

# Shop Manual

# 930E

DUMP TRUCK

SERIAL NUMBERS **32604 - 32789, 32803 - 32815**  
**w/MTU Engine**

# KOMATSU

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# MAJOR COMPONENT DESCRIPTION

## Truck And Engine

The 930E Dump Truck is an off-highway, rear dump truck with AC Electric Drive. The gross vehicle weight is 1,034,000 lbs. (469 012 kg). The engine is an MTU 16V396 TB44L rated @ 2682 HP (2000 kW).

## Alternator (GE-GTA34)

The diesel engine drives an in-line alternator at engine speed. The alternator produces AC current which is rectified to DC within the main control cabinet. The rectified DC power is converted back to AC by groups of devices called "inverters", also within the main control cabinet. Each inverter consists of six "phase modules" under the control of a "gate drive unit" (GDU). The GDU controls the operation of each phase module.

Each phase module contains an air-cooled solid-state switch referred to as a "gate turn-off thyristor" (GTO). The GTO cycles on and off at varying frequencies to create an AC power signal from the DC supply.

The AC power signal produced by each inverter is a variable-voltage, variable-frequency signal (VVVF). Frequency and voltage are changed to suit the operating conditions.

## AC Induction Traction Motorized Wheels

The alternator output supplies electrical energy to the two wheel motors attached to the rear axle housing. The motorized wheels use three-phase AC induction motors with full-wave AC power.

The two wheel motors convert electrical energy back to mechanical energy through built-in gear trains within the wheel motor assembly. The direction of the wheel motors is controlled by a forward or reverse hand selector switch located on the center console.

## Blower

Both the inverters and the wheel motors produce heat while in operation and must be cooled. Cooling air is provided by a separate AC drive blower using rectified DC as its power source. Cooling air flow volume is modulated based on thermal requirements.

## Suspension

HYDRAIR®II suspension cylinders located at each wheel provide a smooth and comfortable ride for the operator and dampens shock loads to the chassis during loading and operation.

## Operator's Cab

The operator cab has been engineered for operator comfort and to allow for efficient and safe operation of the truck. The cab provides wide visibility, with an integral 4-post ROPS/FOPS structure, and an advanced analog operator environment. It includes a tinted safety-glass windshield and power-operated side windows, a deluxe interior with a fully adjustable seat with lumbar support, a fully adjustable/tilt steering wheel, controls mounted within easy reach of the operator, and an analog instrument panel which provides the operator with all instruments and gauges which are necessary to control and/or monitor the truck's operating systems.

## Power Steering

The truck is equipped with a full time power steering system which provides positive steering control with minimum operator effort. The system includes nitrogen-charged accumulators which automatically provide emergency power if the steering hydraulic pressure is reduced below an established minimum.

## Dynamic Retarding

The dynamic retarding is used to slow the truck during normal operation or control speed coming down a grade. The dynamic retarding ability of the electric system is controlled by the operator through the activation of the retarder pedal (or by operating a lever on the steering wheel) in the operators cab and by setting the RSC (Retarder Speed Control). Dynamic Retarding is automatically activated, if the truck speed goes to a preset overspeed setting.

## Brake System

Service brakes at each wheel are oil-cooled multiple disc brakes applied by an all-hydraulic actuation system. Depressing the brake pedal actuates both front and rear brakes, after first applying the retarder. All wheel brakes will be applied automatically, if system pressure decreases below a preset minimum.

The parking brake is a dry disc type, mounted inboard on each rear wheel motor, and is spring-applied/hydraulically-released with wheel speed application protection (will not apply with truck moving).

# PRECAUTIONS DURING OPERATION

## Safety Is Thinking Ahead

**Prevention** is the best safety program. Prevent a potential accident by knowing the employer's safety requirements and all necessary job site regulations. In addition, know the proper use and care of all the safety equipment on the truck. Only qualified operators or technicians should attempt to operate or maintain a Komatsu machine.

Safe practices start before the operator gets to the equipment!

## Safety At The Worksite

- When walking to and from a truck, maintain a safe distance from all machines even when the operator is visible.
- Before starting the engine, thoroughly check the area for any unusual conditions that could be dangerous.
- Examine the road surface at the job site and determine the best and safest method of operation.
- Choose an area where the ground is as horizontal and firm as possible before performing the operation.
- If you need to operate on or near a public road, protect pedestrians and cars by designating a person for work site traffic duty or by installing fences around the work site.
- The operator must personally check the work position, the roads to be used, and existence of obstacles before starting operations.
- Always determine the travel roads at the work site and maintain them so that it is always safe for the machines to travel.
- If travel through wet areas is necessary, check the depth and flow of water before crossing the shallow parts. Never drive through water which exceeds the permissible water depth.

## Fire Prevention

- Thoroughly remove wood chips, leaves, paper and other flammable items accumulated in the engine compartment, as they could cause a fire.
- Check fuel, lubrication, and hydraulic systems for leaks. Repair any leaks. Wipe up any excess oil, fuel or other flammable fluids, and dispose of properly.
- Ensure a fire extinguisher is present and in proper working condition.
- Do not operate the machine near open flames.



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## Preparing For Operation

- Always mount and dismount while facing the truck. Never attempt to mount or dismount the truck while it is in motion. Always use handrails and ladders when mounting or dismounting the truck.
- Check the deck areas for debris, loose hardware, and tools. Check for people and objects that might be in the way.
- Become familiar with and use all protective equipment devices on the truck and ensure that these items (anti-skid material, grab bars, seat belts, etc.) are securely in place.

## Ventilation For Enclosed Areas

- If it is necessary to start the engine within an enclosed area, provide adequate ventilation. Exhaust fumes from the engine can kill.



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# TIRES

## Handling Tires

If tires are not used under the specified conditions, they may overheat and burst, or be cut and burst by sharp stones on rough road surfaces. This may lead to serious injury or damage.

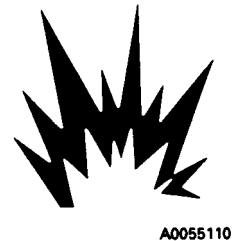
To maintain tire safety, always adhere to the following conditions:

- Inflate the tires to the specified pressure. Abnormal heat is generated particularly when the inflation pressure is too low.
- Use the specified tires.

The tire inflation pressure and permissible speeds are general values. The actual values may differ depending on the type of tire and the condition under which they are used. For details, please consult the tire manufacturer.

When tires become hot, a flammable gas is produced, and may ignite. It is particularly dangerous if the tires become overheated while the tires are pressurized. If the gas generated inside the tire ignites, the internal pressure will suddenly rise, and the tire will explode, resulting in danger to personnel in the area. Explosions differ from punctures or tire bursts because the destructive force is extremely large. Therefore, the following operations are strictly prohibited when the tire is pressurized:

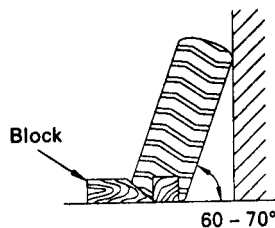
- Welding the rim
- Welding near the wheel or tire.
- Smoking or creating open flames



If the proper procedure for performing maintenance or replacement of the wheel or tire is not used, the wheel or tire may burst and cause serious injury or damage. When performing such maintenance, consult your authorized regional Komatsu distributor, or the tire manufacturer.

## Storing Tires After Removal

- As a basic rule, store the tires in a warehouse in which unauthorized persons cannot enter. If the tires are stored outside, always erect a fence around the tires and put up “No Entry” and other warning signs that even young children can understand.
- Stand the tire on level ground, and block it securely so that it cannot roll or fall over.
- If the tire should fall over, flee the area quickly. The tires for construction equipment are extremely heavy. Trying to hold the tire must not be attempted and may lead to serious injury.



- c. After the engine has started, place rest switch in the OFF position (de-activate the "rest" mode of operation). Refer to discussion of rest switch, in Section N, Operator Cab Controls.

*NOTE: This truck is equipped with an engine prelube system. With this feature, a noticeable time delay may occur (while engine lube oil passages are being filled and pressurized) before engine cranking will begin.*

### **Cold Weather Starting**

- Do not crank an electric starter for more than 30 seconds.
- Allow two minutes for cooling before attempting to start the engine again. **Severe damage to the starter motors can result from overheating.**

### **AFTER ENGINE HAS STARTED**

1. Become thoroughly familiar with steering and emergency controls. After engine has started and low pressure and warning systems are normal, test the truck steering in extreme right and left directions. If the steering system is not operating properly, shut the engine down, immediately. Determine the steering system problem and have repaired before resuming operation.
2. Operate each of the truck's brake circuits at least twice prior to operating and moving the truck. These circuits include individual activation from the operator's cab of the service brake, parking brake, and brake lock. With the engine running and with the hydraulic circuit fully charged, activate each circuit, individually. If any application or release of any brake circuit appears sluggish or improper, or if warning alarms are activated on application or release, shut the engine down and notify maintenance personnel. Do not operate the truck until the brake circuit in question is fully operational.
3. Check gauges, warning lights and instruments before moving the truck to ensure proper system operation and proper instrument functioning. Give special attention to braking and steering circuit hydraulic warning lights. If warning lights come on, shut down the engine immediately and determine the cause.
4. Insure headlights, worklights and taillights are in proper working order. Good visibility may prevent an accident. Check operation of windshield wiper.
5. When truck body is in dump position, do not allow anyone beneath it unless body-up retaining pin or cable is in place.
6. Do not use the fire extinguisher for any purpose other than putting out a fire! If extinguisher is discharged, report the occurrence so the used unit can be refilled or replaced.
7. Do not allow unauthorized personnel to ride in the truck. Do not allow anyone to ride on the ladder of the truck.
8. Do not leave the truck unattended while the engine is running. Shut down the engine and apply the park brake before getting out of the cab.

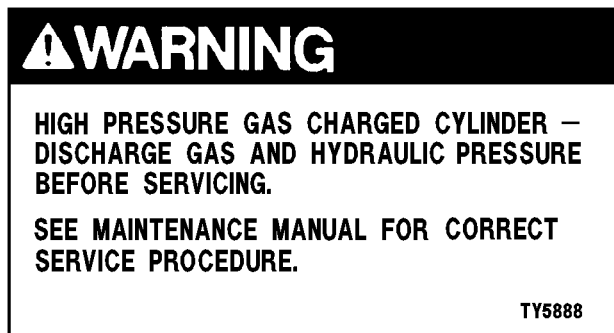
Warning plates are attached to both the hydraulic tank and fuel tank to alert technicians not to work on the truck with the body in the raised position unless body-up retention device (pins or cable) is in position.



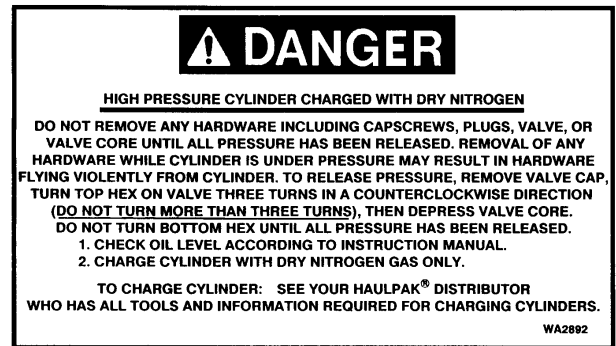
These danger plates are mounted on the outside of each frame rail to alert technicians to read the warning labels attached to the side of each of the accumulators (see below) prior to releasing internal nitrogen pressure or disconnecting any hydraulic lines or hardware. There are similar decals mounted on top of each of the accumulators (both steering and brake) with the same danger message.



These warning decals are mounted on the side of each of the accumulators (both steering and brake) to alert technicians to discharge all gas and hydraulic pressure, and to read the maintenance/service manual prior to performing any service.



This danger plate is attached to all four suspensions.

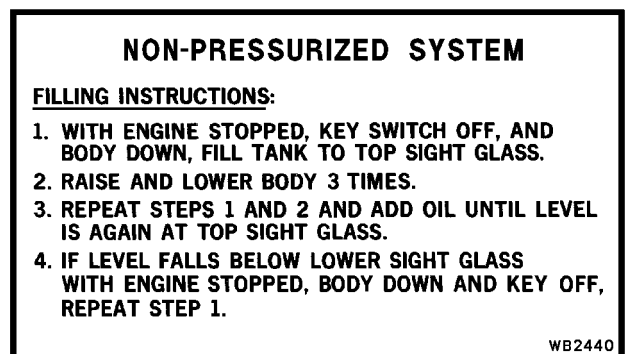


The plate contains instructions for releasing internal pressure before disconnecting any hardware.

Serious injury can occur if these directions are not followed.

A plate on the side of the hydraulic tank furnishes instructions for filling the hydraulic tank.

Keep the system open to the atmosphere only as long as absolutely necessary to lessen chances of system contamination. Service the tank with clean Type C-4 hydraulic oil. All oil being put into the hydraulic tank should be filtered through 3 micron filters.



**TABLE XI. PRESSURE CONVERSIONS**  
**Pounds/square inch (psi) To Megapascals (MPa)**  
**Formula: psi x 0.0069 = MPa**

PSI	0	10	20	30	40	50	60	70	80	90
0	(MPa)	0.069	0.14	0.21	0.28	0.34	0.41	0.48	0.55	0.62
100	0.69	0.76	0.83	0.90	0.97	1.03	1.10	1.17	1.24	1.31
200	1.38	1.45	1.52	1.59	1.65	1.72	1.79	1.86	1.93	2.00
300	2.07	2.14	2.21	2.28	2.34	2.41	2.48	2.55	2.62	2.69
400	2.76	2.83	2.90	2.96	3.03	3.10	3.17	3.24	3.31	3.38
500	3.45	3.52	3.59	3.65	3.72	3.79	3.86	3.93	4.00	4.07
600	4.14	4.21	4.27	4.34	4.41	4.48	4.55	4.62	4.69	4.76
700	4.83	4.90	4.96	5.03	5.10	5.17	5.24	5.31	5.38	5.45
800	5.52	5.58	5.65	5.72	5.79	5.86	5.93	6.00	6.07	6.14
900	6.21	6.27	6.34	6.41	6.48	6.55	6.62	6.69	6.76	6.83

See NOTE below regarding Table usage

**NOTE: Tables such as Table VIII, IX, X, and XI may be used as in the following example:**

**Example:** Convert 975 psi to kilopascals (kPa).

1. Select Table X.
2. Go to PSI row 90, column 7; read 668.8  
97 psi = 668.8 kPa.
3. Multiply by 10:  
970 psi = 6688 kPa.
4. Go to PSI row 0, column 5; read 34.475  
psi = 34.47 kPa. Add to step 3.
5. 970 + 5 psi = 6688 + 34 = 6722 kPa.

**TABLE XII. TEMPERATURE CONVERSIONS**  
**Formula: F° - 32 / 1.8 = C° or C° x 1.8 + 32 = F°**

CELSIUS C°		FAHRENHEIT F°	CELSIUS C°		FAHRENHEIT F°	CELSIUS C°		FAHRENHEIT F°
121	250	482	63	145	293	4	40	104
118	245	473	60	140	284	2	35	95
116	240	464	57	135	275	-1	30	86
113	235	455	54	130	266	-4	25	77
110	230	446	52	125	257	-7	20	68
107	225	437	49	120	248	-9	15	59
104	220	428	46	115	239	-12	10	50
102	215	419	43	110	230	-15	5	41
99	210	410	41	105	221	-18	0	32
96	205	401	38	100	212	-21	-5	23
93	200	392	35	95	203	-23	-10	14
91	195	383	32	90	194	-26	-15	5
88	190	374	29	85	185	-29	-20	-4
85	185	365	27	80	176	-32	-25	-13
82	180	356	24	75	167	-34	-30	-22
79	175	347	21	70	158	-37	-35	-31
77	170	338	18	65	149	-40	-40	-40
74	165	329	15	60	140	-43	-45	-49
71	160	320	13	55	131	-46	-50	-58
68	155	311	10	50	122	-48	-55	-67
66	150	302	7	45	113	-51	-60	-76

NOTE: The numbers in the unmarked columns refer to temperature in either degrees Celsius (C°) or Fahrenheit (F°). Select a number in this unmarked column and read to the left to convert to degrees Celsius (C°) or read to the right to convert to degrees Fahrenheit (F°). If starting with a known temperature (either C° or F°), find that temperature in the **marked** column and read the converted temperature in the center, **unmarked** column.

- d. Check exposed portions of all hydraulic cylinder rams for rust, pitting and corrosion. If plating is deteriorated, the cylinder should be removed and overhauled or replaced; pitted or scored plating will cause leakage at the cylinder seals.
- 8. Check front wheel hub, final drive and wheel axle lubricant. If contamination is suspected, oil should be drained completely and the component serviced with clean prescribed lubricant. If major contamination is present, disassembly and overhaul will be in order.
- 9. Check parking brake. Since it is spring applied, the brake pads may be stuck tightly to the disc; it may be necessary to remove and overhaul the parking brake assembly.
- 10. Lubricate all grease fittings with prescribed lubricants which are not part of the automatic lubrication system. Pay particular attention to the steering linkage connections. All pivot points must be free of any binding.
- 11. Check battery charging alternator for corrosion or deterioration. Alternator rotor must be free, with no binding or roughness. Inspect, install and properly tension the alternator drive belts.
- 12. Check security of steering cylinder ball joints link and hydraulic connections.
- 13. Examine Hydrair suspensions for signs of damage.
  - a. Discharge nitrogen from suspensions as outlined in the service manual. Check condition of suspension oil and cylinder wipers. If wipers are cracked or hardened, the suspension must be rebuilt. Recharge suspension with new oil if old oil is deteriorated.
  - b. Check exposed chrome portions of cylinder for rust, pitting and corrosion. If plating is deteriorated the suspension should be removed and overhauled or replaced; pitted or scored plating will rapidly cause leakage at the seals.
  - c. Recharge suspensions as outlined in the service manual.

If not previously done, install fully-charged batteries and insure that hook-up is correct.

**SECTION B**  
**STRUCTURES**  
**INDEX**

STRUCTURAL COMPONENTS ..... B2-1

DUMP BODY..... B3-1

FUEL TANK..... B4-1

## DUMP BODY

### Removal

### **WARNING**

*Inspect all lifting devices. Slings, chains, and/or cables used for lifting components must be inspected daily for serviceable condition. Refer to the manufacturer's manual for correct capacities and safety procedures when lifting components. Replace any questionable items.*

*Slings, chains, and/or cables used for lifting components must be rated to supply a safety factor of approximately 2X the weight being lifted.*

*When in doubt as to the weight of components or any assembly procedure, contact the Komatsu area representative for further information.*

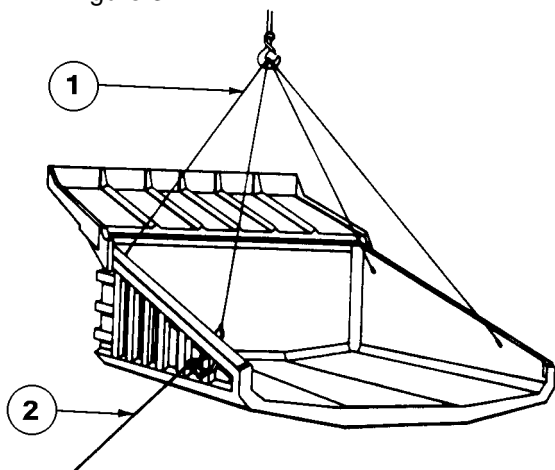
*Lifting eyes and hooks should be fabricated from the proper materials and rated to lift the load being placed on them.*

*Never stand beneath a suspended load. Use of guy ropes are recommended for guiding and positioning a suspended load.*

*Before raising or lifting the body, be sure there is adequate clearance between the body and overhead structures or electric power lines.*

*Be sure that the lifting device is rated for at least a 45 ton capacity.*

1. Park truck on a hard, level surface and block all the wheels. Connect cables and lifting device to the dump body and take up the slack as shown in Figure 3-1.

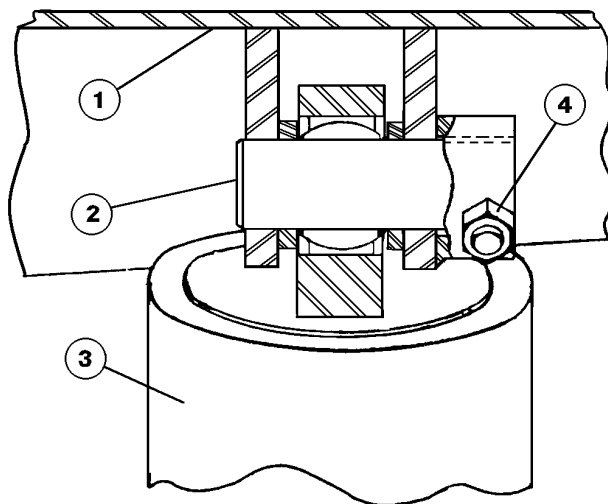


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FIGURE 3-1. DUMP BODY REMOVAL

1. Lifting Cables
2. Guide Rope

2. Remove mud flaps and rock ejectors from both sides of the body. Remove electrical cables, lubrication hoses etc. attached to the body.
3. Attach chains around upper end of hoist cylinders to support them after the mounting pins are removed.
4. Remove pin retainer capscrew (4, Figure 3-2) from each of the upper hoist cylinder mounting eyes. With adequate means of supporting the hoist cylinders in place, remove each of the mounting pins (2, Figure 3-2).



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FIGURE 3-2. HOIST CYLINDER MOUNT (UPPER)

1. Dump Body
2. Hoist Cylinder Pin
3. Hoist Cylinder
4. Pin Retainer

5. Remove capscrews 2, Figure 3-3), lockwashers (3), and retainer (1) from each pivot pin.
6. Remove capscrews (4) and lock nuts (5) from each pivot pin.
7. Attach a body pivot pin support fixture to bracket on underside of dump body to aid in supporting the pin as it is removed.

Remove body pivot pins (6) far enough to allow shims (9) to drop out. Complete removal of pins is not necessary unless new pins are to be installed.

8. Lift dump body clear of the chassis and move to storage or work area. Block the body to prevent damage to the body guide etc.
9. Inspect bushings (8, 11 & 12), body ear (7), and frame pivot (10) for excessive wear or damage.

## FUEL GAUGE SENDER

A fuel gauge sending unit (9, Figure 4-1) mounted on the side of the tank provides an electrical signal to operate the fuel gauge on the instrument panel.

### Removal

1. Drain the fuel below the level of the gauge sender.
2. Disconnect the wire from the terminal.
3. Loosen the small screws holding the fuel gauge sender unit and carefully remove.

### Installation

1. Clean mating surfaces, and install a new gasket.
2. Reinstall the sender unit in the tank. Use care and ensure that the float is oriented properly and works freely in the vertical plane during installation.
3. Reinstall the four socket head capscrews and tighten to standard torque. Reconnect the wire to the terminal.
4. Refill the tank and check for leaks.

## LOW FUEL SWITCH

Low fuel switch (13, Figure 4-1) controls the low fuel level indicator on the overhead warning indicator light panel in the operator cab. The switch is calibrated to turn on the low fuel indicator when the usable fuel remaining in the tank is approximately 25 gallons (95 liters).

## POWER MODULE

The radiator, engine and alternator assemblies are mounted on a roller equipped subframe which is contained within the truck's main frame and is referred to as a "Power Module". This arrangement permits removal and installation of these components with a minimum amount of disconnect and by utilizing the unique "Roll In/Roll Out" feature.

Although the instructions in this section are primarily based upon the "Rollout" method for major component removal, the radiator and fan may be removed as separate items. Instructions for radiator and fan removal are contained later in this section. Optional equipment may be installed on the truck, requiring additional removal and installation steps not listed.

The procedures outlined in this section of the manual are general instructions for power module removal and installation. It may be necessary to perform some procedures in a different order or use different methods for component removal and installation, depending on the lifting equipment available at the mine site.

Prior to removal or repair procedures, it may be necessary to remove the body to provide clearance for lifting equipment to be used. If body removal is not required, the body should be raised and the safety cables installed at the rear of the truck.

Read and observe the following instructions before attempting any repairs!

### **WARNING**

- ***Do not attempt to work in deck area until body safety cables have been installed.***
- ***Do not step on or use any power cable as a handhold when the engine is running.***
- ***Do not open any electrical cabinet covers or touch the retarding grid elements until all shutdown procedures have been followed.***
- ***All removal, repairs and installation of propulsion system electrical components, cables etc. must be performed by an electrical maintenance technician properly trained to service the system.***
- ***In the event of a propulsion system malfunction, a qualified technician should inspect the truck and verify the propulsion system does not have dangerous voltage levels present before repairs are started.***

After the truck is parked in position for the repairs, the truck must be shut down properly to ensure the safety of those working in the areas of the deck, electrical cabinet and retarding grids. The following procedures will ensure the electrical system is properly discharged before repairs are started.

### PREPARATION

1. Reduce the engine speed to idle. Place the selector switch in NEUTRAL and apply the parking brake. Be certain the parking brake applied indicator lamp in the overhead panel is illuminated.
  2. Place the drive system in the REST mode by turning the Rest switch on the instrument panel ON. Be certain the REST warning lamp is illuminated.
  3. Shut down the engine using the keyswitch. If, for some reason the engine does not shut down, use the shutdown switch on the center console.
  4. Verify the LINK VOLTAGE lights are OFF. If they remain on longer than 5 minutes after shutdown, notify the electrical department.
  5. Place the GF Cutout Switch in the CUTOUT position. (See Figure 3-1, page E3-2, Propulsion System, for switch location.)
  6. Verify the steering accumulators have bled down by attempting to steer.
  7. Bleed down the brake accumulators using the manual bleed valves on the brake manifold.
  8. Open the battery disconnect switches.
- ❑ Tag or mark all hydraulic lines, fuel lines and electrical connections to assure correct hookup at time of power module installation. Plug all ports and cover all hose fittings or connections when disconnected to prevent dirt or foreign material from entering.
  - ❑ It is not necessary to remove the radiator prior to the removal of the power module. However, the coolant must be drained and the piping connected to the brake cooling heat exchanger removed. If radiator removal is desired or if only radiator repair is necessary, refer to "Cooling System" in this section.

# COOLING SYSTEM

## RADIATOR

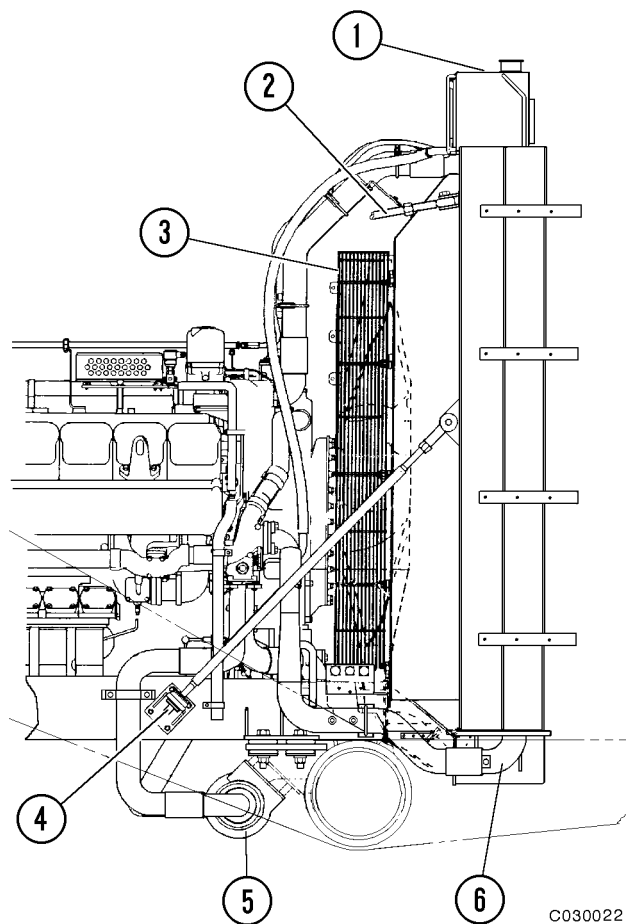
### Removal

1. Drain coolant from radiator and engine. Be prepared to catch approximately 195 gallons (738 liters) of coolant. If the coolant is to be reused, it must be stored in clean containers.
2. If radiator is being removed without the removal of the complete power module, remove grille and hood according to "Removal" instructions in Section "B".

### **WARNING**

**Federal regulations prohibit venting air conditioning system refrigerants into the atmosphere. An approved recovery/recycle station must be used to remove the refrigerant from the air conditioning system.**

3. Refer to instructions in Section N, Operator Comfort, and discharge the refrigerant from the system with a recovery/recycle station. The system is charged with HFC-134A refrigerant.
  - a. Remove refrigerant hose clamps and remove the receiver/dryer mounted on rear, left side of the radiator shroud. Disconnect wiring from low pressure switch.
  - b. Remove clamp and disconnect inlet and outlet hoses (4 & 5, Figure 3-2) at the condenser. Remove mounting capscrews (3) and remove condenser.
  - c. Cap all hoses to prevent contamination. Remove any remaining clamps attaching hoses and wiring to radiator shroud and reposition to allow removal of the radiator and shroud assembly.
4. Unclamp and separate all coolant lines between the radiator and engine.
5. Remove outlet elbows at bottom tanks (6, Figure 3-1). Cap all coolant lines to prevent contamination.
6. Remove and cap hoses from radiator top tank and surge tank.



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FIGURE 3-1. RADIATOR INSTALLATION

- |                       |                       |
|-----------------------|-----------------------|
| 1. Surge Tank         | 4. Lower Support Rods |
| 2. Upper Support Rods | 5. Heat Exchanger     |
| 3. Fan Guard          | 6. Outlet Elbows      |

7. Remove capscrews and lockwashers to free fan guard (3 & 5, Figure 3-3) from radiator shroud (2). The two halves of the fan guard may be disassembled and removed or the complete guard may be moved to the rear to clear the fan shroud during radiator removal.

8. Attach hoist to lift radiator and take up slack.

**NOTE:** The radiator and shroud assembly weigh approximately 4,670 Lbs. (2,118 Kg.).

9. Remove the upper radiator side support rods (2, Figure 3-1). Remove lower support rods (4).
10. Remove nuts, lockwashers, flat washers and capscrews (2, Figure 3-4) from power module subframe (3) at the lower radiator mounts.

## POWER TRAIN

### ALTERNATOR REMOVAL PROCEDURE

#### Removal (MTU Engine)

The following instructions cover the removal of the main alternator from the MTU engine after the power module has been removed from the truck. (Refer to Figure 4-1.)



**When lifting alternator, attach hoist to lift eyes only. The alternator weighs approximately 7,990 lbs. (3624 kg). Use a lifting device that can handle the load safely.**

1. Attach hoist with two lifting chains to the two alternator lifting eyes (8, Figure 4-1).
2. Block under rear of engine
  - a. Loosen cradle adjustments setscrews (3, Figure 4-2).
  - b. Loosen engine/cradle capscrews (5, Figure 4-1).

3. Remove cover plate on the side of the engine flywheel housing and attach the engine barring tool (MTU part # F6 348799).
4. Remove access panel (4). Reach through the access opening and remove capscrews (1, Figure 4-3) that join the engine flywheel to the alternator. Rotate the engine with special tool to remove all the capscrews.
5. Remove capscrews and washers (10 & 11) securing alternator housing (12) to the intermediate housing (9).
6. Take up slack in hoist and remove capscrews and lockwashers (2, Figure 4-1) securing the alternator to the cradle structures.
7. Keep alternator as level as possible and move away from engine. Retain shims for possible use during reinstallation.
8. For further disassembly instructions for the alternator refer to the General Electric Service Manual.

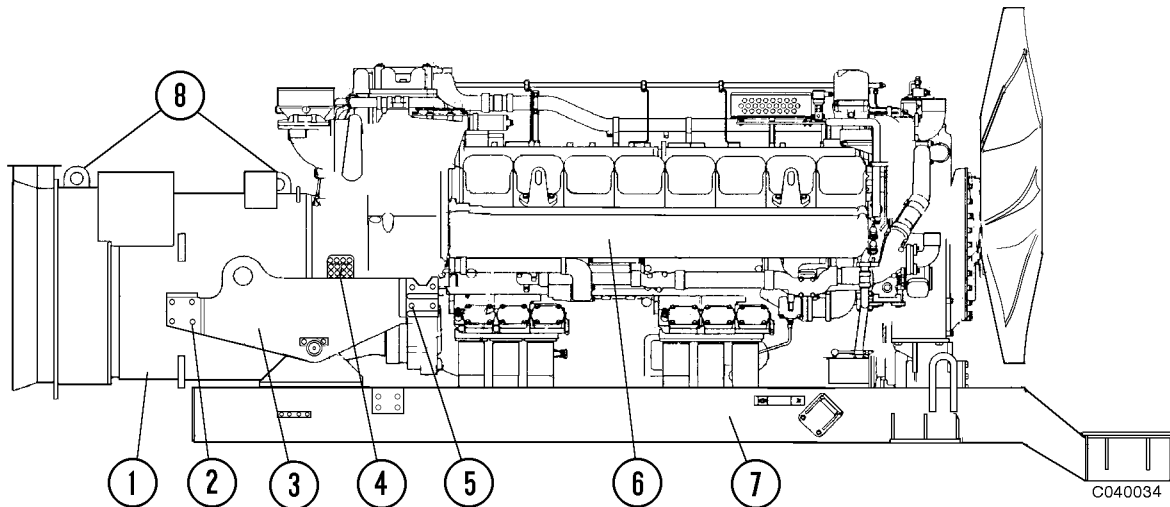


FIGURE 4-1. MTU ENGINE AND ALTERNATOR

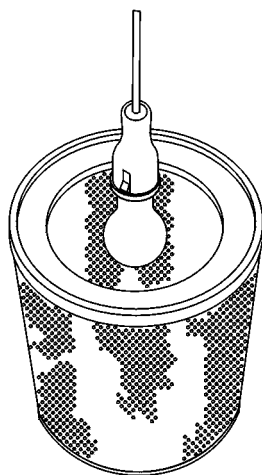
- |                           |                 |                 |
|---------------------------|-----------------|-----------------|
| 1. Alternator             | 4. Access Panel | 7. Sub Frame    |
| 2. Capscrew & Lockwashers | 5. Capscrew     | 8. Lifting Eyes |
| 3. Cradle                 | 6. Engine       |                 |

4. Check safety (secondary) filter element indicator nut (7). If solid red area is showing, safety filter replacement is required. If center is green, safety element does not require service.

## **CAUTION**

**Have a new safety (secondary) filter element on hand before removing old one. Do not keep intake system open to the atmosphere any longer than absolutely necessary.**

5. If indicator indicates safety filter replacement is required, remove indicator and remove safety filter element. Discard element; **DO NOT** attempt to clean the safety element.
6. Reset the indicator nut from RED to GREEN by gently blowing air into threaded hole from gasket side of nut.
7. Install new safety element and tighten safety indicator wing nut to **10 ft. lbs. (13 N.m)** torque.
8. Install clean or new, main filter element into air cleaner and secure with wing nut. Tighten wing nut hand tight, do not use a wrench or pliers. If filter element is being reused, make sure sealing gasket is not damaged. The gasket must seal completely.
9. Close and latch the dust collectors on the bottom of the air cleaner assembly.



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FIGURE 5-3. INSPECTING FILTER ELEMENT

## **Main Filter Element Cleaning**

*NOTE: Remember that only main filter elements may be cleaned and then only if they are structurally intact, do not reuse any element which is damaged. DO NOT clean and reuse the safety (secondary) filter elements, replace these items when clogged or damaged.*

After inspection, determine if the element should be cleaned by either washing or compressed air methods. If element is clogged with dust, compressed air will clean element. If element is clogged with carbon, soot, oil and/or dust, the complete washing procedure will produce the best results.

1. Wash elements with water and detergent as follows:
  - a. Soak the element in a solution of detergent and water for at least 15 minutes. Rotate element back and forth in the solution to loosen dirt deposits. **DO NOT** soak elements for more than 24 hours.
  - b. Rinse element with a stream of fresh water in the opposite direction of normal air flow until rinse water runs clear. Maximum permissible water pressure is 40 psi (276 kPa). A complete, thorough rinse is essential.
  - c. Dry the element thoroughly. If drying is done with heated air, the maximum temperature must not exceed 140°F (60°C) and must be circulated continually. Do not use a light bulb for drying elements.
  - d. When the element is thoroughly clean, inspect carefully for even the slightest ruptures or punctures and for damaged gaskets. A good method to detect ruptures in the paper filter material is to hold a light inside filter element as shown in Figure 5-3 and inspect outer surface of element, any holes or ruptures will be easily spotted. If holes or ruptures are found, do not reuse the element, discard and install a new unit.

## BATTERY SUPPLY SYSTEM

### 24VDC BATTERY CHARGING ALTERNATOR

Refer to *Optional Equipment, Section "M"* for information regarding the truck battery charging alternator.

### BATTERY BOX

The truck batteries are located in an enclosure (1, Figure 2-1) in the center of the truck behind the front bumper. For access to the batteries, remove the two covers by turning the cover handles counterclockwise until released. Lift eyes are attached to the ends of the enclosure if the entire battery container must be removed.

Four Type 8D batteries (2) are installed in the battery box and are used for the 24VDC engine cranking circuit and the 12VDC circuits. Two Type 4D batteries (3) are installed to provide 24VDC for the truck systems other than engine starting. A System Battery Starter Disconnect Relay isolates these batteries from the engine starter circuit during engine cranking.

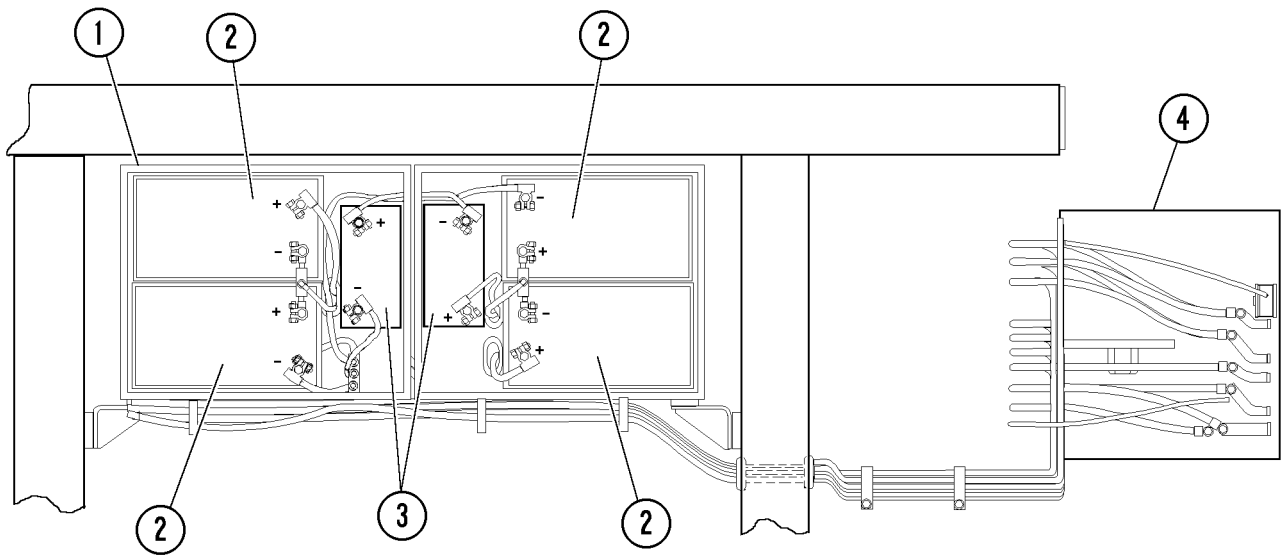
### BATTERY CONTROL BOX

The battery control box (4) is located near the right corner of the front bumper. This box contains the battery disconnect switches and other components listed below.

### SYSTEM BATTERY STARTER DISCONNECT RELAY

The System Battery Starter Disconnect Relay (11, Figure 2-2) isolates the engine cranking circuit, when the starter is actuated, from the system battery circuits to ensure the high current demand in the starter circuit does not affect the control system circuits.

When the operator turns the keyswitch to the start position, a signal is sent from the keyswitch to the Truck Control Interface (TCI) located in the Electrical Interface Cabinet. If all conditions required to engage the starter are acceptable, the TCI panel provides a signal to energize the System Battery Starter Disconnect Relay, disconnecting the system batteries from the start circuit until the cranking sequence is completed and cranking battery voltage returns above a programmed voltage.



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FIGURE 2-1. BATTERY BOX AND BATTERY CONTROL BOX

- |                              |                        |
|------------------------------|------------------------|
| 1. Battery Box               | 3. System Batteries    |
| 2. Engine Cranking Batteries | 4. Battery Control Box |

## Hot Switch Inverter Card (Slot 4) (Not Used)

### Oil Level

The Oil Level Card (**Optional**) is used to turn on the Low Oil Level Indicator Light to warn the operator engine oil/hydraulic tank oil level is below acceptable levels. The oil float is connected to a variable resistor. As the oil level decreases, the resistance goes down causing Q3 to turn on, grounding the indicator light and alarm horn.

### Temperature

The Temperature Card (**Optional**) is used to turn on the High Oil Temperature Indicator Light. The indicator light tells the operator hydraulic tank oil temperature has exceeded acceptable levels. Normal temperature setting is 250oF (121oC). As the temperature goes up the resistance in the probe decreases providing a ground path for the indicator light and alarm horn.

### Diode Matrix (Without Sound)

The Diode Matrix **Without Sound** Card consists of a series of diodes capable of working with eight different indicator circuits. The indicator light can be a flashing light by connecting it to the 12F circuit or a steady light by connecting it to the 12M circuit. When an indicator circuit is not activated, there is no ground circuit for the bulb. When the Indicator detecting switch activates the circuit, it grounds the lamp and grounds the flasher circuit through the diodes. Any circuits connected to terminals C1 through C8 will operate in the same manner. The alarm horn is not activated by this card.

### Diode Matrix (With Sound)

The Diode Matrix **With Sound** Card works very much like the other Diode Matrix Card, except that it contains extra diodes to activate the alarm horn in addition to the flasher. The circuits connected to terminals A1 through A8 operate in the same manner.

### Lamp Test

All of the card circuits are connected to the Lamp Test Switch on the overhead display area. In normal operation, these circuits are open and not functional. When the operator pushes the Lamp Test Switch, it activates all the indicator circuits by grounding them. This is used to verify that all lamps are functional.

## HOIST LIMIT SWITCH

The hoist limit switch (5, Figure 3-10) is located inside the right frame rail above the rear suspension (near the body pivot pin). The hoist limit switch is designed to stop the hoist cylinders before reaching full extension, preventing possible damage to the dump body or hoist cylinders.

### Operation

When the hoist cylinders approach maximum stroke, and the body pivots on the pins, actuator arm (3) moves close enough to the magnetically operated switch to close the electrical contacts. When the contacts close, an electrical signal is sent to the hoist-up limit solenoid valve (located in the hydraulic components cabinet) to prevent further oil flow to the hoist cylinders.

The switch must be properly adjusted at all times. Improper adjustment or loose mounting bolts may cause false signals or damage to the switch assembly.

### Adjustment

With body raised and hoist cylinders within 6 in. (152 mm) of maximum travel, make the following adjustment.

1. Adjust limit switch to achieve an air gap (dimension "A") of 0.50 to 0.56 in. (12.70 to 14.30 mm) between sensing area and actuator arm (3). Retighten capscrews.

### Service

Keep sensing area clean, free of metallic dust and other debris that may damage or inhibit operation of the limit switch. If the switch is not functioning or damaged the unit must be replaced.

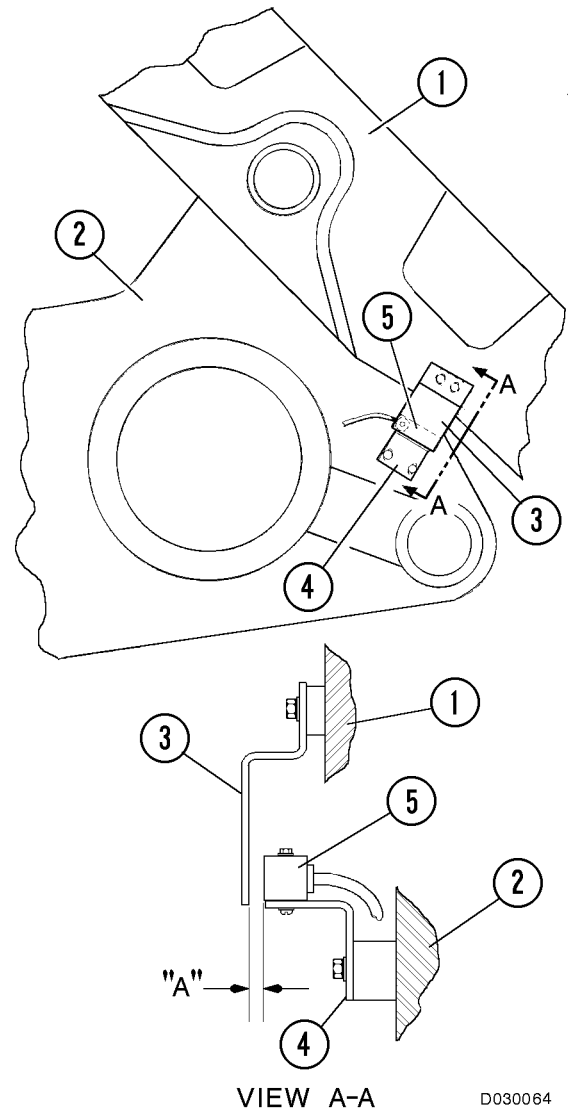


FIGURE 3-9. BODY LIMIT SWITCH ADJUSTMENT

- |                 |                          |
|-----------------|--------------------------|
| 1. Body         | 4. Switch Mounting Plate |
| 2. Frame        | 5. Hoist Limit Switch    |
| 3. Actuator Arm |                          |

# ON VEHICLE TROUBLESHOOTING GUIDE

## ALTERNATOR ELECTRICAL CONDITIONS - Low Voltage - High Voltage - No Voltage

### PRELIMINARY PROCEDURES

#### Common problems, all applications:

- Check alternator drive belt (s).
- Check alternator positive connection
- Check alternator ground connection on alternator.
- Check condition of connector between regulator and alternator.
- Identify model of alternator \_\_\_\_\_
- Identify model of regulator \_\_\_\_\_
- Record voltage regulator set points stated on regulator tag:  
1) \_\_\_\_\_ 2) \_\_\_\_\_ 3) \_\_\_\_\_ (if applicable)

### TOOLS AND EQUIPMENT:

- 1 - Voltmeter (Digital type preferred.)
- 1 - Ammeter (Digital, Inductive type preferred.)
- 1 - 12 gauge lead, 12 inches long, with alligator clip at each end.

### LOW VOLTAGE OUTPUT

#### Causes of low voltage:

- Loose drive belt.
- Low state of charge of battery.
- Current load on system greater than alternator can produce.
- Defective wiring or poor ground path.
- Low regulator set point.
- Defective voltage regulator.
- Defective alternator.

### HIGH VOLTAGE OUTPUT

#### Causes of high voltage:

- Wrong regulator.
- High regulator set point.
- Defective regulator.
- Defective alternator.

### NO VOLTAGE OUTPUT

#### Causes of no voltage output:

- No drive belt.
- No battery (B+) voltage at alternator's "B+" terminal (except isolator type systems).
- No "link" from "R" terminal to energize ("E") terminal on alternator when engine operating.
- Defective regulator.
- Defective alternator.

### BATTERY CONDITIONS AND CHARGE VOLTAGE REACTIONS:

*NOTE: Until electrical system component temperatures stabilize, these conditions may be observed during cold start voltage tests.*

#### Maintenance type:

- Immediately after engine start, system volts are lower than regulator set-point with medium amps.
- 3-5 minutes into charge cycle, higher system volts and reduced amps.
- 5-10 minutes into charge cycle, system volts are at, or nearly at, regulator set point, and amps are reduced to a minimum.

#### Low Maintenance types:

- Same as above, except cycle times may be longer.

## BENCH TEST

**Results of on-vehicle test should be confirmed by these bench tests, if possible. When it is not possible to perform on-vehicle test, alternator performance can be checked quickly by referring to these bench tests.**

### Equipment:

- Test Bench, with 15 - 20 Hp motor set up to drive alternator to 7000 RPM.
- Voltmeter, 0 - 40 Volt Range
- Ammeter, 0 - 400 Amp Range

Mount alternator on test bench according to the bench manufacturer's instructions. Refer to Figure 10-5 for set-up to measure voltage and amperage produced by alternator. Voltage within  $\pm 0.2V$  of regulator setpoint is "normal". Amperage within  $\pm 10\%$  of rated output at 5000 rpm is "high".

### TEST 1 - No Load Test

Without electrical load but with battery connected, run alternator at 5000 rpm. Refer to Table 10-5 below.

Table 10-5: NO-LOAD TEST		
AMPS	VOLTS	DIAGNOSIS
HIGH	LOW	Test bench battery is discharged (or defective). Allow to charge or replace.
HIGH	NORMAL	Give time to stabilize while monitoring VOLTS. If VOLTS rise above normal range (Table 13-2) regulator and/or field coil must be replaced. If AMPS fall, charging system is OK.
HIGH	HIGH	Stop test. Regulator and/or field coil should be replaced. (Go to Static Tests.)
LOW	LOW	Alternator and/or regulator must be repaired or replaced. Go to Test 3.
LOW	NORMAL	Regulator OK. Go to Test 2.
LOW	HIGH	Stop test. Bench malfunction or wiring error.

### TEST 2 - Full Load Test

With load set to rated output (nameplate)  $\pm 10\%$ , run alternator at 5000 rpm. Refer to Table 10-6.

Table 10-6: FULL-LOAD TEST		
AMPS	VOLTS	DIAGNOSIS
HIGH	LOW	Test bench battery is discharged (or defective). Allow to charge or replace.
HIGH	NORMAL	Charging system OK.
HIGH	HIGH	Stop test. Regulator and/or field coil should be replaced. (Go to Static Tests.)
LOW	LOW	Alternator and/or regulator must be repaired or replaced. Go to Test 3.
LOW	NORMAL	Increase load.
LOW	HIGH	Stop test. Bench malfunction or wiring error.

### TEST 3 - Regulator Bypass Test

Perform this test only when suggested by other tests.

Alternator connections and load same as test 2. Bypass regulator as shown in Figure 10-7. Note whether amps rise to within  $\pm 10\%$  of output rating when connecting F- terminal to ground. Note whether amps fall when disconnecting F- terminal. Then refer to Table 10-7 below.

**CAUTION**

**Limit terminal connection to a few seconds to protect charging system from excessive voltage.**

Table 10-7: REGULATOR BYPASS TEST		
CONNECT	DISCONNECT	DIAGNOSIS
Amps Rise	Amps Fall	Alternator is OK. See note, replace regulator only if low AMPS/low VOLTS indicated in Test 1 and/or Test 2.
No Change	No Change	Alternator must be repaired. Go to Static Tests.

*Note: Before replacing regulator, check continuity of energize circuit (refer to Static Tests, Test 5).*

4. Seat field coil bobbin ears over stator tabs (Figure 10-25) by inserting field winding and rotating about 20 degrees after insertion with tool BF4820. Align screw holes in bobbin ears with screw holes in stator tabs.

*Note: Bobbin ears go over stator tabs as viewed from both ends of tube assembly.*

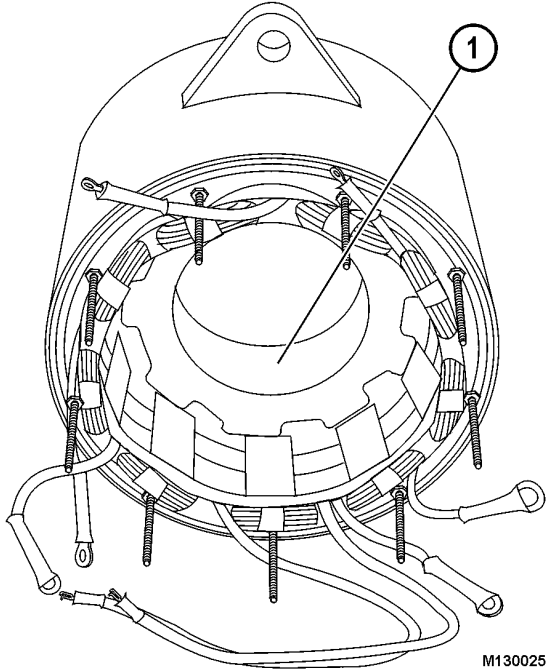


FIGURE 10-25.

1. Field Coil Bobbin Ear

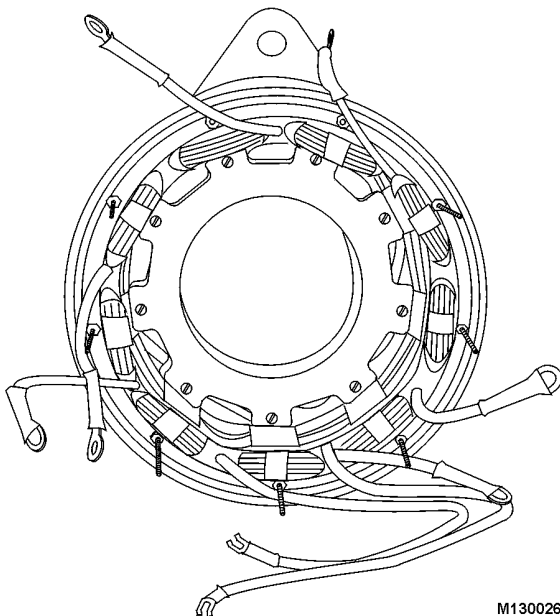


FIGURE 10-26.

5. Make sure field coil leads (white spade terminals) are pulled through proper stator openings with no slack at the field coil and that neither wire is pinched by the bobbin ears.

6. Using eighteen screws coated with loctite, fasten field coil bobbin ears to stator tabs (Figure 10-26). Tighten screws to **8-10 lb-in. (0.9- 1.1 Nm)** torque.

*Note: If field coil leads cannot be threaded through stator openings with the terminal attached, unsolder terminals, remove sleeving and then insert leads. After field coil is in place slip sleeving on field leads, solder terminals to wires and slip sleeving back over terminal.*

### Front Bearing Assembly

1. Clean bearing I.D. surface of front housing.
2. Install retaining ring in rear inner groove of front housing.

*Note: This retaining ring has two flat sides (3, Figure 10-27).*

3. Coat outer race of front bearing (4, Figure 10-27) with thin coat of loctite.

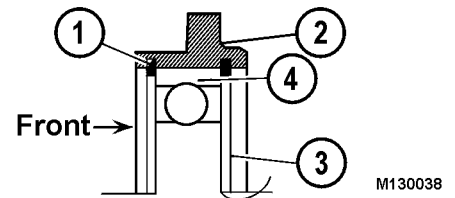


FIGURE 10-27.

- |                             |                                      |
|-----------------------------|--------------------------------------|
| 1. Retaining Ring (Tapered) | 3. Retaining Ring (Flat, both sides) |
| 2. Front Housing            | 4. Bearing - Outer Race              |

### Pressure Plate Setup (Refer to Figure 10-46)

8. Place thrust washer on jack screw. Lube the jack screw for 1", about 1" from the tip of the jack screw. Lubricate approximately 1" of the jack screw where it enters the pressure plate with white lube or a wheel bearing type of grease. Also place a dab of this grease on both sides of the thrust washer that is placed under the hex head of the jack screw.

Insert the jack screw through the top thrust plate. Screw jack screw into the pressure plate about 5 turns. Place a dab of lube on both sides of the thrust washer under hex head of the jack screw. Screw jack screw into the pressure plate until contact is made between head of the jack screw and top thrust plate.

9. Continue threading the jack screw in, until stator contacts shell/shell assembly. Measure from top of locating pin to the top of the top thrust plate. Record this measurement as starting point to be used later.

10. Check the position of stator leads by looking through the large torque arm holes in the top thrust plate. Turn jack screw until significant resistance is encountered.

*NOTE: If the tool assembly starts to rotate, insert torque arm into holes in the top thrust plate for additional leverage.*

11. Check the distance the stator has been inserted into the shell by measuring from the top of the locating pin to the top of the top thrust plate (first measurement taken in step 9, above). This measurement should increase, which indicates the stator is entering the shell.

12. After the stator has been properly seated, disassemble the tool. Pull the stator leads through the correct slots. Continue with the alternator assembly as per instructions in this manual.

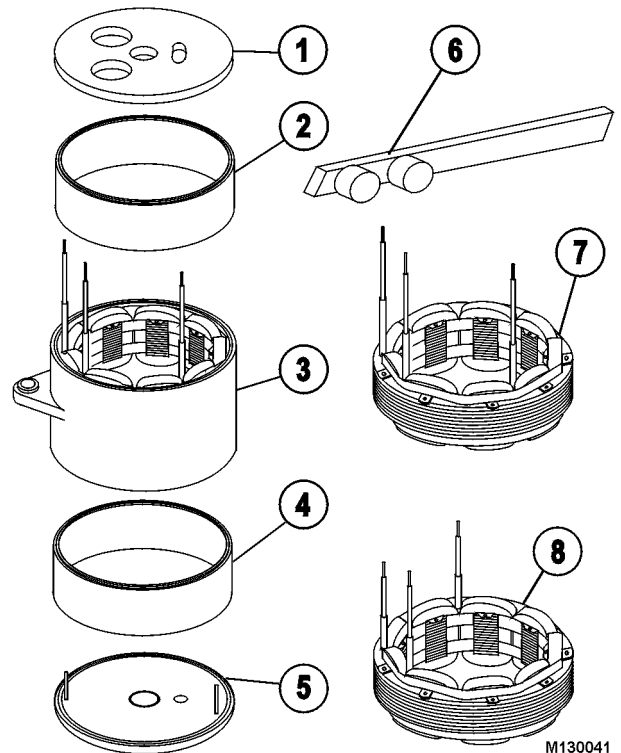


FIGURE 10-45.

- |                            |                        |
|----------------------------|------------------------|
| 1. Top Thrust Plate        | 5. Bottom Thrust Plate |
| 2. Support Ring            | 6. Torque Arm          |
| 3. Stator & Shell Assembly | 7. Front Stator        |
| 4. Support Ring            | 8. Rear Stator         |

## Diagnostic Information Display

The 17FM558 Diagnostic Information Display (DID) (Figure 2-2) is located in the cab, behind the passenger seat. The display provides a means of communications with the TCI by service personnel. Information from the PSC Aux Inverter is also routed through the TCI for display on the DID.

The panel has two display lines, each line 40 characters long. The top line is the "message" line and is used by the TCI to inform service personnel of the truck systems and components status.

The bottom display line provides information in addition to the top line or relates to the keypad, displaying possible selection options and display functions. The keypad, located below the display lines is used by service personnel to direct the activity of the TCI.

The display provides service and status information on the various truck systems and the propulsion system by displaying system status information or fault codes as well as a description of the system status or a problem on the top display line. Information on the second display line may change to indicate what functions are available by pressing the [F1] through [F5] keys.

In addition, the DID panel can be used by to perform the self-load test.

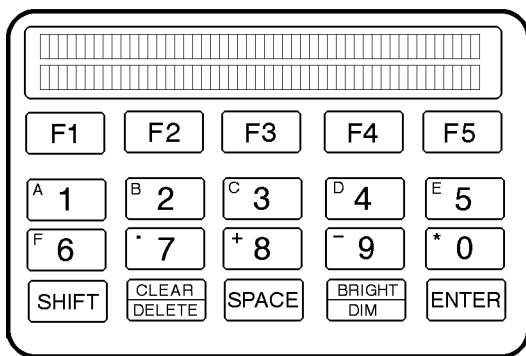


FIGURE 2-2. DIAGNOSTIC INFORMATION DISPLAY

## DID PANEL EVENT CODES

The Tables on the following pages list the possible event codes which may be displayed on the DID panel when accessed. Table I (below) describes restrictions to operation of the propulsion and retarding systems when a fault occurs for a particular code listed in Tables II, III and IV.

*NOTE: Event codes numbered 000 through 099 are applicable to the PSC and are listed in Table II. Codes numbered 100 through 199 are applicable to Inverter 1, and codes numbered 200 through 299 are applicable to Inverter 2 and are listed in Table III. Codes numbered 600 through 699 are applicable to the TCI and are listed in Table IV. The codes listed in the Tables are applicable to Release 18 software.*

TABLE I	
RESTRICTION	DEFINITION
No Power	"NO RETARD" (red) light illuminates. <ul style="list-style-type: none"> <li>• No retarding allowed</li> <li>• No propulsion allowed</li> <li>• No power on the link</li> </ul>
No Propel	"NO PROPEL" (red) light illuminates. <ul style="list-style-type: none"> <li>• No propulsion allowed</li> <li>• Retarding allowed</li> <li>• Link power allowed</li> </ul>
Speed Limit	"PROPEL SYSTEM CAUTION" (amber) light illuminates. <ul style="list-style-type: none"> <li>• Propel, retard and DC link power still allowed.</li> <li>• Speed is limited to 10 MPH (16 KPH)</li> </ul>
INV1 Disable	Prohibits system from enabling inverter #1 drive signal.
INV2 Disable	Prohibits system from enabling inverter #2 drive signal.
Engspd/RP	Raises engine speed to account for a possible stuck RP contactor. Closes RP1
None	No restrictions. Event is for information purposes only.

**TABLE III: DID PANEL FAULT CODES  
(Codes Received from Inverter 1, 2)**

<b>EVENT NUMBER</b>	<b>EVENT DESCRIPTION</b>	<b>EVENT RESTRICTION</b>	<b>DETECTION INFORMATION</b>
103/203 (cont.)			
:21	link V too hi	None	Link voltage too positive
:22	infilV too hi		Input filter voltage too positive
:23	DB chop VCO hi		High freq. on VCO DB chopper channel
:24	DB chopV too hi		DB chopper voltage too positive
:25	VA VCO hi		High freq. on VCO VA channel
:26	VB VCO hi		High freq. on VCO VB channel
:27	VC VCO hi		High freq. on VCO VC channel
:28	VA volts too hi		VA voltage too positive
:29	VB volts too hi		VB voltage too positive
:30	volt scale C flt		Scale C volts out of range 70%, 120%
:31	VC volts too hi		VC voltage too positive
104/204	FIBER OPTIC CARD	INV1 (INV2) off	
:01	fo ps low		Fiber optic power supply monitor
:02	fo card disable		Fiber optic card disabled
:03	fo card enable	Fiber optic card enabled and no dir	
105/205	POWER SUPPLY CARD	INV1 (INV2) off	
:01	P5V not ok		+5 volt not in tolerance
:02	P15V not ok		+15 volt not in tolerance
:03	N15V not ok		-15 volt not in tolerance
:06	P24V not ok		+24 volt not in tolerance
:07	N24V not ok	-24 volt not in tolerance	
106/206	DC WIRING	INV1 (INV2) off	
:01	DC pwr conn open		DC power connection open
:02	link V phase V mismatch	Link and phase voltage mismatch	
107/207	GDPS FAILURE	INV1 (INV2) off	
:01	gate dr ps off		No power to gate drive power supply or it failed
:02	gate dr ps off S		No power to gate drive power supply or it failed with enable/DC volts
:03	multiple GTO not off S	Multiple GTOs not off with enable/DC volts	
109/209	LINK VOLTS SENSOR	INV1 (INV2) off	
:01	linkV sensor flt		Link voltage sensor failed
111/211	INPUT VOLTS SENSOR	INV1 (INV2) off	
:01	Vfil not ok		Filter voltage outside limits

**TABLE IV: DID PANEL FAULT CODES  
(Codes Received from TCI)**

EVENT NUMBER		EVENT DESCRIPTION	EVENT RESTRICTION	DETECTION INFORMATION
601		TCI FB144 CPU CARD	No propel	TCI CPU card problem.
	:01	10ms task failed to init		TCI CPU card problem.
	:02	20ms task failed to init		TCI CPU card problem.
	:03	50ms task failed to init		TCI CPU card problem.
	:04	100ms task failed to init		TCI CPU card problem.
	:05	200ms task failed to init		TCI CPU card problem.
	:06	flt manager task		TCI CPU card problem.
	:07	flash CRC		Flash CRC computation did not match expected value.
	:09	maint task failed to init		Flash CRC computation did not match expected value.
	:10	excess timeouts		Upon power-up, excessive bus timeouts occurred.
	:11	BBRAM bad		
	:12	BBRAM CRC		CRC on BBRAM did not match expected value.
602		FB104 DIGITAL I/O CARD FAULT	No propel	Internal TCI self-test detected a digital I/O card problem.
603		FB160 ANALOG I/O CARD FAULT	No propel	Internal TCI self-test detected an analog I/O card problem.
604		PSC FAULT	Speed limit	Lost RS422 communication with PSC.
	:01	missing message		Lost RS422 communication with PSC.
	:02	bad tick		Lost RS422 communication with PSC.
	:03	bad CRC		Lost RS422 communication with PSC.
	:04	FIFO overflow		Lost RS422 communication with PSC.
	:05	bad start bit		Lost RS422 communication with PSC.
	:06	bad stop bit		Lost RS422 communication with PSC.
605		AUX BLOWER COMM. FAULT	None	Lost RS422 communication with Aux Blower Controller while Aux Blower in failure mode and DC link not energized.
607		POSITIVE 5 VOLTS	Speed limit	+5V power supply out of limits
608		POSITIVE 15 VOLTS	Speed limit	+15V power supply out of limits
609		NEGATIVE 15 VOLTS	Speed limit	-15V power supply out of limits
610		POT REFERENCE	Speed limit	Pot reference (10.8V) out of limits

## Propel Torque Control

This software function commands the appropriate motor torque to the inverters during propel. The torque command is primarily a function of the accel pedal position and is limited by the physical constraints of the system.

Each wheel torque is computed independently because the wheels may be operating at different speeds. Each torque command is adjusted to account for the following constraints:

- **Speed Override**

The propulsion system will attempt to limit truck speed to the design envelope of the wheel motors. As such, the torque command will be modulated as the truck speed approaches the motor overspeed limit so that this limit is not exceeded if possible. Note, however, that steady state operation is kept as close to the overspeed limit as possible without exceeding it.

- **Motor Torque Limits**

The torque command will be constrained to the operating envelope of the inverters and the traction motors. The maximum torque that can be commanded is dependent on motor speed and on DC link voltage.

- **Gear Stress**

The torque commanded will not exceed that which will produce excess gear stress.

- **Horsepower Available**

The horsepower available will be estimated from the engine speed. Parasitic loads are taken into account. The torque will be limited such that the engine does not overload.

- **Jerk Limit**

The torque command will be slew-rate limited to prevent jerking motion.

- **Wheel Spin**

In the event that the inverters detect a wheel spin condition and reduce torque in the slipping wheel, the motor torque in the other wheel may be increased within the above constraints such that as much of the total desired torque as possible is maintained.

## Retard Torque Control

The retard system converts braking torque from the wheel motors to energy dissipated in the resistor grid. The requested retard torque is based on the following three sources:

- **Retard Foot Pedal or Lever**

The maximum short time retard torque (at any speed, hence the constant torque level) will be scaled (linearly) by the retard foot pedal input (RPINHI) to produce the foot pedal retard torque call.

- **Overspeed**

While overspeed is active, the full available retard torque will be requested.

- **Retard Speed Control**

While RSC is active, the RSC retard torque call will be adjusted to control truck speed to the RSC set point. Retard speed control will not request any retard torque if RSC is not active.

The maximum torque call from the above three sources will be selected as the retard torque call.

Retard Torque Limits are as follows:

1. The retard torque call will be limited to the maximum torque level based on speed.
2. The retard torque call will be limited to the maximum torque level available within the thermal constraints of the motors.
3. The retard torque call will be limited as needed to prevent overvoltage on the DC link.
4. While in retard, the minimum retard torque call will provide enough power to support at least one grid with 600 volts on the DC link. Retard will be dropped if the torque call falls below this value.
5. At low speed, the available retard torque will be ramped to zero.

## Wheel Slide Control

The inverters prevent wheel slide by limiting torque to maintain wheel speeds above preset limits. These preset limits are a function of truck speed and the allowable creep; additional compensation will be applied to provide for differences between wheel speeds during turns.

**TABLE V: PROPULSION SYSTEM COMPONENTS DESCRIPTION**

	<b>REF. NO.</b>	<b>COMPONENT</b>	<b>FUNCTION</b>
<b>GFR</b>	52	Alternator Field Relay (17LV66)	Picks up with GF contactor and applies B+ to the AFSE (battery boost) during initial acceleration phase.
<b>GFRS</b>	50	Alternator Field Relay Coil Suppression Module	Suppresses voltage spikes when GF coil is de-energized.
<b>GRR</b>	26	Ground Resistor Panel	Detects power circuit grounds.
<b>INV1 TMC CARD</b>		Inverter 1 Central Processing Unit Card and Input/Output Card (17FB172)	Generates Phase Module turn-on/turn-off commands for the Inverter 1. Monitors voltages and currents from various areas for Inverter 1. Monitors Traction Motor 1 speed.
<b>INV2 TMC CARD</b>		Inverter 2 Central Processing Unit Card and Input/Output Card (17FB172)	Generates Phase Module turn-on/turn-off commands for the Inverter 2. Monitors voltages and currents from various areas for Inverter 2. Monitors Traction Motor 2 speed.
<b>I1CO</b>	57	Inverter 1 Cut Out Switch	Cuts out inverter 1 when in the "cutout" position. Located on switch/LED panel, left front corner of electrical cabinet.
<b>I2CO</b>	58	Inverter 2 Cut Out Switch	Cuts out inverter 2 when in the "cutout" position. Located on switch/LED panel, left front corner of electrical cabinet.
<b>KEYSW</b>		Key Switch	Connects battery voltage to CPR and control circuits when closed. (Located on instrument panel.)
<b>LDBXI</b>	48	Load Box Current Sensing Module	Monitors current during load box test.
<b>LEDP</b>	60	Light Emitting Diode Panel	LED's indicate status of the following: <b>CPR:</b> Illuminated when CPR is energized. <b>SYS RUN:</b> Illuminated when the PSC power-up sequence has completed successfully and control logic is executing. <b>NAFLT:</b> When illuminated, indicates a fault has occurred that prevents propulsion or retarding. <b>TEST:</b> Illuminated when system is in the Test state. <b>REST:</b> Illuminated when system is in Rest state and there is essentially no voltage on the DC link.
<b>LINKI</b>	7	Link Current Sensing Module	Detects amount of current flow through the DC link.
<b>LINKV</b>	3	Link Voltage Measuring Module (17FM458)	Attenuates the high voltage from the DC link to a level acceptable to the electronics on the Analog I/O card in the PSC.
<b>L1, 2, 3</b>		Cabinet Lights	Provide interior cabinet illumination.
<b>M1, 2</b>		Motorized Wheels (5GDY85)	Each Motorized Wheel consists of a Traction Motor and a Transmission Assembly. The 3-phase asynchronous Traction Motors convert electrical energy into mechanical energy. This mechanical energy is transmitted to the wheel hub through a double reduction gear train (Transmission).

# AC DRIVE SYSTEM ELECTRICAL CHECKOUT PROCEDURE

## AC DRIVE SYSTEM MAINTENANCE



**DANGEROUS VOLTAGE LEVELS ARE PRESENT WHEN THE ENGINE IS RUNNING AND CONTINUE TO EXIST AFTER SHUTDOWN IF THE REQUIRED SHUTDOWN PROCEDURES ARE NOT FOLLOWED. Before attempting repairs or working near propulsion system components, the following precautions and truck shutdown procedure must be followed:**

- **DO NOT** step on or use any power cable as a handhold when the engine is running.
- **NEVER** open any electrical cabinet covers or touch the Retarding Grid elements until all shutdown procedures have been completed.
- **ALL** removal, repairs and installation of propulsion system electrical components, cables etc. must be performed by an electrical maintenance technician properly trained to service the system.
- **Power cables must be cleated in wood or other non-ferrous materials. Do not repair cable cleats by encircling the power cables with metal clamps or hardware. Always inspect power cable insulation prior to servicing the cables and prior to returning the truck to service. Discard cables with broken insulation.**
- **IN THE EVENT OF A PROPULSION SYSTEM MALFUNCTION, a qualified technician should inspect the truck and verify the propulsion system does not have dangerous voltage levels present before repairs are started.**



- **If weld repairs are required, the welding ground electrode should be attached as close as possible to the area to be welded. NEVER weld on the rear of the Electrical Control Cabinet or the retard grid exhaust air louvers. Power cables and wiring harnesses should be protected from weld spatter and heat.**
- **Prior to welding, disconnect Engine Control System (ECS) harnesses and ground wire (MTU engine). If equipped with DDEC or Komatsu engine, disconnect ECM harnesses. GE cards should be pulled forward far enough to disconnect card from backplane connector.**
- **Some power cable panels throughout the truck are made of aluminum or stainless steel. They must be repaired with the same material or the power cables may be damaged.**

## TRUCK SHUTDOWN PROCEDURES

After the truck is parked in position for the repairs, the truck must be shut down properly to ensure the safety of those working in the areas of the deck, electrical cabinet, traction motors, and retarding grids. The following procedures will ensure the electrical system is properly discharged before repairs are started.



**If a problem occurs in the AC drive system preventing NORMAL shutdown procedures, ADDITIONAL PRECAUTIONS ARE NECESSARY to ensure dangerous drive system voltages are not present when tests or repairs are performed.**

## TCI PROGRAMMING



**BE SURE TO VERIFY LINK VOLTAGE IS DISCHARGED BEFORE PERFORMING THE FOLLOWING PROCEDURES.**

1. Disconnect Circuits 21SS and 21SR, and insulate from engine starter if equipped with MTU 396 engine. If MTU/DDC 16V4000 or Komatsu engine is installed, disconnect and insulate 21B circuits at starter solenoids. Apply park brake and brake lock.
  - a. Connect the serial communication cable from the PTU to the TCI port located behind the center console in the cab on the passenger side.
  - b. Be certain the Rest Switch in the cab is in the REST position.
2. Turn the key switch ON.

### **To program the 17FB144 CPU card:**

- ◆ c:\>ACNMENU {enter}
  - ◆ Highlight "PROGRAM TCI PANEL" {enter}
  - ◆ Highlight "SELECT TCI SETUP" {enter}
  - ◆ Cursor to the appropriate configuration file for the truck being programmed from the list of configuration files {enter}
  - ◆ Highlight- "PROGRAM TCI PANEL" {enter}
  - ◆ Highlight- "PROGRAM TCI" {enter}
3. Cycle keyswitch or CPS when requested on screen.
  4. Verify the Object Code and Configuration file shown on the screen for downloading is correct.

## PSC PROGRAMMING



**BE SURE TO VERIFY LINK VOLTAGE IS DISCHARGED BEFORE PERFORMING THE FOLLOWING PROCEDURES.**

1. Disconnect Circuits 21SS and 21SR and insulate from engine starter if equipped with MTU 396 engine. If MTU/DDC 16V4000 or Komatsu engine is installed, disconnect and insulate circuit 21B at the starter solenoids. Apply park brake and brake lock.
  - a. Connect the serial communication cable from the PTU to the PSC port located behind the center console in the cab on the operator's side.
  - b. Be certain the Rest Switch in the cab is in the REST position.
2. Turn the Key Switch ON.

### **To program the 17FB147 CPU card:**

- ◆ c:\>ACNMENU {enter}
  - ◆ Highlight "PROGRAM PSC PANEL" {enter}
  - ◆ Highlight "SELECT PSC SETUP"
  - ◆ Cursor to the appropriate configuration file for the truck being programmed from the list of configuration files {enter}
  - ◆ Highlight "PROGRAM PSC PANEL"
  - ◆ Highlight "PROGRAM PSC"
3. Cycle keyswitch or CPS when requested on screen.
  4. verify the Object Code and Configuration file shown on the screen for downloading is correct.

9. Press {enter}. Verify the values on the PTU are similar Figure 3-7 below:

```

PSC_REAL 1.1.1C:  PSC ANALOG INPUT CHANNELS  — SWAP  — GET1 — PTUEVENT
TRK ID = 30255      EXIT  = REPEAT
PSCmode = TEST                                           TIME= 2Aug01 16:48:15

GROUND FAULT = 0 mA      BATT VOLT = 25.96 V
ALTFAMPS     = 0.0 A      VOLTS 24P = 24.0 V
ALTFVOLTS    = 0.0 V      VOLTS 24N = -24.1 V
Alt VA to GND = 0.0 V      VOLTS 15P = 15.0 V
A3PVOLT      = 0 VAC      VOLTS 15N = -15.0 V
LINKV        = 0 V        VOLTS 5P  = 5.0 V
LINKI        = 0 A
LDBXI        = 0 A      B1_VOLTAGE = 0.00 V
RETARD PEDAL = 2.3 V      B1_AMPS  = 0.00 A
RETARD LEVER = 0.8 V      B2_AMPS  = 0.00 A
ENGINE LOAD  = 5.0 V      GROUND    = 0.00 V
ENGSPD       = 0.0 RPM    GAINCHK   = 10.00 V
AUXRPMFB     = 0 RPM      FDIODE DET = 0
PSC VER : 18.10a      MAY 1 2001    CUSTOM 1  = 0.00
                                           CUSTOM 2  = 0.87

ENTR=Sel. F1=Help F2=Files ESC=Abort ←↑↓=Navigate
E030056

```

FIGURE 3-7. PSC ANALOG INPUT CHANNELS SCREEN

10. Press {enter}. Verify the values on the PTU are similar to Figure 3-8 below:

```

OPTEMP 1.1.1D:  PSC TEMPERATURES SCREEN  — SWAP  — GET1 — PTUEVENT
TRK ID = 30255      EXIT  = REPEAT  RESET
PSCmode = REST                                           TIME= 2Aug01 16:48:15

PSCTEMP (0-100) = 3.28
AMBIENT TEMPERATURE = 21.6 DEG C      CHOPPER GTO (9) = 1.0C
ATMOSPHERIC PRESSURE = 14.5 PSIA      CHOPPER DIODE (10) = 1.0C
AUXPC (1) = 20.7 C      LEFT INVERTER GTO (11) = 20.0C
AUXINV (2) = 21.3 C      LEFT INVERTER DIODE (12) = 20.0C
AFSE (3) = 20.5 C      RIGHT INVERTER GTO (13) = 20.0C
ALTERNATOR (4) = 21.6 C      RIGHT INVERTER DIODE (14) = 20.0C
AUXCMD = 0 RPM      LEFT MOTOR STATOR (MAX) (15) = 17.4C
AUXFB = 0 RPM      LEFT MOTOR ROTOR (MAX) (16) = 17.4C
RECTIFIER DIODE JUNCTION (15) =29.2 C      RIGHT MOTOR STATOR (MAX) (17) = 17.4C
                                           RIGHT MOTOR ROTOR (MAX) (18) = 17.4C

ENTR=Sel. F1=Help F2=Files ESC=Abort ←↑↓=Navigate
E030057

```

FIGURE 3-8. PSC TEMPERATURES SCREEN

- PSC REAL 1.1.1A: PSC REAL TIME DATA					SWAP	GET1	PTUEVENT	
TRK ID = 30255					EXIT = REPEAT	RESET	RECORD	
					TIME= 2Aug 01 16:46:57			
A N A L O G	AUXPCT	ambt	AF-I	ENGCMD	BAT	PSCMODE=	REST	TRUCK SPEED
	24C	21C	0A	650RPM	25.9V	SUBSTATE=	ENT/EX	= 0.00 MPH
	AUXIT	AFSET	LINKV	ENGSPD	AFCURREF	PSCLINK=	OFF	lfrpm = 0.0
	24C	24C	0V	0RPM	-10.00	ACCEL-SEL=	0.00	rfrpm = 0.0
	AUXCMD	PTEMP	LINKI	ENGLoad	A3PV	RETRD-SEL=	0.00	M1RPM = 0
0RPM	0.3	0A	5.0V	0V	DIR SEL=	NEUT	M2RPM = 0	
AUXFB	GFAULT	HPLINK	HPADJ	LBXI	COMMLINK =	OK	RETSFD= 37.0	
0RPM	0ma	0	-12HP	0A				
D I	RP1FB	CPSFB	FC1OP	BRKON	from TCI	to TCI		
	RP2FB	GFFB	GFNCO	FC2OP	accinh	lbxrq	NORETARD INV1DIS	
	RP3FB	CNIFB	CNFB	AUXOK	restreq	forin	NOPROPEL INV2DIS	
	KEYSW	CNXFB	FDIODE	AUTON	engstop	revin	SPDLIMIT LINKON	
D O	RP1	GFR	GD1E	TEST	SYSRUN	FORT		
	RP2	GF	GD2E	REST	SYSFLT	REVT		
	RP3	CPRL	CMCTL	AFSE	AUXRSET	SCR3		
I V	RUN1	TQCMD1=	0	TRQFB1=	0	I1V=	0	
	RUN2	TQCMD2=	0	TRQFB2=	0	I2V=	0	
						PWR1=	0	
						PWR2=	0	
						MODE1=	2H	
						MODE2=	2H	
						TEST=	WAITING	
						TEST=	WAITING	
<input type="checkbox"/> ENTR=Sel. F1=Help F2=Files ESC=Abort ←↑↓=Navigate								

E030059

FIGURE 3-10. PSC REAL TIME DATA SCREEN

TCI_REAL 1.1.1A: TCI REAL TIME DATA					SWAP	GET1	PTUEVENT	
TRK ID = 30255					EXIT = REPEAT	RESET	RECORD	
					TIME= 2Aug 01 16:46:57			
A N A L O G	AMBT	CTRLBAT	BAROP	engspd	load	PSCMODE=	REST	TRUCK SPEED
	26C	27.1V	14.6PSI	0rpm	5.0V	COMLINK =	OK	= 0.00 MPH
	HYBKT	CRNKBAT	MOTORBP	aux_fb	linkv	AUX ERR CODE		LFRPM = 0.0
	32C	27.4V	1.50V	0rpm	0V			RFRPM = 0.0
	gfault	ACCPDL	hpadj	inv1tqfb	linki	AUX DC LINKV		M1RPM = 0
0ma	1.3V	-10HP	0	-2A			M2RPM = 0	
POTREF	RSCSPD	elechp	inv2tqfb	propt	AUX SW VER=	48		
10.8V	-0.0V	0HP	0	0.4				
D I	ENGSTRTREQ	ENGVARN	RESTSW	PRKBRKSW	MIDPAYLD	RESET		
	ENGAUTION	ENKILL	REVREQ	PRKBRKFDBK	FULLPAYLD	LAMPTEST		
	CONTROLON	BODYDWN	FORREQ	RSC	OVERPALD	DATSTORE		
D O	ENGCRAK			to PSC	from PSC			
	ENGCRAK2	NORETARDLT	REVERSELT	ACCINH	LBXRQ	noretard	invdis	
	BATSEPC	NOPROPELLT	RETARDXLT	RESTREQ	FORIN	nopropel	inv2dis	
	PRKBRKON	PSCNOTRDY	RETARDLT	ENGSTOP	REVIN	spdlimit	linkon	
	LINKONLT	RESTLT	TEMPWARNLT	MIDPAYLD	SPLIM	rtrdcont	limpok	
	SPD1 SPD2	REDUCELT	PSCWARNLT	FULLPAYLD	RSC	wslidel	eng_rp	
	WINTMODE	RTRDCONLT	HYDBHOTLT	DSPDLON		wslide2	ws1 ws2	
<input type="checkbox"/> ENTR=Sel. F1=Help F2=Files ESC=Abort ←↑↓=Navigate								

E030060

FIGURE 3-11. TCI REAL TIME DATA SCREEN

# TROUBLESHOOTING

## PVM Optimum Load Curve Handshaking Troubleshooting

*Note: a value of below 0.5VDC or above 9.5VDC (on circuit 72E) indicates a failure.*

### Trucks equipped with DDEC engine:

1. 1. With the engine shut down, keyswitch ON and control power ON, measure voltage between 72E (+) and 0 (-) lead. Voltage should be 5.0VDC.
  - a. If the voltage is low or 0VDC, check voltage of circuit 15VL @ TB32. (This supply is from the GE drive system power supply card through the GE/Auxiliary Control harness.)
    - Voltage should be 5.0 volts.
  - b. Then check voltage of circuit 15SIM @ TB32.
    - Voltage should be approximately 14.5 VDC.
  - c. If voltage is 0VDC or considerably lower than 14.5 volts, check the 20 ohm resistor on DB1.
2. 2. With the engine running and under load, with keyswitch and control power switch ON, check the voltage at 72E(+) to 0 (-).
  - Voltage should be 5.0 volts
    - a. If the voltage in step 2 is lower or higher than 5.0 volts, check using the DDR to see the percent of load the engine is given to the PVM module.
    - b. Multiply the percentage value in the previous step by 10. This should equal the 72E to 0 voltage reading. (i.e. 50% X 10 = 5.0 VDC)

*Note: The DDR is updated every second and is not a true real (electronic) time value. The GE system updates every 20msec. A more accurate method of measuring the updated value is to attach an oscilloscope to the circuit 908M terminal point to ground and measure the time the signal is positive divided by the total time of the signal wave form and multiply it by a factor of 10. This should equal the 72E to 0 circuit voltage. This is a 50HZ signal.*

### Examples:

$$10\text{ms}/20\text{ms} = .50 \times 10 = 5.0\text{VDC}$$

$$15\text{ms}/20\text{ms} = .75 \times 10 = 7.5\text{VDC}$$

$$5\text{ms}/20\text{ms} = .25 \times 10 = 2.5\text{VDC}$$

- c. Verify circuit 0 is connected to ground.
- d. If the signal "908M" is correct and the supply voltage (15SIM) to the PVM is correct, but output is incorrect, replace the PVM module.

### Trucks equipped with Komatsu engine:

1. With the engine shut down, keyswitch ON and control power ON, measure voltage between 72E (+) and 0 (-) lead.
  - Voltage should be 5.0 volts.
    - a. Jumper circuit 22FO to ground and verify voltage on 72E to 0 changes to 7.0VDC.
    - b. If the voltage is 0VDC, verify the connections to the PVM are correct and circuit 439 and 11SL connected to CN P382 positions 5 and 40 are 24VDC.
2. With the engine running and under load, with keyswitch and control power switch ON, check the voltage at 72E(+) to 0 (-).
  - Voltage should be 5.0 volts
    - a. Check the PVM diagnostic connector P381.
    - b. Verify the voltage between position A to B is 8 to 11VDC. (A reading of 0VDC indicates the 1939 transmission line failed. Check 1939 wiring.)
    - c. Verify the voltage between position C to B is 8 to 11VDC. (A reading of 0VDC indicates the PVM has failed only if the voltage from position A to B is correct and the filtering circuit is correct.) Check filtering circuit resistors and capacitors connected to P383 positions 12 and 20 and P382 position 33 mounted on diode board DB1.
3. If both step 1 and 2 are 0VDC, then circuit 439 or 11SL or both are incorrect.

### Trucks with Either Engine:

If necessary, a variable voltage can be substituted for the 72E/0 circuit voltage to determine if the problem is caused by the engine or the GE drive system.

This voltage can be varied above and below 5VDC to see if the GE drive system follows this signal, dropping load when the signal is below 5VDC and increasing load if the signal is above 5VDC.

If the GE drive system follows the signal and with 5VDC the system can produce full power, but cannot function normally, troubleshoot engine boost or fuel injection system.

**SECTION G**  
**REAR AXLE, SPINDLES AND WHEELS**  
**INDEX**

TIRES AND RIMS ..... G2-1

FRONT WHEEL HUB AND SPINDLE ..... G3-1

REAR AXLE HOUSING MOUNTING ATTACHMENT ..... G4-1

REAR AXLE HOUSING ..... G5-1

**SECTION G3**  
**FRONT WHEEL HUB AND SPINDLES**  
**INDEX**

FRONT WHEEL HUB AND SPINDLE .....	G3-3
WHEEL HUB AND SPINDLE ASSEMBLY .....	G3-3
PREPARATION .....	G3-3
Removal .....	G3-3
Installation .....	G3-6
Disassembly .....	G3-7
Cleaning and Inspection .....	G3-7
Assembly .....	G3-9
Wheel Bearing Adjustment: .....	G3-10
Seal Assembly Gap Check: .....	G3-11
STEERING CYLINDERS AND TIE ROD .....	G3-12
Spherical Bearing Wear Limits .....	G3-12
Removal .....	G3-13
Installation .....	G3-14
Bearing Replacement .....	G3-14
TOE-IN ADJUSTMENT .....	G3-15

17. Using a depth micrometer, measure and record the distance between the face of the bearing retainer plate (13) and the end of the spindle (26) through each of the 0.50 in (13 mm) diameter holes adjacent to the capscrews installed previously.

- a. Add the two dimensions measured in step 17 and divide by 2 to obtain an averaged depth dimension.
- b. Subtract 0.010 in (.25 mm) from the averaged depth dimension.
- c. Subtract the retainer plate thickness (etched on the surface of the retainer plate (13) from the result calculated in step 17-b.

18. Assemble a shim pack to equal the dimension calculated in step 17-c within 0.001 in (0.0254 mm).

**NOTE:** Shim pack **must be compressed when measuring**. The above procedure results in a shim pack which will provide a 0.020 in. (0.508 mm) preload for the bearings after assembly.

19. Remove capscrews and retainer. Install shim pack and reinstall retainer, capscrews, and hardened washers.
20. Tighten capscrews alternately to **750 ± 75 ft. lbs. (1017 ± 100 N.m)** torque in several successive increments while rotating the hub.
21. Using a new O-ring, install cover (5). Install capscrews & washers and tighten to standard torque.

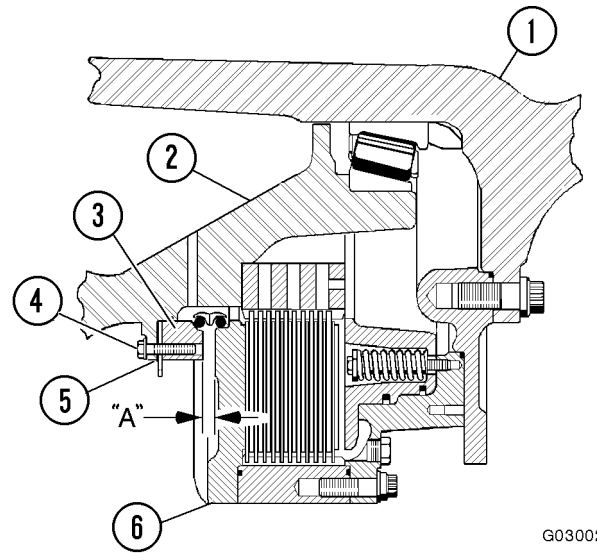
### Seal Assembly Gap Check:

After the hub has been installed, the wheel bearing adjustment completed, and the bearing retainer cap tightened to final torque, the gap between the seal carrier (3, Figure 3-8) and the brake assembly back plate (6) must be measured and adjusted if necessary.

The *ideal* gap is 0.433 in (11.0 mm). If necessary, the gap must be adjusted, using shims as required to maintain a **minimum** gap of 0.413 in (10.5 mm) to 0.453 in (11.5 mm) **maximum**.

22. Measure seal gap as follows:

- a. Measure gap, dimension "A", Figure 3-8 at three, equally spaced places and record the result.
- b. Add the three dimensions and divide the result by 3 to obtain the average gap width.



G03002

FIGURE 3-8. MEASURING SEAL GAP

- |                 |                     |
|-----------------|---------------------|
| 1. Spindle      | 4. Capscrews        |
| 2. Wheel Hub    | 5. Shims            |
| 3. Seal Carrier | 6. Brake Back Plate |
23. If average gap width is not between the minimum and maximum allowable range, loosen the seal retainer capscrews (4, Figure 3-6) and add shims (5) as required to reduce the gap or remove shims to increase the gap. **The quantity and thickness of shims at each of the six locations must be equal.**
  24. Re-tighten seal retainer capscrews to standard torque and measure gap as described in step 22. If necessary, repeat step 23 until proper gap is maintained.
  25. Install speed sensor(s) (16, Figure 3-4) in support bracket(s) (17). Adjust sensor gap as follows:
    - a. Rotate hub to position the top of a gear tooth directly under the sensor tip.
    - b. Insert a 0.060 in (1.5 mm) feeler gauge between sensor tip and gear tooth and adjust sensor clearance.
    - c. Tighten capscrew to lock sensor in place.
    - d. Rotate hub 180° and verify clearance remains within 0.040 in (1.0 mm) minimum to 0.080 in (2.0 mm) maximum.
  26. Install speed sensor cables.
  27. Install hub and spindle assembly on suspension per instructions in "Installation".

## PIVOT EYE REPAIR

If damage occurs to the pivot eye (4, Figure 4-3), it may be necessary to remove it from the rear axle structure (1) to facilitate repair and bearing replacement.

### Removal

To remove the axle housing pivot eye:

1. Follow all the preceding instructions for "**Pivot Pin Removal**".

**Be certain axle housing (1) and wheels are blocked securely!**

2. Attach a lifting device to the pivot eye (4).
3. Remove capscrews (2) and flatwashers (3). Remove pivot eye to work area.

### Disassembly

1. Remove spherical bearing (13, Figure 4-2) as described in "**Pivot Eye Bearing, Disassembly**".

2. If bearing carrier (16) is damaged or worn, setup an appropriate tool to press bearing carrier out of the pivot eye structure bore.

Bearing Carrier (new):

I.D.  $8.7484 \pm 0.0005$  in. ( $222.209 \pm 0.013$  mm)

O.D.  $9.7520 \pm 0.0005$  in. ( $247.701 \pm 0.013$  mm)

3. Inspect pivot eye structure bore for excessive wear or damage.

Pivot Eye Bore (new):

$9.7500 \pm 0.0005$  in. ( $247.650 \pm 0.013$  mm)

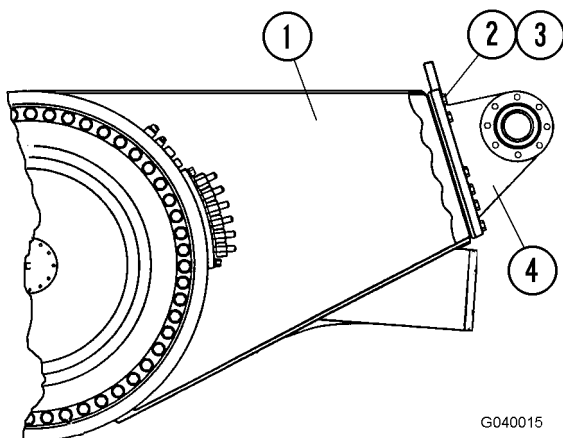


FIGURE 4-3. PIVOT EYE ATTACHMENT

- |                        |               |
|------------------------|---------------|
| 1. Rear Axle Structure | 3. Flatwasher |
| 2. Capscrew            | 4. Pivot Eye  |

### Assembly

1. Setup an appropriate tool to press bearing carrier (16, Figure 4-2) into the bore of the pivot eye structure (15). Be certain the bearing carrier is pressed fully into the pivot eye bore, flush with sides.

Lube groove in bearing carrier outer diameter must align with lube fitting hole in pivot eye structure.

*NOTE: With parts to correct size, the fit of the bearing carrier into the bore of the pivot eye structure may be:*

*0.0010 in. - 0.0030 in. (0.025 mm - 0.08 mm) interference fit.*

*Freezing the bearing carrier will ease installation.*

2. Install spherical bearing (13) as described in "**Pivot Eye Bearing, Assembly**".

### Installation

1. Be certain mating surfaces of axle housing (1, Figure 4-3), and pivot eye (4) are clean and not damaged.
2. Lift pivot eye into position on front of axle housing. Insert several capscrews (2) and flatwashers (3) to align the parts. Remove the lifting device.
3. Install the remaining capscrews and flatwashers. Tighten alternately until the pivot eye is properly seated. Tighten capscrews to **1480 ft. lbs. (2007 N.m)** final torque.

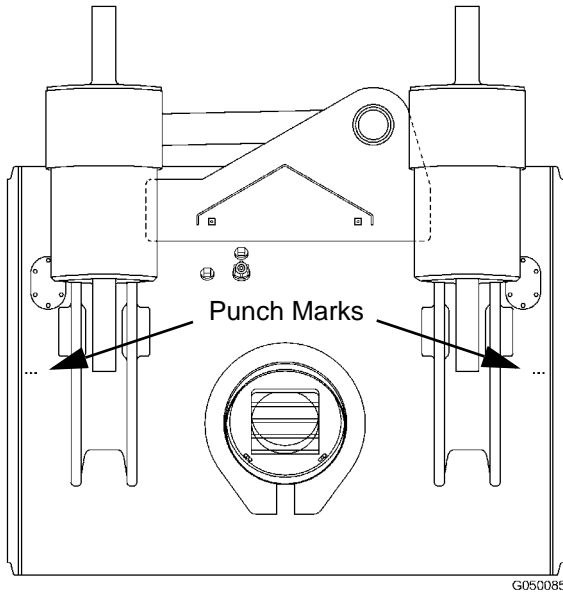


FIGURE 5-4. AXLE HOUSING DIMPLE MARKINGS

3. Install lubricated capscrews and flat washers securing wheel motor to rear axle housing. Snug up all capscrews until wheel motor is seated against axle housing flange at all points. Final tighten (alternating capscrews 180° apart) to **1480 ft. lbs. (2007 N.m)** torque.
4. Connect power cables (7, Figure 5-1) to their appropriate location on the wheel motor. Connect speed sensor cable.

**▲ IMPORTANT ▲**

***All propulsion system power cables must be properly secured in their wood or other non-ferrous cable cleats. If clamps are cracked or broken, replace them with new parts. Inspect cable insulation and replace entire cable if insulation is damaged.***

5. Connect brake apply line (11) to the port on the brake assembly back plate.
6. Using new O-rings, install brake cooling lines.
7. Seal gap around brake cooling hoses (see sealant specification below) where cooling hoses pass through spindle holes. Install clamps (3).

**MASTIC SEALANT**

*Vendor Product Name:*

- Uniseal 310S Sealant

*Description:*

- 2.00 in. wide x 0.125 in. thick x 120 in. long roll

*Vendor Source:*

- Uniseal  
1800 W. Maryland Street  
Evansville, IN 47712
- Other sources may be available throughout the world.

*NOTE: Brake system hoses must be sealed where they pass through axle spindle holes to prevent cooling air loss.*

8. Connect air sensor hose, if removed. Install park brake apply hose (13).
9. Install inspection covers on access holes (17).
10. Install air duct (5). Close duct inspection covers and install duct tube in rear opening of axle housing.
11. Open pump shut-off valves.
12. Check wheel motor oil level. Rotate a magnetic plug to the 6 o'clock position and remove the plug. The oil level should be even with the bottom of the plug opening. Refer to Figure 5-5. Fill as necessary.
13. Check hydraulic tank oil level before and after engine start-up and brake bleeding procedure. Service as necessary.
14. Bleed the brake apply line according to the instructions in "Wet Disc Brake Assembly, Brake Bleeding Procedure", Section "J".

**SECTION H2  
FRONT SUSPENSION  
INDEX**

FRONT SUSPENSION .....	H2-3
Removal .....	H2-3
Installation .....	H2-4
"TURN-OF-THE-NUT" Tightening Procedure .....	H2-6
MINOR REPAIR ONLY (LOWER BEARING & SEALS) .....	H2-7
Lower Bearing Removal .....	H2-7
Lower Bearing Installation .....	H2-7
MAJOR SUSPENSION REBUILD .....	H2-9
Disassembly .....	H2-9
Assembly .....	H2-9

**SECTION H3  
REAR SUSPENSION  
INDEX**

REAR SUSPENSIONS .....	H3-3
Removal .....	H3-3
Installation .....	H3-5
Disassembly .....	H3-6
Cleaning and Inspection .....	H3-6
Assembly .....	H3-6

# SUSPENSION OILING AND CHARGING PROCEDURE

## GENERAL

These procedures cover the oiling and charging of Hydrair®II suspensions on Komatsu 930E dump trucks.

Suspensions which have been properly charged will provide improved handling and ride characteristics while also extending the fatigue life of the truck frame and improving tire wear.

*NOTE: Inflation pressures and exposed piston lengths are calculated for a normal truck gross vehicle weight (GVW). Additions to truck weight by adding body liners, tailgates, water tanks, etc. should be considered part of the payload. Keeping the truck GVW within the specification shown on the Grade/Speed Retard chart in the operator cab will extend the service life of the truck main frame and allow the Hydrair®II suspensions to produce a comfortable ride.*

## **⚠ WARNING**

**All Hydrair®II suspensions are charged with compressed nitrogen gas with sufficient pressure to cause injury and/or damage if improperly handled. Follow all safety instructions, cautions, and warnings provided in the following procedures to prevent any accidents during oiling and charging.**

Proper charging of Hydrair®II suspensions requires that three basic conditions be established in the following order:

1. Oil level must be correct.
2. Suspension piston rod extension for nitrogen charging must be correct.
3. Nitrogen charge pressure must be correct.

For best results, Hydrair® II suspensions should be charged in pairs (fronts together and rears together). If rears are to be charged, the fronts should be charged first.

*NOTE: For longer life of suspension components, a friction modifier should be added to the suspension oil. See Specifications Chart, Figure 4-5 at the end of this chapter.*

*NOTE: Set up dimensions specified in the charts must be maintained during oiling and charging procedures. However, after the truck has been operated, these dimensions may vary.*

## EQUIPMENT LIST

- Hydrair® Charging Kit
- Jacks and/or Overhead Crane
- Support Blocks (Front and Rear) for:
  - Oiling Height Dimensions
  - Nitrogen Charging Height Dimensions
- Hydrair® Oil (See Specifications Chart)
- Friction Modifier (See Specifications Chart)
- Dry Nitrogen (See Specifications Chart)

### Hydrair® Charging Kit

Assemble service kit as shown in Figure 4-1 and attach to container of pure dry nitrogen (8).

### Installation of Charging Kit

1. Remove protective covers and charging valve caps from suspensions to be charged.
2. Turn "T" handles (1, Figure 4-1) of adapters (2) completely counterclockwise.

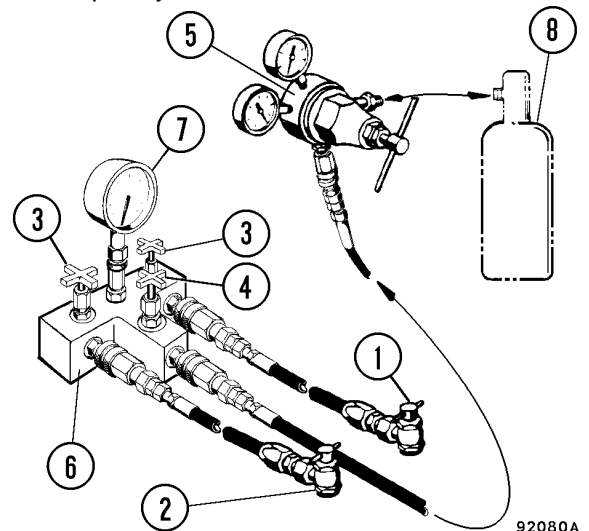


FIGURE 4-1. HYDRAIR® CHARGING KIT

*NOTE: Arrangement of parts may vary from illustration above, depending on charging kit P/N.*

1. "T" Handle Valve
2. Charging Valve Adapter
3. Manifold Outlet Valves (from gauge)
4. Inlet Valve (from regulator)
5. Regulator Valve (Nitrogen Pressure)
6. Manifold
7. Charging Pressure Gauge (Suspensions)
8. Dry Nitrogen Gas (Specifications Figure 4-5)

**SECTION J2  
BRAKE CIRCUIT  
INDEX**

BRAKE CIRCUIT .....J2-3

    SERVICE BRAKE CIRCUIT .....J2-3

    SECONDARY BRAKING AND AUTOMATIC APPLY .....J2-5

    PARKING BRAKE CIRCUIT .....J2-5

    BRAKE LOCK CIRCUIT .....J2-6

    WARNING CIRCUIT .....J2-6

# BRAKE CIRCUIT COMPONENT SERVICE

## BRAKE VALVE

The brake pedal assembly combines the dynamic retarding control with service brake control functions.

As the pedal is depressed, the first portion of pedal travel actuates an internal potentiometer which provides an electrical signal to the propulsion system, signalling a request by the operator for retarding. The electrical signal is modulated by the operator as he continues to depress the pedal, increasing the level of retarding effort from minimum to maximum. Further pedal depression after maximum retarding request is achieved, results in service brake application from minimum to maximum when the pedal is fully depressed. A slight increase in pedal resistance can be felt when service brake actuation occurs. Additionally, indicator lights on the overhead display panel in the cab will turn on as dynamic retarding is applied. A second lamp will turn on when service brakes are applied.

*NOTE: The following information discusses the operation, test and repair of the hydraulic brake valve assembly only. Refer to Section E for information concerning the retarding control portion of the pedal.*

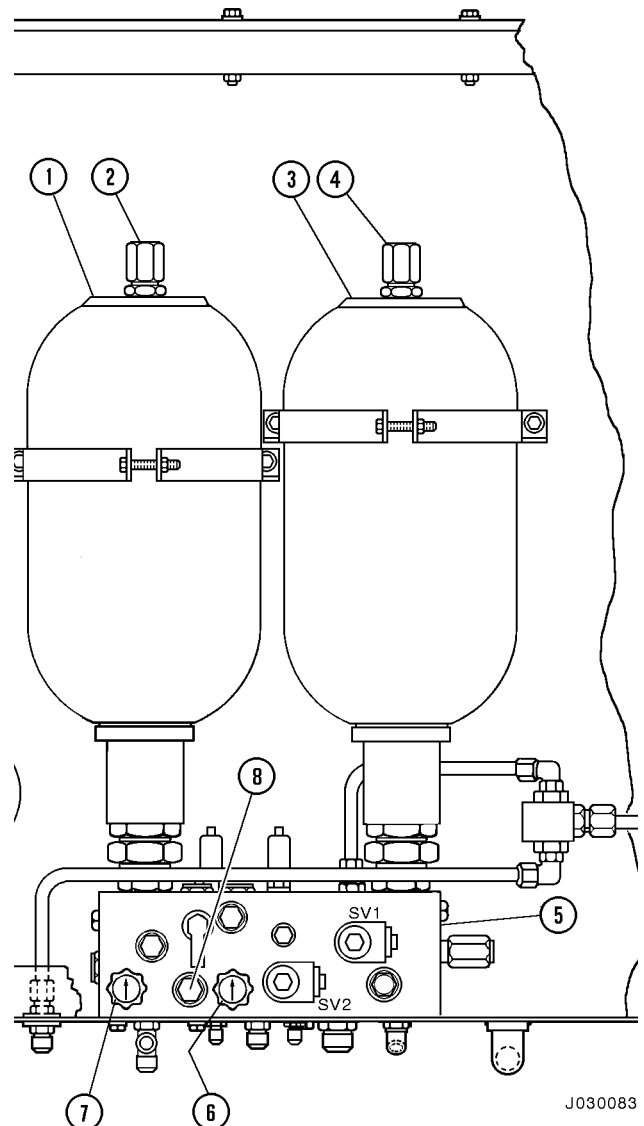
The brake valve is a pressure modulating valve, actuated mechanically (brake pedal) or hydraulically through the automatic apply valve (8, Figure 3-1).

The brake valve controls the pressure delivered to the front and rear service brake dual relay valves which provide the apply pressure for the front wheel and rear wheel disc brake assemblies. Apply pressure can be modulated from zero to maximum braking effort by use of the foot pedal.

### Rebuild Criteria

If any one of the following conditions exist, the brake valve should be removed and repaired:

- Excessive cam rock in pedal actuator.
- Any sign of external leakage.
- Internal leakage at the tank port must be less than 100 cc/minute with the valve in the released position and system pressure supplied to the "P1" and "P2" inlet ports.
- Tank port leakage must be less than 250 cc/minute with valve pilot or manual applied at 2750 psi (18,960 kPa) system pressure.
- Failure of the pedal to return to full release position.



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FIGURE 3-1. BRAKE ACCUMULATOR BLEED DOWN

1. Rear Brake Accumulator
  2. Charging Valve
  3. Front Brake Accumulator
  4. Charging Valve
  5. Brake Manifold
  6. Accumulator Bleed Down Valve (Front)
  7. Accumulator Bleed Down Valve (Rear)
  8. Automatic Apply Valve
- Valve holds pressure when in the neutral position.
  - Varying output pressure with pedal fully depressed.

## Test Set Up Procedure

1. Position the valve in the fixture to allow plungers to be activated by hand using a lever (refer to Figure 3-9).
2. Attach the pilot input supply pressure to the pilot port labeled "PX" on the rear of the valve.
3. Attach the main supply input pressure to the O-ring ports on the rear of the valve labeled "P1" and "P2".
4. Attach the tank return line to the O-ring port labeled "T" on the rear of the valve.
5. Attach the regulated output ports "B1" and "B2" to the test lines. Pressure monitoring devices in these two lines must be capable of 3000 psi (20,680 kPa). Connect all ports. The connections should be according to the diagram shown in Figure 3-9. All ports must be used and connected.



***All ports must be used. Relieve pressure before disconnecting hydraulic and other lines. Tighten all connections before applying pressure.***

***Avoid spillage and contamination! Avoid contact with hot oil if the machine has been operating. The oil will be at very high pressure.***

***Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury and possibly death if proper medical treatment by a physician familiar with this injury is not received immediately.***

6. Start hydraulic pump and regulate output pressure to 2750 psi (18,960 kPa) at pressure gauge (3). Pressure gauges (7 & 10) should read zero.
7. Pilot supply circuit pressure must also be 2750 psi (18,960 kPa).
8. Return line pressure during this test is not to exceed 5 psi (34 kPa).
9. Test the valve with ISO 32 grade hydraulic oil at  $120^{\circ} \pm 10^{\circ} \text{ F}$  ( $49^{\circ} \pm 3^{\circ} \text{ C}$ ).

## Adjustment - Brake Valve Output Pressure

1. Install the pedal pivot shaft pin in the actuator base by itself without installing the pedal assembly.
2. By taking a screw driver or pry bar and placing it under the pivot pin and on top of the threaded plunger assembly, each circuit can be actuated individually. Refer to Figure 3-9.
3. Gradually apply pressure on each circuit (one at a time) to check for leaks around the plunger. Make sure the adjustment collar is screwed all the way down on the threads.
4. **"B1" Adjustment:** Adjust the adjustment collar up (counter-clockwise) starting with one turn increments until the output pressure at port "B1" is  $2400 \pm 75 \text{ psi}$  ( $16,545 \pm 517 \text{ kPa}$ ) with the adjustment collar contacting the actuator base (**fully actuated**). Fine adjustment will require turning the collar only in 1/8 turn increments.
5. **"B2" Adjustment:** Adjust the adjustment collar up (counter-clockwise) starting with one turn increments until the output pressure at port "B2" is  $2400 \pm 75 \text{ psi}$  ( $16,545 \pm 517 \text{ kPa}$ ) with the adjustment collar contacting the actuator base (**fully actuated**). Fine adjustment will require turning the collar only in 1/8 turn increments.
6. Tighten the setscrews in the adjustment collars to **25 - 30 in.lbs. (2.8 - 3.4 N.m)** torque. The entire plunger may have to be rotated to get to the capscrews.
7. Check pressures again after tightening the set screws. If the pressures have moved out of specified range, loosen the appropriate set screw and re-adjust.
8. Cycle each circuit 50 times using pilot apply. This is done by closing needle valve (5) and opening needle valve (4). Read pressure on gauges (7 & 10). Close valve (4) and open valve (5). The pressure gauges should read 0 psi.
9. Recheck pressures after cycling. If they have changed, re-adjust pressures.

## Adjustment - Differential Pressure Switch

10. Attach an ohmmeter or continuity tester lead to connector on the differential pressure switch wire. Attach the other lead to the valve body. Verify that switch contacts are open.
11. Remove plug (6, Figure 3-8) for access to adjustment screw plug (7).
12. Insert pry bar under pivot pin to actuate the "B1" section of valve.

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### Adjustment - Differential Pressure Switch

10. Attach an ohmmeter or continuity tester lead to connector on differential pressure switch wire. Attach other lead to valve body. Verify switch contact is open.
11. Remove plug on bottom of valve body for access to adjustment screw plug (29, Figure 3-11).
12. Open the "B1" regulated output circuit needle valve (11) to bleed the pressure back to tank. Adjust pilot pressure regulator for 0 psi (0 kPa) on gauge (7).
13. Slowly adjust regulator valve to obtain 300 psi (2,068 kPa) on the "B2" circuit pressure gauge (9).
  - a. If switch contact has not closed, turn differential pressure switch adjustment screw (29) counterclockwise until switch contact just closes.
  - b. If switch contact closed before reaching 300 psi (2,068 kPa), turn screw plug counterclockwise and repeat previous step.
14. Reduce pilot pressure until switch opens.
15. Slowly increase pilot pressure and verify switch contact closes at  $300 \pm 30$  psi ( $2,068 \pm 207$  kPa).
16. Reduce pilot pressure. Close "B1" needle valve (11) and open "B2" circuit needle valve (12).
17. Slowly increase pilot pressure and verify switch contacts close at  $300 \pm 30$  psi ( $2,068 \pm 207$  kPa) as read on "B1" circuit gauge (10).
18. If necessary, adjust screw plug (29) and repeat steps 12 through 17.
19. Install plug in switch adjustment port. Tighten to **90 - 100 in. lbs. (10.2 - 11.3 N.m)** torque.
20. Shut down the test bench and relieve all hydraulic pressure from the lines.



***Be certain all hydraulic pressure has been released prior to disconnecting hoses and valve. Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury and possibly death if proper medical treatment by a physician familiar with this injury is not received immediately.***

21. Remove hoses from valve and remove valve from test stand.

## Disassembly and Adjustment - Retarder Control Lever

1. Remove the capscrews (6, Figure 3-30) and lockwashers (7) from lever assembly.
2. Remove potentiometer (8).
3. Bend tangs on washer (10) away from slots in locknut (9).
  - a. If the lever assembly is to be completely disassembled, loosen and remove locknut (9), along with tang washer (10), spring (11), and washer (12). Remove handle and shaft assembly (14).

Wash parts in clean solvent and inspect for excessive wear, burrs, or scratches. Replace defective parts.

- b. If the lever assembly only requires adjustment, loosen or tighten locknut (9) as follows:

The lever assembly should be adjusted such that the frictional forces will hold the lever firmly in the position selected by the operator. At the same time, the adjustment should not be so tight as to cause the operator to use undue force to move the lever.

The position of the lever should remain stationary without moving down (applying the retarder) from its own weight or due to machine vibrations during truck operation.

When the desired adjustment is obtained, bend tang on washer (10) into slot on locknut (9).

## Potentiometer Check - Retarder Control Lever

The potentiometer (8, Figure 3-30) is spring-loaded to the OFF position. With the switch assembly removed from the lever assembly, make the following checks:

1. Rotate the "pot" clockwise to full ON and release. Be sure that the spring returns the "pot" to the OFF position.
2. Using a reliable volt-ohm meter, 0 ohms should be read in the OFF position.
3. Rotate the "pot" clockwise to full ON and hold. 2500 ± 500 ohms should be recorded.

Replace the potentiometer if it does not meet these specifications.

## Assembly - Retarder Control Lever

1. If handle (16, Figure 3-30) or lever (15) has been removed from shaft (14), assemble as follows:
  - a. Apply Loctite™ #271 to lever (15) and install lever fully into shaft (14).
  - b. Apply Loctite™ #271 to opposite end of lever (15) and install handle (16) onto lever.

**Hand Tighten Only!**
2. Inspect the shaft bore and interior friction faces of bracket (13) and remove any scratches or burrs, or replace bracket. Lightly lubricate the surfaces with a Multi-Purpose EP NLGI Consistency #2 grease.
3. Insert the lever, handle, and shaft assembly into bracket (13), and install washer (12), new spring (11) [with the outer spring diameter against washer (12)], tang washer (10), and locknut (9) onto shaft (14).
4. Tighten and secure locknut (9) as described in step 3.b. Disassembly and Adjustment - Retarder Control Lever.
5. Move lever to the UP position as far as travel permits. Align slot in potentiometer (8) with key on shaft (14) and rotate pot until capscrew holes line up with bracket. Install washers (7) and capscrews (6) to secure pot to bracket. Tighten the socket head capscrews to **36 in. lbs. (4.1 N.m)** torque.
6. Install lever assembly to steering column.

45. Depress the brake pedal *very slowly* until the brake differential pressure switch activates the low brake pressure lamp and buzzer.

- ❑ Verify fault indicators are activated at:

Refer to Table I Pressures.

\* Record Pressure on data sheet.

Table 1. Differential Pressure Switch Adjustment		
Spring Color	Pressure - Switch Contacts Closing	
	"B1" Valve Spool	"B2" Valve Spool
Red	300 ± 30 psi (2 068 ± 207 kPa)	300 ± 30 psi (2 068 ± 207 kPa)
Green	600 ± 50 psi (4 137 ± 345 kPa)	600 ± 50 psi (4 137 ± 345 kPa)

**! WARNING ! DO NOT attempt to adjust a "red" spring to 600 ± 50 psi (4 137 ± 345 kPa). This will cause the spring to "bottom out" and the warning switch will not function properly.**

For more specific details regarding Table I, refer to previous chapter: Brake Circuit Component Service, Brake Valve, "Differential Pressure Switch Adjustment".

46. Shut down the engine and turn key switch OFF. Allow steering accumulators to bleed down.

47. Open both accumulator bleeddown valves and bleed entire brake system. Close valves after all pressure is released.

48. Reconnect hose (4, Figure 4-4) to Tee at "AF1" port, bottom of hydraulic cabinet

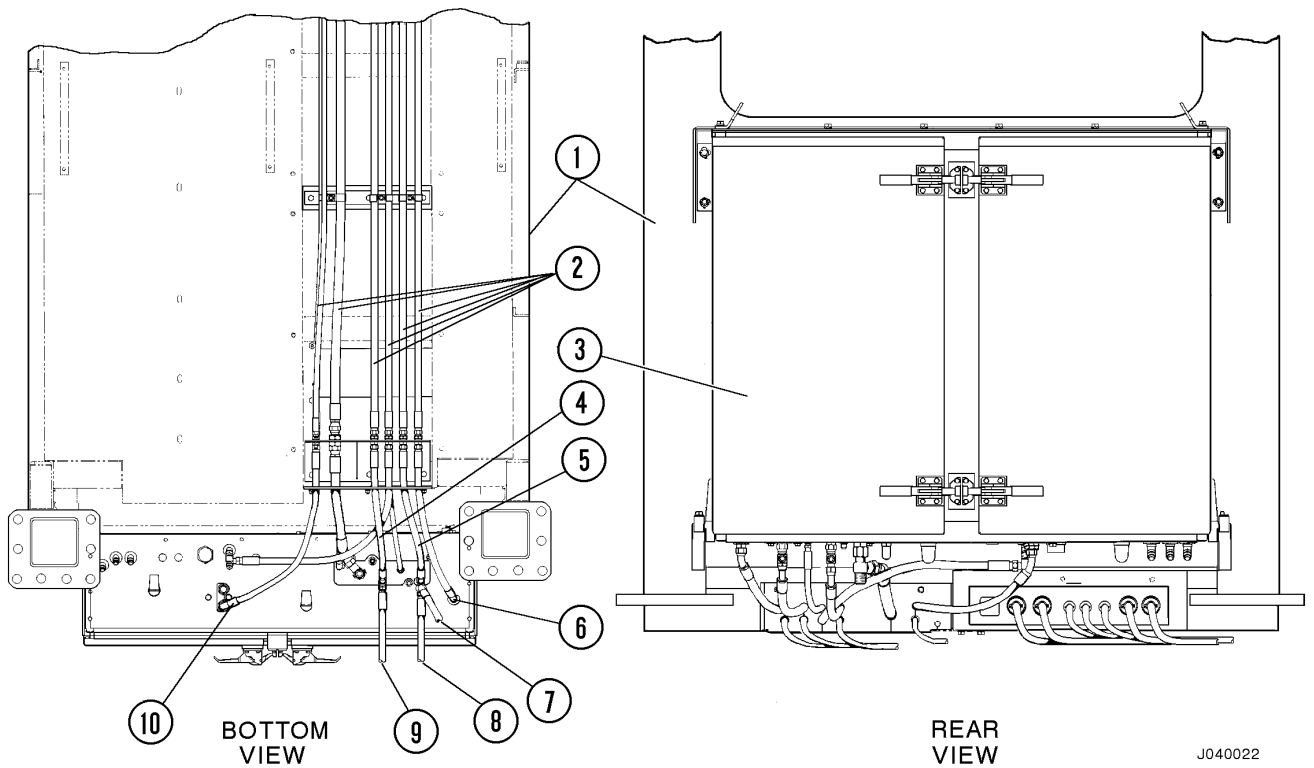


FIGURE 4-4. HYDRAULIC COMPONENTS CABINET

- |                                                  |                                             |                                              |
|--------------------------------------------------|---------------------------------------------|----------------------------------------------|
| 1. Operator's Cab                                | 5. To Brake Valve, Port "P1"                | 8. To Rear Axle Junction Block, Port "P1"    |
| 2. Hoses to Brake Valve & Steering Control Valve | 6. To Brake Valve, Port "B1"                | 9. To Front, Frame Mounted Brake Accumulator |
| 3. Hydraulic Components Cabinet                  | 7. To Rear, Frame Mounted Brake Accumulator | 10. To Brake Valve, Port "B2"                |
| 4. To Brake Valve, Port "P2"                     |                                             |                                              |

## WET DISC BRAKE ASSEMBLY

The oil cooled, wet disc brake assemblies mounted on the front and rear wheels are similar in design. The rear wheel brakes differ from the front in their mounting arrangement only. The rear brake assembly requires an adapter hub (1, Figure 5-1) for installation on the wheel motor wheel hub.

Each disc brake assembly consists of the following basic components:

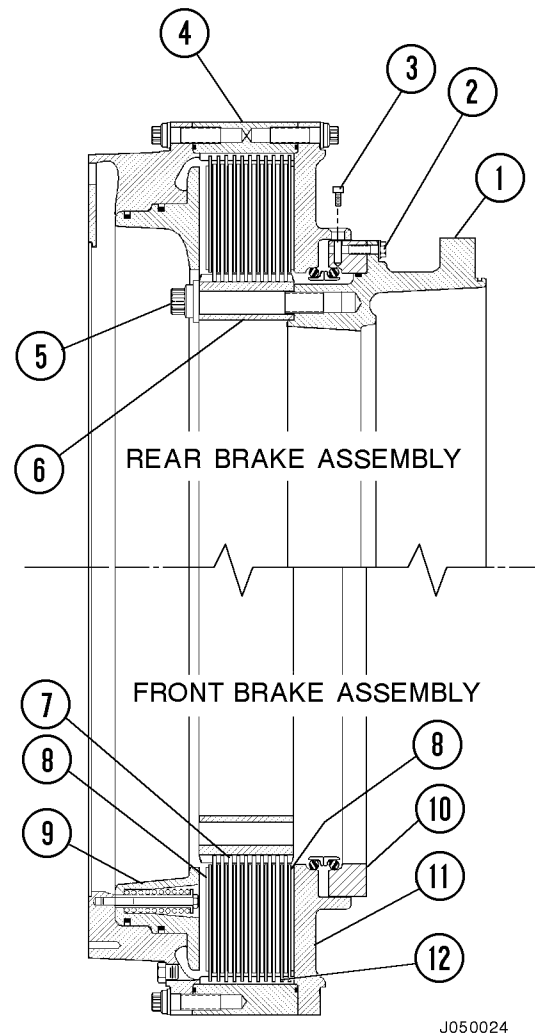
- Ten friction discs
- Nine separator plates
- Two damper discs
- Piston assembly
- Stationary ring gear
- Rotating inner gear
- Floating ring oil seal assembly

### Operation

The ring gear (4, Figure 5-1) is internally splined to retain the dampers (8) and separator plates (12). The separator plates are alternately placed between the friction faced discs (7) which are splined to the inner gear (6). The inner gear mounts directly to the wheel hub on the front wheel brakes. On the rear, the inner gear requires an adapter hub which mounts on the wheel hub on the wheel motor.

The inboard side of the assembly contains the piston (9) which is activated by hydraulic pressure supplied by the dual relay valves (controlled by the brake valve). As hydraulic pressure is applied, the piston moves to compress the rotating friction faced discs against the stationary steel discs. The friction forces generated resist the rotation of the wheels. As hydraulic pressure increases, friction forces are increased and wheel rotation is slowed until maximum force is reached and the wheel is stopped.

The complete brake disc pack is cooled by hydraulic oil. The low pressure cooling circuit is completely isolated from the high pressure, piston apply circuit. Cooling oil flows from the hydraulic tank to the hoist pump, through the hoist circuit high pressure filters, through the hoist valve, and into the brake housings. A parallel circuit from the hoist valve outlet is connected to relief valves at the hydraulic tank which limit brake cooling circuit pressure to 35 psi (241 kPa). Oil routed to the front brakes passes through the oil cooler before entering the front brake housings. In addition, the brake cooling oil provides lubrication for the front wheel bearings. Oil exiting the brake housings returns to the hydraulic tank.



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FIGURE 5-1. WET DISC BRAKE ASSEMBLIES

- |                                  |                     |
|----------------------------------|---------------------|
| 1. Hub Adapter (Rear Only)       | 6. Inner Gear       |
| 2. Capscrew & Lock-washer        | 7. Friction Disc    |
| 3. Socket Head Screw (Temporary) | 8. Damper           |
| 4. Ring Gear                     | 9. Piston Assembly  |
| 5. Capscrew & Hardened Washer    | 10. Seal Carrier    |
|                                  | 11. Back Plate      |
|                                  | 12. Separator Plate |

## Floating Ring Seal Assembly/Installation

Failures are usually caused by combinations of factors rather than one single cause, but many failures have one common denominator: -ASSEMBLY ERROR!

Floating ring seals should ALWAYS be installed in MATCHED pairs: that is, two new rings OR two rings that have previously run together. NEVER assemble one new ring and one used ring; or two used rings that have not previously run together. **ALWAYS USE NEW TORIC RINGS!!**

1. Inspect seal surfaces and mounting cavities for rough tool marks or nicks that may damage rubber seal rings. Hone smooth and clean, if required. Remove any oil, dust, protective coating or other foreign matter from the metal seal rings, the toric rings, and both the housing and seal ring ramps. Use tri-chloroethane #111 which is a non-petroleum base, rapid drying solvent leaving no film. Allow surfaces to dry completely. Use clean, lint-free material such as "Micro-Wipes #05310" for cleaning and wiping.

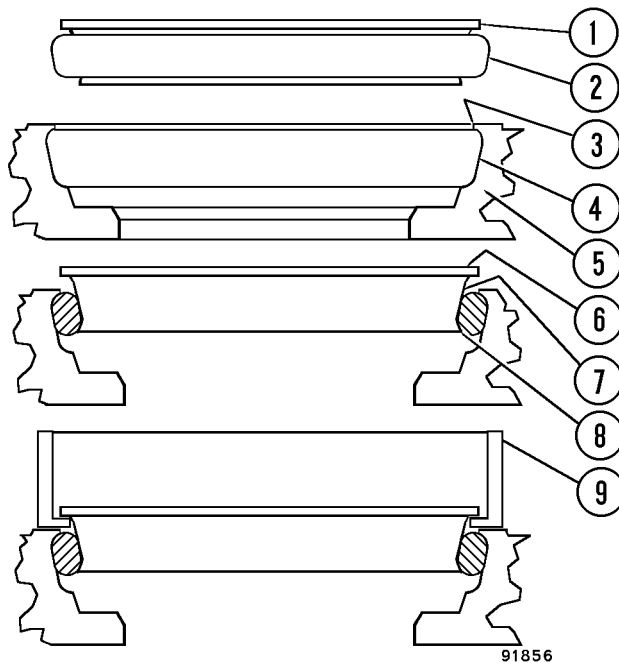


FIGURE 5-13. SEAL TERMINOLOGY

- |                         |                           |
|-------------------------|---------------------------|
| 1. Seal Ring            | 6. Seal Ring Face         |
| 2. Rubber Toric         | 7. Seal Ring Ramp         |
| 3. Housing Retainer Lip | 8. Seal Ring Retainer Lip |
| 4. Housing Ramp         | 9. Installation Tool      |
| 5. Seal Ring Housing    |                           |

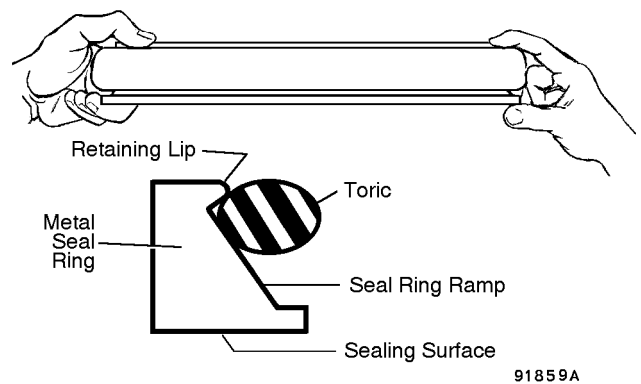
## WARNING

**When using tri-chloroethane or any solvent, avoid prolonged skin contact. Use solvents only in well ventilated areas and use approved respirators to avoid breathing fumes. Do not use near open flame or welding operations or other heated surfaces exceeding 900°F (482°C). Do not smoke around solvents.**

**Both ramps must be dry.** Use clean, lint-free cloths or lint-free paper towels for wiping.

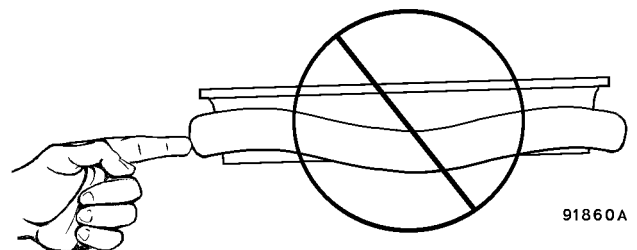
**NOTE:** Oil from adjacent bearing installations or seal ring face lubrication **MUST NOT** get on the ramp or toric **until after both seal rings are together in their final assembled position.**

2. Install the rubber toric on the seal ring.



**Make sure it is STRAIGHT! Make sure the toric ring is not twisted** and that it is seated against the retaining lip of the seal ring ramp. Use the flash line as a reference guide to eliminate twist. The flash line should be straight and uniform around the toric.

**NOTE:** Handle seal carefully; **nicks and scratches on the seal ring face cause leaks.**



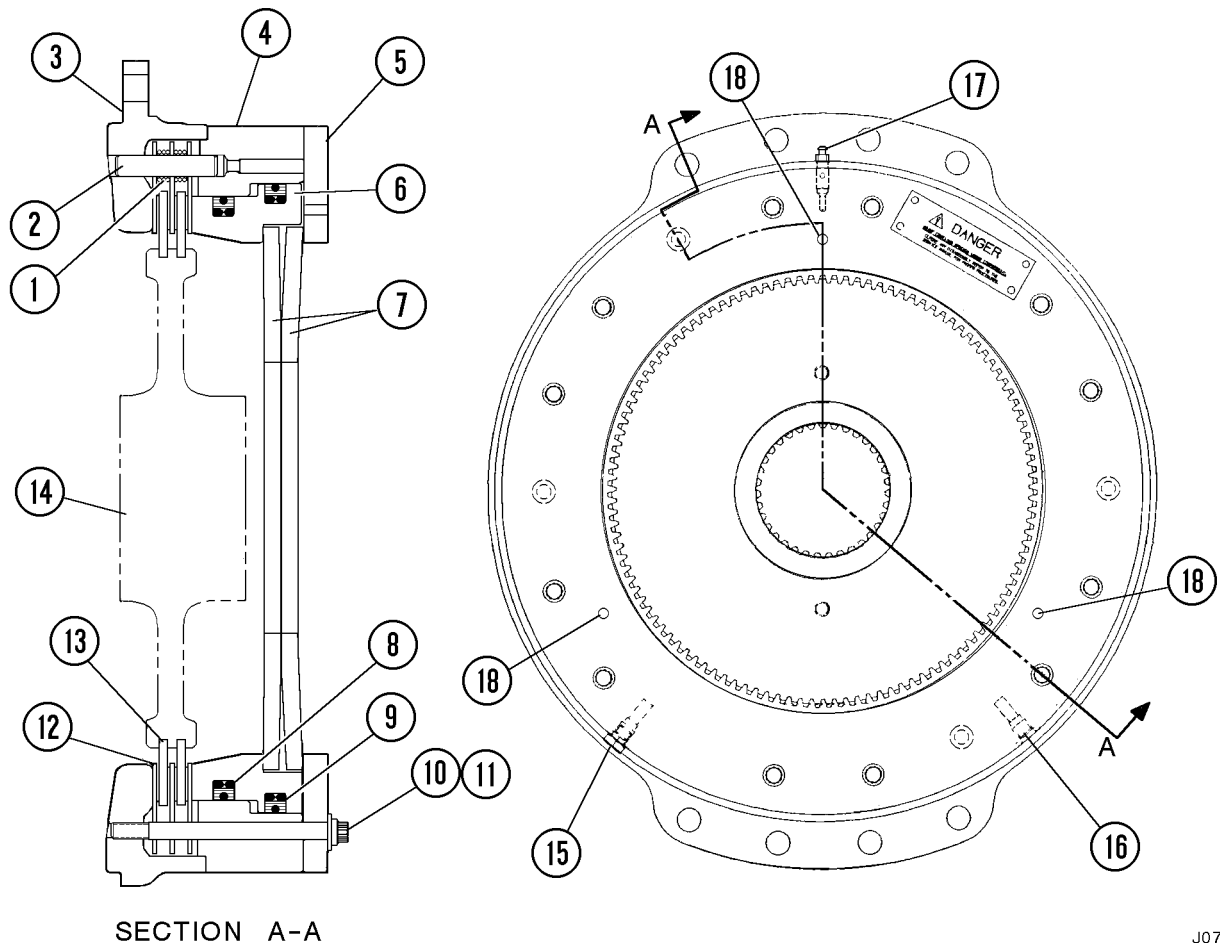


FIGURE 7-2. PARKING BRAKE ASSEMBLY

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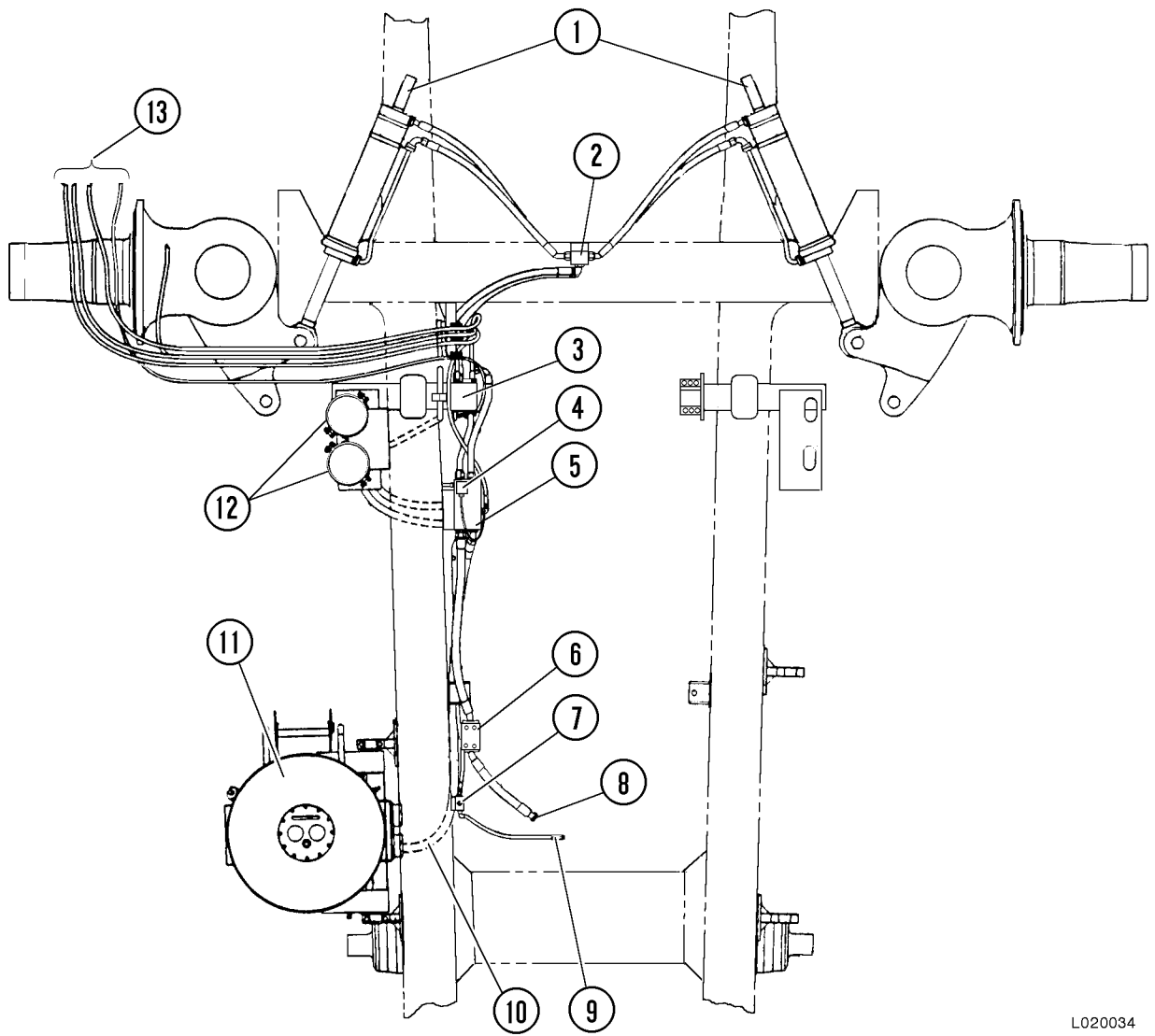
- |                       |                         |                           |
|-----------------------|-------------------------|---------------------------|
| 1. Compression Spring | 7. Belleville Springs   | 13. Friction Disc         |
| 2. Dowel Pin          | 8. Piston Seal Assembly | 14. Gear (Armature)       |
| 3. Housing            | 9. Piston Seal Assembly | 15. Plug                  |
| 4. Piston Housing     | 10. Capscrew            | 16. Oil Supply Port       |
| 5. End Cap Structure  | 11. Hardened Washer     | 17. Bleeder & O-Ring Plug |
| 6. Piston             | 12. Separator Disc      | 18. Piston Position Holes |

9. Select three capscrews 120° apart and mark them.

- a. Tighten the marked capscrews to **30 ft. lbs. (41 N.m)** torque. (Snug the remaining capscrews after each of the marked capscrews are torqued in the following steps.)
- b. Re-tighten the marked capscrews until the gap between the cap structure and piston housing is equalized.
- c. Re-tighten the marked capscrews in **20 ft. lbs. (27 N.m)** increments until fully tight - **90 ft. lbs. (122 N.m)** torque.
- d. Tighten the remaining capscrews to **90 ft. lbs. (122 N.m)** torque.

*Pressure Test:*

10. Install the O-ring plug and bleeder (17). Install a fitting in one of the pressure supply ports and attach a hydraulic power source. Install an O-ring plug in the remaining port.
  - a. Slowly apply pressure and open the bleeder valve to bleed air from the piston cavity. Close the bleeder and apply 300 psi (2068 kPa) hydraulic pressure and hold for one (1) minute.
  - b. Observe for oil leakage. NO leakage is permitted.
  - c. If leakage occurs, the brake assembly must be disassembled and repaired.



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FIGURE 2-4. STEERING SYSTEM COMPONENTS

- |                                        |                                    |
|----------------------------------------|------------------------------------|
| 1. Steering Cylinders                  | 8. Steering/Brake Pump Outlet Hose |
| 2. Manifold                            | 9. Unloader Valve to Manifold Hose |
| 3. Flow Amplifier Valve                | 10. Steering Circuit Return Line   |
| 4. Accumulator Bleddown solenoid       | 11. Hydraulic Tank                 |
| 5. Bleddown Manifold Valve             | 12. Steering Circuit Accumulators  |
| 6. Steering Circuit Filter             | 13. Steering Control Valve Lines   |
| 7. Manifold (Steering Pressure Switch) |                                    |

- Remove connector plate (9, Figure 3-5). Remove O-ring (8) and steel rings (10) and (14). Remove dowels (6) if damaged, or if connector plate replacement is necessary.

*NOTE: If the connector plate is stuck, tap lightly with a plastic hammer to loosen.*

- Remove backup ring (15), O-ring and retainer (16) and isolation plate (17). Grasp the drive gear (12) and idler gear (11) and pull straight up and out of the gear plate (5) bore. Remove pressure plate (18) from gears.

- Remove gear plate (5) and pressure plate (19). Remove steel rings, backup ring, O-ring and retainer and isolation plate. Remove O-ring (3) and stud O-ring (4).

- Remove bearing plate (2, Figure 3-5). Remove O-ring (23) and stud O-rings (1). Remove dowels (20) if damaged or replacement of the bearing plate is necessary.

- Remove coupling (21). Remove snap ring (22) if damaged or replacement is necessary.

*NOTE: Disassembly of the rear pump section is now complete. Do not remove thru studs at this time as the studs serve as guides for disassembly.*

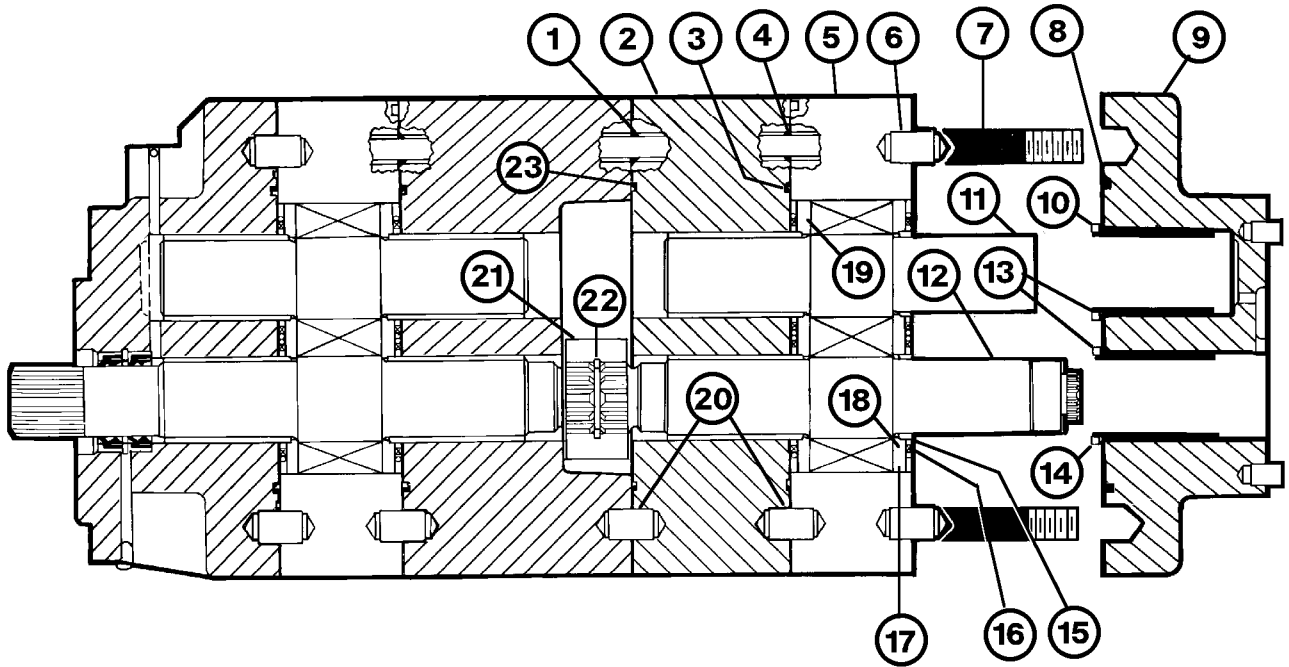


FIGURE 3-5. HOIST PUMP DISASSEMBLY (Rear Section)

- |                  |                       |                       |                    |
|------------------|-----------------------|-----------------------|--------------------|
| 1. O-ring        | 7. Stud               | 13. Bearings          | 19. Pressure Plate |
| 2. Bearing Plate | 8. O-ring             | 14. Steel Ring        | 20. Dowels         |
| 3. O-ring        | 9. Connector Plate    | 15. Backup Ring       | 21. Coupling       |
| 4. O-ring        | 10. Steel Ring        | 16. O-ring & retainer | 22. Snap Ring      |
| 5. Gear Plate    | 11. Idler Gear        | 17. Isolation plate   | 23. O-ring         |
| 6. Dowel         | 12. Drive Gear (Rear) | 18. Pressure Plate    |                    |

## Installation

1. Install hydraulic tank and secure with capscrews and lockwashers. Tighten to standard torque.
2. Uncap hydraulic lines and attach to the proper connections.
3. Replace breather filters if required.
4. Fill the hydraulic tank with clean, filtered C-4 hydraulic oil. Refer to "Filling Instructions".
5. Bleed all air from hydraulic lines.
6. Bleed trapped air inside steering pump. Refer to "Pump Pressure Setting", Section "L" for air bleeding procedure.

*NOTE: If trapped air is not bled from steering pump, possible pump damage and no output may result.*

## HYDRAULIC TANK STRAINERS

### Removal

### **⚠ WARNING**

**Prior to opening the hydraulic tank, allow at least 90 seconds for the accumulator to bleed down after engine shutdown with the key switch "Off".**

1. Shut down the engine and the key switch "Off" for at least 90 seconds.

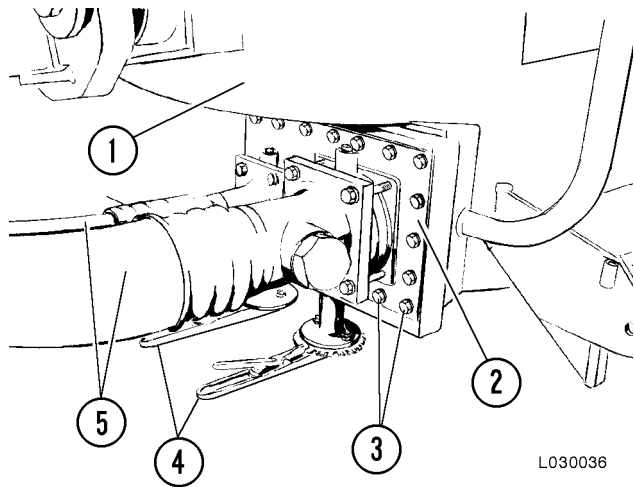


FIGURE 3-19. STRAINER REMOVAL

- |                            |                      |
|----------------------------|----------------------|
| 1. Hydraulic Tank          | 4. Shutoff Valve     |
| 2. Cover                   | 5. Pump Suction Hose |
| 3. Capscrews & Lockwashers |                      |

*NOTE: If the oil is to be reused, clean containers must be used with a filtering (3-micron) system available for refill.*

2. Be prepared to contain approximately 250 gal. (947 l) of hydraulic oil. Drain hydraulic oil from tank.
3. Disconnect pump suction hoses. (5, Figure 3-19).
4. Remove capscrews and lockwashers (3) securing cover (2) to the hydraulic tank. Remove and discard gasket.
5. Remove capscrews and lockwashers securing suction strainers. Remove suction strainers.

### Inspect and Clean

*NOTE: Inspect the strainers thoroughly for metallic particles and varnish build up (if oil has been overheated). The quantity and size of any particles may be an indication of excessive wear of components in the hydraulic system.*

1. Clean the strainers with fresh cleaning solvent from the inside out.
2. Inspect the strainers for cracks or wear. Replace, if necessary.
3. Clean any sediment from bottom of hydraulic tank.

### Installation

1. Install suction strainers and secure in place with capscrews and lockwashers. Tighten capscrews to standard torque.
2. Using new cover gasket move cover (2, Figure 3-19) into place and install capscrews and lockwashers (3). Tighten capscrews to standard torque.
3. Install pump suction hoses.
4. Fill the hydraulic tank; refer to Hydraulic Tank Filling Instructions. Open both suction line shut-off valves (4).
5. Loosen suction line connections at both pumps to bleed any trapped air. Tighten hose connections.
6. Bleed trapped air inside steering pump. Refer to "Steering and Brake Pump Installation", this Section, for air bleeding procedure.

*NOTE: If trapped air is not bled from steering pump, possible pump damage and no output may result.*

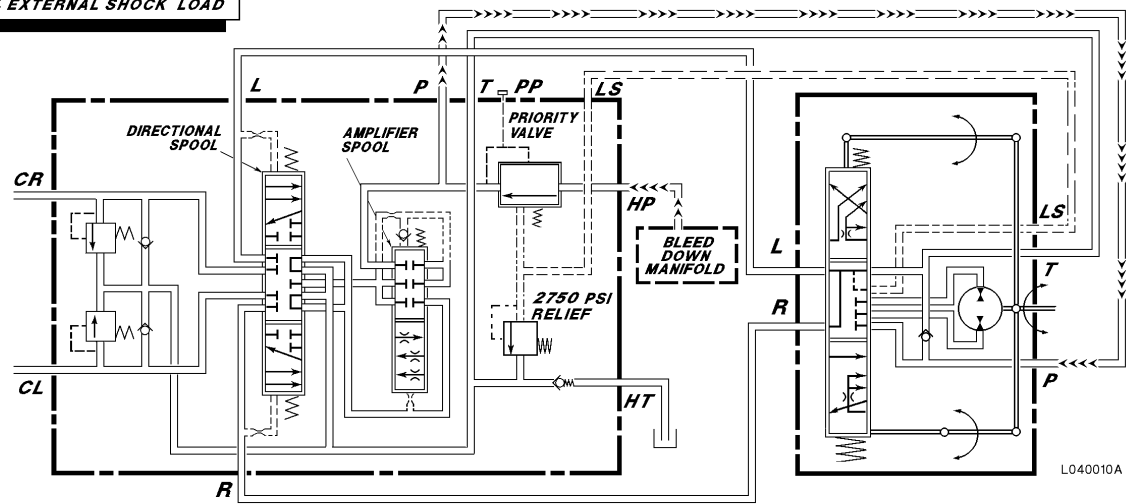
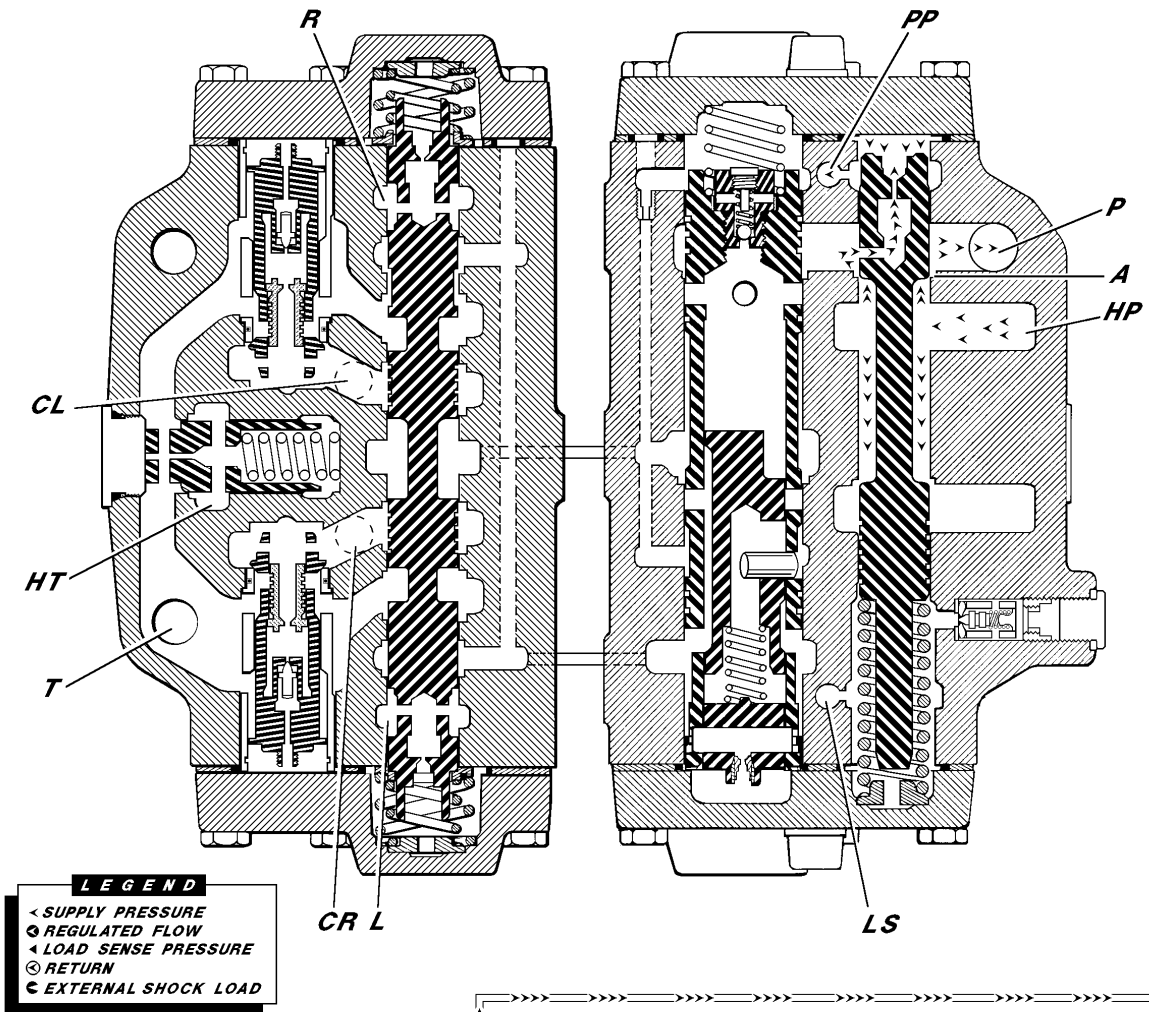


FIGURE 4-5. FLOW AMPLIFIER - NO STEER

## Steering Pump

Figure 4-13 shows the steering pump and the location of the pressure control adjustments. Figure 4-14 shows the schematic of the pump and the pressure control valves.

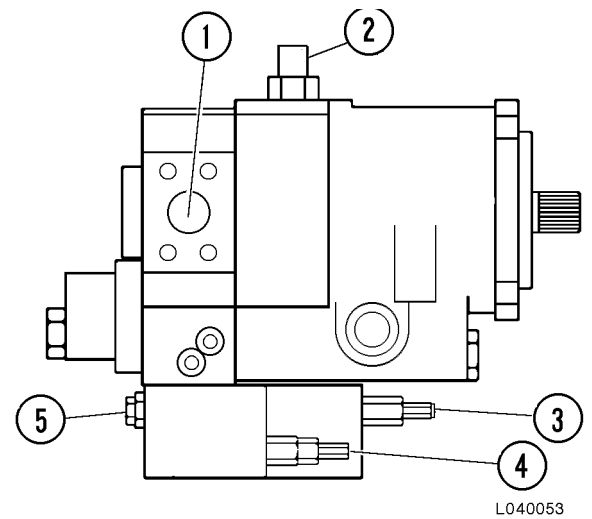


FIGURE 4-13. STEERING PUMP ASSEMBLY

- |                                       |                                    |
|---------------------------------------|------------------------------------|
| 1. Outlet Port                        | 4. Compensator Pressure Adjustment |
| 2. Case Drain                         | 5. 4-Way Valve Pressure Adjustment |
| 3. Unloader Valve Pressure Adjustment |                                    |

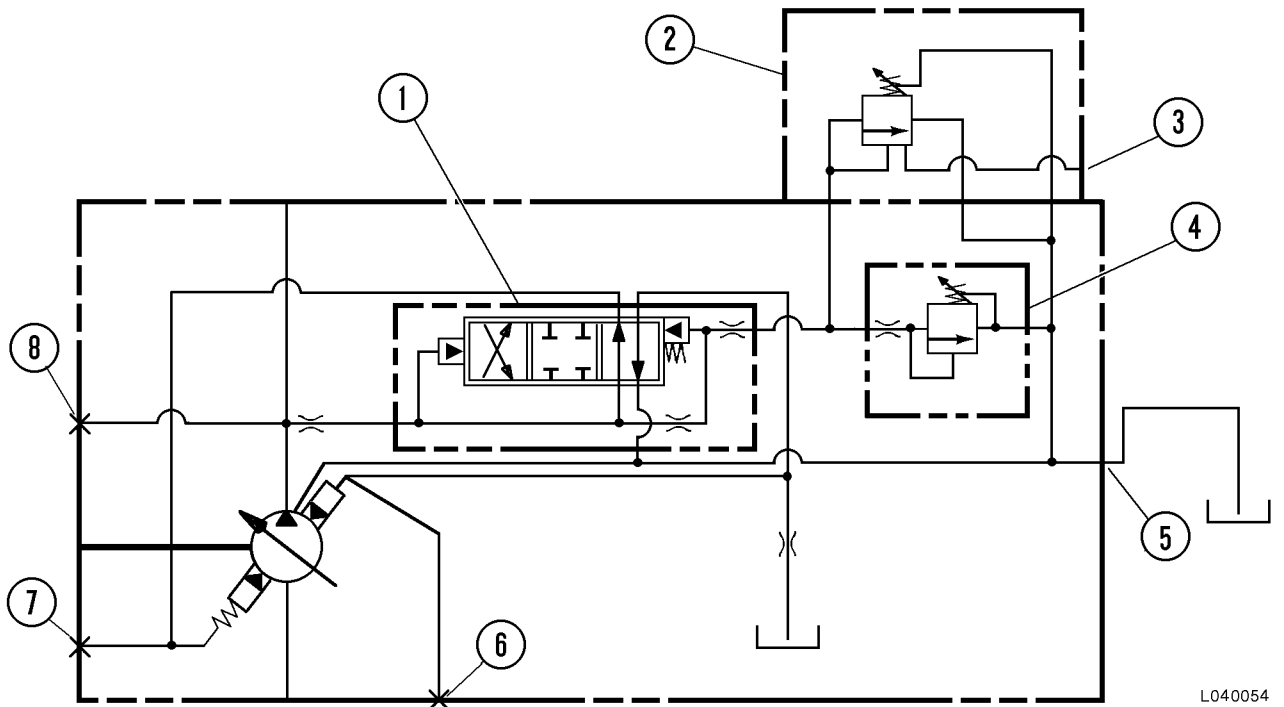


FIGURE 4-14. STEERING PUMP PRESSURE CONTROL SCHEMATIC

- |                           |                                       |
|---------------------------|---------------------------------------|
| 1. 4-Way Valve            | 4. Pressure Compensator Control Block |
| 2. Unloader Control Block | 5. Case Drain                         |
| 3. "ACC" Port             |                                       |

10. Install the check ball in the hole shown in Figure 5-12. Install threaded bushing and lightly tighten.

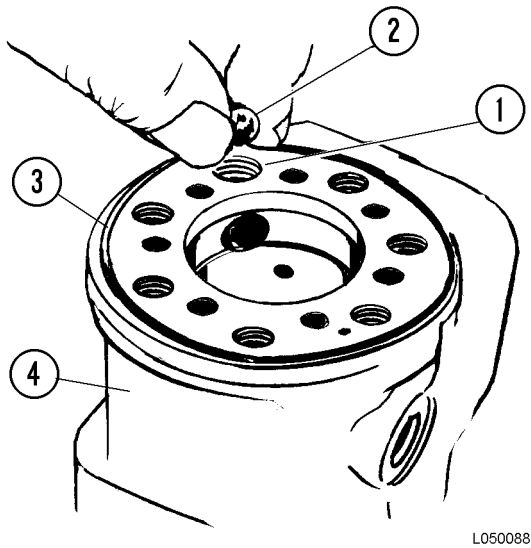


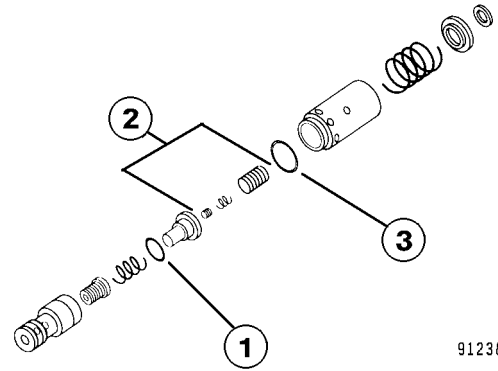
FIGURE 5-12. CHECK BALL INSTALLATION

- |                    |            |
|--------------------|------------|
| 1. Check Ball hole | 3. O-Ring  |
| 2. Check Ball      | 4. Housing |

11. Grease the housing O-ring (3) with Vaseline and install in the housing groove.
12. Install the distribution plate (15, Figure 5-7) with plate holes matching the corresponding holes in the housing.
13. Guide the cardan shaft (11) down into the bore with the slot in the cardan shaft aligned with the cross pin (9).
14. Position inner gear wheel onto cardan shaft. It may be necessary to rotate the gear slightly to find the matching splines on the cardan shaft. (Splines are machined to insure proper alignment of cardan shaft and inner gear wheel.)
15. Grease the O-rings (17 & 18) on both sides of the outer gear wheel with Vaseline and install.
16. Align outer gear wheel bolt holes with tapped holes in housing and match marks.
17. Align cover (19) using match marks as a reference and install using capscrews (23) and washers (20).
18. Install capscrew with pin (22) into proper hole.
19. Tighten cover capscrews in a criss-cross pattern to **2 ± 0.4 ft. lbs. (3 ± 0.5 N.m)** torque.

FIGURE 6-6. FLOW AMPLIFIER VALVE

1. Capscrew
2. Lockwasher
3. Capscrews
4. Lockwasher
5. Cover
6. O-ring
7. O-ring
8. O-ring
9. Seal Plate
10. O-ring
11. O-ring
12. Shock/Suction Valve (Complete)
13. Orifice Screw
14. Valve Housing
15. Counterpressure Valve (Complete)
16. O-ring
17. Plug
18. Plug
19. Seal
20. Stop
21. Spring
22. Spring
23. Spring Control
24. Orifice Screw
25. O-ring
26. Shock/Suction Valve (Complete)
27. Main Spool
28. O-ring
29. Spring Control
30. Spring
31. Spring
32. Spring Stop
33. Orifice Screw
34. Capscrews
35. Capscrew
36. Lockwasher
37. Lockwasher
38. O-rings
39. Cover
40. O-rings
41. Seal Plate
42. Stop
43. Spring
44. Spool
45. Orifice Screw
46. Name Plate
47. Check Valve
48. Orifice Screw
49. Spring
50. Pins
51. O-ring
52. Spring
53. Amplifier Spool Assembly (Complete)
54. Relief Valve Assembly
55. Seal



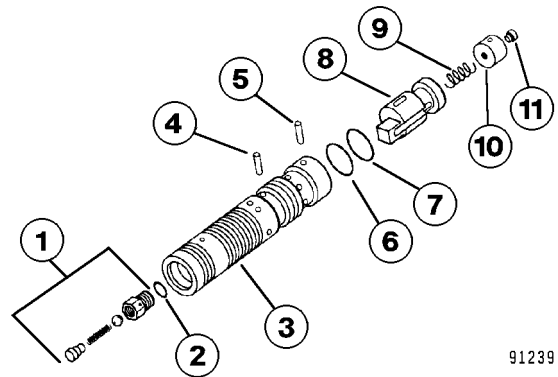
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FIGURE 6-7. SHOCK AND SUCTION VALVE ASSEMBLY

- |                  |           |
|------------------|-----------|
| 1. O-Ring        | 3. O-Ring |
| 2. Pilot Section |           |

*NOTE: Disassembly of the amplifier spool assembly is only necessary should O-ring (2, Figure 6-8), spring (9) or orifice screw (11) require replacement. Otherwise, replace the amplifier spool assembly as a complete unit. For complete disassembly refer to steps 12 & 13.*

56. Remove retaining ring (7, Figure 6-8), remove pin (5). Remove plug (10) and spring (9). Remove retaining ring (6) and pin (4) and remove inner spool (8).
57. Remove check valve (1). Remove O-ring (2). Remove orifice screw (11) from plug (10).
58. Clean and inspect all parts carefully. Make any replacements necessary.



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FIGURE 6-8. AMPLIFIER SPOOL ASSEMBLY

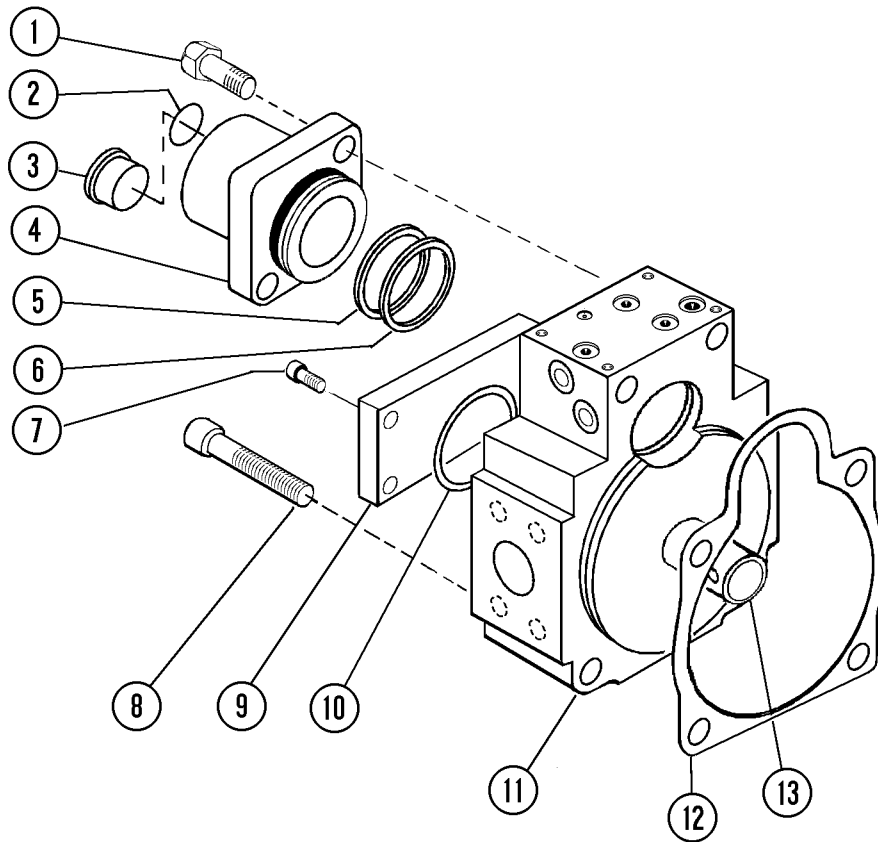
- |                   |                   |
|-------------------|-------------------|
| 1. Check Valve    | 7. Retaining Ring |
| 2. O-Ring         | 8. Inner Spool    |
| 3. Spool          | 9. Spring         |
| 4. Pin            | 10. Plug          |
| 5. Pin            | 11. Orifice Screw |
| 6. Retaining Ring |                   |

10. Check end play as follows:

a. Place square end of piston on bench and hold down firmly. Pull on end of shoe with other hand and note end play. A good piston/shoe fit will have no end play, but the shoe may rotate and pivot on the piston ball. Inspect each shoe face for nicks or scratches.

b. Measure shoe thickness (the part held between retainer (27, Figure 6-13) and cradle. All shoes must be equal within 0.0001 in. (0.003 mm). If one or more piston/shoe assemblies (13) needs to be replaced, all piston/shoes assemblies must be replaced.

c. Inspect cylinder bearing (26) and matching cylinder barrel bearing mating surface for galling, pitting or roughness. Replace if necessary.



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FIGURE 6-14. PUMP, REAR HOUSING

- |                 |                |                 |
|-----------------|----------------|-----------------|
| 1. Capscrew     | 6. O-Ring      | 11. Valve Plate |
| 2. O-Ring       | 7. Capscrew    | 12. Gasket      |
| 3. Plug         | 8. Capscrew    | 13. Bearing     |
| 4. Cap          | 9. Cover Plate |                 |
| 5. Back-Up Ring | 10. O-Ring     |                 |

**SECTION L7**  
**HOIST CIRCUIT DESCRIPTION**  
**INDEX**

HOIST CIRCUIT .....L7-3

    HOIST CIRCUIT OPERATION .....L7-3

    COMPONENT DESCRIPTION .....L7-4

        HYDRAULIC TANK .....L7-4

        HYDRAULIC PUMP .....L7-4

        HIGH PRESSURE FILTERS .....L7-4

        HOIST VALVE .....L7-4

        Inlet Sections .....L7-4

        Spool Sections .....L7-5

        Work Ports (Rear) Spool Section .....L7-5

        Tank Ports (Front) Spool Section .....L7-5

        HOIST PILOT VALVE .....L7-5

        HOIST-UP LIMIT SOLENOID .....L7-6

        PILOT OPERATED CHECK VALVE .....L7-6

    HOIST VALVE OPERATION .....L7-6

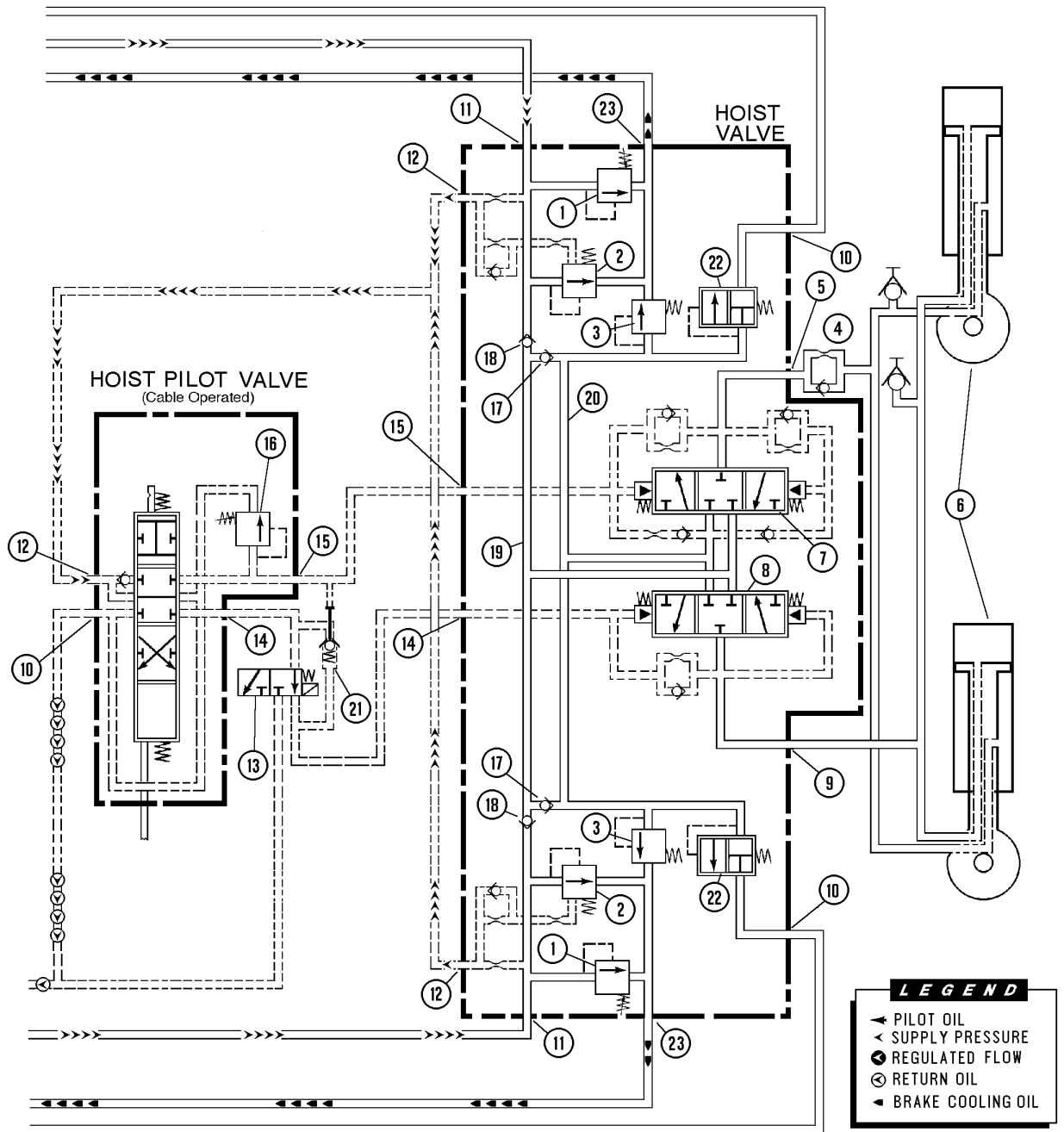
        FLOAT POSITION OF PILOT VALVE WITH TRUCK BODY ON FRAME .....L7-6

        POWER UP OPERATION (Figure 7-5) .....L7-8

        HOLD OPERATION (Figure 7-6) .....L7-10

        POWER DOWN OPERATION (Figure 7-7) .....L7-12

    FLOAT OPERATION (Figure 7-8) .....L7-14



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FIGURE 7-6. HOLD POSITION

- |                                  |                                        |                                |
|----------------------------------|----------------------------------------|--------------------------------|
| 1. Hoist Relief Valve (2500 psi) | 9. Head End Work Port                  | 17. Anti-void Check Valve      |
| 2. Flow Control Valve            | 10. Tank Return Port                   | 18. Load Check Valve           |
| 3. Secondary Low Pressure Valve  | 11. Supply Port                        | 19. High Pressure Passage      |
| 4. Snubber Valve                 | 12. Pilot Supply Port                  | 20. Low Pressure Passage       |
| 5. Rod End Work Port             | 13. Hoist Limit Solenoid               | 21. Pilot Operated Check Valve |
| 6. Hoist Cylinders               | 14. Raise Pilot Port                   | 22. Primary Low Pressure Valve |
| 7. Rod End Spool                 | 15. Down Pilot Port                    | 23. Brake Cooling Circuit Port |
| 8. Head End Spool                | 16. Power Down Relief Valve (1500 psi) |                                |

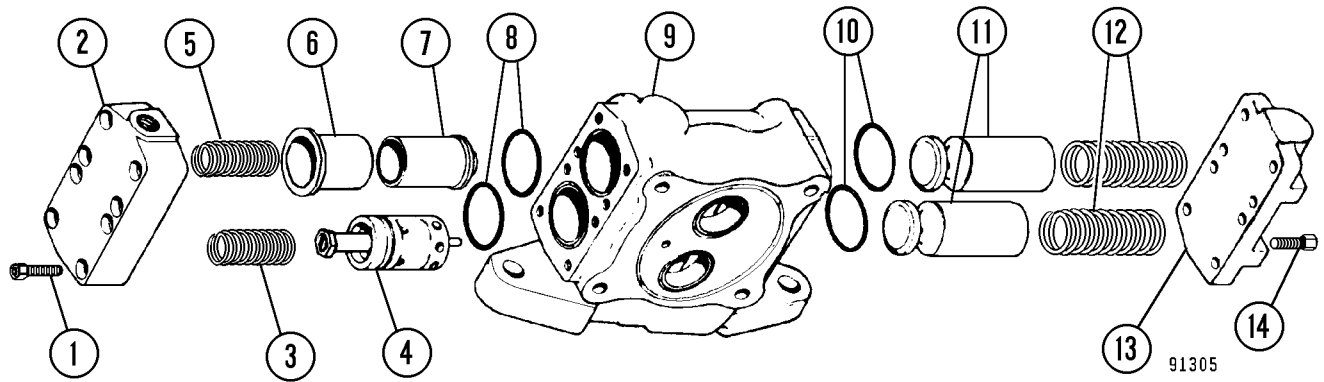


FIGURE 8-5. INLET SECTION DISASSEMBLY

- |                      |                        |                     |               |
|----------------------|------------------------|---------------------|---------------|
| 1. Capscrew          | 5. Spring              | 9. Inlet Valve Body | 13. Cover     |
| 2. Inlet Cover       | 6. Sleeve              | 10. O-Rings         | 14. Capscrews |
| 3. Spring (Orange)   | 7. Low Pressure Relief | 11. Poppets         |               |
| 4. Main Relief Valve | 8. O-Rings             | 12. Springs         |               |

## INLET SECTION

### Disassembly

- Match mark or identify each part when removed in respect to its location or respect to its mating bore to aid reassembly.
- Disconnect the external tube (7, Figure 8-2) at the cover end and remove. Remove capscrews (14, Figure 8-5), remove cover (13). Remove springs (12), poppets (11) and O-rings (10).

*NOTE: Inlet section shown removed from main valve body for clarity.*

- Remove capscrews (1) and cover (2). Remove springs (3 & 5) and main relief valve (4). Remove sleeve (6), low pressure relief (7) and O-rings (8). The main relief valve (4) is factory preset at 2500 psi (17.2 MPa). Replace as a complete assembly only.

*NOTE: If restrictor poppet removal in cover (2, Figure 8-5) is required, refer to step 4 and figure 8-6.*

- Remove sleeve (9), backup ring (8), O-ring (7), backup ring (6). Remove backup ring (5), O-ring (4), backup ring (3) and restrictor poppet (2).
- Repeat steps 1 through 4 for the opposite inlet section if disassembly is required.

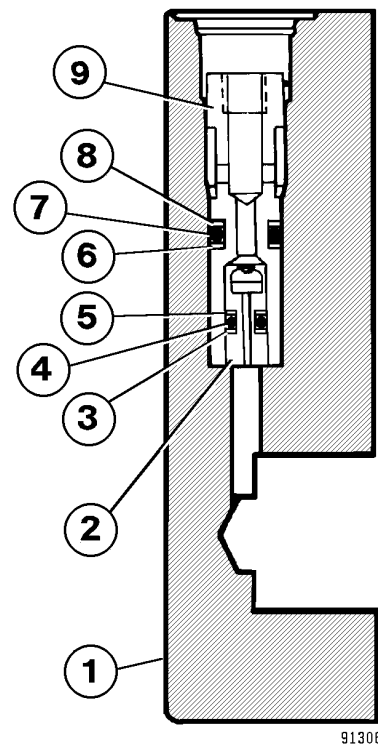


FIGURE 8-6. RESTRICTOR POPPET REMOVAL (Inlet Cover)

- |                      |                |
|----------------------|----------------|
| 1. Inlet Cover       | 6. Backup Ring |
| 2. Restrictor Poppet | 7. O-ring      |
| 3. Backup Ring       | 8. Backup Ring |
| 4. O-Ring            | 9. Sleeve      |
| 5. Backup Ring       |                |

## Installation

### **⚠ WARNING**

**Install a retaining strap or chain to prevent the cylinder from extending during handling. The hoist cylinder weighs approximately 2500 lbs. (1135 kg). Use a suitable lifting device that can handle the load safely.**

1. Raise the cylinder into position over the pivot point on the frame. The cylinder should be positioned with the air bleed vent plug toward the front of the truck. Install spacer (6, Figure 8-19). Align bearing eye with pivot point and push cylinder into place.
2. Install retaining plate (3), locking plate (2), and capscrews. Tighten capscrews to **220 ft. lbs. (298 N.m)** torque. Bend locking plate tabs over capscrew flats.
3. Align the top hoist cylinder bearing eye with the bore of the upper mounting bracket. Refer to Figure 8-18.
4. Align retaining capscrew hole in pin with hole in mounting bracket and install pin. Install capscrew (5) and self-locking nut (4) and tighten to standard torque.
5. Install new O-rings in grooves on hose flange connections and lubricate with clean hydraulic oil. Position flanges over hoist cylinder ports and install flange clamps. Secure clamps with capscrews and lockwashers. Tighten capscrews to standard torque.
6. Reconnect lubrication lines for the upper and lower hoist cylinder bearings.

7. Start engine, raise and lower body several times to bleed air from cylinder. Check for proper operation and inspect for leaks.
8. Service hydraulic tank if necessary.

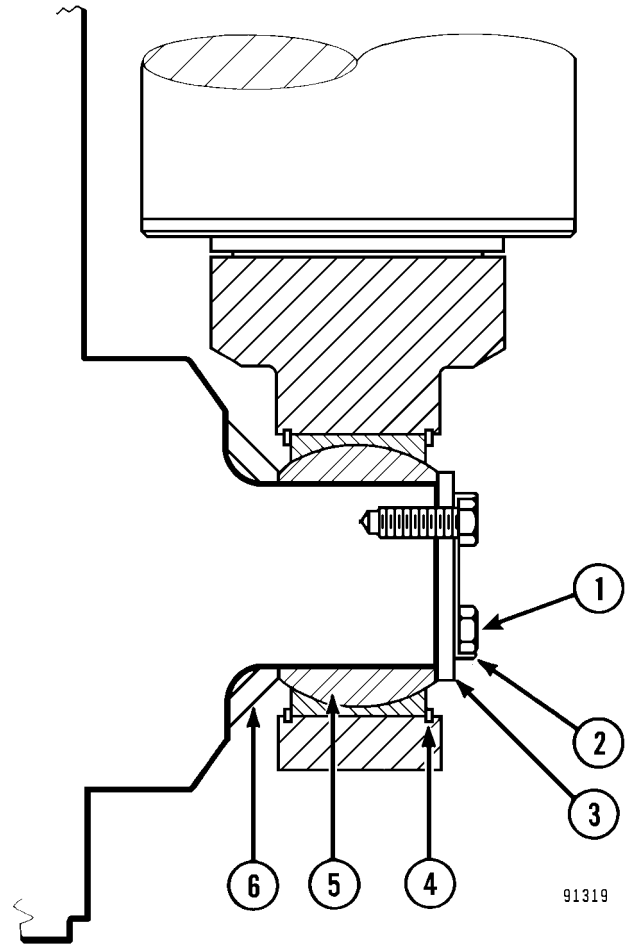


FIGURE 8-19. HOIST CYLINDER LOWER MOUNT

- |               |                  |
|---------------|------------------|
| 1. Capscrew   | 4. Retainer Ring |
| 2. Lock Plate | 5. Bearing       |
| 3. Retainer   | 6. Spacer        |

# HIGH PRESSURE FILTERS

## HOIST CIRCUIT FILTERS

The hoist circuit filters (Figure 9-1) are located on the fuel tank below the right frame rail. The filters provide secondary filtering protection for hydraulic oil flowing to the hoist valve and hoist circuit components.

An indicator switch (8) is designed to alert the operator of filter restriction before actual bypass occurs. The switch contacts close at 40 psi (275 kPa) to actuate the hydraulic oil filter monitor warning lamp on the overhead display panel. Actual filter bypass occurs at 50 psi (345 kPa).

*NOTE: When the engine is initially started and the hydraulic oil is cold, the warning lamp may actuate. Allow the hydraulic system oil to reach operating temperature before using the warning lamp as an indicator to change the element.*

Refer to Section P, *Lubrication and Service* for recommended normal filter element replacement interval. Earlier replacement may be required if the restriction indicator lamp turns on.

Premature filter restriction may indicate a system component failure and signal a service requirement before extensive secondary damage can occur.

*NOTE: An early indication of the filter warning light at first installation may be due to restriction in the filter as it cleans the system. Unless the fluid appears contaminated or has a strong foul odor, do not change the oil; replace only the filter element.*



**Relieve pressure before disconnecting hydraulic and other lines. Tighten all connections before applying pressure.**

**Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury and possibly death if proper medical treatment by a physician familiar with this injury is not received immediately.**

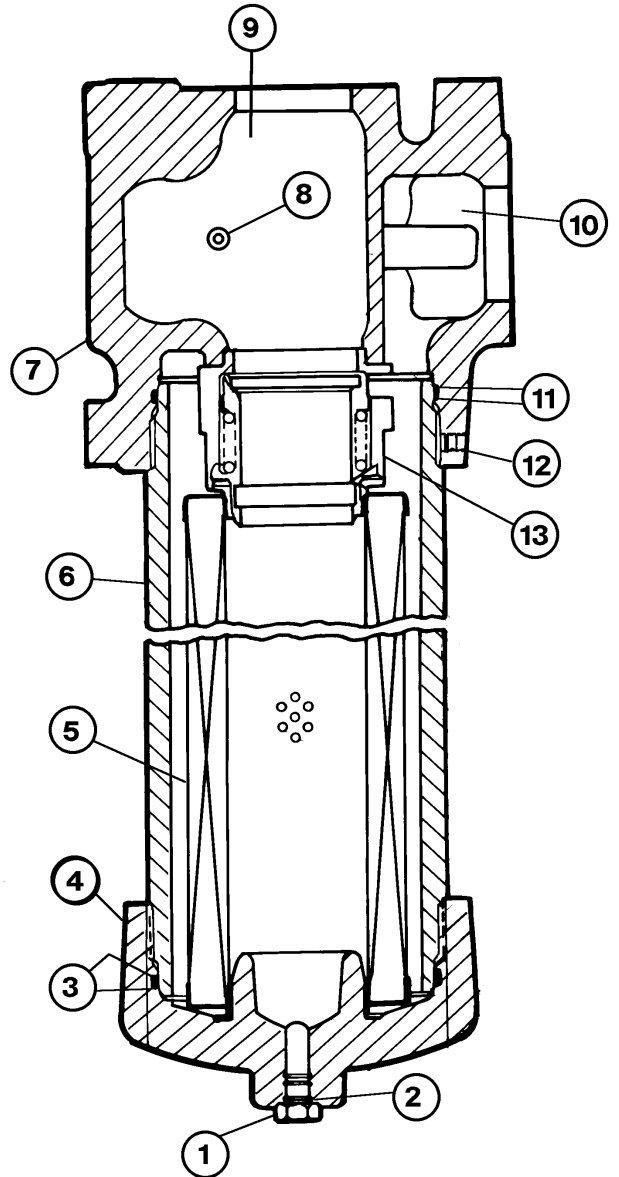


FIGURE 9-1. FILTER ASSEMBLY

- |                         |                          |
|-------------------------|--------------------------|
| 1. Plug                 | 8. Indicator Switch      |
| 2. O-ring               | 9. Outlet                |
| 3. O-ring & Backup Ring | 10. Inlet                |
| 4. Cap                  | 11. O-ring & Backup Ring |
| 5. Filter Element       | 12. Set Screw            |
| 6. Tube                 | 13. By-pass Valve        |
| 7. Housing              |                          |

# HYDRAULIC CHECK-OUT PROCEDURE

## GENERAL INFORMATION

The hydraulic check-out procedure is intended to help the technician check, adjust, and diagnose problems in the steering and hoist circuits. The technician should read the entire check-out procedure prior to performing any steps to become familiar with the procedures and all the warnings and cautions. The check-out procedure begins by checking the basic system before checking individual components.

Included on the last page is a data sheet to record the information observed during the hydraulic system check-out procedure. The data sheet is designed to be removed, copied, and used during the check-out procedure.

\*Steps indicated in this manner should be recorded on the data sheet for reference.

### **WARNING**

*Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury, and possibly death, if proper medical treatment by a physician familiar with this type of injury is not received immediately.*

*Before disconnecting pressure lines, replacing components in the hydraulic circuits, or installing test gauges, ALWAYS bleed down hydraulic steering accumulator.*

*The steering accumulators can be bled down by shutting down the engine, turning key switch "Off", and waiting 90 seconds. Confirm the steering pressure is released by turning the steering wheel; no front wheel movement should occur.*

*Bleed down brake system accumulators prior to removing any hoses supplying oil to the brake system.*

### **IMPORTANT**

*The AC drive system Rest Switch, located on the instrument panel, must be in the ON position and the GF Cutout Switch in the CUTOUT position during test procedures. (See Figure 3-1, page E3-2, Propulsion System, for GF switch location.)*

## STEERING CIRCUIT CHECK-OUT & ADJUSTMENT PROCEDURE

The steering circuit hydraulic pressure is supplied from the piston pump and steering accumulators. Some steering system problems, such as spongy or slow steering or abnormal operation of the "Low Steering Pressure" warning light can sometimes be traced to internal leakage of steering components. If internal leakage is suspected, refer to "Steering Circuit Component Leakage Test".

*NOTE: Excessive internal leakage within the brake circuit may contribute to problems within the steering circuit. Be certain that brake circuit leakage is not excessive before troubleshooting steering circuit. For Brake Circuit Test Procedure, refer to Section "J", Brake System.*

The steering circuit can be isolated from the brake circuit by releasing pressure from the brake accumulators and removing the brake system supply line (13, Figure 10-2) from the brake circuit high pressure filter located near the bleeddown manifold (see WARNING). Plug the brake supply hose and cap the fitting at the filter inlet to prevent high pressure leakage.

Prior to checking the steering system, the hydraulic steering and brake systems must have the correct accumulator precharge and be up to normal operating temperatures. Refer to "Steering Circuit Component Repair, Steering Accumulator Charging Procedure" in this section of the manual for accumulator charging instructions.

### **IMPORTANT**

*If the steering and brake pump has just been installed, it is essential that the steering pump case is full of oil prior to starting the engine. Refer to "Steering Circuit Component Repair, Steering and Brake Pump", this section for instructions.*

10. Increase engine speed to full throttle and perform the following:
  - a. Hoist up to full extension, then allow cylinders to float down.
  - b. Return hoist control to "Neutral".
11. Shut down engine and turn key switch OFF.
12. Allow at least 90 seconds for the accumulators to bleed down. Turn the steering wheel to be certain all pressure has been released.

### **Filter Element Replacement**

1. Reconnect hoist limit solenoid in hydraulic components cabinet.
2. Close both hoist pump suction line shut-off valves. Close the steering pump suction line shut-off valve.
3. Remove hoist, steering, and brake circuit hydraulic filters, clean housings and install new filter elements
4. Check hydraulic tank oil level and refill if necessary.
5. Open all (three) suction line shut-off valves.
6. Bleed air from pump suction lines and steering pump housing. (Refer to "*Steering and Brake Pump*", Section L for procedure.)

# CHECKFIRE ELECTRIC DETECTION AND ACTUATION SYSTEM - SERIES 1

The Checkfire Electric Detection and Actuation System - Series 1 (Figure 2-5) uses linear detection wire. This is a two conductor heat rated thermo cable. When the detection cable is subjected to 221°F (105°C) the insulating coating of the cable melts allowing the conductors to short together closing the electric circuit to the squib which detonates to depress the puncture pin and actuate the expellant cartridge.

Components of the checkfire electric detection and actuation system are shown in Figure 2-5.

## Control Module

(Figure 2-4):

Provides the electrical connections necessary between the power lead and the linear detection wire to the power lead supplying electrical power, via the squib, to the actuator. Also provides a visual check of power availability - pressing the switch button will illuminate the green indicator light if electrical power is available in the system.

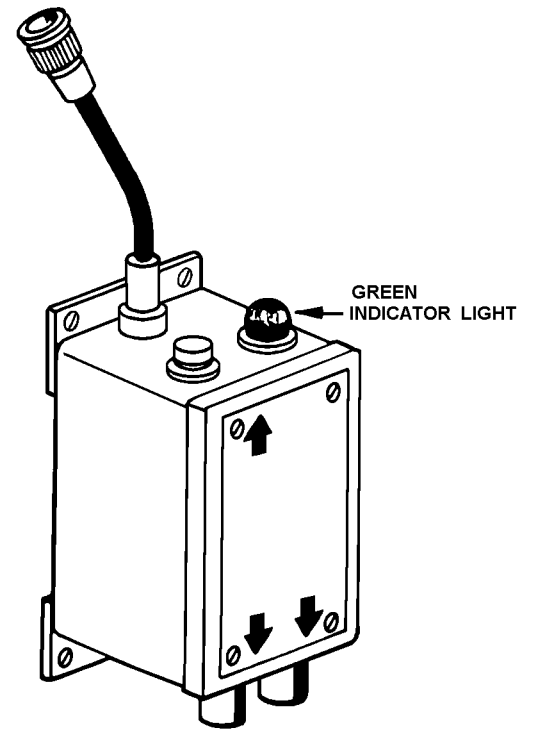


FIGURE 2-4. CONTROL MODULE

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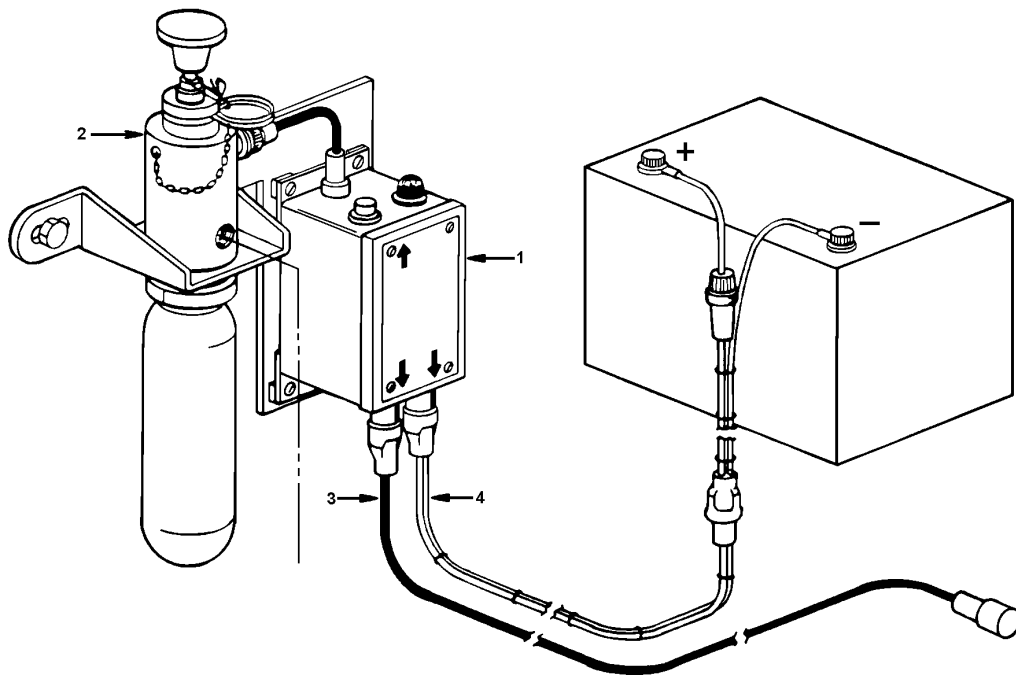


FIGURE 2-5. CHECKFIRE ELECTRIC DETECTION/ACTUATION SYSTEM

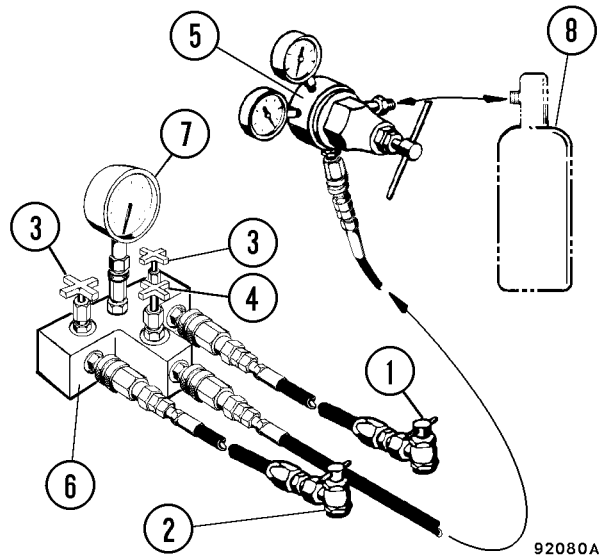
- |                              |                          |                         |
|------------------------------|--------------------------|-------------------------|
| 1. Control Module            | 3. Linear Detection Wire | 5. Test Kit (Not Shown) |
| 2. Manual/Automatic Actuator | 4. Power Wire            |                         |

M020002

## SPECIAL TOOLS

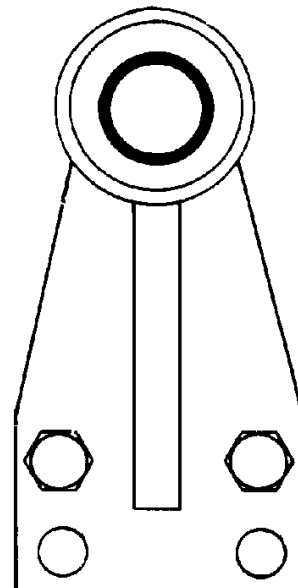
Part Number	Description	Use
EB1759	Nitrogen Charging Kit	Suspension & Accumulator Nitrogen Charging

1. "T" Handle Valve
2. Charging Valve Adapter
3. Manifold Outlet Valves (from gauge)
4. Inlet Valve (from regulator)
5. Regulator Valve (Nitrogen Pressure)
6. Manifold
7. Charging Pressure Gauge (Suspensions)
8. Dry Nitrogen Gas



*NOTE: Arrangement of parts may vary from illustration shown, depending on Charging Kit P/N.*

Part Number	Description	Use
EF4875 (No longer available as complete unit)	Roller Assy.	Power Module Remove & Install
EF4873	Roller Mount	
PB7624	Bearing	
SP5874	Bearing Retainer Ring	
ED2364	Roller Retainer Ring	
C1645	Capscrew 0.75 -10 NC x 2 1/4 in.	
C1542	Lockwasher 0.75 in.	
ED2363	Roller Ring	



# PAYLOAD METER II ON BOARD WEIGHING SYSTEM (OBWS)

## GENERAL INFORMATION

The Payload Meter II™ (PLM II™) On Board Weighing System displays and records the payload weight along with other operating information. The system consists of a payload meter, pressure sensors, deck mounted lights and an inclinometer.

The payload meter (Figure 20-1) uses the four suspension pressures and an inclinometer to determine the load in the truck. The payload weight can be displayed in short tons or metric tons.

## Haul Cycles

The beginning of a new haul cycle starts at the dump, when the body comes down from dumping the last load.

At the loading site, the PLM II™ begins to calculate the size of each shovel pass (swingload) once the payload is greater than 10% of rated load for the truck. There are three external deck-mounted lights on each side of the truck. The lights indicate payload weight divided into three separate stages. A forecast feature will flash a deck mounted light predicting the payload weight if the next bucket of material is dropped into the body.

At the moment the wheels begin to turn after loading under the shovel, the PLM II™ takes one sample of

suspension and inclinometer data. After traveling 160 m (0.10 mi.) from the loading site, the PLM II™ uses the data sampled under the shovel to calculate final payload.

The PLM II™ displays payload on its display when the truck is stopped. For the first 160 m (0.10 mi.) after loading, the payload meter displays distance from the loading site. At all other times when the truck is moving, the display shows the time of day.

The payload meter stores in memory various operating data. This data includes:

- payload, time, distance, and travel speed for each cycle
- date and time that the engine was started and stopped
- date and time of each fault that occurred or was canceled
- total payload and the overall number of cycles for a specific time period

This data is retained even when the power is switched off. The stored data is backed up by an internal battery.

The data can be down loaded from the payload meter to a personal computer when a communication cable is connected to the port inside the cab.

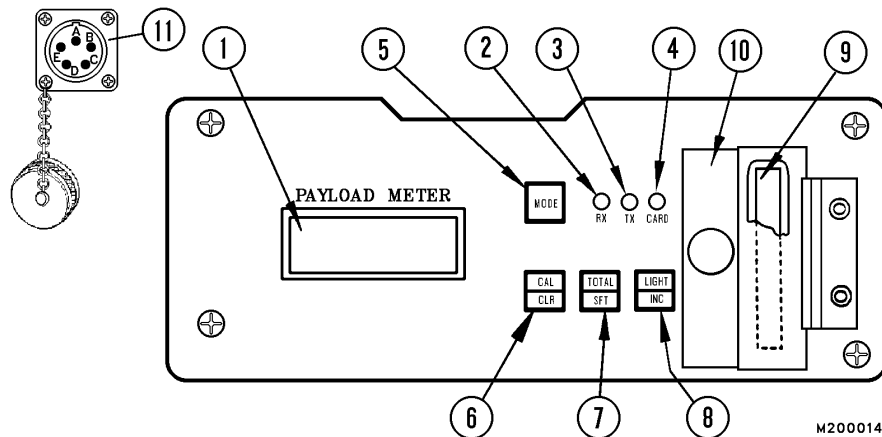


FIGURE 20-1. PAYLOAD METER II

1. Display panel
2. Reception pilot lamp (Rx busy)
3. Transmission pilot lamp (Tx busy)
4. Memory card access lamp (CARD busy)
5. Mode switch [MODE]
6. Calibration/clear switch [CAL] [CLR]
7. Total/shift switch [TOTAL] [SFT]
8. Light/increment switch [LIGHT] [INC]
9. Memory card
10. Cover
11. Diagnostic/Download Port

**WARNING - When not inserting or removing memory card (9), always keep the cover (10) closed**

## OPERATOR FUNCTIONS

### Using the Operator Load Counter

The payload meter makes available to the operator a total load counter and haul cycle counter. This allows each operator to track the tons hauled during their shift. The total is displayed in hundreds of tons. For example, if 223 is displayed, this means that 22,300 tons have been hauled since the last time the cycle counter was cleared.

This memory location is separate from the main payload data storage. This memory is not cleared when the Data All Clear Operation is performed. Clearing this memory does not affect the main payload data storage.

### Viewing the Operator Load Counter

1. Press the TOTAL/SFT switch once.

If there is a fault code present at this time:

2. The error code for that problem will be displayed. This will be a flashing display.
3. Press the TOTAL/SFT switch again. If additional faults or warnings exist, that fault code will be displayed as a flashing code.
4. Repeat step #3 until no fault codes are displayed. ":" will show when no additional faults exist. The display will then show total tons hauled since the last time the counter was cleared. The total is displayed in hundreds of tons.
5. Press the TOTAL/SFT switch again. The number displayed is the number of haul cycles since the last time the cycle counter was cleared.
6. Press the TOTAL/SFT switch again. ":" is displayed for 2 seconds before the display returns to normal operations.

### Clearing the Operator Load Counter

1. Press the TOTAL/SFT switch once. The number displayed is the total tons hauled since the last time the counter was cleared. The total is displayed in hundreds of tons.
2. Press and hold the CAL/CLR switch until the display flashes.
3. Press the CAL/CLR switch until "0000" is displayed. After 2 seconds the meter will return to normal operation.

Clearing this memory **does not** affect the main payload data storage.

### Dimming the Lights on the Display

There are a total of 10 brightness levels on the PLM II™ display.

From the normal operation display:

1. Press the LIGHT/INC switch. The lighting will become one level dimmer. This will continue until the lighting has reached its lowest level.
2. After reaching the lowest level, the display will return to the brightest setting.

If the switch is held in the depressed position, the brightness will change continuously.

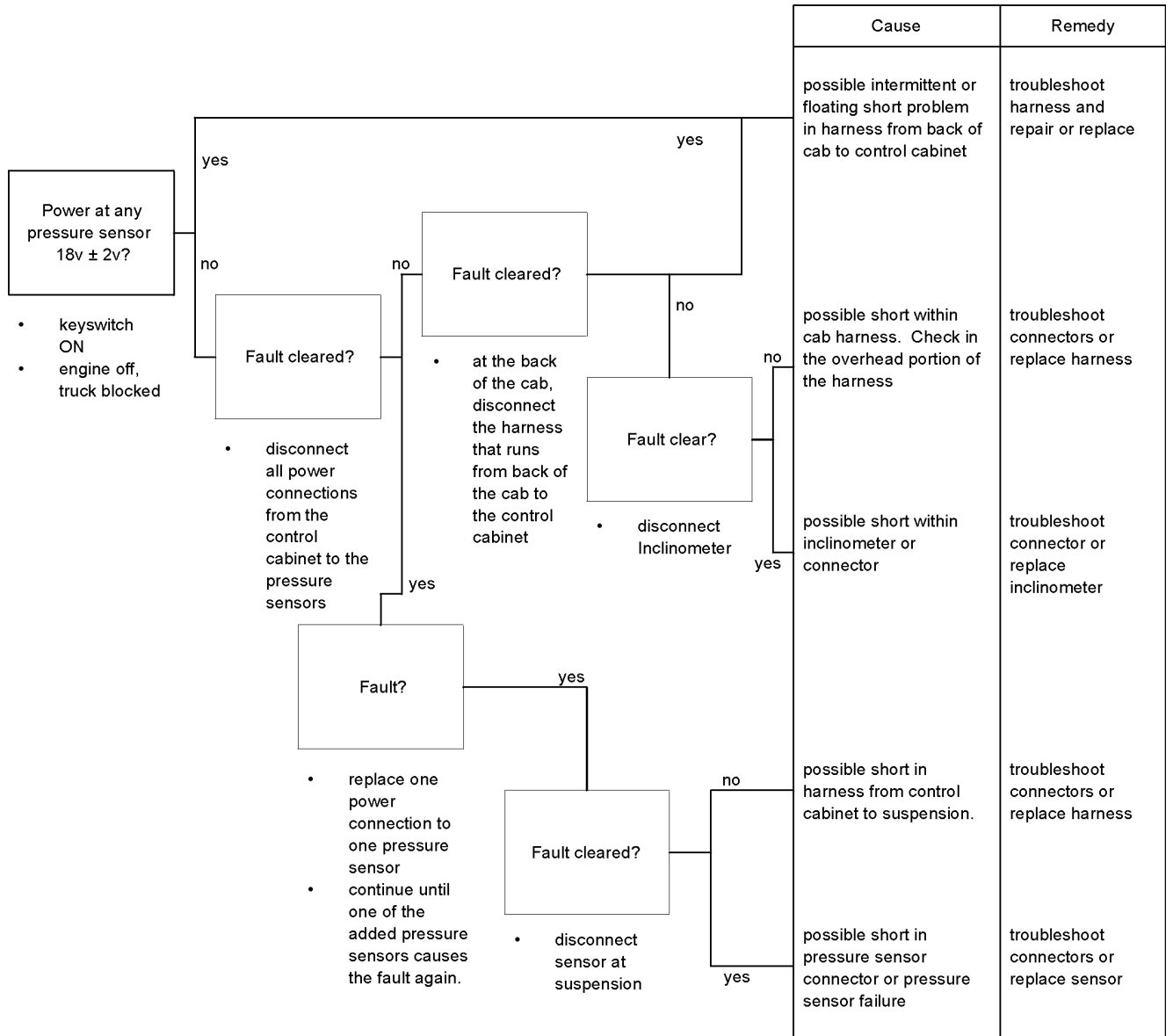
FAULT CODES			
FAULT	CAUSE	CORRECTIVE ACTION	DECK LIGHTS
F-25 Flashing	Left front pressure signal is greater than 5V (1 - 5V normal).	Trouble shoot wiring, likely sensor wires are shorted together.	Flash
F-26 Flashing	Right front pressure signal is greater than 5V (1 - 5V normal).		Flash
F-27 Flashing	Left rear pressure signal is greater than 5V (1 - 5V normal).		Flash
F-28 Flashing	Right rear pressure signal is greater than 5V (1 - 5V normal).		Flash
F-31 Flashing	Inclinometer input less than 1.57V (more than + 10 degrees, nose up).	Trouble shoot wiring, likely an open circuit (Inclinometer output is 2.6V when horizontal, calibration: -103mV/degree)	Flash
F-32 Flashing	Inclinometer input greater than 3.63V (more than - 10 degrees, nose down).	Trouble shoot wiring, likely sensor wires are shorted together.	Flash
FCAL	No calibration has been performed or cal data has been cleared.	Perform calibration.	Flash
F-41 Flashing	Light relay #1 driver short circuit.	Trouble shoot wiring, relay coil likely shorted.	
F-42 Flashing	Light relay #2 driver short circuit.		
F-43 Flashing	Light relay #3 driver short circuit.		
F-44 Flashing	Light relay #4 driver short circuit.		
F-45 Flashing	Light relay #5 driver short circuit.		
L.bad Flashing	Payload measured while chassis is pitching.	Data ignored, error will clear for next load.	
SP:SP Flashing	Speed limit setting is being exceeded.	Set the speed limit, using Operator Check Mode, to 62 mph or 99Km/h depending on the position of the unit selection switch (switch #7 behind the left side panel).	
F-71 F-73 F-80 F-81 F-91 F-92 F-93 F-94 F-95 F-96 F-97 F-98 All Flashing	Communications port error.	Check communication wiring (RS-232) to Modular Mining Hub or to Scoreboard. Check OP setting.	

M200052

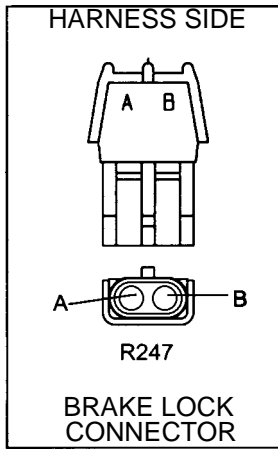
## PAYLOAD CIRCUIT NUMBERS

Circuit Designation	Circuit Description
39F, 39F1...39F5	+18 volt sensor power supply
39FA	Pressure signal Right Rear
39FB	Pressure signal Left Rear
39FC	Pressure signal Right Front
39FD	Pressure signal Left Front
39FE	Inclinometer signal
39FG	Sensor ground
39A	PLM lamp output - green
39B	PLM lamp output - amber
39C	PLM lamp output - red
39D	PLM lamp output - unused
39E	PLM lamp output - unused
39G	+24 volt PLM power
39AA	Load light - green
39BA	Load light - amber
39CA	Load light - red
73FSL	TCI 100% load signal - 930E only
73MSL	TCI 70% load signal - 930E only
714A	Speed signal
714AT	Speed signal
63L	Body up (gnd = up, open = down)
39H	Brake lock (gnd = release, open = lock)
35L1	PLM RS232 RTS (request to send)
35L2	PLM RS232 signal ground
35L3	PLM RS232 receive
35L4	PLM RS232 transmit
35L5	PLM RS232 CTS (clear to send)
35L6	
35L7/35L4	Scoreboard 1 to scoreboard 2
35L8	PLM chan 2 TxD
35L9	PLM chan 2 RxD
21C	Engine oil pressure (gnd = off, open = run)
21D	Alternator R-Terminal (open = off, +24V = run)

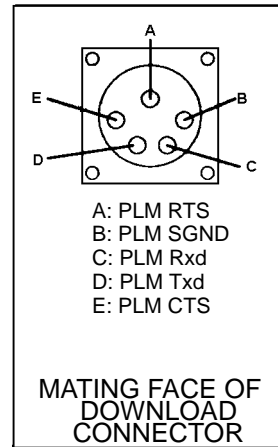
# Sensor Power Fault Fault Tree



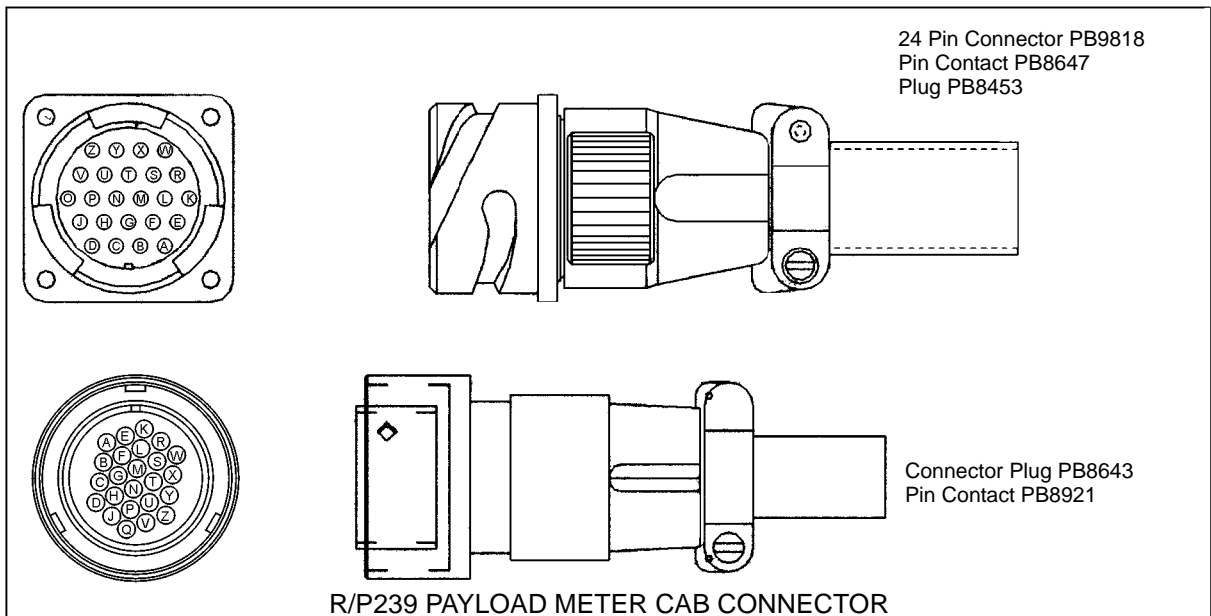
M200061



M200070

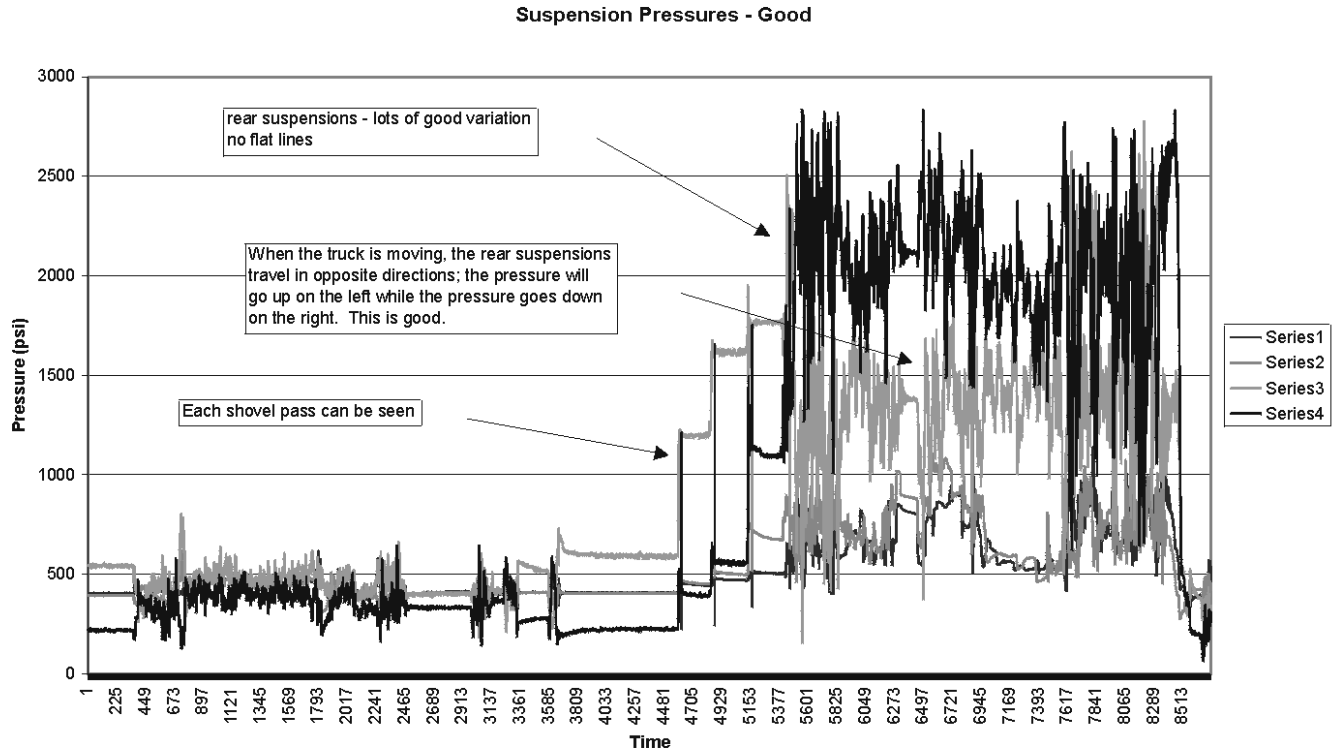


M200071



M200072

15. A good suspension will show lots of motion as the truck drives around and the suspensions bounce around. When the truck is loaded and running, the rear suspensions tend to move in opposite directions. When the left pressure goes up, the right pressure will go down. This is due to the rocking motion of the rear axle as the truck travels. Notice that there is plenty of 'noisy' motion shown in the loaded pressures. This suspension is in good shape.



As shown in the previous examples, Scope can be used to create log files of the suspension pressure data. Graphs of this data can give be used to determine the relative health of the suspensions.

### Pressure Sensor Dummy Loads

A series of dummy loads is now available that simulate a pressure sensor input to the payload Meter. These can be placed on the harness in place of a pressure sensor. This can be used to troubleshoot harness and connector problems between the payload meter and suspension pressure sensors. The payload meter will read each load within the pressure range indicated.

Part Number	Description
EJ5366	970-1150 psi load
EJ5367	710-870 psi load
EJ5368	490-625 psi load
EJ5369	290-410 psi load

## Door Adjustment

If adjustment is necessary to insure tight closure of door, loosen striker bolt in the door jamb, adjust, and retighten.

A rubber sealer strip is mounted with adhesive around the perimeter of the door assembly to exclude dirt and drafts. This sealer strip should be kept in good condition and replaced if it becomes torn or otherwise damaged.

## Door Jamb Bolt Adjustment

Over a period of time, the door latch mechanism and door seals may wear and allow dirt and moisture to enter the cab. To insure proper sealing of the door seals, the door jamb bolt may need to be adjusted periodically.

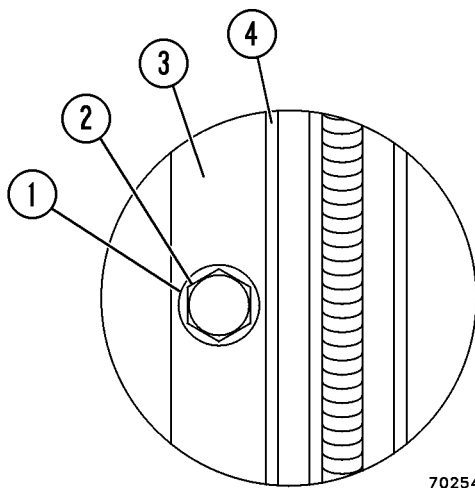


FIGURE 2-3. DOOR JAMB BOLT ADJUSTMENT

- |                 |          |
|-----------------|----------|
| 1. Washer       | 3. Frame |
| 2. Striker Bolt | 4. Seal  |

*Step A.* If the door closes, but not tightly enough to give a good seal between the seal on the door and the cab skin:

1. Mark the washer location (1, Figure 2-3) portion of the door jamb bolt with a marker, pen, or pencil by circumscribing the outside edge of the washer onto the jamb.
2. Loosen the door jamb bolt (2) and move straight inwards 1/16" and retighten.

3. Hold a piece of paper such as a dollar bill between where the door seal (4) will hit the skin of the cab and firmly close the door ensuring that it latches on the second catch. (The door latch mechanism has a double catch mechanism.)
4. The door seal should firmly grip the paper all along the top, front, and bottom edge of the door. If the paper is loose all around, repeat Step 2. If the paper is firmly gripped, but can be removed without tearing it, open door and tighten the jamb bolt completely without affecting the adjustment.
5. If the paper slips out from the door seal easily along the top and not at the bottom, the door itself will have to be "adjusted". Or if the paper slips out easier at the bottom than at the top, the door will have to be "adjusted".

- If seals are tight at bottom of door, but not at top, place a 4 x 4 block of wood at the bottom edge of the door, below the handle. Close the door on the wood block and press firmly inward on the top corner of the door. Press in one or two times, then remove the wood block and check seal tension again using the paper method. Seal compression should be equal all the way around the door. If seal is still loose at the top, repeat procedure again until seal compression is the same all the way around.
- If seal compression is greater at the top than at the bottom of the door, place a 4 x 4 block of wood at the top corner of the cab door. Then press firmly inward on the lower corner of the door. Press in one or two times, then remove the wood block and check seal compression again. Seal compression should be equal all the way around the door. If seal is still loose at the bottom, repeat procedure again until seal compression is uniform all the way around.

## Installation

1. If the weatherstrip material previously removed is broken, weathered, or damaged in any way, use new rubber weatherstrip material.

*NOTE: Using a non-oily rubber lubricant on the weatherstrip material and cab opening will make the following installation easier:*

- a. Install the weatherstrip around the opening in the cab for the glass. Start with one end of the weatherstrip at the center, lower part of the window opening and press the weatherstrip over the edge of the opening.
- b. Continue installing weatherstrip while going all the around the opening. When the ends of the weatherstrip meet at the starting point at the lower, center area of the window opening, there must be 0.5 in. (12.7 mm) of overlapping material.

*NOTE: The ends of the weatherstrip material need to be square-cut to assure a proper fit.*

- c. Lift both ends so that they meet squarely, then while holding ends together, force them back over the lip of the opening.
2. Lubricate the groove of the weatherstrip where the glass is to be seated.
    - a. Lower the glass into the groove along the bottom of the opening.
    - b. Two people should be used for glass installation. Have one person on the outside of the cab and push in on glass against opening, while the person inside uses a soft flat tool (plastic knife) and goes around the glass to work the weatherstrip over the edge of the glass.

3. After the glass is in place, go around the weatherstrip and push in on the locking lip (2, Figure 2-18 or 2-19) to secure the glass in the weatherstrip.
4. If windshield was being replaced, lower windshield wiper arms/blades back to the glass.

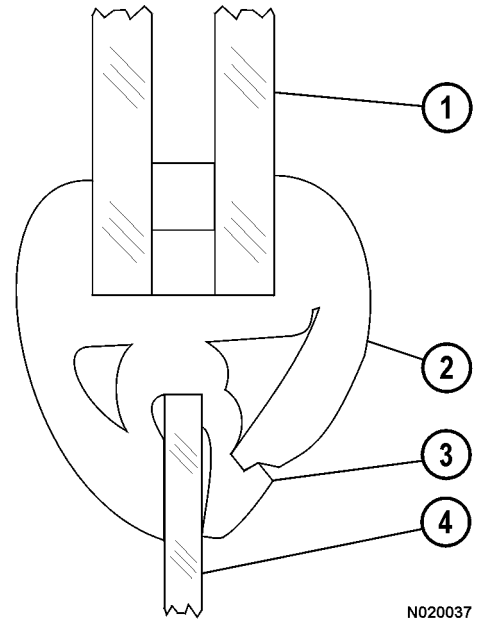


FIGURE 2-19. Rear Window

- |                |                          |
|----------------|--------------------------|
| 1. Glass       | 3. Weatherstrip Material |
| 2. Locking Lip | 4. Sheet Metal           |

# OPERATOR COMFORT

## HEATER/AIR CONDITIONER

The heater assembly incorporates all the controls necessary for regulating the cab interior temperature; heated air during cold weather operation, outside air during mild temperatures and cooled, de-humidified air during warm weather operation.

The following information primarily describes the heater system. Refer to Section Air Conditioning System in this chapter for detailed information concerning the complete air conditioning system operation, repair, and system recharging instructions.

### Operation

Heat for the cab is provided by passing coolant from the engine cooling system through a heater coil. Blowers move air across the heating coil which warms the air for heating or defrosting.

An engine driven freon compressor passes refrigerant through an evaporator coil mounted in the same enclosure. The same blowers used for heating move air across the evaporator to provide cooled air through the outlet vents.

All heater and air conditioner controls are mounted on a pod on the face of the enclosure. Refer to Figure 4-1 for the following:

- **Defroster Switch (1):** This is a 2-position toggle switch; "down" is OFF. "Up" provides air flow through the defroster vents.
- **Heat Vent Control Switch (2):** This is a 2-position toggle switch; "down" is OFF. "Up" provides heated air flow to the cab floor.
- **Fan Control (3):** This is a 3-position rotary switch; rotate knob to select low, medium, or high fan speed.
- **Air Conditioner Temperature Control (4):** This is an infinitely variable rotary control; rotate counterclockwise to reduce cooling, clockwise to increase cooling.
- **Outside/Inside Air Selector(5):** This is a 2-position toggle switch; "down" recirculates cab air. "Up" allows outside air to flow through heater or air conditioner coils.
- **Selection Control (6):** This is a variable rotary control. Rotating the knob counterclockwise (blue arrow) will select increasingly cooler temperatures. Rotating the knob clockwise (red arrow) selects increasingly warmer temperatures.

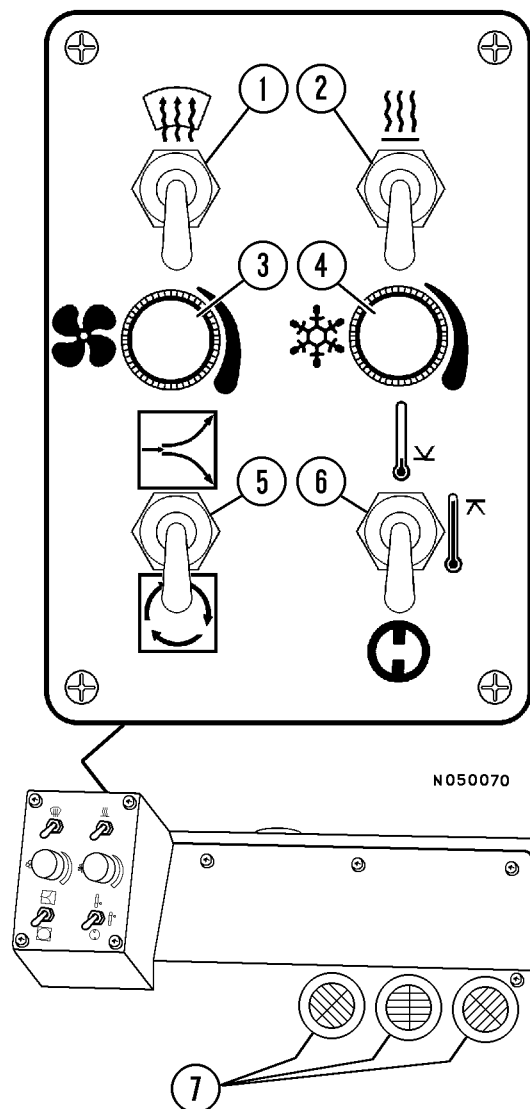


FIGURE 4-1. HEATER/AIR CONDITIONER CONTROLS

- |                            |                                |
|----------------------------|--------------------------------|
| 1. Defroster Switch        | 5. Outside/Inside Air Selector |
| 2. Heater Control Switch   | 6. Selection Control           |
| 3. Fan Speed Switch        | 7. Outlet Vents                |
| 4. A/C Temperature Control |                                |

## ELECTRICAL CIRCUIT

The air conditioner's electrical circuit is fed from an accessory circuit and is fused with a 30-ampere circuit breaker.

The blower control is a switch which provides a range of blower speeds from fast to slow. When the blower switch is turned on, current is available at the compressor clutch. Once the blower is turned on, fan speeds may be changed without affecting the thermostat sensing level.

The thermostat reacts to changing temperatures which cause electrical contacts to open and close. The thermostat has a capillary tube extended into the evaporator coil to sense temperature.

When the contacts are closed, current flows to the clutch field and energizes the clutch, causing the swash plate inside the compressor to turn which starts the refrigeration cycle. When the temperature of the evaporator coil drops to a predetermined point, the contacts open and the clutch disengages.

When the clutch is disengaged, the blower remains at the set speed. After the evaporator temperature rises about twelve degrees above the cutout point, the contacts in the thermostat close and the refrigeration cycle resumes.

### Thermostat

An electromagnetic clutch is used on the compressor to provide a means of constant temperature control of the cab. The clutch is controlled by a thermostat in the evaporator which is set initially by the driver to a predetermined point. Evaporator temperature is then maintained by the cycling action of the clutch.

The thermostat is simply a thermal device which controls an electrical switch. When warm, the switch is closed; when cold, it is open. Most thermostats have a positive OFF position as a means to turn the clutch off regardless of temperature.

The bellows type thermostat has a capillary tube connected to it which is filled with refrigerant. The capillary tube is attached to the bellows inside of the thermostat. Expansion of the gases inside the capillary tube exerts pressure on the bellows, which in turn closes the contacts at a predetermined temperature.

## Compressor Clutch

An electromagnetic clutch is used in conjunction with the thermostat to disengage the compressor when it is not needed, such as when a defrost cycle is indicated in the evaporator, or when the system or blower is turned off.

The stationary field clutch is the most desirable type since it has fewer parts to wear. The field is mounted to the compressor by mechanical means depending on the type field and compressor. The rotor is held on the armature by a bearing and snap rings. The armature is mounted on the compressor body.

When no current is fed to the field, there is no magnetic force applied to the clutch and the rotor is free to rotate on the armature, which remains stationary on the crankshaft.

When the thermostat or switch is closed, current is fed to the field. This sets up a magnetic force between the field and armature, pulling it into the rotor. When the armature becomes engaged with the rotor, the complete unit rotates while the field remains stationary. This causes the compressor crankshaft to turn, starting the refrigeration cycle.

When the switch or thermostat is opened, current is cut off. The armature snaps back out and stops while the rotor continues to turn. Pumping action of the compressor is stopped until current is again applied to the field. In addition, safety switches in the compressor clutch electrical circuit control clutch operation, disengaging the clutch if system pressures are abnormal.

## Stabilizing the AC System



***During this stabilization period, do not open hand valves on manifold for any reason. Equipment damage and personal injury may result.***

1. Start the engine and return to an idle speed of 1200 to 1500 RPM. Turn on the air conditioner.
2. After a performance check of the control functions, blower speeds and air flow, set the AC system controls to maximum cooling and blower speed on high. Open the cab to ensure continuous operation of the compressor.
3. Run the engine and air conditioner about 5 minutes for the system to stabilize.
4. If the humidity is high it will be necessary to place a fan in front of the AC condenser to help the air flow across the condenser. This helps to stabilize the system by simulating normal operating conditions.
5. It is then possible to observe the gauge readings and the temperature coming out of the air ducts with a thermometer.

***NOTE: If low refrigerant is indicated by lower than normal pressure readings, recover and charge the proper amount of refrigerant to enable adequate system testing.***

## SYSTEM PERFORMANCE TEST

This test is performed to establish the condition of all components in the system. Observe these conditions during testing:

1. Start engine and operate at 1200 to 1500 RPM.
2. Place fan in front of condenser to simulate normal ram air flow and allow system to stabilize.
3. Place a thermometer in air conditioning vent closest to evaporator.
4. Evaluate the readings obtained from the gauges to see if they match the readings for the ambient temperature.

As preliminary steps to begin checkout of the system, perform the following:

1. Close all windows and doors to the cab.
2. Set air conditioning system at maximum cooling and blower speed operation.
3. Readings on the two manifold gauges should be within normal range, adjust for ambient temperature.
4. Compare evaporator discharge air temperature reading to see if it matches the recommended temperature for the ambient temperature and gauge readings obtained.
5. Carefully feel the hoses and components on the high side. All should be warm-hot to the touch. Check the inlet and outlet of receiver-drier for even temperatures, if outlet is cooler than inlet, a restriction is indicated.



***Use extreme caution when placing hands on high side components and hoses. Under certain conditions these items can be extremely hot.***

6. Feel the hoses and components on the low side. They should be cool to the touch. Check connections near the expansion valve, inlet side should be warm and cold-cool on the outlet side.
7. If these conditions are met, the system is considered normal. Shut down engine. Remove gauges and install the caps on the service valves.

The moisture must turn to gas before the pump can pull it out. The moisture takes time to boil away, so that it can be drawn out of the system. The vacuum pump can draw most of the air out quickly, but a deep vacuum requires more time; the deeper the vacuum the more time required.

## **⚠ IMPORTANT ⚠**

***The most important factor is the ability for the system to hold the deepest vacuum the pump can pull, and hold it for 15 minutes after the pump has stopped. This may take several tries depending on how long the system was held in a vacuum.***

## **CHARGING THE AC SYSTEM**

When charging the system, it is possible to put it in as a gas or as a liquid. Adding refrigerant as a liquid is faster but can damage the compressor if not done correctly. The procedure used, and where the refrigerant is added in the AC system makes a difference. When using refrigerant as a liquid, never add more than two thirds of system requirements as a liquid. Finish charging the system using gas.

The proper method for charging refrigerant into a R-134a system is to first, recover all of the refrigerant from the system. The charging refrigerant should then be weighed on a scale to ensure the proper amount is charged into the system. Most recovery units include a scale within the apparatus, thus making it very easy to charge the correct amount every time. If equipment such as this is not available, a common scale can be used to determine the weight of charge. Simply weigh the charging tank, subtract the weight of the proper charge, and charge the system until the difference is shown on the scale. On certain types of equipment, it is also possible to add any necessary lubricant when charging the system.

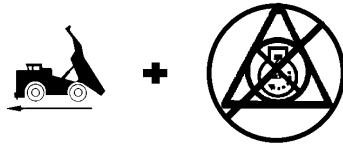
If a scale is not used when charging R-134a into a system, it is difficult to tell if the correct charge has been achieved. The sight glass can provide some indication, but it is not a reliable tool for determining proper charge.

**SECTION N5**  
**OPERATOR CAB CONTROLS**  
**INDEX**

OPERATOR CAB CONTROLS .....	N5-3
STEERING COLUMN .....	N5-3
Removal .....	N5-3
Installation .....	N5-3
STEERING WHEEL AND CONTROLS .....	N5-5
Horn Button .....	N5-5
Telescope Lock Ring .....	N5-5
Tilt Wheel Lever .....	N5-5
Turn Signal/Headlight Dimmer .....	N5-5
DYNAMIC RETARDING .....	N5-5
Dynamic Retarder Control Lever .....	N5-6
Dynamic Retarder/Service Brake Pedal .....	N5-6
Accelerator (Throttle) Pedal .....	N5-6
Starting on a Grade With a Loaded Truck .....	N5-6
GRADE/SPEED RETARD CHART .....	N5-7
INSTRUMENT PANEL .....	N5-8
OVERHEAD PANEL AND DISPLAYS .....	N5-8
F-N-R SELECTOR SWITCH .....	N5-9
HOIST CONTROL LEVER .....	N5-10
OVERRIDE /FAULT RESET SWITCH .....	N5-11
10, FIGURE 5-5 - BLANK .....	N5-11
RETARD SPEED CONTROL (RSC) "OFF/ON" SWITCH .....	N5-11
RETARD SPEED CONTROL (RSC) ADJUST DIAL .....	N5-11
TCI DOWNLOAD PORT .....	N5-12
PASSENGER SEAT .....	N5-12

## VERRIDE /FAULT RESET SWITCH

This push-button switch (9, Figure 5-4) is spring-loaded to the "OFF" position. When pushed in and held, this switch may be used for several functions.



1. This switch permits the operator to override the "body-up" limit switch and move the truck forward when the Selector Switch is in Forward, the dump body is raised, and the brakes are released.

**Use of the override switch for this purpose is intended for emergency situations only!**

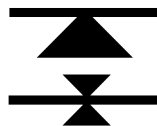
2. The push button deactivates the retard pedal function when speed of truck is below 3 mph (4.8 kph).
3. The override switch is also used to reset an electric system fault when indicated by a red warning light (Refer to "Instrument Panel And Indicator Lights", Overhead Warning / Status panel).

## 10, FIGURE 5-5 - BLANK

This position is not used for the 930E.

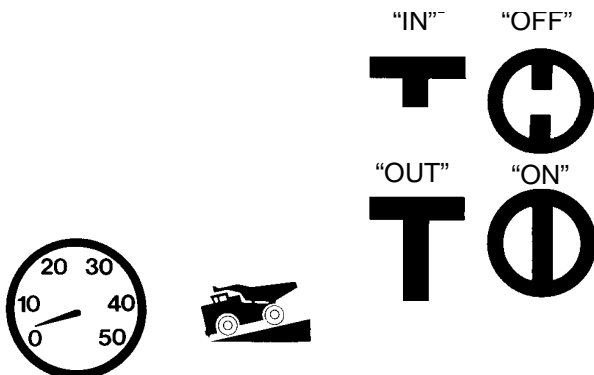


In some other truck models, this position is used for an Engine Idle Switch.



## RETARD SPEED CONTROL (RSC) "OFF/ON" SWITCH

The Retard Speed Control Switch (11, Figure 5-4) turns the system "OFF" or "ON". Push the knob "IN" to turn "OFF" and pull the knob "OUT" to turn the system "ON".



## RETARD SPEED CONTROL (RSC) ADJUST DIAL

The RSC Adjust Dial (12, Figure 5-4) allows the operator to vary the downhill truck speed that the Retard Speed Control system will maintain when descending a grade. This function can be overridden by either the accelerator, retard lever, or retard pedal.

When the dial is rotated counterclockwise toward this symbol, the truck will descend a grade at lower speeds.



When the dial is rotated clockwise toward this symbol, the truck speed will increase.



**ALWAYS refer to the Grade/Speed decal in the operator's cab**, and follow the recommendations for truck operation. **DO NOT** exceed these recommended MAXIMUM speeds when descending grades with a loaded truck.

Throttle pedal position will override RSC setting. If operator depresses throttle pedal to increase truck speed, Dynamic Retarding will not come on unless truck overspeed setting is reached or foot operated retard pedal is used. When throttle pedal is released and RSC switch is "On", Dynamic Retarding will come on at, or above, the RSC dialed speed and will adjust truck speed to, and maintain, the dialed speed.

To adjust RSC control, pull switch (11) "On" and start with dial (12) rotated toward fastest speed while driving truck at desired maximum speed. Relax throttle pedal to let truck coast and turn RSC Adjusting Dial slowly counterclockwise until Dynamic Retarding is activated. Dynamic Retarding will now be activated automatically anytime the "set" speed is reached, the RSC switch is "On", and throttle pedal is released.

With RSC switch "On" and dial adjusted, the system will function as follows: As truck speed increases to the "set" speed and throttle pedal released, Dynamic Retarding will apply. As truck speed tries to increase, the amount of retarding effort will automatically adjust to keep the selected speed. When truck speed decreases, the retarding effort is reduced to maintain the selected speed. If truck speed continues to decrease to approximately 3 mph (4.8 kph) below "set" speed, Dynamic Retarding will turn off automatically. If truck speed must be reduced further, the operator can turn the Adjust Dial to a new setting or depress the foot operated retard pedal.

If the operator depresses the foot operated retard pedal and the retard effort called for is greater than that from the automatic system, the foot pedal retard will override RSC.

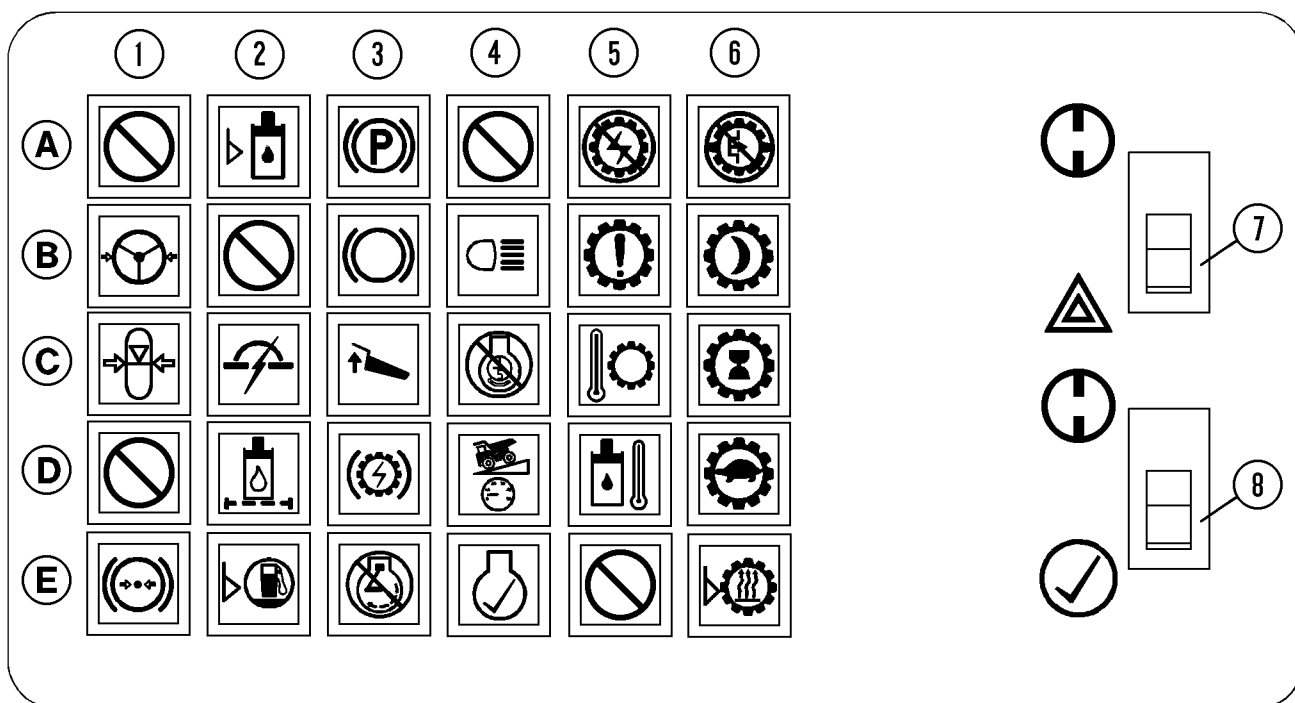


FIGURE 5-6. OVERHEAD STATUS / WARNING INDICATOR LIGHTS

N050075

Row / Column	Indicator Description	Indicator Color Wire Index
A1*	Not Used	12FD/34TL
B1	Low Steering Pressure	Red-12F/33A
C1	Low Accumulator Press.	Red-12F/33K
D1	Not Used	12F/79V
E1	Low Brake Pressure	Red-12F/33L
A2*	Low Hydraulic Tank Level	Red-12MD/34LL
B2*	Not Used	12FD/SPR1
C2*	Circuit Breaker Tripped	Amber-12MD/31CB
D2*	Hydraulic Oil Filter	Amber-12MD/39
E2*	Low Fuel	Amber-12MD/38
A3*	Park Brake Applied	Amber-12MD/52A
B3*	Service Brake Applied	Amber-12MD/44L
C3*	Body Up	Amber-12MD/63L
D3*	Dynamic Retarding	Amber-12MD/44DL
E3	Stop Engine	Red-12M/509MA
A4*	Not Used	12MD/SPR2
B4*	Manual Back-Up Lights	Amber-12MD/47L
C4*	5 Min. Shutdown Timer	Amber-12MD/23L1
D4*	Retard Speed Control	Amber-12MD/31R
E4*	Check Engine	Amber-12MD/419

Row / Column	Indicator Description	Indicator Color Wire Index
A5	No Power	Red-12M/75-7PI
B5	Propulsion System Warning	Amber-12F/79WI
C5	Propulsion System Temperature	Amber -12F/34TW
D5	Hydraulic Oil Temperature High	RED-12F/34TGI
E5*	Not Used	Red-12FD/SPR5
A6	No Propel	Red-12M/75NPI
B6	Propel System @ Rest	Amber-12M/72PR
C6*	Propel System Not Ready	Amber-12MD/72NR
D6*	Reduced Propulsion System	Amber-12MD/72LP
E6*	Retard @ Continuous Level	Amber-12MD/76LR
<b>-SWITCHES-</b>		
7	Hazard Lights Switch N/O	11L/45L/45R
8	Lamp Check Switch (N/O Momentary)	33H/710

Note: Brightness for lamps marked ©\*a can be adjusted using the dimmer control.

**SECTION P2**  
**LUBRICATION AND SERVICE**  
**INDEX**

LUBRICATION AND SERVICE .....	P2-3
930E SERVICE CAPACITIES .....	P2-3
HYDRAULIC TANK SERVICE .....	P2-3
Adding Oil .....	P2-3
WHEEL MOTOR SERVICE .....	P2-3
COOLANT LEVEL CHECK .....	P2-4
RADIATOR FILLING PROCEDURE .....	P2-4
LUBRICATION CHART .....	P2-5
10 HOUR (DAILY) INSPECTION .....	P2-6
50 HOUR LUBRICATION AND MAINTENANCE CHECKS .....	P2-9
100 HOUR LUBRICATION AND MAINTENANCE CHECKS .....	P2-10
250 HOUR LUBRICATION AND MAINTENANCE CHECKS .....	P2-11
500 HOUR LUBRICATION AND MAINTENANCE CHECKS .....	P2-14
1000 HOURS LUBRICATION AND MAINTENANCE CHECKS .....	P2-15
2500 HOUR MAINTENANCE CHECKS .....	P2-16
5000 HOUR MAINTENANCE CHECKS .....	P2-16

## 250 HOUR LUBRICATION AND MAINTENANCE CHECKS

The 10 hour lubrication and maintenance checks should also be performed at this time.

*NOTE: "Lube Key" references are to the Lubrication Chart.*

Truck Serial Number _____ Site Unit Number _____ Date _____			
Hourmeter _____ Name of Service Technician _____			
	TASK	COMMENTS	CHECKED INITIALS
1.	ENGINE - Change the engine oil and lube filters. Lube key "A".		
2.	COOLING SYSTEM - a. COOLANT MIXTURE - Check for proper coolant mixture. Add coolant as required. b. COOLANT FILTERS - Change coolant filters. c. COOLING SYSTEM HOSES - Check cooling system hoses for damage and signs of deterioration.		
3.	FUEL FILTERS - Change the primary and secondary fuel filters, as well as the fuel separator.		
4.	FUEL TANK - Drain water and sediment from the fuel tank. Refer to Section B, Fuel Tank - Cleaning.		
5.	STEERING LINKAGE - Check the torque on pin retaining nuts (1, Figure 2-6) on the steering linkage. <b>(525 ft.lbs. (712 N.m))</b> Check the torque on tie rod retaining nuts (2). <b>(310 ft.lbs. (420 N.m))</b>		
6.	HYDRAULIC PUMP DRIVESHAFT & U-JOINTS - Add one or two applications of grease to each grease fitting. Check that each bearing of the cross & bearing assembly is receiving grease. Lube Key "D".		

*250 HOUR INSPECTION is continued on the following page.*

3. Pump Cycle Timer (7, Figure 3-1) also called a "Flasher" timer, because it contains an LED that illuminates when there is power going to SV2): The Pump Cycle Timer mounts on SV2 solenoid and generates a timed pulse signal to control the reciprocating cycle rate of the grease pump.
4. Grease Reservoir: For the 930E, the Canister or Reservoir (6, Figure 3-1) is mounted on the right side front bumper in front of the upright frame support (View A-A, Figure 3-2). The reservoir has an approximate capacity of 50 lbs. (23 kg) of grease.
5. Vent Valve (11, Figure 3-1 or 10, Figure 3-2): With the vent valve closed, the pump continues to cycle until maximum pressure is achieved. As this occurs, the vent valve opens and allows the grease pressure to drop to 0, so the injectors can recharge for their next output cycle.
6. 24 VDC Solid State System Timer (Not Shown): The Solid State System Timer sends out a 24 VDC timed-interval signal to energize the solenoid valves, causing the grease pump to operate. This timer is mounted in the cab (in the housing under the passenger seat) to insure temperature stability. Its operating temperature range is -20°F to 131°F (-29°C to 55°C).
7. Pressure Switch (N/C 2000 psi [13 790 kPa]): (9, Figure 3-2) opens the 24 volt supply to the pump cycle timer, when the grease line pressure exceeds this limit.

*NOTE: Depending on truck model, the specific pressure at which this switch opens, may vary. Therefore, all references in this coverage to the specific N/C 2000 psi [13 790 kPa] pressure switch would also change. Refer to the truck Parts catalog for a specific switch installation.*

8. Injectors (11 & 12, Figure 3-2): each injector delivers a controlled amount of pressurized lubricant to a designated lube point. Refer to Figure 3-2 for locations.

## System Operation

1. During truck operation, with the pump and timer systems in a rest state, a preset time interval occurs.
2. The solid state system timer sends out a 24 VDC signal to energize SV1, causing it to open.
3. As SV1 opens, the resulting hydraulic fluid pressure flows through the pressure reducing valve closing the vent valve and also flows on to SV2.
4. The pressure reducing valve lowers hydraulic fluid pressure to the operating range of the hydraulic pump [maximum pressure 300 p.s.i. (2069 kPa)].
5. After the system pressure has been reduced, it passes on to SV2. Each operation of SV2 moves the hydraulic cylinder which operates the grease pump. As SV2 turns "On" and "Off" (refer to cycle timer/flasher below), it changes the direction of the hydraulic cylinder movement back and forth, thus causing a "pumping" action.
6. The cycle timer/flasher sends a pulsing signal, 1 second "On" and 1 second "Off" (adjustable), to SV2. Solenoid valve SV2 directs the hydraulic fluid to the pump at 30 cycles/minute.
7. With the vent valve closed, the pump continues to cycle until lubricant pressure rises to 2,000 psi (13 790 kPa) and the injectors have metered grease to the points of lubrication.
8. If system pressure rises above 2000 psi (13 790 kPa), the N/C pressure switch will open until the timed cycle is complete and the solid state system timer terminates the 24VDC signals to SV1 and SV2. (See NOTE: below step 11.)
9. As SV2 is de-energized the pump stops cycling.
10. As SV1 is de-energized, the hydraulic fluid stops flowing to the pressure reducing valve and the vent valve allowing it to open.
11. As the vent valve opens, the grease pressure drops to zero (0), so the injectors can recharge for their next output cycle.

*NOTE: When the N/C pressure switch opens, SV2 is de-energized causing the pump to stop; however, until the timed cycle is complete, SV1 remains energized, keeping the vent valve closed and holding pressure in the grease line. If the grease line pressure now drops to where the switch closes again, the pump will restart to hold grease line pressure, but the injectors will not recharge.*

12. The system is now at rest, ready for another lube cycle and the sequence repeats itself.

## POSSIBLE CAUSES

## SUGGESTED CORRECTIVE ACTION

### **TROUBLE: Timer Turns On At Intervals Two To Ten Times More Often Than Set Time Interval**

Electrical noise is being introduced into the power supply to the timer overcoming suppressor capacitor causing uncontrolled turn-on of its output relay.

***IMPORTANT: In some instances, electrical noise may be generated into vehicle electrical system which may cause timer to turn on at random intervals, independent of timer setting. If this occurs, a 250 to 1,000 MFD capacitor rated 150 to 350 VDC should be added across BAT (+) and BAT (-) terminals to suppress this noise and improve timer performance.***

### **TROUBLE: Timer Turns On At Intervals Faster Than Allowable Tolerances Of Settings**

Timer out of adjustment or damaged component.

Refer to "Timer Adjustment and re-adjust timer or replace timer.



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