CEBM013301

Shop Manual

930E-3

DUMP TRUCK

SERIAL NUMBERS **A30310 thru A30328**

KOMATSU®

TRUCK COMPONENTS AND SPECIFICATIONS

Truck And Engine

The 930E-3 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-GTA41)

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.

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

AC Induction Traction Motorized Wheels

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

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

Suspension

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

Operator's Cab

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

Power Steering

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

Dynamic Retarding

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

Brake System

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

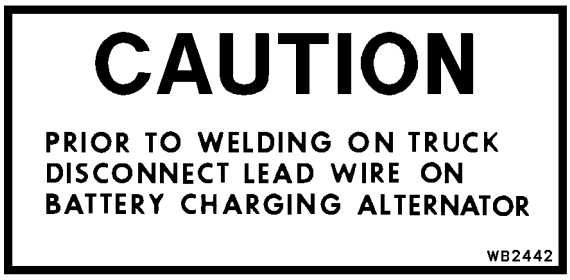
Dynamic Retarder/Service Brake Pedal

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.

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

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

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

Example: Convert 975 psi to kilopascals (kPa).

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

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

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

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

d. Check exposed portions of all hydraulic cylinder rams for rust, pitting and corrosion. If plating is deteriorated, the cylinder should be removed and overhauled or replaced; pitted or scored plating will cause leakage at the cylinder seals.

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

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

SECTION B

STRUCTURES

INDEX

DUMP BODY

Removal

⚠WARNING

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

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

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

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

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

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

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

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

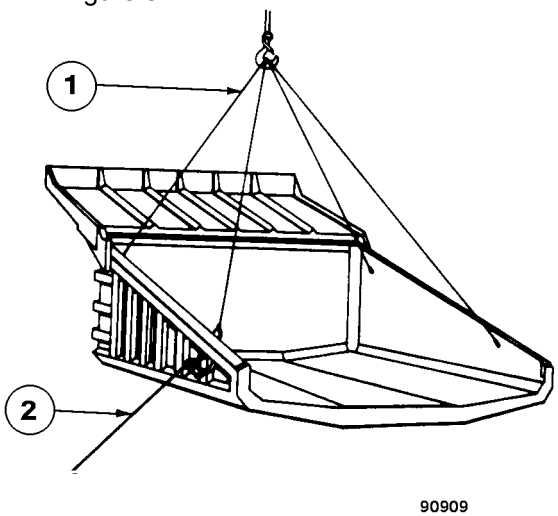


FIGURE 3-1. DUMP BODY REMOVAL

1. Lifting Cables
2. Guide Rope

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

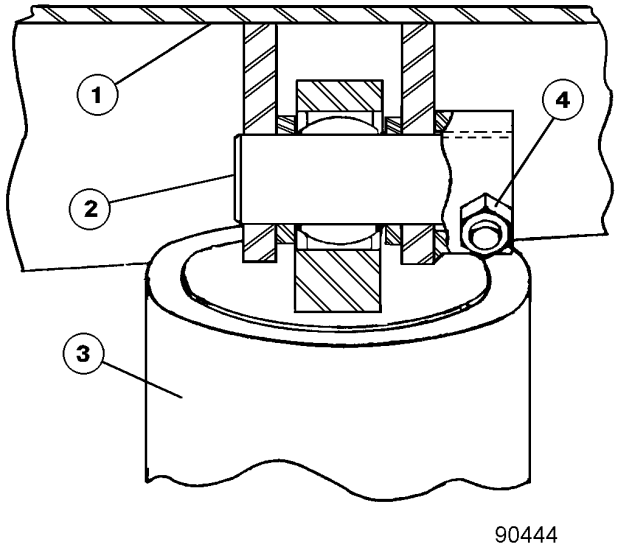


FIGURE 3-2. HOIST CYLINDER MOUNT (UPPER)

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

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

   Remove body pivot pins (3) far enough to allow shims (6) to drop out. Complete removal of pins is not necessary unless new pins are to be installed.
7. Lift dump body clear off the chassis and move to storage or work area. Block the body to prevent damage to the body guide etc.
8. Inspect bushings (5, 8, & 9), body ear (4), and frame pivot (7) for excessive wear or damage.

FUEL GAUGE SENDER

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

Removal

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

Installation

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

LOW FUEL SWITCH

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

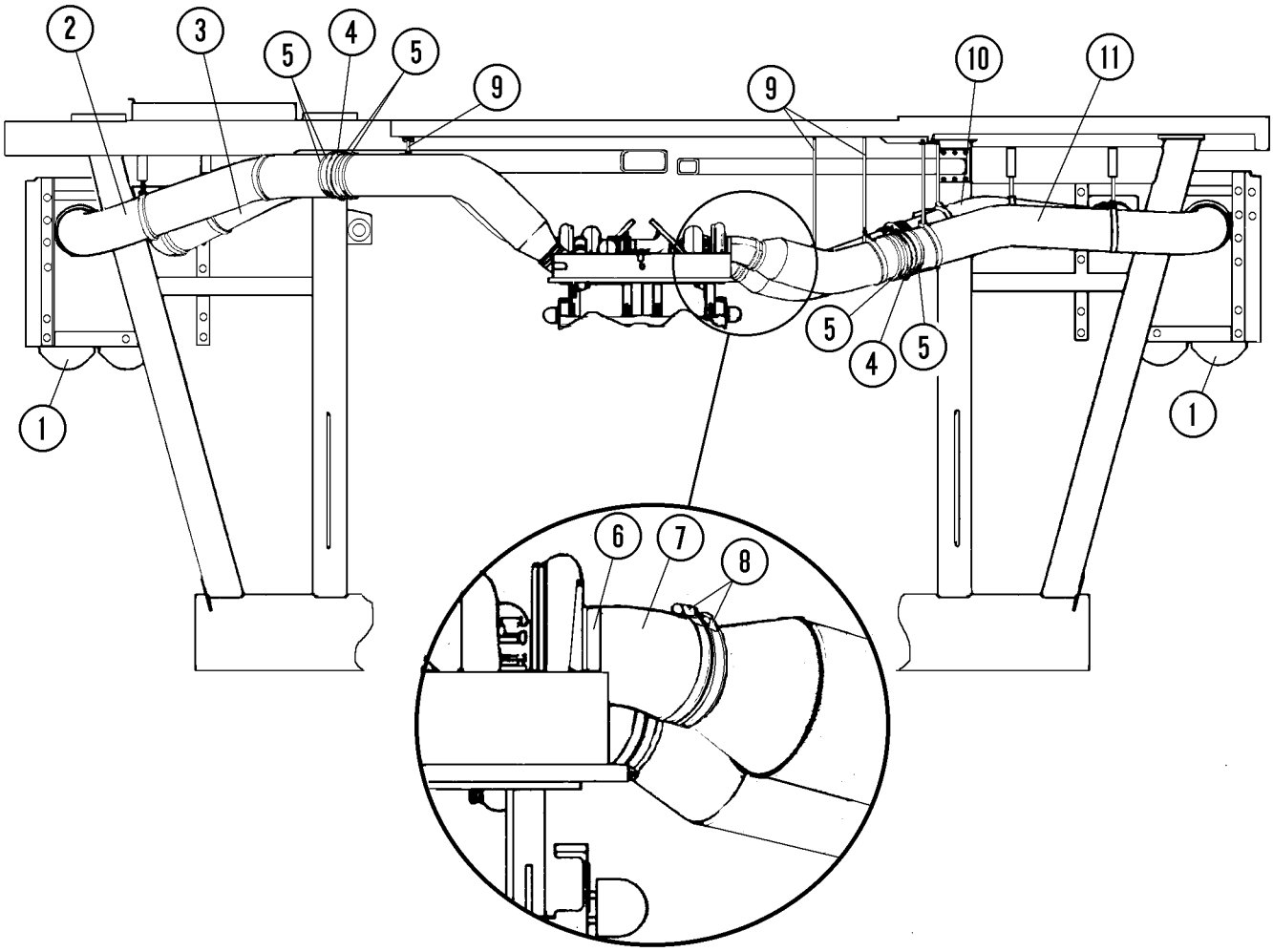


FIGURE 2-3. ENGINE AIR INLET PIPING

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

10. Remove the upper radiator side support rods (4, Figure 3-1). Remove lower support rods (5).
11. Remove nuts, lockwashers, flat washers and capscrews (2, Figure 3-6) from power module subframe (3) at the lower radiator mounts.
12. Verify all hoses and wiring harnesses have been removed. Lift radiator slightly with the hoist, move assembly forward until clear of engine fan. Move radiator to work area for service.

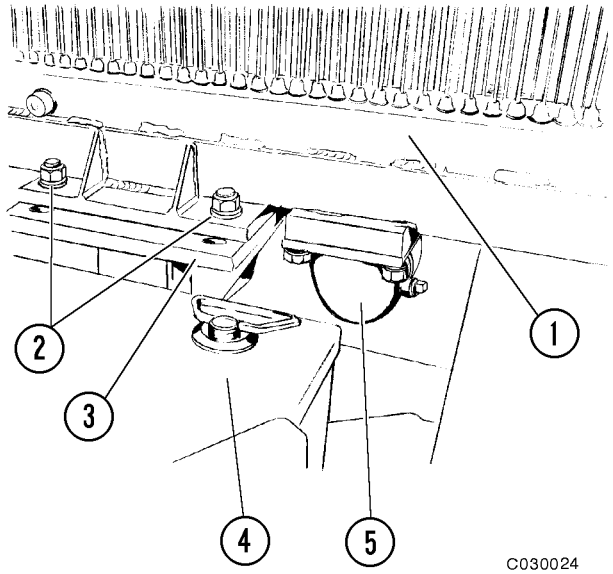


FIGURE 3-6. RADIATOR MOUNT

1. Radiator
2. Mounting Hardware
3. Subframe
4. Battery Box
5. Outlet Elbow

Installation - Radiator

1. Attach a hoist to the radiator assembly and lift into position on the subframe.
2. Insert the capscrews, washers, and nuts (2, Figure 3-6) at the lower radiator mounting brackets but do not tighten at this time.
3. Inspect rubber bushings for lower support rods (5, Figure 3-1) and replace if worn or damaged. Install flatwashers, rubber bushings and nuts on the lower end of radiator support rods and insert rods into the subframe mounting brackets. Insert remaining bushings, flatwashers and locknuts but do not tighten. Install rods at radiator brackets and tighten to standard torque.
4. Install upper support rods (4) and mounting hardware at radiator brackets and front upright brackets. Do not tighten at this time.
5. Adjust the lower stabilizer support rods to position the radiator perpendicular to the subframe within ± 0.12 in. (3.0 mm) measured at top of radiator. When position is established, tighten locknuts to **525 ft. lbs (712 N.m)** to lock adjustment.
6. Tighten upper support rod mounts and recheck perpendicularity of radiator.
7. Tighten nuts on capscrews (2, Figure 3-6) at lower radiator mounting brackets to standard torque.
8. Install the fan guard using capscrews and washers removed during disassembly.
9. Install upper radiator hoses and lines between radiator and engine, seat hoses fully and tighten clamps securely.
10. Install lower radiator hoses and lines between radiator and engine, seat hoses fully and tighten clamps. If outlet elbows (2 & 4, Figure 3-3) have been removed during radiator removal, install new gaskets during installation.
11. Route hoses to fuel cooler, clamp in place and attach to fuel cooler fittings.
12. Reinstall air conditioning system components:
    a. Install condenser, condenser hoses, and clamps.
    b. Install receiver/drier and clamp hoses. Attach wires to low pressure switch.
    c. Clamp all hoses and wiring to studs using clamps removed during disassembly. Refer to Section N, Operator Comfort, for complete instructions to evacuate and recharge the air conditioning system refrigerant supply.
13. Install grille and hood according to instructions in Section B, Structural Components.
14. Make sure all coolant drains are closed, pipe plugs installed, and all hoses installed. Service cooling system with the proper mixture of antifreeze as recommended in Section P, Lubrication and Service Check for static leakage and correct any leaks. Start engine and run until cooling system reaches operating temperature, recheck the cooling system for leakage during engine operation.

ENGINE/ALTERNATOR MATING

⚠ IMPORTANT ⚠

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

General Instructions

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

SERVICE DATA - Eccentricity & Runout Limits	
Description	**T.I.R**
Max. Flywheel Housing Bore Eccentricity	0.66 mm
Max. Face Runout Flywheel Housing	0.25 mm
Max. Eccentricity of Flywheel (Coupling Assy.)	0.18 mm
Max. Axial Runout of Flywheel Face (Coupling Assy.)	0.25 mm

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Measuring Procedure

1. Thoroughly clean the alternator housing mounting surface, rotor drive adapter mounting surface and flywheel housing adapter mounting surfaces.
2. 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:

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

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

   a. Carefully measure Dimension “C” at four locations, 90° apart:
   1st measurement:_____
   2nd measurement:_____
   3rd measurement:_____
   4th measurement:_____
   Dimension “C”: Average_____

   b. Add 1/2 (one-half) of Total End-play (Step 2).

   c. Record (a + b) as;
   ”Measurement C”:_____

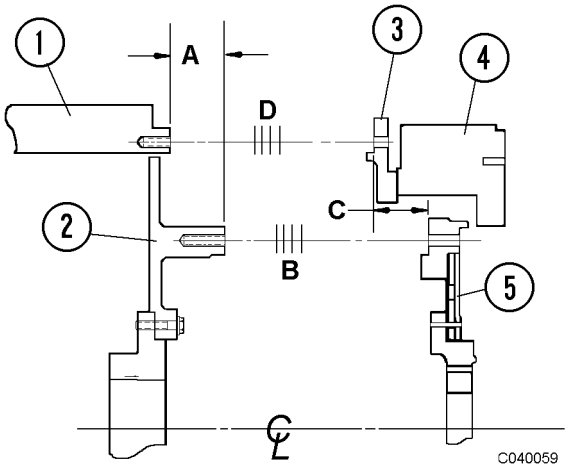


FIGURE 4-4. SHIM LOCATION

1. Alternator Housing
2. Alternator Rotor
3. Flywheel Housing Adapter
4. Engine Flywheel Housing
5. Engine Drive Ring

“A” - Dimension “A”
“B” - Drive Shims
“C” - Dimension “C”
“D” - Housing Shims

5. Submerge precleaner section (see Figure 5-6.) in a solution of Donaldson D-1400 and warm water (mix solution according to package directions). Tube section must be down. Soak for 30 minutes, remove from solution and rinse thoroughly with fresh water and blow dry.
6. Severe plugging may require the use of an Oakite 202 and water solution. The solution should be mixed 50% Oakite 202 and 50% fresh water. Soak precleaner section for 30 minutes, rinse clean with fresh water and blow dry completely.
7. Check precleaner gaskets carefully for any evidence of air leaks and replace if necessary
8. Install precleaner section, with serviceable gaskets, on air cleaner assembly and install all mounting hardware removed.
9. With a serviceable gasket, install dust collector cup assembly on precleaner section and secure with mounting clamps.

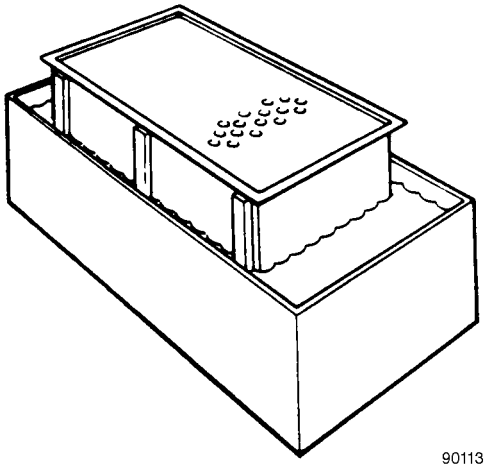


FIGURE 5-6. WASHING AND SOAKING PRECLEANER SECTION

AIR INTAKE TROUBLESHOOTING

To insure maximum engine protection, be sure that all connections between air cleaners and engine intake are tight and positively sealed. If air leaks are suspected, check the following:

1. All intake lines, tubes and hump hoses for breaks, cracks, holes, etc., which could allow an intake air leak.
2. Check all air cleaner gaskets for positive sealing.
3. Check air cleaner elements, main and safety, for ruptures, holes or cracks.
4. Check air cleaner assembly for structural damage, cracks, breaks or other defects which could allow air leakage. Check all mounting hardware for tightness.

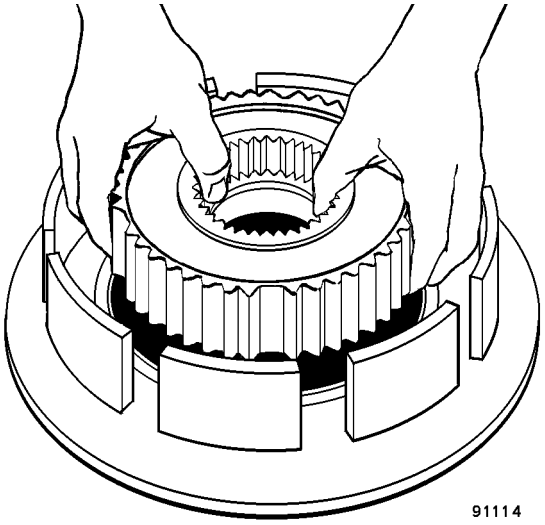


FIGURE 7-6.

5. Remove clutch hub (29).

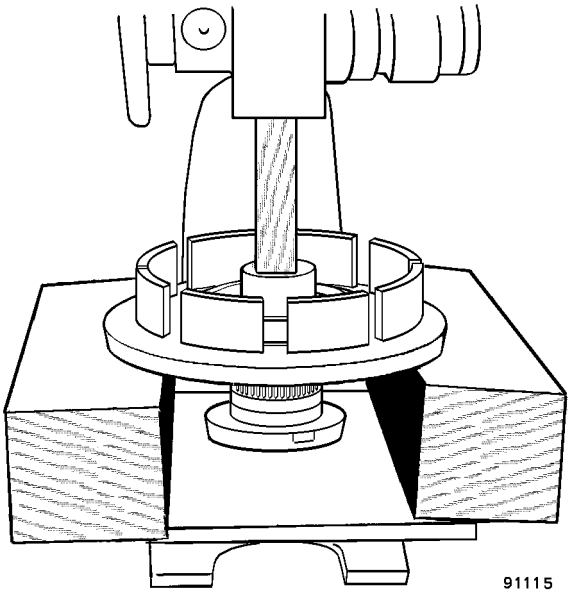


FIGURE 7-7.

6. Position the sub-assembly beneath the ram of a press. Support the assembly beneath the bearing retainer as close as possible to fan mounting hub (42). Press the fan mounting hub out of the front bearing using tooling (B).

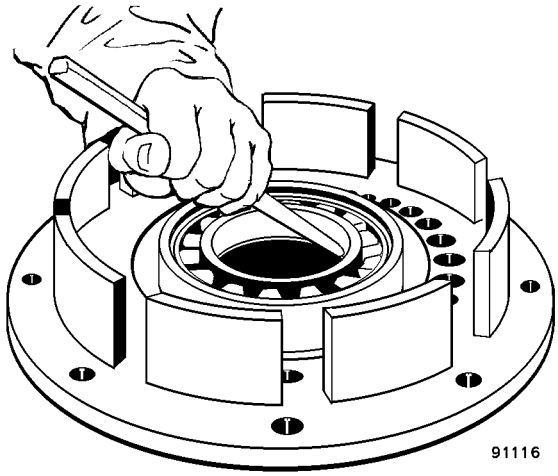


FIGURE 7-8.

7. Remove front oil seal (36).

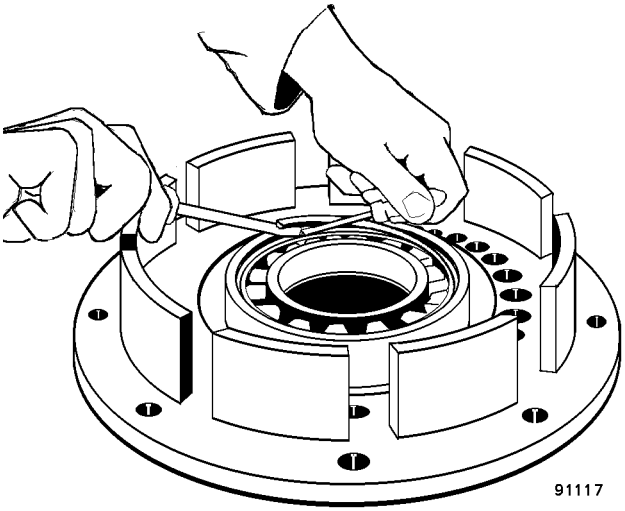


FIGURE 7-9.

8. Remove internal snap ring (32).

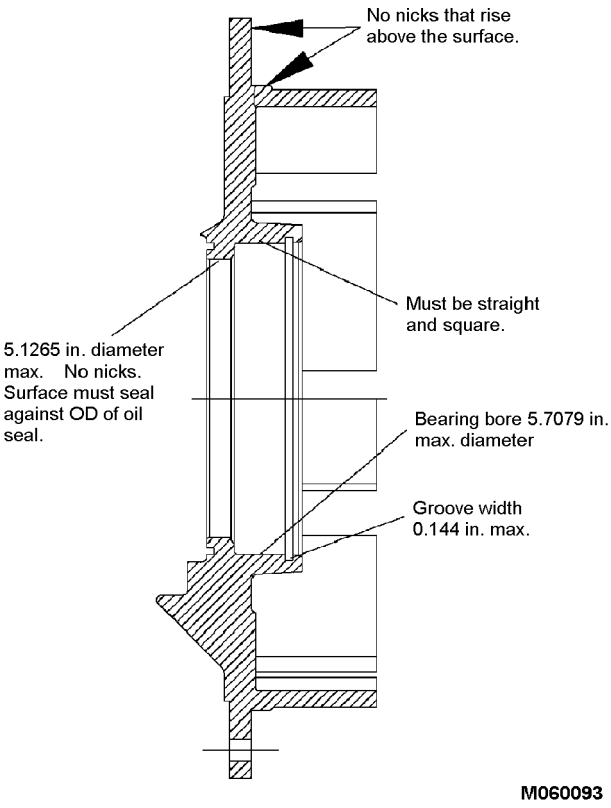


FIGURE 7-37.

11. Inspect front bearing retainer (35).
12. Inspect end cap (45) for any wear or raised nicks.

tube to approximately 0.75 in. (20 mm) from the end.

Push the pitot tubes to the bottom of the hole. The outer end of the tube should be located well within the pulley-locating shoulder of the bearing retainer. Rotate the tube so the open, bent end faces in a counter-clockwise direction, and is *exactly* parallel to the surface of the bearing retainer. (A large phillips-head screwdriver inserted in the end of the tube can be conveniently used as an alignment gage).

Install the second pitot tube in the same manner as the first. Stake each pitot tube in three places, (at the 9, 12, and 3 o'clock positions) to prevent the tubes from rotating in operation.

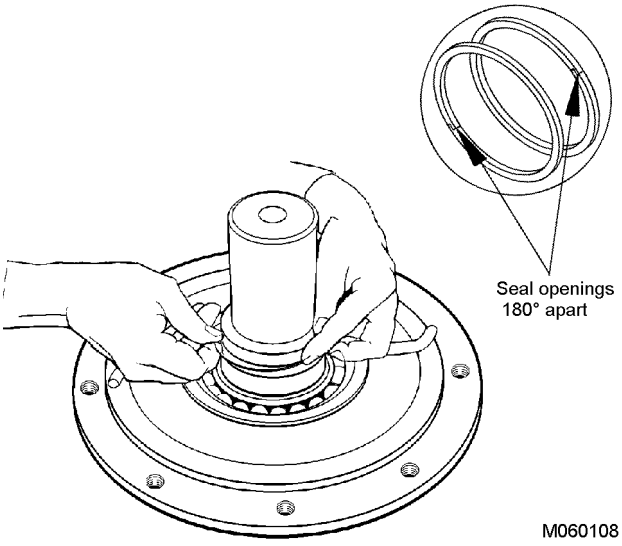


FIGURE 7-65.

25. Install both hook-type seal rings (17) in the grooves in the shaft. Rotate the rings so the slits in the rings are 180° apart from one another.

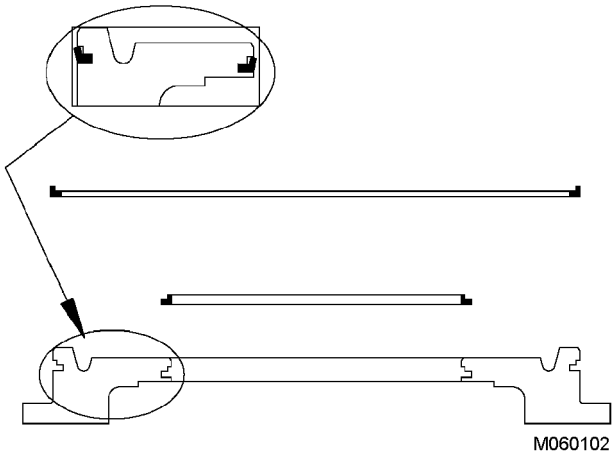


FIGURE 7-66.

26. Install small seal ring (24) in the inside groove, and large seal ring (22) in the outside groove of piston (23). Lubricate the seal ring grooves with an oil-soluble lubricant such as engine assembly grease before installation. Refer to the Figure 7-66 for proper orientation.

FIGURE 7-67.

27. Lubricate the external surfaces of seal rings (22 & 24) with an oil-soluble lubricant such as engine assembly grease. Also, lubricate the seal mating surfaces in the pulley adapter.

24VDC ELECTRIC SUPPLY SYSTEM

ELECTRICAL SYSTEM DESCRIPTION

The truck utilizes a 24VDC electrical system which supplies power for engine starting circuits and most non-propulsion electrical components. The 24VDC engine starting circuit is supplied by four, heavy duty Type 8D, 12 volt storage batteries. Several components require 12VDC and are supplied by circuits tapped off the starting batteries. Two, smaller, 12VDC batteries (Group 31Type) supply 24VDC for the non-propulsion components; engine control system, circuit relays, indicator lamps, etc.

The batteries are of the lead-acid type, each containing six 2-volt cells. With the engine off, power is supplied by batteries. During engine cranking, power is supplied by the four engine cranking batteries only. When the engine is running, power is supplied by an engine driven high capacity alternator.

⚠DANGER

Lead-acid storage batteries contain sulfuric acid, which if handled improperly may cause serious burns on skin or other serious injuries to personnel. Wear protective gloves, aprons and eye protection when handling and servicing lead-acid storage batteries. See the precautions in Section "A" of this manual to insure proper handling of batteries and accidents involving sulfuric acid.

During operation, the storage batteries function as an electrochemical device for converting chemical energy into the electrical energy required for operating the accessories when the engine is shut down.

BATTERIES

Maintenance and Service

The electrolyte level of each cell should be checked at the interval specified in the Lubrication and Service Section P, and water added if necessary. The proper level to maintain is 3/8 to 1/2 in. (10-13 mm) above the plates. To insure maximum battery life, use only distilled water or water recommended by the battery manufacturer. After adding water in freezing weather, operate the engine for at least 30 minutes to thoroughly mix the electrolyte.

⚠DANGER

DO NOT SMOKE or allow flame around a dead battery or during the recharging operation. The expelled gas from a dead cell is extremely explosive.

Excessive consumption of water indicates leakage or overcharging. Normal water usage for a unit operating eight hours per day is about one to two ounces per cell per month. For heavy duty operation (24 hour) normal consumption should run about one to two ounces per cell per week. Any appreciable increase over these figures should be considered a danger signal.

Troubleshooting

Two most common troubles that occur in the charging system are undercharging and overcharging of the truck's batteries.

An undercharged battery is incapable of providing sufficient power to the truck's electrical system.

Some possible causes for an undercharged battery are:

- Sulfated battery plates
- Loose or corroded battery connections
- Defective wire in electrical system
- Loose alternator drive belt
- A defective alternator

Overcharging, which causes overheating, is first indicated by excessive use of water. If allowed to continue, cell covers will push up at the positive ends and in extreme cases the battery container will become distorted and cracked.

Leakage can be detected by continual wetness of the battery or excessive corrosion of the terminals, battery carrier and surrounding area. (A slight amount of corrosion is normal in lead-acid batteries). Inspect the case, covers and sealing compound for holes, cracks or other signs of leakage. Check battery hold down connections to make sure the tension is not great enough to crack the battery, or loose enough to allow vibration to open the seams. A leaking battery should be replaced.

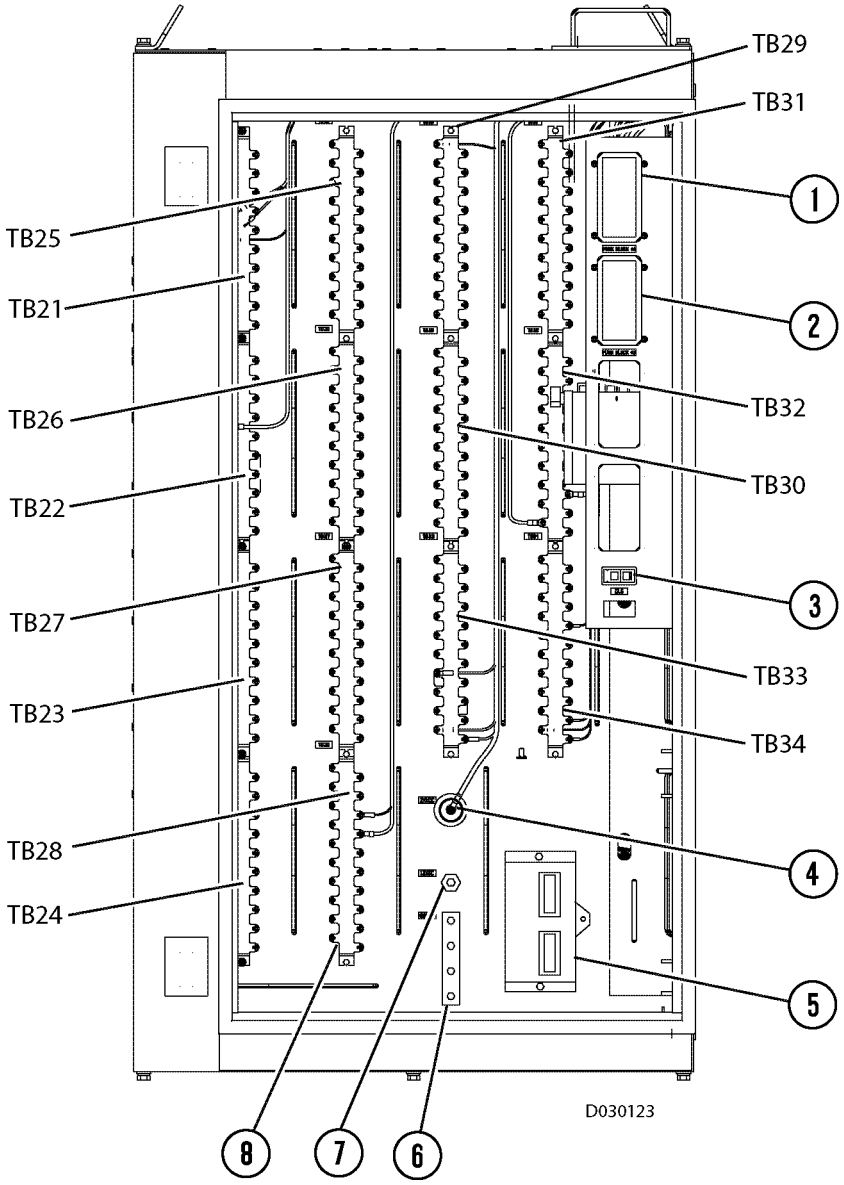


FIGURE 3-1. AUXILIARY CONTROL CABINET - BACK WALL

1. Fuse Block 1
2. Fuse Block 2
3. Dome Light Switch
4. Terminal - 24VDC
5. Pulse Voltage Monitor (PVM)
6. Ground Block (GB31)
7. Terminal - 12VDC
8. Terminal Boards (TB21-TB34)

RELAY BOARD FUNCTIONS

The following describes the components and functions of each relay board.

Relay Board 1 (RB1)

1 - Flasher Power Light (Green): This light will be "ON" when the turn signals or hazard lights are activated.

- ❑ 1 light will be "ON" during right turn signal operation
- ❑ 2 light will be "ON" during left turn signal operation
- ❑ 3 light will be on when clearance lights are activated.
- ❑ 4 light will be flashing when the turn signals or hazard lights are in operation.

NOTE: If circuit breakers (CB13 & CB15) are in the off position, no warning will be noticed until the clearance light switch is turned "ON".

1 - Flasher Module card.

3 - 15 amp circuit breakers (CB13, CB14, CB15)

4 - Relays

- Left Turn Light Relay (K1)
- Right Turn Light Relay (K2)
- Clearance Lights Relay (K3)
- Flasher Relay (K4)

Relay Board 3 (RB3)

1 - Light Module Display card

1 - Rev Light (Green): This light is "ON" whenever the selector switch is in the "reverse" position, and the key switch is in the "ON" position.

4 - 15 amp circuit breakers (CB16, CB17, CB18, CB19)

4 - Relays

- Manual Back-up Lights Relay (K1)
- Stop Lights Relay (K2)
- Retard Lights Relay (K3)
- Slippery Road Relay (K4) (Not used)

Relay Board 4 (RB4)

1- Steering Pressure Bleed Down Timer Module card.

1 - Bleed Down Light (Green): This light is "ON" when the bleeddown solenoid is being energized. The bleeddown timer will energize the solenoid for 90 seconds after key switch is turned "OFF".

2 - 5 amp circuit breakers (CB20, CB22)

1 - 15 amp circuit breaker (CB21)

4 - Relays

- Park Brake Failure Relay (K1)
- Engine Cranking Oil Pressure Interlock Relay (K2)
- Horn Relay (K3)
- Body Up Relay (K4)

Relay Board 5 (RB5)

1 - Light Display Module card

1 - Lights Control Light (Green): This light is "ON" when 24 volts is being supplied to the battery terminal of the light switch.

5 - 15 amp circuit breakers (CB23, CB24, CB25, CB26, CB27)

4 - Relays

- Left Low Beam Relay (K1)
- Right Low Beam Relay (K2)
- Left High Beam Relay (K3)
- Right High Beam Relay (K4)

BATTERY CHARGING SYSTEM (Niehoff)

General Description

The Niehoff model N1227 or C609 (Figure 10-1) is a heavy duty, 24 VDC unit rated at 240 amps. A solid state voltage regulator (6) mounted externally on the end housing assembly provides voltage control during operation. A single output connection (5) is located on the face of the control unit (4) for connection to the truck battery positive circuit. The ground circuit cable can be attached to either of two terminals (10) located on the front housing. A fan guard (7) protects maintenance personnel from the rotating fan when the engine is operating.

TROUBLESHOOTING PROCEDURES (On-Truck)

Most 24 volt charging system problems can be diagnosed with the alternator installed on the truck, operating under normal conditions. Many problems can be attributed to loose or corroded cable connectors. It is essential that all battery charging circuit cables are in satisfactory condition and all connections are clean and securely tightened.

Equipment Required:

- Belt tension scale
- Voltmeter, 0 - 40 volt range
- Ammeter, 0 - 400 amp range

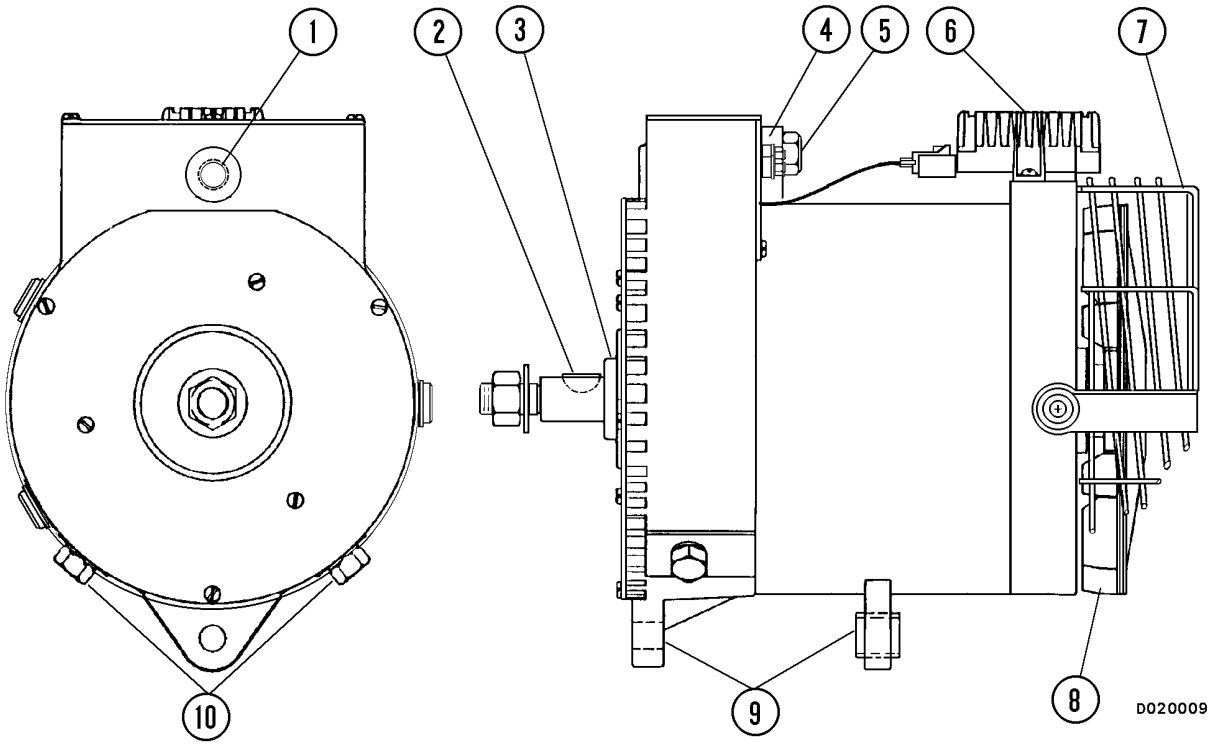


FIGURE 10-1. ALTERNATOR EXTERIOR

1. Belt Tension Adjustment Capscrew
2. Shaft Key
3. Pulley Bushing
4. Control Unit
5. Battery Positive Terminal
6. Voltage Regulator
7. Fan Guard
8. Cooling Fan Assembly
9. Mounting Lugs
10. Ground Terminals

SERVICE PARTS

Ref No.	Part No.	Qty.	Description
1	BF3715	1	LOCKNUT (1)
2	BF1997	1	FLAT WASHER (1)
3	EF3527	1	PULLEY
4	BF1966	1	BUSHING, PULLEY
5	BF1989	1	RING, RETAINER (1)
6	BF1968	1	BEARING, FRONT
7	BF1988	1	RING, RETAINER (1)
8	BF1990	15	SCREW, PAN HEAD - #8 - 32NC X 3/8" (1)
9	BF1970	1	PLATE, COVER
9.a	BF3712	1	HOUSING, FRONT
10	BF2002	18	NUT - (SPECIAL)
11	BF1969	1	COVER, CONTROL UNIT
12	BF1972	1	TERMINAL, OUTPUT
13	BF1971	1	CONTROL UNIT
14	BF3716	1	BOLT (+) - 5/16" - 18NC X 3/4"
15	BF1995	1	LOCKWASHER - 5/16" (1)
16	BF1996	1	FLAT WASHER (1)
17	BF3717	1	LOCKWASHER (1)
18	BF3718	1	CAPSCREW - 1/2" - 13NC X 1" (1)
19	BF3720	1	KEY WOODRUFF (1)
20	BF1973	1	SHAFT/CORE/ROTOR ASSEMBLY
20.a	BF1974	2	ROTOR ASSEMBLY
20.b	BF1975	1	SHAFT/CORE ASSEMBLY
20.c	BF3713	2	RING, RETAINING
21	BF1992	2	LOCKWASHER (1)
22	BF1991	2	CAPSCREW - 3/8" - 16NC X 5/8" (1)
23	BF3719	12	CAPSCREW - #10 - 32NF X 1/2" (1)
24	BF3721	9	NUT - #8 - 32NC (1)
25	BF1976	1	SHELL/STATOR/FIELD ASSEMBLY
25.a	BF1977	1	STATOR, FRONT
25.b	BF1980	9	STUD
25.c		1	SHELL (2)
25.d	BF1981	1	BUSHING, TENSION
25.e	BF1978	1	COIL
25.f	BF1979	1	STATOR, REAR
26	BF3722	18	SCREW, PAN HEAD - #6 - 32NF X 3/8" (1)
27	BF3723	9	NUT - #8 (1)
28	BF1982	1	HOUSING, END
29	BF1983	1	BEARING, REAR
30	BF3724	2	SCREW, LOCK - #10 - 32NC X 5/8" (1)
31	BF1962	1	REGULATOR
32	BF3714	1	O-RING
33	BF1985	1	FAN
34	BF2003	1	FLAT WASHER (HARDENED) (1)
35	BF2004	1	LOCKNUT - 1/4" - 20NF (1)
36	BF1961	1	GUARD, FAN
37	BF3725	3	SCREW, SOCKET HEAD - #10 - 32NF X 7/8" (1)

NOTE: (1) NOT SERVICED SEPARATELY - SUPPLIED ONLY IN BF1986 KIT.NOTE: (2) NOT SOLD SEPARATELY

Front Housing Removal

Note: All control box and front housing connections are coated with RTV Silicone Rubber. Remove RTV Silicone Rubber as alternator is disassembled.

1. Remove five screws from control box cover.
2. Remove control box cover (Figure 10-17 A).
3. Loosen terminal strip screws and disconnect 2 field leads (white wires) from control box terminal strip.
4. Remove six screws from front housing cover plate (Figure 10-17 B).
5. Remove front housing cover plate.
6. Remove the six nuts holding phase leads (black wires) to diode studs (Figure 10-17 C).
7. Remove the six phase leads from the diode studs and push the phase leads back through the large openings in front housing (this will facilitate separation of front housing from tube).
8. Remove nine flanged locknuts from stator/tube assembly studs at front of front housing.

Note: The Front housing is attached to the rotor/shaft core assembly.

9. Separate front housing with the rotor/shaft/core assembly from the stator/tube assembly. Light taps with a soft faced mallet will help in the separation of parts.
10. Support front housing on wood blocks. Using a press, press shaft through front housing bearing.

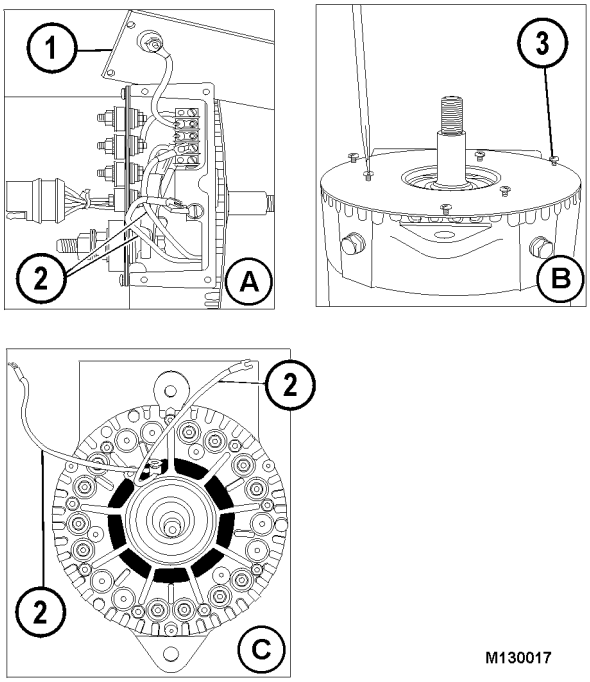


FIGURE 10-17.

1. Cover
2. Field Leads (white wires)
3. Front Cover Screw

Rear Bearing Assembly

1. Assembly alternator, including end housing, but leave out rear bearing and fan. Make sure mounting feet are aligned.Install front pulley bushing on shaft.
2. There are two types of rear bearing systems used: press fit and loose fit.

Press Fit Bearings

Stand alternator on front end, in a press, supporting the front bearing bushing. Insert bearing over rear end of shaft. Place bearing insertion tool (part of BF4821 package) over bearing and press until inner race of bearing is seated onto shaft shoulder (Figure 10-41). Use caution when bearing outer race begins to enter end housing bore because misalignment at this point can damage housing.

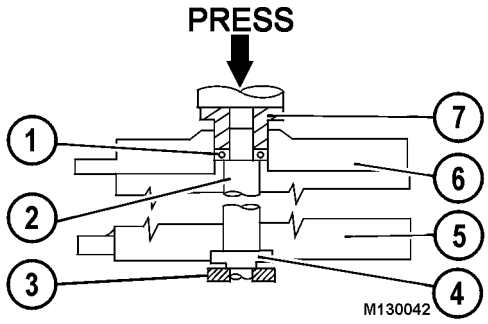


FIGURE 10-41.

1. Ball Bearing
2. Shaft
3. Support
4. Bushing
5. Front Housing
6. End Housing
7. BF4821 Insertion Tool

Loose Fit Bearings

Before starting installation of loose fit rear bearings, check that O-ring is greased (grease with Amoco Rykon or equivalent) and properly installed in O-ring groove in housing bore. Continue with bearing installation as above.

3. Turn shaft by hand to make sure it spins freely. Fan and fan hardware can now be installed.

Regulator Assembly

1. Set regulator on rear housing with regulator plug toward control box.
2. Using mounting hardware (coated with Loctite), attach regulator to end housing (Figure 10-42). Torque screw to **32 in. lbs. (3.6 N.m)** maximum.
3. Connect regulator to regulator harness from control unit.

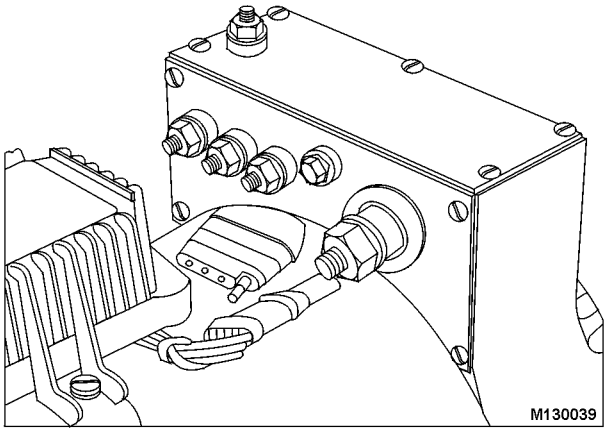


FIGURE 10-42.

ELECTRICAL PROPULSION SYSTEM COMPONENTS

The following information provides a brief description of system operation and major components of the AC propulsion system. Refer to the appropriate GE publication for detailed information and theory of operation.

A list of commonly used propulsion system component abbreviations is listed in Table V at the end of this Section. Figures 2-3 through 2-11 illustrate the physical location of these components where applicable.

GENERAL SYSTEM DESCRIPTION

The AC drive system consists of the following major components:

- Alternator coupled to a diesel engine
- In-line Cooling Blower
- Gate Drive Power Converters
- Main Rectifier
- AC Power Inverters
- AC Induction Traction Motors

The Alternator supplies three phase power for the Gate Drive Power Converters and Main Rectifier. The Main Rectifier supplies DC power to two AC Power Inverters. Each AC Power Inverter inverts the rectified DC voltage, delivering variable voltage, variable frequency power to each of the AC Induction Traction Motors.

Refer to the diagram in Figure 2-1 for the following description.

The two AC Induction Traction Motors, each with its own Inverter, are connected in parallel across the rectified output of the Alternator. The Inverters change the rectified voltage back to AC by turning on and off (chopping) the applied DC voltage.

The output AC voltage and frequency are controlled to produce optimum slip and efficiency in the traction motors. At low speeds, the rectified alternator output (DC link, or DC bus) voltage is chopped with patterns called pulse width modulation (PWM) inverter operation. At higher speeds, the DC link voltage is applied to the motors using square wave inverter operation. The voltage of the DC link is dependent upon the Propulsion System Controller (PSC) and engine RPM during propulsion. The link voltage will vary between 600 and 1400 volts during propulsion and 600 and 1500 volts during retarding.

The alternator field is supplied from a tertiary winding on the alternator and is controlled by a silicon controlled rectifier (SCR) bridge. A starting boost circuit initially energizes the alternator from the truck batteries until the flux builds up enough to sustain excitation.

Cooling air for the Alternator, Control Cabinet and traction motors is supplied by a dual in-line fan assembly mounted on the rear of the alternator. This blower provides cooling air to the traction motors, propulsion inverters, dynamic retarding choppers, and auxiliary inverter.

A resistor grid package is used to dissipate power from the traction motors (operating as generators) when in dynamic retarding mode. The total retard power produced by the traction motors is controlled by the two motor Inverters. The amount of retard power dissipated by the grid package is controlled by a GTO Chopper circuit and stage-controlled contactors.

The PSC, mounted in the main Electrical Control Cabinet, determines optimum engine operating speeds based on what the operator requests, propulsion system requirements, and efficient fuel usage. Interfaces between the PSC and the truck brake system allow the PSC to provide proper retarding, braking, and wheel slide control.

The PSC interfaces with the Truck Control Interface (TCI), mounted in the same card rack as the PSC. System status and control signals are transmitted and received between these two components to access real time data and event information stored in the PSC for displaying on a Diagnostic Information Display (DID), located in the cab behind the operator's seat.

TABLE II: DID PANEL FAULT CODES
(Codes Received from PSC)

EVENT NUMBER		EVENT DESCRIPTION	EVENT RESTRICTION	DETECTION INFORMATION
	:09	chopper GTO temp	Speed limit	Temp out of range.
	:10	chopper diode temp		Temp out of range.
	:11	left GTO module temp		Temp out of range.
	:12	left diode temp		Temp out of range.
	:13	right GTO module temp		Temp out of range.
	:14	right diode temp		Temp out of range.
	:15	rectifier diode temp		Temp out of range.
070		LINK CAPACITANCE LEVEL LOW	SYS Event	Link capacitance level low, but OK
071		LINK CAPACITANCE LEVEL TOO LOW	Speed Limit	Link capacitance level too low
072		GROUND FAULT CIRCUIT	Speed Limit	Ground fault detection circuit
074		INV1 COMM FAILED	INV1 Disable	
	:01	No communication Inverter #1		
	:02	Inverter #1 customer option bit		
075		INV2 COMM FAILED	INV2 Disable	
	:01	No communication Inverter #2		
	:02	Inverter #2 customer option bit		
076		FB173 CARD	No power	FB173 card failure
	:01	speed FPGA DL		
	:02	speed FPGA run		
	:03	ALT FPGA DL		
	:04	Microcontroller		
	:05	slow task		
	:06	med task		
	:07	fast task		
	:08	FD task		
	:09	Alternator 3 phase volts bad		
	:10	alt FPGA timeout		
077		INVERTER FAILED VI TEST	No power	Inverter failed during test.
078		Inverter Background Communication Failure	Sys Event	A failure in the inverter background communication was detected.
084		CONTROL POWER SWITCH OFF	SYS Event	Control Power Switch is turned off while truck is moving.
085		AUX COOLING	SYS Event	A fault has occurred in the auxiliary blower operation.
	:02	aux rpmfb input		Rpm of Aux Blower out of range.
	:03	aux rpm feedback		Rpm feedback does not match rpm command.
	:04	abnormal shutdown		A fault occurred during shutdown
087		HP LOW		Horsepower adjust is at negative limit for 30 seconds.

TABLE III: DID PANEL FAULT CODES (Codes Received from Inverter 1, 2)				
EVENT NUMBER		**EVENT DESCRIPTION**	**EVENT RESTRICTION**	**DETECTION INFORMATION**
135/235		INVERTER, PHASE C+/C-	INV1 (INV2) off	
	:01	alarm CP		Phase C positive GTO did not turn off
	:02	Cup fb not off		Phase C up feedback not off
	:03	phase C modl pos		Phase C positive module failed
	:04	hold CP		Phase C positive and negative GTOs on (positive turn on)
	:05	Cup fb not on		Phase C up feedback not on
	:06	Cup GTO not on		Phase C positive GTO did not turn on
	:07	IGBT_PS_CP		IGBT protective shutoff
136/236		INVERTER, PHASE C+	None	
	:02	Cup temp short		Phase C up thermistor short
	:03	Cup temp open		Phase C up thermistor open
	:04	Cup temp warm		Phase C up thermistor warm
	:05	Cup temp hot		Phase C up thermistor hot
	:06	Cup fb not off S		Phase C up not off with enable/DC volts
137/237		INVERTER, PHASE C-	INV1 (INV2) off	
	:01	alarm CN		Phase C negative GTO did not turn off
	:02	Cdn fb not off		Phase C down feedback not off
	:03	phase C modl neg		Phase C negative module failed
	:04	hold CN		Phase C positive and negative GTOs on (negative turn on)
	:05	Cdn fb not on		Phase C down feedback not on
	:06	Cdn GTO not on		Phase C negative GTO did not turn on
	:07	IGBT_PS_CN		IGBT protective shutoff
138/238		INVERTER, PHASE C- (NR)	None	
	:02	Cdn temp short		Phase C down thermistor short
	:03	Cdn temp open		Phase C down thermistor open
	:04	Cdn temp warm		Phase C down thermistor warm
	:05	Cdn temp hot		Phase C down thermistor hot
	:06	Cdn fb not off S		Phase C down not off with enable/DC volts
141/241		INVERTER, PHASE C VOLTS	INV1 (INV2) off	
	:01	V sensor phase C		Phase C voltage sensor failed
	:02	VC not ok		Phase C voltage too high

Transition from Ready State to Retard State:

The system will transition from Ready state to Retard state if truck speed is such that retard is allowed and at least one of the following conditions exists:

1. The retard pedal or lever is pressed such that a significant amount of retarding effort is requested.
2. All of the following conditions are true:
   a. Retard speed control is selected.
   b. Truck speed exceeds the set retard speed, or the truck is accelerating such that the truck speed will soon exceed the set retard speed if no action is taken.
   c. One or both of the following conditions are true:
      1.) The accel pedal is not pressed, or
      2.) The truck is configured such that accel pedal signal does not override retard speed control.
3. Truck speed is greater than or equal to motor overspeed limit. Overspeed will not be engaged such that it prevents the truck from propelling at 40 mph (64 kph).

Transition from Rest State to Test State:

The system will transition from Rest state to Test state upon release of the TCI rest request.

NOTE: A transition directly from Rest state to Ready state is not allowed because the system is essentially off and should be brought back on-line and checked out before Ready state is entered.

Transition from Propel State to Ready State:

The system will transition from Propel state to Ready state if all of the following conditions exist:

1. The accel pedal is not pressed.
2. The retard pedal or lever is not pressed or is pressed such that an insignificant amount of retarding effort is requested.
3. Truck speed is less than the motor overspeed limit.
4. At least one of the following conditions is true:
   a. Retard speed control is not selected.
   b. Truck speed is below the set retard speed, and acceleration is such that no retard effort is (currently) required to maintain this condition.

Transition from Propel State to Retard State:

The system will transition directly from Propel state to Retard state if at least one of the following conditions exists:

1. Truck speed is such that retard is allowed, and the retard pedal or lever is pressed such that a significant amount of retarding effort is
2. Truck speed exceeds the motor speed limit. Overspeed Will not be engaged such that it prevents the truck from propelling at 40 mph (64 kph).
3. All of the following conditions are true:
   a. Retard speed control is selected.
   b. Truck speed exceeds the set retard speed, or the truck is accelerating such that the truck speed will soon exceed the set retard speed if no action is taken.
   c. The truck is configured such that accel pedal signal does not override retard speed control.

Transition from Retard State to Ready State:

The system will transition from Retard state to Ready state if all of the following conditions exist:

1. Overspeed is not active.
2. At least one of the following conditions is true:
   a. The retard pedal or lever is not pressed or is pressed such that an insignificant amount of retarding effort is requested.
   b. Truck speed is such that retard is not allowed.
3. At least one of the following conditions exists:
   a. Retard speed control is not selected.
   b. Truck speed is low enough such that retard speed control is not active.
   c. The accel pedal is pressed, and the truck is configured such that the accel pedal overrides retard speed control. This allows the configuration constant to determine if pressing on the accel pedal kicks the truck out of retard, even if retard speed control is still active.
4. The retard torque control logic exit sequence is complete.

PROPULSION SYSTEM COMPONENT ABBREVIATIONS

The following Tables list component abbreviations used in schematics and system description information. Refer to Figures 2-3 through 2-11 for the location on the truck of components listed in the Ref. No. column.

The GE part number for major components is shown in parentheses. A short description of the component's primary function is also listed.

TABLE V: PROPULSION SYSTEM COMPONENTS DESCRIPTION

	REF. NO.	COMPONENT	FUNCTION
AFSE	36	Alternator Field Static Exciter Panel (17FM466)	Regulates current in the alternator field based on firing pulses from the PSC.
AFSER	62	Resistor	AFSE Battery boost command pull up resistor.
ALT		Alternator (5GTA34)	Main alternator, propulsion and control system.
AMBTS	11	Ambient Temperature Sensor	Provides ambient air temperature input to the control group.
ANALOG I/O CARD		System analog input/output card (17FB173)	Provides signal conditioning for analog signals to and from the TCI and PSC.
BATFU1, 2	19	System Fuse	Provides overload protection for control equipment and the System Batteries.
BATTSW		Battery Disconnect Switch (System Batteries)	Connects and disconnects the 12 VDC and 24 VDC circuit batteries (located at right front corner of truck).
BDI	30	Battery Blocking Diode	Works in conjunction with BFC and BLFP to maintain battery voltage to CPU.
BFC	34	Battery Line Filter Capacitor	Additional capacitance for BLFP to prevent nuisance CPU resets.
BFCR	60	Battery Filter Resistor	Added to replace Battery line filter that was removed.
BM1, 2	24	Grid Blower Motors 1 and 2 (5GY19)	DC motors driving blowers to provide cooling air for the retarding grids.

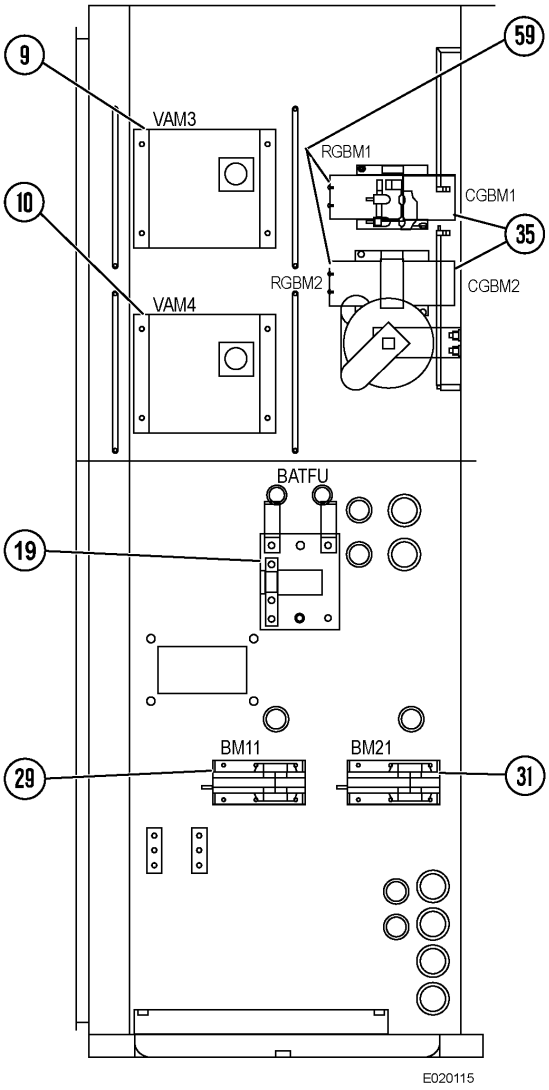


FIGURE 2-7. ELECTRICAL CABINET
VIEW B-B, END VIEW

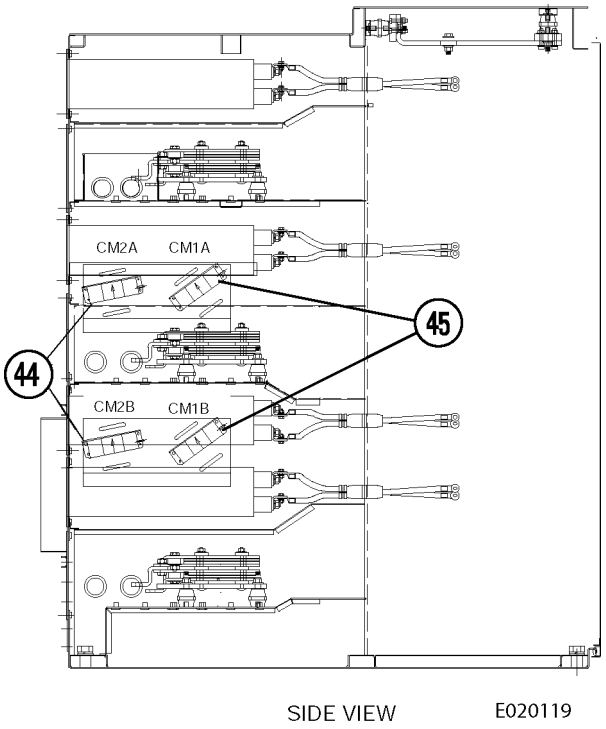
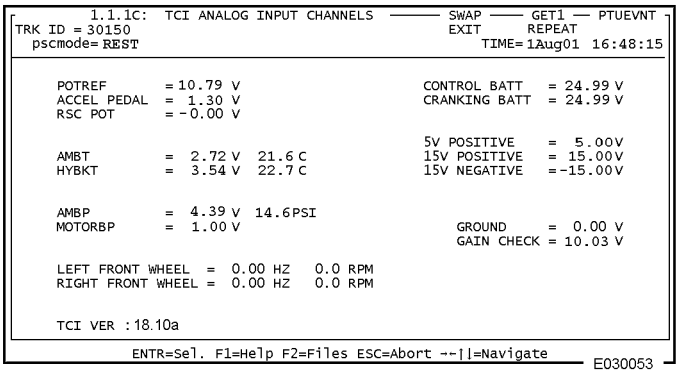


FIGURE 2-8. ELECTRICAL CABINET
VIEW C-C

TABLE I. CIRCUIT RESISTANCE CHECKS
(All readings - from circuit to ground)

CIRCUIT	LOCATION	APPROX. VALUE	NOTES
11B1	*	∞	* Measure at the 12VDC insulator in the Electrical Interface Cabinet
11	*	∞	*Measure at the 24VDC insulator in the Electrical Interface Cabinet. All devices listed for 11A circuit reading must be OFF.
15V	TB21	∞	
71GE	TB22	120Ω	
71TCI	TB23	120Ω	17FL349 Panel Only (Not applicable on 17FL373 Panel.)
439	TB25	∞	
10V	TB28	∞	
11SL	TB28	∞	Engine service lights turned OFF.
11ST	TB28	∞	
15PV	TB29	∞	
11S	TB30	∞	Ground level engine shutdown switch open
11A	TB30	∞	*The following must be turned OFF:* Brake cabinet service light, operator cab light, passenger seat compartment service light, hazard lights, headlights, ground level engine shutdown switch, engine governor heater switch (MTU 396 only - in Electrical Interface Cabinet), left and right side engine service lights.
11T	TB30	>36Ω	Engine governor heater switch in Electrical Interface Cabinet open. (MTU 396 engine only)
11FR	TB30	∞	(MTU 396 engine only)
11HTR	TB30	∞	(MTU 396 engine only)
712	TB32	∞	The Electrical Interface Cabinet service lights must be switched OFF.
71	TB32	∞	
11L	CB30	∞	Measure at circuit breaker CB30 in cab.
12M	*	>10Ω	*Measure at AID Module terminal B-13 under passenger seat in cab.
12F	*	>200Ω	*Measure at AID Module terminal B-12 under passenger seat in cab.

3. Press {enter} to display “TCI ANALOG INPUT CHANNELS” screen below:



Miscellaneous Checks

A3PV Panel

1. Remove the wires from panel terminals A and C.
2. With the Control Power Switch ON, measure voltage between terminals D and F:
   - ☐ Verify 0.0 ±30 Millivolts.
3. Connect a jumper wire from the BATFU fuse located on the bottom left wall in the left compartment to terminal A on A3PV.
4. Connect a jumper wire from a cabinet ground to terminal C on A3PV.
5. Measured voltage between terminals D and F.
   - ☐ Verify panel output is 0.12 volts (battery volts divided by 200)
6. Connect a serial communication cable from the PTU to the PSC.
7. On the PSC PTU, enter the following:

- ◆ c:\>ACNMENU {enter}
- ◆ Highlight “PTU TCI & PSC” {enter}
- ◆ Type your name {enter}
- ◆ Type your password {enter}
- ◆ Cursor to Normal Operation {enter}
- ◆ Cursor to “PSC Real Time Data Screen” {enter}
  - ☐ Verify A3PV is approximately 1.17 X battery volts

8. Remove the jumper wires.
9. Reconnect the wires to terminals A and C.

LINKV Panel

1. Remove the wires from panel terminals A and C.
2. With the Control Power Switch ON, measure voltage between terminals D and F:
   - ☐ Verify 0.0 ±30 Millivolts.
3. Connect a jumper wire from the BATFU fuse located on the bottom left wall in the left compartment to terminal A on LINKV.
4. Connect a jumper wire from a cabinet ground to terminal C on LINKV.
5. Measure voltage between terminals D and F.
   - ☐ Verify panel output is 0.12 volts (battery volts divided by 200)
6. With the PTU connected to the PSC, enter the following:

- ◆ c:\>ACNMENU {enter}
- ◆ Highlight “PTU TCI & PSC” {enter}
- ◆ Type your name {enter}
- ◆ Type your password {enter}
- ◆ Cursor to Normal Operation {enter}
- ◆ Cursor to “PSC Real Time Data” {enter}
  - ☐ Verify LINKV is equal to battery volts

7. Remove the jumper wires. Reconnect the wires to terminals A and C.

Thermistor Checks

1. With the PTU connected to the PSC:

- ◆ Cursor to Normal Operation {enter}
- ◆ Cursor to “PSC Real Time Data” {enter}
  - ☐ Verify AUXPCT is showing ambient temperature
  - ☐ Verify AUXIT is showing ambient temperature
  - ☐ Verify AFSET is showing ambient temperature

17FM384 Panel Check

1. With the PTU connected to the PSC;

- ◆ Cursor to Normal Operation {enter}.
- ◆ Cursor to “PSC Real Time Data” {enter}

2. Carefully remove the “FAILDIOD” wire from terminal D on the 17FM384 panel.
   - ☐ Verify FDIODE is highlighted on PTU screen
3. Reconnect wire to terminal D.

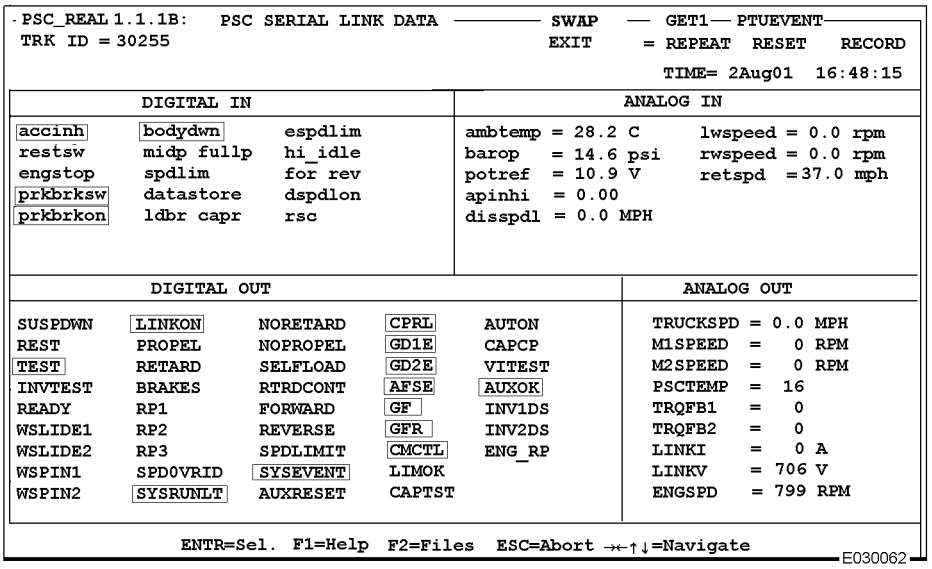


FIGURE 3-14. PSC SERIAL LINK DATA SCREEN

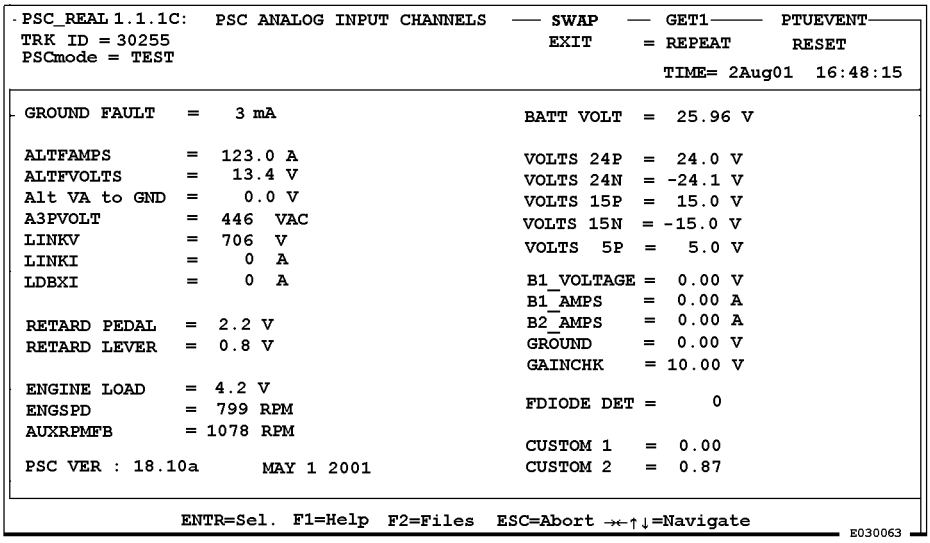


FIGURE 3-15. PSC ANALOG INPUT CHANNELS

Subcode 07:

Description: A low DC bus voltage was detected after the phase controller power up sequence.

1. Check the 3-phase input connections and fuses F1 and F2.
2. If no problem was found in step 1, use an ohmmeter to check for short circuits between AM101, AM201, and AM301 wires and between IV+ and IV-.
3. If no problem was found in step 1 or 2, replace the controller.

Subcode 08:

Description: A high DC bus voltage was detected during operation.

1. Check Capacitor Bank and Controller connections.
2. Check DC Sense connection (connector J13 to IV+ (red wire) and IV- (black wire)).
3. If problem still exists, replace controller.

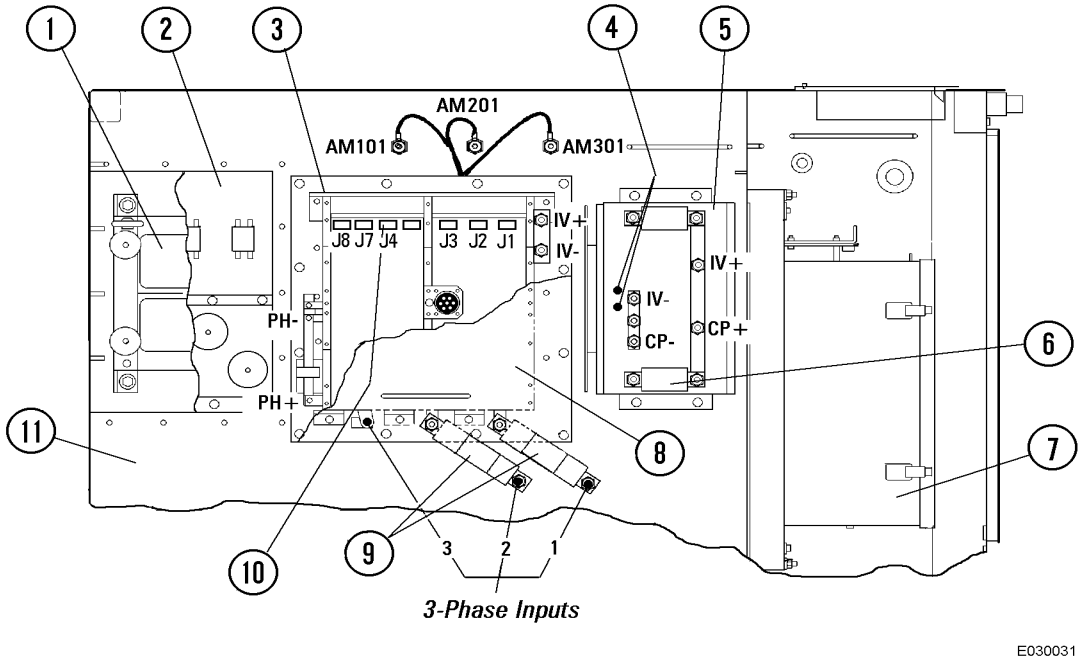


FIGURE 3-22. AUXILIARY BLOWER CONTROL COMPONENTS

1. Auxiliary Inductor (AXIND)
2. Snubber (AUX SNUB)
3. Auxiliary Inverter (Controller AXINV)
4. Blower Control System Warning LED's
5. Auxiliary Power Filter Capacitor Bank (AXCAP)
6. Capacitor Fuses
7. Propulsion System Controller (PSC)
8. Cover
9. Input Fuses (F1 & F2)
10. 3- Pin Connector

TIRES AND RIMS

Truck tires should be inspected and tire pressure checked with an accurate pressure gauge before each working shift. Tire pressure will vary according to manufacturer and local working conditions. Consult the tire manufacturer for recommended tire pressure.

Ensure valve caps are securely applied to valve stems. The caps protect valves from dirt build up and damage. DO NOT bleed air from tires which are hot due to operation; under such circumstances, it is normal for pressure to increase in the tire due to expansion.

A bent or damaged rim which does not support the bead properly may cause abnormal strain on the tire resulting in tire damage. If a tire is deeply cut, it should be removed and repaired. Neglected cuts cause many tire problems. Water, sand, dirt and other foreign materials work into the tire through a cut, eventually causing tread or ply separation.

Tires should be stored indoors if possible. If stored outdoors, cover tires with tarpaulin to keep out dirt, water and other foreign materials. Long exposure to the sun will cause ozone cracks. Storage should be in a cool, dry, dark, draft free location. Tires should be stored vertically. If they must be laid on their sides for a short period, avoid distortion by stacking no more than three tires on top of one another. Avoid contact with oil, grease and other petroleum products.

Before storing used tires, clean thoroughly and inspect for damage. Repair as necessary. When a truck is placed in storage, it should be blocked to remove the weight from the tires. If a stored truck cannot be blocked, check air pressure and inspect tires twice a month for proper inflation pressure.

⚠WARNING

DO NOT weld or apply heat on the rim assembly with the tire mounted on the rim. Remaining gases inside the tire may ignite causing explosion of tire and rim.

DO NOT go near a tire if a brake or wheel motor has experienced a fire until the tire has cooled.

⚠DANGER

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 lockring during inflation procedures. Never overinflate a tire. Refer to tire manufacturers recommendations.

Always keep personnel away from a wheel and tire assembly when it is being removed or installed.

The tire and rim weigh approximately 14,285 lbs. (6,480 kg). Be certain tire handling equipment is capable of lifting and maneuvering the load.

Due to the size and weight of the tire and rim assemblies, special handling equipment such as a modified fork lift (“tire handler”) as shown in Figure 2-1 is desirable. Consult local tire vendors for sources of equipment designed especially to remove, repair, and install large off-highway truck tires.

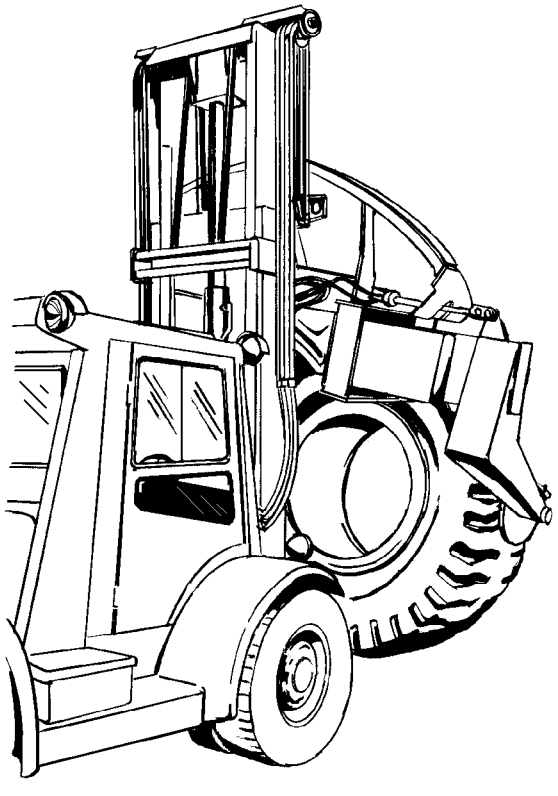


FIGURE 2-1. TYPICAL TIRE HANDLER

SECTION G3

FRONT WHEEL HUB AND SPINDLE

INDEX

23. After the brake assembly is properly positioned on the adapter and the four capscrews are snug, remove the alignment studs.

    Remove socket head capscrews (34) securing seal retainer (37) to brake assembly (18).

    Install the remaining brake adapter/brake assembly mounting capscrews (20) and hardened flatwashers (21). Tighten the capscrews to **1995 ± 100 ft. lbs. (2705 ± 136 N.m)**.

24. Install bearing retainer pin (40) in groove in spindle. Align and slide outer bearing cone (7) over pin. Lubricate the bearing with clean hydraulic oil.

25. Install shim pack (8), retainer (13), capscrews (11), and washers (12). Tighten the capscrews alternately in several successive increments while rotating the hub. Final torque is **750 ± 75 ft. lbs. (1017 ± 100 N.m)**.

26. Install a new O-ring (41) on cover (5). Install the cover, capscrews, and washers. Tighten the capscrews to standard torque.

Seal Assembly Gap Check

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

The ideal gap is 0.433 in (11.0 mm). If necessary, the gap must be adjusted, using shims as required to maintain a **minimum** gap of 0.423 in (10.75 mm) to 0.443 in (11.25 mm) **maximum**.

27. Measure seal gap as follows:

    a. Measure gap, dimension "A", Figure 3-7 at three, equally spaced places and record the results.

    b. Add the three dimensions and divide the result by 3 to obtain the average gap width

28. If average gap width is not between the minimum and maximum allowable range, loosen the seal retainer capscrews (4, Figure 3-6) and add shims (5) as required to **reduce** the gap or remove shims to **increase** the gap. **The quantity and thickness of shims at each of the six locations must be equal.**

29. Re-tighten seal retainer capscrews to standard torque and measure gap as described in Step 28. If necessary, repeat Step 29 until the proper gap is maintained.

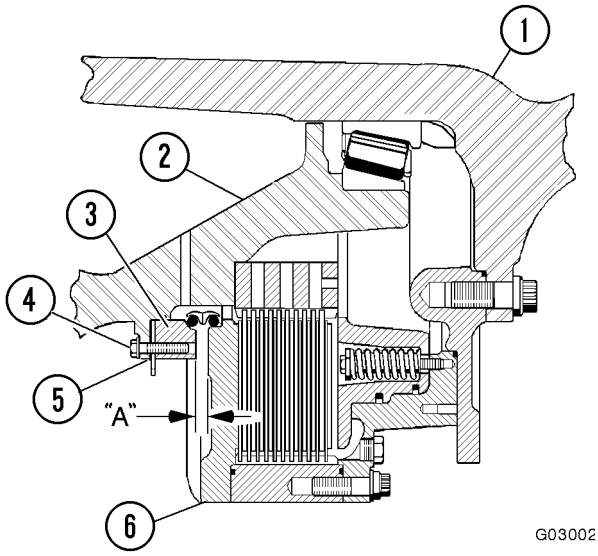


FIGURE 3-7. MEASURING SEAL GAP

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

30. Install speed sensor(s) (16, Figure 3-6) in support bracket(s) (17). Adjust sensor gap as follows:

    a. Rotate hub to position the top of a gear tooth directly under the sensor tip.

    b. Insert a 0.060 in (1.5 mm) feeler gauge between sensor tip and gear tooth. Loosen and adjust sensor clearance.

    c. Lock the sensor in place.

    d. Rotate hub 180° and verify clearance remains within 0.040 in (1.0 mm) minimum to 0.080 in (2.0 mm) maximum.

31. Install speed sensor cables.

32. Install hub and spindle assembly on suspension per instructions in Installation.

PIVOT EYE BEARING

Removal

1. Remove capscrews and locknuts (5 and 6, Figure 4-2).
2. Remove bearing retainers (2).
3. Setup an appropriate tool to press spherical bearing (4) from the pivot eye.
4. Inspect all parts for wear or damage. Replace any parts showing excessive wear or damage.

Spherical bearing outer race O.D.:

8.7500 - 8.7488 in. (222.25 - 222.22 mm)

Bearing bore I.D.:

5.9990 - 6.0000 in. (152.37 - 152.40 mm)

5. If bearing carrier (3) is damaged or worn, refer to Pivot Eye Repair in this section for repair procedure.

NOTE: Some trucks may not be equipped with bearing carrier (3).

Installation

1. Set up an appropriate tool to press spherical bearing (4, Figure 4-2) into the pivot eye. Ensure the bearing is centered and properly installed in the pivot eye to allow proper lubrication.
2. Install bearing retainers (2) using capscrews (5) and locknuts (6). Tighten the capscrews to standard torque.

PIVOT EYE REPAIR

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

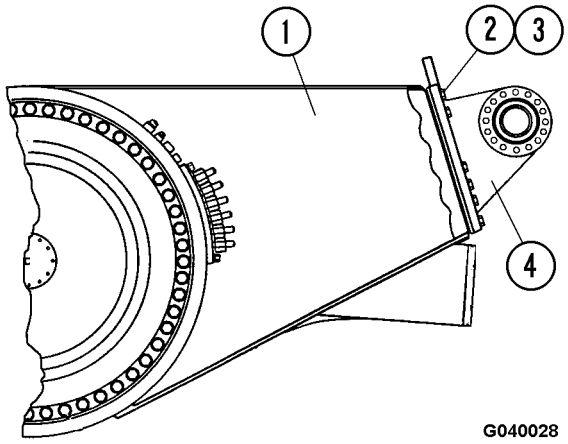


FIGURE 4-3. PIVOT EYE ATTACHMENT

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

Removal

To remove the axle housing pivot eye:

1. Follow all preceding instructions in Pivot Pin - Removal.

Be certain axle housing (1) and wheels are blocked, securely.

2. Attach a lifting device to pivot eye (4). The weight of the pivot eye is 762 lbs. (346 kg).
3. Remove capscrews (2) and flatwashers (3). Remove pivot eye.

Disassembly

1. Remove spherical bearing (4, Figure 4-2) as described in Pivot Eye Bearing - Disassembly.
2. If bearing carrier (3) (if equipped) is damaged or worn, setup an appropriate tool to press the bearing carrier out of the pivot eye bore.

Bearing carrier (new) (if equipped):

I.D. = 8.7484 ± 0.0005 in. (222.209 ± 0.013 mm)

O.D.= 9.7520 ± 0.0005 in. (247.701 ± 0.013 mm)

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

11. Disconnect wheel motor power cables (7) at wheel motor terminals. Disconnect speed sensor cable at connector in center of housing.
12. Tie up cables and hoses as necessary to prevent damage during wheel motor removal.

⚠ IMPORTANT ⚠

Each complete wheel motor assembly weighs approximately 39,975 lbs. (18,132 kg.). Be certain lifting device is capable of handling the load safely.

13. Attach lifting device to wheel motor assembly. **DO NOT allow lifting device to contact brake housing.**
14. Remove capscrews (15) and hardened flatwashers (16) securing wheel motor to rear housing.
15. Move wheel motor assembly out of axle housing, using care to prevent damage to brake hoses if not removed previously.
16. Refer to appropriate GE service information for wheel motor repair instructions.

Cleaning and Inspection - Wheel Motor

1. Thoroughly clean the capscrew holes and mounting faces of the rear housing and the wheel motor.
2. Re-tap holes if threads are damaged.
3. Check mounting faces of wheel motor and rear housing for nicks, scratches or other damage.
4. Check components inside axle housing. Inspect brake system relay valve (6, Figure 5-1) and hoses for leaks. Inspect manifold (4) hose connections and repair leaks or damaged hoses.
5. Inspect wheel motor power cables, terminals, cable grips, and clamps. Replace any cables or hardware that is damaged or worn.

⚠ IMPORTANT ⚠

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

⚠ CAUTION

High tightening force is required on wheel motor mounting capscrews. Repeated tightening will cause capscrew material to fatigue and break. DO NOT reuse wheel motor mounting capscrews and washers more than twice after original installation. The mounting hardware must be replaced after the third use.

The following method is suggested to control the "3 - Use" maximum:

Punch mark the capscrew heads with a center punch after each tightening as follows:

- Initial Installation . . . . . .Zero marks
- Second Installation . . . . . One punch mark
- Third Installation . . . . . .Two punch marks

Before installation, inspect each capscrew for any defects and number of punch marks. Replace capscrews and washers if two punch marks are evident; do not reuse if any defect is suspected. Hardware showing signs of rust, corrosion, galling, or local yielding on any seat or thread surfaces should be replaced. Replace mounting hardware if the truck was operated with the wheel motors in a loose joint condition. Replace wheel motor mounting hardware with original Komatsu parts.

The hardened flat washers used in this application are punched during the manufacturing process, therefore, they must be assembled with the punch lip away from head of the mounting capscrews to prevent damage to the fillet between capscrew head and shank. Refer to Figure 5-2.

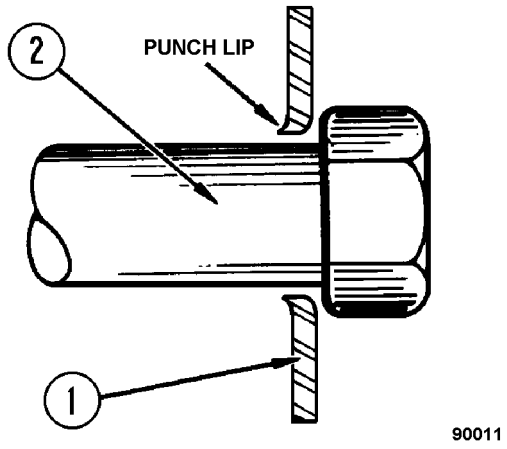


FIGURE 5-2. MOUNTING HARDWARE

1. Washer
2. Capscrew

SECTION H

HYDRAIR® II SUSPENSIONS

INDEX

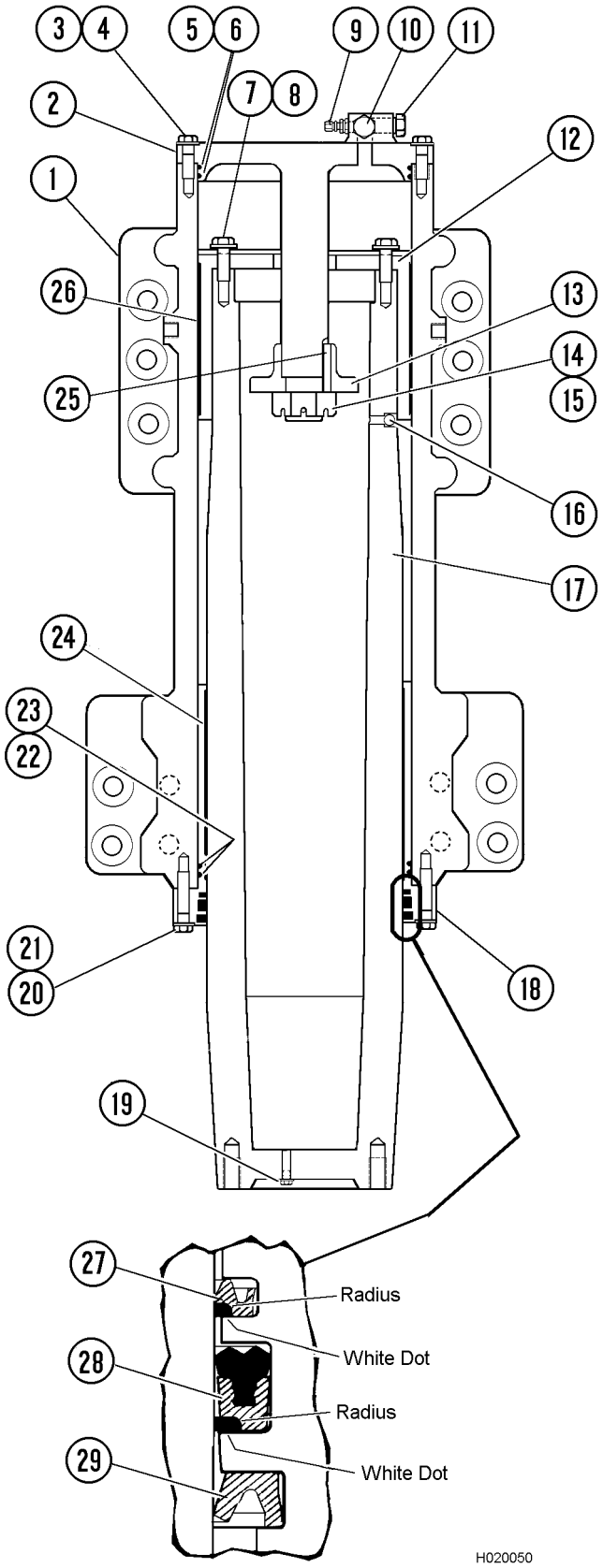
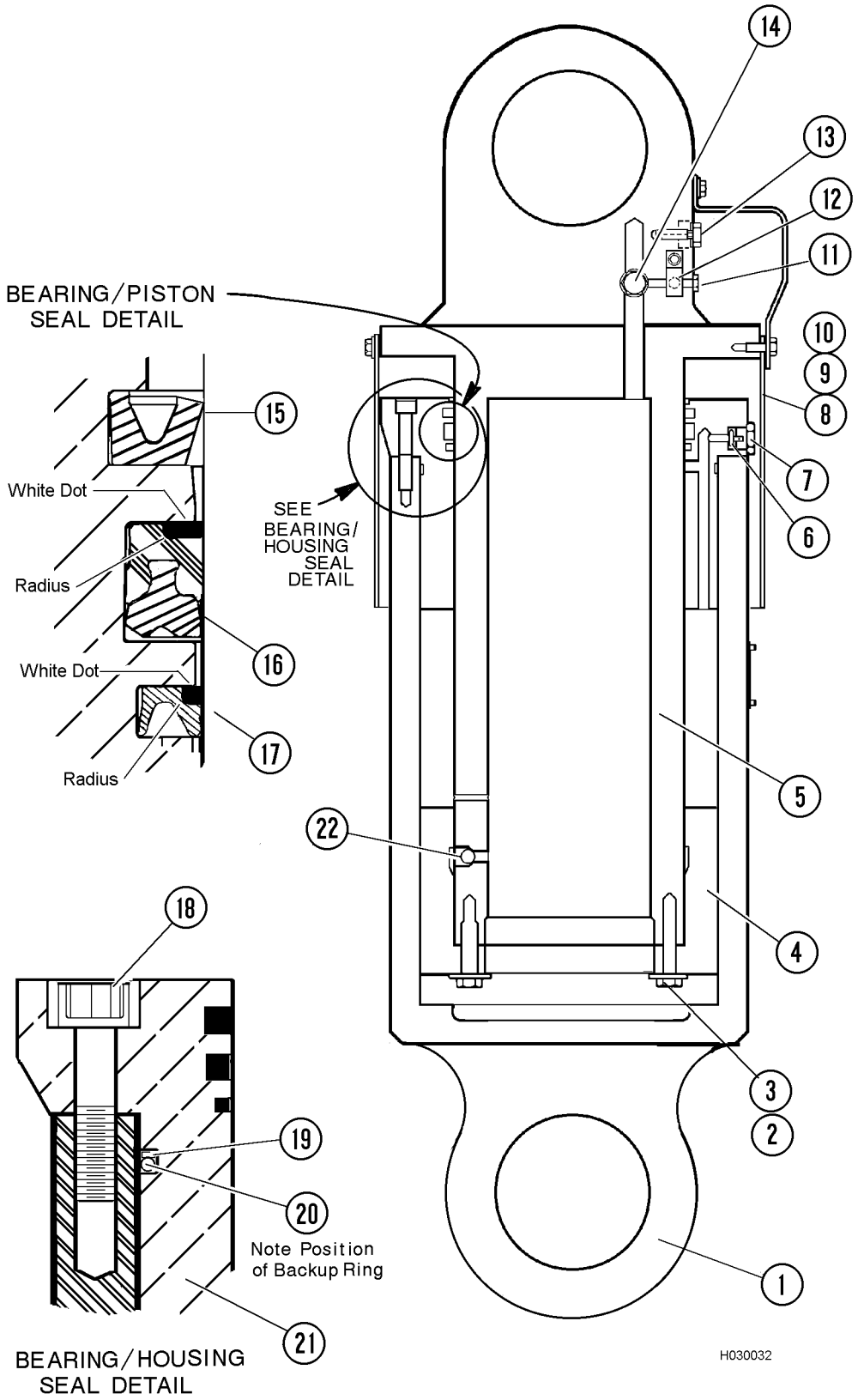


FIGURE 2-9. FRONT SUSPENSION

1. Housing
2. Cap Structure
3. Capscrew
4. Hardened Washer
5. O-Ring
6. Backup Ring
7. Capscrew
8. Hardened Washer
9. Charging Valve Assembly
10. Vent Plug
11. Plug (Pressure Sensor Port)
12. Upper Bearing Retainer
13. Piston Stop
14. Nut
15. Roll Pin
16. Steel Check Ball
17. Piston
18. Lower Bearing Retainer
19. Plug
20. Capscrew
21. Hardened Washer
22. O-Ring
23. Backup Ring
24. Lower Bearing
25. Key
26. Upper Bearing
27. Step Seal
28. Rod Seal
29. Rod Wiper



1. Housing
2. Capscrews
3. Hardened Flatwashers
4. Piston Bearing
5. Piston Rod
6. Bleeder Screw
7. Vent Plug
8. Shield
9. Capscrew
10. Washers
11. Vent Plug
12. Charging Valve
13. Plug (Sensor)
14. Vent Plug
15. Wiper Seal
16. Rod Seal
17. Step Seal
18. Socket Head Capscrew
19. Backup Ring (See Note)
20. O-Ring
21. Housing Bearing
22. Ball Check

FIGURE 3-6. REAR SUSPENSION ASSEMBLY

6. Close inlet valve (4, Figure 4-1). Leave outlet valves (3) open for five minutes in order to allow the pressures in the suspensions to equalize.
7. Ensure both of the suspension cylinders are extended the same distance ± 10 mm (0.39 in.). If the difference in the extension from side to side exceeds 10 mm, check the front suspensions for equal extension. Adjust the front as necessary.

NOTE: A low left front suspension will cause the right rear suspension to be high. A low right front suspension will cause the left rear suspension to be high.

8. Close outlet valves (3) and remove charging kit components. Refer to Removal of Charging Kit in this section.
9. If the charging valve is being reused, tighten swivel nut (4, Figure 4-3) to **4 ft. lbs. (5.4 N.m)** torque.
10. If a new charging valve is being used, tighten swivel nut to **10.5 ft. lbs. (14.2 N.m)** torque, then loosen and retighten the swivel nut to **10.5 ft. lbs. (14.2 N.m)** torque. Again, loosen the swivel nut and retighten to **4 ft. lbs. (5.4 N.m)** torque. Replace valve cap (1) and tighten to **2.5 ft. lbs. (3.3 N.m)** torque (finger tight).
11. Install the protective guards over the charging valves and install the metal covers over the piston rods.

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

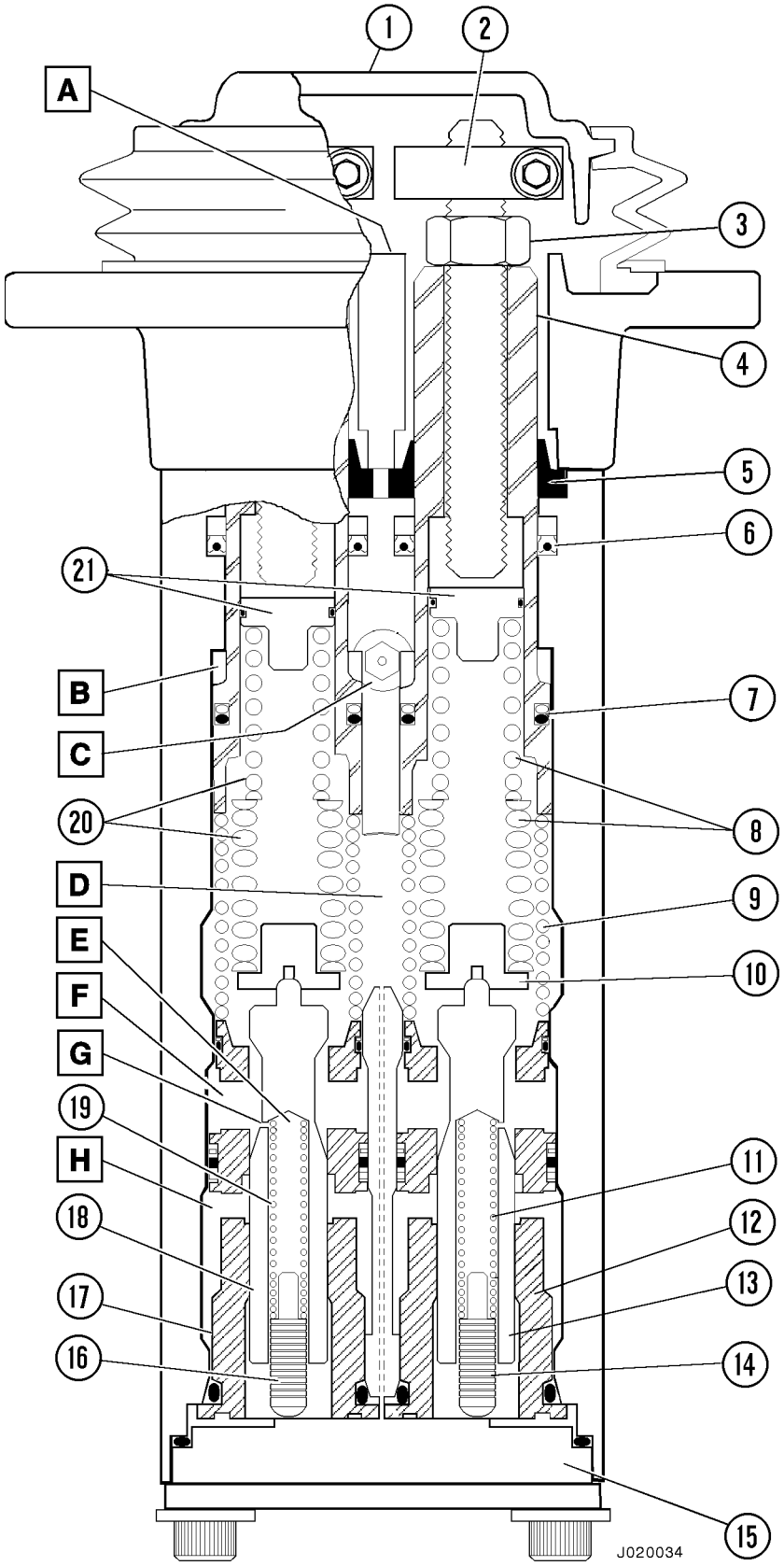


FIGURE 2-2. BRAKE VALVE

1. Actuator Cap
2. Adjustment Collar
3. Nut
4. Actuator Plunger
5. Wiper Seal
6. Poly-Pak Seal Assembly
7. Glyde Ring Assembly
8. Regulator Springs (B1)
9. Plunger Return Spring
10. Spring Seat
11. Spool Return Spring (B1)
12. Regulator Sleeve (B1)
13. Regulator Spool (B1)
14. Reaction Plunger (B1)
15. Base Plate
16. Reaction Plunger (B2)
17. Regulator Sleeve (B2)
18. Regulator Spool (B2)
19. Spool Return Spring (B2)
20. Regulator Springs (B2)
21. Staging Seat

A. Adjustment Collar Maximum Pressure Contact Area
B. Automatic Apply Piston Area
C. PX Port
D. Tank Port
E. Reactionary Pressure Area
F. Brake Apply Port
G. Orifice
H. Supply Port

Note:
B1 - Rear Brakes
B2 - Front Brakes

3. Install the orange back-up ring (4) on top of the poly-pak seal. Start by hand and then continue to work into the groove either by hand or by using an O-ring installation tool.
4. Install the wiper seal (5) in the top counterbore. Position the seal in the groove so that the register lip is facing up toward the actuator.
5. Repeat Steps 1- 4 for the second bore.

Regulator Sleeve O-Ring Installation

1. Install an O-ring (2, Figure 3-6) onto the smallest groove (on the top) of the regulator sleeve (3). Install O-ring (5) onto the middle groove on the regulator sleeve. Install O-ring (6) onto the largest groove (on the bottom) on the regulator sleeve.
2. Install a split nylon back-up ring (4) onto each side of the O-ring (5) located in the middle of the regulator sleeve.
3. Install one split nylon back-up ring behind the O-ring (2) located at the top end of the sleeve. This O-ring is the smallest of the three O-rings. Position the back-up ring so that it is next to the top of the regulator sleeve. The top of the sleeve is the end with the smallest O.D.
4. Repeat Steps 1-3 for the second regulator sleeve.

Actuator Plunger O-ring Installation

1. Install an O-ring (7, Figure 3-4) into the O-ring groove located at the large diameter end of the actuation plunger (3).
2. Install a split Glyde ring over the O-ring. (Twist and squeeze the split Glyde ring into a small circle before installing to insure a tight fit over the O-ring).
3. Repeat Steps 1 & 2 for the second plunger.

Assembly of Valve

NOTE: Start with either side (circuit) of the valve and build that side complete through Step 4. before starting on the other side (circuit). Be careful to assemble components into the circuit from which they were removed.

1. If removed, install stud (4, Figure 3-4) in plunger (3). Tighten nut (2).
2. Install new packing (5) on staging seat (6) and insert in plunger bore.
3. Lightly lubricate the actuation plunger Glyde ring (7).

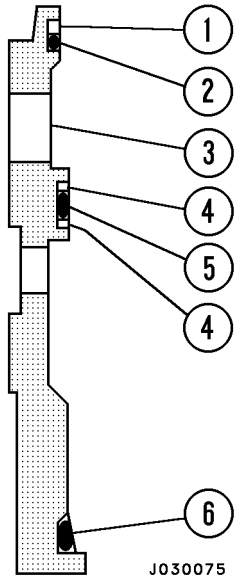


FIGURE 3-6. SLEEVE SEAL PLACEMENT

1. Back-Up Ring	4. Back-Up Ring
2. O-Ring	5. O-Ring
3. Regulator Sleeve	6. O-Ring

4. Install the “B1” actuation plunger (3) into the “B1” circuit. Be careful not to damage or cut the Glyde ring during installation. Observe the Glyde ring assembly through the tank port as the plunger is being installed. (Refer to Figure 3-7) It may be necessary to work the Glyde rings past the sharp edge in the body to prevent damage to the seal. Make sure the actuation plunger is completely seated and bottomed.

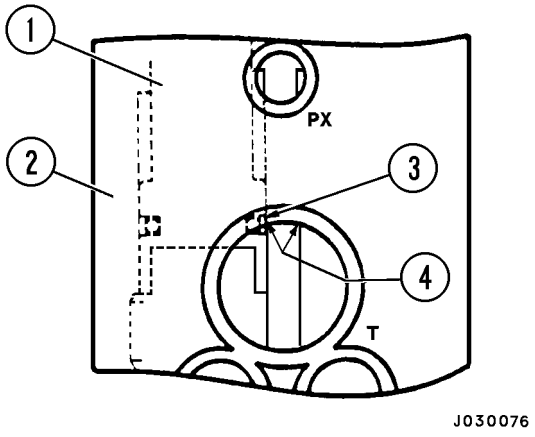


FIGURE 3-7. GLYDE RING INSTALLATION

1. Actuator Plunger	3. Glyde Ring
2. Valve Body	4. Sharp Edges

Disassembly

The parts installed in the valve body for the “B1” and “B2” bores are identical, however the parts must not be interchanged between the two bores.

1. Thoroughly clean valve to remove dirt accumulation. Drain all oil from all ports of the valve by rotating the valve over a suitable container.
2. Use a felt tip pen to mark manifold body (1, Figure 3-11) and valve body (2) to ensure correct reassembly.

NOTE: As the valve is disassembled, lay out parts in order of disassembly, being certain to note the valve body bore from which they are removed. Parts must be reinstalled in the same bore from which they are removed.

3. Secure valve in an upright position in a vice.
4. Remove capscrews securing the differential pressure switch (3) to the valve body. Remove and discard seals behind differential pressure switch ports. Refer to “Differential Pressure Switch” for disassembly.
5. Remove the two socket head capscrews (20) retaining the manifold body (1) to the valve body (2). Remove manifold body and discard O-rings (18).
6. Remove plungers (16) and sleeves (17).
7. Remove controller from vice.
8. Remove the four capscrews and washers (7) from the base of the valve.
9. Remove the sleeve retainer (6).
10. With the valve upright, the plug (5) should fall out. If not, tap lightly to dislodge.
11. Remove the spools (12), reaction plungers (8) and spool return springs (11). Keep parts separate so they may be installed in the same spool from which they were removed.
12. Remove and discard the packing (4) from the counterbore in the base of the valve body.
13. Turn the valve on its side on the work bench and remove the sleeves (9) from the valve body.
14. Remove seal (10), O-rings (22 & 24), and backup rings (21 & 23) and discard.
15. Remove spring seats (13 & 15) and regulator springs (14).

Cleaning and Inspection

1. Clean all metal parts with solvent and air dry.
2. Apply a light film of type C-4 hydraulic oil to plungers (16, Figure 3-11) and insert in sleeves (17). Sleeves must slide smoothly and freely in sleeve bores. If parts do not slide smoothly or excessive wear is apparent, replace both the sleeve and plunger.
3. Apply a light film of oil to regulator spools (12) and slide into bore of sleeves (9). Spools must slide smoothly and freely in sleeve bores. If parts do not slide smoothly or excessive wear is apparent, replace both the sleeve and spool.
4. Inspect each spring carefully for cracks or breaks. Any spring with a crack or break must be replaced. If the valve was not reaching proper regulated pressure, replace the regulator springs.
5. Lubricate all parts with a thin coat of clean type C-4 hydraulic oil. Take care to keep components protected from contamination.

Assembly

1. Install sleeves (17, Figure 3-11) in bores in top of valve body (2).
2. Install plungers (16) in sleeves as shown in Figure 3-11.
3. Apply film of oil to O-rings (18) and position in grooves on top of valve body.
4. Position manifold body (1) on valve body, aligning marks made during disassembly.
5. Secure manifold to valve body with two socket head capscrews (20). Only finger tighten capscrews.
6. Preassemble upper spring seat (15), spring (14) and lower spring seat (13). Insert assembly into bore from bottom of valve. Be certain upper spring seat is positioned against plunger (16). Repeat for other bore.
7. Install sleeve packing seal (10). Refer to Detail “A” and “B”, Figure 3-11 and install O-rings (22 & 24) and backup rings (21 & 23) in the sleeve (9) grooves.
8. Apply a light film of oil to sleeve seals. Carefully push sleeves (9) into their respective bores in the valve body until flange at base of sleeves contact valve body.
9. Preassemble regulator spool (12) as follows:
   a. Insert spool springs (11) into spool bore.
   b. Insert reaction plungers (8) into spool bores and springs.

8. Remove hydraulic port from shell.

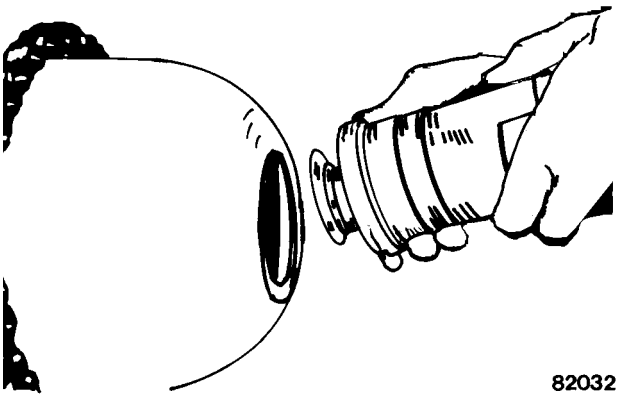


FIGURE 3-20. HYDRAULIC PORT REMOVAL

9. At opposite end of accumulator assembly, remove lock nut (13) from bladder valve stem.
10. Reach inside shell at hydraulic port end and compress bladder to expel as much air as possible.
11. Fold bladder and pull out of bottom of accumulator shell using a twisting motion. A cloth may prevent the hand from slipping due to oil film on bladder.

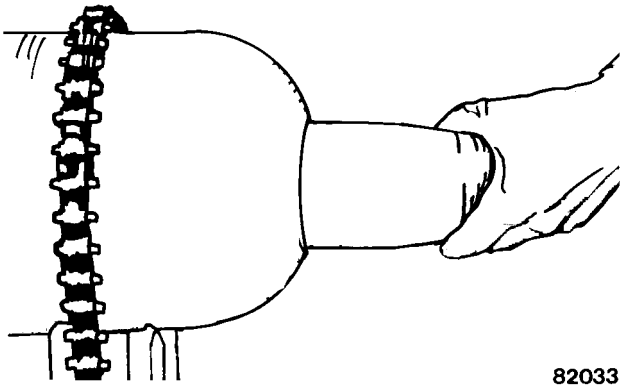


FIGURE 3-21. BLADDER REMOVAL

Cleaning and Inspection

1. All metal parts should be cleaned with a cleaning agent.
2. Seals and soft parts should be wiped clean.
3. Inflate bladder to normal size. Wash bladder with a soap solution. If soap solution bubbles, discard bladder. After testing, deflate bladder immediately.
4. Inspect hydraulic port assembly for damage; check the poppet plunger to see that it spins freely and functions properly.
5. Check anti-extrusion ring and soft seals for damage and wear; replace all worn or damaged seals with original equipment seals.
6. After shell has been cleaned with a cleansing agent, check the inside and outside of shell. Special attention should be given to the area where the gas valve and hydraulic assembly pass through the shell. Any nicks or damages in this area could destroy the accumulator bladder or damage new seals. If this area is pitted consult your Komatsu service manager

Assembly

1. After shell (10, Figure 3-19) has been cleaned and inspected, secure in place to prevent rotation during assembly.
2. Apply 64 oz. (1.91 l) of clean type C-4 hydraulic oil inside the shell to lubricate and provide a cushion for the bladder.
3. With all gas completely exhausted from the bladder (9), collapse bladder and roll longitudinally into a compact roll. To maintain rolled condition, insert gas valve core to prevent air from entering bladder.
4. Insert bladder pull rod through the valve stem opening and through the shell hydraulic port. Attach bladder pull rod to the bladder valve stem.
5. With one hand, pull the bladder pull rod while feeding the bladder into the shell with the other hand. A slight twisting of the bladder will ease installation.
6. Once the bladder valve stem has been pulled through the valve stem opening in the shell, install nameplate (if used) over valve stem and install the valve stem nut (13) by hand.
7. Once the valve stem nut (13) is in place, remove the bladder pull rod. Tighten nut to **56 ft. lbs. (76 N.m)**.

SECTION J4
BRAKE CIRCUIT CHECK-OUT PROCEDURE
INDEX

TROUBLE	POSSIBLE CAUSE	SUGGESTED CORRECTIVE ACTION
Differential Pressure Warning Circuit activates briefly when brakes are applied or released	Brake valve out of balance (not tracking).	Adjust collars according to instructions.
	Differential pressure switch is defective or improperly adjusted.	Check the switch and replace if defective.Check differential pressure switch adjustment.
	Accumulator precharge/leak.	Check accumulators and recharge if necessary.
	Problem in brake valve subassembly.	Remove, disassemble, clean, and inspect brake valve assembly or replace it.
	Dual relay valve defective	Inspect and repair dual relay valve(s)
	Air in one brake circuit.	Bleed brakes.
	Small leak in one circuit.	Inspect brake system and repair leaks.
	Brake warning delay timer defective	Replace timer.
A Low Brake Pressure Warning occurs when brakes are applied	Leak or other malfunction in one brake circuit.	Inspect brake system and repair leaks.
	Brake valve balance is out of adjustment.	Adjust collars according to instructions.
	Differential pressure switch is defective or improperly adjusted.	Check the switch and replace if defective.Check differential pressure switch adjustment.
	A dual relay valve is defective	Inspect and repair dual relay valve(s)
The Differential Pressure Warning circuit is not operating	Low Brake Pressure lamp is burned out.	Replace bulb.
	Electrical problem.	Check switch circuit wiring.
	Differential pressure switch is defective or improperly adjusted.	Check the switch and replace if defective.Check differential pressure switch adjustment.
	Problem in brake valve assembly.	Remove, disassemble, clean, and inspect, or replace brake valve.
	Dual relay valve defective	Inspect and repair dual relay valve(s)
	Brake warning relay defective.	Replace relay.
The Low Pressure Warning circuit not operating properly	The Low Brake Pressure lamp is burned out.	Replace the bulb.
	The electrical circuit is open.	Check switch circuit wiring.
	Pressure switch defective.	Replace the pressure switch.
Low Pressure Warning is on even though system pressure is correct	Short in electrical system.	Check wiring.
	Pressure switch is defective.	Replace the switch.

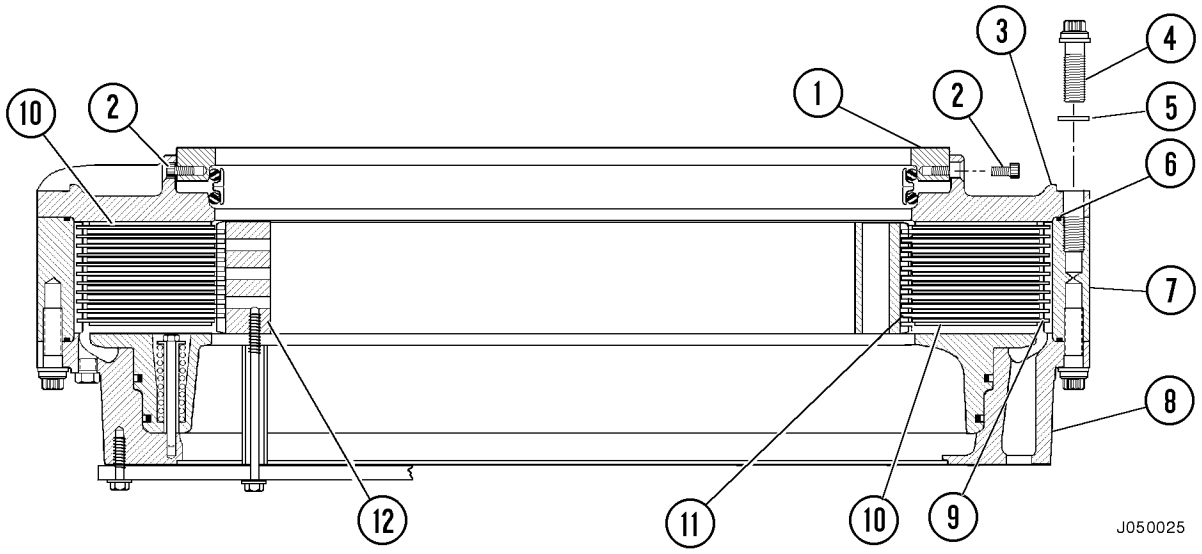


FIGURE 5-5. INITIAL DISASSEMBLY

1. Seal Carrier
2. Capscrew
3. Back Plate
4. Capscrew
5. Hardened Washer
6. O-Ring
7. Ring Gear
8. Piston Housing
9. Separator Plate
10. Damper
11. Friction Disc
12. Inner Gear

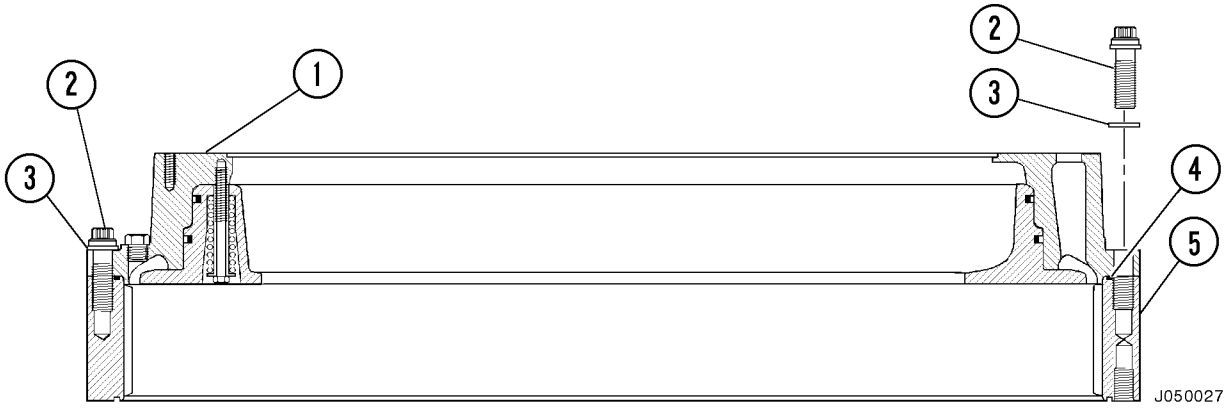


FIGURE 5-6. PISTON/HOUSING ASSEMBLY REMOVAL

1. Piston Housing
2. Capscrew
3. Hardened Washer
4. O-Ring
5. Ring Gear

SECTION J7

PARKING BRAKE

INDEX

SECTION L2
HYDRAULIC SYSTEM
INDEX

SECTION L3
HYDRAULIC SYSTEM COMPONENT REPAIR
INDEX

6. Position the press ring over the seal. Make sure the seal stays centered and true with the bore, and start applying pressure with the vise. Continue pressing the seal until it just clears the snap ring groove in the bore.
7. Install snap ring (2, Figure 3-11) with the snap ring opening over weep hole (10).
8. Install the outboard seal (metal face out), until it just contacts the snap ring.
9. Lubricate thru stud threads (14, Figure 3-11) with hydraulic oil. Thread the studs into flange until snug. There are 4 long studs and 4 short studs. Reference Figure 3-12 for proper stud location. Lubricate and install O-ring (7). Install dowel pins (12), if removed. Install gear plate (13). Make sure the recess in the gear plate will be toward the connector plate, or facing up when the gear plate is installed.
10. Install steel rings (5, Figure 3-12). Lubricate and install backup ring (8), O-ring (7) and ring retainer (6) as shown in Figure 3-12.
11. Install isolation plate (9) on the suction side of the gear plate. The isolation plate has a relief area milled on one side; turn that side up or toward the pressure plate.

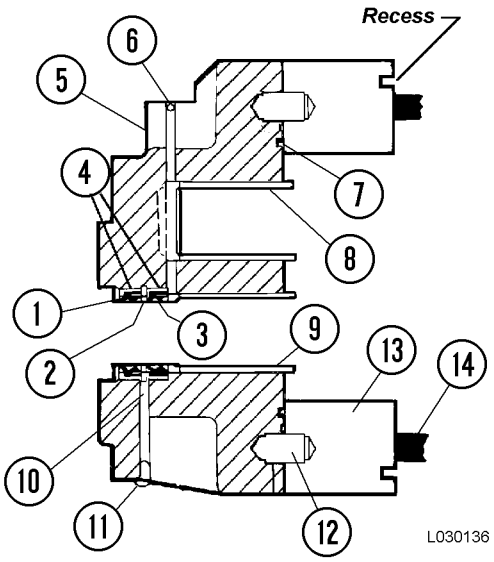


FIGURE 3-11. SHAFT SEAL INSTALLATION

1. Outboard Shaft Seal
2. Snap Ring
3. Inboard Shaft Seal
4. Seal, Metal Face
5. Flange
6. Steel Ball
7. O-ring
8. Bearing
9. Bearing
10. Weep Hole
11. Plug
12. Dowel
13. Gear Plate
14. Thru Studs

12. With the bronze side up and the milled slot facing toward the discharge side, slide pressure plate (2, Figure 3-13) down into the gear bores until it rests on the backup ring and O-ring. Do not force the plate down the gear bores. If it hangs up on the way down, work it back and forth until it slides freely into place.
13. Coat the inside of the gear plate and the gears with clean hydraulic oil.

NOTE: To ensure the gear pump is correctly timed during reassembly, place a mark on the end of the input shaft to indicate the location of the valley between any two gear teeth. Refer to Figure 3-16 which illustrates gear timing.

14. With the extension end of the drive gear facing toward the shaft seals, install the drive gear. Do not drop the gear in the bore as damage to the bronze face of the pressure plate could result. Use care when pushing the drive gear extension thru the shaft seals. Install the idler gear.

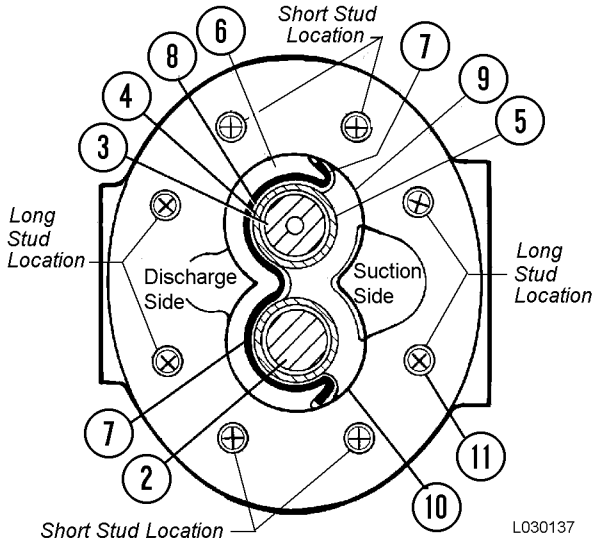


FIGURE 3-12. PUMP REASSEMBLY

1. Gear Plate
2. Drive Gear
3. Idler Gear
4. Bearing
5. Steel Ring
6. Retainer
7. O-ring
8. Backup Ring
9. Isolation Plate
10. Relief Area
11. Thru Studs

STEERING CIRCUIT

STEERING CIRCUIT OPERATION

The pump (8, Figure 4-1) supplies oil to the bleed-down manifold (5) after passing through a high pressure filter (9). This oil supply is then distributed to the brake system and steering system.

System pressure is regulated to between 2750 psi (19.0 MPa) and 3025 psi (20.9 MPa) by an unloader valve located on the bottom of the steering pump case.

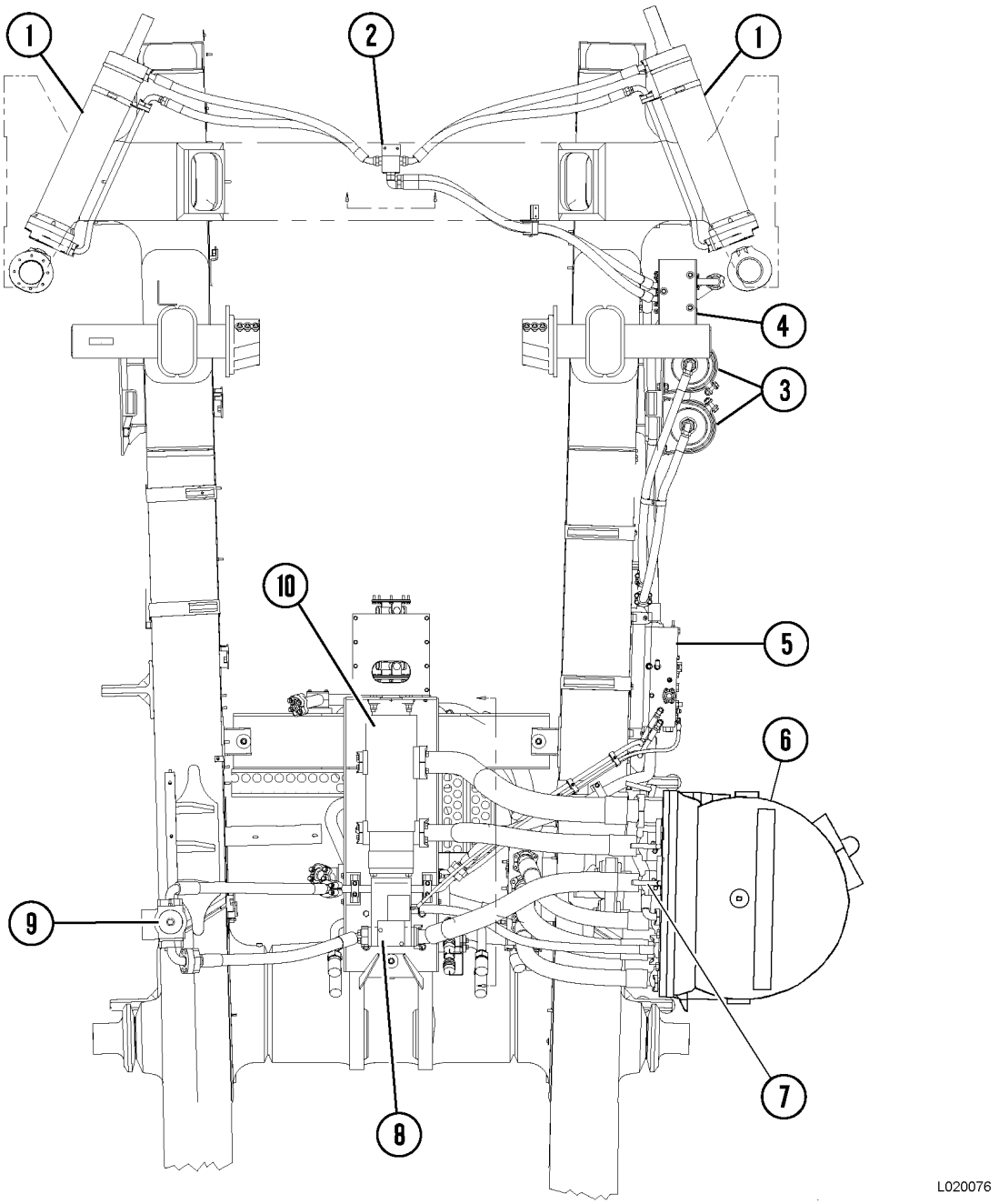


FIGURE 4-1. STEERING SYSTEM COMPONENTS (Bottom View)

1. Steering Cylinders
2. Manifold
3. Steering Accumulators
4. Flow Amplifier Valve
5. Bleeddown Manifold
6. Hydraulic Tank
7. Shut-off Valve
8. Steering/Brake Pump
9. Steering/Brake Circuit Filter
10. Hoist Circuit Pump

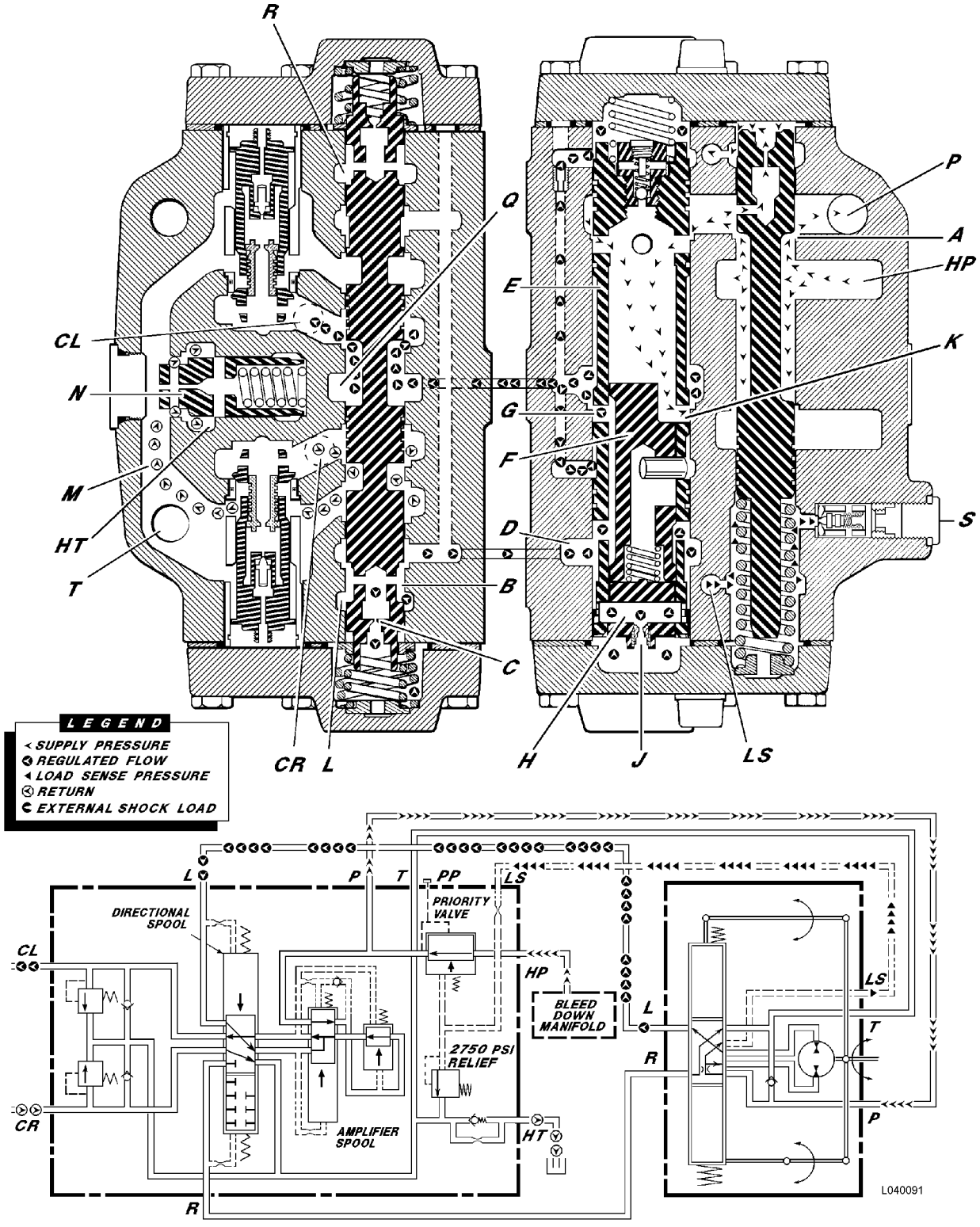


FIGURE 4-8. FLOW AMPLIFIER - LEFT STEER

SECTION L5

STEERING CONTROL UNIT

INDEX

SECTION L6
STEERING CIRCUIT COMPONENT REPAIR
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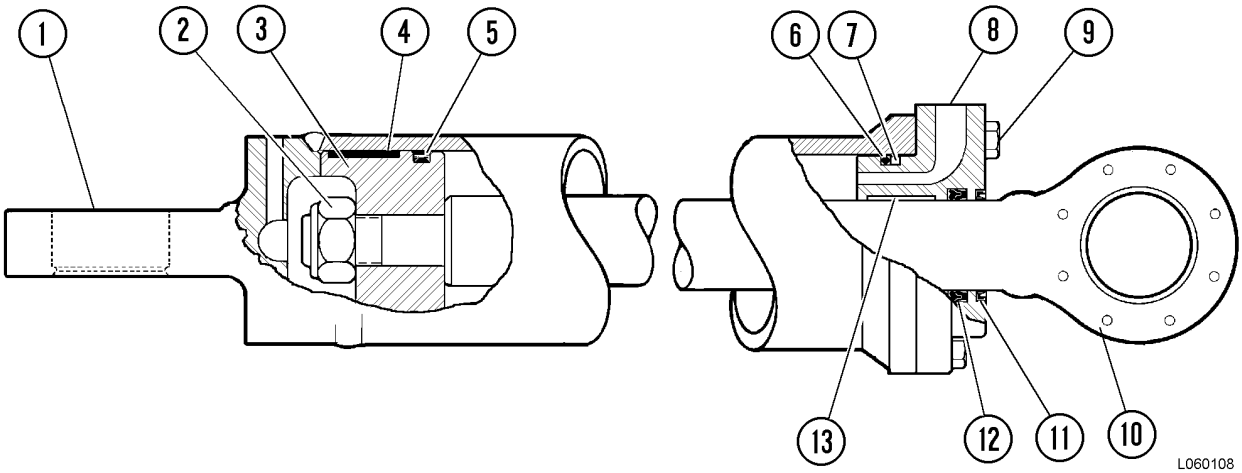


FIGURE 6-7. STEERING CYLINDER ASSEMBLY

1. Housing
2. Locknut
3. Piston
4. Piston Bearing
5. Piston Seal Assembly
6. O-Ring
7. Backup Ring
8. Gland
9. Capscrew
10. Rod Structure
11. Rod Wiper
12. Rod Seal
13. Bearing

Disassembly

1. Remove capscrews (9, Figure 6-7) and pull rod (10) and gland (8) out of cylinder housing (1).
2. Remove locknut (2) and piston (3). Remove piston bearing (4) and piston seal (5) from piston.
3. Pull rod (10) free of gland (8). Remove O-ring (6) and backup ring (7). Remove rod seal (12) and rod wiper (11). Remove Bearing (13).
4. Inspect cylinder housing, gland, piston and rod for signs of pitting, scoring or excessive wear. Clean all parts with fresh cleaning solvent and lubricate with clean Type C-4 hydraulic oil.

Piston Seal & Bearing Installation

1. Install new piston seal (5, Figure 6-7) on piston (3) as follows:
   a. Heat piston seal assembly (5) in boiling water for 3 to 4 minutes.
   b. Remove piston seal from water and assemble on piston. DO NOT take longer than 5 seconds to complete as seal will take a permanent set. The piston bearing (4) may be used to position seal assembly in groove. Apply pressure evenly to avoid cocking seal.
   c. If the seal has taken a slightly larger set (loose on piston) a belt type wrench or similar tool can be used to compress the O.D. of the seal until it fits tightly on the piston.
2. Install bearing (4) in the piston groove.

Cylinder Assembly

1. Install new bearing (13, Figure 6-7), rod seal (12), rod wiper (11), backup ring (7) and O-ring (6) in gland (8).
2. Push rod (10) through top of gland, slowly advancing rod over rod seal and rod wiper.
3. Install piston assembly (3) on rod. Secure piston to rod with locknut (2). Tighten locknut to **2500 ft. lbs. (3390 N.m)**.
4. Carefully install rod and gland assembly into cylinder (1). Insure backup ring and O-ring are not damaged during installation of gland.
5. Install capscrews (9). Tighten capscrews evenly to **310 ft. lbs. (420 N.m)**.

Test

After cylinder assembly rebuild, perform the following tests to verify performance is within acceptable limits.

1. Piston leakage must not exceed 1 in^3/min. (1.6 cm^3/min.) at 2500 psi (17.5 MPa), port to port.
2. Rod seal leakage must not exceed 1 drop of oil in 8 cycles of operation.
3. Piston break-away force should not exceed 100 psi. (69 kPa).

Driveshaft Group

NOTE: Be sure punch marks on cylinder bearing (26, Figure 6-10) will face toward shaft end of pump.

10. Insert cylinder bearing (26) straight into pump housing. Be sure bearing is positioned so bearing retainer pins (17, Figure 6-9) can be inserted in the case and into the bearing.
11. Install O-rings (18) on pins (17) and install pins.
12. An arbor press is required to install shaft bearing (2, Figure 6-9) onto driveshaft (1). IMPORTANT - press ONLY on the inner race of the bearing. Press bearing until it contacts the shoulder on driveshaft.
13. Use a long 6 in (153 mm) sleeve with an I.D. slightly larger than the retaining ring I.D. and press retaining ring (4) towards bearing until it seats in the groove.
14. Place seal retainer (22) over seal (26) inside the pump housing (21). Lubricate shaft seal with clean hydraulic oil.
15. Install entire driveshaft assembly through front of pump housing. A mallet will be required to install the driveshaft through shaft seal.
16. Once the driveshaft assembly is fully seated in the pump housing, install snap ring (3).

Rotating Group

17. Mating surfaces should be greased. Place cylinder assembly on clean table with the valve plate side down.
18. During disassembly, shoe retainer springs were referenced to individual bores. Assemble rotating group by inserting shoe retainer springs (28, Figure 6-10) into the same spring bores located in cylinder barrel (10) that they came from.
19. Slide fulcrum ball (12) over the nose of the cylinder barrel (10).
20. Place shoe retainer (27) over fulcrum ball and align holes in retainer with corresponding holes (marked during disassembly) in the cylinder barrel. Once aligned, insert piston/shoe assemblies (13) into corresponding (marked during disassembly) holes completing the rotating group.

⚠WARNING

The assembled rotating group weighs approximately (30 lbs.). Assistance from others and use of proper lifting techniques is strongly recommended to prevent personal injury.

21. The rotating group can now be carefully installed over the end of the driveshaft and into the pump housing.
22. When installing the rotating group, support the weight of the cylinder barrel (10, Figure 6-10) as cylinder spline is passed over the end of driveshaft to avoid scratching or damage.
23. Push cylinder barrel forward until the cylinder spline reaches the driveshaft spline. Rotate the cylinder slightly to engage shaft splines.
24. Continue to slide cylinder barrel forward until it encounters the cylinder bearing (26). Lifting the driveshaft slightly helps cylinder barrel and cylinder bearing engagement. Continue pushing cylinder forward until the piston shoes contact swashblock (25).
25. At this point, the back of the cylinder barrel should be located approximately 0.25 in (6.3 mm) inside the back of the pump housing.

Control Piston Group

26. Install seal and piston ring (2 & 3, Figure 6-10) into their respective grooves on control piston (11) using care to assure they are in proper location.
27. Insert control piston assembly into sleeve (4).
28. While supporting the control piston, press or slip in pin (8) and secure with cotter or roll pin (18).
29. Order of piston sleeve seal installation starts at widest end of sleeve.
30. Install backup ring (1, Figure 6-14) and O-ring (2) and back-up ring (3) in rear most groove on piston sleeve. Install O-ring (4) and back-up ring (5) in remaining groove.

NOTE: Be certain that the grooves in Sleeve (4, Figure 6-10) are at the 12:00 and 6:00 O-clock positions when inserted into the valve plate.

31. Insert piston and sleeve assembly into valve plate (11, Figure 6-11). Install O-ring (6) with back-up ring (5) in seal groove of control cover cap (4).

Accumulator Storage procedures

⚠WARNING

Always store bladder accumulators with 100 - 120 psi (690 - 827 kPa) nitrogen precharge pressure. Do not exceed 120 psi (827 kPa). Storing accumulators with more than 120 psi (827 kPa) pressure is not safe due to possible leakage.

Only pre-charge accumulators to operating pressure while installed on the truck. Never handle accumulator with lifting equipment with a nitrogen precharge greater than 120 psi (827 kPa). Always set precharge to 100 - 120 psi (690 - 827 kPa) before handling (removing or installing) accumulators.

1. If the accumulator was just rebuilt, make sure there is approximately 106 oz (3.1 l) of clean oil inside the accumulator before adding 100 psi (690 kPa) of nitrogen precharge pressure.
2. Bladder accumulators should always be stored with 100 - 120 psi (690 - 827 kPa) nitrogen precharge pressure, which fully expands the bladder and holds a film of oil against the inner walls for lubrication and rust prevention.
3. The hydraulic port should always be covered with a plastic plug (without threads) to prevent contamination. **NEVER install a threaded plug into the hydraulic port.**
4. Always store the accumulator in an upright position.

Installing A Bladder Accumulator From Storage

1. Refer to Charging Procedure to install the pressure gauges on the accumulator, and to check precharge pressure.
   a. If precharge pressure is 24 psi (165 kPa) or less, slowly drain off any nitrogen precharge, and proceed to Step 2.
   b. If precharge pressure is between 25 psi (172 kPa) and 100 psi (690 kPa), set the regulator to 100 psi (690 kPa), and slowly charge the accumulator to 100 psi (690 kPa). Disconnect pressure gauges from the accumulator, and install on the truck. Refer to Charging Procedure in this chapter to fully charge accumulator to the correct operating precharge pressure.
2. Remove the gauges from the accumulator.
3. Lay the accumulator on a suitable work bench so that the hydraulic port is higher than the other end of the accumulator. Remove the plastic dust cap from the hydraulic port.
4. Pour approximately 106 oz (3.1 l) of clean C-4 hydraulic oil into the accumulator through the hydraulic port. Allow time for the oil to run down the inside of the accumulator to reach the other end.
5. Lay the accumulator flat on the work bench (or floor), and slowly rotate the accumulator two complete revolutions. This will thoroughly coat the accumulator walls with a film of oil necessary for bladder lubrication during precharging.
6. Stand the accumulator upright. Install pressure gauges, and refer to Charging Procedure for instructions to charge the accumulator up to 100 psi (690 kPa). Remove the gauges from the accumulator, and install a plastic dust cap over the hydraulic port.
7. Install the accumulator on the truck.
8. Precharge the accumulator to the correct operating precharge pressure.

Bladder Storage Procedures

The shelf life of bladders under normal storage conditions is one year. Normal storage condition consists of the bladder being heat sealed in a black plastic bag, and placed in a cool dry place away from the sun, ultraviolet and fluorescent lights, as well as electrical equipment. Direct sunlight or fluorescent light can cause the bladder to weather check and dry rot, which will appear on the bladder surface as cracks.

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).

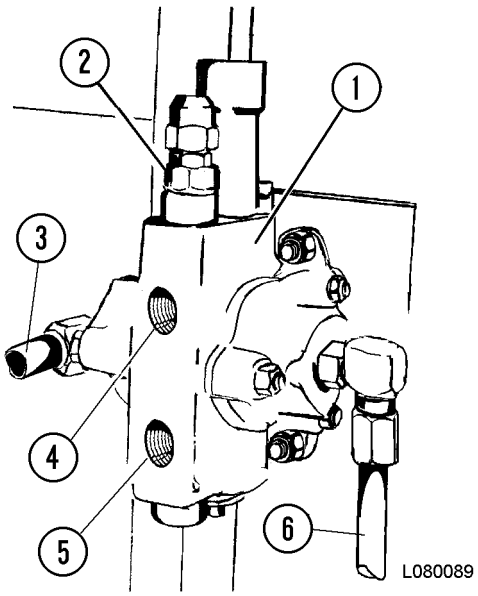


FIGURE 7-3. HOIST PILOT VALVE

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

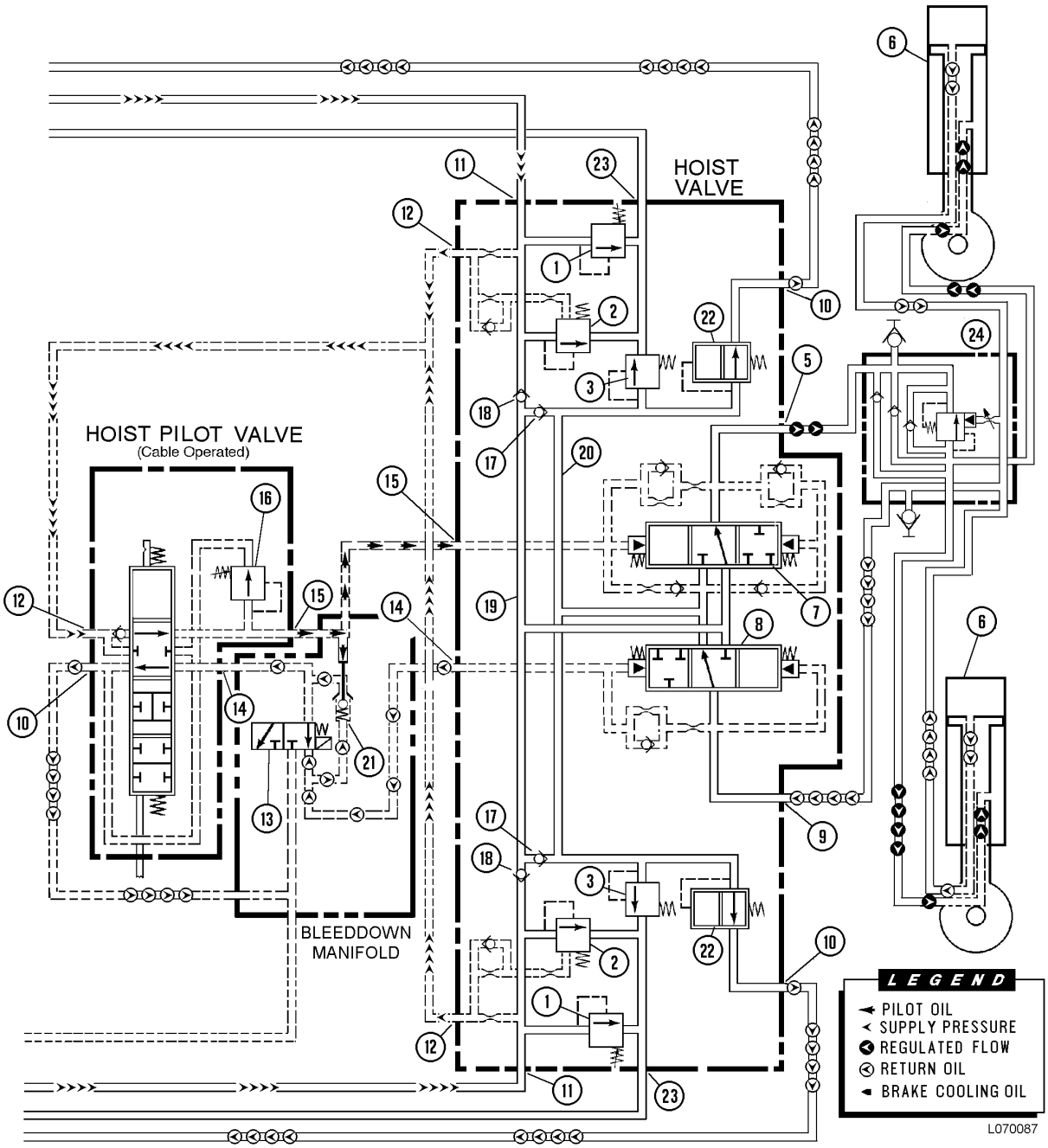


FIGURE 7-8. POWER DOWN POSITION

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

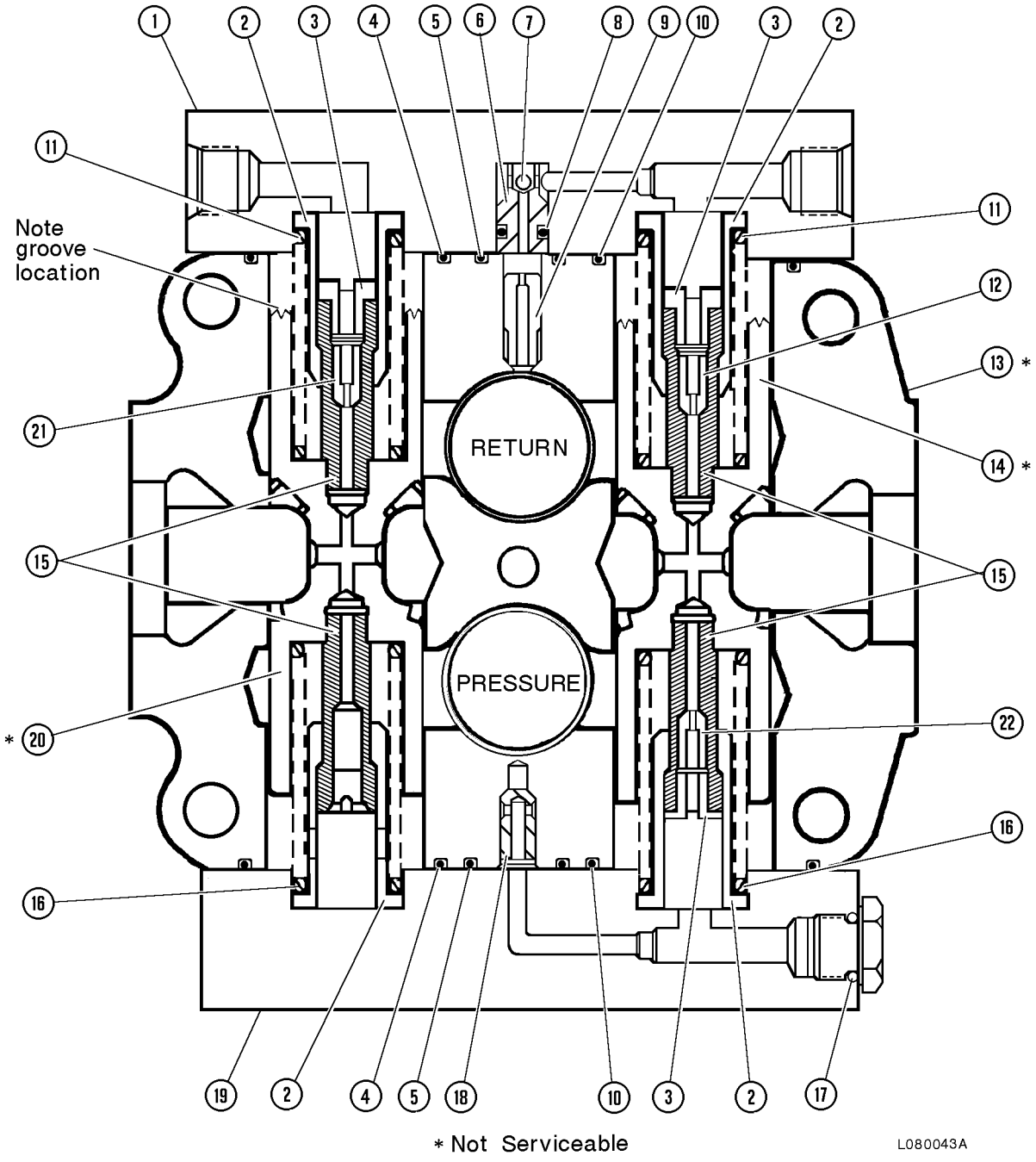


FIGURE 8-9. WORK PORTS SPOOL SECTION ASEMBLY

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

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. Remove cushioin (25).

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.

HYDRAULIC SYSTEM FILTERS

HOIST CIRCUIT FILTER

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

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

NOTE: When the engine is initially started and the hydraulic oil is cold, the warning lamp may illuminate. 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.

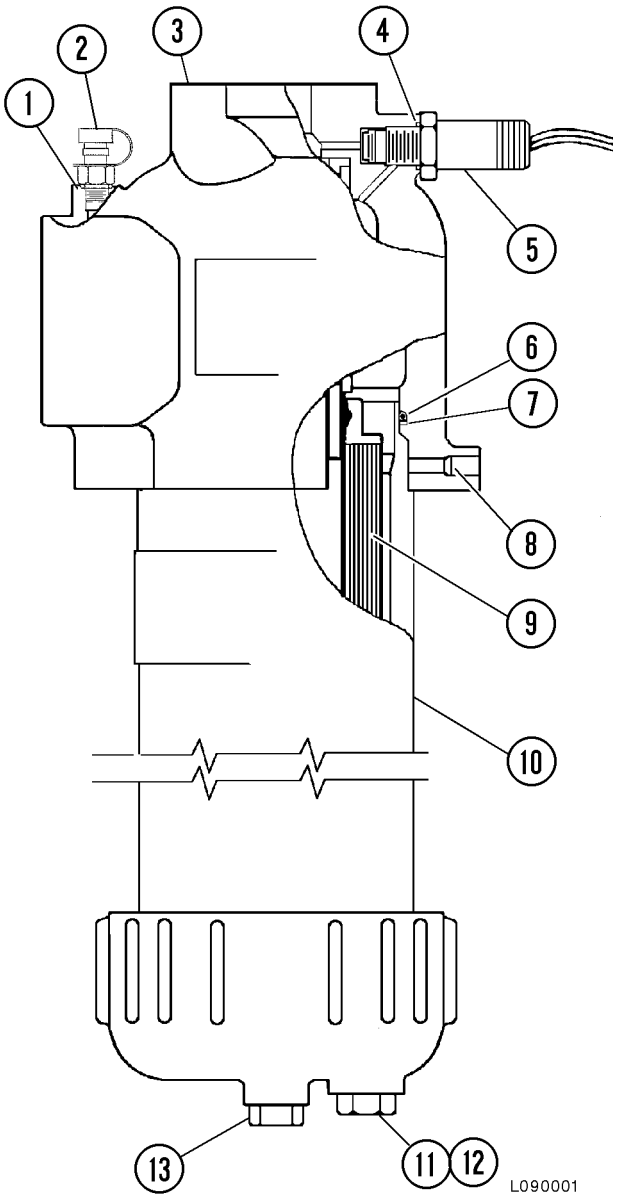


FIGURE 9-1. HOIST CIRCUIT FILTER

1. O-Ring
2. Pressure Tap
3. Filter Head
4. O-Ring
5. Indicator Switch
6. O-Ring
7. Backup Ring
8. Set Screw
9. Filter Element
10. Bowl
11. Drain Plug
12. O-Ring
13. Bottom Plug

Filter Element Replacement

⚠WARNING

Relieve pressure before disconnecting hydraulic and lines. Tighten all connections before applying starting the machine.

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

6. Start engine and adjust pressure compensator (3) to obtain 3325 psi (22,923 kPa) on the pressure gauge at the “GPA” pump port. Tighten compensator jam nut.

* *Record on Data Sheet*

7. Shut down the engine and allow the accumulators to bleed down.
8. Back out unloader valve adjustment screw (2, Figure 10-1) completely.
9. Start engine and allow pump pressure to build until the pump unloads.

NOTE: When the steering pump unloads, pump output pressure at the “GPA” pressure test port will drop to approximately 200 to 400 psi (1380 to 2760 kPa).

10. Steer the truck to cause the accumulator pressure to drop until the pump loads.
11. Adjust unloader valve to reload accumulators when pressure falls to 2750 psi (18,960 kPa). Unload pressure will be approximately 3000 to 3050 psi (20,680 to 21,025 kPa).

    ❑ When unload pressure increases to 3000 to 3050 psi (20,680 to 21,025 kPa), the adjustment has been successfully completed.

* *Record on Data Sheet*

12. Steer the truck slowly again while observing “TP2” steering pressure 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, steps 11 and 12.

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).

14. Tighten jam nut to lock pressure adjustment.
15. Steer the truck to cause several system cycles and verify system pressure begins to increase (pump cycles from unload to load) once pressure has dropped to 2750 psi (18,960 kPa).
16. Shut down engine and allow accumulators to bleed down completely. Turn the steering wheel to verify no pressure remains.
17. Remove gauges and cap test ports.

Steering Control Valve and Flow Amplifier Leakage Test

1. Disconnect the flow amplifier return line (9, Figure 10-2) at the bleeddown manifold. Plug the port on the bleeddown manifold.
2. Disconnect steering control unit return line at the flow amplifier. Install a plug in the open flow amplifier port. **Do not turn steering wheel with hoses disconnected!**
3. Start engine and allow steering system to reach normal operating pressure.
4. Measure leakage from flow amplifier return hose removed in step 1:

    ❑ Maximum permissible leakage is 50 cubic inches (820 ml) per minute.
    If leakage is excessive, the flow amplifier should be repaired or replaced.

* *Record on Data Sheet*

5. Measure leakage from steering control unit return hose removed in step 2:

    ❑ Maximum permissible leakage is 10 cubic inches (164 ml) per minute.
    If leakage is excessive, the steering control valve should be repaired or replaced.

* *Record on Data Sheet*

6. Shut down engine and allow accumulators to bleed down completely. If all steering system hoses are connected, steer the truck to verify all pressure has bled off.

Bleeddown Manifold Leakage Test

1. With hydraulic lines still disconnected from Steering Control Unit and Flow Amplifier Leakage Test, disconnect the hoist pilot valve return hose (14, Figure 10-2) located on the side of the bleeddown manifold. Plug the open port on the bleeddown manifold.
2. Before performing the next step, it will be necessary to draw a vacuum on the hydraulic tank to prevent oil loss when the bleeddown manifold tank return line is disconnected.

930E CHECK-OUT PROCEDURE - STEERING SYSTEM DATA SHEET

MACHINE MODEL _____UNIT NUMBER _____SERIAL NUMBER_____

_____ Steering Accumulators charged to 1400 psi (9650 kPa).

Operate hydraulic steering system to obtain proper operating temperature. Refer to Check-out Procedures.

PUMP PRESSURE CONTROL ADJUSTMENTS

STEP 6_____ Steering pump compensator pressure

STEP 11_____ Steering pump unload pressure.

STEP 12_____ Steering pump load pressure.

STEERING CONTROL VALVE AND FLOW AMPLIFIER LEAKAGE TESTS

STEP 4_____ Flow amplifier return hose leakage.

STEP 5_____ Steering control unit return hose leakage.

BLEEDDOWN MANIFOLD LEAKAGE TEST

STEP 5_____ Bleeddown solenoid, steering relief, and piloted check valve leakage.

SHOCK AND SUCTION VALVES TEST

STEP 6_____ Shock and suction valve pressure, left steer.

STEP 7_____ Shock and suction valve pressure, right steer.

STEP 9_____ Steering relief valve pressure setting.

STEP 12_____ Steering pump reload pressure.

Name of Technician or Inspector Performing Check-Out_____

Date_____

Securing the Detection Wire

After the linear detection wire has been loosely installed, secure it to the equipment being protected as follows:

1. Begin at the control module with the first section of detection wire. If this section is sufficient to cover the total hazard area, no additional lengths are required. If additional lengths are required, remove blank plugged connector from the end of first length and add lengths until the total hazard area(s) is covered.

NOTE: Remember to leave closed blank plug connection on the last length of detection wire.

When making connection, push plug into receptacle until a "click" is heard (Figure 2-11). Plugs and receptacles are keyed to allow insertion only in one direction. After "click" is noted, apply a small amount of back pull to confirm connection has been made.

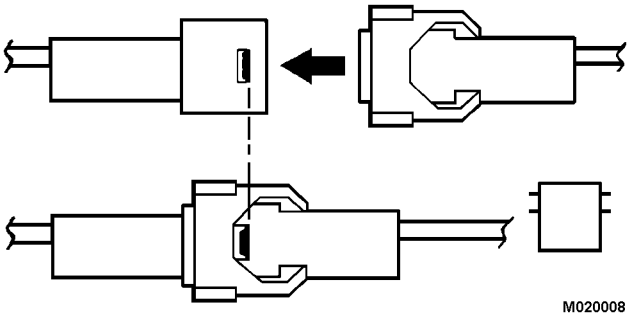


FIGURE 2-11. LINEAR DETECTION WIRE CONNECTOR

2. Secure the wire every 12-18 in. (30-45 cm) throughout the hazard area(s) using the black nylon cable ties provided. Secure more often if desired, or to keep the wire out of the way. Secure the wire to mounting surfaces, decks, struts, hydraulic hoses in the area, or any secure, non-moving part of the protected equipment. Always keep the previously mentioned guidelines in mind when installing the wire.

Preliminary Test Before Final Hook-Up

All necessary linear detection and power wire installation is now completed. Before arming the actuator with the squib, it is necessary to check to insure all connections are made properly.

1. The Power Wire
   a. Depress the button on top of the control module and note green indicator light (Figure 2-12). With button, depressed, light should be on. This indicates the power wire is installed correctly to the control module. If light does not appear, check all connections to insure they are snapped together. Retest by depressing button. If light is not on, refer to Troubleshooting The Electric Detection System covered in this section.
   b. If battery power is correct, proceed to checking total system power.

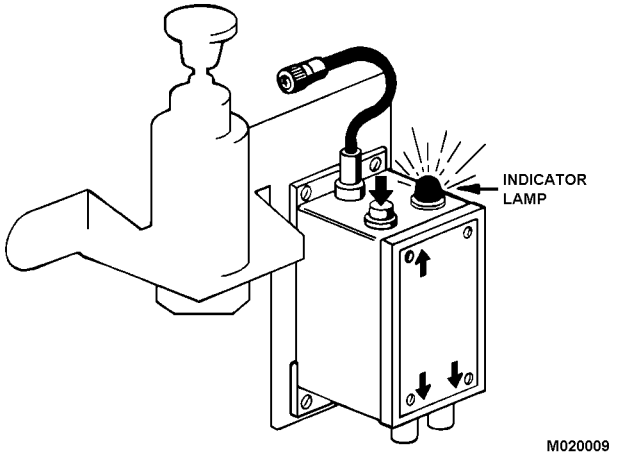


FIGURE 2-12. POWER CHECK

⚠CAUTION

Do Not install squib to power lead at this time (Figure 2-13).

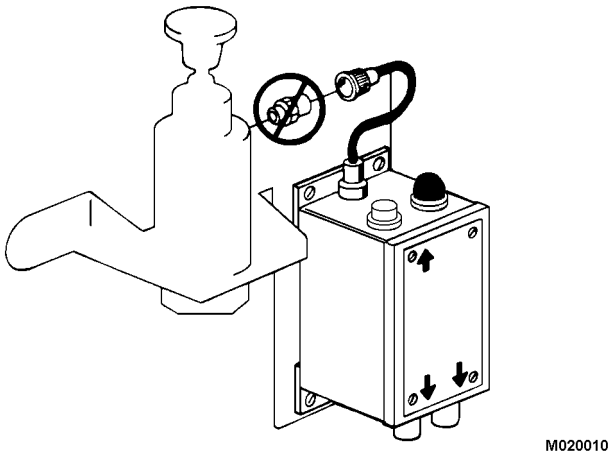
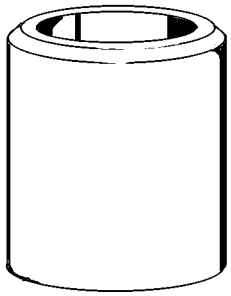
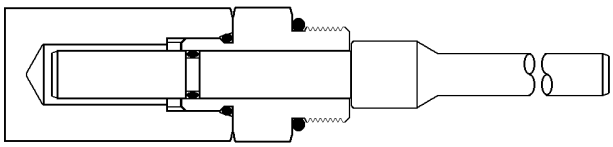


FIGURE 2-13. DO NOT CONNECT SQUIB

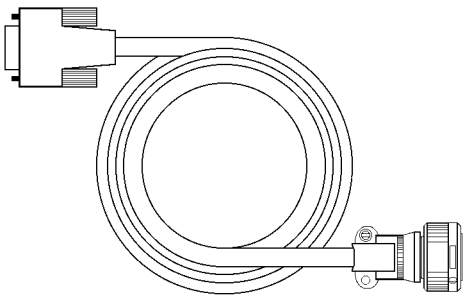
Part Number	Description	Use
EH4638	Sleeve Alignment Tool	Steering Linkage and Tie Rod Assembly, Refer to Section “G”



Part Number	Description	Use
EF9302	Wear Indicator	Brake Disc Wear, Refer to Section “J”
EB1723	Cap, Indicator	
EF9301	Pin, Indicator	
WA0010	O-ring, Indicator Pin	
TL3995	O-ring, Indicator Cap	
EB4813	Housing, Indicator	
SV9812	O-ring, Housing	



Part Number	Description	Use
EF9160	Harness	Payload Meter Download, Refer to Section “M”, Payload Meter



Operator Switch

The payload operator switch is used to set, view and clear the total load counter and total ton counter. It is also used to enter the operator ID number (0-9999). This switch can also be used to view the suspension pressures and inclinometer. The payload meter operator switch is located on the dashboard. It is a two-way momentary switch. The top position is the SELECT position. The SELECT position is used step through the different displays. The lower position is the SET position. The SET position is used to set the operator ID or clear the load and total ton counters. Normally the inputs from the switch to the payload meter are open circuit. The switch momentarily connects the circuit to ground.

Speed Input

PLMIII uses a speed signal to calculate speed, distance, and other performance data. This input is critical to the proper operation of the system. PLMIII receives this signal from the speedometer/operator display on the dashboard. The same signal displayed to the operator is used by the system. Distance calculations are made based on the rolling radius of the tires for a particular truck.

Body-Up Switch

The body-up input signal is received from a magnetic switch located on the inside of the truck frame, forward the pivot pin of the truck body. This is the same switch typically used for input to the drive system. When the body is down, the switch closes and completes the circuit to 71-control power. 24vdc indicates the body is down. Open circuit indicates that the body is up.

Brake Lock Switch

The brake lock is used to lock the rear brakes on the truck. It is necessary for the accurate calculation of swingloads during the loading process. Without the brake lock applied, the payload meter will not calculate swingloads during the loading process. Without the brake lock, the payload meter will assume that the truck was loaded using a continuous loader and flag the haul cycle record. All other functions will be normal regardless of brake lock usage. The brake lock input comes from the switch located on the dash panel. The brake lock switch connects the circuit to ground. Open circuit indicates brake lock off. Ground indicates brake lock on.

Payload Meter

The payload meter is housed in a black aluminum housing. There is a small window on the face of the unit. Status and active alarm codes can be viewed through the window. During normal operation, a two-digit display flashes 0 back and forth. Active fault codes will be displayed for two seconds. These codes are typically viewed using the laptop computer connected to the serial communications port.

There is one 40-pin connector on the payload meter. A jack-screw is used to hold the payload meter and wire harness connector housings together. This screw requires a 4mm or 5/32 hex wrench. The correct tightening torque for this screw is 25 lb-in. Four bolts hold the payload meter housing to its mounting bracket in the cab.

The circuit board inside the payload meter housing is made from multi-layer, dual-sided surface-mount electronics. There are no field serviceable components inside. The electronics are designed to withstand the harsh operating environment of the mining industry. Opening the payload meter housing will result in voiding the warranty.

Communications Ports

The payload meter has two RS232 serial communications ports and two CAN ports. Connections for the two serial ports are available inside the payload meter junction box. The two CAN ports are available for future electronics systems.

Serial port #1 is used to communicate with the dashboard display. It is also used to connect to the laptop computer. The display gauge will remain blank when the PC is using the serial port. This port initially operates with serial settings at 9600,8,N,1. These settings change automatically to increase the communications rate when the PC is using the port. This serial port uses a 3-wire hardware connection.

Serial port #2 is used to communicate to other on-board electronics like Modular Mining's Dispatch® system or the scoreboard from Komatsu. This port uses a 3-wire hardware connection. Connections to this serial port need to be approved by Komatsu. Several protocol options are available and detailed technical information is available depending on licensing.

M: Haul Cycle Too Long

The haul_cycle_too_long flag indicates that the haul cycle took longer than 18.2 hours to complete. The times stored for particular events may not be accurate. This does not affect the payload calculation.

N: Sensor Input Error

An alarm was set for one of the 5 critical sensor inputs during the haul cycle. The five critical sensors are the four pressure sensors and the inclinometer. Without these inputs, the payload meter cannot calculate payload. A haul cycle with this warning flag should not be considered accurate. Haul cycles with this warning are displayed in red on the Payload Summary window and are not included in the summary statistics for reports or display.

Frame Torque Data

Payload meter records the top 5 peak positive and negative frame torque values and the time they occurred. The frame torque is a measure of the twisting action along the centerline of the truck. Positive frame torque is measured when the suspension forces on the front of the truck act to twist the frame in the clockwise direction as viewed from the operator's seat. Negative frame torque is measured when the forces from the suspensions act in the opposite direction.

For example, if the left front and right rear pressure rises as the right front and left rear pressure drops, the truck frame experiences a twisting motion along the longitudinal centerline. In this case, the payload meter will record a positive frame torque.

The 5 highest values in the positive and negative direction are stored in permanent memory within the payload meter.

Sprung Weight Data

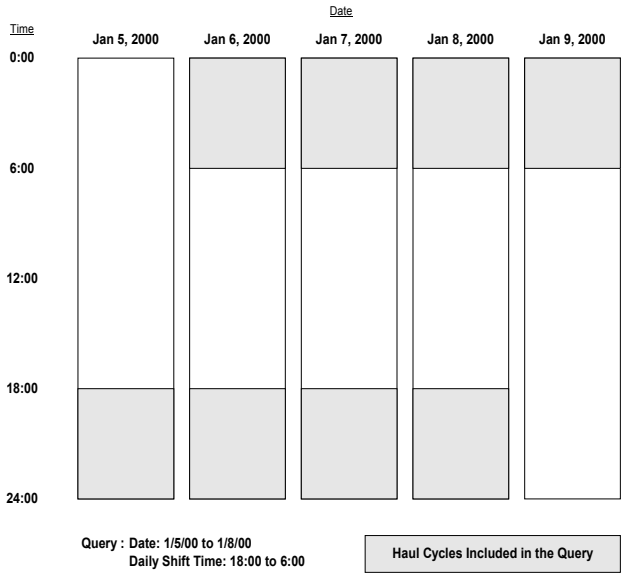
The payload meter is constantly monitoring the live payload calculation. This value naturally rises and falls for a loaded truck depending on road and driving conditions. The payload meter records the top 5 highest payload calculations and the time they occurred. This information is stored in permanent memory inside the meter.

Maximum Speed Data

The payload meter records the top 5 highest speeds and the time they occurred. This information is stored in permanent memory inside the meter.

Alarm Records

The payload meter stores alarm records to give service personnel a working history of the system. All codes are viewed using the PC connected to the payload meter. Active codes are also displayed on the two-digit display on the meter itself. Each code has a specific cause and should lead to an investigation for correction. Some failures can be overcome by the payload meter. Haul cycle data will indicate if an alarm condition was present during the cycle. Failures with the suspension or inclinometer sensors cannot be overcome.



Creating Reports

Reports can be generated and viewed on the screen or printed. These reports are generated from the query displayed on the Payload Summary Screen. From the example in "Sorting on Time Range", the report 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 printing a report.

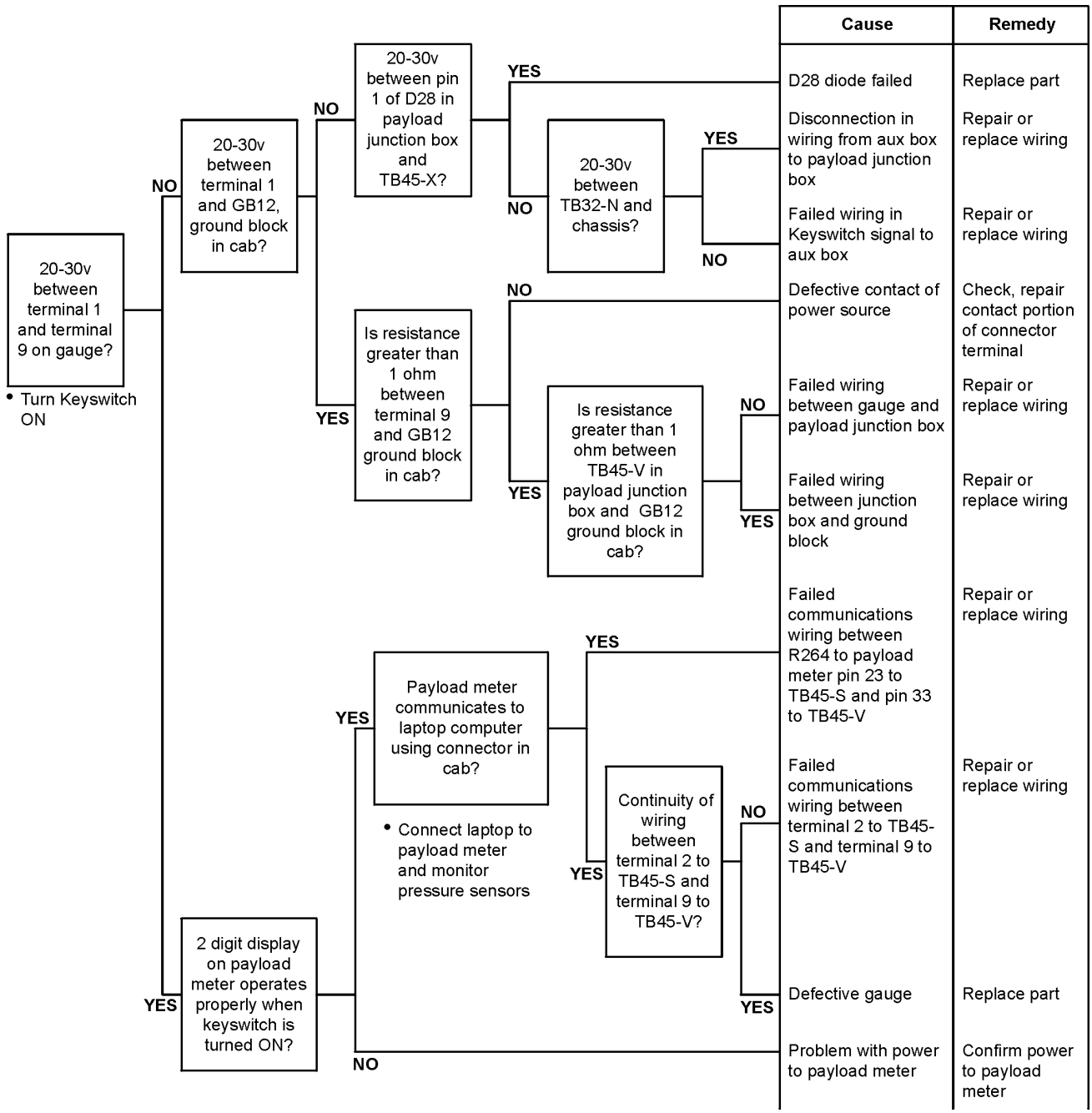
Payload Detail Screen

The Payload Detail screen gives the details for any individual haul cycle. From the “Payload Summary” screen, double-click on any haul cycle to display the detail.

No Display on Speedometer

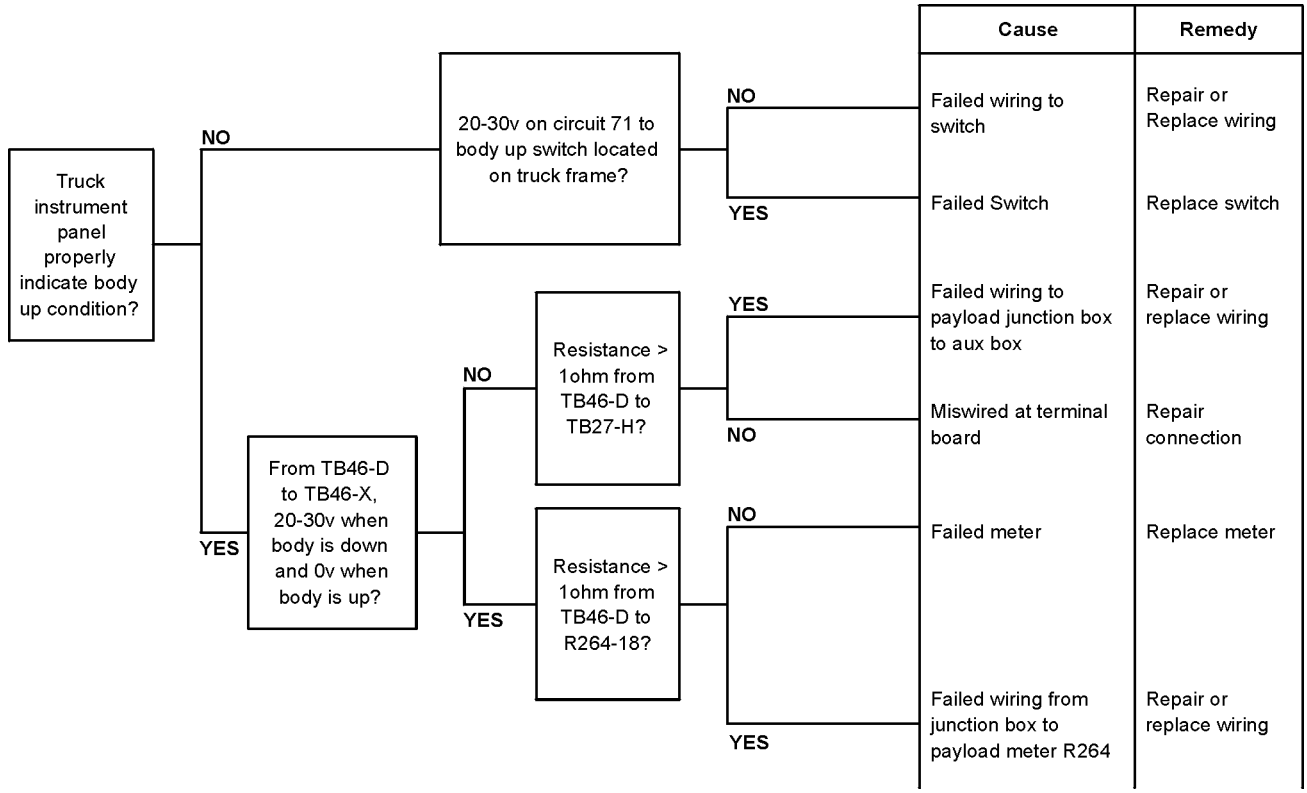
No Display on Operator Display

- If the speedometer works but the operator displays remain blank, confirm payload connections at “No Payload Display When Keyswitch is Turned ON”.



Alarm 13 - Body Up Input Failure

The payload meter senses when the load is dumped without receiving a body-up signal. When the load quickly drops below 50% without the body up signal, Alarm 13 is set. The alarm will be cleared when a normal dump cycle is detected. A normal dump cycle will be detected when the body up signal is received, the load drops quickly and the body down signal is received.



42. Remove the EJ3057 harness from the left front suspension junction box, TB42-A and TB42-B.
43. Wait at least 1 minute and remove the EJ3057 harness from the left-rear connections in the rear junction box, TB61-B and TB61-C.
44. Wait at least 1 minute and remove the EJ3057 harness from the right-rear connections in the rear junction box, TB61-A and TB61-C.
45. Wait at least 1 minute and remove the EJ3057 harness from the right-front connections in the right-front junction box, TB61-B and TB61-C.
46. Wait at least 1 minute.
47. From the main menu of the PC software press the "Connect to Payload Meter" button.
48. From the Connection Menu select "Display Active Alarms". Confirm that the four alarms displayed occurred in the proper order;

    Left-front suspension low

    Left-rear suspension low

    Right-rear suspension low

    Right-front suspension low

49. Close all screens and disconnect the laptop from the PLMIII system.

PLMIII CHECKOUT PROCEDURE CONFIRMATION

Flashburn Programming

General Instructions:

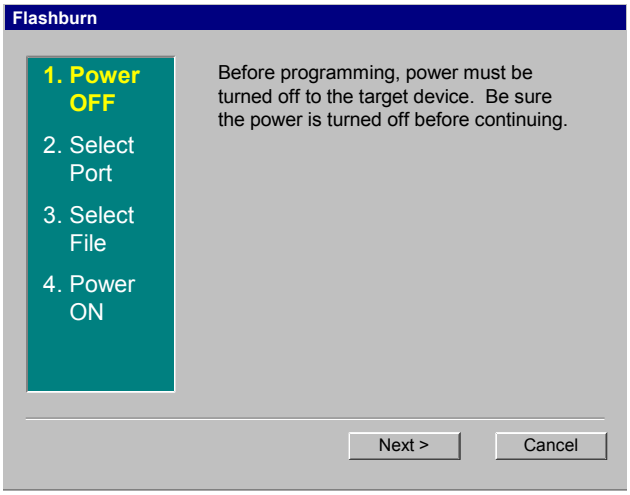
Before beginning, be sure the ".kms" file required to program the product and you know where to find it on your computer.

Programming will reset all the truck configuration information.

NOTE: BEFORE STARTING THIS PROCEDURE, RECORD THE PAYLOAD METER CONFIGURATION INFORMATION.

This information can be found using the Payload Data Manager software. After programming, it will be necessary to restore this information in the payload meter configuration.

1. Turn off power to the payload meter by turning the keyswitch OFF.
2. Start the "Flashburn" software installed on the laptop.



3. Confirm that the payload meter power is OFF and press “NEXT".

TROUBLESHOOTING

It is important to understand the LED signal for the pumping unit. It is used primarily to verify that the system is maintaining the oil level at the level of the open end of the withdrawal tube in the engine oil pan. The signal is also a valuable tool in troubleshooting the system.

When the signal is ‘steady’ (not flashing), pump 1 is running and oil is being withdrawn from the engine and being transferred to the reserve tank.

When the signal is ‘flashing’, pump 1 is drawing air from the suction tube which triggers operation of the pump 2 to operate and transfer oil back to the engine from the tank (the flashing is actually the pulses of pump 2). When the oil is at the correct level in the engine, air and oil are alternatively entering the suction tube, with pump 1 commanding operation of pump 2 with each portion of air that comes through the line.

This is a complete test for proper operation of the pumping unit. This operation can be accomplished without running the engine by jumping the oil pressure switch that activates the system.

1. If the signal light is ‘steady’, pump 1 should be pumping oil. Verify by loosening the hose at pump 1 outlet to verify that oil is coming through (pump 1 is marked by a groove on its outlet).
2. Loosen the hose at the inlet of pump 1 to admit air. Pump 2 should then run and the signal should be flashing. Verify proper pumping of pump 2 by loosening the hose at its outlet to see that oil is coming through.
3. Re-tighten the inlet hose on pump 1. The pump should again receive oil and the flashing should stop.

NOTE: There is a condition that would show a level higher than the controlled point. If both the engine and reserve tank are overfilled, there is no room in the tank to draw the oil level down in the engine. In this case, the LED signal would never start ‘flashing’ because pump 1 is never receiving air. It will continue to pump oil from the engine to the tank, but because the tank is full, the oil will be routed back to the engine via the air relief valve on top of the tank.

There are two explanations for an overfilled tank and engine:

- When the tank is filled to “FULL” and the engine is overfilled.
- When oil is added directly to the engine between oil changes. The system transfers the oil to the reserve tank until it can not receive any more and the engine remains overfilled. It is, therefore, important that oil should be added only to the reserve tank between oil changes; except, of course, if the engine is extremely low.

Circuit Breaker or Fuse

The Reserve System is protected either by a 15 amp circuit breaker or a 15 amp fuse located in the auxiliary control cabinet. If the truck is protected by circuit breakers, it will be CB10. If the truck is protected by fuses, the fuse will be in Fuse Block 2, position 10.

Door Adjustment

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

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

Door Jamb Bolt Adjustment

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

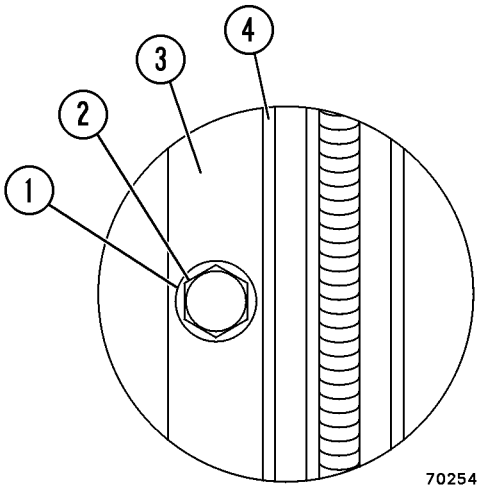


FIGURE 2-3. DOOR JAMB BOLT ADJUSTMENT

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

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

1. Mark the washer location (1, Figure 2-3) portion of the door jamb bolt with a marker, pen, or pencil by circumscribing the outside edge of the washer onto the jamb.
2. Loosen the door jamb bolt (2) and move straight inwards 1/16" and retighten.
3. Hold a piece of paper such as a dollar bill between where the door seal (4) will hit the skin of the cab and firmly close the door ensuring that it latches on the second catch. (The door latch mechanism has a double catch mechanism.)
4. The door seal should firmly grip the paper all along the top, front, and bottom edge of the door. If the paper is loose all around, repeat Step 2. If the paper is firmly gripped, but can be removed without tearing it, open door and tighten the jamb bolt completely without affecting the adjustment.
5. If the paper slips out from the door seal easily along the top and not at the bottom, the door itself will have to be "adjusted". Or if the paper slips out easier at the bottom than at the top, the door will have to be "adjusted".

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

Installation

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

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

   a. Install the weatherstrip around the opening in the cab for the glass. Start with one end of the weatherstrip at the center, lower part of the window opening and press the weatherstrip over the edge of the opening.

   b. Continue installing weatherstrip while going all the around the opening. When the ends of the weatherstrip meet at the starting point at the lower, center area of the window opening, there must be 0.5 in. (12.7 mm) of overlapping material.

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

   c. Lift both ends so that they meet squarely, then while holding ends together, force them back over the lip of the opening.

2. Lubricate the groove of the weatherstrip where the glass is to be seated.

   a. Lower the glass into the groove along the bottom of the opening.

   b. Two people should be used for glass installation. Have one person on the outside of the cab and push in on glass against opening, while the person inside uses a soft flat tool (plastic knife) and goes around the glass to work the weatherstrip over the edge of the glass.

3. After the glass is in place, go around the weatherstrip and push in on the locking lip (2, Figure 2-18 or 2-19) to secure the glass in the weatherstrip.

4. If windshield was being replaced, lower windshield wiper arms/blades back to the glass.

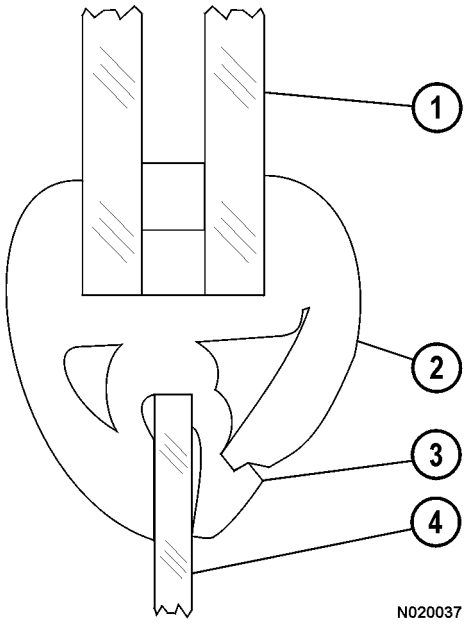


FIGURE 2-19. Rear Window

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

OPERATOR COMFORT

HEATER / AIR CONDITIONER

The heater/air conditioner assembly incorporates all the controls necessary for regulating the cab interior temperature; heated air during cold weather operation, and de-humidified, cool air during warm weather operation.

Operation

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

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

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

Heater/Air Conditioner Vents

Each heater/air conditioner vent (6, Figure 4-1) is a flapper type which may be opened or closed or rotated 360° for optimum air flow. There are four (three not shown) across the top of the panel, one each in the right and left panel modules, and four below the panel.

Defroster Control Switch

Defroster control switch (1, Figure 4-1) directs heated air for windshield defrosting. "Down" position of the toggle switch is OFF. "Up" position of the toggle switch is ON.

Heat Control Switch

Heater control (2, Figure 4-1) directs heated air to the cab floor for heating of the cab. "Down" position of the toggle switch is OFF. "Up" position of the toggle switch is ON.

Temperature Control Knob

Temperature control knob (3, Figure 4-1) allows the operator to select a comfortable temperature.

Rotating the knob counter-clockwise (blue arrow) will select cooler temperatures. Full counter-clockwise position is the coldest air setting. Rotating the knob clockwise (red arrow) will select warmer temperatures. Full clockwise position is the warmest heater setting.

Fan Control Knob

Fan control knob (4, Figure 4-1) controls the cab air fan motor. The fan motor is a 3-speed motor: low (setting 1), medium (setting 2), and high (setting 3). Speeds are selected by rotating the control knob clockwise to the desired position. OFF is full counter-clockwise position (setting 0).

Heater/Air Conditioner Selector Switch

Selector switch (5, Figure 4-1) allows the operator to select heat, A/C, or neither. The left position of the switch activates the air conditioning and the right side of the switch activates the heater. The middle position is OFF. Neither the heat nor the air conditioning can be activated in this position.

NOTE: The air conditioner will not operate unless the fan control knob is turned ON.

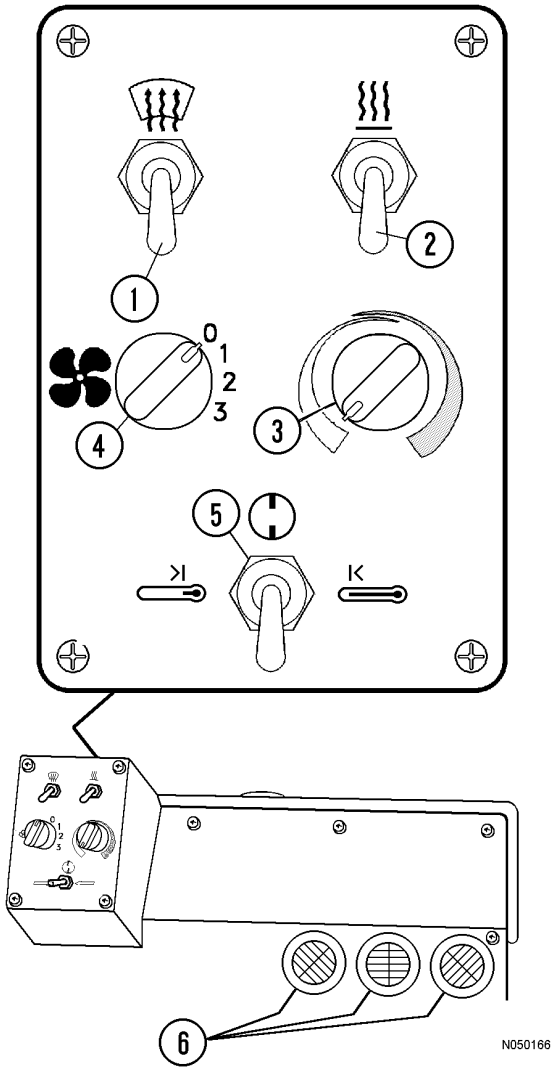


FIGURE 4-1. A/C & HEATER CONTROLS

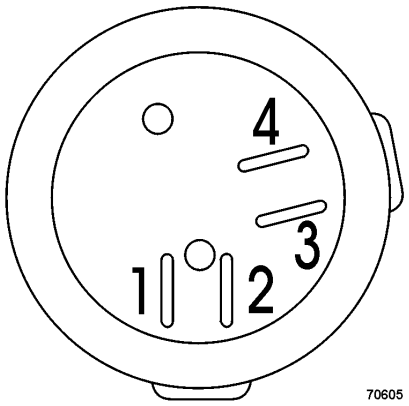
Trinary™ Switch

This switch is mounted on the receiver-drier and has three functions, as implied by the name:

1. Disengage the compressor clutch when system pressure is too high.
2. Disengage the compressor clutch when system pressure is too low.
3. Engage and disengage the radiator fan drive clutch during normal variation of system pressure.

The Trinary™ switch performs three distinct functions to monitor and control refrigerant pressure in the system. This switch is installed on the receiver-drier. The switch functions are:

Terminals 1 & 2 are connected internally through two, normally closed pressure switches in series, the low pressure switch and the high pressure switch.



Terminals 3 & 4 are connected internally through a normally open switch that is used to control the clutch that drives the radiator fan. This switch closes and causes the cooling fan clutch to engage when system pressure rises to 200 - 230 psi. When pressure falls to 140 - 195 psi, the switch contacts open, and the cooling fan clutch disengages.

- Low Pressure - This switch opens and disengages the compressor clutch if system pressure drops into the 15 -30 psi range. When pressure rises above 40 psi, the switch contacts close, and the clutch engages the compressor. Since temperature has a direct effect on pressure, if the ambient temperature is too cold, system pressure will drop below the low range, and the pressure switch will disengage the clutch.
- Fan Clutch - The mid-range function actuates the engine fan clutch, if installed.
- High Pressure - This switch opens and disengages the compressor clutch if system pressure rises above the 300 - 350 psi range. After system pressure drops to 210 - 250 psi, the switch contacts will close and the clutch will engage.

The switch functions will automatically reset when system pressure returns to normal.

	OPENS	CLOSES
Low Pressure	15-30 psi - descending pressure	40 psi - rising pressure
High Pressure	300-350 psi	210-250 psi
Fan Clutch	35-60 psi - below closing pressure	200-230 psi - rising pressure

⚠ IMPORTANT ⚠

The pressures listed above are typical of pressures at the receiver-drier. Due to normal system flow losses and the distance between the service port and the receiver-drier, it is expected that actual system pressure displayed on the gauge will normally be approximately 20 psi higher. This factor should be observed when checking for proper operation of the switch.

NOTE: One other pressure controlling device is installed within the compressor. A mechanical relief valve is located on the back of the compressor. The relief valve will open at 500 - 550 psi. The purpose of this valve is to protect the compressor in the event that pressure should be allowed to rise to that level. Damage to the compressor will occur if pressure exceeds 550 psi.

RECOVERING AND RECYCLING THE REFRIGERANT

Draining the oil from the previous recovery cycle

1. Place the power switch and the controller on the recovery unit in the OFF position.
2. Plug in the recovery station to the correct power source.
3. Drain the recovered oil through the valve marked “oil drain” on the front of the machine.
4. Place the controller knob in the ON position. The low pressure gauge will show a rise.
5. Immediately switch to the OFF position and allow the pressure to stabilize. If the pressure does not rise to between 5 psi and 10 psi, switch the controller ON and OFF again.
6. When the pressure reaches 5 to 10 psi, open the “oil drain” valve, collect the oil in an appropriate container, and dispose of container as indicated by local, state or federal regulation. **The oil is not reusable due to contaminants absorbed during use.**

Performing the Recovery Cycle

1. Be sure the equipment being used is designed for the refrigerant you intend to recover.
2. Observe the sight glass oil level. Having drained it, it should be zero.
3. Check the cylinder refrigerant level before beginning recovery to make sure you have enough capacity.
4. Confirm that all shut-off valves are closed before connecting to the A/C system.
5. Attach the appropriate hoses to the system being recovered.
6. Start the recovery process by operating the equipment as per the manufacturer's instructions.
7. Continue extraction until a vacuum exists in the A/C system.
8. If an abnormal amount of time elapses after the system reaches 0 psi and does not drop steadily into the vacuum range, close the manifold valves and check the system pressure. If it rises to 0 psi and stops, there is a major leak.
9. Check the system pressure after the recovery equipment stops. After five minutes, system pressure should not rise above “0” gauge pressure. If the pressure continues to rise, restart and begin the recovery sequence again. This cycle should continue until the system is void of refrigerant.
10. Check the sight glass oil level to determine the amount of oil that needs to be replaced. (The amount of oil that was lost during the recovery cycle must be replaced back into the system).
11. Mark the cylinder with a “RECOVERED” (red) magnetic label to reduce the chance of charging a system with contaminated refrigerant. Record the amount of refrigerant recovered.

Performing the Recycling Procedure

The recovered refrigerant contained in the cylinder must undergo the recycle procedure before it can be reused. The recycle or clean mode is a continuous loop design and cleans the refrigerant rapidly. Follow the equipment manufacturer's instructions for this procedure.

Evacuating and Charging the A/C System

Evacuate the system once the air conditioner components are repaired or replacement parts are secured, and the A/C system is reassembled. Evacuation removes air and moisture from the system. Then, the A/C system is ready for the charging process, which adds new refrigerant to the system.

CHARGING THE A/C SYSTEM

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

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

1. Charge the A/C system with R-134a refrigerant.

   Non-accumulator systems. . . . . 6.9 lbs (3.1 kg)

   Accumulator systems . . . . . .7.4 lbs (3.4 kg)

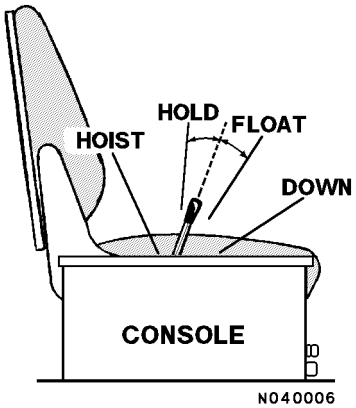
NOTE: Charging is to be performed with the engine and compressor operating. Charge the A/C system through the low side service port. Trucks without accumulators must be charged with the refrigerant in vapor form. Trucks equipped with accumulators may charge the refrigerant as a liquid or as a vapor.

2. Check the system for leaks. Refer to System Leak Testing.
3. If no leaks are found, verify the system's cooling capacity meets requirements. Refer to System Performance Testing.

SECTION N5
OPERATOR CAB CONTROLS
INDEX

Hoist Control Lever

Hoist control (3, Figure 5-5) is a four position hand-operated lever located between the operator seat and the center console (see illustration below).



Raising The Dump Body

1. Pull the lever to the rear to actuate the hoist circuit. (Releasing the lever anywhere during "hoist up" will place the body in HOLD at that position.)
2. Raise engine rpm to increase hoist speed.
3. Reduce engine rpm as the last stage of the hoist cylinders begin to extend and then let the engine go to low idle as the last stage reaches half-extension.
4. Release the hoist lever as the last stage reaches full extension.
5. After material being dumped clears the body, lower the body to frame.

Refer to Operating Instructions - Dumping, Section 3, of the Operation and Maintenance Manual for more complete details concerning this control

Lowering The Dump Body:

Move the hoist lever forward to DOWN position and release. Releasing the lever places the hoist control valve in the FLOAT position allowing the body to return to the frame.

Ash Tray

Ash tray (4, Figure 5-5) is used for extinguishing and depositing smoking materials. Do Not use for flammable materials, such as paper wrappers, etc. Be certain that all fire ash is extinguished!

Lighter

Lighter (5, Figure 5-5) may be used for lighting cigars/cigarettes. Always use caution with smoking materials!

This socket may also be used for a 12 VDC power supply.

L.H. Window Control Switch

LH window control switch (6, Figure 5-5) is spring-loaded to the OFF position.

- Pushing the front of the switch raises the left side cab window.
- Pushing the rear of the switch lowers the window.

R.H. Window Control Switch

RH window control switch (7, Figure 5-5) is spring-loaded to the OFF position.

- Pushing the front of the switch raises the right side cab window.
- Pushing the rear of the switch lowers the window.

Engine Shutdown Switch

Engine shutdown switch (8, Figure 5-4) is used for engine shutdown. Pull the switch up to stop the engine. Push the switch back down to enable engine operation.

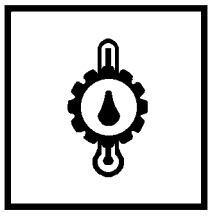
SWITCH UP
ENGINE OFF

SWITCH DOWN
ENGINE ON

Use this switch to shutdown the engine if the key-switch should fail to operate, or to stop the engine without turning off the 24 VDC electrical circuits.

A ground level engine shutdown switch is also located at the right front corner of the truck.

AC Drive System Temperature Gauge

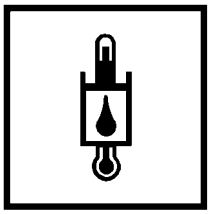


The AC drive system temperature gauge (23, Figure 5-7) indicates the drive system temperature. There are three colored bands: green; yellow; and red. Green indicates "normal" operation.

Yellow indicates the system temperature is rising. There is also an amber (yellow) "temperature warning" light in the overhead panel (C5, Figure 5-8) that will illuminate when the temperature exceeds a certain level. When this condition occurs, the operator should consider changing truck operation in order to reduce system temperature.

If the AC drive system temperature should reach the red band, continued operation could damage components in the system.
Safely stop truck, shutdown engine, and notify maintenance personnel immediately.

Hydraulic Oil Temperature Gauge



The hydraulic oil temperature gauge (25, Figure 5-7) indicates oil temperature in the hydraulic tank. There are two colored bands: green, and red. Green indicates "normal" operation. Red indicates high oil temperature in the hydraulic tank.

As the needle gets close to the red zone, the minimum engine idle speed will increase to help cool the oil as outlined below.

- If the truck is moving, and the oil temperature exceeds 221° F (105° C), the minimum idle speed will be 1200 rpm (normally 1050).
- If the truck is moving, and the oil temperature goes above 230° F (110° C), the minimum idle speed will be 1700 rpm (normally 1050).
- If the truck is stopped, and the oil temperature goes above 212° F (100° C) the minimum idle speed will be 1000 rpm (normally 750).

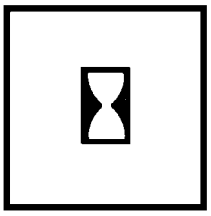
NOTE: Once the oil cools down to the normal operating range, the engine rpm will return to normal speed.

- The red warning light (A1, Figure 5-8) will illuminate if the oil temperature rises above 248° F (120° C). This is when the gauge needle enters the red zone. Continued operation could damage components in the hydraulic system.

If this condition occurs, the operator should safely stop the truck, move selector switch to NEUTRAL, apply the park brake, and operate engine at 1200 - 1500 rpm to reduce system temperature.

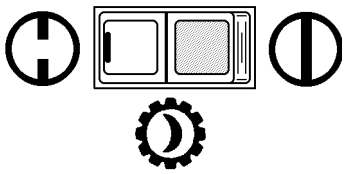
If temperature gauge does not move into the green range after a few minutes, and the red overhead indicator light does not go out, shutdown truck and notify maintenance personnel immediately.

Hourmeter



The hourmeter (24, Figure 5-7) registers the total number of hours the engine has been in operation.

Rest Switch



The rest switch (26, Figure 5-7) is a "rocker" type switch with a locking device for the OFF (left side) position. When in this position, a small black tab must be pushed to the left to unlock the switch before it can be depressed to switch to the ON (right side) position. When in the ON position, an internal amber lamp will illuminate. It should be activated to **de-energize the AC drive system** whenever the engine is to be shutdown, or the truck parked for a length of time with the engine running.

The selector switch must be in NEUTRAL and the vehicle not moving to enable this function. This will allow the engine to continue running while the AC drive system is de-energized.

⚠WARNING

Activation of the rest switch alone does NOT completely ensure that the drive system is safe to work on.
Refer to Safety Procedures, and check all "link-on", or "link energized", indicator lights to verify the AC drive system is de-engergized before performing any maintenance on the drive system.
DO NOT activate the rest switch while the truck is moving! The truck may unintentionally enter the "rest" mode after stopping.

SECTION P

LUBRICATION AND SERVICE

INDEX

50 HOUR LUBRICATION AND MAINTENANCE CHECKS

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

	TASK	COMMENTS	CHECKED	INITIALS
*1.	FUEL FILTERS - Change the fuel filters, (fuel separators). Refer to engine manufacturer's maintenance manual for fuel filter replacement instructions.			
*2.	HYDRAULIC SYSTEM FILTERS - Replace filter elements only, after the initial 50, 100, and 250 hours of operation; then at each 500 hours of operation thereafter.			

*These checks are required **only after the initial hours of operation** (such as: the commissioning of a new truck, or after a new or rebuilt component installation).

AUTOMATIC LUBRICATION SYSTEM

GENERAL DESCRIPTION

The Lincoln automatic lubrication system is a pressurized lubricant delivery system which delivers a controlled amount of lubricant to designated lube points. The system is controlled by an electric timer which signals a solenoid valve to operate a hydraulic motor powered grease pump. Hydraulic oil for pump operation is supplied by the truck steering circuit.

Grease output is proportional to the hydraulic motor input flow. A pump control manifold, mounted on top of the hydraulic motor, controls input flow and pressure. A 24VDC solenoid mounted on the manifold turns the pump on and off.

The pump is driven by the rotary motion of the hydraulic motor, which is then converted to reciprocating motion through an eccentric crank mechanism. The reciprocating action causes the pump cylinder to move up and down. The pump is a positive displacement, double-acting type as grease output occurs on both the up and the down stroke.

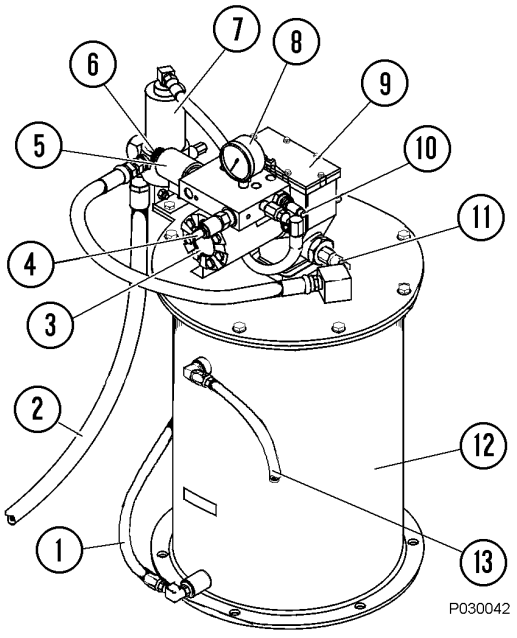


FIGURE 3-1. PUMP/RESERVOIR COMPONENTS

1. Hose from Filter
2. Outlet to Injectors
3. Hydraulic Motor
4. *Pressure Reducing Valve
5. Solenoid Valve
6. Manual Override Switch
7. Vent Valve
8. Pressure Gauge
9. Pump Assembly
10. *Flow Control Valve
11. Pressure Switch
12. Grease Reservoir
13. Vent Hose

**Newer models are equipped with fixed motor controls*

During the down stroke, the pump cylinder is extended into the grease. Through the combination of shovel action and vacuum generated in the pump cylinder chamber, the grease is forced into the pump cylinder. Simultaneously, grease is discharged through the outlet of the pump. The volume of grease during intake is twice the amount of grease output during one cycle. During the upstroke, the inlet check valve closes, and one half the grease taken in during the previous stroke is transferred through the outlet check and discharged to the outlet port.

⚠WARNING

Over-pressurizing of the system, modifying parts, using incompatible chemicals and fluids, or using worn or damaged parts, may result in equipment damage and/or serious personal injury.

- ***DO NOT exceed the stated maximum working pressure of the pump, or of the lowest rated component in the system.***
- ***Do not alter or modify any part of this system unless approved by factory authorization.***
- ***Do not attempt to repair or disassemble the equipment while the system is pressurized.***
- ***Make sure all fluid connections are securely tightened before using this equipment.***
- ***Always read and follow the fluid manufacturer's recommendations regarding fluid compatibility, and the use of protective clothing and equipment.***
- ***Check all equipment regularly and repair, or replace, worn or damaged parts immediately.***

This equipment generates very high grease pressure. Extreme caution should be used when operating this equipment as material leaks from loose or ruptured components can inject fluid through the skin and into the body causing serious bodily injury including possible need for amputation. Adequate protection is recommended to prevent splashing of material onto the skin or into the eyes.

If any fluid appears to penetrate the skin, get emergency medical care immediately! Do not treat as a simple cut. Tell attending physician exactly what fluid was injected.

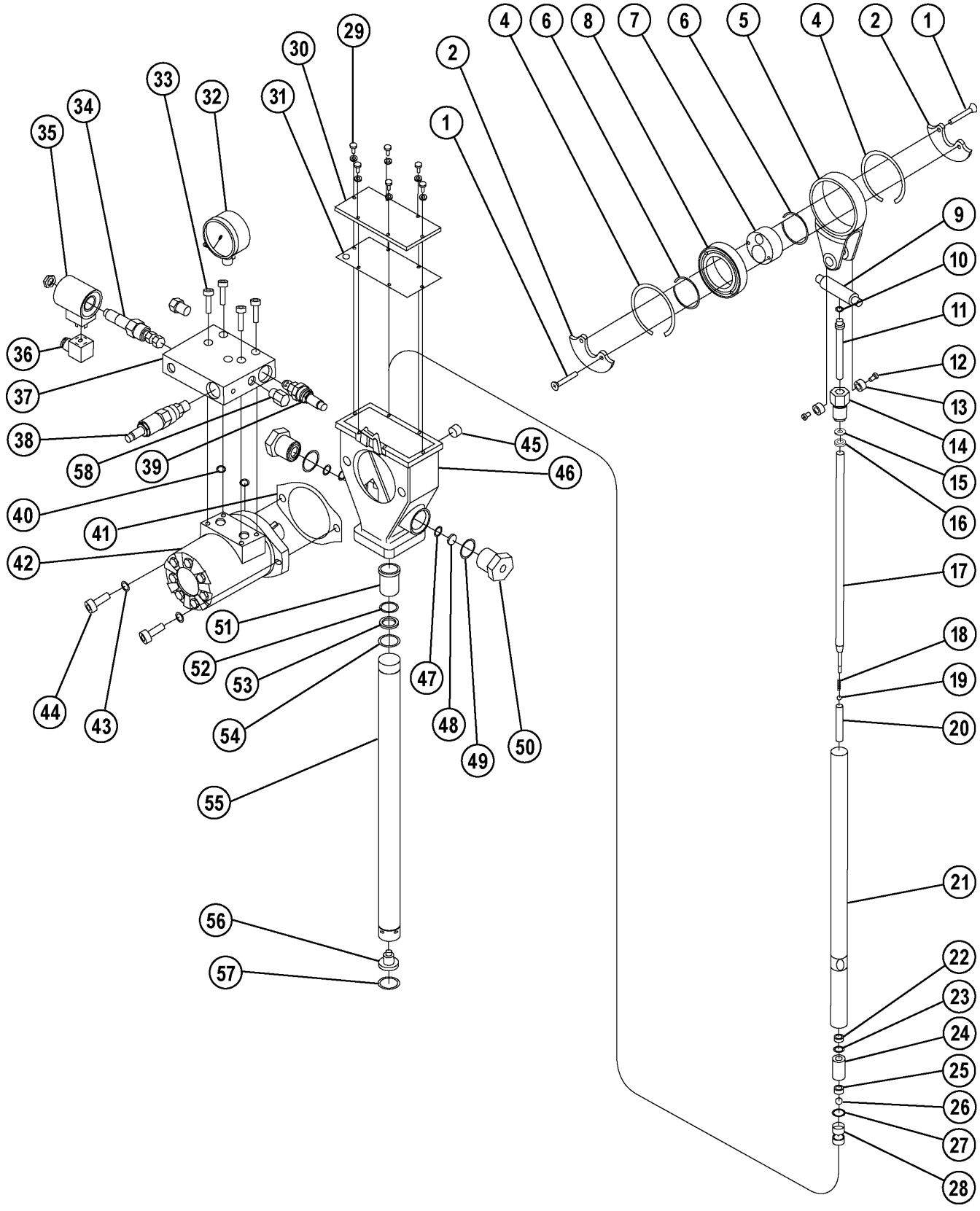


FIGURE 3-9 LUBE PUMP ASSEMBLY

M

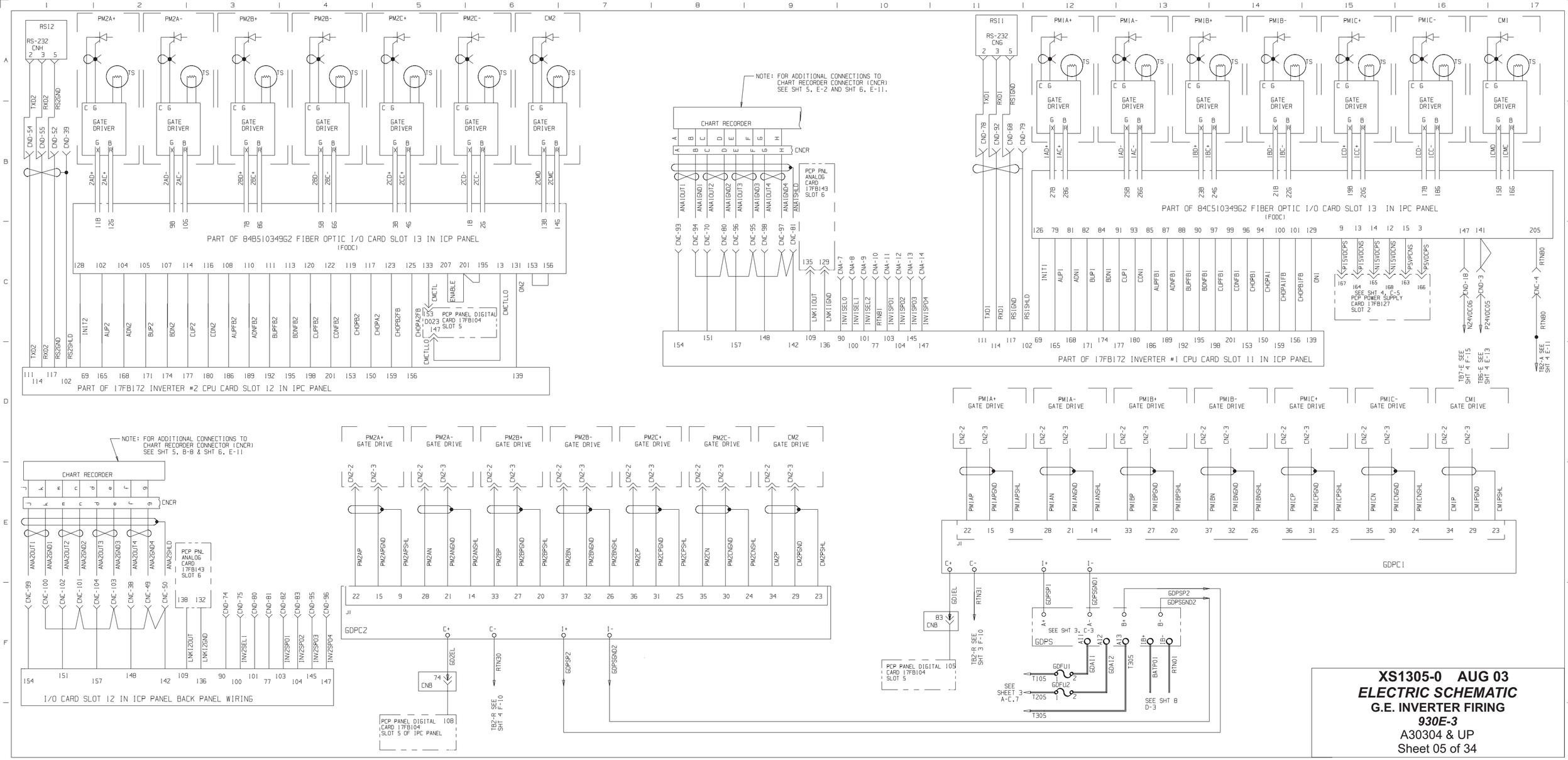
N

O

P

R

S



XS1305-0 AUG 03

ELECTRIC SCHEMATIC

G.E. INVERTER FIRING

930E-3

A30304 & UP

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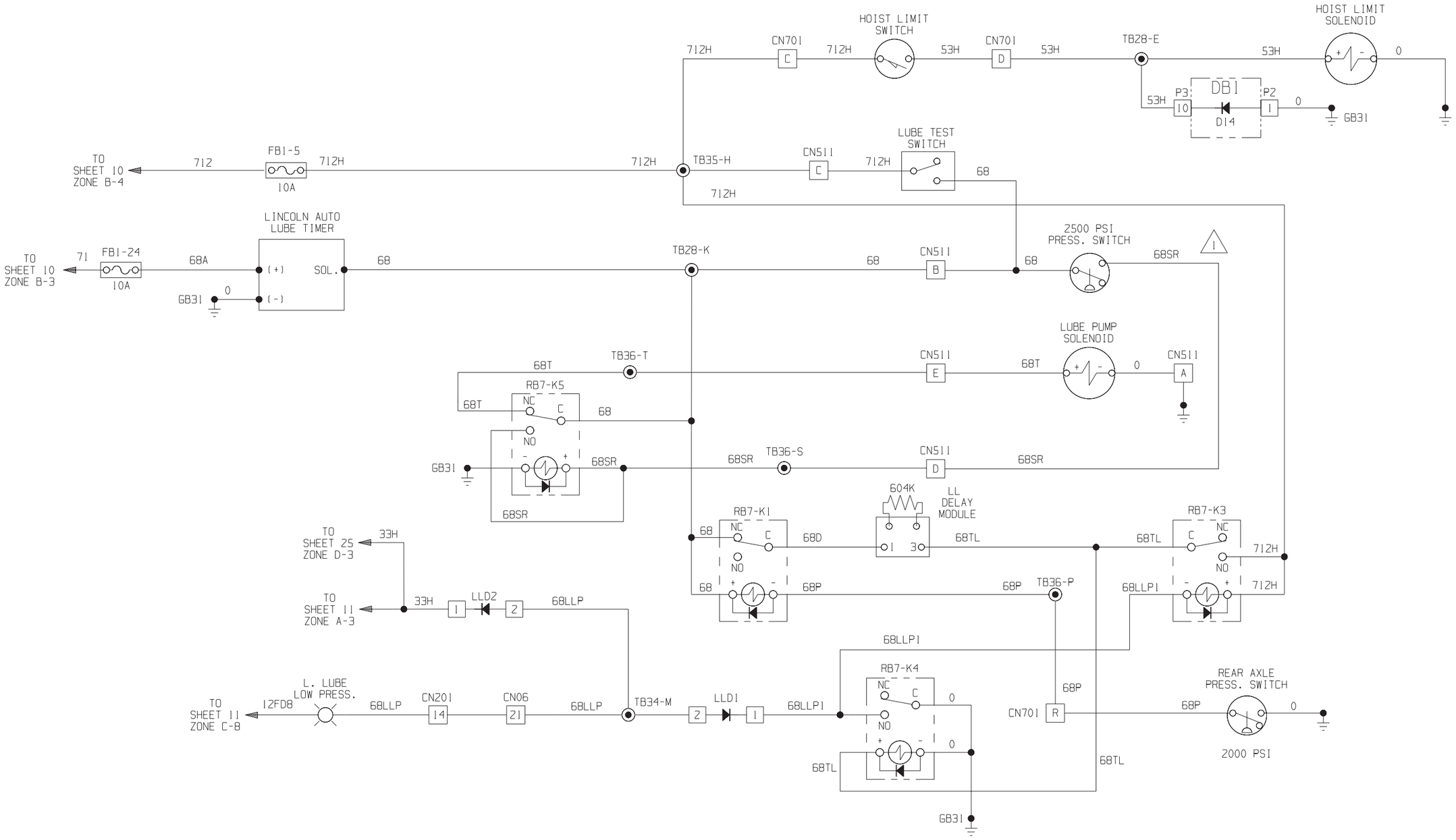

XS1315-1 AUG 03

ELECTRIC SCHEMATIC

LINCOLN LUBE

930E-3

A30304 & UP

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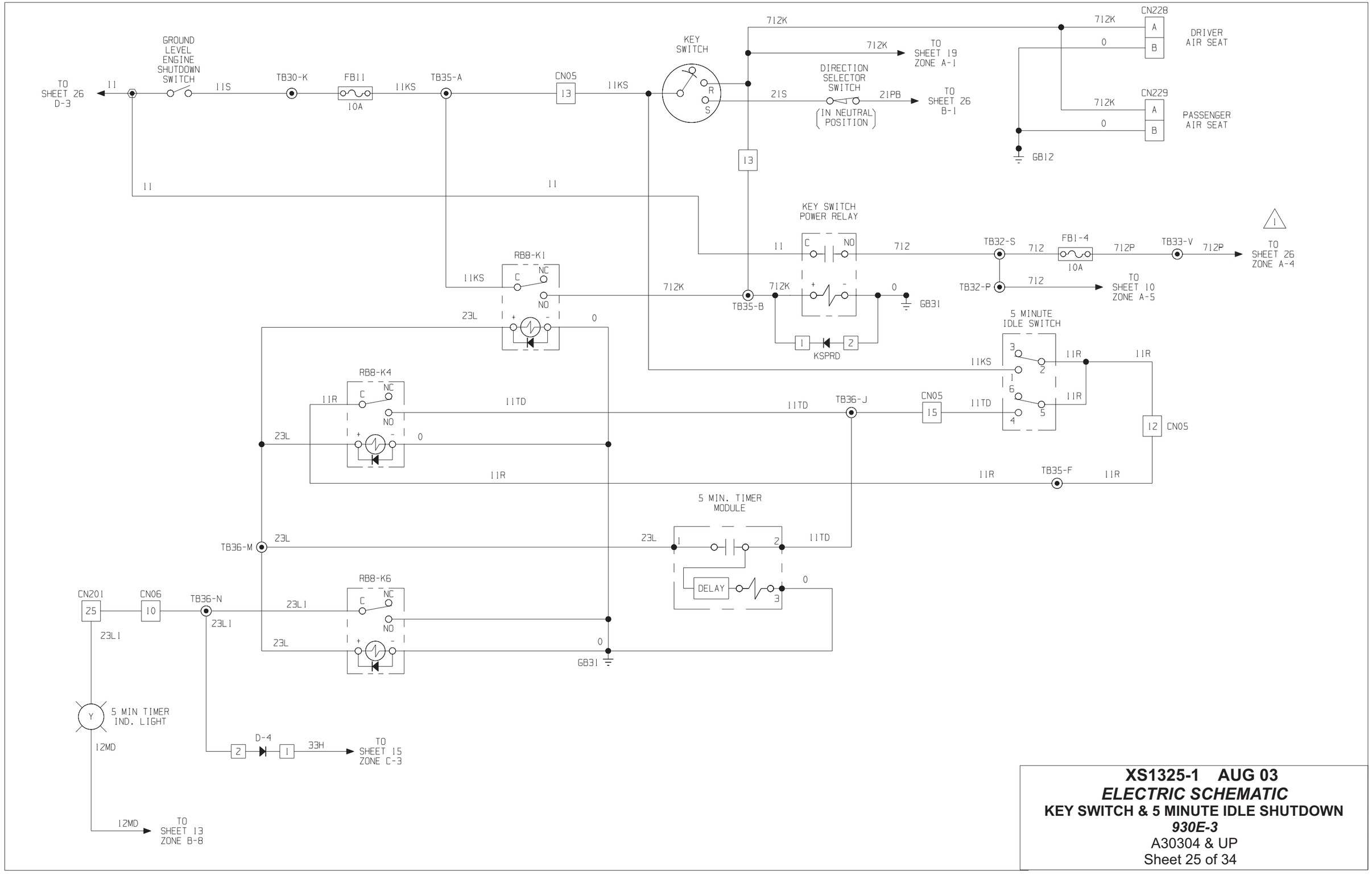

XS1325-1 AUG 03

ELECTRIC SCHEMATIC

KEY SWITCH & 5 MINUTE IDLE SHUTDOWN

930E-3

A30304 & UP

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