut.

NOTE: Do not mix power steering fluids or seal damage can result.

6. Fill the reservoir to the FULL mark on the dipstick (2) with the fluid specified in Lubricant, Fluid and Fuel Types and Capacities on page 2-6.

Filling and Bleeding the Power Steering System

NOTE: Do not turn the wheels during any of these procedures unless instructed to do so.

1. Ensure that the gearbox poppets are adjusted correctly.
2. Add fluid to the reservoir until the reservoir is nearly full.
3. Start up the engine and allow the engine to idle for 10 seconds.

NOTE: Add fluid to the reservoir as needed to ensure that the fluid level does decrease significantly, or that the reservoir is emptied.

FRONT SUSPENSION AND STEERING

4. Shut down the engine, and add fluid to the reservoir as necessary.
5. Repeat steps 3 through 4 three times.
6. Start up the engine and allow the engine to idle for 2 minutes.

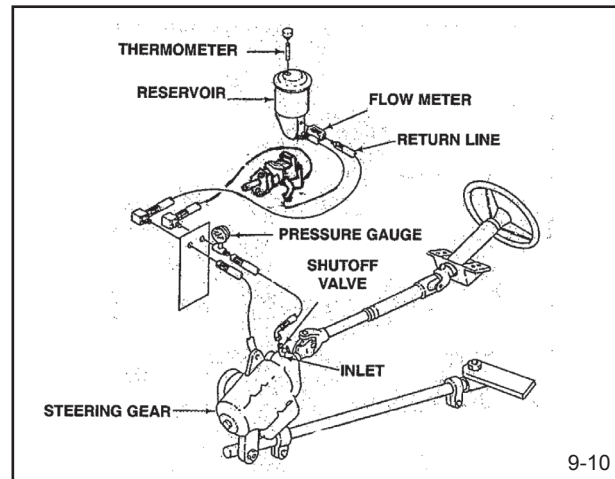
NOTE: Add fluid to the reservoir as needed to ensure that the fluid level does not decrease significantly, or that the reservoir is emptied.
7. Shut down the engine, and add fluid to the reservoir as necessary.
8. Start up the engine and allow the engine to idle.
9. Turn the wheels from full left to full right several times.
10. Add fluid to the reservoir as necessary to bring the fluid level to the FULL mark on the dipstick.
 - If the truck is equipped with a manual bleed system, proceed with step 11.
 - If the truck is equipped with an automatic bleed system, no further action is necessary.
11. With the engine idling, turn the wheels from full left to full right several times.
12. Stop turning the wheels and loosen the gearbox manual bleed screw approximately one turn.

NOTE: Do not turn the wheels when the bleed screw is loose.
13. Allow air and aerated fluid to escape around the manual bleed screw until only clear fluid is seen.
14. Close the manual bleed screw, and refill the reservoir as necessary.
15. Repeat steps 11 through 14 three to four times until all the air has been removed.
16. Tighten the manual bleed screw to 30 lb-in (3.39 N•m) torque.

Power Steering Pump Pressure and Flow Tests

NOTE: Many power steering problems are due to lack of pressure or insufficient flow. In the event any problem occurs, first check for low oil level, restricted lines, loose fitting and plugged filters.

1. Install a pressure gauge and a shut off valve in the line from the pump outlet to the gear inlet. See figure 9-10.



2. Install a flow meter in the line from the gear outlet to reservoir.
3. Place a thermometer in the reservoir. With the shut-off valve open, start up the engine and turn the wheels from stop to stop several times to heat the system fluid to approximately 130° F (54.4° C).
4. Hold the engine speed at approximately 1,000 rpm.

NOTE: Do not keep the shut-off valve closed for more than five seconds or pump damage can occur.

5. Close the shut-off valve and read the pressure gauge.

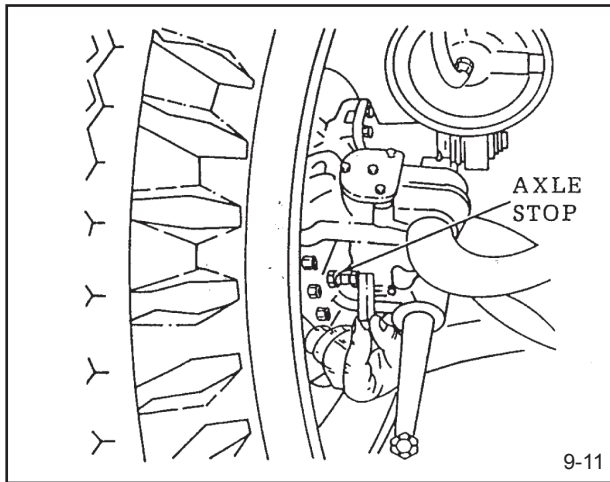
Test	Specification
Pump flow (no pressure)	4.0 to 5.0 gpm (15.1 to 18.9 l/min)
Pump flow (at 1,000 psi)	4.0 gpm (15.1 l/min)
Relief pressure (no flow)	1,300 psi (89.6 bar)

6. If the pressure is not between 1,250 psi (86.2 bar) and 2,000 psi (137.9 bar), repair or replace the power steering pump.
7. Allow the fluid to cool to 130° F (54.4° C).
8. Allow the engine to idle and slowly close the shut-off valve until the pressure gauge indicates 1,000 psi (68.9 bar).
9. Record the flow rate shown on the flow meter.

Test	Specification
Minimum rate	3.0 gpm (11.4 l/min)
Maximum rate	8.0 gpm (30.3 l/min)

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10. If the fluid temperature has risen, allow the fluid to cool to 130° F (54.4° C) before proceeding with step 11.
11. Increase engine speed to 1,200 to 1,300 rpm.
12. Record the flow rate.
13. Slowly close the shut-off valve until the pressure gauge reads 1,000 psi (68.9 bar) and again record the flow rate.
The reduction from the first reading to the second reading should not exceed 20%.
14. Place a steel spacer block that is 1 in. (2.54 cm) square by 6 in. (15.24 cm) long between an axle stop and the stop screw. See figure 9-11.



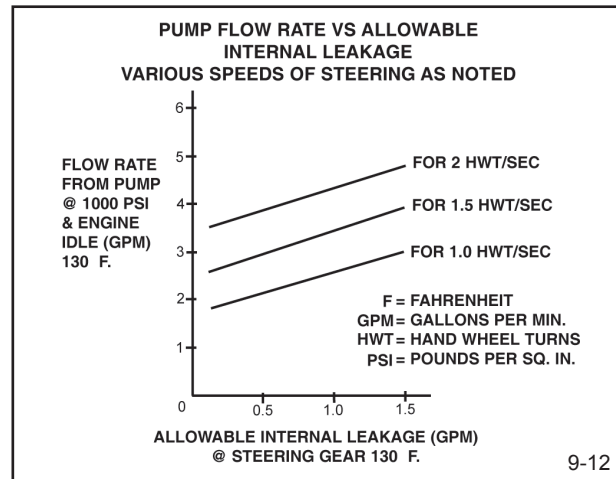
15. Turn the wheels fully in one direction until the linkage bottoms out on the spacer block.

NOTE:

- Apply at least 20 lbs (9.07 kg) to the rim of the steering wheel during this test to make sure the steering gear control valve is closed.
- Do not hold the steering wheel in the maximum turn position for more than five to ten seconds at a time or pump damage can occur.

The pressure gauge should now read system relief pressure as specified in step 5.

16. Read steering gear internal leakage on the flow meter:
 - If leakage is greater than 1.5 gpm (5.7 l/min), repair or replace the steering gear.
 - If leakage is less than 1.5 gpm (5.7 l/min), refer to figure 9-12 and use the flow rates recorded during the pump flow tests to determine the allowable leakage.



17. Repeat steps 14 through 16 with the wheels fully turned in the opposite direction.

Gearbox Poppet Initial Setting

This procedure is designed for the following case:

- When a new gear is received from the OEM or Capacity Trucks aftermarket system, or when a used gear has had the poppet seats replaced or reset during gear disassembly procedures.

AND

- A fixed stop screw is installed in the housing, or a poppet adjusting screw is installed so that it duplicates the fixed stop screw length.

NOTE: To correctly set the poppets, the axle stops and all steering linkage must be set according to specifications, and the pitman arm must be correctly aligned on the sector shaft.

1. With the vehicle unloaded, start up the engine and allow the engine to idle.
2. Turn the wheels to a full stop in one direction.
The maximum input torque to be applied is a 40 lb (18.1 kg) rim pull on a 20 in (50.8 cm) diameter steering wheel.
3. If there is excessive rim pull effort, allow the vehicle to roll forward or jack up the vehicle at the front axle.
4. Repeat steps 1 through 3 with the wheels turned to a full stop in the opposite direction.
The poppets are now positioned to trip and reduce pressure as the steered wheels approach the axle stops in either direction.

Gearbox Poppet Readjustment

This resetting procedure is suitable in most cases with at least 1 3/4 in (44.5 mm) hand-wheel turns

FRONT SUSPENSION AND STEERING

from each side of center. If a large reduction cut is required and this procedure does yield satisfactory results, replace the poppets or reset the poppets internally.

1. Set the axle stops to provide a minimum of 5/8 in (15.9 mm) minimum clearance between the tire and any chassis component.
2. Start up the engine and allow the engine to idle for 5 to 10 minutes to warm the hydraulic fluid.
3. Shut down the engine.
4. Assemble adjusting screw into nut.
5. If a new poppet adjusting screw and nut are being used, turn the screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut.

NOTE: *The steering gear will have either a fixed stop bolt or an adjusting screw. If the adjusting screw is already installed on the steering gear, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.*

6. Make sure the engine is off and that the wheels are in straight-ahead position.
7. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of the housing.

NOTE: *If the unit has a poppet adjusting screw and sealing nut that require replacement, remove and discard the fasteners.*

8. Turn the adjusting screw and sealing nut assembly (without rotating the nut on the screw) into the housing until the nut is firmly against the housing.
9. Tighten the sealing nut against the housing.

NOTE: *If the drive end of the screw is below the face of the nut, the poppet seat flange will break when performing step 15.*

10. Refill the system reservoir with the specified hydraulic fluid.

NOTE: *Do not mix fluid types; mixing transmission fluid, motor oil or other hydraulic fluids will cause the seals to rapidly deteriorate.*

11. Place a jack under the center of the front axle and jack up the front end of the vehicle so the front wheels are off the ground.
12. Start up the engine and allow the engine to idle.
13. Note which output shaft timing mark is nearest the housing piston bore.
14. Turn the wheels in the direction that causes

the nearest timing mark to move toward the adjusting screw (that was just installed in this direction) until axle stop contact is made.

15. Apply up to the equivalent of a 40 lb (18.1 kg) rim pull on a 20 in (50.8 cm) diameter steering wheel on the steering wheel.
16. Turn the wheels in the opposite direction (so that the end of the timing mark moves away from the adjusting screw) until axle stop contact is made.
17. Apply up to the equivalent of a 40 lb (18.1 kg) rim pull on a 20 in (50.8 cm) diameter steering wheel on the steering wheel.
18. Release the steering wheel and shut down the engine.
19. Loosen the sealing nut and back out the adjusting screw until the adjusting screw is 1 in (25.4 mm) past the nut.
20. Tighten the sealing nut against the housing.

NOTE: *Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up from the pump relief pressure may damage components.*

21. Start up the engine and allow the engine to idle.
22. Turn the wheels in the original direction (from step 14), until axle stop contact is made.
23. Hold the steering wheel in this position, applying up to the equivalent of a 40 lb (18.1 kg) rim pull on a 20 in (50.8 cm) diameter steering wheel, for 10 seconds.
24. Release the steering wheel.
25. With steering wheel held tightly at full turn, loosen the jam nut and hold the jam nut in place with a wrench.
26. Turn the adjusting screw in (clockwise), using finger pressure only (don't use a ratchet), until the adjusting screw stops.

NOTE: *Do not attempt to turn the adjusting screw after the adjusting screw stops.*

27. Repeat steps 22 through 26 as many times as necessary.

NOTE: *Stop turning the adjusting screw each time the driver releases the steering wheel, and continue turning the adjusting screw only when the steering wheel is held at full turn.*

28. Back the adjusting screw out 3 1/4 turns and tighten the sealing nut to 35 lb-ft (47.5 N•m) torque.

FRONT SUSPENSION AND STEERING

NOTE:

- The distance of the adjusting screw beyond the nut must not exceed 1 1/16 in (27.0 cm) for proper thread engagement.
- The distance of the adjusting screw beyond the sealing nut may be different for each vehicle.

29. Lower the vehicle.
30. Check the fluid level in the reservoir and add fluid as necessary.

Gearbox Sector Shaft Adjustment

This adjustment is suitable only for vehicles with an accessible adjusting screw jam nut is accessible; this nut is located on the side cover.

1. Shut down the engine.
2. Turn the steering wheel (input shaft) until the timing mark on the sector shaft lines up with the mark on the housing.

The line on the sector shaft should be at a 90 degree angle from the input shaft; this places the sector shaft at its center of travel.

3. Remove the drag link from the pitman arm.

NOTE: To avoid resetting the poppets, do not rotate the input shaft more than 1 1/2 turns from the center-of-travel position while the drag link is disconnected.

4. From the center-of-travel position, attempt to gently rotate the pitman arm to determine if lash exists.

NOTE: If looseness or lash is felt, the sector shaft is out of adjustment.

5. Loosen the jam nut.

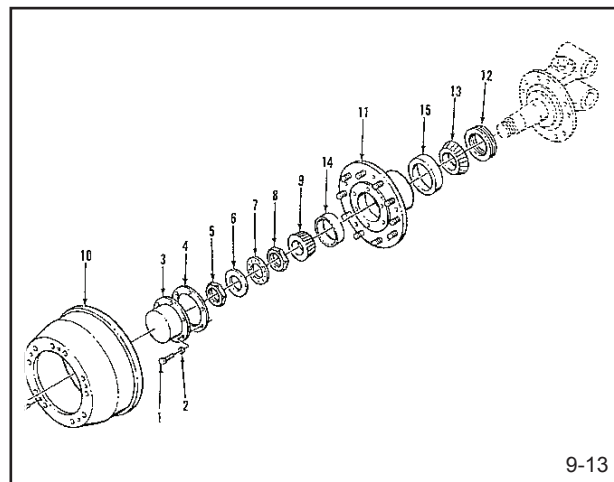
If no lash was felt in step 4, turn the shaft adjusting screw counterclockwise until lash is felt at the output shaft.

6. Slowly turn the shaft adjusting screw clockwise until no lash is felt at the output shaft when applying 10 lb-ft (13.6 N•m) torque.
7. Turn the shaft adjusting screw clockwise an additional 1/8 to 3/16 of a turn.
8. Hold the shaft adjusting screw in place, and tighten the jam nut to 43 lb-ft (58.3 N•m) torque.
9. Turn the steering wheel 1/4 turn to each side of center and back to center, and recheck the pitman arm for lash as described in step 4.
 - If lash is felt, repeat steps 5 through 9.
 - If no lash is felt, proceed with step 10.
10. Reconnect the drag link to the pitman arm.

Repair

Wheel Bearing Service

1. Park the vehicle on a flat, level surface.
2. Place chocks at the rear wheels to prevent vehicle movement.
3. Place a jack under the front axle and raise the front of the vehicle until the tire is lifted off the ground.
4. Remove the wheel.
5. Remove the cap screws (1) and washers (2) from the hub cap (3). See figure 9-13.



6. Remove the hub cap (3) and the gasket (4).
7. Remove the outer bearing nut (5), the outer lock washer (6) and the inner lock washer (7).
8. Remove the inner bearing adjuster nut (8) and the outer bearing cone (9).
9. Remove the drum (10) and hub assembly (11).
10. Remove the inner seal (12) and the inner bearing cone (13).
11. Clean the bearings (9, 13, 14 and 15), the hub assembly and the inner seal.
12. Inspect components for wear or damage, and replace components as necessary.
13. Coat the bearings with the specified lubricant. See Lubricant, Fluid and Fuel Types and Capacities on page 2-6 for the specified lubricant.
14. Install the inner bearing cone (13) and the inner seal (12) in the hub assembly (11) using the proper seal installation tool.
15. Install the hub assembly on the front spindle.
16. Install the outer bearing cone (9).

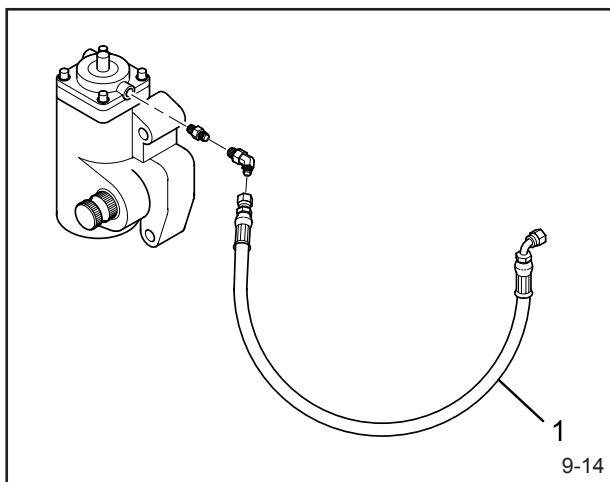
FRONT SUSPENSION AND STEERING

17. Install the inner bearing adjusting nut (8), rotating the hub assembly while threading the nut against the bearing.
18. While rotating the hub assembly back and forth, tighten the inner bearing adjusting nut to 50 lb-ft (67.8 N•m) torque.
19. Loosen the inner bearing adjusting nut 1/6 to 1/4 turn.
20. Install the inner lock washer (7), the outer lock washer (6) and the outer bearing nut (5).
21. Tighten the outer bearing nut as follows:
 - Tighten 1 1/8 in to 2 5/8 in nuts to 100 to 150 lb-ft (135.6 to 203.4 N•m) torque.
 - Tighten nuts larger than 2 5/8 in to 100 to 200 lb-ft (135.6 to 271.2 N•m) torque.
22. Make sure that end play is 0.001 to 0.010 in (0.025 to 0.254 mm).
23. Install the hub cap (3), the gasket (4), the cap screws (1) and the lock washers (2), tightening the cap screws in a crisscross pattern to 24 lb-ft (32.5 N•m) torque.
24. Install the brake drum (10).
25. Install the wheel, and tighten the wheel nuts.

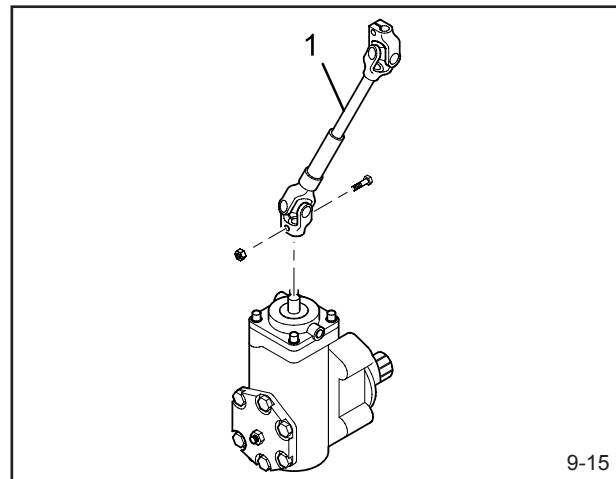
Gearbox Input Shaft Seal Replacement

This procedure uses the vehicle's power steering pump to force out the input shaft seal. For this to occur, the power steering pump should have a minimum of 1,500 psi (103.4 bar) available.

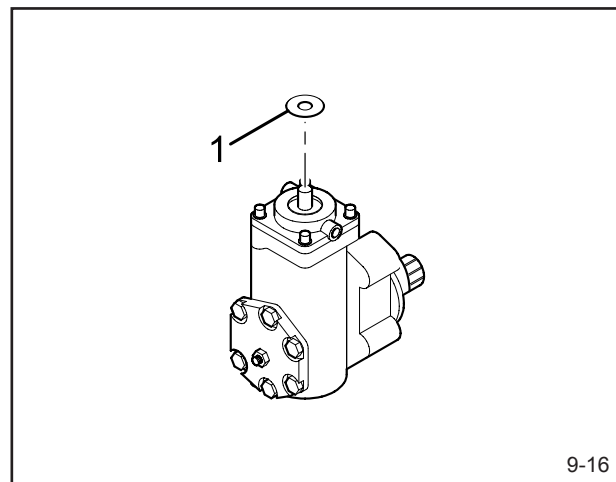
1. Disconnect the return line (1) from the steering gear and plug the line. See figure 9-14.



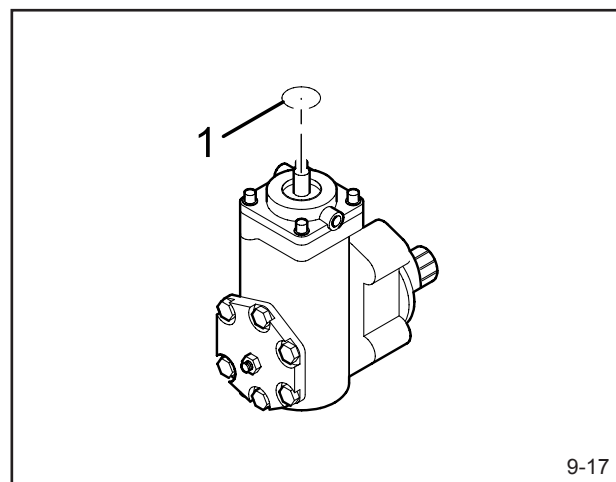
2. Cap the steering gear return port with a high-pressure fitting.
3. Remove the steering column (1) from the input shaft. See figure 9-15.



4. Remove and discard the dirt and water seal (1) from the steering gear. See figure 9-16.



5. Wipe out any residual grease, and remove and discard the spiral retaining ring (1), using a screwdriver inserted into the notch at the end of the ring. See figure 9-17.



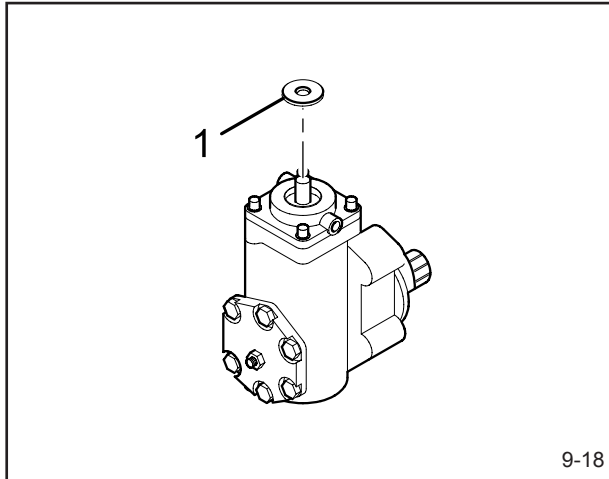
FRONT SUSPENSION AND STEERING

6. Reinstall the steering column onto the input shaft, and loosely install the pinch bolt.
7. Tie or wrap a shop towel around the connection point of the input shaft and the steering column, and place a drip pan under the steering box to catch fluid.
8. Add fluid to the reservoir, as necessary, to the full line on the dipstick.

WARNING

Fill and flush the power steering system with the specified fluid only; do not mix fluids. Any mixture or unapproved fluid could lead to seal deterioration and leaks, which could result in a loss of power steering and cause death or serious injury.

9. With the transmission in neutral, momentarily engage the starter (quickly turn off the engine if it starts) to dislodge the input shaft seal.
10. Remove the shop towel, and disconnect the steering column from the input shaft.
11. Remove the input shaft seal (1). See figure 9-18.



12. Inspect the seal area of the valve housing for seal fragments, and remove any fragments.
13. Inspect the seal for heat damage:
If the seal is stiff and brittle, and not pliable like a new seal, heat damage is the most likely cause. Determine the cause of the excessive heat and remedy this condition.
14. Apply new grease (NLGI-1 or -2, or equivalent) to the ID of the new input shaft seal, and place the seal over the input shaft.

15. Using the appropriate seal driver, tap the seal driver until the shoulder of the seal driver is flush against the valve housing.

NOTE: Do not use a socket to install the seal, as the seal can be installed too far into the housing, which could cause fluid leakage.

16. Remove any seal material that has sheared off in the seal bore or the retaining ring groove.
17. Install a new spiral retaining ring into the retaining ring groove.
18. Pack the bore around the input shaft with clean, grease (NLGI-1 or -2, or equivalent).
19. Apply the same grease to the ID of the new dirt and water seal, and install the seal into the bore around the input shaft.
20. Seat the dirt and water seal into the groove behind the serrations and against the valve housing.
21. Reconnect the steering column to the input shaft and tighten the pinch bolt.
22. Reconnect the return line to the steering gear return port.
23. Bleed air from the power steering system as described in Filling and Bleeding the Power Steering System on page 9-10.

Steering Knuckle Disassembly

1. Apply the parking brake and chock the drive wheels to prevent vehicle motion.
2. Raise the vehicle until the front wheels are off the ground.
3. Place jack stands to support the vehicle.

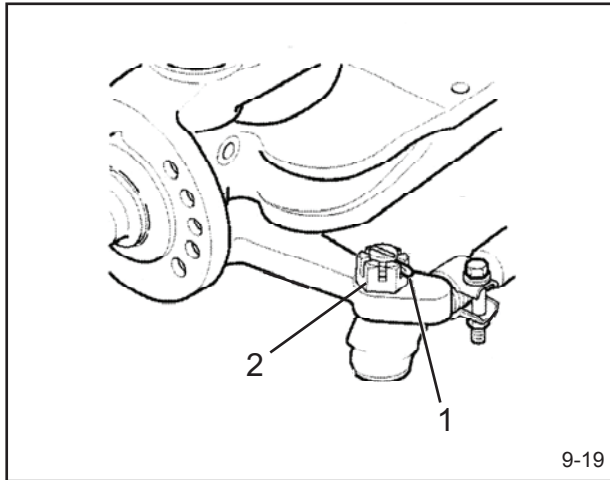
WARNING

Always use jack stands. Never work under a vehicle supported by only a jack or death or serious injury could result.

4. Loosen the slack adjuster so that the brake shoes are in the released position and will clear the brake drum.
5. Remove the hub cap, the cotter pin, the hub nut and washer, and the outer bearing cone assembly.
6. Remove the wheel and the hub assembly.
7. Disconnect the air or hydraulic line from the brake assembly, and plug or cap the line to prevent brake system contamination.

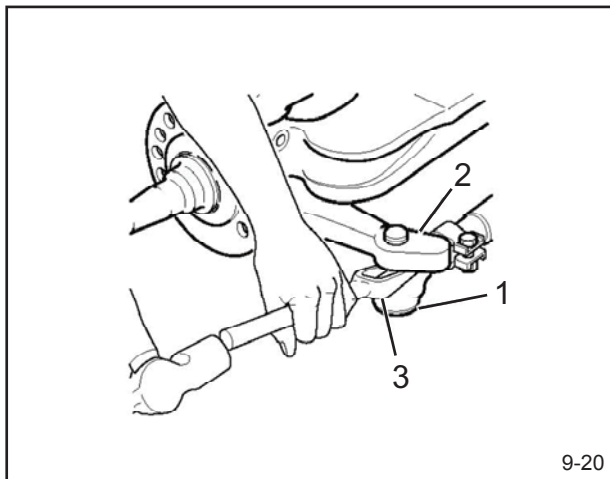
FRONT SUSPENSION AND STEERING

8. Remove the brake assembly.
9. Remove the cotter pin (1) and the slotted nut (2). See figure 9-19.



10. Remove the tie rod end (1) from the tie rod arm (2) using a pickle fork (3). See figure 9-20.
If the tie rod end boot is damaged during removal, replace the tie rod end.

IMPORTANT: Do not use heat on any axle parts or fasteners.



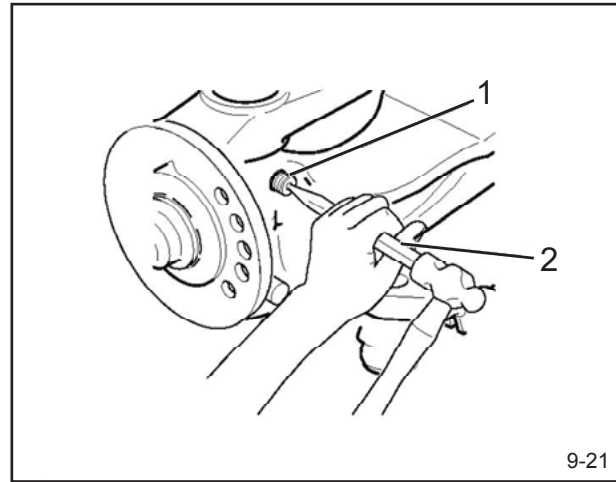
11. Remove the cotter pin and the slotted nut, and remove the drag link from the steering arm.
12. Remove the top and bottom knuckle caps.

NOTE: Depending on the steering system installed, one or two draw keys may be used; if two draw keys are used, remove both keys during step 13.

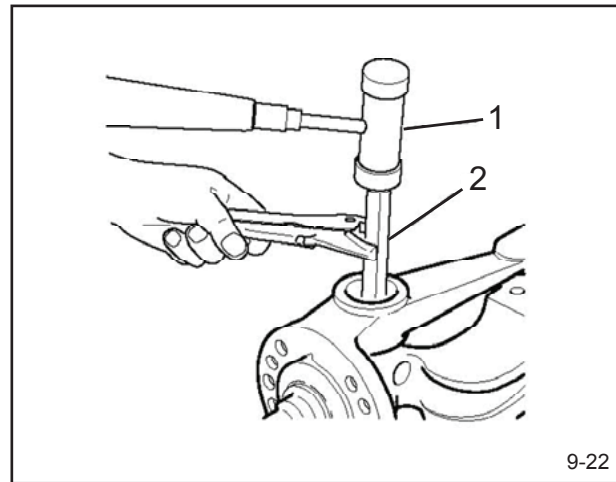
CAUTION

Never strike hardened metal parts with a steel hammer or tool, or minor or moderate injury could result.

13. Remove the draw key nut(s) and drive out the draw key(s) (1) using a brass hammer and a drift (2). See figure 9-21.



14. Drive the kingpin out using a brass hammer (1) and a drift (2). See figure 9-22.



15. Remove the steering knuckle from the axle beam.

DANGER

Do not use gasoline to clean parts. Gasoline is not an acceptable cleaning solvent because of its extreme combustibility. It is unsafe to use gasoline in the workshop environment. Use of gasoline will result in death or serious injury.

16. Clean parts as follows:

- Steel parts with ground or polished surfaces:
 - a. Wash the parts in a suitable cleaning solvent.

FRONT SUSPENSION AND STEERING

- b. Rinse the parts thoroughly to remove residual cleaning solution.
- c. Dry the parts with clean rags.
- Castings, forgings and other rough-surface parts:
Use a wire brush or steam-clean areas that are susceptible to the accumulation of mud, road dirt, salt, etc.

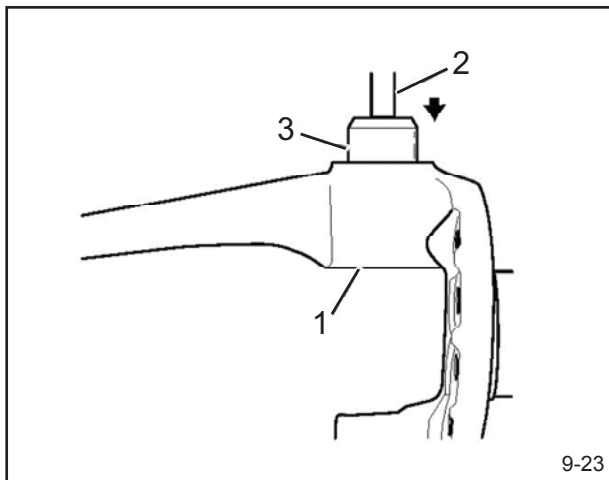
Kingpin Bushing and Seal Replacement

1. Remove the kingpin seals from the knuckle arms using a suitable tool.

CAUTION

Never strike hardened metal parts with a steel hammer or tool, or minor or moderate injury could result.

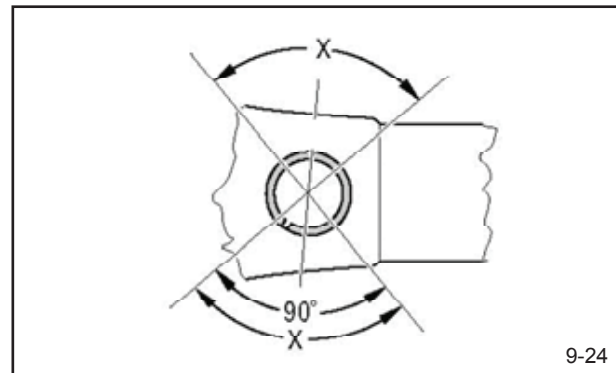
2. Drive the kingpin bushings out of the steering knuckles (1) using a drift (2) with a suitable pilot (3). See figure 9-23.



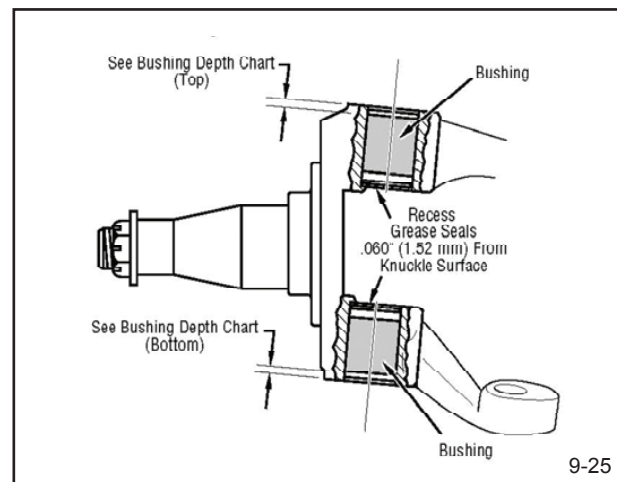
3. Remove all foreign material from the kingpin bores of the steering knuckle and the axle beam.
4. Clean all machined surfaces, including the kingpin bores, using a wire brush, taking care not to cause damage.

IMPORTANT: Some kingpin bushings require reaming after installation. Read the instruction sheet included with the service kit or the bushings prior to installation.

5. Lightly lubricate the OD of the new kingpin bushing to ease installation.
6. Set the bushing into the outer end of the steering knuckle bore so that the bushing seam is within a 90 degree range (X) of the front or the rear of the bore. See figure 9-24.



7. Install the bushing into the steering knuckle bore to a depth as specified by the bushing manufacturer. See figure 9-25.



8. Repeat steps 5 through 7 for each new bushing.
9. Ream the bushings to the proper size using the appropriate tool.

IMPORTANT: When installing the kingpin seals, use a suitable pilot drift or similar device that will not damage the seal.

10. Position each new kingpin seal so that the seal lip faces the bushing, and install the seals to a depth of 0.06 in (1.52 mm) from the bore surface. See figure 9-26.

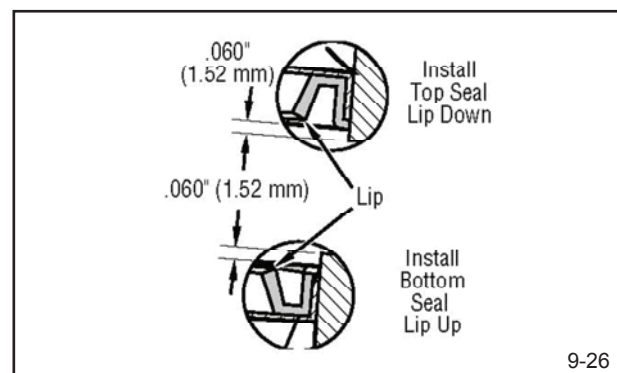
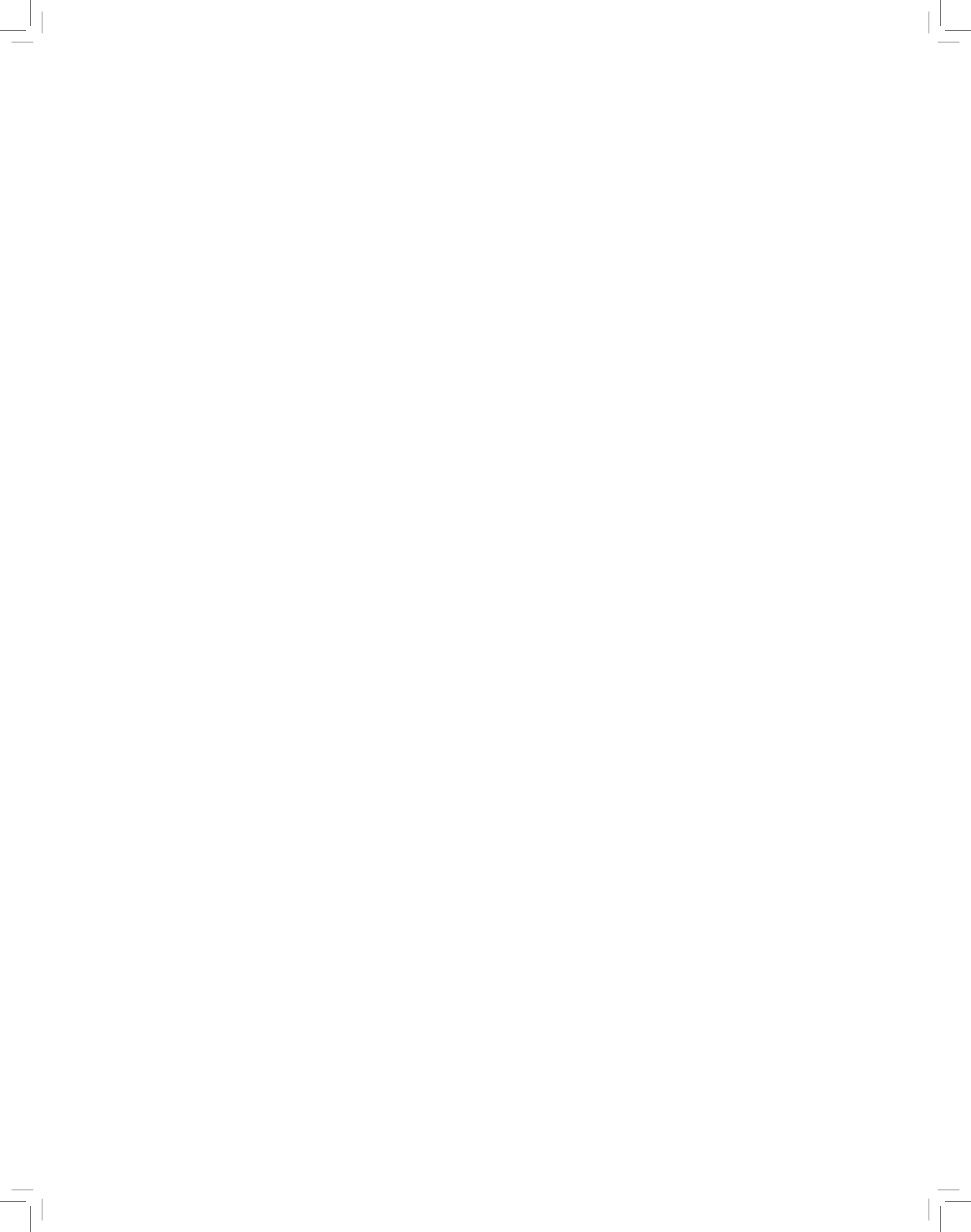


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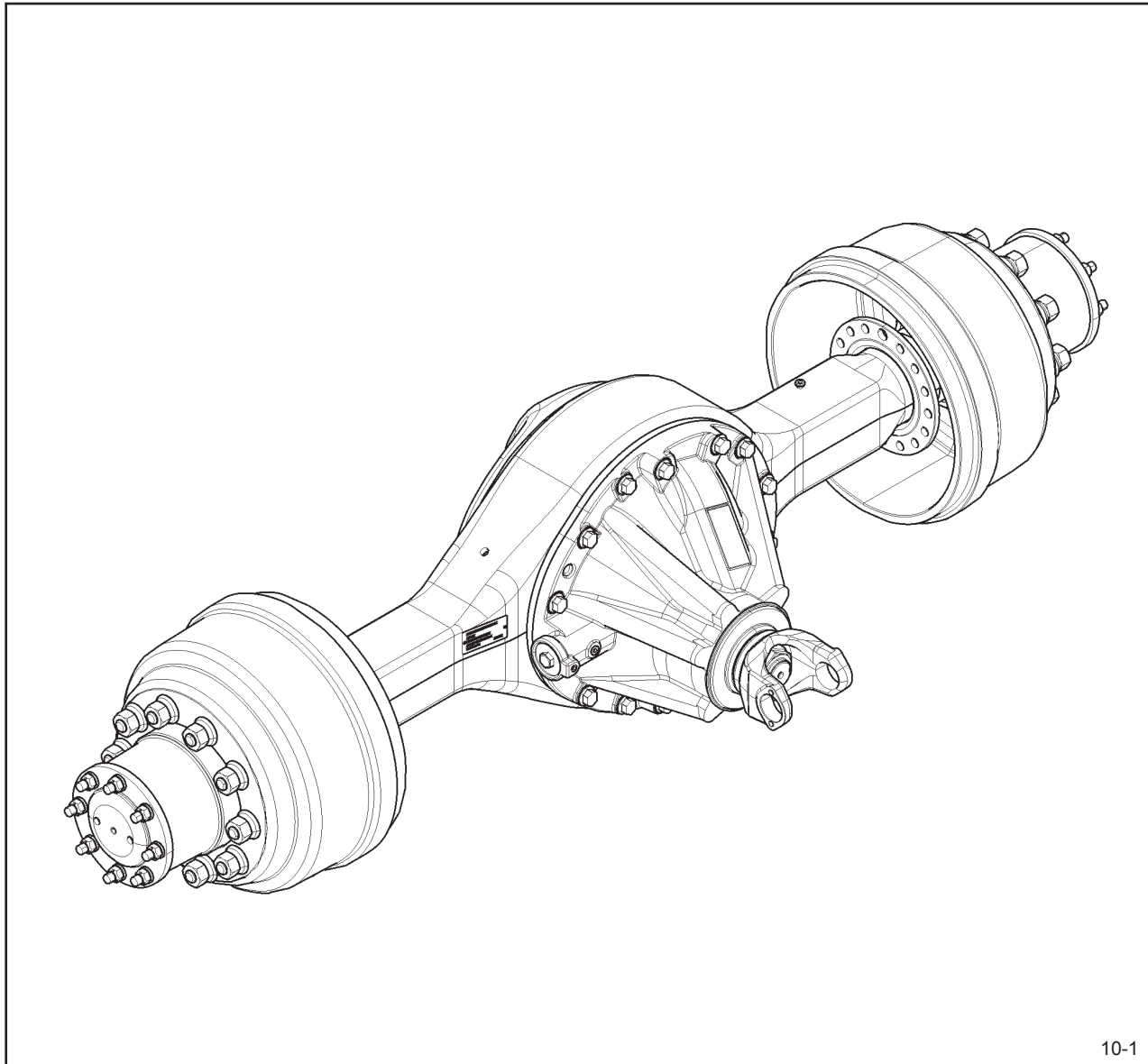
REAR AXLE AND SUSPENSION

COMPONENTS AND THEORY OF OPERATION

Rear Axle

The rear axle consists of the following major components (see figure 10-1):

- Drive gear set
- Rear wheel hubs
- Rear brake drums and shoes



10-1

10

REAR AXLE AND SUSPENSION

Suspension Systems

The two rear suspension systems available are Rigid Mount and Dura-Ride:

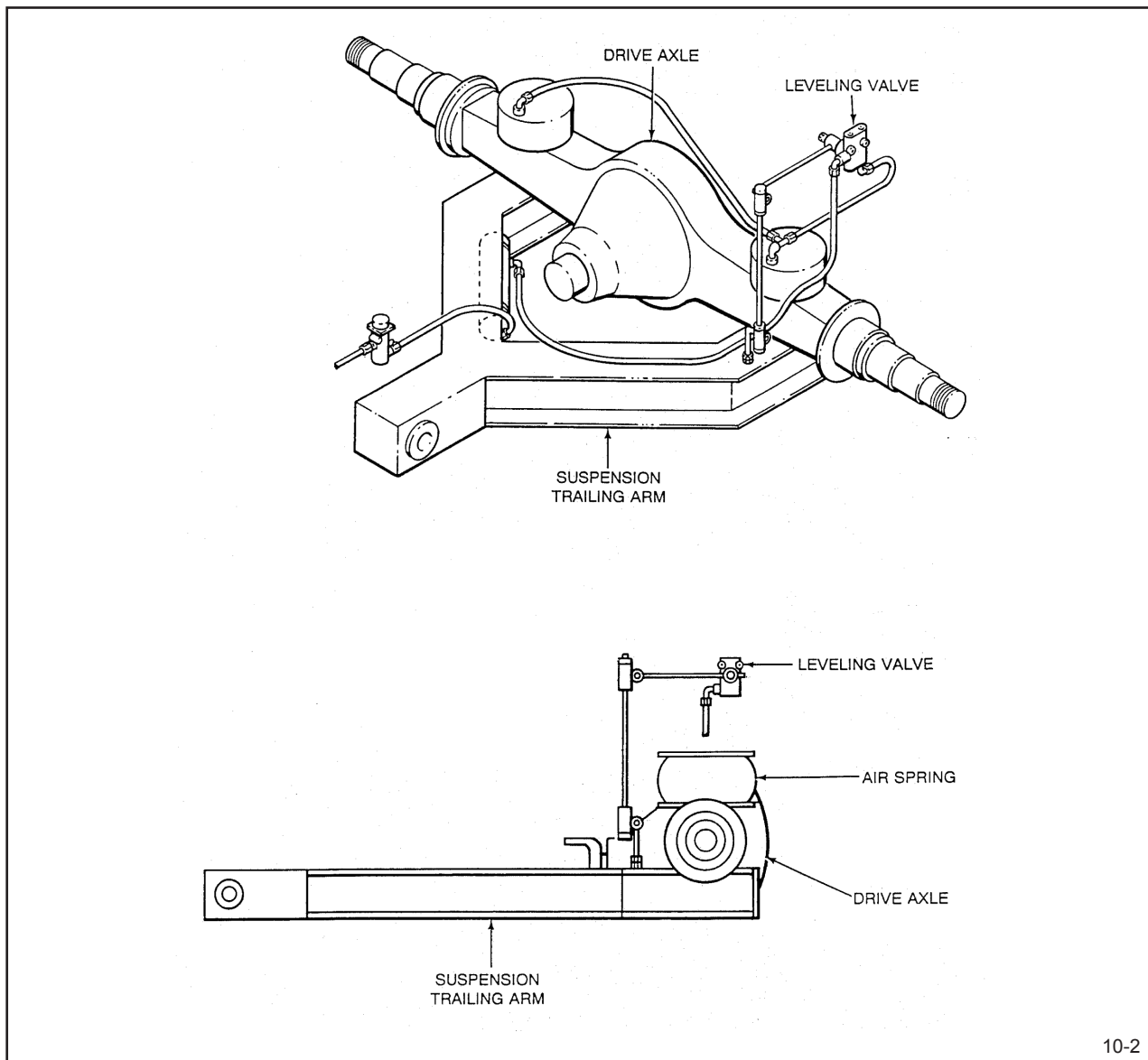
Rigid Mount

The drive axle is mounted to the frame with rigid members and no shock absorbing components.

Dura-Ride

The drive axle is mounted to a suspension trailing arm, and is equipped with air springs and a leveling valve. See figure 10-2.

Two air springs control the ride height through a position-sensitive leveling valve. As more weight is applied to the fifth wheel, the springs collapse. The valve senses the change in position and increases air spring pressure to compensate for the additional load and restore the vehicle to its original ride height. As the load is decreased, air is released from the springs to maintain proper positioning. Spring ride height should be approximately 4 1/2 in (11.4 cm) after air pressure has stabilized. Height changes required for load changes are not instantaneous, as stabilization takes 5 to 7 seconds under normal conditions. Ride height is factory-set and should not require adjustment unless the leveling valve and/or the linkage is replaced.



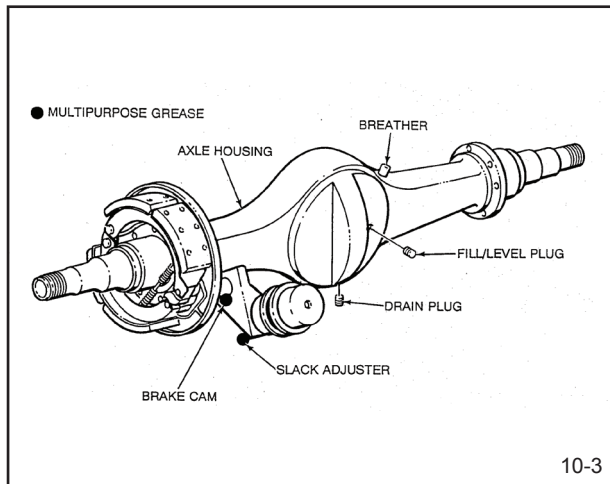
REAR AXLE AND SUSPENSION

REAR AXLE

Maintenance

Drive Axle Oil Level Check

1. Park the vehicle on a flat, level surface.
2. Remove the fill/level plug. See figure 10-3.



3. Add the specified lubricant through the fill/level plug hole until lubricant flows out through the hole. Refer to Lubricant, Fluid and Fuel Types and Capacities on page 2-6 for the specified lubricant.
4. Reinstall the fill/level plug.
5. Wipe residual lubricant from the axle housing.

Drive Axle Oil Change

1. Park the vehicle on a flat, level surface.
2. Place a suitable container under the drain plug to catch the drained lubricant.
3. Remove the drain plug and allow the axle to completely drain of lubricant. See figure 10-3.
4. Add the specified lubricant through the fill/level plug hole until lubricant flows out through the hole. Refer to Lubricant, Fluid and Fuel Types and Capacities on page 2-6 for the specified lubricant.
5. Jack up the LH side of the axle, and leave the side of the axle raised for one minute to allow the lubricant to flow into the RH side wheel end.
6. Lower the LH side of the axle.
7. Jack up the RH side of the axle, and leave the side of the axle raised for one minute to allow the lubricant to flow into the LH side wheel end.
8. Lower the RH side of the axle.

9. Add the specified lubricant through the fill/level plug hole until lubricant flows out through the hole.

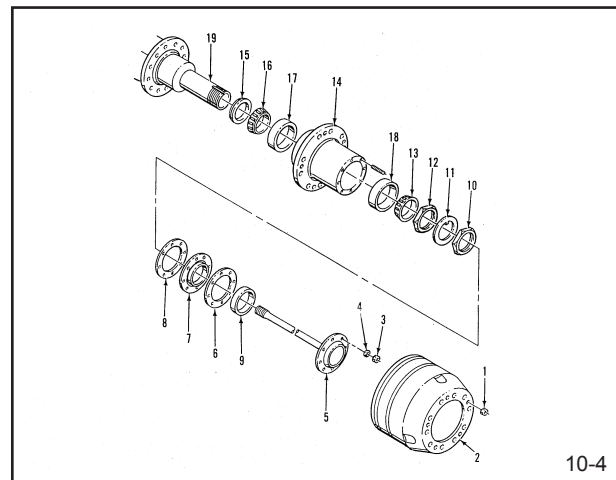
NOTE: The axle should require approximately two additional pints of lubricant to raise the level to the bottom of fill/level plug hole.

Repair

Rear Wheel Bearing Inspection/Replacement

Removal:

1. Park the vehicle on a flat, level surface.
2. Chock the wheel to prevent vehicle movement.
3. Place a jack under the rear axle and raise the vehicle until the tires lift off the ground.
4. Adjust the brake shoes until there is no drag on the wheels.
5. Remove the nuts (1) to remove the wheels and the drum (2). See Figure 10-4.



6. Place a suitable container under the end of the axle to catch the lubricant.
7. Remove the nuts (3), the lock washers (4), the axle shaft (5), the outer gasket (6), the outer seal (7), the inner gasket (8) and the wiper (9).
8. Remove the outer nut (10), the lock washer (11), the inner nut (12) and the bearing cone (13).
9. Carefully pull the hub (14) from the axle housing (19).
10. Remove the seal (15) and the bearing cone (16).
Remove the bearing cups (17 and 18) only if the bearing cups require replacement.

10

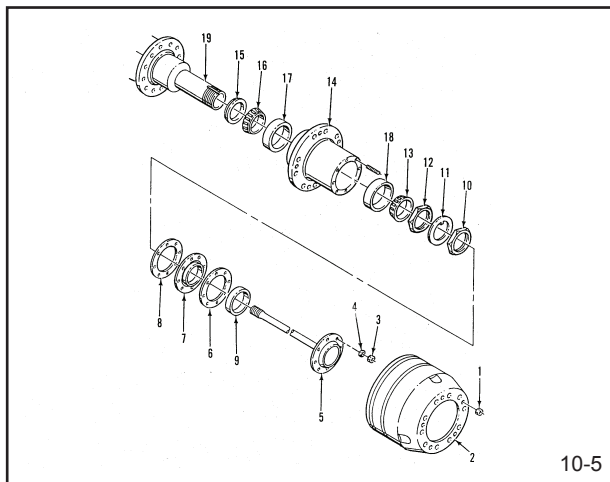
REAR AXLE AND SUSPENSION

Cleaning and Inspection:

1. Clean old lubricant from the bearings, the hub and the seals.
2. Inspect the parts for wear and damage, replacing components as necessary.
3. Repack the hub and the bearings with the specified lubricant.

Installation and Adjustment:

1. If the bearing cups (17 and 18) were removed, install the bearing cups, making sure that the cups are seated squarely in the bores. See figure 10-5.



2. Install the bearing cone (16) and the grease seal (15).
3. Slide the hub (14) onto the axle housing (19).
4. Install the bearing cone (13).
5. While rotating the hub, install the inner nut (12).
6. While rotating the hub back and forth, tighten the inner nut (12) to 50 lb-ft (67.8 N•m) torque.
7. Install the lock washer (11) so that the lock tang on the washer aligns with the keyway in the axle housing (19).

NOTE: If the lock tang and the keyway cannot be aligned, turn over the lock washer. If the lock tang and the keyway still cannot be aligned, loosen the inner nut slightly, but not to exceed 1/3 turn.

8. Make sure that the wheel rotates freely and that end play is within 0.001 in (0.02 mm).
9. Install the outer nut (10) and tighten the nut to 300 to 400 lb-ft (406.7 to 542.3 N•m) torque.
10. Install the inner gasket (8), the outer seal (7), the outer gasket (6), the wiper (9) and the axle shaft (5).

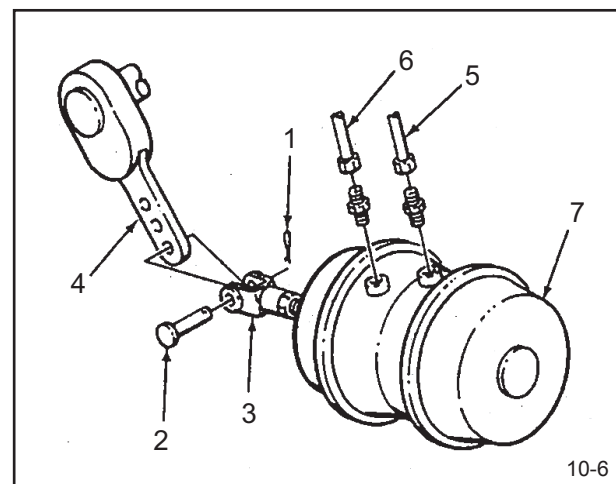
11. Install the lock washers (4) and tighten the nuts (3).
12. Reinstall the drum (2) and tighten the nuts (1).
13. Make sure that the brake shoes are adjusted correctly.
14. Lower the vehicle to the ground and remove the wheel chocks.

Removal: Rigid Mount system

1. Park the vehicle on a flat, level surface, chock the front wheels to prevent vehicle movement and use a jack and jack stands at the vehicle frame to support the vehicle.
2. Remove the rigid mount axle pads and hardware.

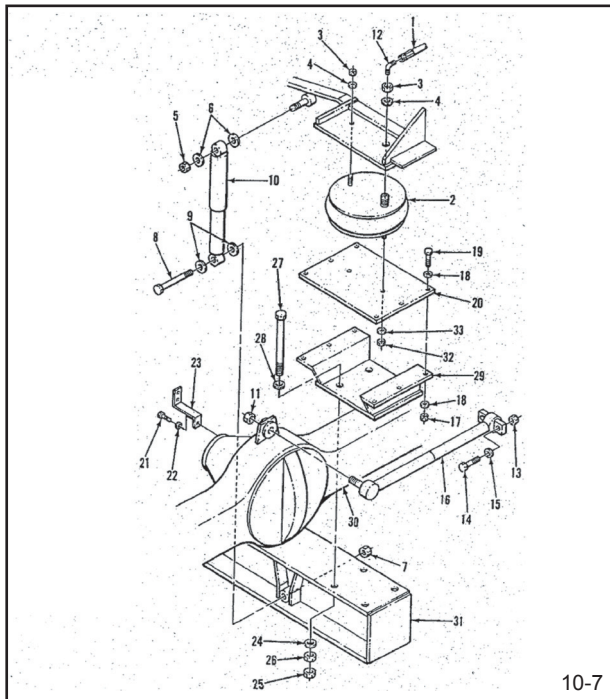
Removal: Dura-Ride system

1. Park the vehicle on a flat, level surface and chock the front wheels to prevent vehicle movement.
2. Remove the release stud from the carrying pocket in the housing.
3. Remove the access plug.
4. Insert the release stud through the hole in the housing and the spring pressure plate.
5. Turn the release stud 1/4 turn to engage the tangs on the release stud with the slots in the pressure plate.
6. Install the release stud nut onto the release stud and tighten the nut until the spring is completely caged.
7. Remove the cotter pin (1) and the clevis pin (2), and disconnect the brake chamber clevis (3) from the slack adjuster (4). See figure 10-6.

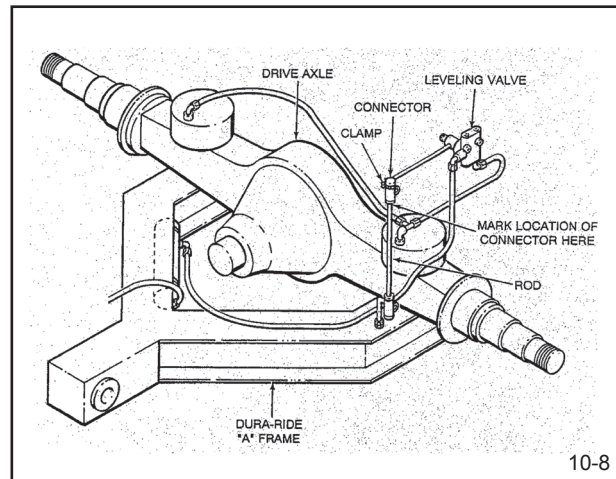


REAR AXLE AND SUSPENSION

8. Apply the parking brake.
9. Press and release the brake pedal approximately thirty times to decrease air brake system pressure to 0 psi (0 bar).
10. Tag, disconnect and plug the air lines (5 and 6) from both brake chambers (7).
11. Raise the boom to the upper limit of its travel, and install supports to hold the boom in the fully raised position.
12. Disconnect the air hose (1) from each air spring (2), and remove the fitting (12), the top locknuts (3) and the washers (4). See figure 10-7.



13. Remove the locknuts (5 and 7), the bolts (8) and the washers (6 and 9), and remove the shock absorbers (10).
14. Remove the locknut (11), the locknuts (13), the bolts (14) and washers (15), and remove the track rod (16).
15. Mark the location of the linkage connector, as shown in figure 10-8, loosen the clamp and slide the connector upwards to remove the connector from the linkage rod.



16. Attach a suitable hoist to the rear of the vehicle frame and raise the frame high enough to allow the axle to be removed.

⚠ WARNING

Do not work under vehicle supported only by jacks. Install jack stands and/or wooden blocks, or death or serious injury could result.

17. Install jack stands to support the raised vehicle frame.
18. Remove the drive shaft.
19. Remove the bolt (21), the lock washer (22) and the hydraulic hose support bracket (23). See figure 10-7.
20. Remove the locknuts (17), the washers (18) and the bolts (19), and remove the air springs (2) and the mounting plates (20).
21. Attach a suitable hoist to the raised end of the boom and exert a lifting force that will support the weight of the boom and the suspension trailing arm (31).

⚠ WARNING

Make sure that the suspension trailing arm is properly supported before removing the axle mount locknuts and bolts, or death or serious injury could result.

22. Remove the jam nuts (25), the locknuts (26), the washers (24), the bolts (27), the washers (28) and the brackets (29).
23. Use the hoist to lower the suspension trailing arm (31) and remove the axle (30) from the vehicle.
24. Lower the boom until the suspension trailing arm rests on the floor.

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REAR AXLE AND SUSPENSION

25. Use a forklift to transport the axle to the prepared work area.
26. Perform the Inspection procedures on page 10-7.

Disassembly and Repair

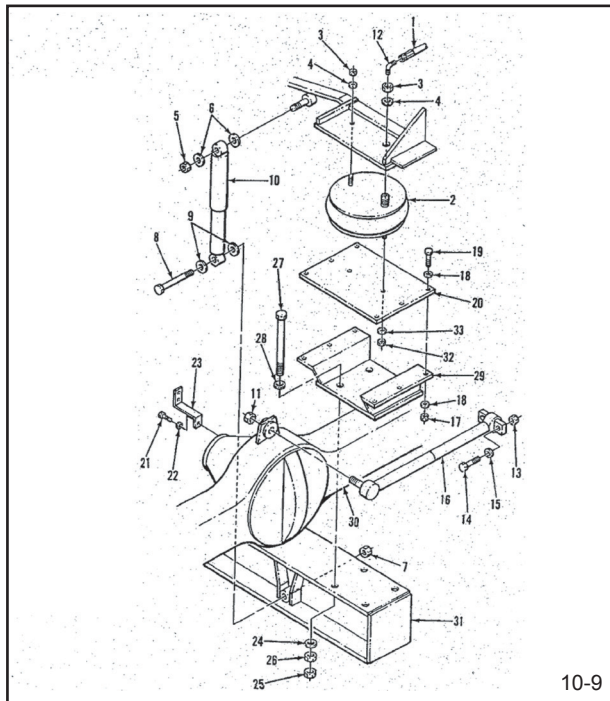
Refer to the axle OEM service information for disassembly and repair procedures.

Installation: Rigid Mount system

With the vehicle frame supported by jack stands, install the rigid mount axle pads and hardware.

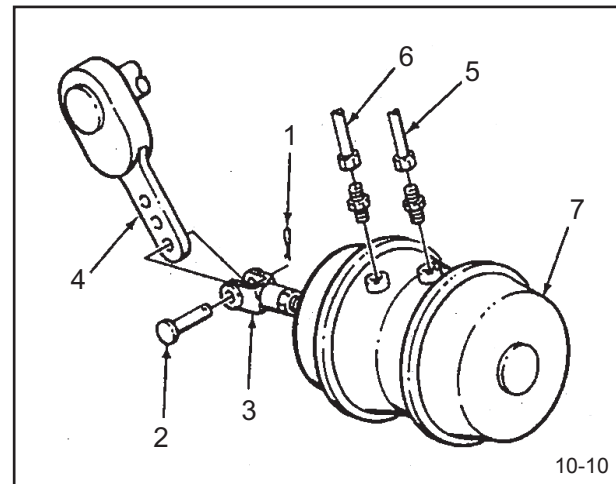
Installation: Dura-Ride system

1. Position the drive axle (30) on the suspension trailing arm (31) and install the brackets (29), the bolts (27), the washers (28 and 24) and the locknuts (26). See figure 10-9.



2. Install the jam the nuts (25).
3. Install the air springs (2) onto the mounting plates (20) using the washers (33) and the locknuts (32).
4. Install the mounting plates (20) onto the brackets (29) using the bolts (19), the washers (18) and the locknuts (17).
5. Use a hoist to raise the boom, the suspension trailing arm (31) and the axle (3).
6. Install the rear wheels.

7. Raise the vehicle frame and remove the jack stands or wooden blocks.
8. Align the studs on the top of the air springs (2) with the mounting holes in the frame.
9. Slowly lower the vehicle frame onto the air spring studs, making sure that the studs remain aligned with the holes in the frame.
10. Install the washers (4), the locknuts (3) and the fitting (12).
11. Connect the air hoses (1) to the air springs (2).
12. Install the track rod (16) using the bolts (14), the washers (15), the locknuts (13) and the locknut (11).
13. Install the shock absorbers (10) using the bolt (8), the washers (6 and 9) and the locknuts (5 and 7).
14. Tighten the locknuts (5 and 7) until the washers (6 and 9) are 1 3/4 in (44.5 mm) apart.
15. Install the air hose support bracket (23) using the bolt (21) and the lock washer (22).
16. Connect the drive shaft to the axle.
17. Connect the air lines (5 and 6) to the brake chambers (7). See figure 10-10.



18. Start up the engine and allow the air pressure to increase to the normal operating level.
19. Release the parking brake.
20. Connect the clevis (3) to the slack adjuster (4) using the clevis pin (2) and the cotter pin (1).
21. Loosen the release stud nut until the spring is fully released to uncage the brake chamber.
22. Remove the release stud assembly and return the assembly to its storage position on the housing.

REAR AXLE AND SUSPENSION

23. Reinstall the access plug.
24. Slide the linkage connector onto the linkage rod to the mark made during step 15 on page 10-5 of the Removal: Dura-Ride system procedures. See figure 10-8 on page 10-5.
25. Tighten the clamp to secure the linkage connector.
26. Refer to Lubricant, Fluid and Fuel Types and Capacities on page 2-6 and fill the drive axle with the specified lubricant.
27. Perform a brake adjustment.
28. Perform the Ride Height Check and Adjustment procedures on page 10-8.
29. Check all air hose connections for leaks using a soapy water solution.

DURA-RIDE SUSPENSION

Maintenance

Inspection

1. Check all threaded components for damaged or stripped threads.
 - Repair light damage with thread chasers.
 - Replace parts that are determined to be unserviceable.
2. Check the air springs for cracks, tears or other signs of damage or wear.

Replace worn air springs.
3. Check the operation of the shock absorbers and check for leaks.

Replace worn or leaking shocks.
4. Check the bracket (29) welds for cracks. See figure on 10-7 on page 10-5.

Weld any cracks.
5. Check the condition of the bushings on the track rod (16) for deterioration. See figure 10-7 on page 10-5.

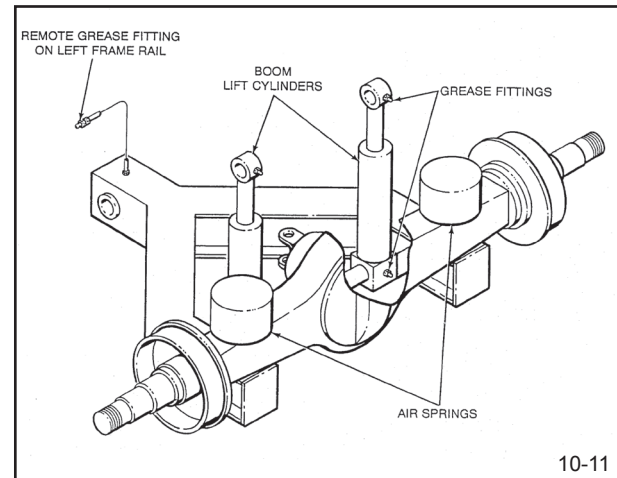
Replace worn bushings.
6. With the axle removed, check the pivot bearing on the suspension trailing arm (31) for wear. See figure 10-7 on page 10-5.

Refer to the Pivot Bearing Inspection procedures on page 10-9.

Spherical Bearing Lubrication

Five spherical bearings are used to allow the system to articulate.

- The spherical bearings are located at each end of the boom lift cylinders and at the swivel point of the suspension trailing arm. See figure 10-11.



- The grease fitting for the swivel point is located above the bearing in the top plate of the suspension trailing arm however, a remote lubrication point is provided in the LH side frame rail.
- Use the grease specified in Lubricant, Fluid and Fuel Types and Capacities on page 2-6.

Shock Absorber Inspection

Shock absorbers are non-repairable components. Maintenance requirements involve replacement of the rubber mounting grommets and tightening of all shock absorber pin nuts at regular intervals.

Shock absorbers are a sealed assembly, and must be replaced when faulty. If a shock absorber becomes inoperative, replace the complete unit.

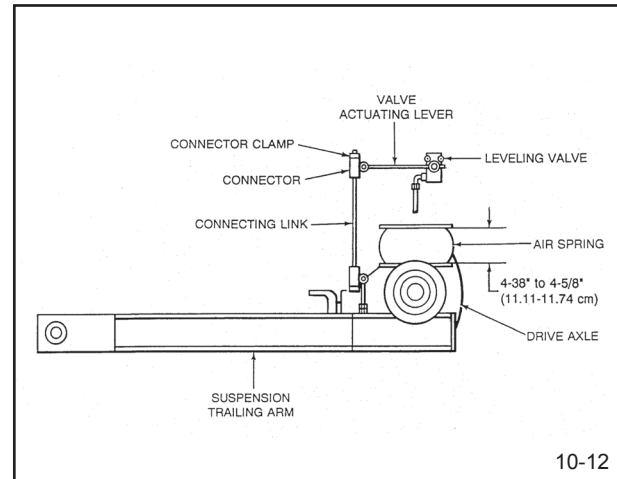
1. Disconnect both lower shock mounts and pull down on the shock until the shock is fully extended.
2. Inspect the shock for leaks in the piston rod seal area.
 - Shock fluid is a thin hydraulic fluid that is dark brown in color with a characteristic odor. A slight trace of fluid seepage is permissible, as the seal is designed to seep a slight amount of fluid to provide for piston rod lubrication.

REAR AXLE AND SUSPENSION

- If more than a slight trace of fluid is present, confirm that the fluid does not originate from another source (i.e. oil spray from the engine, the air compressor, etc.) before making the determination that the shock is leaking.
3. Grip the lower end of the shock securely and compress and extend the piston several times.
 - Rebound resistance (extending the shock) should be greater than the compression resistance. If in doubt, compare the compression and rebound resistances of the suspect shock to a known good shock.
 - Resistance should be smooth and constant in each stroke directions. Replace the shock if any binding or unusual noises are present.
4. Extend the shock to the limit of travel and inspect the rod for bends.
Replace the shock as necessary.
5. Compare the compression and rebound resistances between both shock absorbers by stroking both shock absorbers as described in step 3.
Replace both shock absorbers if a definite difference is noticed in either the compression or rebound resistances.
6. Inspect the mounting brackets for looseness or wear.
Replace/tighten the mounting brackets as necessary.
7. Inspect rubber bushings and grommets for wear or deterioration.
Replace the rubber bushings and/or grommets as necessary.

Ride Height Check and Adjustment

1. Park the vehicle without a trailer on a flat, level surface, apply the parking brake and shut down the engine.
2. Measure the height of the air springs as shown in Figure 10-12.

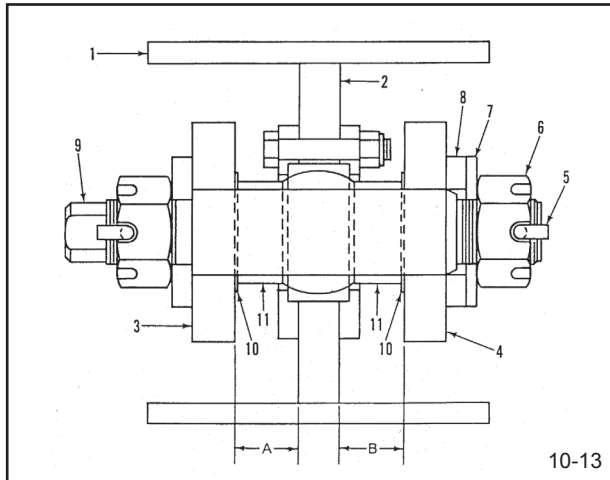


- With no load on the vehicle, air spring height should be 4 3/8 in to 4 5/8 in (11.11 cm to 11.74 cm).
3. Connect the vehicle to a loaded trailer and apply the parking brake.
 4. Measure the height of the air springs.
With a full load, if the air spring height is not 4 3/8 in to 4 5/8 in (11.11 cm to 11.74 cm), continue with step 5.
 5. Loosen the connector clamp at the top linkage connector. See figure 10-12.
 6. Raise the top connector and the valve actuating lever to open the leveling valve and allow more air pressure to enter the air springs.
 7. When the air springs reach the correct ride height, lower the top connector until the leveling valve closes.
 8. Tighten the top connector clamp.
 9. Recheck the air spring height both loaded and unloaded:
 - If the ride height is too low, loosen the top connector clamp, raise the top connector slightly and tighten the top connector clamp.
 - If the ride height is too high, loosen the top connector clamp, lower the top connector slightly and tighten the top connector clamp.

REAR AXLE AND SUSPENSION

Pivot Bearing Inspection

1. Park the vehicle on a flat, level surface, set the parking brake and chock the wheels to prevent vehicle movement.
2. Pry the suspension trailing arm (1) to one side and measure distances between vertical bearing mount plate (2) and each cross tube ear (3 and 4). See figure 10-13, dimensions 'A' and 'B'.



3. Calculate the difference between 'A' and 'B'.
 - If the difference is greater than 1/8 in (3.18 mm), perform the Pivot Bearing Replacement procedures on page 10-10.
 - If the difference is less than 1/8 in (3.18 mm), proceed with step 4 to shim the bearing.
4. Place a suitable jack under the bearing area of the suspension trailing arm (1) and support the weight of trailing arm.
5. Remove the cotter pin (5), the slotted nut (6), the washer (7) and the spacer (8), and discard the cotter pin.
6. Drive out the pivot pin (9), remove the bushings (11), and discard the pivot pin and bushings.
7. Install a new pivot pin, new bushings and as many shims (10) as will fit between the cross tube ears (3 and 4) and the bushings (11).

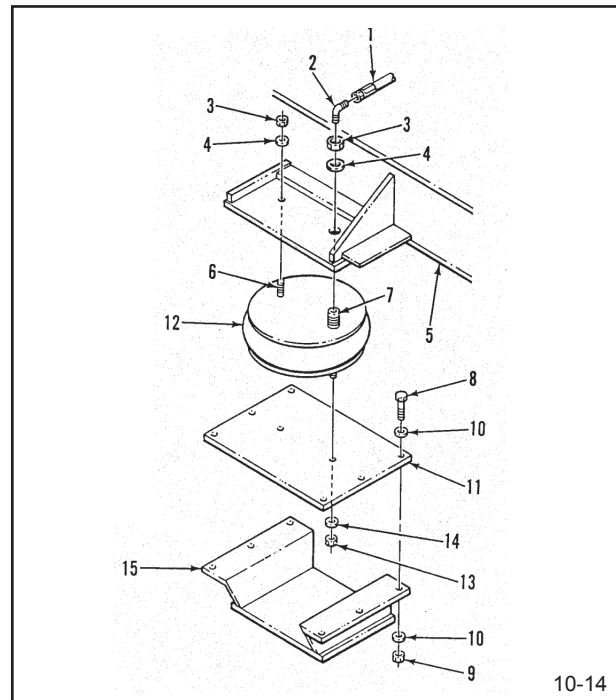
NOTE: Attempt to install an equal quantity of shims on either side of the suspension trailing arm.

8. Install the spacer (8), the washer (7) and the slotted nut (6).
9. Tighten the slotted nut to 500 lb-ft (677.9 N•m) torque.
10. Install a new cotter pin (5).

Repair

Air Spring Replacement

1. Park the vehicle on a flat, level surface and set the parking brake.
2. Raise the boom to the upper limit of its travel to allow access to the air springs.
3. Press and release the brake pedal approximately thirty times to decrease air brake system pressure to 0 psi (0 bar).
4. Disconnect the air line (1) from the air spring fitting (2). See figure 10-14.



5. Remove the locknuts (3) and the washers (4).
6. Attach a suitable hoist to raise the vehicle frame (5) until the frame clears the stud (6) and the tube (7) and so the bolts (8) and locknuts (9) can be accessed.
7. Install jack stands and/or wooden blocks to support the raised vehicle frame.
8. Remove the locknuts (9), the washers (10) and the bolts (8), and remove the mounting plate (11) with air spring (12) from the bracket (15).
9. Remove the locknuts (13) and the washers (14), and remove the air spring (12) from the mounting plate (11).
10. Install the new air spring onto the mounting plate (11) using the washers (14) and the locknuts (13).

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REAR AXLE AND SUSPENSION

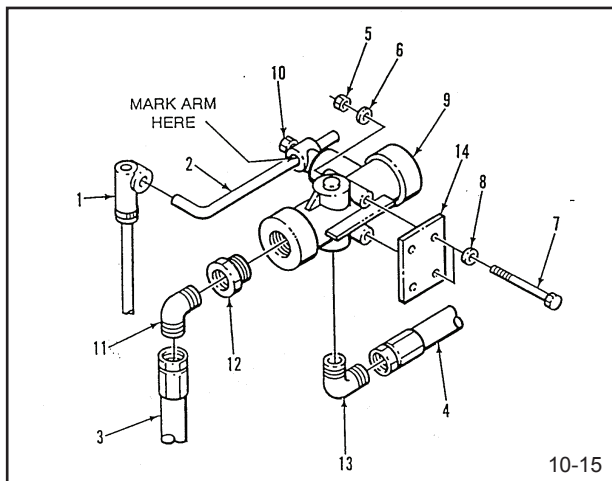
11. Position the mounting plate (11) with air spring (12) on the bracket (15), oriented with the tube (7) towards the rear of the vehicle.
12. Secure the mounting plate (11) to the bracket (15) using the bolts (8), the washers (10) and the locknuts (9).
13. Raise the frame slightly, and remove the jack stands and/or the blocks.
14. Slowly lower the frame (5) onto the air springs (12) making sure that the tube (7) and the stud (6) align with frame mounting holes.
15. Install the washers (4), the locknuts (3) and the fitting (2).
16. Connect the air line (1).
17. Start up the engine and allow the air pressure to increase to the normal operating level.

NOTE: The air springs should inflate automatically.

18. Check air line connections for leaks using a soapy water solution.
19. Perform the Ride Height Check and Adjustment procedures on page 10-8.

Leveling Valve Replacement

1. Park the vehicle on a flat, level surface and set the parking brake.
2. Raise the boom to the upper limit of its travel to allow access to the leveling valve.
3. Press and release the brake pedal approximately thirty times to decrease air brake system pressure to 0 psi (0 bar).
4. Pull the connector (1) from the valve arm (2). See figure 10-15.

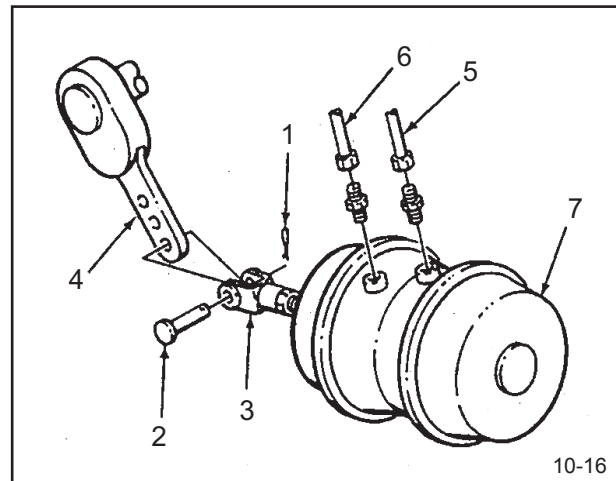


5. Tag, disconnect and plug the air lines (3 and 4).

6. Remove the locknuts (5), the washers (6), the bolts (7) and the washers (8), and remove and discard the leveling valve (9).
7. Mark the valve arm (2), as shown in figure 10-15, loosen the bolt (10) and remove the valve arm.
8. Install the valve arm (2) onto to the new leveling valve (9) to the mark made in step 7.
9. Install the fittings (11, 12 and 13) onto the new leveling valve (9).
10. Install the new leveling valve (9) onto the bracket (14) using the bolts (7), the washers (6 and 8) and the locknuts (5).
11. Connect the air lines (3 and 4).
12. Attach the connector (1) to the valve arm (2).
13. Start up the engine and allow the air pressure to increase to the normal operating level.
14. Check air line connections for leaks using a soapy water solution.
15. Perform the Ride Height Check and Adjustment procedures on page 10-8.

Pivot Bearing Replacement

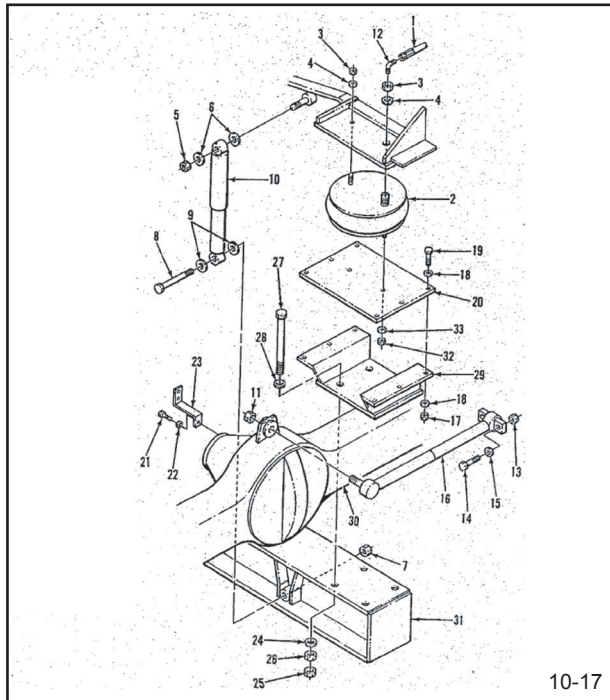
1. Park the vehicle on a flat, level surface and chock the front wheels to prevent vehicle movement.
2. Remove the cotter pin (1) and the clevis pin (2), and disconnect the brake chamber clevis (3) from the slack adjuster (4). Discard the cotter pin. See figure 10-16.



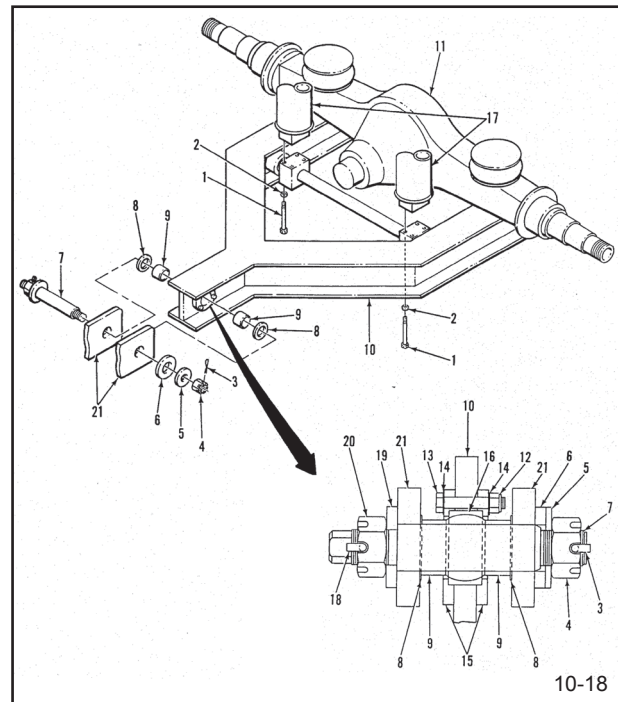
3. Press and release the brake pedal approximately thirty times to decrease air brake system pressure to 0 psi (0 bar).

REAR AXLE AND SUSPENSION

4. Raise the boom to the upper limit of its travel to allow access to the air springs, and install supports to hold the boom in the elevated position.
5. Disconnect the air hose (1) from each fitting (12) and remove the fittings (12), the locknuts (3) and the washers (4) from the air springs (2). See figure 10-17.



6. Remove the locknuts (5 and 7), the bolts (8) and the washers (6 and 9), and remove the shock absorbers (10).
7. Remove the locknut (11), the bolts (14), the washers (15) and locknuts (13), and remove the track rod (16).
8. Attach a suitable hoist to the rear of the vehicle frame and raise the frame until the frame clears the air springs (2).
9. Install jack stands and/or wooden blocks to support the raised vehicle frame.
10. Disconnect the hoist from the vehicle frame and attach the hoist to the boom.
11. Apply a lifting force that is sufficient to support the weight of the boom.
12. Remove the bottom boom cylinder bolts (1) and lock washers (2). See figure 10-18.

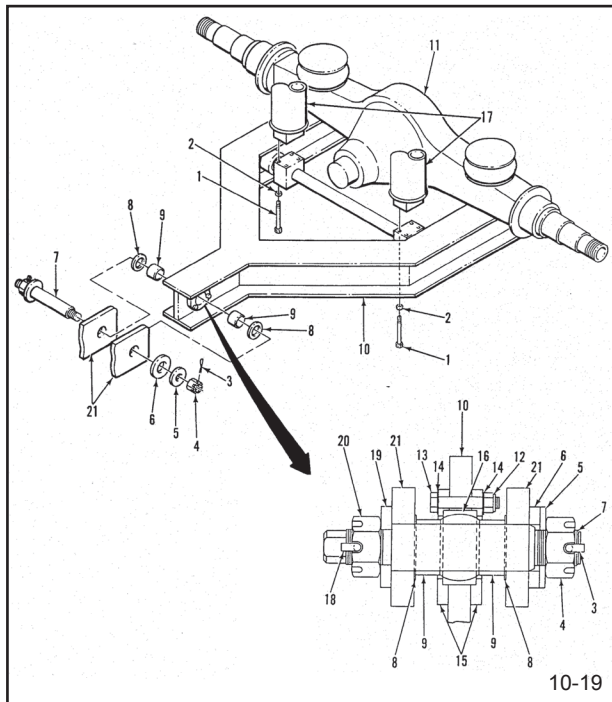


13. Raise the boom slightly.
14. Place a suitable support under the bearing end of the suspension trailing arm (10) that will allow the suspension trailing arm and the axle (11) to be moved towards the rear of the vehicle.
15. Remove the cotter pin (3), the castellated nut (4), the washer (5) and the spacer (6). Discard the cotter pin (3).
16. Drive out the pivot pin (7) and remove the shims (8) and the bushings (9). Discard the pivot pin and the bushings.
17. Move the suspension trailing arm with the axle towards the rear of the vehicle approximately 6 in (15.2 cm).
18. Remove the locknuts (12), the bolts (13) and flat washers (14), and remove the clamp plates (15) and the bearing (16). Discard the bearing.
19. Install the new bearing (16) and the clamp plates (15) onto the suspension trailing arm (10) using the bolts (13), the flat washers (14) and the locknuts (12).
20. Install the pin head (19), the castellated nut (20) and a new cotter pin (18) onto a new pivot pin (7).
21. Move the suspension trailing arm (10) into position between the mounting ears (21).
22. Install the new bushings (9).

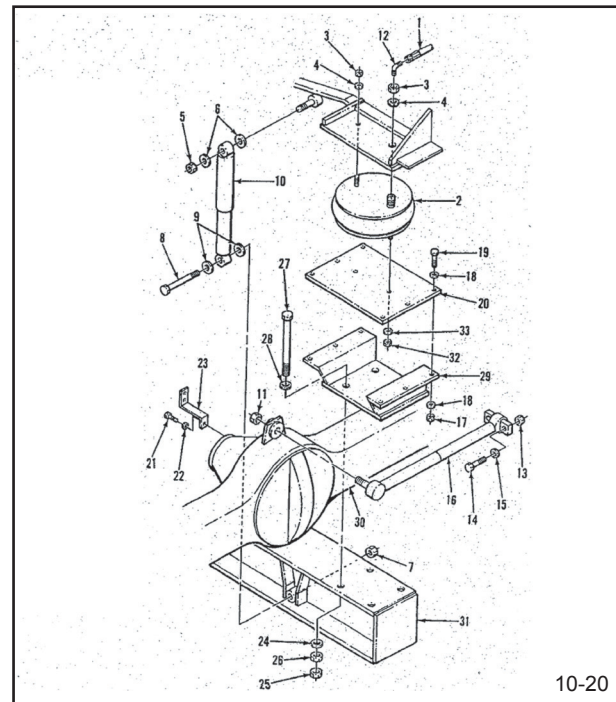
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REAR AXLE AND SUSPENSION

23. Install the pivot pin (7) with pin head, castellated nut and cotter pin. See figure 10-19.



24. Install the spacer (6) and the washer (5).
25. Lubricate the castellated nut (4) and tighten the nut to 500 lb-ft (677.9 N•m) torque.
26. Pry the suspension trailing arm (10) to one side and check the clearance between the bushings (9) and the mounting ears (21).
27. If clearance exists, remove the nut (4) and the pivot pin (7) and install shims (8) between the bushings (9) and the mounting ears (21).
28. Reinstall the spacer (6), the washer (5) and the castellated nut (4).
29. Tighten the nut (4) to 500 lb-ft (677.9 N•m) torque.
30. Install a new cotter pin (3).
31. Align the boom cylinders (17) to the mounting blocks and install the bottom boom cylinder bolts (1) and lock washers (2)
32. Disconnect the hoist from the boom and attach the hoist to the rear of the vehicle frame.
33. Raise the vehicle frame and remove the jack stands.
34. Slowly lower the vehicle frame onto the air springs (2) making sure that the air spring tube and stud align with frame mounting holes. See figure 10-20.



35. Install the washers (4) and the locknuts (3).
36. Install the fittings (12) onto the tubes on the air springs (2) and connect the air hoses (1) to the fittings.
37. Install the track rod (16) using the bolts (14), the washers (15), the lock nuts (13) and the locknut (11).
38. Install the shock absorbers (10) using the locknuts (5) and the washers (6) and the bolts (8), the washers (9) and the locknuts (7).
39. Tighten the locknuts (5 and 7) until the clearance between their corresponding washers (6 and 9) is 1 3/4 in (44.5 mm).
40. Start up the engine and allow the air pressure to increase to the normal operating level.
41. Release the parking brake.
42. Connect the slack adjuster (4) to the brake chamber clevis (3) using the clevis pin (2) and a new cotter pin (1). See figure 10-16.
43. Check air line connections for leaks using a soapy water solution.

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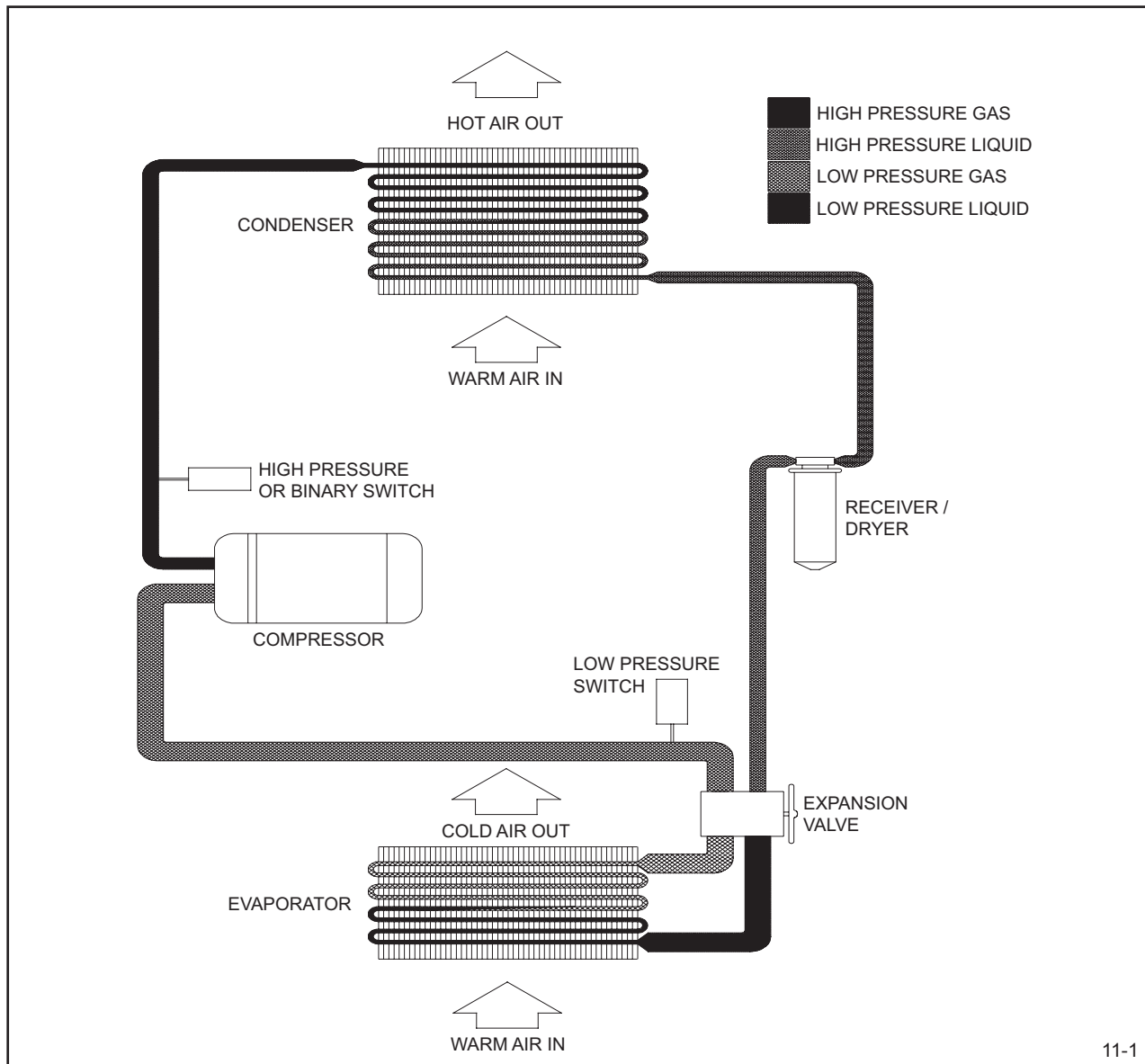


COMPONENTS AND THEORY OF OPERATION

A/C System

The A/C system consists of the following major components (see figure 11-1):

- Compressor/Clutch assembly
- Condenser
- Receiver/Dryer
- Expansion valve
- Evaporator
- Thermostat
- Pressure (binary) switch
- Air filter



HVAC SYSTEM

Compressor/Clutch Assembly

The compressor pumps refrigerant through the system. It is belt-driven and controlled by a magnetic clutch on the drive pulley. The compressor has an outlet to the high/discharge side of the system, and an inlet from the low/suction side of the system. Refrigerant and oil leave the compressor in a gaseous state and flow towards the condenser.

Condenser

The condenser is a heat-transfer coil that is mounted on the front of the radiator. The engine cooling fans provides airflow which cools the refrigerant as it flows through the condenser to remove heat from the system. As the refrigerant passes through the coil and cools, it changes state from a gas into a liquid.

Receiver/Dryer

The receiver/dryer has three functions:

- To remove moisture from the refrigerant:
The receiver/dryer uses a desiccant material to absorb the moisture in the refrigerant.
- To filter contaminants from the system:
The internal matting and screens remove particulates floating in the refrigerant.
- To act as a storage tank for the liquid refrigerant:
If the refrigerant flowing from the condenser is in a combined state of a liquid and a gas, the receiver/dryer separates the gas from the liquid. This ensures a steady flow of liquid refrigerant to the expansion valve under widely varying temperatures and operating conditions.

The refrigerant enters through the top the receiver/dryer and flows through the desiccant material and the filter before exiting through a pickup tube near the bottom of the receiver/dryer tank. The liquid refrigerant then flows to the expansion valve.

NOTE: Although figure 11-1 shows a high pressure switch between the compressor and the condenser and a low pressure switch between the evaporator and the compressor, this system uses a binary pressure switch mounted to a port on the receiver/dryer.

Expansion Valve

When refrigerant exits the receiver/dryer, it passes through another high-pressure hose to a metering device at the inlet of the evaporator coil. This metering device is the expansion valve.

System pressure between the compressor and this point is high and can range from 150 to 250 psi (10.3 to 17.2 bar). The expansion valve effectively separates the high and the low sides of the system. The valve senses the temperature of the refrigerant leaving the evaporator and uses that information to properly meter the refrigerant entering the evaporator.

Evaporator

The evaporator core is the low pressure, low temperature component of the system. The refrigerant absorbs heat energy from the cab air that is blown across the coil fins by the blower. The rapid expansion of the refrigerant that is metered from the orifice in the expansion valve causes a reduction in the temperature of the refrigerant. The difference in the temperature of the refrigerant and the air temperature causes the cold refrigerant to absorb heat energy very rapidly, thus cooling the air. This cooling will also cause moisture in the incoming air to condense on the coil and reduce the humidity of the exiting air. Condensation is drained out of the unit through drain tubes under the cab.

Thermostat

The thermostat is used to cycle the compressor off when the evaporator coil gets too cold. This is done to prevent ice from forming on the evaporator coil, which will degrade system performance. The thermostat is mounted inside the main evaporator housing, and is equipped with a probe that is located inside the evaporator coil.

The probe senses evaporator coil temperature which opens or closes the thermostat switch as needed.

The electrical control circuit functions with power coming from the A/C ON/OFF switch. When the A/C ON/OFF switch is turned ON, current is routed through the thermostat and the binary pressure switch, and ends at the compressor clutch. The compressor can cycle ON and OFF based on high or low pressure (binary) or temperature (thermostat).

Pressure (Binary) Switch

The pressure (binary) switch protects the system from damage to components, such as the compressor, caused by excessively high and excessively low pressures. The pressure (binary) switch is located on the receiver/dryer.

Air Filter

Recirculation air filters clean the cab air that is recycled back through the evaporator. Many of these filters are made of open-cell type foam, although paper types are also used. In special applications, filters can be used that will remove very fine particles and chemical odors. The greater the recirculated cab air volume that can be utilized, the easier it is for the system to cool the cab to the comfort level. It is important to control the recirculation air volume and force the blower to pull enough fresh air to maintain slight cab pressurization and keep dust and odors from entering the cab.

Heating System

The heating system consists of the following major components:

- Heater core
- Electronic water valve

Heater Core

The heater core is located inside the evaporator box. The coolant inlet and outlet flow through bulkhead connectors in the floor of the unit.

Electronic Water Valve

The electronic water valve is located under the cab on the LH front side, beneath the evaporator.

The valve uses an infinitely-variable rotary switch, which is located on the instrument panel, to control coolant flow.

MAINTENANCE

NOTE: *The HVAC air inlet filter, the condenser and the compressor belt should be checked once a week in normal operating conditions and once a day in severe operating conditions.*

HVAC Air Inlet Filter

The inlet air filter is located at the inlet of the HVAC unit. When sitting in the driver's seat, it is under the dash near the left side kick panel, and is held on with velcro. Once removed, it can be cleaned by hand or by carefully blowing compressed air through it from the outlet side, reverse of the normal airflow direction.

Keeping the filter clean is critical to maintaining proper air conditioner and heater performance.

If the filter has been mis-located and there is debris on the evaporator core, this must be cleaned off before reinstalling the filter. When reinstalling, make sure the filter is positioned to fully cover the intake opening.

Condenser

The condenser is located behind the front grill with the air charge cooler and radiator. It needs to be clean to perform as intended. A dirty condenser can also negatively effect the engine's cooling system. Carefully inspect it for dirt, dust, mud or debris and clean with a pressure washer.

Compressor Belt

Check the belt tension and condition regularly. Adjust if the belt is too loose, and replace it if there is any evidence of excessive wear, cracks or damage.

Evacuation and Charging

Equipment Used

- R-134a Manifold Gauge Set
- Vacuum Pump for R-134a
- Electronic Scale (5-100 lb range, accurate to .5 ounce)
- Tank of Refrigerant: R-134a
- PAG Refrigerant Oil
- Thermocouple or RTD temperature measurement device

Evacuation

Proper evacuation is necessary to remove all air, moisture and contaminants from the refrigeration system. Perform the following:

1. Connect the manifold gauge set to the HVAC system.
2. Connect the vacuum pump to the gauge set, and open valves.
3. Turn on the pump and evacuate the system to a minimum of 29.2 in Hg.
4. After fifteen minutes, close the valves and note the vacuum pressure.
 - If the pressure hasn't changed, evacuate the system for a minimum of thirty additional minutes.

HVAC SYSTEM

- If the pressure has changed, the system has a leak. Add a token R- 134a charge to the system to detect leaks.

NOTE: *Never use compressed air to add pressure to a system for a leak check.*

Charging

NOTE: *The proper charge for this system is 1.8 lbs (0.8 kg).*

1. After the system has been evacuated for a minimum of 45 minutes, close both the high and the low manifold gauge valves, and disconnect the vacuum pump.
2. Connect the yellow hose to the refrigerant canister.
3. Open the valve on the canister.
4. Loosen the fitting at the manifold gauge set to purge air from the yellow line, and then retighten the fitting.
5. Place the canister on a scale and record the canister weight.
6. Open both valves on the gauge set to allow refrigerant into the system.
7. When the refrigerant flow stops, close the high side valve and start up the engine.
8. Set the AC controls to high fan and the coldest thermostat setting.
9. Monitor the refrigerant charge on the scale and when the correct 1.8 lb (0.8 kg) weight has been achieved, close the valve on the canister and then close the manifold valve.
10. Turn the ignition switch to the 'OFF' position and disconnect the gauge set.

TROUBLESHOOTING

Symptom	Cause	Solution
Blower fans, condenser fans and compressor clutch are inoperative	Blown fuse	Replace fuse
	Faulty blower fan switch	Replace blower fan switch
	Faulty wiring	Replace or repair wiring
Condenser fans and compressor clutch are inoperative	Faulty blower fan switch	Replace blower fan switch
	Faulty thermostat switch	Replace thermostat switch
	Faulty relay	Replace relay
	Faulty wiring	Replace or repair wiring
	Blown fuse	Replace fuse
	No supply voltage	Repair supply voltage
Blower fan is inoperative	Faulty blower fan switch	Replace blower fan switch
	Faulty wire from fan switch to blower motor	Replace or repair wire
	Faulty blower motor	Replace or repair blower motor
	Blown fuse	Replace fuse
Condenser fans are inoperative	No supply voltage	Repair supply voltage
	Faulty blower fan switch	Replace blower fan switch
	Faulty A/C ON/OFF switch	Replace A/C ON/OFF switch
	Faulty thermostat switch	Replace thermostat switch
	Faulty condenser relay	Replace condenser relay
	Faulty pressure switch(es)	Replace pressure switch(es)
	Faulty wiring	Replace or repair wiring
	Faulty condenser fan motor	Replace condenser fan motor
Compressor clutch is inoperative	Blown fuse	Replace fuse
	No supply voltage	Repair supply voltage
	Faulty blower fan switch	Replace blower fan switch
	Faulty A/C ON/OFF switch	Replace A/C ON/OFF switch
	Faulty thermostat switch	Replace thermostat switch
	Faulty condenser relay	Replace condenser relay
	Faulty pressure switch(es)	Replace pressure switch(es)
	Faulty wiring	Replace or repair wiring
Compressor does not turn	Faulty compressor clutch	Replace compressor clutch
	Loose/broken drive belt	Tighten or replace drive belt
Compressor does not turn	Slipping compressor clutch	Clean or replace compressor clutch
	Faulty compressor	Replace or repair compressor, replace drier and flush, evacuate and recharge system
Obstructed air flow through evaporator or condenser cores	Plugged evaporator core	Clean evaporator core
	Plugged condenser core	Clean condenser core
	Iced up evaporator core	Replace or repair thermostat switch or expansion valve

HVAC SYSTEM

Symptom	Cause	Solution
Unit shuts off too soon	Faulty thermostat switch	Replace thermostat switch
	Faulty pressure switch(es)	Replace pressure switch(es)
	System overcharged	Discharge and recharge system to proper level
Electronic water valve does not operate (24 V voltage regulator only)	Defective voltage regulator (with 24 V on regulator red wire, 12 V should be on regulator blue wire)	Replace voltage regulator
	Defective potentiometer	Replace potentiometer
	Defective water valve	Replace water valve
Suction pressure is too high	Expansion valve stuck open	Replace expansion valve
	Moisture or air in system	Install gauges, discharge and flush system, replace drier and flush, evacuate and recharge system
	Insufficient oil in system	Add oil to system
	Slipping compressor belt	Tighten compressor belt
	Compressor valves defective	Replace or repair compressor, replace drier and flush, evacuate and recharge system
	Condenser malfunction	Replace or repair compressor, replace drier and flush, evacuate and recharge system
Suction pressure is too low	Low refrigerant charge	Install gauges and add refrigerant
	Iced up evaporator core	Check thermostat switch, expansion valve and blower
	Moisture in system	Install gauges, discharge and flush system, replace drier and flush, evacuate and recharge system
	Expansion valve stuck closed	Replace expansion valve
	Restricted liquid line	Discharge system, remove restriction, replace drier and flush, evacuate and recharge system
Discharge pressure is low	Low refrigerant charge	Install gauges and add refrigerant
	Slipping compressor belt	Adjust or replace compressor belt
	Slipping compressor clutch	Clean or replace compressor clutch
	Faulty compressor	Replace or repair compressor, replace drier and flush, evacuate and recharge system
Discharge pressure is high (continued on next page)	Air or excessive oil in condenser	Install gauges, discharge system and flush, replace drier and flush, evacuate and recharge system
	System is overcharged	Discharge system, remove restriction, replace drier and flush, evacuate and recharge system
	Engine overheating	Allow engine to cool
	Fan belt slipping	Tighten fan belt
	Condenser core plugged	Clean condenser core
	Condenser fans are inoperative	See solutions for this Symptom on page 11-5

Symptom	Cause	Solution
Discharge pressure is high	High pressure side restriction	Discharge system, remove restriction, replace drier and flush, evacuate and recharge system
	Expansion valve superheat setting too low	Replace with proper expansion valve
	Expansion valve stuck closed	Replace expansion valve
	Filters or screens plugged	Clean filters or screens
	Faulty thermostat switch	Replace thermostat switch

Procedures

Air and/or Moisture in System

Symptoms:

- Low side normal
- High side normal
- Sight glass is clear or shows few bubbles
- Discharge air is slightly cool
- Low side gauge does not fluctuate with thermostat cycle

Procedures:

1. Test for leaks, especially around the compressor shaft seal area.
2. Recover system and repair any leaks.
3. Replace the receiver/dryer or the accumulator.
4. Evacuate and recharge the system.
5. Check A/C operation and performance.

Excessive Air and/or Moisture in System

Symptoms:

- Low side high
- High side high
- Sight glass shows tiny bubbles
- Discharge becomes warm as low side cycles into vacuum

Procedures:

1. Test for leaks.
2. Recover system and repair any leaks.
3. Replace the receiver/dryer or the accumulator.
4. Evacuate and recharge the system, and check A/C operation and performance.

Faulty Thermostat Switch

Symptoms:

- Low side normal
- High side normal
- Compressor cycles frequently
- Low side pressure may fluctuate in an above-normal range as compressor cycles

Procedures:

1. Test for leaks, especially around the compressor shaft seal area.
2. Recover system and repair any leaks.
3. Check placement of thermostat capillary tube and move if necessary to reduce short-cycling.
4. Replace thermostat with one of same type if the problem is not solved. Make sure that the capillary tube is inserted at the same location in the core as the replaced tube.

Thermostat Switch Not Adjusted Correctly or Faulty Pressure Switch(es)

Symptoms:

- Low side low to normal or normal to high
- High side normal
- Compressor cycles at incorrect temperature or pressure
- Evaporator may freeze and restrict airflow if switch is allowing compressor to remain on too long

Procedures:

1. Turn the thermostat adjusting screw (if equipped) to adjust the cut-out setting.
2. Move the capillary tube to a different location in the evaporator core. Verify that the evaporator core does not freeze with the capillary tube in the new location.
3. Replace pressure switch if defective.

HVAC SYSTEM

Low Refrigerant Charge in System

Symptoms:

- Low side low
- High side low
- Sight glass shows some bubbles
- Discharge air is slightly cool

Procedures:

1. Test for leaks.
2. If a leak is found at a connection, tighten the connection and recheck for leaks, then add refrigerant.
3. If a component requires replacement, recover the system and replace the component.
4. Evacuate and recharge the system.
5. Check A/C operation and performance.

Extremely Low Refrigerant Charge in System

Symptoms:

- Low side low
- High side low
- Sight glass is clear or shows oil streaks
- Discharge air is warm
- Compressor may be inoperable due to properly functioning pressure switch

Procedures:

1. Test for leaks: Add one half the normal full charge amount, then check for leaks.

NOTE: Dry nitrogen gas may be used as an alternative to refrigerant.

2. Use a jumper wire to bypass the low pressure switch in order to operate the compressor, if necessary.
3. After finding a leak, recover the system and replace the leaking component.
4. Evacuate and recharge the system.
5. Check A/C operation and performance.

Expansion Valve Stuck Closed or Plugged

Symptoms:

- Low side low
- High side high
- Discharge air is slightly cool
- Expansion valve is frosted or sweating

Procedures:

1. Perform Thermostatic Expansion Valve (TXV) test:
 - a. Warm the diaphragm and the valve body by hand or with a heat gun.
 - b. Check if the low pressure side rises.
 - c. Spray liquid nitrogen onto the capillary bulb or the valve diaphragm.
The low-side gauge should drop, indicating the valve was part-way open and your action closed it.
 - d. Repeat the test, but first warm the valve diaphragm or capillary by hand.
If the low-side pressure drops again, the valve is not stuck.

NOTE: If low-side pressures did not change during the TXV test, the expansion valve is defective and must be replaced.

2. Recover refrigerant from the system.
3. Remove the TXV and inspect and clean the valve or replace the valve if the valve is contaminated.
4. Replace the receiver/dryer.
5. Evacuate and recharge the system.
6. Check A/C operation and performance.

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COMPONENTS

The electrical system consists of the following major components:

- Batteries
- Alternator
- Voltage regulator
- Ignition and starter switch
- Starter motor
- Body control module
- Instrumentation/gauges

BATTERIES

The vehicle is equipped with two 12 V, 700 CCA, 31-ECO maintenance-free batteries, located under the steps on the RH side of the vehicle.

- Keep the top of the batteries, the terminals and the cable clamps clean. When necessary, apply a solution of baking soda and water, and rinse thoroughly with clean water.

IMPORTANT: Do not allow the cleaning solution to enter the cells through a vent or other opening.

- Clean and reapply a light coating of dielectric grease to the terminals and cable clamps when necessary.
- Inspect the cables, the clamps and the hold-own brackets. Replace any damaged components.
- Test the electrical system if the battery becomes discharged repeatedly. Refer to the table that follows as a guide to determine component failure:

Battery Charge	Charge Rate	Component Failure
Low	Low/None	Alternator, voltage regulator, wiring and/or connections
Low	High	N/A: normal operation
Full	Low	
Full	High	Voltage regulator*

* A high charging rate with a fully-charged battery will damage the battery and other electrical components.

- If the machine is to be inoperative or idle for more than 30 days, remove the batteries, and store them in a cool, dry place.

- Connect a booster battery so that the positive (+) terminal is connected to the positive terminal on the installed battery, and the negative (-) terminal is connected to the negative terminal on the installed battery.

ALTERNATOR

Observe the following precautions when working on or around the alternator, or the diodes and transistors in the alternator circuit can be damaged:

- Never ground the output wires or the field wires between the alternator and the regulator.
- Never run an alternator on an open circuit.
- Never ground an alternator's output wire or terminals; these connections are always live regardless of whether or not the engine is running. Grounding these connections will reverse the battery's polarity and result in damaged diodes.
- Never ground the field circuit, or diode damage will occur.
- Never reverse the battery connections.
- Never disconnect the batteries while the alternator is in operation, or diode damage will occur.

Some voltage regulators provide protection against some of these conditions however, caution should always be exercised when working on or around the alternator.

INSTRUMENTATION

The instrument panel consists of the following gauges:

NOTE: Configuration of the instrument panel depends upon the vehicle model year and options selected.

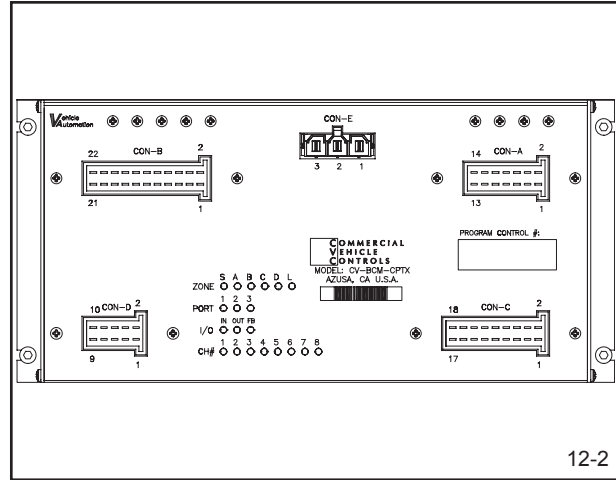
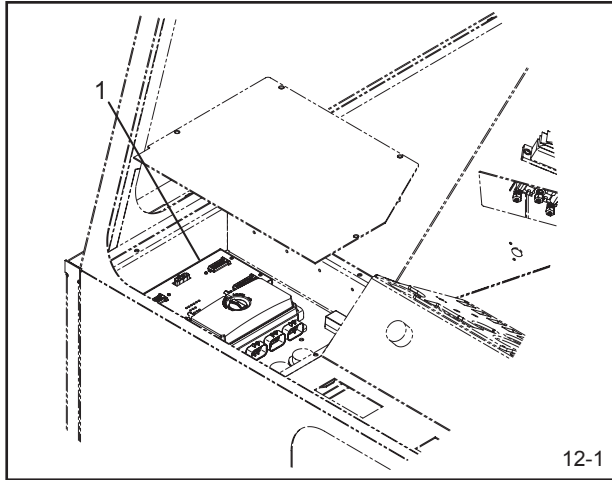
- Air system (primary)
- Air system (secondary)
- Coolant temperature
- Fuel level
- Oil pressure
- Speedometer
- Tachometer
- Voltage

See Light Bar Layout on page 12-58 for display of indicators on the light bar.

ELECTRICAL SYSTEM

BODY CONTROL MODULE (CV-BCM-CPTX)

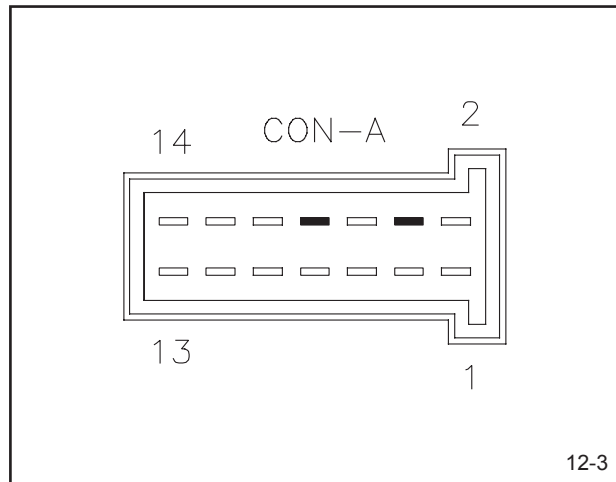
The body control module (1) is located under a panel at the front RH side of the cab. See figures 12-1 and 12-2.



Connector A

Inputs

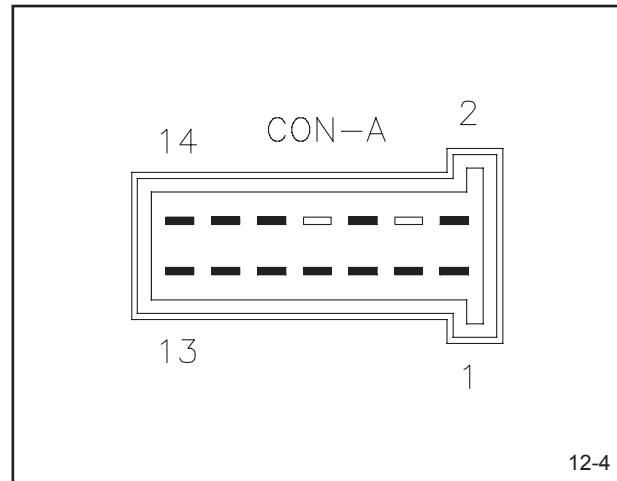
Circuit	Pin
A1-I07: Horn Switch/Wake-Up Signals	4
A1-I07: Generator R. Terminal	8



ELECTRICAL SYSTEM

Outputs

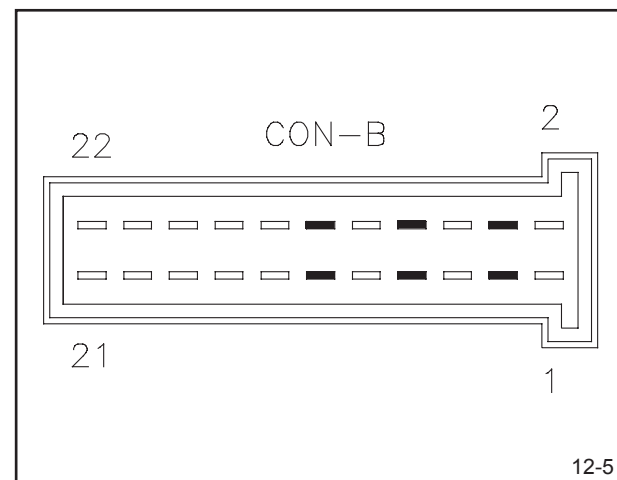
Circuit	Pin
A1-O01: Low Beam LH and RH	2
A1-O02: Turn Signal RH	6
A1-O03: High Beam LH	10
A1-O04: Fifth Wheel Lamp	12
A2-O01: Ignition Relay Signal	1
A2-O02: Work Lamps 1 Signal	3
A2-O03: Work Lamps 2 Signal	5
A2-O04: Alternator Fail Lamp	7
A2-O05: Stop/Turn Signal Lamp LH	9
A2-O06: Stop/Turn Signal Lamp RH	11
A2-O07: Dome Lamp	13
A2-O08: Strobe (Beacon)	14



Connector B

Inputs

Circuit	Pin
A1-I01: Headlight Dimmer Switch	3
A1-I02: Park Brake Switch	4
A1-I03: Interior Lights Switch	7
A1-I04: Fifth Wheel Lamp Switch	8
A1-I05: Exterior Lights Switch/Wake-Up Signal	11
A1-I06: Brake Lamp Switch	12

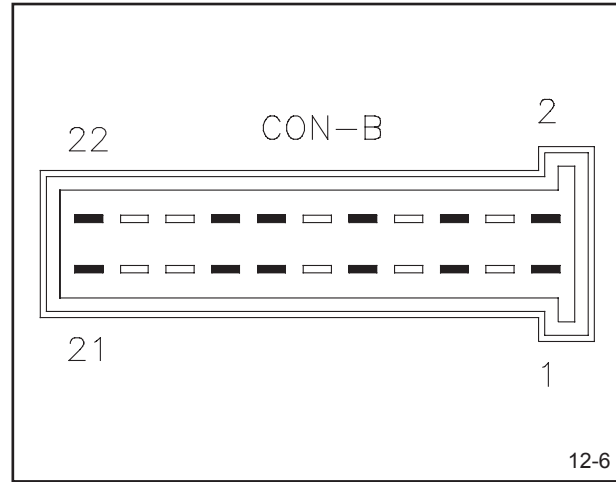


12

ELECTRICAL SYSTEM

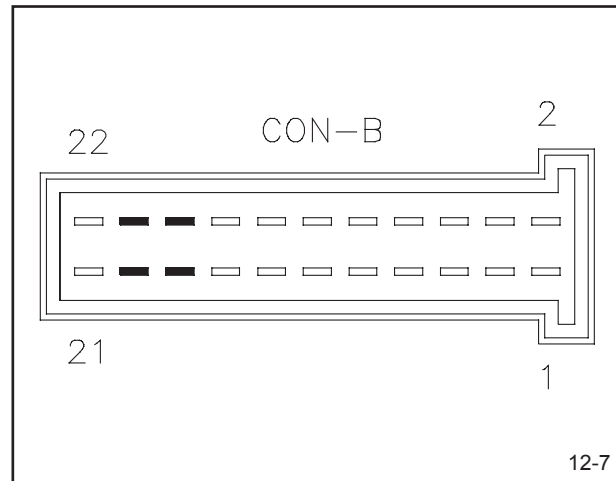
Outputs

Circuit	Pin
A1-O05: Clearance/Maker Lamps	2
A1-O06: High Beam LH	6
A1-O07: Stop Lamps	10
A1-O08: Turn Signal LH	14
A3-O01: Engine Service Brake	1
A3-O02: Engine PTO	5
A3-O03: Spare	9
A3-O04: Starter Relay Signal	13
A3-O05: Transmission Service Brake	15
A3-O06: Transmission Parking Brake	21
A3-O07: Backup Alarm/Lamps	22
A3-O08: Horn	16



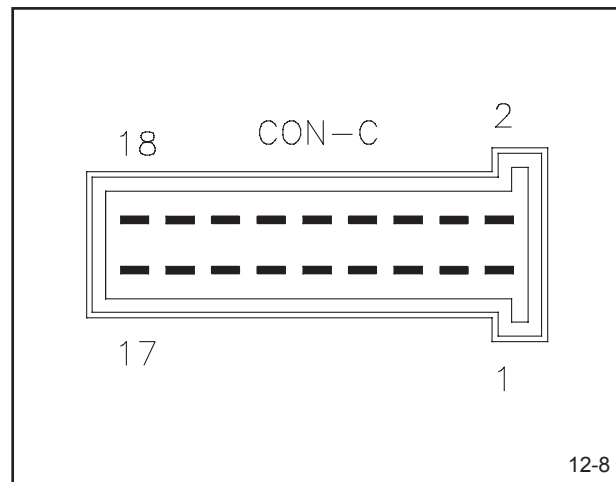
Unused

Circuit	Pin
	17
Unused	18
	19
	20



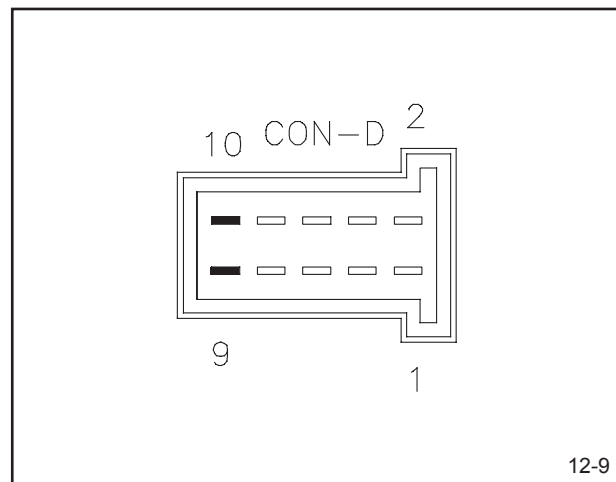
Connector C: Inputs

Circuit	Pin
A2-I01: Head Lights Switch Park	1
A2-I02: Neutral Signal	2
A2-I03: Hazard Switch/Wake-Up Signal	3
A2-I04: Spare/Wake-Up Signal	4
A2-I05: Head Lights Switch Head	5
A2-I06: Spare/Wake-Up Signal	6
A2-I07: Spare	7
A2-I08: Turn Signal Switch RH/Wake-Up Signal	8
A3-I01: Turn Signal Switch LH/Wake-Up Signal	9
A3-I02: Ignition Switch/IGNITION/Wake-Up Signal	10
A3-I03: Ignition Start Switch	11
A3-I03: N/C	17
A3-I04: Starter Lockout	12
A3-I04: N/C	18
A3-I05: Reverse Signal	13
A3-I06: Spare	14
A3-I07: Spare	15
A3-I08: Spare	16



Connector D: Internal Communication Power

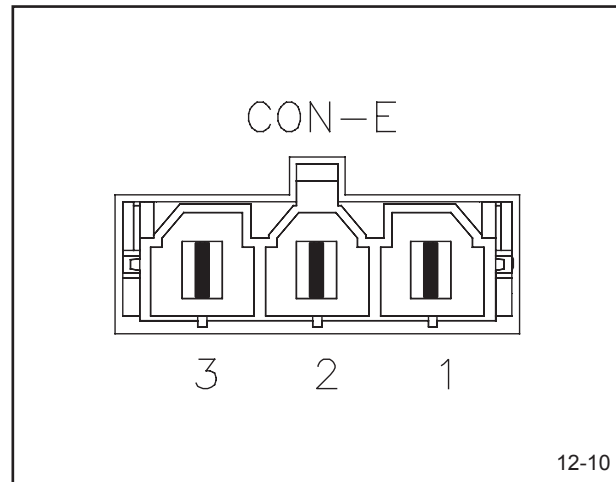
Circuit	Pin
Battery Power (12 V)	9
Battery GRND	10



ELECTRICAL SYSTEM

Connector E: Power Connector

Circuit	Pin
12 V Battery Power for Connector A Outputs and all Inputs	1
Battery GRND	2
12 V Battery Power for Connector B Outputs and all Inputs	3



Diagnostic LED Indicators

Program Revision Check

The system will run an internal self-test each time a wake-up signal is received.

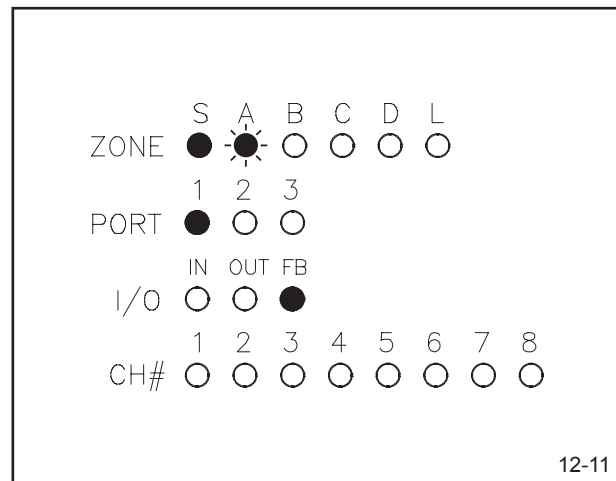
NOTE: See *Wake-Up Signals* on page 12-8 for a list of applicable components.

The following lights will be illuminated (see figure 12-11):

- ZONE S
- ZONE A
- PORT 1
- I/O FB

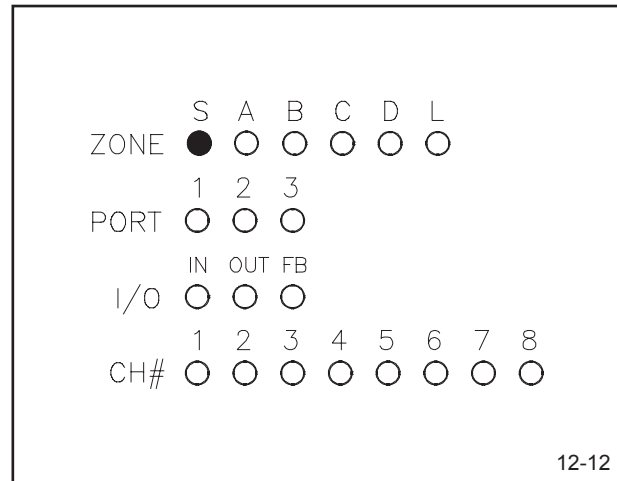
The program revision is indicated by the number of times the ZONE A light flashes, which corresponds to the program revision letter:

Number of Flashes	Revision Letter
1	A
2 through 25	B through Y
26	Z



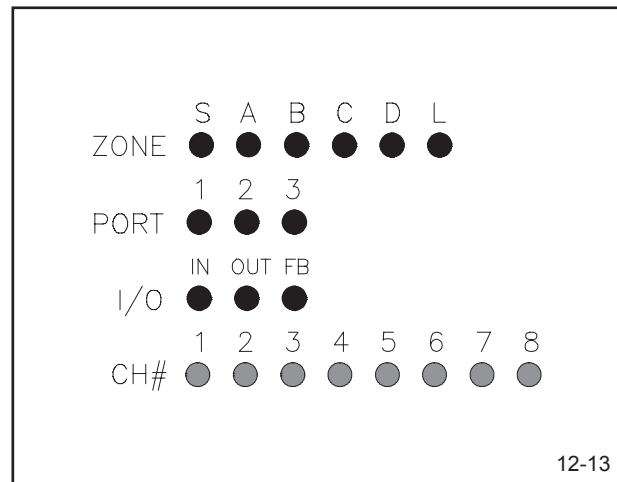
Multiplex System Status

When the multiplex module is operating normally, ZONE S is the only light illuminated. See figure 12-12.



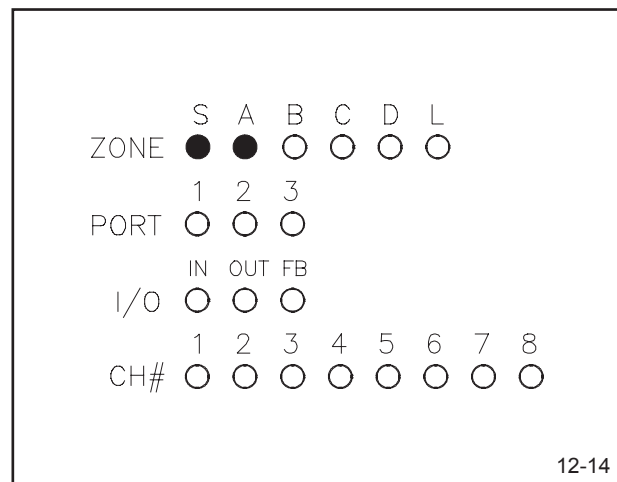
Program Not Installed in Module (WARNING)

When a program is not installed in the module, all the lights are illuminated. See figure 12-13.



Internal Communication Error (WARNING)

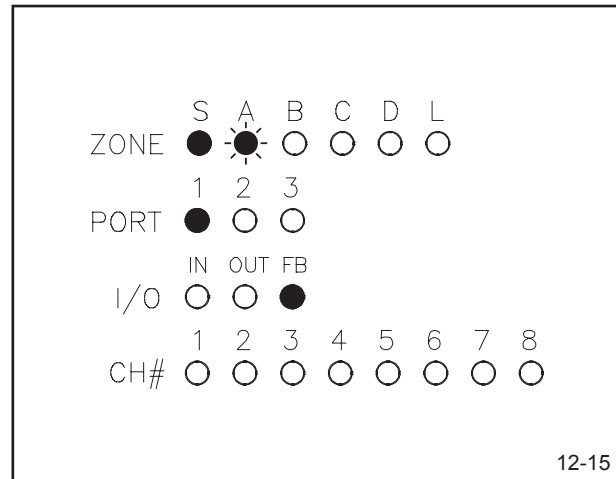
An internal communication error has occurred when ZONE S and ZONE A are the only lights illuminated. See figure 12-14.



ELECTRICAL SYSTEM

Internal Communication Error in Diagnostic Mode (WARNING)

When in diagnostic mode, an internal communication error has occurred when the ZONE A light is flashing. See figure 12-15.



Wake-Up Signals

The module has the following wake-up signal inputs:

- Horn switch
- External light switch
- Hazard switch
- Turn signal switch RH
- Turn signal switch LH
- Ignition Switch/IGNITION

Sleep Time

Fifty-five minutes after all wake-up signals are off, the system will enter sleep time.

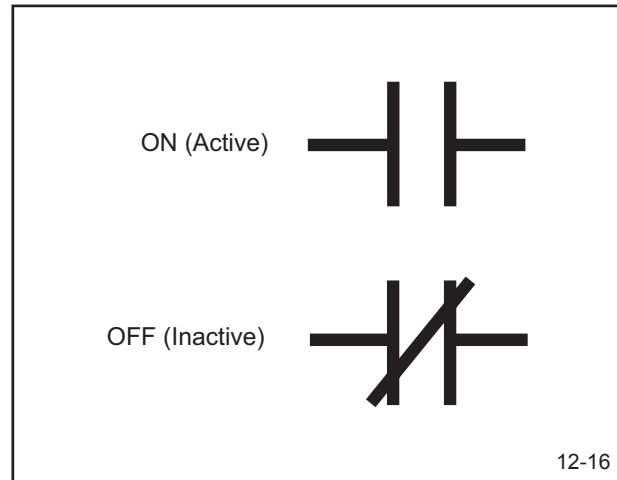
Sleep time is a programmable function that can be altered in the application program, using the GUI software.

Diagnosis and Troubleshooting

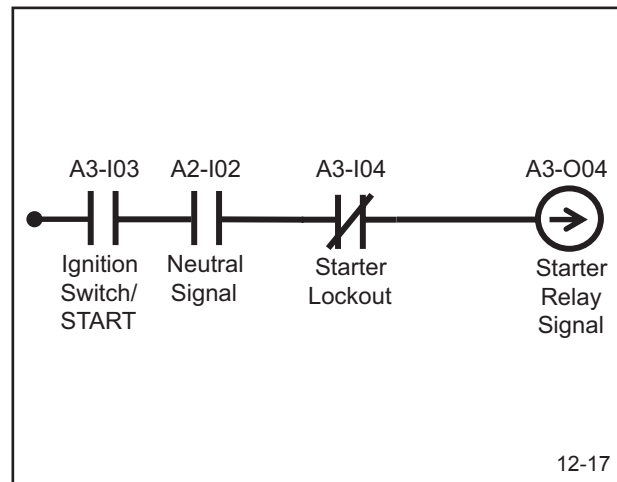
Diagnosis and troubleshooting consists of performing a visual inspection for a fault by checking the input and output conditions and referencing the ladder logic diagrams and the I/O list.

Ladder Logic Diagrams

- Ladder logic diagrams consists of a group of inputs that are required to turn an output on.
- The two main symbols used are ON (Active) and OFF (Inactive). See figure 12-16.



- Ladder logic diagrams will identify the Name of the circuit (i.e. Ignition Switch/START) and the Address of the connection to the body control module (i.e. A3-I03). See figure 12-17.



I/O List

A1

ID	Type	Description
68	DIO 8/8	CV-A1

A1: Input				
Name	Wire No.	Color	Voltage	Description
A1-I01	S10	YEL	GRND	Head Lamp Dimmer Switch
A1-I02	S05	WHT	GRND	Park Brake Switch
A1-I03	S11	RED	12 V	Interior Lights Switch
A1-I04	S13	PNK	12 V	Fifth Wheel Lamp Switch

ELECTRICAL SYSTEM

A1: Input				
Name	Wire No.	Color	Voltage	Description
A1-I05	S16	BLU	12 V	Exterior Lights Switch
A1-I06	S12	YEL	GRND	Brake Lamp Switch
A1-I07	S06	BRN	GRND	Horn Switch
A1-I08	A02	ORG	12 V	Gen R Term

A1: Output					
Name	Wire No.	Color	Voltage	Location	Description
A1-O01	A05	YEL	12 V	A1-D01, R 7	Low Beam LH and RH
A1-O02	A06	BLU	12 V	A1-D01, R 10	Turn Signal RH
A1-O03	L06	WHT	12 V	A1-D01, R 13	High Beam LH
A1-O04	L08	WHT	12 V	A1-D01, R 15	Fifth Wheel Lamp
A1-O05	L03	LGN	12 V	A1-D02, R 1	Clearance/Marker Lamps
A1-O06	L07	BLU	12 V	A1-D02, R 5	High Beam RH
A1-O07	A08	RED	12 V	A1-D02, R 7	Stop Lamps
A1-O08	L05	GRN	12 V	A1-D02, R 9	Turn Signal LH

A1: Timer				
Name	Timer Type	Time	Time Off	Description
A1-T01	Flash	0.50	0.50	Turn Signal Flasher

A2

ID	Type	Description
69	DIO 8/8	CV-A2

A2: Input				
Name	Wire No.	Color	Voltage	Description
A2-I01	S03	GRN	GRND	Head Light Switch/PARK
A2-I02	T141	TAN	12 V	Neutral Signal
A2-I03	S09	PNK	GRND	Hazard Switch
A2-I04			GRND	Unused
A2-I05	S04	LGN	GRND	Head Light Switch/HEAD
A2-I06			GRND	Unused
A2-I07			GRND	Unused
A2-I08	S07	BLU	GRND	Turn Signal Switch RH

A2: Output					
Name	Wire No.	Color	Voltage	Location	Description
A2-O01	P04	RED	12 V	A2-D01, R 5	Ignition Relay Signal

ELECTRICAL SYSTEM

A2: Output					
Name	Wire No.	Color	Voltage	Location	Description
A2-O02	P05	GRY	12 V	A2-D01, R 7	Work Lamps 1 Signal
A2-O03	P06	BLU	12 V	A2-D01, R 11	Work Lamps 2 Signal
A2-O04	A01	GRN	12 V	A2-D01, R 15	Alternator Failure Lamp
A2-O05	A03	BRN	12 V	A2-D02, R 1	Stop/Turn Signal Lamp LH
A2-O06	A04	TAN	12 V	A2-D02, R 5	Stop/Turn Signal Lamp RH
A2-O07	L04	YEL	12 V	A2-D02, R 9	Dome Lamp
A2-O08	A10	PNK	12 V	A2-D02, R 11	Strobe (Beacon)

A2: Timer				
Name	Timer Type	Time	Time Off	Description
A2-T01	Flash	0.50	0.50	Stop/Turn Signal Flash
A2-T02	Delay Off	0.50		0.5S Delay Off

A3

ID	Type	Description
70	DIO 8/8	CV-A3

A3: Input				
Name	Wire No.	Color	Voltage	Description
A3-I01	S08	YEL	GRND	Turn Signal Switch LH
A3-I02	S01	RED	GRND	Ignition Switch/IGNITION
A3-I03	S02	BLU	GRND	Ignition Switch/START
A3-I04	E02	GRN	12 V	Starter Lockout
A3-I05	T165	TAN	GRND	Reverse Signal
A3-I06			GRND	Unused
A3-I07			GRND	Unused
A3-I08			GRND	Unused

A3: Output					
Name	Wire No.	Color	Voltage	Location	Description
A3-O01	E24	WHT	GRND	A3-D01, R 1	Engine Service Brake
A3-O02	E18	YEL	GRND	A3-D01, R 3	Engine PTO
A3-O03			GRND		Unused
A3-O04	E61	BLU	GRND	A3-D01, R 7	Starter Relay Signal
A3-O05	T122	YEL	GRND	A3-D01, R 9	Transmission Service Brake
A3-O06	T101	BLU	GRND	A3-D01, R 11	Transmission Parking Brake
A3-O07	A09	YEL	12 V	A3-D01, R 13	Backup Alarm/Lamps
A3-O08	A07	GRN	12 V	A3-D01, R 15	Horn

ELECTRICAL SYSTEM

TROUBLESHOOTING

Prior to troubleshooting any electrical circuit, check the following:

- Make sure that the circuit breakers are in good condition.
- Make sure that the battery is fully charged and that the battery connections are clean and in good condition.

When checking a wiring circuit, make sure that all connectors are clean with no broken or loose terminals.

When unplugging a connector, do not pull on the wires. Pull only on the connector housings themselves.

A typical electrical circuit consists of an electrical component, switches, relays and circuit breakers related to that component, and the wiring and connectors that link the component to both the power source (batteries) and ground (chassis). To help pinpoint an electrical circuit problem, wiring schematics are included in this chapter on pages 12-14 through 12-58.

Before tracking any troublesome electrical circuit, first study the applicable schematic to obtain a complete understanding of the circuit. Trouble spots, for instance, can often be narrowed down by noting if other components related to the circuit are operating properly. If several components or circuits fail at the same time, chances are the problem is in the circuit breaker or ground connection.

Electrical problems usually stem from simple causes, such as loose or corroded connections, a bad relay and/or circuit breaker. Visually inspect the condition of circuit breakers, wiring and connections in the problem circuit before troubleshooting it.

If testing instruments are to be utilized, use the wiring diagrams to plan where you will make the necessary connections in order to accurately pinpoint the cause.

The basic tools needed for electrical troubleshooting include a circuit tester or voltmeter and a continuity tester.

Voltage Checks

Perform voltage checks when a circuit is not functioning properly:

NOTE: *Some circuits have voltage only when the ignition switch is in the RUN position.*

1. Connect one lead of a circuit tester to either the negative battery terminal or a known good ground.
2. Connect the other lead to a connector in the circuit being tested.

If the bulb in the tester illuminates, voltage is present, which means that part of the circuit is problem-free.

3. Continue checking the rest of the circuit in the same fashion.

When you reach a point at which no voltage is present, the problem lies between that point and the last test point with voltage present.

Most often the problem can be traced to loose or bad connections.

Locating a Short

1. Remove the circuit breaker and connect a test light or voltmeter to the breaker terminal.
There should be no voltage present in the circuit.
2. Move the electrical harness from side to side while watching the test light.

If the light illuminates, there is a short to ground somewhere in that area, probably where the insulation has rubbed through.

Steps 1 and 2 above can be performed on each component in the circuit, including the switch.

Ground Check

Perform a ground test to check whether a component is properly grounded.

1. Disconnect the battery and connect one lead of a self-powered test light or continuity tester to a known good ground.
2. Connect the other lead to the wire or ground connection being tested.
 - If the light illuminates, the ground is good.
 - If the light does not illuminate, the ground is bad.

Continuity Check

Perform a continuity check to determine if an open is present in a circuit.

1. Disconnect the power to the circuit.
2. Connect the test leads of a self-powered

continuity tester to both ends of the circuit (or to the 'hot' side and a good ground).

- If the test light illuminates, the circuit is passing current properly.
- If the test light does not illuminate, an open exists somewhere in the circuit.

Steps 1 and 2 above can be used to test a switch, by connecting the continuity tester to the switch terminals: with the switch turned on, the test light should illuminate.

Finding an Open Circuit

It is difficult to locate open circuits by sight due to oxidation and that terminal misalignment is hidden by connectors; wiggling a connector on a sensor or in the electrical harness may correct the problem.

Intermittent problems can be caused by oxidation or loose connections.

ELECTRICAL SYSTEM

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SD1001

Graphic Symbols Legend

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	9 TERMINAL CONNECTOR (WITH 2 UNUSED TERMINALS)		REVERSE ALARM
	SWITCH, WITH IDENTIFICATION (SHOWN OPEN)		ENGINE FAULT INDICATOR
	DIODE (POWER FLOWS LEFT TO RIGHT AS SHOWN)		LIGHT EMITTING DIODE
	APPLIANCE WITH DIRECT GROUNDING BODY, OR APPLIANCE WITH GROUND DIRECT TO CHASSIS		RELAY (SPDT) WITH RESISTOR SUPPRESSION
	JUNCTION (WHERE TWO WIRES CONNECT)		
	CIRCUIT BREAKER LOCATOR		
			<p>WIRE COLOR CODES</p> <ul style="list-style-type: none"> BLK = BLACK BLU = BLUE BRN = BROWN GRN = DARK GREEN GRY = GREY LBU = LIGHT BLUE LGN = LIGHT GREEN ORG = ORANGE RED = RED PNK = PINK TAN = TAN (LIGHT BRN OR BEIGE) WHT = WHITE YEL = YELLOW

Circuit Listing A (ISB6.7)

FUNCTION	CKT ID	COLOR	GAUGE
ALARM/INDICATOR CIRCUITS			
ALT FAIL LAMP	A01	GRN	18
ALTERNATOR R TERMINAL	A02	ORG	18
LEFT REAR STOP/T5 LAMP	A03	BRN	16
RIGHT REAR STOP/T5 LAMP	A04	TAN	16
LEFT TURN SIGNAL LAMPS	A05	YEL	14
RIGHT TURN SIGNAL LAMPS	A06	BLU	14
BACKUP ALARM/LAMPS	A07	GRN	16
STOP LAMPS	A08	RED	14
HORN	A09	YEL	16
BEACON/STROBE LAMP POWER	A10	PNK	16
FUEL LEVEL SENDER	A12	TAN	18
BEACON/STROBE LAMP SIGNAL	A14	PNK	16
BRAKING SYSTEMS/ABS			
GROUND	B101	GRY	18
TRAILER ABS WL	B102	RED	18
IGNITION	B103	RED	16
ATC-	B104	GRN	16
ATC+	B105	BLU	16
ABS WL	B106	YEL	18
J1939-	B107	GRN	20
J1939+	B108	YEL	20
WSS-DR+	B110	BRN	18
WSS-DR-	B111	BLK	18
ABS WL GROUND	B112	GRY	18
J1587-	B113	WHT	18
J1587+	B114	BLU	18
BATTERY	B116	LRU	18
ATC WL	B118	ORG	18
PMW_SL_HLD	B201	BRN	16
PMW_SL_REL	B202	BLU	16
PMW_SL_CMN	B203	YEL/GRN	16
PMW_SR_HLD	B204	BRN	16
WSS_SL+	B205	BLK	18
PMW_SR_CMN	B206	YEL/GRN	16
PMW_SR_REL	B207	BLU	16
WSS_SI-	B208	BRN	18
PMW_DR_CMN	B209	YEL/GRN	16
PMW_DR_HLD	B210	BRN	16
WSS_SR+	B211	BLK	18
PMW_DL_CMN	B212	YEL/GRN	16
PMW_DR_REL	B213	BLU	16
WSS_SR-	B214	BRN	18
WSS_DL+	B215	BLK	18
PMW_DL_HLD	B216	BRN	16
PMW_DL_REL	B217	BLU	16
WSS_DL-	B218	BRN	18

FUNCTION	CKT ID	COLOR	GAUGE
DASH PANEL/GAUGE CIRCUITS			
DASH GAUGE PANEL BATTERY	D01	RED	16
GROUND	D02	BLK	18
DASH GAUGE PANEL IGNITION	D03	ORG	16
J1708+	D05	RED	18
J1708-	D06	YEL	18
J1939+	D07	YEL	20
J1939-	D08	GRN	20
RESERVED	D09	WHT	18
BACKLIGHT-	D10	BLK	18
DASH SPARE 1	DPSP1	WHT	18
DASH SPARE 2	DPSP2	WHT	18
ENGINE CIRCUITS			
IGNITION KEYSWITCH SIG	E03	BLU	18
INTAKE AIR HTR RLY SIG	E04	WHT	18
ECM G/S RETURN	E13	BLK	18
STARTER LOCKOUT	E14	GRN	18
J1939+	E17	YEL	20
J1939-	E18	GRN	20
ECM RET (SW/TEMP/LEVEL)	E19	BLK	18
DEF LAMP	E20	PNK	18
ACCEL PEDAL POS 2 RETURN	E23/E22	BLK	18
FAN CONTROL SW SIG	E25	GRN	18
MAX ENGINE SPEED	E37	BLU	18
FAST IDLE	E39	YEL	18
ACCEL PEDAL POS 1 RETURN	E41/E28	WHT	18
ACCEL PEDAL POS 1 SUPPLY	E42/E27	RED	18
DPF PRESS SENSOR RETURN	E43	WHT	18
COOLANT LEVEL SIGNAL	E44	RED	18
DOC INLET TEMP SIGNAL	E45	BLK	18
DOC OUTLET TEMP SIGNAL	E48	BLK	18
SERVICE BRAKE	E49	WHT	18
ACCEL PEDAL POS 1 SIGNAL	E51/E35	BLK	18
SENSOR SUPPLY (5VDC)	E52/E26	RED	18
ACCEL PEDAL POS 2 SIGNAL	E53/E25	BLU	18
DPF OUTLET TEMP SIGNAL	E54/E25	BLK	18
DPF DELTA PRESSURE SIGNAL	E55	WHT	18
DPF OUTLET PRESSURE	E58	BLK	18
DPF FORCE REGEN SW	E59	PNK	18
ENG CRANKING RELAY SIGNAL	E61	BLU	16
ENGINE CRANKING RELAY SIGNAL	E62	LRU	10
STARTER RELAY POWER	E65	RED	16
OEM RETURN WIF SCR	E72	BLK	18
SCR OUTLET TEMP	E73	BLU	18
SCR INLET TEMP	E74	GRN	18
WIF SIGNAL	E75	YEL	18
ENGINE SPARE 1	ESP1	WHT	18
ENGINE SPARE 2	ESP2	WHT	18

FUNCTION	CKT ID	COLOR	GAUGE
GROUND CIRCUITS			
SWITCH GROUND	G01	BLK	18
LOAD GROUND	G02	BLK	16
VEE GROUND	G03	BLK	12
ID CONTROLS GROUND	G04	BLK	12
HEADLIGHT GROUND	G05	BLK	14
AIR DRYER GROUND	G06	BLK	16
WORKLAMP/BEACON GROUND	G07	BLK	16
CAB HEATER GROUND	G08	BLK	14
RADIO/WIPER GROUND	G09	BLK	14
ENGINE ECM BATTERY RETURN (-)	G10	BLK	12
LUBE SYSTEM GROUND	G11	BLK	14
LUBE PUMP GROUND	G12	GRY	14
MIRROR HEATER GROUND	G13	BLK	16
TRAILER GND	G14	BLK	12
HORN GROUND	G16	BLK	16
FUEL HTR/WATER SEP GND	G15	BLK	10
PHETT GND HOM 12/24V	G17	BLK	14
SCR/DCU GROUND	G18	BLK	10
HEAT & AC CIRCUITS			
CAB HEAT HIGH	H01	ORG	14
CAB HEAT MED	H02	RED	14
CAB HEAT LOW	H03	YEL	14
WATER VALVE PWR	H04	BLU	16
FUEL FILTER/WATER SEPERATOR	H05	RED	14
AIR DRYER/HEATERS	H06	BLU	14
A/C SWITCH SIGNAL	H07	GRN	14
CAB HEATER THERMO SW OUT	H08	LGN	14
COMPRESSOR SIGNAL	H09	LBU	14
AUX FAN	H10	GRN	14
WATER VALVE FEEDBACK SIG	H11	BRN	16
LIGHTING CIRCUITS			
PANEL/GAUGE LAMPS	L02	YEL	16
CLEARANCE/MARKER LAMPS	L03	LGN	16
DOME LAMPS	L04	YEL	16
LOW BEAM	L05	GRN	14
HIGH BEAM - LEFT	L06	WHT	14
HIGH BEAM - RIGHT	L07	BLU	14
FIFTH WHEEL LAMP	L08	WHT	16
FRONT WORKLAMPS/SPOT	L09	BLU	14
REAR WORKLAMPS	L10	GRN	14

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ELECTRICAL SYSTEM

Circuit Listing B (ISB6.7)

FUNCTION	CKT ID	COLOR	GAUGE
MIRROR CIRCUITS			
MIRROR POWER	M01	RED	14
LH MIRROR CONTROL A	M03	YEL	16
LH MIRROR CONTROL B	M04	WHT	16
RH MIRROR CONTROL A	M06	GRN	16
RH MIRROR CONTROL B	M07	BLU	16
MIRROR HEAT	M10	TAN	14
POWER CIRCUITS			
DVEC POWER 1	P01	RED	8
DVEC POWER 2	P02	RED	8
IO CONTROLS BATTERY FEED	P03	RED	8
IGNITION RELAY SIGNAL	P04	RED	16
WORKLAMP 1 RELAY SIGNAL	P05	GRY	16
WORKLAMP 2 RELAY SIGNAL	P06	BLU	16
GRID HEATER POWER	P07	RED	2
CAB HEATER FAN POWER	P08	RED	14
WIPER/WASHER POWER	P09	RED	14
ENGINE ECM BATT SUPPLY (+)	P10	RED	12
FAN CLUTCH BATTERY	P11	RED	14
A/C COMPRESSOR POWER	P12	RED	14
FUEL FILTER POWER	P13	RED	10
LUBE SYSTEM BATTERY POWER	P14	RED	14
LUBE PUMP POWER	P16	BLU	14
DIAGNOSTIC IGNITION	P17	ORG	16
IO CONTROLS BATTERY 1	P18	RED	12
IO CONTROLS BATTERY 2	P19	RED	12
IO CONTROLS BATTERY 3	P20	RED	16
AUX FAN POWER	P21	RED	14
AUX SWITCH POWER (OPT)	P22	RED	14
MAIN CAB POWER	P24	RED	4
STARTER RELAY POWER	P25	RED	10
ALTERNATOR POWER	P26	RED	2
LINE HEATER POWER	P28	RED	14
SWITCHED BATTERY POWER	P30	RED	14
NOX SENSOR SCR OUTLET PWR	P30A	RED	18
NOX SENSOR ENGINE PWR	P30B	RED	18
DCU POWER	P32	RED	10
DEF TANK LEVEL SENSOR PWR	P33	RED	18

SD1003B

FUNCTION	CKT ID	COLOR	GAUGE
RADIO CIRCUITS			
RADIO POWER - BATT	R01	RED	14
RADIO POWER - IGNITION	R02	ORG	16
ROOF SPARE 1	RFSP1	WHT	16
ROOF SPARE 2	RFSP2	WHT	16
SWITCH CIRCUITS			
IGNITION SWITCH	S01	RED	18
START SWITCH	S02	BLU	18
HEAD LTS SWITCH - PARK	S03	GRN	18
HEAD LTS SWITCH - HEADLAMPS	S04	LGN	18
PARK BRAKE SWITCH	S05	WHT	18
HORN SWITCH	S06	BRN	18
RIGHT TURN SWITCH	S07	BLU	18
LEFT TURN SWITCH	S08	YEL	18
HAZARD SWITCH	S09	PNK	18
DIMMER SWITCH	S10	YEL	18
INT LTS SWITCH	S11	RED	18
BRAKE LAMP SWITCH	S12	YEL	18
5TH WHEEL LAMP SWITCH	S14	WHT	18
MIRROR HEAT SWITCH	S15	YEL	18
EXT LTS SWITCH	S16	BLU	18
AUX SWITCH	S17	GRN	18
5TH WHEEL LOCK SWITCH	S18	BLU	18
5TH WHEEL LEVEL SWITCH	S19	YEL	18
DIFFERENTIAL LOCK SWITCH	S20	WHT	18
IOC - DIAGNOSTICS SWITCH	S21	WHT	18
SWITCH PANEL SPARE 1	SPSP1	WHT	16
WASHER/WIPER CIRCUITS			
WIPER HIGH SPEED	W01	PPL	14
WIPER LOW SPEED	W02	WHT	14
WIPER PARK	W03	GRY	14
WASHER PUMP	W04	YEL	14
AUXILIARY CIRCUITS			
AUX SWITCHED POWER	X01	YEL	14

FUNCTION	CKT ID	COLOR	GAUGE
TRANSMISSION CIRCUITS			
PARK BRAKE	T101	BLU	18
TERMINATING RESISTOR	T107	YEL	18
J1939 -	T108	GRN	20
GROUND	T109	GRY	18
BATTERY	T110	PNK	16
HSD1	T111	ORG	18
OIL LEVEL SIG	T112	PNK	18
OIL LEVEL	T116	BLU	18
OIL LIFE MON	T118	WHT	18
TURBINE SPD-	T120	BLU	18
SERVICE BRAKE STATUS	T122	YEL	18
SPEED SIGNAL	T125	TAN	18
J1939+	T128	YEL	20
HSD3	T131	YEL	18
J1587+	T132	BLU	18
LSD PCS3	T133	YEL	18
DIR SIG	T134	YEL	18
LSD PCS1	T136	ORG	18
LSD TCC	T137	WHT	18
ENG SPEED-	T139	ORG	18
OUTPUT SPEED-	T140	GRN	18
NEUTRAL SIGNAL	T141	TAN	18
MAX ENGINE SPEED(E37)	T145	BLU	18
TERM RESISTOR CAN+	T148	YEL	18
J1939 SHIELD	T149	SHD	20
LSD SS1	T151	WHT	18
LSD PCS2	T152	GRN	18
SUMP TEMP SIG	T154	TAN	18
LSD PCS4	T155	WHT	18
ANALOG RETURN	T158	GRN	18
ENG SPEED+	T159	TAN	18
OUT SPEED+	T160	YEL	18
IGNITION	T163	YEL	16
REVERSE SIGNAL	T165	TAN	18
GROUND	T169	GRY	18
BATTERY	T170	PNK	16
HSD2	T171	YEL	18
J1587-	T172	WHT	18
LSD MAIN MOD	T174	BLU	18
TRANS ID	T176	YEL	18
DIGITAL SIGNAL	T177	GRN	18
TURBINE SPD+	T180	ORG	18
TRANSMISSION SPARE 1	TSP1	WHT	18
TRANSMISSION SPARE 2	TSP2	WHT	18

Circuit Listing C (ISB6.7)

FUNCTION	CKT ID	COLOR	GAUGE
SCR CIRCUITS			
O_S_HH1	101	WHT	16
O_S_HH2	102	YEL	16
ELECTRICAL HEATER CONTROL	103	ORG	16
ELECTRICAL HEATER 12V	105	PNK	16
O_V_RATH	108	GRY	16
O_T_RAMVL	112	TAN	18
PRESSURE SNSOR OUTPUT	117	BRN	18
PRESSURE SNIOSOR GND	118	GRN	18
PRESSURE SENSOR 5V	119	BLU	18
PUMP MOTOR PWM/SM TEMP	124	PUR	18
PUMP MOTOR GROUND	126	WHT	16
O_T_RAMVH	132	YEL	18
PUMP MOTOR SUPPLY	146	ORG	16
O_S_HF3	148	PNK	16
LEVEL SENSOR RETURN	158	GRY	18
LEVEL SENSOR SIGNAL	159	TAN	18
REVERTING VALVE SIGNAL	165	BRN	16
TEMPERATURE SENSOR RET	178	GRN	18
TEMPERATURE SENSOR SIGNAL	179	BLU	18
O_S_RATH	185	PUR	16
REVERTING VALVE 12V	186	WHT	16
DCU GROUND	201	BLK	14
DCU GROUND	202	BLK	14
DCU GROUND	203	BLK	14
DCU GROUND	204	BLK	14
DCU GROUND	205	BLK	14
DCU BATTERY (+)	206	RED	14
DCU BATTERY (+)	207	RED	14
DCU BATTERY (+)	208	RED	14
DCU BATTERY (+)	209	RED	14
LINE HEATER RELAY SIG HIGH	230	WHT	18
LINE HEATER RELAY SIG LOW	241	YEL	18
IGNITION	252	ORG	18

ELECTRICAL SYSTEM

Circuit Listing A (QSBT3)

FUNCTION	CKT ID	COLOR	GAUGE
ALARM/INDICATOR CIRCUITS			
ALT FAIL LAMP	A01	GRN	18
ALTERNATOR R TERMINAL	A02	ORG	18
LEFT REAR STOP/T5 LAMP	A03	BRN	16
RIGHT REAR STOP/T5 LAMP	A04	TAN	16
LEFT TURN SIGNAL LAMPS	A05	YEL	14
RIGHT TURN SIGNAL LAMPS	A06	BLU	14
BACKUP ALARM/LAMPS	A07	GRN	16
STOP LAMPS	A08	RED	14
HORN	A09	YEL	16
BEACON/STROBE LAMP POWER	A10	PNK	16
FUEL LEVEL SENDER	A12	TAN	18
BEACON/STROBE LAMP SIGNAL	A14	PNK	16
BRAKING SYSTEMS/ABS			
GROUND	B101	GRY	18
TRAILER ABS WL	B102	RED	18
IGNITION	B103	RED	16
ATC-	B104	GRN	16
ATC+	B105	BLU	16
ABS WL	B106	YEL	18
J1939-	B107	GRN	20
J1939+	B108	YEL	20
WSS-DR+	B110	BRN	18
WSS-DR-	B111	BLK	18
ABS WL GROUND	B112	GRY	18
J1587-	B113	WHT	18
J1587+	B114	BLU	18
BATTERY	B116	BLU	18
ATC WL	B118	ORG	18
PMW_SL_HLD	B201	BRN	16
PMW_SL_REL	B202	BLU	16
PMW_SL_CMN	B203	YEL/GRN	16
PMW_SR_HLD	B204	BRN	16
PMW_SR_CMN	B205	BLK	18
PMW_SR_REL	B206	YEL/GRN	16
WSS_SI-	B207	BLU	16
WSS_SI+	B208	BRN	18
PMW_DR_CMN	B209	YEL/GRN	16
PMW_DR_HLD	B210	BRN	16
WSS_SR+	B211	BLK	18
PMW_DL_CMN	B212	YEL/GRN	16
PMW_DR_REL	B213	BLU	16
WSS_SR-	B214	BRN	18
PMW_DL_HLD	B215	BLK	18
PMW_DL_REL	B216	BRN	16
PMW_DL_REL	B217	BLU	16
WSS_DL-	B218	BRN	18

FUNCTION	CKT ID	COLOR	GAUGE
DASH PANEL/GAUGE CIRCUITS			
DASH GAUGE PANEL BATTERY	D01	RED	16
GROUND	D02	BLK	18
DASH GAUGE PANEL IGNITION	D03	ORG	16
J1708+	D05	RED	18
J1708-	D06	YEL	18
J1939+	D07	YEL	20
J1939-	D08	GRN	20
RESERVED	D09	WHT	18
BACKLIGHT-	D10	BLK	18
DASH SPARE 1	DPSP1	WHT	18
DASH SPARE 2	DPSP2	WHT	18
ENGINE CIRCUITS			
J1939+	E01	YEL	20
STARTER LOCKOUT	E02	GRN	18
IGNITION KEY SW SIG (DASH/CAB)	E03	BLU	18
AC SWITCH (UNUSED)	E07	BLU	18
FAST IDLE	E18	YEL	18
DIAGNOSTICS SWITCH	E20	PNK	18
J1939-	E21	GRN	20
THROTTLE PEDAL-SW RETURN	E22	BLK	18
SERVICE BRAKE OP	E24	WHT	18
ON IDLE SWITCH	E25	BLU	18
THROTTLE PEDAL-APS SUPPLY	E26	RED	18
THROTTLE PEDAL-APS RETURN	E27	RED	18
THROTTLE PEDAL-APS RETURN	E28	WHT	18
J1587-	E29	WHT	18
FAN CLUTCH RELAY RETURN	E32	BLK	18
THROTTLE PEDAL-APS SIGNAL	E35	BLK	18
COOLANT LEVEL SENSOR RTN3	E38	BLK	18
J1587+	E39	BLU	18
DIAG/REGEN SIG RTN(E22)	E41	ORG	18
GRIT HEATER SIGNAL RTN2	E44	BLK	18
IGNITION KEY SW SIG (ECM)	E45	BLU	18
FAN CLUTCH SIGNAL	E52	GRN	18
GRID HEATER	E54	WHT	18
COOLANT LEVEL	E60	RED	16
ENG CRANKING RELAY SIGNAL	E61	BLU	16
ENGINE CRANKING SIGNAL	E62	BLU	10
IDLE INCREMENT SW (UNUSED)	E63	WHT	18
IDLE INCREMENT SW (UNUSED)	E64	PUR	18
STARTER RELAY POWER	E65	RED	16
ENGINE SPARE 1	ESP1	WHT	18
ENGINE SPARE 2	ESP2	WHT	18

FUNCTION	CKT ID	COLOR	GAUGE
GROUND CIRCUITS			
SWITCH GROUND	G01	BLK	18
LOAD GROUND	G02	BLK	16
VEC GROUND	G03	BLK	12
IO CONTROLS GROUND	G04	BLK	12
HEADLIGHT GROUND	G05	BLK	14
AIR DRYER GROUND	G06	BLK	16
WORKLAMP/BEACON GROUND	G07	BLK	16
CAB HEATER GROUND	G08	BLK	14
RADIO/WIPER GROUND	G09	BLK	14
ENGINE ECM BATTERY RETURN (-)	G10	BLK	12
LUBE SYSTEM GROUND	G11	BLK	14
LUBE PUMP GROUND	G12	GRY	14
MIRROR HEATER GROUND	G13	BLK	16
TRAILER GND	G14	BLK	12
HORN GROUND	G16	BLK	16
FUEL HTR/WATER SEP GND	G15	BLK	10
HEAT & AC CIRCUITS			
CAB HEAT HIGH	H01	ORG	14
CAB HEAT MED	H02	RED	14
CAB HEAT LOW	H03	YEL	14
WATER VALVE PWR	H04	BLU	16
FUEL FILTER/WATER SEPARATOR	H05	RED	14
AIR DRYER/HEATERS	H06	BLU	14
A/C SWITCH SIGNAL	H07	GRN	14
CAB HEATER THERMO SW OUT	H08	LGN	14
COMPRESSOR SIGNAL	H09	LBU	14
AUX FAN	H10	GRN	14
WATER VALVE FEEDBACK SIG	H11	BRN	16
LIGHTING CIRCUITS			
PANEL/GAUGE LAMPS	L02	YEL	16
CLEARANCE/MARKER LAMPS	L03	LGN	16
DOVE LAMPS	L04	YEL	16
LOW BEAM	L05	GRN	14
HIGH BEAM - LEFT	L06	WHT	14
HIGH BEAM - RIGHT	L07	BLU	14
FIFTH WHEEL LAMP	L08	WHT	16
FRONT WORKLAMP/SPOT	L09	BLU	14
REAR WORKLAMP	L10	GRN	14

Circuit Listing B (QSBT3)

FUNCTION	CKT ID	COLOR	GAUGE
MIRROR CIRCUITS			
MIRROR POWER	M01	RED	14
LH MIRROR CONTROL A	M03	YEL	16
LH MIRROR CONTROL B	M04	WHT	16
RH MIRROR CONTROL A	M06	GRN	16
RH MIRROR CONTROL B	M07	BLU	16
MIRROR HEAT	M10	TAN	14
POWER CIRCUITS			
DVEC POWER 1	P01	RED	8
DVEC POWER 2	P02	RED	8
IO CONTROLS BATTERY FEED	P03	RED	8
IGNITION RELAY SIGNAL	P04	RED	16
WORKLAMP 1 RELAY SIGNAL	P05	GRY	16
WORKLAMP 2 RELAY SIGNAL	P06	BLU	16
GRID HEATER POWER	P07	RED	2
CAB HEATER FAN POWER	P08	RED	14
WIPER/WASHER POWER	P09	RED	14
ENGINE ECM BATT SUPPLY (+)	P10	RED	12
FAN CLUTCH BATTERY	P11	RED	14
FUEL COMPRESSOR POWER	P12	RED	14
FUEL FILTER POWER	P13	RED	10
LUBE SYSTEM BATTERY POWER	P14	RED	14
LUBE PUMP POWER	P16	BLU	14
DIAGNOSTIC IGNITION	P17	ORG	16
IO CONTROLS BATTERY 1	P18	RED	12
IO CONTROLS BATTERY 2	P19	RED	12
IO CONTROLS BATTERY 3	P20	RED	16
AUX FAN POWER	P21	RED	14
AUX SWITCH POWER (OPT)	P22	RED	14
MAIN CAB POWER	P24	RED	4
STARTER RELAY POWER	P25	RED	10
ALTERNATOR POWER	P26	RED	2

FUNCTION	CKT ID	COLOR	GAUGE
RADIO CIRCUITS			
RADIO POWER - BATT	R01	RED	14
RADIO POWER - IGNITION	R02	ORG	16
ROOF SPARE 1	RFSP1	WHT	16
ROOF SPARE 2	RFSP2	WHT	16
SWITCH CIRCUITS			
IGNITION SWITCH	S01	RED	18
START SWITCH	S02	BLU	18
HEAD LTS SWITCH - PARK	S03	GRN	18
HEAD LTS SWITCH - HEADLAMPS	S04	LGN	18
PARK BRAKE SWITCH	S05	WHT	18
HORN SWITCH	S06	BRN	18
RIGHT TURN SWITCH	S07	BLU	18
LEFT TURN SWITCH	S08	YEL	18
HAZARD SWITCH	S09	PNK	18
DIMMER SWITCH	S10	YEL	18
INT LTS SWITCH	S11	RED	18
BRAKE LAMP SWITCH	S12	YEL	18
5TH WHEEL LAMP SWITCH	S14	WHT	18
MIRROR HEAT SWITCH	S15	YEL	18
EXT LTS SWITCH	S16	BLU	18
AUX SWITCH	S17	GRN	18
5TH WHEEL LOCK SWITCH	S18	BLU	18
5TH WHEEL LEVEL SWITCH	S19	YEL	18
DIFFERENTIAL LOCK SWITCH	S20	WHT	18
IOC - DIAGNOSTICS SWITCH	S21	WHT	18
SWITCH PANEL SPARE 1	SPSP1	WHT	16
WASHER/WIPER CIRCUITS			
WIPER HIGH SPEED	W01	PPL	14
WIPER LOW SPEED	W02	WHT	14
WIPER PARK	W03	GRY	14
WASHER PUMP	W04	YEL	14
AUXILIARY CIRCUITS			
AUX SWITCHED POWER	X01	YEL	14

FUNCTION	CKT ID	COLOR	GAUGE
TRANSMISSION CIRCUITS			
PARK BRAKE	T101	BLU	18
TERMINATING RESISTOR	T107	YEL	18
J1939-	T108	GRN	20
GROUND	T109	GRY	18
BATTERY	T110	PNK	16
HSD1	T111	ORG	18
OIL LEVEL SIG	T112	PNK	18
OIL LEVEL	T116	BLU	18
OIL LIFE MON	T118	WHT	18
TURBINE SPD-	T120	BLU	18
SERVICE BRAKE STATUS	T122	YEL	18
SPEED SIGNAL	T125	TAN	18
J1939+	T128	YEL	20
HSD3	T131	YEL	18
J1587+	T132	BLU	18
LSD PCS3	T133	YEL	18
DIR SIG	T134	YEL	18
LSD PCS1	T136	ORG	18
LSD TCC	T137	WHT	18
ENG SPEED-	T139	ORG	18
OUTPUT SPEED-	T140	GRN	18
NEUTRAL SIGNAL	T141	TAN	18
MAX ENGINE SPEED(E37)	T145	BLU	18
TERM RESISTOR CAN+	T148	YEL	18
J1939 SHIELD	T149	SHD	20
LSD SS1	T151	WHT	18
LSD PCS2	T152	GRN	18
SUMP TEMP SIG	T154	TAN	18
LSD PCS4	T155	WHT	18
ANALOG RETURN	T158	GRN	18
ENG SPEED+	T159	TAN	18
OUT SPEED+	T160	YEL	18
IGNITION	T163	YEL	16
REVERSE SIGNAL	T165	TAN	18
GROUND	T169	GRY	18
BATTERY	T170	PNK	16
HSD2	T171	YEL	18
J1587-	T172	WHT	18
LSD MAIN MOD	T174	BLU	18
TRANS ID	T176	YEL	18
DIGITAL SIGNAL	T177	GRN	18
TURBINE SPD+	T180	ORG	18
TRANSMISSION SPARE 1	TSP1	WHT	18
TRANSMISSION SPARE 2	TSP2	WHT	18

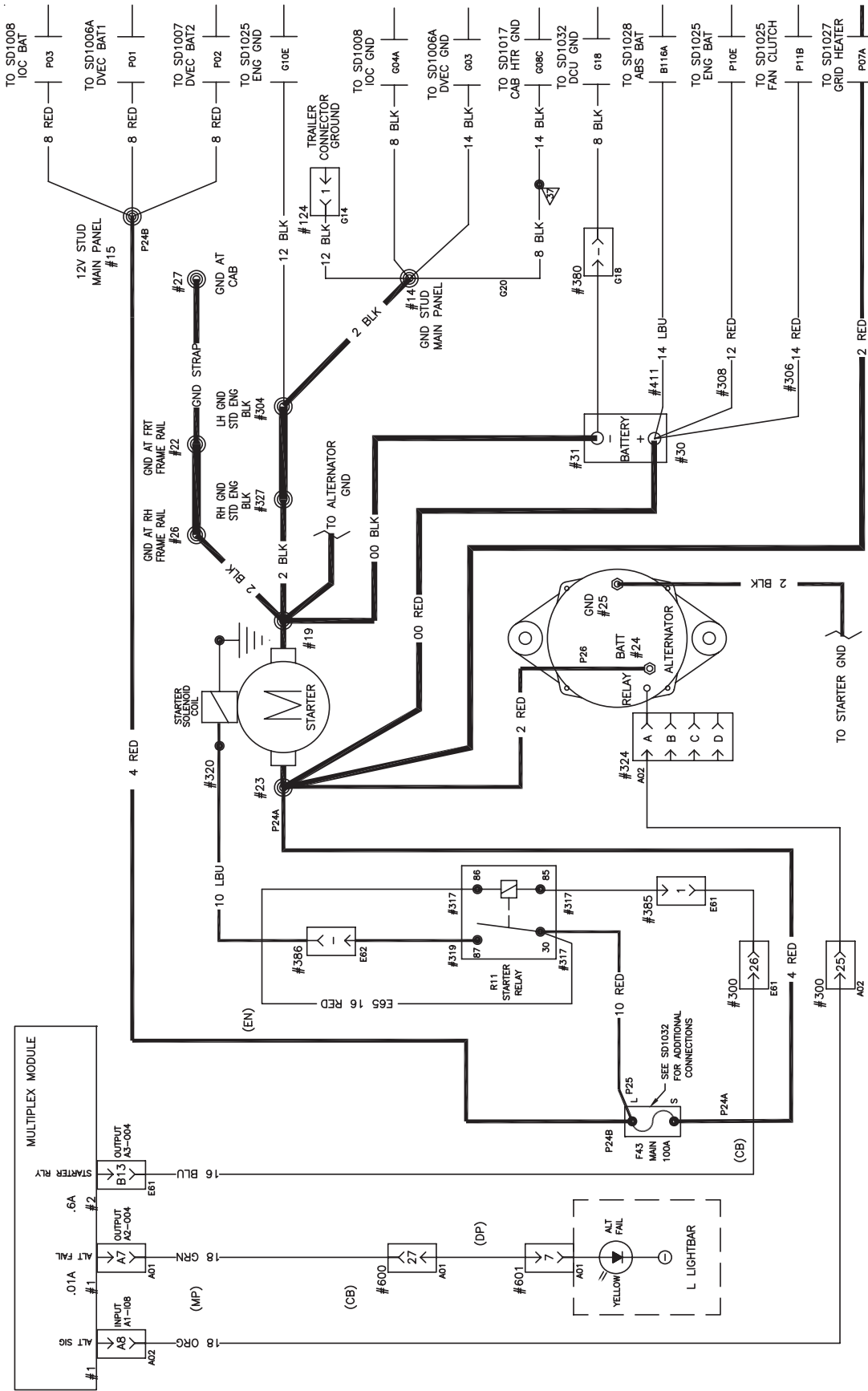
SD1003B

ELECTRICAL SYSTEM

ELECTRICAL SYSTEM

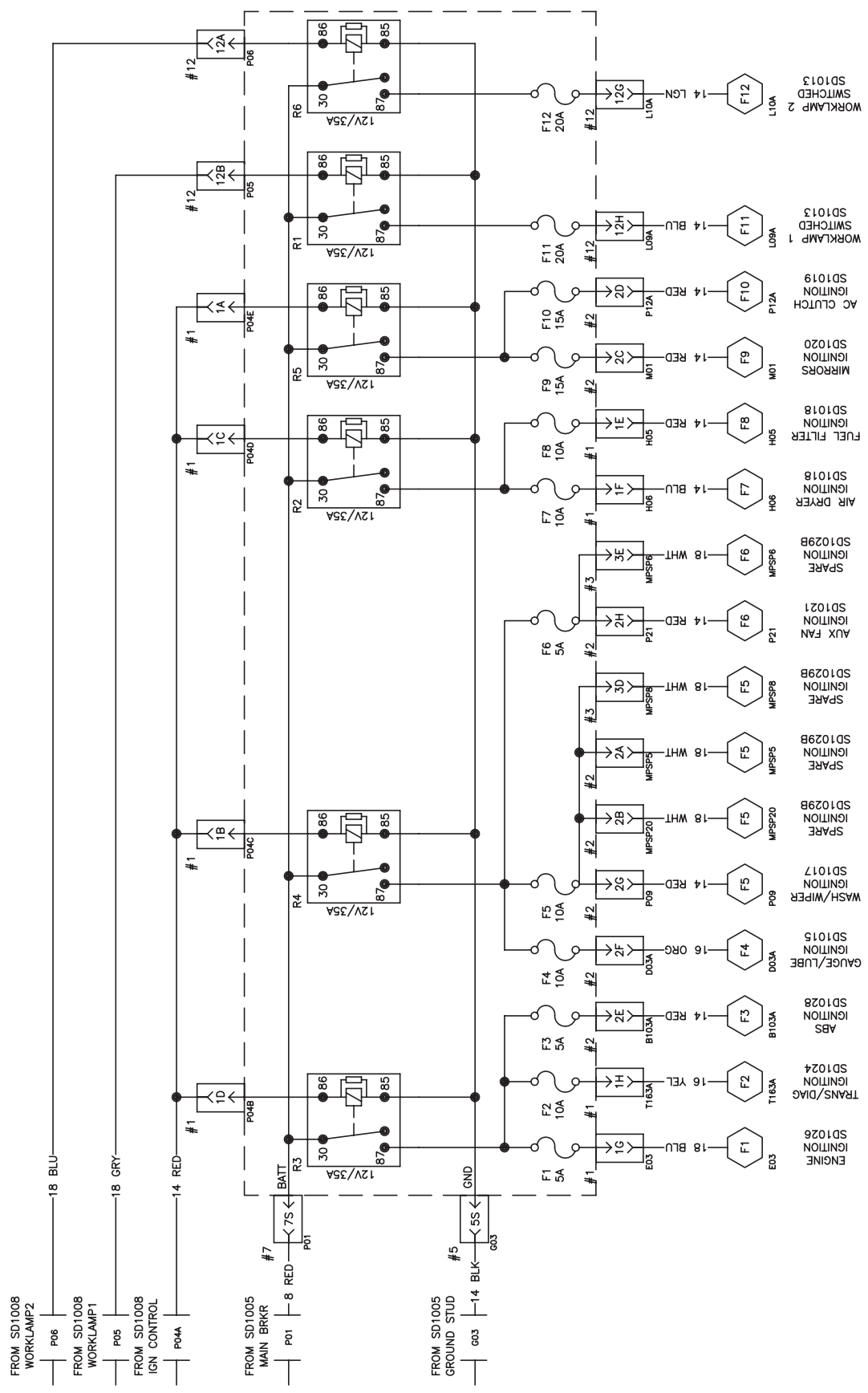
SD1005

Cranking, Charging and Run Circuits



SD1006A

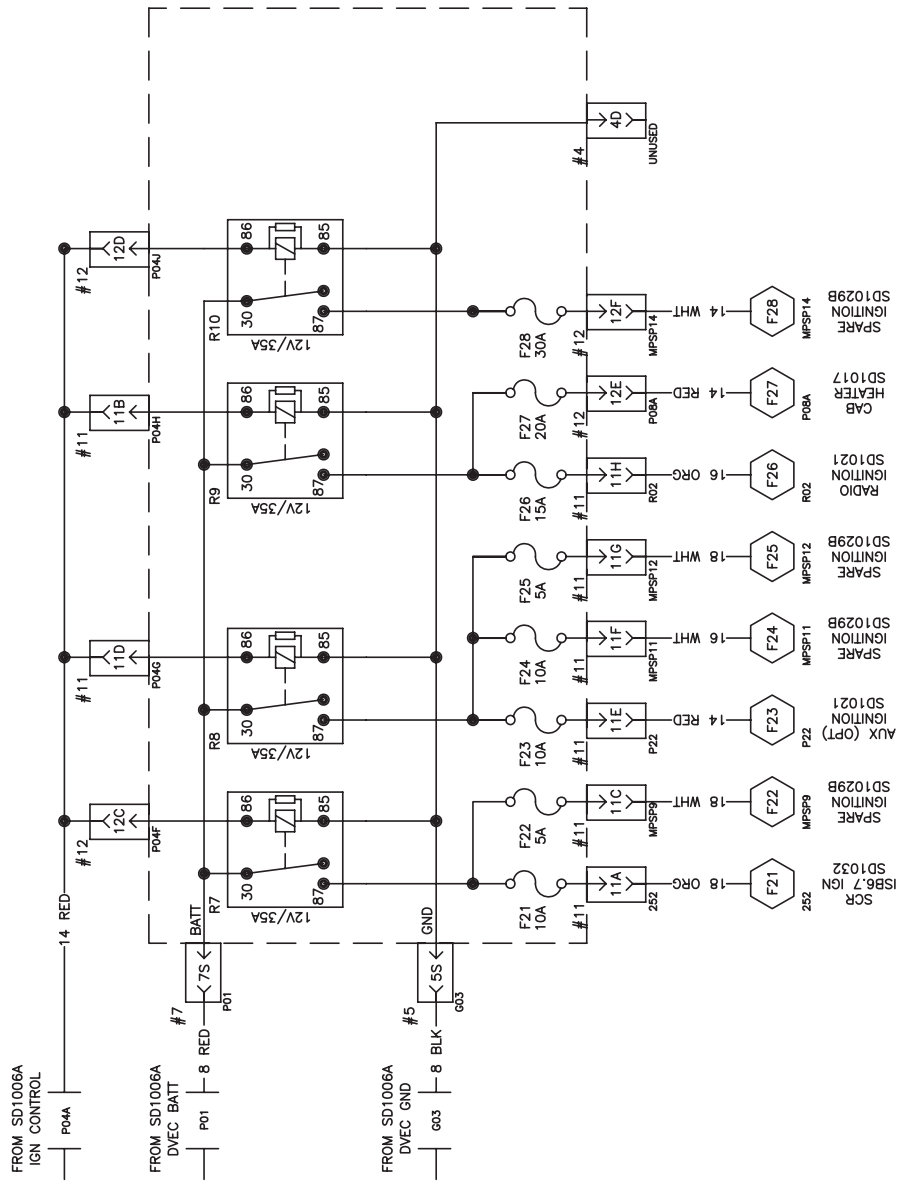
DVEC (12 V) Ignition Fuses A



ELECTRICAL SYSTEM

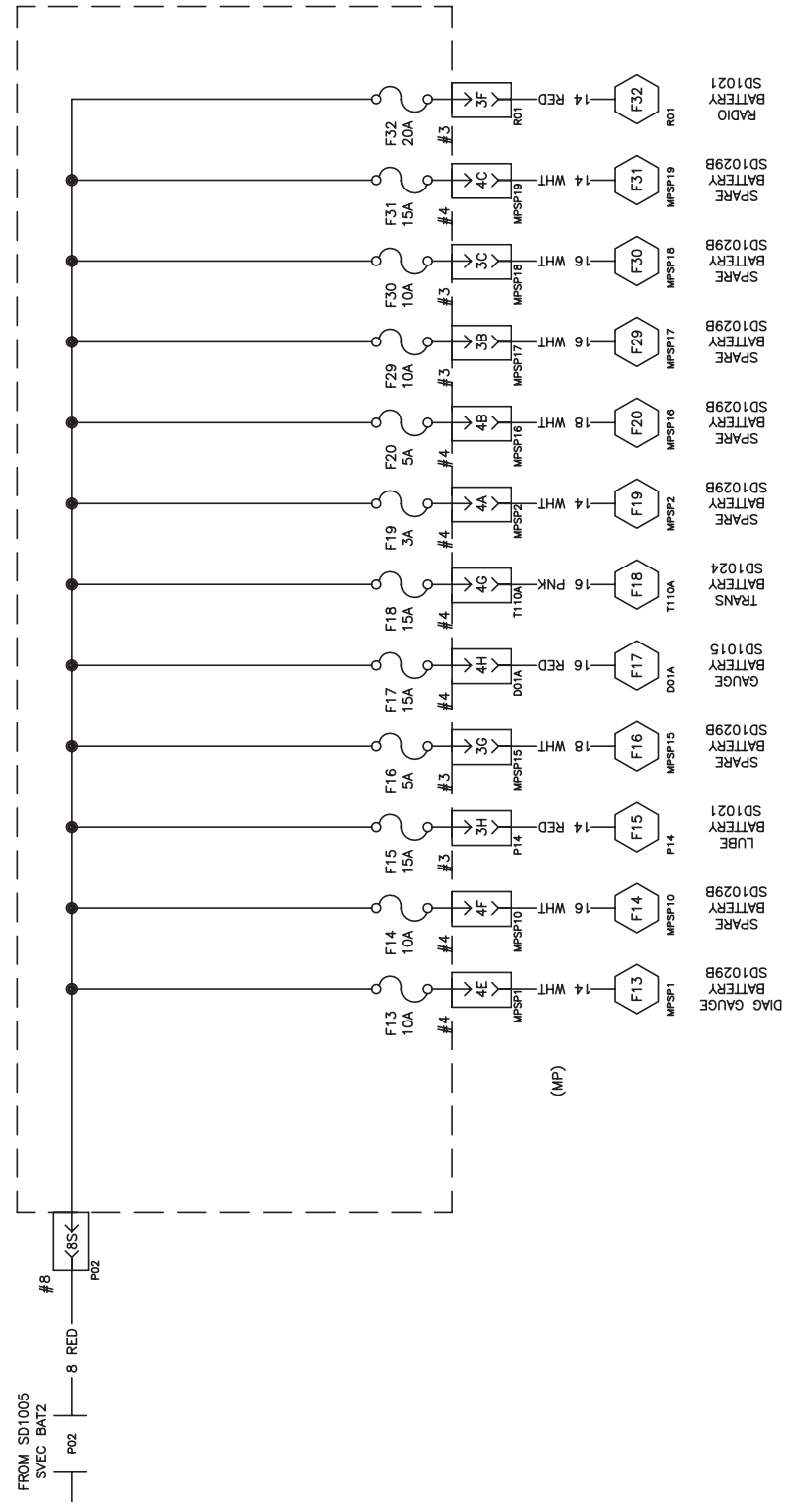
SD1006B

DVEC (12 V) Ignition Fuses B



SD1007

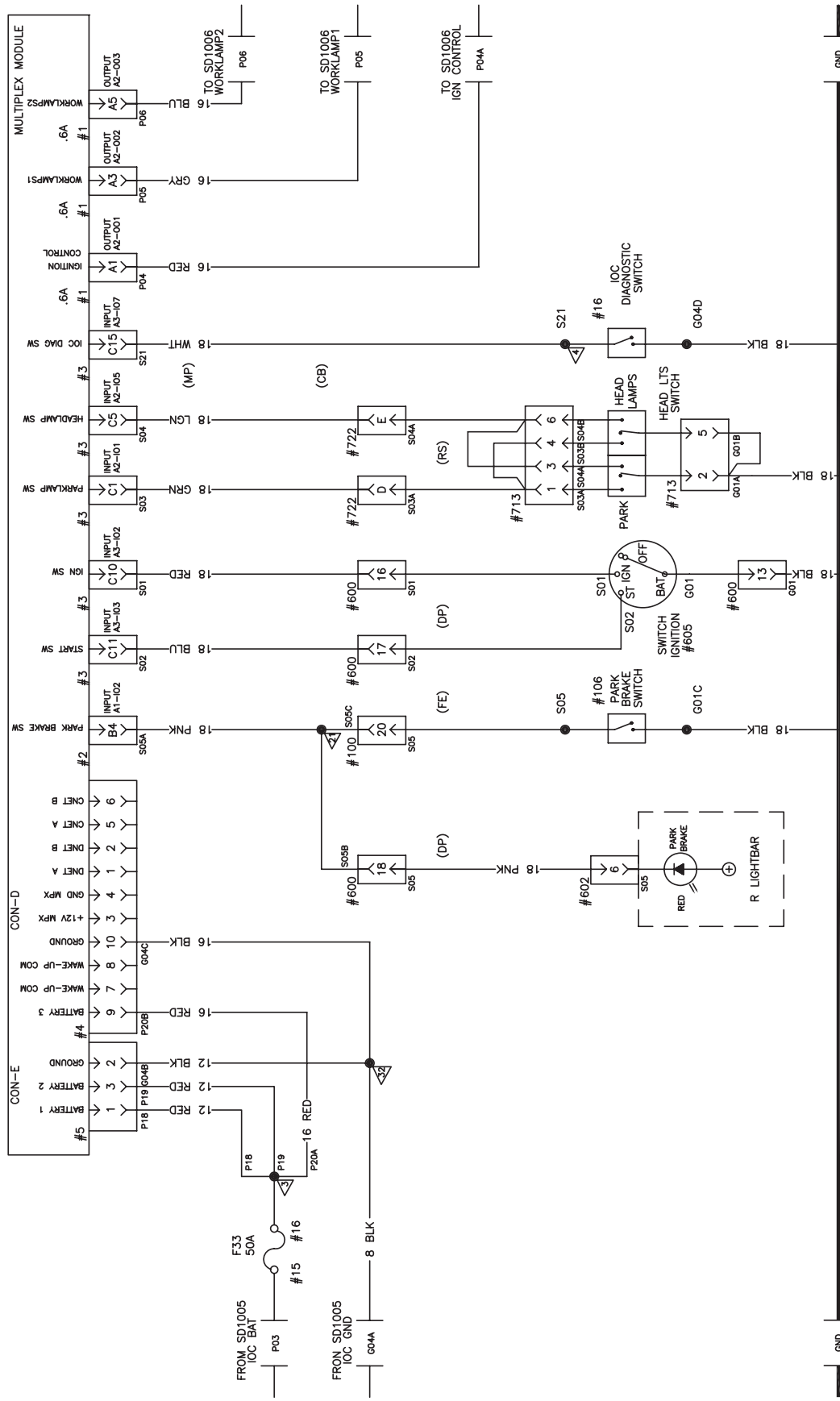
DVEC (12 V) Battery Fuses



ELECTRICAL SYSTEM

SD1008

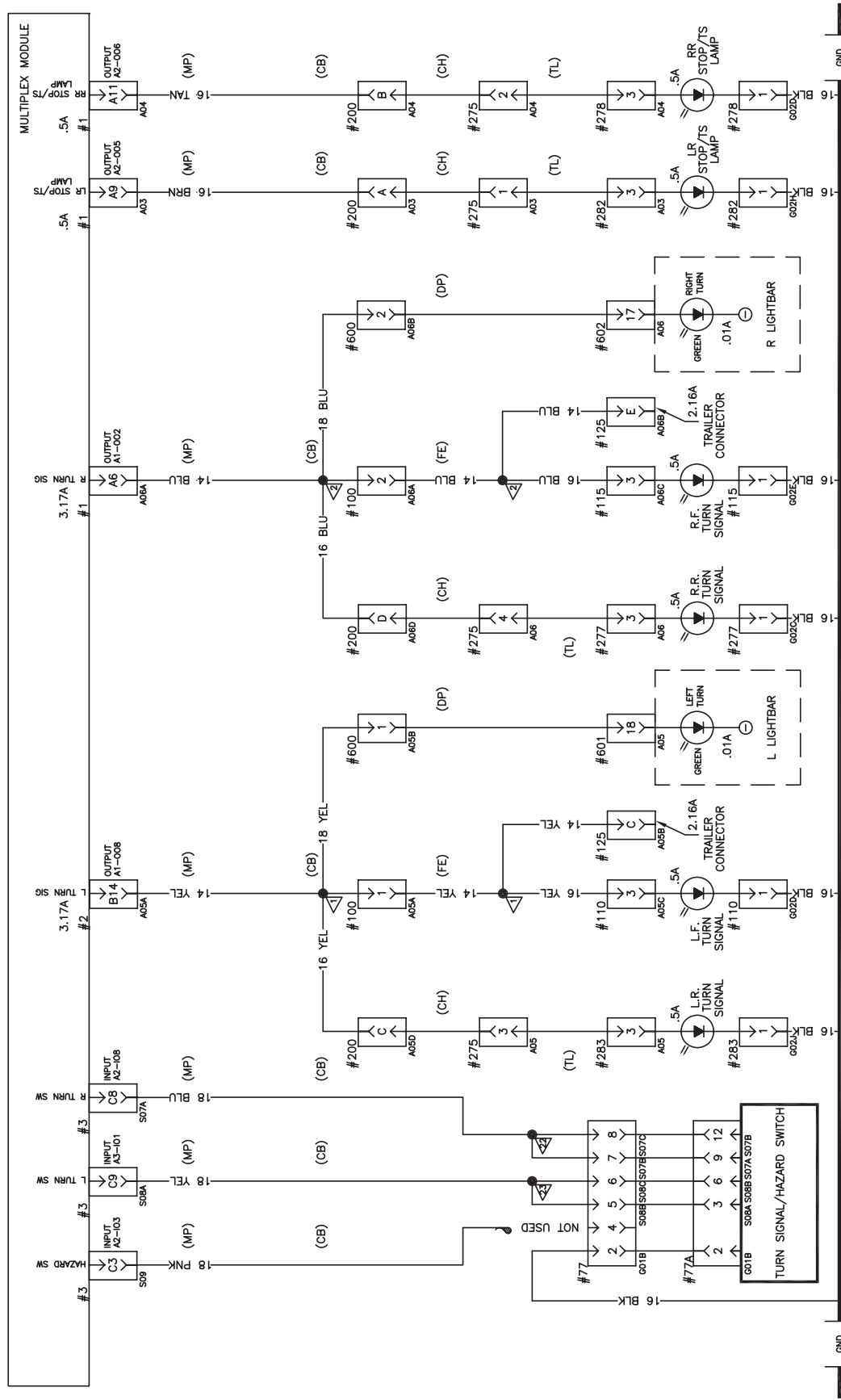
Ignition Master/Lamp, Park Brake Switch, Ignition and Work Lamp Control



ELECTRICAL SYSTEM

SD1010

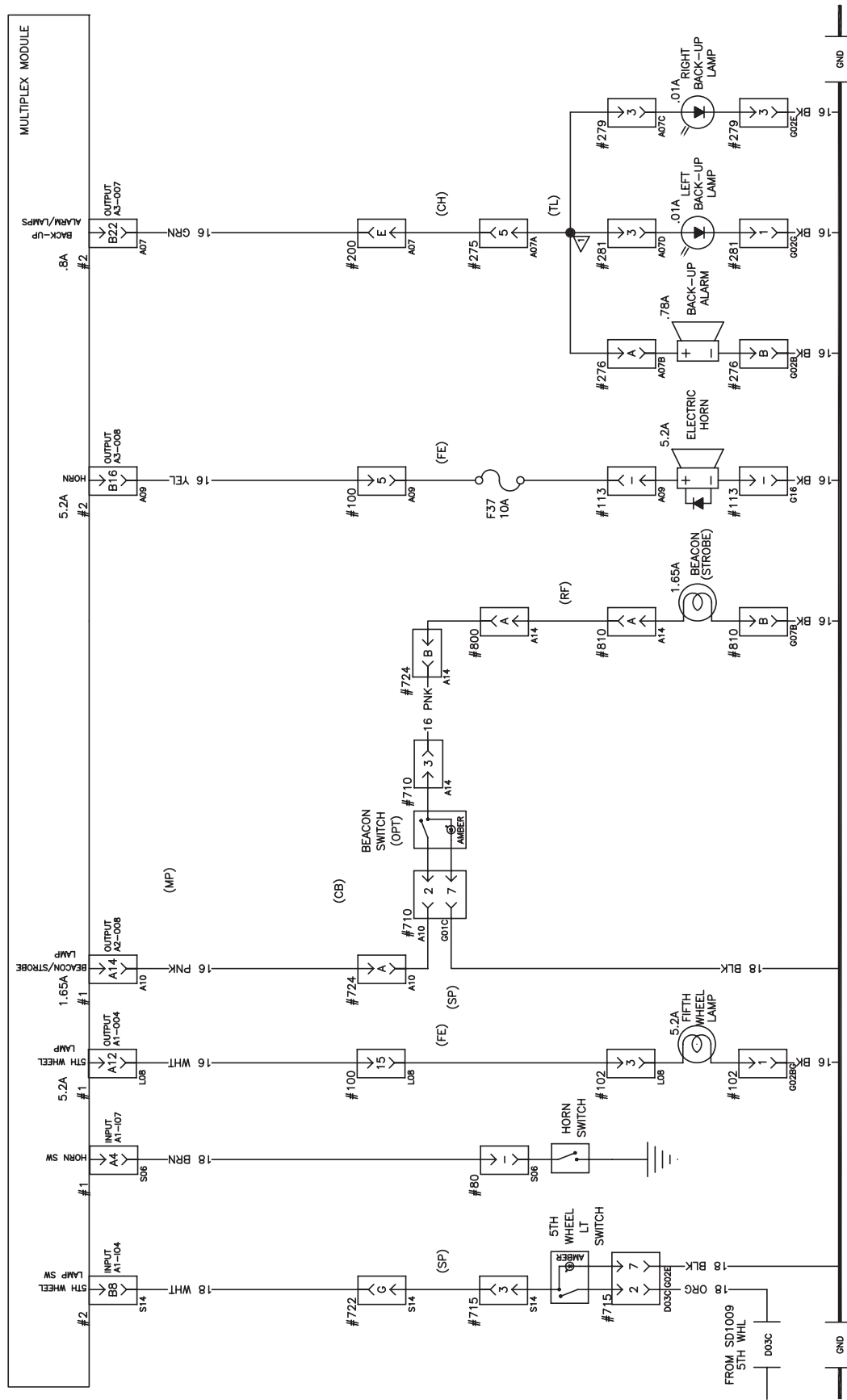
Turn Signal/Hazard Lamps and Rear Tail Lamps

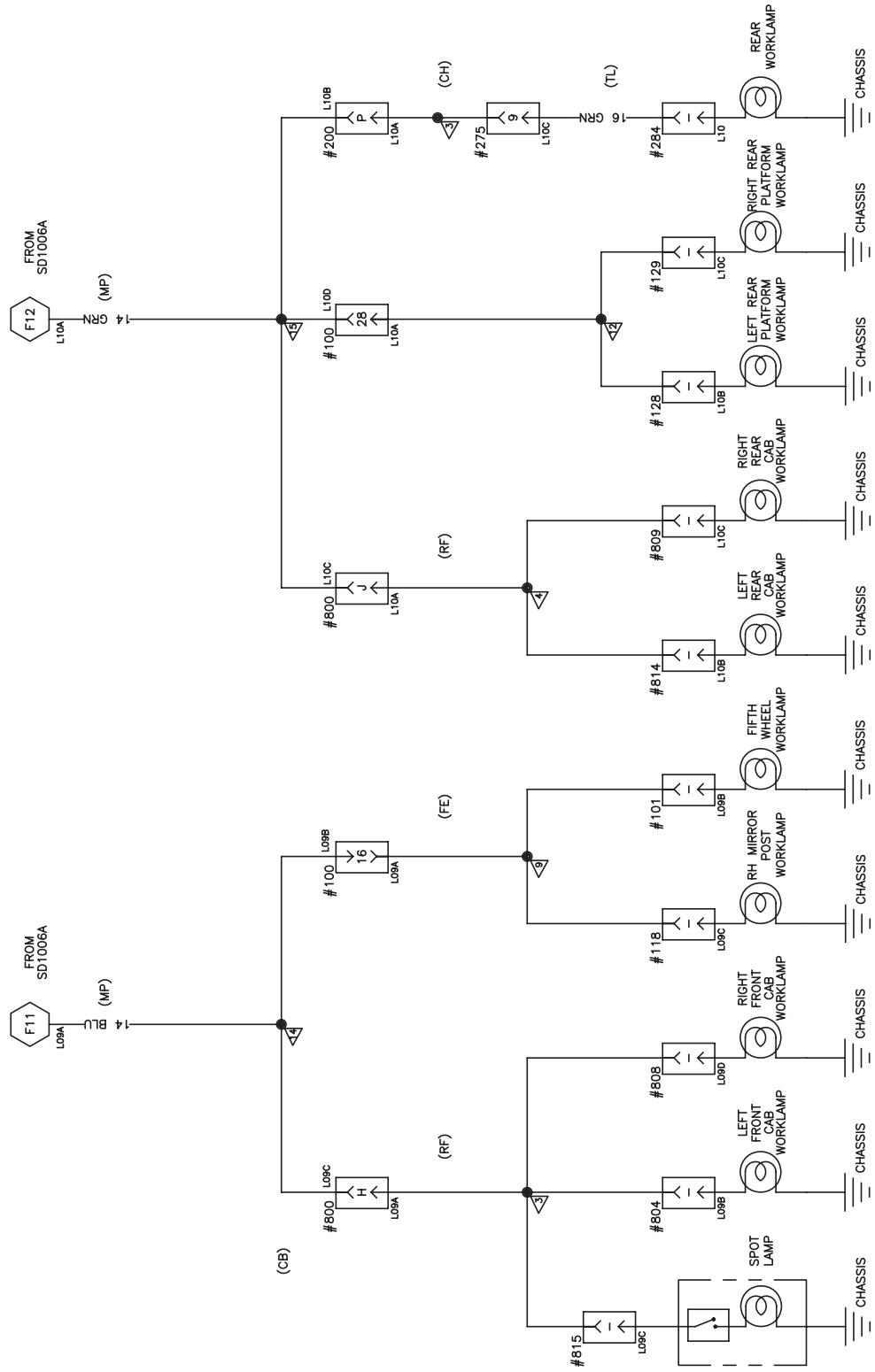


ELECTRICAL SYSTEM

SD1012

Fifth Wheel, Flood, Beacon, Horn and Back Up Alarm/Lamps

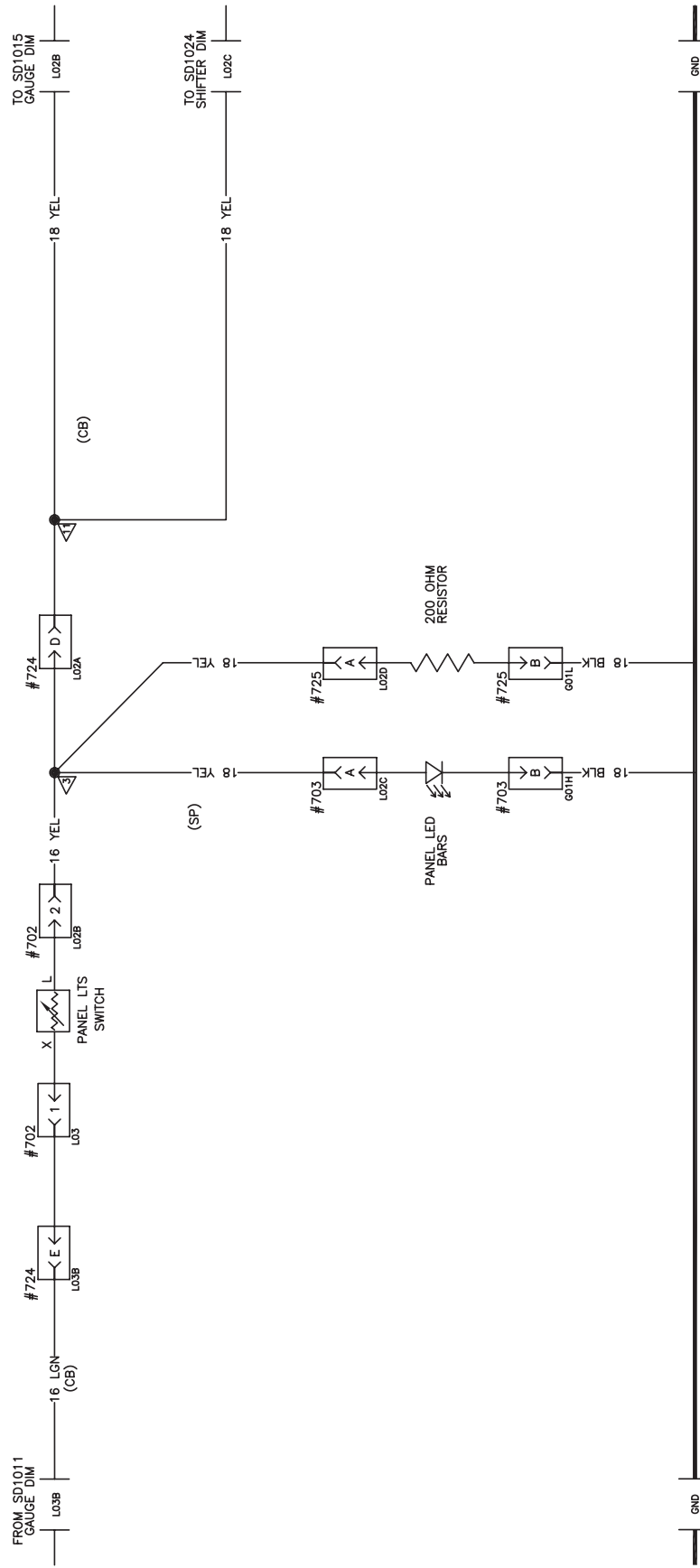




ELECTRICAL SYSTEM

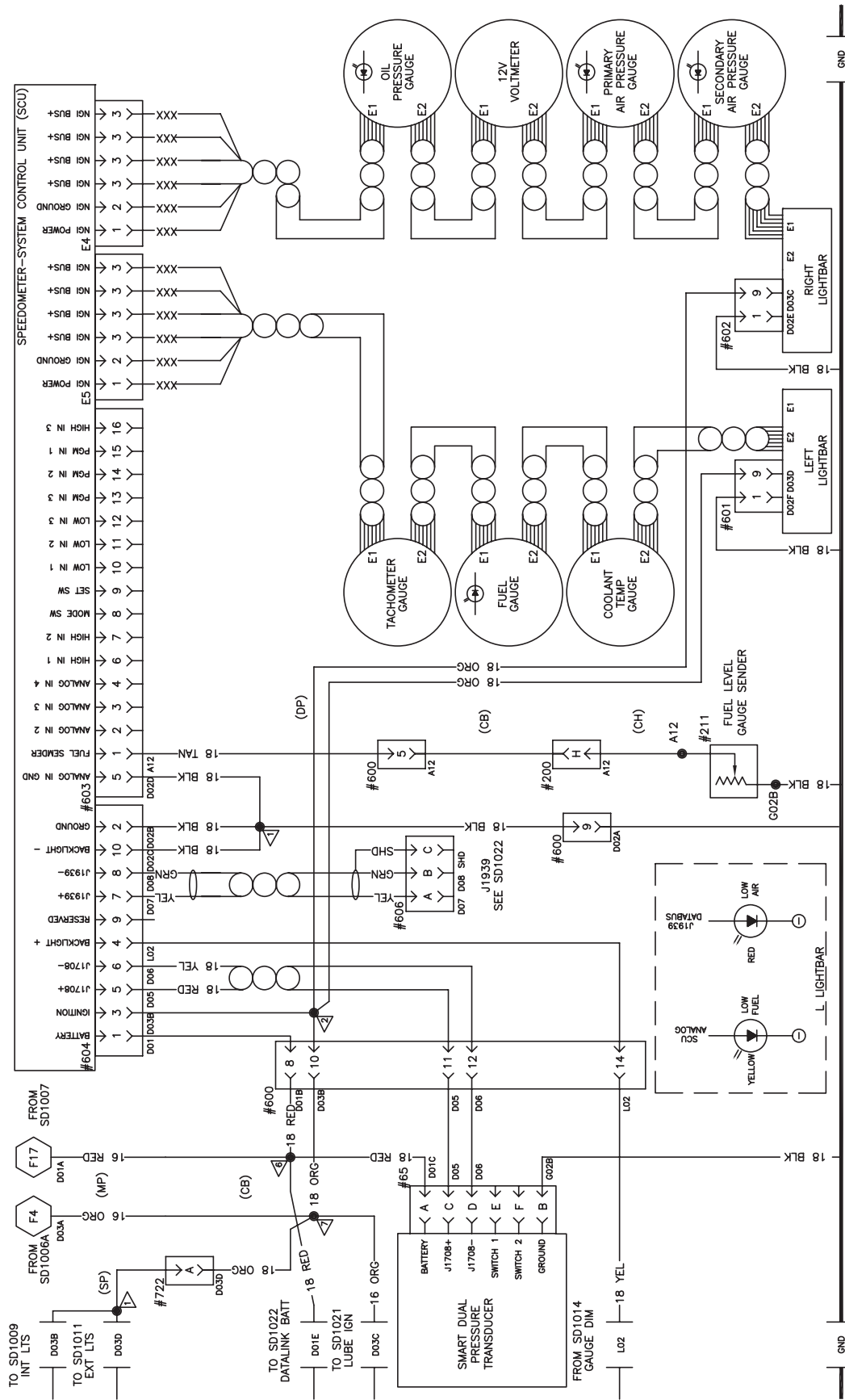
SD1014

Panel/Gauge Lamps



SD1015

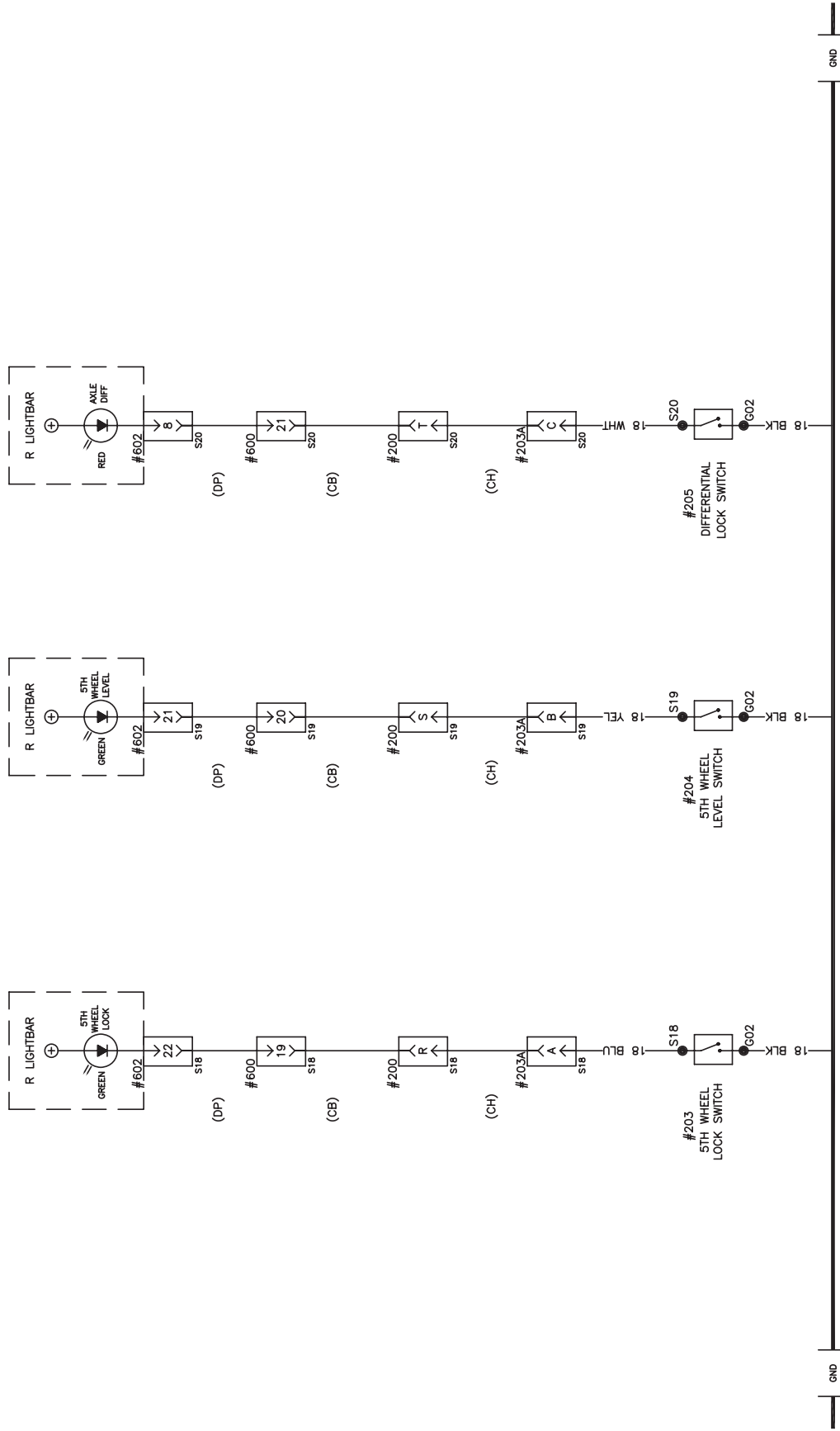
J1939 Gauge Panel



ELECTRICAL SYSTEM

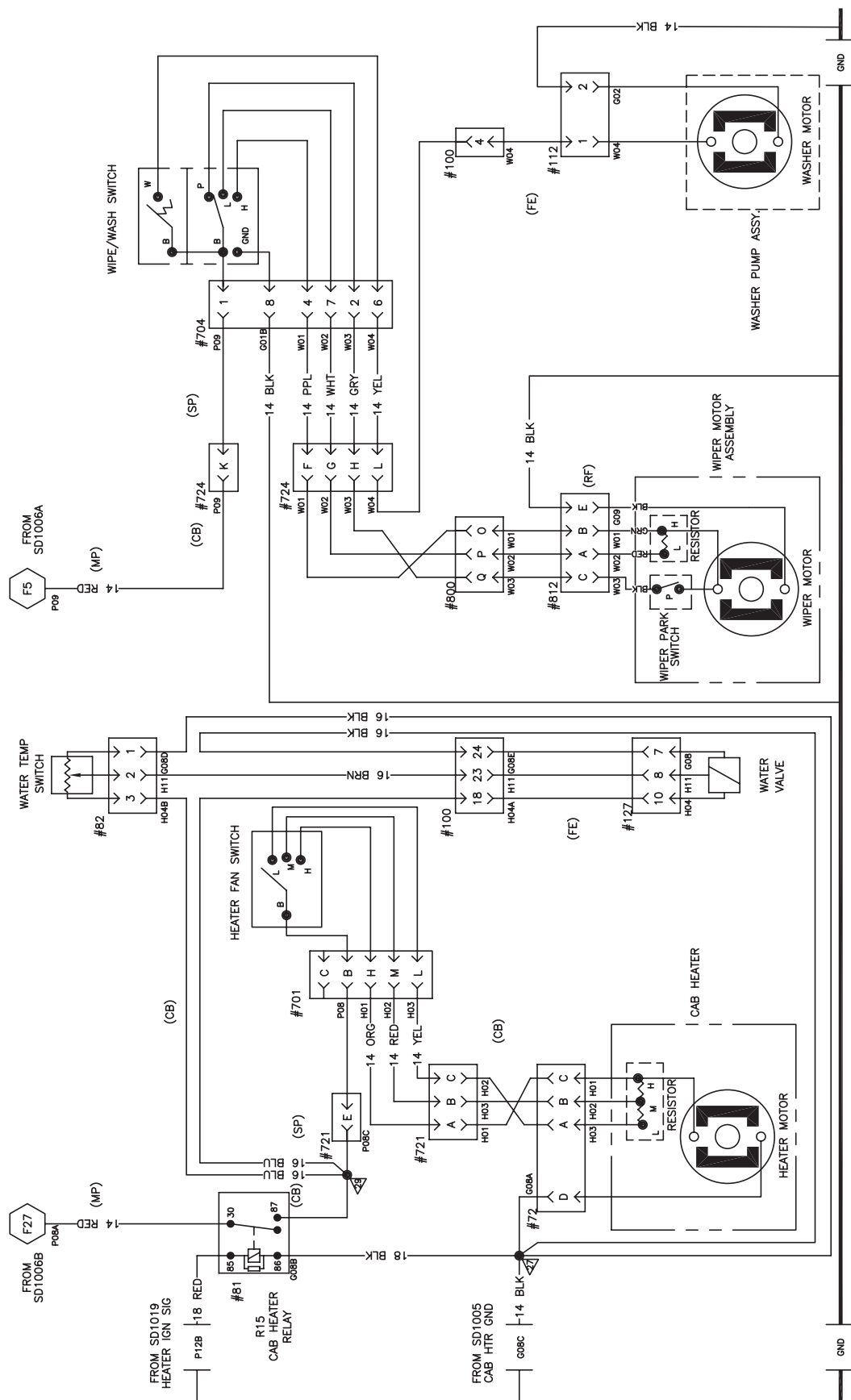
SD1016

Fifth Wheel and Differential Lock Lamps



SD1017

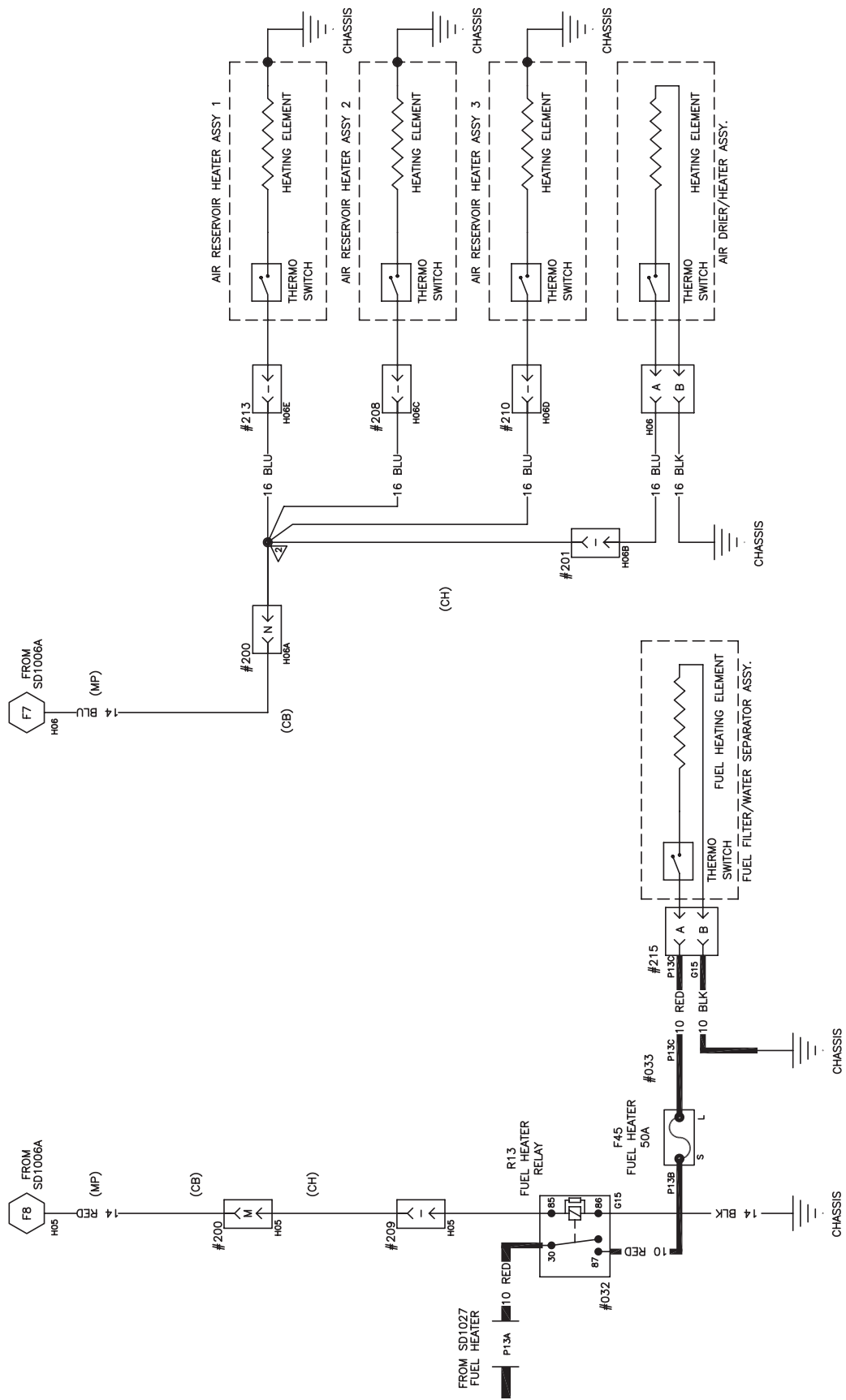
Cab Heater, Wiper/Washer Circuits



ELECTRICAL SYSTEM

SD1018

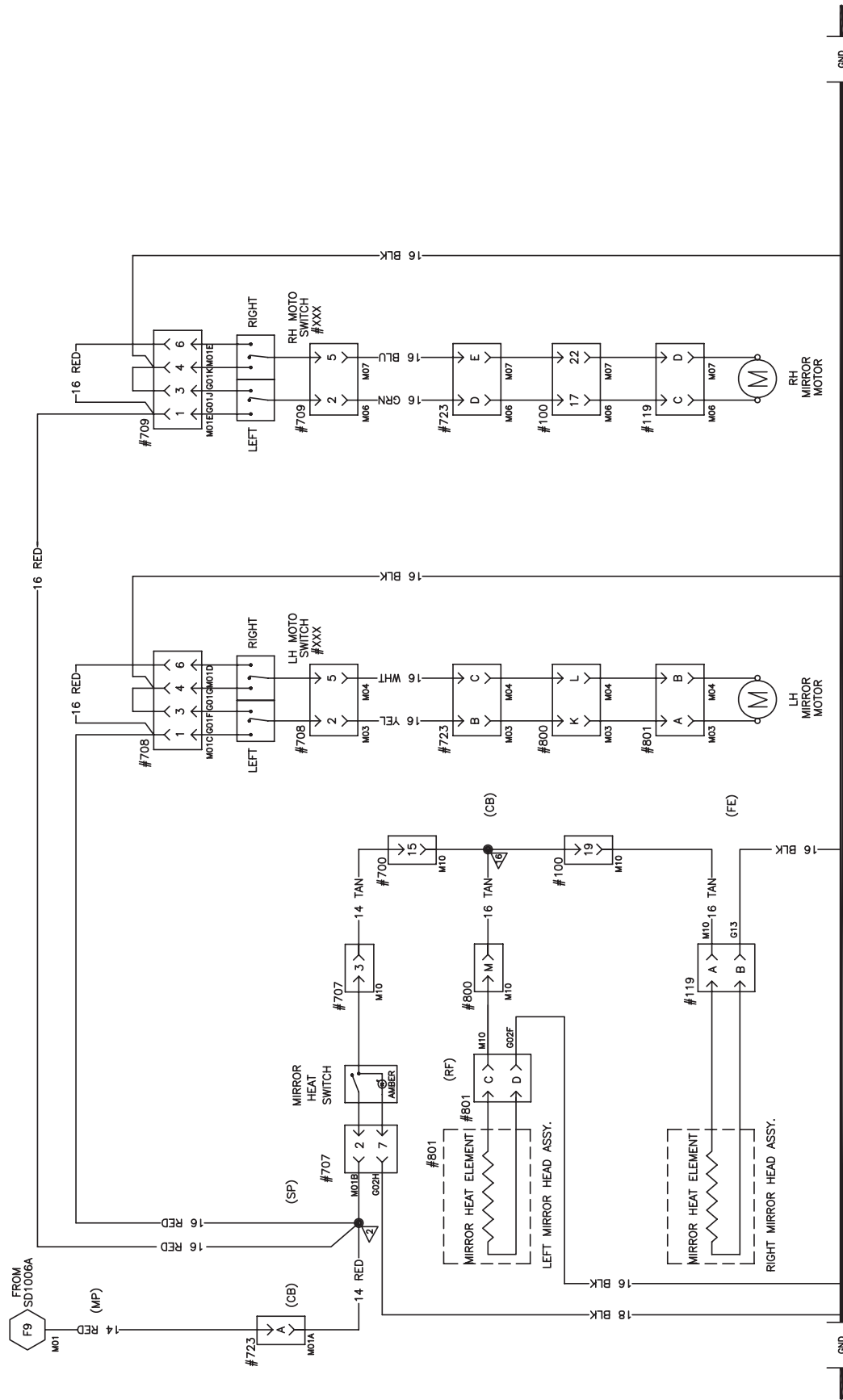
Fuel Heater/Water Separator and Air Dryer/Reservoir Heater



ELECTRICAL SYSTEM

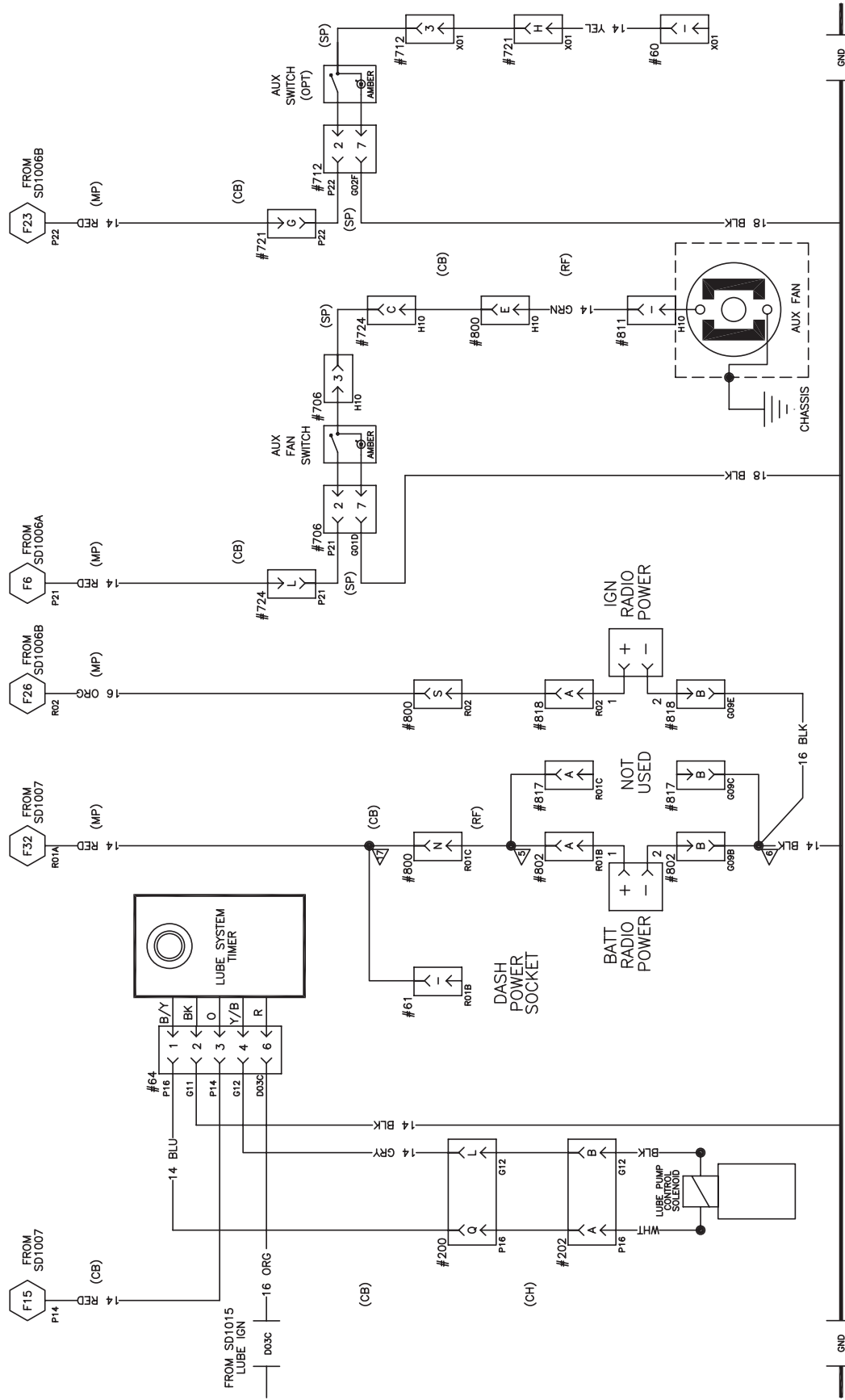
SD1020

Mirrors and Mirror Heat



SD1021

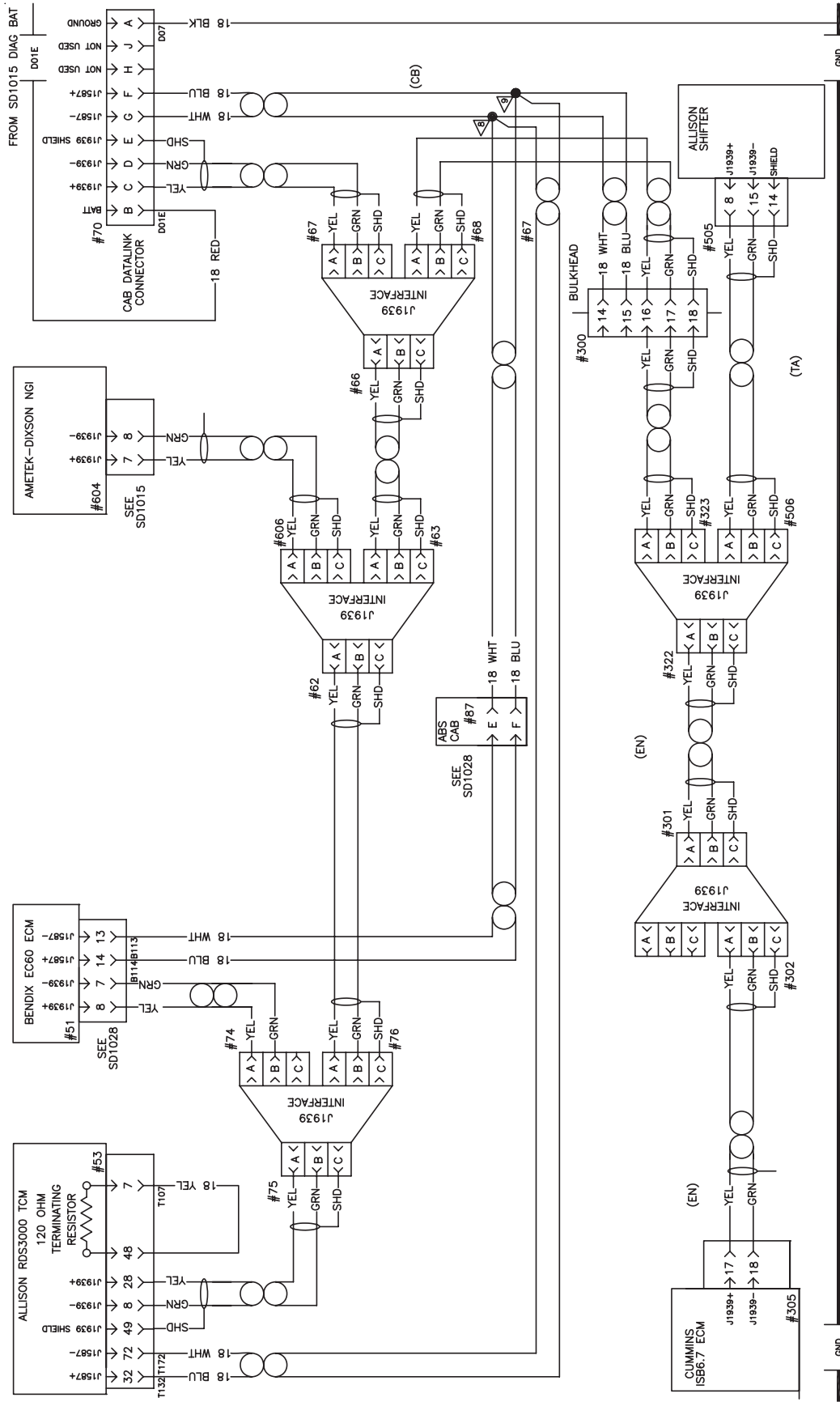
Lube System, Radio, Auxiliary Fan and Auxiliary Switch (Optional)



ELECTRICAL SYSTEM

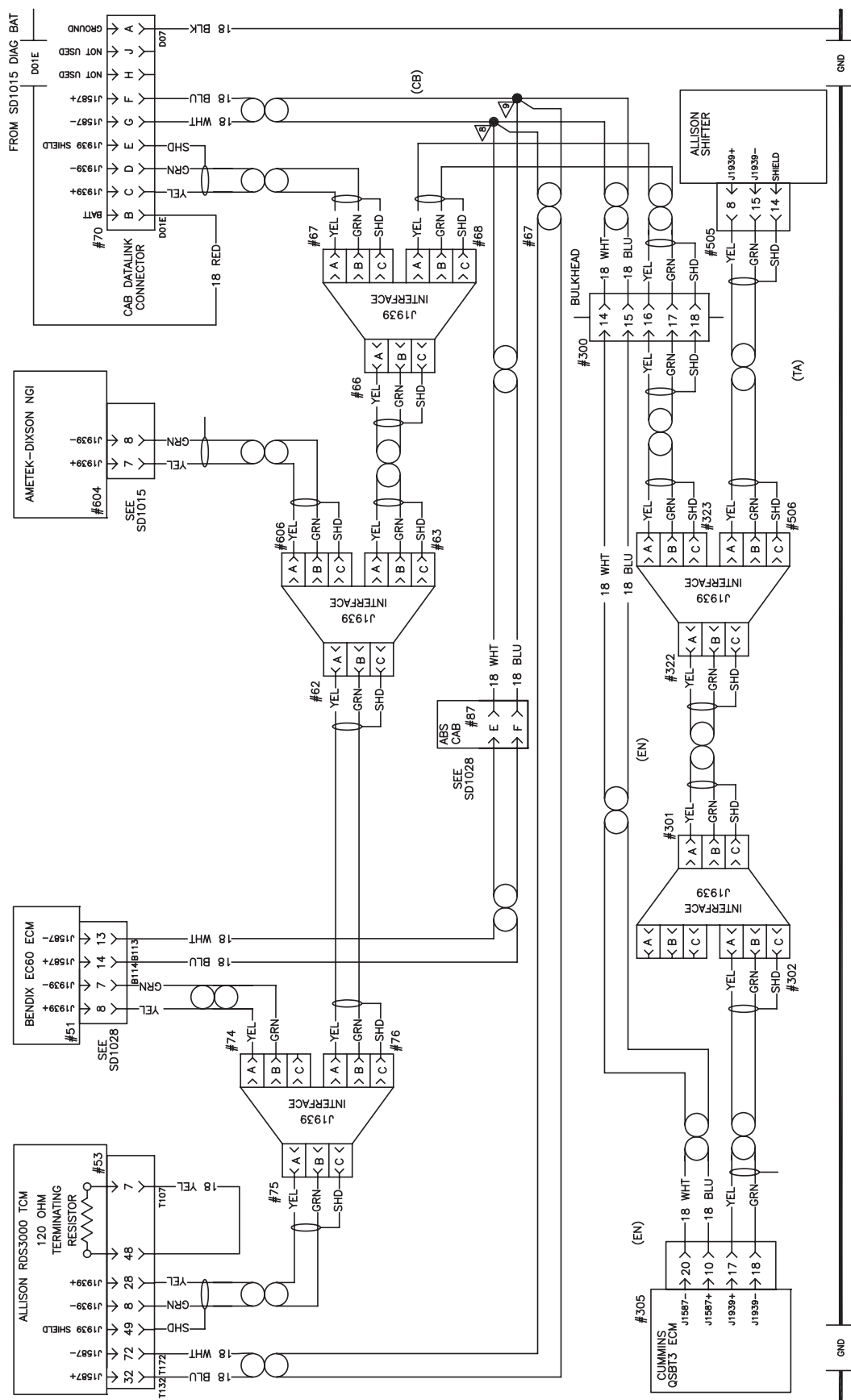
SD1022

Public J1939 and J1587 Datalink (ISB6.7)



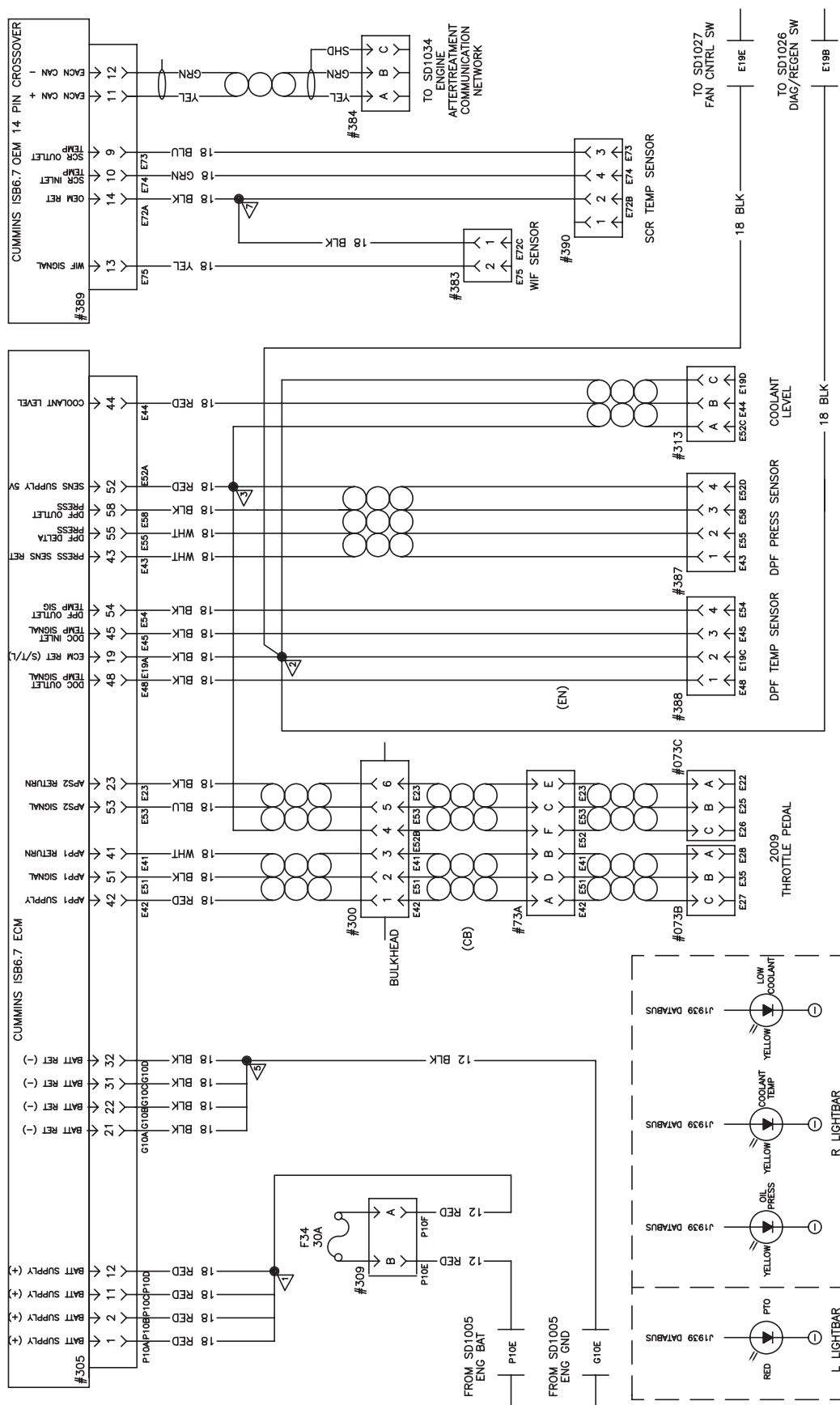
SD1022

Public J1939 and J1587 Datalink (QSBT3)



SD1025

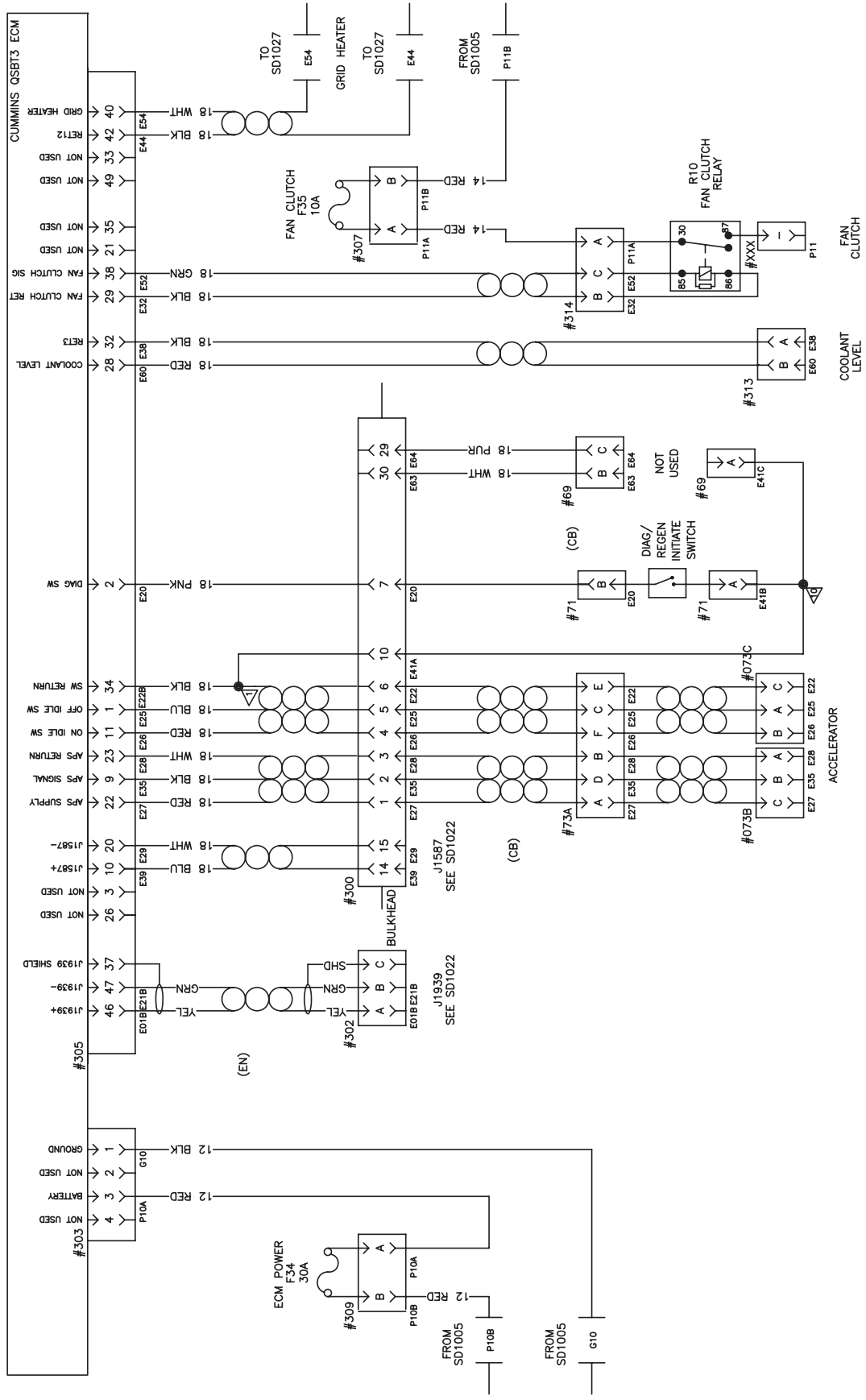
Engine (ISB6.7)



ELECTRICAL SYSTEM

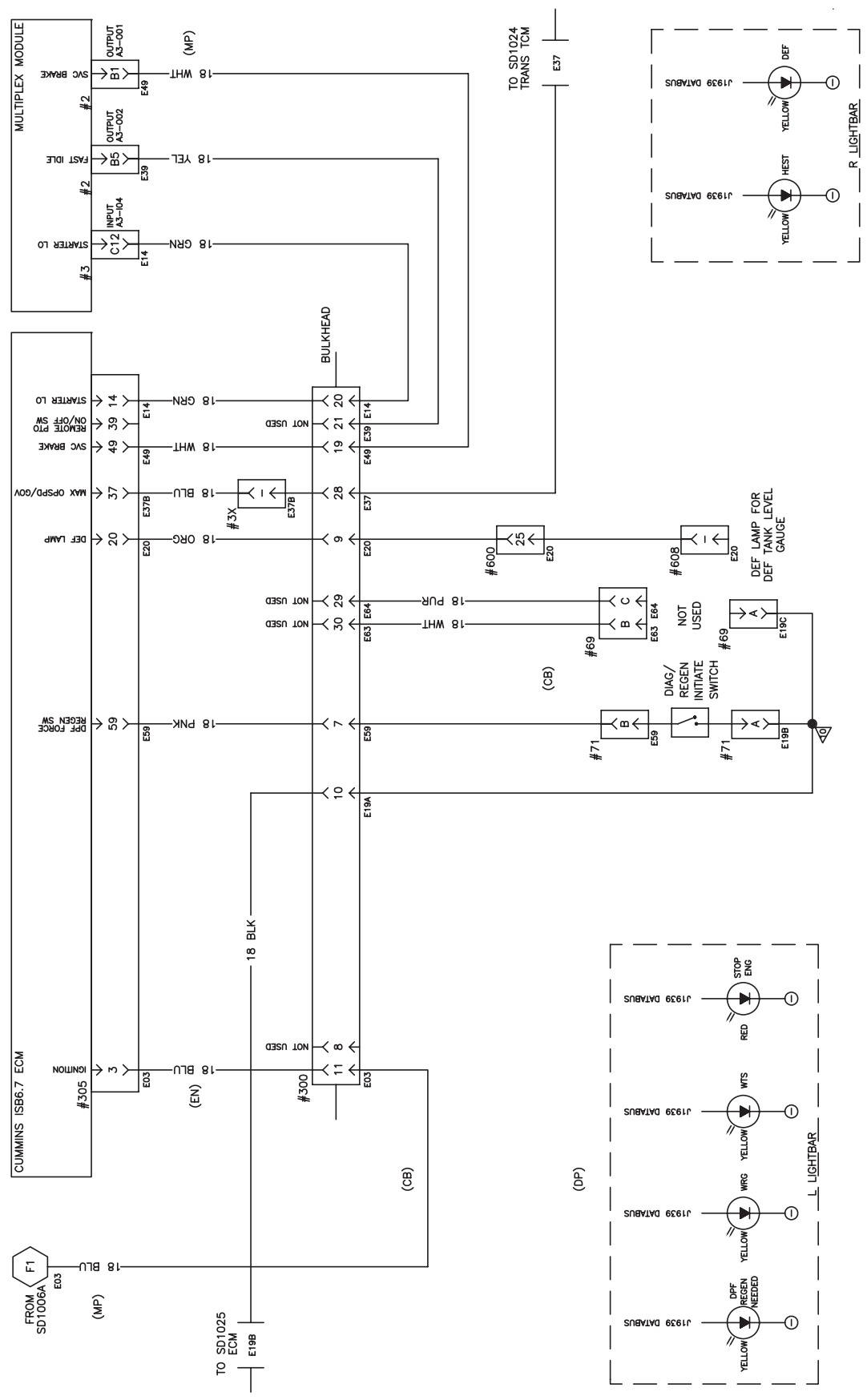
SD1025

Engine (QSBT3)



SD1026

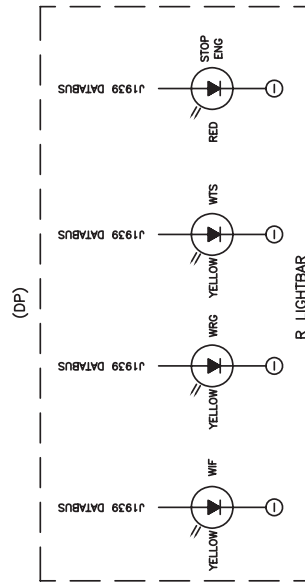
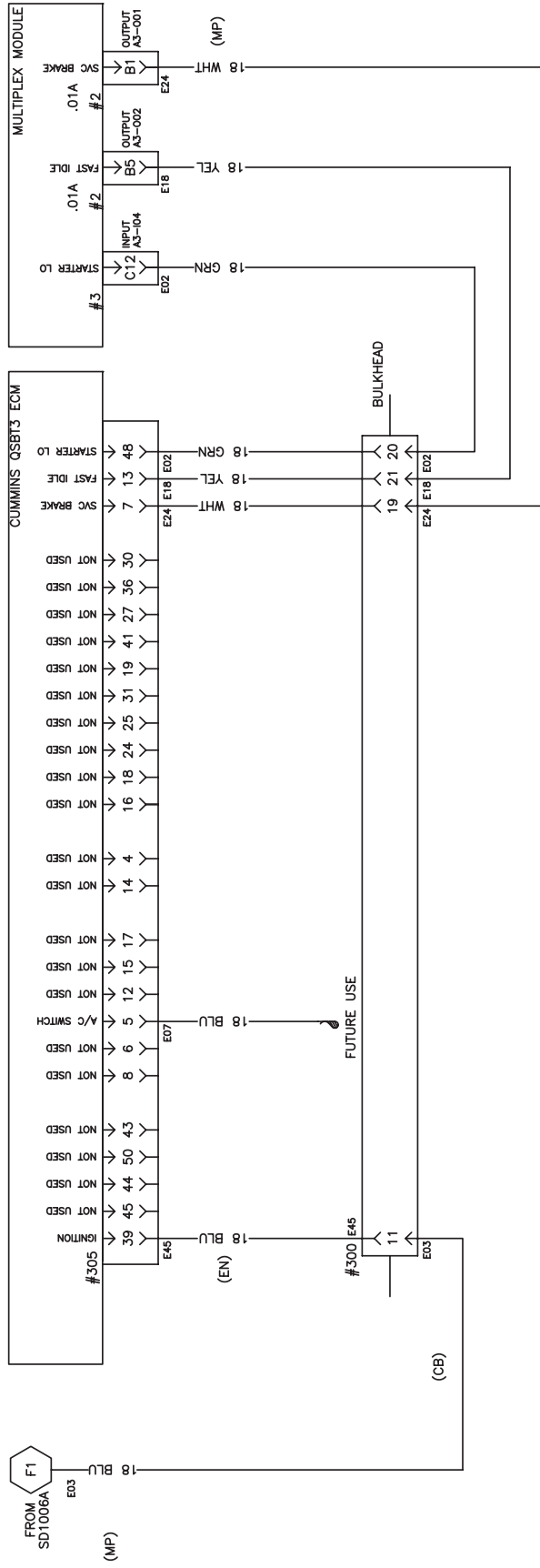
Engine Vehicle Interface (ISB6.7)



ELECTRICAL SYSTEM

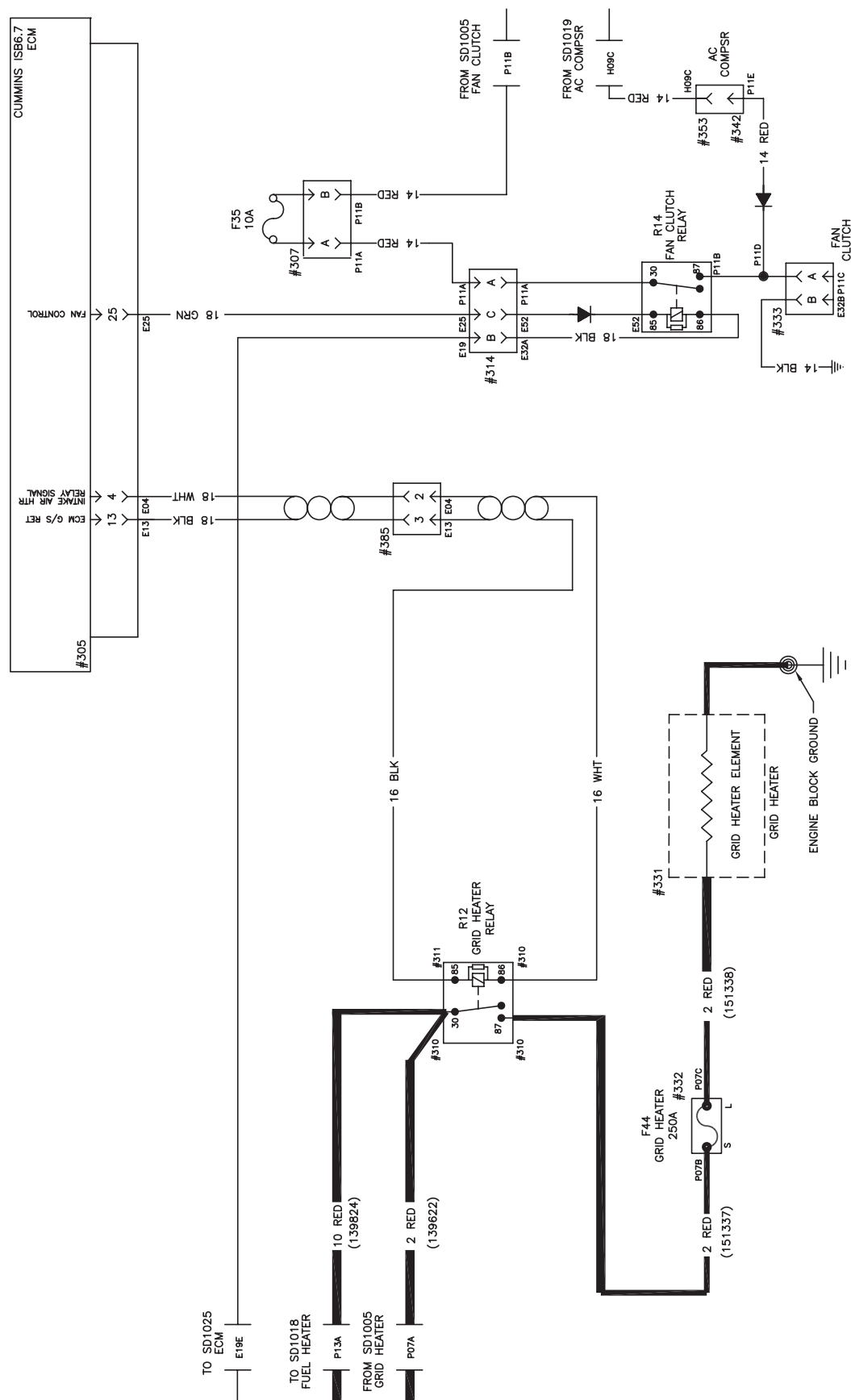
SD1026

Engine Vehicle Interface (QSBT3)



SD1027

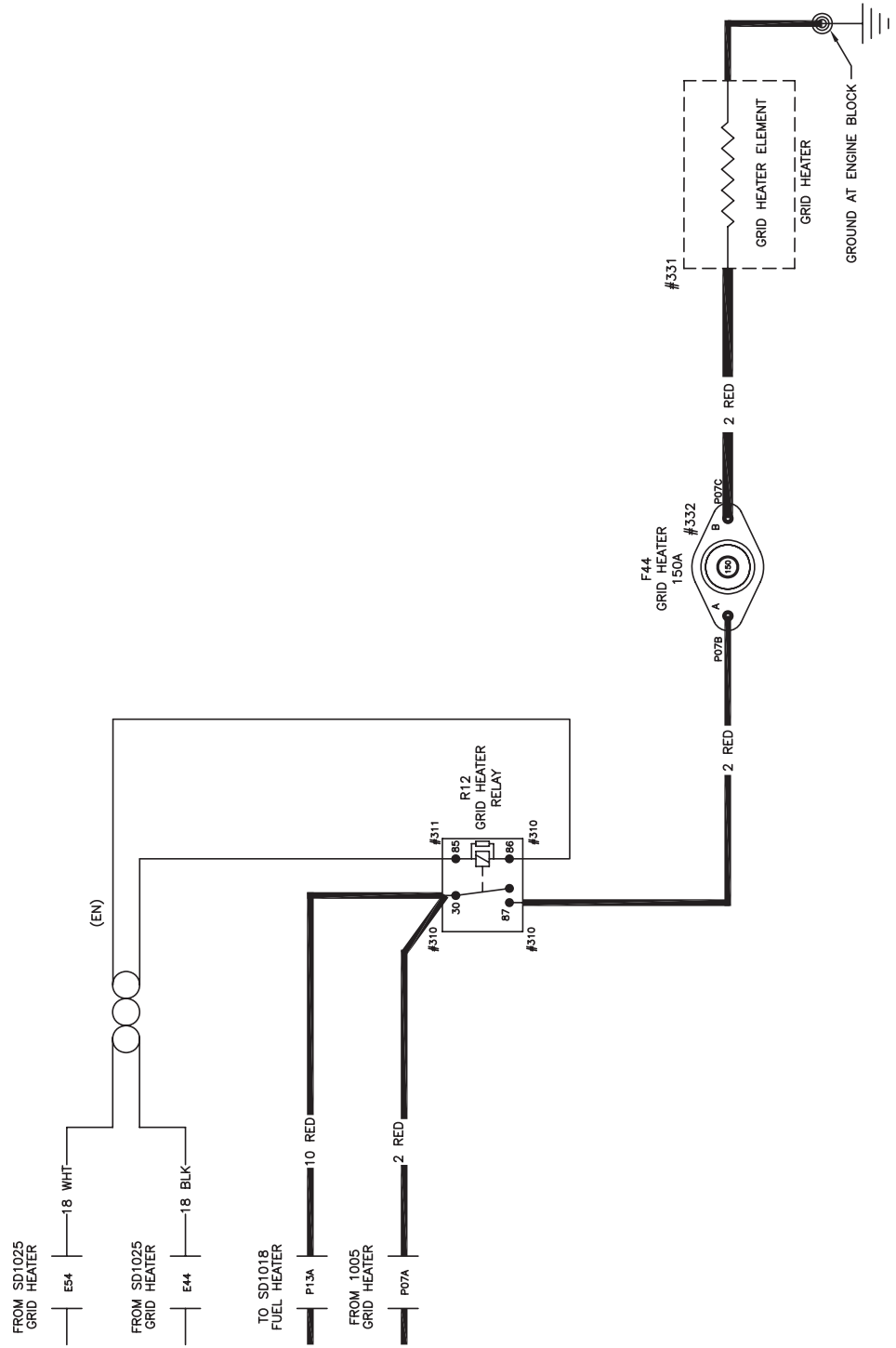
Engine Grid Heater/Fan Control (ISB6.7)



ELECTRICAL SYSTEM

SD1027

Engine Grid Heater (QSBT3)



ELECTRICAL SYSTEM

SD1030A

Relays

RELAYS			
RELAY ID	FUNCTION	RATING	LOCATION
R1	I/O RELAY – WORKLAMP 1	35A	DVEC
R2	IGN RLY – AIR DRYER/FUEL FILTER	35A	DVEC
R3	IGN RLY – ENG/TRANS/ABS/DIAGNOSTICS	35A	DVEC
R4	IGN RLY – GAGE/LUBE/WIPER/AUX FAN	35A	DVEC
R5	IGN RLY – MIRROR/AC	35A	DVEC
R6	I/O RELAY – WORKLAMP 2	35A	DVEC
R7	IGN RLY – SCR ISB6.7/SPARE 9	35A	DVEC
R8	IGN RLY – AUX LTS/SPARES 11, 12	35A	DVEC
R9	IGN RLY – RADIO/CAB HEATER	35A	DVEC
R10	IGN RLY – SPARE 14	35A	DVEC
R11	STARTER RELAY	100A	ENCLOSURE BOX
R12	GRID HEATER RELAY	200A	ENCLOSURE BOX
R13	FUEL HEATER RELAY	100A	ENCLOSURE BOX
R14	FAN CLUTCH RELAY	30A	LEFT FRAME RAIL
R15	CAB HEATER RELAY	30A	DASH
R16	MAX SPEED RELAY	30A	BULKHEAD CONN
R17	LINE HEATERS	20A	ENCLOSURE BOX
R18	SWITCHED BATTY PWR	20A	ENCLOSURE BOX
R19	DEF TANK LEVEL SENS	20A	ENCLOSURE BOX
BPS	BRAKE PRESSURE SWITCH RELAY	20/30A	ENGINE HARNESS

Fuses

SD1030B

FUSE ID	FUNCTION	CIRCUIT ID	CURRENT	VOLTAGE	LOCATION
FUSES					
F1	ENGINE IGNITION	E03	5A	12V IGN	DVEC
F2	TRANSMISSION/DIAG IGNITION	T163A	10A	12V IGN	DVEC
F3	ABS IGNITION	B103A	5A	12V IGN	DVEC
F4	GAUGE/LUBE IGNITION	D03A	10A	12V IGN	DVEC
F5	WASHER/WIPER IGNITION	P09	10A	12V IGN	DVEC
F5	SPARE IGNITION	MPSP20	10A	12V IGN	DVEC
F5	SPARE IGNITION	MPSP5	10A	12V IGN	DVEC
F5	SPARE IGNITION	MPSP8	10A	12V IGN	DVEC
F6	AUX FAN IGNITION	P21	5A	12V IGN	DVEC
F6	SPARE IGNITION	MPSP6	5A	12V IGN	DVEC
F7	AIR DRYER/HEATER	H06	10A	12V IGN	DVEC
F8	FUEL FILTER/SEPERATOR	H05	10A	12V IGN	DVEC
F9	MIRROR POWER	M01	15A	12V IGN	DVEC
F10	A/C CLUTCH	P12A	15A	12V IGN	DVEC
F11	FRONT WORKLAMPS 1/SPOT	L09A	20A	12V IGN	DVEC
F12	REAR WORKLAMPS 2	L10A	20A	12V IGN	DVEC
F13	DIAG GAUGE/SPARE	MPSP1	10A	12V BATT	DVEC
F14	SPARE BATTERY	MPSP10	10A	12V BATT	DVEC
F15	LUBE SYSTEM BATTERY	P14	15A	12V BATT	DVEC
F16	SPARE BATTERY	MPSP15	5A	12V BATT	DVEC
F17	GAUGE PANEL BATTERY	D01	15A	12V BATT	DVEC
F18	TRANSMISSION BATTERY	T110	15A	12V BATT	DVEC
F19	SPARE BATTERY	MPSP2	3A	12V BATT	DVEC
F20	SPARE BATTERY	MPSP16	5A	12V BATT	DVEC
F21	ISB6.7 SCR	252	10A	12V IGN	DVEC
F22	SPARE IGNITION	MPSP9	5A	12V IGN	DVEC
F23	AUX (OPT)	P22	10A	12V IGN	DVEC

FUSE ID	FUNCTION	CIRCUIT ID	CURRENT	VOLTAGE	LOCATION
FUSES					
F24	SPARE IGNITION	MPSP11	10A	12V IGN	DVEC
F25	SPARE IGNITION	MPSP12	5A	12V IGN	DVEC
F26	RADIO IGNITION	R02	15A	12V IGN	DVEC
F27	CAB HEATER	P08	20A	12V IGN	DVEC
F28	SPARE IGNITION	MPSP14	30A	12V IGN	DVEC
F29	SPARE BATTERY	MPSP17	10A	12V BATT	DVEC
F30	SPARE BATTERY	MPSP18	10A	12V BATT	DVEC
F31	SPARE BATTERY	MPSP19	15A	12V BATT	DVEC
F32	RADIO BATTERY	R01	20A	12V BATT	DVEC
F33	IO CONTROLS BATTERY	P03	50A	12V BATT	MAIN PANEL
F34	ENG BATT-CUMMINS(NAVISTAR)	P10	30A(40A)	12V BATT	BATTERY BOX
F35	FAN CLUTCH BATTERY	P11	10A	12V BATT	BATTERY BOX
F36	ABS BATTERY	B116	30A	12V BATT	BATTERY BOX
F37	HORN	A09	10A	12V BATT	16" FROM HORN
F38	TRAILER LEFT TURN SIG	A05	3A	12V	12" FROM TRLR PLG
F39	TRAILER RIGHT TURN SIG	A06	3A	12V	12" FROM TRLR PLG
F40	TRAILER STOP LAMPS	A08	5A	12V	12" FROM TRLR PLG
F41	TRAILER MARKER LAMPS	L03A	5A	12V	12" FROM TRLR PLG
F42	TRAILER TAIL LAMPS	L03B	2A	12V	12" FROM TRLR PLG
F43	MAIN BRKR-CUMMINS(NAV 105A)	P24	100A	12V BATT	ENCLOSURE BOX
F44	GRID HEATER	P07	250A	12V BATT	ENCLOSURE BOX
F45	FUEL HEATER	P13	50A	12V BATT	ENCLOSURE BOX
F46	LINE HEATERS	P28	20A	12V DCU	ENCLOSURE BOX
F47	DCU PWR	P32	20A	12V BATT	ENCLOSURE BOX
F48	NOX SCR OUTLET	P30	10A	12V SWTCHD	ENCLOSURE BOX
F49	NOx ENGINE	P30	10A	12V SWTCHD	ENCLOSURE BOX
F50	DEF TANK LEVEL SNSOR	P33	2A	12V BATT	ENCLOSURE BOX
F51	DCU IGNITION	252	5A	12V IGN	ENCLOSURE BOX

ELECTRICAL SYSTEM

ELECTRICAL SYSTEM

SD1031

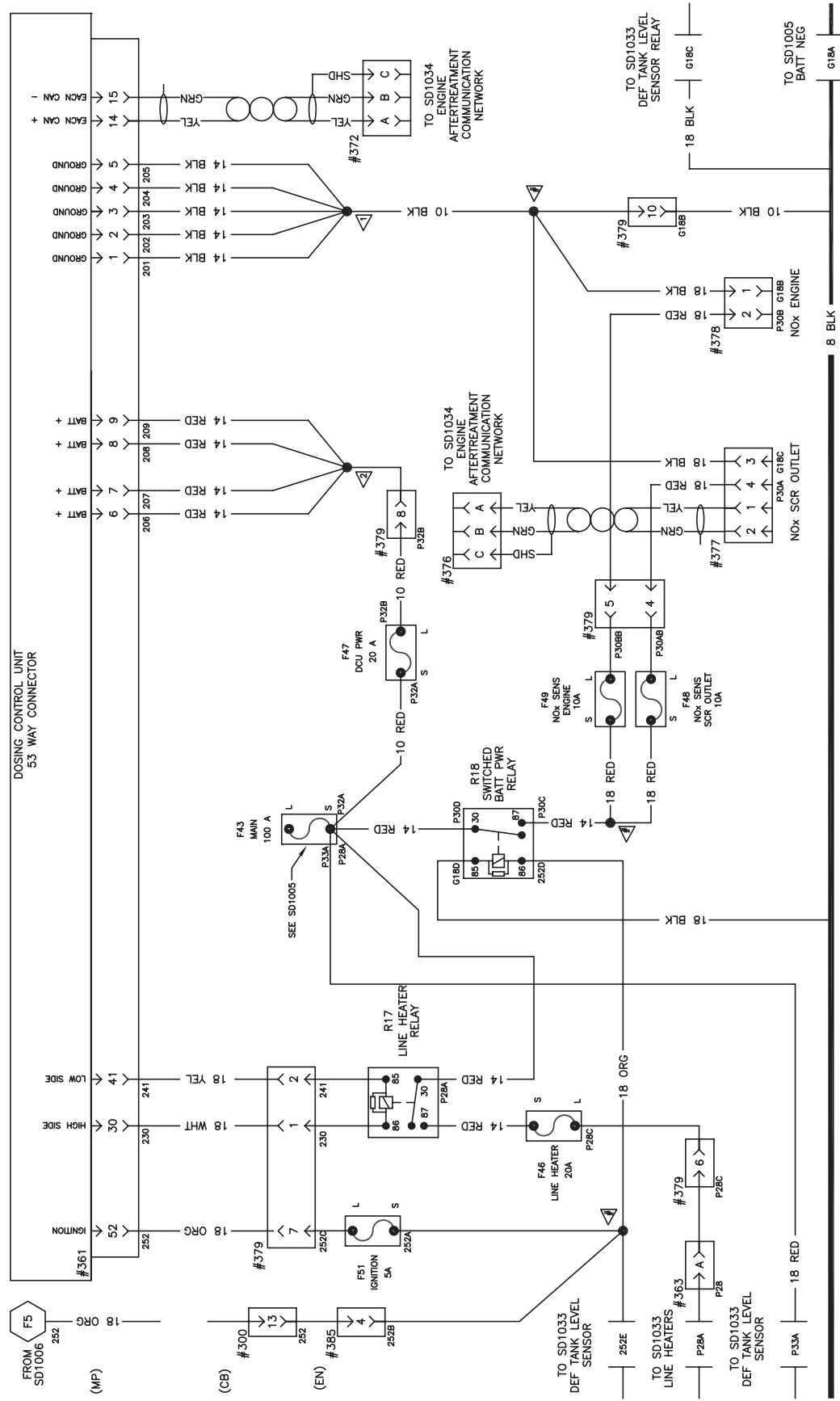
Inputs and Outputs

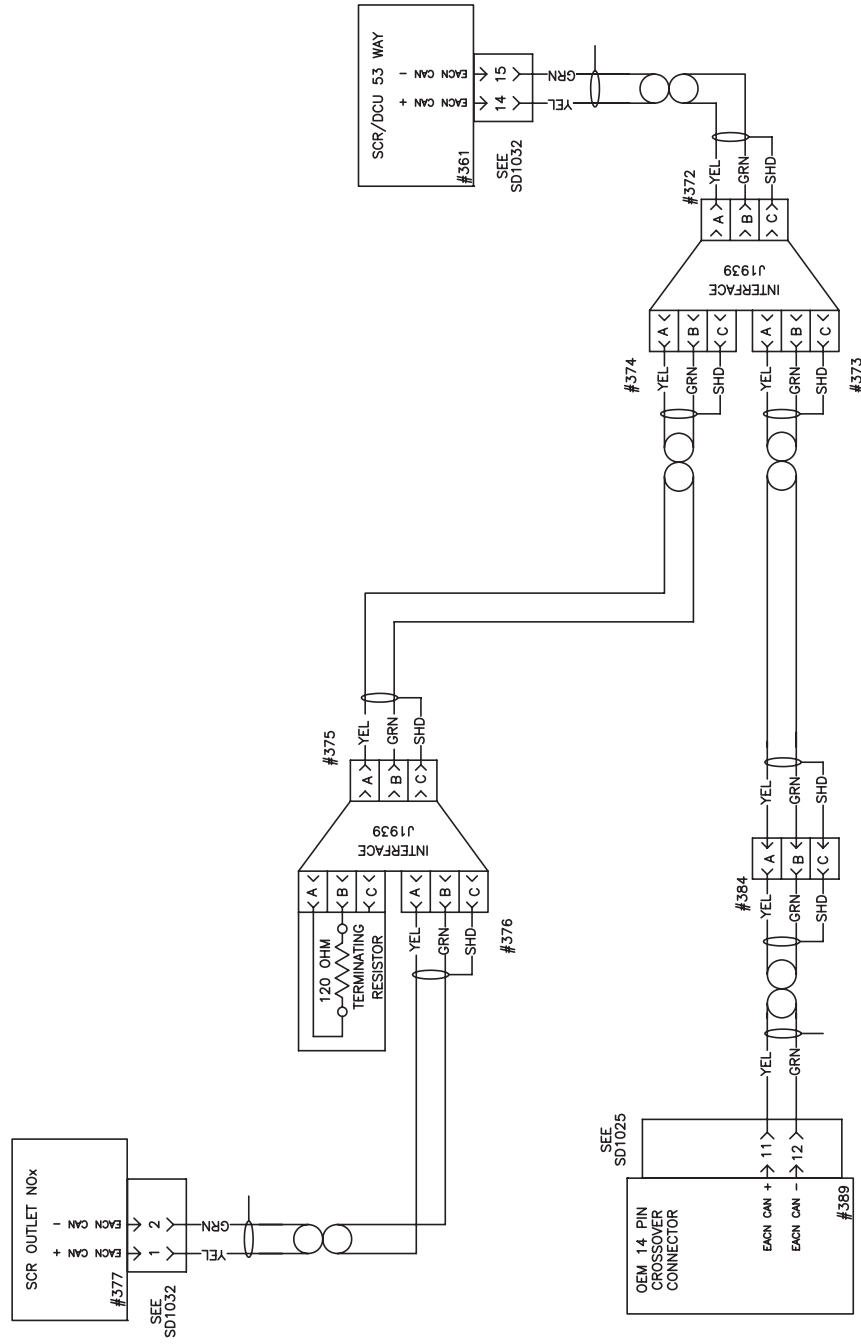
ADDRESS	DESCRIPTION	WIRE #	COLOR	VOLTAGE
IO MODULE A -- INPUTS				
A1-101	HEADLAMP DIMMER SW	S10	YEL	GND
A1-102	PARK BRAKE SW	S05	PNK	GND
A1-103	INT LTS SW	S11	RED	12V
A1-104	5TH WHEEL LAMP SW	S14	WHT	12V
A1-105	EXT LTS SW	S16	BLU	12V
A1-106	BRAKE LAMP SW	S12	YEL	GND
A1-107	HORN SW	S06	BRN	GND
A1-108	GEN R TERM	A02	ORG	12V
A2-101	HEAD LTS SW -- PARK	S03	GRN	GND
A2-102	NEUTRAL SIGNAL	T141	TAN	12V
A2-103	HAZARD SW	S09	PNK	GND
A2-104	--	--	--	GND
A2-105	HEAD LTS SW -- HEAD	S04	LGN	GND
A2-106	--	--	--	GND
A2-107	--	--	--	GND
A2-108	TRUN SIG SW -- R	S07	BLU	GND
A3-101	TURN SIG SW -- L	S08	YEL	GND
A3-102	IGNITION SW -- IGN	S01	RED	GND
A3-103	IGNITION SW -- START	S02	BLU	GND
A3-104	STARTER LOCKOUT	E14	GRN	12V
A3-105	REVERSE SIGNAL	T165	TAN	GND
A3-106	--	--	--	GND
A3-107	I/O DIAGNOSTIC SW	S21	WHT	GND
A3-108	--	--	--	GND

ADDRESS	DESCRIPTION	WIRE #	COLOR	VOLTAGE
IO MODULE A -- OUTPUTS				
A1-001	LOW BEAM -- L&R	L05	GRN	12V
A1-002	TRUN SIG -- RIGHT	A06	BLU	12V
A1-003	HIGH BEAM -- LEFT	L06	WHT	12V
A1-004	5TH WHEEL LAMP	L08	WHT	12V
A1-005	CLEARANCE/MARKER LAMPS	L03	LGN	12V
A1-006	HIGH BEAM -- RIGHT	L07	BLU	12V
A1-007	STOP LAMPS	A08	RED	12V
A1-008	TURN SIGNAL -- LEFT	A05	YEL	12V
A2-001	IGNITION RELAY SIGNAL	P04	RED	12V
A2-002	WORKLAMPS 1 SIGNAL	P05	GRY	12V
A2-003	WORKLAMPS 2 SIGNAL	P06	BLU	12V
A2-004	ALT FAIL LAMP	A01	GRN	12V
A2-005	STOP/TS LAMP -- LEFT	A03	BRN	12V
A2-006	STOP/TS LAMP -- RIGHT	A04	TAN	12V
A2-007	DOVE LAMP	L04	YEL	12V
A2-008	STROBE (BEACON)	A10	PNK	12V
A3-001	ENG SVC BRAKE	E49	WHT	GND
A3-002	ENG PTO	E39	YEL	GND
A3-003	--	MPSF7	WHT	GND
A3-004	STARTER RELAY SIGNAL	E61	BLU	GND
A3-005	TRANS SVC BRAKE	T122	YEL	GND
A3-006	TRANS PARK BRAKE	T101	BLU	GND
A3-007	BACKUP ALARM/LAMPS	A07	GRN	12V
A3-008	HORN	A09	YEL	12V

SD1032

SCR System: Power (ISB6.7)





































ELECTRICAL SYSTEM

SD1035

Light Bar Layout

LEFT TURN 	SPARE 	PTO 	LOW AIR 	ALT 	LOW FUEL 	SPARE 	HIGH BEAM 
R1C1 HIGH J1939	R1C2 RIC2	R1C3 J1939	R1C4 J1939	R1C5 HIGH J1939	R1C6 LOW J1939	R1C7 RIC7	R1C8 HIGH J1939
ABS 	TRLR ABS 	ATC 	STOP ENGINE 	WARNING 	REGEN NEEDED 	WTS 	CHECK TRANS 
R2C1 J1939	R2C2 J1939	R2C3 J1939	R2C4 J1939	R2C5 J1939	R2C6 J1939	R2C7 J1939	R2C8 J1939

LEFT

SPARE 	5TH WHEEL LCK 	5TH WHEEL LVL 	STOP LAMP 	SPARE 	PARKING BRAKE 	AXLE DIFF 	RIGHT TURN 
R1C1	R1C2 LOW	R1C3 LOW	R1C4 HIGH	R1C5	R1C6 LOW	R1C7 LOW	R1C8 HIGH
DEF 	HEST 	OIL PRESSURE 	COOLANT TEMP 	LOW COOLANT 	TRANS TEMP 	SPARE 	SPARE 
R2C1 J1939	R2C2 J1939	R2C3 J1939	R2C4 J1939	R2C5 J1939	R2C6 J1939	R2C7	R2C8

RIGHT

LOCATION	DESCRIPTION	PAGE
DASH INDICATOR LIGHTS		
LEFT		
R1C1	LEFT TURN	SD1010
R1C2	SPARE	-
R1C3	PTO	SD1025
R1C4	LOW AIR	SD1015
R1C5	ALT	SD1005
R1C6	LOW FUEL	SD1015
R1C7	SPARE	-
R1C8	HIGH BEAM	SD1009
R2C1	ABS	SD1028
R2C2	TRLR ABS	SD1028
R2C3	ATC	SD1028
R2C4	STOP ENGINE	SD1026
R2C5	WARNING	SD1026
R2C6	REGEN NEEDED	SD1026
R2C7	WTS	SD1026
R2C8	CHECK TRANS	SD1024
RIGHT		
R1C1	SPARE	-
R1C2	5TH WHEEL LCK	SD1016
R1C3	5TH WHEEL LVL	SD1016
R1C4	STOP LAMP	SD1009
R1C5	SPARE	-
R1C6	PARKING BRAKE	SD1008
R1C7	AXLE DIFF	SD1016
R1C8	RIGHT TURN	SD1010
R2C1	DEF	SD1026
R2C2	HEST	SD1026
R2C3	OIL PRESSURE	SD1025
R2C4	COOLANT TEMP	SD1025
R2C5	LOW COOLANT	SD1025
R2C6	TRANS TEMP	SD1024
R2C7	SPARE	-
R2C8	SPARE	-