CEBM014001

Shop Manual

930E-2

DUMP TRUCK

SERIAL NUMBERS **A30255 thru A30291**

KOMATSU

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TRUCK COMPONENTS AND SPECIFICATIONS

Truck And Engine

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

Alternator (GE-GTA34)

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

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

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

AC Induction Traction Motorized Wheels

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

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

Blower

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

Suspension

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

Operator's Cab

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

Power Steering

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

Dynamic Retarding

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

Brake System

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

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

In The Operator's Cab - Before Starting The Engine

- DO NOT leave tools or spare parts lying around or 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.
- Check the seat belt, buckle and hardware for damage or wear. Replace any worn or damaged parts. Always use the seat belts when operating a machine.
- Read and understand the contents of the Operation & Maintenance manual. Read safety and operating instructions with special attention. 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.
- Ensure the steering wheel, horn, controls and pedals are free of any oil, grease or mud.
- Check operation of the windshield wiper, condition of wiper blades, and check 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.

OPERATING THE MACHINE

Starting The Engine

- Never attempt to start the machine by shorting across the starter terminals. This may cause fire, or serious injury or death to anyone in machine's path.
- Never start the engine if a warning tag has been attached to the controls.
- When starting the engine, sound the horn as an alert.
- Start and operate the machine only while seated in the operator's seat.
- DO NOT allow any unauthorized persons in the operator's compartment or any other place on the machine.

Truck Operation - General

- Wear seat belts at all times.
- Only authorized persons are allowed to ride in the truck. Passengers must be in the cab and belted in the passenger seat.
- DO NOT allow anyone to ride on the decks or on the steps of the truck.
- DO NOT allow anyone to get on or off the truck while it is in motion.
- DO NOT move the truck in or out of a building without a signal person present.
- Know and obey hand signal communications between the operator and spotter. When other machines and personnel are present, the operator should move in and out of buildings, loading areas and through traffic, under the direction of a signal person. Courtesy at all times is a safety precaution!
- Immediately report any adverse conditions on haul road, pit or dump area that may cause an operating hazard.

SPECIAL PRECAUTIONS FOR WORKING ON A 930E TRUCK

Preliminary Procedures before Welding or Performing Maintenance

Prior to welding and/or repairing a 930E dump truck, maintenance personnel should attempt to notify a Komatsu service representative. Only qualified personnel, specifically trained for servicing the A-C 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 should be followed to ensure that the truck is safe for maintenance personnel to work on and to reduce the chance for damage to equipment.

⚠DANGER

Anytime the engine is operating:

- ***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.***

⚠WARNING

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

Normal Engine Shutdown Procedure

1. Stop the truck out of the way of other traffic on a level surface (dry, if possible) and free of overhead power lines or other obstructions (in case the dump body should need to be raised).
   a. Reduce engine speed to idle. Allow the engine to cool gradually by running at low idle for approximately 5 minutes.
   b. Place the selector switch in NEUTRAL.
   c. Apply the parking brake. Be sure the parking brake applied indicator light in the overhead display panel is illuminated.
2. Turn the rest switch to the ON position to put the A-C drive system in “rest” mode of operation. Be sure the “rest” indicator light in the overhead panel is illuminated.
3. After the engine cools, turn the key switch counterclockwise to OFF for normal engine shutdon.
   If the engine does not shutdown with the key switch, use the engine shutdown switch on the center console. Pull the switch up until the engine stops. Push the switch back down to allow future engine operation.
4. With the key switch OFF, and the engine stopped, wait at least 90 seconds. Ensure the steering circuit is completely bled down by turning the steering wheel back and forth several times. No front wheel movement will occur when hydraulic pressure is relieved. If the vehicle continues to steer after shutdown, notify maintenance personnel.
5. Verify that all the link voltage lights are off (one on back wall of operator cab, and two on deck control cabinets). Notify maintenance personnel if any light remains illuminated longer than five minutes after engine shutdown.
6. Close and lock all windows, remove the key from the key switch, and lock the cab to prevent possible unauthorized truck operation. Dismount the truck properly. Place wheel chocks around the wheels.

Engine Shutdown Procedure before Welding or Performing Maintenance

Normal operation of the drive system at shutdown should leave the system safe to maintain. However, in the event of a system failure, performing the following procedure prior to any maintenance activities will ensure that no hazardous voltages are present in the A-C 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 retarder grid cabinet without a trained drive system technician present - even if engine is off.
   Only qualified personnel, specifically trained for servicing the A-C drive system, should perform this service.
2. If all red drive system warning lights are off, follow the “Normal Engine Shutdown Procedure”.

DYNAMIC RETARDING OPERATION

Dynamic retarding is a braking torque (not a brake) produced through electrical generation by the wheel motors when the truck motion (momentum) is the propelling force. For normal truck operation, dynamic retarding should be used to slow and control the speed of the truck.

Dynamic retarding is available in FORWARD/ REVERSE at all truck speeds above 0 mph/kph; however, as the truck speed slows below 3 mph (4.8 kph), the available retarding force may not be effective. Use the service brakes to bring the truck to a complete stop.

Dynamic retarding will not hold a stationary truck on an incline; use the parking brake for this purpose.

Dynamic retarding is available in NEUTRAL only when truck speed is above 3 mph (4.8 kph).

When dynamic retarding is active, the engine rpm will automatically go to an advance rpm retard speed setting (usually 900 - 1000 rpm*).

NOTE: The exact engine speed in retarding may vary due to the temperature of certain components; this is controlled by the Propulsion System Controller (PSC).

Dynamic retarding will be applied automatically if the speed of the truck reaches the maximum truck speed of 40 mph (64 kph). Any application of the dynamic retarding system (automatic, retarder lever, or foot pedal) will cause an indicator light to illuminate in the overhead display panel.

Dynamic Retarder Control Lever

The dynamic retarder control lever mounted on the right side of the steering column can be used to modulate retarding effort. The lever will command the full range of retarding and will remain at a fixed position when released.

a. When the lever is rotated to full "up" (counterclockwise) position, it is in the OFF (No Retard) position.

b. When the lever is rotated to full "down" (clockwise) position, it is in the full ON (Retard) position.

c. For long downhill hauls, the lever may be positioned to provide a desired retarding effort. It will remain where it is positioned.

NOTE: The retard control lever must be rotated back to the OFF position before the truck will resume the "propel" mode of operation.

The lever and foot-operated retarder/service brake pedal can be used simultaneously or independently. The PSC will determine which device is requesting the most retarding effort and apply that amount.

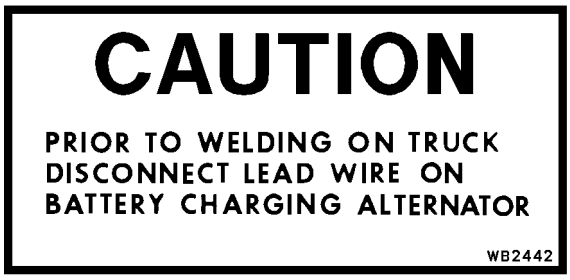
Dynamic Retarder/Service Brake Pedal

The dynamic retarder/service brake pedal is a single, foot-operated pedal which controls both retarding and service brake functions. The first portion of pedal travel commands retarding effort through a rotary potentiometer. The second portion of pedal travel modulates service brake pressure directly through a hydraulic valve. Thus, the operator must first apply, and maintain, full dynamic retarding in order to apply the service brakes. Releasing the pedal returns the brake and retarder to the OFF position.

When the pedal is partially depressed, dynamic retarding is actuated. As the pedal is further depressed to where dynamic retarding is fully applied, the service brakes (while maintaining full retarding) are then actuated through a hydraulic valve, which modulates pressure to the service brakes. Completely depressing the pedal causes full application of both dynamic retarding and the service brakes. An indicator light in the overhead panel will illuminate, and an increase in pedal resistance, will be felt when the service brakes are applied.

Use dynamic retarding (lever or foot-operated pedal), during normal truck operation, to slow and control the speed of the truck. Apply the service brakes only when dynamic retarding requires additional braking force to slow the truck speed quickly, or when bringing the truck to a complete stop.

This caution decal is placed near the battery disconnect switches on the right side of the front bumper to alert servicing technicians that before doing any welding on the truck, always disconnect the battery charging alternator lead wire and isolate electronic control components before making welding repairs.



In addition, always 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; **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.

A high voltage danger plate is attached to the door of the rear hatch cover. High voltage may be present!

Only authorized personnel should access this rear housing.



A caution decal is also attached to the door of the rear hatch cover to alert personnel that hot exhaust air is present and may cause injury.

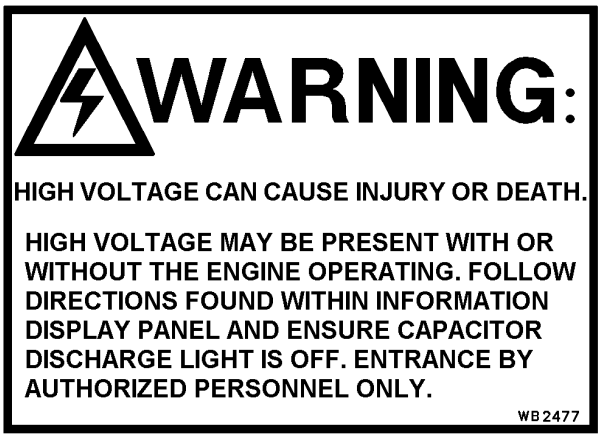


This caution decal is also placed around the retarding grid cabinet.

These warning plates are mounted on all of the AC drive control housings and cabinets.

High voltage may be present, with or without, the engine running!

Only authorized personnel should access these cabinets.



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After The Engine Has Started

Any machine which is unsafe and/or not in top operating condition should not be assigned to an operator for production use.

1. Become thoroughly familiar with steering and emergency controls. Test the steering in extreme right and left directions. If the steering system is not operating properly, shut engine down immediately. Determine the steering system problem and have repairs made before resuming operation.
2. Operate each of the brake circuits at least twice prior to operating and moving the machine. These circuits include individual activation of the service brake and parking brake from the operator's cab.
   a. Activate each circuit individually with the engine running and with hydraulic circuit fully charged.
   b. If any application or release of any brake circuit does not appear proper or if sluggishness is apparent on application or release, shut the engine down and notify maintenance personnel. Do not operate machine until brake circuit in question is fully operational.
3. Check gauges, warning lights and instruments before moving the machine to insure proper system operation and proper gauge functioning. Give special attention to braking and steering circuit warning lights. If warning lights come on, shut down the engine immediately and determine the cause.
4. Cycle hoist controls and steering several times to remove trapped air. Complete steering cycles in both directions to verify steering response, smoothness and reliability. Check seals and lines for leaks.
5. When satisfied that all discrepancies have been corrected, the vehicle is ready for a road test. This test should be done only by a capable and experienced operator and should be accomplished in a large open area where plenty of maneuvering room is available. Some of the road test items which should be covered will include:

- Repeated test of braking efficiency at progressively higher speeds. Start at slow speeds. Don't take chances with higher speeds until the machine is determined to be completely safe.

6. When all tests and checks have been made and the vehicle is ready for work, it should be visually rechecked and fully serviced according to Section P, Lubrication and Service.

A few of the conditions (others may be found) which might be encountered after a machine has been exposed to the elements for a long period would include:

- Increased corrosion and fungus growth on electrical components in humid/tropical areas.
- Accelerated rust formation in humid climates.
- Increased sand and dust infiltration in windy, dry dusty areas. (These conditions can approach sand blasting effects.)
- Deterioration of rubber products in extreme cold areas. Cables, hoses, O- rings, seals and tires may become weather checked and brittle.
- Animal or bird's nests in unsealed openings.

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BODY PADS

It is not necessary to remove the dump body to replace body pads. Pads should be inspected during scheduled maintenance inspections and replaced if worn excessively.

1. Raise the unloaded dump body to a height sufficient to allow access to all pads.

⚠WARNING

Place blocks between the body and frame. Secure blocks in place.

2. Remove hardware attaching pads to the dump body. Refer to Figure 3-4.
3. Remove body pad and shims. Note number of shims installed at each pad location. (The rear pad on each side should have one less shim than the other pads.)
4. Install new pads with the same number of shims as removed in step 3.
5. Install the mounting hardware and torque to **65 ft.lbs. (88.1 N-m).**
6. Remove blocks from frame and lower body onto the frame.

Adjustment

1. Vehicle must be parked on a flat, level surface for inspection.
2. All pads, except the rear pad on each side, should contact the frame with approximately equal compression of the rubber.
3. A gap of approximately 0.075 in. (1.9 mm) is required at each rear pad. This can be accomplished by using one less shim at each rear pad.
4. If pad contact appears to be unequal, repeat the above procedure.

! IMPORTANT !
Proper body pad to frame contact is required to assure maximum pad life.

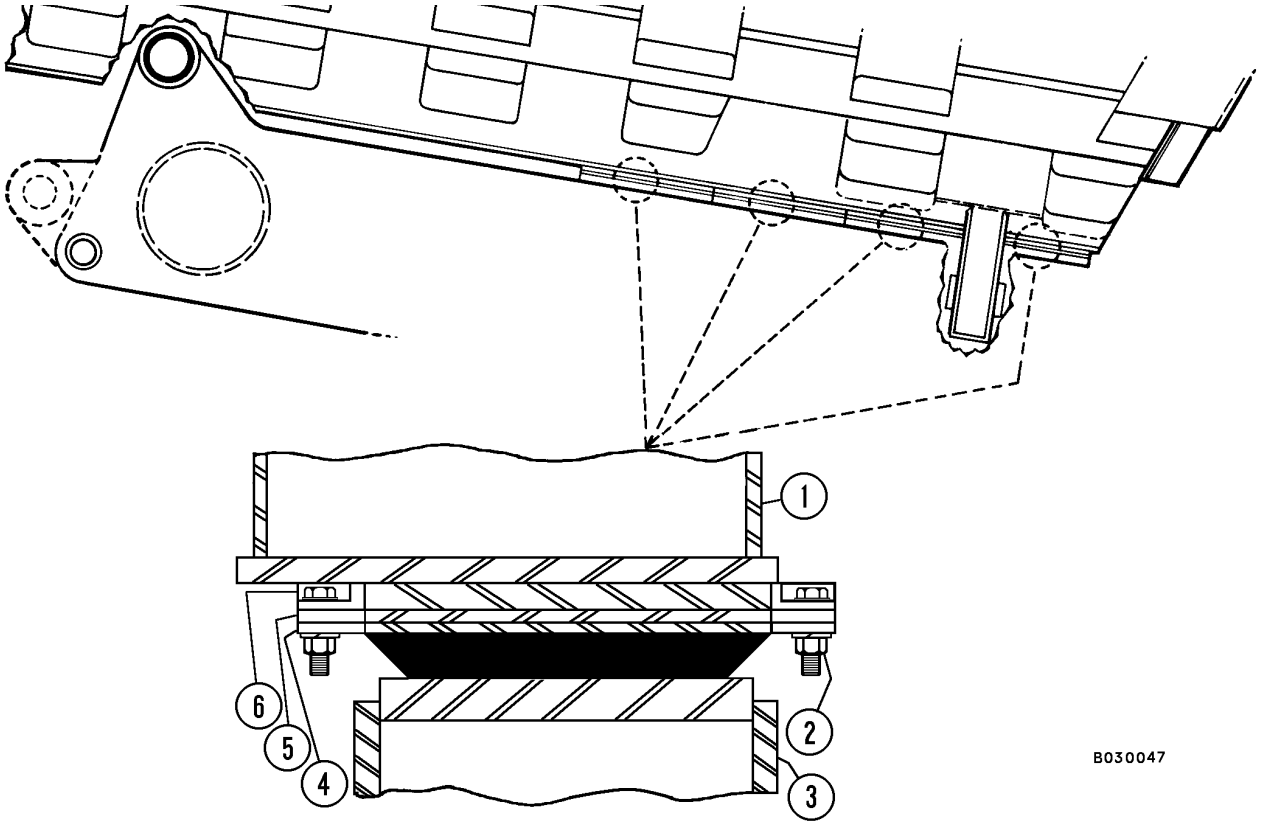


FIGURE 3-4. BODY PAD INSTALLATION

1. Dump Body
2. Pad Mounting Hardware
3. Frame
4. Body Pad
5. Shim
6. Mounting Pad

LEFT SIDE FILL

This location permits fueling the truck from the left side.

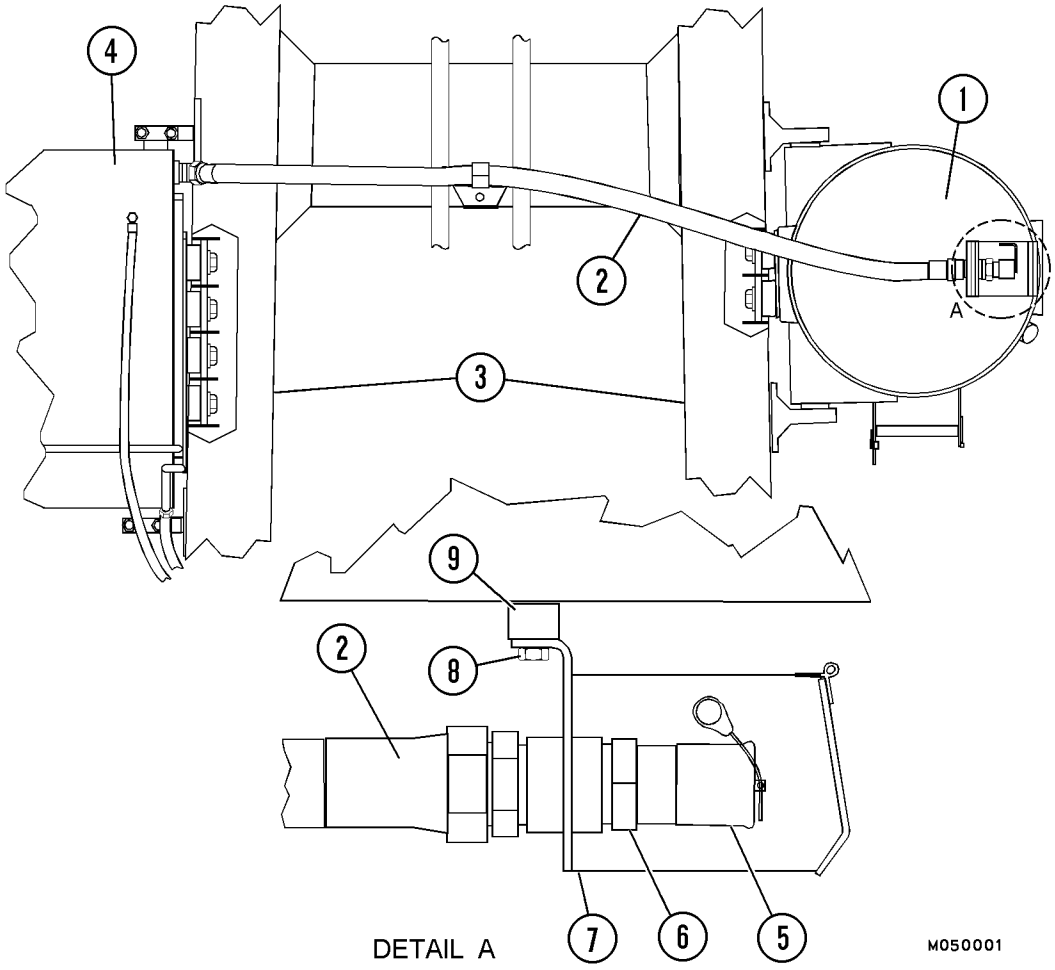


FIGURE 4-3. LEFT SIDE FILL

1. Hydraulic Tank
2. Filler Hose
3. Frame Rails
4. Fuel Tank
5. Filler Cap
6. Receiver Assembly
7. Refueling Box
8. Capscrew
9. Tapped Bar

NOTE: This illustration represents a typical installation. Installation may vary depending on truck model.

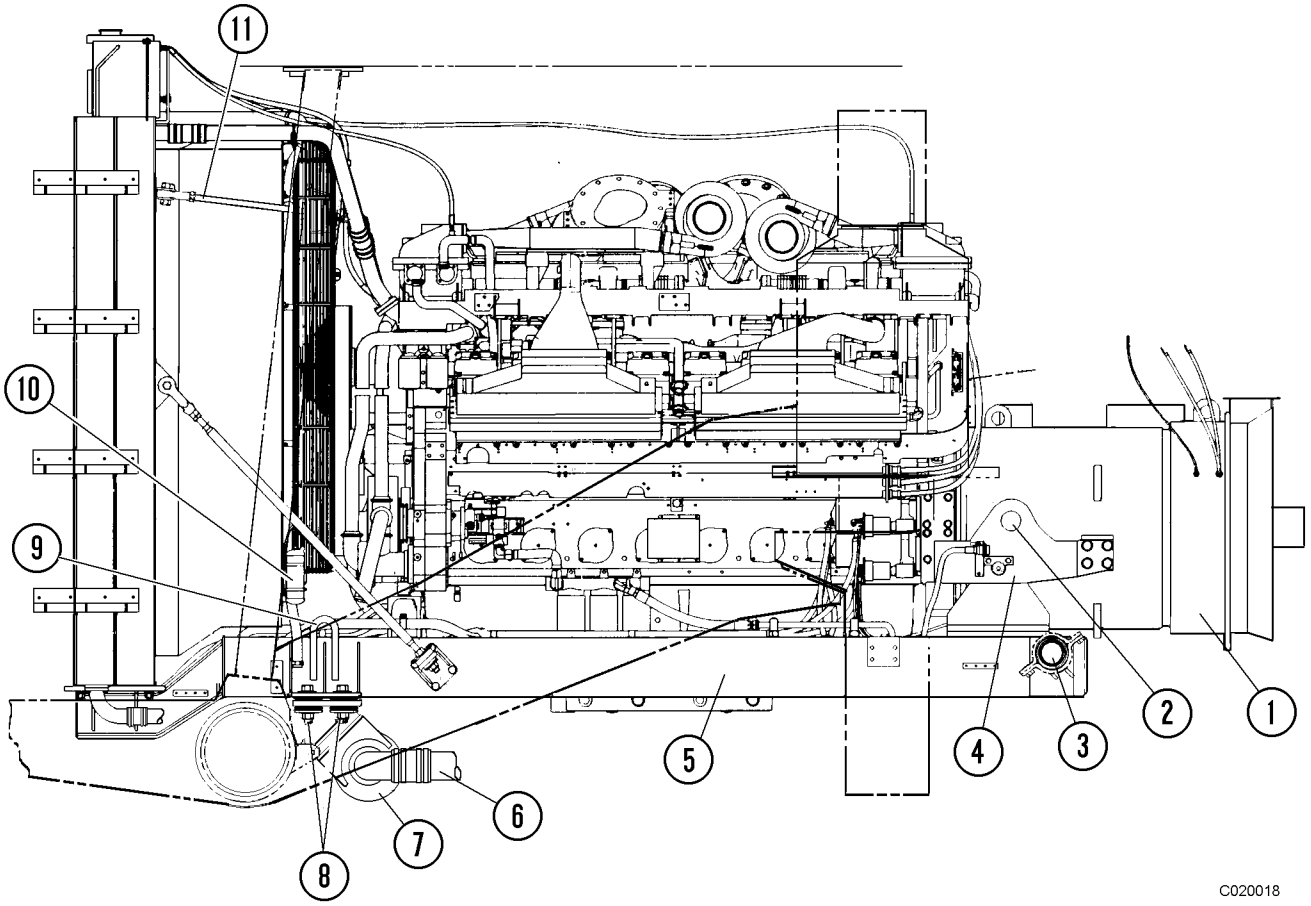


FIGURE 2-5. POWER MODULE REMOVAL & INSTALLATION

1. 1. Alternator
2. 2. Rear Power Module Lift Eye
3. Rear Frame/Sub-frame Mount
4. Engine/Alternator Cradle Structure
5. Power Module Sub-frame
6. Heat Exchanger Piping
7. Heat Exchanger
8. Front Frame/Sub-frame Mount
9. Front Power Module Lift Eye
10. Receiver/Drier
11. Upper Radiator Support Rod

Removal - Power Module

Recheck to be certain all hoses, electrical cables, ground straps etc. have been removed.

1. Remove capscrews, nuts and washers (8, Figure 2-5) securing front subframe support to main frame.

⚠WARNING

Install safety chain around the engine subframe cross member and main frame to prevent the power module from rolling when the subframe rollers are installed.

2. Remove capscrews and caps securing subframe mounting bushings to the subframe support bracket (3) at rear of subframe.
3. Check engine and alternator to make sure all cables, wires, hoses, tubing and linkages have been disconnected.

⚠WARNING

Lift power module only at the lifting points on subframe and engine/alternator cradle structure. (Refer to Figure 2-5 and 2-7.)

4. Remove all the tubes at the top, before removing the bottom tubes.
5. After all of the tubes are removed, pliers can be used to remove the seals from the tanks. Discard all seals. New seals must be used for assembly.

Cleaning and Inspection

1. Clean tube holes using a drill with a 3/4 in. (19 mm) wire brush.
2. Clean the holes of any foreign debris and wipe clean.
3. Clean the inside of the tanks and tubes. In most cases just flushing the inside with a high pressure hot water washer, with soap, will do the job. If not, contact an L&M manufacturing facility or visit the L&M website for further instruction at ***www.mesabi.com***.
4. Check for signs of internal blockage in tubes and tanks. If desired, you may cut open tubes for inspection. If contamination is present, the tube should be analyzed. The radiator must be properly flushed of all contaminants and corrective action must be taken to prevent such contamination from occurring in the future. Refer to Internal Inspection in this section.
5. Buff the tube ends with a polishing wheel and a copper polishing compound. If any debris can not be removed by buffing, emery cloth, steel wool, or a wire wheel (wire size 0.006 - 0.008 in. (0.15 - 0.20 mm) is acceptable for use. Use extreme care not to mar the tube ends.

Assembly

NOTE: For easier installation, soak the seals in hot water before installing.

1. Install the new tube seals onto the bottom tank and the bottom side of the center tank. Do not install seals for the top core at this time. Seals for the top of the tubes do not have locking grooves, bottom tube seals do. Ensure the correct seals are installed in the proper position.

   The seal holes must be dry during installation. Use a rubber mallet and a flat metal plate to lightly tap the seals into place. Using excessive force will drive the seals in too far. The seals should be slightly convex when installed properly. Improperly installed seals are concave with a smaller diameter hole. Refer to Figure 3-9.

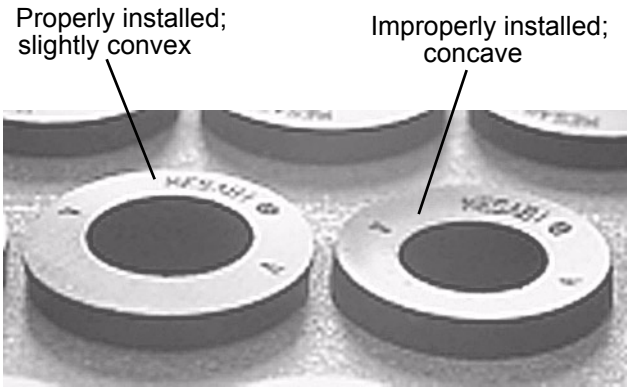


FIGURE 3-9. PROPER SEAL INSTALLATION

2. Use a 1/2 in. (13 mm) diameter brush to lubricate the seals with lube/release agent (XA2308).

⚠WARNING

When lifting the alternator, attach hoist to lift eyes only. The alternator weighs approximately 8,200 lbs. (3,720 kg). Use a lifting device that can handle the load safely.

1. Use the two top lift brackets provided on the alternator for lifting. The top front lifting bracket should be equipped with some method of adjusting the alternator to keep it horizontal.
2. Carefully move alternator into place and engage the engine drive ring (6, Figure 4-6) into the alternator rotor drive (7) using shims “B”, if required (refer to step 5.a. “Determining Shims”, in Measuring Procedure).
3. Install flywheel housing adapter capscrews (2) into alternator housing (1). Tighten to **175 ft. lbs. (237 N.m)** torque.
4. Install capscrews (5) through engine drive ring (6) into the alternator rotor adapter (7). Rotate crankshaft to access and align holes. Tighten capscrews (5) to **175 ft. lbs. (237 N.m)** torque.
5. Install alternator-to-cradle structure mounting capscrews and washers (2, Figure 4-2) and tighten to **525 ft. lbs. (712 N.m)** torque.
6. Tighten engine-to-cradle structure mounting capscrews (5, Figure 4-2) to **345 ft. lbs. (465 N.m)** torque.

⚠IMPORTANT⚠

Never pry on the engine crankshaft damper!

7. With magnetic base mounted on the front of the engine and the dial indicator on the front of the crankshaft, measure total crankshaft end-play:

   Record Total Crankshaft End-play:_____

8. Compare the step 7 value to the measurement taken before alternator was installed on engine.

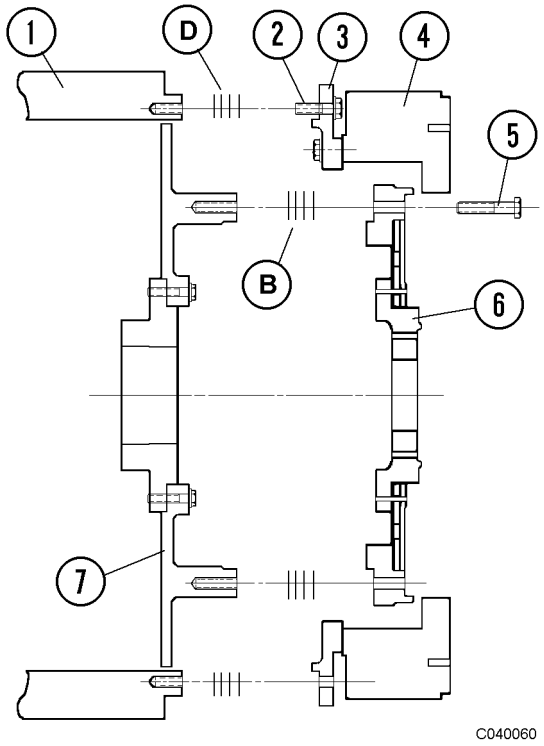


FIGURE 4-6. ALTERNATOR TO ENGINE MOUNTING

1. Alternator Housing
2. Point Capscrew
3. Flywheel Housing Adapter
4. Engine Flywheel Housing
5. Capscrew
6. Engine Drive Ring
7. Alternator Rotor

“B” - Drive Shims
“D” - Housing Shims

The total engine crankshaft end-play (step 7) must equal the original measurement or 0.020 in. (0.51 mm) (alternator end-play), whichever is smaller.

If the end-play after the alternator and engine are assembled is less than 0.020 in. (0.51 mm), and less than the starting engine crankshaft end-play, *Reshimming is required.*

9. Rotate the crankshaft one full revolution and listen for any unusual noise caused by moving components contacting stationary parts.
10. Install engine side cover, if removed. Install lockwire on all alternator mounting capscrews.
11. Install access cover on flywheel housing.

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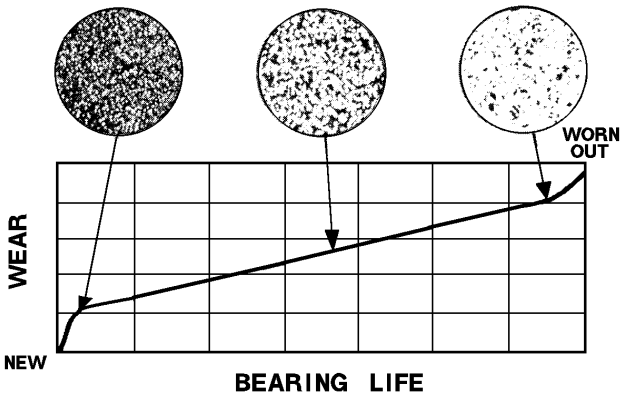


FIGURE 7-14.

12. Inspect sleeve bearing (44) and sleeve bearing (41). Compare the color of each bearing to the chart below. 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.

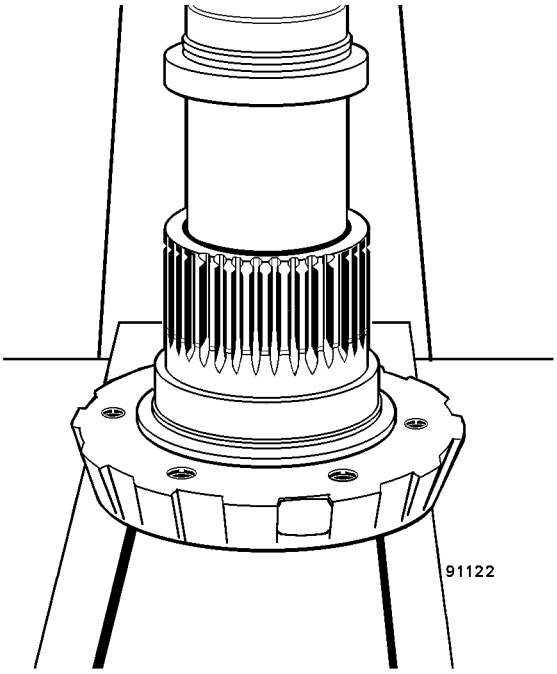


FIGURE 7-15.

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.

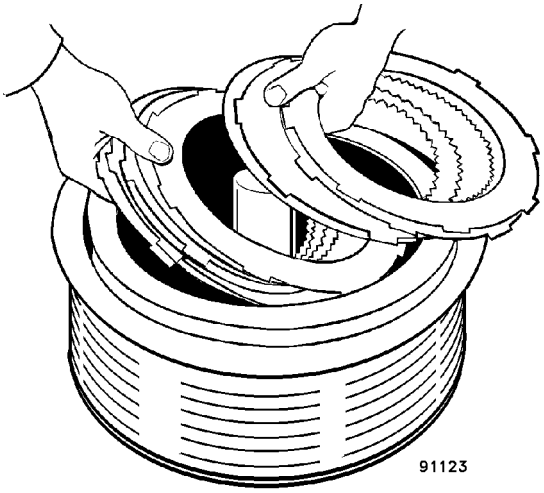


FIGURE 7-16.

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

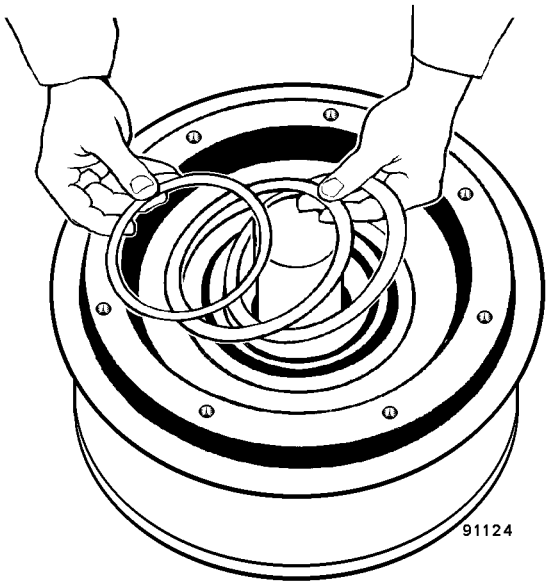


FIGURE 7-17.

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

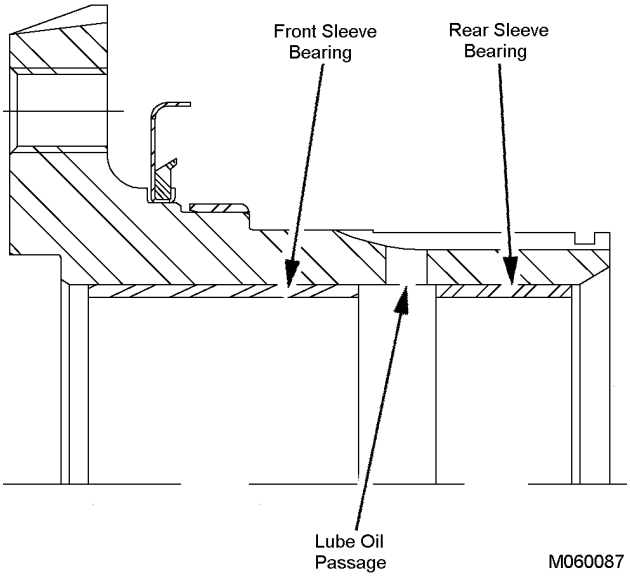


FIGURE 7-40.

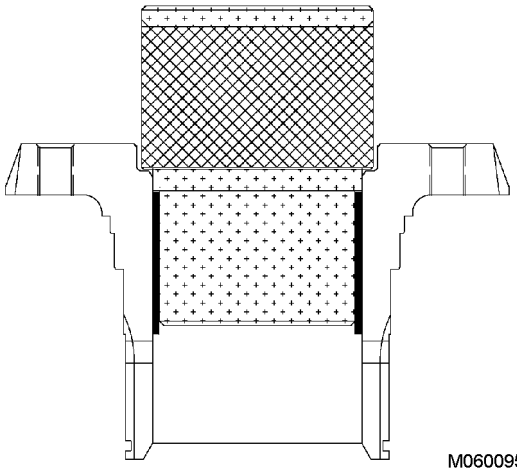


FIGURE 7-41.

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.

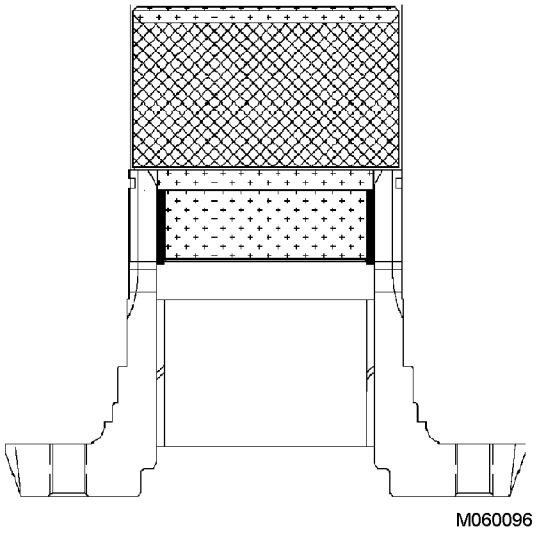


FIGURE 7-42.

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

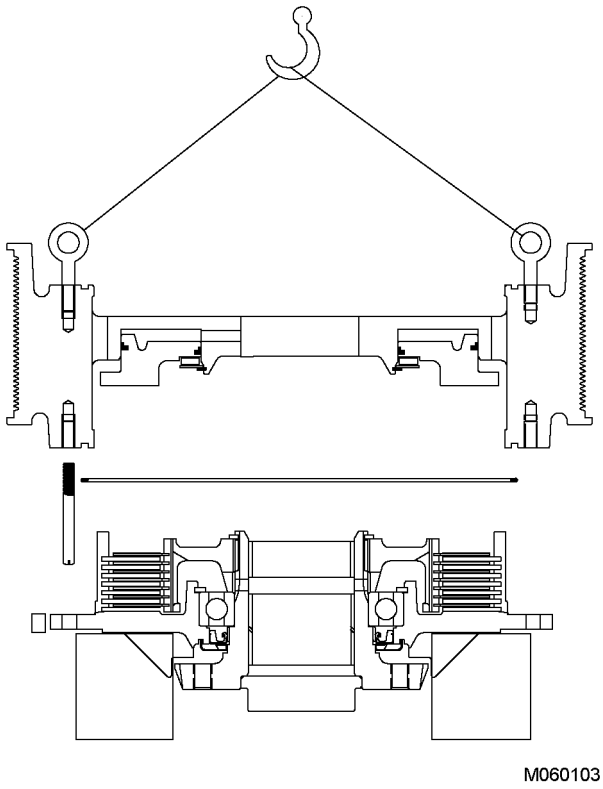


FIGURE 7-71.

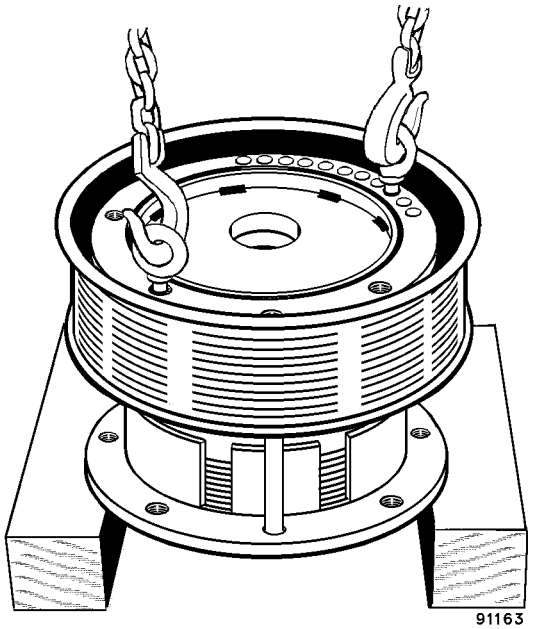


FIGURE 7-72.

32. Turn the pulley adapter assembly over and install two lifting eyes 180° 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 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.

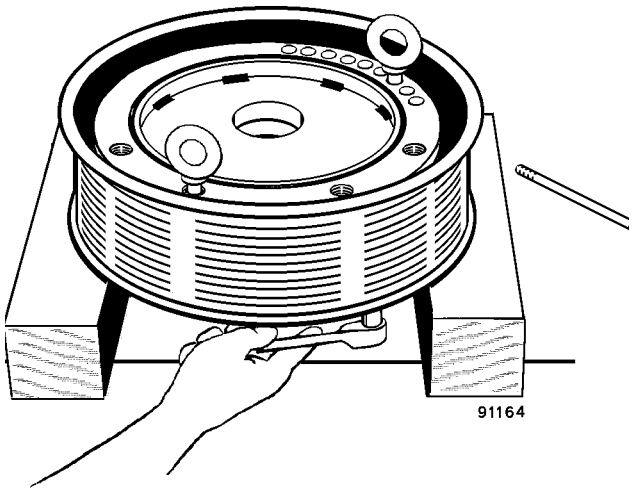


FIGURE 7-73.

33. Install at least four bolts (38) with lockwashers (37) and snug. Insert the bolts 90° apart.

BATTERY SUPPLY SYSTEM

24VDC Battery Charging Alternator

Refer to Section D, Battery Charging Alternator for information regarding the truck battery charging alternator.

Battery Box

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

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

Battery Control Box

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

Isolation Diodes

Schottky type isolation diodes are used to provide isolation between the system and the starter battery circuits, and in the dual starter motor start command circuits. These devices control the direction of current flow in high current applications.

The battery system isolation diode (8) allows charging current from the battery charging alternator to charge both system batteries, but prevents current flow from the system batteries to the starter motors when the engine is started.

The engine starter system isolation diode (4) provides current flow from the cranking batteries through the engine start relay (described below) to the starter motor engagement drives.

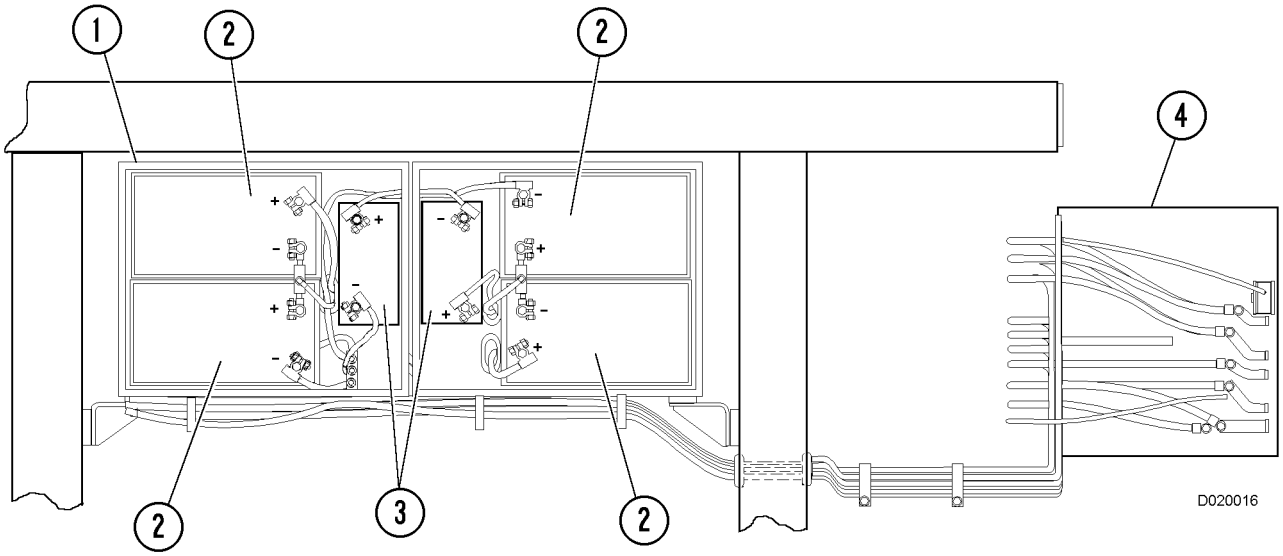


FIGURE 2-1. BATTERY BOX AND BATTERY CONTROL BOX

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

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

Oil Level Card

The oil level card (optional) is used to turn on the low oil level indicator light to warn the operator engine oil/ hydraulic tank oil level is below acceptable levels. The oil float is connected to a variable resistor. As the oil level decreases, the resistance goes down causing Q3 to turn on, grounding the indicator light and alarm horn.

Temperature Card

The temperature card (optional) is used to turn on the high oil temperature indicator light. The indicator light tells the operator hydraulic tank oil temperature has exceeded acceptable levels. Normal temperature setting is 250°F (121°C). As the temperature goes up the resistance in the probe decreases providing a ground path for the indicator light and alarm horn.

Diode Matrix (Without Sound) Card

The diode matrix **without sound** card consists of a series of diodes capable of working with eight different indicator circuits. The indicator light can be a flashing light by connecting it to the 12F circuit or a steady light by connecting it to the 12M circuit. In addition, some of the indicator light circuits are routed through a dimmer module to allow the operator to vary the intensity of the lamps. These lamps are fed by circuits 12FD (flashing) and 12MD (steady).

When an indicator circuit is not activated, there is no ground circuit for the bulb. When the Indicator detecting switch activates the circuit, it grounds the lamp and grounds the flasher circuit through the diodes. Any circuits connected to terminals C1 through C8 will operate in the same manner. The alarm horn is not activated by this card.

Diode Matrix (With Sound) Card

The diode matrix **with sound** card works very much like the other diode matrix card, except that it contains extra diodes to activate the alarm horn in addition to the flasher. The circuits connected to terminals A1 through A8 operate in the same manner.

Lamp Test Switch

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

CIRCUIT BREAKER CHART

	AMPS	DEVICE(S) PROTECTED	CIRCUIT	LOCATION
CB00	50	12 Volt Power Source	11B1	Battery Control Box
CB1	5	ECM Main Power	440	Electrical Interface Cabinet
CB2	20	ECM Main Power	240M	Electrical Interface Cabinet
CB3	20	ECM Main Power	241M	Electrical Interface Cabinet
CB4	20	ECM Main Power	240R1	Electrical Interface Cabinet
CB5	20	ECM Main Power	241R1	Electrical Interface Cabinet
CB6	15	Engine Service Lights	11SL	Electrical Interface Cabinet
CB7	10	Lincoln Lube Solenoids	68	Electrical Interface Cabinet
CB8	10	Body-up Limit Switch/Solenoid	712H	Electrical Interface Cabinet
CB9	10	Aux. Keyswitch Power	712A	Electrical Interface Cabinet
CB10	10	Spare		Electrical Interface Cabinet
CB11	15	Spare		Electrical Interface Cabinet
CB12	5	Spare		Electrical Interface Cabinet
CB13	15	Clearance Lights	11CL	RB1, Elect. Interface Cabinet
CB14	15	Turn Signals	11Z	RB1, Elect. Interface Cabinet
CB15	15	RD1, RD2, & Tail Lights	41T	RB1, Elect. Interface Cabinet
CB16	15	Dynamic Retard Lights	44C	RB3, Elect. Interface Cabinet
CB17	15	Manual Back-up Lights	47B	RB3, Elect. Interface Cabinet
CB18	15	Stop Lights	44A	RB3, Elect. Interface Cabinet
CB19	15	Back-up Horn	79A	RB3, Elect. Interface Cabinet
CB20	5	Control/Key Power, Kontrol Power Relay	439E, 712S, 71	RB4, Elect. Interface Cabinet
CB21	15	Aux. Battery Power	11A	RB4, Elect. Interface Cabinet
CB22	5	Control/Key Power, Engine Shutdown	23D	RB4, Elect. Interface Cabinet
CB23	15	Low Beam Headlight, L.H.	11DL	RB5, Elect. Interface Cabinet
CB24	15	Low Beam Headlight, R.H.	11DR	RB5, Elect. Interface Cabinet
CB25	15	High Beam Headlight, L.H.	11HL	RB5, Elect. Interface Cabinet
CB26	15	High Beam Headlight, R.H.	11HR	RB5, Elect. Interface Cabinet
CB27	15	Headlight Switch	11D	RB5, Elect. Interface Cabinet
CB28	15	Payload Meter	39J	RB2, Elect. Interface Cabinet
CB29	15	Payload Meter	39G	RB2, Elect. Interface Cabinet
CB30	15	Fog/Ladder Lights	11L	Power Distribution Module
CB31	15	Cab Heater/AC Blower Motor	12H	Power Distribution Module
CB32	15	Warning Lights, A.I.D. Module	12M	Power Distribution Module
CB33		Not Used		Power Distribution Module
CB34		Not Used		Power Distribution Module
CB35		Not Used		Power Distribution Module
CB36	10	Cigar Lighter	11B2	Power Distribution Module
CB37	10	Windshield Washer & Wiper	712W	Power Distribution Module
CB38	5	Fuel, Engine Temperature, Oil Pressure, Voltmeter Gauges	712D	Power Distribution Module
CB39		Not Used		Power Distribution Module
CB40A	5	Accessory Plug (12VDC)	12GE	Power Distribution Module
CB40B	10	Radio/Cassette Player	11B4	Power Distribution Module
CB41A	15	Cab Door Window, L.H.	11B6	Power Distribution Module
CB41B	15	Cab Door Window, R.H.	11B7	Power Distribution Module
CB42	15	Air Seat Compressor	712A	Power Distribution Module
CB43	10	Start Signal	21S	Power Distribution Module
CB50	20	Communications Radio	SPR42/SPR46	Power Distribution Module
CB51	20	Dispatch Radio	SPR43/SPR47	Power Distribution Module
CB52		Not Used		Power Distribution Module
CB53		Not Used		Power Distribution Module

ON VEHICLE TROUBLESHOOTING GUIDE

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

PRELIMINARY PROCEDURES

Common problems, all applications:

Check alternator drive belt (s).

Check alternator positive connection

Check alternator ground connection on alternator.

Check condition of connector between regulator and alternator.

Identify model of alternator_____

Identify model of regulator_____

Record voltage regulator set points stated on regulator tag:

1)_____ 2)_____ 3)_____ (if applicable)

TOOLS AND EQUIPMENT:

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

LOW VOLTAGE OUTPUT

Causes of low voltage:

Loose drive belt.

Low state of charge of battery.

Current load on system greater than alternator can produce.

Defective wiring or poor ground path.

Low regulator set point.

Defective voltage regulator.

Defective alternator.

HIGH VOLTAGE OUTPUT

Causes of high voltage:

Wrong regulator.

High regulator set point.

Defective regulator.

Defective alternator.

NO VOLTAGE OUTPUT

Causes of no voltage output:

No drive belt.

No battery (B+) voltage at alternator's "B+" terminal (except isolator type systems).

No "link" from "R" terminal to energize ("E") terminal on alternator when engine operating.

Defective regulator.

Defective alternator.

BATTERY CONDITIONS AND CHARGE VOLTAGE REACTIONS:

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

Maintenance type:

Immediately after engine start, system volts are lower than regulator set-point with medium amps.

3-5 minutes into charge cycle, higher system volts and reduced amps.

5-10 minutes into charge cycle, system volts are at, or nearly at, regulator set point, and amps are reduced to a minimum.

Low Maintenance types:

Same as above, except cycle times may be longer.

BENCH TEST

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

Equipment:

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

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

TEST 1 - No Load Test

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

Table 10-5: N0-LOAD TEST

AMPS	VOLTS	DIAGNOSIS
HIGH	**LOW**	Test bench battery is discharged (or defective). Allow to charge or replace.
HIGH	**NORMAL**	Give time to stabilize while monitoring VOLTS. If VOLTS rise above normal range (Table 13-2) regulator and/or field coil must be replaced. If AMPS fall, charging system is OK.
HIGH	**HIGH**	Stop test. Regulator and/or field coil should be replaced. (Go to Static Tests.)
LOW	**LOW**	Alternator and/or regulator must be repaired or replaced. Go to Test 3.
LOW	**NORMAL**	Regulator OK. Go to Test 2.
LOW	**HIGH**	Stop test. Bench malfunction or wiring error.

TEST 2 - Full Load Test

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

Table 10-6: FULL-LOAD TEST

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

TEST 3 - Regulator Bypass Test

Perform this test only when suggested by other tests.

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

⚠CAUTION

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

Table 10-7: REGULATOR BYPASS TEST

CONNECT	DISCONNECT	DIAGNOSIS
Amps Rise	Amps Fall	Alternator is OK. See note, replace regulator only if low AMPS/low VOLTS indicated in Test 1 and/or Test 2.
No Change	No Change	Alternator must be repaired. Go to Static Tests.
Note: Before replacing regulator, check continuity of energize circuit (refer to Static Tests, Test 5).		

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

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

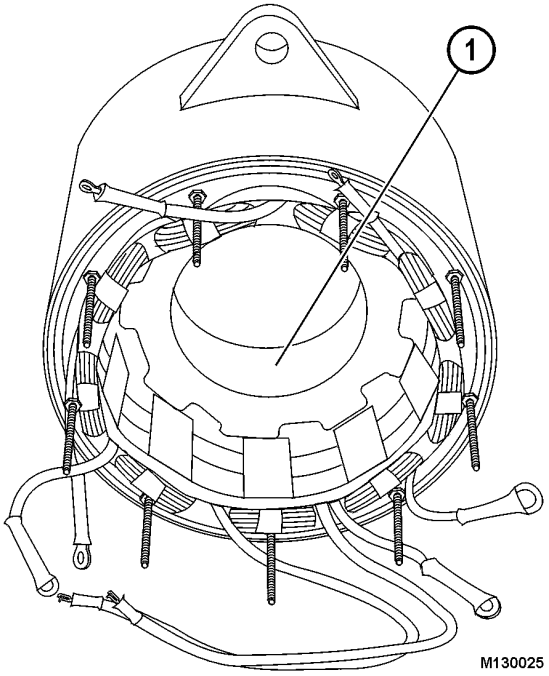


FIGURE 10-25.

1. Field Coil Bobbin Ear

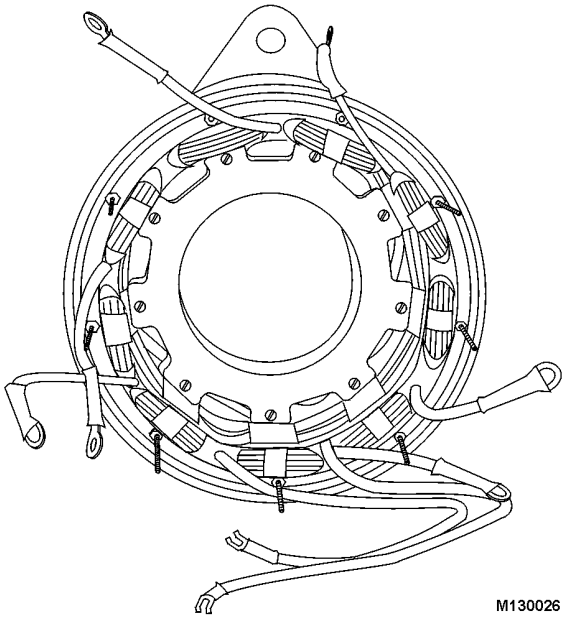


FIGURE 10-26.

5. Make sure field coil leads (white spade terminals) are pulled through proper stator openings with no slack at the field coil and that neither wire is pinched by the bobbin ears.
6. Using eighteen screws coated with loctite, fasten field coil bobbin ears to stator tabs (Figure 10-26). Tighten screws to **8-10 lb-in. (0.9- 1.1 Nm)** torque.

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

Front Bearing Assembly

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

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

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

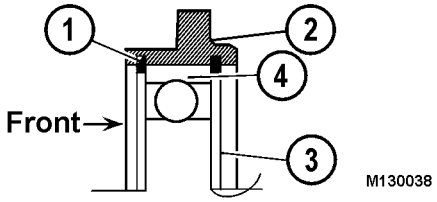


FIGURE 10-27.

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

Pressure Plate Setup (Refer to Figure 10-46)

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

   Insert the jack screw through the top thrust plate. Screw jack screw into the pressure plate about 5 turns. Place a dab of lube on both sides of the thrust washer under hex head of the jack screw. Screw jack screw into the pressure plate until contact is make between head of the jack screw and top thrust plate.
9. Continue threading the jack screw in, until stator contacts shell/shell assembly. Measure from top of locating pin to the top of the top thrust plate. Record this measurement as starting point to be used later.
10. Check the position of stator leads by looking through the large torque arm holes in the top thrust plate. Turn jack screw until significant resistance is encountered.

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

11. Check the distance the stator has been inserted into the shell by measuring from the top of the locating pin to the top of the top thrust plate (first measurement taken in step 9, above). This measurement should increase, which indicates the stator is entering the shell.
12. After the stator has been properly seated, disassemble the tool. Pull the stator leads through the correct slots. Continue with the alternator assembly as per instructions in this manual.

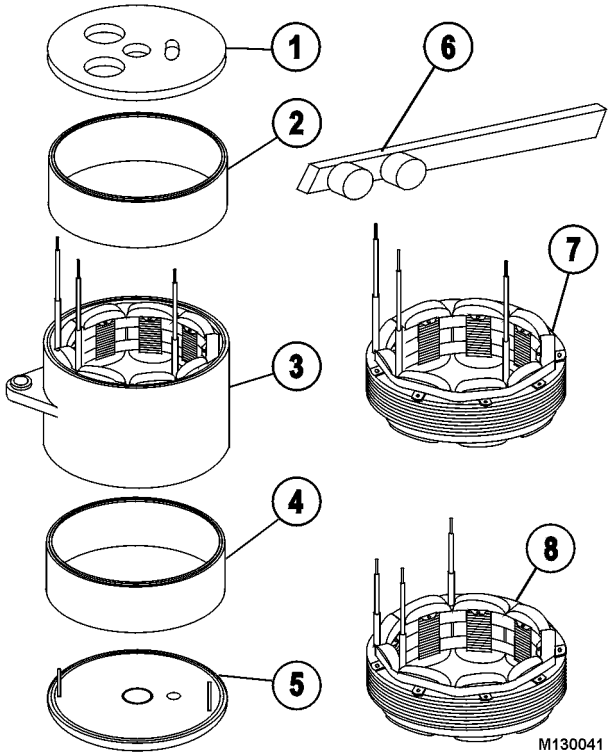


FIGURE 10-46.

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

Diagnostic Information Display

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

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

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

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

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

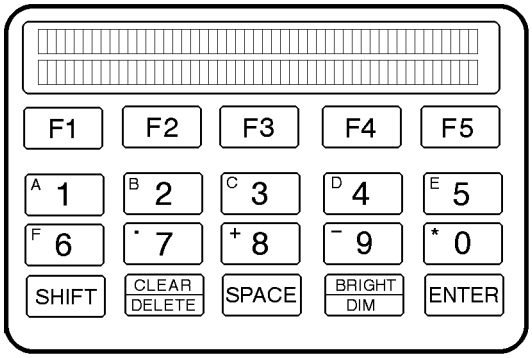


FIGURE 2-2. DIAGNOSTIC INFORMATION DISPLAY

DID PANEL EVENT CODES

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

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

TABLE I

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

TABLE III: DID PANEL FAULT CODES (Codes Received from Inverter 1, 2)				
EVENT NUMBER		**EVENT DESCRIPTION**	**EVENT RESTRICTION**	**DETECTION INFORMATION**
103/203 (cont.)				
	:21	link V too hi	None	Link voltage too positive
	:22	infilV too hi		Input filter voltage too positive
	:23	DB chop VCO hi		High freq. on VCO DB chopper channel
	:24	DB chopV too hi		DB chopper voltage too positive
	:25	VA VCO hi		High freq. on VCO VA channel
	:26	VB VCO hi		High freq. on VCO VB channel
	:27	VC VCO hi		High freq. on VCO VC channel
	:28	VA volts too hi		VA voltage too positive
	:29	VB volts too hi		VB voltage too positive
	:30	volt scale C flt		Scale C volts out of range 70%, 120%
	:31	VC volts too hi		VC voltage too positive
104/204		FIBER OPTIC CARD	INV1 (INV2) off	
	:01	fo ps low		Fiber optic power supply monitor
	:02	fo card disable		Fiber optic card disabled
	:03	fo card enable		Fiber optic card enabled and no dir
105/205		POWER SUPPLY CARD	INV1 (INV2) off	
	:01	P5V not ok		+5 volt not in tolerance
	:02	P15V not ok		+15 volt not in tolerance
	:03	N15V not ok		-15 volt not in tolerance
	:06	P24V not ok		+24 volt not in tolerance
	:07	N24V not ok		-24 volt not in tolerance
106/206		DC WIRING	INV1 (INV2) off	
	:01	DC pwr conn open		DC power connection open
	:02	link V phase V mismatch		Link and phase voltage mismatch
107/207		GDPS FAILURE	INV1 (INV2) off	
	:01	gate dr ps off		No power to gate drive power supply or it failed
	:02	gate dr ps off S		No power to gate drive power supply or it failed with enable/DC volts
	:03	multiple GTO not off S		Multiple GTOs not off with enable/DC volts
109/209		LINK VOLTS SENSOR	INV1 (INV2) off	
	:01	linkV sensor flt		Link voltage sensor failed
111/211		INPUT VOLTS SENSOR	INV1 (INV2) off	
	:01	Vfil not ok		Filter voltage outside limits

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

Propel Torque Control

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

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

- **Speed Override**

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

- **Motor Torque Limits**

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

- **Gear Stress**

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

- **Horsepower Available**

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

- **Jerk Limit**

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

- **Wheel Spin**

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

Retard Torque Control

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

- **Retard Foot Pedal or Lever**

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

- **Overspeed**

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

- **Retard Speed Control**

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

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

Retard Torque Limits are as follows:

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

Wheel Slide Control

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

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

AC DRIVE SYSTEM ELECTRICAL CHECKOUT PROCEDURE

AC DRIVE SYSTEM MAINTENANCE

⚠DANGER

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

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

⚠WARNING

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

TRUCK SHUTDOWN PROCEDURES

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

⚠DANGER

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

TCI PROGRAMMING

⚠WARNING

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

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

To program the 17FB144 CPU card:

- c:\>ACNMENU {enter}
- Highlight “PROGRAM TCI PANEL” {enter}
- Highlight “SELECT TCI SETUP” {enter}
- Cursor to the appropriate configuration file for the truck being programmed from the list of configuration files {enter}
- Highlight- “PROGRAM TCI PANEL” {enter}
- Highlight- “PROGRAM TCI” {enter}

3. Cycle keyswitch or CPS when requested on screen.
4. Verify the Object Code and Configuration file shown on the screen for downloading is correct.

PSC PROGRAMMING

⚠WARNING

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

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

To program the 17FB147 CPU card:

- c:\>ACNMENU {enter}
- Highlight “PROGRAM PSC PANEL” {enter}
- Highlight “SELECT PSC SETUP”
- Cursor to the appropriate configuration file for the truck being programmed from the list of configuration files {enter}
- Highlight “PROGRAM PSC PANEL”
- Highlight “PROGRAM PSC”

3. Cycle keyswitch or CPS when requested on screen.
4. verify the Object Code and Configuration file shown on the screen for downloading is correct.

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

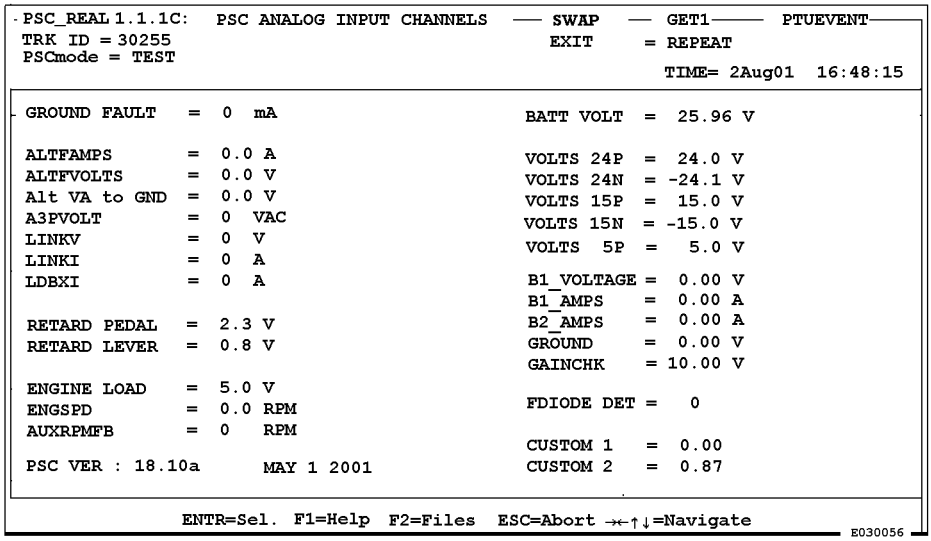


FIGURE 3-7. PSC ANALOG INPUT CHANNELS SCREEN

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

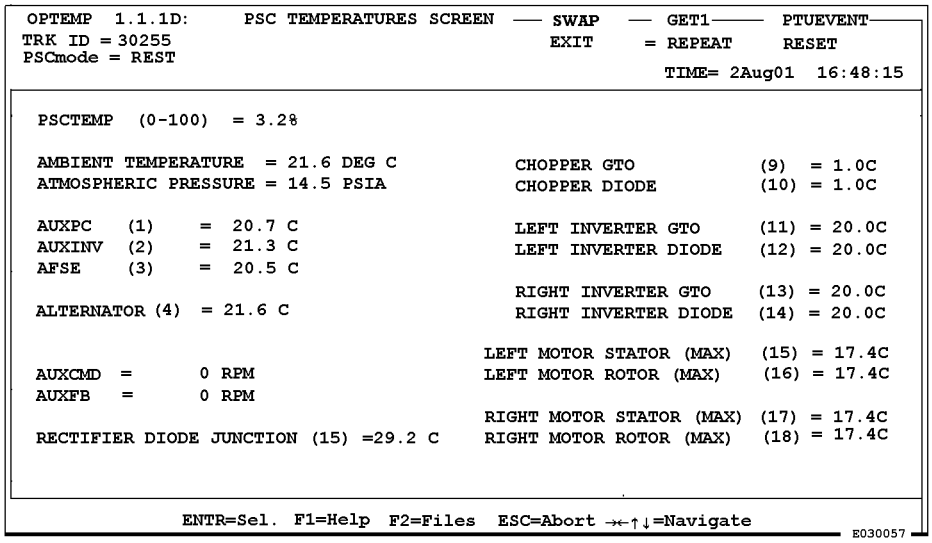


FIGURE 3-8. PSC TEMPERATURES SCREEN

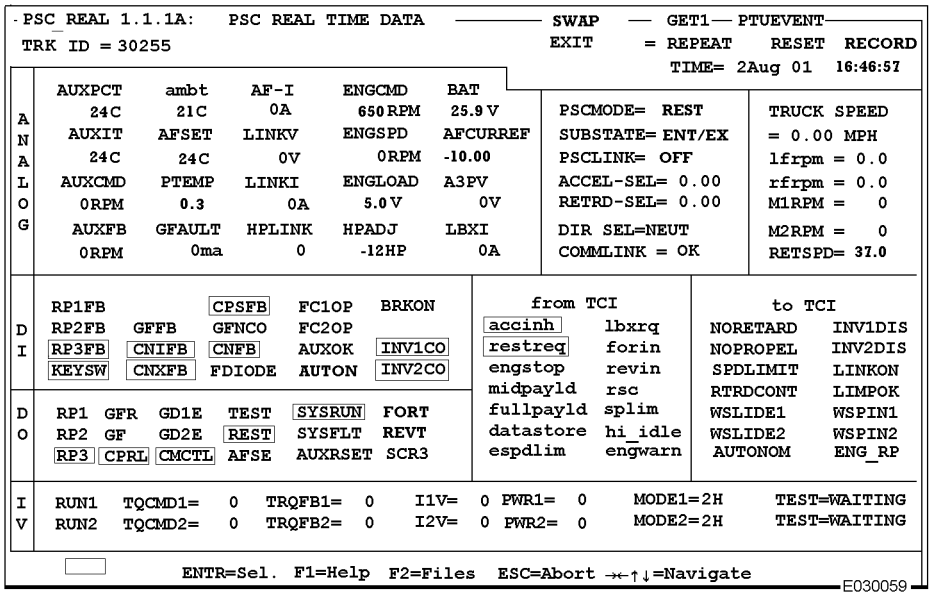


FIGURE 3-10. PSC REAL TIME DATA SCREEN

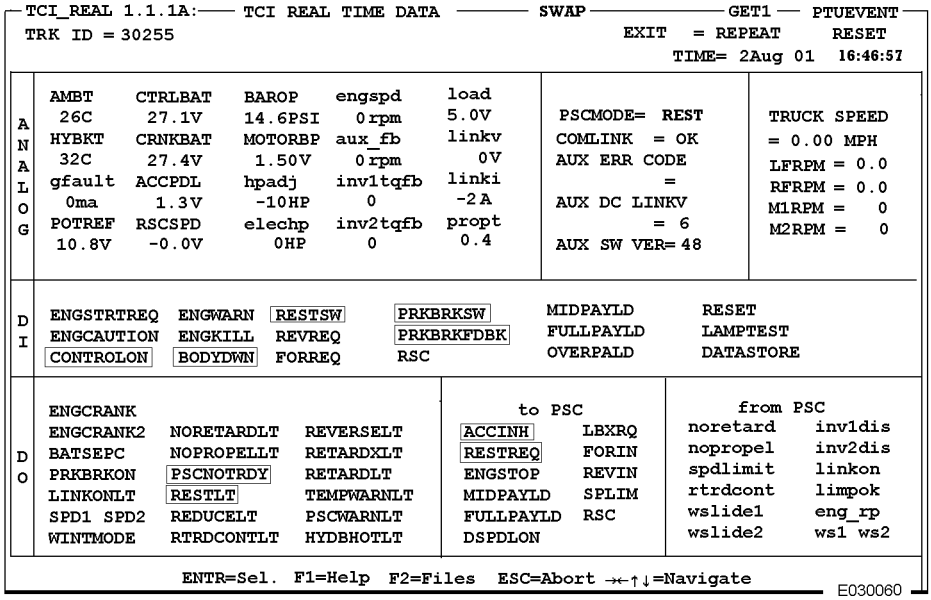


FIGURE 3-11. TCI REAL TIME DATA SCREEN

PVM Optimum Load Curve Handshaking Troubleshooting

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

Trucks equipped with DDEC engine:

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

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

Examples:

10ms/20ms = .50 X 10 = 5.0VDC

15ms/20ms = .75 X 10 = 7.5VDC

5ms/20ms = .25 X 10 = 2.5VDC

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

Trucks equipped with Komatsu engine:

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

Trucks with Either Engine:

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

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

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

SECTION G

REAR AXLE, SPINDLES AND WHEELS

INDEX

TIRES AND RIMS G2-1

FRONT WHEEL HUB AND SPINDLE G3-1

REAR AXLE HOUSING MOUNTING ATTACHMENT G4-1

REAR AXLE HOUSING G5-1

8. Secure inner and outer dual tire inflation lines to bracket (14) on outer rim.
9. Remove blocks from under truck and lower truck to the ground. Operate truck for one load and retighten outer wheel nuts (11) and adapter flange nuts (10) to **1715 ± 100 ft. lbs. (2326 ± 136 N.m)** torque.

NOTE: Inner flanged nuts (5 & 7) and studs should be visually inspected for breakage or missing nuts during scheduled maintenance checks by inserting a mirror between the rear tires.

RIM

Tire Removal

⚠DANGER

DO NOT weld or apply heat on the rim assembly with the tire mounted on the rim. Resulting gases inside the tire may ignite causing explosion of tire.
When inflating tires always use a safety cage. Never inflate a tire until the lockring is securely in place. Do not stand in front of or over the lock-ring during inflation procedures. Never overin-flate a tire. Refer to tire manufacturers recommendations.

1. Place tire and wheel assembly in safety cage and discharge all air pressure from tire.
2. Attach a hydraulic bead breaker to the rim by slipping the jaws of frame assembly over the outer edge of flange (7, Figure 2-7). Make sure the jaws of the frame are as near to the bead seat band (6) as possible.
3. Following tool manufacturers instructions, move tire bead in far enough to permit placing a wedge between tire and flange at side of tool.
4. Repeat this procedure at locations approxi-mately 90° from the first application. Continue this procedure until tire bead is free from rim.
5. After bead is broken loose, insert flat of tire tool in beading notch on lockring (8). Pry lockring up and out of groove on rim.
6. Pry in on bead seat band (6) until O-ring (9) is exposed. Remove O-ring.
7. Remove bead seat band (6) from rim (5) and remove flange (7).
8. Reposition wheel assembly and repeat removal procedure on opposite side of tire. Remove tire from rim.

Disassembly - Wheel Hub and Spindle Assembly

1. Remove the wheel hub and spindle as covered in "Removal" before proceeding to Step 2. Remove any dirt and mud from the assembly.
2. To aid in complete disassembly of the wheel hub and spindle assembly, support the assembly in a vertical (hub cover up) position using a fabricated spindle stand.
3. Install six, 0.50 in. -13 x 0.75 in. long socket head capscrews (34, Figure 3-6) through the disc brake back plate into the mating holes in the seal retainer. Tighten securely.

NOTE: The capscrews installed in Step 3 will secure the seal carrier and face seal assembly to the brake housing during brake removal. ***DO NOT rotate the wheel hub.***

4. Disconnect speed sensor cables. Loosen sensor clamping capscrews and remove speed sensors (16).
5. Remove capscrews (20) and hardened flatwashers (21) securing brake adapter (19) to brake housing.
6. Remove the capscrews and washers that secure cover (5). Remove the cover and discard O-ring seal (41).
7. Remove capscrews (11) and hardened flatwashers (12). Remove bearing retainer (13) and shims (8).
8. Attach a lifting device to the wheel hub/brake assembly and carefully lift it straight up and off the spindle.
9. Remove outer bearing cone (7) and retainer pin (40).
10. Remove spindle cap (10) and O-ring (9).
11. Rotate hub vertically 180° and place on blocking to prevent damage to wheel studs and machined surfaces.
10. Remove capscrews (14) and washers (15) securing seal carrier (37) sensor gear (35) and shims (36) to wheel hub.
11. Remove capscrews (23) and hardened washers (24) securing brake assembly inner gear to wheel hub.
12. Attach a lifting eyes and an overhead hoist to the brake assembly. Carefully lift the assembly off the hub.

    Refer to Section "J" for brake assembly rebuild instructions.
13. Remove and discard seal carrier O-ring (38).
14. Remove speed sensor gear (35) and shims (36).
15. If bearings require replacement, press cups (6 & 29) from the wheel hub.
16. Remove capscrews (31) and hardened flatwashers (32). Remove brake adapter (19) and discard O-rings (22 & 25).
17. Remove inner bearing cone (28) and retainer pin (39).
18. Remove bearing spacer (27).

Cleaning and Inspection - Wheel Hub and Spindle Assembly

1. Clean all metal parts in fresh cleaning solvent.
2. Inspect wheel hub studs (2, Figure 3-6) and replace if damaged or broken.

NOTE: If new studs are installed, coat the hole in the hub and serrated portion of the stud with an anti-seize compound prior to installation. DO NOT coat threads.

3. Inspect tapped hole threads and re-tap if necessary.
4. Inspect bearing seating surfaces in hub and on spindle. Inspect bearing spacer. Use a stone to carefully dress high spots that may interfere with re-assembly.
5. Inspect all other machined surfaces for damage.
6. Always use new O-ring seals during assembly.

SECTION G4

REAR AXLE HOUSING ATTACHMENT

INDEX

REAR AXLE HOUSING ATTACHMENT G4-3

PIVOT PIN G4-3

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PIVOT EYE BEARING G4-4

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Installation G4-6

Disassembly G4-6

Cleaning and Inspection G4-6

Assembly G4-6

Cleaning and Inspection - Rear Axle Housing

1. Thoroughly clean the capscrew holes and wheel motor mounting faces. Re-tap holes if threads are damaged.
2. Check wheel motor mounting faces for nicks, scratches or other damage. Inspect all welds and repair as necessary.
3. Inspect pivot pin bearing. If worn or damaged, refer to Section G, Rear Axle Housing Attachment - Pivot Eye Bearing, and repair as required.
4. Inspect brake system relay valve (6, Figure 5-1) and hoses for leaks. Inspect manifold (4) hose connections and repair leaks or damaged hoses.

Installation - Rear Axle Housing

1. Position axle housing under frame.
2. Align pivot pin bores and install pivot pin. Refer to Section G, Rear Axle Housing Attachment.
3. Install anti-sway bar. Refer to Section G, Rear Axle Housing Attachment.
4. Install rear suspensions, as described in Section H, Rear Suspensions.
5. Connect auto lube system hoses and clamps.
6. Route wheel motor cables (7, Figure 5-1) into housing and clamp in place. Install cable grip mounting plate and cable grips.
7. Install speed sensor harness (9, Figure 5-1) through housing. Install cable grip.
8. Install air sensor/light harness through housing, clamp in place and install connectors. Install cable grip.
9. Install wheel motors, cables, brake lines and tires as described on the following pages.
10. Connect hoses to manifold (4) at front of housing.
11. Install air duct (5). Close duct inspection covers and install duct tube in rear opening of axle housing.
12. Reconnect wheel motor cooling air duct and clamp securely.
13. Open pump shut-off valves. Service hydraulic system.

Wheel Motor Oil Sampling Record

Mine truck number:		KMS truck serial number:	
Truck side:	Left or Right (circle)	Oil:	
Wheel serial number:			
Wheel install date:			

Sample Date	Sample #	Hours on Truck	Hours on oil	Iron	Chromium	Nickel	Copper	Silicon	Phosphorus	Zinc	Calcium	Viscosity @ 100° C
Max Values:				**600**	**10**	**10**	**50**	**50**	**400**	**75**	**40**	**53**

"Turn-Of-The-Nut" Tightening Procedure

a. Tighten all fourteen capscrews (1, 6, 8, Figure 2-3) to **400 ± 40 ft.lbs. (542 ± 5 N.m)**. Use a torque wrench of known calibration.

b. Maintain this torque on the top two corner capscrews and the bottom, outer four capscrews (the bottom four capscrews without spacers).

c. Loosen the 8 remaining capscrews and then tighten again using "turn-of-the-nut" tightening procedure as follows:

d. For the four capscrews (1, Figure 2-3) at the upper mount, initially tighten the capscrews to **70 ft. lbs. (95 N.m)**, then advance the capscrew head 60° using steps d-1.) through d-3.). Refer to Figure 2-6.

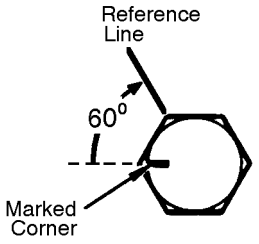


FIGURE 2-6. REFERENCE MARKS FOR 60 DEGREE ADVANCE

(6.0 in. (15 cm) Capscrews)

For the bottom four capscrews (6, Figure 2-3), initially tighten the capscrews to **100 ft. lbs. (136 N.m)**, then advance the capscrew head 120° using steps d-1) through d-3). Refer to Figure 2-7.

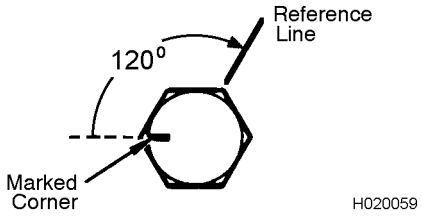


FIGURE 2-7. REFERENCE MARKS FOR 120 DEGREE ADVANCE

14.0 in. (36 mm) Capscrews

1.) Mark a reference line on a corner of the hexagonal capscrew head or nut and the mounting surface opposite this corner, as shown. Then mark the position located 60° or 120° clockwise relative to the first reference line on the mounting surface. Refer to Figures 2-6 and 2-7.

2.) To ensure that the opposite end of the turning member, either the capscrew head or nut, remains stationary, scribe a reference mark for this check.

3.) Each corner of a hexagon represents 60°. The turning member, either the capscrew head or nut, is turned until the marked corner is adjacent with the marked reference line. Ensure that the opposite end of the turning member has NOT turned during the tightening procedure.

NOTE: Do not exceed 4 RPM tightening speed. Do not hammer or jerk the wrench during the tightening procedure.

e. Loosen the top two corner capscrews (1) and the bottom outer four capscrews (8), (the bottom four capscrews without spacers).

1.) Tighten the top two corner capscrews to **70 ft. lbs. (95 N.m)**, then use "turn-of-the-nut" method to advance the capscrew heads 60°.

2.) Tighten the bottom, outer four capscrews to **200 ft. lbs. (271 N.m)**, then use the "turn-of-the-nut" method to advance the capscrew heads 120°.

NOTE: If for any reason, these fasteners need to be checked for tightness after completing the above procedure; loosen and inspect all 14 capscrews and repeat the entire process, starting with cleaning and lubricating the capscrews, washers, and nuts.

7. Charge the suspension with dry nitrogen to fully extend the suspension piston before installing the front wheel hub and spindle.
8. Install spindle, wheel and tire according to instructions in Section G.
9. Service the suspension. For instructions refer to Section H, Oiling and Charging Procedures.
10. Install the suspension boot and secure with the boot clamp.

13. When the cylinder reaches the end of its stroke, remove one of the shackles from the cylinder and connect the cylinder shackle directly to the pin removal tool. This is necessary to pull the pin the remaining distance.
14. Remove the pin from the lower mounting.
15. Install the tool on the upper pin and repeat the pin removal process. (If the pin does not contain the necessary puller holes, an alternative removal method is needed.)
16. Remove the cylinder from the truck.
17. If it is necessary to remove the remaining rear suspension cylinder, insert the pins back into the upper and lower mountings.
18. Secure the pins using locking capscrews (4), and repeat the removal process.

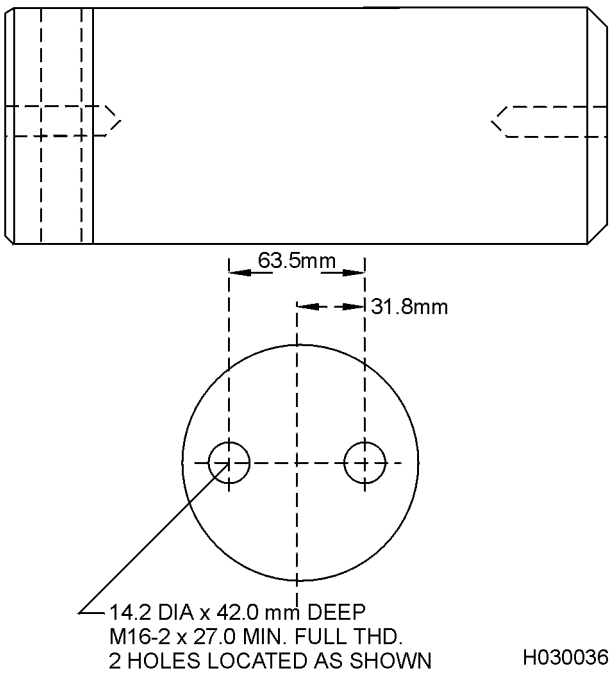


FIGURE 3-5. SUSPENSION PIN REWORK

Installation - Rear Suspension

1. Inspect mounting bore sleeves (9, Figure 3-3) and bearing spacers for damage or wear. Check fit of pins in bores prior to installing suspension. Replace worn or damaged parts.
2. As noted earlier, all pins must have 2 threaded holes at the inboard ends of the pin for future pin removal tool usage. Install new pins or rework the existing pins per Figure 3-5.
3. Secure suspension to fork lift and raise into position. (Suspension assembly should be retracted as far as possible prior to installation.)
4. Position top suspension eye with its spherical bearing, between the ears on the frame as shown in Figure 3-3. Be certain the upper and lower mounting eyes are aligned and the vent plugs are positioned to the rear.
5. Lubricate all pin to bearing and pin to sleeve contact surfaces with Anti-Seize. Lubricating the pin surfaces aids in removal and installation, as well as prevention of rust and corrosion.
6. Align the retaining capscrew hole in pin (1, Figure 3-3) with the hole in the mounting bore. Drive in far enough to hold pin in position.
7. Insert spacer (4) and continue to drive the pin in through the spherical bearing. Insert the remaining spacer and continue to drive the pin in until the retaining capscrew hole is aligned with the hole in the pin.
8. Install capscrew (2) and locknut (3). Tighten to **343 ft. lbs. (465 N.m)** torque. If further alignment of the capscrew and hole are necessary, install a pin removal tool onto the pin. Use the tool in conjunction with a large pipe wrench or other suitable device to align the locking capscrew holes.
9. Lower the suspension housing until the lower mount bearing aligns with the bore in the rear axle housing and repeat the above procedure to install the bottom pin. Mounting components in the top and bottom joints are identical.
10. Install the nitrogen charging kit and add nitrogen to raise frame off stands or cribbing, or use a lifting device if available.
11. Connect lubrication lines and pressure sensor.
12. Service the suspension. For instructions, refer to Section H, Oiling and Charging Procedures.
13. Install piston rod shield (2, Figure 3-1) with the capscrews, flat washers, and lockwashers.

14. Install the protective guard over the charging valve.
15. Raise the truck body in order to extend the front suspensions and allow for removal of the nitrogen charging blocks. **Ensure that sufficient overhead clearance exists before raising the body.** If the suspensions do not extend after raising the body, turn the steering wheel from stop to stop several times. If the suspensions still do not extend enough to allow for removal of the blocks, use a crane or floor jacks to raise the truck and remove the blocks.

The front Hydrair® suspensions are now ready for operation. Visually check the extension with the truck both empty and loaded. Record the extension dimensions. Maximum downward travel is indicated by the dirt ring at the base of the piston. Operator comments on steering response and suspension rebound should also be noted.

REAR SUSPENSION

1. Park the unloaded truck on a hard, level surface. Apply the parking brake, and chock the wheels.
2. Thoroughly clean the area around the charging valve on the suspensions. Remove the protective covers from the charging valves and the metal covers from the suspension piston.

⚠WARNING

When the blocks are in place on a suspension, they must be secured in place with a strap or other means to insure the blocks staying in place while being used. An unsecured block could fly loose as weight is applied, presenting the possibility of serious injury and/or damage.

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

Rear Suspension Oiling

1. If the suspensions are extended, position and secure oiling height dimension blocks (supports) in place (See Figure 4-4) so the blocks are seated between the piston flange and the cylinder housing. Ensure the blocks do not mar or scratch the plated surfaces on the piston or damage the wiper seals in the cylinder barrel. Support blocks must seat on the piston flange and the cylinder housing. The blocks should be positioned 180° apart to provide stability.

⚠WARNING

Make certain all personnel are clear and support blocks are secure before relieving nitrogen pressure from the suspension. Use a face mask or goggles when venting nitrogen.

2. Remove charging valve cap. Turn the charging valve swivel nut (small hex) counterclockwise three full turns to unseat valve seal. **DO NOT turn the large hex.** The charging valve body has a bleeder groove in its mounting threads, but for safety of all personnel, the valve body **must not** be loosened until all nitrogen pressure has been vented from the suspension.

SECONDARY BRAKING AND AUTOMATIC APPLY

A fundamental function of the secondary brake system is to provide reserve braking in the event of any single failure. For this reason, the system is divided into multiple circuits, each with its own isolation check valve, two accumulators, and circuit regulator. The secondary system becomes whatever circuit(s) is operable after a failure. If the failure is a jammed treadle valve, then the brake lock becomes the secondary system, otherwise, either of the two brake circuits would be the secondary system.

The four brake accumulators perform two functions; to provide rapid flow for good response and to store energy for secondary braking. The check valves assure this energy is retained should a failure occur in the brake system supply or an accumulator circuit. An additional check valve located between the supply line from the brake/steering pump and the brake manifold, provides additional protection against pressure loss if the oil supply is interrupted.

If a failure occurs in the pump, steering or either brake accumulator circuit, a low brake pressure warning light (on the overhead display panel in the cab) and an audible alarm will actuate and the vehicle should be stopped as soon as practical. When the pressure in one accumulator circuit is less than the preset level, all the service brakes will be automatically applied. Automatic brake application is accomplished by the "automatic apply valve" (PS), located in the brake manifold. This valve senses the lower brake accumulator pressure, and when the pressure is less than 1650 psi (11.4 MPa), the valve shifts, operating the brake treadle valve hydraulically which in turn applies pressure to the dual relay valves and applying all the brakes.

Regardless of the nature of location of a failure, sensing the lowest brake accumulator circuit pressure assures two to four full brake applications after the low brake warning light and buzzer, and before automatic apply. This allows the operator the opportunity to safely stop the truck after the warning has turned on.

PARKING BRAKE CIRCUIT

The parking brakes are spring applied and hydraulically released.

NOTE: Whenever the park brake solenoid is de-energized, a spring in the solenoid valve will shift the spool, diverting oil pressure from the parking brakes to direct the oil back to the hydraulic tank.

Normal Operation (key switch on, engine running)

- **Parking brake switch ON**
  The parking brake solenoid (15, Figure 2-1) is de-energized. The oil pressure in the parking brake lines return to tank and the springs in the parking brake will apply the brake. The parking brake pressure switch (21) will close, completing a path to ground, and illuminating the parking brake light on the overhead display panel.
- **Parking brake switch OFF**
  The parking brake solenoid is energized. The oil flow is routed from the park brake solenoid, to the park brake calipers for release. The parking brake circuit is protected against accidental application by monitoring a wheel motor speed sensor to determine truck ground speed. The park brake will not apply until the truck is virtually stopped. This eliminates park brake damage and will extend brake adjustment intervals.
- If the **key switch is turned OFF** (park brake switch ON or OFF), the park brake will not apply until vehicle speed is less than 1/3 MPH (0.5 km/h).
- If a loss of hydraulic supply pressure occurs, **with the parking brake switch OFF**, the parking brake solenoid will still be energized. The supply circuit (that lost pressure) is still open to the parking brake calipers. To prevent park brake pressure oil from returning to the supply circuit, a check valve (in the park brake circuit) traps the oil, holding the parking brake in the released position.

NOTE: Normal internal leakage in the parking brake solenoid may allow leakage of the trapped oil to return back to tank, and eventually allow park brake application.

- If 24 volt power to the solenoid is interrupted, the park brake will apply at any vehicle speed. The spring in the solenoid will cause it to shift, opening a path for the oil pressure in the park brake line to return to tank and the springs in the parking brake will apply the brake. The parking brake pressure switch (21) will close, completing a path to ground, illuminating the parking brake light on the overhead display panel and interrupting propulsion.

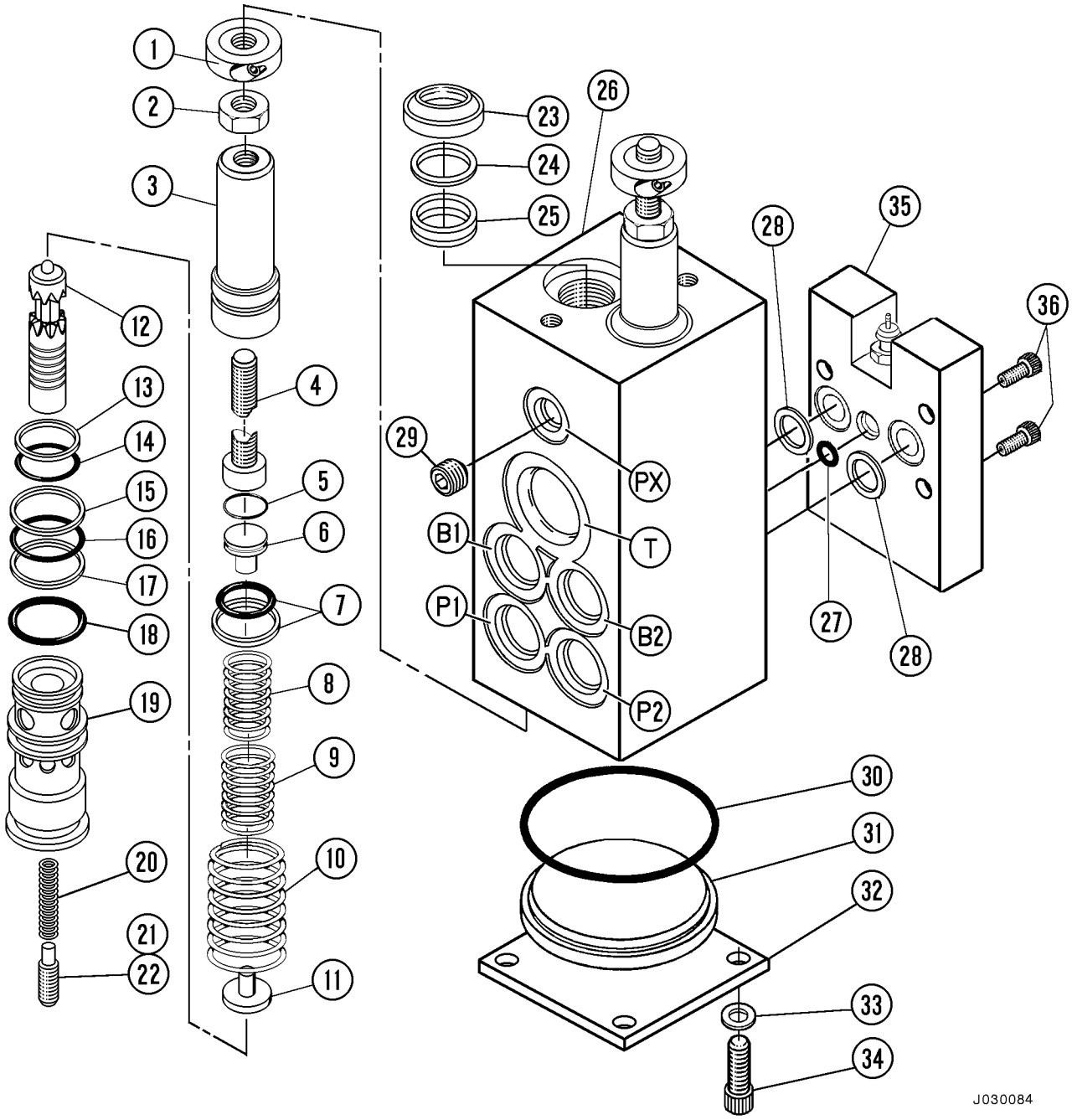


FIGURE 3-4. BRAKE VALVE

1. Adjustment Collar
2. Nut
3. Actuator Plunger
4. Stud
5. Packing
6. Staging Seat
7. Glyde Ring Assembly
8. Regulator Spring
9. Regulator Spring
10. Plunger Return Spring
11. Spring Seat
12. Regulator Spool
13. Back-up Ring
14. O-Ring
15. Back-up Ring
16. O-Ring
17. Back-up Ring
18. O-Ring
19. Regulator Sleeve
20. Spool Return Spring
21. Reaction Plunger (B1)
22. Reaction Plunger (B2)
23. Wiper Seal
24. Back-up Ring
25. Poly-Pak Seal
26. Valve Body
27. Seal
28. Seal
29. Set Screw Orifice Plug
30. O-Ring
31. Retaining Plug
32. Base Plate
33. Washer
34. Capscrew
35. Differential Pressure Switch
36. Capscrew

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DUAL RELAY VALVE

The dual relay valves (one for front and one for rear brake circuits) supply the apply pressure for each disc brake assembly. When the operator depresses the brake valve, hydraulic pressure, proportional to the amount of brake valve application, is applied to the pilot pressure circuit of each dual relay valve. Regulated pressure (proportional to the pilot pressure applied) is then delivered from the "B1" and "B2" ports of each dual relay valve to each wheel.

The regulated pressures supplied to each wheel are equal. If a malfunction occurs, causing a pressure differential greater than 600 psi (4137 kPa) between the right and left brake apply circuit, a differential pressure switch (3, Figure 3-11) mounted on the valve activates a warning horn and lamp in the cab. If a pressure differential greater than 600 psi (4137 kPa) occurs in the pilot circuit supplying the front and rear dual relay valves, a differential pressure switch mounted on the brake valve activates the warning horn and lamp in the cab.

The dual relay valve for the front brake circuit is located in the hydraulic components cabinet behind the cab. The dual relay valve for the rear brake circuit is located in the rear axle housing and requires removal of the wheel motor cooling air duct components for access to the valve as described below.

⚠DANGER

Before disconnecting pressure lines, replacing components in the hydraulic circuits, or installing test gauges, always bleed down hydraulic steering and brake accumulators. The steering accumulators can be bled down with engine shut down, turning the key switch OFF and waiting 90 seconds. Confirm the steering pressure is released by turning the steering wheel - No front wheel movement should occur.

Open bleed down valves (6 & 7, Figure 3-1) located on the brake manifold. This will allow both accumulators for the rear brakes and both accumulators for the front brakes to bleed down. Before disabling brake circuit, be sure truck wheels are blocked to prevent possible roll-away.

Removal

1. Securely block the wheels of the truck.
2. Place selector switch in NEUTRAL, turn the rest switch ON. Turn key switch OFF to shut down engine and allow 90 seconds for steering system accumulators to bleed down. Open valves (6 & 7, Figure 3-1) to bleed down all four brake accumulators. Close valves after all pressure is released.

NOTE: Follow Steps 3 & 4 below for the front valve or Steps 5 through 9 for rear valve removal.

Front Brake Circuit:

3. Tag and remove all hydraulic lines from dual relay valve. Plug lines and ports to prevent possible contamination. Disconnect wiring harness at differential pressure switch connector.
4. Remove two capscrews and washers securing valve to rear wall of cabinet. Remove valve and move to clean work area for disassembly.

Rear Brake Circuit:

5. Open rear access cover and remove wing nuts securing duct tube to axle housing. Remove tube.
6. Open access covers inside axle housing.
7. Remove wheel motor cooling air exhaust duct from between wheel motors.
8. Tag and remove all hydraulic lines from dual relay valve. Plug lines and ports to prevent possible contamination. Disconnect wiring harness at differential pressure switch connector.
9. Remove two capscrews and washers securing valve to mounting bracket. Remove valve and move to clean work area for disassembly.

Installation

1. Install dual relay valve in hydraulic components cabinet (front brake circuit) or rear axle housing (rear brake circuit). Install the two mounting capscrews and lockwashers to secure valve. Tighten capscrews to standard torque.
2. Remove hose and fitting caps and plugs and attach hoses to the proper valve ports. Connect differential pressure switch connector to wire harness.
3. Start engine and check for leaks and proper brake operation. Shut down engine.
4. For the rear valve, reinstall the wheel motor cooling air duct between wheel motors. Close access covers and reinstall tube in axle access opening.

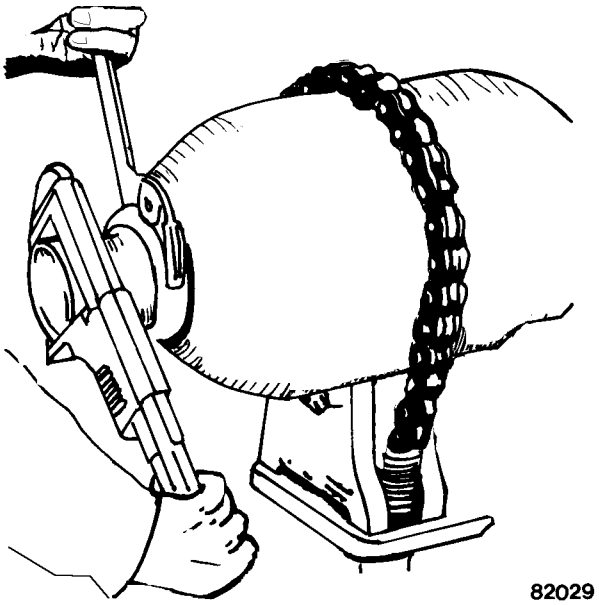


FIGURE 3-16. LOCKNUT REMOVAL

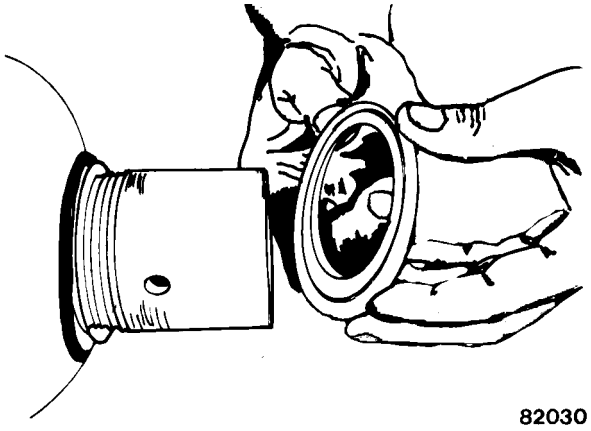


FIGURE 3-17. SPACER REMOVAL

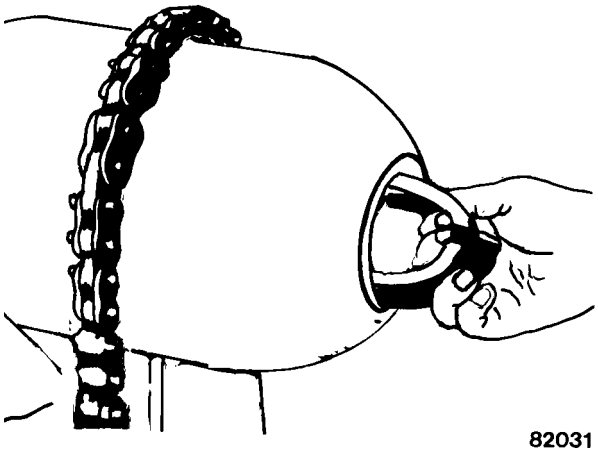


FIGURE 3-18. ANTI-EXTRUSION RING REMOVAL

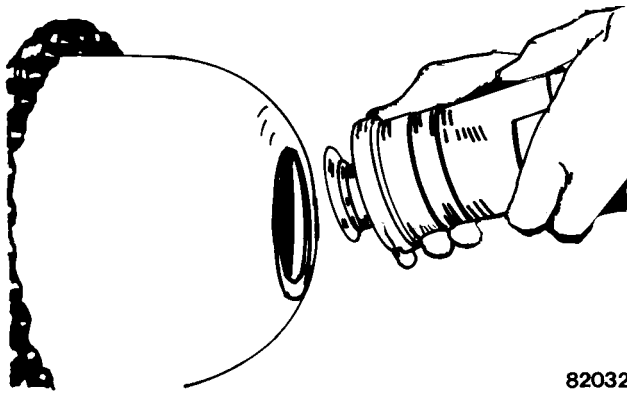


FIGURE 3-19. PLUG AND POPPET REMOVAL

8. Remove plug and poppet assembly from shell. (Refer to Figure 3-19.)
9. With wrench on valve stem flats, remove the nut from the valve stem.
10. Insert hand into shell fluid opening. Depress bag and eliminate as much gas pressure as possible.

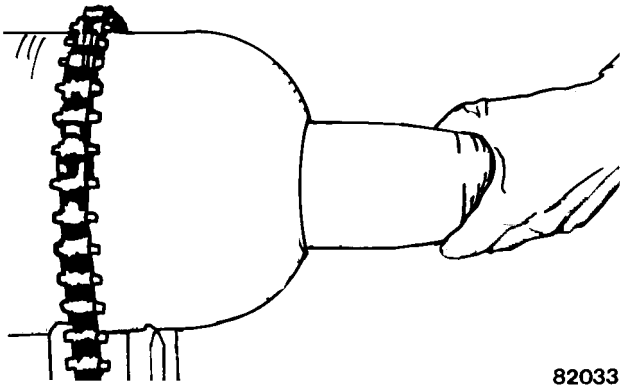


FIGURE 3-20. BLADDER REMOVAL

11. Grasp heel of the bladder and withdraw from shell. (Refer to Figure 3-20).

ACCUMULATOR CHARGING PROCEDURE

(Frame Mounted Brake Accumulators)

⚠WARNING

Do not loosen or disconnect any hydraulic line or component until engine is stopped and key switch has been OFF for at least 90 seconds and the brake accumulators have been manually bled down.

Pure dry nitrogen is the only gas approved for use in the brake accumulators. The accidental charging of oxygen or any other gas in this compartment may cause an explosion. Be sure pure dry nitrogen gas is being used to charge the accumulators.

When charging/discharging accumulators, be sure the warning labels are observed and the instructions regarding the charging valve are carefully read and understood.

1. With engine shut down, the rest switch ON and key switch in the OFF position, allow at least 90 seconds for steering accumulators to bleed down. Turn steering wheel to be certain no oil remains in accumulators.
2. Open the bleed valves (6 & 7, Figure 3-1) located on the brake manifold in the hydraulic components cabinet to completely bleed the pressure from all brake system accumulators.
3. Remove charging valve guards.

⚠WARNING

If nitrogen pressure is present in the accumulators, make certain only the small swivel hex nut is turned during the next step. Turning the complete valve assembly may result in the valve assembly being forced out of the accumulator by the nitrogen pressure inside.

4. Remove charging valve cap (1, Figure 3-31). Turn small swivel hex nut (4) three complete turns counterclockwise.
5. Depress the valve stem and hold down until all nitrogen has been released.
6. If a loss in nitrogen pressure is the reason for recharging, inspect the charging valve and accumulator for damage. Replace or repair items, as necessary, before recharging.

1. Valve Cap
2. Seal
3. Valve Core
4. Swivel Nut
5. Rubber Washer
6. Valve Body
7. O-ring
8. Valve Stem
9. O-ring

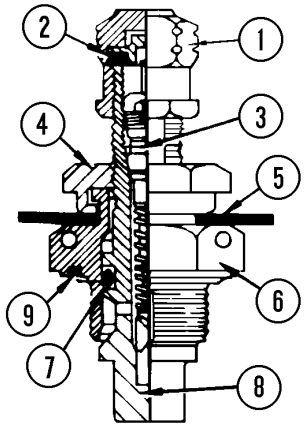


FIGURE 3-32. CHARGING VALVE

7. Connect the charging kit to the charging valves. Open the regulator and charge the accumulators simultaneously to 1400 psi (9.8 MPa).

NOTE: When charging the accumulators, allow adequate time for the system to fully charge. Insure all oil has returned from the accumulators to the hydraulic tank.

8. Shut off charging kit and check pressure gauge reading. If gauge does not maintain 1400 psi (9.7 MPa) continue charging procedure until pressure is stabilized.
9. Remove charging kit and tighten small hex nut on charging valve to **4 ft.lbs. (5.4 N.m)** torque.

NOTE: If a new charging valve was installed, the valve stem must be seated as follows:

   a. Tighten small hex swivel nut to **10.5 ft.lbs. (14.2 N.m)** torque.
   b. Loosen swivel nut.
   c. Retighten swivel nut to **10.5 ft.lbs. (14.2 N.m)** torque.
   d. Again, loosen swivel nut.
   e. Finally, tighten swivel nut to **4 ft.lbs. (5.4 N.m)** torque.

10. Install charging valve cap (1) and tighten finger tight. Install charging valve guard and tighten capscrews to **25 ft.lbs. (33.9 N.m)** torque.
11. Close brake accumulator bleed valves.
12. If necessary, recharge the smaller brake accumulators. Refer to Bladder Accumulator Charging Procedure.
13. Operate truck and check brake system operation.

BRAKE SYSTEM CHECKOUT

NOTE: Unless otherwise specified, perform the following checks with engine running, rest switch in the ON position, park brake on and brake lock released.

9. Apply brake lock. Turn the parking brake switch to the OFF position:
   - ❑ Verify park brake indicator lamp is off.
   - ❑ Verify park brake release pressure (gauge installed in "PK2" port in hydraulic cabinet) is 2700 ± 100 psi (18,615 ± 690 kPa).

* *Record on data sheet.*

10. Cycle park brake several times to assure crisp application and release of oil pressure when switch is OFF.
11. Place parking brake switch in the ON position and release the brake lock.
12. Install a 3000 psi (20,685 kPa) pressure gauge at the "LBP" (9, Figure 4-5) and "RBP" (8) test ports on the junction block at the left front corner of the rear axle housing.
13. Very slowly depress brake pedal. Force feedback of pedal on foot should be smooth with no abnormal noise or mechanical roughness.
14. Slowly depress brake pedal:
    - ❑ Verify brake indicator lamp and stop lights illuminate at 75 ± 5 psi (517 ± 34 kPa) rear brake pressure.

* *Record on data sheet.*

15. Quickly and completely depress pedal. Verify that within 1 second after brake is applied:
    - ❑ Left rear brake pressure ("LBP", 9) reads 2400 ± 75 psi (16,545 ± 517 kPa).
    - ❑ Right rear brake pressure ("RBP", 8) reads 2400 ± 75 psi (16,545 ± 517 kPa).
    - ❑ Both pressures must remain above their minimum values for a minimum of 20 seconds.

* *Record on data sheet.*

16. Release pedal, assure that each circuit's pressure is zero.
17. Move the two 3000 psi (20,685 kPa) gauges to the test ports on the front brake backplates.
18. Quickly and completely depress pedal. Verify that within 1 second after brake is applied:
    - ❑ Left front brake pressure reads 2400 ± 75 psi (16,545 ± 517 kPa)
    - ❑ Right front brake pressure reads 2400 ± 75 psi (16,545 ± 517 kPa).
    - ❑ Both pressures must remain above their minimum values for a minimum of 20 seconds.

* *Record on data sheet.*

19. Release pedal, assure that each circuit's pressure is zero.
20. Remove gauges from front brake test ports and install at the "BR" and "BF" test ports in the hydraulic cabinet.
21. Disconnect circuit #52B wire on the coil of the brake lock solenoid (SV1) (14, Figure 4-1). Install a jumper wire between circuits #33 and #33W at the brake warning delay timer (27, Figure 4-1).
22. Apply the brake lock; the brake lock degradation switch should close:
    - ❑ Verify the warning buzzer turns on.
    - ❑ Verify the low brake pressure warning lamp illuminates.
23. Depress the brake pedal until the warning stops.
24. **Very slowly**, release the brake pedal while observing the "BR" pressure gauge:
    - ❑ Verify warning resumes when pressure drops to 1000 ± 25 psi (6,895 ± 172 kPa).

* *Record pressure reading when alarm resumes.*

25. Reconnect #52B wire at brake lock solenoid coil. Remove jumper between circuits #33 and #33W.
26. Cycle brake lock several times to assure crisp shift of solenoid valve and release of oil pressure. Verify stop lights illuminate when brake lock is on.
27. Apply brake lock and read brake pressure at "BR" gauge:
    - ❑ Pressure should be 2000 ± 100 psi (13,788 ± 690 kPa).

* *Record on data sheet.*

28. If above pressure is not correct, remove plug on end of PR valve (13, Figure 4-1) and adjust to obtain correct pressure. Reinstall plug after adjustment.

SECTION J5

WET DISC BRAKE ASSEMBLY

INDEX

WET DISC BRAKE ASSEMBLY J5-3

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WET DISC BRAKE BLEEDING PROCEDURE J5-16

17. Follow procedures in Floating Ring Seal Assembly/Installation to install seal assembly in cavities in the back plate and seal carrier.

18. Install seal carrier on back plate. Secure in place with six 1/2 UNC x 0.75 in. socket head capscrews to retain seal carrier in position until brake assembly is installed on the truck.

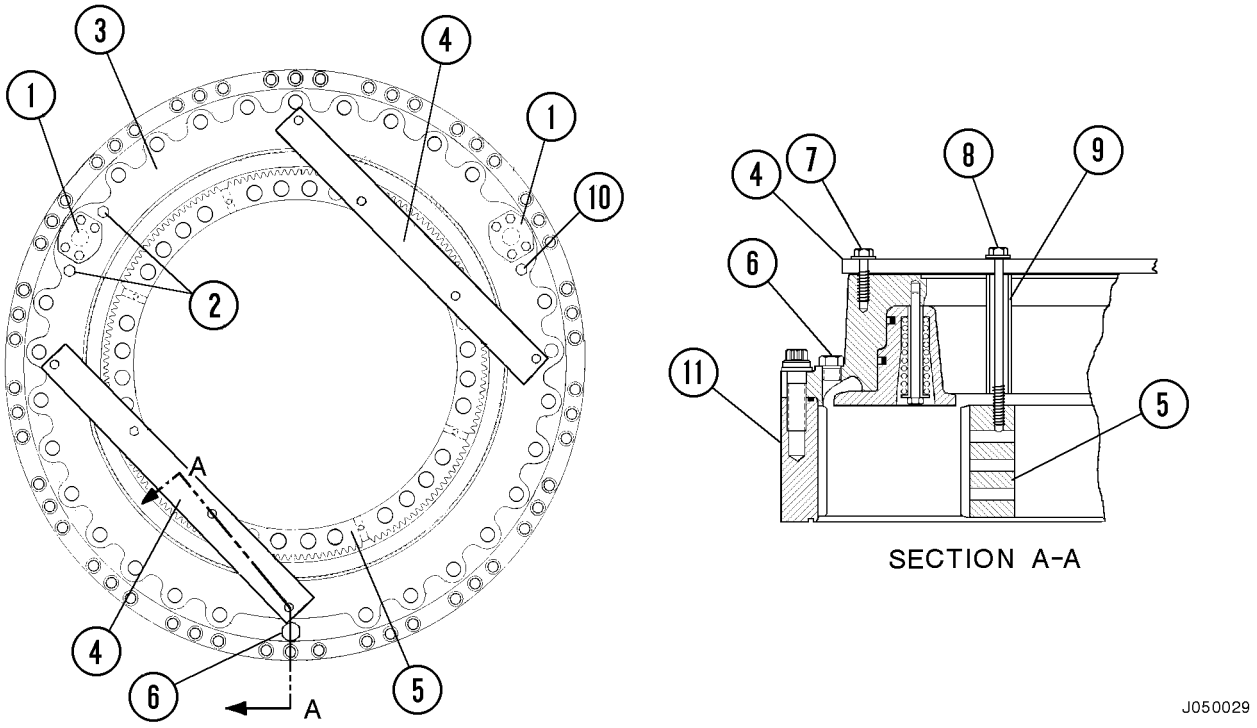


FIGURE 5-9. INNER GEAR INSTALLATION

1. Cooling Oil Port
2. Brake Apply Pressure Ports
3. Piston Housing
4. Shipping Bar
5. Inner Gear
6. Drain Plug
7. Capscrew & Washer
8. Capscrew & Washer
9. Spacer
10. Wear Indicator Installation Port
11. Ring Gear

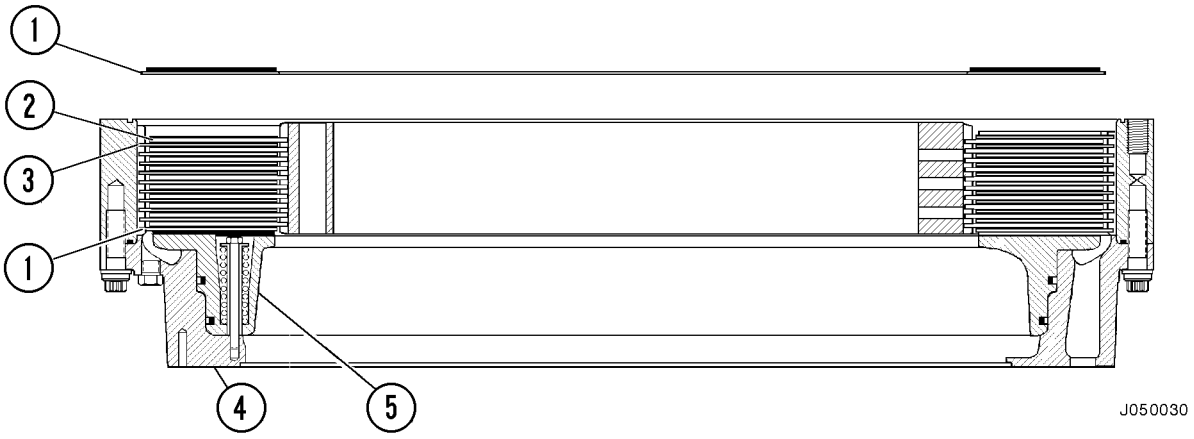


FIGURE 5-10. DISC PACK INSTALLATION

1. Damper
2. Friction Disc
3. Separator Plate
4. Piston Housing
5. Piston

Gear Removal:

If the rotor shaft gear (4, Figure 7-1) is worn, damaged or otherwise requires removal, follow the procedures below:

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

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

Installation - Parking Brake

Gear Installation:

If the wheel motor rotor shaft gear was removed, install gear prior to parking brake installation.

1. Thoroughly clean gear (4, Figure 7-1) and shaft. Inspect splines and remove burrs, etc. that may interfere with installation.
2. Heat gear to 536°F (280°C). Install immediately on shaft; gear must be **fully seated against shoulder** on rotor shaft.
3. Install retainer plate (5), washer and capscrew (6). Tighten capscrew to **440-495 ft. lbs. (595-670 N.m)**.

Park Brake Installation:

NOTE: Two oil supply ports are provided on the lower half of the parking brake assembly. Install the O-ring fitting for attaching the supply hose (7, Figure 7-1) to the lowest port, depending on whether the brake is to be installed on the right or left wheel motor. Install an O-ring plug in the unused port.

1. Install two guide studs in wheel motor end frame to guide brake assembly into position. Be certain mating surfaces are clean and free of burrs.
2. Lift parking brake into position for installation. Note proper orientation depending on whether brake is to be installed on a left or right wheel motor. (Bleeder screw at top of brake will be tilted toward front of truck.)
3. Slide assembly over guide studs and gear on wheel motor rotor shaft.
4. Install capscrews and lockwashers (9, Figure 7-1) Tighten evenly to be certain brake housing is properly seated on the wheel motor. Tighten to **220 ft. lbs. (298 N.m)** final torque.
5. Install brake oil supply hose (7). Remove lifting equipment.
6. Refer to Park Brake Bleeding Procedure in this chapter and bleed air from brake apply line and housing.
7. Reinstall all ducts removed.

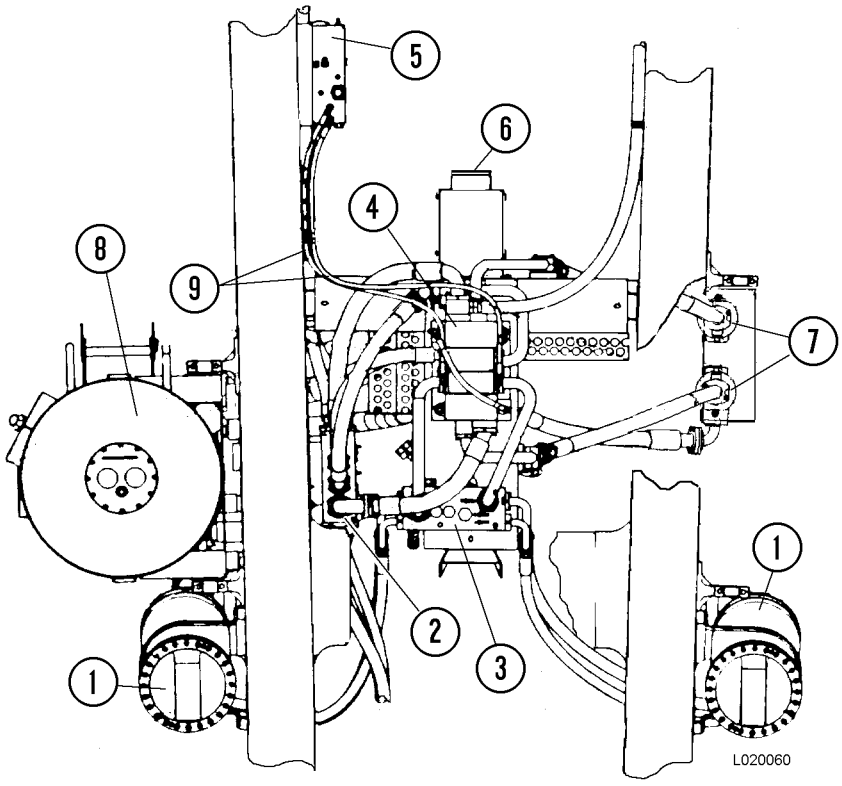


FIGURE 2-2. HOIST PUMP PIPING (Top View)

1. Hoist Cylinders
2. Brake/Hoist Return Oil Manifold
3. Overcenter Manifold
4. Hoist Valve
5. Bleeddown Manifold
6. Pump Drive Shaft
7. Hoist Circuit Filters
8. Hydraulic Tank
9. Hoist Valve Pilot Circuit Hoses

7. Attach a suitable lifting or support device to the hoist pump capable of handling approximately 250 lbs (113 kg). Attach a support to the front end of the steering pump to hold it in place during removal of the hoist pump.
8. Remove the four capscrews (2, Figure 3-2) securing the hoist pump to the front support bracket. Remove the six capscrews holding the support bracket (6) to the pump module support. Remove support bracket.
9. Make sure the lifting and support devices are in place on both pumps. Loosen (but do not remove) the rear support bracket capscrews holding the steering pump. Lower the pumps allowing hoist pump to come down further than steering pump.
10. Remove the four steering/brake pump mounting capscrews (4). Slide hoist pump forward to disengage the splines of drive coupling (9, Figure 3-3) from the steering pump.
11. Move pump to a clean work area for disassembly.

Installation

NOTE: The following assumes the steering pump is already in position on the truck.

1. Install O-ring (16, Figure 3-3) to steering pump (11). Install coupler (9) to hoist pump.

⚠WARNING

The hoist pump weighs approximately 310 lbs (140 kg). The hoist and steering pump together weigh approximately 560 lbs (254 kg). Use a suitable lifting or support device that can handle the load safely.

2. Attach a suitable lifting or support device to the hoist pump capable of handling approximately 250 lbs (113 kg). Move pump into position in truck.
3. Lubricate the steering pump spline shaft and align with coupling (9). Install hoist pump to steering pump and install capscrews (10) with hardened washers and tighten to standard torque. Raise pumps up into position.
4. Attach front support bracket to the pump module support structure and to the pump with capscrews, lockwashers and nuts. Tighten capscrews to standard torque.
5. Connect hoist pump drive flange to drive shaft with capscrews, lockwashers and nuts. Tighten to standard torque.
6. Tighten steering pump support bracket (7, Figure 3-2) capscrews to standard torque.
7. Uncap inlet and outlet hoses and install to pumps using new O-rings. Tighten capscrews securely.
8. Service the hydraulic tank with C-4 type hydraulic fluid. Refer to Hydraulic Tank in this section for filling instructions.
9. Open the three suction line shut-off valves. Loosen capscrews (at the pump) on suction hoses to bleed trapped air. Then loosen capscrews (at the pump) on pressure hoses to bleed any trapped air. Tighten all capscrews securely.

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

10. Reinstall blower duct and support bracket.

TROUBLESHOOTING GUIDE (HOIST PUMP)

TROUBLE	POSSIBLE CAUSE	SUGGESTED CORRECTIVE ACTION
1. Sandblasted band around pressure plate bores 2. Angle groove on face of pressure plate 3. Lube groove enlarged and edges rounded 4. Dull area on shaft at root of tooth 5. Dull finish on shaft in bearing area 6. Sandblasted gear bore in housing	1. Abrasive wear caused by fine particles. a. Dirt (fine contaminants, not visible to the eye)	1. Was clean oil used? 2. Was filter element change period correct? 3. Were correct filter elements used? 4. Hoist cylinder rod wiper and seals in good condition? 5. Cylinder rods dented or scored? 6. Was system flushed properly after previous failure?
1. Scored pressure plates. 2. Scored shafts 3. Scored gear bore	2. Abrasive wear caused by metal particles a. Metal (coarse)contaminants, visible to the eye	1. Was system flushed properly after previous failure? 2. Contaminants generated elsewhere in hydraulic system? 3. Contaminants generated by wearing pump components?
1. Any external damage to pump 2. Damage on rear of drive gear and rear pressure plate only	3. Incorrect installation	1. Did shaft bottom in mating part? 2. Any interference between pump and machine?
1. Eroded pump housing 2. Eroded pressure plates	4. Aeration-Cavitation a. Restricted oil flow to pump inlet b. Aerated Oil	1. Tank oil level correct? 2. Oil viscosity as recommended? 3. Restriction in pump inlet line? 4. Air leak in pump inlet line? 5. Loose hose or tube connection?
1. Heavy wear on pressure plate 2. Heavy wear on end of gear	5. Lack of oil	1. Was oil level correct? 2. Any leaks in piping inside tank?
1. Housing scored heavily 2. Inlet peened and battered 3. Foreign object caught in gear teeth	6. Damage caused by metal object	1. Metal object left in system during initial assembly or previous repair? 2. Metal object generated by another failure in system?
1. Pressure plate black 2. O-rings and seals brittle 3. Gear and journals black	7. Excessive Heat	1. Metal object left in system during initial assembly or previous repair? 2. Was relief valve setting too low? 3. Was oil viscosity correct? 4. Was oil level correct?
1. Broken shaft 2. Broken housing or flange	8. Over Pressure	1. Relief valve setting correct? 2. Did relief valve function?

Relief Valves

The 4000 psi (28. MPa) relief valve limits maximum steering circuit pressure by returning oil to the hydraulic tank through internal passages in the bleeddown manifold.

The 600 psi (4.1 MPa) relief valve provides maximum pressure protection for the oil returning to the hydraulic tank.

Hoist Limit Solenoid

The body-up limit solenoid is a 3-way valve, activated by the hoist limit switch (refer to Section D for additional information) when the hoist cylinders approach the maximum extension limit. When activated, the solenoid will close the power up pilot line to the hoist valve from the hoist pilot valve mounted in the hydraulic cabinet.

Pilot operated check valve (30, Figure 4-4) is opened by the power down pilot pressure line (19) to allow oil in the raise port to bypass the body-up limit solenoid (24) for the initial power down operation while the solenoid is activated by the hoist limit switch.

Refer to Section D, Electrical System (24VDC) for adjustment procedure of the hoist limit switches.

Accumulators

The steering accumulators (5, Figure 4-1) are a floating piston type. The top side of the accumulators are charged to 1400 psi (9.7 MPa) with pure dry nitrogen with the piston at the bottom.

Oil entering the accumulators pushes the piston upward compressing the nitrogen on the top side of the piston. The nitrogen pressure increases directly with steering circuit pressure. When steering circuit pressure reaches 3025 psi (20.9 MPa) the unloader valve will unload the pump. The accumulators will contain a quantity of oil under pressure and held by check valves in the bleeddown manifold, available for steering the truck. When system pressure drops to 2750 psi (19.0 MPa) the pump output will again increase, to refill the accumulators and increase steering system pressure. The accumulators also provide oil, for a limited period of time, to be used in case the pump becomes inoperative.

Low Precharge Warning Switch

Pressure switches located in the top of each accumulator monitor nitrogen pressure and are used to activate the accumulator precharge warning light if the nitrogen pressure drops below 1100 psi (7.6 MPa).

The switches monitor nitrogen pressure when the key switch is turned ON and before the engine is started. If nitrogen pressure is too low, the warning lamp turns on - a latching circuit prevents the warning lamp from turning off when the engine is started and steering system pressure compresses the nitrogen remaining in the accumulator.

⚠WARNING

Do not operate the truck with less than 1100 psi (7.6 MPa) nitrogen precharge in the accumulator. Low nitrogen pressure may not provide an adequate supply of steering system oil in some emergency conditions. If the low precharge warning light remains on, check accumulator precharge pressure and recharge if necessary.

High Pressure Filters

The high pressure filter (10, Figure 4-1) filters oil for the steering and brake circuits.

If the filter element becomes restricted, a warning indicator is activated at 40 psi (276 kPa) and oil will bypass the element at 50 psi (345 kPa).

Refer to Section L, Hydraulic System Filters, for further information regarding the various system filters and maintenance procedures.

Quick Disconnect Ports

Ports on the bleeddown manifold allow service personnel to connect an external hydraulic supply to allow operation of the truck steering and service brake systems if the steering/brake pump, engine etc. is not operational.

The external supply is connected to port 13, Figure 4-4 and the return is connected to port 15. This feature should only be used for emergency use to allow operation of the truck to return to the shop for service or move the truck out of haul road traffic.

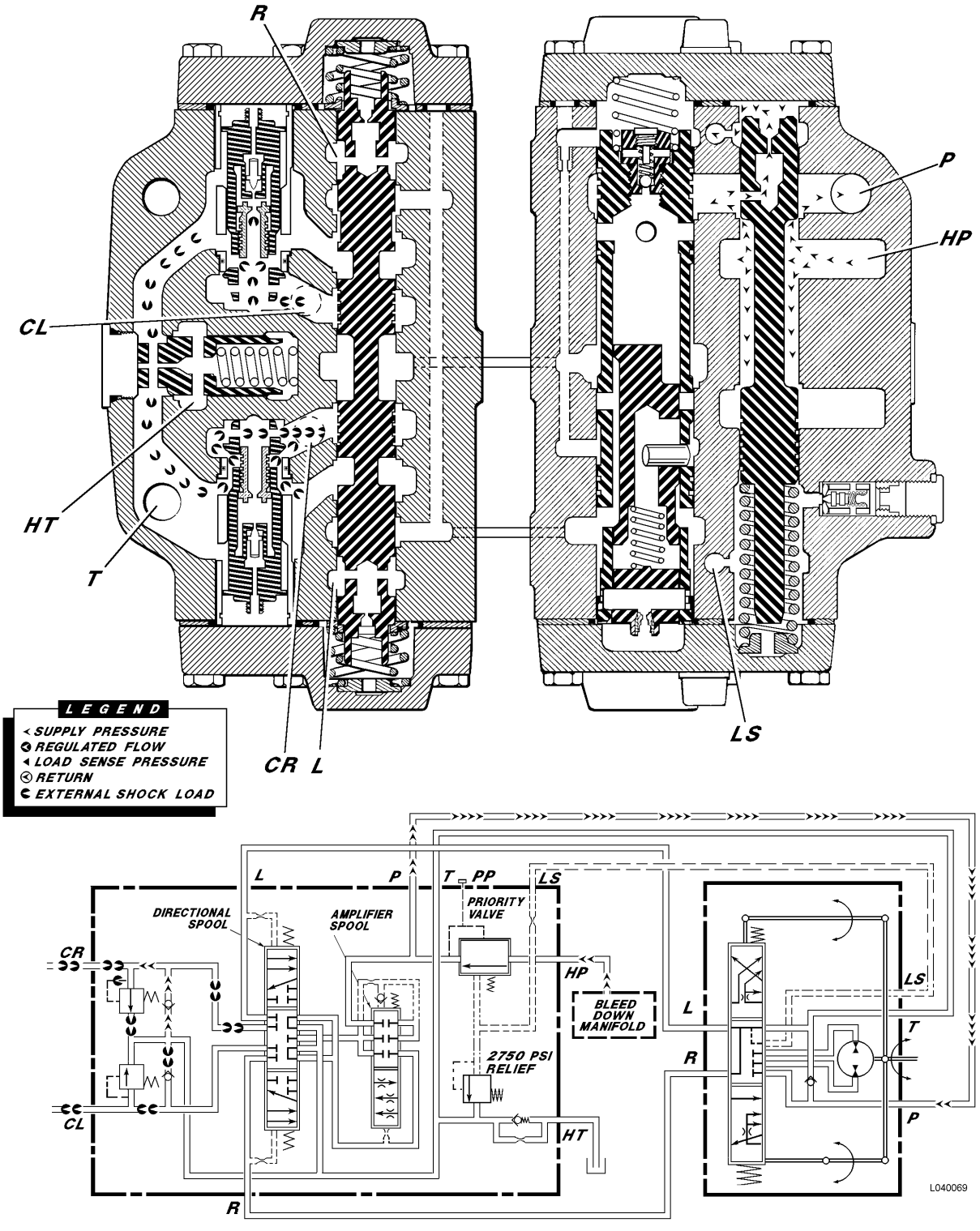


FIGURE 4-9. FLOW AMPLIFIER
NO STEER - EXTERNAL SHOCK LOAD

4. Remove end cover (4) and O-ring (2, Figure 5-5).

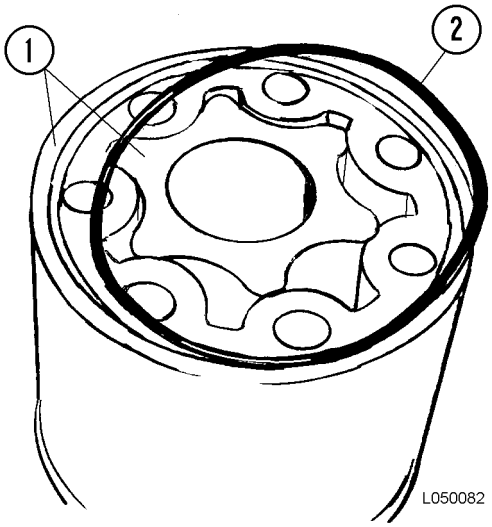


FIGURE 5-5. END COVER REMOVAL

1. Gear Wheel Set 2. O-Ring

5. Remove outer gear of gear wheel set (1) and O-ring between gear set and distribution plate.
6. Lift inner gear off cardan shaft.
7. Remove cardan shaft (11, Figure 5-7), distribution plate (15) and O-ring (14).
8. Remove threaded bushing (4) and ball (3).
9. With valve housing positioned with the spool and sleeve vertical, carefully lift spool assembly out of housing bore.

⚠ IMPORTANT ⚠

If housing is not vertical when spool and sleeve are removed, pin (9) may slip out of position and trap spools inside housing bore.

10. Remove O-ring (5), kin ring (6) and bearing assembly (7).
11. Remove ring (8) and pin (9) and carefully push inner spool out of outer sleeve.
12. Press the neutral position springs (10) out of their slot in the inner spool.
13. Remove the dust seal (2, Figure 5-6) using a screwdriver. Take care not to scratch or damage the dust seal bore.

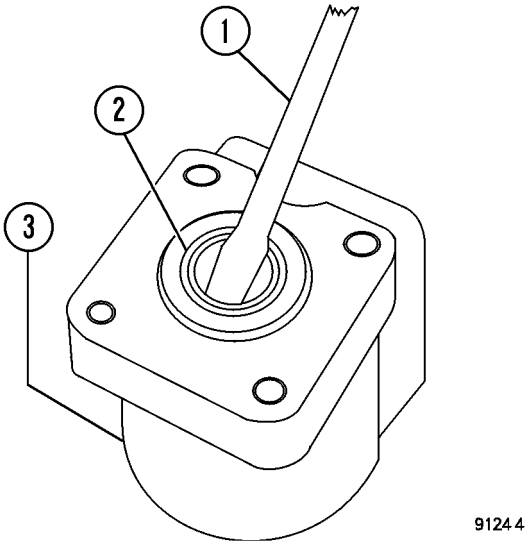


FIGURE 5-6. DUST SEAL REMOVAL

1. Screwdriver 3. Housing
2. Dust Seal

Cleaning and Inspection - Steering Control Unit

1. Clean all parts carefully with fresh cleaning solvent.
2. Inspect all parts carefully and make any replacements necessary.

NOTE: All O-rings, seals and neutral position springs should be replaced with new. Prior to reassembly thoroughly lubricate all parts with clean type C-4 hydraulic oil.

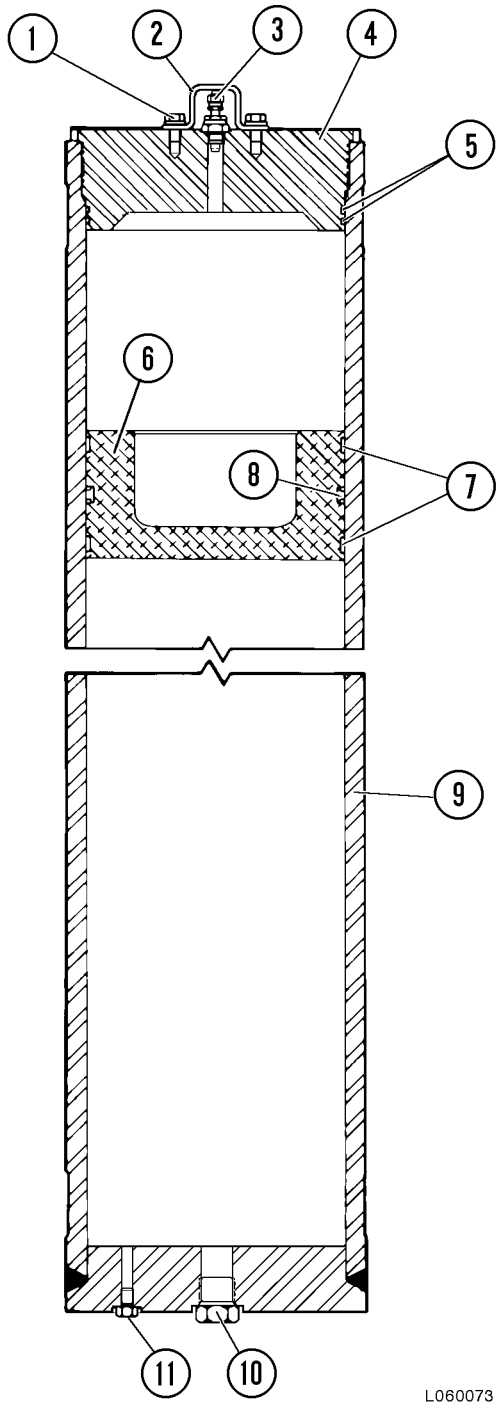


FIGURE 6-4. ACCUMULATOR ASSEMBLY

1. Capscrew
2. Cover
3. Charging Valve
4. Gland
5. O-ring & Backup Ring
6. Piston
7. Bearing
8. "T" Ring Seal
9. Housing
10. Plug (or Adaptor)
11. Plug

Disassembly - Accumulators

1. Remove charging valve (3, Figure 6-4).
2. Remove gland (4).

Note: Figure 6-5 illustrates a tool that can be fabricated locally to aid in removing the gland.

3. Remove plugs and/or adaptor (10 & 11). Using a round rod, push piston (6) out of accumulator.
4. Remove piston rings (7) and seal (8).

Cleaning and Inspection - Accumulators

1. Clean parts using fresh cleaning solvent, lint free wiping cloth and filtered compressed air. All parts must be absolutely free of any foreign matter larger than 3 microns.
2. Inspect piston for damage. If scored or otherwise damaged, replace with a new part.
3. Minor defects in the housing bore may be corrected by honing.
   a. Measure the bore at several places along the length of the housing. Make two measurements, 90° apart at each point to verify tube is not out-of-round.

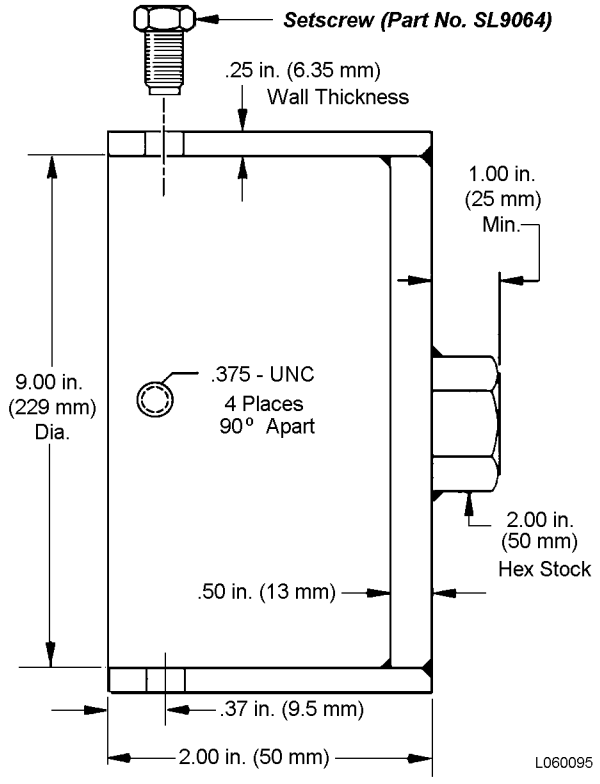


FIGURE 6-5. GLAND REMOVAL TOOL
(Fabricate Locally)

3. Move the steering pump into position. Engage steering pump shaft with hoist pump spline coupler.
4. Install rear support bracket with capscrews (6, Figure 6-12). Do not tighten capscrews at this time.
5. Align capscrew holes and install steering pump mounting capscrews (4). Tighten mounting capscrews to standard torque. Tighten rear support capscrews to standard torque.
6. Remove plugs from pump inlet and outlet ports. Remove caps from inlet and outlet lines and install to steering pump using new O-rings. Tighten capscrews securely. Do not connect steering pump drain hose to the steering pump, at this time (see Step 7).
7. Remove case drain fitting from top of pump housing and **add clean C-4 oil to pump through opening until steering pump housing is full.** This may require 2 - 3 qt. (2 - 3 L) of oil.
8. Uncap the case drain line, connect to steering pump fitting and tighten case drain line.
9. Replace hydraulic filter elements. Refer to Section L, Hydraulic System Filters.

⚠ IMPORTANT ⚠

Use only Komatsu filter elements, or elements that meet the Komatsu hydraulic filtration specification of Beta 12 = 200.

10. Open shut-off valve in steering pump suction line completely.
11. With the body down and the engine shut-off, fill the hydraulic tank with clean C-4 hydraulic fluid (as specified on the truck Lubrication Chart) to the upper sight glass level.
12. With suction line shut-off valve open, loosen suction (inlet) hose capscrews (at the pump) to bleed any trapped air. Tighten hose connection capscrews to standard torque.

⚠ IMPORTANT ⚠

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

13. If required, top-off the oil level in the hydraulic tank, to the level of the upper sight glass.
14. In the hydraulic components cabinet, open both brake accumulator needle valves completely to allow the steering pump to start under a reduced load.
15. Move the hoist pilot control valve to the FLOAT position.
16. Start the truck engine and operate at low idle for one (1) to two (2) minutes.

⚠ WARNING

Do not allow the engine to run with the needle valves in the open position for longer than this recommendation: excessive hydraulic system heating will occur.

Do Not start any hydraulic pump for the first time after an oil change, or pump replacement, with the truck dump body raised. Oil level in the hydraulic tank may be below the level of the pump(s) causing extreme pump wear during this initial pump start-up.

17. Shutdown the engine. Fully close both brake accumulator needle valves in the hydraulic components cabinet.
18. Verify that the oil level in the hydraulic tank is at the upper sight glass when the engine is off and the body is resting on the frame. If the hydraulic oil level is not at the upper sight glass, follow service manual instructions for filling/adding oil.
19. Start engine and check for proper pump operation. If necessary, refer to Steering Circuit Check-out and Adjustment Procedure in Section L10, or the Troubleshooting Chart at the end of this section.

TROUBLESHOOTING CHART
(STEERING CIRCUIT)

POSSIBLE CAUSES	SUGGESTED CORRECTIVE ACTION
TROUBLE: Slow steering, hard steering or loss of power assist	
Overloaded steering axle	Reduce axle loading
Malfunctioning relief valve preventing adequate system pressure build-up	Check system pressure. Adjust or replace relief valve.
Worn or malfunctioning pump	Replace pump.
Restricted high pressure filter or suction strainer	Replace filter element or clean strainer.
TROUBLE: Drift - truck veers slowly in one direction.	
Rod end of cylinder slowly extends without turning the steering wheel	A small rate of extension may be normal on a closed center system.
Worn or damaged steering linkage	Inspect and replace linkage if necessary. Check alignment or toe-in of the front wheels.
TROUBLE: Wander - truck will not stay in straight line	
Air in system due to low oil level, pump cavitation, leaking fitting, pinched hoses, etc.	Correct oil supply problem or bleed air.
Loose cylinder piston	Repair or replace steering cylinder.
Broken centering springs (spool valve, steering valve)	Repair or replace steering control unit.
Worn mechanical linkage	Repair or replace.
Bent linkage or cylinder rod	Repair or replace defective components.
Severe wear in steering control unit	Repair or replace steering control unit.
TROUBLE: Slip - a slow movement of steering wheel fails to steer front wheels	
Leakage of steering cylinder piston seals	Repair or replace steering cylinder
Worn steering control unit meter	Replace steering control unit.
TROUBLE: Spongy or soft steering	
Low oil level	Service hydraulic tank and check for leakage.
Air in hydraulic system. Probably air trapped in cylinders or lines.	Bleed air from system.

The secondary low pressure relief is located between the low pressure core and the outlet to the brake cooling circuit. It provides for pressure relief if pressure spikes occur in the low pressure passage area.

The load check allows free flow from the inlet to the high pressure core and prevents flow from the high pressure core to the inlet.

The anti-void check valve allows free flow from the low pressure core to the high pressure core and prevents flow from the high pressure core to the low pressure core.

Spool Sections - Hoist Valve

Work Ports (Rear) Spool Section

The rear spool section of the hoist valve consists of the following components:

- Pilot ports
- Main spools
- Work ports
- Check poppets

The pilot ports are located in the spool section cover. These ports provide connections for a pilot line to the hoist pilot valve. Each work port has a corresponding pilot port.

The work ports provide for a line connection between the spool section and the hoist cylinders. One main spool for each work port is spring biased at both end to block the work port from the high and low pressure cores when there is no flow through the spool cross holes.

When there is flow through the pilot ports to the spools, a positive differential pressure at the top of the spool will overcome the bottom spring bias and the spool will shift to connect the work port to the high pressure core.

When there is flow from the main valve work port to the pilot port through the cross-holes, a positive differential pressure at the bottom of the spool will overcome the top spring bias and the spool will shift to connect the work port to the low pressure core.

The check poppets located in the spool section permit free flow from the work port to the pilot port and restrict flow from the pilot port to the work port. These check poppets control spool response and spool movements during void conditions.

Tank Ports (Front) Spool Section

The primary low pressure valves are located in the front spool section of the hoist valve. These valves maintain back pressure on the low pressure passage and direct the hoist cylinder return oil back to the hydraulic tank.

Hoist Pilot Valve

The hoist pilot valve (Figure 7-3) is mounted in the hydraulic components cabinet behind the operator's cab. The hoist pilot valve spool is spring centered to the neutral position and is controlled directly by the operator through a lever mounted on the console between the operator and passenger seat. A cable connects the cab mounted lever to the hoist pilot valve in the hydraulic components cabinet.

When the operator moves the lever, the pilot valve spool moves and directs pilot flow to the appropriate pilot port on the hoist valve. The pilot flow causes the main spool to direct oil flow to the hoist cylinders.

The hoist pilot valve is equipped with a one way load check valve which allows free flow from the center passage to bridge core and prevents reverse flow. The valve also contains the power down relief valve (2), used to limit power down pressure to 1500 psi (10.4 MPa).

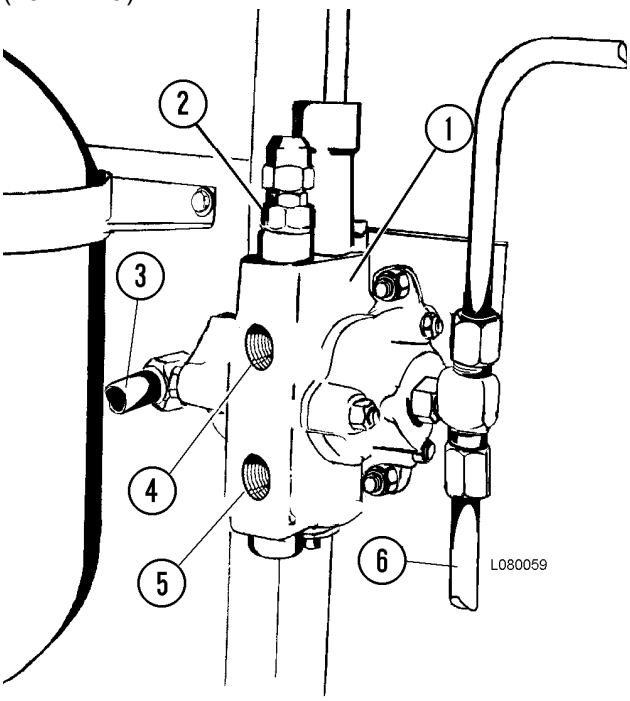


FIGURE 7-3. HOIST PILOT VALVE

1. Hoist Pilot Valve
2. Relief Valve
3. Supply Port
4. To Hoist Valve (Rod End)
5. To Hoist Valve (Base End)

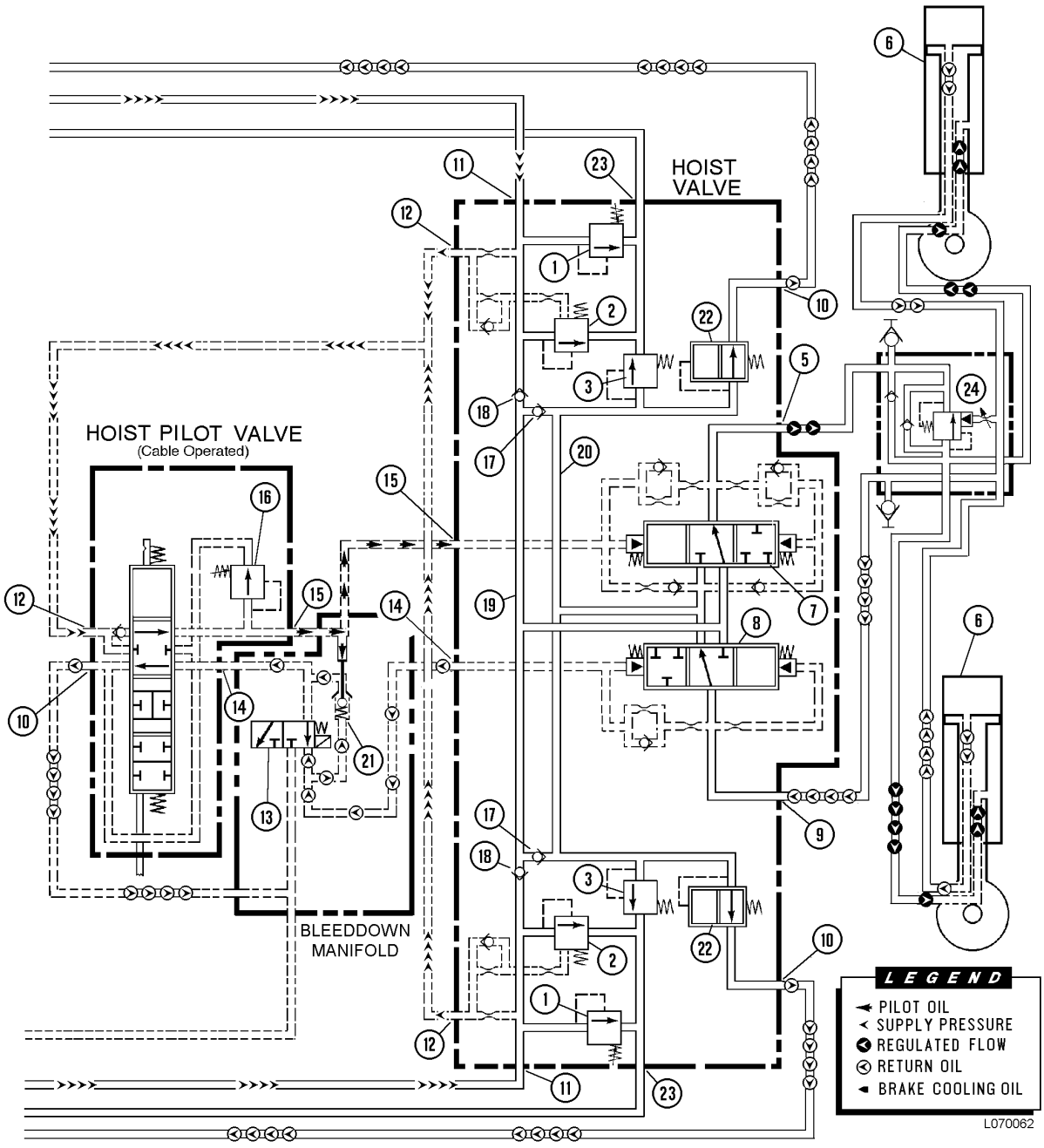


FIGURE 7-8. POWER DOWN POSITION

1. Hoist Relief Valve (2500 psi)
2. Flow Control Valve
3. Secondary Low Pressure Valve (250 psi)
4. Snubber Valve
5. Rod End Work Port
6. Hoist Cylinders
7. Rod End Spool
8. Head End Spool
9. Head End Work Port
10. Tank Return Port
11. Supply Port
12. Pilot Supply Port
13. Hoist Limit Solenoid
14. Raise Pilot Port
15. Down Pilot Port
16. Power Down Relief Valve (1500 psi)
17. Anti-void Check Valve
18. Load Check Valve
19. High Pressure Passage
20. Low Pressure Passage
21. Pilot Operated Check Valve
22. Primary Low Pressure Valve (26 psi)
23. Brake Cooling Circuit Port
24. Overcenter Manifold

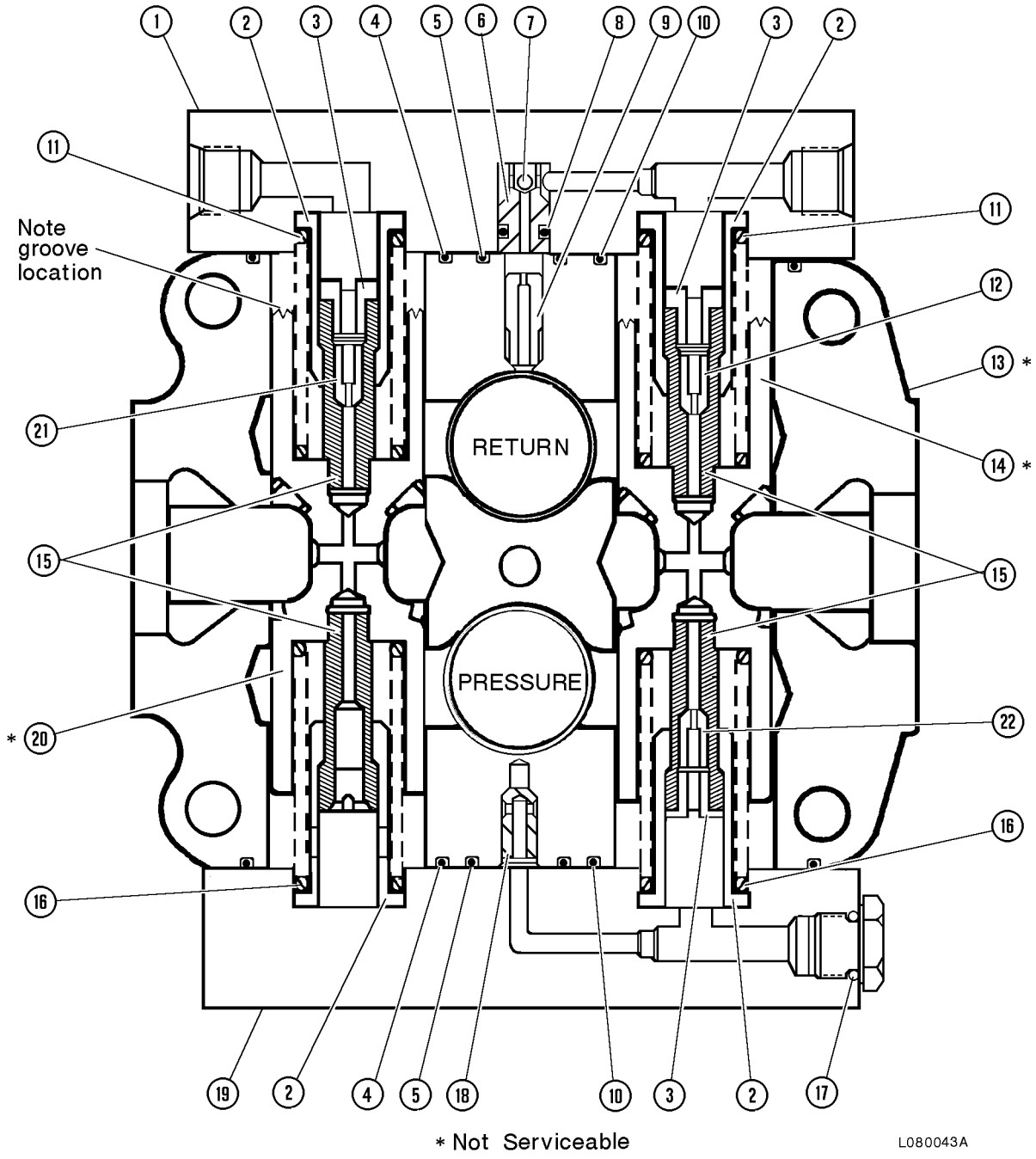


FIGURE 8-9. WORK PORTS SPOOL SECTION ASSEMBLY

1. Spool Cover
2. Spring Seat
3. Plug
4. O-Ring
5. O-Ring
6. Poppet
7. Ball
8. O-Ring
9. Restrictor Poppet
10. O-Ring
11. Spring
12. Restrictor Poppet (Red)
13. Spool Housing
14. Spool Assembly
15. Spool End
16. Spring (Blue)
17. O-Ring
18. Poppet
19. Spool Cover
20. Spool Assembly
21. Restrictor Poppet (Green)
22. Restrictor Poppet (White)

Disassembly - Hoist Cylinder

1. If removal of the hoist cylinder eye bearings is necessary, remove retainer ring (4, Figure 8-19) and press out bearing (5).
2. Mount the hoist cylinder in a fixture which will allow it to be rotated 180°.
3. Position cylinder with the cover (10, Figure 8-20) mounting eye at the top. Remove capscrews (11) and lockwashers retaining the cover to the housing (4).
4. Install two 0.88 in. dia. x 9 in. long, threaded capscrews into the two threaded holes in the cover (10). Screw the capscrews in evenly until the cover can be removed. Lift cover straight up until quill assembly (22) is clear. Remove O-ring (12) and backup ring (23).
5. Remove capscrews (7) and plate (5) attaching the rod bearing retainer (6) to the rod (1). Remove the seal (8).
6. Fabricate a retainer bar using a 1/4" x 1" x 18" (6 x 25 x 460 mm) steel flat. Drill holes in the bar to align with a pair of tapped holes spaced 180° apart in the housing. Attach bar to housing using capscrews (11).

NOTE: A retainer bar is required to prevent the first and second stage cylinders from dropping out when the housing is inverted.

7. Rotate the cylinder assembly 180°, to position the lower mounting eye at the top. Hook a lifting device to the eye on the rod (1) and lift the rod and third stage cylinder assembly out of the cylinder housing.

NOTE: As internal parts are exposed during disassembly, protect machined surfaces from scratches or nicks.

8. Rotate the cylinder housing 180°. Remove the retainer installed in step 6.
9. Fabricate a round disc 12.5 in. (318 mm) in diameter 0.38 in. (10 mm) thick with a 0.56 in. (14 mm) hole in the center. Align the disc over the second (2) and first (3) stage cylinders at the bottom of the cylinder housing.
10. Insert a 0.50 in. (13 mm) dia. x 53 in. (1350 mm) threaded rod through the top and through the hole in the disc. Thread a nut on the bottom end of the threaded rod below the disc.
11. Screw a lifting eye on the top end of the rod. Attach it to a lifting device and lift the second and first stage cylinders out of the housing.
12. Remove lifting tools from the second and first stage cylinder assembly.
13. Slide the second stage cylinder (2) down inside the first stage cylinder (3). Remove snap ring (9) from inside the first stage cylinder.
14. Remove second stage cylinder from first stage cylinder by sliding it out the top.
15. Remove all old bearings, O-rings, and seals from the hoist cylinder parts.

STEERING CIRCUIT FILTER

The steering circuit filter (Figure 9-2) is located on the inboard side of the fuel tank. The filter provides secondary filtering protection for hydraulic oil flowing to the bleeddown manifold valve for the steering and brake systems.

An indicator switch (1) is designed to alert the operator of filter restriction before actual bypass occurs. The switch contacts close at 35 ± 5 psid (240 ± 35 kPa) to actuate a warning lamp on the overhead display panel. Actual filter bypass occurs at 50 psi (345 kPa).

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

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

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

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

Filter Element Replacement

WARNING

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

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

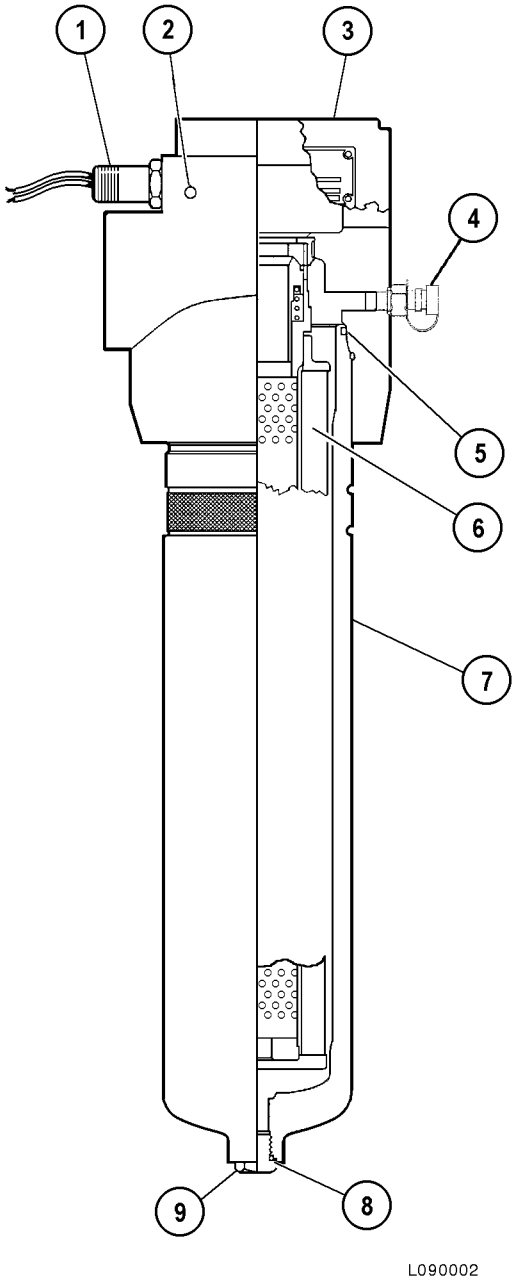


FIGURE 9-2. STEERING CIRCUIT FILTER

1. Indicator Switch
2. Setscrew
3. Head
4. Pressure Tap
5. O-Ring
6. Filter Element
7. Bowl
8. O-Ring
9. Drain Plug

Shock And Suction Valves

Equipment Requirements

The following equipment will be necessary to properly test the steering circuit shock and suction valves:

- Hydraulic schematic, refer to Section "R".
- Three 0-5000 psi (0-35,000 kPa) range calibrated pressure gauges and hoses.

Before the shock and suction valves in the steering circuit can be tested, steering system pressure must be increased to obtain sufficient pressure for testing. In addition, the steering relief valve pressure must be raised above the pressure required to actuate the shock and suction valves.

1. Install a 5000 psi (0-35,000 kPa) pressure gauge at "TP2" (3, Figure 10-2) in the steering bleeddown manifold.
2. Install a 5000 psi (0-35,000 kPa) gauge in each steering cylinder manifold test port. (Located on frame crossmember, under engine.)
3. Raise steering relief valve pressure as follows:
   a. Remove external plug (2, Figure 10-3) on flow amplifier valve, using an 8 mm allen wrench.
   b. Insert a 5 mm allen wrench into opening and gently bottom out adjustment (4) by turning clockwise.
4. Start the engine and allow steering system to build pressure.
5. While observing gauge at the "TP2" steering pressure test port, turn unloader valve adjustment (2, Figure 10-1) clockwise until approximately 3300 psi (22,750 kPa) is obtained.

NOTE: This pressure is near the pump compensator pressure setting and the pump may not unload, however it is not necessary for the pump to unload during this test.

6. While observing the two gauges installed on the steering manifold, steer the truck against the left stop.

   ❑ Pressure on one of the gauges should read 3100 psi (21,370 kPa).

**Record on Data Sheet*

7. Steer the truck to the opposite stop.

   ❑ The other gauge should read 3100 psi (21,370 kPa).

**Record on Data Sheet*

8. If pressure is incorrect during step 6 or 7, the shock and suction valves must be replaced.

NOTE: The shock and suction valves are only serviced as complete units, and cannot be adjusted while installed in the flow amplifier valve.

9. After the above test is complete, lower the steering relief pressure to 2750 psi (18,960 kPa) as follows:
   a. Steer full left or right and maintain a slight pressure against the steering wheel.
   b. Adjust steering relief valve, using the 5 mm allen wrench to obtain 2750 psi (18,960 kPa) on the gauge showing pressure.

**Record on Data Sheet*

10. After adjustment is complete, install plug (2, Figure 10-3) with O-ring (3) on valve body.
11. Reset unloader valve to specified unload pressure; back out the unloader valve adjustment screw completely counterclockwise.
12. Steer the truck to reduce pressure in the steering circuit and cause the pump to load.
    a. Observe increasing pressure readings on the gauge installed at the steering pressure, "TP2" test port (3, Figure 10-2).

    ❑ When pressure increases to 3000 to 3050 psi (20,680 to 21,025 kPa), adjust unloader valve by turning adjustment screw clockwise until the pump unloads and feedback pressure begins to decrease.

    b. Steer the truck again while observing the steering pressure feedback gauge.

    ❑ The pump must reload when pressure drops to 2750 psi (18,960 kPa) minimum.

**Record on Data Sheet*

13. If minimum reloading pressure in step 12. is not correct, repeat unloader valve adjustment.

**Record on Data Sheet*

NOTE: The critical pressure setting is the 2750 psi (18,960 kPa) when the pump loads. The unloading pressure follows the loading pressure adjustment and should occur at approximately 3025 psi (20,855 kPa).

SECTION M

OPTIONS AND SPECIAL TOOLS

INDEX

FIRE CONTROL SYSTEMS M2-1

SPECIAL TOOL GROUP M8-1

PAYLOAD METER III - ON BOARD WEIGHING SYSTEM. M20-1

RESERVE ENGINE OIL SYSTEM M31-1

Installation Procedure for Squib

After all testing has been completed and all test kit components removed, proceed to arm the system.

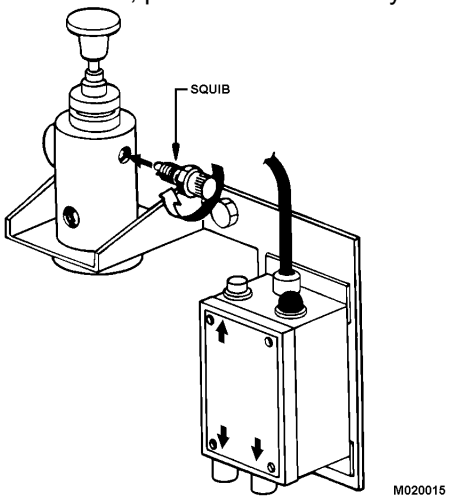


FIGURE 2-18.

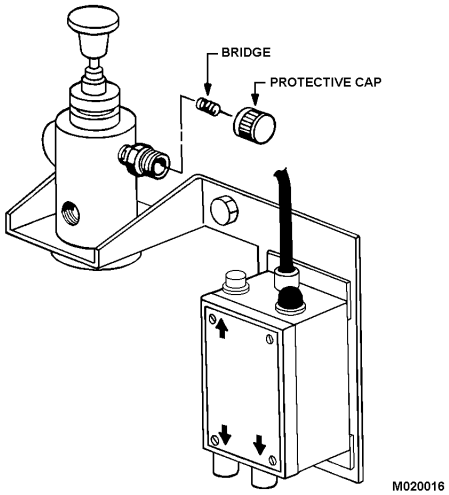


FIGURE 2-19.

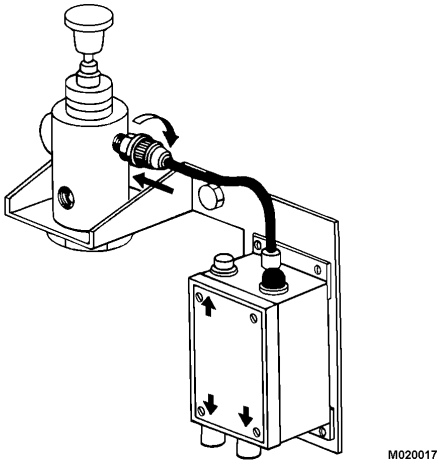


FIGURE 2-20.

Using wrench, insert squib into upper right inlet hole on actuator body and firmly tighten (Figure 2-18).

After installing squib into actuator body, loosen protective shipping cap from squib and remove bridge (Figure 2-19).

⚠CAUTION

Always install squib into actuator body first, before installing connector onto threaded body of squib. Possible injury could result if squib was actuated outside of actuator body.

Install squib connector onto threaded stud of squib (Figure 2-20). Hand tighten as firmly as possible.

Placing the Electric Detection & Actuation System Into Service

To place the electric detection and actuation system into service, proceed as follows:

1. Check all fasteners for tightness. Insure jam nut on actuator body is securely tightened.
2. Before installing actuator cartridge, push manual puncture lever several times to insure smooth operation.
3. Insert ring pin in hole and attach lead wire seal (See Figure 2-21).

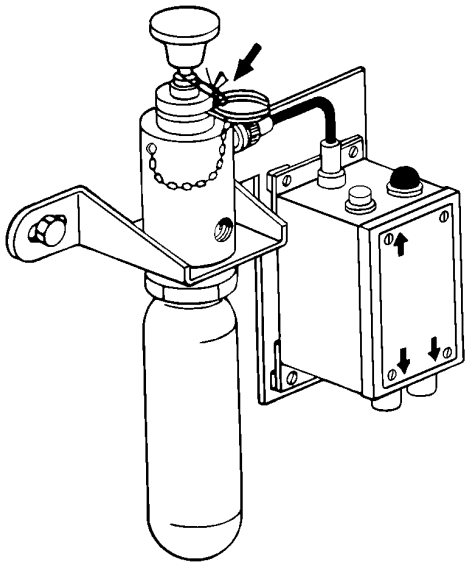
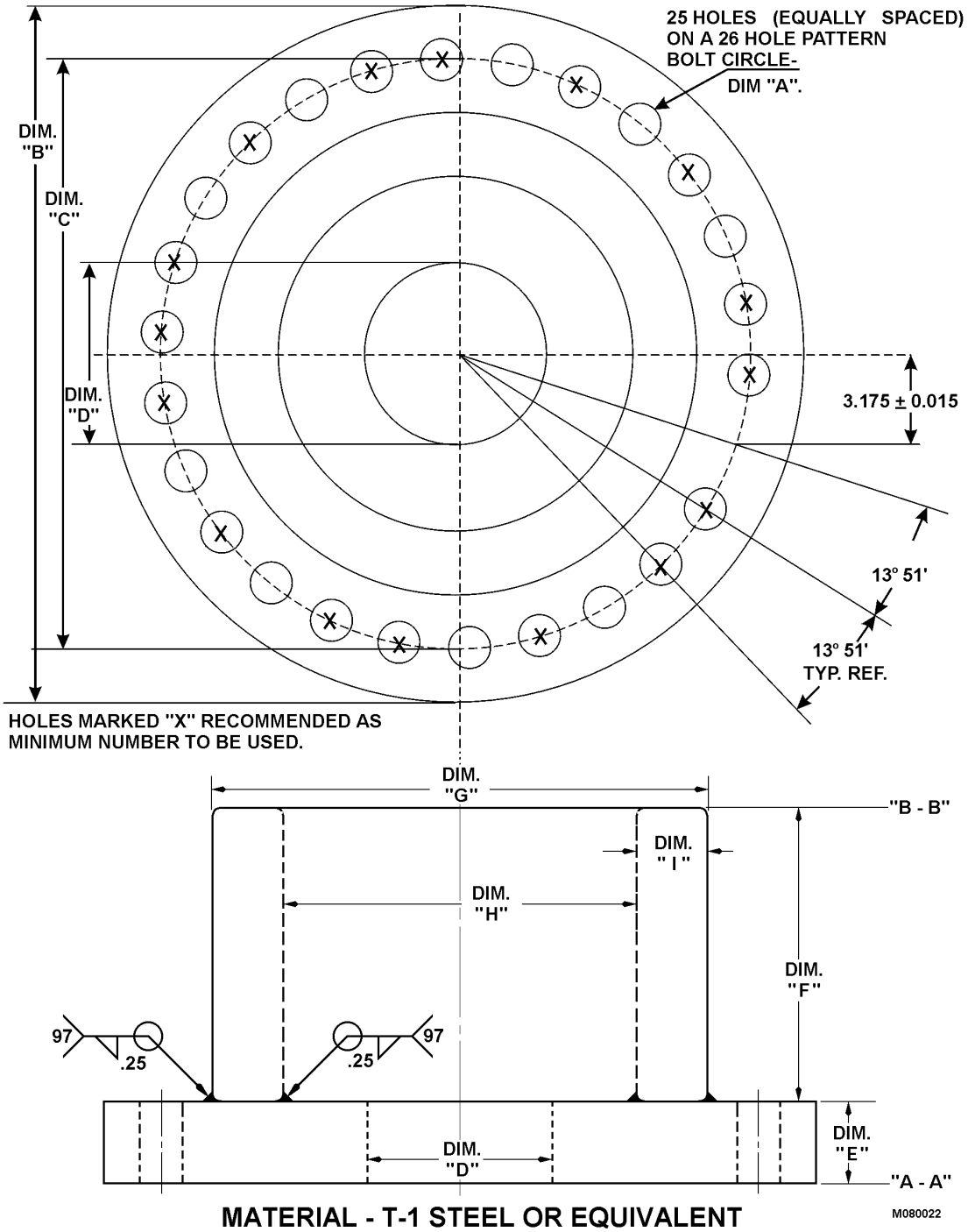


FIGURE 2-21. INSTALL ACTUATOR CARTRIDGE

4. Insert LT-5-R cartridge (PB0674) into lower actuator body and hand tighten firmly.
5. Record date that system was placed in service.



MATERIAL - T-1 STEEL OR EQUIVALENT

930E-2 SPINDLE REMOVAL TOOL

Dimension "A" - Bolt Hole Diameter
Dimension "B" - Plate Outside Diameter
Dimension "C" - Bolt Circle Diameter
Dimension "D" - Plate Inside Diameter
Dimension "E" - Plate Thickness
Dimension "F" - Cylinder Height
Dimension "G" - Cylinder Outer Diameter
Dimension "H" - Cylinder Inner Diameter
Dimension "I" - Cylinder Wall Thickness

NOTE: Surface A-A must be parallel to surface B-B within 0.062 in. after welding.

Wiring and Termination

Most of the PLMIII truck connections use a heavy-duty cable. This yellow multi-conductor cable uses a 16awg, finely stranded wire designed for continuous motion operations. The conductors are protected by a foil and braided shield for electronic noise immunity and physical strength. This wire is typically terminated with a #10 ring terminal. Most connections for the PLMIII system are made in the payload meter junction box.

TCI Outputs

The GE drive system on the 930E requires information from the payload meter regarding the loaded condition of the truck. There are three outputs from the payload meter to GE to indicate the relative load in the truck. 24 vdc on the 73MSL circuit indicates that the load is 70% of rated load. 24 vdc on the 73FSL circuit indicates the truck is 100% loaded. The 73OSL circuit is not currently used.

PC SOFTWARE OVERVIEW

PC Overview

The PC software has several basic functions:

- Configure the PLMIII system on the truck.
- Troubleshoot and check the PLMIII system.
- Download data from the PLMIII system.
- Analyze data from the payload systems.

Configuration, troubleshooting and downloading require a serial connection to the payload meter on the truck. Analysis can be done at any time without a connection to the payload meter.

Payload data is downloaded from several trucks into one database on the PC. The database can be queried to look at the entire fleet, one truck or truck model. The data can be graphed, reported, imported or exported. The export feature can take payload data and save it in a format that spreadsheet programs like Excel or word processing programs can easily import.

System Configuration

PLMIII needs to be configured for operation when it is first installed on the truck. This process requires several steps and uses the laptop computer to make the necessary settings. The setup procedure can be broken down into several steps:

- Connecting the laptop to the PLMIII system.
- Starting communications
- Setting the time & date
- Setting the truck type
- Setting the truck ID
- Setting the speedometer/display gauge units

Installing the PLMIII Software

The CD ROM containing the Payload Data Management (PDM) Software will automatically begin installation when it is inserted into the drive on the PC. If this does not happen, the software can be installed by running the Setup.exe program on the CD ROM.

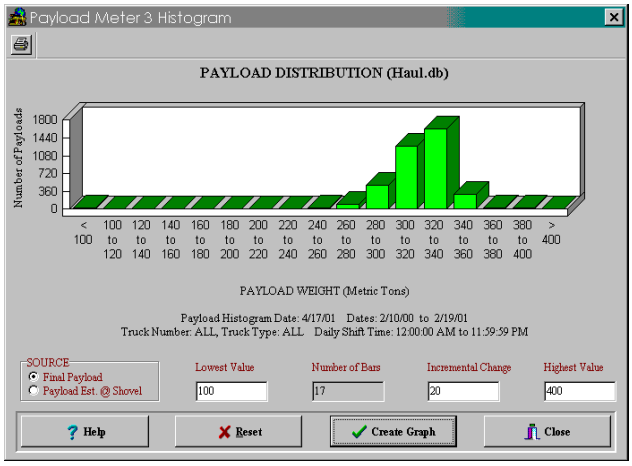
The minimum PC requirements for running the software is a Pentium 133Mhz with 64 MB of ram and at least 300 MB of free hard drive space available. For improved performance, the recommended PC would be a Celeron, AMD K6-2 or better processor with 128 MB of ram running at 400 Mhz. The PDM Software uses a powerful database to manipulate the large amounts of data gathered from the PLMIII system. Using a more powerful computer and added memory to run the software can result in a significant improvement in performance. The software is written to use a minimum 800x600 screen resolution.

Creating Graphs

The PLMIII software can generate graphs that quickly summarize payload data. These graphs can be customized for printing. Just like the reports, the graphs are generated from the query displayed on the “Payload Summary” screen. From the "Sorting on Time Range" example, the graph that is printed would only contain data from truck 374 during the month of July 2000, from 8:00 AM to 5:00 PM.

It is important to carefully select the query data and press the "Query Database & Display" button before creating a graph.

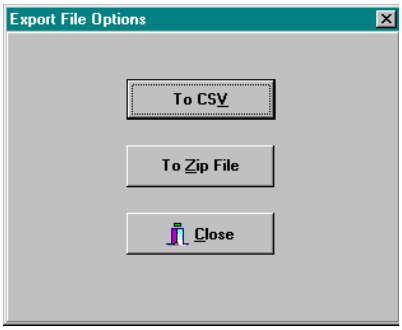
1. From the Payload Summary Screen select the “Graph” button at the bottom. The Histogram Setup screen will display



2. Enter the "Lowest Value". This will be the lowest payload on the graph. Any payloads less than this value will be summed in the first bar.
3. Enter the "Highest Value". This will be the highest value on the graph. Payloads over this value will be summed in the last bar.
4. Enter the "Incremental Change". This will determine the number of bars and the distance between them. The program limits the number of bars to 20. This allows graphs to fit on the screen and print onto 1 page.
5. Press the “Create Graph” button.

The graph will be displayed based on the query settings from the Payload Summary screen. The graph can be customized and printed.

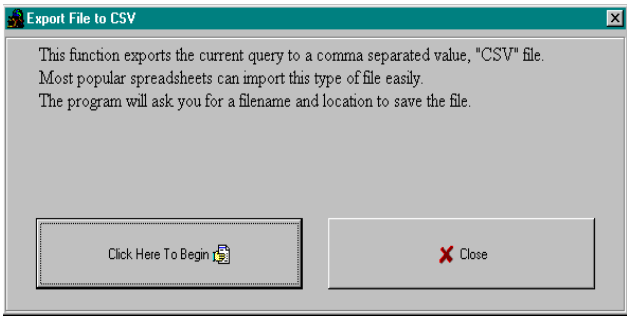
Exporting Data



The data from the database can be exported for use with other software applications. The data is selected from the currently displayed query. The exported data can be put into a ".CSV" file or a compressed ".zip" file.

- The “.CSV” format allows data to be easily imported into spreadsheet applications and word processing applications.
- The “.Zip” format allows data to be transferred from one computer to the PDM Software database on another computer. This offers a compact way to transfer data from one computer to another.

CSV Export



CSV stands for Comma Separated Value. This is an ASCII text file format that allows spreadsheet applications like Excel and Lotus 123 to import data easily. To export the data into a ".csv" file, press the "Export" button at the bottom of the payload summary screen and select "To CSV". The program will request a filename and location for the file.

Load Lights Don’t Light During Loading

- Confirm that the truck operator uses the brake lock switch (NEUTRAL) during loading. Without this input, the payload meter will not properly recognize swingloads.
- Confirm bulbs in payload lights by using lamp check mode.
- Confirm 15 A breaker CB-B in payload junction box.
- To continue troubleshooting, turn on all the payload lights using the lamp check mode of the Payload Data Manager software.

Alarm 18

Payload meter detected an undercharged suspension condition on the rear right suspension.

The suspension may be in need of servicing. Refer to Section H in the shop manual for information on charging the suspensions.

Alarm 19

Payload meter detected an undercharged suspension condition on the rear left suspension.

The suspension may be in need of servicing. Refer to Section H in the shop manual for information on charging the suspensions.

Alarm 22

The payload meter detected an empty carryback load in excess of the user-defined carryback threshold on two consecutive haul cycles.

Stop the truck and clean any stuck material from the truck body.

Confirmation Checklist
Use the Real Time Data Screen in order to verify the checklist items in the table below.

Checklist Item	Value	Initials
PLMIII Software Version		
User switch and display works properly		
Left - Front Pressure		
Right - Front Pressure		
Left - Rear Pressure		
Right - Rear Pressure		
Inclinometer		
Green light works properly		
Amber light works properly		
Red light works properly		
Brake Lock input works properly		
Body Up input works properly		
Speed input works properly		
Date		
Truck		
Signature		

SECTION N

CAB COMPONENTS

INDEX

TRUCK CAB N2-1

CAB COMPONENTS N3-1

OPERATOR COMFORT N4-1

OPERATOR CAB CONTROLS N5-1

- Carefully lower the door panel a few inches. Hold glass at top to prevent it from dropping. Slide the door panel toward the cab to disengage the window regulator roller (Figure 2-7) from the track on the bottom of the glass. Slide the panel away from the cab to disengage the other top roller and lower roller from its tracks. Place the panel out of the way after removal.
    a. Lift door glass and support at the top of the frame.
    b. Remove 2 screws (Figure 2-8) holding the roller track to the bottom of the door glass.

3. Remove capscrew and nut from inside release lever (1, Figure 2-14).
4. Remove the four mounting screws that holds the latch mechanism in the door (2).
5. Remove door latch mechanism (4). Check to see if door latch mechanism works properly by performing the following test.
    a. Close latch mechanism pawls
    b. Operate inside door release lever to see if pawls open. If pawls do not open, replace assembly.
    c. Close pawls again.
    d. Press the outside door button to see if pawls open.
    e. If mechanism operates properly go on to Step 6. If mechanism does not work properly, replace with a new door latch assembly then continue with Step 6.
6. Remove the mounting screws (3) from the outside door handle. With the door handle removed, adjust the plunger counter clock wise to increase the height of the door handle release button. Lock the plunger capscrew with locking nut. Apply lock tight to prevent screw from working loose.
7. Reassemble door assembly by reversing the previous steps.

Door Glass Replacement

1. Remove hair pin clip (1, Figure 2-6) and bolt (2) from the door check strap closes to the door.

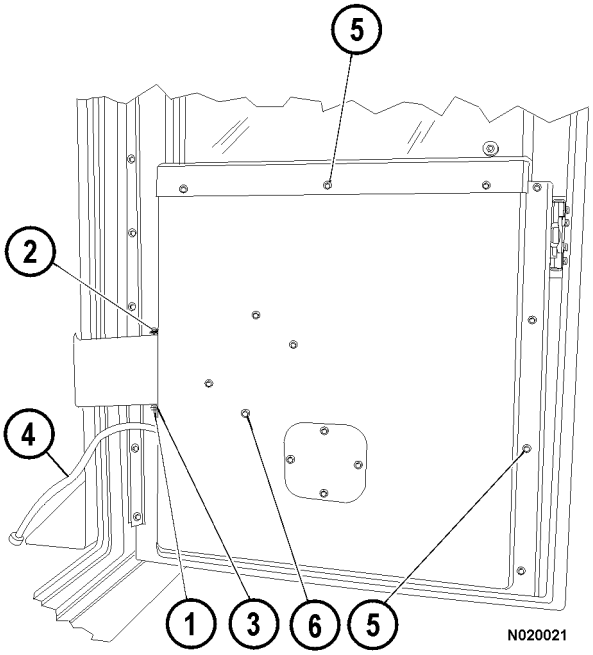


FIGURE 2-6.

1. Hair Pin Clip
2. Door Strap Bolt
3. Strap Bracket
4. Wiring Harness
5. Panel Screws
6. Window Regulator Mounting Screw

2. Remove 2 M8x12 capscrews (3), which hold the door strap bracket to the door.
3. Disconnect wiring harness (4) to the window regulator.
4. Open the door as far as possible in order to remove the internal door panel.

⚠CAUTION

Door glass and internal door panel will drop when door panel screws are removed.

SECTION N3

CAB COMPONENTS

INDEX

CAB COMPONENTS N3-3

WINDSHIELD WIPERS N3-3

Wiper Motor Replacement N3-3

Removal N3-3

Installation N3-3

Wiper Arm Replacement N3-3

Removal N3-3

Installation N3-4

Wiper Linkage Replacement N3-4

Removal N3-4

Installation N3-4

WINDSHIELD WASHER N3-5

Operation N3-5

Service N3-5

OPERATOR SEAT N3-6

Adjustment N3-6

Removal N3-6

Installation N3-6

Fan Motor And Speed Control

Fan speed is controlled by inserting resistor(s) in series with the supply circuit to the blower motor to reduce voltage. The number of resistors in series is determined by the position of the fan speed selector switch.

At low speed, 3 resistors are used, at medium speed, 1 resistor is used, and for high speed, the full 24 volts is supplied to the blower motor, bypassing all resistors.

Test

If the motor does not operate at any of the speed selections, check voltage supplied to the motor. If approximately 24 volts (at high speed setting) is available, the motor is probably defective and should be removed and replaced.

If the motor operates at high speed, but does not operate at reduced speed, inspect the resistors for physical damage or an open circuit. Replace resistors as required.

Actuators

Three linear actuators (22, Figure 4-3) are installed inside the heater housing and are used to actuate the flappers for the following:

- Defroster outlet
- Bi-level or floor outlets
- Inside or outside air selection

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

Test

Visually inspect the flapper and linkage for the function being diagnosed. Make certain the flapper is not binding or obstructed, preventing movement from one mode to the other.

Verify voltage is present at the actuator when the toggle switch is closed or absent when the toggle switch is opened.

If voltage is proper, disconnect actuator from flapper and verify actuator force is comparable to a known (new) actuator. If not, replace with a new actuator.

Filter Service

Inlet filters in the heater cover and the cab access panel need periodic cleaning to prevent restrictions in air circulation. 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.

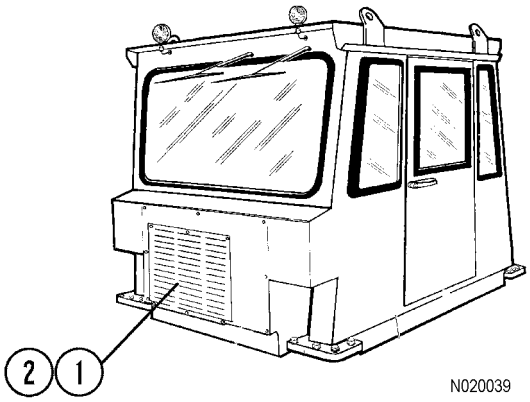


FIGURE 4-3. CAB FILTER LOCATION

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.

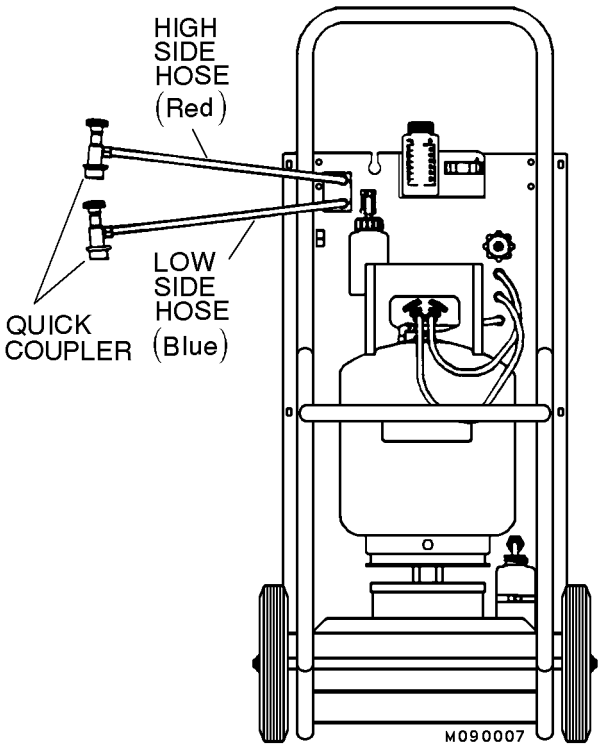


FIGURE 4-6. RECOVERY/RECYCLE STATION

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 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 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 the leak detector being used applies to the refrigerant in the system.

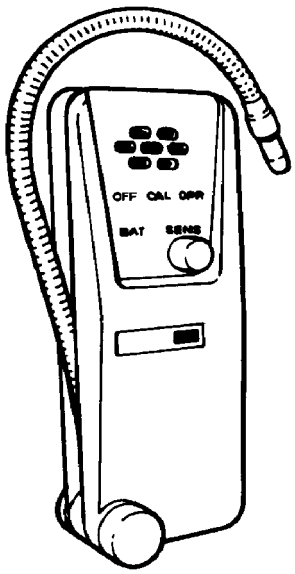


FIGURE 4-7. TYPICAL ELECTRONIC LEAK DETECTOR

Fitting Size	Foot Pounds	Newton Meters
6	10 - 15 ft.lbs.	14 - 20 Nm
8	24 - 29 ft.lbs.	33 - 39 Nm
10	26 - 31 ft.lbs.	36 - 42 Nm
12	30 - 35 ft.lbs.	41 - 47 Nm

Installation torque for the single M10 or 3/8 in. capscrews securing the inlet and outlet fittings onto the compressor ports is **11 - 25 ft.lbs. (15 - 34 Nm)**.

Expansion Valve

When removing the expansion valve from the system, remove the insulation, clean the area and disconnect the line from the receiver-drier. Detach the capillary (bulb) and external equalizer tube (if present) from their mounting locations. Remove the expansion valve from the evaporator inlet. Expansion valve service is limited to cleaning or replacing the filter screen. If this is not the problem, replace the valve. Secure the capillary and equalizer, if used, to clean surfaces and replace or attach any insulating material.

Receiver-Drier

The receiver-drier can not be serviced or repaired. ***It must be replaced whenever the system is opened for any service.*** The receiver-drier has a pressure switch to control the clutch, and should be removed and installed onto the new unit.

Thermostat

A thermostat can be stuck open or closed due to contact point wear or fusion. The thermostat temperature sensing element (capillary tube) may be broken or kinked closed and therefore unable to sense evaporator temperature.

When thermostat contact points are stuck open or the sensing element can not sense temperature in the evaporator, the clutch will not engage (no A/C system operation). Causes are a loss of charge in the capillary tube or a kink, burned thermostat contact or just no contact. When troubleshooting, bypass the thermostat by hot wiring the clutch coil with a fused lead. If the clutch engages, replace the thermostat.

Thermostat contact points may be fused (burned) closed and the clutch will not disengage. Causes are a faulty switch that could be due to fatigue. The thermostat must be replaced. When the clutch will not disengage you may also note that condensate has frozen on the evaporator fins and blocked air flow. There will also be below normal pressure on the low side of the system. Side effects can be compressor damage caused by oil accumulation (refrigeration oil tends to accumulate at the coldest spot inside the system) and lower than normal suction pressure that can starve the compressor of oil.

Compressor

The compressor can fail due to shaft seal leaks (no refrigerant in the system), defective valve plates, bearings, or other internal parts or problems associated with high or low pressure, heat, or lack of lubrication. Be sure the compressor is securely mounted and the clutch pulley is properly aligned with the drive pulley.

Use a mechanic's stethoscope to listen for noises inside the compressor.

⚠CAUTION

When installing a new compressor, the compressor must be completely drained of its oil before installation. Add 7 oz. (207 ml) of new PAG oil to the compressor to ensure proper system oil level. Failure to adjust the amount of oil in the compressor will lead to excessive system oil and poor A/C performance.

⚠CAUTION

Under no circumstances should the A/C compressor be stood upright onto the clutch assembly. Damage to the compressor clutch will result, leading to premature compressor failures.

Accumulator

The accumulator (if equipped) can not be serviced or repaired. ***It must be replaced whenever the system is opened for any service.***

TROUBLESHOOTING BY MANIFOLD GAUGE SET READINGS

PROBLEM: Insufficient Cooling

Indications:

Low side pressure - LOW.
High side pressure - LOW.
Discharge air is only slightly cool.

Possible Causes	Suggested Corrective Actions
- Low refrigerant charge, causing pressures to be slightly lower than normal.	Check for leaks by performing leak test. ***If No Leaks Are Found:*** Recover the refrigerant and use a scale to charge the proper amount into the system. Check system performance. ***If Leaks Are Found:*** After locating the source of the leak, recover the refrigerant, and repair the leak. Evacuate the system and recharge using a scale. Add oil as necessary. Check A/C operation and perform-ance test the system.

PROBLEM: Little or No Cooling

Indications:

Low side pressure - VERY LOW
High side pressure - VERY LOW
Discharge air is warm.
No bubbles observed in sight glass, may show oil streaks.

Possible Causes	Suggested Corrective Actions
- Pressure sensing switch may have compressor clutch disengaged. - Refrigerant excessively low; leak in system.	Add refrigerant (make sure system has at least 50% of its normal amount) and leak test system. It may be necessary to use a jumper wire to enable the compressor to operate, if the com-pressor has shut down due to faulty pressure sensing switch. Repair any leaks and evacuate the system if necessary, Replace the receiver-drier if the system was opened. Recharge the system using a scale and add oil as necessary. Check A/C operation and do system performance test.

OPERATOR CAB CONTROLS

STEERING COLUMN

The steering column and steering wheel adjust at a tilt angle to provide the most comfortable wheel position for the operator. A telescoping feature also provides optimum operator comfort. The steering column also contains a turn signal lever and headlight selector switch. Refer to *Steering Wheel And Controls* for a list of controls and functionality.

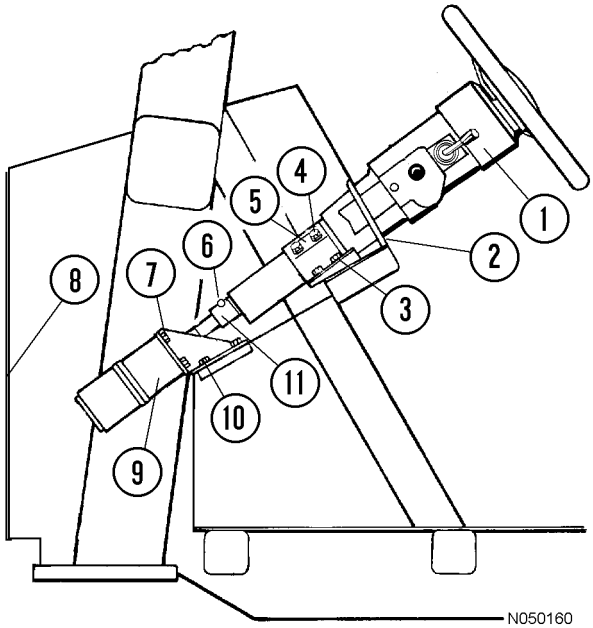


FIGURE 3-1. STEERING COLUMN INSTALLATION

1. Steering Column
2. Trim Cover
3. Capscrews & Washers
4. Capscrews & Washers
5. Saddle Bracket
6. Capscrew & Nut*
7. Capscrews & Washers
8. Front Access Cover
9. Steering Control Unit
10. Capscrews & Washers
11. Splined Stub Shaft

Removal

1. Shut down the engine by turning the key switch "Off" and allow the steering accumulators to bleed down. Allow at least 90 seconds for bleed down. Turn the steering wheel to ensure no pressure remains.
2. Open the battery disconnect switches.
3. Remove access cover (8, Figure 5-1) from the front of the cab.
4. Loosen capscrews (7 & 10) on control unit (9).
5. Disconnect wire harness from the steering column at the connector.
6. Remove screws retaining trim cover (2) where steering column enters the instrument panel and remove cover.
7. Remove four capscrews and washers (4) at saddle bracket (5). Access to these screws is from the front of the cab, through access opening (8). Remove capscrews and washers (3).
8. Lift the column out of the instrument panel.

Installation

1. Install stub shaft (11, Figure 5-1) on steering column splines. Leave a 0.125 in. (3.2 mm) gap between end of stub shaft and end of steering column housing. Tighten clamp capscrew (6) to standard torque.
2. Apply molybdenum disulphide or multi-purpose NLGI grease to external splines of stub shaft.
3. With the steering column tilted at approximately 30°, insert the lower end of the column into the opening in the instrument panel. Attach saddle bracket (5) with capscrews and washers (4). Tighten to standard torque.
4. Position saddle bracket over tapped mounting holes and install capscrews and washers (3). Tighten capscrews just enough to secure column in position.
5. With capscrews (3) loosened, allow steering column to slide downward until stub shaft (11) splines bottom in steering control unit (9). When the stub shaft is at rest at the bottom of the input collar, slide column out to obtain 0.08 to 0.120 in. (2 to 3 mm) clearance between end of stub shaft and steering control unit. Tighten capscrews (3) to standard torque.

NOTE: The gap in Step 5 can be measured by etching a line across saddle bracket (5) and the bracket mounting face while the stub shaft is at rest in the control unit. Pull the column away from the control unit until the correct gap exists between the mark on the bracket and the mark on mounting face.

6. Carefully tighten capscrews (7 & 10). It is important to use care when tightening to be certain no binding occurs between stub shaft and steering unit splines.

Note: Be certain clearance adjusted in Step 5 remains between 0.08 and 0.120 inches (2 to 3 mm) *when capscrews are tightened.*

PSC Download Port

PSC download port (13, Figure 5-5) is for use by qualified personnel to access diagnostic information from the Propulsion System Controller (PSC).

Engine Diagnostics Download Port

Engine diagnostics download port (14, Figure 5-5) is for use by qualified personnel to access the diagnostic information for the engine control system. (CENSE)

Engine Control System

Engine control system port (17, Figure 5-5) is for use by qualified personnel. This 9-PIN connector is used to access diagnostic information for the engine control system. (QUANTUM)

TCI Download Port

TCI download port (15, Figure 5-5) is for use by qualified personnel to access the Truck Control Interface (TCI) diagnostic information and data.

Passenger Seat

Passenger seat (16, Figure 5-5) is mounted on top of the right hand portion of the center console structure.

The area beneath the passenger seat provides a cabinet for various 24 VDC electrical components.

Modular Mining System (Optional)

Modular mining system connector (18, Figure 5-5) is for use by qualified personnel to access the Modular Mining System for diagnostic information and data.

PAYLOAD METER

Payload meter (1, Figure 5-6) and download connector (2) are used to provide management with operational data such as tonnage hauled and cycle times. The payload meter is located on the back wall inside of the cab.

Refer to Section M, Payload Meter, for a more complete description of the payload meter and its functions.

Payload Meter Download Connector

Connector (2, Figure 5-6) is used with a special cable to allow the payload meter to communicate with a portable computer.

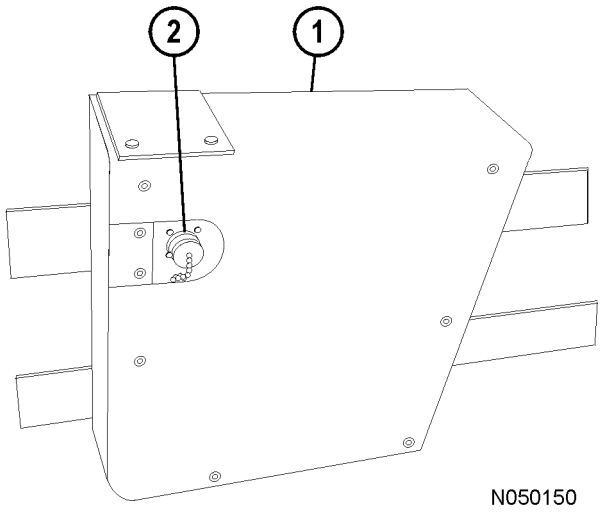


FIGURE 3-6. PAYLOAD METER

1. Payload Meter III
2. Download Connector

OVERHEAD STATUS / WARNING INDICATORS

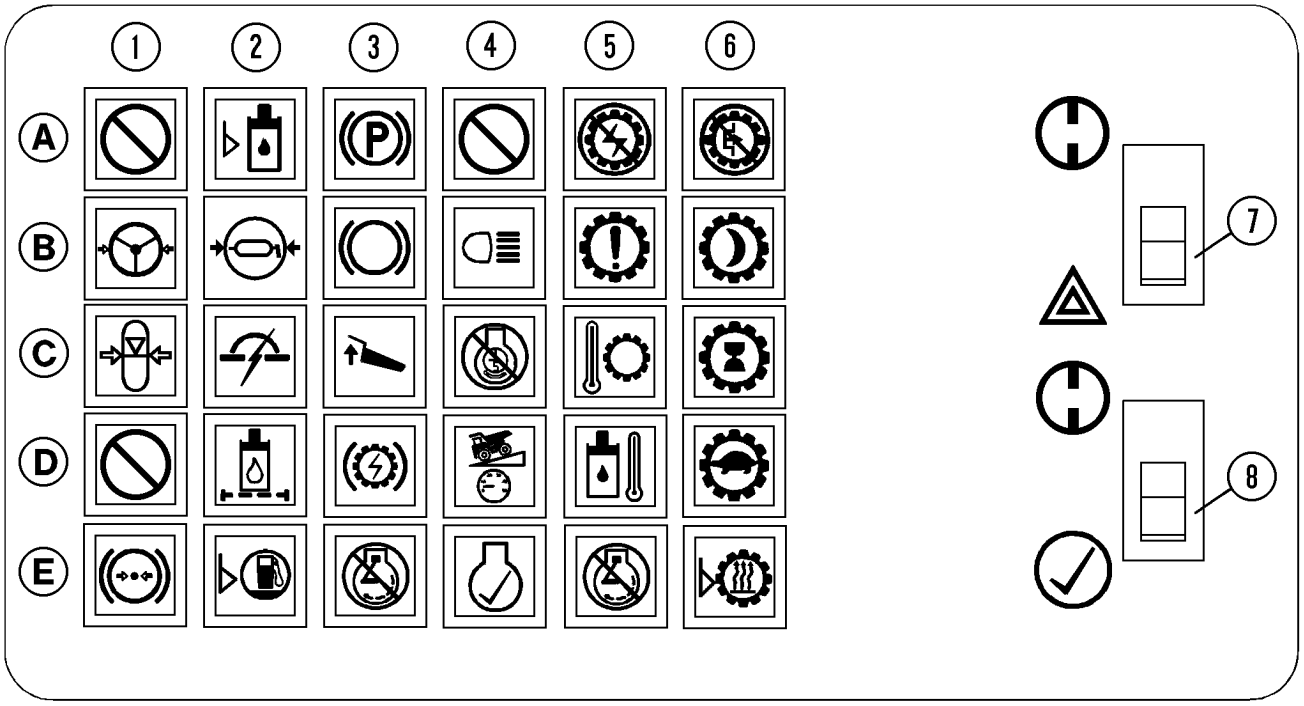


FIGURE 3-8. OVERHEAD STATUS / WARNING INDICATOR

Row / Column	Indicator Description	Indicator Color Wire Index
A1*	Not Used	12FD/34TL
B1*	Low Steering Pressure	Red-12FD/33A
C1	Low Accumulator Pr.	Red-12F/33K
D1	Not Used	Red-12F/79V
E1	Low Brake Pressure	Red-12F/33L
A2*	Hydraulic Tank Level	Red-12FD4/34LL
B2*	Low Automatic Lubrication Pressure	Amber-12FD8/ 68LLP
C2*	Circuit Breaker Tripped	Amber-12FD/31CB
D2*	Hydraulic Oil Filter	Amber-12MD/39
E2*	Low Fuel	Amber-12MD/38
A3*	Park Brake Applied	Amber-12MD/52A
B3*	Service Brake Applied	Amber-12MD/44L
C3*	Body Up	Amber-12MD6/63L
D3*	Dynamic Retarding	Amber-12MD/44DL
E3	Stop Engine	Red-12M/509MA
A4*	Not Used	Amber-12MD/SPR2
B4*	Manual Back-Up Lights	Amber-12MD/47L
C4*	5 Min. Shutdown Timer	Amber-12MD/23L1
D4*	Retard Speed Control	Amber-12MD/31R
E4*	Check Engine	Amber-12MD7/419

Row / Column	Indicator Description	Indicator Color Wire Index
A5	No Power	Red-12M/75-6PI
B5	Propulsion System Warning	Amber-12F/79WI
C5	Propulsion System Temperature	Amber -12F/34TW
D5	Hydraulic Oil Temperature High	Red-12F/34TGI
E5	Stop Engine	Red-12M/528A
A6	NO PROPEL	Red-12M/75NPI
B6	Propulsion System @ Rest	Amber-12M/72PR
C6*	Propulsion System Not Ready	Amber-12MD/72NR
D6*	Reduced Propulsion System	Amber-12MD/72LP
E6*	Retard @ Continuous Level	Amber-12MD/76LR
-Switches-		
7	Hazard Lights Switch N/O	11L/45L/45R
8	Lamp Check Switch N/O (Mom.)	33H/528/710/712

** NOTE: Brightness for these Indicator Lamps can be adjusted by using dimmer control (12, Figure 5-2).*

SECTION P2

LUBRICATION AND SERVICE

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250 HOUR LUBRICATION AND MAINTENANCE CHECKS

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

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

Truck Serial Number_____ **Site Unit Number**_____ **Date**_____
Hourmeter_____ **Name of Service Technician**_____

	TASK	COMMENTS	CHECKED	INITIALS
1.	ENGINE - **Refer to Cummins Operation & Maintenance manual** for complete specifications regarding engine lube oil specifications. *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. Refer to Cummins Operation & Maintenance manual for specific oil and filter change intervals.* * The Centinel™ system is a duty-cycle-dependent lubrication management system whereby oil is blended with the fuel and burned and an extension of oil change intervals can occur. a. Change engine oil. Lube Key "A". b. Replace lube oil filters. *NOTE: When installing spin-on filter elements, follow the instructions as specified by the filter manufacturer. The tightening instructions are normally printed on the outside of the filter. **Do not use a wrench or strap to tighten filter elements**.* c. If the truck is equipped with a reserve engine oil tank, change the reserve tank oil filter. d. Check belt tension and condition of each accessory belt. Refer to Cummins Operation & Maintenance manual for specific adjustment instructions. e. Check the torque on the mounting capscrews on cooling fan (1, Figure 2-5). Tighten eight capscrews (2) to **175 ft.lbs. (237 Nm)**.			
2.	COOLING SYSTEM - a. COOLANT MIXTURE - Check for proper coolant mixture. Add coolant as required. b. COOLANT FILTERS - Change coolant filters. c. COOLING SYSTEM HOSES - Check cooling system hoses for damage and signs of deterioration. Refer to the Cummins maintenance manual for coolant filter replacement instructions and proper coolant mixture instructions.			

(CONTINUED NEXT PAGE)

SYSTEM COMPONENTS

Filter (21, Figure 3-2)

A filter assembly 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 (3 & 8, Figure 3-1)

The rotary hydraulic pump is a fully hydraulically operated grease pump. An integrated pump control manifold is incorporated with the motor to control input flow and pressure.

Note: The pump crankcase oil level must be maintained to the level of the pipe plug port. If necessary, refill with 10W-30 motor oil.

⚠WARNING

Hydraulic oil supply inlet pressure must not exceed 3000 psi (20 685 kPa). Exceeding the rated pressure may result in damage to the system components and personal injury.

Grease Reservoir (12, Figure 3-1)

The reservoir has an approximate capacity of 60 lbs. (27 kg) 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 (4, Figure 3-1)

The pressure reducing valve, located on the manifold reduces the hydraulic supply pressure (from the truck steering circuit) to a suitable operating pressure, [325-350 psi (2 240 to 2 415 kPa)] for the hydraulic motor used to drive the lubricant pump.

Flow Control Valve (9, Figure 3-1)

The flow control valve 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 (5, Figure 3-1)

The solenoid valve, when energized, allows oil to flow to the hydraulic motor.

Vent Valve (6, Figure 3-1)

With the vent valve 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 0, so the injectors can recharge for their next output cycle.

Lubrication Cycle Timer (1, Figure 3-4)

The solid state lubrication cycle timer provides a 24 VDC timed-interval signal to energize the solenoid valve (5, Figure 3-1), providing oil flow to operate the grease pump motor. This timer is mounted in the Electrical Interface Cabinet.

Delay Timer (11, Figure 3-4)

The delay timer, located in the electrical interface cabinet, provides a one minute delay in the low pressure warning lamp circuit to allow a normally operating system to attain full grease system pressure without activating the warning lamp. If the system fails to reach 2000 psi (13 789 kPa) within this time period, the timer will apply 24VDC to several relays which will illuminate the low pressure warning lamp in the overhead display. An external 604K ohm resistor determines the delay period.

Pump Cutoff Pressure Switch (N.O. 2500 psi [17 237 kPa]) (10, Figure 3-1)

This pressure switch de-energizes the pump solenoid relay when the grease line pressure reaches the switch pressure setting, turning off the motor and pump.

Grease Pressure Failure Switch (N.O. 2000 psi [13 789 kPa]) (9, Figure 3-2)

This pressure switch monitors grease pressure in the injector bank on the rear axle housing. If the proper pressure is not sensed within 60 seconds (switch contacts do not close), several relays energize, actuating a warning lamp circuit to notify the operator a problem exists in the lube system.

Pressure Gauge (7, Figure 3-1)

The pressure gauge monitors hydraulic oil pressure to the inlet of the hydraulic motor.

Injectors (24, Figure 3-2)

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

SYSTEM TROUBLESHOOTING CHART

If the following procedures do not correct the problem, contact a factory authorized service center.

POSSIBLE CAUSES	*SUGGESTED CORRECTIVE ACTION*
TROUBLE: Pump Does Not Operate	
Lube system not grounded.	Correct grounding connections to pump assembly and truck chassis.
Electrical power loss.	Locate cause of power loss and repair. Check circuit breaker CB7. Be sure keyswitch is ON.
Timer malfunction.	Replace timer assembly.
Solenoid valve malfunctioning.	Replace the solenoid valve assembly.
RB7K5 Relay malfunctioning	Replace relay.
Motor or pump malfunction.	Replace motor and/or pump assembly.
Pressure switch defective	Replace pressure switch.

NOTE: On initial startup of the lube system, the timing capacitor will not contain a charge, therefore the first timing cycle will be about double in length compared to the normal interval. Subsequent timer cycles should be as specified.

TROUBLE: Pump Will Not Prime	
Low lubricant supply.	Dirt in reservoir, pump inlet clogged, filter clogged.
TROUBLE: Pump Will Not Build Pressure	
Air trapped in lubricant supply line.	Prime system to remove trapped air.
Lubricant supply line leaking.	Check lines and connections to repair leakage.
Vent valve leaking.	Clean or replace vent valve.
Pump worn or scored.	Repair or replace pump assembly.

TROUBLE: Injector Indicator Stem Does Not Operate

NOTE: Normally, during operation, the injector indicator stem will move into the body of the injector when pressure builds properly. When the system vents (pressure release) the indicator stem will again move out into the adjusting yoke.

Malfunctioning injector - usually indicated by the pump building pressure and then venting.	Replace individual injector assembly.
All injectors inoperative - pump build up not sufficient to cycle injectors.	Service and/or replace pump assembly.

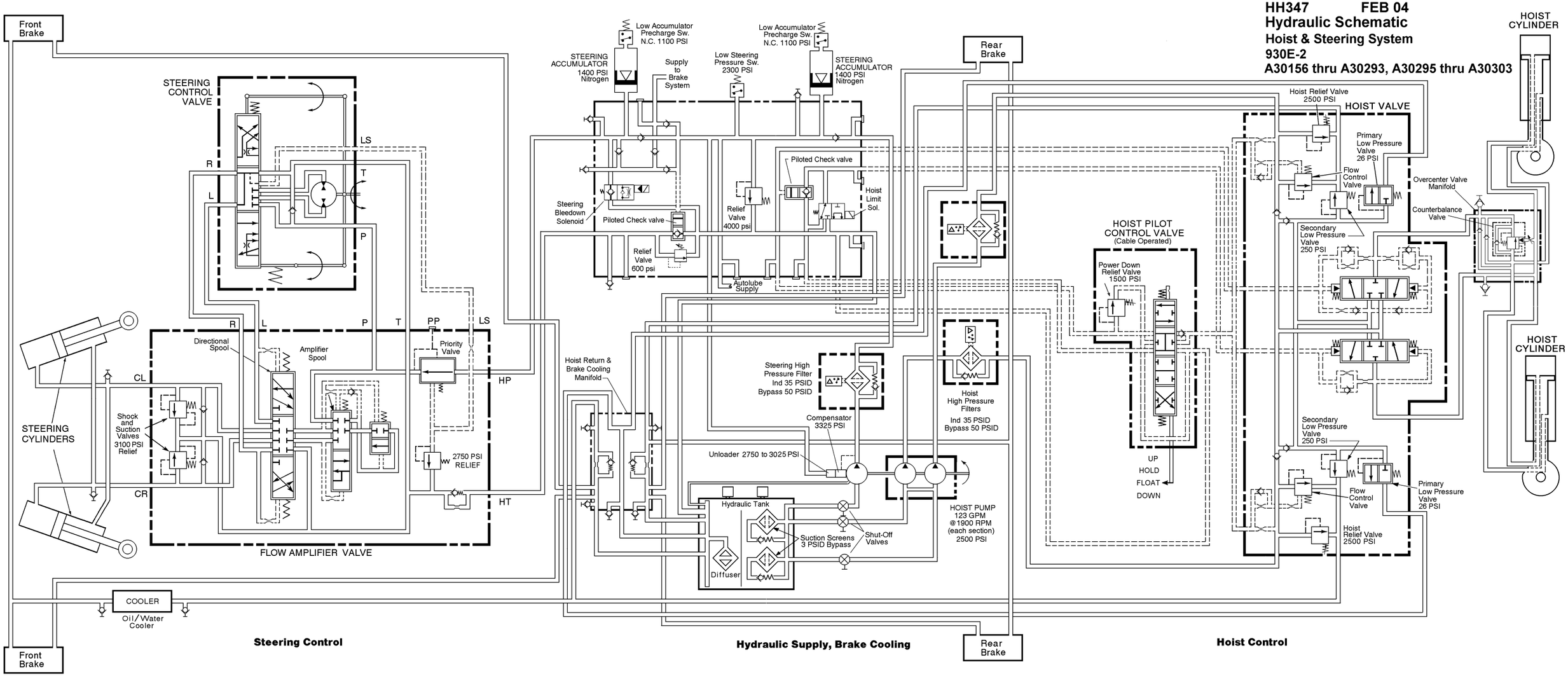
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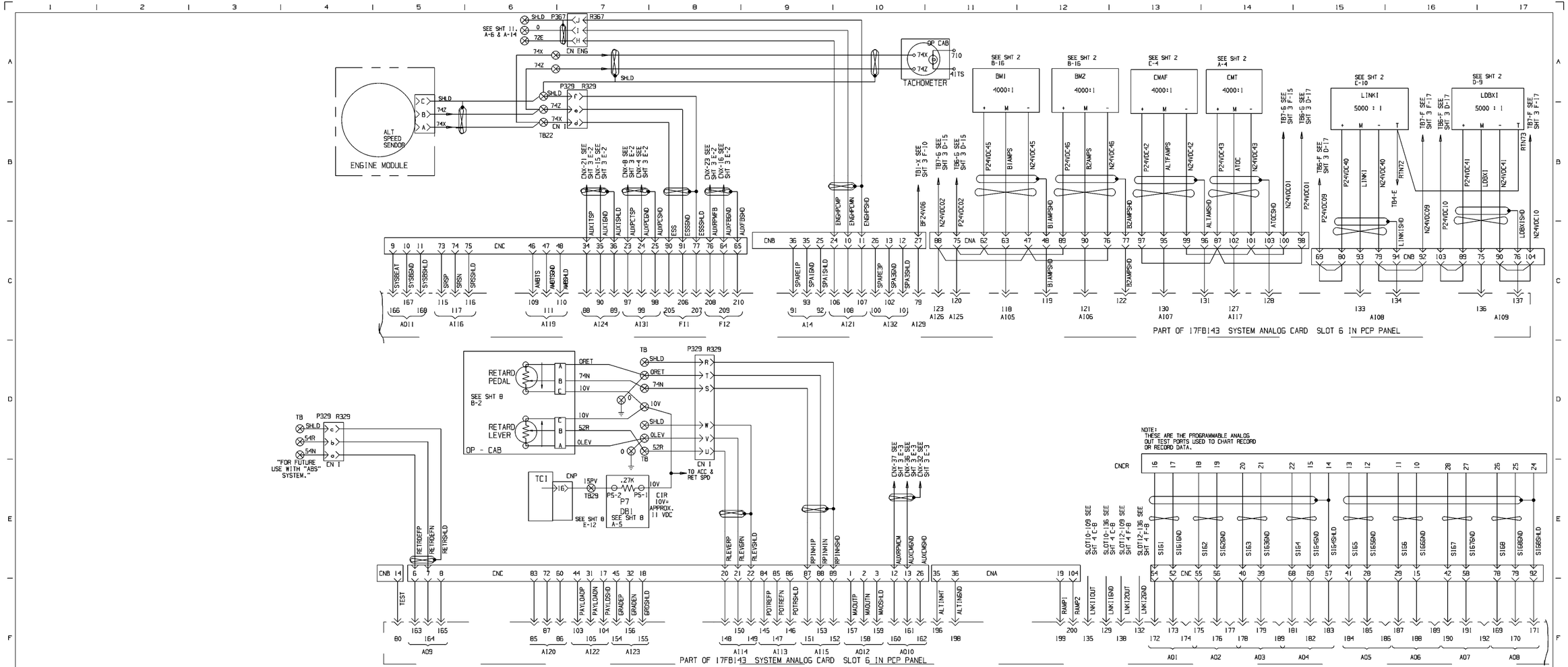
Hydraulic Schematic

Hoist & Steering System

930E-2

A30156 thru A30293, A30295 thru A30303





XS0507 MAR03

ELECTRIC SCHEMATIC

ENGINE - I/O

930E

A30255 - A30293 & A30295 - A30303

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