

# Shop Manual

# 930E-4

## DUMP TRUCK

SERIAL NUMBERS

**A30796 - A31001**

**Tier II**

**KOMATSU®**

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# MAJOR COMPONENTS & SPECIFICATIONS

## TRUCK AND ENGINE

The 930E-4 Dump Truck is an off-highway, rear dump truck with AC Electric Drive. The gross vehicle weight is 498,960 kg (1,100,000 lbs). The engine is a Komatsu SSDA16V160 rated @ 2700 HP (2014 kW).

## MAIN ALTERNATOR

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", which are also within the main control cabinet. Each inverter consists of six phase modules under the control of a gate driver power converter (GDPC). The two GDPCs control the operation of each phase module.

Each phase module contains paired positive and negative semiconductor switches referred to as insulated gate bipolar transistors (IGBT). The IGBTs cycle 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 (VVVF) signal. Frequency and voltage are changed to suit the operating conditions.

Cooling air for the control/power group and wheel motors, as well as the alternator itself, is provided by dual fans mounted on the alternator shaft.

## 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 directional control lever located on the center console.

## 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 the brake 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 and hydraulically-released with wheel speed application protection (will not apply with truck moving).

## Fire Prevention

- Remove wood chips, leaves, paper, and other flammable items that have accumulated in the engine compartment. Failure to do so could result in a fire.
- Check the fuel, lubrication, and hydraulic systems for leaks. Repair any leaks. Clean any excess oil, fuel or other flammable fluids, and dispose of them properly.
- Make sure that a fire extinguisher is present and in proper working condition.
- Do not operate the truck near open flames.



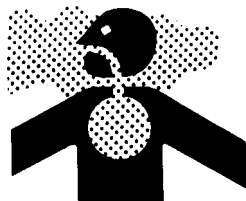
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## Preparing For Operation

- 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 area.
- 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 In Enclosed Areas

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



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## In Operator's Cab - Before Starting The Engine

- Do not leave tools or spare parts lying around. Do not allow trash to accumulate in the cab of the truck. Keep all unauthorized reading material out of the truck cab.
- Keep the cab floor, controls, steps and handrails free of oil, grease, snow and excess dirt.
- Read and understand the contents of this manual. Pay special attention to Sections 30 and 32 pertaining to safety and operating instructions. Become thoroughly acquainted with all gauges, instruments and controls before attempting operation of the truck.
- Read and understand the **WARNING** and **CAUTION** decals in the operator's cab.
- Make sure that the steering wheel, horn, controls and pedals are free of any oil, grease or mud.
- Check the operation of the windshield wiper, condition of wiper blades, and the washer fluid reservoir level.
- Be familiar with all steering and brake system controls, warning devices, road speeds and loading capabilities before operating the truck.

## Seat Belts

- On both driver and passenger seats, check the seat belt fabric, buckle, all belt retractors and hardware for damage or wear. Replace any worn or damaged parts immediately.
- Even if there are no signs of damage, replace both driver and passenger seat belts 5 years after seat belt manufacture, or every 3 years after start of use, whichever comes first. The passenger seat belt date of manufacture label is sewn into the seat belt near the buckle. The driver seat belt date of manufacture label is sewn into the shoulder harness belt, near the retractor end.

## Mirrors, Windows And Lights

- Remove any dirt from the surface of the windshield, cab windows, mirrors and lights. Good visibility may prevent an accident.
- Adjust the rear view mirror to a position where the operator can see best from the operator's seat. If any glass or light is broken, replace it with a new part.
- Make sure that the headlights, work lights, and taillights are in proper working order. Make sure that the truck is equipped with the proper work lamps that are needed for the operating conditions.

## **SPECIAL PRECAUTIONS FOR WORKING ON AC DRIVE TRUCKS**

### **Preliminary Procedures Before Welding or Performing Maintenance**

Before welding or repairing an AC drive truck, maintenance personnel should notify a Komatsu service representative. Only qualified personnel, specifically trained for servicing the AC drive system, should perform this service.

If it is necessary to perform welding or repair to the truck without the field engineer present, the following procedures must be followed to ensure that the truck is safe for maintenance personnel to work on and to reduce the chance for damage to equipment.



***Anytime the engine is running, do not open any of the cabinet doors or remove any covers. Do not use any of the power cables for hand holds or foot steps. Do not touch the retarding grid elements.***



***Before opening any cabinets or touching a retarding grid element or a power cable, the engine must be shutdown and the red drive system warning lights must not be illuminated.***

### **Engine Shutdown Procedure Before Welding or Performing Maintenance**

Normal operation of the AC drive system at shutdown should leave the system safe to service. However, in the event of a system failure, performing the following procedure before any maintenance activities will ensure that no hazardous voltages are present in the AC drive system.

1. Before shutting down the engine, verify the status of all the drive system warning lights on the overhead display panel. Use the lamp test switch to verify that all lamps are functioning properly.  
If any of the red drive system warning lights remain on, do not attempt to open any cabinets, disconnect any cables, or reach inside the retarding grid cabinet without a trained drive system technician present, even if the engine is off. Only qualified personnel, specifically trained for servicing the AC drive system, should perform this service.
2. If all red drive system warning lights are off, follow the Normal Engine Shutdown Procedure on page A3-27.
3. After the engine has been stopped for at least five minutes, inspect the link voltage lights on the exterior of the main control cabinet and back wall of the operator's cab (DID panel). If all lights are off, it is safe to work on the retarding grids, wheel motors, alternator and related power cables.
4. Locate the GF cut-out switch in the access panel on the left side of the main control cabinet. Place the switch in the "alternator cutout" position. This will prevent the alternator from re-energizing and creating system voltage until the switch is returned to its former position.

## ENGINE START-UP

### **DANGER**

**Never attempt to start the engine by shorting across the starter terminals. This may cause fire, or serious injury or death to anyone in the machine's path. Start the engine from the operator's seat only.**

**If the truck is equipped with an auxiliary cold weather heater system, do not attempt to start the engine while the heaters are in operation. Damage to the coolant heaters will result!**



1. Make sure that all personnel are clear of the truck before starting the engine. Always sound the horn as a warning before moving any controls.
2. If the truck is in an enclosure, make sure that there is adequate ventilation before start-up. Exhaust fumes are dangerous!
3. Make sure that the directional control lever is in PARK before starting.
4. Place the rest switch in the ON position to put drive system in rest mode. For more information, refer to Section N5, Operator Cab Controls.

### **CAUTION**

**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.**

5. The key switch is a four-position switch (ACC, OFF, RUN, START). The ACC position is not currently used.
  - a. Turn the key switch one position clockwise to the RUN (not START) position. All electrical circuits except the start circuit are activated.
  - b. Turn the key switch fully clockwise to the START position and hold this position until the engine starts. The START position is spring-loaded and will return the switch to the RUN position when the key is released.

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

6. After the engine has started, place the rest switch in the OFF position to deactivate the rest mode. Refer to Section N5, Operator Cab Controls for more information on the rest switch.

**NOTE:** In cold ambient conditions and when the engine is cold, the engine rpm will not increase above low idle speed until the engine controller determines it is safe to do so. This time delay will vary from 30 seconds to 11 minutes which allows the coolant and engine oil to warm up.

### Lowering The Dump Body (When dumping over a berm or into a crusher):

1. Move the hoist lever forward to the DOWN position. Release the lever to place the hoist control valve in the FLOAT position, which allows the body to return to the frame.

If dumped material builds up at the rear of the body and the body cannot be lowered, perform the following steps:

- a. Move hoist lever back to the HOIST position to fully raise the dump body. Release the hoist lever so it returns to the HOLD position.

**NOTE:** Do not drive forward if the tail of body will not clear the crusher wall in the fully raised position.

- b. Move the directional control lever to FORWARD, release the brake lock, depress the Override button, and drive forward to clear the material.
- c. Stop, move the directional control lever to NEUTRAL, apply the brake lock and lower the body.

**NOTE:** Failure to hoist the body after making an unsuccessful attempt at lowering the body may result in the dump body **suddenly lowering** after the truck has pulled ahead of the material that was previously preventing the body from lowering.



**Do not move the truck with the dump body raised except in an emergency. Failure to lower the body before moving the truck may cause damage to the hoist cylinders, frame and/or body hinge pins.**

2. With the body returned to the frame, move the directional control lever to FORWARD, release the brake lock, and leave the dump area carefully.

## TOWING



**Before towing a truck, many factors must be carefully considered. Serious personal injury and/or significant property damage may result if important safety practices, procedures and preparation for moving heavy equipment are not observed.**

A disabled machine may be towed after the following precautions have been taken.

- Do not tow the truck any faster than 8 kph (5 mph).
- Tow with a solid tow bar. DO NOT tow with a cable. Use a towing device with ample strength for the weight of this truck.
- Never tow a truck on a slope.
- Inspect towing components, such as tow bars and couplings, for any signs of damage. Never use damaged or worn components to tow a disabled vehicle.
- Keep a safe distance from the trucks and towing apparatus while towing a vehicle.
- When connecting a truck that is to be towed, do not allow anyone to go between the tow vehicle and the disabled vehicle.
- Set the coupling of the truck being towed in a straight line with the towing portion of the tow truck, and secure it in position.
- An operator is to remain in the cab of the towed vehicle at all times during the towing procedure.

## WELDING

This caution decal is placed near the battery disconnect switches on the right side of the front bumper to alert service technicians to always disconnect the battery charging alternator lead wire before making welding repairs.

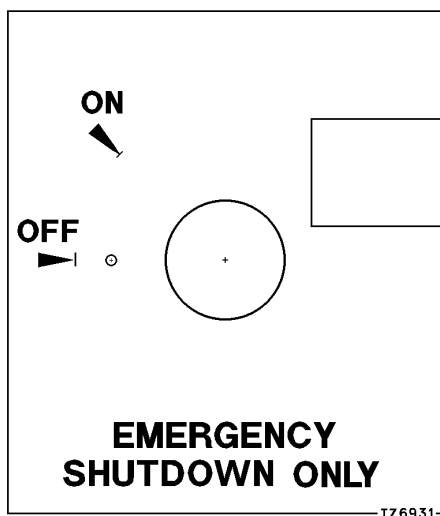
In addition, always isolate electronic control components and disconnect the positive and negative battery cables of the vehicle. Failure to do so may seriously damage the battery and electrical equipment.



Always fasten the welding machine ground (-) lead to the piece being welded. **The grounding clamp must be attached as near as possible to the weld area.** Never allow welding current to pass through ball bearings, roller bearings, suspensions, or hydraulic cylinders. Always avoid laying welding cables over or near the vehicle electrical harnesses. Welding voltage could be induced into the electrical harness and possibly cause damage to components.

## EMERGENCY SHUTDOWN

This decal is placed on the ground level engine shutdown switch, which is mounted on the right side of the front bumper structure. It specifies that this switch is for emergency shutdown only.



## CAPACITORS

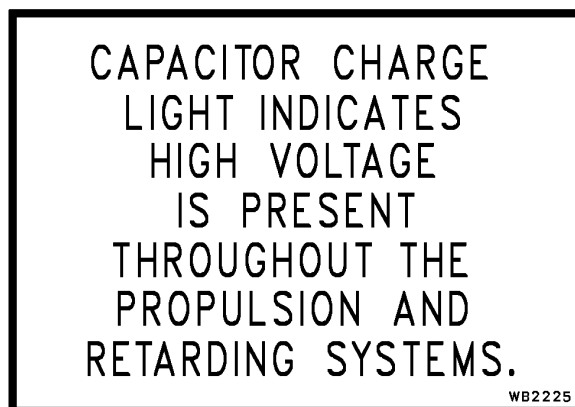
This caution decal is placed on the back of the control cabinet to alert service technicians that this area contains capacitors and must not be disturbed in any manner.



This decal is placed near three different indicator lights:

- In the operator cab, on the D.I.D. panel on the rear wall.
- On the front of the control box, which is mounted on the right side of the main control cabinet.
- On the outside of the left control cabinet wall that faces the right side of the operator cab.

When any of these indicator lights are on, high voltage is present throughout the propulsion and retarding system. Extreme care should be exercised!



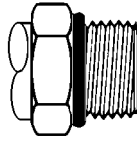


**TABLE 9.**  
**Torque Chart For**  
**O-ring Boss Fittings**

| Size Code | Tube Size (OD) | Threads UNF-2B | Newton meters (N·m) | Foot Pounds (ft lb) |
|-----------|----------------|----------------|---------------------|---------------------|
| – 2       | 0.125          | 0.312 – 24     | 4 ± 3               | 4 ± 2               |
| – 3       | 0.188          | 0.375 – 24     | 7 ± 3               | 5 ± 2               |
| – 4       | 0.250          | 0.438 – 20     | 11 ± 4              | 8 ± 3               |
| – 5       | 0.312          | 0.500 – 20     | 14 ± 4              | 10 ± 3              |
| – 6       | 0.375          | 0.562 – 18     | 18 ± 4              | 13 ± 3              |
| – 8       | 0.500          | 0.750 – 16     | 33 ± 7              | 24 ± 5              |
| – 10      | 0.625          | 0.875 – 14     | 43 ± 7              | 32 ± 5              |
| – 12      | 0.750          | 1.062 – 12     | 65 ± 7              | 48 ± 5              |
| – 14      | 0.875          | 1.188 – 12     | 73 ± 7              | 54 ± 5              |
| – 16      | 1.000          | 1.312 – 12     | 98 ± 7              | 72 ± 5              |
| – 20      | 1.250          | 1.625 – 12     | 109 ± 7             | 80 ± 5              |
| – 24      | 1.500          | 1.875 – 12     | 109 ± 7             | 80 ± 5              |
| – 32      | 2.000          | 2.500 – 12     | 130 ± 14            | 96 ± 10             |

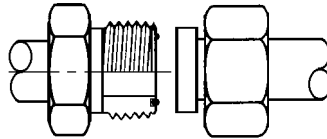


**TABLE 10.**  
**Torque Chart For**  
**O-ring Face Seal Fittings**

| Size CodeE | Tube Size (O.D.) | Threads UNF-2B | Newton meters (N·m) | Foot Pounds (ft lb) |
|------------|------------------|----------------|---------------------|---------------------|
| – 4        | 0.250            | 0.438 – 20     | 15 ± 1              | 11 ± 1              |
| – 6        | 0.375            | 0.562 – 18     | 24 ± 3              | 18 ± 2              |
| – 8        | 0.500            | 0.750 – 16     | 48 ± 5              | 35 ± 4              |
| – 10       | 0.625            | 0.875 – 14     | 69 ± 7              | 51 ± 5              |
| – 12       | 0.750            | 1.062 – 12     | 96 ± 10             | 71 ± 7              |
| – 16       | 1.000            | 1.312 – 12     | 133 ± 8             | 98 ± 6              |
| – 20       | 1.250            | 1.625 – 12     | 179 ± 10            | 132 ± 7             |
| – 24       | 1.500            | 1.875 – 12     | 224 ± 20            | 165 ± 15            |

10. Lubricate all grease fittings that are not part of the automatic lubrication system with the recommended lubricants. Pay special attention to the steering linkage connections. All pivot points must move freely with no binding.
11. Check the battery charging alternator for corrosion or deterioration. The alternator rotor must move freely with no binding or roughness. Inspect, install and properly tension the alternator drive belts.
12. Ensure that the steering cylinder ball joints link and hydraulic connections are secure.
13. Examine the Hydrair suspensions for damage.
  - a. Discharge the nitrogen from the suspensions as outlined in Section H, Hydrair II Suspensions.
  - b. Check the condition of the suspension oil and cylinder wipers. If the wipers are cracked or hardened, the suspension must be rebuilt. Recharge the suspension with new oil if the old oil is deteriorated.
  - c. Check the exposed chrome portions of cylinder for rust, pitting and corrosion. If the plating is deteriorated, the suspension should be removed and overhauled or replaced. Pitted or scored plating will rapidly cause leakage at the seals.
  - d. Recharge the suspensions as outlined in Section H, Hydrair II Suspensions.
14. If not done previously, install fully-charged batteries and ensure that the hook-up is correct.

## ENGINE OPERATION

After all reconditioning procedures have been completed, a static check of engine operation, systems operations, and verification of the braking and steering functions must be done before the vehicle is moved.



***Before starting the engine, clear the immediate area of personnel and obstructions. Ensure that all tools and loose equipment have been removed from the vehicle. Always sound the horn as a warning before starting the engine or actuating any operational controls.***

***Never start the engine in a building unless the doors and windows are open and ventilation is adequate.***

1. Turn the key switch ON. The warning lights for low brake and steering pressure should illuminate and the horn should sound. If it does not, check all components in the circuit and correct the problem before continuing.
2. Turn the key switch to the START position to crank the engine. Release the key when the engine starts. Watch the engine oil pressure gauge. If the pressure does not show within 10 - 15 seconds, turn off the engine and locate the problem.
3. While the engine is warming up, inspect the coolant, oil and fuel lines for leaks. Check the hydraulic pump and hydraulic lines for leaks.
4. When the engine is at operating temperature, check the operation of the throttle circuit. Acceleration should be smooth. Watch the gauges for any abnormal activity. Proper temperatures and pressures are shown in the Operation and Maintenance Manual.

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# SECTION B3 DUMP BODY INDEX

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## FUEL TANK

### Removal

1. Raise the truck body and install the body up retention cable.
2. Loosen filler cap (5, Figure 4-1) and open drain cock (10) to drain the fuel from the tank into clean containers. Tighten the filler cap when the fuel is completely drained.
3. Disconnect wire harness (13) and remove the clamps attached to the fuel tank. Remove ground wire (17).
4. If equipped, close the inline shutoff valves. Remove fuel return hose (6) and fuel supply hose (8). Cap the hoses and tank fittings to prevent contamination.
5. Remove hoist circuit filter assemblies (11) and steering circuit filter assembly (12) from the frame side of the tank. Support the filter assembly by placing a chain over the frame rail. It is not necessary to remove the hydraulic hoses.

*NOTE: The weight of the empty fuel tank is approximately 1 690 kg (3,725 lb). Use lifting devices with adequate capacity to remove the fuel tank.*

6. Attach a lifting device to the lifting eyes on each side of the tank.
7. Remove lower mounting hardware (14), flat washer (15) and rubber dampeners (16). Remove upper mounting hardware (3) and mounting caps (4).
8. Lift the fuel tank from the brackets and move it to a work area.
9. Remove fuel gauge sender (9), breather (5), and other fittings as required to perform interior cleaning. See "Fuel Gauge Sender" in this section for removal of the fuel gauge sender.

### Repair

If a tank has been damaged and requires structural repair, perform such repairs before final cleaning.



*If a tank is to be weld repaired, special precautions are necessary to prevent fire or explosion. Consult local authorities for safety regulations before proceeding.*

### Cleaning

The fuel tank has drain cock (10, Figure 4-1) and a cleaning port in the side that allows steam or solvent to be used for cleaning tanks that have accumulated foreign material.

It is not necessary to remove the tank from the truck for cleaning of sediment. However, rust and scale on the walls and baffles may require complete tank removal. This allows cleaning solutions to be in contact with all interior surfaces by rotating the tank in various positions.

Before a cleaning procedure of this type, all vents, the fuel gauge sender, and hose connections should be removed and temporarily sealed. After cleaning is complete, the temporary plugs can be removed.

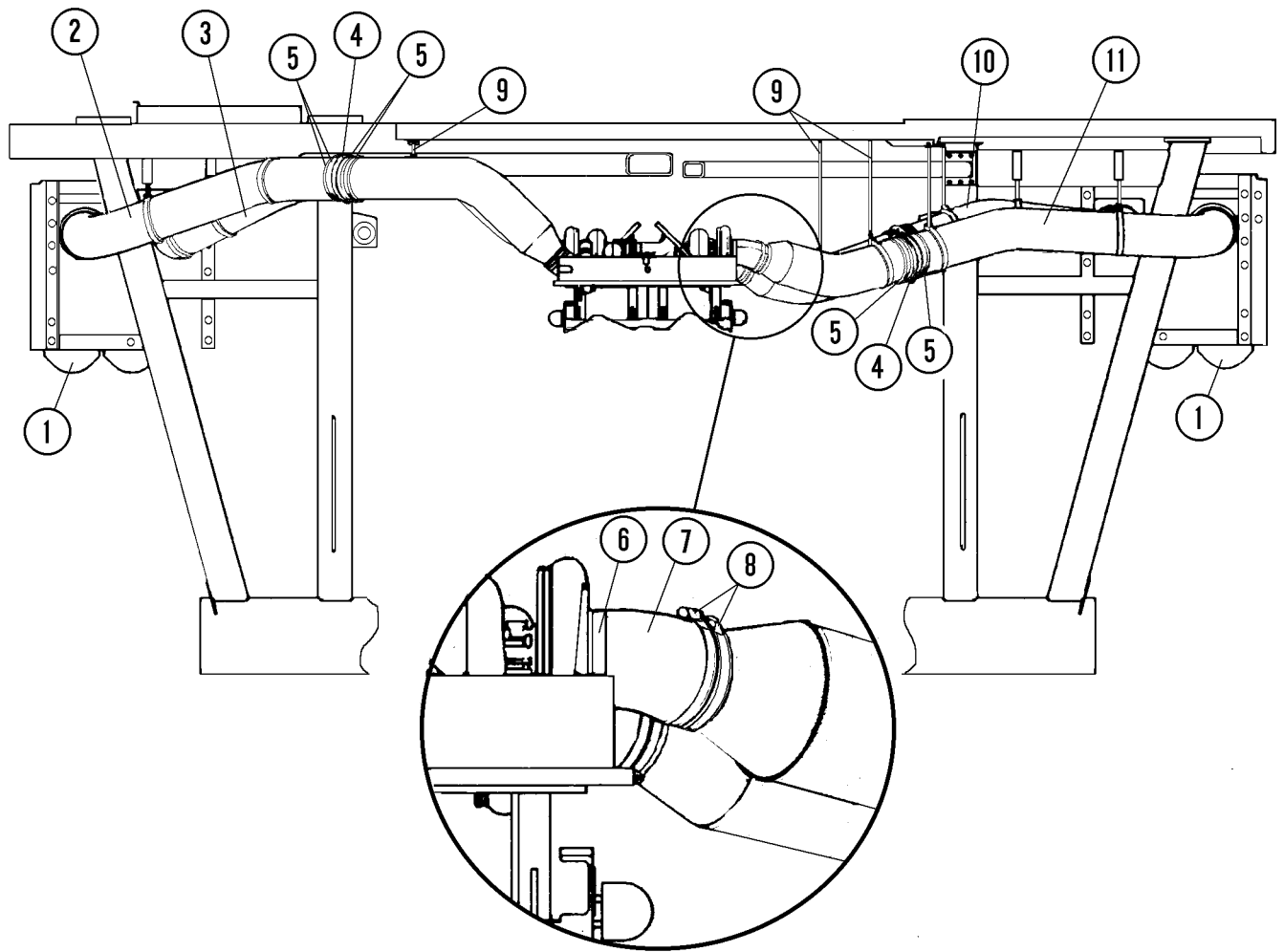
If the tank is to remain out of service, a small amount of light oil should be sprayed into the tank to prevent rust. All openings should be sealed for rust prevention.

### Installation

1. Thoroughly clean the frame mounting brackets and the mounting hardware holes. Re-tap the threads if damaged.

*NOTE: The weight of the empty fuel tank is approximately 1690 kg (3725 lbs). Use lifting devices with adequate capacity to remove the fuel tank.*

2. Lift the fuel tank into position over the frame trunnion mounts and lower it into position. Install mounting caps (4, Figure 4-1), washers and capscrews (3). Do not tighten the capscrews at this time.
3. Install rubber dampeners (16), flat washers (15) and capscrew (14) in the lower mounts. Tighten the capscrews to **420 ± 42 N•m (310 ± 31 ft lb)**.
4. Tighten capscrews (3) to **711 ± 72 N•m (525 ± 53 ft lb)**.
5. Install hoist circuit filter assemblies (11) and steering circuit filter assembly (12) on the frame side of the tank.
6. Connect fuel return hose (6) and fuel supply hose (8). Install wire harness (13) and all clamps. Open the inline shutoff valves, if equipped.



*Turbocharger Inlet Piping Detail*

C020016

FIGURE 2-3. ENGINE AIR INLET PIPING

- |                           |                             |
|---------------------------|-----------------------------|
| 1. Air Cleaner Assemblies | 7. Reducer Elbow            |
| 2. Left Rear Intake Duct  | 8. T-Bolt Clamp             |
| 3. Left Front Intake Duct | 9. Duct Support Rod         |
| 4. Hump Hose              | 10. Right Front Intake Duct |
| 5. T-Bolt Clamp           | 11. Right Rear Intake Duct  |
| 6. T-Bolt Clamp           |                             |

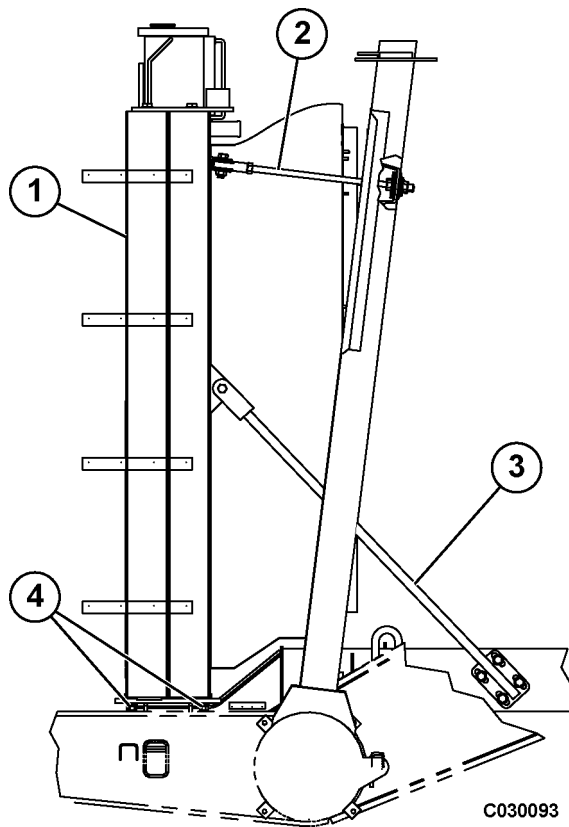


FIGURE 3-5. RADIATOR MOUNTING

- |                      |                               |
|----------------------|-------------------------------|
| 1. Radiator          | 4. Radiator Mounting Hardware |
| 2. Upper Support Rod |                               |
| 3. Stabilizer Bar    |                               |

### Installation

1. Attach a hoist to the radiator and lift it into position on the power module subframe.
2. Install radiator mounting hardware (4, Figure 3-5) at the lower radiator mounting brackets. Do not tighten at this time.
3. Inspect the rubber bushings for upper support rods (2) and replace them if worn or damaged.
4. Install upper support rods (2) and the mounting hardware at both ends. Do not tighten at this time.
5. Adjust the upper support rods until the radiator is positioned perpendicular to the subframe within  $\pm 3.0$  mm (0.12 in.) measured at top of radiator. When the position is established, tighten the upper support rod locknuts and recheck the perpendicularity of the radiator.

6. Tighten radiator mounting hardware (4) at the lower radiator mounting brackets to the standard torque.
7. For added stability, stabilizer bars (3) may be installed. Install the stabilizer bars at the radiator brackets and subframe as shown, then tighten the mounting hardware to the standard torque.
8. Install fan guards (1, Figure 3-4) and (2) using the original mounting hardware.
10. Install the upper hoses between the radiator and the engine. Seat the hoses fully and tighten the clamps securely.
11. Install outlet elbows (2, Figure 3-3) and (4) with new gaskets.
12. Route the lines to the fuel cooler and clamp them in place. Attach the lines to the fuel cooler fittings.
13. Install the air conditioning system components.
  - a. Install condenser (2, Figure 3-2), hoses (4) and (5), and all clamps.
  - b. Install receiver/drier (3, Figure 3-1) and clamp the hoses. Attach the harness to the low pressure switch.
  - c. Clamp all hoses and wiring to the studs using the original clamps. Refer to Section N, Heater / Air Conditioner, for complete instructions on evacuating and recharging the air conditioning system.
14. Install the grille and hood according to the instructions in Section B, Structural Components. Make sure that both radiator bumpers are adjusted and secured.
15. Make sure that all coolant drains are closed, all pipe plugs are installed, and all hoses are connected securely. Service the cooling system with the proper mixture of antifreeze as recommended in Section P, Lubrication and Service. Check for leaks and correct as needed.
16. Start and operate the engine until the cooling system reaches normal operating temperature. Recheck for leaks during engine operation. Turn off the engine and correct any leaks.

## ALTERNATOR INSTALLATION



**The following instructions must be followed to ensure proper alignment and engine crankshaft endplay. Failure to follow these instructions can result in serious damage to the engine and/or alternator.**

- Never pry on the engine crankshaft damper.
- Loosen or remove fan belts before measuring crankshaft endplay to ensure that the crankshaft moves easily and completely.
- When taking measurements, always take four equally spaced readings and average them.
- Always measure from mating surface to mating surface.
- A reference to crankshaft rotation - clockwise (CW) or counterclockwise (CCW) - is the direction of rotation when looking at the front (damper end) of engine.
- **Crankshaft end play: 0.13 - 0.38 mm (0.005 - 0.015 in.)**

| SERVICE DATA - Eccentricity & Runout Limits               |                     |
|-----------------------------------------------------------|---------------------|
| Description                                               | T.I.R               |
| Maximum Eccentricity of Flywheel Housing Bore             | 0.66 mm (0.026 in.) |
| Maximum Face Runout of Flywheel Housing                   | 0.25 mm (0.010 in.) |
| Maximum Eccentricity of Flywheel (Coupling Assembly)      | 0.18 mm (0.007 in.) |
| Maximum Axial Runout of Flywheel Face (Coupling Assembly) | 0.25 mm (0.010 in.) |

## Measuring Procedure

1. Thoroughly clean the alternator housing mounting surface, rotor drive adapter mounting surface and flywheel housing adapter mounting surfaces.

2. Mount a magnetic base on the front of the engine and a dial indicator on the front of the crankshaft. Measure total crankshaft endplay.

Verify end play is within 0.13 - 0.38 mm (0.005 - 0.015 in.).

Total Crankshaft Endplay \_\_\_\_\_

3. Refer to Figure 4-4. Move the engine crankshaft to the rear of its end travel.

- a. Carefully measure Dimension "C" at four locations, 90° apart:

1st measurement: \_\_\_\_\_

2nd measurement: \_\_\_\_\_

3rd measurement: \_\_\_\_\_

4th measurement: \_\_\_\_\_

Dimension "Cavg": \_\_\_\_\_

- b. Add 1/2 (one-half) of Total Crankshaft Endplay from step 2 to Dimension "Cavg".

- c. Record (Step 3a + Step 3b) as Measurement "C": \_\_\_\_\_

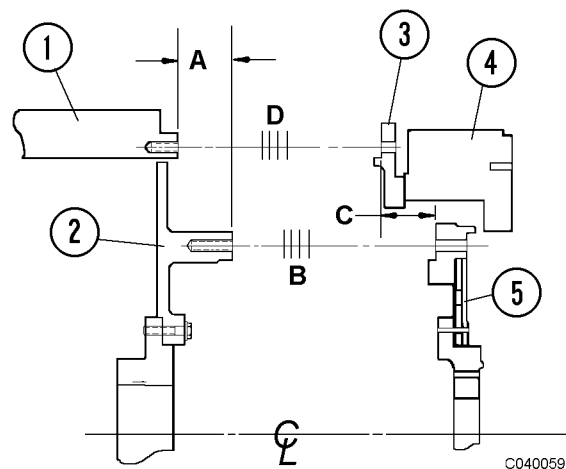


FIGURE 4-4. SHIM LOCATION

- |                             |                     |
|-----------------------------|---------------------|
| 1. Alternator Housing       | "A" - Dimension "A" |
| 2. Alternator Rotor         | "B" - Drive Shims   |
| 3. Flywheel Housing Adapter | "C" - Dimension "C" |
| 4. Engine Flywheel Housing  | "D" - Housing Shims |
| 5. Engine Drive Ring        |                     |

## **AIR INTAKE TROUBLESHOOTING**

To ensure maximum engine protection, all connections between the air cleaners and the engine intake are tight and sealed. If air leaks are suspected, check the following:

1. Check all intake lines, tubes and hump hoses for breaks, cracks, and holes which could allow an intake air leak.
2. Check that all air cleaner gaskets are sealing properly.
3. Check the main and safety filter elements for ruptures, holes or cracks.
4. Check the air cleaner assembly for structural damage, cracks, breaks or other defects which could allow air leakage. Check that all mounting hardware is tightened properly.

# SECTION C7 FAN CLUTCH INDEX

|                                      |       |
|--------------------------------------|-------|
| REMOVAL & INSTALLATION TOOLING ..... | C7-3  |
| DISASSEMBLY .....                    | C7-6  |
| CLEANING AND INSPECTION .....        | C7-16 |
| ASSEMBLY .....                       | C7-20 |
| TEST PROCEDURE .....                 | C7-34 |

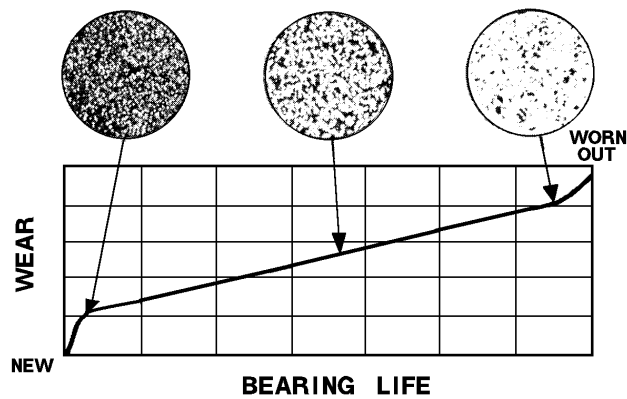


FIGURE 7-14.

12. Inspect sleeve bearing (44) and sleeve bearing (41). Compare the color of each bearing to the chart above. The lighter the appearance of the bearing, the more worn it is. If either bearing needs replacing, proceed to the next step. If the bearings are in good condition, skip the next step.

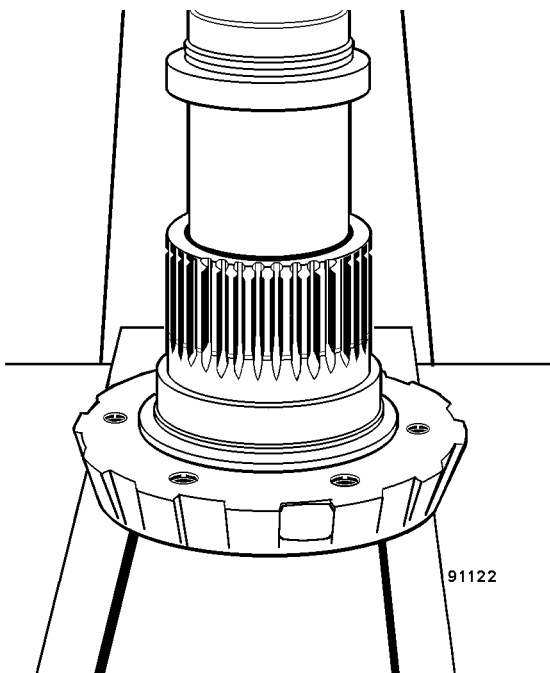


FIGURE 7-15.

13. Position tooling (C) against sleeve bearing (41). Press the front sleeve bearing downward to press it out of the fan mounting hub. Rear sleeve bearing (44) will be pressed out simultaneously.

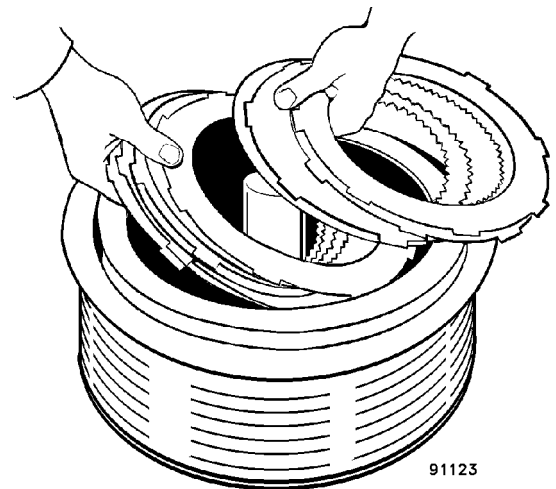


FIGURE 7-16.

14. Remove the stack of facing plates (30) and steel clutch plates (31) from inside the pulley.

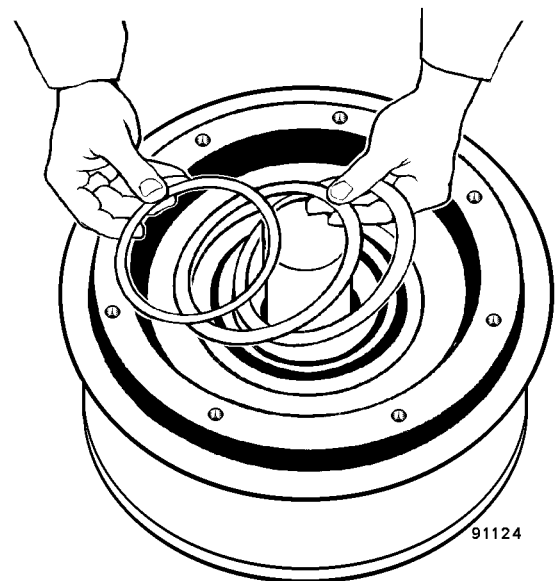


FIGURE 7-17.

15. Remove external snap ring (27), shim (26), and spring washer (25).

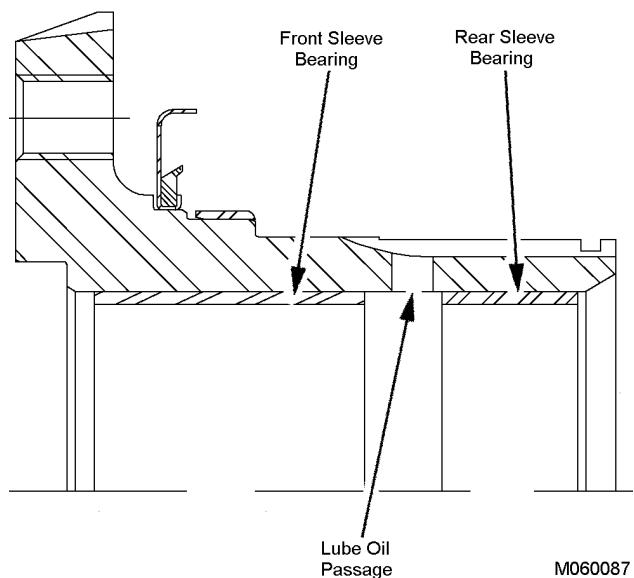


FIGURE 7-40.

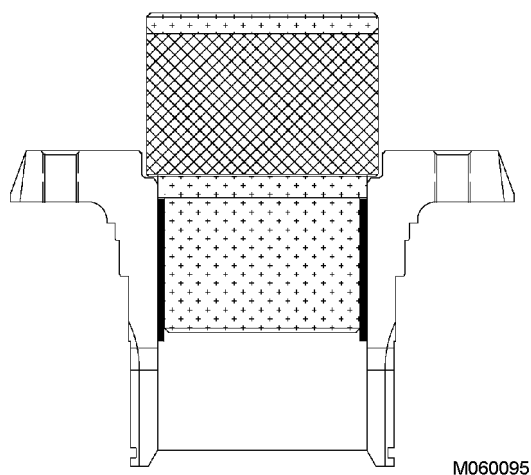


FIGURE 7-41.

3. Using tooling (A), press front (long) sleeve bearing (44) into the fan mounting hub until the tool contacts the shoulder of the hub. Ensure the correct bearing is installed. There are two sleeve bearings, and each one must be installed in the proper area of the hub to ensure the lube passage is not restricted. Refer to Figure 7-40.

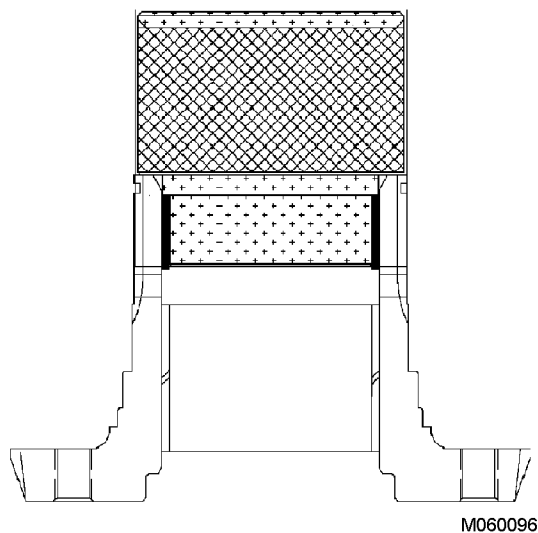
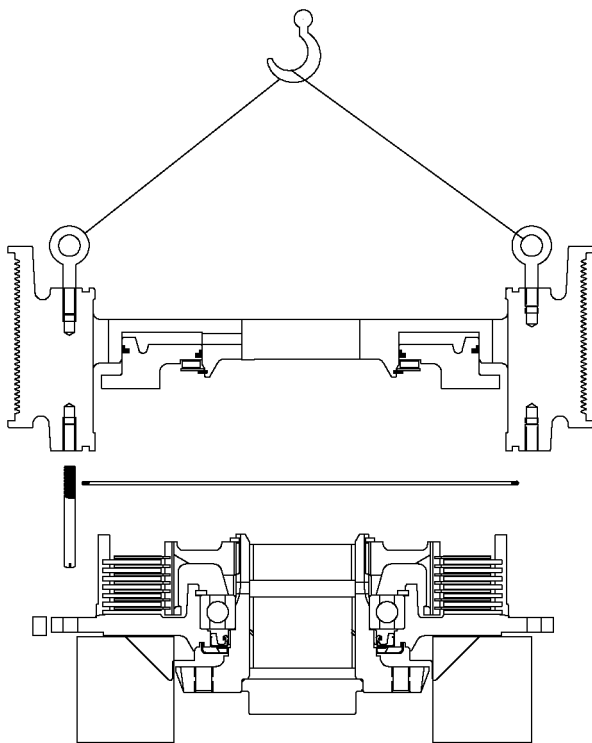


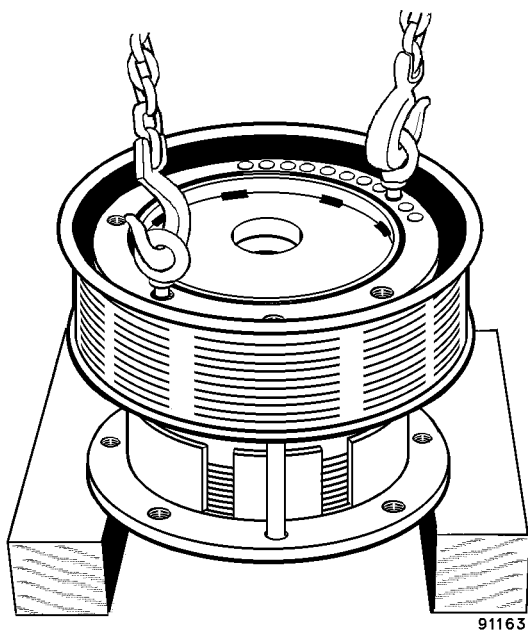
FIGURE 7-42.

4. Turn the hub over on the bed of the press. Using tooling (B), press rear sleeve bearing (41) into the fan mounting hub until the tool contacts the shoulder of the hub.



M060103

FIGURE 7-71.



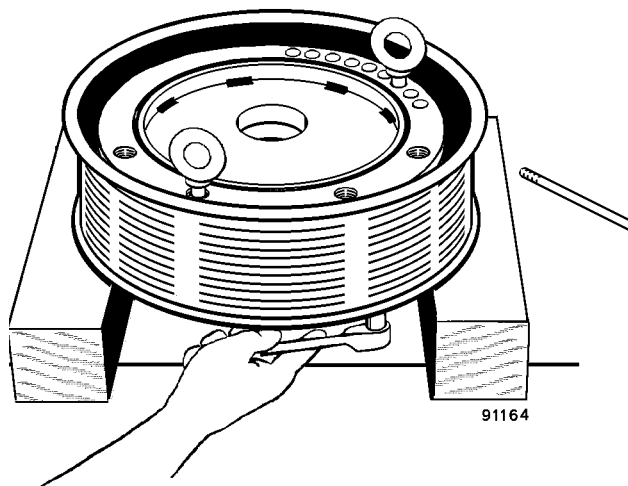
91163

FIGURE 7-72.

32. Turn the pulley adapter assembly over and install two lifting eyes 180 degrees apart. Install a guide bolt in one bolt hole of the pulley. Refer to Figure 7-71.

Coat front O-ring seal (34) with petroleum jelly or an oil-soluble grease. Place the seal in the groove in the pulley. The grease should secure the seal in the groove during installation.

Carefully lower the pulley. Ensure that the guide bolt is aligned with a bolt hole in the bearing retainer assembly and the O-ring seal is still securely in place. Lower the pulley until it rests on the front bearing retainer.



91164

FIGURE 7-73.

33. Install at least four bolts (38) with lockwashers (37) 90 degrees apart. Snug them down.

## BATTERY SUPPLY SYSTEM

### 24VDC Battery Charging Alternator

The battery charging alternator is a Prestolite 26-Volt (140 Amp) alternator.

### Battery Box

Four type 8D batteries (3, Figure 2-1) for the 24VDC engine start circuit are located in the battery box in the center of the front platform. For access to the batteries, open the two hinged covers by turning the cover latches counterclockwise until released. Lifting eyes are attached to each end of the battery box so that the entire battery box assembly can be removed, if necessary.

### Battery Control Box

Battery control box (4) is located to the left of the battery box. This box contains the engine start relay, isolation diode, auxiliary battery receptacles and battery disconnect switches.

### Engine Start Relay

Engine start relay (6) receives the signal to begin cranking from the start relay located on relay board RB6. When the engine start relay is activated, it provides current to the starter motors to engage the drives and begin cranking the engine, eliminating the need for magnetic switches.

### Isolation Diode (if equipped)

*NOTE: Later model trucks may be equipped with an additional engine start relay (6) instead of this diode, which is no longer available for service.*

A Schottky type isolation diode is used to provide isolation between the electrical system battery circuits and the dual starter motor start command circuits. This device controls the direction of current flow in high current applications.

Battery system isolation diode (5) allows current from the battery charging alternator to charge the batteries, but prevents current flow from the batteries to the starter motors when the engine is started.

### 24VDC Auxiliary Battery Receptacles

Two pairs of receptacles (2), located near the battery disconnect switches, are provided to attach battery charger leads for charging the batteries.

These receptacles can also be used for connecting external batteries to aid engine starting during cold weather. When external batteries are used, they should be of the same type (8D) as the batteries installed on the truck. Two pairs of batteries should be used. Each pair should be connected in series to provide 24VDC, with one pair connected to the front receptacle and the other pair connected to the rear receptacle on the truck.

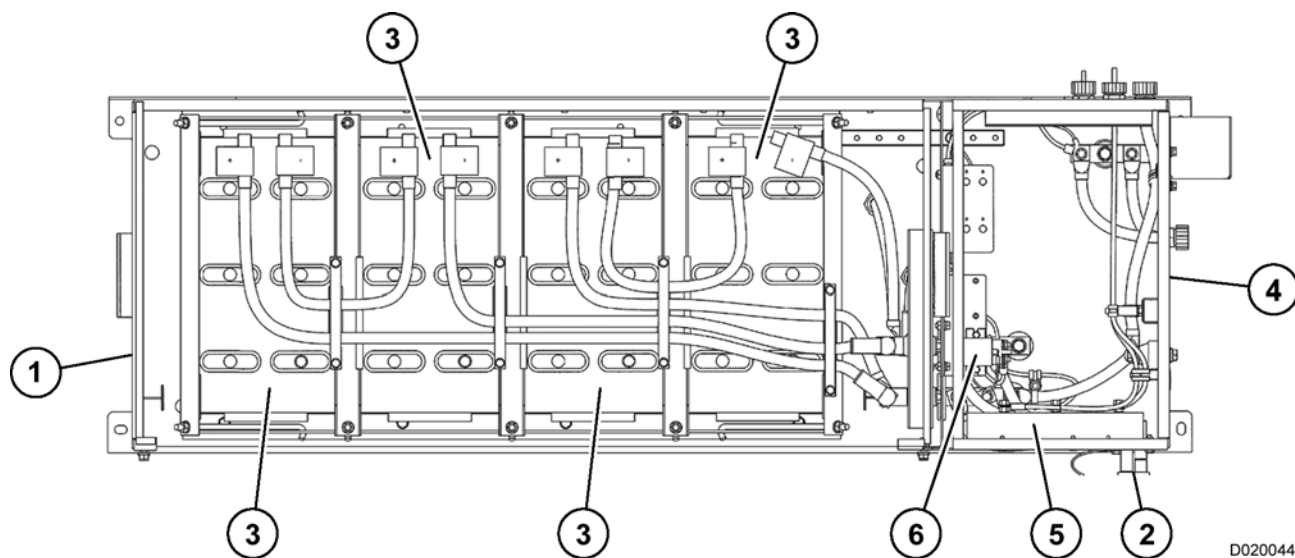


FIGURE 2-1. BATTERY BOX & BATTERY CONTROL BOX

- |                                  |                                   |
|----------------------------------|-----------------------------------|
| 1. Battery Box                   | 4. Battery Control Box            |
| 2. Auxiliary Battery Receptacles | 5. Battery System Isolation Diode |
| 3. Batteries                     | 6. Engine Start Relay             |

## RELAY BOARDS

The auxiliary control cabinet contains eight relay boards to provide control for many of the 24VDC circuits. Two types of boards are used. One type of board contains circuit breakers in addition to 24VDC relays and a PC board for special functions. The second type of board contains relays only.

All relays are interchangeable. The circuit breakers are also interchangeable as long as the circuit breaker capacity is the same.



***Do not interchange or replace any circuit breaker with one of a different capacity than specified for the circuit. Serious damage or a fire may result if the wrong capacity breaker is used.***

The relay boards are identified as follows:

| Relay Board | Functions                                                                                                 |
|-------------|-----------------------------------------------------------------------------------------------------------|
| RB1         | Clearance/Turn Signal Lights                                                                              |
| RB3         | Stop, Retard, Backup Lights                                                                               |
| RB4         | Parking Brake, Horn, Body-Up, Engine Cranking                                                             |
| RB5         | Headlights (standard)                                                                                     |
| RB6         | Headlights (HID), Backup Horn, Auto Lube Solenoid & Timer, Ether Start, Engine Interlock, Bleeddown Power |
| RB7         | Brake Lock, IM Warning, Timed Engine Shutdown                                                             |
| RB8         | PLMIII Lights, Shutter Control, TCI                                                                       |
| RB9         | Start Circuit, Brake Auto Apply, Low Steering Pressure, Parking Brake OFF, Key Switch START               |

Refer to Figure 3-1 for the location of each relay board. Refer to the Circuit Breakers chart at the end of this section for electrical circuit identification numbers.

## Relay Boards RB1, RB3, RB4, RB5

Each relay board of this type is equipped with four green lights (9, Figure 3-6) and one red “breaker open” light (7). Each relay board has a fifth green (8) light that has a different function on each board.

Four green lights (9) are labeled K1, K2, K3, or K4. These lights will be on only when that particular control circuit has been switched ON and the relay coil is being energized. The light will not turn on if the relay board does not receive the 24 volt signal to turn on a component.

If illuminated, red “breaker open” light (7) indicates that a circuit breaker on that relay board is in the OFF position. A light on the overhead display panel will also illuminate, informing the operator that a circuit breaker is in the OFF position. The red “breaker open” light will turn ON whenever there is a voltage difference across the two terminals of a circuit breaker.

If a control switch has been turned ON and a green (K) light is on, but that component is not operating, check the following on the relay board for that circuit:

- ☐ If a circuit breaker light is on, press all the circuit breakers to make sure that they are all on. There is no visual indication as to which circuit breaker has been tripped. Check the operation of the component. If it trips again, check the wiring or component for the cause of the overload.
- ☐ The contacts inside the relay may not be closing, or the contacts may be open, preventing an electrical connection. Swap relays and check again. Replace defective relays. Relays may take one minute to trip and 30 seconds before they can be reset.
- ☐ Check the wiring and all of the connections between the relay board and the component for an open circuit.
- ☐ The component may be defective. Replace the component.
- ☐ There is a poor ground at the component. Repair the ground connection.

### FUSE BLOCK #3

| Location | Amps | Devices protected           | Circuit |
|----------|------|-----------------------------|---------|
| 1        | 15   | Cab Drive System Power      | 71P     |
| 2        | 10   | Auto Lube Pump Power        | 68ES    |
| 3        | 15   | Interface Module (GE Power) | 71IM    |
| 4        | 20   | Operator Seat Power         | 71OS    |
| 17       | 10   | 12V Auxiliary Power Outlets | 67C     |
| 18       | 20   | R.H. Cab Window Switch      | 67R     |
| 19       | 20   | L.H. Cab Window Switch      | 67P     |

### FUSE BLOCK #4

| Location | Amps | Devices protected          | Circuit |
|----------|------|----------------------------|---------|
| 1        | 10   | Brake Circuits             | 71BC    |
| 2        | 5    | Payload Meter Controller   | 712PL   |
| 3        | 5    | Interface Module           | 87      |
| 4        | 10   | VHMS Controller            | 71VHM   |
| 5        | 5    | Modular Mining Hub         | 712MM   |
| 6        | 5    | Display Module             | 86      |
| 7        | 15   | Hydraulic Bleed Down Power | 71BD    |
| 8        | 10   | Switch LED Power           | 71LS    |
| 9        | 1    | Selector Switch Power      | 71SS    |
| 17       | 5    | Gauge Voltage              | 15V     |
| 18       | 5    | Pedal Voltage              | 15PV    |
| 19       | 5    | Engine Interface           | 15VL    |

### FUSE HOLDERS

| Location | Amps | Devices protected              | Circuit |
|----------|------|--------------------------------|---------|
| FH #1    | 1    | Left Rear Wheel Speed Sensor   | 15LRW   |
| FH #2    | 1    | Right Rear Wheel Speed Sensor  | 15RRW   |
| FH #3    | 1    | Left Front Wheel Speed Sensor  | 15SLW   |
| FH #4    | 1    | Right Front Wheel Speed Sensor | 15SRW   |

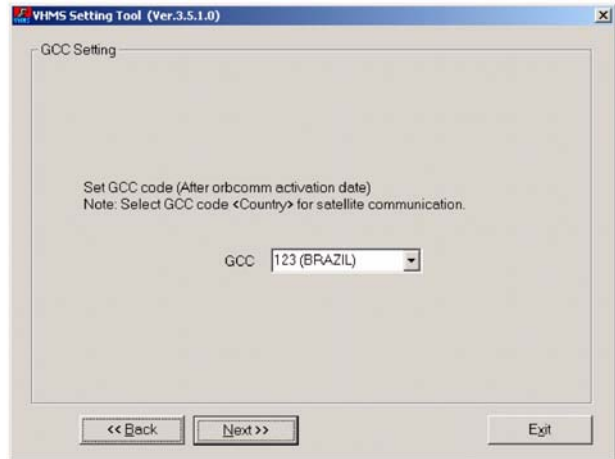
The following two fuses are located in the fusable link between the prelube timer solenoid and #2 cranking motor.

| Location     | Amps     | Devices protected | Circuit |
|--------------|----------|-------------------|---------|
| Fusable link | 150 each | Cranking Motors   | 11ST    |

| <b>Table 3: Snapshot Data</b>         |                            |
|---------------------------------------|----------------------------|
| <b>Data Item</b>                      | <b>Data Source</b>         |
| Engine Coolant Temperature            | Cummins QUANTUM Controller |
| Engine Oil Pressure                   | Cummins QUANTUM Controller |
| Accelerator Position%                 | Cummins QUANTUM Controller |
| Engine Speed                          | Cummins QUANTUM Controller |
| Exhaust Gas Temperature (Left Front)  | Cummins CENSE Controller   |
| Exhaust Gas Temperature (Left Rear)   | Cummins CENSE Controller   |
| Exhaust Gas Temperature (Right Front) | Cummins CENSE Controller   |
| Exhaust Gas Temperature (Right Rear)  | Cummins CENSE Controller   |
| Engine Oil Temperature                | Cummins CENSE Controller   |
| Fuel Rate                             | Cummins QUANTUM Controller |
| Boost Pressure                        | Cummins QUANTUM Controller |
| Blow-by Pressure                      | Cummins QUANTUM Controller |
| Vehicle Speed                         | PLM III                    |
| Sprung Weight                         | PLM III                    |
| haul cycle State                      | PLM III                    |
| Brake Pressure                        | Interface Module           |
| Hoist Pressure 1                      | Interface Module           |
| Hoist Pressure 2                      | Interface Module           |
| Steering Pressure                     | Interface Module           |
| Front Left Brake Oil Temperature      | Interface Module           |
| Front Right Brake Oil Temperature     | Interface Module           |
| Rear Left Brake Oil Temperature       | Interface Module           |
| Rear Right Brake Oil Temperature      | Interface Module           |
| Ambient Temperature                   | Interface Module           |

## GCC Setting

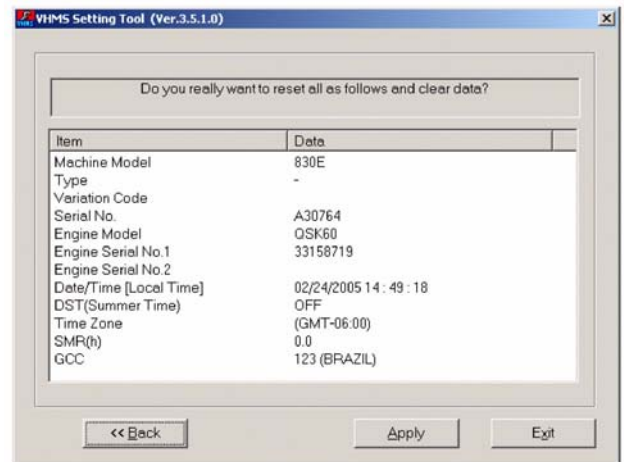
7. Choose the correct GCC code. The GCC code tells trucks that are equipped with Orbcomm which satellite ground station to use. Then click [Next].



D120040

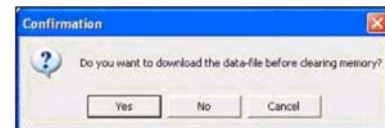
## Setting Summary

8. Verify that all the setting information is correct and click [Apply].



D120041

9. Click [YES].



D120042

10. Click [OK].



D120043

11. Click [OK]. The VHMS Setting Tool program will close.



D120044

## VHMS CONTROLLER CHECKOUT

### Necessary Equipment

- Checkout procedure
- System schematic
- Laptop personal computer (PC)
- *VHMS Technical Analysis Toolbox* software
- *VHMS Setting Tool* software
- Tera Term Pro software
- Serial cable (RS232)  
(male DB9 connector on one end, female connector on the other end)

**NOTE:** Before performing this procedure, the interface module must be fully functional and the VHMS controller must be initialized and fully functional.

### Preliminary

1. Turn the key switch to the OFF position to stop the engine. Verify that the seven segment LED display on the VHMS controller is off.
2. Turn the key switch to the ON position, but DO NOT start the engine.
3. Allow the VHMS controller to boot up. Watch the red, two digit LED display on the VHMS controller to show a circular sequence of seven flashing segments on each digit. After a short time the two digit display should start counting up from 00 - 99 at a rate of ten numbers per second.
4. Attach the VHMS serial cable to the truck's VHMS diagnostic port (2, Figure 13-3) and the other end to the laptop PC's serial port.
5. Double-click on the *VHMS Technical Analysis Tool Box* icon on the laptop PC's desktop.
6. Enter the appropriate User Name and Password and click the [OK] button.
7. Check for any active fault codes. If any are found, these circuits should be analyzed to determine the cause of the fault and they must be repaired before continuing.

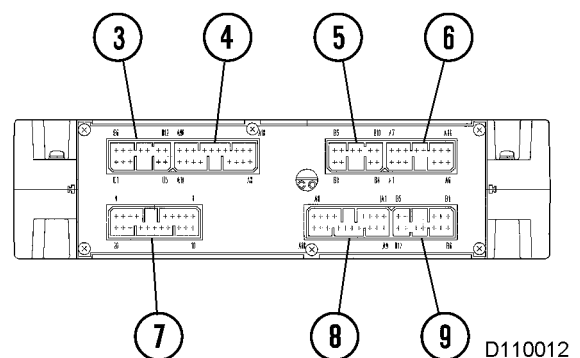
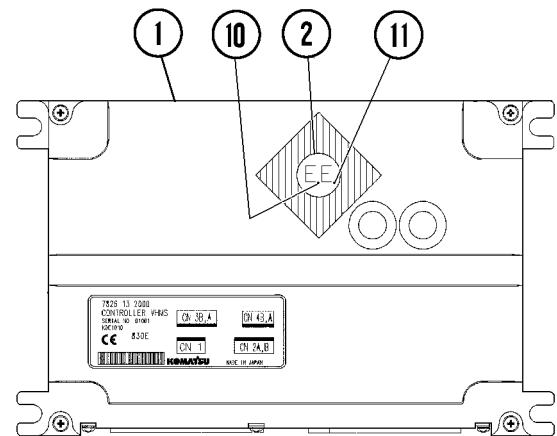


FIGURE 13-7. VHMS CONTROLLER

- |                    |                   |
|--------------------|-------------------|
| 1. VHMS Controller | 7. Connector CN1  |
| 2. LED Display     | 8. Connector CN2A |
| 3. Connector CN3B  | 9. Connector CN2B |
| 4. Connector CN3A  | 10. PLM III Light |
| 5. Connector CN4B  | 11. OrbComm Light |
| 6. Connector CN4A  |                   |

## INTERFACE MODULE CHECKOUT

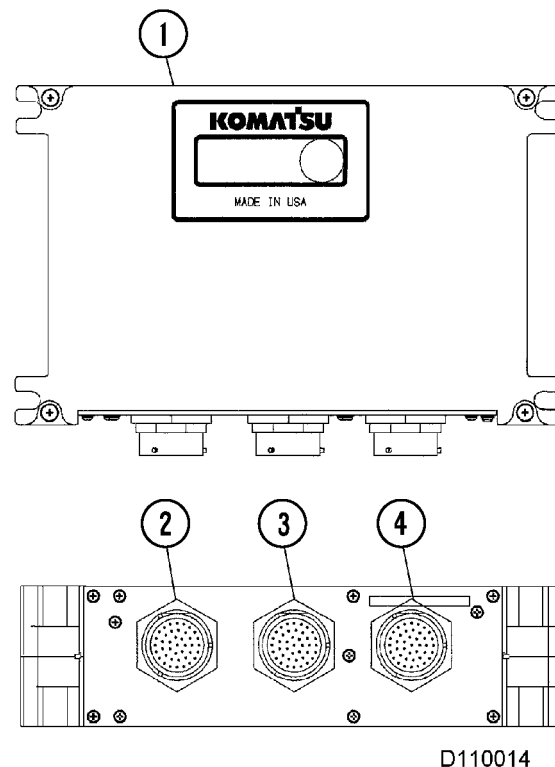
### **⚠ IMPORTANT ⚠**

*If a new truck with VHMS is being assembled, or a new VHMS system has just been installed, refer to the VHMS System for instructions regarding the VHMS Initialization Procedure. The initialization procedure and form must be completed before the truck can be put into service.*

#### Necessary Equipment

- System schematic
- Laptop PC
- *Interface Module Real Time Data Monitor* software
- Serial cable (RS232)
- Jumper wire 77 mm (3 in.) or longer
- Volt Meter
- 300 to 332 ohm resistor
- 3/8 in. nut driver

*NOTE: The interface module must already have the application code installed.*



D110014

FIGURE 12-4. INTERFACE MODULE

- |                     |                  |
|---------------------|------------------|
| 1. Interface Module | 3. Connector IM2 |
| 2. Connector IM1    | 4. Connector IM3 |

## VHMS LED Display Fault Codes

The VHMS controller also indicates some faults on the two red LED digits on the top of the controller. Fault codes are flashed as a two part sequence, as shown in the table below.

When no communication errors are occurring, the VHMS LED digits count from 00 - 99 continuously at a rate of ten numbers per second.

| Table 2: VHMS LED Display Error Codes |                                              |                          |
|---------------------------------------|----------------------------------------------|--------------------------|
| Fault Code                            | Fault Condition                              | VHMS LED Display         |
| M101                                  | Truck Frame Number Changed                   | Alternates 'n1' and '01' |
| M801                                  | Can-net System (J1939)                       | Alternates 'n8' and '01' |
| M804                                  | Can-net System (RPC)                         | Alternates 'n8' and '04' |
| M806                                  | IM Stopped Real Time Data                    | Alternates 'n8' and '06' |
| M807                                  | Too Much Payload Data For Requested Period   | Alternates 'n8' and '07' |
| M808                                  | PLMIII Stopped Real Time Data                | Alternates 'n8' and '08' |
| M809                                  | Can-net System (QUANTUM)                     | Alternates 'n8' and '09' |
| M80A                                  | Can-net System (CENSE)                       | Alternates 'n8' and '0A' |
| M901                                  | Source Voltage Error                         | Alternates 'n9' and '01' |
| M902                                  | VHMS 24V Source System Error                 | Alternates 'n9' and '02' |
| M903                                  | VHMS 12V Source System Error                 | Alternates 'n9' and '03' |
| M904                                  | VHMS 5V Source System Error                  | Alternates 'n9' and '04' |
| M905                                  | Abnormality in VBAT Voltage (VHMS VBAT <10V) | Alternates 'n9' and '05' |
| M990                                  | Ethernet Power Short                         | Alternates 'n9' and '90' |
| MC10                                  | MEMORY CLEAR: Failure History                | Alternates 'nc' and '10' |
| MC31                                  | MEMORY CLEAR: (Load Map)                     | Alternates 'nc' and '31' |
| MC40                                  | MEMORY CLEAR: (Trend Analysis)               | Alternates 'nc' and '40' |
| MC60                                  | MEMORY CLEAR: (Snap Shot)                    | Alternates 'nc' and '60' |
| MC91                                  | MEMORY CLEAR: (Maintenance History)          | Alternates 'nc' and '90' |
| ME01                                  | Change Service Meter                         | Alternates 'ne' and '01' |
| ME02                                  | Change Calendar                              | Alternates 'ne' and '02' |
| ME03                                  | Orbcomm Settings                             | Alternates 'ne' and '03' |
| ME04                                  | Other Settings                               | Alternates 'ne' and '04' |
| ME05                                  | MEMORY CLEAR: All                            | Alternates 'ne' and '05' |
| ME06                                  | Initialized                                  | Alternates 'ne' and '06' |
| MF11                                  | VHMS Connector Mismatch                      | Alternates 'nf' and '11' |
| MFA0                                  | Manual Trigger                               | Alternates 'nf' and 'A0' |

| Table 4: Engine Fault Codes (continued) |                                       |        |                  |                  |
|-----------------------------------------|---------------------------------------|--------|------------------|------------------|
| VHMS Fault Code                         | VHMS Fault Description                | Source | Sent via OrbComm | Snapshot Trigger |
| C2144                                   | High Exh Temp #9 LB                   | Engine |                  |                  |
| C2145                                   | High Exh Temp #9 RB                   | Engine |                  |                  |
| C2146                                   | Exh Temp Ckt Failed Low #9 LB         | Engine |                  |                  |
| C2147                                   | Exh Temp Ckt Failed Low #9 RB         | Engine |                  |                  |
| C2148                                   | High Power #9 LB                      | Engine |                  |                  |
| C2149                                   | High Power #9 RB                      | Engine |                  |                  |
| C2151                                   | Low Power #9 LB                       | Engine |                  |                  |
| C2152                                   | Low Power #9 RB                       | Engine |                  |                  |
| C2154                                   | Post Oil Filter Press Ckt Failed High | Engine |                  |                  |
| C2155                                   | Post Oil Filter Press Ckt Failed Low  | Engine |                  |                  |
| C2157                                   | Rapid Rise in LBR IMT                 | Engine |                  |                  |
| C2158                                   | Rapid Rise in RBF IMT                 | Engine |                  |                  |
| C2159                                   | Rapid Rise in RBR IMT                 | Engine |                  |                  |
| C2241                                   | High IMT LBM                          | Engine |                  |                  |
| C2242                                   | LBM IMT Ckt Failed High               | Engine |                  |                  |
| C2243                                   | LBM IMT Ckt Failed Low                | Engine |                  |                  |
| C2244                                   | Rapid Rise in LBM IMT                 | Engine |                  |                  |
| C2245                                   | High IMT RBM                          | Engine |                  |                  |
| C2246                                   | RBM IMT Ckt Failed High               | Engine |                  |                  |
| C2247                                   | RBM IMT Ckt Failed Low                | Engine |                  |                  |
| C2248                                   | Rapid Rise in RBM IMT                 | Engine |                  |                  |

### **Machine Information**

- Enter machine information. All fields are required.
- VHMS and Orbcomm controller part numbers and serial numbers can be found on a sticker on each controller. Verify that this matches the information displayed in the *VHMS Setting Tool* and download.

### **VHMS Setting Tool Information**

- Enter the setting date. This should be the date when the first data download was taken and the *VHMS Setting Tool* program was first used.
- Enter the setting time. This should be the time shown in the first data download. Verify that it is the correct time.
- Enter the Greenwich Mean Time (GMT) for the location the machine will be working.
- Check whether the location where the machine will be working uses Daylight Savings Time (DST).
- Enter the service meter reading (SMR) at time of the first download.
- Enter the GCC Code. This setting tells the Orbcomm unit which satellite network to communicate with. Select the correct location from the drop down menu list.
- Enter the Orbcomm activation date. In the Orbcomm Activation Date field, enter a date at least two weeks ahead of today's date

### **Reason for Form Submittal**

Check the reason for submitting the VHMS Initialization Form.

## SYSTEM COMPONENTS

The ICP (Integrated Control Panel) consists of three major components: the PSC (Propulsion System Controller), the TCI (Truck Control Interface) and the TMC (Traction Motor Controller).

### Propulsion System Controller (PSC)

The PSC is the main controller for the AC drive system. The ICP panel receives input signals from speed sensors mounted on the alternator and traction motors, voltage and current feedback signals from various control devices, and status/command inputs from the TCI. Using these inputs, the PSC controls the two inverters, retarding circuits, relays, contactors, and other external devices to provide the following functions:

- Propulsion and wheel slip control
- Retarding and wheel slide control
- Engine speed control
- Event detection
- Initialization of the necessary operating restrictions, including the shut down of the truck if a serious system fault (event) is detected. If the fault is not serious, an indicator lamp alerting the operator to the problem will illuminate. All event data is recorded for future review by maintenance personnel.
- Log event data
- Store statistical data of the history of various component and system function operations.
- Communicate with the TCI to exchange propulsion system status and control data (event data, statistical data, etc.) and to receive required truck systems status data.
- Communicate with the TCI to exchange propulsion Portable Test Unit (PTU) data (propulsion real time, history, diagnostic, and parameter data such as software code, etc.)
- Drive the operator cab status and warning lamps.

The PSC contains the following internal, removable printed circuit boards and two fiber optic boards:

**System CPU Card:** Provides serial communications and control functions, RS232 communications to PTU, and microprocessor controls for internal panel circuits.

**Digital I/O Card:** Receives digital inputs and feedback information from various propulsion and control system components. Digital outputs drive propulsion system contactors, relays and provide equipment enable commands.

**System Analog I/O Card:** Receives engine, voltage and current signals for the main alternator, link voltage and current, retard pedal input, and retard lever input. Controls retard effort, engine speed request, and AFSE firing pulses.

**Inverter 1 & 2 CPU and I/O Cards (2 ea.):** Receives motor speed signals, link voltage, phase voltages, and phase currents for microprocessor control for inverters 1 and 2. Controls IGBT phase modules through the fiber optic assembly. Phase module status is returned via a separate fiber optic assembly.

**Fiber Optic Assembly:** Provides electrical isolation for control and feedback signals for phase modules and chopper modules.

**Table 3: DID PANEL FAULT CODES**  
**(Codes Received from Inverter 1 & 2)**

| EVENT NUMBER |     | EVENT DESCRIPTION    | EVENT RESTRICTION | DETECTION INFORMATION                       |
|--------------|-----|----------------------|-------------------|---------------------------------------------|
| 102/202      |     | INV I/O CARD (FB172) | INV1 (INV2) off   |                                             |
|              | :05 | gnd not ok           |                   | Logic ground not OK                         |
|              | :08 | no IO card           |                   | Could not access I/O card                   |
|              | :09 | eoc not working      |                   | A/D conversion did not work.                |
|              | :10 | DB no brake          |                   | DB on too long while not braking            |
|              | :11 | ptf A signal         |                   | Phase A overcurrent signal too long         |
|              | :12 | ptf B signal         |                   | Phase B overcurrent signal too long         |
|              | :13 | ptf C signal         |                   | Phase C overcurrent signal too long         |
|              | :14 | IC zero not ok       |                   | Current IC not zero at start up             |
|              | :15 | IC not ok            |                   | C phase current too high                    |
|              | :16 | ptl not ok           |                   | Protective turn off circuit not OK          |
|              | :17 | cur measure not ok   |                   | Phase A and B currents do not match.        |
| 103/203      |     | INV I/O CARD (NR)    | None              |                                             |
|              | :01 | chop 1 cmd not off   |                   | Chopper 1 command not off                   |
|              | :02 | chop 2 cmd not off   |                   | Chopper 2 command not off                   |
|              | :03 | chop 1 cmd not on    |                   | Chopper 1 command not on                    |
|              | :04 | chop 2 cmd not on    |                   | Chopper 2 command not on                    |
|              | :05 | volt scale A flt     |                   | Scale A volts out of range 70%, 100%        |
|              | :06 | volt scale B flt     |                   | Scale B volts out of range 70%, 100%        |
|              | :07 | link V scale flt     |                   | Link V scale out of range 70%, 100%         |
|              | :08 | current scale A flt  |                   | Scale A current out of range 70%, 100%      |
|              | :09 | current scale B flt  |                   | Scale B current out of range 70%, 100%      |
|              | :10 | input V scale flt    |                   | Input V scale out of range 70%, 100%        |
|              | :11 | V test VCO high      |                   | High frequency on VCO Vtest channel         |
|              | :12 | V test VCO low       |                   | Low frequency on VCO Vtest channel          |
|              | :13 | IA VCO hi            |                   | High frequency on IA channel                |
|              | :14 | IB VCO hi            |                   | High frequency on IB channel                |
|              | :15 | link V VCO hi        |                   | High frequency on VCO link filter V channel |
|              | :16 | infilV VCO hi        |                   | High frequency on VCO in filter V channel   |
|              | :17 | IA too high          |                   | IA current too positive                     |
|              | :18 | IA too low           |                   | IA current too negative                     |
|              | :19 | IB too high          |                   | IB current too positive                     |
|              | :20 | IB too low           |                   | IB current too negative                     |
|              | :21 | link V too hi        |                   | Link voltage too positive                   |
|              | :22 | infilV too hi        |                   | Input filter voltage too positive           |
|              | :23 | DB chop VCO hi       |                   | High frequency on VCO DB chopper channel    |

**Table 4: DID PANEL FAULT CODES**  
**(Codes Received from TCI)**

| EVENT NUMBER |     | EVENT DESCRIPTION                              | EVENT RESTRICTION | DETECTION INFORMATION                                                                                  |
|--------------|-----|------------------------------------------------|-------------------|--------------------------------------------------------------------------------------------------------|
| 633          |     | BBRAM CORRUPTED                                | SYS Event         | Battery backed RAM has failed.                                                                         |
| 634          |     | TRUCK OVERLOADED - RESTRICTIVE                 | NO PROPEL         | The over-payload signal is on, operation restricted.                                                   |
| 635          |     | TRUCK OVERLOADED - NON-RESTRICTIVE             | SYS Event         | The over-payload signal is on, propulsion allowed.                                                     |
| 636          |     | AUX INVERTER                                   | SYS Event         | An auxiliary blower control failure has occurred.                                                      |
|              | :01 | buss volts low                                 |                   | Low DC bus was detected during powerup.                                                                |
|              | :02 | buss volts high                                |                   | High DC bus was detected during powerup.                                                               |
|              | :03 | overcurrent                                    |                   | Overcurrent condition was detected during operation.                                                   |
|              | :04 | battery loss                                   |                   | Loss of blower control battery voltage has occurred.                                                   |
|              | :05 | high dc buss when running                      |                   | High DC bus voltage was detected during operation.                                                     |
|              | :06 | high dc buss after pc powerup                  |                   | High DC bus voltage was detected after phase controller powerup.                                       |
|              | :07 | Low dc buss after pc powerup                   |                   | Low DC bus voltage was detected after phase controller powerup.                                        |
|              | :08 | high dc buss when running                      |                   | High DC bus voltage was detected during operation.                                                     |
|              | :09 | overcurrent after pc powerup, current overload |                   | Overcurrent condition was detected after phase controller power up.                                    |
|              | :10 | current overload                               |                   | Sustained current overload exists.                                                                     |
|              | :11 | low dc buss overcurrent                        |                   | Overcurrent due to low DC bus voltage                                                                  |
|              | :12 | low dc buss current overload                   |                   | Sustained current overload due to low DC bus voltage                                                   |
|              | :13 | gate drive trip                                |                   | IGBT protection circuit detected an overload.                                                          |
|              | :14 | no input voltage                               |                   | Zero input voltage was detected.                                                                       |
| 638          |     | ENGINE CRANKING TIMEOUT                        | SYS Event         | Engine is cranking longer than allowed.                                                                |
| 639          |     | ENGINE START REQUEST WHILE RUNNING             | SYS Event         | Engine start request signal occurred while engine RPM greater than 600 RPM, and longer than 3 seconds. |
| 640          |     | ACCEL PEDAL TOO HIGH                           | No Propel         | Accelerator pedal voltage is high.                                                                     |
| 641          |     | ACCEL PEDAL TOO LOW                            | SYS Event         | Accelerator pedal voltage is low.                                                                      |
| 696          |     | UNEXPECTED TCI CPU RESET                       | SYS Event         | TCI CPU reset without request.                                                                         |
| 698          |     | DATA STORE                                     | SYS Event         | A data snapshot has been manually initiated.                                                           |

TCI:

1. With the PTU serial cable attached to the TCI port, type `c:\ACNMENU` and press {enter}.
2. Select "PTU TCI and PSC and press {enter}
3. Type your name and press {enter}.
4. Type your password and press {enter}.
5. Cursor to "Special Operation" and press {enter}.
6. Cursor to "Event Data Menu" and press {enter}.
7. Cursor to "View Data Packs" and press {enter}.
8. Type PK number to be recorded and press {enter}.
9. Watch the lower right of the screen as 100 frames are recorded. Press the F2 key.
10. Cursor to "Record Screen" and press {enter}.
11. Assign a file name for the data pack.
12. Press {escape} until back to the DOS "C:>" prompt.
13. Insert a blank disk in the appropriate drive.
14. Type the following command: `copy c:\geoh-vac\ptuaccu\rf2data\filename`

*NOTE: Insert the name assigned to the file in Step 11 in place of "filename" in the command in Step 14.*

15. Press {enter} to copy the file to the disk.

### Event Reset

There are two basic types of event resets: *soft* and *hard*. The difference between the soft and hard reset is that a soft reset only affects events that have not been locked out and a hard reset affects events regardless of lockout status.

Events will be reset:

- *On power-up* - A soft reset will be issued against all events at power-up.
- *By DID commands* - The TCI can issue both hard and soft resets.
- *By PTU commands* - The PTU can issue both hard and soft resets.

## SERIAL DATA COMMUNICATIONS

The PSC system CPU card uses serial data busses to communicate with the TCI, the PTU, and the two inverter CPU cards.

### PSC - TCI Communications Processing

This software function performs the processing necessary for the PSC to communicate with the TCI. The communication is comprised of periodic data and non-periodic data.

Periodic data is a predefined set of data which is used for transferring real time control information from the PSC to the TCI and from the TCI to the PSC at a fixed rate.

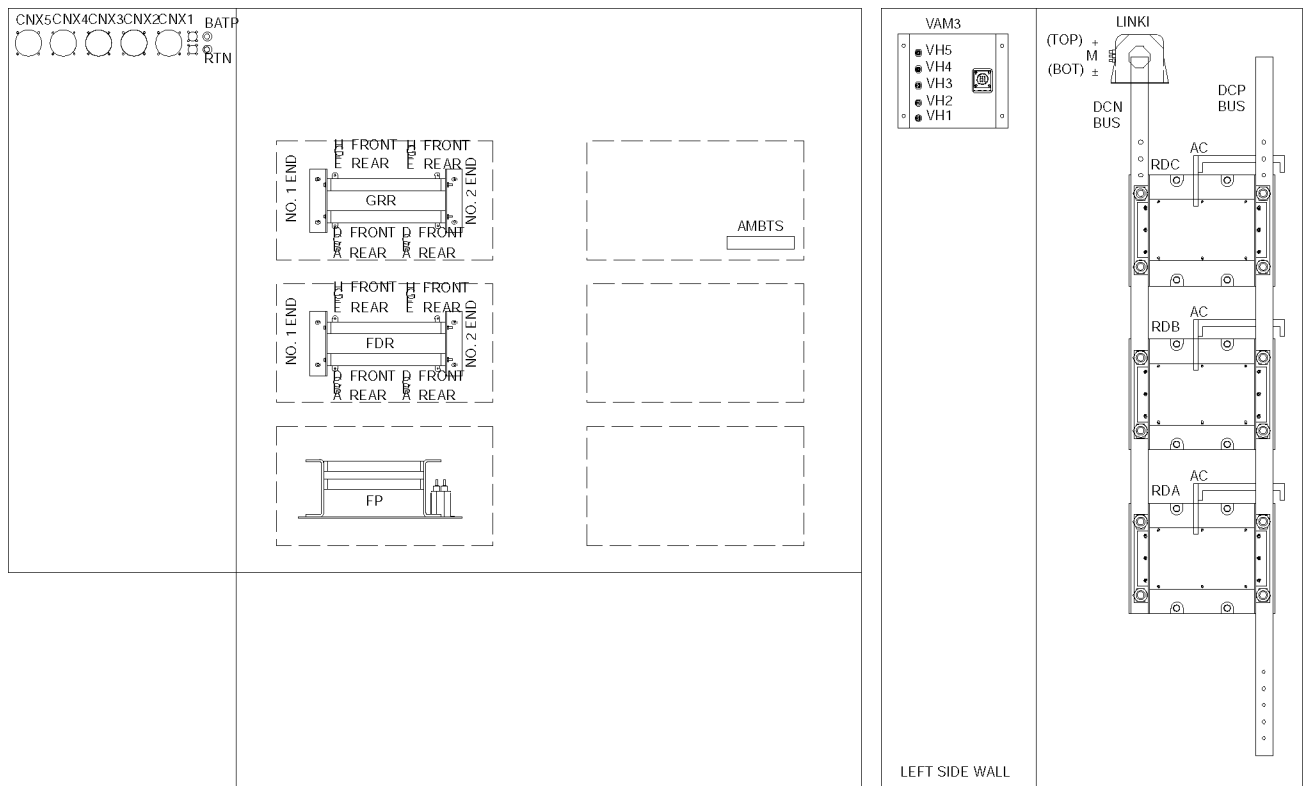
The non-periodic messages are used to transfer all background data. Background data consists of DID commands, remote monitor data, and download code.

Packets containing periodic data will be asynchronously (not initiated) transmitted from the PSC to the TCI and from the TCI to the PSC every 200 ms. The TCI initiates the transfer of non-periodic data.

The TCI and the PSC are interfaced using the General Electric Asynchronous Communications Protocol (ACP). ACP provides two general types of messages: *acknowledged* and *unacknowledged*. The acknowledged messages are used to transmit the background data. The unacknowledged messages are used to transmit the periodic data.

### PSC - PTU Communications Processing

This software function performs the processing necessary for the PSC to communicate through an RS-232 serial link to the Portable Test Unit (PTU).



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FIGURE 2-6. CONTROL CABINET COMPONENTS - REAR CABINET VIEW

### Checks with Key Switch OFF

5. With key switch OFF, verify 25VDC to ground minimum for the following circuits:

- ☐ 11
- ☐ 11s on TB30
- ☐ 11L on CB30
- ☐ 11A on TB30
- ☐ 11SL on TB28

*NOTE: The voltage should be at least 25VDC. If the voltage is significantly low, check the battery circuits. If the voltage is slightly low, install a battery charger.*

6. Check circuit 11B1 voltage to ground.

- ☐ The voltage should be approximately 12VDC.

7. Make sure that the CN1 connector on the power supply is connected. Install the BATFU fuse.

8. Activate the battery disconnect switches and turn on the ground level engine shutdown switch. Make sure all circuit breakers are closed.

10. Use a digital multimeter to check the polarity of the battery voltage at the BATFU fuse holder. Connect the positive lead to BATP and the negative lead to RTN.

- ☐ The voltage at BATP should be +24V.

### Checks with Key Switch ON

1. Deactivate the battery disconnect switches. Turn the key switch ON.

2. Check the voltage of circuit 712 to ground.

- ☐ The voltage should be 25VDC.

3. Check the voltage of circuit 71CK to ground.

- ☐ The voltage should be 25VDC.

4. Turn control power switch (1, Figure 3-1) to ON. Verify that all five green lights in the power supply are lit.

5. Verify that the display on the DID panel is lit.

6. Check the voltage on the following circuits in the auxiliary control cabinet. Voltage at each should be at least 25VDC:

- ☐ 71 on TB32
- ☐ 71GE on TB22

7. Verify the specified voltage to ground at the following locations in the auxiliary control cabinet:

- ☐ +15VDC at the 15PV wire on TB29 (from TCI, supply to operator control pedals)
- ☐ +15VDC at the 15V wire on TB21 (from TCI, power to cab gauges)
- ☐ +15VDC at the 15SPD, 15RWS and 15LWS wires on TB21 (from TCI, power to front wheel speed sensors)
- ☐ Approximately 11VDC at the 10V wire on TB28
- ☐ +15VDC at the 15VL wire on TB32
- ☐ Approximately 14.8VDC at the 15SIM wire on TB32.

8. Measure voltage between circuit 72E (+) (TB24) and circuit 0 (-) (TB24-H) in the auxiliary control cabinet.

- ☐ The voltage should be 5VDC.

9. Install a jumper from 22F0 @ TB32 to ground.

- ☐ The voltage should change to 7VDC.

10. Remove the jumper to 22F0.

11. Verify 12VDC to ground for the following circuits:

- ☐ 65
- ☐ 67C
- ☐ 67R
- ☐ 67P

### CPU Battery Checks

12. Turn the control power switch to OFF.

13. Connect a VOM across the screws securing the green plate on the edge of the PSC CPU card in the ICP panel. Connect the positive lead to top screw (2, Figure 3-2) and the negative lead to bottom screw (4).

- ☐ The value should be approximately 3.5 volts.

14. Connect a VOM across the screws securing the green plate on the edge of the TCI CPU card in the TCI panel. Connect the positive lead to top screw (2) and the negative lead to bottom screw (4).

- ☐ The value should be approximately 3.5 volts.

*NOTE: If battery voltage is low in either battery check, refer to "Memory Backup Battery Replacement" instructions on the following page.*

**TABLE IV. TCI DIGITAL INPUT CHECKS**

| STEP | INPUT             | DESCRIPTION                                                                                                                                                                                                                                                              |
|------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | ENGSTRTREQ        | Engine Start Request - DO NOT CHECK AT THIS TIME.                                                                                                                                                                                                                        |
| 2    | ENGCAUTION        | Check Engine Caution Lamp - Jumper circuit 419M @ TB30 to ground to illuminate the lamp in the overhead panel. ENGCAUTION on the PTU should be highlighted.                                                                                                              |
| 3    | CONTROLON WARM-UP | Control Power ON & Engine Warm-Up - DO NOT CHECK AT THIS TIME.                                                                                                                                                                                                           |
| 4    | ENGWARN           | Engine Service Light - Jumper 528A @ TB32 to ground to illuminate the blue indicator lamp on the back of the center console.                                                                                                                                             |
| 5    | ENGINILL          | Engine Shutdown Switch - Pull up on switch on center console. Verify that circuit 439 @ TB25 changes from 24VDC to 0VDC. Push down the switch to reset the system.                                                                                                       |
| 6    | BODYDOWN          | Body Up Switch (activated when body is down) - Place a washer on body-up switch. Verify that circuits 63L & 71F change from 0VDC to 24VDC and the lamp in the overhead panel is OFF.                                                                                     |
| 7    | RESTSW            | Rest Switch - Move the Rest Switch to the REST position. Verify that the internal lamp on the Rest Switch illuminates when in the REST position.                                                                                                                         |
| 8    | REVREQ            | Reverse Request - Move the selector lever to the REVERSE position. The parking brake will release, circuit 52PBO will be 24VDC, and circuit 52CS will be 0VDC.                                                                                                           |
| 9    | FORREQ            | Forward Request - Move the selector lever to the FORWARD position. The parking brake will release, circuit 52PBO will be 24VDC, and circuit 52CS will be 0VDC.                                                                                                           |
| 10   | NEUREQ            | Neutral Request - Move the selector lever to the NEUTRAL position. The parking brake will release, circuit 52PBO will be 24VDC, and circuit 52CS will be 0VDC.                                                                                                           |
| 11   | PRKBRKSW          | Parking Brake Switch - Move the selector lever to the PARK position. PRKBRKSW on the PTU should be highlighted. (NOTE: The parking brake solenoid is controlled by the VHMS Interface Module. See VHMS/Interface Module Checkout Procedure to fully test this function.) |
| 12   | RSC               | Retard Speed Control Switch - Pull up the switch on the center console.                                                                                                                                                                                                  |
| 13   | MIDPAYLD          | Truck at 70% Payload - Jumper 73MS @TB25 to ground. (NOTE: RB2 circuit breakers must be OFF if installed.)                                                                                                                                                               |
| 14   | FULLPAYLD         | Truck Fully Loaded - Jumper 73LS @TB25 to ground. (NOTE: RB2 circuit breakers must be OFF if installed.)                                                                                                                                                                 |
| 15   | OVERPAYLD         | Truck Overloaded - Jumper circuit 72IP@TB29 to circuit 712 @ TB32.                                                                                                                                                                                                       |
| 16   | RESET             | Override/Fault Reset Switch - Push the switch on the center console.                                                                                                                                                                                                     |
| 17   | LAMPTEST          | Lamp Test Switch - Push the switch on the dash panel. All warning/status lights in the overhead panel should illuminate except for the bottom two rows, the backup horn sounds, and the retard lights at the rear of the truck and on top of the cab turn on.            |
| 18   | DATASTORE         | Data Store Switch - Push the switch on the back of the center console.                                                                                                                                                                                                   |
| 19   | AXLEP             | Axle Pressure Switch - Jumper across the air pressure switch in the rear axle housing.                                                                                                                                                                                   |

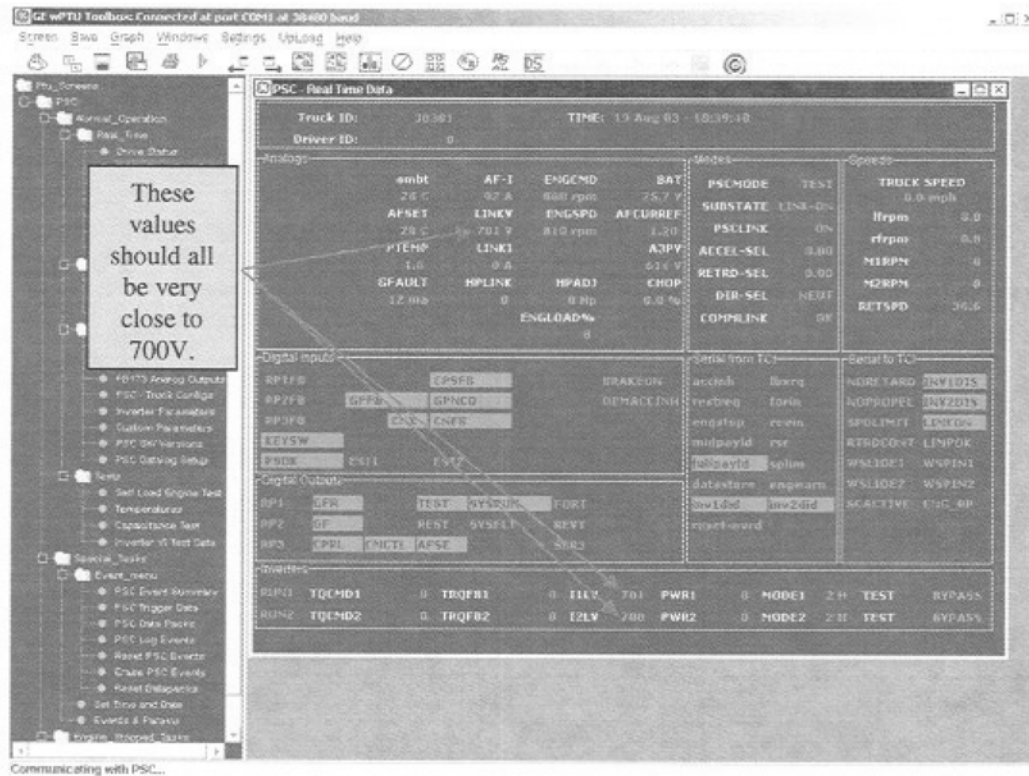


FIGURE 3-12. PSC REAL TIME DATA SCREEN

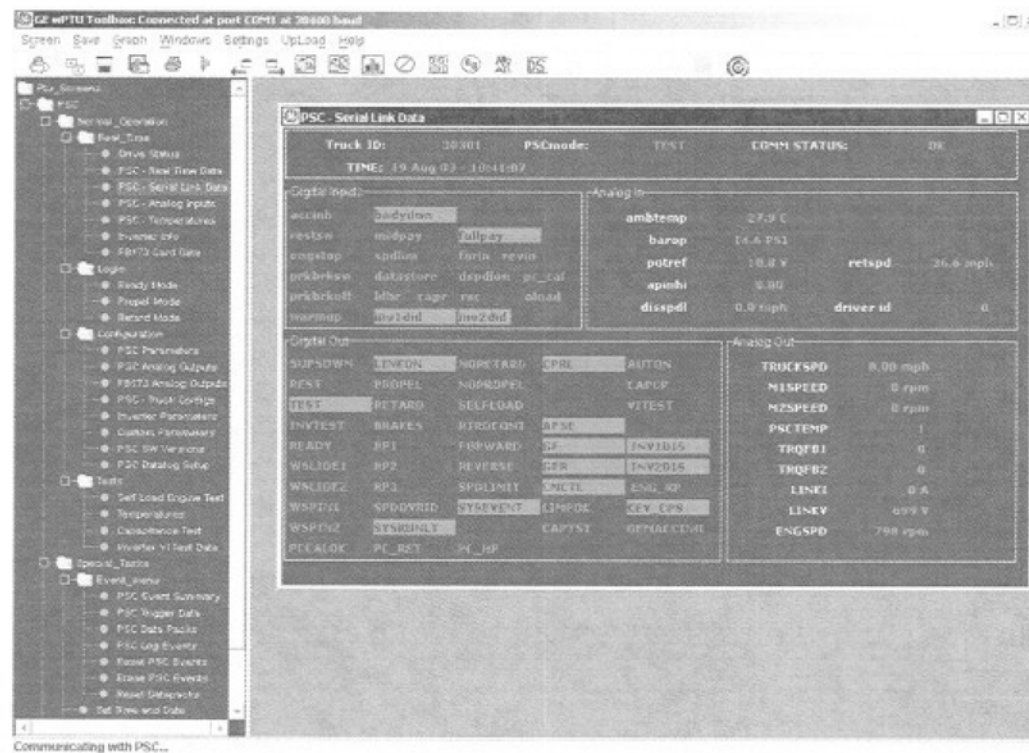


FIGURE 3-13. PSC SERIAL DATA SCREEN

## SECTION G2

### TIRES AND RIMS

#### INDEX

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# **SECTION G3** **FRONT WHEEL HUB AND SPINDLE** **INDEX**

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22. Lift the hub over the spindle and slowly lower while aligning the brake mounting holes with the alignment studs.
  - a. When the brake piston housing is approximately 13 mm (0.50 in.) from the adaptor, install four capscrews (20) and flat washers (21) spaced evenly in between the alignment studs.
  - b. Carefully pull the brake and wheel hub assembly into position by tightening the capscrews evenly and in small increments.
  - c. DO NOT allow the assembly to “cock” (angle). If the assembly is cocked, lift the assembly and inspect O-ring (22) for damage. Replace the O-ring if necessary, and repeat the procedure.
23. After the brake assembly is properly positioned on the adapter and the four capscrews are snug, remove the alignment studs.
24. Remove socket head capscrews (34) that secure seal carrier (37) to brake assembly (18).
25. Install remaining brake adapter/brake assembly mounting capscrews (20) and hardened flat washers (21). Tighten the capscrews to **2 705 ± 135 N·m (1,995 ± 100 ft lb)**.
26. Install bearing retainer pin (40) in the groove in the spindle. Align and slide outer bearing cone (7) over the pin. Lubricate the bearing with clean hydraulic oil.
27. Install shim pack (8), retainer (13), capscrews (11), and washers (12). Tighten the capscrews alternately in several successive increments while rotating the hub to a final torque of **1 017 ± 102 N·m (750 ± 75 ft lb)**.
28. Install new O-ring (41) on cover (5). Install the cover, capscrews, and washers. Tighten the capscrews to the standard torque.

### Seal Assembly Gap Check

After the assembly of the wheel and brake is complete, the gap between seal carrier (3, Figure 3-7) and back plate (6) must be measured and adjusted if necessary.

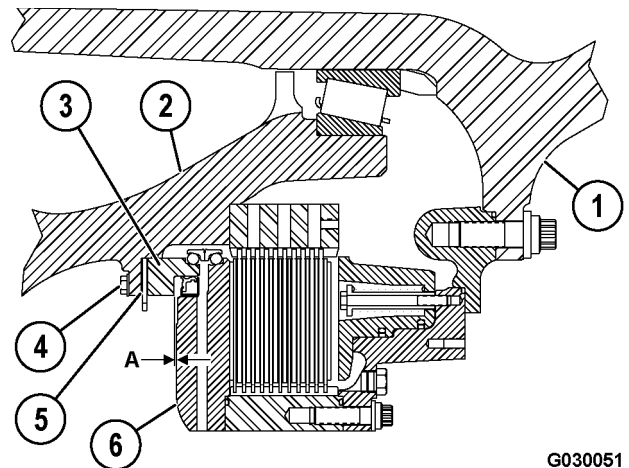
The ideal gap is 4.81 mm (0.189 in). If necessary, use shims to maintain a gap of 4.56 - 5.06 mm (0.179 - 0.199 in.).

29. Measure the seal gap as follows:

- a. Measure gap (dimension “A”, Figure 3-7) at three equally-spaced places and record the results.
- b. Add the three dimensions and divide the result by 3 to obtain the average gap width.

30. If the average gap width is not within the allowable range, loosen seal carrier capscrews (4) 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.**

31. Re-tighten the seal carrier capscrews to the standard torque and measure the seal gap as described in Step 29. If necessary, repeat Step 30 until the proper gap is maintained.



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FIGURE 3-7. MEASURING SEAL GAP

- |                 |               |
|-----------------|---------------|
| 1. Spindle      | 4. Capscrews  |
| 2. Wheel Hub    | 5. Shims      |
| 3. Seal Carrier | 6. Back Plate |

## PIVOT EYE REPAIR

If damage occurs to the pivot eye, it may be necessary to remove it from the rear axle to facilitate repair and bearing replacement.

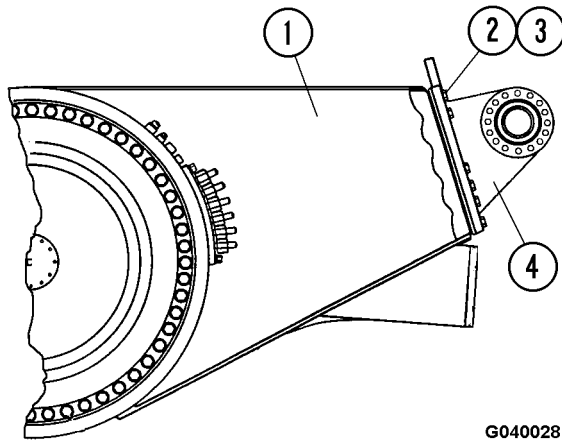


FIGURE 4-2. PIVOT EYE ATTACHMENT

- |                 |                |
|-----------------|----------------|
| 1. Axle Housing | 3. Flat Washer |
| 2. Capscrew     | 4. Pivot Eye   |

### Removal

1. Attach a lifting device to pivot eye (4, Figure 4-2). The weight of the pivot eye is 346 kg (762 lb).
2. Remove capscrews (2) and flat washers (3). Remove the pivot eye from axle housing (1).
3. Remove the spherical bearing as described in Pivot Eye Bearing - Removal.
4. Inspect the pivot eye bore for excessive wear or damage.

### Pivot eye bore (new):

222.164 ± 0.013 mm (8.7466 ± 0.0005 in.)

## Installation

### ⚠ IMPORTANT ⚠

*The lubrication groove in the bearing carrier outer diameter must be aligned with the lubrication fitting hole in the pivot eye structure.*

1. Install the spherical bearing as described in Pivot Eye Bearing - Installation.
2. Make sure that the mating surfaces of axle housing (1, Figure 4-2) and pivot eye (4) are clean and not damaged.
3. Install an appropriate lifting device to the pivot eye. The weight of the pivot eye is 346 kg (762 lb).
4. Lift the pivot eye into position on the front of the axle housing. Insert several capscrews (2) and flat washers (3) to align the parts. Remove the lifting device.
5. Install the remaining capscrews and flat washers. Tighten the capscrews alternately until the pivot eye is properly seated. Then tighten all of the capscrews to **2 325 ± 231 Nm (1,715 ± 170 ft lb)**.

## ⚠ WARNING

***Each complete wheel motor assembly weighs approximately 18 132 kg (39,975 lb). Make sure that the lifting device is capable of handling the load safely.***

11. Attach the lifting device to the wheel motor assembly. **Do not allow the lifting device to contact the brake housing.**

12. Remove 70 capscrews and hardened flat washers that secure the wheel motor to the rear axle housing.
13. Move the wheel motor assembly out of the axle housing. Be careful to prevent damage to the brake hoses if not removed previously.
14. Refer to the appropriate GE service manual for wheel motor repair instructions.

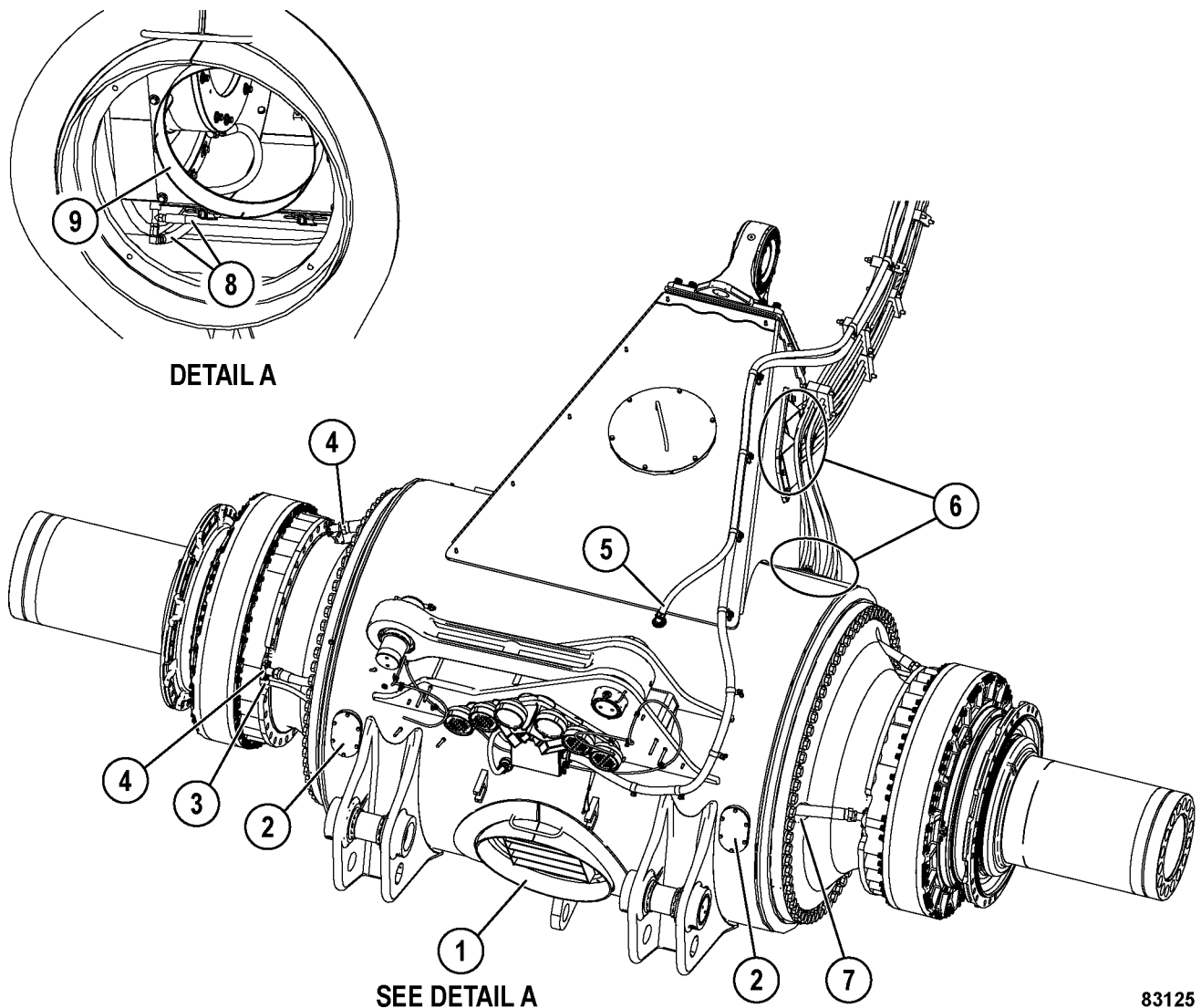


FIGURE 5-4. WHEEL MOTOR INSTALLATION

- |                     |                        |                        |
|---------------------|------------------------|------------------------|
| 1. Access Tube      | 4. Brake Cooling Hose  | 7. Spindle Hole        |
| 2. Access Cover     | 5. Wheel Speed Harness | 8. Parking Brake Hoses |
| 3. Brake Apply Hose | 6. Power Cables        | 9. Air Duct            |

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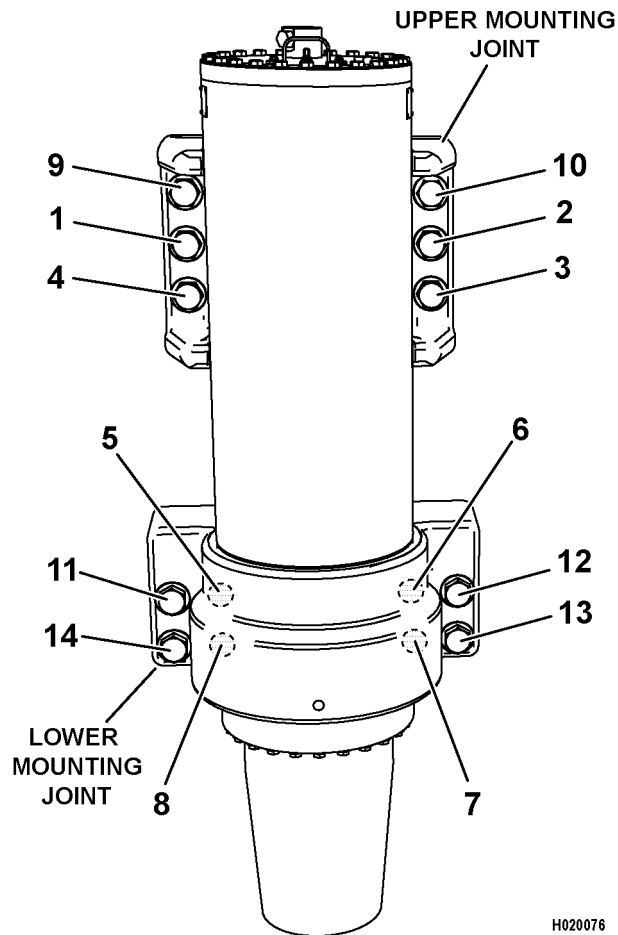


FIGURE 2-7. TIGHTENING SEQUENCE MAP

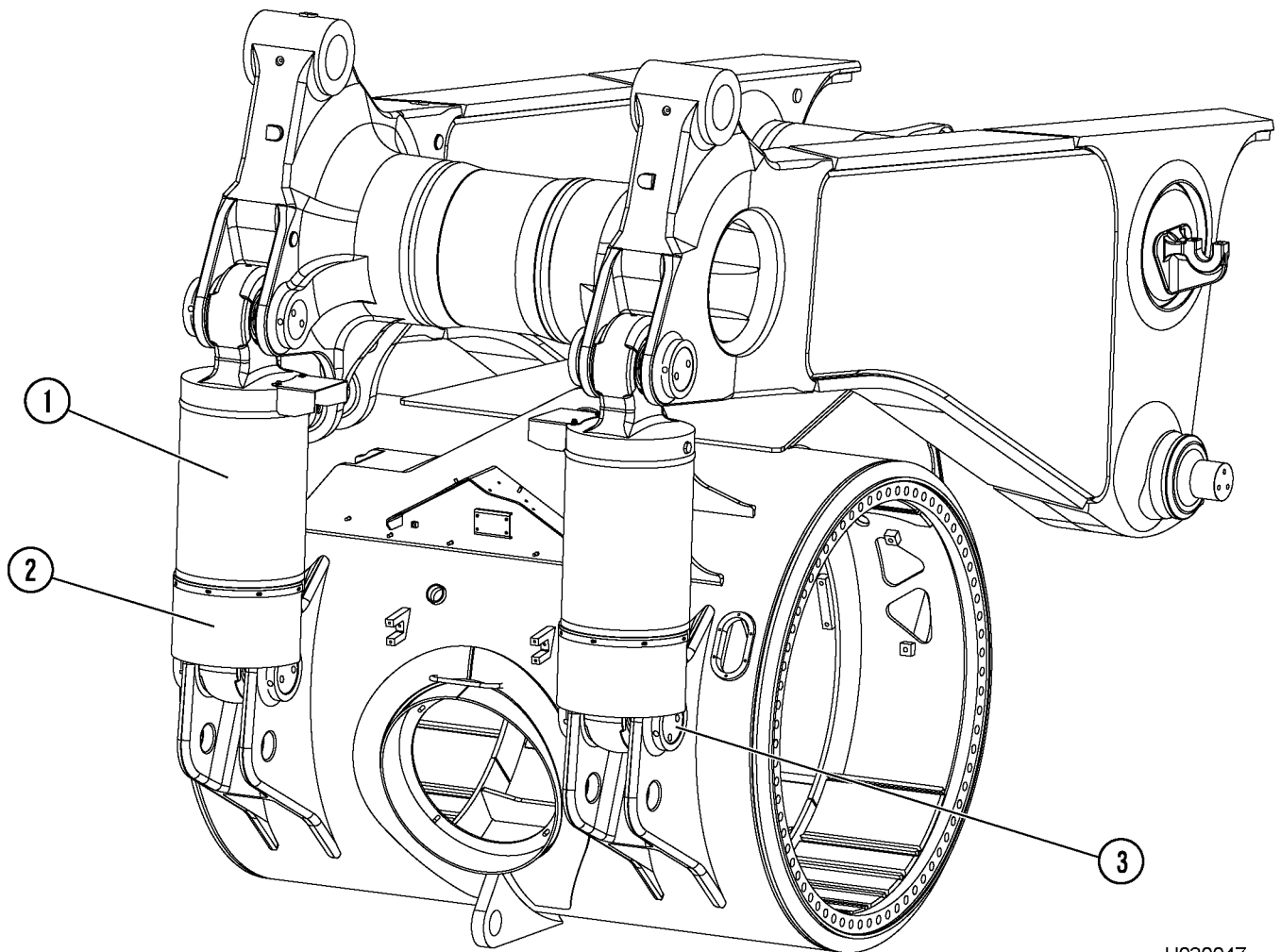
The mounting cap screws will now need to be loosened and then tightened using angle-advance. The first set of cap screws to be adjusted will be at the upper mounting joint. The cap screws must be loosened one at a time and then tightened by advancing a specified rotational degree. Use the map shown in Figure 2-7 for proper tightening sequence.

## REAR SUSPENSIONS

The Hydrair® II suspensions are hydro-pneumatic components containing oil and nitrogen gas. The oil and gas in the four suspensions carry the gross truck weight less wheels, spindles and final drive assembly.

The rear suspension cylinders consist of two basic components: a suspension housing attached to the frame and a suspension rod attached to the rear axle housing.

The Hydrair® II suspension cylinder requires only normal care when handling as a unit. However, after being disassembled, these parts must be handled with extreme care to prevent damage to the machined surfaces. Surfaces are machined to extremely close tolerances and are precisely fitted. All parts must be completely clean during assembly.



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FIGURE 3-1. REAR SUSPENSION INSTALLATION

- |                        |                 |
|------------------------|-----------------|
| 1. Suspension Cylinder | 3. Mounting Pin |
| 2. Mud Flap            |                 |

# SUSPENSION OILING AND CHARGING PROCEDURE

## GENERAL

These procedures cover the oiling and charging of Hydrair® II suspensions on Komatsu electric drive 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 chart in the operator cab will extend the service life of the truck main frame and allow the suspensions to produce a comfortable ride.*



***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. The oil level must be correct.
2. The suspension piston rod extension for nitrogen charging must be correct.
3. The nitrogen charge pressure must be correct.

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

*NOTE: For longer life of suspension components, a friction modifier should be added to the suspension oil. See the Specifications Charts at the end of this section.*

*NOTE: Setup dimensions in the Specifications 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 for:
  - Oiling Height Dimensions (Front and Rear)
  - Charging Height Dimensions (Front Only)
- Hydrair® Oil (see Specifications Chart)
- Friction Modifier (see Specifications Chart)
- Dry Nitrogen (see Specifications Chart)

If both the front and rear suspensions are to be serviced at the same time, service the front suspensions first. Do not remove the front suspension nitrogen charging blocks until after the rear suspensions have been completely serviced

# SECTION J BRAKE CIRCUIT INDEX

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# SECTION J3

## BRAKE CIRCUIT COMPONENT SERVICE

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## BRAKE VALVE BENCH TEST AND ADJUSTMENT

The following parts and test equipment will be required to completely bench test and adjust the brake valve.

- Three 20,680 kPa (3000 psi) pressure gauges
- Hydraulic pressure supply, regulated to 18,960 kPa (2750 psi)
- Hydraulic test stand (Refer to Figure 3-9)

- Hose fittings for valve ports:  
 Port PX . . . . . 7/16 in., # 4 SAE  
 Ports P1, P2, B1 and B2. . . . . 3/4 in., #8 SAE  
 Port T . . . . . 1 1/16 in., #12 SAE
- Ohmmeter or continuity tester

*NOTE: It is possible to check the pressures with the brake valve installed and connected to the vehicle. Remove the brake pedal assembly and actuator cap and boot assembly to adjust individual brake circuit pressures.*

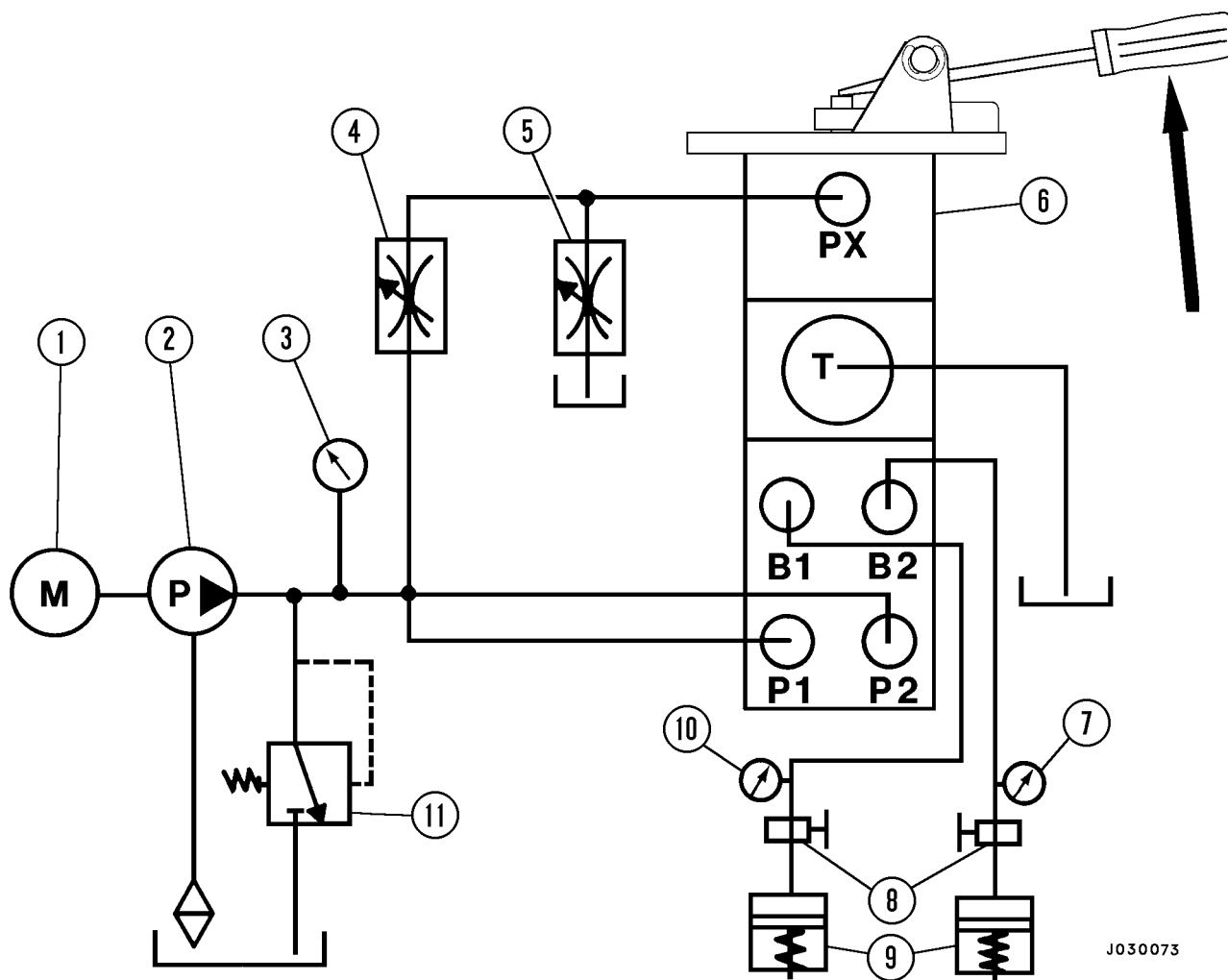


FIGURE 3-9. TEST BENCH SETUP

- |                          |                               |                               |
|--------------------------|-------------------------------|-------------------------------|
| 1. Motor                 | 5. Needle Valve               | 9. Simulated Brake Volume     |
| 2. Pump                  | 6. Brake Valve                | 10. Rear Brake Pressure Gauge |
| 3. System Pressure Gauge | 7. Front Brake Pressure Gauge | 11. Relief Valve              |
| 4. Needle Valve          | 8. Shutoff Valves             |                               |

## Removal

1. Securely block the wheels to prevent the truck from rolling away.
2. Place the directional control lever in PARK and turn the rest switch ON. Turn the key switch OFF to shut down the engine and allow 90 seconds for the steering system accumulators to bleed down. Open bleed down valves (1) and (2, Figure 3-12) to bleed down the brake accumulators.
3. Remove protective cover (3, Figure 3-14) from the charging valve guard on top of the accumulator.
4. Install a charging valve kit onto the accumulator charging valve. Use the charging kit to release nitrogen from the accumulator that is to be removed.
5. Disconnect oil line (6) from the bottom hydraulic port. Cap the port and hose fitting to prevent contamination.
6. Attach a lifting device to accumulator.

## **⚠ WARNING**

***Each accumulator weighs approximately 100 kg (220 lbs). Ensure that the lifting device has adequate capacity for handling the load.***

7. Remove accumulator mounting clamps (5) and lift the accumulator off the mounting pad. Move the accumulator to a clean work area.

## Installation

1. Position the accumulator on mounting bracket (7, Figure 3-14) with warning label visible.
2. Install mounting clamps and hardware. Tighten capscrews to standard torque.
3. Install oil line (6) at bottom (hydraulic) port.
4. Refer to Accumulator Charging Procedure in this section.
5. Install protective cover (3) over charging valve on top of accumulator.

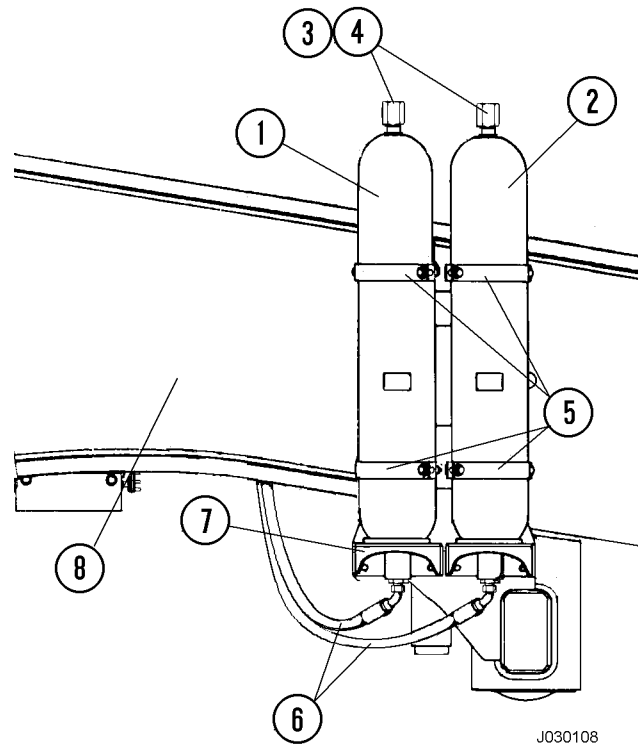
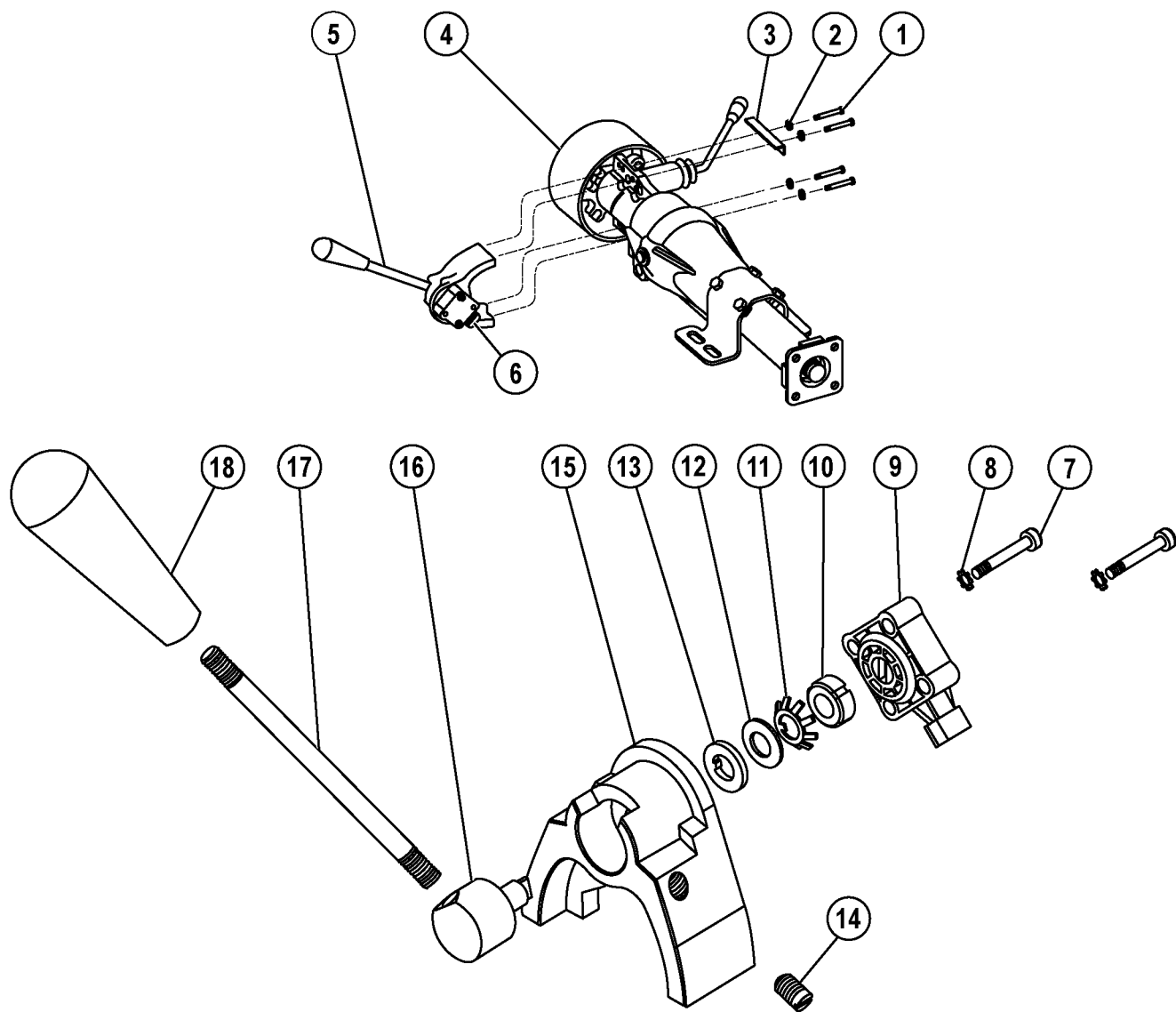


FIGURE 3-14. BRAKE SYSTEM ACCUMULATORS

- |                                    |                     |
|------------------------------------|---------------------|
| 1. Rear Brake Circuit Accumulator  | 4. Charging Valve   |
| 2. Front Brake Circuit Accumulator | 5. Mounting Clamps  |
| 3. Protective Cover                | 6. Oil Lines        |
|                                    | 7. Mounting Bracket |
|                                    | 8. R.H. Frame Rail  |



J030112

FIGURE 3-22. COLUMN-MOUNTED RETARDER LEVER ASSEMBLY

- |                             |                   |                          |
|-----------------------------|-------------------|--------------------------|
| 1. Capscrew                 | 7. Capscrew       | 13. Internal Tang Washer |
| 2. Lockwasher               | 8. Lockwasher     | 14. Set Screw            |
| 3. Bracket                  | 9. Potentiometer  | 15. Housing              |
| 4. Steering Column Assembly | 10. Locknut       | 16. Shaft                |
| 5. Retarder Control Lever   | 11. Tanged Washer | 17. Lever                |
| 6. Harness Connector        | 12. Disc Spring   | 18. Handle               |

## LOW ACCUMULATOR PRESSURE AND AUTO APPLY CHECK-OUT

29. Move both 20,685 kPa (3000 psi) pressure gauges back to test ports "BF" (21, Figure 4-1) and "BR" (22) in the hydraulic brake cabinet.
30. Start the engine and allow the low brake accumulator pressure to stabilize at or above 18,615 kPa (2700 psi).
31. Turn the key switch OFF to shut off the engine and allow 90 seconds for the steering system accumulators to bleed down.
32. Disable the steering pressure switch by unplugging the diode between circuits #33 and #33F on diode board DB1 in the auxiliary control cabinet or by disconnecting the wire harness at the steering pressure switch.
33. Turn the key switch ON, but do not start the engine. Wait for two minutes, then check the low accumulator pressure reading at low accumulator pressure (LAP1) test port (15).
  - ☐ If the pressure is below 14,480 kPa (2100 psi), there is excessive leakage in the system. The source of the leakage must be identified and repaired.

*\* Record on data sheet.*
34. Very slowly open front brake accumulator bleed valve (9) a small amount while observing the decreasing pressure at low accumulator pressure (LAP1) test port (15).
  - ☐ The low brake pressure warning light and buzzer must activate when the pressure drops to  $12,755 \pm 517$  kPa ( $1850 \pm 75$  psi).

*\* Record on data sheet.*

  - ☐ When the low accumulator pressure reaches 11,375 kPa (1650 psi), brake pressures "BF" and "BR" should begin to rise (auto apply).

*\* Record on data sheet.*
35. Close front brake accumulator bleed valve (9). Record the front and rear brake apply pressures after auto apply has occurred.

*\* Record on data sheet.*
36. Start the engine and allow the low brake accumulator pressure to stabilize at or above 18,615 kPa (2700 psi).
37. Turn the key switch OFF to shut off the engine and allow 90 seconds for the steering system accumulators to bleed down.
38. Turn key switch ON, but do not start the engine.
39. Very slowly open rear brake accumulator bleed valve (7) a small amount while observing the decreasing pressure at low accumulator pressure (LAP1) test port (15).
  - ☐ Verify that the low accumulator pressure warning activation pressure and the auto apply set point are within 690 kPa (100 psi) of the pressures that were recorded previously for Step 33.
40. Close rear brake accumulator bleed valve (7). Record the front and rear brake apply pressures after auto apply has occurred.

*\* Record on data sheet.*
41. Reinstall the diode on diode board DB1 or reconnect the wire harness at the steering pressure switch.
42. Start the engine and allow the low brake accumulator pressure to stabilize at or above 18,615 kPa (2700 psi).
43. Use the emergency shutdown switch on the center console to shut off the engine. Do not turn the key switch OFF. The steering accumulators must not be allowed to bleed down.
44. While observing the pressure gauges, make repeated, slow brake applications until auto apply comes on.
  - ☐ Auto apply must not occur before the sixth pedal application.
  - ☐ Auto apply must not occur until after the low accumulator pressure warning activates.

*\* Record on data sheet.*
45. Turn the key switch OFF and allow the steering accumulators to bleed down.
46. Open both accumulator bleed valves and bleed down the entire brake system. Close the valves after all pressure is released.
47. Remove all test equipment from the truck.

8. Release the brakes. Shut off the engine and wait 90 seconds to allow the steering accumulators to bleed down.
9. Open the bleeddow valves on the brake manifold in the hydraulic brake cabinet and bleed all pressure from the brake accumulators. Close the valves after the pressure is released.
10. Remove the brake disc wear indicator tool and reinstall the O-ring plug in the port.
11. To check the remaining brake assemblies, repeat Steps 4 through 10.

**NOTE:** Checking the disc wear in all the brake assemblies is recommended. Disc wear in one brake assembly may be different from another due to dissimilar operation of parts and/or haul profiles which require repeated braking while steering in one direction only.

12. Refill the hydraulic tank as required.
13. If brake repairs are necessary, refer to Brake Rebuild later in this section.

**NOTE:** If any leakage is observed around the brake disc wear indicator tool, replace O-rings (4, 5, and 7, Figure 5-2).

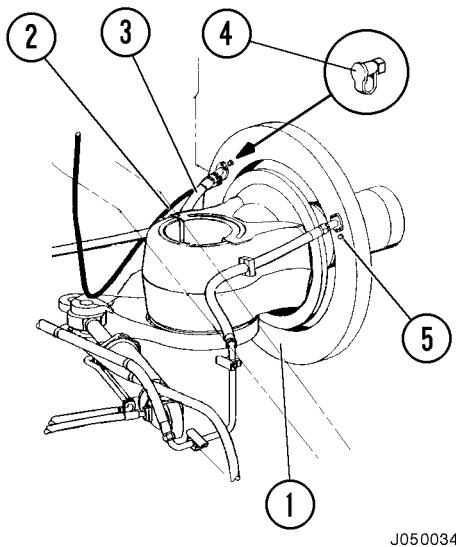


**FIGURE 5-3. BRAKE DISC WEAR INDICATOR INSTALLATION**  
(Left Front Brake Shown)

- |                       |                       |
|-----------------------|-----------------------|
| 1. Brake Assembly     | 4. Diagnostic Coupler |
| 2. Brake Apply Line   | 5. Wear Indicator     |
| 3. Brake Cooling Line | Installation Port     |

## BRAKE REBUILD

The brake assembly should be disassembled and reassembled on a clean, dry work surface. The surface should be wooden if possible. If it is metal, the surface should be covered with padding to prevent damaged to machined surfaces. Match mark individual parts for correct orientation before disassembly.

If a rear wheel brake is to be disassembled, start with Step 1 below. If a front wheel brake is to be disassembled, start with Step 5.

## **WARNING**

**The front brake assembly weighs approximately 1460 kg (3210 lb). The rear brake assembly weighs approximately 1820 kg (4000 lb). Make sure that any lifting devices are rated to handle the load.**

### Disassembly

#### Rear Wheel Brake Only:

Refer to Wheel Motor Rebuild instructions for removal of the rear wheel brake assembly from the wheel motor.

1. Verify that socket head capscrews (3, Figure 5-1) are installed at each of the six locations on back plate (11). These capscrews are required to retain seal carrier (10) to the back plate when the brake assembly is not installed on the truck. Shipping bars (4, Figure 5-4) must be installed.
2. Remove 12-point capscrews and hardened washers (5, Figure 5-1).
3. Remove capscrews and lockwashers (2) that retain the hub to the seal carrier.
4. Make sure that the hub and other parts are marked to ensure proper orientation during reassembly. Lift hub adaptor (1) from the brake assembly. Note the number of shim packs that are installed at six locations between the seal carrier and hub.

## 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 the seal surfaces and mounting cavities for rough tool marks or nicks that may damage rubber seal rings. Hone them smooth and clean, if required.
2. 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 based, rapid drying solvent that leaves no film. Allow the surfaces to dry completely. Use clean, lint-free material such as Micro-Wipes # 05310 for cleaning and wiping.

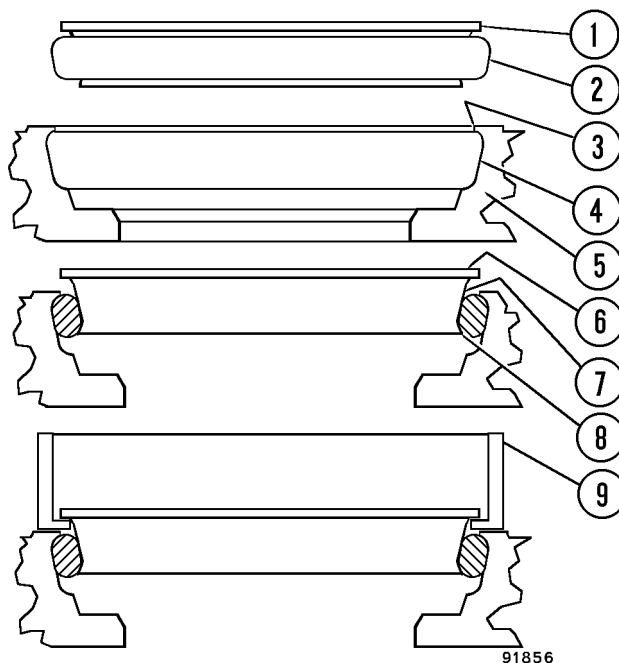


FIGURE 5-13. SEAL TERMINOLOGY

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

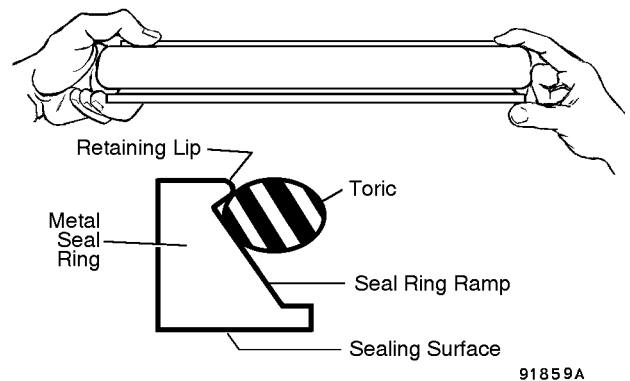
## WARNING

*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, welding operations or other heated surfaces exceeding 482°C (900°F). Do not smoke around solvents.*

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

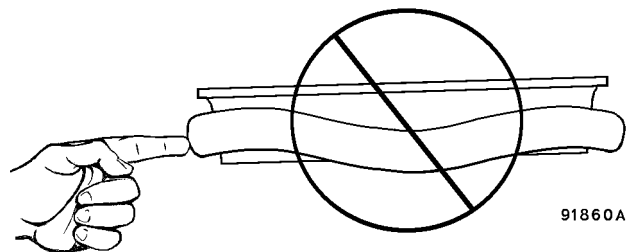
*NOTE: Oil from adjacent bearing installations or seal ring face lubrication must not get on the ramp or toric until after both seal rings are together in their final assembled position.*

3. Install the rubber toric on the seal ring.



*Make sure that it is **STRAIGHT!** Make sure that 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 ring.*

*NOTE: Handle the seal carefully. Nicks and scratches on the seal ring face can cause leaks.*



7. If rotor shaft gear (4, Figure 7-1) is worn, damaged or otherwise requires removal, perform the following steps:

**NOTE:** *The gear is shrink fit on the splined motor shaft.*

- a. Remove capscrew and hardened washer (6, Figure 7-1) from the shaft. Remove retainer plate (5).
- b. Install a gear puller using the tapped holes provided in gear (4).
- c. Apply heat around gear hub area while tightening the puller until gear is removed from shaft.

### Installation

1. If the rotor shaft gear was removed, install the gear before installing the parking brake on the wheel motor:
  - a. Thoroughly clean gear (4, Figure 7-1) and the shaft. Inspect the splines and remove any burrs that may interfere with installation.
  - b. Heat the gear to 280°C (536°F). Immediately install the gear on the shaft. The gear must be fully seated against the shoulder of the rotor shaft.
  - c. Install retainer plate (5), washer and capscrew (6). Tighten the capscrew to **595 - 670 N·m (440 - 495 ft lbs)**.
2. Install two guide studs in the wheel motor frame to guide the parking brake assembly into position. Ensure that the mating surfaces are clean and free of burrs.
3. Lift the parking brake into position for installation. Note the proper orientation depending on whether the parking brake is to be installed on a left or right wheel motor. (The bleeder screw at the top of the parking brake will be tilted toward the front of the truck.)
4. Slide the parking brake over the guide studs and the gear on the wheel motor rotor shaft.
5. Install capscrews and lockwashers (9) Tighten the capscrews evenly to ensure that the parking brake housing is properly seated on the wheel motor. Tighten the capscrews to a final torque of **300 N·m (220 ft lbs)**.
6. Connect parking brake supply hose (7) and remove any lifting equipment.
7. Bleed the air from the parking brake apply line and housing. Refer to Parking Brake Bleeding Procedure later in this section.
8. Install all ducts that were removed.

### Disassembly

1. Match mark parking brake housing (3, Figure 7-4), piston housing (4), and end cap (5).



***The following procedure is necessary to properly relieve the pressure exerted by the belleville springs on the end cap. Failure to follow this procedure could result in capscrew failure and personal injury during disassembly.***

2. Loosen 12-point capscrews (10) evenly in **27 N·m (20 ft lbs)** increments. Alternate by selecting a successive capscrew that is located approximately 180 degrees from the previously loosened capscrew.

Continue loosening capscrews until the spring pressure is released and the capscrews and washers can be removed by hand.

3. Remove end cap (5). Lift belleville springs (7) out of the counterbore of piston (6).
4. Lift the piston/housing assembly off the dowels in housing (3).
5. Remove springs (1), separator discs (12), and friction discs (13).
6. Remove piston (6) from piston housing (4). Remove and discard piston seals (8) and (9).

### Cleaning and Inspection

1. Clean all parts thoroughly.
2. Inspect dowel pins (2). If the dowel pins are grooved from excessive wear or otherwise damaged, press them out of housing (3).
3. Check the free height of compression springs (1) and test for height under load. Replace the springs if they are not within approximately 10% of specification.

Free Height: . . . . . 11.58 mm (0.456 in.)

Height @ 162 N (36.4 lb): . . . . . 8.89 mm (0.350 in.)

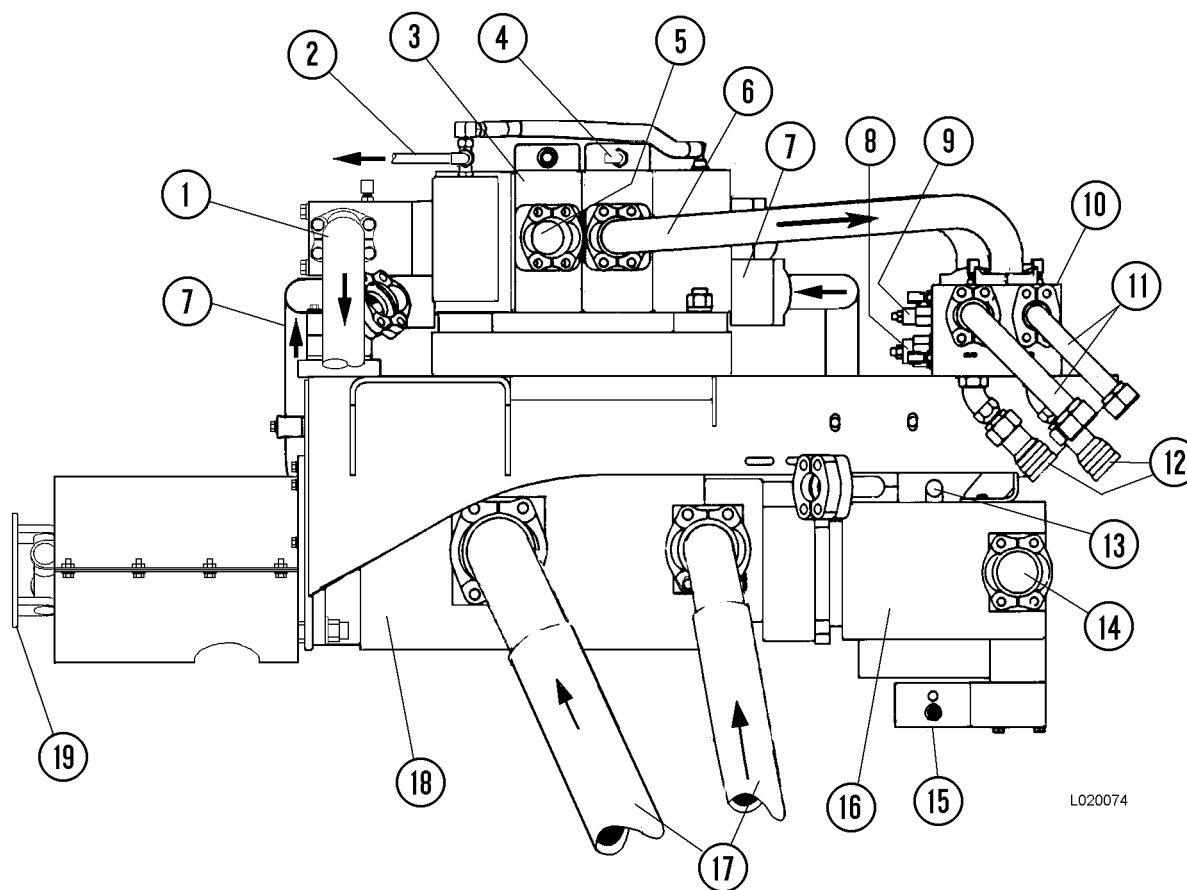
## HYDRAULIC SYSTEM

The following is a general description of the hydraulic system. Additional information concerning individual component description and operation can be found under the different system circuits such as the hoist circuit, steering circuit, and hydraulic brake circuit.

### HYDRAULIC PUMP MODULE

Hydraulic pumps (16) and (18, Figure 2-1) are mounted on a modular structure behind the traction alternator. The pump module also contains pilot operated hoist valve (3), which controls operation of the hoist cylinders during body dumping operations. Overcenter manifold (10) contains internal valves (8) and (9), which ensure smooth operation and maximum service life from the hoist cylinders.

The overcenter manifold also provides quick disconnect fittings (12) to allow operation of the hoist circuit by an external hydraulic source or to use the hoist circuit of the truck to dump the load from a disabled truck.



L020074

FIGURE 2-1. HYDRAULIC PUMP MODULE

- |                                                             |                                    |                              |
|-------------------------------------------------------------|------------------------------------|------------------------------|
| 1. Hoist Valve Tank Return (To Brake/Hoist Return Manifold) | 7. Supply From Hoist Pump & Filter | 14. Steering Pump Inlet Port |
| 2. Supply to Pilot Valve                                    | 8. Counterbalance Valve            | 15. Unloader Valve           |
| 3. Hoist Valve                                              | 9. Needle Valve                    | 16. Steering/Brake Pump      |
| 4. From Pilot Valve                                         | 10. Overcenter Manifold            | 17. Hoist Pump Inlet Hoses   |
| 5. To Brake/Hoist Return Manifold                           | 11. Hoist Cylinder Supply Tubes    | 18. Hoist Pump               |
| 6. Work Port Outlet                                         | 12. Hoist Quick Disconnects        | 19. Pump Driveshaft          |
|                                                             | 13. Pump Case Drain Line           |                              |

# HYDRAULIC SYSTEM COMPONENT REPAIR

## HOIST PUMP

### Removal

*NOTE: The hoist pump can be removed without removing the steering pump from the truck if desired.*

1. Turn key switch OFF and allow approximately 90 seconds for the accumulators to bleed down.
2. If necessary, drain the hydraulic tank by using the drain valve located on the rear side of the tank.

*NOTE: If oil in the hydraulic tank has not been contaminated, the shutoff valves can be closed and both pump inlet lines can be drained, eliminating the need to completely drain the tank.*

3. Remove the rear axle blower duct to allow the hoist pump to be lowered from the pump module mounting bracket for removal. Remove duct support bracket.

4. Close the pump supply shutoff valves.

## ! IMPORTANT !

***Always maintain complete cleanliness when opening any hydraulic connection. Make sure that all system lines and components are capped while the component is removed from the truck.***

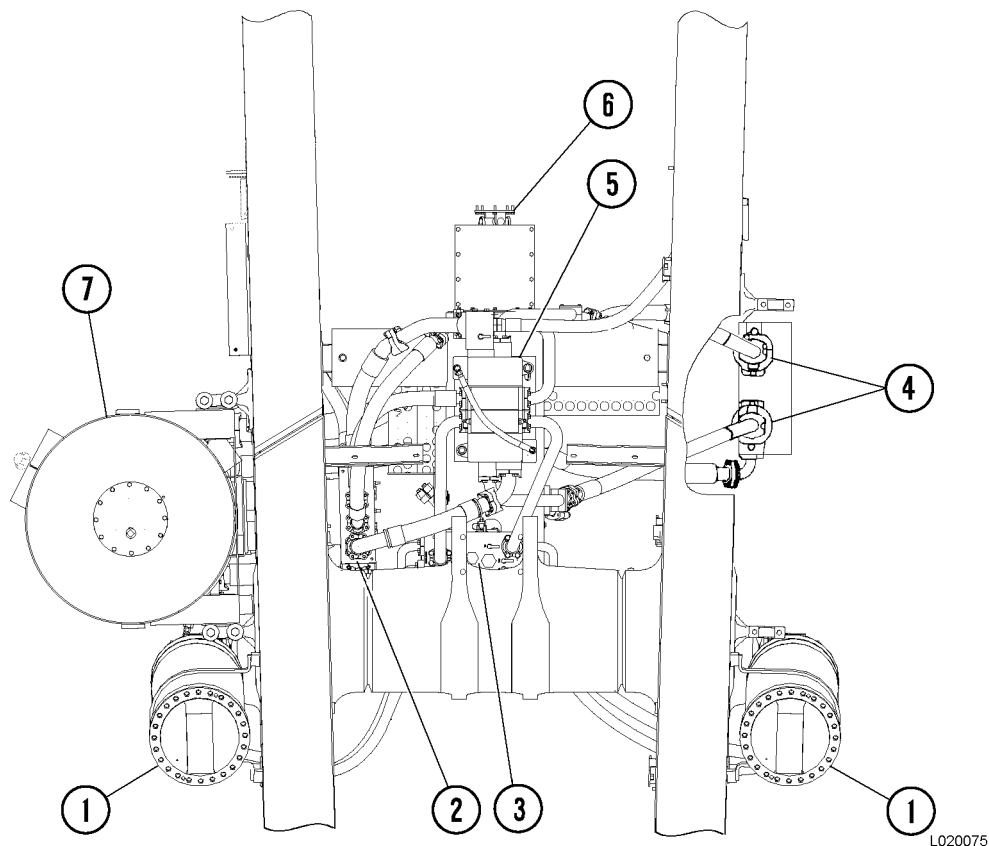
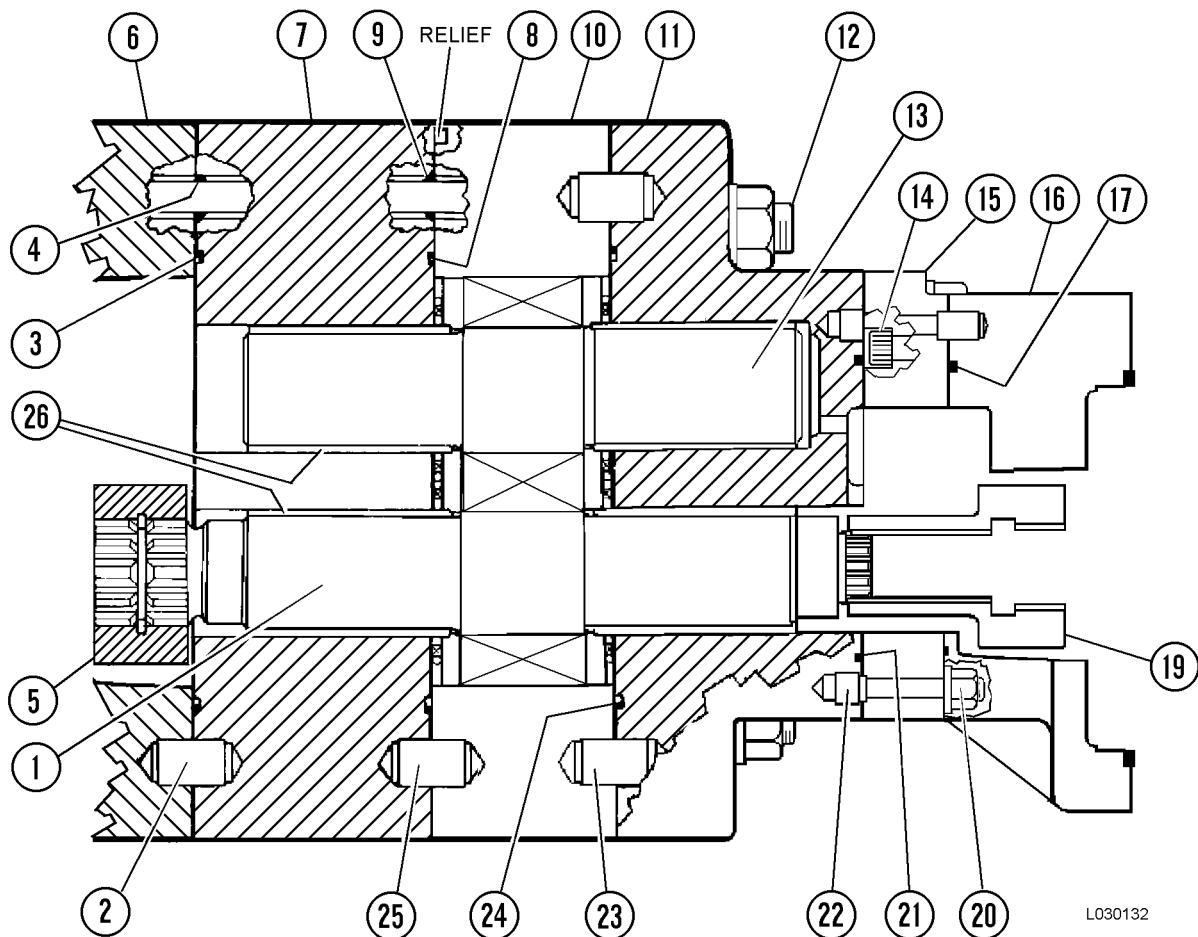


FIGURE 3-1. HOIST AND STEERING PUMP PIPING (Top View)

- |                                    |                     |
|------------------------------------|---------------------|
| 1. Hoist Cylinders                 | 5. Hoist Valve      |
| 2. Brake/Hoist Return Oil Manifold | 6. Pump Drive Shaft |
| 3. Overcenter Manifold             | 7. Hydraulic Tank   |
| 4. Hoist Circuit Filters           |                     |

17. Lubricate O-ring (3, Figure 3-15) and install it in bearing plate (7). Lubricate O-rings (4) and install them over studs (12). Replace dowel (2) if removed. Install bearing plate (7).
18. Repeat Steps 9, 10 and 11 for installation of the steel rings, backup ring, O-ring, retainer, isolation plate and pressure plate.

19. Lubricate the inside diameter of bearings (26). Install O-rings (8 & 9) and dowel (25) if removed. Install gear plate (10). Make sure that the relief in the gear plate is toward bearing plate (7).



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FIGURE 3-15. HOIST PUMP REASSEMBLY

- |                      |                     |                      |              |
|----------------------|---------------------|----------------------|--------------|
| 1. Drive Gear (Rear) | 8. O-ring           | 15. Bearing Plate    | 22. Dowel    |
| 2. Dowel             | 9. O-ring           | 16. Transition Plate | 23. Dowel    |
| 3. O-ring            | 10. Gear Plate      | 17. O-ring           | 24. O-ring   |
| 4. O-ring            | 11. Connector Plate | 18. (Not Used)       | 25. Dowel    |
| 5. Coupling          | 12. Stud            | 19. Coupling         | 26. Bearings |
| 6. Connector Plate   | 13. Idler Gear      | 20. Nut              |              |
| 7. Bearing Plate     | 14. Capscrew        | 21. O-ring           |              |

## Bleeddown Manifold Valve

Bleeddown manifold (5, Figure 4-1) is located on the outside of the left hand frame rail just behind the accumulators. The bleeddown manifold is equipped with the following major circuit components, as shown in Figure 4-3:

- Low steering system pressure switch (7)
- Steering accumulator bleeddown solenoid (6)
- 4100 kPa (600 psi) relief valve (12)
- 27,500 kPa (4000 psi) relief valve (13)
- Hoist up limit solenoid valve (15)
- Pilot operated check valve (23)

The bleeddown manifold receives oil from the steering/brake pump through a high pressure filter and directs oil to the accumulators, brake circuit, flow amplifier and auto lube system hydraulic pump. Oil supply for the steering control unit and steering cylinders is supplied via the flow amplifier. The manifold also provides hoist circuit control when the body is raised.

The relief valves, steering accumulator bleeddown solenoid, and hoist up limit solenoid valve are factory preset and cannot be individually rebuilt.

## Steering Accumulator Bleeddown Solenoid

Each time the key switch is turned OFF with the truck stopped, steering accumulator bleeddown solenoid (6, Figure 4-3 and 27, Figure 4-5) is energized. When the solenoid is energized, all hydraulic steering pressure, including the accumulators, is bled back to the hydraulic tank. Brake pressure, however, will not bleed down due to internal check valves in the brake manifold and bleeddown manifold (see Figure 4-5).

After approximately 90 seconds, the solenoid will de-energize to close the return port to the tank. By this time, all the oil in the accumulators should be returned to the tank. At startup, the steering circuit and brake circuit will be charged. The low steering pressure light and buzzer will turn on until steering pressure reaches 15,900 kPa (2300 psi). This is controlled by the low steering pressure switch (7, Figure 4-3).

If steering pressure falls below 15,900 kPa (2300 psi) during operation, the low steering pressure warning light will illuminate until pressure returns to normal.

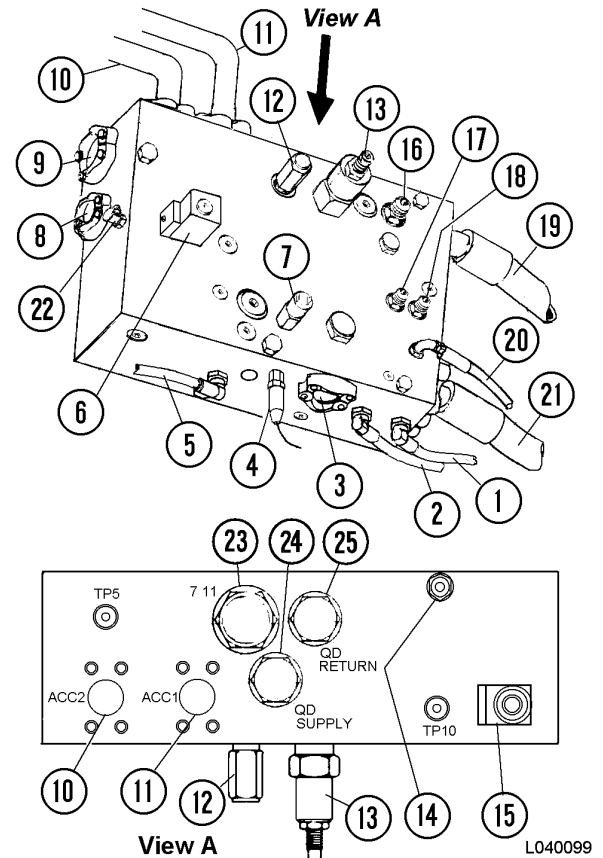


FIGURE 4-3. BLEEDDOWN MANIFOLD

1. To Hoist Valve, Power Up
2. To Hoist Valve, Power Down
3. Spare Pressure Port
4. VHMS Pressure Sensor (Port TP2)
5. To Brake System
6. Steering Accumulator Bleeddown Solenoid
7. Low Steering System Pressure Switch
8. Supply To Flow Amp
9. Return From Flow Amp
10. To Front Steering Accumulator
11. To Rear Steering Accumulator
12. Relief Valve, 4100 kPa (600 psi)
13. Relief Valve, 27,500 kPa (4000 psi)
14. Auto Lube Pump Supply Port
15. Hoist Up Limit Solenoid Valve
16. Return From Hoist Pilot Valve
17. Hoist Pilot Valve, Power Down
18. Hoist Pilot Valve, Power Up
19. Return to Tank
20. Feedback Pressure to Unloader valve
21. Supply From Pump
22. Test Port (TP3)
23. Pilot Operated Check Valve
24. Quick Disconnect, Supply Port
25. Quick Disconnect, Return Port

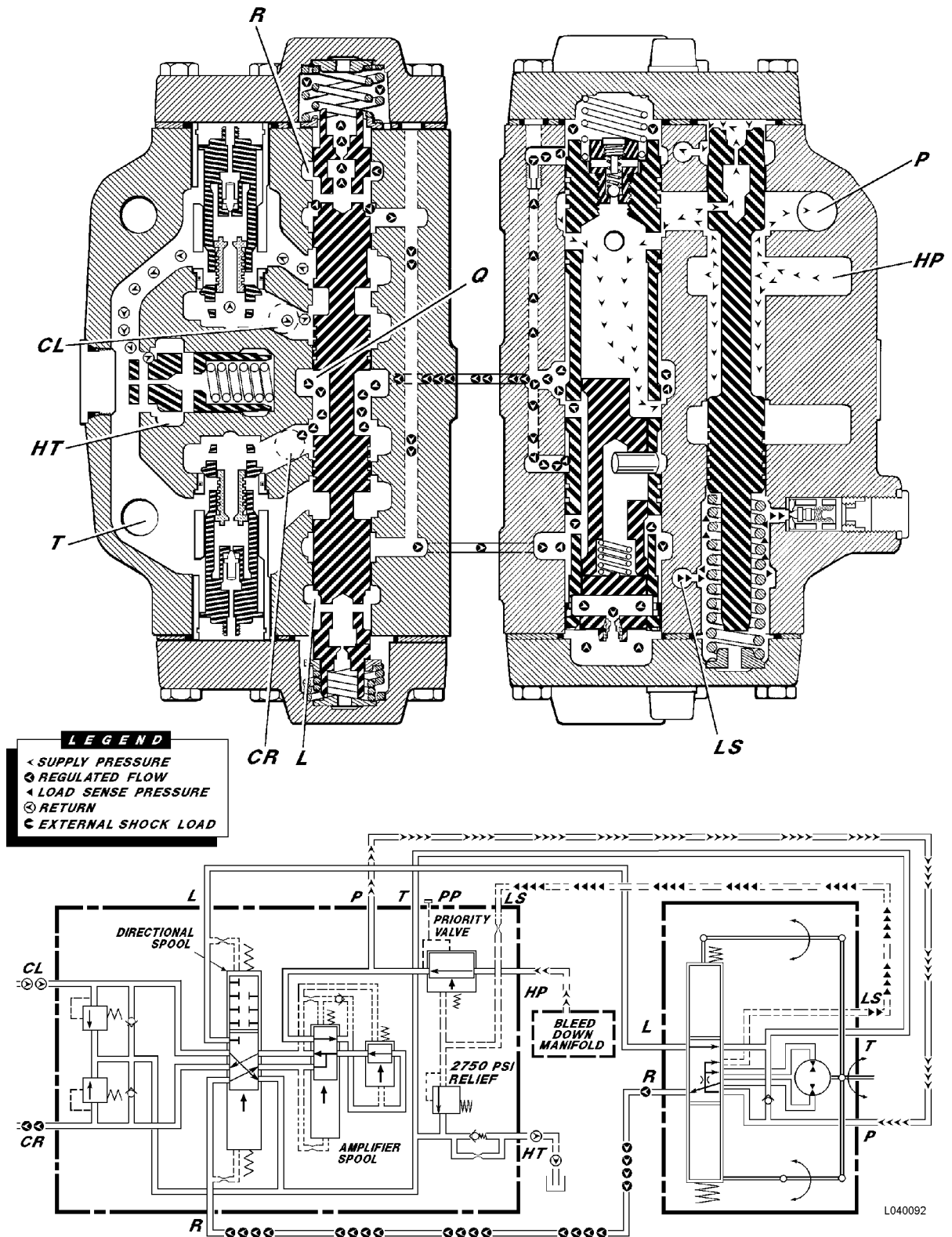


FIGURE 4-9. FLOW AMPLIFIER - RIGHT STEER

# STEERING CONTROL UNIT

## REMOVAL

### **⚠ WARNING**

*Relieve pressure before disconnecting hydraulic 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 type of injury is not received immediately.*

1. Turn the key switch OFF and allow 90 seconds for the accumulators to bleed down. Turn the steering wheel to ensure that no oil remains under pressure.
2. Remove the capscrews and lockwashers that secure the access cover on the front side of the operator's cab. Remove the access cover.

*NOTE: Clean the steering control unit and surrounding area to help avoid contaminating the hydraulic oil when any lines are opened.*

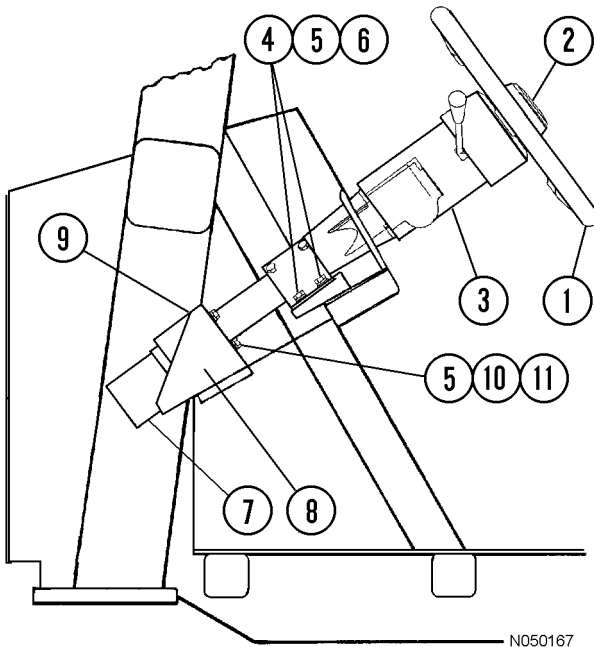


FIGURE 5-1. STEERING CONTROL UNIT

- |                    |                          |
|--------------------|--------------------------|
| 1. Steering Wheel  | 7. Steering Control Unit |
| 2. Button Horn     | 8. Bracket L.H.          |
| 3. Steering Column | 9. Bracket R.H.          |
| 4. Capscrew        | 10. Capscrew             |
| 5. Flat Washer     | 11. Lockwasher           |
| 6. Lockwasher      |                          |

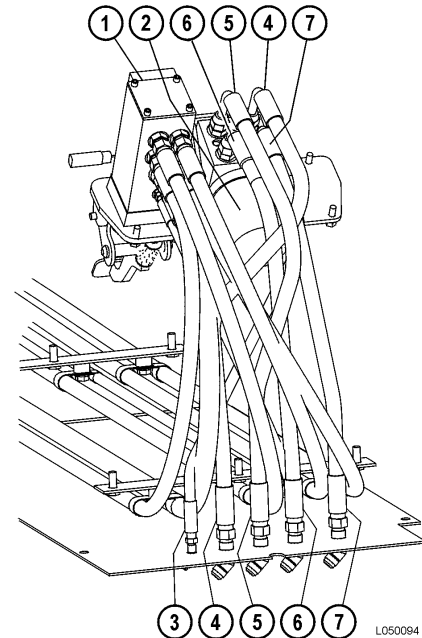


FIGURE 5-2. STEERING CONTROL UNIT

- |                          |                  |
|--------------------------|------------------|
| 1. Brake Valve           | 5. "T" Port Hose |
| 2. Steering Control Unit | 6. "P" Port Hose |
| 3. "LS" Port Hose        | 7. "R" Port Hose |
| 4. "L" Port Hose         |                  |

3. Tag all hydraulic lines for proper identification during installation. Disconnect the hydraulic lines (see Figure 5-2) at the steering control unit. Plug all hoses.
4. Remove four mounting capscrews (10, Figure 5-1), flat washers and lockwashers. Remove steering control unit (7).
5. Place the steering control unit in a clean work area for disassembly.

## SPLINE INSPECTION

Whenever the steering control unit is removed for service, the steering column shaft should be inspected for excessive wear.

1. Thoroughly clean the splines on the steering column shaft. Inspect for damage and excessive wear.
2. Use an outside micrometer or dial caliper to measure the outside diameter of the male splines on the steering column shaft.
  - **Minimum diameter:** 24.13 mm (0.950 in.)
3. If the splines are worn more than minimum diameter specification, replace the steering column. Refer to Section N.

# STEERING CIRCUIT COMPONENT REPAIR

## BLEEDDOWN MANIFOLD VALVE

### **WARNING**

*Do not loosen or disconnect any hydraulic line or component connection until engine is stopped and the key switch has been off for at least 90 seconds. 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.*

### Removal

*NOTE: It may not be necessary to remove the bleeddown manifold from the truck for component replacement. If the problem area has been isolated, remove the inoperative component and replace it.*

1. Perform normal truck shutdown procedures. Turn the key switch OFF and allow 90 seconds for the accumulators to bleed down. Manually bleed the brake system accumulators by using the needle valves located in the hydraulic components cabinet.
2. Remove the protective cover from the manifold. Disconnect the wires from solenoids (6, Figure 6-1) and (15), and pressure switch (7).
3. Disconnect, identify and plug each hydraulic line to prevent contamination.
4. Remove the mounting capscrews and bleeddown manifold. Clean the exterior of the manifold before starting disassembly. The weight of the manifold is 170 kg (375 lbs.).

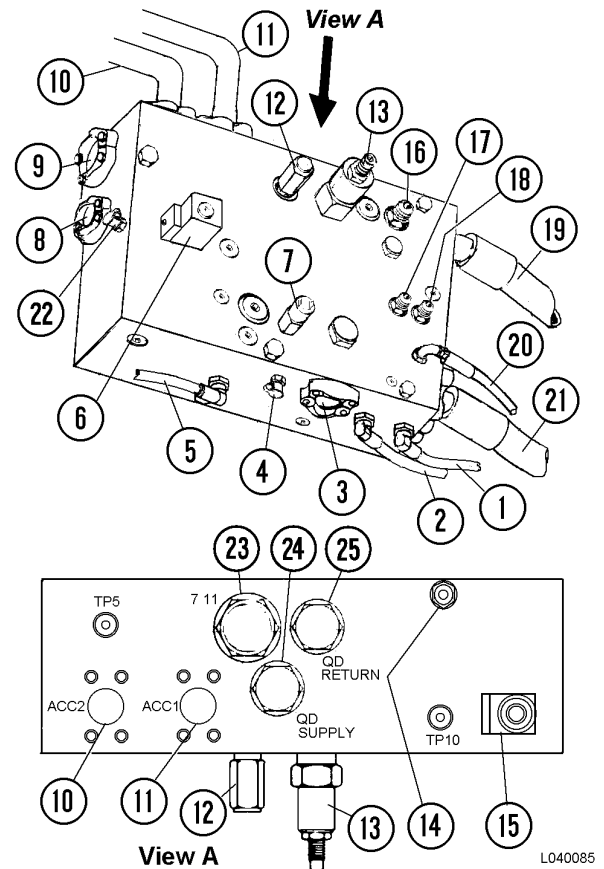


FIGURE 6-1. BLEEDDOWN MANIFOLD

1. To Hoist Valve, Power Up
2. To Hoist Valve, Power Down
3. Spare Pressure Port
4. Test Port
5. To Brake System
6. Steering Accumulator Bleeddown Solenoid
7. Steering System Pressure Switch
8. Supply To Flow Amp
9. Return From Flow Amp
10. To Front Steering Accumulator
11. To Rear Steering Accumulator
12. Relief Valve, 4100 kPa (600 psi)
13. Relief Valve, 27,500 kPa (4000 psi)
14. Auto Lube Pump Supply Port
15. Hoist Up Limit Solenoid
16. Return From Hoist Pilot Valve
17. Hoist Pilot Valve, Power Down
18. Hoist Pilot Valve, Power Up
19. Return to Tank
20. Feedback Pressure to Unloader valve
21. Supply From Pump
22. Test Port (TP3)
23. Check Valve
24. Quick Disconnect Port (Supply)
25. Quick Disconnect Port (Return)

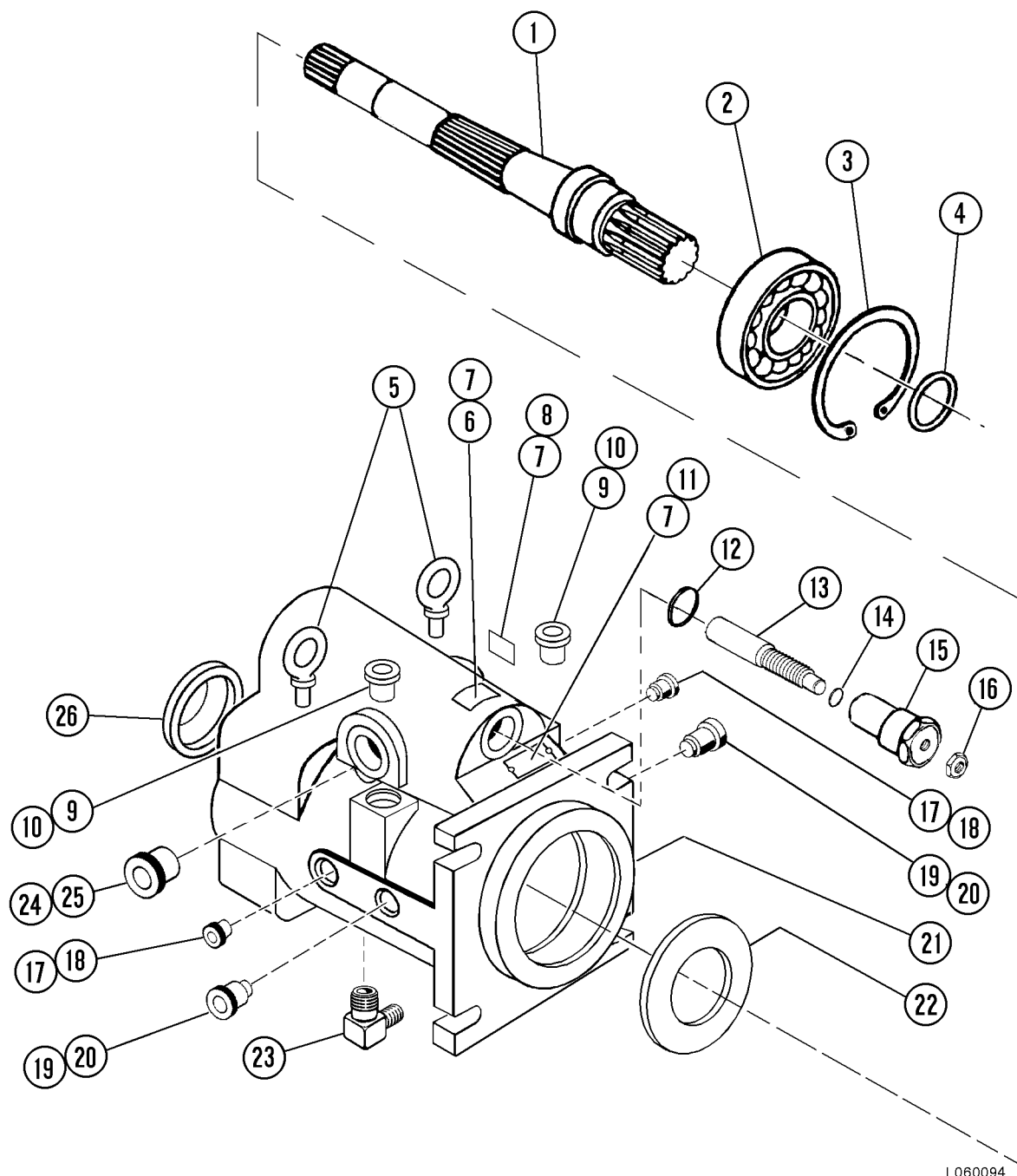


FIGURE 6-9. PUMP, FRONT HOUSING

- |                  |               |             |                   |
|------------------|---------------|-------------|-------------------|
| 1. Shaft         | 8. Name Plate | 15. Gland   | 22. Seal Retainer |
| 2. Bearing       | 9. Plug       | 16. Jam Nut | 23. Elbow Fitting |
| 3. Snap Ring     | 10. O-ring    | 17. Pin     | 24. Plug          |
| 4. Retainer Ring | 11. Plate     | 18. O-ring  | 25. O-ring        |
| 5. Lifting Eyes  | 12. O-ring    | 19. Pin     | 26. Seal          |
| 6. Name Plate    | 13. Stem      | 20. O-ring  |                   |
| 7. Drive Screw   | 14. O-ring    | 21. Housing |                   |

## Assembly

**NOTE:** Assemble the accumulator(s) in a dust and lint free area. Maintain complete cleanliness during assembly to prevent possible contamination.

Use only nitrogen that meets or exceeds CGA (Compressed Gas Association) specification G-10.1 for type 1, grade F. The nitrogen should be 99.9% pure. Use only nitrogen cylinders with standard CGA number 580 connections with the appropriate high pressure regulator.

1. After shell (4, Figure 6-18) has been cleaned and inspected, place the accumulator shell in a vise or on a table.
2. Thoroughly spray the inside of the accumulator shell with 3.1 L (106 oz.) of clean C-4 hydraulic oil to lubricate and cushion the bladder. Ensure that the entire internal surface of the shell is lubricated.
3. With all gas completely exhausted from the bladder, collapse the bladder and fold it longitudinally in a compact roll.
4. Install the gas valve on the bladder.
5. Insert the bladder pull rod into the valve stem opening and out through the shell fluid port. Attach the bladder pull rod to the bladder valve stem.
6. With one hand, pull the bladder pull rod while feeding the bladder into the shell with the other hand. Slight twisting of the bladder will assist in this insertion.
7. Once the bladder valve stem has been pulled through the valve stem opening in the shell, install valve stem nut (5) by hand. Remove the bladder pull rod.
8. Use a wrench to hold the bladder valve stem on the flats, then tighten nut (5) securely.
9. If removed, install pressure switch (15) into valve assembly (11). Tighten the switch to  $41 \pm 5 \text{ N}\cdot\text{m}$  ( $30 \pm 4 \text{ ft. lbs.}$ ). Then install valve assembly (11) onto gas valve manifold (14) and tighten it to  $18 \pm 4 \text{ N}\cdot\text{m}$  ( $13 \pm 3 \text{ ft. lbs.}$ ).

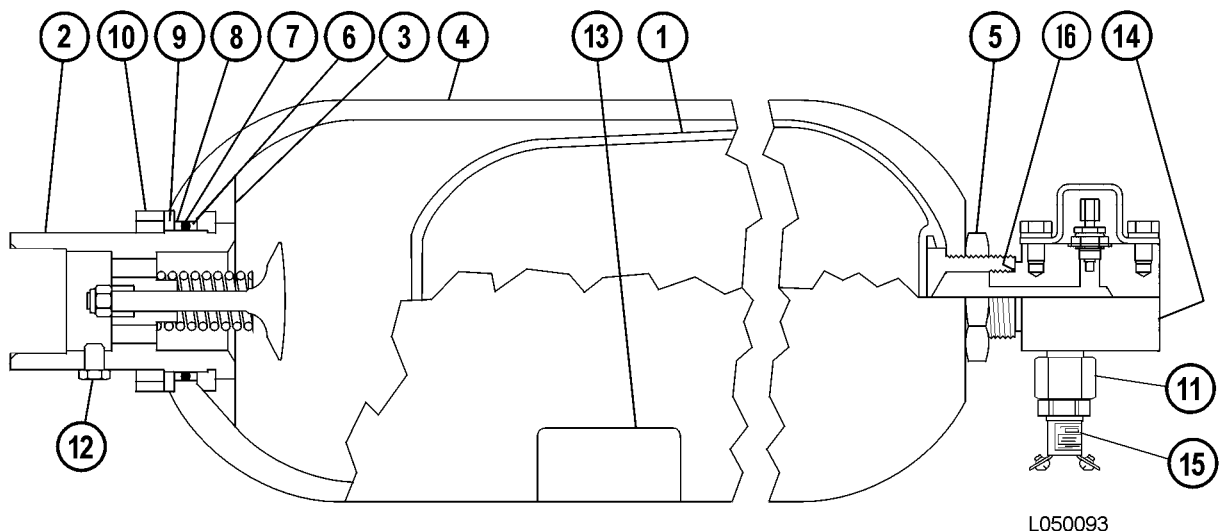


FIGURE 6-18. ACCUMULATOR ASSEMBLY

- |                            |                    |                        |
|----------------------------|--------------------|------------------------|
| 1. Bladder Assembly        | 7. O-ring          | 13. Warning Plate      |
| 2. Hydraulic Port Assembly | 8. O-ring Backup   | 14. Gas Valve Manifold |
| 3. Anti-Extrusion Ring     | 9. Spacer          | 15. Pressure Switch    |
| 4. Shell                   | 10. Locking Ring   | 16. O-ring             |
| 5. Nut                     | 11. Valve Assembly |                        |
| 6. Metal Backup Washer     | 12. Bleed Plug     |                        |

| TROUBLE                                          | POSSIBLE CAUSE                                                                                                         | SUGGESTED CORRECTIVE ACTION                                                                                                                                                                                         |
|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>FLOW AMPLIFIER</b>                            |                                                                                                                        |                                                                                                                                                                                                                     |
| Slow or hard steer                               | 1. Stuck amplifier spool<br>2. Obstruction in orifice, directional spool<br>3. Incorrect relief valve pressure setting | 1. Disassemble valve and check amplifier spool for damage or obstruction.<br>2. Disassemble valve and check directional spool and orifices for damage or obstruction.<br>3. Check and correct relief valve setting. |
| Free wheeling<br>(no end stop)                   | 1. Leaking shock and suction relief valve<br>2. Pressure setting of shock valve too low                                | 1. Disassemble valve, check and clean shock and suction valves. Replace valves if necessary.<br>2. Adjust pressure settings                                                                                         |
| Inability to steer<br>(no pressure build-up)     | 1. Defective steering control unit                                                                                     | 1. Repair or replace steering control unit.                                                                                                                                                                         |
| Resistance when initially turning steering wheel | 1. Air in "LS" line<br>2. Priority valve spring compression weak<br>3. Obstruction in orifice in "LS" or "PP" port     | 1. Bleed air from "LS" line.<br>2. Disassemble flow amplifier. Replace priority valve spring.<br>3. Disassemble flow amplifier. Inspect and clean orifice.                                                          |

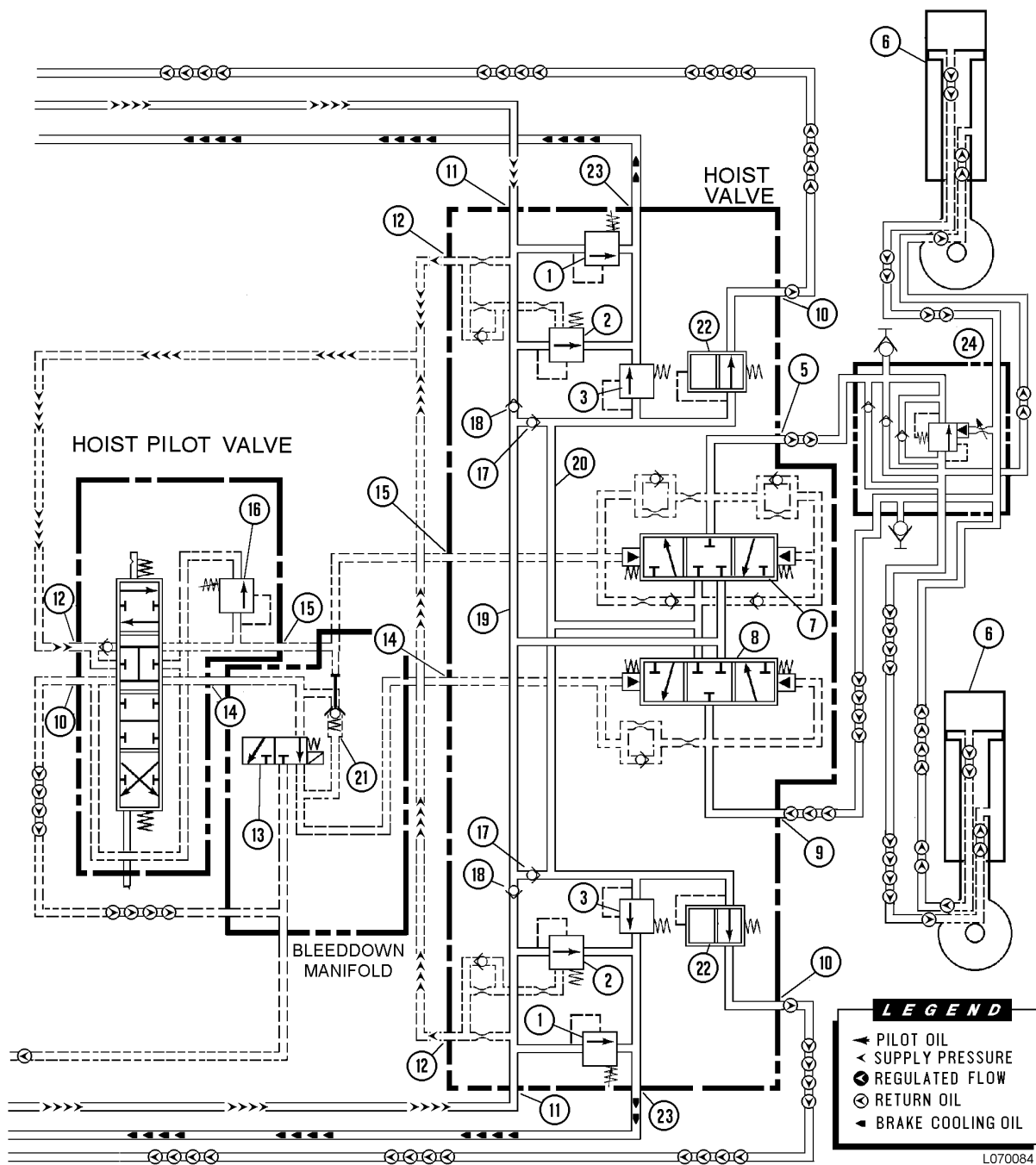


FIGURE 7-5. FLOAT POSITION

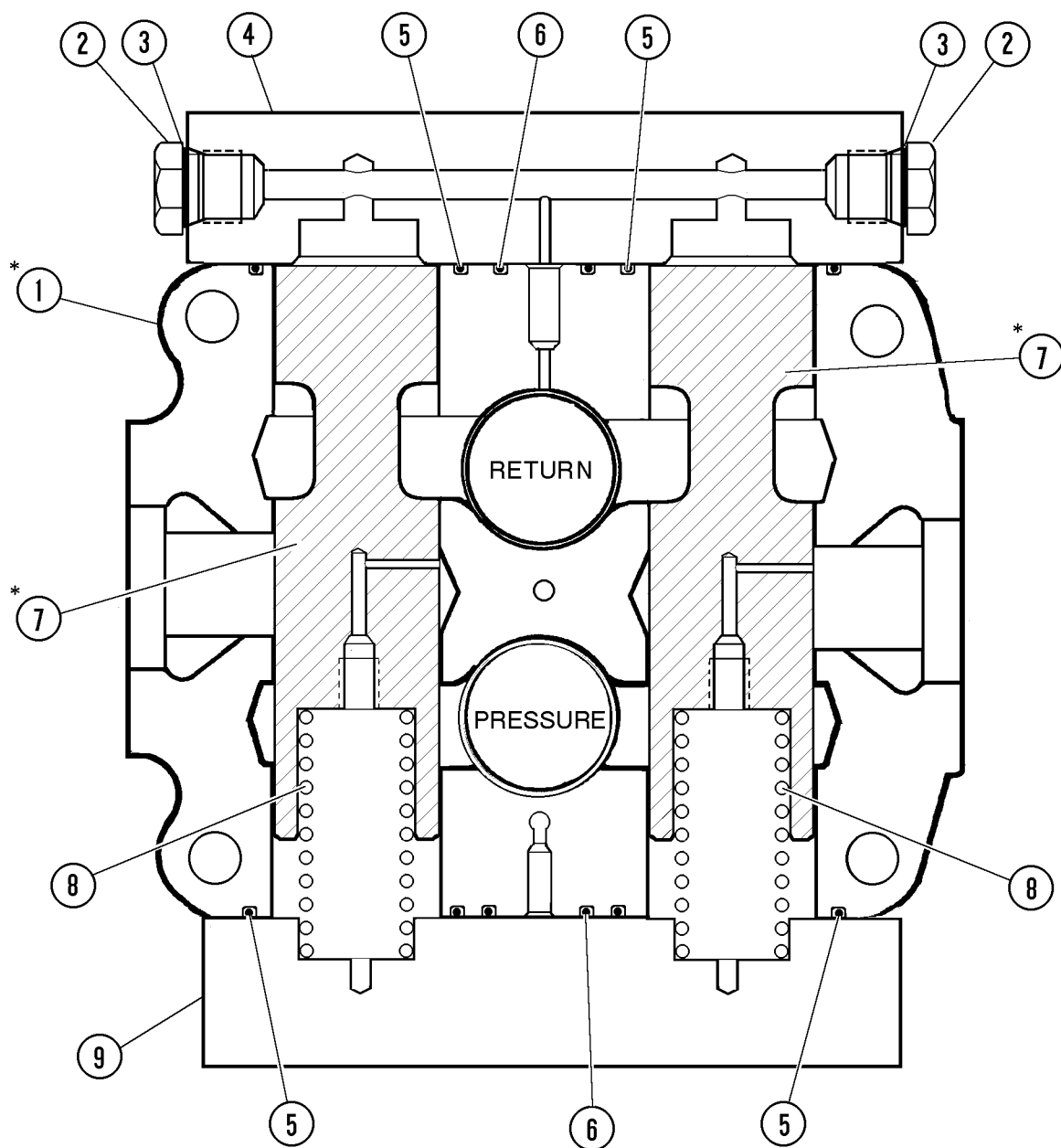
- |                                           |                                        |                                         |
|-------------------------------------------|----------------------------------------|-----------------------------------------|
| 1. Hoist Relief Valve (2500 psi)          | 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 (250 psi) | 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 (26 psi) |
| 7. Rod End Spool                          | 15. Down Pilot Port                    | 23. Brake Cooling Circuit Port          |
| 8. Head End Spool                         | 16. Power Down Relief Valve (1500 psi) | 24. Overcenter Manifold                 |

# SECTION L8

## HOIST CIRCUIT COMPONENT REPAIR

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\* Not Serviceable

L080051

FIGURE 8-11. TANKS PORTS SPOOL SECTION ASSEMBLY

1. Spool Housing  
2. Plug  
3. O-Ring

4. Spool Cover  
5. O-Ring  
6. O-Ring

7. Spool  
8. Spring  
9. Spool Cover

## Installation Of Check Balls And Plugs In Quill

Check balls (4, Figure 8-21) in the side of quill assembly (2) are held in place with threaded plugs (3).

If a plug is missing and the check ball is not found in the cylinder, the opposite side hoist cylinder and the plumbing leading to the hoist valve should be examined for damage. The hoist valve itself should also be checked to see whether the ball or plug has caused internal damage to the spool. Peening of the necked down sections of the spool may result. Spool sticking may also occur.

Refer to Figure 8-22 for SS1158 tool that can be fabricated for installing and removing the check ball plugs.

Check the plugs during any cylinder repair to ensure that they are tight. If they move, remove the plugs and check whether the ball seat in the quill is deformed.

- If deformation of the ball seat has occurred, the quill should be replaced.
- If the ball seat area is not deformed, measure the plug thickness as shown in Figure 8-21:

**Older plug:** 6.35 ± 0.50 mm (0.25 ± 0.02 in.)

**Newer plug:** 9.65 ± 0.50 mm (0.38 ± 0.02 in.)

1. Use the newer plugs. Ensure that the threads in the quill tube and on the plugs are clean, dry and free of oil and solvent.
2. Spray the mating threads of both plugs (3, Figure 8-21) and quill assembly (2) with LOCQUIC® Primer T (Komatsu part number TL8753) or equivalent. Allow the primer to dry 3 to 5 minutes.
3. Apply Loctite® Sealant #277 (Komatsu part number VJ6863) or equivalent to mating threads of both plugs and quill assembly.
4. Place check balls (4) in the quill tube and install plugs (3) with the concave side facing the ball. Use the SS1158 tool to tighten the plugs to **95 N•m (70 ft lb)**. Allow the parts to cure for two hours before exposing the threaded areas to oil.

**NOTE:** If LOCQUIC® Primer T (TL8753) was not used, the cure time will require 24 hours instead of two hours.

5. Stake the plug threads in two places (between the holes, as shown in Figure 8-21) to prevent loosening of the plug.

If removal of the plug is necessary in a later rebuild, it will be necessary to carefully drill out the stake marks and destroy the plug. A new plug should be installed and staked as previously detailed.

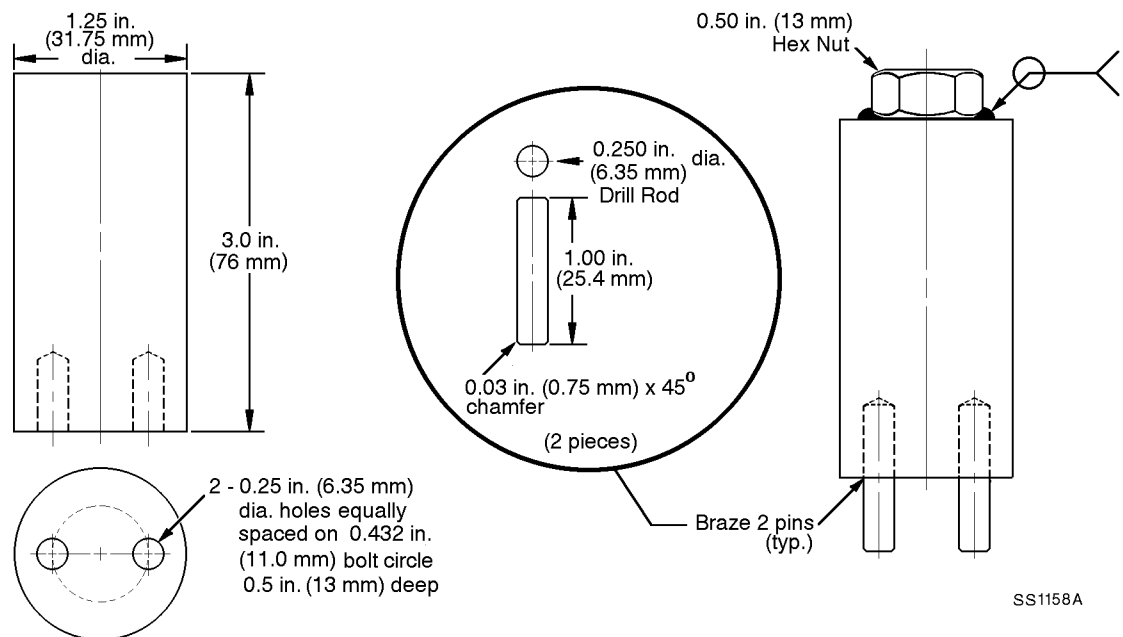
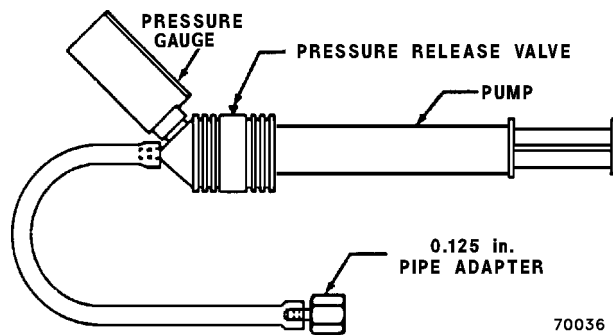


FIGURE 8-22. SS1158 PLUG INSTALLATION & REMOVAL TOOL

## PRESSURE SWITCH TESTER



The indicator switch tester may be ordered from:

Kent-Moore Heavy Duty Division  
Sealed Power Corp.  
29784 Little Mack  
Roseville, MI 40866-9984

Phone: (313) 774-9500

FIGURE 9-3. INDICATOR SWITCH TESTER  
Kent-Moore Part No. J-33884-4

## TEST BLOCK for DIFFERENTIAL PRESSURE SWITCH

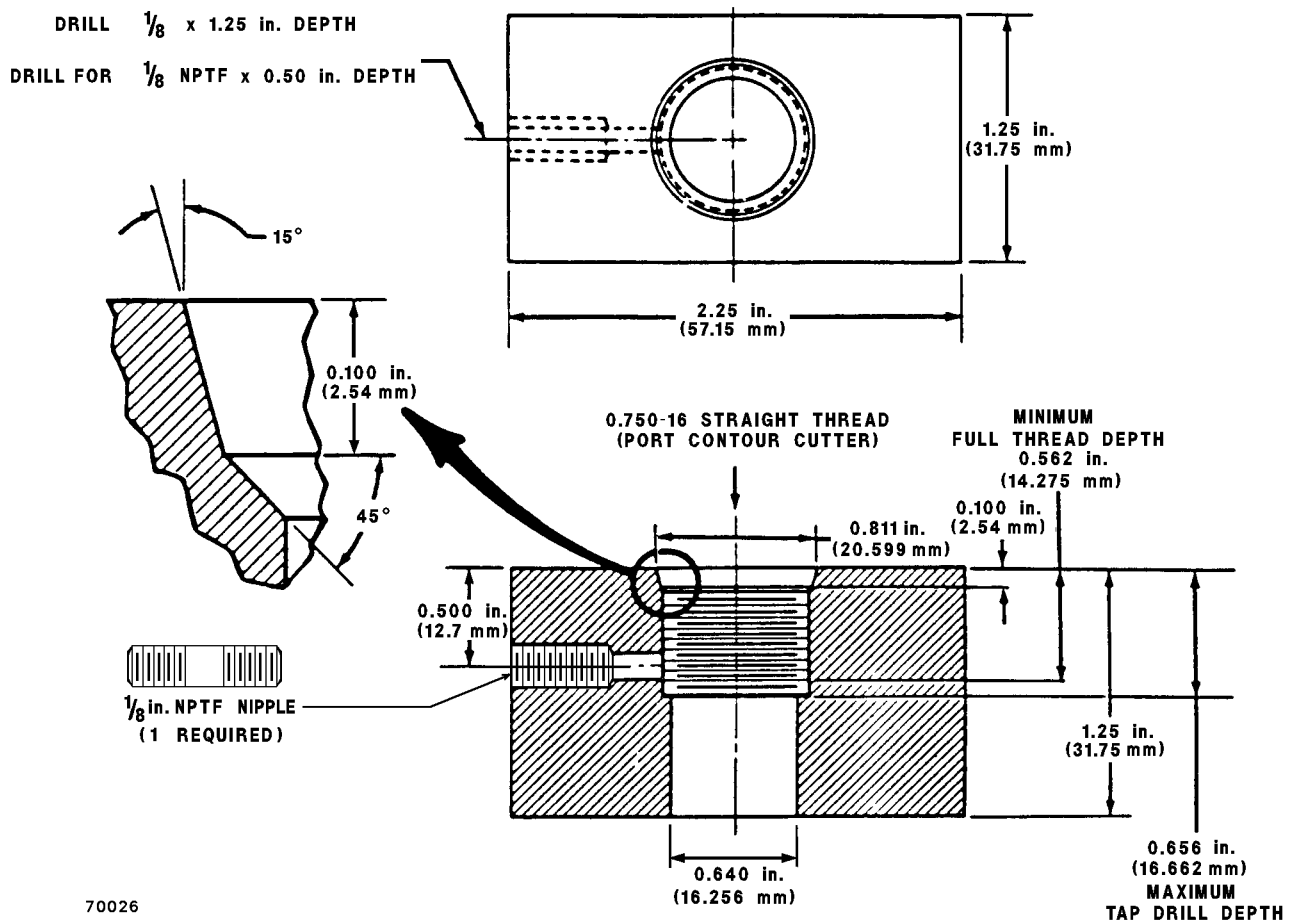


FIGURE 9-4. INDICATOR SWITCH PRESSURE TEST BLOCK

22. If all pump pressures and brake cooling oil supply pressures are correct as stated in Steps 20 and 21, increase engine speed to 1500 rpm and flush the system for 20 minutes. During this time, move the hoist control lever to the POWER UP position for 30 seconds, and then move it to the POWER DOWN position for 30 seconds. Repeat this hoist control cycle five times. This process will carry any system contaminants to the hydraulic filters.

Monitor the pressure gauges at the front and rear brake cooling test ports during this step. The pressure readings should always be 0 kPa (0 psi) when the hoist valve is in the POWER UP or POWER DOWN positions, and approximately 345 kPa (50 psi) while in the HOLD or FLOAT positions.

23. When the 20 minute flushing process is complete, turn the key switch to the OFF position and allow at least two minutes after the engine has stopped for the steering accumulators to completely depressurize.
24. Remove the adapters from both front wheel brake cooling hoses and re-connect the cooling hoses to the front brake assemblies.
25. Remove the tee fitting assembly from the three rear brake cooling hoses. Re-connect the three rear brake cooling hoses to the axle housing.
26. Check the pressure gauge connected to the "TP3" port on the bleed down manifold. If any pressure is still in the system, the bleed down process did not complete. Locate and repair the problem. If the pressure is 0 kPa (0 psi), remove the jumper hose and fittings installed in the bleed down manifold. Install the two plugs (1 & 2, Figure 10-1) previously removed back into the bleed down manifold.
27. Check the hydraulic tank oil level. If necessary, add oil.
28. Close both brake accumulator bleed down valves (1, Figure 10-8).

*NOTE: Do not combine Step 29 with any other steps. Do not apply the brakes or steer the truck during Step 29.*

29. To flush the accumulators, start the engine and operate the engine until the pressure at the "TP3" port on the bleed down manifold is approximately 21 200 kPa (3,075 psi). This is the pressure where the steering pump unloader valve shifts and unloads the pump.

- If the accumulator pressure exceeds 21 546 kPa (3,125 psi), immediately turn the engine off and open the brake accumulator bleed down valves. Refer to Steering pump pressure control adjustments in the shop manual, then repeat Step 29.
- If the accumulator pressure does not reach 20 856 kPa (3,025 psi), check for faults on the Interface Realtime Data Monitor program. If there is a bleed down fault active, locate and correct the problem. If no faults are active, refer to Steering pump pressure control adjustments in the shop manual, then repeat Step 29.

30. When the pressure gauge connected to "TP3" reads approximately 21 200 kPa (3,075 psi):

a. For the first time only through this step:

- Leave the key switch in the ON position, and use the engine shut down switch on the center console to stop the engine.
- After the engine has stopped, confirm that steering accumulator bleed down does not occur, and that no bleed down faults or any other faults are displayed on the Interface Realtime Data Monitor.

b. The second and subsequent times through this step:

- Turn the key switch to the OFF position. Confirm that after the engine has stopped that the steering accumulator bleed down process begins.
- Confirm that accumulator bleed down completes within two minutes. The pressure gauge at the bleed down manifold pressure test port "TP3" will be 103 kPa (15 psi) or less after a successful bleed down.

### Counterbalance Valve Pressure Check

1. Ensure that the engine is off, the body is resting on the frame or properly secured in its raised position, the hoist control valve is in the FLOAT position, and all hydraulic system pressure is bled down.
2. Loosen the locknut on the adjustment stem of needle valve (9, Figure 10-16) on the overcenter manifold. Turn the adjustment stem fully clockwise.
3. Remove the plug from "PILOT VENT" port (8) on the overcenter manifold. This port will remain open to the atmosphere during the adjustment. Do not allow dirt to enter the open port.

*NOTE: It is suggested that a clean SAE #4 (1/4") hydraulic hose be installed in the open port and pointed downward.*

4. Install a 35 000 kPa (5,000 psi) gauge at test port "TR" (7) on the overcenter manifold. Use a hose that is long enough for the technician to read the pressure gauge while in the cab of the truck. Do not read the gauge near the overcenter manifold or make adjustments while the engine is running. The gauge will measure the rod end pressure (the pressure controlled by the counterbalance valve).

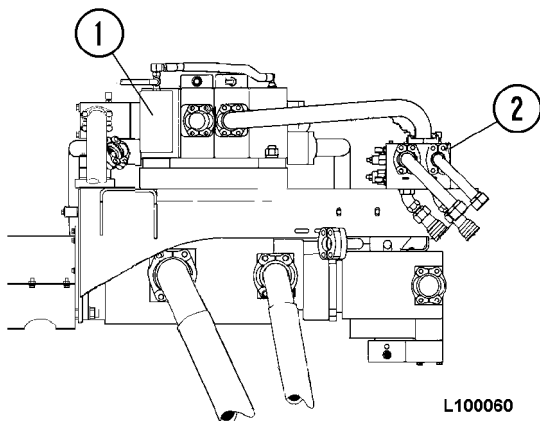


FIGURE 10-15. COUNTERBALANCE VALVE ADJUSTMENT

1. Hoist Valve

2. Overcenter Manifold

5. Start the engine and operate at low idle. If the body is in the raised position, lower the body to the frame.
6. Raise the body and, as it extends to the third stage, read the pressure on the gauge connected to the "TR" port. (All counterbalance valve pressures are read and adjusted while the hoist cylinders are in the third stage.)
  - a. If pressure is 20 700 kPa (3,000 psi) or above, stop raising the body immediately. The pressure is adjusted too high and must be lowered. Refer to "Counterbalance Valve Adjustment".
  - b. If pressure is below 20 700 kPa (3,000 psi), lower the body, increase engine speed by approximately 300 rpm and repeat Step 6 until the engine is at high idle or 20,700 kPa (3000 psi) is obtained.
  - c. If the gauge indicates 20 700 kPa (3,000 psi) with the engine at high idle, the hoist control lever in POWER UP and the hoist cylinders in the third stage, the counterbalance valve adjustment is correct.

#### \* Record on Data Sheet

- d. If the gauge still does not indicate 20 700 kPa (3,000 psi) with the engine at high idle, the hoist control lever in POWER UP and the hoist cylinders in the third stage, or if 20 700 kPa (3,000 psi) was obtained before the engine reached high idle, adjust the counterbalance valve.

# ENGINE COOLANT HEATER

## GENERAL

To aid in cold weather starting, the truck can be equipped with cooling system heaters. Two high capacity coolant heating units are mounted under the engine on the power module subframe. The system includes:

- Heaters
- Thermostats
- Coolant Shutoff Valves and Hoses
- 220 volt Receptacle
- Power Cables, Thermostat Wiring, and Junction Box

Heater operation is controlled by a thermostat mounted on the intake end of the heating units. The thermostat turns the heater ON at 48°C (120°F) and OFF at 60°C (140°F). Shutoff valves allow heater element or thermostat sensor replacement without loss of engine coolant.



***Do not operate engine while the cooling system heater is plugged in. The flow check valve eliminates coolant flow through the heater while the engine is running. This will cause a lack of circulation in the heater and burn out the heating elements.***

## Maintenance

To check for operation of the heating units, the outlet water hoses should feel warm to the touch.

1. Check all electrical connections to insure proper connections are made.
2. Check for a burned out heating element. (Do not remove heating unit from the truck.)
  - a. Remove the two Phillips head screws and slide end cover out of the way.
  - b. Connect a voltmeter at the two electrical terminals and check for operating voltage (220 to 230 volts) while coolant temperature is below 48°C (120°F). If correct voltage is present, the heating element is defective and should be replaced.
3. If correct voltage (measured above) is not read at heating element terminals, the thermostat is defective and should be replaced.

## HEATING ELEMENT

### Removal

1. Disconnect the external power source at the plug-in receptacle.
2. Close the shut-off valves located at the inlet and outlet ports.
3. Remove heating element.
  - a. Remove the two Phillips head screws from cover at power cable entry. Slide cover out of the way.
  - b. Disconnect the two electrical leads and remove heating element from the cartridge.

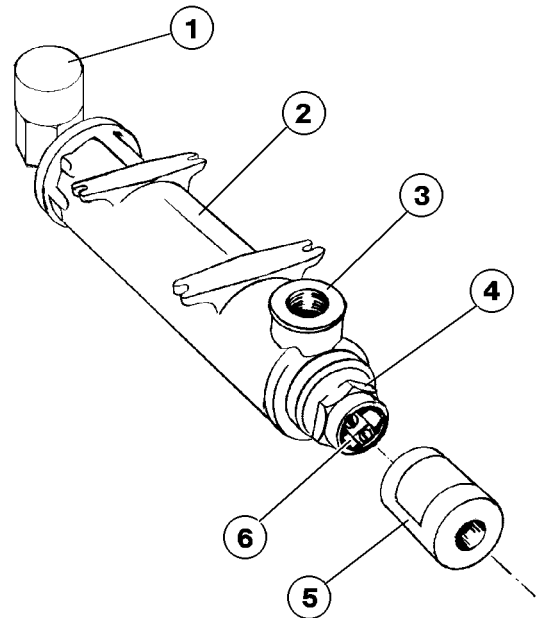


FIGURE 7-4. COOLANT HEATER

- |                      |                    |
|----------------------|--------------------|
| 1. Thermostat        | 4. Heating Element |
| 2. Heater Assembly   | 5. Cover           |
| 3. Water Outlet Port | 6. Terminals       |

**SECTION M19**  
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## Load Calculation

The final load calculation is different from the last swingload calculation. The accuracy of the swingload calculation depends on loading conditions and the position of the truck during loading. The last swingload calculation is not the value recorded in memory as the final load. The final load is determined by a series of calculations made while the truck is traveling to the dump site.

## Carry Back

Carry back is calculated as the difference between the current truck tare and the clean truck tare. The clean truck tare is calculated using the PC software. When the suspensions are serviced or changes are made that may affect the sprung weight of the truck, a new clean truck tare should be calculated.

## Measurement Accuracy

Payload measurements are typically repeatable within 1%. Accuracy for a particular scale test depends on specific combinations of pressure sensors and payload meters as well as the specifics of each scale test. Comparisons from different scale tests are often made without considering the differences introduced by the specific installation and operation of the scales for each test. In addition, each pressure sensor and payload meter introduces its own non-linearity. Each truck becomes an individual combination of sensors and payload meter. Errors from these sources can introduce up to a  $\pm 7\%$  bias in the payload meter calculations for a specific scale test, for an individual truck.

Because the PLMIII calculates a new empty tare for each payload, a detailed scale test must weigh the trucks empty and loaded for each haul cycle. Using a simple average of 2 or 3 empty truck weights as an empty tare for the entire scale test will introduce significant error when comparing scale weights to PLMIII weights.

## SOURCES FOR PAYLOAD ERROR

### Payload Error

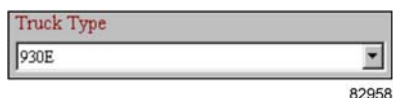
The number one source of error in payload calculation is improperly serviced suspensions. The payload meter calculates payload by measuring differences in the sprung weight of the truck when it is empty and when it is loaded. The sprung weight is the weight of the truck supported by the suspensions. The only method for determining sprung weight is by measuring the pressure of the nitrogen gas in the suspensions. If the suspensions are not properly maintained, the payload meter cannot determine an accurate value for payload. The two critical factors are proper oil height and proper nitrogen charge.

If the suspensions are overcharged, the payload meter will not be able to determine the empty sprung weight of the truck. The suspension cylinder must be able to travel up and down as the truck drives empty. The pressure in an overcharged suspension can push the suspension rod to full extension. In this case, the pressure inside the cylinder does not accurately represent the force necessary to support that portion of the truck.

If the suspensions are undercharged, the payload meter will not be able to determine the loaded sprung weight of the truck. The suspension cylinder must be able to travel up and down as the truck drives loaded. If the pressure in an undercharged suspension cannot support the load, the suspension will collapse and make metal-to-metal contact. In this case, the pressure inside the cylinder does not accurately represent the force necessary to support that portion of the truck.

Low oil height can also introduce errors by not correctly supporting a loaded truck. This is why the correct oil height and nitrogen charge are the most critical factors in the measurement of payload. If the suspensions are not properly maintained, accurate payload measurement is not possible. In addition, suspension maintenance is very important to the life of the truck.

## Setting the Truck Type



1. From the Truck Configuration screen, use the pull-down menu to select the truck type that the payload meter is installed on.
2. Press the "Save Changes" button to program the change into the meter.

## Setting the Gauge Display Units

The payload meter speedometer / display gauge displays the speed on the upper display. The units for the speed display are selected using a jumper on the rear of the case.

The payload units on the lower display can be changed from metric to short tons or long tons using the Truck Configuration screen. This selection also switches between metric (kg/cm<sup>2</sup>) and psi (lbs/in<sup>2</sup>) for the live display of pressure on the gauge.

1. From the Truck Configuration screen, select the payload units to be used on the lower display of the speedometer/display gauge.
2. Press the "Save Changes" button to program the change into the payload meter.

## Setting the Frame Serial Number

|                     |          |
|---------------------|----------|
| Frame Serial Number | A950010  |
| Truck Number        | T3444    |
| KMS Distributor     | RMS      |
| KMS Customer        | Pit Mine |

The frame serial number is located on the plate mounted to the truck frame. The plate is outboard on the lower right rail facing the right front tire. It is very important to enter the correct frame serial number. This number is one of the key fields used within the haul cycle database. The field will hold 20 alpha-numeric characters.

1. On the Truck Configuration screen, enter the truck frame serial number in the appropriate field.
2. Press the "Save Changes" button to program the change into the payload meter.

## Setting the Truck Number

Most mining operations assign a number to each piece of equipment for quick identification. This number or name can be entered in the Truck Number field. It is very important to enter a unique truck number for each truck using the PLMIII system. This number is one of the key fields used within the haul cycle database. The field will hold 20 alpha-numeric characters.

1. On the Truck Configuration screen, enter the truck number in the appropriate field.
2. Press the "Save Changes" button to program the change into the payload meter.

## Setting the Komatsu Distributor

This field in the haul cycle record can hold the name of the Komatsu distributor that helped install the system. Komatsu also assigns a distributor number to each distributor. This number is used on all warranty claims. This Komatsu distributor number can also be put into this field. The field will hold 20 alpha-numeric characters.

1. On the Truck Configuration screen, enter the distributor name or number in the appropriate field.
2. Press the "Save Changes" button to program the change into the payload meter.

## Setting the Komatsu Customer

This field in the haul cycle record can hold the name of the mine or operation where the truck is in service. Komatsu also assigns a customer number to each customer. This number is used on all warranty claims. This Komatsu customer number can also be put into this field. The field will hold 20 alpha-numeric characters.

1. On the Truck Configuration screen, enter the customer name or number in the appropriate field.
2. Press the "Save Changes" button to program the change into the payload meter.

# TROUBLESHOOTING SECTION

## TROUBLESHOOTING

Troubleshooting the PLMIII system is done through the PC software you can:

- View active alarms.
- View the sensor inputs using the Real-Time Data Display.
- Test the payload lights.
- Create log files of sensor inputs for further analysis.
- These activities require a connection to the PLMIII system.

### Viewing Active Alarms

Active alarms are alarms that have been set, but not yet cleared. Each alarm is set when the conditions for activation are held for 5 seconds. Each alarm is cleared when the condition has been returned to normal range for 5 seconds. For example, 5 seconds after the left-rear pressure sensor is disconnected, the LR-Pressure Lo alarm will be activated. This can be viewed using the "Connect to Payload Meter" screen. 5 seconds after the pressure sensor is re-connected, the alarm will clear and be recorded in memory.

Active alarms are recorded in memory as "cleared" when the key switch is turned off. When power is restored to the payload meter, the alarms will be re-activated if the conditions still exist for 5 seconds.

To view active alarms:

1. Connect to the payload meter and start the PC software.
2. From the main menu, select "Connect to Payload Meter". The PC will request the latest status information from the payload meter.
3. If there are active alarms, the "Display Active Alarms" button in the lower left corner will be available. If the button is not available, there are no active alarms at the time of connection. The screen does not automatically refresh. If a condition changes to cause an alarm, the user must exit and re-enter the "Connect to Payload Meter" screen.

### Real-Time Data Display

| Real Time Data                                                                                               |      |                          |           |
|--------------------------------------------------------------------------------------------------------------|------|--------------------------|-----------|
| <b>Pressure PSI</b>                                                                                          |      | <b>Truck Status</b>      |           |
| Left Front                                                                                                   | 304  | Inclinometer             | 0.5       |
| Right Front                                                                                                  | 287  | Body Up                  | No        |
| Left Rear                                                                                                    | 299  | Brake Lock               | Off       |
| Right Rear                                                                                                   | 293  | Haul Cycle State         | Tare Zone |
| <b>Speed MPH</b>                                                                                             |      | <b>Weight Short Tons</b> |           |
| Truck                                                                                                        | 20.0 | Sprung Weight            | 107       |
| <b>Lights</b>                                                                                                |      |                          |           |
| <input type="checkbox"/> Green Light <input type="checkbox"/> Amber Light <input type="checkbox"/> Red Light |      |                          |           |
| Set FileName                                                                                                 |      | Start Log                | Stop Log  |
| Set Lights                                                                                                   |      | Close                    |           |

The PC software can be used to view the 'live' input readings from the payload meter. The numbers displayed are 1-second averages.

1. Connect to the payload meter and start the PC software.
2. From the main menu, select "Connect to Payload Meter". The PC will request the latest status information from the payload meter.
3. Select the "Real Time Data" button. The data screen will pop up. The PC will request the payload meter to begin transmitting data.
4. To exit, press the "Close" button.

The units for each measurement are determined by the setting in the Program Options for the PC software. The four suspension pressures and inclinometer are shown. The status of the Body-Up and Brake-Lock inputs is also shown. The haul cycle state and speed is displayed. The current sprung weight is displayed. This differs from pure payload. The sprung weight is a measurement of the weight of the truck above the suspension. It does not include the tires, spindles, wheel motors, drive case, or anything below the suspensions.

### Testing the Payload Lights

The real time data display also allows the user to individually power the payload lights. This can be useful for testing the lights. To turn on a particular color payload light:

1. Click the check box beside the color light to power.
2. Press the "Set Lights" button to turn on the light.
3. Uncheck the box and press "Set Lights" to turn off the light.

The lights will return to their normal state when the real time data display is closed.

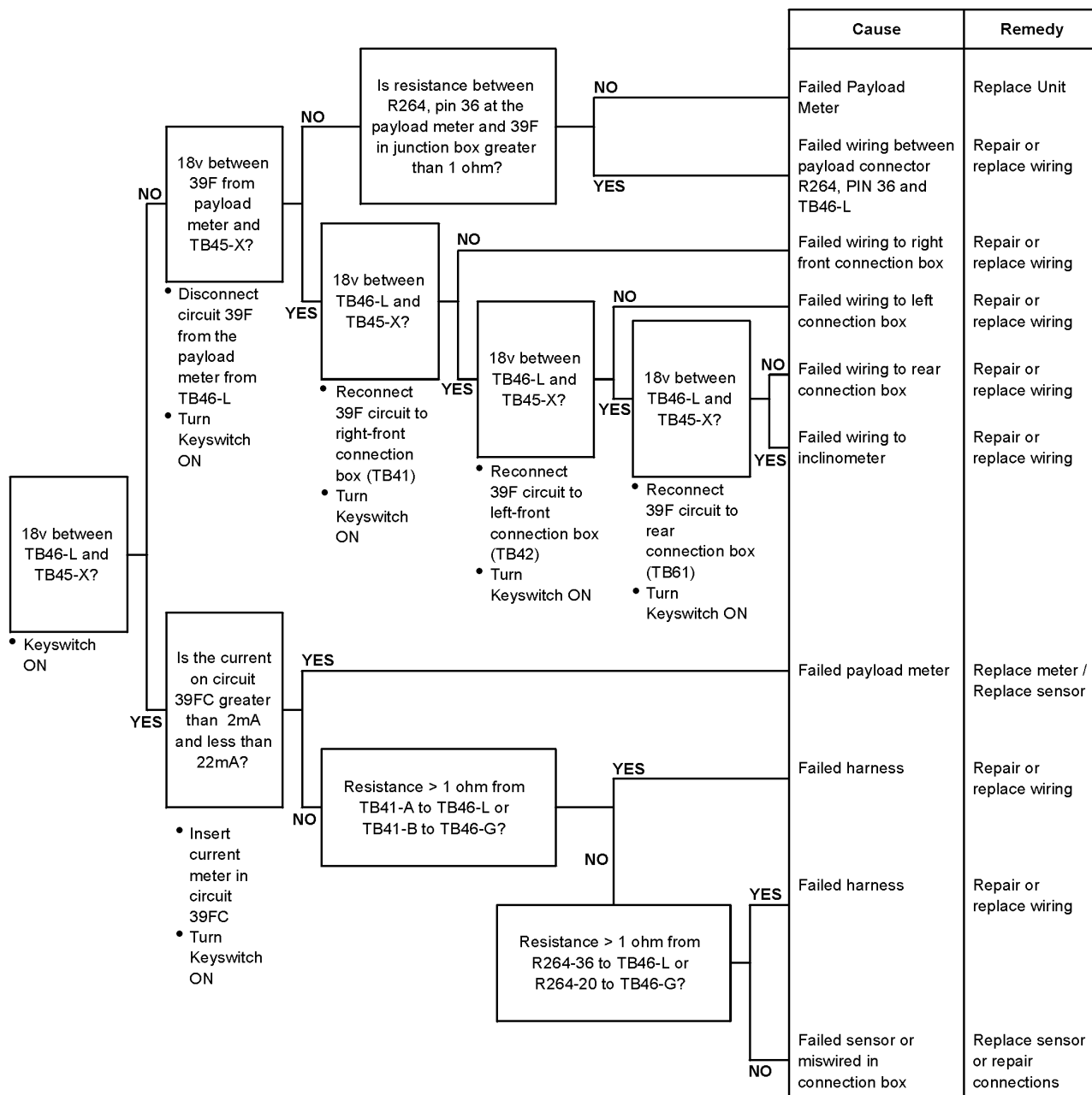
### Alarm 3 - Right Front Pressure High

### Alarm 4 - Right Front Pressure Low

### Troubleshoot Wiring to Right Front Suspension

These alarms indicate that the current being read by the payload meter is higher than 22ma or lower than 2ma. The pressure sensor is designed to output 4-20ma over a pressure range of 4000 psi.

- Confirm 18v sensor supply at TB46-L in payload junction box.
- Confirm proper connection of signal circuit 39FC from right suspension connection box, TB41-B to payload junction box TB46-G to payload meter connector R264, pin 20.



# PLMIII CHECK OUT PROCEDURE

## General Description

The process consists of attaching dummy loads in place of the suspension pressure sensors and checking the pressures indicated by the payload meter. In addition, connecting to the payload meter using a laptop PC in order to confirm the latest software version and the rest of the inputs and outputs of the system.

## Tools Required

- Payload Data Manager software
- EF9160 or PC2525 - Download Harness
- EJ3057 - Harness Str, PLMIII test (4 needed).

## Checkout Procedure

1. Attach one EJ3057 harness to the left-front suspension connection box. The red alligator clip attaches to the 39F circuit at TB42-A. The white alligator clip attaches to the 39FD circuit at TB42-B. The EJ3057 acts as a dummy load to simulate a suspension pressure sensor for the payload system.
2. Attach one EJ3057 harness to the right-front suspension connection box. The red alligator clip attaches to the 39F circuit at TB41-A. The white alligator clip attaches to the 39FC circuit at TB41-B.
3. Attach one EJ3057 harness to the left-rear suspension connection in the rear suspension connection box. The red alligator clip attaches to the 39F circuit at TB61-A. The white alligator clip attaches to the 39FB circuit at TB61-C.
4. Attach one EJ3057 harness to the right-rear suspension connection in the rear suspension connection box. The red alligator clip attaches to the 39F circuit at TB61-A. The white alligator clip attaches to the 39FA circuit at TB61-B.
5. In the PLMIII junction box, check the input voltage on circuit 39G between TB45-B and TB45-X. This voltage should be 24vdc from the batteries.
6. Turn the key switch ON. The speedometer/display gauge on the dashboard will scroll the truck type across the lower display. The payload meter defaults to 930E.
7. In the PLMIII junction box, check the sensor supply voltage on circuit 39F between TB46-L and TB45-X. This voltage should be 18vdc  $\pm 1$ vdc.

8. Return to the cab and check the speedometer/display gauge. The gauge will display the current payload. With the EJ3057 harnesses attached at the sensor locations, the payload should be 0.

*NOTE: The display can be used to quickly show the current readings from the four suspension pressure sensors and the inclinometer. This can be used during regularly scheduled service periods to check the state of the suspensions. These displays are live and will update as the values change. The display is changed by pressing the 'SELECT' button on the dashboard. The sequence of displays is:*

- $P L$  = Payload
- $I d$  = Operator ID
- $T L$  = Total Shift Tons
- $L C$  = Shift Load Counter
- $L F$  = Left Front Suspension Pressure
- $r F$  = Right Front Suspension Pressure
- $L r$  = Left Rear Suspension Pressure
- $r r$  = Right Rear Suspension Pressure
- $I n$  = Inclinometer

*NOTE: The live displays cannot be cleared and the SET button will have no effect.*

*NOTE: The units for the display are controlled by the configuration of the payload meter. The payload meter defaults to display metric units, the pressures will be displayed in tenths of  $kg/cm^2$ . For example, if the display shows  $20.2$  the actual value is  $20.2 kg/cm^2$ . If the payload meter is set to display short tons, the pressures will be displayed in psi ( $lbs/in^2$ ). To convert from  $kg/cm^2$  to psi, multiply by 14.2233.  $14.2233 psi (lbs/in^2) = 1 kg/cm^2$ .*

*NOTE: The inclinometer displays whole degrees of incline. Positive incline is when front of truck is pointing up.*

*NOTE: The gauge will quickly display the type of information being displayed every 1 minute. For example, if the left-front pressure is being displayed,  $L F$  will quickly display every minute. Only the payload display,  $P L$  does not display this information.*

## RESERVE ENGINE OIL SYSTEM

The reserve engine oil system is designed to add more oil capacity to the engine sump and to reduce frequent servicing of the engine oil. The constant circulation of oil between the engine sump and reserve tank (9, Figure 31-1) increases the total volume of working oil. This dilutes the effects of contamination and loss of additives and maintains the oil quality over longer periods. The system adds or removes oil from the engine as required to maintain a constant level which prevents over fills or under fills.

The normal reserve system capacity of oil carried in the tank can be one half or nearly the same (depending on tank size) volume inside the engine. In the process of continuous adjustment of the engine oil level, there is a constant circulation of oil between the engine and the reserve tank. The volume of oil in the tank becomes part of the working oil for the engine. Oil change intervals may usually be extended in proportion to the increased working oil volume. Extension beyond a proportional increase is often possible, but should be undertaken only as determined by oil sampling and analysis. Local conditions such as engine application, climate, and fuel quality should be taken into consideration before determining permissible oil life.

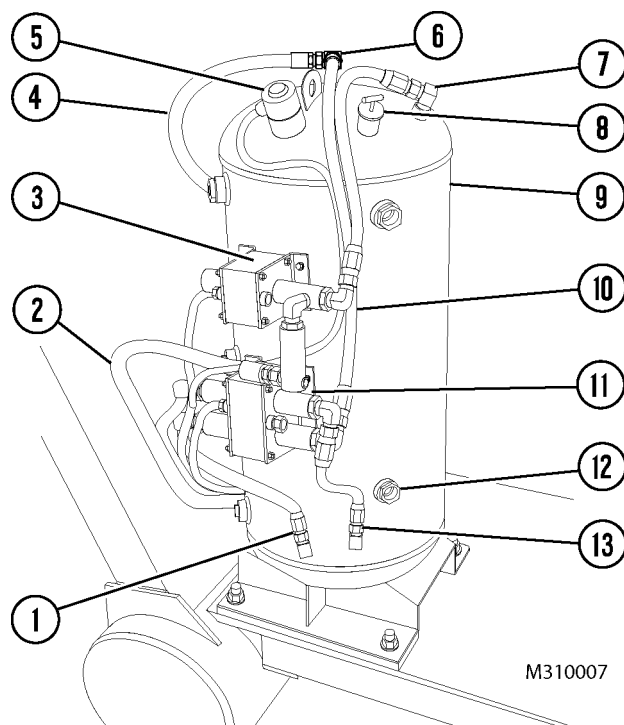


FIGURE 31-1. OIL RESERVE TANK

- |                     |                     |
|---------------------|---------------------|
| 1. Suction Line     | 8. Tank Fill Cap    |
| 2. Remote Fill Line | 9. Reserve Tank     |
| 3. Fill Valve       | 10. Engine Add Line |
| 4. Engine Add Line  | 11. Pumping Unit    |
| 5. Fill Switch      | 12. Sight Gauge     |
| 6. Air Relief Valve | 13. Tank Add Line   |
| 7. Tank Fill Line   |                     |

## TRUCK CAB AND COMPONENTS

### TRUCK CAB

#### Description

The truck cab is a fully insulated design incorporating an integral ROPS structure for maximum operator comfort and safety. All gauges, switches, and controls have been designed to simplify operation and are placed within easy reach of the operator. Servicing of cab and associated electrical systems is simplified by use of heavy duty connectors on the various wiring harnesses. Hydraulic components are located outside the cab interior and are accessed through cover (1, Figure 2-1) on the front of the cab.

#### **⚠ WARNING**

***DO NOT attempt to modify or repair damage to the ROPS structure without written approval from the manufacturer. Unauthorized repairs to the ROPS structure will void certification. If modification or repairs are required, contact the servicing Komatsu Distributor.***

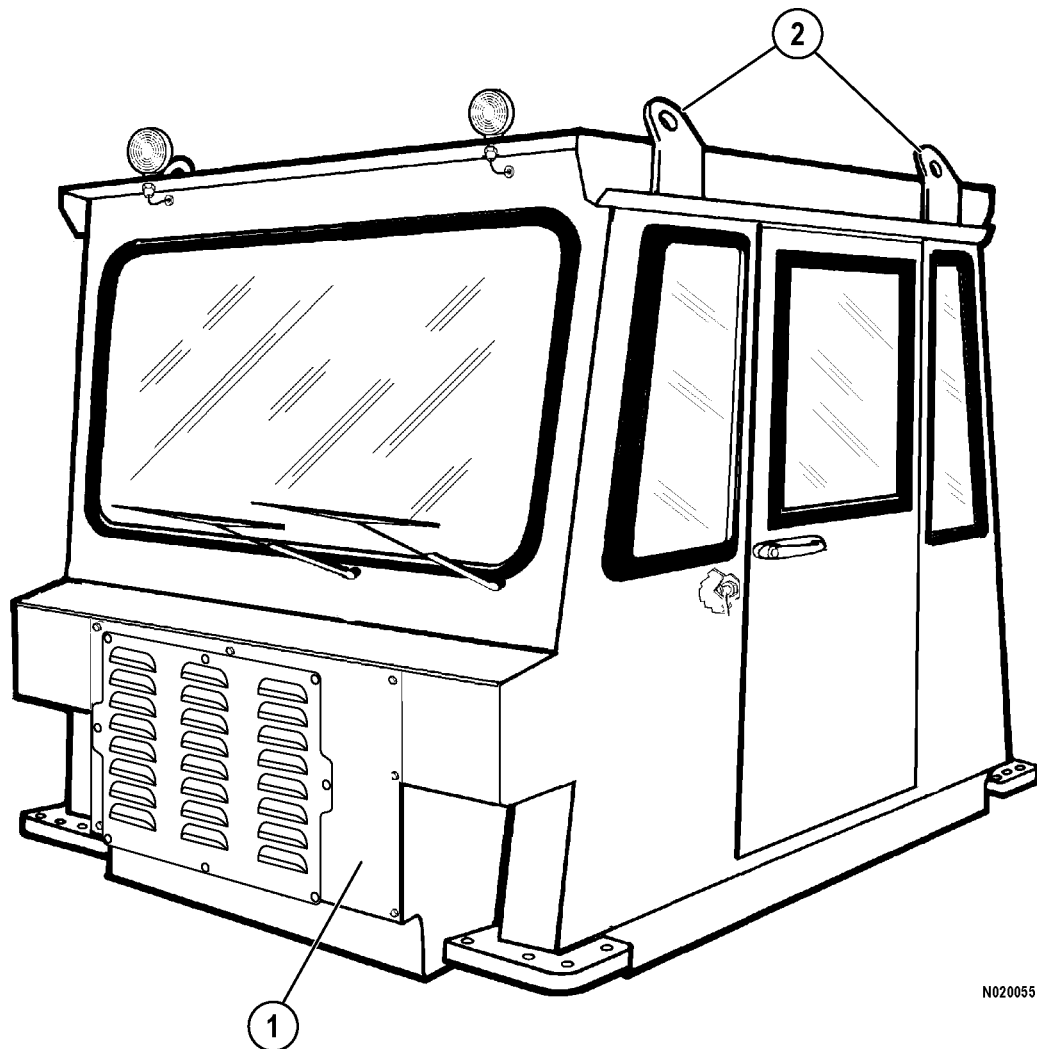


FIGURE 2-1. CAB ASSEMBLY (FRONT VIEW)

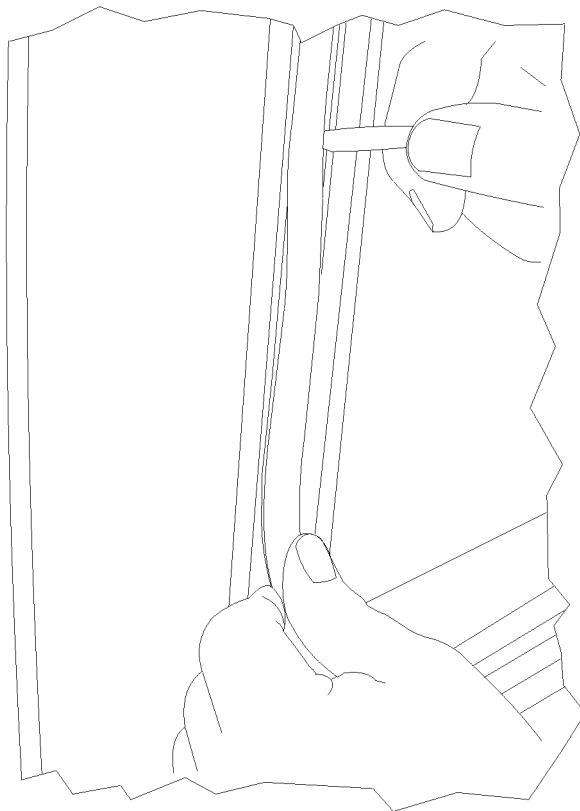
1. Access Cover

2. Lifting Eyes

19. Install the two screws that were removed in Step 8. Ensure that the rubber felt insert is back in place after the screws are installed.
20. Install the window regulator track bracket as shown in Figure 2-7. Ensure that the nylon bushings and gaskets are installed properly to prevent damage to the glass.
21. Lift the window glass in the frame and install the window regulator roller track onto the bracket installed in Step 20. See Figure 2-8.
22. While holding the window glass as shown in Figure 2-9 (a few inches from the top), install the lower and upper regulator rollers in their tracks. Start by moving the door panel (with the window regulator) away from the cab just far enough to allow the rollers to enter their tracks. Then, with the rollers in the tracks, slide the panel toward the cab. Move the panel just far enough to allow the upper regulator roller to go into the track on the bottom of the glass.
23. Lift up the door panel, regulator and glass to align the screw holes in the panel with the holes in the door frame. Install the screws that secure the panel to the door frame.
24. Hook up the electrical connector for the window regulator. Install the two capscrews that hold the door strap bracket to the door frame.
25. Align the door check strap opening with the holes in the bracket and install the bolt. Install the hair pin clip. See Figure 2-6.

### Replacing the Door Window Regulator

1. Perform Steps 1 through 6 in the procedure "Replacing the Door Glass".
2. Move the inner panel assembly to a work area.
3. Remove four mounting screws (6, Figure 2-6).
4. If replacing the motor assembly of the window regulator, ensure that the worm gear on the motor is engaged properly into the regulator gear. Also, the regulator should be in the UP position before replacing the motor assembly. Ensure that the motor mounting screws are tight.
5. If replacing the window regulator assembly, the new regulator should be in the UP position before being mounted.
6. Mount the window regulator to the inner panel with the four mounting screws that were removed in Step 3. Ensure that the screws are tight.
7. Perform Steps 22 through 25 in the procedure "Replacing the Door Glass".



N020030

FIGURE 2-15.

## WINDSHIELD WASHER

### Operation

The windshield washer, mounted on the right side of the hydraulic components cabinet behind the cab, has a 3.8 liter (1 gal) plastic reservoir (1, Figure 4-4) with a 24 volt electric pump (2).

The washer is controlled by the windshield wiper switch mounted on the turn signal lever. When the switch is activated, washing solution is pumped through outlet hose (3) and fed to a jet located in each of the windshield wiper arms.

### Service

If windshield washer maintenance is required, check the strainer opening for obstructions and inspect the hoses for damage. Check the voltage to the pump from the control switch. If the pump is inoperable, replace it with a new pump assembly.

*Note: The pump is only available as an assembly and cannot be repaired.*

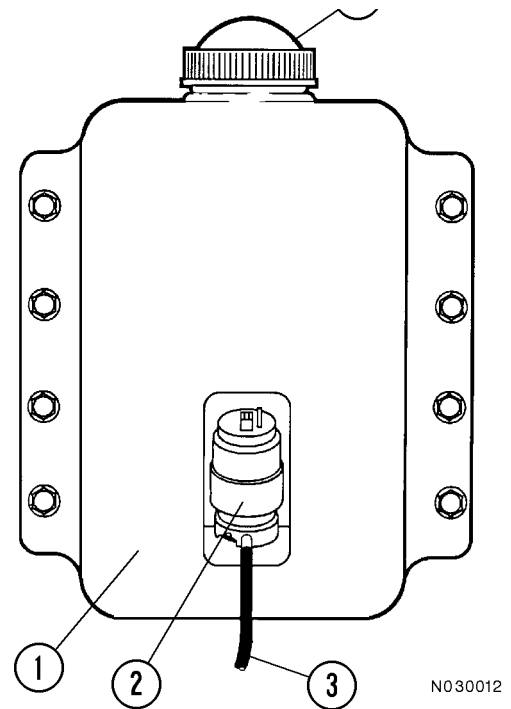


FIGURE 3-4. WINDSHIELD WASHER FLUID RESERVOIR AND PUMP

- |              |                |
|--------------|----------------|
| 1. Reservoir | 3. Outlet Hose |
| 2. Pump      | 4. Filler Cap  |

## Heater Core

Heater core (2, Figure 4-4) receives engine coolant through water valve (33) when heat is selected. If temperature control knob (2, Figure 4-1) is placed in between the red and blue area, or turned counterclockwise to the blue area, coolant flow should be blocked.

If temperature control knob (2) and water valve (33, Figure 4-4) appear to be working properly, yet no heat is apparent in heater core (2), the core may be restricted. Remove and clean or replace the core.

## Fan Motor And Speed Control

Fan speed is controlled by the position of the fan speed control knob (1, Figure 4-1).

If blower assembly (3, Figure 4-4) does not operate at any of the speed selections, verify that battery voltage is available at the switches and relay. Refer to the electrical schematic in Section R. If voltage is present, the blower assembly is probably defective and should be removed and replaced.

## Actuators

Two rotary actuator motors (9, Figure 4-4) are installed inside the heater housing and are used to actuate the damper doors for the following:

- Defroster outlet
- Bi-level or floor outlets

A failure to switch one of the above modes of operation may be caused by a faulty actuator.

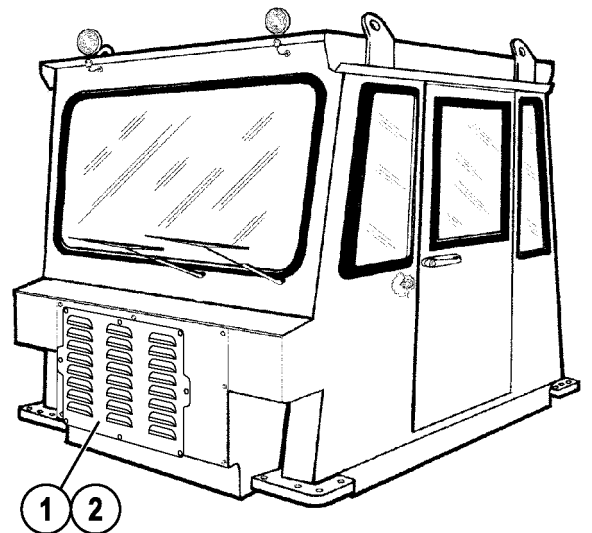
Visually inspect damper doors (35, 36) and the linkage for the function being diagnosed. Ensure that the damper door is not binding or obstructed, preventing movement from one mode to the other.

Verify that 24 VDC is present at the actuator when air flow directional knob (5, Figure 4-1) is moved through its various positions of operation.

If the correct voltages are present during operation of the air flow knob, disconnect the actuator from the damper door and verify that actuator force is comparable to a known (new) actuator. If it is not, install a new actuator.

## Cab Air Filter

Recirculation air filter (5, Figure 4-4) and fresh air filter (2, Figure 4-3) in the front access panel of the cab need periodic cleaning to prevent restrictions in air circulation. Restricted filters will decrease the performance of the heater and air conditioner. The recommended interval for cleaning and inspection is 250 hours, but in extremely dusty conditions the filters may need daily service and inspection, especially the outer panel filter on the cab shell. The filter elements should be cleaned with water and dried in a dust free environment before reinstallation. Replace the filter element every 2000 hours, or sooner if inspection indicates a clogged or damaged filter.



N04007

FIGURE 4-3. CAB FILTER LOCATION

1. Access Cover

2. Cab Filter

## SERVICE TOOLS AND EQUIPMENT

### Recovery/Recycle Station

Whenever refrigerant must be removed from the system, a dual purpose station, as shown in Figure 4-6, performs both recovery and recycle procedures which follows the new guidelines for handling used refrigerant. The recovered refrigerant is recycled to reduce contaminants, and can then be reused in the same machine or fleet.

To accomplish this, the recovery/recycle station separates the oil from the refrigerant and filters the refrigerant multiple times to reduce moisture, acidity, and particulate matter found in a used refrigerant.

*NOTE: To be re-sold, the gas must be "reclaimed" which leaves it as pure as new, but requires equipment normally too expensive for all but the largest refrigeration shops.*

Equipment is also available to just remove or extract the refrigerant. Extraction equipment does not clean the refrigerant; it is used to recover the refrigerant from an A/C system prior to servicing.

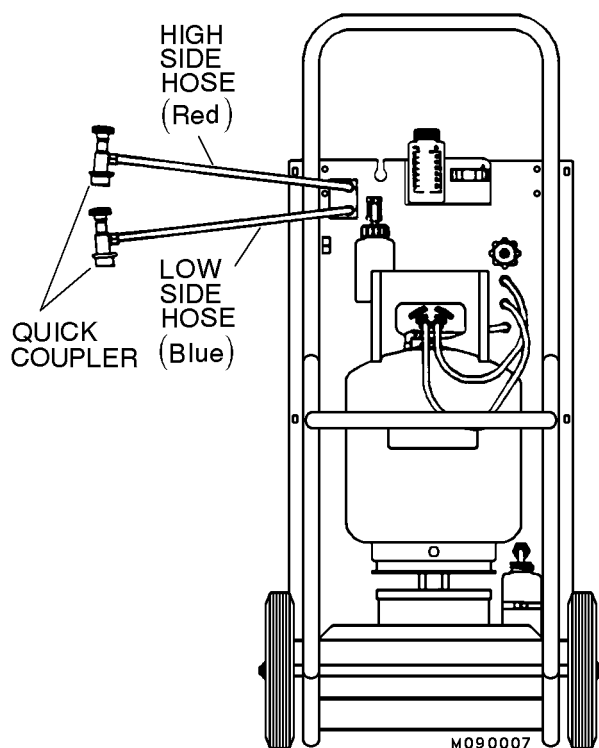


FIGURE 4-6. RECOVERY/RECYCLE STATION

## CAUTION

**Mixing different types of refrigerant will damage equipment. Dedicate one recovery/recycle station to each type of refrigerant processing to avoid equipment damage. DISPOSAL of the gas removed requires laboratory or manufacturing facilities.**

Test equipment is available to confirm that the refrigerant in the system is actually the type intended for the system and has not been contaminated by a mixture of refrigerant types.

Recycling equipment must meet certain standards as published by the Society of Automotive Engineers (SAE) and carry a UL approved label. The basic principals of operation remain the same for all machines, even if the details of operation differ somewhat.

### Leak Detector

The electronic leak detector (Figure 4-7) is very accurate and safe. It is a small hand-held device with a flexible probe used to seek refrigerant leaks. A buzzer, alarm or light will announce the presence of even the smallest leak.

Some leak detectors are only applicable to one type of refrigerant. Ensure that the leak detector being used applies to the refrigerant in the system.

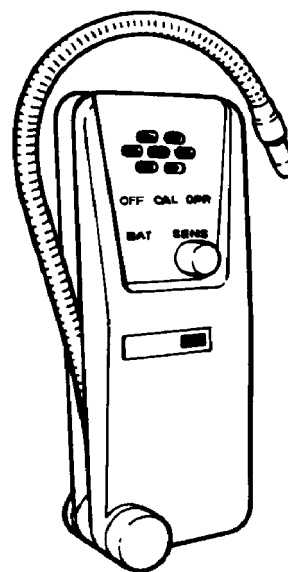


FIGURE 4-7. TYPICAL ELECTRONIC LEAK DETECTOR

## A/C DRIVE BELT CHECKOUT PROCEDURE

This procedure must be performed each time any component in the accessory drive is serviced, such as replacing a belt or removing the compressor. In addition, a 250 hour inspection of the AC drive belt is mandatory. The belts must be inspected for indications of wear and damage that may hinder performance. Replace as necessary and perform the following procedure.

### Pulley Alignment

1. Install alignment tool (EL8868) onto the pulleys to check the alignment. Refer to Figure 4-15. If misalignment of the pulleys exceeds 3 mm (0.13 in.), the position of the compressor must be adjusted.

### Belt Tension Check

*NOTE: This procedure has been written for use with belt tension tool (XA3379), shown in Figure 4-13. Other tension tools may differ in functionality.*



FIGURE 4-13. BELT TENSION TOOL - XA3379

2. Refer to Figure 4-16 for the proper distance from the centerline of the drive pulley to the centerline of the compressor pulley. Set the tension tool accordingly on the "deflection" scale by moving the deflection O-ring to the corresponding distance on the scale.
3. Slide the O-ring for the "force" scale to zero.



FIGURE 4-14. DEFLECTION MEASUREMENT

4. Find the approximate center of the belt between the two pulleys. Place the tip of the tool onto the outer face of the belt and apply pressure, as shown in Figure 4-14. The tool must be perpendicular to the belt. Push on the tool until the bottom edge of the deflection scale O-ring is even with the outer face of the adjacent drive belt. If only one belt is used, rest a straight edge across both pulleys to serve as the indicating plane.
5. The O-ring on the force scale indicates the force used to deflect the belt. The belt must deflect 5.3 mm (0.21 in.) under a force of  $1.6 \pm 0.1$  kgf ( $3.44 \pm 0.11$  lbf). If not, adjust the belt accordingly and recheck the tension.

## TROUBLESHOOTING

### Preliminary Checks

If the system indicates insufficient cooling, or no cooling, the following points should be checked before proceeding with the system diagnosis procedures.

*NOTE: If equipped, ensure that the rest switch in the cab is ON. Place the GF cutout switch in the CUTOUT position.*

Some simple, but effective checks can be performed to help determine the cause of poor system performance. Check the following to ensure proper system operation.

- Compressor belt - Must be tight, and aligned.
- Compressor clutch - The clutch must engage. If it does not, check fuses, wiring, and switches.
- Oil leaks - Inspect all connection or components for refrigeration oil leaks (especially in the area of the compressor shaft). A leak indicates a refrigerant leak.
- Electrical check - Check all wires and connections for possible open circuits or shorts. Check all system fuses.
- Cooling system - Check for correct cooling system operation. Inspect the radiator hoses, heater hoses, clamps, belts, water pump, thermostat and radiator for condition or proper operation.
- Radiator shutters - Inspect for correct operation and controls, if equipped.
- Fan and shroud - Check for proper operation of fan clutch. Check installation of fan and shroud.
- Heater/water valve - Check for malfunction or leaking. With the heat switch set to COLD, the heater hoses should be cool.

- System ducts and doors - Check the ducts and doors for proper function.
- Refrigerant charge - Make sure system is properly charged with the correct amount of refrigerant.
- Cab filters - Ensure the outside air filter and inside recirculation filter are clean and free of restriction.
- Condenser - Check the condenser for debris and clogging. Air must be able to flow freely through the condenser.
- Evaporator - Check the evaporator for debris and clogging. Air must be able to flow freely through the condenser.

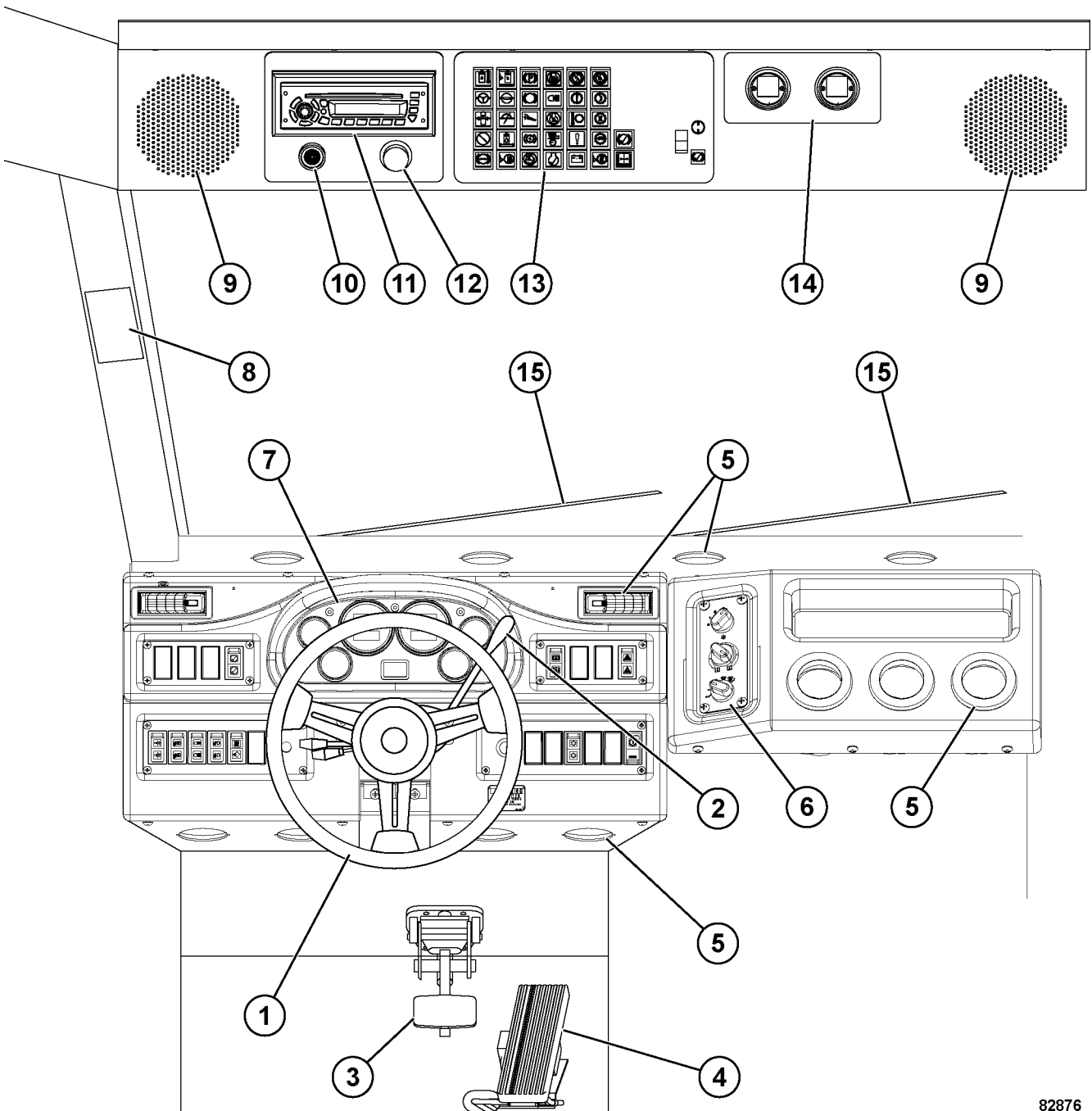
### Diagnosis Of Gauge Readings And System Performance

Successfully servicing an air conditioning system, beyond the basic procedures outlined in the previous section, requires additional knowledge of system testing and diagnosis.

A good working knowledge of the manifold gauge set is required to correctly test and diagnose an air conditioning system. An accurate testing sequence is usually the quickest way to diagnose an internal problem. When correctly done, diagnosis becomes an accurate procedure rather than guesswork.

The following Troubleshooting Chart lists typical malfunctions encountered in air conditioning systems. Indications and or problems may differ from one system to the next. Read all applicable situations, service procedures, and explanations to gain a full understanding of the system malfunction. Refer to information listed under "Suggested Corrective Action" for service procedures.

## OPERATOR CAB CONTROLS



82876

FIGURE 5-1. CAB INTERIOR - OPERATOR VIEW

- |                                 |                                    |                                     |
|---------------------------------|------------------------------------|-------------------------------------|
| 1. Steering Wheel               | 6. Heater/Air Conditioner Controls | 11. Radio/CD Player                 |
| 2. Retarder Lever               | 7. Instrument Panel                | 12. Warning Lights Dimmer Control   |
| 3. Brake/Retarder Pedal         | 8. Grade/Speed Chart               | 13. Warning/Status Indicator Lights |
| 4. Throttle/Accelerator Pedal   | 9. Radio Speakers                  | 14. Air Cleaner Restriction Gauges  |
| 5. Heater/Air Conditioner Vents | 10. Warning Alarm Buzzer           | 15. Windshield Wipers               |

### Data Store Button

Button (10, Figure 5-5) is for use by qualified maintenance personnel to record in memory a "snapshot" of the AC drive system. It will also trigger the VHMS system to store a snapshot of the truck operating system. Light (11, Figure 5-5) will stay illuminated while the VHMS system is recording the snapshot.

### VHMS Snapshot In Progress Light

Light (11, Figure 5-5) is an indicator that will illuminate while VHMS is in the process of taking a snapshot of machine data.

### Link Energized Light

Light (12, Figure 5-5) is a red indicator that, when illuminated, indicates that the AC drive system is energized. No one is permitted to work on the AC drive system while this light is illuminated.

### Service Engine Light

Light (13, Figure 5-5) is a blue indicator that will illuminate if a problem is detected by the electronic engine monitoring system.

Electric propulsion and dynamic retarding will still be available.

If this light is ON, notify maintenance personnel so they can diagnose and repair the problem the next time the truck is in the shop for repairs or at the next PM (Preventive Maintenance) interval.

### 12V Auxiliary Power Outlets

Outlets (14, Figure 5-5) can be used to provide 12VDC power for tools and accessories.

## DIAGNOSTIC PORTS

### VHMS Diagnostic Port

Diagnostic port (1, Figure 5-6) is used to download truck operation data from the VHMS controller.

### Interface Module (IM) Diagnostic Port

Diagnostic port (2) is used to connect the interface module to a computer for installing software.

### Payload Meter Diagnostic Port

Diagnostic port (3) is used to download data from the payload meter system. Refer to Section 60, Payload Meter III, for a more complete description of the payload meter and its functions.

### Truck Control Interface (TCI) Diagnostic Port

Diagnostic port (4) is used to access diagnostic information for the Truck Control Interface (TCI).

### Propulsion System Controller (PSC) Diagnostic Port

Diagnostic port (5) is used to access diagnostic information for the Propulsion System Controller.

### Engine Diagnostic Port (CENSE)

3-pin diagnostic port (6) is used to access diagnostic information for the engine monitoring system.

### Engine Diagnostic Port (QUANTUM)

9-pin diagnostic port (7) is used to access diagnostic information for the engine monitoring system.

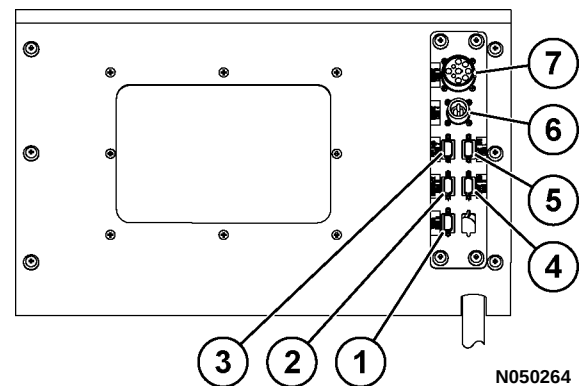


FIGURE 5-6. DIAGNOSTIC PORTS  
(D.I.D. PANEL AT REAR OF CAB)

- |                                  |                                     |
|----------------------------------|-------------------------------------|
| 1. VHMS Diagnostic Port          | 5. PSC Diagnostic Port              |
| 2. IM Diagnostic Port            | 6. Engine Diagnostic Port (CENSE)   |
| 3. Payload Meter Diagnostic Port | 7. Engine Diagnostic Port (QUANTUM) |
| 4. TCI Diagnostic Port           |                                     |

## D2. Hydraulic Oil Filter Monitor

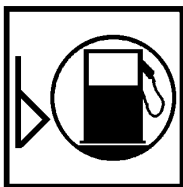
This amber indicator light indicates a restriction in the high pressure filter assembly for either the steering or hoist circuit. This light will come on before the filters start to bypass. Notify maintenance personnel as soon as possible after the light comes on.



*NOTE: The filter monitor warning light may also illuminate after the engine is initially started if the oil is cold. If the light turns off after the oil is warmed, filter maintenance is not required.*

## E2. Low Fuel

When the usable fuel remaining in the tank is approximately 95 liters (25 gallons), this amber indicator light will flash twice and the warning buzzer will also sound twice. Then, the warning buzzer will sound once more and the indicator light will remain illuminated. This will repeat every 15 minutes while the fuel level is still low.



## A3. Parking Brake

This amber indicator light will illuminate when the parking brake is applied. The parking brake is applied by placing the directional control lever in the PARK position.

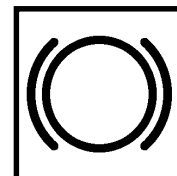


If the indicator light is flashing, that is an indication that the parking brake is requested, but has not applied. The operator must not leave the cab. Notify maintenance personnel immediately.

This light will also flash along with service brake indicator light (B3) and maintenance monitor indicator light (E7) to indicate that the service brakes or parking brake should be applied under the current operating conditions, but are not applied.

## B3. Service Brake

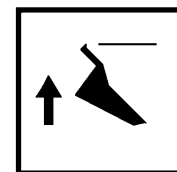
This amber indicator light will illuminate when the service brake pedal is applied or when wheel brake lock or emergency brake is applied. Do not attempt to drive the truck from a stopped position with the service brakes applied, except as noted in Section 30, Operating Instructions - Starting On A Grade With A Loaded Truck.



This light will flash if the interface module (IM) detects any service brake abnormalities. This light will also flash along with parking brake indicator light (A3) and maintenance monitor indicator light (E7) to indicate that the service brakes or parking brake should be applied under the current operating conditions, but are not applied.

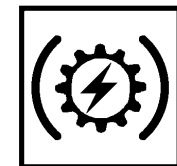
## C3. Body Up

This amber indicator light will illuminate if the body is not completely down on the frame. The truck should not be driven until body is down and the light is off.



## D3. Dynamic Retarding

This amber indicator light illuminates whenever the brake/retarder pedal (or retarder lever) is operated, retarder speed control (RSC) switch is activated, or the automatic overspeed retarding circuit is energized, indicating that the dynamic retarding function of the truck is operating.



## SECTION P2

# LUBRICATION AND SERVICE

## INDEX

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## 250 HOUR LUBRICATION AND MAINTENANCE CHECKS (Cont.)

All 10 Hour (Daily) Inspections should also be performed at this time.

NOTE: "Lube Key" references are to the **Lubrication Chart** on page P2-6.

|           |        |                                  |       |      |      |        |       |
|-----------|--------|----------------------------------|-------|------|------|--------|-------|
| Truck     | Serial | Number                           | _____ | Site | Unit | Number | _____ |
| Date      |        | _____                            |       |      |      |        |       |
| Hourmeter |        | _____                            |       |      |      |        |       |
|           |        | Name of Service Technician _____ |       |      |      |        |       |

|    | TASK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | COMMENTS | CHECKED | INITIALS |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|----------|
| 2. | <b>ENGINE -</b><br><br>1. Change the engine oil. Refer to the engine operation and maintenance manual for engine oil specifications. (Lube Key "A")<br><br><i>NOTE: If the engine is equipped with the Centinel™ oil system and/or the Eliminator™ filter system, engine oil and filter change intervals are extended beyond 250 hours. Take an engine oil sample for analysis. Refer to engine operation and maintenance manual for specific oil and filter change intervals.</i><br><br>2. Replace the engine oil filters. Follow the instructions of the filter manufacturer, which are normally printed on the outside of the filter. <b>Do not use a wrench or strap to tighten filter elements.</b><br><br>3. Change the reserve tank oil filter.<br><br>4. Check the tension and condition of each accessory drive belt. Refer to the engine operation and maintenance manual for specific adjustment instructions.<br><br>5. Check the torque on the cooling fan mounting capscrews. Tighten to <b>237 N•m (175 ft lb)</b> . |          |         |          |
| 3. | <b>COOLING SYSTEM -</b><br><br>1. Check the coolant level and fill the radiator with the proper coolant mixture according to Coolant Specifications on page P-4. Refer to the engine operation and maintenance manual for additional coolant recommendations.<br><br>2. Change the coolant filters. Refer to the engine operation and maintenance manual for coolant filter replacement instructions.<br><br>3. Check the cooling system hoses for damage and deterioration. Replace as necessary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |         |          |
| 4. | <b>FUEL FILTERS -</b> Change the Stage 1 and Stage 2 fuel filters. Refer to the engine operation and maintenance manual for filter replacement instructions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |         |          |
| 5. | <b>FUEL TANK -</b> Drain water and sediment from the fuel tank. Refer to Section B4, Fuel Tank - Cleaning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |         |          |

## SYSTEM COMPONENTS

### Filter

Filter assembly (21, Figure 3-2), mounted on the grease reservoir, filters the grease prior to refilling the reservoir from the shop supply. A bypass indicator alerts service personnel when the filter requires replacement.

### Hydraulic Motor and Pump

Rotary hydraulic pump (3 & 9, Figure 3-1) is a fully hydraulically-operated grease pump. An integrated pump control manifold is incorporated with the motor to control input flow and pressure.



***Hydraulic oil supply inlet pressure must not exceed 20 685 kPa (3,000 psi). Exceeding the rated pressure may result in damage to the system components and personal injury.***

### Grease Reservoir

Reservoir (12, Figure 3-1) has an approximate capacity of 41 kg (90 lb) of grease. When the grease supply is replenished by filling the system at the service center, the grease is passed through the filter to remove contaminants before it flows into the reservoir.

### Pressure Reducing Valve

Pressure reducing valve (4, Figure 3-1), located on the manifold, reduces the hydraulic supply pressure (from the truck steering circuit) to a suitable operating pressure for the hydraulic motor used to drive the lubricant pump. **The pressure control valve has been factory adjusted and the setting should not be disturbed.**

### Flow Control Valve

Flow control valve (10, Figure 3-1), mounted on the manifold, controls the amount of oil flow to the hydraulic motor. **The flow control valve has been factory adjusted and the setting should not be disturbed.**

### Solenoid Valve

Solenoid valve (5, Figure 3-1), when energized, allows oil to flow to the hydraulic motor.

### Vent Valve

With vent valve (7, Figure 3-1) closed, the pump continues to operate until maximum grease pressure is achieved. As this occurs, the vent valve opens and allows the grease pressure to drop to zero, so the injectors can recharge for their next output cycle.

### Lubrication Cycle Timer

The solid state lubrication cycle timer provides a 24 VDC timed-interval signal to energize solenoid valve (3, Figure 3-3), providing oil flow to operate the grease pump motor. This timer is mounted in the Electrical Interface Cabinet.

### Over Pressure Cutoff Switch

Pressure switch (18, Figure 3-2) is a normally open switch set at 20 684 kPa (3,000 psi). This switch de-energizes the pump solenoid relay if the grease line pressure reaches the switch pressure setting, turning off the motor and pump.

### Grease Pressure Failure Switch

Pressure switch (24, Figure 3-2) is a normally open switch set at 13 789 kPa (2,000 psi). If the appropriate grease pressure is not achieved during the normal pump cycle, the warning system will be activated, illuminating the warning lamp in the overhead display to notify the operator a problem exists in the lube system.

### Pressure Gauge

***NOTE: This gauge is optional equipment. A plug will be installed in this port at the factory.***

Optional pressure gauge (8, Figure 3-1) can be installed where pipe plug (3, Figure 3-5) is located. The pressure gauge will indicate hydraulic oil pressure to the inlet of the hydraulic motor. Normal pressure is 2 241 - 2 413 kPa (325 - 350 psi). monitors hydraulic oil pressure to the inlet of the hydraulic motor.

### Injectors

Each injector (23, Figure 3-2) delivers a controlled amount of pressurized lubricant to a designated lube point. Refer to Figure 3-2 for locations.

### Relief Valve (Unloader Valve)

Relief valve (14, Figure 3-3) protects the pump from high pressures. This relief valve is set at 27 580 kPa (4,000 psi).

| TROUBLE                                                                                  | POSSIBLE CAUSES                                                              | SUGGESTED CORRECTIVE ACTION                                                                                         |
|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| <b>Pump Pressure Builds Very Slowly Or Not At All</b>                                    | No signal at solenoid.                                                       | Check timer.                                                                                                        |
| <b>Controller Does Not Operate</b>                                                       | No electric power to controller.                                             | Turn on electric power to pump. "POWER" LED should light, "PUMP ON" LED should light when "MANUAL LUBE" is pressed. |
| <b>"PUMP ON" LED Lights, But Load Connected To Terminals 3 &amp; 4 Will Not Energize</b> | Printed circuit board failure.                                               | Remove and replace.                                                                                                 |
| <b>Load Connected To Terminals 3 &amp; 4 Energized, But "PUMP ON" LED Does Not Light</b> | Failure of the printed circuit board or keypad.                              | Remove and replace.                                                                                                 |
| <b>Bearing Points Excessively Lubricated</b>                                             | Controller memory mode is OFF.                                               | Switch controller memory mode to ON.                                                                                |
|                                                                                          | Injector output adjustment setting too high.                                 | Readjust to lower setting.                                                                                          |
| <b>Bearing Points Are Not Sufficiently Lubricated</b>                                    | Timer/controller cycle time setting too low.                                 | Set to longer cycle time or reevaluate lube requirements.                                                           |
|                                                                                          | Injector output adjustment setting too low.                                  | Readjust injector output setting.                                                                                   |
|                                                                                          | Timer/controller cycle time setting does not deliver lubricant often enough. | Set to shorter cycle time or reevaluate lube requirements.                                                          |
|                                                                                          | System too large for pump output.                                            | Calculate system requirements per planning manual.                                                                  |

A

B

C

D

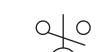
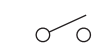
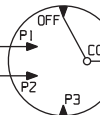
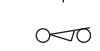
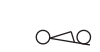
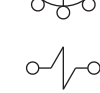
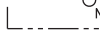
1 | 2 | 3 | 4 | 5 | 6 | 7 |

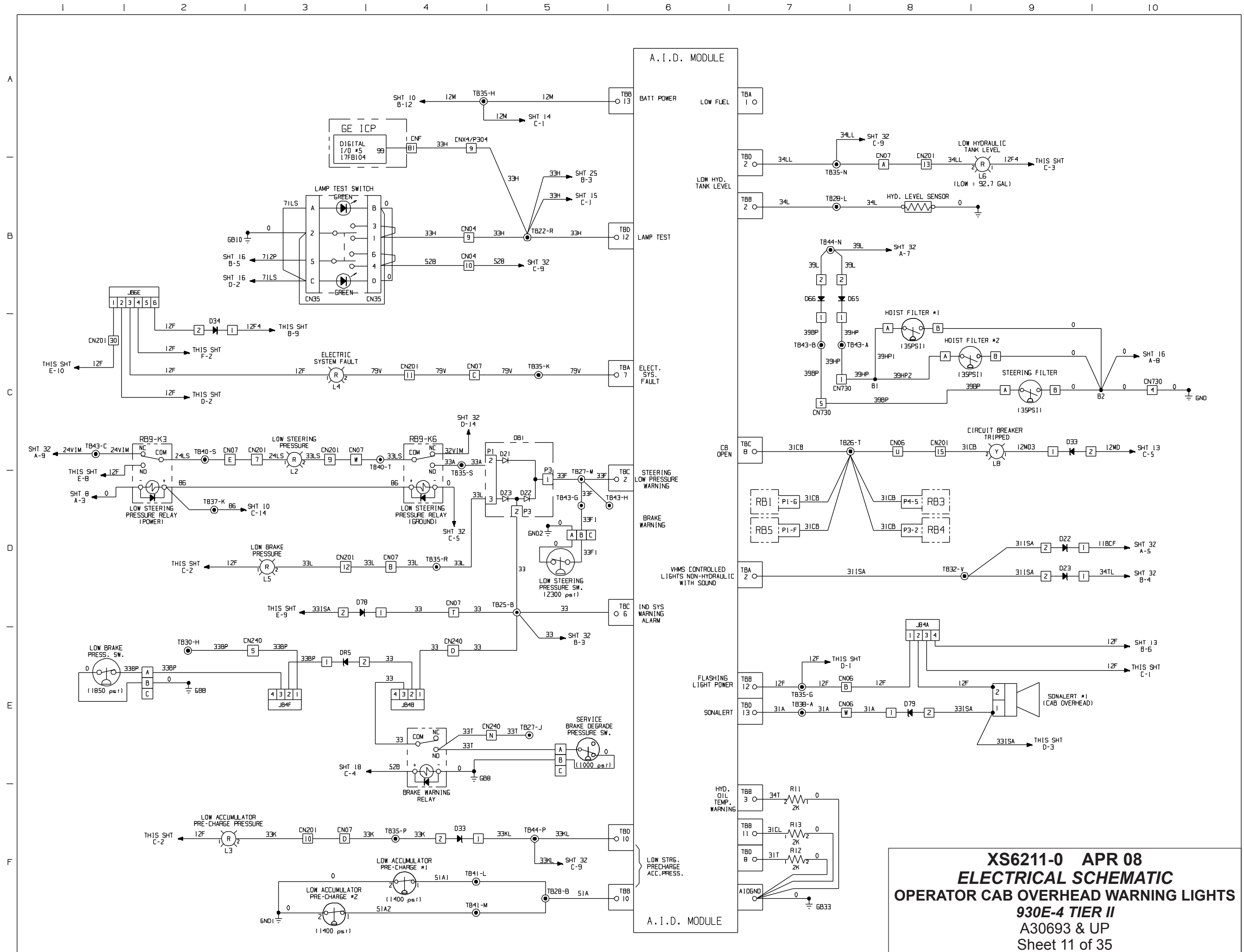
SYMBOLS USED IN SCHEMATICS

PART NO. INDEX GENERAL TOPIC

|        |          |                                                         |
|--------|----------|---------------------------------------------------------|
| XS6201 | SHEET 1  | - INDEX AND SYMBOLS                                     |
| XS6202 | SHEET 2  | - GE SYSTEM BLOCK DIAGRAM                               |
| XS6203 | SHEET 3  | - MAIN PROPULSION SCHEMATIC                             |
| XS6204 | SHEET 4  | - 24V/15V POWER DISTRIBUTION                            |
| XS6205 | SHEET 5  | - G.E. INVERTER FIRING                                  |
| XS6206 | SHEET 6  | - G.E. INVERTER FIRING                                  |
| XS6207 | SHEET 7  | - ENGINE - I/O                                          |
| XS6208 | SHEET 8  | - G.E./24V - DIGITAL I/O                                |
| XS6209 | SHEET 9  | - CONTROL PANEL - ANALOG INPUTS                         |
| XS6210 | SHEET 10 | - 24V POWER DISTRIBUION & CIRCUIT PROTECTION            |
| XS6211 | SHEET 11 | - OPERATOR/CAB OVERHEAD WARNING LIGHTS                  |
| XS6212 | SHEET 12 | - OPERATOR/CAB OVERHEAD WARNING LIGHTS                  |
| XS6213 | SHEET 13 | - OPERATOR/CAB OVERHEAD WARNING LIGHTS                  |
| XS6214 | SHEET 14 | - OPERATOR/CAB OVERHEAD WARNING LIGHTS                  |
| XS6215 | SHEET 15 | - AUTO LUBE SYSTEM WITH WARNING                         |
| XS6216 | SHEET 16 | - OPERATOR CAB GAUGES & OPTION SWITCHES                 |
| XS6217 | SHEET 17 | - HEATER, AIR CONDITIONER CONTROLS                      |
| XS6218 | SHEET 18 | - WORK LIGHTS AND HORN                                  |
| XS6219 | SHEET 19 | - RETARD LIGHTS, BACKUP LIGHTS & HORNS                  |
| XS6220 | SHEET 20 | - OPERATOR DRIVE SYSTEM CONTROLS                        |
| XS6221 | SHEET 21 | - RADIO AND WINDOW CONTROLS                             |
| XS6222 | SHEET 22 | - CLEARANCE LIGHTS                                      |
| XS6223 | SHEET 23 | - FOG LIGHTS AND HEAD LIGHTS                            |
| XS6224 | SHEET 24 | - OPERATOR CAB INSTRUMENT LIGHTS                        |
| XS6225 | SHEET 25 | - KEY SWITCH & 5-MINUTE IDLE                            |
| XS6226 | SHEET 26 | - QSK-60 START CIRCUIT                                  |
| XS6227 | SHEET 27 | - ENGINE CIRCUITS - CUMMINS QSK-60                      |
| XS6228 | SHEET 28 | - PAYLOAD METER 3 CIRCUITS                              |
| XS6229 | SHEET 29 | - DIAGNOSTIC CONNECTORS,/MM DISPATCH SYS. & VNMS/ORBCOM |
| XS6230 | SHEET 30 | - PARK BRAKE & GE I/O                                   |
| XS6231 | SHEET 31 | - WINDSHIELD WIPER & TURN SIGNAL CONTROLS               |
| XS6232 | SHEET 32 | - INTERFACE MODULE & RPC, 1939 COMMUNICATION            |
| XS6233 | SHEET 33 | - BATTERY BOX                                           |
| XS6234 | SHEET 34 | - CIRCUIT LOCATOR SHEET                                 |
| XS6235 | SHEET 35 | - COMPONENT LOCATOR SHEET                               |

|                                                                                     |                                                 |
|-------------------------------------------------------------------------------------|-------------------------------------------------|
|    | TERMINAL BOARD POINT                            |
|    | TERMINAL IN LOWER INSTRUMENT PANEL              |
|    | TERMINAL IN REAR AXLE JUNCTION BOX              |
|    | TERMINAL POINT IN FRAME AREA                    |
|    | CONNECTION POINT                                |
|    | KNIFE DISCONNECT/BULLET TERMINAL                |
|    | GENERAL GROUND                                  |
|    | FRAME GROUND                                    |
|    | WIRING                                          |
|    | SHIELDED WIRE                                   |
|    | CONNECTOR, INLINE<br>(X IS CAVITY IDENTIFIER)   |
|    | CONNECTOR, BULKHEAD<br>(X IS CAVITY IDENTIFIER) |
|    | MOTOR                                           |
|    | MAGNETIC PICKUP                                 |
|    | PROXIMITY SWITCH                                |
|    | SINGLE ELEMENT LAMP                             |
|  | DUAL ELEMENT LAMP                               |
|  | HORN, BUZZER, OR SPEAKER                        |
|  | TEMPERATURE SENSOR                              |
|  | LED (LIGHT EMITTING DIODE)                      |
|  | BATTERY                                         |
|  | FUSE                                            |

|                                                                                      |                                                   |
|--------------------------------------------------------------------------------------|---------------------------------------------------|
|    | PRESSURE SWITCH - PRESSURE TO OPEN                |
|    | PRESSURE SWITCH - PRESSURE TO CLOSE               |
|    | TOGGLE SWITCH                                     |
|    | ROTARY SWITCH                                     |
|    | PUSHBUTTON SWITCH - NORMALLY CLOSED               |
|    | CIRCUIT BREAKER - MANUAL RESET                    |
|    | PRESSURE OPERATED VARIABLE RESISTOR               |
|    | TEMPERATURE SWITCH - INCREASE TEMP. TO OPEN       |
|    | TEMPERATURE SWITCH - DECREASE TEMP. TO OPEN       |
|    | TEMPERATURE OPERATED VARIABLE RESISTOR            |
|   | LIMIT SWITCH - CAM TO CLOSE                       |
|  | LIMIT SWITCH - CAM TO OPEN                        |
|  | DIODE                                             |
|  | FIXED RESISTOR                                    |
|  | VARIABLE RESISTOR (POTENTIOMETER)                 |
|  | SOLENOID                                          |
|  | RELAY                                             |
|  | TIMER MODULE                                      |
|  | CNX(1-5)/P30(1-5)<br>GE IDENTIFIER/KAC IDENTIFIER |
|  | X (X IS CAVITY IDENTIFIER)                        |





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