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CEBM013200

Shop Manual

830E

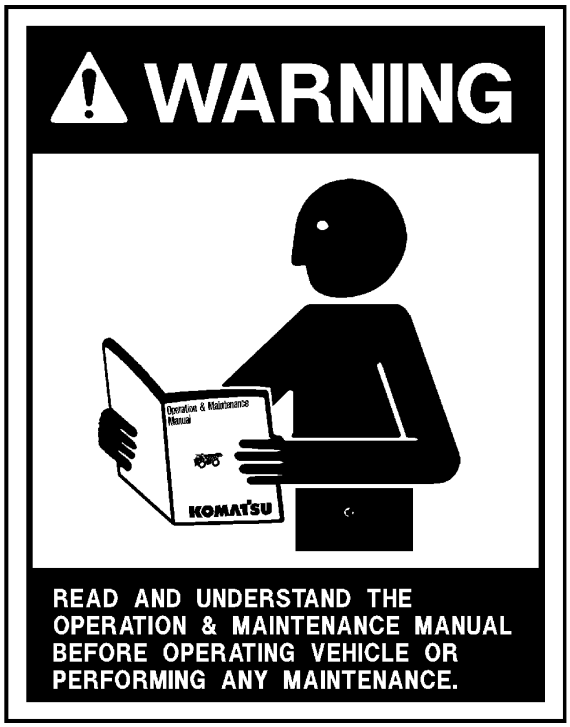
DUMP TRUCK

SERIAL NUMBERS **A30708 - A30732**

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Unsafe use of this machine may cause serious injury or death. Operators and maintenance personnel must read and understand this manual before operating or maintaining this machine.

This manual should be kept in or near the machine for reference, and periodically reviewed by all personnel who will come into contact with it.

This material is proprietary to Komatsu America Corp (KAC), and is not to be reproduced, used, or disclosed except in accordance with written authorization from KAC.

It is the policy of the Company to improve products whenever it is possible and practical to do so. The Company reserves the right to make changes or add improvements at any time without incurring any obligation to install such changes on products sold previously.

Because of continuous research and development, periodic revisions may be made to this publication. Customers should contact their local Komatsu distributor for information on the latest revision.

CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust, some of its constituents, and certain vehicle components contain or emit chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

CALIFORNIA
Proposition 65 Warning

Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. Wash hands after handling.

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NOTES:

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FOREWORD

This Shop Manual is written for use by the service technician and is designed to help the technician become fully knowledgeable of the truck and all its systems in order to keep it running and in production. All maintenance personnel should read and understand the materials in this manual before performing maintenance and/or operational checks on the truck. All safety notices, warnings and cautions should be understood and followed when accomplishing repairs on the truck.

The first section covers component descriptions, truck specifications and safe work practices, as well as other general information. The major portion of the manual pertains to disassembly, service and reassembly. Each major serviceable area is dealt with individually. For example: The disassembly, service and reassembly of the radiator group is discussed as a unit. The same is true of the engine and engine accessories, and so on through the entire mechanical detail of the truck. Disassembly should be carried only as far as necessary to accomplish needed repairs.

The illustrations used in this manual are, at times, typical of the component shown and may not necessarily depict a specific model.

This manual shows dimensioning of U.S. standard and metric (SI) units throughout and all references to “Right”, “Left”, “Front”, or “Rear” are made with respect to the operator's normal seated position, unless specifically stated otherwise.

Standard torque requirements are shown in torque charts in the general information section and individual torques are provided in the text in bold face type, such as **100 ft.lbs. (135 N.m)** torque. All torque specifications have ±10% tolerance unless otherwise specified.

A Product Identification plate is normally located on the truck frame in front of the right side front wheel and designates the Truck Model Number, Product Identification Number (vehicle serial number), and Maximum G.V.W. (Gross Vehicle Weight) rating.

The KOMATSU Truck Model designation consists of three numbers and one letter (i.e. 830E). The three numbers represent the basic truck model. The letter “E” designates an Electrical propulsion system.

The Product Identification Number (vehicle serial number) contains information which will identify the original manufacturing bill of material for this unit. This complete number will be necessary for proper ordering of many service parts and/or warranty consideration.

The Gross Vehicle Weight (GVW) is what determines the load on the drive train, frame, tires, and other components. The vehicle design and application guidelines are sensitive to the **total maximum Gross Vehicle Weight (GVW)** and this means **the total weight:** the Empty Vehicle Weight + the fuel & lubricants + the payload.

To determine allowable payload: Service all lubricants for proper level and fill fuel tank of empty truck (which includes all accessories, body liners, tailgates, etc.) and then weigh truck. Record this value and subtract from the GVW rating. The result is the allowable payload.

NOTE: Accumulations of mud, frozen material, etc. become a part of the GVW and reduces allowable payload. To maximize payload and to keep from exceeding the GVW rating, these accumulations should be removed as often as practical.

Exceeding the allowable payload will reduce expected life of truck components.

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This "ALERT" symbol is used with the signal words, "DANGER", "WARNING", and "CAUTION" in this manual to alert the reader to hazards arising from improper operating and maintenance practices.

⚠ DANGER

"DANGER" identifies a specific potential hazard WHICH WILL RESULT IN EITHER INJURY OR DEATH if proper precautions are not taken.

⚠WARNING

"WARNING" identifies a specific potential hazard WHICH MAY RESULT IN EITHER INJURY OR DEATH if proper precautions are not taken.

⚠CAUTION

"CAUTION" is used for general reminders of proper safety practices OR to direct the reader's attention to avoid unsafe or improper practices which may result in damage to the equipment.

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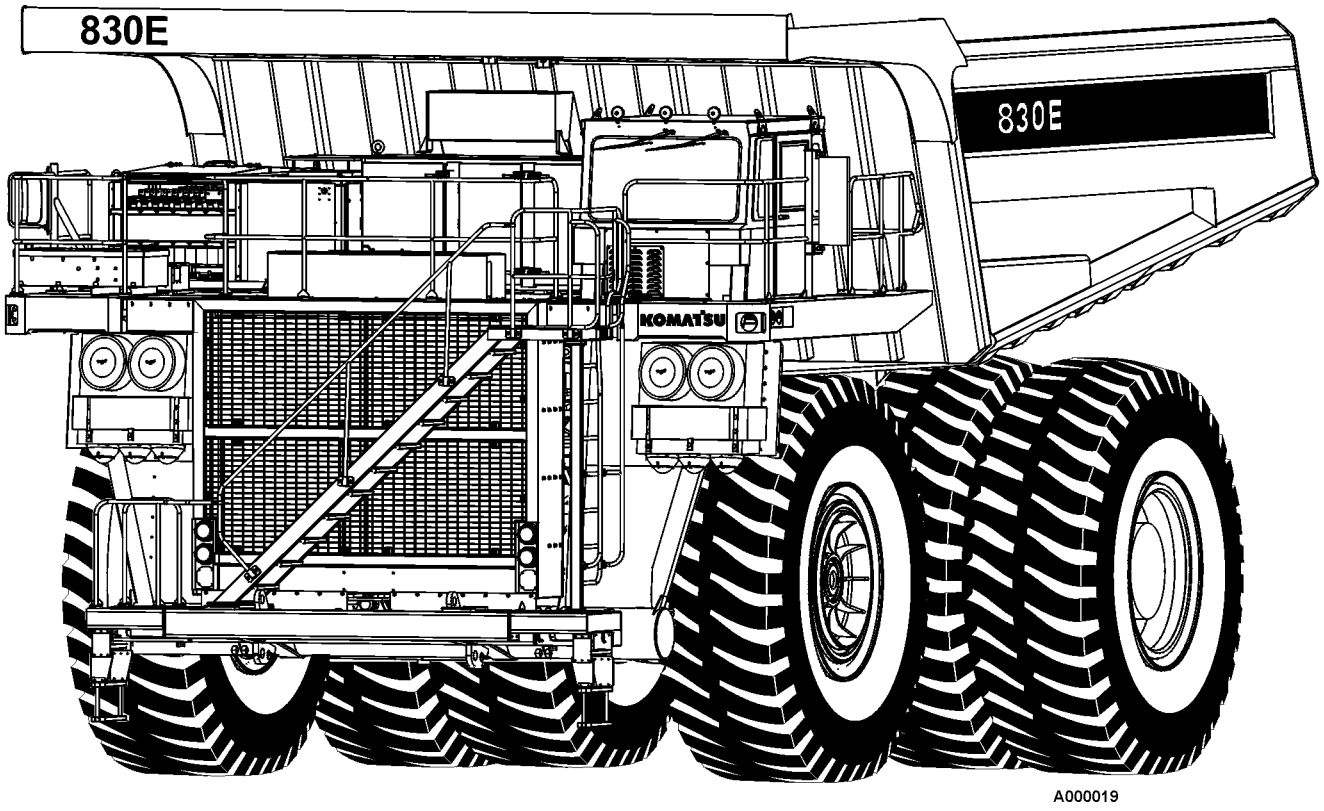
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KOMATSU MODEL 830E TRUCK

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SECTION A

GENERAL INFORMATION

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MAJOR COMPONENT DESCRIPTION

The KOMATSU Model 830E Truck is an electric drive, off-highway, rear dump truck whose gross vehicle weight is 850,000 lbs. (385 553 kg) (240 - 255 ton nominal payload).

ENGINE

This Model 830E Truck is powered by a Komatsu SDA16V160 diesel engine rated at 2500 hp (1864 kW) @ 1900 RPM. The radiator, engine, alternator, and blower are mounted on a separate subframe to provide fast, easy removal and installation of the power module.

ALTERNATOR (G.E. GTA-26)

The alternator is mounted in-line with the engine. The alternating current (AC) output of the alternator is rectified to direct current (DC) and sent to the wheel mounted DC drive traction motors.

BLOWER

The dual impeller, in-line blower supplies cooling air for the alternator, rectifiers, and both traction motors. The air is exhausted to atmosphere through the wheel motors.

WHEEL MOTORS

Traction motors located within each rear wheel structure receive electrical energy from the alternator. The two traction motors convert electrical energy back to mechanical energy through built-in gear trains within the wheel structure. The direction of the drive motors is controlled by a forward or reverse hand selector switch located on a console in the cab to the right side of the operator.

POWER STEERING

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

OPERATOR'S CAB

The Operator's Cab has been engineered for operator comfort and to allow for efficient and safe operation of the truck. The cab contains an integrated ROPS and is fully insulated to reduce noise and vibration. The tinted safety-glass windshield and side windows provide excellent visibility. The seat is a comfortable, adjustable suspension seat, the steering wheel provides tilt and telescoping adjustments and controls are mounted within easy reach of the operator. The instrument panel provides the operator with instruments and gauges that are necessary to control and monitor the truck's operating systems and is marked with international symbols for easy identification of functions.

DYNAMIC RETARDING

Dynamic retarding is used to slow the truck during normal operation or control speed coming down a grade. The dynamic retarding ability of the DC electric system is controlled by the operator by depressing the foot operated retarder pedal and/or setting the RSC (Retarder Speed Control) on the instrument panel. Dynamic Retarding is automatically activated if truck exceeds the overspeed setting.

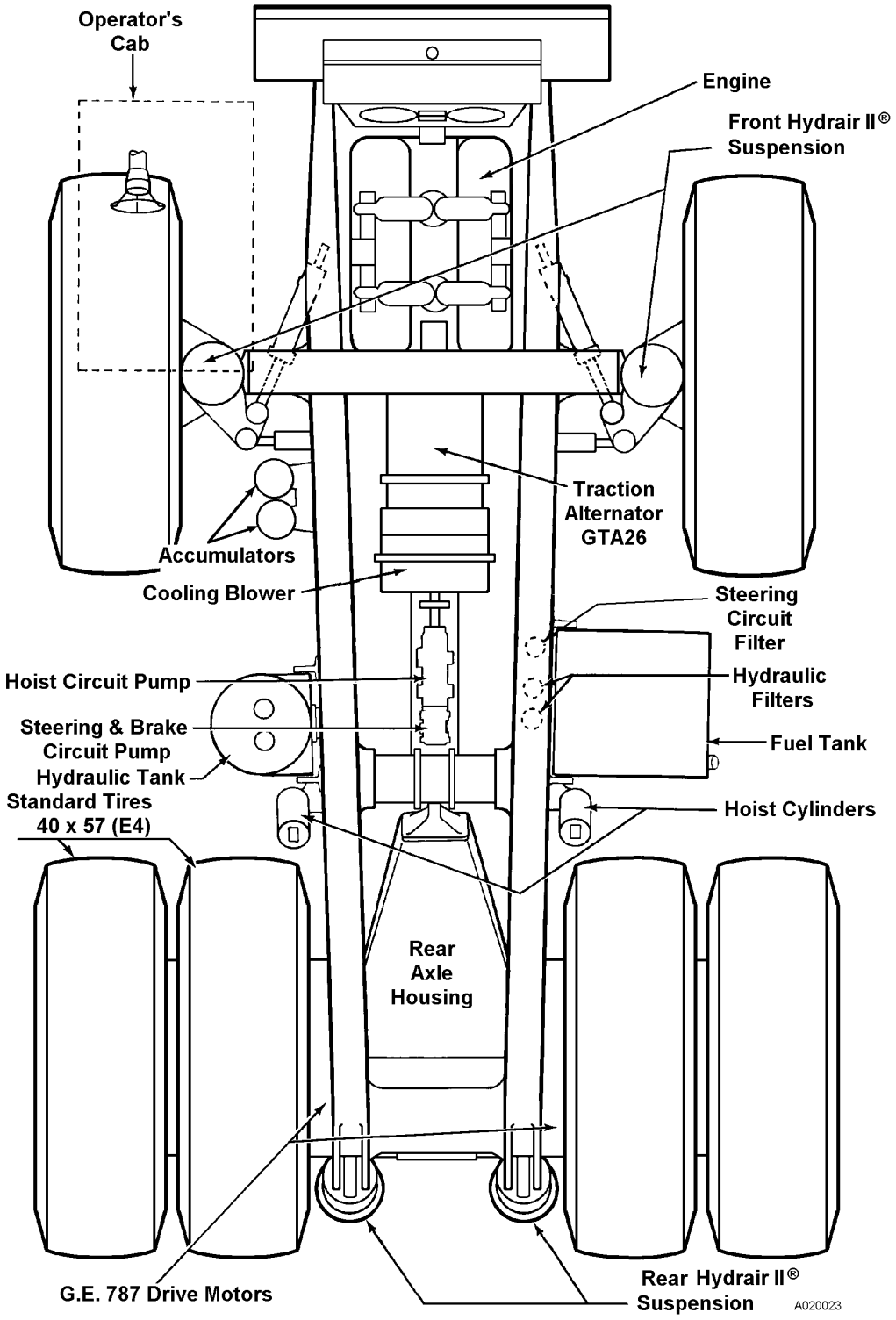
BRAKE SYSTEM

The braking system consists of an all hydraulic actuation system. Depressing the brake pedal actuates wheel-speed single disc front brakes and armature-speed dual disc rear brakes. The brakes can also be activated by operating a switch on the instrument panel. The brakes will be applied automatically if system pressure decreases below a preset minimum.

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.

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830E MAJOR COMPONENTS

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SPECIFICATIONS

These specifications are for the standard Komatsu 830E Truck. Customer Options may change this listing.

ENGINE

Komatsu SDA16V160
(Optional SSDA16V160)
No. of Cylinders 16
Operating Cycle 4-Stroke
Rated Brake HP. . 2500 HP (1887 kW) @ 1900 RPM
Flywheel HP . . . . 2409 HP (1818 kW) @ 1900 RPM
Weight* (Dry) . . . . . .18,868 pounds (8 558 kg)

* Weight does not include Radiator, Sub-frame, or Alternator

ELECTRIC DRIVE SYSTEM - STATEX III

(AC/DC Current)

Alternator . . . . . .General Electric GTA - 26
Dual Impeller, In-Line Blower 9000 cfm (255 m^3/min)
Motorized Wheels . . . . . .General Electric 787
Ratio 31.875:1
Maximum Speed* . . . . . 35.3 MPH (56.9 km/h)
(*w/40.00-57 Tires and 31.875:1 gear train)

DYNAMIC RETARDING

Extended Range Retarding with fully blown 18-Resistor grids and reverse retarding standard equipment.

Maximum Rating . . . . . 4000 HP (2983 kW)

TIRES

Rock Service, Deep Tread. . . . . (E-4) Tubeless
Standard Tire . . . . . 40.00 - 57, 68 Ply Rating

(w/787 Wheelmotor)
Separable Tire Rims *
5 Piece New Generation™ Rims *

Rims* are interchangeable with different positions on the truck, but due to improved design for greater load support, rims are not interchangeable with other manufacturer's rims.

Rim Size:
29 in. (737 mm) X 57 in. (1448 mm) X 6 in. (152 mm)

24 VDC ELECTRIC SYSTEM

Batteries . . Four 12 Volt Batteries in Series/Parallel
. . . 220 Ampere-Hour Capacity w/Disconnect Switch
Alternator . . . . . 24 Volt, 260 Ampere Output
Lighting . . . . . 24 Volt
Starters. . . . . (2) 24 Volt

SERVICE CAPACITIES

	U.S. Gallons	(Liters)
Crankcase *	74.0	280.0
* Includes Lube Oil Filters		
Cooling System	150	568
Fuel	1200	4543
Hydraulic System	250	946
Hydraulic Tank	238	901
Wheel Motor Gear Box (each)	10.5	39.7

HYDRAULIC SYSTEMS*

Pumps

Hoist . . . . . Tandem Gear Pumps
Rated @ . . . . . 230 GPM (870 l/min.) @ 1900 RPM
Steering . . . . Radial Piston-Pressure Compensating
(also Brake) . . . . 65 GPM (246 l/min.) @ 1900 RPM

System Relief Pressures

Hoist/Steering. . . . . 2500 psi (17.2 MPa)
Brakes . . . . . 3500 psi (24.1 MPa)
Hoist Cylinders (2) 3-Stage
Tank (Vertical/Cylindrical) . . . . . Non-Pressurized
Filtration . Remote-mounted, Replaceable, Elements
Suction . . . . . .Single, Full Flow, 100 Mesh
Hoist & Steering . . . . . .
. . . . . Full Flow, Dual In-Line,
. . . . . High Pressure Beta 12 Rating =200

*With Quick Disconnects for powering disabled truck and system diagnostics.

STEERING (w / Accumulators)

Turning Circle - Front Wheel Track. . . 93 ft. (28.4 m)
Full Time Power Steering . . . . . Twin Cylinders
Automatic Emergency Steering . . . . . Standard

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SERVICE BRAKES

Actuation. . . . . .All Hydraulic
Front . . . . . .Wheel Speed, Single Disc
Inboard Mounted . . . . . 3 Calipers
Disc Diameter, O.D. . . . . 47.75 in. (1213 mm)
Rear . . . . . Armature Speed, Dual Disc
Disc Diameter, O.D. . . . . 25.00 in. (635 mm)
Emergency Brake-Automatically Applied (Standard)
Wheel Brake Lock. . . . . Manual Switch on Panel
. . . . . .(Loading and Dumping)

DISC PARKING BRAKE

Each Rear Wheel . . . . . Dual Caliper
. . . . . .Spring Applied, Hydraulically Released

DUMP BODY CAPACITIES AND DIMENSIONS

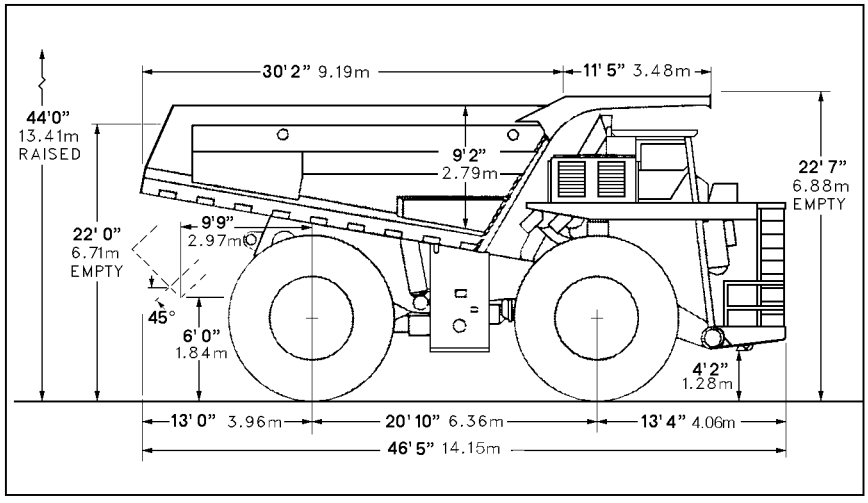
Standard, Heaped @ 2:1 (SAE) . . 193 yd^3 (147 m^3)
Struck . . . . . 153 yd^3 (117 m^3)
Loading Height Empty . . . . . 22 ft. 1 in. (6.71 m)
Dumping Angle. 45
Non-heated Body w/Exhaust Mufflers . . . . Standard

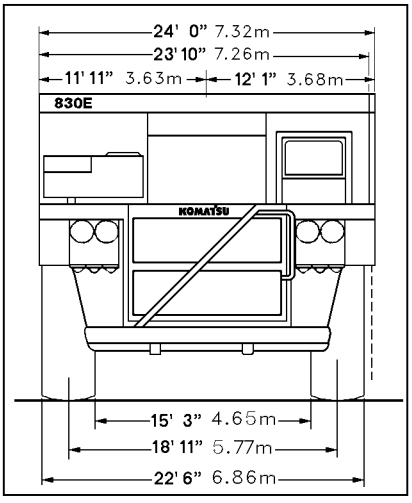
WEIGHT DISTRIBUTION

Empty Vehicle . . . . . Pounds. . . . . (Kilograms)		
Front Axle	177,217.	(80 384)
Rear Axle.	172,792.	(78 377)
Total.	350,009.	(158 761)

Loaded Vehicle . . . . . Pounds. . . . . (Kilograms)		
Front Axle	283,595.	(128 636)
Rear Axle.	566,405.	(256 917)
Total *	850,000.	(385 553)

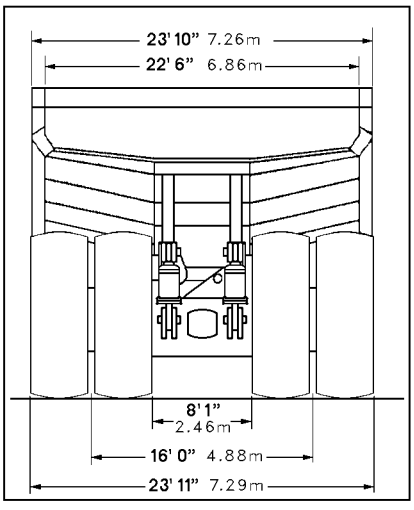
*Not To Exceed 850,000 lbs. (385 553 kg) including options, liners, fuel and payload, and subject to approval by Komatsu.





OVERALL TRUCK DIMENSIONS
(Empty with Standard Body)

Length. . . . . .46 ft. 5 in. (14.15 m)
Width. . . . . .24 ft. 0 in. (7.32 m)
Height with Canopy. . . . . .22 ft. 7 in. (6.88 m)
Height with Dump Body Up. . . . . .44 ft. 0 in. (13.41 m)
Turning Circle (on front track) . . . . . .93 ft. 0 in. (28.35 m)



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GENERAL SAFETY

Safety records of most organizations will show that the greatest percentage of accidents are caused by unsafe acts of persons. The remainder are caused by unsafe mechanical or physical conditions. Report all unsafe conditions to the proper authority.

The following safety rules are provided as a guide for the operator. However, local conditions and regulations may add many more to this list.

⚠WARNING

Read and follow all safety precautions. Failure to do so may result in serious injury or death.

SAFETY RULES

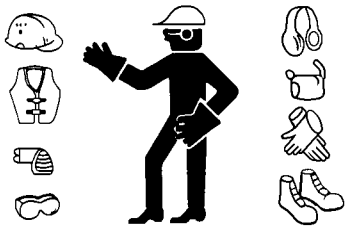
- ONLY trained and authorized personnel can operate and maintain the machine.
- Follow all safety rules, precautions and instructions when operating or performing maintenance on the machine.
- When working with another operator or a person on work site traffic duty, be sure all personnel understand all hand signals that are to be used.

SAFETY FEATURES

- Be sure all guards and covers are in their proper position. Have guards and covers repaired if damaged. (See Walk-Around Inspection, Operating Instructions - Section 3)
- Learn the proper use of safety features such as safety locks, safety pins, and seat belts, and use these safety features properly.
- NEVER remove any safety features. ALWAYS keep them in good operating condition.
- Improper use of safety features could result in serious bodily injury or death.

CLOTHING AND PERSONAL PROTECTIVE ITEMS

- Avoid loose clothing, jewelry, and loose long hair. They can catch on controls or in moving parts and cause serious injury or death. Also, do not wear oily clothes because they are flammable.
- Wear a hard hat, safety glasses, safety shoes, mask or gloves when operating or maintaining the machine. Always wear safety goggles, hard hat and heavy gloves if your job involves scattering metal chips or minute materials--this is so particularly when driving pins with a hammer and when cleaning the air cleaner element with compressed air. Check also that there is no one near the machine.


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UNAUTHORIZED MODIFICATION

- Any modification made to this vehicle without authorization from Komatsu can possibly create hazards.
- Before making any modification, consult the authorized regional Komatsu distributor. Komatsu will not be responsible for any injury or damage caused by any unauthorized modification.

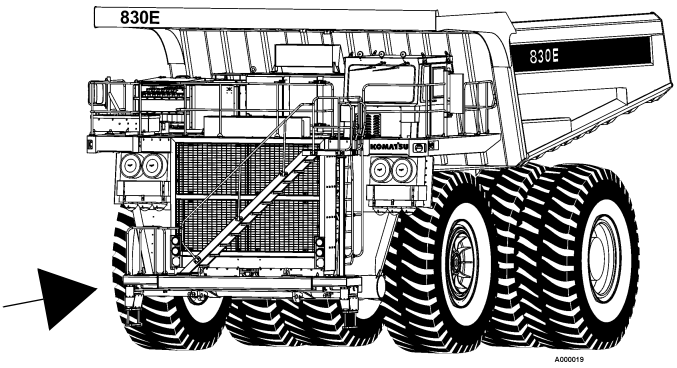
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LEAVING THE OPERATOR'S SEAT

- When preparing to leave the operator's seat, do not touch any control lever that is not locked. To prevent accidental operations from occurring, always carry out the following:
- Move the shift control lever to Neutral (N) and set the parking lever/switch to the PARKING position.
- Lower the dump body, set the dump lever to the FLOAT position.
- Stop the engine. When leaving the machine, always lock everything. Always remember to take the key with you. If the machine should suddenly move or move in an unexpected way, this may result in serious bodily injury or death.

MOUNTING AND DISMOUNTING

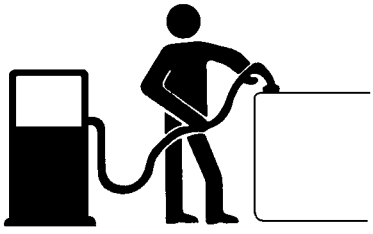
- NEVER jump on or off the machine. NEVER get on or off a moving machine.
- When getting on or off the machine, face the machine and use the hand-hold and steps.
- Never hold any control levers when getting on or off the machine.
- Always maintain three-point contact with the hand-holds and steps to ensure that you support yourself.
- When bringing tools to the operator's compartment, always pass them by hand or pull them up by rope.
- If there is any oil, grease, or mud on the hand-holds or steps, wipe it off immediately. Always keep these parts clean. Repair any damage and tighten any loose bolts.
- Use the handrails and steps marked by arrows in the diagram below when getting on or off the machine.

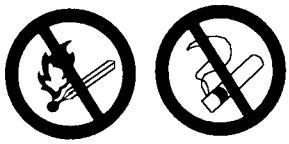


FIRE PREVENTION FOR FUEL AND OIL

- Fuel, oil, and antifreeze can be ignited by a flame. Fuel is particularly FLAMMABLE and can be HAZARDOUS.
- Keep flame away from flammable fluids.
- Stop the engine and do not smoke when refueling.
- Tighten all fuel and oil tank caps securely.
- Refueling and oiling should be made in well ventilated areas.
- Keep oil and fuel in the determined place and do not allow unauthorized persons to enter.







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PRECAUTIONS WHEN HANDLING AT HIGH TEMPERATURES

- Immediately after operations, the engine cooling water, engine oil, and hydraulic oil are at high temperature and are under pressure. If the cap is removed, or the oil or water is drained, or the filters are replaced, there is danger of serious burns. Always wait for the temperature to cool down, and carry out the operation according to the specified procedure.
- To prevent hot water from spurting out:
  1) Stop the engine.
  2) Wait for the water temperature to cool down.
  3) Turn the cap slowly to release the pressure before removing the cap.
- To prevent hot engine oil from spurting out:
  1) Stop the engine.
  2) Wait for the oil temperature to cool down.
  3) Turn the cap slowly to release the pressure before removing the cap.


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ASBESTOS DUST HAZARD PREVENTION

Asbestos dust can be HAZARDOUS to your health if it is inhaled.If you handle materials containing asbestos fibers, follow these guidelines as given below:

- NEVER use compressed air for cleaning.
- Use water for cleaning to keep down the dust.
- Operate the machine with the wind to your back, whenever possible.
- Use an approved respirator if necessary.

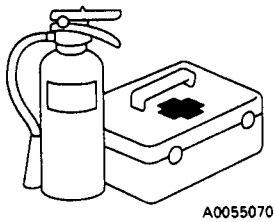

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PREVENTION OF INJURY BY WORK EQUIPMENT

- Never enter or put your hand or arm or any other part of your body between movable parts such as the dump body and chassis or cylinders. If the work equipment is operated, the clearance will change and this may lead to serious bodily injury or death.

FIRE EXTINGUISHER AND FIRST AID KIT

- Be sure fire extinguishers have been provided and know how to use them.
- Provide a first aid kit at the storage point.
- Know what to do in the event of a fire.
- Be sure you know the phone numbers of persons you should contact in case of an emergency.


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PRECAUTIONS WHEN USING ROPS

- If ROPS is installed, the ROPS must never be removed when operating the machine.
- The ROPS is installed to protect the operator if the machine should roll over. It is designed not only to support the load if the machine should roll over, but also to absorb the impact energy.
- The ROPS installed on equipment manufactured and designed by Komatsu America Corp. fulfills all of the regulations and standards for all countries, but if it is modified or repaired without authorization from Komatsu America Corp., or is damaged when the machine rolls over, the strength will drop and it will not be able to fulfill its function properly. It can only display its performance if it is repaired or modified in the specified way.
- When modifying or repairing the ROPS, always consult the authorized regional Komatsu distributor.
- Even if the ROPS is installed, it cannot show its full effect if the operator does not fasten the seat belt properly. Always fasten the seat belt when operating.

PRECAUTIONS FOR ATTACHMENTS

- When installing and using optional equipment, read the instruction manual for the attachment and the information related to attachments in this manual.
- Do not use attachments that are not authorized by Komatsu America Corp., or the authorized regional Komatsu distributor. Use of unauthorized attachments could create a safety problem and adversely affect the proper operation and useful life of the machine.
- Any injuries, accidents, and product failures resulting from the use of unauthorized attachments will not be the responsibility of Komatsu America Corp., or the authorized regional Komatsu distributor.

PRECAUTIONS ON STARTING MACHINE

- START THE ENGINE FROM THE OPERATOR'S SEAT ONLY.
- NEVER ATTEMPT TO START THE ENGINE BY SHORTING ACROSS THE STARTER TERMINALS. This may cause fire, or serious injury or death to anyone in machine's path.



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PRECAUTIONS DURING OPERATION

SAFETY IS THINKING AHEAD

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

Safe practices start before the operator gets to the equipment!

SAFETY AT WORKSITE

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

FIRE PREVENTION

- Thoroughly remove wood chips, leaves, paper and other flammable things accumulated in the engine compartment. These could cause a fire.
- Check fuel, lubrication, and hydraulic systems for leaks. Have any leaks repaired. Wipe up any excess oil, fuel or other flammable fluids.
- Be sure a fire extinguisher is present and working.
- Do not operate the machine near any flame.



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PREPARING FOR OPERATION

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

VENTILATION FOR ENCLOSED AREAS

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



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IN OPERATOR'S CAB - BEFORE STARTING ENGINE

- Do not leave tools or spare parts lying around in the operator's compartment or allow trash to accumulate in cab of truck. Keep all unauthorized reading material out of 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 seat belts when operating your machine.
- Read and understand the contents of this manual. Read the Section 3 pertaining to 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.
- Insure steering wheel, horn, controls and pedals are free of any oil, grease or mud.
- Check operation of windshield wiper, condition of wiper blades, and check washer reservoir for fluid level.
- Be familiar with all steering and brake system controls and warning devices, road speeds and loading capabilities, before operating the truck.

KEEP MIRRORS, WINDOWS, AND LIGHTS CLEAN

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

OPERATING THE MACHINE

WHEN STARTING ENGINE

- NEVER ATTEMPT TO START THE ENGINE 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 control.
- 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 person other than the operator 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 truck. Riders should be in cab only and belted in passenger seat.
- Do not allow anyone to ride on decks or steps of truck.
- Do not allow anyone to get on or off truck while it is in motion.
- Do not move truck into or out of a building without a signal person present.
- Know and obey the hand signal communications between 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!**

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- Report immediately to supervisor any conditions on haul road, pit or dump area that may cause an operating hazard.
- Check for flat tires periodically during shift. If truck has been run on a “flat”, **it must not be parked in a building until the tire cools**. If tire must be changed, do not stand in front of rim and locking ring when inflating tire mounted on the machine. Observers should not be permitted in the area and should be kept away from the side of such tires.

⚠DANGER

Tire and rim assembly may explode if subjected to excessive heat. Personnel should move to a remote or protected location if sensing excessively hot brakes, smell of burning rubber or evidence of fire near tire and wheel area.

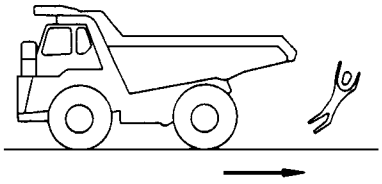
If the truck must be approached, such as to fight a fire, those personnel should do so only while facing the tread area of the tire (front or back), unless protected by use of large heavy equipment as a shield. Stay at least 50 ft. (15 m) from the tread of the tire.

In the event of fire in the tire and wheel area (including brake fires), stay away from the truck at least 8 hours or until the tire and wheel are cool.

- Keep serviceable fire fighting equipment at hand. Report used extinguishers for replacement or refilling.
- Always have parking brake applied when the truck is parked and unattended. **DO NOT** leave truck unattended while engine is running.
- When parking, park a safe distance from other vehicles as determined by supervisor.
- Stay alert at all times! In the event of an emergency, be prepared to react quickly and avoid accidents. If an emergency arises, know where to get prompt assistance.

CHECK WHEN TRAVELING IN REVERSE

Before operating the machine or work equipment, do as follows:



- Sound the horn to warn people in the area. For machines equipped with a back-up alarm, check that the alarm works properly.
- Check that there is no one near the machine. Be particularly careful to check behind the machine.
- If necessary, designate a person to check the safety. This is particularly necessary when traveling in reverse.
- When operating in areas that may be hazardous or have poor visibility, designate a person to direct work site traffic.
- Do not allow any one to enter the line of travel of the machine. This rule must be strictly observed even on machines equipped with a back-up alarm or rear view mirror.

TRAVELING

- When traveling on rough ground, travel at low speed. When changing direction, avoid turning suddenly.
- Lower the dump body and set the dump lever to the FLOAT position when traveling.
- If the engine should stop when the machine is traveling, the emergency steering system will be activated. Apply the brakes immediately and stop the machine as quickly and safely as possible, and off the haul road, if possible.

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TRAVELING ON SLOPES

- Traveling on slopes could result in the machine tipping over or slipping.
- Do not change direction on slopes. To ensure safety, go down to level ground before turning.
- Do not travel up and down on grass, fallen leaves, or wet steel plates. These materials may make the machine slip on even the slightest slope. Avoid traveling sideways, and always keep the travel speed low.
- When traveling downhill, use the retarder to reduce speed. Do not turn the steering wheel suddenly. Do not use the foot brake except in an emergency.
- If the engine should stop on a slope, apply the service brakes fully stop the machine and apply the parking brake after the machine has stopped.

ENSURE GOOD VISIBILITY

- When working in dark places, install work lamps and head lamps, and set up lighting in the work area if necessary.
- **Stop operations if the visibility is poor, such as in mist, snow, or rain, and wait for the weather to improve to a condition that allows the operation to be carried out safely.**

OPERATE CAREFULLY ON SNOW

- When working on snowy or icy roads, there is danger that the machine may slip to the side on even the slightest slope, so always travel slowly and avoid sudden starting, turning, or stopping.
- Be extremely careful when carrying out snow-clearing operations. The road shoulder and other objects are buried in the snow and cannot be seen. When traveling on snow-covered roads, always install tire chains.

AVOID DAMAGE TO DUMP BODY

- When working in tunnels, on bridges, under electric cables, or when entering a parking place or any other place where there are height limits, always drive extremely carefully and lower the dump body completely before driving the machine.

DO NOT GO CLOSE TO HIGH-VOLTAGE CABLES

- Going close to high-voltage cables can cause electric shock. Always maintain the safe distance given below between the machine and the electric cable.

Voltage	Minimum Safety Distance	
6.6 kV	3 m	10 ft.
33.0 kV	4 m	14 ft.
66.0 kV	5 m	17 ft.
154.0 kV	8 m	27 ft.
275.0 kV	10 m	33 ft.

- The following actions are effective in preventing accidents:
  1) Wear shoes with rubber or leather soles.
  2) Use a signalman to give warning if the machine approaches too close to the electric cable.
- If the work equipment should touch the electric cable, the operator should not leave the operator's compartment.
- When carrying out operations near high voltage cables, do not let anyone come close to the machine.
- Check with the electrical maintenance department about the voltage of the cables before starting operations.

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WHEN DUMPING

- Before starting the dumping operation, check that there is no person or object behind the machine.
- Stop the machine in the correct position, and check again that there is no person or object behind the machine. Give the determined signal, then slowly operate the dump body. If necessary, use blocks for the wheels or position a flagman.
- When carrying out dumping operations on slopes, the machine stability will become poor and there is danger that it may tip over. Always carry out such operations extremely carefully.
- Do not travel with the dump body raised.

WORKING ON LOOSE GROUND

- Avoid operating the machine too close to the edge of cliffs, overhangs, and deep ditches. If these areas collapse, the machine could fall or tip over and result in serious injury or death. Remember that the soil after heavy rain or blasting is weakened in these areas.
- Earth laid on the ground and the soil near ditches is loose. It can collapse under the weight or vibration of the machine. Avoid these areas, if possible.

WHEN LOADING

- Check that the surrounding area is safe, stop the machine in the correct loading position, then load the body uniformly.
- Do not leave the operator's seat during the loading operation.

PARKING THE MACHINE

- Choose a horizontal road surface to park the machine. If the machine has to be parked on a slope, always put blocks under all the wheels to prevent the machine from moving.
- When parking on public roads, provide fences and signs, such as flags or lights, on the machine to warn pedestrians and other vehicles. Be sure that the machine, flags, or lights do not obstruct the traffic.
- Before leaving the machine, lower the dump body fully, set the parking lever to the PARKING position, stop the engine, then lock everything. Always take the key with you.

TOWING

WHEN TOWING, FIX WIRE TO HOOK

- Towing in the wrong way may lead to serious personal injury or damage.
- When using another machine to tow this machine, use a towing device with ample strength for the weight of this machine.
- Never tow a machine on a slope.
- Do not use any towing rope that has kinks or is twisted.
- Do not stand astride the towing cable or wire rope.
- When connecting a machine that is to be towed, do not let any one come between the towing machine and the machine that is being towed.
- Set the coupling of the machine being towed in a straight line with the towing portion of the machine, and secure it in position.

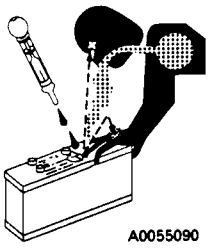
(For towing method, see Section A, “Operating Instructions, TOWING”.)

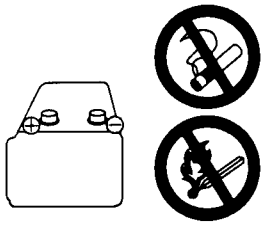
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BATTERY

BATTERY HAZARD PREVENTION

- Battery electrolyte contains sulfuric acid and can quickly burn the skin and eat holes in clothing. If you spill acid on yourself, immediately flush the area with water.
- Battery acid could cause blindness if splashed into the eyes. If acid gets into the eyes, flush them immediately with large quantities of water and see a doctor at once.
- If you accidentally drink acid, drink a large quantity of water or milk, beaten egg or vegetable oil. Call a doctor or poison prevention center immediately.
- When working with batteries ALWAYS wear safety glasses or goggles.
- Batteries generate hydrogen gas. Hydrogen gas is very EXPLOSIVE, and is easily ignited with a small spark of flame.
- Before working with batteries, stop the engine and turn the starting switch to the OFF position.
- Avoid short-circuiting the battery terminals through accidental contact with metallic objects, such as tools, across the terminals.
- When removing or installing, check which is the positive (+) terminal and negative (-) terminal.
- Tighten the battery cap securely.
- Tighten the battery terminals securely. Loosened terminals can generate sparks and lead to an explosion.


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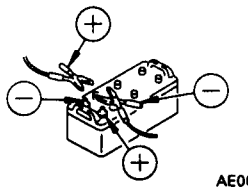

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STARTING WITH BOOSTER CABLES

- ALWAYS wear safety glasses or goggles when starting the machine with booster cables.
- When starting from another machine, do not allow the two machines to touch.
- Be sure to connect the positive (+) cable first when installing the booster cables. Disconnect the ground or negative (-) cable first when removing them.
- If any tool touches between the positive (+) terminal and the chassis, it will cause sparks. This is dangerous, so be sure to work carefully.
- Connect the batteries in parallel: positive to positive and negative to negative.
- When connecting the ground cable to the frame of the machine to be started, be sure to connect it as far as possible from the battery.

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PRECAUTIONS FOR MAINTENANCE

BEFORE CARRYING OUT MAINTENANCE

WARNING TAG



- If others start the engine or operate the controls while you are performing service or lubrication, you could suffer serious injury or death.
- ALWAYS attach the WARNING TAG to the control lever in the operator's cab to alert others that you are working on the machine. Attach additional warning tags around the machine, if necessary.
- These tags are available from your Komatsu distributor.
- Part No. 09963-03000

PROPER TOOLS



- Use only tools suited to the task. Using damaged, low quality, faulty, or makeshift tools could cause personal injury.

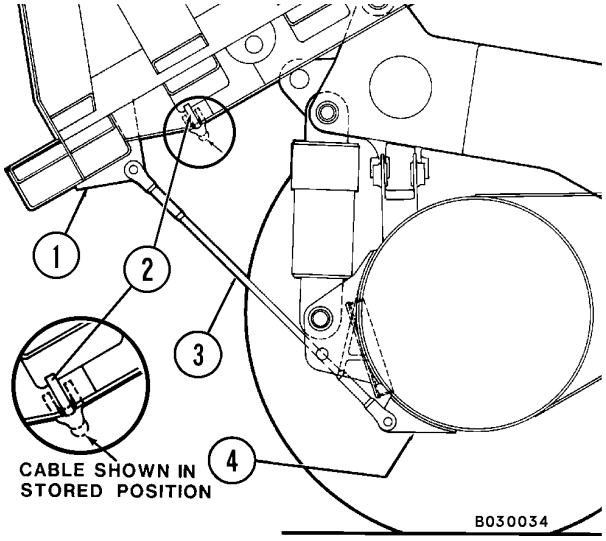
STOPPING THE ENGINE BEFORE SERVICE

- When carrying out inspection or maintenance, always stop the machine on firm flat ground, lower the dump body, then stop the engine.
- If the engine must be run during service, such as when cleaning the radiator, always move the shift control lever to the Neutral (N) position and set the parking brake lever to the PARKING position. Always carry out the work with two people. One person should sit on the operator's seat to stop the engine if necessary. NEVER move any controls not needed to operate.
- When servicing the machine, be careful not to touch any moving part or get clothing caught.
- Put blocks under the wheels.
- When carrying out service with the dump body raised, always place the dump lever at the HOLD position, and apply the lock (if equipped). Install the body-up safety pins (or cable) securely.

SECURING THE DUMP BODY

Any time personnel are required to perform maintenance on the vehicle with the dump body in the raised position, the body-up retention cable MUST be installed.

1. To hold the dump body in the up position, raise the body to it's maximum height.
2. Remove cable (3) from its stored position on the body, and install between rear body ear (1) and axle housing ear (4).
3. Secure the cable clevis pins with cotter pins.
4. Return the cable to stored position (2) after maintenance is complete.



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DURING MAINTENANCE

PERSONNEL

- Only authorized personnel can service and repair the machine. Extra precaution should be used when grinding, welding, and using a sledge-hammer.

ATTACHMENTS

- Place attachments that have been removed from the machine in a safe place so that they do not fall. If they fall on you or others, serious injury could result.



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WORK UNDER THE MACHINE

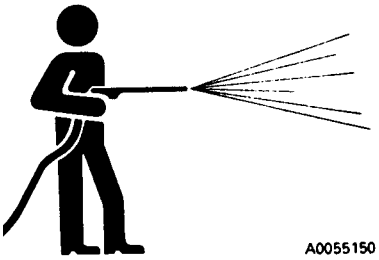
- Always lower all movable work equipment to the ground or to their lowest position before performing service or repairs under the machine.
- Always block the tires of the machine securely.
- Never work under the machine if the machine is poorly supported.



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KEEP THE MACHINE CLEAN

- Spilled oil or grease, or scattered tools or broken pieces are dangerous because they may cause you to slip or trip. Always keep your machine clean and tidy.
- If water gets into the electrical system, there is danger that the machine may not move or may move unexpectedly.Do not use water or steam to clean the sensors, connectors, or the inside of the operator's compartment.
- Use extreme care when washing the electrical control cabinet. Do not allow water to enter the control cabinet around the doors or vents. Do not allow any water to enter the cooling air inlet duct above the electrical control cabinet. If water enters the control cabinet (through any opening or crevice) major damage to the electrical components is possible.
- Never spray water into the rear wheel electric motor covers. Damage to the wheel motor armature can occur.
- Do not spray water into the retard grids. Excess water in the retard grids can cause a ground fault, which will prevent propulsion.



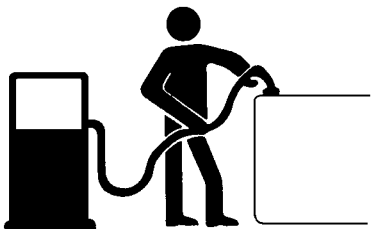
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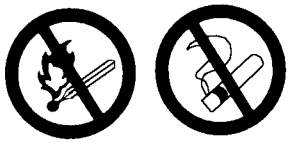
RULES TO FOLLOW WHEN ADDING FUEL OR OIL

- Spilled fuel and oil may cause slipping. Always clean up spills immediately.
- Always tighten the cap of the fuel and oil fillers securely.
- Never use fuel for washing any parts.
- Always add fuel and oil in a well-ventilated place.



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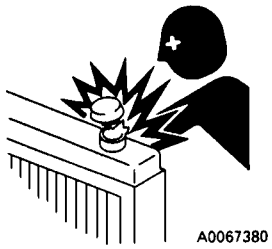


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RADIATOR WATER LEVEL

- If it is necessary to add water to the radiator, stop the engine and allow the engine and radiator to cool down before adding the water.
- Slowly loosen the cap to relieve pressure before removing the cap.


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USE OF LIGHTING

When checking fuel, oil, coolant, or battery electrolyte, always use lighting with anti-explosion specifications. If such lighting equipment is not used, there is danger or explosion.


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PRECAUTIONS WITH BATTERY

- When repairing the electrical system or when carrying out electrical welding, remove the negative (-) terminal of the battery to stop the flow of current.


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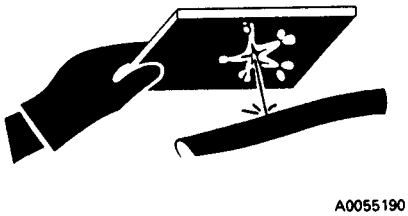
HANDLING HIGH-PRESSURE HOSES

- Do not bend high-pressure hoses or hit them with hard objects. Do not use any bent or cracked piping, tubes or hoses. They may burst during use.
- Always repair any loose or broken fuel hoses or oil hoses. If fuel or oil leaks, it may cause a fire.

PRECAUTIONS WITH HIGH PRESSURE OIL

- Do not forget that the work equipment circuits are always under pressure.
- Do not add oil, drain oil, or carry out maintenance or inspection before completely releasing the internal pressure.
- If oil is leaking under high pressure from small holes, it is dangerous if the jet of high-pressure oil hits the skin or enters the eyes. Always wear safety glasses and thick gloves, and use a piece of cardboard or a sheet of wood to check for oil leakage.
- If you are hit by a jet of high-pressure oil, consult a doctor immediately for medical attention.


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PRECAUTIONS WHEN CARRYING OUT MAINTENANCE AT HIGH TEMPERATURE OR HIGH PRESSURE

- Immediately after stopping operations, the engine cooling water and oil at all parts are at high temperature and under high pressure.In this condition, if the cap is removed, or the oil or water are drained, or the filters are replaced, it may result in burns or other injury. Wait for the temperature to go down, then carry out the inspection and maintenance in accordance with the procedures given in this manual.


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ROTATING FAN AND BELT

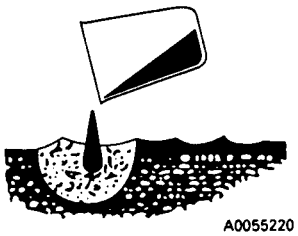
- Keep away from rotating parts and be careful not to let anything get caught in them.
- If your body or tools touch the fan blades or fan belt, they may be cut off or sent flying, so never touch any rotating parts.


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WASTE MATERIALS

- Never dump waste oil in a sewer system, rivers, etc.
- Always put oil drained from your machine in containers. Never drain oil directly on the ground.
- Obey appropriate laws and regulations when disposing of harmful objects such as oil, fuel, coolant, solvent, filters, batteries, and others.

INCORRECT


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TIRES

HANDLING TIRES

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

To maintain safety, always keep to the following conditions:

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

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

If the tires become hot, a flammable gas is produced, and this may ignite. It is particularly dangerous if the tires become overheated when the tires are under pressure. If the gas generated inside the tire ignites, the internal pressure will suddenly rise, and the tire will explode, and this may lead to serious personal injury. Explosions differ from punctures or tire bursts, because the destructive force is extremely large. Therefore, the following operations are strictly prohibited when the tire is under high internal pressure:

- Welding the rim
- Building fires or carrying out welding near the wheel or tire.

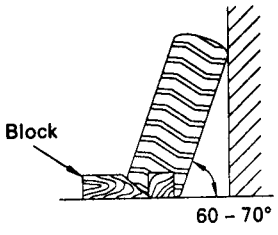


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If the proper procedure for carrying out maintenance or replacement of the wheel or tire is not used, the wheel or tire may burst and cause serious injury or damage. When carrying out such maintenance, please consult the authorized regional Komatsu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

STORING TIRES AFTER REMOVAL

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



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ADDITIONAL JOB SITE RULES

- Use this space to add any ADDITIONAL Job Site Rules not covered in any of the previous discussions.
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WHEN REPAIRS ARE NECESSARY

1. Only qualified maintenance personnel who understand the systems being repaired should accomplish repairs.
2. Many components on the Komatsu Truck are large and heavy. Insure that lifting equipment - hoists, slings, chains, lifting eyes - are of adequate capacity to handle the lift.
3. DO NOT WORK under a suspended load. Do not work under raised body unless body safety cables, props, or pins are in place to hold the body in up position.
4. Do not repair or service truck while engine is running, except when adjustments can only be made under such conditions. **Keep a safe distance from moving parts.**
5. When servicing any air conditioning system with refrigerant, wear a face shield and cold resistant gloves for protection against freezing. Be certain to follow all current regulations for handling and recycling refrigerants.
6. Follow package directions carefully when using cleaning solvents.
7. If an auxiliary battery assist is needed, first use one cable to connect the 24V positive (+) post of the disabled truck batteries to the 24V positive (+) post of the auxiliary assist. Use second cable to connect the 24V negative (-) post of the auxiliary assist battery to **a frame ground (-)** on the disabled truck away from the battery.
8. Always disconnect the positive and negative battery cables of the vehicle before doing any welding on the unit. Failure to do so may seriously damage the battery and electrical equipment. Disconnect battery charging alternator lead wire and isolate electronic control components before making welding repairs. (It is not necessary to disconnect or remove any control circuit cards on Electric Drive Dump Trucks or any of the “AID” circuit control cards.)

   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.
9. If truck is to be towed for any reason, use a rigid tow bar. Check truck cab for decal recommending special towing precautions. (Also refer to Towing Procedure in OPERATING INSTRUCTIONS.)
10. Drain, clean and ventilate fuel tanks and/or hydraulic tanks before making any welding repairs.

⚠WARNING

Any operating fluid, such as hydraulic oil or brake fluid escaping under pressure, can have sufficient force to enter a person's body by penetrating the skin. Serious injury and possibly death may result if proper medical treatment by a physician familiar with this injury is not received immediately.

11. Relieve pressure in lines or hoses before making any disconnects.
12. After adjustments or repairs, replace all shields, screens and clamps.
13. Tire Care:

⚠WARNING

Do not stand in front of rim and locking ring when inflating tire mounted on the machine. Observers should not be permitted in the area and should be kept away from the side of such tires.

Do not weld or apply heat on the rim assembly with the tire mounted on the rim. Resulting gases inside the tire may ignite, causing explosion of tire and rim.

14. Only a qualified operator or experienced maintenance personnel who are also qualified in operation should move the truck under its own power in the repair facility or during road testing after repairs are complete.

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NOTES:

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OPERATING INSTRUCTIONS

PREPARING FOR OPERATION

The safest trucks are those which have been properly prepared for operation. At the beginning of each shift, a careful check of the truck should be made by the operator before attempting to start the engine.

SAFETY IS THINKING AHEAD

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

Safe practices start before the operator gets to the equipment!

- Wear the proper clothing. Loose fitting clothing, unbuttoned sleeves and jackets, jewelry, etc., can catch on a protrusion and cause a potential hazard.
- Always use the personal safety equipment provided for the operator such as hard hat, safety shoes, safety glasses or goggles. There are some conditions when protective hearing devices should also be worn for operator safety.
- When walking to and from the truck, maintain a safe distance from all machines even if the operator is visible.

At The Truck - Ground Level Walk Around Inspection

At the beginning of each shift, a careful walk around inspection of the truck should be made before the operator attempts engine start-up. A walk around inspection is a systematic ground level inspection of the truck and its components to insure that the truck is safe to operate before entering the operator's cab.

Start at the left front corner of the truck (see illustration, next page), and move in a counter-clockwise direction, front-to-rear, across the rear, and continuing forward up the opposite side of the truck to the original starting point.

If these steps are taken in sequence, and are repeated from the same point and in the same direction before every shift, many potential problems may be avoided, or scheduled for maintenance. UNSCHEDULED downtime and loss of production can be reduced.

Local work practices may prevent an operator from performing all tasks suggested here, but to the extent permitted, the operator should follow this or similar routine.

1. Start at left front of truck. While performing the walk around inspection, visually inspect all lights and safety equipment for external damage from rocks or misuse. Make sure lenses are clean and unbroken.

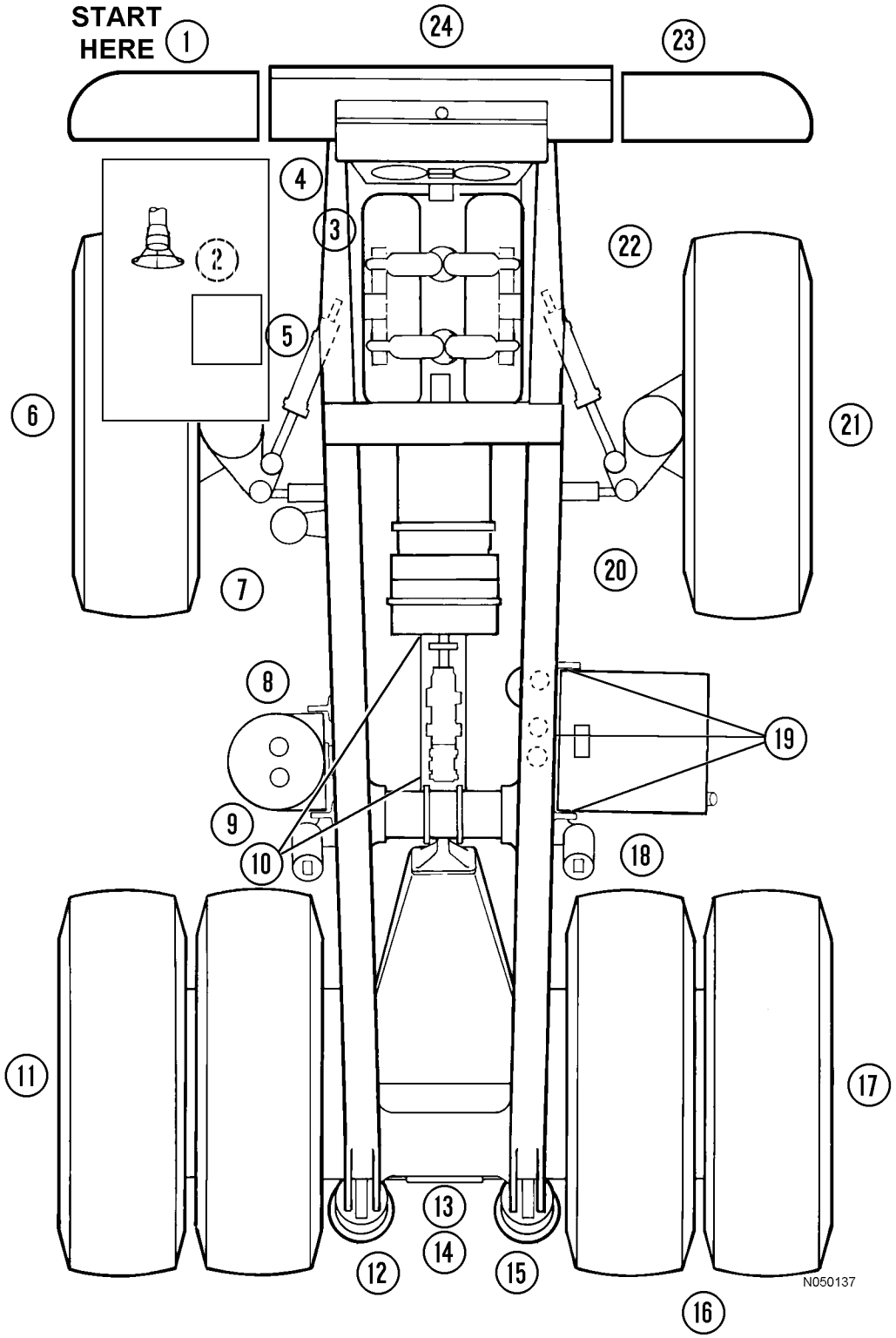
   Empty the dust pans on the left side air cleaner assemblies.
2. Move behind the front of the left front tire, inspect the hub and brake assemblies for leaks and any abnormal conditions.

   Check that all suspension attaching hardware is secure and inspect mounting key area for evidence of wear. Check that the suspension extension (exposed piston rod) is correct, and that there are no leaks.
3. With engine stopped, check engine oil level. If dark, turn on service light.
4. Inspect fan and air conditioner belts for correct tension, obvious wear, and tracking. Inspect fan guard for security and condition. When leaving this point, be sure to turn off service light, if used.
5. Inspect anchor end of steering cylinder for proper greasing and for security.
6. Move outboard of the front wheel, and inspect attaching lugs/wedges to be sure all are tight and complete. Check tires for cuts, damage or “bubbles” and that inflation appears to be correct.
7. Move behind the rear of the front wheel, inspect for leaks at hub or brakes or any unusual conditions. Inspect suspension hardware to be sure it is all in place. Inspect live end of steering cylinder for proper greasing, and for security of all parts. Inspect for any hydraulic leaks.
8. Swing hydraulic inspection ladder down. Inspect sight glass on hydraulic tank. With engine stopped and body down, hydraulic fluid must be visible in upper sight glass. If not, oil must be added. Be sure ladder is in the up position and is secure.

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PREPARING FOR OPERATION

GROUND LEVEL CHECKS



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9. Move on around the hydraulic tank and in front of the rear dual tires, inspect the hoist cylinder for any damage and leaks, also that lower guard is in place. Inspect both upper and lower hoist cylinder pins for security, and for proper greasing.
10. Before leaving this position, look under the lower edge of the chassis to be sure the flexible duct that carries the air from the main blower to the final drive housing is in good condition with no holes or breakage. Also look up at the main hydraulic pumps to see that there is no leakage or any other unusual condition with pumps or pump drive shafts.
11. Move on around the dual tires, check to see that all lugs/wedges are in place and tight. Inspect latches on wheel cover to be sure they are properly latched. Inspect wheel motor for any leakage that may be coming from inside the wheel cover that would indicate brake leakage, or wheel motor leakage.

    Check dual tires for cuts, damage or "bubbles" and that inflation appears to be correct. If truck has been run on a "flat", **the tire must be cooled before parking truck inside**. Inspect for any rocks that might be lodged between dual tires, and that rock ejector is in good condition and straight so that it can not damage a tire.
12. Inspect left rear suspension for damage and for correct rod exposure, and that there are no leaks. Ensure that the covers over the chrome piston rod are in good condition and inspect for proper greasing.
13. Open rear hatch cover, turn on work light if necessary. Inspect for leaks around wheelmotor mounting to rear axle housing, and also brake hoses and fittings. Be sure that covers on wheel motor sump are in place, and that there are no rags or tools left behind. Inspect condition of hatch cover gasket, report any bad gasket to maintenance. Turn off work light if used, close and latch hatch.
14. While standing in front of rear hatch, look up to see that rear lights are in good condition, along with dual back up horns. Look up at panhard rod to see that it is getting proper greasing. Also look at both body hinge pins for greasing and any abnormal condition. Check hoist limit switch and clear any mud/debris from contacts.
15. Perform the same inspection on the right rear suspension as done on the left.
16. Move on around the right dual tires, inspect between the tires for rocks, and for condition of the rock ejector, inspect the tires for cuts or damage, and for correct inflation.
17. Perform the same inspection for wheel lugs/ wedges, wheel cover latches, and for leaks that was done on the left side.
18. Move in front of right dual tires, and inspect hoist cylinder the same as was done on the left side.
19. Move on around the fuel tank, inspect the fuel quantity gauge, (this should agree with what will show on the gauge in the cab). Inspect the attaching hardware for the fuel tank at the upper saddles, and then at the lower back of the tank for the security and condition of the mounts. Check hoist filters for leaks.
20. Move in behind the right front wheel, and inspect the steering cylinder, suspension attaching hardware and suspension extension, as well as greasing and attaching hardware for the steering cylinder. Inspect the hub and brakes for leaks and any unusual condition. Be sure the suspension protective boot is in good condition.
21. Move out and around the right front wheel, inspect that all lugs/wedges are in place and tight.
22. Move in behind the front of the right front wheel, check hub and brakes for leaks and any unusual condition. Inspect steering cylinder for security and for proper greasing. Inspect the engine compartment for any leaks and unusual condition. Inspect the fan guard, and belts also for any rags or debris behind radiator. Turn work light off, if used, and secure the ladder up and latched.
23. Move on around the front of the truck, drop the air cleaner pans to remove dirt, latch up and secure.
    Inspect auto lube system. See Lincoln Auto Lube in Section "M", for specific details concerning auto lube system.
24. As you move in front of the radiator, inspect for any debris that might be stuck in front of the radiator and remove it. Check for any coolant leaks. Inspect all head and fog lights.
25. Before climbing ladder to first level, be sure ground level engine shutdown switch is "ON". Inspect fire control actuator to be sure safety pin is in place and plastic tie that prevents accidental actuation is in place and in good condition.

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26. Climb ladder to main deck. Always use grab rails and ladder when mounting or dismounting from the truck. Clean ladder and hand rails of any foreign material, such as ice, snow, oil or mud.

⚠WARNING

Always mount and dismount ladders facing the truck. Never attempt to mount or dismount while the truck is in motion.

27. When checking coolant in radiator, use coolant level sight gauge (if equipped) or observe coolant level through opening in end of hood. If it is necessary to remove radiator cap, shut down engine (if running), and relieve coolant pressure SLOWLY, before removing radiator cap.

⚠WARNING

If engine has been running, allow coolant to cool, before removing the fill cap or draining radiator. Serious burns may result if coolant is not allowed to cool.

28. Be sure battery disconnect switches are on. Be sure battery box hold down wing nuts are in place and secure. Inspect covers over retarding grids to be sure latches are in place and secure. Inspect main air inlet to be sure it is clear. Be sure all cabinet door latches are secure.
29. Move on around the cab to the back, open the doors to the brake cabinet, inspect for leaks. Before latching doors, turn work lights off, if used.
30. Clean cab windows and mirrors; clean out cab floor as necessary. Insure steering wheel, controls and pedals are free of any oil, grease or mud.
31. Stow personal gear in cab so that it does not interfere with any operation of the truck. Dirt or trash buildup, specifically in the operator's cab, should be cleared. Do not carry tools or supplies in cab of truck or on the deck.
32. Adjust seat and steering wheel so that it is comfortable for use.
33. If truck is in an enclosure, insure adequate ventilation before start-up. Exhaust fumes are dangerous!
34. Read and understand the description of all Operator Controls in Section "N", Cab, "Instrument Panel and Indicator Switches". Be familiar with all control locations and functions BEFORE operating truck.

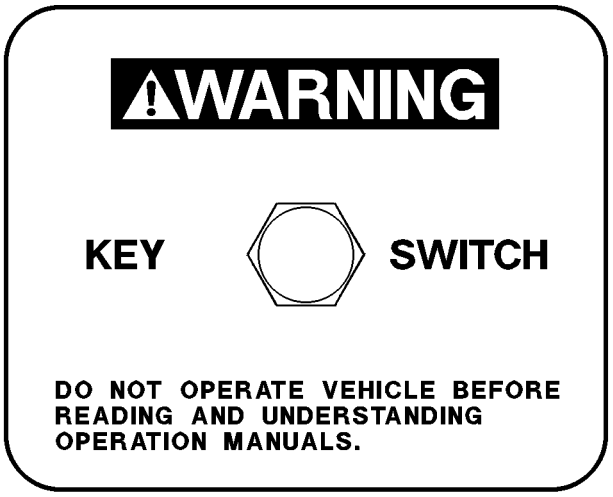
ENGINE START-UP SAFETY PRACTICES

⚠DANGER

NEVER ATTEMPT TO START THE ENGINE BY SHORTING ACROSS THE STARTER TERMINALS. This may cause fire, or serious injury or death to anyone in machine's path.

START THE ENGINE FROM THE OPERATOR'S SEAT ONLY.

1. Insure all personnel are clear of truck before starting engine. Always sound the horn as a warning before actuating any operational controls. If the truck is in an enclosure, insure adequate ventilation before start-up. Exhaust fumes are dangerous!
2. Be sure parking brake switch is in "On" position. Check and insure Selector Switch is in "Neutral" before starting.
3. If truck is equipped with auxiliary cold weather heater system(s);
   Do not attempt to start engine while heaters are in operation. Damage to coolant heaters will result!



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4. The keyswitch is a three position (Off, Run, Start) switch. When switch is rotated one position clockwise, it is in the "Run" position and all electrical circuits (except "Start") are activated.
   a. Turn keyswitch to "Run" (not "Start") position.
   b. With Selector Switch in "Neutral", rotate keyswitch fully clockwise to "Start" position, and HOLD this position until engine starts (see NOTE below). "Start" position is spring-loaded to return to "Run" when key is released.

NOTE: If the truck is equipped with a Komatsu engine, a time delay will occur before starter engagement and engine cranking begins. The Komatsu engine is equipped with a Prelub™ System that circulates engine oil throughout the engine prior to start-up. The colder the engine oil, the longer the delay before cranking begins. *In addition, if the engine is equipped with the Engine Starting Aid for cold weather starting, the Engine Prelub™ System should be engaged* ***FIRST*** *for 5 to 10 seconds, or until the starters are engaged,* ***BEFORE*** *activating the Engine Starting Aid.*

⚠WARNING

Starting fluid is extremely volatile and flammable! Use with extreme care.

If truck is equipped with optional Engine Starting Aid and ambient temperature is below 50°F (10°C), turn the keyswitch to the “Start” position, and while cranking engine, move the Engine Starting Aid switch to the “On” position for three (3) seconds **MAXIMUM**; then release Engine Starting Aid. If engine does not start, wait at least fifteen (15) seconds before repeating the procedure.

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

AFTER ENGINE HAS STARTED

1. After engine has started, do not accelerate engine speed or drive truck until low pressure and warning systems are normal, and the coolant temperature is at least 160 F (71C).
2. Become thoroughly familiar with steering and emergency controls. Test the truck steering in extreme right and left directions. If the steering system is not operating properly, shut engine down immediately. Determine the steering system problem and have repairs made before resuming operation.
3. Operate each of the truck's brake circuits at least twice prior to operating and moving the truck. These circuits include individual activation from the operator's cab of the service brake, parking brake, and brake lock. With the engine running and with the hydraulic circuit fully charged, activate each circuit individually. If any application or release of any brake circuit appears sluggish or improper, or if warning alarms are activated on application or release, shut the engine down and notify maintenance personnel. Do not operate truck until brake circuit in question is fully operational.
4. Check gauges, warning lights and instruments before moving the truck to insure proper system operation and proper instrument functioning. Give special attention to braking and steering circuit hydraulic warning lights. If warning lights come on, shut down the engine immediately and determine the cause.
5. Insure headlights, worklights and taillights are in proper working order. Good visibility may prevent an accident. Check operation of windshield wiper.
6. When truck body is in dump position, do not allow anyone beneath it unless body-up retaining pin or cable is in place.
7. Do not use the fire extinguisher for any purpose other than putting out a fire! If extinguisher is discharged, report the occurrence so the used unit can be refilled or replaced.
8. Do not allow unauthorized personnel to ride in the truck. Do not allow anyone to ride on the ladder of the truck.
9. Do not leave truck unattended while engine is running. Apply park brake and shut down engine before getting out of cab.

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MACHINE OPERATION SAFETY PRE-CAUTIONS

After the truck engine is started and all systems are functioning properly, the operator must follow all local safety rules to insure safe machine operation.

⚠WARNING

If any of the red warning lights come "On" or if any gauge reads in the red area during truck operation, a malfunction is indicated. Stop truck as soon as safety permits, shut down engine if problem indicates and have problem corrected before resuming truck operation.

⚠WARNING

Operating truck with stalled or free spinning wheel motors may cause serious damage to wheel motors! If truck does not begin to move within 10 seconds after depressing throttle pedal (Selector Switch in a drive position), release throttle pedal and allow wheels to regain traction before accelerating engine again.

1. Always look to the rear before backing the truck. Watch for and obey ground spotter's hand signals before making any reverse movements. Sound the warning horn (3 blasts). Spotter should have a clear view of the total area at the rear of the truck.
2. Operate the truck only while properly seated with seat belt fastened. Keep hands and feet inside the cab compartment while truck is in operation.
3. Check gauges and instruments frequently during operation for proper readings.
4. Observe all regulations pertaining to the job site's traffic pattern. Be alert to any unusual traffic pattern. Obey the spotter's signals.
5. Match the truck speed to haul road conditions and slow the truck in any congested area. Keep a firm grip on steering wheel at all times.
6. Do not allow engine to run at "Idle" for extended periods of time.
7. Check parking brake periodically during shift. Use parking brake **ONLY** for parking. Do not use park brake for loading / dumping. **Do not attempt to apply parking brake while truck is moving**!

⚠WARNING

Do not use "Brake Lock" or "Emergency Brake" (if equipped) for parking. With engine stopped, hydraulic pressure will bleed down, allowing brakes to release!

8. Check brake lock performance periodically for safe loading and dump operation.
9. Proceed slowly on rough terrain to avoid deep ruts or large obstacles. Avoid traveling close to soft edges and the edge of fill area.
10. Truck operation requires concentrated effort by the driver. Avoid distractions of any kind while operating the truck.

MACHINE OPERATION ON THE HAUL ROAD

1. Always stay alert! If unfamiliar with the road, drive with extreme caution. Cab doors should remain closed at all times if truck is in motion or unattended.
2. Obey all road signs. Operate truck so it is under control at all times. Govern truck speed by the road conditions, weather and visibility. Report haul road conditions immediately. Muddy or icy roads, pot holes or other obstructions can present hazards.
3. Initial propulsion with a loaded truck should begin from a level surface whenever possible, but when there are circumstances where starting on a hill or grade cannot be avoided, refer to the **"STARTING ON A GRADE WITH A LOADED TRUCK"** procedure.
4. When backing the truck, give back-up signal (three blasts on the horn); when starting forward, two blasts on the horn. These signals must be given each time the truck is moved forward or backward.
5. Use extreme caution when approaching a haul road intersection. Maintain a safe distance from oncoming vehicles.
6. Maintain a safe distance when following another vehicle. Never approach another vehicle from the rear, in the same lane, closer than 50 ft. (15 m). When driving on a down grade, this distance should not be less than 100 ft. (30 m).

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7. Do not stop or park on a haul road unless unavoidable. If you must stop, move truck to a safe place, apply parking brake, and shut down engine before leaving cab. Block wheels securely and notify maintenance personnel for assistance.
8. Before starting up or down a grade, maintain a speed that will insure safe driving and provide effective retarding under all conditions (refer to **"DYNAMIC RETARDING OPERATION"**). The Grade/Speed Chart in the operator's cab should always be referenced to determine MAXIMUM safe truck speeds for descending various grades with a loaded truck.
9. When operating truck in darkness, or when visibility is poor, do not move truck unless all headlights, clearance lights, and tail lights are on. Do not back truck if back-up horn or lights are inoperative. Always dim headlights when meeting oncoming vehicles.
10. If the "Emergency Steering" light and/or "Low Brake Pressure Warning" light (if equipped) illuminate during operation, steer the truck **immediately** to a safe stopping area, away from other traffic if possible. Refer to item 7 above.
11. The Statex III system monitors wheel motor, ambient, and static exciter temperatures. If wheel motor or static exciter temperature is outside the limits established, the Statex III controls will cause the engine to increase to 1650 RPM. (Normal engine RPM for haul road/retarding operation is 1250 RPM).
12. When maximum truck speed is reached, the truck will experience a DECREASE in engine RPM.
13. Check tires for proper inflation periodically during shift. If truck has been run on a "flat", or under-inflated tire, **it must not be parked in a building until the tire cools**.

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 or Wheel Lock 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 in operation, the engine RPM will automatically go to an advance RPM retard speed setting (usually 1250 RPM*).

NOTE: The exact engine speed in retarding may vary due to the temperature of certain components; this is controlled by the Statex III control system.

Dynamic retarding will be applied **automatically**, if the speed of the truck reaches the predetermined overspeed retard setting. Any application of the Dynamic retarding system (automatic or foot pedal) will cause an indicator light to illuminate in the overhead display panel.

OPTIONAL - DUAL FUNCTION / SINGLE PEDAL

The Dynamic Retarder/Service Brake Pedal is a single, foot-operated pedal which controls both retarding and service brake functions. 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, the 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.

For normal truck operation, Dynamic Retarding should be used to slow and control the speed of the truck.

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STARTING ON A GRADE WITH A LOADED TRUCK

Initial propulsion with a loaded truck should begin from a level surface whenever possible, but when there are circumstances where the starting on a hill or grade cannot be avoided, use the following procedure:

1. With service brakes fully applied, move the selector switch to a drive position (Forward/ Reverse). If equipped with a dual function retarder/service pedal, fully depress pedal to hold the truck on the grade. Depress the override switch on the center console and increase engine RPM with throttle pedal.
2. As engine RPM increases and operator senses propulsion effort working against the brakes, release the brakes and let truck movement start. If equipped with a dual function retarder/ service pedal, be sure to completely release the pedal. As truck starts to move, release the override switch.

NOTE: As truck speed increases above 3-5 MPH (5-8 KPH) the Statex III system will drop propulsion if the retarder pedal is still applied.

PASSING

1. Do not pass another truck on a hill or blind curve!
2. Before passing, make sure the road ahead is clear. If a disabled truck is blocking your lane, slow down and pass with extreme caution.
3. Use only the areas designated for passing.

LOADING

1. Pull into the loading area with caution. Remain at a safe distance while truck ahead is being loaded.
2. Do not drive over unprotected power cables.
3. When approaching or leaving a loading area, watch out for other vehicles and for personnel working in the area.
4. When pulling in under a loader or shovel, follow "Spotter" or "Shovel Operator" signals. The truck operator may speed up loading operations by observing the location and loading cycle of the truck being loaded ahead, then follow a similar pattern.
5. When being loaded, operator should stay in truck cab with engine running. Place Selector Switch in "Neutral" and apply Wheel Brake Lock.
6. When loaded, pull away from shovel as quickly as possible but with extreme caution.

DUMPING

1. Pull into dump area with extreme caution. Make sure area is clear of persons and obstructions, including overhead utility lines. Obey signals directed by the spotter, if present.

   Avoid unstable areas. Stay a safe distance from edge of dump area. **Position truck on a solid, level surface before dumping.**

⚠DANGER

As the body raises, the truck Center of Gravity (CG) will move. Truck must be on level surface to prevent tipping / rolling!

2. Carefully maneuver truck into dump position. DO NOT rely on Wheel Brake Lock to stop truck; this control is not modulated and applies REAR SERVICE BRAKES ONLY.
3. When truck is stopped and in dump position, apply Wheel Brake Lock and move the Selector Switch to the "Neutral" position.

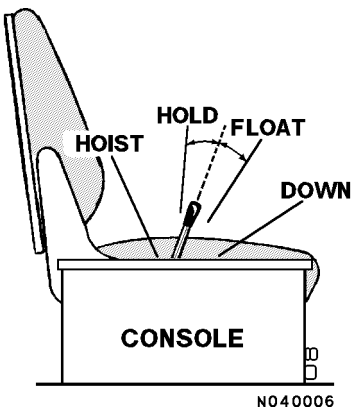
To Raise dump body:

⚠WARNING

The dumping of very large rocks (10% of payload, or greater) or sticky material (loads that do not flow freely from the body) may allow the material to move too fast and cause the body to move RAPIDLY and SUDDENLY. This sudden movement may jolt the truck violently and cause possible injury to the operator, and/or damage to the hoist cylinders, frame, and/or body hinge pins. If it is necessary to dump this kind of material, refer to the WARNING in the following procedure:

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4. Pull the lever to the rear to actuate hoist circuit. (Releasing the lever anywhere during "hoist up" will place the body in "hold" at that position.)



5. Raise engine RPM to accelerate hoist speed. Refer to the WARNING below.

⚠WARNING

If dumping very large rocks or sticky material as described in WARNING above, slowly accelerate engine RPM to raise body. When the material starts to move, release hoist lever to "HOLD" position. If material does not continue moving and clear body, repeat this procedure until material has cleared body.

6. Reduce engine RPM as last stage of hoist cylinder begins to extend and let engine go to low idle as last stage reaches half-extension.
7. Release hoist lever as last stage of hoist cylinder reaches full extension.

To Lower Body

(When dumping over a berm or into a crusher):

8. Move hoist lever forward to "down" position and release. Releasing the lever places hoist control valve in the "float" position allowing the body to return to frame.

NOTE: If dumped material builds up at the rear of the body and the body cannot be lowered, perform steps "a" & "b" below:



a. Move hoist lever back to the "hoist" position to fully raise the dump body. Then release the hoist lever so it returns to the "hold" position.

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

b. Shift Selector Switch to "Forward", release Brake Lock, depress Override button and drive forward to clear the material. Stop, shift Selector Switch to "Neutral", apply Brake Lock and lower body again.

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

⚠WARNING

CAUTION! The truck is not to be moved with the dump body raised except for emergency moves only. Failure to lower body before moving truck may cause damage to hoist cylinders, frame and/or body hinge pins.

To Lower Body

(When dumping on flat ground):

It is very likely when dumping on flat ground that the dumped material will build up enough to prevent the body from lowering. In this case, the truck will have to be driven forward a short distance (just enough to clear the material) before the body can be lowered.

a. Shift Selector Switch to "Forward", release Brake Lock, depress Override button and drive just far enough forward for body to clear material. Stop, shift Selector Switch to "Neutral", apply Brake Lock.

b. Move hoist lever forward to "down" position and release. Releasing the lever places hoist control valve in the "float" position allowing the body to return to frame.

NOTE: If dumped material builds up at the rear of the body and the body cannot be lowered, then perform steps "c" and "d" below:



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c. Move hoist lever back to the "hoist" position to fully raise the dump body. Then release the hoist lever so it returns to the "hold" position.

d. Shift Selector Switch to "Forward", release Brake Lock, depress Override button and drive forward to clear the material. Stop, shift Selector Switch to "Neutral", apply Brake Lock and lower body again.

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

⚠WARNING

CAUTION! The truck is not to be moved with the dump body raised except for emergency moves only. Failure to lower body before moving truck may cause damage to hoist cylinders, frame and/or body hinge pins.

10. With body returned to frame, move Selector Switch to "Forward", release Brake Lock, and leave dump area carefully.

SAFE PARKING PROCEDURES

The operator must continue the use of safety precautions when preparing for parking and engine shutdown.

In the event that the equipment is being worked in consecutive shifts, any questionable truck performance the operator may have noticed must be checked by maintenance personnel before the truck is released to another operator.

1. The truck should be parked on level ground, if at all possible. If parking must be done on a grade, the truck should be positioned at right angles to the grade.
2. The parking brake must be applied and/or chocks placed fore/aft of wheels so that the truck cannot roll. Each truck should be parked at a reasonable distance from another.
3. Haul roads are not safe parking areas. In an emergency, pick the safest spot most visible to other machines in the area. If the truck becomes disabled where traffic is heavy, mark the truck with warning flags in daylight or flares at night.

TOWING

Prior to towing a truck, many factors must be carefully considered. Serious personal injury and/or significant property damage may result if important safety practices, procedures and preparation for moving heavy equipment are not observed. **Do not tow the truck any faster than 5 MPH (8 kph).**

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

1. Shut down engine.
2. Chock wheels on disabled truck to prevent movement while attaching tow bar.
3. If truck is equipped, install hydraulic connections for steering and dumping between towing and towed vehicles. Check towed vehicle for normal braking and steering system operation.
4. Empty all material from dump body of truck that is to be towed.
5. Inspect tow bar for adequacy (approximately 1.5 times the gross vehicle weight of truck being towed).
6. Determine that towing vehicle has adequate capacity to both move and stop the towed truck under all conditions.
7. Protect both operators in the event of tow bar failure.
8. Release disabled truck brakes and remove blocking.
9. Sudden movement may cause tow bar failure. Smooth and gradual truck movement is preferred.
10. Minimize tow angle at all times - NEVER EXCEED 30°. The towed truck must be steered in the direction of the tow bar.

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NORMAL ENGINE SHUTDOWN PROCEDURE

The following procedure should be followed at each engine shutdown.

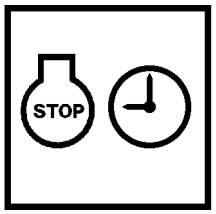
1. Stop the truck out of the way of other traffic on a level surface and free of overhead power lines or other obstructions (in case dump body should need to be raised).
   a. Reduce engine speed to idle.
   b. Place the directional Selector Switch in "Neutral".
   c. Apply the Parking Brake switch. Be sure the "Parking Brake Applied" indicator light in the overhead display panel is illuminated.
   d. Allow engine to cool gradually by running at low idle for 3 to 5 minutes, or if preferred, activate the 5 minute shutdown delay timer as described on the following page.
2. *With engine cooled down, turn keyswitch counterclockwise to "Off" position for* normal shutdown of engine.

   If engine does not shutdown with keyswitch, use Engine Shutdown Switch on operator cab center console, and hold this switch down until engine stops.
3. With keyswitch "Off", and engine stopped, wait at least 90 seconds. Insure steering circuit is completely bled down by turning 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.
4. Close and lock all windows, remove key from keyswitch and lock cab to prevent possible unauthorized truck operation. Dismount truck properly. Put wheel chocks in place.

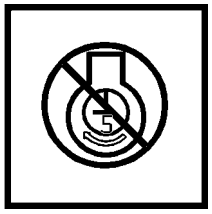
NOTE: A switch is located at the right front corner of the truck for ground level engine shutdown.

DELAYED ENGINE SHUTDOWN PROCEDURE

1. Stop the truck out of the way of other traffic on a level surface and free of overhead power lines or other obstructions (in case dump body should need to be raised).
   a. Reduce engine speed to low idle.
   b. Place the directional Selector Switch in "Neutral".
   c. Apply the Parking Brake switch. Be sure the "Parking Brake Applied" indicator light in the overhead display panel is illuminated.
2. Refer to INSTRUMENT PANEL AND INDICATOR LIGHTS section for location on instrument panel of the **Engine Shutdown Switch with 5 Minute Idle Timer Delay**. This is a 3-position rocker-type switch (Off-On-Momentary).
3. Press the top of the engine shutdown switch to select the “ON” (center) position. Press the top of the switch again to activate the timer delay (momentary position). Release the switch and allow it to return to the “ON” position.



   When the engine shutdown timer has been activated, the timer delay indicator light in the overhead status panel will illuminate to indicate that the shutdown timing sequence has started. The engine will continue to idle for approximately 5 minutes to allow for proper engine cool-down before stopping.



4. Turn the keyswitch counterclockwise to the "OFF" position to cause the engine to shutdown when the timing sequence is complete. When the engine stops, this will activate the hydraulic bleeddown timer and turn off the 24 VDC electric circuits controlled by the keyswitch.

NOTE: To cancel the 5 minute idle timer sequence, press the timer delay shutdown switch to the "OFF" (lower) position. If the keyswitch is in the "OFF" position, the engine will stop. If the keyswitch is in the "ON" position, the engine will continue to run.

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SUDDEN LOSS OF ENGINE POWER

NOTE: If the engine suddenly stops, there is enough hydraulic pressure stored in the brake and steering accumulators to allow the operation of the steering and brake functions. However, this oil supply is limited so it is important to stop the truck as quickly and safely as possible after the loss of engine power. If the brake supply pressure drops to a predetermined level, the "Low Brake Pressure" warning light will illuminate and a buzzer will sound. If the brake pressure continues to decrease, the "Auto-Apply" feature will activate and the service brakes will apply automatically to stop the truck. Apply parking brake as soon as the truck comes to a complete stop.

1. Bring the truck to a safe stop as quickly as possible by using the foot pedal to apply the service brakes.

⚠WARNING

Dynamic retarding will not be available! Do not use the service brakes for continuous retarding purposes.

2. If possible, steer the truck to the side of the road while bringing it to a complete stop. Apply the parking brake as soon as the truck has stopped moving. Turn key switch “Off" and notify maintenance personnel immediately.
3. If safe to do so, place wheel chocks in front or behind the wheels to that truck cannot roll.
4. If the truck becomes disabled where traffic is heavy, mark the truck with warning flags in daylight or flares at night.

RESERVE ENGINE OIL SYSTEM (Optional)

The reserve oil tank for the engine is designed to add more oil capacity to the engine and to make less frequent servicing of the engine oil. The circulation of oil between the engine sump and reserve tank increases the total volume of working oil. This dilutes the effects of contamination and loss of additives and maintains the oil quality over longer periods. A filter in the supply circuit protects the pumping unit and prevents transfer of contaminants to the engine sump which might enter the tank during servicing. It also gives an added level of oil cleanup.

Operation

Engine oil is circulated between the engine sump and the reserve tank by two electrically driven pumps within a single pumping unit (11). The pump unit is mounted on the side of the reserve tank. The pump unit is equipped with an LED monitor light on one side.

Pump 1 (in the pump unit) draws oil from the engine sump at a preset control point (determined by the height of the suction tube). Oil above this point is withdrawn and transferred to the reserve tank (9). This lowers the level in the engine sump until air is drawn.

Air reaching the pumping unit activates Pump 2 (in the pump unit) which returns oil from the reserve tank and raises the engine sump level until air is no longer drawn by Pump 1. Pump 2 then turns "Off". The running level is continuously adjusted at the control point by alternation between withdrawal and return of oil at the sump.

LED Monitor Light

- Steady - Pump 1 is withdrawing oil from the engine sump and bringing down the oil level.
- Regular Pulsing - Pump 2 is returning oil to the engine sump and raising the oil level.
- Irregular Pulsing - Oil is on the correct running level.

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Changing Oil

Drain both the engine sump and the reserve tank. Refill both engine and reserve tank with new oil to proper levels.

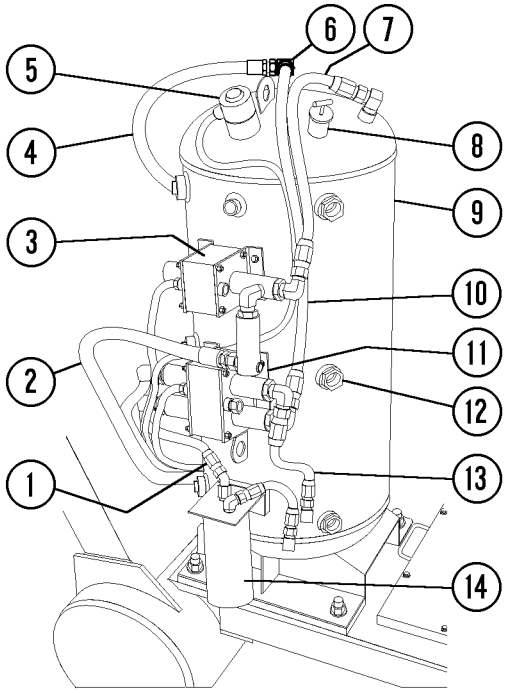
Change engine and reserve tank filters as required.

Start engine and check for proper operation.

NOTE: Do not use the oil in the reserve tank to fill the engine sump. Both must be at proper level before starting engine.

The engine oil level should be checked with the engine dipstick at every shift change. If the oil level in the engine is incorrect, check for proper operation of the reserve engine oil system.

The oil level in the reserve tank must also be checked at every shift change. Oil must be visible in the middle sight gauge (12). If not, add oil to the reserve tank by using the quick fill system utilizing the tank fill pump (3). For filling instructions, refer to the "Lubrication and Service" section.



M310001

. Oil Suction
. Oil Tank Fill
. Fill Valve
. Engine Fill Line
. Oil Level Sensor
. Air Valve
. Tank Fill Line
8. Fill Cap
9. Reserve Oil Tank
10. Engine Fill Line
11. Pump Unit
12. Sight Gauge
13. Tank Return Line
14. Oil Filter

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NOTES:

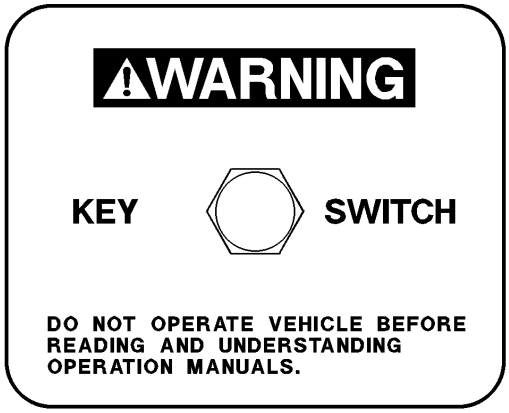
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WARNINGS AND CAUTIONS

The following pages give an explanation of the Warning, Caution, and Service Instruction plates and decals attached to the truck. The plates and decals listed here are typical of this model, but because of customer options, individual trucks may have plates and decals that are different from those shown here.

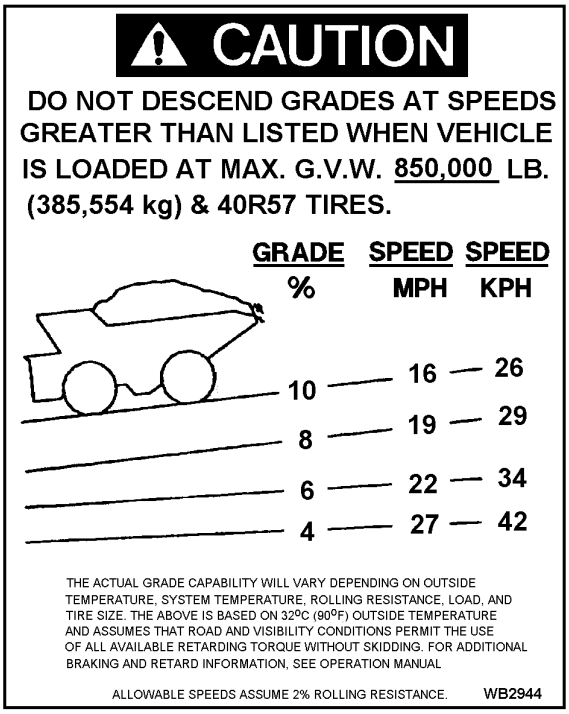
The plates and decals must be kept clean and legible. If any decal or plate becomes unable to be read or damaged, it should be replaced with a new one.

A warning decal surrounds the key switch located to the right of the steering column on the instrument panel. The warning stresses the importance of reading the operator's manual before operation.



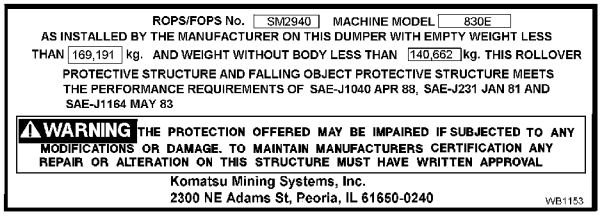
A Grade/Speed plate is located on the left front post of the operator's cab and provides the recommended MAXIMUM speeds to be used when descending various grades with a loaded truck. Always refer to the decal in operator's cab.

This decal in the truck may differ from the decal shown here due to OPTIONAL truck equipment such as: wheel motor drive train ratios, retarder grids, tire sizes, etc.



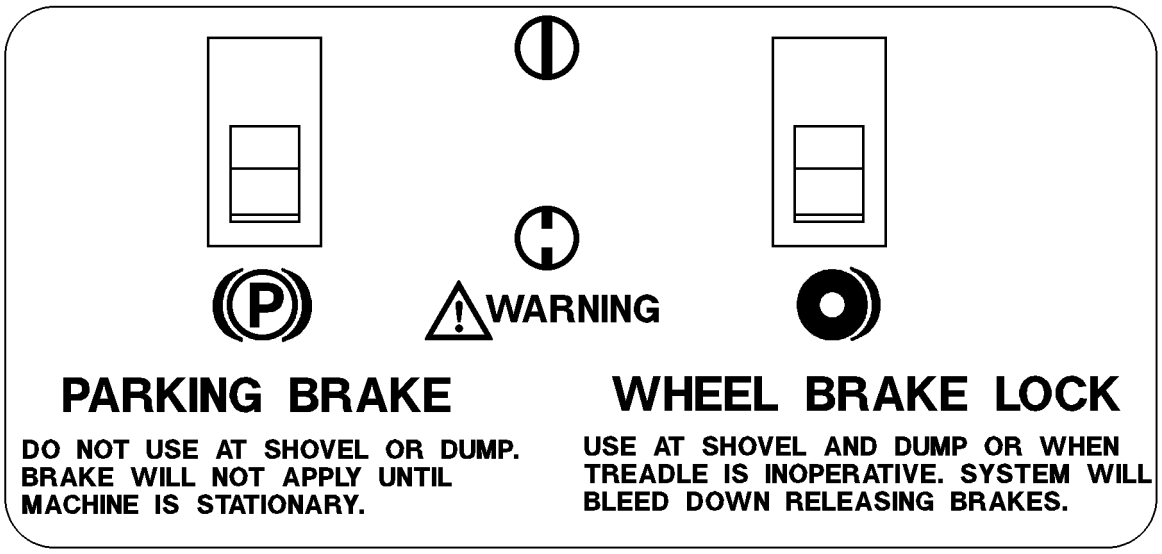
A plate attached to the right rear corner of the cab states the Rollover Protective Structure and Falling Object Protective Structure meets various SAE performance requirements.

! WARNING ! Do not make modifications to this structure, or attempt to repair damage without written approval from the Manufacturer. Unauthorized repairs will void certification.



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A warning instruction is applied below the Parking Brake and the Rear Wheel Brake Lock switches, which are located to the right of the steering column on the instrument panel. Pushing the top of the rocker-style switch turns the function ON, pushing the bottom, turns it OFF.

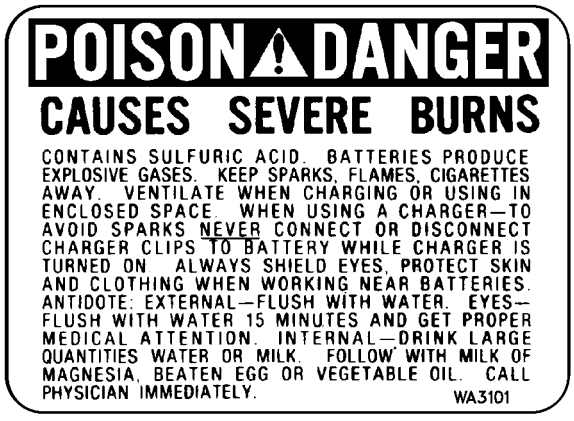


The **Parking Brake** is spring applied and hydraulically released. It is designed to hold a stationary truck when the engine is shutdown and keyswitch is turned "Off". The truck must be completely stopped before applying the parking brake, or damage may occur to parking brake.To apply the parking brake, press the rocker switch toward the "On" symbol. To release the parking brake, press the rocker switch toward the "Off" symbol. When the keyswitch is "On" and Parking Brake switch is applied, the Parking Brake indicator light (in Overhead Panel) will be illuminated.

NOTE: Do not use the parking brake at shovel or dump. With keyswitch "On" and engine running, sudden shock caused by loading or dumping could cause the system's motion sensor to RELEASE the park brake.

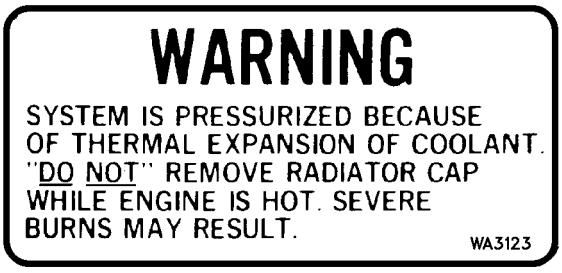
The **Wheel Brake** Lock switch is for holding the truck while parked at the shovel during loading, or while dumping. It applies the **rear service brakes only**. If the brake treadle valve does not operate, apply this brake to stop the truck. Do NOT use this brake as a parking brake when leaving the truck. With engine shut down, the hydraulic system will eventually bleed down, releasing the service brakes.

Attached to the exterior of the battery compartment is a danger plate. This plate stresses the need to keep from making any sparks near the battery. When another battery or 24VDC power source is used for auxiliary power, all switches must be "Off" prior to making any connections. When connecting auxiliary power cables, positively maintain correct polarity; connect the positive (+) posts together and then connect the negative (-) lead of the auxiliary power cable to a good frame ground. **Do not connect to the negative posts of the truck battery or near the battery box.** This hookup completes the circuit but minimizes danger of sparks near the batteries. Sulfuric acid is corrosive and toxic. Use proper safety gear, goggles, rubber gloves and rubber apron when handling and servicing batteries.



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A warning plate is mounted on top of the radiator surge tank cover near the radiator cap.The engine cooling system is pressurized. **Always turn the engine off and allow the engine to cool before removing radiator cap.** Unless the pressure is first released, removing the radiator cap after the engine has been running for a time will result in the hot coolant being expelled from the radiator. **Serious scalding and burning can result.**



Warning plates are mounted on the frame in front of, and to the rear, of the front tires. All personnel are warned that the clearances change when the truck is steered and could cause serious injury.

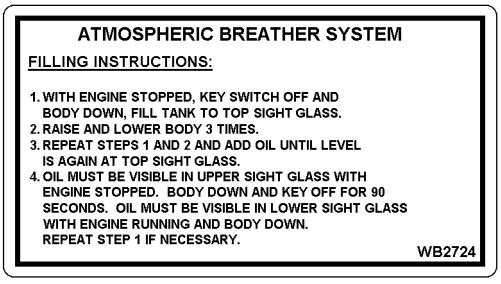


Warning plates are attached to both the hydraulic tank and fuel tank to alert technicians **not to work** on the truck **with the body in the raised position** unless body-up retention device (pins or cable) is in position.



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

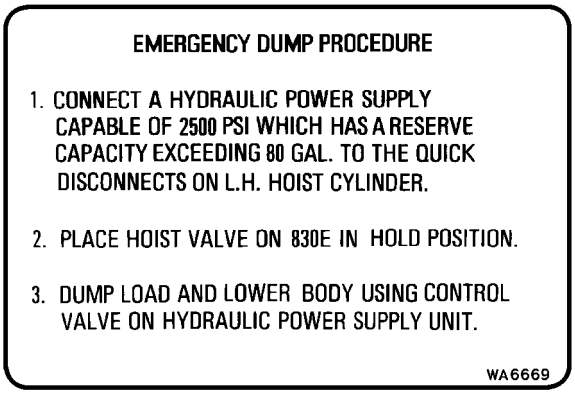
Keep the system open to the atmosphere only as long as absolutely necessary to lessen chances of system contamination. Service the tank with clean Type C-4 hydraulic oil. All oil being put into the hydraulic tank should be filtered through 3 micron filters.



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A decal plate is located on the frame near the left hoist cylinder which provides the operator or technician with the hook-up procedure for dumping a loaded, disabled truck, by using a functional truck for hydraulic power.

Refer to the Service manual for additional instructions for using this procedure.



A CAUTION decal is attached below the hydraulic tank oil level sight gauge. Check level with body down, engine stopped, and key switch "Off". Add oil per filling instructions, if oil level is below top of sight glass.



A warning plate is attached to the frame above the hydraulic system (APU) quick disconnect fittings to alert technicians that high pressure hydraulic oil is present during operation. Care must be taken when it is necessary to open the hydraulic system. There is always a chance of residual pressure being present. Open fittings slowly to allow any pressure to bleed off before removing any connections.



WARNING

Any operating fluid, such as hydraulic oil, escaping under pressure can have sufficient force to enter a person's body by penetrating the skin. Serious injury and possibly death may result if proper medical treatment by a physician familiar with this injury is not received immediately.

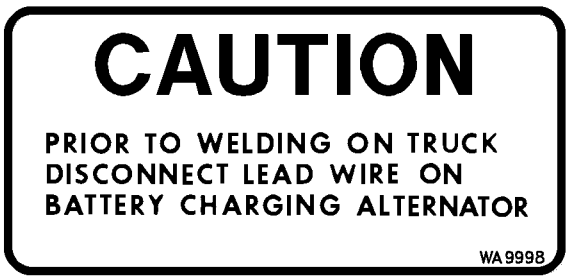
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High Voltage Danger Plates and Caution Plates are attached to the doors of the Electrical Control Cabinet. The High Voltage Plate is also attached to the blown grid housing, extended range housing, rectifier housing, inlet duct structure and rear hatch cover.



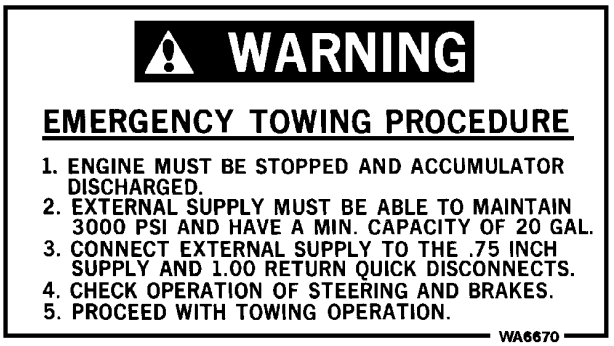
Before doing any welding on the truck, always disconnect the positive and negative battery cables of the vehicle. Failure to do so may seriously damage the battery and electrical equipment. Disconnect battery charging alternator lead wire and isolate electronic control components before making welding repairs. (It is not necessary to disconnect or remove any control circuit cards on electric drive Komatsu Trucks or any of the "AID" circuit control cards.)

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 WARNING plate is located above the hydraulic system (APU) quick disconnect fittings in front of the hydraulic tank which provides instructions to the operator or technician for towing a disabled truck. This plate specifies the requirements for an auxiliary source of supply for hydraulic oil and the proper hookup.

TEST STEERING AND BRAKE SYSTEM FOR NORMAL OPERATION BEFORE TOWING.



A wheel motor oil level decal is attached to the gear cover on both electric wheel motors. This decal stresses the fact that the truck must be on a level surface and parked for 20 minutes prior to checking the oil level. This is necessary in order to get an accurate reading.



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Warning and Danger plates are located inside the door of the brake system cabinet behind the cab.

This DANGER plate alerts technicians to read the warning labels attached to the side of each of the accumulators prior to releasing internal nitrogen pressure or disconnecting any hydraulic lines or hardware.



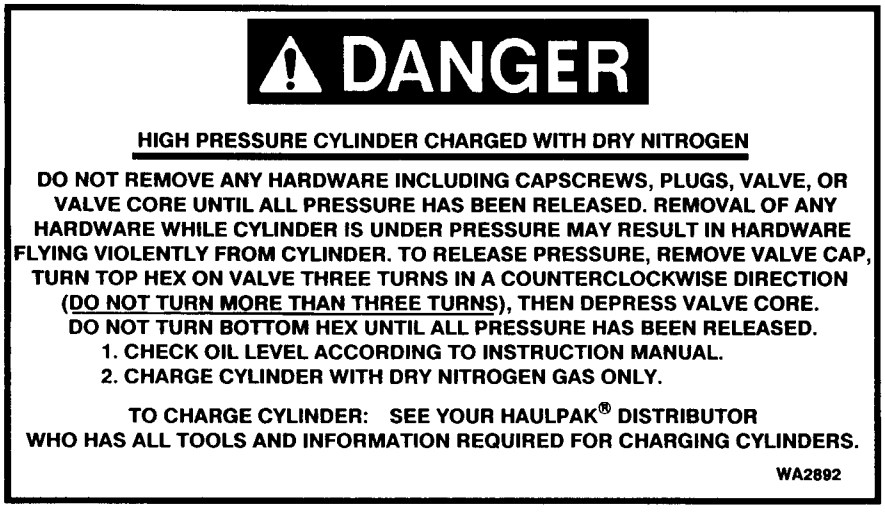
This WARNING plate warns the technician to stop the engine, turn off the key switch, and open the drain valves on all three accumulators to bleed the hydraulic pressure before loosening or disconnecting a brake line.



This WARNING plate, attached to the automatic lube system grease reservoir warns the technician not to remove the reservoir cover. The grease reservoir should be filled through the grease filter to prevent contamination of the grease supply.



This DANGER plate is attached to all four suspensions and steering accumulator(s). The plate contains instructions for releasing internal pressure before disconnecting any hydraulic lines or hardware.

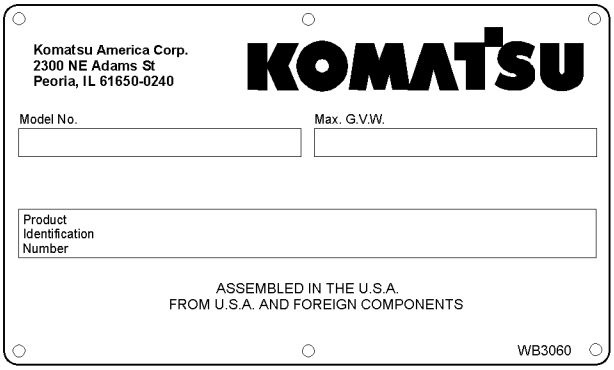


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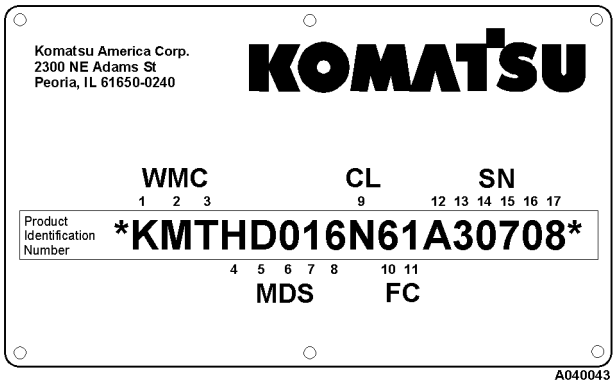
A WARNING Plate is located near the brake accumulators inside the hydraulic components cabinet behind the operators cab. This warning reminds the servicing technicians to be sure to close the accumulator drain valves after they have been opened to bleed brake pressure. It further warns not to over-tighten the drain valves to prevent damage to the valve seat(s).



A product identification plate is located on the frame in front of the right side front wheel and shows the Truck Model Number, Maximum G.V.W. and Product Identification Number (PIN).



The Product Identification Number (PIN) consists of 19 total characters. The first and last characters are tamper preventative symbols (*). The remaining 17 alpha/numeric characters are used to identify 5 characteristics of the machine. The 5 characteristics are detailed below.



WMC - Character positions 1, 2 and 3 identify the Worldwide Manufacturer Code (WMC). The WMC designates the manufacturer of the product. Komatsu brand products are identified with the letters KMT.

MDS - Character positions 4, 5, 6, 7 and 8 identify the Machine Descriptor Section (MDS). The MDS code identifies general information regarding machine specifications. The MDS is a code for the machine type and model.

CL - Character position 9 identify the Check Letter (CL). The CL is used to verify the accuracy of the individual PIN.

FC - Character positions 10 and 11 identify the Factory Code (FC). The FC identifies the Komatsu factory in charge of claims for the product. The FC for electric drive trucks is 61.

SN - Character positions 12, 13, 14, 15, 16, and 17 identify the Serial Number (SN). The SN is a unique sequential number.

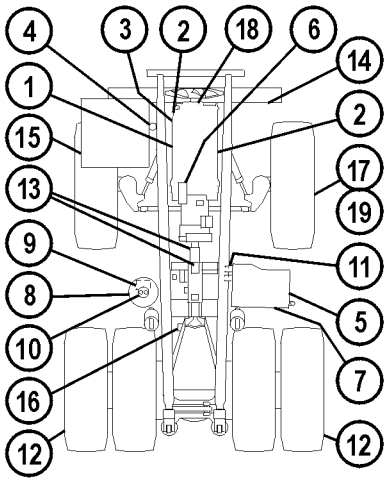
The Lubrication Chart is located on the right hand side of the radiator grille and is for reference. Refer to the "Lubrication Section" in this manual for more complete lubrication instructions.

LUBRICATION CHART

LUBRICATION SPECIFICATIONS

LUBE KEY	TYPE LUBRICANT
A	ENGINE OIL - - - - - SEE ENGINE MANUAL
B	HYDRAULIC OIL - - - - - SAE 10W C - 4 - - - - - AUXILIARY HEATERS REQUIRED BELOW -10°F(-23°C)
C	HEAVY-DUTY SYNTHETIC GEAR OIL - - - - - SEE DRIVE SYSTEM MANUAL
D	MULTI - PURPOSE EXTREME PRESSURE GREASE - - - - - NLGI NO.2 (5% MIN. MOLY-DISULFIDE)
E	MULTI - PURPOSE GEAR OIL - - - - - SAE 80W - 90

SYM	DESCRIPTION	PTS	LUBE KEY	10 HR	50 HR	100 HR	250 HR	500 HR	1000 HR	2000 HR	2500 HR
1	CRANKCASE OIL LEVEL	1	A	CHECK							
2	ENGINE LUBE OIL FILTERS			SEE ENGINE MANUAL							
3	FUEL FILTER										
4	FUEL SEPERATOR (DAVCO)										
5	FUEL TANK	1					DRAIN H_2O & SEDIMENT				
6	GE PREFILTER BREATHER	1	D				GREASE				
7	FUEL TANK BREATHER	1							CLEAN		
8	HYDRAULIC OIL LEVEL	1	B	CHECK					*CHANGE		
9	HYDRAULIC STRAINER	2							CLEAN		
10	HYDRAULIC TANK BREATHER	2						CHANGE			
11	HYDRAULIC FILTERS	3			**	**	**	CHANGE			
12	MOTORIZED WHEEL OIL LEVEL	2	C	SEE DRIVE SYSTEM MANUAL							
13	HYD. PUMP DRIVE SHAFT	2	D				GREASE				
14	CHASSIS LUBE LEVEL	1	D				GREASE				
15	SEAT SLIDES & STEER SHAFT	4	D						GREASE		
16	WHEEL MOTOR BLOWER	2	D				GREASE				
17	FRONT WHEEL BEARINGS ***	2	E				CHECK				CHANGE
18	FRONT TRUNION	1	D						GREASE		
19	MAGNETIC PLUG FRONT WHL COVER ****	2					CHECK				



630E, 730E, 830E, & 930E

* 1000 HR INTERVAL CAN BE EXTENDED TO 2500 HR PROVIDED OIL SAMPLING AND ANALYSIS IS CONDUCTED EVERY 250 HR.
** ONE-TIME CHANGE AT 50, 100 AND 250 HR.
*** NOT APPLICABLE FOR 930E
**** APPLICABLE FOR 930E ONLY

WB2790

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STANDARD CHARTS AND TABLES

This manual provides dual dimensioning for most specifications. U.S. standard units are specified first, with metric (SI) units in parentheses. References throughout the manual to standard torques or other standard values will be to one of the following Charts or Tables. For values not shown in any of the charts or tables, standard conversion factors for most commonly used measurements are provided in TABLE XIII, page 1-14.

INDEX OF TABLES

TABLE I . . . . . .Standard Torque Chart (SAE) . . A5-1
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TABLE V . . . . . Pipe Thread Torque Chart . . A5-3
TABLE VI. . . . . O-Ring Boss Torque Chart . . A5-3
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TABLE VIII. Torque Conversions (ft.lbs. - N.m) . . A5-4
TABLE IX. .Torque Conversions (ft.lbs. - kg.m) . . A5-4
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TABLE XI. . Pressure Conversions (psi - MPa) . . A5-5
TABLE XII . . . . . Temperature Conversions . . A5-5
TABLE XIII. . . Common Conversion Multipliers . . A5-6

EFFECT OF SPECIAL LUBRICANTS On Fasteners and Standard Torque Values

KOMATSU engineering department does NOT recommend the use of special “friction-reducing” lubricants such as, “Copper Coat”, “Never Seize”, and other similar products on the threads of standard fasteners where “standard torque” values are applied.

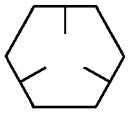
The use of special “friction-reducing” lubricants will significantly alter the clamping force being applied to fasteners during the tightening process.

If special “friction-reducing” lubricants are used with the “Standard Torque” values listed below in Table I (and in Komatsu shop manuals), excessive stress and possible breakage of the fasteners may result.

Where Torque Tables specify “Lubricated Threads” for the Standard Torque values listed, **these standard torque values are to be used with simple lithium base chassis grease (multi-purpose EP NLGI) or a rust- preventive grease (see list, page 1-10) on the threads and seats,** unless specified otherwise.

NOTE: Always be sure threads of fasteners and tapped holes are free of burrs and other imperfections before assembling.

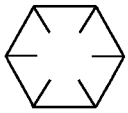
Standard torque values are not to be used when “Turn-of-the-Nut” tightening procedures are recommended.



Grade 5

TABLE I. -STANDARD TORQUE CHART SAE HEX HEAD CAPSCREW AND NUT ASSEMBLY (LUBRICATED THREADS) - TOLERANCES ±10%

Grade 8



Capscrew Thread Size	TORQUE - GRADE 5			TORQUE - GRADE 8			Capscrew Thread Size	TORQUE - GRADE 5			TORQUE - GRADE 8		
	ft. lbs.	kg.m	N.m	ft. lbs.	kg.m	N.m		ft. lbs.	kg.m	N.m	ft. lbs.	kg.m	N.m
1/4-20	7	0.97	9.5	10	1.38	13.6	3/4-16	235	32.5	319	335	46.3	454
1/4-28	8	1.11	10.8	11	1.52	14.9	7/8-9	350	48.4	475	500	69.2	678
5/16-18	15	2.07	20.3	21	2.90	28	7/8-14	375	51.9	508	530	73.3	719
5/16-24	16	2.21	22	22	3.04	30	1.0-8	525	72.6	712	750	103.7	1017
3/8-16	25	3.46	34	35	4.84	47	1.0-12	560	77.4	759	790	109.3	1071
3/8-24	30	4.15	41	40	5.5	54	1.0-14	570	78.8	773	800	110.6	1085
7/16-14	40	5.5	54	58	8.0	79	1 1/8-7	650	89.9	881	1050	145	1424
7/16-20	45	6.2	61	62	8.57	84	1 1/8-12	700	96.8	949	1140	158	1546
1/2-13	65	9	88	90	12.4	122	1 1/4-7	910	125.9	1234	1480	205	2007
1/2-20	70	9.7	95	95	13.1	129	1 1/4-12	975	134.8	1322	1580	219	2142
9/16-12	90	12.4	122	125	17.3	169	1 3/8-6	1200	166	1627	1940	268	2630
9/16-18	95	13.1	129	135	18.7	183	1 3/8-12	1310	181	1776	2120	293	2874
5/8-11	125	17.3	169	175	24.2	237	1 1/2-6	1580	219	2142	2560	354	3471
5/8-18	135	18.7	183	190	26.2	258	1 1/2-12	1700	235	2305	2770	383	3756
3/4-10	220	30.4	298	310	42.8	420							
1 ft. lbs. = 0.138 kg.m = 1.356 N.m													

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Standard Assembly Torques For 12-Point, Grade 9, Capscrews (SAE)

The following specifications apply to required assembly torques for all 12-Point, Grade 9 (170,000 psi minimum tensile), Capscrews.

- Capscrew threads and seats SHALL be lubricated when assembled.

Unless instructions specifically recommend otherwise, these standard torque values are to be used with simple lithium base chassis grease (multi-purpose EP NLGI) or a rust-preventive grease (see list, this page) on the threads.

- Torques are calculated to give a clamping force of approximately 75% of proof load.
- The maximum torque tolerance shall be ±10% of the torque value shown.

TABLE II. - STANDARD ASSEMBLY TORQUE for 12-Point, Grade 9 Capscrews

CAPSCREW SIZE*	TORQUE ft. lbs.	TORQUE N.m	TORQUE kg.m
0.250 - 20	12	16	1.7
0.312 - 18	24	33	3.3
0.375 - 16	42	57	5.8
0.438 -14	70	95	9.7
0.500 -13	105	142	14.5
0.562 - 12	150	203	20.7
0.625 - 11	205	278	28.3
0.750 - 10	360	488	49.7
0.875 - 9	575	780	79.4
1.000 - 8	860	1166	119
1.000 - 12	915	1240	126
1.125 - 7	1230	1670	170
1.125 - 12	1330	1800	184
1.250 - 7	1715	2325	237
1.250 - 12	1840	2495	254
1.375 - 6	2270	3080	313
1.375 - 12	2475	3355	342
1.500 - 6	2980	4040	411
1.500 - 12	3225	4375	445
* Shank Diameter (in.) - Threads per inch			
This table represents standard values only. Do not use these values to replace torque values which are specified in assembly instructions.			

Standard Metric Assembly Torque For Class 10.9 Capscrews & Class 10 Nuts

The following specifications apply to required assembly torques for all metric Class 10.9 finished hexagon head capscrews and Class 10 nuts.

- Capscrew threads and seats SHALL NOT be lubricated when assembled. These specifications are based on all capscrews, nuts, and hardened washers being phosphate and oil coated.NOTE: If zinc-plated hardware is used, each piece must be lubricated with a Rust Preventive Grease or Lithium-base grease to achieve the same clamping forces provided below.
- Torques are calculated to give a clamping force of approximately 75% of proof load.
- The maximum torque tolerance shall be within ±10% of the torque value shown.

TABLE III. - STANDARD METRIC ASSEMBLY TORQUE

CAPSCREW SIZE*	TORQUE N.m	TORQUE ft.lbs.	TORQUE kg.m
M6 x1	12	9	1.22
M8 x 1.25	30	22	3.06
M10 x 1.5	55	40	5.61
M12 x 1.75	95	70	9.69
M14 x 2	155	114	15.81
M16 x 2	240	177	24.48
M20 x 2.25	465	343	47.43
M24 x 3	800	590	81.6
M30 x 3.5	1600	1180	163.2
M36 x 4	2750	2028	280.5
* Shank Diameter (mm) - Threads per millimeter			
This table represents standard values only. Do not use these values to replace torque values which are specified in assembly instructions.			

Suggested* Sources for Rust Preventive Grease:

- AMERICAN ANTI-RUST GREASE #3-X from Standard Oil Company (also American Oil Co.)
- GULF NORUST #3 from Gulf Oil Company.
- MOBILARMA 355, Product No. 66705 from Mobil Oil Corporation.
- RUST BAN 326 from Humble Oil Company.
- RUSTOLENE B GREASE from Sinclair Oil Company.
- RUST PREVENTIVE GREASE - CODE 312 from the Southwest Grease and Oil Company.

**** NOTE: This list represents the current Engineering approved sources for use in Komatsu manufacture. It is not exclusive. Other products may meet the same specifications of this list.***

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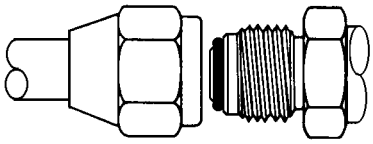


TABLE IV.
TORQUE CHART FOR JIC 37° SWIVEL NUTS
WITH OR WITHOUT O-RING SEALS

SIZE CODE	TUBE SIZE (O.D.)	THREADS UNF-2B	TORQUE FT. LBS.
– 2	0.125	0.312 – 24	4 ±1
– 3	0.188	0.375 – 24	8 ±3
– 4	0.250	0.438 – 20	12 ±3
– 5	0.312	0.500 – 20	15 ±3
– 6	0.375	0.562 – 18	18 ±5
– 8	0.500	0.750 – 16	30 ±5
– 10	0.625	0.875 – 14	40 ±5
– 12	0.750	1.062 – 12	55 ±5
– 14	0.875	1.188 – 12	65 ±5
– 16	1.000	1.312 – 12	80 ±5
– 20	1.250	1.625 – 12	100 ±10
– 24	1.500	1.875 – 12	120 ±10
– 32	2.000	2.500 – 12	230 ±20

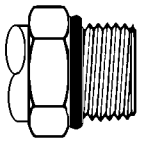


TABLE VI.
TORQUE CHART FOR
O-RING BOSS FITTINGS

SIZE CODE	TUBE SIZE (O.D.)	THREADS UNF-2B	TORQUE FT. LBS.
– 2	0.125	0.312 – 24	4 ±2
– 3	0.188	0.375 – 24	5 ±2
– 4	0.250	0.438 – 20	8 ±3
– 5	0.312	0.500 – 20	10 ±3
– 6	0.375	0.562 – 18	13 ±3
– 8	0.500	0.750 – 16	24 ±5
– 10	0.625	0.875 – 14	32 ±5
– 12	0.750	1.062 – 12	48 ±5
– 14	0.875	1.188 – 12	54 ±5
– 16	1.000	1.312 – 12	72 ±5
– 20	1.250	1.625 – 12	80 ±5
– 24	1.500	1.875 – 12	80 ±5
– 32	2.000	2.500 – 12	96 ±10

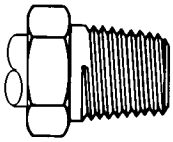


TABLE V.
TORQUE CHART FOR
PIPE THREAD FITTINGS

SIZE CODE	PIPE THREAD SIZE	WITH SEALANT FT. LBS.	WITHOUT SEALANT FT. LBS.
– 2	0.125 – 27	15 ±3	20 ±5
– 4	0.250 – 18	20 ±5	25 ±5
– 6	0.375 – 18	25 ±5	35 ±5
– 8	0.500 – 14	35 ±5	45 ±5
– 12	0.750 – 14	45 ±5	55 ±5
– 16	1.000 – 11.50	55 ±5	65 ±5
– 20	1.250 – 11.50	70 ±5	80 ±5
– 24	1.500 – 11.50	80 ±5	95 ±10
– 32	2.000 – 11.50	95 ±10	120 ±10

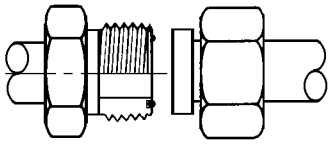


TABLE VII.
TORQUE CHART FOR
O-RING FACE SEAL FITTINGS

SIZE CODE	TUBE SIZE (O.D.)	THREADS UNF-2B	TORQUE FT. LBS.
– 4	0.250	0.438 – 20	11 ±1
– 6	0.375	0.562 – 18	18 ±2
– 8	0.500	0.750 – 16	35 ±4
– 10	0.625	0.875 – 14	51 ±5
– 12	0.750	1.062 – 12	71 ±7
– 16	1.000	1.312 – 12	98 ±6
– 20	1.250	1.625 – 12	132 ±7
– 24	1.500	1.875 – 12	165 ±15

TABLE VIII. TORQUE CONVERSIONS
Foot Pounds – ft. lbs. To Newton-meters (N.m)

FT. LBS.	0	1	2	3	4	5	6	7	8	9
0	(N.m)	1.36	2.71	4.07	5.42	6.78	8.14	9.49	10.85	12.20
10	13.56	14.91	16.27	17.63	18.98	20.34	21.69	23.05	24.40	25.76
20	27.12	28.47	29.83	31.18	32.54	33.90	35.25	36.61	37.96	39.32
30	40.67	42.03	43.39	44.74	46.10	47.45	48.81	50.17	51.52	52.87
40	54.23	55.59	56.94	58.30	59.66	60.01	62.37	63.72	65.08	66.44
50	67.79	69.15	70.50	71.86	73.21	74.57	75.93	77.28	78.64	80.00
60	81.35	82.70	84.06	85.42	86.77	88.13	89.48	90.84	92.20	93.55
70	94.91	96.26	97.62	98.97	100.33	101.69	103.04	104.40	105.75	107.11
80	108.47	109.82	111.18	112.53	113.89	115.24	116.60	117.96	119.31	120.67
90	122.03	123.38	124.74	126.09	127.45	128.80	130.16	131.51	132.87	134.23
See NOTE on page A5-5 regarding Table usage										

TABLE IX. TORQUE CONVERSIONS
Foot Pounds – ft. lbs. To kilogram-meters (kg.m)

FT. LBS.	0	1	2	3	4	5	6	7	8	9
0	(kg.m)	0.138	0.277	0.415	0.553	0.692	0.830	0.968	1.106	1.245
10	1.38	1.52	1.66	1.80	1.94	2.07	2.21	2.35	2.49	2.63
20	2.77	2.90	3.04	3.18	3.32	3.46	3.60	3.73	3.87	4.01
30	4.15	4.29	4.43	4.56	4.70	4.84	4.98	5.12	5.26	5.39
40	5.53	5.67	5.81	5.95	6.09	6.22	6.36	6.50	6.64	6.78
50	6.92	7.05	7.19	7.33	7.47	7.61	7.74	7.88	8.02	8.16
60	8.30	8.44	8.57	8.71	8.85	8.99	9.13	9.27	9.40	9.54
70	9.68	9.82	9.96	10.10	10.23	10.37	10.51	10.65	10.79	10.93
80	11.06	11.20	11.34	11.48	11.62	11.76	11.89	12.03	12.17	12.30
90	12.45	12.59	12.72	12.86	13.00	13.14	13.28	13.42	13.55	13.69
See NOTE on page A5-5 regarding Table usage										

TABLE X. PRESSURE CONVERSIONS
Pounds/square inch (psi) To Kilopascals (kPa)
Formula: psi x 6.895 = kPa

PSI	0	1	2	3	4	5	6	7	8	9
0	(kPa)	6.895	13.79	20.68	27.58	34.47	41.37	48.26	55.16	62.05
10	68.95	75.84	82.74	89.63	96.53	103.42	110.32	117.21	124.1	131.0
20	137.9	144.8	151.7	158.6	165.5	172.4	179.3	186.2	193.1	200.0
30	206.8	213.7	220.6	227.5	234.4	241.3	248.2	255.1	262.0	268.9
40	275.8	282.7	289.6	296.5	303.4	310.3	317.2	324.1	331.0	337.9
50	344.7	351.6	358.5	365.4	372.3	379.2	386.1	393.0	399.9	406.8
60	413.7	420.6	427.5	434.4	441.3	448.2	455.1	462.0	468.9	475.8
70	482.6	489.5	496.4	503.3	510.2	517.1	524.0	530.9	537.8	544.7
80	551.6	558.5	565.4	572.3	579.2	586.1	593.0	599.9	606.8	613.7
90	620.5	627.4	634.3	641.2	648.1	655.0	661.9	668.8	675.7	682.6
See NOTE on page A5-5 regarding Table usage										

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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.

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TABLE XIII
COMMON CONVERSION MULTIPLIERS

COMMON CONVERSION MULTIPLIERS ENGLISH To METRIC		
To Convert From	**TO**	**Multiply By**
inch – in.	millimeter (mm)	25.40
inch – in.	centimeter (cm)	2.54
foot – ft.	meter (m)	0.3048
yard – yd.	meter (m)	0.914
mile – mi.	kilometer (km)	1.61
sq. in. – $in.^2$	sq. centimeters (cm^2)	6.45
sq. ft. – $ft.^2$	sq. centimeters (cm^2)	929
cu. in. – $in.^3$	cu. centimeters (cm^3)	16.39
cu. in. – $in.^3$	liters (l)	0.016
cu. ft. – $ft.^3$	cu. meters (m^3)	0.028
cu. ft. – $ft.^3$	liters (l)	28.3
ounce – oz.	kilogram (kg)	0.028
fluid ounce – fl. oz.	milliliter (ml)	29.573
pound (mass)	kilogram (kg)	0.454
pound (force) – lbs.	Newton (N)	4.448
in. lbs. (force)	Newton.meters (N.m)	0.113
ft. lbs. (force)	Newton.meters (N.m)	1.356
ft. lbs. (force)	kilogram.meters (kg.m)	0.138
kilogram.meters (kg.m)	Newton.meters (N.m)	9.807
psi (pressure)	kilopascals (kPa)	6.895
psi (pressure)	megapascals (MPa)	0.007
psi (pressure)	kilograms/cm^2 (kg/cm^2)	0.0704
ton (short)	kilogram (kg)	907.2
ton (short)	metric ton	0.0907
quart – qt.	liters (l)	0.946
gallon – gal.	liters (l)	3.785
HP (horsepower)	Watts	745.7
HP (horsepower)	kilowatts (kw)	0.745

COMMON CONVERSION MULTIPLIERS METRIC To ENGLISH		
To Convert From	**TO**	**Multiply By**
millimeter (mm)	inch – in.	0.0394
centimeter (cm)	inch – in.	0.3937
meter (m)	foot – ft.	3.2808
meter (m)	yard – yd.	1.0936
kilometer (km)	mile – mi.	0.6210
sq. centimeters (cm^2)	sq. in. – $in.^2$	0.1550
sq. centimeters (cm^2)	sq. ft. – $ft.^2$	0.001
cu. centimeters (cm^3)	cu. in. – $in.^3$	0.061
liters (l)	cu. in. – $in.^3$	61.02
cu. meters (m^3)	cu. ft. – $ft.^3$	35.314
liters (l)	cu. ft. – $ft.^3$	0.0353
grams (g)	ounce – oz.	0.0353
milliliter (ml)	fluid ounce – fl. oz.	0.0338
kilogram (kg)	pound (mass)	2.2046
Newton (N)	pound (force) – lbs.	0.2248
Newton.meters (N.m)	kilogram.meters (kg.m)	0.102
Newton.meters (N.m)	ft. lbs. (force)	0.7376
kilogram.meters (kg.m)	ft. lbs. (force)	7.2329
kilogram.meters (kg.m)	Newton.meters (N.m)	9.807
Kilopascals (kPa)	psi (pressure)	0.1450
megapascals (MPa)	psi (pressure)	145.038
kilograms/cm^2 (kg/cm^2)	psi (pressure)	14.2231
kilograms/cm^2 (kg/cm^2)	kilopascals (kPa)	98.068
kilogram (kg)	ton (short)	0.0011
metric ton	ton (short)	1.1023
liters (l)	quart – qt.	1.0567
liters (l)	gallon – gal.	0.2642
Watts	HP (horsepower)	0.00134
kilowatts (kw)	HP (horsepower)	1.3410

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STORAGE AND IDLE MACHINE PREPARATION

There may be periods when it is necessary for a machine to be idle for an extended period of time. Properly prepared, a stored machine may promptly and safely be put back into operational service. Improper preparation, or complete lack of preparation, can make the job of getting the vehicle back to operating status difficult.

The following information outlines the essential proper steps for preparing a unit for extended storage, and the necessary steps to bring it back to operational status - these are the ideals. Additional information is given to help restore those machines which were not put into storage, merely shut down and left idle for a long period of time.

Much of this material is of a general nature since the environment, where the machine has been standing idle, will play a big part in its overall condition. Hot, humid climate will affect vehicle components much differently than the dry desert atmosphere or a cold arctic environment. These climatic aspects must be considered, and appropriate actions taken when restoring a long term idle vehicle.

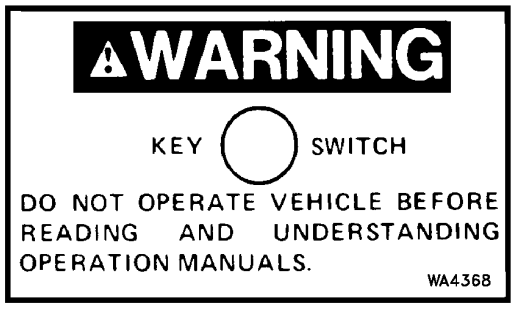
These instructions are not intended to be all inclusive, but are furnished to provide the minimum guide lines. The final aim should always be to provide the operator with a safe, fully productive vehicle, that he can rely on.

SHORT TERM IDLE PERIODS

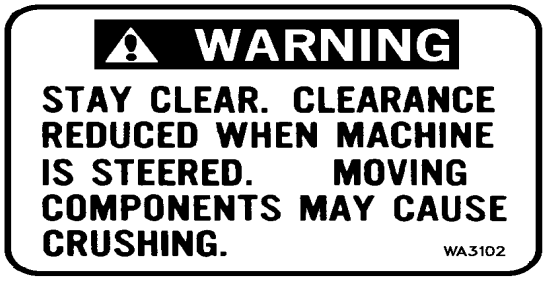
There will be periods when a vehicle may be idle from 30-60 days, but must be ready for use at all times.

The most effective handling of this type situation is to follow the procedure given below to prevent any deterioration from beginning.

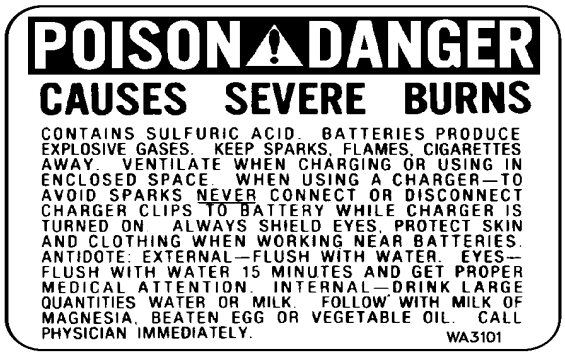
1. Keep the vehicle fully serviced.



2. On a weekly schedule, perform a visual check of the vehicle, start and run the engine until both the engine and transmission are up to operating temperature. Move the vehicle around the yard for a few minutes to insure that all internal gears and bearings are freshly lubricated.
3. Operate all hydraulic functions through complete range to insure that cylinder rams and all seals are fully lubricated.
4. Check and operate all systems.
5. After shutdown, drain air tank (if so equipped) to expel any accumulated moisture.



6. Once a month, perform the 10 hour service items shown in the Operation and Maintenance Manuals. Keep batteries properly serviced.

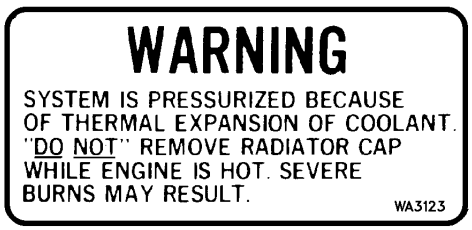


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PREPARATION FOR STORAGE

For long term idle periods, proper preparation will pay large dividends in time and money when future operation of the vehicle is scheduled.

1. Engine should be prepared for storage according to instructions found in the engine manufacturers manual.
2. Transmission should be prepared for storage. Instruction will be found in the transmission Service Manual. Several storage variations are given.
3. The vehicle should be in top operating condition with all discrepancies corrected. Paint should be in good condition, no rust or corrosion, all exposed, machined or unpainted surfaces should be coated with a good rust preventative grease.
4. After the vehicle has been parked in its storage location, all hydraulic cylinders, including Hydrair suspensions (Trucks), should be retracted as much as possible (steering cylinders centered). Wipe the exposed portion of all cylinder rams clean and, coat (including seals on ends of barrel) with good preservative grease.
5. If long term storage is anticipated, the vehicle should be blocked up with the tires clear of the ground or floor to remove vehicle weight from the tires. Lower air pressure in the tires to 15-25 psi (103-172 kPa). Completely cover the tires with tarpolins to minimize rubber oxidation and deterioration.
6. (Trucks equipped with air-actuated park brake) With air tanks pressurized and parking brake valve "Off", remove a clevis pin from the brake actuator linkage. This will relieve spring pressure from applying the parking brake while the vehicle is idle. Replace clevis pin in link to prevent loss. Tag steering wheel with a parking brake disconnected tag.
7. Drain air tank(s) completely (if equipped). When tank compartments are empty, fog the inside of each tank compartment with a light application of preservative oil to deter rust and corrosion.



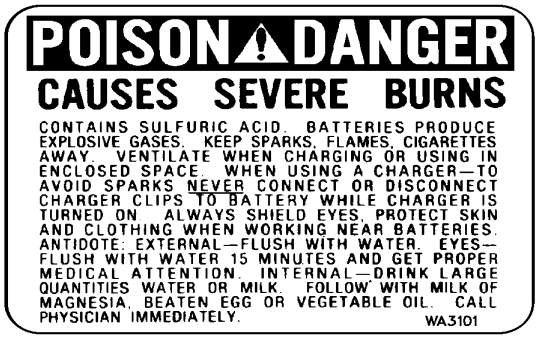
8. Clean the radiator; refer to Engine Service Manual and the Vehicle Service Manual for the proper cleaning instructions.
9. The cooling system should be completely drained, chemically flushed, and refilled with a conditioned water/antifreeze solution suitable for the lowest temperature anticipated.
   Refer to Section "P", Fluid Specifications and Charts, of the Shop Manual for the proper antifreeze and conditioner concentrations. After refilling the system, always operate the engine until the thermostats open to circulate the solution through the cooling system.

NOTE: NEVER store a vehicle with a dry cooling system.

10. New hydraulic filters should be installed and the hydraulic tank fully serviced with Type C-4 oil as specified in Section "P", Lubrication and Service, of the Shop Manual.



Any operating fluid, such as hydraulic oil, escaping under pressure can have sufficient force to enter a person's body by pentrating the skin. Serious injury and possible death may result if proper medical treatment by a physician familiar with this injury is not received immediately.



11. Disconnect batteries, If possible, batteries should be removed and stored in a battery shop or a cool dry location on wooden blocks. Do not store batteries on a concrete floor. Clean battery compartment, remove all corrosion and paint compartment with acid proof paint.
12. Wheel axle housings and final drives should be fully serviced with prescribed lubricants. Seal all vents.

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13. Exhaust openings and air cleaners should be covered tightly with moisture barrier paper and sealing tape.
14. All lubrication points (grease fittings) should be serviced with the prescribed lubricants.
15. Relieve tension from all drive belts. The engine manufacturer recommends insertion of heavy kraft paper between belts and pulleys to prevent sticking.
16. All vandalism covers and locks should be in place and secured.
17. If so equipped, cab windows should be closed, locked and sealed and the cab door locked to prevent vandalism and weather effects.
18. The vehicle fuel tanks should be completely drained of fuel, fogged with preservative lubricant, ("NOX-RUST" MOTOR STOR., SAE10) and closed tightly. All fuel filters should be replaced.
19. If at all possible, to aid those who will eventually place the unit back in operation, all available service publications (vehicle, engine and transmission) and a current parts catalog should be packaged in a moisture proof package and placed in the vehicle cab.
20. Be certain water drain holes in body (trucks) are open.

REMOVAL FROM STORAGE

If the foregoing preparations were conscientiously followed in placing the vehicle into storage, getting it back to operational status is a simple matter of reversing these steps.

NOTE: Before starting the job or restoring a vehicle to operation, obtain copies of the Operation and Maintenance Manual, Shop Manual, Engine and Transmission Manuals and/or the Parts Book and follow ALL special instructions regarding servicing the vehicle and its components.

In addition to removing the storage materials, the following actions should be taken.

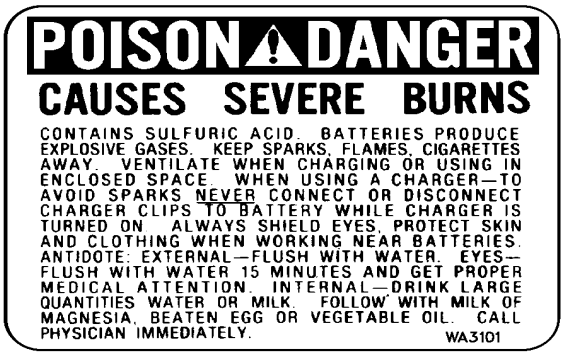
1. Inspect the entire vehicle carefully for rust and corrosion, correct as necessary.
2. Service the engine according to the Engine Manufacturer's Operation and Maintenance Manual.
3. Clean the radiator; refer Engine Manufacturer's Operation and Maintenance Manual.
4. The cooling system should be completely drained, chemically flushed, and refilled with a conditioned water/antifreeze solution suitable for the lowest temperature anticipated. Refer to **Fluid Specifications** in Section "P", Lubrication and Service, of the Shop Manual for the proper anti-freeze and conditioner concentrations. After refilling the system, always operate the engine until the thermostats open to circulate the solution through the cooling system.
5. Refer to the proper transmission service manual for returning the transmission to operation.
6. Thoroughly inspect all drive belts, hydraulic, air and oil lines for evidence of damage, wear or deterioration. Replace any suspected lines. Don't take chances on ruptures or blow-outs.
7. New hydraulic filters should be installed and the hydraulic tank (reservoir) checked and serviced with Type C-4 oil as specified in Section "P", Lubrication and Service, of the Shop Manual.
8. Drain on fuel tank should be opened to remove any build up of moisture or sediment that may have accumulated while in storage. Close drain then fill the fuel tank with approved diesel fuel.

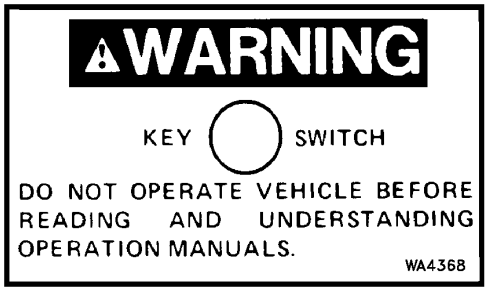
⚠DANGER

NEVER blend gasoline, gasohol and/or alcohol with diesel fuel. This practice creates an extreme FIRE HAZARD and under certain conditions may cause an EXPLOSION.

9. Make certain that all hydraulic controls, steering linkage and throttle linkage points are lubricated and operate freely before engine start up.
10. All electrical connections must be clean and tight. Check security of all ground straps and cables.

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11. Install fully charged batteries in unit. Clean connectors and connect battery cables. Compartment must be free of corrosion. Secure batteries with hold downs.
12. Check all electrical cables for weathering, cracks and/or damage. Replace any defective cables.

DANGER

Air pressure must be released from tires with bad cuts or wear that extends into the plies, before removal from the vehicle. Also, do not allow personnel to stand in removal path of tires.

13. Check all tires carefully for serviceability and inflate to proper pressure.
14. If disconnected, reconnect the parking brake linkage.
15. Completely service the vehicle as recommended in Section "P", Lubrication and Service, of the Shop Manual for both 10 and 100 hour inspections.
16. Adjust all drive belts to specified tension.
17. Make certain that all hydraulic controls, steering linkage and throttle linkage points are free before engine start up.
18. Use the Operation and Maintenance Manual for guidance on engine start and vehicle checkout. Make a thorough check of all hose and line connections for leakage when the engine is running.
19. Before moving the vehicle, cycle all hydraulic controls and steering to verify proper operation. Verify proper operation of service brakes, emergency braking system and parking brake. Check ALL system instruments to insure that all systems are operational.
    (Trucks with air-over-hydraulic brakes.)
    Bleed air system down with brake pedal applications to insure that the air governor is functioning properly.

    Consult the service manual for the specific truck being serviced. Verify proper operation of the air compressor, the air governor, and the air tank safety valve. If any of these components do not function as prescribed in the service manual, shut down engine and correct any discrepancy before continuing operation.
20. When all systems are operational and all discrepancies are corrected, road test the vehicle in a smooth, level, unobstructed area (with qualified, experienced operator only) to check steering response, transmission shifting, service brake efficiency, and hydraulic functions. Only when it is assured that the vehicle is in safe operational condition should it be turned over to an operator.
21. Fire protection equipment on a machine which has been in storage should be recharged before the machine is returned to service.

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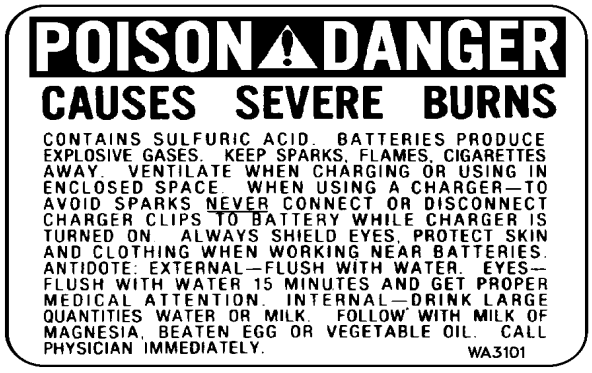
RECONDITIONING AN IDLE VEHICLE

⚠WARNING

NEVER attempt operation of a vehicle which has been standing idle for a long period until all systems which affect steering, brakes, engine, transmission and running gear have been completely reconditioned. An unsafe vehicle can cause serious injuries and/or major property damage - DON'T TAKE CHANCES!

At times a vehicle is subjected to long idle periods without being properly serviced for storage - merely shut down and left to the elements for an extended period. Reconditioning of this vehicle can and does present a major expenditure of time and money when it is to be put into operating condition.

1. Remove all trash and thoroughly clean the vehicle before starting any inspection or maintenance.



2. Remove vehicle batteries and move to battery shop for service and charging or replacement as necessary.

⚠WARNING

Do not disassemble an inflated tire. Remove valve core slowly, and allow pressure to bleed off, before attempting to remove lockring. Also, eye protection should be worn during tire deflation to protect against any foreign object being projected into the eyes.

3. Inspect tires thoroughly for tread and side wall condition, weathering, cuts and cracks.
   a. Any tire suspected of being unserviceable should be dismounted and thoroughly inspected inside and out before being inflated.

⚠WARNING

Do not mix rim parts of different rim manufacturers. Rim parts may resemble those of a different manufacturer, but the required tolerances may be wrong. Use of mismatched rim parts is hazardous.

   b. If tires are dismounted, all wheel components must be cleaned, inspected, all rust and corrosion removed and parts repainted as applicable before remounting the tires. Follow the safety rules when mounting and inflating tires.
   c. Mount and inflate tires as shown in Operation and Maintenance Manual or service manual.
4. Inspect vehicle service brakes carefully.

⚠WARNING

Before disabling the brake circuit, block all wheels to prevent possible movement of the vehicle.

   a. If dust covers are installed on the inboard side of the wheels, remove the covers to allow for inspection of brake calipers/shoes and/or brake discs/drums.

⚠WARNING

The use of vapor degreasing or steam cleaning is not recommended, either for brake assemblies or the component parts. Corrosion and rusting may occur.

   b. All brake lines, connections and pressure converters must be clean, serviced and free of rust and corrosion.
   c. Check condition of brake fluid; fill or replace fluid as necessary.

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5. Inspect air system components (if equipped) for corrosion and deterioration.
   a. Safety valve plunger must be free. Remove rubber cap from air governor to check for any corrosion and rust. Governor should be replaced if any defect is suspected.
   b. Air compressor should turn by hand without appreciable binding. Check and tighten drive belts to prescribed tension; if one belt of a set is unserviceable, replace the set.
   c. If internal air tank corrosion is suspected, the drain cocks of the dual air tank should be opened or removed and the automatic moisture ejector removed from the tank.
   d. Disconnect the tank line from the compressor and connect a shop air line to the tank line. Slowly apply shop pressure to the system while observing the openings in the tanks. If excess moisture, dirt, rust or other foreign material is ejected from tanks, the complete air system should be reconditioned, including replacement of suspect components. Air tanks cannot be easily checked for wall thickness; if rust or corrosion is present in the tank, replacement of the tank should be considered.
   e. If contamination is eliminated as a possible problem, shop air may be used to charge air system and check all air operated components except the compressor and governor.
   f. Treadle valves must operate smoothly and show no internal or external damage or contamination. Leakage limitations are shown in Section "J", Brake System, of the Shop Manual.
   g. The throttle cylinder and parking brake actuator must cycle smoothly when actuated by the treadle valves or parking brake valve.
   h. When air system servicing is complete and all defective components repaired or replaced, the service brake hydraulic circuits should be bled according to instructions in Section "J", Brake System, of the Shop Manual.
6. The vehicle engine should be inspected and serviced according to the Engine Manufacturer's Operation And Maintenance Manuals.
   a. Insure that exhaust is clear and clean, no foreign materials. If water entry is suspected, disconnect air tubes at the turbochargers to check for water damage before attempting startup.
   b. Replace fuel filters, fill filter cans with fresh fuel for engine priming.

⚠WARNING

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

   c. Remove and replace both the primary and safety filter (secondary) elements in the air cleaners. Check all intake lines between air cleaners and engine. All clamps must be tight. Indicating plunger in filter condition indicators must be free.
   d. The tubes in precleaner section of air cleaner assembly should be inspected, all tubes should be clear and clean. Use a light to inspect the tubes. The light should be visible. If clogging is evident, precleaner must be cleaned. Clean precleaner according to instructions in Section "C", of the Shop Manual.
   e. Drain and flush engine cooling system. Fill with coolant and inhibitors after checking all lines, hoses and connections. Refer to Section "P", Lubrication and Service, of the Shop Manual, for anti-freeze recommendations. Radiator cores must be clear of dirt and trash.

⚠WARNING

To prevent injuries, always release spring tension before replacing the fan belt.

   f. Check and tighten engine fan drive belts, install new belt set if necessary.
   g. Check and tighten engine mounts.
7. Inspect and service the transmission (mechanical drive vehicles) according to the Transmission manufacturer's service manual.

NOTE: If hydraulic pump or engine is inoperative, dump body (trucks) should be raised with a crane so body holding devices can be installed.

   a. Check all transmission electrical connections for corrosion, cleanliness and tightness. Check electrical cables for weathering, damage and proper clamping.
   b. Check drive lines for tightness of hardware and worn U-joints.
   c. Check transmission mounts for condition and security.

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8. If fuel was left in the tanks, it must be removed. *Do not attempt to use old diesel fuel.*
   a. With tanks empty, remove inspection plates and thoroughly check interior of tanks; clean if necessary to remove sediment and contamination. If fuel was contaminated, lines should be disconnected and blown clear.
   b. Check all fuel lines for deterioration or damage. Replace lines as necessary.
   c. Replace inspection covers, use new gaskets.
   d. Service tanks with specified diesel fuel.
   e. Replace fuel filters.

⚠WARNING

Any operating fluid, such as hydraulic oil or brake fluid escaping under pressure, can have sufficient force to enter a person's body by penetrating the skin. Serious injury and possible death may result if proper medical treatment by a physican familiar with this injury is not received immediately.

9. Hydraulic tank should be drained. If oil is not contaminated and is stored in clean containers, it may be reused if filtered through 3-micron filter elements when being pumped back into the tank. Do not attempt to use contaminated hydraulic oil, especially if water entry into the system is suspected.

NOTE: If filling is required, use clean hydraulic oil only. Refer to the Lubrication chart in Section "P", Lubrication and Service, of the Shop Manual for proper oil specifications.

   a. Replace hydraulic filter elements and clean suction strainer elements. While suction strainers are removed, inspect and clean interior of tank thoroughly to remove all sediment and foreign material.
   b. Inspect all hydraulic lines for deterioration or damage. Replace suspected lines - don't risk hose ruptures or blow outs.
   c. Check all hydraulic components - pumps, valves and cylinders for damage and corrosion. Secure all mountings and connections. Control valves in the cab must be free moving with no binding.
   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.

10. 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.

11. Check parking brake. Since it is spring applied, the brake shoes/pads may be stuck tightly to the drum/disc, it may be necessary to remove and overhaul the parking brake assembly.

12. 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.

13. Check generator/alternator for corrosion or deterioration. Generator/alternator rotor must be free, with no binding or roughness. Inspect, install and properly tension the generator/alternator drive belts.

14. Check security of steering cylinder ball joints link and hydraulic connections.

15. Examine Hydrair suspensions (trucks) 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.

16. If not previously done, install fully charged batteries and completely charge air tank (if equipped) with shop air.

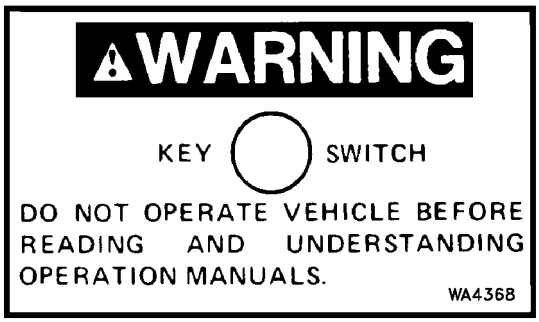
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ENGINE OPERATION

⚠WARNING

Insure that all tools and loose equipment have been removed prior to engine start-up. Sound horn prior to engine start. Make sure emergency shut down is reset. Cables must be free moving in their housings.

When all reconditioning operations have been completed, a static check of engine operation along with operation of systems as well as verification of braking and steering must be done before the vehicle is moved.



1. Insure all personnel are clear of Equipment before starting engine. Always sound the horn as a warning before actuating any operational controls.

⚠WARNING

Before starting engine, clear the immediate area of personnel and obstructions.

⚠WARNING

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

2. Turn key switch "On". Warning lights for low air, brake, and steering pressure should illuminate and the horn should sound. If it does not, check all components in the circuit (both air and electrical) and correct the discrepancy before continuing.

3. Turn key switch to start position to crank engine, release switch when engine fires. Watch engine oil pressure gauge; if pressure does not show in 10 - 15 seconds, shut down and locate problem. On air throttle engines, there will be no throttle control until air pressure builds, engine should run about 1000 RPM.

4. While engine is warming up, make a careful inspection of engine coolant, oil and fuel lines for leaks. Check hydraulic pump for leakage as well as all hydraulic lines.
   Mechanical Drive vehicles – Check transmission and retarder cooler lines and aftercooler for leakage. If leakage is evident, shut down and correct before continuing checkout. Listen for unusual sounds, which may indicate problems in components.

5. When engine is up to operating temperature, check operation of throttle circuit; acceleration should be smooth. Keep a close watch on the gauges for any abnormal activity. Proper temperatures and pressures are shown in the Operation and Maintenance Manual.

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AFTER ENGINE HAS STARTED

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

1. Become thoroughly familiar with steering and emergency controls. Test the steering in extreme right and left directions. If the steering system is not operating properly, shut engine down immediately. Determine the steering system problem and have repairs made before resuming operation.
2. Operate each of the brake circuits at least twice prior to operating and moving the machine. These circuits include individual activation of the service brake and parking brake from the operator's cab.
   a. Activate each circuit individually with the engine running and with hydraulic circuit fully charged.
   b. If any application or release of any brake circuit does not appear proper or if sluggishness is apparent on application or release, shut the engine down and notify maintenance personnel. Do not operate machine until brake circuit in question is fully operational.
3. Check gauges, warning lights and instruments before moving the machine to insure proper system operation and proper gauge functioning. Give special attention to braking and steering circuit warning lights. If warning lights come on, shut down the engine immediately and determine the cause.
4. Cycle hoist controls and steering several times to remove trapped air. Complete steering cycles in both directions to verify steering response, smoothness and reliability. Check seals and lines for leaks.
5. When satisfied that all discrepancies have been corrected, the vehicle is ready for a road test. This test should be done only by a capable and experienced operator and should be accomplished in a large open area where plenty of maneuvering room is available. Some of the road test items which should be covered will include:
   a. Repeated test of braking efficiency at progressively higher speeds. Start at slow speeds. Don't take chances with higher speeds until the machine is determined to be completely safe.
   b. Mechanical Drive vehicles –
   Progressive upshifting and downshifting through all speed ranges to insure proper transmission shifting and synchronization.
6. When all tests and checks have been made and the vehicle is ready for work, it should be visually rechecked and fully serviced according to Section "P", Lubrication and Service, of the Shop Manual.

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

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

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ENGINE STORAGE-CUMMINS

Engine Storage-(Short Term)

1 Month to 6 Months

This procedure describes the proper method for the short term storage of an engine.

Prepare the Engine for Short Term Storage

1. Operate the engine at "HIGH IDLE" until the coolant temperature is **160° F** (70° C).
2. Turn the engine "OFF".
3. Disconnect the fuel lines to the engine fuel filter and the injector return line.
4. Use a preservative oil. Use Dauber T Chemical NoxRust No. 518, or equivalent. The oil **must** meet Military Specification MIL-L-644, Type P-9.
5. Fill **two** containers, **one** with diesel fuel, and the **second** with preservative oil. Put both fuel lines in the container of diesel fuel.
6. "START" the engine.
7. After the engine is operating smoothly, transfer the fuel supply line to the container of preservative oil. Operate the engine until the preservative oil flows out of the injector return line.
8. Turn the engine "OFF". Connect the fuel lines to the fuel filter and the injector return line.
9. Drain the oil pan sump, oil filters, and fuel filters.
10. Install the drain plugs in the oil sump. The sump can remain empty until the engine is ready to be returned to service.

⚠WARNING

Put a warning tag on the engine. The tag must indicate:

- ***The engine does not contain oil.***
- ***Do not operate the engine.***

11. Disconnect the electrical wiring from the fuel pump solenoid.
12. Turn the fuel pump manual shutoff valve **counterclockwise** until it stops.
13. Crank the engine slowly. Spray lubricating oil into the intake manifold and the inlet of the air compressor.
14. Cover all of the openings with tape to prevent dirt and moisture from entering the engine.
15. Drain the coolant.

NOTE: It is not necessary to drain the coolant if it is a permanent type antifreeze with a rust inhibitor.

16. Store the engine in an area that is dry and has a uniform temperature.
17. Bar turn the Crankshaft two or three revolutions every 3 to 4 weeks.

Remove the Engine from Short Term Storage

1. Prime the lubricating system.
   Refer to Cummins Engine Shop Manual, (Section 14-01, Engine Run-in-Period).
2. Fill the coolant system if necessary.
3. Adjust the injector and the valve clearance. Refer to Cummins Engine Shop Manual, (Section 00-02, Engine Assembly).
4. Tighten the intake manifold mounting capscrews to specified torques, refer to the Cummins Service Manual for specifications.
5. Fill the oil pan sump, oil filters, and fuel filters with recommended lubricants and fuels..

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Engine Storage- (Long Term)

6 Months to 24 Months

This procedure describes the proper method for the long term storage of an engine.

Prepare the Engine for Long Term Storage

1. Operate the engine at "HIGH IDLE" until the coolant temperature is **160° F** (70° C).
2. Turn engine "OFF".
3. Drain the oil. Install the drain plugs. Use Shell 66202 or equivalent, preservative oil. The oil **must** meet Military Specification MIL-L-21260, Type P-10, Grade 2, SAE 30. Fill the engine to the "HIGH" mark.
4. Disconnect the fuel lines to the engine fuel filter and the injector return line.
5. Use Daubert Chemical NoxRust No. 518, or an equivalent preservative oil. The oil **must** meet Military Specification MIL- L- 644 Type P9.
6. Fill **two** (2) containers:
   one with diesel fuel,
   the **second** with preservative oil.
   Put both fuel lines in the container of diesel fuel.
7. "START" engine.
8. After the engine is operating smoothly, transfer the fuel supply line to the container of preservative oil. Operate the engine until the preservative oil flows out of the injector return line.
9. Turn the engine "OFF". Connect the fuel lines to the fuel filter and the injector return.
10. Drain the preservative oil from the engine oil pan sump, the air compressor and the oil filters.
11. Remove the **intake** and **exhaust** manifolds. Spray preservative oil into the intake and exhaust ports in the cylinder heads and in the manifolds.
12. Spray preservative oil in the intake port on the air compressor.
13. Use a rust preventative compound that meets Military Specification MIL-C-16173C, Type P-2, Grade 1 or 2. Brush or spray the compound on all of the exposed surfaces that are **not** painted.
14. Remove the rocker lever covers. Spray the rocker levers, the valve stems, the springs, the valve guides, the crossheads, and the push rods with preservative oil. Install the covers.
15. Cover all the openings with heavy paper and tape to prevent dirt and moisture from entering the engine.

⚠WARNING

Put a WARNING tag on the engine. The tag must indicate:

- ***The engine has been treated with preservatives.***
- ***Do not bar turn the crankshaft.***
- ***The coolant has been removed.***
- ***The date of treatment.***
- ***Do not operate the engine.***

16. Store the engine in an area that is dry and has a uniform temperature.

Remove the Engine from Long Term Storage

1. Use clean diesel fuel. Flush the fuel system until all of the preservative oil is removed.
2. Remove the plug from the main oil rifle passage. Use a hot, lightweight mineral oil.
   To flush all of the preservative oil from the engine: Bar the engine crankshaft three to four revolutions during the flushing procedure.
3. Fill the oil pan sump, oil filters, and fuel filters.
4. Drain the rust preventative compound from the cooling system. Fill the cooling system with coolant.
5. Prime the lubricating system.
   Refer to Cummins Engine Shop Manual, (Section 14-01, Engine Run-in-Period).
6. Adjust the injector and the valve clearance.
   Refer to Cummins Engine Shop Manual, (Section 00-02, Engine Assembly).
7. Tighten the intake manifold mounting capscrews.

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ENGINE STORAGE - DETROIT DIESEL

Preparing Engine For Storage

When an engine is to be stored or removed from operation for a period of time, special precautions should be taken to protect the interior and exterior of the engine and other parts from rust accumulation and corrosion. The parts requiring attention and the recommended preparations are given below.

It will be necessary to remove all rust or corrosion completely from any exposed part before applying a rust preventative compound.

Therefore, it is recommended that the engine be processed for storage as soon as possible after removal from operation.

The engine should be stored in a building which is dry and can be heated during the winter months. Moisture absorbing chemicals are available commercially for use when excessive damage prevail in the storage area.

Temporary Storage (30 Days Or Less)

To protect an engine for a temporary period of time, proceed as follows:

1. Drain the engine crankcase.
2. Fill the crankcase to proper level with the recommended viscosity and grade of oil.
3. Fill the fuel tank with the recommended grade of fuel oil. Operate the engine for two minutes at 1,200 rpm and no load. Shut down engine, do not drain the fuel system or the crankcase after this run.
4. Check the air cleaner and service it, if necessary, as outlined in Detroit Diesel Service Manual.
5. If freezing weather is expected during the storage period, add an ethylene glycol base antifreeze solution in accordance with the manufacturer's recommendations.
6. Clean the entire exterior of the engine (except the electrical system) with fuel oil and dry it with compressed air.

⚠WARNING

To prevent possible personal injury, wear adequate eye protection and do not exceed 40 psi (276 kPa) compressed air pressure.

7. Seal all of the engine openings. The material used for this purpose must be waterproof, vaporproof and possess sufficient physical strength to resist puncture and damage from the expansion of entrapped air.

An engine prepared in this manner can be returned to service in a short period of time by removing the seals at the engine openings, checking the engine coolant, fuel oil, lubricating oil, transmission oil and priming the raw water pump (if used).

Extended Storage (more Than 30 Days)

To prepare an engine for extended storage, (more than 30 days), follow this procedure:

1. Drain the cooling system and flush with clean, soft water. Refill with clean, soft water and add a rust inhibitor to the cooling system (refer to Corrosion Inhibitor under Coolant Specifications in Detroit Diesel Service Manual .
2. Remove, check and recondition the injectors, if necessary, to make sure they will be ready to operate when the engine is restored to service.
3. Reinstall the injectors, time them and adjust the exhaust valve clearance.

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4. Circulate the coolant by operating the engine until normal operating temperature is reached **160° - 185° F** (71° - 85° C).
5. Stop the engine.
6. Drain the engine crankcase, then reinstall and tighten the drain plug. Install new lubricating oil filter elements and gaskets.
7. Fill the crankcase to the proper level with a 30-weight preservative lubricating oil MIL-L-21260C, Grade 2.
8. Drain the fuel tank. Refill with enough clean No. 1 diesel fuel or pure kerosene to permit the engine to operate for about ten (10) minutes. If it isn't convenient to drain the fuel tank use a separate portable supply of the recommended fuel.

⚠WARNING

If engines in vehicle are stored where condensation of water in the fuel tank may be a problem, add pure, waterless isopropyl alcohol (isopropanol) to the fuel at a ratio of one pint to 125 gallons(473 L) of fuel, or 0.010% by volume. Where biological contamination of fuel may be a problem, add a biocide such as Biobor JF, or equivalent to the fuel. When using a biocide, follow the manufacturer's concentration recommendations, and observe all cautions and warnings.

9. Drain and disassemble the fuel filter and strainer. Discard the used elements and gaskets. Fill the cavity between the element and shell with No. 1 diesel fuel or pure kerosene, and reinstall on the engine. If spin-on fuel filters and strainers are used, discard the used cartridges, fill the new ones with No. 1 diesel fuel or pure kerosene, and reinstall on the engine.
10. Operate the engine for five (5) minutes to circulate the clean fuel oil throughout the fuel system.
11. Refer to Detroit Diesel Service Manual and service the air cleaner.
12. Turbocharger bearings are pressure lubricated through the external oil line leading from the engine cylinder block while the engine is operating. However, the turbocharger air inlet and turbine outlet connections should be sealed off with moisture resistant tape.
13. Apply a rust preventive compound to all exposed non-painted surfaces.
14. Drain the engine cooling system.
15. Drain the preservative oil from the engine crankcase. Reinstall and tighten the drain plug.
16. Remove and clean the batteries and battery cables with baking soda-water solution and rinse them with fresh water. Do not allow the soda solution to enter the battery. Add distilled water to the electrolyte, if necessary, and fully charge the battery. Store the battery in a cool (never below **32° F** or 0° C) dry place. Keep the battery fully charged and check the level and the specific gravity of the electrolyte regularly. Never set batteries on concrete floor. Place on wooded blocks.
17. Insert heavy paper strips between the pulleys and belts to prevent sticking.
18. Seal all engine openings, including the exhaust outlet, with moisture resistant tape. Use cardboard, plywood or metal covers where practical.
19. Clean and dry the exterior painted surfaces of the engine and spray with a suitable liquid automotive body wax, a synthetic resin varnish or a rust preventive compound.
20. Protect the engine with a good weather-resistant tarpaulin and store it under cover, preferably in a dry building with temperatures above freezing.

Detroit Diesel Corporation does not recommend the outdoor storage of engines. However, in some cases outdoor storage may be unavoidable. If units must be kept out-off-doors, follow the preparation and storage instructions already given. Protect units with quality, weather-resistant tarpaulins (or other suitable covers) arranged to provide air circulation.

⚠WARNING

Do not use plastic sheeting for outdoor storage. Plastic may be used for indoor storage. However, when used outdoors, moisture can condense on the inside of the plastic and cause ferrous metal surfaces to rust and/or pit aluminum surfaces. If a unit is stored outside for any extended period of time, severe corrosion damage can result.

The stored engine should be inspected periodically. If there are any indication of rust or corrosion, corrective steps must be taken to prevent damage to the engine parts. Perform a complete inspection at the end of one year and apply additional treatment, as required.

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PROCEDURE FOR RESTORING AN ENGINE TO SERVICE WHICH HAS BEEN IN EXTENDED STORAGE

1. Remove the covers and tape from all of the openings of the engine, fuel tank and electrical equipment. Do not overlook the exhaust outlet or the intake system.
2. Wash the exterior of the engine with fuel oil to remove the rust preventive.
3. Remove the rust preventive from the flywheel.
4. Remove the paper strips from between the pulleys and the belts.
5. Remove the drain plug and drain the preservative oil from the crankcase. Reinstall the drain plug. Then, refer to Lubrication System in Detroit Diesel Service Manual and fill the crankcase to proper level, using a pressure prelubricator, with the recommended grade of lubricating oil.
6. Fill the fuel tank with the fuel specified under Fuel Oil in Detroit Diesel Service Manual.
7. Close all of the drain cocks and fill the engine cooling system with clean soft water and a rust inhibitor. If the engine is to be exposed to freezing temperatures, fill the cooling system with an ethylene glycol base antifreeze solution refer to Coolant Specifications in Detroit Diesel Service Manual.
8. Install and connect the fully charged batteries.
9. Service the air cleaner as outlined in Detroit Diesel Service Manual.
10. Remove the covers from the turbocharger air inlet and turbine outlet connections. Refer to the lubricating procedure outlined in Preparation for Starting Engine First Time in Detroit Diesel Service Manual.
11. After all of the preparations have been completed, start the engine. The small amount of rust preventive compound which remains in the fuel system will cause a smoky exhaust for a few minutes.

NOTE: Before subjecting the engine to a load or high speed, it is advisable to check the engine tune-up.

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ELECTRIC DRIVE TRUCKS

Storage Instructions and Procedures

This instruction provides the recommended procedures for protecting equipment from damage during both short-term and long-term storage periods and for maintaining adequate protection while in storage. Also included are instructions for placing this equipment into service after having been stored.

For the purposes of this instruction, a short-term storage period is considered to be less than three months; a long-term storage period is considered to be three months or longer.

General Electric recommends a maximum storage period of three years, with these storage procedures being repeated after each year. After a storage period of three years or more, the Motorized Wheels should be removed and sent to an overhaul facility for teardown and inspection of seals and bearings. These should be replaced if necessary.

Periodic (every three months) inspections should be made to determine the lasting qualities of long-term storage protection measures. Such inspections will indicate the need for renewing protective measures when necessary to prevent equipment deterioration.

Proper storage of this equipment is vital to equipment life. Bearings, gears, and insulation may deteriorate unless adequate protective measures are taken to protect against the elements. For example, bearings and gears in the Motorized Wheel gear case are susceptible to the formation of rust; insulation in rotating electrical equipment can accumulate moisture; and bearings may become pitted.

⚠WARNING

NEVER APPLY ANY SPRAY, COATING OR OTHER PROTECTIVE MATERIALS TO AREAS NOT SPECIFICALLY RECOMMENDED .

It is also important to note that these instructions cannot possibly anticipate every type of storage condition and, therefore, cannot prevent all equipment deterioration problems caused by inadequate storage. However, these instructions should be considered as a minimum procedure to achieve the best possible equipment life and the lowest operating cost when the equipment is returned to service.

NOTE: Local conditions and/or experience may require ADDITIONAL procedures and/or additional storage precautions.

Placing Equipment Into Storage

Perform the following instructions when preparing General Electric equipment for storage. There are three main equipment categories to consider:

1. When storing a truck that is operational.
2. When storing a truck that is not operational.
3. When storing major components (Motorized Wheel, alternator, etc.).

These three major categories are the basis for determining required protective measures.

NOTE: In addition to these instructions, refer to truck storage instructions.

When Storing A Truck That Is Operational

When a fully operational truck is being placed into storage for less than three months, the best protective measure which can be taken is to drive the truck once a week for at least 30 minutes. Prior to driving the truck, the rotating equipment should be Meggered and:

1. If greater than 2 megohms, run normally.
2. If less than 2 megohms, isolate condition and correct before running.

Driving the truck circulates oil in the gear case to keep gears and bearings lubricated and free from rust. It also prevents deterioration of the brushes, commutators and slip rings.

When a fully operational truck is being placed into storage for three months or longer, and the truck **cannot** be operated weekly throughout the storage period as indicated above, perform the following instructions:

1. Drain the oil from the gear case and install rust preventive compound 4161 (product of Van Straaten Chemical Co.)or equivalent. Fill per General Electric Motorized Wheel Service Manual.
2. Megger the wheels as indicated in the instructions above. Operate the truck for at least 30 minutes to insure that the rust preventive compound has been thoroughly circulated throughout the gear case. Stop the truck and drain the rust preventive compound.

NOTE: Do not run a LOADED truck with rust preventive compound in Motorized Wheel gear cases.

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⚠WARNING

Do not operate trucks without oil in the Motorized Wheel gear cases.

3. Perform a megohmmeter test. Refer to the truck's Vehicle Test instructions for the correct procedure. Record the Megger readings for future reference. They will be helpful in determining if deterioration is being experienced when additional Megger tests are made as part of the periodic inspection.
4. Lift all brushes in the Motorized Wheels, blowers and the alternator. They must be removed from the brushholder. Disconnecting brush pigtails is not required.
5. Cover any open ductwork with screening material to prevent rodents from entering. Then tape over the screen to prevent the entry of water and dirt (allow breathing).
6. Examine all exposed machined surfaces for rust or other dirt accumulation. Remove all dirt as necessary. Remove rust by using a fine abrasive paper. Old flushing compound can be removed with mineral spirits (GE-D5B8). Methanol should be used to remove all residue. When clean, coat with Tarp B rust preventive.
   Refer to General Electric Motorized Wheel Service Manual for specifications.
7. Loosen exciter drive belts (where applicable).
8. Open all switches in the control compartment.
9. Install a 500 watt heat source inside all control groups which house electronic control equipment. These heat sources are to be energized below 32° F (0° C) and de-energized above 41° F (5° C).
10. Install a 500 watt heat source inside the commutator chamber of both Motorized Wheels and inside the alternator slip ring chamber. This will minimize the accumulation of moisture. A hole in the bottom of the hubcap will accommodate the electrical cord for the heat source in the Motorized Wheels. These heat sources are to be energized continuously.
11. Seal compartment doors with a weatherproof tape to prevent entry of rain, snow and dirt (allow breathing).

When Storing A Truck That Is Not Operational

When a truck which is not fully operational is being stored for a period of any length, perform the following:

1. Drain the oil from the gear case and install rust preventive compound 4161 (or equivalent). Fill per General Electric Motorized Wheel Service Manual.
2. Jack each side of the truck (one side at a time) enough to rotate the tires.
3. Connect a D-C welder as described in the Vehicle Test Instructions (Wheel Motor inst. 400A, arm & field in stress 900- 1000 rpm arm).
4. Rotate each Motorized Wheel (one at a time) for at least 30 minutes to insure that the rust preventive compound has been thoroughly circulated throughout the gear case. Disconnect the welder. Remove the jacks. Drain the gear case.
5. If the truck is partially dismantled, pay careful attention to ductwork, blower shrouds, etc., which may be exposed to weather conditions as a consequence. These areas will require the same sealing measures as in Step 5 above which deals with protecting ductwork. Cover exposed blower housings to prevent entry of water and dirt.
6. Perform Steps 3 through 11 under **When Storing a Truck that is Operational.**

When Storing A Major Component

When storing a Motorized Wheel, alternator, blower or control group for a period of any length, always store it inside a warm, climate-controlled environment. Do not attempt to store individual components where they would be exposed to inclement weather, climatic changes, high humidity and/or temperature extremes.

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Periodic Inspections

It is important that periodic inspections (every three months) of stored equipment be performed to insure the continued serviceability of all protective measures initially taken when the storage period began. Items which should be checked at each inspection interval are listed as follows:

1. Remove the weatherproof tape from the compartment doors and preform a Megger test as described in the Vehicle Test Instructions. Record the test results and compare them with the recorded Megger readings taken when storage first began, and those taken throughout the storage period. Remove all test equipment and close up the compartment. Reseal the compartment doors with new weatherproof tape. If Megger readings indicate a deterioration of insulation quality, to below 2.0 megohms then consideration should be given to providing more protection.
2. Check all other weatherproofing tape. Replace any that has become loose or is missing completely.
3. Check all heat sources. Replace or repair any units which have become inoperative.
4. Check all machine surfaces which were coated with flushing compound when storage began. If compound appears to be deteriorating, it must be cleaned off and renewed.

Placing Equipment Into Service After Storage

When taking equipment out of storage, perform the following procedures:

When A Truck Is Operational

If a truck has been operated weekly throughout the storage period, perform a complete visual inspection of the Motorized Wheels, blowers, alternator and control compartments. Repair any defects found, then place the truck directly into service.

When A Truck Is Not Operational

If the truck was not operated weekly throughout the storage period, perform the following procedures:

1. Remove all weatherproofing tape from control compartment doors and ductworks.
2. Remove all screening material from ductwork.
3. Remove all heat sources from Motorized Wheels, control compartments and the alternator.
4. Fill with recommended oil. Refer to the Motorized Wheel Service Manual for the type and amount oil to be used. This oil should be drained and new oil should be added after 500 hours of operation.
5. Clean all Motorized Wheel grease fittings in the axle box. Insure that all grease lines are completely full of grease. Then add the recommended amount of grease to all fittings.
6. Install brushes in the Motorized Wheels, blowers and the alternator. Make sure that brushes move freely in their carbonways and that they have enough length to serve until the truck's next inspection period. Install new brushes if necessary. Insure that all brush pigtail screws are tight.
7. Perform a megohmmeter test. Refer to the truck's Vehicle Test Instructions for the correct procedure. If Megger readings are less than 2.0 megohms, the problem could be an accumulation of moisture in motor or alternator. If this is the case, the faulty component will have to be isolated and dried out using procedures recommended in the G.E.Service Manual.
8. Perform a thorough inspection of the Motorized Wheels, alternator, blowers and control compartments. Look for:
   a. Rust or dirt accumulation on machine surfaces
   b. Damaged insulation
   c. An accumulation of moisture or debris
   d. Loose wiring and cables
   e. Any rust on electrical connectors in the control compartment
   f. Any loose cards in the card panels
   g. Any accumulation of moisture or debris in ductwork.

   Clean and make repairs as necessary.
9. Check retarding grids and insulators for loose connections and dirt accumulation. Clean and make corrections as necessary.
10. Where applicable, check exciter drive belts for cracks, and deterioration. If acceptable, set belt tension to specification.
11. Before starting engine, turn on control power. Check that contactors and relays pick up and drop out normally.
12. Perform a start-up procedure on the complete system to insure maximum performance during service. Refer to the truck's Vehicle Test Instructions for the complete test procedure.

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For The First Hour

After all storage protection has been removed, the truck has been cleaned and inspected and repairs made as necessary, the Motorized Wheel gear case has been filled with new oil, the dirt seals have been completely purged with new grease and the system completely checked, the truck can be placed into service. It is recommended, however, that the truck be **driven unloaded** at a low speed (10 mph) for the first hour of operation.

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PRESERVATION AND STORAGE
ALLISON TRANSMISSION

Storage, New Transmission

(Prior to installation). New transmissions are tested at Allison with preservative oil and drained prior to shipment. The residual oil remaining in the transmission provides adequate protection to safely store the transmission for up to one year (stored inside the conditions of normal climate and with all shipping plugs installed) without further treatment.

Preservation Methods. When the transmission is to be stored or remain inactive for an extended period (one or more years), specific preservation methods are recommended to prevent damage due to rust, corrosion, and organic growth in the oil. Preservation methods are presented for storage with and without transmission fluid.

Storage, One Year -- Without Oil

1. Drain the oil.
2. Spray two ounces (60 milliliters) of VCI #10 through the fill tube.
3. Seal all openings and the breather with moisture-proof tape.
4. Coat all exposed, unpainted surfaces with preservative grease such as petroleum (MIL-C-11796, Class 2).
5. If additional storage time is required, repeat steps (2), (3) and (4) at yearly intervals.

Storage, One Year With Oil (normally in a vehicle chassis)

1. Drain the oil and replace the oil filter element(s).
2. Fill the transmission to operating level with a mixture of one part VCI #10 (or equivalent) to 30 parts C-3 transmission fluid. Add 1/4 teaspoon of Biobor JF (or equivalent) for each 3 gallons (11 liters) of fluid in the system.

NOTE: When calculating the amount of Biobor JF required, use the total volume of the system, not just the quantity required to fill the transmission. Include external lines, filters, and the cooler.

3. Run the engine for approximately five minutes at 1500 rpm with the transmission in neutral.
4. Drive the vehicle. Make sure the transmission shifts through all ranges. Make sure the lockup clutch is working.
5. Continue running the engine at 1500 rpm with the transmission in neutral until normal operating temperature is reached.

⚠WARNING

If the unit does not have a converter-out temperature gage, do not stall the converter.

6. If normal operating temperature is less than **225° F** (107° C), shift the transmission to the highest forward range and stall the converter.
   When the converter-out temperature reaches **225° F** (107° C), stop the engine. Do not exceed **225° F** (107° C).
7. As soon as the transmission is cool enough to touch, seal all openings and the breather with moisture-proof tape.
8. Coat all exposed, unpainted surfaces with preservative grease such as petrolatum (MIL-C-11796, Class 2).
9. If additional storage time is required, repeat steps (2) through (8) at yearly intervals; except, it is not necessary to drain the transmission each year. Just add Motorstor and Biobor Jf (or equivalents).

Restoring Transmission to Service

1. Remove all tape from openings and the breather.
2. Wash off all external grease with mineral spirits.
3. If the transmission is new, drain the residual preservative oil. Refill the transmission to the proper level with C-4 transmission fluid.
4. If the transmission was prepared for storage without oil, drain the residual oil and replace the oil filter elements. Refill the transmission to the proper level with C-4 transmission fluid.
5. If the transmission was prepared for storage with oil, it is not necessary to drain and refill the transmission with new transmission fluid. Check for proper fluid level. Add or drain transmission fluid as required to obtain to proper level.

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STRUCTURAL COMPONENTS

LADDERS

A diagonally mounted ladder (7, Figure 2-1) provides an easy and safe path for the operator to mount and dismount the truck. In addition, a vertical ladder (6) is available if emergency exit from the cab is necessary. Anti-skid material is placed at various places on the decks and ladder platform area. Be certain this material is in good condition and replace when worn.

The diagonal ladder must be removed from the truck if it becomes necessary to remove the radiator or the complete power module for major repairs.

When removing the ladder(s), check to be certain all wiring and hoses which may be attached to the structure have been removed.

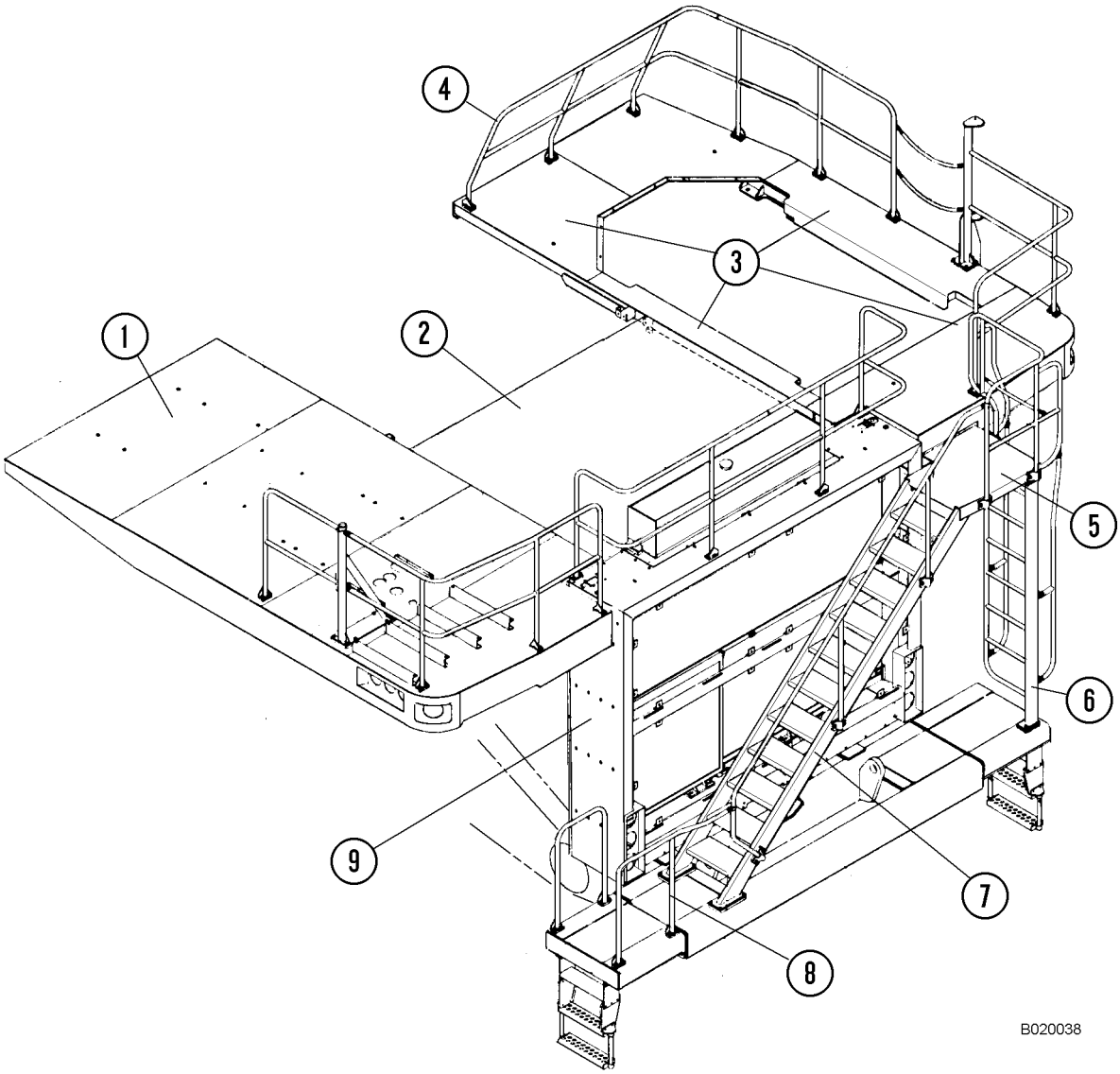


FIGURE 2-1. ACCESS LADDERS AND DECKS

1. Right Deck
2. Center Deck
3. Left Deck Components
4. Deck Handrail
5. Platform
6. Vertical Ladder
7. Diagonal Ladder
8. Ladder Handrail
9. Grille Structure

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Removal

1. Remove handrails (8, Figure 2-1) attached to diagonal ladder handrail and the platform.
2. Attach a lifting device to ladder structure (7).
3. Remove all attaching hardware and lift diagonal ladder from mounts.
4. If vertical ladder removal is necessary, attach a lifting device to ladder structure (6).
5. Disconnect ladder light wiring and any other wiring harnesses, hoses, etc. that may be attached.
6. Remove mounting hardware and lift ladder off truck.

Installation

Repeat above steps in reverse order for installation of components. Tighten all attaching hardware to standard torque values listed in Section “A”.

Reinstall all wiring and hoses removed and be certain all clamps are installed and secure.

RIGHT HAND DECK

The procedure below describes the sequence to follow for complete removal of all the right hand deck components. If complete disassembly is not required, select the appropriate steps for removal of the desired component. Additional removal of equipment, wiring, hoses etc. may be required depending on optional factory installed and field installed equipment.

Refer to figure 2-1 for location and nomenclature of parts described.

Removal

1. Open battery disconnect switch at battery box on right deck.
2. Remove clamps and electrical cables.
   a. Remove power cables routed to retarding grids (3, Figure 2-2).
   b. Remove cables from batteries.
   c. Remove all 24 volt wiring (clearance lights, ground straps, etc.) that will interfere with deck and ladder removal.
   d. Remove hoses or wiring routed to optional equipment; fire suppression system etc.

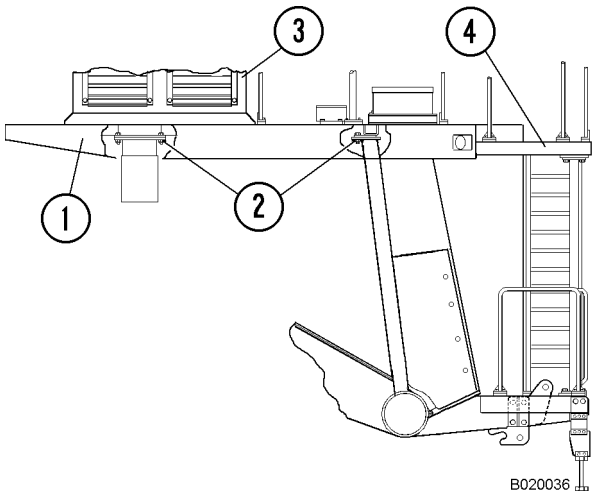


FIGURE 2-2. RH DECK MOUNTING

1. Right Deck Structure
2. Mounting Hardware
3. Retard Grid Package
4. Diagonal Ladder Structure

3. Attach overhead hoist to lifting eyes on grid package (3).
4. Remove hardware attaching grid package to the deck, lift assembly off deck and move to storage or work area.
5. Remove plugs covering deck mounting hardware (see Figure 2-2).
6. Attach lifting device to right hand deck, remove mounting hardware (2) and lift deck structure off supports.

Installation

Repeat above steps in reverse order for installation of components. Tighten all attaching hardware to standard torque values listed in Section “A”.

- Be certain all electrical connections and harness clamps are secure.
- Clean mounting surface before reinstalling ground cables.
- Replace plugs covering deck mounting hardware to prevent dirt accumulation.

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CENTER AND LEFT HAND DECK COMPONENTS

The center deck and left hand deck utilize several individual structures mounted on the main deck supports. Refer to Figure 2-1 for the location of individual sections.

- When removing center deck, be certain to check for and remove engine air inlet duct supports and any other wiring or hoses that may be attached.
- The deck supports and attachment points shown for the RH deck in Figure 2-2 are also typical of the LH deck mounts
- If cab removal is required, refer to Section “N” for removal instructions.

⚠WARNING

Before performing deck removal or repairs, be certain the battery disconnect switch is open and all hydraulic pressure has been released prior to removing any hoses, electrical harness connectors, etc.

⚠ IMPORTANT ⚠

The decks are covered with anti-slip surfaces. These surfaces must be kept clean and replaced as they become worn.

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FUEL TANK

Removal

1. Raise truck body and install body safety cables.
2. Drain sediment from tank and dispose of properly. Drain remainder of fuel into clean containers.
3. Disconnect fuel tank wire harness and remove clamps (9, Figure 2-4).
4. Remove ground wire (7).
5. Remove fuel supply (3, Figure 2-3) and return hoses (2) and plug to prevent contamination.
6. Remove hydraulic filter assembly (5) mounting hardware from fuel tank. Support filters by placing a chain over the frame rail. (It is not necessary to disconnect hydraulic hoses.)
7. Attach lifting device to tank lift eyes.
8. Remove capscrews (4, Figure 2-4), and flat washers (3).
9. Remove capscrews, lockwashers, and caps (1, Figure 2-3) from upper mounting brackets.
10. Lift tank from brackets and move to work area.
11. Inspect rubber dampeners (2, Figure 2-4) and replace, if necessary.

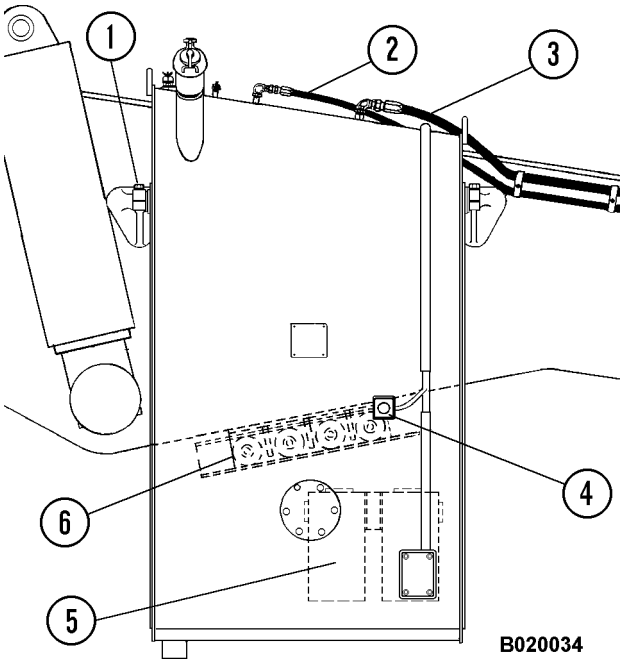


FIGURE 2-3. FUEL TANK

1. Upper Mount Trunnion
2. Fuel Return Hose
3. Fuel Supply Hose
4. Fuel Gauge
5. Hydraulic Filters
6. Lower Mounting Bracket

Installation

1. Lower tank into position over upper mounting brackets.
2. Install caps, lockwashers, and capscrews at upper mounting trunnions (1, Figure 2-3) and tighten to **459 ft. lbs. (622 N.m)** torque.
3. Install lower mount flatwashers (3, Figure 2-4) and capscrews (4) and tighten to **310 ft. lbs. (420 N.m)** torque.
4. Attach ground wire, connect wire harness and clamp in place.
5. Attach fuel supply (3, Figure 2-3) and return (2) hoses.
6. Attach hydraulic filter (5) assembly to fuel tank.
7. Refill tank with clean fuel.

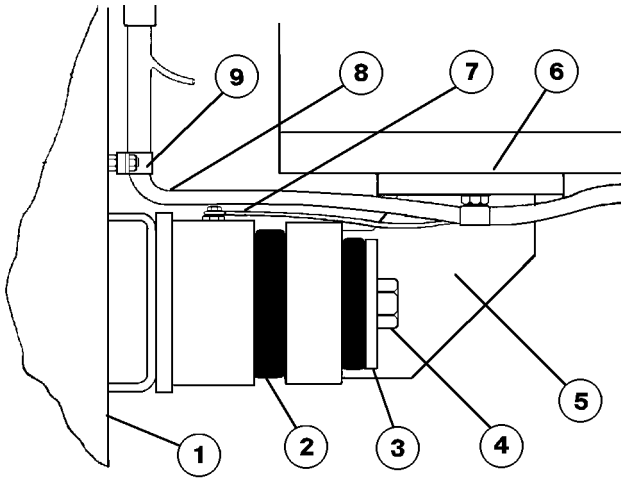


FIGURE 2-4. FUEL TANK MOUNTING BRACKET (Lower Mount)

1. Fuel Tank
2. Rubber Dampener
3. Flatwasher
4. Capscrew
5. Frame Bracket
6. Main Frame
7. Ground Wire
8. Wire Harness
9. Harness Clamp

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DUMP BODY

Removal

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 3-2.

⚠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.

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 3-3) 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).
5. Remove capscrews (4, Figure 3-1) from each pivot pin.

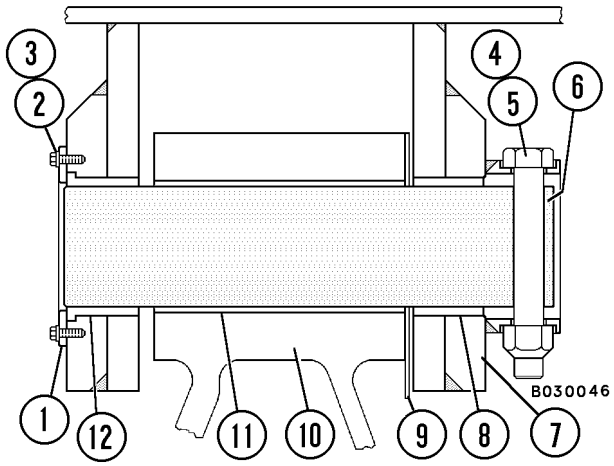


FIGURE 3-1 DUMP BODY PIVOT PIN

1. Retainer
2. Capscrew - M10
3. Lock Washer - M10
4. Capscrew - M36
5. Lock Nut - M36
6. Body Pivot Pin
7. Body Ear
8. Body Pivot Bushing
9. Shim
10. Frame Pivot
11. Pivot Bushing
12. Body Pivot Bushing

6. Remove body pivot pins (6) far enough to allow spacer (9) to drop out. Complete removal is not necessary unless a new pin is to be installed.
7. Lift dump body clear of the chassis and move to storage or work area. Block the body to prevent damage to the body guide etc.
8. Inspect bushings (8, 11, and 12) for excessive wear or damage. Replace as required.

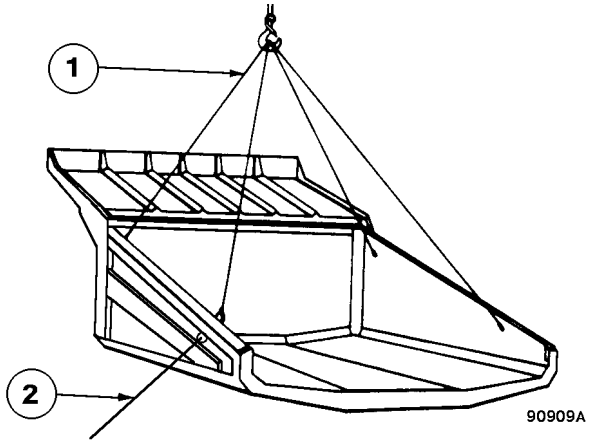


FIGURE 3-2. DUMP BODY REMOVAL

1. Lifting Cables
2. Guide Rope

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Installation

⚠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. Attach lifting device to dump body and lower over the truck frame. Align body pivot and frame pivot holes.
2. Install shims (9, Figure 3-1) in <u>both</u> body pivots, as required, to fill the <u>outside</u> gaps and center the body on the frame pivot. ***Do not install shims at the inside***.

A minimum of 1 shim is required at the outside end of <u>both</u> frame pivots.

3. If not already installed, install retainer (1) and capscrews (2) to hold bushing (12) in place. Tighten capscrews to **40 ft. lbs. (55 N.m)** torque.
4. Align the hole in pivot pin (6) with capscrew hole in pin retainer (part of body pivot ear, 7) and push the pivot pin through the shims (9), frame pivot (10), and into the pivot bushings (8, 12) in each side of the body pivot.
5. Install capscrew (4) through each pin and tighten the locknuts (5) to **407 N.m (300 ft. lbs.)** torque. Be sure locknuts (5) are in good condition.
6. Align hoist cylinder upper bushings with the hole through the body. With pin retaining capscrew hole and the retaining hole in dump body aligned, install the pin.
7. Install the pin retaining capscrews (4) and locknuts and tighten to **407 N.m (300 ft. lbs.)** torque. Be sure locknuts are in good condition.
8. Install mud flaps, rock ejectors, electrical cables and lubrication hoses.

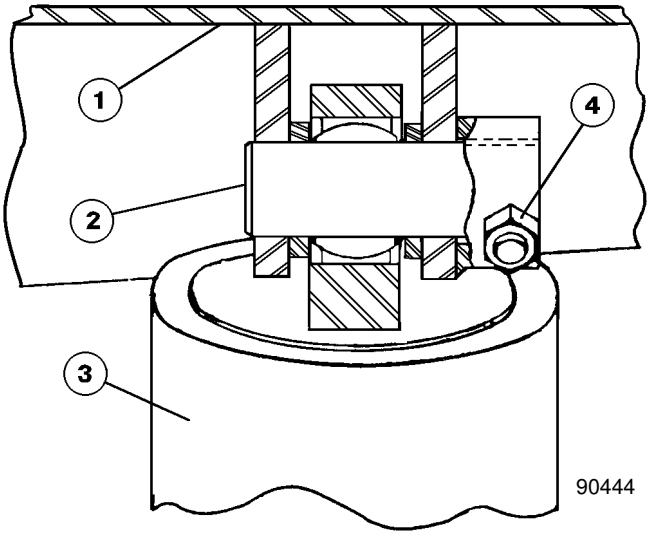


FIGURE 3-3. HOIST CYLINDER MOUNT (UPPER)

1. Dump Body
2. Hoist Cylinder Pin
3. Hoist Cylinder
4. Capscrew & Locknut

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BODY PADS

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

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

⚠WARNING

Place blocks between the body and frame. Secure blocks in place. Never work under a raised body unless safety device(s) are in position to prevent dump body from lowering.

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

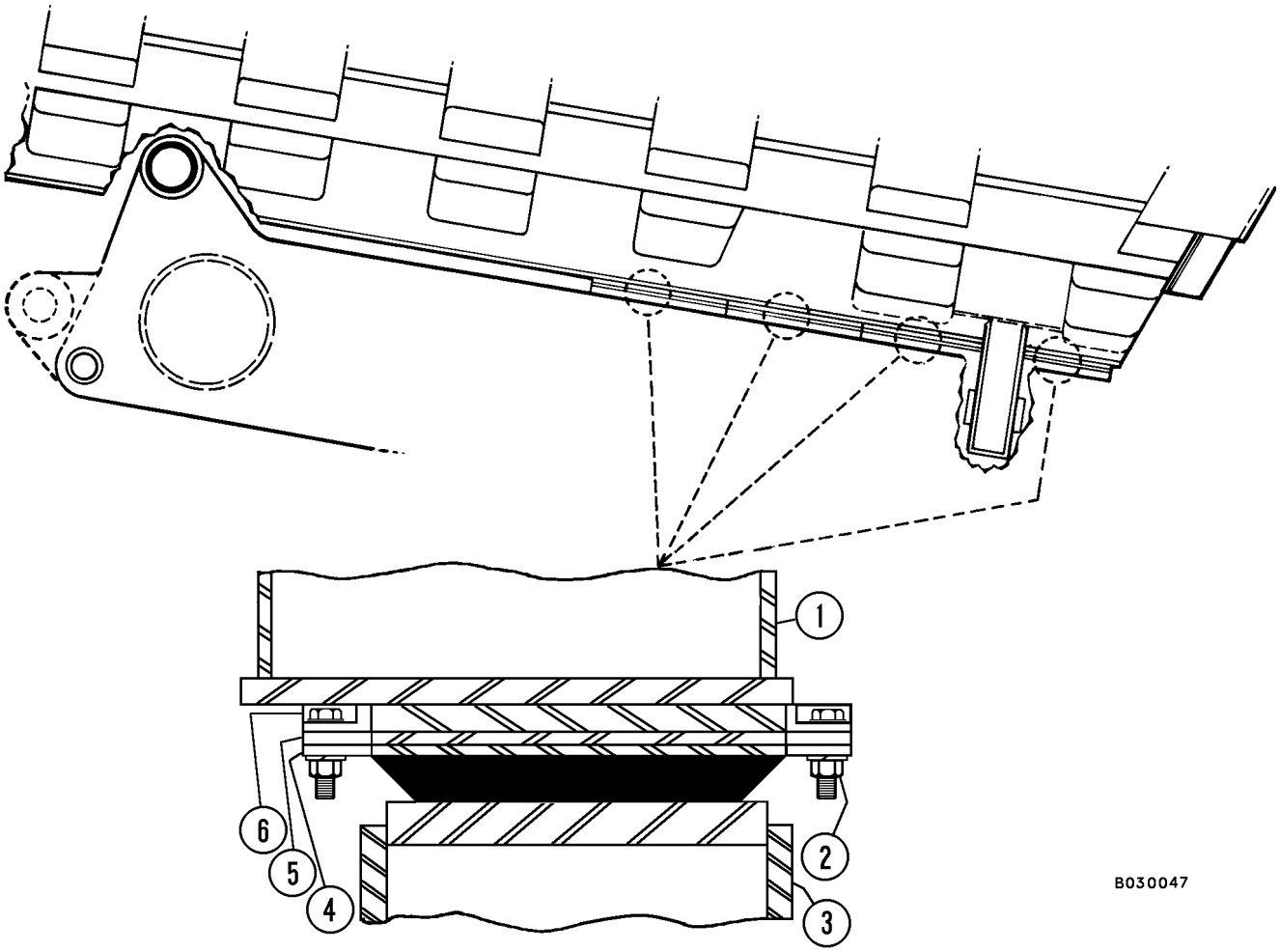


FIGURE 3-4. BODY PAD INSTALLATION

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

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Adjustment

1. Vehicle must be parked on a flat, level surface for inspection.
2. All pads, except the rear pad on each side, should contact the frame with approximately equal compression of the rubber.
3. A gap of approximately 0.06 in. (1.5 mm) is required at each rear pad. This can be accomplished by using one less shim at each rear pad.
4. If pad contact appears to be unequal, repeat the above procedure.

⚠ IMPORTANT ⚠

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

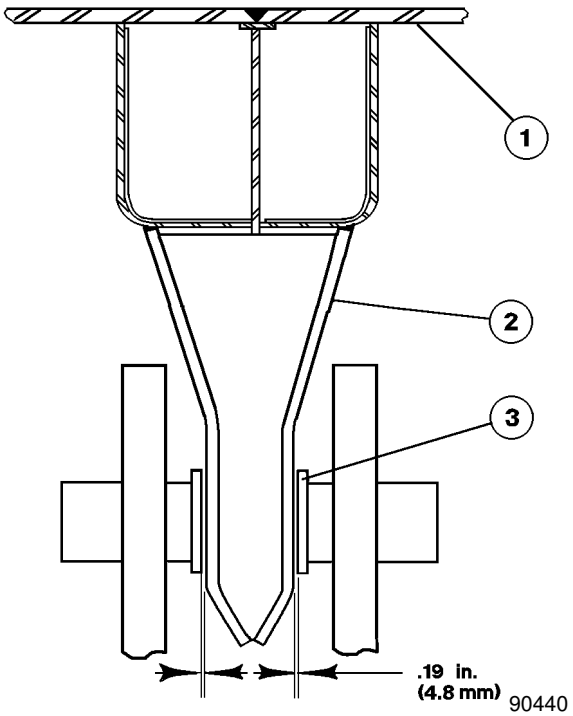


FIGURE 3-5. BODY GUIDE

1. Dump Body
2. Body Guide
3. Body Guide Wear Plates

BODY GUIDE

1. Body guide wear points should be inspected each time a body pad inspection is performed. (Refer to Figure 3-5.) The body guide should be centered between the wear plates (3), with a maximum gap of 0.19 in. (4.8 mm) at each side when new.
2. If gap becomes excessive, replacement parts should be installed. (Refer to the Parts Catalog.)

BODY-UP RETENTION CABLE

⚠WARNING

Any time personnel are required to perform maintenance on the vehicle with the dump body in the raised position, the body-up retention cable MUST be installed.

1. To hold the dump body in the up position, raise the body to its maximum height. (Refer to Figure 3-6.)
2. Remove the cable (3) from its stored position on the body and install between the Rear Body Ear (1) and the Axle Housing Ear (4).

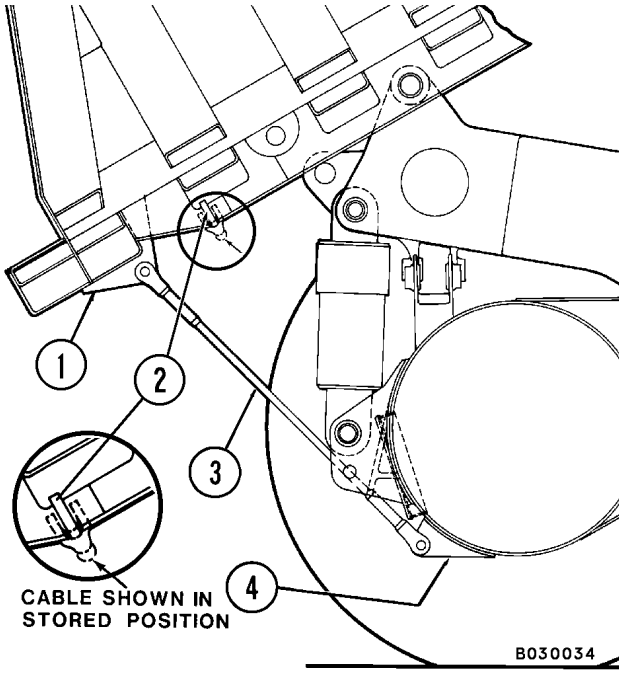


FIGURE 3-6. BODY-UP CABLE INSTALLATION

1. Rear Body Ear Structure
2. Cable Storage
4. Axle Housing Ear Structure

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3. Secure the cable clevis pins with cotter pins.
4. After maintenance work is completed, reverse the above procedure to remove cable assembly and place it in the storage position.

BODY POSITION INDICATOR

The Body Position Indicator is a device mounted on the canopy of the dump body. When the body is lowered, the indicator is visible to the operator. This device should be inspected daily and repairs made if required.

ROCK EJECTORS

Rock Ejectors are placed between the rear dual wheels to keep rocks or other material from lodging between the tires. Failure to maintain the Rock Ejectors could allow debris to build up between the dual wheels and cause damage to the tires.

Inspection

1. The ejectors must be positioned on the center line between the rear tires within 0.25 in. (6.35 mm).
2. With the truck parked on a level surface, the arm structure (Refer to Figure 3-7) should be approximately 3.50 in. (88 mm) from the wheel spacer ring (3) when hanging vertical.

NOTE: With rock ejector arm (1, Figure 3-8) hanging vertical as shown, there must be NO GAP at stop block (3). Adjust stop block as necesary to to obtain NO GAP.

3. If the arm (1) becomes bent, it must be removed and straightened.
4. The wear plates (2) must be replaced if severely worn.
5. Inspect the mounting brackets (4, Figure 3-8), pins (2) and stops (3) for wear and/or damage and repair as necessary.

HOIST LIMIT SWITCH

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

BODY UP SWITCH

Refer to Section "D", Electrical System (24VDC) for adjustment procedure of the body up switch.

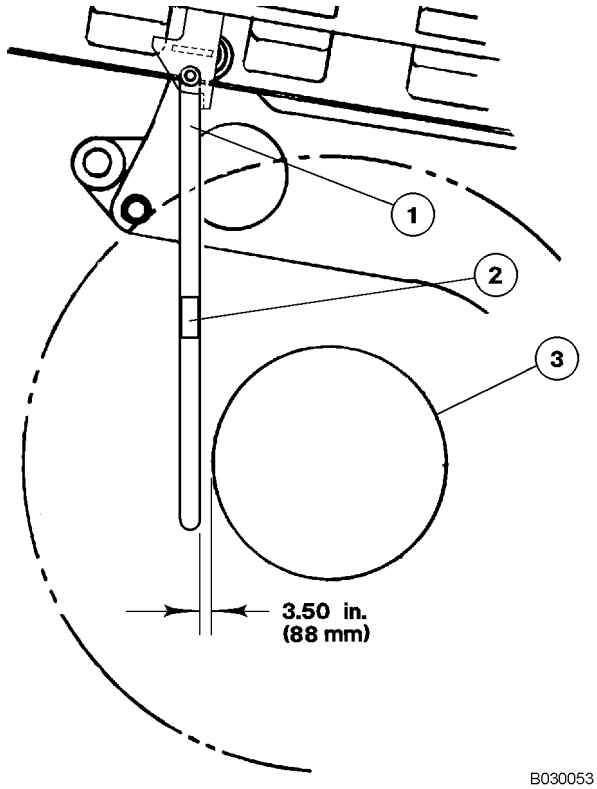


FIGURE 3-7. ROCK EJECTOR INSTALLATION

1. Rock Ejector Arm
2. Wear Plate
3. Rear Wheel Spacer Ring

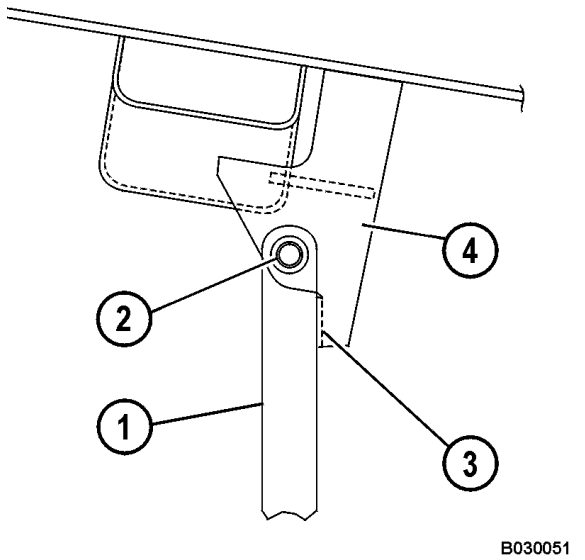


FIGURE 3-8. ROCK EJECTOR MOUNTING BRACKET (Detail View)

1. Rock Ejector Arm
2. Pin
3. Stop Block
4. Mounting Bracket

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NOTES:

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NOTES

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POWER MODULE

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

Although the instructions in this section are primarily based upon the “Rollout” method for major component removal, the radiator and fan may be removed as separate items. Instructions for radiator and fan removal are contained later in this section.

PREPARATION

⚠WARNING

The complete power module weighs approximately 36,950 lbs. (16 760 kg). Make sure lifting device to be used is of an adequate capacity.

1. Position the truck in a work area with a flat, level surface and adequate overhead clearance to permit raising the dump body.
2. Apply parking brake and block wheels to prevent truck movement. Raise body and install safety lock pin and body cable.

⚠WARNING

Do not work under raised body without first making sure the body lock pin and body cable is installed.

3. Tag or mark all air lines, oil lines, fuel lines and electrical connections to assure correct hookup at time of power module installation. Plug all ports and cover all hose fittings or connections when disconnected to prevent dirt or foreign material from entering.
4. It is not necessary to remove the grille or radiator prior to the removal of the power module. If radiator removal is desired or if only radiator repair is necessary, refer to “Cooling System” in this section.

Removal

1. Disconnect batteries using the following procedure in this order:
   a. Open battery disconnect switch located on battery equalizer box on deck of truck.
   b. Remove battery equalizer GND (-) terminal.
   c. Remove +12V (output) terminal at equalizer.
   d. Remove +24V (input) terminal at equalizer.
   e. Disconnect battery negative (-) terminal at battery box.
   f. Disconnect battery positive (+) terminal.
2. Disconnect hydraulic pump drive shaft (1, Figure 2-4) at the drive shaft U-joint companion flange.
3. Remove main alternator blower duct (Refer to Figure 2-1):
   a. Remove clamps and disconnect power cables from the rectifier diode and resistor panels (2, 3) located on the rear of the blower intake duct. Remove cover and disconnect cables (routed to main alternator) from front side of transition structure (5).
   b. Attach a lifting device to the rear center deck structure (4), remove attaching hardware and remove from truck.
   c. Remove clamps and disconnect air hose (6) at electrical cabinet and main alternator.
   d. Attach hoist to lifting eyes on blower inlet duct assembly. Remove hardware attaching duct to main alternator inlet. Remove hardware attaching upper duct mounts to electrical cabinet. Remove hardware attaching duct to deck at right and left sides.
   e. Recheck for any other cables or hoses and lift duct assembly from the truck. Cover all openings to prevent entrance of foreign material.

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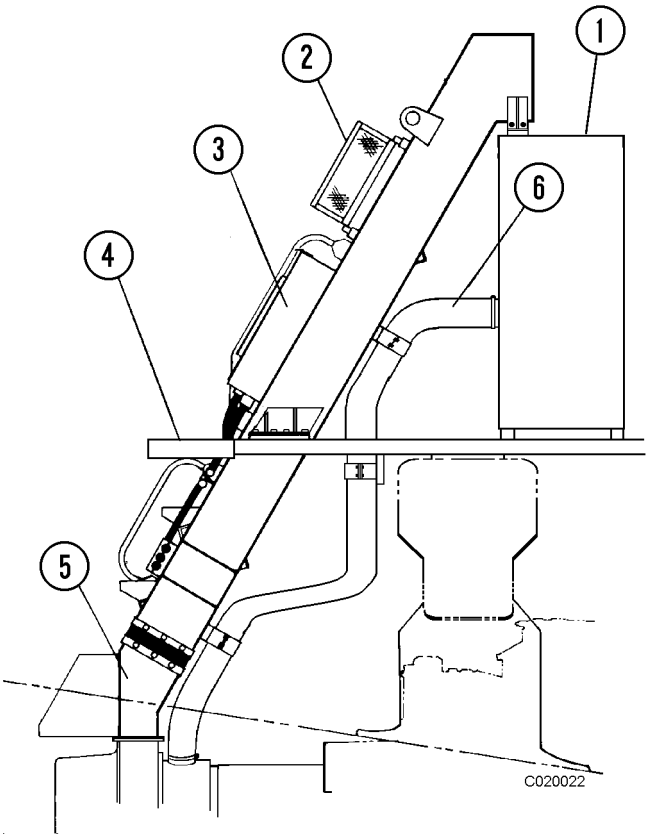


FIGURE 2-1. MAIN ALTERNATOR BLOWER DUCT

1. Electrical Cabinet
2. Resistor Panel (2)
3. Rectifier Diode Panel
4. Rear, Center Deck
5. Transition Str.
6. Air Hose

4. Remove clamp and remove the outlet hose to rear axle on the blower assembly.
5. Disconnect all (already marked) electric, air, oil and fuel lines that would interfere with power module removal. Cover or plug all lines and their connections to prevent entrance of dirt or foreign material. To simplify this procedure, most connections utilize quick disconnects.
6. Disconnect the air cleaner restriction gauge hoses. Disconnect electrical wiring and hoses etc. that would interfere with front center deck removal.
7. Remove air inlet duct support rods on underside of center deck.
8. Attach hoist to the front center deck. Remove all capscrews, flat washers, lockwashers and nuts securing the deck. Check for any remaining wiring, hoses or other items on underside of deck. Lift deck and remove from truck.
9. Close both cab heater shutoff water valves disconnect water lines and drain water from the heater core. Secure water lines away from engine compartment so as not to interfere with power module removal.
10. Remove capscrews (2, Figure 2-2) and nuts securing left (1) and right (3) exhaust ducts to turbocharger outlets. Remove “V” band clamps (5) and support clamps (4). Remove exhaust ducts and move clear of engine. Cover turbocharger exhaust openings to prevent entrance of foreign material.

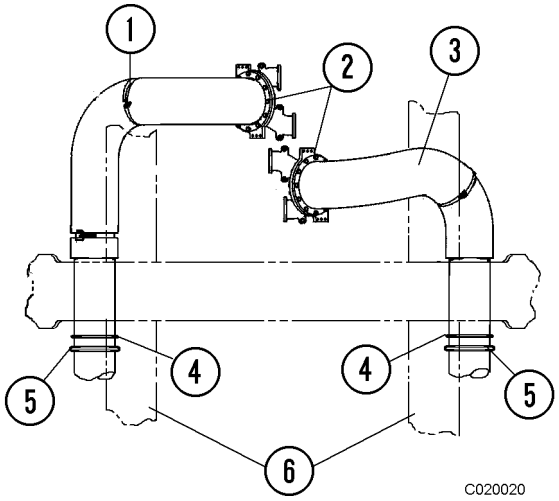


FIGURE 2-2. EXHAUST DUCTS
(Heated Body Exhaust & 2 Stage Turbochargers Shown)

1. LH Exhaust Duct
2. Capscrews
3. RH Exhaust Duct
4. Support Clamp
5. “V” Band Clamp
6. Frame Rails

11. Remove clamps (6, Figure 2-3) securing the air intake ducts (3) to turbochargers (4). Remove clamps at hump hoses (1). Remove air intake ducts and cover inlets on turbochargers and ducts to air cleaners.

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Note: Illustration shows engine equipped with two-stage turbochargers. Single stage turbocharger equipped engine ducts and supports are similar.

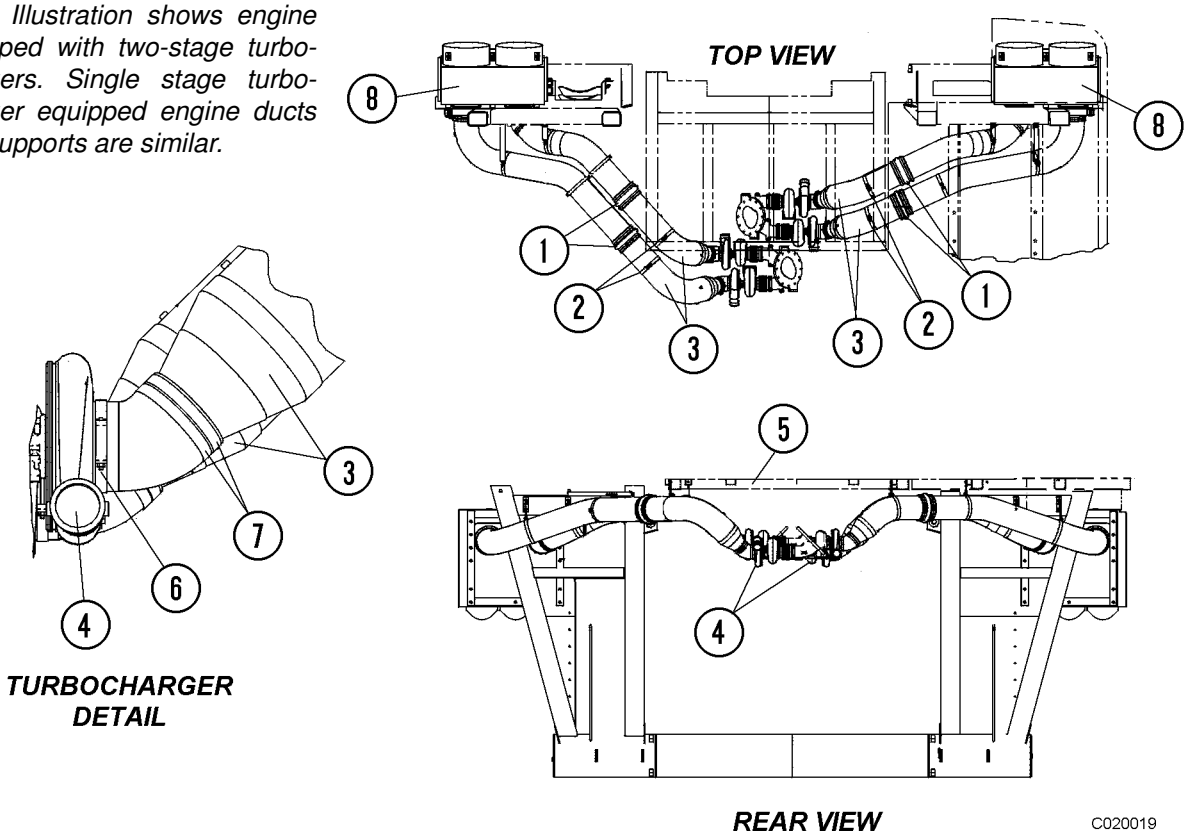


FIGURE 2-3. AIR INTAKE DUCTS

1. Hump Hose
2. Support Rods
3. Air Intake Ducts
4. Turbocharger
5. Center Deck Str.
6. Clamp
7. T-Bolt Clamp
8. Air Cleaner Assembly

12. Remove upper radiator support struts (12, Figure 2-4).
13. Disconnect grounding strap located near the front subframe mount.
14. Remove capscrews and washers securing cover (10, Figure 2-4) to grille at center of front bumper and remove. Remove capscrews and lockwashers (9) securing front subframe support to main frame.

⚠WARNING

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

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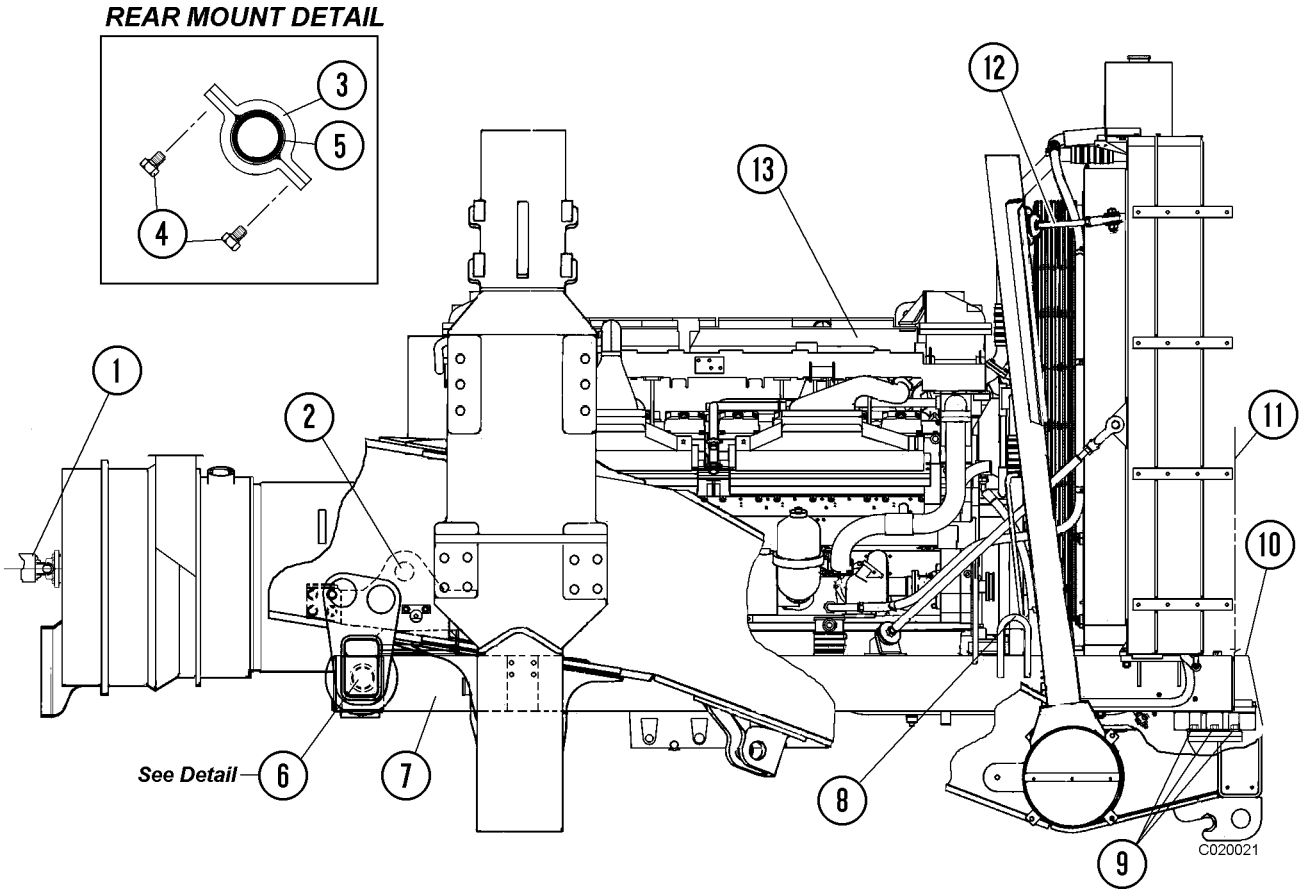


FIGURE 2-4. ENGINE MODULE INSTALLATION

1. Pump Driveshaft
2. Rear Module Lift Eye
3. Cap
4. Capscrews
5. Bushing
6. Rear Subframe Mount Bracket
7. Module Subframe
8. Front Module Lift Eye
9. Front Mount Capscrews
10. Cover
11. Grille Str.
12. Upper Radiator Support Rod
13. Engine

15. Remove capscrews (4, Figure 2-4) and caps (3) securing subframe mounting bushings to the subframe support bracket (6) at rear of subframe.

16. Check engine and alternator to make sure all cables, wires, hoses, tubing and linkages have been disconnected.

⚠WARNING

Only lift power module at the lifting points on subframe and engine/alternator cradle structure. (Refer to Figure 2-6.)

17. Attach hoist to lift points (2, Figure 2-4) at engine/alternator cradle structure. Raise the rear portion of engine subframe and install subframe rollers (Refer to Figure 2-5). Lower the rear portion of the subframe carefully until the rollers rest on the main frame guide rail.

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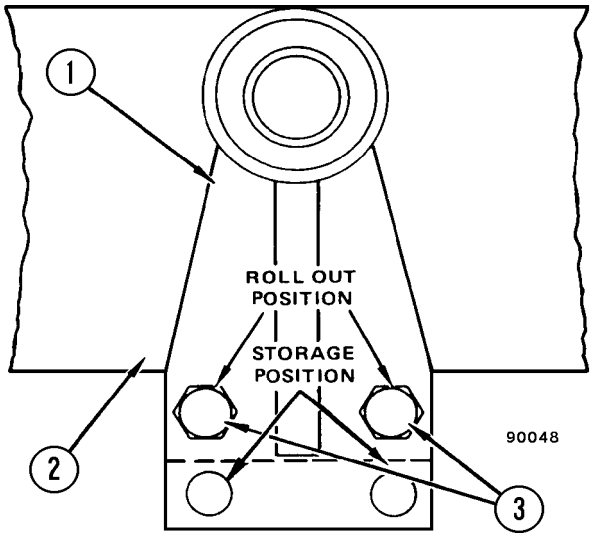


FIGURE 2-5. SUBFRAME ROLLERS

1. Roller Assembly
2. Subframe
3. Capscrews

NOTE: Subframe rollers are supplied in the truck tool group and can be installed in the storage position after use, as shown in Figure 2-5.

18. Reposition hoist to front subframe lifting points (8, Figure 2-4). Raise the engine subframe until the engine is on a level plane. Remove the safety chain.

⚠WARNING

The engine, alternator, radiator and subframe weigh approximately 36,950 lbs. (16 760 kg). Make sure the lifting device used is of an adequate capacity.

19. Roll the power module forward sufficiently so that adequate clearance is provided for the lifting device to be attached to the engine/alternator cradle structure and front subframe lifting points. Place stands or block under front of subframe and lower hoist until front of subframe is supported. Install safety chain to prevent subframe from rolling.
20. Attach lifting device to hoist and attach to engine/alternator cradle structure and front subframe lifting points as shown in Figure 2-6. Remove safety chain.

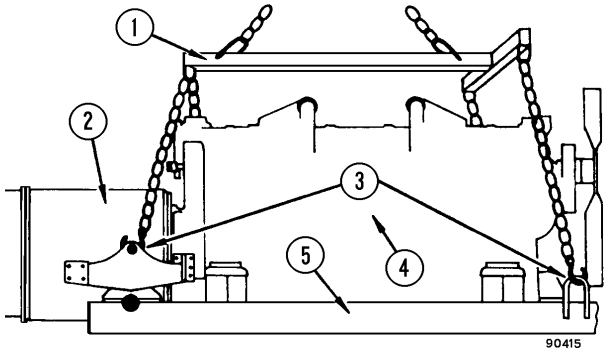


FIGURE 2-6. POWER MODULE LIFT POINTS

1. Module Lifting Tool
2. Main Alternator
3. Module Lift Points
4. Engine
5. Power Module Subframe

21. Raise the power module slightly to determine if module is on an even plane. Move the power module straight out of truck to a clean work area for disassembly.

For further disassembly of the engine, alternator, and radiator, refer to the appropriate section of this manual.

Installation

1. Inspect the main frame guide rails. Remove any debris which would interfere with power module installation.
2. Clean the main frame rear support brackets. Apply a light film of soap solution to each rubber bushing (5, Figure 2-4) located at the rear of the subframe.
3. Check the subframe rollers making sure they roll freely and are in the “roll-out” position. (Figure 2-5).
4. Attach a lifting device to engine/alternator cradle structure and front subframe lifting points. (Figure 2-6)

⚠WARNING

The complete power module weighs approximately 36,950 lbs. (16 760 kg). Make sure lifting device to be used is of an adequate capacity.

5. Raise the power module and align the subframe rollers within the main frame guide rails.

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6. Lower the power module to the subframe guide rails, relax the hoist slightly and roll the power module into truck frame until lifting chains contact frame crossmember.
7. Place stands or blocking under front of subframe to support assembly while repositioning hoist.
8. Install a safety chain around the truck frame and the front subframe cross member. The safety chain will prevent the power unit from rolling forward.
9. Place a small block behind each rear subframe roller to prevent rolling.
10. Lower hoist to allow subframe to rest on stands and rollers. Remove lifting device.
11. Attach hoist to front lifting eyes on subframe.
12. Remove the small blocks behind the subframe rollers, remove safety chain, and slowly roll the power module into position over the main frame mounts. Lower hoist until front subframe mount is aligned and seated on the front, main frame mount. Reinstall safety chain.
13. Relocate hoist to the rear portion of the engine/alternator cradle structure and raise just enough to permit removing the subframe rollers.
14. Lower the rear portion of the subframe until the subframe rubber bushings are seated in the rear mounting brackets located on the main frame of the truck.
15. After subframe is seated in frame mounts, the safety chain may be removed from the front subframe member.
16. Install capscrews (9, Figure 2-4) and lockwashers in the front mount and tighten capscrews to **220 ±22 ft. lbs. (298 ±30 N.m)** torque. Install ground strap between frame and subframe. Reinstall air dam. Install cover (10) if grille is installed.
17. Install the rear subframe mounting caps (3) and secure caps in place with lubricated capscrews (4). Tighten capscrews to **407 ±15 ft. lbs. (551 ±21 N.m)** torque.
18. Install radiator support struts (12).
19. Install exhaust ducts (1 & 3, Figure 2-2) Install capscrews (2) washers and nuts to secure ducts to turbochargers. Install “V” band clamps (5) and support clamps (4).
20. Connect the cab heater inlet and outlet hoses and open both valves.
21. Connect the hydraulic pump drive shaft (1, Figure 2-4) to the companion flange on the alternator. Tighten capscrews to standard torque.
22. Connect wheel motor cooling blower air outlet hose. Tighten all clamps securely to insure a positive air seal.
23. Lift main alternator blower intake duct into position and install hardware at mounts. (Refer to Figure 2-1)
    a. Install hardware at transition structure to blower inlet joint, electrical cabinet, and deck mounts.
    b. Install control cabinet air hose (6), electrical cables and any other hoses and wiring removed during power module removal.
    c. Lift rear, center deck structure (4) in place and install hardware.
24. Connect all remaining electric, oil, and fuel lines.
25. Attach hoist to the front center deck and lift into position. Align the rear center deck mounting holes with the support structure in front of the electrical cabinet. Install capscrews and flat washers. Do not tighten at this time.
26. Align the front center deck, front mounting holes with both left and right fender supports. Install capscrews and flat washers. Tighten all deck mounting capscrews to standard torque values.
27. Install air intake duct supports (2, Figure 2-3). Install engine air intake ducts (3). Position adjusters of adjacent T-bolt clamps 180° apart. Tighten clamps securely to insure a positive.
28. Connect the air filter restriction gauge hoses.
29. Connect the batteries as follows:
    a. Install battery positive (+) cable.
    b. Install battery ground (-) cable.
    c. Install battery equalizer +24V (input) terminal.
    d. Install equalizer +12V (output) terminal.
    e. Install equalizer GND (-) terminal.
    f. Close battery disconnect switch.
30. Service radiator and engine with appropriate fluids. Refer to Section “P”, *Lubrication and Service*, for capacity and fluid specifications.

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COOLING SYSTEM

COOLING SYSTEM DESCRIPTION

The standard 830E engine is a Komatsu model SDA16V1610 single stage turbocharged engine equipped with aftercoolers.

The engine cooling radiator assembly contains two cores; A “low temperature” core (2, Figure 3-1) is connected to the four aftercoolers (7). There are two aftercoolers located on each cylinder bank. This coolant is circulated by the engine’s LTA (Low Temperature Aftercooler) water pump (6). The LTA thermostats (4) begin to open at 115° F (46° C) and are fully open at 135° F (57° C).

A second, “high temperature” core (3), located at the rear of the radiator assembly is used for the engine coolant circuit. In this circuit, the engine water pump (10) circulates coolant through the engine block (9) (heads, liners, internal oil coolers etc.). The engine coolant thermostats (5) begin to open at 180° F (82° C) and are fully open at 202° F (94° C).

In addition, a fuel cooler, located on the lower right corner of the radiator assembly reduces fuel temperature after fuel leaves the engine, before it is returned to the tank. The air conditioning system refrigerant condenser is mounted on the lower left corner of the radiator assembly.

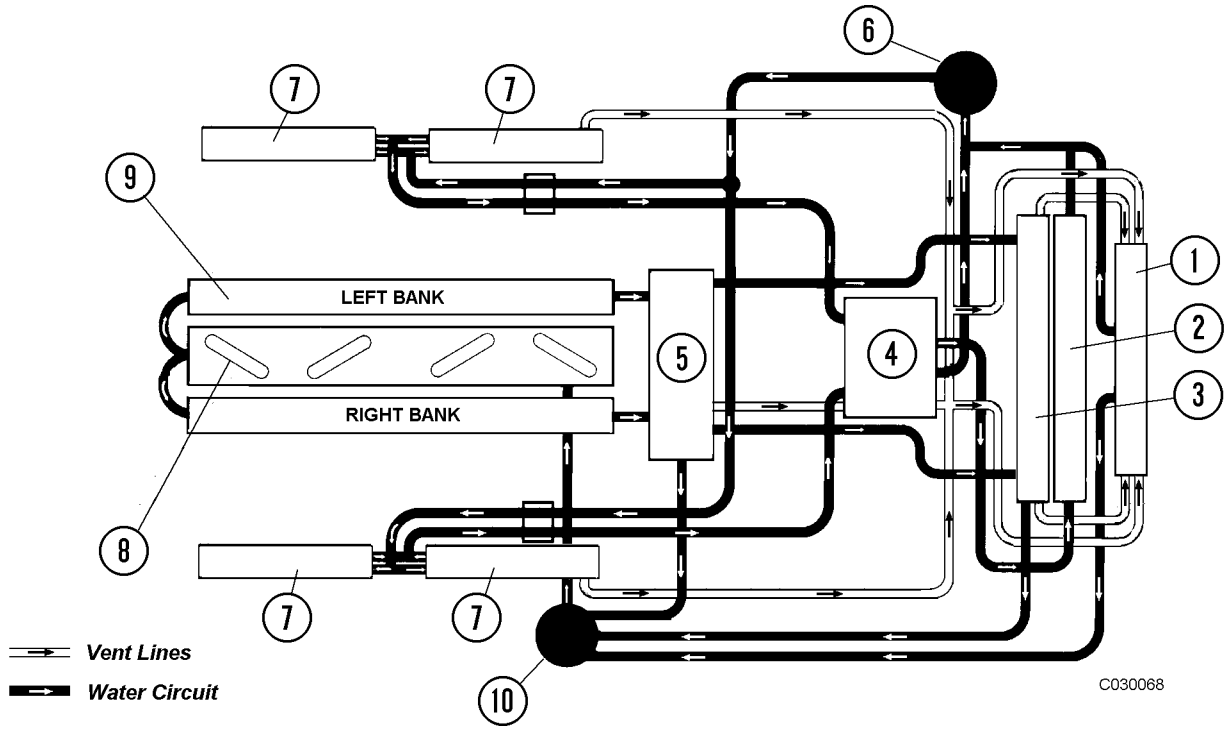


FIGURE 3-1. COOLING SYSTEM DIAGRAM

1. Surge/Fill Tank
2. Low Temperature Core (LTA)
3. High Temperature Core
4. Low Temperature Thermostats
5. Engine (Hi Temp) Thermostats
6. LTA Circuit Water Pump
7. Aftercooler
8. Engine Oil Coolers
9. Engine Block (Heads, Liners)
10. Engine Circuit Water Pump

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RADIATOR

Removal

1. Place battery disconnect switch in the “OFF” position.
2. Release pressure from cooling system and drain coolant.
3. Remove cover (7, Figure 3-2) protecting surge tank (1).

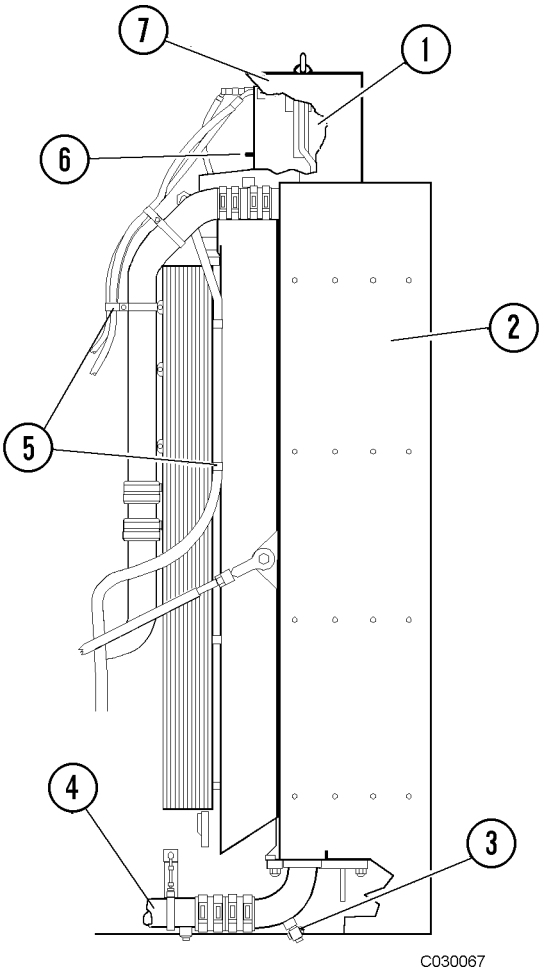


FIGURE 3-2. GRILLE INSTALLATION

1. Surge Tank
2. Grille Structure
3. Coolant Drain Cock
4. Water Pump Inlet
5. Clamp
6. Coolant Level Probe
7. Surge Tank Cover

4. Disconnect surge tank vent hoses and electrical cable attached to coolant level probe (6). Remove clamps (5) securing hoses and electrical cables to fan shroud, tubes and support rods.

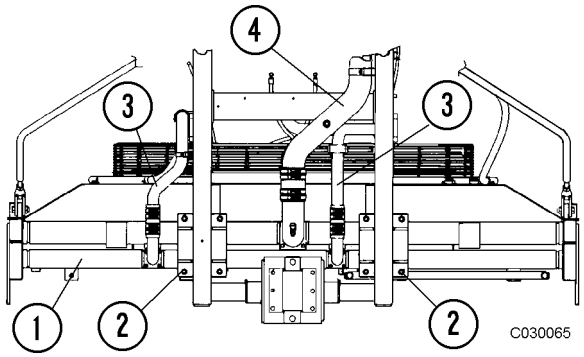


FIGURE 3-3. RADIATOR PIPING AND MOUNTS
(Viewed from Below)

1. Radiator Assembly
2. Mount Hardware
3. Low Temp Core Tubes
4. High Temp Core Tubes

5. Loosen clamps and remove coolant piping at upper and lower radiator tanks. Refer to Figure 3-2 and 3-4).
6. Remove fan guard (2, Figure 3-4) from shroud:
   a. Guard can be completely removed from the truck by separating the halves and removing.
   b. If complete removal is not necessary, remove hardware attaching guard to shroud and slide assembly toward the engine and allow it to hang on the fan clutch.
7. Grille structure (2, Figure 3-2) removal:
   a. Remove lower left grille section for access to condenser hoses.
      1.) Attach an air conditioner manifold gauge set at the compressor. (Refer to *“Heater/ Air Conditioning”* in Section, “M”, for detailed information.)
      2.) Completely evacuate the refrigerant from the air conditioning system.

NOTE: Follow all local laws concerning the evacuation and handling of refrigerants.

      3.) After system is evacuated, remove hoses from condenser and cap all openings to prevent contamination. Unclamp hoses and remove from radiator area to prevent interference when radiator is removed.
      4.) Disconnect hoses and pressure switch at receiver/drier located on fan shroud.
   b. Remove lower right grille section and disconnect hoses from fuel cooler.

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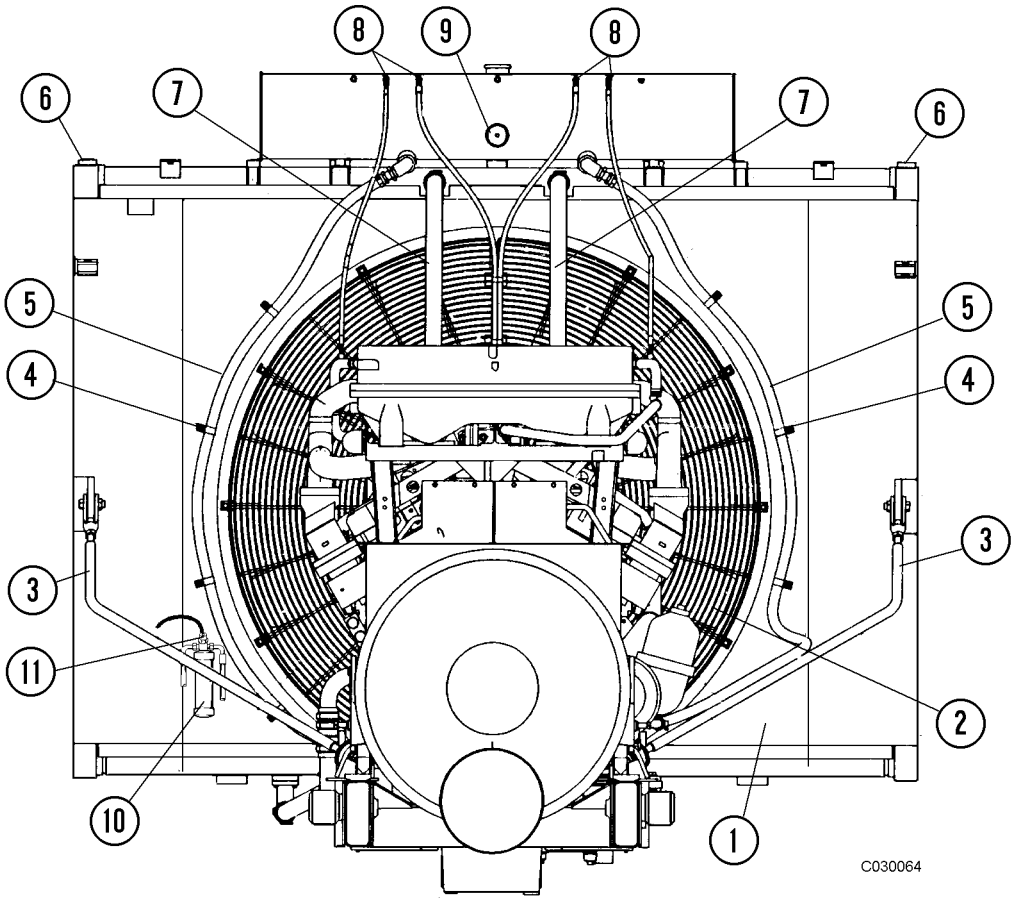


FIGURE 3-4. RADIATOR AND SHROUD (Rear View)

1. Shroud
2. Fan Guard Str.
3. Support Rod
4. Clamp
5. Hose
6. Lift Points
7. Upper Tubes
8. Vent Hoses
9. Level Sensor
10. Receiver/Drier
11. Pressure Switch

c. Disconnect headlight wire harness at each light. Remove cable clamps and remove harness to allow radiator removal.

d. Remove hardware attaching grille structure to radiator assembly, attach overhead crane, and lift slightly. Move grille structure forward to clear radiator assembly.

8. Install lift eyes (included in truck tool group) in tapped blocks (6, Figure 3-4) at upper corners of radiator assembly and attach overhead crane.

WARNING

The radiator assembly weighs approximately 4,200 lbs. (1907 kg.) Be sure lifting device is capable of lifting the load.

9. Remove radiator support struts (3), upper support rods, and hardware (2, Figure 3-3) attaching radiator assembly to power module subframe.

10. Lift radiator enough to separate from mounts on subframe and move forward until shroud clears the engine fan.

Do not allow shroud to contact fan blades.

11. Move assembly to a work area and remove hardware attaching shroud to radiator assembly. Remove air conditioner condenser and fuel cooler.

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Service

Radiator service is a specialized function usually not accomplished by most maintenance shops. The large size and weight of the off-road truck radiators requires that a radiator repair shop equipped with special tools and handling equipment be used for service and repair.

Installation

1. Reinstall shroud (1, Figure 3-4), air conditioner condenser, and fuel cooler. Install air conditioner receiver/drier (10) if removed.

⚠WARNING

The radiator assembly weighs approximately 4,200 lbs. (1907 kg.) Be sure lifting device is capable of lifting the load.

2. Attach lifting eyes in tapped blocks at upper corners of radiator assembly (6, Figure 3-4). Attach hoist and lift into place on power module subframe.
3. Position radiator assembly to equalize gap between tip of fan blades and shroud at right and left sides. Install mounting hardware (2, Figure 3-3) through lower mounts and tighten to **220 ft.lbs. (298 N.m)** torque.
4. Install radiator support rods (3, Figure 3-4). If necessary, adjust to position radiator perpendicular to the subframe. Tighten the support strut locknuts. Install upper support rods to brackets on front upright supports.
5. Adjust fan shroud ring vertically to equalize gap between tip of fan blades and ring.
6. Lift grille structure (2, Figure 3-2) into position and install mounting hardware.
7. Route headlight wire harness to lights. Attach connectors to lights and clamp harness at weld studs.
8. Install upper and lower radiator piping. Seat hoses and clamps securely.
9. Position fan guard against shroud and tighten mounting hardware to **40 ft.lbs. (55 N.m)** torque. (If halves of guard were disassembled, tighten capscrews clamping halves together to **25 ft.lbs. (34 N.m)** torque.
10. Attach hoses to fuel cooler.
11. Route A/C condenser hoses to condenser and attach. Install lower grille sections. Install receiver/drier (10) hoses. Connect pressure switch (11).
12. Install surge tank hoses and electrical wiring to the coolant level probe (9, Figure 3-4). Clamp hoses and electrical cables to the shroud. Install surge tank cover.
13. Make sure all coolant drains are closed, hoses are installed, and all wiring reconnected. Close drain valve on main air tank.
14. If the truck is equipped with air conditioning, the system must be evacuated and recharged. Refer to “Heater/Air Conditioning System” in Section M for detailed instructions for recharging with refrigerant.
15. Service the cooling system per the instructions below.
16. Check for static leakage and correct any leaks. After servicing is complete, start the engine and run until normal operating temperature is reached. Repeat check for leaks and correct as required.

RADIATOR FILLING PROCEDURE

⚠WARNING

Cooling System is pressurized due to thermal expansion of coolant. DO NOT remove radiator cap while engine and coolant are hot. Severe burns may result.

1. With engine and coolant at ambient temperature, remove radiator cap.

*Note: If coolant is added using the Wiggins quick fill system, the radiator cap **MUST** be removed prior to adding coolant.*

2. Fill radiator with proper coolant mixture (as specified by the engine manufacturer) until coolant is visible in the sight gauge.
3. Install radiator cap.
4. Run engine for 5 minutes, check coolant level.
5. If coolant is not visible in the sight gauge, repeat steps 1 through 4. Any excess coolant will be discharged through the vent hose after the engine reaches normal operating temperature.

Engine coolant must always be visible in the sight gauge before truck operation.

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POWER TRAIN

ALTERNATOR REMOVAL PROCEDURE

Removal (Komatsu SSDA16V160 or SDA16V160 Engine)

The following instructions cover the removal of the main alternator from the engine after the power module has been removed from the truck. (Refer to Figure 4-2.)

⚠WARNING

When lifting alternator, attach hoist to lift eyes only. The alternator weighs approximately 7,700 lbs. (3493 kg). Use a lifting device that can handle the load safely.

1. Attach hoist with two lifting chains to the alternator lifting eyes (7, Figure 4-2).
2. Block under rear of engine
   a. Loosen cradle adjustments setscrews (3, Figure 4-1).
   b. Loosen engine/cradle capscrews (3, Figure 4-2).

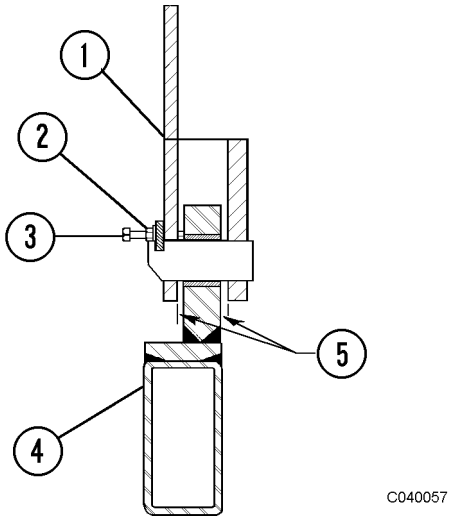


FIGURE 4-1. CRADLE STRUCTURE

1. Cradle Structure
2. Jam Nut
3. Adjustment Setscrew
4. Subframe
5. Gap

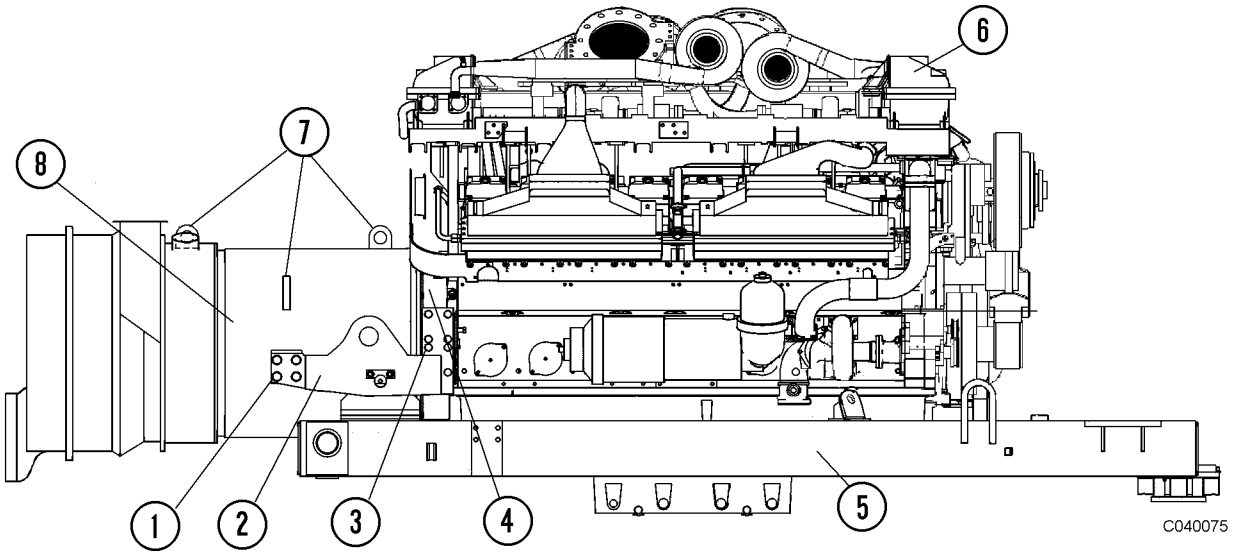


FIGURE 4-2. ENGINE AND ALTERNATOR

1. Capscrews and Lockwashers
2. Cradle Structure
3. Capscrews
4. Flywheel Housing
5. Subframe
6. Engine
7. Alternator Lift Eyes
8. Alternator/Blower

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3. Remove access covers at front, right side of the engine flywheel housing. Install engine barring tool as shown in Figure 4-3.

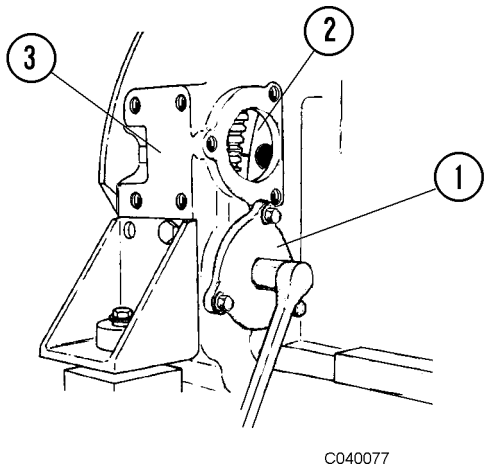


FIGURE 4-3. ACCESS TO ALTERNATOR/ ENGINE DRIVE RING CAPSCREWS

1. Engine Barring Tool
2. Access Hole
3. Flywheel Housing

4. Reach through the access opening and remove twelve [12] capscrews (6, Figure 4-4) joining the engine drive ring (7) to the alternator rotor (8). (Rotate crankshaft with barring tool to align each capscrew with access hole.)

⚠ IMPORTANT ⚠

Be certain all capscrews have been removed!

5. Remove sixteen [16] capscrews (3) securing flywheel housing adapter (2) to the alternator housing (1).

NOTE: The clearance between the head of the capscrew (3) and the Flywheel Housing (4) will not permit complete removal of the capscrews at all locations. Be sure all the capscrew threads are completely disengaged from the alternator housing (1).

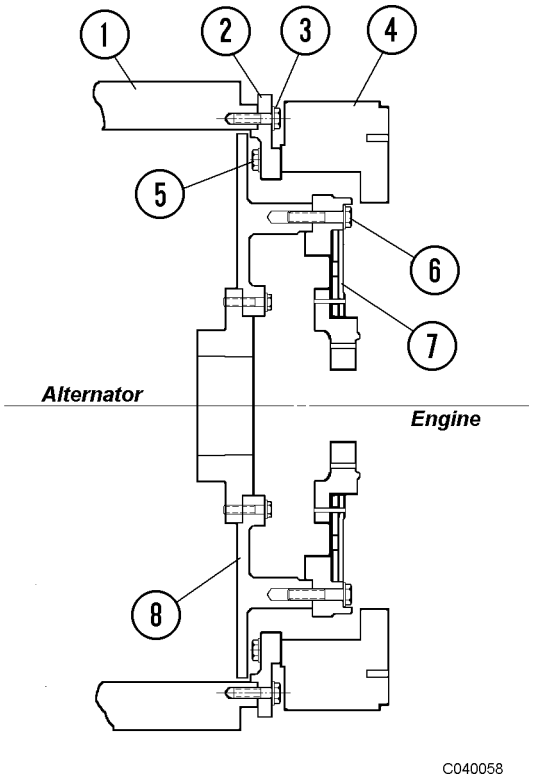


FIGURE 4-4. ALTERNATOR TO ENGINE MOUNTING

1. Alternator
2. Flywheel Housing Adapter
3. Capscrew (16 each)
4. Flywheel Housing
5. Capscrew
6. Capscrew (12 each)
7. Engine Drive Ring
8. Alternator Rotor

6. Take up slack in hoist and remove capscrews and lockwashers (1, Figure 4-2) securing the alternator to the cradle structures.
7. Keep alternator as level as possible and move away from engine.
8. Note shim location and quantity. Retain shims for possible use during reinstallation.
9. For further disassembly instructions for the alternator refer to the General Electric Service Manual.

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ENGINE/ALTERNATOR MATING

Komatsu SSDA16V160 or SDA16V160 Engine

⚠ 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 belt 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** for Komatsu SSDA16V160 **or SDA16V160**
  Engine: 0.005 - 0.015 in. (0.13 - 0.38 mm).

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

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 0.005 - 0.015 in. (0.13 - 0.38 mm).

*Record Total Crankshaft End-play:*_____

3. Refer to Figure 4-5. 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”:*_____

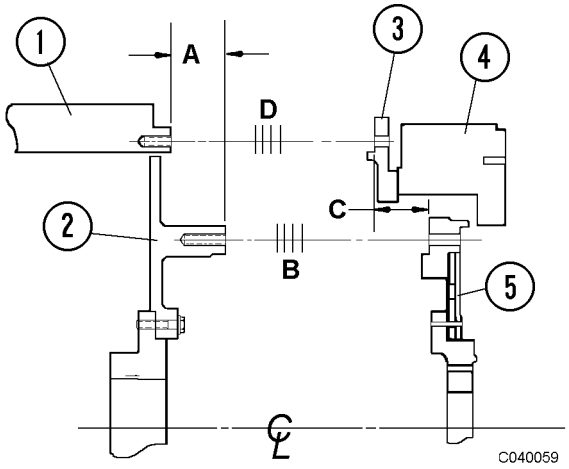


FIGURE 4-5. SHIM LOCATION

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

“A”: Dimension “A”
“B”: Dimension “B”
“C”: Dimension “C”
“D”: Dimension “D”

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4. Refer to Figure 4-6. Alternator End-play:
   a. Using a flat steel bar (3, Figure 4-6) bolted rigidly to the alternator rotor (2), install a 5/8" - 11 capscrew (4) at each end into the alternator housing (1). Leave capscrews finger-tight.
   b. Move the alternator rotor (2) axially towards the rear (slip-ring end) by alternately tightening the capscrews (4) one-half-turn-at-a-time. Do NOT exceed **12.0 ft. lbs. (16.3 N.m)** torque on each capscrew. This establishes the maximum permissible rear travel for the alternator rotor.
   c. Alternately loosen the capscrews (4) one-turn-at-a-time, until all torque is released. Carefully remove the bar (3).
   Note: The object is to leave the rotor in its most rearward position.

Refer to Figure 4-5.

   d. Carefully measure Dimension “A” (Do not move alternator rotor) at four locations, 90° apart, and average the measurements.

*1st measurement:*_____

2nd measurement: _____

3rd measurement: _____

*4th measurement:*_____

Dimension “A”: _____ *Average*

   e. Add 0.010" to Dimension “A”.
   f. Record (d + e) as;

*“Measurement A”:*_____

5. Determining Shims: Compare “Measurement C” (Step 3.c.) with “Measurement A” (Step 4.f.).
   a. If C is greater than A, subtract: (C - A) = B
   B = _____ Shim pack thickness to be installed at location “B”, Figure 4-5.

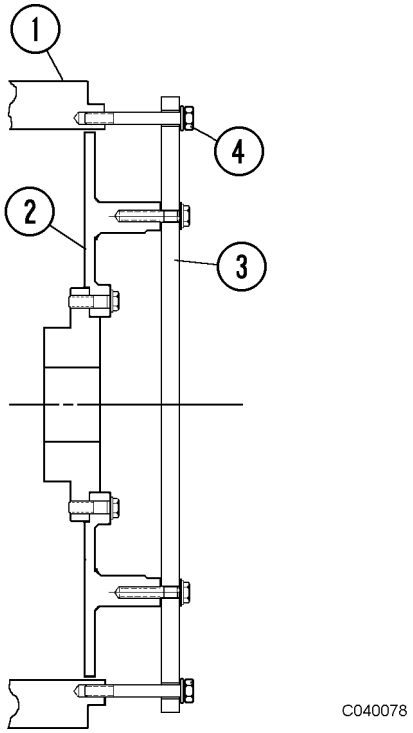


FIGURE 4-6. ALTERNATOR END-PLAY

1. Alternator Housing
2. Alternator Rotor
3. Steel Bar
4. Capscrew

   b. If A is greater than C, subtract: (A - C) = D
   D = _____ Shim pack thickness to be installed at location “D”, Figure 4-5.

Rotor-to-Drive Ring, Location “B”	
Shim Part Number	Shim Thickness
TM3467	0.004 in. (0.102 mm)
TM3469	0.007 in. (0.178 mm)

Alternator-to-Flywheel Housing Adapter, Location “D”	
Shim Part Number	Shim Thickness
TM3466	0.004 in. (0.102 mm)
TM3468	0.007 in. (0.178 mm)

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Joining Alternator and Komatsu SSDA16V160 or SDA16V160 Engine

⚠WARNING

When lifting alternator, attach hoist to lift eyes only. The alternator weighs approximately 7,700 lbs. (3493 kg). Use a lifting device that can handle the load safely.

1. Use the two top lift brackets provided on the alternator for lifting. The top front lifting bracket should be equipped with some method of adjusting the alternator to keep it horizontal.
2. Carefully move alternator into place and engage the engine drive ring (6, Figure 4-7) into the alternator rotor drive (7) using shims “B”, if required (refer to step 5.a. “Determining Shims”).
3. Install flywheel housing adapter capscrews (2) into alternator housing (1). Tighten to **175 ft. lbs. (237 N.m)** torque.
4. Install capscrews (5) through engine drive ring (6) into the alternator rotor adapter (7). Rotate crankshaft to access and align holes. Tighten capscrews (5) to **175 ft. lbs. (237 N.m)** torque.
5. Install alternator-to-cradle structure mounting capscrews and washers (1, Figure 4-2) and tighten to **750 ft. lbs. (1017 N.m)** torque.
6. Tighten engine-to-cradle structure mounting capscrews (3, Figure 4-2) to **345 ft. lbs. (465 N.m)** torque.

⚠IMPORTANT⚠

Never pry on the engine crankshaft damper!

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

Record Total Crankshaft End-play: _____

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

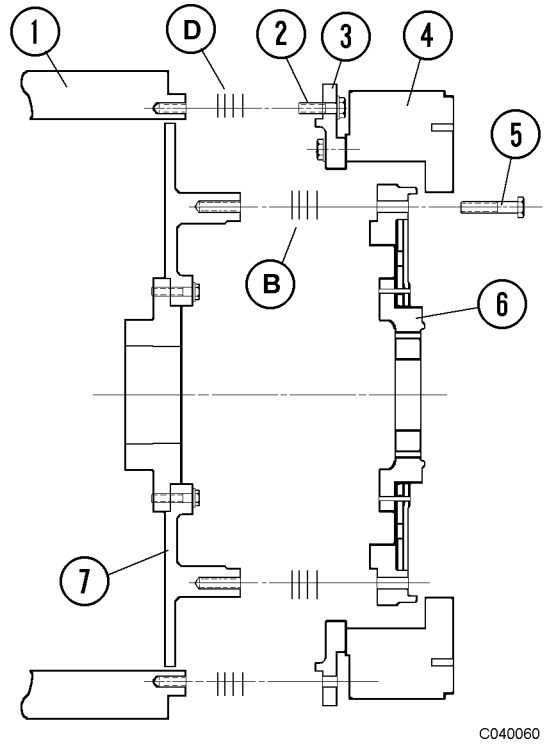


FIGURE 4-7. ALTERNATOR TO ENGINE MOUNTING

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

“B” Drive Shims

“D” Housing Shims

The total Engine Crankshaft End-play (step 7) must equal the original measurement or 0.020 in. (0.51 mm) (alternator end-play), whichever is smaller. If the end-play after the alternator and engine are assembled is less than 0.020 in. (0.51 mm), and less than the starting engine crankshaft end-play, RESHIMMING IS REQUIRED.

9. Rotate the crankshaft one full revolution and listen for any unusual noise caused by moving components contacting stationary parts.
10. Install engine sidecover, if removed. Install lockwire on all alternator mounting capscrews.
11. Remove barring tool and install access covers on flywheel housing.
12. Reinstall fan belt. Refer to engine manufacturer’s Operation and maintenance Manual.

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ENGINE

Removal

Refer to instructions in previous sections for removal instructions for the Power Module, alternator, and radiator assembly.

⚠WARNING

The engine weighs approximately 21,200 lbs. (9616 kg) wet. Be sure lifting devices are capable of handling the load safely.

1. Disconnect any remaining wiring or hoses between the engine and subframe.
2. Remove capscrews and lockwashers (5, Figure 4-7) securing front engine mount to subframe.
3. Attach spreader bar with lifting straps at front lift hooks and rear lift hooks (6) on engine. Remove capscrews and lockwashers (2) at rear engine mount securing engine to cradle structure (1).

Always use a spreader bar to ensure lift straps are vertical at each lift hook.

4. Lift engine from subframe and move to clean work area for further disassembly.

Service

Complete instructions covering the disassembly, assembly and maintenance of the engine and its components can be found in the engine manufacturer's service manual.

Installation

1. Align engine to subframe and install front mounting capscrews and lockwashers (5, Figure 4-7). Align and install rear engine mounting capscrews and lockwashers (2) through cradle structure, but do not tighten at this time. Tighten front mount capscrews to **345 ft. lbs. (465 N.m)** torque.
2. Install alternator on engine following instructions for “Engine/Alternator Mating”.
3. Tighten rear engine mounting capscrews (2) to **345 ft. lbs. (465 N.m)** torque after alternator is installed.
4. Adjust setscrew (3, Figure 4-1) to equalize gap (5) between cradle structure (1) and subframe (4) at left and right side. Lock setscrew with jam nut (2).

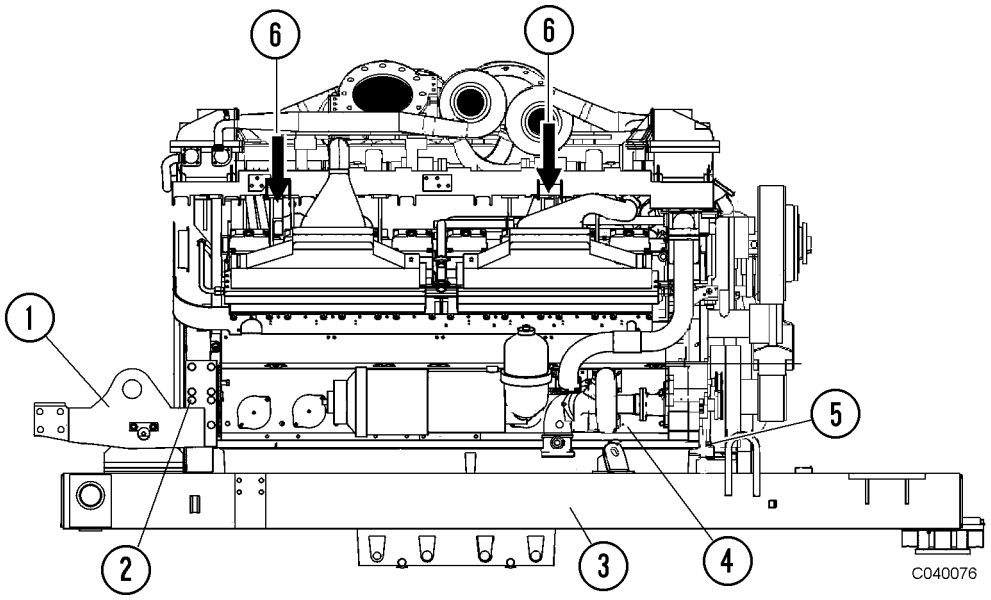


FIGURE 4-8. ENGINE MOUNTING

1. Cradle Structure
2. Capscrews and Lockwashers
3. Engine Module Subframe
4. Engine
5. Capscrews and Lockwashers
6. Engine Lift Points

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AIR FILTRATION SYSTEM

AIR CLEANER

Operation

Intake air, required by the diesel engine and by the truck air system, passes through the air cleaner assemblies mounted on each side of the radiator. These air cleaners discharge heavy particles of dust and dirt by centrifugal action and then remove finer particles by passing air through filter cartridges. The air compressor inlet line is connected to the engine filtered air supply.

The engine demand for air creates a vacuum in the air cleaners and causes outside air to be drawn in through air inlets on the air cleaners. Dirty air entering here is drawn through a series of tubes that are designed to produce a cyclonic action. As the air passes through the outer portion of the tubes, a circular motion is set up causing dust and dirt particles to be thrown from the air stream into dust collector cups. At the same time, the air stream turns and is directed up through the center of the tubes into the filter chamber. Here the air passes through the main filter element and safety filter element and out the clean air outlet to the engine's air intake system.

General Service Information

1. Inspect dust collector cups (1, Figure 5-1) at regular intervals - daily inspection is recommended. Never allow dust level build up to the tube chamber

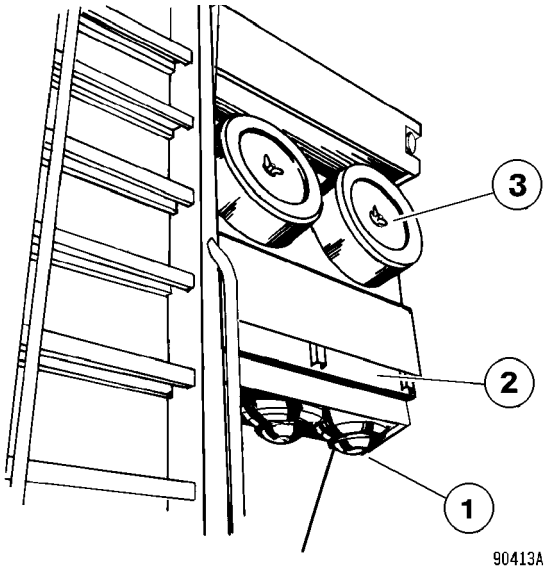


FIGURE 5-1. AIR CLEANERS

1. Dust Collector
2. Precleaner Section
3. Element Cover

2. Check filter restriction gauges, during operation. The filters should be cleaned or replaced when the gauges read between 20 and 25 inches H_2O vacuum or when a warning message is presented on the overhead display by the HMS system. Refer to Filter Service Procedure for maintenance and cleaning instructions.
3. Check to insure air inlet is not obstructed, plugged or damaged.
4. Check all connections between air cleaner outlet and engine intake manifold to insure they are tight and make a positive seal.
5. Check all air cleaner housing capscrews to insure they are tight.

MAIN FILTER ELEMENT

Removal

Remove and inspect the main filter element as outlined below.

⚠CAUTION

The truck engine must be shut down before servicing the air cleaner assemblies or opening the engine air intake system.

1. Shut down engine. Clean dirt and dust off air cleaner assembly exterior surfaces.
2. Loosen large wing nut (5, Figure 5-2) on air cleaner cover to free main element assembly (10). Pull main element clear of assembly.
3. Inspect filter element carefully for possible damage, holes, breaks, etc., which might affect reuse of element. If element appears serviceable other than being dirty, proceed with the cleaning procedure. If defects are found in filter element, wing nut assembly (5) must be removed from element assembly and installed on the new filter element.
4. Check safety filter element indicator nut (7). If solid red area is showing, safety filter service is required. If center is green, safety element does not require replacement.

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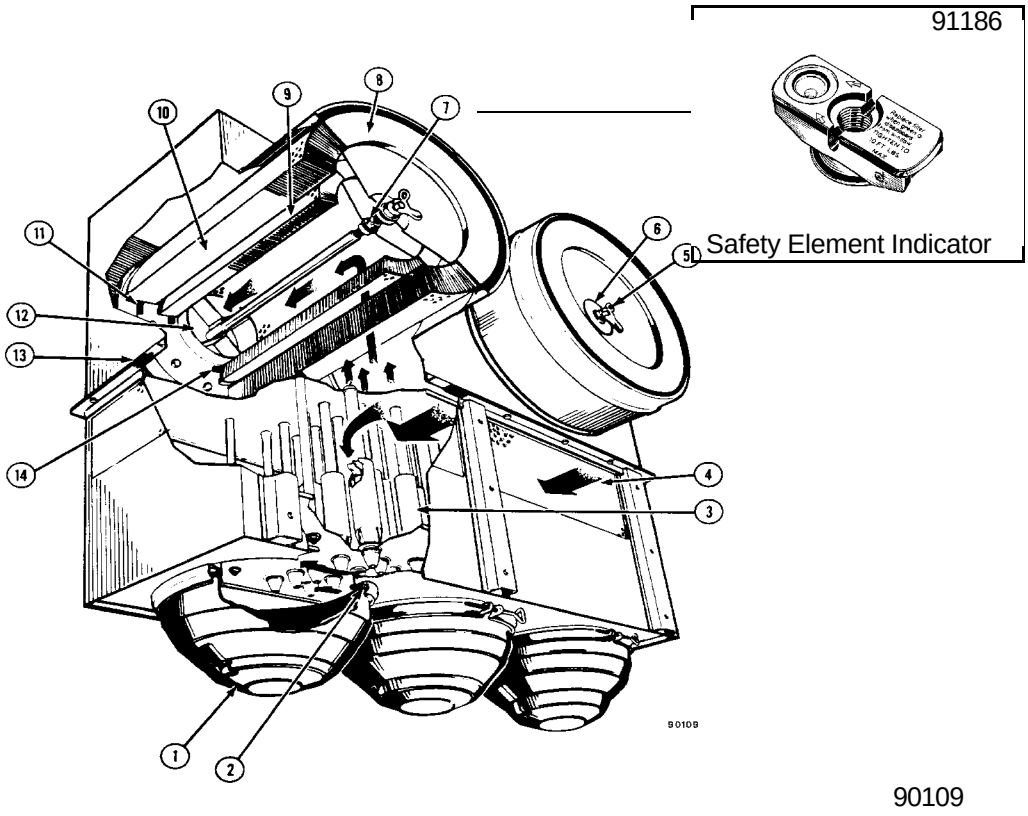


FIGURE 5-2. AIR CLEANER ASSEMBLY

Installation **Removal**

1. Dust Cap
2. Dust Cap Gasket
3. Tube
4. Unfiltered Air Inlet
5. Wing Nut
6. Wing Nut Gasket
7. Safety Element Indicator
8. End Cover
9. Safety Filter Element
10. Main Filter Element
11. Main Element Gasket
12. Clean Air Outlet
13. Pre-Cleaner Gasket
14. Safety Filter Element Gasket

1. Install clean or new, main filter element into air cleaner and secure with wing nut. Tighten wing nut hand tight, do not use a wrench or pliers.
2. If filter element is being reused, make sure main element (10) is not damaged, the gasket must seal completely.

SAFETY FILTER ELEMENT

⚠CAUTION

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

The function of the safety filter is to increase overall reliability and engine protection. If the safety element indicator shows red the element has become clogged, and should be discarded and replaced with a new one.

1. Shut down the engine. Clean the dirt and dust off the element end cover.
2. Loosen wing nut (5, Figure 5-2) and remove end cover (8) and main element (10).
3. Remove indicator nut (7) holding safety element in place. Remove safety element (9). Inspect gasket (14) and replace if necessary.
4. Remove any dust lodged in the clean air outlet and around element sealing surface.

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Installation

1. Reset the indicator nut from red to green by gently blowing air through threaded hole from gasket end of indicator wing nut.
2. Replace safety element and tighten the safety indicator nut to **10 ft. lbs. (13 N.m)** torque.

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.

AIR CLEANER ASSEMBLY CLEANING

Main Filter Cleaning

For best results, after inspection, determine the condition of the element and choose either the "Washing" or "Compressed Air" method for cleaning the filter element.

1. Wash elements with water and liquid detergent or a 50-50 solution of Oakite 202 and warm water.

NOTE: This method is best when element is loaded with carbon, soot, oil or dust.

   a. Soak the element in a solution of liquid detergent and water for 15 to 30 minutes. Rotate element back and forth in the solution to free element of dirt deposits. DO NOT soak elements for more than 24 hours.
   b. Rinse element with a stream of fresh water in the opposite direction of normal air flow until rinse water runs clear. Maximum permissible water pressure is 40 psi (276 kPa). A complete, thorough rinse is essential.
   c. Dry the element thoroughly. If drying is done with heated air, the maximum temperature must not exceed 140°F (60°C) and must be circulated continually. Do not use a light bulb for drying elements.
   d. After cleaning the element, inspect thoroughly for slightest ruptures and damaged gaskets. A good method to detect paper ruptures is to place a light inside the filter element as shown in Figure 5-3, and inspect the outer surface of the filter element.

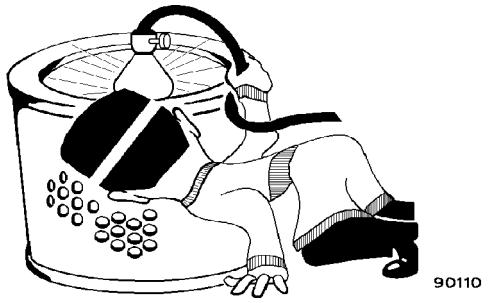


FIGURE 5-3. INSPECTING FILTER ELEMENT

2. Clean dust loaded elements with dry filtered compressed air:
   a. Maximum nozzle pressure must not exceed 30 psi (207 kPa). Nozzle distance from filter element surface must be at least one inch (25 mm) to prevent damage to the filter material.
   b. As shown in Figure 5-4, direct stream of air from nozzle against inside of filter element. This is the clean air side of the element and air flow should be opposite of normal air flow.
   c. Move air flow up and down vertically with pleats in filter material while slowly rotating filter element.
   d. When cleaning is complete, inspect filter element as shown in Figure 5-3 and if holes or ruptures are noted, discard the element.

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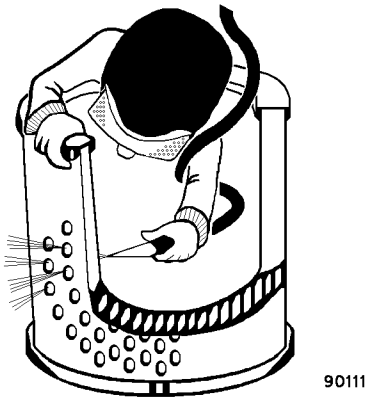


FIGURE 5-4. CLEANING FILTER ELEMENT WITH COMPRESSED AIR

Precleaner Section Cleaning

The tubes in precleaner section of air cleaner assembly should be cleaned at least once annually and at each engine overhaul. More frequent cleaning may be necessary depending upon operating conditions and local environment should tubes become clogged with oil, sludge or dirt.

To inspect tubes in precleaner section, remove main filter element. Do not remove the safety element. Loosen clamps and remove dust collector cup. Use a light to inspect the tubes, all tubes should be clear and the light should be visible.

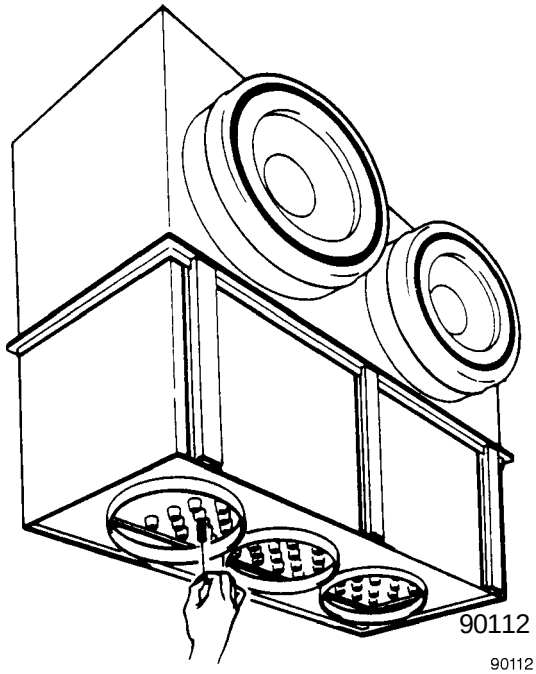
Clean the tubes as follows if clogging is evident:

⚠CAUTION

Both the main and safety elements must be installed in the air cleaner while Steps 1 and 2 are being accomplished to prevent any possibility of dirt being forced into the engine intake area.

1. Dust can best be removed with a stiff fiber brush. DO NOT use a wire brush. Dust may also be removed effectively using compressed air.
2. Heavy plugging of tubes may require soaking and washing of complete precleaner section. The following instructions cover these procedures.

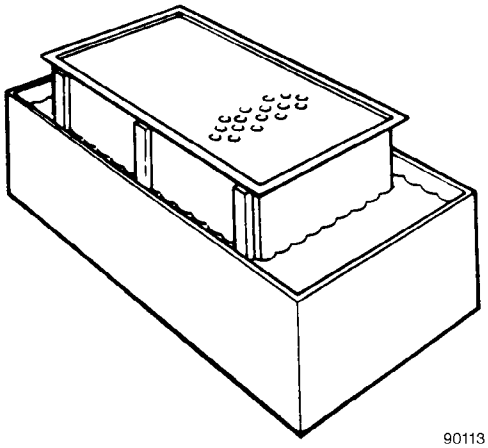
NOTE: The precleaner section may be separated from the air cleaner assembly without dismounting the complete air cleaner from the truck. (Refer to Figure 5-2)



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FIGURE 5-5. REMOVING DUST FROM TUBES

3. Remove capscrews and locknuts holding precleaner section to the cleaner assembly and remove precleaner. The safety element must remain in place to protect the engine intake.
4. Loosen clamps and remove dust collector cup (1) from precleaner section. Wash dust cup with water and liquid soap solution.



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FIGURE 5-6. WASHING AND SOAKING PRECLEANER SECTION

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5. Submerge precleaner section (see Figure 5-6.) in a solution of Donaldson D-1400 and warm water (mix solution according to package directions). 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 (13) carefully for any evidence of air leaks, 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 (2), install dust collector cup assembly on precleaner section and secure with mounting clamps.

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NOTES

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SECTION D
ELECTRICAL SYSTEM (24VDC NON-PROPULSION)
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NOTE: Electrical system wiring hookup and electrical schematics are located in Section "R" of this service manual.

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⚠WARNING

- ***Electric shock can cause serious or fatal injury. Only qualified electrical maintenance personnel should perform electrical testing***

- ***This system is capable of causing physical harm. Use caution during test procedures to protect personnel from injury.***

- ***All potential testing should be considered hazardous. Proper precautions are necessary.***

- ***Any time one of the plug-in circuit cards must be removed or reinstalled, be certain the control power switch is "OFF". When removing a G.E. Propulsion system circuit board, a grounding strap should be worn to dissipate static electrical charges.***

- ***Extreme care should be exercised to prevent damage to the various semi-conductor devices and low impedance circuits under test. When using an ohmmeter to check diodes, transistors and low power conductors, care must be used when using the X1 scale. Excessive current can damage meter.***

- ***Check wiring and cables for proper routing, clamping and termination.***

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24VDC ELECTRIC SUPPLY SYSTEM

ELECTRICAL SYSTEM DESCRIPTION

The truck utilizes a 24VDC electrical system which supplies power for all non-propulsion electrical components. The 24VDC is supplied by four 12 volt storage batteries wired in series and parallel. The batteries are a lead-acid type, each containing six 2-volt cells. With keyswitch “On”, and engine not operating, power is supplied by batteries. When the engine is operating, electrical power is supplied by a 24 volt alternator.

BATTERY

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.

⚠WARNING

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.

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 - 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.

⚠WARNING

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 battery connections
- Defective wire in electrical system
- Loose alternator drive belt
- A defective alternator
- A defective battery equalizer

Overcharging, which causes battery 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.

To remove corrosion, clean the battery with a solution of ordinary baking soda and a stiff, non-wire brush and flush with clean water. Make sure none of the soda solution is allowed into the battery cells. Be sure terminals are clean and tight. Clean terminals are very important in a voltage regulated system. Corrosion creates resistance in the charging circuit which causes undercharging and gradual starvation of the battery.

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NOTE: When washing batteries, make sure cell caps are tight to prevent cleaning solution from entering the cells.

Addition of acid will be necessary if considerable electrolyte has been lost through spillage. Before adding acid, make sure battery is fully charged. This is accomplished by putting the battery on charge and taking hourly specific gravity readings on each cell. When all the cells are gassing freely and three successive hourly readings show no rise in specific gravity, the battery is considered charged. Additional acid may now be added. Continue charging for another hour and again check specific gravity. Repeat the above procedure until all cells indicate a specific gravity of 1.260-1.265 corrected to 80°F (27°C).

NOTE: Use 1.400 strength sulfuric acid when making specific gravity adjustments. Acid of higher strength will attack the plates and separators before it has a chance to diffuse into the solution.

If the temperature of the electrolyte is not reasonably close to 80°F (27°C) when the specific gravity is taken, temperature should be corrected to 80°F (27°C):

- For every 10°F (5°C) below 80°F (27°C), 0.004 should be SUBTRACTED from the specific gravity reading.
- For every 10°F (5°C) above 80°F (27°C), 0.004 should be ADDED to the reading.

Idle batteries should not be allowed to stand unattended. If equipment is to stand unused for more than two weeks, the batteries should be removed and placed in a cool, dry place where they may be checked periodically and charged when necessary. Remember, all lead-acid batteries discharge slowly when not in use. This self discharge takes place even though the battery is not connected in a circuit and is more pronounced in warm weather than in cold.

The rate of self-discharge of a battery kept at 100°F (38°C) is about six times that of a battery kept at 50°F (19°C) and self-discharge of a battery kept at 80°F (27°C) is about four times that one at 50°F (10°C). Over a thirty day period, the average self-discharge runs about 0.002 specific gravity per day at 80°F (27°C).

To offset the results of self-discharge, idle batteries should receive a booster charge (not a quick charge) at least once every thirty days. Batteries allowed to stand for long periods in a discharged condition are attacked by a crystallization of the lead sulfate on the plates. Such batteries are called sulfated and are, in the majority of cases, irreparably damaged. In less severe cases, the sulfated battery may be restored to limited service by prolonged charging at a low rate (approximately normal rate).

An undercharged battery is extremely susceptible to freezing when allowed to stand in cold weather.

The electrolyte of a battery in various stages of charge will start to freeze at temperatures indicated in the table.

The temperatures in table I indicate the points at which the first ice crystals appear. Lower temperatures must be reached for a solid freeze. Solid freezing of the electrolyte may crack the battery case and damage the positive plates. As will be noted, a charged battery is in no danger of freezing, therefore, a charge or better is desirable, especially during winter weather.

Specific Gravity Corrected to 80° F (27° C)	Freezing Temperature Degrees
1.280	-90°F (-70°C)
1.250	-60°F (-54°C)
1.200	-16°F (-27°C)
1.150	+5°F (-15°C)
1.100	+19°F (-7°C)

TABLE I.

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BATTERY CHARGING SYSTEM (Niehoff)

General Description

The Niehoff alternator (Figure 2-1) is a heavy duty, 24 VDC unit rated at 240 amps. A solid state voltage regulator (5) mounted externally on the end housing assembly provides voltage control during operation. A single output connection (4) is located on the face of the control unit (3) for connection to the truck battery positive circuit. The ground circuit cable can be attached to either of two terminals (8) located on the cover plate. A fan guard (6) 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

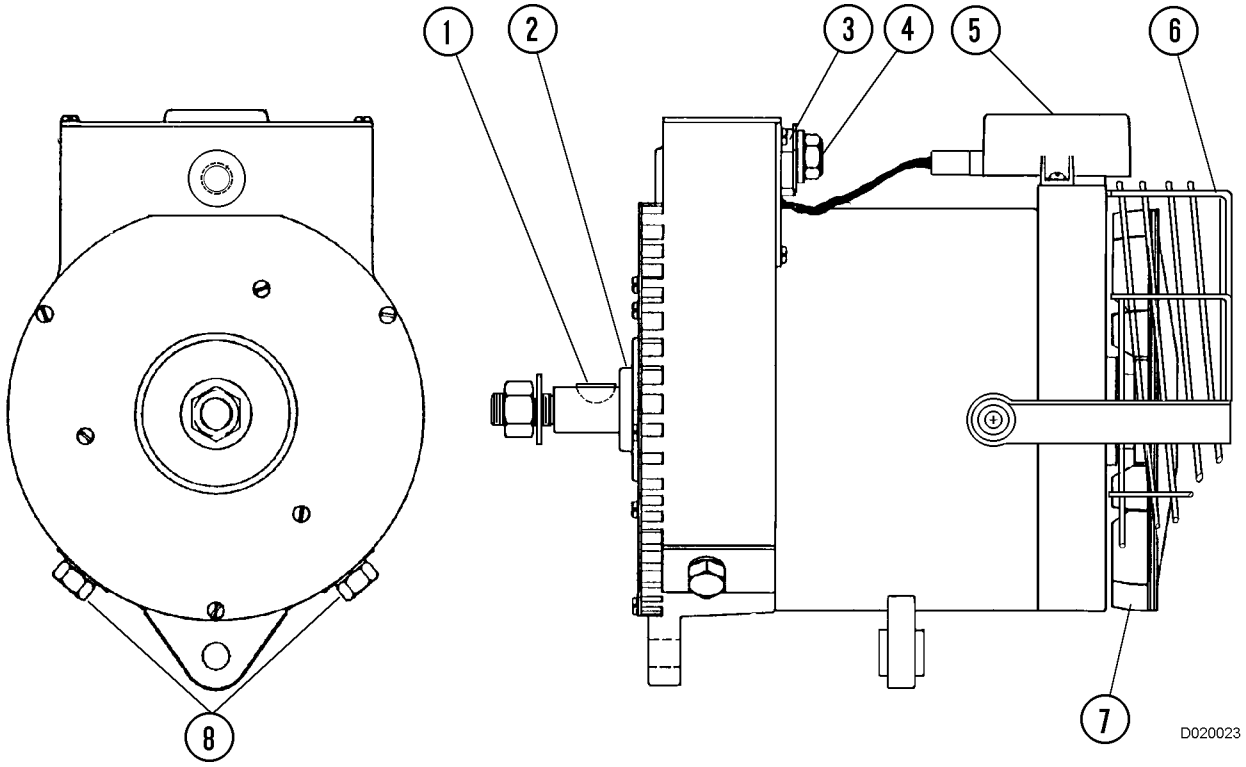


FIGURE 2-1. ALTERNATOR ASSEMBLY

1. Shaft Key
2. Pulley Bushing
3. Control Unit
4. Battery Positive Terminal
5. Voltage Regulator
6. Fan Guard
7. Cooling Fan Assembly
8. Ground Terminals

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Preliminary Checks

1. Check the drive belt tension. Refer to engine manufacturer's Operation and Maintenance Manual for belt tension requirements.
2. Insure that an undercharged battery condition has not been caused by accessories having been left ON for extended periods.
3. If a battery defect is suspected, check battery as specified in "Battery - Troubleshooting".
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness. Remove and clean battery cables.
5. If truck is equipped with a battery equalizer system, verify proper operation of equalizer and individual battery voltages. Refer to "Battery Equalizer", this Section.

Test Setup

1. Discharge batteries sufficiently to insure adequate loading of alternator when engine is operated during tests.
2. Open battery disconnect switch. Remove battery cable from alternator B+ terminal.

Refer to Figure 2-2 for the following steps. Meters should be installed directly at the alternator as shown to eliminate variations in readings due to cable lengths etc.:

3. Install an ammeter (negative lead) between the battery positive cable removed in step 2. and the alternator B+ terminal (ammeter positive lead).
4. Install a voltmeter between the alternator B+ terminal (positive lead) and the ground terminal (voltmeter negative lead).
5. Secure all test equipment leads to prevent damage or short circuits when engine is started. Reconnect battery disconnect switch.

⚠WARNING

The following tests require working near the engine when running. Use caution when working near engine fan, alternator fan and belt.

Test Procedure

1. Start engine, accelerate to high idle and observe meters.

⚠WARNING

If voltmeter reading exceeds 30.5 volts, stop engine immediately and refer to Table II.

- If batteries are sufficiently discharged, amps should be "high" (240 amps ±10%) and voltage should be between 27.3 and 28.9 volts (normal range) or may be less than 23.7 volts if the batteries are significantly discharged.

2. As the batteries approach full charge, the amperage should fall as voltage rises.
3. When amps and volts readings stabilize, note readings and refer to Table II to diagnosis system condition.

AMPS	VOLTS	DIAGNOSIS
HIGH	LOW	Charging system is OK. Batteries are not yet fully charged. Wait for charging system to bring to full charge; amps should decrease and voltage should stabilize between 27.3 and 28.9 volts.
HIGH	NORMAL	Watch until amps decrease or voltage exceeds 28.9 volts. If amps decrease and volts remain normal, system is OK. If voltage exceeds 28.9 volts, regulator and/or alternator defective.
HIGH	HIGH	STOP TEST! Regulator and/or alternator defective.
LOW	LOW	1. Recheck voltmeter leads. If connections are OK, alternator and/or regulator defective. 2. Perform Regulator Bypass Test per instructions on following page: a. If volts and/or amps increase, alternator is OK but regulator is defective. b. If no effect, replace alternator
LOW	NORMAL	Charging system is OK.
LOW	HIGH	STOP TEST! If battery and voltmeter check is OK, regulator and/or alternator defective.

TABLE II. TROUBLESHOOTING CHART

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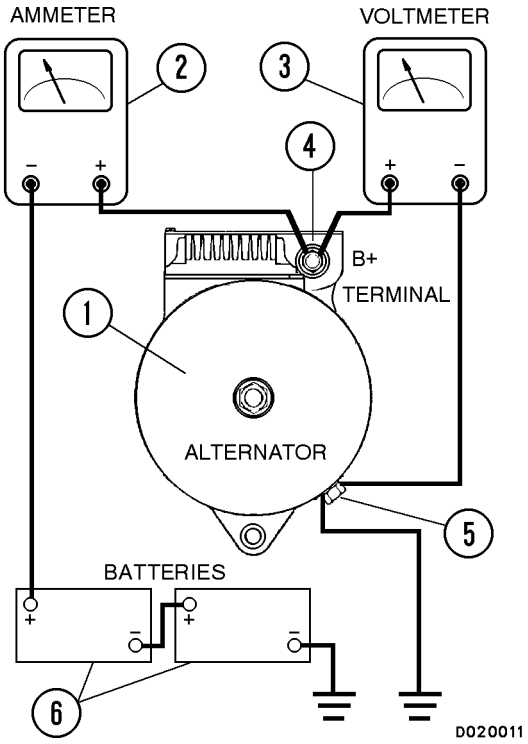


FIGURE 2-2. TEST METER HOOKUP

1. Alternator Under Test
2. 0 to 400 AMP Ammeter
3. 0 to 40 VDC Voltmeter
4. Alternator “B+” Terminal
5. Alternator Ground Terminal
6. Truck Batteries

Regulator Bypass Test

If the test procedure outlined on the previous page indicates **low current output *and* low voltage output,** perform the following test to determine if the voltage regulator is defective or if the alternator is defective.

1. Disconnect alternator/regulator harness plug (5, Figure 2-3).
2. *Momentarily* touch connector male pin “F-” to ground.
3. Observe meter readings:

- If voltage or amperage rises, the alternator is OK. The regulator is defective and should be replaced.
- If grounding the harness male pin has no effect, the alternator is defective and should be replaced.

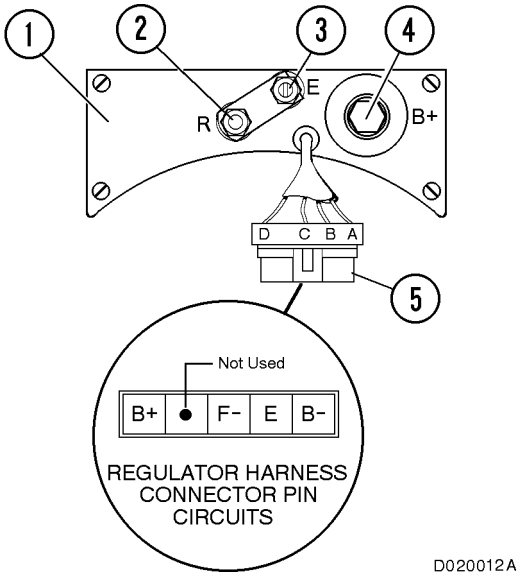


FIGURE 2-3. REGULATOR BYPASS TEST

1. Alternator Control Unit
2. “R” Terminal (Relay)
3. “E” Terminal (Energize)
4. Alternator “B+” Terminal
5. Alternator/Voltage Regulator Harness Plug

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ON VEHICLE TROUBLESHOOTING GUIDE - SELF ENERGIZED ALTERNATOR

ALTERNATOR ELECTRICAL CONDITION - Low Voltage - High Voltage - No Voltage

PRELIMINARY PROCEDURES

Common problems, all applications:

- ❑ Check alternator drive belt (s).
- ❑ Check alternator positive connection
- ❑ Check alternator ground connection on alternator.
- ❑ Check condition of connector between regulator and alternator.

Identify model of alternator_____

Identify model of regulator_____

Record voltage regulator set points stated on regulator tag:

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

LOW VOLTAGE OUTPUT

Causes of low voltage:

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

HIGH VOLTAGE OUTPUT

Causes of high voltage:

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

NO VOLTAGE OUTPUT

Causes of no voltage output:

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

TOOLS AND EQUIPMENT:

1 - Voltmeter (Digital type preferred.)

1 - Ammeter (Digital, Inductive type preferred.)

1 - 12 gauge lead, 12 inches long, with alligator clip at each end.

BATTERY CONDITIONS AND CHARGE VOLTAGE REACTIONS:

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

Maintenance Type:

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

Low Maintenance Types:

Same as above, except cycle times may be longer.

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Maintenance Free types:

- Immediately after engine start, system volts are lower than regulator setpoint with low amps.
- 15-30 minutes into charge cycle, still low volts and low amps.
- 15-30 minutes into charge cycle, volts rise several tenths, amps increase gradually then increase quicker to medium to high amps.
- 20-35 minutes into charge cycle, volts rise to setpoint and amps lower.

High-Cycle Maintenance Free Types:

These types respond much better than standard maintenance free types. The charge acceptance of these batteries may display characteristics similar to standard, maintenance type batteries.

CHARGE VOLT AND AMP VALUES

Voltage and amperage levels are functions of battery state of charge. If the batteries are charged 95% or higher when the engine is cranked, the charge voltage will be near regulator setpoint and the amps will taper quickly from medium to low. True battery voltage is obtained AFTER removing any surface charge from the battery or after 24 hours of non-use.

DEFINITIONS

NOTE: Charge voltage and amp rates vary from battery type to battery type, based on battery construction technology and physical size of battery.

Low amps are the necessary amps that a battery will take continuously over a period of time without damage to the battery when the battery *is in an operating system and is constantly cycling.* Batteries such as the Group-8D may accept rates up to 15 amps over several hours without raising their internal temperature more than a few degrees. Group-31 batteries may accept rates up to 5 amps over several hours with minimal temperature rise.

Medium amps are defined as some multiple of the low amp value, perhaps 30 amps for the Group-8D and 10-15 amps for the Group-31. This rate of amperage will cause a rise in battery temperature over a long period of time (4-8 hrs) and may lead to an overcharge condition if temperature elevates too high.

High amps would be 50 to 75 amps for a Group-8D, and 25 to 35 amps for a Group-31 size. High amperage rates over a short period of time (2-3 hrs.) can severely damage any battery by overheating the battery and causing thermal runaway. The battery, in effect, forgets its state of charge and will accept all amps offered. The electrolyte solution is boiled off as the battery moves into an excessive gassing stage.

Charge voltage is the voltage delivered to the battery when the alternator and regulator are operating properly. This charge voltage value is the voltage regulator's setpoint. At times the charge voltage value may be less than the regulator's setpoint but it will never be higher than that setpoint.

Battery voltage is the steady state voltage of the battery. The value of this voltage relates directly to state of charge.

B+ voltage is battery positive voltage, but does not refer to a specific value as does battery voltage.

Surface charge is a higher than normal terminal voltage a battery has when it comes off a charger or after extended time in vehicle operation. The surface charge must be removed to determine true battery voltage.

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ADVANCED SYSTEM TROUBLESHOOTING
24V/240A Self Energized

NO ALTERNATOR OUTPUT

STATIC TEST - ENGINE OFF, KEY ON, BATTERY SWITCH ON.

Identify and locate “B+”, “E”, and “R” and ground (“B-”) terminals on alternator and check for link from terminal “R” to “E”. (See Figure 2-4.)

GO TO ALTERNATOR”

Test for battery B+ voltage (_____V) at “B+” terminal on alternator:

- ❑ If there is no B+ voltage on “B+” terminal, repair VEHICLE wiring as necessary. Continue test.
- ❑ If B+ voltage is present on “B+” terminal, continue test.
- ❑ Remove strap between “R” and “E” terminal.
- ❑ Connect a 12 gauge jumper wire from the “B+” terminal on alternator to the “E” terminal on alternator.

⚠WARNING

DAMAGE WILL OCCUR IF UNIT IS OPERATED WITH STRAP CONNECTED AND B+ APPLIED!

- ❑ Hold a steel wrench or screwdriver near alternator drive pulley: wrench or screwdriver held near drive pulley will be attracted to pulley by magnetism.

- If there is no magnetic attraction, alternator may not be turned on. Go to “Regulator Test” that follows and continue test.
- If there is magnetic attraction, alternator is good and regulator should be considered good. Alternator will produce electricity because regulator is on. This test only shows regulator as either on or off.

NOTE: Alternator may not be turned on when engine is operating. Go to “R” terminal test next, to prove if vehicle “E” circuit will turn alternator on.

GO TO “R” TERMINAL ON ALTERNATOR

- ❑ With engine running, measure value of AC voltage from “R” terminal to “Ground”.

- If no AC volts are present, alternator is not capable of turning on regulator.

NOTE: On a new, first time start up of an alternator, the alternator may test at less than 5 volts on "R" terminal. The cause of this problem may be loss of residual magnetism within the alternator during shipping and handling of the alternator. To restore the residual magnetism: With engine off and battery switch on, momentarily (1-2 seconds) connect a jumper wire from “B+” terminal to “E” terminal. (May spark - this is OK.) Remove jumper and restart engine. Alternator should generate properly once the residual magnetism is restored.

- If AC voltage is approximately 14 Volts, alternator is properly turned on and output of alternator will be approximately 28 Volts.
- If AC voltage is 3 Volts to 5 Volts, alternator is NOT turned on (regulator is OFF) but alternator is capable of turning on a GOOD regulator. NOTE: This test shows only if alternator is capable of energizing regulator. To check harness from alternator to regulator go to "Regulator Connector On Alternator" test. Continue testing.

Vehicle Charging Circuit Test Is Now Complete: Remove all jumper wires from alternator used to test charging circuit.

RE-TEST CHARGING CIRCUIT FOR OPERATION with ENGINE RUNNING.

Check charging system voltage with engine running.

- ❑ If no charge voltage, test for voltage at "E" terminal of alternator, with engine running.
- ❑ If no voltage on "E" terminal, shut engine down and inspect link from "R" terminal to "E".
- ❑ Run engine and re-test charging circuit.

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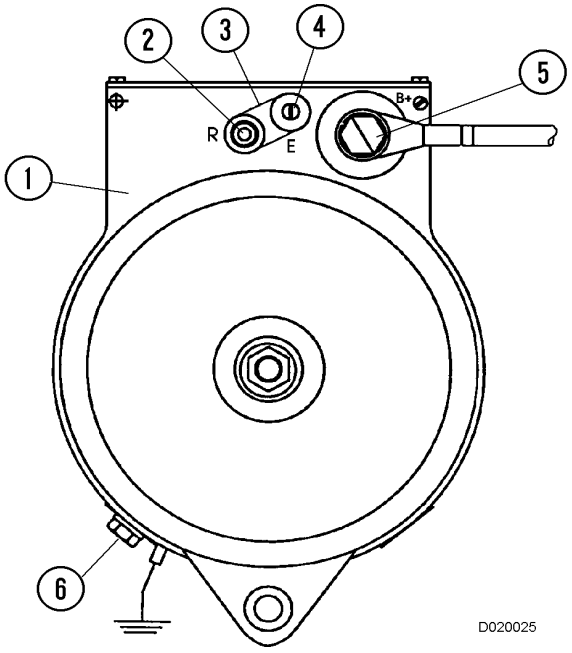


FIGURE 2-4. ALTERNATOR TERMINALS

1. Control Unit
2. “R” Terminal
3. Link Strap
4. “E” Terminal
5. “B+” Terminal
6. Ground Terminal

GO TO REGULATOR (IF REQUIRED)

Disconnect voltage regulator from alternator. There are no static tests available for the regulator. Continue test.

GO TO REGULATOR CONNECTOR ON ALTERNATOR

- ❑ Connect a jumper wire from ground on alternator into “F-” pin of connector attached to alternator. (See Figure 2-3.)
- ❑ Hold a steel wrench or screwdriver near alternator drive pulley; wrench or screwdriver held near drive pulley will be attracted to pulley by magnetism.

- If there is no attraction, alternator field is defective. Replace alternator.
- If there is magnetic attraction, alternator field is good. Continue test.
  - ❑ With jumper still connected between “B+” terminal and “E” terminal on alternator: Insert “+” probe of voltmeter into “E” terminal of connector, and Ground negative probe of voltmeter to alternator ground terminal.
- If meter shows no voltage, alternator is defective. Replace alternator.
- If meter shows battery voltage, circuit is good. Continue test.
  - ❑ Insert “+” probe of voltmeter into “B” pin in connector. Insert negative probe of voltmeter into “B-” pin in connector. (This is power circuit for voltage regulator.)
- If circuit shows open (no voltage), alternator is defective. Replace alternator.
- If circuit shows B+ voltage, regulator is defective. Replace REGULATOR ONLY.

NOTE: Turn key and battery switch OFF before installing new regulator. Turn battery switch and key back on AFTER installing new regulator. Continue test.

Remove all jumper wires from alternator used to test charging circuit. Reconnect link from “R” terminal to “E” terminal

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24 VDC ELECTRIC STARTER SYSTEM (WITH PRELUBE)

The Komatsu SSDA16V160 engine includes an engine pre-lubrication system designed to reduce wear due to dry starts.

The prelube system automatically, safely and quickly fills filters and all oil passages prior to cranking at each engine startup. In addition, the system prevents startup if no oil is present in the engine.

The prelube system includes:

- Remote mounted 24VDC powered pump
- Timer solenoid
- Oil pressure switch
- Oil suction line
- Oil outlet line
- Check valve
- Electrical harness.

OPERATION

(Refer to electrical schematic diagram, Figure 2-5.)

The prelube system is activated when the operator turns the key switch and holds it in the “start” position. This allows the current to flow to the prelube starter solenoid timer (3). When this solenoid timer is activated, current flows through fusible link (9) to the prelube motor (10), driving the prelube pump, but does not allow the starter motors to engage the starter pinion gears at this time. The prelube pump supplies oil from the engine oil pan to fill the engine oil filters and oil passages prior to cranking.

When the pressure in the engine cam oil rifle reaches 2.5 psi (17.2 kPa), the circuit to the timer solenoid is opened. After a 3 second delay, the current is directed to the standard starter solenoids (8); the starter motors will then be activated and the pinion gears will be engaged into the flywheel ring gear. Normal cranking will now occur with sufficient lubrication to protect the engine bearings and other components.

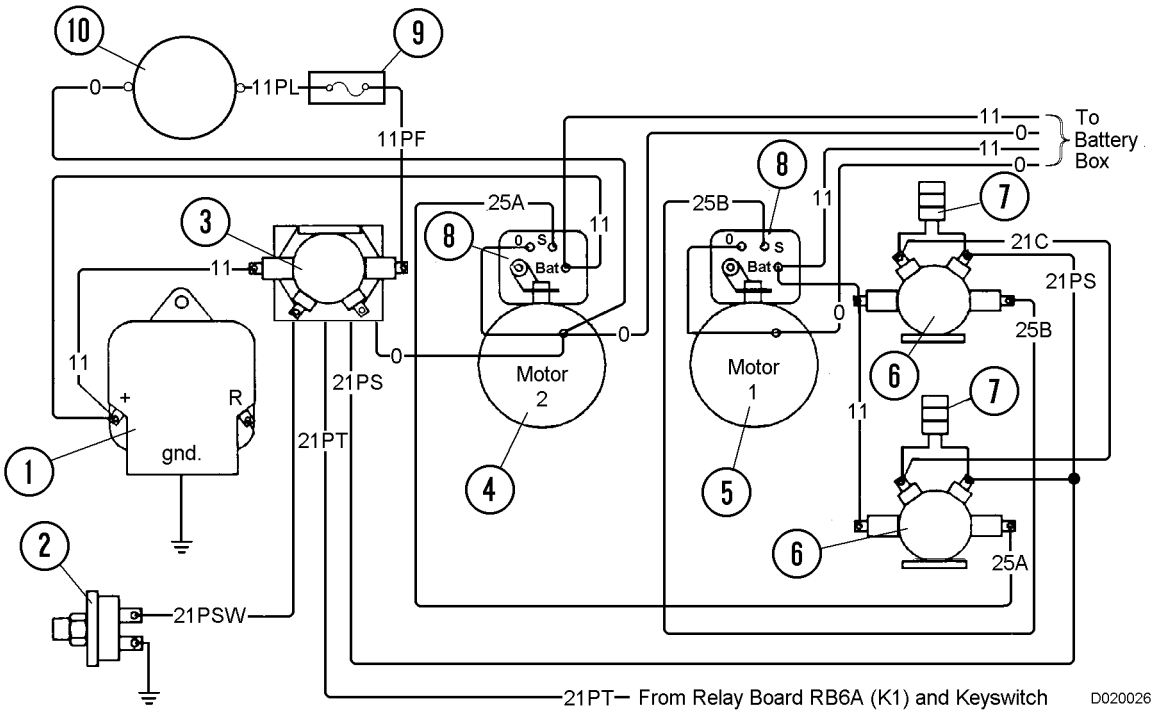


FIGURE 2-5. PRELUBE MOTOR AND CRANKING MOTOR ELECTRICAL DIAGRAM

1. Battery Charging Alternator
2. Oil Pressure Switch (N.C.) 2.5 psi
3. Prelube Timer Solenoid
4. Starter Motor No. 2
5. Starter Motor No. 1
6. Magnetic Switch
7. Diode (Coil Suppression)
8. Starter Solenoid
9. Fusible Link (400 AMP)
10. Prelube Pump & Motor

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Pressure Switch

The pressure switch (2, Figure 2-5) is a 2.5 psi (17.2 kPa), normally closed (N.C.) switch, located so that it can sense oil pressure after the engine oil has passed through the filters. (Normally, this location is the cam cover at the rear of the engine block.)

Check Valve

The oil pressure supply hose will have a check valve installed between the prelube pump and the engine. The oil flow through the valve (arrow on valve) must be toward the engine. The check valve prevents the passage of oil from the engine back through the prelube pump to the pan after the engine is started.

Timer Solenoid

The timer solenoid (3, Figure 2-5) controls the prelubrication cycle. Current is supplied to the timer through the key switch. The ground path is completed by the normally closed pressure switch (2).

When the switch opens, current is redirected to the engine starter solenoids (8) for engine cranking, following a 3 second delay.

⚠WARNING

DO NOT Attempt to jump start the truck using the terminals on the timer solenoid. INTERNAL DAMAGE TO TIMER WILL RESULT.

MAINTENANCE

Prelube system maintenance should be performed annually or at 5000 hour intervals as described below.

Prelube System Operation Checks

Verify system operates according to the two phases of operation as listed in *"Troubleshooting Prelube Starter Circuit"* on the following page. If a problem exists, refer to the list of problems and possible causes for troubleshooting system components.

If system is operating properly, continue with the inspection of component parts below:

Check Valve

Verify no internal leakage exists in the check valve when the engine is running. Check valve leakage back to the prelube pump will cause extensive damage to the pump.

If check valve replacement is required, be certain the valve is installed with the arrow pointed toward the engine, NOT toward the pump.

Timer Solenoid

Inspect Timer Solenoid for physical damage and to verify wiring is in good condition.

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Troubleshooting Prelube Starter Circuit

Two distinct phases are involved in a complete prelubrication cycle. The two phases are:

1. *Prelubrication Phase*- Begins when the key switch is held in the START position. A circuit is provided to ground through the normally closed pressure switch. The circuit is interrupted upon opening of the pressure switch when the prelube pressure reaches 2.5 psi (17.2 kPa).
2. *Delay and Crank Phase*- Begins when the pressure switch opens. A 3 second delay precedes the crank mode.

Problem	Probable Cause
• Starter prelubricates only. Does not delay or crank.	Indicates oil pressure is not sufficient to open the pressure switch. a. No oil or low oil in engine. The pump can not build sufficient pressure to open switch. b. Pump failure. c. Pressure switch has failed (closed) and is grounding circuit. d. Oil pressure switch wire chafed and shorting to block.
• Starter prelubricates continuously regardless of key switch position.	Indicates Prelube Timer Solenoid contacts have welded. a. Low voltage can cause relay failure. b. Jump starting of the vehicle with a voltage that is higher than was designed for the system, can cause solenoid contacts to weld.
• Starter delays and cranks. No prelubrication mode.	If an operator indicates the ignition is totally dead, make certain the key is being held in the crank position for 3 to 4 seconds. If the engine cranks after a short delay, this indicates that a ground connection to the pressure switch has been broken. Without a ground path, the prelubrication unit will proceed to delay and crank. a. Check the wire to the pressure switch. If the wire is removed or cut, replace it. b. Check the ground strap to engine block. If the ground strap is missing the block is not grounded. c. Check the pressure switch for an open circuit. Remove the wire, then check for an open circuit between the switch terminal and the switch base. If open, replace the pressure switch.
• Starting circuit is irregular when in crank mode.	a. Check for low or dead batteries. b. Check alternator output. c. Check ground connection at “G” terminal of starter bendix solenoid. d. Check for defective starter safety relays. e. If everything checks OK, replace batteries. *NOTE: Maximum allowable voltage drop is - 2 volts for starter control circuit.*

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Problem	Probable Cause
• Starter has very long prelubrication cycle.	Except for severe cold weather starts, the prelube cycle should not exceed 45 seconds. a. Low oil pressure. b. Make sure oil of the proper viscosity is being used in respect to outside temperature. (Refer to engine manufacturer's specifications). c. Check for suction side air leaks, loose connections, cracked fittings, pump casting, or hose kinks and blockage. d. Check the oil pressure switch for the correct location. Be certain that it has not been moved into a metered oil flow, as in a bypass filter or governor assembly.
• Starter has no prelubrication, no delay and no crank.	If the starter is totally inoperative and no prelubrication, no delay and crank, this indicates a possible failure of the prelubrication timer solenoid. Remove the wire from the pressure switch (ground wire) and activate the key switch for several seconds. a. If the starter delays - then cranks, the Prelube Timer Solenoid is bad. Replace the timer solenoid assembly. b. If the starter is still inoperative, check the truck starter switch circuit. Make sure proper voltage is available to the Prelube Timer Solenoid when the key is activated.
• Starter prelubricates, delays, then does not crank.	Indication is either a timer failure, or a starter problem. a. Place a jumper wire to the starter solenoid “S” post. If the engine starts to crank, replace the Prelube Timer Solenoid. b. If the engine fails to crank when the "S" post is energized with voltage, check out starter bendix solenoid and starter pinion drive.

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24 VDC ELECTRIC START SYSTEM

CRANKING MOTORS

OPERATION

Heavy duty batteries supply 24VDC to each of the two cranking motors through magnetic switches activated by the key switch on the instrument panel.

Note: When a Komatsu SSDA16V160 engine with a prelube system is installed, there is a delay between the time the key switch is moved to the START position, and the starter motors actuate.

When the keyswitch is placed in the “Start” position, the magnetic switches close, connecting the motor solenoid “S” terminals to the batteries. When the solenoid windings are energized, the plunger (56, Figure 2-8) is pulled in, moving the starter drive (71) assembly forward in the nose housing to engage the engine flywheel ring gear. Also, when the solenoid plunger is pulled in, the main solenoid contacts close to provide current to the motor armature and cranking takes place. When the engine starts, an overrunning clutch in the drive assembly protects the armature from excessive speed until the keyswitch is released. When the keyswitch is released, a return spring causes the drive pinion to disengage.

After the engine is running, a normally closed pressure switch senses engine oil pressure and opens the electrical circuit to prevent actuation of the motor(s) after the engine has started.

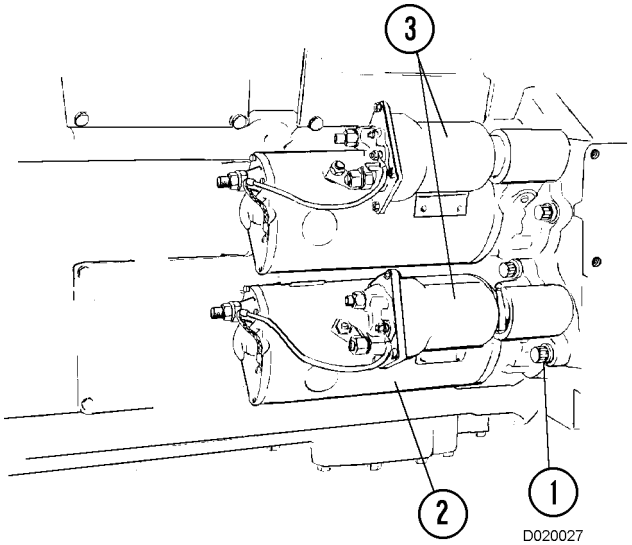


FIGURE 2-6. CRANKING MOTORS

1. Mounting Capscrews
2. Cranking Motor
3. Solenoid

Removal

1. Disconnect battery power:
   a. Open the battery disconnect switch to remove power from the system.
   b. Remove the battery cables using the following sequence:
      1.) Remove the battery positive (+) cables first.
      2.) Remove the negative (-) cables last.
2. Mark wires and cables and remove from motor (2, Figure 2-6) and solenoid (3) terminals.
3. Remove motor mounting capscrews (1).
4. Remove motor assembly from flywheel housing.

Installation

1. Align motor (2, Figure 2-6) housing with the flywheel housing adaptor mounting holes and slide into position.
2. Insert motor mounting capscrews (1).
3. Connect marked wires and cables to motor and solenoid terminals.
4. Install in the following sequence:
   a. Install the battery negative (-) cables first.
   b. Install the battery positive (+) cables.
5. Close the battery disconnect switch.

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CRANKING MOTOR TROUBLESHOOTING

If the cranking system is not functioning properly, check the following to determine which part of the system is at fault:

- ❑ Batteries -- Verify the condition of the batteries, cables, connections and charging circuit.
- ❑ Wiring -- Inspect all wiring for damage or loose connections at the keyswitch, magnetic switches, solenoids and cranking motor(s). Clean, repair or tighten as required.

If the above inspection indicates the starter motor to be the cause of the problem, remove the motor and perform the following tests prior to disassembly to determine the condition of the motor and solenoid and repairs required.

Preliminary Inspection

1. Check the starter to be certain the armature turns freely.
   a. Insert a flat blade screwdriver through the opening in the nose housing.
   b. Pry the pinion gear to be certain the armature can be rotated.
2. If the armature does not turn freely, the starter should be disassembled immediately.
3. If the armature can be rotated, perform the No-Load Test before disassembly.

No-Load Test

Refer to Figure 2-7 for the following test setup.

⚠ IMPORTANT ⚠

Be certain switch is open before connections or disconnections are made during the following procedures.

1. Setup the motor for test as follows:
   a. Connect a voltmeter from the motor terminal to the motor frame.
   b. Use an RPM indicator to measure armature speed.
   c. Connect a carbon pile across one battery to limit battery voltage to 20 VDC.

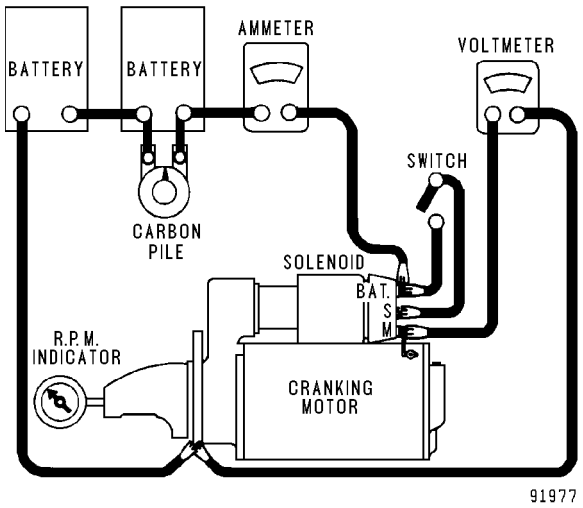


FIGURE 2-7. NO-LOAD TEST CIRCUIT

⚠ WARNING

Do not apply voltages in excess of 20 volts. Excessive voltage may cause the armature to throw windings.

   d. Connect the motor and an ammeter in series with two fully charged 12 volt batteries.
   e. Connect a switch in the open position from the solenoid battery terminal to the solenoid switch terminal.
2. Close the switch and compare the RPM, current, and voltage reading to the following specifications:
   - ❑ **RPM**: 5500 Minimum to 7500 Maximum
   - ❑ **AMPS**: 95 Minimum to 120 Maximum
   - ❑ **VOLTS**: 20 VDC

Interpreting Results of Tests

1. Rated current draw and no-load speed indicates normal condition of the cranking motor.
2. Low free speed and high current draw indicates:
   a. Too much friction; tight, dirty, or worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.
   b. Shorted armature. This can be further checked on a growler after disassembly.
   c. Grounded armature or fields. Check Further after disassembly.

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3. Failure to operate with high current draw indicates:
   a. A direct ground in the terminal or fields.
   b. “Frozen” bearings (this should have been determined by turning the armature by hand).
4. Failure to operate with no current draw indicates:
   a. Open field circuit. This can be checked after disassembly by inspecting internal connections and tracing circuit with a test lamp.
   b. Open armature coils. Inspect the commutator for badly burned bars after disassembly.
   c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.
5. Low no-load speed and low current draw indicates:
   a. High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under Number 4.
6. High free speed and high current draw indicates shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

Disassembly

The cranking motor should be disassembled only as far as necessary to repair or replace defective parts.

1. Note the relative position of the solenoid (53, Figure 2-8), lever housing (78), nose housing (69), and C.E. frame (1) so the motor can be reassembled in the same manner.
2. Disconnect field coil connector (42) from solenoid motor terminal, and lead from solenoid ground terminal.
3. Remove the brush inspection plug (52), and brush lead screws (15).
4. Remove the attaching bolts (34) and separate the commutator end frame (1) from the field frame (35).
5. Separate the nose housing (69) and field frame (35) from lever housing (78) by removing attaching bolts (70).
6. Remove armature (45) and drive assembly (71) from lever housing (78).
7. Separate solenoid (53) from lever housing by pulling apart.

FIGURE 2-8. CRANKING MOTOR ASSEMBLY

1. C.E. Frame
2. Washers
3. O-Rings
4. Insulator
5. Support Plate
6. Brush Plate Insulator
7. Washers
8. Plate & Stud
9. Plate
10. Brush Holder
11. Lockwasher
12. Screw
13. Brush (12 required)
14. Lockwasher
15. Screw
16. Brush Spring
17. Screw
18. Screw
19. Screw
20. Lockwashers
21. {;ate
22. Brush Holder Insulator
23. Screw
24. Lockwasher
25. Washer
26. O-Ring
27. Bushing
28. Insulator
29. Washer
30. Lockwasher
31. Nut
32. Nut
33. Lockwasher
34. Screw
35. Field Frame
36. Stud Terminal
37. Bushing
38. Gasket
39. Washers
40. Washers
41. Nut
42. Connector
43. Lockwasher
44. Nut
45. Armature
46. Field Coil
47. Shoe
48. Insulator
49. Screw
50. Washer
51. O-ring
52. Inspection Plug
53. Solenoid Housing
54. Lockwasher
55. Screw
56. Plunger
57. Washer
58. Boot
59. Washer
60. Spring
61. Retainer
62. Snap Ring
63. Shift Lever
64. Nut
65. O-Ring
66. O-Ring
67. Snap Ring
68. Lever Shaft
69. Drive Housing
70. Screw
71. Drive Assembly
72. Gasket
73. Plug
74. Gasket
75. Brake Washer
76. Screw
77. Lockwasher
78. Lever Housing
79. Washer
80. O-Ring

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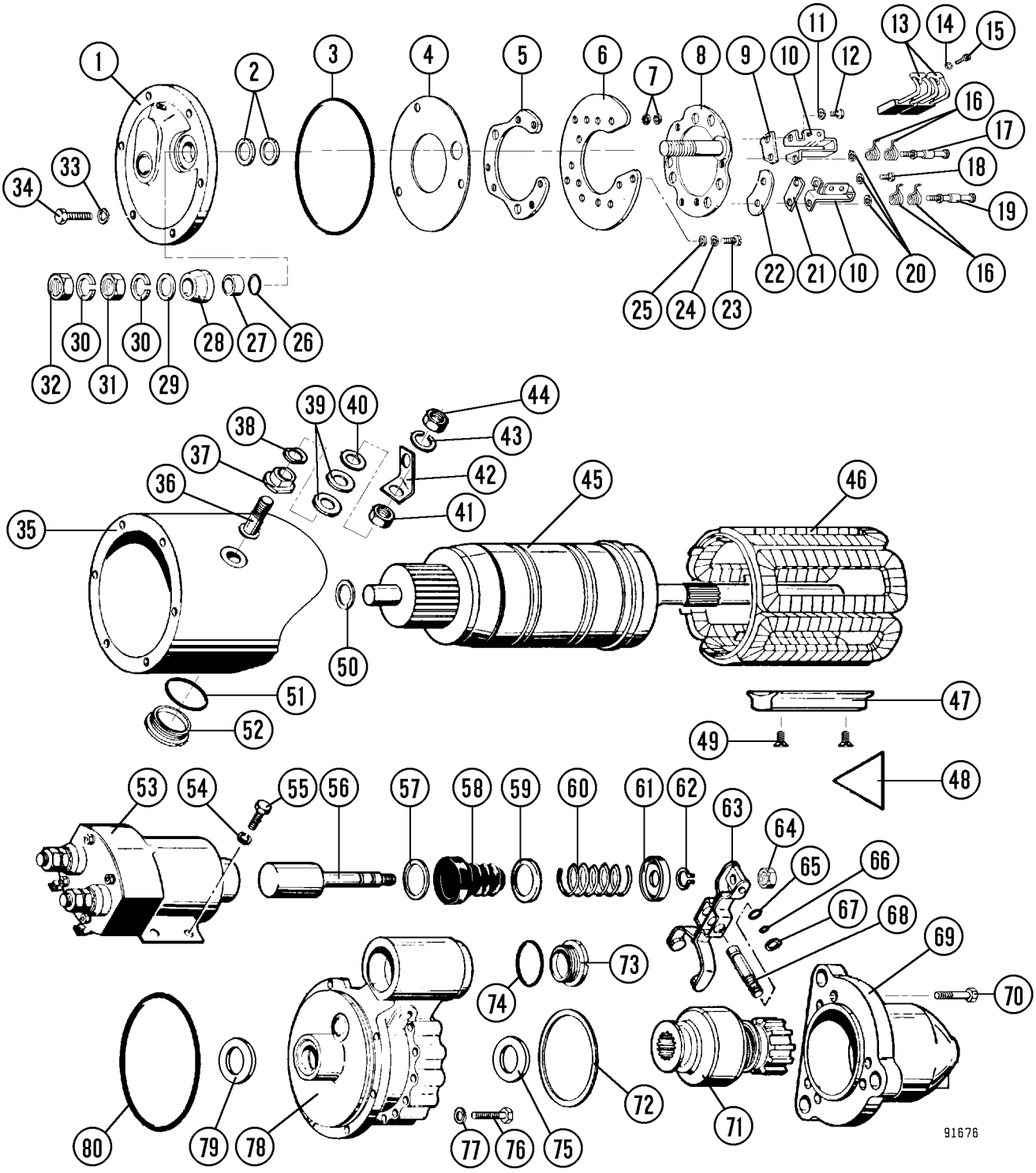


FIGURE 2-8 CRANKING MOTOR ASSEMBLY

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Cleaning and Inspection

1. The drive (71), armature (45) and fields (46) should not be cleaned in any degreasing tank, or with grease dissolving solvents, since these would dissolve the lubricant in the drive and damage the insulation in the armature and field coils.
2. All parts except the drive should be cleaned with mineral spirits and a clean cloth.
3. If the commutator is dirty, it may be cleaned with No. 00 sandpaper.

NOTE: Never use emery cloth to clean commutator.

4. Inspect the brushes (13, Figure 2-8) for wear.
   a. If worn excessively when compared with a new brush, they should be replaced.
   b. Make sure the brush holders (10) are clean and the brushes are not binding in the holders.
   c. The full brush surface should ride on the commutator. Check by hand to insure that the brush springs (16) are giving firm contact between the brushes (13) and commutator.
   d. If the springs (16) are distorted or discolored, they should be replaced.

Armature Servicing

If the armature commutator is worn, dirty, out of round, or has high insulation, the armature (45) should be put on a lathe and the commutator turned down. The insulation should then be undercut 0.031 in. (.79 mm) wide and 0.031 in. (.79 mm) deep, and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedure.

The armature should be checked for opens, short circuits and grounds as follows:

1. Opens are usually caused by excessively long cranking periods. The most likely place for an open to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of the commutator as the cranking motor is used. If the bars are not too badly burned, repair can often be effected by resoldering or welding the leads in the riser bars (using rosin flux), and turning down the commutator in a lathe to remove the burned material. The insulation should then be undercut.
2. Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots.
3. Grounds in the armature can be detected by the use of a 110-volt test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the cranking motor produced by excessively long cranking periods or by accumulation of brush dust between the commutator bars and the steel commutator ring.

Field Coil Checks

The field coils (46, Figure 2-8) can be checked for grounds and opens by using a test lamp.

1. **Grounds** - The ground connections must be disconnected during this check. Connect one lead of the 110 volt test lamp to the field frame (35) and the other lead to the field connector (42). If the lamp lights, at least one field coil is grounded and must be repaired or replaced.
2. **Opens** - Connect test lamp leads to ends of field coils (46). If lamp does not light, the field coils are open.

Field Coil Removal

Field coils can be removed from the field frame assembly by using a pole shoe screwdriver. A pole shoe spreader should also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place. Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

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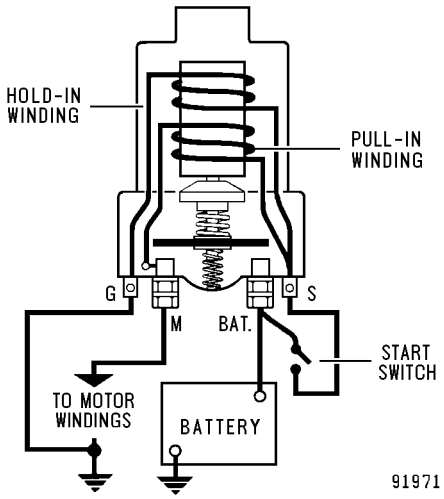


FIGURE 2-9. SIMPLIFIED SOLENOID CIRCUIT

Solenoid Checks

A basic solenoid circuit is shown in Figure 2-9. Solenoids can be checked electrically using the following procedure.

Test

1. With all leads disconnected from the solenoid, make test connections as shown to the solenoid, switch terminal and to the second switch terminal “G”, to check the hold-in winding (Figure 2-10).
2. Use the carbon pile to decrease the battery voltage to 20 volts. Close the switch and read current.

   ❑ The ammeter should read 6.8 amps maximum.
3. To check the pull-in winding, connect from the solenoid switch terminal “S” to the solenoid motor “M” or “MTR” terminal (Figure 2-11).

⚠WARNING

To prevent overheating, do not leave the pull-in winding energized more than 15 seconds. The current draw will decrease as the winding temperature increases.

4. Use the carbon pile to decrease the battery voltage to 5 volts. Close the switch and read current.

   ❑ The ammeter should read 9.0 to 11.5 amps.

NOTE: High readings indicate a shorted winding. Low readings indicate excessive resistance.

5. To check for grounds, move battery lead from “G” (Figure 2-10) and from “MTR” (Figure 2-11) to the solenoid case. Ammeter should read zero. If not, the winding is grounded.

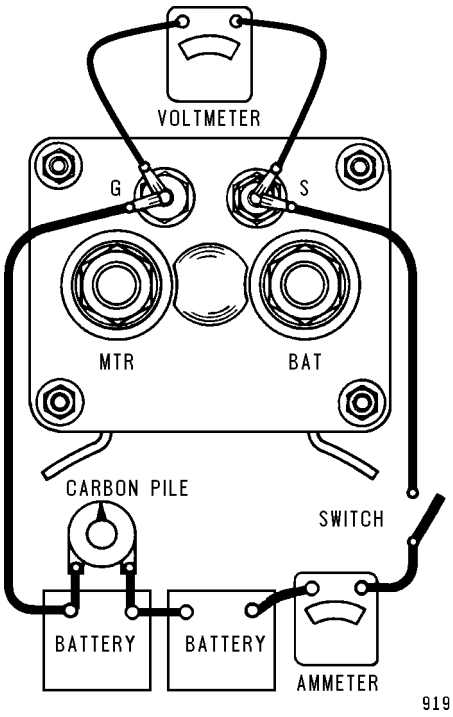


FIGURE 2-10. SOLENOID HOLD-IN WINDING TEST

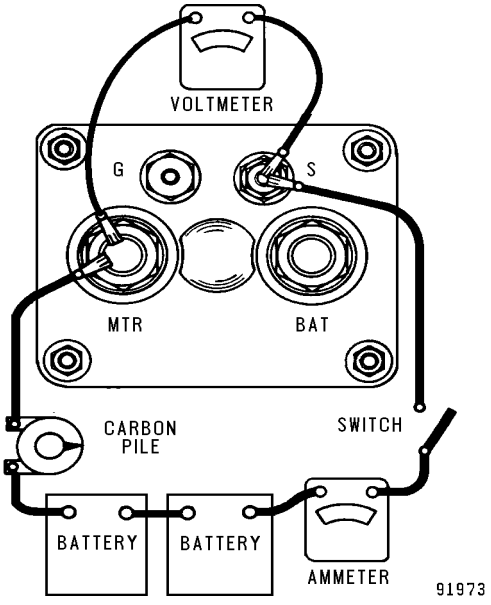


FIGURE 2-11. SOLENOID PULL-IN WINDING TEST

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Assembly

Lubricate all bearings, wicks and oil reservoirs with SAE No. 20 oil during assembly.

Bearing Replacement:

1. If any of the bronze bearings are to be replaced, dip each bearing in SAE No. 20 oil before pressing into place.
2. Install wick, soaked in oil, prior to installing bearings.
3. Do not attempt to drill or ream sintered bearings. These bearings are supplied to size. If drilled or reamed, the I.D. will be too large and the bearing pores will seal over.
4. Do not cross-drill bearings. Because the bearing is so highly porous, oil from the wick touching the outside bearing surface will bleed through and provide adequate lubrication.
5. The middle bearing is a support bearing used to prevent armature deflection during cranking. The clearance between this bearing and the armature shaft is large compared to the end frame bearings.

Motor Assembly:

1. Install the end frame (with brushes) onto the field frame as follows:
   a. Insert the armature (45, Figure 2-8) into the field frame (35). Pull the armature out of the field frame just far enough to permit the brushes to be placed over the commutator.
   b. Place the end frame (1) on the armature shaft. Slide end frame and armature into place against the field frame.
   c. Insert screws (34) and washers (33) and tighten securely.
2. Assemble lever (63) into lever housing (78) If removed.
3. Place washer (79) on armature shaft and install new O-ring (80). Position drive assembly (71) in lever (63) in lever housing. Apply a light coat of lubricant (Delco Remy Part No. 1960954) on washer(75) and install over armature shaft. Align lever housing with field frame and slide assembly over armature shaft. Secure with screws (76) and washers (77).
4. Assemble and install solenoid assembly through lever housing and attach to field frame. Install nut (64) but do not tighten at this time. Install brush inspection plugs (52).

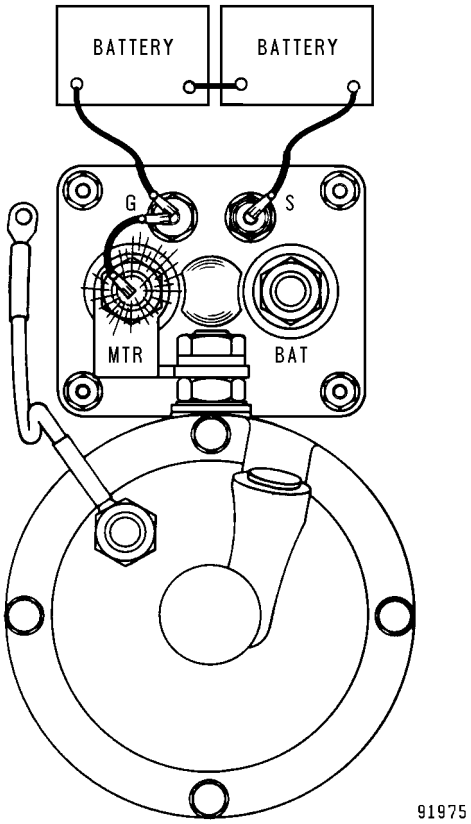


FIGURE 2-12. PINION CLEARANCE CHECK CIRCUIT

5. Using a new gasket (72), install drive housing (69) and secure with screws (70).
6. Assemble field coil connector (42) to solenoid.
7. Adjust pinion clearance per instructions on the following page.
8. After pinion clearance has been adjusted, install gasket (74) and plug(73).

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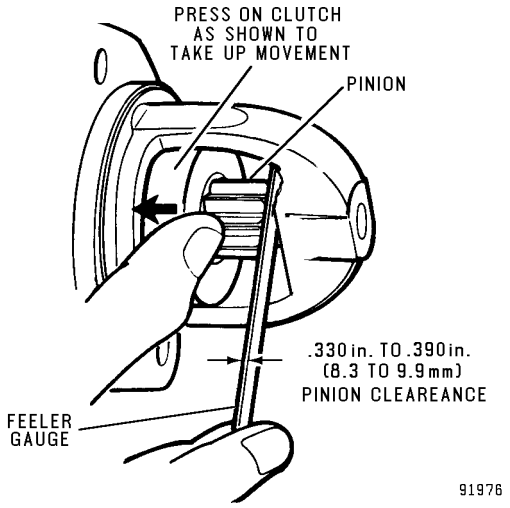


FIGURE 2-13. CHECKING PINION CLEARANCE

Pinion Clearance

To adjust pinion clearance, follow the steps listed below.

1. Make connections as shown in Figure 2-12.
2. Momentarily flash a jumper lead from terminal "G" to terminal "MTR". The drive will now shift into cranking position and remain so until the batteries are disconnected.
3. Push the pinion or drive back towards the commutator end to eliminate slack movement.
4. The distance between the drive pinion and housing should be between 0.330 in. to 0.390 in. (8.3 mm to 9.9 mm) as shown in Figure 2-13.
5. Adjust clearance by turning shaft nut (64, Figure 2-8).

MAGNETIC SWITCH

The magnetic switch is a sealed unit and not repairable.

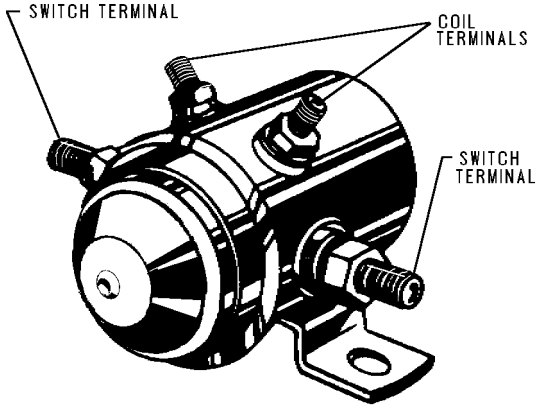


FIGURE 2-14. MAGNETIC SWITCH ASSEMBLY

Removal

1. Remove battery power as described in Cranking Motor "Removal".
2. Disconnect cables from the switch terminals and wires from coil terminals (Figure 2-14).

NOTE: If the magnetic switch being removed has a diode across the coil terminals, mark the leads prior to removal to ensure correct polarity during installation.

3. Remove mounting capscrews and washers. Remove switch from mounting bracket.
4. The switch coil circuit can be tested as described below.

Installation

1. Attach magnetic switch to the mounting bracket using the capscrews and lockwashers removed previously.
2. Inspect cables and switch terminals. Clean as required and install cables.
3. Install the diode across the coil terminals. Be certain diode polarity is correct. Attach wires from the truck harness to the coil terminals (See Figure 2-5).
4. Connect battery power as described in Cranking Motor "Installation".

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Coil Test

1. Using an ohmmeter, measure the coil resistance across the coil terminals.
   a. The coil should read approximately 28Ω at 72°F (22.2° C).
   b. If the ohmmeter reads ∞, the coil is open and the switch must be replaced.
   c. If the ohmmeter reads 0 Ω, the coil is shorted and the switch must be replaced.
2. Place one of the ohmmeter probes on a coil terminal and another on the switch mounting bracket. If the meter displays any resistance reading, the coil is grounded and the switch must be replaced.
3. The ohmmeter should display when the probes are placed across the switch terminals.

NOTE: The switch terminals should show continuity when 24 VDC is applied to the coil terminals, however high resistance across the internal switch contacts due to arcing etc. could prevent the switch from delivering adequate current to the cranking motor. If the coil tests are satisfactory but the switch is still suspect, it should be replaced with a new part.

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24 VDC ELECTRICAL SYSTEM COMPONENTS

PASSENGER SEAT BASE COMPARTMENT

The 24 VDC electrical system components shown in Figure 3-1 are accessed by unlatching the passenger seat base lid and tilting the passenger seat forward.

The electrical schematics in Section R should be used when troubleshooting problems with the following components.

COMPONENTS

TAIL LIGHT RESISTOR DIODE ASSEMBLIES

The tail light resistor diode assembly RD1, RD2 (2, Figure 3-1) is a circuit designed to vary the intensity of each of the stop/tail lamp bulbs.

With the tail lights on, a resistor in series with the lamp reduces voltage supplied to the lamp, thereby reducing the lamp intensity. When the service brakes are applied and the stop lights are activated, current flows from the stop light relay, through a diode, bypassing the resistor and applies 24 VDC to the lamp filament.

RD1 controls the left lamp and RD2 controls the right lamp. No adjustments are available or necessary.

INCLINOMETER

The inclinometer (8) is used by the on-board load weighing system to determine whether the truck is on a level surface or tilted fore or aft. The information provided by the inclinometer is sent to the weighing system for use in calculating the payload. Refer to Section M for detailed information on the inclinometer and on board load weighing system.

BRAKE WARNING BUZZER (BWB)

The brake warning buzzer (11) provides an audible alarm for the operator if a malfunction occurs in the hydraulic service brake system. Refer to Section J for additional operational details.

LUBRICATION SYSTEM TIMER

Automatic Lubrication System lubrication interval is controlled by the timer (17, Figure 3-1). Lubrication cycle frequency can be adjusted by removing the timer cover and selecting one of five different timing intervals available. System “on” time is automatically determined by the timer and is not adjustable. Refer to Section “P” for additional automatic lubrication system details.

5 MINUTE IDLE TIMER COMPONENTS

The 5 minute idle timer circuit automatically provides approximately 5 minutes engine idle time before actual engine shutdown occurs. This system allows the engine cooling system to circulate coolant to reduce and stabilize engine component temperatures, when engine power requirements are minimal, resulting in extended engine life.

The circuit is controlled by a 3-position rocker switch. Pressing the bottom of the switch will turn the circuit OFF. The engine will shut down by use of the Key Switch, console mounted Engine Shutdown Switch, or the Ground Level Shutdown Switch.

With the rocker switch in the middle position, the circuit is ON, but does not activate the 5 minute idle timer circuit. The engine can be shut down immediately using any one of the three switches described above.

When the top of the switch is depressed and held momentarily, the idle timer circuit is activated. At the same time, the operator must turn the keyswitch to the OFF position. When released, the rocker switch will return to the ON (middle) position, and the 5 minute idle timer circuit is latched on through the switch. The amber “5 Minute Idle Timer” lamp in the overhead display will illuminate. The engine will then shut down after the 5 minute period.

However, if during the 5 minute idle timing sequence, the 5 minute delay switch (on the instrument panel) is pressed to the OFF position, the console shutdown switch is depressed, or the Ground Level Shutdown switch is activated, the engine will shut down immediately, followed by the normal shutdown of all systems.

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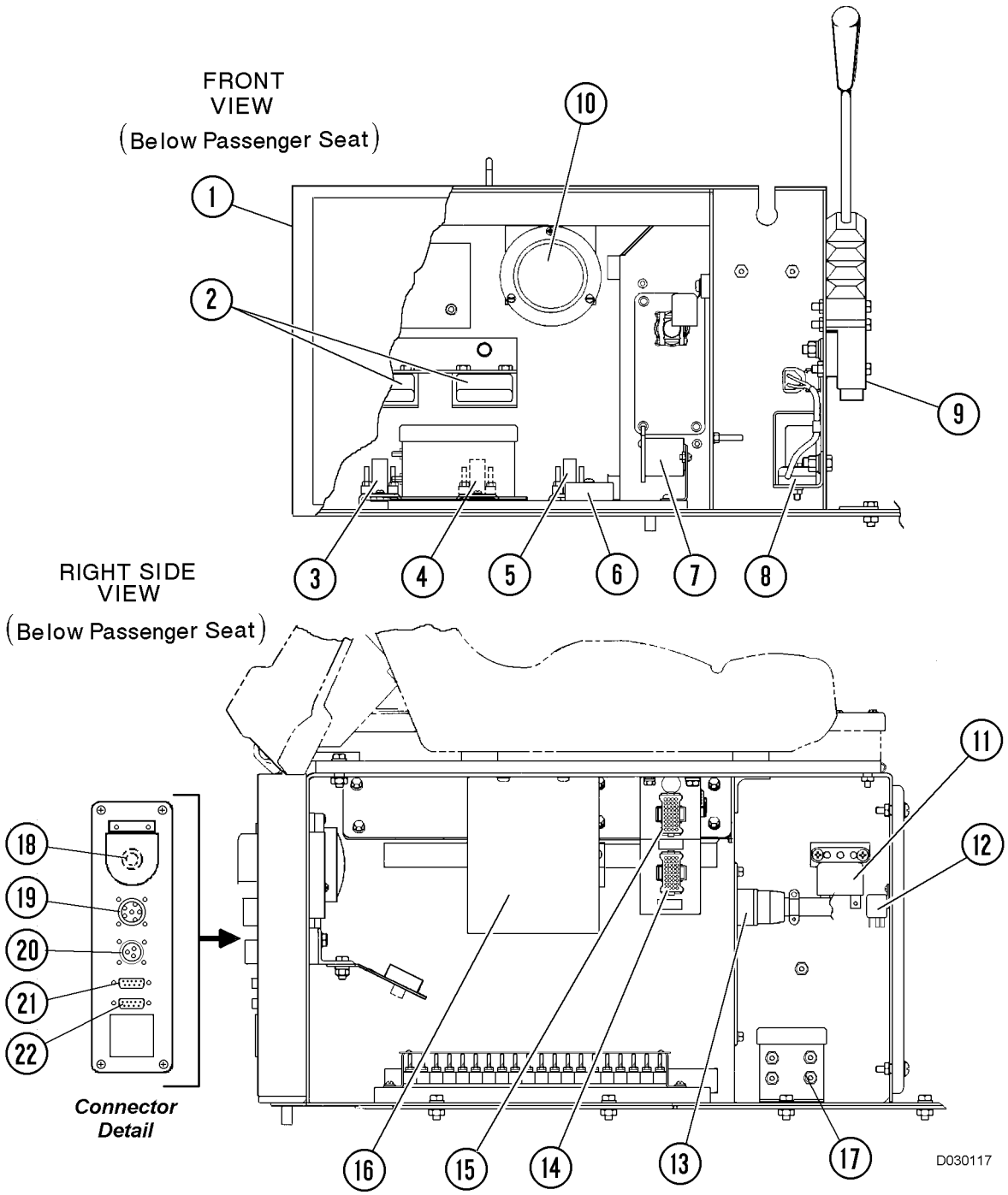


FIGURE 3-1. PASSENGER SEAT BASE COMPARTMENT

1. Seat Base
2. Tail Light Resistor/Diodes (RD1/RD2)
3. Terminal Board (TB13)
4. Terminal Board (TB12)
5. Terminal Board (TB11)
6. 5 Minute Idle Timer
7. 5 Minute Idle Contactor
8. Inclinometer
9. Hoist Control
10. Compartment Service Light
11. Brake Warning Buzzer (BWB)
12. 5 Minute Idle Relay
13. Connector (RP226)
14. Connector (RP231)
15. Connector (RP230)
16. AID Module
17. Lube System Cycle Timer
18. Data Store Switch
19. QUANTUM Diagnostic Port (Engine)
20. CENSE Diagnostic Port (Engine)
21. G.E. Propulsion System Diagnostic Port
22. For Optional Equipment

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5 Minute Idle Timer

The 5 minute idle timer (6) circuit is activated when the operator presses the 5 minute idle timer engine shutdown switch mounted on the instrument panel. (This is a momentary switch that also latches the 5 minute idle timer in the energized position.) When the timer is energized, internal contacts close and energize the relay and contactor described below.

5 Minute Idle Relay

The relay (12) contacts close when the idle delay timer is energized. When the contacts are closed, the AID system indicator light circuit (12M) is grounded through the “5 minute idle timer” indicator lamp on the overhead display, turning the lamp on.

5 Minute Idle Contactor

The contactor (7) energizes the idle timer and maintains current flow to the engine “run” circuit if the operator turns the key switch off.

5 MINUTE IDLE CIRCUIT TEST

Check 5 minute idle timer circuits as follows:

1. With the key switch ON, press the Engine Shutdown switch firmly to the momentary position and release (switch will return to the ON position).
2. Turn the key switch OFF and verify the following:
   - ❑ Circuit 712 (to ground) remains 24 volts for approximately 5 minutes. After 5 minutes, the voltage drops to 0.
   - ❑ The 5 minute idle indicator lamp on the overhead display is ON when circuit 712 reads 24 volts.
3. Repeat step 1. While monitoring voltage at circuit 712, turn the key switch OFF. Turn the engine shutdown switch off.
   - ❑ Verify voltage at circuit 712 drops to 0 when the shutdown switch is turned to OFF.

DATA STORE SWITCH

The Data Store switch (18) allows a technician to store propulsion system event data during truck operation while troubleshooting the system. Refer to Section “E” for additional information.

KOMATSU ENGINE QUANTUM CONNECTOR

This connector (19) is for use by qualified personnel to access engine diagnostic information for the QUANTUM system. Refer to engine manufacturer’s service publications for troubleshooting information.

KOMATSU ENGINE CENSE CONNECTOR

This 3-pin connector (20) is for use by qualified personnel to access engine diagnostic information for the CENSE system. Refer to engine manufacturer’s service publications for troubleshooting information.

STATEX III PROPULSION SYSTEM DIAGNOSTIC CONNECTOR

This 9-pin connector (21) is for use by qualified personnel to access G.E. STATEX III electric propulsion system diagnostic information and data. Refer to Section “E” for additional information.

SPARE CONNECTOR LOCATION

This connector (22) location may be used for optional equipment installed on the truck such as a Modular Mining Dispatch system.

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ALARM INDICATING DEVICE (AID) SYSTEM

The Alarm Indicating Device (16) is connected to the electrical accessories circuits to provide the operator with a warning indication of a malfunction. This system consists of up to eight printed circuit cards, located under the passenger seat in the operators cab. The actual quantity of cards will depend on options installed on the truck.

The AID system enables the indicating lights to be flashing or constant. The AID also has the capability of operating an audible alarm along with the light. The eight printed circuit cards are (refer to Figure 3-2):

- Diode Matrix (With Sound) Card . . . . . (Slot 1)
- Diode Matrix (Without Sound) Card . . . (Slot 2)
- Hot Switch Inverter Card . . . . . (Slot 3)
- Hot Switch Inverter Card . . . (Slot 4) (Not Used)
- Temperature Card . . . . . (Slot 5)
- Oil Level Card . . . . . (Slot 6)
- Temperature and Latch Card . . . . . (Slot 7)
- Coolant Level and Flasher Card . . . . . (Slot 8)

NOTE: Each card is identified with a number which corresponds with a mating number on the housing. If cards are removed, make sure card numbers correspond with housing numbers during installation (See Figure 3-2).

The following information briefly describes each card and its function. Refer to Section “R” for circuit components described below.

⚠CAUTION

Prior to welding on the truck, disconnect the AID system plug-in cards.

Diode Matrix (Without Sound)

The Diode Matrix Without Sound Card (2, Figure 3-2) consists of a series of diodes capable of working with eight different indicator circuits. The indicator light can be a flashing light by connecting it to the 12F circuit or a steady light by connecting it to the 12M circuit. In addition, some of the indicator light circuits are routed through a dimmer module to allow the operator to vary the intensity of the lamps. These lamps are fed by circuits 12FD (flashing) and 12MD (steady).

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

Diode Matrix (With Sound)

The Diode Matrix With Sound Card (1, Figure 3-2) works very much like the other Diode Matrix Card, except that it contains extra diodes to activate the alarm horn in addition to the flasher. The circuits connected to terminals A1 through A8 operate in the same manner.

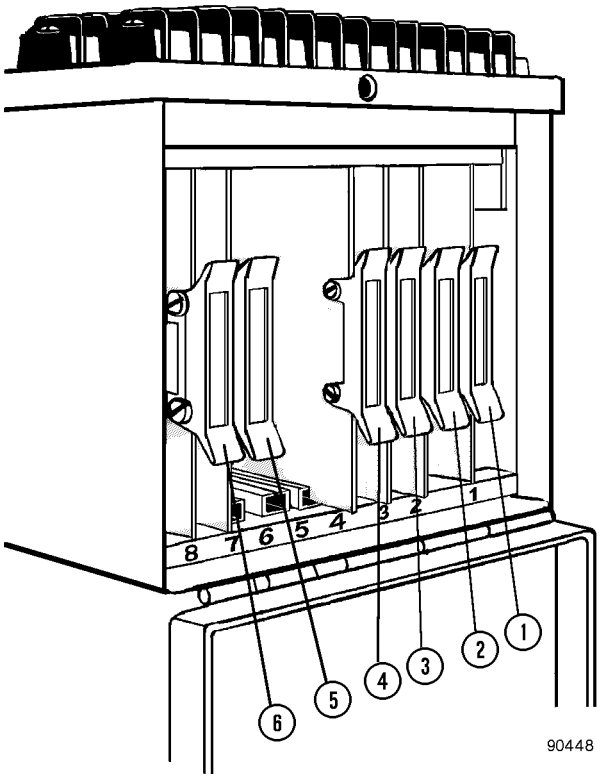


FIGURE 3-2. AID SYSTEM CARD ENCLOSURE

1. Diode Matrix With Sound
2. Diode Matrix Without Sound
3. Hot Switch Inverter
4. Hot Switch Inverter (Not Used)
5. Temperature & Latch
6. Coolant Level & Flasher

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Hot Switch Inverter

The Hot Switch Inverter Card in slot 3 (3, Figure 3-2) is used to operate and test the service brake indicator light. In normal conditions Q4 transistor is off and the Indicator Light is off. When the stoplight switch is activated, 24 volts is sent to pin “E” of the Hot Switch Inverter Card. Transistor Q4 is turned on by this voltage and, in turn, grounds the service brake Indicator Light. There is no alarm horn operation with this card.

A second circuit on this card is used to operate and test the Retard Speed Control indicator light. When RSC is turned Off, transistor Q7 is off and the indicator light is off. When RSC is turned on, 24 volts is sent to pin “J” of the card. This voltage turns on Q7, grounding the indicator light circuit.

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

Temperature

The Temperature Card is used to turn on the High Oil Temperature Indicator Light. The indicator light tells the operator hydraulic tank oil temperature has exceeded acceptable levels. Normal temperature setting is 204°F (96°C). As the temperature goes up the resistance in the probe decreases providing a ground path for the indicator light and alarm horn.

Oil Level

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

Temperature and Latch

The Temperature and Latch Card (5, Figure 3-2) has two circuits to operate two different indicating lights. The temperature circuit is controlled by a coolant temperature sensor which decreases electrical resistance as its temperature increases. It will have a resistance of approximately 1000 ohms at 185°F (85°C) and 500 ohms at 250°F (122°C). Normal setting is 204°F (96°C).

When the temperature is low and the resistance is high, Q1 is off and no high temperature indication occurs. When the coolant temperature is excessive, resistance decreases to a point where Q1 will turn on and ground the flasher through D8, the alarm horn through D12, and the High Temperature Light through terminal D8. R14 can adjust the temperature (resistance) at which the circuit is activated.

NOTE: Some electronic engine controls monitor coolant temperature. If the engine controls monitor the circuit, a 2KΩ resistor is installed to replace the temperature sensor and disable the AID system circuit.

The Latch Circuit monitors the accumulator precharge pressure switches. When one of the pressure switches closes, Q5 will be turned off which supplies power to the gate of SCR Q7. With Q7 turned on, Q9 will supply the ground path to turn on the Low Accumulator Precharge Indicator Light and sound the alarm horn. The Indicator Light is connected to 12F and will flash off and on. The SCR will remain on until power is removed from the card by turning the key switch “Off”.

Coolant Level/Flasher

The Coolant Level and Flasher Card (6, Figure 3-2) contains two separate circuits. The flasher circuit at the top of the card has Q12 transistor biased to be saturated when no malfunction is present, resulting in there being 24 volt positive output on pin “H” of the card and on wire 12F. When a indicating circuit is activated, the ground side of the circuit connected to card pin “K” is grounded. Q12 will turn off initially and then after a delay, adjusted by R20, will turn on and off to give the intermittent 24 volt output.

The other half of the circuitry on the Coolant Level and Flasher Card operates the Coolant Level Light. The Water Level Probe connected to terminal B11 grounds the 31L circuit when the coolant in the radiator is above the probe position. The coolant saturates the probe and electrically grounds the circuit. When the circuit is grounded, Q6 transistor is off, resulting in no indication. When the coolant level drops below the probe, 31L is no longer grounded and Q6 turns on to ground the flasher through D5, ground the Coolant Level Light through terminal D11, and ground the alarm horn through D6. The light and alarm horn will operate intermittently as their 24 volt supply is from circuit 12F, the flasher output.

NOTE: Some electronic engine controls monitor coolant level. If the engine controls monitor the circuit, a 2KΩ resistor is installed to replace the probe and disable the AID system circuit.

Lamp Test

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

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BATTERY EQUALIZER BOX

Most truck control and accessory circuits operate at 24VDC. However, a 12VDC Power Source is available for the cigar lighter socket, power window motors, and AM/FM, communications and dispatch radios.

For this purpose, a battery equalizer system is utilized to obtain the required 12VDC and insure that the two pairs of 12 volt, series wired batteries are charged and discharged equally.

The battery equalizer is mounted in a box on the right hand deck. This box also contains the DDEC circuit breakers (when equipped with DDC 4000 engine), 12VDC control relay, 12VDC circuit breaker, and the main battery disconnect switch. (See Figure 3-3.)

Troubleshooting

Refer to the “Battery” information in this section of the manual for detailed instructions regarding proper battery maintenance and service procedures. Prior to troubleshooting the battery equalizer system, inspect all battery circuit connections for excessive corrosion, loose cables, ground connections etc.

Use the following procedure to check the battery equalizer.

1. Check the circuit breakers.
   a. If a circuit breaker has opened, check circuits and repair cause.
   b. Reset circuit breaker.
2. Check battery voltage with the battery equalizer connected and the engine running.
   a. Verify battery charging alternator output is 27.8 to 28.2 volts.
3. If alternator voltage is outside above limits, adjust voltage regulator as described in *“Battery Charging System”.*
4. With the engine running, verify voltages at the battery equalizer terminals.
   a. Measure the voltage between the 24 volt and 12 volt terminals.
   b. Measure the voltage between the 12 volt terminal and ground.
5. If the difference between the voltage measurements above exceeds 0.75 volts, the battery equalizer is defective and should be replaced.

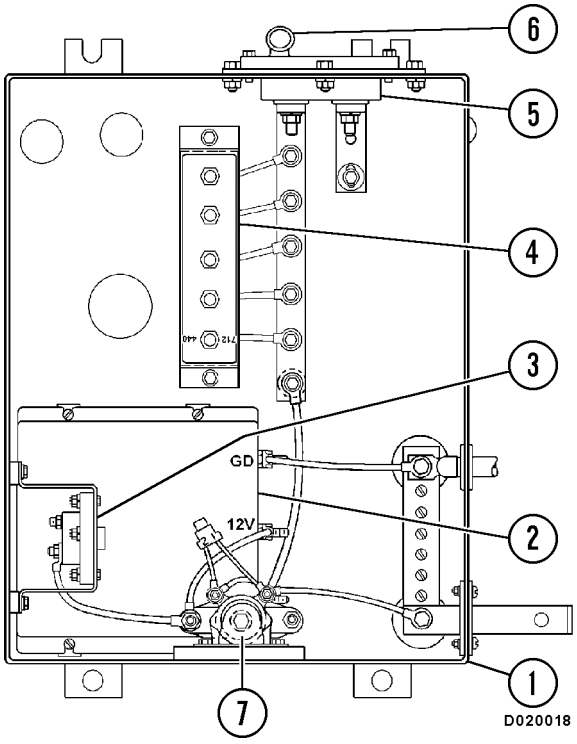


FIGURE 3-3. BATTERY EQUALIZER BOX

1. Battery Equalizer Box Assembly
2. Battery Equalizer
3. Circuit Breaker
4. Circuit Breaker Panel
5. Battery Disconnect Switch
6. Disconnect Switch Handle
7. 12VDC Control Relay

⚠CAUTION

Always open main battery disconnect switch prior to removing or connecting any wires or cables in the Battery Equalizer box or prior to welding on the truck.

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BODY-UP SWITCH

The body-up switch is designed to prevent propulsion in “Reverse” with the dump body raised. This switch also prevents forward propulsion unless the override button is depressed and held.

The body-up switch, located on the right frame rail ahead of the body guide, must be adjusted to within limits. Improper adjustment or loose mounting bolts may cause false signals or damage to the body-up switch assembly. The switch should be checked daily and the sensing area cleaned of any dirt or metallic dust accumulation.

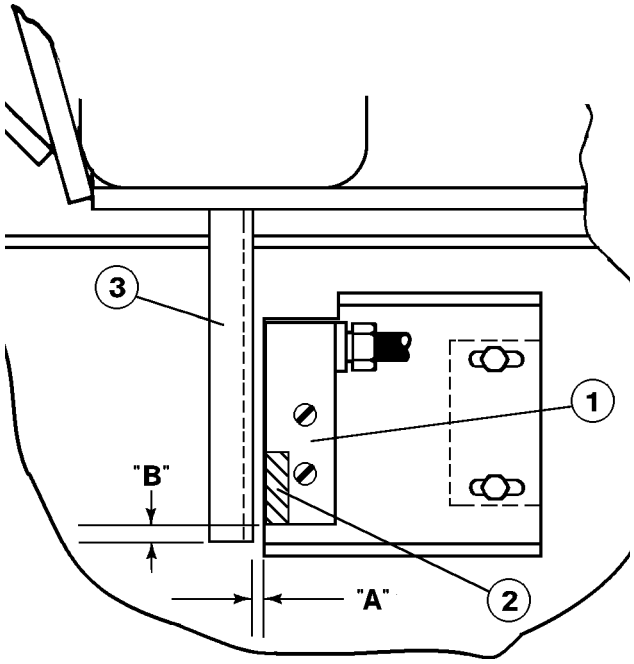


FIGURE 3-4. BODY-UP SWITCH ADJUSTMENT

1. Proximity Switch
2. Sensing Area
3. Actuator

Adjustment

Adjust the proximity switch bracket to maintain an air gap (Dimension “A”, Figure 3-4) between the sensing area and actuator bracket, of between 0.50 in. (12.7 mm) minimum and 0.62 in. (15.7 mm) maximum. Set up measurement “B” should be approximately 1.00 in. (25.4 mm).

Service

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

HOIST LIMIT SWITCH

The hoist limit switch actuates a solenoid in the hoist circuit to stop the hoist cylinders short of full extension and prevent possible damage to the dump body or hoist cylinders.

The hoist limit switch is located inside the right frame rail above the rear suspension. The switch must be properly adjusted at all times. Improper adjustment or loose mounting bolts may cause false signals or damage to the switch assembly.

The hoist limit switch should be checked daily and the sensing area cleaned of any dirt or metallic dust accumulation.

Adjustment

With body raised and hoist cylinders within 10 in. (254 mm) of maximum travel, make the following adjustments:

Adjust the proximity switch bracket to maintain an air gap (Dimension “A”, Figure 3-5) between the sensing area and actuator bracket, of between 0.50 in. (12.7 mm) minimum and 0.62 in. (15.7 mm) maximum. Set up measurement “B” should be approximately 1.50 in. (38.1 mm).

Service

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

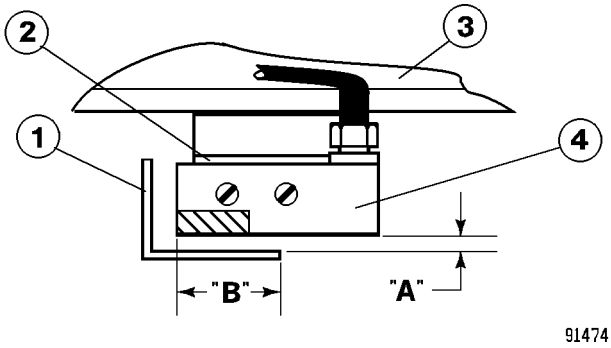


FIGURE 3-5. HOIST LIMIT SWITCH ADJUSTMENT

1. Actuator (On Body)
2. Mounting Bracket
3. Frame
4. Proximity Switch

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24 VOLT RELAY AND DIODE BOARDS

The truck is equipped with 5 relay boards and a diode board to provide control in many of the 24 volt electrical system circuits. Some trucks may have a sixth (Auxiliary) relay board installed.

Each relay board contains 4 relays, all of which are interchangeable.

Each relay board also contains circuit breakers, which are also interchangeable between the relay boards.

⚠WARNING

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

The six relay boards and their primary use are identified as follows:

- Relay Board 1 . . . . . Turn Signal
- Relay Board 2 . . . . . Payload Meter
- Relay Board 3 . . . . . .Stop Lights
- Relay Board 4 . . . . . Parking Brake
- Relay Board 5 . . . . . Head Lights
- Relay Board 6 . . . . . .Auxiliary Panel

The truck is also equipped with a diode board:

- Diode Board 1

Refer to *"Table I, Circuit Breakers"* for the circuits each circuit breaker protects.

RELAY BOARDS

Description

Each relay board is equipped with four green lights (9, Figure 3-6) and one red light (7). The four green lights are labeled K1, K2, K3, or K4. These lights will be "ON" only when that particular control circuit has been switched "ON" and the relay coil is being energized. The light will not turn on if the relay board does not receive the 24 volt signal to turn "ON" a component, or if the relay coil has an "open" circuit.

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

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

- ❑ Check for a circuit breaker that is in the "OFF" position or a red (breaker open) light is "ON". If a circuit breaker is "OFF", turn it "ON". Check operation of component. If it trips again, check the wiring or component for defects that could be causing the circuit to be overloaded.
- ❑ The contacts inside the relay may not be closing, preventing an electrical connection. Swap relays and check again. Replace defective relays.
- ❑ Check the wiring and all of the connections between the relay board and the component for an "open" circuit.
- ❑ Defective component. Replace component.
- ❑ Poor ground at the component. Repair the ground connection.

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SERVICE

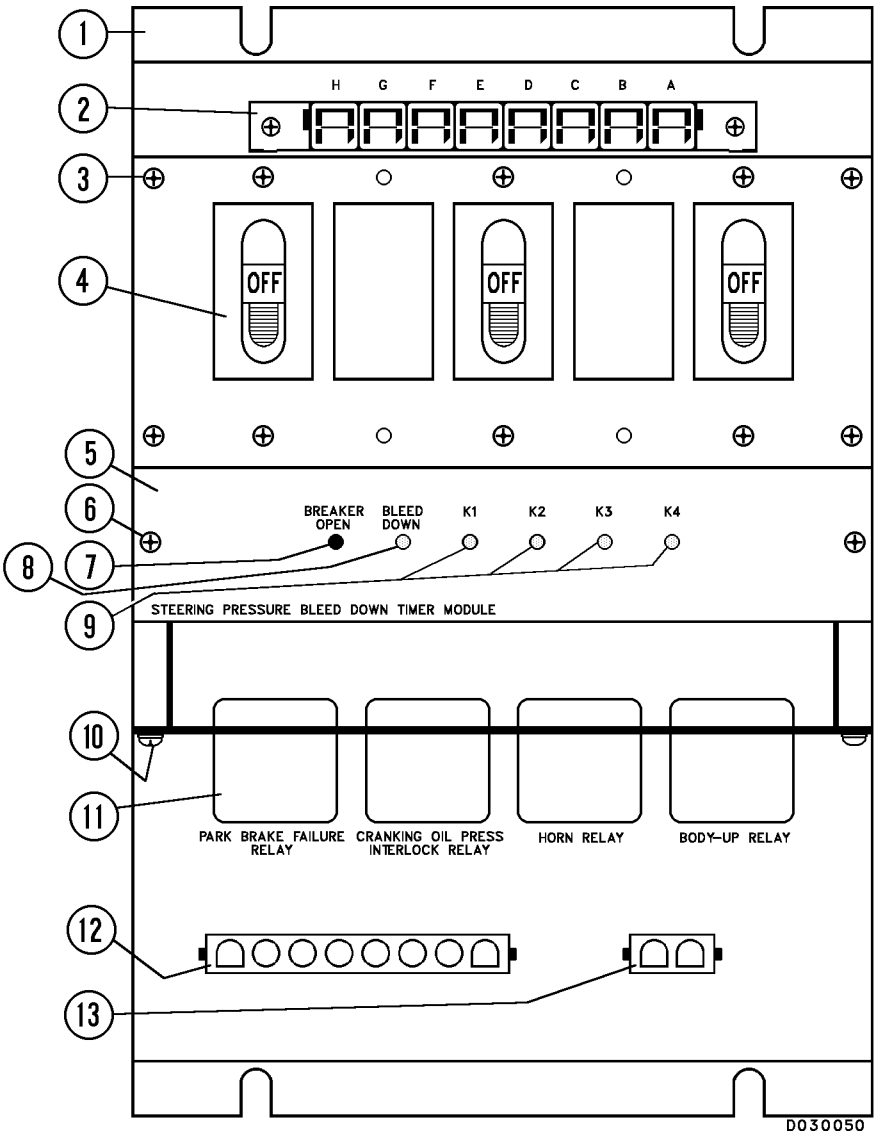
To replace a relay:

1. Remove one screw (10, Figure 3-6) holding the crossbar in place and loosen the other screw.
2. Swing crossbar away.
3. Gently wiggle and pull upward to remove relay (11).
4. Line up tabs and install new relay.
5. Place crossbar in original position and install screw (10) that was removed and tighten both screws.

To replace a circuit breaker:

NOTE: Always replace a circuit breaker with one of the same amperage capacity as the one being removed.

1. Place battery disconnect switch in the “OFF” position.
2. Unplug all wiring harness(es) from relay board. Remove four relay mounting screws and remove relay board from truck.
3. Remove four hold down screws (3) (one in each corner) in circuit breaker cover plate and all circuit breaker screws. Remove cover plate from circuit breakers.



1. Relay Board
2. Main Harness Connector
3. Screw
4. Circuit Breaker
5. Circuit Panel Card
6. Screw
7. Breaker Open Light (RED)
8. Bleed Down Light (GREEN)
9. K1, K2, K3, K4 Lights (GREEN)
10. Screw
11. Relay
12. Harness Connector
13. Harness Connector

FIGURE 3-6. TYPICAL RELAY BOARD

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4. Remove nuts and star washer from back side of circuit board that holds the breaker in place.
5. Lift out circuit breaker. Retain flat washers that were between inner circuit breaker nut and relay board.
6. Install one nut and two flat washers to each pole on the circuit breaker. Nuts must be adjusted to the same height as on the other circuit breakers. This is necessary so when cover plate is installed, it will not press circuit breaker into, or pull up on, the circuit board. Install new circuit breaker of the same capacity rating as the one removed.
7. Install star washer and nut to circuit breaker poles (on the back side) and tighten nuts.
8. Install cover plate and all screws removed during disassembly.

To replace a circuit panel card

DO NOT remove the small screws that hold the cover plate to the circuit panel. Replace circuit panel as a complete assembly.

1. Place battery disconnect switch in the “OFF” position.
2. Remove the two mounting screws (6, Figure 3-6) and carefully remove the circuit panel card from the relay board.
3. Line up the new circuit panel in slots and with the socket on the relay board and install carefully.
4. Install two mounting screws (6).

RELAY BOARD COMPONENTS

Relay Board 1 . . . . . Turn Signal

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

- K1 light will be “ON” during right turn signal operation
- K2 light will be “ON” during left turn signal operation
- K4 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

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

Relay Board 2 . . . . . Payload Meter

1 - Data Storage Module card.

1 - Payload Stored Light (Green): This light is “ON” for one second when the payload meter actually stores the load data into memory.

1 - 5 amp circuit breaker (CB29) (To payload meter)

1 - 15 amp circuit breaker (CB28) (To all light relays)

4 - Relays

- Light Relay 1 (Green) . . . . . (K1)
- Light Relay 2 (Amber) . . . . . (K2)
- Light Relay 3 (Red) . . . . . (K3)
- Light Control Relay . . . . . (K4)

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Relay Board 3. . . . . Stop Lights

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 Light Relay . . . . . (K2)
- Retard Light Relay . . . . . (K3)
- Slippery Road Relay . . . . . (K4)
  (Not installed on all trucks)

Relay Board 4. . . . . Parking Brake

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 two to three minutes after key switch is turned “OFF”.

2 - 5 amp circuit breakers (CB20, CB22)

1 - 15 amp circuit breaker (CB21)

4 - Relays

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

Relay Board 5 . . . . . .Head Lights

1 - Light Display Module card

1 - Lights Control Light (Green): This light is “ON” when there is 24 volts 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)

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Relay Board 6 . . . . . Auxiliary Panel

If the Auxiliary Panel, Relay Board 6 is installed, additional circuits may be added by utilizing the empty relay terminals provided. (Refer to Figure 3-7.)

To add an additional circuit with a relay, connect the wires as described below:

The coil circuit for the relay is the "+" and "-" terminal:

- ❑ "+" terminal is for positive voltage.
- ❑ "-" terminal is for grounding of the control circuit.

Either circuit can be switched "open" or "closed" to control the position of the relay.

The terminals of the switched circuit from the relay contacts are labeled as follows:

- ❑ NC - Normally Closed
- ❑ COM - Common
- ❑ NO - Normally Open

- "COM" terminal is for the voltage source (protected by a circuit breaker) coming into the relay which will supply the electrical power for the component being controlled.
- "NC" terminal is connected (through the relay) to the "COM" terminal when the relay is not energized (when the control circuit terminals "+" & "-") are not activated).
- "NO" terminal is connected (through the relay) to the "COM" terminal when the relay is energized (by the control circuits "+" & "-") being energized).

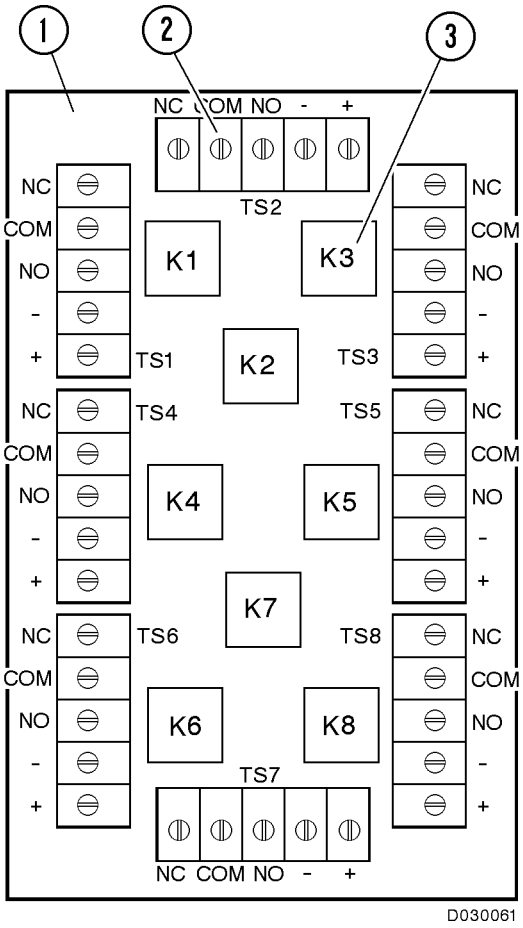


FIGURE 3-7. RELAY BOARD 6

1. Relay Board (RB6)
2. Terminal Strips (TS1 - TS8)
3. Relays (K1 - K8)

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DIODE BOARD 1

The truck is equipped with a diode board (1, Figure 3-8) containing replaceable diodes (4). Some of the diodes are used in the coil circuit of various relays to suppress the resultant coil voltage spike when power is removed from the circuit, preventing damage to other circuit components (lamp filaments etc.). Other diodes are used to control the flow of current in a circuit as required. Resistors may also be installed in sockets P7 through P12 (3).

Diode Testing

Refer to the electrical schematic in Section R of this manual for the specific circuit and diode to be tested.

If a diode failure is suspected, remove and check the diode as follows:

1. Grasp the diode connector, compressing the locking “ears” while pulling the connector off the board. Note the connector “key” used to ensure correct polarity.

NOTE: Some digital multimeters are designed to test diodes. If this type is used, follow the manufacturer's instructions for proper test.

2. An analog ohmmeter can be used to test the diode as follows:
   a. Place the meter on the “X100” scale.
   b. With the red meter lead (+) on the banded end of the diode and the black lead (-) on the other diode lead, the meter should read between 1000 and 2000 ohms.
   c. Reverse the meter leads and read infinite resistance.
3. If no resistance is read on the meter, the diode is open and must be replaced.
4. If the meter reads zero ohms, the diode is shorted and must be replaced.
5. Orient the diode assembly for proper polarity (“key” noted in step 1.) and insert connector until locked in position on mating receptacle.

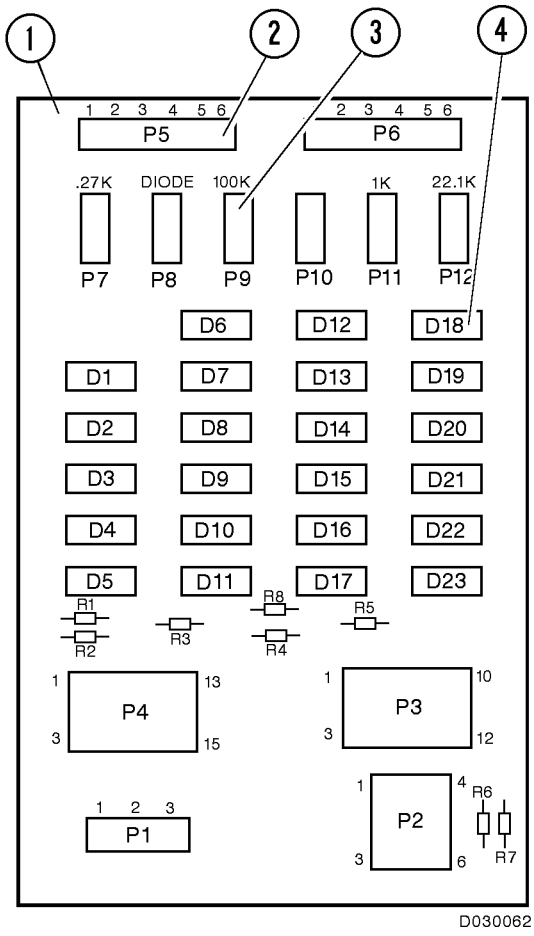


FIGURE 3-8. DIODE BOARD 1

1. Diode Board (DB1)
2. Connectors (P1 - P6)
3. Sockets (P7 - P12)
4. Diodes (D1 - D23)

CIRCUIT BREAKERS

Table I on the following page lists the circuit breakers on the truck, their function and location.

Additional circuit information can be found in Section “R”, Electrical Schematics.

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TABLE I. CIRCUIT BREAKERS

	AMPS	DEVICE(S) PROTECTED	LOCATION
CB13	15	Turn Signal & Clearance Lights	RB1, Control Cabinet
CB14	15	Flashing Lights	RB1, Control Cabinet
CB15	15	RD1, RD2, & Tail Lights	RB1, Control Cabinet
CB16	15	Dynamic Retard Lights	RB3, Control Cabinet
CB17	15	Manual Back-up Lights	RB3, Control Cabinet
CB18	15	Stop Lights	RB3, Control Cabinet
CB19	15	Back-up Horn	RB3, Control Cabinet
CB20	5	Parking Brake Failure Relay	RB4, Control Cabinet
CB21	15	Fluid Components Cabinet Service Lights, Rear Axle Service Light, Horn Solenoid, Steering Accumulator Bleed Down Solenoid, Horn	RB4, Control Cabinet
CB22	5	DDEC Master ECM Control Power (DDEC Engine Only)	RB4, Control Cabinet
CB23	15	Low Beam Headlight, L.H.	RB5, Control Cabinet
CB24	15	Low Beam Headlight, R.H.	RB5, Control Cabinet
CB25	15	High Beam Headlight, L.H.	RB5, Control Cabinet
CB26	15	High Beam Headlight, R.H.	RB5, Control Cabinet
CB27	15	Clearance Light Relay, Panel Lights, High Beam Indicator	RB5, Control Cabinet
CB28	15	Payload Meter	RB2, Control Cabinet
CB29	5	Payload Meter	RB2, Control Cabinet
CB30	15	Ladder, Engine Service & (Optional) Fog Lights, Hourmeter	Operator Cab, Power Distribution Module
CB31	15	Heater/AC Circuits	Operator Cab, Power Distribution Module
CB32	15	Warning Lights, A.I.D. Module, Voltmeter, Turn Signal Relays & Indicator Lights	Operator Cab, Power Distribution Module
CB33	15	Hoist Solenoid	Operator Cab, Power Distribution Module
CB34	10	Air Dryer Heater	Operator Cab, Power Distribution Module
CB35	10	Lincoln Lube Solenoid	Operator Cab, Power Distribution Module
CB36	10	Cigar Lighter	Operator Cab, Power Distribution Module
CB37	10	Windshield Washer & Wiper	Operator Cab, Power Distribution Module
CB38	5	Fuel gauge, Engine Temperature Gauge	Operator Cab, Power Distribution Module
CB39	5	Radiator Pressure Solenoid / Auto Lubrication	Operator Cab, Power Distribution Module
CB40	5	12VDC Accessory Receptacle (DDEC Engine Only)	Operator Cab, Power Distribution Module
CB40A	5	12VDC Accessory Receptacle	Operator Cab, Power Distribution Module
CB40B	10	Radio/Cassette Player	Operator Cab, Power Distribution Module
CB41A	15	Cab Door Window, L.H.	Operator Cab, Power Distribution Module
CB41B	15	Cab Door Window, R.H.	Operator Cab, Power Distribution Module
CB42	15	Air Seat	Operator Cab, Power Distribution Module
CB43	10	Starter Solenoid, Oil Pressure Latch Relay	Operator Cab, Power Distribution Module
CB44	20	DDR Connections, Coolant Level Module (DDEC Engine Only)	Battery Equalizer Box
CB45	20	DDEC Main ECM 12VDC Power (DDEC Engine Only)	Battery Equalizer Box
CB46	20	DDEC Main ECM 12VDC Power (DDEC Engine Only)	Battery Equalizer Box
CB47	20	DDEC Receiver ECM 12VDC Power (DDEC Engine Only)	Battery Equalizer Box
CB48	20	DDEC Receiver ECM 12VDC Power (DDEC Engine Only)	Battery Equalizer Box
CB50	20	Communications Radio	Operator Cab, Power Distribution Module
CB51	20	Dispatch Radio	Operator Cab, Power Distribution Module
CB52	5	MM Dispatch	Operator Cab, Power Distribution Module
CB53	25	MM Dispatch	Operator Cab, Power Distribution Module

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SECTION E
ELECTRICAL PROPULSION COMPONENTS
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⚠WARNING

1. ***Electric shock can cause serious or fatal injury. Only qualified electrical maintenance personnel should perform electrical testing. Use caution during test procedures to protect personnel from injury. All potential testing should be considered hazardous and proper precautions are necessary.***

2. ***General Electric DOES NOT recommend removing control cards or panel connectors prior to welding. When welding on a truck, connect the welder's ground cable directly to, or as close as possible to the part being welded. Welder cables should not be placed near truck system power cables or wiring harnesses.***

3. ***Any time one of the plug-in circuit cards must be removed or reinstalled, be certain that the control power switch is "Off". Wear a properly grounded wrist strap when removing a card to prevent damage caused by static electricity. After card removal, place in a static proof bag or container.***

4. ***Extreme care should be exercised to prevent damage to the various semi- conductor devices and low impedance circuits under test. When using an ohmmeter to check diodes, transistors and low power conductors, care must be used when using the ohms x 1 scale. Excessive current can damage the meter. When using the Hi-pot tester or megger, disconnect the 104 pin connectors CNA, CNB, CND and CNE located at the top of the 17FL275 panel. Refer to the GE publication "VEHICLE TEST INSTRUCTIONS FOR OHV STATEX III SYSTEMS" for additional instructions.***

5. ***Do not make open circuit voltage checks in propulsion mode.***

6. ***Parking brakes and service brakes have to be released for some tests. When this occurs, make sure wheels are blocked.***

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ELECTRICAL PROPULSION COMPONENTS

GENERAL SYSTEM DESCRIPTION

The electric propulsion and control system of the Komatsu truck consists of an engine driven alternator and cooling air blower, control system, wheel motors, retarding grids and blower motor. The alternator produces A.C. current which is rectified to D.C. current. The wheel motors use D.C. current to operate as motors in propulsion and generators in retarding.

When the operator selects FORWARD or REVERSE propulsion, the armatures of the motors drive planetary gear sets connected to the rear wheels to propel the truck in FORWARD or REVERSE.

During truck operation, the operator initiates command signals to the engine and control system. The signals are received at the FL275 electronic card panel initiating a series of checks to determine the status of system components. After checking the control system, the FL275 panel energizes the necessary contactors to set up the control system for propulsion or retarding and send a control signal to the static exciters.

During it's operation, the FL275 panel maintains the propulsion system within the design limits of the alternator, engine, and wheel motors. Regulation of alternator field current and engine speed determine traction motor armature current. Regulation of motor field current determines traction motor horsepower.

The control system responds to electrical signals generated by the operator and by “feedback” signals generated by various devices within the system. These feedback signals monitor voltage, current, speed, etc. of the various control and propulsion equipment.

When the operator depresses the retard pedal or the truck exceeds the automatic overspeed setting, the dynamic retarding circuit is activated causing the wheel motors to become generators. The truck momentum causes the armatures of the wheel motors to rotate, generating a D.C. output that is applied across the retarding grids. This load opposes armature rotation to slow the truck. The energy from the wheel motor is dissipated in the retarding grids in the form of heat.

Retarding grid cooling is provided by a motor-driven fan, blowing air across the grids. The cooling air blower connected in-line to the rear of the alternator provides cooling air for the static exciters, alternator and wheel motors during truck operation.

Refer to the following information for detailed descriptions of component functions.

CONTROL SYSTEM

The Statex III control system electronics provide all of the functions necessary to initiate and regulate operation of the truck. It monitors operator input and system feedback signals, calculates a response, and initiates the appropriate control action.

The system . . . .

- Establishes the propulsion circuit by energizing contactors P1, P2 (if installed), MF, GF, and GFR to power the wheelmotors.
- Establishes the retarding circuit by energizing contactors MF, GF, GFR, RP1, RP2, RP3, RP4, RP5, (and optionally RP6, RP7, RP8 and RP9) for extended range retarding to connect grid resistors RG1 and RG2 in the motor circuits. Extended range retarding is regulated automatically by sequentially energizing the RP3-RP9 contactors.
- Provides current limit control so that specific rates may be maintained in both motoring and retarding.
- Provides Retard Speed Control for automatic speed regulation on long down-hill runs.
- Provides two-speed overspeed control which allows a higher overspeed restriction when traveling empty.
- Provides Alternator Tertiary Winding protection and Wheelmotor overcurrent protection.
- Initiates the necessary operating restrictions, including the shut down of the truck if a system fault is detected. Lesser faults or events cause respective indicating lights to light. All events are recorded for future review by technicians.
- Provides fault/event information to the operator/technician as to the status of the system via the 2-digit display panel, located in the control cabinet. This panel, showing a two digit display of 00 to 99, indicates to the technician the existence of possible faults or other events which have occurred within the control and/or propulsion system.
- Provides automatic and manual diagnostic self-test routines to detect faults and to assist maintenance personnel in locating a poorly operating system/subsystem.
- Provides a statistical data history log which indicates lifetime, quarterly, monthly and daily performance data. This history log can be accessed using a “laptop” computer, and can be a valuable aid in determining equipment use and maintenance schedules.

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System Operation

When the operator depresses the accelerator foot pedal to propel the truck, two signals are generated. One signal is generated by a potentiometer on the foot pedal and is sent to the engine control system to regulate engine speed. The other signal is generated by closing a switch* and is sent to the digital input/output card to set up propulsion circuits for power.

**NOTE: On trucks equipped with the "Fuel Saver" system, the foot pedal potentiometer signal is sent directly to the FL275 panel and the switch signal is not required.*

A speed sensor signal from the engine is sent to the analog input and output card to establish the acceleration (power) reference signal used by the propulsion control system to establish horsepower demand.

NOTE: The analog input and output card in the FL275 panel responds to both accelerator and retard foot pedal signals. Both signals are processed through the central processing unit CPU, returned to the analog card where another signal is generated and fed to the FM466 and FM467 Static Exciter panels.

The output signal from the analog card is a burst of firing pulses. This AC signal is constant in frequency and amplitude, and is of both negative and positive polarities. Synchronizing AC signals from the tertiary windings of the Alternator provide timing to synchronize the firing pulses to the AC power frequency from the Alternator.

NOTE: Firing pulses are generated according to the demand from the operator (accelerate or retard) and biased by feedback signals from the power circuit. They are used to fire Silicon Control Rectifiers (SCRs) in two, single-phase, full-wave rectifier bridges, one each in FM466 and FM467 rectifier panels, and thereby regulate output current from these panels.

The output current from the FM466 AFSE (Alternator Field Static Exciter) panel energizes the field coils of the Alternator. The level of current in this field coil determines Alternator output.

The output current from the FM467 MFSE (Motor Field Static Exciter) panel energizes the field coils of the Motorized Wheels. The level of current in these field coils determine motor horsepower output.

The main output voltage from the Alternator, generated by the rotation of the Alternator rotor and regulated by its exciter field coil, is 3-phase high voltage AC. This AC power is fed to a rectifier panel to convert AC to DC for use in the Motorized Wheel armatures.

The output of the FM528 rectifier panel is variable high voltage DC current, used to power the Motorized Wheels. A full wave bridge in the panel rectifies the 3-phase input voltage from the Alternator to DC.

In parallel with the Motorized Wheels, high voltage DC is also fed to the VMM1 panel, to be used for feedback to the control system.

High voltage from the power circuit is attenuated by the VMM1 panel to a level acceptable to the electronics on the analog input/output card. From there it is processed through the CPU card to bias power and retard demand signals in the analog card.

Speed Sensor signals from both Motorized Wheels are sent to the control system analog input and output card to operate various speed event functions.

The CPU card uses speed sensor signals to develop various levels of output voltages for use in generating the speed taper function in retarding and for (optionally) driving the speedometer and tachometer.

NOTE: Speed taper is used to reduce maximum dynamic retarding effort at high truck speeds. This is to protect the Motorized Wheel motors from excessive current and possible damage.

When the operator depresses the retard foot pedal to slow the truck, a signal is generated by a potentiometer on the foot pedal and sent to the control system to establish the retarding circuits and the desired retarding effort.

A wheel slide compensation option, *"Wet Weather Retard Speed Control"*, can be enabled which will modify the method of retarder application on slippery roads.

This software settable option reduces wheel slide during operation on wet or icy roads by automatically reducing the retarding effort (requested by the operator) to a slipping wheel if the system senses a slide is occurring. When the system determines the slipping wheel has regained traction (the wheel speed increases to approximate the speed of the non-slipping wheel), retarding effort is restored based on the amount of retarding effort requested by the operator.

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FL275 PANEL

The FL275 electronic card panel contains a microprocessor (CPU), a small computer which monitors a variety of input signals and establishes certain controlling output signals which result in the regulation of the propulsion system. If a “laptop” computer, referred to as a Portable Test Unit (PTU) is connected, it can also provide a readout of the “memory” of the operating history of many of the sub-systems which make up the control system. This is useful to technicians looking for problem areas during troubleshooting.

Setting up new trucks or making changes to truck control system parameters requires a PTU and an authorized technician to operate it. The microprocessor in the electronic card panel can only be changed electronically with appropriate commands and programs using the PTU.

Previous control systems provided on Komatsu trucks required system adjustments to be made by removing the plug-in control cards and adjusting potentiometers mounted on the cards. With the FL275 panel, no control card removal is required. The majority of adjustments are made electronically using a menu driven software program installed on the hard disk drive of the “laptop” computer (PTU). The PTU is then connected to a 9 pin connector mounted in the control cabinet or cab of the truck enabling communication with the microprocessor (CPU).

The FL275 panel has five 104-pin connectors mounted above the cards for connecting input and output circuits. They are identified as CNA, CNB, CNC, CND and CNE. Only four connectors are used; connector CNC is not used.

The cards in this panel are protected by a cover which is hinged at the bottom, swings up, and latches at the top.

The card complement of the FL275 panel consists of the following five cards:

- 17FB100 - Power Supply (P1)
- 17FB101/144* - Central Processing Unit (CPU)
- 17FB102/140** - Analog Input/Output (A1)
- 17FB103 - Digital Input/Output (D1)
- 17FB104 - Digital Input/Output (D2)

NOTES:

** Later model trucks, shipped July 2001 and later are equipped with a 17FB144 card, replacing the 17FB101 card.*

*** Trucks equipped with “Fuel Saver” circuitry require 17FB140 card to replace 17FB102 card.*

The FL275 panel receives input signals from speed sensors on the alternator and wheelmotors, voltage and current feedback signals from various control devices, and command inputs from the operator. Using these inputs, it provides the following:

- Propulsion and dynamic retarding control of the truck.
- Speed restrictions during overspeed and other operating restrictions if faults occur.
- Event data for technicians through the 2-Digit Diagnostic Display panel.
- Statistical data of the history of various component and system function operations, accessible only with a PTU.

It is also capable of receiving inputs from the engine (oil pressure, crankcase pressure, engine coolant pressure, and engine coolant temperature), wheelmotor temperature, and alternator blower pressure to provide warning signals to the driver if malfunctions in these areas occur.

Additionally, on current production trucks (equipped with “Fuel Saver”), the FL275 panel monitors alternator intake temperature and static exciter temperatures to provide:

- Engine low idle speed reduced to 650 RPM.
- Control of engine RPM during propel to obtain the most efficient engine speed for the amount of power requested by the operator.
- Control of engine RPM during retarding ranging from a low of 1250 RPM to a high of 1650 RPM.

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CARD REPLACEMENT

⚠WARNING

Some of the components on the cards are sensitive to static electricity. To prevent damage, it is recommended that a properly connected ground strap be worn whenever removing, handling or installing a card. After a card has been removed, it must be carried and stored in a static proof bag or container. Be certain control power is OFF before removing a card.

NOTE: There are no adjustment potentiometers on the control cards. Cards should not be removed during troubleshooting unless it has been determined that a card is at fault.

Removal

1. The FB cards are removed by first loosening the two spring clips on the top of the hinged cover. Swing the cover down to gain access to the cards.
2. Each card is locked in place with a locking quick-release lever at the top and bottom. Lift both levers at the same time to release the locking arrangement and move the card out of the socket in the backplane.
3. Using both hands, grasp the card at the top and bottom and pull gently. It will slide easily in its guide strips to complete the removal.
4. Place the card in a static proof bag or container.

Installation

The cards are keyed to prevent them from inadvertently being inserted into the wrong card slot.

1. To install a card, carefully insert it into its top and bottom card slots. Slide the card into the panel until the locking quick-release levers are close to the panel edges.
2. Hold the levers and gently press the card further into the panel, feeling the card and backplane connectors start to engage. When the card is inserted far enough for the locking levers to catch on the panel edge, move both locking levers to the locking position at the same time.
3. Swing the cover up and over the cards, latching the two spring clips at the top.

CARD REPAIR

FB cards in the FL275 panel are not field repairable. Should one of the cards become inoperable, it should be returned to the Komatsu Distributor under the GE Unit Exchange Program.

Cards should be packed in a special shipping container, designed specifically for shipping these cards. Contact your Komatsu Distributor for instructions on how to obtain these containers.

PANEL WIRING

The connectors for the FB cards, located on the end of the card that plugs into the panel, each contain 210 pins.

The panel back, or backplane, has receptacles for the card connectors, each having 210 pins to which wires are wrapped, not soldered. The wrapping is done with a special tool which wraps the wire tightly around the pin. The pins are long enough to enable connecting multiple wires. The panel backplane also has printed circuits on it to facilitate inter-card circuit connections.

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COMPUTER DESCRIPTION

A total understanding of the following concepts is not essential to properly maintaining and troubleshooting the Komatsu truck control system. This information is presented as additional background information concerning operation of the FL275 panel computer and software programs required for operation. The technician should however, become familiar with basic operation of portable, MSDOS operating system computers (PTU) and must have the ability to use the menu operated software described later in this publication. These skills are necessary for programming the FL275 panel computer, troubleshooting, and obtaining statistical data.

Microprocessor

The microprocessor, located on the FB101 card (or FB144 card on later model trucks), contains the logical elements necessary to perform calculations and to carry out stored instructions. It is used as the central processing unit (CPU) of a computer. Computer operation is managed by a software program, which resides in the computer's memory. The software program also contains instructions to test and fault isolate the system.

A program is a sequence of specific instructions in an order that, when the microprocessor executes them, proper results occur. A program is generally stored in a read-only-memory (ROM). To execute the program, the microprocessor reads an instruction from ROM, interprets the instruction, performs whatever task that is dictated by the instruction, and then starts the process over again by reading a new instruction from ROM.

The microprocessor utilizes address, control, and data buses to accomplish the above process. A bus is a group of wires or circuits that collectively serve a similar function. For example, the address bus identifies the location that the microprocessor is reading from or writing to. The data bus provides a path for the flow of data from one point to another. The control bus is somewhat different from the other two buses in that each wire normally serves a separate and generally unrelated function used to control the actions of the system.

While executing the program, reading and writing of data is often necessary. This data is stored in a random-access-memory (RAM). A RAM is a temporary storage device, that is, if power to the RAM is lost, the data is cleared. The RAM stores all types of data, such as, input/status from external devices, fault information, specific program addresses, etc.

The final result is to provide instructions to external devices that tell them when and/or how to operate. Throughout the execution of the program, the microprocessor acts like a traffic officer; taking in instructions, interpreting them, and acting accordingly in order to process instructions to the output.

Download Capability

The computer can be reprogrammed by “downloading” new software into its memory. Downloading refers to transferring software program instructions from the PTU to the FL275 panel FB101/144 card through the serial port connector cable. This capability allows the system software to be changed if any new hardware or software option is to be installed or if an updated version of the existing software is to be implemented.

SOFTWARE

“Software” refers to computer programs written using coded instructions that can be understood by the CPU.

The following is a brief description of how the software establishes and regulates propulsion and retarding.

Base Monitor Program

The Base Monitor Program performs functions for the system, including power-up tests on the CPU card. This software is programmed on four Eprom chips at the factory and installed on the FB101/144 card.

Runtime Monitor Program - OBJRunning Code

The Runtime Monitor Program is used to control common truck functions. It is downloaded to Flash (Electrically Erasable Read Only Memory) chips on the CPU card from OBJ files stored on the PTU hard drive. This is done initially during factory check-out and can be redone in the field using the PTU.

After being downloaded to Flash, it is then copied to RAM (Random Access Memory) chips on the CPU card at system power-up.

This software:

- Controls contactors, relays, lights, solenoid, firing pulses, etc.
- Monitors truck running parameters and stores event/fault data for later examination.
- Communicates with the PTU to display operating parameters and event/fault data.

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Configuration Software - CFG

The CFG program is used to set values which are specific to a particular Komatsu truck model, such as engine, alternator and wheelmotor configuration, retard current limit, speed taper, power reference and control stability constants.

The operating software that controls current, voltage and horsepower limit in propulsion and current, speed taper and field amps in retarding uses a set of constants and look-up functions unique to and consistent with the configuration on each Komatsu truck model.

The CFG program is also used to set values which are specific to a particular mine, such as overspeed settings.

“Configuration software”, also sometimes referred to as “configuration download software”, allows the end user (mine) or Komatsu Distributor to select, via an easy to use, menu driven program screen, any one of a number of pre-recorded configurations stored in the PTU software. All the user has to do is select the configuration file that matches the truck being serviced.

The available combinations have been pre-recorded to be consistent with and ensure proper limits on the components used in that system. Thus, the Mine personnel do not have to be concerned with questions such as: “Is this the correct current limit for a GE776 or GE772 wheel?” or “Will speed taper in retarding work properly if I use a wheel with 23:1 gear ratio?” The configuration software will ensure compatible combinations of parameters.

The Mine technician must select or create the correct CFG file to match the truck.

The CFG program is downloaded to Flash chips on the CPU card from CFG files on the PTU hard drive. This is done initially during factory checkout, and can be redone in the field using the PTU.

NOTE: This MUST be done if the FB101/144 card is changed

PTU - Portable Test Unit Code

The PTU program is used to enable menu driven viewing of truck data in the CPU while the truck is moving or stationary. Using the PTU, it can also be used to view and change contactor positions.

It is also used to establish a communication link between the PTU and the CPU to download OBJ and CFG software files.

The PTU program is loaded onto the PTU hard drive using GE/Komatsu supplied floppy disks. Instructions for loading this software onto the PTU and downloading to the CPU are discussed later in this section.

System Regulation

The micro-processor, located on the CPU card (17FB101 or 17FB144), in the FL275 panel is set up electronically with the use of a Portable Test Unit (PTU) when the software described previously is downloaded. After being set up, certain operating parameters can be changed to “fine tune” the system to a particular road profile.

In addition to establishing propulsion and retarding circuits and regulating truck speed and retarding, the software restricts the control system from certain transitions under certain conditions. For example, the system will not allow a direction change while in the retard or propulsion without passing through the **“nomo”**, or **“no motion”** state. The software does, however, allow transition among the three retard states when in retard, these states being **retarding, retard speed control** and **overspeed**. These transitions are allowed because, once the contactors are in the retard position, no other contactor changes are necessary.

NOTE: The term “nomo” is a state which is entered at a truck speed of 0.30 mph or less.

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Propulsion

As part of the total software package, a particular group of regulatory software commands is included called a **“state machine”.** The state machine controls the various operating functions of truck operation.

The software implements the state machine by keeping track of which state the truck is in, and which state the truck is allowed to move into if the operator requests a different mode of operation.

For example, assume the operator has turned the key switch On to start the control system software, and then starts the engine. When the accelerator pedal is pressed to request contactor sequence and excitation, the state machine enforces a sequence of actions.

First, the software initializes the system. This includes ensuring that the contactors are all positioned correctly. (Initialization takes about 8 seconds after control power has been applied to the FL275 panel.)

Then, when the initialization is completed, the state becomes the **“nomo”**, or no motion, state. No propulsion or braking contactors are picked up.

Next, the state machine enters the **“into accelerate”** state. This state can only be entered if there are no restriction flags set in the software such as brake (service or park), **ACCINH, DUMPBS, NAFLT, or GNDFLT.** In this state, contactor sequence is initiated. If all contactors necessary for acceleration are in their correct positions, then the state machine enters the ”accelerate” state. If the contactor sequence does not complete successfully, then a fault, **NAFLT**, prohibiting acceleration is tripped.

When the state machine enters the **“accelerate”** state, firing commands can be issued. Firing commands are based on operator request and truck volt and amp feedbacks. They are used to generate a pulse burst firing signal from the CPU. The Alternator is thus excited, generating electrical power (horsepower) to the wheelmotors which will drive the truck forward or backward, depending on the position of the selector switch.

Retarding

When the operator presses the retard pedal, acceleration is canceled and the propulsion contactors are dropped out. The state machine enters the **“coast”** state and then the **“into retarding”** state. It remains in this state until all of the contactors necessary for retarding are in the correct position.

The state machine then enters the **“retard”** state. Firing pulses are issued to the static exciters based on operator request and on various system feedbacks.

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2-DIGIT DISPLAY PANEL

The 2-Digit Display panel (Figure 2-1.), located in the control cabinet, consists of the following:

- Two digit “event” number display,
- “First” LED
- “Last” LED
- “Previous (up arrow) search key
- “Next” (down arrow) search key
- “Reset” key

Under normal operation, with no events having been recorded, the 2-Digit Display Panel will display only two zeros (00). The “first” LED and the “last” LED will be dark (not illuminated). The “previous” and “next” search keys will be illuminated (green). The “reset” key will also be illuminated (red).

NOTE: The terms “event” and “fault” are used interchangeably to indicate a system occurrence which has been recorded into memory. The system recognizes each as an event, that is, a fault is nothing more to the system than an event. Some events (or faults) result in restrictions being placed on truck operation. Therefore, when discussing a fault situation, the term “fault” seems more appropriate and less confusing.

THE CODED NUMBER

The 2-Digit Display panel displays a coded two digit number. This number indicates certain data stored in the memory of the CPU card regarding the recent operating history of the truck's propulsion and control systems. Refer to Table I for a description of the two digit code numbers ranging from 00 to 99.

If an active fault condition exists, in which a fault has not been locked out or reset, the corresponding fault number will appear on the display. For example, if the P1 contactor is out of position, a number thirteen (13) will be displayed. By referring to Table I, you can quickly determine that a 13 refers to P1 contactor. Troubleshooting tips are provided for isolating the cause of the fault.

If another fault were to occur, such as the RP1 feedback indicating that RP1 contactor is in the wrong position, a number seventeen (17) would be displayed. Referring to Table I, you could see that a problem exists with the RP1 contactor. You can also see that the “last” LED is illuminated and the “first” LED is extinguished. This means that event 17 is the last one stored in the 2-Digit Display. To view the first event, simply press the ”previous” search key (up arrow).

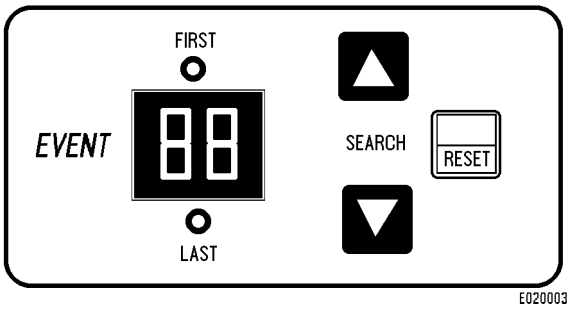


FIGURE 2-1. 2-DIGIT DISPLAY PANEL

If the first event were being displayed, the “first” LED would be illuminated and the “last” LED would be off. This indicated that the event being displayed is the first one in the CPU memory and that there are additional events to be displayed. To view the last event, press the “next” search key (down arrow).

Once a fault has been serviced, press the “reset” key and the event will be reset. If the problem has not been corrected, the fault will be relogged the next time it occurs.

NOTE: Resetting the fault from the 2-Digit Display does not remove the event from the CPU memory on the FB101 card in the FL275 panel. This can only be done using the Portable Test Unit (PTU).

EVENTS

This panel provides a variety of operational and fault codes which electronically document certain system events. For this reason, these codes are referred to as “event” codes.

The diagnostic system on the CPU card stores up to 500 events. If more are encountered after the storage is full, the system will purge the oldest event to make room for the newest event. It will then record the fact that this purge has occurred.

Stored events can only be removed from the system using the PTU, or by being purged by the system when new events occur after the storage is full.

When an event is reported, the system records the time and date, as well as the event's code, subcode, and 2 floating point values. This data, besides the time and date, are determined by the section of software reporting the event. This data is stored in the computer's memory and the “event” code is displayed on the 2-Digit Display panel.

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FRAMES

Every few seconds the system also collects “frames” which are bits of time. The time duration of each frame is set using the PTU, in increments of 0.01 seconds. Frames are collected right after all of the systems' input/output functions (events) are complete, as a record of system function at the time of the event.

Each frame contains 40 floating point values, all digital input and output values, the state machine's current state at the time of the event.

Each time an event is reported, a frame (known as the trigger frame) is kept for that event until the event is erased.

WINDOWS

Some events may also have frame “windows” - a collection of 51 frames, that is, all the frames that occur for 40 frames before the event, a frame at the event, and 10 frames after the event.

The system will save each event window for the first 16 events that are qualified to have windows. They will be saved until the event is erased. After 16 windows are stored, no additional windows can be stored.

SYSTEM CATEGORIES

All of the possible events which can occur have been programmed to fall into eight different categories, to enable the system to respond correctly. They are:

Active Events Count

This is the current number of events of this type which are “active”, i.e., which may affect truck operation.

Decay Active Events Count Time

This is the time in seconds which specified the rate at which the Active Events Count “decays”, allowing a certain number of events to occur ”normally” over a given time frame without affecting truck operation.

Lockout DOS Limit

This controls how often a truck operator may reset the operating restrictions caused by an event type, using the Dump Override Switch (DOS) switch in the cab.

If the Active Events Count is equal to the Lockout DOS Limit for a given type, the Override switch (DOS) will have no effect on operating restrictions caused by that event. The Active Events Count (for that type) will not be decayed by the Decay Active Events Count.

Running Count

This is the total count of all events of this type seen since Running Count was last cleared by the PTU.

Life Count

This is the total count of all events of this type ever recorded. The maximum number which can be recorded is 4,294,967,295. When this number is reached, the count will roll over.

Accept Limit

This is the number of events of this type that will be recorded by the system. See the discussion under Limits On Resetting Faults.

Window Captures Allowed Limit

This tells how many windows will be captured for events of this type, subject to space restrictions. When the window capture limit is exceeded, only a single frame of data is saved.

Window Captures Count

This is the count of windows saved for this event type. This value is incremented by 1 each time a window is saved for this event type. It is decremented or cleared when events are cleared by the PTU.

LIMITS ON RESETTING FAULTS

In the fault system, there are three limits associated with resetting faults:

Accept limit (accept_limit)

This is the limit on the number of faults which may be stored. When the limit of a given fault is exceeded, the oldest event of this type recorded without a window will be replaced with the new event, it will not be overwritten. The system does not allow events with windows to be overwritten. If the oldest event has a window, the oldest non-window event will be overwritten.

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Lockout limit (lockout_limit)

This is the limit on the number of faults which may occur until the Dump Override Switch (DOS) will no longer clear the restriction. For example, a GF contactor fault, (code 10) has a lockout limit of three. Every time this fault occurs, a no acceleration restriction is placed on the propulsion system.

When the first and second GF contactor faults occur, the driver may bring the truck to a stop and depress the Override switch. This will clear the restriction and allow acceleration. On the third occurrence of the GF contactor fault within the decay time however, the Override switch will not remove the no-acceleration. Rather, the RESET button on the 2-Digit Display must be pressed, then the driver can clear the no_accel restriction with the Override switch.

Decay time (decay_time)

Decay time is associated with lockout-limit.

The “active lockout count” is decayed by one count every decay-time period. If the driver gets two GF contactor faults in an hour, then the third (at least one hour after the first GF contactor fault), he will be able to clear the third fault with the Override switch because the oldest of the two has “decayed” the lockout count to one.

There are still three data packs of GF contactor fault information in the CPU, however. If the driver gets three GF contactor faults in one hour, the 2-Digit Display reset is required to “decay” the “active lockout count”.

NA FAULTS

Some events, called Acceleration Inhibit faults, prohibit the truck from accelerating. When an “acc-inh” fault is reported, a SYSFLT lamp will illuminate in the cab and acceleration will be prohibited.

The truck operator may clear an acceleration inhibit fault restriction by depressing the Override switch (DOS). When the Override switch is depressed, the restriction is removed, unless the Active Events Count for 1 or more event types is equal to the Lockout Limit. If such is the case, acceleration inhibit restriction will remain in effect until it is reset with the 2-Digit Display or the PTU.

When reset via the 2-Digit Display RESET button, the Override switch must be depressed next in order to remove the fault restriction.

EVENT SEQUENCE

The 2-Digit Display shows the event code numbers for all event types which have Active Event Counts greater than 0. The event types for which this is true are presented in the order in which the events have been reported. An event appears in the list once for each count in Active Event Counts, again in the order in which the events were reported.

A technician may use the “up” and “down” arrow keys on the 2-Digit Display to scroll through the list. The “first” and “last” lights will indicate the beginning and end of the list.

RESETTING EVENTS

When the RESET button on the 2-Digit Display is pressed while displaying an event code, that one specific event code is reset, and the active event count is reduced by one. If the event occurred several times, each one must be displayed and reset to get the active event count to zero for that event type.

If event types have Active Event Counts equal to Lockout Override switch (DOS) limit values, any acceleration inhibit restriction is removed when the event is reset and then the Override switch (DOS) is depressed.

EVENT DESCRIPTIONS

Refer to Table I for a listing of all of the possible events, what restrictions (if any) would apply, and the definition of each type. Troubleshooting tips are also provided.

SUBCODE DESCRIPTIONS

Subcodes can only be viewed using the PTU to read stored events. Subcodes provide additional information for the following event code numbers: 30, 32, 33 and 37. Refer to Table II for a listing of subcodes.

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NOTE: The information listed under "Event Values" provides additional detail for each event and is described as follows:

Decay Time . . . . . How long events are held in "active count" memory (in seconds).

Lock Limit . . . . . Operator cab reset is disabled when lock limit is reached within decay time.

Acceptable Limit: . . . . . Maximum number of occurrances of an event code which can be recorded in FL275.

Window Limit: . . . . . Maximum number of an event with 51 frame windows.

TABLE I. 2-DIGIT DISPLAY PANEL CODES

EVENT CODE	EVENT DESCRIPTION	EVENT RESTRICTION	DETECTION INFORMATION	EVENT VALUES			
				Decay Time	Lock Limit	Accept Limit	Window Limit
00	Reset All (no events displayed)	None	Used to reset all events				
01	Low level ground fault	System Event • ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	A ground fault is detected if leakage current to ground (truck chassis) exceeds 114 ma.There is a 0.2 second delay on shutdown. In the following order, check for: Moisture in motors, grids, power cables, motor flash, insulation failure in power circuit, defective FB102/140 card.	1800	5	20	5
02	High Level Ground Fault	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	A ground fault is detected if leakage current to ground (truck chassis) exceeds 400 ma.There is a 0.05 second delay on shutdown. Same checks as No. 01.	N/A	1	1	1
08	Pedal Accel	System Event • Turn on SYSFLT light only.	Incorrect accelerator output.	3600	3	10	2
09	Pedal Retard	System Event • Turn on SYSFLT light only.	Incorrect retard pedal output.	3600	3	10	2
10	GF Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	GF Contactor command and feedback do not agree.In the following order, Check for: welded tips, blocked armature, defective coil or position sensor, loose wiring connections, mechanical obstruction, defective FB104 card.	3600	3	10	2
11	GFR Relay	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	GFR Relay command and feedback do not agree. Check for: Same as No. 10.	N/A	1	20	5

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TABLE I. 2-DIGIT DISPLAY PANEL CODES (Cont.)

EVENT CODE	EVENT DESCRIPTION	EVENT RESTRICTION	DETECTION INFORMATION	EVENT VALUES			
				Decay Time	Lock Limit	Accept Limit	Window Limit
12	MF Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	MF Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2
13	P1 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	P1 Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2
14	P2 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	P2 Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2
17	RP1 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	RP1 Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2
18	RP2 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	RP2 Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2
19	RP3 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	RP3 Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2
20	RP4 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	RP4 Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2
21	RP5 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	RP5 Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2
22	RP6 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	RP6 Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2
23	RP7 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	RP7 Contactor command and feedback do not agree. Check for: Same as No. 10.	3600	3	10	2

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TABLE I. 2-DIGIT DISPLAY PANEL CODES (Cont.)

EVENT CODE	EVENT DESCRIPTION	EVENT RESTRICTION	DETECTION INFORMATION	EVENT VALUES			
				Decay Time	Lock Limit	Accept Limit	Window Limit
24	RP8 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	RP8 Contactor command and feedbak do not agree. Check for: Same as No. 10.	3600	3	10	2
25	RP9 Contactor	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	RP9 Contactor command and feedbak do not agree. Check for: Same as No. 10.	3600	3	10	2
26	Forward Coil	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	Forward position of reverser command and feedback do not agree. Check For: Same as No.10.	3600	3	10	2
27	Reverse Coil	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	Reverse position of reverser command and feedback do not agree. Check For: Same as No.10.	3600	3	10	2
30	Analog Output (See Subcodes)	Recorded in memory only No truck shutdown	Analog input exceeds 10V for .05 seconds. Software error, bad FB101 or FB102/ 140 card.Check subcodes (Table II) with PTU for more detail.	N/A	N/A	5	0
31	Frequency Output	Recorded in memory only No truck shutdown	Engine RPM signal <500 or >2300.	N/A	N/A	5	0
32	Analog Input (See Subcodes)	Recorded in memory only No truck shutdown	Software error. Bad 101/144 or 102/140 card. Check subcodes (Table II) with PTU for more detail.	N/A	N/A	5	1
33	Frequency Input (See Subcodes)	Recorded in memory only No truck shutdown	Incorrect M1, M2 or engine speed input. Same checks as No. 30.Check subcodes (Table II) with PTU for more detail.	N/A	N/A	5	0
37	Hardware Startup (See Subcodes)	Recorded in memory only No truck shutdown	Check for defective FB101/ 144 card. Check subcodes (Table II) with PTU for more detail.	1800	3	5	1
45	Diode Fault	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	Ripple current in alternator field circuit exceeds a pre-set value. Indicates shorted diodes in main rectifier. Check diodes, wiring between FDP and FL275 panel. Defective FDP or FB103 card.	N/A	1	4	2

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TABLE I. 2-DIGIT DISPLAY PANEL CODES (Cont.)

EVENT CODE	EVENT DESCRIPTION	EVENT RESTRICTION	DETECTION INFORMATION	EVENT VALUES			
				Decay Time	Lock Limit	Accept Limit	Window Limit
46	Motor 1 Overcurrent	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Current in Motor 1 armature exceeds limits for a preset time. Limit is a function of being in retard or acceleration.	3600	3	10	2
47	Motor 2 Overcurrent	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Current in Motor 2 armature exceeds limits for a preset time. Limit is a function of being in retard or acceleration.	3600	3	10	2
48	Motor Field Fault	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Motor field current not in correct proportion with motor armature current. Check for defective shunt, iso-amp, wiring, FB102/140 card.	3600	3	10	4
49	Motor Field Overcurrent	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Current in motor fields exceeds limits. Limit is a function of being in retard or acceleration.	3600	3	10	4
50	Motor Stall	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Motors stalled with motor current above 1000 amps, inverse time function. Could be caused by overloaded truck, grade or rolling resistance too high. Check for defective speed sensors, shunts, iso-amps, wiring, FB102/140 card.	3600	3	10	2
51	Motor Spin	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	One motor stuck, the other spinning for longer than 10 seconds with motor current >100A. Check for: Same as No. 50.	3600	3	10	4
52	Alternator Tertiary Overcurrent	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Current in alternator field tertiary windings exceeds limits for a preset time. Check for shorted diodes or SCRs in AFSE.	N/A	1	4	2
53	Motor Tertiary Overcurrent	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Current in motor field tertiary windings exceeds limits for a preset time. Check for shorted diodes or SCRs in MFSE. Check for low engine rpm in retarding.	N/A	1	4	2

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TABLE I. 2-DIGIT DISPLAY PANEL CODES (Cont.)

EVENT CODE	EVENT DESCRIPTION	EVENT RESTRICTION	DETECTION INFORMATION	EVENT VALUES			
				Decay Time	Lock Limit	Accept Limit	Window Limit
54	+15 Power	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Out of limit (±1V) for 4 seconds. Check for battery volts below 20V, excessive load on supply (iso-amps or VMM), defective FB100 card.	3600	3	10	2
55	-15 Power	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Out of limit (±1V) for 4 seconds. Check for: Same as No. 54.	3600	3	10	2
56	+19 Power	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Out of limit (±3V) for 4 seconds. Check for: Same as No. 54.	3600	3	10	2
57	Motor Polarity	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	Motor 1 and motor 2 opposite polarity. Check for: Loose shunt wiring, cabling to motors or shunts, defective FB102/140 card.	3600	3	10	2
59	PTU Configuration	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYSFLT light only.	PTU configuration inputs are inconsistent.	3600	3	4	2
61	Retard GridMotor 1 Failure	System Event • In RETARD: Turn on SYSFLT light only.	M1 amps less than 20 and M2 amps greater than 500 for 5 seconds. Check for loose cabling to grids, RP contactors. Inspect grids for damage, foreign objects.	3600	3	10	2
62	Retard GridMotor 2 Failure	System Event • In RETARD: Turn on SYSFLT light only.	M1 amps greater than 500 and M2 amps less than 20 for 5 seconds. Check for loose cabling to grids, RP contactors. Inspect grids for damage, or foreign objects.	3600N	3	10	2
63	Low Axle Box Pressure	If BPS does not pick up in 101 seconds (or time set on Truck Specifics Screen). • Turn on light and buzzer.	Axle box air pressure not sensed with engine above 1550 rpm. Check for: Leaking air ducts, open axle box door, leaking door gasket, defective BPS switch or FB103 card.	N/A	1	10	0
64	Motor 1 Over Temperature	Turn On Motor Light	Motor 1 is over a specific temperature limit. Check for: Excessive load or duty cycle, lack of cooling air.	N/A	1	10	0

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TABLE I. 2-DIGIT DISPLAY PANEL CODES (Cont.)

EVENT CODE	EVENT DESCRIPTION	EVENT RESTRICTION	DETECTION INFORMATION	EVENT VALUES			
				Decay Time	Lock Limit	Accept Limit	Window Limit
65	Motor 2 Over Temperature	Turn On Motor Light	Motor 2 is over a specific temperature limit. Check for: Same as No. 64.	N/A	N/A	10	0
66	Overspeed Retarding	Apply maximum retard level to reduce speed below over-speed point.	Vehicle speed exceeds pre-set limit.	N/A	N/A	50	0
67	Overspeed Overshoot	Recorded in memory only	Vehicle speed exceeds pre-set limit.	N/A	N/A	10	3
68	Retard Overcurrent	Recorded in memory only	Retard current level exceeded. Check for: Defective shunt, iso-amp or FB102/140 card.	N/a	N/A	25	1
69	Horsepower Low	Recorded in memory only	Engine low on horsepower.	N/A	N/A	25	1
70	Horsepower Limit Exceeded	Recorded in memory only	Engine horsepower limit exceeded.	N/A	N/A	10	1
71	Engine Over-speed Exceeded	Recorded in memory only	Engine speed exceeded.	N/A	N/A	10	1
NOTE: * The following event codes (72 & 73) applicable only to Cummins engines with special sensors installed and options activated.							
72	*Engine Sensor-Warning	Recorded in memory • Turn On ENGSERV Light.	An engine sensor is in the warning zone. Check engine, sensor or FB102/140 card.	N/A	N/A	10	1
73	*Engine Sensor Shutdown	• In ACCEL: No propel and turn on SYSFLT lightand ENGSDWN Light. • In RETARD: Turn on SYS-FLT and ENGSDWN light.	Engine sensor in shutdown zone. Check for: Same as No. 72.	3600	2	10	4
78	Engine Service	Recorded in memory • Turn On ENGSERV Light.	Engine Warning. Service as soon as possible.	N/A	N/A	10	1
79	Engine Shutdown	Recorded in memory. • Turn On ENGSDWN Light. Will inhibit propulsion after a 0.5 second delay and will continue to inhibit as long as Engine Shutdown Light is lit.	Shutdown the engine as soon as possible.	N/A	N/A	10	1
80	Engine Speed Retard	Recorded in memory.	Engine speed less than 1500 rpm measured 4 seconds after high idle command when going into retard. Check engine control	N/A	N/A	10	1
81	Motor 1 Voltage Limit Exceeded	Reduce alternator excitation to below voltage limit.	Motor 1 over voltage limit. Check for defective VMM1, VMM2, or FB101/144 card.	N/A	N/A	10	1
82	Motor 2 Voltage Limit Exceeded	Reduce alternator excitation to below voltage limit.	Motor 2 over voltage limit. Check for defective VMM1, VMM2, or FB101/144 card.	N/A	N/A	10	1

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TABLE I. 2-DIGIT DISPLAY PANEL CODES (Cont.)

EVENT CODE	EVENT DESCRIPTION	EVENT RESTRICTION	DETECTION INFORMATION	EVENT VALUES			
				Decay Time	Lock Limit	Accept Limit	Window Limit
83	Alternator Field Current Level	Recorded in memory only.	Alternator field current slow to decay. Check for: Defective shunt, iso-amp, or FB102/140 card.	N/A	N/A	10	1
88	Lamp Test	None	Lamp test in progress. • Not a true event. • Not logged.				
90	Battery Volts Low	System Event • In ACCEL: No propel and turn on SYSFLT light. • In RETARD: Turn on SYS-FLT light only.	Battery volts low. Less than 21 volts for 4 seconds and engine speed greater than 600 rpm. Check for: Check 24V alternator or batteries.	3600	3	10	2
91	Battery Volts High	Recorded in memory only.	Battery volts high. Greater than 32 volts for 4 seconds. Check 24V alternator regulator.	N/A	N/A	10	1
92	Bad Engine Sensor	Recorded in memory only.	Engine sensor output outside normal range. Check sensor and wiring.	N/A	N/A	10	3
98	Data Store	Recorded in memory.	Indicates a data snapshot has been initiated by manual means.	N/A	N/A	11	10
99	Software	Recorded in memory.	Software problem. The allocated fault registers in memory are full, insufficient space exists. Reset event list, erase events.	1800	3	5	1

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TABLE II. 2-DIGIT DISPLAY PANEL SUBCODES

PRIMARY CODE No.	SUBCODE No.	TERM	DESCRIPTION
			ANALOG OUTPUT
30:	54	AF_CURR_REF	D/A Commanded to output >10 volts for over 0.05 seconds
	55	MF_CURR_REF	D/A Commanded to output >10 volts for over 0.05 seconds
	56	BRKBLV	D/A Commanded to output >10 volts for over 0.05 seconds
	57	ENGRPMCMD	D/A Commanded to output >10 volts for over 0.05 seconds
	61	SIG1	D/A Commanded to output >10 volts for over 0.05 seconds
	62	SIG2	D/A Commanded to output >10 volts for over 0.05 seconds
	63	SIG3	D/A Commanded to output >10 volts for over 0.05 seconds
	64	SIG4	D/A Commanded to output >10 volts for over 0.05 seconds
	65	SIG5	D/A Commanded to output >10 volts for over 0.05 seconds
			ANALOG INPUT
32:	18	GND	A/D Scaled output > 16 or <-16 for 0.02 seconds
	19	GAINCHK	A/D Scaled output > 1675 or <-1600 for 0.02 seconds
	20	GROUND_FAULT	A/D Scaled output > 523 or <-523 for 0.3 seconds
	21	M1_AMPS	A/D Scaled output > 3500 or <-3500 for 1.0 second
	22	M2_AMPS	A/D Scaled output > 3500 or <-3500 for 1.0 second
	23	MF_AMPS	A/D Scaled output > 1500 or <-1500 for 1.0 second
	24	ALT_F_AMPS	A/D Scaled output > 800 or <-30 for 0.5 seconds
	25	ENGHPCUT	A/D Scaled output > 4.95 or <-4.95 for 1.0 second
	26	SRS	A/D Scaled output > 23 or <-1 for 1.0 second
	27	RPINHI	A/D Scaled output > 23 or <-1 for 1.0 second
	28	ALTFVOLT	A/D Scaled output > 1000 or <-25 for 1.0 second
	29	ALT_OUT_VOLT	A/D Scaled output > 2250 or <-50 for 1.0 second
	30	M2_VOLTS	A/D Scaled output > 1200 or <-1200 for 1.0 second
	31	APINHI	A/D Scaled output > 25 or <-1.0 for 1.0 second
	32	SVBE	A/D Scaled output > 5.2 or <-5.2 for 10.0 seconds
	33	TMFSE	A/D Scaled output > 5.2 or <-5.2 for 10.0 seconds
	34	ATOC	A/D Scaled output > 2400 or <-50 for 1.0 second
	35	MTOC	A/D Scaled output > 2400 or <-50 for 1.0 second
	36	M1TS	A/D Scaled output > 5.2 or <-5.2 for 10.0 seconds
	37	M2TS	A/D Scaled output > 5.2 or <-5.2 for 10.0 seconds
	38	TAFSE	A/D Scaled output > 5.0 or < 0 for 1.0 second
	39	PAYLOAD	A/D Scaled output > 10.0 or < 0 for 1.0 second
	40	COOLT	A/D Scaled output > 5.2 or <-5.2 for 10.0 seconds
	41	COOLP	A/D Scaled output > 5.2 or <-5.2 for 10.0 seconds
	42	CRANKP	A/D Scaled output > 5.2 or <-5.2 for 10.0 seconds
	43	OILP	A/D Scaled output > 5.2 or <-5.2 for 10.0 seconds

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TABLE II. 2-DIGIT DISPLAY PANEL SUBCODES (Cont.)

PRIMARY CODE No.	SUBCODE No.	TERM	DESCRIPTION
		ANALOG INPUT	
32:	44	VOLTS_15P	A/D Scaled output > 16.5 or <13.5 for 0.1 seconds
	45	VOLTS_15N	A/D Scaled output > -13.5 or <-16.5 for 0.1 seconds
	46	LO_BATT_VOLT	A/D Scaled output < 15.0 for 4.0 seconds
	47	HI_BATT_VOLT	A/D Scaled output > 33.0 for 4.0 seconds
	48	VOLTS_19P	A/D Scaled output > 20.9 OR <17.1 for 1.0 second
	49	TAMB	A/D Scaled output > 5.2 or <-5.2 for 1.0 second
	50	Undefined3	A/D Scaled output > 5.2 or <-5.2 for 1.0 second
		FREQUENCY INPUT	
33:	51	ENG_SPD	ENGSPD exceeds ENG_MAX_RPM = 2400 RPM
	52	M1_SPD	MOTOR1SPD exceeds MTR_RPM_MAX = 3000 RPM
	53	M2_SPD	MOTOR2SPD exceeds MTR_RPM_MAX = 3000 RPM
		HARDWARE STARTUP	
37:	1	EPROM CRC	Checksum failed for base monitor buck EPROMS
	2	WATCHDOG TEST	Test for infinite loop failed
	3	READY TIMEOUT	Test for bad address failed
	4	CLOCK INTERRUPT	Test of interrupt circuitry failed
	5	FLASH CRC	Checksum failed for OBJ application code
	6	SRAM TEST	Static RAM read/write test failed
	7	BRAM CRC	Battery backed RAM checksum failed
	8	BRAM BATTERY CHK	Battery voltage low for BRAM
	9	DATE/TIME CHECK	Hour <24, day<32, Check for realistic date and time
	10	BUCK RAM STACK	Check of static RAM used by buck
	11	INTERRUPT OVER-FLOW	Not enough real-time for master loop
	12	WATCHDOG	Application tripped an infinite loop
	13	BAD MEMORY	Application bad memory address
	14	MANUAL	Command to manually test 37 was issued
	15	ANALOG READBACK	Output signal feedbacks indicate error
	16	ANALOG A TO D	Analog to digital conversion too long
	17	ANALOG GNDCHK	Analog input conversion lost power
	18	FCLOCK STATUS	Frequency input conversion error
	19	FCLOCK STOPPED	Frequency input conversion error
	20	FCLOCK SEQUENCE	Frequency input conversion error
	21	FPULSE STATUS	Frequency input conversion error
	22	FPULSE SEQUENCE	Frequency input conversion error
	23	FPULSE COUNT	Frequency input conversion error

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TABLE II. 2-DIGIT DISPLAY PANEL SUBCODES (Cont.)

PRIMARY CODE No.	SUBCODE No.	TERM	DESCRIPTION
		ENGINE SENSOR WARNING	
72:	1	COOLANT PRESSURE	Coolant pressure in warning zone for 10 sec.
	2	OIL PRESSURE	Oil pressure in warning zone for 10 sec.
	3	CRANKCASE PRESSURE	Crankcase pressure >16 in. H_2O for 5 sec.
	4	COOLANT TEMP	Coolant temperature >205°F for 10 sec.
	5	ENGINE OVERSPEED	RPM >2375 rpm for 2 sec.
		ENGINE SENSOR	
92:	1	COOLANT PRESSURE	Sensor output <0.2 VDC or >4.8 VDC for 4 sec.
	2	OIL PRESSURE	Sensor output <0.2 VDC or >4.8 VDC for 4 sec.
	3	CRANKCASE PRESSURE	Sensor output <0.2 VDC or >4.8 VDC for 4 sec.
	4	COOLANT TEMP	Sensor output <0.2 VDC or >4.8 VDC for 4 sec.

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PORTABLE TEST UNIT (PTU)

DESCRIPTION

The minimum requirements for the laptop computer to be used for the PTU are as follows:

- IBM compatible, portable PC
- 20 megabyte hard disk drive
- 3.5" floppy diskette drive
- 2 megabytes RAM
- Serial Port & cable

A larger capacity hard disk, additional RAM, and a spare battery pack are desirable.

Control software provided by GE or Komatsu on a 3.5" floppy disk must be transferred to the PTU hard disk drive prior to transferring the Control Program to the truck.

All adjustments, setup procedures and diagnostic troubleshooting of the truck's control system can be made via this PTU. Most of the procedures are menu driven, with function screens provided as part of the operating software. Figure 2-2. illustrates the “Main Menu” which appears when the software program opens. Figure 2-3 illustrates the “menu tree” showing the various screen menus available from the main menu and the path required to reach the next level sub-menu.

Sample PTU screens illustrated on the following pages show menus and data screens as they appear in the Statex III Enhanced Version 1.00, April 2001 software release. Minor differences may appear on the Statex III Version 14.00, April 2000 PTU screens. Earlier and later versions of the software may differ.

*Note: Statex III Enhanced Version 1.00 software **must** be used if the truck was equipped originally with a 17FB144 CPU card **or** if the original 17FB101 card was replaced with a 17FB144 card. Version 14 should be used if the truck is equipped with a 17FB101 CPU card.*

The information that follows is presented in the sequence that would most likely be used at a mine site that was receiving new Statex III trucks or a mine that was updating software from previous release versions. It is assumed the technician is familiar with the basic operation of a laptop computer.

OPERATIONAL HINTS

Here are a few things to remember about the use of the PTU and software:

- Some instructions in this manual call for the user to type certain operating commands. These commands are shown in a typewriter style type font within quotation marks to indicate the characters to be typed from the keyboard. The operating commands should be typed in lower case letters. Do not type the quotation marks when entering commands on the PTU. (Refer to the chart below.) Other operations require pressing an individual key on the keyboard; these keys are shown in square brackets. For example, if an operation requires pressing the key labelled “Enter”, it will be shown as [ENTER]. Keys shown as [F1] through [F10] refer to the Function keys across the top of the keyboard. Note that many portable computers require pressing another key (usually labelled “Fn”) in conjunction with each Function key.
- Keep the PTU plugged into its charger when possible to maintain a full charge on the battery.
- There is an indicator light on the PTU which, when lit, indicates low battery power. If this light should come on while using the PTU, continue until you reach a convenient break point. Return to the main menu and turn off the PTU. Then, replace the battery with a spare and continue.
- If a spare battery pack is available, switch the PTU battery occasionally to ensure that both batteries are kept fully charged. Battery life can be extended by fully discharging and recharging every 3 months.

CONVENTION	APPLIES TO:	SAMPLE
Bold Type	Menu & Screen Titles	GE OHV STATEX III MENU
Quotation Marks	Menu Selection Choice	“PTU TALK TO TRUCK”
Typewriter Font in Quotes	Command to be typed from keyboard	“gemenu”
[Brackets]	Keyboard Key To Press	[ENTER], [CTRL], [ALT], [F1] etc.

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SOFTWARE INSTALLATION PREPARATION

The software code disk contains the operating software in compressed form which is automatically expanded as the main file is copied to the PTU hard drive.

The following files are located on the disk:

STATEX III Enhanced, Version 1.0

- 502ddg1.exe
  This file contains the Enhanced Version 1.00 software for use with trucks equipped with the 17FB144 CPU card.
- Install1.bat
  A batch file to be selected to start software installation on the PTU if the PTU communicates with the truck through COM port 1.
- Install2.bat
  A batch file to be selected to start software installation on the PTU if the PTU communicates with the truck through COM port 2.
- Readme.txt
  A text file describing the software version and instructions for installing the software program.

STATEX III Version 14.00

- 502dbg1.exe
  This file contains the Version 14.00 software for use with trucks equipped with the 17FB101 CPU card.
- Install1.bat
  A batch file to be selected to start software installation on the PTU if the PTU communicates with the truck through COM port 1.
- Install2.bat
  A batch file to be selected to start software installation on the PTU if the PTU communicates with the truck through COM port 2.
- Readme.txt
  A text file describing the software version and instructions for installing the software program.

Either of the above software disks is used to update the *March 1996, Version 12.10* software release or can be installed on a new PTU for use with the appropriate truck, depending on the CPU card installed. Since both versions may be required for some trucks in a fleet equipped with the FB101 card and others equipped with the FB144 card, the Enhanced version 1.00 and version 14.00 are automatically installed in different directories on the PTU.

HARD DISK SPACE REQUIREMENTS

Software installation will require approximately 3.2 megabytes of disk space on the PTU hard disk. Additional space will be required for saving event and statistical data. Be certain there is enough disk space available.

⚠ IMPORTANT ⚠

Inadequate disk space will prevent all the required files from loading and the software will not operate properly!

If older versions of the software must be deleted to make space, backup all data to be retained (i.e statistical data) before deleting. Do not delete truck configuration files as they will be updated using the new version of software

SOFTWARE INSTALLATION ON PTU

The following instructions describe the procedures for initial installation of the GE software on the PTU or procedures to update the PTU with the latest version software code. It is not necessary to connect the PTU to the truck during software installation.
NOTE: To determine the latest version of software code, contact your Komatsu Distributor. If new code is required, the current disk can be obtained.

Use the following procedure when initially installing the GE software on the PTU hard drive or if updating the current software to a new release version.

1. The computer must be at any DOS prompt prior to installing the software.
2. Insert the diskette into the computer diskette drive.
3. If the floppy disk drive containing the diskette is designated drive “A”, type “a:install1” if COM 1 is used for attaching the serial cable to the truck for communication or type “a:install2” if COM 2 is used for communication. Press [ENTER] to start the software installation process.

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4. If the floppy disk drive containing the diskette is designated drive “B”, type “b:install1” or “b:install2” and press [ENTER] key.
5. When all the diskette files have been copied to the hard drive, a message will appear stating the installation of the desired software version is complete. In addition, the message states that if this is the first time the STATEX III PTU software has been installed on this computer, it may be necessary to modify the AUTOEXEC.BAT and CONFIG.SYS files to ensure proper operation.
   a. The file C:\CONFIG.SYS must have the FILES variable set to a minimum of 20 and BUFFERS variable set to a minimum of 20.
   b. The file AUTOEXEC.BAT must have the following directory included in the PATH variable:
   Enhanced Version 1.00 -
   C:\GEOHV3E\TOOLS\BATS

   Version 14.00 -
   C:\GEOHV\TOOLS\BATS
6. If necessary, edit the above files using DOS to change the minimum FILES and BUFFERS variables and to add the PATH statement as described above.
7. Remove the diskette from the drive and reboot the computer if the changes described in step 5 were required.
8. When using the software, at the DOS C:> prompt, type “`geohv3e`” to start the Enhanced version 1.00 program or type “`geohv`” to start the version 14.00 program.

PTU/Truck Communication Problems

Communication problems will occur if the amount of DOS free memory available on the PTU is less than 460K bytes after the software has loaded. If significantly less than 460K is available, it will not be possible to communicate with the truck at all.

In some instances, if the PTU has less than (but very close to) 460K available, the software may appear to function properly until features such as retreiving and saving an event to a file are attempted at which point the program will terminate.

To determine the amount of free memory available, start the software program and on the Main Menu, observe the amount of “free memory:” displayed in the upper right corner of the screen (see Figure 2-2). If the amount shown is less than 460K, it will be necessary to free up memory before using the PTU.

Suggestions for obtaining more free memory:

The following suggestions provide a starting point to provide additional free memory. If necessary, edit the laptop's CONFIG.SYS as follows:

- Load DOS and device drivers into high memory.
- Eliminate any TSR (terminate-stay-ready) programs such as shells or antivirus programs. Do not allow Microsoft Windows™ to load.
- Disable PCMCIA card drivers if the laptop is equipped with PCMCIA slots.
- If DOS version 6.2 or higher is used, it is advisable to create multiple start-up configurations. This will allow the user to choose the appropriate configuration from a menu list for the desired use of the laptop computer. A CONFIG.SYS file can be created for specific use with the GE software, preventing unwanted drivers from loading and using the required free memory. Alternate menu choices will allow the computer to boot and load the necessary drivers for other functions such as Microsoft Windows™.

Note: Consult the laptop computer manufacturer's instructions and the DOS operating system technical manuals for editing the CONFIG.SYS file, creating multiple configuration files, and additional suggestions to obtain maximum free memory.

If Microsoft Windows™ is installed on the computer, be certain to operate in MS-DOS mode, NOT Windows.

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THE MAIN MENU

The main menu, titled **GE OHV STATEX III Enhanced MENU** (or **GE OHV STATEX III MENU** if version 14 is installed) as shown in Figure 2-2, illustrates the major selections available. Note the software release date also appears in the title. This menu is used to access all other operating menus. Options on this menu are selected by using the arrow keys or typing the first letter of the name of the selection.

To view the main menu, turn the PTU power switch on. After the PTU performs a self-test startup procedure, the DOS "C:>" prompt will appear.

Type "`gemenu3e`" ["`gemenu`", if using vers. 14] and press the [ENTER] key. The main menu will appear on the PTU screen.

The following identifies each of the options listed on the main menu:

"QUIT MENU"

When selected, the PTU exits the GE software and returns to the DOS "C:>" prompt. When the "C:>" prompt appears, the PTU is functioning as a standard laptop computer.

"PTU TALK TO TRUCK"

Used to "talk" to the CPU (Central Processing Unit) in the FL275 panel. All PTU/CPU communication is done through this selection. To enter this selection, a log-on with an appropriate password is required and the serial communication cable should be attached.

"VIEW PTU SAVED FILES"

Used to examine the contents of saved event files in the PTU. No password is required. Can only be used to playback events already stored in a filename.

"LIST STAT DATA FILES"

Used to examine the statistical data from a truck's CPU which has been stored on the PTU.

"TRUCK SETUP (CFG)"

Used to edit or create CFG files. Refer to PROGRAM TRUCK, for a procedure for downloading configuration files to the CPU in the FL275 panel.

"SELECT TRUCK SETUP"

Used to view the current list of configuration files and to select a configuration file for downloading to the CPU. Refer to PROGRAMMING TRUCK for additional information.

"UPDATE CFG VERSION"

Permits conversion of truck configurations from older versions of software to be compatible with newer versions without requiring retyping values for overspeed, serial numbers etc.

"CHANGE PTU PASSWORD"

Used to set passwords which permit different levels of access to the operating screens in the software.

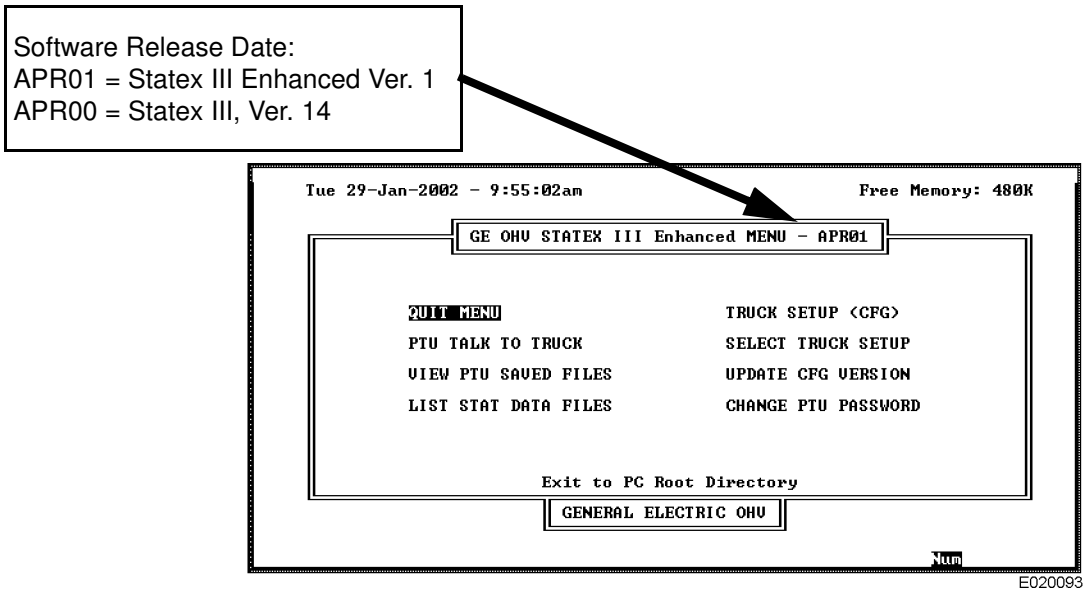
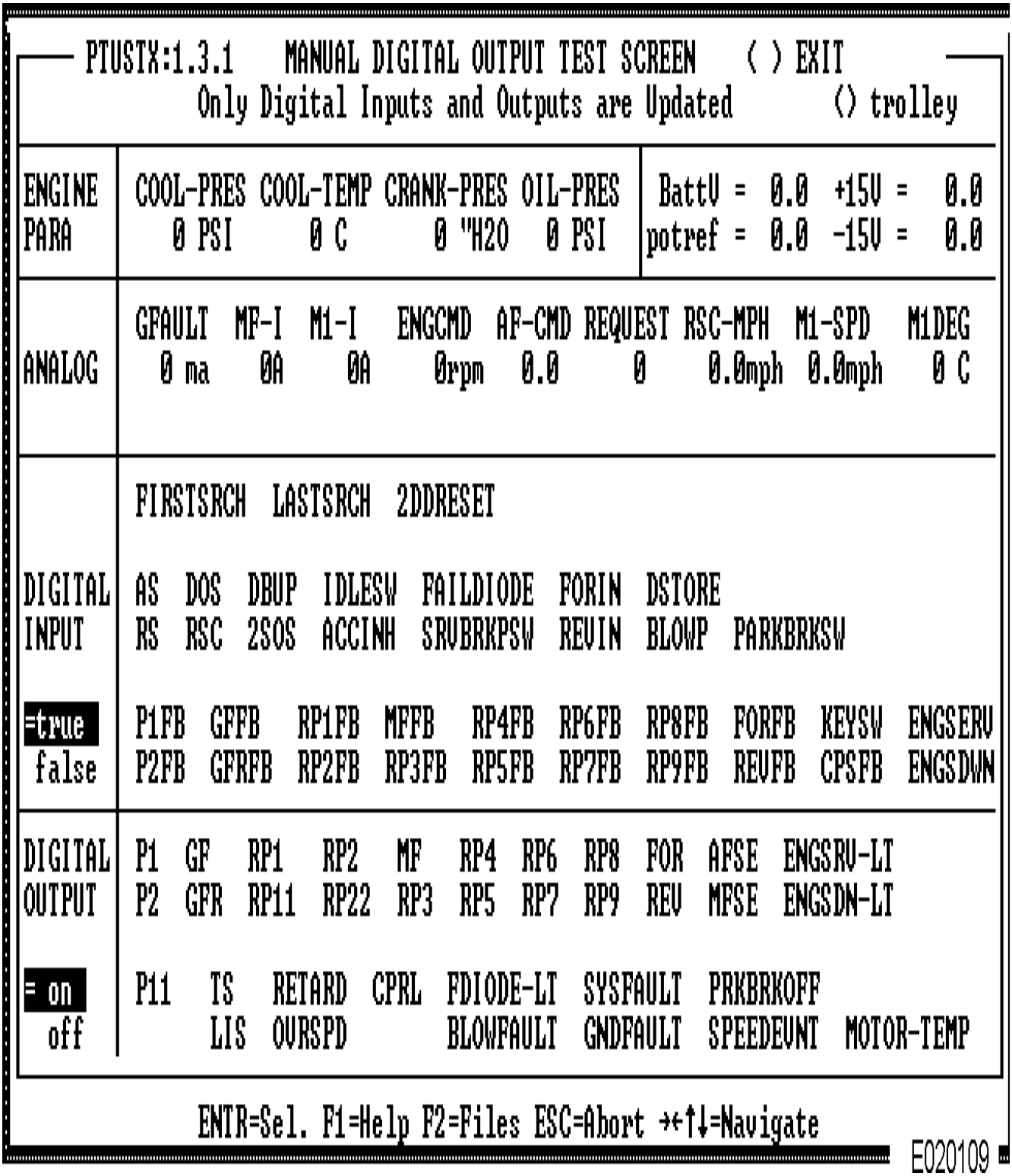


FIGURE 2-2. MAIN MENU


PTUSTX:1.3.1 MANUAL DIGITAL OUTPUT TEST SCREEN ( ) EXIT
Only Digital Inputs and Outputs are Updated () trolley
ENGINE PARA
COOL-PRES COOL-TEMP CRANK-PRES OIL-PRES
0 PSI 0 C 0 "H2O 0 PSI
BattV = 0.0 +15V = 0.0
potref = 0.0 -15V = 0.0
ANALOG
GFAULT MF-I M1-I ENGCMD AF-CMD REQUEST RSC-MPH M1-SPD M1DEG
0 ma 0A 0A 0rpm 0.0 0 0.0mph 0.0mph 0 C
FIRSTSRCH LASTSRCH 2DDRESET
DIGITAL INPUT
AS DOS DBUP IDLESW FAILDIODE FORIN DSTORE
RS RSC 2SOS ACCINH SRVBRKPSW REVIN BLOWP PARKBRKSW
=true
false
P1FB GFFB RP1FB MFFB RP4FB RP6FB RP8FB FORFB KEYSW ENGSERV
P2FB GFRFB RP2FB RP3FB RP5FB RP7FB RP9FB REVFB CPSFB ENGSDWN
DIGITAL OUTPUT
P1 GF RP1 RP2 MF RP4 RP6 RP8 FOR AFSE ENGSRV-LT
P2 GFR RP11 RP22 RP3 RP5 RP7 RP9 REV MFSE ENGSDN-LT
= on
off
P11 TS RETARD CPRL FDIODE-LT SYSFAULT PRKBRKOFF
LIS OVRSPD BLOWFAULT GNDFAULT SPEEDEVNT MOTOR-TEMP
ENTR=Sel. F1=Help F2=Files ESC=Abort →←↑↓=Navigate
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CONFIGURATION (CFG) FILE CONVERSION

When new GE software code is installed on the PTU to replace older versions of software, it will not contain the existing truck configuration data (overspeeds, serial numbers, option choices etc.) already in current truck files.

The Configuration Conversion Tool ("UPDATE CFG VERSION" option on the main menu) eliminates the need for any truck configuration data retyping. It will convert this truck data from the previous software release configuration files.

CONVERSION PROCEDURE

Use the following procedure to convert configuration files used with previous versions of software for use in the current version:

Search for old CFG filenames:

1. Select the previous software version by typing "`oldge`" at the DOS "C:>" prompt.
2. Select "TRUCK SETUP (CFG)" from the GE OHV STATEX III MENU and press [ENTER].
3. The cursor should be at number 1. Press [ENTER]. The screen shown in Figure 2-5 is a typical example. Make a list of the files listed on your screen.

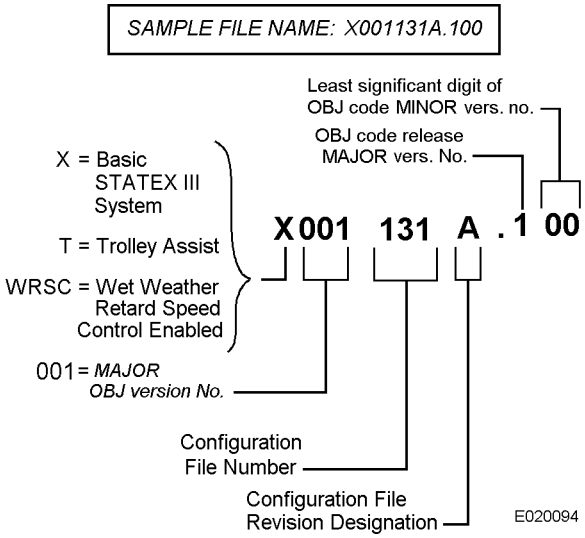


FIGURE 2-4. ELEMENTS OF A GE FILE NAME

NOTE: Refer to Figure 2-4 for an explanation of the elements of a GE file name. This information can be used to determine the release version of files stored on the PTU.

```
3  STATEX Truck Configurations in C:\prior_release\TRUCK

DOS file ext  Truck ID              Date        Time          GE file      ext
-------- ---  ---------------------------------------------------------------
MINE1    .214  truck one id        (mo/dy/yr)  (hr:mn:sec)  (Config file).(Oldver)
MINE2    .214  truck two id        (mo/dy/yr)  (hr:mn:sec)  (Config file).(Oldver)
OEMFILE  .214  [default]           (mo/dy/yr)  (hr:mn:sec)  (Config file).(Oldver)




  Position cursor to desired Configuration then Press Enter to Select
   or  Press ESCape to return to Truck Configuration Menu

Sort by 1=DOS FILE, 2=ext, 3=trk id, 4=date, 5=ge file, 6=ge ext; Del=Delete
```

E020097

FIGURE 2-5. SAMPLE CFG FILES CREATED IN EARLIER SOFTWARE RELEASE

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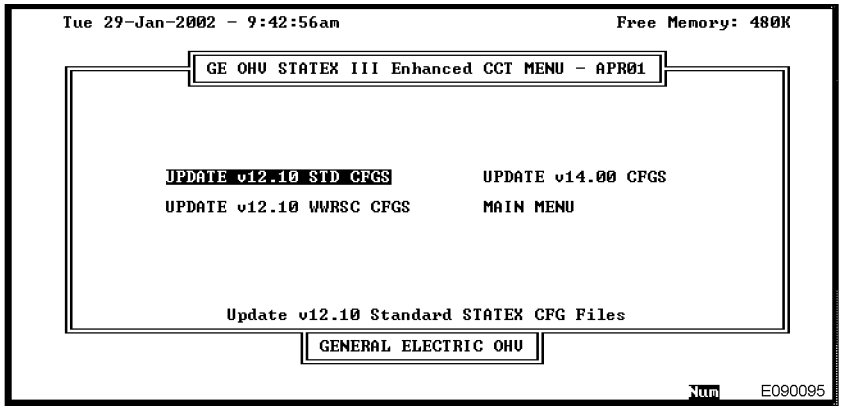


FIGURE 2-6. CONFIGURATION FILE CONVERTER MENU (Enhanced Vers. 1.00 Shown)

4. Exit back to the GEOHV STATEX III Menu, use the arrow keys to highlight “QUIT MENU” and press [ENTER] to return to DOS.
5. Open the main menu for the current software release by typing “`gemenu3e`” (or “`gemenu`” if using version 14 software) and press [ENTER]. The main menu (Figure 2-2) should appear. (Note the software release date in the menu title.)

Convert old CFG files for new software:

6. Select “UPDATE CFG VERSION” by typing [u] or move the cursor with the arrow keys and press [ENTER]. The screen shown in Figure 2-6 will appear.
7. Note there are four selections available. (The version 14 screen will not display “UPDATE v14.00 CFGS”.) Cursor to the desired operation and press [ENTER].
   a. Select “UPDATE v12.10 STD CFGS” if using Enhanced version 1.00 to convert from version 12.10 on a truck **without** wet weather retard speed control.
   b. Select “UPDATE v12.10 WWRSC CFGS” if using Enhanced version 1.00 to convert from version 12.10 on a truck **with** wet weather retard speed control.
   c. Select “UPDATE v14.00 CFGS” to convert from version 14.00 software to Enhanced version 1.00.
   d. Select “MAIN MENU” if not converting files.

For the following example, “UPDATE v12.10 STD CFGS” was selected and the screen in Figure 2-7 appears.

8. Note the screen shows a series of options labelled “F1” through “F9”, referring to the Function Keys [F1] through [F9] and provides a description of each.
   - [F1] provides a Help Screen to assist you directly on the screen.
   - [F2] names the new configuration file in column NEWCFG with the old configuration file name in column OLDCFG (only at the line where the cursor is).
   - [F3] names the new configuration file with no configuration file name.
   - [F4] creates a new configuration file with a new configuration file name (only at the line where the cursor is).
   - [F5] creates multiple configuration files with new configuration file names for all files in the NEWCFG column.
   - [F6] resets all new file names to their original OLDCFG names.
   - [F7] sorts the old configuration files in the NEWCFG column by file names.
   - [F8] sorts the old configuration files by their extensions.

Note: The description of [F7] or [F8] will be capitalized, depending on which sort has been used.

   - [F9] exits the Configuration Converter Tool and returns to the GEOHV Main Menu.

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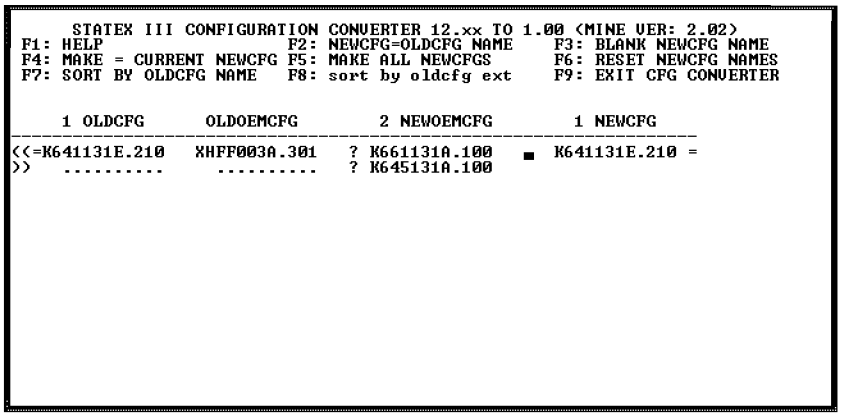


FIGURE 2-7. CONFIGURATION CONVERSION SCREEN

9. Note in Figure 2-7 the four columns headed by “OLDCFG”, “OLDOEMCFG”, “NEWOEMCFG” and “NEWCFG.” These are described as follows:
   - Files listed under “OLDCFG” are the old truck configuration files created by the mine using the previous software release which is displayed for possible conversion.
   - Files listed under “OLDOEMCFG” are the old OEM files created by Komatsu and given to the mine to create the previous release configuration files.
   - Files listed under “NEWOEMCFG” are the new OEM files created by Komatsu and given to the mine for the current software release version to create the new configuration files.
   - Files listed under “NEWCFG” are the names of the new configuration files to be created by the Configuration Conversion Tool. The cursor is there, blinking in front of the first file name in the last column to indicate that the computer is ready to edit these file names. The numbers which precede each column heading indicate the number of different files listed.
10. Note equal (=) signs appear at the beginning and the end of the first file name line, and follows the cursor up and down the list of files.
11. Using the RIGHT arrow key, move the cursor to the right. The cursor will fall under the first letter of the first file name in the last column. The UP, DOWN and LEFT arrow keys are now ineffective.
12. Type in the name for the new file over the old name. There is room for eight characters. If there are more letters in the old name than in the new, simply erase them using the space bar.

If an error is made in naming this file, the operation can be cancelled any time before [ENTER] is pressed by first pressing [ESC]. This returns the cursor to its original starting position where it can once again be moved with the arrow keys. A note to this effect is displayed at the bottom of the screen.

Note the asterisk (*) which appears in front of the new name, and another asterisk appears in front of the column heading when you begin typing. This means the file name is being changed, but the file has not yet been created. The asterisks disappear if [ESC] is pressed to cancel the renaming operation.

13. After the new name has been typed in, press [ENTER]. This records the new file name. Note the cursor moves back to its starting position at the left of the file name asterisk.

This operation can be cancelled, even after [ENTER] has been pressed by pressing [F6]. This resets the file back to its original name.

14. Press [F4] to create the new file. The mine data from the file in the first column is copied and put into the OEM file in the third column to create the name you entered in the fourth column. Note that both asterisks (*) have changed to plus signs (+), indicating the file has been created and copied to the hard disk.

Use the DOWN arrow to move the cursor to the next file name. Note the equal (=) signs move with the cursor.

15. Use the RIGHT arrow key and move the cursor to the right.
16. Type in the new file name.
17. Press [ENTER]. The example in Figure 2-9 shows the new file name to be “TEST2.”

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18. Use the DOWN arrow key and move the cursor to the next file name.
19. Move the cursor to the right to position the cursor on the name.
20. Type in the new file name and press [ENTER]. Note an asterisk (*) appears in front of both filenames, indicating the names have been changed but the files have not yet been created.
21. You can now press [F5] to create all new files at once.
    a. Note the screen prompts you to make a decision; “(O)” for Overwrite the file name, “(S)” for Skip creation of the noted file & continue with the remaining files, “(A)” for Abort creation of any new files. This is because the [F5] key tries to create all of the new files, and the first file has already been created. The computer is looking at the first file and is asking which of these three options to apply. Since the first file has already been created, the correct option is “(S)” for Skip & continue.

NOTE: This feature can be used to change a file name which was already created by selecting “(O)”, or abort the last changes made by selecting “(A)”.

22. Press [S]. Note the computer went directly to the second file and created it, and went on to the third file and created it. Note also that all asterisks (*) are now changed to plus signs (+).
23. Press [F9] or [ESC] to exit this screen and return to the GE OHV STATEX III MENU.
24. Select “TRUCK SETUP (CFG)” and press [ENTER].
25. Select No. [1] to view the current truck configurations on file. Note that the new configuration files are listed and are available for use. These new files contain the latest release of GE software and all of the truck configuration data from the previous files.

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STATEX CONFIGURATION FILES

Truck Configuration files must be properly setup and the correct file selected prior to programming the FB101 or the FB144 card in the FL275 Panel.

The following examples illustrate the various selections available from the **TRUCK SETUP CONFIGURATION MINE MENU** and the procedure required to create and save a configuration file for a specific truck.

1. Turn on the PTU. When the DOS "C:>" prompt appears, type "gemenu3E" (or "gemenu" if using version 14.00) and press [ENTER].
2. With the **GE OHV STATEX III MENU** displayed, use the arrow keys to move the cursor to "TRUCK SETUP (CFG) and press [ENTER]. The **TRUCK SETUP CONFIGURATION MINE MENU** shown in Figure 2-8 will appear.
3. The first line under the heading indicates the number of configuration files stored on the PTU (hard drive) source directory shown in the second line. The example in Figure 2-8 lists 4 configuration files stored in the directory named C:\GEOHV\CFG\STXAPR01\TRUCK.

Each time a new configuration file is created and saved it will be added to the list of files available and the number of "STATEX truck configurations" will increase.

"0) Source Directory: . . ."

When the **TRUCK SETUP CONFIGURATION MINE MENU** first appears, a default source directory used to store truck configuration files will appear in line 0).

In some cases it may be beneficial to create other directories for storing truck configuration files. For example, a mine operating several models of trucks may prefer to create directories named "510E", "685E" and "830E" to separate configuration files.

*NOTE: If additional directories as described above are desired, the **new directories MUST be created using DOS**, prior to using the GE software.*

If configuration files are to be retrieved from a different directory, use the following procedure:

1. Move the cursor to line 0) and press [ENTER].
2. With the cursor on "0", type in the full DOS path name of the alternate directory used to store configuration files. Press [ENTER].
3. The alternate directory name will appear and the number of configuration files stored in the alternate directory will be displayed above line 0).

If all configuration files are stored in the default directory that appears when the **TRUCK SETUP CONFIGURATION MINE MENU** appears, no change to line A) is necessary.

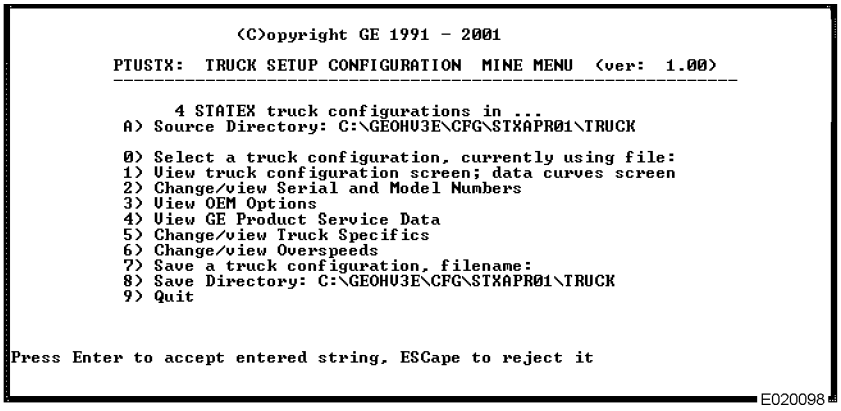


FIGURE 2-8. TRUCK CONFIGURATION MINE MENU

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"1) Select A Truck Configuration . . ."

*Note: A truck configuration **must** be selected before menu choices 1 through 8 can be used.*

1. With the **TRUCK SETUP CONFIGURATION MINE MENU** displayed, press [1] or move the cursor to 1) and press [ENTER] to select "Select a truck configuration, . . . ".
2. A listing of the configuration files stored in the source directory (line 0), will appear as shown in Figure 2-9.

NOTE: Normally, the display would show the base configuration that was provided by the OEM, to define the specific truck model options plus a configuration that was made by the mine specifically for each truck.

3. Note that across the bottom of the screen, six different file list sort options are available.

   1 = DOS file name

   2 = DOS filename.extension

   3 = Truck ID

   4 = Date that the file was created

   5 = GE file name

   6 = GE filename.extension

   DEL = Choosing delete will prompt for a Y/N input to delete the selected file or not.

When many files are listed, it is helpful to sort the file names in a different order from what they appear. For example, to sort the files by truck ID, press the [3] key. If the Delete key [DEL] is chosen, the file next to the cursor will be deleted after the prompt appears and [Y] is chosen. If the file should not be deleted, press [N] to return the cursor to the file list.

When many files are listed, [Page Up] and [Page Down] keys help move the cursor around the screen faster. Otherwise use the UP arrow and DOWN arrow keys.

4. Move the cursor to the desired configuration and press [ENTER] to select the filename and return to the **TRUCK CONFIGURATION MINE MENU**. The file selected will then appear in line "1)" of the **TRUCK SETUP CONFIGURATION MINE MENU**.

NOTE: Press [ESCAPE] if leaving the screen without making a selection.

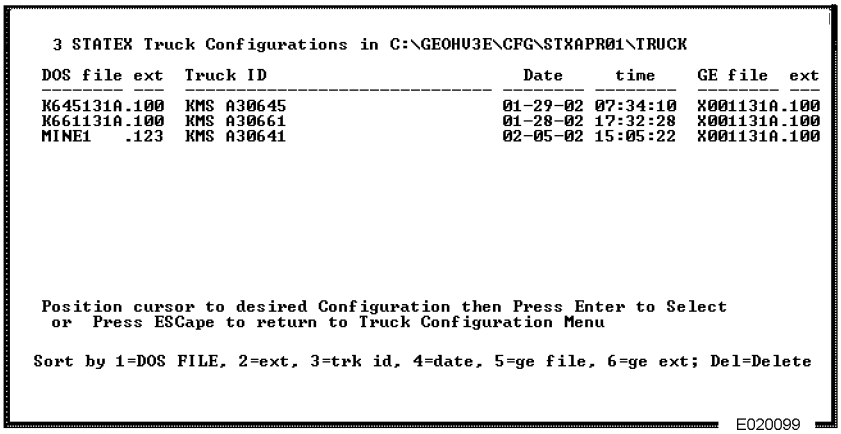


FIGURE 2-9. TRUCK CONFIGURATION FILE SELECTION SCREEN

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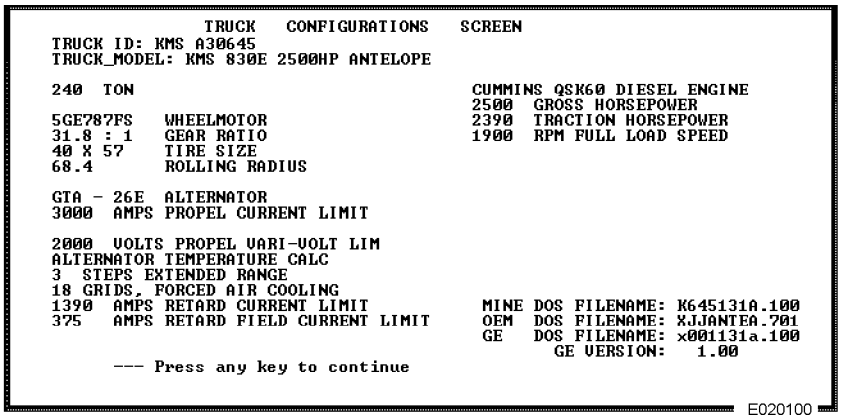


FIGURE 2-10. TRUCK CONFIGURATIONS SCREEN
(830E Truck Sample Data)

"2) View Truck Configuration: Data Curves . . ."

NOTE: The following screens are "view only". No changes can be made.

1. With the sample configuration file selected and displayed at the end of line 1) of the **TRUCK SETUP CONFIGURATION MINE MENU**, use the Down arrow to move the cursor to the menu position "VIEW TRUCK CONFIGURATION SCREEN; DATA CURVES SCREEN" and press [ENTER], or press [2]. An example of a model 830E truck configuration is shown in Figure 2-10.
2. Press any key to view the second screen: **TRUCK CONFIGURATION DATA CURVES SCREEN**. An example of the data curves is provided in Figure 2-11.
3. Press any key to return to the **TRUCK CONFIGURATION MINE MENU.**

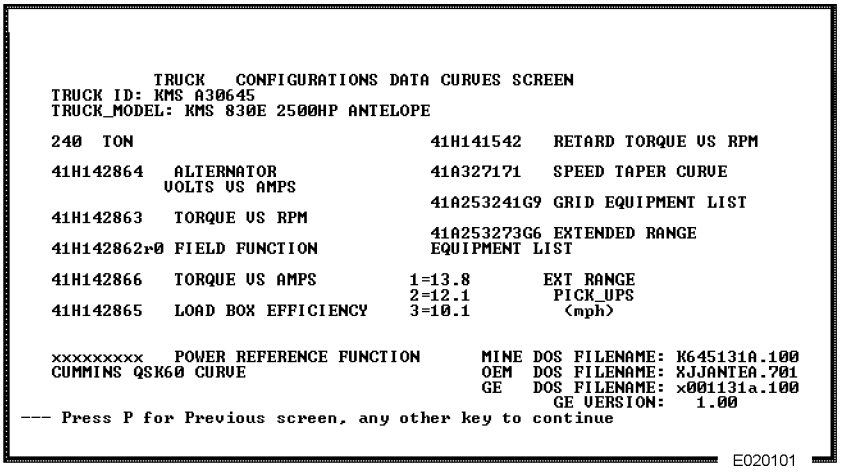


FIGURE 2-11. DATA CURVES SCREEN

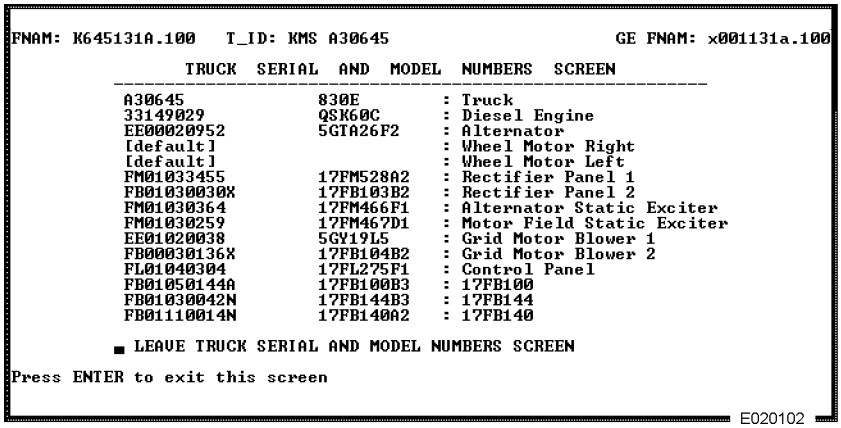


FIGURE 2-12. TRUCK COMPONENT SERIAL NUMBERS

"3) Change/View Serial and Model Numbers . . ."

1. Use the down arrow key to move the cursor to the menu position "CHANGE/VIEW SERIAL AND MODEL NUMBERS SCREEN", or press [3]. All of the major component serial numbers will be displayed, or serial number information can be typed in. Refer to the screen shown in Figure 2-12. If a serial number is changed, an asterisk (*) will appear next to it.
2. To insert new serial numbers, move the cursor to the desired location, type in the information, and press [ENTER]. When finished entering serial numbers, exit the screen by moving the cursor to the "leave truck serial numbers screen" selection and press [ENTER].

"4) View Options . . ."

NOTE: The options on this screen can be changed only by the manufacturer.

1. Use the Down arrow to move the cursor to the menu position "VIEW OPTIONS" and press [ENTER], or press [4]. The screen shown in Figure 2-13 will appear.
2. Several codes are used to indicate the status of various options and equipment.

The Y, N and X codes are described as follows:

Y = OEM has selected YES

N = OEM has selected NO

X = Not available to OEM

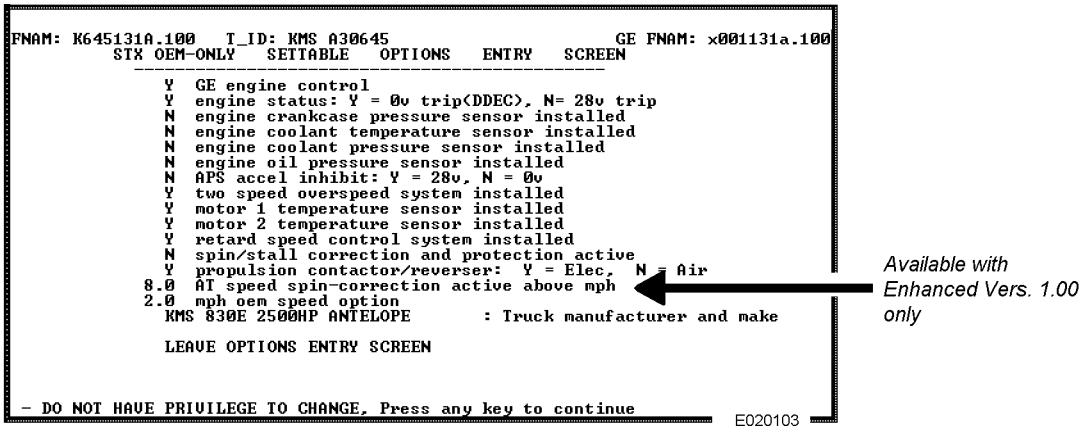


FIGURE 2-13. OPTIONS ENTRY SCREEN (View Only)

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The following list defines each option:

a. GE engine control

Y: “Fuel Saver” circuitry is installed. The engine, accelerator and retard pedals interface with the FL275 panel.

N: Accelerator and retard pedals interfaced with ACC/RET panel.

b. Engine Status (voltage signal from engine system fault which inhibits propel):

Y: 0 v trip

N: 28 v trip

NOTE: Y is used for DDEC and MTU engine system interface for Engine Service and Engine Shutdown digital inputs.

c. Engine crankcase pressure sensor installed

Y: Analog engine crankcase pressure sensor has been installed on the engine.

N: Ignore this input.

d. Engine coolant temperature sensor installed

Y: Engine coolant temperature sensor has been installed on the engine.

N: Ignore this input.

e. Engine coolant pressure sensor installed

Y: Analog engine coolant pressure sensor has been installed on the engine.

N: Ignore this input.

f. Engine oil pressure sensor installed

Y: Analog engine oil pressure sensor has been installed on the engine.

N: Ignore this input.

g. APS (Accelerator Pedal Switch) accel inhibit:

Y: 28 v at the “accinh” digital input will inhibit acceleration.

N: 0 v at the “accinh” digital input will inhibit acceleration.

h. Two speed overspeed system installed

Y: Loaded/empty load weighing system is operating on the truck.

N: System not installed on the truck.

i. Optional motor 1 temperature sensor installed

Y: Motor 1 temperature sensor option is installed.

N: Ignore this input.

j. Optional motor 2 temperature sensor installed

Y: Motor 2 temperature sensor option is installed.

N: Ignore this input.

k. AS switch overrides retard speed control

Y: Pressing the accelerator pedal will override the retard speed control system and allow acceleration with the retard speed control system turned on.

N: Pressing the accelerator pedal does not override the retard speed control system.

l. Retard speed control system installed

Y: FL275 panel accepts the retard speed control system input.

N: Control computer ignores this input.

m. Spin/stall option

Y: Spin stall system is active.

N: Function is turned off.

n. Electric contactor/reverser option

Y: Electric propulsion contactor an reverser are active.

N: Function is not computed. (Air operated components are installed.)

o. AT speed spin-correction active above mph (*Enhanced Version 1.00 only*)

At speeds greater than the mph number entered, both wheelmotors are monitored for evidence of wheel spin and if detected, traction horsepower is reduced until the spinning wheel regains traction or until the wheel with traction falls to the mph value specified.

p. mph OEM option

The number entered is the value in miles per hour at which the digital output OEM SPEED EVENT is turned On. When the truck slows to a speed below this setting, the OEM SPEED EVENT is turned Off.

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“5) Change/View Truck Specifics . . .”

NOTE: If values are changed on the TRUCK SPECIFICS SCREEN, the truck MUST be re-programmed before the changes will be in effect.

The **TRUCK SPECIFICS SCREEN** is used to enter the desired values of engine horsepower, engine load rpm, accelerator and retard pedal calibration, the blower pressure fault time delay, the fault data collection interval, statistical data quarter start month, and the mine truck identification.

1. Use the Down arrow to move the cursor to the menu position “CHANGE\VIEW TRUCK SPECIFICS” and press [ENTER], or press [5].
2. The **TRUCK SPECIFICS SCREEN,** Figure 2-14, will be displayed. Move the cursor to the line where a change is desired. Enter the values desired as a permanent value in the truck code. (Type the value and press [ENTER].) A note at the bottom of the screen shows the range of values that may be entered.

   a. Manual horsepower limit set

      Used to select manual or automatic horsepower limit.

      Y: Manual

      N: Automatic

NOTE: It is recommended that this value is always set to “N” to select automatic. In this condition the system will automatically adjust the electrical system load to maintain the ENGINE FULL LOAD RPM value specified in step d.

   b. Ignore high idle switch when empty

      Y: Operator request for high idle is ignored if sensors indicate truck is empty.

      N: Load weighing sensors do not affect idle selection.

Note: This option is only applicable when OEM-options “GE engine control is set to “N” and “two speed overpseed system installed” is set to “Y”.

   c. Wet weather retard speed control

      Y: Enables wheel slide compensation option.

      N: Disables option.

   d. Engine horsepower output adjust

      This line allows entering the reducer or adder to the nominal horsepower that was determined in the manual load box screen. For example, if in the manual mode load box screen the nominal HP is set at 2350 NHP, use the increment/decrement keys to load the engine to the point where it starts to bog the engine. The horsepower output adjust value shown at the bottom of the screen is entered here. The available range is displayed at the bottom of the screen when this line is selected with the cursor. This allows modification of the value of the horsepower pre-programmed in the configuration data tables.

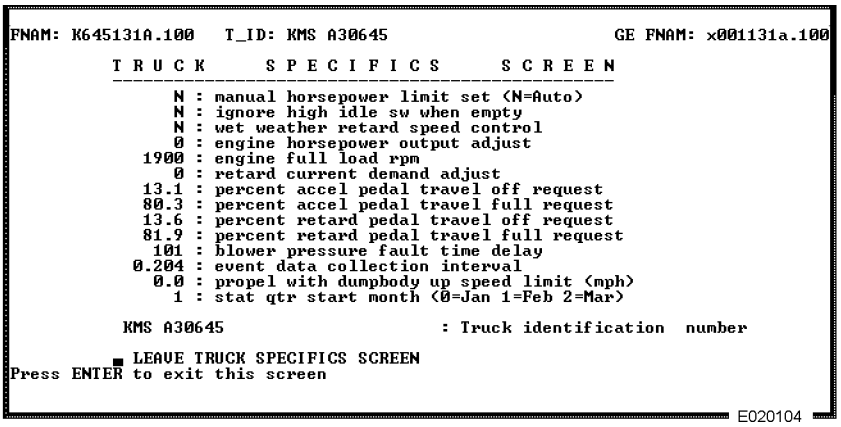


FIGURE 2-14. TRUCK SPECIFICS SCREEN

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e. Engine full load rpm value

Used when the manual horsepower limit set is “N”. Sets the engine rpm value that the control system will maintain by automatically adjusting the load. The available range is displayed at the bottom of the screen when this line is selected with the cursor. This generally is set to the rated RPM of the engine.

f. Retard current demand adjust

This line allows entering the adder or reducer to make the system regulate at the proper retard current limit by compensating for the offset error in the isolation amplifiers. Use the TEMPORARY RETARD CURRENT ADJUST SCREEN to determine what this value should be. The number entered (units are amps) can be + or -, and it will cause the control to change the retard current limit by that amount.

1. With the truck shut down and control power ON, measure the output of Iso-amps IA3 and IA4 at terminal “D” and record the values.
2. Use the higher of the two readings. (1 amp =0.001 volts). (For example, if the higher reading was +0.01 volts, the offset is +10 amps.)
3. Using the above example, enter -10 amps in the temporary screen.
4. Operate the truck and verify the correct retard limit was obtained.
5. If the correct retard limit was observed in step 4, enter that number (-10 in this example) on this screen to make it permanent.

Note: Items g. through j. are applicable only if truck is equipped with “Fuel Saver” system and “GE engine control” on the OEM-ONLY SETTABLE OPTIONS ENTRY SCREEN is set to “Y”.

g. Percent accel pedal travel off request

Used to enter the percent of pot reference volts at which the accelerator pedal is calibrated to have zero accel request.

h. Percent accel pedal travel full request.

Used to enter the percent of pot reference volts at which the accelerator pedal is calibrated to have full accel request.

Note: Refer to “Statex III Electrical System Checkout Procedure, Throttle System Check and Adjustment” for accelerator pedal calibration.

i. Percent retard pedal travel Off request

Used to enter the percent of pot reference volts at which the retard pedal is calibrated to have zero retard request.

j. Percent retard pedal travel full request

Used to enter the percent of pot reference volts at which the retard pedal is calibrated to have full retard request.

Note: Refer to “Statex III Electrical System Checkout Procedure, Retard System Check and Adjustment” for retard pedal calibration.

k. Blower pressure fault time

Use to set the blower fault time delay in seconds. A value between 30 seconds and 101 seconds may be entered if a delay other than the default setting of 101 seconds is desired.

l. Event data collection interval (sec)

Used to set the time interval in seconds that the CPU collects fault data.

m. Propel with dumpbody up limit (mph)

Sets maximum forward propulsion speed (0 to 4 mph) with dump body up and override switch not activated.

n. Statistical quarter start month (0=jan, 1=feb, 2=mar)

Used to set the starting month for the active calendar quarters on the CPU clock. Example:

0=Jan, Apr, Jul, Oct

1=Feb, May, Aug, Nov

2=Mar, Jun, Sept, Dec

o. Truck identification number

For use by the mine to enter the truck identification number. Truck ID shows up with the event data and must be unique for each truck.

3. When changes are completed, move the cursor to “LEAVE TRUCK SPECIFICS SCREEN” and press [ENTER]. This automatically returns the program to the TRUCK SETUP CONFIGURATION MINE MENU.

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“6) Change/View Overspeeds . . .”

The OVERSPEEDS ENTRY SCREEN is used to enter the desired speed settings for overspeed pickup, overspeed dropout, speed override, and the maximum retard speed control speed.

1. Use the down arrow key to move the cursor to the menu position “CHANGE/VIEW OVERSPEEDS” and press [ENTER], or press [6].
2. The OVERSPEEDS ENTRY SCREEN, Figure 2-15, will be displayed. Using the UP and DOWN arrows, move the cursor to the line where a change is desired. Note that the empty or loaded values are selected in the control system only based on the input from the 2 speed overspeed switch where 0 volts selects loaded value and +28 volts selects empty values. Move the cursor to the proper line and enter the desired value as a permanent value in the truck code. (Type the number and press [ENTER].)

General guidelines for picking entry speeds:

- Loaded values must be less than or equal to empty values.
- Overspeed dropout must be less than or equal to 0.95 of detect speed.
- Speed override must be set at 1.0 mph (or more) below the overspeed detect point.

Note: As the cursor is moved from one selection to another, a variety of instructions appears at the bottom of the screen, one for each selection.

a. Empty overspeed overshoot . . .mph

Overspeed overshoot speed setting (to be set above the empty overpseed retarding mph) in miles per hour for an empty truck.

b. Empty overspeed detect . . . mph

Overspeed retarding pickup setting in miles per hour for an empty truck.

c. Empty overspeed dropout . . . mph

Speed at which overspeed retarding is released in miles per hour for an empty truck.

d. Empty speed override . . . mph

Speed override value in miles per hour for an empty truck. It must be at least 1 mph lower than the empty overspeed detect value.

e. Empty maximum retard pot . . . mph

Maximum retarding speed for the retard speed control system when the pot is set at maximum on an empty truck.

f. Loaded overspeed overshoot . . . mph

Overspeed overshoot speed setting (to be set above the loaded overpseed retarding mph) in miles per hour for a loaded truck.

g. Loaded overspeed detect . . . mph

Overspeed retarding pickup setting in miles per hour for a loaded truck.

h. Loaded overspeed dropout . . . mph

Speed at which overspeed retarding is released in miles per hour for a loaded truck.

i. Loaded speed override . . . mph

Speed override value in miles per hour for a loaded truck. It must be at least 1 mph lower than the loaded overspeed detect value.

j. Loaded maximum retard pot . . . mph

Maximum retarding speed for the retard speed control system when the pot is set at maximum on a loaded truck.

3. Move the cursor to the “leave overspeeds entry screen” when finished entering values and press [ENTER]. This automatically returns the program to the TRUCK SETUP CONFIGURATION MINE MENU. If you have made an inconsistent entry for the speeds, you will not be able to exit the screen. A note will appear at the bottom to guide you in correcting the error.

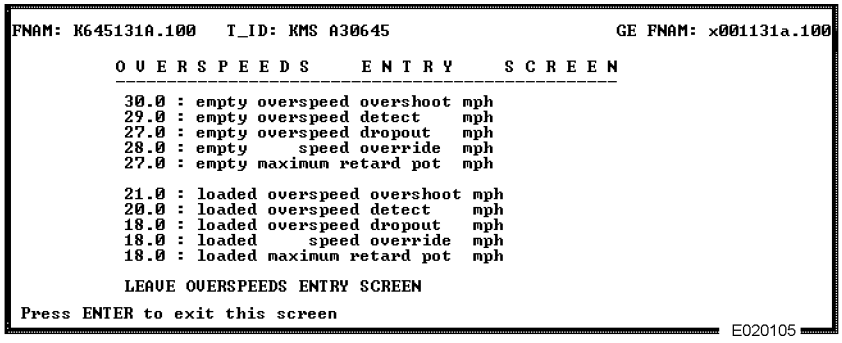


FIGURE 2-15. OVERSPEEDS ENTRY SCREEN

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"7) Save a Truck Configuration, filename: . . ."

NOTE: If the configuration file is to be saved into a directory other than the directory shown at the end of line 8), the new directory must be specified before "Save a truck configuration, . . ." in line 7) is selected. Refer to "Save Directory: . . . " on the following page.

Changes to the Configuration File represent changes made by the mine specific to their equipment and operating conditions. When the Truck Configuration file is modified, it should be saved under a new file name rather than being resaved under the originally selected file name.

Example:

The Mine configuration file name may be defined as M123131A.202 where:

M = Mine designation letter

123 = Mine truck identification number (last three digits)

131 = Hardware Configuration (GE defined truck config. screen)

A = Revision Letter (A =1st release of this config. file)

. = Period (Used to separate first 8 characters from last 3)

2 = Current Month (Jan =1, ... Sep =9, Oct = A, Nov = B, Dec = C)

02 = Current Year (2002)

The Mine may choose to set up its own system for naming and recording the Truck configuration files currently installed on its trucks, but it is strongly recommended that a file naming system be established.

NOTE: The file name length is limited to 8 characters maximum, followed by a period, then followed by a maximum 3 characters.

1. From the TRUCK SETUP CONFIGURATION MINE MENU screen, move the cursor to line 7) and press [ENTER] or press [7] key to select "Save a truck configuration, filename:"
   a. After "filename:. . . " the original selected truck configuration file name will appear as a prompt.
   b. Type the desired Mine truck configuration file name defined above to replace the original file name as shown by the arrow in Figure 2-16. Press [ENTER] key.
   c. The saved Mine configuration file name should now appear in the source directory. Press the [0] key to verify the file has been added to the list of configuration files as shown by the arrow in Figure 2-17. The Mine configuration file is now accessible in the subdirectory for installation into the CPU.
   d. Press [ESC] key to return to the previous menu screen.

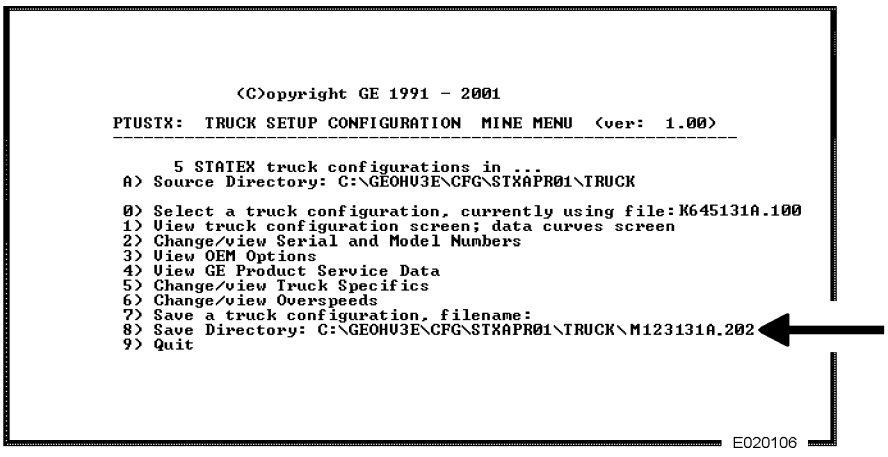


FIGURE 2-16. ENTERING NEW CONFIGURATION FILE NAME
(Enhanced Version 1.00 Software Shown)

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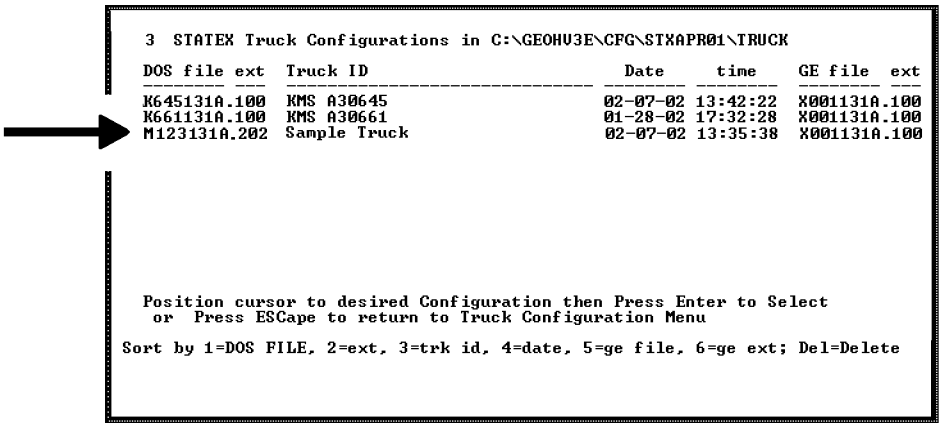


FIGURE 2-17. TRUCK CONFIGURATION FILE LIST
(Sample file name shown added to the list)

"8) Save Directory: . . ."

At the end of line 8) a directory is displayed for storing the new truck configuration file. The sample in Figure 2-16 shows:

"C:\GEOHV3E\CFG\STXAPR01\TRUCK".
This directory will be the same as the directory shown in line A).

If the newly created configuration file is to be stored in this directory, it is not necessary to change line 8). When line 7) is selected and the file saved, it will automatically be saved to the directory shown in line 8).

If the configuration file is to be saved in a different directory, *use the following procedure **BEFORE** selecting line 7) to save the file:*

1. Move the cursor to line 8) and press [ENTER] or press [8].
2. Type in the full DOS path name of the directory in which to store the new configuration file. Press [ENTER].

NOTE: If a new directory is specified, the directory name MUST exist on the PTU hard drive. The software is not capable of creating a new directory. New directories must be created using DOS.

3. Move the cursor to line 7) and press [ENTER] or press [7].
4. The current file name will appear at the end of line 7).
5. Type in the new file name (M123131A.202 in the example shown). The original filename will disappear as the new name is typed.
6. Press [ENTER] to save the new file name into the directory shown on line 8).
7. Move the cursor to line 1) and press [ENTER] or press [1]. This will display the list of configuration files as shown in Figure 2-17. Verify the new file name has been added to the list.
8. When finished with the **TRUCK SETUP CONFIGURATION MINE MENU**, move the cursor to line 9) and press [ENTER] or press the [9] key to Quit.
   a. The prompt, "Quitting, Are you sure (Y/N):" appears as a warning against quitting without saving the modified configuration file. Press [Y] key if you are sure that the Mine renamed configuration file has been properly saved.
9. The **GE OHV STATEX III MENU** will appear on the PTU screen.

NOTE: It is advisable to make a backup copy (to a floppy disk) of the current Truck Configuration File whenever changes are made to the file. This will provide a backup copy of configuration information which will not have to be manually re-entered in the event data on the PTU hard disk drive is lost. Refer to the DOS operating system manuals supplied with the PTU for specific procedures for copying files from the PTU to a floppy disk.

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"CHANGE PTU PASSWORD"

The ability to set passwords for access privilege levels is provided using the "CHANGE PTU PASSWORD" selection from the GE OHV STATEX III MENU. A password is required to enter the screen. The system is designed to show the privilege level of the password used to enter this screen and all those of lesser privilege. The chart below lists the levels and the PTU screens that can be accessed at the various privilege levels.

- Level 1 has a privilege level of 200 and is the base level for mechanics. It requires a privilege of 190 or greater. A level 1 password, "TEST" is available to anyone and is set by GE as part of the software code.
- Level 2 has a privilege level of 1000. It must not be less than 300 or greater than 1099. This password can be set by Komatsu or the mine.
- Level 3 has several privilege levels to allow or prevent access to the screens listed. The password privilege must be equal to or greater than the value indicated. The upper limit for level 3 is 14899.

Selections listed at the bottom of the screen allow passwords to be added, changed and deleted. Additional help is available by pressing [F1].

It is recommended that supervisors assign passwords and privilege levels below their own.

NOTE: On some PTUs, some difficulty has been experienced if passwords were entered which have zeros. The problem was found to be caused by the PTU being in the "Numlock" mode (or "Keypad" mode on some PCs). This interprets a section of the normal keypad as a numeric keypad and hence produces the wrong characters.

PTU USER PRIVILEGE LEVELS

Level	Privelege	Screen Title
1	200	GE OHV Statex III Menu
		Normal Operation Menu
		Monitor Real Time Data Screen
		Automatic Load Box Test Screen
		Manual Load Test Box Screen
		Accelerate State Logic Screen
2	1000	Monitor Analog Input Channels Screen
		Retard State Logic Screen
		Special Operation Menu
		Event Data Menu
		Event Summary Screen
		Event Data Display Screen
		Special F1 Help Screen
		Upload GE Event Data Yes/No Screen
		Statistical Data Menu
		Stat Parameter Counters Screen
		Profiles Screen

Level	Privelege	Screen Title
2	1000	Upload Statistical Data Menu
		Temporary Truck Settings Menu
		Temporary Speed Set Screen
		Temporary Retard Current Adjust Screen
		Temp. Event Data Collection Interval Screen
		Truck Specific Information menu
		OEM Option Screen
		Mine Option Screen
		View Speed Settings Screen
		Serial Numbers Screen
		GE Version Information Screen
		Special Control Engine Stopped Test Menu
		Manual Digital Output Test Screen
		View Program Truck File
3	1100	Reset "All" Yes/No Menu (Erase Event Data)
	2990	Date and Time Set Screen
	4990	Program Truck Yes/No Menu

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PROGRAMMING THE TRUCK

The following procedures should be followed to program a new truck or reprogram an operational truck when necessary. Reprogramming is required if the FB101 or FB144 CPU card is replaced, equipment is added or removed, or if changes are made to the Truck Configuration File.

It is assumed the correct Truck Configuration File is available for programming the truck. If not available, or if changes are required, refer to previous information in "STATEX CONFIGURATION FILES" and make the required changes before proceeding.

Perform the following steps to program the truck:

Connect PTU to the Truck

1. Connect the PTU to the control system on the truck:
   a. Connect the PTU cable male plug to the "A" receptacle located at the Two-Digit Display panel in the control cabinet or in the cab. Plug the female connector end of the cable into the serial port receptacle at the back of the PTU.

NOTE: Connector A is used for communication with the truck CPU. Connector B uses a cable with a female connector on both ends and is used for communicating with a mine dispatch computer.

   b. Provide 110 vac to the work area on the truck. Connect the portable battery charger for the PTU to 110 vac and the PTU. This will maintain the charge on the PTU battery.
2. Turn on the PTU. After warm-up and self-test, the DOS "C:>" prompt will appear.
3. Type "`gemenu3e`" (or "`gemenu`" if using version 14.00) and press [ENTER]. The main menu titled **GE OHV STATEX III MENU** will appear.

NOTE: There may be other available GE OHV menus on the portable computer. If installed, a previous software version can be accessed by typing oldge3e (or "`oldge`" if version 14 is installed at the DOS prompt.

Select Configuration File

1. Use the arrow keys to move the cursor to select "SELECT TRUCK SETUP".
2. Select the proper Truck Configuration file by moving the cursor to the correct file and pressing [ENTER].
3. The GE OHV STATEX III MENU will reappear.

Activate The PTU Mode

1. Use the arrow keys to move the cursor to the "PTU TALK TO TRUCK" selection on the main menu and press [ENTER].
2. Logon by responding to the prompts shown in Figure 2-18, typing in your name (initials will suffice) and password.
3. A menu titled **GE STATEX III PTU MAIN MENU** (Figure 2-19) will appear after the PTU goes through necessary loading (about 10 seconds).

NOTE: Various screens may display caution statements about contactors moving. This is to protect maintenance personnel who may be working in the control cabinet while the PTU is being used to perform test and set-up functions.

NOTE: If a PTU lock-up occurs at any time during communications with the truck, it may necessary to start over. Perform the following:

1. If the PTU screen has a message at the bottom of the screen, press the [SPACE] bar and wait for the message to clear.
2. If the PTU still does not communicate, turn the Control Power switch Off. (Sometimes it may be necessary to turn the battery disconnect switch off to insure a complete cycle of power.)
3. If this doesn't work, press the [CTRL], [ALT] and [DEL] keys simultaneously. This reboots the PTU and takes the PTU to the DOS "C:>" prompt. Then, type "`gemenu3e`" (or "`gemenu`") to reopen the main menu.

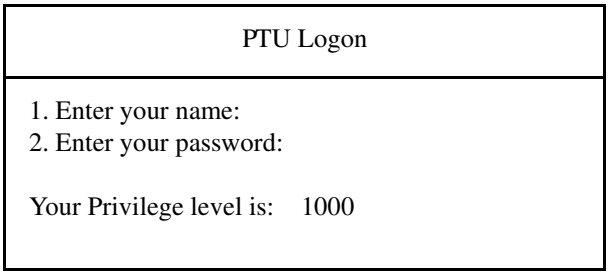


FIGURE 2-18. PTU LOGON INFORMATION ENTRY

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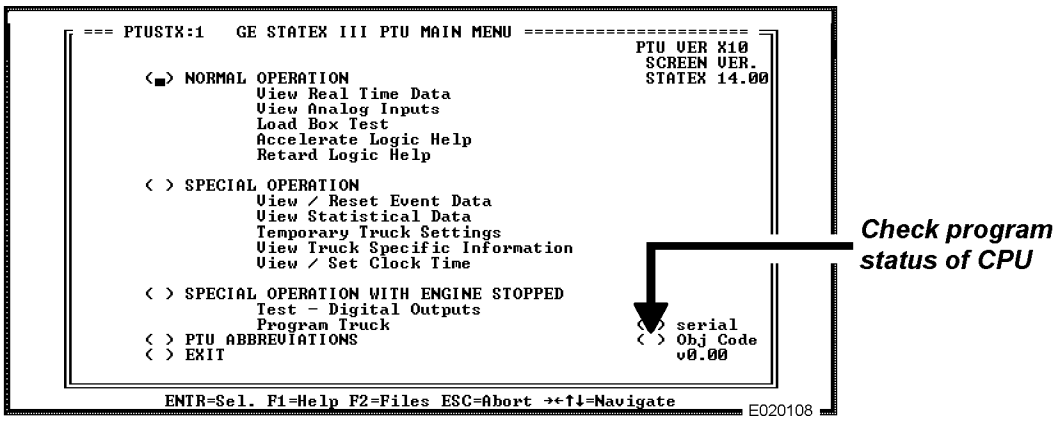


FIGURE 2-19. PTU MAIN MENU

Check Object Code Version

Before downloading configuration files to the truck CPU, use the cursor to select “OBJ CODE V0.00” (or whatever number is displayed on the screen) as shown in Fig. 2-19. When selected, one of two events will take place:

1. If a number appears on the screen, code has been installed into the truck CPU, and the downloading selection on the **PROGRAM TRUCK YES/NO MENU** will be “YES, RELOAD PROGRAM INTO TRUCK”.
2. If code has not been installed, the truck CPU is not programmed, and an error message will appear as shown in Figure 2-20. If this happens, the downloading selection will be “YES, INSTALL PROGRAM INTO TRUCK”.

PR0BLEMS COMMUNICATING WITH VEHICLE

Unable to successfully communicate
with vehicle after 1 attempt

Press “C” to continue attempts,
“R” to re-initialize Serial Port
Anthing else to abort this packet.

Overrun error:	0
Parity error:	0
Framing Error:	0
TOTAL ERRORS	1

FIGURE 2-20. PTU/CPU COMMUNICATION ERROR MESSAGE

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Download Configuration Files

Download configuration files into the CPU on the truck as follows:

1. From the GE STATEX III PTU MAIN MENU (Figure 2-19) use the arrow keys to move the cursor to the “SPECIAL OPERATION WITH ENGINE STOPPED” selection and press [ENTER]. An intermediate screen will appear asking yes or no. With the cursor on “yes” press [ENTER]. The SPECIAL CONTROL ENGINE STOPPED TEST MENU screen appears.
2. Use the arrow keys to move the cursor to the VIEW PROGRAM TRUCK FILE selection and press [ENTER]. The screen will show the CFG and OBJ file to be downloaded.
3. Press [ESC] to return to the previous menu.
4. Use the arrow keys to move the cursor to the “program truck yes/no menu” selection and press [ENTER]. The PROGRAM TRUCK YES/NO MENU screen appears.
5. Use the arrow keys to move the cursor to desired program truck selection.
   a. “NO, Return to Engine Stopped Test Menu”This selection will take the computer back to the SPECIAL CONTROL ENGINE STOPPED TEST MENU.If, for some reason programming is not desired, select this choice.
   b. “YES, RELOAD PROGRAM INTO TRUCK” Use whenever the truck CPU has already been programmed and re-programming is desired. This selection is appropriate if, for example, the truck configuration file has been modified. The configuration file must be reloaded for the changes to become effective.
   c. YES, INSTALL PROGRAM INTO TRUCKUse to install a program into the truck CPU for the first time or into a new or modified FB101 card. For example, if the FB101/144 card EPROM's are updated.
6. Press [ENTER] to begin programming the truck. The programming will take approximately 15 minutes to complete.
7. During the downloading operation, various messages are displayed on the PTU screen as the procedure progresses. At completion, press [SPACE] per instruction on the screen.

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DATE AND TIME

When the initial programming of a truck is completed, the date and time should be set.

⚠WARNING

Selecting "SPECIAL OPERATION" in the following procedure may present a safety hazard if the engine is running. Control of the propulsion system may transfer from the truck driver to the PTU operator with this software operation. See step 1. below for details.

1. Use the arrow keys to move the cursor to the "SPECIAL OPERATION" selection on the GE STATEX III PTU MAIN MENU and press [ENTER]. The message shown in the lower half of screen shown in Figure 2-21. will be displayed.This warning notifies the operator when control of the truck is being transferred from the truck driver to the PTU, based on the PTU selection of "SPECIAL OPERATION". When finished and the PTU is returned to the PTU MAIN MENU, control of the propulsion system is returned to the truck driver. Before activating this command, the screen shown in Figure 2-22 will be displayed.The PTU user should always keep the truck driver informed of this control.
2. Select "Yes" on the caution screen and press [ENTER].
3. Use the arrow keys to move the cursor to the "SET DATE & TIME" selection and press [ENTER]. The DATE & TIME SET SCREEN screen will be displayed.
4. If the date and time displayed is correct, press [ENTER] at the "No, Do not reset date and time" selection.
5. Use the arrow keys to move the cursor to the various other selections.
6. Type the day of the month, 1 thru 31, and press [ENTER].
7. Press the Down arrow key. Type the month as a two-digit number, 01 thru 12, and press [ENTER].
8. Press the Down arrow key. Type the year as a two-digit number, 00 thru 99, and press [ENTER].
9. Press the Down arrow key. Type the hour based on a 24 hour clock, 00 to 23, and press [ENTER].
10. Press the Down arrow key. Type minute, 00 thru 59, and press [ENTER].
11. Press the Down arrow key to the "RESET CLOCK" selection and press [ENTER] at the moment you want the clock to be set to the time setting you have entered. The DATE & TIME SET SCREEN is automatically displayed. Verify that the time displayed is correct. If not, repeat Steps 5 thru 11.
12. Use the Up arrow to move the cursor to the "No, Do not reset date and time" selection and press [ENTER]. The SPECIAL OPERATION MENU is displayed.
13. Use the Page Down key to move the cursor directly to the "EXIT" selection and press [ENTER] to return to the PTU MAIN MENU.

Selection of NORMAL OPERATION gives truck control to the driver.
Continue? ( ) Yes
( ) No

OR

Selection of SPECIAL OPERATION will override truck driver controls until you exit to the PTU main menu.
Continue? ( ) Yes
( ) No

FIGURE 2-21. CAUTION SCREEN FOR PTU OPERATOR

Return to PTU Main Menu gives truck control to the driver. CAUTION: Contactors may move!
Continue? ( ) Yes
( ) No

FIGURE 2-22. CAUTION SCREEN FOR PTU OPERATOR

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EVENT DATA

The “EVENT DATA MENU” selection from the SPECIAL OPERATION MENU allows the technician to view event data stored in the CPU, save the event data to a file and to erase event data when storage of the information is no longer necessary. Event data is used to troubleshoot system problems and is normally erased after the problem has been corrected and the information is no longer needed.

The event data is accessed by initially selecting “PTU TALK TO TRUCK” from the GE OHV STATEX III MENU and following the procedure below:

⚠WARNING

Selecting “SPECIAL OPERATION” in the following procedure may present a safety hazard if the engine is running. Control of the propulsion system may transfer to the PTU operator from the truck driver with this software operation. Refer to Step 1. below:

1. When the GE STATEX III PTU MAIN MENU appears, select “EVENT DATA MENU” and press [ENTER]. The screen shown in Figure 2-21 will be displayed to alert the operator about the state of the truck software.This warning notifies the operator when control of the truck is being transferred from the truck driver to the PTU, based on the PTU selection of “SPECIAL OPERATION”. When finished and the PTU is returned to the GE STATEX III PTU MAIN MENU, control of the propulsion system is returned to the truck driver. Before activating this command, the screen shown in Figure 2-22 will be displayed.The PTU user should always keep the truck driver informed of this control.
2. Select “YES” on the caution screen (Figure 2-21) and press [ENTER]. The SPECIAL OPERATION MENU will be displayed.
3. Use the arrow keys to move the cursor to the “EVENT DATA MENU” selection and press [ENTER]. The Event Data Menu screens will be displayed.
   a. If no event data has been stored, the screen will indicate 0 (zero) events stored. If no events have been stored, the cursor will be positioned on “EXIT”. Press the [ENTER] key to return to the previous menu.

```
PTUSTX: 1.2.1  EVENT DATA MENU

Special Operation
     5        Events stored

   ( ) VIEW EVENT DATA
            Event Summary and Details
   ( ) reset hardware startup event
   ( ) EXIT
```

FIGURE 2-23.

4. If one or more events have been stored, a screen as shown in either Figure 2-23 or 2-24 will be displayed.
5. If Figure 2-23 is displayed, select “reset hardware startup event” with the cursor and press [ENTER].
   a. The screen shown in Figure 2-25 will appear. Follow the on-screen instructions to cycle power to the control system.
   b. After the system is powered up, repeat steps 1 through 3 to view the event data.
6. If Figure 2-24 is displayed, select “VIEW EVENT DATA” and press [ENTER]. A screen displaying a list of stored events appears.
   a. To view a particular event, type in the number of the event desired and press [ENTER]. The EVENT DATA DISPLAY SCREEN will appear showing the status of system components at the time the event occurred.

```
PTUSTX: 1.2.1 EVENT DATA MENU

Special Operation
     5        Events stored

   ( ) VIEW EVENT DATA
            Event Summary and Details
   ( ) erase event data yes/no menu
   ( ) EXIT
```

FIGURE 2-24. EVENT DATA MENU
(All Choices Available)

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PTUSTX: 1.2.H RESET HARDWARE STARTUP EVENT

To reset the hardware startup event,
control power must first be cycled

Please exit this screen,
and then turn off the control power
while the PTU is at the PTU MAIN MENU screen.
observe the normal 2 second shutdown sequence.

Remember to wait about 20 seconds after the panel
powers up before attempting to use the PTU to
communicate with the GE control system.

Once PTU communication is established,
you may reset and erase all events including the
HARDWARE STARTUP event.

FIGURE 2-25. RESET HARDWARE STARTUP EVENT INSTRUCTIONS

b. When the EVENT DATA DISPLAY SCREEN is displayed, press the help key [F1] for additional information regarding the event description and troubleshooting tips.

Note: Moving too quickly between Event Menu, Event Summary, and Event Details screens may cause the PTU to issue an error message at the bottom of the screen. If this occurs, press the [SPACE] bar to continue.

7. To upload event data for future review, return to the EVENT DATA MENU and move the cursor to select “GE engineering format event data” and press [ENTER]. A screen titled UPLOAD GE EVENT DATA YES/NO MENU will appear.

   a. Select “YES, UPLOAD GE FORMAT EVENT DATA to a File”. Press [ENTER]. A screen asking for a path name will appear.

      1.) If only the file name is entered, the data will be saved, under the file name typed, to the GE default directory.

      2.) If a specific directory has been setup on the PTU hard drive for storing event data files, type in the full path name followed by the file name chosen. For example, if a directory named EVENTDAT has been setup on drive “C” for storing event data files, and the name of the file is to be EV001, this entry would be typed as:

      `C:\eventdat\ev001`

      3.) If the event data is to be stored on a floppy disk, insert a formatted floppy disk in drive “A”. If the file name used above is chosen, the entry would be typed as: `A:ev001`

   b. After entering the appropriate name, press [ENTER]. The information will then be transferred from the CPU to the PTU and stored under the file name assigned. The transfer may take several minutes to complete depending on the number of events being saved to the file. After the file transfer is complete, a message will appear stating “`Received xxxxxx bytes. . . Returning to PTU. Press Space`”. Press [SPACE] bar to return to the UPLOAD GE EVENT DATA YES/NO MENU.

8. When the recorded events are no longer needed, they may be erased by selecting “erase event data yes/no menu” from the EVENT DATA MENU.

*NOTE: **ALL EVENTS WILL BE ERASED!** Only certain privilege levels are authorized to erase event data.*

   a. With the cursor on “erase event data yes/no menu”, press [ENTER]. A screen titled RESET “ALL” YES/NO MENU appears.

   b. To erase the event data, move the cursor to “YES, Erase Truck Events” and press [ENTER].

   c. Exit back to the desired menu following screen instructions as they appear.

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STATISTICAL DATA

The Statistical Data Collector uses the memory capability of the computer to record and store hundreds of system parameters unique to each individual truck. These parameters are divided into two types; Counters and Profiles.

Detailed information concerning the Statistical Data Collector is discussed on the following pages. Tables III and IV list parameter code numbers, descriptions, units of measure, count conditions, etc. The information below outlines the procedures required to view Statistical Data on the PTU and save the information to a file.

⚠WARNING

Selecting "SPECIAL OPERATION" in the following procedure may present a safety hazard if the engine is running. Control of the propulsion system may transfer to the PTU operator from the truck driver with this software operation. Refer to Step 1. below:

1. Use the arrow keys to move the cursor to the "SPECIAL OPERATION" selection on the GE STATEX III PTU MAIN MENU and press [ENTER]. The screen shown in Figure 2-21 will be displayed to alert the operator about the state of the truck software.This warning notifies the operator when control of the truck is being transferred from the truck driver to the PTU, based on the PTU selection of "SPECIAL OPERATION". When finished and the PTU is returned to the GE STATEX III PTU MAIN MENU, control of the propulsion system is returned to the truck driver. Before activating this command, the screen shown in Figure 2-22 will be displayed.The PTU user should always keep the truck driver informed of this control.
2. Select "YES" on the caution screen (Figure 2-21) and press [ENTER]. The SPECIAL OPERATION MENU will be displayed.
3. Use the arrow keys to move the cursor to the "STATISTICAL DATA MENU" selection and press [ENTER]. The STATISTICAL DATA MENU screen will be displayed. Selections available on this menu are as follows:

"VIEW COUNTERS"

The STATISTICAL COUNTERS SCREEN displays the number of times various operations have occurred in the history of the truck operation or in how many seconds or miles the event has lasted. Refer to Table III, for a listing of all active counters.

1. While the STATISTICAL DATA MENU is displayed, use the arrow keys to move the cursor to the "VIEW COUNTERS" selection and press [ENTER]. The STATISTICAL COUNTERS SCREEN will be displayed.
2. Use the up and down arrow keys to scroll through the counters. Press [ESC] to return to the exit choice.
3. When finished viewing the information, press [ENTER] again to exit this screen.

"VIEW PROFILES"

This screen displays currents, voltages and speeds as a history of truck operation. Each profile is broken into a number of "Bins" and each Bin has a range of values. In this manner, the entire range of the parameter from minimum to maximum is covered. The result is a histogram for each parameter covered by a profile. Refer to Table IV for a listing of all active profiles.

1. Use the arrow keys to move the cursor to the "VIEW PARAMETER PROFILES" selection and press [ENTER]. The PROFILE screen will be displayed. Use [F3] and [F4] to move through all profiles.
2. When finished viewing this screen, press [ENTER] again to exit this screen.

"UPLOAD STATISTICAL DATA TO A FILE"

Use the arrow keys to move the cursor to the "UPLOAD STATISTICAL DATA TO A FILE" selection and press [ENTER]. The UPLOAD STATISTICAL DATA MENU screen will be displayed. Use the directions on this screen to upload data from the truck CPU to your PTU.

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STATISTICAL DATA CODES - COUNTERS

The Statistical Data Collector uses Parameter Counters and Parameter Profiles to record operating conditions for various occurrences on the truck.

To make data most useful, there are four counters for every statistical counter and five for every statistical profile. These counts are named by the method used to reset the count to zero. For the counter, there is a life-time count, “LCount”, which is associated with its date, “LCount Start”. Then there are three other counters, “Last Qtr”, “This Qtr”, and “This Day”.

A “parameter” is a defined occurrence. Each parameter has an identification number called “Par #”, and a short name called “Description”. Each parameter is an occurrence that is counted in some unit such as hours or the number of times the conditions have been correct to declare that the occurrence happened.

The units for which the counters count is listed under “Units” in Table III. The tables contain additional explanation of the conditions which define a statistical parameter as having occurred. This column is entitled “Count Conditions”.

There are two types of parameters; Counter (Table III, and Profile (Table IV). The profile parameters have one more characteristic, “Range Counted”, which sorts the actual value of the parameter and then counts time of the parameter-at-the-value.

When examining the number of counts for a parameter, it is often useful to know over what period of time the counts occurred. To aid in determining how long it took to get a certain number of counts for a Statistical Data Counter parameter, the Statistical Data is presented in the form of four counters. The first counter, “LCount, indicates how many counts have occurred since the “LCount Start” date. This is intended to be lifetime counter. It can be reset to zero by a privileged user, and the “LCount Start” will automatically be set to the date on the CPU board when the user performed the reset.

The second counter, “Last Qtr” is just the total number of counts for the parameter over the last-fiscal-quarter, also known as the last-three-months. This counter has the same value in it all quarter long. At midnight on a quarter change, this counter is overwritten by the “This Qtr” value as this-quarter becomes last-quarter.

The third counter, “This Qtr”, keeps a moment by moment count of occurrences of the parameter. The counts are not reset to zero until midnight of the next quarter.

The fourth counter, “This Day”, keeps a moment by moment count of occurrences of the parameter just as “This Qtr”, except the “This Day ” count is reset to zero every midnight whether it is a quarter change or not.

If the GE control panel is shut off before midnight, any necessary resetting of counters is done when the panel next powers up after midnight.

Whenever the truck is programmed, that is, the CPU Card has the contents of the flash proms changed, the “LCount”, “Last Qtr”, and “This Qtr” counts are not changed. However, the “This Day” count will be reset to zero.

In order to use the Statistical Data Collector to monitor maintenance of the vehicle, it is recommended that an office spread sheet or data base computer program be used to keep quarterly records of the statistical data. To aid in getting the data off the CPU card and into the office computer, a feature called UPLOAD STATISTICAL DATA TO A FILE has been provided in the PTU. This feature puts all the collected statistical data in an ASCII file which can then be processed in the office to keep records on truck use. The [F2] feature of the PTU can be used to capture statistical data playback on the PTU in the office.

NOTE:The Statistical Data Collector is a part of the program run by the CPU card. If the CPU card does not have power, or if the code is stopped (as when looking at event and statistical data via the (PTU), then the Statistical Data Collector is also stopped. Hence, the Statistical Data Collector cannot count occurrences of, for example, toggling the AS pedal, while the code is stopped.

Also note that the Statistical Data Collector is initialized at power-up. The counter conditions are initialized to their respective inactive states, usually false. If, again for example, the AS pedal is depressed while power is cycled, then the Statistical Data Collector will be initialized to AS not depressed at power-up. Momentarily after power-up however, the Statistical Data Collector will detect that AS is depressed and increment the count. Thus, cycling power has resulted in the Statistical Data Collector counting an occurrence of AS depressed even though AS has been depressed for some time and has not really been released and depressed again.

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TABLE III. STATISTICAL DATA CODES - COUNTERS

PAR No.	DESCRIPTION	UNITS	COUNT CONDITIONS
1	Engine Operating Hours	Hours	Number of hours engine has operated above 450 RPM
2	Wheel #1 Operating Hours	Hours	Number of hours wheel was powered in either propulsion or retard mode and: . . . Speed is above 50 RPM . . . Current is above 50 amps (absolute value)
3	Wheel #2 Operating Hours	Hours	Number of hours wheel was powered in either propulsion or retard mode and: . . . Speed is above 50 RPM . . . Current is above 50 amps (absolute value)
4	Alternator Operating Hours	Hours	Number of hours alternator has been rotating at or above 450 RPM
5	Propulsion Mode Hours	Hours	Number of hours in propulsion mode when propulsion mode is active and: . . . Wheel #1 or wheel #2 speed is above 50 RPM and . . . Motor #1 or motor #2 current is above 50 amps (absolute value)
6	Retard Mode Hours	Hours	Number of hours in retarding mode when propulsion mode is active and: . . . Wheel #1 or wheel #2 speed is above 50 RPM and . . . Motor #1 or motor #2 current is above 50 amps (absolute value)
7	Coast Mode Hours	Hours	Number of hours in coast mode when propulsion mode is active and: . . . Wheel #1 or wheel #2 speed is above 50 RPM and . . . Motor #1 or motor #2 current is above 50 amps (absolute value)
8	Idle Hours	Hours	Number of hours engine is idling, truck is stationary and: . . . Engine speed is above 450 RPM . . . Wheel #1 and wheel #2 speeds are both less than 50 RPM
9	Fault Down Time Hours	Hours	Number of hours truck has propulsion system faults and the accelerator pedal is depressed. . . . Clock will start anytime a fault is recorded that restricts propulsion and . . . the propulsion mode is requested. . . . Clock will stop when propulsion mode is no longer requested or . . . when all restrictive faults are reset
10	Truck Operating Hours	Hours	Sum of propulsion mode, retard mode, coast mode and idle hours
11	Propulsion Mode Net KW Hours	Hours	Net KW hours generated by the alternator in propulsion mode
12	Retard Mode KW Hours	Hours	KW hours generated by the alternator in retard mode
13	Truck Distance Travelled	Miles	Value is calculated by integrating the higher of the two wheel speed signals and displaying the cumulative value in miles . . . Active when control power (CPR) is on . . . Not sensitive to vehicle direction
14	Truck Distance Travelled	Kilometers	Value is calculated by integrating the higher of the two wheel speed signals and displaying the cumulative value in kilometers . . . Active when control power (CPR) is on . . . Not sensitive to vehicle direction
19	Spin Mode	Occurrences	Number of times the spin/stall mode has been entered
20	Speed Override	Occurrences	Number of times Speed Override mode condition has changed from false to true
21	Body Up Switch	Occurrences	Number of times Dump Body Switch input has changed from false to true
22	RS Switch	Occurrences	Number of times Retard Switch input has changed from false to true
23	AS Switch	Occurrences	Number of times Accel Switch input has changed from false to true
24	Override Switch	Occurrences	Number of times Override Switch input has changed from false to true
25	Forward Switch	Occurrences	Number of times Selector Switch was moved to FORWARD position
26	Reverse Switch	Occurrences	Number of times Selector Switch was moved to REVERSE position
27	Neutral Switch	Occurrences	Number of times Selector Switch was moved to NEUTRAL position
28	Retard Mode	Occurrences	Number of times Retard Contactor sequence has been completed or Retard mode entered

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TABLE III. STATISTICAL DATA CODES - COUNTERS (Cont.)

PAR No.	DESCRIPTION	UNITS	COUNT CONDITIONS
29	Propel Mode	Occurrences	Number of times Propel Contactor sequence has been completed or Propel mode entered
30	Coast Mode	Occurrences	Number of times Coast mode entered
31	P1 Pickup	Occurrences	Number of times P1 feedback has changed from false to true
32	P2 Pickup	Occurrences	Number of times P2 feedback has changed from false to true
33	RP1 Pickup	Occurrences	Number of times RP1 feedback has changed from false to true
34	RP2 Pickup	Occurrences	Number of times RP2 feedback has changed from false to true
35	RP3 Pickup	Occurrences	Number of times RP3 feedback has changed from false to true
36	RP4 Pickup	Occurrences	Number of times RP4 feedback has changed from false to true
37	RP5 Pickup	Occurrences	Number of times RP5 feedback has changed from false to true
38	RP6 Pickup	Occurrences	Number of times RP6 feedback has changed from false to true
39	RP7 Pickup	Occurrences	Number of times RP7 feedback has changed from false to true
40	RP8 Pickup	Occurrences	Number of times RP8 feedback has changed from false to true
41	RP9 Pickup	Occurrences	Number of times RP9 feedback has changed from false to true
42	GF Pickup	Occurrences	Number of times GF feedback has changed from false to true
43	GFR Pickup	Occurrences	Number of times GFR feedback has changed from false to true
44	MF Pickup	Occurrences	Number of times MF feedback has changed from false to true
48	DBUP & >8 MPH	Occurrences	Number of times dump body is raised with truck speed above 8 MPH
49	Srv Brk >8 MPH	Occurrences	Number of times service brake has been applied with truck speed above 8 MPH
50	Park Brake	Occurrences	Number of times Park Brake Off has changed from false to true
51	Service Brake	Occurrences	Number of times Service Brake Pressure Switch has changed from false to true
52	Loaded Switch	Occurrences	Number of times Two-Speed Overspeed has changed from false to true . . . (empty to loaded)
53	Reverser Moves	Occurrences	Number of times Reverser feedback has changed from FORWARD to REVERSE or REVERSE to FORWARD
54	SS Move > 2 MPH	Occurrences	Number of times Selector Switch was moved with truck speed greater than “no motion” (2 MPH)
55	CPR Pickup	Occurrences	Number of times CPR feedback has changed from false to true
56	Engine Starts	Occurrences	Number of times engine speed goes from <450 RPM to >450 RPM
57	2dd Reset Switch	Occurrences	Number of times reset button on 2 Digit Display has been pushed
58	Both AS & RS	Occurrences	Number of times AS & RS activated at same time
59	AS & Service Brake	Occurrences	Number of times AS and service brake activated at same time
60	RS & Service Brake	Occurrences	Number of times RS and service brake activated at same time
61	AS & Temp >220°C	Occurrences	Number of times AS is activated with either motor temperature greater than 220°C
62	RS & nomotion	Occurrences	Number of times RS is activated at truck speeds below “no motion” (2 MPH)
63	RSC Switch On	Occurrences	Number of times Retard Speed Control switch is turned On
64	RSC Pot Moved	Occurrences	Number of times Retard Speed Control pot is moved more than 1 MPH while RSC is On.
65	Test Digital Output	Occurrences	Number of times “MANUAL DIGITAL OUTPUT TEST” screen has been selected at the “SPECIAL OPERATION WITH ENGINE STOPPED TEST” menu
66	Program Truck	Occurrences	Number of times PTU has been used to program the truck

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TABLE III. STATISTICAL DATA CODES - COUNTERS (Cont.)

PAR No.	DESCRIPTION	UNITS	COUNT CONDITIONS
67	Special Operation	Occurrences	Number of times “SPECIAL OPERATION” menu has been selected at “PTU MAIN MENU”
68	Events Erased	Occurrences	Number of times PTU has been used to erase event data
69	Normal Operation	Occurrences	Number of times “NORMAL OPERATION” menu has been selected at “PTU MAIN MENU”
70	AS & Park Brake Applied	Occurrences	Number of times AS and Park Brake have been activated at the same time. New counts will be recorded when a state change occurs. If both signals are present for 2 hours, only one count is recorded.
71	Park Brake Switch >0.3 MPH	Occurrences	Number of times Park Brake switch has been turned On when truck speed is above 0.3 MPH.
72	Alternator Field Too Hot	Occurrences	Number of times (estimated) alternator field temperature has exceeded 220°C
80	M1 Amps Propel	Seconds	Refer to Table IV, PROFILES
81	M2 Amps Propel	Seconds	
82	M1 Amps Retard	Seconds	
83	M2 Amps Retard	Seconds	
84	MF Amps Propel	Seconds	
85	MF Amps Retard	Seconds	
86	Net Input Engine HP	Hours	
87	Net Input Engine KW	Hours	
88	M1 Temp Degrees C	Seconds	
89	M2 Temp Degrees C	Seconds	
90	Truck Speed MPH	Seconds	
91	Engine Speed RPM	Seconds	
98	AFSE Temp Degrees C	Seconds	
99	MFSE Temp Degrees C	Seconds	
101	Low Level Ground Fault	Occurrences	Refer to Table I, TWO DIGIT DISPLAY CODES
102	High Level Ground Fault	Occurrences	
108	Accelerator Pedal	Occurrences	
109	Retard Pedal	Occurrences	
110	GF	Occurrences	
111	GFR	Occurrences	
112	MF	Occurrences	
113	P1	Occurrences	
114	P2	Occurrences	
115	RF1	Occurrences	
116	RF2	Occurrences	
117	RP1	Occurrences	
118	RP2	Occurrences	
119	RP3	Occurrences	

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TABLE III. STATISTICAL DATA CODES - COUNTERS (Cont.)

PAR No.	DESCRIPTION	UNITS	COUNT CONDITIONS
120	RP4	Occurrences	Refer to Table I, TWO DIGIT DISPLAY CODES
121	RP5	Occurrences	
122	RP6	Occurrences	
123	RP7	Occurrences	
124	RP8	Occurrences	
125	RP9	Occurrences	
126	FORWARD	Occurrences	
127	REVERSE	Occurrences	
130	Analog Output	Occurrences	
131	Analog Read Back	Occurrences	
132	Analog Input	Occurrences	
133	Frequency Input	Occurrences	
137	Startup Fault	Occurrences	
145	Diode Fault	Occurrences	
146	Motor 1 Overcurrent	Occurrences	
147	Motor 2 Overcurrent	Occurrences	
148	MFld Marm	Occurrences	
149	MF Overcurrent	Occurrences	
150	Motor Stall	Occurrences	
151	Motor Spin	Occurrences	
152	Alternator Tertiary Overcurrent	Occurrences	
153	Motor Tertiary Overcurrent	Occurrences	
154	+15V Power	Occurrences	
155	-15V Power	Occurrences	
156	+19V Power	Occurrences	
157	Motor Polarity	Occurrences	
161	Retard Grid 1	Occurrences	
162	Retard Grid 2	Occurrences	
163	Blower Fault	Occurrences	
164	M1 Overtemp	Occurrences	
165	M2 Overtemp	Occurrences	

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TABLE III. STATISTICAL DATA CODES - COUNTERS (Cont.)

PAR No.	DESCRIPTION	UNITS	COUNT CONDITIONS
166	Overspeed	Occurrences	Refer to Table I, TWO DIGIT DISPLAY CODES
167	Speed Retard Exceeded	Occurrences	
168	Retard Overcurrent	Occurrences	
169	Horsepower Low	Occurrences	
170	HP Limit Exceeded	Occurrences	
171	Engine Overspeed Exceeded	Occurrences	
172	Engine Oil Pressure Warning	Occurrences	
173	Engine Oil Pressure Shutdown	Occurrences	
174	Engine Coolant Pressure Warning	Occurrences	
175	Engine Coolant Press Shutdown	Occurrences	
176	Engine Crankcase Pressure	Occurrences	
177	Engine Coolant Temperature	Occurrences	
178	Engine Service	Occurrences	
179	Engine Shutdown	Occurrences	
180	Engine Speed Retard	Occurrences	
181	Motor 1 Voltage Limit	Occurrences	
182	Motor 2 Voltage Limit	Occurrences	
183	Alternator Field Amps	Occurrences	
190	Battery Voltage Low	Occurrences	
191	Battery Voltage High	Occurrences	
192	Engine Speed Sensor	Occurrences	
193	Motor Speed Sensor	Occurrences	
198	Datastore	Occurrences	
199	Software	Occurrences	

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TABLE IV. STATISTICAL DATA CODES - PROFILES

PAR No.	DESCRIPTION	COUNT CONDITIONS	BUCKET No.	CURRENT VALUE (AMPS)
80	M1 Amps Propel (In seconds)	This is a histogram of Motor #1 armature current in propulsion mode. . . . . Sample time is 1.0 second . . . . The clock will start whenever propulsion mode is selected. The histogram breaks the current spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	1	500 & below
			2	501 to 750
			3	751 to 850
			4	851 to 950
			5	951 to 1050
			6	1051 to 1150
			7	1151 to 1250
			8	1251 to 1350
81	M2 Amps Propel (In seconds)	This is a histogram of Motor #2 armature current in propulsion mode. . . . . Sample time is 1.0 second . . . . The clock will start whenever propulsion mode is selected. The histogram breaks the current spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	9	1351 to 1450
			10	1451 to 1550
			11	1551 to 1800
			12	1801 to 2150
			13	2151 to 2300
			14	2301 to 2600
			15	2601 to 2900
			16	2901 to 3200
			17	3201 & above

PAR No.	DESCRIPTION	COUNT CONDITIONS	BUCKET No.	CURRENT VALUE (AMPS)
82	M1 Amps Retard (in seconds)	This is a histogram of Motor #1 armature current in retard mode. . . . . Sample time is 1.0 second . . . . The clock will start whenever retard mode is selected. The histogram breaks the current spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	1	200 & below
			2	201 to 300
			3	301 to 400
			4	401 to 500
			5	501 to 600
			6	601 to 700
			7	701 to 800
			8	801 to 900
83	M2 Amps Retard (in seconds)	This is a histogram of Motor #2 armature current in retard mode. . . . . Sample time is 1.0 second . . . . The clock will start whenever retard mode is selected. The histogram breaks the current spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	9	901 to 1000
			10	1001 to 1100
			11	1101 to 1200
			12	1201 to 1350
			13	1351 to 1450
			14	1451 to 1550
			15	1551 to 1650
			16	1651 to 1750
			17	1751 & above

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TABLE IV. STATISTICAL DATA CODES - PROFILES (Cont.)

PAR No.	DESCRIPTION	COUNT CONDITIONS	BUCKET No.	CURRENT VALUE (AMPS)
84	MF Amps Propel (in seconds)	This is a histogram of Motor Field current in propulsion mode. . . . . Sample time is 1.0 second . . . . The clock will start whenever propulsion mode is selected. The histogram breaks the current spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	1	0 to 100
			2	101 to 125
			3	126 to 150
			4	151 to 175
			5	176 to 200
			6	201 to 225
			7	226 to 250
			8	251 to 275
85	MF Amps Retard (in seconds)	This is a histogram of Motor Field current in retard mode. . . . . Sample time is 1.0 second . . . . The clock will start whenever retard mode is selected. The histogram breaks the current spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	9	276 to 300
			10	301 to 325
			11	326 to 375
			12	376 to 450
			13	451 to 550
			14	551 to 650
			15	651 to 800
			16	801 to 950
			17	951 to 9999

PAR No.	DESCRIPTION	COUNT CONDITIONS	BUCKET No.	NET INPUT HP RANGE
86	Net Input Engine Horsepower (in minutes)	This is a histogram of net input horsepower. It is a calculated value, calculated as follows: HP= $(I_a \times V_a) \div (746 \times$ Load Box Efficiency in %$)$	1	200 & below
			2	201 to 400
			3	401 to 600
			4	601 to 800
			5	801 to 1000
			6	1001 to 1200
			7	1201 to 1400
			8	1401 to 1600
87	Net Input Engine Kilowatts (in minutes)	This is a histogram of net input horsepower. It is a calculated value, calculated as follows: HP= $(I_a \times V_a) \div (1000 \times$ Load Box Efficiency in %$)$	9	1601 to 1800
			10	1801 to 2000
			11	2001 to 2200
			12	2201 to 2400
			13	2401 to 2600
			14	2601 to 2800
			15	2801 to 3000
			16	3001 to 3200
			17	3201 & above

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TABLE IV. STATISTICAL DATA CODES - PROFILES (Cont.)

PAR No.	DESCRIPTION	COUNT CONDITIONS	BUCKET No.	TEMP RANGE (°C)
88	M1 Temp °C (in seconds)	This is a histogram of Motor #1 temperature. . . . . Sample time is 60.0 seconds . . . . The clock will start whenever control power (CPR) is on. The histogram breaks the temperature spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	1	-40 to 100
			2	101 to 110
			3	111 to 120
			4	121 to 130
			5	131 to 140
			6	141 to 150
			7	151 to 160
			8	161 to 170
89	M2 Temp °C (in seconds)	This is a histogram of Motor #2 temperature. . . . . Sample time is 60.0 seconds . . . . The clock will start whenever control power (CPR) is on. The histogram breaks the temperature spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	9	171 to 180
			10	181 to 190
			11	191 to 200
			12	201 to 210
			13	211 to 220
			14	221 to 230
			15	231 to 240
			16	241 to 250
			17	251 to 9999

PAR No.	DESCRIPTION	COUNT CONDITIONS	BUCKET No.	TRUCK SPEED MPH	ENGINE SPD RPM
90	Truck Speed MPH (in seconds)	This is a histogram of truck speed for all modes of operation. . . . . Sample time is 1.0 second . . . . The clock will start whenever control power (CPR) is on. The buckets are defined in the Truck Speed column at right:	1	0 to 1	600 & below
			2	2 to 3	601 to 800
			3	4 to 6	801 to 900
			4	7 to 9	901 to 1000
			5	10 to 12	1001 to 1100
			6	13 to 15	1101 tto 1200
			7	16 to 18	1201 to 1300
			8	19 to 21	1301 to 1400
91	Engine Speed RPM (in seconds)	This is a histogram of engine speed in RPM for all modes of operation. . . . . Sample time is 1.0 second . . . . The clock will start whenever control power (CPR) is on. The buckets are defined in the Engine Speed column at right:	9	22 to 24	1401 to 1500
			10	25 to 27	1501 to 1600
			11	28 to 30	1601 to 1700
			12	31 to 33	1701 to 1800
			13	34 to 36	1801 to 1900
			14	37 to 39	1901 to 2000
			15	40 to 42	2001 to 2100
			16	43 to 45	2101 to 2200
			17	45 & above	2200 & above

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TABLE IV. STATISTICAL DATA CODES - PROFILES (Cont.)

PAR No.	DESCRIPTION	COUNT CONDITIONS	BUCKET No.	TEMP RANGE (°C)
98	AFSE Temp °C (in seconds)	This is a histogram of Alternator Field Static Exciter temperature. . . . . Sample time is 60.0 seconds . . . . The clock will start whenever control power (CPR) is on. The histogram breaks the temperature spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	1	20 & below
			2	21 to 40
			3	41 to 50
			4	51 to 60
			5	61 to 70
			6	71 to 80
			7	81 to 90
			8	91 to 100
99	MFSE Temp °C (in seconds)	This is a histogram of Motor Field Static Exciter temperature. . . . . Sample time is 60.0 seconds . . . . The clock will start whenever control power (CPR) is on. The histogram breaks the temperature spectrum into 17 buckets defined at right, and displays the time spent in each bucket.	9	101 to 105
			10	106 to 110
			11	111 to 120
			12	121 to 125
			13	126 to 130
			14	131 to 135
			15	136 to 140
			16	141 to 145
			17	146 & above

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TRUCK SPECIFIC INFORMATION

To quickly review the various options on the current truck, the **TRUCK SPECIFIC INFORMATION MENU** can be used to view configuration options, speed settings, serial numbers, etc. Information accessed through this menu is for viewing only and cannot be changed. If changes are required, use the “TRUCK SETUP (CFG)” selection from the **GE OHV STATEX III MENU**.

⚠WARNING

Selecting “SPECIAL OPERATION” in the following procedure may present a safety hazard if the engine is running. Control of the propulsion system may transfer to the PTU operator from the truck driver with this software operation. Refer to Step 1. below:

1. With the **GE STATEX III PTU MAIN MENU** displayed, select “SPECIAL OPERATION” and press [ENTER]. The screen shown in Figure 2-26 will be displayed to alert the operator about the state of the truck software.This warning notifies the operator when control of the truck is being transferred from the truck driver to the PTU, based on the PTU selection of “SPECIAL OPERATION”. When finished and the PTU is returned to the **GE STATEX III PTU MAIN MENU**, control of the propulsion system is returned to the truck driver. Before activating this command, the screen shown in Figure 2-27 will be displayed.The PTU user should always keep the truck driver appraised of this control.
2. Select “YES” on the caution screen (Figure 2-26) and press [ENTER]. The **SPECIAL OPERATION MENU** will be displayed.
3. Use the arrow keys to move the cursor to the “TRUCK SPECIFIC INFORMATION MENU” selection and press [ENTER].

Selections available on this menu are:

- “VIEW OEM CONFIGURATION OPTIONS”

This selection permits reviewing the setup information programmed into the truck configuration file by Komatsu. (These options cannot be changed by mine personnel.)

- “VIEW MINE CONFIGURATION OPTIONS”

This selection displays options set by mine personnel when the truck configuration file was setup for a specific truck.

- “VIEW SPEED SETTINGS”

This selection allows viewing the current speed settings contained in the configuration file.

- “VIEW SERIAL AND MODEL NUMBERS”

This selection permits verification of component serial and model numbers.

- “VIEW GE VERSION INFORMATION”

This selection lists the truck ID number, model number, and applicable filenames. This screen also lists the GE code version number and CFG version number. This information can be useful in determining whether or not the software has been updated to the latest release version.

- “VIEW GE PRODUCT SERVICE DATA”

This selection lists information pertinent to the specific truck.

- “EXIT”

Select “EXIT” to leave the **TRUCK SPECIFIC INFORMATION MENU** and return to the **GE STATEX III PTU MAIN MENU.**

Selection of NORMAL OPERATION gives truck control to the driver.
Continue? ( ) Yes
( ) No

OR

Selection of SPECIAL OPERATION will override truck driver controls until you exit to the PTU main menu.
Continue? ( ) Yes
( ) No

FIGURE 2-26. CAUTION SCREEN

Return to PTU Main Menu gives truck control to the driver. CAUTION: Contactors may move!
Continue? ( ) Yes
( ) No

FIGURE 2-27. CAUTION SCREEN

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TEMPORARY TRUCK SETTINGS

When troubleshooting a truck, it is sometimes necessary to make temporary changes to the system. The **TEMPORARY TRUCK SETTINGS MENU** allows changes to be made to speed settings, retard current or event data collection intervals. Since any changes made on these screens are temporary, changes made using the options on this menu will be lost when control power is turned off. If the changes made using this menu should be made permanent, the truck configuration file must be changed accordingly and the CPU reprogrammed.

⚠WARNING

Selecting "SPECIAL OPERATION" in the following procedures may present a safety hazard if the engine is running. Control of the propulsion system may transfer to the PTU operator from the truck driver with this software operation. Refer to Step 1. below:

1. With the **GE STATEX III PTU MAIN MENU** displayed, select "SPECIAL OPERATION" and press [ENTER]. The screen shown in Figure 2-26 will be displayed to alert the operator about the state of the truck software.This warning notifies the operator when control of the truck is being transferred from the truck driver to the PTU, based on the PTU selection of "SPECIAL OPERATION". When finished and the PTU is returned to the **GE STATEX III PTU MAIN MENU,** control of the propulsion system is returned to the truck driver. Before activating this command, the screen shown in Figure 2-27 will be displayed.The PTU user should always keep the truck driver appraised of this control.
2. Select "YES" on the caution screen (Figure 2-26) and press [ENTER]. The **SPECIAL OPERATION MENU** will be displayed.
3. Use the arrow keys to move the cursor to the **"TEMPORARY TRUCK SETTINGS MENU"** selection and press [ENTER].

Selections available on this menu are:

- "SPEED SETTINGS"

New speed setting values may be typed over the existing values to override the current configuration file settings.

1. Move the cursor to the speed to be changed and type the first digit of the speed desired.
2. A screen will appear with the instruction "ENTER FLOATING POINT NUMBER". Type the remaining digits and press [ENTER].

NOTE: It is not necessary to enter values for every line. For example, if only Loaded Speed Limit is to be changed, select that line with the cursor, and type in the desired value. The remaining speeds will be determined by the values in the truck configuration file.

3. When the new values have been entered, move the cursor to "ACTIVATE TEMPORARY SPEED SETTINGS and TRKSPD SCALE" and press [ENTER].
4. The **TEMPORARY SPEED SET SCREEN** will change to reflect the new values entered.
5. Select "EXIT" to return to the previous menu.

- "RETARD CURRENT ADJUST"

This screen allows entering a value to adjust retard current. Enter the amount to be added or subtracted from the nominal retard current limit value to make the computer control the proper current limit as measured at the shunt.

1. For example, if the shunt reads 1300 amps, and the retard current limit is 1320 amps, enter "20" to add 20 amps to what the computer receives as feedback. This will cause the control to current limit at 1300 + 20 amps instead of the 1300 amps.
2. In another example, if the shunt reads 1340 amps, enter "-20" to subtract 20 amps from what the computer receives as feedback. This will cause the control to current lmit at 1340 - 20 amps instead of 1340 amps.
3. Select "ACTIVATE TEMPORARY RETARD CURRENT ADJUST" and press [ENTER]. Exit to the **PTU MAIN MENU**.

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Note: The changes made above are only temporary. When the proper adjustment value has been determined, the truck configuration file should be permanently changed by entering this value on the ***TRUCK SPECIFICS SCREEN.*** *This screen is accessed by returning to the* ***GE OHV STATEX III MENU,*** *selecting "TRUCK SETUP (CFG)", and then line 5); "Change/view Truck Specifics".*

"TEMPORARY EVENT DATA COLLECTION INTERVAL"

This feature will allow changing the event data collection interval to a more frequent or less frequent period. This feature may be necessary during troubleshooting procedures to capture system operation over a different time period other than normally used.

1. Select "EVENT DATA COLLECTION INTERVAL" from the **TEMPORARY TRUCK SETTINGS MENU** and press [ENTER].
2. Type the desired interval on the **TEMPORARY EVENT DATA COLLECTION INTERVAL SCREEN.**

Note: This new setting will remain in effect until it is changed again on this screen or when power is cycled on and off.

3. Move the cursor to select ACTIVATE TEMPORARY EVENT DATA COLLECTION INTERVAL and press [ENTER].

MISCELLANEOUS FEATURES

SAVING DATA

Various screens showing event data, digital input and output test data, real time data, etc. can be saved to the PTU.

Many screens will have a selection labelled "GET1". When selected, the data gathered and displayed on the screen will be suspended and can then be saved permanently to a file. If this selection is available, it should be chosen before pressing [F2] to save to a file.

To use this feature:

1. When it is desired to save the screen display, select "GET1" using the arrow keys and press [ENTER].
2. Press [F2] to save the screen to a file.
   a. Follow the screen instructions for assigning a file name and location for storing the file.
   b. After the file has been saved, the PTU screen data will remain suspended until the next step is completed.
3. Selecting "GET1" again will update the screen with new data and hold it there. Step 2. may be repeated to save the updated data if desired.
4. To resume and allow the data to be continuously updated, move the cursor to "REPEAT" and press [ENTER].

If the "GET1" selection is not available, the [F2] key is used to save the screen display when applicable. The availability of the [F2] key for saving the data will be shown at the bottom of the screen.

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PTU ABBREVIATIONS

Due to limited screen space, many abbreviations are necessary for displaying information on the various screens. A definition of each abbreviation and special term can be accessed as follows:

1. From the **GE OHV STATEX III MENU**, select "PTU TALK TO TRUCK" to access the **STATEX III PTU MAIN MENU**.
2. Move the cursor to select "PTU ABBREVIATIONS" and press [ENTER].
3. The **GE STATEX III PTU ABBREVIATIONS** screen will appear with instructions for viewing the information.
4. When finished viewing, press the [SPACE] bar to leave the screen.

OTHER MENU SELECTIONS

Software menu items not covered in this section of the manual are normally used for truck checkout and troubleshooting only.

Refer to Section E3 for information regarding use of the following selections from the **GE STATEX III PTU MAIN MENU** selections:

"NORMAL OPERATION"

- View Real Time Data
- View Analog Inputs
- Load Box Test
- Accelerate Logic Help
- Retard Logic Help

"SPECIAL OPERATION WITH ENGINE STOPPED"

- Test - Digital Outputs

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MISCELLANEOUS ELECTRICAL PROPULSION COMPONENTS

ALTERNATOR

Refer to applicable GE publication for service and maintenance procedures.

ELECTRIC WHEEL MOTORS

Refer to applicable GE publication for service and maintenance procedures.

RETARDING GRIDS

Refer to applicable GE publication for service and maintenance procedures. (Cooling Blower Only).

ELECTRONIC ACCELERATOR AND RETARD PEDALS

The accelerator and retard pedals provide a variable voltage signal directly to the FB140 card in the FL275 panel. During some phases of truck operation, the FL275 panel assumes control of engine RPM to reduce engine RPM, maintaining a power level that satisfies the operator and system requirements. The reduction in engine RPM results in less fuel usage and longer component life.

As the operator depresses the pedal, the internal potentiometer's wiper is rotated by a lever. The output voltage signal varies in proportion to the angle of depression of the pedal. Refer to “Electrical Checkout Procedure” for recalibration of the applicable pedal potentiometer.

NOTE: Some trucks are equipped with individual pedals for service brake and retarder application (Figure 2-29). Others utilize a single pedal combining service brake/retarder application as shown in Figure 2-30. Refer to Section J, “Brake Circuit Component Service” for retarder pedal removal and installation procedure for a single pedal system. Pedal potentiometer replacement instructions on the following page are applicable to either type.

The retard pedal is suspended from the front wall of the cab and the accelerator is floor mounted. Potentiometer replacement procedures are the same for both pedals. (Refer to Figures 2-28 and 2-29.)

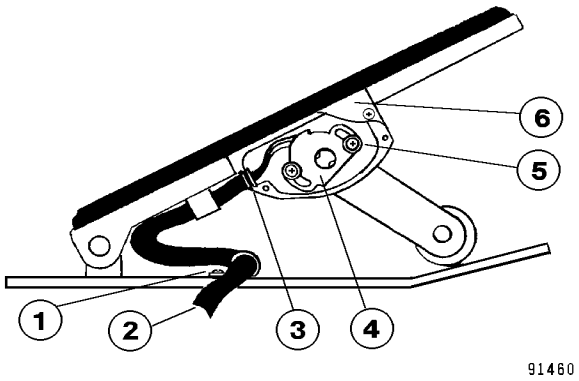


FIGURE 2-28. ELECTRONIC ACCLERATOR PEDAL

1. Clamp and Screws
2. Harness
3. Grommet
4. Potentiometer
5. Mounting Screws
6. Cover

Removal

1. Disconnect pedal wire harness from truck harness at the connector.
2. Remove mounting capscrews, lockwashers and nuts and remove pedal assembly.

NOTE: Note proper routing and clamp location of wire harness. Proper wire routing is critical to prevent damage during operation after reinstallation.

Installation

1. Install pedal assembly using hardware removed in step 2, “Removal”. Connect potentiometer harness to truck wiring harness.
2. Calibrate throttle potentiometer per instructions in *“Throttle System Check and Adjustment”*, Section E3.
3. Calibrate retard pedal potentiometer per instructions in *“Retard System Check and Adjustment - Electronic Pedal System”*, Section E3.

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Disassembly

1. Remove screws on cable clamps (1, Figure 2-28 or 2-29) and potentiometer cover (6).
2. Remove potentiometer mounting screws (5) and grommet (3). Remove potentiometer (4).

Reassembly

1. Position new potentiometer with the flat side toward the potentiometer cover and install on shaft as follows:
   a. Align cutouts in shaft with the potentiometer drive tangs.
   b. Press potentiometer onto shaft until it bottoms against the housing.
2. Install screws (5, Figure 2-28 or 2-29) and lockwashers but do not tighten.
3. Rotate potentiometer counterclockwise until mounting slots contact the mounting screws and tighten screws (5) to **10-20 in lbs. (1.13-2.26 N-m)** torque.
4. Install grommet (3) and potentiometer cover. Tighten screws to **10-20 in lbs. (1.13-2.26 N-m)** torque.
5. Install cable clamps and tighten screws to **35-45 in. lbs. (3.4-5.1 N-m)** torque.
6. Inspect assembly and verify proper wiring clearance during operation of pedal throughout the range of travel.

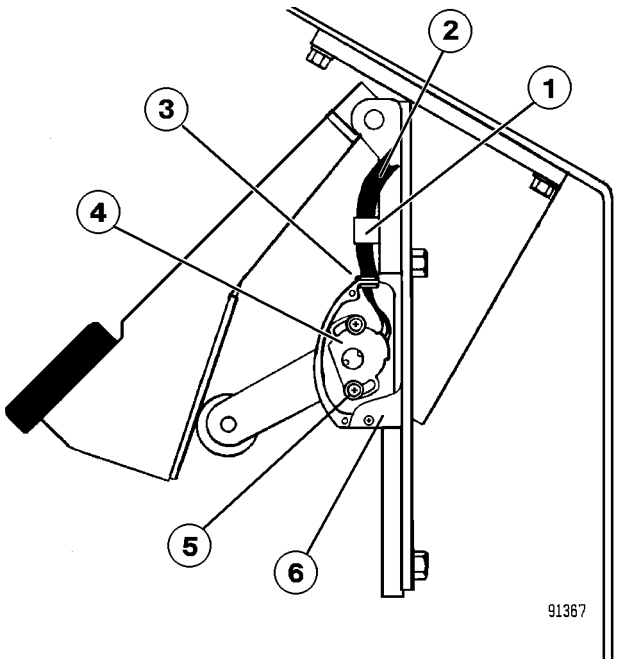


FIGURE 2-29. ELECTRONIC RETARD PEDAL
(Two Pedal System)

1. Clamp and Screws
2. Harness
3. Grommet
4. Potentiometer
5. Mounting Screws
6. Cover

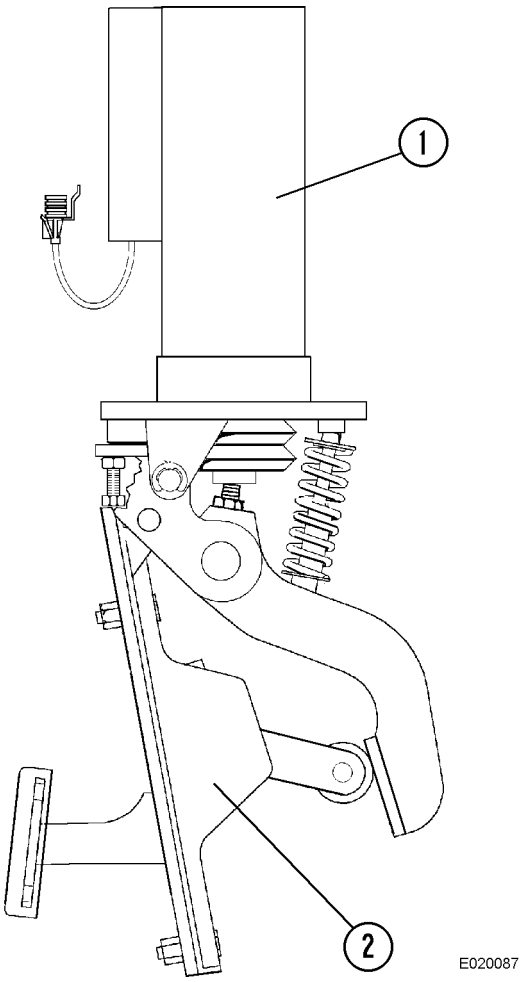


FIGURE 2-30. BRAKE/RETARDER PEDAL
(Single Pedal System)

1. Service Brake Valve
2. Electronic Retard Pedal

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COOLING BLOWER WARNING SYSTEM

The Komatsu truck is equipped with a cooling blower to supply cooling air to the alternator, exciters and wheel motors.

The cooling blower warning system which consists of a pressure switch, warning light, buzzer, and an adjustable time delay controlled by the CPU in the FL275 panel. The time delay can be adjusted by entering the desired value using the software used to program the CPU. The default delay time is 101 seconds.

The purpose of the warning system is to alert the operator in case of blower loss or low blower output. Blower loss or low blower output could result in component malfunction due to the lack of cooling air.

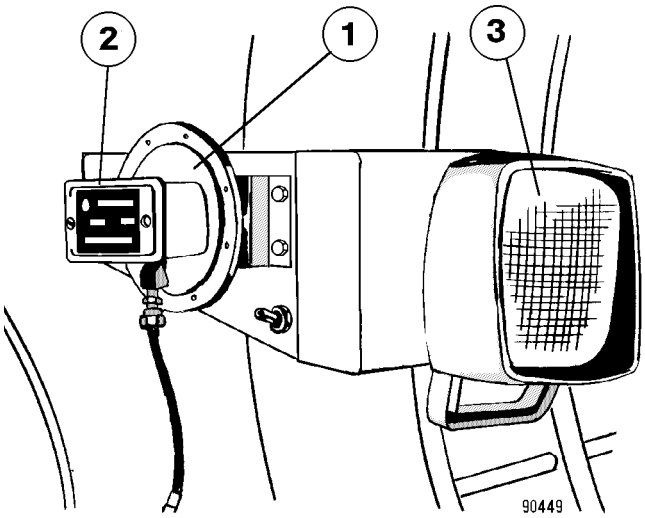


FIGURE 2-31. COOLING BLOWER PRESSURE SWITCH (Rear Axle)

1. Blower Pressure Switch
2. Adjustment Access Cover
3. Maintenance Light

Operation

The warning light and buzzer will only come on if the throttle is depressed while selector is in FORWARD or REVERSE for a period exceeding 101 seconds and blower output is less than normal. The 101 second time cycle is controlled by the FL275 panel CPU.

Test

Check the operation of the blower loss warning system as follows:

1. With the engine not running, turn the key switch and control power On and place the selector switch in FORWARD.
2. Depress the throttle pedal until the propulsion contactors pull in.
3. After 101 seconds, (or the value entered on the **TRUCK SPECIFICS SCREEN**) the Motor Blower warning light on the instrument panel should turn on.

If the switch requires adjustment, refer to instructions in *"Miscellaneous Component Test and Adjustment"* in the STATEX III ELECTRICAL SYSTEM CHECKOUT PROCEDURE in Section E3.

Removal

NOTE: If the blower pressure switch cannot be adjusted to specifications and no air leaks are found, a new switch assembly must be installed.

1. Inspect rear axle access door cover gasket, blower duct hose and wheel covers for damage or possible leaks.
2. Open rear axle access door and locate switch (1, Figure 2-31).
3. Remove nylon tubing attached to switch.
4. Remove the four capscrews, lockwashers, and nuts attaching switch assembly to mounting bracket and remove.

Installation

1. Attach switch assembly (1, Figure 2-31) to mounting bracket using hardware removed in above procedure.
2. Install nylon tube
3. Close rear axle access door and calibrate switch per instructions in *"Miscellaneous Component Test and Adjustment"*.

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ELECTRICAL CONTROL CABINET

The following pages illustrate the electrical control cabinet and components located inside the cabinet and the control cabinet junction box located on the rear of the cabinet (Figure 2-37). All contactors and the reverser in this control cabinet are electrically operated - no air supply is required.

The retarding grid package (retarding grids and blower) and the retarding grid contactor box are shown in Figure 2-38.

This information should be used in conjunction with applicable electrical schematics and checkout procedures when troubleshooting the electrical system.

NOTE: The illustrations shown are typical of various truck models. Actual components installed on the truck will vary depending on the truck model and optional equipment installed.

Components in the electrical control cabinet and other areas of the truck are identified with abbreviated name labels. These abbreviations also appear on schematics and may be referenced in checkout procedures. Refer to the list of abbreviations at the end of this section for a full name description.

⚠DANGER

This system is capable of developing high voltage. Use caution when working with the system.

⚠WARNING

Some of the components on the cards are sensitive to static electricity. To prevent damage, it is recommended that a properly connected ground strap be worn whenever removing, handling or installing a card. It is also recommended that after a card has been removed, it is carried and stored in a static proof bag or container.

NOTE: There are no adjustment potentiometers on the control cards. Cards should not be removed during troubleshooting unless it has been determined that a card is at fault.

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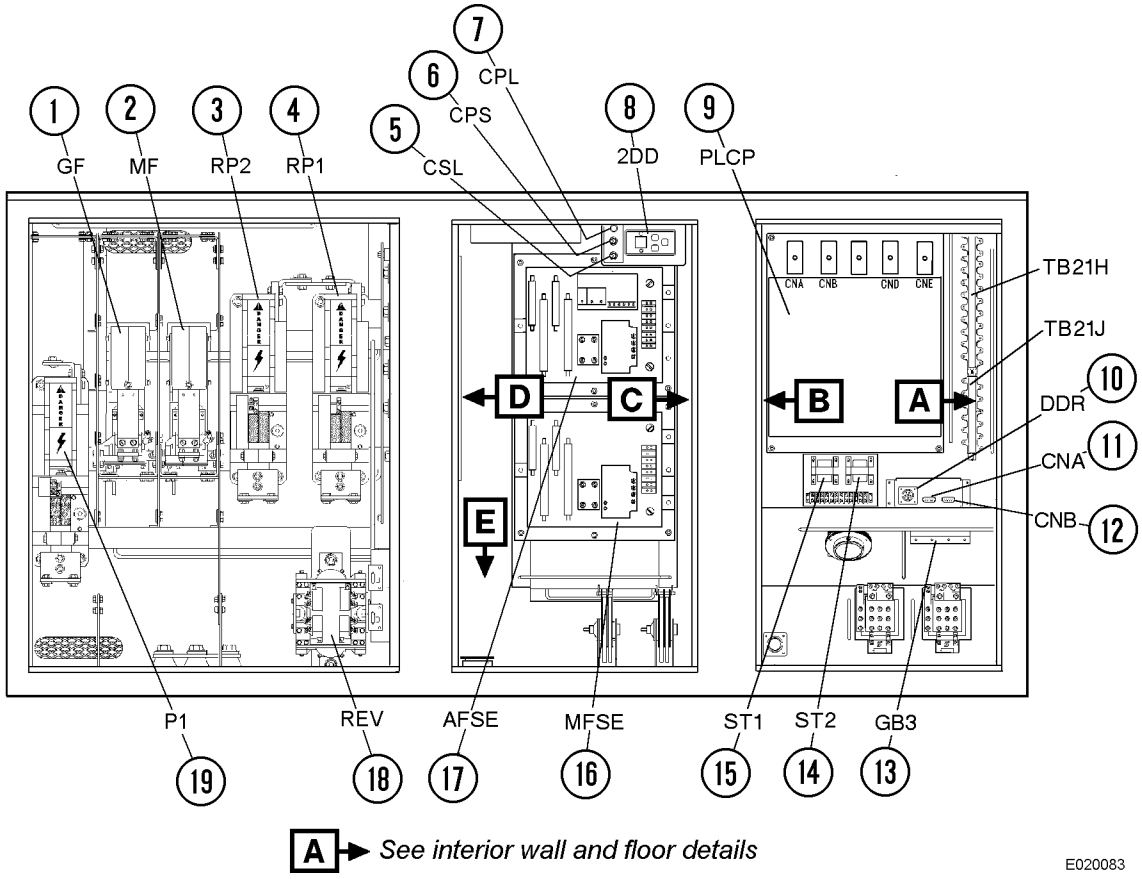


FIGURE 2-32. ELECTRICAL CONTROL CABINET
(Component Location, Front View. See Figure 2-37 for Relay Board Panel inside R.H. Door)

1. Alternator Field Contactor
2. Motor Field Contactor
3. Retard Power Contactor No. 2
4. Retard Power Contactor No. 1
5. Cabinet Service Light Switch
6. Control Power Switch
7. Control Power Light
8. Two Digit Display Panel
9. Propulsion Load Control Panel (FL275)
10. Diagnostic Data Reader Connector
11. Statex Channel A (PTU) Connector
12. Statex Channel B Connector
13. Ground Bus No. 3
14. Synchronizing Transformer No. 2
15. Synchronizing Transformer No. 1
16. Motor Field Static Exciter
17. Alternator Field Static Exciter
18. Reverser
19. Propulsion Contactor No. 1

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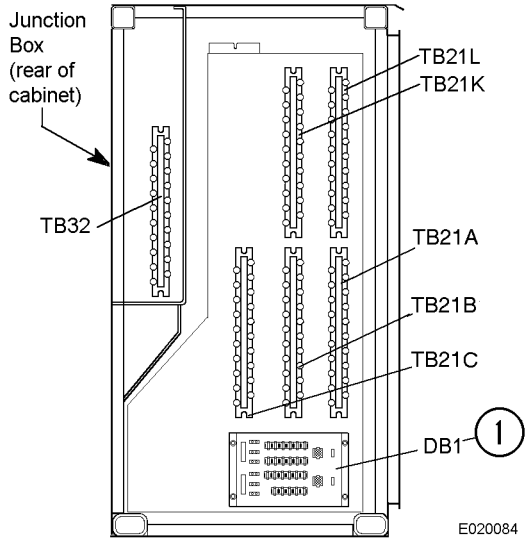


FIGURE 2-33. CONTROL CABINET, VIEW A

1. Diode Board DB1

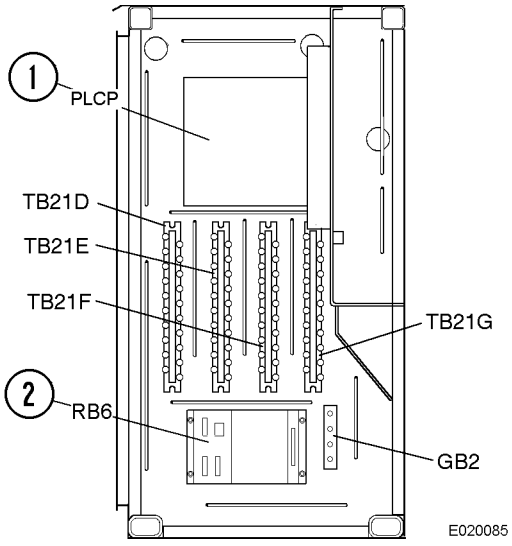


FIGURE 2-35. CONTROL CABINET, VIEW B

1. Propulsion Load Control Panel (PLCP)
2. Relay Board RB6

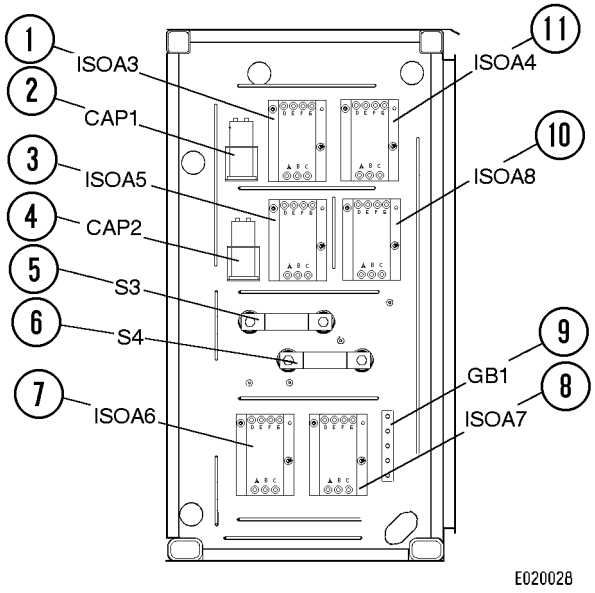


FIGURE 2-34. CONTROL CABINET, VIEW C

1. Isolation Amplifier #3
2. Capacitor #1
3. Isolation Amplifier #5
4. Capacitor #2
5. Motor Field Current Shunt
6. Alt. Field Current Shunt
7. Isolation Amplifier #6
8. Isolation Amplifier #7
9. Ground Bus #1
10. Isolation Amplifier #8
11. Isolation Amplifier #4

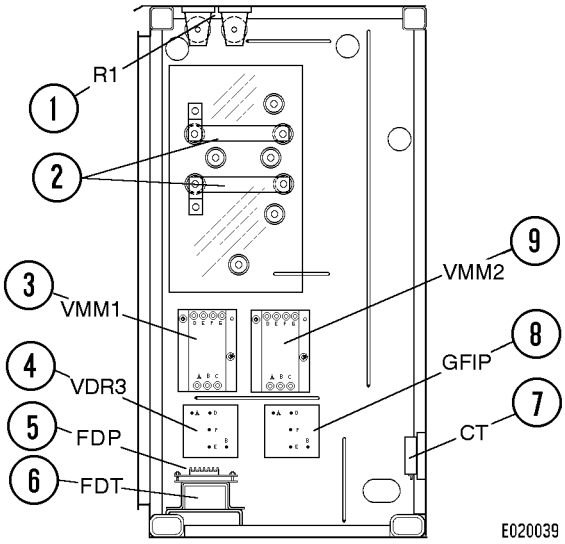
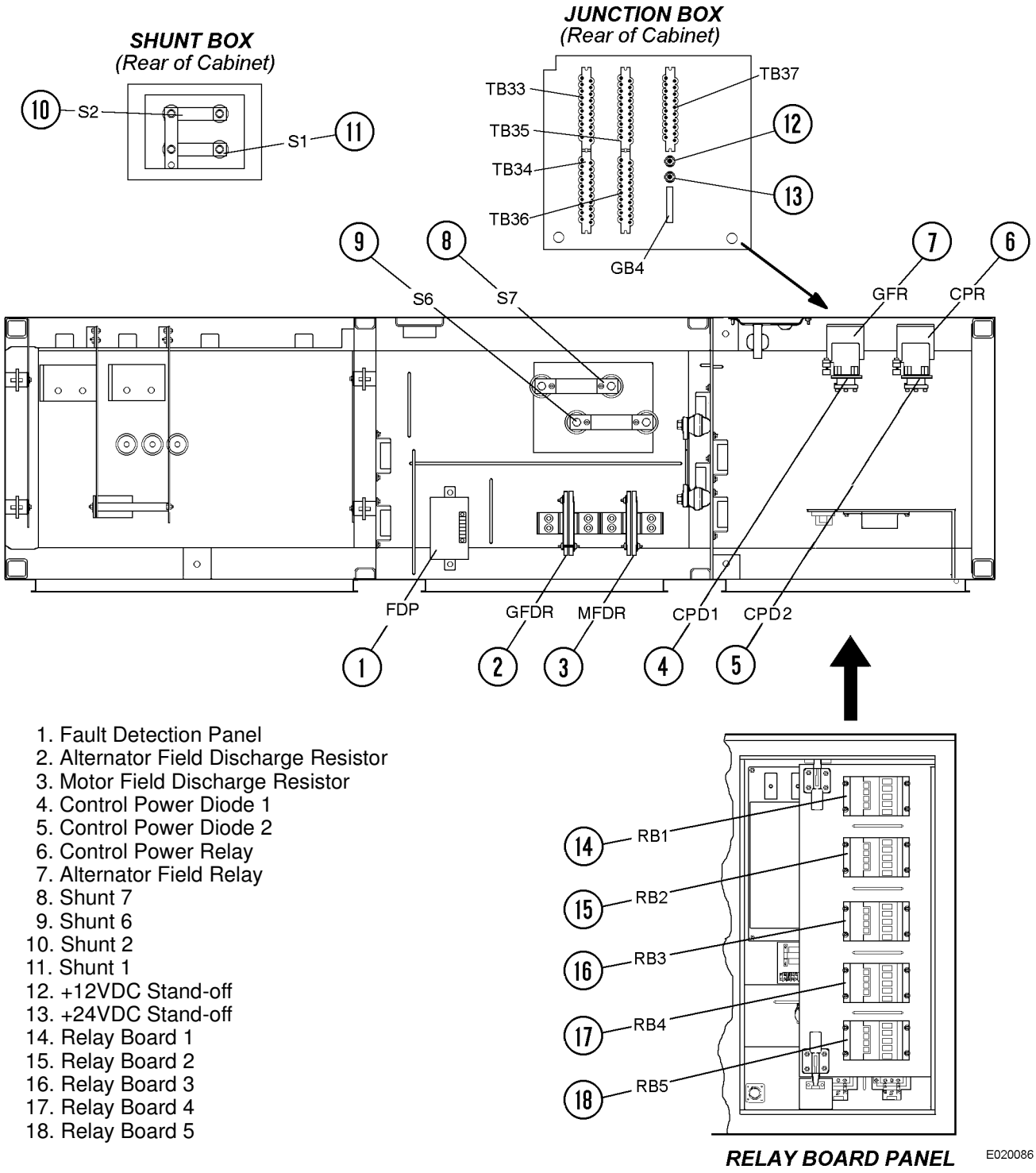


FIGURE 2-36. CONTROL CABINET, VIEW D

1. Alt. Field Current Limit Resistor Panel
2. Load Test Links
3. Voltage Measuring Module #1
4. Voltage Divider Resistor Panel #3
5. Fault Detection Panel
6. Diode Fault Detection Transformer
7. Current Transformer
8. Ground Fault Interrupt Panel
9. Voltage Measuring Module #2

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1. Fault Detection Panel
2. Alternator Field Discharge Resistor
3. Motor Field Discharge Resistor
4. Control Power Diode 1
5. Control Power Diode 2
6. Control Power Relay
7. Alternator Field Relay
8. Shunt 7
9. Shunt 6
10. Shunt 2
11. Shunt 1
12. +12VDC Stand-off
13. +24VDC Stand-off
14. Relay Board 1
15. Relay Board 2
16. Relay Board 3
17. Relay Board 4
18. Relay Board 5

FIGURE 2-37. CONTROL CABINET, VIEW E

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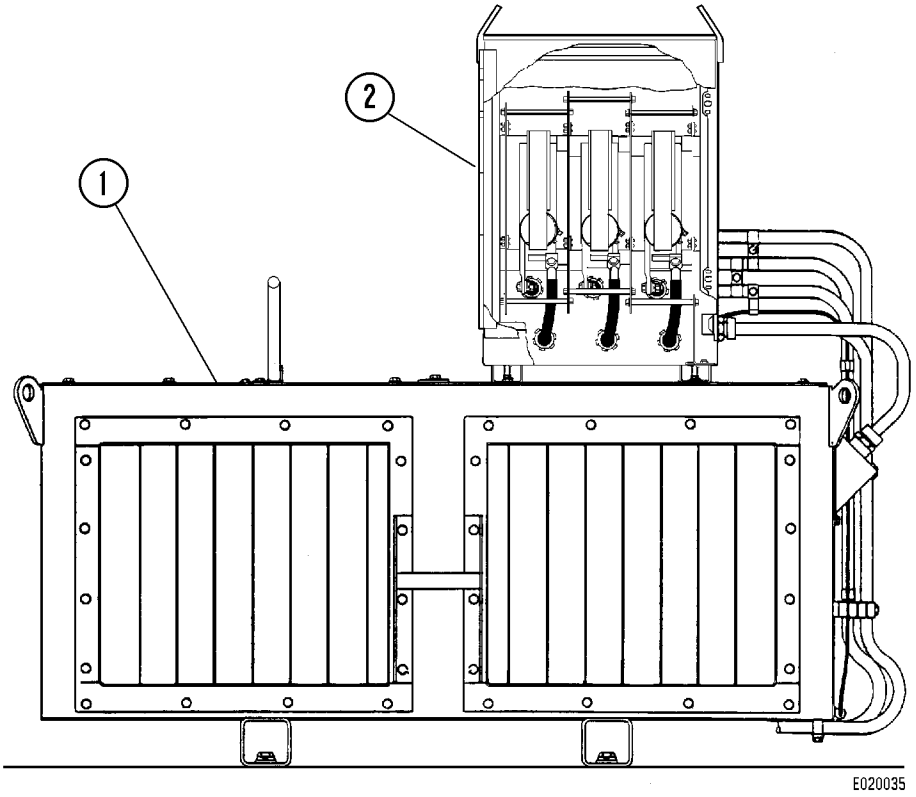


FIGURE 2-38. RETARDING GRIDS & CONTACTORS (R.H. DECK)

1. Retarding Grids and Blower(s)
2. Retarding Contactor Box

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ABBREVIATIONS FOR STATEX III ELECTRIC DRIVE COMPONENTS

NOTE: Some components listed may be optional equipment.

ACC . . . . . Accelerator Pedal Position Detector Card
AFCT . . . . . Alternator Field Current Transformer
AFSE . . . . . Alternator Field Static Exciter
AID . . . . . Alarm Indicating Device
ALT . . . . . Alternator (Traction)
ALT(24V) . . . . . Alternator (Battery Charging)
BATT . . . . . .Battery
BD. . . . . Body Down Proximity Switch
BIR . . . . . Brake Interrupt Relay
BM . . . . . .Blower Motor
BUR . . . . . Body Up Relay
CPC . . . . . .Control Power Contactor
CPD . . . . . .Control Power Diode
CPR . . . . . .Control Power Relay
CPRL . . . . . Control Power Relay Light
CPS . . . . . Control Power Switch
CSL . . . . . Cabinet Service Lights
CSLS . . . . . Cabinet Service Light Switch
CT. . . . . Current Transformer
CTR . . . . . .Current Transformer Resistor
DIAG. . . . . Diagnostic Connector
DL. . . . . Dome Light
DFR . . . . . Diode Fault Relay
EIS . . . . . Engine Idle Switch
ESSU . . . . . Engine Speed Sensing Unit
FBS. . . . . .Feedback Switch
FDP . . . . . Fault Detection Panel
FDT. . . . . .Fault Detection Transformer
FL275 . . . . . .System Control Panel
FP. . . . . Filter Panel
GB 1-4 . . . . . .Ground Bus No. 1,2, 3, & 4
GF. . . . . .Alternator Field Contactor
GFDR . . . . . Alternator Field Discharge Resistor
GFIP . . . . . Ground Fault Interrupt Panel
GFR . . . . . Alternator Field Relay
GRR . . . . . Ground Relay Resistor
ISOA3-8 . . . . . Isolation Amplifiers No. 3 through 8
KS. . . . . Key Switch
M1. . . . . Wheel Motor No. 1, Left Hand
M2. . . . . Wheel Motor No. 2, Right Hand
MF1, 2 . . . . . .Wheel Motor Field No. 1, 2
MFC . . . . . .Motor Field Contactor
MFDR . . . . . Motor Field Discharge Resistor
MFSE . . . . . Motor Field Static Exciter
OR . . . . . .Override Pushbutton
P1, 2 . . . . . .Propulsion Contactor No. 1, 2
PBR . . . . . .Parking Brake Relay
PBS . . . . . Parking Brake Switch
PTU . . . . . Portable Test Unit
RD . . . . . Rectifier Diode Panel
REV . . . . . .Reverser
R1 . . . . . Alternator Field Current Limit Resistor
RG1, 2 . . . . . .Retarding Grid No. 1, 2
RLCB . . . . . Retard Light Circuit Breaker
RLR . . . . . Retard Light Relay
RP1, 2, ... Retard Power Contactor No. 1, 2
RP3, 4, 5. . . . . .Extended Range Retard Contactors
6, 7, 8, 9. . . . . .No. 3, 4, 5, 6, 7, 8, 9
RSC . . . . . .Retard Speed Control
S1, 2 . . . . . Motor Armature Circuit Shunt No. 1, 2
S3 . . . . . Power Circuit Shunt
S4 . . . . . Alternator Field Current Shunt
S6, 7 . . . . . .Alternator Tertiary Shunts
SBDT . . . . . Steering Bleeddown Timer
SLR . . . . . Stop Light Relay
SRR . . . . . .Slippery Road Relay
SS . . . . . .Selector Switch (Direction Control)
SSU1, 2 . . . . . Speed Sensing Unit No. 1, 2
ST1, 2. . . . . Synchronizing Transformer 1, 2
VDR3 . . . . . Voltage Divider Resistor
VMM 1, 2 . . . . . Voltage Measuring Module No. 1, 2

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CARD IDENTIFICATION LIST 17FL275 PANEL, STATEX III

17FB100 . . . . . .Power Supply
17FB101/144. . . . . Central Processing Unit (CPU)
17FB102/140. . . . . .Analog Input/Output
17FB103 . . . . . Digital Input/Output
17FB104 . . . . . Digital Input/Output

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NOTES

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STATEX III ELECTRICAL SYSTEM CHECKOUT PROCEDURE

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STATEX III ELECTRICAL SYSTEM CHECKOUT PROCEDURE

GENERAL INFORMATION

This checkout procedure describes test and adjustment procedures for the G.E. STATEX III Electric Wheel Drive Systems used on Model 445E, 510E, 630E, 685E, 730E, and 830E electric drive trucks with the following alternator and wheelmotor combinations.

TRUCK MODEL	ALTERNATOR	WHEELMOTOR
445E, 510E	GTA-25	GE772, GE776, GE791
630E, 685E, 730E	GTA-22	GE776, GE788
630E, 685E, 830E	GTA-26	GE788, GE787

⚠WARNING

This system is capable of developing high voltage. Use caution when working with the system.

⚠ IMPORTANT ⚠

The test and adjustment procedures list standard and optional equipment which may be installed. It is the responsibility of the personnel using this Electrical Checkout Procedure to determine what equipment is installed on the truck being serviced and to select the applicable test and adjustment procedure.

If any of the cards in the FL275 panel must be removed, a wrist ground strap MUST be worn to ground personnel to the truck chassis to prevent static discharge damage to the circuit boards. After the board has been removed from the panel, it must immediately be placed in a static-free protective bag.

Sample PTU screens illustrated in the following pages show menus and data screens as they appear in the April, 2001 STATEX III Enhanced Version 1.00 software release. Instructions are also applicable to the April 2000, version 14.00 software release. Later versions of the software may differ.

The following type fonts and styles are used to differentiate between menu titles, screen titles, menu selections and keyboard keys to be pressed:

CONVENTION	APPLIES TO	SAMPLE
Bold Type	Menu & Screen Titles	**GE OHV STATEX III MENU**
“Quotation Marks”	Menu Selection Choices	“PTU TALK TO TRUCK”
[Brackets]	Key to be pressed	[ENTER], [ESC], [DEL] etc.

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PTU Hookup

NOTE: The following procedure will verify correct PTU hookup and verify communication between the PTU and the CPU. Additionally, all previous event data can be cleared prior to performing the checkout procedure. If the truck has not been previously programmed, refer to "Electrical Propulsion Components", Section E of this manual for instructions.

1. Connect PTU communication cable male plug to connector "A" located in control cabinet near two digit display as shown in Figure 3-1 or to cab Communications Port located near bottom right side of selector switch console. Turn Control Power On.

Note: Connector "A" actual location may differ depending on truck model.

2. Connect female end of cable to serial port connector on rear of PTU.
3. Turn PTU power on. After warm-up and self-test, type "`gemenu3e`" (or "`gemenu`" if using version 14.00 software) at the C:> prompt and press the [ENTER] key. (Do not type quotes.)
4. From the **GEOHV STATEX III (Main) MENU**, select "PTU TALK TO TRUCK" and press [ENTER].
5. At **PTU LOGON** screen, enter your name and assigned password. Press [ENTER].
6. When the **GE STATEX III PTU MAIN MENU** appears, move the cursor to "SPECIAL OPERATION" and press [ENTER].
   a. A screen will appear that states: "Selection of SPECIAL OPERATION will override truck driver controls until you exit to the PTU main menu. Continue?"
   b. With the cursor next to "Yes", press [ENTER].
7. The **SPECIAL OPERATION MENU** will appear.
8. Use the arrow keys to move the cursor to the "EVENT DATA MENU" selection and press [ENTER]. The Event Data Menu screen will be displayed.
   a. If no event data has been stored, the screen will indicate 0 (zero) events stored. If no events have been stored, the cursor will be positioned on "EXIT". Press the [ENTER] key to return to the previous menu.

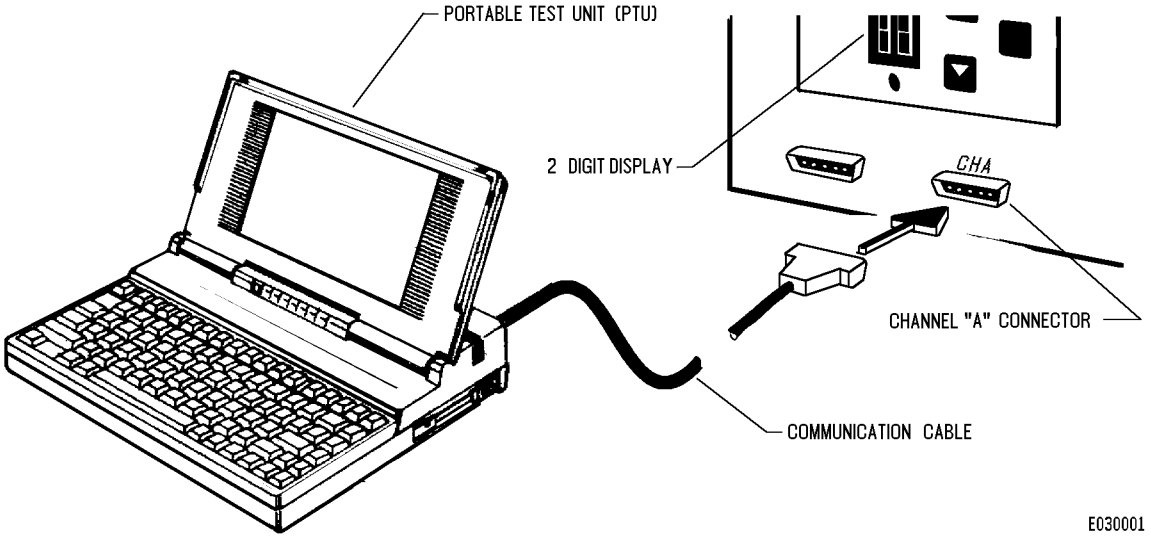


FIGURE 3-1. PTU HOOKUP

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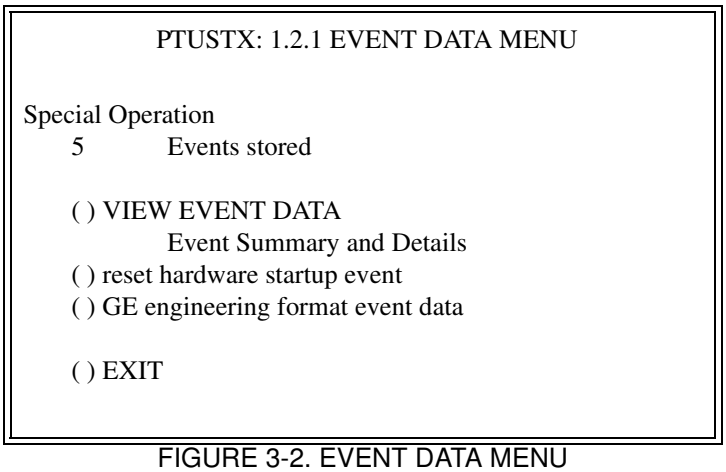


FIGURE 3-2. EVENT DATA MENU
(Requires Control System Reset)

9. If one or more events have been stored, a screen as shown in either Figure 3-2 or 3-3 will be displayed.
10. If Figure 3-2 is displayed, select “reset hardware startup event” with the cursor and press [ENTER].
    a. A screen will appear with instructions for cycling control power to reset the system. Follow the on-screen instructions to cycle power to the control system.
    b. After the system is powered up, repeat steps 4 through 8 to return to the event data.
11. If Figure 3-3 is displayed, you may select “VIEW EVENT DATA” and press [ENTER] to view events currently stored. A screen displaying a list of stored events appears.
12. Any stored events may be uploaded to a file for storage by selecting “GE engineering format event data” and following directions on the subsequent screens.
13. To erase the event data currently stored, select “erase event data yes/no menu” from the EVENT DATA MENU screen.
    a. On the screen titled RESET ALL YES/NO MENU, move the cursor to YES, Erase Truck Events and press [ENTER].
    b. Exit back to the **GE STATEX III MENU** following screen instructions as they appear.

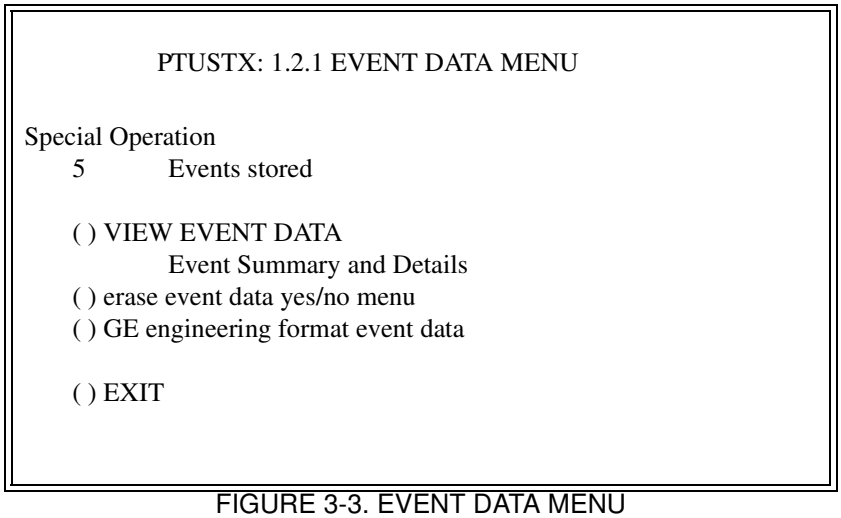


FIGURE 3-3. EVENT DATA MENU

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1.0 SEQUENCE TESTS - (Engine not running)

Preparation & Setup

It is assumed the truck has been programmed using the correct Truck Configuration File and GE Statex III Enhanced version 1.00 (if truck is equipped with a 17FB144 CPU card) or version 14.00 (if truck is equipped with a 17FB101 CPU card) or later software prior to proceeding with the following tests. If not, refer to *"Electrical Propulsion Components"* for instructions for preparing the Truck Configuration File, programming the truck, and usage of the GE software menu system.

- Always disconnect 74C at GFR for static testings (engine not running). Failure to do so may result in damage to battery boost SCR and/or dead batteries.
- If the truck body has not been installed or the body is raised, place a steel washer on Body Up Switch or jumper circuit 71F to circuit 71, to simulate body down condition.
- If hydraulic pressure is low, connect a jumper wire between circuit 73S and 710. (This step will be necessary if all hydraulic brakes are installed and engine is not running).

CONTROL SYSTEM SELF-TEST

1. Set up PTU as described previously using the communication port in the electrical cabinet.
2. Turn control power switch On.
3. Verify the two digit display shows 00 after a 10 second delay. If only a single digit 8 is displayed, check for a faulty CPU (FB101 or FB144) card.
4. If the two digit display shows numbers other than 00, refer to "Electrical Propulsion Components" for a listing of possible codes, code descriptions, event restrictions, detection information and possible reasons for the problem. An attempt should be made to correct any obvious problems before proceeding.
5. If the problem has not been resolved, select the proper section of this procedure (digital, analog etc.) and use the PTU to aid in troubleshooting the problem.
6. If the entire electrical system is to be checked, the checkout procedures should be performed in the sequence listed if possible.

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1.1 Throttle System Check and Adjustment

NOTE: If the truck is an early production unit, not equipped with the Fuel Enhancement ("Fuel Saver") system, refer to step 1.1.1. If the truck is a later or current production unit, refer to step 1.1.2.

1.1.1 Electronic Throttle System. (Williams electronic foot pedal, Dresser ACC/RET Interface Circuit and Pedal Detector Card).

NOTE: Foot pedal with adjustable pedal potentiometer is used with a TZ6661 or EB2635 (non-adjustable) ACC card. Non-adjustable foot pedal requires use of EC1806 (adjustable) ACC card.

1. Turn key switch On.
2. Turn control power switch in control cabinet to the Off position.
3. Normal/Advance Idle switch should be in the Off ("Normal") position.
   - ❑ Measure 4.80 ±0.10 vdc between circuits 916 and 952 in Control Cabinet.
4. If not correct, check 916 circuit to engine.
5. If available, use the DDR (DDEC engine trucks) to read the PTO counts or use a voltmeter to measure voltages shown below. (The Control Power switch and Normal/Advance Idle switch should be in the Off ("Normal") position and the accelerator pedal released.) If unable to adjust properly, replace ACC card.

STEP	CIRCUIT	ACC CARD	VOLTS	PTO COUNTS	ADJUSTMENT
1	525(+) to 952(-)	TZ6661	.75 (approx.)	18 ±1	Position of pedal potentiometer. If unable to adjust, replace potentiometer.
		EB2635	.78 (approx.)	17 ±1	
		EC1806	.53 (approx.)	21 ±3	Adjust P1 on ACC card. If unable to adjust, replace pedal assembly.
2	510(+) to 952(-)	TZ6661	.34 (approx.)	18 ±1	If out of tolerance, replace ACC card.
		EB2635	.37 (approx.)	17 ±1	
		EC1806	.40 (approx.)	21 ±3	Adjust P1 on ACC card (Seal pot). If unable to adjust, replace pedal assembly.

6. Measure the voltage between circuits 76L and 710.
   - ❑ Read 25.25 to 28 vdc. If voltage is low, recharge truck batteries.
7. With the Normal/Advance Idle switch in Off ("Normal") position, turn key switch Off, then On.
   - ❑ Measure voltage between circuits 510 to 952. Repeat 3 times. If voltage ever reaches or exceeds 2.0 vdc, replace ACC card. Verify the Normal/Advance Idle switch is in Off position.
8. Turn control power switch On, place selector switch in FORWARD. With throttle pedal depressed just until propulsion contactors pick up, measure the following:

CIRCUIT	ACC CARD	VOLTS	PTO COUNTS
510(+) to 952(-)	TZ6661	.107 (approx.)	33 ±2
	EB2635	.68 (approx.)	32 ±2
	EC1806	.64 (approx.)	34 ±2

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9. With throttle pedal fully depressed, measure the following:

CIRCUIT	ACC CARD	VOLTS	PTO COUNTS	ACTION IF OUT OF TOLERANCE
510(+) to 952(-)	TZ6661	3.80 (approx.)	203 -4/ +10	Replace ACC card or pedal
	EB2635	4.35 (approx.)	215 -4/ +10	
	EC1806	4.05 (approx.)	215 -4/ +10	

10. Release throttle pedal.
11. Measure voltage at circuit 525 and 952 while slowly pressing throttle pedal from minimum to full throttle.
    - ❑ For **adjustable** pedal with TZ6661/EB2635 card, meter reading should start from approximately 0.70 vdc and increase to approx. 4.35 vdc in a smooth and linear fashion.
    - ❑ For **non-adjustable** pedal with EC1806 card, meter reading should start from approximately 0.54 vdc and increase to approximately 4.30 vdc in a smooth and linear fashion.

If there are positions of voltage drop off, replace pedal potentiometer.

12. Release throttle pedal. Measure circuits 73R to 710 with pedal released.
    - ❑ Measure 0.0 vdc.
13. Depress throttle pedal fully. Measure circuits 73R to 710 with pedal pressed fully.
    - ❑ Measure approximately 26.0 vdc.
14. Release pedal. If step 12 or 13 readings are incorrect, replace accelerator card.

1.1.2 Electronic Throttle System (Fuel Saver System).

NOTE: Instructions are also included in the following procedure for retard pedal setup which can be performed in conjunction with accelerator pedal setup on trucks equipped with the "Fuel Saver" circuitry.

- Turn Key Switch and Control Power On.
- Set up PTU as described previously using the communication port in the electrical cabinet. Start the GE software program be typing "`gemenu3e`" if using Statex III Enhanced version 1.00 software (or type "`gemenu`" if using version 14.00 software) from the DOS C:> prompt.
  a. From the **GEOHV STATEX III MENU**, select "PTU TALK TO TRUCK" and press [ENTER].
  b. At **PTU LOGON** screen, enter your name and assigned password. Press [ENTER].
  c. When the **GE STATEX III PTU MAIN MENU** appears (Figure 3-4), move the cursor to "NORMAL OPERATION" and press [ENTER].
  d. A screen appears with the message: "Selection of NORMAL OPERATION gives truck control to the driver - Continue?". With the cursor at the "Yes" option, press [ENTER].
  e. The **NORMAL OPERATION MENU** will appear. Select "MONITOR ANALOG INPUT CHANNELS" and press [ENTER]; the screen shown in Figure 3-5. will appear.

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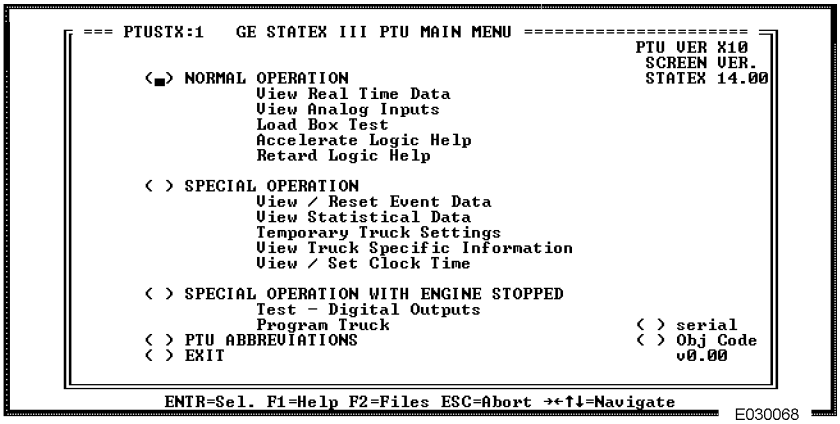


FIGURE 3-4. PTU MAIN MENU

1. Record the accelerator pedal % (percent) values shown on the MONITOR ANALOG INPUT CHANNELS screen:
   a. Pedal OFF - note on paper the % value shown on the PTU screen for “acc pedal”. (For example, 11.3)
   b. Depress the accelerator pedal and observe the % value increases - note on paper the % value shown on the PTU screen when the pedal is fully depressed. (For example, 87.2)

Note: It is also necessary to perform the above procedure for the retard pedal as described in the following step. Retard pedal % values should be recorded at this time as follows:

2. Record the retard pedal % (percent) values shown on the MONITOR ANALOG INPUT CHANNELS screen:
   a. Pedal OFF - note on paper the % value shown on the PTU screen for “ret pedal”. (For example, 9.7)
   b. Depress the retard pedal and observe the % value increases - note on paper the % value shown on the PTU screen when the pedal is fully depressed. (For example, 89.5)

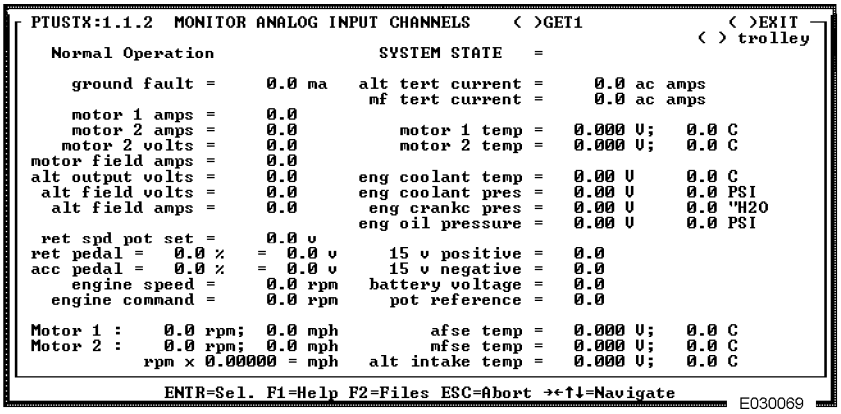


FIGURE 3-5. MONITOR ANALOG INPUT CHANNELS SCREEN

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NOTE: If either pedals' "off %" is greater than 15% before making the pedal setting changes to the configuration file, the system will interpret the pedal as being pressed and may cause the contactors to energize.

3. Exit to the **NORMAL OPERATION MENU, GE STATEX III PTU MAIN MENU** and exit to the G**E OHV MENU.**
4. Move the cursor to TRUCK SETUP (CFG) and press [ENTER].
5. Choose "1) Select a truck configuration, currently using file: ".
6. Move the cursor to the configuration file for the truck and press [ENTER].
7. Select "5) Change/view Truck Specifics".
8. Compare the values recorded in steps 1 and 2 with values shown on the TRUCK SPECIFICS screen. If the values differ by more than ±3%, the configuration file must be changed to the values recorded above:
   a. Move the cursor to " :percent accel pedal travel off request". Type the value recorded in step 1.a above and press [ENTER].
   b. Move the cursor to " :percent accel pedal travel full request". Type the value recorded in step 1.b above and press [ENTER].
   c. Move the cursor to " :percent retard pedal travel off request". Type the value recorded in step 2.a above and press [ENTER].
   d. Move the cursor to " :percent retard pedal travel full request". Type the value recorded in step 2.b above and press [ENTER]
9. Move the cursor to LEAVE TRUCK SPECIFICS SCREEN and press [ENTER].
10. At the **TRUCK SETUP CONFIGURATION MINE MENU**, select "7) Save a truck configuration, filename: " and press [ENTER].
11. The current filename will be displayed. Press [ENTER] to accept this name. Type "y" to overwrite the old file with the new file containing the correct pedal values.
12. Choose "9) Quit." Type "y" to exit and return to the GE OHV STATEX III MENU.
13. Move the cursor to SELECT TRUCK SETUP and press [ENTER].
14. Move the cursor to the configuration file saved in step 11. and press [ENTER].
15. For the foot pedal changes to become effective, it is now necessary to reload the program into the truck. Refer to *"PROGRAMMING THE TRUCK"* and follow the instructions for *"Download Configuration Files"* in section E2.

1.2 Retard System Check and Adjustment

1.2.1 Williams Electronic Retard Pedal and Dresser ACC/RET or RET Interface Box.

1. With key switch and control power switch On, move selector switch to FORWARD.
2. With retard pedal released, measure the following circuits in the control cabinet using a digital voltmeter:
   a. From 76B to 710:
   - ❑ Read 20.0 ±2.0 vdc.

   b. From 15V to 710:
   - ❑ Read 15.00 ±0.10 vdc. Adjust P1 on RET Card if necessary. Seal P1 pot after adjustment.

   c. From 54N to 710:
   - ❑ Read 1.50 ±.50 vdc.

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d. From 74N to 710:

- ❑ Read .09 ±.10 vdc.

3. With retard pedal depressed just until retard contactors pick up, measure the voltage between the following circuits:

a. From 74N to 710:

- ❑ Read 0.20 ±.20 vdc. If out of tolerance replace RET card.

b. From 54N to 710:

- ❑ Read 2.60 ±.50 vdc. If out of tolerance, replace retard pedal potentiometer.

c. DDEC equipped trucks only:

- ❑ Use the DDR to read PTO counts or measure voltages at circuits 510(+) to 952(-) shown in the following table:

ACC CARD	VOLTS	PTO COUNTS	ACTION IF OUT OF TOLERANCE
TZ6661	2.77 (approx.)	150 ±2	Replace ACC card
EB2635	3.63 (approx.)	162 ±2	Replace ACC card
EC1806	3.04 (approx.)	162 ±2	Adjust Pot P2 on ACC card

4. With retard pedal fully depressed, measure the voltage between the following circuits:

a. From 74N to 710:

- ❑ Read 15.50 ±.25 vdc. If out of tolerance replace RET card.

b. From 54N to 710:

- ❑ Read 12.50 vdc minimum. If out of tolerance replace retard pedal resistor.

c. DDEC equipped trucks only:

- ❑ Use the DDR to read PTO counts or measure voltages at circuits 510(+) to 952(-) shown in the following table:

ACC CARD	VOLTS	PTO COUNTS	ACTION IF OUT OF TOLERANCE
TZ6661	2.77 (approx.)	150 ±2	Replace ACC card
EB2635	3.63 (approx.)	162 ±2	Replace ACC card
EC1806	3.04 (approx.)	162 ±2	Adjust Pot P2 on ACC card

5. Depress the throttle pedal fully, and again read the PTO Counts. If values change replace ACC Card. Release throttle and retard pedals.

1.2.2 Electronic Retard Pedal; Fuel Saver Equipped Trucks and Current Production.

- Refer to Section 1.1.2 for both, accelerator and retard pedal setup instructions.

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PTU SETUP

- If not done previously, Set up PTU using the communication port in the electrical cabinet.
- Select the **MONITOR REAL TIME DATA** screen as follows:

  a. From the **GEOHV STATEX III MENU**, select “PTU TALK TO TRUCK” and press [ENTER].

  b. At PTU LOGON screen, enter your name and assigned password. Press [ENTER].

  c. When the **GE STATEX III PTU MAIN MENU** (Figure 3-6.) appears, move the cursor to “NORMAL OPERATION” and press [ENTER].

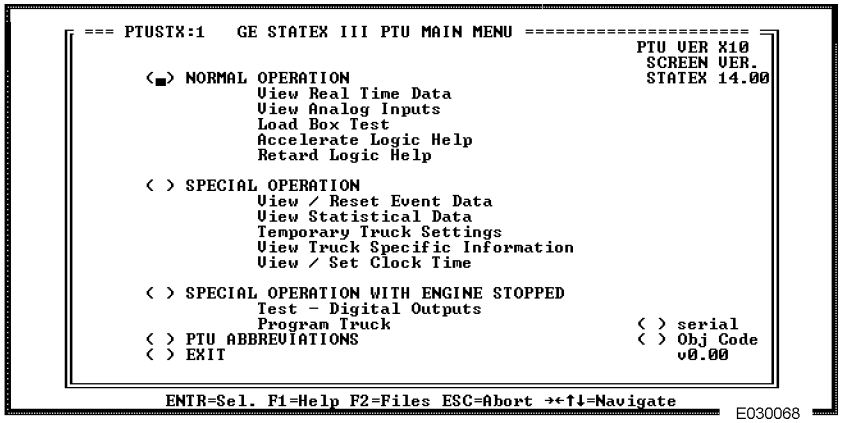


FIGURE 3-6. PTU MAIN MENU (Version 14.00 Shown)

  d. A screen appears with the message: “Selection of NORMAL OPERATION gives truck control to the driver - Continue?”. With the cursor at the “Yes” option, press [ENTER].

  e. The **NORMAL OPERATION MENU** (Figure 3-7.) will appear. Select “MONITOR REAL TIME DATA” and press [ENTER]; the screen shown in Figure 3-8. will appear.

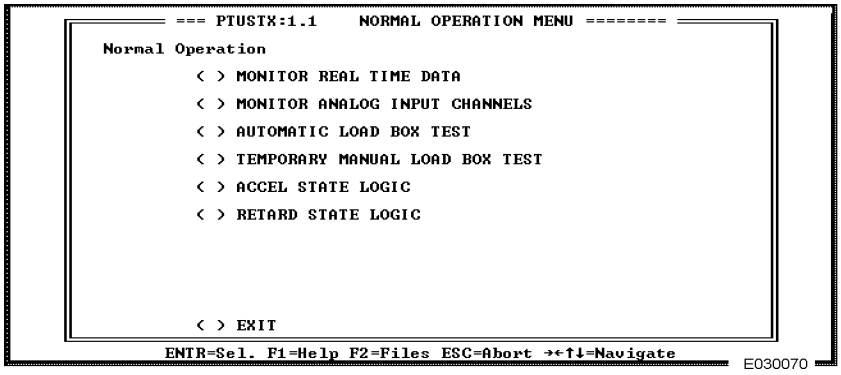


FIGURE 3-7. NORMAL OPERATION MENU

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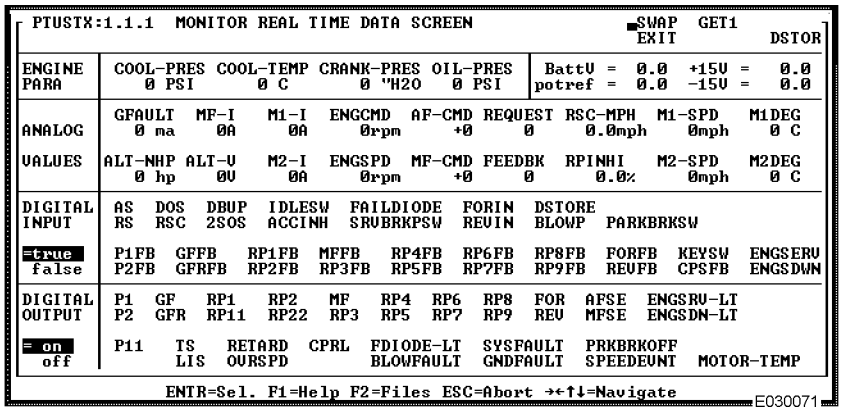


FIGURE 3-8. MONITOR REAL TIME DATA SCREEN

NOTE: PTU abbreviations shown with a line above and below after the following steps indicate highlighted items to be observed on PTU display screen. Highlighted items will be preceded by an "equals" sign to indicate a digital input is "true" and a digital output is "ON". Steps 1.3, and 1.4 may also be checked using the ***ACCELERATE STATE LOGIC SCREEN*** *and step 1.5 may be checked using the* ***RETARD STATE LOGIC SCREEN*** *if desired. If used, exit back to the* ***Normal Operation Menu*** *and select* ***MONITOR REAL TIME DATA SCREEN*** *when performing step 1.6 and the remaining sequence checks.*

1.3 Reverser and Propulsion Contactors Check

NOTE: When the Selector Switch is moved to change the Reverser from REVERSE to FORWARD or NEUTRAL, FOR on the PTU display will be highlighted for a brief moment. If the Selector Switch is moved to change the Reverser from FORWARD or NEUTRAL to REVERSE, REV on the PTU display will be highlighted for a brief moment. This occurs very quickly and may not be visible on some PTU's. (The FOR and REV signals are used to momentarily energize the Reverser solenoids when a directional change is requested.)

1. Move Selector Switch to NEUTRAL. Turn key switch and control power switch to On position.
2. Verify that Reverser either remains in or shifts to forward position (to the right).
   a. Verify the feedback signal:

FORFB

3. Depress throttle. No contactors should pick up. Release throttle.
4. Move Selector Switch to FORWARD.

FORIN

5. Verify that Reverser remains in forward position (to the right).
   a. Verify the feedback signal:

FORFB

6. Depress throttle until AS contact is closed, and propulsion contactors MF, P1/(P2), GF, and GFR are picked up in this sequence.

AS MF P1 (P2) GF GFR

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7. Verify feedback signals are present:

MFFB P1FB (P2FB) GFFB GFRFB

8. Release throttle. Propulsion contactors should drop out.
9. Move Selector Switch to REVERSE.
10. Verify that Reverser shifts to reverse position (to the left).

REVIN

a. Verify the feedback signal:

REVFB

11. Verify rear back-up lights and back-up horn are energized.
12. Depress throttle until AS contact is closed, and propulsion contactors MF, P1/(P2), GF, and GFR are picked up.

AS MF P1 (P2) GF GFR

13. Verify feedback signals are present:

MFFB P1FB (P2FB) GFFB GFRFB

14. Release throttle. All contactors should drop out and will no longer be highlighted on the PTU screen.
15. Move Selector Switch to NEUTRAL.
16. Verify that Reverser shifts to forward position (to the right) and back-up lights and horn are de-energized.

1.4 Propulsion Lockout Test (DDEC & MTU Engine Trucks Only)

1. Move Selector Switch to FORWARD, turn Control Power Switch to On, and depress throttle pedal until propulsion contactors MF, P1/(P2), GF, and GFR pick up.

AS MF P1 (P2) GF GFR

a. Verify feedback signals are present:

MFFB P1FB (P2FB) GFFB GFRFB

Detroit Diesel DDEC engine trucks:

2A. For 16 cylinder engines, jumper circuits 509M & 509S to ground, one at a time. For 20 cylinder engines (3 ECM's) jumper circuits 509M, 509R1 & 509R2 to ground. On DDEC III engines, jumper circuit 509 to ground. The propulsion contactors should drop out after approximately a 7 second time delay.

MTU engine trucks:

2B. Jumper circuit 31MS to ground. The propulsion contactors should drop out after approximately a 7 second time delay.

3. Turn control power Off. Remove jumpers to restore wiring to its original condition.

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1.5 Retard Contactors Operation Check

1. Put Selector Switch in FORWARD and depress retard pedal.

FORIN RS

2. Verify that the contactors pick up in the following sequence; RP1, RP2, MF, GF, and GFR then RP3, RP4, RP5 (and RP6, RP7, RP8, and RP9 if used).

RP1 RP2 MF GF GFR RP3 RP4 RP5 RP6 RP7 RP8 RP9

a. Verify the feedback signals:

RP1 FB RP2FB MFFB GFFB GFRFB RP3FB RP4FB RP5FB

RP6FB RP7FB RP8FB RP9FB

3. MF, GF, and GFR must pick up after RP1 and RP2 but timing is very close. If installed, the Dynamic Retard Light in the cab should illuminate.

4. Release retard pedal. Verify GF, GFR, and MF, RP3, RP4, RP5, (and RP6, RP7, RP8, and RP9 if used) drop out first, then after a one second delay RP1 and RP2 also drop out, and Dynamic Retard Light (if installed) turns Off.

1.6 Ground Fault Sensing Check

1. Place Selector Switch in FORWARD and depress throttle.

2. Propulsion contactors MF, P1/(P2), GF, and GFR should pick up.

AS MF P1 (P2) GF GFR

a. Verify feedback signals are present:

MFFB P1FB (P2FB) GFFB GFRFB

3. Momentarily jumper from circuit 71 to terminal “A” on GFIP.

GFAULT

4. All contactors should drop out immediately and remain open, and Electric System Fault light (in cab) should illuminate and remain On, even after circuit 71 to terminal “A” jumper is removed. Event code 01 should appear on two digit display.

5. An analog value indicating current flow to ground should appear on PTU screen under GFAULT.

6. Release throttle. Operate Override pushbutton on console to reset ground fault (Electric System Fault) light. Press reset button on two digit display to clear event code.

1.7 Ground Fault in Retard Operation Check

1. Put Selector Switch in FORWARD and depress retard pedal.

FORIN RS

a. Verify feedback signal is present:

FORFB

2. Retard contactors RP1, RP2, MF, GF, and GFR, RP3-RP5, (and RP6-RP9 if used) should energize.

RP1 RP2 MF GF GFR RP3 RP4 RP5 RP6 RP7 RP8 RP9

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a. “RETARD” should be highlighted:

RETARD

3. Momentarily jumper from circuit 71 to terminal “A” on GFIP.

GFAULT

4. All contactors should remain energized. Event code 01 should appear on two digit display. Electric system fault light should come on.
5. Release retard pedal.
6. With jumper removed from circuit 71 to terminal “A”, operate Override pushbutton on console to reset electric system fault light. Press reset button on two digit display panel to clear event code.

1.8 Override Operation Check

1. Move selector switch to FORWARD, and depress throttle fully.

FORIN AS

a. Verify the feedback signal:

FORFB

2. Propulsion contactors MF, P1/(P2), GF and GFR should pick up.

MF P1 (P2) GF GFR

a. Verify the feedback signals:

MFFB P1FB (P2FB) GFFB GFRFB

3. Depress retard pedal.

RS

4. Verify that propulsion contactors MF, P1/(P2), GF and GFR drop out and then retard contactors RP1, RP2, MF, GF, GFR, RP3, RP4, RP5, (and RP6-RP9 if used) pick up. MF, GF and GFR must pick up after RP1 and RP2 but timing is very close.

RP1 RP2 MF GF GFR RP3 RP4 RP5 RP6 RP7 RP8 RP9

a. Verify the feedback signals:

RP1FB RP2FB MFFB GFFB GFRFB RP3FB RP4FB RP5FB

RP6FB RP7FB RP8FB RP9FB

5. Operate Override Switch.

DOS

6. Verify that retard contactors RP1, RP2, MF, GF, GFR, RP3, RP4, RP5, (and RP6-RP9 if used) drop out. Propulsion contactors P1/(P2) should pick back up when RP1 and RP2 drop out. MF, GF and GFR should then pick up.

P1 (P2) MF GF GFR

7. Release Override Switch. The propulsion contactors drop out and retard contactors pick back up (as in step 4).
8. Release retard pedal and throttle pedal.

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1.9 Anti-Reversal Function (AR) Check

- Disconnect wheel motor speed sensor wires 77, 77A, 714 & 714A in control cabinet. Jumper circuit 77 to 714. Jumper circuit 77A to 714A.
- Connect an oscillator to circuit 77 and 77A at control cabinet terminal board. Do not turn oscillator on.

1. Move Selector Switch to FORWARD. Depress throttle.

FORIN AS

a. Verify the feedback signal:

FORFB

2. Propulsion contactors MF, P1/(P2), GF, and GFR should energize.

MF P1 (P2) GF GFR

a. Verify the feedback signals:

MFFB P1FB (P2FB) GFFB GFRFB

3. Turn oscillator On and increase frequency until M1-SPD & M2-SPD reads 3 mph.
4. Move Selector Switch to REVERSE.
5. All contactors should drop out, Reverser should stay in forward position (to the right).
6. Release throttle and remove oscillator. Remove jumpers and reconnect speed sensor wires at terminal board.
7. Reverser should shift to REVERSE position (to the left).

a. Verify the feedback signal:

REVFB

8. Move selector switch to NEUTRAL.

1.10 Overspeed Retard Operation Check

- Disconnect wheel motor speed sensor wires 77, 77A, 714 & 714A at control cabinet terminal board.
- Jumper circuit 77 to 714, jumper circuit 77A to 714A on terminal board.
- Connect an oscillator to circuit 77 and 77A at terminal board.

1. Move Selector Switch to FORWARD, and depress throttle.

FORIN AS

a. Verify the feedback signal:

FORFB

2. Propulsion contactors MF, P1/(P2), GF, and GFR should energize.

MF P1 (P2) GF GFR

a. Verify the feedback signals:

MFFB P1FB (P2FB) GFFB GFRFB

3. Increase the oscillator frequency until OVRSPD DIGITAL OUTPUT changes from off to = on, which will indicate that overspeed condition has been obtained.

OVRSPD

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4. Verify that propulsion contactors MF, P1/(P2), GF and GFR drop out and then retard contactors RP1, RP2, MF, GF, GFR, RP3, RP4, RP5, (and RP6-RP9 if used) pick up and the Dynamic Retard Light in the cab comes on.

RP1 RP2 MF GF GFR RP3 RP4 RP5 RP6 RP7 RP8 RP9

   a. Verify the feedback signals:

RP1FB RP2FB MFFB GFFB GFRFB RP3FB RP4FB RP5FB

RP6FB RP7FB RP8FB RP9FB

5. Release throttle and reduce oscillator frequency to 0. Place selector switch in NEUTRAL.
6. Depress override pushbutton in console, and press reset button on display to clear overspeed event code.
7. Disconnect oscillator from circuits 77 and 77A and remove. Remove jumpers and reconnect speed sensor wires.

1.11 Hoist Interlock Operation Check

1. Put Selector Switch in FORWARD, and depress throttle. Propulsion contactors MF, P1/(P2), GF, and GFR should energize.

FORIN AS

MF P1 (P2) GF GFR

   a. Verify feedback signals are present:

FORFB MFFB P1FB (P2FB) GFFB GFRFB

2. If truck body is raised or not installed, momentarily remove metal washer from Body Up Switch. If body is installed and in down position, momentarily open circuit 71F.

DBUP

3. Propulsion contactors should drop out.
4. Operate Override Switch.

DOS

5. Contactors should respond to throttle only when Override Switch is held.
6. Put Selector Switch in NEUTRAL and release throttle. Reconnect 71F or replace metal washer.
7. Put Selector Switch in REVERSE, and depress throttle.

REVIN AS

   a. Verify the feedback signal:

REVFB

8. Propulsion contactors should energize.

MF P1 (P2) GF GFR

   a. Verify feedback signals are present:

FORFB MFFB P1FB (P2FB) GFFB GFRFB

9. If truck body is raised or not installed, momentarily remove metal washer from Body Up Switch. If body is installed and in down position, momentarily open circuit 71F.

DBUP

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10. Propulsion contactors should drop out. Operate override switch.

DOS

11. Contactors should not pick back up. Release override switch.
12. Replace metal washer or reconnect 71F. The contactors should not energize.
13. Release throttle. Put Selector Switch in NEUTRAL, then to REVERSE.
14. Depress throttle pedal. The propulsion contactors should energize.
15. Move selector to NEUTRAL and release throttle.

1.12 Motor Blower Fault Light Operation Check

1. Place Selector Switch in FORWARD, and depress throttle.

FORIN_AS

2. Propulsion contactors should energize.

MF_P1_(P2)_GF_GFR

a. Verify feedback signals are present:

FORFB_MFFB_P1FB_(P2FB)_GFFB_GFRFB

3. After 101 seconds (default time delay value), the Motor Blower Off Light should turn On, and event code 63 should appear on the two digit display.

BLOWP_BLOWFAULT

4. Put selector switch in NEUTRAL, depress override pushbutton and press reset button on two digit display to clear event code.

NOTE: If Motor Blower Fault Light is not operational, refer to "Miscellaneous Component Test and Adjustment", for switch adjustment procedure.

Return to Main Menu

1. This completes the sequence tests.
2. Move cursor to select "EXIT" on the menu and press [ENTER] key.
3. Select "EXIT" as necessary until returned to **GE STATEX III PTU MAIN MENU.**
4. Move cursor to select "EXIT" on this menu and press [ENTER] key.
5. At "QUIT PTU?" menu screen prompt , press [Y] key (or any key except [N]) to exit back to the **GE OHV STATEX III MENU**.

NOTE: it is always necessary to exit back to this menu before turning off control power to avoid lock up of PTU computer screen.

6. Turn control power switch Off.
7. Turn key switch Off.

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2.0 DIGITAL INPUT/OUTPUT SIGNALS TEST - FL275 CARD PANEL

- Connect PTU at control cabinet as described previously.
- Turn PTU On and type "`gemenu3e`" (or "`gemenu`", for version 14.00) at the C:> prompt. Press [ENTER].

2.1 Setup Manual Digital Input/Output Test on PTU

1. With control power On, select "PTU TALK TO TRUCK" on **GE OHV STATEX III MENU**. Press [ENTER] key.
2. At "Enter your name:" type your name. Press [ENTER] key.
3. At "Enter your password:" type your password. Press [ENTER] key.
4. The **GE STATEX III PTU MAIN MENU** should appear on the screen.
5. Select "SPECIAL OPERATION WITH ENGINE STOPPED". Press [ENTER] key.
   a. A screen will appear that states: "Selection of SPECIAL OPERATION will override truck driver controls until you exit to the PTU main menu. Continue?"
   b. With the cursor next to "Yes", press [ENTER].
6. The **SPECIAL CONTROL ENGINE STOPPED TEST MENU** should appear on the screen.
7. Select "MANUAL DIGITAL OUTPUT TEST". Press [ENTER] key.
8. The **MANUAL DIGITAL OUTPUT TEST SCREEN** (Figure 3-9.) should appear on the PTU screen. This screen is divided into four sections:
   a. **ENGINE PARA** - the functions displayed are not active.
   b. **ANALOG** - the functions displayed are not active.
   c. **DIGITAL INPUT** - this section monitors 38 digital inputs. The status of the input functions will be shown by displaying the Name of the input as follows (unless otherwise noted): = true inverse display = input energized (28 volts) false regular display = input not energized (0 volts)
   d. **DIGITAL OUTPUT** - this section monitors 35 digital outputs. = on inverse display = output energized

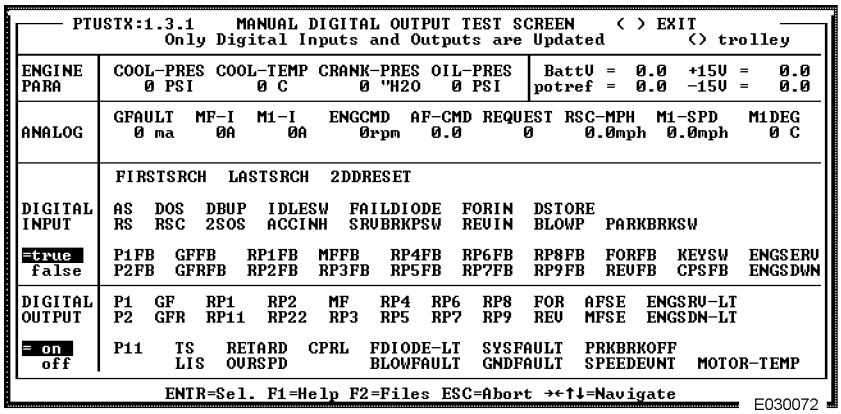


FIGURE 3-9. MANUAL DIGITAL OUTPUT TEST SCREEN

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2.2 Digital Input Checks

1. The two digit diagnostic display panel should have a **00** event code to indicate that all previous event codes have been cleared. If not, press reset switch to clear codes.
2. For the digital inputs listed below, do the **PROCEDURE TO ACTIVATE** as specified, and verify that the display status of the digital input name on the **MANUAL DIGITAL OUTPUT TEST** SCREEN changes from false (regular display) to **= true** (inverse display), unless otherwise noted. Restore any switch settings and wiring changes to their original condition before moving on to check the next digital input.
3. All digital inputs have now been checked, except contactor feedback inputs, which will be checked with digital outputs in next section.

DI NAME	DESCRIPTION	PROCEDURE TO ACTIVATE	FUNCTION
FIRSTSRCH	FIRST SEARCH SW	Press Up Arrow Switch on Two Digit Display.	= true (inverse display) = switch depressed
LASTSRCH	LAST SEARCH SW	Press Down Arrow Switch on Two Digit Display.	= true (inverse display) = switch depressed
2DDRESET	LOCAL RESET SW	Press Reset Switch on Two Digit Display.	= true (inverse display) = switch depressed
AS	ACCELSWITCH (Non-Fuel Saver Only)	Accelerator pedal applied.	= true (inverse display) = ACCEL request =28v input
		Pedal released	false (regular display) = no ACCEL request =0v input
RS	RETARD SWITCH (Non-Fuel Saver Only)	Press retard pedal.	= true (inverse display) = retard request = 0v input
		Pedal released	false (regular display) = no request = 28v input
DOS	DUMP OVERRIDE SWITCH	Press override switch.	= true (inverse display) = switch depressed
RSC	RETARD SPEED CONTROL SWITCH	Pull retard speed control switch to On position.	= true (inverse display) = switch depressed
DBUP	DUMP BODY UP SWITCH	Remove wire 71F.	= true (inverse display) = body up = 0v input Verify Body-Up light in cab illuminates.
		Restore circuit 71F.	false (regular display) = body down = 28v input
2SOS	2 SPEED OVERSPEED SYSTEM (LOAD WEIGHT SWITCH)	Disconnect wire 73LS routed to the rear suspension pressure switches and insulate. Jumper from 71 to 73LS.	= true (inverse display) = loaded truck = 0v input
		Remove 71 to 73LS jumper (Reconnect 73LS.)	false (regular display) = empty truck = 28v input
IDLESW	IDLE SWITCH (Non-Fuel Saver only)	Move idle switch from low (turtle) position to high idle position.	= true (inverse display) = high idle = 0v input
		Place switch in low position.	false (regular display) = low idle = 28v input
ACCINH	ACCEL INHIBIT SIGNAL	No signal (0v input)	= true (inverse display) = inhibit = 0v input
		Jumper 73S to 710 to energize park brake failure relay coil. (Leave jumper connected to simulate Park Brake Not Applied)	false (regular display) = not inhibit = 28v input
FAILDIODE	FAILED DIODE PANEL SIGNAL	Remove wire 73A from FDP term D.	= true (inverse display) = failed diode = 0v input Verify that electrical system fault light on instrument panel comes On with wire 73A removed.
		Replace wire 73A.	false (regular display) = ok diode = 28v input

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DI NAME	DESCRIPTION	PROCEDURE TO ACTIVATE	FUNCTION
SRVBRKPSW	SERVICE BRAKE PRESSURE SWITCH	In control cabinet, jumper 28 volts from 712 to 44R to simulate service brake applied.	= true (inverrse display) = brake applied = 28v input
		Remove jumper.	false (regular display) = brake released = 0v input
FORIN	SELECTOR SWITCH FORWARD SIGNAL	Move selector switch to FORWARD position.	= true (inverse display) = FORWARD selected
REVIN	SELECTOR SWITCH REVERSE SIGNAL	Move selector switch to REVERSE position.	= true (inverse display) = REVERSE selected
DSTORE	DATA STORE SWITCH	Press data store switch.	= true (inverse display) = switch closed = 28v input
		Release switch.	false (regular display) = switch open = 0v input
BLOWP	BLOWER PRESSURE SWITCH	Remove 75A1 wire.	= true (inverse display) = ok pressure = 0v input
		Re-attach wire 75A1.	false (regular display) = no pressure = 28v input
PARKBRKSW	PARK BRAKE	Turn park brake switch to ON.	= true (inverse display) = apply brake request = 0v input
		Turn park brake switch to OFF.	false (regular display) = release brake request = 28v input
KEYSW	KEY SWITCH	Key switch On.	= true (inverse display)
		Key switch Off.	false (regular display)
CPSFB	CONTROL POWER-SWITCH	Control power switch On.	= true (inverse display)
		Control power switch Off.	false (regular display)
ENGSERV	ENGINE SERVICE SIGNAL	Jumper 419 to GND at the junction box.	= true (inverse display) = with jumper = 0v input Verify Engine Check light in cab Turns On.
		Remove jumper.	false (regular display) = w/o jumper = 28v input
	ENGINE SERVICE SIGNAL (MTU engine)	Jumper wire 419 to GND at junction box.	= true (inverse display) = with jumper = 0v input Verify Engine Check light in cab turns On.
		Remove jumper.	false (regular display) = w/o jumper = 28v input
ENGSDWN	ENGINE SHUT DOWN SIGNAL (DDEC engine)	Jumper 509 to GND at junction box.	= true (inverse display) = with jumper = 0v input Verify Engine Shut Down light in cab turns On.
		Remove jumper.	false (regular display) = w/o jumper = 28v input
	ENGINE SHUT DOWN SIGNAL (MTU engine)	Jumper wire 31MS to GND at junction box.	= true (inverse display) = with jumper = 0v input Verify that Engine Shut Down light in cab turns On.
		Remove jumper.	false (regular display) = w/o jumper = 28v input

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2.3 Digital Output Checks

- For each of the digital outputs listed in the following tables, perform the procedure as specified in steps 1 and 2, and verify the results on the **MANUAL DIGITAL OUTPUT TEST SCREEN** as noted in the following table. Be sure to restore any switch settings and wiring changes to their original condition before moving on to check the next digital output.

1. Set digital output driver On.
   a. Move cursor with the arrow keys to the output name (DO NAME) of the desired output.
   b. Press [ENTER] key to change status of selected output from off to on.
   c. The display status of the output name **DO NAME** on the **MANUAL DIGITAL OUTPUT TEST SCREEN** changes from off (regular display) to = on (inverse display) in a flashing mode.
   d. Output device will be energized, or take voltage reading to verify that output driver is turned on, as noted in the **OUTPUT DEVICE CHECKOUT** column.
   e. Status of related feedback input name **DI NAME** (if used) on the **MANUAL DIGITAL OUTPUT TEST SCREEN** changes from false (regular display) to = true (inverse display).
2. Set digital output driver Off.
   a. With cursor still on the same output name **DO NAME** press [ENTER] key again to change status of selected output from on to off.
   b. The display status of the output name **DO NAME** on the **MANUAL DIGITAL OUTPUT TEST SCREEN** changes from = on (inverse display) to off (regular display).
   c. Output device will be de-energized, or take voltage reading to verify that output driver is turned off as noted in the **OUTPUT DEVICE CHECKOUT** column.
   d. Status of related feedback input name **DI NAME** (if used) on the **MANUAL DIGITAL OUTPUT TEST SCREEN** changes from **= true** (inverse display) to **false** (regular display).
   e. Be sure to restore any metering or wiring changes to their original condition before moving on to check the next output.
3. After all digital outputs have been checked, move cursor to (select) “EXIT” on the menu and press [ENTER] key.
4. Repeat step 3. as required until returned to **GE STATEX III PTU MENU**.

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DO NAME	DESCRIPTION	OUTPUT DEVICE CHECKOUT		
		DEVICE STATE	PTU DISPLAY-DEVICE	PTU DISPLAY-FEEDBACK
***NOTE: P11, RP11, & RP22 are digital outputs (not physical devices) wired in parallel with outputs P1, RP1, & RP2 respectively. These outputs are only used if airless contactors are installed. If installed, test by activating both outputs (P1 and P11), (RP1 & RP11), (RP2 & RP22) at the same time and verifying the corresponding feedback signal.**				
P1	P1 CONTACTOR	P1 energized	P1 = on	P1FB = true
		P1 de-energized	P1 off	P1FB false
***P11**	P11 CONTACTOR OUTPUT	P11 energized	P11 = on	P1FB = true
		P11 de-energized	P11 off	P1FB false
P2 (GTA26 only)	P2 CONTACTOR	P2 energized	P2 = on	P2FB = true
		P2 de-energized	P2 off	P1FB false
GF	GF CONTACTOR	GF energized	GF = on	GFFB = true
		GF de-energized	GF off	GFFB false
GFR	GFR CONTACTOR	GFR energized	GFR = on	GFRFB = true
		GFR de-energized	GFR off	GFRFB false
MF	MF CONTACTOR	MF energized	MF = on	MFFB = true
		MF de-energized	MF off	MFFB false
RP1	RP1 CONTACTOR	RP1 energized	RP1 = on	RP1FB = true
		RP1 de-energized	RP1 off	RP1FB false
***RP11**	RP11 CONTACTOR OUTPUT	RP11 energized	RP11 = on	RP1FB = true
		RP11 de-energized	RP11 off	RP1FB false
RP2	RP2 CONTACTOR	RP2 energized	RP2 = on	RP2FB = true
		RP2 de-energized	RP2 off	RP FB false
***RP22**	RP22 CONTACTOR	RP22 energized	RP22 = on	RP2FB = true
		RP22 de-energized	RP22 off	RP2FB false
RP3	RP3 CONTACTOR	RP3 energized	RP3 = on	RP3FB = true
		RP3 de-energized	RP3 off	RP3FB false
RP4	RP4 CONTACTOR	RP4 energized	RP4 = on	RP4FB = true
		RP4 de-energized	RP4 off	RP4FB false
RP5	RP5 CONTACTOR	RP5 energized	RP5 = on	RP5FB = true
		RP5 de-energized	RP5 off	RP5FB false
RP6 (optional)	RP6 CONTACTOR	RP6 energized	RP6 = on	RP6FB = true
		RP6 de-energized	RP6 off	RP6FB false
RP7 (optional)	RP7 CONTACTOR	RP7 energized	RP7 = on	RP7FB = true
		RP7 de-energized	RP7 off	RP7FB false
RP8 (optional)	RP8 CONTACTOR	RP8 energized	RP8 = on	RP8FB = true
		RP8 de-energized	RP8 off	RP8FB false
RP9 (optional)	RP9 CONTACTOR	RP9 energized	RP9 = on	RP9FB = true
		RP9 de-energized	RP9 off	RP9FB false
FOR	FORWARD COIL ON REVERSER	FORWARD coil energized	FOR = on	FORFB = true
		FORWARD coil de-energized	FOR off	FORFB false
REV	REVERSE COIL ON REVERSER	REVERSE coil energized	REV = on	REVFB = true
		REVERSE coil de-energized	REV off	REVFB false
NOTE: After checking REV operation, silence backup horn by turning on output FOR momentarily to move reverser back to forward position.				

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DO NAME	DESCRIPTION	OUTPUT DEVICE CHECKOUT	
		DEVICE STATE	VERIFICATION
AFSE	ALTERNATOR FIELD STATIC EXCITER	Output AFSE = on	Measure 28v from AFSE terminal +25v (wire 711A) to GND.
		Output AFSE off	Measure 0v from AFSE terminal +25v (wire 711A) to GND.
MFSE	MOTOR FIELD STATIC EXCITER	Output MFSE = on	Measure 28v from MFSE terminal +25v (wire 711B) to GND.
		Output MFSE off	Measure 0v from MFSE terminal +25v (wire 711B) to GND.
ENGSRV_LT	ENGINE SERVICE LIGHT IN CAB	Do not check, output driver not used.	
ENGSDN_LT	ENGINE SHUTDOWN LIGHT IN CAB	Do not check, output driver not used.	
TS	THROTTLE SOLENOID (Non-Fuel Saver only)	Output TS = on (Relay energized)	Measure 0v from 76MM to 710.
		Output TS off (Relay de-energized)	Measure 28v from 76MM to 710.
LIS	LOW IDLE SOLENOID (Non-Fuel Saver only)	Output LIS = on (Relay energized)	Measure 0v from 76L to 710.
		Output LIS off (Relay de-energized)	Measure 28v from 76L to 710.
RETARD	RETARD DASH LIGHT	Output RETARD = on (RLR Relay energized)	Retard dash light on.
		Output RETARD off (RLR Relay de-energized)	Retard dash light off.
OVRSPD	OVERSPEED LIGHT	Output OVRSPD = on	Measure approx. 3 Ohms at 73V to 710.
		Output CPRL = on (Relay energized)	Measure infinite Ohms at 73V to 710.
CPRL	CONTROL POWER RELAY LATCH	Output CPRL = on (Relay energized)	CPRL light is on.
NOTE: Verify System Fault Light is not On, prior to checking next output.			
FDIODE_LT	FAILED DIODE LIGHT	Output FAILDIODE = on	Elect. System Fault Light on.
		Output FAILDIODE off	Elect. System Fault Light on.
SYSFAULT	SYSTEM FAULT LIGHT	Output SYSFAULT = on	Elect. System Fault Light on.
		Output SYSFAULT off	Elect. System Fault Light on.
GNDFAULT	GROUND FAULT LIGHT	Output GNDFAULT = on	Elect. System Fault Light on.
		Output GNDFAULT off	Elect. System Fault Light on.
BLOWFAULT	BLOWER FAULT LIGHT	Output BLOWFAULT = on	Motor Blower Fault Light on.
		Output BLOWFAULT off	Motor Blower Fault Light off.
PRKBRKOFF	PARK BRAKE SOLENOID	Output PRKBRKOFF = on (Park Brake Solenoid energized)	Measure 28v from 71 to 52CS. Park Brake is off.
		Output PRKBRKOFF off (Park Brake Solenoid de-energized)	Measure 0v from 71 to 52CS. Park Brake is on.
SPEEDEVNT	SPEED EVENT	Do not check, output driver not used.	
MOTOR TEMP	MOTOR OVERTEMP LIGHT (Optional)	Output MOTOR_TEMP = on	Motor Overtemp Light on.
		Output MOTOR_TEMP off	Motor Overtemp Light off.

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3.0 ANALOG INPUT SIGNALS TEST - FL275 CARD PANEL

The PTU will be used to test analog inputs to the FL275 panel analog I/O Card, to verify proper truck wiring, control panel wiring and component operation.

- Connect PTU at control cabinet as described previously.
- Turn PTU On and type "`gemenu3e`" (or "`gemenu`") at the DOS "C:>" prompt. Press [ENTER].

3.1 Setup Analog Input Monitor Screen on PTU

1. With control power On, select "PTU TALK TO TRUCK" on **GE OHV STATEX III MENU**. Press [ENTER] key.
2. At "Enter your name:" type your name. Press [ENTER] key.
3. At "Enter your password:" type your password. Press [ENTER] key.
4. The **GE STATEX III PTU MAIN MENU** should appear on the screen.
5. Move cursor to select "NORMAL OPERATION". Press [ENTER] key.
   a. A screen will appear that states: "Selection of NORMAL OPERATION gives truck control to the driver. Continue?"
   b. With the cursor next to "Yes", press [ENTER].
6. The **NORMAL OPERATION MENU** should appear on the screen.
7. Move cursor to select "MONITOR ANALOG INPUT CHANNELS". Press [ENTER] key.
8. The **MONITOR ANALOG INPUT CHANNELS** screen, Figure 3-10. should appear.

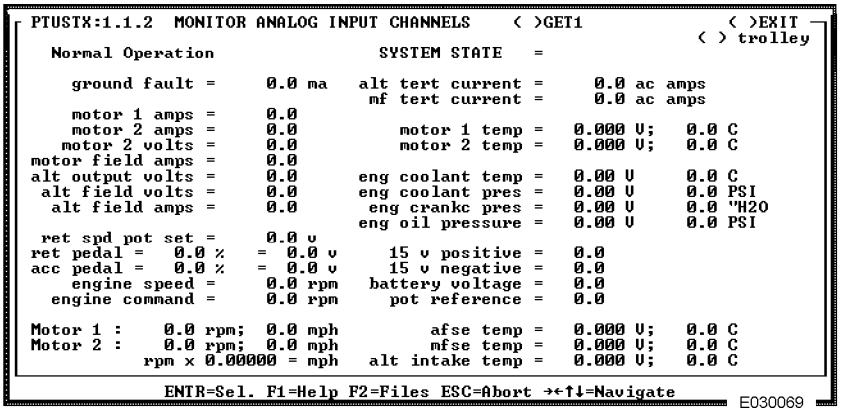


FIGURE 3-10. MONITOR ANALOG INPUT CHANNELS SCREEN

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3.2 Analog Input Checks

- The two digit diagnostic display panel should have a 00 event code to indicate that all previous event codes have been cleared. If not, press reset button to clear codes.
- For each of the analog inputs listed, perform the test procedure specified, and verify the results on the MONITOR ANALOG INPUT CHANNELS screen. Be sure to restore any switch settings and wiring changes to their original condition before moving on to check the next analog input. Reset as required to clear event data after each test.

1. GROUND FAULT CHECK: . . . . . ground fault = 0.0 ma

(Screen value ma = 48.1 x analog card input volts).

a. Jumper 24 vdc, circuit 71 to GFIP terminal “A” to simulate a “Low Ground” fault.

- ❑ Read approximately 135 ma on PTU screen.
- ❑ Event code 01 should appear on the 2 digit display.
- ❑ The Electrical System Fault light should turn on.

b. Remove jumper attached to GFIP terminal “A”.

- ❑ PTU screen should read approximately 0 ma.

c. Press Override switch and reset button on 2 digit display to clear event code to 00.

d. Jumper 24 vdc, circuit 71 to GFIP terminal “D” to simulate a “High Ground” fault.

- ❑ Read approximately 535 ma on PTU screen.
- ❑ Event code 02 should appear on the 2 digit display.
- ❑ The Electrical System Fault light should turn on.

e. Remove jumper attached to GFIP terminal “D”.

- ❑ PTU screen should read approximately 0 ma.

f. Press Override switch and reset button on 2 digit display to clear event code to 00.

g. To check GFIP, disconnect circuit 79H at terminal “A”. Attach an ohmmeter to terminals “A” and “E”.

- ❑ Read 100K ±1K ohms.

h. Reinstall wire 79H at terminal “A”.

i. To check GRR panel, remove protective grille and disconnect the following wires routed to the control cabinet: 7J1 from terminal “C” and wire 79H from terminal “B”.

j. Use an ohmmeter to measure the following values.

- ❑ Terminal “A” to “B”: 200 ±20 ohms.
- ❑ Terminal “B” to “C”: 800 ±80 ohms.
- ❑ Terminal “A” to “C”: 1000 ±100 ohms.

k. Reinstall 7J1 and 79H wires removed in step i. Install GRR protective grill.

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2. MOTOR 1 ARMATURE CURRENT - ISOA3 :. . . . . motor 1 amps = 0.0

(Screen value amps = 1000 x input voltage).

a. Test zero offset on isolation amplifier. Place a digital voltmeter between terminals “D” (+) and “F” (-) on ISOA3. With control power On and no other signal applied, meter should read:

- ❑ Less than 30 millivolts.

b. Remove wire from input terminal “B” on ISOA3. Connect test jumpers from “G” (+15 volt) to “A”, and from “C” to “F” on ISOA3 and measure the following:

- ❑ Read +1.00 ±.05 volts from “D” to “F”.
- ❑ PTU should read +1000 ±50 amps.

c. Remove jumper from terminal “G”.

d. Connect test jumper from “E” (-15 volt) to “A”.

- ❑ Read -1.00 ±.05 volts from “D” to “F”.
- ❑ PTU should read -1000 ±50 amps.

e. Remove jumpers and voltmeter. Reconnect wire to terminal “B”.

3. MOTOR 2 ARMATURE CURRENT - ISOA4 :. . . . . motor 2 amps = 0.0

a. Repeat same test procedure used on motor 1 amps, except substitute ISOA4 instead of ISOA3.

4. MOTOR FIELD CURRENT - ISOA5:. . . . . motor field amps = 0.0

(Screen value amps = 400 x input voltage).

a. Test zero offset on isolation amplifier ISOA5, using same procedure as on motor 1 amps.

b. Remove wire from input terminal “B” on ISOA5. Connect test jumpers from “G” (+15 volt) to “A”, and from “C” to “F” on ISOA5 and measure the following:

- ❑ Read +1.00 ±.05 volts from D to F.
- ❑ PTU should read +400 ±20 amps.

c. Remove jumper from terminal “G”.

d. Connect test jumpers from “E” (-15 volt) to “A”.

- ❑ Read -1.00 ±.05 volts from “D” to “F”.
- ❑ PTU should read -400 ±20 amps.

e. Remove jumpers and voltmeter. Reconnect wire to terminal “B”.

5. ALTERNATOR FIELD CURRENT - ISOA8 :. . . . . .alt field amps = 0.0

a. Repeat same test procedure used on motor field amps, except substitute ISOA8 instead of ISOA5.

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6. RETARD SPEED POT SETTING: . . . . . ret spd pot set = 0.0v

a. Close Retard Speed Control Switch in cab.

b. Vary Retard Speed Control adjustment from minimum to maximum.

- ❑ Read 0.0 volts at minimum to +19 ±0.50 volts at maximum on PTU screen for non-Fuel Saver truck.
- ❑ Read 0.0 volts at minimum to +10 ±0.50 volts at maximum on PTU screen for Fuel Saver truck.

RETARD PEDAL : . . . . . ret pedal = 0.0% = 0.0v

Note: Retard pedal , "%" value may vary with each truck. This value is entered into the truck configuration file when the "Fuel Saver " system is installed and is used to scale the pedal OFF signal when the pedal is released and maximum retard request when fully depressed.

Fuel Saver equipped trucks:

a. With retard pedal released:

- ❑ Read approximately 0.0 volts on PTU screen.

b. Depress retard pedal fully.

- ❑ Read approximately 10.0 volts on PTU screen.

Non-Fuel Saver trucks:

a. With retard pedal released:

- ❑ Read approximately 0.0 volts on PTU screen.

b. Depress retard pedal fully.

- ❑ Read approximately 15.5 volts on PTU screen.

8. ACCELERATOR PEDAL:. . . . . acc pedal = 0.0% = 0.0v

Note: Accelerator pedal , "%" value may vary with each truck. This value is entered into the truck configuration file when the "Fuel Saver " system is installed and is used to scale the pedal OFF signal when the pedal is released and maximum power request when fully depressed.

Fuel Saver equipped trucks:

a. With accelerator pedal released:

- ❑ Read approximately 0.0 volts on PTU screen.

b. Depress accelerator pedal fully.

- ❑ Read approximately 10.0 volts on PTU screen.

Non-Fuel Saver trucks:

Refer to "Throttle System Check and Adjustment".

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9. ALT. TERTIARY OVERCURRENT - ISOA6 : alt tert current = 0.0 ac amps

(Screen value AC amps = 275 x DC input voltage).

NOTE: Prior to testing, the PTU screen will display erroneous data.

a. Test zero offset on isolation amplifier. Place a digital voltmeter between terminals “D” (+) and “F” (-) on ISOA6. With control power On and no other signal applied, meter should read:

- ❑ Less than 30 millivolts.

b. Remove wire from input terminal “B” on ISOA6. Connect test jumpers from “G” (+15 volt) to “A”, and from “C” to “F” on ISOA6 and measure the following:

- ❑ Read +1.00 ±.05 volts from “D” to “F”.
- ❑ PTU should read +275 ±20 amps.

c. Remove jumpers and voltmeter. Reconnect wire to terminal “B”.

10. MOTOR TERTIARY OVERCURRENT - ISOA7: mf tert current = 0.0 ac amps

a. Repeat same test procedure used on alternator tertiary current, except substitute ISOA7 instead of ISOA6.

11. ALTERNATOR OUTPUT VOLTS - VMM1: . . . . . alt output volts = 0.0

(Screen value volts = 200 x analog input volts).

a. Verify that circuit 74C is disconnected at GFR.

b. Disconnect the wires from terminals “A” and “C” on VMM1.

c. Connect digital voltmeter between VMM1 output terminals “D” (+) and “F” (-). With no other signal applied:

- ❑ Meter should read less than ±.010 volts.

d. Jumper circuit 71 (battery +) to VMM1 input terminal “A”. Jumper circuit 710 (ground) to terminal “C”. Attach second digital voltmeter to VMM1 terminal “A” (+) and “C” (-) to measure actual voltage applied.

e. With control power On and battery voltage applied at terminals “A” and “C”, read the following at the output voltmeter attached to terminals “D” (+) and “F”(-):

- ❑ Output voltage = Input voltage ÷ 200 (±.025)
- ❑ PTU screen should read approximate input voltage.

Example:

If input voltage is 25.25 vdc, output should read .126 ±.025 vdc.
PTU display should read approximately 25 vdc.

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f. Reverse polarity of input. Jumper circuit 71 to terminal “C” and jumper circuit 710 to terminal “A” at VMM1.

❑ Verify negative value of output voltage measured in step e. and negative value on PTU screen.

g. Remove jumpers and voltmeters. Restore all disconnected wiring.

12. MOTOR M2 ARMATURE VOLTS - VMM2: . . . . . motor 2 volts = 0.0

a. Repeat same test procedure used on alt output volts, except substitute VMM2 instead of VMM1.

13. ALTERNATOR FIELD VOLTAGE - VDR3:. . . . . alt field volts = 0.0

(Screen value volts = 10.6 x input volts).

a. Disconnect wires from VDR3 terminal “E” and “D”.

b. Connect a 1.5 volt battery (i.e. flashlight battery) to wire removed from “E” (-) and to VDR3 terminal “D” (+).

c. Measure actual voltage of battery used in above step.

❑ PTU screen should read actual test battery voltage x 10.6

Example:

If test battery voltage measures 1.550 volts, PTU screen should read 16.43 volts.

d. Remove test battery. Screen should read 0 volts.

e. Reconnect wires removed in step a.

MOTOR 1 TEMPERATURE . . . . . motor 1 temp = 0.000 V; 0.0° C

NOTE: Motor Temperature monitoring system is optional.

a. Disconnect motor 1 temperature sensor wires 722C and 722A routed to wheel motor from terminal board in control cabinet.

b. Connect a 100 ohm resistor to terminal board in place of wires removed in previous step to simulate 0°C temperature signal into analog input card.

❑ Screen value on PTU should read 1.96 ±.04 volts and 0.0° C.

c. Replace 100 ohm resistor with a 181 ohm resistor. (210°C)

❑ Screen value on PTU should read 3.55 ±.07 volts and 210° C.

d. Remove resistor and replace sensor wires at terminal board.

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15. MOTOR 2 TEMPERATURE. . . . . motor 2 temp = 0.000 V; 0.0° C

a. Disconnect motor 2 temperature sensor wires 722F and 722H routed to wheel motor from terminal board in control cabinet.

b. Connect a 100 ohm resistor to terminal board in place of wires removed in previous step to simulate 0° C temperature signal into analog input card.

❑ Screen value on PTU should read 1.96 ±.04 volts and 0.0° C.

c. Replace 100 ohm resistor with a 181 ohm resistor. (210° C)

❑ Screen value on PTU should read 3.55 ±.07 volts and 210° C..

d. Remove resistor and replace sensor wires at terminal board.

NOTE: Sensors for functions 16 through 19 are not installed on all trucks. To verify installation, select the proper truck configuration file, then select "View OEM Options" from the ***TRUCK SETUP CONFIGURATION MINE MENU*** *screen.*

16. COOLANT TEMPERATURE . . . . . .eng coolant temp = 0.00 V; 0.0C

a. Connect a 1.5 volt battery to circuit 31CT (+) and circuit 0CT (-) at control cabinet terminal board.

❑ Screen value on PTU should read +1.5 volts; 0°C.

b. Remove battery from terminal board.

17. COOLANT PRESSURE. . . . . eng coolant pres = 0.00 V; 0.0 PSI

a. Connect a 1.5 volt battery to circuit 31ECP (+) and circuit 0ECP (-) at control cabinet terminal board.

❑ Screen value on PTU should read +1.5 volts; 25 psi.

b. Remove battery from terminal board.

18. CRANKCASE PRESSURE . . . . . .eng crankc pres = 0.00 V; 0.0 PSI

a. Connect a 1.5 volt battery to circuit 31CKP (+) and circuit 0CKP (-) at control cabinet terminal board.

❑ Screen value on PTU should read +1.5 volts; 8 psi.

b. Remove battery from terminal board.

19. OIL PRESSURE. . . . . .eng oil pressure = 0.00 V; 0.0 PSI

a. Connect a 1.5 volt battery to circuit 310P (+) and circuit 0OP (-) at control cabinet terminal board.

❑ Screen value on PTU should read +1.5 volts; 25 psi.

b. Remove battery from terminal board.

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20. +15 VOLT SUPPLY. . . . . .15 v positive = 0.0

- ❑ Screen should read +15.0 ±0.3 volts.

21. -15 VOLT SUPPLY . . . . . 15 v negative = 0.0

- ❑ Screen should read -15.0 ±0.3 volts.

22. BATTERY VOLTAGE . . . . . .battery voltage = 0.0

- ❑ Screen should be approximately +28.0 volts, dependent on battery condition.

23. POT REFERENCE . . . . . pot reference = 0.0

- ❑ Screen should be +19.0 ±0.5 volts for non-Fuel Saver truck.
- ❑ Screen should be +10 ±0.5 volts for Fuel Saver truck.

24. AFSE TEMPERATURE. . . . . afse temp = 0.000 v; 0.0 C

a. Disconnect AFSE temperature sensor wires at terminal board TB-1 located on the face of the AFSE; 72TA at terminal “D” and 0TA at “B”.

b. Connect a 100K ohm resistor accross wires removed in step a.

- ❑ Screen value on PTU should read approximately 9.0 volts and 25°C.

c. Remove resistor installed above and reconnect sensor wires at TB-1.

25. MFSE TEMPERATURE . . . . . .mfse temp = 0.000 v; 0.0 C

a. Disconnect MFSE temperature sensor wires at terminal board TB-1 located on the face of the MFSE; 72TM at terminal “F” and 0TM at “E”.

b. Connect a 100K ohm resistor across wires removed in step a.

- ❑ Screen value on PTU should read approximately 9.0 volts and 25°C.

c. Remove resistor installed above and reconnect sensor wires at TB-1.

26. ALTERNATOR INTAKE TEMPERATUREalt intake temp = 0.000 v; 0.0 C

a. Disconnect ambient air temperature sensor wires 72AM and 0AMB at terminal board located in electrical cabinet.

b. Connect a 100K ohm resistor across terminals where wires were removed in step a.

- ❑ Screen value on PTU should read approximately 9.0 volts and 25°C.

c. Remove resistor installed above and reconnect sensor wires.

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3.3 Frequency Input Checks

- For each of the frequency inputs listed below, perform the test procedure specified, and verify the results on the MONITOR ANALOG INPUT CHANNELS screen as noted. Be sure to restore any switch settings and wiring changes to their original condition before moving on to check the next frequency input.

1. ENGINE SPEED . . . . . .engine speed = 0.0 rpm

(Screen value rpm = 1.2 x input frequency)

a. Connect an oscillator to circuits 74X and 74Z at control cabinet terminal board. Increase oscillator frequency until PTU reads 1900 ±10 rpm.

Verify tachometer in the cab reads 1900 ±10 rpm.

b. If necessary, adjust tachometer calibration pot (located under plug on rear of tach).

c. Remove oscillator.

2. ENGINE COMMAND . . . . . engine command = 0.0 rpm

- Applicable to “Fuel Saver” equipped trucks only. The value displayed is the engine RPM command controlled by the FL275 panel based on various truck operating condition inputs. (Input cannot be tested.)

3. MOTOR 1 SPEED . . . . . .Motor 1: 0.0 rpm; 0.0 mph

(Screen value rpm = 1.0 x input frequency; 787, or 788 motors)

(Screen value rpm = 2.0 x input frequency; 772, 776 or 791 motors)

(Screen value mph = screen value rpm x conversion factor mph/rpm)

a. Connect an oscillator to circuits 77 and 77A at control cabinet terminal board.

b. Increase the oscillator frequency to obtain 3 MPH (5 KPH) value on the PTU screen.

❑ Verify the cab speedometer reads 3 MPH (5 KPH)

c. Increase oscillator to obtain 25 MPH (40 KPH) value on the PTU screen.

❑ Verify cab speedometer reads 25 ±2 MPH (40 ±3 KPH)

d. If necessary, adjust speedometer calibration pot (located under plug at rear of speedometer).

e. Remove oscillator.

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4. MOTOR 2 SPEED . . . . . Motor 2: 0.0 rpm; 0.0 mph

a. Connect oscillator to circuits 714 and 714A at control cabinet terminal board. Repeat same test procedure for Motor 2 as used for Motor 1.

5. CONVERSION FACTOR - RPM TO MPH. . . . . rpm x 0.00000 = mph

- Value displayed 0.00000 is conversion factor to convert from wheelmotor rpm to mph. Compare value displayed with value given in **MAXIMUM TRUCK SPEED CHART**. (Refer to “Miscellaneous Charts; Maximum Allowable Truck Speeds.”)

Return to Main Menu

1. This completes Analog and Frequency Input Checks.
2. Move cursor to select “EXIT” on the menu and press [ENTER] key.
3. Select “EXIT” as necessary until returned to GE STATEX III PTU MAIN MENU.
4. Move cursor to select “EXIT” on this menu and press [ENTER] key.
5. At “QUIT PTU?” menu screen prompt , press [Y] key (or any key except [N]) to exit back to the GE OHV STATEX III MENU.
6. Turn control power switch Off.
7. Turn key switch Off.

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4.0 SPEED EVENT CHECKS

Preparation & Setup

- Always disconnect 74C at GFR for static testings. Failure to do so may result in damage to battery boost SCR and/or dead batteries.
- If the truck is equipped with the Two Speed Overspeed, remove and insulate circuit wire 73LS going to the control cabinet junction box. There should be one circuit wire 73LS from the terminal block to the FL275 card panel.

⚠WARNING

If the 73LS circuit wire going to the control cabinet junction box hasn't been removed and insulated, damage may result to the Rear Suspension Pressure Switches.

- Wheelmotor Speed Sensors:a. Disconnect external 714 wire and external 77 wire at control cabinet terminal board.b. Jumper from 77 to 714 and jumper from 77A to 714A. c. Connect an oscillator to 714 and 714A.
- All checks are to be made with control power On and the selector switch in FORWARD.
- Obtain speed event setting information and extended range retarding pickup speeds from the truck configuration file and use the Retard State Logic screen as instructed below:

Setup PTU

1. With the **GE OHV STATEX III MENU** on the screen, select TRUCK SETUP (CFG).
2. At the **TRUCK SETUP CONFIGURATION MINE MENU** screen, select the proper truck configuration file.
3. From the **TRUCK SETUP CONFIGURATION MINE MENU** screen, select “6) Change/view Overpeeds.”
4. Record the values shown on the **OVERPEEDS ENTRY SCREEN**.
5. Exit back to the **TRUCK SETUP CONFIGURATION MINE MENU** and select “1) View truck configuration screen; data curves screen”.
6. Record the values for “EXT RANGE PICK_UPS” listed on the second screen that appears.
7. Exit back to the **GE OHV STATEX III MENU** and select “PTU TALK TO TRUCK”.
8. After logging on, select “NORMAL OPERATION” from the **GE STATEX III PTU MAIN MENU**.
9. From the **NORMAL OPERATION** menu, select “RETARD STATE LOGIC”. Information will be read from this screen for the following procedures.

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4.1 Single Speed Overspeed Truck - Overspeed Settings Check

1. While observing the **RETARD STATE LOGIC SCREEN**, increase the oscillator frequency from minimum until the retard contactors RP1 and RP2 pick up in overspeed.
2. Verify the **M1- SPD** and **M2 - SPD** mph readings agree with values recorded from the truck configuration file **OVERSPEEDS ENTRY SCREEN**.
3. Lower the oscillator frequency and verify that retard contactors RP1 and RP2 drop out at the specified dropout frequency as recorded from the **OVERSPEEDS ENTRY SCREEN**.

4.2 Two Speed Overspeed Truck (Empty Truck) - Overspeed Settings Check

1. Jumper 71 to 73LS in control cabinet to simulate an empty truck.
2. While observing the **RETARD STATE LOGIC SCREEN**, increase the oscillator frequency from minimum until the retard contactors RP1 and RP2 pick up in overspeed.
3. Verify the **M1- SPD** and **M2 - SPD** mph readings agree with values recorded from the truck configuration file **OVERSPEEDS ENTRY SCREEN**.
4. Lower the oscillator frequency and verify that retard contactors RP1 and RP2 drop out at the specified dropout frequency as recorded from the **OVERSPEEDS ENTRY SCREEN**.

4.3 Two Speed Overspeed Truck (Loaded Truck) - Overspeed Settings Check

1. Remove jumper 71 to 73LS to simulate a Loaded Truck.
2. While observing the **RETARD STATE LOGIC SCREEN**, increase the oscillator frequency from minimum until the retard contactors RP1 and RP2 pick up in overspeed.
3. Verify the **M1- SPD** and **M2 - SPD** mph readings agree with values recorded from the truck configuration file **OVERSPEEDS ENTRY SCREEN**.
4. Lower the oscillator frequency and verify that retard contactors RP1 and RP2 drop out at the specified dropout frequency as recorded from the **OVERSPEEDS ENTRY SCREEN**.

4.4 Other Speed Events Checks

NOTE: 3 Step or 7 Step Extended Range Retarding Contactors (RP3-RP5, and RP6-RP9 if used) should all be picked up at low frequencies, then drop out one by one when frequency is increased to their specified DROPOUT point. They should then pick up one by one as frequency is decreased to their specified PICKUP point.

1. With the selector switch in FORWARD position, depress retard pedal.
2. While observing the **RETARD STATE LOGIC SCREEN**, verify the **M1- SPD** and **M2 - SPD** mph readings agree with values recorded from the T**RUCK CONFIGURATIONS DATA CURVES SCREEN.**
3. Turn the oscillator frequency to minimum. Verify that the RP contactors drop out in the sequence listed, as the oscillator frequency is slowly increased.
   a. 3 Step Extended Range Retarding - RP5, RP4, and RP3 contactors.
   b. 7 Step Extended Range Retarding - RP9, RP8, RP7, RP6, RP5, RP4, and RP3 contactors.

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4. Turn the oscillator frequency to maximum. Verify that the RP contactors pick up in the sequence listed, as the oscillator frequency is slowly decreased.
   a. 3 Step Extended Range Retarding - RP3, RP4, and RP5 contactors.
   b. 7 Step Extended Range Retarding - RP3, RP4, RP5, RP6, RP7, RP8, and RP9 contactors.
5. Release retard pedal and place selector switch in NEUTRAL position.
6. Disconnect oscillator from 714, 714A wires.
7. Remove jumpers from 77, 77A, 714, and 714A.
8. Reconnect external 77 and 714 wires.
9. Reconnect circuit 73LS if truck has two speed overpseed.

Return to Main Menu

1. This completes the speed event checks. Be certain all wiring has been restored to original condition.
2. Leave the **PTU RETARD STATE LOGIC SCREEN** screen by moving cursor to select “Exit” on the menu and press [ENTER] key.
3. Select “EXIT” as necessary until returned to **GE STATEX III PTU MAIN MENU**.
4. Move cursor to select “Exit” on the menu and press [ENTER] key.
5. At “QUIT PTU?” menu screen prompt , press [Y] key (or any key except [N]) to exit back to the **GE OHV STATEX III MENU**.
6. Turn control power Off.

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5.0 RETARD SPEED CONTROL SYSTEM CHECK

Preparation and Setup

- Disconnect external 77 and 714 wires (routed to the wheel motors) from control cabinet terminal board.
- Jumper 77 to 714, and jumper 77A to 714A.
- Connect an oscillator to circuits 77 and 77A.
- If truck is equipped with Two Speed Overspeed, remove and insulate wire 73LS routed to the rear suspension pressure switches. Install a jumper between circuit 71 and 73LS on the control cabinet terminal block to simulate an Empty Truck.

Setup PTU

1. With control power On, select “PTU TALK TO TRUCK” on **GE OHV STATEX III PTU MAIN MENU**. Press [ENTER] key.
2. At “Enter your name:” type your name. Press [ENTER] key.
3. At “Enter your password:” type your password. Press [ENTER] key.
4. The **GE STATEX III PTU MAIN MENU** should appear on the screen.
5. Move cursor to select “NORMAL OPERATION”. Press [ENTER] key.
   a. A screen will appear that states: “Selection of NORMAL OPERATION gives truck control to the driver. Continue?”
   b. With the cursor next to “Yes”, press [ENTER].
6. The **NORMAL OPERATION MENU** should appear on the screen.
7. Move cursor to select “RETARD STATE LOGIC”. Press [ENTER] key.
8. The **RETARD STATE LOGIC SCREEN** screen should appear. Information on this screen will be observed for the following tests.

5.1 Overspeed Pickup and Dropout Check

1. With control power On, place selector switch to FORWARD position, and place retard speed control switch to Off position.
2. Increase oscillator frequency until Overspeed Pickup point is reached (RP1 and RP2 retard contactors pick up and **PTU SYSTEM STATE** = changes to **RETARD**). Record MPH observed on digital speedometer or PTU screen. Verify that this reading agrees with empty overspeed detect mph setting recorded during Speed Event Checks from the **OVERPSPEEDS ENTRY SCREEN.**
3. Lower the frequency until the retard contactors drop out. Verify this point is approximately 3 MPH below the Overspeed Pickup point and agrees with **empty overspeed dropout mph setting**. Turn off oscillator, ***without disturbing frequency setting***.

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5.2 Retard Pot Maximum Setting Check

1. Set the retard speed control potentiometer (in cab) to maximum and turn the retard speed control switch to the On position. Note the retard speed control light turns On.
2. Turn on oscillator, and the retard contactors should pick up. If not, increase frequency slightly until the contactors pick up. Verify that the frequency and MPH observed agree with the empty maximum retard pot mph speed setting. Turn off oscillator without disturbing frequency setting and the retard contactors should drop out.

5.3 Retard Pot Minimum Setting Check

1. Set the retard speed control potentiometer to minimum and turn on oscillator. Retard contactors should pick up.
2. Decrease oscillator frequency slowly until the retard contactors drop out. Verify this occurs at approximately 3 MPH. Turn off oscillator.
3. Turn on oscillator and increase frequency until retard contactors pick up. This should occur at a speed just slightly above the drop out frequency noted in step 2. Turn off oscillator. Contactors should drop out.

5.4 Accelerator Pedal Override of Retard Speed Control

1. Set the retard speed control switch to Off position and the retard speed control potentiometer to mid range.
2. Place selector switch in FORWARD and depress throttle pedal. The propulsion contactors should engage. Release throttle pedal.
3. Turn the retard speed control switch to On position. Turn oscillator On and increase frequency until retard contactors pick up.
4. Depress throttle pedal. The throttle pedal should override; the retard contactors should drop out and the propulsion contactors should energize.
5. Release throttle pedal, place selector switch in NEUTRAL and turn retard speed control off.
6. Turn off and disconnect oscillator.

Return to Main Menu

1. This completes the checkout of the retard speed control system.
2. Leave the **PTU RETARD STATE LOGIC SCREEN** screen by moving cursor to select “EXIT” on the menu and press [ENTER] key.
3. Select “EXIT” as necessary until returned to **GE STATEX III PTU MAIN MENU**.
4. Move cursor to select “Exit” on the menu and press [ENTER] key.
5. At “QUIT PTU?” menu screen prompt , press [Y] key (or any key except [N]) to exit back to the **GE OHV STATEX III MENU**.

NOTE: it is always necessary to exit back to this menu before turning off control power to avoid lock up of PTU computer screen.

6. Turn control power Off, remove jumpers and restore all wiring back to the original condition.

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6.0 LOAD TEST USING TRUCK RETARD GRIDS

NOTE: DO NOT RUN OPEN CIRCUIT TEST.

NOTE: The single ended grid used on the 772 wheel drive system will be operating at 100% capacity when loaded with a 1200 HP engine. ***The grid should be monitored closely on extended horsepower tests to avoid overheating.***

Setup and Preparation

Engines equipped with Rockford Clutch only:

- Disconnect the fan clutch solenoid to fully engage fan.

All trucks:

- Connect swing shunts to load test position:

  a. Top shunt swings to upper position, bottom shunt swings to bottom position.

  b. For 830E or 685E trucks, left shunt swings to left position, right shunt swings to right position.

⚠WARNING

If load test must be run any longer than to just read horsepower, the motor field leads must be disconnected to prevent overheating of the motor fields. Follow disable procedure below:

To disable the motor field:

- Disconnect circuit 716E at “-1” terminal on the GFM on the MFSE.
- Disconnect circuit 716F at “+2” terminal on the GFM on the MFSE.

PTU Setup

- Select the **AUTOMATIC LOAD BOX TEST** screen as follows:

  a. From the **GEOHV STATEX III MENU**, select “PTU TALK TO TRUCK”, press [ENTER].

  b. At **PTU LOGON** screen, enter your name and assigned password. Press [ENTER].

  c. When the **GE STATEX III PTU MAIN MENU** appears, move the cursor to “NORMAL OPERATION” and press [ENTER].

  d. A screen appears with the message: “Selection of NORMAL OPERATION gives truck control to the driver - Continue?”. With the cursor at the “Yes” option, press [ENTER].

  e. The **NORMAL OPERATION MENU** will appear. Select “AUTOMATIC LOAD BOX TEST” and press [ENTER].

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6.1 Load Test

1. Monitor horsepower output using the PTU **AUTOMATIC LOAD BOX TEST SCREEN**.
2. Put selector switch in FORWARD and depress throttle to load engine.
3. With the engine at full RPM, record the following from the PTU screen:

NOTE: All information on the screen can be conveniently recorded by selecting "GET1" with the cursor, pressing [ENTER], and then pressing [F2] to save the information to a file.

- ❑ Engine RPM
- ❑ Alternator volts
- ❑ Motor 1 amps
- ❑ Load box efficiency ("LB EFFICIENCY")
- ❑ Net HP to alternator

4. After recording the above information, release the throttle pedal.
5. Compare the "NET HP TO ALTERNATOR" value recorded from the PTU screen to the calculated Net HP to the alternator using the formula below:

   NET HP TO ALT = (VOLTS x AMPS) ÷ (746 x LB Efficiency)

6. Verify the ENGINE RPM is approximately equal to the ENGINE LOAD RPM shown at the bottom of the screen.
7. Verify the calculated NET HP TO ALT value is approximately equal to the measured NET HP TO ALTERNATOR value read from the PTU screen within ±5%.
8. After completing test, restore all circuits to normal and reconnect fan clutch where applicable.

NOTE: Net horsepower may be affected by many variables such as ambient temperature, altitude, fuel temperature, parasitic losses, tertiary losses, engine condition etc. Parasitic horsepower loss values that have been corrected for temperature and altitude may be obtained from the Komatsu Distributor.

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7.0 MOTOR FIELD CURRENT CHECK IN RETARDING

NOTE: If wheelmotors were not installed on truck during factory check-out, this test must be performed during truck check-out at mine site.

Setup PTU

- Select the **AUTOMATIC LOAD BOX TEST** screen as follows:

  a. From the **GEOHV STATEX III MENU**, select “PTU TALK TO TRUCK” and press [ENTER].

  b. At **PTU LOGON** screen, enter your name and assigned password. Press [ENTER].

  c. When the **GE STATEX III PTU MAIN MENU** appears, move the cursor to “NORMAL OPERATION” and press [ENTER].

  d. A screen appears with the message: “Selection of NORMAL OPERATION gives truck control to the driver - Continue?”. With the cursor at the “Yes” option, press [ENTER].

  e. The **NORMAL OPERATION MENU** will appear. Select “AUTOMATIC LOAD BOX TEST” and press [ENTER].

7.1 Retard Check

1. Start engine, put selector switch in FORWARD and depress retard pedal for full retarding.
2. The following approximate values should be read from the **AUTOMATIC LOAD BOX TEST SCREEN:**

AUTOMATIC LOAD BOX TEST SCREEN (PTU Screen Display)	WHEELMOTOR		
	772	776, 791 788, 787	788 (20 Element Grid)
ENGINE RPM (non-Fuel Saver) =	1675	1675	1675
ENGINE RPM (Fuel Saver) =	1250	1250	1250
ALTERNATOR VOLTS =	1320	1320	1320
MOTOR FIELD AMPS =	275	375	450

3. Release retard pedal. Put selector switch in NEUTRAL.
4. Exit from **AUTOMATIC LOAD BOX TEST SCREEN** back to the N**ORMAL OPERATION MENU**. Select “MONITOR ANALOG INPUT CHANNELS”.
5. Put selector switch in FORWARD and depress retard pedal for full retarding.
6. The following values should be read from the **MONITOR ANALOG INPUT CHANNELS** screen:

MONITOR ANALOG INPUT CHANNELS (PTU Screen Display)	WHEELMOTOR		
	772	776, 791 788, 787	788 (20 Element Grid)
ALTERNATOR TERTIARY CURRENT =	140	140	140
MF TERTIARY CURRENT =	333	333	333

7. Release the retard pedal and place the selector switch in NEUTRAL.
8. Exit back to the **GEOHV STATEX III MENU** screen.
9. The engine may now be shutdown.

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8.0 MISCELLANEOUS COMPONENT TEST AND ADJUSTMENT

8.1 Brake System Interlocks Check

⚠WARNING

Block truck wheels securely to prevent rolling when the brakes are released.

NOTE: On brake and steering checks, the engine is to be started and run until proper hydraulic and air pressures are achieved and all instrument panel warning lights are turned Off.

Preparation

- After normal pressures are reached, the engine is then shut down and the key switch is left in the RUN (On) position.
- On 830E trucks the key switch must first be turned Off to shut down the engine, and then returned to the RUN (On) position to maintain hydraulic pressures.

⚠WARNING

The hydraulic pressures will bleed off if the key switch is not left in the RUN (On) position.

1. With air tanks fully charged to 120 PSI or more for trucks with air brakes, or hydraulic pressure at normal operating pressure or more for trucks with hydraulic brakes, and all brakes released, place selector switch in FORWARD and depress the throttle pedal.
   - ❑ The propulsion contactors should energize.
   - ❑ It should be possible to remove jumper between 73R and 73P (if installed) and still get the propulsion contactors to energize.
2. With brake lock switch On, depress the throttle pedal.
   - ❑ Propulsion contactors should not energize.
3. Turn brake lock switch Off, turn emergency brake switch On and depress the throttle pedal.
   - ❑ Propulsion contactors should not energize. (Some trucks do not have emergency brake switch.)
4. Turn emergency brake switch Off, turn operational parking brake switch On and depress the throttle pedal.
   - ❑ Propulsion contactors should not energize. Park brake light on instrument panel should come On.
5. Turn park brake switch Off.
6. With selector switch in REVERSE, depress the throttle pedal.
   - ❑ Propulsion contactors should energize.
7. Depress the service brake pedal.
   - ❑ Propulsion contactors should drop out.
   - ❑ Service brake light on instrument panel should come On.
8. Operate override switch on instrument panel or on selector switch console.
   - ❑ Propulsion contactors should pull in and stay pulled in as long as override switch is held manually.

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8.2 Blower Loss Pressure Switch Adjustment

NOTE: If wheelmotors were not installed on truck during factory check-out, this test must be performed during truck check-out at mine site. Be certain the rear axle box door is closed and the rear wheel covers are installed.

1. Setup PTU to read the **MONITOR REAL TIME DATA SCREEN** to monitor the BLOWP digital input signal. This signal will be displayed in regular display (false) when the engine is off.
2. Start engine with selector switch in NEUTRAL. The BLOWP signal should be Off (false). Slowly increase engine speed to 800 to 1000 rpm.
   - ❑ Verify the BLOWP signal changes from false to =true (inverse display) as engine speed reaches 800 to 1000 rpm and remains =true at higher rpm.
3. If the switch does not operate in the above rpm range, shut down engine and readjust the blower pressure switch.
4. After adjustment, repeat the above steps until switching occurs at the proper rpm.

8.3 SYNC Transformer Checkout

NOTE: If sync transformer output voltage feeding motor or alternator sync inputs at FB102/140 analog I/O card is suspect, perform the following check:

1. Remove power and check that sync transformers ST1 and ST2 are properly connected.
2. Disconnect leads 716C, 716D, 716H, and 716J at sync transformers and read approximately 11 ohms across each transformer secondary windings.
3. Disconnect leads 74E, 71J, 75X, and 71K at transformers and read approximately 560 ohms across each transformer primary.
4. Reconnect all leads that were disconnected.

8.4 Power Contactor Position Sensor Adjustment

1. P1 and P2 Contactors:
   a. With coil de-energized, adjust screw on position sensor to just close N.O. circuit, then turn screw an additional 2 1/4 turns CW.
2. All other Power Contactors:
   a. With coil de-energized, place a 0.081 (#46 drill bit) shim between main tips and then close tips manually. (**DO NOT ENERGIZE COIL**). The normally open position sensor contacts should read open with an ohmmeter.
   b. Place a 0.041 (#59 drill bit) shim between the main tips and then close tips manually. The position sensor contacts should now read closed.

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8.5 Battery Boost Adjustment

1. Turn On key switch and control power. Start engine and place selector switch in NEUTRAL.
2. Setup the PTU to read values on the AUTOMATIC LOAD BOX TEST SCREEN.
3. Connect voltmeter to R1 battery boost resistor, 74C (+) and 74AA (-).
4. Depress the override switch to clear any faults. If necessary, clear event codes on 2 digit display.
5. Place the selector switch in FORWARD. Slowly depress accelerator.
   - ❑ Observe +15 to +20 volts at R1 as engine rpm increases from low idle speed.
   - ❑ Verify R1 voltage drops to 0.0 volts as the engine begins to load (approximately 800 to 1000 rpm). Adjust Pot P1 on AFSE panel if necessary
   - ❑ Verify positive (+) values for MOTOR 1 & 2 AMPS, MOTOR FIELD AMPS, and ALTERNATOR VOLTS on PTU screen.
6. Seal pot adjustment screw when completed.
7. Place selector in NEUTRAL and shut down engine. Remove voltmeter.
8. Exit back to the **GEOHV STATEX III MENU** screen.

8.6 Isolation amplifier & voltage module test.

NOTE: If there is a discrepancy with the card test procedure results, consult the appropriate GE Publication.

The system utilizes two types of Isolation Amplifiers (Iso-Amps). Two are used for voltage measurement (VMM1 and VMM2). The other six are used for current measurement (ISOA-3, ISOA-4, ISOA-5, ISOA-6, ISOA-7, and ISOA-8).

8.6.1 Voltage Measuring Module Test (VMM1 and VMM2)

NOTE: There are two recommended test procedures for testing the 17FM458 Voltage Measuring Module. One test requires the use of a high voltage power supply and can be found in the 17FM458 Instruction Book and all appropriate Vehicle Test Manuals. The alternate test method is detailed below.

1. Disconnect 74C at GFR relay.
2. Disconnect the wires from terminals “A” and “C”.
3. Turn On control voltage (B+).
   - ❑ Verify +15V on terminal “G” and -15V on terminal “E.”
   - ❑ Measure and record B+ voltage on wire 71.
4. Connect a voltmeter from terminals “D” (+) to “F” (-).
5. Jumper terminals “C” to “F” and terminals “A” to “F”.
   - ❑ Verify 0.00 ±.02V on the voltmeter.
6. Remove jumper from terminals “A” to “F”.
7. Jumper terminal “A” to B+.
   - ❑ Verify voltmeter reads (B+) ÷ 200, ±2%.

Example: If B+ = 25v, the voltmeter should read: 25÷ 200 = 0.125 ±0.0025 volts.

8. Turn off control power, disconnect voltmeter and jumpers and reconnect all wiring to the panel.

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8.6.2 ISOA3, ISOA4, ISOA5, ISOA6, ISOA-7, and ISOA-8 Test.

1. Connect a voltmeter between terminal “D” (+) and terminal “F” (-) of the Iso-Amp to be tested.
2. Turn the control power On.
   - ❑ Verify the voltage at “D” is less than 0.030 volts.
3. Turn the control power switch “Off”. Disconnect the terminal “B” input for each Iso-Amp:

- 75A for ISOA3
- 75C for ISOA4
- 717S for ISOA5
- 72T for ISOA6
- 72W for ISOA7
- 73Y for ISOA8

4. Connect a jumper wire from terminal “C” to terminal “F” and another from terminal “A” to terminal “G”.
5. Turn the control power switch On.
   - ❑ Verify the voltage at terminal “D” is 1.00 ±0.05 volt.
6. Turn the control power switch Off. Remove the jumper wires and meter.
7. Reconnect 75A, 75C, 717S , 72T, 72W, and 73Y wires disconnected at ISOA3, ISOA4, ISOA5, ISOA6, ISOA7, and ISOA8.
8. Reconnect 74C at GFR.

8.7 Motor Rotation Test

NOTE: If wheelmotors were not installed on truck during factory check-out, this test must be performed during truck check-out at mine site.

If rear wheels are raised off ground:

1. Start the engine and place the selector switch in FORWARD.
2. Depress the accelerator pedal just far enough to enter propel state and the wheelmotors begin to rotate.
   - ❑ Verify both wheelmotors turn forward.

If rear wheels and tires are installed and resting on the ground:

- Check each wheel motor individually with the following cable hookup:

1. Place a jumper across the left wheelmotor armature (from cable 7GA1 (7G10 on the 830E) to 7J1) to check the right wheelmotor rotation.
2. Depress the accelerator pedal just far enough to enter propel state and the wheels begin to rotate.
   - ❑ Verify the right wheelmotor is turning forward.
3. Place a jumper across the right wheelmotor armature (from cable 7J1 to 7J2) to check the left wheelmotor rotation.
4. Depress the accelerator pedal just far enough to enter propel state and the wheels begin to rotate.
   - ❑ Verify the left wheelmotor is turning forward.
5. Shut down the truck and remove the jumper cables.

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8.8 Ground Fault Checks

If a ground fault occurs during operation, the Electrical System Fault light will turn On and the amount of leakage to ground will be displayed on the **MONITOR ANALOG INPUT CHANNELS** screen of the PTU. To isolate a ground fault problem, the following procedures should be followed:

1. Visually inspect the truck for obvious causes of the fault:
   a. Remove the rear wheel covers and inspect wheel motor armature commutators for evidence of flashover. Inspect brushes for length and damage. Inspect field coils for evidence of moisture, oil or other contaminants which may accumulate in the armature cavity. If flashover is severe or field coils are damaged by contaminants, the wheel motor should be removed for repair. If moisture is present, it may be possible to dry the wheel motor without removal.
   b. Remove inspection covers on main alternator to inspect slip rings, brushes and check for moisture or other contamination.
   c. Inspect cables for damaged insulation.
   d. Inspect exposed connections for possible short circuit to nearby metallic objects.
   e. Inspect retarding grids for damage and dirt accumulation.
2. If no physical evidence of the ground fault can be found during the above inspection, refer to the appropriate GE *"Vehicle Test Instructions for OHV Statex III Systems"* publication for procedures required to perform a megger test on the power circuit, alternator field and control. This publication provides specific procedures to be followed to prevent damage to system components and additional information to help isolate the ground fault.

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9.0 OPTIONAL PAYLOAD METER (PLM II) CHECK-OUT PROCEDURE

9.1 Check The Deck Mounted Lights

Turn the payload meter system on by switching the truck key switch to the On position. The payload meter automatically runs a 10 second self test. During the self test the deck mounted lights are On. If they are not all lit, check connections, wiring and bulbs. After successful completion of the self test, the time of day or “O” will be displayed depending on whether the brake lock switch is Off or On respectively.

9.2 Check Pressure Sensors

Turn the payload meter On. Allow the payload meter to run through its self test. Disconnect one pressure sensor at the suspension cylinder. An error code (refer to table) will be displayed on the payload meter after five seconds. Check the error code and re-connect the pressure sensor. Clear the error by pushing the “Cal” button on the payload meter. Complete checking all four pressure sensors with the same procedure.

PRESSURE SENSOR LOCATION	ERROR CODE
Right Rear	E-01
Left Rear	E-02
Right Front	E-03
Left Front	E-04
NOTE: In some earlier units on 685E, 630E, 510E, 445E model trucks the rear component harness has 39FA & 39FD reversed. To correct this reverse the circuits of the rear component harness at terminal board TB5C in the 24 volt junction box. Be sure to relabel circuits. Reference the payload meter kit installation drawing of the particular model truck.	

9.3 Check Operation of Data Storage Trigger Module

Drive to a loading area, stop the truck, switch the brake lock On and put a load in the body of the truck. Do not exceed the load limit. When finished loading, the payload meter display should indicate the tons of material loaded into the truck. Switch the brake lock Off. The display should change to O for one second then change to the time of day. Switch the brake lock On. The display should change back to the tons loaded without indicating O for one second.

9.4 Zero The Angle Sensor

Park the loaded truck on a 0% grade. Refer to the Options section of this service manual for operation of the payload meter system diagnostics. Put the payload meter into the check mode and call up the slope on the display. Loosen the three angle sensor mounting nuts and rotate the angle sensor until 0.0 is indicated on the display. Then re-tighten the mounting nuts.

9.5 Check Body Up Switch Function

Drive the loaded truck to the unloading area. Dump the load. The payload meter display should indicate 0 when the body is off the pads.

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10.0 MISCELLANEOUS CHARTS

10.1 Wheel Motor Gear Ratios

WHEEL GEAR RATIO CHART		
GE WHEELMOTOR MODEL NO.	**GEAR RATIO (xx.xxx : 1)**	**TIRE SIZE**
5GE772YS3, YS4	28.8	30 X 51
5GE776HS8B	2.88	30 X 51
5GE776KS5B, KS7B	23.0	36 X 51
5GE776KS6B, KS8B, KS10B	28.8	36 X 51
5GE776HS2C	23.0	30 X 51
5GE776HS9B, HS10	28.8	30 X 51
5GE791AS3B, AS5B	23.0	33 X 51
5GE791AS4B, AS6B	28.8	33 X 51
5GE788DS2	26.075	37 X 57
5GE788ES1,HS2,HS4	26.1	36 X 51
5GE788ES2,FS2,FS4	26.1	37 X 57
5GE788FS1,FS3	21.7	37 X 57
5GE788HS1,HS3	21.7	36 X 51
5GE788HS8	26.825	36 X 51
5GE788HS5	22.354	36 X 51
5GE788HS6	26.825	36 X 51
5GE788FS5, FS7	26.825	37 X 57
5GE788FS6	22.354	37 X 57
5GE787FS5, FS10	36.4	40 X 57
5GE787ES1,2,3	32.4	40 X 57
5GE787FS1,FS3	31.875	40 X 57
5GE787FS2,FS4, FS8	26.625	40 X 57
5GE787FS7	31.875	40 X 57
5GE787FS6, FS9	28.125	40 X 57

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10.2 Maximum Allowable Truck Speeds

MAX TRUCK MPH = (MAX. WHEEL RPM x ROLLING RADIUS) ÷ (GEAR RATIO x 168)

RPM/MPH CONVERSION FACTOR = MAX. WHEEL RPM ÷ MAX. TRUCK SPEED

MPH/RPM CONVERSION FACTOR = MAX. TRUCK SPEED ÷ MAX. WHEEL RPM

MAXIMUM TRUCK SPEED CHART FOR GIVEN WHEELMOTOR

WHEEL MOTOR	GEAR RATIO XX.X:1	TIRE SIZE	ROLLING RADIUS	MAX. WHEEL RPM	MAX. TRUCK MPH	CONV. FACTOR RPM/MPH	CONV. FACTOR MPH/RPM
772	28.8	30 x 51	55.1	2750	31.32	87.81	0.01139
776	28.8	30 x 51	55.1	2750	31.32	87.81	0.01139
776	23.0	36 x 51	61.1	2750	43.48	63.24	0.01581
776	28.8	36 x 51	61.1	2750	34.73	79.19	0.01263
791	23.0	33 x 51	57.0	2750	40.57	67.79	0.01475
791	28.8	33 x 51	57.0	2750	32.40	84.88	0.01178
788	26.1	36 x 51	61.1	2320	32.33	71.76	0.01394
788	26.1	37 x 57	65.4	2320	34.60	67.05	0.01491
788	21.7	37 x 57	65.4	2320	41.62	55.74	0.01794
788	21.7	36 x 51	61.1	2320	38.88	59.67	0.01676
788	26.825	36 x 51	61.1	2320	31.48	73.69	0.01357
788	26.825	37 x 57	65.4	2320	33.67	68.92	0.01451
788	22.354	36 x 51	61.1	2320	37.75	61.45	0.01627
788	22.354	37 x 57	65.4	2320	40.40	57.42	0.01741
787	28.125	40 x 57	68.4	2320	33.58	69.06	0.01448
787	36.4	40 x 57	68.4	2320	25.95	89.40	0.01119
787	32.4	40 x 57	68.4	2320	29.15	79.58	0.01256
787	31.9	40 x 57	68.4	2320	29.61	78.35	0.01276
787	26.6	40 x 57	68.4	2320	35.51	65.33	0.01531

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10.3 Engine Options

CUMMINS ENGINE OPTION CHART				
ENGINE MODEL	**RATED ENGINE RPM**	**TOP NO LOAD RPM**	***RETARDING RPM (No Load)**	***LOW IDLE RPM**
KTA-38	1900	2100 ±75	1675 ±10	750 ±25
KTTA-50-C	1900	2100 ±75	1675 ±10	750 ±25
KTTA-50-C	2000	2200 ±75	1675 ±10	750 ±25
KTTS-50-C	2100	2300 ±75	1675 ±10	750 ±25
K2000E	1900	2100 ±75	1675 ±10	750 ±25
QSK60	1900	2150 ±75	1675 ±10	750 ±25

DETROIT DIESEL ENGINE OPTION CHART				
ENGINE MODEL	**RATED ENGINE RPM**	**TOP NO LOAD RPM**	***RETARDING RPM (No Load)**	***LOW IDLE RPM**
12V149TI (Mechanical Governor)	1900	2040 ±10	1675 ±10	750 ±25
12V149TI (Hydraulic Governor)	1900	2040 ±20	1675 ±10	750 ±25
12V149TI (DDEC II)	1900	1910 ±5	1675 ±25	750 ±25
16V149TI (Mechanical Governor)	1900	2040 ±10	1675 ±10	750 ±25
16V149TI (Hydraulic Governor)	1900	2040 ±20	1675 ±10	750 ±25
16V149TI (DDEC III)	1900	1910 ±5	1675 ±25	750 ±25
12V4000 (DDEC IV)	1900	1920 ±5	See *Notes	600 ±25
16V4000 (DDEC IV)	1900	1920 ±5		600 ±25

MTU ENGINE OPTION CHART				
ENGINE MODEL	**RATED ENGINE RPM**	**TOP NO LOAD RPM**	***RETARDING RPM (No Load)**	***LOW IDLE RPM**
MTU 16V396TE44	1900		1675 ±10	750 ±25

** NOTES: Trucks equipped with "Fuel Saver" system:*
***Low Idle RPM** = 650 RPM*
***Retarding RPM**: Will vary from 1250 to 1605 RPM, dependent on operating conditions. (Controlled by FL275 panel)*

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DRIVE AXLE, SPINDLE AND WHEELS
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TIRES AND RIMS

The 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 tire manufacturer for recommended tire pressure.

Insure 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 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 a malfunction. If a tire should become deeply cut, it should be removed and repaired. Neglected cuts cause many tire problems. Water, sand, dirt and other foreign materials work into a 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 or 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 deflated tires. If stored truck cannot be blocked, check air pressure and inspect tires twice a month for proper inflation pressure.

FRONT TIRES AND RIMS

Removal

⚠DANGER

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 11,000 lbs. (4995 kg). Be certain tire handling equipment is capable of lifting and maneuvering the load.

Manual tire removal and installation is possible but, due to the size and weight of the components, special handling equipment is desirable. Consult local tire vendors for sources of equipment designed especially to remove, repair, and install large off-highway truck tires.

If the studs in the front wheel hub require replacement, use a special stud installer tool and tighten studs to **540 ft.lbs. (732 N.m)** torque.

1. Apply parking brake and block rear wheels to prevent movement of truck.
2. Shut down engine, turn keyswitch OFF, and allow at least 90 seconds for the accumulator to bleed down. Turn the steering wheel to be sure no pressure remains. As a safety precaution, bleed down brake accumulators.
3. Place jack under spindle or under frame at the front cross tube.
4. Raise front end of truck until tires clear ground and block up securely under frame.
5. Visually inspect all brake components for damage or wear. Inspect hydraulic brake lines for damage or leaking fittings.
6. Secure wheel assembly to hoist or fork lift and take up slack. Remove wheel nuts (8, Figure 2-1), and wheel retainer lugs (7) securing wheel assembly to wheel hub. Remove the clamp that secures the tire inflation valve to the wheel hub.

⚠CAUTION

Care should be taken not to damage the inflation stem during tire removal.

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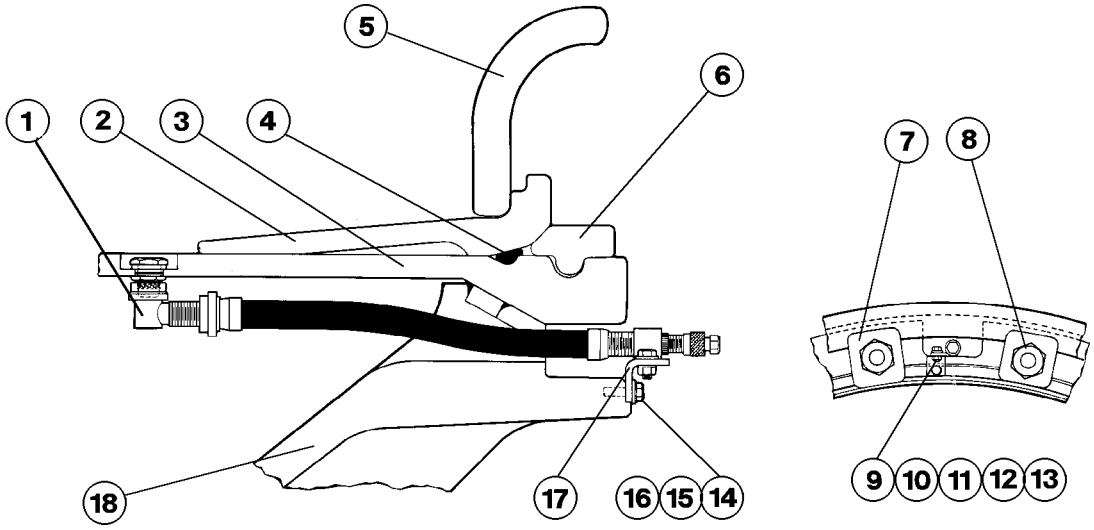


FIGURE 2-1. FRONT WHEEL ASSEMBLY

1. Valve Assembly
2. Bead Seat Band
3. Rim
4. O-Ring
5. Side Flange
6. Lock Ring
7. Wheel Retainer Lug
8. Nut
9. Capscrew
10. Flat Washer
11. Lockwasher
12. Nut
13. Clamp
14. Capscrew
15. Flatwasher
16. Lockwasher
17. Bent Plate
18. Hub

7. Move wheel assembly away from wheel hub and into clean work area.

⚠WARNING

Do not attempt to disassemble wheel assembly until all air pressure is bled off.

Due to its size and weight, always keep personnel away from a wheel assembly when it is being removed or installed.

Installation

NOTE: Remove all dirt and rust from mating parts before installing wheel assembly.

1. Using a tire handler, lift wheel into position on wheel hub. Install wheel retainer lugs (7, Figure 2-1) and lubricated nuts (8). Evenly tighten each nut using the sequence shown in Figure 2-2 to **300 ft.lbs (407 N.m)** torque.
2. Spin the wheel and check rim run-out. Maximum run-out is 0.20 in. (5mm). If run-out exceeds specifications, then loosen all the nuts and re-tighten them evenly as shown in Figure 2-2.
3. If run-out is OK, then tighten each nut using the sequence in Figure 2-2 to **550 ft. lbs. (746 N.m)** torque.
4. Connect the valve stem to the wheel hub.
5. Operate truck for one load and retighten wheel nuts as specified in Step 3. Recheck nut torque daily (each 24 hours of operation) to insure proper torque is maintained on each nut. Once torque is maintained, daily checking is no longer required. Check intermittently to insure torque is maintained.

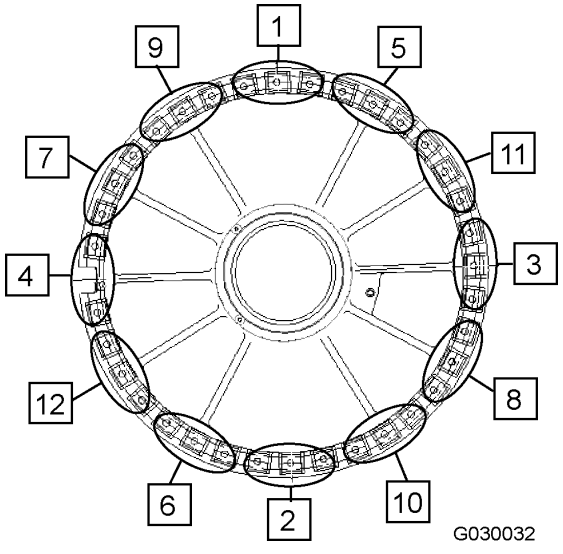


FIGURE 2-2. FRONT WHEEL TIGHTENING SEQUENCE

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REAR TIRES AND RIMS

If the studs in the rear wheel motor require replacement, use a special tool and tighten studs to **540 ft.lbs. (732 N.m)** torque.

Removal

1. Park truck on level ground and block front wheels. Position a jack in recess of rear suspension mount casting as shown in Figure 2-3.
2. Raise rear axle housing of truck until tires clear ground. Securely block up rear axle housing near the wheel motor mounting flange.
3. Disconnect inner wheel valve stem extension from outer wheel valve stem vinyl clamp by loosening capscrews. Lift valve extension out of vinyl clamp.
4. Using a tire handler (or hoist and sling if body has been removed as shown in Figure 2-4) to grasp outer wheel assembly. Remove wheel nuts (10, Figure 2-4) and wedges (11) securing outer wheel to the wheel motor hub.

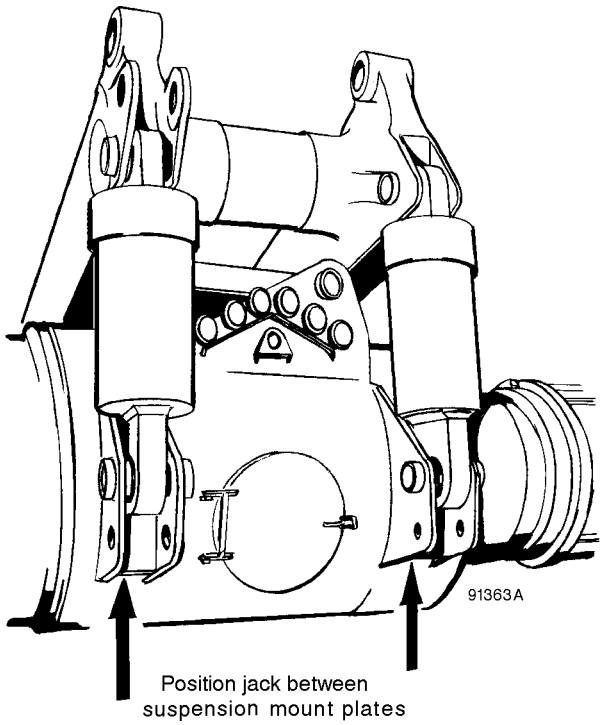


FIGURE 2-3. TIRE LIFTING SLING (BODY REMOVED)

⚠CAUTION

Use a strap or other means, to secure inner wheel before removing outer wheel assembly. This will prevent the accidental slipping of inner wheel during this operation.

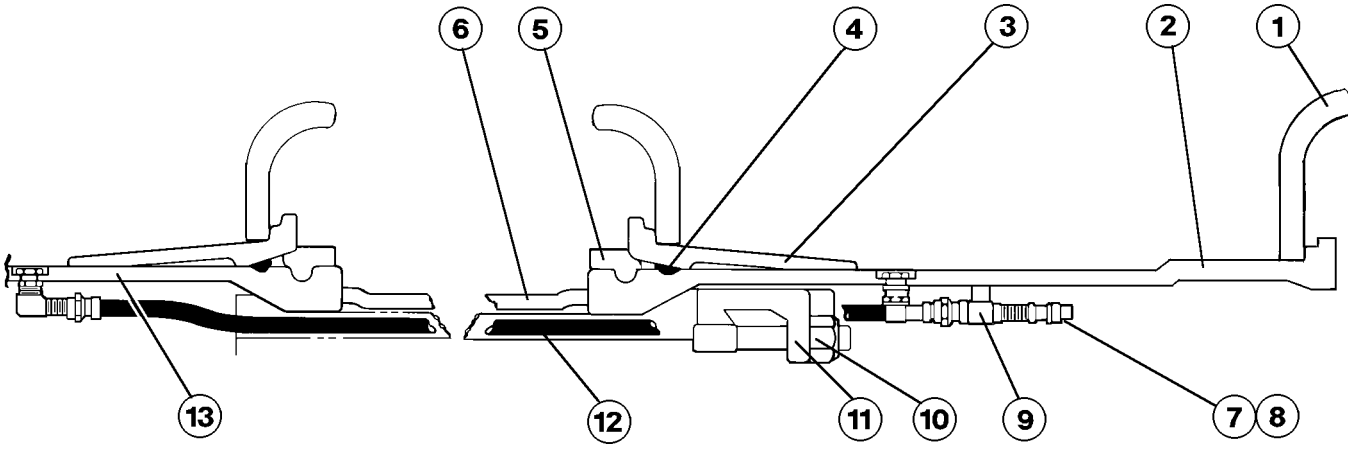


FIGURE 2-4. REAR WHEEL ASSEMBLY

1. Side Flange
2. Outer Wheel Rim
3. Bead Seat Band
4. O-Ring
5. Lock Ring
6. Spacer
7. Valve Cap
8. Core
9. Clamp
10. Nut
11. Wheel Retainer Wedge
12. Valve Extension Tube
13. Inner Wheel Rim

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5. Pull straight out on outer wheel assembly and remove.
6. If inner wheel removal is necessary, remove spacer (6, Figure 2-4) by pulling straight out and removing from rear hub. (Refer to Figure 2-6.)

NOTE: Use care when removing spacer and inner wheel so as not to damage tire inflation extension tube.

7. Secure tire handler (or lifting device) to inner wheel and pull straight out to remove from wheel hub.

Installation

NOTE: Clean all mating surfaces before installing wheel assembly.

1. Attach tire handler (or lifting device) to inner dual and install inner dual onto wheel motor hub. Use care not to damage tire inflation extension line.

NOTE: During inner wheel installation be sure air inflation line lays in channel on wheel hub assembly.

2. Using a lifting device, install spacer (6, Figure 2-4) onto wheel motor hub. Tap spacer up against inner dual.
3. Attach tire handler to outer dual and position onto wheel motor hub.

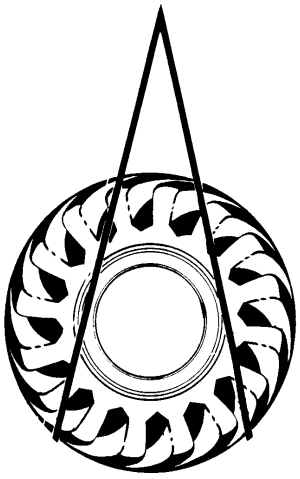


FIGURE 2-5. TIRE LIFTING SLING (BODY REMOVED)

⚠WARNING

Due to its size and weight, always keep personnel away from a wheel assembly when it is being removed and installed.

NOTE: Be sure to position outer dual wheel so that tire valve bracket aligns with inner wheel inflation line.

4. Install wedges onto studs and secure in place with lubricated wheel nuts. Evenly tighten each nut in an alternating (criss-cross) pattern as shown in Figure 2-7) to **300 ft.lbs (407 N.m)** torque.
5. Spin the wheel and check rim run-out. Maximum run-out is 0.20 in. (5mm). If run-out exceeds specifications, then loosen all the nuts and re-tighten them evenly as shown in Figure 2-7.
6. If run-out is OK, then tighten each nut in as shown in Figure 2-7 to **550 ft. lbs. (746 N.m)** torque.

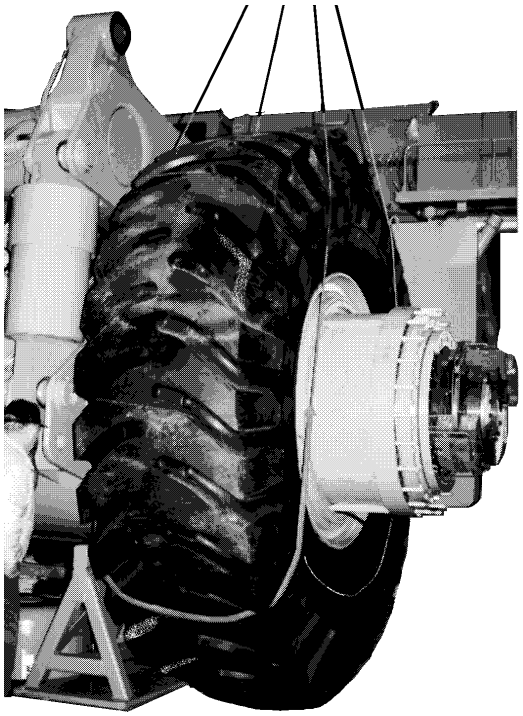


FIGURE 2-6. INNER TIRE REMOVAL AND INSTALLATION

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7. Secure inner and outer dual tire inflation lines to bracket on outer rim. Tighten capscrews to standard torque.
8. Install wheel cover. Remove blocks from under truck and lower truck to the ground.
9. Operate truck for one load and retighten wheel nuts as specified in Step 6. Recheck nut torque daily (each 24 hours of operation) to insure proper torque is maintained on each nut. Once torque is maintained, daily checking is no longer required. Check intermittently to insure torque is maintained.

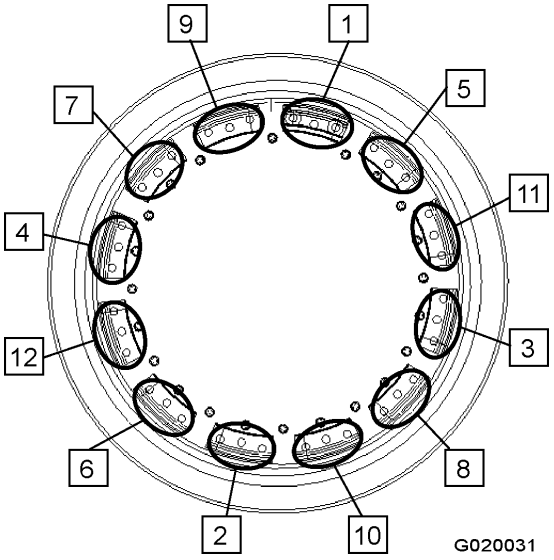


FIGURE 2-7. REAR WHEEL TIGHTENING SEQUENCE

RIM

Tire Removal

DANGER

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

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

RIM AND TIRE PREPARATION

The first step in mounting radial off-road tires is to properly prepare the tire and rim assembly.

1. Clean the rim base, bead seat band, and flanges with a wire brush. Remove all paint from knurling on bead seat band and back section.

DANGER

Never weld or repair damaged rims.

2. Check rim assembly for damage or corrosion. Replace any damaged or broken components. Verify that the rim does not have any burrs.
3. Apply rust inhibitor to any corrosion.
4. Clean the tire and bead area.
5. Check for and remove any object(s) from the interior of the tire that could cause damage to the tire.
6. Check the tire bead area and inner liner for damage that would allow air to leak from the tire. Replace or repair any tire with bead damage.

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LUBRICANTS

The proper amount and type of lubricant is key to successful mounting of radial off-road tires.

⚠ IMPORTANT ⚠

For lubrication, use only water-based or vegetable-based lubricant. Lubricants should be of a type that vaporize over time and not leave any residue on the rim or tire surfaces.

1. Paste lubricants should be diluted with water as per specific lubricant manufacturers recommendations.
2. Only lubricate all parts on the rim that are in contact with the bead sole area of the tire.

FIGURE 2-8.

NOTE: Be careful not to apply lubricant in the O-ring gutter.

3. When lubricating the tire bead, lubricant should be sparingly applied to the tire bead surface **ONLY**. The lubricant should be painted or sprayed on uniformly without any lumps in the paste or soap. The total amount of lubricant applied per tire should not exceed 50 grams (1.75 oz.).

TIRE INSTALLATION

The preferred method for mounting tires is horizontally and off of the truck, especially for initial tire mounting on a new truck. For horizontal tire mounting, a workman's stand is recommended for working inside the tire. Similar methods and precautions should be used when mounting tires vertically, on the truck.

NOTE: With each tire mounting, it is required that a new O-ring and a new air valve be installed.

1. Before mounting tire to rim, remove all dirt and rust from rim parts, particularly the O-ring groove and bead seats. It is advisable to touch up all metal parts with a good anti-rust paint to prevent bare metal from being exposed to the weather.

NOTE: Do not allow paint, rust or other contamination to cover mating faces of lockring (6) and rim (3).

⚠ WARNING

Check to be sure that proper rim parts are used for reassembly. Use of incompatible parts may not properly secure the assembly resulting in violently flying parts upon inflation.

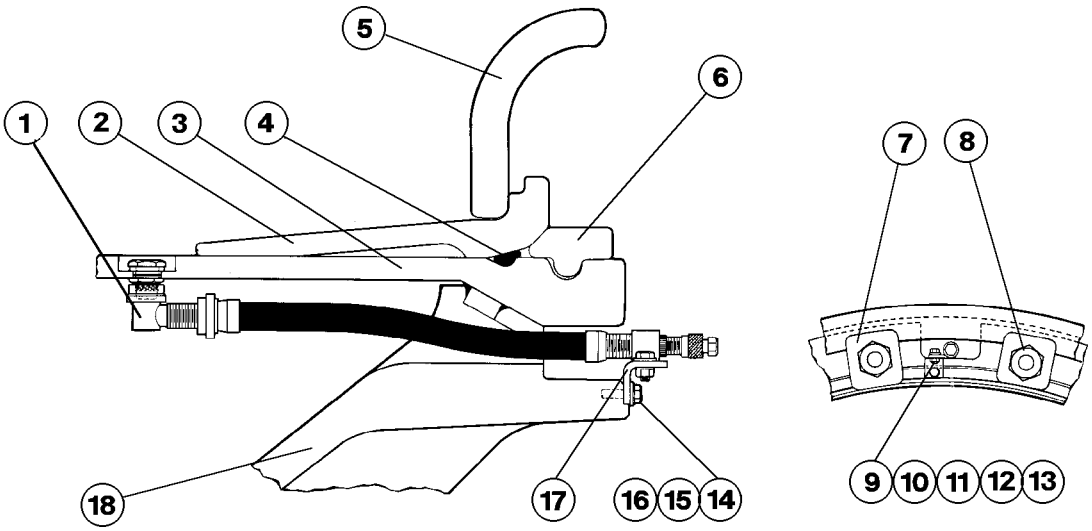


FIGURE 2-8. FRONT WHEEL ASSEMBLY

1. Valve Assembly
2. Bead Seat Band
3. Rim
4. O-Ring
5. Side Flange
6. Lock Ring
7. Wheel Retainer Lug
8. Nut
9. Capscrew
10. Flatwasher
11. Lockwasher
12. Nut
13. Clamp
14. Capscrew
15. Flatwasher
16. Lockwasher
17. Bent Plate
18. Hub

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2. If valve stem and spud assembly were removed, reinstall in rim. Install valve stem assembly onto rim and install spud assembly to inside of rim. Tighten spud assembly to **35 in. lbs. (4 N.m)** torque.
3. Adjust vinyl clamp and capscrew on valve stem and rim assembly. Tighten capscrew to standard torque.
4. Install inner flange on rim. Coat beads of tire with tire mounting soap solution.

⚠CAUTION

Prying against tire bead may cause damage to tire bead and will cause air leaks.

5. Position tire over rim and work tire on as far as possible without prying against the beads. Any damage to tire bead will destroy air seal and cause air leaks at these points.
6. Install outer flange (5, Figure 2-8) in position and replace bead seat band (2). Push in on bead seat band to expose O-ring groove in rim.
7. Lubricate new O-ring (4) with soap solution and install in groove of rim.
8. Install lockring (6) and tap into place with lead hammer. **Lockring lug must fit into slot of rim.**
9. Remove valve core from valve stem and inflate tire to seat beads of tire and O-ring as specified by tire manufacturer.

⚠DANGER

Use a safety cage whenever possible. Stand to one side as tire is being inflated. Never start inflating unless lockring is securely in place. DO NOT stand in front of or over lockring when inflating.

10. If beads of tire and O-ring do not seat within one minute, raise tire slightly and tap bead seat band. This will help the air pressure to push the tire bead out into position.
11. As soon as seating has been accomplished, install valve core and inflate tire to recommended tire pressure.
12. Follow tire manufacturers recommendations concerning tire bead seating procedures and final tire pressure setting for each application.

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NOTES:

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FRONT WHEEL HUB AND SPINDLE

WHEEL HUB AND SPINDLE ASSEMBLY

Removal

The following instructions will cover the complete removal, installation, disassembly, assembly and bearing adjustment of front wheel hub and spindle. If only brake service is to be performed, refer to Section "J", "Brake Circuit".

⚠WARNING

Do not loosen or disconnect any hydraulic brake line or component until engine is stopped, key switch is turned "Off" for 90 seconds and drain valves on brake accumulators are opened.

For ease of handling, refer to the "Front Tire and Rim Removal" instructions to remove front tire and rim assembly.

1. Bleed down steering accumulator by shutting down the engine and turn key switch "Off" for at least 90 seconds. Open drain valves at the bottom of each of the brake system accumulators. Allow adequate time for the accumulators to bleed down.
2. Disconnect brake lines leading to each caliper and main brake supply line (1, Figure 3-1) at the junction block. Plug or cap all lines to prevent contamination of the hydraulic system.
3. Remove any grease lines being used for a group lube or automatic lube system for the steering cylinder and tie rod. Cap all lines.
4. Remove capscrews and washers securing brake line junction block (2), and main brake supply line (1) from spindle assembly. Plug or cap all lines to prevent contamination of the hydraulic system.
5. If internal work is to be performed, remove hub drain plug (24, Figure 3-5) and allow oil to drain.
6. Remove lubrication lines from tie rod and steering cylinder. Disconnect tie rod and steering cylinder rod from spindle being removed. Refer to "Steering Cylinder and Tie Rod Removal" in this section.
7. Position a fork lift under the wheel hub and spindle assembly as shown in Figure 3-4.
8. Remove capscrews (1, Figure 3-2) securing retainer plate (2) to spindle structure and suspension. Loosen capscrews in torque increments of **500 ft. lbs. (678 N.m)**. Remove retainer plate.
9. Carefully remove 13 of the steering arm capscrews (5) as follows:
   a. Identify capscrews designated with an "X" on the spindle pusher fabrication drawing shown in Section "M".
   b. Remove the capscrews identified in step a, loosening them in small increments in a circular pattern.

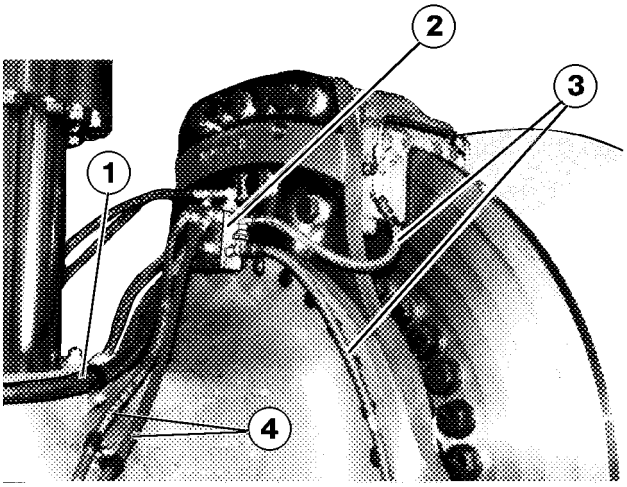


FIGURE 3-1. BRAKE SUPPLY LINES

1. Brake Supply Line
2. Junction Block
3. Caliper Supply Lines
4. Lubrication (Grease) Supply Lines

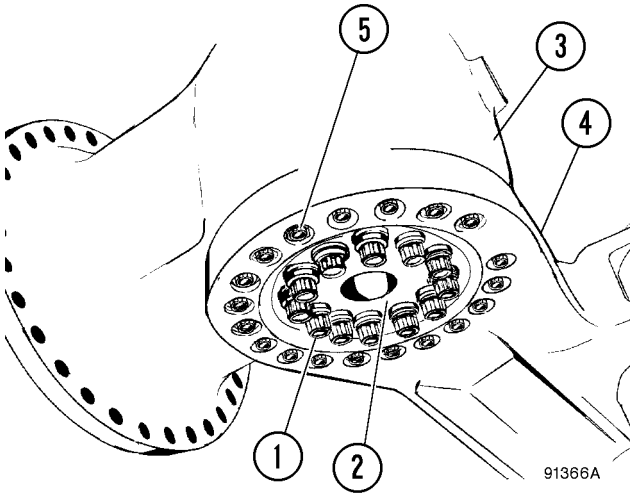


FIGURE 3-2. WHEEL HUB & SPINDLE REMOVAL

1. Capscrews
2. Retainer Plate
3. Spindle
4. Spindle Steering Arm
5. Retaining Capscrews

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⚠CAUTION

DO NOT remove the capscrews in one step with an air wrench. Revolve around the circular pattern at least 3 times, gradually loosening the capscrews during each revolution.

10. Run the proper size tap into the threaded holes to ensure good, quality threads.
11. Install spindle pusher tool and remove spindle as described below.

Spindle Pusher Tool Usage

⚠WARNING

Heavy structures and high forces are involved in this procedure. Use caution at all times when applying force to these parts. Sudden release of the spindle could cause components to move forcefully and unexpectedly.

Refer to Section "M", Options & Special Tools for dimensions for fabricating the spindle pusher tool and the capscrews and washers required. Multiple flatwashers may be required under the capscrews to be effective.

Note: Hardened flat washers must be used under the pusher capscrews to prevent galling. Lubricate capscrew threads and washers with a lubricant such as chassis lube.

1. Install pusher tool as shown in Figure 3-3. using the capscrews (1) and washers (2) specified below for the appropriate model truck:

830E (AFE 32)

Capscrew P/N KC7091. . . . . .1.125 x 7 in.

Min. Thread engagement: . . . . . .1.50 in.

Washer P/N WA0365 . . . . . .1.125 in.

830E (AFE 50)

Capscrew P/N KC7095. . . . . .1.25 x 8 in.

Min. thread engagement . . . . . .1.62 in.

Washer P/N WA0366 . . . . . .1.25 in.

Note: Verify minimum thread engagement on pusher capscrews when inserted.

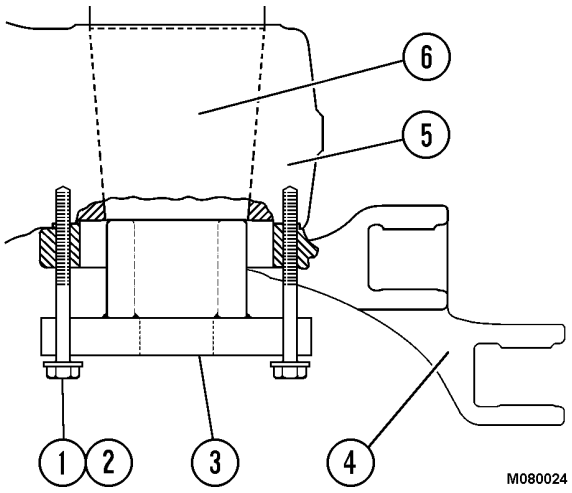


FIGURE 3-3. PUSHER TOOL INSTALLATION

1. Capscrew
2. Washer
3. Pusher Tool
4. Steering Arm
5. Spindle
6. Suspension Piston

2. After the tool has been installed, progressively increase the torque on the capscrews in a circular pattern until the tapered piston breaks loose, or until the maximum specified torque on the capscrews (see below) is reached.

   Max. torque, 1.125 in. capscrews

   . . . . . .1140 ft. lbs.(1546 Nm)

   Max. torque, 1.25 capscrews

   . . . . . .1580 ft. lbs.(2142 Nm)

3. If the specified torque is reached and the tapered piston has not broken free, slightly loosen the capscrews and apply heat to two places, 180° apart, on the spindle. *The saturated temperature of the spindle must not exceed 850°F (454°C).*

⚠CAUTION

Heating the spindle in excess of 850° F (454° C) may cause serious damage to the spindle.

4. Tighten the capscrews again to the maximum specified torque as described in step 2.
5. Using a large hammer and heat at the specified locations, carefully tap on the top surface of the spindle until the piston breaks free.

Note: In extreme cases, it may be necessary to remove additional steering arm retaining capscrews and use additional pusher capscrews to apply more force.

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6. With a fork lift supporting the hub and spindle assembly as shown in Figure 3-4, move to clean work area for repair.

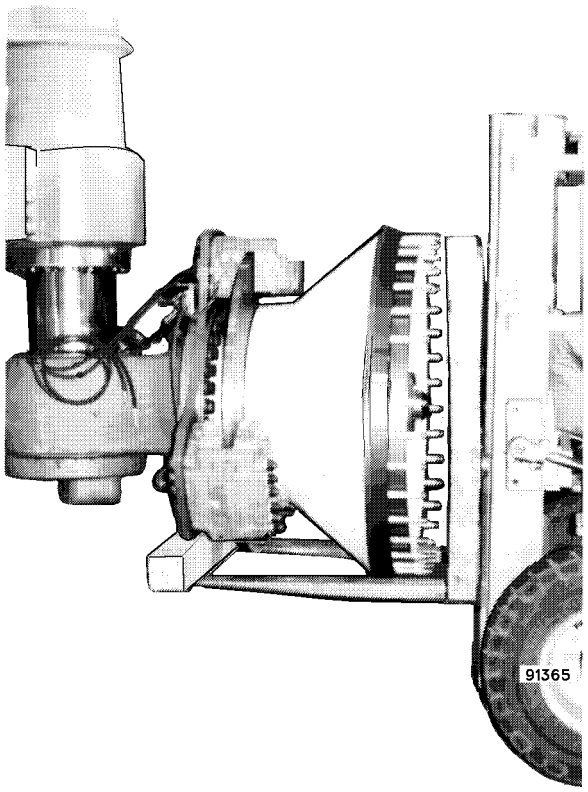


FIGURE 3-4. SPINDLE ANE WHEEL HUB REMOVAL

Installation

1. Clean spindle bore and suspension rod taper so they are free of all rust, dirt, etc. Clean and check the tapped holes in bottom of Hydrair® piston for damaged threads. Retap holes, if necessary, with 1.250 in. - 12NF tap.
2. Lubricate spindle bore and suspension rod taper with multi-purpose grease Number 2 with 3% Molybdenum Disulphide.

NOTE: Never use any lubricants on the spindle bore containing copper, such as many "anti'-seize" compounds. Products containing copper will contribute to corrosion in this area.

3. Position spindle and wheel hub assembly on fork lift or similar lifting device as shown in Figure 3-4.
4. Raise the spindle and wheel hub assembly into position.
5. Secure spindle to suspension using retainer plate (2, Figure 3-2) and capscrews (1). Tighten capscrews using the following procedure:
   a. Tighten capscrews (1) uniformly to **500 ft. lbs. (678 N.m)** torque.
   b. Continue to tighten capscrews in increments of **250 ft. lbs. (339 N.m)** to obtain a final torque of **1580 ft. lbs. (2142 N.m)**.
6. If removed, install steering arm (4). Clean and check the tapped holes in bottom of spindle for damaged threads. Retap holes, if necessary

   830E, AFE 32 . . . . . 1.125 in. - 12NF tap

   830E, AFE 50 . . . . . 1.25 in. - 12NF tap
7. Install capscrews (5) and torque to:

   830E, AFE 32 . . . . . 1430 ± 200 ft. lbs.

   . . . . . (1940 ± 271 N.m)

   830E, AFE 50 . . . . . 1995 ± 100 ft. lbs.

   . . . . . (2705 ± 135 N.m)
8. Install steering cylinder and tie rod in their respective mounting holes on the spindle. Tighten retaining nuts to **525 ± 52 ft. lbs. (712 ± 71 N.m)** torque. Connect lubrication lines.
9. Rotate the wheel hub to position the fill plug at the 12 o'clock position. Remove the fill plug and level plug. Fill wheel hub assembly at fill hole with SAE 80W-90 oil. When properly filled, oil should be present at the level (lower) hole. Replace fill and level plugs.
10. Install junction block with the spacer, capscrews, and flat washers.
11. Attach supply lines to brake calipers and connect main supply lines to connection on frame. Bleed brakes according to "Bleeding Brakes", Section "J".
12. Install wheel and tires as described in "Front Wheel and Tire Installation".

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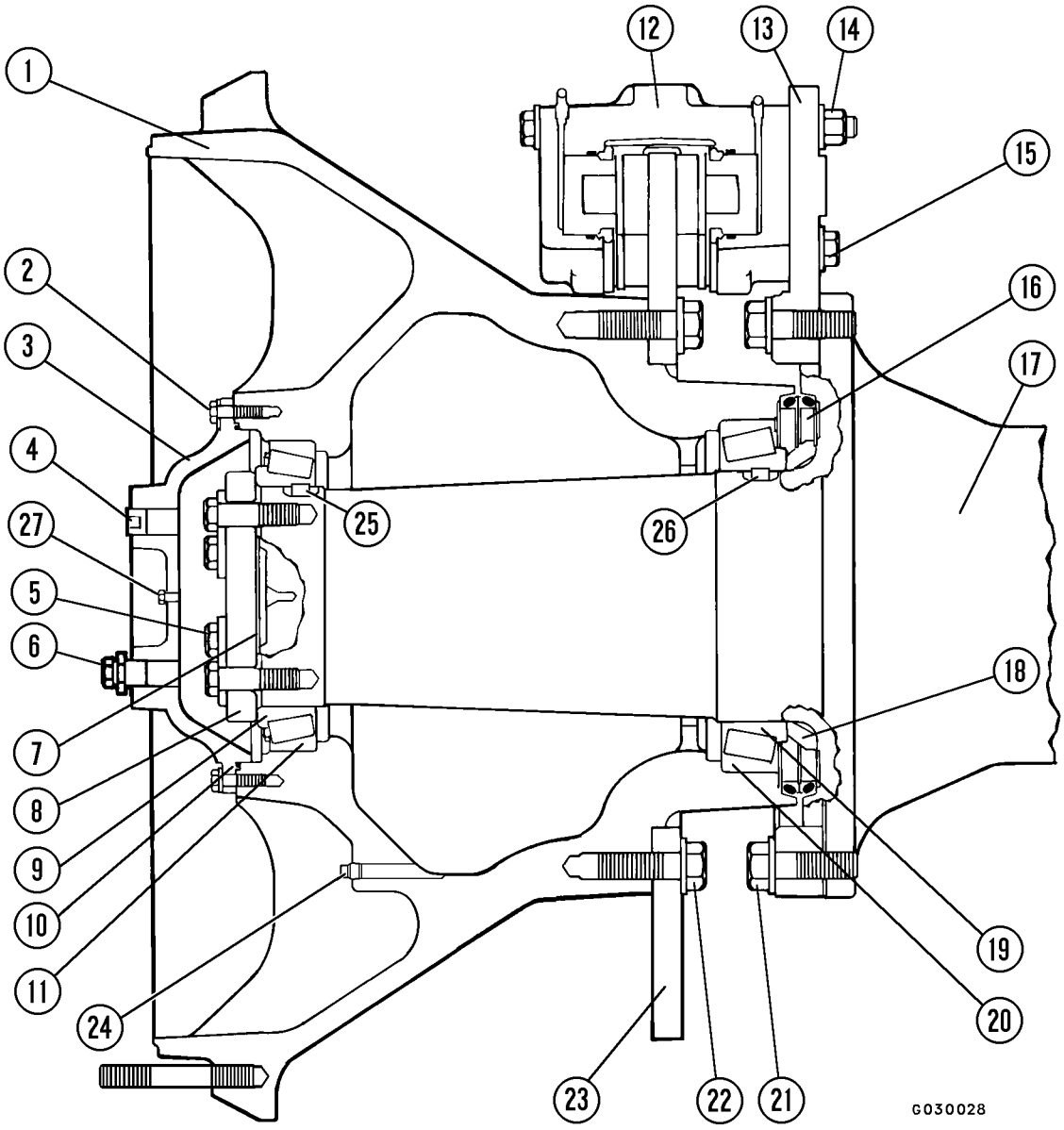


FIGURE 3-5. SPINDLE AND WHEEL HUB ASSEMBLY

1. Hub
2. Capscrews & Lockwashers
3. Cover
4. Oil Fill Plug
5. Capscrews & Flatwashers
6. Oil Level Sight Gauge
7. Shims
8. Bearing Retainer
9. Cone
10. O-Ring
11. Cup
12. Disc Brake
13. Brake Support
14. Capscrew, Flatwasher, & Nut
15. Capscrew & Flatwasher
16. Seal Assembly
17. Spindle
18. Spacer
19. Cone
20. Cup
21. Capscrew & Flatwasher
22. Capscrew & Flatwasher
23. Brake Disc
24. Oil Drain Plug
25. Bearing Pin, Outboard
26. Bearing Pin, Inboard
27. Relief Valve

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Disassembly

Note: The preferred method for rebuilding the front wheel hub and spindle assembly is to remove these components as a complete unit, then support the assemblies in a fabricated rebuild fixture, allowing disassembly and reassembly with the axis of the spindle positioned vertically. If repairs are made with spindle installed on truck, be certain to observe CAUTION statement below.

1. Remove wheel hub and spindle as a complete assembly as covered in "Removal".
2. To aid in complete disassembly of wheel hub and spindle assembly, support assembly in a vertical position using a fabricated spindle stand.
3. Remove brake calipers from support as outlined in Section "J", Brakes.
4. Remove capscrews & lockwashers (2, Figure 3-5) and cover (3).
5. Remove O-ring (10) from cover.
6. Remove capscrews & flat washers (5), bearing retainer plate (8), and shims (7).
7. Attach a lifting device to the wheel hub and carefully lift it straight up and off the spindle. Remove outboard bearing cup (10) and cone (9).

⚠CAUTION

If disassembly of the wheel hub is accomplished while on the truck, the outboard bearing cone should be supported during wheel hub removal to prevent cone from dropping and being damaged.

NOTE: Half of the face seal (16) will remain in the bore of the hub. Do not remove seal unless replacement is required. Use extreme caution when handling face seals. Seals must be replaced in a matched set. ***If one seal is damaged, both seals must be replaced.***

8. Remove face seal, bearing cone (19), and spacer (18) from spindle.
9. If brake disc replacement is required, attach a lifting device to the brake disc (1, Figure 3-6), remove capscrews (2), and lift and brake disc from hub (3).
10. If brake support replacement is necessary, remove capscrews and flatwashers (21, Figure 3-5) and remove support (13).

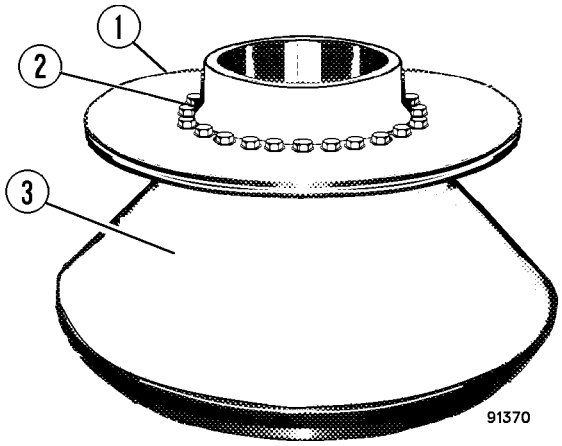


FIGURE 3-6. BRAKE DISC REMOVAL

1. Brake Disc
2. Capscrews & Flatwashers
3. Wheel Hub

Cleaning and Inspection

1. Clean all metal parts in fresh cleaning solvent.
2. Replace any worn or damaged parts.
3. Replace O-rings and face seals if worn or damaged.
4. Inspect wheel hub and spindle for damage.
5. Check all lips and cavities in spindle and wheel hub for nicks or tool marks that may damage the rubber seal ring on the face seals.

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Assembly

1. Assemble brake support, (13, Figure 3-5) to the spindle (17), if removed.
2. Align the brake support so the center line of one of the brake head mounting surfaces is above the horizontal center line, and in line with the vertical center line of the tapered bore on the inboard end of the spindle. The completely machined side of brake support plate should face the outboard end.
3. Lubricate underside of capscrew (21) heads and threads with multi-purpose grease Number 2 with 5% Molybdenum Disulphide. Install capscrews and flat washers and tighten to **1,480 ft. lbs. (2007 N.m)** torque.

NOTE: The mating surfaces between the spindle and the brake caliper support must be clean and dry, and with no excess capscrew lubricant on these surfaces.

4. Install spacer (18). If necessary, tap lightly to seat spacer against spindle. Spacer must fit tightly against spindle shoulder.
5. Check that inner bearing cone (19) is a slip fit on spindle (17), then remove. Install pin (26) into slot on spindle and install inner bearing cone (19) on spindle (17) over pin (26) and tight against spacer (18).

NOTE: Cone is a loose fit on the spindle.

6. Install one half of seal assembly (16) on spindle (17) using seal installation tool, TY2150 (Figure 3-7) and soft tipped mallet. For proper installation, use the following instructions:
   a. Handle all parts with care to avoid damaging critical areas. The sealing face of seal must not be nicked or scratched.
   b. Remove all oil and protective coating from seal and from the seal seat using nonflammable cleaning solvent, make certain all surfaces are absolutely dry.
   c. Check seal seat retaining lip for rough tool marks or nicks. Smooth any nicks and reclean.
   d. Install rubber sealing ring so it seats uniformly in the relief of seal. Be sure that it rests uniformly against the retaining lip.
   e. Using seal installation tool, install the floating ring seal assembly in the seal seat. The depth around the circumference of the seal should be uniform.
   f. Before assembling wheel hub and spindle, wipe the seal faces with lint-free cloth to remove any foreign material and fingerprints.
   g. Place a few drops of light oil on a clean cloth and completely coat the sealing faces of seals.

Do not allow oil to contact the rubber sealing ring or its seats.

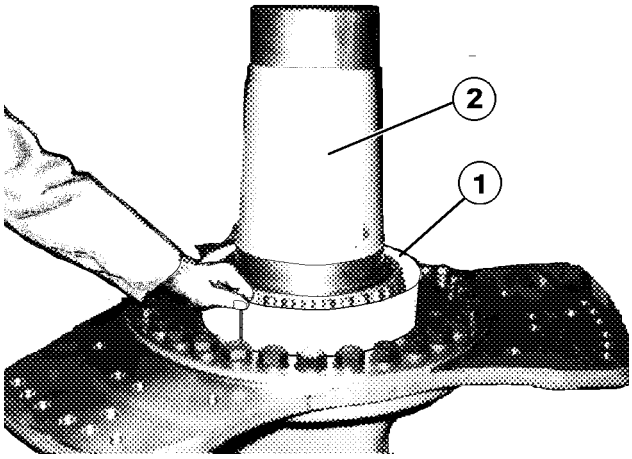


FIGURE 3-7. INBOARD SEAL INSTALLATION

1. Seal Installation Tool (TY2150)
2. Spindle

NOTE: To assure bearing lubrication during initial operation lightly lubricate the bearings with SAE 80W-90 oil.

7. If removed, install disc (1, Figure 3-6) on the wheel hub using capscrews and flat washers (2). Lubricate the underside of capscrew (2) heads and threads with multi-purpose grease Number 2 with 5% Molybdenum Disulphide. Tighten capscrews to **1,480 ft. lbs. (2007 N.m)** torque.

NOTE: The mating surfaces between the spindle and the brake disc must be clean and dry, and with no excess capscrew lubricant on these surfaces.

8. Install bearing cups (11 & 20 Figure 3-5) in the wheel hub (1) as follows:
   a. Preshrink cups by packing them in dry ice, or by placing then in a deep-freeze unit.

NOTE: Do not cool below -65° F (-54° C).

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b. Install cups in wheel hub bores.

c. After cups have warmed to ambient temperature, press the cups tight against hub shoulder as follows:

1.) Inner Cup (20) - Apply **30,000 lbs. (133,450 N)** force.

2.) Outer Cup (10) - Apply **23,000 lbs. (102,300 N)** force.

9. Install the other half of the seal assembly (16) in the hub using installation tool (TY2150) and soft tipped mallet. Follow procedure outlined in step 6.

10. Check bearing cone (9) for free fit on the spindle (17), then remove.

11. Referring to Figure 3-8, lift the hub and carefully lower it down over the spindle. To aid installation and to prevent damaging the seal, the spindle and hub should be level.

NOTE: All parts must be in place before wheel hub (1) is installed.

12. Install outboard pin (25, Figure 3-5) into slot on spindle (17) and install inner bearing cone (9) on spindle over pin (25).

13. Refer to *Wheel Bearing Adjustment* for final assembly.

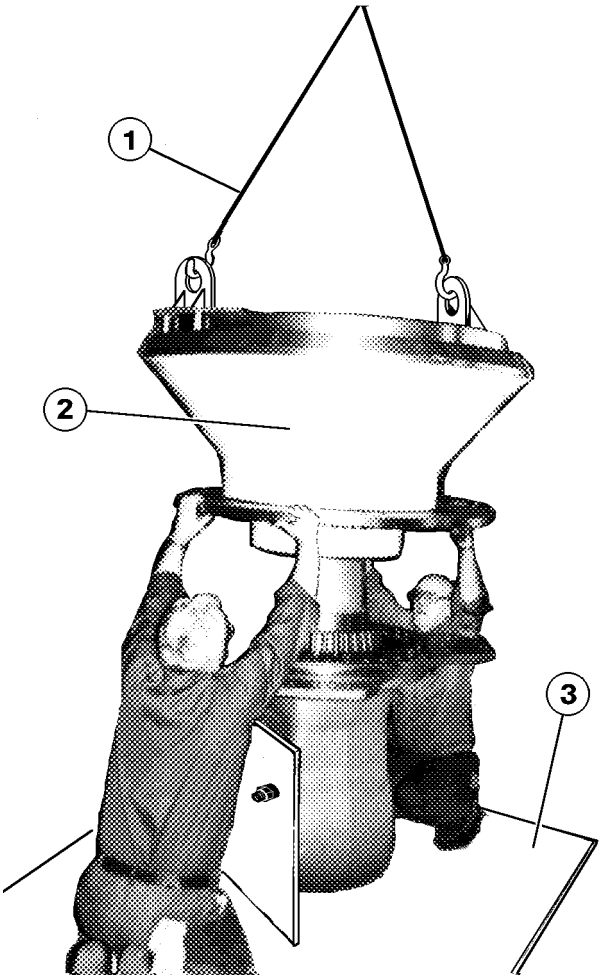


FIGURE 3-8. WHEEL HUB INSTALLATION

1. Support Chains
2. Wheel Hub
3. Fabricated Support Stand

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Wheel Bearing Adjustment (Tire Removed)

1. Install bearing retainer (1, Figure 3-9), ***without*** shims, with the thickness dimension stamp facing toward the outside. Install all six capscrews (2) with flat washers. Tighten capscrews alternately using the following procedure:
   a. Tighten all capscrews to **100 ft. lbs. (135 N.m)** torque, while rotating hub (3 revolutions min).
   b. Increase torque to **250 ft. lbs. (339 N.m)** torque, while rotating hub (3 revolutions min).
   c. Repeat step b. above until the torque on all capscrews is maintained.
2. Loosen all six capscrews until the flat washers are free. Rotate wheel hub (3 revolutions min).Then select two capscrews 180° apart, and adjacent to the 0.50 in. (13 mm) diameter depth measurement holes (refer to Figure 3-9). Tighten capscrews to **60 ft. lbs. (81 N.m)** torque, while rotating the wheel hub (3 revolutions min).
3. Tighten the same two capscrews to **110 ft. lbs. (149 N.m)** torque, while rotating the hub (3 revolutions min).
4. Using a depth micrometer, measure and record the depth to the end of the spindle from the face of the retainer plate (1) through each of the two holes (3) in the retainer plate (adjacent to the capscrews tightened in step 2).
5. Add the two dimensions measured in step 4 and divide the total by 2 to obtain an averaged depth dimension.
6. Subtract the dimension stamped on the face of the retainer plate from the average depth established in step 5.
7. Assemble a shim pack to equal the dimension in step 6 within 0.001 in. (0.025 mm).

NOTE: The above procedure results in a shim pack which will provide a 0.007 in. (0.178 mm) nominal preload for the bearings.

Shim pack must be compressed when measuring to obtain an accurate measurement.

8. Remove capscrews and retainer. Install shim pack and then re-install retainer, all capscrews, and hardened washers.
9. In successive increments of **250 ft. lbs. (339 N.m)** torque, while rotating the hub (3 revolutions min), tighten capscrews alternately to **750 ± 75 ft. lbs. (1017 ± 102 N.m)** final torque.

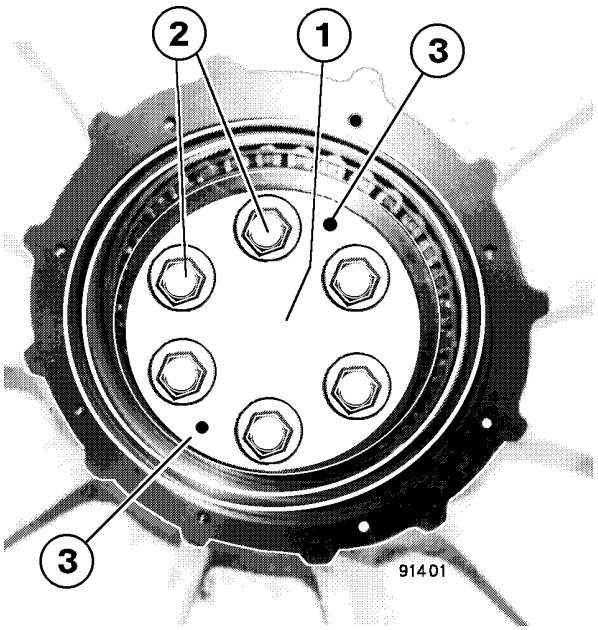


FIGURE 3-9. BEARING ADJUSTMENT

1. Retainer Plate
2. Capscrews
3. Depth Measurement Hole

10. Using a new O-ring (10, Figure 3-5), install cover (3). Install capscrews and washers (2) and tighten capscrews to standard torque.
11. Install hub and spindle assembly and add oil per instructions in "Front Wheel Hub" Installation.

Wheel Bearing Adjustment (Tire mounted)

The following procedure covers adjustment of front wheel bearings while the tire and rim, hub, and spindle are installed on the truck.

1. Park truck in a level area.
2. Apply the parking brake and block wheels to prevent movement.
3. Lift the truck until the tire of the wheel being adjusted is off the ground. Place blocking securely under truck frame.

NOTE: The placement of binder chains (2 & 3, Figure 3-10) is necessary anytime that the retainer plate (8, Figure 3-3) is removed in the following procedure. These binders must be tight enough to prevent the wheel hub from moving out and dislocating the floating seal assembly (16). An additional chain (1, Figure 3-10) may be installed to prevent full extension of the suspension cylinder when the truck is raised off the ground.

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4. Wrap a chain and chain binder (2, Figure 3-10) around the top half of the tire. Secure chain through the frame. Chain should be tightened enough to prevent movement during bearing adjustment procedure when the retainer plate is removed.
5. Install another chain (3) around the bottom half of the tire and tighten enough to prevent movement during bearing adjustment procedure.
6. Drain oil at wheel hub drain plug (24, Figure 3-5). Remove cover (3).
7. Remove capscrews (5), retainer plate (8), and shims (7).
8. Reinstall retainer plate (with the thickness dimension stamp facing toward the outside), capscrews, and hardened washers. **Do not install shims.**
9. Remove tire retaining chains (2 & 3, Figure 3-10).
10. Torque retainer capscrews alternately using the following procedure:
    a. Tighten all capscrews to **60 ft. lbs. (81 N.m)** torque while rotating the hub.
    b. Increase torque on all capscrews to **120 ft. lbs. (163 N.m)** while rotating hub.
    c. Increase torque on all capscrews to **180 ft. lbs. (244 N.m)** while rotating hub.
    d. Increase torque on all capscrews to **240 ft. lbs. (325 N.m)** while rotating hub.
    e. Increase torque on all capscrews to **250 ft. lbs. (339 N.m)** while rotating hub.

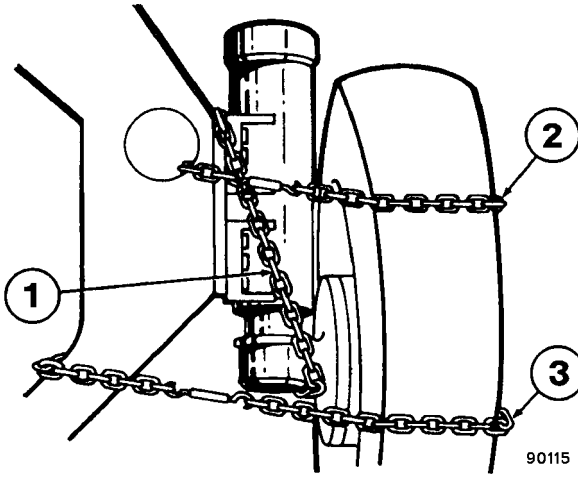


FIGURE 3-10. WHEEL SUPPORT CHAIN INSTALLATION

1. Suspension Support Chain
2. Chain & Binder
3. Chain & Binder

11. Loosen all six capscrews until the flat washers are free, then select two capscrews 180° apart and adjacent to the 0.50 in. (13 mm) holes in the retainer plate. Tighten only these two capscrews to **55 ft. lbs. (75 N.m)** torque while rotating the wheel hub. Refer to Figure 3-9.
12. Tighten the same two capscrews to **110 ft. lbs. (149 N.m)** while rotating the hub.
13. Using a depth micrometer, measure and record the depth to the end of the spindle from the face of the retainer plate through each of the two holes in the retainer plate adjacent to the capscrews tightened in step 12.
14. Add the two depth dimensions measured in step 13 and divide the total by 2, to obtain an averaged depth dimension.

    Record average Depth (d_a):_____
15. Subtract the dimension stamped on the face of the retainer plate from the averaged depth above to determine the required shim pack.

    ave. Depth(d_a) - plate Thickness(t_p)=Shim Pack

    d_a - t_p = _____ Shim Pack

NOTE: The above procedure results in a shim pack which will provide a nominal 0.007 in. (0.178 mm) preload for the bearings.

16. Assemble a shim pack equal to the dimension established in step 15 (within 0.001 in.).

NOTE: Shim pack must be compressed when measuring.

17. Reinstall tire support chains (2 & 3, Figure 3-10).
18. Remove capscrews and retainer. Install shim pack and reinstall retainer, capscrews, and hardened washers.
19. Tighten all capscrews alternately to **750 ± 75 ft. lbs. (1017 ± 102 N.m)** torque in several successive increments while rotating the hub.
20. Using a new O-ring (10, Figure 3-5), install cover (3). Install capscrews and washers (2) and tighten to standard torque.
21. Remove tire support chains (2 & 3, Figure 3-10).
22. Rotate the wheel hub to position the fill plug (4, Figure 3-5) at the 12 o'clock position. Remove the fill plug and level plug (6). Fill wheel hub assembly at fill hole with SAE 80W-90 oil. When properly filled, oil should be present at the level (lower) hole. Replace fill and level plugs.

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23. Remove suspension support chain (1, Figure 3-10) if installed, and all cribbing. Lower truck tire to ground.

NOTE: The wheel bearing preload should be checked 500 hours after truck is commissioned and after the first 500 hours following the assembly or servicing of the wheel bearings. During the 500 hour preload check, if the shim pack requires a change larger than 0.007 in, disassemble the wheel and bearing assembly and check for wear or damage. Replace worn or damaged parts and assemble wheel assembly. Check bearing preload again at 500 hours.

24. Check bearing adjustment after first 500 hours of operation and at each 5000 hour maintenance interval thereafter.

STEERING CYLINDERS AND TIE ROD

The steering cylinders and tie rod are mounted in the same manner. The removal and installation instructions are applicable to both.

Spherical Bearing Wear Limits

It is necessary to determine the condition of spherical bearings on steering linkage components for optimum steering performance. Ball diameter new dimensions and maximum allowable wear specifications are listed in Table 1. Bearings that exceed the maximum wear limits must be replaced.

If premature wear of the bearings is evident, check the automatic lubrication system to ensure the proper amount of lubrication is being received at the joint(s) in question. If lubrication is done manually, ensure that a sufficient amount of grease is being applied on a regular basis. Refer to Section P, Lubrication and Service, for information on proper lubrication intervals.

It is also important to ensure that steering linkage components are tightened to the proper torque. Use the proper torque specifications listed in this section for steering linkage components.

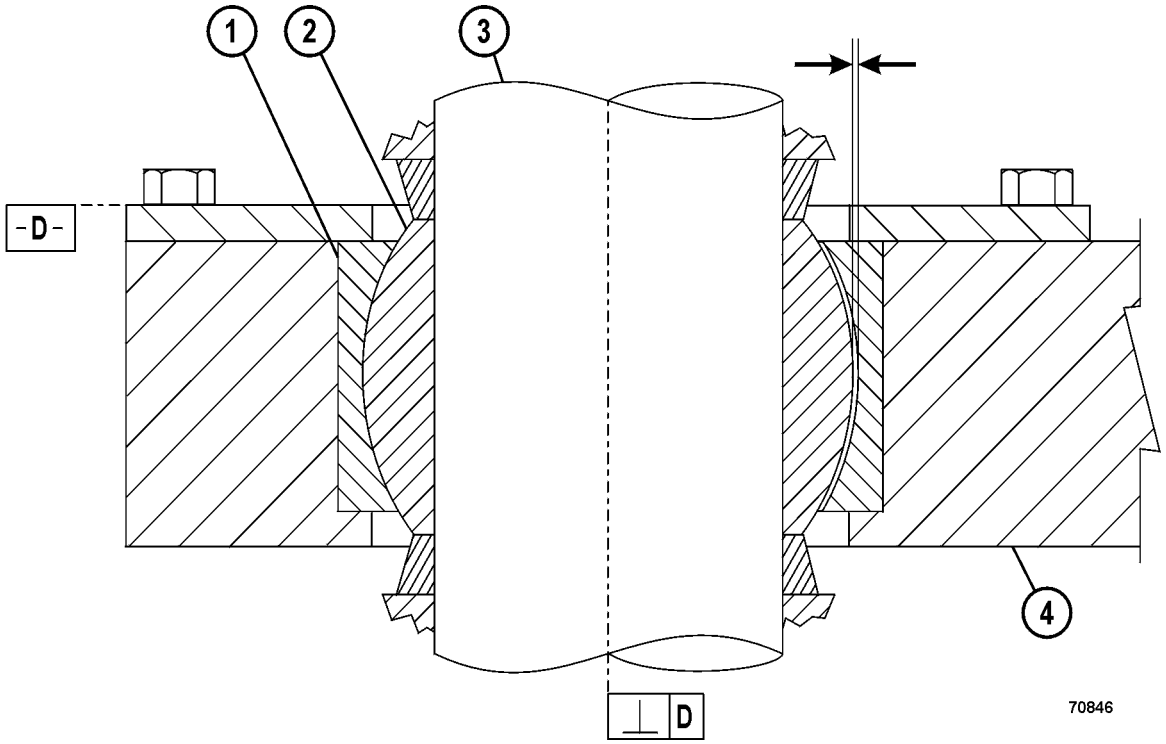


FIGURE 3-11. SPHERICAL BEARING WEAR LIMITS

1. Outer Race
2. Ball
3. Pin
4. Housing

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⚠WARNING

Use extreme caution when performing maintenance on any vehicle with an active steering system. Serious injury or death can result from contact with moving parts. Always keep a safe distance from crush points.

TABLE 1. STEERING SPHERICAL BEARING WEAR SPECIFICATIONS	
Spherical Bearing Ball Diameter (New)	3.59 in. (91.19 mm)
Maximum Allowable Wear	0.040 in. (1.01 mm)

NOTE: Figure 3-12 has two "View A"'s. These two views represent a running change in the method of attaching the steering cylinders to the main frame mount (19, Figure 3-12). Assembly for each version is essentially the same.

Removal

1. With engine shut down and key switch "Off", allow at least 90 seconds for the accumulator to bleed down. Turn the steering wheel to make sure no hydraulic pressure is present. Block front and back of rear wheels.
2. Disconnect hydraulic lines at the steering cylinders. Plug all line connections and cylinder ports to prevent contamination of hydraulic system.
3. Remove locknuts (9, Figure 3-12) capscrews, (3) and retainers (6 or 7) from both ends of assembly.
4. Remove pins (4 or 5) from each end of assembly and move assembly to clean work area. Bearing spacers (10) will be free when pin is removed. **Insure bearing spacers do not drop out and become damaged when removing pin.**

Installation

1. Align bearing spacers (10) and rod end (15) with pin bores on spindle and frame.
2. Install pins (4 or 5), capscrews (3) and retainers (6 or 7) and secure with locknut (9). Tighten to **525 ft. lbs. (712 N.m)** torque.
3. Connect grease lines to their respective ports. Operate steering and check for leaks and proper operation.

NOTE: Tie rod is to be installed with clamping bolts toward the rear of the truck.

Bearing Replacement

1. Remove capscrews (2, Figure 3-13) and lockwashers (3). Remove bearing retainer (4).
2. Press bearing (1) out of bore in steering cylinder or tie rod end.
3. Press new bearing into bore.
4. Install bearing retainers with capscrews and lockwashers. Tighten capscrews to standard torque.

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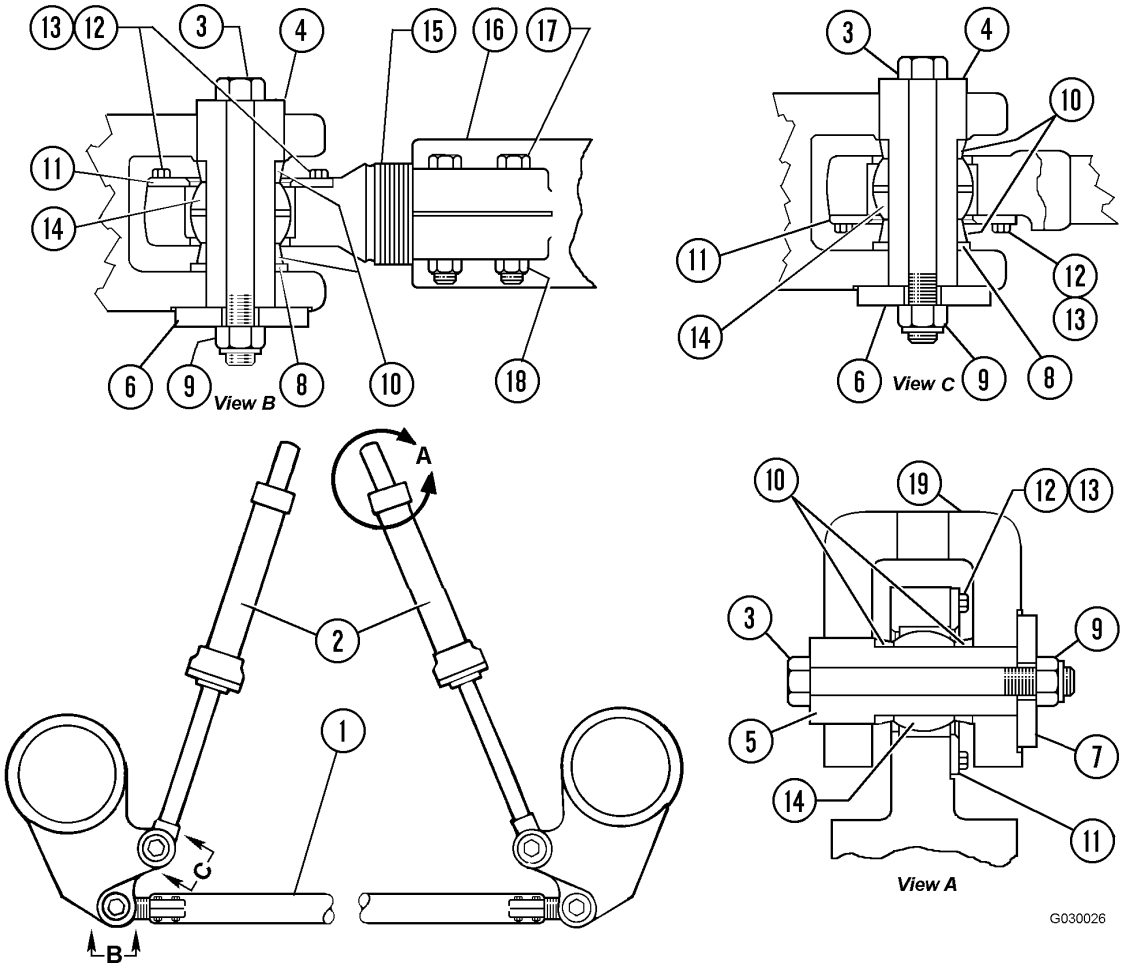


FIGURE 3-12. STEERING CYLINDER AND TIE ROD INSTALLATION

1. Tie Rod Assembly
2. Steering Cylinder
3. Capscrew
4. Pin
5. Pin
6. Retainer
7. Retainer
8. Hardened Washer
9. Locknut
10. Bearing Spacer
11. Bearing Retainer
12. Capscrew
13. Lockwasher
14. Bearing
15. Tie Rod End
16. Tie Rod Assembly
17. Capscrew
18. Locknut
19. Main Frame Mount

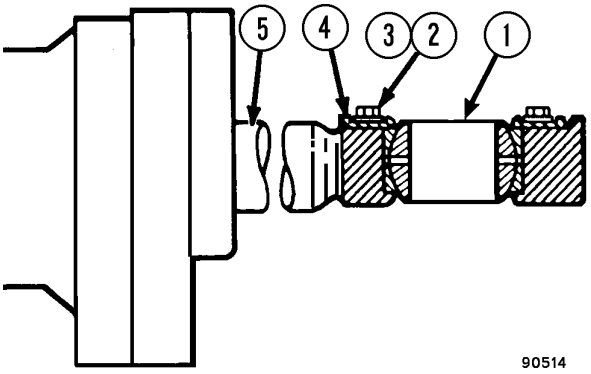
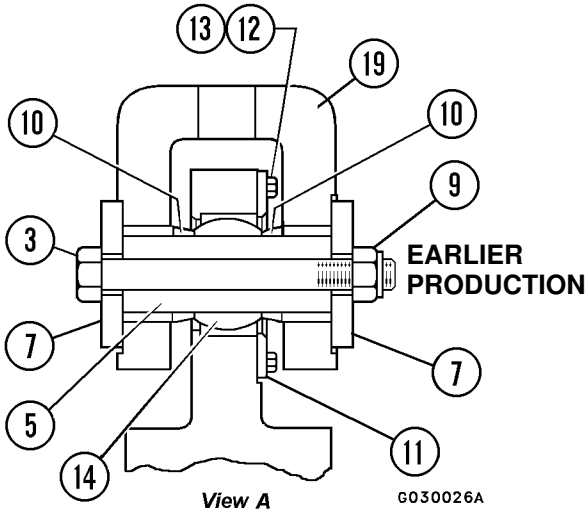


FIGURE 3-13. STEERING CYLINDER

1. Bearing
2. Capscrew
3. Lockwasher
4. Bearing Retainer
5. Rod End



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TOE-IN ADJUSTMENT

1. The steering system must first be centered in the straight ahead position. Shut down engine and turn key switch "Off", and allow at least 90 seconds for the accumulator to bleed down.
   DO NOT turn steering wheel.
   Block front and back of **rear** wheels.
2. Check toe-in by measuring the distance between the centers of the front tires. These measurements should be taken on a horizontal center line at front and rear of tires. Refer to Figure 3-14.
3. The front measurement should be 0.75 ± 0.25 in. (1.9 ± 0.6 mm) less than rear measurement for bias-ply tires. Radial tires and undesignated tires should have equal measurements (zero toe-in).
4. For trucks with an adjustable rod end at only one end of the tie-rod, remove tie rod pin from spindle at adjustable end according to the instructions in "Steering Cylinders and Tie Rod, Removal".

NOTE: For trucks with adjustable rod ends at both ends of the tie-rod, pin removal is not necessary.

5. Loosen clamp nuts (18, Figure 3-12) on tie-rod and adjust as necessary.
   a. For trucks with an adjustable rod end at only one end of the tie-rod, adjust length by turning rod end "in" or "out". When dimension required is attained, rotate the rod end to align the bearing bore with the bearing bore on the opposite end. Reinstall pin at spindle according to the instructions in "Steering Cylinders and Tie Rod, Installation".
   b. For trucks with adjustable rod ends at both ends of the tie-rod, rotate tie-rod to obtain the required dimension.

See chart under Figure 3-14 for "Toe-in Data"

6. Tighten clamp nuts on tie rod to **310 ft. lbs. (420 N.m)** torque.

NOTE: In order to obtain proper torque, castellated nuts and cotter pins may be replaced with self-locking nuts.

7. Install lubrication line(s) to pin ends.
8. Remove blocks from rear wheels.

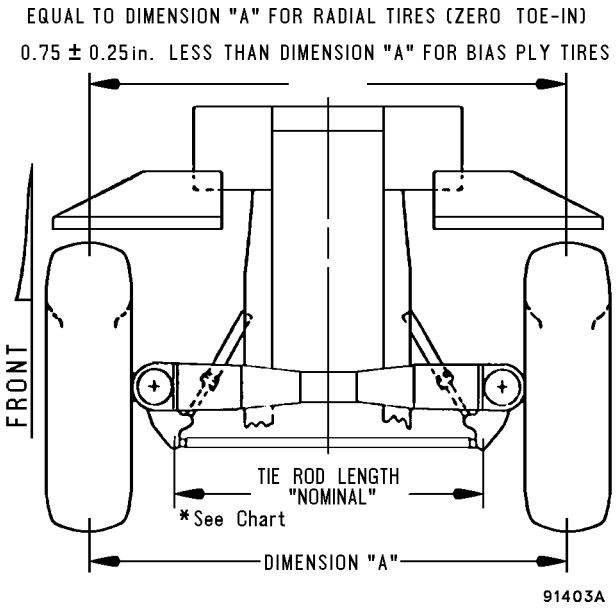


FIGURE 3-14. MEASURING TOE-IN

830E Toe-In Data	in. (cm)
Nominal Tie-rod Length, Radial Tires, "0" Toe-in Loaded	144.00 (365.76)
Nominal Tie-rod Length, Bias Ply Tires, "0.75" Toe-in Loaded	144.29 (366.50)
Change In Toe-in From Loaded to Empty	0
Change In Toe-in Length with: One Full Turn Of One Rod-end	0.328 (0.833)
Change In Toe-in Length with: One Full Turn Of Double End Tie Rod	0.656 (1.666)

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NOTES:

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REAR AXLE HOUSING ATTACHMENT

PIVOT PIN

Removal

1. Park truck on firm, level surface and block front and rear of all tires.

⚠WARNING

Truck body must be empty and down against frame before attempting this procedure.

2. Release all brakes.
3. Charge rear suspensions with nitrogen until pistons are fully extended.
4. Place blocks or stands under each frame member beneath the hoist cylinders.

⚠WARNING

Blocks must be securely in place before lowering the frame. Check blocks on wheels to make sure they are in place.

5. Release nitrogen out of front suspensions.
6. Release nitrogen out of rear suspensions.
7. Place a jack below the pivot pin to control any downward movement when the pin is removed.
8. Disconnect pin lube line. Remove ground wire between pivot structure and frame.
9. Remove capscrew and lockwasher (3, Figure 4-1). Remove capscrews (4). Remove retainer plate (2).
10. Install puller using tapped holes in head of pin. Remove pin (6).

NOTE 1: Placement of a jack between mounting structure and pivot eye may be necessary to push the pivot eye down away from frame structure. Pivot eye may also need to be moved to one side to clear welded spacer.

NOTE 2: If the bore for the Pivot Pin (6, Figure 4-1) in the Mounting Structure (1, Retainer Plate side) has been damaged, a rework procedure to install a sleeve is available. The rework drawing, EG4670, is available in AK4952 Nose Cone Repair Kit.

Installation

1. Raise pivot eye into position.
2. Be certain spherical bearing inner race (7) is aligned. Install spacers (5, Figure 4-1), cover rings (10), and pin (6).
3. Line up capscrew holes in pin with capscrew holes in retainer plate (2). Install capscrews (4).
4. Rotate pin and retainer plate to align capscrew holes in frame mounting structure.
   a. Install capscrews and lockwashers (3).
   b. Tighten capscrews (3) to **125 ft. lbs. (170 N.m)** torque.
   c. Tighten capscrews (4) to **1715 ft. lbs. (2325 N.m)** torque.
5. Install clamps (14) on cover rings (10). Tighten clamps just enough to hold covers in place.
6. Install ground wire and lubrication line. Pressurize lube line to assure bearing receives grease.

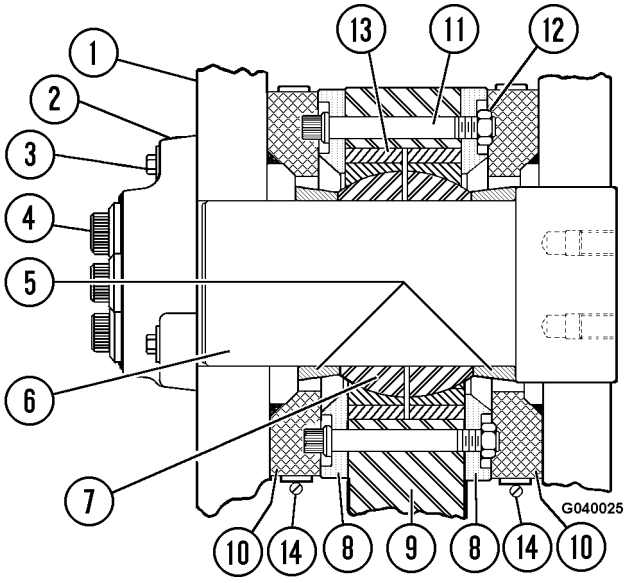


FIGURE 4-1. PIVOT PIN INSTALLATION

1. Mounting Structure
2. Retainer Plate
3. Retainer Capscrew & Lockwasher
4. Capscrew (12pt. - G9) & Hardened Flatwasher
5. Bearing Spacer
6. Pivot Pin
7. Bearing
8. Bearing Retainer
9. Pivot Eye Structure
10. Cover Ring
11. Capscrew (12pt. - G9
12. Locknut
13. Bearing Carrier
14. Clamp

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7. Charge front suspension as described in "Oiling and Charging Procedure", Section "H".
8. Charge rear suspensions with nitrogen to fully extend pistons.
9. Remove blocks or stands from beneath the frame.
10. Release nitrogen from rear suspensions and charge suspensions according to procedure in "Oiling and Charging Procedure", Section "H".

⚠WARNING

Before removing blocks from the wheels, make sure parking brake is applied.

11. Remove blocks from wheels.

PIVOT EYE BEARING

Disassembly

1. Remove locknuts (6, Figure 4-2) and capscrews (5) and bearing retainers (2).
2. Remove spherical bearing (4) from bearing carrier (3).
3. Inspect all parts for wear or damage. Replace parts showing excessive wear or damage.

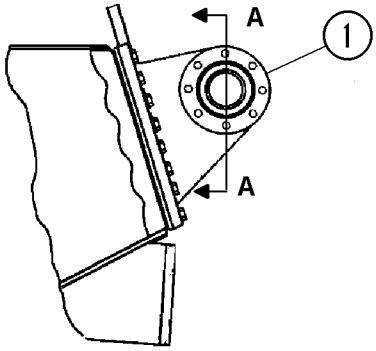
   Spherical Bearing Outer Race O.D.: 8.75.00 - 8.7488 in. (222.25 - 222.22 mm)

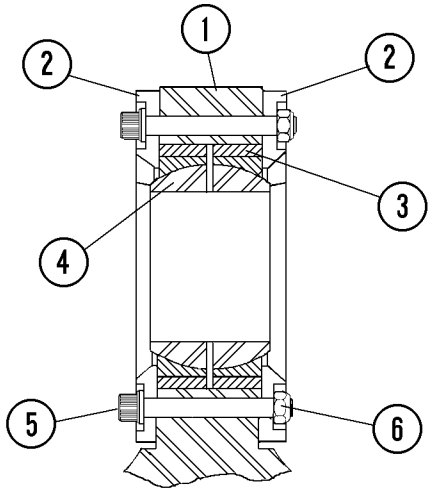
   Bearing Bore I.D.: 5.9990 - 6.0000 in. (152.37 - 152.40 mm)

   If bearing carrier (3) is damaged or worn, refer to "PIVOT EYE REPAIR".

Assembly

1. Setup an appropriate tool to press spherical bearing (4, Figure 4-2) into bearing carrier (13). Be sure bearing outer race is flush with bearing carrier sides.
2. Install bearing retainers (2) with capscrews (5) and locknuts (6). Tighten capscrews to **360 ft. lbs. (488 N.m)** torque.





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FIGURE 4-2. PIVOT EYE BEARING INSTALLATION

1. Pivot Eye Structure
2. Bearing Retainer
3. Bearing Carrier
4. Bearing
5. Capscrew (G9)
6. Locknut

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PIVOT EYE REPAIR

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

Removal

To remove the axle housing pivot eye:

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

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

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

Disassembly

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

   Bearing Carrier (new):

   I.D. 8.7484 ± 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.

   Pivot Eye Bore (new):

   9.7500 ± 0.0005 in. (247.650 ± 0.013 mm)

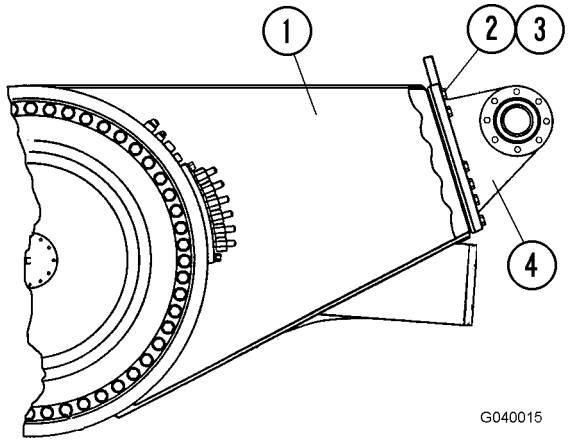


FIGURE 4-3. PIVOT EYE ATTACHMENT

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

Assembly

1. Setup an appropriate tool to press bearing carrier (3, Figure 4-2) into the bore of the pivot eye structure (1). Be certain the bearing carrier is pressed fully into the pivot eye bore, flush with sides. Lube groove in bearing carrier outer diameter must align with lube fitting hole in pivot eye structure.

NOTE: With parts to correct size, the fit of the bearing carrier into the bore of the pivot eye structure may be: 0.0010 in. - 0.0030 in. (0.025 mm - 0.08 mm) ***interference*** *fit.*

Freezing the bearing carrier will ease installation.

2. Install spherical bearing (4) as described in **"Pivot Eye Bearing, Assembly"**.

Installation

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

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ANTI-SWAY BAR

Removal

1. Position frame and final drive case to enable use of a puller arrangement to remove anti-sway bar pins (7, Figure 4-4) on the rear axle housing and frame. Note that the parts on both ends are identical.
2. Block securely or place stands under each side of frame beneath hoist cylinder mounting area.
3. Remove lubrication lines and position a fork lift to remove anti-sway bar.
4. Remove capscrews (1) and locknut (2) from both pins.
5. Attach puller and remove pin (3) at each end of the anti-sway bar.
6. Remove anti-sway bar from mount (10).
7. Remove bearing spacers (3).

Installation

1. Start the pin (7) in through the front of the frame mount (10) and one of the spacers (3). Rotate the pin to align the retaining capscrew (1) hole with the hole in the mounting bracket.
2. Raise the anti-sway bar (9) into position and finish pushing the pin (7) through to the far side of the spherical bearing. Position the other spacer (3) and finish pushing the pin into the other mounting ear. If necessary, realign the pin with the mounting bracket retainer capscrew hole. Install retaining capscrew and locknut. Install capscrew (5) and lockwasher (6) if removed.
3. Repeat above procedure to install remaining pin, spacers, and retainer capscrew and locknut. Start the pin into the bore of the rear axle housing from the rear of the truck.
4. Attach lubrication lines.
5. Remove blocks or stands from under frame.
6. Charge suspensions if necessary. Refer to Section "H" for suspension charging.

Disassembly

1. Remove snap rings (4) from bores of both ends of anti-sway bar.
2. Press out spherical bearing (8).

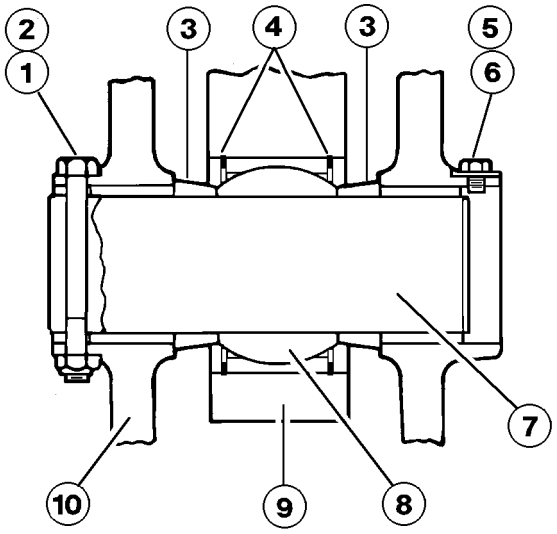


FIGURE 4-4. ANTI-SWAY BAR INSTALLATION (Typical, Both Ends)

1. Retainer Capscrew
2. Locknut
3. Bearing Spacer
4. Snap Ring
5. Capscrew
6. Lockwasher
7. Pin
8. Bearing
9. Anti-Sway Bar
10. Mounting Structure

Cleaning and Inspection

1. Inspect bearing bores of anti-sway bar. If bores are damaged, repair or replace anti-sway bar.
2. Inspect bearing spacers (3) for damage or wear.

Assembly

1. Press in new bearings.
2. Install snap rings.

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REAR AXLE HOUSING

REAR AXLE HOUSING

Removal

1. Remove the dump body as outlined in Section "B".

NOTE: It is not necessary to remove the rear axle assembly to service the anti-sway bar or pivot pin.

2. Loosen hose clamps and disconnect wheel motor cooling flexible air duct from connection on front center of housing.
3. Mark and disconnect lube and brake lines from center case.
4. Mark electrical cables for identification and disconnect at wheel motors. Loosen cable grips and pull cables free.
5. Remove rear tires as covered in this section.
6. Remove wheel motors as covered in this section.
7. Block up truck frame and remove rear HYDRAIR® suspensions as outlined in Section "H".
8. Remove pivot pin as outlined previously in this Section.
9. Remove anti-sway bar as outlined earlier in this Section.
10. Move housing from under truck for repair or replacement.

Installation

1. Position axle housing under frame.
2. Align pivot pin bores and install pivot pin.
3. Install anti-sway bar.
4. Install rear suspensions, as covered in Section "H", Suspensions.
5. Install wheel motors.
6. Hook up lube lines on wheel motors.
7. Route electrical cables through cable grips on right hand end of axle.
8. Connect electrical cables to motorized wheels inside axle housing using identifications made at removal.
9. Reconnect all brake lines, air and remaining lube lines. Bleed brake and lube lines.
10. Reconnect wheel motor cooling air duct and clamp securely.
11. Install wheels and tires.

WHEEL MOTOR

Removal

1. Block front wheels to prevent movement. Turn key switch "Off". Wait for 90 seconds to bleed hydraulic pressure from the steering system. Turn the steering wheel to ensure no hydraulic pressure remains. Open the drain valves on the brake accumulators and bleed off hydraulic pressure.
2. Raise the rear of truck, using jack adapter as described in "Wheels and Tires", this Section, until tires clear the ground. Use support stands or cribbing to block under rear housing.
3. Remove the inner and outer wheels from wheel motor. Refer to "Wheels and Tires", this Section, for wheel removal instructions.
4. Drain oil from wheel motor gear case.

NOTE: To aid in assembly tag all lines and electrical connections prior to disassembly.

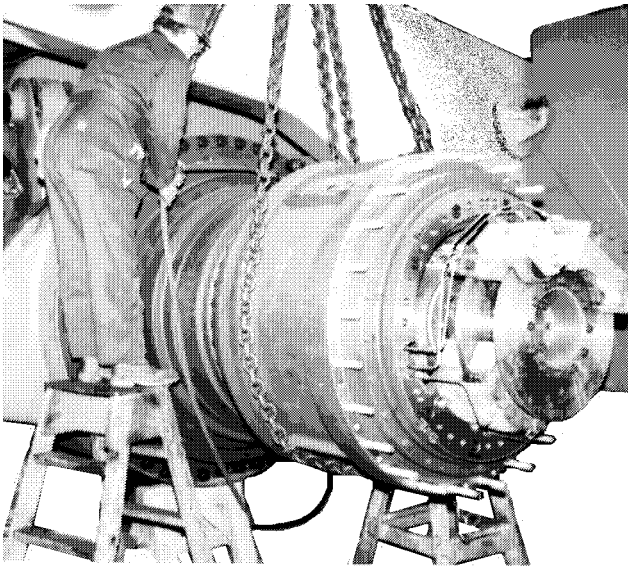


FIGURE 5-1. WHEEL MOTOR REMOVAL AND INSTALLATION

(Shown with the body removed.)

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5. Disconnect brake, lubrication and electrical connections from wheel motor.

⚠WARNING

The wheel motors weigh approximately 25,750 lbs. (11,680 kg.). Make sure lifting device is capable of handling the load safely.

6. Attach a lifting device to wheel motor and take up slack. Figure 5-1 illustrates use of an overhead crane if the body has been removed. Remove capscrews securing wheel motor to rear housing. Refer to appropriate General Electric Service Manual for complete service instructions on electric wheel motor.

Cleaning and Inspection

1. Thoroughly clean the capscrew holes and mounting faces of the rear housing and the wheel motor.
2. Check mounting faces of wheel motor and rear housing for nicks, scratches or other damage.

Installation

Maximum Capscrew Usage

⚠WARNING

High tightening force is required to attach wheel motors. Repeated tightening operations will cause capscrew material to fatigue and break. DO NOT reuse mounting hardware (capscrews and hardened washers) more than twice after original installation (3 total - see NOTE below). Replace capscrews and washers after third use.

NOTE: 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 . . . . . .No (0) marks.
- ❑ Second Installation . . . . . One (1) punch mark.
- ❑ Third Installation . . . . . Two (2) punch marks.

Wheel motor mounting capscrews are specially hardened bolts that meet or exceed Grade 8 specifications. Replace only with bolts of correct hardness. Refer to Komatsu Parts Catalog for correct part number. Before installation, inspect each capscrew for any defects and number of punch marks. Replace capscrew and related hardware 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 all wheel motor mounting hardware if the truck was operated with the wheel motor mounting in a loose joint condition.

1. Install two guide pins 180° apart in the rear housing.

⚠WARNING

The wheel motors weigh approximately 25,750 lbs. (11,680 kg). Make sure lifting device is capable of handling the load safely.

2. Lift wheel motor into position on the rear housing. Make sure all cables and lines are clear before installation. (Figure 5-1).
3. Install lubricated capscrews and flat washers securing wheel motor to rear housing. Snug up all capscrews and then final tighten (alternating capscrews 180° apart) to **1480 ft. lbs. (2007 N.m)** torque.
4. Connect all cables and lines to their appropriate location on the wheel motor.
5. Insure wheel motor breathers are properly installed. No sharp bends, or kinks in hoses are allowed in any line between the wheel motors and the breathers. Install wheel cover.
6. Fill wheel motor gear with oil specified in Section "P", "Lubrication and Service".
7. Install tires and rims using procedures outlined earlier in this section.
8. Raise truck, remove support stands. Lower truck and remove jack.
9. Close bleeder valves on brake accumulators and bleed brakes as outlined in Section J.

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SECTION H
HYDRAIR® II SUSPENSIONS
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FRONT SUSPENSION

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

The front suspension cylinders consist of two basic components; a suspension housing attached to the truck frame and a suspension rod attached to the front spindle. Check valves and orifice dampening holes control suspension travel to provide good ride qualities on haul roads under loaded and empty conditions. The front suspension rods also act as kingpins for steering the truck.

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

Removal

1. Park unloaded truck on hard level surface. Block wheels and apply parking brake. Remove front wheel and tire according to “Removal” instructions in Section “G”, Front Tire and Rim. Remove front wheel hub and spindle as covered in Section “G”.
2. Remove boot clamp and boot from around suspension. Disconnect pressure sensor.
3. Discharge nitrogen pressure from suspension by removing cap from charging valve (5, Figure 2-1). Turn the charging valve swivel nut (small hex) (3, Figure 2-2) counterclockwise 3 full turns to unseat valve seal (DO NOT turn more than three turns). **DO NOT TURN LARGE HEX (4)** (see DANGER below). Wearing face mask or goggles, depress valve stem until all nitrogen pressure has been relieved.

⚠DANGER

Make certain only the swivel nut (3) turns. Turning the complete charging valve assembly may result in the valve assembly being forced out of the suspension by the gas pressure inside.

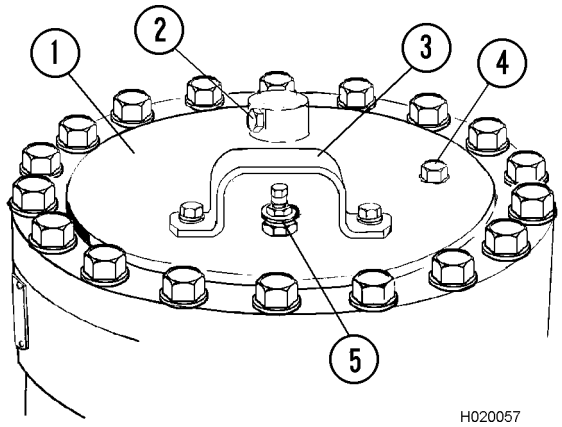


FIGURE 2-1. SUSPENSION CAP

1. Cap Structure
2. Sensor Port Plug
3. Charging Valve Guard
4. Vent Plug
5. Nitrogen Charging Valve

4. After all nitrogen pressure has been relieved, loosen large hex (4) and remove charging valve assembly. Discard flat gasket under large hex.

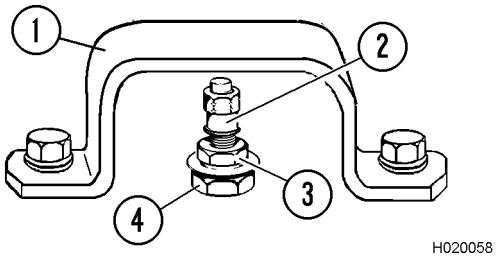


FIGURE 2-2. CHARGING VALVE INSTALLATION

1. Valve Guard
2. Valve Cap
3. Swivel Nut (Small He
4. Valve Body (Large

5. Place a suitable container under suspension cylinder. Remove bottom drain plug and allow cylinder to drain completely.

NOTE: Front HYDRAIR®II suspensions are equipped with lower bearing retainer puller holes. If only rod wiper, rod seals, bearing, O-ring and backup ring replacement is required, it will not be necessary to remove suspension from truck. Refer to “Minor Repair Only (Lower Bearing Structure & Seals)” for bearing structure removal and installation.

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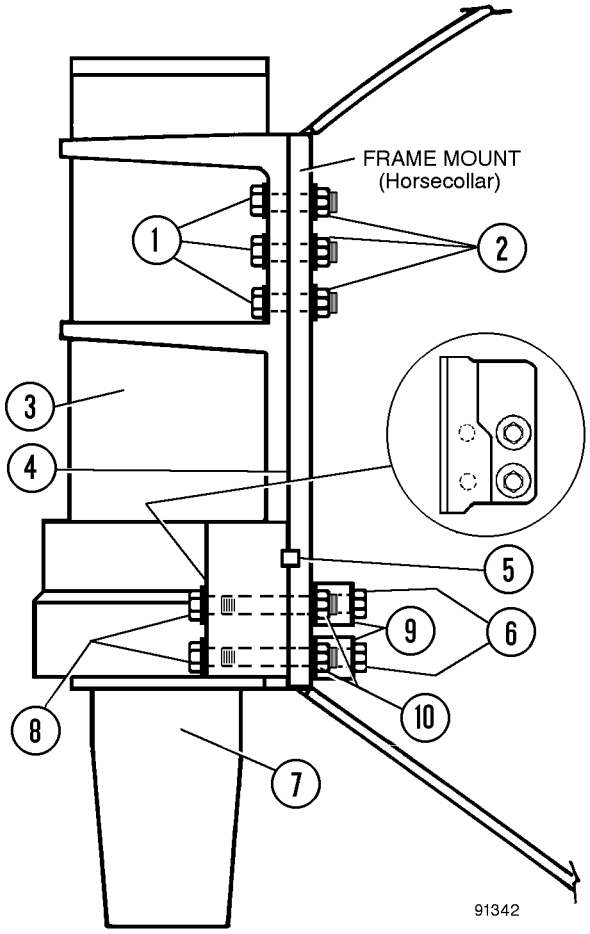


FIGURE 2-3. SUSPENSION INSTALLATION

1. Capscrews & Washers
2. Nuts & Washers
3. Housing
4. Mounting Surface
5. Shear bar
6. Capscrews & Washers
7. Piston
8. Capscrews & Washers
9. Spacer
10. Nuts & Washers

6. If major suspension rebuild is required, continue removal procedure.
7. Attach fork truck or suitable lifting device to suspension. Secure suspension to lifting device.

⚠WARNING

The front HYDRAIR® II suspension weighs approximately 4900 pounds (2225 kg). Be certain the lifting device to be used is of sufficient capacity to handle load.

8. Remove capscrews and washers (1, Figure 2-3) and nuts and washers (2).
9. Remove capscrews and washers (8), and nuts and washers (10).
10. Remove capscrews and washers (6), and spacers (9).
11. Move suspension to a clean work area for disassembly.

Installation

Use the following procedure for preparing mounting surfaces and mounting hardware.

1. The mounting surface of both the suspension and the frame must be clean and dry. Use a cleaning agent that does not leave a film after evaporation, such as trichlorethylene, tetrachlorethylene, acetone or lacquer thinner.

⚠WARNING

When using a cleaning agent, follow the manufacturer's instructions for use, proper ventilation and/or use of breathing apparatus.

2. Inspect suspension and frame mounting surfaces and spotfaces for flatness. Surface finish must not exceed 250 (RMS) (medium tool cut). Surface flatness must be within 0.010 in. (0.254 mm).
3. Clean and dry all capscrews, nuts and washers as stated in Step 1, above.

NOTE: The use of dry threads in this application is not recommended. Due to the high tightening forces required to load these capscrews, dry threads may cause damage to tools.

4. Lubricate capscrew threads, capscrew head seats, washer face, and nut seats with a rust preventive compound. Approved sources are:
   - AMERICAN ANTI-RUST GREASE #3-X from Standard Oil Division of American Oil Company.
   - RUSTOLENE D grease from Sinclair Oil Company.
   - GULF NORUST #3 from Gulf Oil Company.
   - RUST BAN 326 from Humble Oil Company.
   - 1973 RUSTPROOF from the Texas Company.
   - RUST PREVENTIVE GREASE-CODE 362 from the Southwest Grease and Oil Company.

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NOTE: If none of the rust preventive greases listed above are available for field assembly, use one of the following lubricants:

- SAE 30 weight oil.
- 3% Molybdenum - Disulphide Grease

MAXIMUM CAPSCREW USAGE

⚠WARNING

High tightening force is required to load front suspension mounting capscrews. Repeated tightening operations will cause capscrew material to fatigue and break. DO NOT reuse mounting hardware (capscrews, hardened washers, and nuts) more than twice after original installation (3 total - see NOTE below). Replace capscrews, washers and nuts after third use.

NOTE: 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 ..... No (0) marks.
- ❑ Second Installation ..... One (1) punch mark.
- ❑ Third Installation ..... Two (2) punch marks.

Suspension mounting capscrews are specially hardened bolts that meet or exceed Grade 8 specifications. Replace only with bolts of correct hardness. Refer to Komatsu Parts Catalog for correct part number. Before installation, inspect each capscrew for any defects and number of punch marks. Replace capscrew and related hardware 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 all suspension mounting hardware, if the truck was operated with the suspension mounting in a loose joint condition.

5. Attach fork truck or lifting device to suspension and mount suspension to the truck frame making certain shear bar (5, Figure 2-3) is flush with end of suspension keyway. Install fourteen capscrews (1, 6, 8) with hardened washers and nuts. (A flatwasher is used under each capscrew head and each nut. See Figure 2-4 for washer installation.) The four bottom holes tapped into suspension housing require capscrews (6) with hardened washers, and spacers (9) only.

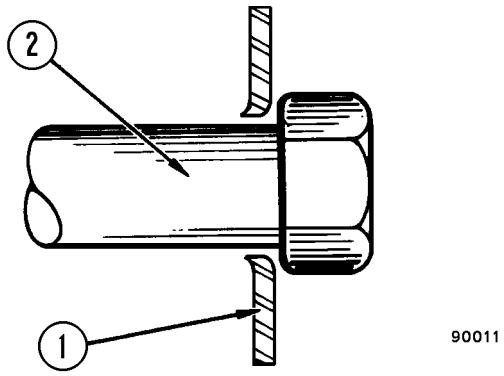


FIGURE 2-4. HARDENED WASHER INSTALLATION

1. Hardened Washer 2. Grade 8 capscrew

NOTE: Special hardened flat washers are punched during the manufacturing process, therefore when used under the capscrew head they must be assembled with the inside diameter radius of the hole toward the head (punch lip away from head) to prevent damage to the fillet between capscrew head and shank. See illustration above.

6. The capscrews are now ready for tightening using the "Turn-of-the-Nut" Tightening Procedure described on the following page.

NOTE: The "Turn-of-the-Nut" tightening procedure was developed for high strength 1 1/2" UNC capscrews (grade 8 or better) in this joint application only. Do not use this tightening method for other joint types or capscrews of lesser grade/size.

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"TURN-OF-THE-NUT" Tightening Procedure

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

b. Maintain this torque on the top two corner capscrews and the bottom outer four capscrews (item 8, the 4 bottom capscrews with nuts).

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

d. For the four, 6.0 in. (15 cm) long capscrews (1, Figure 2-3) at the upper mount, tighten capscrews initially to **70 ft. lbs. (95 N.m)** torque; then advance capscrew head 60° using steps d-1.) through d-3.). Refer to Figure 2-5.

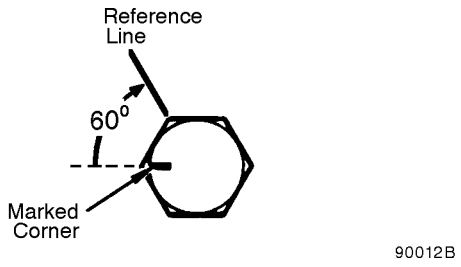


FIGURE 2-5. REFERENCE MARKS FOR 60° ADVANCE (6.0 in. Capscrews)

For the four **inner,** 12.5 in. (32 cm) long capscrews (6, Figure 2-3), tighten capscrews initially to **150 ft. lbs. (203 N.m)** torque; then advance capscrew head 90° using steps d-1). through d-3). Refer to Figure 2-6.

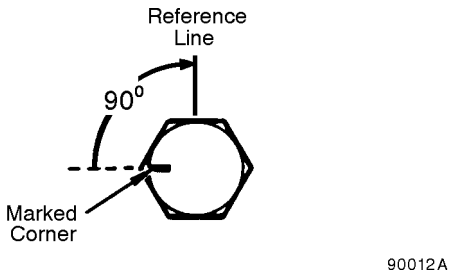


FIGURE 2-6. REFERENCE MARKS FOR 90° ADVANCE (12.5 in. Capscrews)

1.) Mark a reference line on a corner of the hexagonal capscrew head or nut and the mounting surface opposite this corner as shown. Then mark the position located 60° or 90° clockwise relative to the first reference line on the mounting surface. Refer to Figures 2-5 and 2-6.

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

3.) Each corner of a hexagon represents 60°. The turning members, either the capscrew head or nut, is turned until the marked corner is adjacent with the marked reference line. Check to make sure that the opposite end of the turning member has NOT turned during the tightening procedure. ***NOTE: Do not exceed 4 RPM tightening speed. Do not hammer or jerk wrench during the tightening procedure.***

e. Loosen the **top two** corner capscrews (1) and the bottom **outer four** capscrews (8, the 4 bottom capscrews with nuts).

1.) Tighten the top, two corner 6.0 in. (15 cm) capscrews to **70 ft. lbs. (95 N.m)** torque, then use "turn-of-the-nut" method to advance capscrew heads 60°.

2.) Tighten the bottom, outer four 12.5 in. (32 cm) capscrews to **150 ft. lbs. (203 N.m)** torque, then use "turn-of-the-nut" method to advance capscrew heads 90°.

NOTE: If for any reason, these fasteners need to be checked for tightness after completing the above procedure; loosen and inspect all 14 capscrews and repeat entire process, starting with cleaning and lubricating capscrews, washers, and nuts. In addition, the capscrew head will need to be appropriately marked to show an additional use.

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

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MINOR REPAIR ONLY
(Lower Bearing Structure & Seals)

Bearing Structure Removal

If only rod seals, O-rings, and backup rings (and if necessary, bearing structure) are to be replaced, refer to steps below for lower bearing structure removal.

1. Remove lower bearing structure capscrews and hardened washers (18 & 19, Figure 2-8). Install pusher bolts into tapped holes in bearing flange.
2. Tighten pusher bolts evenly and prepare to support bearing structure as it exits the suspension housing. Remove bearing (16).
3. Remove wiper (26), rod lip seal (25), and buffer seal (24). Remove O-ring (20) and backup ring (21).

Bearing Structure Installation

1. Install new rod buffer seal (24, Figure 2-8), lip seal (25) and rod wiper (26).

⚠ IMPORTANT ⚠

When installing backup rings with rod seal (25) and buffer seal (24), be certain radius is positioned toward the seal as shown in Figure 2-8.

2. Install new O-rings (20) and backup rings (21) in their appropriate grooves in the lower bearing structure (16).

NOTE: Backup rings must be positioned toward the flange of bearing structure as shown in Figure 2-9.

3. Install temporary, guide bolts to ensure bolt hole alignment as bearing retainer is seated. Lift lower bearing structure (16) assembly into place and carefully start into suspension housing. Install capscrews and hardened washers (18 & 19). Tighten capscrews to **310 ft. lbs. (420 N.m)** torque.
4. Install wheel, tire and spindle assembly. Refer to steps in Section “G”, *“Wheel, Tire and Spindle Installation”* for installation instructions.

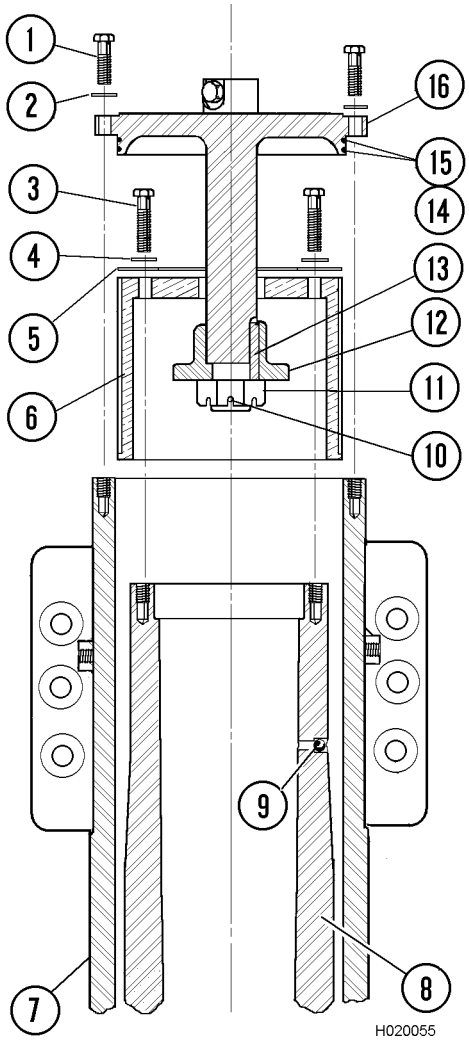


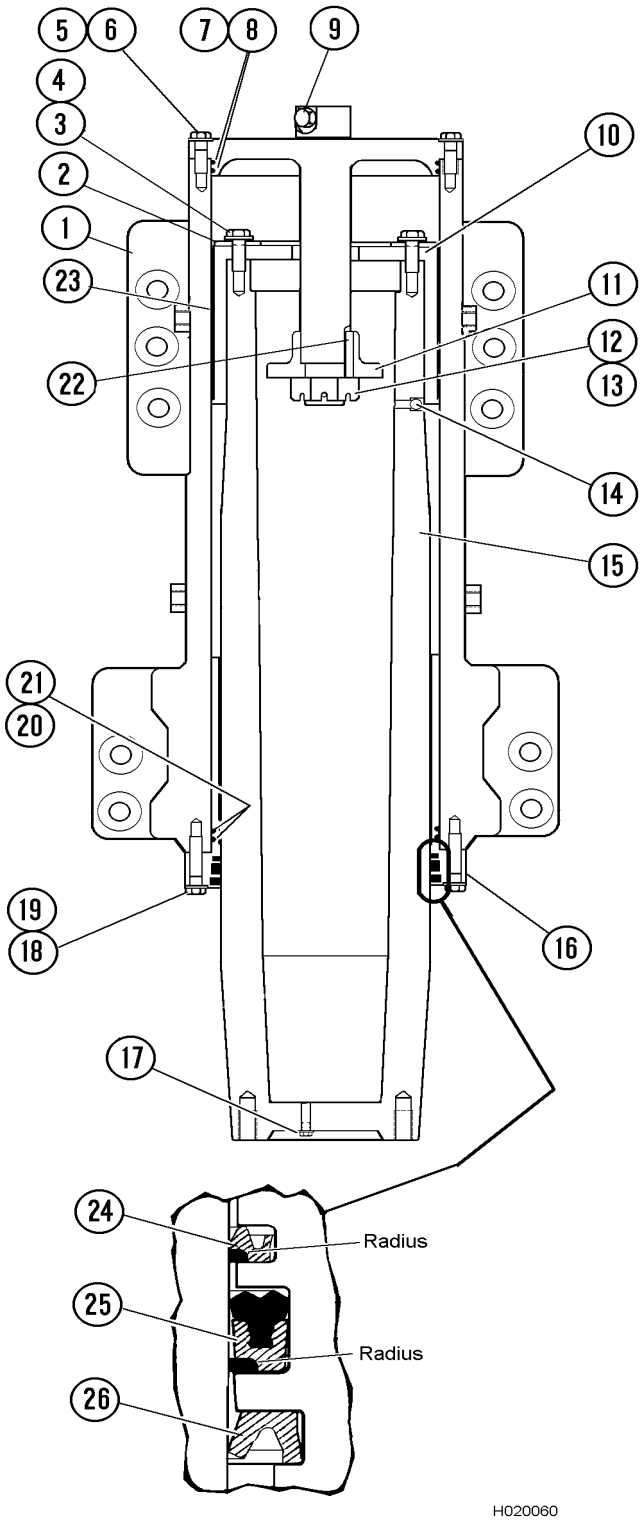
FIGURE 2-7. PISTON ROD REMOVAL

1. Capscrew
2. Hardened Flatwasher
3. Capscrew
4. Hardened Flatwasher
5. Plate
6. Upper Bearing Structure
7. Housing
8. Piston
9. Steel Ball (2 ea.)
10. Roll Pin
11. Nut
12. Piston Stop
13. Key
14. O-Ring
15. Backup Ring
16. Cap Structure

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FIGURE 2-8. SUSPENSION ASSEMBLY

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



MAJOR SUSPENSION REBUILD

Disassembly

NOTE: Refer to your Komatsu Distributor for HYD-RAIR®II repair information and instructions not covered in this manual.

1. With suspension held in a vertical position (end cap up), remove capscrews (1, Figure 2-5) and hardened washers (2). Attach hoist to end cap structure (16) and lift end cap out of suspension housing (7) until piston stop (12) contacts upper bearing structure (6). Remove capscrews (3) and hardened washers (4). Lift cap structure and bearing from housing.
2. Remove roll pin (10), nut (11), piston stop (12) and key (13). Separate cap and bearing. Remove O-rings (14) and backup rings (15). Remove bearing (6).
3. Rotate the suspension 180°.

NOTE: Steel balls (9) will fall free when the housing is rotated.

4. Attach lifting device to the piston (8) and carefully lift out of housing.
5. Remove capscrews and washers (18 & 19, Figure 2-8). Install pusher bolts and remove lower bearing structure (16).
6. Remove and discard rod wiper seal (26) lip seal (25) and buffer seal (24). Remove and discard O-rings (20) and backup rings (21).

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Assembly

NOTE: All parts must be completely dry and free of foreign material. Lubricate all interior parts with clean HYDRAIR® suspension oil (see Oil Specification under "Oiling and Charging Procedure").

⚠ IMPORTANT ⚠

Take care not to damage the machined or plated surfaces, O-rings or seals when installing piston assembly.
When installing backup rings with rod lip seal (25) and buffer seal (24), be certain radius is positioned toward the seal as shown in Figure 2-8.

1. Install new rod buffer seal (24, Figure 2-8), lip seal (25), and rod wiper (26).
2. Install new O-rings (20) and backup rings (21) in their appropriate grooves in the bearing structure (16).

NOTE: Backup rings must be positioned toward bearing retainer bolt flange as shown in Figure 2-9.

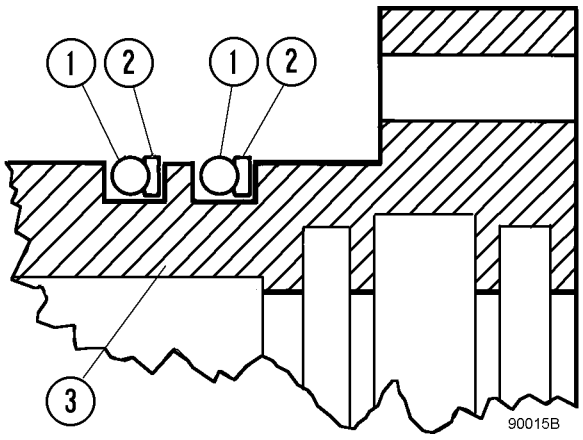


FIGURE 2-9. BACKUP RING PLACEMENT

1. O-Ring
2. Backup Ring
3. Bearing Structure

3. Install lower bearing assembly (16) into lubricated suspension housing. Install capscrews and hardened lockwashers (18 & 19) through retainer flange and into tapped holes in housing. Tighten to **310 ft. lbs. (420 N.m)** torque.
4. Install new backup rings and O-rings (14 & 15, Figure 2-7) in end cap grooves. Backup rings must be positioned toward the flange on the end cap.
5. Slide upper bearing structure (6) over cap structure rod.
6. Install key (13) and piston stop (12) on cap structure rod. Make sure piston stop is fully seated against the rod shoulder. Install locknut (11) against piston stop. Tighten locknut one half turn further, until hole for the roll pin (10) is in alignment. Install roll pin.
7. Attach a lifting device to top side of end cap assembly. Lower assembly down on piston (8). Insert steel balls (9) in holes in piston prior to fully seating bearing on top of piston. A small amount of petroleum jelly will prevent the balls from dropping out during assembly.
8. Install upper bearing structure (6) onto piston rod. Secure bearing in place with NEW capscrews (3) and hardened washers (4). Tighten capscrews to **500 ft. lbs. (678 N.m)** torque.

NOTE: ALWAYS use new capscrews (3, Figure 2-7) during assembly. Used capscrews will be stressed and fatigued because of loads imposed on these capscrews during operation.

10. Apply a light coating of petroleum jelly to the seals, wiper and bearings. With suspension housing in a vertical position, carefully lower the piston rod and end cap assembly into the bore of the cylinder housing to its fully retracted position
11. Install capscrews and hardened washers (1 & 2) and tighten to **310 ft. lbs. (420 N.m)** torque.
12. Install bottom plug (17, Figure 2-6) and tighten to **13 ft. lbs. (17.5 N.m)** torque.
13. Install charging valve (5, Figure 2-1) using a new flat gasket under the large hex (valve body). Tighten large hex of charging valve to **16.5 ft. lbs. (27.4 N.m)** torque.
14. Install remaining plugs and/or pressure sensor.
15. Pressure test according to instructions on the following page.

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PRESSURE TEST

After rebuild is complete, suspension assembly should be tested for leakage.

⚠ IMPORTANT ⚠

When pressure testing, suspension must not be allowed to extend. Assembly must be mounted in a container that is adequate to prevent piston extension.

1. Using air or nitrogen, pressurize suspension to 1100 ±200 psi (7585 ±1380 kPa) through the charging valve and maintain pressure for twenty (20) minutes minimum.

   ❑ No leakage is permissible.

2. Release pressure from suspension assembly and remove from containment structure. Do not remove charging valve.
3. Install charging valve guard.
4. If suspension is to be stored, install suspension oil prior to storage. (Refer to *"Front Suspension Oiling"*, this section.)
5. Protect exposed chrome surface to prevent damage during storage and handling.
6. Protect remaining exposed, machined surfaces with a rust preventive grease.

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REAR SUSPENSIONS

The HYDRAIR® II suspensions are hydro-pneumatic components containing oil and nitrogen gas. The oil an gas in the four suspensions carry the gross truck weight less wheels, spindles and final drive assembly. The rear suspension cylinders consist of two basic components; a suspension housing attached to the rear axle housing, and a suspension rod attached to the frame.

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

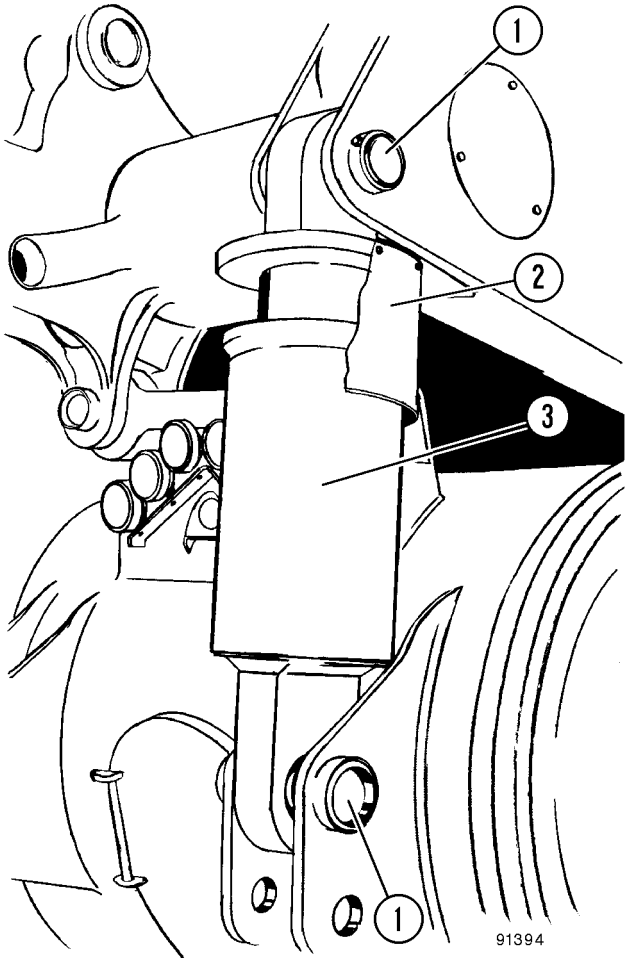


FIGURE 3-1. REAR SUSPENSION INSTALLATION

1. Mounting Pins
2. Piston Rod Shield
3. Suspension Cylinder

Removal

TABLE 1. TOOL LIST FOR SUSPENSION PIN REMOVAL

Part Number	Description	Quantity
EJ2847	Pin Removal Tool	2
EJ2848	Cylinder	1
EJ2849	Hand Pump	1
EJ2850	Shackle	2
VN2707	Capscrew (0.625-11UNC x 2.75 in)	4

NOTE: Suspension mounting pins must contain threaded holes at the inboard end of each pin in order to use the removal tools listed above. If the pins do not contain the necessary holes, new pins may be purchased, or a rework of the pins is necessary. Refer to Figure 3-5 for pin rework details.

1. Remove capscrews, washers, and metal shield (2, Figure 3-1) from the suspension.
2. Remove charging valve cap, (1, Figure 3-2) loosen small hex (4) on charging valve and turn counterclockwise three full turns to unseat valve seal. Connect suspension charging kit.

⚠WARNING

Make certain only the swivel nut turns. Turning the complete charging valve assembly may result in the valve assembly being forced out of the suspension by the gas pressure inside.

3. If necessary, charge the suspension to be removed with dry nitrogen until the rod is exposed approximately 5.0 in. (127 mm).
4. Place stands or cribbing under the truck frame at each hoist cylinder mount
5. Open valve on suspension charging kit to release nitrogen from the suspension. Disconnect charging kit.
6. Disconnect lubrication lines. Disconnect pressure sensor cable.
7. Position a fork lift under the suspension housing, above the lower mounting pin. Secure suspension to fork lift.

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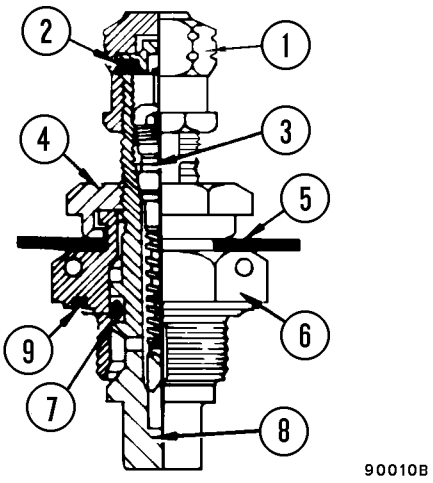


FIGURE 3-2. NITROGEN CHARGING VALVE

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

NOTE: The mounting arrangement for the top and bottom pins is identical.

8. Remove locknuts (3, Figure 3-3) and capscrews (2) at upper and lower pins (1) just on the suspension cylinder to be removed.
9. Install pin removal tool (1, Figure 3-4) to each lower pin using the capscrews listed in Table 1. Tighten the capscrews to **177 ± 17 ft.lbs (240 ± 24 Nm)** torque.

⚠WARNING

The rear HYDRAIR® II suspension weighs approximately 2,400 pounds (1088 kg.). Be certain the capacity of the lifting device used is sufficient for lifting this load.

10. Position a fork lift (or other suitable lifting device) under the suspension to be removed and secure it to the lifting device.
11. Attach both shackles (2) to cylinder (3).
12. Attach each shackle to pin removal tools (1).

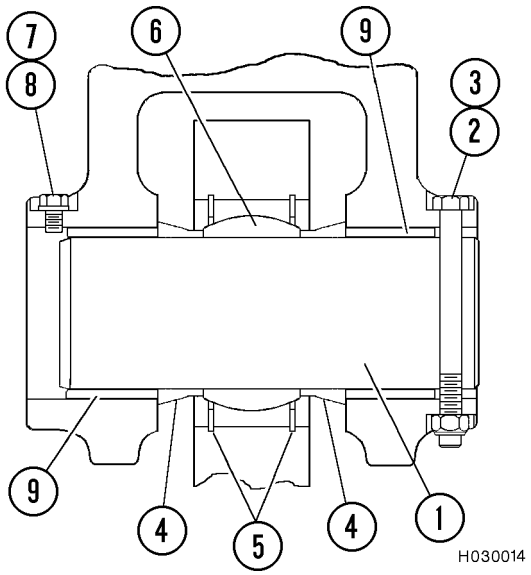


FIGURE 3-3. SUSPENSION MOUNTING PIN
(Typical, Top and Bottom)

1. Pin
2. Capscrew
3. Locknut
4. Bearing Spacer
5. Retainer Ring
6. Bearing
7. Capscrew
8. Washer
9. Sleeve

⚠WARNING

Do not exceed 10 tons of force when applying pressure to the cylinder. Damage to the tool or suspension components may result, as well as personal injury to maintenance personnel

13. Apply pressure to the cylinder using the hand pump (not shown).
14. When the cylinder reaches the end of its stroke, remove one of the shackles from the cylinder and connect the cylinder shackle directly to the pin removal tool. This is necessary to pull the pin the remaining distance.
15. Remove the pin from the lower mounting.
16. Install the tool on the upper pins and repeat the pin removal process. (If the pin does not contain the necessary puller holes, an alternative removal method is needed.)

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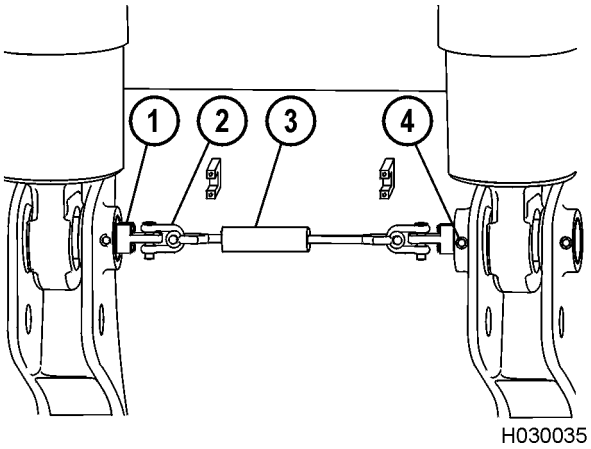


FIGURE 3-4. REAR SUSPENSION PIN REMOVAL TOOL

1. Pin Removal Tool
2. Shackle
3. Cylinder
4. Capscrew

17. Remove the cylinder from the truck. Clean the exterior of the suspension thoroughly and move to a clean work area for disassembly.
18. If it is necessary to remove the remaining rear suspension cylinder, insert the pins back into the upper and lower mountings.
19. Secure the pins using locking capscrews (4), and repeat the removal process for the remaining suspension cylinder.

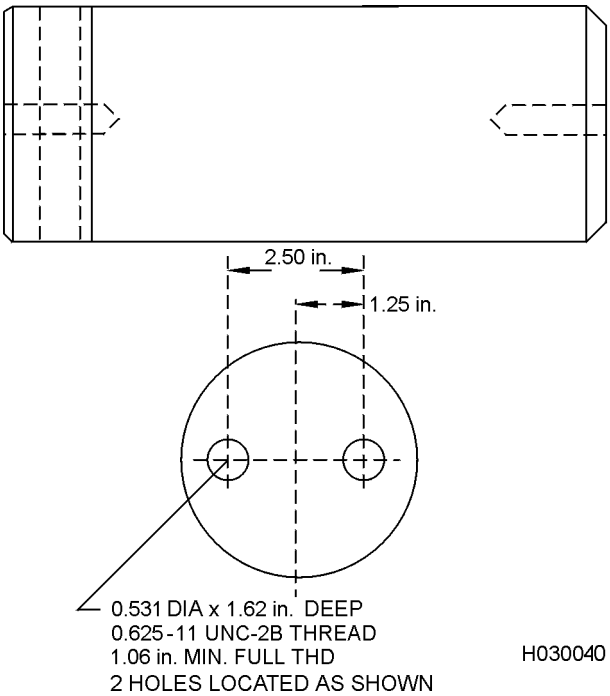
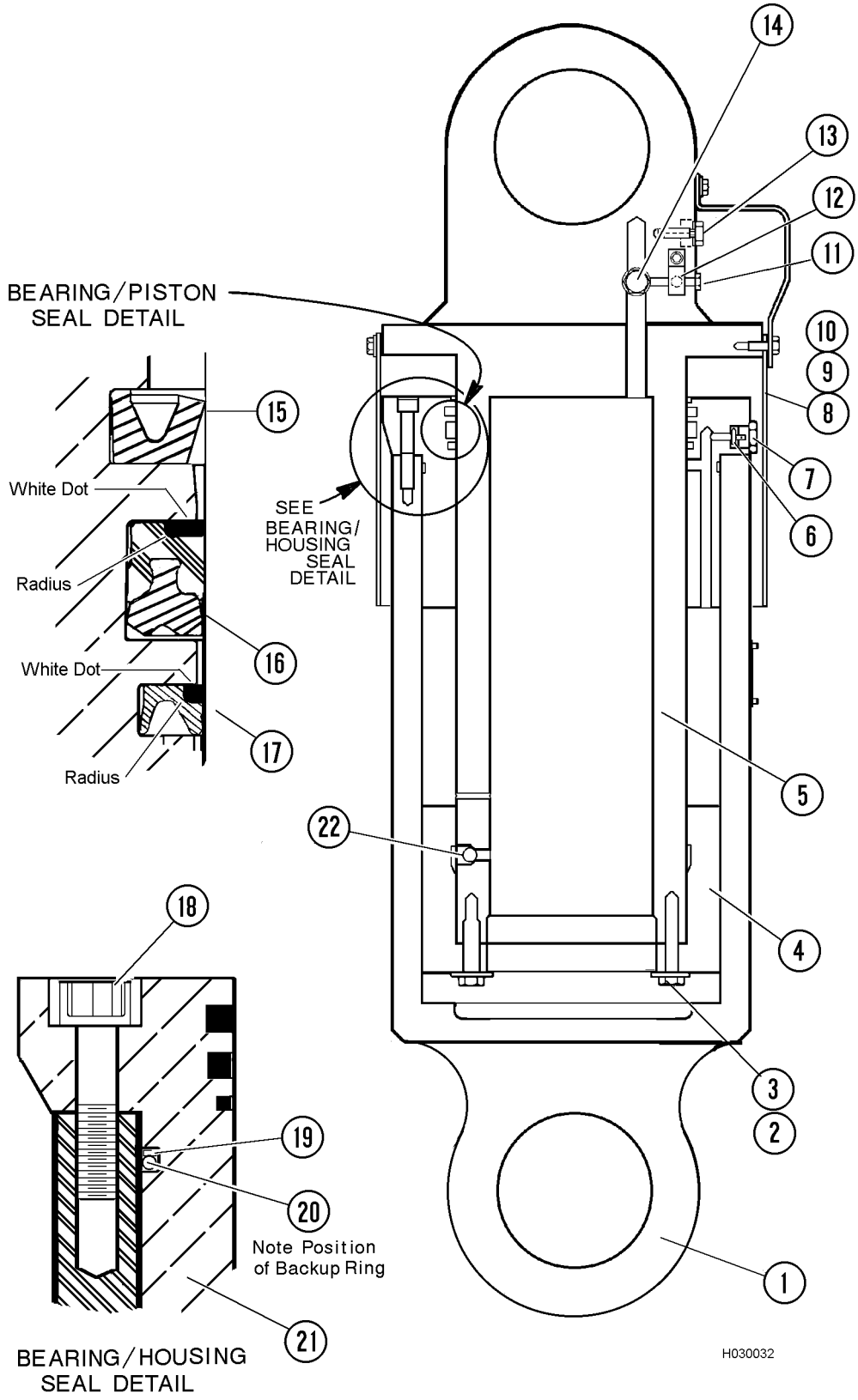


FIGURE 3-5. SUSPENSION PIN REWORK

Installation

1. Inspect mounting bore sleeves (9, Figure 3-3) and bearing spacers for damage or wear. Check fit of pins in bores prior to installing suspension.
2. Secure suspension to fork lift and raise into position. (Suspension assembly should be retracted as far as possible prior to installation.)
3. Position top suspension eye with its spherical bearing, between the ears on the frame as shown in Figure 3-3. Be certain the upper and lower mounting eyes are aligned and the vent plugs are positioned to the rear.
4. Lubricate the pin (1), align the retaining capscrew hole with the hole in the mounting bore and drive in far enough to hold pin in position.
5. Insert the spacer (4) and continue to drive the pin in through the spherical bearing. Insert the remaining spacer and continue to drive the pin in until the retaining capscrew hole is aligned with the hole in the pin.
6. Install capscrew (2, Figure 3-3) and locknut (3). Tighten to **310 ft. lbs. (420 N.m)** torque.
7. Lower the suspension housing until the lower mount bearing aligns with the bore in the rear axle housing and repeat the above procedure to install the bottom pin. The parts in the top and bottom joint are identical.
8. Install the nitrogen charging kit and add nitrogen to raise frame off stands or cribbing, or use a lifting device if available.
9. Connect lubrication lines. Connect pressure sensor.
10. Service the suspension. For instructions, refer to HYDRAIR® II *"Oiling and Charging Procedure"*, this section.
11. Install piston rod shield (2, Figure 3-1) with the capscrews, flat washers, and lockwashers.

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FIGURE 3-6. REAR SUSPENSION ASSEMBLY

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 (or Pressure Sensor)
14. Vent Plug
15. Wiper Seal
16. Rod Lip Seal
17. Buffer Seal
18. Socket Head Capscrew
19. Backup Ring (See note)
20. O-Ring
21. Housing Bearing
22. Ball Check

Disassembly

NOTE: The suspension should be placed in a fixture which will allow it to be rotated 180° vertically.

1. Remove charging valve guard and cover over pressure sensor.
2. Depress charging valve stem to insure all nitrogen gas pressure has been released prior to removing charging valve. Wear face mask or goggles while relieving nitrogen gas.
3. Remove piston protection shields (8), if installed.
4. Remove charging valve (12, Figure 3-4). Remove and discard charging valve gasket. Remove vent plug (14).
5. Remove vent plug (7). Remove bleeder screw (6). Remove pressure sensor or plug (13).
6. Place the suspension in a vertical position (piston rod down). Suspension will contain oil which will drain through the vent ports. Rotate the suspension 180°. Remove socket head capscrews (18) and pull suspension piston assembly (5) from housing (1). The housing bearing (21) will be removed with the piston assembly.
7. Remove capscrew and hardened washers (2 & 3). Remove piston bearing (4) from piston rod. Remove ball checks (22) from piston. Slide the housing bearing (21) off of the piston.
8. Remove and discard wiper seal (15), rod lip seal (16), buffer seal (17), O-ring (20), and backup ring (19) from housing bearing.
9. If the spherical bearings (6, Figure 3-3) require replacement, remove the retainer rings (5). Press bearing out of bore.

Cleaning and Inspection

1. Clean all parts thoroughly in fresh cleaning solvent. Use a solvent that does not leave a film after evaporation, such as Trichlorethylene, Acetone or Lacquer Thinner.

⚠WARNING

When using cleaning agents follow the solvent manufacturer's instructions.

2. Dry all parts completely using only dry, filtered compressed air and lint free wiping materials.
3. Inspect all parts for evidence of wear or damage. Inspect plated surfaces for scratches, nicks or other defects. Replace or repair any damaged parts.

NOTE: If other repairs are necessary, refer to your local Komatsu Distributor for repair information and instructions not covered in this manual.

Assembly

Assembly must be accomplished in a clean, dust free work area. All parts must be completely clean, dry and free of rust or scale. Lubricate all interior parts and bores with fresh suspension oil. (See Oil Specifications under *"Oiling and Charging Procedure",* this section). As an alternate, coat seals, wiper and bearing with a light coat of petroleum jelly.

1. Install the spherical bearing (6, Figure 3-3) in the eye of the piston rod and of the cylinder housing.
2. Place the ring retainers (5) in position to secure the bearings.

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3. Install the wiper seal (15, Figure 3-6), rod lip seal (16), and buffer seal (17). When installing backup rings with rod seal (16) and step seal (17), be certain radius is positioned toward the seal and the white dot is positioned away from the seal as shown in Figure 3-6.
4. Install O-ring (20) and backup ring (19) on the bearing (21). Backup rings must be positioned toward the flange of the bearing.
5. Slide the bearing (21) onto the lubricated piston rod (5).
6. Place the ball checks (22) in the piston and install the piston rod bearing (4) with the capscrews and hardened washers (2 & 3). Tighten the capscrews to **310 ft.lbs. (420 N.m)** torque.
7. With the lubricated housing (1) held in a vertical position, slide the piston assembly part way into the housing. Slide the loose housing bearing down onto the housing and fasten with socket head capscrews (18). Tighten the capscrews to standard torque. Use care during piston installation to prevent damage to machined and chrome surfaces.
8. Install the bleeder screw (6, Figure 3-6) and vent plug (7). Install vent plug (14) and tighten both vent plugs to **64 ft. lbs. (87 N.m)** torque.
9. Install vent plug (11) and pressure sensor or plug (13). Install protective cover.
10. Install shield (8).
11. Using new gasket, install charging valve. Tighten large hex of charging valve to **16.5 ft.lbs. (22.4 N.m)** torque.

PRESSURE TEST

After rebuild is complete, suspension assembly should be tested for leakage.

⚠WARNING

When pressure testing, suspension must not be allowed to extend. Assembly must be mounted in a container that is adequate to prevent piston extension.

1. Using air or nitrogen, pressurize suspension to 1100 ±200 psi (7585 ±1380 kPa) through the charging valve and maintain pressure for twenty (20) minutes minimum.

❑ No leakage is permissible.

2. Release pressure from suspension assembly and remove from containment structure. Do not remove charging valve.
3. Install charging valve guard.
4. If suspension is to be stored, install suspension oil prior to storage. (Refer to *"Rear Suspension Oiling"*, this section.)
5. Protect exposed chrome surface to prevent damage during storage and handling.

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OILING AND CHARGING PROCEDURE

GENERAL

These procedures cover the Oiling and Charging of HYDRAIR®II suspensions on Komatsu Electric Drive Dump Trucks.

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

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

⚠WARNING

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

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

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

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

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

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

EQUIPMENT LIST

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

HYDRAIR® CHARGING KIT

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

Installation of Charging Kit

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

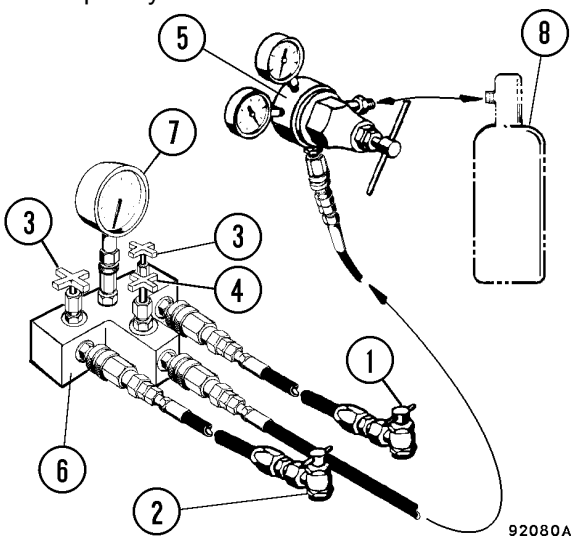


FIGURE 4-1. HYDRAIR® CHARGING KIT

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

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

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3. Ensure outlet valves (3) and inlet valve (4) are closed (turned completely clockwise).
4. Turn swivel nut (small hex) on charging valve three full turns counterclockwise to unseat the valve.
5. Attach charging valve adapters (2) to each suspension charging valve stem.
6. Turn "T" handles (1) clockwise (this will depress core of charging valve and open the gas chamber of the suspension).
7. Open both outlet valves (3).

NOTE: By selective opening and closing of outlet valves (3), and inlet valve (4), suspensions may be charged separately or together.

Removal of Charging Kit

1. Close both outlet valves (3).
2. Turn "T" handles (1) counterclockwise to release charging valve cores.
3. Remove charging valve adapters (2) from charging valves.
4. Tighten swivel nut (small hex) on charging valve. 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 swivel nut to **10.5 ft. lbs. (14.2 N.m)** torque. Again loosen 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).
5. Install charging valve caps and protective covers on both suspensions.

SUPPORT BLOCKS FOR OILING AND CHARGING DIMENSIONS

Prior to starting oiling and charging procedures, supports should be fabricated which will maintain the correct exposed piston rod extensions.

⚠ IMPORTANT ⚠

Rear support blocks for nitrogen charging are no longer necessary. Rear suspensions still require support blocks for oil charging.

Exposed piston rod extensions are specified for both oil level and nitrogen charging for HYDRAIR®II suspensions. These dimensions are listed in the Tables below Figures 4-2 and 4-4. Measure dimensions from the face of the cylinder gland to the machined surface on the spindle at the front suspension. Measure from the face of the cylinder gland to the piston flange at the rear suspension.

Support blocks may be made in various forms. Mild steel materials are recommended. Square stock or pipe segments [1 in. (25 mm) minimum] may be used. Blocks must be capable of supporting the weight of the truck during oiling and charging procedures while avoiding contact with plated surfaces and seals on the suspension. Refer to Figure 4-2 for front suspension support block placement and Figure 4-4 for rear support block placement.

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FRONT SUSPENSION

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

⚠WARNING

All HYDRAIR®II suspensions are charged with compressed nitrogen gas with sufficient pressure to cause injury and/or damage if improperly handled. Follow all the safety notes, cautions and warnings in these procedures to prevent accidents during servicing and charging.

Front Suspension Oiling

⚠WARNING

When blocks are in place on a suspension, they must be secured with a strap or other means to accidental discharge. An unsecured block could fly loose as weight is applied, presenting the possibility of serious injury to nearby personnel and/or damage to the equipment. Overhead clearance may be reduced rapidly and suddenly when nitrogen pressure is released!

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

1. Position and secure oiling height dimension blocks in place (Figure 4-2). When nitrogen pressure is released, suspensions will lower to rest on the blocks. Ensure the blocks do not mar or scratch the plated surfaces of the pistons or damage wiper seals in the lower bearing retainer. Support blocks must seat on the spindle and the cylinder housing. The blocks should be positioned 180° apart to provide stability.

⚠WARNING

Wear a face mask or goggles while relieving nitrogen pressure.

2. Remove charging valve cap. Turn the charging valve swivel nut (small hex) counterclockwise three full turns to unseat valve seal. DO NOT TURN LARGE HEX. The charging valve body has a bleeder groove in its mounting threads but for safety of all personnel the valve body MUST NOT be loosened until ALL nitrogen pressure has been vented from the suspension.
3. Depress the charging valve core to release nitrogen pressure from the suspension. When all nitrogen has been vented to the atmosphere, the suspension should have collapsed slowly and be seated solidly on the support blocks. Remove top fill plug next to the charging valve (Figure 4-2).

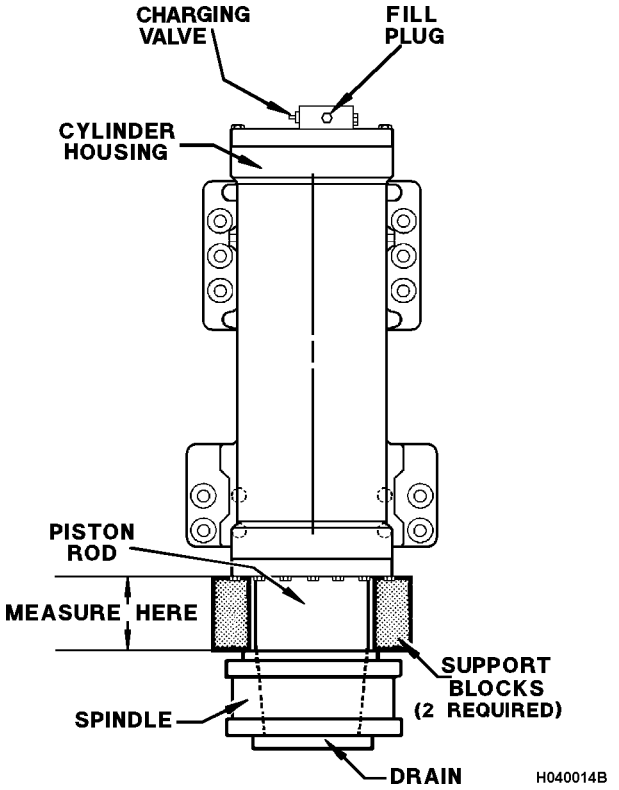


FIGURE 4-2. FRONT SUSPENSION

FRONT SUSPENSION DIMENSIONS (EMPTY)			
TRUCK MODEL & OPTIONS	OILING HEIGHT IN. (mm)	CHARGING HEIGHT IN. (mm)	CHARGING PRESSURE psi (kPa)
730E*	1.5 (38.1)	9.0 (229)	400 (2758)
830E*	1.0 (25.4)	9.0 (229)	390 (2689)
830E**	1.0 (25.4)	9.0 (229)	410 (2827)
930E*	1.0 (25.4)	9.0 (229)	440 (3034)
930E-2*	1.0 (25.4)	9.0 (229)	425 (2930)

* with standard Rock Body
** with Combination Body / Tailgate
Note: If truck starts to lift off blocks before charging pressure is attained, STOP CHARGING.

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4. Fill the suspension with clean HYDRAIR® oil (with 6% friction modifier) until the cylinder is full to the top of the fill plug bore. Drip pans should be used and all spillage cleaned from outside of the suspension. Allow the suspension to stand for at least 15 minutes to clear any trapped nitrogen and/or bubbles from the oil. Add more suspension oil if necessary. Install a new fill plug O-ring, and install the plug.

Front Suspension Nitrogen Charging

⚠WARNING

Lifting equipment (crane or hydraulic jacks) must be of sufficient capacity to lift the truck weight. Be certain that all personnel are clear of lift area before lift is started. Clearances under the truck may be suddenly reduced.

1. If removed, install the charging valve with new O-ring (9, Figure 4-3). Lubricate the O-ring with clean HYDRAIR®oil.

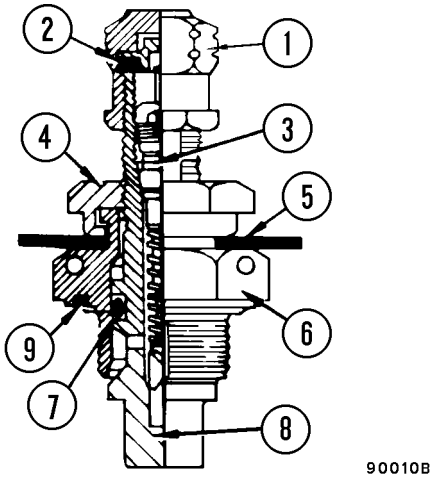


FIGURE 4-3. CHARGING VALVE

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

2. Tighten valve body (large hex, 6) to **16.5 ft. lbs. (22.4 N.m)** torque. The valve swivel nut (small hex, 4) must be unseated by turning counter-clockwise three full turns.

⚠WARNING

Dry nitrogen is the only gas approved for use in HYDRAIR®II suspensions.Charging of these components with oxygen or other gases may result in an explosion which could cause fatalities, serious injuries and/or major property damage. Use only nitrogen gas meeting the specifications shown in chart (Figure 4-5).

3. Install HYDRAIR® Charging Kit and a bottle of pure dry nitrogen. Refer to *Installation of Charging Kit*.
4. Charge the suspensions with nitrogen gas to 2 in. (50.8 mm) greater than the charging height listed in Figure 4-2. Close inlet valve (4, Figure 4-1).
5. Remove the oiling blocks from the suspensions and install the nitrogen charging blocks. Secure the blocks to prevent accidental dislodging.

NOTE: Use caution to prevent damage to plated cylinder surfaces and oil seals when installing the blocks.

6. Remove the center hose from manifold (6).
7. Open inlet valve (4) until the pressure has dropped below the pressure listed in Figure 4-2, and then close the valve.
8. Install the center hose to manifold (6).
9. Charge the suspensions to the pressure listed in Figure 4-2. DO NOT use an overcharge of nitrogen to lift the suspensions off of the charging blocks.
10. 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.
11. Close outlet valves (3) and remove charging kit components. Refer to *Removal of Charging Kit*.
12. If charging valve is being reused, tighten swivel nut (4, Figure 4-3) to **4 ft. lbs. (5.4 N.m)** torque.
13. 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 swivel nut to **10.5 ft. lbs. (14.2 N.m)** torque. Again loosen 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).

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

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

REAR SUSPENSION

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

⚠WARNING

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

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

Rear Suspension Oiling

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

⚠WARNING

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

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

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3. Depress the charging valve core to release nitrogen pressure from the suspension. When nitrogen pressure has been vented to atmosphere, loosen and remove the fill plug. The suspension should have collapsed slowly as gas pressure was released. Truck weight is now supported by the support blocks.
4. Use a plastic tube to help bleed off trapped air inside the piston. Remove vent plugs and the bleeder screw. Service the suspension with clean HYDRAIR® Oil (with 6% friction modifier) until clean oil comes out of the port where the bleeder screw and plug were removed from the side of the housing. Drip pans should be used and all spillage cleaned from the outside of the suspension. Install the bleeder and vent plugs. Continue to fill the oil until it reaches the fill port. Allow the suspension to stand for at least 15 minutes to clear any trapped nitrogen and/or air bubbles from the oil. Add oil if necessary, and install the fill plug.

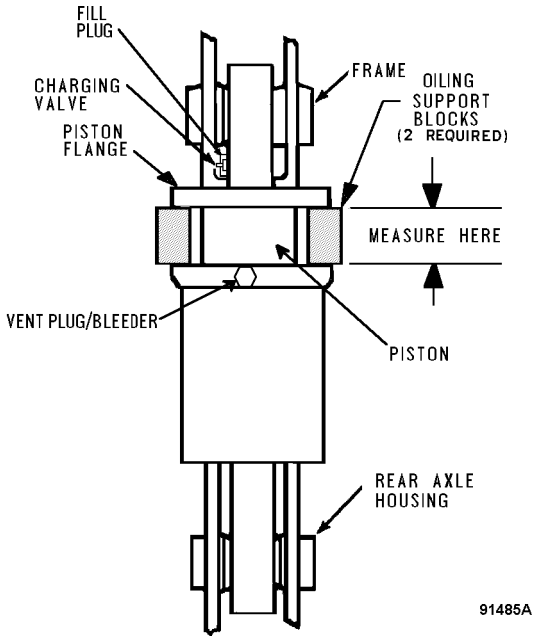


FIGURE 4-4. REAR SUSPENSION

REAR SUSPENSION DIMENSIONS (EMPTY)			
TRUCK MODEL & OPTIONS	OILING HEIGHT IN. (mm)	CHARGING HEIGHT IN. (mm)	*CHARGING PRESSURE psi (kPa)
730E	1.0 (25.4)	9.0 (229)	280 (1931)
830E	1.0 (25.4)	9.5 (241)	250 (1724)
830E	1.0 (25.4)	9.5 (241)	315 (2172)
930E, E2	1.0 (25.4)	7.5 (190)	215 (1482)

* Note: Charging pressures are for reference only and may vary depending on body weights.

Rear Suspension Nitrogen Charging

⚠WARNING

Lifting equipment (overhead or mobile cranes, or hydraulic jacks) must be of sufficient capacity to lift the truck weight. Be certain that all personnel are clear of lift area before lift is started. Clearances under the truck may be suddenly reduced.

⚠ IMPORTANT ⚠

Ensure the automatic apply circuit has not applied the service brakes during truck maintenance. If the front brakes are applied during rear suspension charging, the axle cannot pivot for frame raising / lowering, and the rear suspension may be unable to move up or down.

1. If removed, install charging valve with new O-ring (9, Figure 4-3). Lubricate the O-ring with clean HYDRAIR®oil.
2. Tighten valve body (large hex, 6) to **16.5 ft. lbs. (22.4 N.m)** torque. The valve swivel nut (small hex, 4) must be unseated by turning counterclockwise three full turns.

⚠WARNING

Dry nitrogen is the only gas approved for use in HYDRAIR®II suspensions. Charging of these components with oxygen or other gases may result in an explosion which could cause fatalities, serious injuries and/or major property damage. Use only nitrogen gas meeting the specifications shown in chart (Figure 4-5).

3. Install HYDRAIR® Charging Kit and a bottle of pure dry nitrogen. Refer to *Installation of Charging Kit*.
4. Charge the suspensions with nitrogen gas to 2 in. (50.8 mm) greater than the charging height listed in Figure 4-4.
5. Slowly release gas until the suspensions match the charging height listed in Figure 4-4.

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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*.
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.

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OIL AND NITROGEN SPECIFICATIONS CHART

HYDRAIR® II OIL SPECIFICATIONS			
Ambient Temperature Range	**Part No.**	**Approved Sources**	
-30°F & above (-34.5°C & above)	VJ3911 (need to add 6% of AK3761)	Mobil 424 Mobil D.T.E. 15 Texaco TDH Oil AMOCO ULTIMATE Motor Oil 5W-30	Sunfleet TH Universal Tractor Fluid Chevron Tractor Hydraulic Fluid- Conoco Power Tran III FluidPetro Canada Duratran Fluid Shell Canada Donax TDL
	AK4063	Suspension Oil (premixed with 6% Friction Modifier)	5 Gallon container
	AK4064		55 Gallon container
-55°F & above (-48.5°C & above)	VJ5925 (need to add 6% of AK3761)	Emery 2811, SG-CD, 5W-30 Mobil Delvac I, 5W-30	Petro Canada Super Arctic Motor Oil, 0W-30 Conoco High Performance Synthetic Motor Oil, 5W-30
	AK4065	Suspension Oil (premixed with 6% Friction Modifier)	5 Gallon container
	AK4066		55 Gallon container
NOTE: *VJ3911 and VJ5925 oils are not compatible and must not be mixed in a suspension.VJ3911 and VJ5925 oils are supplied in 5 gallon (19 Liter) cans.*			

FRICTION MODIFIER	**FRICTION MODIFIER Mixing Instructions (94% Suspension oil, 6% Friction Modifier)**	
Part Number	**Suspension Oil**	**Amount of Friction Modifier to add**
AK3761 (5 Gallon container of 100% Friction Modifier)	1 gallon of suspension oil	add 7.7 oz.
	5 gallons of suspension oil	add 38.4 oz.
	55 gallons of suspension oil	add 3.3 gal.

NITROGEN GAS (N_2)SPECIFICATIONS		
	Property	**Value**
Nitrogen gas used in HYDRAIR® II Suspension Cylinders must meet or exceed CGA specification G-10.1 for Type 1, Grade F Nitrogen Gas	Nitrogen	99.9% Minimum
	Water	32 PPM Maximum
	Dew Point	-68°F (-55°C) Maximum
	Oxygen	0.1% Maximum

FIGURE 4-5. SPECIFICATIONS CHART

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BRAKE CIRCUIT

The 830E truck is equipped with hydraulic actuated disc brakes. The front brakes have three calipers applying braking effort to a single disc on each wheel. The rear brakes have two (armature-speed) discs with one caliper per disc. Each rear outboard disc also contains a parking brake caliper.

The fundamental function of the brake system is to provide an operator the control he needs to stop the truck in either a slow modulating fashion or in as short a distance as reasonably possible.

Outlined below are the functions that are necessary for safe truck operation:

1. Warn the operator as soon as practical of a serious or potentially serious loss of brake pressure so proper action can be taken to stop the truck before the secondary system is exhausted of power.
2. Provide secondary brake circuits such that any single failure leaves the truck with sufficient stopping power.
3. Automatically apply service brakes if low pressure warnings are ignored and pressures continue to decrease.
4. Wheel brake lock to relieve the operator from holding the brake pedal while at the dump or shovel.
5. Spring applied park brake for **holding, not stopping**, the truck during periods other than loading or dumping.
6. Brake system that is easy to diagnose and perform necessary service.

The following brake circuit description should be used in conjunction with the hydraulic brake system schematic, refer to Section "R".

The brake system consists of two major valve components; the dual circuit treadle valve (heart of the system) and brake manifold. The dual circuit treadle valve is the only component located in the operator's cab. The remainder of the system, including the brake manifold, circuit accumulators, and electrical components, are located in a weatherproof cabinet behind the cab. This cabinet is accessible for diagnostic and service work.

The brake manifold contains dual circuit isolation check valves, accumulator bleed down valves, and valves for brake lock, park brake and automatic apply functions. All of these components are screw-in cartridge type valves.

In the 830E truck, there are two independent means of brake actuation, the service brake pedal and brake lock switch.

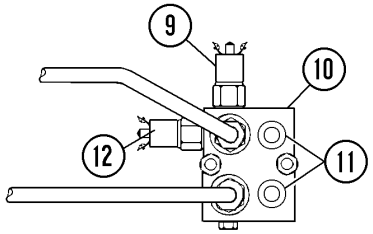
SERVICE BRAKE CIRCUIT OPERATION

This portion of the system provides the operator the precise control he needs to modulate (feather) brake pressure to slowly stop the truck or develop full brake effort to stop as quickly as possible. The heart of this circuit is the treadle operated dual circuit brake valve. This valve enables the operator to control the relatively high pressure energy within the brake accumulators directly to the brakes. The only element between the operators foot and the actual brake fluid is the dual circuit treadle valve.

As the pedal is depressed, each valve within the dual circuit treadle valve simultaneously delivers fluid from its respective accumulator to the wheel brakes at a pressure proportional to both pedal position and force. The further the pedal is depressed, the higher the brake force, giving a very positive feel of control.

Brake accumulators have two functions; storing energy for reserve braking in the event of a failure and, provide rapid oil flow for good brake response. Depression of the brake pedal actuates the stop light pressure switch, which in turn actuates stop and service brake indicator lights and propulsion interlock. The stop light switch (12, Figure 2-1) is located on the junction block (10) inside the brake cabinet.

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VIEW A - A

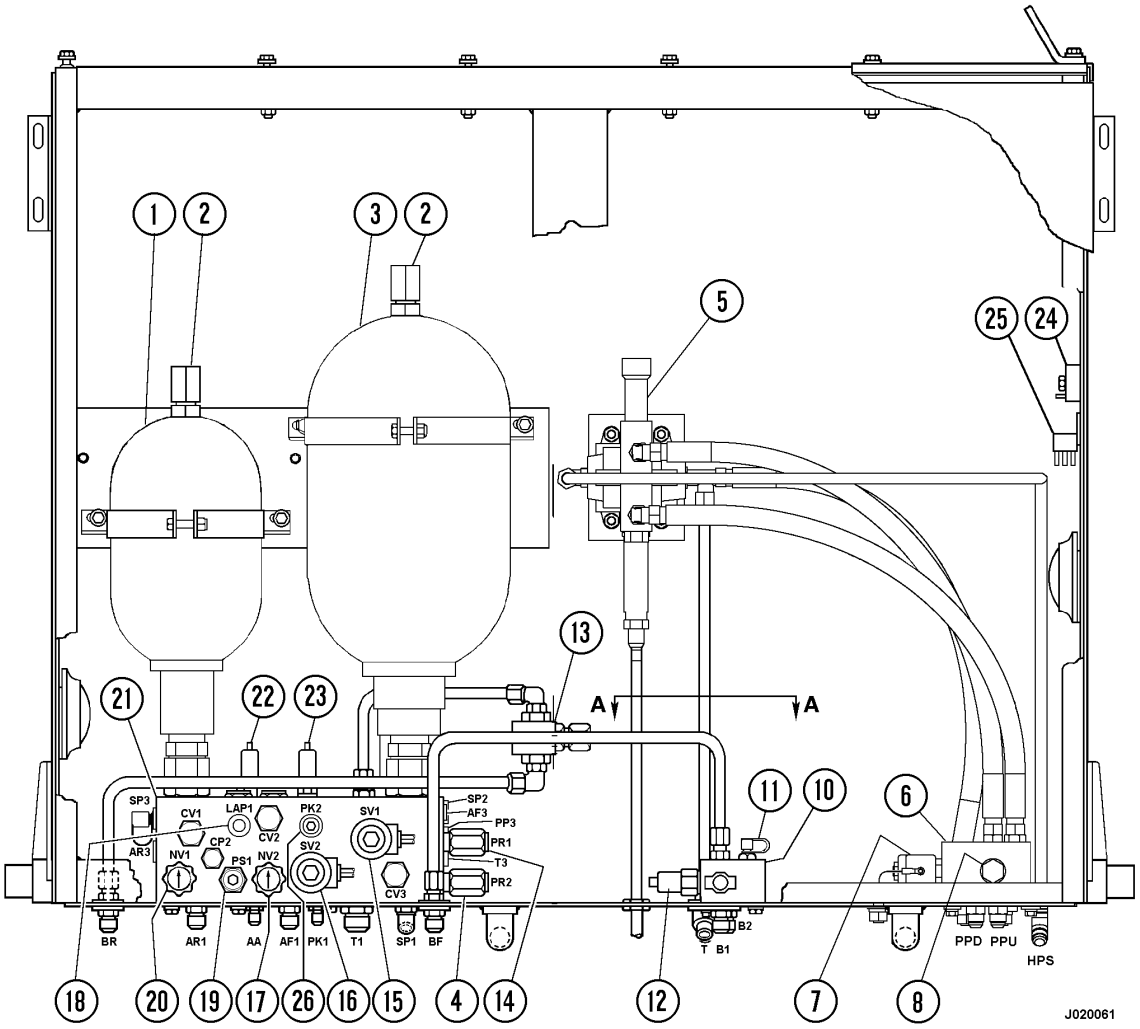


FIGURE 2-1. HYDRAULIC BRAKE CABINET

1. Rear Brake Accumulator
2. Charging Valve
3. Front Brake Accumulator
4. Park Brake Pressure Reducer Valve
5. Hoist Pilot Valve
6. Hoist Pilot Manifold
7. Hoist-Up Limit Solenoid
8. Pilot Operated Check Valve
9. Brake Lock Degradation Pressure Switch
10. Junction Block
11. BF & BR Test Port (Front & Rear Brake)
12. Stop Light Switch
13. Brake Lock Shuttle Valve
14. Brake Lock Pressure Reducing Valve
15. Brake Lock Solenoid
16. Park Brake Solenoid
17. Bleed Down Valve (Front Brake Accumulator)
18. Accumulator Test Port
19. Automatic Apply Valve
20. Bleed Down Valve (Rear Brake Accumulator)
21. Brake Manifold
22. Low Brake Accumulator Pressure Switch
23. Park Brake Pressure Switch
24. Brake Warning Delay Timer
25. Brake Warning Light Relay
26. Park Brake Test Port

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SECONDARY BRAKING AND AUTOMATIC APPLY

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

The brake accumulators (1 & 3, Figure 2-1), (as described under service brake circuit) perform two functions; rapid flow for good response and store energy for secondary braking. The circuit check valve assures this energy is retained should a failure occur in brake system supply or an accumulator circuit.

If a failure occurs in the pump, steering or either brake accumulator circuit, a low brake pressure warning light (on the instrument panel) and an audible alarm (in the cab) will actuate and the vehicle should be stopped as soon as practical. When the pressure in one accumulator circuit is less than the preset level, all the service brakes will be automatically applied. Automatic brake application is accomplished by the "Automatic Apply Valve" (PS1, 19), located in the brake manifold. This valve senses the lower brake accumulator pressure, and when the pressure is less than 2000 ±75 psi (13800 ±520 kPa), the valve shifts, operating the brake treadle valve and applying all the brakes full on.

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

PARKING BRAKE CIRCUIT

The parking brake is spring applied and hydraulically released.

NOTE: Whenever the park brake solenoid is de-energized, a spring in the solenoid valve will shift the spool to the position to allow the park brake to be applied.

Normal Operation (key switch on, engine running)

- **Parking brake switch "ON"**
  The parking brake solenoid (16) is de-energized. The oil pressure in the parking brake lines return to tank and the springs in the parking brake will apply the brake. The parking brake pressure switch (23) will close, completing a path to ground, and illuminating the parking brake light on the instrument panel.
- **Parking brake switch "OFF"**
  The parking brake solenoid is energized. The pressure oil is routed from the park brake solenoid, to the parking brake pressue regulator (4) (reducer), then to the park brake calipers for release. The parking brake circuit is protected against accidental apply by monitoring a wheel motor speed sensor. The park brake with not apply until the truck is virtually stopped. This eliminates park brake damage and will extend brake adjustment intervals.
- If the **key switch is turned "OFF"** (park brake switch "ON" or "OFF"), the park brake will not apply until vehicle speed is less than 1/3 MPH, due to the monitoring of the wheel motor speed.
- If loss of hydraulic supply pressure occurs, **with Parking brake switch "OFF"**, the parking brake solenoid will still be energized. The hydraulic supply circuit is still open to the parking brake calipers. A check valve in the park brake hydraulic supply circuit traps the oil, holding the parking brake in the release position.

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

- If 24 volt power to the solenoid is interupted, the park brake will apply at any vehicle speed. The spring in the solenoid will cause it to shift, opening a path for the oil pressure in the park brake line to return to tank and the springs in the parking brake will apply the brake. The parking brake pressure switch (23) will close, completing a path to ground, and illuminating the parking brake light on the instrument panel.

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BRAKE LOCK CIRCUIT

The primary function of the brake lock is to provide a means for the operator to hold the vehicle while at the shovel or dump. The brake lock only applies the rear service brakes. It may also provide a second means to stop the truck in the event the primary means (treadle valve) malfunctions.

By turning on the dash mounted toggle switch, a solenoid valve (15, Figure 2-1) and pressure reducing valve (PR2, 14) will apply unmodulated pressure oil at 1500 ±75 psi (10343 ±517 kPa) to fully actuate the rear brakes. A shuttle valve (13) in the rear brake line provides the independence from the brake treadle valve for brake application.

WARNING CIRCUIT

The brake warning circuit is equipped with a low brake pressure warning light (on the overhead panel) and an audible alarm (in the cab) to alert the operator of low brake pressures. Several electrical sensors, a relay and delay timer are used to detect brake system problems.

- **Pressure Sensor, system supply pressure**
  Located below the bleed down manifold on a tee fitting is the low steering pressure switch. When system supply pressure drops below 2300 psi (15860 kPa), the low steering pressure light, low brake pressure light and buzzer will turn on.
- **Pressure Sensor, low accumulator pressure (22)**
  Located on the brake manifold. When the accumulator with the lower pressure falls below 2350 psi (16200 kPa), the low brake pressure light and buzzer will turn on.
- **Differential Pressure Switch**
  Located in the cab on the brake dual controller (foot treadle) (12, Figure 3-2) is the Pressure Differential Manifold. During brake application, if the difference in brake apply pressure between the front and rear circuits are greater than a preset level, the low brake pressure light and buzzer will turn on. The pressure differential switch completes a path to ground in order to turn on the low brake pressure light and buzzer. Use of the differential pressure switch allows detection of faults between the front and rear circuits, such as brake line ruptures, poor brake valve tracking, line blockage, and excessive air or brake displacement.
- **Brake Lock Degradation Switch (9, Figure 2-1)**
  Located on the junction block (10) in the brake cabinet. When the brake lock switch is turned on, a pressure imbalance inside the differential pressure manifold occurs (normal at this time) as only the rear brakes are applied. The brake warning light relay is energized and switches the electrical connection from the differential pressure switch to the low brake lock pressure switch. If the brake lock apply pressure is less than 1000 psi (6900 kPa), a path to ground will be completed and the low brake pressure light and buzzer will turn on.
- **Brake Warning Relay (25)**
  Located in the brake cabinet. When the brake lock switch is turned on, the brake warning light relay is energized and switches the electrical connection from the differential pressure switch to the low brake lock pressure switch. When the brake lock switch is turned off, the relay is de-energized and switches the connection from the low brake lock apply pressure switch to the differential pressure switch.
- **Brake Delay Timer (24)**
  Located in the brake control cabinet. The delay timer is connected in series between the low brake pressure light/buzzer and the two switches, the differential pressure switch and the low brake lock apply pressure switch. If either switch completes a path to ground, the delay timer will not complete the circuit for 1.2 seconds. This will allow sufficient time for the hydraulic brake to reach the proper pressures after actuation to avoid false alarms.

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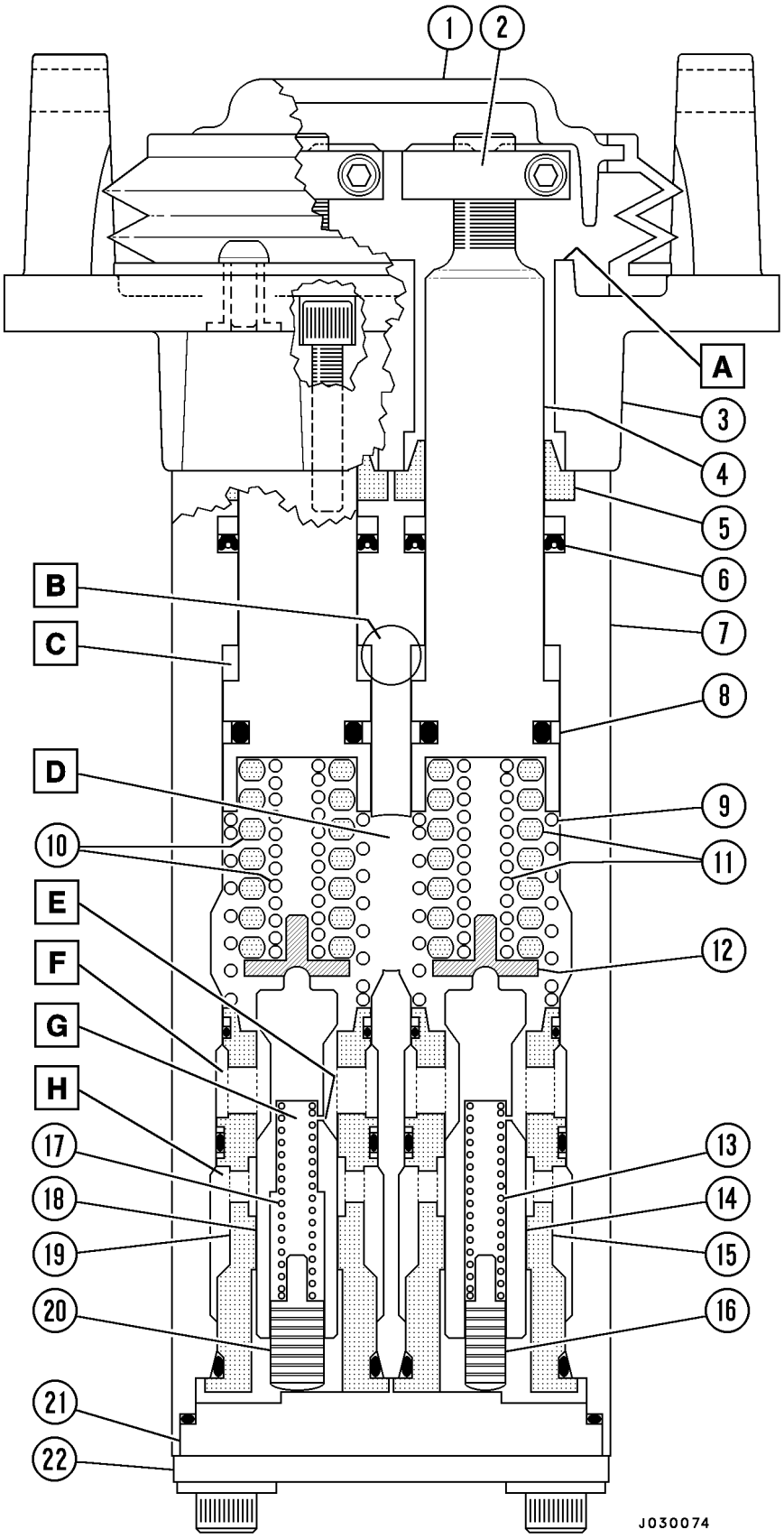


FIGURE 2-2. BRAKE VALVE (FULL CUT-AWAY)

1. Actuator Cap
2. Adjustment Collar
3. Actuator Base
4. Actuator Plunger
5. Wiper Seal
6. Poly-Pak Seal Assembly
7. Valve Body
8. Glyde Ring Assembly
9. Plunger Return Spring
10. Regulator Springs (B1)
11. Regulator Springs (B2)
12. Spring Seat

(B2 Parts 13-16)
(Front Brake)

13. Spool Return Srping
14. Regulator Spool
15. Regulator Sleeve
16. Reaction Plunger

(B1 Parts 17-20)
(Rear Brake)

17. Spool Return Spring
18. Regulator Spool
19. Regulator Sleeve
20. Reaction Plunger
21. Retainer Plug
22. Base Plate

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

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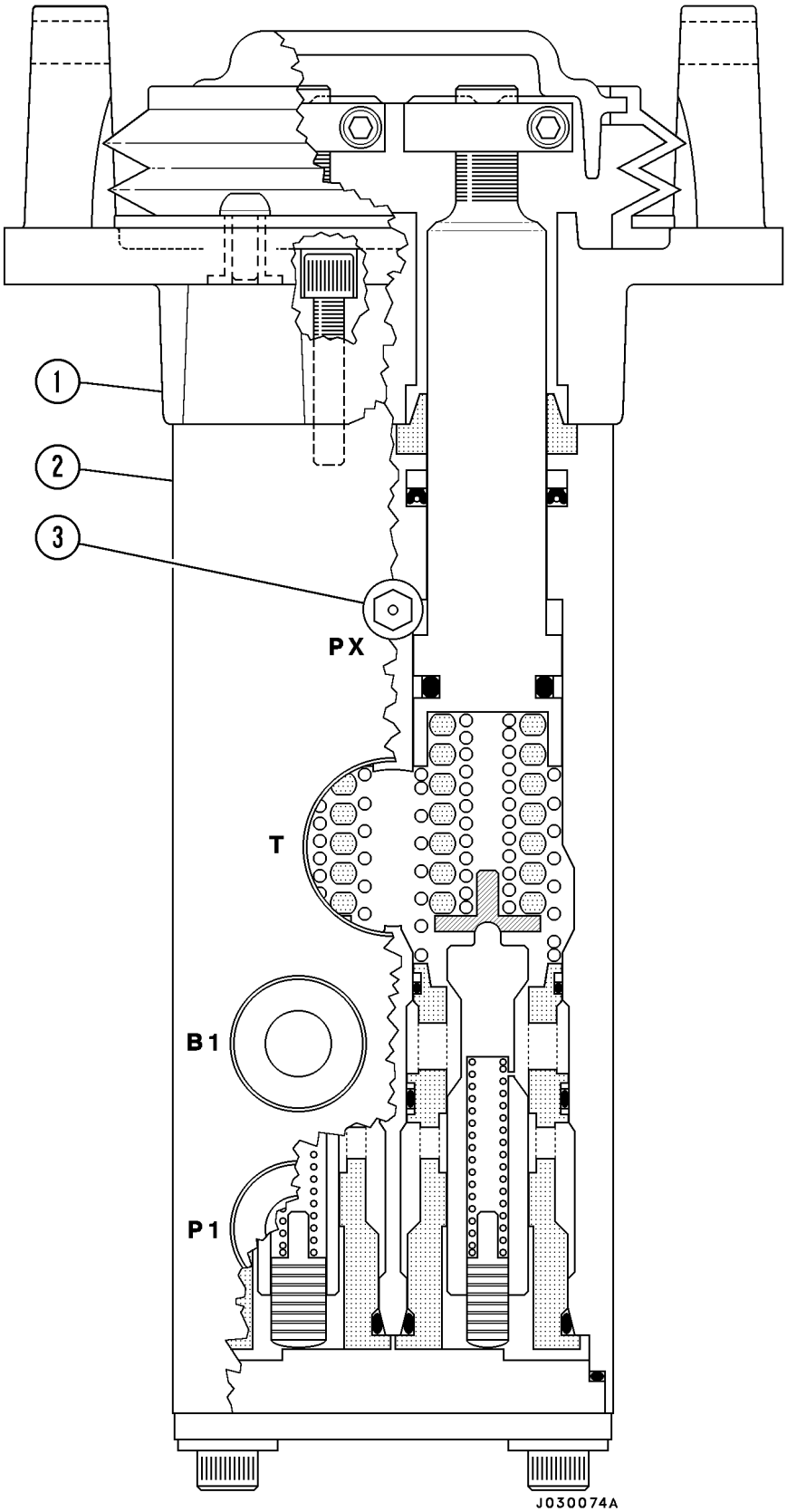


FIGURE 2-3. BRAKE VALVE
(PARTIAL CUT-AWAY)

1. Actuator Base
2. Brake Valve
3. Orifice Set-Screw

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BRAKE CIRCUIT COMPONENT SERVICE

BRAKE VALVE

The Brake Valve is a pressure modulating valve, actuated mechanically (brake pedal) or hydraulically through the automatic apply valve (11, Figure 3-1).

The Brake Valve independently controls the pressure delivered to the front and rear service brake assemblies. Apply pressure can be modulated from zero to maximum braking effort by use of the foot pedal.

Rebuild Criteria

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

- Excessive cam rock in pedal actuator.
- Any sign of external leakage.
- Internal leakage at the tank port must be less than 100 cc/minute with the valve in the released position and system pressure supplied to the “P1” and “P2” inlet ports.
- Tank port leakage must be less than 250 cc/minute with valve pilot or manual applied at 3,000 psi (20 685 kPa) system pressure.
- Failure of the pedal to return to full release position.
- Valve holds pressure when in the neutral position.
- Varying output pressure with the pedal fully depressed.

Removal

If the Brake Valve is to be removed from the vehicle for repair or adjustment, additional equipment will be required as outlined in disassembly, assembly.

NOTE: Minor repairs and service adjustment may not require the removal of the brake valve.

⚠WARNING

Before disconnecting pressure lines, replacing components in the hydraulic circuits, or installing test gauges, always bleed down hydraulic steering and brake accumulators. The steering accumulators can be bled down with engine shut down, turning the key switch “Off” and waiting 90 seconds. Confirm the steering pressure is released by turning the steering wheel - No front wheel movement should occur. Open bleed down valves (10 & 12, Figure 3-1) located on the brake manifold and allow both accumulators to bleed down.

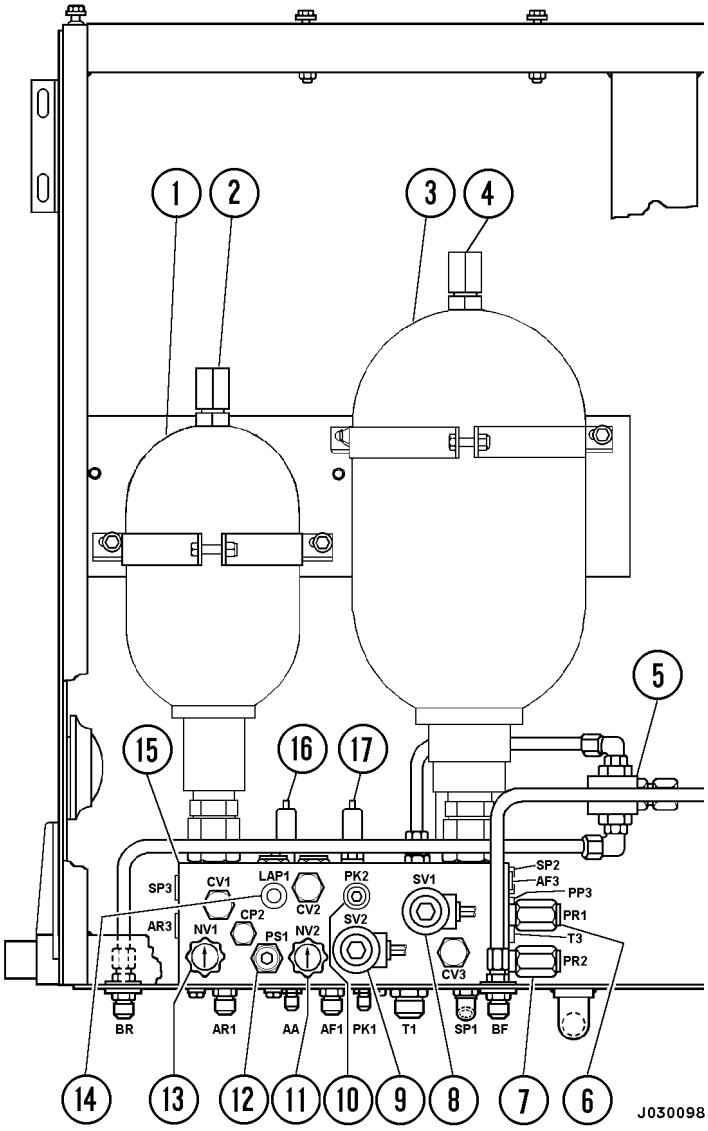


FIGURE 3-1. BRAKE ACCUMULATOR BLEED DOWN

1. Rear Brake Accumulator
2. Charging Valve
3. Front Brake Accumulator
4. Charging Valve
5. Brake Lock Shuttle Valve
6. Brake Lock Pressure Reducing Valve (PR1)
7. Park Brake Reducing Valve (PR2)
8. Brake Lock Solenoid
9. Park Brake Solenoid
10. Park Brake Test Port
11. Bleed Down Valve (Front Brake Accumulator)
12. Automatic Apply Valve
13. Bleed Down Valve (Rear Brake Accumulator)
14. Accumulator Test Port (LAP1)
15. Brake Manifold
16. Low Brake Accumulator Pressure Switch
17. Park Brake Pressure Switch

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⚠WARNING

Before disabling brake circuit, be sure truck wheels are blocked to prevent possible roll-away.

1. Securely block the wheels to prevent possible roll-away.
2. Turn key switch OFF and allow 90 seconds for steering system accumulators to bleed down. Open valves (10 & 12, Figure 3-1) to bleed down both brake accumulators.
3. Remove access panel in front of operator's cab.
4. Tag and remove all hydraulic lines from brake valve. Plug lines and ports to prevent possible contamination. Remove all valve fittings. Disconnect wiring harness at differential pressure switch connector.
5. If equipped, remove retard pedal that is located on brake pedal.
6. In the cab at the brake valve, remove capscrews and lockwashers securing the brake valve assembly to the mounting structure.
7. Slide brake valve downward and remove from cab.
8. Move brake valve assembly to a clean work area for disassembly.

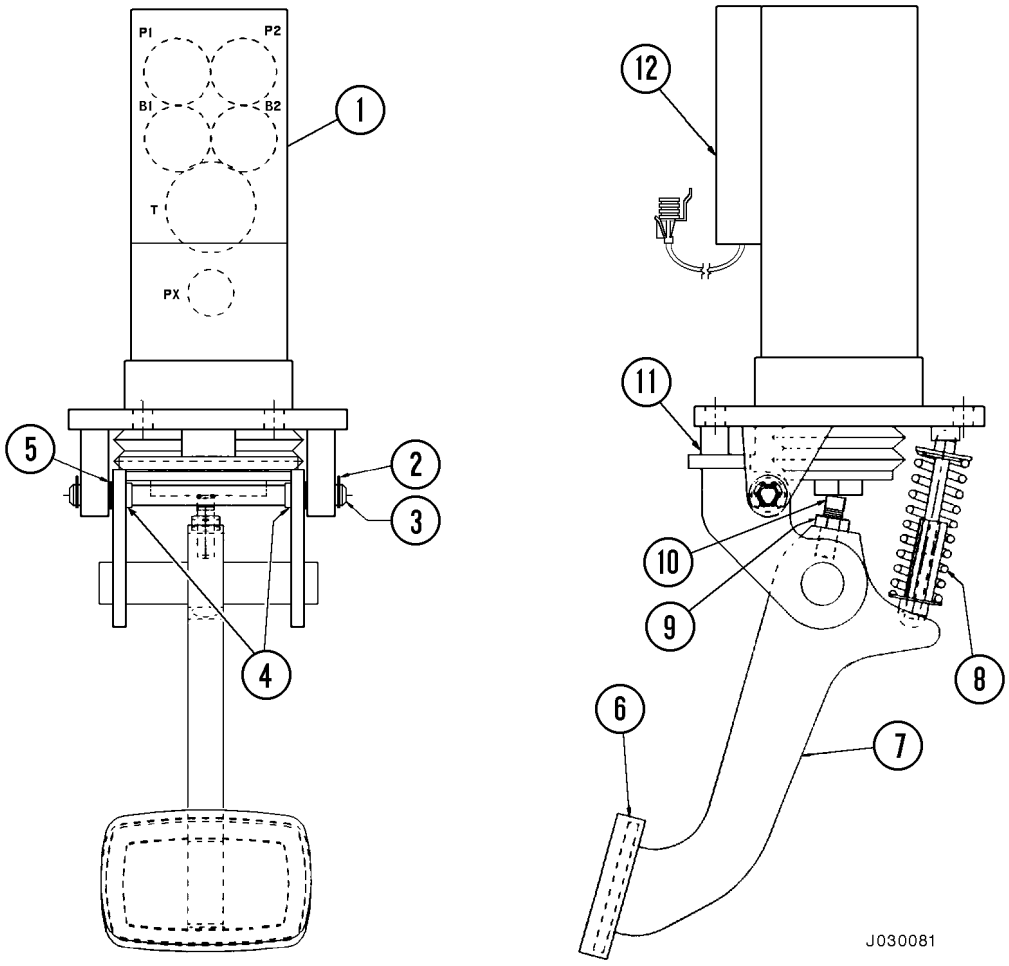


FIGURE 3-2. SINGLE PEDAL BRAKE VALVE ASSEMBLY

1. Brake Valve
2. Retainer Clip
3. Pivot Shaft
4. Bushings
5. Shims
6. Foot Pad
7. Brake Pedal Actuator
8. Spring Assembly
9. Jam Nut
10. Set Screw
11. Pedal Return Stop
12. Differential Pressure Switch

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Installation

1. Move the brake valve assembly into position and secure in place with capscrews and lockwashers. Tighten capscrews to standard torque.
2. Remove plugs from brake valve assembly and hydraulic lines. Install fittings and connect lines to brake valve assembly and tighten. Connect differential pressure switch to harness.

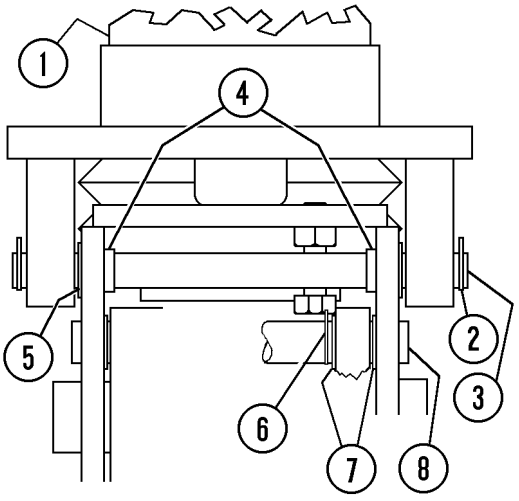
NOTE: Prior to checking the brake valve operation, the steering system must have the proper nitrogen precharge in the steering accumulators (refer to Section L, "Hydraulic System" for steering accumulator precharge procedure). In addition, the brake system lines must be bled of air and the brake accumulators must also be precharged with nitrogen (refer to brake accumulator precharge procedures, this section).

3. If equipped, install electronic retard pedal to brake pedal (Figure 3-3).
4. With the engine shut down and key switch OFF, open both brake accumulator bleed down valves. Precharge both accumulators.

NOTE: For best performance, charge the accumulators in the temperature conditions the vehicle is expected to operate in. During the precharge, allow temperature of the nitrogen gas to come into equilibrium with the ambient temperature.

5. Close both accumulator bleed down valves after precharge is complete.

NOTE: To prevent excess oil from coming in contact with the brake assemblies during the brake bleeding procedure, attach a hose to the bleeder screw. Direct the hose into a container.



VIEW A-A

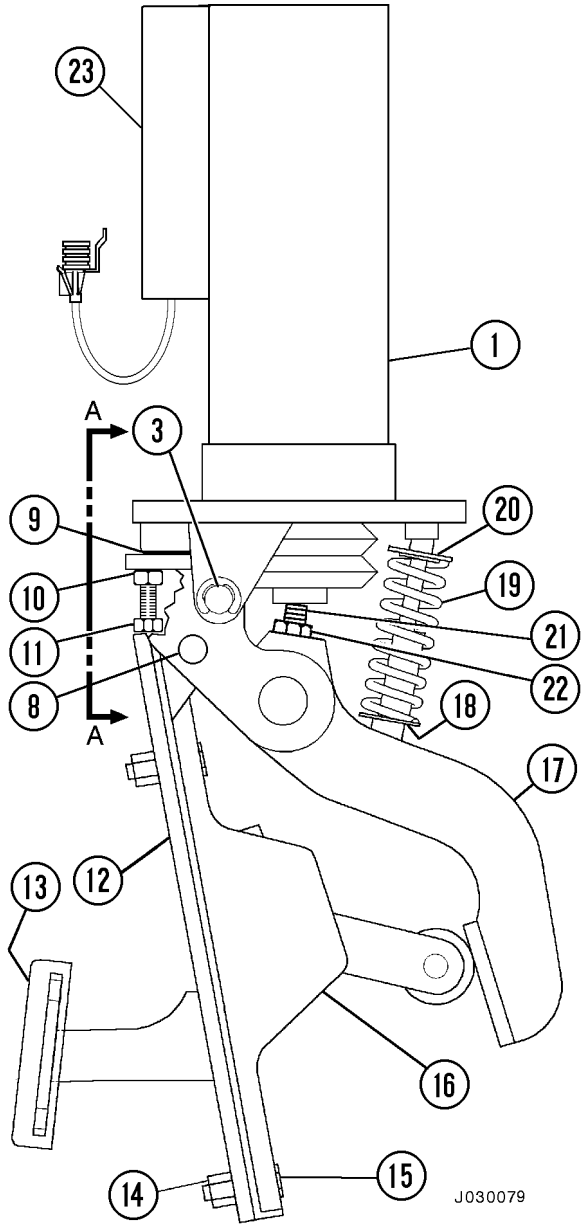


FIGURE 3-3. BRAKE VALVE WITH RETARD PEDAL

1. Brake Valve
2. Retainer Clip
3. Pivot Shaft
4. Bushings
5. Shims
6. Retainer Clip
7. Nylon Bearing
8. Pivot Shaft
9. Place 0.025 in. Shim Here
10. Jam Nut
11. Capscrew
12. Pedal Structure
13. Pad
14. Nut
15. Capscrew
16. Electronic Retard Pedal Assembly
17. Brake Pedal Actua-
18. Spring Pivot (Lower)
19. Spring
20. Spring Pivot (Top)
21. Set Screw
22. Jam Nut
23. Differential Pressure Switch

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6. Start the engine and bleed air from brake lines and brakes. Actuate the brake lock switch and open the uppermost bleeder screw on all rear brake assemblies until a steady stream of oil appears. Close bleeder screw.
7. Release the brake lock switch and bleed the remaining front brakes in the same manner by depressing the brake pedal. Check for fluid leaks at the brake valve.

Disassembly

NOTE: If equipped with, and not already removed, remove electronic retard pedal (16, Figure 3-3) from brake pedal by removing pivot shaft (8). The rebuild and adjustment procedures for the brake valve (1) are the same, whether or not the brake pedal has the retard pedal assembly attached to it.

NOTE: During disassembly, precision machined parts should be ink marked or tagged to ensure proper reassembly and minimize adjustment time. All items must be placed back into the bores from which they were removed.

1. Match mark each section of the brake valve prior to disassembly.

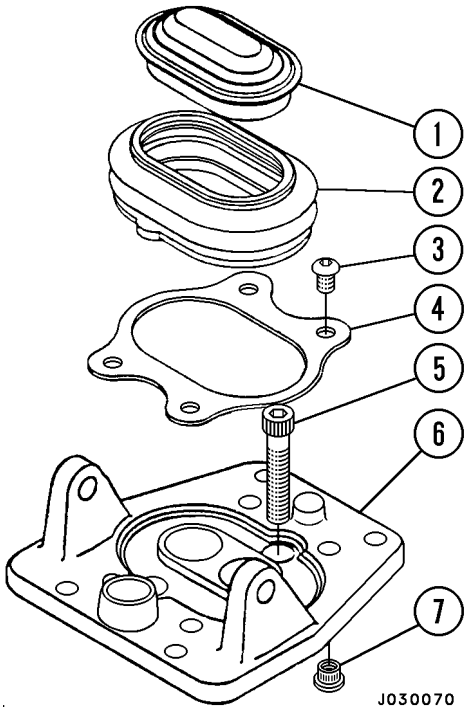


FIGURE 3-4. ACTUATOR CAP & BOOT

1. Actuator Cap
2. Boot
3. Capscrew
4. Retainer Plate
5. Capscrew
6. Actuator Base
7. Threaded Insert

2. Drain all oil from all ports of the valve by rotating the valve over a suitable container.
3. Secure brake valve in an upright position in a vice.
4. Remove the brake pedal actuator (7, Figure 3-2) by removing the retaining clips (2), then remove the pivot shaft (3) with a punch and hammer.
5. Remove the four button head allen screws (3, Figure 3-4) securing the boot retainer plate (4).
6. Remove the boot retainer plate (4), boot (2), and actuator cap (1) as an assembly by grasping the boot and gently lifting from the valve body.
7. Remove capscrews (36, Figure 3-5) and the differential pressure switch (35).
8. Remove and discard the O-ring (27) and face seal (28).
9. Loosen the plunger locknuts (2). Loosen the socket head capscrew from the adjustment collars (1).
10. Unscrew and remove the adjustment collars.
11. Remove the two socket head capscrews (5, Figure 3-4) that retain the actuator base (6) to the valve body.
12. Remove the actuator base from the valve body.
13. Remove controller from vice.
14. Remove the four capscrews (34, Figure 3-5) and washers (33) from the base of the valve.
15. Remove the base plate (32).
16. With the valve upright, the retaining plug (31) should fall out. If the plug does not fall out, lightly tap to dislodge the plug.

NOTE: The spools (12), reaction plungers (21, 22) and spool return springs (20) may fall out at this time. Keep parts separate so they may be installed in the same bores from which they were removed.
The "B1" reaction plunger (21) is larger than the "B2" reaction plunger (22).

17. Remove and discard the O-ring (30) from the counterbore in the base of the valve body.
18. With the controller upright on the work bench, hold the valve with one hand and push the "B1" actuator plunger (3) down with the other hand until the regulator sleeve (19) pops loose.
19. Repeat the above procedure to loosen the "B2" regulator sleeve.
20. Turn the valve on its side on the work bench and remove the regulator sleeves (19) from the valve body.

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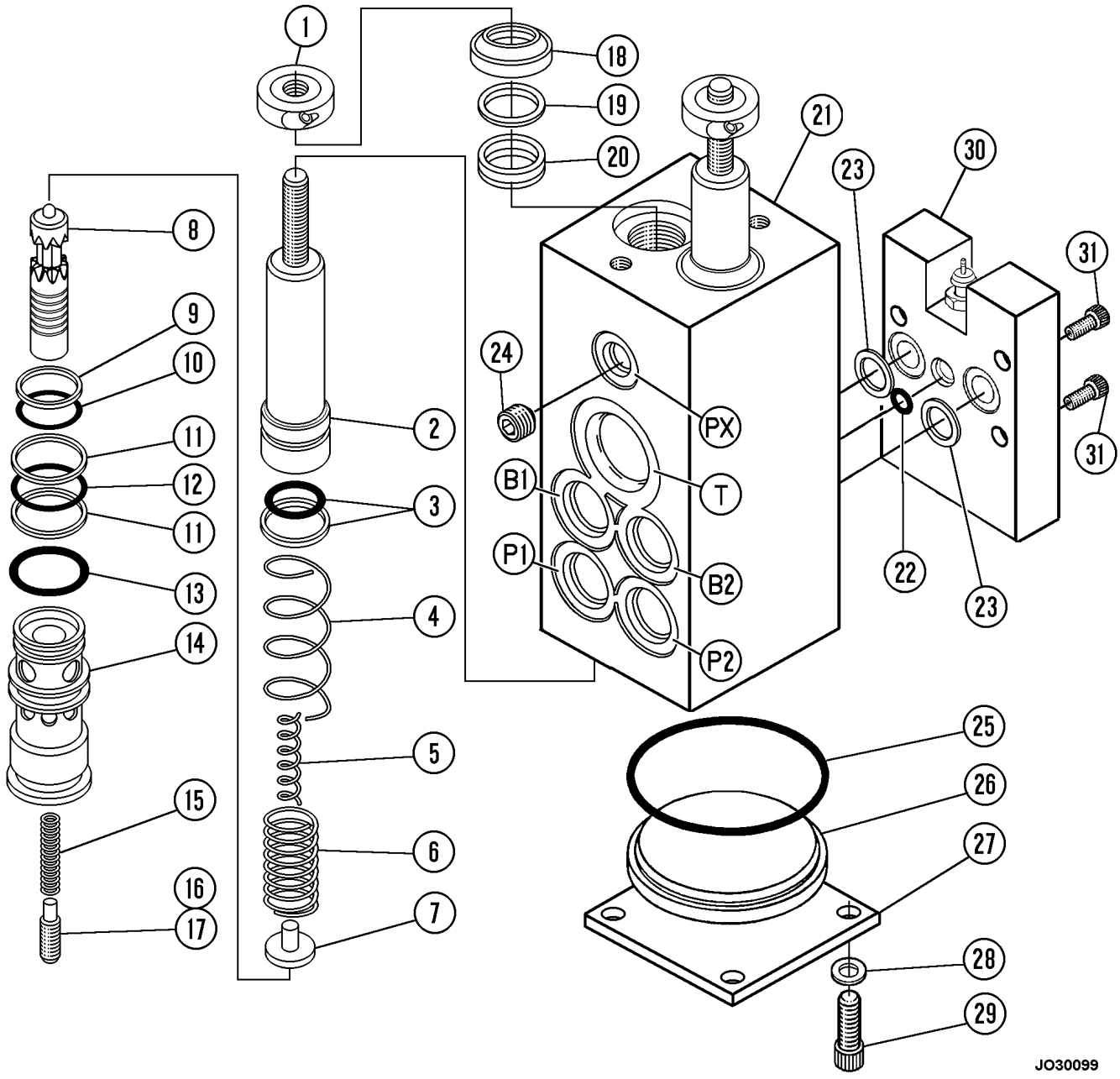


FIGURE 3-5. BRAKE VALVE

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

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NOTE: Throughout the following steps, it is important to keep the circuits and circuit components identified as to which side of the unit they came from. For a given circuit, all the components have a tolerance stack which could vary. Keep the "B1" and "B2" parts separate. ***Springs (8 & 9) are also different in "B1" and "B2" bores.***

21. Remove the spools (12), reaction plungers (21, 22) and spool return springs (20) from the regulator sleeves (19).
22. Remove the plunger return springs (10), regulator springs (8 & 10), and spring seats (11) from the valve body.
23. Remove the actuator plungers (3) by pushing down (toward the bottom of the valve) on the actuator plunger with your hand until the actuator plunger slides out.
24. Remove the staging seat (6). Remove and discard packing (5).
25. Remove the glyde ring assembly (7) from the actuator plunger.
26. Remove the O-rings (14, 16 & 18) and teflon back-up rings (13, 15 & 17) from the regulator sleeves and discard.
27. Remove the wiper seals (23), poly-pak seals (25), and the orange back-up rings (24) from the actuator section of the valve and discard.

Cleaning and Inspection

1. Clean all metal parts with solvent and air dry.
2. Inspect the plunger (3, Figure 3-5) for wear on the sides where it moves through the seals. If axial grooves are seen or if any wear is apparent, replace the plunger. Plungers with diameter worn below 0.747 in (18.974 mm) must be replaced.
3. Place the regulating spool (12) into its sleeve (19). Push the spool lightly through the sleeve. The spool must be able to move freely and smoothly the entire length of the sleeve. If it cannot, it must be replaced. Never replace just the spool or sleeve. They must be replaced as a matched set.
4. Inspect each spring carefully for cracks or breaks. Any spring with a crack or break must be replaced. Also, if the valve was not reaching proper regulated pressure, replace all regulator springs.
5. Inspect the threaded inserts (7, Figure 3-4) in the actuator base. If any of the threads are damaged, the inserts must be replaced.
6. Lubricate all parts with a thin coat of clean type C-3 hydraulic oil. Take care to keep components protected from contamination.

ASSEMBLY

Actuator Base Threaded Inserts

1. If any inserts (7, Figure 3-4) were removed from the actuator base (6), position the actuator base upside down on the work bench and support directly under each of the four floor mounting holes.
2. Install the threaded inserts into the actuator base by tapping lightly with a small hammer until the insert flanges become flush with the actuator base. Be sure the base is supported to avoid breaking the base.
3. Thoroughly clean the actuator base and set aside.

Boot and Cap

1. Examine the boot (2, Figure 3-4) for any cracks, tears, or other damage. If damage is evident, the boot must be replaced To replace the boot, follow the procedure below.
2. Remove the boot from the actuator cap (1) and discard the old boot. Thoroughly clean the sides of the cap by scraping the lip where the cap contacts the boot. Use a knife or suitable scraper. Clean thoroughly to remove all residual adhesive or particles of the old boot.
3. Apply a thin bead of Loctite Prism 410 onto the upper sides of the cap. Apply the bead to the two long sides only. Do not apply it to the rounded ends, these must not be sealed to allow the boot to "breathe".
4. Carefully position the cap into the new boot groove wiping off the excess glue.
5. Position the boot such that it conforms to the contour of the cap, then set aside. Adhesive requires about 30 minutes to cure.

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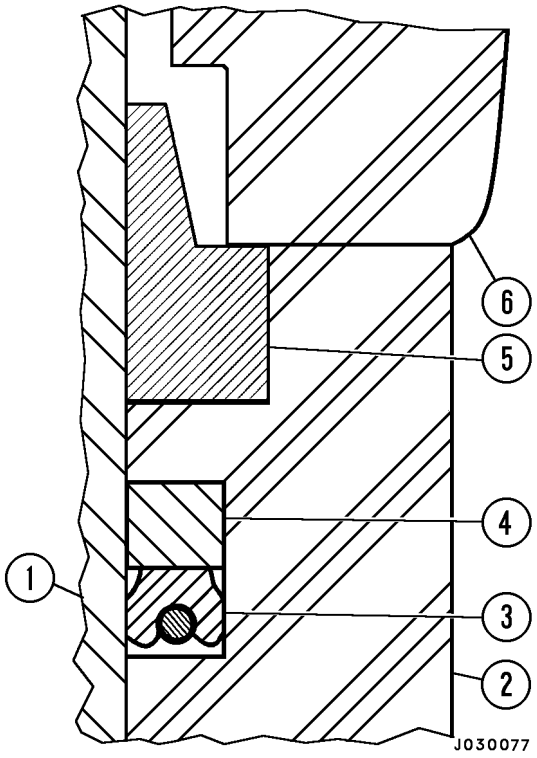


FIGURE 3-6. VALVE BODY SEAL INSTALLATION

1. Actuator Plunger
2. Valve Body
3. Poly - Pak Seal
4. Back-Up Ring
5. Wiper Seal
6. Actuator Base

Valve Body Seal Installation

1. Install the poly-pak seal (3, Figure 3-6) in the seal groove first. Position the seal in the groove so that the internal O-ring inside the poly-pak seal is facing down toward the bottom of the valve.
2. Make sure the internal O-ring is still seated inside the poly-pak seal (3) and did not get dislodged during installation. Position the poly-pak seal to the bottom of the groove.
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.

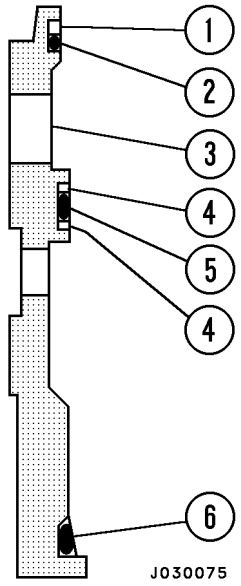


FIGURE 3-7. SLEEVE SEAL PLACEMENT

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

Regulator Sleeve O-Ring Installation

1. Install an O-ring (2, Figure 3-7) 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 3-5) 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.

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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 3-5) 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 (3, Figure 3-5).
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 3-8) 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.
5. Repeat Steps 1 through 4 for the “B2” actuation plunger.
6. Install the plunger return spring (10, Figure 3-5), regulator springs (8 & 9) and spring seat (11) into the appropriate circuit. If spring seat does not seat correctly on top of the control spring, lightly shake the valve to correctly position the spring seat.
7. Lightly lubricate the regulator spool (12).
8. Install the regulator spool into the regulator sleeve (19). The spherical end of the spool should be at the top of the regulator sleeve. The top of the sleeve is the end with the smallest O.D.

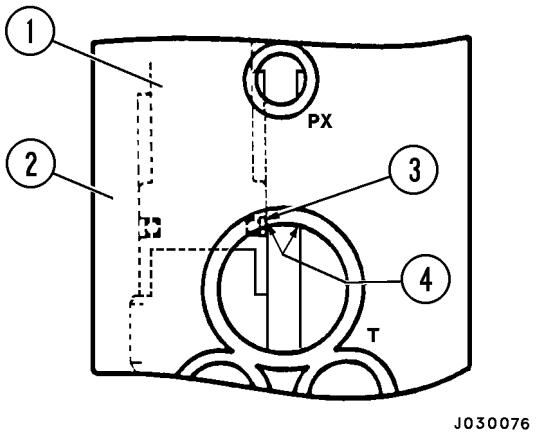


FIGURE 3-8. GLYDE RING INSTALLATION

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

NOTE: Check to insure that the spool will slide smoothly and freely. Replace the entire sleeve assembly and spool, if the spool does not slide smoothly and freely.

9. Remove spool from sleeve before installing sleeve into body.
10. Lightly lubricate the O-rings (14, 16, & 18) on the regulator sleeve.
11. Install the regulator sleeve assembly into the correct circuit in the valve. Make sure the spring seat is correctly seated in the regulator spring before installing the regulator sleeve assembly. Push sleeve into bore until sleeve retaining flange at the base of sleeve contacts the valve body.
12. Install the spool return spring (20) into spool (12).
13. Insert reaction plunger (21 or 22) into regulator spool.
14. Install regulator spool (12) into regulator sleeve (19).
15. Repeat Steps 6 through 14 for the second circuit.
16. Lightly lubricate the large retainer plate O-ring (30) and install into the counter bore in the bottom end of the valve.
17. Install the retainer plug (31) into the counter bore on the bottom of the valve. Make sure steps on the retainer plug are facing the counter bore or toward the top of the valve.
18. Install the base plate (32) on top of the retainer plug. Tighten the four allen screws (34) evenly, alternating diagonally, to evenly seat the regulator sleeve assembly. Tighten to **140 - 150 in.lbs. (15.8 - 16.9 N.m) torque**.
19. Using a new O-ring (27, Figure 3-5) and seal (28), install pressure differential pressure switch assembly (35) on valve body.
20. Install the actuator base (6, Figure 3-4) on top of the valve. Make sure to position properly for correct port direction. Tighten the two socket head capscrews (5) and tighten to **180 - 190 in.lbs (20.3 - 21.5 N.m) torque**.
21. Screw the adjustment collars (1, Figure 3-5) onto the top of the actuation plungers. Screw all the way down until they bottom on the threads.

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DIFFERENTIAL PRESSURE SWITCH

The differential pressure switch (1, Figure 3-9) mounted on the brake valve detects an imbalance in brake apply pressure between the front and rear brake circuits. If the pressures differ more than shown in Table I, "Differential Pressure Switch Test", the switch (3) activates a warning horn and lamp in the cab to alert the operator to a potential brake system problem.

Disassembly

1. Remove the four socket head capscrews attaching the differential pressure switch body (1, Figure 3-9) to the valve body (2).
2. Remove switch assembly (3) and O-ring (12).
3. Remove plugs (5, 6 & 11).
4. Insert a hex wrench through bottom port and remove screw plug (7).
5. Remove spring (8) and piston (9).
6. Carefully push spool assembly (10) our of its bore.

Cleaning and Inspection.

1. Clean all metal parts with solvent and air dry.
2. Inspect spool assembly (10, Figure 3-9) for scoring and other evidence of damage. Inspect spool bore in body (4). If seals are damaged, entire differential switch assembly should be replaced.
3. Lightly lubricate spool assembly and carefully insert in bore. Spool must slide freely and smoothly in bore. If there is binding, the entire differential pressure switch assembly must be replaced.
4. Lubricate piston (9) and insert in its bore. Piston must move freely with no binding.
5. Inspect spring (8) for cracks, distortion, etc.
6. Attach an ohmmeter to switch assembly (3) center terminal and switch body. Actuate the switch plunger to verify contacts close when plunger is depressed and contacts open when released. Plunger must operate freely in switch body.

Assembly

1. Install plug (11, Figure 3-9). Tighten plug to **190-210 in. lbs. (21.5 - 23.7 N.m)** torque.
2. Lightly lubricate Glyde rings on spool assembly (10) and carefully insert in body (4) until it bottoms on plug (11).
3. Install plug (5). Tighten plug to **190-210 in. lbs. (21.5 - 23.7 N.m)** torque.
4. Using new O-ring (12), install switch assembly (3). Tighten to **55 - 60 in. lbs. (6.2 - 6.8 N.m)** torque.

NOTE : In the following assembly, make a note of the color (red or green) of spring (8). The spring color will determine final adjustment of the switch. Refer to Table I, "Differential Pressure Switch Adjustment".
In addition, for future service reference, the outside of the valve should be marked to indicate the color (red or green) of spring (8).

5. Turn valve over and install piston (9), spring (8) and screw plug (7). Plug should be inserted approximately 0.5 in. (13 mm) below edge of body. Temporarily install plug (6) in screw plug port.

NOTE : The adjustment of screw plug (7) controls the switch actuation point. Refer to "Valve Bench Test and Adjustment, Differential Pressure Switch Adjustment " for calibration procedure.

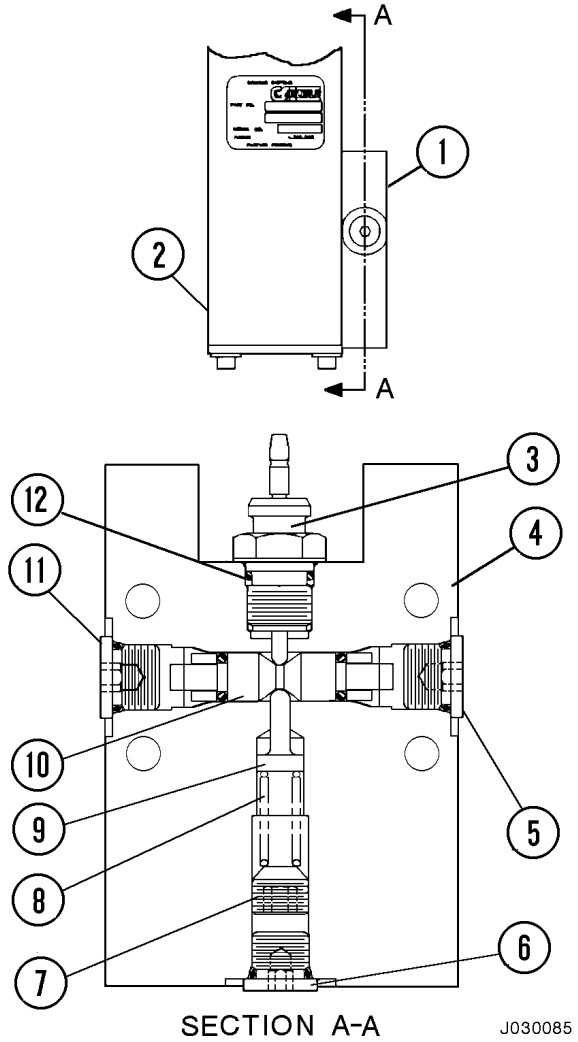


FIGURE 3-9. DIFFERENTIAL PRESSURE SWITCH

1. Differential Pressure Switch Assembly
2. Valve Body
3. Switch Assembly
4. Body
5. Plug
6. Plug
7. Screw Plug
8. Spring
9. Piston
10. Spool Assembly
11. Plug
12. O-Ring

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VALVE BENCH TEST AND ADJUSTMENT

The following parts and test equipment will be required to completely bench test and adjust the dual control treadle valve. Differrential pressure switch operation can also be tested.

- Pressure gauges (3), 0-to-3500 psi (24 132 kPa).
- Hydraulic pressure supply, regulated to 3200 psi (22 064 kPa).
- Hydraulic test stand, Refer to Figure 3-10.
- Hose fittings for valve ports:
  Port PX is 7/16 in. – 4 SAE.
  Ports P1, P2, B1 and B2 are 3/4 in. – 8 SAE.
  Port T is 1 1/16 in. - 12 SAE.
- Ohmmeter

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

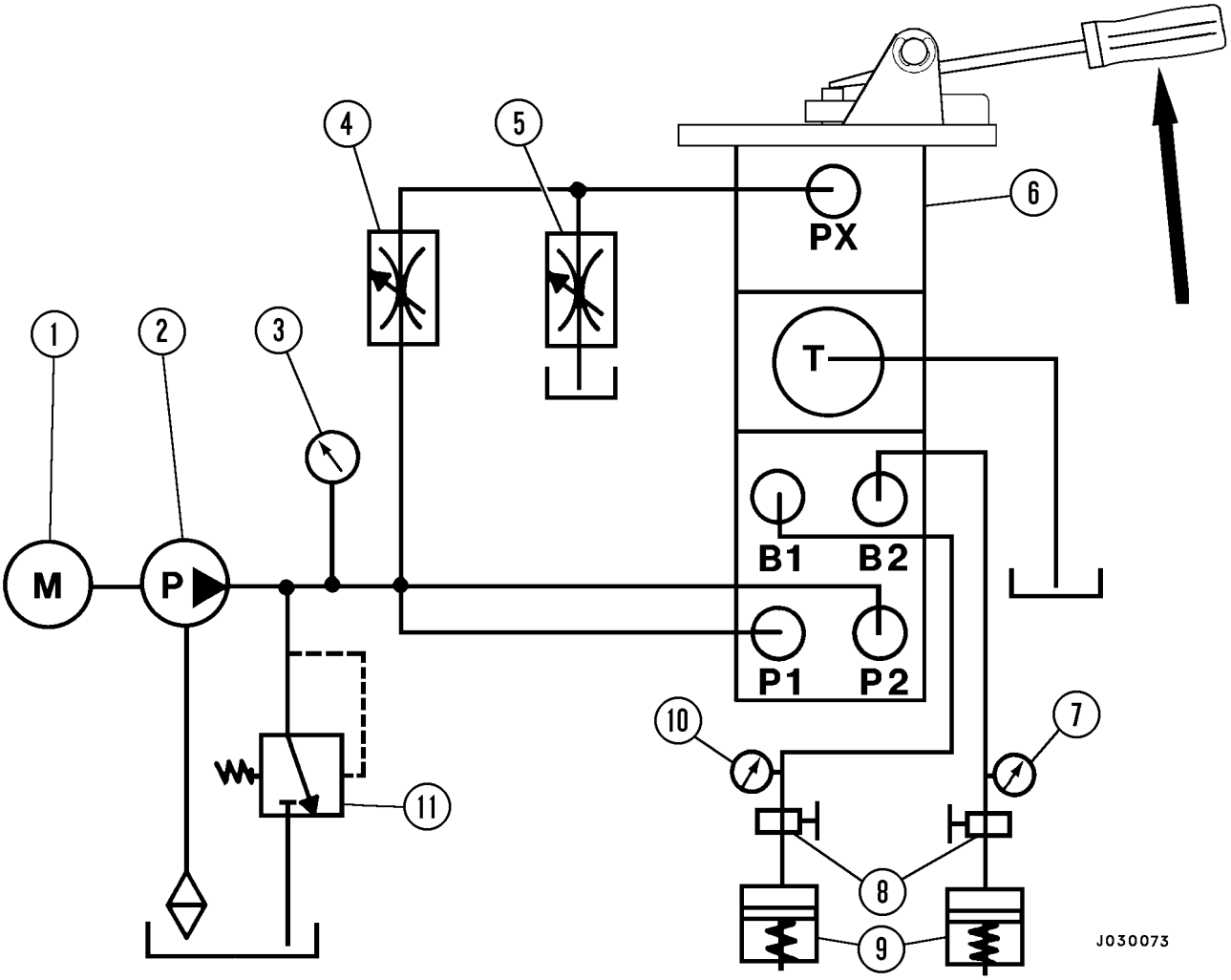


FIGURE 3-10. TEST BENCH SET UP

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

NOTE: Shut off valves (8) for tests not requiring simulated brake loads, such as circuit tracking.
NOTE: B1 Cylinder must be capable of a 10 cubic inch maximum displacement.
NOTE: B2 Cylinder must be capable of a 20 cubic inch maximum displacement.

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Test Set Up Procedure

1. Position the valve in the fixture to allow plungers to be activated by hand using a lever (refer to Figure 3-10).
2. Attach the pilot input supply pressure to the pilot port labeled “PX” on the rear of the valve.
3. Attach the main supply input pressure to the O-ring ports on the rear of the valve labeled “P1" and "P2".
4. Attach the tank return line to the O-ring port labeled “T” on the rear of the valve.
5. Attach the O-ring regulated output ports “B1” and “B2” to the test lines. Pressure monitoring devices in these two lines must be capable of 3,500 psi (24 132 kPa). Connect all ports. The connections should be according to the diagram shown in Figure 3-10. All ports must be used and connected.

⚠ DANGER

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

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

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

6. Start hydraulic pump and regulate output pressure to 3200 psi (22 064 kPa) at pressure gauge (3). Pressure gauges (7 & 10) should read zero.
7. Set pilot supply pressure on test stand to 3200 psi (22 064 kPa).
8. Return line pressure during this test is not to exceed 5 psi (34 kPa).
9. Test the valve with ISO grade hydraulic oil at 120° ±10° F (49° ±3° C).

Brake Valve Output Pressure Adjustment

1. Install the pedal pivot shaft pin in the actuator base by itself without installing the pedal assembly.
2. By taking a screw driver or pry bar and placing it under the pivot pin and on top of the threaded plunger assembly, each circuit can be actuated individually. Refer to Figure 3-10.
3. Gradually apply pressure on each circuit (one at a time) to check for leaks around the plunger. Make sure the adjustment collar is screwed all the way down on the threads.
4. **“B1” Adjustment:** Adjust the adjustment collar up (counter-clockwise) starting with one turn increments until the output pressure at port “B1” is 2000 -0/+75 psi (13 790 -0/+517 kPa) with the adjustment collar contacting the actuator base **(fully actuated)**. Fine adjustment will require turning the collar only in 1/8 turn increments.
5. **“B2” Adjustment:** Adjust the adjustment collar up (counter-clockwise) starting with one turn increments until the output pressure at port “B2” is 3000 -0/+150 psi (20 685 -0/+1 034 kPa) with the adjustment collar contacting the actuator base **(fully actuated)**. Fine adjustment will require turning the collar only in 1/8 turn increments.
6. Tighten the setscrews in the adjustment collars to **25 - 30 in.lbs. (2.8 - 3.4 N.m) torque.** The entire plunger may have to be rotated to get to the capscrews.
7. Check pressures again after tightening the set screws. If the pressures have moved out of specified range, loosen the appropriate set screw and re-adjust.
8. Cycle each circuit 50 times using pilot apply. This is done by closing needle valve (5) and opening needle valve (4). Read pressure on gauges (7 & 10). Close valve (4) and open valve (5). The pressure gauges (7 & 10) should read 0 psi.
9. Recheck pressures after cycling. If they have changed, re-adjust pressures.

Differential Pressure Switch Test

10. Attach ohmmeter lead to connector on differential pressure switch wire. Attach other lead to valve body.
11. Insert pry bar under pivot pin to actuate the “B1” section of valve.
12. Slowly depress plunger while observing the ohmmeter; switch contacts should close at pressure shown in Table I.

Table I - Differential Pressure Switch Adjustment

Spring Color	Pressure - Switch Contacts Closing	
	“B1” Valve Spool	“B2” Valve Spool
Red	250 ±30 psi (1 724 ±207 kPa)	375 ±50 psi (2 585 ±345 kPa)
Green	600 ±50 psi (4 137 ±345 kPa)	1000 ±75 psi (6 895 ±517 kPa)

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13. Insert pry bar under pivot pin to actuate the “B2” section of valve.
14. Slowly depress the plunger while observing the ohmmeter; switch contacts should close at the pressure shown in Table I, "Differential Pressure Switch Test".
15. Shut down the test bench and relieve all hydraulic pressure from the lines.

⚠DANGER

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

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

16. Remove hoses from valve and remove valve from test stand. Refer to instructions below for pedal actuator installation prior to final test.

Final Test and Adjustment

The brake pedal actuator must be installed on the brake valve body prior to final test and adjustment. Refer to “Installation of Brake Pedal actuator to Brake Valve”

NOTE: The “Final Test and Adjustment” procedure can also be performed with the brake valve installed in the truck. To perform final test with brake valve mounted in the truck, install valve per instructions in “Installation”. Install 3500 psi (24 132 kPa) gauges at the BF and BR diagnostic test connectors in the brake cabinet. Follow steps 18. - 29 below for final test.

17. Reinstall brake valve (with actuator pedal attached) on the test stand following steps 2 through 9. under “Test Setup Procedure”.
18. With test stand pump adjusted for 3200 psi (22 064 kPa) or with engine running and brake system supply pressure at or above 3000 psi (20 685 kPa), depress the pedal as quickly as possible. The pressure on the output circuits must reach the minimum pressure listed below at port “B1” and port “B2” within 1.0 seconds. Measurement of time begins the moment force is applied to move the pedal.
    - ☐ Rear Brake - “B1” (“BR” on truck): 2000 ±80 psi (13 790 ±552 kPa)
    - ☐ Front Brake - “B2” (“BF” on truck): 3000 ±150 psi (20 685 ±1034 kPa)
19. With “B1” and “B2” plugged into a strip chart recorder, (if available) check the modulation by slowly applying pressure until the maximum pressure is reached. Make sure the pressure increase is smooth and no sticking of the spools is observed. Fully depress the pedal. Pressures must remain within specification at “B1” and “B2” for 20 seconds.
20. Turn set screw (10, Figure 3-11) out (counter-clockwise) so that set screw is not touching the actuator cap. Apply Locktite® 242 to the adjustment screw prior to setting the deadband.
21. Set the deadband by placing a 0.025 in (0.635 mm) thick shim at location (11) between the pedal structure and return stop boss on pivot structure.
22. Turn the set screw (10) in (clock-wise) just until the set screw is touching the cap.
23. Continue turning the set screw clock-wise until pressure begins to rise on one of the brake apply pressure gauges.
24. Back-off the set screw 1/8 turn (counter-clock-wise).
25. Tighten the jam nut (9) and remove the shim stock inserted in step 21.
26. Fully stroke the brake pedal actuator to check that output pressure at port “B1” and “B2” are within specifications.

NOTE: If pedal is adjusted properly, the spring and spring pivots will not interfere with pedal travel.

27. If pressure is not within specifications, re-adjust. If pressure is within specifications, apply a few drops of Locktite to the jam nut.
28. Check internal leakage at port “T”. Leakage must be less than 100 cc/minute with the valve in the released position and system pressure supplied to the “P1” and “P2” inlet ports.
29. “T” port leakage must be less than 250 cc/minute with valve pilot pressure or manual applied.

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Installation Of Brake Pedal Actuator Assembly to Brake Valve

1. Install jam nut (9, Figure 3-11) and set screw (10) to brake pedal actuator (7).
2. Insert nylon bushings (4) into brake pedal actuator.
3. Install one retaining clip (2) to one end of pivot shaft.
4. Align pedal structure to brake valve (1) and partially insert pivot pin. Move pedal structure to the "B2" side of valve and insert shims (5) between pedal structure and brake valve ear to fill gap. Fully insert the pivot shaft (3). Install the remaining retainer clip (2).
5. Assemble spring assembly (8) and install complete assembly to brake pedal actuator as shown.

CAUTION

Be sure to install spring assembly correctly, with larger ball socket end pointing to the pedal structure and smaller end toward the valve assembly.

NOTE: If pedal is adjusted properly, the spring assembly will not interfere with pedal travel.

The spring and spring pivots are different for pedals equipped with and without the electric retard pedal mounted to the brake pedal. DO NOT interchange the springs or spring pivots.

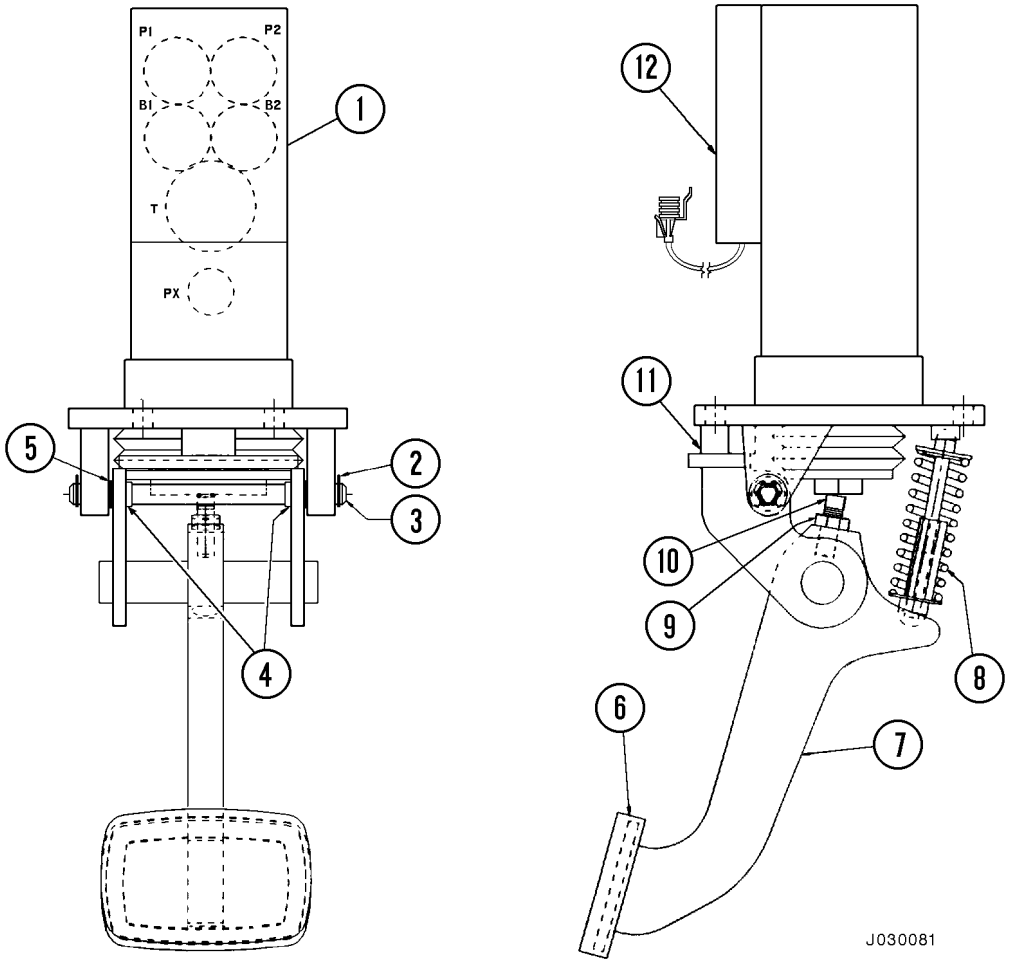


FIGURE 3-11. SINGLE PEDAL BRAKE VALVE ASSEMBLY

1. Brake Valve
2. Retainer Clip
3. Pivot Shaft
4. Bushings
5. Shims
6. Foot Pad
7. Brake Pedal Actuator
8. Spring Assembly
9. Jam Nut
10. Set Screw
11. Pedal Return Stop
12. Differential Pressure Switch

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BRAKE ASSEMBLIES WITH INTEGRAL MOUNTED ELECTRONIC RETARD PEDAL (Dual Function Pedal)

Installation of Retard Pedal To Brake Pedal

Follow "Installation Of Brake Pedal Actuator Assembly to Brake Valve" instructions on previous page. Although the brake pedal actuator structure (7, Figure 3-11 & 18, Figure 3-11) is different on each valve, the assembly procedure is identical.

1. Install nylon bearings (7, Figure 3-12) in retard pedal.
2. Install retard pedal (16) to brake pedal actuator (17) with pivot shaft (8). Install two retainer clips (6).
3. With jam nut (10) loose, adjust capscrew (11) until roller on retard pedal **just contacts** the brake pedal actuator. Tighten jam nut (10).
4. Connect wiring harness to retard pedal.

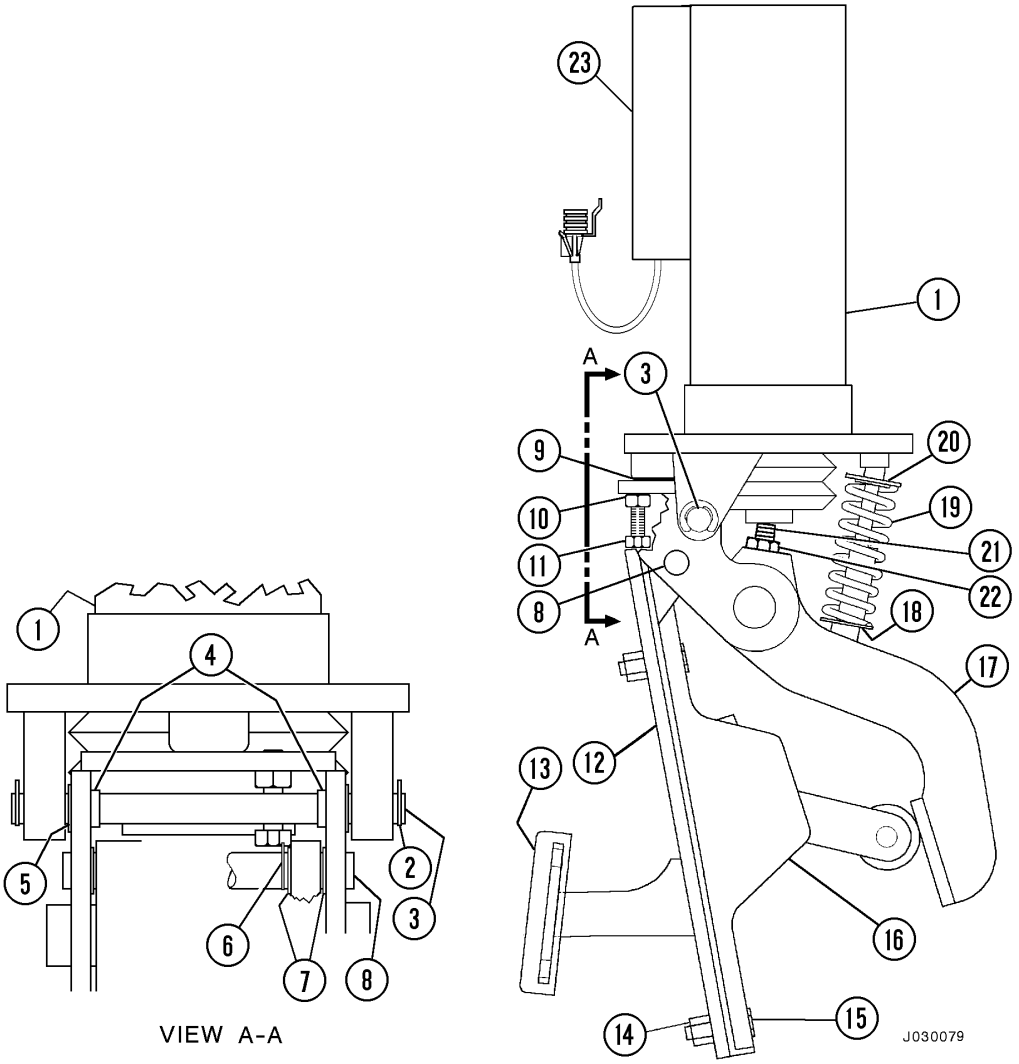


FIGURE 3-12. BRAKE VALVE WITH RETARD PEDAL

1. Brake Valve
2. Retainer Clip
3. Pivot Shaft
4. Bushings
5. Shims
6. Retainer Clip
7. Nylon Bearing
8. Pivot Shaft
9. Place 0.025 in. Shim Here
10. Jam Nut
11. Capscrew
12. Pedal Structure
13. Pad
14. Nut
15. Capscrew
16. Electronic Retard Pedal Assembly
17. Brake Pedal Actuator
18. Spring Pivot (Lower)
19. Spring
20. Spring Pivot (Top)
21. Set Screw
22. Jam Nut
23. Differential Pressure Switch

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HYDRAULIC BRAKE ACCUMULATORS

There are two hydraulic brake accumulators located on the brake manifold in the brake control cabinet behind the operator's cab. The larger accumulator [2.5 gal. (9.51 l) capacity] supplies the pressure necessary for actuation of the front service brakes. The small accumulator [1 gal. (3.79 l) capactiy] supplies pressure to activate the rear service brakes.

⚠DANGER

Accumulators maintain high pressure. DO NOT disconnect any hydraulic line from the accumulators or brake system until all hydraulic pressure has been manually drained from accumulators. Open manual drain valves located on the brake manifold in the brake cabinet to drain pressurized oil. The manual bleeddown valve for the rear accumulator is identified as "NVR". The manual bleeddown valve for the front accumulator is identified as "NVF".

Brake Accumulator Bleed Down Procedure

The brake accumulators can be bled down by rotating the manual bleeddown valves (NVR and NVF) counterclockwise. The valves are located on the brake manifold in the hydraulic brake cabinet.

1. Turn handles counterclockwise to open valves.
2. Confirm accumulators are bled down by applying the "Brake Lock" switch (key switch "On", engine shut down) and applying service brake pedal. The service brake light should not come on.
3. Close the bleeddown valves by rotating clockwise.

Removal

1. Shut down engine and exhaust all hydraulic pressure from the system by opening accumulator manual drain valves.
2. Remove the valve guard and "Dyna-seal" from top of accumulators.
3. Depress valve core to release gas precharge pressure from accumulator bladder. (Refer to Figure 3-13).
4. Remove accumulator mounting bracket. Loosen and remove accumulator from the brake manifold. Plug opening on brake manifold to prevent contamination.
5. Transfer accumulator to work area.

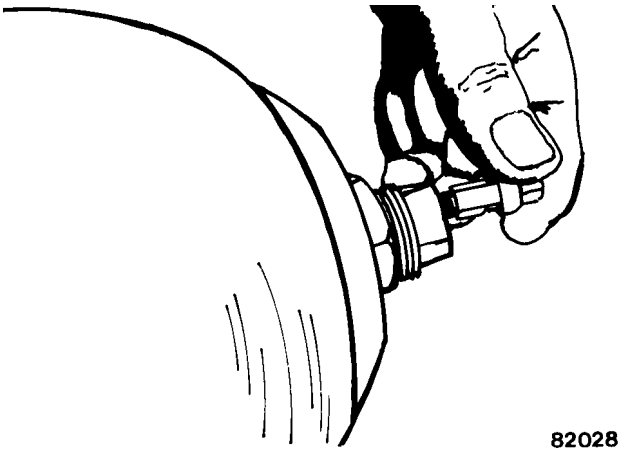


FIGURE 3-13. VALVE CORE REMOVAL

Installation

1. After service repairs or bench test has been completed, move the accumulators to the brake control cabinet. DO NOT precharge accumulators on the bench test.
2. Position the accumulators on the brake manifold. Tighten fittings securely. Install mounting brackets. Secure mounting brackets in place with capscrews and lockwashers. Tighten capscrews to standard torque.
3. Refer to "Charging Procedure" in this section.
4. Replace "Dyna-seal" and valve guard on top of accumulators.

Disassembly

1. Securely clamp accumulator (preferably in a chain vise). Make sure accumulator shell is suitably protected by strips of padding or soft metal on vise base.
2. Remove core from gas valve using valve core tool. (Refer to Figure 3-13).
3. Remove pipe plug from plug & poppet assembly.
4. Remove locknut from plug and poppet assembly using a spanner wrench and an adjustable wrench. One for torque and one for counter-torque. (Refer to Figure 3-14).
5. Remove spacer, Figure 3-15.
6. With palm of hand, push plug and poppet assembly into the shell.
7. Insert hand into shell and remove O-ring, washer and anti-extrusion ring from plug. Fold anti-extrusion ring to enable removal. (Refer to Figure 3-16).
8. Remove plug and poppet assembly from shell. (Refer to Figure 3-17.)

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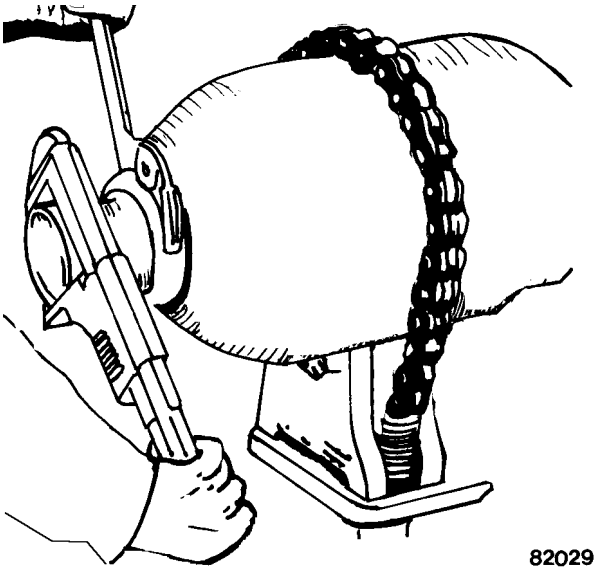


FIGURE 3-14. LOCKNUT REMOVAL

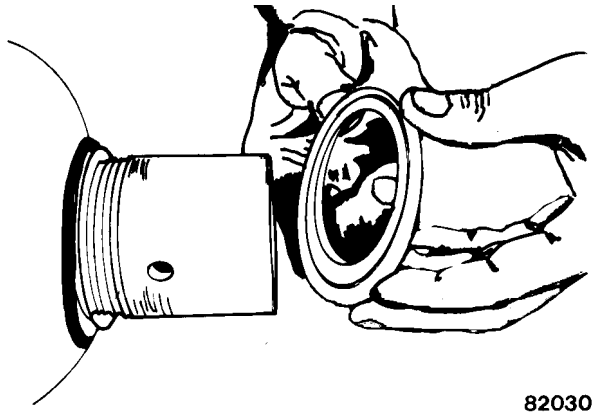


FIGURE 3-15. SPACER REMOVAL

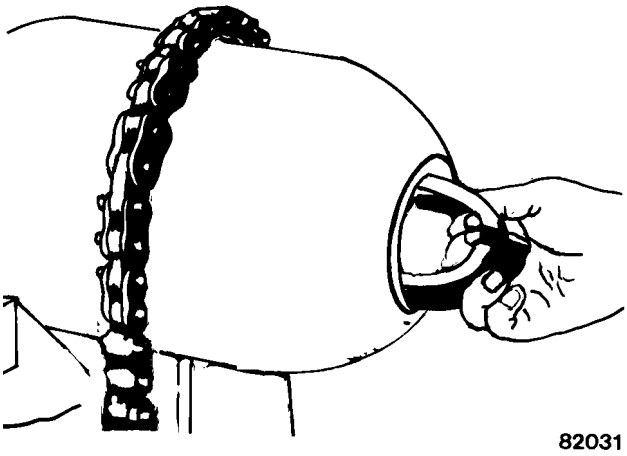


FIGURE 3-16. ANTI-EXTRUSION RING REMOVAL

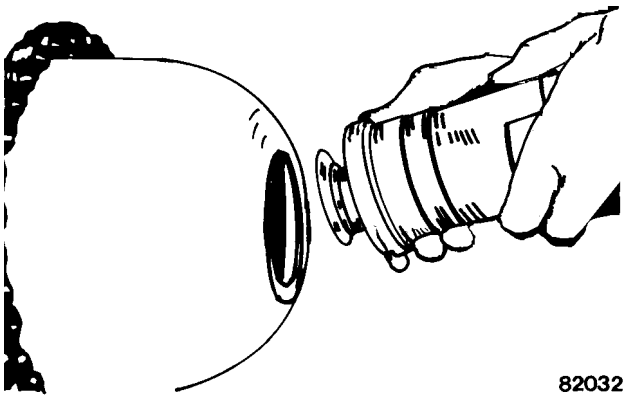


FIGURE 3-17. PLUG AND POPPET REMOVAL

9. With wrench on valve stem flats, remove the nut from the valve stem.
10. Insert hand into shell fluid opening. Depress bag and eliminate as much gas pressure as possible.
11. Grasp heel of the bladder and withdraw from shell. (Refer to Figure 3-18).

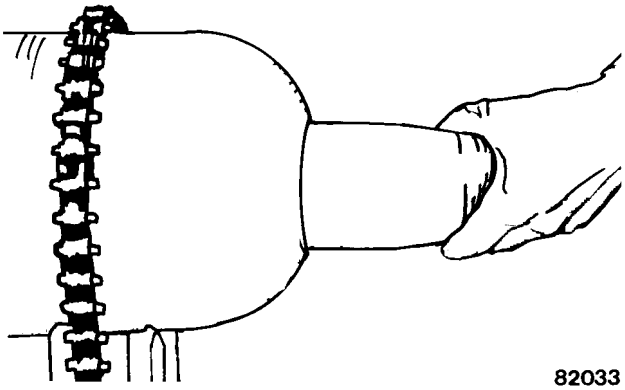


FIGURE 3-18. BLADDER REMOVAL

Cleaning and Inspection

1. After disassembly, clean all parts with an approved cleaning solution.
2. Blow all parts dry with air and keep free from foreign matter.
3. Check all rubber items for deterioration, abrasion marks, cracks, holes, bubbles or any similar defects.
4. Replace all O-rings and any other items deemed unsuitable for further usage.
5. Bladder may be checked by inflating to normal size and checking with a soapy solution. After testing, deflate immediately.
6. Check plug and poppet valve for proper functioning.

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Assembly

1. Replace shell in vise, if removed.
2. Pour a liberal amount of clean C-4 hydraulic oil into shell to serve as a cushion.
3. With bladder assembly on bench, expel all air to completely collapse bladder and fold bladder longitudinally into a compact roll. To maintain rolled condition of bladder, install gas valve core into the valve stem, thereby preventing air from entering the bladder.
4. Attach bladder pull rod to bladder valve stem.
5. Pass bladder pull rod through shell oil port and out through valve stem opening. (Refer to Figure 3-19).
6. Pull bladder pull rod out of shell with one hand while feeding bladder into shell with other hand.

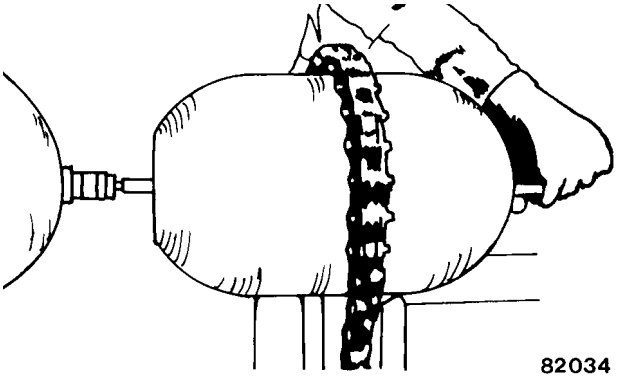


FIGURE 3-19. BLADDER INSTALLATION

7. Position name plate over valve stem and install valve stem nut by hand (Figure 3-20). Remove bladder pull rod.
8. Grasp threaded section of plug and insert poppet end into shell mouth.

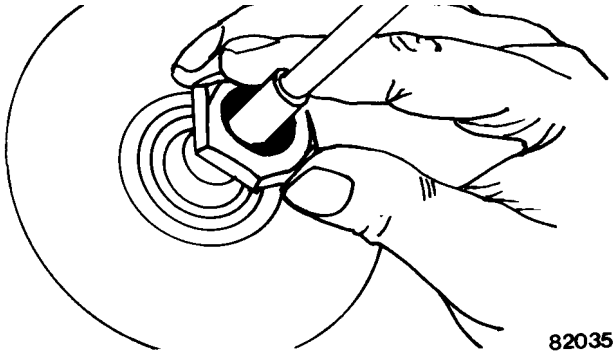


FIGURE 3-20. VALVE STEM INSTALLATION

9. Install anti-extrusion ring inside shell. Fold anti-extrusion ring to enable insertion into shell. Place anti-extrusion ring on plug and poppet assembly with its steel collar toward shell mouth.
10. Withdraw threaded end of plug through shell mouth. (Refer to Figure 3-21).
11. Pull plug until seated solidly into position on shell mouth opening.

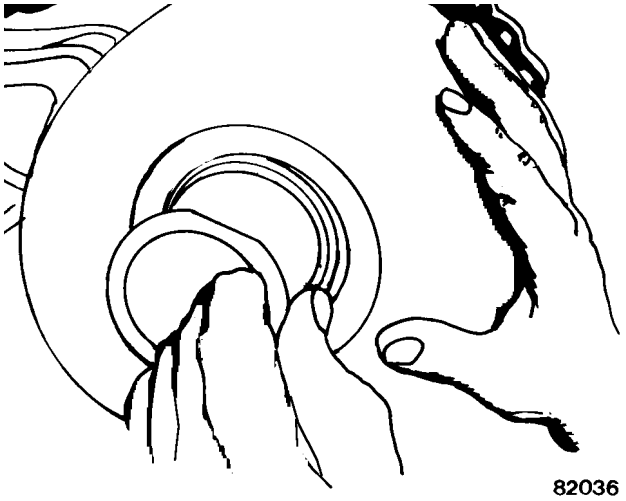


FIGURE 3-21. PLUG ASSEMBLY

12. Install valve core. Using dry nitrogen, slowly pressurize bladder with sufficient pressure [approximately 5 psi (34 kPa)] to hold plug and poppet assembly in place.
13. Install washer onto plug and poppet assembly and push until seated against anti-extrusion ring. (Refer to Figure 3-22).

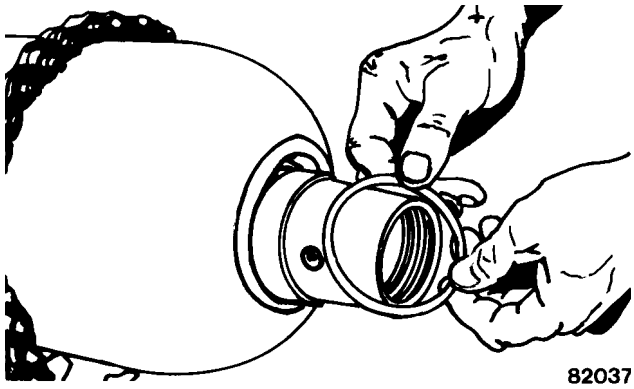


FIGURE 3-22. WASHER INSTALLATION

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14. Install O-ring over plug and poppet assembly and push until seated.

⚠CAUTION

DO NOT TWIST O-RING.

15. Install spacer with smaller diameter of the shoulder toward shell.
16. Install locknut on plug and poppet assembly and tighten securely. This will squeeze O-ring into place. (Refer to Figure 3-23).
17. Replace pipe plug into plug and poppet assembly.
18. Install accumulator on truck and charge according to “Charging Procedure”.

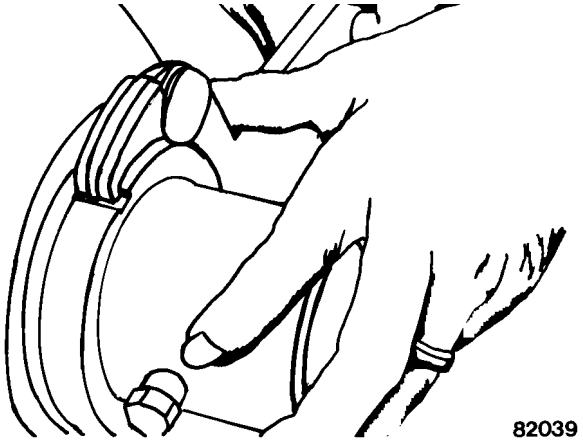


FIGURE 3-23. LOCKNUT INSTALLATION

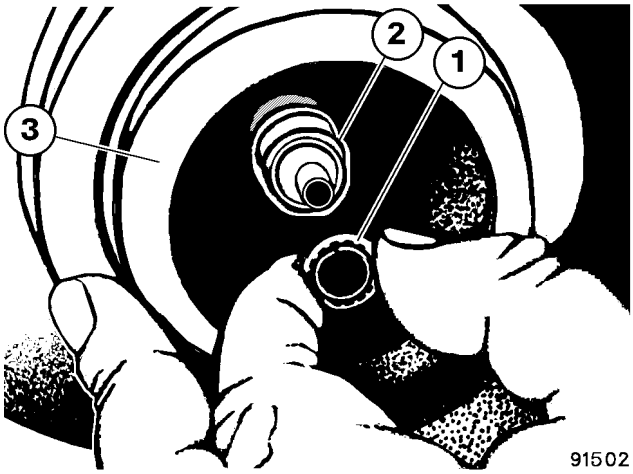


FIGURE 3-24. INSTALLATION/REMOVAL OF "DYNA-DEAL"

1. “Dyna-Seal”
2. Accumulator Charging Valve
3. Accumulator

Charging Procedure

1. Mount hose assembly gland nut on pressure regulator.

⚠DANGER

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

NOTE: Remove “Dyna-seal” or O-ring (if equipped) prior to attaching connector to accumulator gas valve. Refer to Figure 3-24.

2. Attach swivel connector of hose assembly to gas valve. Hand tighten sufficiently to compress gasket swivel connector in order to prevent gas leakage.

NOTE: If leakage is still present, replacement of the small copper washer in the swivel connector may be necessary.

3. Precharge bladder slowly to about 10 psi (69 kPa) before completely tightening the valve stem nut. With wrench on valve stem flats, tighten valve stem nut.
4. Proceed to inflate accumulator to 1400 ±50 psi (9653 ± 345 kPa) pressure by slowly opening the pressure regulator valve on nitrogen cylinder, closing it occasionally to allow needle on pressure gauge to stabilize (thus giving accurate reading of precharge pressure). When correct precharge has been reached, close pressure regulator valve on nitrogen cylinder securely.
5. Bleeder valve can be used to release any gas pressure in excess of desired precharge.
6. Replace “Dyna-seal” and valve guard over valve stem.

NOTE: For recharging only:

Exhaust all hydraulic pressure from the system. Remove valve guard and “Dyna-seal”. Then, follow “Charging Procedure”, Steps 1 thru 6.

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BRAKE CIRCUIT CHECK-OUT PROCEDURE

The brake circuit hydraulic pressure is supplied from the steering circuit at the bleed down manifold. Some brake system problems, such as spongy brakes, slow brake release, or abnormal operation of the overhead panel mounted "Low Brake Pressure" warning light can sometimes be traced to internal leakage of brake components. If internal leakage is suspected, refer to Brake Circuit Component Leakage Test.

NOTE: If internal leakage within the steering circuit is excessive, this also may contribute to problems within the brake circuit. Be certain that steering circuit leakage is not excessive before troubleshooting brake circuit. For Steering Circuit Test Procedure, refer to Section "L", Hydraulic System.

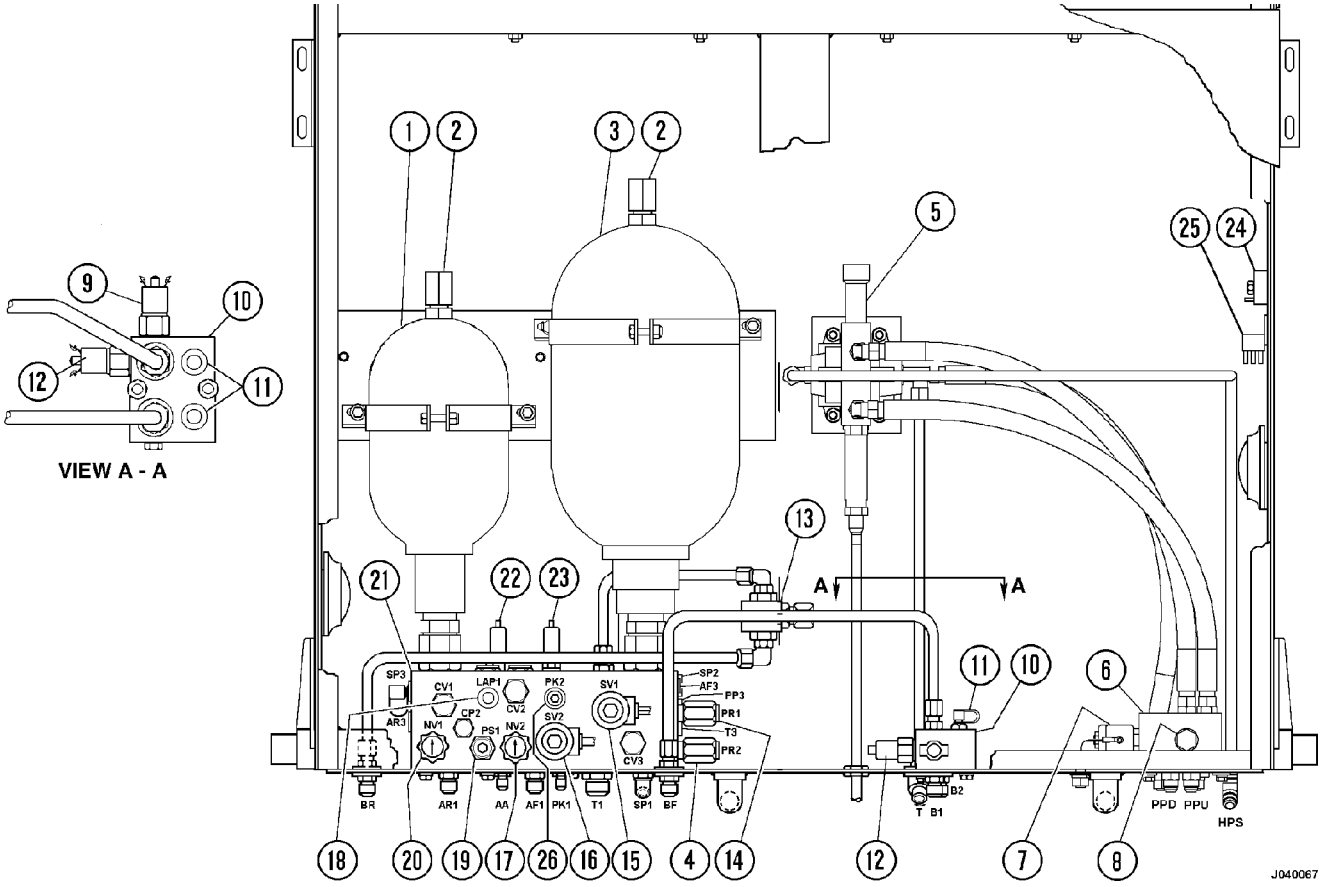


FIGURE 4-1. HYDRAULIC BRAKE CABINET

1. Rear Brake Accumulator
2. Charging Valve
3. Front Brake Accumulator
4. Park Brake Pressure Reducer Valve
5. Hoist Pilot Valve
6. Hoist Pilot Manifold
7. Hoist-Up Limit Solenoid
8. Pilot Operated Check Valve
9. Brake Lock Low Pressure Switch
10. Junction Block
11. BF & BR Test Port (Front & Rear Brake)
12. Stop Light Switch
13. Brake Lock Shuttle Valve
14. Brake Lock Pressure Reducing Valve
15. Brake Lock Solenoid
16. Park Brake Solenoid
17. Bleed Down Valve (Front Brake Accumulator)
18. Accumulator Test Port
19. Automatic Apply Valve
20. Bleed Down Valve (Rear Brake Accumulator)
21. Brake Manifold
22. Low Brake Accumulator Pressure Switch
23. Park Brake Pressure Switch
24. Brake Warning Delay Timer
25. Brake Warning Light Relay
26. Park Brake Test Port

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The steering circuit can be isolated from the brake circuit by removing the brake supply line from the bottom side of the bleeddown manifold (refer to **WARNING** below). Plug the brake supply line and cap the port in the bleeddown manifold.

⚠WARNING

Before disconnecting pressure lines, replacing components in the hydraulic circuits, or installing test gauges, ALWAYS bleed down hydraulic steering and brake accumulators.
Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury, and possibly death, if proper medical treatment by a physician familiar with this type of injury is not received immediately.

The steering accumulator can be bled down with engine shut down, turning key switch "Off", and waiting 90 seconds. Confirm the steering pressure is released by turning the steering wheel - No front wheel movement should occur. Fully open both bleed down valves on brake manifold to bleed down brake accumulators.

⚠WARNING

Before disabling brake circuit, be sure truck wheels are blocked to prevent possible rollaway.

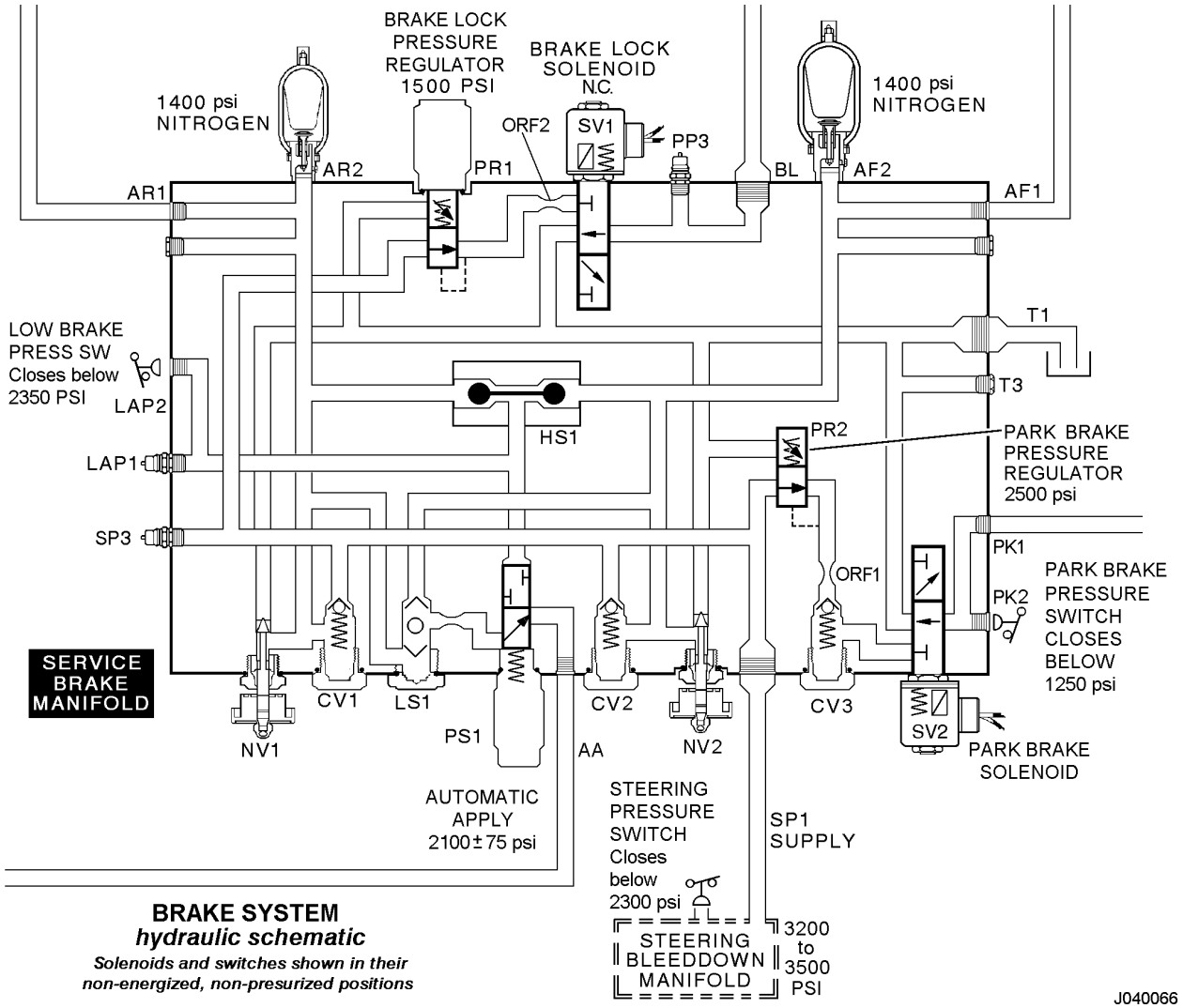


FIGURE 4-2. BRAKE MANIFOLD

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BRAKE CIRCUIT ABBREVIATIONS	
AA	Automatic Apply Pressure
AF2	Accumulator, Front Brake
AF1	Supply Pressure to Dual Controller for Front Brakes
AR2	Accumulator, Rear Brake
AR1	Supply Pressure to Dual Controller for Rear Brakes
BF	Brake Pressure, Front (11, Figure 4-1)
BL	Brake Lock Apply Pressure
BR	Brake Pressure, Rear (11, Figure 4-1)
CV1	Check Valve, Rear
CV2	Check Valve, Front
CV3	Check Valve, Park Brake
LS1	Shuttle Valve
HS1	Low Pressure Emergency Apply Shuttle Apply Valve
LAP1	Pressure Tap Test Port Low Accumulator Pressure
LAP2	Low Accumulator Pressure Switch {N.C., 2350 ± 75 psi (16.2 MPa)}
NV1	Rear Accumulator Manual Drain Valve
NV2	Front Accumulator Manual Drain Valve
ORF1	Orifice (0.062 in.)
ORF2	Orifice (0.100 in.)
PK1 & 2	Park Brake Release Pressure
PP3	Pressure Tap Test Port Brake Lock Pressure
PR1	Pressure Reducing Valve
PR2	Park Brake Pressure Regulator (To Release)
PS1	Automatic Apply Valve
SP1	Supply Oil Inlet
SP3	Pressure Tap Test Port Brake Circuit Supply Oil Pressure
SV1	Brake Lock Solenoid
SV2	Park Brake Solenoid
T1 & T3	Return to Tank

EQUIPMENT REQUIRED

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

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

The following equipment will be necessary to properly check-out the hydraulic brake circuit.

a. Hydraulic brake schematic, refer to Section "R" this manual.

b. Calibrated pressure gauges:

-Two 0-5000 psi (0-34,475 kPa) range.

-Three 0-3000 psi (0-20,685 kPa) range.

c. One PB6039 female quick disconnect and hose long enough to reach from brake cabinet to the inside of the operator's cab for each gauge.

d. Accumulator charging kit (EB1759 or equivalent) with gauges and dry nitrogen.

NOTE: A gas intensifier pump will be required, if using "T type" nitrogen bottles.

e. Clear plastic hose and bucket for bleeding brakes.

f. Volt/ohm meter with leads and two 24 inch (61 mm) leads with alligator clips.

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INITIAL SYSTEM SET-UP

Prior to checking the brake system, the hydraulic steering system must have proper accumulator pre-charge and be up to normal operating temperatures. Refer to Section "L" this manual for steering system operation procedures and specifications. Also prior to checking the brake system make sure the parking brake is properly adjusted. Refer to parking brake adjustment this section. With the steering system functioning properly and the parking brake adjusted, proceed as follows:

1. Turn engine and key switch off.
2. Fully open each brake accumulator bleeddown valve and precharge both accumulators to 1400 psi (9650 kPa). Allow gas temperature to approach ambient temperature before completing precharge process.

   · Record on data sheet.

NOTE: For best performance, charge accumulators in the ambient conditions in which the machine will be operating.

3. Close both accumulator bleeddown valves.
4. Install pressure gauges at:
   a. Front Brake Test Port "BF" (brake cabinet) - 5000 psi (34,475 kPa) gauge.
   b. Rear Brake Test Port "BR" (brake cabinet) - 5000 psi (34,475 kPa) gauge.
   c. Low Accumulator Pressure Test Port "LAP1" (brake manifold) - 5000 psi (34,475 kPa) gauge.
5. Set park brake. Release brake lock.
6. Start engine. Observe rising brake pressures as system charges. Brake pressure should begin to fall when Auto Apply Valve releases. Brakes should release at approximately 2000 psi (13,790 kPa).

   · Record on data sheet.
7. Partially depress brake pedal and bleed air from bleeders located at each brake.

PARKING BRAKE

NOTE: Move one of the pressure measuring instruments from the BF or BR locations to the PK2 test port above the Park Brake Solenoid.

8. Actuate brake lock. Release parking brake with park brake switch. Verify that Park Brake Status Light indicates parking brake is released. Park Brake pressure should be 2500 ± 100 psi (17,238 ± 690 kPa).

   · Record on data sheet.
9. Measure the lining to disc clearance with feeler gauge and record the clearances.

   · Record on data sheet.
10. Apply parking brake and release brake lock.

NOTE: Return the pressure gauge to the BF or BR location from which it was removed.

BRAKE SYSTEM CHECK-OUT

NOTE: Unless otherwise specified, perform the following checks with engine running, park brake set and brake lock released.

11. VERY SLOWLY depress brake pedal to check circuit tracking. Rear brake pressure must begin to rise before front brake pressure. Rear brake pressure should be between 45 psi (310 kPa) and 205 psi (1413 kPa) when front brake pressure begins to rise. Force feedback of pedal on foot should be smooth with no abnormal noise or mechanical roughness.

    · Record on data sheet.
12. Slowly depress brake pedal and check to see that brake indicator lamp and stop lights illuminate at 75 ± 5 psi (517 ± 34 kPa) rear brake pressure.

    · Record on data sheet.
13. Quickly and completely depress pedal and check to see that front brake pressure reads 3000 ± 150 psi (20685 ± 1034 kPa) and that rear brake pressure reads 1980 ± 100 psi (13650 ± 689 kPa) within one second of brake application and that both pressures remain above their minimum values for a minimum of 20 seconds.

    · Record on data sheet.

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14. Release pedal, assure that each circuit's pressure is zero.

    · Record on data sheet.

15. To check pedal free play, refer to the procedure "Additional Testing and Adjustment (With brake pedal installed)" in this "Section J" of the service manual.

NOTE: Free play is defined by the gap between the setscrew (in the pedal structure) and the actuator cap. There must be a gap to prevent brake drag.

16. Cycle brake lock several times to assure crisp shift of solenoid valve and release of oil pressure.

17. Apply brake lock and read brake pressures. Front pressure should be zero and rear pressure should be 1500 ± 100 psi (10343 ± 690 kPa).

    · Record on data sheet.

Failure Modes Check-Out

18. Allow engine to run until low brake accumulator pressure stabilizes at or above 3200 psi (22,064 kPa).

19. Shut engine down. Allow 90 seconds for the steering accumulator to bleed completely down. Disable steering pressure switch from the brake warning circuit by unplugging the diode between circuits 33 and 33F. (This is diode 22 on diode board 1) Turn key switch on. After two minutes, record the low accumulator pressure (LAP1 port). If LAP1 pressure is below 2600 psi (17,927 kPa), then leakage in the system is excessive and the source of the leakage needs to be identified.

    · Record on data sheet.

20. Crack the front brake accumulator bleed down valve and observe LAP1 pressure. The Low Brake Pressure lamp and buzzer must actuate at 2300 ± 75 psi (15,859 ± 517 kPa).

    · Record on data sheet.

21. Brake pressures should begin to rise (Auto Apply) when LAP1 reaches 2000 ± 100 psi. Close front brake accumulator bleed down valve.

    · Record on data sheet.

22. Start engine to recharge hydraulic system. Allow engine to run until low brake accumulator pressure stabilizes at or above 3200 psi (22,064 kPa).

23. Shut engine down. Allow the steering accumulator to bleed completely down. Turn Key Switch on. Crack the rear brake accumulator bleed down valve and observe LAP1 pressure. Verify that the Low Brake Pressure lamp and buzzer, and Auto Apply set points are within a 100 psi (690 kPa) of those recorded in step 20. Record Auto Apply brake pressures. Close the rear brake accumulator bleed down valve.

    · Record on data sheet.

24. Enable the steering pressure switch by plugging in the diode removed between circuits 33 and 33F.

25. Start the engine to recharge hydraulic system. Allow engine to run until low brake accumulator pressure stabilizes at or above 3200 psi (22,064 kPa).

26. Shut engine down. Do not allow steering accumulator to bleed down. Make repeated slow, complete brake applications with pedal until auto apply comes on. Record the number of brake applications prior to auto apply.

    · Record on data sheet.

27. Bleed down both brake accumulators by fully opening the manual bleed down valves on the brake manifold.

28. Outside the brake cabinet, disconnect the hose that supplies oil from the front brake accumulator to the brake pedal in the cab for the front brakes (port AF1) and plug the tube end at the cabinet. Be sure to leave end of hose vented to atmosphere.

29. Start engine and allow low brake accumulator pressure (LAP1) to stabilize at 3200 psi (22064 kPa) before proceeding.

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

    Verify fault indicators are activated at:

    Refer to Table I Pressures.

    · Record Pressure on data sheet.

Table 1. - Differential Pressure Switch Adjustment		
Spring Color	Pressure - Switch Contacts Closing	
	"B1" Valve Spool	"B2" Valve Spool
Red	250 ± 30 psi (1 724 ± 207 kPa)	375 ± 50 psi (2 585 ± 345 kPa)
Green	600 ± 50 psi (4 137 ± 345 kPa)	1000 ± 75 psi (6 895 ± 517 kPa)

! WARNING ! DO NOT attempt to adjust a "red" spring to the higher "green" spring pressures. This will cause the spring to "bottom out" and the warning switch will not function properly.

    For more specific details regarding Table I, refer to previous chapter: BRAKE CIRCUIT COMPONENT SERVICE, BRAKE VALVE, "Differential Pressure Switch Adjustment".

    · Record on data sheet.

31. Turn key switch off and bleed down both brake accumulators by opening the manual bleed down valves on the brake manifold.

32. Outside the brake cabinet, reconnect the hose that connects the front brake accumulator (port AF1)to the brake pedal in the cab. Disconnect the hose that supplies oil from the rear brake accumulator to the brake pedal in the cab for the rear brakes (port AR1) and plug the tube end at the cabinet. Be sure to leave end of hose vented to atmosphere.

33. Slowly depress brake pedal. Differential switch must actuate the low brake pressure buzzer and lamp at 375 ± 50 psi (2586 ± 345 kPa) front brake pressure. Adjust if necessary.

    · Record on data sheet.

34. Turn key switch off and bleed down both brake accumulators by opening the manual bleed down valves on the brake manifold.

35. Outside the brake cabinet, reconnect the hose that supplies oil from the rear brake accumulator to the brake pedal in the cab.

36. Install a jumper wire between circuits #33 and #33W at the brake warning timer. Install another jumper wire between circuits #33W and #33T on the brake warning relay. Both circuits are in the brake cabinet.

37. Start engine and build accumulator pressures.

NOTE: With engine running, and service and brake lock released, the low brake pressure warning system should be activated.

38. Slowly depress the service brake pedal until the low brake pressure warnings are deactivated.

39. Slowly release pedal, the low brake pressure warning should activate when the rear brake pressure reaches 1000 ± 25 psi (6895 ± 172 kPa). (Checks brake lock degradation pressure switch.)

40. Remove jumper between circuits #33W and #33.

41. Disconnect one end of the jumper between #33T and #33W.

NOTE: With engine running, there should be no warnings.

42. Reattach jumper between #33T and #33W. The low brake pressure warning should actuate approximately 1.0 second after reconnecting jumper. (Checks delay of timer).

    · Record on data sheet.

43. Remove all jumper wires, and gauges. This concludes the brake check out.

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BRAKE CIRCUIT AND BRAKE VALVE TROUBLESHOOTING

POSSIBLE CAUSES	SUGGESTED CORRECTIVE ACTION
TROUBLE: The Brakes are Locked, Service and/or Parking	
Parking brake solenoid is de-energized.	Check power to solenoid
Connections to tank and pressure ports reversed.	Correct the plumbing.
Parking brake solenoid coil defective.	Replace coil.
Parking brake solenoid valve defective.	Replace solenoid valve.
Tank line is plugged or restricted.	Remove restriction.
TROUBLE: Both Brake Circuits are Dragging	
Tank line has back pressure.	Ensure tank line has no back pressure.
Pedal set screw out of adjustment; residual pressure.	Adjust pedal deadband with set screw.
TROUBLE: One Brake Circuit is Dragging	
Obstruction in the brake valve subassembly.	Remove obstruction.
Brake valve is out of balance.	Adjust balance according to instructions.
Actuator piston defective.	Replace piston.
Brake valve is defective.	Rebuild or replace Brake Valve assembly.
TROUBLE: The Brakes are Not Going to Full Pressure	
Internal malfunction of modulating section of Brake Valve.	Remove, disassemble, clean, and inspect brake valve.
Supply pressure is low.	Check steering/brake pump system and accumulators.
Improper collar adjustment inside brake valve.	Adjust collars according to instructions.
TROUBLE: A Brake Accumulator Bleeds Off Quickly When Supply Pressure is Cut Off	
Accumulator bleeddown valve is open.	Close valve, check precharge.
Accumulator precharge is low.	Recharge accumulator.
Leak in one circuit.	Check plumbing.
Malfunction in brake valve.	Remove, disassemble, clean, reassemble; or replace.

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TROUBLE: 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 is improperly adjusted.	Check the switch and replace if necessary. Check differential pressure switch adjustment. *NOTE: Refer to Step 30, Table I - Differential Pressure Switch Adjustment. If the differential pressure switch is O.K. and the differential pressure indicates a "red" spring is being used, replace "red" spring in Differential Pressure Switch Assembly with "green" spring and re-adjust differential pressures according to Table I.*
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.
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.

TROUBLE: The Differential Pressure Warning Circuit is not Operating

Low Brake Pressure lamp is burned out.	Replace bulb.
Electrical problem.	Check wiring.
Differential pressure switch is defective or is improperly adjusted.	Check the switch and replace if necessary.Check differential pressure switch adjustment. Refer to Table I - Differential Pressure Switch Adjustment. See *NOTE:* above.
Problem in brake valve assembly.	Remove, disassemble, clean, and inspect, or replace brake valve.
Brake warning relay defective.	Replace relay.

TROUBLE: 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 is improperly adjusted.	Check the switch and replace if necessary.Check differential pressure switch adjustment. Refer to Table I - Differential Pressure Switch Adjustment. See *NOTE:* above.

TROUBLE: The Low Pressure Warning Circuit Not Operating Properly

The Low Brake Pressure lamp is burned out.	Replace the bulb.
The circuit is open.	Check the wiring.
Pressure switch defective.	Replace the pressure switch.

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POSSIBLE CAUSES	SUGGESTED CORRECTIVE ACTION
TROUBLE: Low Pressure Warning is On Even Though System Pressure is Proper	
Short in electrical system.	Check wiring.
Pressure switch is defective.	Replace the switch.
TROUBLE: Low Pressure Warning Comes On and Pressure is Low	
Steering circuit is malfunctioning.	Check steering circuit pressures.
The pump is worn.	Rebuild or replace pump.
TROUBLE: A "Squeal" is Heard When Controller is Operated	
Rapid operation of controller.	Normal.
Brake Valve assembly is damaged.	Replace the brake valve assembly.
Hydraulic oil is too hot.	Check entire hydraulic system for restriction etc.
TROUBLE: The Output Pressure At Controller is Correct but Brakes are Not Applying	
Brake lines are blocked or improperly connected.	Check plumbing.
TROUBLE: The Brake Pressures Drift Excessively While Pedal is Held Steady	
Contamination in brake valve assembly.	Remove, disassemble, clean, reassemble; or replace.
Damage in brake valve assembly.	Repair or replace brake valve assembly.
TROUBLE: Oil is Leaking Around the Pedal Base	
Defective seal on top of brake valve.	Replace the seal.
TROUBLE: The Pump Cycles Too Often Or Low Pressure Warning Comes On At Low Engine RPM	
Excessive internal leakage in a component.	Check all steering and brake system components.
Accumulator precharge too high or too low.	Check accumulator precharge.
Brake Valve plumbed incorrectly.	Correct plumbing.
Internal leakage in brake valve assembly.	Replace brake valve assembly.
Pump is worn.	Rebuild or replace pump.
TROUBLE: The Pump Cycles Too Often Or Low Pressure Warning Comes On At Low Engine RPM	
Leak in charge system.	Check charge system.
Accumulators precharge too high or too low.	Check accumulator precharge.
Brake Valve plumbed incorrectly.	Correct plumbing.
Internal leakage in brake valve assembly.	Replace brake valve assembly.
Pump is worn.	Rebuild or replace pump.

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NOTES

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KOMATSU CHECK-OUT PROCEDURE
HYDRAULIC BRAKE SYSTEM DATA SHEET

MACHINE MODEL_____UNIT NUMBER_____SERIAL NUMBER_____

Initial System Set-up

Operate Hydraulic Steering System to obtain proper operating temperature. Refer to Check-out Procedures.

STEP 2 _____ Brake Accumulators charged to 1400 psi (9.65 MPa).

STEP 6 _____ Auto apply brake release pressure.

Parking Brake System

STEP 8 _____ Parking brake release pressure.

STEP 9 _____ Left outboard lining/disc gap.
_____ Left inboard lining/disc gap.
_____ Right outboard lining/disc gap.
_____ Right inboard lining/disc gap.

Service Brake System

Refer to appropriate Service Manual procedures and Bleed brakes; Bleed park brakes.

STEP 11 _____ Rear brake pressure when front brake pressure begins to rise.

STEP 12 _____ Rear brake pressure when stop lights energize.

STEP 13 _____ Front brake pressure, pedal applied.
_____ Rear brake pressure, pedal applied.

STEP 14 _____ Front brake circuit pressure, pedal completely released.
_____ Rear brake circuit pressure, pedal completely released.

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KOMATSU CHECK-OUT PROCEDURE
HYDRAULICBRAKESYSTEMDATASHEET

Brake Lock/Secondary System

STEP 17 _____ Rear brake pressure when brake lock is applied.

_____ Low Brake Pressure and Auto Apply

STEP 19 _____ LAP pressure after 2 minutes.

STEP 20 _____ LAP pressure when low brake pressure fault occurs.

_____ LAP pressure when auto apply occurs.

STEP 21 _____ Front brake pressure after auto apply occurs.

_____ Rear brake pressure after auto apply occurs.

STEP 23 _____ Front brake pressure after auto apply occurs.

_____ Rear brake pressure after auto apply occurs.

Reapplications

STEP 26 _____ Number of applications prior to auto apply.

Differential Pressure Switch

STEP 30 _____ Rear brake pressure at which the front differential fault occurs.

STEP 33 _____ Front brake pressure at which the rear differential fault occurs.

Name of Mechanic or Inspector Doing Check-Out _____

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ROCKWELL WHEEL SPEED FRONT DISC BRAKES

BRAKE CALIPER

Each front wheel speed brake assembly has three* calipers on one disc. Each caliper has six pistons and two linings (three apply pistons and one lining for each side of disc). Lining should be changed when friction material is worn to 0.125 in. (3.22 mm) thickness.

**NOTE: Some trucks may be equipped with FOUR (4) Brake Calipers per wheel. Service and adjustment for these calipers are the same as presented here.*

If inspection of front brake calipers and disc assembly indicate repair beyond lining replacement, it is necessary to remove calipers and disc from front wheel hub and spindle. Refer to Figure 5-4 for maximum wear limits of front disc.

Clean brake assemblies before performing any service. If brake has not accumulated excessive surface dirt, preliminary cleaning can be done in the overhaul area. However, preliminary cleaning should be done before removal of pistons from housing.

- Cleaning may be done by brush or spray, using a petroleum base cleaning solvent.
- Clean diesel fuel is acceptable for this operation.
- Cleaning should be thorough enough for preliminary inspection and disassembly.
- Subassemblies should be blown dry with compressed air after cleaning. Dust shields should be wiped dry with a clean cloth.
- The use of vapor degreasing or steam cleaning **is not recommended** for the brake assemblies or the component parts. Moisture will cause parts to rust.

⚠WARNING

Be certain that all wheels are securely blocked to prevent truck from moving.
Do not loosen or disconnect any hydraulic brake line or component until engine is stopped, key switch is "Off" and drain valves on brake accumulators are opened and steering accumulators are bled down. Turn steering wheel to be sure steering accumulators are completely bled down.

Caliper Removal

1. Remove front tires and rims according to procedure in Section "G".
2. If necessary, remove disc from front wheel hub. Refer to Section "G", *"Front Wheel Hub and Spindle Removal"*.

NOTE: Mark or tag each brake caliper assembly for reassembly at its correct location. Do not interchange parts.

3. Open the brake bleed valves (2, Figure 5-3) at each caliper and bleed down the caliper by disconnecting the two lower hoses at "T" connection (5 & 6, Figure 5-1). Drain the fluid into a container. Do not reuse fluid.
4. Disconnect the top brake hose at "T" connection (3).
5. Disconnect and remove crossover tubes (2, 4, & 7).

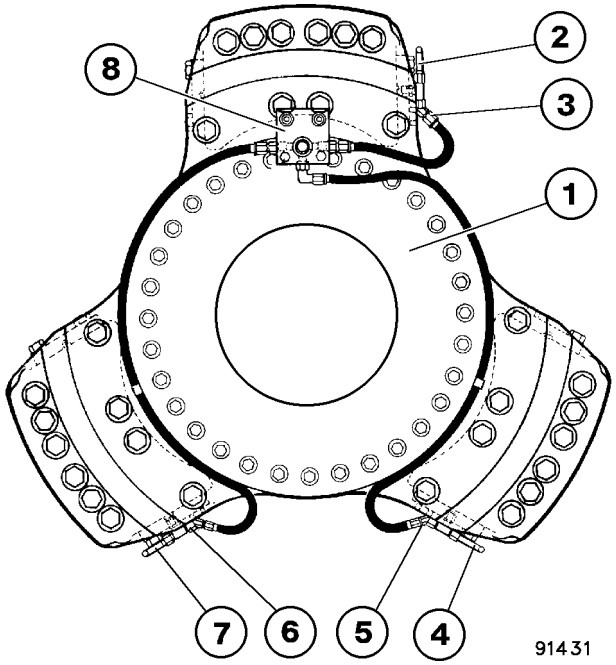


FIGURE 5-1. FRONT BRAKE ASSEMBLY

1. Brake Adapter
2. Crossover Tube
3. "T" Connection
4. Crossover Tube
5. "T" Connection
6. "T" Connection
7. Crossover Tube
8. Junction Block

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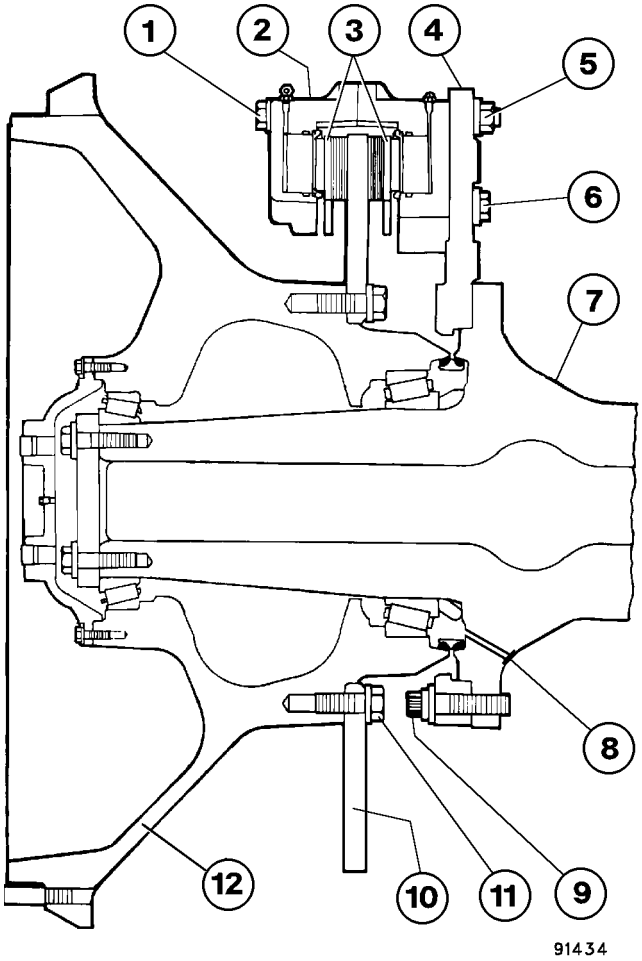


FIGURE 5-2. DISC AND CALIPER ASSEMBLY

1. Capscrew/Flatwasher
2. Brake Caliper
3. Lining
4. Brake Adapter
5. Nut & Flatwasher
6. Capscrew/Flatwasher
7. Spindle
8. Oil Drain
9. Capscrew/Flatwasher
10. Brake Disc
11. Capscrew/Flatwasher
12. Wheel Hub

6. Remove nuts and flatwashers (5, Figure 5-2) and remove outboard half of brake caliper. Remove capscrews and flatwashers (6) securing inboard half of caliper to the brake adapter (4). Remove Inboard caliper.

NOTE: It may be necessary to pry between the brake lining and disc in order to force the piston inward to permit inboard caliper removal.

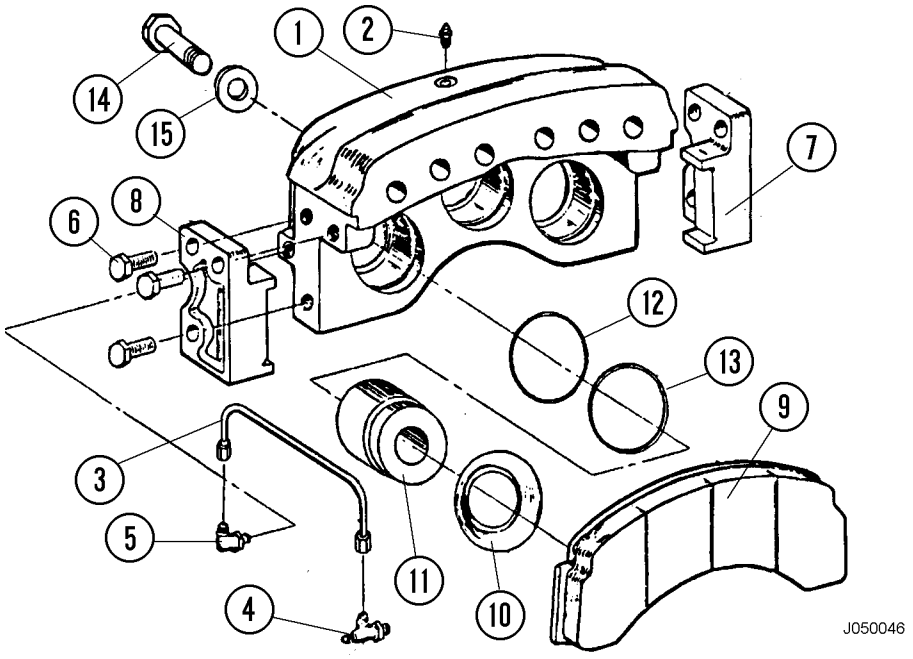
7. Move the brake caliper assemblies to a clean work area for rebuild.

Installation

Prior to brake caliper installation, refer to “Brake Lining” for wear limits regarding brake linings and brake discs. If linings and/or disc is worn beyond acceptable limits, replace the parts at this time.

1. After repair, cleaning and inspection of the brake caliper, install each brake component to its original location.
2. Install the inboard half of caliper assembly (2, Figure 5-2) to the top leg of the brake caliper support and secure caliper assembly with four capscrews (6). Tighten capscrews to standard torque.
3. Repeat Step 2. at the other two brake caliper support legs.
4. Install the upper outboard half of brake caliper assembly (2) to the top leg of the brake caliper adapter (4) and secure with six capscrews, washers and nuts (1 & 5). The pistons in both caliper assemblies will collapse against the brake disc. Tighten capscrews to standard torque.
5. Install crossover tubes (2, 4 & 7, Figure 5-1). Tighten crossover tube connections securely.
6. Install the three brake line hoses at each “T” connection (3, 5 & 6).
7. Refer to “Brake Bleeding Procedures” in this Section and bleed air from caliper assemblies.

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1. Housing
2. Bleeder
3. Crossover Tube
4. T-Fitting
5. Elbow Fitting
6. Retainer Bolt
7. End Cap
8. End Cap
9. Brake Lining
10. Piston Dust Shield
11. Piston
12. Piston O-Ring Seal
13. Backup Ring
14. Brake Mounting Bolt
15. Washer

FIGURE 5-3. BRAKE CALIPER (HALF)

Disassembly

1. Remove bleeders (2, Figure 5-3) and end caps (7 and 8) from each end of each brake caliper housing (1).
2. Remove linings from the caliper assembly.

NOTE: A shallow container may be necessary to receive any remaining fluid that will drain from cavities. Do not reuse fluid.

3. Carefully remove the piston dust shields (10) from behind the groove lip in the housing and from the grooved lips on the piston.
4. Mark each piston and corresponding brake caliper housing position and pull piston out of the housing. Do not interchange parts.
5. Remove O-ring seals (12) and backup ring (13) from the piston cavity using small flat non-metallic tool having smooth round edges.
6. Refer to *"Caliper Cleaning and Inspection"* on the following page for detailed instructions regarding condition and usability of parts.

Assembly

When assembling pistons (11, Figure 5-3) into the housings (1), lubricate all cylinder walls, threads, seals, piston seal surfaces, etc., with clean C-4 hydraulic oil.

1. Install new piston seals (12) and backup rings (13) in housings.
2. With housing lying on mounting face, gently push each piston past piston seal until seated in bottom of cavities.
3. Install new or reusable dust shields (10).

NOTE: Do not allow lubricant to contact dust shields.

4. Install all fittings (4 & 5) and bleeder (2) in correct position in housings.
5. Apply Loctite® 271 to threads of capscrew (6). Install linings (9) and end caps (7 & 8) with bolts (6) and tighten to **403 ft. lbs. (546 N.m)** torque.
6. Refer to "Rear Disc Brakes" in this Section and perform "Bench Test" before installing caliper.
7. After bench test is performed, refer to "Installation" for procedures for installing calipers on brake adapter.

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Cleaning and Inspection

1. Preliminary cleaning can be more effective if linings are first removed. However, retaining plates should be temporarily reinstalled in order to stay with brake assembly through overhaul cycle.

⚠ IMPORTANT ⚠

Use care when wiping dust shields. Too much pressure on shield over sharp tip of housing cavity may cause dust shield to be cut.

2. Cleaning may be done by brush or spray, using a petroleum base cleaning solvent. Clean diesel fuel is acceptable for this operation. Cleaning should be thorough enough for preliminary inspection and disassembly. Subassemblies should be blown dry with compressed air after cleaning. Dust shields should be wiped dry with a clean cloth.

NOTE: If brake has not accumulated excessive surface dirt, preliminary cleaning can be done in the overhaul area. However, it is recommended that preliminary cleaning be done before removal of pistons from housings.

3. Inspect dust shields (10, Figure 5-3) for any physical damage or rupture, and any hardening, cracking, or deterioration of material from excessive heat. Failure of dust shield can admit dirt to the piston cavity, causing damage to surface finish of piston and cylinder wall, and damage to seal. If dust shields are found to be soft and pliable, with no sign of hardening or cracking, they should be wiped clean and set aside for reuse.
4. Inspect piston cavities and surfaces of piston for evidence of dirty fluid, particularly if dust shields were ruptured.
5. Inspect piston cavities for evidence of varnish formation, caused by excessive and prolonged heating of brake oil.

⚠ IMPORTANT ⚠

Piston should be handled with care. The usual cause of nicked piston surfaces is mishandling during the cleaning procedure.
Steel tools should never be used in piston cavities and seal grooves. Copper, brass, aluminum, wood, etc. are acceptable materials for such purposes.

NOTE: All seals (12, Figure 5-3) should be replaced at assembly.

6. Inspect piston (11) surfaces for scratches, excessive wear, nicks, and general surface finish deterioration that can contribute to seal damage and fluid leakage.

NOTE: In normal operation, a very slow rate of wear should be experienced, and will be noticeable by the slow disappearance of the hard chrome finish. Minor nicks and scratches may be blended out by hand with 180 grit aluminum oxide or carborundum cloth, then successively finer grades used until a surface comparable to the original surface is obtained. Extensive local polishing should be avoided, since the ***minimum piston diameter is 3.619 in. (91.923 mm).*** *The piston finish is important in providing a proper seal surface and seal wear life. Where surface finish has deteriorated beyond restoration by moderate power buffing with a fine wire brush, piston should be replaced. Determination of ideal surface finish quality can be made by comparison with a new piston. Surface roughness of piston face through contact with lining back plate is not detrimental to its operation, and is a normal condition.*

7. Inspect piston cavities for damage similar to Step 6 above, with particular attention to the edge of the seal grooves. These must feel smooth and sharp with no nicks or sharp projection that can damage seals or scratch pistons. Seal groove surfaces must be smooth and free of pits or scratches. Finish of cylinder wall is not as critical as surface finish of piston. Surface deterioration near entrance of cavity should be hand polished very carefully to avoid enlarging cavity beyond a **maximum of 3.629 in. (92.176 mm) inside diameter** at the outer edge of the seal groove. Power polishing or honing may be used in cases of extreme surface finish deterioration of cavity walls.

NOTE: Care must be taken that a minimum amount of material is removed, within the previous maximum diameter limitation of 3.629 in. (92.176 mm). Power polishing will not normally be required, and should not be used as a standard overhaul procedure.

8. Inspect inlet and bleeder ports in housings for damage to threads or seal counterbores. Thread damage that cannot be repaired by use of a 0.475-20 UNF-2B tap will require housing to be replaced.
9. Inspect retainer plates (7 & 8) for bent or cracked condition, replace if such damage is found. Inspect retainer plate bolts (6), and tapped holes in housing.

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NOTE: These bolts are highly stressed and should be replaced whenever their condition appears questionable. A 3/4-16 UNF-28 tap lubricated with a light oil may be used to inspect tapped holes in housings for thread damage and to clean up any minor thread roughness.

10. Brake housings and pistons should be thoroughly cleaned. After cleaning, passages, cavities, and external surfaces should be blown dry with clean, dry, compressed air. Piston should also be cleaned and blown dry.

NOTE: Cleaned and dried parts should not be left exposed for any appreciable time without a protective coating of lubricant; for short term storage, coating all internal cavities, passages, and bosses with hydraulic fluid will be adequate protection; for longer term storage wipe cavities, connector bosses, and threads with a protective grease, such as petroleum jelly.

BRAKE LINING

Replacement

Each front wheel speed disc assembly has three (some trucks may have four) calipers on one disc. Each caliper has six pistons and two linings, three apply pistons and one lining for each side of disc. Lining should be changed when friction material is worn to 0.125 in. (3.22 mm) thickness.

⚠WARNING

Failure to replace lining when worn to limits will result in loss of braking and possible catastrophic failure.

1. To replace front linings, remove front tire and rims, refer to *"Wheel and Tire Installation",* Section "G".
2. Remove end plates (7 or 8) Figure 5-3 from either end of caliper.
3. Pry between lining and disc to force pistons to bottom in caliper housing.
4. Remove lining from inboard and outboard sides of disc.
5. Inspect dust seals. Seals should be soft, pliable, and show no evidence of hardening or rupture. If damage is observed, the dust covers must be replaced. This will require disassembly of the caliper.
6. Inspect end plates for wear. Replace if grooves will not allow lining back plate to slide freely.
7. Inspect disc for wear limits, Figure 5-4. If disc is worn below the limits shown, the disc must be replaced. Refer to "Wheel and Tire Installation", Section "G".
8. If original linings have sufficient lining material for reuse, inspect lining back plate for cracks or excessive yielding where plate fits into end plates 7 or 8 (Figure 5-3).

⚠CAUTION

When replacing linings, never mix new and used linings in a brake assembly.

9. Slide linings (9) into caliper. It may be necessary to again pry pistons into housing (1).
10. Install end plates (7 & 8), apply Loctite® 271 to threads of end plate capscrews (6). Install capscrews and tighten to **403 ft.lbs. (54.6 N.m)** torque. Check that linings (9) slide freely between end plates.
11. After completing lining replacement, reinstall front wheels. Refer to "Wheel and Tire Installation", Section "G".

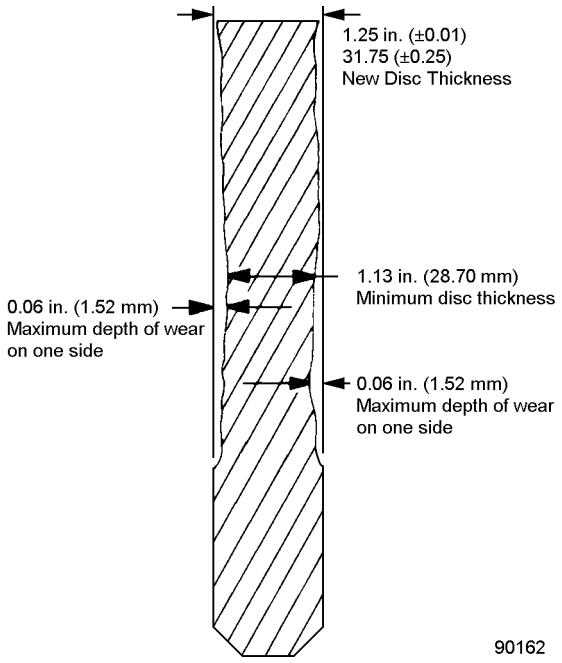


FIGURE 5-4. DISC WEAR LIMITS

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FRONT SERVICE BRAKE CONDITIONING (BURNISHING) PROCEDURE

After any brake lining replacement, or at new truck start up, the brake linings and discs must be burnished. A surface pyrometer will be necessary to accurately record disc temperature during brake burnishing procedure.

SAFETY PRECAUTIONS

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⚠WARNING

- ***BEFORE DISCONNECTING PRESSURE LINES, REPLACING COMPONENTS IN THE HYDRAULIC CIRCUITS, OR INSTALLING TEST GAUGES, ALWAYS BLEED DOWN HYDRAULIC STEERING ACCUMULATORS AND BRAKE SYSTEM ACCUMULATORS.***
  The steering accumulators can be bled down with engine shut down, turning the key-switch "Off" and waiting 90 seconds. Confirm the steering pressure is released by turning the steering wheel - No front wheel movement should occur.
  The brake accumulators are bled by opening the two valves (7, Figure 5-5) on the brake manifold (inside brake cabinet).
- ***BEFORE DISABLING ANY BRAKE CIRCUIT, insure truck wheels are blocked to prevent possible rollaway.***
- ***REAR BRAKES MUST BE DISCONNECTED WHEN BURNISHING THE FRONT BRAKES. Front brakes require burnishing independently from rear brakes in order to control disc temperatures***
- ***EXTREME SAFETY PRECAUTIONS SHOULD BE USED WHEN MAKING HIGH-ENERGY/ HIGH-SPEED BRAKE STOPS ON ANY DOWNGRADE.***
  Safety berms or adequate run off ramps are necessary for any stopping performance tests.
- ***Heavy smoke and foul odor from brake linings is normal during burnishing procedures.***

Front Brake Conditioning

1. To prevent overheating and possible destruction of rear brakes, temporarily disconnect the REAR brakes while burnishing front wheel brakes as follows:
   a. Relieve stored pressure in hydraulic system according to the previous **"WARNING"** instructions.
   b. Disconnect "BR" hydraulic tube (1, Figure 5-5) at both ends inside brake control cabinet. Install a #8, 0.75 x 16 UNF-2B, 37° flare Cap Nut (WA2567, or equivalent) on each fitting where tube was removed. Tighten caps to standard torque to prevent leakage. Cap or plug tube to prevent contamination.

NOTE: This will disconnect the hydraulic supply from the operator's brake pedal to the rear brakes. There will be a noticeable loss of "braking action" at the pedal. However, this method of temporarily disabling the brakes will still permit the application of Brake Lock, in the event of an emergency.

   c. Close brake accumulator bleed valves (7, Figure 5-5).
2. Drive truck at speeds of 5 to 10 MPH with brake alternately applied and released using sufficient pressure to make engine "work" to a noticeable extent during apply.

NOTE: The Override Switch on the instrument panel must be depressed and held by the operator in order to propel with the brakes applied.

3. Apply front brakes at full pressure until discs reach 900°- 1000°F (482°-538°C). Hold in override switch to maintain propulsion to obtain disc temperature. Check temperature after 200 yards (182 meters).
4. Let discs cool to 400°F (204°C) and repeat procedure two more cycles.
5. Allow front disc to cool to 300°F (149°C).
6. RECONNECT rear brakes:
   a. Relieve pressure in hydraulic system according to the previous **"WARNING"** instructions.
   b. Remove Cap Nuts and reinstall tube (1). Tighten tube nuts to standard torque.
   c. Close accumulator bleed valve (7) handles.
7. Start engine and check for leaks. Bleed brakes according to bleeding procedures.
8. Insure all brakes are functioning properly.

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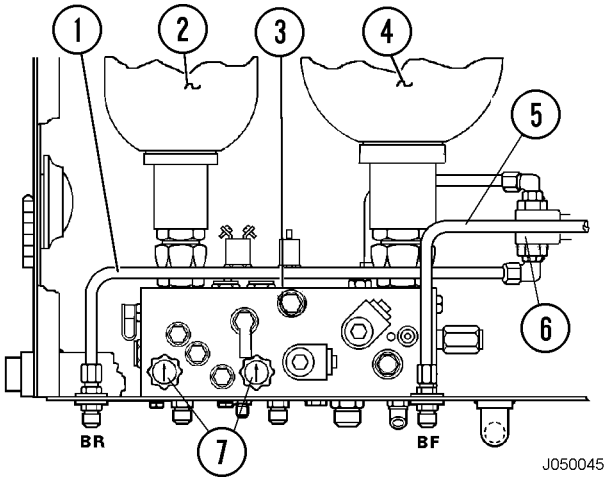


FIGURE 5-5. BRAKE MANIFOLD AND COMPONENTS

1. "BR" Hydraulic Tube
2. Rear Brake Accum.
3. Brake Manifold
4. Front Brake Accum.
5. "BF" Hydraulic Tube
6. Brake Lock Shuttle Valve
7. Brake Accumulator Bleed Valves

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BRAKE BLEEDING PROCEDURES

Attach brake lines and bleed brake calipers according to the following instructions.

1. Fill hydraulic tank following procedure in Section "P", *Hydraulic Tank Service*.
2. Close brake accumulator drain valves (7, Figure 5-5), if open.
3. Securely attach bleeder hose to highest bleeder valve of each caliper, direct hose away from brake assembly and into a container to catch excess oil.
4. With engine at idle make partial brake application of service brake pedal:
   a. Maintaining partial application, open bleeder valve until a clean stream of oil is discharged from caliper.
   b. Close bleeder valve.
5. Repeat above steps until all air is bled from all calipers.
6. Check hydraulic tank oil level as bleeding takes place. Maintain correct oil level as needed.

⚠WARNING

Before returning truck to production, all new brake linings must be burnished. Refer to "Service Brake Conditioning".

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NOTES

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ROCKWELL ARMATURE SPEED REAR DISC BRAKES

REAR BRAKES

Each rear wheel service brake assembly consists of two discs, each with a four piston caliper and a lining on each side of the disc. Both discs are attached by adapters to the wheel motor armature. Also mounted on each wheel motor is a dual piston, two lining caliper acting on each outboard disc as a parking brake.

NOTE: Some trucks may be equipped with TWO (2) Park Brake Calipers per wheel. Service and adjustment for these calipers are the same as presented here.

A constant brake-release clearance between pistons and linings, and lining and disc, is maintained by an automatic adjustment feature of the piston subassembly. As lining wears, the position of grips on a return pin advances to allow maximum piston force to be applied to lining. Upon brake release, the piston is retracted by a return spring for the amount of the predetermined clearance.

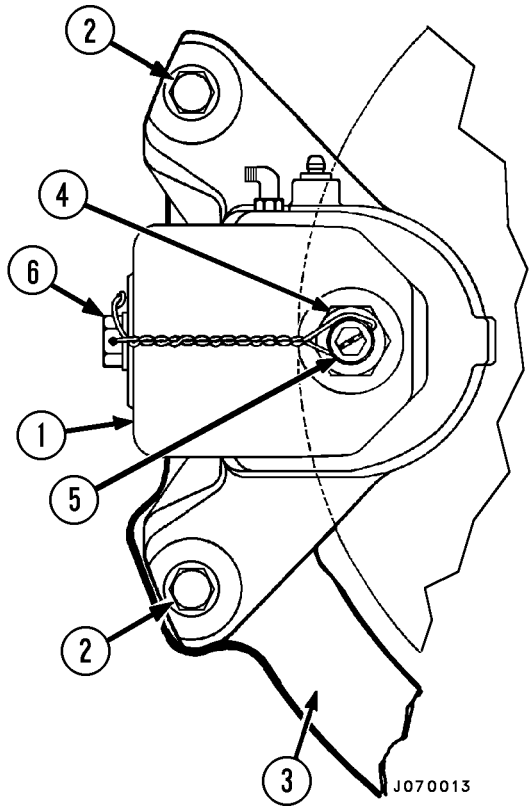


FIGURE 6-1. PARKING BRAKE

1. Parking Brake Caliper
2. Capscrew
3. Mounting Bracket
4. Jam Nut
5. Adjustment Bolt
6. Clamping Capscrew

CALIPER, DISC, AND PARKING BRAKE

⚠WARNING

Do not loosen or disconnect any hydraulic brake line or component until engine is stopped, key switch is "Off" and drain valves on brake accumulators are opened and steering accumulator is bled down. Turn steering wheel to be sure steering accumulator is completely bled down.

Caliper, Disc, and Parking Brake Removal

NOTE: For electric wheels equipped with a two-piece brake hub adapter (9 & 20, Figure 6-3), follow the instructions below. For electric wheels equipped with a one-piece wheel adapter (16, Figure 6-3A), refer to page 4.

NOTE: The Park Brake caliper may be removed from either wheelmotor without disassembly of other brake components.

1. Securely block wheels to prevent truck movement.
2. Remove rear wheel cover.
3. Open the highest bleeder valve (5, Figure 6-2) and attach a bleeder hose to the lowest bleeder valve (6). Open bleed valve and allow oil to drain into a container. Disconnect and remove brake supply tubes from service and park brake calipers. Take care to prevent hydraulic oil from coming in contact with commutator and brushes of wheelmotor.
4. Disconnect brake line connected to the park brake caliper.
5. Loosen jam nut (4, Figure 6-1) on park brake adjustment bolt (5). Loosen clamping capscrew (6) one turn and back out adjustment bolt (5) six turns to release park brake linings from outer disc.
6. Support park brake caliper and remove capscrews (2) securing caliper (1) to park brake mounting bracket (3). Remove caliper from disc.
7. Remove crossover tube (4, Figure 6-2) from upper service brake caliper. Remove crossover tube on lower brake assembly.
8. Removal of brake caliper is easier with linings removed. Remove retainer capscrews (1), lining retainers (2) and linings.

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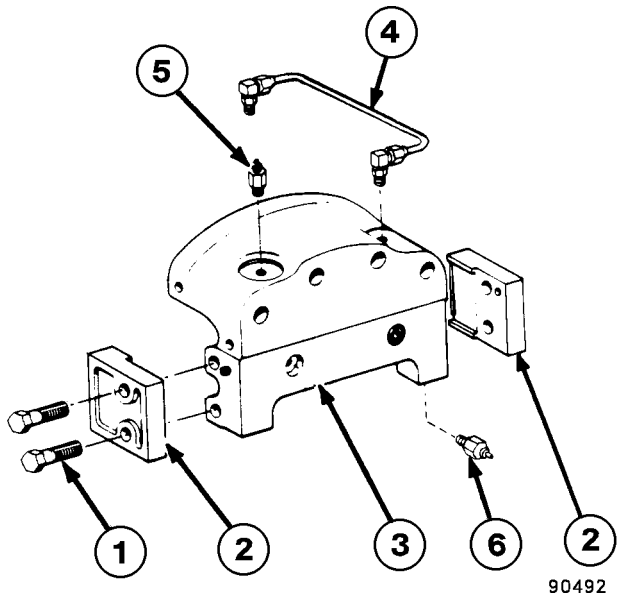


FIGURE 6-2. BRAKE CALIPER

1. Capscrews
2. Retainer
3. Calipers
4. Crossover Tube
5. Bleed Valve
6. Bleed Valve

9. Remove two center caliper mount capscrews (4, Figure 6-3) from outboard caliper and install two 0.875 in., 9 UNC x 14 in. studs.
10. Remove two remaining caliper mount capscrews and remove outer half of caliper (5).
11. Support disc (16) and remove disc mount capscrews (15) and washers. Slide disc from outboard adapter (8). Shims (13) will be found between disc and adapter. Remove bushing (14) and inner half of caliper (5). Remove park brake bracket (3).
12. Remove capscrews and flatwashers (11). Remove adapter (8).
13. Remove two center caliper mount capscrews (17, Figure 6-3) from outboard caliper and install two 0.875 in., 9 UNC x 14 in. studs.
14. Remove two remaining caliper mount capscrews and remove outer half of caliper (18).
15. Support disc (19) and remove capscrews and flatwashers (12). Remove inboard disc (19). Remove shims (6) and bushing (10).
16. Remove inner half of caliper (18).
17. Remove capscrews and flatwashers (7) and remove adapter (9).
18. Remove capscrews and flatwashers (1) and remove adapter (2).

Caliper, Disc, And Parking Brake Installation

1. If removed, install adapter (2, Figure 6-3) and secure in place with capscrews and flatwashers (1). Tighten capscrews to standard torque.
2. Install adapter (9) on armature shaft drive (20) and secure in place with capscrews and flatwashers (7). Tighten hex head capscrews (7) to standard torque. Tighten 12 point head capscrews (7) to **212 ± 20 ft.lbs (287 ±27 N.m)** torque.
3. Install disc (19) with four equally spaced capscrews. Tighten capscrews, but do not tighten to final torque at this time.
4. Measure and record distance from inner caliper mount surface to inside face of inner brake disc (19), (Dimension “A”, Figure 6-3).

NOTE: All measurements in the following references are inches, unless otherwise stated.

5. Subtract dimension “A” from 4.375 in (11.113 cm). The difference is shim pack thickness to be placed between inner disc (19) and disc adapter (9).
6. Select shim pack as follows:
   Example: If result found in Step 5 is 0.051", then 0.051 is between 0.045 - 0.055 in Shim Pack Chart. This range indicates one 0.010 in. shim and one 0.040 in. shim is required to provide correct shim pack thickness.
7. Remove disc mounting capscrews (12) and disc (19).
8. Install two 7/8 UNC - 16 in. studs in the two center caliper mounting capscrew holes for caliper (18).
9. Install inner brake caliper half (18).
10. Install shim pack, determined in Step 5, on inner disc adapter (9) and install inner disc (19) and bushing (10).
11. Install capscrews and flatwashers (12). Tighten capscrews (12) to standard torque.
12. Install outer half of caliper (18) and the outer two capscrews and flatwashers (17).
13. Remove studs, install center two capscrews. Tighten all capscrews (17) to **580 ft.lbs. (786 N.m)** torque.
14. Install outer disc adapter (8). Install capscrews and flat washers (11). Tighten hex head capscrews (11) to standard torque. Tighten 12 point head capscrews (11) to **212 ± 20 ft.lbs (287 ±27 N.m)** torque.

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SHIM PACK CHART		
Shim Pack Required (in.)	**0.010 in. Shim Qty.**	**0.040 in. Shim Qty.**
0.000 – 0.005	0	0
0.005 – 0.015	1	0
0.015 – 0.025	2	0
0.025 – 0.035	3	0
0.035 – 0.045	0	1
0.045 – 0.055	1	1
0.055 – 0.065	2	1
0.065 – 0.075	3	1
0.075 – 0.085	0	2
0.085 – 0.095	1	2
0.095 – 0.105	2	2
0.105 – 0.115	3	2
0.115 – 0.125	0	3
0.125 – 0.135	1	3
0.135 – 0.145	2	3
0.145 – 0.155	3	3
0.155 – 0.165	0	4
0.165 – 0.175	1	4
0.175 – 0.185	2	4

15. Install two 7/8 UNC-16 in. studs in the two center caliper mounting capscrew holes for the upper brake caliper (5).
16. Install park brake bracket (3).
17. Install outboard disc (16) with four equally spaced mounting capscrews (15). Tighten, but do not establish final torque at this time.
18. Measure distance from outer face of park brake bracket (3) [caliper mounting surface] to inner face of outboard disc (Dimension “B”, Figure 6-3).
19. Subtract distance determined in Step 18 from 4.375 in (11.113 cm). This difference is the shim pack thickness to be placed between adapter (8) and outer brake disc (16). Refer to Shim Pack Chart.
20. Make up shim pack from Shim Pack Chart.
21. Remove outer disc and install inner half of caliper (5) over the two studs.
22. Install shim pack determined in Step 19 on adapter (8).
23. Install outboard disc (16) and bushings (14). Install capscrews and flatwashers (15). Tighten capscrews to standard torque.
24. Remove studs and install outer caliper half (5) and secure in place with capscrews and flatwashers (4). Tighten capscrews to standard torque.

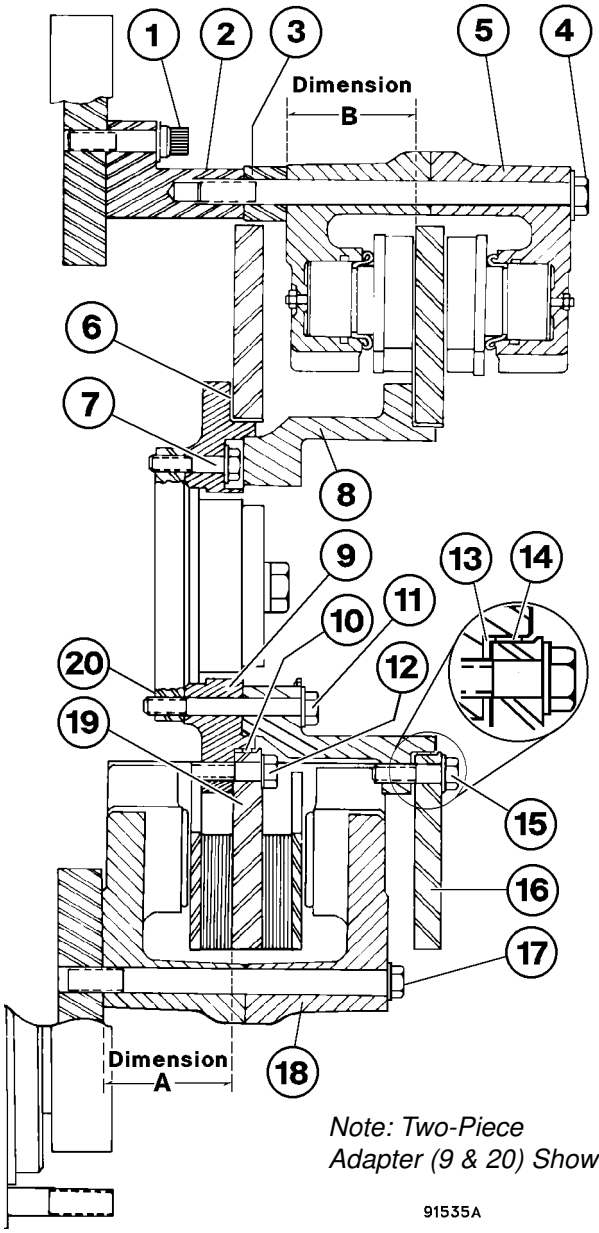


FIGURE 6-3. REAR DISC BRAKE

1. Capscrew/Flatwasher
2. Adapter
3. Park Brake Bracket
4. Capscrew/Flatwasher
5. Brake Assembly
6. Shim
7. Capscrew/Flatwasher
8. Adapter, Brake Disc
9. Adapter, Brake Disc
10. Bushing
11. Capscrew/Flatwasher
12. Capscrew/Flatwasher
13. Shim
14. Bushing
15. Capscrew/Flatwasher
16. Disc
17. Capscrew/Flatwasher
18. Brake Assembly
19. Disc
20. Armature Shaft Drive

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25. Install linings (Refer to “Lining Replacement”).
26. Install bleeders in both calipers. Install crossover tubes and brake lines.
27. Install park brake caliper, refer to “Park Brake Caliper Installation”.
28. Brakes must be bled and burnished before truck is returned to production. Refer to “Bleeding” and “Service Brake Conditioning” procedure.

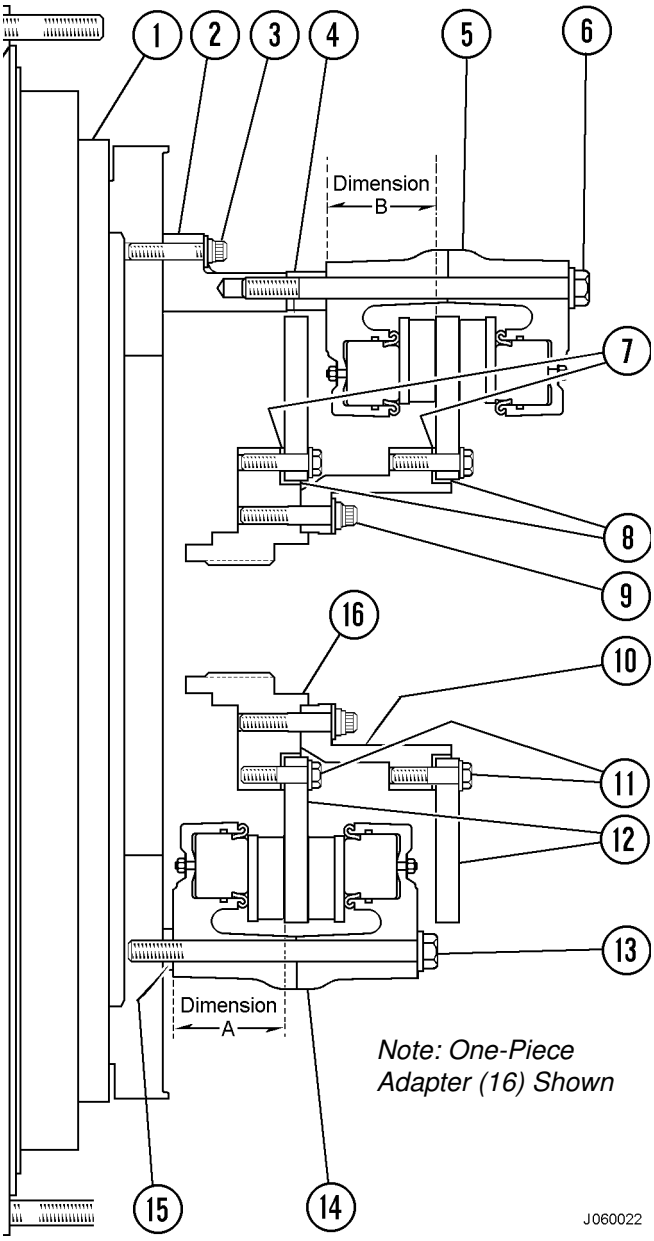


FIGURE 6-3A REAR DISC BRAKE

1. Wheel Motor
2. Adapter
3. Capscrew
4. Park Brake Bracket
5. Brake Assembly
6. Capscrew/Flatwasher
7. Shims
8. Bushing
9. Capscrew
10. Adapter, Brake Disc
11. Capscrew/Flatwasher
12. Disc
13. Capscrew/Flatwasher
14. Brake Assembly
15. Spacer
16. Adapter/Armature Shaft Drive

CALIPER, DISC, AND PARKING BRAKE REMOVAL [For trucks equipped with one-piece adapter (16, Figure 6-3A)]

NOTE: Refer to “Caliper, Disc, and Parking Brake Removal”, Steps 1-6 (page 1) to remove the park brake caliper.

1. Remove crossover tube (4, Figure 6-2) from upper service brake caliper. Remove crossover tube on lower brake assembly.
2. Removal of brake caliper is easier with linings removed. Remove retainer capscrews (1), lining retainers (2) and linings.
3. Remove two center caliper mount capscrews (6, Figure 6-3A) from outboard caliper and install two 0.875 in., 9 UNC x 14 in. studs.
4. Remove two remaining caliper mount capscrews and remove outer half of caliper (5).
5. Support outer disc (12) and remove disc mount capscrews (11) and washers. Slide disc from outboard adapter (10). Shims (7) will be found between disc and adapter. Remove bushing (8) and inner half of caliper (5). Remove park brake bracket (4).
6. Remove capscrews and flatwashers (9). Remove adapter (10).
7. Remove two center caliper mount capscrews (13) from inboard caliper and install two 0.875 in., 9 UNC x 14 in. studs.
8. Remove two remaining caliper mount capscrews and remove outer half of caliper (14).
9. Support inner disc (12) and remove capscrews and flatwashers (11). Remove inboard disc (12). Remove shims (7) and bushing (8) between disc and adapter.
10. Remove inner half of caliper (14) and spacer (15).
11. Remove capscrews and flatwashers (3) and remove adapter (2).

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Caliper, Disc, And Parking Brake Installation

1. If removed, install adapter (2, Figure 6-3A) and secure in place with capscrews and flatwashers (3). Tighten capscrews to standard torque.
2. Install two 7/8 9 UNC - 14 in. studs in two center caliper mounting capscrew holes (in place of capscrews 13). Install spacer (15) and secure in place with two 0.875 - 9 UNC - 2.5 in. capscrews and two flat washers. Tighten capscrews securely, but not to final torque.
3. Install inboard disc (12) with four equally spaced capscrews with flatwashers. Tighten capscrews, but do not tighten to final torque at this time.
4. Measure and record distance from inner caliper mount surface (on spacer 15) to inside face of inner brake disc (12), Dimension “A”, Figure 6-3A.

NOTE: All measurements in the following references are inches, unless otherwise stated.

5. Subtract dimension “A” from 4.375 in. The difference is shim pack thickness to be placed between inner disc (12) and one-piece disc adapter (16).
6. Refer to *“Shim Pack Chart”* and select shim pack as follows:
   Example: If result found in Step 5 is 0.051", then 0.051 is between 0.045 - 0.055 in Shim Pack Chart. This range indicates one 0.010 in. shim and one 0.040 in. shim is required to provide correct shim pack thickness.
7. Remove disc mounting capscrews (11) and inner disc (12).
8. Remove the two 0.875 - 9 UNC - 2.5 in. capscrews securing spacer (15).
9. Install inner brake caliper half (14) over the two studs and spacer (15).
10. Install shim pack (7), determined in Step 5, on inner one-piece disc adapter (16) and install inner disc (12) with bushing (8).
11. Install all capscrews and flatwashers (11) to inner disc. Tighten capscrews (11) to standard torque.
12. Install outer brake caliper half (14) and two capscrews and flatwashers (13).
13. Remove the two studs in the center and install two capscrews (13) and hardened flatwashers. Tighten all capscrews (13) to standard torque.
14. Install outer disc adapter (10). Install capscrews and flat washers (9). Tighten 12 point head capscrews (9) to standard torque.
15. Install two 7/8 UNC-14 in. studs in the two center caliper mounting capscrew holes for the upper brake caliper (5).
16. Install park brake bracket (4) over the two studs and secure in place with two 0.875 - 9 UNC - 2.5 in. capscrews and two flat washers. Tighten capscrews securely, but not to standard torque.
17. Install outboard disc (12) with four equally spaced mounting capscrews (11). Tighten, but do not tighten to final torque at this time.
18. Measure distance from outer face of park brake bracket (4) [caliper mounting surface] to inner face of outboard disc (Dimension “B”, Figure 6-3A).
19. Subtract distance determined in Step 18 from 4.375 in (11.113 cm). This difference is the shim pack thickness to be placed between adapter (10) and outer brake disc (12).
20. Make up shim pack from Shim Pack Chart.
21. Remove capscrews (11) and outer disc (12).
22. Install the shim pack (7) determined in Step 19 between outboard disc (12) and adapter (10).
23. Install outboard disc (12) with bushing (8). Install capscrews and flatwashers (11). Tighten capscrews (11) to standard torque.
24. Install outboard caliper half (5) and secure in place with the outer capscrews and flatwashers (6). Remove the two studs in the center holes and install the remaining two capscrews (6) with washers. Tighten capscrews (6) to standard torque.
25. Install linings (Refer to “Lining Replacement”).
26. Install bleeders in both calipers. Install crossover tubes and brake lines.
27. Install park brake caliper, refer to “Park Brake Caliper Installation”.
28. Brakes must be bled and burnished before truck is returned to production. Refer to “Bleeding” and “Service Brake Conditioning” procedure.

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CALIPER PISTON

Piston Assembly Removal

1. Position brake caliper so that return pin nut (1) is in an upright position. (Refer to Figure 6-7).
2. Hold return pin (10) in place with a narrow bladed screwdriver or hex key wrench and remove nut (1).
3. Using a 0.25 in. (6.35 mm) diameter copper or brass drift and a plastic mallet, gently tap on the end of the pin to drive piston assembly from housing. Carefully remove dust shield (12) from groove of housing and from groove in piston.
4. Remove O-ring seal (7) and backup ring (16) from the housing using a soft non-metallic round edged tool.
5. Necessary functional inspections of piston return mechanism can be made without disassembly of piston assembly. Piston assembly may be disassembled for detailed inspection, reassembled and readjusted.
6. If piston assembly can be cleaned thoroughly without disassembly, and if piston surface condition is acceptable for reuse, then piston assembly can be functionally inspected for operation of the return mechanism, and if satisfactory, returned to service.

Inspection

1. Inspect piston surfaces for nicks, scratches or rust.
2. Inspect housing bore for nicks, scratches or rust. Minor nicks, scratches and rust can be removed with fine emery cloth providing the following wear limits are not exceeded:
   - Piston O.D. . . . . .2.621 in. (66.5 mm) **min**.
   - Housing Bore I.D. . 2.630 in. (66.8 mm) **max.**
3. Replace parts if worn beyond above limits.

Piston Assembly Installation

1. Lubricate pistons, seals, and housing bores with clean C-3 hydraulic oil.
2. Install piston O-ring (7, Figure 6-7) into housing seal groove and push to bottom of groove. (Considering opening to housing bore as top.)
3. Install backup ring (16) into top of housing seal groove with concave or curved side against O-ring.

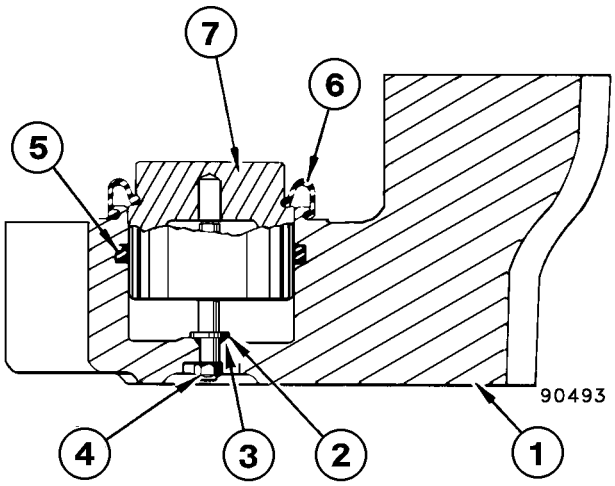


FIGURE 6-4. PISTON ASSEMBLY INSTALLATION

1. Brake Housing
2. Return Pin Washer
3. O-Ring
4. Return Pin Nut
5. Piston Seal Assembly
6. Dust Shield
7. Piston Assembly

4. With brake housing lying on mounting face, gently push piston assembly (7, Figure 6-4) past piston seal assembly (5) until O-ring (3) and washer (2) are seated in bottom of cavity.
5. Install new or reusable dust shields (6). Keep these parts free of lubricant.

⚠ IMPORTANT ⚠

When installing dust shields, avoid applying pressure on shields over sharp edge of shield groove surrounding piston cavities. Underside of shields can be cut if care is not taken and cause failure of shields in service.

6. Position and support housing assembly on bench with return pins up. Install return pin nuts with washers (4) where required. Hold return pin from turning with a narrow-bladed screwdriver or hex key wrench, and tighten nuts to **135 ±15 in.lbs. (15.3 ±1.7 N.m)** torque.

⚠ IMPORTANT ⚠

DO NOT tighten nuts with hydraulic pressure applied to piston or caliper assembly.

7. Place brake housing assembly on arbor press, press piston assembly into cavity to fully retracted position as shown in Figure 6-5.

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NOTE: If desired, installation of brake housing components may be temporarily withheld to perform a "Functional Test".

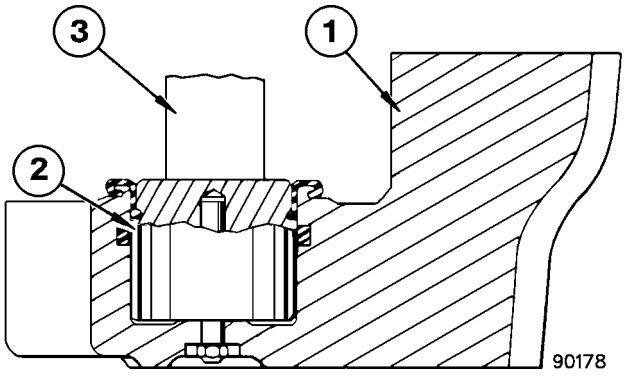


FIGURE 6-5. PISTON INSTALLATION
(Retracted Position)

1. Brake Housing
2. Piston Assembly
3. Arbor Press

8. Install all fittings with new packings into correct position in brake housings.
9. For ease of brake caliper installation, do not install linings and retaining plates in calipers. "Bench Test" should be performed on brake calipers before installation.

FUNCTIONAL TEST OF PISTON ASSEMBLY

NOTE: Perform functional test prior to disassembling piston assembly to determine if any components require replacement. To assure proper operation, also perform functional test prior to installing piston assembly in caliper housing, if disassembled.

Return Spring Force

Return spring (14, Figure 6-7) captured between outer spring guide (8) and spring retainer (5), exerts a return force, through spring retainer (5) and threaded retaining ring (4) on piston (11). With brake applied (spring compressed to a minimum height) return spring force should be between 180-250 lb. (800-1112 N).

Built-In Clearance

This is the amount piston will retract when brake pressure is released. Piston is retracted by force of piston return spring (14, Figure 6-7). Required built- in clearance is 0.065-0.073 in. (1.65-1.85 mm), obtained by the setting of threaded retaining ring (4).

1. The piston subassembly can be inspected for required return spring force and built-in clearance adjustment at the same time. Use the set-up on a spring checker as shown in Figure 6-8.
2. Set up dial indicator between arbor of spring checker and table.
3. Place sleeve (A, Figure 6-6) over return pin, lower arbor and fully compress spring (indicator pointer will stop moving).
4. With spring compressed, set indicator dial to zero.

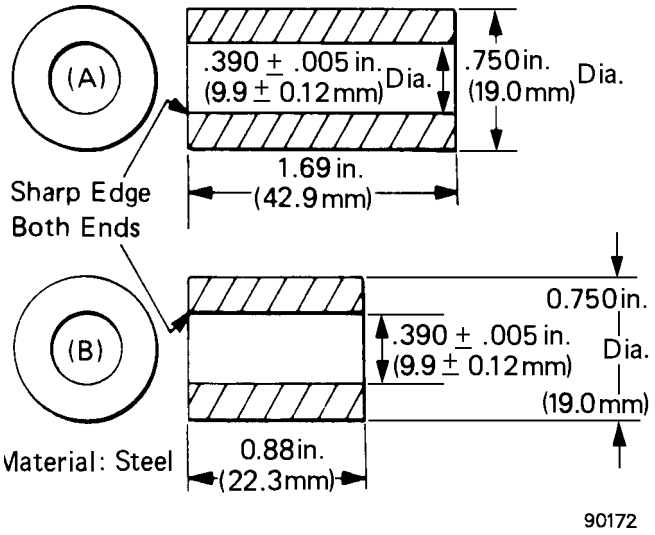


FIGURE 6-6. GRIP SPACE AND INSTALLATION SLEEVES

5. Raise arbor slowly until spring checker force scale reads zero. Reading on indicator dial will be the built-in clearance which should be 0.055-0.073 in. (1.65-1.85 mm).
6. Lower arbor slowly until dial indicator reads zero. Reading on spring checker force scale will now indicate the return spring force which should be 180-250 lbs. (808-1112 N) force.
7. Slowly raise and lower arbor several times to verify both built-in clearance and spring force measurements. If measurements are outside this range, remove lockwire (15, Figure 6-7), lower arbor until spring is fully compressed, screw threaded retaining ring clockwise until bottomed (a spanner wrench is recommended for this) then back off one full turn (minimum), plus any additional amount to reach the next locking position, raise arbor and install lockwire. Recheck for correct built-in clearance adjustment by repeating Steps 3, 4 & 5).

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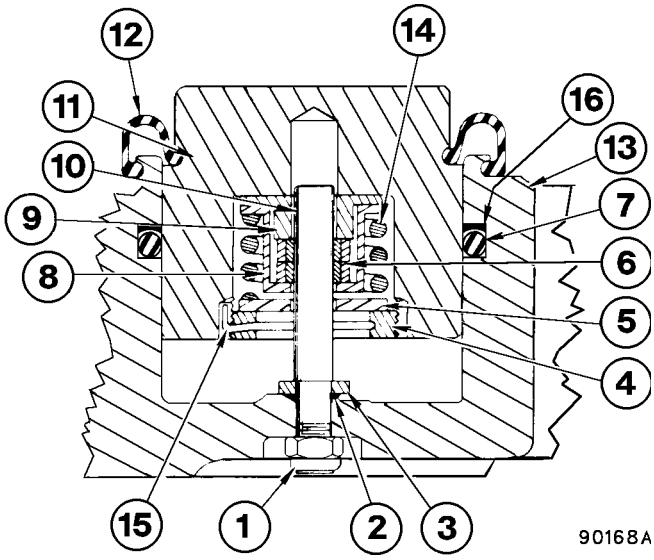


FIGURE 6-7. DISK BRAKE PISTON ASSEMBLY

1. Return Pin
2. O-Ring
3. Washer
4. Retaining Ring
5. Spring Retainer
6. Grip Assembly
7. O-Ring
8. Outer Spring Guide
9. Inner Spring guide
10. Return Pin
11. Piston
12. Dust Shield
13. Brake Caliper
14. Piston Return Spring
15. Lockwire Ring
16. Backup Ring

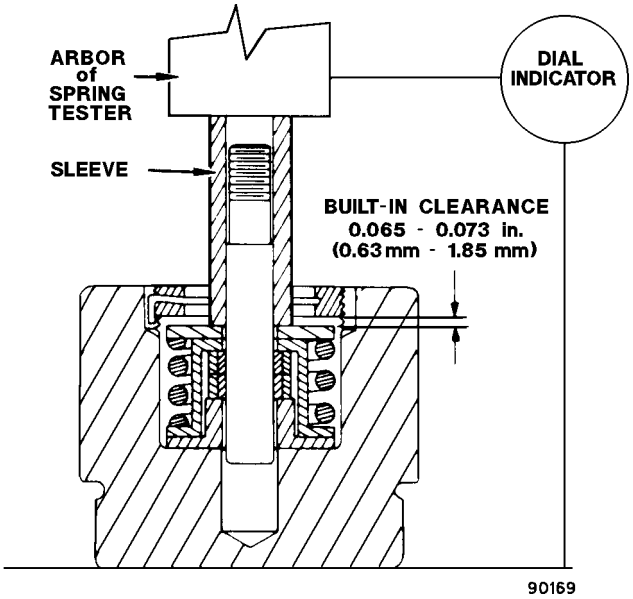


FIGURE 6-8. CHECKING SPRING FORCE AND BUILT-IN CLEARANCE ADJUSTMENT

8. Return spring force indication, Step 6, should be a minimum of 180 lbs. (808 N) when fully compressed in the piston subassembly. Although sufficient force will still exist to return the piston when force is as low as 135-140 lbs. (606- 628 N), and under emergency conditions may continue to be used, it is recommended that the piston assembly be disassembled and the spring replaced. Return spring (14, Figure 6-7) should then be inspected for evidence of permanent set.

NOTE: Whenever a spring is found to exert too low a force, it is probable that all other return springs from the same brake assembly will measure the same low value. High brake temperature can cause permanent spring set, hardening of piston seals and blue coloring of lining backer plates.

Grip Force

This is the force that is required to make the pair of grip assemblies (6, Figure 6-7) slip on return pin (10). Grip force should always be a minimum of approximately two times the return spring force. The slip force of a pair of grips will normally measure between 400 (1779 N) and 800 lb. (3558 N). If it is necessary to measure force required to slip the return pin in grip assemblies while installed in this piston assembly, it will be necessary to provide several special tools, such as those illustrated in Figure 6-9 & 6-10 or tools that will perform equivalent functions. Special tool as shown in Figure 6-9, (calibrated spring pod) need not be provided if a hydraulic press is available with a pressure gauge calibrated to read pounds of force exerted by the ram. A typical hydraulic press with an effective ram area of 3.53 sq. in. (22.7 cm^2 will exert a force of 400 lb. (1779 N) at a pressure reading of 113 psi (779 kPa) and 800 lb. (3558 N) at a pressure reading of 226 psi (1558 kPa). Gauge readings of 110 psi (758 kPa) minimum and 230 psi (1558 kPa) maximum will be sufficient for the measurement of grip force. A gauge of about 500 psi (3447 kPa) should be used, with a shutoff valve provided between pump and gauge to protect gauge from damage when press is used for higher pressure duty. Pump pressure should be applied slowly. Where a hydraulic press is not available, refer to illustration in Figure 6-10 for special tool, (or similar), used in conjunction with a standard arbor press, to make grip force measurements. To make grip force measurements, use the special tools illustrated in Figures 6-9 & 6-10.

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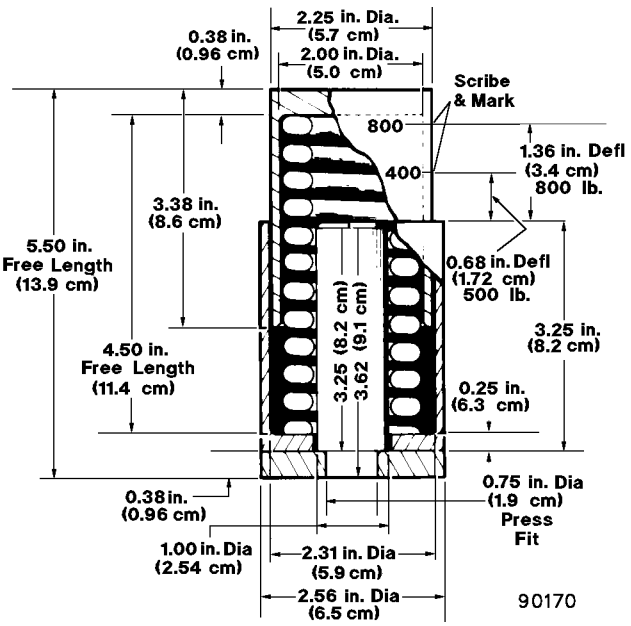


FIGURE 6-9. CALIBRATED SPRING POD

NOTE: The spring for the calibrated spring pod is from Danly Machine Corporation, Spring Part Number 9-3218-21. If Danly spring is not available, use an equivalent, stamping die spring, with these specifications.

- 2.00 in. (5.08 cm) Hole Diameter
- 1.00 in. (2.54 cm) Rod Diameter
- 4.50 in. (11.43 cm) Free Length
- 590 lbs/in. (2624 N/cm) Force Required to Deflect

1. Normally, piston assembly will be removed from brake assembly with return pin in an extended position. Set calibrated spring pod (Figure 6-9) on table of arbor press, place piston assembly on top of spring pod and apply arbor force slowly to return pin to retracted position. Pin should slip between 400-800 lb. (1779-3558 N) scribed marks on spring pod.
2. If slippage definitely occurs before the 400 lbs. (1779 N) mark on spring pod, grips and return pin should be replaced. Slippage above the 800 lb. (3558 N) limit is unlikely, but if this occurs return pin and grip assembly should be removed and inspected for grip slippage, and return pin examined for damage. If slippage of return pin and grip assemblies are over 800 lb. (3558 N), pins and grip should also be replaced.
3. Return pin should be placed in extended position when assembling into brake caliper for a special pin retraction tool (Figure 6-10) or equivalent, is required for this. Insert piston assembly in tool and secure firmly with knurled nut. Place pin return tool/piston assembly combination on arbor press table, drop in 3 dowel pins as indicated, place spring pod tool on top of dowels, apply force slowly to top of spring pod and again observe if grip slippage occurs within the prescribed limits.

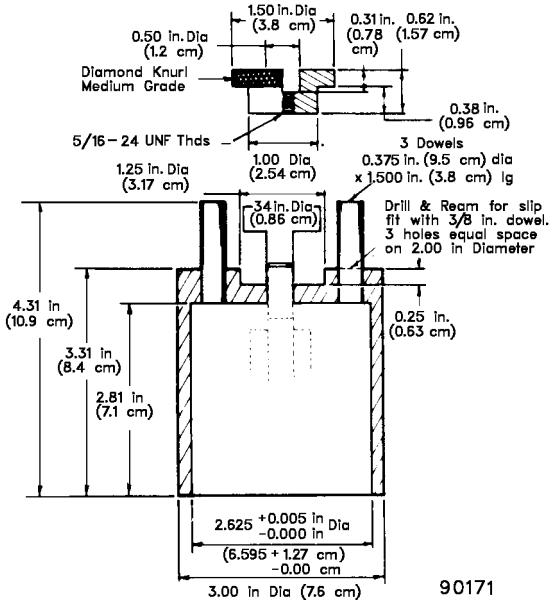


FIGURE 6-10. RETURN PIN RETRACTION

Grip Force Measurement

To measure grip force of grip assemblies installed on return pin, it is necessary to have available either a force calibrated hydraulic press, or a calibrated spring pod (Figure 6-9) used with a standard arbor press.

⚠CAUTION

Do not use spring checker for making grip force measurements. Sudden grip force release can destroy calibration and possibly result in damage to checker.

1. Place spring pod on arbor press table, use sleeves A & B (Figure 6-6) as illustrated in Figure 6-11 to move grips back and forth several times on return pin.
2. Apply force slowly, observe that slippage occurs between the 400 (1779 N) and 800 lb. (3558 N) markings on spring pod.

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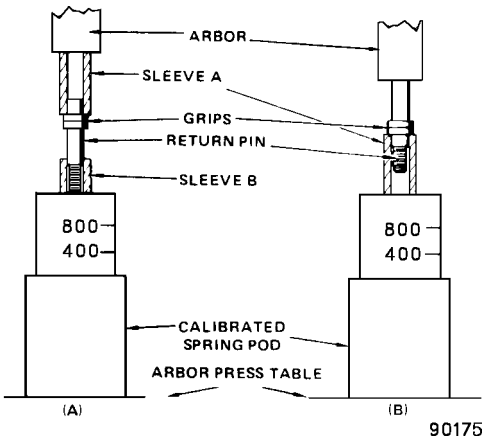


FIGURE 6-11. GRIP FORCE SLIPPAGE CHECK

3. If slippage occurs between the specified force limits, move grips to position on pin (shown in Figure 6-13) and install in piston assembly.

4. If slippage occurs below the 400 lb. (1779 N) limit, either grips or grips and return pin assembly must be replaced. Use sleeve (A) (Figure 6-6) and arbor press to slip both grips off return pin. Inspect return pin for nicks and wear. Slight nicks that can be polished out by hand can be reused, if subsequent slip inspection is acceptable. Any rework of return pin should be avoided unless absolutely necessary. Burred threads can be repaired by use of a 3/8-24 UNF 3 thread die. Bent, battered or badly worn return pins must be replaced.

⚠CAUTION

Grip assemblies and return pins are critical items in the operation of the piston return mechanism and should not be mishandled. Under no circumstances should pin diameter be clamped in a vise or gripped with pliers. In normal use, surface of pin will show only a very slow rate of wear and both pins and grips will normally last through many brake lining changes and brake overhauls.

5. Install grips on return pin, as illustrated in Figure 6-13. Position grip and pilot pin assembly as shown to transfer grip assembly from pilot pin to piston return pin. Second grip should be seated firmly against first, after which slip force should be checked as previously described. After correct slippage is verified, position of grips on pin should remain as shown in Figure 6-13, for piston assembly.

Spring Force Measurement

1. Inspect return spring for a free height dimension of 1.888 in. (30 mm). A measured height of less than 1.125 in. (28.5 mm) is an indication that brake assembly has been subjected to high temperature operation, resulting in permanent set of spring. This will result in loss of spring force at working height.

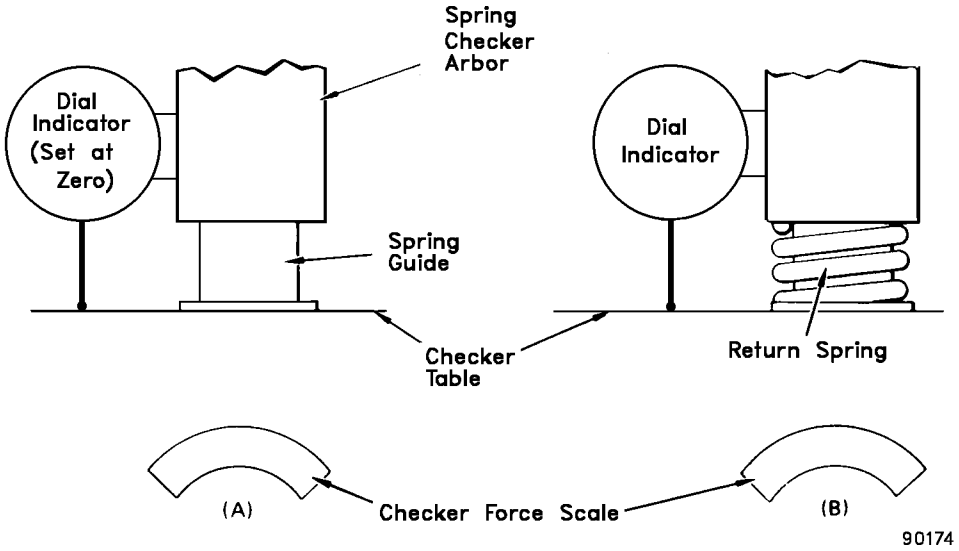


FIGURE 6-12. MEASURING SPRING FORCE

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2. Measure spring force at maximum service deflection on a spring checker. Use the outer spring guide (8, Figure 6-7) for test setup purposes, as shown in Figure 6-12.
   a. Set up dial indicator spring between checker arbor and table.
   b. Place outer spring guide under checker arbor.
   c. Lower arbor firmly onto spring guide and hold arbor in this position.
   d. Set indicator dial to zero (Figure 6-12) and raise arbor.
   e. Place spring over spring guide and lower arbor slowly until dial indicator again reads zero.
   f. Read spring force on checker scale (Figure 6-12).
3. The value read in Step 2 (f.) is the spring return force exerted by spring the under maximum deflection while installed in the piston assembly. Because of manufacturing tolerances, this can be as low as 180 lb. (800 N), but will usually measure greater than 200 lb. (890 N). It is recommended that springs measuring a force of 180 lbs. (800 N) or less under these test conditions be replaced.

Disassembly of Piston Assembly

To disassemble piston assembly for separate inspection of return spring (14, Figure 6-7), return pin and grip assembly (6), proceed as follows:

1. Remove O-ring (2, Figure 6-7) and return pin washer (3) from return pin.
2. Remove lockwire ring (15).
3. Place piston assembly on arbor press table, place sleeve (A) special tool illustrated in Figure 6-6 or equivalent) over return pin, lower arbor and fully compress return spring (Figure 6-14) and hold.
4. Back out threaded retaining ring (4, Figure 6-7). With compression relieved, threaded ring can usually be unscrewed by hand. If threads are burred it may be necessary to use a spanner wrench. Spanner wrench may also be necessary for assembly and for setting of built-in clearance.
5. Slowly raise arbor until all compression on the piston return spring (14) is relieved.

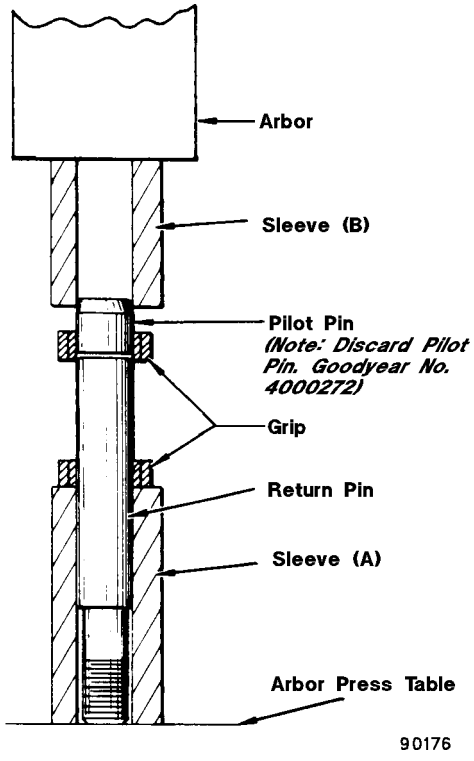


FIGURE 6-13. GRIP INSTALLATION

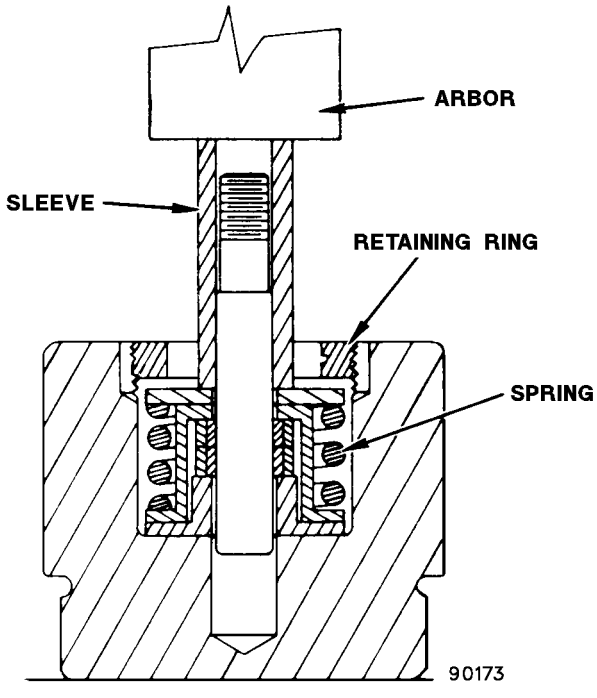


FIGURE 6-14. RETAINER RING REMOVAL

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Assembly of Piston Assembly

1. Assemble inner spring guide (10, Figure 6-15), return pin and grip assembly (8 & 9) and spring retainer (5) loosely into piston (11).
2. Using sleeve (A), (Figure 6-6) install sleeve over return pin against spring retainer.
3. Apply force with a press to fully compress return spring.
4. With spring compressed, turn (clockwise direction) threaded retaining ring (2, Figure 6-15) down against spring retainer. Use a spanner wrench to be certain retaining ring is fully bottomed.
5. Continue holding spring compression and turn retaining ring one full turn (minimum) counterclockwise, plus any additional amount (1/8 turn max.) to allow for lockwire installation. This provides the necessary built-in clearance adjustment required for piston retraction after brake release.
6. Install lockwire ring (1).
7. Lubricate cylinder walls, threads, seals, piston seal surfaces, etc. with clean C-3 hydraulic oil.
8. Install return pin washer (4, Figure 6-15) on piston assembly return pin (8) and install new return pin O-ring (3).
9. Install dust shield (12) in groove of piston (11).
10. Refer to “Caliper Piston Installation”.

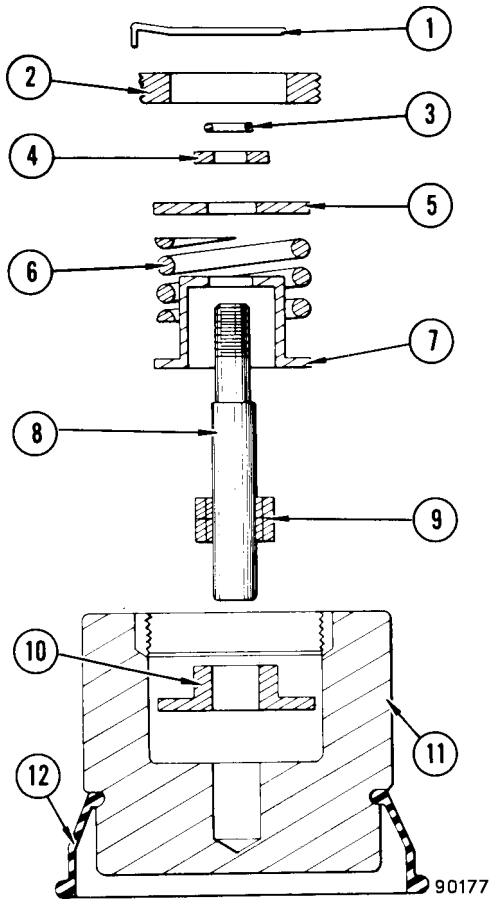


FIGURE 6-15. PISTON ASSEMBLY

1. Lockwire Wing
2. Retaining Ring
3. O-Ring
4. Return Pin Washer
5. Spring Retainer
6. Piston Return Spring
7. Outer Spring Guide
8. Return Pin
9. Grip Assembly
10. Inner Spring Guide
11. Piston
12. Dust Shield

BENCH TEST

The purpose of this test is to verify that overhaul of the calipers was performed satisfactorily. If any leakage occurs during this test the caliper assembly must be rebuilt.

A hydraulic supply with sufficient volume and pressure capacity to extend piston assemblies will be necessary. A gauge of 0-2000 psi (0-14 MPa) should be placed in the output line of the hydraulic source.

Fabricate two blocks using (front and rear) lining backing plates as templates. Thickness of plate for the front caliper should be 1.25 in. (31.75 mm) thick. Thickness of plate for rear caliper should be 1.0 in. (25.4 mm) thick.

1. If necessary, bolt caliper halves together with mounting hardware or Grade 8 capscrews and nuts of adequate diameter and length to securely retain caliper halves together during testing. Tighten capscrews and/or nuts to standard torque.
2. Install new lining assemblies and appropriate test block for caliper being tested.
3. Connect oil lines between two caliper halves.

⚠CAUTION

Be sure test block is securely retained in caliper head before applying pressure.

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⚠CAUTION

Oil used in the hydraulic source must be of the same type as used in the Brake Circuit on the Komatsu truck.

4. Attach hydraulic source to inlet port of caliper assembly.
5. Bleed air from caliper assembly.

⚠CAUTION

During testing or bleeding procedure, DO NOT allow oil to come into contact with brake linings.

6. Gradually increase hydraulic pressure to 1200 psi (8.4 MPa), observing piston assembly for leakage.
7. Reduce pressure to 0 psi (0 MPa) and repeat Step 6 three times.
8. If no leakage has been observed, reduce pressure to 0 psi (0 MPa) and disconnect hydraulic source.
9. After caliper has been installed on wheel assembly prior to lining installation, pry each piston until fully retracted into caliper housing.

NOTE: Use adequate force to pry each piston into caliper fully into housing.

10. Install brake calipers according to “Installation” instructions this Section.

BRAKE LINING

Replacement

Inspect brakes periodically for wear. Linings must be replaced when lining material has been worn to a minimum of 0.31 in. (7.8 mm). Use of linings beyond this wear limit will result in a decrease of braking action, and possible damage to disc.

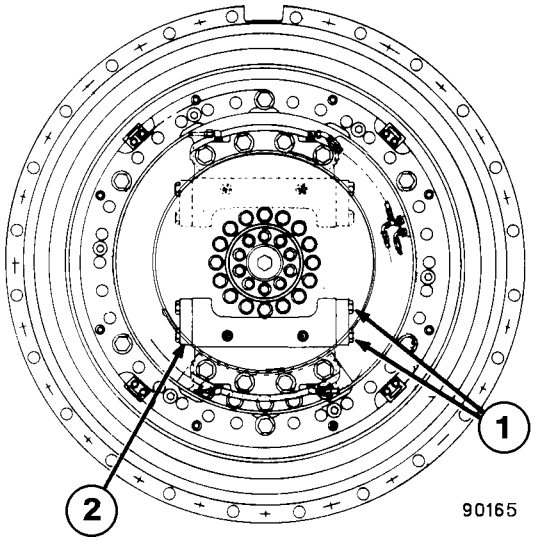


FIGURE 6-16. REAR BRAKE CALIPER LINING REPLACEMENT

1. Capscrew 2. Retaining Plates

When replacing linings, never mix new and used linings in an assembly.

1. To change linings, remove retaining plates (2, Figure 6-16) on the end of caliper and slip out worn linings.
2. Before installing new linings, pistons must be forced back into brake assemblies until fully retracted, using a piston retraction tool (Figure 6-17) or similar tool, between face of piston and disc.

NOTE: Considerable force will be required to retract piston. If a piston should move too easily, brake should be removed for complete disassembly for inspection of grip and return pin assembly. In returning pistons to a retracted position, care must be taken not to damage dust shields with retraction tool.

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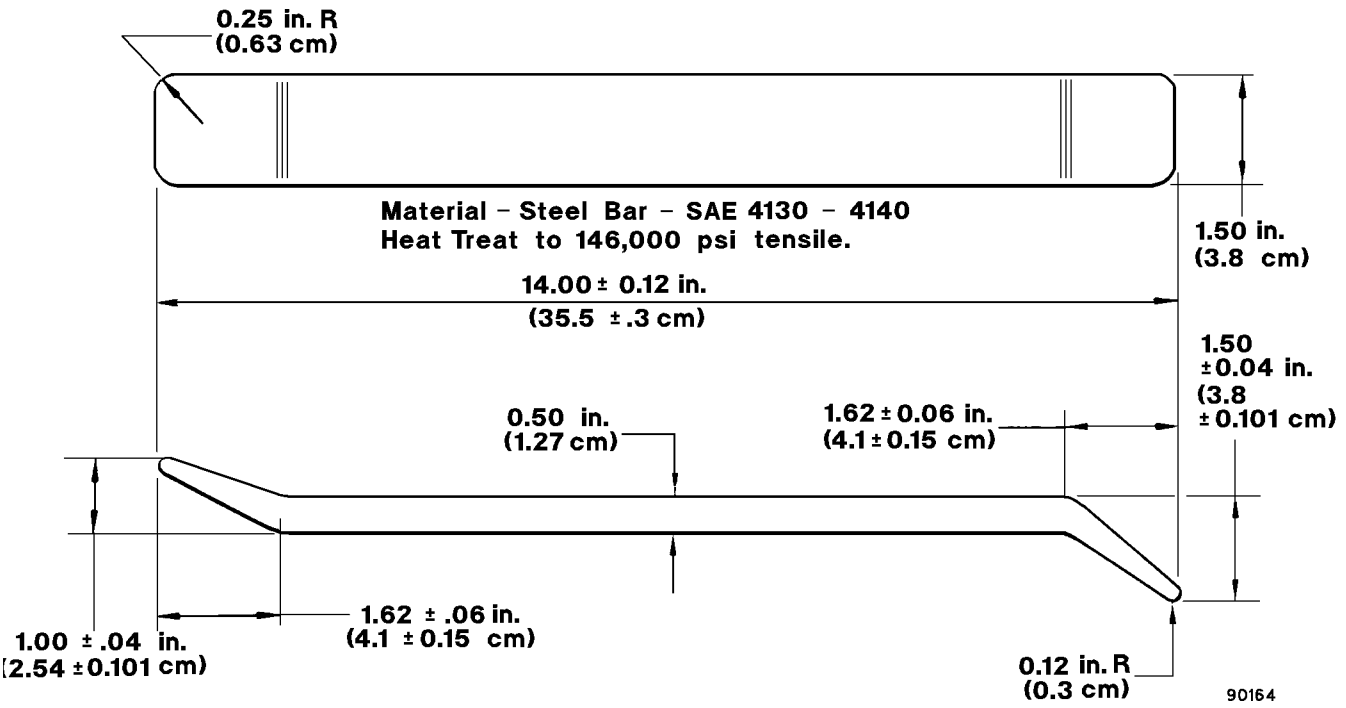


FIGURE 6-17. PISTON RETRACTION TOOL

3. Inspect condition of brake caliper thoroughly before installing linings.

   a. Inspect for evidence of fluid leakage. If present, brake must be removed for disassembly, inspection and repair.

   b. Inspect condition of dust shields. These should be soft and pliable, and show no evidence of hardening of material, rupture, etc. Where replacement is necessary, removal and disassembly of brake for inspection is recommended to insure that dirt has not entered piston cavity through a ruptured seal.

   c. Inspect condition of tubing and fittings. If leakage is evident, correct or replace fittings as necessary.

⚠CAUTION

Do not rub or press dust shield directly over sharp edge around piston cavity. This may cause dust shields to be cut.

   d. Wipe brake housing and lining retaining plates clean before installation of new linings. If a petroleum base cleaning fluid is used, such as diesel fuel, use sparingly on dust shields and wipe dry after cleaning.

4. Inspect discs for wear (Figure 6-18). Place a straight edge across face of disc and measure from straight edge to worn face. It is recommended that the disc be replaced when this measurement is 0.06 in. (1.52 mm) each side of disc or at a minimum worn thickness of 0.88 in. (22.3 mm). It may be difficult to use a straight edge on the back surface of the disc so a visual comparison may be used with that of the front. Normally, wear will be the same on both sides.

NOTE: When installing new linings to be used against a worn disc, useful lining life will be shortened by the depth of the disc wear, since the lining must advance this additional distance before braking force is effective. In addition, the uneven wear on the disc face will accelerate lining wear.

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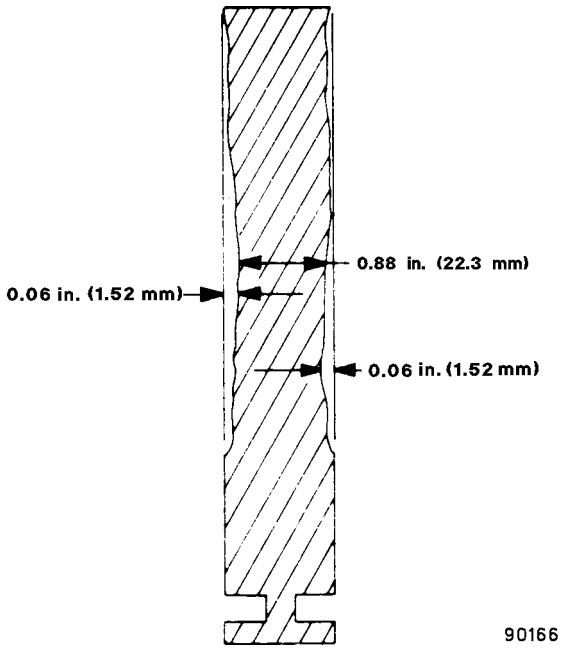


FIGURE 6-18. DISC WEAR LIMITS

5. Install new linings and lining retaining plate (2, Figure 6-16).
6. Apply Loctite® 271 to threads of capscrews (1) and tighten to **190 ft.lbs. (258 N.m)** torque. Check that linings slide freely between retainer plates.
7. Check brakes for operation. Linings should be free after release, with minimum of 0.03 in. (0.76 mm) disc to lining clearance. If clearance not present, each piston must be pried completely into caliper housings.
8. After installing new brake pads, and before releasing truck to production, the brakes must be burnished. Refer to Conditioning (Burnishing) Procedure.

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SERVICE BRAKE CONDITIONING (BURNISHING) PROCEDURE

General

These procedures apply **ONLY** to the brake lining assemblies obtained from Komatsu Parts Dept. for use on Komatsu Electric Drive Trucks equipped with Rockwell/Goodyear disc brakes.

Conditioning and burnishing of service brake linings must be performed each time a new set of brake linings are installed, or before a new Komatsu Truck is put into operational service. A surface pyrometer is required to measure brake disc temperatures during the conditioning procedures.

If “Brake Certification” type tests are to be run, all linings and discs should be new and the factory should be notified. For in-service testing of service brakes, new linings or discs are not necessary.

Front discs should be in serviceable condition with no metal smearing or metal buildup from previous use and not extensively rough or grooved. Inspect discs for wear limits.

Rear discs will operate at higher temperatures and can be dark blue in color and show periodic spots [approximately 1.5 in. (3.8 cm) in size] and still be serviceable. A disc that is extremely heat-checked with radial cracks open to show a gap should not be used.

⚠ IMPORTANT ⚠

To prevent lining damage during burnishing, as well as for stop distance tests, release the brakes as quickly as possible at the end of each cycle or stop.

The burnish procedure consists of:

1. Alternately applying and releasing the service brakes until the recommended brake disc surface temperature is reached: then allow brakes to cool. Cool brakes, if necessary, by driving machine. (Rear brakes will normally cool faster than fronts.) Repeat cycle 3 - 4 more times.
2. To expedite the burnishing cycles of heating and cooling, operate the brakes on only one axle at a time, so that the other system will be cooling (operate front brakes with rear brakes disconnected, or rear brakes with front brakes disconnected).
3. The recommended order for burnishing is: Front, Rear, Front, Rear, Front, Rear and Front.

Safety Precautions

⚠WARNING

- ***BEFORE DISCONNECTING PRESSURE LINES, REPLACING COMPONENTS IN THE HYDRAULIC CIRCUITS, OR INSTALLING TEST GAUGES, ALWAYS BLEED DOWN HYDRAULIC STEERING AND BRAKE ACCUMULATORS. The steering accumulators can be bled down with engine shut down, turning the keyswitch "Off" and waiting 90 seconds. Confirm the steering pressure is released by turning the steering wheel - No front wheel movement should occur. Open the two valves (7, Figure 6-19) at the bottom of the brake accumulators (inside brake cabinet) to bleed down the two brake accumulators.***
- ***BEFORE DISABLING ANY BRAKE CIRCUIT, insure truck wheels are blocked to prevent possible rollaway.***
- ***FRONT BRAKES MUST BE DISCONNECTED WHEN BURNISHING THE REAR BRAKES. Front brakes require burnishing independently from rear brakes in order to control disc temperatures***
- ***EXTREME SAFETY PRECAUTIONS SHOULD BE USED WHEN MAKING HIGH-ENERGY/ HIGH-SPEED BRAKE STOPS ON ANY DOWNGRADE. Safety berms or adequate run off ramps are necessary for any stopping performance tests.***
- ***Heavy smoke and foul odor from brake linings is normal during burnishing procedures.***

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Rear Brake Conditioning

Note: Front brakes will require burnishing independently from rear brakes in order to control disc temperatures.

⚠WARNING

Extreme safety precautions should be used when making high-energy/high-speed brake stops on any downgrade. Safety berms or adequate run off ramps are necessary for any stopping performance tests.

1. Temporarily disconnect the FRONT brakes using the following procedure:
   a. Observe safety precautions on the previous page and relieve stored pressure in hydraulic system.
   b. Disconnect “BF” hydraulic tube (5, Figure 6-19) at both ends inside brake control cabinet. Install a #8, 0.75 x 16UNF-2B, 37° flare Cap Nut (WA2567, or equivalent) on each fitting where tube was removed. Tighten caps to standard torque to prevent leakage. Cap or plug tube to prevent contamination.
   NOTE: This will disconnect the hydraulic supply from the operator's brake pedal to the front brakes. There will be a noticeable loss of “braking action” at the pedal. However, this method of temporarily disabling the brakes will still permit the application of Brake Lock, in the event of an emergency.
   c. Close accumulator bleed valves handles (7).
2. Drive empty truck on level terrain at speeds of 5 to 10 MPH while applying (dragging) the brakes using sufficient pressure to make engine “Work” until the disc temperatures reach or exceed 600°F (316°C).

NOTE: The Override Switch on the instrument panel must be depressed and held by the operator in order to propel the truck with the brakes applied.

⚠CAUTION

Do not exceed 800°F (427°C) disc temperatures during burnishing.

3. Allow the brake discs to cool to approximately 250°F (121°C) between cycles.
4. Repeat steps 2 and 3.
5. If linings smoke or smell during the second cycle, continue to repeat burnishing cycle until smoke and smell are gone or are significantly reduced.
6. Reconnect front brakes:
   a. Relieve pressure in hydraulic system according to the previous “WARNING” instructions.
   b. Remove Cap Nuts and reinstall tube (5). Tighten tube nuts to standard torque.
   c. Close accumulator bleed valve (7) handles.
7. Start engine and check for leaks. Bleed brakes according to procedure on the following page.
8. Insure all brakes are functioning properly before releasing truck.

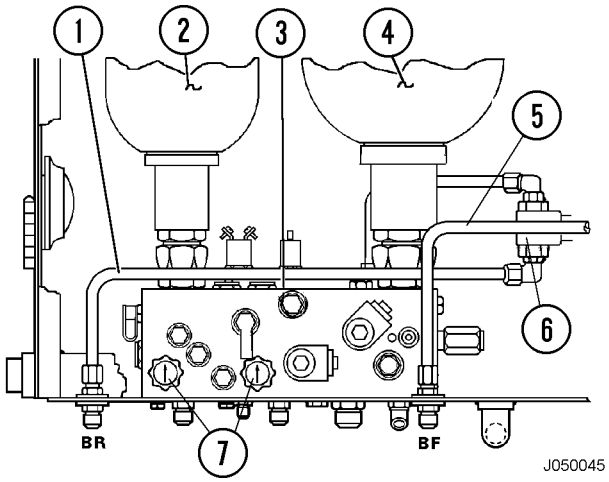


FIGURE 6-19. BRAKE MANIFOLD AND COMPONENTS

1. “BR” Hydraulic Tube
2. Rear Brake Accum.
3. Brake Manifold
4. Front Brake Accum.
5. “BF” Hydraulic Tube
6. Brake Lock Shuttle Valve
7. Brake Accumulator Bleed Valves

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BRAKE BLEEDING PROCEDURE

Attach brake lines and bleed brake calipers according to the following instructions:

1. Fill hydraulic tank following procedure in Section “P”, *Hydraulic Tank Service*.
2. Close brake accumulator drain valves (7, Figure 6-19), if open.
3. Securely attach bleeder hose to highest bleeder valve of each caliper, direct hose away from brake assembly and into a container to catch excess oil.
4. With engine at idle make partial brake application of service brake pedal:
   a. Maintaining partial application, open bleeder valve until a clean stream of oil is discharged from caliper.
   b. Close bleeder valve.
5. Repeat above Steps until all air is bled from all calipers.
6. Check hydraulic reservoir level as bleeding takes place, maintain correct level.
7. Before returning truck to production, brake lining must be burnished.

⚠WARNING

All new brake linings must be burnished prior to being put in service. Refer to “Service Brake Conditioning”.

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ROCKWELL DISC PARKING BRAKE

A park brake assembly is mounted to each wheel motor on each outboard disc and is intended for parking only. The park brake caliper is a dual piston, spring applied, hydraulically released type brake designed for petroleum base fluid.

NOTE: Some trucks may be equipped with TWO (2) Park Brake Calipers per wheel. Service and adjustment for these calipers are the same as presented here.

The parking brake housing contains two spring loaded, lining faced, pistons. The spring preload is controlled by an adjustment bolt. A yoke, which fits over the housing, contains the adjustment bolt and is secured to the housing with a clamping bolt.

The springs are held in place by spring retainers. The spring retainers are grooved to receive the inside diameter of the piston dust boot, and the housing is grooved to receive the outside diameter of the piston dust boot.

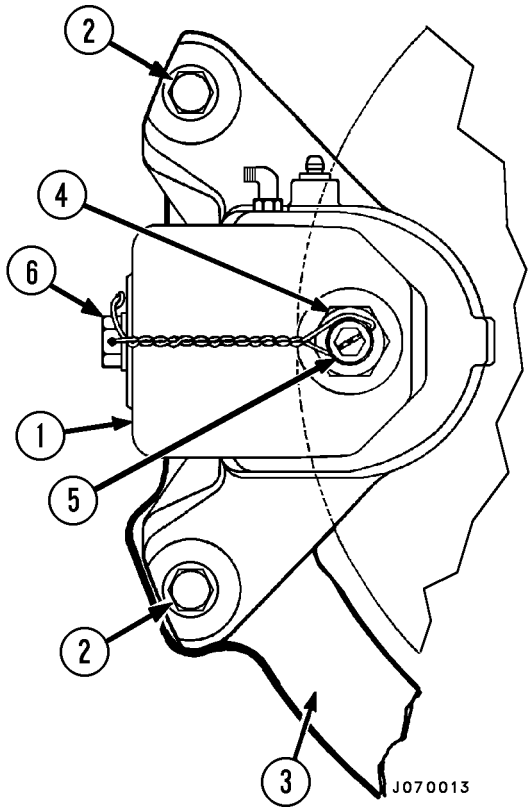


FIGURE 7-1. PARK BRAKE ASSEMBLY (SCL-70)

1. Parking Brake Caliper
2. Capscrew
3. Mounting Bracket
4. Jam Nut
5. Adjustment Bolt
6. Clamping Capscrew

PARK BRAKE CALIPER

Removal

The park brake caliper may be removed from wheel without disassembling other brake components.

1. Securely block truck to prevent movement.

⚠WARNING

Do not loosen or disconnect any hydraulic brake line or component until engine is stopped, key switch is "Off" and drain valves on brake accumulators are opened and steering accumulators are bled down.
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.

2. Disconnect brake line connected to caliper.
3. Loosen jam nut (4, Figure 7-1) on adjustment bolt (5). Loosen clamping capscrew (6) one turn and back out adjustment bolt (5) six turns to release park brake linings from outer disc.
4. Support park brake caliper and remove capscrews (2) securing caliper to mounting bracket (3).
5. Remove caliper from disc and set aside for repairs or replacement.

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Installation

⚠WARNING

Do not start the truck engine until the parking brake has been installed, adjusted, and the hydraulic brake lines are tightly connected.

Before installing the park brake caliper, the caliper mounting must be checked to determine that caliper is centered over the disc.

Refer to “Caliper, Disc, And Parking Brake Installation”, (determination of Dimension “B”), in Armature Speed Rear Disc Brakes section. Shim disc as necessary.

NOTE: Do not apply any hydraulic pressure to release the parking brake until installation and adjustment are completed.

1. Loosen clamp capscrew (3, Figure 7-2) on yoke of parking brake caliper. Loosen jam nut (17) on adjuster capscrew (16).
2. Open bleeder to each piston and push linings back to obtain disc clearance. Retighten bleeders.
3. Install park brake caliper onto park brake adapter. Lubricate the threads of mounting capscrews (2, Figure 7-1) with rust preventative grease and tighten to **310 ft.lbs. (420 N.m)** torque.
4. Install hydraulic supply line to park brake caliper.

Parking Brake Adjustment

⚠WARNING

Do not start truck engine until both parking brake assemblies have been installed, adjusted, and all hydraulic brake lines are tightly connected.

1. Block all wheels, front and rear, to prevent truck from moving.
2. Loosen clamp capscrew (3, Figure 7-2) which secures the yoke to the housing.
3. Loosen the jam nut (17).
4. Loosen adjusting bolt (16) until the bolt does not contact the spring retainer (15).
5. Tighten clamp capscrew (3) finger tight until no gap exists between yoke (1) and housing (2), **but yoke must be free to slide on housing**.
6. Be sure the yoke is positioned inside housing groove and the end of the adjuster bolt are centered on the spring retainers (15).
7. Turn adjusting bolt (16) **IN** (clockwise) **until both the inboard and outboard linings (5) just touch the brake disc**. Use long feeler gauge [0.001 - 0.002 in. (0.0002 - 0.0005 mm)] to be sure linings are in contact with disc; gauge should not slide in between disc and lining.
8. Turn adjusting bolt (16) **IN** (clockwise) an additional 4 1/4 turns to obtain proper brake force.

*NOTE: The torque to obtain 4 1/4 turns **should NOT exceed 220 ft. lbs. (298 N.m)**. If torque exceeds this value, repeat steps 2 - 8. If torque to obtain 4 1/4 turns still exceeds 220 ft. lbs. (298 N.m), remove park brake caliper and check for improper assembly. Rebuild caliper assembly correctly and reinstall following ALL specified procedures. Repeat steps 1 - 8 above.*

9. Tighten clamp capscrew (3) to **125 ft.lbs. (170 N.m)** torque to lock yoke (1) to housing (2).
10. Turn adjusting bolt (16) **OUT** (counterclockwise) 1/4 turn.
11. Hold adjusting bolt (16) to prevent turning in either direction and tighten jam nut (17).

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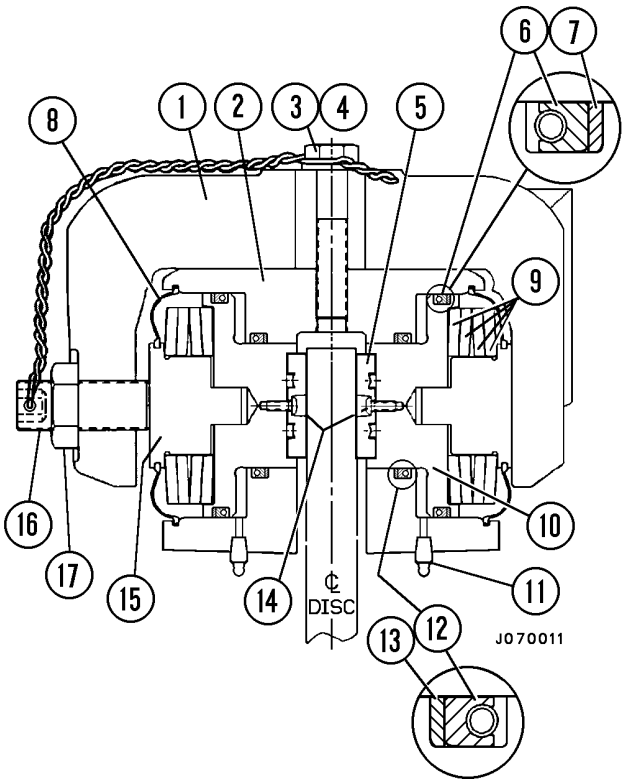


FIGURE 7-2 PARK BRAKE ASSEMBLY (SCL70-4)

1. Yoke
2. Housing
3. Clamping Capscrew
4. Washer
5. Lining
6. Seal Assembly
7. Backup Ring
8. Dust Boot
9. Spring (4/piston)
10. Piston
11. Bleed Screw
12. Seal Assembly
13. Backup Ring
14. Screw
15. Spring Retainers(2)
16. Adjustment Bolt
17. Jam Nut

NOTE: Earlier version (SCL70-3) had a different style Seal Assembly, 6 & 12, and did not have Backup Rings, 7 & 13.

12. With truck engine running, apply and release park brake three (3) times. Check for leaks. If caliper leaks, refer to “Caliper Removal and Disassembly” procedures and repair leaking caliper.

NOTE: If another source of hydraulic power (such as “porta-power”) is used for this check, install a gauge in line. Use 2200 - 2500 psi (10.3 MPa - 17.2 MPa) pressure for adjustment.

⚠CAUTION

Exceeding MAXIMUM pressure of 3000 psi (20.7 MPa) may rupture seals in park brake caliper and cause leakage.

13. Tighten clamp capscrew (3) to **125 ft.lbs. (170 N.m)** torque and insure parking brake lines are tightly connected. Lockwire clamp capscrew (3) to adjusting bolt (16) as shown to prevent loosening.
14. Bleed park brake after starting engine. Refer to “Brake Bleeding Procedure”.
15. With engine running and park brake switch “OFF” (brake released*), check the lining-to-disc clearance for both inboard and outboard linings with a long feeler gauge. Clearance should be **0.025 in. - 0.060 in. (0.635 mm - 1.524 mm)** for both inboard and outboard linings.

**NOTE: If another source of hydraulic power (such as “porta-power”) is used for this check, install a gauge in line and use 2200 - 2500 psi (10.3 MPa - 17.2 MPa) pressure for adjustment.*

⚠CAUTION

Exceeding MAXIMUM pressure of 3000 psi (20.7 MPa) may rupture seals in park brake caliper and cause leakage.

16. If the lining-to-disc clearance is not as specified, repeat steps 2 through 14 and also refer to determination of Dimension “B”, “Caliper, Disc, And Park Brake Installation”, in Armature Speed Rear Disc Brakes section. Re-shim disc if necessary.
17. Condition park brake linings according to “Lining Conditioning” procedure before releasing truck to production.

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Park Brake Caliper Disassembly

NOTE: To assure that tension on springs (9, Figure 7-2) has been released, be certain that jam nut (17) has been loosened on adjustment bolt (16) and that clamping capscrew (3) has been loosened one turn. Be sure that adjustment bolt (16) has been loosened six turns.

1. Remove bleeder screws (11, Figure 7-2) from housing (2) and drain fluid from brake caliper.
2. Loosen jam nut (17) and remove adjustment bolt (16) from yoke (1).
3. Remove clamp capscrew (3) and washer (4) to release housing (2) from yoke (1).
4. Remove piston dust boots (8) from spring retainers (15).
5. Remove spring retainers (15) and springs (9). Note order and orientation of springs.
6. Remove pistons (10) from housing.
7. Remove seal and backup ring (6 & 7) from pistons and discard these parts.
8. Remove screws (14) releasing the lining (5) from pistons.
9. Remove seal and backup ring (6 & 7) from housing and discard these parts.

Cleaning and Inspection

⚠WARNING

Petroleum base cleaning solvents are flammable. DO NOT USE NEAR OPEN FLAME.

1. Clean all metal parts of brake assembly in cleaning solvent.
2. Inspect all metal parts for breaks or cracks. Replace all cracked parts.
3. Measure pistons and housing bores. Replace the parts if they are worn beyond the following limits:

Piston:

- Large O.D. . . . . 4.494 in. (114.1 mm)
- Small O.D. . . . . .2.493 in. (63.3 mm)
- Seal groove . . . . . .4.126 in. (104.8 mm)

Housing Bore:

- Large I.D. . . . . .4.503 in. (114.4 mm)
- Small I.D. . . . . 2.504 in. (63.6 mm)
- Seal groove. . . . . 2.869 in. (73.6 mm)

4. Inspect inlet and bleeder holes in housing (2) for thread damage. If re-threading is necessary, use the following taps:

- Lining bolt hole in piston . . . . 10-24 UNC-2B tap
- Inlet hole . . . . . 7/16-20 UNF-2B tap
- Bleeder hole . . . . . 1/4-28 UNF-2B tap

⚠IMPORTANT⚠

After tapping, be certain all metal chips and residue are removed from openings and hydraulic passages. If threads are not serviceable, replace housing.

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5. Inspect housing cylinder walls for damage. Scratches or corrosion to a depth of 0.002 in. (0.005 cm) or less on the cylinder wall can be blended out with 300-500 grit wet-or dry sandpaper or emery cloth. Replace housing if damage is beyond these limits.

⚠CAUTION

Excessive localized polishing of the cylinder wall may result in fluid leakage.

6. Inspect spring washers (9) for cracks or corrosion. Replace parts that are cracked or severely corroded.
7. Inspect capscrews (3 & 16) for cracks, corrosion, or thread damage. Replace damaged bolts.
8. Inspect threaded hole (for adjustment bolt) in yoke. The threaded hole in yoke for adjustment bolt can be cleaned up with a 1-14 UNF-2B tap. If threads are not serviceable, replace yoke.
9. Inspect threaded hole (for clamping capscrews) in housing. The threaded hole in housing for clamping bolt can be cleaned up with a 5/8-11UNC-2B tap. If threads are not serviceable, replace housing.

Park Brake Caliper Assembly

1. Using all new seal assemblies, lubricate seals (6 & 12, Figure 7-2) with clean hydraulic oil as used in brake circuit. Lubricate cylinder walls with Dow Corning # 4 (or equivalent).
2. Install lubricated seals and backup ring (12 & 13) in housing.
3. Install lubricated seals and backup ring (6 & 7) on pistons.
4. Attach lining (5) to pistons with screws (14). (Refer to “Lining Replacement” Procedure).
5. Install piston in housing.
6. Lubricate spring washers (9) with anti-seize compound.
7. Place spring retainers (15) on a flat surface with the largest diameter on the bottom. Install piston dust boots (8) in groove of spring retainer (15). Place lubricated spring washers (9) on spring retainer so that the concave surface of each pair of springs face one another.
8. Install spring retainers (15) with spring washers on pistons.
9. Install the outer edge of dust boot (8) in grooves of housing.
10. Place yoke (1) over housing (2) and align hole in yoke with the hole in housing.
11. Place washer (4) on clamping bolt (3) and install bolt and washer loosely. Attach yoke to housing.
12. Screw jam nut (17) all the way on adjustment bolt (16) and apply anti-seize compound to threads and end of bolt. Screw bolt in yoke part way, approximately five (5) turns.
13. Install bleeder valves (11) on housing.

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PARK BRAKE LINING REPLACEMENT

Inspect park brake linings periodically for wear. Linings must be replaced before lining material has been worn to the top of the retaining screws. Use of linings beyond this wear limit will result in decrease of braking action, and possible damage to disc.

1. Change linings. Refer to “Park Brake Caliper Removal” and “Disassembly” procedure.
2. Remove screws (14, Figure 7-2) releasing the lining (5) from the piston (10).
3. Install new lining and secure lining to piston with screws (14).

NOTE: If lining mounts screws are reused, use Loctite® No. 242 (or equivalent) on threads.

4. After lining replacement, refer to “Park Brake Caliper Installation, Bleeding, Adjustment and Conditioning”.

BRAKE BLEEDING PROCEDURE

1. Bleed parking brake after starting engine.
2. Move parking brake switch on instrument panel to “Off” position. Connect bleeder hose to bleeder valve, open bleeder valve until clear air-free oil (no bubbles) runs from hose. Close bleeder valve.
3. Repeat for each bleeder.

PARK BRAKE BURNISH PROCEDURE

Lining Conditioning

1. Preheat brake disc with service brakes to clean and heat rear discs to between 350°F - 500°F (177°C - 260°C).
2. Park on hot disc (3 to 5 minutes) to clean and heat parking brake linings.

*NOTE: Parking capabilities can be tested by parking loaded truck **(Do NOT exceed rated GVW shown on Grade/Speed decal in cab)** on steepest hauling grade in mine (not to exceed 15% grade).*

If parking brake does not hold on grade, allow vehicle to start to roll down grade for approximately 15 ft. (4.6 m), then stop truck with service brakes. While holding truck with service brakes, release park brake. Reapply park brake and release service brakes.

If park brake still does not hold truck, refer to “Parking Brake Adjustment” and repeat procedure.

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HYDRAULIC SYSTEM

HYDRAULIC SYSTEM OPERATION

The following describes the basic hydraulic system operation. Further system description is outlined under different system circuits such as the hoist circuit and steering circuit in this section of the manual. Refer to Section “J” for details regarding the hydraulic brake system.

The hoist, steering and brake circuits share a common hydraulic tank (1, Figure 2-1). The tank is located on the left frame rail forward of the rear wheels.

The service capacity of the tank is 238 gal. (901 l). Type C-4 hydraulic oil is recommended for use in the hydraulic system.

NOTE: It is recommended that any hydraulic oil to be used for filling or adding to the hydraulic system is routed through a 3 micron filter device prior to use.

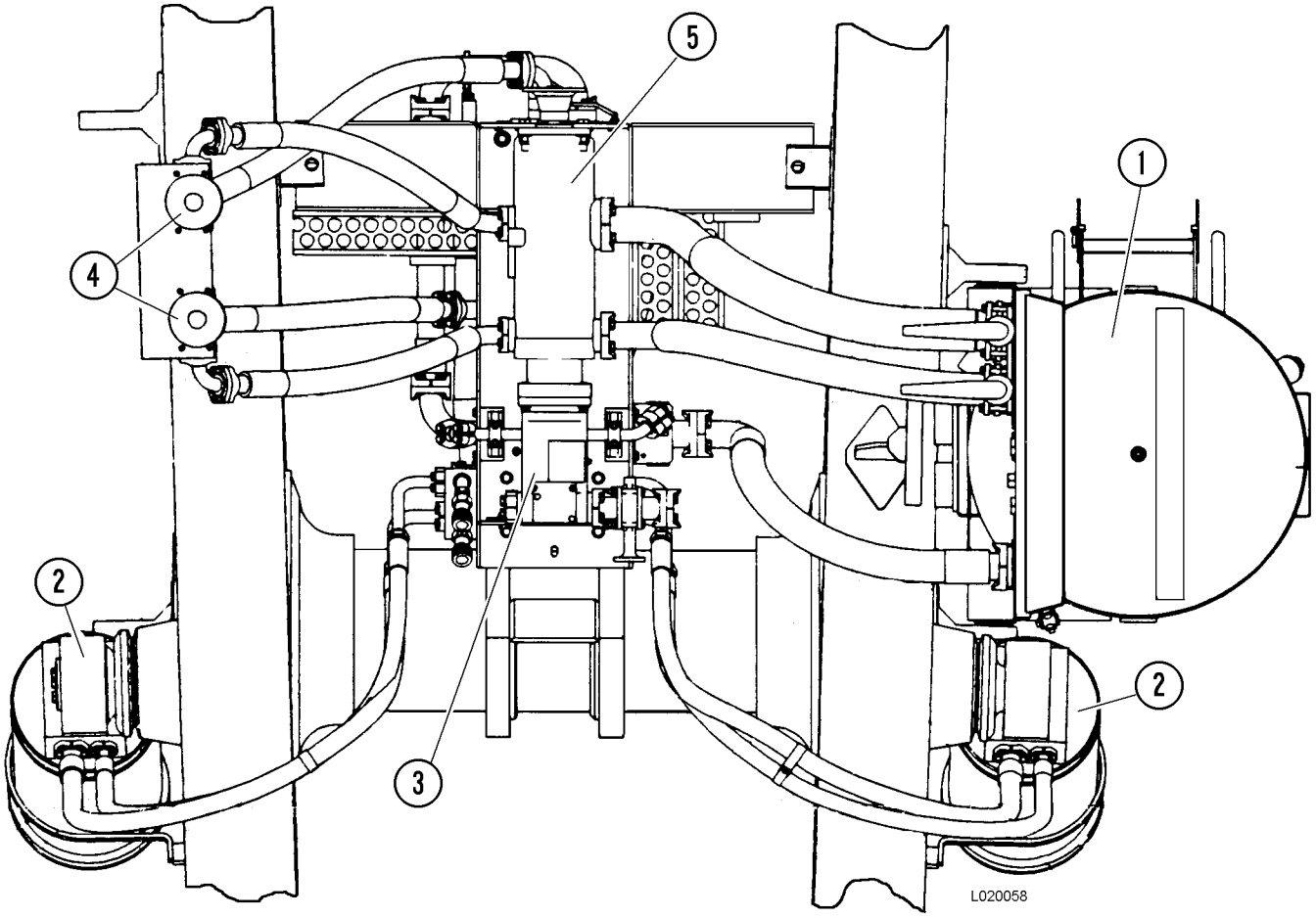


FIGURE 2-1. HYDRAULIC PUMPS AND TANK (VIEWED FROM BELOW TRUCK)

1. Hydraulic Tank
2. Hoist Cylinder
3. Steering / Brake Pump
4. Hoist Circuit Filters
5. Hoist Circuit Hydraulic Pump

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⚠WARNING

When servicing the hydraulic system, relieve pressure before disconnecting hydraulic and other lines. Tighten all connections before applying pressure.

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

COMPONENT DESCRIPTION

HOIST PUMP

The hoist pump (5, Figure 2-2) is a tandem gear type pump. The pump is mounted behind the main alternator and driven by a drive shaft connection between the pump and the accessory drive output of the alternator. The pump has a total output of 230 GPM (870 l/min.) at 1900 RPM.

STEERING/BRAKE PUMP

The Steering/Brake system pump (3) is mounted on the rear of the hoist system pump and coupled to the hoist pump driveshaft. This pump has an output of 65 GPM (246 l/min) at 1900 RPM. Output from this pump provides oil for the truck steering system as well as the service brake system.

TANK

The hydraulic tank provides a common supply of oil for the hoist, steering, and brake systems. The hydraulic tank service capacity is 238 Gal (901 l).

Oil leaving the hydraulic tank (1) passes through two 100 mesh wire strainers before entering the hydraulic pumps. Oil level should be checked periodically and be visible in the bottom sight glass when the body is down and the engine is running. If filling is required, use only clean, filtered type C-4 hydraulic oil.

HIGH PRESSURE HYDRAULIC FILTERS

The truck is equipped with high pressure hydraulic oil filters to filter the oil supply at the outlet of the pumps. The steering/brake system filter (4) and two hoist circuit filters (4, Figure 2-1) are located on the right side, behind the fuel tank.

Flow restriction through the filter element is sensed by a pressure differential switch. When restriction is excessive, the switch will turn on an indicator lamp inside the cab to notify the operator that filter service is required.

BLEEDDOWN MANIFOLD

The bleeddown manifold (6, Figure 2-2) receives oil from the steering/brake pump and directs it to the steering accumulators (9), brake system, and to the flow amplifier (7), for steering circuit components.

STEERING SYSTEM ACCUMULATORS

The steering accumulators (9) provide an adequate volume of pressurized oil to allow the truck to be steered to a safe area if a malfunction occurs in the pump. (Brake system accumulators store a supply of oil to allow several brake applications if the steering/brake pump malfunctions. Refer to Section “J” for detailed information.)

DISABLED TRUCK CONNECTORS

Quick disconnect fittings are provided to allow operation of the steering and brake circuits for temporary truck operation if the steering/brake pump is not operational. The steering circuit fittings (10) are connected to another (operational) truck by hoses. A jumper hose must be installed between the two brake circuit quick disconnects (11) to enable service brake operation. This will allow maintenance personnel to move the truck to a suitable area for performing repairs.

Another pair of quick disconnect fittings are installed on the Overcenter Valve Manifold located above the steering/brake pump. These fittings are used to attach hoses to an operational truck in the event that the hoist pump, hoist valve or other hoist system component malfunctions. This will allow maintenance personnel to raise the truck body to dump the load before moving the disabled truck.

The steering circuit and hoist circuit relief valves are adjusted to 2500 psi (17 240 kPa). The brake system relief is adjusted to 3500 psi (24 132 kPa).

Refer to the appropriate information in this section of the manual for repair and troubleshooting procedures for the hoist system components and steering system components. Refer to Section “J” for repair and troubleshooting procedures for the hydraulic brake system components.

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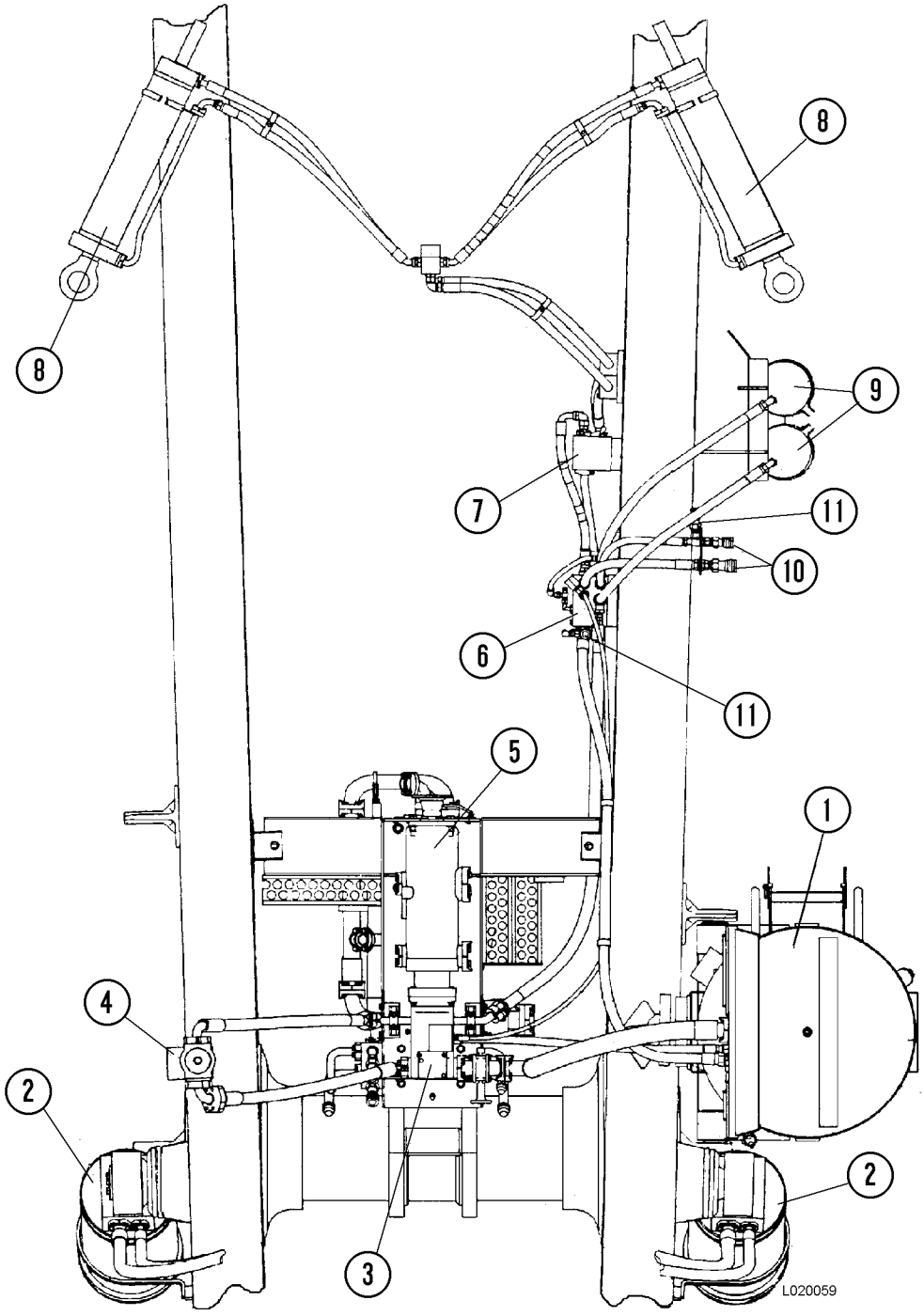


FIGURE 2-2. STEERING CIRCUIT COMPONENTS (VIEWED FROM BELOW TRUCK)

1. Hydraulic Tank
2. Hoist Cylinders
3. Steering / Brake Pump
4. Steering Circuit Filter
5. Hoist Circuit Pump
6. Bleeddown Manifold
7. Flow Amplifier
8. Steering Cylinders
9. Steering Accumulators
10. Steering Quick Disconnects
11. Brake Quick Disconnects (For Jumper Hose)

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NOTES

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HYDRAULIC SYSTEM COMPONENT REPAIR

HOIST PUMP

Removal

NOTE: It is not necessary to remove the steering pump with the hoist pump. The steering pump may be disengaged and supported as the hoist pump is removed.

1. Turn the keyswitch “Off” and allow ample time (approximately 90 seconds) for the accumulators to bleed down. Turn the steering wheel to be sure no oil remains under pressure.
2. Drain the hydraulic tank by use of the drain valve (12, Figure 3-1) located on the bottom of the tank.

NOTE: If oil in the hydraulic tank has not been contaminated, the shut-off valves can be closed and both pump inlet lines can be drained, eliminating the need to completely drain the tank. Refer to Figure 3-1.

3. Remove the rear axle blower hose support strap.

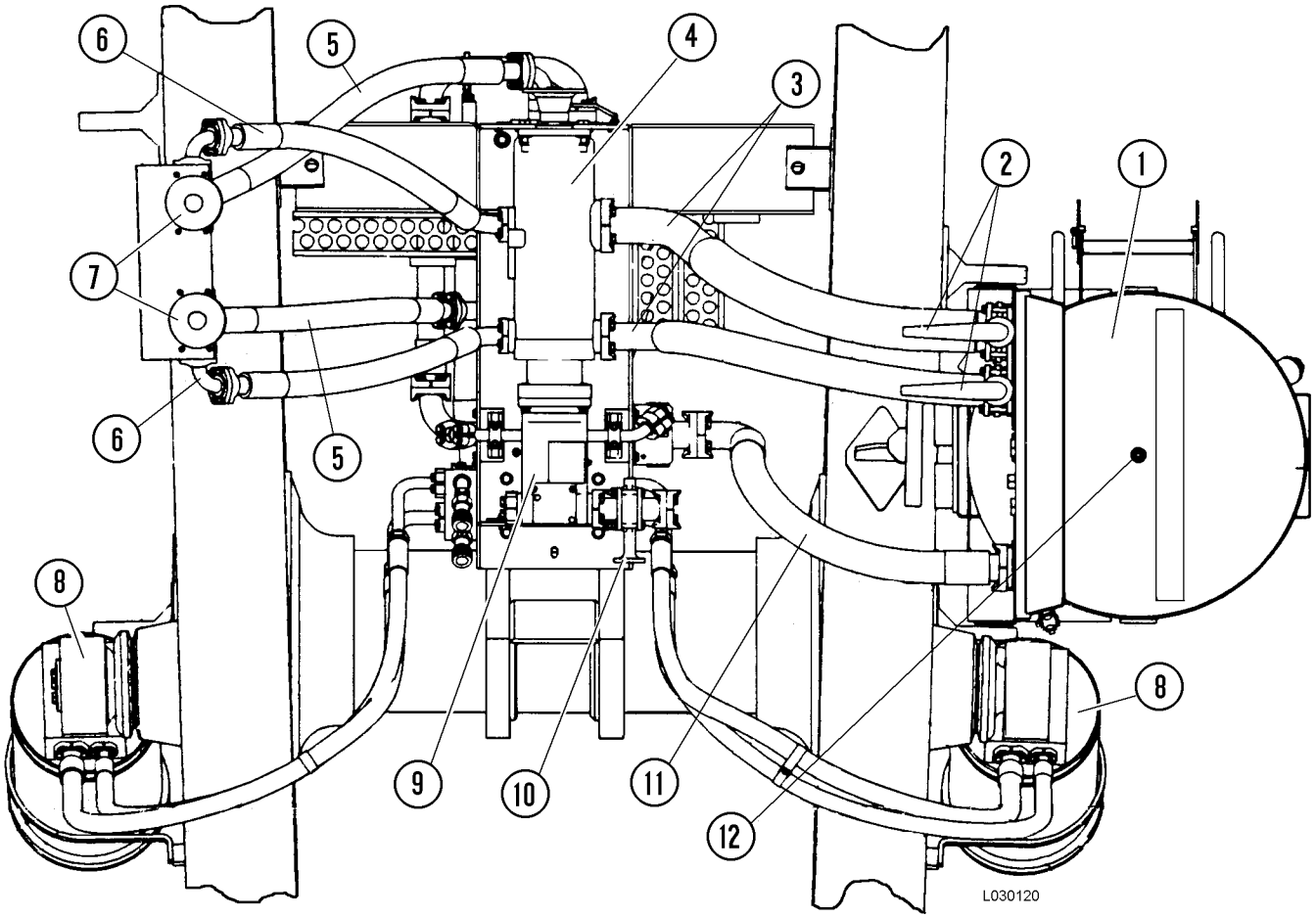


FIGURE 3-1. HOIST PUMP PIPING (BOTTOM VIEW)

1. Hydraulic Tank
2. Hoist Pump Shut-Off Valves
3. Hoist Pump Suction Hoses
4. Hoist Pump
5. Filter Outlet To Hoist Valve Hose
6. Hoist Pump Outlet To Filter Hose
7. Hoist Circuit Filters
8. Hoist Cylinders
9. Steering / Brake Pump
10. Steering Pump Shutoff Valve
11. Hoist Valve Return To Tank Hose
12. Hydraulic Tank Drain

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4. Disconnect and remove the hose at the alternator end and swing clear of work area.
5. Close the shut-off valves (2 & 10, Figure 3-1).

⚠ IMPORTANT ⚠

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

6. Cap or cover all lines and pump inlets and outlets to prevent contamination.
7. Remove the capscrews securing the hoist pump drive flange to the drive shaft.
8. Loosen the capscrews securing the inlet hoses (3) and outlet hoses (6) on the hoist pump and allow oil to drain. Remove inlet and outlet hoses.

⚠WARNING

The hoist pump weighs approximately 282 lbs (128 kg). The hoist and steering pump together weigh approximately 500 lbs (227 kg). Use a suitable lifting or support device that can handle the load safely.

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

Installation

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

1. Install O-ring (16, Figure 3-2) to steering pump (11). Install coupler (9) to hoist pump. If removed coupler has a snap ring, remove the snap ring and dispose.

⚠WARNING

The hoist pump weighs approximately 282 lbs (128 kg). The hoist and steering pump together weigh approximately 500 lbs (227 kg). Use a suitable lifting or support device that can handle the load safely.

2. Attach a suitable lifting or support device to the hoist pump capable of handling approximately 250 lbs (113 kg). Move pump into position in truck.
3. Lubricate the steering pump spline shaft and align with coupling (9). Install hoist pump to steering pump and install capscrews (10) with hardened washers and tighten to standard torque. Raise pumps up into position.
4. Attach front support bracket to the “T” bracket and to the pump with capscrews, lockwashers and nuts. Tighten capscrews to standard torque.
5. Connect hoist pump drive flange to drive shaft with capscrews, lockwashers and nuts. Tighten to standard torque.
6. Tighten support bracket capscrew (on rear of steering pump) to standard torque.
7. Uncap inlet and outlet hoses and install to pumps using new O-rings. Tighten capscrews securely.
8. Service the hydraulic tank with C-4 type hydraulic fluid. Refer to *Hydraulic Tank*, this section for filling instructions.
9. Open the three suction line shut-off valves. Loosen capscrews (at the pump) on suction hoses (12 & 16) to bleed trapped air. Then loosen capscrews (at the pump) on pressure hoses to bleed any trapped air. Tighten all capscrews securely.

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

10. Reconnect blower tube and install blower tube support strap.

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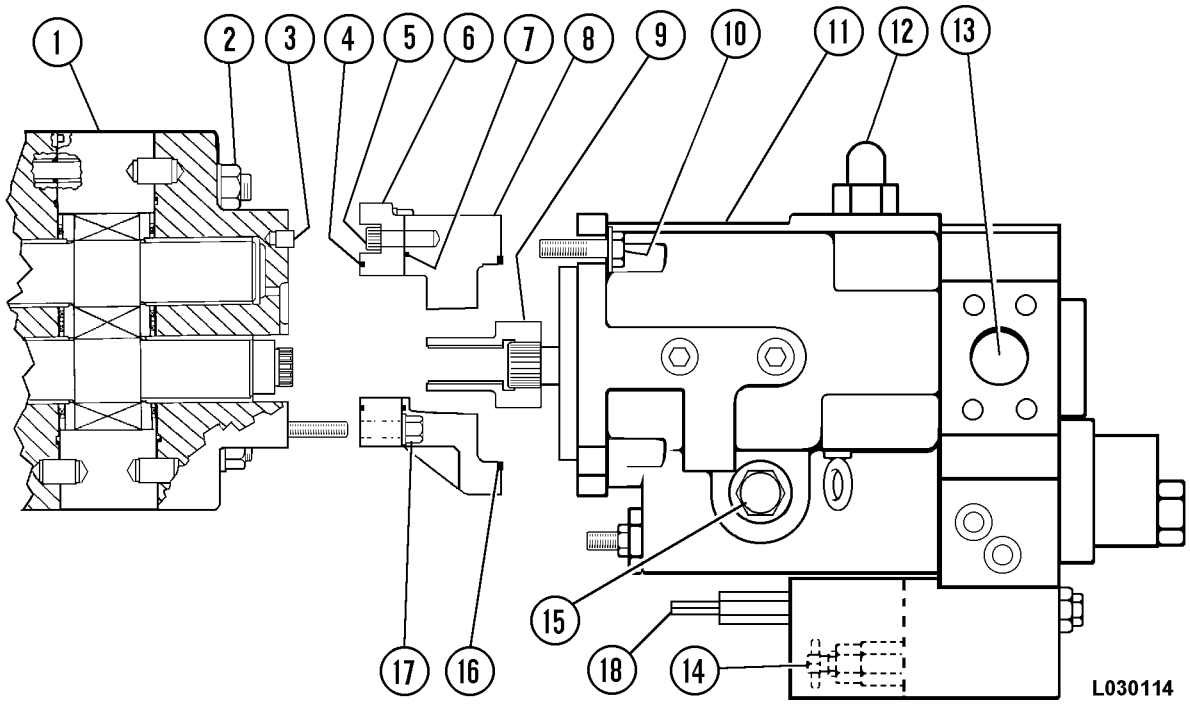


FIGURE 3-2. STEERING PUMP REMOVAL

1. Hoist Pump
2. Nut & Washer
3. Dowel
4. O-Ring
5. Capscrew
6. Bearing Plate
7. O-Ring
8. Transition Plate
9. Coupling
10. Capscrew
11. Steering & Brake Pump
12. Pump Case Drain
13. Inlet Port
14. Compensator Adjuster
15. Plug
16. O-Ring
17. Nut
18. Unloader Adjuster

Disassembly

NOTE: As parts are removed they should be laid out in a group in the same order in which they are removed.

1. Clean the exterior of the pump assembly thoroughly. If the steering pump is attached, remove capscrews (10, Figure 3-2) and pull the steering pump free of transition plate (8). Remove O-ring (16).
2. Remove companion flange from driveshaft. If necessary, heat to 400° to 500°F (204° to 260°C) to ease removal.
3. Remove coupling (9). Remove snap ring (18) if damaged or replacement of the coupling is necessary. Remove dowels (3) if damaged, or if replacement of the bearing plate is necessary.
4. The pump may be supported by placing on wood blocks with the input drive shaft pointing down. Mark each section nearest the input drive gear to facilitate reassembly.
5. Remove nuts (17, Figure 3-2) and remove bearing plate (6) with transition plate (8) and O-ring (4). Remove capscrews (5) securing the bearing plate to the transition plate and remove O-ring (7). Remove dowels if damaged, or if replacement of the transition plate is necessary.
6. Remove connector plate (9, Figure 3-3). Remove O-ring (8) and steel rings (10) and (14). Remove dowels (6) if damaged, or if connector plate replacement is necessary.

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

7. Remove backup ring (15), O-ring and retainer (16) and isolation plate (17). Grasp the drive gear (12) and idler gear (11) and pull straight up and out of the gear plate (5) bore. Remove pressure plate (18) from gears.
8. Remove gear plate (5) and pressure plate (19). Remove steel rings, backup ring, O-ring and retainer and isolation plate. Remove O-ring (3) and stud O-ring (4).

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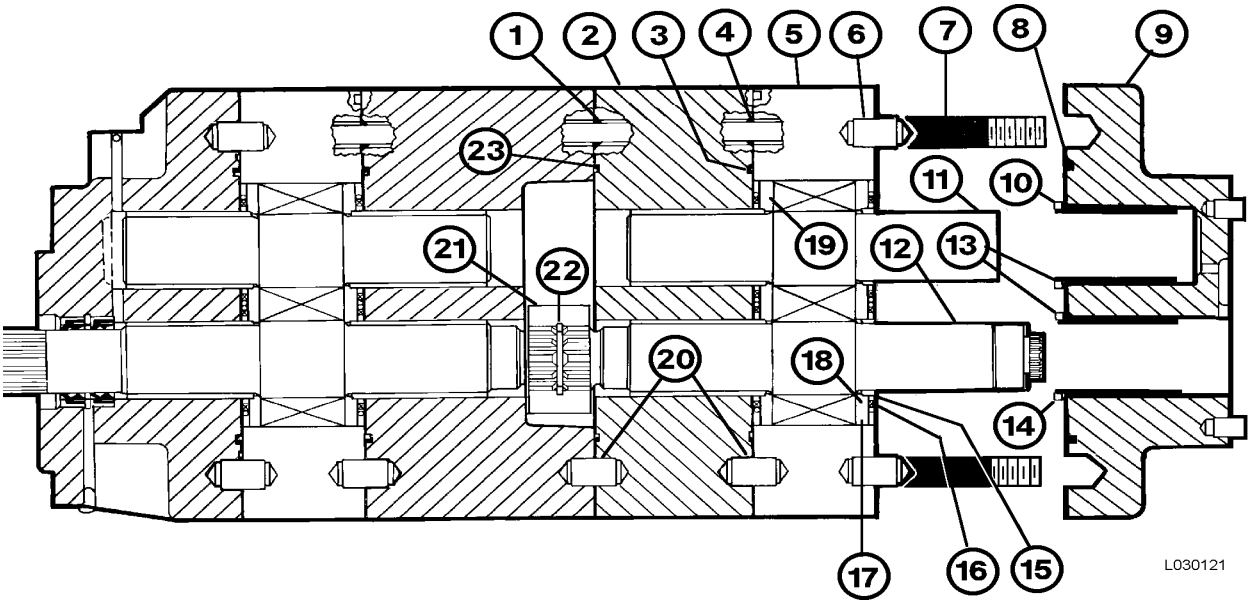


FIGURE 3-3. HOIST PUMP DISASSEMBLY

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

9. .Remove bearing plate (2). Remove O-ring (23) and stud O-rings (1). Remove dowels (20) if damaged or replacement of the bearing plate is necessary.
10. Remove coupling (21). Remove snap ring (22) if damaged or replacement is necessary.

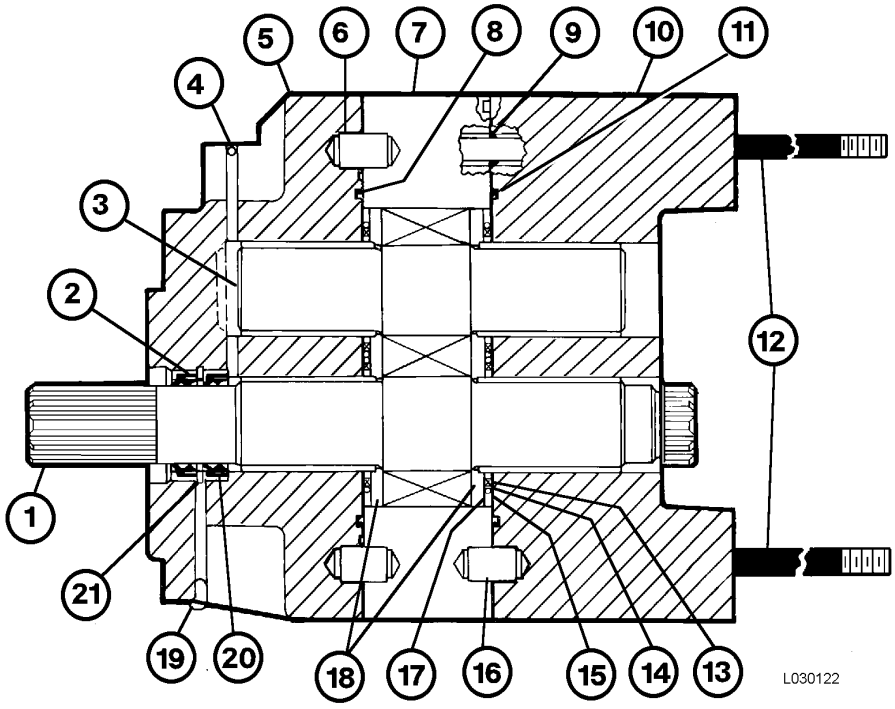
NOTE: Disassembly of the rear pump section is now complete. Do not remove thru studs at this time as the studs serve as guides for disassembly.

11. Remove bearing plate (10, Figure 3-4). If the bearing plate is stuck, tap lightly with a plastic hammer to loosen it. Remove O-rings (9) and (11).
12. Remove steel rings (13), backup ring (14), O-ring, retainer (15) and isolation plate (17). Remove dowels (16) if damaged or if replacement of the bearing plate (10) is necessary.
13. Unthread the thru studs (12) and remove. Remove flange (5), if stuck tap flange lightly with a plastic hammer to loosen. Remove O-ring (8). Remove dowels (6) if damaged or if replacement of the flange (5) or gear plate (7) is necessary.
14. Remove steel rings, backup ring, O-ring and retainer. Remove drive gear (1) and idler (3) from gear plate (7). Remove both pressure plates (18).
15. Remove outboard shaft seal (2), snap ring (21) and inboard shaft seal (20).

NOTE: To aid in shaft seal removal place the flange on two small wooden blocks, refer to Figure 3-5.

16. Use a punch and hammer and tap the outboard shaft seal out of the flange bore. (Refer to Figure 3-6.) Use care not to mar, scratch or damage the seal bore surface, or bearings.
17. After the seals and snap ring have been removed, clean the bore thoroughly. If necessary, the bore may be smoothed with number 400 emery paper (only).

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1. Drive Gear & Shaft
2. Seal
3. Idler Gear
4. Steel Ball
5. Flange
6. Dowel
7. Gear Plate
8. O-Ring
9. O-Ring
10. Bearing Plate
11. O-Ring
12. Thru Studs
13. Steel Rings
14. Backup Ring
15. O-Ring & Retainer
16. Dowel
17. Isolation Plate
18. Pressure Plate
19. Plug
20. Seal
21. Snap Ring

FIGURE 3-4. HOIST PUMP DISASSEMBLY (FRONT SECTION)

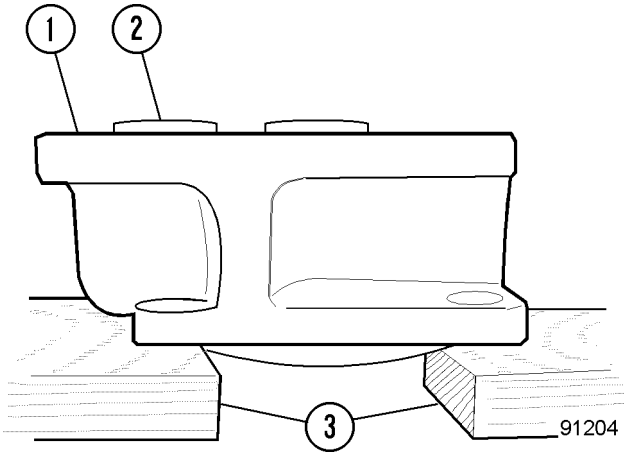


FIGURE 3-5. SEAL REMOVAL PREPARATION
1. Flange
2. Bearings
3. Wooden Blocks

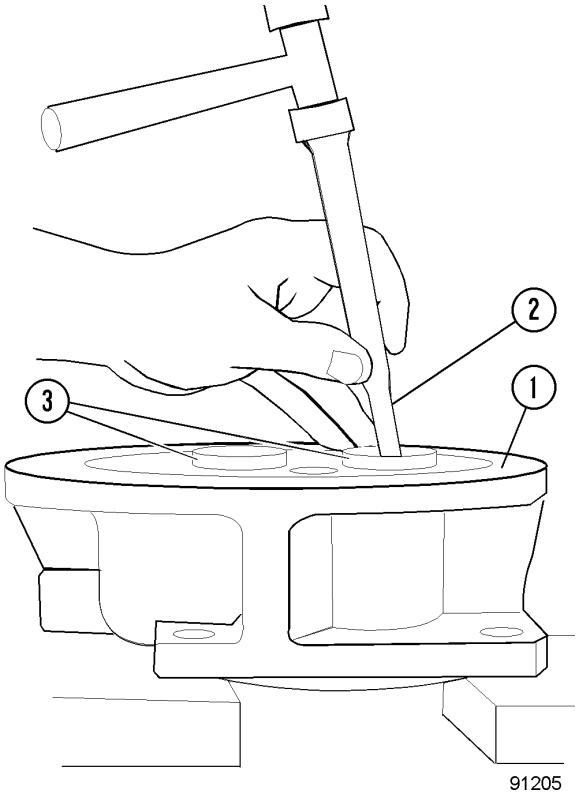


FIGURE 3-6. SHAFT SEAL REMOVAL
1. Flange
2. Punch
3. Bearings

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INSPECTION OF PARTS

1. Examine the gear bores in both gear plates, reference Figure 3-7. During the initial break-in, the gears cut into the gear plates. The nominal depth of this cut is 0.008 in (0.203 mm) and should not exceed 0.015 in (0.381 mm). As the gear teeth cut into the gear plates, metal is rolled against the pressure plates. Using a knife or sharp pointed scraper, remove the metal that was rolled against the pressure plates. Remove all metal chips that were broken loose.

⚠ IMPORTANT ⚠

When removing the rolled up metal, do not attempt to remove the gear track-in grooves.

2. Examine the pressure plates. They should not show excessive wear on the bronzed side. If deep curved wear marks are visible, discard and replace with new.
3. Examine the gears. If excessive wear is visible on the journals, sides, or face of the gears, or at the point where the drive gear rotates in the lip seal, discard and replace with new.
4. If any of the internal parts show excessive wear, replace with new. Replace all O-rings and seals with new.

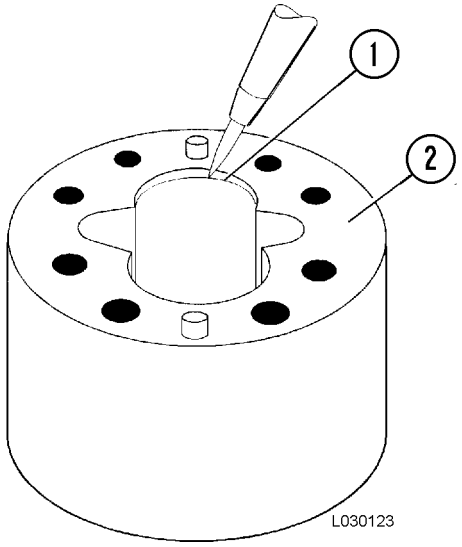


FIGURE 3-7. GEAR BORE INSPECTION

1. Gear Track-In 2. Gear Plate

5. Inspect the bearings, if they are worn beyond the gray teflon into the bronze material, the complete flange connector plates or bearing plate should be replaced.

NOTE: Replacing new bearing in the flange, connector plates or bearing plate is not recommended due to close tolerances and special tooling required for crimping the bearing in place to prevent bearing spin.

6. Inspect the flange seal bore for scratches or gouges which may interfere with shaft seal installation.
7. For additional pump and system inspection refer to the Troubleshooting Guide.

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Assembly

1. A suitable seal press ring or plug and two small wood blocks should be available.
2. The following seal installation procedures are outlined for use with a vise, but they can be adapted for use with a press if one is available.
3. Open the vise jaws wide enough to accept the combined thickness of the flange, wood blocks and press ring.
4. Place the wood blocks flat against the fixed jaw of the vise. Place the flange plate against the blocks in such a position that the bearing projections are between the blocks and clear of the vise jaw, refer to Figure 3-8.

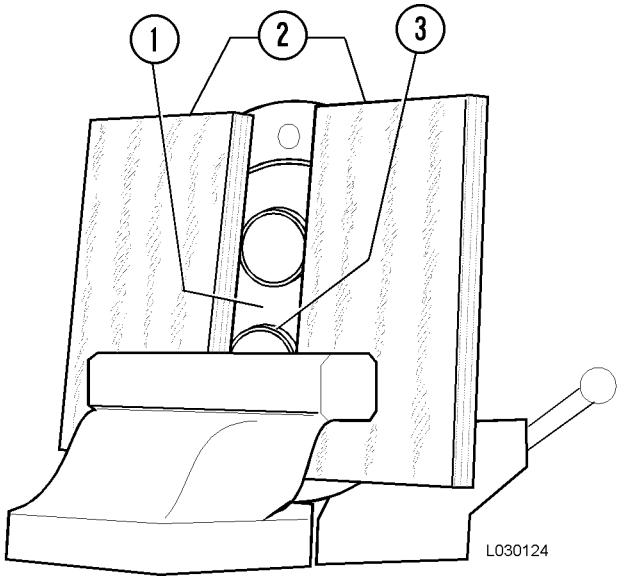


FIGURE 3-8. SHAFT SEAL INSTALLATION

1. Flange
2. Wood Blocks
3. Bearing Projection

5. Lubricate the seals with hydraulic oil. Position the inboard shaft seal (3, Figure 3-9) with the metal face toward the outboard end of the flange.
6. Position the press ring over the seal. Make sure that 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 3-9). Make sure the snap ring opening is over the weep hole (10).

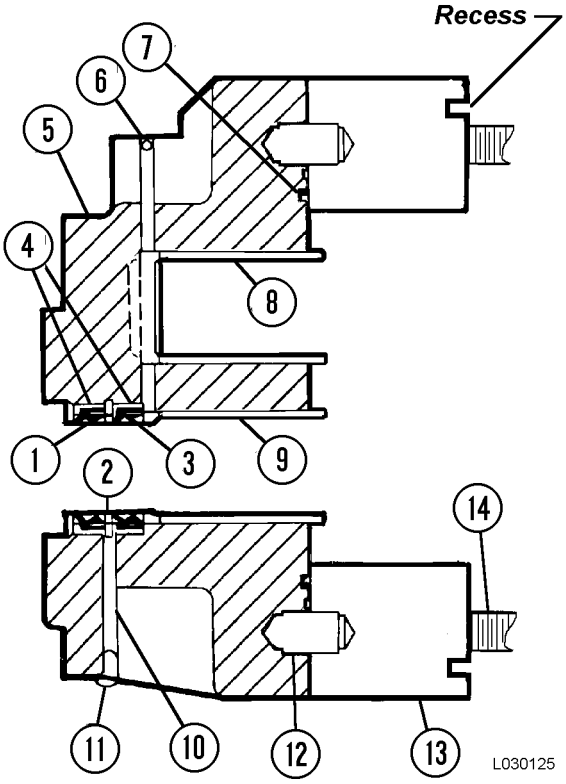


FIGURE 3-9. SHAFT SEAL INSTALLATION

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

8. Install the Outboard seal (metal face out), until it just contacts the snap ring.
9. Lubricate the thru stud threads (14, Figure 3-9) with hydraulic oil. Thread the studs into flange until snug. There are 4 long studs and 4 short studs. Reference Figure 3-10 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.

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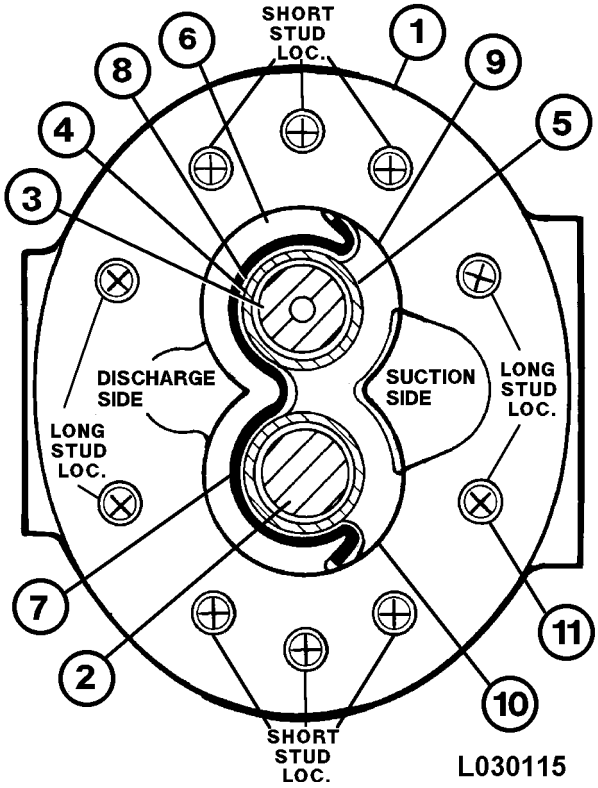


FIGURE 3-10. PUMP REASSEMBLY

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

10. Install steel rings (5, Figure 3-10). Lubricate and install backup ring (8), O-ring (7) and ring retainer (6) as shown in Figure 3-10.
11. Install the 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.
12. With the bronze side up and the milled slot facing toward the discharge side, slide pressure plate (2, Figure 3-11) 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.

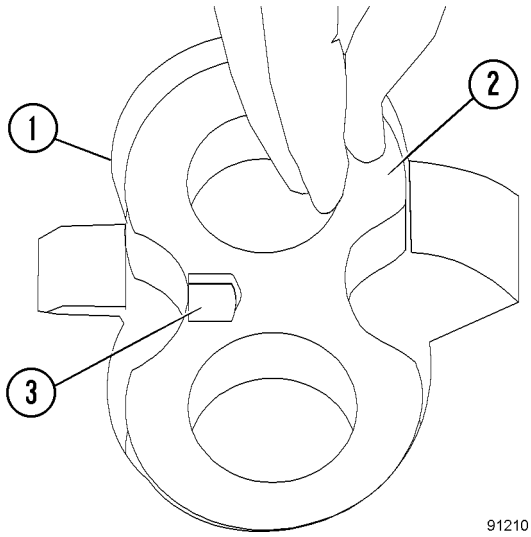


FIGURE 3-11. PRESSURE PLATE INSTALLATION

1. Gear Plate
2. Pressure Plate
3. Slot

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 3-12 which illustrates gear pump timing.

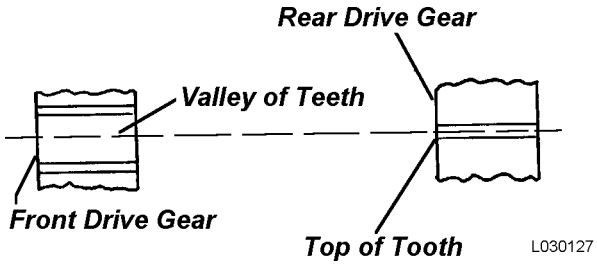


FIGURE 3-12. PUMP GEAR TIMING

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.

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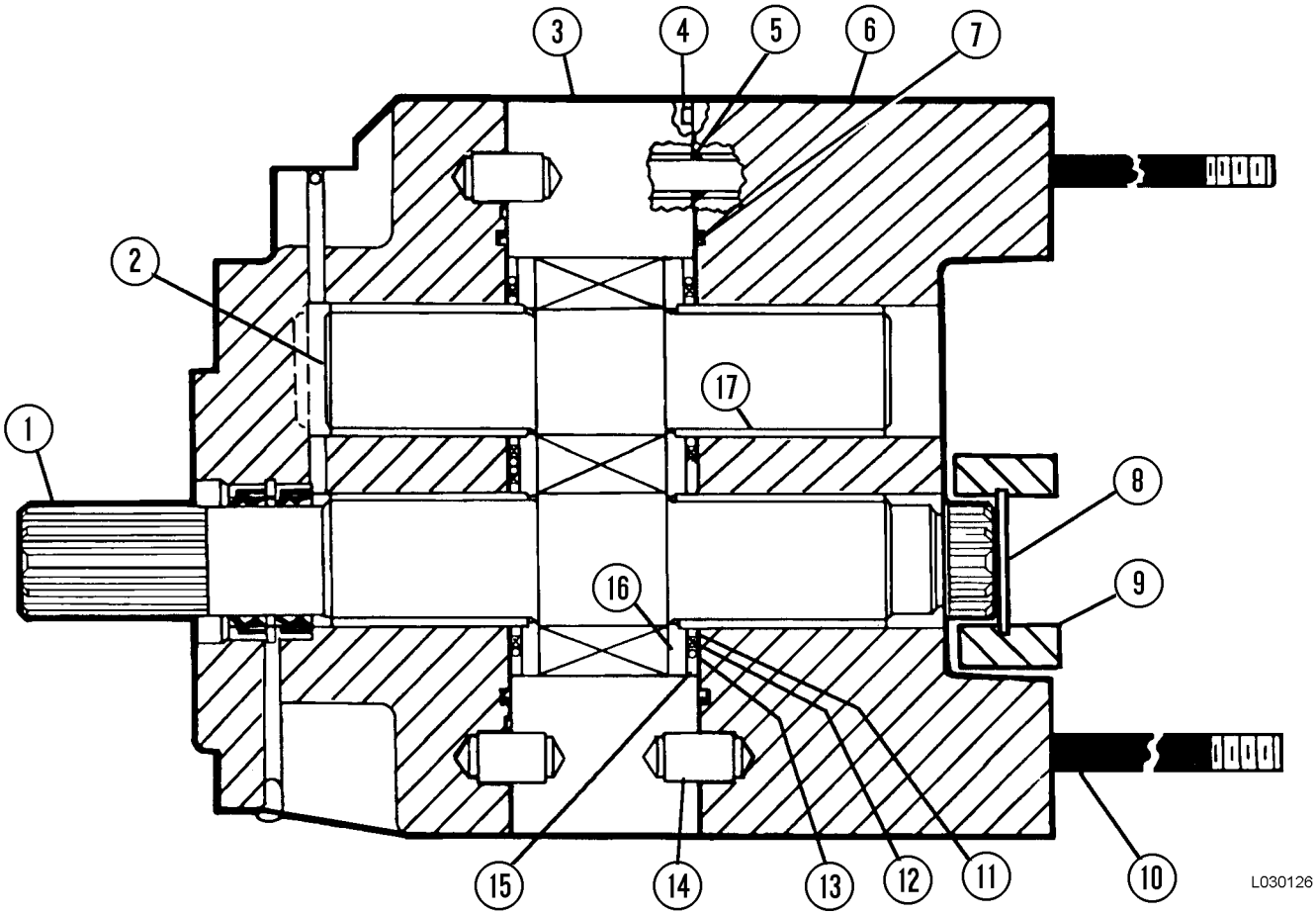


FIGURE 3-13. HOIST PUMP REASSEMBLY

1. Drive Gear and Shaft
2. Idler Gear
3. Gear Plate
4. Relief
5. O-Ring
6. Connector Plate
7. O-Ring
8. Snap Ring
9. Coupling
10. Thru Studs
11. Steel Ring
12. Backup Ring
13. O-Ring & Retainer
14. Dowel
15. Isolation Plate
16. Pressure Plate
17. Bearing

15. Install the opposite pressure plate with the bronze side down and the milled slot facing toward the discharge side.
16. Install steel rings (11, Figure 3-13), backup ring (12), O-ring and retainer (13). Install isolation plate with its relief toward the pressure plate.
17. Lubricate and install thru stud O-rings (5) and connector plate O-ring (7). Install dowel (14) if removed. Lubricate the I.D. of the bearings (17) and install connector plate (6). Install snap ring (8) and coupling (9).
18. Lubricate O-ring (3, Figure 3-14) and install in bearing plate (7). Lubricate O-rings (4) and install over studs (12). Replace dowel (2) if removed. Install bearing plate (7).
19. Repeat steps 10, 11 and 12 for installation of the steel rings, backup ring, O-ring, retainer, isolation plate and pressure plate.
20. Lubricate I.D. of bearings (18, Figure 3-14). Install O-rings (8 & 9) and dowel (25) if removed. Install gear plate (10). Make sure relief in gear plate is toward bearing plate (7).
21. Install rear drive gear (1) and idler gear (13). The rear drive gear must be timed with the front drive gear. This is accomplished by lining up a tooth on the rear drive gear with the valley of two teeth on the front drive gear, as shown in Figure 3-12.
22. Repeat steps 15 and 16 for installation of the remaining pressure plate, steel rings, backup ring, O-ring, and retainer and isolation plate.

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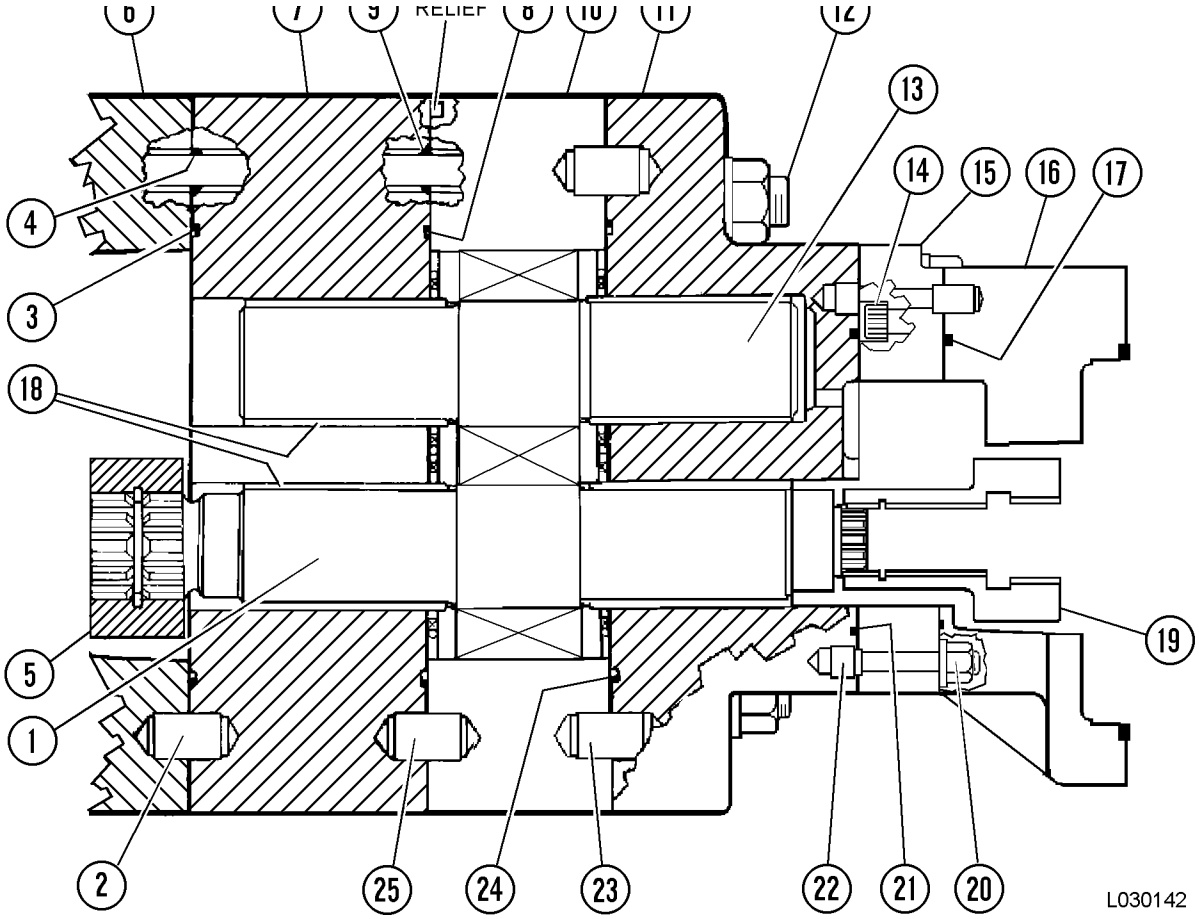


FIGURE 3-14. HOIST PUMP REASSEMBLY

1. Drive Gear (Rear)
2. Dowel
3. O-Ring
4. O-Ring
5. Coupling
6. Connector Plate
7. Bearing Plate
8. O-RIng
9. O-Ring
10. Gear Plate
11. Connector Plate
12. Stud
13. Idler Gear
14. Capscrew
15. Bearing Plate
16. Transition Plate
17. O-Ring
18. Bearings
19. Coupling
20. Nut
21. O-Ring
22. Dowel
23. Dowel
24. O-Ring
25. Dowel

23. Lubricate and install O-ring (24, Figure 3-14) in connector plate (11). Install dowel (23) if removed. Lubricate I.D. of bearing in the connector plate (11). Install connector plate (11) with flat washers and nuts.
24. Install dowel (22) if removed. Lubricate and position O-ring (17) in transition plate (16). Assemble bearing plate (15) to transition plate and install capscrews (14). Tighten capscrews to standard torque.
25. Lubricate O-ring (21) and position on bearing plate (15). Install the assembled bearing plate and transition plate (15 & 16) to the connector plate (11) and secure in place with nuts (20). Tighten nuts to standard torque.
26. IInstall coupling (19).
27. Lubricate the thru stud threads and install two opposite stud nuts and hardened washers. Tighten nuts to **240 to 250 ft lbs (325 to 339 N.m)** torque.

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28. Using an 18 inch (45 cm) adjustable wrench, check pump drive shaft rotation. The drive shaft will be tight but should turn freely with a maximum of **5 to 10 ft lbs (7 to 14 N.m)** torque, after the initial surge. (Refer to Figure 3-15.)
29. If the shaft will not turn properly, disassemble the pump and examine the parts for burrs or foreign material causing buildup or interference between parts.
30. When the input shaft turns properly install the remaining hardened washers and nuts. Tighten nuts to **240 to 250 ft lbs (325 to 339 N.m)** torque.
31. Install a new O-ring on steering pump flange and install steering pump to the transition plate (16, Figure 3-14). Install capscrews and tighten to standard torque.
32. Install companion flange on pump driveshaft. If necessary, heat to 400° to 500°F (204° to 260°C) to ease installation.

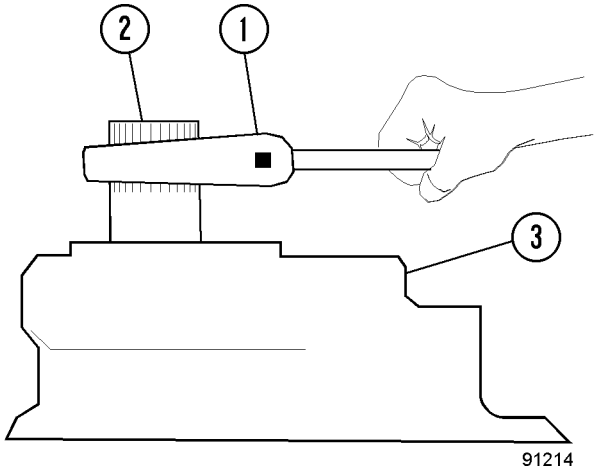


FIGURE 3-15. PUMP ROTATION CHECK

1. Wrench
2. Input Shaft
3. Pump

⚠ IMPORTANT ⚠

Do not force flange onto shaft. Be certain flange is bottomed on shaft before it cools.

33. After flange has cooled, install nut and washer on pump shaft. Tighten to **300 ft. lbs. (407 N.m)** torque.

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HYDRAULIC TANK

Filling Instructions

NOTE: If filling is required, use only type C-4 hydraulic oil as specified on the truck Lubrication Chart. Filtering of oil with a 3 micron filtering system is recommended.

⚠WARNING

Prior to opening the hydraulic tank, allow at least 90 seconds for the accumulator to bleed down after engine shutdown and keyswitch "Off".

1. With the engine stopped, body down, and the key switch "Off", wait for at least 90 seconds.
2. Remove the fill cap (1, Figure 3-16) and add clean type C-4 hydraulic oil until oil is at the top sight gauge.
3. Replace fill cap.
4. Start engine, raise and lower the dump body three times.

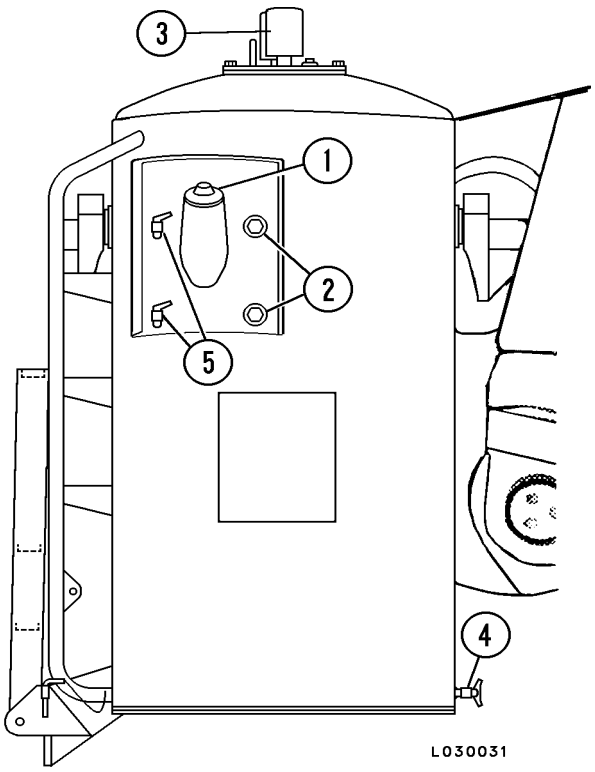


FIGURE 3-16. HYDRAULIC TANK

1. Fill Cap
2. Sight Gauges
3. Breather Filters (2)
4. Drain Valve
5. Oil Sampling Drain Cock

5. Continue to repeat steps 1 thru 4 until oil level is maintained in the top sight gauge with the engine stopped, key switch "Off", and body down.

NOTE: With engine running and oil at operating temperature, the oil should be visible in the lower sight glass. If not, shut down engine and add oil per "Filling Instructions". Minor adjustments to oil level can be made by using the drain cocks (5) next to filler neck.

⚠IMPORTANT⚠

If a hydraulic system component fails, an oil analysis should be made before replacing any component. If foreign particles are evident, system must be flushed. Refer to "Hydraulic System Flushing" instructions.

Removal

1. Turn keyswitch "Off" and allow at least 90 seconds for the steering accumulator to bleed down.

Be prepared to contain approximately 238 gal. (901 L) of hydraulic oil. If the oil is to be reused, clean containers must be used with a filtering (3 micron) system available for refill.

2. Thoroughly clean the outside of the hydraulic tank and attached equipment.
3. Drain the hydraulic tank by removing the drain plug (2, Figure 3-17) located on the bottom of the tank.

⚠WARNING

Take care to avoid contact with hot oil if truck has been operating. Avoid spillage and contamination.

4. Disconnect hydraulic lines. Plug lines to prevent possible contamination to the system. Tag each line at removal for proper identification during installation.
5. Attach a lifting device to the hydraulic tank.
6. Remove the capscrews and lockwashers securing the hydraulic tank mount caps to the frame.
7. Move hydraulic tank to a clean work area for disassembly or repair.

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Installation

1. Install hydraulic tank and secure mount caps with capscrews and lockwashers. Tighten to **454 ft. lbs. (615 N.m)** torque.
2. Uncap hydraulic lines and attach to the proper connections.
3. Replace breather filters if required.
4. Fill the hydraulic tank with clean, filtered C-4 hydraulic oil. Refer to “Filling Instructions”.
5. Bleed all air from hydraulic lines.
6. Bleed trapped air inside steering pump. Refer to *“Pump Pressure Setting”*, Section “L” for air bleeding procedure.

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

HYDRAULIC TANK STRAINERS

Removal

WARNING

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

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

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

2. Be prepared to contain approximately 238 gal. (901 l) of hydraulic oil. Drain hydraulic oil from tank at port on bottom of tank (2, Figure 3-17).
3. Disconnect hoist pump supply hoses at the tank. (3).
4. Remove the 22 capscrews and lockwashers (4) securing cover to the hydraulic tank. Remove and discard gasket.
5. Remove capscrews and lockwashers securing suction strainers. Remove suction strainers.

Inspect and Clean

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

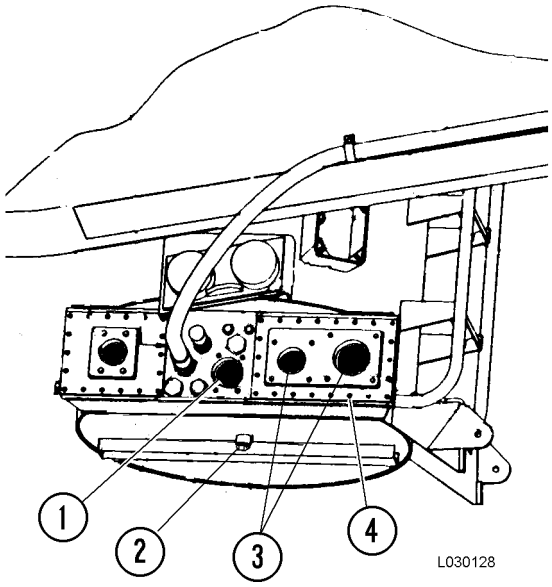


FIGURE 3-17. STRAINER REMOVAL

1. Steering Pump Supply
2. Drain Port
3. Hoist Pump Supply
4. Capscrews & Washers

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

Installation

1. Install suction strainers and secure in place with capscrews and lockwashers. Tighten capscrews to standard torque.
2. Using new cover gasket, install cover and secure in place using capscrews and lockwashers (4, Figure 3-17). Tighten capscrews to standard torque.
3. Fill the hydraulic tank, refer to Hydraulic Tank Filling Instructions. Open the three suction line shut-off valves.
4. Loosen suction line connections at both pumps to bleed any trapped air. Tighten hose connections.
5. Bleed trapped air inside steering pump. Refer to *“Pump Pressure Setting”*, Section “L” for air bleeding procedure

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

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HYDRAULIC TANK BREATHERS

There are two breather filters (3, Figure 3-16) located on top of the hydraulic tank to allow air in and out of the tank. The filters should be replaced at the interval specified on the lubrication chart.

Keep the area around the breather filters clean and free of debris build up. If there is any sign that the breather filters are oil soaked, replace the filters as soon as possible and check for proper oil level. Once the breather filters become oil soaked, they will plug very quickly.

NOTE: Plugged breather filters can cause pressure build up inside the hydraulic tank and can cause the service brakes to drag.

HOIST CIRCUIT FILTERS

Two hoist circuit filters (Figure 3-18) are located on the fuel tank below the right frame rail. The filters provide secondary filtering protection for hydraulic oil flowing to the hoist valve and hoist circuit components.

An indicator switch (5) is designed to alert the operator of filter restriction before actual bypass occurs. The switch contacts close at 35 psi (241 kPa) to actuate a warning lamp on the overhead display panel. Actual filter bypass occurs at 50 psi (345 kPa).

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

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

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

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

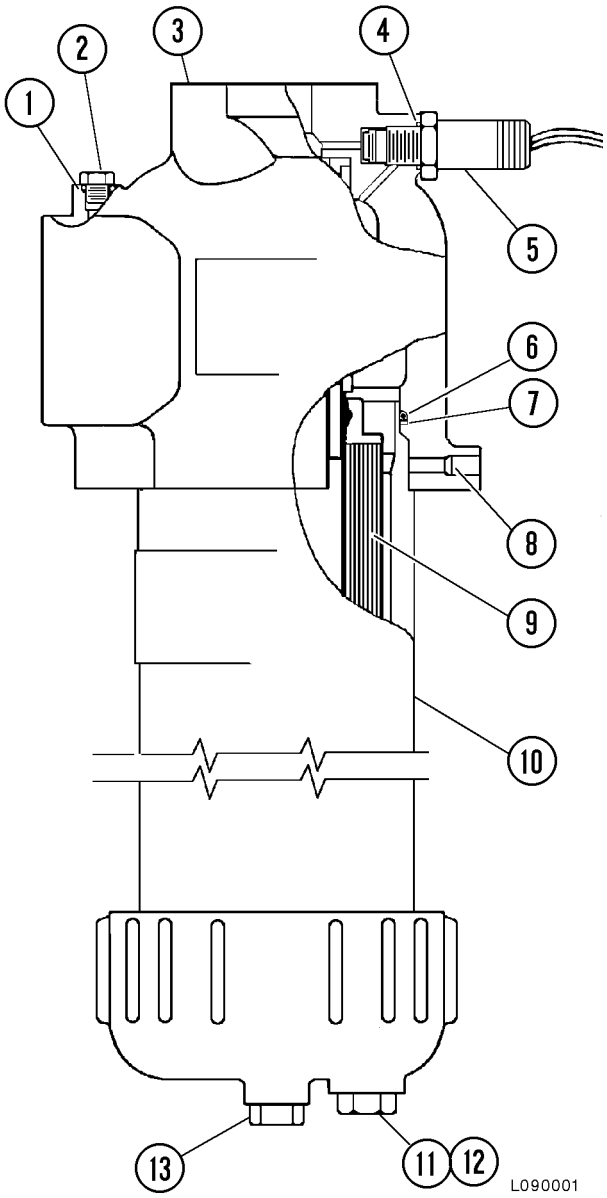


FIGURE 3-18. HOIST CIRCUIT FILTER ASSEMBLY

1. O-Ring
2. Plug
3. Filter Head
4. O-Ring
5. Indicator Switch
6. O-Ring
7. Backup Ring
8. Setscrew
9. Filter Element
10. Bowl
11. Bleed Plug
12. O-Ring
13. Bottom Plug

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FILTER ELEMENT REPLACEMENT

⚠WARNING

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

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

Removal

1. With the key switch OFF, allow at least 90 seconds for the accumulators to bleed down.
2. Remove bleed plug (11, Figure 3-18). Remove bottom plug (13) and drain oil from the housing into a suitable container.

⚠WARNING

Take care to avoid contact with hot oil if truck has been operating. Avoid spillage and contamination!

3. Loosen setscrew (8). Remove bowl (10).
4. Remove filter element (9).
5. Remove and discard backup ring (7) and O-ring (6).
6. Clean bowl in solvent and dry thoroughly.

Installation

1. Install new element (9). Install new O-ring (6) and backup ring (7).
2. Install bowl on filter head and tighten. Lock in place with setscrew (8).
3. Install bottom plug (13), and bleed plug (11).

INDICATOR SWITCH

The indicator switch (5, Figure 3-18) is factory preset to actuate at 35 psi (241 kPa). When activated, the switch will illuminate the amber “Hydraulic Oil Filter” warning lamp located on the overhead display panel in the operator’s cab.

*Note: Excessive restriction in **either** the hoist circuit filter, or the steering circuit filter element will cause the Hydraulic Oil Filter warning lamp to illuminate.*

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NOTES

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STEERING CIRCUIT

STEERING CIRCUIT OPERATION

The steering/brake pump (2, Figure 4-1) delivers oil to the high pressure steering filter (7), then to a bleed down manifold valve (4) which is located on the inside left frame rail. The bleed down manifold diverts oil between the steering circuit and brake circuit. The bleed down manifold directs oil to the steering accumulators (6), flow amplifier (7), brake circuit and steering cylinders via the flow amplifier.

Oil entering the accumulator via the bleed down manifold pushes the floating piston within the accumulator upward, compressing the nitrogen on the opposite side of the piston. The nitrogen pressure increases directly with steering circuit pressure. The top side of the piston is pre-charged to 1400 psi (9 653 kPa) with pure dry nitrogen when the piston is at the bottom.

The accumulator oil is supplied constantly to the flow amplifier, via the bleed down manifold. The accumulators also act as a reservoir for pressurized hydraulic oil to be used during an emergency situation should the hydraulic steering oil supply malfunction for any reason.

⚠WARNING

If a loss in steering pressure occurs, stop the truck immediately. The pressure in the accumulator allows the operator to steer the truck only for a short period. Do not attempt further operation until the problem is located and corrected.

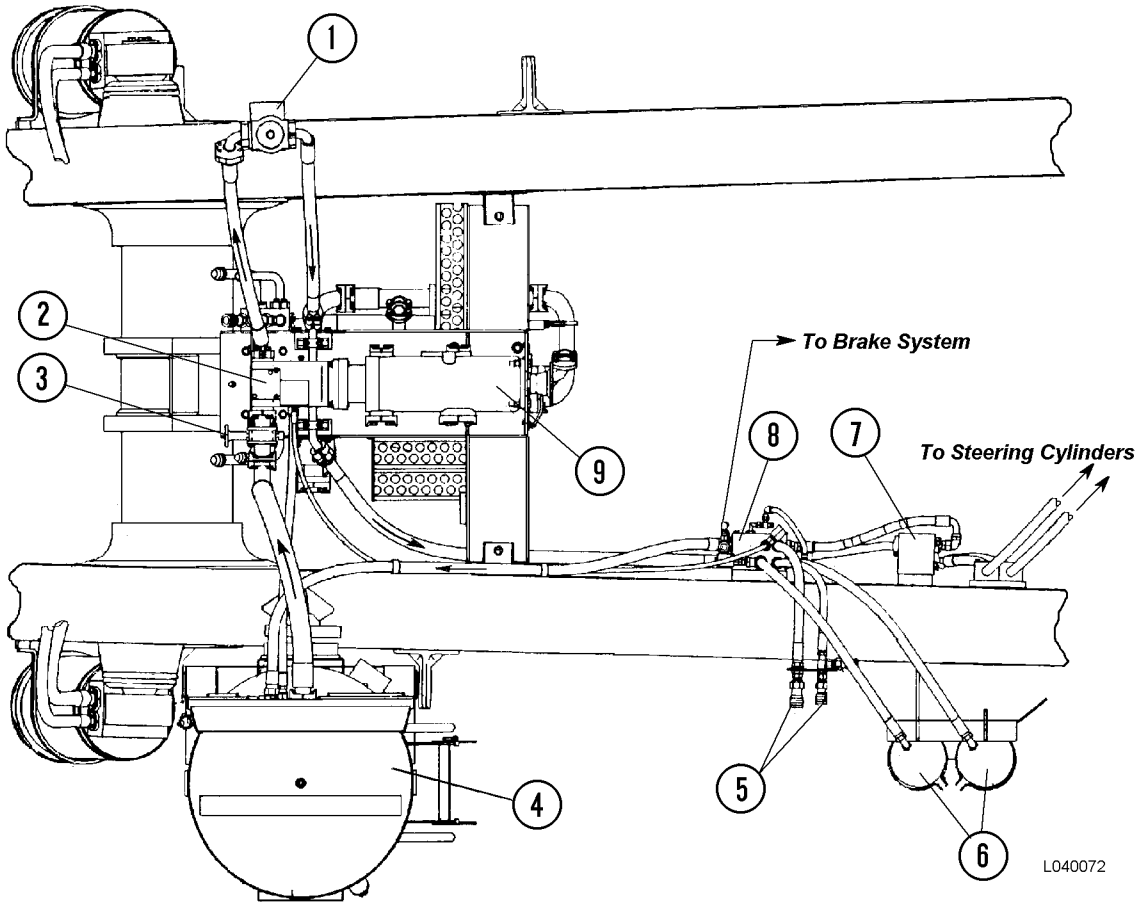


FIGURE 4-1. STEERING CIRCUIT (BOTTOM VIEW)

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

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Hydraulic oil flows to the closed center steering valve via the flow amplifier. The flow amplifier is pilot-controlled by the steering valve. Due to large oil displacement in the steering cylinders, the flow amplifier is incorporated in the steering circuit. The steering column is connected directly to the steering valve. When the steering wheel is rotated, oil is directed to the steering cylinders via the flow amplifier to the appropriate side of the pistons in the steering cylinders. When steering circuit pressure reaches 2500 psi (17 238 kPa) at the flow amplifier, or during a no steer situation, flow is blocked at the priority valve within the flow amplifier.

COMPONENT DESCRIPTION

STEERING CONTROL UNIT

The steering control unit is located behind an access cover on the front of the operator's cab. The steering control unit is connected directly to the steering column. The valve incorporates a rotary meter which ensures the oil volume supplied to the steering cylinders is proportional to the rotation of the steering wheel.

Operation of the steering control unit is both manual and hydraulic in effect, providing the operator with power steering. The valve will be spring returned automatically to its closed, neutral position when turning is stopped.

FLOW AMPLIFIER

The flow amplifier (Figure 4-2) is located on the left inside frame rail just forward of the bleed down manifold. The flow amplifier is required in the steering circuit due to the large volume of oil displacement required for steering. The flow amplifier uses the amount of flow from the steering control valve to determine the amount of amplified flow to send from the bleed down manifold to the steering cylinders. Reference Figures 4-3 through 4-6 for oil flow paths during the neutral, steering and external shock load conditions.

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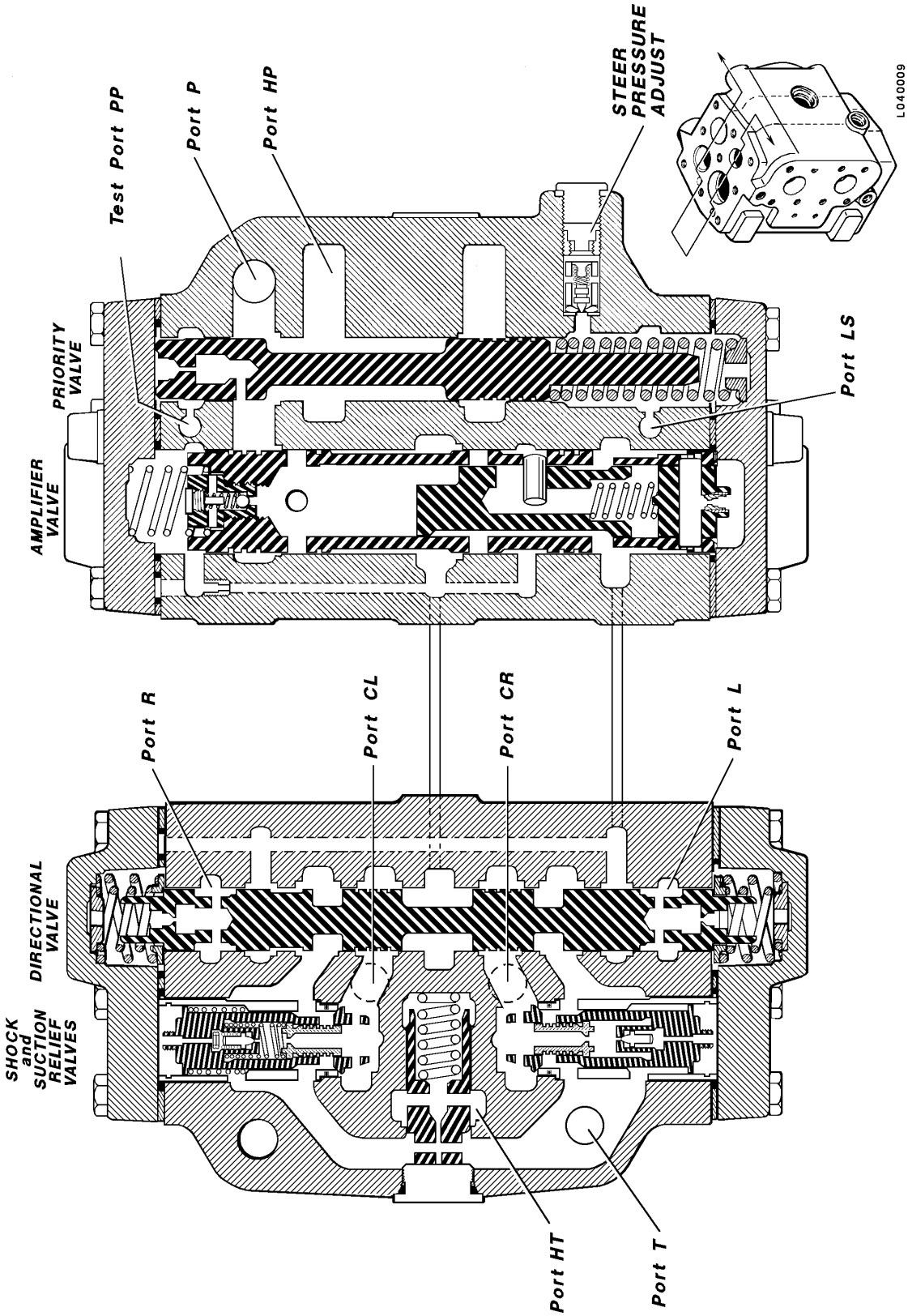


FIGURE 4-2. FLOW AMPLIFIER

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No Steer

(Refer to Figure 4-3):

High pressure oil from the steering pump and steering accumulators is available through the steering bleeddown manifold to the HP port on the flow amplifier assembly.

Upon Entering the priority valve, it goes past the spool to the closed amplifier valve and also out port P through a hose to port P on the steering control unit. In the control unit, it goes to a closed area in the control valve.

As pressure builds up in these two areas, oil passes through orifices in the end of the priority valve and builds pressure on the end of the valve and port PP. When pressure reaches approximately 500 psi (3 447 kPa), the spool moves compressing its spring and closes off oil supply through area “A” resulting in only 500 psi (3 447 kPa) at the amplifier spool, steering control unit, and PP port.

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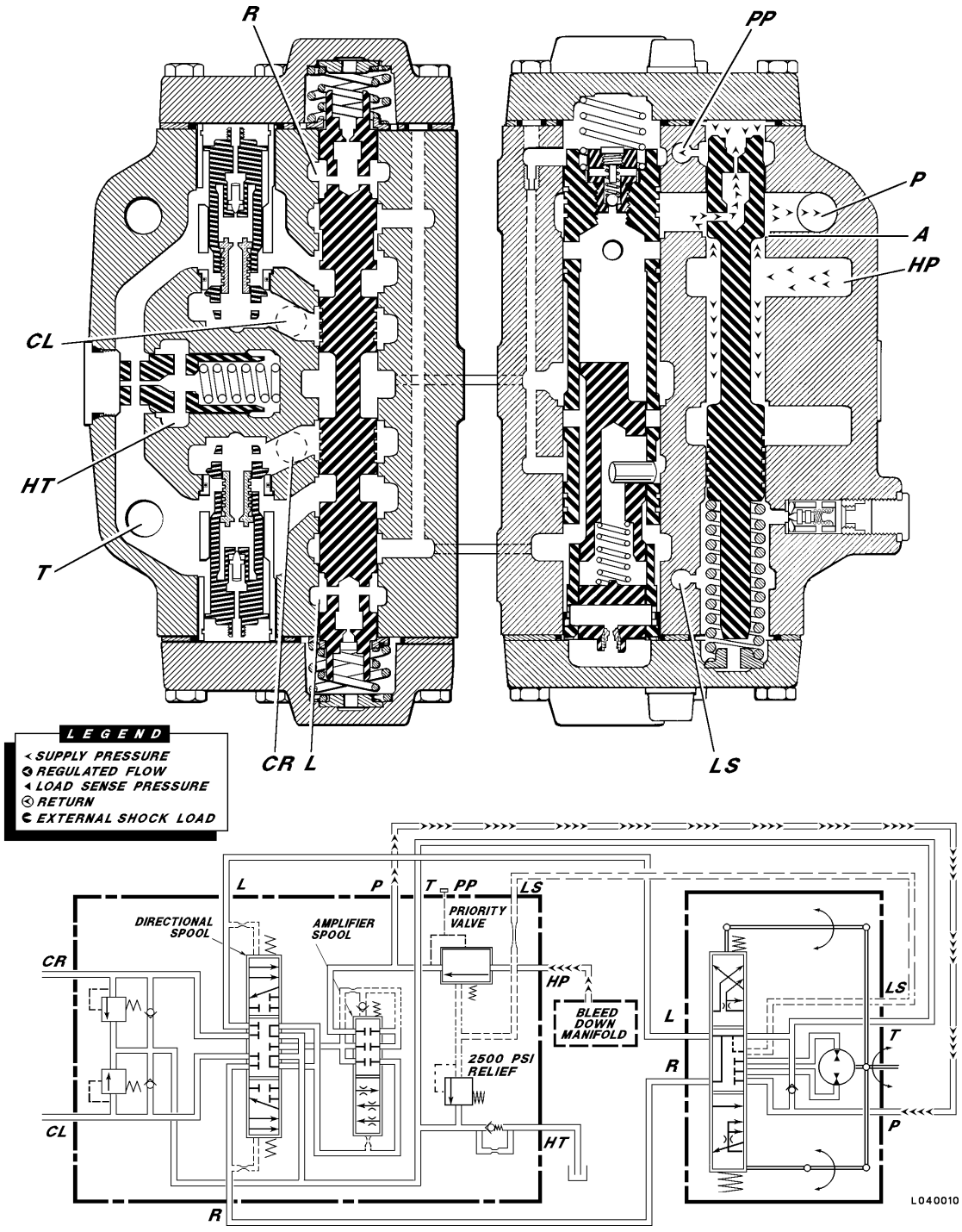


FIGURE 4-3. FLOW AMPLIFIER (No Steer)

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Steering Left

(Refer to Figure 4-4):

When the operator turns the steering wheel “left”, the steering control unit valve is opened to allow oil coming in port P to pass to the gerotor section of the control unit to turn the rotor. Oil in the other side of the gerotor flows through other passages in the control unit valve and out steering control unit port L. This oil enters port L of the flow amplifier assembly and goes to a closed area B in the directional valve. As pressure in this area builds, it also passes into the spool through orifice C to the spring area on the end of the directional valve. The pressure then moves the spool compressing the springs on the opposite end. This movement allows the oil entering area B to pass through the directional valve to area D of the amplifier valve through sleeve E holes to a passage between sleeve E and valve F through hole G in sleeve E where it initially is blocked by the valve body. As pressure builds up in this area, oil also flows from area D around the OD sleeve E around pin H through orifice J to build pressure on the end of the amplifier valve and opens hole G only enough to allow the flow of oil coming from the steering control unit to pass to the control area of the directional valve. At the same time, the movement of sleeve E opened the holes near the spring end to allow the oil from the priority valve to flow into the center of sleeve E. This oil now inside sleeve E pushes valve F against its spring to give the oil access to a series of holes K that are in the same plane as hole G. The passage of oil through holes K past the valve body is metered by holes K being opened the same proportion as is hole G.

The number of holes K (9) in sleeve E determine the amount of additional oil that is added to the steering control unit oil passing through hole G. This combined oil going to the center area Q of the directional valve passes out port CL of the flow amplifier assembly and travels to the steering cylinders to steer the front wheels to the left. As the cylinders move, oil is forced to return out the opposite ends, enter port CR of the flow amplifier assembly, pass through the directional valve to area M, passes through the return check valve N, and exit port HT to the hydraulic reservoir.

At the steering control unit, when the operator turned the steering wheel, supply oil from port P was also delivered through the control unit valve to port LS. This oil enters the flow amplifier assembly through its LS port and builds pressure in the spring area of the priority valve. This additional force on the spring end of the priority valve causes area A to open and allow the necessary flow and pressure to pass through the amplifier valve to operate the steering cylinders.

The flow amplifier assembly includes a relief valve in the priority valve spring area that is used to control maximum steering working pressure to 2500 psi (17 237 kPa) even though supply pressure coming into port HP is higher. When 2500 psi (17 237 kPa) is obtained, the relief valve prevents the LS pressure from going higher and thereby allows the priority valve to compress the spring enough to close off area A when 2500 psi (17 237 kPa) is present.

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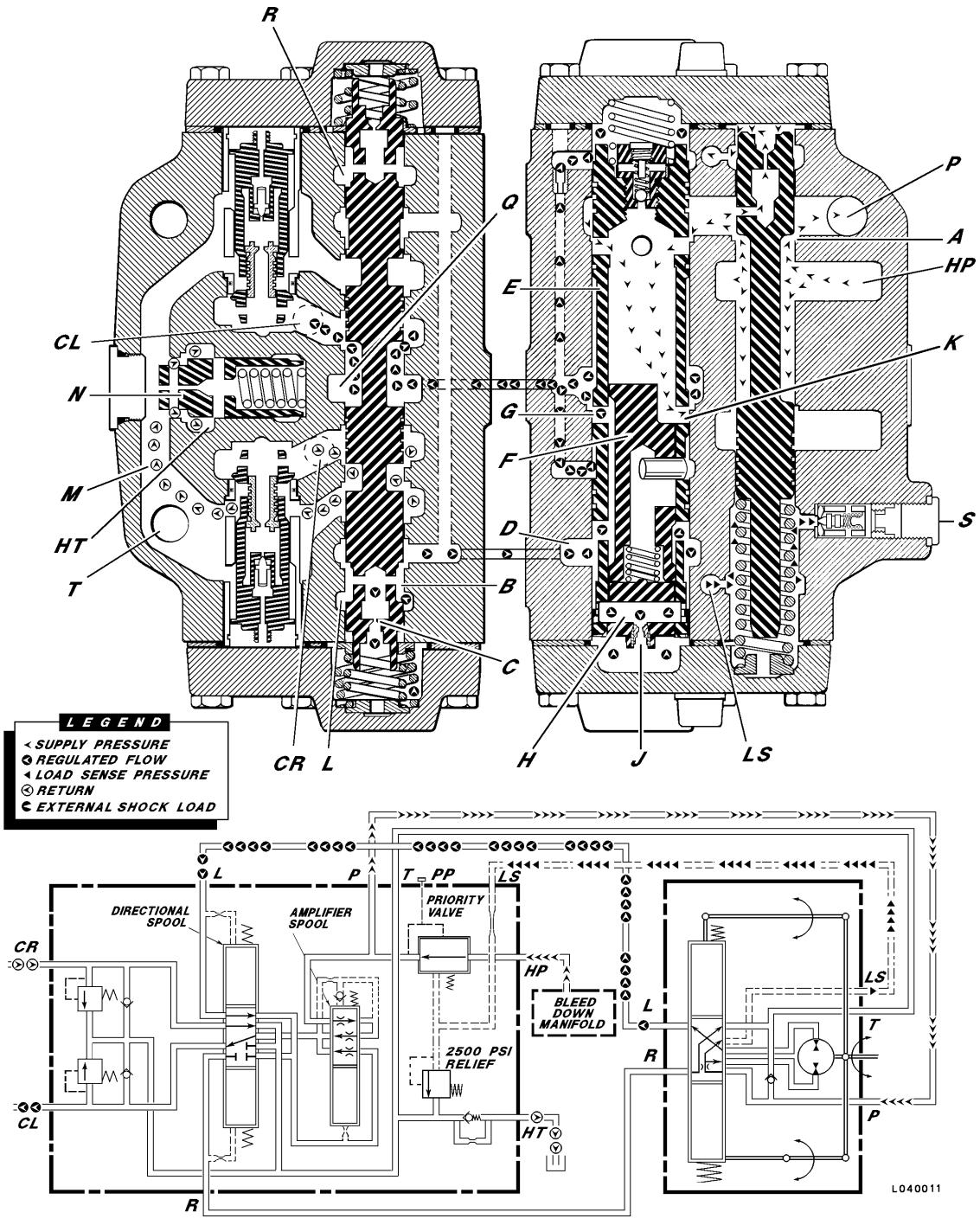


FIGURE 4-4. FLOW AMPLIFIER (Steering Left)

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Steering Right

(Refer to Figure 4-5):

Only a few differences occur between steer left and steer right. When the operator turns the steering wheel right, oil is supplied out ports R and LS of the steering control unit. The oil enters the flow amplifier assembly at port R and shifts the directional valve the opposite direction. The oils flow through the amplifier valve exactly the same.

The combined oil from the amplifier valve passes through the center area Q of the directional valve to port CR where it goes to the opposite ends of the steering cylinders to turn the wheels right. The returning oil comes back through port CL to go to the tank. The LS oil operates exactly the same as steer left.

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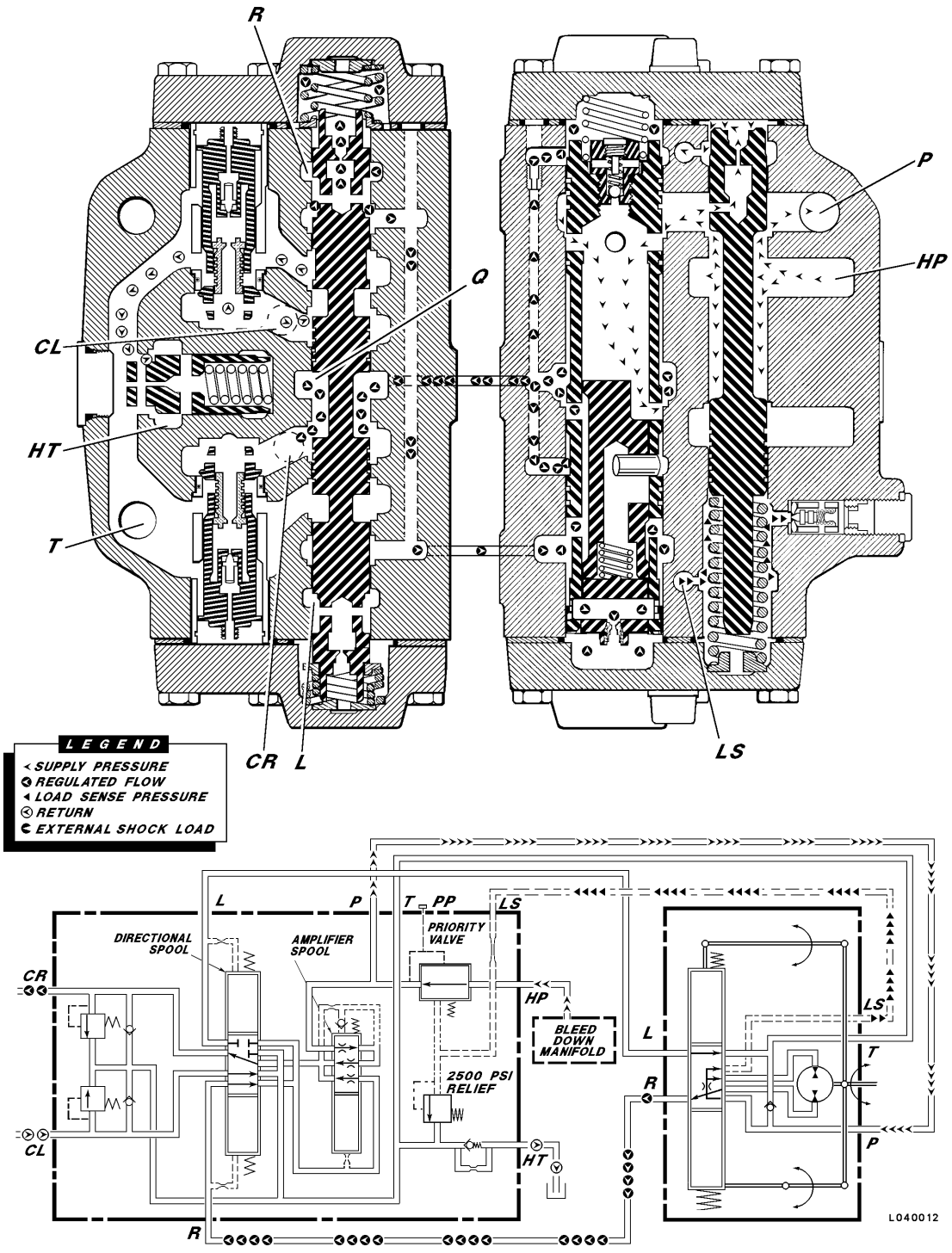


FIGURE 4-5. FLOW AMPLIFIER (Steering Right)

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No Steer, External Shock Load

(Refer to Figure 4-6):

When the operator is not turning the steering wheel, the steering control unit valve supply is closed. The directional valve remains centered by its springs thus closing the passages to ports CL and CR. This creates a hydraulic lock on the steering cylinders to prevent their movement. If the tires hit an obstruction to cause a large shock load to force the wheels to the left, increased pressure will occur in the ends of the cylinders connected to port CR. The shock and suction relief valve inside the flow amplifier assembly at port CR will open at its adjusted setting (2900 psi, (19 995 kPa)) and allow oil to escape from the pressurized ends of the cylinders preventing a higher pressure.

As the cylinders are allowed to move, the other ends will have less than atmospheric pressure on port CL. This low pressure permits oil that is escaping through the CR port relief valve to flow through the check valve portion of the shock and suction relief valve connected to port CL. The oil then flows to the low pressure ends of the cylinders to keep the cylinders full of oil and prevent cavitation. A shock load in the opposite direction merely reverses the above procedure.

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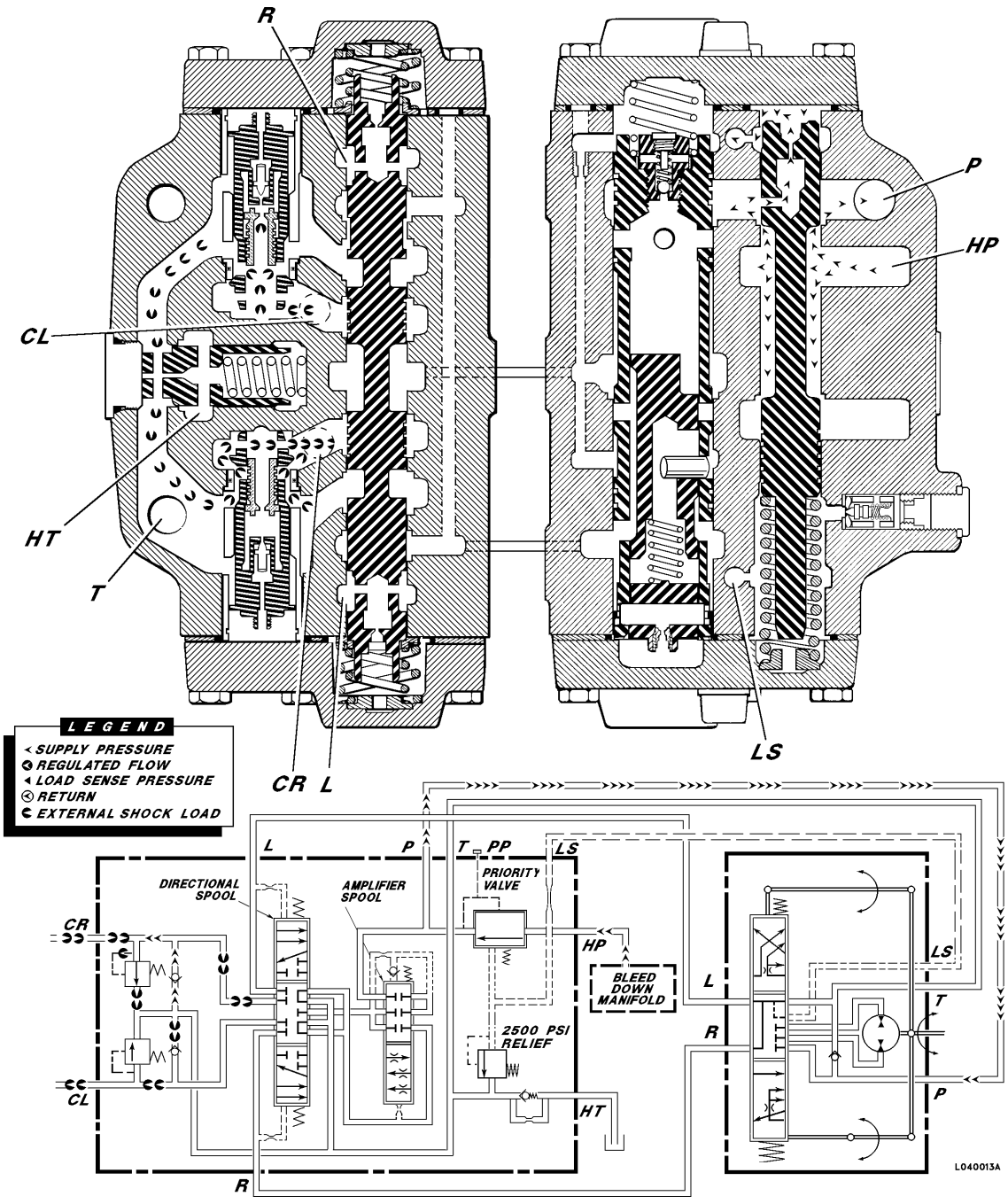


FIGURE 4-6. FLOW AMPLIFIER (No Steer, External Shock Load)

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BLEED DOWN MANIFOLD

The bleed down manifold (10, Figure 4-7) is located on the inside of the left hand frame rail just behind the flow amplifier (6).

The bleed down manifold is equipped with two bleed down solenoid valves (1), two relief valves (5 & 9), a low steering pressure switch (4), and pilot operated check valve (13). The bleed down manifold receives oil from a high pressure filter. Oil within the bleed down manifold is directed to the accumulators, brake circuit, and flow amplifier. Oil supply for the steering control valve and steering cylinders is supplied by the flow amplifier.

If for any reason the steering pump supply is lost, the truck can be slaved from another truck by using the quick disconnects. Connect “disabled truck” lines to the quick disconnect fittings located on the outside of the left frame rail, by the steering accumulators. Also connect a jumper hose between the quick disconnects (2), one located on the bleeddown manifold, the other just inside the left frame rail by the disabled truck quick disconnect. **This jumper hose must capable of withstanding 3500 psi (24 MPa) brake system pressure.**

The relief valves, accumulator bleed down solenoids, and steering pressure switch are not individually rebuildable and are factory preset. Refer to “Steering Circuit Check-Out Procedure” for relief valve setting.

Each time the keyswitch is turned “Off”, it energizes the bleed down solenoids. When the bleed down solenoids are energized, all hydraulic steering pressure, including the accumulator, is bled back to the hydraulic tank. Brake pressure however, will not bleed down due to internal check valves in the brake manifold.

After approximately 90 seconds, the solenoids will de-energize to close the return port to tank. By this time all the oil in the accumulator should be returned to tank. At start-up, the steering circuit will be charged, including the brake circuit. The Low Steering Pressure light and buzzer will turn on until steering pressure reaches 2300 psi (15 858 kPa). This is controlled by the steering pressure switch located on the bleed down manifold. During operation, if steering pressure falls below 2300 psi (15 858 kPa), the Low Steering Pressure warning light will illuminate.

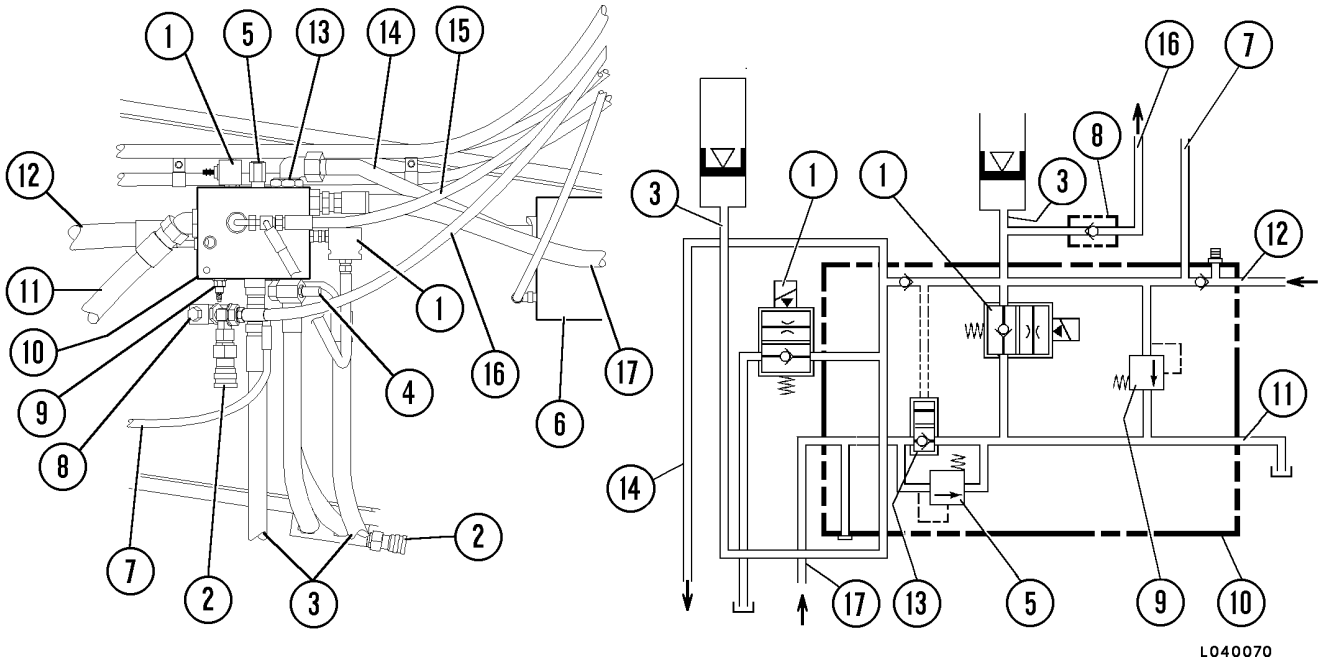


FIGURE 4-7.

1. Bleed Down Solenoid
2. Brake Quick Disconnect
3. Accumulator Supply
4. Low Steering Pressure Switch
5. Return Relief Valve (500 psi)
6. Flow Amplifier
7. Unloader Valve Line
8. Check Valve
9. Relief Valve (4000 psi)
10. Bleed Down Manifold
11. Return Line
12. From Steering Filter
13. Check Valve (Piloted)
14. Outlet to Flow Amplifier
15. Hoist Pilot Valve Return Line
16. Supply to Brakes
17. Return from Flow Amplifier

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ACCUMULATORS

The accumulators (6, Figure 4-1) are a bladder type. The accumulators are charged to 1400 psi (9.7 MPa) with pure dry nitrogen.

Oil entering the accumulator pushes the bladder upward compressing the nitrogen. The nitrogen pressure increases directly with steering circuit pressure. When brake/steering circuit pressure reaches 3500 to 3550 psi (24.5 to 24.85 MPa), the unloader valve will unload the pump output to approximately 400 psi (2.8 MPa). The accumulators will contain a quantity of oil under pressure available for steering the truck. When system pressure drops to 3200 psi (22.4 MPa), the pump output will again increase to refill the accumulators and increase steering system pressure. The accumulators also provide oil, for a limited amount of use, to be used in case of an emergency situation should the pump become inoperative.

Low Precharge Warning Switch

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

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

⚠WARNING

Do not operate the truck with less than 1100 psi (7 584 kPa) nitrogen precharge in the accumulators because there may be inadequate oil supply in some emergency conditions. If low nitrogen precharge pressure is determined, recharge the accumulators to 1400 psi (9 653 kPa).

HIGH PRESSURE FILTER

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

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

STEERING/BRAKE PUMP

The Steering/Brake pump (2, Figure 4-1) is mounted on the rear of the tandem hoist pump. This pump supplies oil to both the brake system and steering system. Figure 4-8 shows the location of various steering pump components. Refer to Figure 4-13 for a hydraulic circuit schematic of the pump with unloader and compensator.

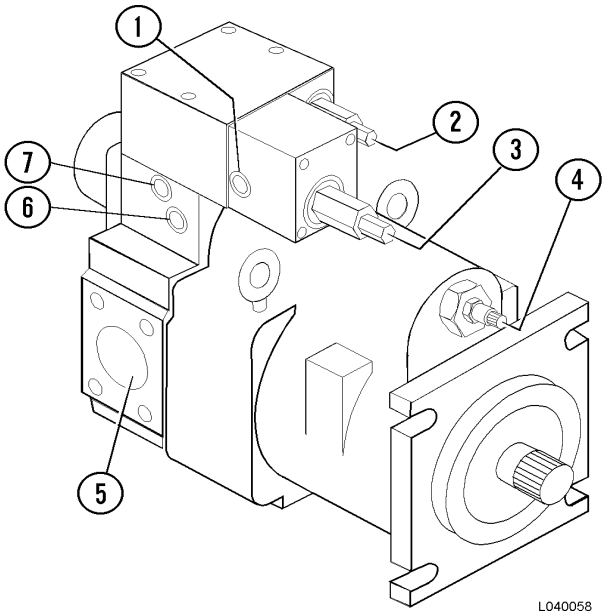


FIGURE 4-8. STEERING / BRAKE PUMP

1. Accumulator Connection
2. Pressure Compensator Adjuster
3. Unloader Adjuster
4. Stroke Adjuster
5. Outlet Port
6. GP2 Port
7. GPA Port

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Operation

Refer to the parts list at right and the pump illustration in Figure 4-9 for the following description of operation.

- The driveshaft (38, Figure 4-9) runs through the centerline of pump housing (40) and valve plate (51).
- Cylinder barrel (48) is splined to the drive shaft.
- A ball bearing (36) supports the outboard end of the driveshaft and a (bushing type) bearing (50) supports the inboard end.
- The pump cylinder barrel is carried in a polymerous (journal type) bearing (44).
- The valve plate (51) has two crescent shaped ports (inlet and outlet).
- Pumping pistons (47) in the cylinder barrel are held against a swashblock (31) by a shoe retainer (17).
- The shoe retainer is held in position by the fulcrum ball (43) which is forced outward by retainer springs (13). The springs act against the pump cylinder barrel (48) forcing it against the valve plate (51) while also forcing the piston shoes against the swashblock.
- The semi-cylindrical shaped swashblock limits the piston stroke and can be swivelled in arc shaped saddle bearings (21).
- The cradle is swivelled by the control piston (14).

FIGURE 4-9. CUT-AWAY VIEW OF STEERING PUMP

1. Plug
2. O-Ring
3. Spring
4. Back-Up Ring
5. O-Ring
6. Back-Up Ring
7. O-Ring
8. Piston Ring
9. O-Ring
10. Back-Up Ring
11. Spring
12. Control Piston Stop Pin
13. Spring
14. Piston
15. Pin
16. Control Piston Stop Pin
17. Shoe Retainer
18. Pin
19. Retainer Ring
20. Washer
21. Saddle Bearing
22. Roll Pin
23. O-Ring
24. Link
25. O-Ring
26. Gland
27. Jam Nut
28. Maximum Flow Stop Adjuster
29. Retaining Ring
30. Back-Up Ring
31. Swashblock
32. Dowel Pin
33. Saddle
34. Roll Pin
35. Retainer Ring
36. Bearing
37. Shaft Retainer Ring
38. Shaft
39. Seal Retainer
40. Pump Housing
41. Shaft Seal
42. O-Ring
43. Fulcrum Ball
44. Cylinder Bearing
45. Pressure Compensator
46. Compensator Adjuster
47. Piston/Shoe Assembly
48. Cylinder Barrel
49. Gasket
50. Bearing
51. Valve Plate
52. Capscrew
53. O-Ring
54. Cover
55. Piston Ring
56. Cap
57. Unloader Block
58. Unloader Adjuster

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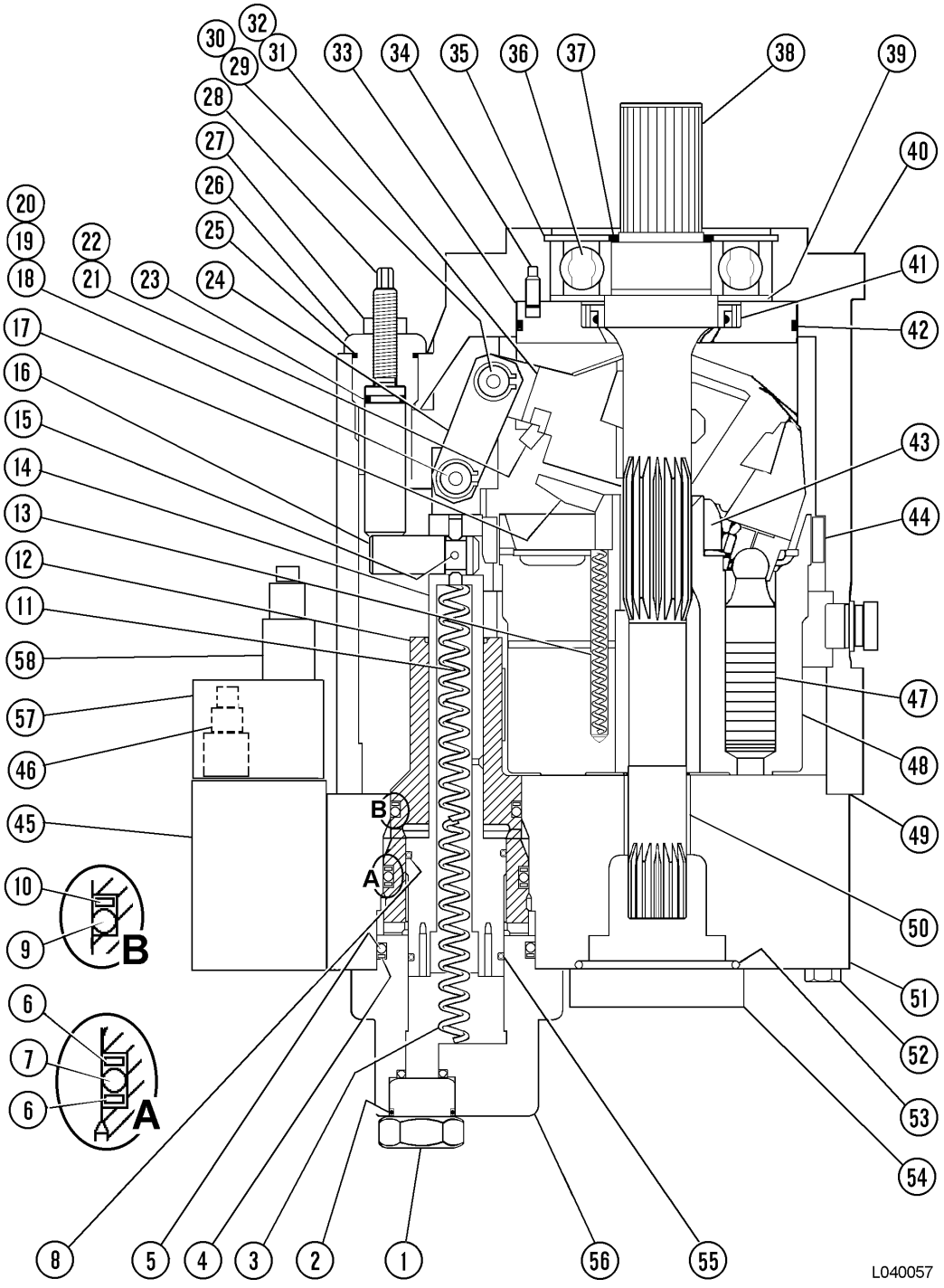


FIGURE 4-9. CUT-AWAY VIEW OF STEERING PUMP

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PRINCIPLE OF OPERATION

Full Pump Volume:

Control piston (1, Figure 4-10) controls the angle of the swashblock (4). When the control piston moves to the full right position, the pump is at maximum pumping capacity.

The driveshaft turns the splined housing (2) which contains the pumping pistons (3). When the housing is rotated, the pistons move in and out of their bores and the piston shoes “ride” against the angled swashblock (4).

As the cylinder rotates, the individual piston bores are connected, alternately to the left (port A) and right (port B) crescent shaped ports in the valve plate. While connected to left side (suction) port A, each piston moves outward, drawing fluid from port A into the piston bore until its outermost stoke is reached. At that point the piston bore passes from the left crescent port to the right crescent port.

While rotating across the right side crescent, each piston moves downward on the angled swashblock face. Thus, each piston is forced inward. Each piston displaces fluid through the right side crescent to port B until it's innermost stroke is reached. At that point, the piston bore again passes from the right to the left side crescent and the operating cycle is repeated.

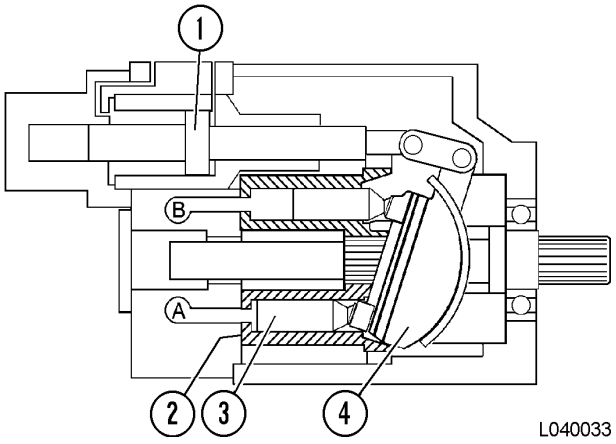


FIGURE 4-10. PUMP AT FULL VOLUME

1. Control Piston
2. Housing
3. Piston
4. Swashblock

Half Pump Volume:

Figure 4-11 shows that the position of the control piston (1) is near the center of its travel. The swashblock is not angled as steep as before, and therefore the pistons have a shorter stroke. As the piston stroke gets shorter, the pump output also decreases.

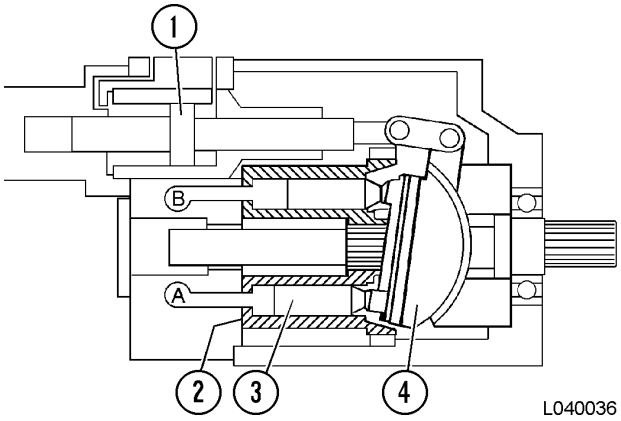


FIGURE 4-11. PUMP AT HALF VOLUME

1. Control Piston
2. Housing
3. Piston
4. Swashblock

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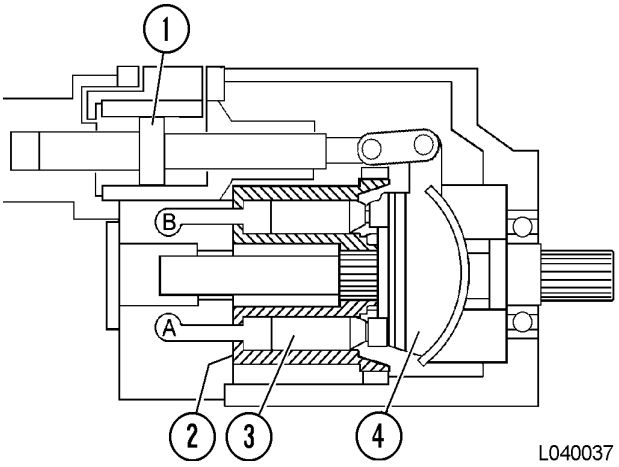


FIGURE 4-12. PUMP IN NEUTRAL POSITION

1. Control Piston
2. Housing
3. Piston
4. Swashblock

Neutral Position:

Neutral position (Figure 4-12) results when the control piston (1) centers the swashblock (4). The swashblock angle is now zero and swashblock face is now parallel to cylinder face. Therefore, no inward or outward motion of the pump pistons exists as piston shoes rotate around the swashblock face. The lack of inward and outward motion results in no fluid being displaced from the piston bores to the crescents in the valve plate and subsequently no delivery from pump ports.

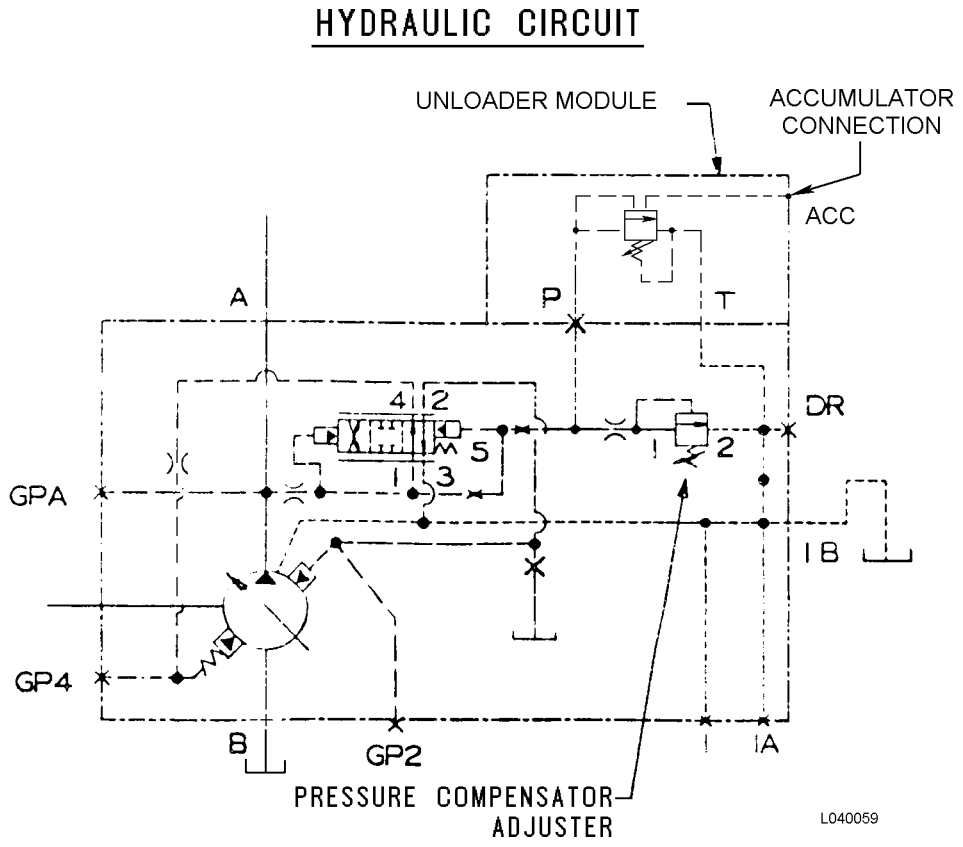


FIGURE 4-13. STEERING PUMP HYDRAULIC SCHEMATIC

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NOTES

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STEERING CIRCUIT COMPONENT REPAIR

BLEED DOWN MANIFOLD

Removal

NOTE: The Bleed Down Manifold may not have to be removed from the truck to replace components. If problem area has been isolated simply remove defective components and replace with new.

⚠WARNING

Relieve pressure before disconnecting hydraulic and other lines. Tighten all connections before applying pressure.
Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury and possibly death if proper medical treatment by a physician familiar with this injury is not received immediately.

1. Turn keyswitch “Off” and allow 90 seconds for the accumulators to bleed down.
2. Disconnect wires at the bleed down solenoid (1, Figure 5-1) and steering pressure switch.
3. Disconnect, identify and plug each hydraulic line to prevent contamination.
4. Remove mounting capscrews and remove the bleed down manifold (10).
5. Clean exterior of manifold before removing any components.

Installation

1. Install bleed down manifold. Secure in place with capscrews. Tighten capscrews to standard torque.
2. Unplug lines and attach. Tighten connections securely.
3. Attach electrical leads to the bleed down solenoid and steering pressure switch. If check valves or relief valves were removed, replace using new O-ring seals.
4. Start the engine and check for proper operation and leaks. Check steering and brake application.

NOTE: Adjustment of the relief valves is not necessary or recommended. Relief valves are factory preset. Do not attempt to rebuild or repair if relief valves are defective. Replace as a unit. The steering pressure switch and check valves are also replaced only as units.

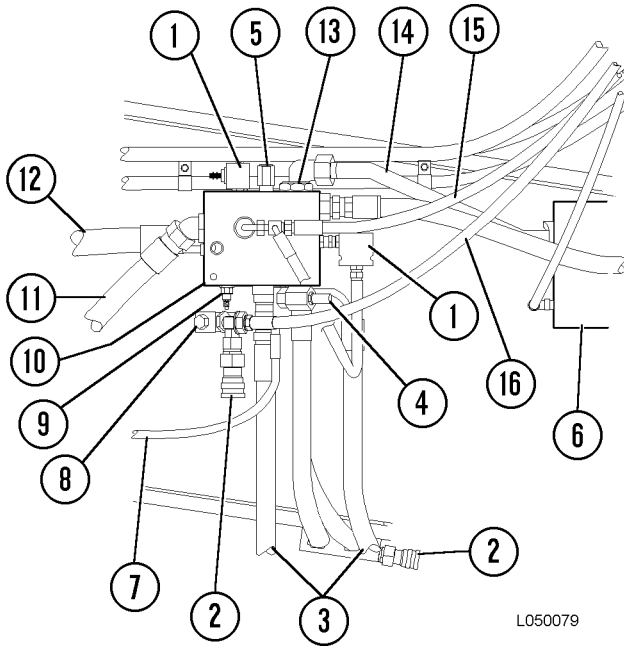


FIGURE 5-1. BLEED DOWN MANIFOLD

1. Bleed Down Solenoid
2. Brake Quick Disconnect
3. Accumulator Supply
4. Low Steering Pressure Switch
5. Return Relief Valve (500 psi)
6. Flow Amplifier
7. Unloader Valve Line
8. Check Valve
9. Relief Valve (4000 psi)
10. Bleed Down Manifold
11. Return Line
12. From Steering Filter
13. Check Valve (Piloted)
14. Outlet To Flow Amplifier
15. Hoist Pilot Valve Return Line
16. Supply to Brakes

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ACCUMULATOR

Removal

⚠WARNING

Relieve pressure before disconnecting hydraulic and other lines. Tighten all connections before applying pressure. Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury and possibly death if proper medical treatment by a physician familiar with this injury is not received immediately.

1. Turn keyswitch “Off” and allow 90 seconds for the accumulators to bleed down. Turn the steering wheel to be certain no oil remains in the accumulator.
2. Remove Guard (5, Figure 5-3).

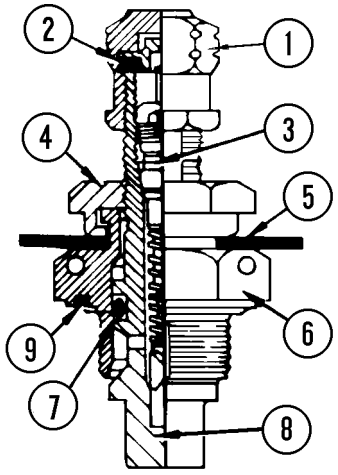


FIGURE 5-2. CHA

1. Valve Cap
2. Seal
3. Valve Core
4. Swivel Nut (Small Hex Nut)
5. Rubber Washer
6. Valve Body (Large Hex Nut)
7. O-Ring
8. Valve Stem
9. O-Ring

⚠WARNING

Make certain only the small swivel hex nut (4, Figure 5-2) turns. Turning the complete charging valve assembly may result in the valve assembly being forced out of the accumulator by the nitrogen pressure inside. Wear protective face mask when discharging nitrogen gas.

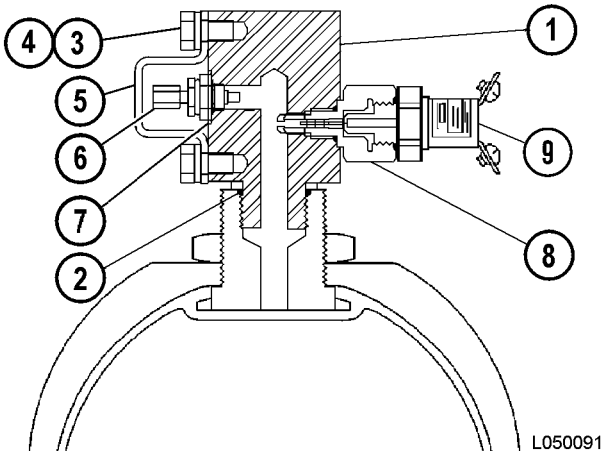


FIGURE 5-3. ACCUMULATOR VALVES

1. Valve Manifold
2. O-Ring
3. Capscrew
4. Lockwasher
5. Guard
6. Cap
7. Flat Gasket
8. Valve Assembly
9. Pressure Switch

3. Loosen small hex nut (4, Figure 5-2) three complete turns. Remove valve cap (1). Depress the valve stem until all nitrogen pressure has been relieved.
4. Disconnect electrical leads at the pressure switch located on top of the accumulator.
5. Disconnect and plug the hydraulic line (3, Figure 5-4) at the bottom of the accumulator.
6. Connect a lifting device to the top section of the accumulator and take up slack.

⚠WARNING

The accumulator weighs approximately 310 lbs. (140 Kg). Use a suitable lifting device that can handle the load safely.

7. Remove the capscrews, flatwashers and locknuts on the clamps (2, Figure 5-4) securing the accumulator to the mounting bracket.
8. Lift accumulator clear of the mounting bracket and move to a clean work area for disassembly.
9. Clean exterior of accumulator before starting disassembly.

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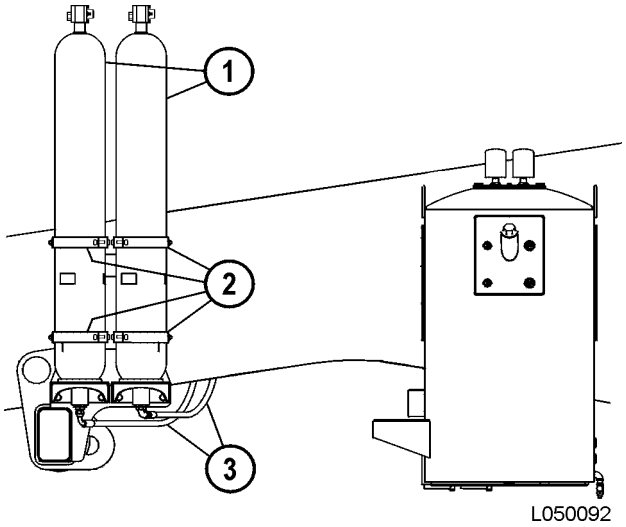


FIGURE 5-4. ACCUMULATOR MOUNTING

1. Accumulators
2. Clamps
3. Hoses (to Bleed-down Manifold)

Installation

⚠WARNING

The accumulator weighs approximately 310 lbs. (140 Kg). Use a suitable lifting device that can handle the load safely.

1. Attach a lifting device to the top section of the accumulator. Accumulator should be positioned in the lower mounting bracket with the anti-rotation block positioned between the two stop blocks.
2. Install mounting clamps (2, Figure 5-4) and secure in place using capscrews, locknuts and flatwashers. Tighten capscrews securely, but do not overtighten as this may distort the accumulator wall.
3. If the pressure switch (9, Figure 5-3) or valve assembly (8) were removed, install at this time. Connect electrical leads to the pressure switch. Using a new O-ring, uncap and connect the hydraulic line to the accumulator.
4. Precharge the accumulator with pure dry nitrogen to 1400 psi (9653 kPa) as outlined in the “Steering Accumulator Charging Procedure”.

NOTE: Permanent damage to accumulator bladder will result if engine is started without accumulators properly precharged.

Disassembly

1. Once the accumulator has been removed from the equipment, the accumulator body should be secured in a vise, preferably a chain vise. If a standard jaw vise is used, brass inserts should be used to protect the hydraulic port assembly from damage. Clamp on wrench flats only when using a jaw vise to prevent accumulator from turning.
2. Remove bleeder plug (12, Figure 5-5) on hydraulic port assembly. Using a spanner wrench, remove locking ring (10) from the hydraulic port assembly. Use an adjustable wrench on the flats located on the port assembly to prevent port assembly from rotating.
3. Remove spacer (9), then push the hydraulic port assembly into the shell prior to Step 4.
4. Insert hand into the accumulator shell and remove the O-Ring backup (8), O-Ring (7), and metal backup washer (6). Separate the anti-extrusion ring from the hydraulic port. Fold anti-extrusion ring to enable removal of anti-extrusion ring from shell.
5. Remove hydraulic port from accumulator shell.
6. Secure bladder valve stem from twisting with an appropriate wrench applied to the valve stem flats and remove gas valve manifold (14). Then remove nut (5) while still holding bladder valve stem from turning.
7. Fold bladder and pull out of accumulator shell. A slight twisting motion while pulling on the bladder reduces effort required to remove bladder from shell. If bladder is slippery, hold with a cloth.

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 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.

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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.

⚠DANGER

Repair of the housing by welding, machining or plating to salvage a worn area is NOT APPROVED. These procedures may weaken the housing and result in serious injury to personnel when pressurized.

Assembly

Assemble the accumulator in a dust and lint free area. Maintain complete cleanliness during assembly to prevent possible contamination.

1. After shell (4, Figure 5-5) has been cleaned and inspected, place accumulator shell in vise or on table.
2. Thoroughly coat the inside of the accumulator shell with a liberal amount of clean hydraulic oil to lubricate and cushion the bladder. Make sure the entire internal of the shell is lubricated.
3. With all gas completely exhausted from bladder, collapse bladder and fold longitudinally in a compact roll.
4. Insert the bladder pull rod into the valve stem opening and out through the shell fluid port. Attach the bladder pull rod to the bladder valve stem.
5. With one hand, pull the bladder pull rod while feeding the bladder into the shell with the other hand. Slight twisting of bladder will assist in this insertion.
6. Once the bladder valve stem has been pulled through the valve stem opening in the shell, install the valve stem nut (5) by hand. Once the valve stem nut is in place, remove the bladder pull rod.

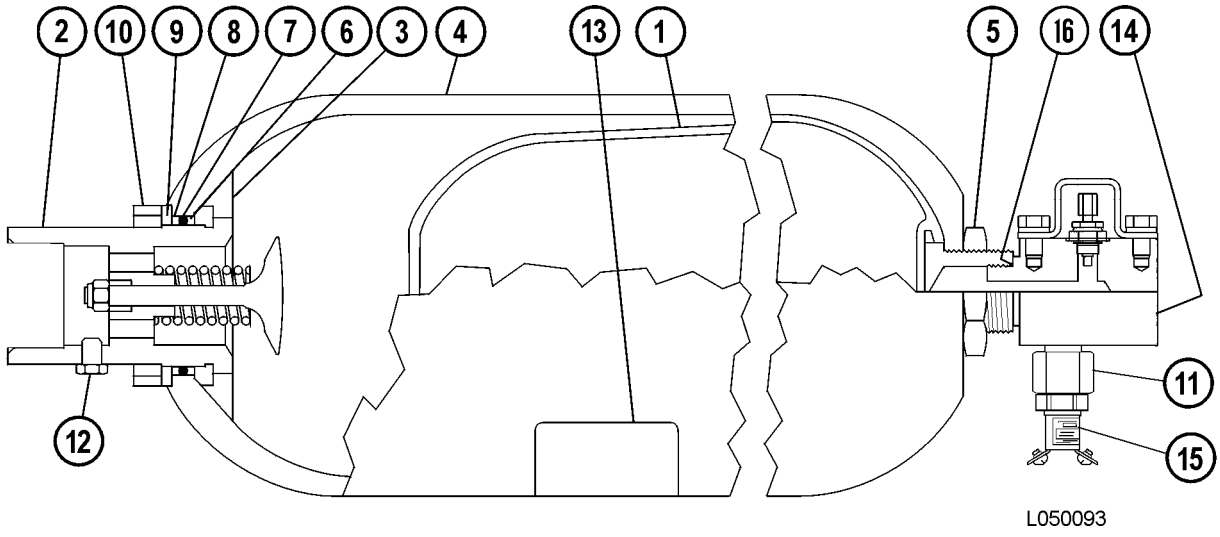


FIGURE 5-5. ACCUMULATOR ASSEMBLY

1. Bladder Assembly
2. Hydraulic Port Assembly
3. Anti Extrusion Ring
4. Shell
5. Nut
6. O-Ring Back-Up (Metal)
7. O-Ring
8. O-Ring Back-Up
9. Spacer
10. Locking Ring
11. Valve Assembly
12. Bleed plug
13. Warning Plate
14. Gas Valve Manifold
15. Pressure Switch
16. O-Ring

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7. Hold bladder valve stem on the flats with a wrench and tighten nut (5) securely.
8. If removed, install pressure switch (15), valve assembly (11) and charging valve onto gas valve manifold (14). Install new O-Ring (16) on gas valve manifold (14). Hold bladder valve stem with wrench and install gas valve manifold (14) and tighten securely.
9. Holding the hydraulic port assembly (2) by the threaded end, insert the poppet end into the shell fluid port. Lay complete assembly in side shell.
10. Fold anti-extrusion ring (3) to enable insertion into the shell. Once the anti-extrusion ring has cleared the fluid port opening, place the anti-extrusion ring on the hydraulic port assembly with the steel collar facing toward the shell fluid port.
11. Pull the threaded end of the port assembly through the shell fluid port until it seats solidly into position on the shell fluid port opening.
12. Connect nitrogen charging kit to charging valve. With hydraulic port assembly firmly in place, slowly pressurize the bladder using dry nitrogen with sufficient pressure (approximately 40-50 psi) to hold port assembly in place so both hands are free to continue with assembly.
13. Install the metal O-Ring backup washer (6) over hydraulic port assembly and push into the shell fluid port to bottom it out on anti-extrusion ring.
14. Install O-ring (7) over hydraulic port assembly and push it into the shell fluid port until it has bottomed out against the metal O-Ring backup washer (6).

⚠CAUTION

Do not twist O-ring.

15. Install O-ring back-up (8) over hydraulic port assembly an push until it bottoms against O-ring
16. Insert spacer (9) with the smaller diameter of the shoulder facing the accumulator shell.
17. Install the locking ring (10) on the hydraulic port assembly and tighten securely. This will squeeze the O-ring into position. Use appropriate wrench on flats on port assembly to insure the unit does not turn.
18. Install bleeder plug (12) into the hydraulic port assembly.
19. Precharge accumulator to 100 - 120 psi (690 - 827 kPa). Refer to “Steering Accumulator Charging Procedure” for details. After precharging, install plastic cover over hydraulic port to prevent contamination. Do not use a screw-in type plug.

⚠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 in case of leaks.

NOTE: Bladder accumulators should be stored with 100 - 120 psi (690 - 827 kPa) precharge, which fully expands the bladder, and holds oil against the inner walls for lubrication and to prevent rust formation.

TESTING

To carry out the testing required, it will be necessary to check for internal and external leaks at high pressure. A source of 3500 psi (24132 kPa) hydraulic pressure and nitrogen pressure of 1400 psi (9653 kPa) will be required. A small water tank will be necessary for a portion of the test.

1. Remove charging valve guard and charging valve cap.
2. Close bleed valve.
3. Attach gauging assembly to charging valve and tighten swivel nut (10-15 in.lb) (11.5 -17 cm kg).
4. Hold valve body (6, Figure 5-6) with one wrench while unscrewing swivel nut (4) with a second wrench. This will open the poppet inside the gas valve.

Note: Four turns will fully open poppet.

5. SLOWLY charge accumulator to 100 psi (690 kPa). After 100 psi is obtained, charging rate can be increased until fully charged at 1400 psi.
6. Tighten swivel nut (4) to close internal poppet (10-15 in. lb.) (11.5 -17 cm kg).
7. Submerge accumulator assembly under water and observe for 20 minutes. No leakage (bubbles) is permitted. If leakage is present, go to Step 14.
8. Hold charging valve (6) with a wrench and remove swivel nut assembly.
9. Replace cap on charging valve (10-15 in. lb.) (11.5-17 cm kg) and install gas valve guard.

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10. Connect a hydraulic power supply to the oil port on the accumulator. Be sure bleed plug (12, Figure 5-5) is installed.
11. Pressurize accumulator with oil to 3,500 psi (24132 kPa). This may take 6-8 gallons of oil.
12. No external oil leakage is permitted.
13. Slowly relieve oil pressure and remove hydraulic power supply. Install plastic cover over hydraulic port to prevent contamination.
14. If any gas or oil leakage was present, discharge all nitrogen gas using the charging equipment and repair as necessary. If there were no leaks of any kind, then use the nitrogen charging equipment and adjust nitrogen precharge pressure to 100 - 120 psi (690 - 827 kPa).

⚠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 in case of leaks.

15. Verify all warning and caution labels are attached and legible. Refer to parts book if replacements are required.

STEERING ACCUMULATOR CHARGING PROCEDURE

⚠WARNING

Do not loosen or disconnect any hydraulic line or component until engine is stopped and key switch has been "Off" for at least 90 seconds.
Pure dry nitrogen is the only gas approved for use in the steering accumulator. The accidental charging of oxygen or any other gas in this compartment may cause an explosion. Be sure pure dry nitrogen gas is being used to charge the accumulator.
When charging or discharging nitrogen gas in the accumulator, be sure the warning labels are observed and the instructions regarding the charging valve are carefully read and understood.
Only precharge accumulators to 1400 psi (9653 kPa) while installed on the truck. Never handle accumulator with lifting equipment with a nitrogen precharge of 1400 psi (9653 kPa). Always set precharge to 100 - 120 psi (690 - 827 kPa) before handling (removing or installing) accumulators.

NOTE: If one accumulator is low on nitrogen, it is recommended that both accumulators be checked/ charged at the same time.

1. With engine shut down and key switch in the "Off" position, allow at least 90 seconds for the accumulator to bleed down. Turn the steering wheel to be certain no oil remains in accumulator under pressure.
2. Remove charging valve cover. Be certain oil pressure has been relieved, then remove bleed plug (12, Figure 5-5).

NOTE: On the front accumulator, bleed plug (12) must be removed during charging procedure to insure there is no trapped oil or air inside accumulator which will affect the nitrogen precharge pressures. If only the rear most accumulator is being charged, both brake accumulator bleed down valves can be opened instead of removing bleed plug (12).

⚠WARNING

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

3. Remove charging valve cap (1, Figure 5-6). Turn small swivel hex nut (4) three complete turns counterclockwise.
4. If a loss in nitrogen pressure is the reason for recharging, inspect the charging valve and accumulator for damage. Replace or repair items, as necessary, before charging procedure.
5. Connect the nitrogen charging kit to the charging valves.
   a. If the nitrogen precharge is to be bled off, open the needle valve and slowly bleed off the pressure.
   b. If the precharge is 0 psi, open the regulator and SLOWLY charge until the bladder is fully expanded (approximately 100 psi, 690 kPa). Once the bladder is fully expanded, the charging rate can be increased.

NOTE: The bladder could be permanently damaged if it is charged too quickly before it is fully expanded.

   c. If the precharge is already above 100 psi (690 kPa), open the regulator and charge the accumulator to 1400 psi (9653 kPa).

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NOTE: When charging the accumulators, allow adequate time for the system to fully charge and for the nitrogen gas temperature to stabilize (10-15 minutes).

6. Shut off charging kit and check pressure gauge reading. If gauge does not maintain 1400 psi (9.8 MPa) continue charging procedure until pressure is stabilized.

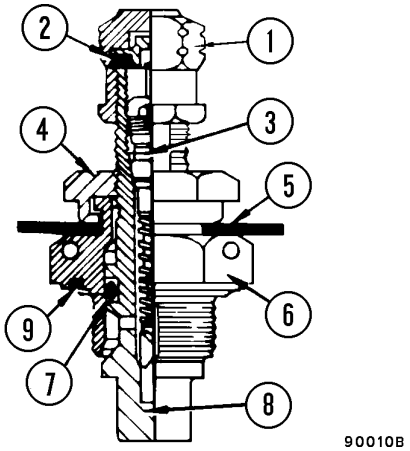


FIGURE 5-6. CHARGING VALVE

1. Valve Cap
2. Seal
3. Valve Core
4. Swivel Nut (Small Hex Nut)
5. Rubber Washer
6. Valve Body (Large Hex Nut)
7. O-Ring
8. Valve Stem
9. O-Ring

7. Install bleed plug(s) (12, Figure 5-5). If opened, close brake accumulator bleed down valves.
8. Remove the charging kit and tighten small hex nut (4, Figure 5-6) on charging valve to **4 ft. lbs. (5.4 N.m)** torque.

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

a. Tighten small hex swivel nut (4, Figure 5-6) to **10.5 ft. lbs. (14.2 N.m)** torque.

b. Loosen small hex swivel nut.

c. Retighten small hex swivel nut to **10.5 ft. lbs. (14.2 N.m)** torque.

d. Again, loosen small hex swivel nut.

e. Finally, tighten small hex swivel nut to **4 ft. lbs. (5.4 N.m)** torque.

9. Install charging valve cap (1) and tighten finger tight. Install charging valve cover and tighten capscrews to **25 ft. lbs. (40 N.m)** torque.
10. Operate truck and check steering for normal operation.

FLOW AMPLIFIER

Removal

⚠WARNING

Relieve pressure before disconnecting hydraulic and other lines. Tighten all connections before applying pressure.
Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury and possibly death if proper medical treatment by a physician familiar with this injury is not received immediately.

1. Turn keyswitch “Off” and allow 90 seconds for the accumulators to bleed down. Turn steering wheel to make sure no oil under pressure remains. Disconnect, plug, and identify each hydraulic line.
2. Support the flow amplifier valve and remove the mounting capscrews. Remove valve.
3. Move valve to a clean work area for disassembly.

Installation

1. Support the flow amplifier and move into position.
2. Install mounting capscrews and tighten to standard torque.
3. Identify hydraulic line location, unplug lines and connect at proper location, tighten fittings securely. Use new O-rings on the flange fittings.

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Disassembly

NOTE: The flow amplifier valve is a precision unit manufactured to close tolerances, therefore complete cleanliness is a must when handling the flow amplifier valve. Work in a clean area and use lint free wiping materials or dry compressed air. Use a wire brush to remove foreign material and debris from around the exterior of the valve before disassembly. Clean solvent and type C-4 hydraulic oil should be used to insure cleanliness and initial lubrication.

1. Remove counter pressure valve plug (17, Figure 5-7), and O-ring (16). Remove counter pressure valve assembly (15).

NOTE: As parts are removed, they should be laid out in a group in the same order in which they are removed.

2. Remove relief valve plug (18) and seal (19). Using an 8 mm hex head allen wrench, remove the relief valve assembly (20). Remove steel seal (21).
3. Remove capscrew (37) and capscrews (36) using a 10 mm and 13 mm hex head allen wrench. Remove lockwashers (38 & 39). Remove end cover (47).
4. remove spring stop (41) and spring (42). Remove spring stop (34) and springs (32 & 33). Remove O-rings (40 & 49).
5. Remove spring control (31) and main spool (29). Remove priority valve spool (43). Remove spring control (25), springs (23 & 24) and spring stop (22).
6. Remove amplifier valve spool assembly (51). Set amplifier valve spool assembly aside for further disassembly, if required.
7. Remove shock and suction valve (28). Set shock and suction valve aside for further disassembly, if required.
8. Remove capscrews (1 & 3) using a 10 mm and 13 mm hex head allen wrench. Remove lockwashers (2 & 4). Remove end cover (5).
9. Remove O-rings (6, 7 & 8) and spring (55).
10. Remove shock and suction valve assembly (12). Set the shock and suction valve aside for further disassembly, if required. Remove orifice screw (13).
11. Remove orifice screw (53). Remove check valve (54).

FIGURE 5-7. FLOW AMPLIFIER VALVE

1. Capscrew
2. Lockwasher
3. Capscrews
4. Lockwasher
5. Cover
6. O-Ring
7. O-Ring
8. O-Ring
9. Not Used
10. O-Ring
11. O-Ring
12. Shock/Suction Valve (Complete)
13. Orifice Screw
14. Valve Housing
15. Counterpressure Valve (Complete)
16. O-Ring
17. Plug
18. Plug
19. Seal
20. Relief Valve (Complete)
21. Steel Seal
22. Stop
23. Spring
24. Spring
25. Spring Control
26. Orifice Screw
27. O-Ring
28. Shock/Suction Valve (Complete)
29. Main Spool
30. O-Ring
31. Spring Control
32. Spring
33. Spring
34. Spring Stop
35. Orifice Screw
36. Capscrews
37. Capscrew
38. Lockwasher
39. Lockwasher
40. O-Rings
41. Stop
42. Spring
43. Spool
44. Name Plate
45. Orifice Screw
46. Spring
47. Cover
48. Pins
49. O-Rings
50. Not Used
51. Amplifier Spool Assembly (Complete)
52. O-Ring
53. Orifice Screw
54. Check Valve
55. Spring

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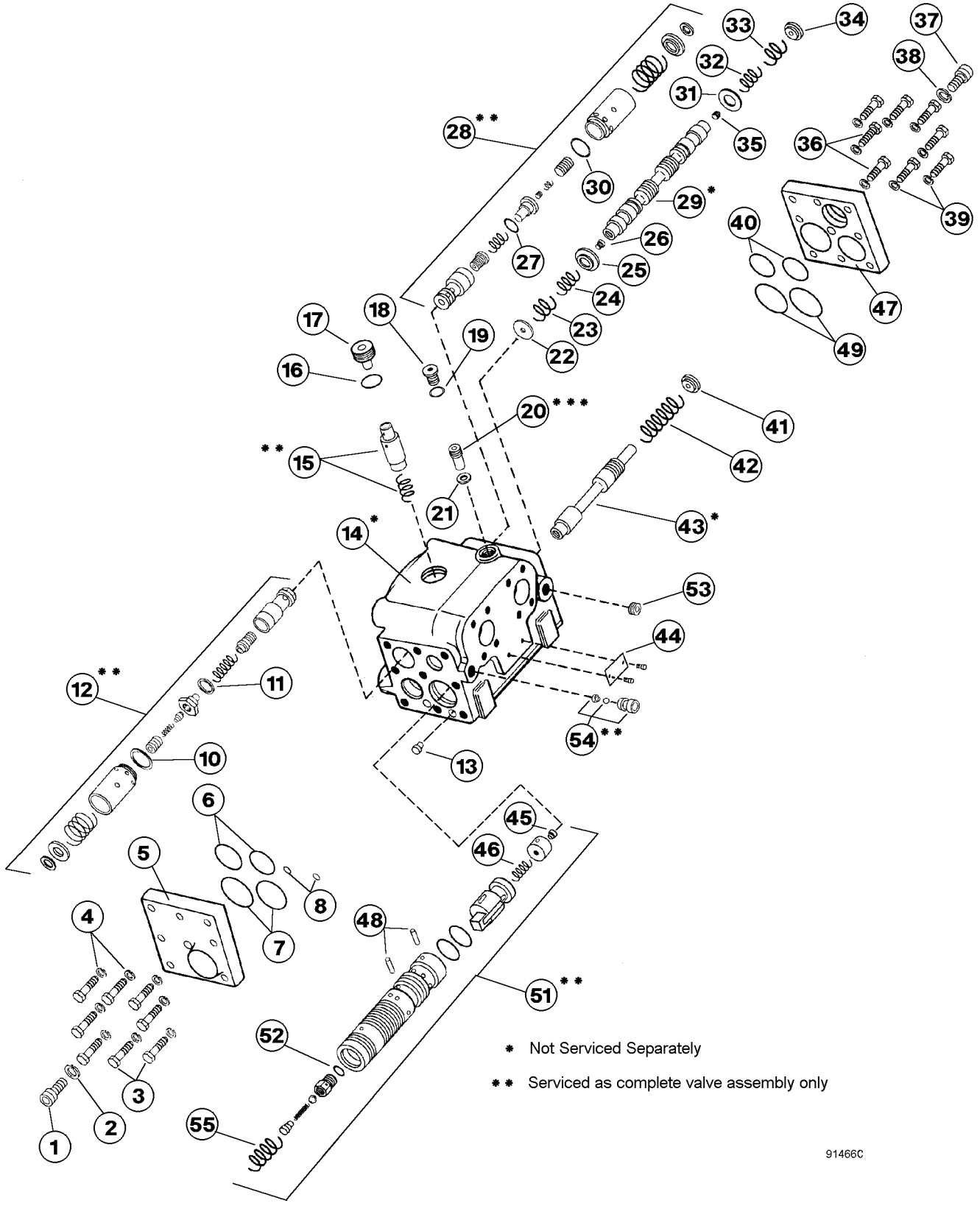


FIGURE 5-7 FLOW AMPLIFIER VALVE

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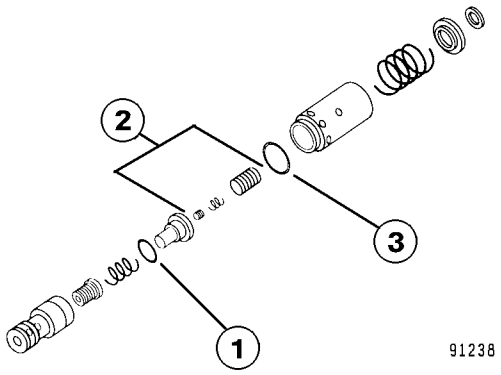


FIGURE 5-7. SHOCK AND SUCTION VALVE ASSEMBLY

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

NOTE: If further disassembly is required for the shock and suction valves refer to Figure 5-8.

NOTE: The flow amplifier valve is equipped with two shock and suction valves and they are identical. The shock and suction valves are only serviced as complete valve assemblies. O-rings 1 & 3, Figure 5-8 are replaceable. Relief valve (20, Figure 5-7) check valve (54) and counter pressure valve (15) are also serviced only as assemblies.

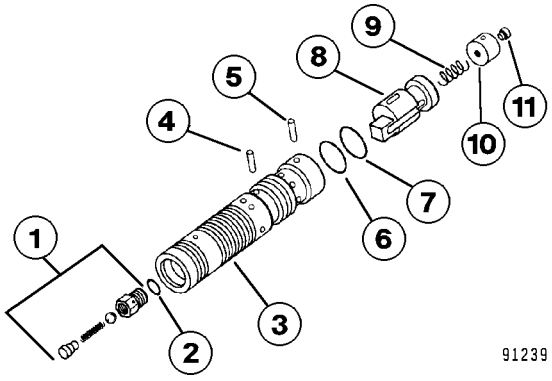


FIGURE 5-8. AMPLIFIER SPOOL ASSEMBLY

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

NOTE: Disassembly of the amplifier spool assembly is only necessary should O-ring (2, Figure 5-9), spring (9) or orifice screw (11) require replacement, otherwise replace the amplifier spool assembly as a complete unit. For complete disassembly refer to steps 12 & 13.

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

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Reassembly

1. Thoroughly lubricate each part prior to installation using clean, type C-4 hydraulic oil.
2. Reassemble the Amplifier spool assembly in reverse order. Refer to steps 12 & 13, and Figure 5-9 under disassembly.
3. Install orifice screw (13, Figure 5-7). Tighten orifice screw to **4 in. lbs. (.5 N.m).** Install check valve (54). Tighten check valve to **8 in. lbs. (1 N.m).** Install orifice screw (53). Tighten orifice screw to **8 in. lbs. (1 N.m)** torque.
4. Install seal (21). Install relief valve assembly (20), seal (5), and plug (20). Tighten plug to **22 in. lbs. (2.5 N.m)** torque.
5. Install counterpressure valve assembly (15). Install plug (17) using new O-ring (16).
6. Install both shock and suction valves (12 & 28) as complete units. Install spring stop (22) springs (23 & 24) and spring control (25). Install orifice screws (26 & 35) if removed from main spool (29). Install main spool (29).
7. Install amplifier spool assembly (51). Install priority valve spool (43) and spring (42). Install spring (55).
8. Install spring control (31), springs (32 & 33) and spring stop (34).
9. Lubricate O-rings (6, 7 & 8) with molycote grease and position on cover (5). Install end cover (5). Install capscrews (3) with lockwashers (4). Tighten capscrews to **2 ft. lbs. (2.5 N.m)**. Install capscrew (1) and lockwasher (2). Tighten capscrew to **6 ft. lbs. (8 N.m)** torque.
10. Lubricate O-rings (40 & 49) with molycote grease and install on cover (47). Install end cover (47). Install capscrews (36) with lockwashers (39). Tighten capscrews to **2 ft. lbs. (2.5 N.m)**. Install capscrew (37) with lockwasher (38). Tighten capscrew to **6 ft. lbs. (8 N.m)** torque.
11. To help prevent contamination during storage or installation, install plastic plugs in each valve port.

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STEERING CONTROL UNIT

Removal

⚠WARNING

Relieve pressure before disconnecting hydraulic and other lines. Tighten all connections before applying pressure. Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury and possibly death if proper medical treatment by a physician familiar with this injury is not received immediately.

1. Turn keyswitch “Off” and allow 90 seconds for the accumulators to bleed down. Turn steering wheel to ensure no oil remains under pressure.
2. Remove capscrews and lockwashers securing the steering control unit access cover in place (Access cover is located on the front side of the operator's cab.) Remove access cover.

NOTE: Clean the steering control unit and surrounding area carefully to help avoid contamination of hydraulic oil when lines are opened.

3. Tag all hydraulic lines for proper identification during installation. Disconnect hydraulic lines (3, 4, 5, 6, & 7, Figure 5-10) at steering control unit (2) ports and plug. Move lines clear of valve.
4. Remove the four mounting capscrews, flatwashers and lockwashers securing the steering control unit to the mounting bracket. Remove the steering control unit.
5. Place the steering control unit in a clean work area for disassembly.

Spline Inspection

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

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

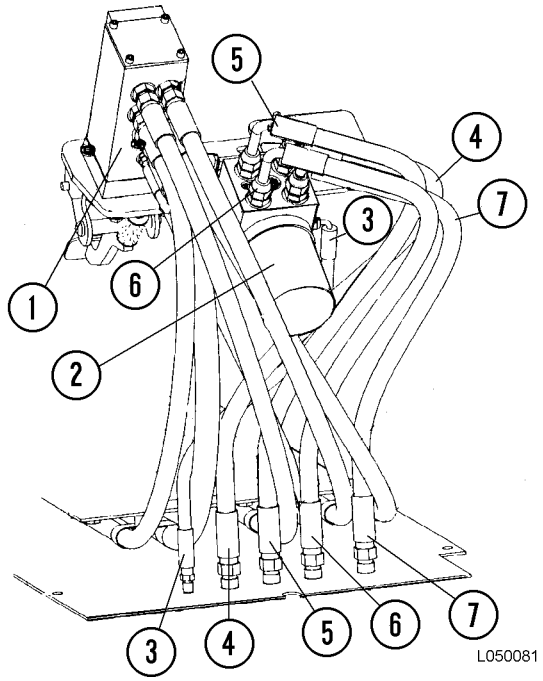


FIGURE 5-9. STEERING CONTROL UNIT

1. Brake valve
2. Steering Control Unit
3. “LS” Port Hose
4. “L” Port Hose
5. “T” Port Hose
6. “P” Port Hose
7. “R” Port Hose

Installation

1. Lubricate splines of steering column shaft with a molybdenum disulphide or multi-purpose NLGI grease.
2. Move steering control unit into position and align with steering column shaft splines. Secure the steering control unit in place using four capscrews, flatwashers and lockwashers.
3. Check for proper steering wheel rotation without binding. Be certain wheel returns to neutral after rotating 1/4 turn left and right. If necessary, adjust steering unit and/or steering column to realign column and control unit.

⚠WARNING

Serious personal injury to the operator or to anyone positioned near the front wheels may occur if a truck is operated with the hydraulic steering lines improperly installed. Improperly installed lines can result in uncontrolled steering and/or SUDDEN AND RAPID rotation of the steering wheel as soon as the steering wheel is moved. It will turn rapidly and cannot be stopped manually.

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⚠WARNING

After servicing the steering control unit, hydraulic steering lines should be checked for correct hook-up before starting the engine.

4. Tighten all capscrews to standard torque. Unplug and attach hydraulic lines to their proper ports. Refer to Figure 5-10 for port locations.
5. Start engine and check for proper steering function and any leaks.
6. Replace access cover and secure in place with capscrews and lockwashers.

Disassembly

⚠IMPORTANT⚠

The steering control unit is a precision unit manufactured to close tolerances, therefore complete cleanliness is a must when handling the valve assembly. Work in a clean area and use lint free wiping materials or dry compressed air. Clean type C-4 hydraulic oil should be used during reassembly to insure initial lubrication.

1. Allow oil to drain from valve ports.
2. Match mark gear wheel set and end cover to insure proper relocation during reassembly. Refer to Figure 5-11.

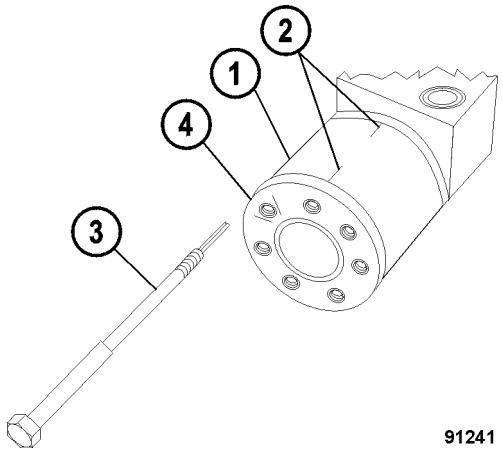


FIGURE 5-10. DISASSEMBLY PREPARATION

1. Valve Assembly
2. Match Marks
3. Capscrew with Pin
4. End Cover

3. Remove end cover capscrews and washers. Remove capscrew with rolled pin (3, Figure 5-11). Mark hole location of capscrew with rolled pin on end cover to facilitate reassembly.
4. Remove end cover (4) and O-ring (2, Figure 5-12).
5. Remove outer gear of gear wheel set (1) and O-ring between gear set and distribution plate.
6. Lift inner gear off cardan shaft.
7. Remove cardan shaft (11, Figure 5-18), distribution plate (15) and O-ring (14).
8. Remove threaded bushing (4) and ball (3).
9. With valve housing positioned with the spool and sleeve vertical, carefully lift spool assembly out of housing bore.

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

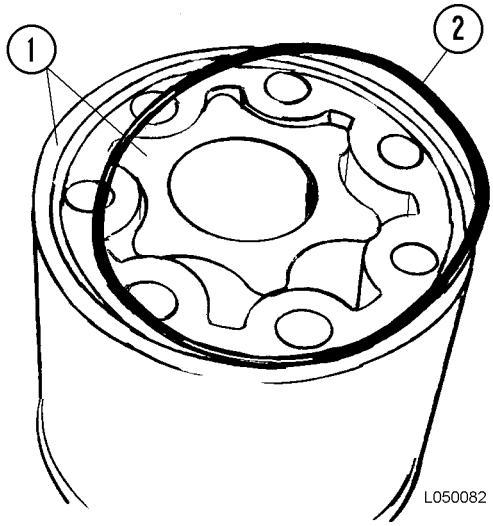


FIGURE 5-11. COVER END O-RING

1. Gear Wheel Set
2. O-Ring

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

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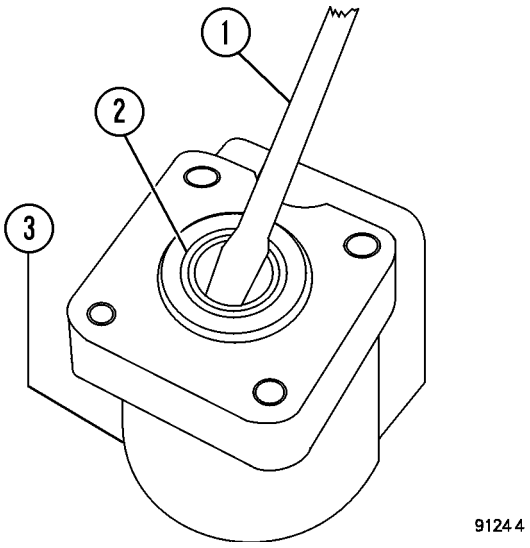


FIGURE 5-12. SEAL REMOVAL

1. Screwdriver
2. Dust Seal
3. Housing

Cleaning and Inspection

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

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

Assembly

NOTE: When assembling the spool and sleeve, only one of the two possible matching positions of the spring slots can be used. The reason is that in the other end of the sleeve and spool (opposite end of the spring slots) there are three slots in the spool and three holes in the sleeve. These must be opposite each other on assembly so that the holes are partly visible through the slots in the spool, refer to Figure 5-14.

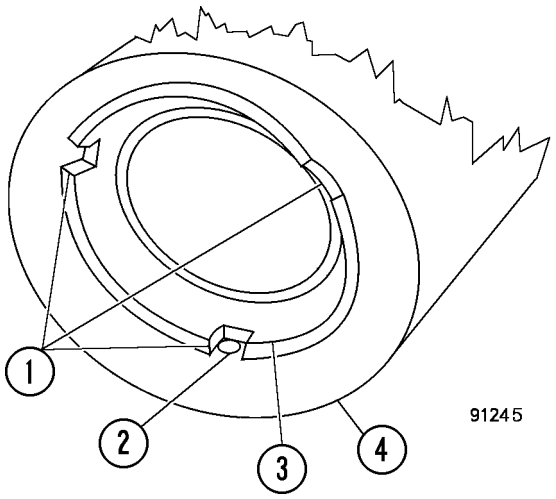


FIGURE 5-13. SPOOL AND SLEEVE ASSEMBLY

1. Slots
2. Hole
3. Spool
4. Sleeve

1. To install the neutral position springs, place a screwdriver in the spool slot as shown in Figure 5-15.
2. Place one flat neutral position spring on each side of the screwdriver blade. Do not remove screwdriver.
3. Push two curved neutral position springs in between one side of the screwdriver blade and a flat spring. Repeat for the opposite side. Remove the screwdriver.
4. Slide the inner spool in the sleeve. Compress the ends of the neutral position springs and push the neutral position springs in place in the sleeve.
5. Install the cross pin (9, Figure 5-18).

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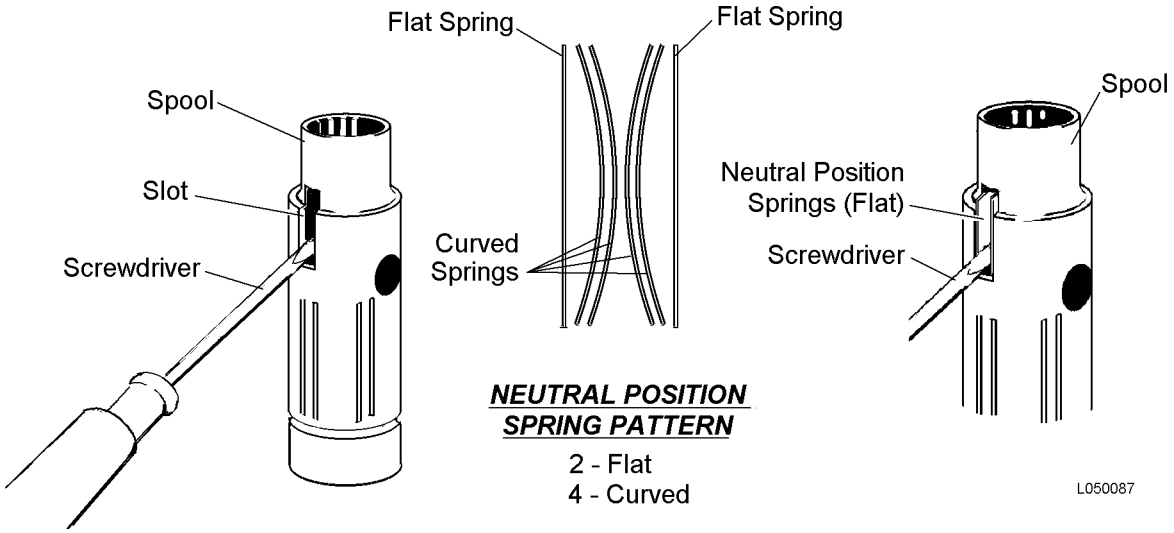


FIGURE 5-14. NEUTRAL POSITION SPRING INSTALLATION

6. With neutral position springs (7, Figure 5-16) centered in spool and sleeve, install ring (3), rear bearing race (4), thrust bearing (5) and front bearing race (6) in that order. **The chamfer on the rear bearing race must be facing away from the bearing.**

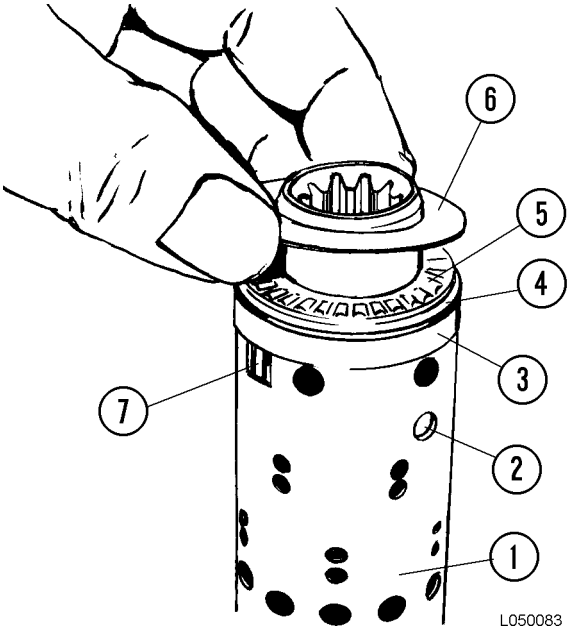


FIGURE 5-15. BEARING INSTALLATION

1. Sleeve
2. Cross Pin
3. Ring
4. Bearing Race (with chamfer)
5. Thrust Bearing
6. Bearing Race
7. Neutral Position Springs

7. Place the dust seal (1, Figure 5-18) in position. Using a flat iron block over the seal, tap into position.
8. Position the O-ring and kin ring on the spool.
9. Position the steering unit with the housing horizontal. Slowly guide the (lubricated) spool and sleeve with fitted parts, into the bore using light turning movements. Refer to Figure 5-17.

NOTE: Cross pin must remain horizontal when spool and sleeve are pushed into bore to prevent pin from dropping out of spool.

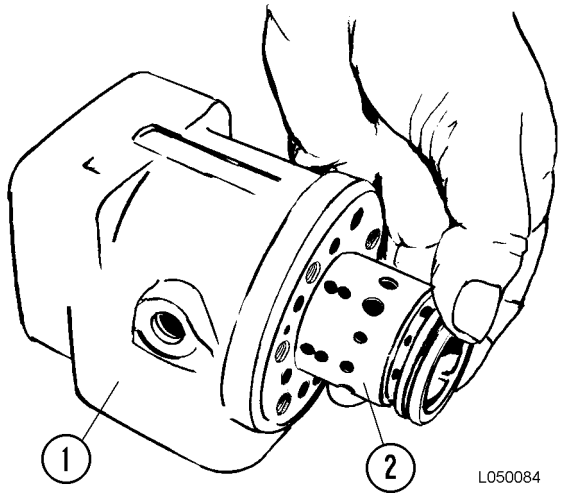


FIGURE 5-16. SPOOL INSTALLATION

1. Housing
2. Spool Assembly

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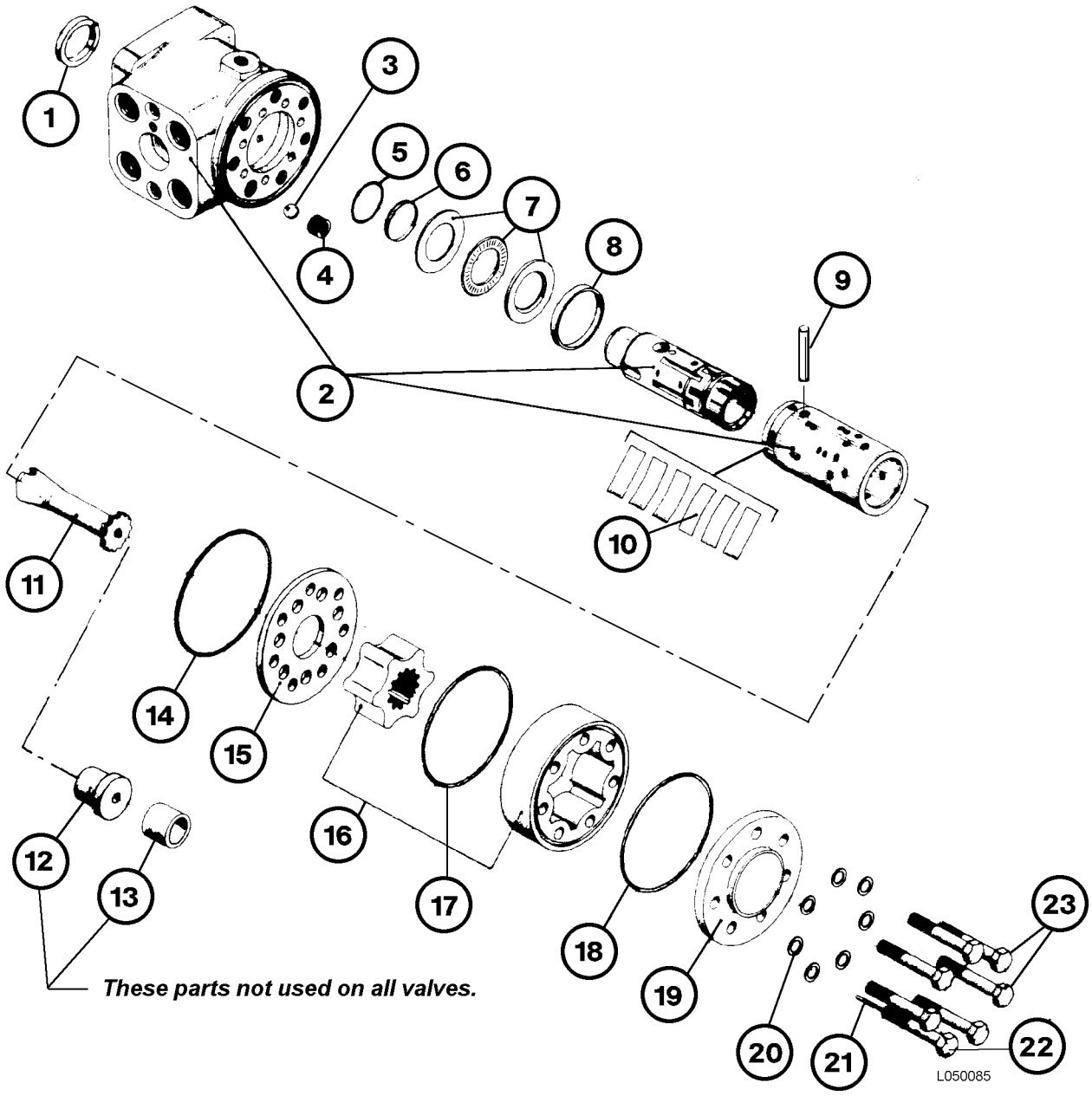


FIGURE 5-17. STEERING CONTROL UNIT

1. Dust Seal
2. Housing & Spools
3. Ball
4. Threaded Bushing
5. O-Ring
6. Kin Ring
7. Bearing Assembly
8. Ring
9. Pin
10. Neutral Position Springs
11. Cardan Shaft
12. Spacer
13. Tube
14. O-Ring
15. Distribution Plate
16. Gear Wheel Set
17. O-Ring
18. O-Ring
19. End Cover
20. Washers
21. Rolled Pin
22. Capscrews with Pin
23. Capscrews

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10. Install the check ball in the hole shown in Figure 5-19. Install threaded bushing and lightly tighten.

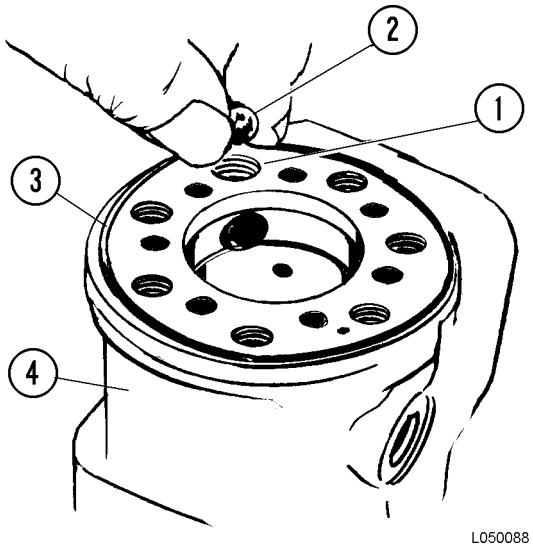


FIGURE 5-18. CHECK BALL INSTALLATION

1. Check Ball Hole
2. Check Ball
3. O-Ring
4. Housing

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

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STEERING CYLINDER

For steering cylinder removal and installation procedure, refer to Section "G".

Disassembly

1. Remove capscrews (9, Figure 5-20) and pull gland (8) rod (10) and piston (5) from housing (6).
2. Remove O-ring & backup ring (7). Remove nut (2) and remove piston (5). Remove bearing (3) and piston seal (4).
3. Pull rod (10) from gland (8). Remove rod wiper (11) and rod seal (12).

Inspection and Cleaning

1. Clean all parts using fresh cleaning solvent, lint free wiping cloth and dry compressed air.
2. Inspect cylinder housing, gland, piston and rod for signs of pitting, scoring or excessive wear.
3. Lubricate the cylinder housing, gland, piston and rod with clean, type C-4 hydraulic oil. Lubricate new seals, wiper and bearing using clean, type C-4 hydraulic oil.

Assembly

1. Install new O-ring and backup ring (7, Figure 5-20). The backup ring must be positioned toward the rod eye.
2. Install new rod seal (12) and rod wiper (11) in gland (8).
3. Push rod (10) through top of gland, slowly advancing rod over rod seal and rod wiper.
4. Install new piston seal (4) and bearing (3) on piston (5). Make sure the piston seal is tight on piston.

NOTE: Installation of the piston seal may require the following procedure.

   a. Heat the piston seal assembly in boiling water for 3 to 4 minutes.

   b. Remove piston seal assembly from the water and assemble on the piston. Do not take longer than 5 seconds to complete assembly as seal will take a permanent set.

   c. Apply even pressure to avoid cocking the seal.

   d. If the seal assembly has taken a slightly large set, the use of a belt type wrench or similar tool can be used to compress the seal to the desired diameter, (tight on piston).

5. Install piston on rod structure and secure in place with locknut. Tighten locknut to **2000 ft. lbs. (2712 N.m)** torque.
6. Carefully install rod and gland assembly into cylinder housing. Insure backup ring and O-ring on gland are not damaged during installation.
7. Install capscrews (9) and tighten to **310 ±31 ft. lbs. (420 ±42 N.m)** torque.

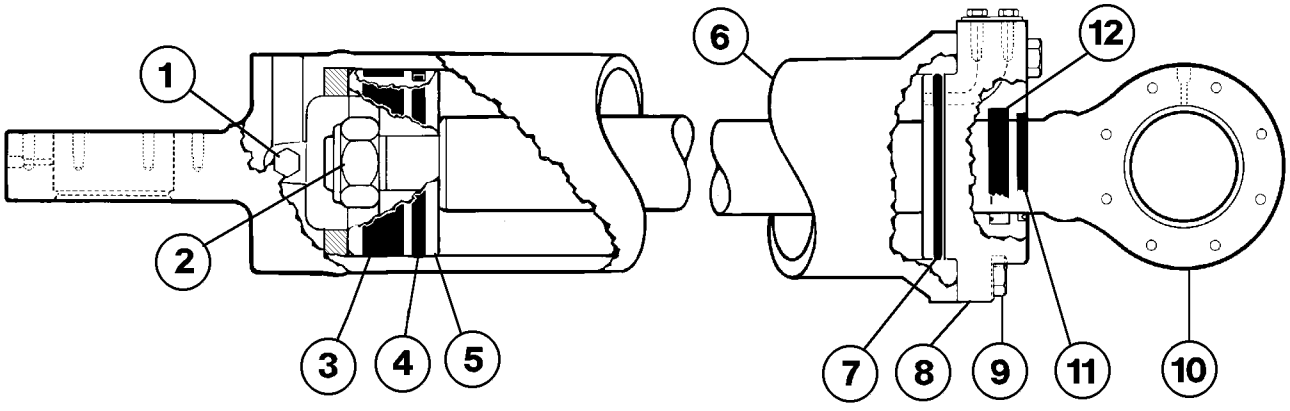


FIGURE 5-19. STEERING CYLINDER ASSEMBLY

1. Vent Plug
2. Locknut
3. Bearing
4. Piston Seal
5. Piston
6. Housing
7. O-Ring & Backup Ring
8. Gland
9. Capscrews
10. Rod
11. Rod Wiper
12. Rod Seal

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STEERING CIRCUIT FILTER

The brake and steering circuit filter (Figure 5-21) is located on the right, inside frame rail, behind the fuel tank. The filter provides secondary filtering protection for hydraulic oil flowing to the bleeddown manifold valve for the steering and brake systems.

An indicator switch (1) is designed to alert the operator of filter restriction before actual bypass occurs. The switch contacts close at 35 psid (241 kPa) to actuate a warning lamp on the overhead display panel. Actual filter bypass occurs at 50 psi (345 kPa).

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

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

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

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

FILTER ELEMENT REPLACEMENT

⚠WARNING

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

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

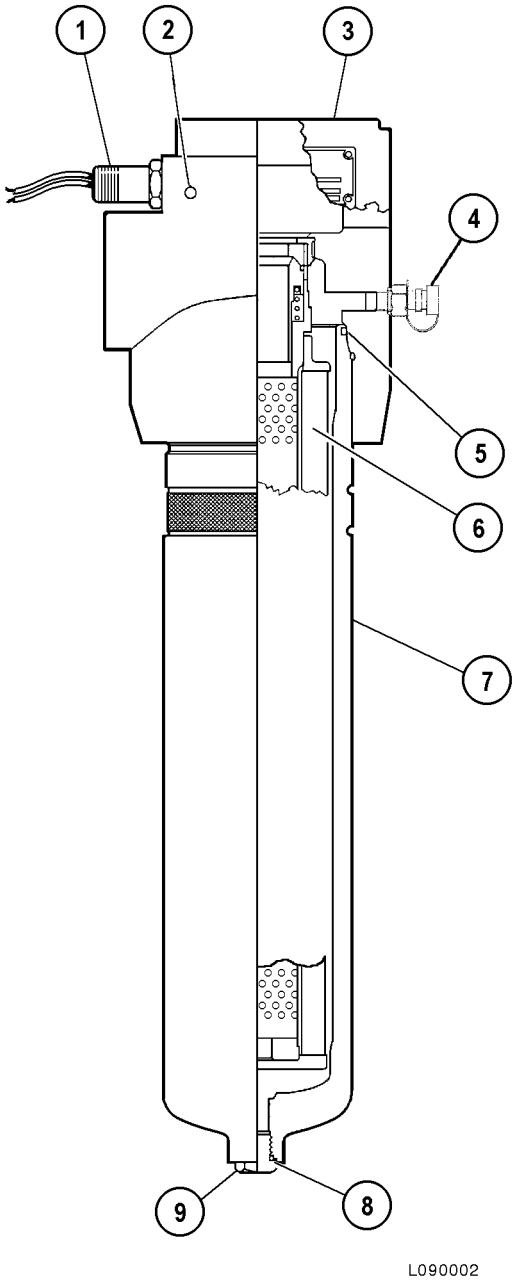


FIGURE 5-20. STEERING/BRAKE CIRCUIT FILTER

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

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Removal

1. With the key switch OFF, allow at least 90 seconds for the accumulators to bleed down.
2. Remove plug (10, Figure 5-21), loosen bleed plug (4) and drain oil from the housing into a suitable container.

⚠WARNING

Take care to avoid contact with hot oil if truck has been operating. Avoid spillage and contamination!

3. Remove bowl (8) and element (7).
4. Remove and discard O-ring (6) on filter bowl.
5. Clean bowl in solvent and dry thoroughly.

Installation

1. Install new element (7). Install new O-ring (6) on bowl.
2. Install bowl on filter head and tighten.
3. Install drain plug (10), and O-ring (9). Tighten bleed plug (4).

INDICATOR SWITCH

The indicator switch (1, Figure 5-21) is factory preset to actuate at 35 psid (241 kPa). When activated, the switch will illuminate the amber “Hydraulic Oil Filter” warning lamp located on the overhead display in the operator’s cab.

Note: Excessive restriction in either the hoist circuit filters, or the steering circuit filter will cause the Hydraulic Oil Filter warning lamp to illuminate.

The indicator switch is not individually repairable. If the switch is inoperative, replace with a new part.

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STEERING AND BRAKE PUMP

Removal

NOTE: Clean the steering pump and surrounding area carefully to help avoid contamination of hydraulic oil when lines are opened.

⚠WARNING

Relieve pressure before disconnecting hydraulic and other lines. Tighten all connections before applying pressure.
Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury and possibly death if proper medical treatment by a physician familiar with this injury is not received immediately.

1. Turn keyswitch OFF and allow 90 seconds for the accumulators to bleed down. Turn the steering wheel to be sure no oil remains under pressure.

NOTE: If oil in the hydraulic tank has not been contaminated, the shut-off valve (6, Figure 5-22) between the tank and steering pump can be closed, eliminating the need to completely drain the tank.

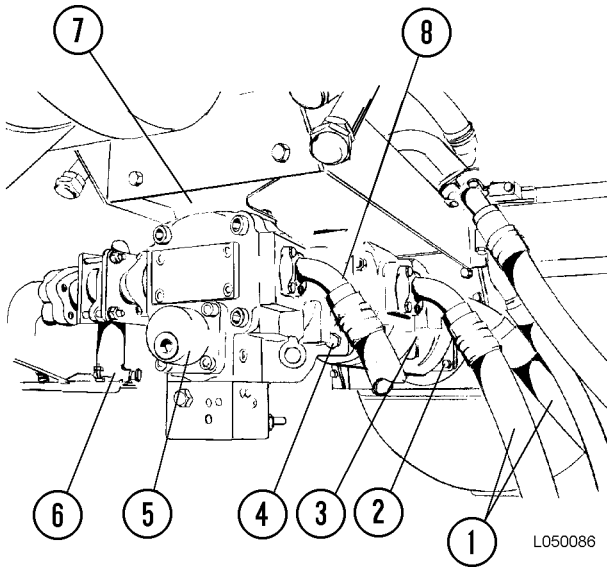


FIGURE 5-21. STEERING PUMP REMOVAL

1. Hoist Pump Outlet Hoses
2. Mounting Capscrews
3. Hoist Pump
4. Mounting Capscrews
5. Steering/Brake Pump
6. Shut-off Valve
7. Pump Mount Bracket
8. Outlet Hose

2. Drain the hydraulic tank by use of the drain located on the bottom side of the tank.

NOTE: Be prepared to contain approximately 238 gal. (901 L) of hydraulic oil.If the oil is to be reused, clean containers must be used with a 3 micron filtering system available for refill.

3. Disconnect the suction and discharge lines at the steering pump (5, Figure 5-22). Disconnect and cap pump case drain line from fitting at top of pump housing. Plug all lines to prevent oil contamination.

⚠CAUTION

The steering pump weighs approximately 250 lbs (113 kgs). Use a suitable lifting device capable of handling the load safely.

4. Support the steering pump (5) and the rear section of the hoist pump (3). Remove mounting capscrews and rear support bracket (7). Remove the four pump mounting capscrews (4).
5. Move the steering pump rearward to disengage the drive coupler splines from the hoist pump and remove pump.
6. Clean exterior of steering pump.
7. Move the steering pump to a clean work area for disassembly.

Installation

1. Install a new O-ring on pump mounting flange.
2. Make sure the steering pump spline coupler is in place (inside hoist pump) prior to steering pump installation.

⚠CAUTION

The steering pump weighs approximately 250 lbs (113 kgs). Use a suitable lifting device capable of handling the load safely.

3. Move the steering pump (5, Figure 5-22) into position. Engage steering pump shaft with hoist pump spline coupler.
4. Install rear support bracket (7) with capscrews. Do not tighten capscrews at this time.

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5. Align capscrew holes and install steering pump mounting capscrews (4). Tighten mounting capscrews to standard torque and tighten rear support capscrews to standard torque.
6. Remove plugs from pump inlet and outlet ports. Remove caps from inlet and outlet lines and install to steering pump using new O-rings. Tighten capscrews securely. Do not connect steering pump drain hose to the steering pump, at this time (see Step 7). Cap the drain hose securely.
7. Remove case drain fitting from top of pump housing and add clean C-4 oil to pump through opening until steering pump housing is full. This may require 2 - 3 qts (2 - 3 l) of oil.
8. Uncap the case drain line, connect to steering pump fitting and tighten case drain line.
9. Replace hydraulic filter elements. Refer to *"Hydraulic Filters",* earlier in this section.

⚠ IMPORTANT ⚠

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

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

⚠ IMPORTANT ⚠

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

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

⚠WARNING

Do not allow the engine to run with the needle valves in the open position for longer than this recommendation: excessive hydraulic system heating will occur.
DO NOT start any hydraulic pump for the first time after an oil change, or pump replacement, with the truck dump body raised. Oil level in the hydraulic tank may be below the level of the pump(s) causing extreme pump wear during this initial pump start-up.

17. Shut-off the engine and fully close both brake accumulator needle valves in the brake cabinet.
18. Verify that the oil level in the hydraulic tank is at the upper sight glass when the engine is off and the body is resting on the frame. If the hydraulic oil level is not at the upper sight glass, follow service manual instructions for filling/adding oil.
19. Start engine and check for proper pump operation. If necessary, refer to *"Steering Circuit Checkout Procedure"*, later in this Section, or the *"Trouble Shooting Chart"* or *"Pressure Check and Adjustment Procedure"*.

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Disassembly

⚠ IMPORTANT ⚠

When disassembling or assembling unit, choose a work area where no traces of dust, sand or other abrasive particles which could damage the unit are in the air. Do not work near welding, sand-blasting, grinding benches and the like. Place all parts on a CLEAN surface. To clean parts which have been disassembled, it is important CLEAN solvents are used. All tools and gauges should be clean prior to working with these units and new, CLEAN and threadless rags used to handle and dry parts.

1. Drain off excess hydraulic oil from pump inlet and discharge ports. It may be necessary to loosen the four valve plate capscrews (20, Figure 5-25) pull back on valve plate to allow fluid to seep out of the case.
2. Thoroughly clean and dry the outside surface of the pump housing.

NOTE: Depending upon what part or parts are to be inspected, it may not be necessary to completely take apart all assemblies.

Control Piston Group

3. Remove the two large plugs (23, Figure 5-23) with O-rings (15) from both sides of pump.
4. Back out four capscrews (3, Figure 5-25), then remove cap (24). Remove bias control spring (1, Figure 5-24).
5. Control piston (11, Figure 5-24) must be in the “neutral” position. Control link pin (16) should be centered in the plug opening. If pin is not centered, pry control piston to position link pin for access through hole.
6. Using appropriate snap ring pliers, remove retaining rings (14, Figure 5-24) from both sides of the pin and remove control link washers (15).
7. For handling purposes, insert a 1/4"-20UNC capscrew into the threaded end of the control link pin (16).
8. Using a brass rod and hammer, tap on end opposite the capscrew to remove control link pin (16).

⚠CAUTION

Maximum volume stop gland (14, Figure 5-23) MUST be removed BEFORE further disassembly of control piston.

9. Without disturbing jam nut (16, Figure 5-23), unscrew gland (14) and remove stroke adjuster as a complete assembly.

Valve Plate Group

NOTE: Valve plate (17, Figure 5-25) is a slight press fit in the pump housing (20, Figure 5-23).

10. Support valve plate (17, Figure 5-25) from an overhead crane (lifting lug holes are provided) and remove four capscrews (20) from valve plate.
11. Remove valve plate (17) from pump housing (20, Figure 5-23) by tapping away from the housing with a mallet until valve plate pilot diameter disengages from the case 0.25 in (6.35 mm).
12. With the weight of the valve plate still suspended from the overhead crane, slide valve plate back until it disengages from driveshaft and set valve plate aside. Care must be taken not to damage the wear face of valve plate (17).
13. To further disassemble control piston assembly, move control piston (11, Figure 5-24) into sleeve (4) until control piston maximum stop pin (8) contacts the sleeve. Use a large mallet to drive piston and sleeve assembly outward from the valve plate.
14. When all sleeve seals (5, 6, & 7) are clear of the valve plate, re-extend control piston (11). While tipping the assembly enough to clear the hole, pull the assembly from the valve plate.
15. Remove pin (18) from control piston by pressing or tapping it out through the hole on opposite side. Control stop pin (8) can be removed and control piston (11) slipped out of sleeve (4).
16. Remove capscrews (9, Figure 5-25) and remove compensator block (13).
17. Remove capscrews (21) and cover plate (19).

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Rotating Group

CAUTION

Rotating group weighs approximately 30 lbs. Extreme care must be taken not to damage cylinder wear face of cylinder wear plate face, bearing diameters or piston shoes. Assistance from others and use of proper lifting techniques is strongly recommended to prevent personal injury.

18. To remove rotating group, firmly grasp the cylinder barrel (10, Figure 5-24) and pull assembly outward until cylinder spline disengages from driveshaft spline about 2.5 in. (63.5 mm). Once clear, rotate cylinder barrel a revolution or two to break any contact between piston/shoe assemblies (13) and swashblock (25) wear face.
19. Slide rotating group off the driveshaft and out of the pump housing and place it on a clean, protective surface with piston shoes facing upward.
20. Mark each piston, its cylinder bore and location in shoe retainer for ease of inspection and assembly.
21. Piston/shoe assemblies (13) can be removed individually or as a group by pulling upward on shoe retainer (27).
22. Remove fulcrum ball (12).
23. If shoe retainer springs (28) are removed, mark which spring came from which bore as they must be returned to that individual bore on assembly.
24. Remove the two pins (17, Figure 5-23) and pull the cylinder bearing (26, Figure 5-24) straight out of the pump housing.

Swashblock Group

25. Remove the two swashblock retaining pins (19, Figure 5-23), tilt the bottom of the swashblock (25, Figure 5-24) outward and remove the swashblock from the pump case.
26. Saddle bearings (24) can be removed by using a very short screwdriver or back hammer to pry them loose; or continue to the next step for further disassembly which will make their removal easier.

Driveshaft Group

27. Remove bearing retaining ring (3, Figure 5-23). Use a mallet on the tail shaft and tap driveshaft (1) out from the front of the pump housing.
28. Remove seal retainer (21) from pump housing. Use a mallet and tap saddle (20) out from the inside of the pump housing. Saddle bearings (24) can then be easily removed and saddle O-ring (21) may also be removed at this time.

INSPECTION

CAUTION

Always wear safety goggles when using solvents or compressed air. Failure to wear safety goggles could result in serious personal injury.

1. Clean all parts thoroughly.
2. Replace all seals and O-rings with new parts.
3. Check all locating pins for damage and all springs for cracking or signs of fatigue.

Control Piston Group

4. Control piston (11, Figure 5-24) must slide smoothly in sleeve (4).
5. Linkage to cradle should operate smoothly but not loosely (with slop). Check piston and bore in sleeve for signs of scratching or galling. Polish with fine emery if needed.

Valve Plate Group

6. Closely examine mating faces of valve plate (17, Figure 5-25) and cylinder barrel (10, Figure 5-24) for flatness, scratches or grooves. If faces are not flat and smooth, the cylinder side will “lift off” from the port plate (valve plate) resulting in delivery loss and damage to the pump. Replace if necessary.

Rotating Group

7. Check all pump piston assemblies (13, Figure 5-24) for smooth action in their bores.
8. Check piston walls and bores for scratches or other signs of excessive wear (pistons should not have more than a few thousandths clearance). Replace if necessary.

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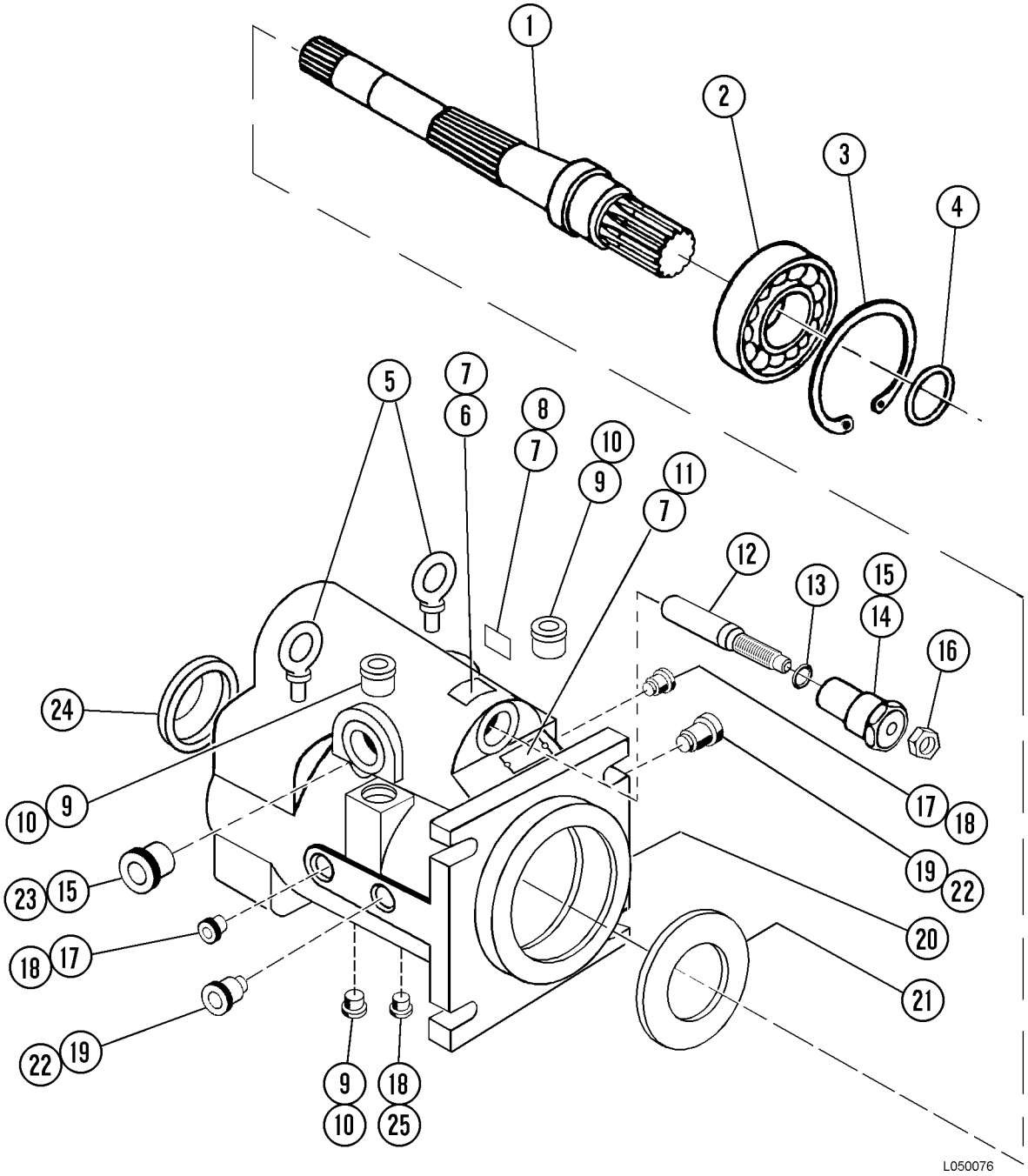


FIGURE 5-22. PUMP, FRONT HOUSING

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

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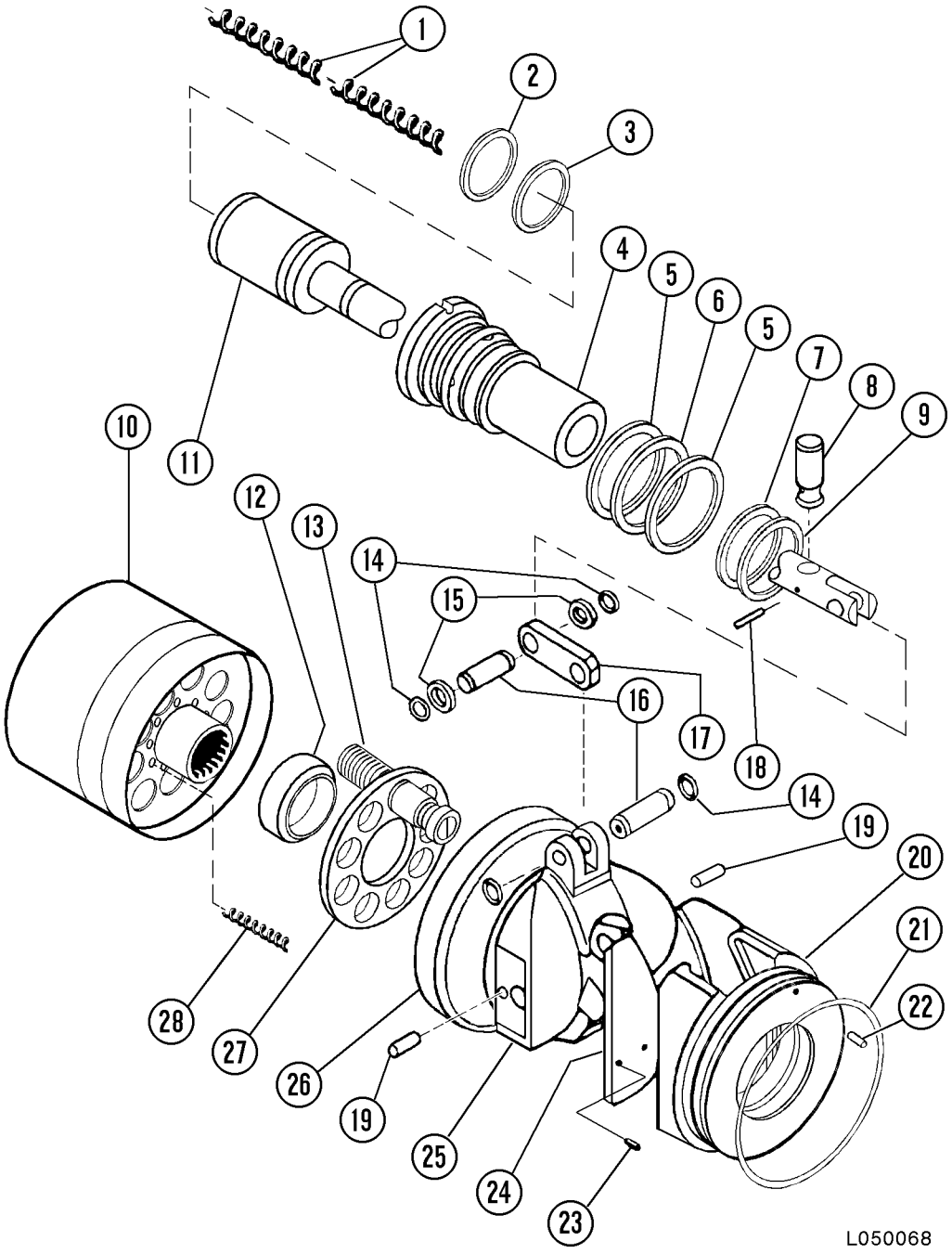


FIGURE 5-23. PUMP, ROTATING GROUP

1. Springs
2. Seal
3. Piston Ring
4. Sleeve
5. Back-up Ring
6. O-Ring
7. O-Ring
8. Pin
9. Back-up Ring
10. Cylinder Barrel
11. Control Piston
12. Ball
13. Piston Shoe Assembly
14. Retainer Ring
15. Washer
16. Pin
17. Link
18. Pin
19. Dowel Pin
20. Saddle
21. O-Ring
22. Roll Pin
23. Roll Pin
24. Saddle Bearing
25. Swash Block
26. Cylinder Bearing
27. Retainer
28. Spring

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9. Piston shoes must pivot smoothly, but end play must not exceed 0.003 in (0.076 mm).
10. Check end play as follows:
    a. Place square end of piston on bench and hold down firmly. Pull on end of shoe with other hand and note end play. A good piston/shoe fit will have no end play, but the shoe may rotate and pivot on the piston ball. Inspect each shoe face for nicks or scratches.
    b. Measure shoe thickness (the part held between retainer (27, Figure 5-24) and cradle. All shoes must be equal within 0.0001in (0.003 mm). If one or more piston/shoe assemblies (13) needs to be replaced, all piston/shoes assemblies must be replaced.
    c. Inspect cylinder bearing (26) and matching cylinder barrel bearing mating surface for galling, pitting or roughness. Replace if necessary.

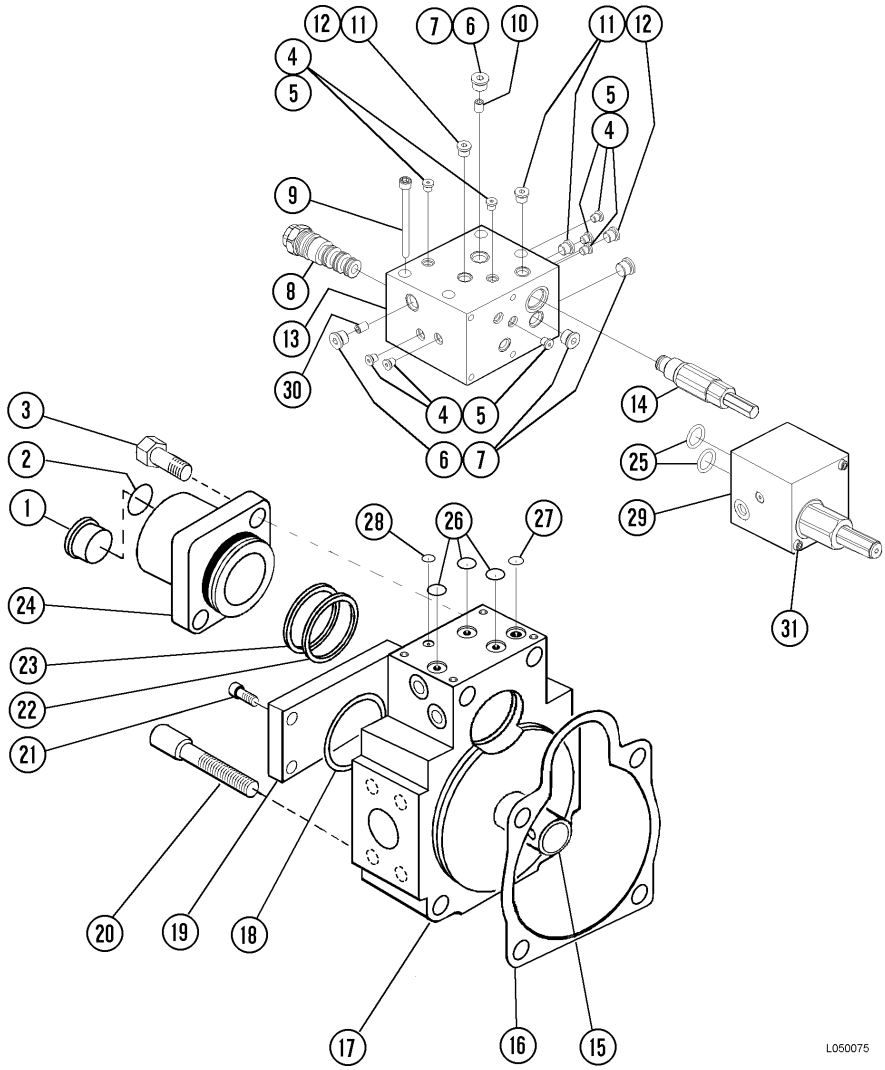


FIGURE 5-24. PUMP, REAR HOUSING

1. Plug
2. O-Ring
3. Capscrew
4. O-Ring
5. Plug
6. O-Ring
7. Plug
8. Valve, 4-Way
9. Capscrew
10. Orifice
11. O-Ring
12. Plug
13. Compensator
14. Valve, Relief
15. Bearing
16. Gasket
17. Valve Plate
18. O-Ring
19. Cover Plate
20. Capscrew
21. Capscrew
22. O-Ring
23. Back-up Ring
24. Cap
25. O-Ring
26. O-Ring
27. O-Ring
28. O-Ring
29. Unloader Module
30. Orifice
31. Capscrew

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Swashblock Group

11. Inspect swashblock (25, Figure 5-24) for scratches, grooves, cracks or uneven surface. Replace if defective.

NOTE: Wear face is coated with a gray colored epoxy based dry film lubricant for break-in purposes. Scratching or wear of this coating is not detrimental as long as the metal surface underneath the coating is not scored or "picked-up".

12. Compare saddle bearing (24) thickness in wear area to thickness in a non-wear area. Replace saddle bearings if difference is greater than 0.004 in (0.102 mm).
13. Check mating surface of swashblock for cracks or excessive wear. Replace if necessary.
14. Swashblock movement in saddle and saddle bearing (24) must be smooth.

Driveshaft Group

15. Remove shaft seal (24, Figure 5-23).
16. Check shaft bearing (2) for galling, pitting, binding or roughness. Replace if necessary.
17. Check shaft and its splines for wear. Replace any parts necessary.

Compensator Block and Unloader Module

18. Remove screws (31, Figure 5-25) and separate unloader module (29) from compensator block (13).
19. Remove 4-way valve (8) and relief valve (14) from compensator block. Remove all plugs and orifices (10 & 30). Clean block in solvent; inspect all passages and orifices for obstructions.
20. Remove unloader valve from block (29). Remove plugs and clean block passages. If unloader is inoperative, replace entire module.

Stroke Adjuster Assembly

21. Measure and record dimension "A" on stroke adjuster assembly as shown in Figure 5-26.
22. Loosen jam nut (4). Separate stem (1) from gland (3). Remove and discard O-ring (2).
23. Inspect parts for damage or excessive wear.
24. Install new O-ring on stem and reassemble to gland. Adjust stem to gland to dimension "A" recorded in step 21. Tighten jam nut.

ASSEMBLY

The procedures for assembling the pump are basically the reverse order of disassembly procedures. During assembly, install new gaskets, seals, and O-rings.

Apply a thin film of CLEAN grease or hydraulic fluid to sealing components to ease assembly. If a new rotating group is used, lubricate thoroughly with CLEAN hydraulic fluid. Apply fluid generously to all wear surfaces.

Swashblock Group

1. Press or tap roll pin (22, Figure 5-24) into pump housing (20, Figure 5-23).
2. Press new shaft seal (24) into saddle (20, Figure 5-24) using an arbor press. Install O-ring (21) into the groove in the saddle.
3. Press four roll pins (23) into saddle (20) until they bottom, then press saddle bearing (24) onto the pins to locate the bearing in the saddle.

⚠ IMPORTANT ⚠

Extreme care should be used to prevent damage to saddle bearing surfaces while installing the saddle into the pump housing.

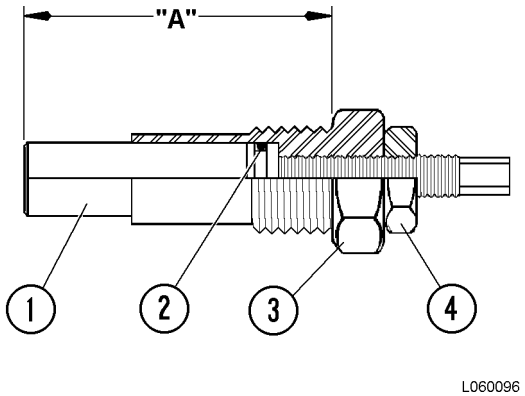


FIGURE 5-25. STROKE ADJUSTER ASSEMBLY

1. Stem
2. O-Ring
3. Gland
4. Jam Nut

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4. Use a long brass bar and a mallet (or an arbor press), to install saddle and bearing assembly into pump housing. Tap or press ONLY on the area of the saddle that is exposed between the saddle bearings (DO NOT tap on bearing surfaces). Saddle is fully seated when a distinct metallic sound is heard when installing saddle into pump housing.
5. Fasten control link (17, Figure 5-24) to swashblock (25) using link pin (16) and two retaining rings (14).
6. Be sure the two dowel pins (19), are pressed into swashblock (25).
7. Insert swashblock (25) into pump housing (20, Figure 5-23) until it engages in saddle bearing and allow swashblock to settle to its lowest natural position.
8. Retain by installing two swashblock retaining pins (19) and O-rings (18) in place. Once pinned, make certain swashblock strokes SMOOTHLY in the saddle by pulling firmly on the free end of control link (17, Figure 5-24).

Driveshaft Group

NOTE: Be sure punch marks on cylinder bearing (26, Figure 5-24) will face toward shaft end of pump.

9. Insert cylinder bearing (26) straight into pump housing. Be sure bearing is positioned so bearing retainer pins (17, Figure 5-23) can be inserted in the case and into the bearing.
10. Install O-rings (18) on pins (17) and install pins.
11. An arbor press is required to install shaft bearing (2) onto driveshaft (1). IMPORTANT - press ONLY on the inner race of the bearing. Press bearing until it contacts the shoulder on driveshaft.
12. 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.
13. Place seal retainer (21) over seal (24) inside the pump housing (20). Lubricate shaft seal with clean hydraulic oil.
14. Install entire driveshaft assembly through the front of the pump housing. A mallet will be required to install the driveshaft through shaft seal (2).
15. Once the driveshaft assembly is fully seated within the pump housing, install snap ring (3).

Rotating Group

16. Mating surfaces should be greased. Place cylinder assembly on clean table with the valve plate side down.
17. During disassembly, shoe retainer springs were referenced to individual bores. Assemble rotating group by inserting shoe retainer springs (28, Figure 5-24) into the same spring bores located in cylinder barrel (10) that they came from.
18. Slide fulcrum ball (12) over the nose of the cylinder barrel (10).
19. 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.

⚠CAUTION

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

20. The rotating group can now be carefully installed over the end of the driveshaft and into the pump housing (20, Figure 5-23).
21. When installing the rotating group, support the weight of the cylinder barrel (10, Figure 5-24) as cylinder spline is passed over the end of driveshaft to avoid scratching or damage.
22. Push cylinder barrel forward until the cylinder spline reaches the driveshaft spline. Rotate the cylinder slightly to engage shaft splines.
23. Continue to slide cylinder barrel forward until it encounters the cylinder bearing (26, Figure 5-24). Lifting the driveshaft slightly helps cylinder barrel (10) and cylinder bearing engagement. Continue pushing cylinder forward until the piston shoes contact swashblock (25).
24. 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.

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Control Piston Group

25. Install piston rings (2 & 3, Figure 5-24) into their respective grooves on control piston (11) using care to assure they are in proper location.
26. Insert control piston assembly into sleeve (4).
27. While supporting the control piston, press or slip in pin (8) and secure with cotter or roll pin (18).
28. Order of piston sleeve seal installation starts at widest end of sleeve.
29. Install backup ring (1, Figure 5-27) and O-ring (2) and backup ring (3) in rear most groove on piston sleeve. Install O-ring (4) and backup ring (5) in remaining groove.

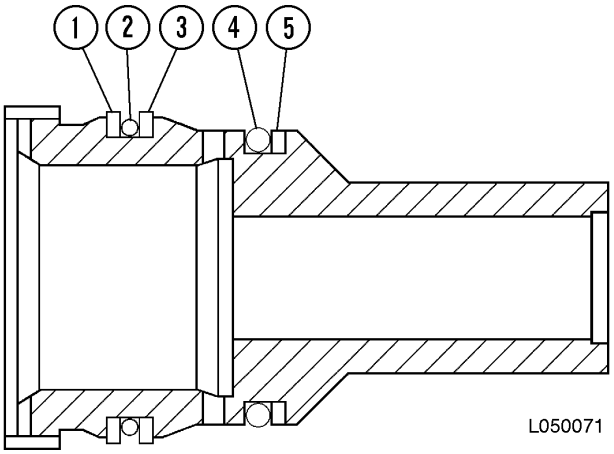


FIGURE 5-26. O-RING LOCATION ON PISTON SLEEVE

1. Backup Ring
2. O-Ring
3. Backup Ring
4. O-Ring
5. Backup Ring

30. Insert piston and sleeve assembly (4, Figure 5-24) into valve plate (17, Figure 5-25).
31. Install O-ring (18) in rear of valve plate. Use four capscrews (21) to fasten cover plate (19) over opening in valve plate (17).
32. Pull free end of control link (17, Figure 5-24) toward back of pump housing until the open hole in the link lines up with open ports on sides of pump case.
33. Install maximum volume stop gland (14, Figure 5-24) and adjusting screw (12) to hold swashblock in place.

Valve Plate Group

34. Be sure driveshaft bearing (15, Figure 5-25) is in place. Using assembly grease (to hold desired position), place valve plate gasket (16) in position on valve plate (17).
35. Support valve plate assembly from an overhead crane (lifting lug holes are provided) in preparation for mating to the pump housing.
36. Assemble one control link retainer ring (14, Figure 5-24) and one control link washer (15) onto the threaded hole side of the control link pin (16). Then thread a 1/4 in - 20 UNC capscrew into pin to ease holding.
37. Carefully maneuver valve plate assembly, supported by overhead crane, over driveshaft and into pump housing so slot on control piston (11) engages control link (17).
38. With hole in control piston lined up with hole in the link, carefully insert control link pin (16).

⚠ IMPORTANT ⚠

Care should be taken during this next step to prevent the washer and retaining ring from falling into pump housing.

39. Install second control link washer (15) and control link retaining ring (14) onto pin.
40. Once assembled, remove capscrew from pin.

NOTE: Valve plate is a slight press fit into pump housing. Make sure pilot diameter on valve plate (17, Figure 5-25) is aligned with mating diameter on the pump housing prior to assembly.

41. Insert four capscrews (20, Figure 5-25) and alternately tighten until valve plate is drawn up to the pump housing. Tighten capscrews evenly to **244 ft. lbs. (330 N.m)** torque.
42. Install O-ring (22) with backup ring (23) in seal groove of control cover cap (24).
43. Insert bias control piston springs (1, Figure 5-24) into control piston (11). Use four capscrews (3, Figure 5-25) to fasten control cover cap to back of valve plate (17). Tighten capscrews (3) evenly to **138 ft. lbs. (187 N.m)** torque.
44. Install cover plate (19) with new O-ring (18) and capscrews (21).

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45. Install O-rings (26, 27 and 28) in proper location on top of valve plate. Install compensator (13) to valve plate with capscrews (9) and tighten securely.
46. Install 4-way valve (8), and relief valve (14).
47. Install 0.062 in. (1.575 mm) diameter orifice (30) and plug (7) with new O-ring (6) in side of compensator block as shown in Figure 5-25. Install 0.032 in. (0.813 mm) diameter orifice (10), plug (7) and O-ring (6) in top of block.
10. Install remaining plugs with new O-rings.
11. Install unloader module (29) on compensator block with new O-rings (25) and socket head capscrews (31). Tighten capscrews to **87 in. lbs. (9.8 N.m)** torque.
12. Install plugs (9 & 23, Figure 5-23) and O-rings (10 & 15) in pump housing.
13. Measure pump rotation torque. Rotation torque should be approximately **15 ft. lbs. (20.4 N.m)**.

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NOTES

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HOIST CIRCUIT

HOIST CIRCUIT OPERATION

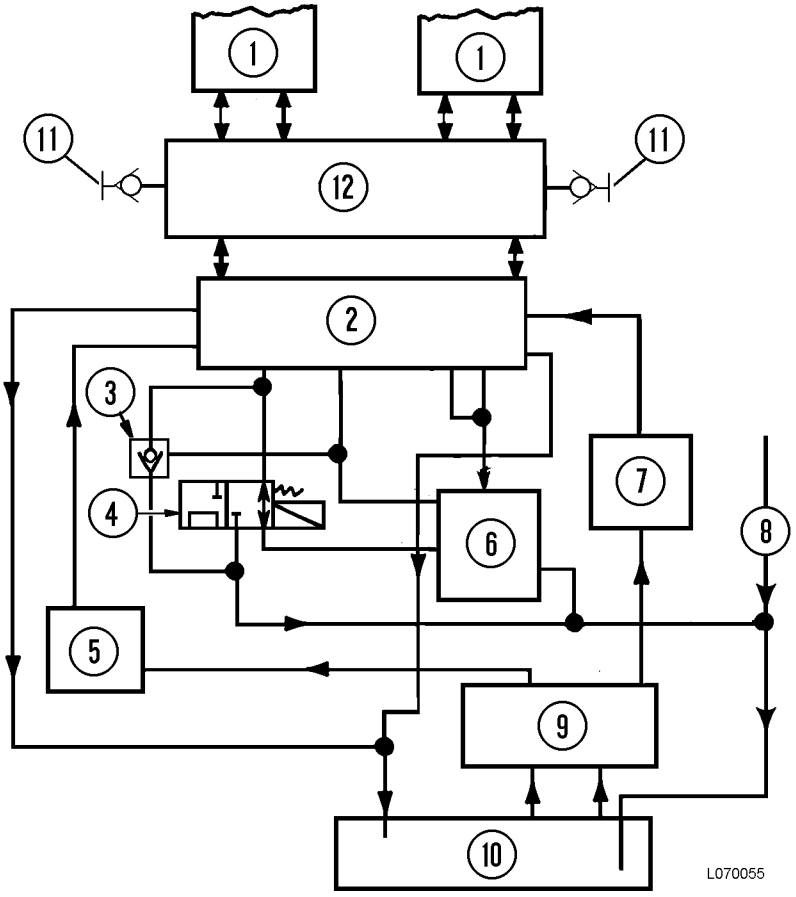
The following hoist circuit operation description describes the basic hoist circuit. Details of individual component operation is outlined under the individual component descriptions.

Hydraulic fluid is supplied by a tank (10, Figure 7-1) located on the left frame rail. Hydraulic oil is routed to a tandem gear type pump (9), driven by a driveshaft on the traction alternator.

Pump output is directed to two, high pressure filters (5 & 7) mounted on the side of the fuel tank. Hydraulic oil from the filters is directed to the hoist valve (2), mounted on a modular assembly containing the hoist pump, steering/brake pump, hoist valve and counterbalance valve manifold.

The hoist valve directs oil to the body hoist cylinders (1) for raising and lowering the dump body. Hoist valve functions are controlled by the operator through a flexible cable to the hoist pilot valve (6) in the hydraulic component cabinet located behind the operator's cab. Also in the hydraulic cabinet is the hoist-up limit solenoid (4). The hoist-up limit solenoid prevents the hoist cylinders from extending to maximum physical limit. A counterbalance valve in the overcenter manifold (12) prevents abrupt cylinder extension due to material buildup on the tail of the body.

Quick disconnect fittings (11) allow the use of another truck's hydraulic system to dump a load in the body if the hoist pump, hoist valve or related components are inoperable.



1. Hoist Cylinders
2. Hoist valve
3. Pilot Operated Check Valve
4. Hoist Up Limit Solenoid
5. Filter
6. Hoist pilot valve
7. Filter
8. Return from Flow Amplifier valve
9. Hoist Pump
10. Hydraulic Tank
11. Quick Disconnects
12. Counterbalance Valve Manifold

⚠WARNING

Hydraulic hoses deteriorate with age and use. Prevent possible malfunctions by inspecting all hoses periodically. Replace any hose showing wear, damage, or deterioration.

FIGURE 7-1. HOIST CIRCUIT SCHEMATIC

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COMPONENT DESCRIPTION

HYDRAULIC TANK

The hydraulic tank supplies hydraulic oil for the hoist, steering, and brake circuits. The tank is located on the left hand frame rail forward of the rear wheels. The service capacity is 238 gal. (901 l). Refer to Section “P” for the correct type hydraulic oil recommended for use in the hydraulic system.

Oil used in the hoist circuit flows through two 100 mesh wire suction strainers to the inlet housing of the hoist pump. Air drawn into the tank during operation is filtered by dual air filters located on the top of the tank. Oil level can be checked visually at sight glasses located on the face of the tank. Oil level should be checked periodically and be visible in the bottom sight glass when the body is down and the engine is running.

HOIST PUMP

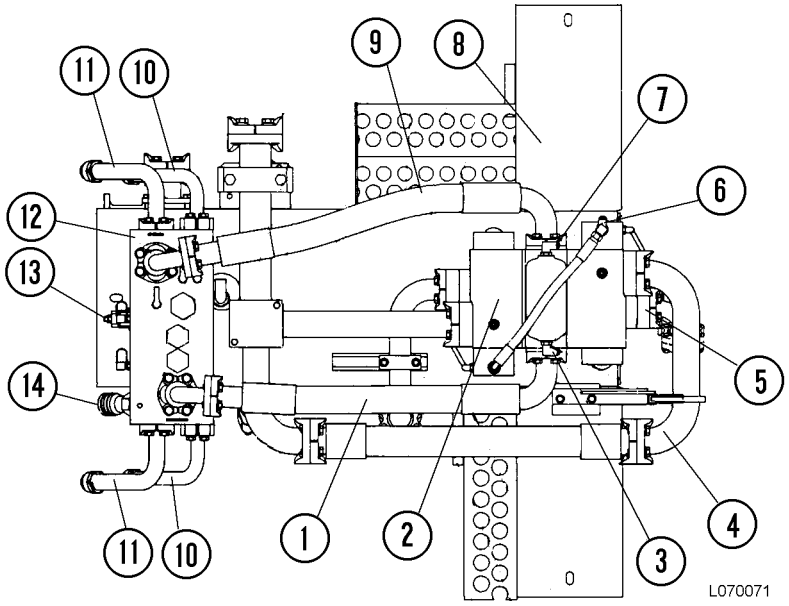
The hoist pump is a tandem gear type pump driven by an accessory drive at the rear of the traction alternator. The pump has a total output of 240 GPM at 1900 RPM. The hoist pump also drives the steering and brake supply pump located at the rear of the hoist pump. Hoist pump output is directed to two remote mounted high pressure filters. Maximum hoist pump output pressure is 2500 psi (17.2 MPa).

HIGH PRESSURE FILTERS

Hoist pump output flows to two remote mounted high pressure filters located on the lower inboard side of the fuel tank. The filter elements are rated at 7 micron. The filter assembly is equipped with a bypass valve which permits oil flow if the filter element become plugged. Flow restriction through the filter element is sensed by a pressure differential switch.

This switch will turn on an overhead panel mounted, yellow warning light to indicate filter service is required. The light is labeled “Filter Monitor” and will come on when restriction reaches approximately 35 psi (241 kPa). Actual filter bypass will result when the filter element restriction reaches approximately 50 psi (345 kPa).





1. POWER DOWN Line
2. Hoist Valve Assembly
3. DOWN Pilot port
4. Hoist Valve Return to Tank
5. Hoist Valve Inlet from Filter
6. Supply to Pilot Valve
7. RAISE Pilot Port
8. Pump/Valve Module Mount Str.
9. POWER UP Line
10. POWER DOWN to Hoist Cylinder
11. POWER UP to Hoist Cylinder
12. Counterbalance Valve Manifold
13. Counterbalance Valve
14. APU Quick Disconnect

FIGURE 7-2. HOIST PUMP/VALVE MODULE

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HOIST VALVE

The hoist valve (Figure 7-3) is mounted above the hoist and steering pump. Hydraulic oil from the high pressure filters is routed to the hoist valve. The hoist valve is a split spool design. (The term “split spool” describes the spool section of the valve.)

Separate spools control oil flow to each end of the cylinders. The valve consists of two identical inlet sections, a spool section, and a separator plate.

The hoist valve precisely follows differential pressure input signals generated by the hoist pilot valve. (Refer to Figures 7-6 through 7-10.)

The inlet sections of the hoist valve consist of the following components:

- Flow control and main relief valve (system relief).
- Low pressure relief valve.
- Load check poppet.
- Anti-void poppet.

The flow control portion of the flow control and main relief valve allows pump flow to return directly to tank through the inlet section with low pressure loss. The relief portion of the valve is direct acting and has the capacity to limit the working pressure at full pump flow.

The low pressure relief is located between the low pressure core and the outlet, and provides a controlled back pressure in the low pressure core when oil is returning to tank.

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.

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

- Two pilot ports
- Two main spools
- Two work ports
- Check poppets

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

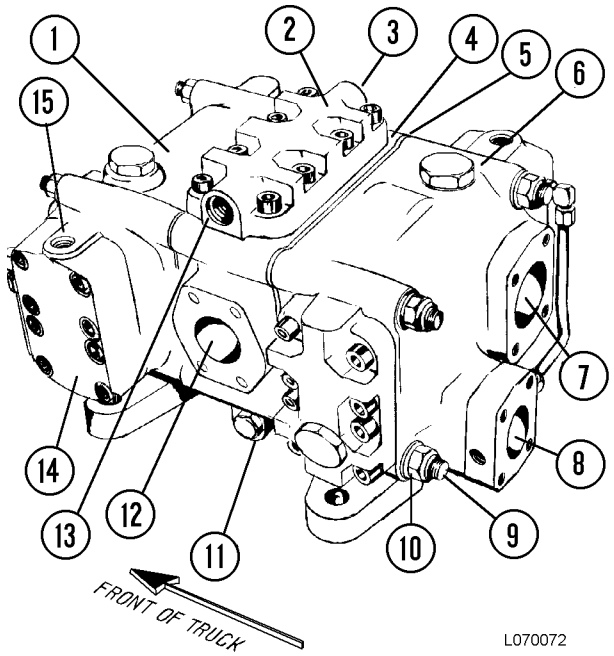


FIGURE 7-3. HOIST VALVE

1. Inlet Section
2. Top Spool Section Cover
3. Down Pilot Port
4. Spool Section
5. Separator Plate
6. Inlet Section
7. Return to Tank Port
8. Supply Inlet port
9. Tie Rod
10. Nut
11. Bottom Spool Cover
12. Head End Work Port
13. Raise Pilot Port
14. Inlet Section Cover
15. Pilot Valve Supply Port

The work ports provide for line connections between the spool section and the hoist cylinders. One main spool for each work port is spring centered at both ends to close the work port from the high and low pressure cores when there is no flow to the pilot ports.

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

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HOIST PILOT VALVE

The hoist pilot valve (1, Figure 7-4) is located in the hydraulic component cabinet directly behind the operators cab. The hoist pilot valve spool is spring centered to the hold position. The valve is controlled directly by the operator through a lever and cable arrangement. The control lever is located between the operator and center console. When the operator moves the lever, the pilot valve spool moves and directs pilot flow to the appropriate pilot port on the hoist valve causing the main spools to direct working pump 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 hoist pilot valve is also equipped with a power down relief valve (8). The power down relief valve is located between the power down control port and return galley. The power down relief valve limits power down pressure at 1500 psi (10.5 MPa).

HOIST-UP LIMIT SOLENOID

The Hoist-up Limit Solenoid (2, Figure 7-4) is used in the hydraulic circuit to prevent maximum hoist cylinder extension.

This solenoid valve is “normally open” between the hoist pilot valve raise port and the hoist valve raise pilot port. The return-to-tank port is “normally closed”. The solenoid is controlled by the proximity switch (hoist limit switch) located inside the rear frame rail near the body pivot and above the right rear suspension. When the solenoid is signaled by the proximity switch, the raise pilot port on the hoist valve is closed. The hoist pilot valve raise port is opened to return to tank.

PILOT OPERATED CHECK VALVE

The Pilot Operated Check Valve (7, Figure 7-4) is opened by power down pilot pressure to allow oil in the raise port to bypass the hoist up limit solenoid for initial power down operation while the solenoid is activated by the hoist limit switch.

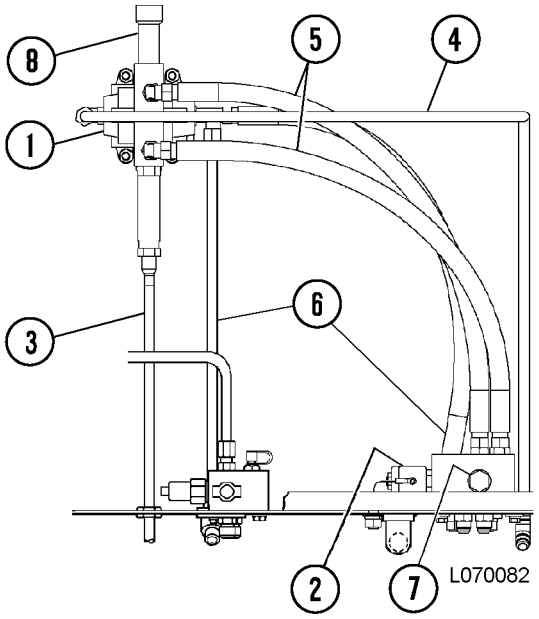


FIGURE 7-4. HOIST PILOT VALVE

1. Hoist Pilot Valve
2. Hoist-Up Limit Solenoid
3. Control Cable
4. Supply From Hoist Valve
5. Pilot Pressure to Hoist
6. Return Line
7. Pilot Operated Check Valve
8. Power Down Relief Valve

COUNTERBALANCE VALVE MANIFOLD

The counterbalance valve manifold (12, Figure 7-2) is mounted at the rear of the pump/hoist valve module. The counterbalance valve (13) controls the pressure (like a relief valve) of the oil in the annulus area of the hoist cylinders when the body approaches the maximum dump angle. The valve restricts the maximum pressure build-up by relieving pressure in excess of 3000 psi (20.7 MPa), preventing possible seal damage. Also see Figure 7-5 for a schematic view of the counterbalance valve.

There are 2 pilot pressures that can open it (cylinder head raise pressure & rod return pressure. If there is no raise pressure, it will take 3000 psi of rod end return pressure to open it. If there is theoretically 666 psi or more of raise pressure, it is wide open for the return oil. In between these 2 maximums the ratio of raise:return pressure is 1:4.5 to open the return flow

Quick disconnect fittings (14) installed on the manifold allow service personnel to dump a load in the truck body if the engine, hoist pump, or other hoist circuit component is inoperable, by connecting hoses to the quick disconnects of an operable truck.

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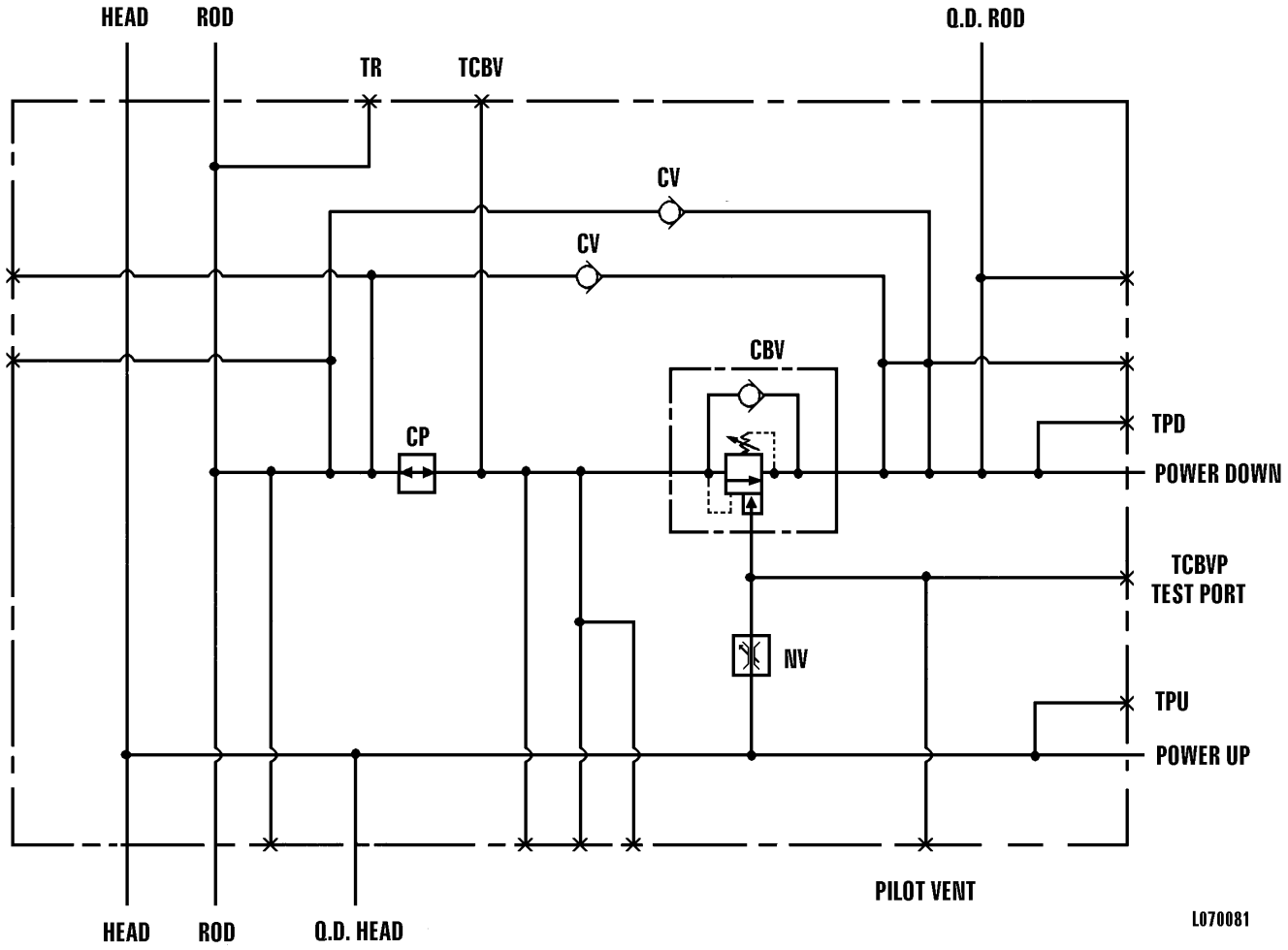


FIGURE 7-5. COUNTERBALANCE VALVE SCHEMATIC

The following pages describe hoist circuit operation in the float, power up, hold, and power down positions. (Refer to Figures 7-6 through 7-10.)

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FLOAT POSITION OF PILOT VALVE AND BODY ON FRAME (Figure 7-6)

This is the condition while the truck is hauling. The Pilot Valve spool position is as shown in Figure 7-6; however all Hoist Valve components are in position shown in Figure 7-10.

Oil from the hoist pumps enters each inlet section of the Hoist Valve in Port 11, passes through check valve 18, and stops at the closed High Pressure Passage 19 at the two main spools. Pressure builds to approximately 60 psi (414 kPa) on the pilot of the Flow Control Valve 2 causing the valve to compress the spring and open, allowing the oil to return to the tank through Hoist Valve Port 10. Oil also flows out Hoist Valve Port 12 to Port 12 on the Pilot Valve, through the Hoist Pilot Valve spool, and out Pilot Valve Port 10 to the tank. This oil flow is limited by orifices in the inlet sections of the Hoist Valve and therefore has no pressure buildup.

FIGURE 7-6. HOIST CIRCUIT: FLOAT POSITION

1. Hoist Relief Valve 2500 psi (17.2 MPa)
2. Flow Control Valve
3. Low Pressure Relief Valve 75 psi (517 kPa)
4. Counterbalance Valve
5. Rod End Work Port
6. Hoist Cylinders
7. Rod End Spool
8. Head End Spool
9. Head End Work Port
10. Return Port
11. Supply Port
12. Pilot Supply Port
13. Power Up Pilot Line Solenoid Valve
14. Raise Pilot Port
15. Down Pilot Port
16. Power Down Relief Valve, 1500 psi (10.5 MPa)
17. Anti-void Check Valve
18. Load Check Valve
19. High Pressure Passage
20. Low Pressure Passage
21. Pilot Operated Check Valve
22. Manifold Power Up Port
23. Manifold Power Down Port
24. Solenoid Valve Return Port
25. Overcenter Manifold Check Valve (CV)

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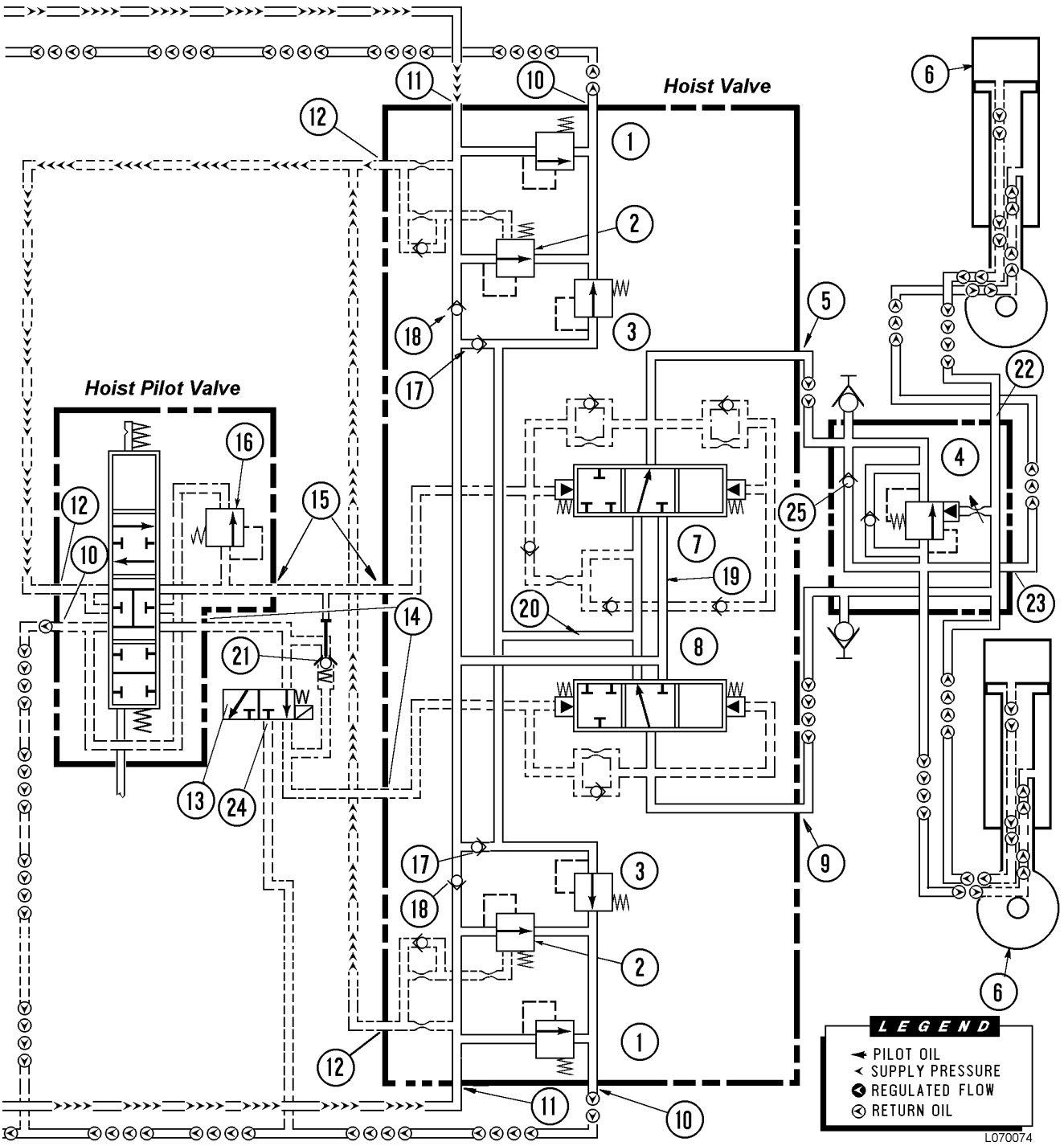


FIGURE 7-6. FLOAT POSITION

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POWER UP OPERATION (Figure 7-7)

The Hoist Pilot Valve spool is moved to the Power Up position when the operator moves the lever in the cab. The pilot supply oil coming in Port 12 is prevented from returning to the tank and, instead, is directed out Port 14 through hoist limit solenoid 13 and into Port 14 of the Hoist Valve. There it goes to the top of the Head End Spool 8, builds pressure on the end of the spool, causes the spool to move down compressing the bottom spring, and connects the High Pressure Passage 19 to Head End Port 9. Working oil flow in the High Pressure Passage is now allowed to flow through the spool and out Port 9 to extend the hoist cylinders. Even though a small amount of oil flows through the check poppet in the top of Spool 8, raise pilot pressure at Ports 14 increases to slightly higher pressure than the required hoist cylinder pressure. As a result, the pilot supply pressure in Ports 12 also increases causing back pressure to occur in the spring area of Flow Control Valve 2. This overcomes the pilot pressure on the other end of the Flow Control Valve causing it to close and direct the incoming pump oil through Head End Spool 8 to the hoist cylinders to extend them.

If at any time the resistance to the flow of the pump oil coming into the inlet section causes the pressure to increase to 2500 psi (17.2 MPa), the pilot pressure against Hoist Relief Valve 1 causes it to open and allow flow to exit out Port 10 and return to the tank.

As the hoist cylinders extend, oil in the annulus area of the second and third stages must exit from the cylinders. Initially, the Rod End Spool 7 ports are closed. As the returning oil entering Port 5 builds low pressure, it flows through the check-poppet in the top of the spool, through Port 15, through the Pilot Valve spool, and out Port 10 of the Pilot Valve to the tank. No pressure is present on the top of Spool 7. Cylinder return pressure passes through the check-poppet in the bottom of Spool 7 to build pressure under the spool which moves the spool upward compressing the top spring. This movement allows the returning cylinder oil to flow into the Low Pressure Passage 20 to the Low Pressure Relief Valve 3. Approximately 75 psi (517 kPa) causes this valve to open, allowing the oil to flow out Port 10 to the tank.

The counterbalance valve 4 will open as the body is raised and close as the operator releases the hoist lever and the raise pressure at port 22 decreases. If the load were to stick near the tail of the body and the body is overcenter, pressure in the annulus area of the hoist cylinders will increase.

If the pressure exceeds 3000 psi (20.7 MPa) at port 23, the counterbalance valve will open again to direct oil back to the hoist valve, preventing damage to the hoist cylinder seals from excessive pressure.

When the operator releases the lever, the valves change to the HOLD position. If the body raises to the position that activates the hoist limit switch located above the right rear suspension before the operator releases the lever, the Hoist Limit Solenoid 13 is energized. The solenoid valve closes the raise pilot Port 14 on the hoist and releases the Hoist Pilot Valve raise pilot pressure at Port 24 to tank, allowing the Head End Spool 8 to center and shut off supply of oil to the hoist cylinders. This prevents maximum extension of the hoist cylinders.

FIGURE 7-7. HOIST CIRCUIT: POWER UP POSITION

1. Hoist Relief Valve 2500 psi (17.2 MPa)
2. Flow Control Valve
3. Low Pressure Relief Valve 75 psi (517 kPa)
4. Counterbalance Valve
5. Rod End Work Port
6. Hoist Cylinders
7. Rod End Spool
8. Head End Spool
9. Head End Work Port
10. Return Port
11. Supply Port
12. Pilot Supply Port
13. Power Up Pilot Line Solenoid Valve
14. Raise Pilot Port
15. Down Pilot Port
16. Power Down Relief Valve, 1500 psi (10.5 MPa)
17. Anti-void Check Valve
18. Load Check Valve
19. High Pressure Passage
20. Low Pressure Passage
21. Pilot Operated Check Valve
22. Manifold Power Up Port
23. Manifold Power Down Port
24. Solenoid Valve Return Port
25. Overcenter Manifold Check Valve (CV)

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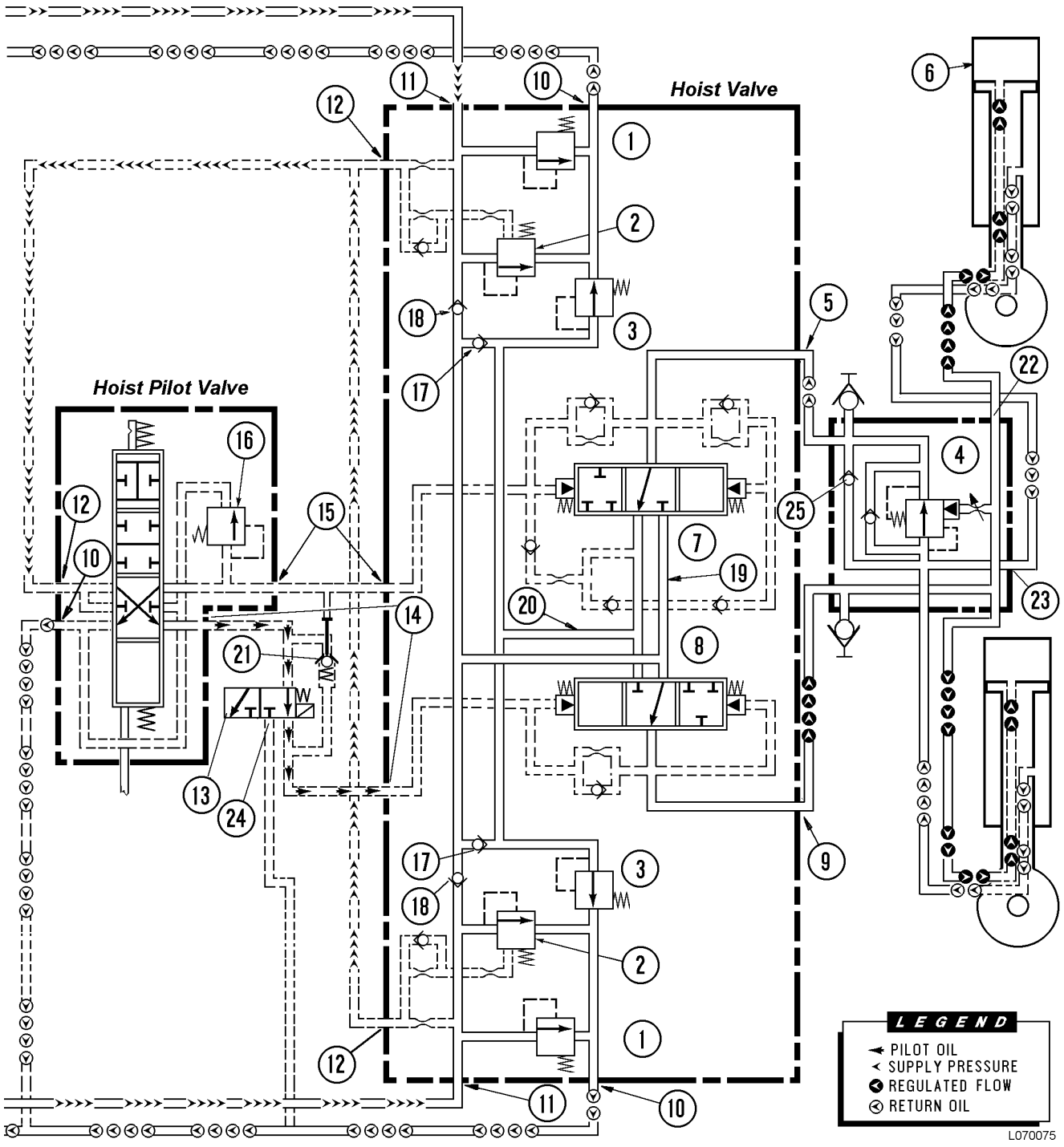


FIGURE 7-7. POWER UP

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HOLD OPERATION (Figure 7-8)

The Pilot Valve spool is positioned to allow the pilot supply oil entering Port 12 to return to the tank through Port 10. Pilot supply pressure in Ports 12 then decreases to no pressure allowing Flow Control Valve 2 to open and return the incoming pump oil to the tank through Port 10. Both pilot Ports 14 & 15 in the Pilot Valve are closed by the Pilot Valve spool. In this condition pressure is equalized on each end of each main spool allowing the springs to center the spools and close all ports to trap the oil in the cylinders and hold the body in its current position.

FIGURE 7-8. HOIST CIRCUIT: HOLD POSITION

1. Hoist Relief Valve 2500 psi (17.2 MPa)
2. Flow Control Valve
3. Low Pressure Relief Valve 75 psi (517 kPa)
4. Counterbalance Valve
5. Rod End Work Port
6. Hoist Cylinders
7. Rod End Spool
8. Head End Spool
9. Head End Work Port
10. Return Port
11. Supply Port
12. Pilot Supply Port
13. Power Up Pilot Line Solenoid Valve
14. Raise Pilot Port
15. Down Pilot Port
16. Power Down Relief Valve, 1500 psi (10.5 MPa)
17. Anti-void Check Valve
18. Load Check Valve
19. High Pressure Passage
20. Low Pressure Passage
21. Pilot Operated Check Valve
22. Manifold Power Up Port
23. Manifold Power Down Port
24. Solenoid Valve Return Port
25. Overcenter Manifold Check Valve (CV)

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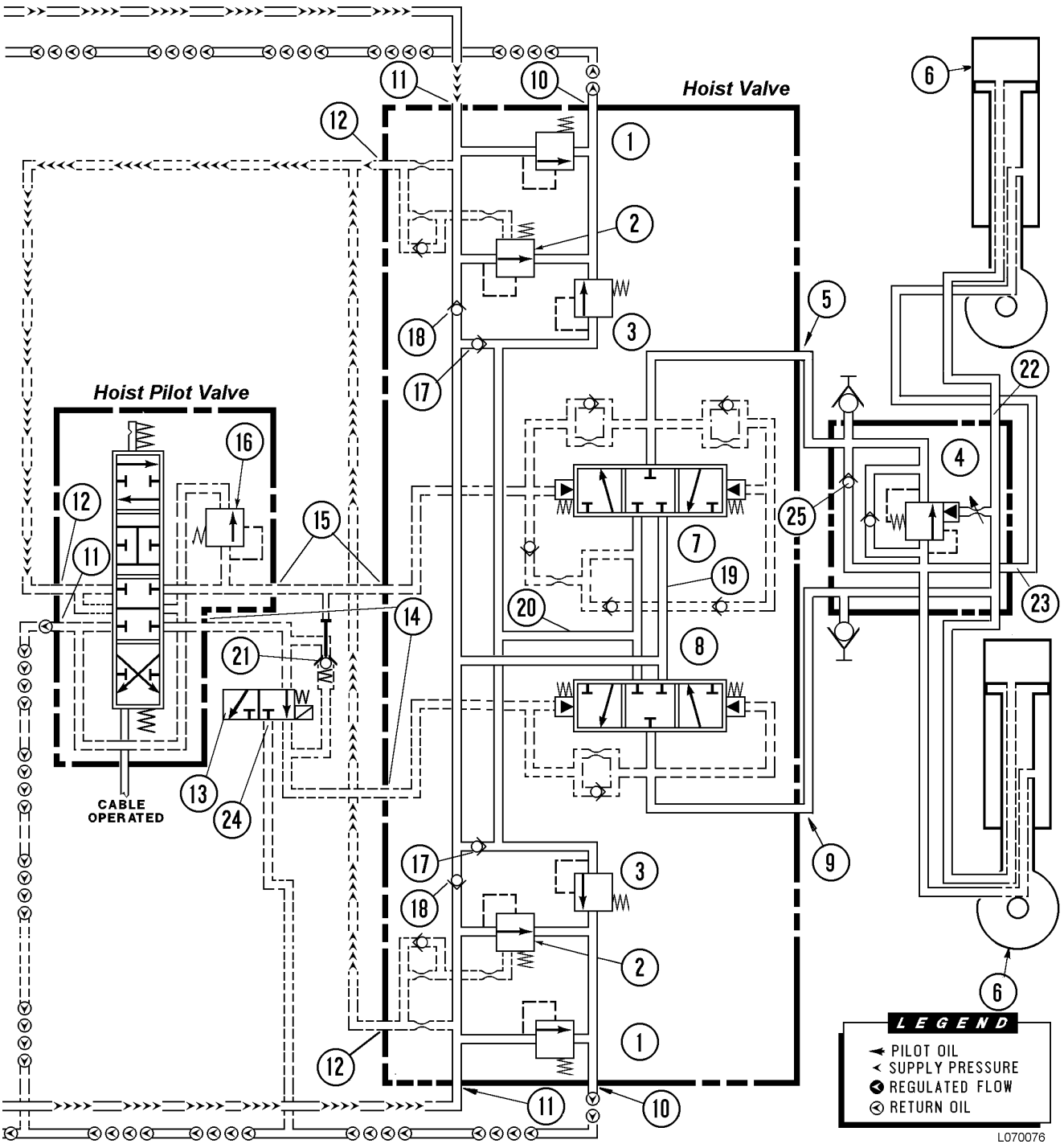


FIGURE 7-8. HOLD POSITION

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POWER DOWN OPERATION (Figure 7-9)

When the operator moves the lever to lower the body, the Hoist Pilot Valve is positioned to direct the pilot supply oil in Ports 12 to Port 15 on the Hoist Valve to the top of the Rod End Spool 7. Pilot pressure increases to move the spool down compressing the bottom spring. Movement of the spool connects the High Pressure Passage 19 to the rod end (annulus area) of the hoist cylinders. At the same time, the Flow Control Valve 2 is forced to close as pilot pressure increases thus directing the incoming pump oil to the hoist cylinders through Spool 7 and the overcenter manifold check valve 25 rather than back to the tank.

If the body is at the maximum up position, the hoist limit switch has the hoist limit solenoid activated, closing the raise port 14 on the hoist valve. Power down pilot pressure in Ports 15 pushes open the pilot operated check valve 21 so the pilot pressure in Ports 14 is open to tank through the Pilot Valve spool. As oil attempts to return from the head end of the hoist cylinders, it initially encounters the closed Head End Spool 8. Pressure increases on the bottom end of the spool causing it to move upward. This allows the returning oil to go into the Low Pressure Passage 20, build up 75 psi (517 kPa) to open the Low Pressure Relief 3, and exit the Hoist Valve through Port 10 to the tank. As the body descends and the hoist limit solenoid is no longer activated, the pilot operated check valve is no longer necessary.

FIGURE 7-9. HOIST CIRCUIT: POWER DOWN POSITION

1. Hoist Relief Valve 2500 psi (17.2 MPa)
2. Flow Control Valve
3. Low Pressure Relief Valve 75 psi (517 kPa)
4. Counterbalance Valve
5. Rod End Work Port
6. Hoist Cylinders
7. Rod End Spool
8. Head End Spool
9. Head End Work Port
10. Return Port
11. Supply Port
12. Pilot Supply Port
13. Power Up Pilot Line Solenoid Valve
14. Raise Pilot Port
15. Down Pilot Port
16. Power Down Relief Valve, 1500 psi (10.5 MPa)
17. Anti-void Check Valve
18. Load Check Valve
19. High Pressure Passage
20. Low Pressure Passage
21. Pilot Operated Check Valve
22. Manifold Power Up Port
23. Manifold Power Down Port
24. Solenoid Valve Return Port
25. Overcenter Manifold Check Valve (CV)

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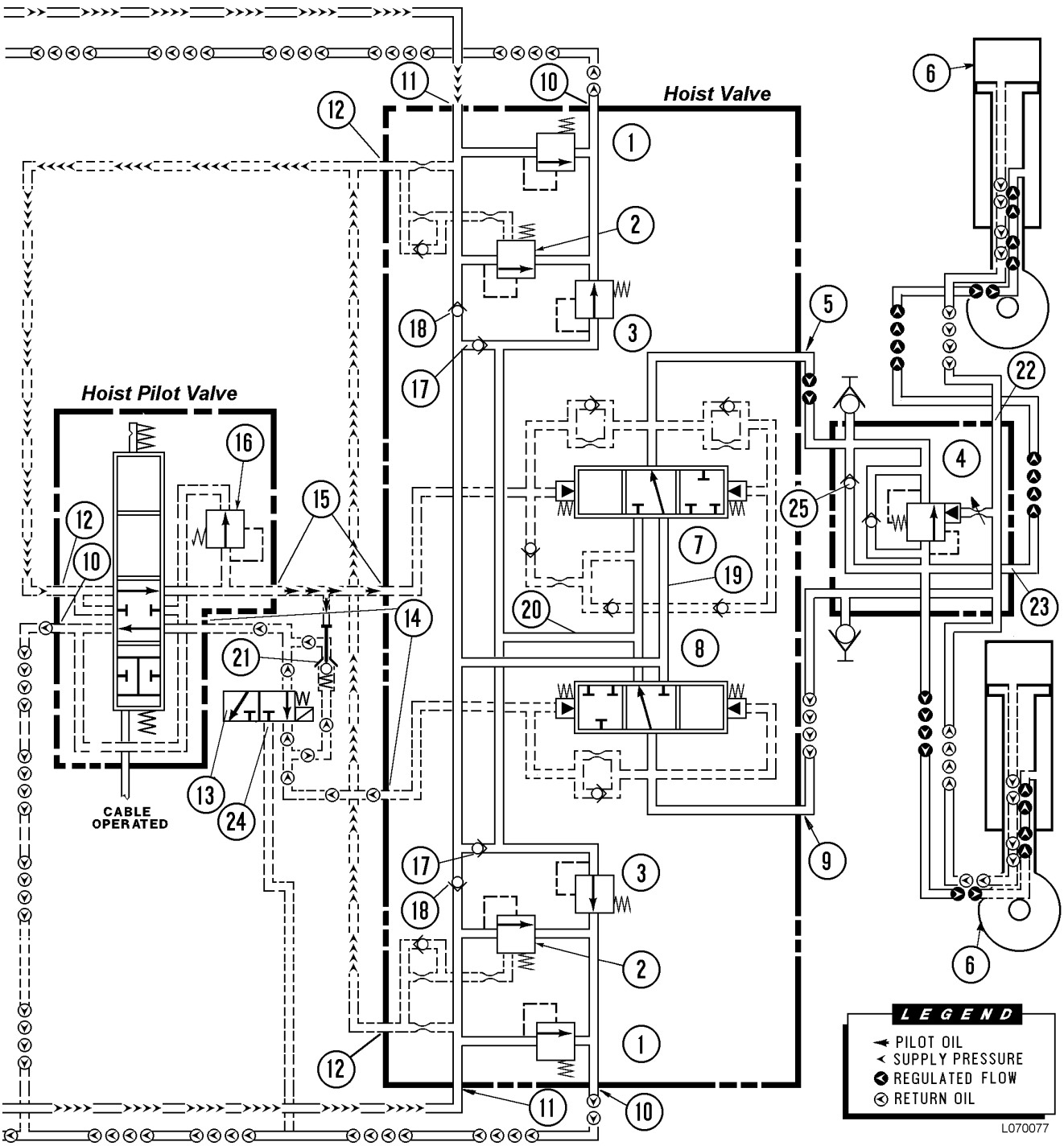


FIGURE 7-9. POWER DOWN

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FLOAT OPERATION (Figure 7-10)

When the operator releases the lever as the body travels down, The Hoist Pilot Valve spool returns to the FLOAT position. In this position all ports (10, 12, 14, & 15) and the Power Down Pilot Line Solenoid Valve are common with each other. Therefore; the pilot supply oil is returning to tank with no pressure buildup thus allowing the Flow Control Valve 2 to remain open to allow the pump oil to return to the tank through Hoist Valve Port 10. With no blockage of either Raise or Down Pilot Ports 14 & 15 in the Pilot Valve, there is no pressure on the top of either main spool. The oil returning from the Head End of the hoist cylinders builds pressure on the bottom of the Head End Spool 8 exactly like in Power Down allowing the returning oil to transfer to the Low Pressure Passage 20. The back pressure in the Low Pressure Passage created by the Low Pressure Relief Valve 3 causes pressure under the Rod End Spool 7 to move the spool upward. This connects the Low Pressure Passage to the Rod End of the hoist cylinders. The 75 psi (517 kPa) in the Low Pressure Passage causes oil to flow to the rod end of the cylinders to keep them full of oil as they retract. When the body reaches the frame and there is no more oil flow from the cylinders, the Main Spools center themselves and close the cylinder ports and the High and Low Pressure Passages.

FIGURE 7-10. HOIST CIRCUIT: FLOAT POSITION

1. Hoist Relief Valve 2500 psi (17.2 MPa)
2. Flow Control Valve
3. Low Pressure Relief Valve 75 psi (517 kPa)
4. Counterbalance Valve
5. Rod End Work Port
6. Hoist Cylinders
7. Rod End Spool
8. Head End Spool
9. Head End Work Port
10. Return Port
11. Supply Port
12. Pilot Supply Port
13. Power Up Pilot Line Solenoid Valve
14. Raise Pilot Port
15. Down Pilot Port
16. Power Down Relief Valve, 1500 psi (10.5 MPa)
17. Anti-void Check Valve
18. Load Check Valve
19. High Pressure Passage
20. Low Pressure Passage
21. Pilot Operated Check Valve
22. Manifold Power Up Port
23. Manifold Power Down Port
24. Solenoid Valve Return Port
25. Overcenter Manifold Check Valve (CV)

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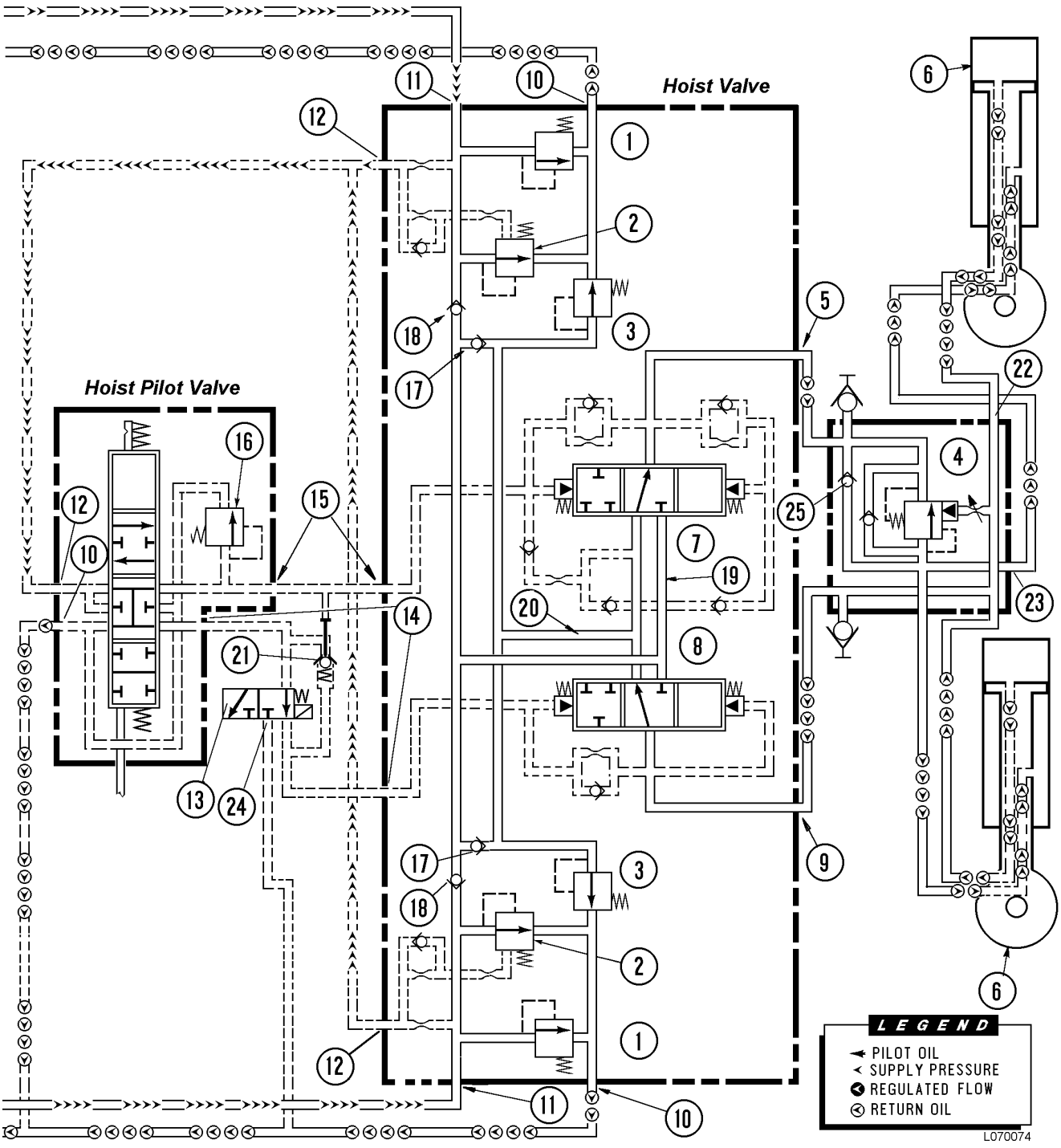


FIGURE 7-10. FLOAT POSITION

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NOTES

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HOIST CIRCUIT COMPONENT REPAIR

HOIST VALVE

⚠DANGER

Relieve pressure before disconnecting hydraulic lines. Tighten all connections securely before applying pressure.

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

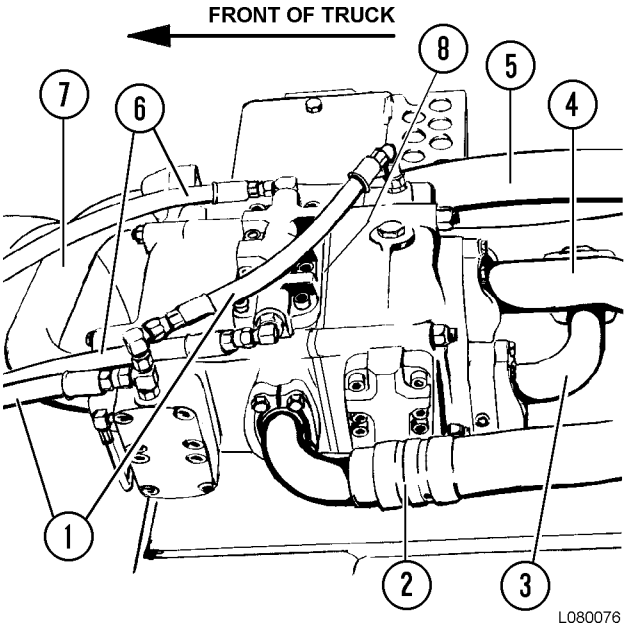


FIGURE 8-1. HOIST VALVE INSTALLATION

1. Hoist Pilot Valve Supply
2. Power Up Line
3. Inlet From Filters
4. Return To Tank
5. Power Down Line
6. To Hoist Pilot Valve
7. Return To Tank
8. Separator Plate

Removal

1. Shut down engine and turn keyswitch “Off”.
2. Thoroughly clean the exterior of the hoist valve.
3. Disconnect and cap or plug all line connections to help prevent hydraulic oil contamination, refer to Figure 8-1.
4. Remove capscrews and lockwashers securing the hoist valve to its mounting bracket.

⚠WARNING

The hoist valve weighs approximately 320 lbs. (145 Kg). Use a suitable lifting device that can handle the load safely.

5. Attach a suitable lifting device (that can handle the load safely) to the hoist valve and remove hoist valve from truck.
6. Move the hoist valve to a clean work area for disassembly.

Installation

1. Attach a suitable lifting device to the hoist valve. Move the hoist valve into position with the separator plate (8, Figure 8-1) located to the rear. Secure in place with capscrews, nuts and lockwashers. Tighten capscrews to standard torque.

Note: Be certain hoist valve assembly is positioned with separator plate (8, Figure 8-1) towards rear of truck when valve is lowered onto mounting plate.

2. Using new O-rings at the flange fittings, connect hydraulic lines. Tighten flange capscrews to standard torque. Refer to Figure 8-1 for hydraulic line location.
3. Connect pilot supply lines, tighten fittings securely.
4. Start the engine. Raise and lower body to check for proper operation. Observe for leaks.
5. Service hydraulic tank if necessary.

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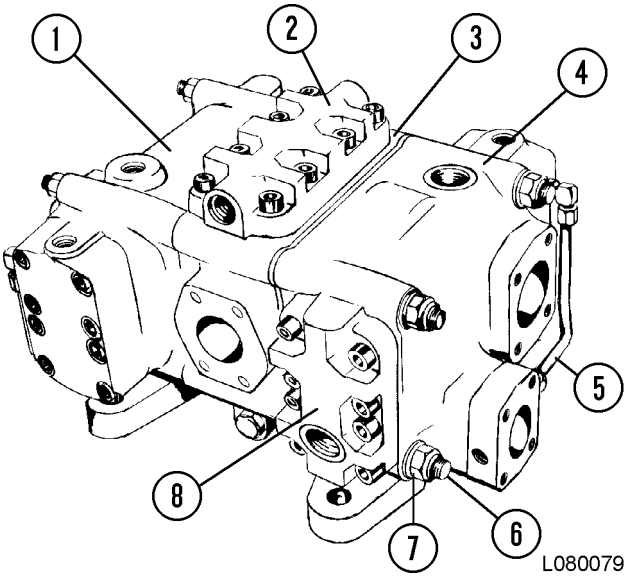


FIGURE 8-2. HOIST VALVE ASSEMBLY

1. Inlet Section
2. Spool Section Cover
3. Spool Section
4. Inlet Section
5. Tube
6. Tie Rods
7. Nuts and Washers
8. Inlet Section Cover

O-Ring Replacement

NOTE: It is not necessary to remove the individual valve sections to accomplish repair, unless emergency field repair is required to replace the O-rings between sections to prevent leakage. Loosening and retightening of the main valve tie rod nut could cause distortion resulting in binding or severely sticking plungers, poppet and spools.

To replace the O-rings between the valve sections:

1. Match mark each part on the hoist valve to aid in reassembly. Remove the four tie rod nuts from one end of the valve. Slide the tie rods from the valve and separate the sections.
2. Inspect the machined sealing surfaces for scratches or nicks. If scratches or nicks are found, remove by lapping on a smooth flat steel surface with fine lapping compound.
3. Lubricate the new O-rings lightly with multipurpose grease. Replace O-rings between sections. Stack the sections together making sure O-rings between the sections are properly positioned.
4. Install the four tie rods with the dished washer between the nut and housing (Figure 8-3).

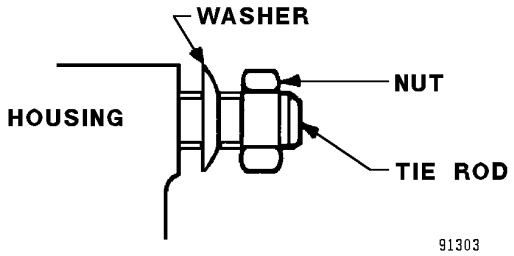


FIGURE 8-3. TIE ROD INSTALLATION

5. A torque wrench should be used to tighten the nuts in the pattern as shown in Figure 8-4. The tie rods should be tightened evenly to **160 ft. lbs. (217 N.m)** torque in the following sequence.
   a. Tighten nuts evenly to **20 ft. lbs. (27 N.m)** torque in order 1, 4, 2, 3.
   b. Tighten nuts evenly to **50 ft. lbs. (68 N.m)** torque in order 1, 4, 2, 3.
   c. Tighten nuts evenly to **160 ft. lbs. (217 N.m)** torque in order 1, 4, 2, 3.

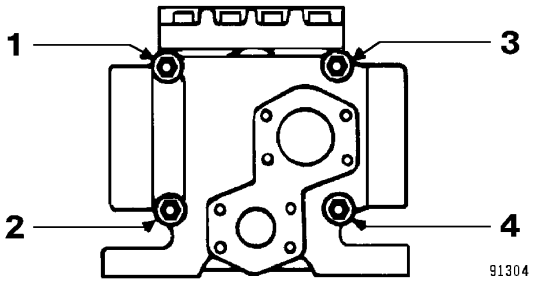


FIGURE 8-4. TIGHTENING SEQUENCE

INLET SECTION

Disassembly

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

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

3. Remove capscrews (1) and cover (2). Remove springs (3 & 5) and main relief valve (4). Remove sleeve (6), low pressure relief (7) and O-rings (8). The main relief valve (4) is factory preset at 2500 psi (17.2 MPa). Replace as a complete assembly only. If adjustment is necessary, refer to *"Checking Hoist System Pressure Relief Valve"* later in this section.

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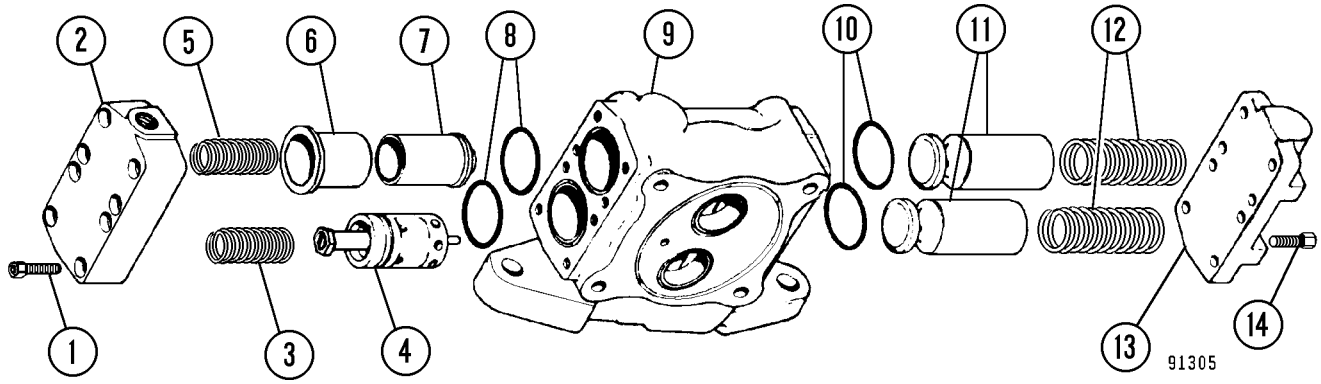


FIGURE 8-5. INLET SECTION DISASSEMBLY

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

NOTE: If restrictor poppet removal in cover (1) is required, refer to step 4 and Figure 8-6.

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

Cleaning and Inspection

1. Discard all O-rings and backup rings. Clean all parts in solvent and dry with compressed air.
2. Inspect all springs for breaks or distortion. Inspect poppet seating surfaces for nicks or excessive wear. All seats must be sharp and free of nicks.
3. Inspect all bores and surfaces of sliding parts for nicks, scores or excessive wear.
4. Inspect poppets in their respective bore for fit. Poppets should move freely, without binding, through a complete revolution.
5. Inspect fit and movement between sleeve and low pressure relief valve.

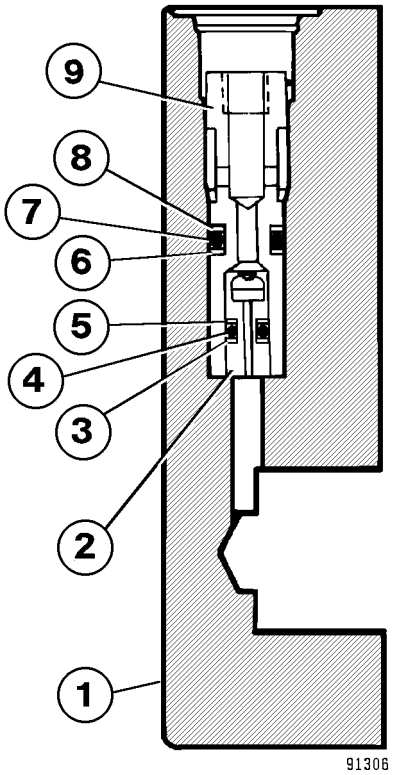


FIGURE 8-6. RESTRICTOR POPPET REMOVAL

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

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Assembly

1. Coat all parts including housing bores with clean type C-4 hydraulic oil. Lubricate O-rings lightly with a multipurpose grease.
2. If restrictor poppet (2, Figure 8-6) was removed, reassemble in the order shown.
3. Install poppets (11, Figure 8-5) in their respective bores. Install springs (12).
4. Install O-rings (10), and cover (13). Install capscrews (14). Tighten capscrews to **60 ft. lbs. (81 N.m)** torque.
5. Install low pressure relief (7) in sleeve (6) and install assembly in housing (9). Install main relief valve (4). Install springs (3 & 5). Install cover (2). Install capscrews (1). Tighten capscrews to **60 ft. lbs. (81 N.m)** torque. Connect external tube, tighten nuts to **25 ft. lbs. (34 N.m)** torque.

SPOOL SECTION

Disassembly

NOTE: It is not necessary to remove the inlet sections (4, Figure 8-2) to accomplish spool section (3) disassembly.

1. Match mark or identify each part when removed in respect to its location or respect to its mating bore to aid reassembly.
2. Remove capscrews and remove spool section cover (2, Figure 8-2). Remove and discard O-rings (4 & 5, Figure 8-8).
3. Remove poppet (1, Figure 8-7), remove and discard O-ring (3).

NOTE: The poppet (1) is equipped with a small steel ball. Do not misplace.

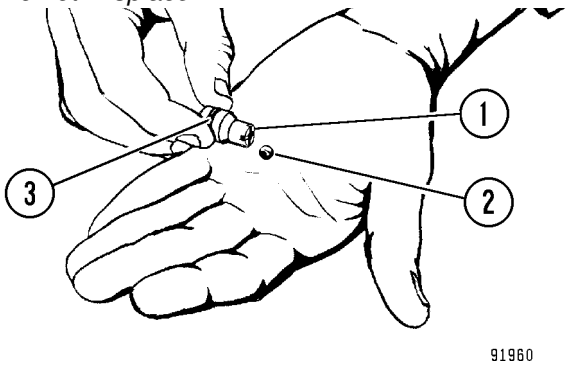


FIGURE 8-7. POPPET & BALL

1. Poppet
2. Steel Ball
3. O-Ring

4. Remove restrictor poppet (1, Figure 8-8). Remove and discard O-ring (2) and backup ring (3), if used. Note the position of the restrictor when removed to insure correct reassembly.

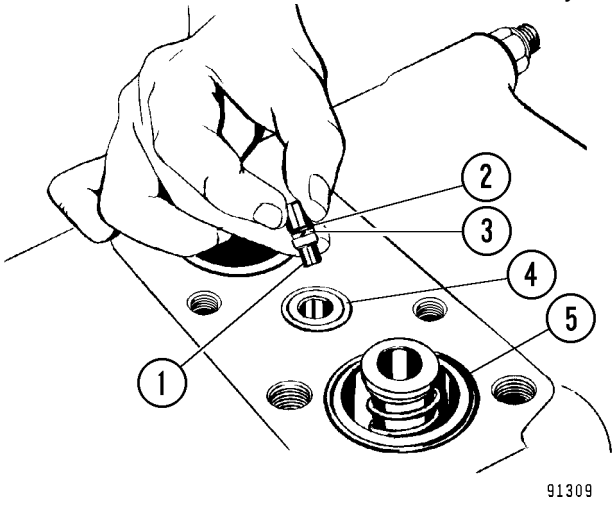


FIGURE 8-8. RESTRICTOR POPPET REMOVAL

1. Restrictor Poppet
2. O-ring *
3. Backup Ring *
4. Seal Ring
5. O-Ring

***Note: Items 2 & 3 not used on all valves.**

5. Remove spool assembly (2, Figure 8-9). Note the color of the lower spring (blue) to insure proper location during reassembly. Also note the “V” groove (1) on end of spool.

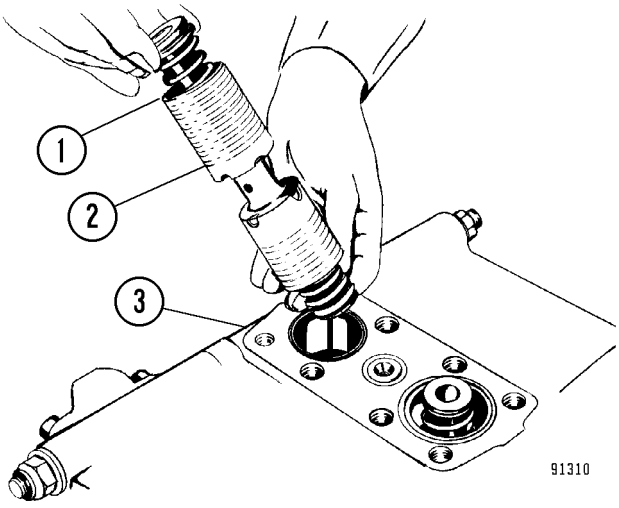


FIGURE 8-9. SPOOL REMOVAL

1. “V” Groove
2. Spool Assembly
3. Spool

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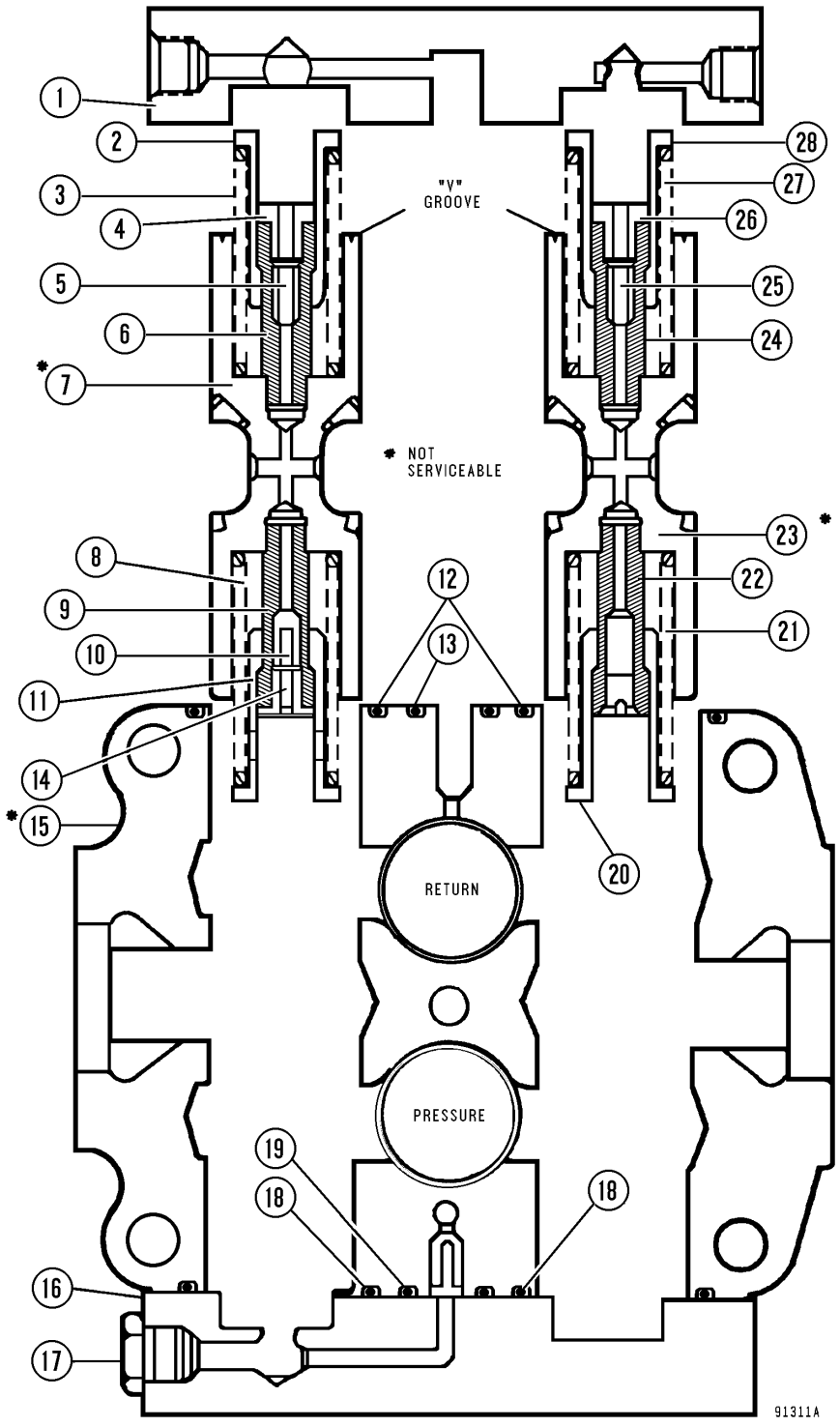


FIGURE 8-10. SPOOL SECTION ASSEMBLY

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

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6. Remove plug (4, Figure 8-10) from end of spool (7). Remove spring seat (2) and spring (3). Remove poppet (5) and spool end (6).

NOTE: Pay special attention to poppets (5, 10 and 25, Figure 8-10) during removal to ensure proper location during reassembly. Poppets may be identified with a colored dot; red, white or green. If poppets are not color coded, use the following chart for identification:

POPPET COLOR	ORIFICE DIAMETER	DRILL SIZE
White	0.063 in. (1.6 mm)	#52
Green	0.093 in. (2.4 mm)	#42
Red	0.110 in. (2.8 mm)	#35

7. Repeat step 6 for the opposite end of spool (7) and the top end of spool (23).
8. Remove spool end (22), spring retainer (20) and spring (21).
9. Remove cover (16), remove O-rings (18 & 19).

Cleaning and Inspection

1. Discard all O-rings and backup rings. Clean all parts in solvent and blow dry with compressed air.
2. Inspect all springs for breaks or distortion. Inspect poppet seating surfaces for nicks or excessive wear. All seats must be sharp and free of nicks.
3. Inspect all bores and surfaces of sliding parts for nicks, scores or excessive wear.
4. Inspect all poppets in their respective bore for fit. Poppets should move freely without binding through a complete revolution.

Assembly

1. Lubricate O-rings (18 & 19, Figure 8-10), with clean hydraulic oil. Install O-rings in spool housing and install cover (16). Secure cover in place with capscrews. Tighten capscrews to **60 ft. lbs. (81 N.m)** torque.
2. Install spring (3, Figure 8-10) in spool (7). Install spring seat (2). Apply Loctite® to the threads of spool end (6). Install spool end (6) and tighten to **25 ft. lbs. (34 N.m)** torque. Install poppet (5). Apply Dri-loc #204 to the threads of plug (4). Install plug (4) and tighten to **15 ft. lbs. (20 N.m)** torque.

NOTE: Poppets 5, 10 and 25 may be color coded and must be installed in their original location.

3. Repeat step 2 for the opposite end of spool (7). Make sure spring (8) is blue in color.
4. Lubricate spool assembly (7) and carefully install in spool housing (15). Make sure the “V” groove in spool (7) is in the up position, or toward cover (1).
5. Repeat step 2 for the top end of spool (23). The bottom end of spool (23) does not contain a poppet or plug. Install spring (21) which is blue in color, spring seat (20) and spool end (22). Apply Loctite to spool end threads. Install spool end (22) and tighten to **25 ft. lbs. (34 N.m)** torque.
6. Lubricate the assembled spool (23) and install in spool housing (15). Make sure the “V” groove is in the up position, or toward cover (1).

NOTE: Spools (7) and (23) are physically interchangeable. Make sure spool (23) is installed toward the base port of the spool housing.

7. Install new O-ring and backup ring on restrictor poppet (1, Figure 8-8). Install restrictor poppet in housing.
8. Install new O-rings (12 & 13, Figure 8-10).
9. Install new O-ring and backup ring on poppet (1, Figure 8-7). Make sure the small steel ball is installed in poppet (1). Install poppet (1) in cover (3).
10. Install covers (1, Figure 8-10). Secure cover in place with capscrews. Tighten capscrews to **60 ft. lbs. (81 N.m)** torque.

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HOIST PILOT VALVE

Removal

1. Place the hoist control lever in the body down position. Make sure the body is in the full down position. Release the hoist control lever to return the hoist valve spool to the FLOAT position.
2. Disconnect hydraulic lines at the hoist pilot valve (1, Figure 8-11). Remove capscrews (4).
3. Loosen and unthread jam nut (7). Unthread sleeve (6) until cotter pin (5) and pin (9) are exposed.
4. Remove cotter pin (5) and pin (9).
5. Remove the hoist pilot valve mounting hardware (10). Remove hoist pilot valve. Refer to hoist pilot valve disassembly for repair instructions.

Installation

1. Place the hoist pilot valve into position on the mounting bracket. Secure valve in place with capscrews (10, Figure 8-11).
2. Position hydraulic lines (2, 13, 14 and 15) over valve ports and assemble fittings. Tighten hydraulic line connections securely.
3. Place hoist control lever in spring-centered position. Adjust pilot valve spool until centerline of cable attachment hole extends 1.16 in. (29.5 mm) from the face of the valve body.
4. Align control cable eye with pilot valve spool hole and insert pin (9). Secure pin in place with cotter key (5).
5. Thread sleeve (6) upward until contact is made with valve body. Move flange (3) into position and secure in place with capscrews (4).
6. Thread jam nut (7) against sleeve (6). Tighten jam nut securely.
7. Start the engine and check for proper hoist operation. Observe for leaks.

Disassembly

1. Thoroughly clean the exterior of the valve. Place the valve in a clean work area for disassembly.
2. Remove machine screw (15, Figure 8-12) seal plate (16), wiper (13) and O-ring (12).

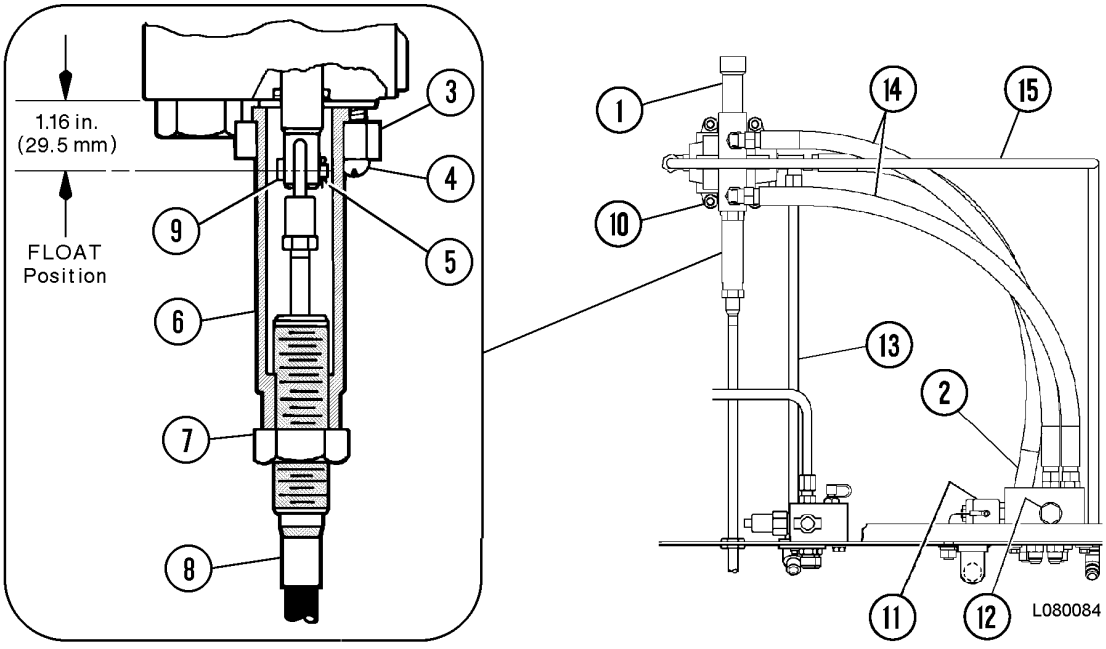


FIGURE 8-11. HOIST PILOT VALVE REMOVAL

1. Hoist Pilot Valve
2. Hydraulic Lines
3. Flange
4. Capscrew
5. Cotter Pin
6. Sleeve
7. Jam Nut
8. Control Cable
9. Pin
10. Capscrews
11. Solenoid Valve (Body Up Limit)
12. Pilot Operated Check Valve
13. Return Line
14. Pilot Pressure to Hoist Valve
15. Supply Pressure From Hoist Valve

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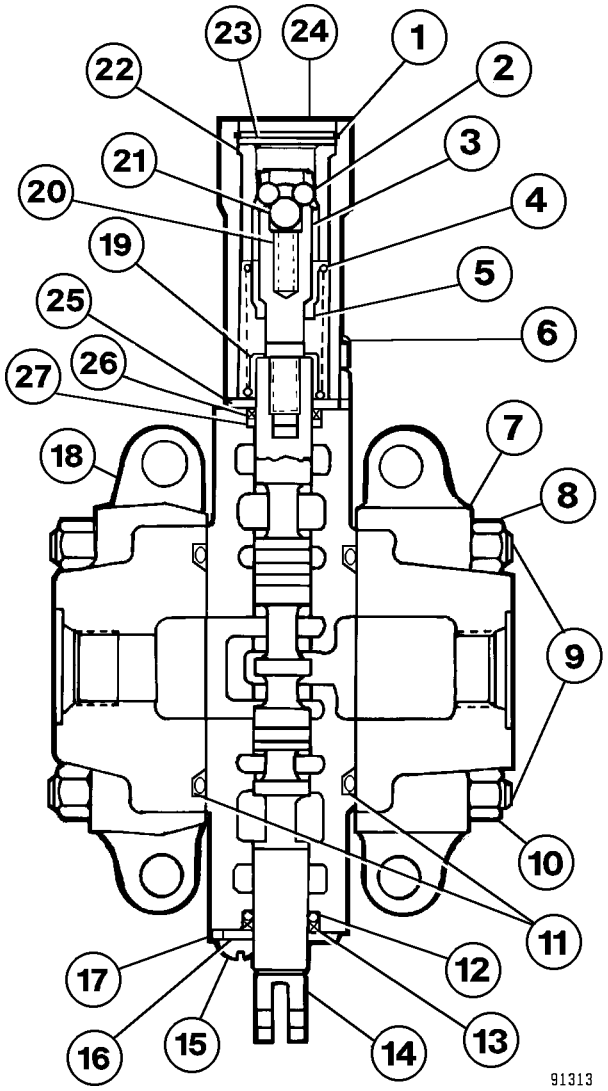


FIGURE 8-12. HOIST PILOT VALVE

1. Snap Ring
2. Ball (4)
3. Detent Pin
4. Spring
5. Spacer
6. Capscrew
7. Outlet Housing
8. Nut
9. Tie Rod
10. Nut
11. O-Ring
12. O-Ring
13. Wiper
14. Spool
15. Machine Screw
16. Seal Plate
17. Spool Housing
18. Inlet Housing
19. Spring Seat
20. Spring
21. Ball (1)
22. Detent Sleeve
23. Spacer
24. Cap
25. Seal Retainer
26. Wiper
27. O-Ring

3. Remove snap ring (1, figure 8-12), capscrews (6), cap (24), spacer (23), and detent sleeve (22). Detent Balls (2) and (21) will fall free when the cap and detent sleeve are removed. Separate cap (24), spacer (23) and detent sleeve (22), as this will be necessary for reassembly.
4. Carefully slide the spool (14) out of the spool housing (17). Remove seal retainer (25), wiper (26) and O-ring (27) from spool (14).
5. Insert a rod in the cross holes of the detent pin (3) and unscrew from spool (14). Slight pressure should be exerted against the detent pin as it disengages and spring tension is released.
6. Remove spring seats (19), spring (4) and spacer (5).
7. Remove relief valve (2, Figure 8-13) from the spool housing (1).
8. Match mark the inlet and outlet housings in relationship to the spool housing to insure correct location during reassembly.
9. Remove nuts (8) and (10) and remove tie rods (9). Separate the valve housings. Remove O-ring (11). Remove the poppet check and spring from the spool housing which are located on the outlet housing side of the spool housing.

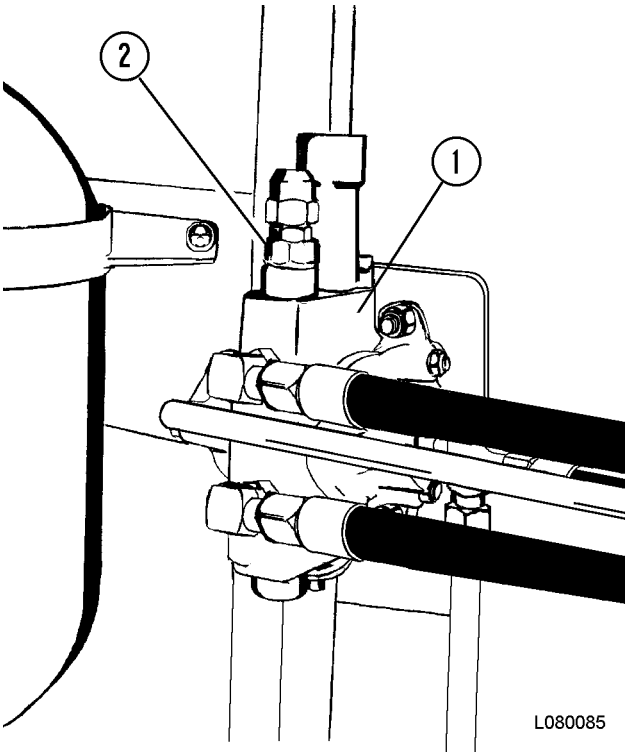


FIGURE 8-13. RELIEF VALVE

1. Valve Housing
2. Relief Valve

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Cleaning and Inspection

1. Clean all parts including housings in solvent and blow dry with compressed air.
2. Inspect seal counter bores, they must be free of nicks or grooves.
3. Examine springs for breaks or distortion.
4. Inspect spool (14, Figure 8-12). The spool must be free of longitudinal score marks, nicks or grooves.
5. Test spool (14) in spool housing for fit. Spool must fit freely, without binding, through a complete revolution.

NOTE: The spool housing (17), spool (14), inlet housing (18) and outlet housing (7) are not serviced separately. Should any of these parts require replacement, the entire control valve must be replaced.

Assembly

1. Thoroughly coat all parts including housing bores with clean type C-4 hydraulic oil.
2. If the inlet and outlet housings were removed follow steps 3 through 5 for reassembly.
3. Install check poppet (2, Figure 8-14) and spring (3) in spool housing (1).
4. Install new O-ring (4) in spool housing. Move the inlet and outlet housings into position.
5. Install tie rods. Install tie rod nuts. Tighten tie rod nuts to the torques shown in Figure 8-15.
6. Install a new O-ring (27, Figure 8-12) and wiper (26). Install seal retainer (25).
7. Install spacer (5), spring seats (19), and spring (4). Thread detent pin (3) into spool (14). Slight pressure will be required to compress the detent spring. Tighten detent pin **84-96 in. lbs. (9-11 N.m)** torque. Install spring (20). Carefully install spool into spool housing.
8. Apply grease to the cross holes of the detent pin (3) to hold balls (21) and (2).
9. Slide detent sleeve (22) into cap (24) and place over a punch. Using this punch, depress ball (21) and insert balls (2) in detent pin cross holes.
10. While holding down on ball (21), slide detent sleeve (22) and cap (24) as an assembly over the detent pin (3). Continue to insert detent sleeve (22) until it contacts spring seat (19).
11. Secure cap (24) in place with capscrews (6). Tighten capscrews (6) to **5 ft. lbs. (7 N.m)** torque. Install spacer (23) and snap ring (1).
12. Install a new O-ring (12) and wiper (13). Install seal plate (16). Install machine screws (15).
13. Using new O-rings, install relief valve (2, Figure 8-13) in spool housing.

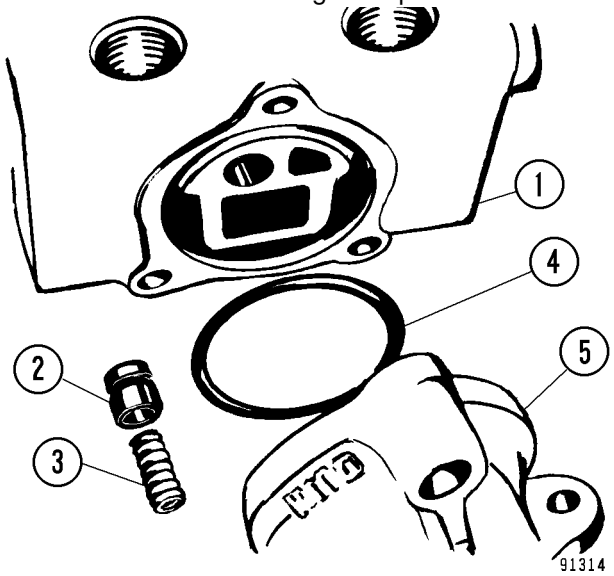


FIGURE 8-14. HOIST PILOT VALVE ASSEMBLY

1. Spool Housing
2. Check Poppet
3. Spring
4. O-ring
5. Outlet Housing

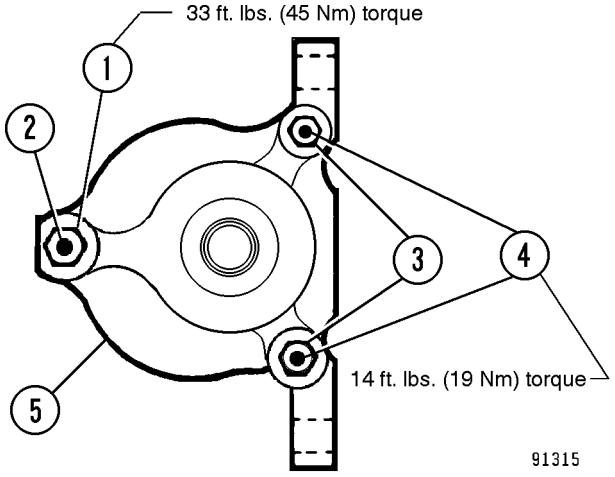


FIGURE 8-15. TIE ROD NUT TORQUE

1. Nut
2. Tie Rod
3. Nut
4. Tie Rod
5. Outlet Housing

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BODY UP LIMIT SOLENOID

The body up limit solenoid valve (11, Figure 8-11) is located inside the hydraulic cabinet behind the operators cab. This valve has no serviceable parts except for O-ring replacement. Should the solenoid valve malfunction, replace as a unit.

PILOT OPERATED CHECK VALVE

The pilot operated check valve (12, Figure 8-11) is located inside the hydraulic cabinet behind the operators cab. This valve has no serviceable parts except for O-ring replacement. Should the pilot operated check valve malfunction, replace as a unit.

HOIST CYLINDERS

Removal

⚠DANGER

Relieve pressure before disconnecting hydraulic lines. Tighten all connections securely before applying pressure.

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

1. Insure engine and key switch has been “Off” for at least 90 seconds to allow accumulator to bleed down. Be sure Park Brake is applied.
2. Disconnect the lubrication lines to the upper and lower bearings of the hoist cylinder.
3. Remove capscrew and lockwashers from clamps securing the hydraulic hoses to the hoist cylinder. Cap and plug lines and ports to prevent excessive spillage and contamination. Secure cylinder to frame to prevent movement during next step.

⚠WARNING

The hoist cylinder weighs approximately 2200 lbs. (1000 kg). Some means of support is necessary to prevent it from falling or causing injury when removing from the truck. Use a suitable lifting device that can handle the load safely.

4. At the upper mount, remove self-locking nut (4, Figure 8-16) from pin retaining capscrew. Remove capscrew (5). Use a brass drift and hammer to drive pin (1) from bore of mounting bracket.
5. Carefully lower cylinder until it lays against the inside dual tire. The hoist cylinder weighs approximately 2200 lbs. (1000 kg.). Attach a suitable lifting device that can handle the load safely to the upper cylinder mounting eye.
6. Install a retaining strap or chain to prevent the cylinder from extending during handling.

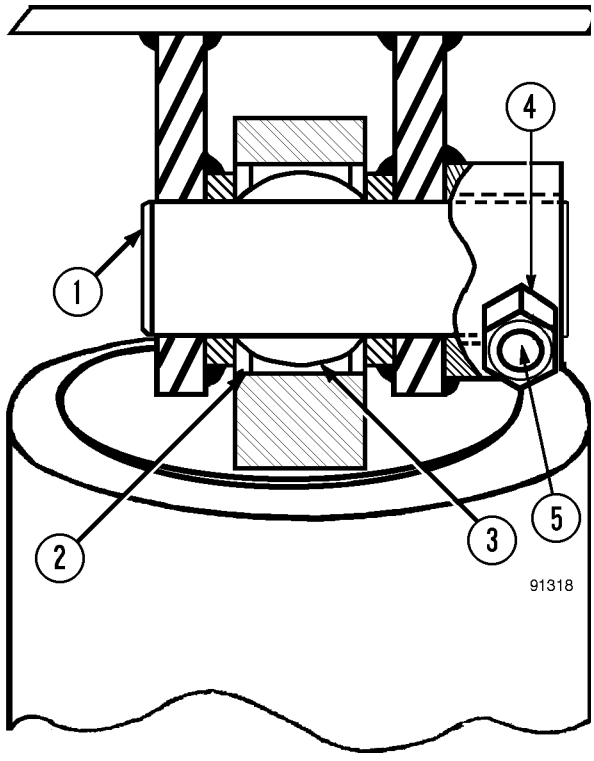


FIGURE 8-16. HOIST CYLINDER UPPER MOUNT

1. Pin
2. Retainer Ring
3. Bearing
4. Locknut
5. Capscrew

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7. At the lower mount, straighten drive lock plate tabs to allow capscrew removal. Remove all capscrews (1, Figure 8-17), locking plate (2) and retainer plate (3).
8. Carefully remove cylinder from frame pivot by pulling outward. Move cylinder to a clean area for disassembly.

NOTE: Do not lose spacer (6, Figure 8-17) between cylinder bearing and frame.

9. Clean exterior of the cylinder thoroughly.

Installation

⚠WARNING

Install a retaining strap or chain to prevent the cylinder from extending during handling. The hoist cylinder weighs approximately 2200 lbs. (1000 kg). Use a suitable lifting device that can handle the load safely.

1. The hoist cylinder weighs approximately 2200 lbs. (1000 kg). Use a suitable lifting device that can handle the load safely. Raise the cylinder into position over the pivot point on the frame. The cylinder should be positioned with the air bleed vent plug toward the front of the truck. Install spacer (6, Figure 8-17). Align bearing eye with pivot point and push cylinder into place.
2. Install retaining plate (3), locking plate (2),and capscrews. Tighten capscrews to **220 ft. lbs. (298 N.m)** torque. Bend locking plate tabs over capscrew flats.
3. Align the top hoist cylinder bearing eye with the bore of the upper mounting bracket. Refer to Figure 8-16.
4. Align retaining capscrew hole in pin with hole in mounting bracket and install pin. Install capscrew (5) and self-locking nut (4) and tighten to standard torque.
5. Install new O-rings in grooves on hose flange connections and lubricate with clean hydraulic oil. Position flanges over hoist cylinder ports and install flange clamps. Secure clamps with capscrews and lockwashers. Tighten capscrews to standard torque.
6. Reconnect lubrication lines for the upper and lower hoist cylinder bearings.
7. Raise and lower body several times to bleed air from cylinder. Check for proper operation and inspect for leaks.
8. Service hydraulic tank if necessary.

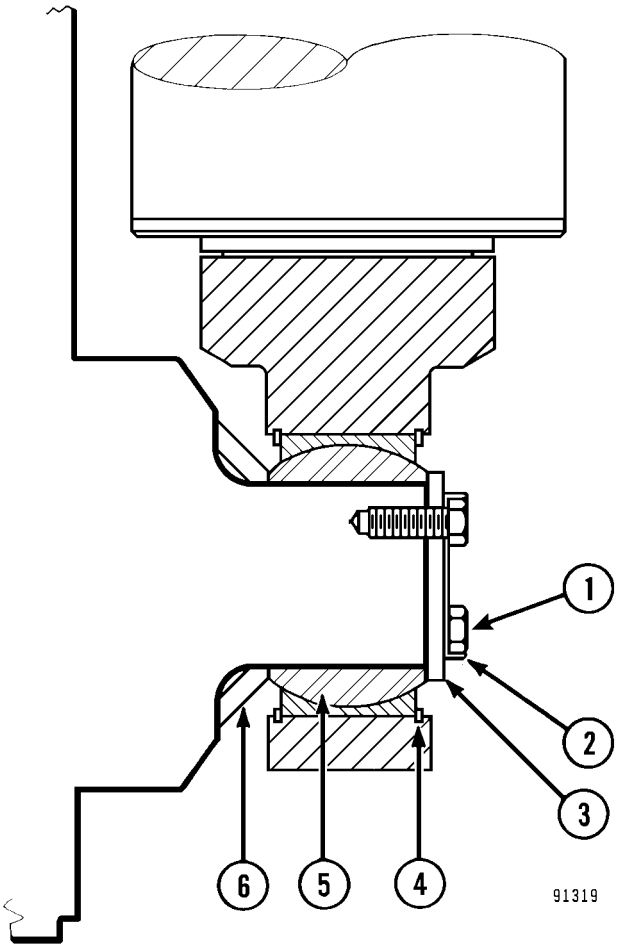


FIGURE 8-17. HOIST CYLINDER LOWER MOUNT

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

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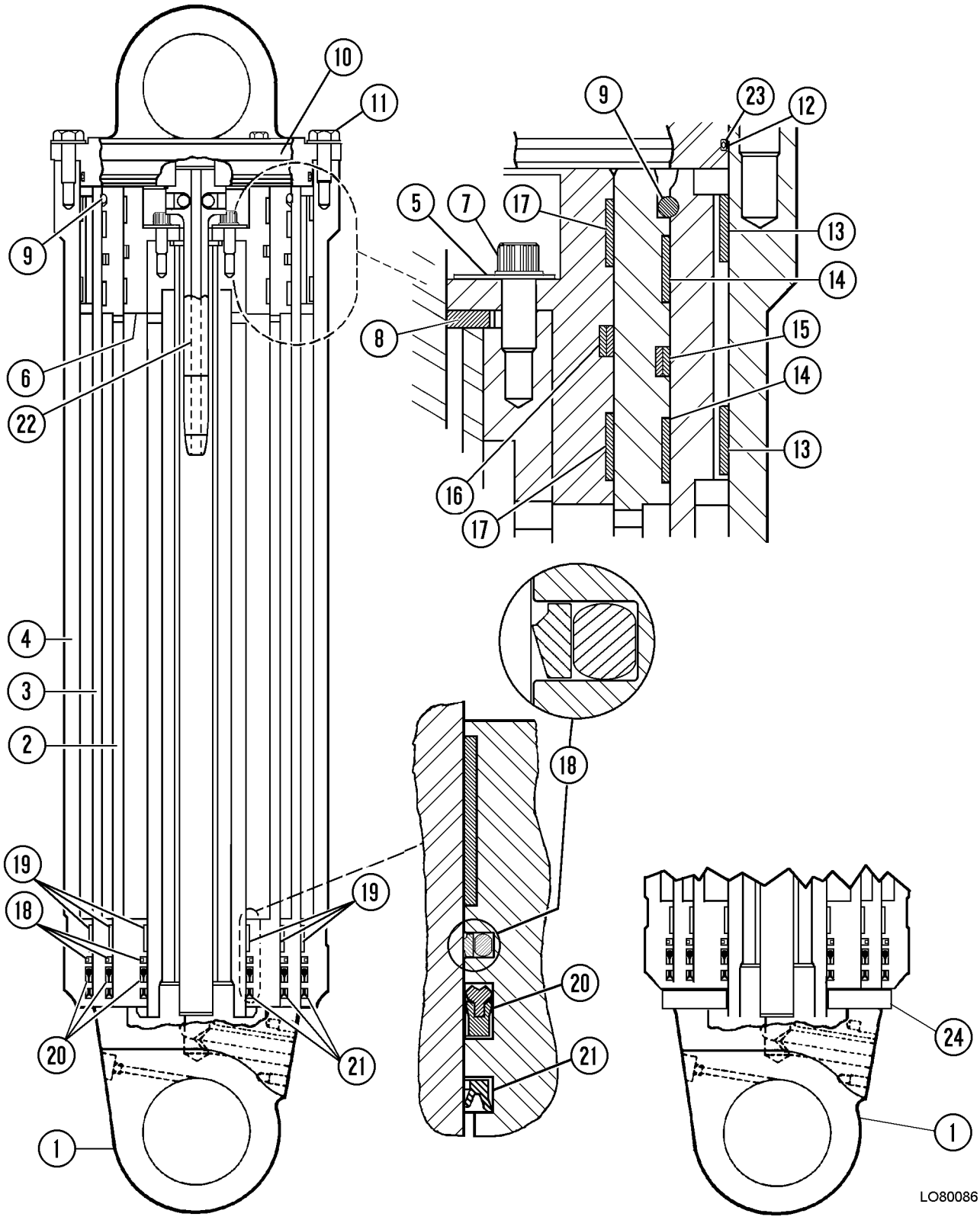


FIGURE 8-18. HOIST CYLINDER

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Disassembly

1. If removal of the hoist cylinder eye bearings is necessary, remove retainer ring (4, Figure 8-17) 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 8-18) mounting eye at the top. Remove capscrews (11) and lockwashers retaining the cover to the housing (4).
4. Using two 0.88 in. dia. x 9 in. long, threaded capscrews, thread them 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 flatwashers (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).

FIGURE 8-18 HOIST CYLINDER

1. Rod & Third Stage
2. Second Stage Cylinder
3. First Stage Cylinder
4. Housing
5. Plate
6. Rod Bearing Retainer
7. Capscrew (12-point)
8. Seal
9. Snap Ring
10. Cover
11. Capscrews
12. O-Ring
13. Bearing
14. Bearing
15. Seal
16. Seal
17. Bearing
18. Buffer Seal
19. Bearing
20. Rod Seal
21. Rod Wiper
22. Quill Assembly
23. Backup Ring
24. Ring, Cushion

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°, until the lower mounting eye is 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 cylinder housing. If equipped, remove cushion ring (24).

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

8. Rotate the cylinder housing 180°. Remove the retainer installed in step 5.
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 52 in. (1320 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.

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Cleaning and Inspection

NOTE: Use only fresh cleaning solvent, lint free wiping cloth and dry filtered compressed air when cleaning and handling hydraulic cylinder parts. Immediately after cleaning and inspection, coat all surfaces and parts with clean hydraulic oil (Type C-4).

1. Thoroughly clean and dry all parts.
2. Visually inspect all parts for damage or excessive wear.
3. If cylinder bores or plated surfaces are excessively worn of grooved, the parts must be replaced or, if possible, re-plated and machined to original specifications.
4. The quill (2, Figure 8-19) should be checked for tightness ***if it has not previously been tack welded.***
   a. Check the quill for tightness by using special tool SS1143 (Figure 8-19) and applying a tightening torque of **1000 ft. lb. (1356 N.m)**.
   b. If the quill moves, remove quill, clean threads in cover assembly and quill, and reinstall using the procedure in *"Quill Installation".*
5. When a cylinder assembly is dismantled, the capscrews (7, Figure 8-18) should be checked carefully for distress and, if in doubt, replace them.

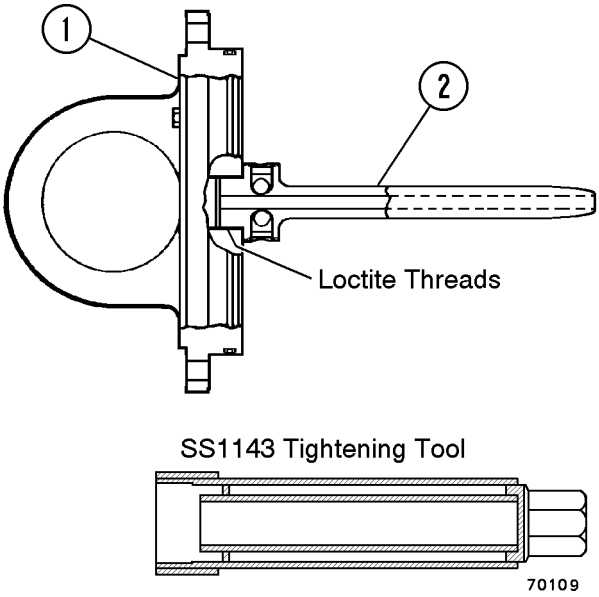


FIGURE 8-19. QUILL INSTALLATION

1. Cap Assembly 2. Quill Assembly

SS1143 Tightening Tool - Assembly Drawing

S1144 – Square Tube
(3.50" x 3.50" x 0.19" wall x 2.0" long)

SS1145 – Plate
(2.50" x 2.50" x 0.25" thick)

SS1146 – Square Tube
(3.00" x 3.00" x 0.25" wall x 15.50" long)

SS1147 – Tube, Brass
(1.75"O.D. x 1.50" I.D. x 13.50" long)

SS1148 – Square Cut
(2.50" x 2.50" x 0.75" thick)

SS1149 – Hex Drive
(1.75" Hex stock x 2.50" long)

All materials are 1020 Steel except SS1147.

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ASSEMBLY OF QUILL AND CYLINDER

NOTE: Use only new seals, bearings and O-rings during reassembly. Thoroughly lubricate all parts and seals with hydraulic oil to aid in assembly and to provide lubrication during initial operation.

Quill Installation

1. The plugs (3, Figure 8-20) and the check balls (4) in the quill should be checked during any cylinder repair to insure the plugs are tight and ball seats are not damaged. Refer to *"Installation of Check Balls and Plugs in Quill".*
2. Secure cap assembly (1) in a sturdy fixture. Make certain threads in cap and threads on quill are clean and dry (free of oil and solvent).
3. Using Loctite "LOCQUIC" Primer "T" (TL8753, or equivalent), spray mating threads of both cap assembly (1) and quill assembly (2). Allow primer to dry 3 to 5 minutes.
4. Apply Loctite Sealant #277 (VJ6863, or equivalent) to mating threads of both cap assembly and quill assembly.
5. Install quill and use SS1143 tool to tighten quill to **1000 ft. lbs. (1356 N.m)** torque. Allow parts to cure for 2* hours before exposing threaded areas to oil.

** Note: If "LOCQUIC" primer "T" (TL8753) was not used, the cure time will require 24 hours instead of 2 hours.*

6. Tack weld quill in 2 places as shown in Figure 8-20.
7. Remove all slag and foreign material from tack weld area before assembly of cylinder.

During future cylinder rebuilds, removal of the quill will not be necessary, unless it has loosened or is damaged. Removal, if necessary, will require a break-loose force of at least **2000 ft. lbs. (2712 N.m)** torque after the tack welds are ground off.

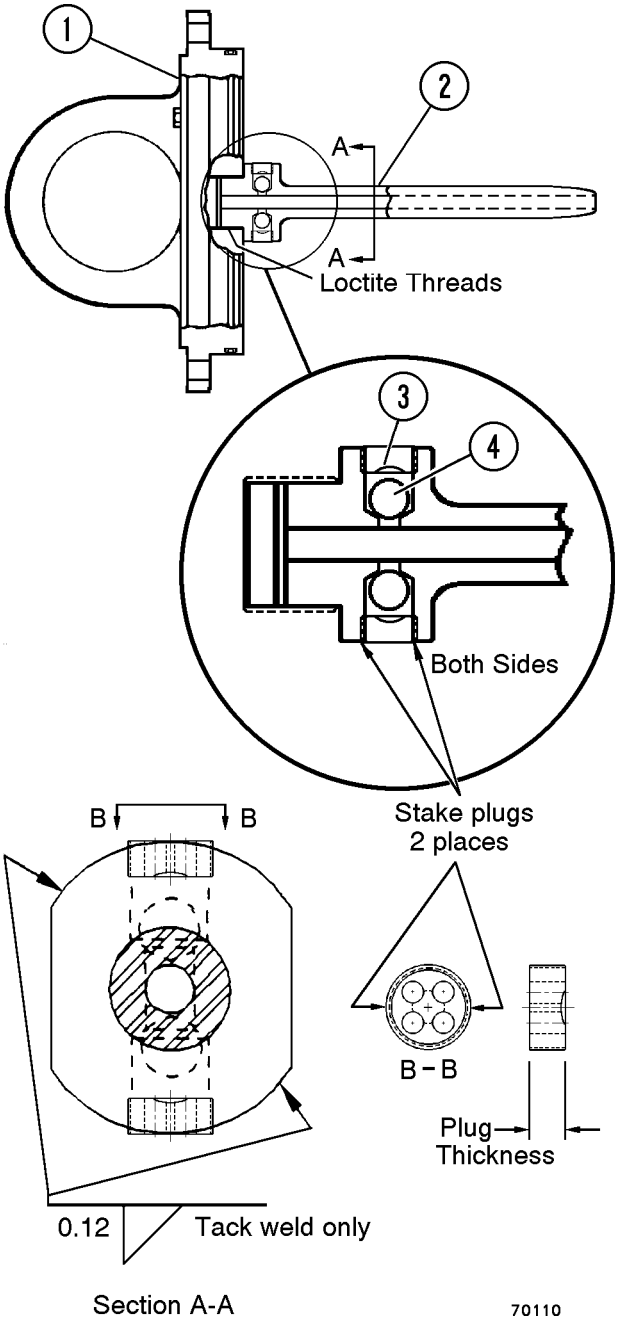


FIGURE 8-20. PLUG & CHECK BALL INSTALLATION

1. Cap Assembly
2. Quill Assembly
3. Plug
4. Check Ball

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Installation of Check Balls and Plugs in Quill

The check balls (4, Figure 8-20) in the side of the quill assembly (2) are held in place with threaded plugs (3).

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

Refer to Figure 8-21 for SS1158 tool that can be made for installing or removing the check ball plugs.

Plugs should be checked during any cylinder repair to be sure they are tight. If found to have any movement, they should be removed and the ball seat in the quill checked to see if it is deformed.

- If deformation of the ball seat has occurred, the quill should be replaced.
- If the ball seat area is not deformed, measure the plug thickness as shown in Figure 8-20:
  Older Plug is 0.25 ±0.02 in. thick.
  Newer plug is 0.38 ±0.02 in. thick.

1. Use the newer plugs and make certain threads in quill tube and on plugs are clean and dry (free of oil and solvent).
2. Use Loctite “LOCQUIC” Primer “T” (TL8753, or equivalent), and spray mating threads of both plugs (3, Figure 8-20) and quill assembly (2). Allow primer to dry 3 to 5 minutes.
3. Apply Loctite Sealant #277 (VJ6863, or equivalent) to mating threads of both plugs and quill assembly.
4. Place check balls (4) in quill tube (2) and install plugs (3) with concave side facing ball. Using SS1158 tool, tighten plugs to **70 ft. lbs. (95 N.m)** torque. Allow parts to cure for 2* hours before exposing threaded areas to oil.

** Note: If “LOCQUIC” primer “T” (TL8753) was not used, the cure time will require 24 hours instead of 2 hours.*

5. Stake plug threads in two places (between holes) as shown in Figure 8-20 to prevent loosening of plug.

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

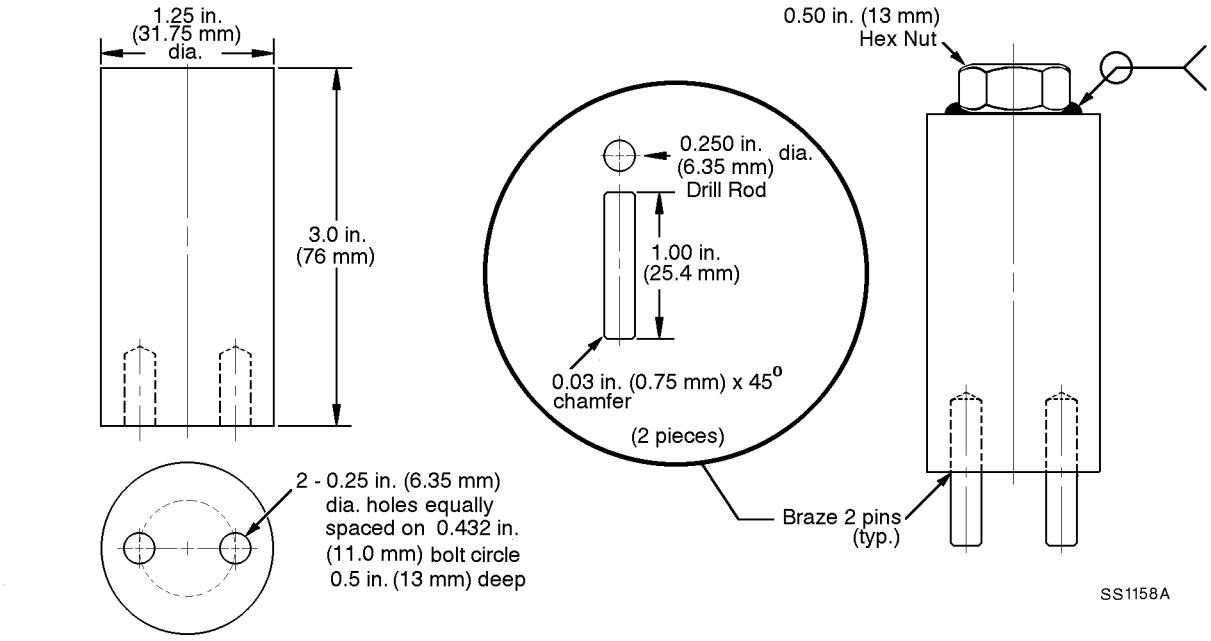


FIGURE 8-21. SS1158 PLUG INSTALLATION/REMOVAL TOOL

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Assembly of Cylinder

1. Install seals (15, Figure 8-18) and bearing (14) on second stage cylinder. Install bearings (19) and buffer seal (18), rod seal (20) and rod wiper (21) on first stage cylinder. Lubricate with clean hydraulic oil (Type C-4).
2. Align and slide the second stage cylinder (2) inside the first stage cylinder (3). Allow the second stage to protrude far enough to install the snap ring (9) on the inside of the first stage cylinder.
3. Mount the housing (4) in the fixture with the cover end positioned at the top. Install bearings (19) and buffer seal (18), rod seal (20) and rod wiper (21) in the housing.
4. Install lifting tool used during disassembly in the second and first stage cylinder assembly.
5. Install bearings (13) on the first stage cylinder (3). Lift and align this assembly over the housing (4). Lower the second and first stage cylinders into the housing.
6. Install retainer used during disassembly to hold the second and first stage cylinder in place when the housing is rotated. Rotate housing 180° to position the lower mounting eye at the top.
7. Install bearings (19) and buffer seal (18), rod seal (20) and rod wiper (21) in the second stage cylinder (2).
8. Attach a lifting device to the rod eye (1) and align it over the housing (4). If equipped, install cushion ring (24) on rod. Lubricate the rod with hydraulic oil and lower the rod into the housing.

NOTE: A cushion ring (24) can be added to hoist cylinders even if one was not removed during disassembly.

9. Rotate housing 180° to position the cover end at the top. Remove retainer installed in Step 6. Install bearings (17) and seal (16) on the rod bearing retainer (6).
10. Thread two guide bolts 4 in. (100 mm) long in the end of the rod (1). Install seal (8) on the end of the rod.
11. Align piston rod bearing retainer (6) over guide bolts and lower it over the end of the rod (1). Remove guide bolts.

NOTE: Check capscrews carefully for distress and, if in doubt, replace them with new.

12. Make certain threads on capscrews (1, Figure 8-22) and threads in rod are clean and dry (free of oil and solvent).

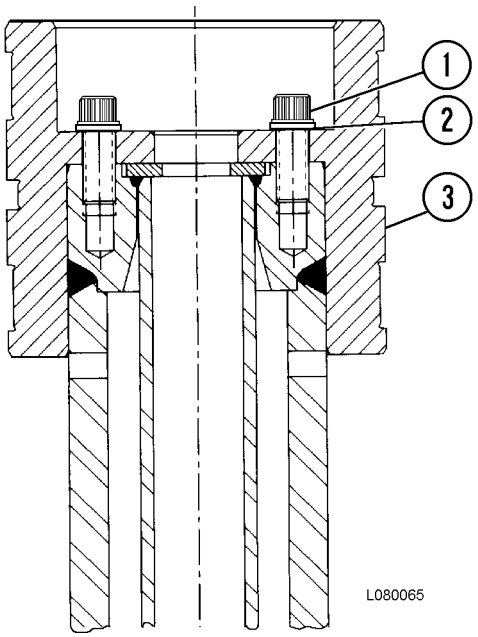


FIGURE 8-22. 3rd. Stage Piston

1. 12 Pt. Capscrew
2. Plate
3. Piston

13. Use Loctite “LOCQUIC” Primer “T” (TL8753, or equivalent), to spray mating threads on capscrews and threads in rod. Allow primer to dry 3 to 5 minutes.
14. Apply Loctite Sealant #277 (VJ6863, or equivalent) to threads of capscrews and threads in rod.
15. Install plate (2), and capscrews (1). Tighten capscrews to **575 ft. lbs. (780 N.m)** torque.

NOTE: Allow parts to cure for 2 hours before exposing threaded areas to oil.*

** Note: If “LOCQUIC” primer “T” (TL8753) was not used, the cure time will require 24 hours instead of 2 hours.*

16. Install O-ring (12, Figure 8-18) and backup ring (23) on cover (10). Align and lower cover onto housing (4). Install capscrews (11) and lockwashers. Tighten capscrews to standard torque.
17. Install hoist cylinder eye bearing (5, Figure 8-17) and retainer rings (4) if removed.

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COUNTERBALANCE MANIFOLD

The counterbalance manifold is located to the rear of the hoist valve. The internal counterbalance valve relieves excessive pressure that can develop in the annulus area of the hoist cylinders if the load sticks to the tail of the body as the body goes overcenter while dumping.

Figures 8-23 through 8-25 show the proper placement of the O-rings and backup-rings on the needle valve, counterbalance valve and the cavity plug.

For information on how the counterbalance valve functions, see “Hoist Circuit Operation”, this section. For adjusting of the counterbalance valve, refer to the “Hydraulic Checkout Procedure” in this Section.

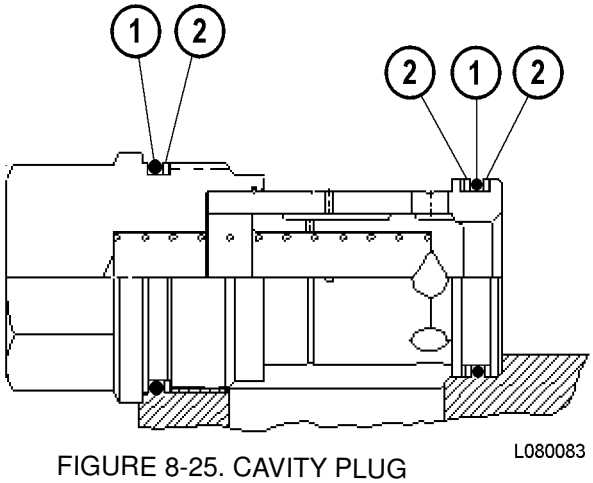


FIGURE 8-25. CAVITY PLUG

1. O-Rings 2. Backup-Rings

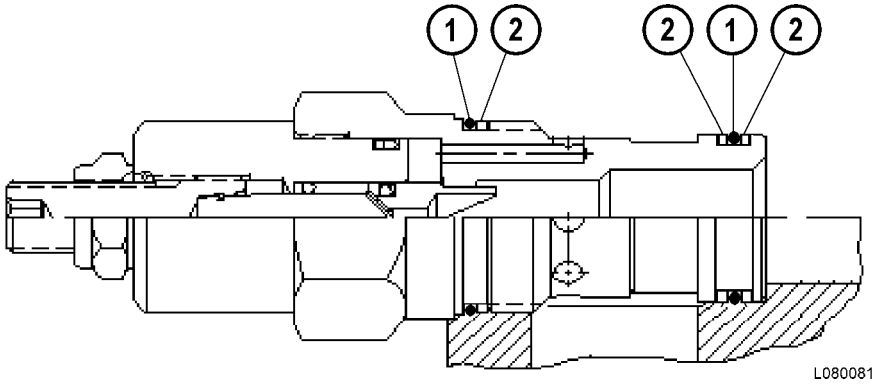


FIGURE 8-23. NEEDLE VALVE

1. O-Rings 2. Backup-Rings

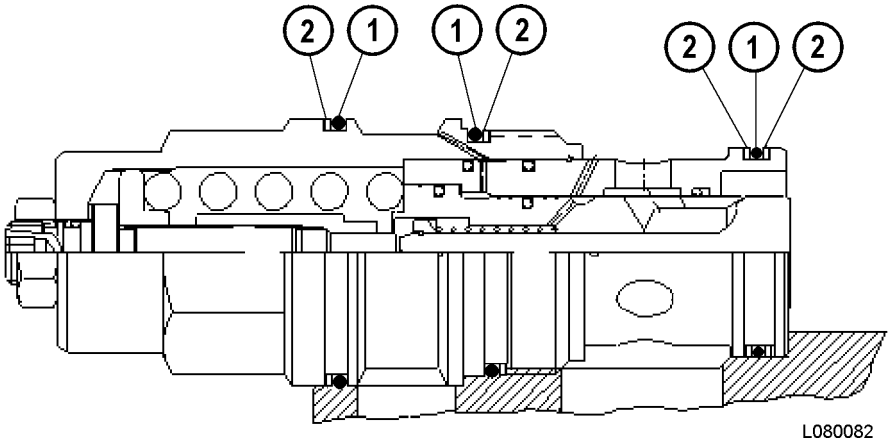


FIGURE 8-24. COUNTERBALANCE VALVE

1. O-Rings 2. Backup-Rings

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DISABLED TRUCK DUMPING PROCEDURE

Sometimes it is necessary to dump a load from the body of a truck when the hoist system is inoperable. The following instructions describe the use of a “good” truck to provide the hydraulic power required to raise the body of the “disabled” truck to dump the load.

In the example below, Figure 8-23 illustrates a typical hookup from the good truck. The disabled truck may be another Model 830E, or a different Komatsu model.

HOOKUP

Be certain there is an adequate, clear area to dump the loaded box. When the good truck is in position, shut down the engine and allow the hydraulic system to bleed down. Be certain pressure has bled off before connecting hoses.

1. With the good truck parked as close as possible to the disabled truck, attach a hose from the **power up** quick disconnect (3, Figure 8-23) to the **power down** circuit of the disabled truck. (Hose must be rated to withstand 2500 psi (17 MPa) or greater pressure.

NOTE: The power down circuit will use a smaller diameter hose (tube) than the power up circuit.

2. Connect another hose from the **power down** quick disconnect (4) to the **power up** circuit of the disabled truck.

*NOTE: If both trucks are a Model 830E, the hoses will be installed at the quick disconnects shown in Figure 8-23 and **will be crossed** when connected.*

DUMPING PROCEDURE

Raising the Body:

3. On the disabled truck, move the hoist control lever to power up and then release it to place the hoist pilot valve in the HOLD position (leave in this position during entire procedure).
4. Start the engine on the good truck, place the hoist control in the power down position and increase engine RPM to high idle to dump the disabled truck. If the body of the disabled truck fails to raise, increase the good truck power down relief pressure as follows:
   a. Shut down engine and allow the hydraulic system to bleed down.

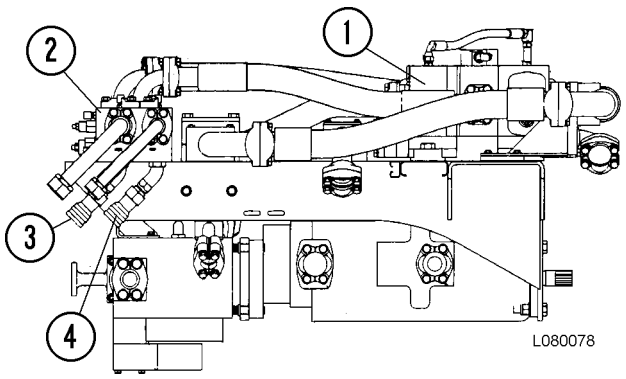


FIGURE 8-26. PUMP MODULE, HOSE HOOKUP (Model 830E Shown)

1. Hoist Valve
2. Overcenter Manifold
3. Power Up Quick Disconnect; Connect to power down circuit of “disabled” truck
4. Power Down Quick Disconnect; Connect to power up circuit of “disabled” truck

   b. Remove the cap from the Hoist Pilot Valve relief valve (2, Figure 8-13) located in the hydraulics components cabinet behind the cab. While counting the number of turns, slowly screw the relief valve adjustment screw clockwise until it bottoms.
5. Repeat step 4 to dump the disabled truck.

Lowering the Body:

6. Place the hoist lever of the good truck in FLOAT to lower the body. If necessary, momentarily place the hoist control in POWER UP until the body is able to descend in FLOAT. Do not accelerate the engine.
7. After body is lowered, shut down the truck, bleed the hydraulic system and disconnect the hoses.
8. Reduce power down relief valve pressure to normal on good truck by turning the adjustment counterclockwise the same number of turns as required in step 4 b.
9. Check power down relief pressure using instructions in Section L10.
10. Check hydraulic tank oil level.

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NOTES:

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HYDRAULIC CHECKOUT PROCEDURE

STEERING AND BRAKE PUMP

Pressure Check And Adjustment Procedure

NOTE: If steering and brake pump has just been installed, make sure the steering pump crankcase is full of oil prior to starting the engine.

⚠DANGER

Relieve pressure before disconnecting hydraulic lines. Tighten all connections securely before applying pressure.

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

Blocking pressure line between pump and system (or pump) high pressure relief valve will result in damage and could result in serious personal injury.

1. Shut down engine, turn keyswitch “Off” and allow accumulator to completely bleed down before opening circuits to take measurements, to make repairs, or to install or remove gauges.
2. Install a calibrated 5000 psi (35,000 kPa) gauge on the diagnostic coupling on the steering pump test port marked “GPA”, located on the same side of the pump as the suction port.
3. Make sure all pump suction line shut-off valves are fully open. (The shut-off valves are open when the handles are in line with the hose.

NOTE: Serious pump damage will result if all shut-off valves are not completely open when the engine is started.

4. If the pump has just been installed on the machine, and prior to starting the engine, bleed air from inside pump to make sure the steering pump crankcase is full of oil.

To Bleed Air From Pump:

a. With the engine “Off” and the hydraulic oil level in the tank is at the proper level, open shut-off valve in steering pump suction line.

b. With suction line shut-off valve open, loosen suction hose capscrews (at the pump) to bleed any trapped air. Then loosen pressure hose capscrews (at the pump) to bleed any trapped air. Tighten hose connection capscrews to standard torque.

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

c. Disconnect pump case drain hose (from fitting 2, Figure 10-1) and cap the hose.

d. Remove fitting (2) and add clean C-4 type oil to pump through opening until pump housing is completely full.

e. When pump housing is full of oil, install fitting (2) and connect pump case return hose to fitting.

f. Check for proper oil level in hydraulic tank. Add oil if necessary.

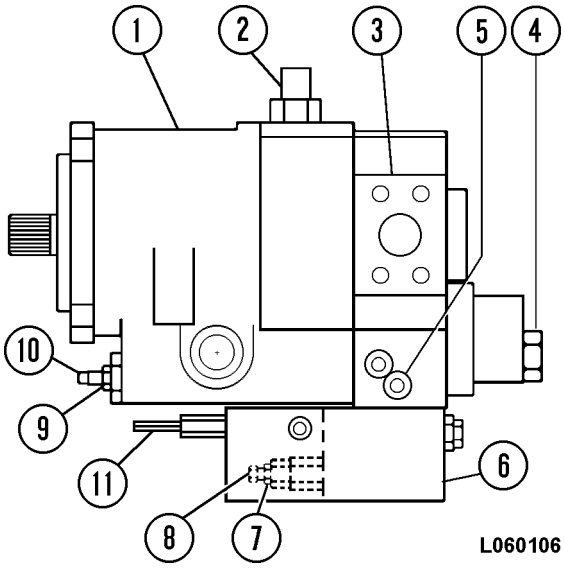


FIGURE 10-1. STEERING PUMP

1. Steering Pump
2. Pump Crankcase Drain Fitting
3. Inlet Port
4. Plug
5. Diagnostic Port (GPA)
6. Compensator Housing
7. Jam Nut
8. Compensator Adjuster
9. Jam Nut
10. Maximum Stroke Screw
11. Unloader Adjuster

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NOTE: Allow adequate time for the accumulator to fully charge after start up.

5. Start engine and run at low idle. The steering pump with unloader valve is preset to unload the pump at 3500 to 3550 psi (24 133 to 24 477 kPa), and reload accumulators when their pressure falls to 3200 ±50 psi (2,2064 ±345 kPa). If necessary to adjust pump pressure:
   a. Install calibrated pressure gage capable of 5000 psi (35 000 kPa) at base of either steering accumulator in the SAE #4 port or on a tee placed in the port marked “ACC” on the unloader valve block on the pump.
   b. Bottom out the unloader valve adjustment screw (11, Figure 10-1).
   c. Back out the pressure compensator adjustment screw (8).
   d. Fully open all shut-off valves.
   e. Start truck and adjust pressure compensator until 3800 psi is read and maintained on gauge at steering pump “GPA” test port (5). Tighten jam nut (7).
   f. Shut down the engine and allow sufficient time for the accumulators to bleed down
   g. Back out unloader valve adjustment screw (11) completely.
   h. Start truck and allow pump to unload:

- ❑ Pressure gauge at steering pump “GPA” test port will read about 200 to 400 psi (1 379 to 2 758 kPa) when the pump is unloaded.

i. Adjust unloader valve:

- ❑ Adjust to reload pump when pressure drops to 3200 ±50 psi (2,2064 ±345 kPa).

   j. Steer to cause accumulator pressure to decrease enough so accumulators are reloaded to verify unloader valve setting:

- ❑ The pressure gauge in the port marked “ACC” should read 3200 ±50 psi (2,2064 ±345 kPa). Tighten jam nut.

*Note: The critical pressure adjustment is the unloader valve **reload pressure.** The pressure at which it unloads is not adjustable separately but will follow the reload pressure adjustment.*

Leakage Check

To check for worn piston pump, measurement of the leakage can be made from the case drain while the pump is under pressure.

1. Disconnect steering pump drain line from the hydraulic tank and securely plug port in hydraulic tank with a steel cap.
2. Connect a flow meter to the pump drain line or have the drain line directed into a large container or reservoir. The pump case must remain full of oil during this test.
3. Connect a calibrated 5000 psi (35,000 kPa) pressure gauge to diagnostic receptacle located on the junction block from the outlet hose from the steering pump.
4. Start engine and warm hydraulic oil to operating temperature of 110°F (43°C).
5. With engine at 1800 rpm and accumulator completely full, verify steering pressure is 3200 psi (22,064 kPa) on pressure gauge. Adjust unloader valve pressure if necessary.
6. Read the flow meter or time the case drain flow used to fill a known size container and calculate the flow rate in terms of cubic inches per minute ($in.^3$/min.).
7. The leakage should not exceed 177 oz. per min. (5.25 Liters per minute) at 3200 psi (22,064 kPa) system pressure. Additional leakage indicates wear, but does not become critical until it impairs performance.

BLEEDDOWN MANIFOLD

Adjustment of the relief valves is not necessary or recommended. Relief valves are factory preset. Do not attempt to rebuild or repair if relief valves are defective. Replace as a unit. The steering pressure switch and check valves are also replaced only as units.

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SHOCK & SUCTION VALVES

Shock & Suction Valve Settings

⚠DANGER

Relieve pressure before disconnecting hydraulic lines. Tighten all connections securely before applying pressure.

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

Be sure accumulator oil pressure has been bled down. Turn steering wheel; the wheels should not move if oil pressure has been relieved.

1. Shut down engine, turn keyswitch “Off” and allow accumulator to completely bleed down before opening circuits to take measurements, to make repairs, or to install or remove gauges.
2. Install a calibrated 5000 psi (35,000 kPa) gauge on one of the two diagnostic ports located on the steering cylinder manifold located just below the engine.
3. Prior to checking the shock & suction valves in the flow amplifier, raise the steering relief pressure.
   a. Remove steering relief valve external plug using an 8 mm metric allen wrench. Refer to Figure 10-3.
   b. Gently bottom out the steering relief valve using a 5 mm metric allen wrench. Refer to Figure 10-3 for relief valve location.

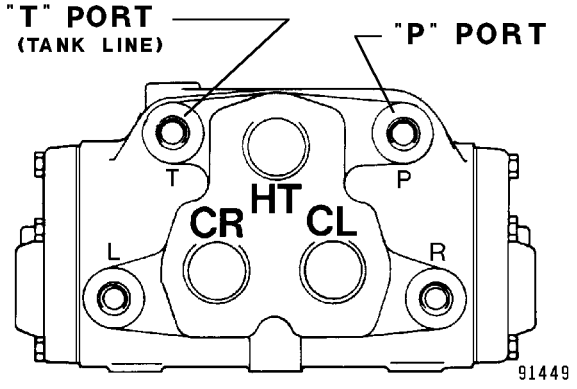


FIGURE 10-2. FLOW AMPLIFIER VALVE

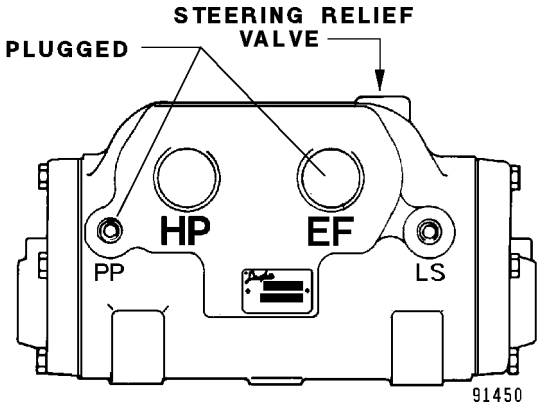


FIGURE 10-3. FLOW AMPLIFIER VALVE

4. Check flow amplifier shock & suction valve pressure. Pressure check can be accomplished by steering away from steering cylinder stops, then steering into stop and continue to turn steering wheel. Gauge should read 2900 psi (19,996 kPa). Move the gauge connection to the other diagnostic port to test the pressure of the other valve. If shock & suction valve pressure is not correct, replace valves.

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

5. After checking shock & suction valves, lower the steering relief pressure to 2500 psi (17,237 kPa). Steering relief pressure can be adjusted by steering full left or right and adjusting steering pressure at the flow amplifier while holding slight pressure on the steering wheel. Replace the external steering relief valve plug.
6. Remove test equipment and reconnect all lines and hoses to the proper location.

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LEAKAGE TESTS

⚠DANGER

Relieve pressure before disconnecting hydraulic lines. Tighten all connections securely before applying pressure. Hydraulic fluid escaping under pressure can have sufficient force to enter a person's body by penetrating the skin and cause serious injury and possibly death if proper medical treatment by a physician familiar with this type of injury is not received immediately.

NOTE: The hydraulic system must be at normal operating temperature (110°F or 43°C) or higher before performing leakage tests.

Steering Control Unit & Flow Amplifier

1. Shut down engine and turn keyswitch "Off". Wait 90 seconds for steering accumulator to bleed down. Turn steering wheel to be sure no pressure remains.
2. To check combined leakage from the steering unit and the flow amplifier, disconnect flow amplifier return hose from bleed down manifold. Cap fitting on manifold and start engine. Maximum allowable combined leakage is 60 $in.^3$ (984 ml.) per minute from steering return hose. If leakage is excessive, perform next two steps.
   a. Remove steering control unit tank (return) line at the flow amplifier ("T" port). For location of the tank line ("T" port), refer to Figure 10-2. Plug the tank port opening on flow amplifier.
   b. Remove the flow amplifier return hose at the "HT" port on the flow amplifier. Refer to Figure 10-2. Plug the return hose.
   c. Start engine and run at low idle.
   d. Measure leakage from steering control unit tank line. Leakage not to exceed 10 $in.^3$ (164 ml) per minute. If leakage is excessive, replace steering control unit.
   e. Measure leakage from the flow amplifier at the "HT" port. Maximum allowable leakage is 50 $in.^3$ (820 ml) per minute. If leakage is excessive, replace flow amplifier.
   f. Shut down engine, turn keyswitch "Off" and wait 90 seconds for the steering accumulator to bleed down.
   g. Remove test equipment and reconnect all hoses to their proper location.

Bleeddown Manifold

3. Disconnect hoist pilot valve return line (15, Figure 10-4). Plug the port on bleeddown manifold.

⚠IMPORTANT⚠

Hydraulic tank oil level is above the level of this return line. It is necessary to draw a vacuum on the hydraulic tank to prevent a large amount of oil from draining out of the tank with the return line disconnected from the bleeddown manifold.

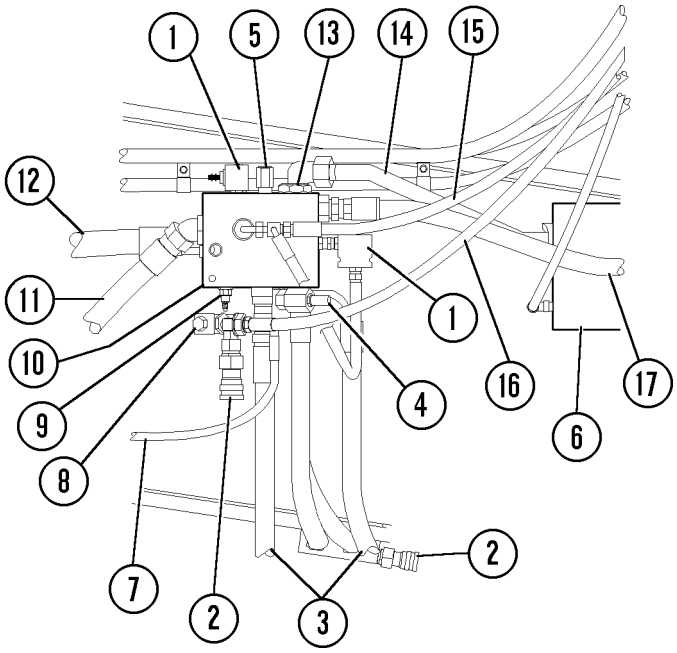
4. Draw a vacuum on the hydraulic tank to prevent oil loss. Disconnect return line to tank from bleeddown manifold (11, Figure 10-4). Connect the hoist pilot valve return line (15) and the return line to tank (11) together.
5. Remove vacuum on the hydraulic tank. Start engine. Allow accumulator to fill up. Measure leakage from the return hose fitting in the bleeddown manifold. Maximum allowable leakage from the bleeddown manifold is 33.0 $in.^3$ (541 ml) per minute. If leakage is excessive, the following components should be replaced until the leakage is within the allowable limits:
   - Bleeddown Solenoid
   - System Relief Valve (4000 psi)
   - Piloted Check Valve
6. After test is complete, shut down the engine with the Shut Down switch on the console next to the seat. **Do not use the keyswitch to shut down the engine.**

⚠WARNING

If keyswitch is used, all the oil in the accumulator will come out the port that was used to check manifold leakage.

7. Before removing plugs on bleeddown manifold or disconnecting lines that have been connected, be sure to draw a vacuum on the hydraulic tank to prevent spillage. Remove test equipment and reconnect all hoses to their proper location.
8. Turn key switch to the "OFF" position to allow steering accumulators to bleed down.

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1. Bleeddown Solenoid
2. Quick Disconnect, Brake System
3. To Steering Accumulators
4. Low Steering Pressure Switch
5. Relief Valve (500 psi)
6. Flow Amplifier
7. Feedback Pressure to Unloader Valve
8. Check Valve
9. Relief Valve (4000 psi)
10. Bleeddown Manifold Valve Assembly
11. Tank Return Line
12. Supply (From Filter)
13. Check Valve (Piloted)
14. Supply to Flow Amplifier
15. Hoist Pilot Valve Return to Tank
16. Brake System Supply
17. Return From Flow Amplifier

FIGURE 10-4. BLEEDDOWN MANIFOLD

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TROUBLESHOOTING CHART (Steering Circuit)		
Trouble	**Possible Cause**	**Suggested Corrective Action**
Slow steering, hard steering or loss of power assist	Overloaded steering axle. Malfunctioning relief valve. System pressure lower than specified. Worn or malfunctioning pump.	Reduce axle loading. Replace relief valve. Replace pump. See steering pump trouble-shooting chart.
Drift - Truck veers slowly in one direction	Rod end of cylinder slowly extends without turning the steering wheel. Worn or damaged steering linkage.	A small rate of extension may be normal on a closed center system. Replace linkage and check alignment or toe-in of the front wheels.
Wander - Truck will not stay in straight line	Air in system due to low oil level, pump cavitation, leaking fittings, pinched hoses, etc. Loose cylinder piston. Broken neutral position springs in steering control unit. Improper toe-in setting. Bent linkage or cylinder rod. Severe wear in steering control valve.	Correct oil supply problem and/or oil leak-age. Repair or replace defective components. Replace neutral position springs. Adjust. Repair or replace defective components. Repair steering control valve.
Slip - A Slow move-ment of steering wheel fails to cause any movement of the steered wheels	Leakage of cylinder piston seals. Worn steering control valve.	Replace seals. Replace steering control valve.
Spongy or soft steering	Low oil level. Air in hydraulic system. Most likely air trapped in cylinders or lines.	Service hydraulic tank and check for leak-age. Bleed air from system. Positioning ports on top of cylinder will help avoid trapping air.
Erratic steering	Air in system due to low oil level, cavitating pump, leaky fittings, pinched hose, etc. Loose cylinder piston.	Correct condition and add oil as necessary. Repair or replace cylinder.
Free Wheeling - Steer-ing wheel turns freely with no back pressure or no action of the front wheels	Lower splines of column may be disengaged or damaged. No flow to steering valve can be caused by: 1. Low oil level 2. Ruptured hose 3. Broken cardan shaft pin (steering unit)	Repair or replace steering column. 1. Add oil and check for leakage 2. Replace hose 3. Replace pin

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TROUBLESHOOTING CHART (Steering Circuit)		
Trouble	**Possible Cause**	**Suggested Corrective Action**
Excessive free play at steered wheels	Broken or worn linkage between cylinder and steered wheels.	Check for loose fitting bearings at anchor points in steering linkage between cylinder and steered wheels.
	Leaky cylinder seals.	Replace cylinder seals.
Binding or poor centering of steered wheels	Binding or misalignment in steering column or splined column or splined input connection.	Align column pilot and spline to steering control valve.
	High back pressure in tank can cause slow return to center. Should not exceed 300 psi (2068 kPa).	Reduce restriction in the lines or circuit by removing obstruction or pinched lines, etc.
	Large particles can cause binding between the spool and sleeve.	Clean the steering control unit. If another component has malfunctioned generating contaminating materials, flush the entire hydraulic system.
Steering control valve locks up	Large particles in spool section.	Clean the steering control unit.
	Insufficient hydraulic power.	Check hydraulic oil supply.
	Severe wear and/or broken cardan shaft pin.	Replace pin or the steering control unit.
Steering wheel oscillates or turns by itself	Lines connected to wrong ports.	Check line routing and connections.
	Parts assembled incorrectly.	Reassemble correctly.
Steering wheels turn in opposite direction when operator turns steering wheel	Lines connected to wrong cylinder ports.	Correct cylinder port line connections.

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TROUBLESHOOTING CHART
(Steering Pump)

Trouble	Possible Cause	Suggested Corrective Action
No pump output	Trapped air inside steering pump.	Bleed trapped air. Refer to “Pressure Check And Adjustment Procedure”, this Section.
	Broken pump drive shaft.	Replace pump drive shaft.
	Excessive circuit leakage.	Check for loose fittings, broken or cracked tubes.
	No oil to pump inlet.	Check hydraulic tank oil level. Make sure shut-off valve is open.
Low pump output	Low pump pressure.	Check or adjust compensator pressure setting.
	Compensator valve, seat, spring or packing failure.	Repair or replace compensator.
	Worn or scored pistons and bores.	Repair or replace pistons or pump housings.
	Maximum volume stop limiting pump stroke.	Turn volume stop screw counterclockwise. Tighten jam nut.
	Worn or damaged piston shoes, swashblock or swashblock wear plate.	Repair or replace defective parts.
	Worn or grooved cylinder wear plate and/or port plate.	Repair or replace defective parts.
	Restricted inlet.	Clear restriction. Make sure suction line shut-off valve is open. Clean suction strainer.
	Insufficient inlet oil.	Check for proper hydraulic tank oil level and make sure suction line shut-off valve is open.
Unresponsive or sluggish control	Control piston seals broken or damaged.	Repair or replace broken parts.
	Swashblock saddle bearings worn or damaged.	Repair or replace broken parts.
Loss of pressure	Faulty output circuit components.	Repair or replace relief valve or pressure compensator valve.
	Worn piston pump.	Repair or replace worn parts.
	Worn or grooved cylinder wear plate and/or port plate: wear plate and/or port plate separation from cylinder, each other or valve plate.	Repair or replace worn parts.
	Worn pistons, shoes or piston bores.	Repair or replace worn parts.
Excessive or high peak pressure	Faulty output circuit components.	Repair or replace relief valve or pressure compensator valve.

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TROUBLESHOOTING CHART (Steering Pump)		
Trouble	**Possible Cause**	**Suggested Corrective Action**
Noise or squeal	Low compensator pressure setting.	Check compensator pressure setting.
	Fluid too cold or viscosity too high.	Use proper viscosity oil or warm oil before starting.
	Air leak at inlet connection.	Inspect inlet hose and connections for looseness.
	Insufficient inlet oil.	Check for proper hydraulic tank oil level. Check for clogged suction strainer. Make sure suction line shut-off valve is open.
	Broken or worn piston/shoe assembly.	Repair or replace broken/worn parts.
Steering function slow	Low pressure compensator pressure setting.	Check and adjust compensator pressure setting.
	Plugged filter or suction strainer.	Replace filter element or clean suction strainer.
Irregular or unsteady operation	Fluid level is reservoir is low or supercharge is insufficient.	Check for proper hydraulic tank oil level.
	Air entering hydraulic system.	Inspect inlet hose and connections.
	Worn piston pump.	Repair or replace broken/worn parts.
	Faulty output circuit components.	Repair or replace relief valve or pressure compensator valve.
Excessive heating	Operating pump above rated pressure.	Refer to “Pressure Check and Adjustment Procedure”, this Section.
	Low fluid level in reservoir.	Check for proper oil level in hydraulic tank.
	Air entering hydraulic system.	Inspect inlet hose and connections.
	Worn piston pump.	Repair or replace worn components.
	Worn or grooved cylinder wear plate and/or port plate.	Repair or replace worn components.
	Faulty output circuit components.	Repair or replace relief valve or pressure compensator valve.

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TROUBLESHOOTING CHART (Flow Amplifier - Refer to Figure 10-5)		
Trouble	**Possible Cause**	**Suggested Corrective Action**
Slow or hard steer	Stuck piston (position 2, Figure 10-5).	Disassemble and check piston movement.
Heavy steering wheel movement with a simultaneous opening of the relief valve	Dirty throttle-check valve, (position 3) or dirty orifice screw (position 4).	Disassemble and clean the throttle check valve and/or the orifice screw.
Free Wheeling (no end stop)	Leaky shock valve or suction valve, (position 6). Setting pressure of shock valve too low, (position 6).	Disassemble, clean and check shock and suction valves. Adjust the shock valve pressure setting.
Inability to Steer (No Pressure Build-up)	Leaky relief valve in the priority valve, (position 1). Defective steering control unit.	Clean and perhaps replace the relief valve. Replace the steering control unit.
Hard point when beginning to turn the steering wheel	Air in “LS” line. Spring compression in the priority valve too low. Clogged orifice in the “LS” or “PP” port (positions 7 & 8).	Bleed the “LS” line. Replace priority valve spring. Clean the orifice.

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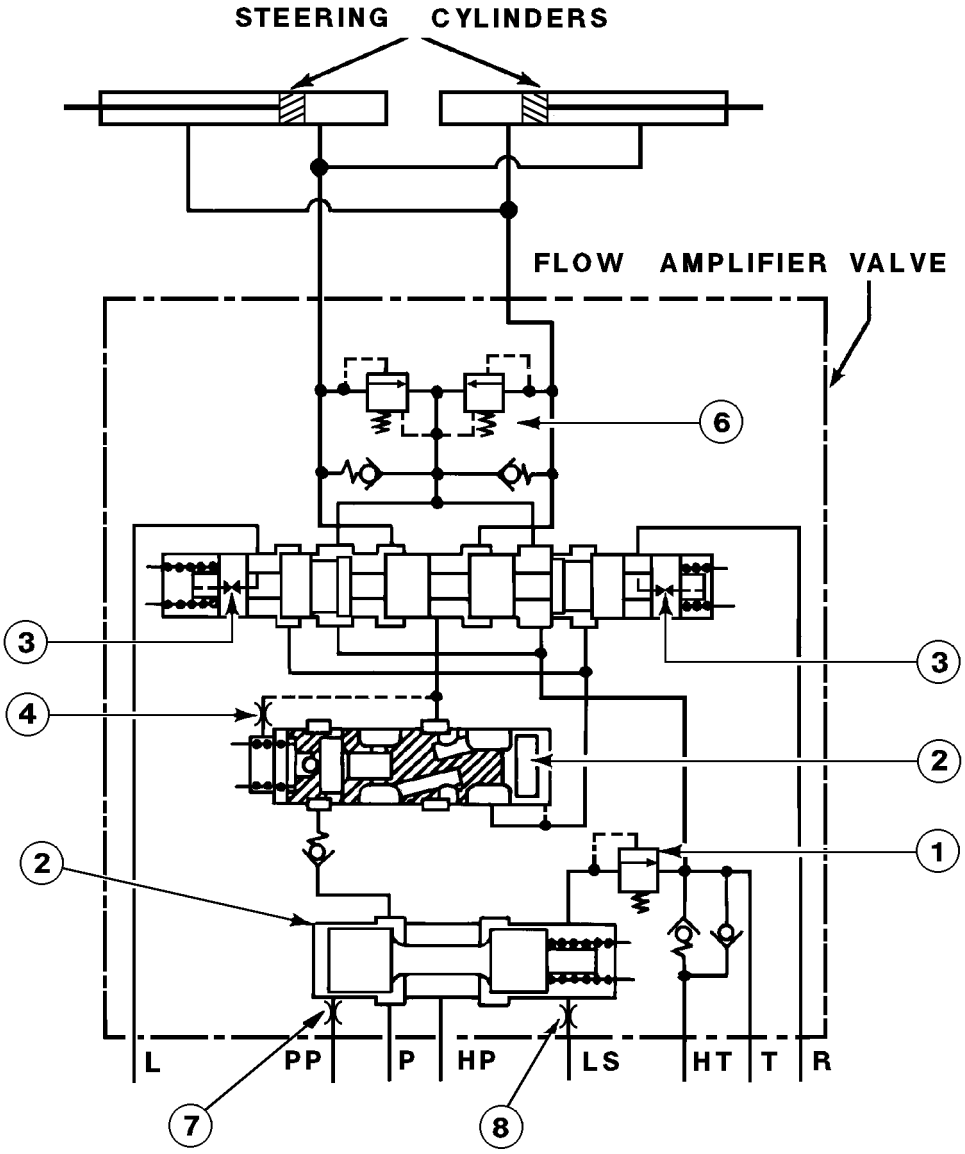


FIGURE 10-5. FLOW AMPLIFIER VALVE

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CHECKING HOIST SYSTEM PRESSURES

NOTE: If relief valve or hoist valve assembly has been replaced or rebuilt, hoist relief valve pressure should be checked.

⚠DANGER

Relieve pressure before disconnecting hydraulic lines. Tighten all connections securely before applying pressure.

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

Hoist System Relief Pressure Adjustment

1. Install two 0-5000 psi (0-35,000 kPa) pressure gauges (one to each diagnostic coupler located at each outlet port on the hoist pump).
2. Start engine and run at low idle.
   - ❑ Pressure at both hoist pumps should be approximately 75 psi (517 kPa) or less with oil temperature at 70°F (29°C).
3. To allow full extension of the hoist cylinders, disconnect the hoist up limit solenoid from the wiring harness located in the hydraulic cabinet behind the operators cab.

⚠WARNING

Be sure there is adequate (safe) overhead clearance before raising body to full up position.

4. With engine at low-idle, place hoist lever in power up position and hold until body is in the full raised position.
   - ❑ Pressure at both hoist pumps should be 2500 ±100 psi (17,237 ± 690 kPa).

NOTE: Each hoist pump section supplies oil to a separate inlet section on the hoist valve. Each inlet section on the hoist valve contains a power up relief valve. If the either relief pressure is not within specifications, adjust or replace the respective relief valve.

5. If power up relief pressure is not correct, adjust pressure as follows:
   a. Move hoist control lever to the “power down” position and allow body to completely rest on frame rails. Shut down engine.
   b. Relieve all hydraulic pressure from hoist system.

NOTE: One relief valve is located under each inlet valve cover.

   c. Remove small external tube and capscrews (1, Figure 10-6) from inlet section cover (2) where the relief valve needs serviced. Remove cover from hoist valve and spring (3) from relief valve.
   d. Loosen jam nut on relief valve (4) and turn screw in (clockwise) to increase pressure or out (counter-clockwise) to decrease pressure.

NOTE: Each 1/4 turn of the adjustment screw will cause approximately 150 psi (1,034 kPa) change in pressure.

   e. Install spring (3) and cover (2) with new O-rings (8). Install and tighten capscrews (1).
   f. Check pressure again (Steps 2 - 4).

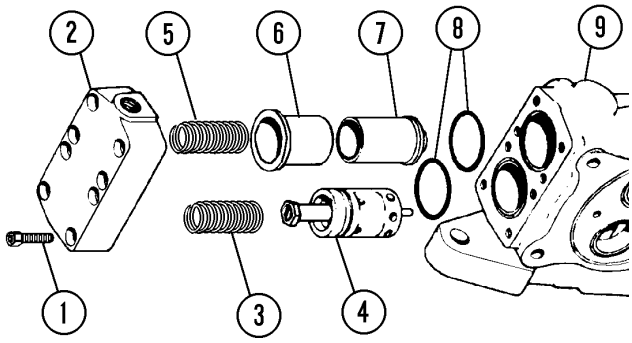


FIGURE 10-6. HOIST RELIEF VALVE

1. Capscrew
2. Inlet Cover
3. Spring
4. Main Relief Valve
5. Spring
6. Sleeve
7. Low Pressure Relief
8. O-Rings
9. Inlet Section

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Power Down Relief Pressure Adjustment

1. Install a 0-3500 psi (0-25,000 kPa) pressure gauge at the power down test port “TPD” (3, Figure 10-9) on the counterbalance manifold (2).
2. With engine at low idle, allow the steering accumulator to fill and the pump to unload. With the body resting on the frame, place the hoist lever in the POWER DOWN position and then read pressure at “TPD” test port gauge:

   ❑ Pressure should be 1500 ± 75 psi (10,342 ± 517 kPa).

3. If power down relief pressure is not within specifications, remove cap and adjust relief valve (2, Figure 10-7) on hoist pilot valve (1).

- To increase power down relief pressure, turn adjusting screw **in** (clockwise).
- To decrease power down relief pressure, turn adjusting screw **out** (counter-clockwise).

NOTE: The power down relief valve is located on the pilot control valve in the hydraulic components cabinet located behind the cab.

4. When pressure is within specifications, shut down engine and move hoist control lever to the “float” position to allow body to completely rest on frame rails and allow accumulator to bleed down completely.
5. Remove pressure gauge.

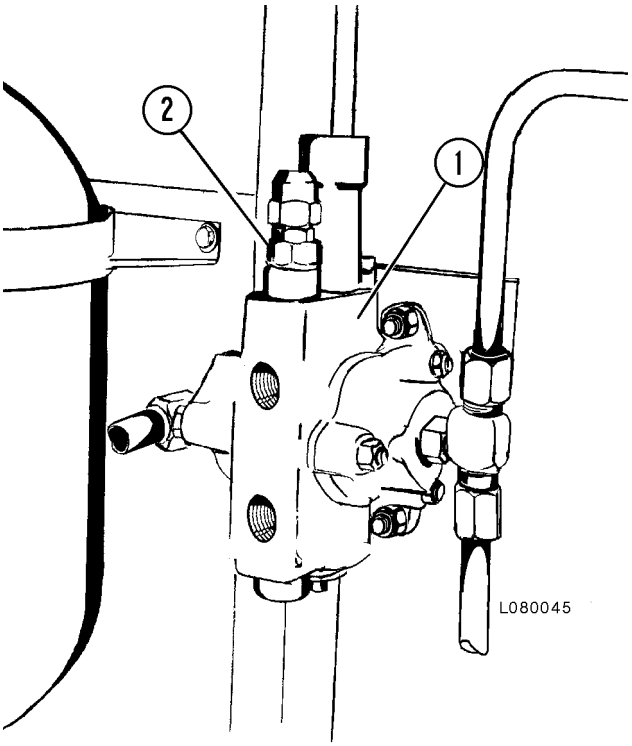


FIGURE 10-7. POWER DOWN RELIEF VALVE

1. Hoist Pilot Valve
2. Relief Valve

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Hoist Counterbalance Valve Adjustment

Preparation:

Note: The ports and valves referred to in the following procedures are labelled on the counterbalance manifold valve body.

1. With the engine shut down, the body resting on the frame, the hoist valve in the FLOAT position and hydraulic system pressure bled down, loosen locknut on adjustment stem of needle valve (9, Figure 10-9) on counterbalance manifold (2). Turn adjustment stem fully clockwise.
2. Remove fitting from “PILOT VENT” port (8) on counterbalance manifold. This port will remain open to atmosphere during adjustment; do not allow dirt to enter open port.

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

3. Install a 5000 psi (35,000 kPa) gauge at test port “TR” (7) on counterbalance manifold. (Gauge will measure rod end pressure; the pressure controlled by the counterbalance valve.)

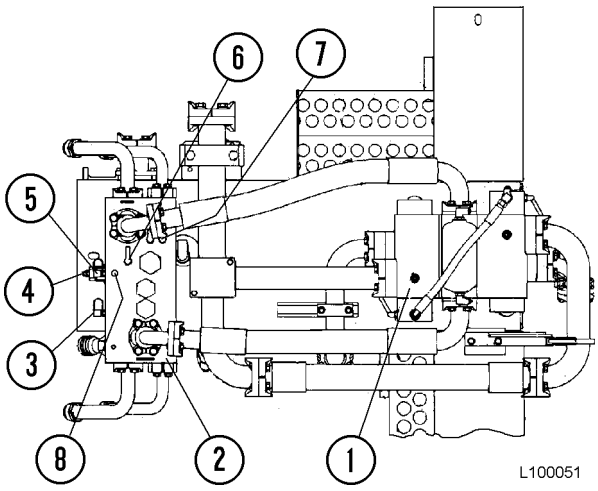


FIGURE 10-8. COUNTERBALANCE VALVE

1. Hoist Valve
2. Counterbalance Manifold
3. Power Down Test Port (TPD)
4. Counterbalance Valve (CBV)
5. Counterbalance Valve Test Port (TCBVP)
6. Power Up Test Port (TPU)
7. Test Port (TR)
8. Pilot Vent Port

Counterbalance Valve Pressure Check Only:

1. Start the engine. At low idle, raise the body and as it extends to the third stage, read the pressure on the gauge connected to the “TR” port. (All counterbalance valve pressures are read/adjusted while hoist cylinders are in third stage.)
   a. *If pressure is 3000 psi (20.7 MPa) or above,* **stop hoisting immediately**.
   Pressure is adjusted too high and must be lowered. Go to “Counterbalance Valve Adjustment” and perform adjustment procedure.
   b. *If pressure is below 3000 psi (20.7 MPa),* increase engine speed by approximately 300 rpm and observe pressure on gauge.

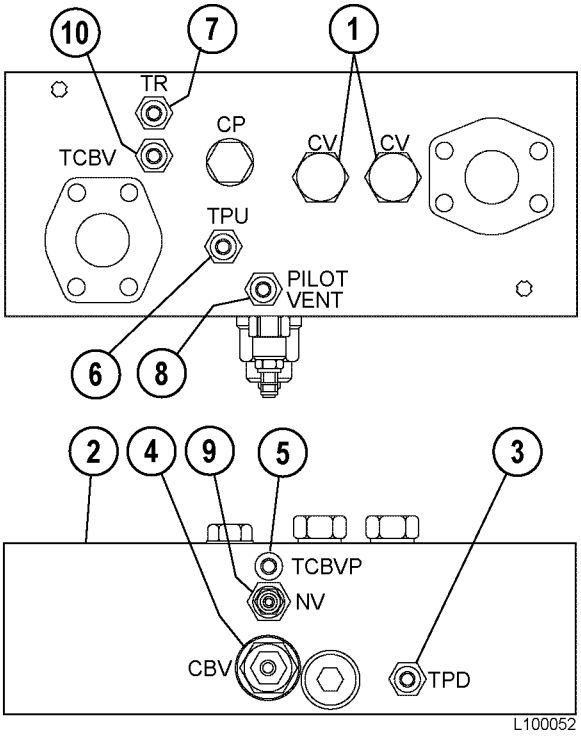


FIGURE 10-9. COUNTERBALANCE VALVE

1. Check Valves
2. Counterbalance Manifold
3. Power Down Test Port (TPD)
4. Counterbalance Valve
5. Counterbalance Valve Test Port (TCBVP)
6. Power Up Test Port (TPU)
7. Test Port (TR)
8. Pilot Vent Port
9. Needle Valve
10. Counterbalance Valve Port (TCBV)

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1.) If pressure is still below 3000 psi (20.7 MPa), continue increasing engine speed in steps of 300 rpm, while in third stage and observing pressure gauge.

2.) Continue monitoring pressure gauge until engine high idle is attained.

c. If gauge indicates 3000 psi (20.7 MPa) while at high idle, in POWER UP and in third stage, counterbalance valve adjustment is correct.

d. If gauge does not indicate 3000 psi (20.7 MPa) while in third stage and at high idle (or a lesser rpm during step 1b, 1.) perform “Counterbalance Valve Adjustment” procedure.

Counterbalance Valve Adjustment

1. Loosen locknut on adjustment stem of counterbalance valve (4, Figure 10-9) on manifold. Turn adjustment stem fully clockwise to start adjustment procedure so counterbalance valve pressure is as low as possible.

Note: Turning adjustment stem in (clockwise) decreases the pressure. Turning the stem out (counterclockwise) increases the pressure. ***Complete valve adjustment range is 3 turns.***

2. Start the engine and operate at high idle. Raise the body while observing the pressure gauge.
3. Slowly adjust counterbalance valve to obtain 3000 psi (20.7 MPa) as the hoist cylinder 3rd stage extends while in POWER UP. When adjustment is complete, secure locknut on adjustment stem.
4. Repeat *“Counterbalance Valve Pressure Check”,* Step 1 to verify proper adjustment.
5. Replace fitting in “PILOT VENT” port (8). Remove pressure gauge.
6. Turn needle valve adjustment stem (9) out 3 turns and secure locknut.

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TROUBLESHOOTING CHART (Hoist Pump)		
Trouble	**Possible Cause**	**Suggested Corrective Action**
Visible damage in the following areas: **• Sandblasted band around pressure plate bores** **• Angle groove on face of pressure plate** **• Lube groove enlarged and edges rounded** **• Dull area on shaft at root of tooth** **• Dull finish on shaft in bearing area** **• Sandblasted gear bore in housing**	Abrasive wear caused by fine particles in oil supply — Dirt (fine contaminants, not visible to the eye).	Change hydraulic oil. Hydraulic filters may need changing. Verify correct filter elements are being used. Check hoist and steering cylinders for dents, scoring, or seal damage. Entire hydraulic system may require complete cleaning (See “Flushing Procedure” in the following pages).
Visible damage in the following areas: **• Scored pressure plates** **• Scored shafts** **• Scored gear bore**	Abrasive wear caused by metal particles — Metal (coarse contaminants, visible to the eye).	Entire hydraulic system may require complete cleaning (See “Flushing Procedure” in the following pages). Check other hydraulic system components for possible source of contaminants.
External damage to pump	Incorrect installation.	Remove and repair as required.
Damage on rear of drive gear and rear pressure plate only	Defective pump driveshaft.	Check pump driveshaft. Check cross and bearings for smooth operation. Check for adequate joint lubrication.
Eroded pump housing or pressure plate	Aeration - cavitation • Restricted oil flow to pump • Aerated oil	Check hydraulic tank oil level. Verify correct oil viscosity. Check for restriction or air leak at pump inlet line. Check for loose fittings, clamps etc.
Excessive wear on pressure plate and/or end of gear	Lack of oil.	Check hydraulic oil level. Check pump inlet hoses for obstructions or leaks.

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TROUBLESHOOTING CHART (Hoist Pump)		
Trouble	**Possible Cause**	**Suggested Corrective Action**
• Housing scored heavily **• Inlet peened and battered** **• Foreign object caught in gear teeth**	Damage caused by metal object - Object not removed during a previous failure repair.	Thoroughly clean and flush hydraulic system. Check other system components for possible source of metallic object.
• Pressure plate black **• O-rings and seals brittle** **• Gear and journals black**	Excessive heat.	Check hoist system relief valve settings. Verify correct hydraulic oil level. Verify correct oil viscosity.
• Broken shaft **• Broken housing or flange**	Excessive pressure.	Check relief valve pressure. Verify relief valve is functioning properly.

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HYDRAULIC SYSTEM FLUSHING PROCEDURE

The following instructions outline the procedure for flushing the hydraulic system:

1. Shut down engine and turn key switch “Off”. Allow at least 90 seconds for the accumulator to bleed down.
2. Thoroughly clean the exterior of the tank. Be prepared to contain approximately 238 gal. (901 l) of hydraulic oil. Drain the hydraulic tank and flush the interior of hydraulic tank with a cleaning solvent. Inspect all hydraulic hoses for deterioration or damage.
3. Remove, clean and replace the hydraulic tank strainers. Change both hydraulic filter elements, and also high pressure steering filter element.

NOTE: The final filter in the filling apparatus must be 3 micron.

4. Fill the hydraulic tank with clean, Type C-4 hydraulic oil.
5. Bleed trapped air inside steering pump. Refer to “Pump Pressure Setting”, this Section for air bleeding procedure.

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

6. Set all controls in the “Neutral” position. Do not steer the truck or operate controls until the next step is completed.
7. Start the engine and run at 1000 RPM for five minutes. This will circulate oil with all valves in the neutral position.
8. To increase flow and turbulence in the system, increase engine speed to full throttle and maintain for four minutes. This will circulate oil with all valves in the neutral position.
9. Shut down engine and turn key switch “Off”. Allow at least 90 seconds for the accumulator to bleed down. This will return all contaminants to the hydraulic tank.
10. To be able to fully extend the hoist cylinders in the following procedure, disconnect hoist limit solenoid in brake cabinet behind cab.
11. Restart engine and run at 1000 RPM while performing the following:
    a. Steer truck full left then full right - repeat four times.
    b. Steer full left (keeping pressure against the steering wheel) and hold for 10 seconds.
    c. Steer full right (keeping pressure against the steering wheel) and hold for 10 seconds.
12. Increase engine speed to full throttle and steer full left and full right.

NOTE: Hydraulic tank oil temperature should be 110°-130°F (43°- 54°C) after accomplishing Step 12. If not, repeat Step 11 to increase oil temperature to the proper operating range.

13. Return all controls to “Neutral”.

⚠WARNING

Be certain that their is enough clearance from power lines, ceiling or any other structures that will allow raising the body to the full up position without hitting anything.

14. Reduce engine speed to 1000 RPM and perform the following:
    a. Extend hoist cylinders fully and “FLOAT” down - repeat four times.
    b. Extend hoist cylinders and hold at full extension for 10 seconds. Hoist control lever must be held in the power up position.
    c. Lower hoist cylinders and hold lever in power down position for 10 seconds after cylinders are fully retracted.
15. Increase engine speed to full throttle and perform the following:
    a. Hoist up to full extension, hold for 10 seconds, then allow cylinders to float down.
16. Return hoist control to “Neutral”.
17. Shut down engine and turn key switch “Off”. Allow at least 90 seconds for the accumulator to bleed down.
18. Reconnect hoist limit solenoid in brake cabinet.
19. Close both hoist pump suction line shut-off valves. Close steering pump suction line shut-off valve.
20. Remove hoist & steering filter elements. Clean housings and install new elements.
21. Fill hydraulic tank if necessary.
22. Open all (three) suction line shut-off valves. Bleed all air from pump suction lines and steering pump before starting engine. Refer to *“Pump Pressure Setting”*, Section “L” for air bleeding procedure.

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SECTION M
OPTIONS AND SPECIAL TOOLS
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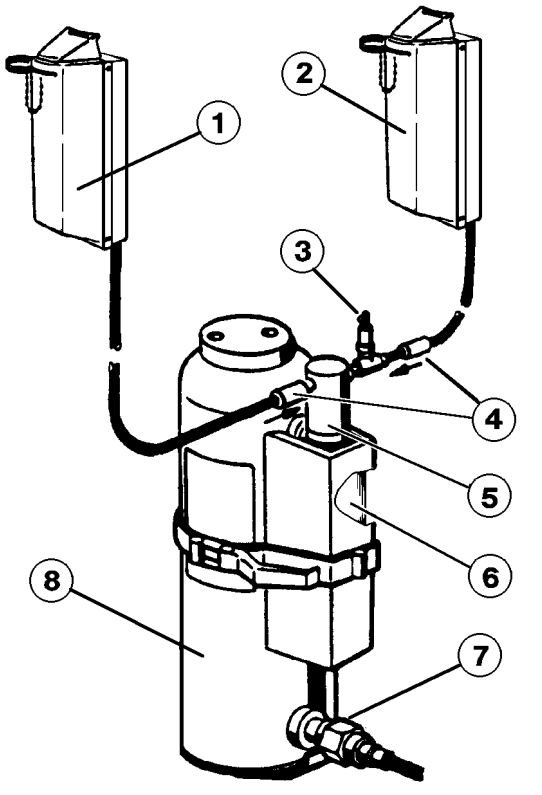
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FIRE CONTROL SYSTEM (MANUAL)

The fire control system aids in protecting the machine in the event of a fire. The system consists of:

- Actuators
- Pneumatic Actuator/Cartridge Receivers
- Pressure Relief Valve
- Check Valves
- Dry Chemical Tanks
- Hoses And Nozzles.

When either actuator is depressed, a nitrogen cartridge will pressurize the dry chemical tank. Once the dry chemical tank has pressurized to a sufficient pressure, a bursting disc in the tank outlet will break, allowing the fluidized chemical to flow to the nozzles. The nozzles will direct the agent at the fire and extinguish the flames.



91461

FIGURE 2-1. FIRE CONTROL SYSTEM

1. Cab Actuator
2. Remote Actuator
3. Safety Relief Valve
4. Check Valves
5. Actuator Receiver
6. Cartridge
7. Bursting Disc Union
8. Dry Chemical Tank

Operation

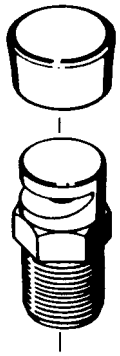
To actuate the fire control system, pull the safety ring on either of the actuators and depress the lever. One actuator is located in the cab near the operator. Another actuator is located on the left fender structure near the bumper.

NOTE: Operating either actuator will activate fire control system.

Inspection and Maintenance

It is imperative that the fire control system is inspected at least every six months. To insure that it will operate effectively:

1. Check the system for general appearance, mechanical damage and corrosion.
2. Inspect each chemical tank fill cap gasket for damage and replace if necessary. Examine cap for nicks, burrs, cross threading or rough edges.
3. Check the level of dry chemical. The level should not be less than three inches (76 mm) from bottom of fill opening. Dry chemical must be free flowing, with no caking.
4. Insure that the vent in the fill opening threads is not obstructed.
5. Remove the cartridge from the extinguisher and examine the disc-seal. Replace seal if necessary. Install cartridge hand tight.



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FIGURE 2-2. NOZZLE AND BLOW-OFF CAP

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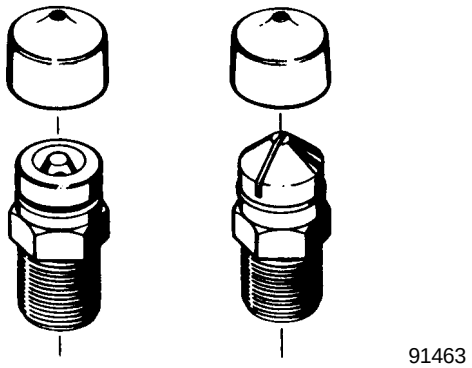


FIGURE 2-3. NOZZLES AND BLOW-OFF CAP

6. Inspect lines, fittings and nozzles for mechanical damage and cuts.
7. Check nozzle openings. The openings should be packed with silicone grease or equipped with plastic blow-off caps if equipped with nozzles as shown in Figure 2-2. Nozzles of the type shown in Figure 2-3 are not to be packed with grease. Only the protective caps shown are to be used on this type of nozzle.
8. Remove and inspect the cartridge of the remote actuators. Replace if ruptured. Check operation of puncture pin.
9. Replace any broken or missing lead and wire seals.

Recharging Procedures

After actuating the fire control system, the system should be recharged. Follow the procedure below for each dry chemical tank and actuator installed:

1. Relieve the pressure from the lines by pulling the ring on the safety relief valve.
2. Disconnect line from tank actuator and remove line from the bursting disc union.
3. Remove each extinguisher from its bracket.
4. Disassemble bursting disc union and replace the ruptured bursting disc with **flat side toward extinguisher.**
5. Fill tank with dry chemical to not more than three inches (76 mm) from the bottom of the fill opening.
6. Inspect fill opening threads and gasket. If necessary clean threads.
7. Install the fill cap and tighten the cap hand tight.
8. Remove the cartridge guard from the dry chemical tank and remove the cartridge.
9. Insure that the cartridge puncture pin is fully retracted.
10. Weigh the new cartridge. The weight must be within 0.25 ounce (7.0 grams) of the weight stamped on the cartridge.
11. Screw the new cartridge onto the actuator assembly, hand tight.
12. Replace the cartridge guard and install the dry chemical tank into its bracket.
13. Connect line at the bursting union, and line at the tank actuator.
14. Remove the cartridge guard from the remote actuators and replace the cartridges.
15. Replace the cartridge guards, and install ring pins on the push buttons.
16. Inspect hose, fittings and nozzles for mechanical damage. Replace all hose that has been exposed to fire areas.
17. Clean the nozzles and repack the openings with silicone grease or install blow-off caps. Use caps for new designed nozzles shown in Figure 2.1-2.

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ALTERNATOR AND WHEELMOTOR COOLING AIR FILTER SYSTEM

The cooling air for the alternator and wheelmotors passes through a filter assembly prior to entering the blower on rear of alternator. The filter housing is mounted on the inlet of the air duct. The dirt removed by the filter is drawn off each end of the filter housing by a hydraulic motor driven blower and discharged to atmosphere.

The hydraulic circuit for the evacuation fan consists of the following:

- Main Hydraulic Reservoir
- Engine Driven Pump
- Remote Mounted Relief Valve
- Hydraulic Motor
- Supply and Return Piping

The pump is located at left rear of the engine. The relief valve and fan motor are mounted on deck near the control cabinet.

Oil from reservoir flows to inlet side of a gear type pump. The outlet from the pump flows to a gear type motor and direct acting relief valve. Oil flows through the motor and returns to the main reservoir. The flow is blocked at the remote mounted relief valve.

At engine high idle pump flow is approximately 12 GPM (45 lpm). Maximum relief setting is 1000 ± 50 psi (7 ± .35 MPa).

SYSTEM ADJUSTMENT

⚠WARNING

Before opening blower drive hydraulic system, be sure steering accumulators are completely bled down. Turn steering wheel to check that accumulators have bled down.

1. Install 0-2000 psi (0-14 MPa) gauge in tee where motor supply line connects to line routed to relief valve.
2. Remove line from tee to motor and plug.
3. Install cap on tee.
4. Loosen jam nut on circuit relief and back out relief adjusting screw.
5. Start engine and slowly increase engine speed to high idle while observing gauge.

⚠CAUTION

There is no directional control valve in this circuit to divert flow to tank. if gauge reading increases rapidly, immediately shutdown engine.

6. With engine speed at high idle, slowly turn in relief adjusting screw until 1000 ± 50 psi (7 ± .35 MPa) is observed on gauge. Tighten jam nut.
7. Return engine to idle speed and shutdown engine. Be sure steering accumulators are bled down.
8. Remove gauge, install plug in tee. Connect supply line to tee.

PUMP

⚠WARNING

Before removing hydraulic lines from pump, be sure steering accumulators are completely bled down. Turn steering wheel to check that accumulators have bled down.

Removal

1. Disconnect lines from pump and cap to prevent contamination.
2. Remove nuts from mounting studs and slide pump from mount studs.

Disassembly

1. Clean pump before disassembly.
2. Remove nuts (16, Figure 4-2) and lockwashers (15) from pump body studs (14).
3. Separate front cover (10) from center section (8).
4. Remove wear plate (9) and center section (8).
5. Remove gears (6 & 7) and wear plate (4) from rear cover (1).

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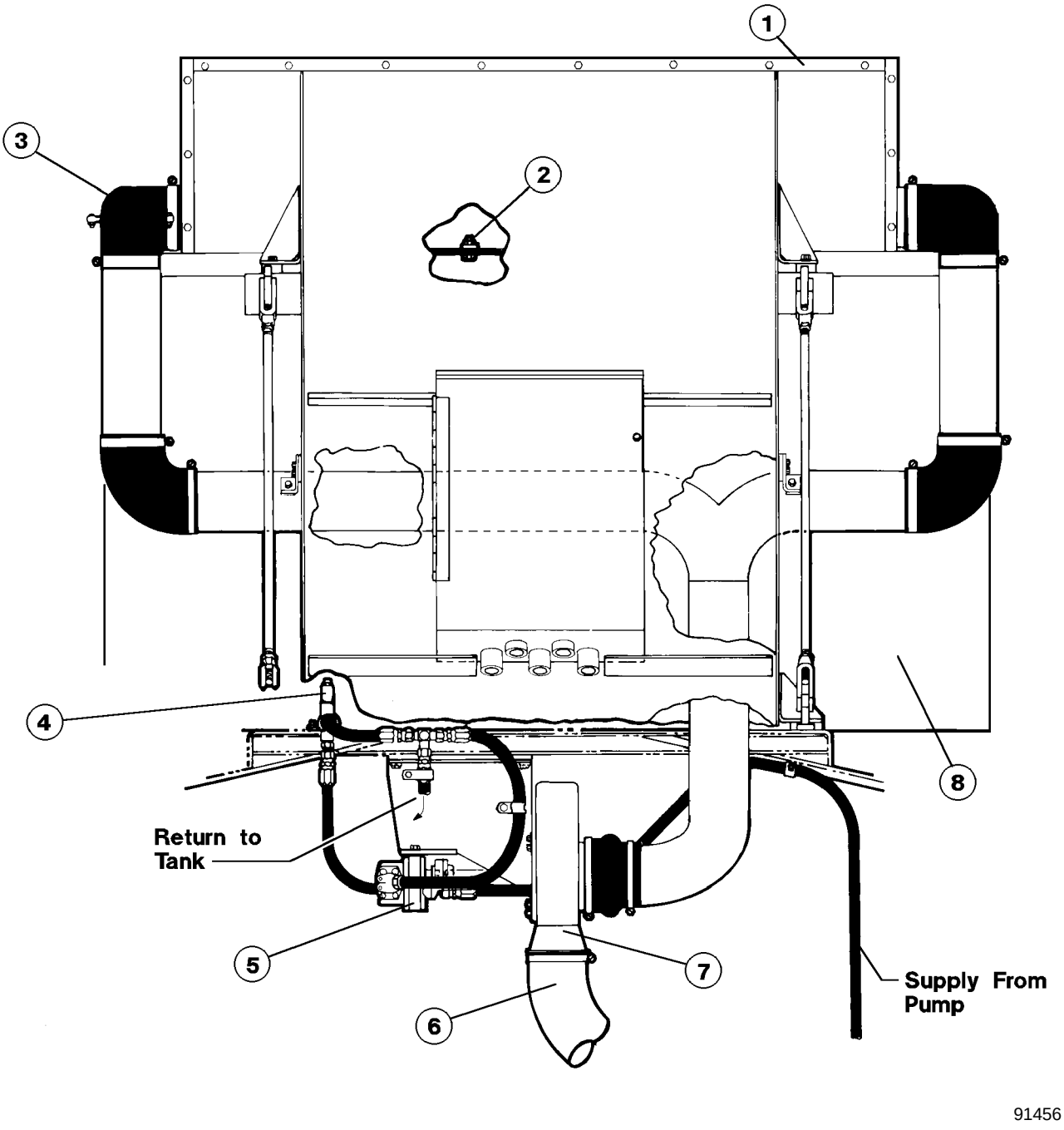


FIGURE 4-1. BLOWER AIR FILTERING SYSTEM

1. Air Filter Assembly
2. Mounting Hardware
3. Scavenge Tubing Elbow
4. Relief Valve
5. Hydraulic Motor
6. Blower Discharge
7. Evacuation Blower
8. Electrical Control Cabinet

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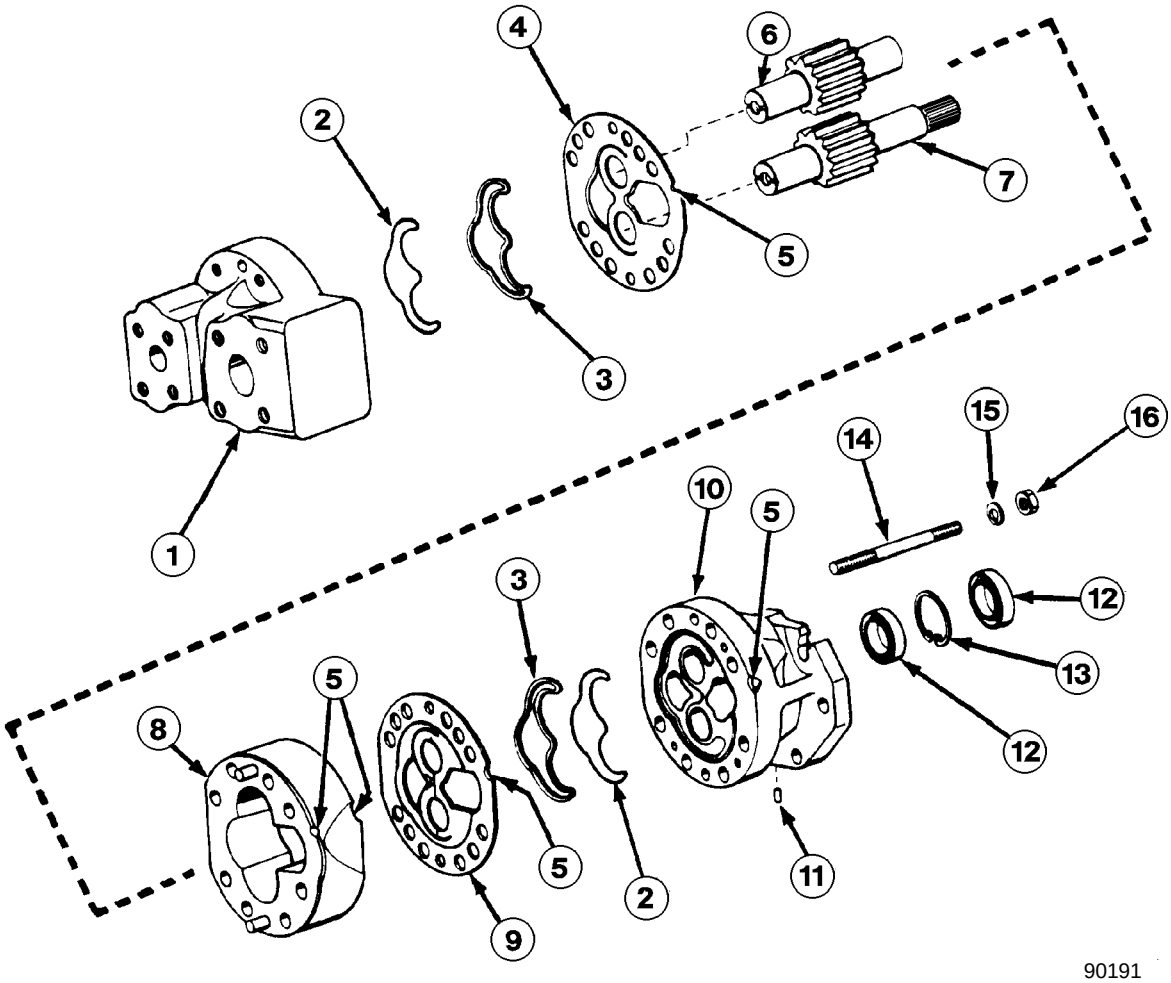


FIGURE 4-2. HYDRAULIC PUMP

1. Rear Cover
2. Seal
3. Seal Retainer
4. Rear Wear Plate
5. Notch
6. Driver Gear
7. Drive Gear
8. Center Section
9. Front Wear Plate
10. Front Cover
11. Plug
12. Shaft Seal
13. Snap Ring
14. Stud
15. Lockwasher
16. Nut

Inspection

a. Inspect wear plate for scoring and erosion.

b. Inspect gears for wear.

c. Inspect center section for scoring and scratches.

d. Check all bushings for scoring.

e. If any damage is found to these components, replace pump assembly. Only seals are available for pump repair.

Assembly

1. Install seal retainer (3) and seal gland (2), flat side of seal retainer against wear plate face (4).

2. Install wear plate (4) on rear cover, bronze side toward gears.

3. Position center section on rear cover wear plate.

4. Install idler and drive gears (6 & 7).

5. Install front wear plate (9), bronze against gears. Install seal retainer (3) and seal gland (2).

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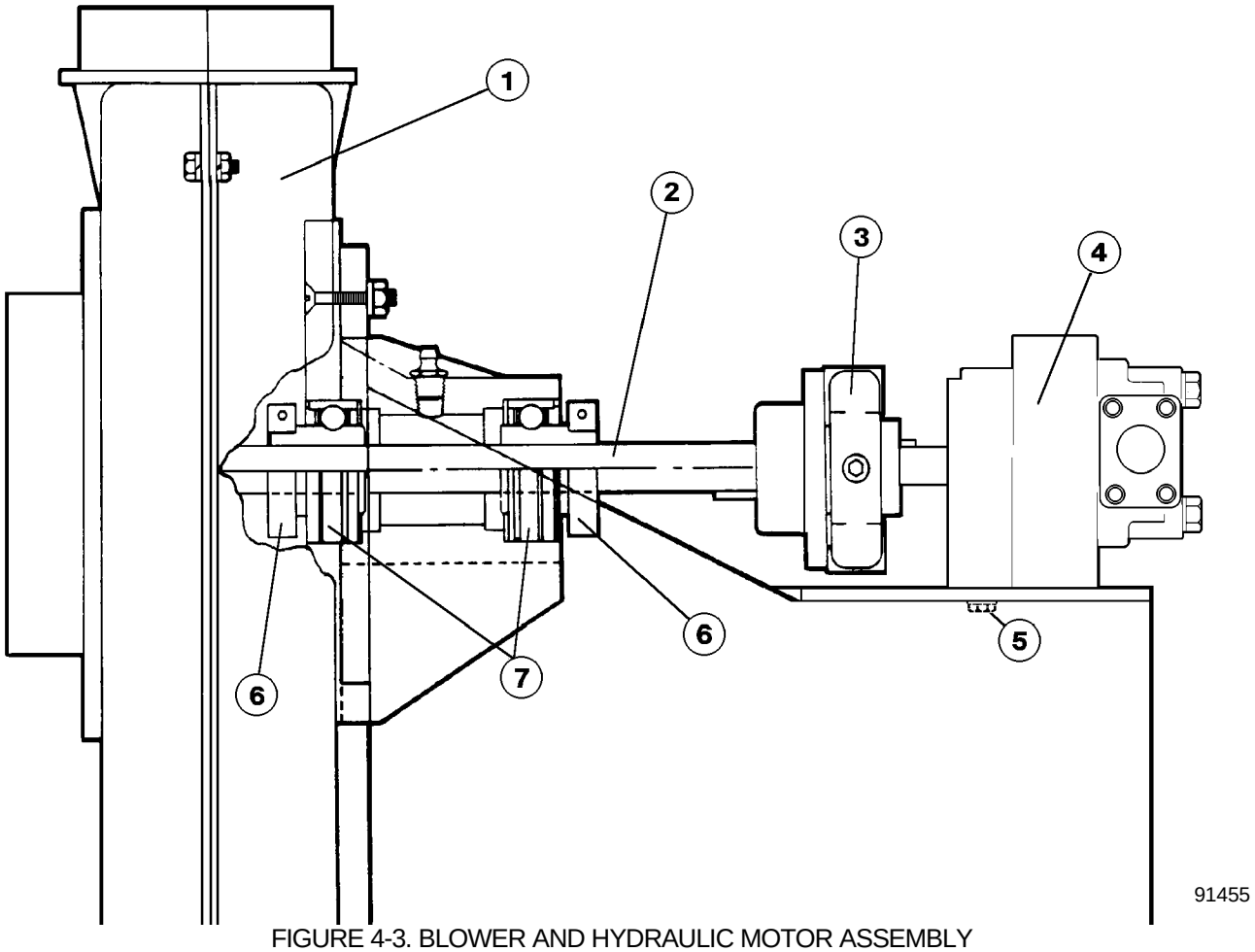


FIGURE 4-3. BLOWER AND HYDRAULIC MOTOR ASSEMBLY

1. Fan Assembly
2. Blower Shaft
3. Flex Coupling
4. Hydraulic Motor
5. Motor Mounting Capscrews
6. Locking Collar
7. Bearings

6. Install front cover, tighten nuts to **115 ft.lbs. (156 N-m)** torque.
7. Pack grease in spring side of shaft seal and install into bore of front cover.
8. Install snap ring (13).
9. Install outer seal. Pack spring side of seal before installation.
10 After assembly is complete, **3 ft. lbs. (4 N-m)** torque should rotate shaft.

Installation

1. With a new gasket, install pump on mounting studs.
2. Tighten nuts to standard torque.
3. Pour hydraulic oil into pump.
4. Connect hoses, O-rings and split flange clamps. Tighten outlet split flange to standard torque.
5. With suction hose loose, temporarily pressurize the hydraulic tank with 15 psi (103 kPa) regulated air pressure. Be sure oil is present at pump. Tighten suction line split flange capscrews to standard torque.

BLOWER DRIVE MOTOR

⚠WARNING

Before removing hydraulic lines from motor be sure steering accumulators are completely bled down. Turn steering wheel to check that accumulators have bled down.

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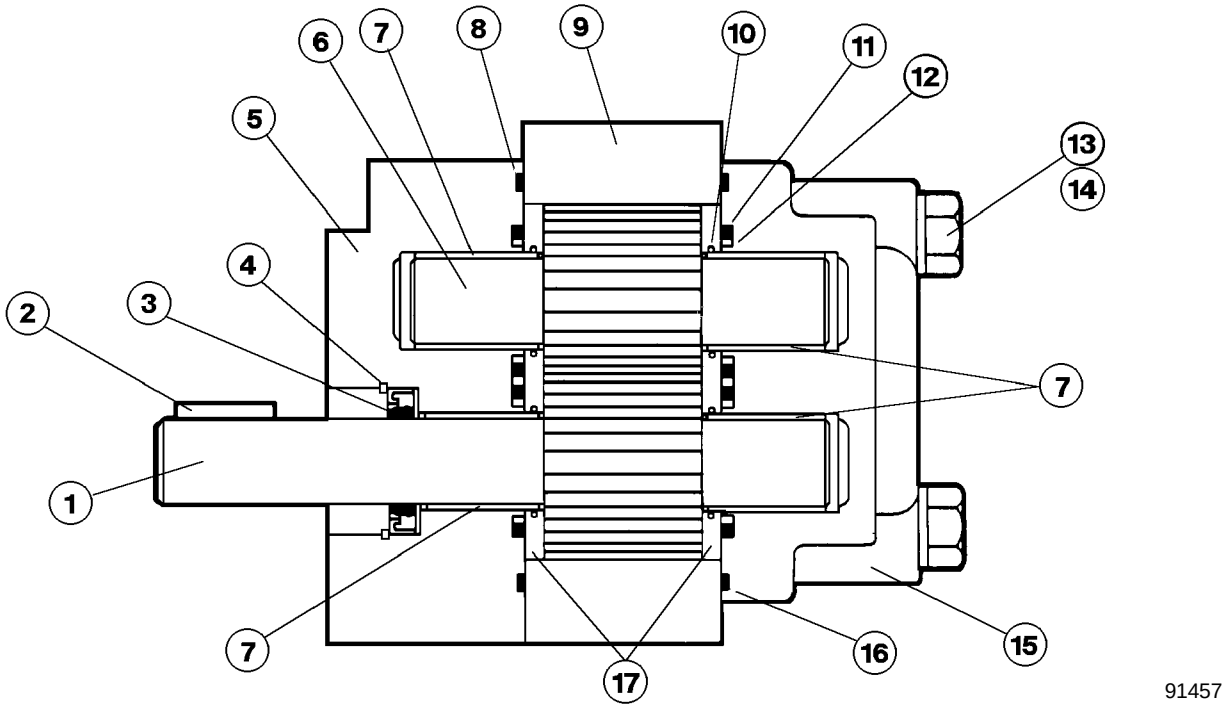


FIGURE 4-4. HYDRAULIC MOTOR

1. Gear and Shaft
2. Key
3. Shaft Seal
4. Snap Ring
5. Mounting Flange
6. Idler Gear
7. Bushing
8. O-ring
9. Gear Plate
10. O-ring
11. O-ring
12. Backup Ring
13. Capscrew
14. Washer
15. Cover Plate
16. O-ring
17. Pressure Plate

Removal

1. Disconnect hoses from fan motor. Cap lines to prevent contamination.
2. Loosen set screw of flex coupling (3, Figure 4-3)connecting motor shaft to blower wheel shaft.
3. Remove motor mounting capscrews (5) and washers.
4. Slide motor out of flex coupling.

Disassembly

1. Using solvent and brush to clean outside of motor thoroughly.
2. Mark the motor plates nearest to drive shaft extension side. These marks can be used for matching in reassembling motor.
3. Place motor in machinist vise. Use blocks of wood or cardboard between motor and vise jaws.
4. Loosen and remove capscrews (13) and washers (14).
5. Remove motor from vise. Using wood mallet or plastic hammer, tap connector bosses to loosen cover plate (15). Lift plate straight up off gear journals.
6. Remove O-ring (16), pressure balance O-ring (11), and back-up ring (12).
7. Remove pressure plate (17). Remove O-rings (10) from journal bores of pressure plate.
8. Lift drive gear (1) and idler gear (6) straight up out of gear plate.
9. Tap edges of gear plate (9) with mallet or plastic hammer to loosen. If gear plate does not move by this method, lift the plates up off work bench slightly and tap the ears of flange plate lightly.
10. Dowels (4, Figure 4-5) are pressed into gear plate. There are four dowels on each side and unless gear plate is to be replaced, it is not necessary to remove them.

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a. To remove the dowels, use a rod or punch and hammer to drive them out. Place driver inside of dowel and against end of dowel on opposite side and tap out.

12. Repeat steps 6 and 7 for remaining seals.

13. Slide a punch of appropriate size through the bearing and against the metal casing of the seal (3, Figure 4-4). Hold the punch away from the bearings and drive the seal out without damaging seal bore or bearing. Move the punch around the seal as it is driven out. Do not allow the punch to rest against the seal bore or bearing while driving the seal out.

14. Check the seal bore for scratches. If scratches are apparent, us a four hundred grit sandpaper to clean up the bore. Do not use coarse grit sandpaper. It will cut heavy grooves in the bore and will allow the seal to leak around the O.D.

15. Wash all motor parts in clean solvent and wipe dry with clean shop towel or blow dry with shop air.

Inspection Of Parts

Visually inspect all parts. After a visual inspection those parts which are in questionable condition should be replaced with new ones.

1. Examine the bores in the gear plate.
   a. If any grooves are cut deeper than .015" (.38 mm) or the plate is cracked or damaged in some other way, it should be rejected.
2. Examine the gears.
   a. If excessive wear is visible on the journals, sides, or faces of the gears, or at the point where the drive gear shaft rotates in the lip seal, reject them. If keyway is excessively worn, replace the drive gear.
3. Examine the pressure plates.
   a. They should not show excessive wear on the bronze side. If deep curved wear marks are visible, replace the plate with a new one.
4. Shaft seals should be replaced. All O-ring seals and back-up rings or strips should be replaced with new.
5. Bearing I.D.'s should have a gray coating.
   a. If bronze can be seen shining through the teflon on the inlet side, the bearings and plate they are in, should be replaced.

Assembly

1. Using an arbor press, press the new seal (3, Figure 4-4) into flange bore.
   a. Center the seal over the seal bore with metal face of the seal facing out.
   b. Make sure the seal is started and pressed straight into the bore.
   c. Place a socket wrench (having an O.D. just slightly smaller than seal bore) against seal.
   d. Press against socket and press seal in until seal has just cleared snap ring groove in seal bore.
3. Apply two or three drops of # 290 Locite against seal bore and O.D. of seal.
   a. Hold the flange at a 45 degree angle and rotate it slowly to allow the locite to flow all the way around the O.D. of the seal.
4. Install the snap ring and wipe the excess Locite out of seal bore and seal lip.
5. Install O-ring (1, Figure 4-5) in cover plate (5). After O-ring has been placed in groove, spread a light coat of grease on the O-ring to hold it in place.
6. If for any reason, gear plate (3, Figure 4-6) had to be replaced, dowels (4) must be pressed into both sides of replacement gear plate before assembling it to cover plate. Dowels can be tapped in with hammer, but it is best to use a dowel guide and press. Whichever method is used, make sure they are straight in dowel bores. If press is used, do not apply rapid force on dowels. If a hammer is used, do not drive the dowels in aggressively. Tap them lightly until they are against the shoulder.
7. With matching marks made in step 2 toward you, and the four cast recesses in the outer edge of gear plate toward cover plate, line up dowels. Tap gear plate lightly until it is against O-ring in cover plate.
8. Install back-up ring (3, Figure 4-5) and O-ring (2).
9. Install O-ring (5, Figure 4-6) in pressure plate (2). With trap (small oblong hole) in pressure plate toward inlet side of gear plate and bronze side up, slide pressure plate down gear bores.
10. Install drive gear in gear bore nearest to matching mark and idler gear in opposite bore.
11. Install O-ring in remaining pressure plate . With trap toward inlet side and bronze side down, place pressure plate down against gear faces.

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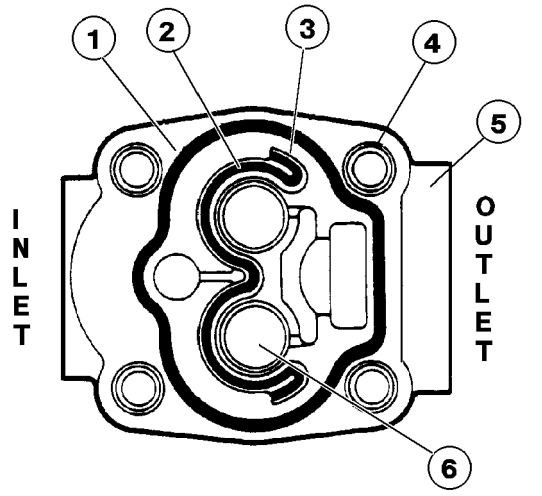


FIGURE 4-5. COVER PLATE SEALS

1. O-ring
2. O-ring
3. Backup Ring
4. Dowel
5. Cover Plate
6. Drive Gear Bore

12. Install back-up ring, O-ring, and O-ring in flange plate. Use clean, heavy grease to hold O-rings in grooves.

13. Attach a piece of tape over shaft keyway to protect seal during assembly.

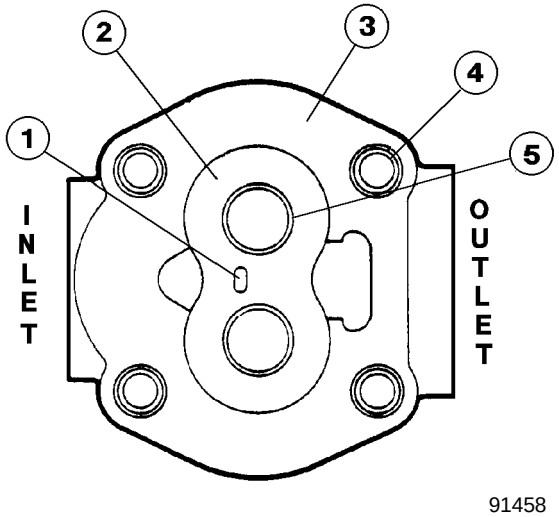


FIGURE 4-6. PRESSURE PLATE INSTALLATION

1. Trap
2. Pressure Plate
3. Gear Plate
4. Dowel

14. With O-ring in flange plate facing down and keeping plate true with shafts, slide it down until it contacts dowels in gear plate. Bump flange very lightly with hands or plastic hammer to force the plate down on dowels, at the same time making sure grease is holding O-rings in grooves. Once plate is in position, remove tape protecting seal from shaft keyway.

15. Coat capscrew (13, Figure 4-4) threads with clean hydraulic oil. Install washers (14) on capscrews. Tighten to **80 ft. lbs (108 N-m)** torque.

16. Using a twelve inch wrench, check to see if shaft will turn. It will be tight but should turn free with a **15 lbs (6.8 Kg)** maximum force on wrench.

Installation

1. Slide motor shaft with key into flex coupling on blower wheel shaft. Tighten set screw of flex coupling to **65 ft. lbs. (88 N-m)** torque.
2. Install motor mounting capscrews, tighten to standard torque.
3. Connect all hoses, tighten split flange capscrews to standard torque.

BLOWER BEARING REPAIR

Removal

1. Remove blower inlet and outlet hoses.
2. Loosen setscrew in flex coupling (3, Figure 4-3) on blower wheel shaft.
3. Remove all nuts, washers and capscrews securing housing halves. Remove inlet half of blower housing.
4. Loosen setscrews in blower wheel. Slide wheel from shaft.
5. Remove four blower housing retainer plates from blower housing and mount bracket.
6. Slide bearing housing and remaining blower housing half from mount brackets and flex coupling.

Replacement

1. Loosen clamp ring setscrew in locking collar (6, Figure 4-3) of one bearing.
2. Push other bearing with shaft out of housing.
3. Remove bearing remaining in housing.

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4. Remove bearing from shaft.
5. Clean all parts and inspect shaft and housing. Remove any scores or burrs from shaft. If either shaft or housing are damaged beyond use, the complete bearing housing assembly must be replaced. The shaft and housing are not serviced separately.
6. Remove the following from the new bearings:
   a. Remove snap ring from outer race and discard.
   b. Remove felt from side of bearings that will be pushed into housing.
7. Press bearing into housing, slide shaft through this bearing until 4 in. (102 mm) extends from drive motor end of housing.
8. Fill cavity between bearings with grease.
9. Press remaining bearing into housing, check that 4 in. (102 mm) of shaft extends from drive motor end of housing.
10. Tighten bearing locking collar setscrews to **65 in. lbs. (7.35 N-m)** torque.

Assembly

1. Position mounting half of blower housing against bearing housing. Install two flat head capscrews, lockwashers and nuts.
2. Install blower housing, bearing housing assembly to mount structure engaging shaft into flex coupling.
3. Install remaining two flathead capscrews, retaining bars, lockwashers and nuts. Align retaining bars with tapped holes in mount structures. Install retaining bar capscrews. Tighten nuts and capscrews to standard torque.
4. Remove nuts from first two taper head capscrews. Repeat Step 3. Tighten flex coupling setscrews to **65 in.lbs. (7.35 N-m)** torque.
5. Slide blower wheel onto key and shaft. Tighten both setscrews to **65 in.lbs. (7.35 N-m)** torque.
6. Install inlet half of blower housing and tighten nuts to standard torque.
7. Rotate shaft by hand to insure wheel rotates freely.
8. Install inlet duct hose and clamp.
9. Install outlet hose and clamp.

AIR CLEANER

Assembly

The air cleaner separates dirt from air entering the cooling blower at the rear of the main alternator.

If excess dirt builds up in tubes of air cleaner and cannot be cleaned by blowing with compressed air, the unit can be removed from front of the duct and washed.

Removal

1. Remove scavenge tubing from each end of air cleaner.
2. Support air cleaner so it will not drop when mounting hardware is removed.
3. Remove mounting capscrews, nuts, and lockwashers.
4. Attach lifting device and remove air cleaner from truck.

Washing Air Cleaner

1. Submerge filter assembly in a solution of Donaldson D-1000 and warm water. Mix solution according to instructions on Donaldson D-1000 package.
2. Soak for 30 minutes, remove from solution, rinse with fresh water and blow dry.

Assembly

1. Lift filter assembly and align with air inlet duct.
2. Install all mounting capscrews, lockwashers and nuts. Tighten to standard torque.
3. Install scavenge tubing and clamps.

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WIGGINS QUICK FILL FUEL SYSTEM

FUEL RECEIVER

The fuel receiver (3, Figure 5-1) is normally mounted on the fuel tank (1). Optional locations are the left hand frame rail (Figure 5-3) or at the Service Center in front.

Keep the cap on the receiver to prevent dirt build up in valve area and nozzle grooves. If fuel spills from tank breather valve, or tank does not completely fill, check breather valve to see that float balls are in place and outlet screen is clean. If valve is operating properly, the problem will be with the fuel supply system.

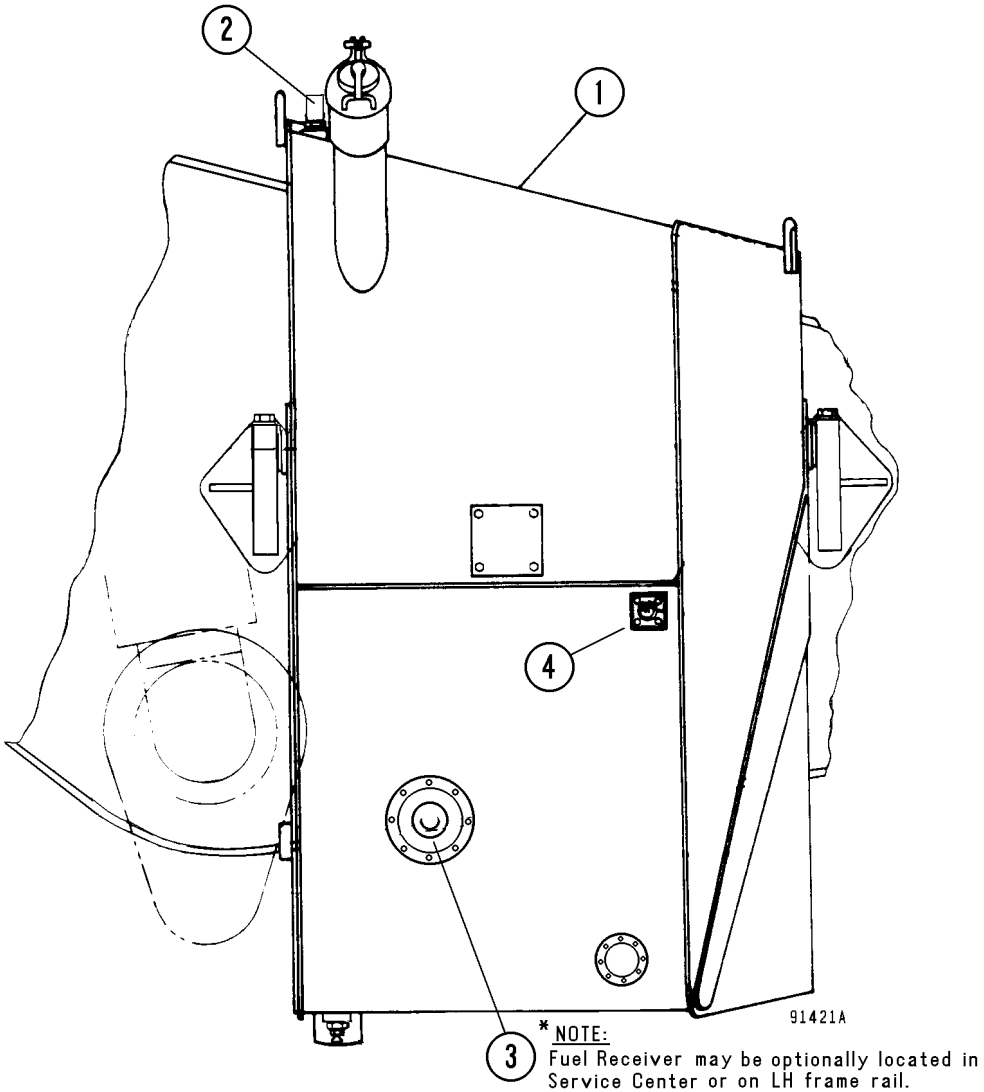


FIGURE 5-1. FUEL TANK BREATHER & RECEIVER INSTALLATION

1. Fuel Tank
2. Breather Valve
3. Fuel Receiver
4. Fuel Level Gauge

NOTE: This Illustration Represents a Typical Installation.
Fuel tank may vary in size, shape and location depending on truck model.

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TANK BREATHER VALVE

Removal

Unscrew breather valve (2, Figure 5-1) from tank (1).

Installation

Screw breather valve into tank.

Disassembly

1. Remove spring clamp (4, Figure 5-2) from outlet.
2. Pull off rubber cover and screen (3).
3. Unscrew nut (5) from top of breather valve. Remove cover (6), spring (7), and steel ball (8).
4. Slide valve assembly (9) from housing.
5. Disengage tapered spring (1) containing three balls (2) from valve stem.

Assembly

1. Clean and inspect all parts. If valve, body, or springs are damaged, replace complete breather valve.
2. Install in order; tapered spring, one steel ball, one cork ball and one hollow aluminum ball.
3. Engage three coils of spring on small end of valve stem with hollow aluminum ball.
4. Install valve into housing.
5. Place steel ball (8) on top of valve. Install spring (7).
6. Place cover (6) over spring. Screw on large nut (5).
7. Install screen and rubber cover (3) over outlet.
8. Install spring clamp (4).

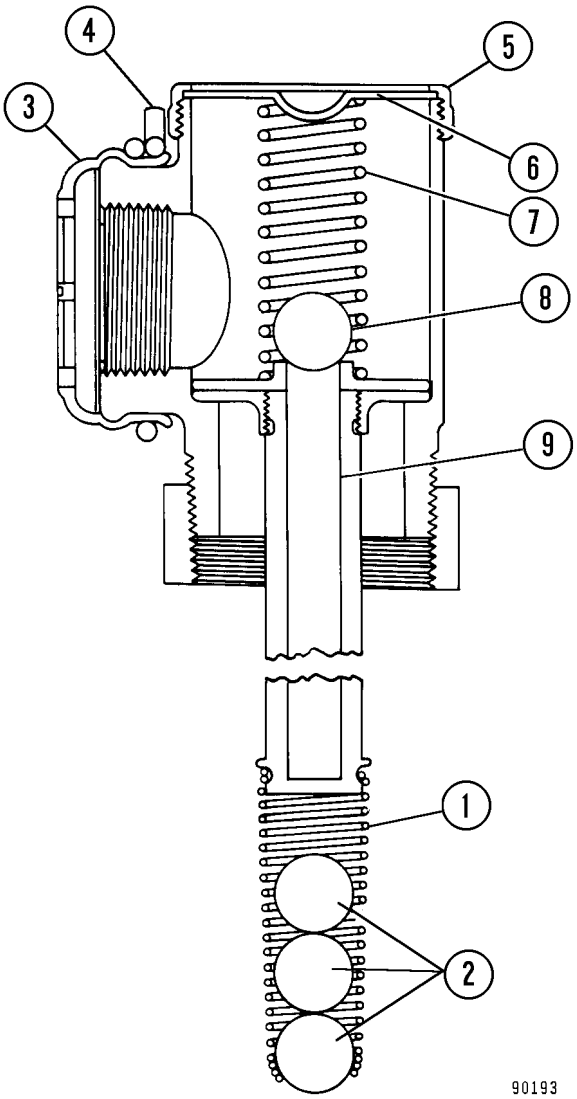


FIGURE 5-2. BREATHER VALVE

1. Tapered Spring
2. Float Balls
3. Cover and Screen
4. Spring Clamp
5. Nut
6. Cover
7. Spring
8. Steel Ball
9. Valve Assembly

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LEFT SIDE FILL

This location permits fueling the truck from the left side.

Keep the cap on the receiver to prevent dirt build up in valve area and nozzle grooves. If fuel spills from tank breather valve, or tank does not completely fill, check breather valve to see that float balls are in place and outlet screen is clean. If valve is operating properly, the problem will be with the fuel supply system.

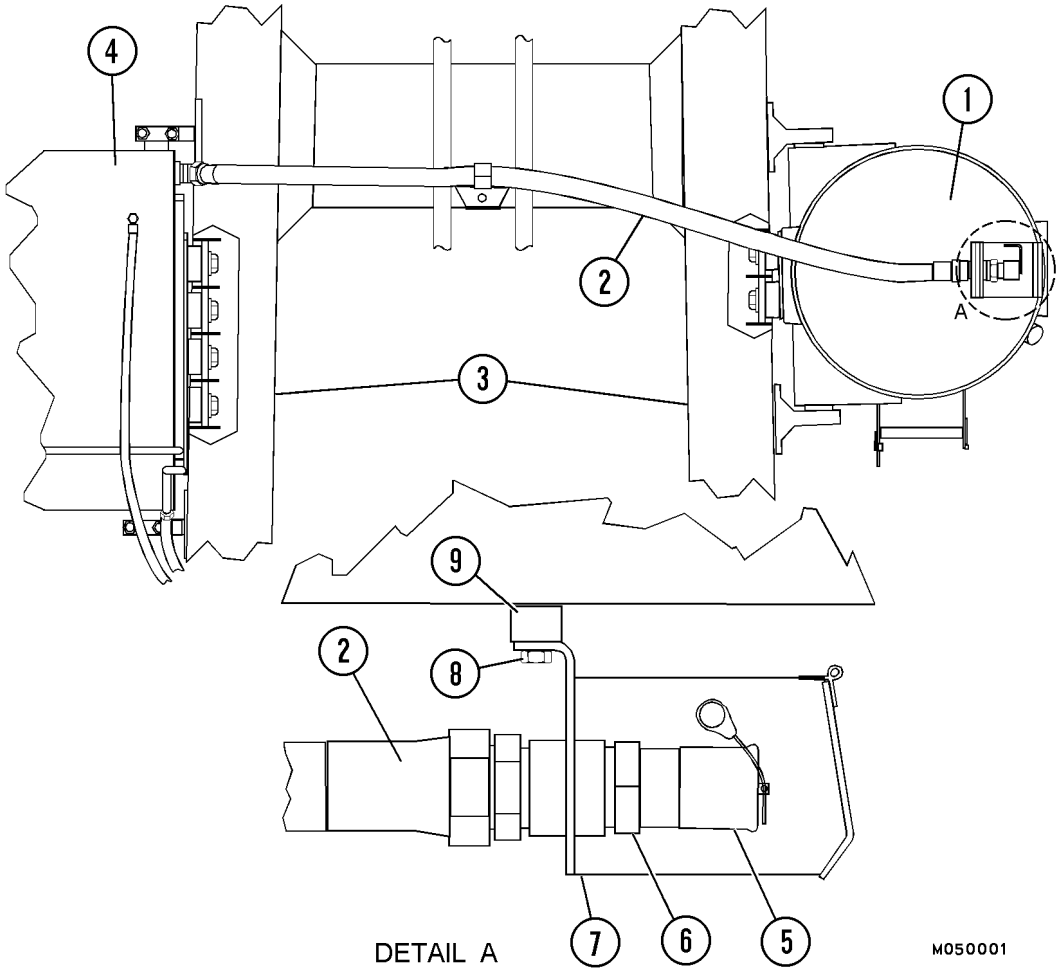


FIGURE 5-3. LEFT SIDE FILL

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

NOTE: This Illustration Represents a Typical Installation. Installation may vary depending on truck model.

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NOTES

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BUCKEYE QUICK FUEL SYSTEM

FUEL TANK BREATHER VALVE

Maintenance

Normal maintenance involves cleaning or replacement of the breather valve filter during 1000 hour servicing. Operation in extremely dusty conditions may require more frequent cleaning or replacement intervals.

Filter Service

1. Remove three capscrews (7, Figure 5-1) on vent housing.
2. Remove housing (1) and filter (3).
3. Clean the filter in solvent and blow dry with compressed air.
4. Inspect filter for damage and replace if necessary.
5. Install filter on seat (6).
6. Inspect the housing O-ring seal (8) and replace if necessary.
7. Install the housing and secure in place with capscrews (7).

Disassembly

1. Remove breather valve assembly from the fuel tank. (Refer to Figure 5-2.)
2. Loosen three capscrews (7, Figure 5-1) and remove vent housing (1).
3. Remove filter (3).
4. Compress the spring (12, Figure 5-1) and remove the cotter pin (17).
5. Remove the retaining washer (16), spring and balls (13, 14, and 15).

Inspection

1. Inspect filter and clean or replace as required.
2. Clean all parts thoroughly and inspect for damage.

Assembly

1. Assemble using new O-ring seals.
2. Install filter (3) and housing (1).
3. Insert balls in order as shown in Figure 5-1.
   a. Install aluminum ball.
   b. Install plastic ball.
   c. Install steel ball.
4. Insert spring (12) and retaining washer (16). Compress spring to insert cotter pin (17).
5. Install assembly in fuel tank.

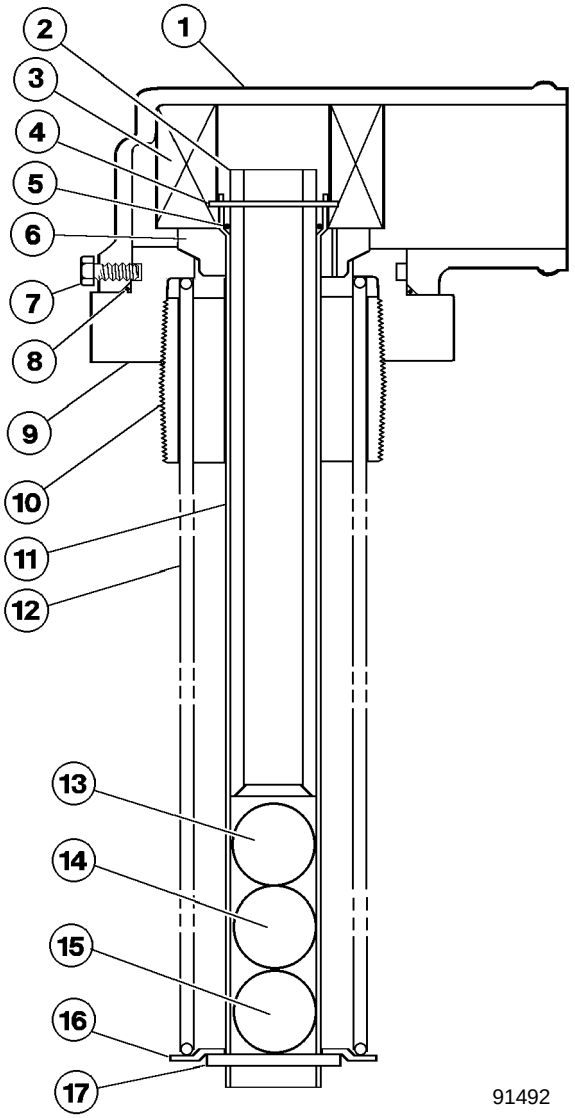


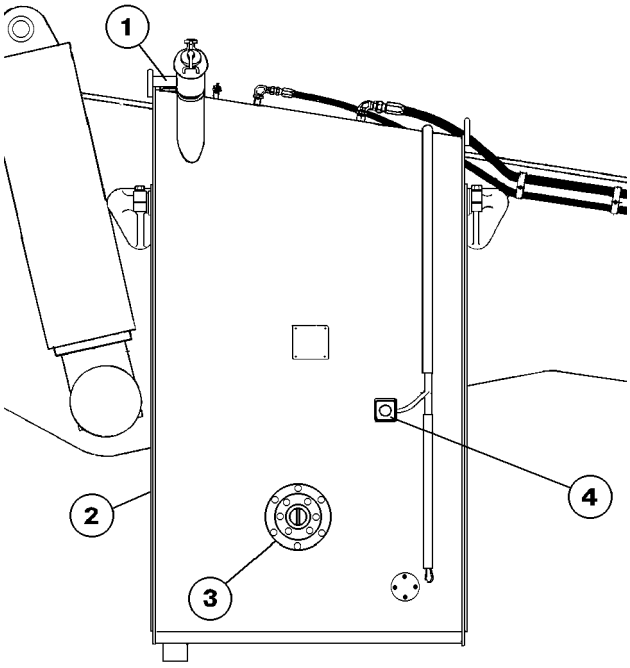
FIGURE 5-1. FUEL TANK BREATHER VALVE

1. Vent Housing
2. Inner Tube
3. Filter
4. Cotter Pin
5. O-ring
6. Seat
7. Capscrew
8. O-ring
9. Vent Base
10. Nipple
11. Outer Tube
12. Spring
13. Aluminum Ball
14. Plastic Ball
15. Steel Ball
16. Retaining Washer
17. Cotter Pin

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FUEL RECEIVER

The fuel receiver (3, Figure 5-2) is mounted on the fuel tank (2). Keep the cap on the receiver to prevent dirt build-up during truck operation. If fuel spills from breather valve or tank does not fill completely, check breather to see that the balls are in place and the filter is clean.



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FIGURE 5-2. FUEL TANK BREATHER AND RECEIVER INSTALLATION

1. Breather Valve
2. Fuel Tank
3. Fuel Receiver
4. Fuel Level Gauge

NOTE:
This Illustration Represents a Typical Installation.

Fuel tank may vary in size, shape and location depending on truck model.

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ENGINE COOLANT HEATER

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

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

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

⚠CAUTION

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

Maintenance

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

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

HEATING ELEMENT

Removal

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

Installation

1. Install new heating element.
   a. Cover the new heating element threads with an anti-seize thread compound.

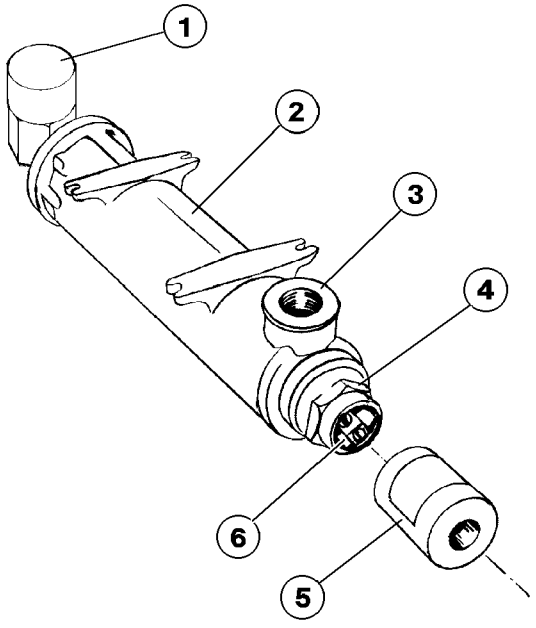


FIGURE 7-1. COOLANT HEATER

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

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b. Screw heating element into cartridge and tighten securely to insure against leaks.

2. Connect the electrical leads.
3. Slide element cover into position and secure with screws.
4. Open shut-off valves.
5. Plug in the external power source. After allowing time for the element to warm up, outlet hoses should feel warm to the touch.
6. Check for leaks and proper coolant level.

THERMOSTAT

Removal

1. Disconnect the external power source at the plug in receptacle.

NOTE: It is not necessary to remove the thermostat assembly from the heater.

2. Remove the two screws and slide cover out of the way.
3. Disconnect the two electrical leads.
4. Loosen the two setscrews and remove the temperature sensing unit.

Installation

1. Install a new temperature sensing unit and secure in place with two setscrews.
2. Connect the electrical leads.
3. Move cover into position and secure in place with screws.
4. Plug in the external power source.

After allowing time for the element to warm up, outlet hoses should feel warm to the touch.

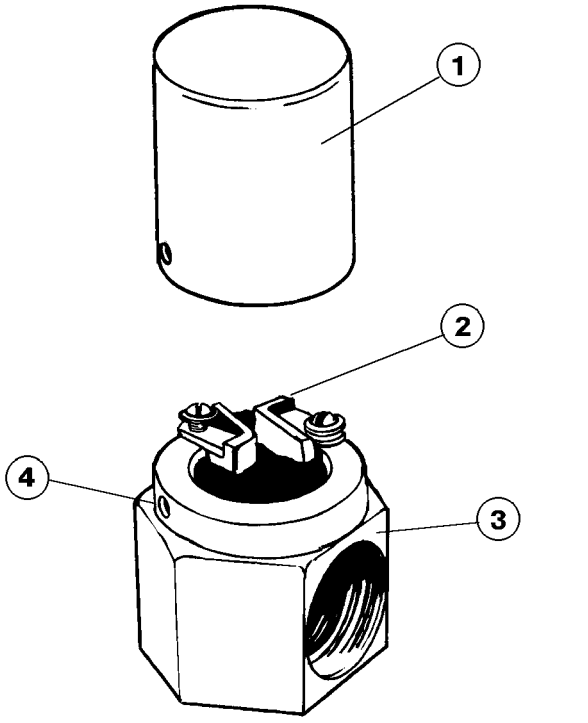


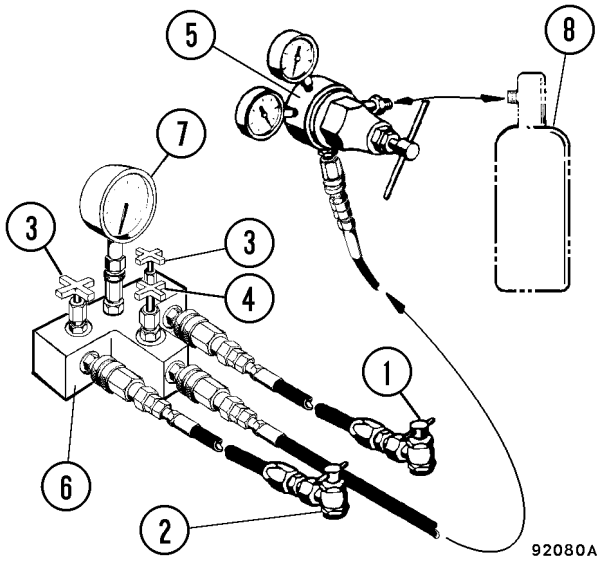
FIGURE 7-2. THERMOSTAT ASSEMBLY

1. Cover
2. Temperature Sensing Unit
3. Housing
4. Setscrew

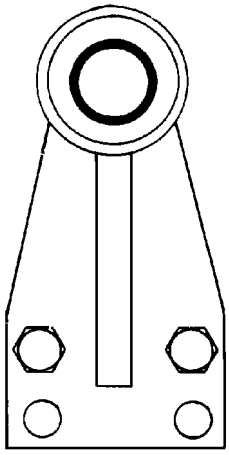
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SPECIAL TOOLS

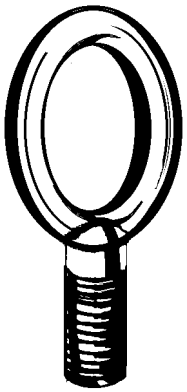
PART NO.	DESCRIPTION	USE
EB1759	NItrogen Charging Kit	Suspension & Accumulator Nitrogen Charging



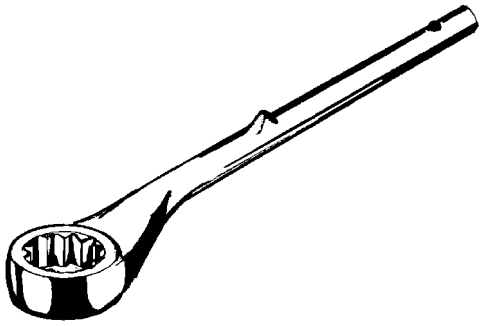
PART NO.	DESCRIPTION	USE
TY2930	Roll-Out Assembly	Power Module Removal & Installation



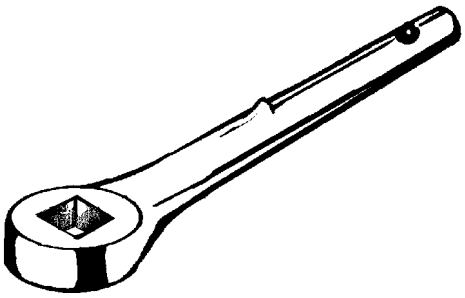
PART NO.	DESCRIPTION	USE
TG1106	Eye Bolt, .75–10 UNC	Misc. lifting requirements
WA4826	Eye Bolt, 1.25–7 UNC	



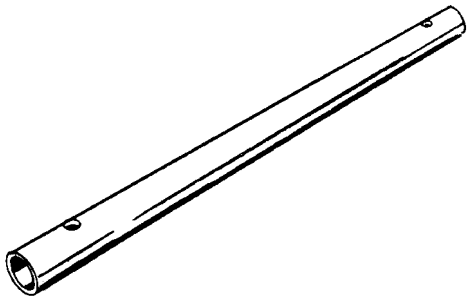
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PART NO.	DESCRIPTION	USE
TZ3535	Offset Box End Wrench, 1 1/2"	Miscellaneous



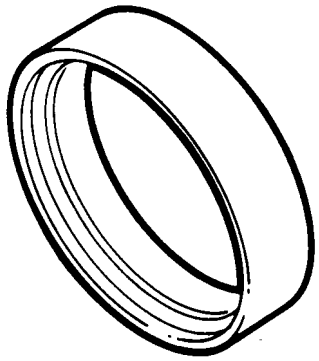
PART NO.	DESCRIPTION	USE
TZ2734	3/4" Female Adapter	Torque Wrench Extension



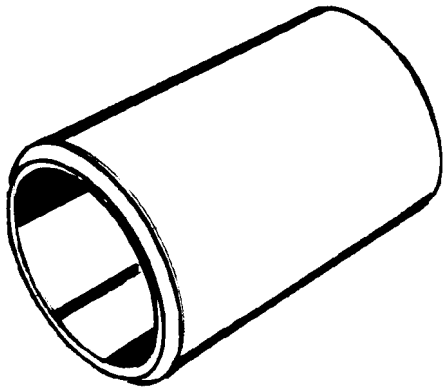
PART NO.	DESCRIPTION	USE
TZ2733	Tubular Handle	Use with TZ3535 & TZ2734

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PART NO.	DESCRIPTION	USE
TY2150	Seal Installation Tool	Installation of Front Wheel Bearing Face Seals



PART NO.	DESCRIPTION	USE
TZ0992	Alignment Sleeve	Rear Suspension And Anti-sway Bar Installation
TY4576	Alignment Sleeve	Steering Linkage Assembly

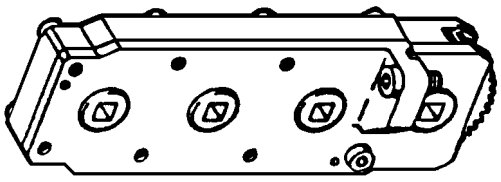


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PART NO.	DESCRIPTION	USE
ED8860*	Engine Turning Tool (MTU Engine Only)	To Rotate Engine Crankshaft

NOTE:
To use this tool for the MTU/DDC 4000 Series Engine, it must be used with the locally made Adapter Plate.

* This tool may also be acquired as MTU Part Number F6 555 766.



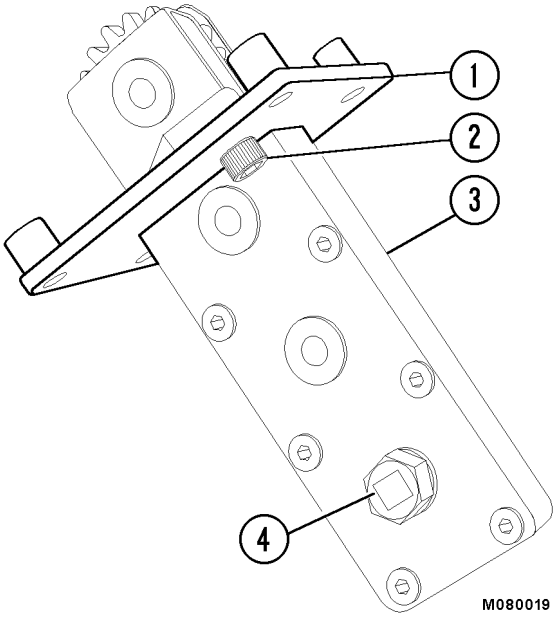
ED8860

PART NO.	DESCRIPTION	USE
ED8860 w/Adapter Plate	Engine Turn-over Tool for MTU/DDC 4000 Series Engine	To Rotate Engine Crankshaft

NOTE: To use the MTU engine turn-over tool for the MTU/DDC 4000 Series Engine, it must be used with the locally made Adapter Plate as shown here.

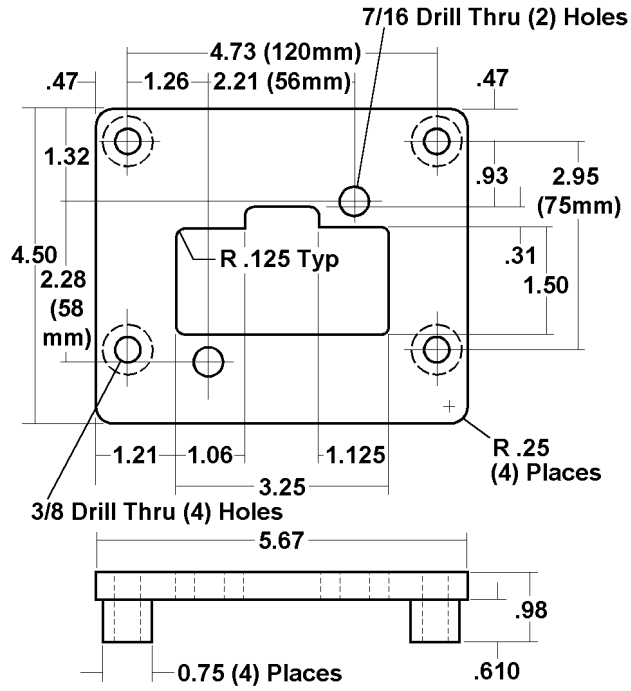
Remove screen/cover plate on the bottom of the engine flywheel housing at the 5 or 7 o'clock position.
Install assembly and use 1/2" drive wrench in driver socket (4) to turn engine.

1. Adapter Plate
2. Sockethead Capscrew



M080019

PART NO.	DESCRIPTION	USE
Make Locally	Adapter Plate	Use with ED8860 Engine Turning Tool as shown above.

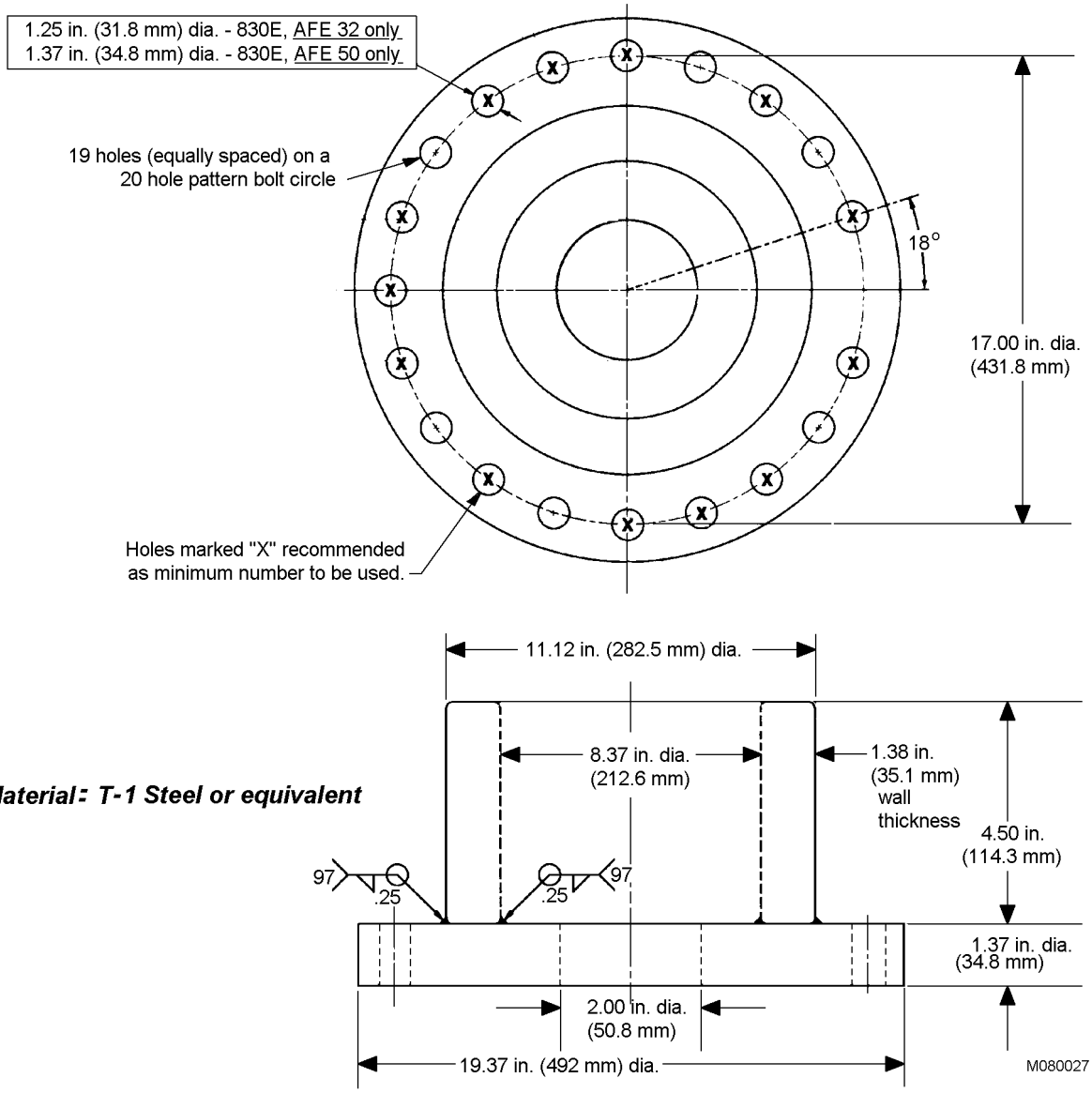


WELDMENT
Mat'l 101B C.R.S.

M080020

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PART NO.	DESCRIPTION	USE
Make locally using dimensions shown below	Puller Tool	To separate front wheel spindle from suspension piston
KC7091	Pusher Capscrews, 1.12 x 7 in.	Use for 830E, **AFE 32 ONLY**
WA0365	Hardened Flat Washers 1.12 in.	
KC7095	Pusher Capscrews, 1.25 x 8 in.	Use for 830E, **AFE 50 ONLY**
WA0366	Hardened Flat Washers 1.25 in.	



Material: T-1 Steel or equivalent

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NOTES

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AIR CONDITIONING SYSTEM

Environmental Impact

Environmental studies have indicated a weakening of the earth's protective Ozone (O_3) layer in the outer stratosphere. Chloro-flouro-carbon compounds (CFC's), such as R-12 refrigerant (Freon), commonly used in mobile equipment air conditioning systems, have been identified as a possible contributing factor of the Ozone depletion.

Consequently, legislative bodies in more than 130 countries have mandated that the production and distribution of R-12 refrigerant be discontinued after 1995. Therefore, a more "environmentally-friendly" hydro-flouro-carbon

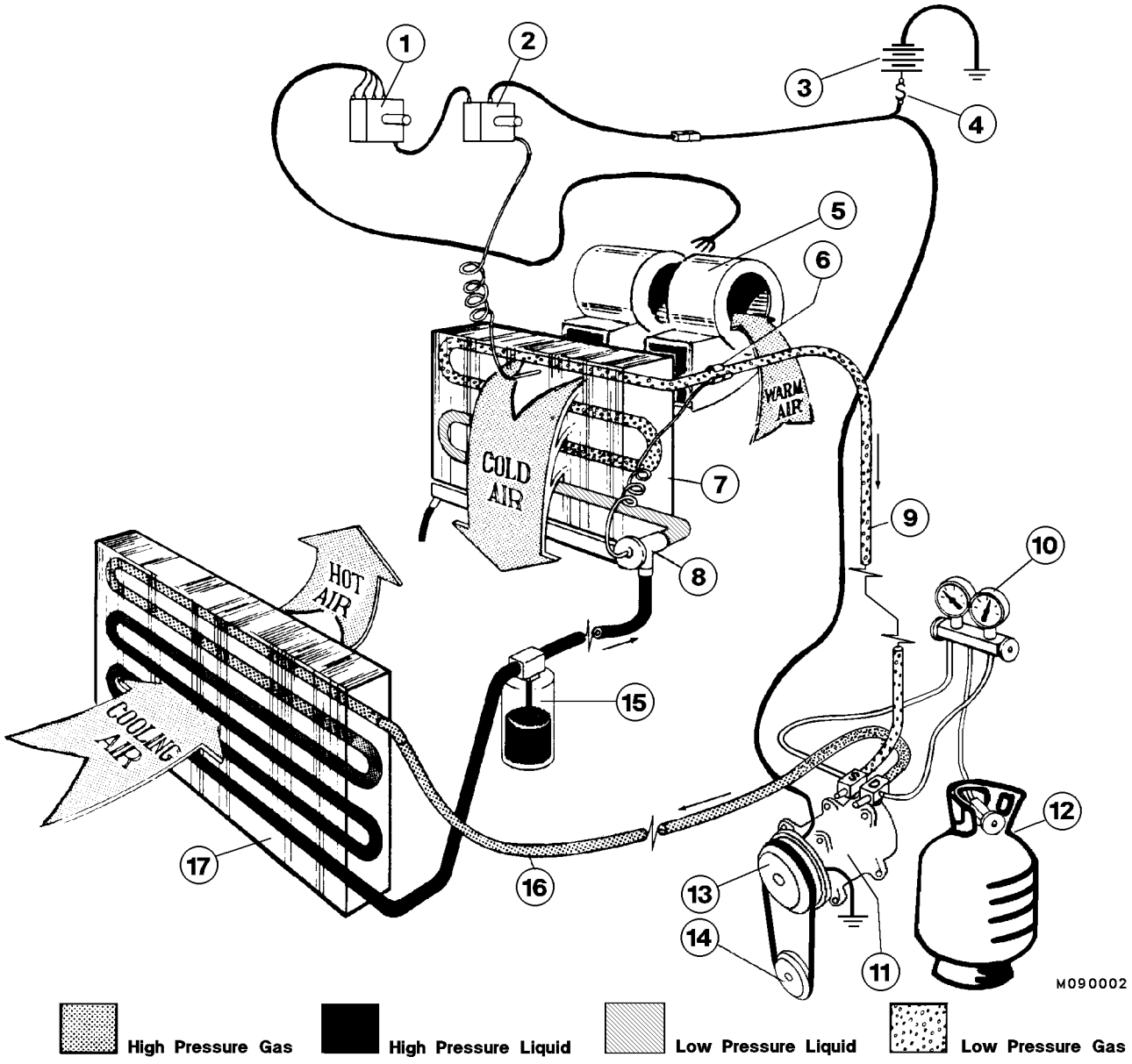


FIGURE 9-1. BASIC AIR CONDITIONING SYSTEM

1. Blower Switch
2. Thermostatic Switch
3. Battery Supply
4. Circuit Breaker
5. Blower
6. Temperature Sensor
7. Evaporator
8. Expansion Valve
9. Suction Line
10. Test Gauges & Manifold
11. Compressor
12. Refrigerant Container
13. Magnetic Clutch
14. Compressor Drive Pulley
15. Receiver / Dryer
16. Discharge Line
17. Condenser

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(HFC) refrigerant, commonly identified as HFC-134a or R-134a, is being used in most current mobile air conditioning systems. Additionally, the practice of releasing either refrigerant to the atmosphere during the charging/ recharging procedure is prohibited.

These restrictions require the use of equipment and procedures which are significantly different from those traditionally used in air conditioning service techniques. The use of new equipment and techniques allows for complete recovery of refrigerants, which will not only help to protect the environment, but through the “recycling” of the refrigerant will preserve the physical supply, and help to reduce the cost of the refrigerant.

OPERATOR CAB AIR CONDITIONING

Mining and construction vehicles have unique characteristics of vibration, shock-loading, operator changes, and climate conditions that present different design and installation problems for air conditioning systems. Off-highway equipment, in general, is unique enough that normal automotive or highway truck engineering is not sufficient to provide the reliability to endure the various work cycles encountered.

The cab tightness, insulation, and isolation from heat sources is very important to the efficiency of the system. It is advisable to close all vents, even the intakes of pressurization systems, when there are high humidity conditions.

The general cleanliness of the system and components is important. Dust or dirt collected in the condenser, evaporator, or air filters decreases the system's cooling capacity.

The compressor, condenser, evaporator units, hoses and fittings must be installed clean and tight and be capable of withstanding the strain and abuse they are subjected to on off-highway vehicles.

Equipment downtime costs are high enough to encourage service areas to perform preventative maintenance at regular intervals on vehicle air-conditioning systems. (Cleaning, checking belt tightness, and operation of electrical components).

PRINCIPLES OF REFRIGERATION

A brief review of the principles of air conditioning is necessary to relate the function of the components, the technique of troubleshooting and the corrective action necessary to put the AC unit into top operating efficiency.

Too frequently, the operator and the serviceman overlook the primary fact that no AC system will function properly unless it is operated within a completely controlled cab environment. The circulation of air must be a directed flow. The cab must be sealed against seepage of ambient air. The cab interior must be kept free of dust and dirt which, if picked up in the air system, will clog the intake side of the evaporator coil.

AIR CONDITIONING

Air conditioning is a form of environmental control. As applied to the cab, it refers to the control of temperature, humidity, cleanliness, and circulation of air. In the broad sense, a heating unit is as much an air conditioner as is a cooling unit. The term “Air Conditioner” is commonly used to identify an air cooling unit. To be consistent with common usage, the term “Air Conditioner” will refer to the cooling unit utilizing the principles of refrigeration; sometimes referred to as the evaporator unit.

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REFRIGERATION - THE ACT OF COOLING

- There is no process for producing cold; there is only heat removal.
- Heat always travels toward cooler temperatures. This principle is the basis for the operation of a cooling unit. As long as one object has a temperature lower than another, this heat transfer will occur.
- Temperature is the measurement of the intensity of heat in degrees. The most common measuring device is the thermometer.
- All objects have a point at which they will turn to vapor. Water boiling is the most common example of heating until vapor is formed. Boiling is a rapid form of evaporation. Steam is a great deal hotter than boiling water. The water will not increase in temperature once brought to a boil. The heat energy is used in the vaporization process. The boiling point of a liquid is directly affected by pressure. By changing pressure, we can control the boiling point and temperature at which a vapor will condense. When a liquid is heated and vaporizes, the gas will absorb heat without changing pressure.
- Reversing the process, when heat is removed from water vapor, it will return to the liquid state. Heat from air moves to a cooler object. Usually the moisture in the cooled air will condense on the cooler object.
- Refrigerant - Only R-134a should be used in the new mobile systems which are designed for this refrigerant.

THE REFRIGERATION CYCLE

In an air conditioning system, the refrigerant is circulated under pressure through the five major components in a closed circuit. At these points in the system, the refrigerant undergoes predetermined pressure and temperature changes.

The compressor (refrigerant pump) takes in low pressure heat laden refrigerant gas through the suction valve (low side), and as its name indicates, pressurizes the heat laden refrigerant and forces it through the discharge valve (high side) on to the condenser.

Ambient air, passing through the condenser removes heat from the circulating refrigerant resulting in the conversion of the refrigerant from gas to liquid.

The liquid refrigerant moves on to the receiver drier where impurities are filtered out, and moisture removed. This component also serves as the temporary storage unit for some liquid refrigerant.

The liquid refrigerant, still under high pressure, then flows to the expansion valve. This valve meters the amount of refrigerant entering the evaporator. As the refrigerant passes through the valve, it becomes a low temperature, low pressure liquid and saturated vapor. This causes the refrigerant to become cold.

The remaining low pressure liquid immediately starts to boil and vaporize as it approaches the evaporator, adding to the cooling. The hot, humid air of the cab is pulled through the evaporator by the evaporator blower. Since the refrigerant is colder than the air, it absorbs the heat from the air producing cool air which is pushed back into the cab. The moisture in the air condenses upon movement into the evaporator and drops into the drain pan from which it drains out of the cab.

The cycle is completed when the heated low pressure gas is again drawn into the compressor through the suction side.

This simplified explanation of the principles of refrigeration does not call attention to the fine points of refrigeration technology. Some of these will be covered in the following discussions of the components, controls, and techniques involved in preparing the unit for efficient operation.

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AIR CONDITIONER SYSTEM COMPONENTS

COMPRESSOR (Refrigerant Pump)

The compressor is where the low pressure side of the system changes to high pressure. It concentrates the refrigerant returning from the evaporator (low side) creating high pressure and a temperature much higher than the outside air temperature. The high temperature differential between the refrigerant and the outside air is necessary to aid rapid heat flow in the condenser from the hot refrigerant gas to much cooler outside air.

To create high pressure concentration, the compressor draws in refrigerant from the evaporator through the suction valve and during compression strokes, forces it out through the discharge valve to the condenser. The pressure from the compressor action moves the refrigerant through the condenser, receiver-drier and connecting hoses to the expansion valve.

The compressor is driven by the engine through a v-belt driving an electrically operated clutch mounted on the compressor drive shaft.

SERVICE VALVES

Quick-connect hose end fittings with integral service valves attach to system service ports for servicing the unit. A manifold gauge set is connected into the system at the service valve ports and all procedures, such as discharging, evacuating and charging the system, are performed through the service valves.

CONDENSER

The condenser receives the high pressure, high-temperature refrigerant vapor from the compressor and condenses it to high pressure, hot liquid.

It is designed to allow heat movement from the hot refrigerant vapor to the cooler outside air. The cooling of the refrigerant changes the vapor to liquid. Heat exchange is accomplished using cooler air flowing through the condenser. Condenser cooling is achieved by air flowing from the radiator fan along with ram air provided by vehicle movement. The radiator fan moves more than 50% of condenser air flow unless travel speed is at least 25 mph.

Ram air condensers depend upon the vehicle movement to force a large volume of air past the fins and tubes of the condenser. The condenser is usually located in front of the radiator or on the roof of the truck.

Condensing of the refrigerant is the change of state of the refrigerant from a vapor to a liquid. The action is affected by the pressure of the refrigerant in the coil and air flow through the condenser. Condensing pressure in an AC system is the controlled pressure of the refrigerant which affects the temperature at which it condenses to liquid, giving off large quantities of heat in the process. The condensing point is sufficiently high to create a wide temperature differential between the hot refrigerant vapor and the air passing over the condenser fins and tubes. This difference permits rapid heat transfer from the refrigerant to ambient air.

RECEIVER-DRIER

The receiver-drier is an important part of the air conditioning system. The drier receives the liquid refrigerant from the condenser and removes any moisture and foreign matter present which may have entered the system. The receiver section of the tank is designed to store extra refrigerant until it is needed by the evaporator. The storage of this refrigerant is temporary and is dependent on the demand of the expansion valve.

A desiccant is a solid substance capable of removing moisture from gas, liquid or solid. It is held in place within the receiver between two screens, which also act as strainers.

The receiver-drier is also equipped with a sight glass and a moisture indicator. The sight glass can give a good indication of the charge of the system. If the sight glass is not clear, the system is low on refrigerant.

The moisture indicator is a device to notify service personnel that the drier is full of moisture and must be replaced. The indicator is blue when the component is free from moisture. When the indicator turns beige or tan, the drier must be replaced.

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EXPANSION BLOCK VALVE

The expansion block valve controls the amount of refrigerant entering the evaporator coil. Both internally and externally equalized valves are used.

The expansion valve is located near the inlet of the evaporator and provides the functions of throttling, modulating, and controlling the liquid refrigerant to the evaporator coil.

The refrigerant flows through a restriction creating a pressure drop across the valve. Since the expansion valve also separates the high side of the system from the low side, the state of the refrigerant entering the valve is warm to hot high pressure liquid; exiting it is low pressure liquid and gas. The change to low pressure allows the flowing refrigerant to immediately begin changing to gas as it moves toward the evaporator. This produces the desired cooling effect.

The amount of refrigerant metered into the evaporator varies with different heat loads. The valve modulates from wide open to the nearly closed position, seeking a point between for proper metering of the refrigerant.

As the load increases, the valve responds by opening wider to allow more refrigerant to pass into the evaporator. As the load decreases, the valve reacts and allows less refrigerant into the evaporator. It is this controlling action that provides the proper pressure and temperature control in the evaporator.

This system uses an internally equalized, block type expansion valve. With this type valve, the refrigerant leaving the evaporator coil is also directed back through the valve so the temperature of the refrigerant is monitored internally rather than by a remote sensing bulb. The expansion valve is controlled by both the temperature of the power element bulb and the pressure of the liquid in the evaporator.

NOTE: It is important that the sensing bulb, if present, is tight against the output line and protected from ambient temperatures with insulation tape.

EVAPORATOR

The evaporator cools and dehumidifies the air before it enters the cab. Cooling a large area requires that large volumes of air be passed through the evaporator coil for heat exchange. Therefore, a blower becomes a vital part of the evaporator assembly. It not only draws heat laden air into the evaporator, but also forces this air over the evaporator fins and coils where the heat is surrendered to the refrigerant. The blower forces the cooled air out of the evaporator into the cab.

Heat exchange, as explained under condenser operation, depends upon a temperature differential of the air and the refrigerant. The greater the temperature differential, the greater will be the amount of heat exchanged between the air and the refrigerant. A high heat load condition, as is generally encountered when the air conditioning system is turned on, will allow rapid heat transfer between the air and the cooler refrigerant.

The change of state of the refrigerant in and going through the evaporator coil is as important as that of the air flow over the coil.

All or most of the liquid that did not change to vapor in the expansion valve or connecting tubes boils (expands) and vaporizes immediately in the evaporator, becoming very cold. As the process of heat loss from the air to the evaporator coil surface is taking place, any moisture (humidity) in the air condenses on the cool outside surface of the evaporator coil and is drained off as water.

At atmospheric pressure, refrigerant boils at a point lower than water freezes. Therefore, the temperature in the evaporator must be controlled so that the water collecting on the coil surface does not freeze on and between the fins and restrict air flow. The evaporator temperature is controlled through pressure inside the evaporator, and temperature and pressure at the outlet of the evaporator.

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ELECTRICAL CIRCUIT

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

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

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

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

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

THERMOSTAT

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

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

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

COMPRESSOR CLUTCH

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

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

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

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

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

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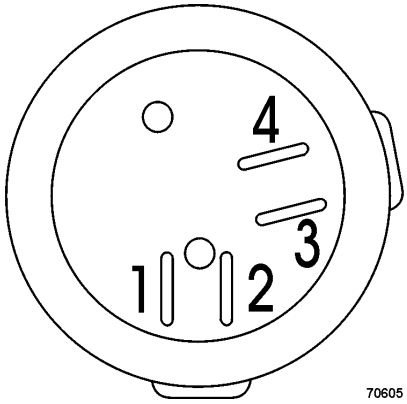
TRINARY™ SWITCH

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.

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SYSTEM SERVICING

Servicing an air conditioning system really means closely monitoring refrigerant flow. For this reason, the following procedures deal extensively with the proper use, handling, care and safety factors involved in the R-134a refrigerant quality and quantity in an air conditioning system.

Because the refrigerant in an air conditioning system must remain pressurized and sealed within the unit to function properly, safety is a major consideration when anything causes this pressurized, sealed condition to change. The following warnings are provided here to alert service personnel to their importance BEFORE learning the correct procedures. Read, remember, and observe each warning before beginning actual system servicing.

NOTE: If the mine operates a fleet with some trucks using R-12 and others using R-134a refrigerant, it is essential that servicing tools that come into contact with the refrigerant (gauge sets, charging equipment, recycle/recovery equipment etc.) be dedicated to one type refrigerant only, to prevent cross contamination.

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⚠WARNING

Federal regulations prohibit venting R-12 and R134a refrigerant into the atmosphere. An SAE and UL approved recovery/recycle station must be used to remove refrigerant from the AC system. Refrigerant is stored in a container on the unit for recycling, reclaiming, or transporting. In addition, technicians servicing AC systems must be certified they have been properly trained to service the system.

Although accidental release of refrigerant is a remote possibility when proper procedures are followed, the following warnings must be observed when servicing AC systems:

Provide appropriate protection for your eyes (goggles or face shield) when working around refrigerant.

A drop of the liquid refrigerant on your skin will produce frostbite. Wear gloves and exercise extreme care when handling refrigerant.

If even the slightest trace of refrigerant enters in your eye, flood the eye immediately with cool water and seek medical attention as soon as possible.

Ensure sufficient ventilation whenever refrigerant is being discharged from a system, keeping in mind refrigerant is heavier than air and will seek low areas of shop.

When exposed to flames or sparks, the components of refrigerant change and become deadly phosgene gas. This poison gas will damage the respiratory system if inhaled. NEVER smoke in area where refrigerant is used or stored.

Never direct steam cleaning hose or torch in direct contact with components in the air conditioning system. Localized heat can raise the pressure to a dangerous level.

Do not heat or store refrigerant containers above 120° F (49° C).

Do not flush or pressure test the system using shop air or another compressed air source. Certain mixtures of air and R-134a refrigerant are combustible when slightly pressurized. Shop air supplies also contain moisture and other contaminants that could damage system components.

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SYSTEM OIL

R-134a air conditioning systems require the use of polyalkylene glycol (PAG) lubricating oil. This is the only oil recommended for use in this system. At present time, General Motors part number (12345923) is the oil that is furnished in the system on Komatsu trucks. This clear oil can be found at AC Delco dealers. In some areas, it can be found from other suppliers as U-Con 488. The only other alternative is General Motors part number (12356151) which is now becoming more popular and is expected to become the furnished oil in Komatsu AC systems. This oil is light blue-green in color and may be mixed with the other recommended oil.

Handling and Reusing PAG Oil

- •Avoid skin contact and inhalation of PAG oil, as these are normal precautions with any chemical.
- •No PAG oil removed from new or old components should be retained for re-use. It should be stored in a marked container and properly sealed. PAG oil is an environmental pollutant and should be properly disposed of after use.
- •PAG oil in containers or in an air conditioning system should not be left exposed to the atmosphere any longer than necessary. PAG oil absorbs moisture very rapidly, and therefore, any absorbed moisture could cause damage to an air conditioning system.

OIL QUANTITY

It is critical to keep the correct amount of lubricant in the air conditioning system at all times. Failure to do so could result in damage to the compressor.

Damage to the compressor can be a result from not only a lack of oil, but from too much oil, also. A lack of oil will cause excess friction and wear on moving parts. Excessive oil can result in “slugging” the compressor. This condition occurs when the compressor attempts to compress liquid oil as opposed to vaporized refrigerant. Since liquid cannot be compressed, damage to internal parts results.

Replacing Oil After Servicing the System

Replace oil that has been removed from the system through recovery of refrigerant and replacement of components. Refer to the chart below for adding oil.

REPLACING OIL	
Component	**Oil to add**
Condenser	2-3 ounces
Evaporator	1 ounce
Receiver-Drier	2 ounces
Compressor	Compressors come with 10.5 ounces of oil in the sump. Refer to "Setting Up a New Compressor"
Block Valve (Expansion)	Adding oil is not necessary
Hoses	Drain and measure amount removed

Setting Up a New Compressor

Compressors come with 10.5 ounces of oil in the sump. Compressors being replaced should have been operating with 6 ounces of oil in the sump, therefore, the new compressor should be adjusted, accordingly. **Example:** If a compressor is being replaced, the receiver drier must also be replaced. (The receiver-drier should be replaced whenever the system is opened.) Since the new compressor comes with 10.5 ounces of oil, 2.5 ounces of oil should be removed from the compressor leaving 8 ounces. 8 ounces accounts for the 6 ounces needed for the compressor, and the 2 ounces for the new receiver-drier.

⚠CAUTION

Never run the system with more than 10.5 ounces of oil in the compressor sump. Damage to the compressor as well as other system components may occur. It is important to have a good balance of oil throughout the system.

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REFRIGERANT

Recycled Refrigerant
Recycled refrigerant has been extracted from a mobile air conditioning system using a recovery unit. The refrigerant is cleaned by the recovery unit as it passes through filters located on the unit that meet specifications stipulated by Society of Automotive Engineers, SAE J2099. The refrigerant that has passed through the filtering process has only been cleaned of contaminants that are associated with mobile systems. Therefore, recycled refrigerant from mobile systems is only acceptable for reuse in mobile systems.

Reclaimed Refrigerant
Reclaimed refrigerant has been filtered through a more thorough filtering process and has been processed to the same standards of purity as virgin refrigerant. Because of this, reclaimed refrigerant is acceptable for use in all systems, not just mobile. The reclaiming equipment used for this process is expensive, and therefore, not common among normal maintenance shops. Equipment such as this is more commonly found in air conditioning specialty shops.

⚠CAUTION

Always use new, recycled, or reclaimed refrigerant when charging a system. Failure to adhere to this recommendation may result in premature wear or damage to air conditioning system components and poor cooling performance.

REFRIGERANT QUANTITY

If not enough refrigerant is charged into the system, cooling ability will be diminished. If too much refrigerant is charged into the system, the system will operate at higher pressures, and in some cases, may damage system components. Exceeding the specified refrigerant charge will not provide better cooling.

If an incorrect charge is suspected, recover the refrigerant from the system, and charge the system with the correct operating weight **(6.9 lb, 3.13 kg)**. This is not only the recommended procedure, but it is also the best way to ensure that the system is operating with the proper charge and providing optimum cooling. **Using the sight glass to determine the charge is not an accurate method.**

⚠IMPORTANT⚠

An unclear sight glass on R-134a systems can indicate that the system may be low on refrigerant. However, the sight glass should not be used as a gauge for charging the system. Charging the system must be done with a scale to ensure the proper amount of refrigerant has been added.

R-134a Refrigerant Containers

Two basic, readily available containers are used to store R-134a: the 30 or 60 pound bulk canisters (Figure 9-2).

Always read the container label to verify the contents are correct for the system being serviced. Note the containers for R-134a are painted light blue.

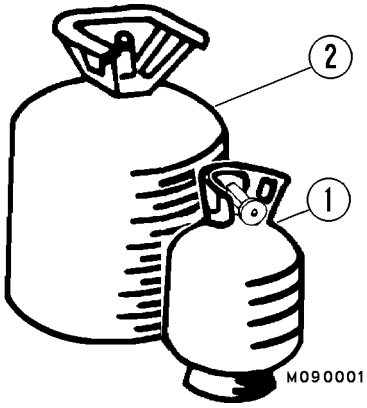


FIGURE 9-2. R-134a CONTAINERS

1. 30 lb. Cylinder 2. 60 lb. Cylinder

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SERVICE TOOLS AND EQUIPMENT

RECOVERY/RECYCLE STATION

Whenever refrigerant must be removed from the system, a dual purpose station as shown in Figure 9-3, performs both recovery and recycle procedures which follows the new guidelines for handling used refrigerant. The recovered refrigerant is recycled to reduce contaminants, and can then be reused in the same machine or fleet.

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

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

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

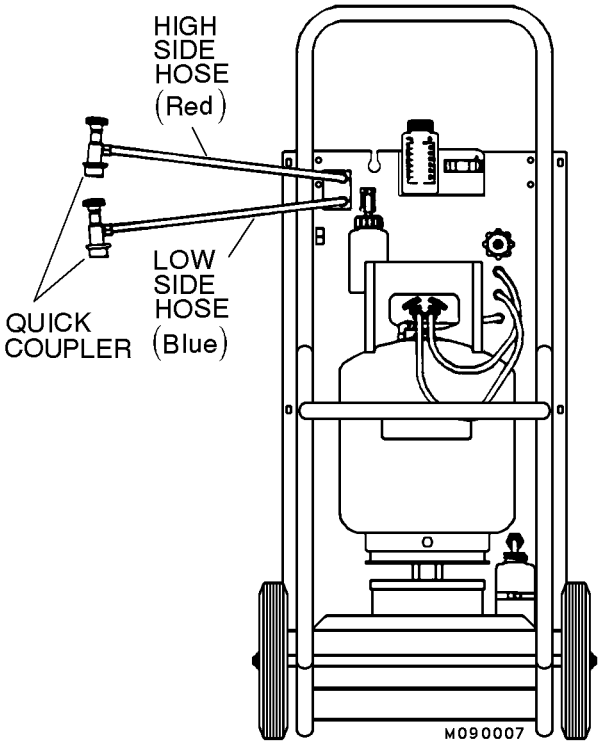


FIGURE 9-3. RECOVERY / RECYCLE STATION

⚠CAUTION

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

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

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

LEAK DETECTOR

The electronic detector (Figure 9-4) is very accurate and safe. It is a small hand-held device with a flexible probe used to seek refrigerant leaks. A buzzer, alarm or light will announce the presence of even the smallest leak.

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

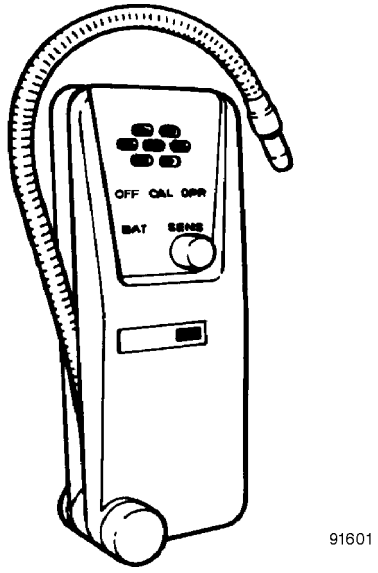


FIGURE 9-4. TYPICAL ELECTRONIC LEAK DETECTOR

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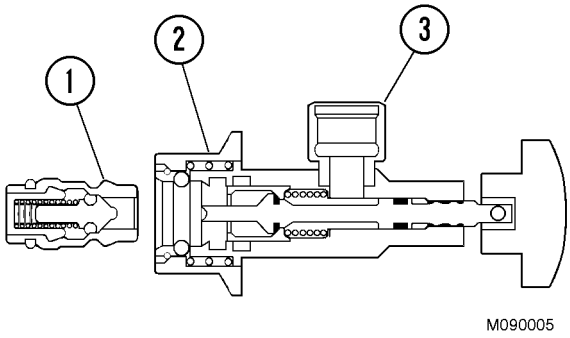


FIGURE 9-5. R-134a SERVICE VALVE

1. System Service Port Fitting
2. Quick Connect
3. Service Hose Connection

SERVICE VALVES

Because an air conditioning system is a sealed system, two service valves are provided on the compressor to enable diagnostic tests, system charging or evacuation. Connecting the applicable hoses from the manifold gauge set to the compressor service valves enables each of these to be readily performed.

New and unique service hose fittings (Figure 9-5) have been specified for R-134a systems. Their purpose is to avoid accidental cross-mixing of refrigerants and lubricants with R-12 based systems. The service ports on the system are quick disconnect type with no external threads. They do contain a Schrader type valve. The low side fitting has a smaller diameter than the high side attachment.

Protective caps are provided for each service valve. When not being used these caps should be in place to prevent contamination or damage to the service valves.

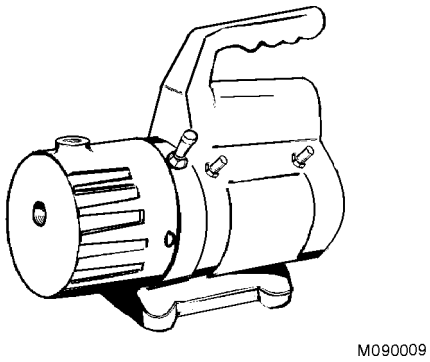


FIGURE 9-6. VACUUM PUMP

VACUUM PUMP

The vacuum pump (Figure 9-6) is used to completely evacuate all of the refrigerant, air, and moisture from the system by deliberately lowering the pressure within the system to the point where water turns to a vapor (boils) and together with all air and refrigerant is withdrawn (pumped) from the system.

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MANIFOLD GAUGE SET

A typical manifold gauge set (Figure 9-7) has two screw type hand valves to control access to the system, two gauges and three hoses. The gauges are used to read system pressure or vacuum. The manifold and hoses are for access to the inside of an air conditioner, to remove air and moisture, and to put in, or remove, refrigerant from the system. Shutoff valves are required within 12 inches of the hose end(s) to minimize refrigerant loss.

A gauge set for R-134a will have a blue hose with a black stripe for the low side, a red hose with a black stripe for the high side, and a yellow hose with a black stripe for the utility (center) hose. The hoses use a 1/2 in. ACME female nut on the gauge end. Special quick disconnect couplings are normally combined with a shutoff valve on the high and low side hoses. The free end of the center hose contains a 1/2 in. ACME female nut and a shutoff device within 12 inches of the hose end. These special hoses and fittings are designed to minimize refrigerant loss and to preclude putting the wrong refrigerant in a system.

NOTE: When hose replacement becomes necessary, the new hoses must be marked "SAE J2916 R-134a".

Functions of the manifold gauge set are included in many of the commercially available recovery or recovery/recycle stations.

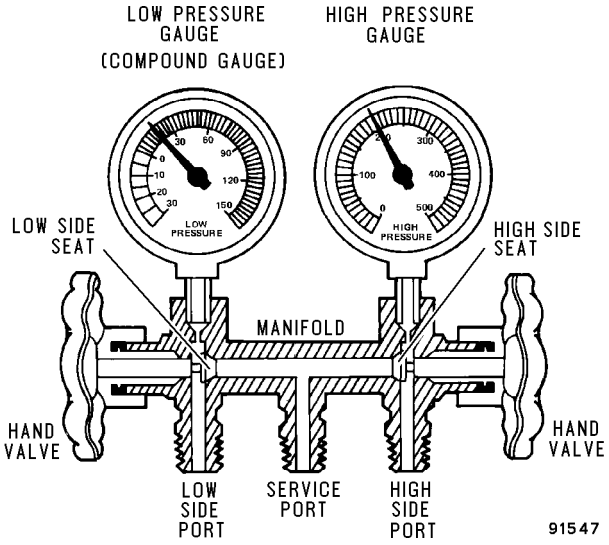


FIGURE 9-7. MANIFOLD GAUGE SET

Low Side Gauge

The Low Side Gauge, registers both vacuum and pressure. The vacuum side of the scale is calibrated from 0 to 30 inches of mercury (in. Hg). The pressure side of the scale is calibrated to 150 psi.

⚠WARNING

Never open the hand valve to the high side at anytime when the air conditioning system is operating. High side pressure, if allowed, may rupture charging containers and potentially cause personal injury.

High Side Gauge

The High Side Gauge is used to measure pressure only on the discharge side of the compressor. The scale is calibrated from 0 to 500 psi.

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INSTALLING MANIFOLD GAUGE SET

Before attempting to service the air conditioning system, a visual inspection of both the engine and system components is recommended. Particular attention should be given to the belts, hoses, tubing and all attaching hardware plus the radiator cap, fan clutch, and thermostat. Inspect both the condenser and the radiator for any obstructions or potential contamination. Minimize all the possibilities for error or malfunction of components in the air conditioning system.

⚠WARNING

Shut off engine. DO NOT attempt to connect service equipment when the engine is running.

1. Be sure all valves on the manifold are closed all the way (turn them clockwise).
2. Check the hose connections on the manifold for tightness.
3. Locate the low and high side system service fittings and remove their protective caps.
4. Connect the two service hoses from the manifold to the correct service valves on the compressor as shown in Figure 9-8. (High side to compressor discharge valve and low side to compressor suction side.) Do not open service valves at this time.

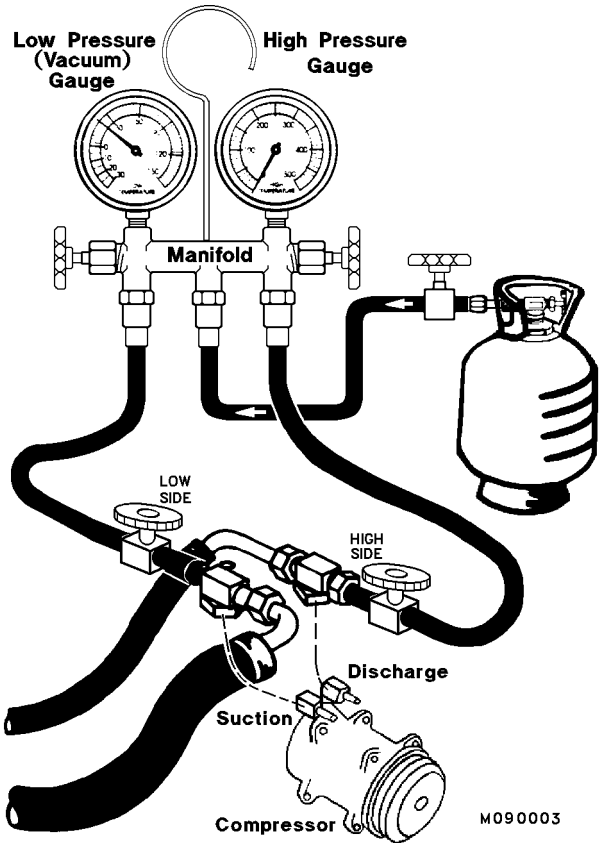


FIGURE 9-8. SERVICE HOSE HOOK-UP

This gauge hook-up process will be the same, regardless of the gauge set being installed. Whether it is a recovery station or individual gauges, the connections are the same. The procedures performed next will vary depending what type of equipment is being used. If a recovery/recycling station is being used, complete servicing can be accomplished. Using only a set of gauges will limit the servicing to only adding refrigerant or observing pressures.

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Purging Air From Service Hoses

The purpose of this procedure is to remove all the air trapped in the hoses prior to actual system testing. Environmental regulations require that all service hoses have a shutoff valve within 12 inches of the service end. These valves are required to ensure only a minimal amount of refrigerant is lost to the atmosphere. R-134a gauge sets have a combination quick disconnect and shutoff valve on the high and low sides. The center hose also requires a valve.

The initial purging is best accomplished when connected to recovery or recycle equipment. With the center hose connected to the recovery station, service hoses connected to the high and low sides of the system, we can begin the purging. The manifold valves and service valves should be closed. Activating the vacuum pump will now pull any air or moisture out of the center hose. This will require only a few minutes of time. The hose is the only area that is being placed in a vacuum and this will not require a lengthy process. Closing the valve will then insure the hose is purged. It is now safe to open the other manifold valves.

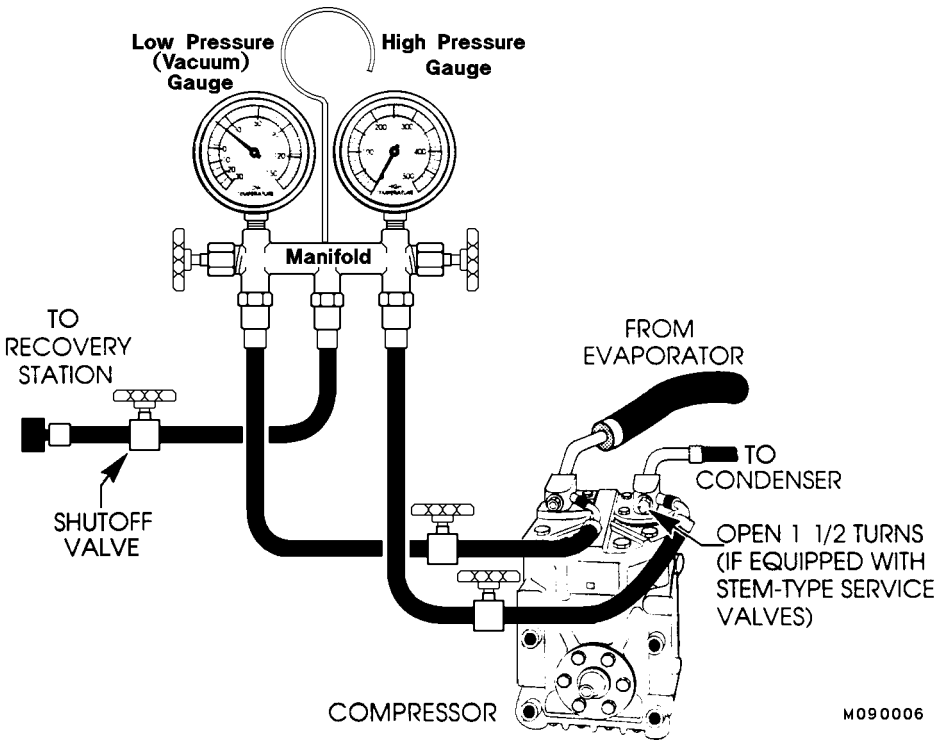


FIGURE 9-9. PURGING SYSTEM

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Stabilizing the AC System

⚠WARNING

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

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

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

SYSTEM PERFORMANCE TEST

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

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

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

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

⚠WARNING

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

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

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SYSTEM LEAK TESTING

Refrigerant leaks are probably the most common cause of air conditioning problems, resulting from improper or no cooling, to major internal component damage. Leaks most commonly develop in two or three places. The first is around the compressor shaft seal, often accompanied by an indication of fresh refrigerant oil. If a system is not operated for a while (winter months), the shaft seal may dry out and leak slightly. The centrifugal force of the clutch pulley spinning can also cause the problem. When the system is operated and lubricant wets the seal, the leak may stop. Such leaks can often be located visually, or by feeling with your fingers around the shaft for traces of oil. (The R-134a itself is invisible, odorless, and leaves no trace when it leaks, but has a great affinity for refrigerant oil.)

A second common place for leaks is the nylon and rubber hoses where they are crimped or clamped to the fittings, or where routing allows abrasion. Other threaded joints or areas where gaskets are used should be visually and physically examined. Moving your fingers along the bottom of the condenser and evaporator, particularly near the drain hole for the condensate will quickly indicate the condition of the evaporator. Any trace of fresh oil here is a clear indication of a leak.

Usually, a 50% charged system is enough to find most leaks. If the system is empty, connect the manifold gauge set to the system and charge at least 3.5 lbs. of refrigerant into the system.

⚠WARNING

Use extreme caution when leak testing a system while the engine is running.

In its natural state, refrigerant is a harmless, colorless gas, but when combined with an open flame, it will generate toxic fumes (phosgene gas), which can cause serious injuries or death.

NOTE: The refrigerant is heavier than air and will move downward when it leaks. Apply pickup hose or test probe on the under-surface of all components to locate leaks.

Electronic leak detector

(Refer to Figure 9-4). As the test probe is moved into an area where traces of refrigerant are present, a visual or audible announcement indicates a leak. Audible units usually change tone or speed as intensity changes.

Tracer dyes

Tracer dyes are available that can be added to the system as refrigerant is added. The system is then operated to thoroughly circulate the dye. As refrigerant escapes, it leaves a trace of the dye at the point of leakage, which is then detected using an ultraviolet light (“black light”), revealing a bright fluorescent glow.

Soap and water

Soap and water can be mixed together and applied to system components. Bubbles will appear to pinpoint the specific location of leaks.

After determining the location or source of leak(s), repair or replace leaking component(s).

NOTE: The length of the hose will affect the refrigerant capacity. When replacing hoses, always use the same hose length, if possible.

⚠CAUTION

Before system assembly, check the compressor oil level and fill to specifications.

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SYSTEM REPAIR

The following service and repair procedures are not any different than typical vehicle service work. However, AC system components are made of soft metals (copper, aluminum, brass, etc.). Comments and tips that follow will make the job easier and reduce unnecessary component replacement.

⚠WARNING

All of the service procedures described are only performed after the system has been discharged. Never use any lubricant or joint compound to lubricate or seal any AC connections.

NOTE: To help prevent air, moisture or debris from entering an open system, cap or plug open lines, fittings, components and lubricant containers. Keep all connections, caps, and plugs clean.

SYSTEM CLEANING

When performing repairs on air conditioning components, a thorough inspection should be performed. Inspect the parts that have been removed. If they contain any loose or foreign material, the rest of the system should be checked for the source of the material.

⚠CAUTION

Only SAE and/or Mobile Air Conditioning Society (MACS) approved flushing methods with the appropriate refrigerants are to be performed when removing debris from the system. Other methods may be harmful to the environment, as well as air conditioning components.

Hoses and Fittings

When replacing hoses, be sure to use the same type and ID hose you removed. When hoses or fittings are shielded or clamped to prevent vibration damage, be sure these are in position or secured.

Lines

Always use two wrenches when disconnecting or connecting AC fittings attached to metal lines. You are working with copper and aluminum tubing which can kink or break easily. When grommets or clamps are used to prevent line vibration, be certain these are in place and secured.

⚠IMPORTANT⚠

It is important to always torque fittings to the proper torque. Failure to do this may result in improper contact between mating parts and leakage may occur. Refer to the following torque chart for tightening specifications.

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

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

Expansion Valve

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

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Receiver-Drier

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

Thermostat

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

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

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

Compressor

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

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

Clutch

Clutch problems include electrical failure in the clutch coil or lead wire, clutch pulley bearing failure, worn or warped clutch plate or loss of clutch plate spring temper. Defective clutch assembly parts may be replaced or the whole assembly replaced. If the clutch shows obvious signs of excessive heat damage, replace the whole assembly.

The fast way to check electrical failure in the lead wire or clutch coil is to hot wire the coil with a fused lead. This procedure enables you to bypass clutch circuit control devices.

Clutch pulley bearing failure is indicated by bearing noise when the AC system is off or the clutch is not engaged. Premature bearing failure may be caused by poor alignment of the clutch and clutch drive pulley.

Sometimes it may be necessary to use shims or enlarge the slots in the compressor mounting bracket to achieve proper alignment.

Excessive clutch plate wear is caused by the plate rubbing on the clutch pulley when the clutch is not engaged or the clutch plate slipping when the clutch coil is energized. A gap that is too small or too large between the plate and clutch pulley or a loss of clutch plate spring temper are possible causes. The ideal air gap between the clutch pulley and the clutch plate is 0.023 to 0.057 in. (1.02 ± 0.043 mm). If the gap is too wide, the magnetic field created when the clutch coil is energized will not be strong enough to pull and lock the clutch plate to the clutch pulley.

⚠ IMPORTANT ⚠

NOTE: Some compressors may be discarded because it is suspected that internal components within the compressor have seized. Ensure that the compressor clutch is working properly before discarding a compressor for internal seizure. The normal compressor life span should be about twice as long as the normal life span of the compressor clutch.

It is important to note that often times a weak clutch coil may be mistaken for a seized compressor. When a coil's resistance has increased over time and the magnetic field weakens, the coil may not be able to pull the load of the compressor. Failure of the coil to allow the compressor shaft to be turned, may appear as though the compressor is locked up.

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Before a compressor is dismissed as being seized, a check for proper voltage to the coil should be performed. In addition, the coil should be ohm checked for proper electrical resistance. The coil should fall within the following range:

12.0 ± 0.37 Ohms @ 68° F (20° C)

16.1 ± 0.62 Ohms @ 240° F (116° C)

The temperatures specified above are roughly typical of a summer morning before first start-up and the heat beside an engine on a hot day. At temperatures in between those listed above, the correct resistance is proportionate to the difference in temperature.

Servicing the Compressor Clutch

* RECOMMENDED TOOLS FOR COMPRESSOR CLUTCH REMOVAL AND INSTALLATION	
J-9399	Thin Wall Socket
**J-9403	Spanner Wrench
**J-25030	Clutch Hub Holding Tool
J-9401	Clutch Plate and Hub Assembly Remover
J-8433	Pulley Puller
J-9395	Puller Pilot
***J-24092	Puller Legs
J-8092	Universal Handle
J-9481	Pulley and Bearing Installer
J-9480-01	Drive Plate Installer
J-9480-02	Spacer, Drive Plate Installer

*Tools are available though your local Kent-Moore dealer.
** These tools are interchangeable.
***For use on multiple groove pulleys.

CAUTION

Use the proper tools to remove and replace clutch components. Using the recommended tooling helps prevent damage to compressor components during maintenance.

Do not drive or pound on the clutch plate, hub assembly, or shaft. Internal damage to the compressor may result.

1. Remove the belt guard from the front of the air conditioning compressor.

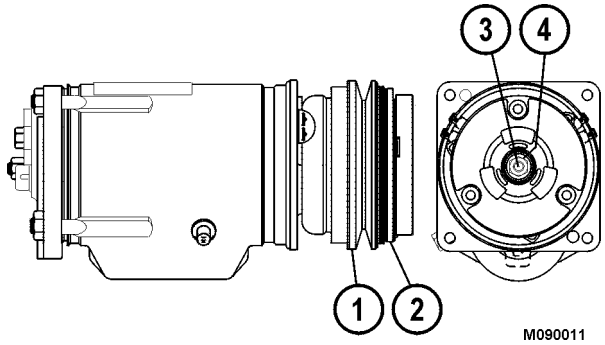


FIGURE 9-10.

1. Belt Pulley
2. Clutch Hub/Drive Plate
3. Shaft
4. Locknut

2. Remove the drive belt from compressor belt pulley (1, Figure 9-10).

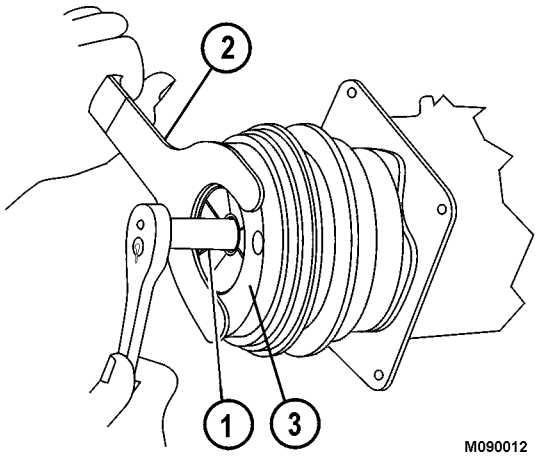


FIGURE 9-11.

1. Thin Wall Socket
2. Clutch Hub Holding Tool
3. Clutch Hub

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3. Remove locknut (4) using thin wall socket (1, Figure 9-11) or the equivalent. Use clutch hub holding tool (2), spanner wrench (J-9403), or the equivalent to hold clutch plate (3) while removing the locknut. It is recommended that the locknut be replaced after it has been removed.

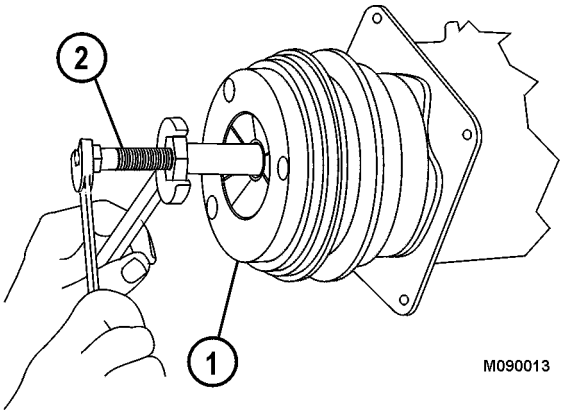


FIGURE 9-12.

1. Clutch Assembly
2. Clutch Plate & Hub Assembly Remover

4. Thread clutch plate and hub assembly remover (2, Figure 9-12) into the hub of clutch assembly (1). Hold the body of the remover with a wrench and tighten the center screw to pull the clutch plate and hub assembly from the compressor.

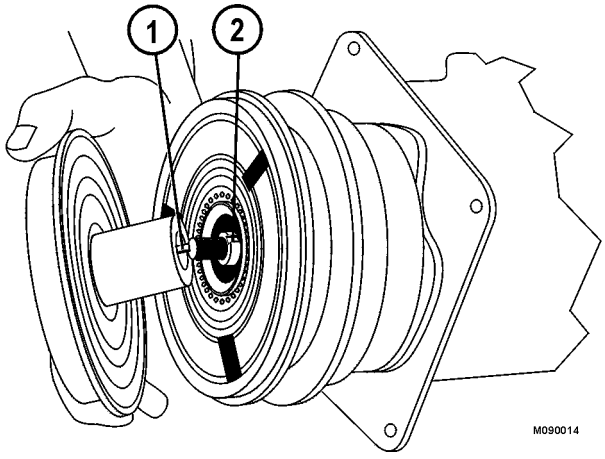


FIGURE 9-13.

1. Square Key
2. Keyway in Shaft

5. Remove square key (1, Figure 9-13) from the keyways.

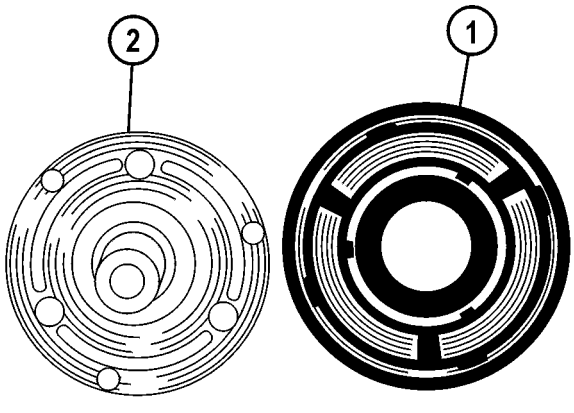


FIGURE 9-14.

1. Clutch Hub
2. Pulley

6. Inspect the friction surface on the clutch hub and the friction surface on the pulley. Scoring on the friction surfaces is normal. DO NOT replace these components for this condition only.

⚠ IMPORTANT ⚠

Inspect the steel friction surface on the clutch and ensure that it is not damaged by excessive heat. Inspect the other components near the clutch for damage due to heat. If signs of excessive heat are evident, it may be necessary to replace the compressor. Excessive heat may cause leakage in the seals and damage to internal components as well as external components.

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PULLEY REMOVAL

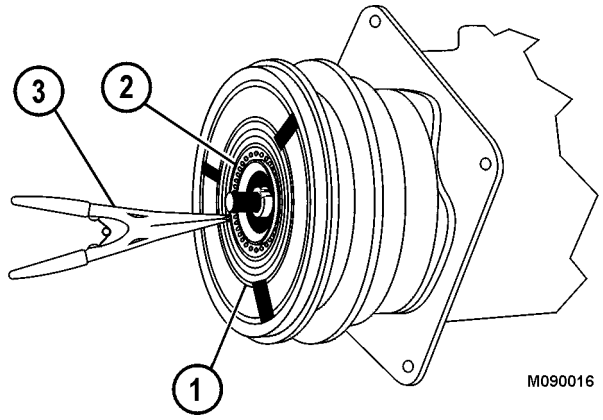


FIGURE 9-15.

1. Pulley Assembly
2. Pulley Retainer Ring
3. Retaining Ring Pliers

7. Use retaining ring pliers (3, Figure 9-15) to remove pulley retainer ring (2) from pulley (1).
8. Pry the absorbent sleeve retainer from the neck of the compressor, and remove the sleeve.

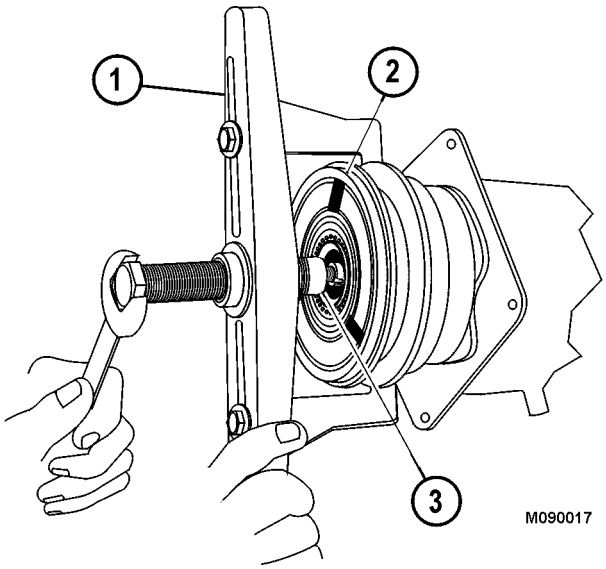


FIGURE 9-16.

1. Pulley Puller
2. Pulley Assembly
3. Puller Pilot

9. Install pulley puller (1, Figure 9-16) and puller pilot (3) onto the compressor, as shown. If a multiple groove pulley is used, install puller legs (J-24092) onto the puller in place of the standard legs. Extend the puller legs to the back side of the pulley. DO NOT use the belt grooves to pull the pulley from the compressor.
10. Tighten the center screw on the puller against the shaft of the compressor to remove the pulley.
11. Clean the pulley and pulley bearing with solvent. Inspect the assembly for damage. Check the bearing for brinneling, excessive looseness, noise, and lubricant leakage. Replace the assembly if any of these warning signs are evident.

CLUTCH COIL CHECK

12. Use a multi-meter to ohm check the clutch coil. The resistance should be as follows:
    - @ 68° F (20° C) 12 ± 0.37 ohms
    - @ 239° F (115° C) 16.1 ± 0.62 ohms

If the resistance of the coil is not within the specifications, the clutch will not operate properly. Remove the retaining ring and replace the coil.

PULLEY INSTALLATION

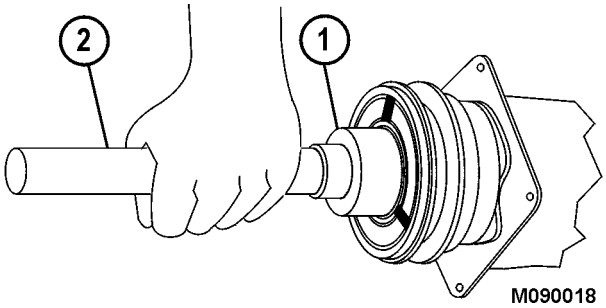


FIGURE 9-17.

1. Bearing Installer
2. Universal Handle

1. Place the pulley assembly into position on the compressor. Use bearing installer (1, Figure 9-17), universal handle (2), and a hammer to lightly tap the pulley assembly onto the compressor until it seats. Use of the installer or the equivalent ensures that the force driving the bearing into position acts on the inner race of the bearing. Applying force to the outer race of the bearing will result in bearing damage.
2. Ensure that the pulley rotates freely. If the pulley does not rotate freely, remove the pulley and check for damaged components. Replace any damaged components and reinstall the pulley.
3. Install the pulley retainer ring and ensure that the ring is properly seated.
4. Install the absorbent sleeve into the neck of the compressor. Install the sleeve retainer.

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CLUTCH ASSEMBLY INSTALLATION

1. Insert square key (1, Figure 9-13) into the keyway in the clutch hub. Allow the key to protrude about 4.5 mm (0.18 in.) from the outer edge of the hub. Use petroleum jelly to hold the key in place.

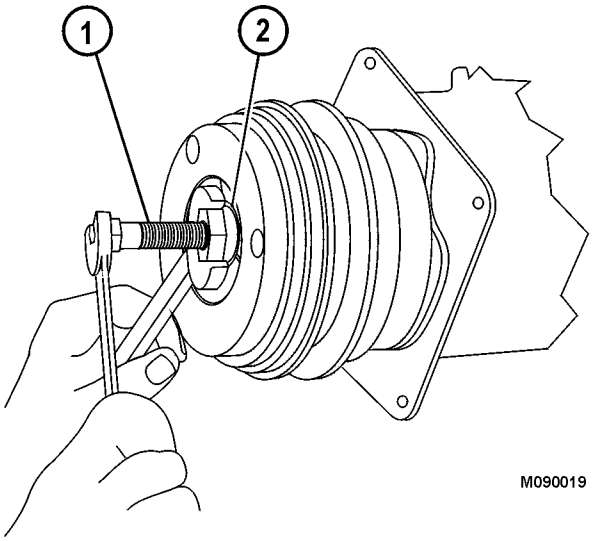


FIGURE 9-18.

1. Thin Wall Socket
2. Clutch Hub Holdi Tool

2. Place the clutch assembly into position on the compressor. Align the square key with the keyway on the shaft.

3. Thread drive plate installer (1, Figure 9-18) onto the shaft of the compressor. Spacer (2) should be in place under the hex nut on the tool.

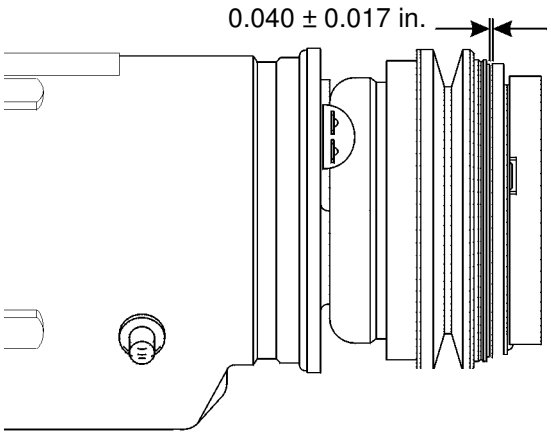


FIGURE 9-19.

4. Press the clutch onto the compressor using installer (1). Continue to press the clutch plate until a 2 mm (0.079 in.) gap remains between the clutch friction surface and the pulley friction surface. Refer to Figure 9-19.

NOTE: The outer threads of installer (J-9480-01) are left handed threads.

5. IInstall locknut (4, Figure 9-10) and tighten the nut until it seats. The gap should now measure 1.02 ± 0.043 mm (0.040 ± 0.017 in.). If the gap is not within the specification, check for proper installation of the square key.

10. Install the drive belt onto the compressor. Ensure that the proper tension on the belt is attained. Refer to the belt tension chart in the appropriate engine manual for the proper specifications.

11. After assembly is complete, burnish the mating parts of the clutch by operating the air conditioning system at maximum load conditions with the engine at high idle. Turn the air conditioning control "ON" and "OFF" at least 15 times for one second intervals.

12. Install the belt guard if no further servicing is required.

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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 AC 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 AC 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 equipment manufacturer's instructions for this procedure.

Evacuating and Charging the AC System

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

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Evacuating the System

Evacuating the complete air conditioning system is required in all new system installations, and when repairs are made on systems requiring a component replacement (system opened), or a major loss of refrigerant has occurred. All these conditions will require that a vacuum be pulled using a vacuum pump that completely removes any moisture from the system. Once properly evacuated, the system can be recharged again.

Using a pump to create a vacuum in the air conditioning system effectively vaporizes any moisture, allowing the water vapor to be easily drawn out by the pump. The pump does this by reducing the point at which water boils (212°F at sea level with 14.7 psi). In a vacuum, water will boil at a lower temperature depending upon how much of a vacuum is created.

As an example, if the ambient air outside the truck is 75°F at sea level, by creating a vacuum in the system so that the pressure is below that of the outside air (in this case, at least 29.5 inches of vacuum is needed), the boiling point of water will be lowered to 72°F. Thus any moisture in the system will vaporize and be drawn out by the pump if the pump is run for approximately an hour. The following steps indicate the proper procedure for evacuating all moisture from the heavy duty air conditioning systems.

Do not use the air conditioning compressor as a vacuum pump or the compressor will be damaged.

NOTE: Lower the vacuum requirement one inch for every 1000 feet above sea level at your location.

1. With the manifold gauge set still connected (after discharging the system), connect the center hose to the inlet fitting of the vacuum pump as shown in Figure 9-10. Then open the low side hand valves to maximum.
2. Open the discharge valve on the vacuum pump or remove the dust cap from the discharge outlet. Turn the pump on and watch the low side gauge. The pump should pull the system into a vacuum (if not, the system has a leak).
3. Run the pump for five minutes and close the hand valves and shut off the pump.

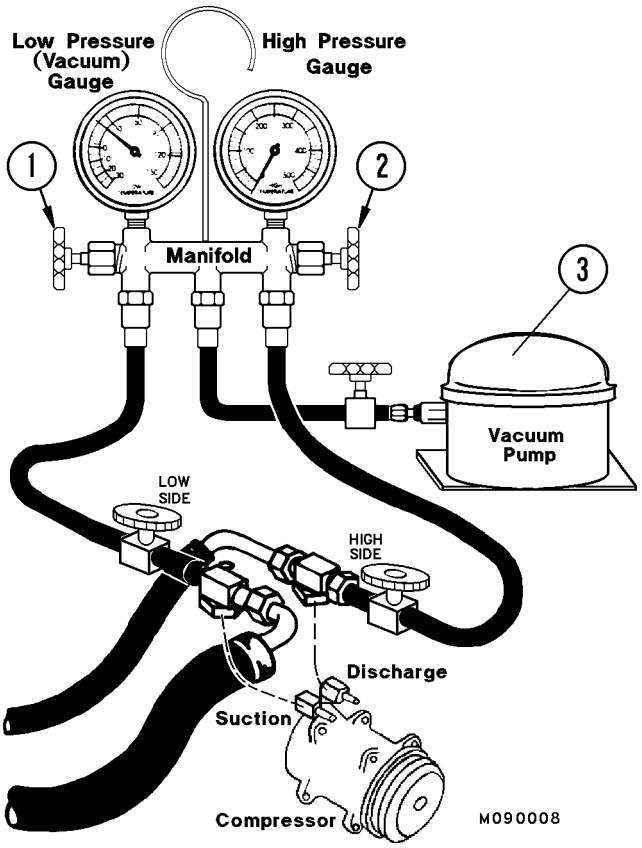


FIGURE 9-20. VACUUM PUMP HOOKUP

1. Low Pressure Hand Valve
2. High Pressure Hand Valve
3. Vacuum Pump

4. Observe gauge reading and wait 10 minutes. Reading should not vary more than 1-2 in. hg. After waiting, if more vacuum is lost than this, a serious leak is indicated and the system must be recharged, leak tested, repaired and evacuated.
5. Turn on pump, open hand valves and continue evacuation for at least one hour.

NOTE: If system has excessive amounts of moisture, 60 minutes evacuation may not be sufficient since the water must turn to a vapor to be drawn out of the system. If it has been verified that no system leaks exist and gauge readings increase after 1 hour, extend the evacuation time to ensure total moisture removal.

6. Close the manifold hand valves and turn off vacuum pump, watching the low side gauge reading. If vacuum remains for a few minutes, the system is ready for charging.

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

⚠ IMPORTANT ⚠

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

Charging the AC System

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

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

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

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TROUBLESHOOTING

PRE-DIAGNOSIS CHECKS

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

NOTE: If the truck being serviced is a Model 930E, be certain the Rest Switch in the cab is ON. Place the GF Cutout Switch in the CUTOUT position. (Refer to Fig. 3-1, Page E3-2, Propulsion System, for switch location.)

PREPARING FOR DIAGNOSIS

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

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

- Compressor Belt - Must be tight, and aligned.
- Compressor Clutch - The clutch must engage. If it does not, check fuses, wiring, and switches.
- Oil Leaks - Inspect all connection or components for refrigeration oil leaks (especially in the area of the compressor shaft). A leak indicates a refrigerant leak.
- Electrical Check - Check all wires and connections for possible open circuits or shorts. Check all system fuses.

Note: Some systems use different safety devices in the compressor circuit to protect the compressor. Check the thermal fuse, the low pressure cutout switch, high pressure cutout switch or trinary pressure switch if equipped.

- Cooling System - Check for correct cooling system operation. Inspect the radiator hoses, heater hoses, clamps, belts, water pump, thermostat and radiator for condition or proper operation.
- Radiator Shutters - Inspect for correct operation and controls, if equipped.
- Fan and Shroud - Check for proper operation of fan clutch. Check installation of fan and shroud.
- Heater/Water Valve - Check for malfunction or leaking.
- System Ducts and Doors - Check the ducts and doors for proper function.
- Refrigerant Charge - Make sure system is properly charged with the correct amount of refrigerant.

PRELIMINARY STEPS

The following steps outline the correct procedures necessary to prepare the truck and the system for testing and diagnosis:

1. Correctly connect the manifold gauge set to the system. Refer to the connection and purging procedures outlined in this section.
2. Run the engine with the air conditioning system on for five to ten minutes to stabilize the system.
3. With the engine and the system at normal operating temperature, conduct a Performance Test as outlined in this section.

SYSTEM PERFORMANCE TEST

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

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

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

1. Close all windows and doors to the cab.
2. Set air conditioning system at maximum cooling and blower speed operation.
3. Readings on the two manifold gauges should be within normal range, adjust for ambient temperature.

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4. Compare evaporator discharge air temperature reading to see if it matches the recommended temperature for the ambient temperature and gauge readings obtained.
5. Carefully feel the hoses and components on the high side. All should be warm-hot to the touch. Check the inlet and outlet of receiver-drier for even temperatures, if outlet is cooler than inlet, a restriction is indicated.



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

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

DIAGNOSIS OF GAUGE READINGS & SYSTEM PERFORMANCE

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

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TROUBLESHOOTING BY MANIFOLD GAUGE SET READINGS

PROBLEM: Insufficient Cooling

Indications:

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

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

PROBLEM: Little or No Cooling

Indications:

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

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

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PROBLEM: Extremely Low Refrigerant Charge in the System

Indications:

Low side pressure - LOW.
High side pressure - LOW.
Discharge air is warm.
The low pressure switch may have shut off the compressor clutch.

Possible Causes	Suggested Corrective Actions
- Extremely low or no refrigerant in the system. Possible leak in the system.	Check for leaks by performing leak test. ***No Leaks Found:*** Recover refrigerant from the system. Recharge using a scale to ensure correct charge. Check AC operation and performance. ***Leaks Found:*** Add refrigerant (make sure system has at least 50% of its normal amount) and leak test system. It may be necessary to use a jumper wire to enable the compressor to operate, if the compressor has shut down due to faulty pressure sensing switch. Repair any leaks and evacuate the system if necessary, Replace the receiver-drier if the system was opened. Recharge the system using a scale and add oil as necessary. Check AC operation and do system performanc test.

PROBLEM: Air and/or Moisture in the System

Indications:

Low side pressure - Normal
High side pressure - Normal
Discharge air is only slightly cool.
(In a cycling type system with a thermostatic switch, the switch may not cycle the clutch on and off, so the low pressure gauge will not fluctuate.)

Possible Causes	Suggested Corrective Actions
Leaks in the system.	Test for leaks, especially around the compressor shaft seal area. When the leak is found, recover refrigerant from the system and repair the leak. Replace the receiver-drier or accumulator because the desiccant may be saturated with moisture. Check the compressor and replace any refrigerant oil lost due to leakage. Evacuate and recharge the system with refrigerant using a scale. Check AC operation and performance.

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PROBLEM: Air and/or Moisture in the System

Indications:
Low side pressure - HIGH
High side pressure - HIGH
Discharge air is only slightly cool.

Possible Causes	Suggested Corrective Actions
- Leaks in system.	Test for leaks, especially around the compressor shaft seal area. After leaks are found, recover refrigerant from the system and repair leaks. Replace the receiver-drier. Check the compressor and replace any oil lost due to leakage. Evacuate and recharge the system using a scale to ensure proper quantity. Check AC operation and performance.

PROBLEM: Expansion Valve Stuck or Plugged

Indications:
Low side pressure - VERY LOW or in a Vacuum
High side pressure - HIGH
Discharge air only slightly cool.
Expansion valve body is frosted or sweaty.

Possible Causes	Suggested Corrective Actions
An expansion valve malfunction could mean the valve is stuck in the closed position, the filter screen is clogged (block expansion valves do not have filter screens), moisture in the system has frozen at the expansion valve orifice, or the sensing bulb is not operating. If the sensing bulb is accessible, perform the following test. If not, proceed to the Repair Procedure.	**Test:** Warm diaphragm and valve body with your hand, or very carefully with a heat gun. Activate the system and watch to see if the low pressure gauge rises. Next, carefully spray a little nitrogen, or any substance below 32° F, on the capillary coil (bulb) or valve diaphragm. The low side gauge needle should drop and read at a lower (suction) pressure on the gauge. This indicates the valve was partially open and that your action closed it. Repeat the test, but first warm the valve diaphragm or capillary with your hand. If the low side gauge drops again, the valve is not stuck. **Repair Procedure:** Inspect the expansion valve screen (except block type valves). To do this, remove all refrigerant from the system. Disconnect the inlet hose fitting from the expansion valve. Remove, clean, and replace the screen. Reconnect the hose and replace the receiver-drier. Evacuate and recharge the system with refrigerant using a scale. Check AC operation and performance. If the expansion valve tests did not cause the low pressure gauge needle to rise and drop, and if the other procedure described did not correct the problem, the expansion valve is defective. Replace the valve.

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PROBLEM: Expansion Valve Stuck Open

Indications:

Low side pressure - HIGH
High side pressure - Normal
Air from vents in the cab seems warm or only slightly cool.

Possible Causes	Suggested Corrective Actions
The expansion valve is stuck open and/or the capillary tube (bulb) is not making proper contact with the evaporator outlet tube. Liquid refrigerant may be flooding the evaporator making it impossible for the refrigerant to vaporize and absorb heat normally. In vehicles where the expansion valve sensing bulb is accessible, check the capillary tube for proper mounting and contact with the evaporator outlet tube. Then perform the following test if the valve is accessible. If it is not, proceed to the Repair Procedure.	**Test:** Operate the AC system on it's coldest setting for a few minutes. Carefully spray nitrogen or another cold substance on the capillary tube coil (bulb) or head of the valve. The low pressure (suction) side gauge needle should now drop on the gauge. This indicates the valve has closed and is not stuck open. Repeat the test, but first warm the valve diaphragm by warming with hands. If the low side gauge shows a drop again, the valve is not stuck. Clean the surfaces of the evaporator outlet and the capillary coil or bulb. Make sure the coil or bulb is securely fastened to the evaporator outlet and covered with insulation material. Operate the system and check performance. **Repair Procedure:** If the test did not result in proper operation of the expansion valve, the valve is defective and must be replaced. Recover all refrigerant from the system and replace the expansion valve and the receiver-drier. Evacuate and recharge the system with refrigerant using a scale. Check AC operation and performance.

PROBLEM: High Pressure Side Restriction

Indications:

Low side pressure - LOW
High side pressure - Normal to HIGH
Discharge air is only slightly cool.
Look for sweat or frost on high side hoses and tubing. The line will be cool to the touch near the restriction.

Possible Causes	Suggested Corrective Actions
Kink in a line, collapsed hose liners, plugged receiver-drier or condenser, etc.	**Repair Procedure:** After you locate the defective component containing the restriction, recover all of the refrigerant. Replace the defective component and the receiver-drier. Evacuate and recharge the system with refrigerant, then check AC operation and performance.

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PROBLEM: Compressor Malfunction

Indications:

Low side pressure - HIGH
High side pressure - LOW
Compressor operates noisily.

Possible Causes	Suggested Corrective Actions
- Defective reed valves or other internal components.	**Repair Procedure:** If the belt is worn or loose, replace or tighten it and recheck system performance and gauge readings. If inspection of the compressor is required, all of the refrigerant must be recovered and the compressor disassembled to the point that inspection can be performed. Replace defective components or replace the compressor. If particles of desiccant are found in the compressor, flushing of the system will be required. It will also be necessary to replace the receiver-drier. Always check the oil level in the compressor, even if a new unit has been installed. Rotary compressors have a limited oil reservoir. Extra oil must be added for all truck installations. Tighten all connections and evacuate the system. Recharge the system with refrigerant using a scale. Check system operation and performance.

PROBLEM: Thermostatic Switch Malfunction

Indications:

Low side pressure - Normal
High side pressure - Normal
Low side pressure may cycle within a smaller range as the compressor clutch cycles more frequently than normal. This may indicate the thermostat is set too high.

Possible Causes	Suggested Corrective Actions
- Thermostat malfunctioning possibly due to incorrect installation.	Replace the thermostatic switch. When removing the old thermostat, replace it with one of the same type. Take care in removing and handling the thermostat and the capillary tube that is attached to it. Use care not to kink or break the tube. Position the new thermostat capillary tube at or close to the same location and seating depth between the evaporator coil fins as the old one. Connect the electrical leads

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PROBLEM: Condenser Malfunction or System Overcharge

Indications:

Low Side High
High Side High
Discharge air may be warm.
High pressure hoses and lines are very hot.

Possible Causes	Suggested Corrective Actions
- Lack of air flow through the condenser fins	**Repair Procedure:** Check the engine cooling system components, fan and drive belt, fan clutch operation, and the radiator shutter. Inspect condenser for dirt, bugs, or other debris, and clean if necessary. Be sure the condenser is securely mounted and there is adequate clearance (about 38 mm) between it and the radiator. Check the radiator pressure cap and cooling system, including the fan, fan clutch, drive belts and radiator shutter assembly. Replace any defective parts and then recheck AC system operation, gauge readings, and performance. If the problem continues, the system may be over-charged. Recover the system refrigerant. Use a scale to recharge the system using the correct amount. Recheck AC system operation, gauge readings and performance. If the gauge readings do not change, all of the refrigerant should be recovered and the system flushed. The condenser may be partially blocked -replace condenser. The receiver-drier must also be replaced. Evacuate the system, recharge, and check operation and performance.

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Preventive Maintenance Schedule for AC System

Truck Serial Number_____

Site Unit Number_____

Date:_____Hour Meter:_____

Last Maintenance Check:_____

Name of Service Technician_____

NOTE: Compressor should be run at least 5 minutes (40°F minimum ambient temperature) every month, in order to circulate oil and lubricate components.

COMPONENT	Maintenance Interval (months)			
	3	6	12	Done
1. Compressor Check noise level Check clutch pulley Check oil level Run system 5 min. Check belt tension (80-100) lbs; V-belt Inspect shaft sea for leakage Check mounting bracket (tighten bolts) Check clutch alignment w/ crankshaft pulley (within 0.06 in.) Perform manifold gauge check Verify clutch is engaging				
2. Condenser Clean dirt, bugs, leaves, etc. from coils (w/compressed air) Verify engine fan clutch is engaging (if installed) Check inlet/outlet for obstructions/damage				
3. Receiver-Drier Check inlet line from condenser (should be hot to touch) Replace if system is opened				

COMPONENT	Maintenance Interval (months)			
	3	6	12	Done
4. Expansion Valve Inspect capillary tube (if used) (leakage, damage, looseness)			X	
5. Evaporator Clean dirt, bugs, leaves, etc. from fins (w/ compressed air) Check solder joints on inlet/ outlet tubes (leakage) Inspect condensation drain				
6. Other Components Check discharge lines (hot to touch) Check suction lines (cold to touch) Inspect fittings/clamps/hoses Check thermostatic switch for proper operation Outlets in cab: 40°F to 50° F Inspect all wiring connections Operate all manual controls through full functions				

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RADIATOR SHUTTERS

The optional radiator shutters aid in maintaining proper engine coolant temperature, primarily in cold climate operations.

The shutter system contains the following components:

- Shutter assembly with hydraulic control actuator cylinder
- Hydraulic oil supply pressure reducing valves and cylinder control solenoid
- Solenoid control relays
- Shutter enable/disable switch

Operation

Hydraulic Circuit

Hydraulic oil pressure to operate the shutter assembly actuator cylinder is supplied from the truck steering circuit. A hose (2, Figure 19-1) attached to a “T” fitting at the automatic lubrication system pump supply port routes oil to the pressure reducing valve (3). This valve reduces the steering circuit pressure, 3500 psi (24 132 kPa) to 1500psi (10 342 kPa). The pressure is further reduced to 75 psi (517 kPa) by the pressure reducing valve (4) which supplies the shutter solenoid valve (5) to pressurize the head end of the shutter actuator cylinder (11), closing the shutters during engine warm-up. When the shutters are signalled to open, the solenoid valve will be de-energized and the spool will shift to direct oil to the rod end of the actuator cylinder. Oil returns to tank through the hose (10) routed to the hydraulic tank.

1. Radiator Shroud
2. Oil Supply
3. Pressure Reducing Valve
4. Pressure Reducing Valve
5. Shutter Solenoid Valve
6. To Cylinder Head End
7. To Cylinder Rod End
8. Electrical Harness (To RH Frame Junction Box)
9. To Shutter Enable Switch box)
10. Oil Return to Tank Hose
11. Shutter Actuator Cylinder

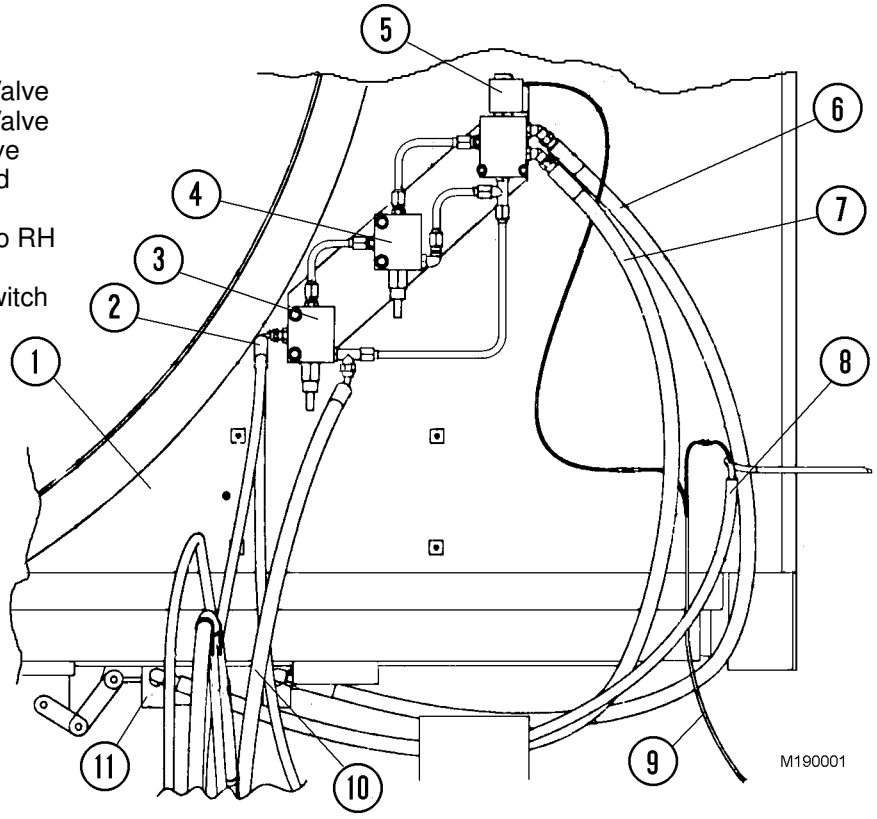


FIGURE 19-1. SHUTTER ACTUATOR CYLINDER OIL SUPPLY VALVES

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Electrical Circuit:

A switch is located in a box (2, Figure 19-2) attached to the right upright structure beside the automatic lubrication system grease reservoir (4) that may be used to enable the shutters for cold weather operation or to disable the shutters during warm weather.

Note: Refer to the electrical schematic in Figure 19-3 for the following component descriptions.

The shutters are normally activated by the engine ECM. The engine controller monitors coolant temperature and provides a signal to close the shutters when coolant temperature is low.

Komatsu SSDA16V1610 Engine:

If equipped with the Komatsu engine, the ECM will provide a +24VDC signal (circuit 65S) to energize relay K5 located on relay board #6. This will close the N.O. relay contacts fed by relay K3 which provides +24VDC when the key switch is ON. Current through K5 is fed through the shutter enable switch (closed for shutter operation) and will energize the shutter solenoid valve to direct oil to the head end of the shutter actuator cylinder to close the shutters.

After the coolant has reached the proper operating temperature, the ECM will remove the +24VDC to the K5 relay coil and it will de-energize, opening the N.O. contacts and removing +24VDC from the shutter solenoid circuit, directing oil to the rod end of the cylinder to open the shutters.

MTU/DDEC Engine:

If the MTU/DDEC engine is installed, the ECM will provide a ground path to energize relay K5 on relay board #6 to energize it and close the N.O. contacts to provide +24VDC from relay K3 to the shutter control solenoid when the key switch is ON and the shutter enable switch is closed.

After the coolant temperature has reached the proper operating temperature, the ECM will open the ground circuit (563M) and de-energize relay K5 opening the N.O. contacts and removing +24VDC from the shutter solenoid circuit, directing oil to the rod end of the cylinder to open the shutters.

Both Engine Installations:

If the cab air conditioner is switched on, relay K3 will energize, opening the +24VDC circuit (712ST) supplying the shutter control solenoid, preventing the shutters from closing.

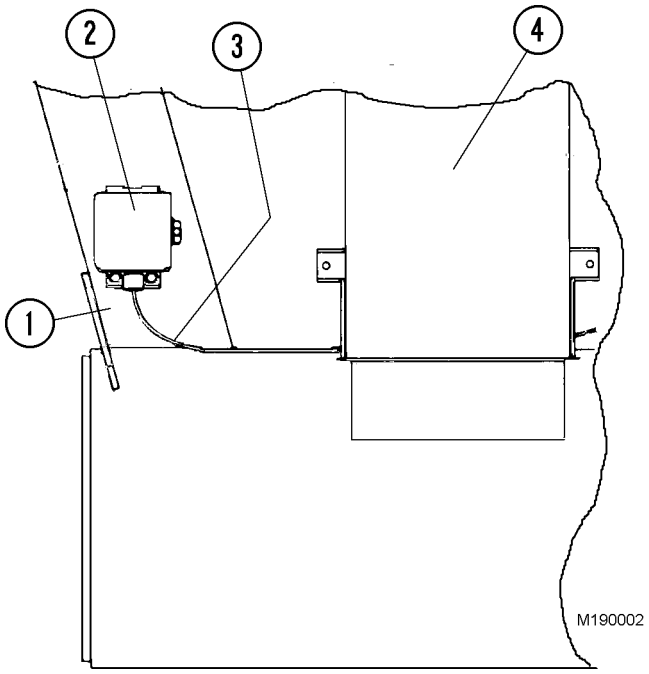


FIGURE 19-2. SHUTTER ENABLE SWITCH BOX

1. Right Upright Structure
2. Switch Box
3. Harness Wire to Shutter Solenoid Valve
4. Auto-Lube Grease Reservoir

Maintenance and Repair

The solenoid valve (5, Figure 19-1) and pressure reducing valves (3 & 4) in the hydraulic circuit are factory set and not adjustable. If a valve is inoperative, remove and replace the complete valve and body assembly.

Relays K3 and K5 are plug-in devices that may easily be replaced if defective. The relays are located on Relay board #6, located in the electrical cabinet. Its location may vary depending on the engine installed, options installed, and the date the truck was manufactured. The example in Figure 19-3 shows relay board #6 located on the left wall of the right compartment.

The shutter assembly should be inspected for physical damage and to be certain it opens and closes completely without binding. If necessary, adjust actuator cylinder linkage to ensure proper operation.

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1. Shutter Solenoid Valve
2. Shutter Enable/Disable Switch
3. Relay K5
4. Relay Board #6
5. Relay K3
6. Electrical Cabinet
7. Junction Box (Rear of Cabinet)

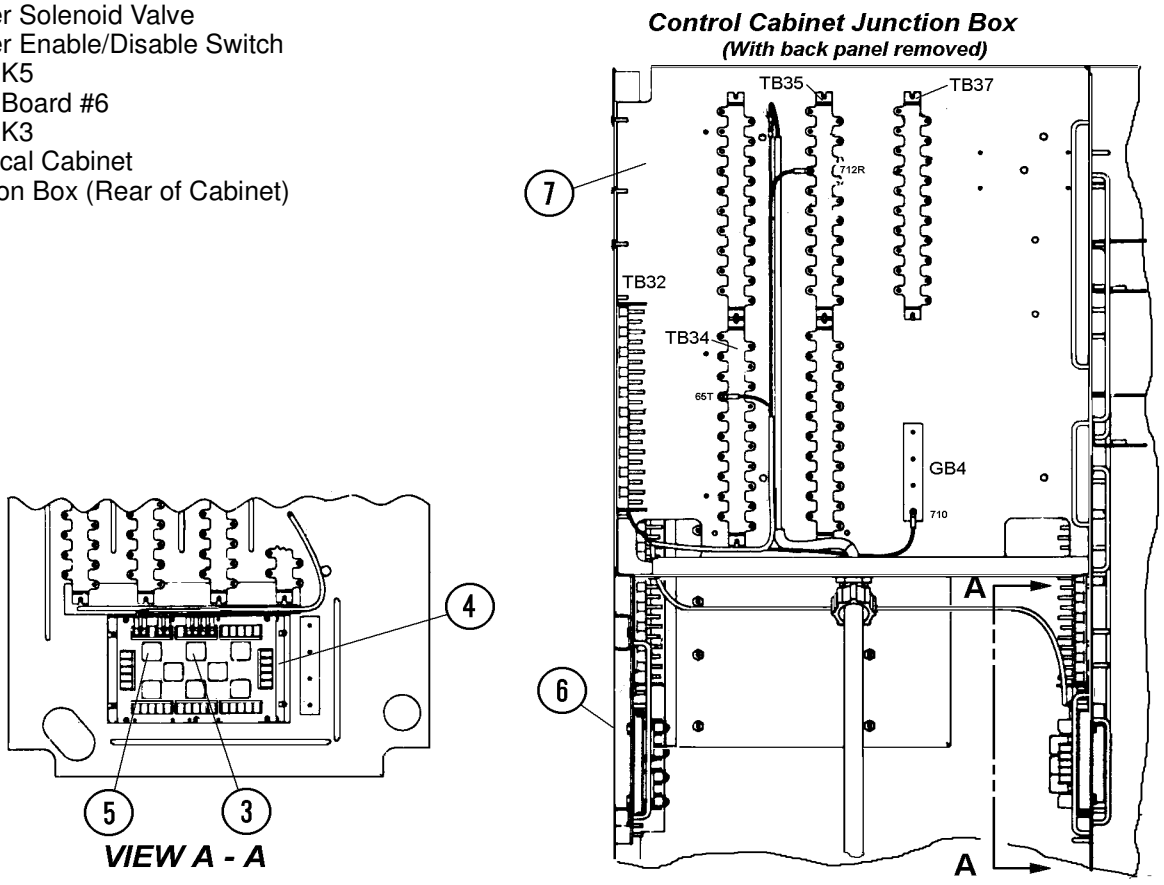


FIGURE 19-3. ELECTRICAL HOOKUP AND SCHEMATIC

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PAYLOAD METER III™

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OPERATION SECTION

INTRODUCTION

Payload Meter III (PLMIII) measures, displays and records the weight of material being carried by an off-highway truck. The system generally consists of a payload meter, a gauge display, deck-mounted lights, and sensors. The primary sensors are four suspension pressures and an inclinometer. Other inputs include a body up signal, brake lock signal, and speed.

Data Summary

5208 haul cycles can be stored in memory. The following information is recorded for each haul cycle:

- Payload
- Operator ID number (0000-9999)
- Distance traveled loaded and empty
- The amount of time spent empty run/stop, loading, loaded run/stop, and dumping
- Maximum speed loaded and empty with time of day
- Average speed loaded and empty
- Empty carry-back load
- Haul-cycle, loading, dumping start time of day.
- Peak positive and peak negative frame torque with time of day
- Peak sprung load with time of day
- Tire ton-mph for each front and average per rear tires

The payload meter stores lifetime data that cannot be erased. This data includes:

- Top 5 maximum payloads and time stamps.
- Top 5 positive and negative frame torque and time stamps
- Top 5 maximum speeds and time stamps

Data Gathering

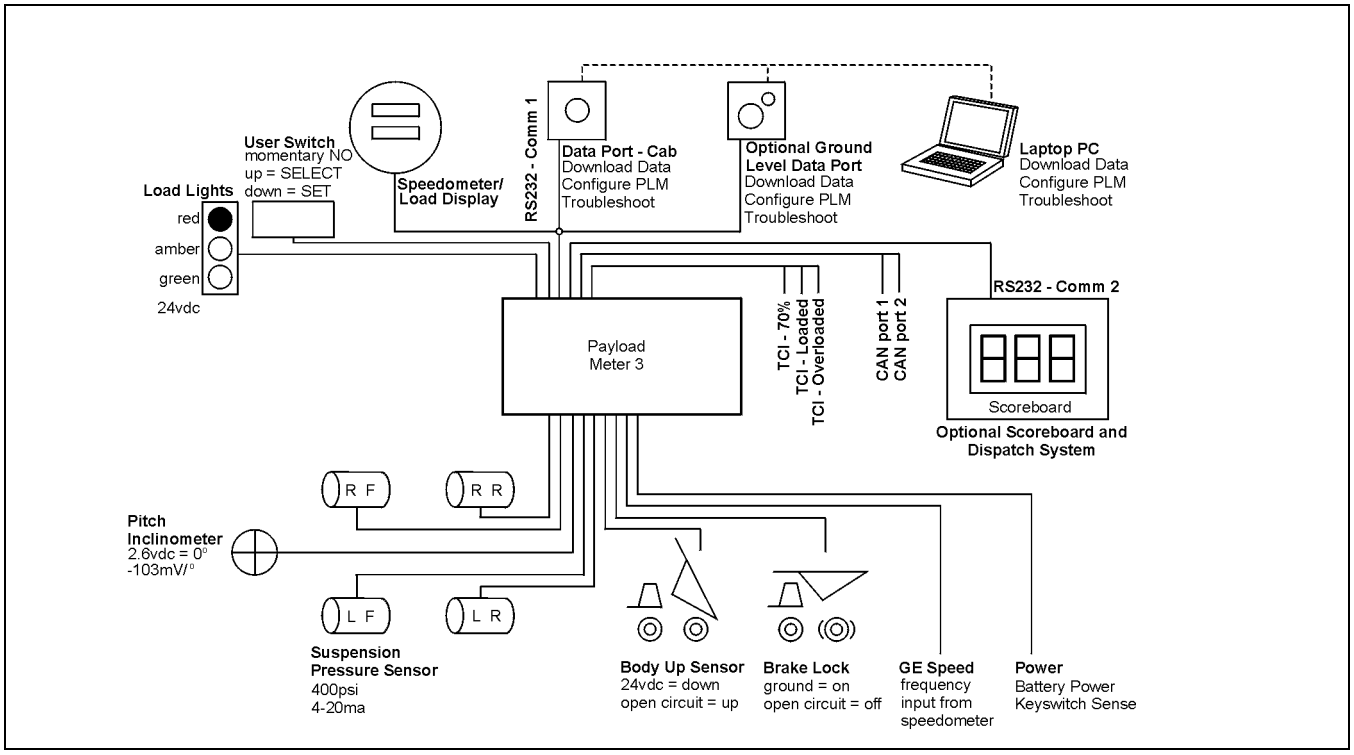
Windows 95/98/NT software is available to download, store and view payload and fault information. The PC software will download an entire truck fleet into one Paradox database file. Users can query the database by date, time, truck type and truck number to produce reports, graphs and export the data. The software can export the data in '.CSV' format that can be easily imported into most spreadsheet applications. The Windows software is not compatible with the Payload Meter II system.

It is important that each payload meter be configured for each truck using the PC software. The information for frame serial number and truck number is used by the database program to organize the payload data. In addition, the payload meter must be configured to make calculations for the proper truck model. Improper configuration can lead to data loss and inaccurate payload calculations.

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Component Description

System Diagram



Suspension Pressure Sensors

PLMIII uses a two-wire pressure sensor. The range for the pressure sensor is 4000 psi (281 kg/cm^2) and the overload limit is 10,000 psi (700 kg/cm^2). One wire to the sensor is the supply voltage and the other is the signal. The 0-4000 psi range is converted into an electrical current between 4-20 ma. The supply voltage for the sensor is nominally +18vdc. Each pressure sensor has an 90" length of cable that is terminated with #10 ring terminals. The cable is specially shielded and reinforced to provide mechanical strength and electronic noise immunity. A typical part number for the pressure sensor is PC0328.

Inclinometer

The inclinometer is used to increase the accuracy of load calculations on an incline. The inclinometer uses three wires. For the sensor, red is the +18vdc supply voltage, black is ground and the white is the signal. The incline signal is a voltage between 1 and 4 volts. Zero degrees of incline is represented by 2.6vdc on the signal line. The voltage signal will be decreased by 0.103vdc for every degree of nose up incline. A typical part number for the inclinometer assembly is 7861-92-5330.

Operator Display

The speedometer/display gauge is used as a speedometer and payload display. The top display is used for speed and can display metric (km/h) or English (mph) units. Grounding terminal #4 on the back of the speedometer will switch the meter to display metric units. Leaving terminal #4 unconnected will cause the gauge to display English units. The speedometer can be adjusted using a calibration potentiometer in the back just like existing speedometers.

The payload meter uses the lower display for payload information. The normal display mode shows the current payload. The display can be changed to show the load and total tons counter or the Operator ID. Using the operator switch on the dash panel, the current suspension pressures and incline can be displayed. The units for display are set using the PC software. Payloads can be displayed in Short Tons, Long Tons or Metric Tons. A typical part number for this gauge is the PC0550.

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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 onboard 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.

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Keyswitch Input

PLMIII monitors the status of the keyswitch. 24vdc indicates that the keyswitch is on, open indicates the keyswitch is off. The payload meter does not receive its electrical power from the keyswitch circuit. The payload meter will remain on for several seconds after keyswitch is removed. When the keyswitch power is removed, payload meter performs a series of internal memory operations before turning itself off. To allow for these operations, the keyswitch should be turned off for at least 15 seconds before turning the keyswitch back on. The payload meter will automatically reset itself without error if not enough time is given for these operations. The display may blink briefly.

Payload Meter Power

The payload meter receives its power from the battery circuit on the truck. Removing battery power from the payload meter before removing keyswitch and waiting 15 seconds may result in lost haul cycle data. The payload meter turns itself off approximately 15 seconds after the keyswitch power is removed. Some haul cycle data will be lost if battery power is removed before waiting 15 seconds. The payload meter system operates at a nominal voltage of 24vdc at 1 to 2 amps depending on options. The payload meter is designed to turn itself off if the supply voltage rises above 36vdc. The payload meter is also protected by a 5 amp circuit breaker located in the junction box.

Power to the load lights comes from the same battery circuit. The load lights are powered through a relay. The keyswitch circuit controls the relay. The load lights are also protected by a 15 amp circuit breaker in the junction box.

Load Lights

PLMIII uses load lights to indicate to the shovel operator the approximate weight of the material in the truck. The load lights are illuminated only when the brake lock is applied. The lights are controlled by the payload meter through a series of relays in the junction box. The payload meter controls the relays with 24vdc outputs. A 24vdc signal from the payload meter powers the relay coil and connects battery power to the load light. When the relay is not powered by the payload meter, a pre-warm resistor connects the load light to a reduced voltage. This circuit pre-warms the load light filaments and reduces the inrush current when the light is fully illuminated. This lengthens the operating life of the load lights.

The load lights progressively indicate to the shovel operator the approximate weight of the material in the truck.

A flashing green light indicates the next swingload will make the measured load greater than 50% of rated load. A solid green light indicates that the current load is greater than 50% of rated capacity.

A flashing amber light indicates the next swingload will make the measured load greater than 90% of rated load. A solid amber light indicates that the current load is greater than 90% of rated capacity.

A flashing red light indicates the next swingload will make the measured load greater than 105% of rated load. A solid red light indicates that the current load is greater than 105% of rated capacity.

The optimal loading target is a solid green and amber lights with a flashing red light. This indicates that the load is between 90% and 105% of rated load for the truck and the next swingload will load the truck over 105%.

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Wiring and Termination

Most of the PLMIII truck connections use a heavy-duty cable. This yellow multi-conductor cable uses a 16awg, finely stranded wire designed for continuous motion operations. The conductors are protected by a foil and braided shield for electronic noise immunity and physical strength. A typical part number for this wire is LW086-63. This wire is typically terminated with a #10 ring terminal, part number VH2584. Most connections for the PLMIII system are made in the payload meter junction box.

TCI Outputs

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

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Operator's Display and Switch

Reading the Speedometer

The top window of the speedometer/display gauge is the speedometer section. The display shows the speed indicated by the frequency being received by the gauge. This can be adjusted using the potentiometer on the back of the gauge. In addition, the units for the display can be changed. Terminal #4 controls the displayed units. If #4 is grounded, the display will be metric. If terminal #4 is left open, the display will be in English units.

Reading the Load Display

The lower display on the speedometer/display gauge is used for payload information. The SELECT position on the operator switch allows the user to scroll through a number of useful displays. The order for the displays is as follows:

- PL = Payload
- Id = Operator ID
- tL = Total Shift Tons
- LC = Shift Load Counter
- LF = Left Front Suspension Pressure
- rF = Right Front Suspension Pressure
- Lr = Left Rear Suspension Pressure
- rr = Right Rear Suspension Pressure
- In = Inclinometer

The display holds the displayed information until the SELECT switch is pressed again. The suspension pressures, inclinometer, and payload displays are based on current sensor inputs.
Communications to the display use the same serial link as the download connection. Whenever another computer is connected to serial port #1 to download or configure the system, the lower display will blank. This is not the same connection used by mine dispatch systems.

Using the Operator ID

The current Operator ID number is recorded with each haul cycle. The number can be between 0 and 9999.

To set the Operator ID:

1. Press the “SELECT” switch until Id: is displayed.
2. Hold the “SET” button until 0000 is displayed. The first digit should be flashing.
3. Press the “SET” button again to change the digit.
4. Press the “SELECT” button once to adjust the second digit.
5. Use the “SET” button again to change the digit.
6. Press the “SELECT” button once to adjust the third digit.
7. Use the “SET” button again to change the digit.
8. Press the “SELECT” button once to adjust the fourth digit.
9. Use the “SET” button again to change the digit
10. Press the “SELECT” button one more time to enter the ID.

If no buttons are pressed for 30 seconds, the display will return to normal operation. The number being entered will be lost and the ID number returns to the previous ID number.

Using the Load and Ton Counter

PLMIII allows the truck operator to monitor and track the total tons hauled and the number of haul cycles during the shift. This display can be cleared at the beginning of each shift to allow the operator to record how many loads and tons have been hauled during the shift.

Total Ton Counter

The Total Ton Counter records the number of tons hauled since the last time it was cleared. This display is in 100’s of tons. For example, if the display shows 432 the total tons is 43,200. This display can be cleared at the beginning of each shift to allow the operator to record how many tons have been hauled during the shift. The units are selected using the PC software.

- To view the Total Ton Counter press and release the “SELECT” switch until tL: is displayed on the gauge.

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Total Load Counter

The Total Load Counter records the number of loads hauled since the last time it was cleared. This display can be cleared at the beginning of each shift to allow the operator to record how many loads have been hauled during the shift.

- To view the Total Load Counter press and release the "SELECT" switch until LC= is displayed on the gauge.

Clearing the Counters

Clearing the Total Ton Counter or Total Load Counter clears both records.

To clear the total ton and total load counter:

1. Press the "SELECT" switch until tL= or LC= is displayed.
2. Hold the "SET" button until the display clears.

Viewing Live Sensor Data

The display can also be used to quickly show the current readings from the four suspension pressure sensors and the inclinometer. This can be used during regularly scheduled service periods to check the state of the suspensions. These displays are live and will update as the values change.

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

The units for the display are controlled by the configuration of the payload meter. If the payload meter is set to display metric units, the pressures will be displayed in tenths of kg/cm^2. For example, if the display shows 202 the actual value is 20.2 kg/cm^2. If the payload meter is set to display short tons, the pressures will be displayed in psi (lbs/in2). To convert from kg/cm^2 to psi, multiply by 14.2. 1 1kg/cm^2 = 14.2 psi. There is no way to detect the units setting for the gauge without the PC software.

The inclinometer displays whole degrees of incline. Positive incline is truck nose up. The gauge will quickly display the type of information shown every 10 seconds. For example, if the left-front pressure is being displayed, LF= will flash on the display every minute. Only the payload display, PL= does not display this information.

- Left Front Pressure - To display the pressure in the left-front suspension, press and release the "SELECT" switch until LF= is displayed.
- Right Front Pressure - To display the pressure in the right-front suspension, press and release the "SELECT" switch until rF= is displayed.
- Left Rear Pressure - To display the pressure in the left-rear suspension, press and release the "SELECT" switch until Lr= is displayed.
- Right Rear Pressure - To display the pressure in the right-rear suspension, press and release the "SELECT" switch until rr= is displayed.
- Inclinometer - To display the truck incline, press and release the "SELECT" switch until In= is displayed.

Other Display Messages

On startup of the payload meter system, the gauge display will scroll the truck type that the PLMIII is configured for. For example, on a 930E, the gauge will scroll, ----930E---.

If the PLMIII encounters memory problems, it will display Er88 where 88 is the specific memory error. In this very rare circumstance, the system should be turned off for 30 seconds and restarted.

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Payload Operation & Calculation

Description of Haul Cycle States

The typical haul cycle can be broken down into eight distinct stages or states. Each state requires the payload meter to make different calculations and store different data.

"States" or stages of a typical haul cycle

1. Tare Zone
2. Empty
3. Loading
4. Maneuvering
5. Final Zone
6. Hauling
7. Dumping
8. After Dump

Haul Cycle Description

A new haul cycle is started after the load has been dumped from the previous cycle. The payload meter will stay in the after_dump state for 10 seconds to confirm that the load has actually been dumped. If the current payload is less than 20% of rated load, the payload meter will switch to the tare_zone and begin calculating a new empty tare. If, after dumping, the payload has not dropped below 20% of rated load the meter will return to the maneuvering or hauling states. In this case, the false_body_up flag will be recorded in the haul cycle record.

While in the tare_zone state, and moving faster than 5 km/h (3 mph), the payload meter calculates the empty sprung weight of the truck. This tare value will be subtracted from the loaded sprung weight to calculate the final payload. The payload meter will switch from the tare_zone or empty to the loading state if swingloads are detected. By raising the dump body while in the empty state the payload meter can be manually switched back to the tare_zone to calculate a new tare.

From the empty state, the payload meter will switch to the loading state through one of two means. If the brake lock is applied, the payload meter will be analyzing the suspension pressures to detect a swingload. If a swingload is detected, the meter will switch to the loading state. The minimum size for swingload detection is 10% of rated load. Swingload detection usually takes 4-6 seconds. The second method to switch from empty to loading is through continuous loading. This can happen if the brake lock is not used during loading. If the load increases above 50% of rated load for 10 seconds without the brake lock applied, the meter will switch to loading and record the continuous_loading flag in the haul cycle.

The payload meter switches from loading to maneuvering as soon as the truck begins moving. The maneuvering zone is 160m and is designed to allow the operator to reposition the truck under the shovel. More payload can be added anytime within the maneuvering zone. Once the truck travels 160m (0.1 miles) the payload meter switches to the final_zone and begins calculating payload. If the body is raised while the payload meter is in the maneuvering state, the no_final_load flag will be recorded in the haul cycle record, no payload will be calculated, and the meter will switch to the dumping state.

While in the final_zone moving faster than 5 km/h (3 mph), the payload meter calculates the loaded sprung weight of the truck. The same advanced algorithm is used to calculate the empty and loaded sprung weights. The payload meter will switch from the final_zone to the dumping state if the Body-Up signal is received. If the truck has moved for less than 1 minute in the final_zone, the payload meter will calculate the final payload using an averaging technique which may be less accurate. If this happens, the average_load flag will be recorded in the haul cycle.

The payload meter switches to the dumping state when the dump body rises. The payload meter will switch from dumping to after_dump when the dump body comes back down.

From the after_dump, the payload meter will switch to one of three states:

1. If the average payload is greater than 20% of rated load and no final payload has been calculated, the payload meter will return to the maneuvering state. After the truck travels 160m (0.1 mile) the meter will switch to the final_zone and attempt to calculate the payload again. The false_body_up flag will be recorded in the haul cycle record.

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2. If the average payload is greater than 20% of rated load and the final payload has been calculated, the payload meter will switch back to the hauling state. The false_body_up flag will be recorded in the haul cycle record.
3. If the average payload is less than 20% of rated load, the payload meter will switch to the tare_zone and begin to calculate a new empty tare.

Load Calculation

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

Carry Back

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

Measurement Accuracy

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

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

Sources for Payload Error

Payload Error

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

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

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

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

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Loading Conditions

The final load calculation of the PLMIII system is not sensitive to loading conditions. The final load is calculated as the truck travels away from the shovel. Variations in road conditions and slope are compensated for in the complex calculations performed by the payload meter.

Pressure Sensors

Small variations in sensors can also contribute to payload calculation error. Every pressure sensor is slightly different. The accuracy differences of individual sensors along the range from 0 to 4000 psi can add or subtract from payload measurements. This is also true of the sensor input circuitry within individual payload meters. These differences can stack up 7% in extreme cases. These errors will be consistent and repeatable for specific combinations of payload meters and sensors on a particular truck.

Swingloads

Swingload calculations can be affected by conditions at the loading site. Parking the truck against the berm or large debris can cause the payload meter to inaccurately calculate individual swingloads. While the PLMIII system uses an advanced calculation algorithms to determine swingloads, loading site conditions can affect the accuracy.

Speed and Distance

The payload meter receives the same speed signal as the speedometer. This signal is a frequency that represents the speed of the truck. The payload meter uses this frequency to calculate speeds and distances. The meter assumes a single value for the rolling radius of the tire. The rolling radius may change at difference speeds by growing larger at higher speeds. The actual rolling radius of the tire will also change between a loaded and empty truck. The payload meter does not compensate for these changes.

HAUL CYCLE DATA

PLMIII records and stores data in its on-board flash memory. This memory does not require a separate battery. The data is available through the download software.

PLMIII can store 5208 payload records. When the memory is full, the payload meter will erase the oldest 745 payload records and continue recording.

PLMIII can store 512 alarm records in memory. When the memory is full, the payload meter will erase the oldest 312 alarm records and continue recording.
All data is calculated and stored in metric units within the payload meter. The data is downloaded and stored in metric units within the Paradox database on the PC. The analysis program converts units for displays, graphs and reports.

The units noted in the Table 1 are the actual units stored in the data file. The value for the haul cycle start time is the number of seconds since January 1, 1970 to the start of the haul cycle. All other event times are referenced in seconds since the haul cycle start time. The PC download and analysis program converts these numbers into dates and times for graphs and reports.

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Haul Cycle Data

The following information is recorded for each haul cycle:

Table 1: Haul Cycle Data

Data	Unit	Remark
Truck #	alpha-numeric	Up to 22 characters can be stored in this field to identify the truck. Typically this field will be just the truck number.
Haul Cycle Start Date/Time	seconds	Number of seconds from 1/1/70 to the start of the haul cycle, haul cycle starts when the meter transitions from dumping to empty state after the previous haul cycle, download program converts seconds into date and time for display
Payload	tons	Stored as metric, download program allows for conversion to short or long tons.
Number of Swingloads	number	The number of swingloads detected by the payload meter
Operator ID	number	This is a 4 digit number that can be entered by the operator at the start of the shift.
Warning Flags	alpha	Each letter represents a particular warning message about the haul cycle, details are located on page 19.
Carry-back load	tons	The difference between the latest empty tare and the clean truck tare
Empty haul time	seconds	Number of seconds in the tare_zone and empty states with the truck moving
Empty stop time	seconds	Number of seconds in the tare_zone and empty states with the truck stopped
Loading time	seconds	Number of seconds in the loading state
Loaded haul time	seconds	Number of seconds in the maneuvering, final_zone and loaded states with the truck moving
Loaded stop time	seconds	Number of seconds in the maneuvering, final_zone and loaded states with the truck stopped
Dumping time	seconds	Number of seconds in the dumping state
Loading start time	seconds	Number of seconds from the start of the haul cycle to when the meter transitions from empty to loading state
Dump start time	seconds	Number of seconds from the start of the haul cycle to the time when the meter switches from loaded to dumping state
Loaded haul distance	m	Distance traveled while loaded
Empty haul distance	m	Distance traveled while empty
Loaded max speed	km/h	Maximum speed recorded while the truck is loaded
Loaded max speed time	seconds	Number of seconds from the start of the haul cycle to the time when the max speed occurred
Empty max speed	km/h	Maximum speed recorded while the truck is empty
Empty max speed time	seconds	Number of seconds from the start of the haul cycle to the time when the max speed occurred
Peak positive frame torque	ton-meter	Positive frame torque is measured as the frame twists in the clockwise direction as viewed from the operator’s seat.
Peak frame torque time	seconds	Number of seconds from the start of the haul cycle to the peak torque, download program converts to time for display
Peak negative frame torque	ton-meter	Negative frame torque is measured as the frame twists in the counter-clockwise direction as viewed from the operator's seat.
Peak frame torque time	seconds	Number of seconds from the start of the haul cycle to the peak torque, download program converts to time for display
Peak sprung load	tons	Peak dynamic load calculation
Peak sprung load time	seconds	Number of seconds from the start of the haul cycle to the peak instantaneous load calculation
Front-left tire-ton-km/h	t-km/h	Tire ton-km/h for haul cycle
Front-right tire-ton-km/h	t-km/h	Tire ton-km/h for haul cycle
Average rear tire-ton-km/h	t-km/h	Tire ton-km/h for haul cycle
Truck Frame Serial Number	alpha	The truck serial number from the nameplate on the truck frame
Reserved 1-10	number	These values are internal calculations used in the continued development of the PLMIII system and should be ignored

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Haul Cycle Warning Flags

The payload meter expects haul cycles to progress in a particular way. When something unexpected takes place, the system records a warning flag. Several events within the haul cycle can cause a warning flag to be generated. Each one indicates an unusual occurrence during the haul cycle. They do not necessarily indicate a problem with the payload meter or payload calculation.

A: Continuous Loading

This message is generated when the truck is loaded over 50% full without the payload meter sensing swingloads. This indicates that a continuous loading operation was used to load the truck. It may also indicate that the payload meter did not receive the Brake Lock input while the truck was being loaded. There may be a problem with the wiring or the Brake Lock was not used. The payload meter will not measure swingloads unless the Brake Lock is used during the loading process.

B: Loading to Dumping Transition

This message is generated when the payload meter senses a body up input during the loading process. This message is usually accompanied by a no_final_load flag.

C: No Final Load

This message is generated when the payload meter is unable to determine the final payload in the truck. Typically, this means that the payload meter switched from a loaded state to the dumping state before the load could be accurately measured.

D: Maneuvering to Dumping Transition

This message is generated when the payload meter senses a Body-Up input during the maneuvering or repositioning process indicating that the operator has dumped the load. It may also be generated if the Body-Up signal is not properly reaching the payload meter and the weight in the truck falls dramatically while the truck is maneuvering or repositioning.

E: Average Load or Tare Used

This message indicates that the recorded payload may not be as accurate as a typical final load calculation. Typically, this is recorded when loading begins before an accurate tare is calculated or the load is dumped before the load can be accurately measured.

F: Final Zone to Dumping Transition

This message is generated when the payload meter senses a Body-Up while it is calculating the final payload indicating that the operator has dumped the load. It may also be generated if the Body-Up signal is not properly reaching the payload meter and the weight in the truck falls dramatically while the truck is calculating the final payload.

H: False Body Up

This message indicates that the body was raised during the haul cycle without the load being dumped. The Body-Up signal indicated that the truck was dumping, but the weight of the truck did not fall below 20% of the rated load.

I: Body Up Signal Failed

This message indicates that the load was dumped without a Body-Up signal being received by the payload meter. The weight of the truck fell below 20%, but the payload meter did not receive a Body-Up signal from the sensor.

J: Speed Sensor Failed

This message indicates that the payload meter sensed the truck loading and dumping without receiving a speed signal.

K: New Tare Not Calculated

The payload meter was not able to accurately calculate a new empty sprung weight for the truck to use as the tare value for the haul cycle. The tare value from the last haul cycle was used to calculate payload.

L: Incomplete Haul Cycle

The payload meter did not have proper data to start the haul cycle with after powering up. When the PLMIII powers off, it records the data from the haul cycle in progress into memory. This flag indicates that this data was not recorded the last time the payload meter was shut down. This can happen when the main battery disconnect is used to shut the truck down instead of the keyswitch. 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.

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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.

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.

Table 2: Fault Code Data

Fault Code	Name	Description
1	Left front pressure high	Input current > 22 ma
2	Left front pressure low	Input current < 2 ma
3	Right front pressure high	Input current > 22 ma
4	Right front pressure low	Input current < 2 ma
5	Left rear pressure high	Input current > 22 ma
6	Left rear pressure low	Input current < 2 ma
7	Right rear pressure high	Input current > 22 ma
8	Right rear pressure low	Input current < 2 ma
9	Inclinometer high	Input voltage < 0.565 vdc
10	Inclinometer low	Input voltage > 5.08 vdc
13	Body-up input failure	Payload meter detected dumping activity without receiving a body up signal
16	Memory write failure	Indicates possible memory problem at power start up. Cycle power and recheck.
17	Memory read failure	Indicates possible memory problem at power start up. Cycle power and recheck.
24	System key-on status	Payload Meter failed to correctly start at power up. Cycle power and recheck.
26	User switch fault - SELECT	Select switch on for more than 2 minutes, may indicate short to ground
27	User switch fault - SET	Set switch on for more than 2 minutes, may indicate short to ground

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.

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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.

PC Software Overview

PC Overview

The PC software has several basic functions:

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

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

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

System Configuration

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

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

Installing the PLMIII Software

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

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

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Downloading Data

PLMIII records many types of data. The PLMIII PC software is designed to download the data from a whole truck fleet. Instead of creating one data file for each truck, the PC software combines all the data from many trucks into one database on the hard drive of the computer. The software then allows users to query the database to create custom reports and graphs. Data for individual trucks or groups of trucks can be easily analyzed. This same data can be exported for use in other software applications like word processors and spreadsheet applications.

As the database grows, performance of the PC software for analysis will slow down. It may be helpful to periodically export data. For example, query the database to show the oldest quarter, month, or half year and print out a summary report. Then export the data to a compressed format and save the file in a secure location. Once the data is exported, delete the entire query results from the database. If necessary, the data can easily be imported back into the main database for analysis at a future date. Removing this older data will improve performance.

The PC software downloads the data from the payload meter into a single Paradox database. The data from all the trucks is added to the same database. Downloading the payload meter can take several minutes. The data is added to the database on the laptop used to download.



To move the data to another computer, a query must be run to isolate the particular data for export. Do not press the operator switch on the dashboard while downloading

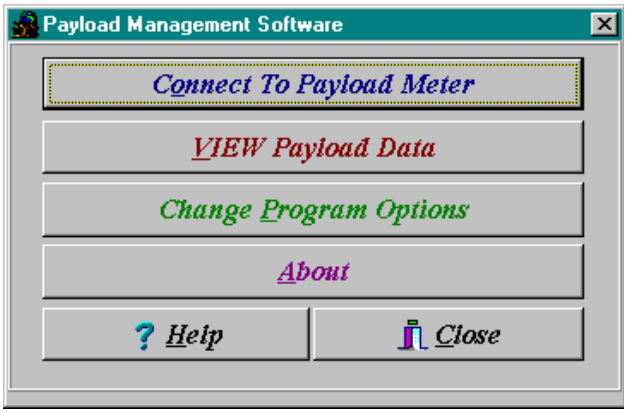
To download the payload meter:

1. Connect to the payload meter and start the PC software.
2. From the main menu, select "Connect to Payload Meter". The PC will request the latest status information from the payload meter. The number of haul cycles and alarms will be displayed.
3. Select the " Begin Download" button. The PC will request the payload and alarm data from the payload meter and save it into the database. This may take several minutes. A progress bar at the bottom will show the approximate time left.

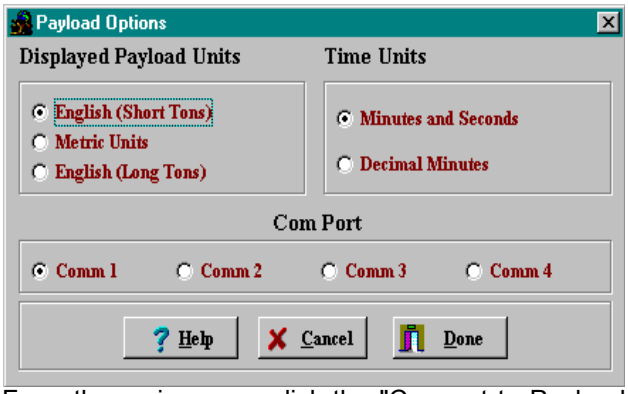
PLMIII System Configuration

Starting Communications

The PDM software allows users to download and configure the system.



Before connecting to the payload meter, select "Change Program Options" and confirm that the program has selected the correct laptop serial port. Most laptops use Comm 1 for serial communications. The units displayed for reports and graphs by the PC software can be set on this form. Click “Done” to return to the main menu.



From the main menu, click the "Connect to Payload Meter" button. The PC will try to connect to the payload meter and request basic information from the system. In the event of communications trouble, the PC will try 3 times to connect before "timing-out". This may take several seconds.

Displayed Payload Units

Three options are available for the display of units in the PC software, reports, and graphs:



Short Tons: Payload is displayed in short tons, distances and speeds will be displayed in Miles

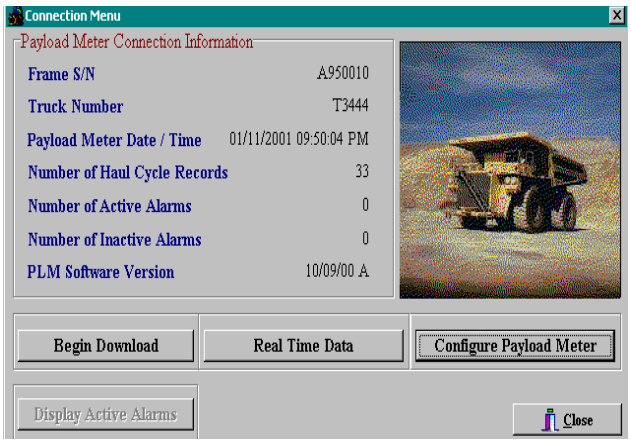
Metric Tons: Payload is displayed in metric tons, distances and speeds are displayed in Kilometers

Long Tons: Payload is displayed in long tons, distances and speeds are displayed in Miles

Time Units

Minutes and Seconds Example:
Five minutes and thirty-two seconds = 5:32
Decimal Minutes Example:
Five minutes and thirty-two seconds = 5.53

Connection Menu



The connection screen displays basic system information to the user.

- Frame S/N should agree with the truck serial number from the serial plate located on the truck frame.
- Truck Number is an ID number assigned to the truck by the mine.
- The Payload Meter Date / Time values come from the payload meter at the moment of connection.
- Number of Haul Cycle Records is the number of haul cycles records stored in memory and available for download.
- Number of Active Alarms shows how many alarms are currently active in the system at the time of connection. If there are active alarms, the "Display Active Alarms" button is available.
- Number of Inactive Alarms shows how many alarms have been recorded in memory and are available for download.
- PLM Software Version displays the current version of software in the payload meter.

The information on the connection menu comes from the configuration of the payload meter system on the truck.

There are also many configuration and download options available from this screen. The Connection Menu is updated only when the connection is first made. It does not update automatically. To view changes made while connected, the user must close the window and reconnect to the payload meter.

The connection menu is displayed after a serial connection has been established and the PC software has connected to the payload meter.

Connecting to the Payload Meter

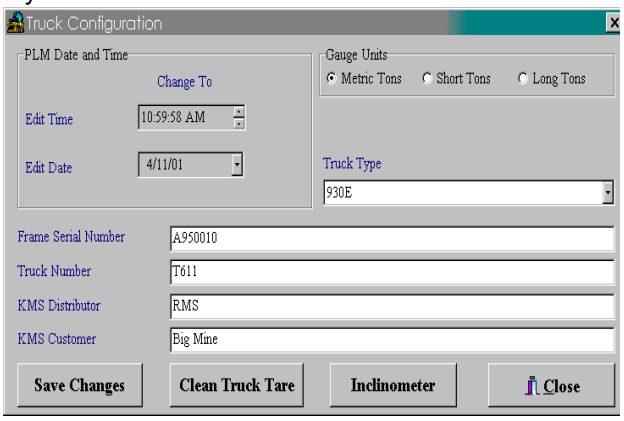
Communications to the PLMIII requires a laptop computer running the PDM software. The software connects to the payload meter through the meter's serial port #1. This is the same port used by the speedometer/display gauge. When the laptop is using the serial port, the lower display on the operator gauge on the dashboard will be blank. This does not affect the operation of the speedometer.

- Connect the laptop to the system using the EF9160 communications harness. The download connector is typically located on the housing mounted in the cab to the back wall. The PLMIII system uses the same connection as the Payload Meter II system.

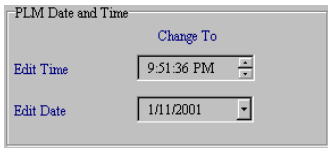
Configure the Payload Meter

Configuration of the payload meter requires a serial connection to the PLMIII system. Clicking the "Configure Payload Meter" button will bring up the Truck Configuration screen and menu. This screen displays the latest configuration information stored on the payload meter.

When changes are made to the configuration, the "Save Changes" button must be pressed to save the changes into the payload meter. To confirm the changes, exit to the main menu and re-connect to the payload meter.



Setting the Date and Time



The time shown on the form is the time transmitted from the payload when the connection was first established.



The date and time are maintained by a special chip on the PLMIII circuit board. The memory for this chip is maintained by a very large capacitor when the power is removed from the payload meter. This will maintain the date and time settings for approximately 30 days. After this time, it is possible for the payload meter to lose the date and time setting. It is recommended that the system be powered every 20 days to maintain the date and time. If the date and time is lost, simply reset the information using this procedure. It takes approximately 90 minutes to recharge the capacitor.

Changing the date and time will affect the haul cycle in progress and may produce unexpected results in the statistical information for that one haul cycle.

To change the time:

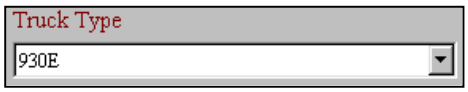
1. Click on the digit that needs to be changed.
2. Use the up/down arrows to change or type in the correct value.
3. Press the "Save Changes" button to save the new time in the payload meter.

To change the date:

1. Click on the digit that needs to be changed.
2. Type in the correct value or use the pull-down calendar to select a date.
3. Press the "Save Changes" button to save the new time in the payload meter.

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Setting the Truck Type



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

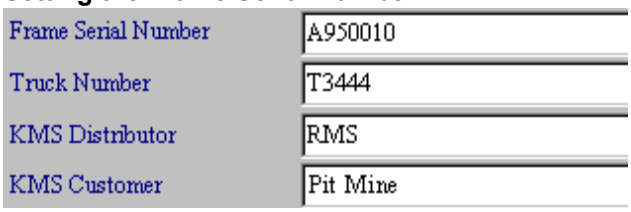
Setting the Gauge Display Units

The Payload Meter Speedometer / Display Gauge displays the speed on the upper display. The units for the speed display are selected using a jumper on the rear of the case.

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

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

Setting the Frame Serial Number



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

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

Setting the Truck Number

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

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

Setting the Komatsu Distributor

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

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

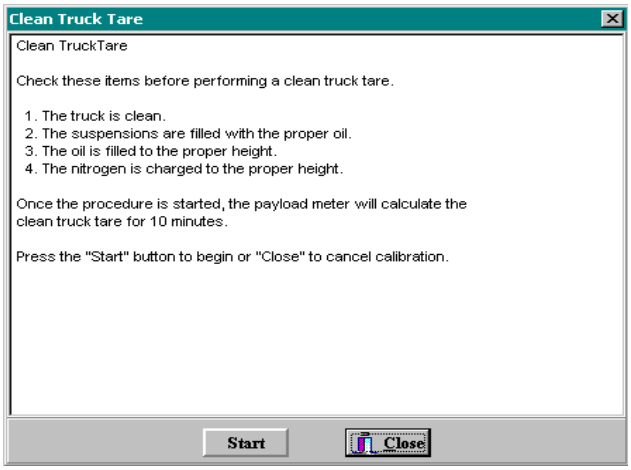
Setting the Komatsu Customer

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

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

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Clean Truck Tare



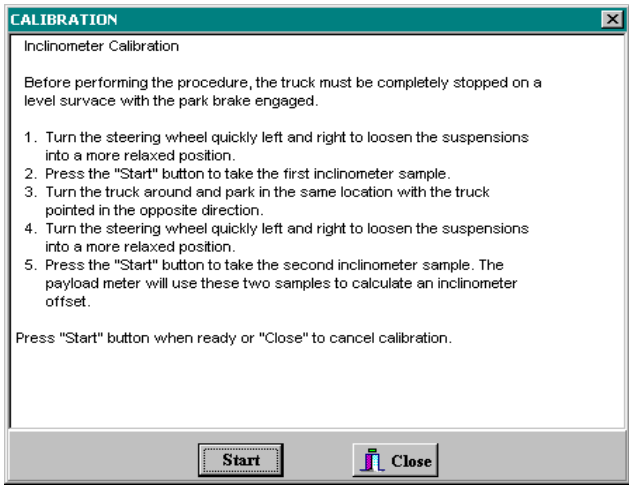
The payload meter uses the clean truck tare value to calculate carry-back load for each haul cycle. The carry-back stored in the haul cycle record is the new empty tare minus the clean truck tare.

This procedure should be performed after service to the suspensions or when significant changes are made to the sprung weight of the truck. Before performing this procedure, be sure the suspensions are properly filled with oil and charged. It is critical to payload measurement that the proper oil height and gas pressure be used.

Once the clean tare process is started, the payload meter will begin to calculate the clean empty sprung weight of the truck. This calculation continues while the truck drives to the next loading site. Once the procedure is started, there is no reason to continue to monitor the process with the PC. The truck does not need to be moving to start this procedure.

1. After cleaning debris from the truck and checking to see that the suspensions are properly serviced, use the PLMIII software to connect to the payload meter.
2. From the "Truck Configuration" screen, select "Clean Truck Tare".
3. Be sure to follow the screen instructions.

Inclinometer Calibration



The inclinometer calibration procedure is designed to compensate for variations in the mounting attitude of the inclinometer. The inclinometer input is critical to the payload calculation.

This procedure should be performed on relatively flat ground. Often the maintenance area is an ideal location for this procedure.

1. After cleaning debris from the truck and checking to see that the suspensions are properly serviced, use the PLMIII software to connect to the payload meter.
2. From the "Truck Configuration" screen, select "Inclinometer".
3. With the truck stopped and the brake lock on, press the “Start” button. This instructs the payload meter to sample the inclinometer once.
4. Turn the truck around. Drive the truck around and park in the exact same spot as before, facing the other direction.
5. With the truck stopped and the brake lock on, press the “Start” button. This instructs the payload meter to sample the inclinometer again. The payload meter will average the two samples to determine the average offset.
6. Be sure to follow the screen instructions.

Data Analysis

The data analysis tools allow the user to monitor the performance of the payload systems across the fleet. Analysis begins when the "View Payload Data" button is pressed. This starts an "all trucks, all dates, all times" query of the database and displays the results in the Payload Summary Form.

The user can change the query by changing the dates, times, or trucks to include in the query for display.

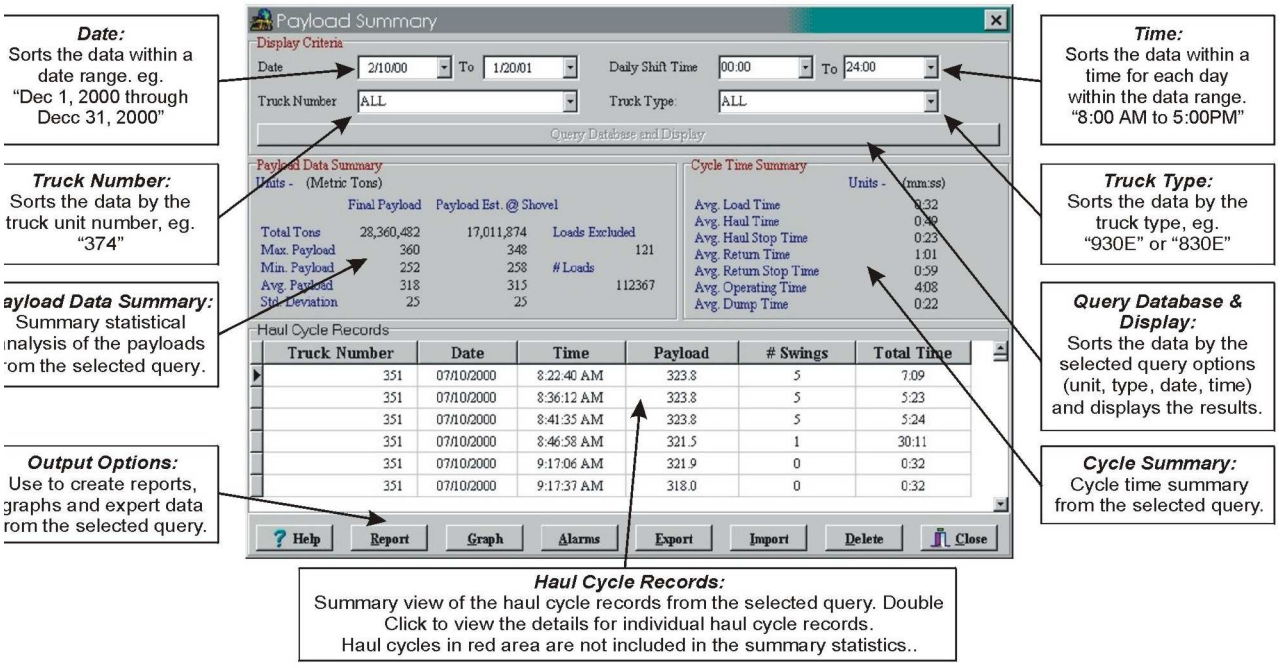
Haul cycles in the data grid box at the bottom can be double-clicked to display the detailed results of that haul.

Sorting on Truck Unit Number

The truck unit number is the truck unit number entered into the payload meter when it was configured at installation. The query can be set to look for all trucks or one particular truck number. When the program begins, it searches through the database for all the unique truck numbers and creates a list to select from.

Choosing one particular truck number will limit the data in the displays, summaries and reports to the one selected truck. To create reports for truck number 374, select 374 from the pull-down menu and hit the "Query Database and Display" button.

Payload Summary Form



Creating a Query

The program defaults to show all trucks, all types, all dates and all times for the initial query. The display can be narrowed by selecting which trucks or types to view and for what dates and times.

The query items are added in the "AND" condition. If the user selects a truck # and date range, the query will sort the data for that truck number AND the date range.

Sorting on Truck Type

The truck type is the size of the truck from the family of Komatsu trucks. This allows the user to quickly view results from different types of trucks on the property. For example, a separate report can be generated for 830E and 930E trucks.

Sorting on Date Range

The default query starts in 1995 and runs through the current date on the PC. To narrow the range to a specific date, change the “From” and “To” dates.
For example, to view the haul cycle reports from truck 374 for the month of July, 2000:

1. Select truck 374 from the Truck Unit pull-down menu.



2. Change the “From” date to July 1, 2000.



3. Change the “To” date to July 31, 2000.
4. Press the "Query Database and Display" to view the results.

Sorting on Time Range

The time range sorts the times of the day for valid dates. Changing the time range to 6:00AM to 6:00PM will limit the payloads displayed to the loads that occurred between those times for each day of the date range. Times are entered in 24:00 format. To view the haul cycle reports from the first shift for truck 374 from January 5, 2000 to January 8, 2000:

1. Select truck 374 from the Truck Unit pull-down menu.



2. Change the “From” date to July 1, 2000.

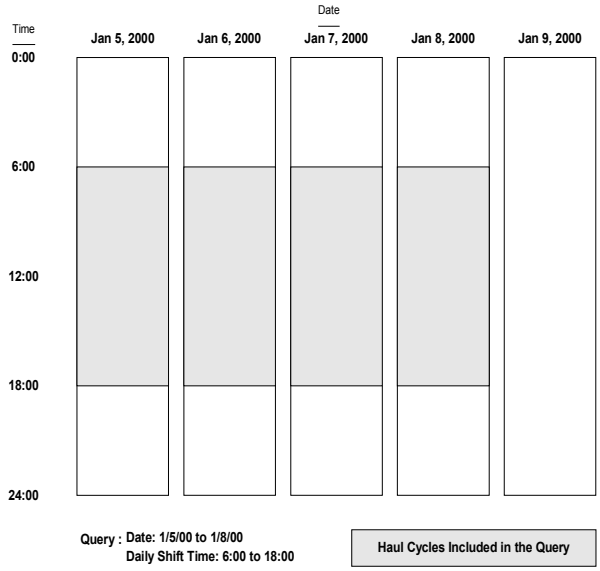


3. Change the “To” date to July 31, 2000.
4. Change the “From” time to 06:00.
5. Change the “To” time to 18:00.

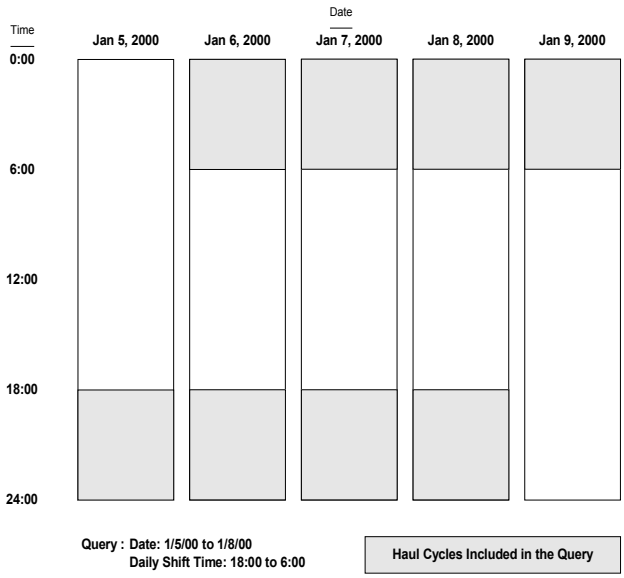


6. Press the "Query Database and Display" to view the results.

This query will display haul cycles from January 5 to January 8, from 6:00 AM to 6:00 PM.



The shift times selected can extend the query past the original date. If the dates set for the query are January 5 to January 8 and the times were changed to query the 6:00 PM (18:00) to 6:00 AM (06:00) shift, the results would extend into the morning of the 9th. This can been seen in the following example:



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.



NOTE: Some haul cycles may contain the Sensor Input warning flag. This indicates that one of the four pressure sensors or inclinometer was not functioning properly during the haul cycle. 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.

Summary - one page report

A summary of the queried data can be printed onto 1 page. The cycle data is summarized onto one sheet. Displayed is the speeds, cycle times, load statistics, frame and tire data.

Detailed - multi-page report

The detail report starts with the summary report and follows with pages of data for each haul cycle. The detailed report prints date, time, payload, cycle times, and cycle distances, speeds and the number of swing loads.

Payload Summary Report
Report Date: April 11, 2001
Query used for summary:
Truck Number: ALL
Truck Type: ALL
Dates: 2/10/00 to 2/19/01
Daily Shift Time: 00:00 to 24:00

Time Period	Date	Time
First Load	02/10/2000	03:25:30 PM
Last Load	02/19/2001	07:20:30 AM

Cycle Distance Averages	(miles)
Loaded	1.9
Empty	2.0
Avg Total Distance	3.9

Payload Data	Short Tons	Date	Time
Final Payload			
Total, All Loads	1,495,086		
Maximum	421	01/24/2001	09:05:22 AM
Minimum	0	01/27/2001	04:11:24 AM
Average	321		
Standard Deviation	28.6		
Payload Estimate @ Shovel			
Total, All Loads	1,532,025		
Maximum	425	01/11/2001	06:45:58 PM
Minimum	250	02/11/2000	06:27:34 AM
Average	320		
Standard Deviation	36.3		
Number of Loads	4,654		
Avg Carry Back	2.2		

Cycle Time Averages	(Min:Sec)
Load	2:34
Haul Run	9:48
Haul Stop	1:08
Empty Run	6:09
Empty Stop	4:19
Dump	1:17
Avg Total Cycle Time	25:17

Avg Tire	(Ton-MPH)
Left Front	583
Right Front	576
Rear	415

Speed Data	(mph)
Loaded Max	37.32
Loaded Avg	10.57
Empty Max	37.97
Empty Avg	11.43

Payload Detail Report **Page 1**
Report Date: October 17, 2000
Query used for summary:
Truck Number: ALL
Truck Type: ALL
Dates: 8/28/00 to 10/3/00
Daily Shift Time: 00:00 to 24:00

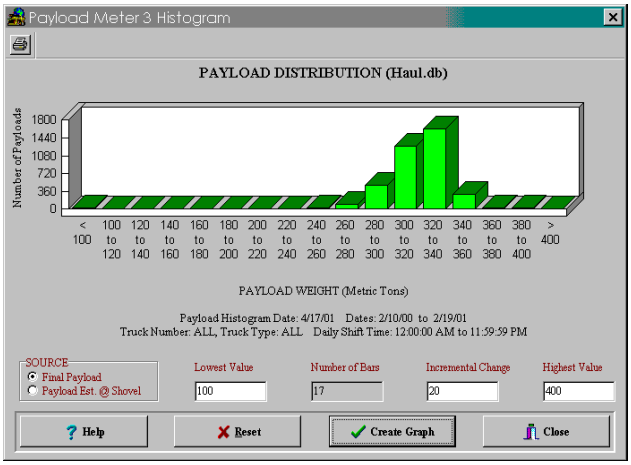
					CYCLE Times(min:sec)							CYCLE DISTANCE(mi.)			SPEEDS(mph)			
			Payload			Haul			Return						Haul		Return	
No.	Date	Time	S.Tons	#Swings	Load	Haul	Stop	Dump	Return	Stop	Total	Haul	Return	Total	Max.	Avg.	Max.	Avg.
1	8/28/00	3:54P	347	7	4:40	11:11	0:06	0:52	7:54	14:28	39:11	1.9	2.0	4.0	21.99	10.14	31.03	5.48
2	8/28/00	5:18P	301	6	3:39	11:10	0:25	0:43	8:12	3:43	27:52	1.9	1.9	3.8	23.02	9.91	26.05	9.42
3	8/28/00	5:46P	300	6	3:32	11:32	2:32	0:56	7:07	0:09	25:48	1.9	1.9	3.8	23.02	8.30	25.02	15.49
4	8/28/00	6:11P	330	4	1:58	17:51	2:49	1:58	11:34	1:41	37:51	3.9	2.6	6.5	36.21	11.37	24.07	11.73
5	8/28/00	6:49P	344	4	1:54	18:26	13:04	1:50	11:20	0:24	46:58	4.0	3.9	7.9	34.97	7.56	37.06	20.15
6	8/28/00	7:36P	380	5	2:12	19:52	1:07	1:39	11:32	0:48	37:10	4.0	4.0	8.0	30.00	11.28	34.03	19.59
7	8/28/00	8:13P	352	4	2:26	18:17	0:23	1:54	11:54	1:56	36:50	3.9	4.0	8.0	31.97	12.62	34.07	17.49
8	8/28/00	8:50P	356	4	1:56	18:52	0:21	1:55	11:59	0:38	35:41	4.0	4.0	8.0	36.17	12.34	36.21	19.09
9	8/28/00	9:25P	370	5	2:18	16:17	2:18	0:53	12:25	0:25	34:36	2.7	4.1	6.7	34.97	8.55	36.17	19.14
10	8/28/00	10:00P	363	5	3:07	16:56	5:48	0:52	9:02	0:33	36:18	2.7	2.7	5.3	32.97	6.99	32.97	16.61
11	8/28/00	10:36P	341	7	3:58	12:23	0:23	0:53	7:26	0:57	26:00	2.0	2.0	3.9	21.03	9.20	32.00	14.10
12	8/28/00	11:02P	321	4	2:24	16:19	5:06	0:50	10:17	1:05	36:01	2.7	2.6	5.3	34.03	7.49	31.97	13.71
13	8/28/00	11:38P	316	5	2:49	15:21	7:06	0:58	13:01	13:11	52:26	3.9	4.0	7.9	40.12	10.30	40.12	9.16
14	8/29/00	12:56A	320	5	2:23	15:18	0:07	0:55	13:16	11:43	43:42	3.9	3.8	7.7	36.21	14.99	41.10	9.18
15	8/29/00	1:40A	302	4	1:55	14:12	0:08	0:54	10:34	0:11	27:54	3.9	3.9	7.7	40.12	16.15	41.10	21.64
16	8/29/00	2:08A	310	5	2:21	15:14	4:55	1:01	9:46	4:59	38:16	3.9	3.9	7.7	40.12	11.51	41.16	15.67
17	8/29/00	2:46A	318	5	2:25	14:44	0:15	0:54	10:36	0:19	29:13	3.9	3.9	7.7	41.10	15.50	41.10	21.28
18	8/29/00	3:15A	278	4	2:01	15:53	1:12	0:46	10:38	2:08	32:38	4.3	3.8	8.1	38.13	15.06	41.10	18.05
19	8/29/00	3:48A	328	5	2:25	17:38	3:08	0:57	10:07	0:20	34:35	4.3	3.9	8.2	34.03	12.41	41.10	22.19
20	8/29/00	4:22A	287	4	2:49	17:00	15:44	1:02	11:59	4:49	53:23	4.3	4.0	8.2	40.12	7.87	41.10	14.09
21	8/29/00	1:41P	285	4	2:15	16:08	6:14	5:21	9:02	14:43	53:43	4.0	3.0	6.9	34.97	10.58	34.03	7.55
22	8/29/00	2:50P	340	7	3:38	10:14	0:06	0:54	8:41	7:10	30:43	1.8	3.3	5.2	27.07	10.54	39.07	12.65
23	8/29/00	3:20P	326	5	3:32	9:47	0:08	1:09	5:21	0:16	20:13	1.8	1.8	3.6	27.05	10.98	30.02	18.98
24	8/29/00	3:41P	342	6	3:59	11:24	0:08	0:47	19:49	15:18	51:25	1.9	6.2	8.1	23.02	10.02	32.00	10.56
25	8/29/00	4:43P	349	7	4:46	11:12	0:18	0:57	7:32	3:12	27:57	1.8	1.9	3.8	23.02	9.50	27.07	10.87
26	8/29/00	5:11P	322	4	2:11	5:29	19:58	1:29	15:38	59:19	104:04	1.1	5.1	6.1	42.20	2.52	42.20	4.05
27	8/30/00	4:27A	330	7	4:27	10:33	0:09	1:02	21:08	159:27	196:46	1.7	4.3	6.0	23.02	9.69	28.01	1.42
28	8/30/00	4:55P	320	6	3:52	10:42	0:14	1:00	5:43	1:42	23:13	1.7	1.7	3.4	24.07	9.55	29.06	13.47
29	8/30/00	5:18P	338	6	3:16	10:45	0:51	0:58	6:00	2:34	24:24	1.7	1.6	3.3	23.02	8.71	29.04	11.36
30	8/30/00	5:42P	343	6	3:52	10:28	0:08	1:01	6:06	0:25	22:00	1.7	1.6	3.3	24.08	9.57	28.03	14.70

Creating Graphs

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

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

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

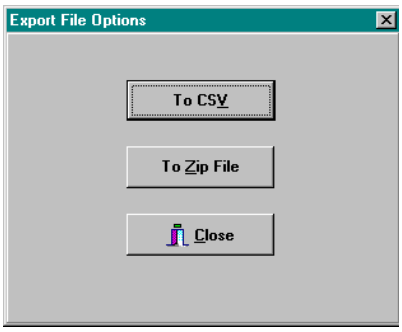


   Setup screen will display

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

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

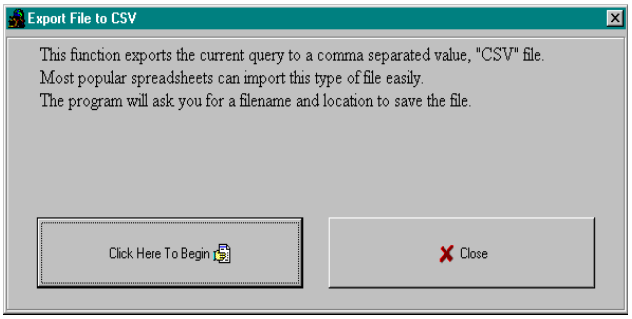
Exporting Data



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

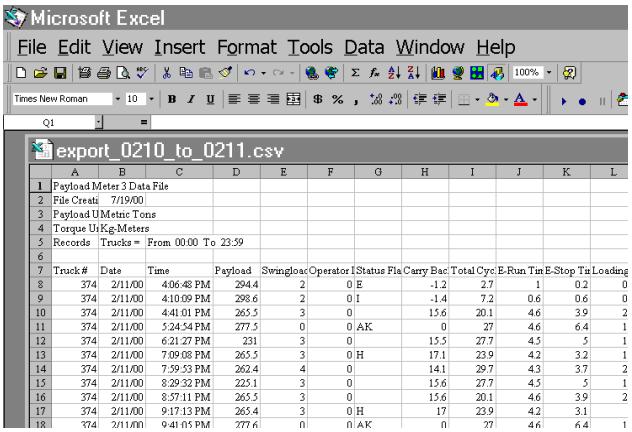
- The “.CSV” format allows data to be easily imported into spreadsheet applications and word processing applications.
- The “.Zip” format allows data to be transferred from one computer to the PDM Software database on another computer. This offers a compact way to transfer data from one computer to another.

CSV Export



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

.



	A	B	C	D	E	F	G	H	I	J	K	L
1	Payload Meter 3 Data File											
2	File Creati	7/19/00										
3	Payload U	Metric Tons										
4	Torque Ur	Kg-Meters										
5	Records	Trucks =	From 00:00 To 23:59									
6												
7	Truck #	Date	Time	Payload	Swingloac	Operator I	Status Fla	Carry Bac	Total Cyc	E-Run Tin	E-Stop Tir	Loading
8	374	2/11/00	4:06:48 PM	294.4	2	0	E	-1.2	2.7	1	0.2	0
9	374	2/11/00	4:10:09 PM	298.6	2	0	I	-1.4	7.2	0.6	0.6	0
10	374	2/11/00	4:41:01 PM	265.5	3	0		15.6	20.1	4.6	3.9	2
11	374	2/11/00	5:24:54 PM	277.5	0	0	AK	0	27	4.6	6.4	1
12	374	2/11/00	6:21:27 PM	231	3	0		15.5	27.7	4.5	5	1
13	374	2/11/00	7:09:08 PM	265.5	3	0	H	17.1	23.9	4.2	3.2	1
14	374	2/11/00	7:59:53 PM	262.4	4	0		14.1	29.7	4.3	3.7	2
15	374	2/11/00	8:29:32 PM	225.1	3	0		15.6	27.7	4.5	5	1
16	374	2/11/00	8:57:11 PM	265.5	3	0		15.6	20.1	4.6	3.9	2
17	374	2/11/00	9:17:13 PM	265.4	3	0	H	17	23.9	4.2	3.1	
18	374	2/11/00	9:41:05 PM	277.6	0	0	AK	0	27	4.6	6.4	1

Two sets of data are exported. At the top of the file will be the haul cycle data. The columns, left to right are:

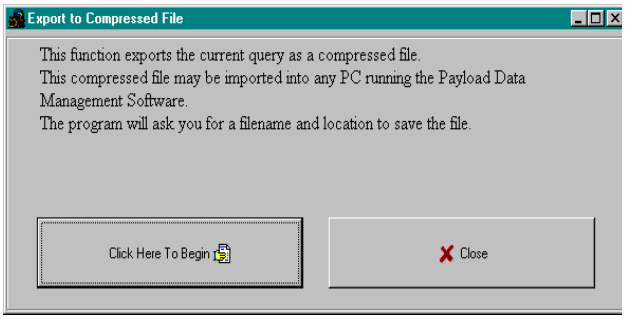
- Truck number
- Haul cycle start date
- Haul cycle start time
- Payload
- Swingloads
- Operator ID
- Warning Flags
- Carry Back
- Total Haul Cycle time
- Empty Running Time
- Empty stop time
- Loading time
- Loaded running time
- Loaded stopped time
- Dumping time
- Loading start time
- Dumping start time
- Loaded haul distance
- Empty haul distance
- Loaded maximum speed
- Time when loaded maximum speed occurred
- Empty maximum speed
- Time when loaded maximum speed occurred
- Maximum + frame torque
- Time when the maximum + frame torque occurred
- Maximum - frame torque
- Time when the maximum - frame torque occurred
- Maximum sprung weight calculation
- Time when the maximum sprung weight calculation occurred
- Left Front Tire-kilometer-hour
- Right Front Tire-kilometer-hour
- Average Rear Tire-kilometer-hour
- Frame serial number
- Reserved 1-5, 7-10: These values are internal calculations used in the continued development of PLMIII and should be ignored.
- Reserved 6: This value is the payload estimate at the shovel just before the truck begins to move.

Alarm Records					
Alarm Type	Date Set	Time Set	Description	Date Cleared	Time Cleared
10	12/5/99	8:51:25 AM	INCL SENSOR LO	12/5/99	8:51:29 AM
10	12/5/99	8:56:07 AM	INCL SENSOR LO	12/5/99	8:56:12 AM
10	12/5/99	9:00:49 AM	INCL SENSOR LO	12/5/99	9:00:54 AM
10	12/5/99	9:05:31 AM	INCL SENSOR LO	12/5/99	9:05:36 AM
10	12/5/99	9:10:13 AM	INCL SENSOR LO	12/5/99	9:10:17 AM
10	12/5/99	9:14:54 AM	INCL SENSOR LO	12/5/99	9:14:59 AM
10	12/5/99	9:19:37 AM	INCL SENSOR LO	12/5/99	9:19:41 AM
10	12/5/99	9:24:19 AM	INCL SENSOR LO	12/5/99	9:24:24 AM
10	12/5/99	9:29:01 AM	INCL SENSOR LO	12/5/99	9:29:06 AM
10	12/5/99	9:33:44 AM	INCL SENSOR LO	12/5/99	9:33:48 AM
10	12/5/99	9:38:26 AM	INCL SENSOR LO	12/5/99	9:38:30 AM
10	12/5/99	9:43:08 AM	INCL SENSOR LO	12/5/99	9:43:13 AM
10	12/5/99	9:47:50 AM	INCL SENSOR LO	12/5/99	9:47:55 AM
10	12/5/99	9:52:32 AM	INCL SENSOR LO	12/5/99	9:52:37 AM
10	12/5/99	9:57:13 AM	INCL SENSOR LO	12/5/99	9:57:17 AM
10	12/5/99	10:01:55 AM	INCL SENSOR LO	12/5/99	10:01:59 AM

The second series of data below the haul cycle data is the alarms. The alarm columns, left to right are:

- The alarm type
- The date the alarm was set
- The time the alarm was set
- Alarm description
- The date the alarm was cleared
- The time the alarm was cleared

Compressed



This export function allows the data from one laptop to be transferred to another computer. This can be useful when a service laptop is used to download multiple machines and transfer the data to a central computer for analysis. This can also be used to copy haul data from a particular truck onto a diskette for analysis.

The file format is a compressed binary form of the displayed query. The file can only be imported by another computer running the PDM Software.

To export data in ZIP format:

1. Confirm that the data displayed is the query data that needs to be exported.
2. From the payload summary screen, press the "EXPORT" button and select "To ZIP".
3. The program will ask for a filename and location.

Importing Data

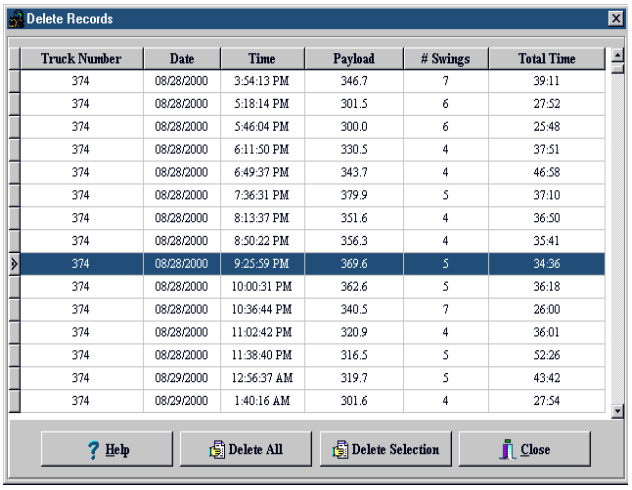
This import function allows the data from one laptop to be transferred to another computer. This can be useful when a service laptop is used to download multiple machines and transfer the data to a central computer for analysis. This can also be used to copy haul data from a particular truck from a diskette into a database for analysis.

To import data, press the "IMPORT" button at the bottom of the “Payload Summary” screen. The program will ask for a ".zip" file to import, locate the file and press "Open". The program will only import ".zip" files created by another computer running the PDM Software.

Deleting Haul Cycle Records

To delete haul cycle records from the main database, press the "Delete" button at the bottom of the “Payload Summary” screen. The program will display a summary of the records from the displayed query. To delete a record, select one at a time and press the "Delete" button. It is recommended that records be exported to a zip file for archival purposes before deletion. Multiple records may be selected by holding down the Shift key. Pressing the "Delete All" button will select all the records from the current query and delete them.

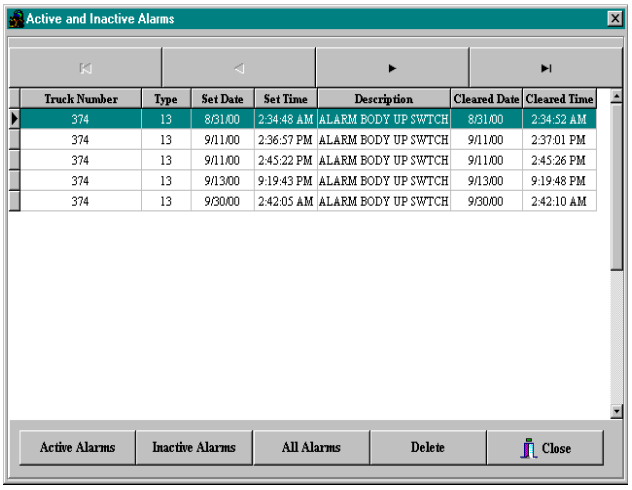
NOTE: There is no recovery for records that have been deleted from the main database. It is highly recommended that all records be exported and archived in a compressed file format for future reference before being deleted.



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Viewing Alarms

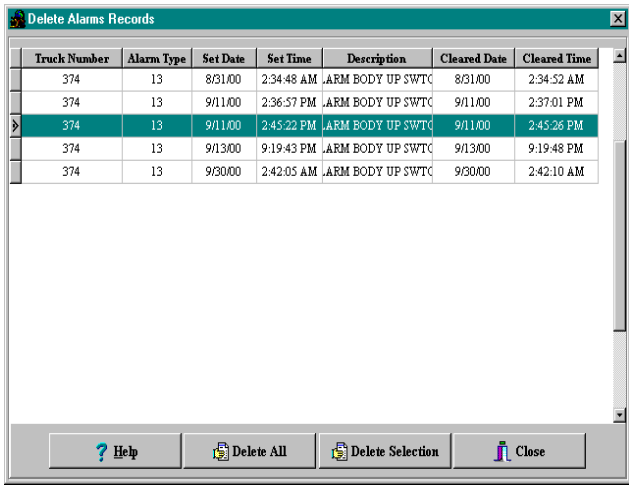
From the Payload Summary screen, click the “Alarms” button to display the alarm screen. The alarms are sorted by the query settings from the Payload Summary screen. Alarms can be displayed as Active or Inactive.



Deleting Alarm Records

To delete alarm records from the main database, press the "Delete" button at the bottom of the “Alarm Display” screen. The program will display a summary of the alarms from the query. To delete an alarm, select one at a time and press the "Delete" button. It is recommended that the query data be exported to a “.zip” file for archival purposes before deletion. Multiple records may be selected by holding down the Shift key. Pressing the "Delete All" button will select all the alarms from the current query and delete them.

NOTE: There is no recovery for alarms that have been deleted from the main database. It is highly recommended that all records be exported and archived in a compressed file format for future reference before being deleted.



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TROUBLESHOOTING SECTION

Troubleshooting

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

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

Viewing Active Alarms

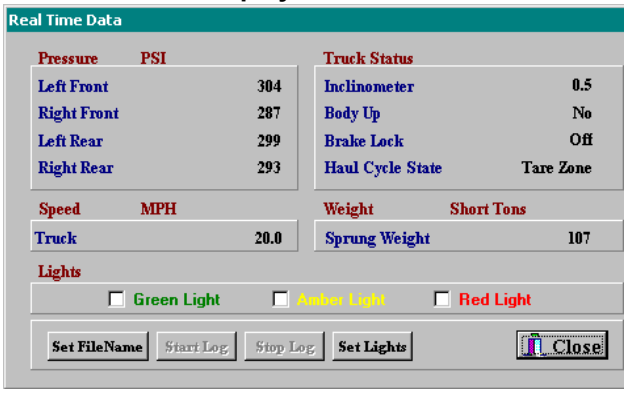
Active alarms are alarms that have been set, but not yet cleared. Each alarm is set when the conditions for activation are held for 5 seconds. Each alarm is cleared when the condition has been returned to normal range for 5 seconds. For example, 5 seconds after the left-rear pressure sensor is disconnected,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

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

To view active alarms:

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

Real-Time Data Display



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

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

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

Testing the Payload Lights

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

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

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

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Creating Log Files of Inputs

The PC software can create a text file of the live data stream from the payload meter. This can be very useful for diagnostic purposes. The data is written into a text data file in comma separated value format. The data is recorded in metric units at 50 samples per second. The data file can grow large very quickly. Each sample writes one line into the ASCII file in comma separated format.
The order for each line of data in is:

- Date
- Time
- Sprung Weight
- LF Pressure
- RF Pressure
- LR Pressure
- RR Pressure
- Incline
- Speed
- Body Up State (1=up)
- Brake Lock State (1=on)
- Payload State
- Status Flags
- Spare

To create a log file:

1. Connect to the payload meter and start the PC software.
2. From the main menu, select "Connect to Payload Meter". The PC will request the latest status information from the payload meter.
3. Select the "Real Time Data" button. The real time data screen will pop up. The PC will request the payload meter to begin transmitting data.
4. Click the "Set File Name" button and enter a name and location for the text file. The default extension is ".txt". This data can be easily imported into spreadsheets as a comma separated value (.CSV) format.
5. Once the filename has been entered, the Start Log and Stop Log buttons will be active.
6. Press the “Start Log” button to start taking data and recording into the file. Once a file is started, it cannot be stopped and started again.
7. Press the “Stop Log” button to stop recording data. Attempting to start the log file again will overwrite the previous file and erase the previous data. To gather more data, close the real time data window, start it again and create a new log file.

Daily Inspections

An important part of maintaining the Payload Meter III (PLMIII) system is monitoring the basic inputs to the system. It is recommended that the truck operator walk around the truck and visually inspect the following:

- Charging condition of the suspensions - not flat, not overcharged.
- Pressures in the suspensions - check suspensions by using the operator gauge and the operator switch.

Periodic Maintenance

It is recommended that the following items be checked every 500 hours:

- Confirm the suspension pressures using external gauges.
- Confirm proper suspension height.
- Confirm suspensions do not collapse and make metal-to-metal contact when the truck is loaded.
- Confirm that inclinometer indicates positive (+) values for truck nose up, and negative (-) values for truck nose down.

In addition, it may be useful to confirm proper operation of the suspensions by riding the truck during a complete haul cycle. Record the suspension pressures using the CSV log file tool in the Payload Data Manager software for the PC. The suspension pressures in this log file can be graphed to inspect for flat or overcharged suspensions.

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Abnormal Displays at Power-Up

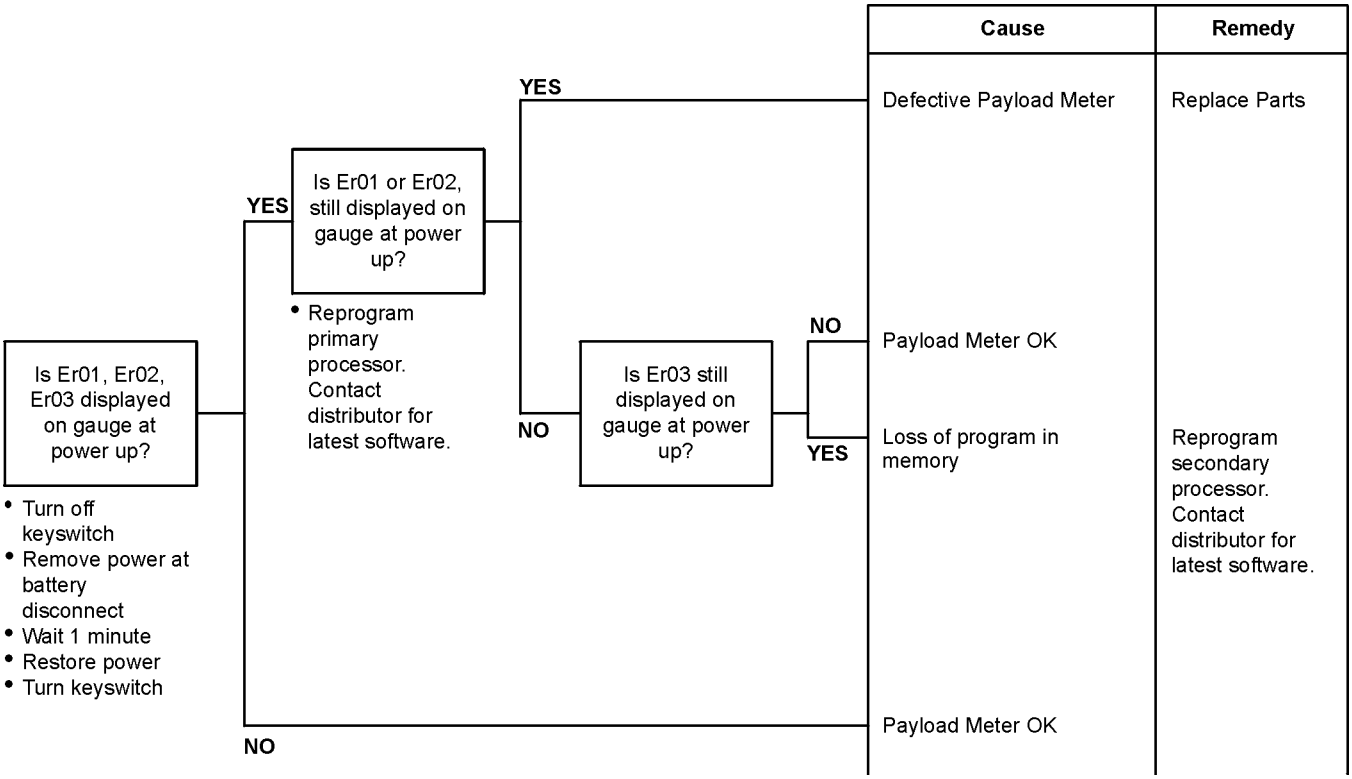
The payload meter performs several internal memory system checks every time it powers-up. In case of error, the operator gauge may display an error code when power is applied to the PLMIII system.

Er:01 - Bad Truck Configuration error indicates that the meter encountered an error while reading the current truck configuration record from memory.

Er:02 - Bad Calibration Record error indicates that the meter encountered an error while passing messages between the microprocessors on the circuit board.

Er:03 - Interprocessor Communications error indicates that the meter encountered an error while passing messages between the microprocessors on the circuit board.

To resolve these errors:

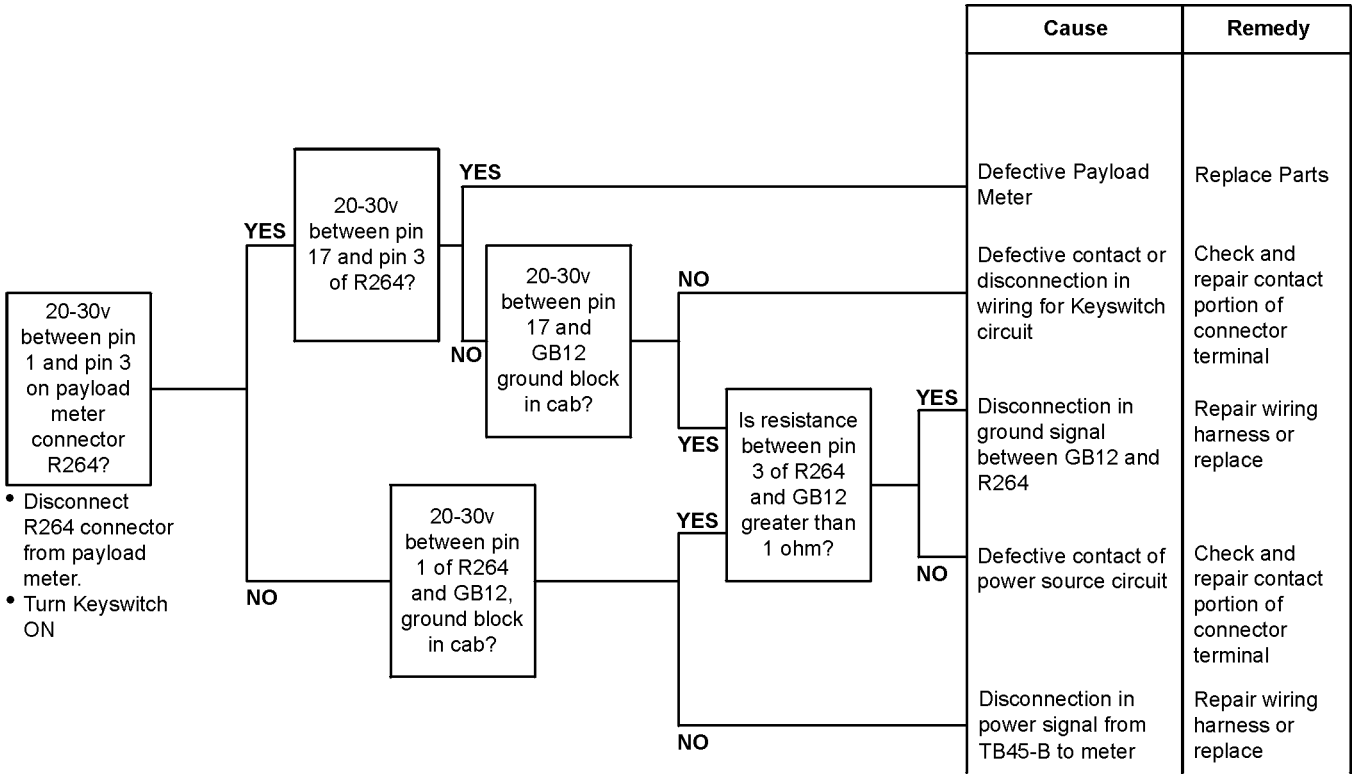


- If these errors persist after reprogramming, the primary and secondary processors then the payload meter must be replaced.

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No Payload Display When Keyswitch is Turned ON

- Confirm battery voltage in PLMIII junction box between TB45-A (positive) and TB45-X (ground).
- Check the 5A circuit breaker (CB A) in PLMIII junction box.
- Check all connectors and terminal connectors in the power circuits to the payload meter.
- If two digit display on payload meter displays 00 then 88 on power up, continue to “No Display on Operator Display”. This two digit display normally alternates 0 on each display. In the case of active alarms, this display will show the code for each active alarm. The alarm codes are in the operation section.

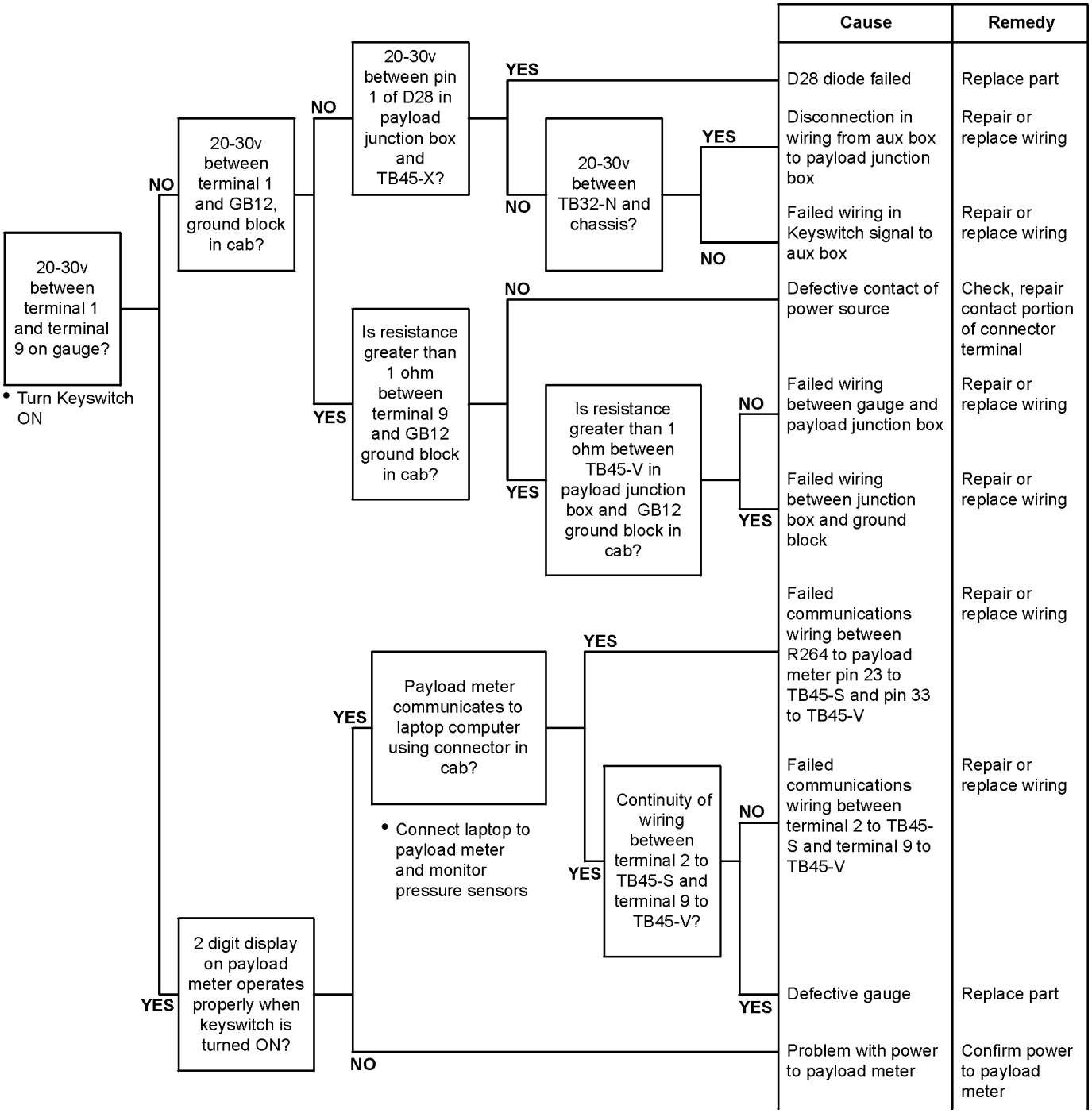


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No Display on Speedometer

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”.

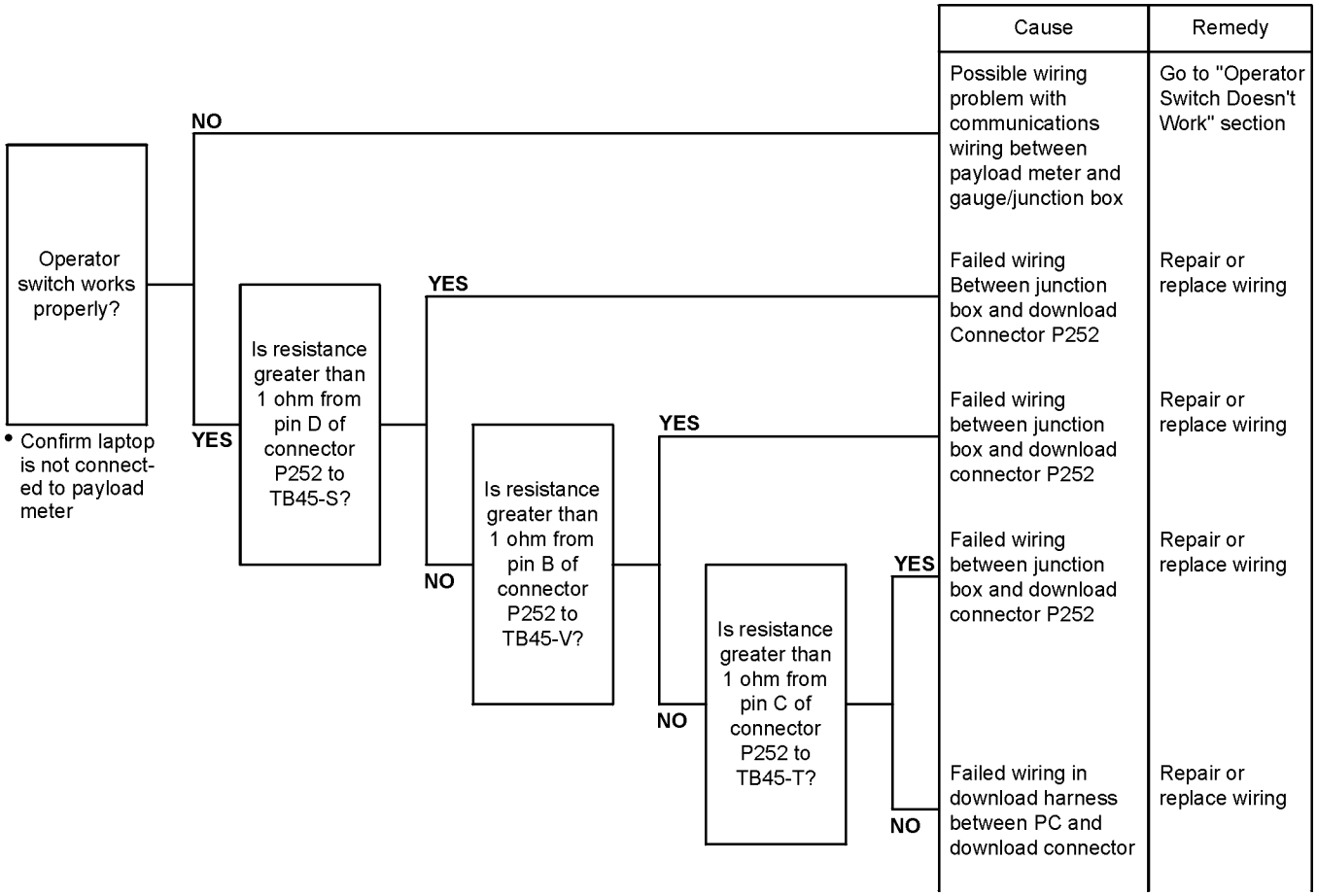


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No Communications With PC

In a case where the laptop PC will not properly connect to the PLMIII system:

- Confirm power to the payload meter.
- Confirm laptop serial port setting using the PC software. From the mail menu select "Change Program Options". Confirm that the selected serial port is correct and that it is available.
- Confirm that a Personal Digital Assistants (PDA) synchronization software is not using the serial port. Often, PDA software like Palm Pilot's HotSync software will take control of the serial port and not let other applications use the serial connection. Close the synchronization software and retry the Payload Data Manager software.
- Confirm Operator Switch use. If this switch works properly, it confirms that the communications wiring between the payload meter and the junction box is functional.
- Before the beginning of troubleshooting, turn keyswitch "OFF". Wait 1 minute and turn keyswitch "ON".



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Load Lights Don’t Light During Loading

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

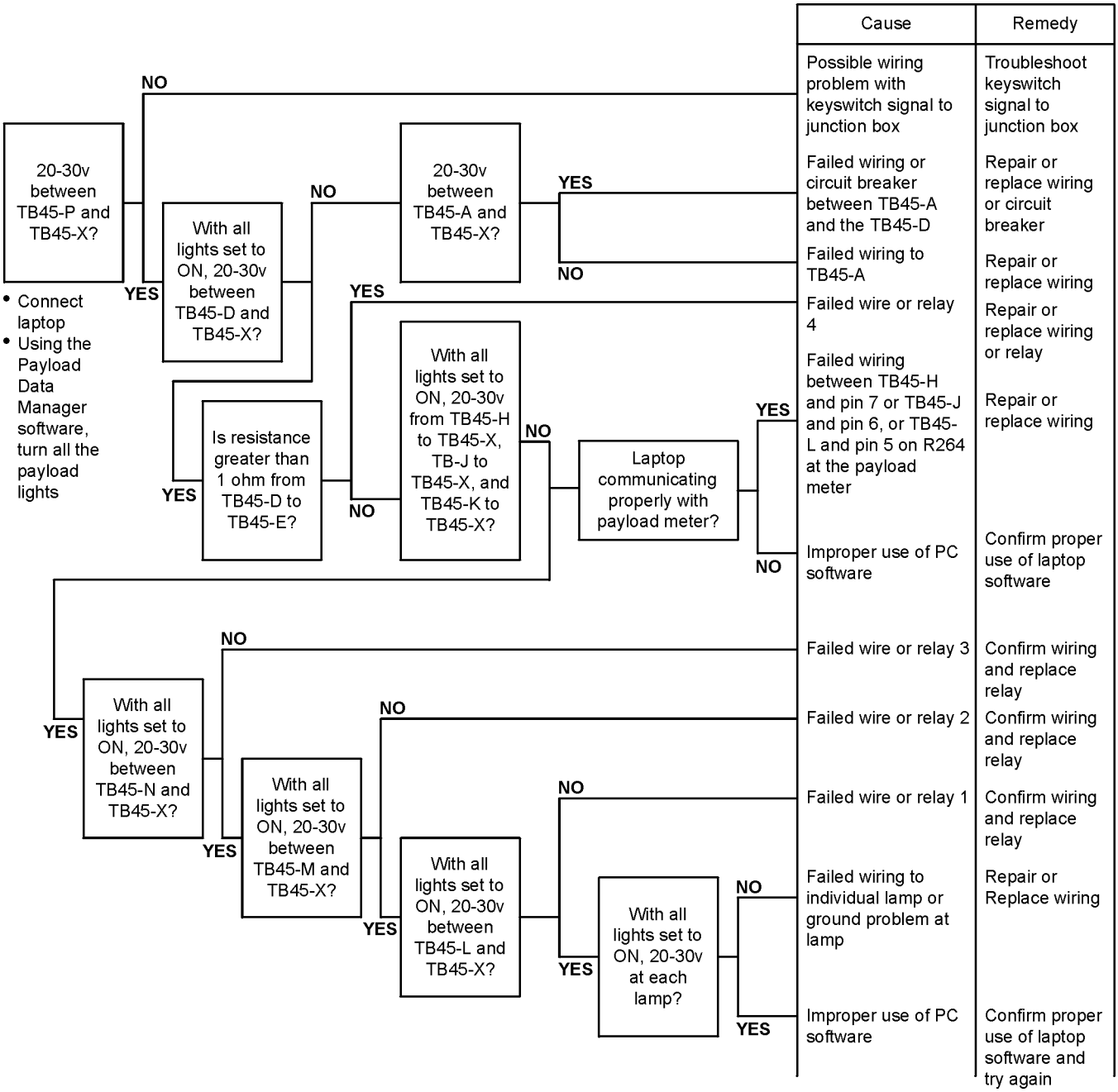
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Load Lights Remain ON

Load Lights Remain ON During Dumping

Display Doesn't Clear When The Load Is Dumped

- Confirm the Body Up switch signal. When the Body Up signal is not properly received during dumping, the payload meter may maintain the lights after the body is lowered.
- Confirm the payload light wiring using the procedures in "Load Lights Don't Light During Loading".



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Calibration Problems

- Confirm that the truck is empty and clean.
- Confirm that the payload meter is in the proper haul state. The payload meter must be in the empty, or tare zone states to begin calibration. This can be checked by using the real-time monitor mode of the Payload Data Manager software.
- The payload meter can be reset to acknowledge the beginning of a new haul cycle by raising the body when the truck is empty. This may be necessary after servicing the suspensions.

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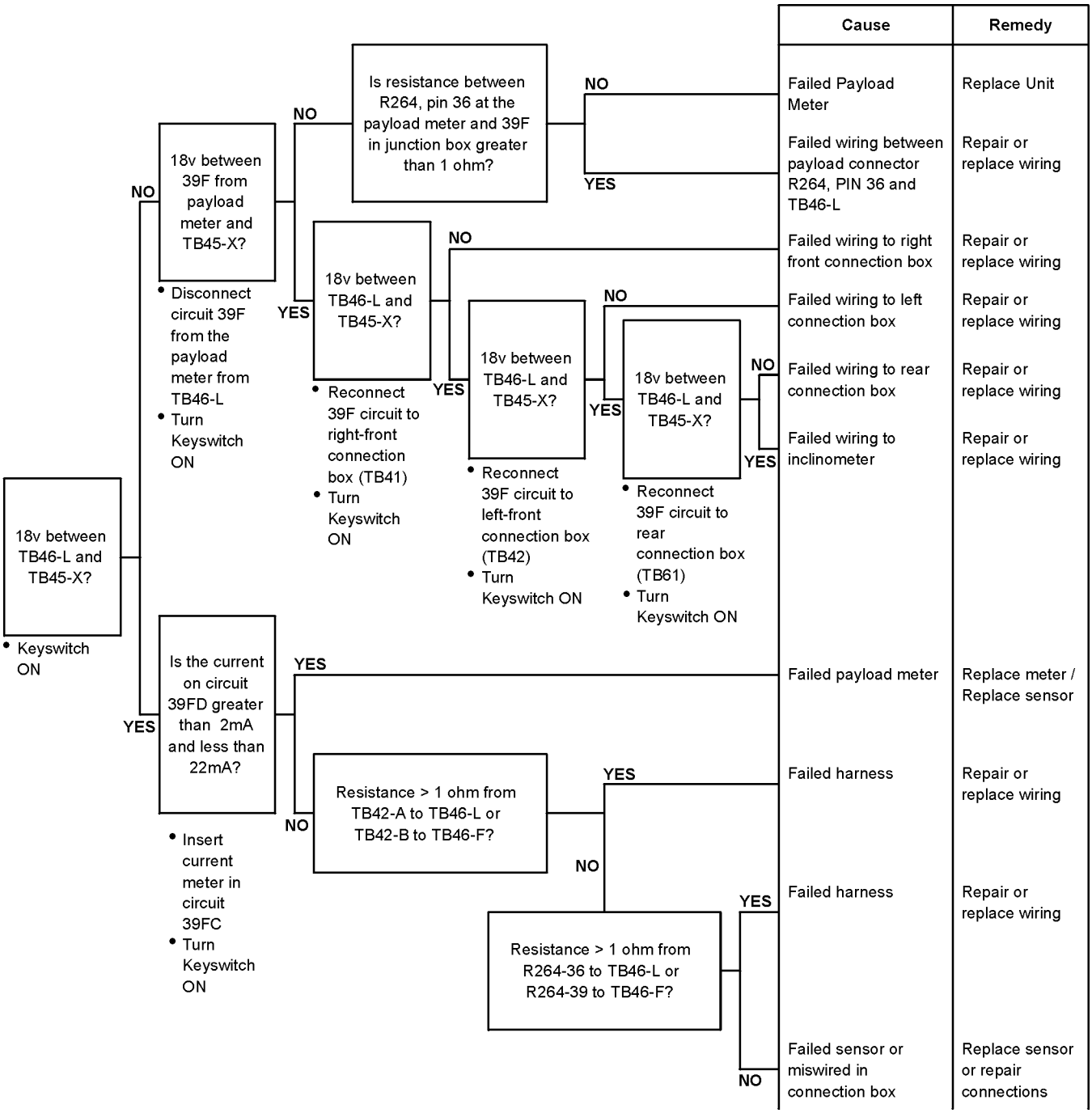
Alarm 1 - Left Front Pressure High

Alarm 2 - Left Front Pressure Low

Troubleshoot Wiring to Left Front Suspension

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

- Confirm 18v sensor supply at TB46-L in payload junction box.
- Confirm proper connection of signal circuit 39FD from left suspension connection box, TB42-B to payload junction box TB46-F to payload meter connector R264, pin 39.



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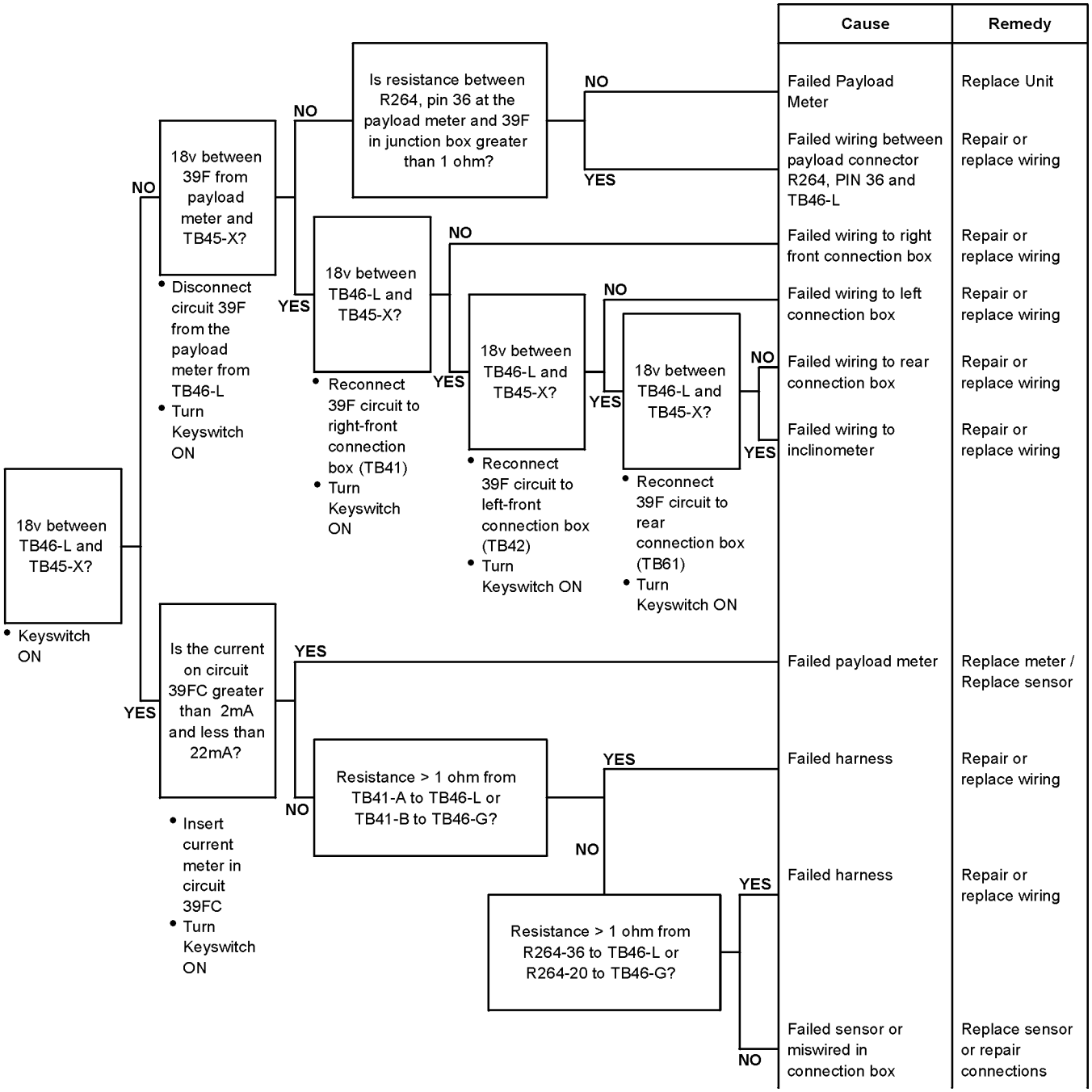
Alarm 3 - Right Front Pressure High

Alarm 4 - Right Front Pressure Low

Troubleshoot Wiring to Right Front Suspension

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

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



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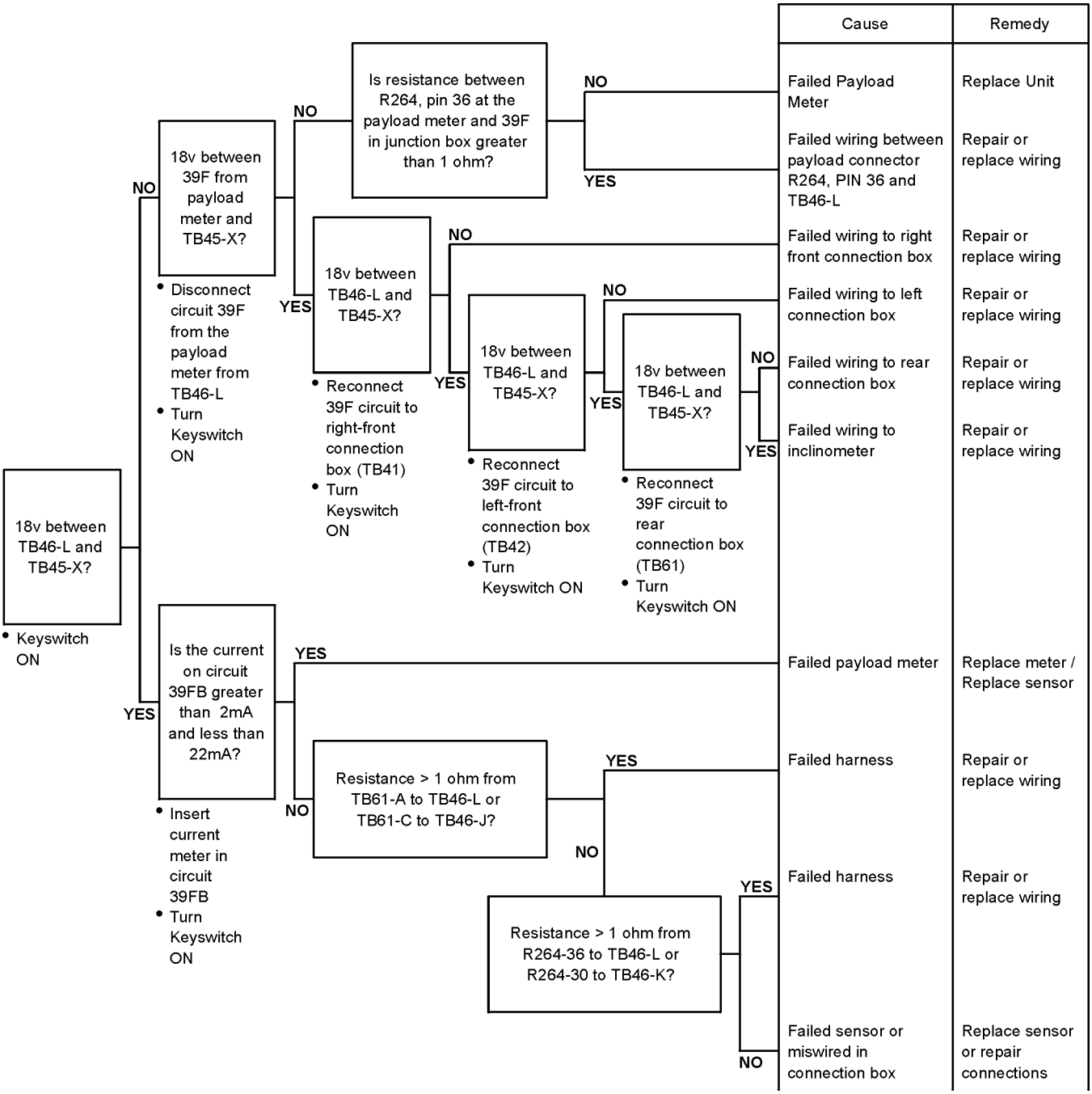
Alarm 5 -Left Rear Pressure High

Alarm 6 - Left Rear Pressure Low

Troubleshoot Wiring to Left Rear Suspension

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

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



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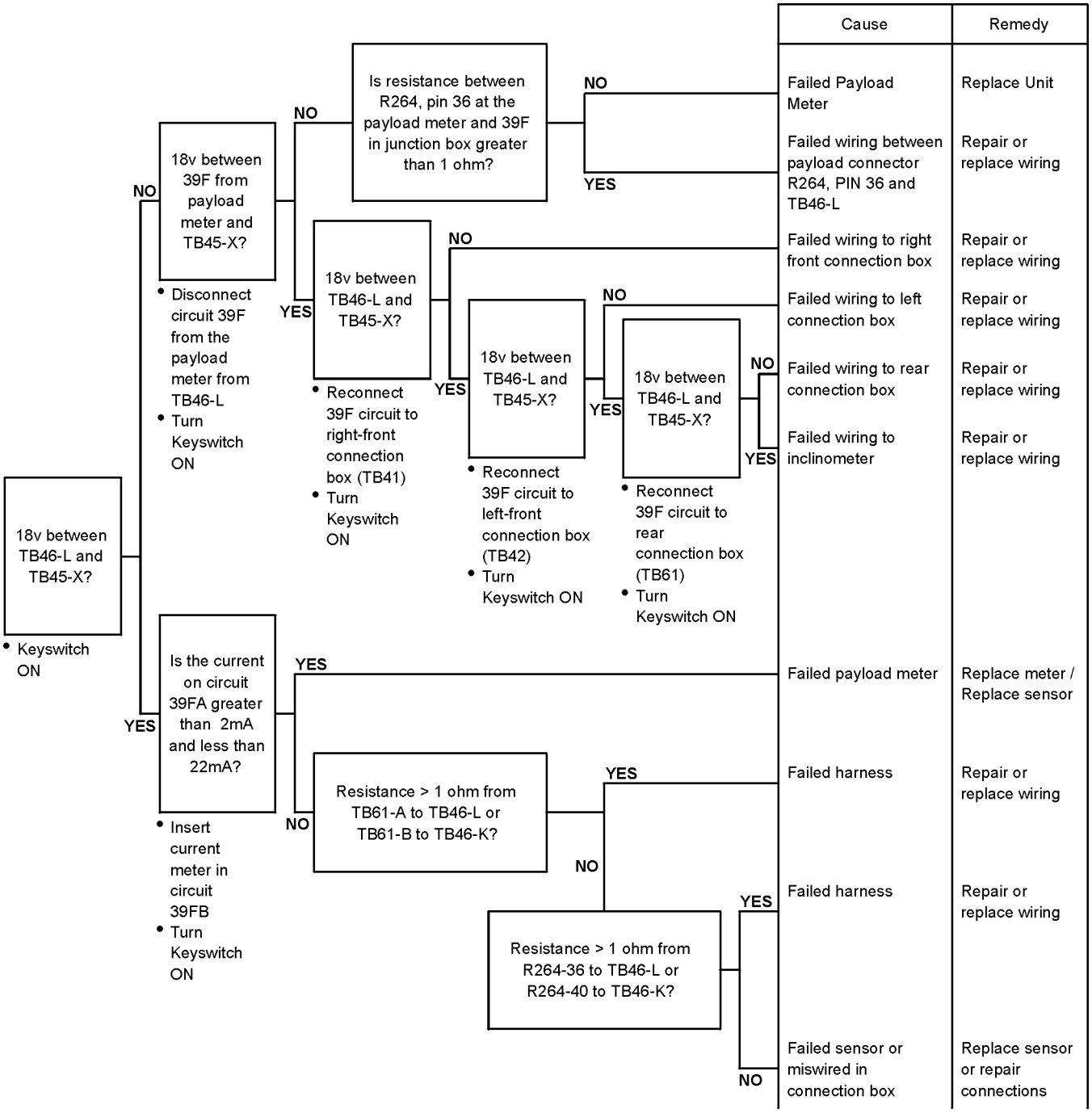
Alarm 7 - Right Rear Pressure High

Alarm 8 - Right Rear Pressure Low

Troubleshoot Wiring to Right Rear Suspension

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

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



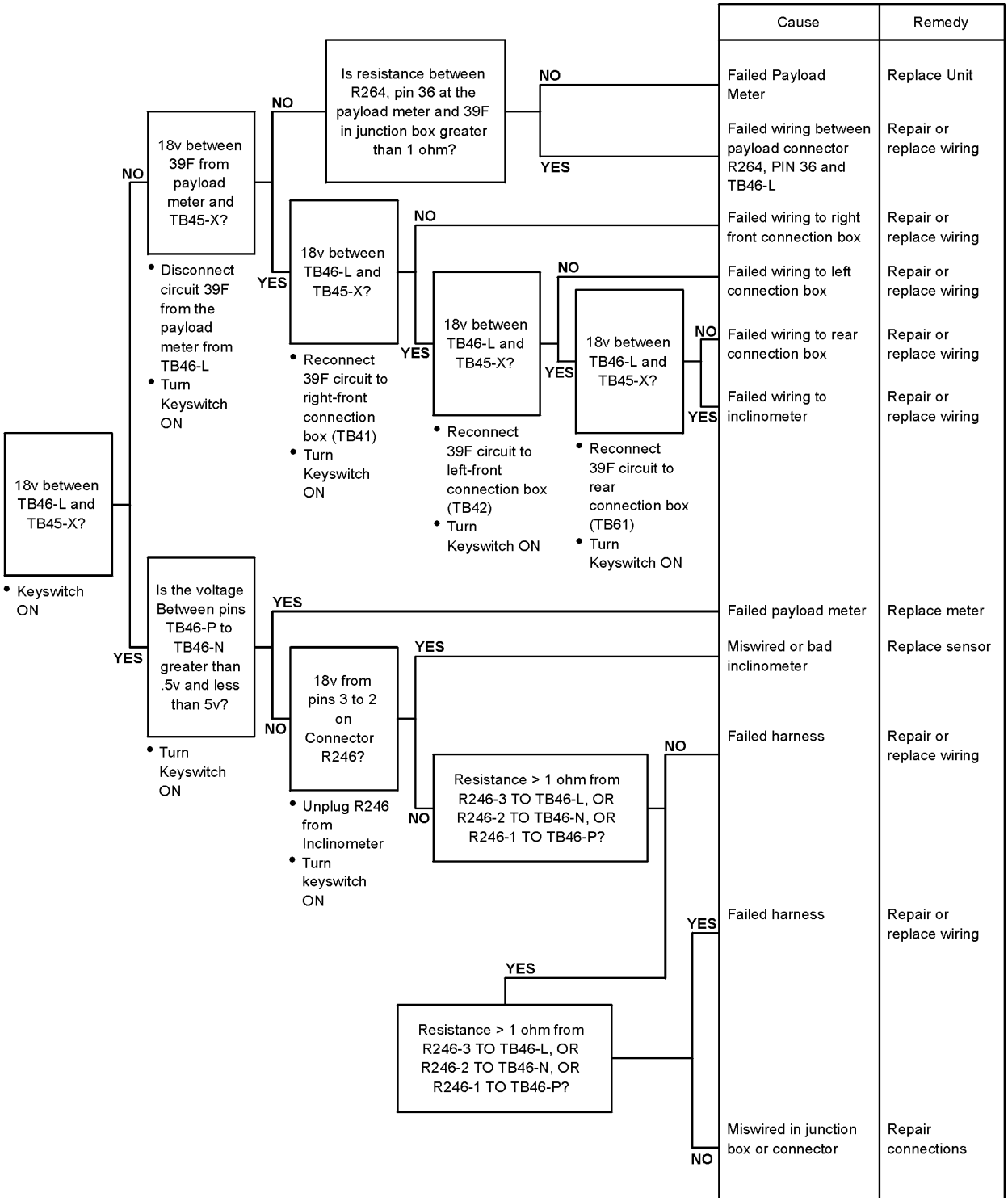
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Alarm 9 - Inclinometer High

Alarm 10 - Inclinometer Low

Troubleshoot Inclinometer Wiring

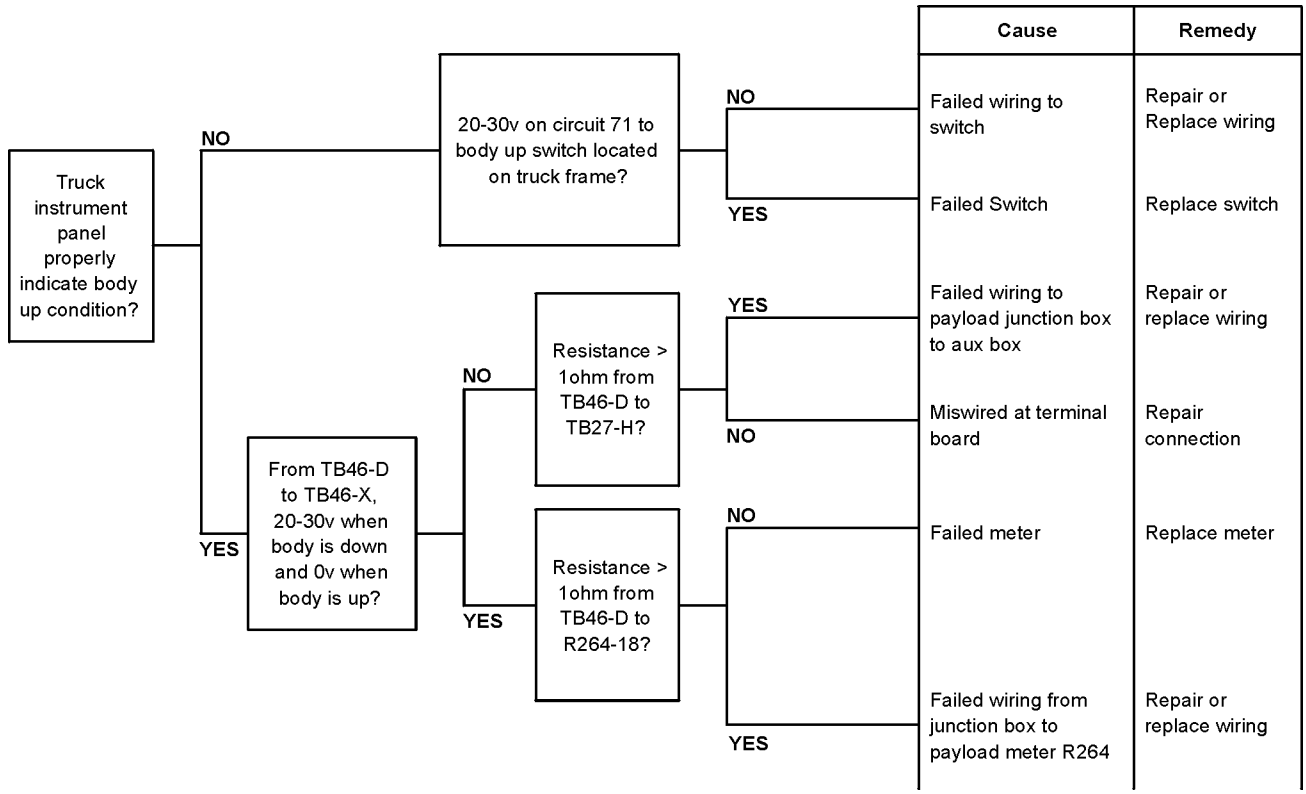
These alarms indicate that the voltage to the payload meter from the inclinometer is out of range. The voltage on signal 39FE should be greater than .5v and less than 5.0v as measured in the junction box between TB46-.



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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.



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Alarm 15 - Memory Write Failure

Alarm 16 - Memory Read Failure

Alarm 24 - System Key-On Status

These alarms indicate that the payload meter has encountered a problem internally with its memory. It is recommended that power to the payload meter be removed for 1 minute. First turn the keyswitch “OFF”. Wait 30 seconds, then turn the battery disconnect “OFF”. Wait 1 minute before restoring power.

In cases where repowering the payload meter does not restore normal operation, it may necessary to reprogram the payload meter. All current data in memory will be lost. This will effectively restart the payload meter.

- See “Troubleshooting Abnormal Displays at Power-Up” for more information.

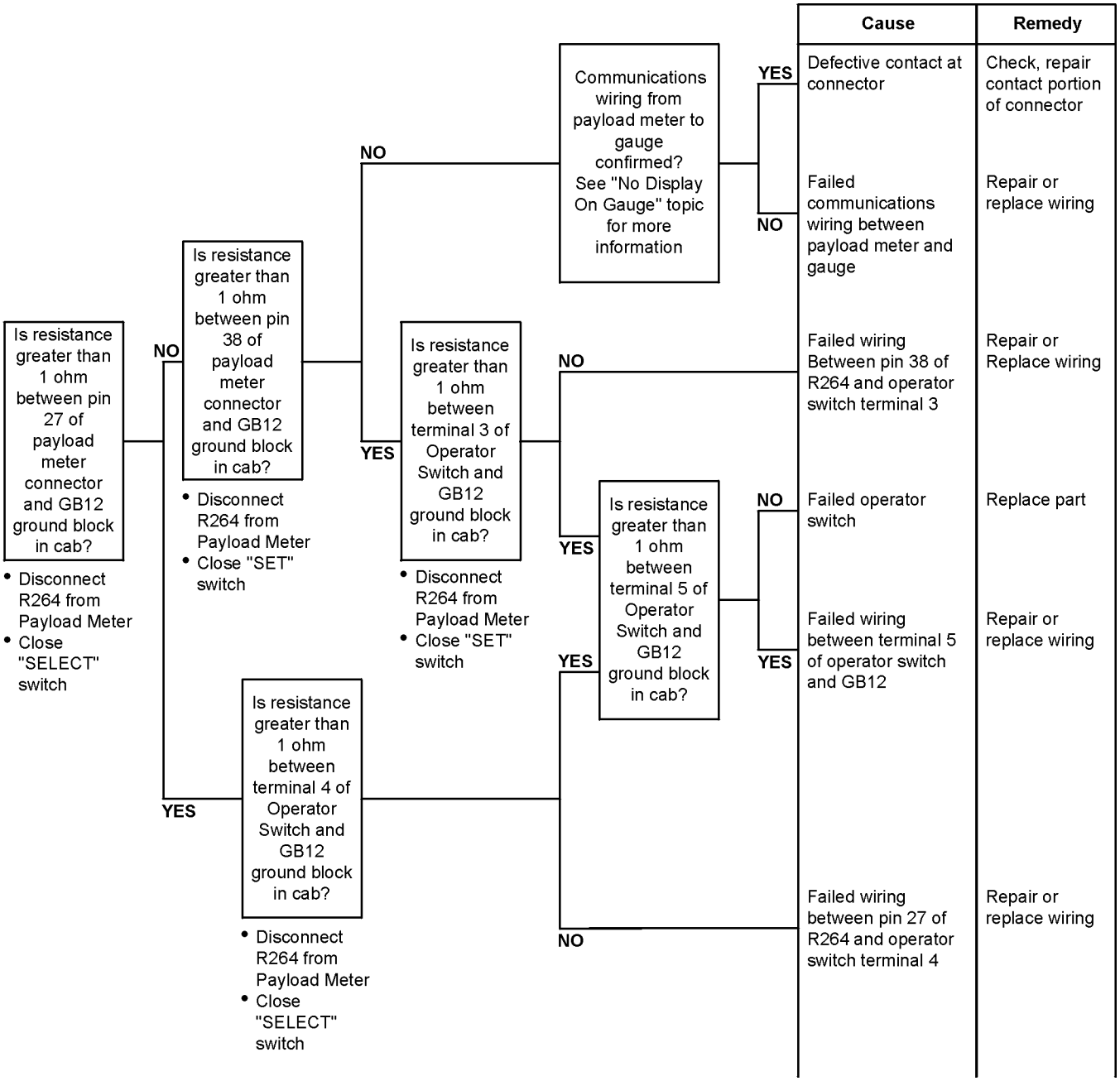
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Operator Switch Doesn't Work

Alarm 26 - User Switch Fault - SELECT

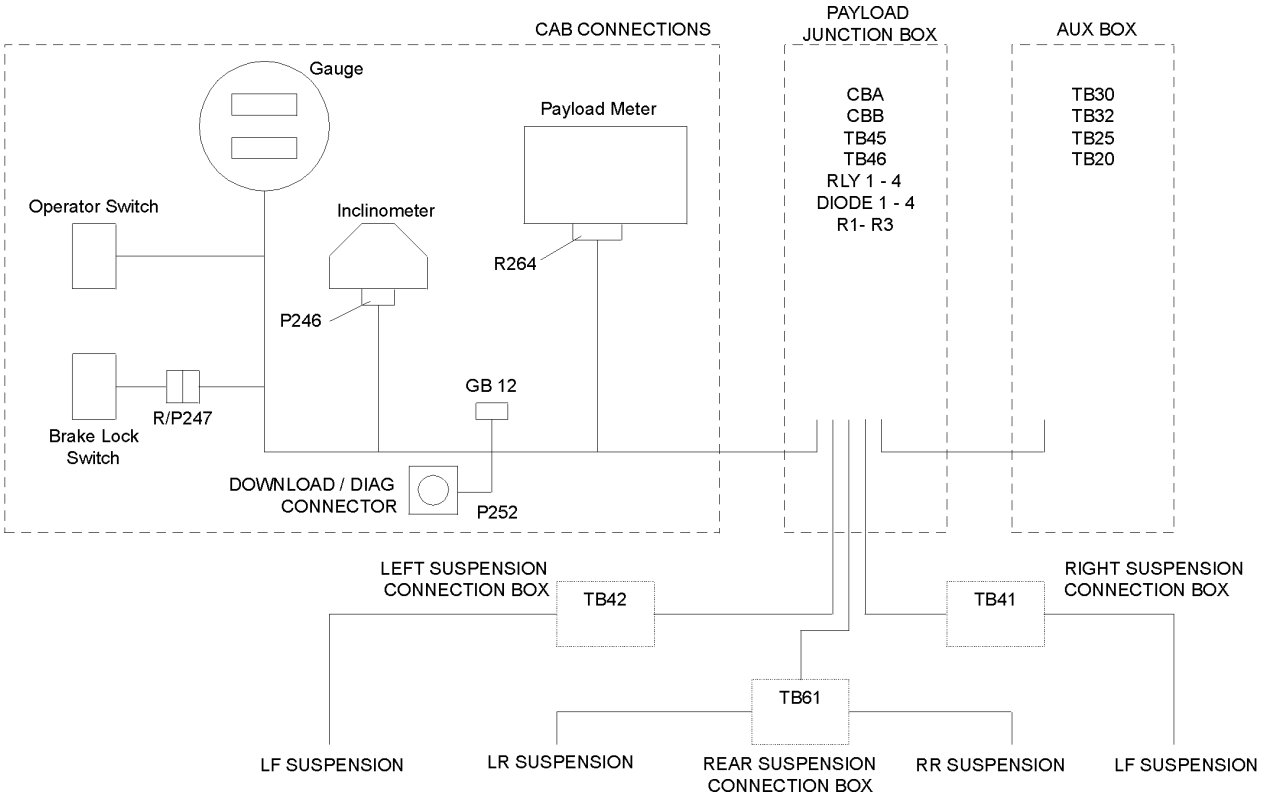
Alarm 27 - User Switch Fault - SET

- Confirm power to the Payload Meter Speedometer and Display gauge.
- Confirm that a laptop is not connected to the PLMIII system.
- Turn keyswitch “OFF”. Wait 1 minute and turn keyswitch “ON”. Confirm problem still exists.



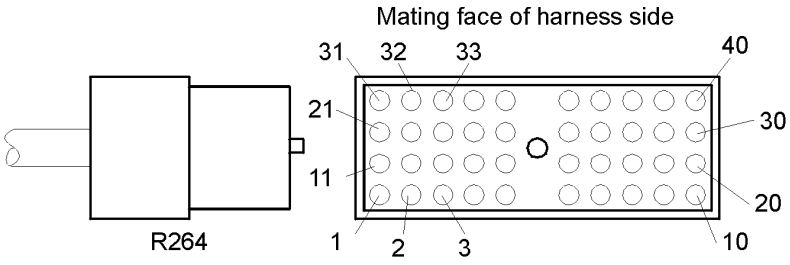
Connector Map

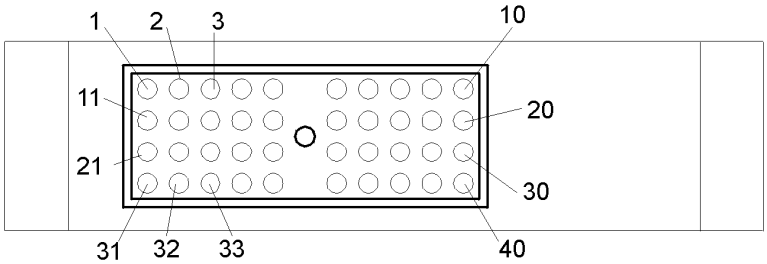
This diagram shows the general location of connectors, terminal boards and miscellaneous connections.



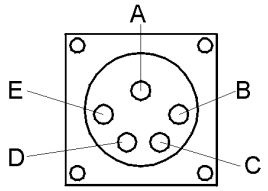
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Connectors

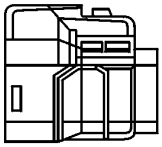




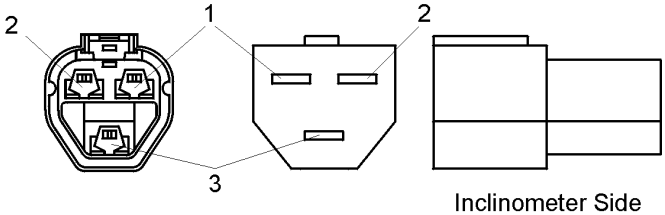
Mating face of Payload Meter



Mating face of diagnostic connector P252

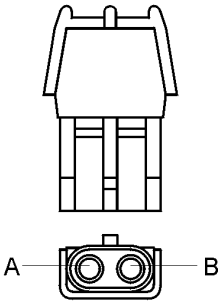


Harness Side P246



Mating Faces

Inclinometer Side



R247
Brake switch connector harness side

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NOTES:

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PLMIII CHECK OUT PROCEDURE

General Description

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

Tools Required

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

Checkout Procedure

1. Attach one EJ3057 Harness Structure to the left-front suspension connection box. The red alligator clip attaches to the 39F circuit at TB42-A. The white alligator clip attaches to the 39FD circuit at TB42-B. The EJ3057 acts as a dummy load to simulate a suspension pressure sensor for the payload system.
2. Attach one EJ3057 Harness Structure to the right-front suspension connection box. The red alligator clip attaches to the 39F circuit at TB41-A. The white alligator clip attaches to the 39FC circuit at TB41-B.
3. Attach one EJ3057 Harness Structure to the left-rear suspension connection in the Rear suspension connection box. The red alligator clip attaches to the 39F circuit at TB61-A. The white alligator clip attaches to the 39FB circuit at TB61-C.
4. Attach one EJ3057 Harness Structure to the right-rear suspension connection in the Rear suspension connection box. The red alligator clip attaches to the 39F circuit at TB61-A. The white alligator clip attaches to the 39FA circuit at TB61-B.
5. In the PLMIII junction box, check the input voltage on circuit 39G between TB45-B and TB45-X. This voltage should be 24vdc from the batteries.
6. Turn the keyswitch ON. The speedometer/display gauge on the dashboard will scroll the truck type across the lower display. The payload meter defaults to 930E.
7. In the PLMIII junction box, check the sensor supply voltage on circuit 39F between TB46-L and TB45-X. This voltage should be 18vdc ±1vdc.
8. Return to the cab and check the speedometer/display gauge. The gauge will display the current payload. With the EJ3057 harnesses attached at the sensor locations, the payload should be 0.

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

- PL = Payload
- id = Operator ID
- tL = Total Shift Tons
- LC = Shift Load Counter
- LF = Left Front Suspension Pressure
- rF = Right Front Suspension Pressure
- Lr = Left Rear Suspension Pressure
- rr = Right Rear Suspension Pressure
- in = Inclinometer

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

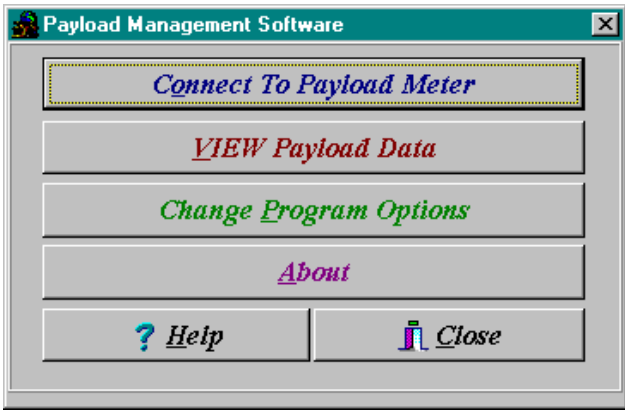
NOTE: The units for the display are controlled by the configuration of the payload meter. The payload meter defaults to display metric units, the pressures will be displayed in tenths of kg/cm^2. For example, if the display shows 202 the actual value is 20.2 kg/cm^2. If the payload meter is set to display short tons, the pressures will be displayed in psi (lbs/in^2). To convert from kg/cm^2 to psi, multiply by 14.2233. 14.2233 psi (lbs/in^2) = 1 kg/cm^2.

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

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

9. Press and hold the "SELECT" button on the dashboard. Id= will be displayed. Release the button and the Operator ID will be displayed. This value should be 0.
10. Press and hold the "SELECT" button on the dashboard. tL= will be displayed. Release the button and the total tons will be displayed. This value should be 0.
11. Press and hold the "SELECT" button on the dashboard. LC will be displayed. Release the button and the number of loads will be displayed. This value should be 0.
12. Press and hold the "SELECT" button on the dashboard. LF= will be displayed. Release the button and the left-front pressure will be displayed. This value should be in metric units. The nominal value should be 23.4 kg/cm^2 (332psi). Values between 17.6 and 29.2 kg/cm^2 (250 psi and 416 psi) are acceptable.
13. Press and hold the "SELECT" button on the dashboard. rF= will be displayed. Release the button and the right-front pressure will be displayed. This value should be in metric units. The nominal value should be 23.4 kg/cm^2 (332psi). Values between 17.6 and 29.2 kg/cm^2 (250 psi and 416 psi) are acceptable.
14. Press and hold the "SELECT" button on the dashboard. Lr= will be displayed. Release the button and the left-rear pressure will be displayed. This value should be in metric units. The nominal value should be 23.4 kg/cm^2 (332psi). Values between 17.6 and 29.2 kg/cm^2 (250 psi and 416 psi) are acceptable.
15. Press and hold the "SELECT" button on the dashboard. rr= will be displayed. Release the button and the right-rear pressure will be displayed. This value should be in metric units. The nominal value should be 23.4 kg/cm^2 (332psi). Values between 17.6 and 29.2 kg/cm^2 (250 psi and 416 psi) are acceptable.
16. Press and hold the "SELECT" button on the dashboard. In= will be displayed. Release the button and the inclinometer value will be displayed. This value is in degrees. The incline will depend on how the truck is set during assembly. Values between ±3° are acceptable. It is not necessary to zero this reading by adjusting the attitude of the inclinometer in the buddy seat.
17. Press and hold the "SELECT" button on the dashboard. PL= will be displayed. Release the button and the current payload will be displayed.
18. Connect a laptop to the PLMIII system. Typically an EF9160 download cable is used. The payload meter connector is behind the buddy seat on the back wall on the side of the PLMIII mounting bracket. The laptop must have the Payload Data Manager software installed.
19. Run the PC software.
20. From the main menu, select "Connect to Payload Meter".

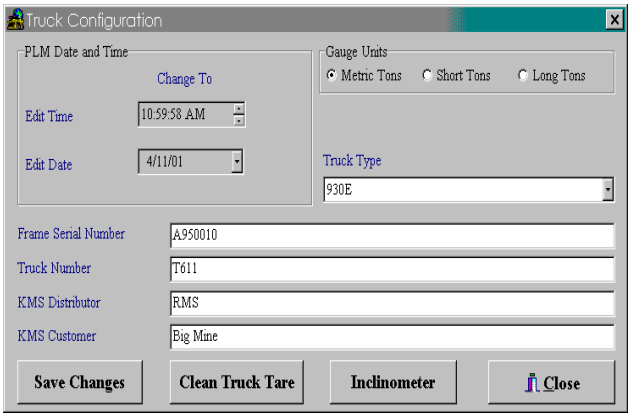


21. The Connection Menu will be displayed. Select "Configure Payload Meter".



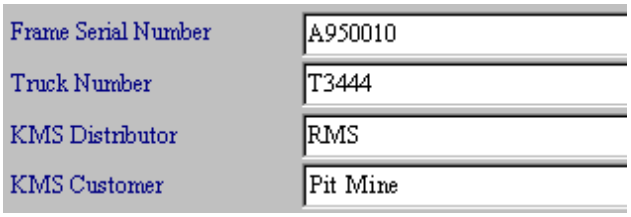
22. Confirm that the PLMIII software version matches the latest available version. As of 09-May-01 the EJ0575-1 software version will display as "01/28/01A". The latest version can be found at *http://www.kms-peoria.com/payload*. If the version does not match the latest indicated on the internet, download the latest and update the PLMIII software using the Flashburn software. See “Checkout Procedure Confirmation” for more information.

23. Using the Truck Configuration menu, set the following:



- Set the time.
- Set the Date to today’s date.
- Set the Gauge display units to Metric, Short Tons or Long Tons according to the final destination of the vehicle. If nothing has been specified, set to Metric Tons.
- Set the truck type to the proper truck model.
- Press the “Save Changes” button to program the change into the payload meter.

24. Setting the Frame Serial Number.



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

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

25. Setting the Customer Unit Number.

NOTE: Most mining operations assign a number to each piece of equipment for quick identification. This number or name can be entered in the Customer Unit Number field. It is very important to enter customer unit number. This number is one of the key fields used within the haul cycle database. The field will hold 20 alpha-numeric characters. If no truck number has been specified, enter the frame serial number.

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

26. Setting the Komatsu Distributor.

NOTE: This field in the haul cycle record can hold the name of the Komatsu distributor that helped install the system. Komatsu also assigns a distributor number to each distributor. This number is used on all warranty claims. This Komatsu distributor number can also be put into this field. This number is one of the key fields used within the haul cycle database. The field will hold 20 alpha-numeric characters. If the distributor is not known, enter "UNKOWN".

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

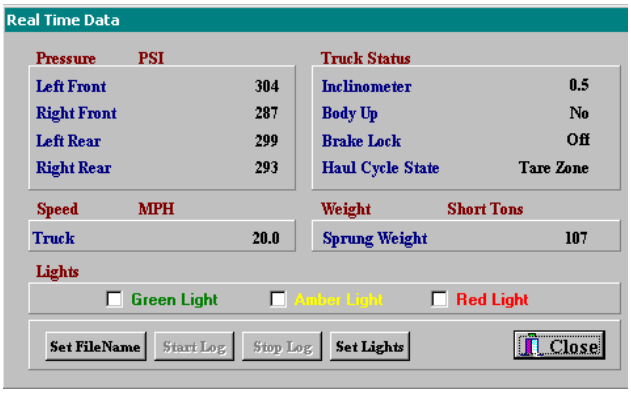
27. Setting the Komatsu Customer.

NOTE: This field in the haul cycle record can hold the name of the mine or operation where the truck is in service. Komatsu also assigns a customer number to each customer. This number is used on all warranty claims. This Komatsu customer number can also be put into this field. This number is one of the key fields used within the haul cycle database. The field will hold 20 alpha-numeric characters. If the customer is not known, enter "UNKOWN"

·On the Truck Configuration screen, enter the customer name or number in the appropriate field.

·Press the "Save Changes" button to program the chnge into the payload meter.

28. Press "Save Changes" and close the Truck Configuration screen and the Connection Menu.
29. From the main menu select "Connect to Payload Meter".
30. From the Connection Menu select "Configure Payload Meter". Confirm that all previous changes have been saved and close the Truck Configuration form.
31. From the Connection Menu select "Real Time Data".



NOTE: The weight shown on the real time data screen is the sprung weight and includes the weight of the truck. Given the suspension pressure dummy loads, the nominal value shown should be 112 short tons (101 metric tons).

32. Confirm that the suspension pressures are within range. The nominal value should be 23.4 kg/cm^2 (332psi). Values between 17.6 and 29.2 kg/cm^2 (250 psi and 416 psi) are acceptable. Record the values displayed.
33. Confirm that the inclinometer is within range and record the value.
34. Confirm that the Body Up input is working correctly. Place a steel washer on the body up switch. The real time data screen should indicate "No". Remove the washer and the real time data screen should indicate "Yes". The Haul Cycle State should change to "Dumping".
35. Confirm that the Brake Lock input is working correctly. Turn the Brake Lock on using the switch on the dashboard. The real time data screen should indicate "On". Turn the Brake Lock off. The real time data screen should indicate "Off".
36. Turn on the green payload lights by checking "Green Light" and pressing the "Set Lights" button. Check to be sure that only the green payload lights on the truck are illuminated.
37. Uncheck the green light and turn on the amber payload lights by checking "Amber Light" and pressing the "Set Lights" button. Check to be sure that only the amber payload lights are illuminated.
38. Uncheck the amber light and turn on the red payload lights by checking "Red Light" and pressing the "Set Lights" button. Check to be sure that only the red payload lights are illuminated.
39. Uncheck all the payload lights and press the "Set Lights" button. Confirm that all the lights are off.
40. Use the procedure for speedometer calibration for the particular truck type to simulate a 25 MPH (40.2 Km/h) speed signal. Confirm that this value is displayed by the speedometer on the dashboard and the real time data screen. The value can be ±1 MPH (±2 km/h). The brake lock must be off for the PLMIII to recognize speed input.
41. On the PC, close the Real Time Screen and the Connection Menu and return to the Main Menu.
42. Remove the EJ3057 harness from the left front suspension junction box, TB42-A and TB42-B.

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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

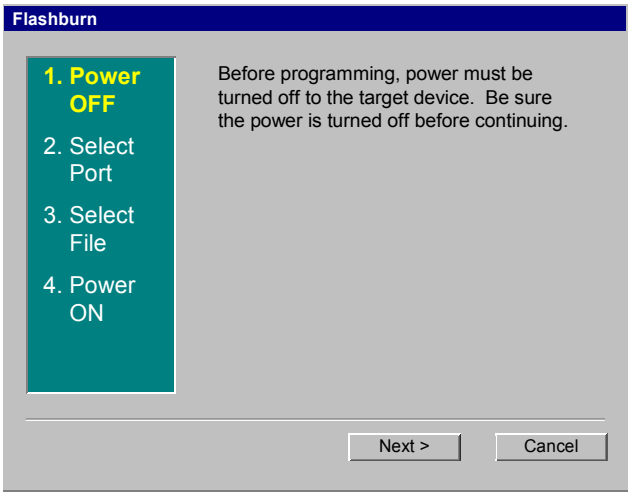
Before beginning, be sure the ".kms" file required to program the product and you know where to find it on your computer.

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.

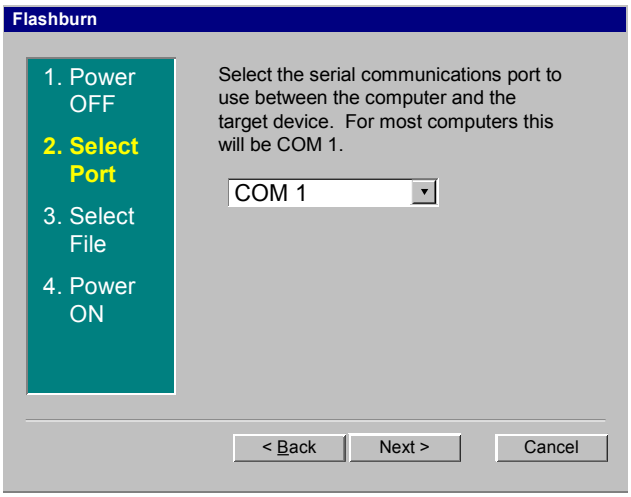
1. Turn off power to the payload meter by turning the keyswitch “OFF”.
2. Start the "Flashburn" software installed on the laptop.



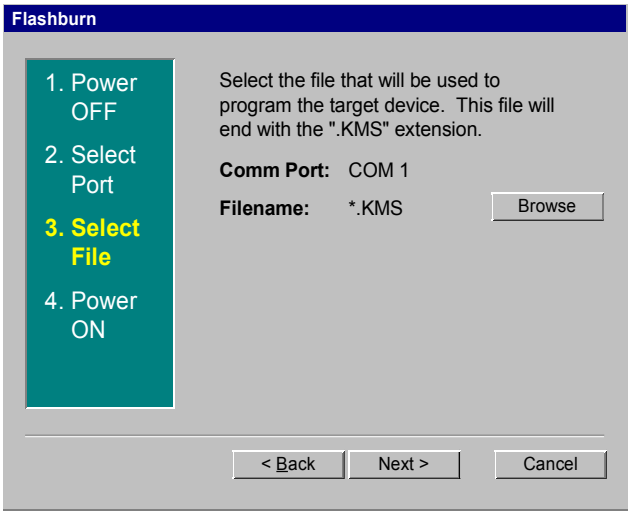
3. Confirm that the payload meter power is OFF and press “NEXT".

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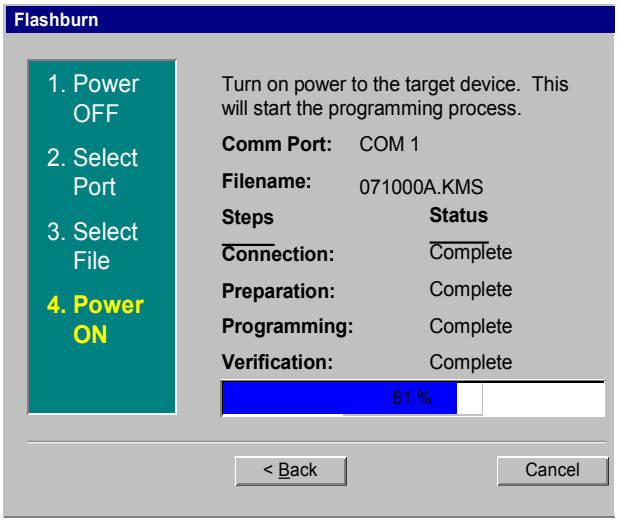
4. Confirm the proper communications port for the programming laptop. This is usually COM 1. Press “NEXT”.



5. Press “BROWSE” and select the ".kms" file to program into the payload meter. Press “NEXT”.



6. When instructed, turn the keyswitch “ON” in order to power-up the payload meter. The PC will begin to reprogram the payload meter. This process takes approximately 5 minutes.



7. After successful programming, turn the key witch “OFF”.
8. Wait 20 seconds and turn the keyswitch “ON”.
9. The payload meter will need to be configured as instructed in the manual using the Payload Data Manager software on the laptop computer.

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PLMIII Checkout Procedure

Confirmation Checklist

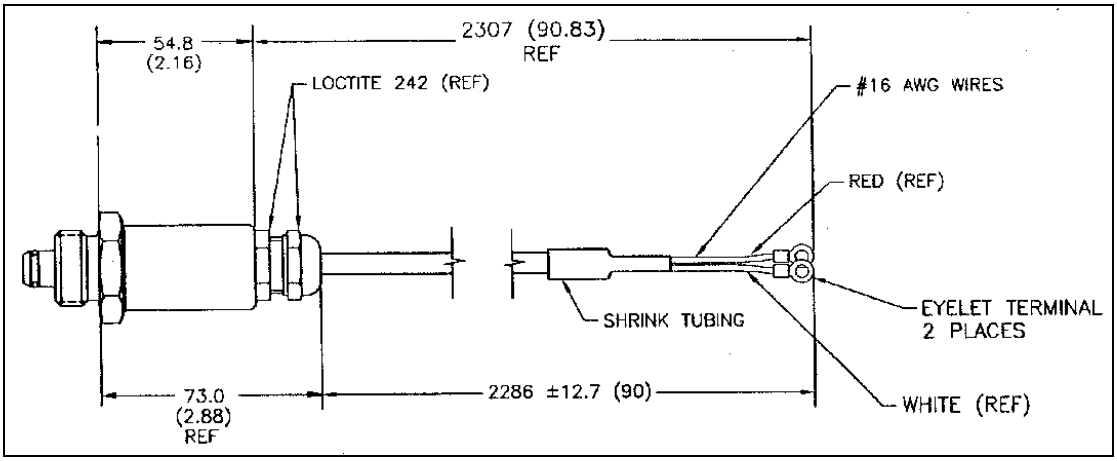
Use the Real Time Data Screen in order to verify the checklist items in the table below.

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

The following pages are typical component and schematic pages for the PLMIII system.

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Payload Meter III - COMPONENTS

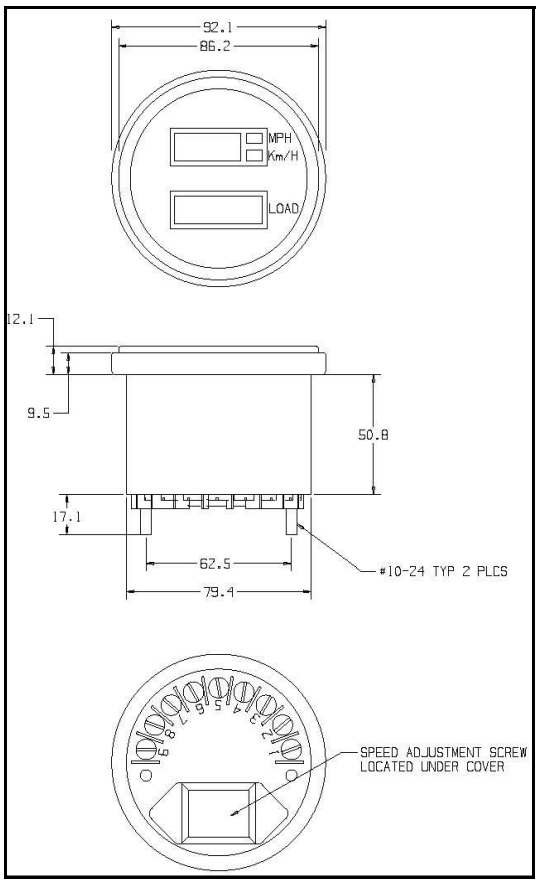


Pressure Sensor - PC0328



PLMIII Controller - EG6514

All Reference dimensions are in mm.



Speedometer - PC0550

PORTIONS OF THIS PRODUCT RELATING TO PAYLOAD MEASURING SYSTEMS ARE MANUFACTURED UNDER LICENSE FROM

L.G. HAGENBUCH holder of
U.S. Patent Numbers 4,831,539 and 4,839,835

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Reserve Engine Oil System

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

A filter (14) in the supply circuit protects the pumping unit (11) and prevents transfer of contaminants to the engine sump which might enter the tank during servicing. It also gives an added level of oil cleanup.

Extend oil change intervals

The normal supply system capacity of oil carried in the reserve tank is roughly equivalant to the volume in the engine. In the process of continuous adjustment of the engine oil level, there is a constant circulation of oil between the engine and the reserve tank. The volume of oil in the tank becomes part of the working oil for the engine. Oil change intervals may usually be extended in proportion to the increased working oil volume. Extension beyond a proportional increase is often possible, but should be undertaken only as determined by oil sampling and analysis. Local conditions such as engine application, climate and fuel quality should be taken into account in determining permissible oil life.

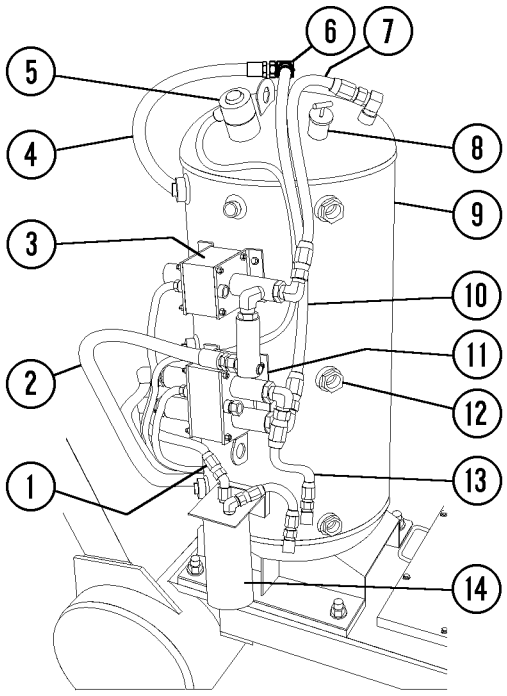


FIGURE 31-1. OIL RESERVE TANK

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

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Operation

Engine oil is circulated between the engine oil pan (1, Figure 31-2) and the reserve tank (2) by two electrically driven pumps (Pump 1 and Pump 2) within a single pumping unit (4). The pumping unit is mounted on the side of the reserve tank. The pump unit is equipped with an LED monitor light on one side.

Pump 1 draws oil from the engine oil pan (1) at a preset control point determined by the height of the suction tube (6). Oil above this point is withdrawn and transferred to the reserve tank. This lowers the level in the engine oil pan until air is drawn.

Air reaching the pumping unit activates Pump 2, which returns oil from the reserve tank (2) and raises the engine oil level until air is no longer drawn by Pump 1. Pump 2 then turns "OFF". The running level is continuously adjusted at the control point by alternating between withdrawal and return of oil at the engine oil pan. The oil returning to the engine oil pan is below the normal operating level to prevent aeration of the oil.

LED Monitor Light

- Steady - Pump 1 is withdrawing oil from the engine sump and bringing down the oil level.
- Regular Pulsing - Pump 2 is returning oil to the engine sump and raising the oil level.
- Irregular Pulsing - Oil is at the correct running level.

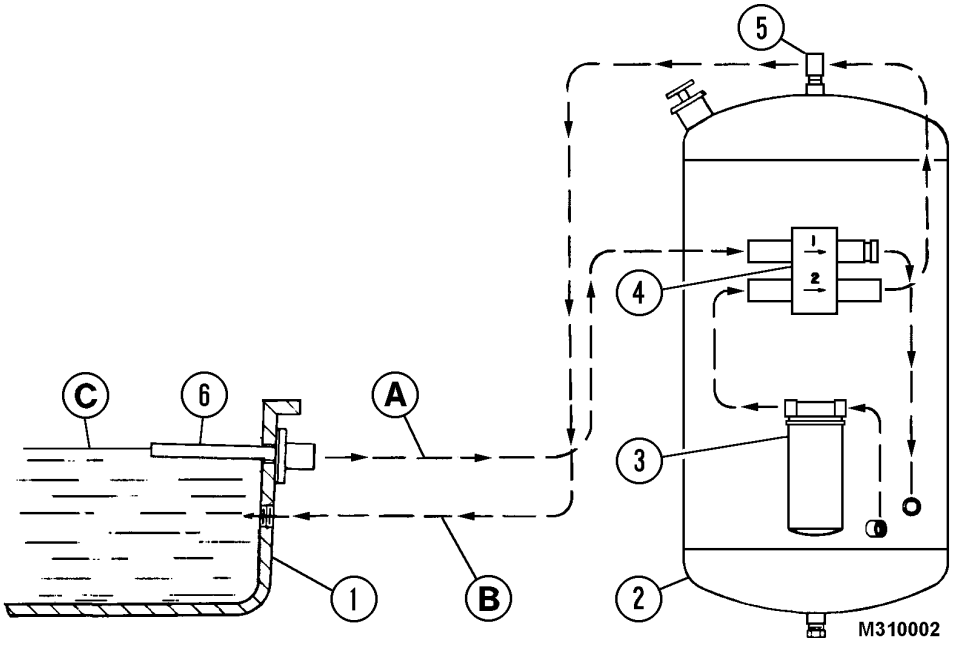


FIGURE 31-2. RESERVE SYSTEM SCHEMATIC

1. Engine Oil Pan (Sump)
2. Oil Tank
3. Oil Filter
4. Pumping Unit (1 & 2)
5. Air Relief Valve
6. Suction Tube

A. Oil Suction Line
B. Oil Return Line
C. Engine Oil Level

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Tank Fill Control (Optional)

With the reserve oil system the engine oil level is held constant, with only the reserve tank needing routine filling. The fill system automatically controls the filling of remote tank from a convenient ground level position. Filling of the tank to the proper “FULL” level is fast and accurate and accomplished in 2 to 3 minutes.

The reserve oil tank for the engine is designed to add more oil capacity to the engine to reduce the frequent servicing of the engine oil. The engine oil level must still be checked every shift using the dipstick.

If the engine oil has been drained from the engine oil pan, the new oil must be added through the engine fill tube. After an oil change, both engine and reserve tank must be full of oil before starting the engine.

NOTE: DO NOT use the oil in the reserve tank to fill the engine pan.

The system switch (2, Figure 31-3) is an illuminated push-pull POWER ON switch that powers the fill system. The start switch (3) is a momentary push button switch that opens the fill valve mounted on the reserve tank to begin the automatic filling of the reserve tank. Supply oil under pressure flows through the fill valve and into the tank.

Filling Procedure (Remote fill feature)

NOTE: This procedure adds oil to the reserve tank.

1. Connect the pressure supply hose from the new oil supply to the quick coupler on the truck. Open valve on supply hose to apply pressure.
2. Pull out on system switch (2, Figure 31-3) to turn the fill system "ON".
3. Push the start switch (3). The "Valve Open" light (5) should illuminate and the filling process will begin.
4. When tank is full, the "Valve Open" light will turn "OFF" and the FULL light (4) will illuminate.
5. Close the oil supply valve in the fill hose.
6. Press and hold the start switch (3) for a couple of seconds to relieve oil pressure in the line.
7. Disconnect the new oil supply hose.
8. Push switch (2) in to turn fill system power "OFF".

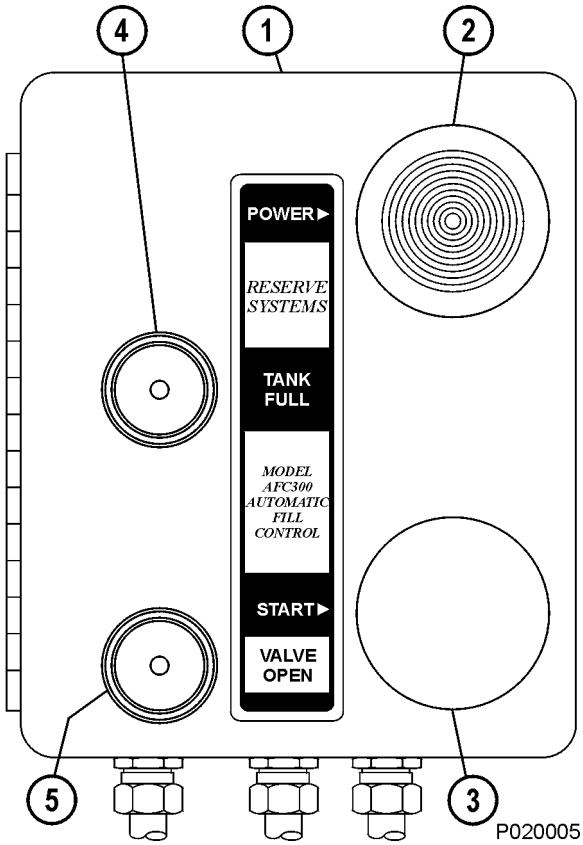


FIGURE 31-3. RESERVE OIL TANK REMOTE FILL

1. Remote Control Box
2. System Switch
3. Start Switch
4. “Full” Light
5. “Valve Open” Light

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Service

Between oil drains, the only normal servicing required is routine replenishment of oil at the reserve supply tank. Maintenance of running levels should be checked routinely; manually before starting the engine and with the LED system monitor on the reserve tank pumping unit (11, Figure 31-1) when the engine is running.

The is also an in-line filter (screen) installed at the inlet of the fill valve (3, Figure 31-1). This filter requires no periodic maintence, but it can be cleaned by removing it from the system and back flushing through the filter.

CAUTION: Always check the engine oil level before starting engine. Use the engine dipstick.

1. Every 10 Hours, or once each shift:

a. Before starting engine, check oil level using engine dipstick. Oil level should be in normal operating range. If not, check the reserve system for proper operation.

b. The engine oil quality will be best if the reserve tank is kept reasonably full. Check the oil level in the reserve tank. As a minimum guideline, if the oil is below the half-full level, fill the tank manually so the oil is just visible in the top sight glass or by using the automatic fill control method.

c. After starting and warm-up, check engine oil level signal (LED) to verify that the engine is being maintained at the preset running oil level. The signal should alternate between periods of STEADY ON and FLASHING.

2. Every 500 Hours:

a. Change all engine and system filters, if applicable.

b. More system failures result from bad electrical connections than all other causes combined. Check electrical system connections for tightness, corrosion and physical damage. Check battery, alternator, oil pressure switch, junction boxes, remote control fill box and circuit breakers.

c. Examine electrical cables over their length for possible damage.

d. Small hose leaks can cause system malfunction. Examine all hoses, including those on the reserve tank and the ones leading to and from the engine for leaks, cracks or damage. Check all fittings for tightness, leakage or damage.

Changing Oil

1. Drain both the engine sump and the reserve tank. Refill both engine and reserve tank with new oil to proper levels.
2. Change engine and reserve tank filters as required.
3. Start engine and check for proper operation.

NOTE: Do not use the oil in the reserve tank to fill the engine sump. Both must be at proper level before starting engine.

The engine oil level should be checked with the engine dipstick at every shift change. The oil level in the reserve tank must also be checked at every shift change. Oil must be visible in the middle sight gauge. If not, add oil to the reserve tank until oil is visible in the top sight gauge

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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 recieve 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.

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System Electrical Schematics

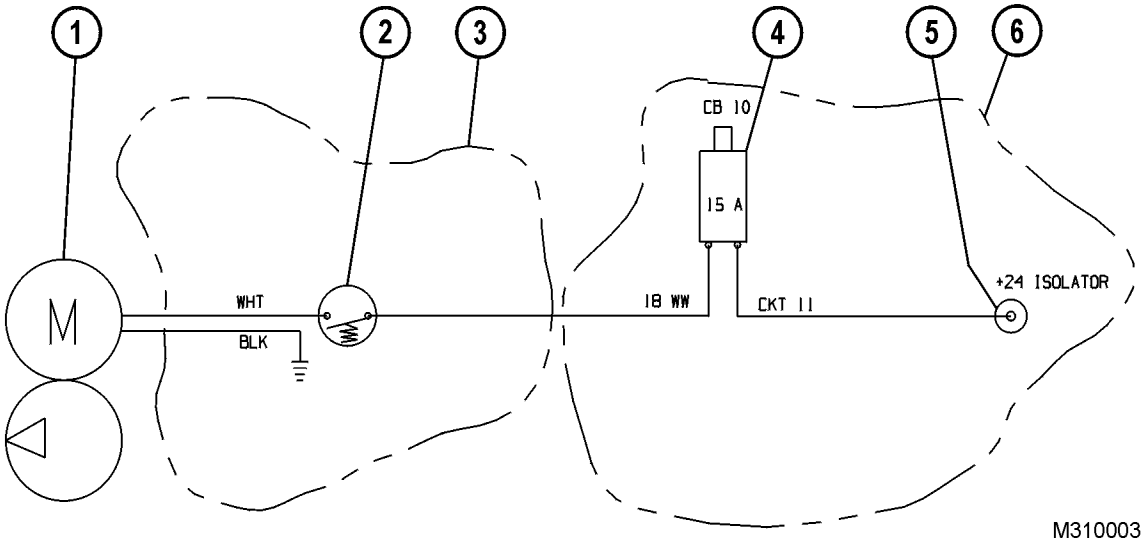


FIGURE 31-4. SYSTEM SCHEMATIC

1. Pumping Unit (Pump 1 & Pump 2)
2. Engine Oil Pressure Switch
3. Engine Subframe
4. 15 Amp Circuit Breaker
5. Power Supply
6. Auxillary Box

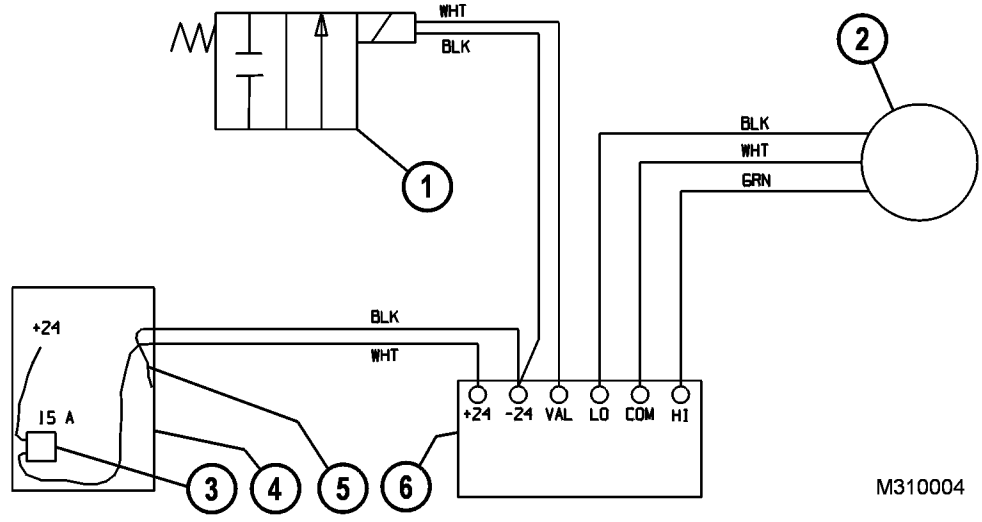


FIGURE 31-5. FILL SYSTEM SCHEMATIC

1. Fill Valve
2. Oil Level Sensor (top of reserve oil tank)
3. 15 Amp Circuit Breaker
4. Battery Disconnect Box
5. Ground Wire
6. Remote Fill Control Box

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OPERATOR'S CAB
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TRUCK CAB

Description

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

⚠WARNING

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

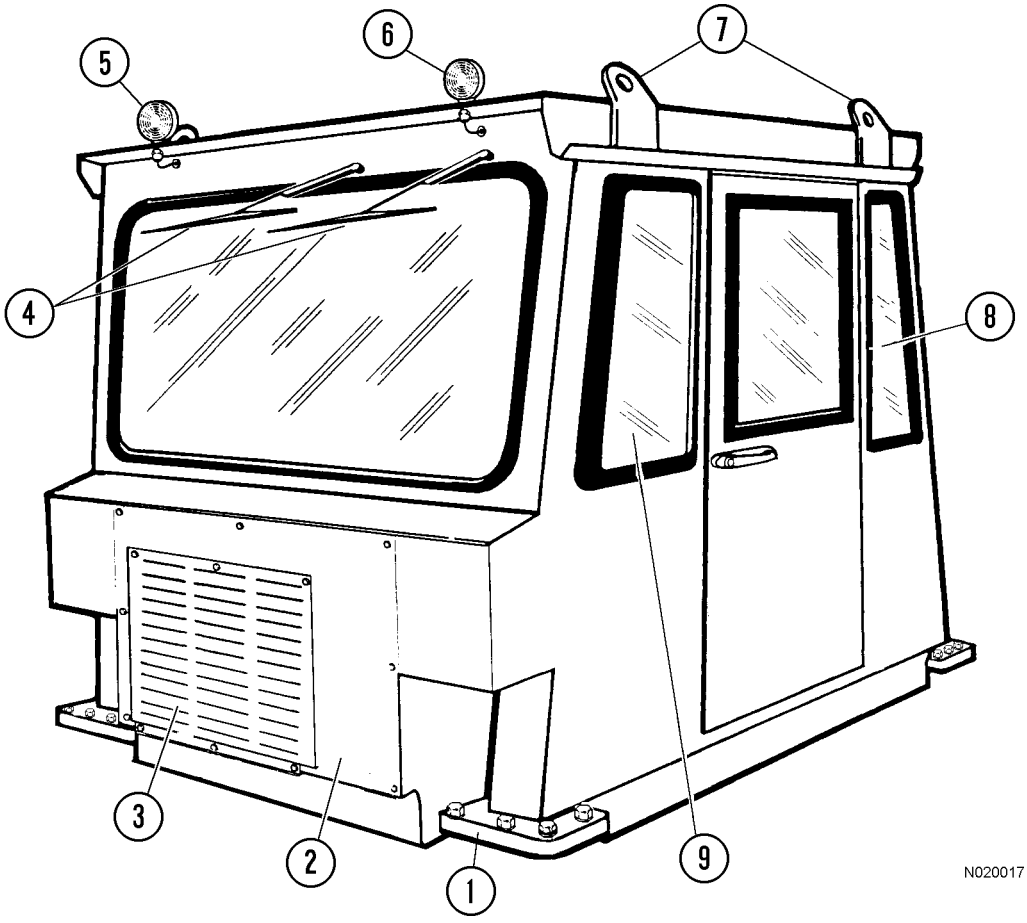


FIGURE 2-1. CAB ASSEMBLY

1. Mounting Pad
2. Access Covers
3. Filter Cover
4. Windshield Wiper Arms
5. Stop Light (Service Brakes Applied)
6. Retard Light (Retarder Applied)
7. Lifting Eye
8. Rear, Side Glass
9. Front, Side Glass

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

⚠WARNING

Do not attempt to work in deck area until body safety cables have been installed.

Removal

NOTE: The following procedure describes removal of the cab as a complete module with the hydraulic brake cabinet attached. All hoses and wire harnesses should be marked prior to removal for identification to ensure correct reinstallation:

1. Turn the key switch to the "Off" position and allow at least 90 seconds to bleed the steering accumulator. Turn the steering wheel to be sure no pressure remains. If installed, open the automatic/manual drain valve mounted below the air tank and drain air supply.
2. Block truck securely, and open the brake accumulator bleed down valves on the accumulators located in the cabinet mounted on the rear of the cab. Allow sufficient time for accumulators to bleed down completely.
3. Open the battery disconnect switch located at the left hand ladder.
4. Disconnect hydraulic hoses routed to frame from fittings at rear of cab under brake cabinet (3, Figure 2-2). (It is not necessary to disconnect hoses (2) attached to, and routed under the cab.) Cap all fittings and plug hoses to prevent contamination.
5. Disconnect wire harnesses at connectors (5) located under hydraulic cabinet.
6. Remove cable and hose clamps as needed for cab removal
7. Close heater shutoff valves located at the water pump inlet housing on the right side of the engine and at the water manifold. Disconnect heater hoses at each valve and drain coolant into a container.
8. Remove clamps and heater hoses from fittings underside of deck, below heater.

⚠IMPORTANT⚠

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

9. If the truck is equipped with air conditioning, evacuate the air conditioning system:
   a. Attach a recycle/recovery station at the air conditioning compressor service valves. (Refer to "Heater/Air Conditioning System" in Section "M" for detailed instructions.)
   b. Evacuate air conditioning system refrigerant.
   c. Remove the air conditioner system hoses routed to the cab from the receiver/drier and compressor. Cap hoses and fittings to prevent contamination.
10. Attach a lifting device to the lifting eyes provided on top of the cab.

⚠WARNING

The cab assembly weighs approximately 5000 lbs. (2270 kg). Be sure lifting device is capable of lifting the load.

11. Remove the capscrews and washers from each mounting pad (1, Figure 2-1) at the corners of the cab.

NOTE: The tool group shipped with the truck contains the following tools which may be used to remove the inner capscrews, as clearance is limited:

- PB8326 - 1-1/2" offset wrench
- TZ2733 - Tubular Handle
- TZ2734 - 3/4" torque wrench Adaptor

12. Check for any other hoses or wiring which may interfere with cab removal.
13. Lift the cab assembly off the truck and move to an area for further service.
14. Place blocking under each corner of the cab to prevent damage to floor pan and hoses before cab is lowered to the floor.

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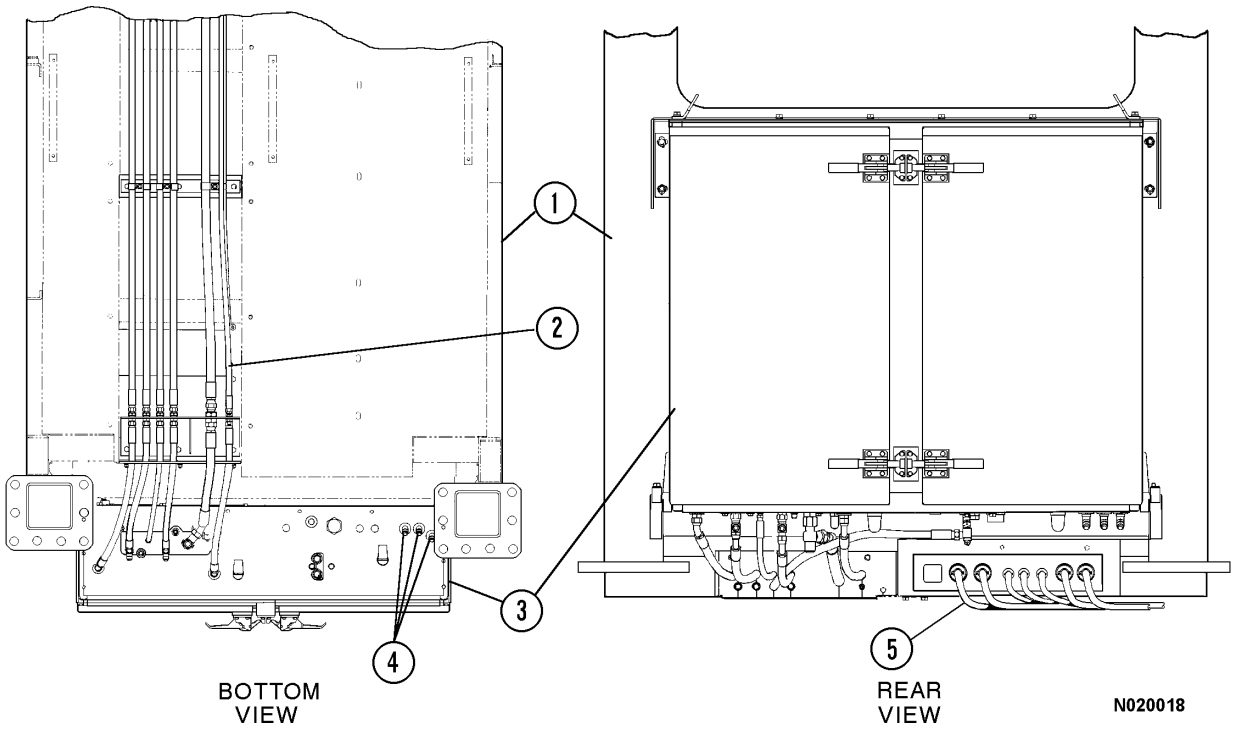


FIGURE 2-2. CAB HYDRAULIC AND ELECTRICAL CONNECTIONS

1. Cab
2. Steering Control Valve
3. Hydraulic Components Cabinet
4. Hoist Valve Hoses
5. Electrical Harness Connectors

Installation

1. Lift cab assembly and align mounting pad holes with tapped pads. Insert at least one capscrew and hardened washer at each of the four pads prior to lowering cab onto the truck.

NOTE: The tool group shipped with the truck contains the following tools which may be used to remove the inner capscrews, as clearance is limited:

- PB8326 - 1-1/2" offset wrench
- TZ2733 - Tubular Handle
- TZ2734 - 3/4" torque wrench Adaptor

2. After cab is positioned, insert the remaining capscrews and hardened washers. (32 total). Tighten the capscrews to **700 ft. lbs. (950 N.m)** torque.
3. Route wire harnesses to the electrical connectors on the rear corner of the cab (5, Figure 2-2). Align cable connector plug key with receptacle key and push plug onto receptacle. Carefully thread retainer onto receptacle and tighten securely. Install clamps if removed during cab removal.
4. Remove caps from hydraulic hoses and tubes and reinstall. Reinstall hose clamps as required.
5. Install heater hoses and clamps on fittings on underside of cab. Connect other end of hose to fittings at shutoff valves on engine. Open heater shutoff valves. Connect air cleaner restriction indicator hoses.
6. Remove caps and reinstall air conditioning system hoses from compressor and receiver/drier.
7. Refer to Section M, "Heater/Air Conditioning System" for detailed instructions regarding evacuation and recharging with refrigerant.
8. Close brake accumulator bleed down valves.
9. Close battery disconnect switch.
10. Service hydraulic tank and engine coolant as required.
11. Start the engine and verify proper operation of all controls.
12. Assure air conditioning system is properly recharged.

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CAB DOOR

The cab door assemblies are similar except for the hinge side. Each is hinged on the rear edge with a heavy duty hinge. For repairs on the door latches or window controls it is usually better, but not necessary, to remove the door from the cab and lower it to the floor for service.

Removal

1. If overhead space is available, raise body to allow access to door with overhead hoist. Secure body in raised position with safety cables.
2. Lower door glass far enough to allow insertion of lifting sling when door is removed.
3. Remove door panel for access to power window motor harness connector. Disconnect motor and remove cab harness from door.
4. Remove the retainer clip and bolt clip from the travel limiting strap.
5. Insert lifting sling through door and attach to hoist. Remove capscrews (a swivel socket works best) securing door hinge to cab and lift door from cab.
6. Place door on blocks or on a work bench to protect the window glass and allow access to internal components for repair.

Installation

1. Attach sling and hoist to door assembly, lift door up to the deck and position door hinges to cab.
2. Align door hinges with cab and install capscrews securing door to cab.
3. Attach the travel limiting strap with the bolt and clip removed previously.
4. Reconnect door harness to receptacle mounted in the cab floor.
5. Verify proper operation of power window and door latch adjustment.
6. Install door panel.

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.

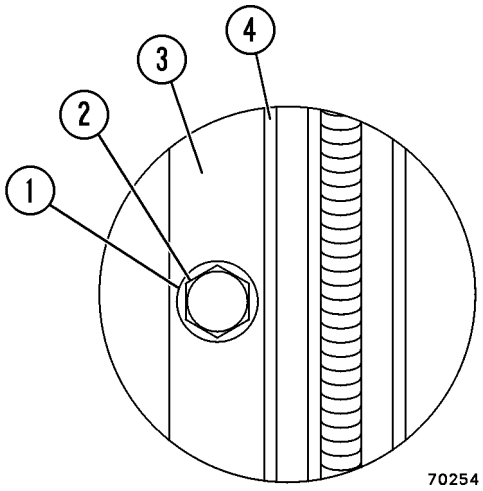


FIGURE 2-3. DOOR JAMB BOLT ADJUSTMENT

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 1) 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.

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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.

Step B. If the door bucks back when trying to close it, the striker bolt (2, Figure 2-4) has probably loosened and slipped down from where the catch can engage with the bolt.

1. Open the door and close both claws (3 & 5, Figure 2-4) on the catch until they are both fully closed.
2. Transfer the center of this opening onto the skin of the cab nearest where the door jamb bolt is located. Use a T-square or other measuring equipment and mark on the cab with a pencil.

NOTE: Release the door catch before trying to close the door.

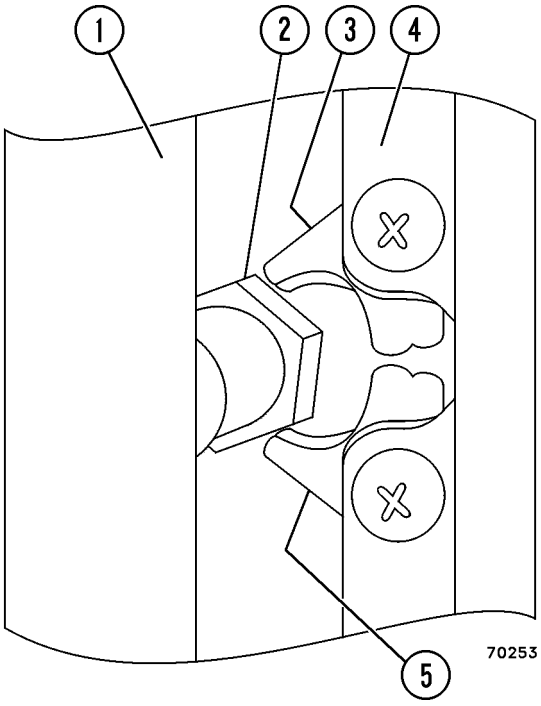


FIGURE 2-4. DOOR JAMB BOLT ADJUSTMENT

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

3. Loosen and vertically align (center) the door jamb bolt with this mark and tighten it firmly enough to hold it in place but still allow some slippage.
4. Carefully try to close the door (4) and determine if this has helped the "bucking" problem. If the door latches but not firmly enough, follow procedures listed previously in "Step A". If the door latch does not catch, move the bolt outwards and try again. When corrected, follow adjustment procedures listed in "Step A" to ensure a good seal. By design, if both seals are in good condition, proper adjustment of the outside seal will ensure good contact on the inside seal to prevent dust and moisture from entering the cab.

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Door Handle Plunger Adjustment

If the door handle becomes inoperative, it can either be adjusted or replaced. The following is a procedure for adjusting the exterior door handle plunger.

1. Determine the amount of free play in the door release plunger by pushing in on the plunger until it just contacts the door release mechanism. Measure the distance that the plunger travels (Figure 2-5) from this position to where the plunger is fully released.

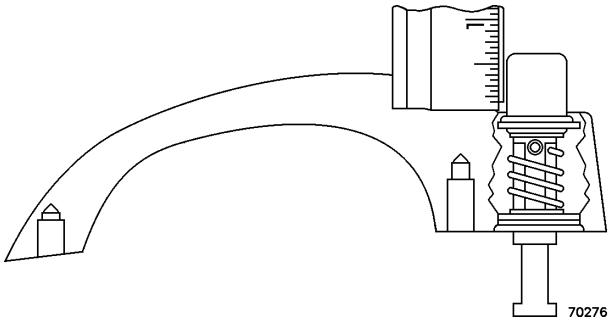


FIGURE 2-5. MEASURING TRAVEL DISTANCE OF PLUNGER

2. Remove door panel.
   a. Remove hair pin clip (1, Figure 2-6) and bolt (2) from the door check strap closest to the door.
   b. Remove 2 capscrews (3), which hold the door strap bracket to the door.
   c. Disconnect wiring harness (4) to the window regulator.
   d. Open the door as far as possible in and remove the internal door panel.
   e. Before removing all door panel mounting screws, support the panel to prevent the assembly from dropping. Remove 15 mounting screws (5).

NOTE: Remove panel screws across the top last.

⚠CAUTION

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

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

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

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Replace Door Glass

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

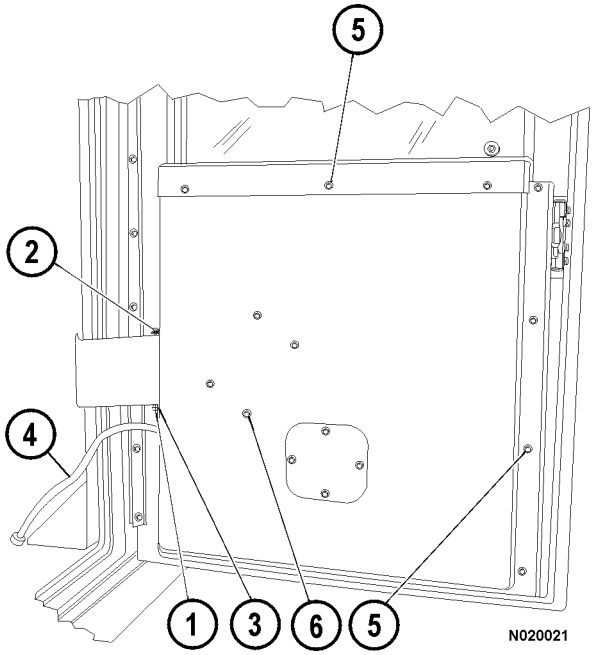


FIGURE 2-6.

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

2. Remove 2 M8X12 capscrews (3), which hold the door strap bracket to the door.
3. Disconnect wiring harness (4) to the window regulator.
4. Open the door as far as possible in order to remove the internal door panel.

CAUTION

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

5. Before removing all door panel mounting screws, support the panel to prevent the assembly from dropping. Remove 15 mounting screws (5).

NOTE: Remove panel screws across the top last.

6. Carefully lower the door panel a few inches (Figure 2-7). Hold glass at top to prevent it from dropping. Slide the door panel toward the cab to disengage the window regulator roller from the track on the bottom of the glass. Then slide the panel away from the cab to disengage the other top roller and the lower roller from their tracks. Place the panel out of the way after removal.

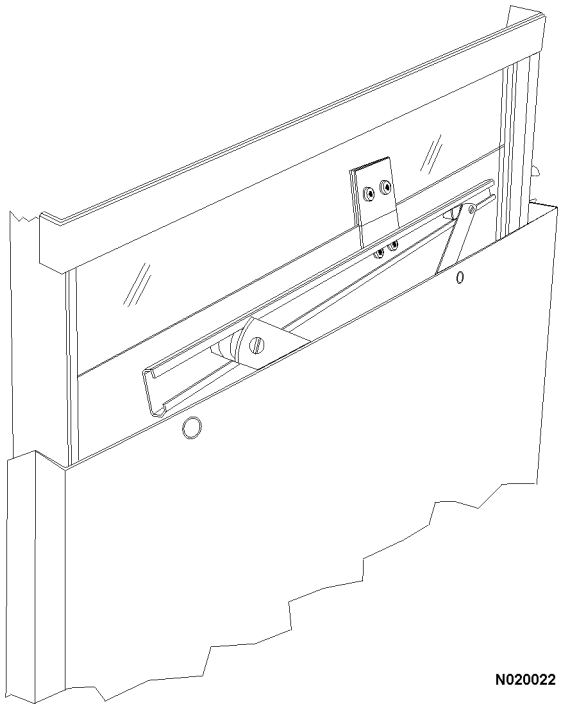


FIGURE 2-7.

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7. Remove 2 screws (Figure 2-8) holding the roller track to the bottom of the door glass.

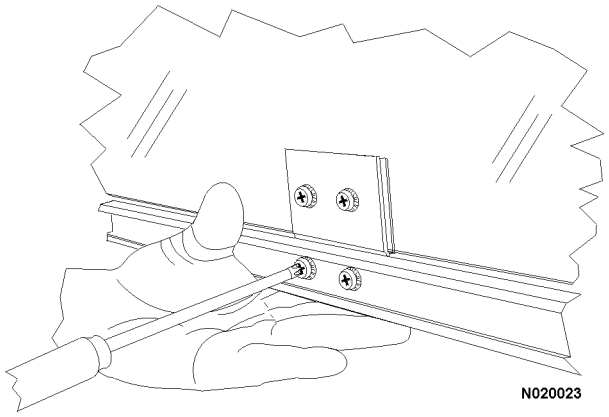


FIGURE 2-8.

8. Support glass in door frame as shown (1, Figure 2-9). Remove screws (2) that hold the adapter for the window regulator track.

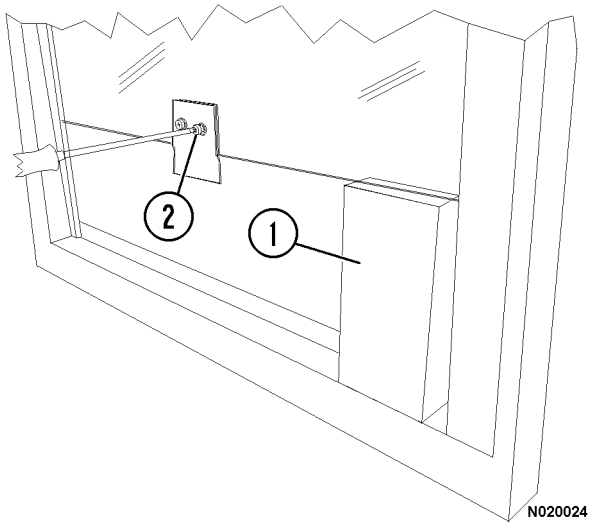


FIGURE 2-9.

1. Support Block 2. Screws

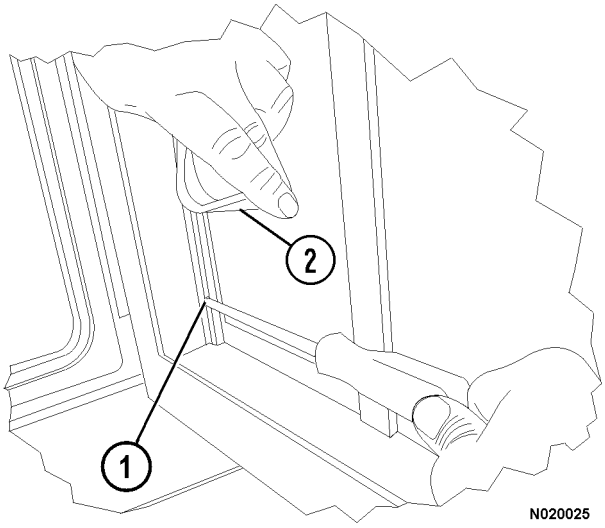


FIGURE 2-10.

1. Screws 2. Rubber Felt Insert

Remove the screw at the lower end of the window channels. It is necessary to pull the rubber felt insert (2, Figure 2-10) out of the channel in order to be able to remove the screws.

9. Remove the trim material covering the screws holding the window frame to the door. Remove screws (1, Figure 2-11) holding window frame to the door.

Note: Screws along the bottom of window frame may be shorter than along the top and sides.

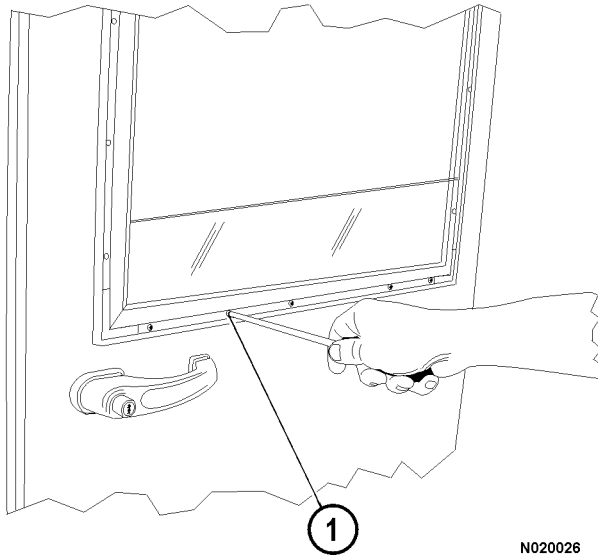


FIGURE 2-11.

1. Screws

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Lift door glass up in the frame (1, Figure 2-12) so that it is near the top. Holding the glass in place, tilt frame out at the top. Lift frame and glass straight up and out of door.

⚠CAUTION

Bracket (2, Figure 2-9) at bottom of glass must clear the door frame, if still on glass.

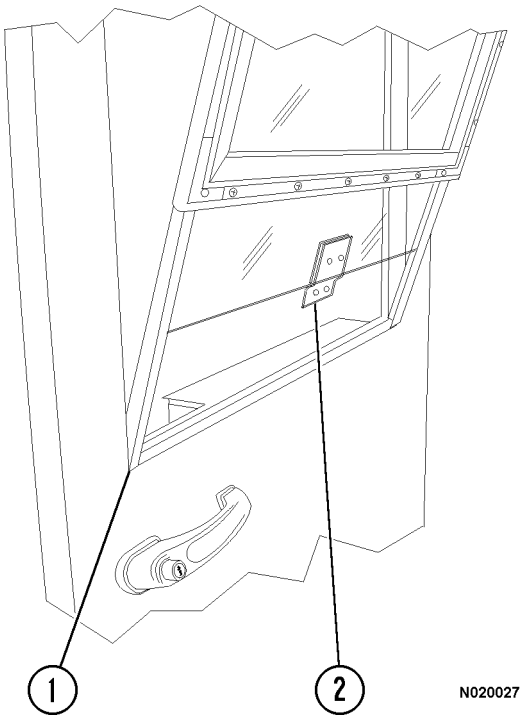


FIGURE 2-12.

1. Window Frame 2. Window Bracket

10. Move window glass and frame to an area where the glass can be removed. Slide the glass down and out of the window channels.
11. Before installing new window glass, first inspect the window frame. In each corner there is an "L" shaped bracket with 2 screws in it to hold the corners of the frame together. Check the screws (1, Figure 2-10) to be sure they are tight. Also be sure the rubber felt insert in the window channels is in good condition. Replace, if necessary.
12. Slide the new window glass into the window frame glass channels. Move the glass to the top of the frame.
13. Lift window frame, holding glass at the top of the frame, and lower the assembly into the door.

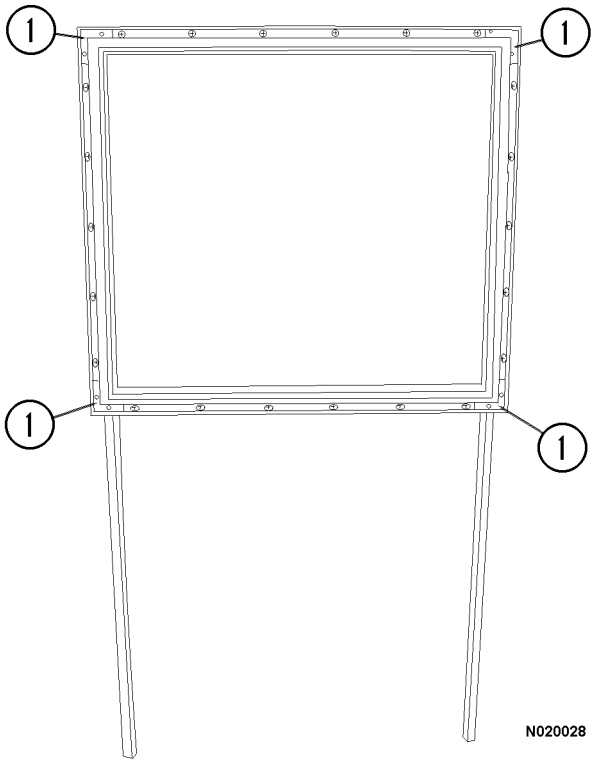


FIGURE 2-13.

1. "L" Shaped Brackets

⚠IMPORTANT⚠

Be sure the one channel (5, Figure 2-14) which is next to the door latch passes to the inside of the latch assembly (4).

14. Lower glass in frame and support it as seen in Figure 2-9.
15. Reinstall window frame screws which holds it to the door frame.

⚠CAUTION

Screws along the bottom of window frame may be shorter than the ones along the sides and top. These screws must be used in this area to prevent the window glass from being scratched or cracked. See Figure 2-11.

16. Install trim material over the top of screws that holds the window frame to the door. Use a flat blade screwdriver to assist with installing the trim material. See Figure 2-15. Be careful not to cut the retainer lip on the trim material.

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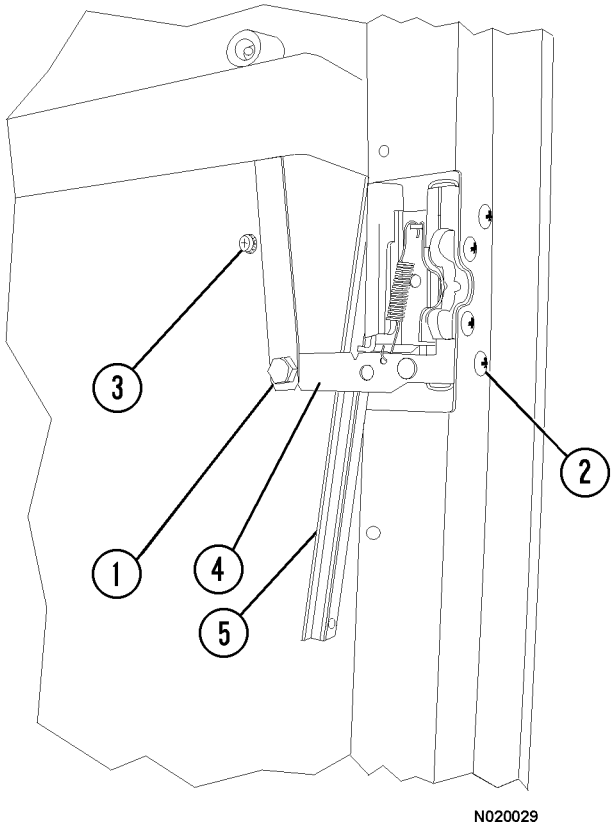


FIGURE 2-14.

1. Capscrew & Nut
2. Mounting Screws - Latch
3. Mounting Screw - Outside Door Handle
4. Latch Assembly
5. Window Frame

17. Install the 2 screws removed in step 8. Be sure the rubber felt insert is back in place after installing the screws.
18. Reinstall window regulator track bracket as seen in Figure 2-7. Be sure nylon bushings and gaskets are installed properly to prevent damage to the glass.
19. Lift window glass in frame and install window regulator roller track to bracket installed in step 18. See Figure 2-8.
20. Holding window glass as seen in Figure 2-9 (a few inches from the top.) Install lower and upper regulator rollers in their tracks. Start by moving door panel (with window regulator) away from cab just far enough to allow the rollers to enter their tracks. Then with the rollers in the tracks slide the panel toward the cab. Move the panel just far enough to allow the upper regulator roller to go into the track on the bottom of the glass.

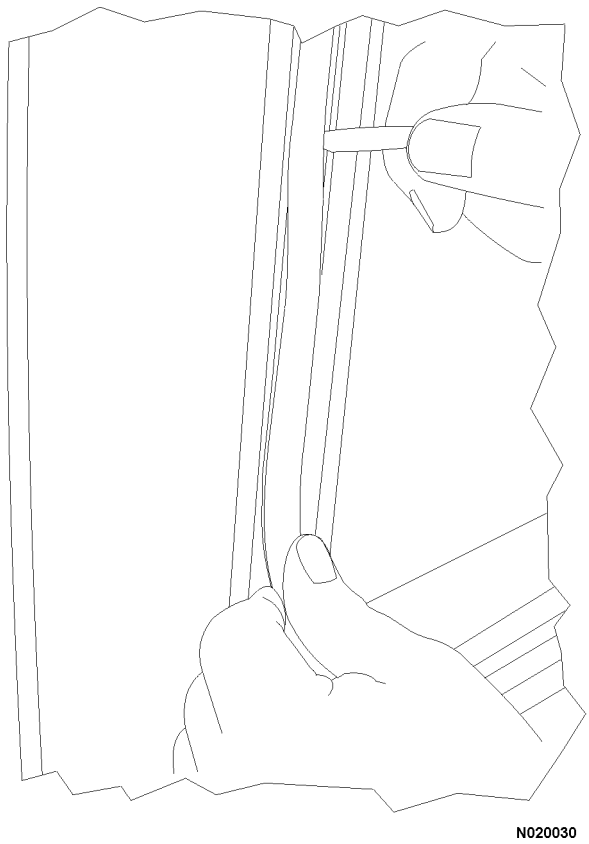


FIGURE 2-15.

21. Lift door panel, regulator and glass up to align screw holes in the panel with holes in door frame. Install screws that retain panel to door frame.
22. Hook-up electrical connector for the window regulator. Install the two cap screws that hold the door strap bracket to the door frame.
23. Align door check strap opening with holes in the bracket and install bolt. Install the hair pin clip. See Figure 2-6.

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Replace Door Window Regulator

1. Follow steps 1-6 procedure for door glass replacement.
2. Move inner panel assembly to a work area to enable replacement of the window regulator. Remove 4 mounting screws. See 6, Figure 2-6.
3. Replacing Window Regulator Motor, or Window Regulator Assembly:
   a. If replacing the motor assembly of the window regulator, be sure the worm gear on the motor is engaged properly into the regulator gear. Also, the regulator should be in the "UP" position before replacing the motor assembly. Be sure the motor mounting screws are tight.
   b. If replacing the window regulator assembly, the new regulator should be in the "UP" position before being mounted.
4. Mount window regulator to the inner panel with the 4 mounting screws removed in step 2. Be sure screws are tight.
5. Refer to door glass replace procedure and follow steps 20-23 to complete replacement.

Replace Door Handle or Latch Assembly

The cab doors are equipped with serviceable latch handle assemblies (inner and outer). If they become inoperative, they should be replaced by a new assembly. The outer latch handle assembly on each door is furnished with a key-operated lock to enable the operator to lock the truck cab while the truck is parked unattended.

1. Follow steps 1-6 procedure for door glass replacement.
2. Refer to Figure 2-14. Remove capscrew and nut (1) from inside door handle.
3. Remove 4 mounting screws (2) for the latch. Remove old latch assembly.

   * If replacing the latch assembly go to step 5.
4. If replacing the outside door handle, remove 3 screws holding handle to door panel (3, Figure 2-14).

Note: Only 1 screw is shown, the other 2 are behind the latch assembly.

5. Install new latch assembly and align mounting holes. Install 4 mounting screws. Be sure they are tight.
6. Align inside door handle and install capscrew and nut (3 Figure 2-14).
7. Follow steps 20-23 of the door glass replacement procedure to complete the repair.

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Door and Door Hinge Seal Replacement

1. The door assembly seal has only three members to it (sides and top) and is glued on the door. This seal can be replaced by peeling the seal away from the door frame. Then use a suitable cleaner to remove the remaining seal and glue material.
2. The area where the door seal mounts should be free of dirt and oil. Spread or spray a glue which is quick drying and waterproof onto the area where the seal is to installed.
3. Install the seal so that the corners of the seal fit up into the corners of the door frame (3, Figure 2-16).
4. The Door Hinge Seal is glued to the hinge. Use the same procedure as above for this seal (2, Figure 2-17).

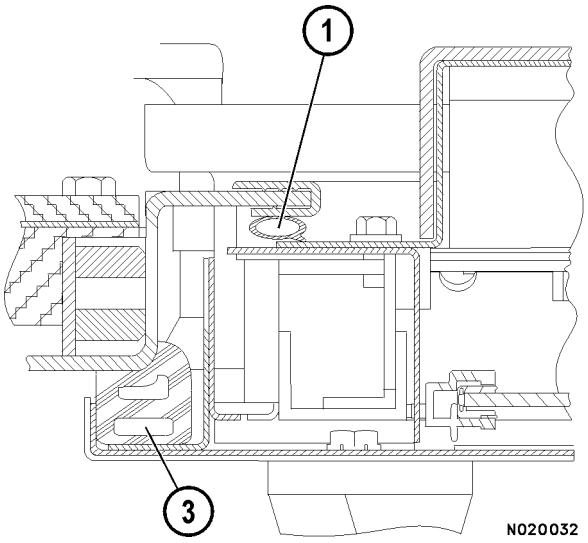


FIGURE 2-16.

1. Door Opening Seal 3. Door Assembly Seal

Door Opening Seal Removal

1. Starting at the lower center of the door opening, pull up on one end of the seal. Seal should pull loose from the cab opening lip. Pull seal loose all the way around the opening (1, Figures 2-16 & 2-17).
2. Inspect cab opening lip for damage, dirt, or oil. Repair or clean cab opening as necessary. Remove dirt, old sealant etc. Be certain perimeter of opening is clean and free of burrs, etc.

Installation

1. Install the seal material around the door opening in the cab. Start at the bottom center of the cab opening and work the seal lip over the edge of the opening. Go all the way around the opening. Be sure that the seal fits tight in corners. A soft face tool may be used to work the seal up into the corners.
2. Continue going all the around the opening. When the ends of the seal meet at the starting bottom center of the cab opening, it may be necessary to trim off some of the seal.

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

3. Fit both ends so that they meet squarely, then while holding ends together, push them firmly into the center of the opening.

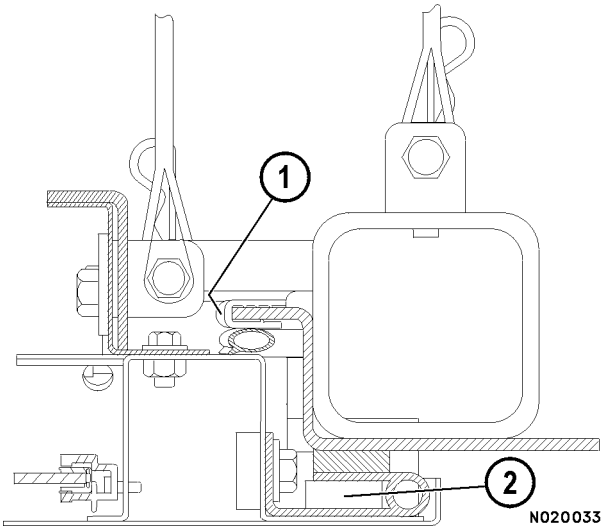


FIGURE 2-17.

1. Door Opening Seal 2. Door Hinge Seal

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GLASS REPLACEMENT

ADHESIVE-BONDED WINDOWS

Recommended Tools/Supplies

- Cold knife, pneumatic knife, or a piano wire cutting device, long knife. Cutout tools are available at an auto glass supply store.
- Heavy protective gloves
- Safety eyeglass goggles
- Windshield adhesives, proper cleaners, primers & application gun
- SM2897 glass installation bumpers (6 - 7 per window)
- Window glass (Refer to Parts Catalog)

Recommended adhesives: SikaTack Ultrafast or Ultrafast II (both heated). Vehicle can be put into service in 4 hours under optimum conditions. Heated adhesives require a Sika approved oven to heat adhesive to 80°C (176°F).
Sikaflex 255FC or Drive (unheated). Vehicle can be put into service in 8 hours under optimum conditions.

Sika Corporation
30800 Stephenson Hwy.
Madison Heights, MI 48071
Toll Free Number: 1-800-688-7452
Fax number: 248-616-7452
http://www.sika.com or
http://www.sikasolutions.com

⚠WARNING

Due to the severe duty application of off-highway vehicles, the cure times listed by the adhesive manufacturer should be doubled before a truck is moved. If the cure time is not doubled, vibration or movement from a moving truck will weaken the adhesive bond before it cures, and the glass may fall off the cab.
If another adhesive manufacturer is used, be certain to follow that manufacturer's instructions for use, including the use of any primers, and double the allowances for proper curing time.

Replacement Procedure

⚠IMPORTANT⚠

The first concern with all glass replacement is SAFETY! Wear heavy protective gloves and safety eyeglass goggles when working with glass.

1. Using chosen cut-out tool, slice into existing urethane adhesive and remove window.
2. Carefully clean and remove all broken glass chips from any remaining window adhesive. The surface should be smooth and even. Use only clean water.

NOTE: Removal of all old adhesive is not required; just enough to provide an even bedding base.

3. Using a long knife, cut remaining urethane from vehicle, leaving a bed 2-4 mm thick. If existing urethane is loose or otherwise unsound, completely remove. Leave the installation bumpers in place, if possible. Clean metal with Sika Aktivator, allow ten minutes to dry. Then paint on a thin coat of Sika Primer 206G+P and allow ten minutes to dry.
4. Using only the new side window(s) which are to be bonded in place, center the new glass over opening in the cab. Using a permanent marker, mark on the cab skin along all the edges of the new glass that is to be installed. All edges must be marked on the cab in order to apply the adhesive in the proper location.
5. Using Sika Primer 206G+P, touch up any bright metal scratches on the metal frame of vehicle. Do not prime existing urethane bed. Allow to dry for ten minutes.
6. Using a clean lint free cloth, apply Sika Aktivator to the black ceramic Frit surrounding the new window. Use a clean cloth and wipe off Sika Aktivator. Allow ten minutes to dry.
7. For the **side windows**, be sure to utilize a total of six or seven (SM2897) glass installation bumpers to the cab, equally spaced around the previously marked glass perimeter, approximately 0.75 in (19 mm) inboard from where the edge of the glass will be when installed.

NOTE: Be careful not to place adhesive too far inboard, as it will make any future replacement more difficult.

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8. Apply a continuous even bead of the adhesive approximately 0.38 in. (10 mm) in diameter to the cab skin at a distance 0.50 - 0.63 in. (13 - 16 mm) inboard from the previously marked final location of the glass edges from Step 4.
9. Immediately install glass to the vehicle. Carefully locate the glass in place with the black masking side towards the adhesive. Carefully press firmly, but not abruptly, into place assuring that the glass is properly seated. DO NOT POUND THE GLASS INTO PLACE.
10. Using a wooden prop and furnace/duct tape, hold the glass in place for at least two (2) full hours (or double the adhesive manufacturer's curing time, which ever time is longer).

NOTE: Do not allow the truck to move until ***double the cure time*** *for the adhesive has passed. Otherwise, vibration or movement from a moving truck will weaken the adhesive bond and the glass may fall off the cab.*

⚠ IMPORTANT ⚠

Be certain to follow all the adhesive manufacturer's instructions for use, including full allowances for proper curing time. The curing time may be as long as 48 hours (24 hours for some adhesives, then double it) before a truck can be driven.

11. Remove tape or prop from glass after the cure time has expired.

WINDSHIELD & REAR GLASS

Two people are required to remove and install the windshield or rear glass. One person inside the cab, and the other person on the outside.

Special tools are available from local tool suppliers that are helpful in removing and installing automotive glass.

Removal

1. If windshield is to be replaced, lift windshield wiper arms out of the way.
2. Starting at the lower center of the glass, pull the weatherstrip locking lip out (2, Figure 2-18 or 2-19). Use a non-oily rubber lubricant and a screwdriver to release the locking lip.
3. Remove glass from weatherstrip by pushing out from inside the cab.
4. Clean weatherstrip grooves of dirt, sealant etc. Be certain perimeter of cab glass opening is clean and free of burrs etc.

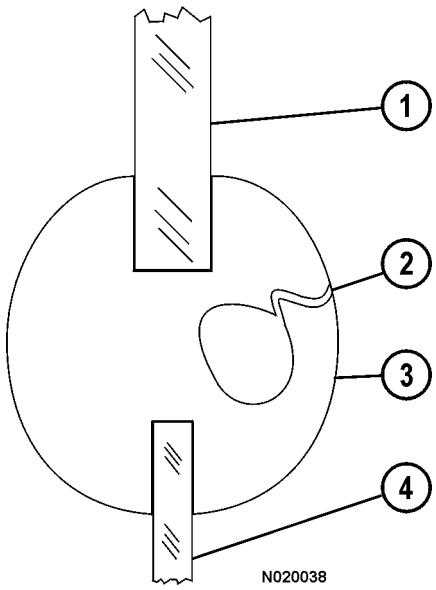


FIGURE 2-18. Front Windshield

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

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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.

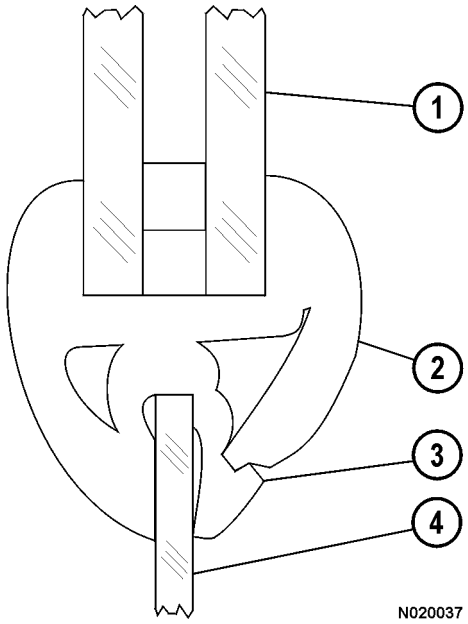


FIGURE 2-19. Rear Window

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

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NOTES:

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CAB COMPONENTS

WINDSHIELD WIPERS

The windshield wipers are operated by a 24 volt electric motor. The wipers can be adjusted for a variable intermittent delay or a constant low or high speed by the switch mounted on the instrument panel.

Wiper Motor

Removal

1. Remove the five screws inside of the cab that secure the visor assembly/access panel. Lower the access panel.
2. Disconnect the wiper motor harness connector.
3. While holding the linkage stationary, remove nut (4, Figure 3-1) and disconnect the linkage from the motor.
4. Remove three capscrews (3) with washers attaching the wiper motor to plate (2). Remove the motor assembly.

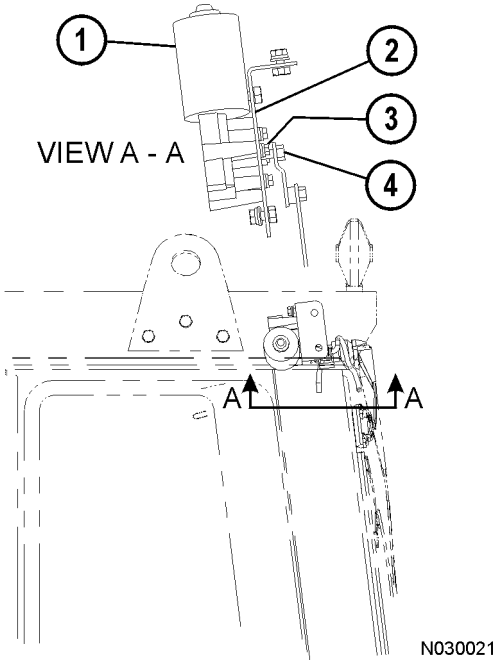


FIGURE 3-1. WINDSHIELD WIPER INSTALLATION

1. Wiper Motor
2. Plate
3. Capscrew
4. Nut

Installation

1. Place wiper motor (1, Figure 3-1) into position on plate (2).
2. Install three capscrews (3) with washers. Tighten capscrews to **71-79 in. lbs. (8-9 Nm)** torque.
3. Align the motor output shaft with the wiper linkage. Install nut (4) and while holding the linkage stationary, tighten nut to **16-18 ft. lbs. (22-24 Nm)** torque.
4. Reconnect the wiper motor harness connector.
5. Verify the wipers operate properly and park in the proper position. Refer to Figure 3-3.

Wiper Arm

Removal

1. Note the parked position of wiper arm (1, Figure 3-2).
2. Lift the wiper arm cover and remove nut (2) and washer (3).
3. Disconnect the washer hose, and remove the wiper arm.

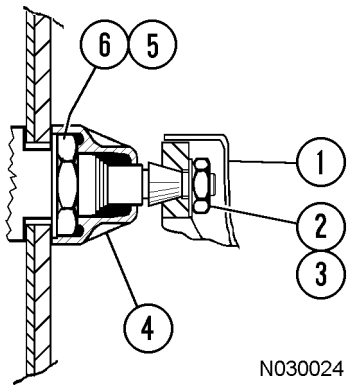


FIGURE 3-2. WIPER ARM DETAIL

1. Wiper Arm
2. Nut
3. Spring Washer
4. Cap
5. Washer
6. Nut

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Installation

1. Place wiper arm (1, Figure 3-2) into the position noted during removal. Install washer (3) and nut (2). Tighten the nut to **142-177 in. lbs. (16-20 Nm)** torque. Close the cover.
2. Connect the washer hose to the wiper arm.
3. Ensure the wipers arms operate properly and park in the proper position after installation is complete. Refer to Figure 3-3.

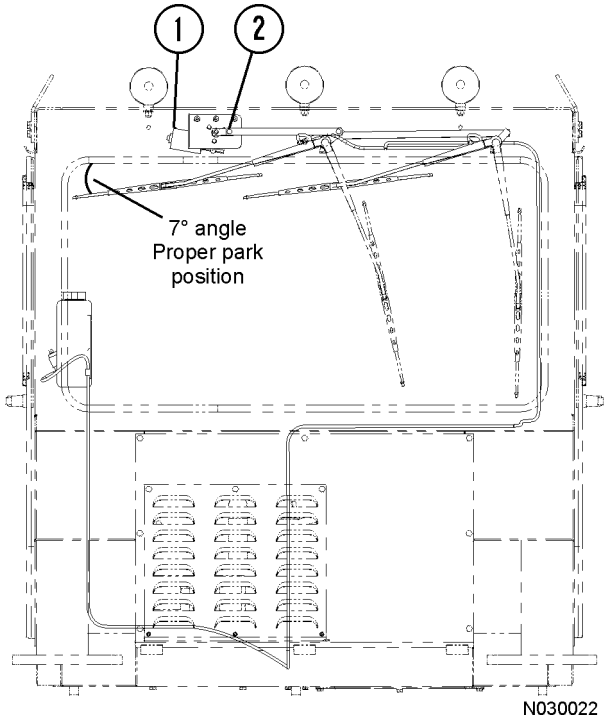


FIGURE 3-3. PARK POSITION

1. Wiper Motor
2. Linkage Retainer

Wiper Linkage

Removal

1. Remove the wiper arms. Refer to Wiper Arm Removal in this section.
2. Remove wiper retainer (2, Figure 3-3) and disconnect the wiper linkage from the wiper motor drive arm.
3. Remove nut (6, Figure 3-2) and the washer (5) from each wiper shaft.
4. If equipped, remove four capscrews (2, Figure 3-4) with washers.
5. Remove the pillow blocks (3) from the wiper compartment.

Installation

1. Place the linkage into position in the wiper compartment.
2. Install pillow blocks (3, Figure 3-4). Install capscrews (2) with washers and tighten capscrews.
3. Install nut (6, Figure 3-2) with washer (5) on each wiper shaft and tighten finger-tight. Tighten the nuts to **160-177 in. lbs. (18-20 Nm) torque**. **Do not overtighten. The threads on the shafts are easily stripped when improperly tightened.** Install cap (4) over nut (6).
4. Align the linkage and attach to the wiper motor drive arm using retainer (2, Figure 3-3).

NOTE: When the motor is parked, the drive arm will be in the 3 o'clock position as shown in Figure 3-3.

5. Install the wiper arms. Refer to Wiper Arm Installation. Ensure the wipers arms operate properly and park in the proper position after installation is complete.

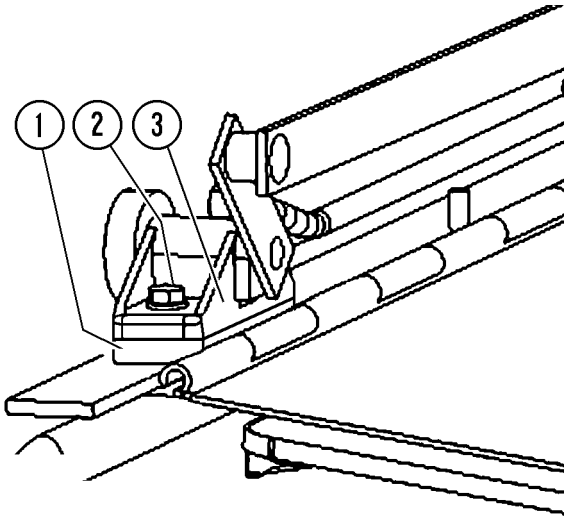


FIGURE 3-4. PILLOW BLOCK INSTALLATION

1. Spacer Block
2. Capscrew
3. Pillow Block

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WINDSHIELD WASHER

Operation

The windshield washer, mounted on the right side of the hydraulic components cabinet behind the cab, has a 3.8 liter (1 gal) plastic reservoir (1, Figure 3-5) with a 24 volt electric pump (2).

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

Service

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

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

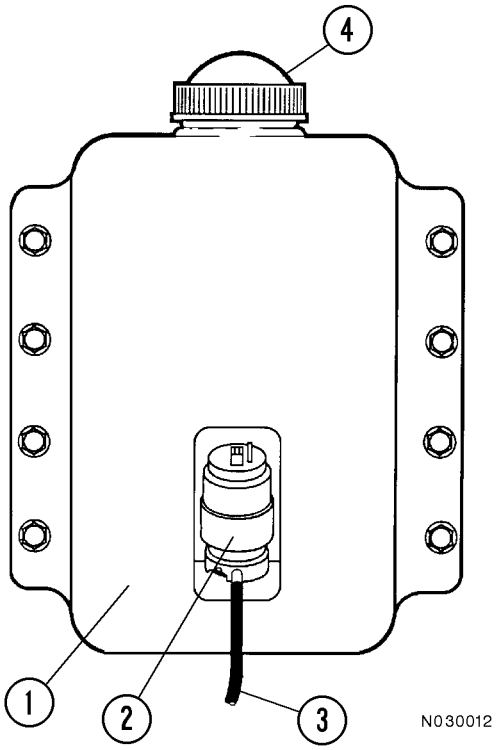


FIGURE 3-5. WINDSHIELD WASHER FLUID RESERVOIR AND PUMP

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

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NOTES:

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OPERATOR COMFORT

OPERATOR SEAT

The operator's seat provides a fully adjustable cushioned ride for the driver's comfort and ease of operation.

Adjustment

The following adjustments must be made while sitting in the seat.

1. **Headrest**: Move up, down, fore, or aft by moving headrest (1, Figure 4-1) to desired position.
2. **Armrests**: Rotate adjusting knob until armrest is in desired position.
3. **Backrest**: Lift handle (3) to release and select backrest angle; release control handle to set.
4. **Seat Belt**: Operator should always have seat belt (4) buckled in place and properly adjusted whenever vehicle is in motion.
5. **Seat Slope**: Lift lever (5) and hold to adjust the slope of seat. Release lever to lock adjustment.
6. & 7 **Air Lumbar Support:** Each rocker switch (6 or 7) controls an air pillow. Switch (7) controls the lower air pillow and switch (6) controls the upper air pillow. To inflate, press on top of rocker switch and hold for desired support, then release. To deflate, press on bottom of rocker switch and hold for desired support, then release. Adjust each pillow for desired support.
8. **Seat Suspension**: Move rocker switch (8) up to increase ride stiffness and down to decrease ride stiffness.
9. **Horizontal Adjustment:** Lift control lever (9) and hold. Bend knees to move seat to a comfortable position; release control lever to lock adjustment
10. **Seat Height**: Lift lever (12) and hold to adjust the height of the seat. Release lever to lock adjustment.

Seat Removal

1. Remove capscrews (10, Figure 4-1) and hardware that secures the seat base to the riser. Remove capscrews (11) that secures tether to floor.
2. Remove seat assembly from cab to clean work area for disassembly.

Seat Installation

1. Mount seat assembly to seat riser. Install capscrews (10, Figure 4-1), lockwashers, flatwashers and nuts. Tighten capscrews to standard torque.
2. Fasten tether straps to floor with capscrews (11), flatwashers and lockwashers. Tighten capscrews to standard torque.

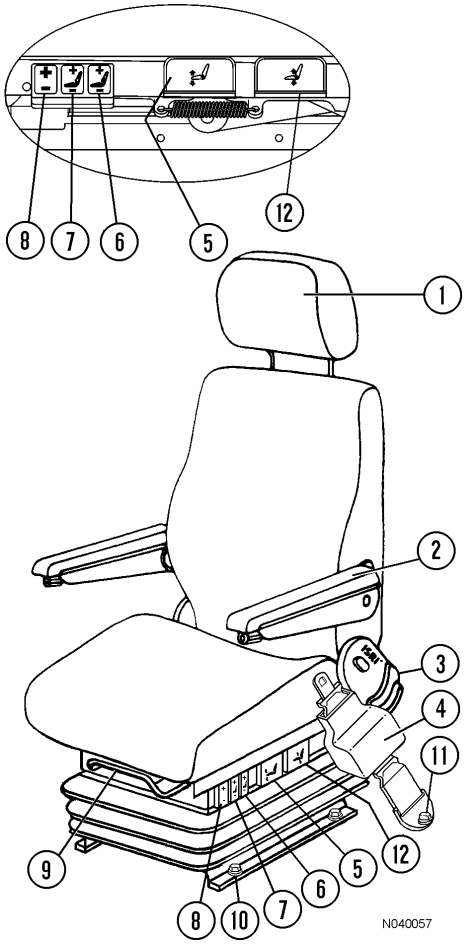


FIGURE 4-1. OPERATOR'S SEAT ADJUSTMENT CONTROLS

1. Headrest
2. Armrest Adjustment
3. Backrest Adjustment
4. Seat Belt
5. Seat Slope Adjustment
6. Upper Air Pillow Lumbar Support
7. Lower Air Pillow Lumbar Support
8. Suspension Adjustment
9. Horizontal Adjustment
10. Mounting Capscrews and Hardware
11. Seat Tether Capscrew
12. Seat Height Adjustment

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HEATER/AIR CONDITIONER CONTROLS

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

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

OPERATION

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

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

All heater and air conditioner controls are mounted on a pod on the face of the enclosure. Refer to Figure 4-2 for the following:

- Defroster Switch (1): This is a 2-position toggle switch; "down " is "OFF". "Up" provides air flow through the defroster vents.
- Heat Vent Control Switch (2): This is a 2-position toggle switch; "down " is "OFF". "Up" provides heated air flow to the cab floor.
- Temperature Control Knob (3): This is a variable rotary control. Rotating the knob counterclockwise (blue arrow) will select increasingly cooler temperatures. Rotating the knob clockwise (red arrow) selects increasingly warmer temperatures.
- Fan Control (4); This is a 4-position rotary switch; rotate knob to select off, low, medium, or high fan speed.
- Heater/Air Conditioner Selector Switch (5): This is a three position switch; the right position activates the heater, the left position activates the air conditioner, and the center position is "OFF"

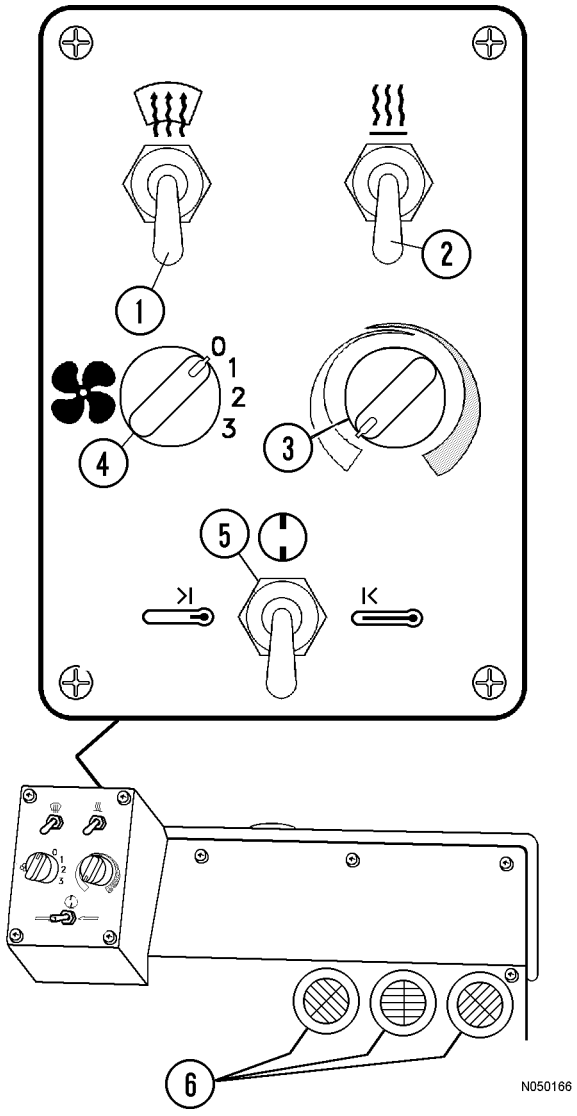


FIGURE 4-2. HEATER/AIR CONDITIONER CONTROLS

1. Defroster Control
2. Heat Control
3. Temperature Control
4. Fan Control
5. Heater/Air Conditioner Selector
6. Outlet Vents

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HEATER/AIR CONDITIONER

The heater assembly incorporates all the controls necessary for regulating the cab interior temperature; heated air during cold weather operation and cooled, de-humidified air during warm weather operation if the optional air conditioning system is installed.

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

OPERATION

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

An engine driven freon compressor passes air conditioning system refrigerant through an evaporator core 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.

HEATER COMPONENTS

Figures 4-3 and 4-4 illustrate both the heater system and air conditioning system parts contained in the cab mounted enclosure. Refer to Section "M" for additional information regarding air conditioning system components, maintenance and repair.

CIRCUIT BREAKERS

Before attempting to troubleshoot the electrical circuit in the heater enclosure, turn key switch ON and verify circuit breaker CB31 (located on Power Distribution Module behind operator's seat) and the internal heater circuit breaker have not opened by verifying +24VDC is present on the junction block (38, Figure 4-4).

RELAYS

There are five relays (9, Figure 4-3) that control the air dampers, A/C compressor and the heater valve. All five relays require 12 volts D.C. through the coil which is supplied by a 24VDC - 12VDC converter (2).

One relay (Relay 1) switches 24 volt current to actuate the A/C compressor clutch. The temperature control switch, heater valve and the actuator motors all operate on 12 volts D.C. current.

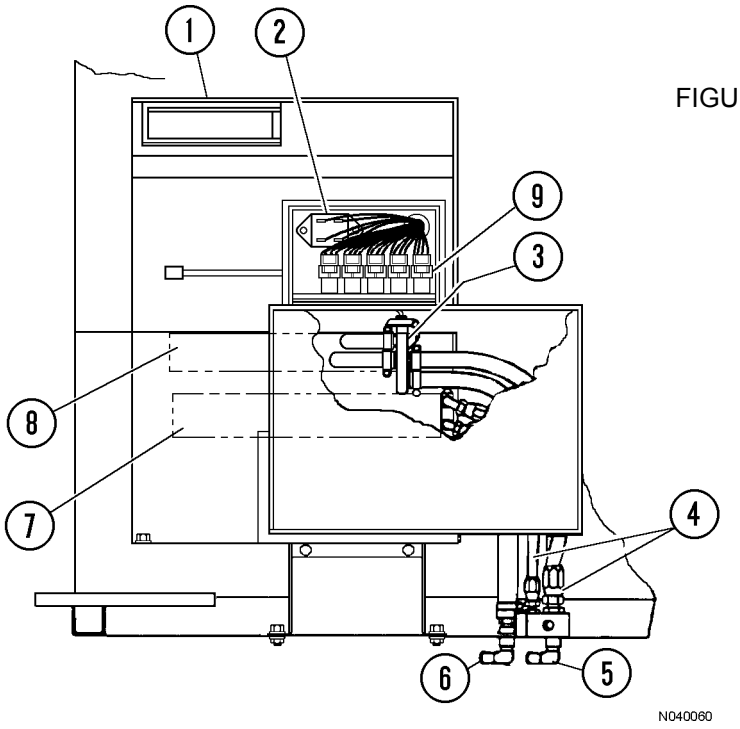


FIGURE 4-3. CAB HEATER/AIR CONDITIONER COMPONENTS

1. Enclosure
2. Converter (24 V to 12 V)
3. Water Control (Heater) Valve
4. A/C Freon Hoses
5. Water Outlet (To Engine)
6. Water Inlet (From Engine Water Pump)
7. Evaporator Core
8. Heater Core
9. Relays

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HEATER CORE

The heater core (46, Figure 4-4) receives engine coolant through the heater valve (14) when HEAT is selected. If the temperature control potentiometer (37) is placed in between the red and blue area, or turned counterclockwise to the blue area, coolant flow should be blocked.

If the selector switch (34) and heater valve appear to be working properly, yet no heat is apparent in the heater coil (46), the coil may be restricted. Remove and clean or replace the coil.

FAN MOTOR AND SPEED CONTROL

Fan speed is controlled by inserting resistor(s) (49 & 50) in series with the supply circuit to the blower motor to reduce voltage. The number of resistors in series is determined by the position of the fan speed selector switch.

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

Test

If the motor (5) does not operate at any of the speed selections, verify battery voltage is available at the switches, relay, and circuit breakers (refer to electrical schematic, Section R). If voltage is present, the motor is probably defective and should be removed and replaced.

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

ACTUATORS

Two (2) rotary actuators (8, Figure 4-4) are installed inside the heater housing and are used to actuate the flappers for the following:

- Defroster outlet
- Bi-level or floor outlets

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

Test

Visually inspect the flappers (11, or 43) and linkage for the function being diagnosed. Make certain the flapper is not binding or obstructed, preventing movement from one mode to the other.

Verify voltage (12 volts) is present at the actuator when the toggle switch is closed or absent when the toggle switch is opened.

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

FILTER

Service

Inlet filters in the heater cover (19) and the cab access panel need periodic cleaning to prevent restrictions in air circulation. Restricted filters will decrease the performance of the heater and air conditioner. The recommended interval for cleaning and inspection is 250 hours, but in extremely dusty conditions, the filters may need daily service and inspection, especially the outer panel filter on the cab shell. The filter elements should be cleaned with water and dried in a dust free environment before reinstallation. Replace the filter element every 2000 hours or sooner if inspection indicates a clogged or damaged filter.

AIR CONDITIONER COMPONENTS

Components installed in the heater housing, unique to the air conditioner system, are discussed in Section M, "Air Conditioning System" .

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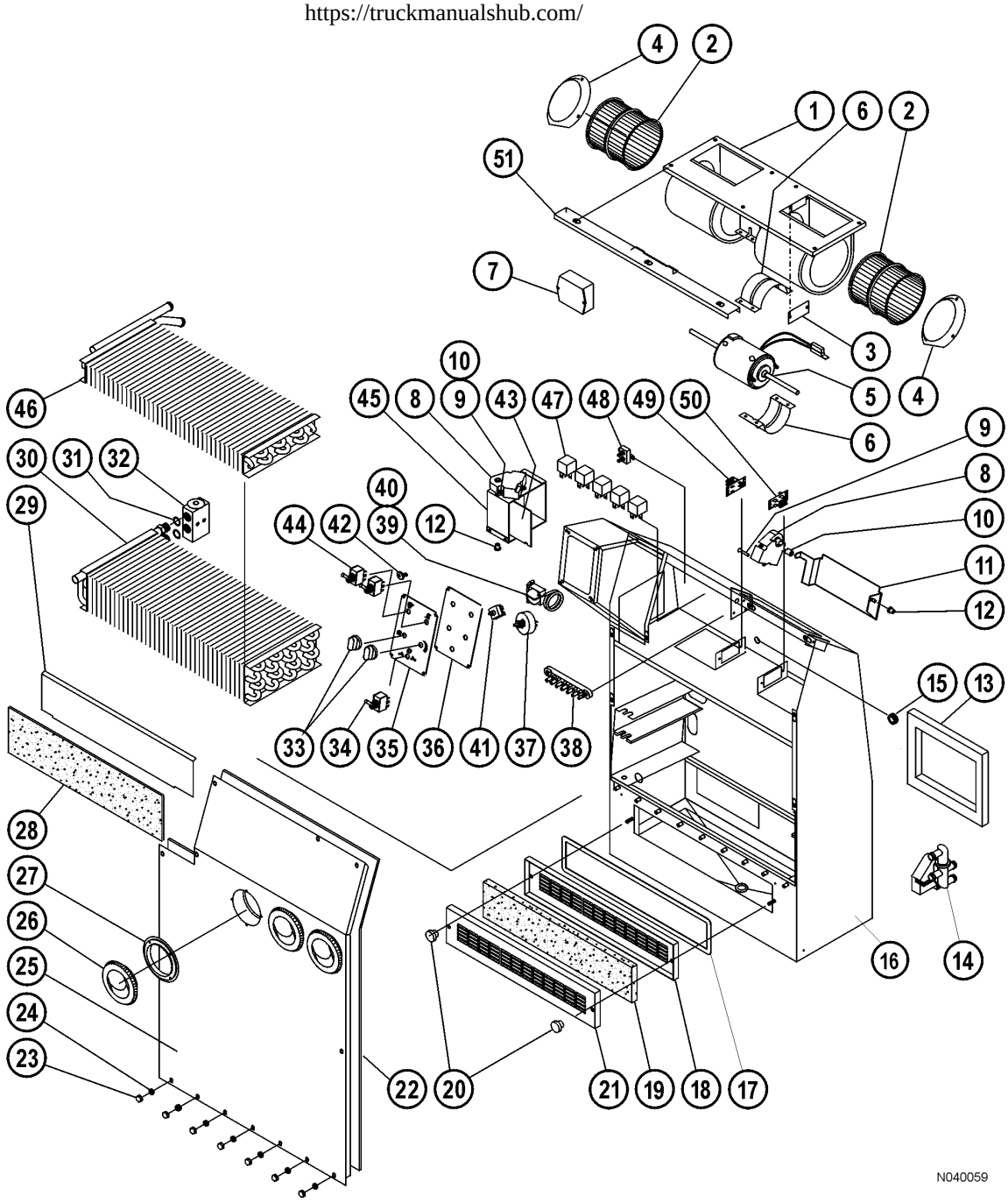


FIGURE 4-4. HEATER/AIR CONDITIONER ASSEMBLY

1. Blower Housing
2. Blower Wheel
3. Cover Plate
4. Venturi
5. Motor, 24V
6. Motor Mount
7. Converter (24V-12V)
8. Actuator Motor
9. Screw
10. Spacer
11. Defrost Flapper
12. Snap Bushing
13. Foam
14. Heater Valve
15. Grommet
16. Casing
17. Gasket
18. Filter Holder
19. Air Filter
20. Knob
21. Filter Holder
22. Foam Insulation
23. Nut
24. Flatwasher
25. Cover
26. Louver
27. Louver Adapter
28. Foam
29. Plate, Coil
30. Evaporator Core
31. O-Ring
32. Expansion Valve
33. Knob
34. Toggle Switch (3 pos.)
35. Overlay
36. Plate, Control
37. Potentiometer
38. Block, Junction
39. Thermostat
40. Hose
41. Switch, Blower
42. Screw
43. Discharge Flapper
44. Toggle Switch (2 pos.)
45. Bracket, Flapper
46. Heater Core
47. Relay (12V)
48. Circuit Breaker
49. Resistor (12 Volt)
50. Resistor (24 Volt)
51. Retainer, Blower

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NOTES:

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OPERATOR CONTROLS AND EQUIPMENT

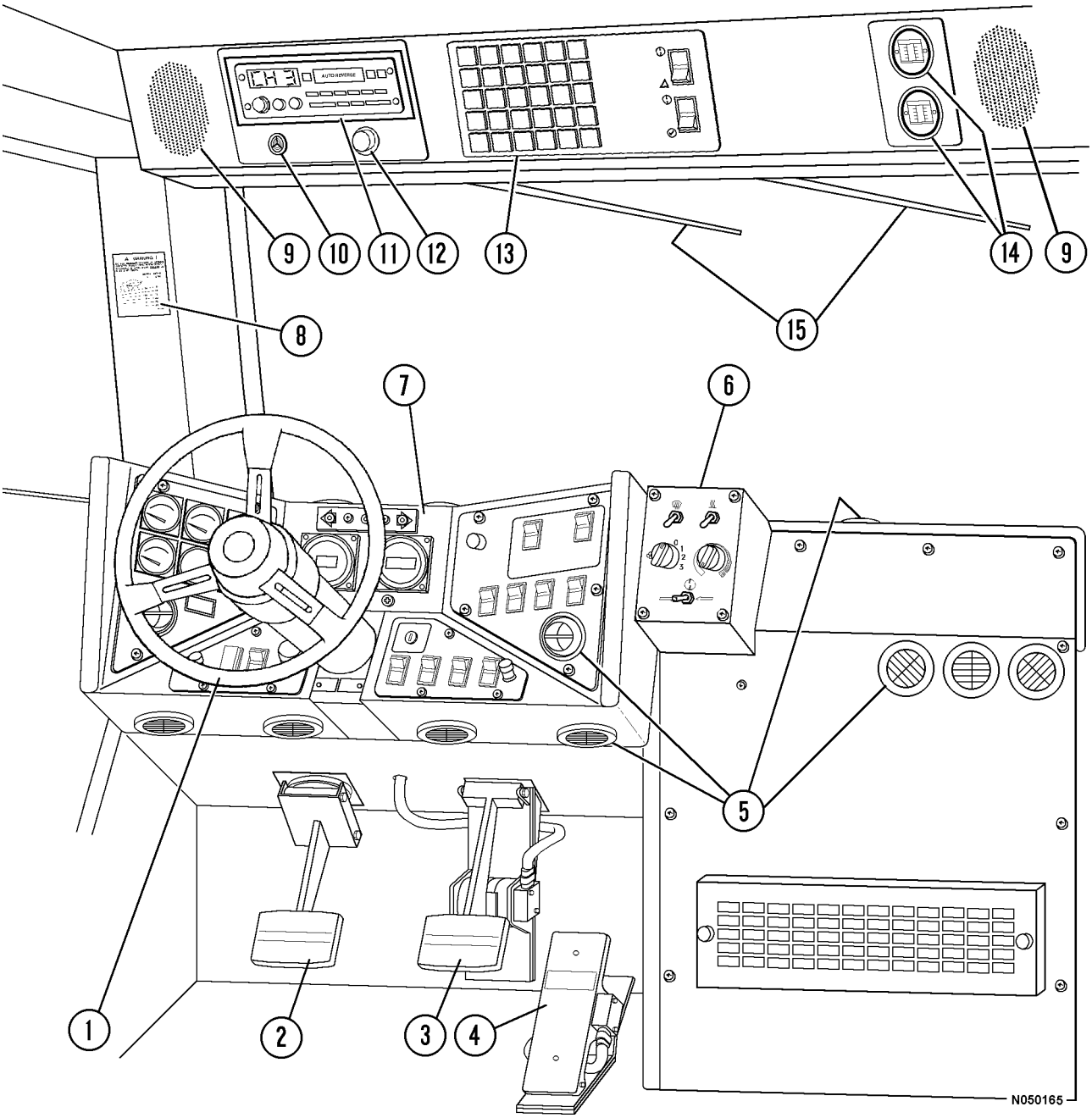


FIGURE 5-1. CAB INTERIOR - OPERATOR CONTROLS

1. Steering Wheel
2. Service Brake Pedal
3. Retarder Pedal
4. Throttle / Accelerator Pedal
5. Heater / Air Conditioner Vents
6. Heater / Air Conditioner Controls
7. Instrument Panel
8. Grade / Speed Chart
9. Radio Speakers
10. Warning Alarm Buzzer
11. Radio, AM/FM Stereo, Cassette
12. Warning Lights Dimmer Control
13. Warning / Status Indicator Lights
14. Air Cleaner Vacuum Gauges
15. Windshield Wipers

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STEERING WHEEL AND CONTROLS

The steering wheel (1, Figure 5-2) will telescope “in” and “out” and adjust through a tilt angle to provide a comfortable wheel position for most operators.

HORN BUTTON

The horn (2, Figure 5-2) is actuated by pushing the button in the center of the steering wheel. Operation of the horn should be verified before moving the truck. Observe all local safety rules regarding the use of the horn as a warning signal device before starting engine and moving the vehicle.

TILT / TELESCOPE LEVER

The steering column can be telescoped or the wheel tilted with the lever (3, Figure 5-2) in front of the turn signal lever.

Adjust the tilt of the steering wheel by pulling the lever toward the steering wheel and moving the wheel to the desired angle. Releasing the lever will lock the wheel in the desired location.

Adjust the telescope function by pushing the lever forward to unlock. After positioning as desired, release the lever to lock position.

TURN SIGNAL / HEADLIGHT DIMMER

The Turn Signal Lever (4, Figure 5-2) is used to activate turn signal lights and to select either high or low headlight beams.



Move the lever upward to signal a turn to the right.

An indicator in the top, center of the instrument panel will illuminate to indicate turn direction selected. Refer to INSTRUMENT PANEL & INDICATOR LIGHTS.



Move the lever downward to signal a turn to the left.

Moving the lever toward the steering wheel changes the Headlight beam. When high beams are selected, the indicator in the top, center of the instrument panel will illuminate.



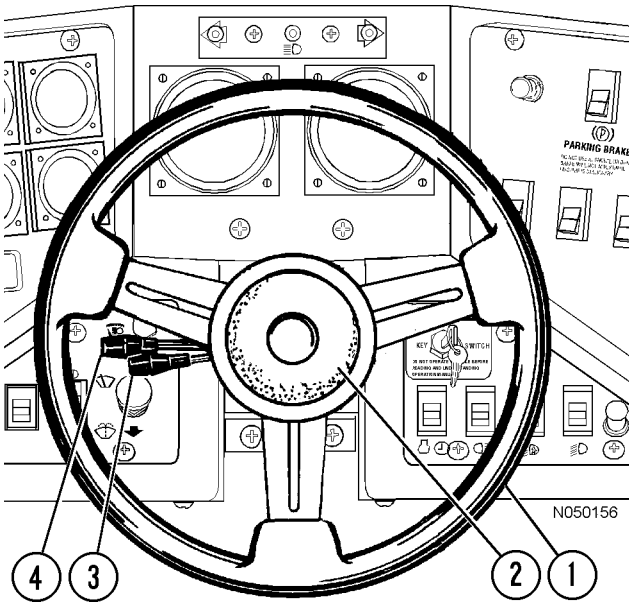


FIGURE 5-2. STEERING WHEEL AND CONTROLS

STEERING COLUMN

Removal

1. Shut down engine by turning the key switch OFF and allow at least 90 seconds for the steering accumulators to bleed down. Turn the steering wheel to be certain no pressure remains.
2. Open the battery disconnect switch.
3. Remove the access cover (15, Figure 5-3) from the front of the cab. If steering control unit is OK, do not disconnect any hydraulic lines.
4. Loosen capscrews (10) on steering control unit (7) and move it out of the way.
5. Disconnect wire harness(s) from the steering column.
6. Remove screws retaining trim cover (14) where steering column enters the instrument panel and remove cover.
7. Remove four capscrews (4). Access to these screws is from the front of the cab through the access opening. Also remove capscrews (12).
8. Lift the steering column out of the instrument panel.

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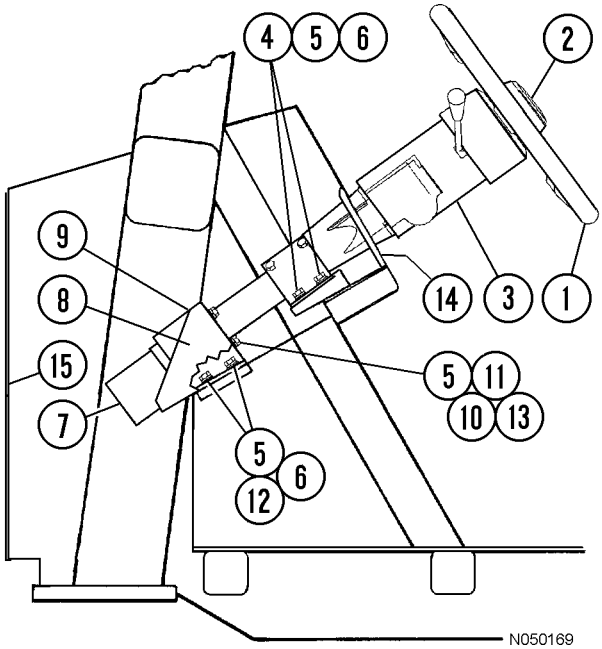


FIGURE 5-3. STEERING COLUMN INSTALLATION

1. Steering Wheel
2. Button Horn
3. Steering Column
4. Capscrew
5. Flat Washer
6. Lock Washer
7. Steering Control Unit
8. Bracket L.H.
9. Bracket R.H.
10. Capscrew
11. Lock Washer
12. Capscrew
13. Nut
14. Trim Cover
15. Access Cover

Steering Column Inspection

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

1. With steering column assembly removed from truck, thoroughly clean splines on steering column shaft and inspect for damage or excessive wear.
2. Using an outside micrometer or dial caliper, measure the outside diameter of the male splines on the steering column shaft.

- **Minimum diameter:** 0.950 in. (24.13 mm)

3. If splines are smaller than minimum diameter specification, replace steering column.

Installation

1. Insert capscrew (10) with lockwashers (11) and flatwashers (5) through brackets (8 & 9) and then through steering column flange. Add second flatwasher (5) and nut (13) to each capscrew to hold parts together. Tighten nuts securely.
2. Slide the entire assembly down the tapered blocks until the brackets (8 & 9) contact the mounting surface in the cab. Install capscrews (4) and (12) with washers (5) and (6). Only tighten capscrews (4).
3. Inspect brackets (8 & 9) to see if they contact the mounting surface evenly, and are flat and inline with the surface. If so, then tighten capscrews (12). If brackets are not quite parallel, then install flat washers (as needed) between brackets and mounting surface to eliminate any gaps. Tighten capscrews (12) to standard torque.
4. After capscrews (4 & 12) are tightened to standard torque, remove nuts (13) and flatwashers (5) that were holding the steering column to the two brackets. Do not remove capscrews (10) from the brackets.
5. Lubricate the male splines on the end of the steering column shaft.

Note: There is no lower end bearing in this new steering column assembly, therefore the male end of the shaft will have to be guided into the mating female part of the steering control unit (7).

6. Without removing capscrews (10) from the holes, move the steering control unit (7) into place and start each of the capscrews.
7. Tighten the four capscrews (10) to standard torque.
8. Check for proper steering wheel rotation without binding. Be certain wheel returns to neutral after rotating 1/4 turn left and right.
9. If disconnected, re-connect the hoses to the steering control unit.
10. Connect the steering column wire harness(es) to the harness(es) in the cab.

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PEDAL CONTROLS

THROTTLE PEDAL

The Throttle Pedal (4, Figure 5-4) is a foot operated pedal which allows the operator to control engine RPM depending on the amount of pedal depression.

SERVICE BRAKE PEDAL

The Service Brake Pedal (2, Figure 5-4) is a foot operated pedal controlling a hydraulic valve, which modulates pressure to the service brakes.

*NOTE: Some trucks may be equipped with an **optional**, single brake pedal. This pedal combines the dynamic retarder and service brake functions on the same pedal. Trucks with this option will not have a pedal on the left side (2, Figure 5-4). Refer to description below.*

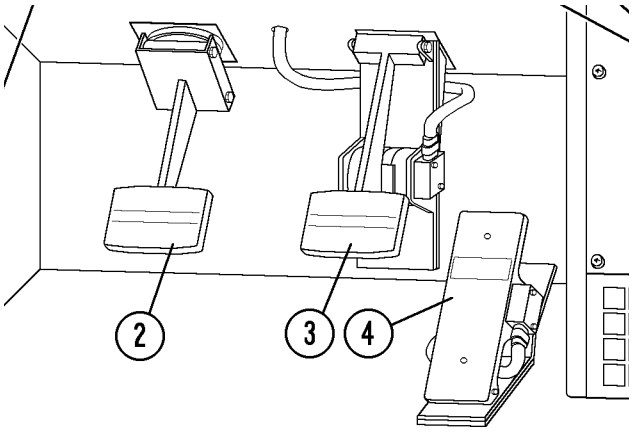


FIGURE 5-4. OPERATOR PEDALS

2. Service Brake Pedal
3. Dynamic Retarder Pedal
4. Throttle Pedal

OPTIONAL DUAL FUNCTION/ SINGLE PEDAL

The optional Dynamic Retarding/Brake pedal is a single pedal controlling both the retarding and service brake functions. With this system, the operator must first apply maximum dynamic retarding before the service brakes may be applied.

When the pedal is depressed, the first portion of the pedal stroke actuates an electronic pedal potentiometer, sending an electrical signal to the Statex III electrical system, initiating the dynamic retarding function. The amount of retarding effort applied depends on the amount of pedal depression, varying from minimal when lightly depressed to maximum when the pedal potentiometer signal reaches maximum voltage as more pressure is applied.

Further pedal depression starts application of the service brakes as the hydraulic brake valve is actuated. (A slight increase in pedal effort will be felt.) Note that use of the service brakes also ensures maximum dynamic retarding has been applied.

Completely depressing the pedal causes full application of both dynamic retarding and the service brakes.

DYNAMIC RETARDING PEDAL

The Dynamic Retarder Pedal (3, Figure 5-4) is a foot-operated pedal which allows the operator to slow the truck and maintain a safe productive speed without the use of the service brakes. For normal truck operation, only dynamic retarding should be used to slow and control the speed of the truck. The Grade/Speed Chart (8, Figure 5-1) should always be followed to determine MAXIMUM safe truck speeds for descending various grades with a loaded truck. Service brakes should be applied only when dynamic retarding requires additional braking force to slow the truck speed quickly and to bring the truck to a complete stop.

When dynamic retarding is in operation, the engine RPM will automatically go to an advance RPM retard speed setting (usually 1250 RPM)*. Dynamic retarding will be applied automatically, if the speed of the truck reaches the predetermined overspeed retard setting. Dynamic Retarding is available in “Forward/ Reverse” at all truck speeds above 0 mph/kph, but is available in “Neutral” only when truck speed is above 3 mph (4.8 kph).

** NOTE: The exact engine speed in retarding may vary (1250 - 1650 RPM) due to the temperature of certain components; this is controlled by the Statex III control system.*

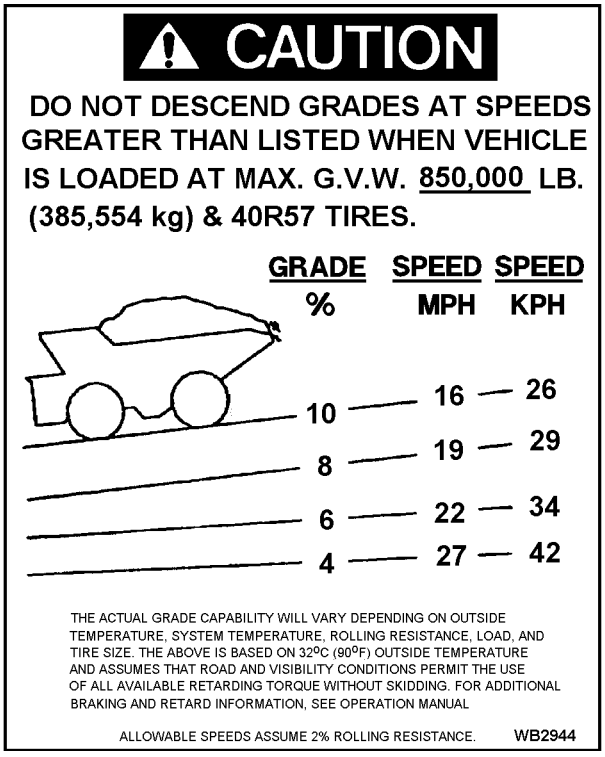
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OVERHEAD CONTROLS, GAUGES, ETC.

GRADE/SPEED WARNING CHART

The Grade/Speed WARNING chart (8, Figure 5-1 and also shown below) provides the recommended MAXIMUM truck speeds for descending various grades with a loaded truck. The operator should reference this chart before descending any grade with a loaded truck. Proper use of Dynamic Retarding will maintain a safe speed.

DO NOT exceed these recommended MAXIMUM speeds when descending grades with a loaded truck.



The sample chart above applies to a model 830E equipped with GE787 wheel motors with 31.875:1 gear ratio, 40R57 tires, and 18 element 3-step retarding grids. This decal may change with OPTIONAL truck equipment such as: wheelmotor gear ratios, retarder grids, tire sizes, etc. **ALWAYS refer to this decal in the operator's cab**, and follow these recommendations for truck operation.

RADIO SPEAKERS

Radio Speakers (9, Figure 5-1) for the AM/FM Stereo radio are located at the far left and right of the overhead panel.

WARNING ALARM BUZZER

This alarm (10, Figure 5-1) will sound when activated by any one of several truck functions. Refer to *"Instrument Panel and Indicator Lights"*, for a detailed description of functions and indicators that will activate this alarm.

CAB RADIO

This panel will normally contain an AM/FM Stereo radio (11, Figure 5-1). Refer to Section 6, Optional Equipment, for a more complete description of the radio and its functions. Individual customers may use this area for other purposes, such as a two-way communications radio.

WARNING LIGHTS DIMMER CONTROL

This control knob (12, Figure 5-1) permits the operator to adjust the brightness of the Warning Indicator Lights.

STATUS / WARNING INDICATOR LIGHT PANEL

This panel (13, Figure 5-1) contains an array of indicator lights to provide the operator with important status messages concerning selected truck functions. Refer to *"Instrument Panel and Indicator Lights",* for a detailed description of these indicators.

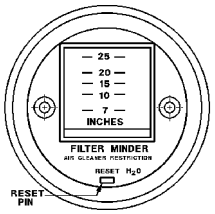
WINDSHIELD WIPERS

The windshield wipers (15, Figure 5-1) are powered by an electric motor. Refer to *"Instrument Panel and Indicator Lights",* for location and description of the windshield wiper and washer controls.

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AIR CLEANER VACUUM GAUGES

The air cleaner vacuum gauges (14, Figure 5-1) provide a continuous reading of maximum air cleaner restriction reached during operation.



The air cleaner(s) should be serviced when the gauge(s) shows the following maximum recommended restriction:

Komatsu SDA16V160 or SSDA16V160 Engine: 25 inches of H_2O vacuum.

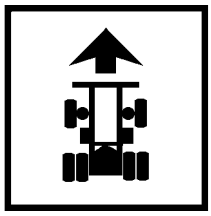
NOTE: After service, push the reset button on face of gauge to allow the gauge to return to zero.

CENTER CONSOLE CONTROLS

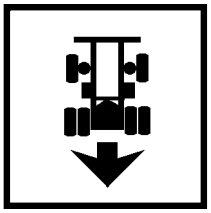
Refer to Figure 5-5 for the following controls.

F-N-R SELECTOR SWITCH

The selector switch (2, Figure 5-5) is mounted on a console to the right of the operator's seat. The Selector Switch controls the FORWARD-NEUTRAL-REVERSE motion of the truck. When the Selector Switch handle is positioned to the center, it is in the **"N"** position and is in "NEUTRAL". **The handle must be in neutral to start the engine.**



The operator can select FORWARD drive by moving the handle forward.



REVERSE drive is selected by moving the handle to the rear.

The truck should be stopped before the selector handle is moved to a drive position.

1. Center Console
2. F-N-R Selector Switch
3. Hoist Control Lever
4. Ash Tray
5. Cigar Lighter
6. L.H. Window Switch
7. R.H. Window Switch
8. Engine Shutdown Switch
9. Override Switch
10. (Not Used)
11. RSC Switch
12. RSC Dial
13. Statex III Diagnositics Port
14. Engine Diagnostic Port (CENSE)
15. Modular Mining Port (Optional)
16. Passenger Seat
17. Engine Diagnostic Port (QUANTUM)
18. Not Used
19. Data Store Button
20. Service Engine Light (Blue)

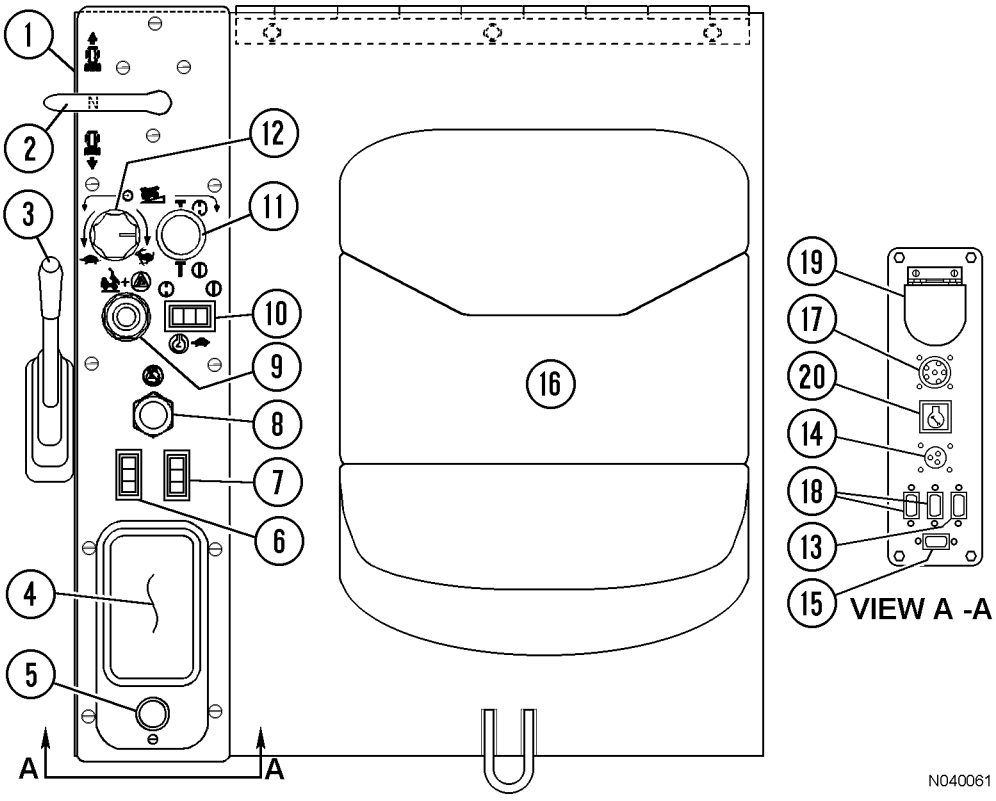


FIGURE 5-5. CONSOLE CONTROLS

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HOIST CONTROL

The hoist control lever (3) is a three position hand operated device located to the right of the operator seat. (Refer to Figure 5-6)

To Raise dump body:

1. Pull the lever to the rear to actuate 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 last stage of hoist cylinder begins to extend and let engine go to low idle as last stage reaches half-extension.
4. Release hoist lever as last stage reaches full extension.

To lower body:

Move hoist lever forward to "down" position and release. Releasing the lever places hoist control valve in the "float" position allowing the body to return to frame.

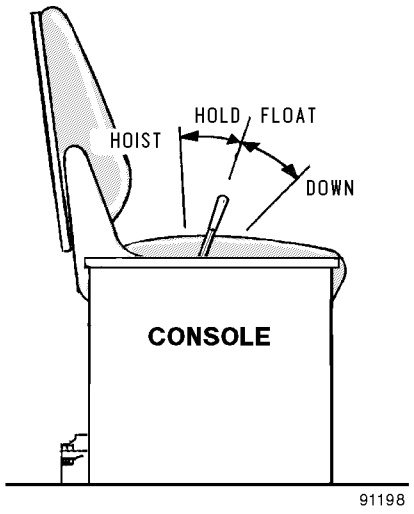


FIGURE 5-6. HOIST CONTROL LEVER

ASH TRAY

The ash tray (4, Figure53-5) is used for extinguishing and depositing smoking materials. DO NOT use for flammable materials, such as paper wrappers. **Be certain that all fire ash is extinguished**!

LIGHTER

The 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.

WINDOW SWITCHES

The window switches (6 & 7, Figure 5-5) are 3-position switches. The center position is OFF, pressing the front of the switch raises the window, pressing the rear of the switch lowers the window.

ENGINE SHUTDOWN SWITCH



The engine shutdown switch (8, Figure 5-5) provides an alternate method of shutting down the engine. (Normally the key switch is turned OFF to shutdown the engine.)

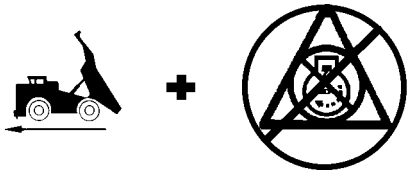
The switch may be used, if for some reason the key switch does not shut down the engine or to shut down the engine without turning off the 24 VDC electrical circuits as is sometimes necessary during troubleshooting operations.

In addition, a ground level shutdown switch is located near the right access ladder.

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OVERRIDE SWITCH

The override switch (9) is spring loaded to the OFF position. When pushed in and held, the switch may be used for several functions.



- The override switch may be used to move the truck forward when the selector switch is in FORWARD, the dump body is raised, and the brakes are released.

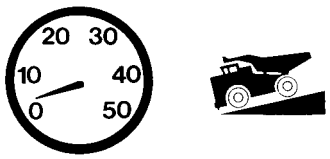
⚠CAUTION

Use of the override switch is intended for emergency situations only.

- If the operator stops the truck on an uphill incline, the override switch can be used to set up forward propulsion while the brakes are applied. As soon as forward propulsion is felt, completely release the brakes and a few seconds later release the override switch.
- The push button deactivates the retard pedal function when truck speed is below 3 MPH (4.8 km/h).
- The override switch is also used to reset the electric system fault when indicated by the red warning light. (Refer to *"Indicator Lights"*)

RETARD SPEED CONTROL (RSC) SWITCH

The Retard Speed Control Switch (11) turns the system "On" or "Off".



"IN"

Push the Retard Speed Control Switch knob "IN" to turn "OFF".



"OFF"



"OUT"



Pul the Retard Speed Control knob "OUT" to turn the system "ON".

"OUT



Then the system is ON, an amber indicator light on the overhead panel is illuminated. (Refer to "Indicators Lights" for location.

RSC ADJUST DIAL

The RSC Adjust Dial (12, Figure 5-5) allows the operator to vary the downhill truck speed that the Retard Speed Control system will maintain when descending a grade.

Operation

When the dial is rotated counterclockwise, the truck will descend at a lower speed.



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



The position of the throttle pedal will override the RSC setting. If the operator depresses the throttle pedal to increase truck speed, dynamic retarding will not activate unless the truck overpseed setting is reached or the foot applied retard pedal is depressed.

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When the throttle pedal is released and the RSC switch is ON, dynamic retarding will activate at, or above, the RSC dialed speed and will adjust truck speed to maintain, the dialed speed.

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

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

RSC Control Adjustment

While operating truck at desired maximum speed:

1. Rotate RSC dial (12) clockwise to fastest speed.
2. Pull RSC switch (11) out to engage system.
3. Reduce throttle, allowing truck to coast.
4. Rotate RSC dial counterclockwise until dynamic retarding is activated.

Dynamic retarding will now be activated automatically whenever the "set" speed adjusted in the above steps is reached, provided the RSC switch is ON and the throttle pedal is released.

STATEX III PROPULSION SYSTEM DIAGNOSTIC CONNECTOR

This 9-pin connector (13, Figure 5-5) is for use by qualified personnel to access G.E. STATEX III electric propulsion diagnostic information and data. Refer to Section “E” for additional information.

MODULAR MINING PORT CONECTOR

This connector (15, Figure 5-5) location is used if the optional Modular Mining System is installed on the truck.

UNUSED CONNECTOR

This connector (18, Figure 5-5) location is not used for this model truck.

KOMATSU ENGINE QUANTUM CONNECTOR

This connector (17, Figure 5-5) is for use by qualified personnel to access engine diagnostic information for the QUANTUM system. Refer to engine manufacturer’s publications for troubleshooting information.

KOMATSU ENGINE CENSE CONNECTOR

This 3-pin connector (14, Figure 5-5) is for use by qualified personnel to access engine diagnostic information for the CENSE system. Refer to engine manufacturer’s service publications for troubleshooting information.

DATA STORE BUTTON

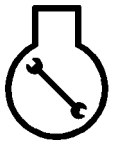
This button (19, Figure 5-5) is for use by qualified maintenance personnel to record in memory a “snapshot” of the Statex III drive system.

PASSENGER SEAT

The passenger seat (16, Figure 5-5) is mounted on top of the right hand portion of the Center Console structure.

The area beneath the passenger seat provides a cabinet for various 24 VDC electrical components. Refer to Section “D” for service involving any of these components.

SERVICE ENGINE LIGHT (Blue)



The service engine light (20, Figure 5-5) will illuminate if a problem is detected by the electronic engine monitoring system.

Electric propulsion and dynamic retarding will still be available.

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

PAYLOAD METER (NOT SHOWN)

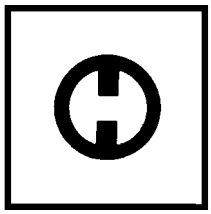
The Payload Meter and Download Connector (located on the back wall behind the passenger seat) is used to provide management with operational data such as tonnage hauled and cycle times. Refer *“Optional Equipment”*, for a more complete description of the payload meter and its functions.

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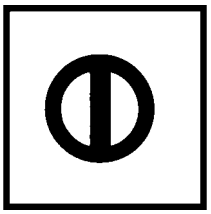
INSTRUMENT PANEL AND INDICATOR LIGHTS

CONTROL SYMBOLS

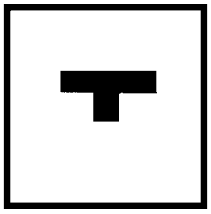
Many control functions are identified with “International” symbols that the operator should learn to recognize immediately. The operator must understand the function and operation of each instrument and control. This knowledge is essential for proper and safe operation of the machine.
The following symbols are general indicators and may appear in multiple locations and combinations on the instrument panel.



This symbol may be used alone or with another symbol. This symbol identifies the “Off” position of a switch or control.



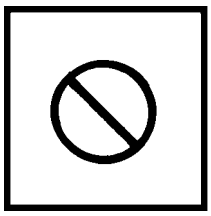
This symbol may be used alone or with another symbol. This symbol identifies the “On” position of a switch or control.



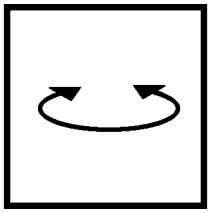
This symbol identifies the “Pushed-In” position of a push-pull switch or control.



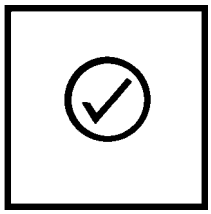
This symbol identifies the “Pulled-Out” position of a push-pull switch or control.



This symbol when it appears on an indicator or control identifies that this indicator or control is NOT used.



This symbol identifies a rotary control or switch. Rotate the knob clockwise or counterclockwise for functions.



This symbol identifies a switch used to test or check a function. Press the switch on the side near the symbol to perform the test.

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INSTRUMENT PANEL

The operator must understand the function and operation of each instrument and control. Control functions are identified with "International" symbols that the operator should learn to recognize immediately.

This knowledge is essential for proper and safe operation of the machine.

Items that are marked **OPTIONAL** do not apply to every truck.

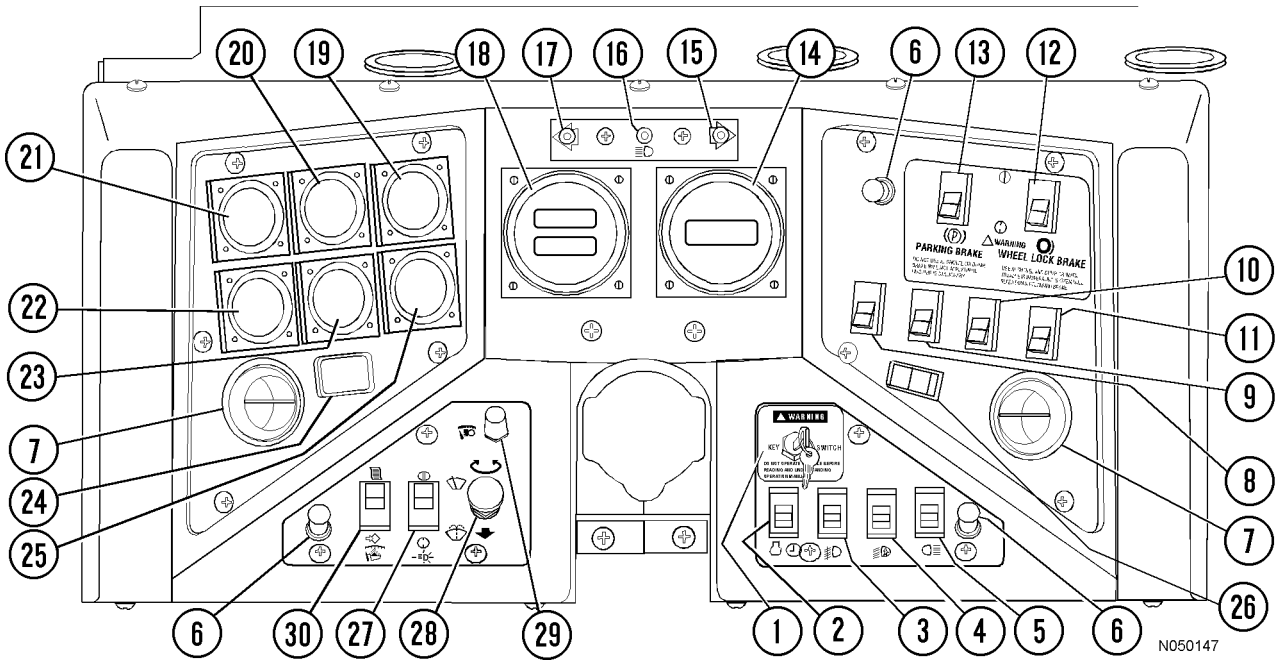


FIGURE 5-7. INSTRUMENT PANEL

1. Key Switch
2. Engine Shutdown Switch with Timer Delay
3. Fog Light Switch (Optional)
4. Ladder Light Switch
5. Backup Light Switch
6. Panel Illumination Light(s)
7. Vent(s) - Cab Air Conditioner/Heater
8. Engine Starting Aid Switch (Optional)
9. Rotating Beacon Light Switch (Optional)
10. Heated Mirror Switch (Optional)
11. Blank - Not Used In This Application
12. Wheel Brake Lock Switch
13. Parking Brake Switch
14. Digital Tachometer
15. Right Turn Signal Indicator Light
16. High Beam Headlight Indicator Light
17. Left Turn Signal Indicator Light
18. Digital Speedometer and Payload Meter Display
19. Voltmeter Gauge
20. Engine Oil Pressure Gauge
21. Engine Water Temperature Gauge
22. Fuel Gauge
23. Blank - Not Used In This Application
24. Engine Hourmeter
25. Blank - Not Used In This Application
26. Blank - Not Used In This Application
27. Headlight Switch
28. Wiper / Washer Switch
29. Panel Illumination Lights Dimmer Rheostat
30. Payload Meter Switch

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PANEL GAUGES, INDICATORS, AND CONTROLS (Figure 5-7)

Refer to Figure 5-7 for the following descriptions.

(1, Figure 5-7) KEY SWITCH

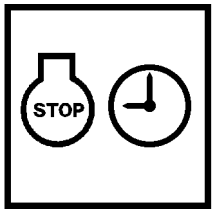
The key switch is a three position (Off, Run, Start) switch.

- When the switch is rotated one position clockwise, it is in the "run" position and all electrical circuits (except "start") are activated.
- When rotated fully clockwise to "start" position and the Selector Switch is in "NEUTRAL", the operator must hold this position until the engine starts. "Start" position is spring loaded to return to "run" when the key is released.
- With the truck stopped, turn counterclockwise to OFF for normal engine shutdown.

An engine shutdown switch located on the center console may be used if the key switch does not shut down the engine.

NOTE: A ground level shutdown switch is located near the diagonal ladder steps on right front corner of the truck.

(2, Figure 5-7) ENGINE SHUTDOWN SWITCH with TIMER DELAY)

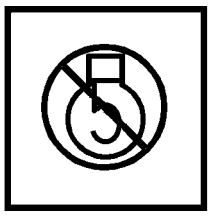


The timer delayed, engine shutdown switch is a 3-position, rocker type switch with OFF, ON and Momentary positions. When used, the engine is allowed to idle for approximately 5 minutes before actual shutdown occurs. The delayed shutdown feature allows the engine to cool down slowly, reducing internal temperatures as coolant is circulated through the engine.

Operation

1. Press the top of the switch to select the ON (center) position.
2. Press top of switch again to activate the timer delay (momentary position). Release switch and allow it to return to the ON position.
3. Turn the key switch to the OFF position.

When the delay system has been activated, the "5 Minute Idle Delay" (amber) lamp on the overhead display will illuminate, indicating the shutdown timing sequence has started. The engine will then continue to idle for approximately 5 minutes and then shut down automatically, providing the key switch is OFF.



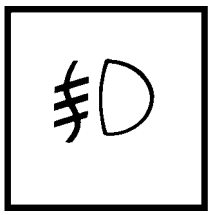
The Engine Shutdown Timer DOES NOT turn off the 24VDC electrical power. The keyswitch must be turned OFF to cause the engine to shut down after the timing sequence is complete. When the engine stops, the bleeddown timer will activate and the 24VDC electrical circuits will turn OFF.

To Cancel Delay Sequence

Press the bottom of the switch to select the OFF position.

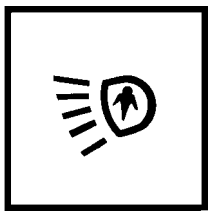
- If the keyswitch is **OFF**, the engine will stop.
- If the keyswitch is **ON**, the engine will continue to run.

(3, Figure 5-7) FOG LIGHTS (OPTIONAL)



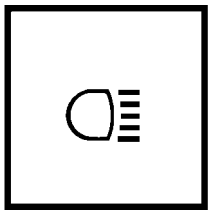
Fog Lights are optional equipment that are useful in foggy conditions and heavy rain. Pressing the top of the rocker switch turns the lights ON. Pressing the bottom of the switch turns the lights OFF.

(4, Figure 5-7) LADDER LIGHT SWITCH



The switch turns the ladder lights ON or OFF. Pressing the top of the rocker switch turns the lights ON. Pressing the bottom of the switch turns the lights Off. Another switch is mounted at the front right of truck near the base of ladder.

(5, Figure 5-7) BACKUP LIGHT SWITCH



The Manual Backup Switch allows the backup lights to be turned on, providing added visibility and safety when the Selector Switch is not in REVERSE position.

When the switch is pressed toward the ON position, the "Manual Back Up Light" indicator on the overhead display panel will be illuminated.

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(6, Figure 5-7) PANEL ILLUMINATION LIGHTS

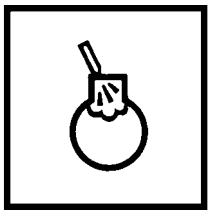
The instrument panel illumination lights are controlled by the panel light dimmer rheostat (29).

(7, Figure 5-7) CAB AIR CONDITIONER/HEATER VENTS

The vents are spherically mounted to direct air flow as desired.

(8, Figure 5-7) ENGINE COLD WEATHER STARTING AID (Optional)

The optional Engine Starting Aid switch is spring loaded to the OFF position. This system should be used only when ambient air temperature is below 50°F (10°C).



Operation

1. Press switch to the ON position to inject ether into the engine air intake while cranking the engine for **three (3) seconds maximum** and then release starting aid switch.
2. If the engine does not start, **wait at least fifteen (15) seconds** before repeating the procedure.

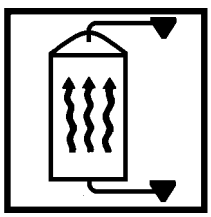
(9, Figure 5-7) ROTATING BEACON LIGHT SWITCH (Optional)

This switch (9) will turn on the optional rotating beacon when pressed to the ON position.



(10, Figure 5-7) HEATED MIRROR SWITCH (OPTIONAL)

If truck is equipped with the OPTIONAL Heated Mirror, it will be activated by this rocker type switch when it is pressed toward the ON position.



(11, Figure 5-7) BLANK (Not Used In This Application)

Reserved for future options.

(12, Figure 5-7) WHEEL BRAKE LOCK CONTROL

The Wheel Brake Lock should be used with the engine running for dumping and loading operations only. The brake lock switch actuates the hydraulic brake system which locks the rear wheel service brakes only.

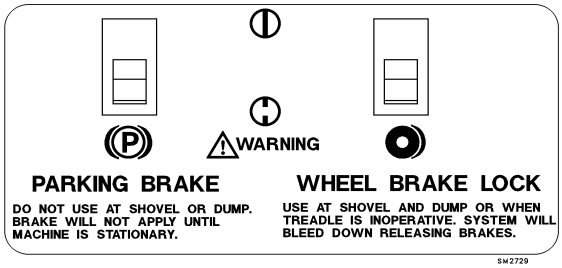
Operation

1. When pulling into shovel or dump area, stop the truck using the service brake pedal.
2. When truck is completely stopped and in position, apply the brake lock by pressing the rocker switch to the ON position.

⚠WARNING

- **Use at shovel and dump only to hold truck in position**
- **Do not use to stop truck unless the foot-operated treadle valve is inoperative. Use of this switch applies rear service brakes at full, unmodulated pressure.**
- **Do not use brake lock for parking. With engine stopped, hydraulic pressure will bleed down, allowing brakes to release.**

When the wheel brake lock is applied, the Service Brake Lamp on the Overhead Display Panel will illuminate.



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(13, Figure 5-7) PARKING BRAKE CONTROL

The parking brake is spring applied and hydraulically released. It is designed to hold a stationary truck when the engine is shut down and the keyswitch is turned OFF.



Operation

1. Stop truck, then press the rocker switch (13) on the top side toward the "On" symbol to apply the parking brake.
2. To release, press the rocker switch on the bottom side toward the "Off" symbol.

⚠WARNING

The truck must be completely stopped before applying the parking brake or damage may occur to the parking brake
Do not use the parking brake at the shovel or dump. With the keyswitch ON and the engine running, sudden shock caused by loading or dumping could cause the system's motion sensor to RELEASE the parking brake.

When the key switch is ON and the parking brake is applied, the Parking Brake indicator light will be illuminated on the Overhead Display.

(14, Figure 5-7) TACHOMETER

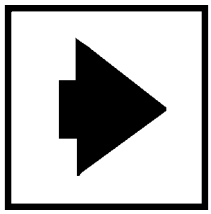
The tachometer registers engine crankshaft speed in hundreds of revolutions per minute (RPM).

Governed RPM (Komatsu Engine)

- Low Idle: 750 RPM
- High Idle, No load: 1910 RPM Maximum
- High Idle, loaded: 1900 RPM

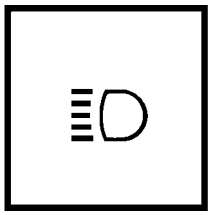
(15, Figure 5-7) RIGHT TURN SIGNAL INDICATOR

This indicator illuminates to indicate the right turn signals are operating when the turn signal lever on the steering column is moved upward. Moving the lever to its center position will turn the indicator OFF.



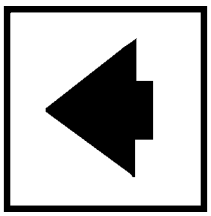
(16, Figure 5-7) HIGH BEAM INDICATOR

The high beam indicator when lit, indicates that the truck headlights are on "High" beam. To switch headlights to "High" beam, push the turn indicator lever away from the steering wheel. For "Low" beam, pull the lever toward the steering wheel.



(17, Figure 5-7) LEFT TURN SIGNAL INDICATOR

This indicator illuminates to indicate the left turn signals are operating when the turn signal lever on the steering column is moved downward. Moving the lever to its center position will turn the indicator "Off".

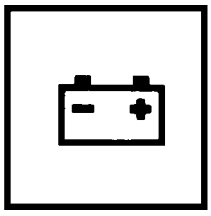


(18, Figure 5-7) SPEEDOMETER / PAYLOAD METER

The speedometer indicates the truck speed in miles per hour (MPH) or with the optional speedometer, it may indicate truck speed in kilometers per hour (KPH). The display also shows Payload Meter information.

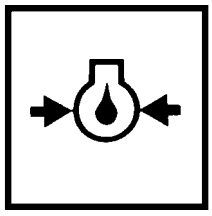
(19, Figure 5-7) VOLTMETER

The voltmeter indicates the voltage of the 24VDC battery system. Normal indicated voltage at high RPM is 27 to 28 volts with batteries in fully charged condition. When the key switch is ON and the engine is NOT running, the voltmeter indicates battery charge condition.



(20, Figure 5-7) ENGINE OIL PRESSURE GAUGE

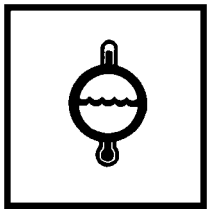
The engine oil pressure gauge indicates pressure in the engine lubrication system in pounds per square inch (psi). Normal operating pressure after engine warm up should be:



- **Idle:** minimum: 20 psi (138 kPa),
  nominal: 25 psi (172 kPa)
- **Rated Speed** - minimum: 40 psi (276 kPa),
  nominal: 65 psi (448 kPa)

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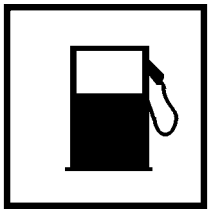
(21, Figure 5-7) WATER TEMPERATURE GAUGE



The water temperature gauge indicates the temperature of the coolant in the engine cooling system. The temperature range after engine warm-up and truck operating under normal conditions should be:

- 185° to 207°F (85° to 97°C)

(22, Figure 5-7) FUEL GAUGE

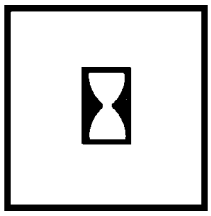


The fuel gauge indicates how much diesel fuel is in the fuel tank. Fuel tank capacity is 1200 gallons (4543 liters).

(23, Figure 5-7) (Not Used)

BLANK - Reserved for future options.

(24, Figure 5-7) HOURMETER

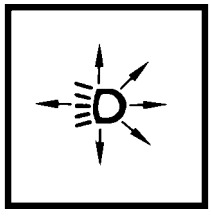


The hourmeter registers the total number of hours the truck engine has been operating.

(25 & 26, Figure 5-7) (Not Used)

BLANK - Reserved for future options.

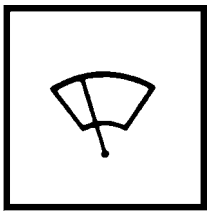
(27, Figure 5-7) HEADLIGHT SWITCH



The instrument panel lights, clearance lights, and the headlights are controlled by this three position rocker type switch.

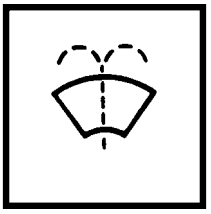
- OFF is selected by pressing the bottom of the switch.
- Press the top of the switch until it reaches the first detent to select the panel, clearance and tail lights only.
- Press the top of the switch again until it reaches the second detent to select headlights and tail lights.

(28, Figure 5-7) WINDSHIELD WIPER AND WASHER



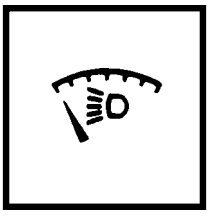
The windshield wiper control switch is a four position rotary switch with intermittent wiper delay and wash feature.

- OFF is the detent position when the knob is rotated fully counterclockwise against the stop.
- The intermittent wiper position is located between OFF and the first detent position, when rotating the knob clockwise.
- Rotate the knob clockwise to the first detent position for slow speed.
- Rotate the knob to the second position for fast speed



To use the windshield washer, press and hold the knob in.

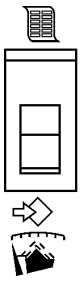
(29, Figure 5-7) PANEL LIGHT DIMMER



The panel light dimmer control is a rheostat which allows the operator to vary the brightness of the instruments and panel lights.

- Rotating knob to the full counterclockwise position turns panel lights ON to brightest condition.
- Rotating knob clockwise continually dims lights until OFF position is reached at full clockwise rotation.

(30, Figure 3-6) PAYLOAD METER SWITCH



The Payload Meter Switch is a two-way, momentary switch. The top position is the Select position. The Select position is used to 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. Refer to Section M, Optional Equipment, for a more complete description of the Payload Meter System and its functions.

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OVERHEAD STATUS / WARNING INDICATOR LIGHTS

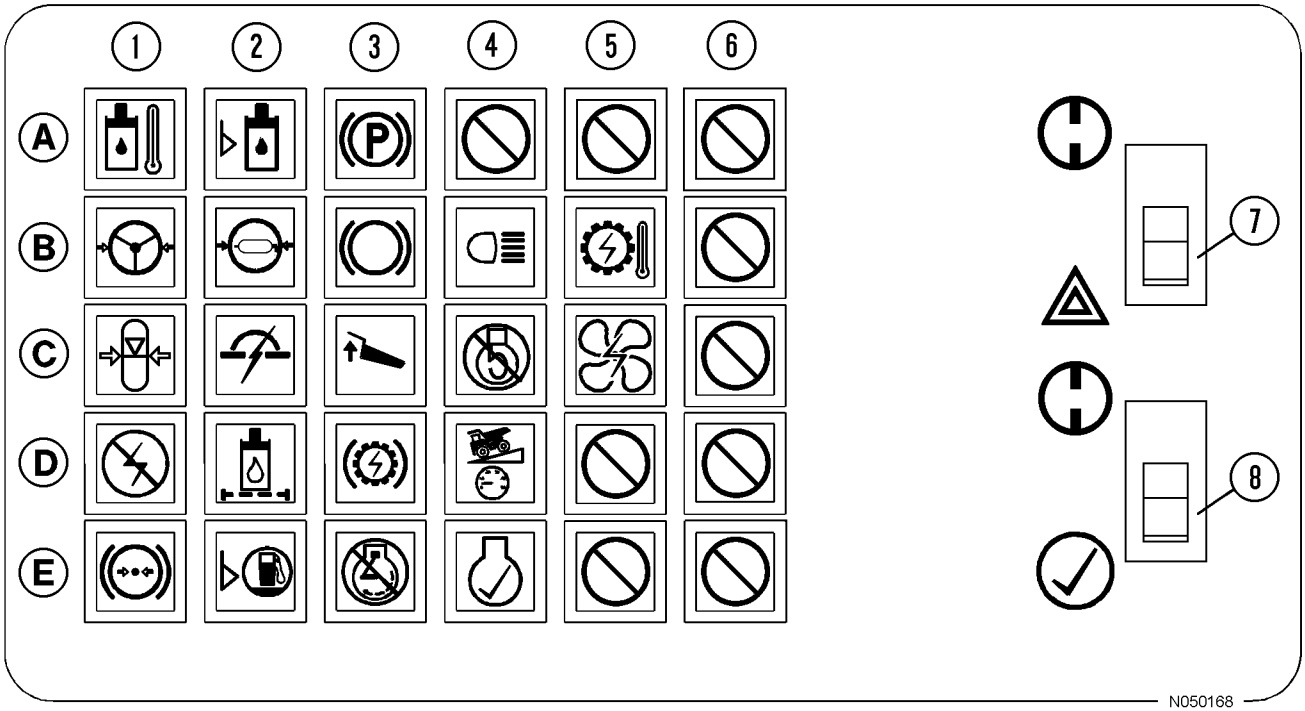


FIGURE 5-8. OVERHEAD STATUS / WARNING INDICATOR LIGHTS

Row/ Column	Indicator Description	Indicator Color - Wire Index
A1	Hydraulic Oil Temp.	Red - 12FD1/34TL
B1	Low Steering Pressure	Red - 12FD/33A
C1	Low Accumulator Pressure	Red - 12F/33K
D1	Electric System Fault	Red - 12F/79V
E1	Low Brake Pressure	Red - 12F/33L
A2	Low Hydraulic Tank Oil Level	Red - 12F4/34LL
B2	Autolube Low Press.	Yellow - 12FD8/ 68LLP
C2	Circuit Breaker Tripped	Yellow - 12FD/31CB
D2	Hydraulic Oil Filter	Yellow - 12FD/39
E2	Low Fuel	Yellow - 12F5/38
A3	Park Brake	Yellow - 12MD/52A
B3	Service Brake	Yellow - 12MD/44L
C3	Body Up	Yellow - 12MD6/63L
D3	Dynamic Retarding	Yellow - 12MD/44DL
E3	Stop Engine	Red - 12M/509MA
A4	Blank - For Future Use	Yellow - 12MD/SP2
B4	Back-up Lights	Yellow - 12MD/47L
C4	5 Minute Idle Timer	Yellow - 12MD/23L1

Row/ Column	Indicator Description	Indicator Color - Wire Index
D4	Retard Speed Control	Yellow - 12MD/31R
E4	Check Engine	Yellow - 12MD7/419
A5	Blank - For Future Use	Red - 12MD/528A
B5	Wheel Motor Temperature	Red - 12FD1/722L
C5	Blower OFF	Red - 12FDZ/32B
D5	Blank - For Future Use	Yellow - 12F/SP4
E5	Blank - For Future Use	Red - 12FD/SP5D1
A6	Blank - For Future Use	Yellow - 12M/SP6
B6	Blank - For Future Use	Red - 12M/SP7D2
C6	Blank - For Future Use	Yellow - 12MD/ SP7D1
D6	Blank - For Future Use	Yellow - 12MD/528
E6	Blank - For Future Use	Red - 12MD/SP5D2
SWITCHES		
#7	Hazard Lights Switch, N.O.	11L/45L/45R
#8	Lamp Check Switch, N.O. (Momentary)	712/528/33H/710

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INDICATOR LIGHTS

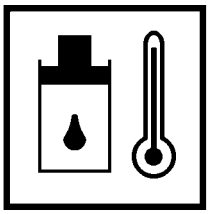
Figure 5-8 illustrates the system indicator lights located on the Overhead Display, above the operator's line-of-sight. The following describes the lamps shown in Figure 5-8 and should be referenced by the intersection of row locators A through E and column locators 1 through 6. (Refer to Table I for a chart of symbols and descriptions.)

- The AMBER (Yellow) indicator lamps are intended to alert the operator that the indicated truck function requires some precaution when lit.
- The RED indicator lamps alert the operator that the indicated truck function requires immediate action by the operator. Safely stop the truck and shut down the engine.

⚠WARNING

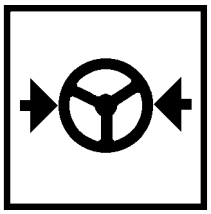
DO NOT OPERATE THE TRUCK WITH A RED WARNING LIGHT ILLUMINATED.

A1. High Hydraulic Oil Temperature (optional)



This warning light indicates high oil temperature in the hydraulic tank. Continued operation could damage components in the hydraulic system. Refer to Section L for hydraulic system troubleshooting and repair procedures. Notify maintenance personnel immediately. The light turns on at 225° F (107° C).

B1. Low Steering Pressure



When the key switch is turned ON, the low steering pressure warning light will illuminate until the steering system hydraulic pressure reaches 2100 psi (14.7 MPa). The warning horn will also turn on, and both will remain on until the accumulator has been charged.

During truck operation, the low steering pressure warning lamp and warning horn will turn on if steering system hydraulic pressure drops below 2100 psi (14.7 MPa).

- If the light illuminates momentarily while turning the steering wheel at low truck speed and low engine RPM, this may be considered normal, and truck operation may continue.
- If the light illuminates at higher truck speed and high engine RPM, **DO NOT OPERATE TRUCK**.

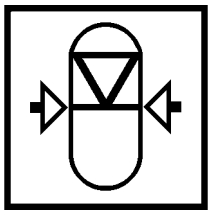
⚠WARNING

If the low steering warning light continues to illuminate and the alarm continues to sound, low steering pressure is indicated. The remaining pressure in the accumulators allows the operator to control the truck to a stop.

Do not attempt further operation until the malfunction is located and corrected.

Refer to Section L for steering system troubleshooting and repair procedures.

C1. Low Accumulator Precharge Pressure



The low accumulator precharge warning lamp, if illuminated, indicates a low nitrogen precharge in the steering accumulator(s). To check for proper steering accumulator precharge:

1. Stop the engine and turn the key switch OFF to bleed the steering accumulators
2. After approximately 90 seconds, turn the key switch ON.
3. If the accumulators are properly charged, the warning lamp will not illuminate.
4. If the nitrogen precharge in one or both of the accumulators is below 1100 ± 45 psi, (7585 ± 310 kPa) the warning lamp will flash.

⚠WARNING

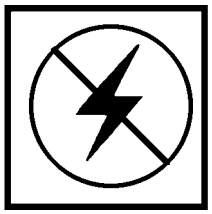
If the low accumulator precharge warning lamp flashes, do not operate the truck. Investigate the problem and repair or recharge accumulator(s) as necessary. Sufficient energy for emergency steering may not be available if the system is not properly charged.

Refer to Section L for steering and accumulator system troubleshooting and repair procedures.

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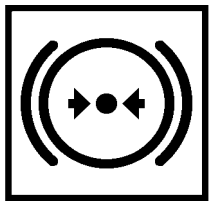
D1. Electric System Fault



The electric system fault warning light will flash on and off when a malfunction occurs in the electrical system. The warning horn will also sound intermittently. When the light illuminates, propulsion will be dropped automatically. Reset by pushing the override button. If the fault occurs again, the truck should be stopped and the problem investigated.

NOTE: The STATEX III system records the number of faults (events) that occur during operation. When the number of allowable faults (events) recorded within a given time frame has been exceeded, the operator will not be able to reset the system using the override switch. Refer to Section E for information regarding troubleshooting and determining the cause of the fault.

E1. Low Brake Pressure

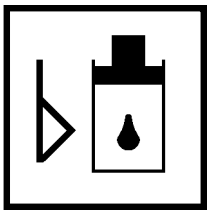


This red light indicates a malfunction within the hydraulic brake circuit. If this light comes on and the buzzer sounds, **shut down truck operation, troubleshoot and repair the problem**.

NOTE: Adequate hydraulic fluid is stored to allow the operator to safely stop the truck.

Refer to Section J for hydraulic brake system troubleshooting and repair procedures.

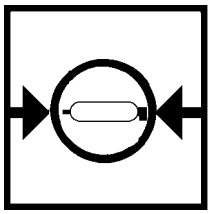
A2. Low Hydraulic Tank Level (optional)



This warning light indicates the oil level in the hydraulic tank is below recommended level. Damage to hydraulic pumps may occur if operation continues. Shut truck down and determine cause of oil loss.

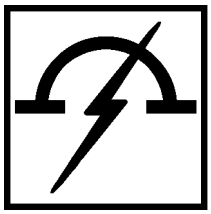
Refer to Section L for hydraulic tank filling procedure, system troubleshooting, and repair procedures.

B2. Low Automatic Lubrication Pressure



This amber light will illuminate if the automatic lubrication system fails to reach 2,200 PSI (at the junction block located on the rear axle housing) within one minute after the Lube Timer indicates a cycle of grease. To turn the light off, turn key switch off, then back on again. Notify maintenance personnel at earliest opportunity after light comes on.

C2. Circuit Breaker Tripped



This lamp will illuminate if any of the circuit breakers on the relay circuit boards are tripped.

Refer to Section D for relay board troubleshooting and repair procedures and Section R for electrical schematics.

NOTE: Additional circuit breakers are in the operator cab behind the center console, however tripping of these circuit breakers will not activate this light.

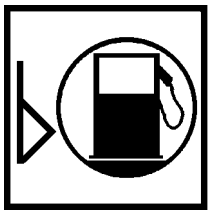
D2. Hydraulic Oil Filter Monitor



The filter monitor warning light will illuminate if the hoist system or steering system hydraulic filter restriction reaches 40 psi (276 kPa), indicating filter replacement is required. Actual filter bypass will occur at 50 psi (345 kPa). Refer to Section M for filter element replacement.

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

E2. Low Fuel (optional)



The AMBER low fuel indicator will illuminate when the usable fuel remaining in the tank is approximately 25 gallons (95 liters). A warning buzzer will also sound.

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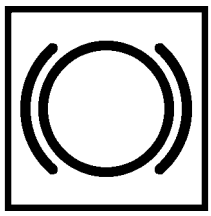
A3. Parking Brake

The AMBER parking brake indicator will illuminate when the parking brake is applied. Do not attempt to drive the truck with the parking brake applied.



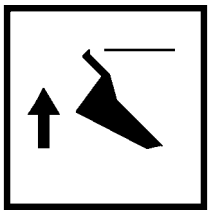
B3. Service Brake

The AMBER service brake indicator light will illuminate when the service brake pedal is applied or when the wheel brake lock or emergency brake is applied. Do not attempt to drive truck from stopped position with service brakes applied.



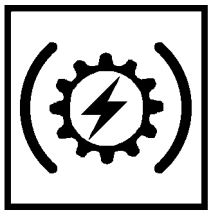
C3. Body Up

The AMBER body up indicator, when illuminated, shows that the body is not completely down on the frame. The truck should not be driven until body is down and the light is off.



D3. Dynamic Retarding

The AMBER dynamic retarding indicator light illuminates when the retarder pedal is operated, RSC (Retard Speed Control) is activated, or the automatic overspeed retarding circuit is energized, indicating the dynamic retarding function of the truck is operating.



E3. Stop Engine

The RED engine monitor warning light will illuminate if a serious engine malfunction is detected in the electronic engine control system.



- Electric propulsion to the wheel motors will be discontinued and maximum engine speed will be reduced to 1250 RPM.
- Dynamic retarding will still be available to slow the truck.

⚠WARNING

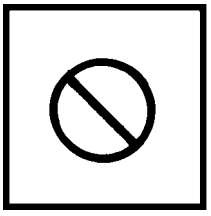
If this lamp illuminates, the operator should stop the truck as quickly as possible in a safe area, apply the parking brake.

SHUT DOWN THE ENGINE IMMEDIATELY. Additional engine damage is likely to occur if operation is continued.

Listed below are a few conditions that could cause the Stop Engine light to illuminate:

- Low Oil Pressure - red warning light will illuminate, but engine does not shut down.
- Low Coolant Level - red warning light will illuminate, but engine does not shut down.
- Low Coolant Pressure - red warning light will illuminate, but engine does not shut down.
- High Coolant Temperature - red warning light will illuminate, but engine does not shut down.

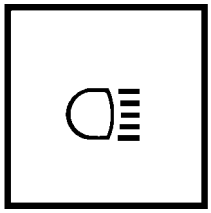
A4. Blank (Reserved for future use)



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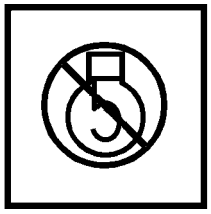
B4. Manual Backup Lights

The AMBER indicator will illuminate when the manual backup switch is turned on.



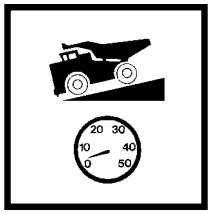
C4. Engine Shutdown Timer - 5 Minute Idle

When the engine shutdown timer switch has been activated, the indicator light will illuminate to indicate the shutdown timing sequence has started.



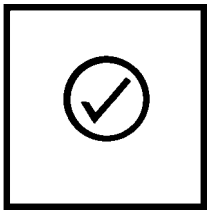
D4. Retard Speed Control Indicator

The AMBER light is illuminated when the RSC switch mounted on the console is pulled out to the "On" position.



E4. Check Engine Monitor

This amber “Check Engine” indicator will illuminate if a malfunction is detected by the electronic engine control system. **If this indicator illuminates, notify maintenance personnel as soon as possible.**

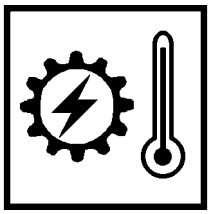


A5. Not Used

Not currently used. Reserved for future use or options.

B5. High Wheel Motor Temperature (optional)

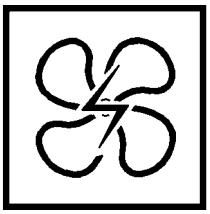
When this light is illuminated and the alarm sounds, high wheel motor temperature is indicated. The operator must stop the truck, place the Selector Switch in NEUTRAL and raise engine RPM to high idle for several minutes to cool the wheel motors.



If the indicator does not turn off, investigate the cause and repair as required. Refer to Section E for propulsion system troubleshooting and data retrieval.

C5. Motor Blower Off

The motor blower warning light will flash on and off and an alarm will sound when a malfunction occurs in the cooling air circuit for the alternator and motorized wheels. Stop the truck immediately and notify maintenance personnel if warning light illuminates.

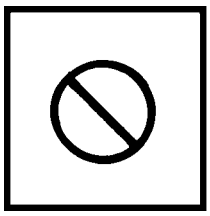


Do not operate the truck if the warning light illuminates as damage may result without proper ventilation of rotating equipment.

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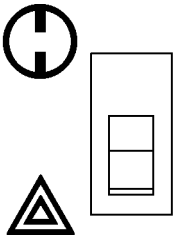
A5, D5, E5, A6, B6, C6, D6, E6: Blank

(Reserved for future use)



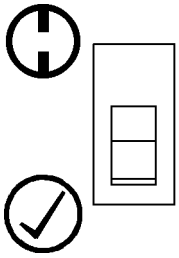
(7) Hazard Warning Lights

The hazard warning light switch flashes all the turn signal lights. Pressing the bottom side of the rocker switch (toward the triangle) activates these lights. Pressing the top side of the rocker switch (toward the “OFF” symbol) turns these lights off.



(8) Lamp Test Switch

The Lamp Test switch is provided to allow the operator to test the indicator lamps prior to starting the engine. Any lamp bulbs which do not illuminate should be replaced before operating the truck.



Lamp Test:

To test the lamps and the warning horn:

1. Turn the key switch to the RUN position.
2. Press the bottom of the rocker switch for the "check" position:
3. All lamps should illuminate unless they relate to optional equipment not installed on the truck.
4. The warning horn should sound.
5. Releasing the spring-loaded switch will allow the switch to return to the “Off” position.

If any lamp does not illuminate, the bulb should be replaced before operating the truck.

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NOTES:

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LUBRICATION AND SERVICE

Recommended Preventive Maintenance will contribute to the long life and dependability of the Komatsu truck and its components. The use of proper lubricants and the performance of checks and adjustments at the recommended intervals is most important.

Lubrication requirements are referenced to the lube key found in the Truck Lubrication Specifications Chart (page P2-3). For detailed service requirements for specific components, refer to the shop manual section for that component (i.e. Section “H” for Suspensions, Section “L” for Hydraulic System, etc.).

Refer to manufacturer's service manual when servicing any components of the General Electric System or the engine.

830E SERVICE CAPACITIES		
	Liters	U.S. Gallons
Crankcase: (including lube oil filters). Komatsu SDA16V160 or SSDA16V160 Engine	280.0	74.0
Cooling System:	568	150
Hydraulic System: Hydraulic Tank: Refer to “Hydraulic Tank Service”	947 901	250 238
Fuel tank:	4543	1200
Wheel Motor Gearbox (each side)	39.7	10.5

The service intervals presented here are in hours of operation. **These intervals are recommended in lieu of an oil analysis program which may determine different intervals.** However, if the truck is being operated under extreme conditions, some or all, of the intervals may need to be shortened and the service performed more frequently.

Many Komatsu Trucks are equipped with an Automatic Lubrication System. The initial setup for this system provides for nominal amounts of lubricant to be delivered to each serviced point. The lubrication injectors can be adjusted to vary the amount of lubricant delivered. In addition, the timer for lubrication intervals is normally adjustable. For adjustments to these devices, consult the “Automatic Lubrication System” later in this section of the manual.

HYDRAULIC TANK SERVICE

There are two sight gauges on the side of the hydraulic tank. With engine stopped, keyswitch OFF, hydraulic system bled down and body down, oil should be visible in the top sight gauge. If hydraulic oil is not visible in the top sight gauge, follow “Adding Oil” instructions below.

Adding Oil

Keep the system open to the atmosphere only as long as absolutely necessary to lessen chances of system contamination.

Service the tank with clean Type C-4 hydraulic oil only. All oil being put into the hydraulic tank should be filtered through 3 micron filters.

1. With engine stopped, keyswitch OFF, hydraulic system bled down and body down, check to see that hydraulic oil is visible in the top sight gauge.
2. If hydraulic oil is not visible in the top sight gauge, remove the tank fill cap and add clean, filtered C-4 hydraulic oil (Lubrication Chart, Lube Key “B”) until oil is visible in the top sight gauge.
3. Replace fill cap.
4. Start engine. Raise and lower the dump body three times.
5. Repeat steps 1 through 4 until oil is maintained in the top sight gauge with engine stopped, body down, and hydraulic system bled down.

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COOLANT LEVEL CHECK

Inspect the coolant sight gauge. If coolant cannot be seen in the sight gauge, it is necessary to add coolant to the system before truck operation. Refer to the procedure below for the proper filling procedure.

RADIATOR FILLING PROCEDURE

⚠WARNING

Cooling System is pressurized due to thermal expansion of coolant. DO NOT remove radiator cap while engine and coolant are hot. Severe burns may result.

1. With engine and coolant at ambient temperature, remove radiator cap.

*Note: If coolant is added using the Wiggins quick fill system, the radiator cap **MUST** be removed prior to adding coolant.*

2. Fill radiator with proper coolant mixture (as specified by the engine manufacturer) until coolant is visible in the sight gauge.
3. Install radiator cap.
4. Run engine for 5 minutes, check coolant level.
5. If coolant is not visible in the sight gauge, repeat steps 1 through 4. Any excess coolant will be discharged through the vent hose after the engine reaches normal operating temperature.

NOTE: Engine coolant must always be visible in the sight gauge before truck operation.

COOLING SYSTEM ANTI - FREEZE RECOMMENDATIONS (Ethlyene Glycol Permanent Type Anti-Freeze)		
Percentage of Anti-Freeze	**Protection To:**	
10	+23°F	-5°C
20	+16°F	-9°C
25	+11°F	-11°C
30	+4°F	-16°C
35	-3°F	-19°C
40	-12°F	-24°C
45	-23°F	-30°C
50	-34°F	-36°C
55	-48°F	-44°C
60	-62°F	-52°C

Reserve Engine Oil System (Optional)

The reserve oil tank for the engine is designed to add more oil capacity to the engine to reduce the frequent servicing of the engine oil. The engine oil level must still be checked every shift using the dipstick. If engine oil level is not correct, check for proper operation of reserve oil system. Never add oil to engine unless it has been drained.

If the engine oil has been drained from the oil pan, the new oil must be added to the engine oil pan before starting. DO NOT use the oil in the reserve tank to fill an empty engine with oil. After an oil change, both engine and reserve tank must be full of oil before starting the engine.

Reserve Oil Tank Filling Procedure (Remote fill)

1. Connect the pressure supply hose from the new oil supply to the quick coupler on the truck. Open valve on supply hose to apply pressure.
2. Pull out on switch (2) to turn the system ON.
3. Push start switch (3). The "Valve Open" light (5) should illuminate and the filling process will begin.
4. When tank is full, the "Valve Open" light will turn OFF and the FULL light (4) will illuminate.
5. Close the oil supply valve in the fill hose.
6. Press and hold start switch (3) for several seconds.
7. Disconnect the new oil supply hose.

Push switch (2) in to turn system power OFF

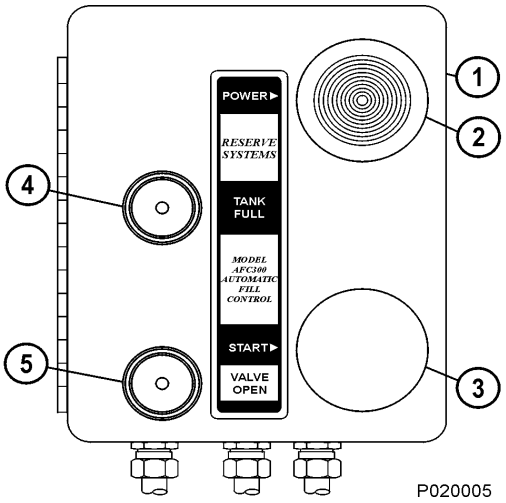


FIGURE 2-1. RESERVE SYSTEM CONTROL

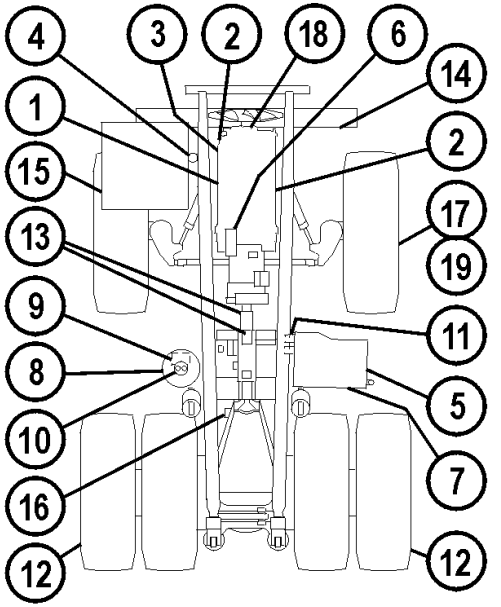
1. Remote Control Box
2. System Switch
3. Start Switch
4. “Full” Light
5. “Valve Open” LighT

LUBRICATION CHART

LUBRICATION SPECIFICATIONS

LUBE KEY	TYPE LUBRICANT
A	ENGINE OIL - - - - - SEE ENGINE MANUAL
B	HYDRAULIC OIL - - - - - SAE 10W C - 4 - - - - - AUXILIARY HEATERS REQUIRED BELOW -10°F(-23°C)
C	HEAVY-DUTY SYNTHETIC GEAR OIL - - - - - SEE DRIVE SYSTEM MANUAL
D	MULTI - PURPOSE EXTREME PRESSURE GREASE - - - - - NLGI NO.2 (5% MIN. MOLY-DISULFIDE)
E	MULTI - PURPOSE GEAR OIL - - - - - SAE 80W - 90

SYM	DESCRIPTION	PTS	LUBE KEY	10 HR	50 HR	100 HR	250 HR	500 HR	1000 HR	2000 HR	2500 HR
1	CRANKCASE OIL LEVEL	1	A	CHECK							
2	ENGINE LUBE OIL FILTERS			SEE ENGINE MANUAL							
3	FUEL FILTER										
4	FUEL SEPERATOR (DAVCO)										
5	FUEL TANK	1					DRAIN H_2O & SEDIMENT				
6	GE PREFILTER BREATHER	1	D				GREASE				
7	FUEL TANK BREATHER	1							CLEAN		
8	HYDRAULIC OIL LEVEL	1	B	CHECK					*CHANGE		
9	HYDRAULIC STRAINER	2							CLEAN		
10	HYDRAULIC TANK BREATHER	2						CHANGE			
11	HYDRAULIC FILTERS	3			**	**	**	CHANGE			
12	MOTORIZED WHEEL OIL LEVEL	2	C	SEE DRIVE SYSTEM MANUAL							
13	HYD. PUMP DRIVE SHAFT	2	D				GREASE				
14	CHASSIS LUBE LEVEL	1	D				GREASE				
15	SEAT SLIDES & STEER SHAFT	4	D						GREASE		
16	WHEEL MOTOR BLOWER	2	D				GREASE				
17	FRONT WHEEL BEARINGS ***	2	E				CHECK				CHANGE
18	FRONT TRUNION	1	D						GREASE		
19	MAGNETIC PLUG FRONT WHL COVER ****	2					CHECK				



630E, 730E, 830E, & 930E

* 1000 HR INTERVAL CAN BE EXTENDED TO 2500 HR PROVIDED OIL SAMPLING AND ANALYSIS IS CONDUCTED EVERY 250 HR.
** ONE-TIME CHANGE AT 50, 100 AND 250 HR.
*** NOT APPLICABLE FOR 930E
**** APPLICABLE FOR 930E ONLY

WB2790

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10 HOUR (DAILY) LUBRICATION AND MAINTENANCE CHECKS

Prior to each operating shift, a “walk around” inspection should be performed. Check the truck for general condition. Look for evidence of hydraulic leaks; check all lights and mirrors for clean and unbroken lenses; check operator's cab for clean and unbroken glass; check frame, sheet metal and body for cracks. Notify proper maintenance authorities if any discrepancies are found. Give particular attention to the following:

Note: The following checks include some optional equipment that may not be applicable.

Truck Serial Number _____

Site Unit Number _____

Date: _____ Hour Meter: _____

Name of Service Person _____

10 HOUR LUBRICATION AND MAINTENANCE CHECKS

1. FAN DRIVE AND TURBOCHARGERS - Check for leaks, vibration or unusual noise. Check alternator and fan belts for proper tension, condition and for alignment.
2. RADIATOR - Check coolant level and fill with proper mixture as shown in Cooling System Recommendation Chart. Refer to Engine Manual for proper coolant additives.
3. ENGINE - Check oil level. Refer to engine manufacturer's shop manual for oil recommendations (Lube key “A”) and the following checks:

- Intake & exhaust piping - check for security.
- CENTINEL™ - Check reservoir oil level.
- Eliminator Filter - Check operating indicator.
- Fuel Filters (Fuel Separators) - Drain water from bottom of each filter housing.

NOTE: If truck is equipped with a reserve engine oil tank, the oil should be visible in the center (middle) sight gauge. If not, add oil to reserve tank until oil is visible in top sight gauge. Also, with engine running, check operation of the LED indicator light. See below for description of LED Light Signals.

LED Light Signals:

- Steady - Pump 1 is withdrawing oil from the engine sump and bringing down the oil level.
- Regular Pulsing - Pump 2 is returning oil to the engine sump and raising the oil level.
- Irregular Pulsing - Oil is at the correct running level.

4. FUEL FILTERS (Fuel Separators) - Drain water from bottom of each filter housing.
5. HYDRAULIC TANK - Check oil level in tank, add oil if necessary. Refer to “Hydraulic Tank Service”. Oil should be visible in sight glass. - DO NOT OVERFILL. Lube Key “B”.

COMMENTS	√’d	INITIALS

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10 HOUR (DAILY) LUBRICATION AND MAINTENANCE CHECK (continued)

6. AIR CLEANERS (NOT SHOWN) - Check air cleaner vacuum gauges in operator cab. The air cleaner(s) should be serviced, if the gauge(s) shows the following maximum restriction:

   Komatsu SDA16V160 or SSDA16V160 Engine: 25 in. of H_2O vacuum.

   See Section “C” for servicing air cleaner elements. Empty air cleaner dust caps.

NOTE: After service, push the reset button on face of gauge to allow the gauge to return to zero.

7. WHEELS AND TIRES -
   a. Inspect tires for proper inflation and wear.
   b. Inspect for debris embedded in cuts or tread.
   c. Inspect for damaged, loose, or missing wheel mounting nuts/studs.

NOTE: After each wheel mounting operation, recheck wheel mounting capscrew tightness after first load, again at each 24 hours of operation until all capscrews hold at the prescribed 550 ft.lbs. (746 N.m) torque. This requirement is prescribed for both front and rear wheels.

8. CAB AIR FILTER (NOT SHOWN) - Under normal operating conditions, clean every 250 hours. In extremely dusty conditions, service as frequently as required. Clean filter element with mild soap and water, rinse completely clean and air dry with maximum 40 psi (275 kPa) air pressure. Reinstall filter.
9. AUTOMATIC LUBE SYSTEM -
   a. Check grease reservoir; fill as required. Lube Key “D”.
   b. When filling reservoir, check grease filter indicator. Clean or replace grease filter if indicator detects a problem.
   c. Inspect system and check for proper operation. Be certain the following important areas are receiving adequate amounts of grease. Lube Key “D”.
   - Steering Linkage
   - Final Drive Pivot Pin
   - Rear Hydrair® Suspension Pin Joints
   - Body Hinge Pins -
   - Hoist Cylinders Pins - Upper & Lower
   - Anti-sway Bar - Both Ends
10. COOLING AIR DUCTWORK - Inspect ductwork from blower to rear drive case to be certain that ductwork is secure and undamaged and there are no cooling air restrictions.

COMMENTS	√’d	INITIALS

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50 HOUR LUBRICATION AND MAINTENANCE CHECKS

Maintenance for every 10 hours/shift checks should also be carried out at this time.

Truck Serial Number _____

Site Unit Number _____

Date: _____ Hour Meter: _____

Name of Service Person _____

1. * FUEL FILTERS - Change the Fuel Filters, (Fuel Separators). Refer to the engine manufacturer's maintenance manual for fuel filter replacement instructions.

2. * HYDRAULIC SYSTEM FILTERS - Replace filter elements after the initial 50, 100, and 250 hours of operation; then at each 500 hours of operation thereafter.

3. * FAN DRIVE ASSEMBLY - Check fan mounting capscrew torque. Refer to the engine manufacturer's maintenance manual for torque specification.

COMMENTS	√'d	INITIALS

* 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).

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100 HOUR LUBRICATION AND MAINTENANCE CHECKS

Truck Serial Number_____

Site Unit Number _____

Date:_____Hour Meter:_____

Name of Service Person _____

Maintenance for every 10 & 50 hour Lubrication and Maintenance Checks should also be carried out at this time.

1. * HYDRAULIC SYSTEM FILTERS - Replace filter elements after the initial 50, 100, and 250 hours of operation; then at each 500 hours of operation thereafter.

COMMENTS	√'d	INITIALS

* 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).

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250 HOUR LUBRICATION AND MAINTENANCE CHECKS

Maintenance for every 10 & 50 hour Lubrication and Maintenance Checks should also be carried out at this time.

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

1. ENGINE - Refer to engine manufacturer's maintenance manuals for complete specifications regarding engine lube oil specifications and change intervals.

*NOTE: If engine is equipped with the *CENTINEL™ oil system and/or the ELIMINATOR™ filter system, engine oil and filter change intervals are extended beyond 250 hours. Refer to Cummins Operation & Maintenance manual for specific oil & filter change intervals.*

a. Change engine oil. Lube Key "A".

b. Replace engine oil filters.

NOTE: When installing spin-on filter elements, follow the instructions as specified by the filter manufacturer. The tightening instructions are normally printed on the outside of the filter. ***Do not use a wrench or strap to tighten filter elements.***

c. If truck is equipped with a Reserve Engine Oil Tank, change the reserve tank oil filter.

d. Check fan belt tension. Refer to engine manufacturer's Operation and Maintenance Manual for specific fan belt adjustment instructions.

e. Eliminator Filter - Check pressure drop

2. FUEL FILTERS - Change the fuel filters (fuel separators). Refer to engine manufacturer's Operation and Maintenance Manual for specific fuel filter replacement instructions.
3. HYDRAULIC PUMP DRIVESHAFT & U-JOINTS - Add one or two applications of grease to each grease fitting. Check that each bearing of the cross & bearing assembly is receiving grease. Lube Key "D".
4. FUEL TANK - Drain water and sediment from fuel tank drain cock.
5. FRONT WHEELS - Check oil level. Lube key "E".

* The CENTINEL™ system is a duty cycle dependent lubrication management system whereby oil is blended with the fuel and extension of oil change intervals can occur.

Truck Serial Number _____

Site Unit Number _____

Date: _____ Hour Meter: _____

Name of Service Person _____

COMMENTS	√'d	INITIALS

(CONTINUED NEXT PAGE)

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250 HOUR LUBRICATION AND MAINTENANCE CHECKS (CONTINUED)

6. COOLING SYSTEM -
   a. Check cooling system for proper coolant mixture. Add coolant mixture as required.
   b. COOLANT FILTERS - Change coolant filters. Refer to engine manufacturer's Operation and Maintenance Manual for coolant filter replacement instructions and recommended coolant mixture and additives.
7. STEERING LINKAGE - Check torque on steering pin nuts **525 ft. lbs. (712 N.m)** torque. Check torque on tie rod clamping capscrews, **310 ft.lbs. (420 N.m)** torque. Inspect all lube points to be certain all are receiving adequate grease. Look for broken lines, or signs that injectors may be inoperative.
8. CAB AIR FILTER (NOT SHOWN) - Under normal operating conditions, clean every 250 hours. In extremely dusty conditions, service as frequently as required. Clean filter element with mild soap and water, rinse completely clean and air dry with maximum of 40 psi (275 kPa). Reinstall filter.
9. HYDRAULIC SYSTEM FILTERS - Replace filter elements, after the initial 50, 100, and 250 hours of operation; then at each 500 hours of operation thereafter. Check oil level. Add oil as necessary. Lube Key “B”
10. MOTORIZED WHEEL GEAR CASE - Refer to the G.E. Planned Maintenance Manual and specific motorized wheel shop manual. Check for correct oil level. Lube key “C”.
11. WHEEL MOTOR BLOWER - Grease motor blower shaft bearings. Lube key “D”.
12. G.E. PREFILTER BLOWER - Add one or two applications of grease to the grease fitting. Lube key “D”.
13. BATTERIES (NOT SHOWN) - Check electrolyte level and add water if necessary.
14. BODY UP SWITCH (NOT SHOWN) - Clean sensing area of any dirt accumulation.

COMMENTS	√’d	INITIALS

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500 HOUR LUBRICATION AND MAINTENANCE CHECKS

Maintenance for every 10 & 250 hour Lubrication and Maintenance Checks should also be carried out at this time.

NOTE: “Lube Key” references are to the Lubrication Specification Chart.

1. FINAL DRIVE CASE BREATHERS - Remove breather elements for motorized wheels and clean or replace elements.
2. HYDRAULIC SYSTEM FILTERS - Replace filter elements. Check oil level. Add hydraulic oil as necessary. Lube Key “B”.
3. HYDRAIR® SUSPENSION - Check for proper piston extension (front and rear).
4. THROTTLE AND BRAKE PEDAL (NOT SHOWN) - Lubricate treadle roller and hinge pins with lubricating oil. Lift boot from mounting plate and apply a few drops of oil between mounting plate and plunger.
5. HOIST LIMIT SWITCH (NOT SHOWN) - Check operation. Clean and adjust as necessary.
6. HOIST ACTUATOR LINKAGE (NOT SHOWN) - Check operation. Clean, lubricate, and adjust as necessary.
7. PARKING BRAKE (NOT SHOWN) - Refer to the Shop Manual, Section "J", PARKING BRAKE MAINTENANCE, and perform the recommended inspection.
8. RESERVE ENGINE OIL SYSTEM (OPTIONAL)
   a. Check electrical system connections for tightness, corrosion and physical damage. Check battery, oil pressure switch, junction boxes, remote control fill box and circuit breakers.
   b. Examine all electrical cables over their entire length for possible damage.
   c. Examine all hoses, including those on reserve tank and ones leading to and from engine, for leaks, cracks or damage. Check all fittings for tightness, leakage or damage.
9. WHEEL MOTOR OIL ***(Initial 500 hours only)*** - Change or filter wheel motor gear oil only after initial 500 hours or operation. Wheel motor gear oil must be filtered or changed every 2500 hours of operation thereafter.
10. FRONT WHEELS - Check front wheel bearing preload 500 hours after truck commissioning (and at 500 hours after each rebuild) and every 5,000 hours there after. Refer to Section “G” for bearing preload adjustment procedures.

Truck Serial Number _____

Site Unit Number _____

Date: _____ Hour Meter: _____

Name of Service Person _____

COMMENTS	√’d	INITIALS

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1000 HOURS LUBRICATION AND MAINTENANCE CHECKS

Maintenance for every 10, 250 & 500 hour Lubrication and Maintenance Checks should also be carried out at this time.

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

1. HYDRAULIC TANK - Drain hydraulic oil* and clean inlet strainer. Refill tank with oil, approximate capacity 238 gal. (901 liters). Use Lube Key "B".

** NOTE: Oil change interval can be extended to 2500 hours if oil is sampled at regular intervals.*

Hydraulic Tank Breather - Replace breather.

2. RADIATOR - Clean cooling system with a quality cleaning compound. Flush with water. Refill system with anti-freeze and water solution. Check Cooling System Recommendation Chart for correct mixture. Refer to engine manufacturer's manual for recommended additives.
3. FUEL TANK - Remove breather and clean in solvent. Dry with air pressure and reinstall.
4. OPERATOR'S SEAT - Apply grease to slide rails. Use Lube Key "D"."
5. AUTOMATIC BRAKE APPLICATION - Check that brakes are automatically applied when hydraulic brake pressure decreases below specified limit. Refer to Section "J", *"Brake Checkout Procedure".*
6. FRONT ENGINE MOUNT TRUNION - Add one or two applications of grease at fitting. Lube key "D".
7. AUTOMATIC LUBE SYSTEM PUMP - Check pump housing oil level. Refill to bottom of level plug with SAE 10W-30 motor oil.
8. ELIMINATOR FILTER - Clean and check centrifuge. Refer to engine manufacturer's Operation and Maintenance Manual. (Service interval is dependent on duty cycle, oil quality etc.)

Truck Serial Number_____

Site Unit Number _____

Date:_____Hour Meter:_____

Name of Service Person _____

COMMENTS	√'d	INITIALS

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2500 HOUR MAINTENANCE CHECKS

Maintenance for every 10, 250, & 500 hour Lubrication and Maintenance Checks should also be carried out at this time. NOTE: "Lube Key" references are to the Lubrication Specification Chart.

Truck Serial Number _____

Site Unit Number _____

Date: _____ Hour Meter: _____

Name of Service Person _____

1. FRONT WHEELS - Drain oil and refill to proper level. Lube key "E".

2. MOTORIZED WHEELS - Drain and replace gear oil. Refer to G.E. Motorized Wheel Service & Maintenance Manual for lubrication specifications. Lube Key "C".

COMMENTS	√'d	INITIALS

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5000 HOURS LUBRICATION AND MAINTENANCE CHECKS

Maintenance for every 10, 250, 500, 2,500 & 1,000 hour Lubrication and Maintenance Checks should also be carried out at this time. NOTE: "Lube Key" references are to the Lubrication Specification Chart.

Truck Serial Number_____

Site Unit Number _____

Date:_____Hour Meter:_____

Name of Service Person _____

1. FRONT WHEELS - Drain oil and completely disassemble and check all parts for wear or damage. Refer to Section "G" of the service manual for disassembly and assembly procedures. Refill with oil. Check the oil level at oil level plug on wheel hub. Lube Key "C". Check bearing preload at the first 500 hours after each rebuild.

2. AIR CLEANERS - Clean the Donaclone Tubes in the pre-cleaner section of the air filter. Use low pressure cold water or low pressure air to clean tubes. Refer to Section "C" of the shop manual.

   NOTE: Do not use a hot pressure washer or high pressure air to clean tubes, high pressure causes pre-cleaner tubes to distort.

COMMENTS	√'d	INITIALS

10,000 HOURS LUBRICATION AND MAINTENANCE CHECKS

Maintenance for every 10, 250, 500, 1,000, 2,500 & 5,000 hour Lubrication and Maintenance Checks should also be carried out at this time. NOTE: "Lube Key" references are to the Lubrication Specification Chart.

Truck Serial Number_____

Site Unit Number _____

Date:_____Hour Meter:_____

Name of Service Person _____

1. WHEEL MOTORS - Clean the area around the grease ports to prevent dirt of other contaminates from entering. Remove the six grease port plugs on each wheel motor. Grease the inboard and outboard wheel hub bearings with one 14 ounce grease cartridge for each grease port.

COMMENTS	√'d	INITIALS

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NOTES:

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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 (3, Figure 3-1), controls input flow and pressure. A 24VDC Solenoid (5) 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.

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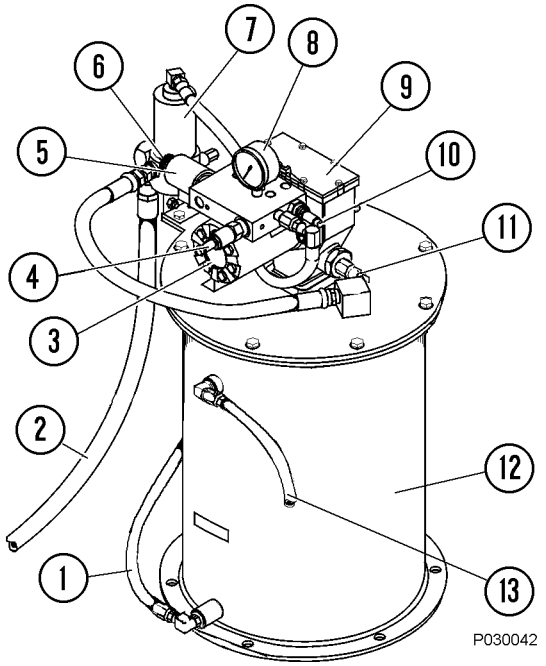


FIGURE 3-1. PUMP COMPONENTS

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

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.

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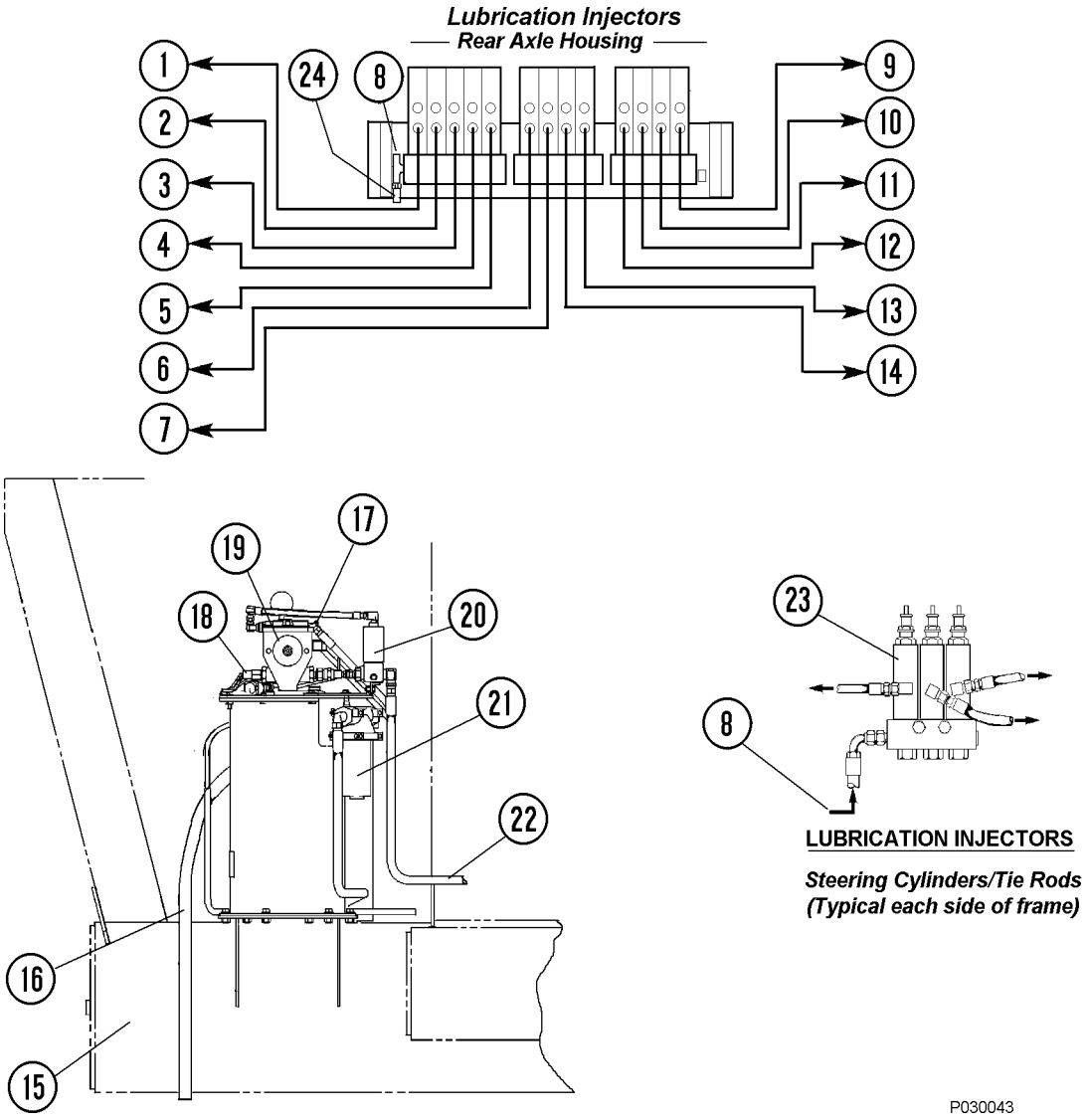


FIGURE 3-2. AUTO LUBE SYSTEM INSTALLATION

1. L.H. Suspension, Bottom Bearing
2. L.H. Hoist Cylinder, Top Bearing
3. L.H. Hoist Cylinder, Bottom Bearing
4. L.H. Suspension, Top Bearing
5. L.H. Body Pivot Pin
6. R.H. Body Pivot Pin
7. R.H. Suspension, Top Bearing
8. Grease Supply From Pump
9. R.H. Suspension, Bottom Bearing
10. R.H. Hoist Cylinder, Top Bearing
11. R.H. Hoist Cylinder, Bottom Bearing
12. Rear Axle Pivot Pin
13. L.H. Anti-Sway Bar Bearing
14. R.H. Anti-Sway Bar Bearing
15. Truck Frame
16. Vent Hose
17. Manual Override Knob
18. Pressure Switch, N.O., 2500 psi (17 237 kPa)
19. Grease Pump
20. Vent Valve
21. Filter
22. Grease Supply to Injectors
23. Injector
24. Pressure Switch, N.O., 2000 psi (13 790 kPa)

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SYSTEM COMPONENTS

Filter (21, Figure 3-2)

A filter assembly mounted on the grease reservoir filters the grease prior to refilling the reservoir from the shop supply. A bypass indicator alerts service personnel when the filter requires replacement.

Hydraulic Motor and Pump (3 & 9, Figure 3-1)

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

Specifications are as follows:

Max. hydraulic oil inlet pressure:

. . . . . 3,000 psi (20 685 kPa)

Hydraulic oil operating pressure:

. . . . . 325-350 psi (2 240-2 415 kPa)

Hydraulic inlet flow

. . . . . up to 7 GPM (28 L/min.)

Pump ratio: approx. 9:1

. . @300 to 350 psi (2 068 to 2 415 kPa) oil pressure

. . . . . @less than 2 GPM (7 L/min.) flow

Operating temperature

. . . . . -20 to +150° F (-10 to +65° C)

⚠WARNING

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

Grease Reservoir (12, Figure 3-1)

The reservoir has an approximate capacity of 90 lbs. (41 kg) of grease. When the grease supply is replenished by filling the system at the service center, the grease is passed through the filter to remove contaminants before it flows into the reservoir.

Pressure Reducing Valve (4, Figure 3-1)

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

Flow Control Valve (10, Figure 3-1)

The flow control valve mounted on the manifold, controls the amount of oil flow to the hydraulic motor. ***The flow control valve has been factory adjusted and the setting should not be disturbed.***

Solenoid Valve (5, Figure 3-1)

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

Vent Valve (7, Figure 3-1)

With the vent valve closed, the pump continues to operate until maximum grease pressure is achieved. As this occurs, the vent valve opens and allows the grease pressure to drop to 0, so the injectors can recharge for their next output cycle.

24 VDC Lubrication Cycle Timer (Not Shown)

The lube cycle timer provides a 24 VDC timed-interval signal to operate the solenoid valve (5, Figure 3-1), causing the grease pump motor to operate. This timer is mounted in the cab (in the housing under the passenger seat) to insure temperature stability.

Pressure Switch (N.O. 2500 psi [17 237 kPa])(11, Figure 3-1)

The pressure switch energizes the normally closed pump solenoid relay when the grease line pressure reaches the switch pressure setting, turning off the motor and pump.

Unloader Valve (Not Shown)

The unloader valve is mounted on a "tee" fitting with the pressure switch described above. This valve will relieve grease pressure in the pump if pressure exceeds 4000 psi (27.6 MPa). This valve has been factory adjusted and is not repairable.

Pressure Gauge (8, Figure 3-1)

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

Manual Override (6, Figure 3-1)

The manual override is used to actuate the hydraulic motor to manually activate a lubrication cycle.

Injectors (23, Figure 3-2)

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

Pressure Switch (24, Figure 3-2)

This pressure switch will activate a Lube System Low Pressure Warning lamp on the overhead display if adequate grease pressure (2000 psi (13 790 kPa)) is not attained within 1 minute.

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System Operation

Refer to Figure 3-3 & 3-4:

Normal Operation

1. During truck operation, with the pump and timer systems in a rest state, a preset time interval occurs.
2. The solid state system timer (1, Figure 3-4) provides a 24 VDC signal through the normally closed contacts in relay RB6-K1 (12) used to energize the pump solenoid valve (5), allowing hydraulic oil provided by the truck steering pump circuit to flow to the pump motor and initiate a pumping cycle.
3. The hydraulic oil pressure from the steering circuit is reduced to 325 to 350 psi (2 240 to 2 413 kPa) by the pressure reducing valve (4, Figure 3-3) before entering the motor. In addition, the amount of oil supplied to the pump is limited by the flow control valve (6). Pump pressure can be read using the gauge (5) mounted on the manifold.
4. With oil flowing into the hydraulic motor, the grease pump will operate, pumping grease from the reservoir to the injectors (13), through a check valve (10) and to the vent valve (11) and the normally open pressure switch (9).
5. During this period, the injectors will meter the appropriate amount of grease to each lubrication point.
6. When grease pressure reaches the pressure switch (4, Figure 3-4) setting, the switch contacts will close and energize relay RB6-K1 (12), removing power from the hydraulic motor/pump solenoid (5) and the the pump will stop. The relay will remain energized until grease pressure drops and the pressure switch opens again or until the timer turns off.
7. After the pump solenoid valve is de-energized, hydraulic pressure in the manifold drops and the vent valve (11, Figure 3-3) will open, releasing grease pressure in the lines to the injector banks. When this occurs, the injectors are then able to recharge for the next lubrication cycle.
8. The system will remain at rest until the solid state timer turns on and initiates a new grease cycle.

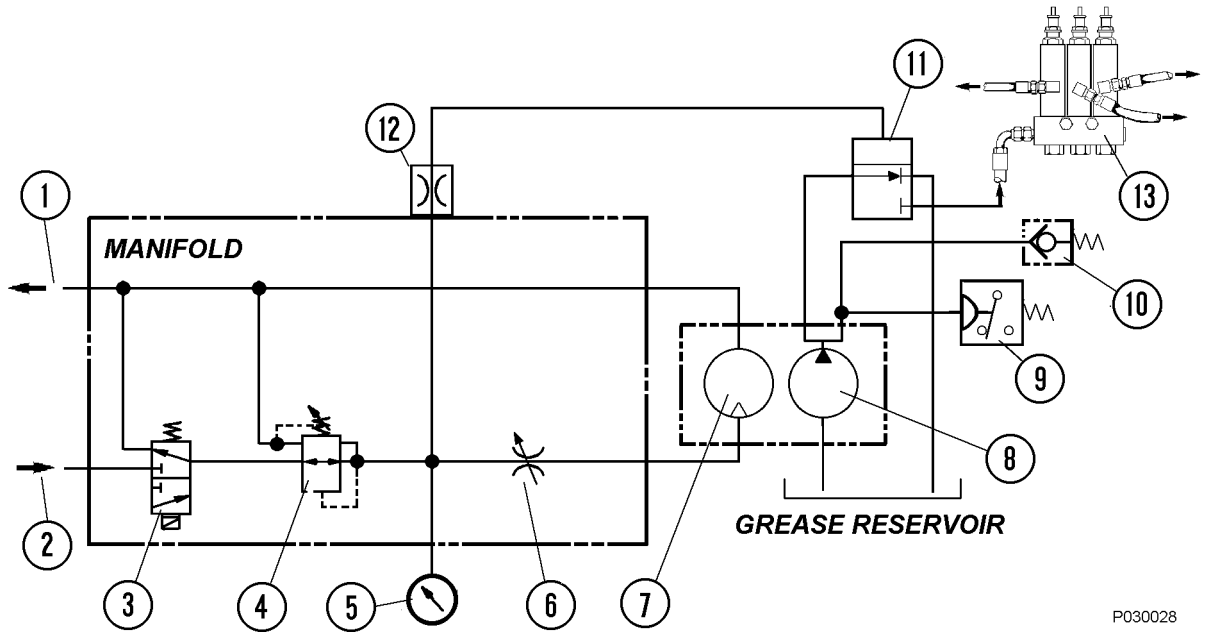


FIGURE 3-3. HYDRAULIC SCHEMATIC

1. Hydraulic Oil Return
2. Hydraulic Oil Supply
3. Pump Solenoid Valve
4. Pressure Reducing Valve
5. Motor Pressure Gauge
6. Flow Control Valve
7. Hydraulic Motor
8. Grease Pump
9. Pressure Switch (N.O.)
10. Unloader Valve
11. Vent Valve
12. Orifice
13. Injector Bank

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Pressure Failure Detection Circuits

1. When the lubrication cycle is initiated, 24VDC flows through relay RB6-K4 (8, Figure 3-4) N.C. contacts to a 1 minute delay timer (7).
2. If the system is operating normally, grease pressure at the rear axle injector bank will rise to pressure switch (9) setting of 2000 psi (13.8 MPa), closing the switch contacts and energizing relay RB6-K4 (8), removing 24 volts from the delay timer. The timer is then reset and no current will flow from the timer output terminal.
3. If a problem occurs and the system is not able to attain 2000 psi (13.8 MPa), the delay timer (7) will energize relay RB6-K2 after 60 seconds, turning on the ©Low Lube System Pressure[a] warning lamp on the overhead display. After RB6-K2 energizes, it will ground the coil of RB6-K6 and allow it to energize.
4. Once RB6-K6 is energized, it will latch and remain latched as long as the key switch is On. Also, RB6-K2 will remain energized and the Low Lube Pressure Warning light will remain on to notify the operator a problem exists and the system requires service.
5. The warning circuits are reset when the key switch is turned Off.

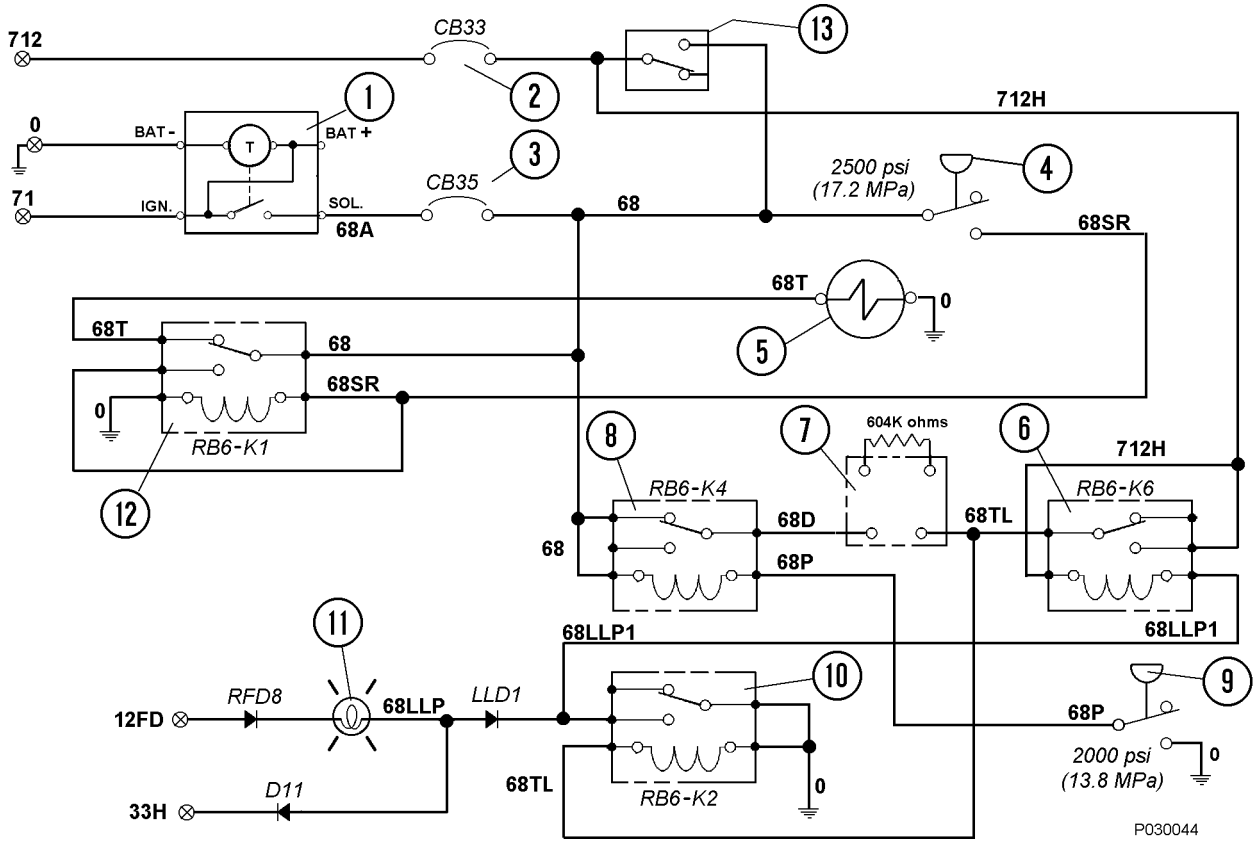
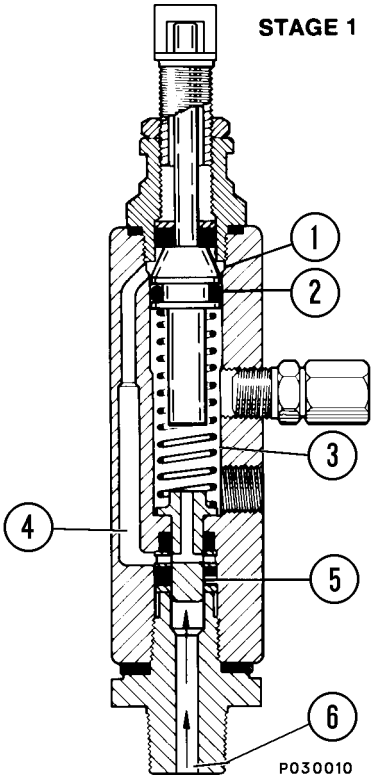


FIGURE 3-4. ELECTRICAL SCHEMATIC

1. Solid State Timer
2. Circuit Breaker 33 (Power Distribution Module in Cab)
3. Circuit Breaker 35 (Power Distribution Module in Cab)
4. Pressure Switch (On Grease Pump)
5. Pump Solenoid Valve
6. Relay Board 6, Relay K6
7. Time Delay Module
8. Relay Board 6, Relay K4
9. Pressure Switch (Rear Axle Injector Bank)
10. Relay Board 6, Relay K2
11. Auto Lube Low Pressure Warning Lamp
12. Relay Board 6, Relay K1
13. Manual Override Switch

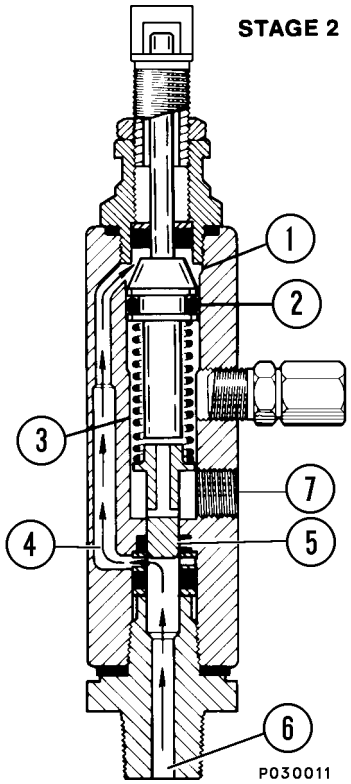
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INJECTOR OPERATION



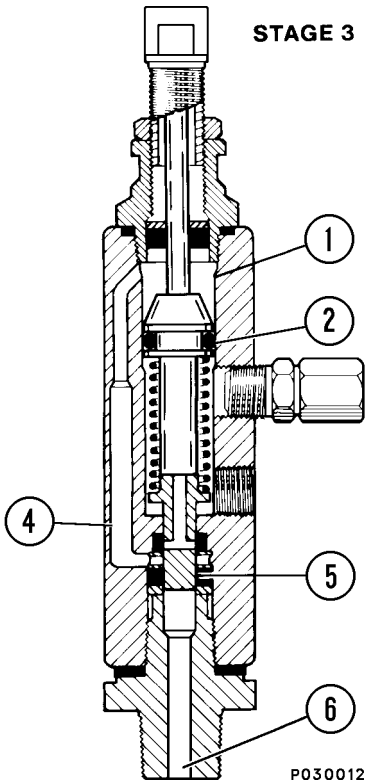
STAGE 1.

The injector piston (2) is in its normal or "rest" position. The discharge chamber (3) is filled with lubricant from the previous cycle. Under the pressure of incoming lubricant (6), the slide valve (5) is about to open the passage (4) leading to the measuring chamber (1) above the injector piston (2).



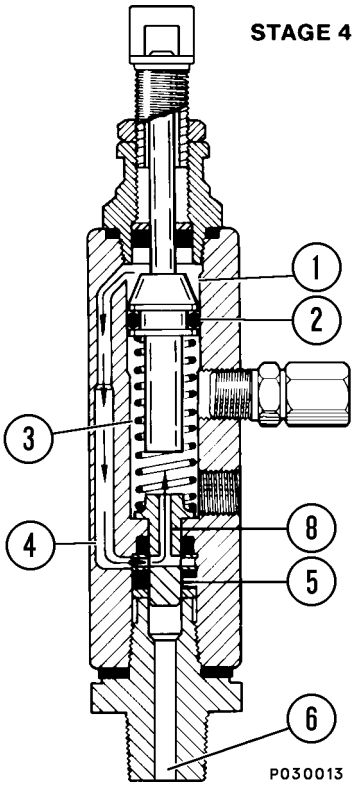
STAGE 2.

When the slide valve (5) uncovers the passage (4), lubricant (6) is admitted to the measuring chamber (1) above the injector piston (2) which forces lubricant from the discharge chamber (3) through the outlet port (7) to the bearing.



STAGE 3.

As the injector piston (2) completes its stroke, it pushes the slide valve (5) past the passage (4), cutting off further admission of lubricant (6) to the passage (4) and measuring chamber (1). The injector piston (2) and slide valve (5) remain in this position until lubricant pressure in the supply line (6) is vented.



STAGE 4.

After venting, the injector spring expands, causing the slide valve (5) to move, so that the passage (4) and discharge chamber (3) are connected by a valve port (8). Further expansion of the spring causes the piston to move upward, forcing the lubricant in the measuring chamber (1) through the passage (4) and valve port (8) to refill the discharge chamber (3).

Injector is now ready for the next cycle.

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GENERAL INSTRUCTIONS

LUBRICANT REQUIRED FOR SYSTEM

Grease requirements will depend on ambient temperatures encountered during truck operation:

- Above 90°F (32°C) - Use NLGI No.2 multipurpose grease (MPG).
- -25° to 90°F (-32° to 32°C) - Use NLGI No. 1 multipurpose grease (MPG).
- Below -25°F (-32°C) - Refer to local supplier for extreme cold weather lubricant requirements.

SYSTEM PRIMING

The system must be full of grease and free of air pockets to function properly. After maintenance, if the primary or secondary lubrication lines were replaced, it will be necessary to prime the system to eject all entrapped air.

1. Fill lube reservoir with lubricant, if necessary.
2. To purge air from the main supply line, remove the main supply line (2, Figure 3-1) at the pump outlet port and connect an external grease supply to the line.
3. Remove plugs from each injector group in sequence (right front, left front, and rear axle).
4. Using the external grease source, pump grease until grease appears at the group of injectors and re-install the pipe plug. Repeat for remaining injector groups.
5. Remove the caps from each injector and connect an external grease supply to the zerk on the injector and pump until grease appears at the far end of the individual grease hose or the joint being greased.

FILTER ASSEMBLY

The filter assembly (21, Figure 3-2) element should be replaced if the bypass indicator shows excessive element restriction. See Figure 3-5 for detailed information about the filter assembly.

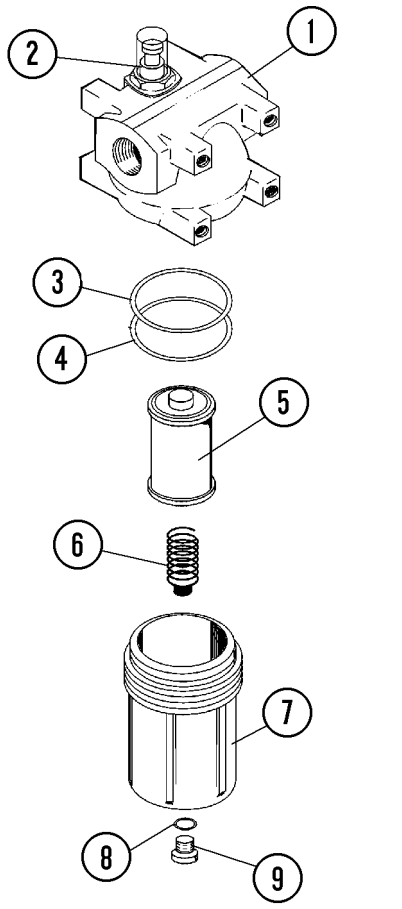


FIGURE 3-5. FILTER ASSEMBLY

1. Housing
2. Bypass Indicator
3. O-Ring
4. Backup Ring
5. Element
6. Spring
7. Bowl
8. O-Ring
9. Plug

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LUBRICANT PUMP

Pump Housing Oil Level

The pump housing must be filled to the proper level with SAE 10W-30 motor oil. Oil level should be checked at 1000 hour intervals. To add oil, remove pipe plug (4, Figure 3-6) and fill housing to bottom of plug hole.

Pump Pressure Control

High pressure hydraulic fluid from the truck steering system is reduced to 325 to 350 psi (2 240 to 2 413 kPa) by the pressure reducing valve located on the manifold on top of the pump motor. This pressure can be read on the gauge (3, Figure 3-6) installed on the manifold and should be checked occasionally to verify pressure is within the above limits.

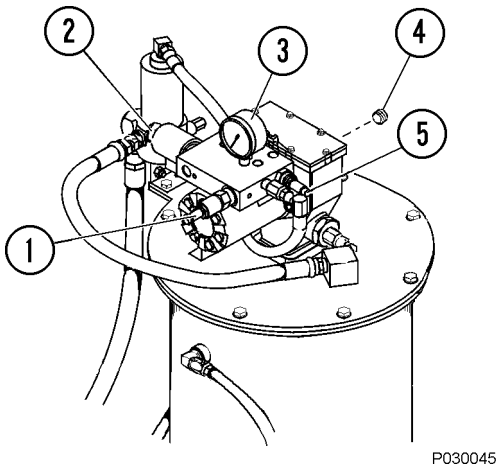


FIGURE 3-6. PUMP CONTROLS

1. Pump Pressure Control
2. Manual Override Knob
3. Pressure Gauge
4. Oil Level Plug
5. Flow Control Valve

Pressure Control Valve Adjustment

1. With the truck engine running, actuate the manual override (2, Figure 3-6) to start the hydraulic motor and grease pump.
2. Loosen the locknut on the pressure control (1, Figure 3-6) by turning the nut counterclockwise.
3. Turn the valve stem counterclockwise until it no longer turns. (The valve stem will unscrew until it reaches the stop - it will not come off.)

Note: This is the minimum pressure setting, which is about 170 psi (1 172 kPa).

4. With the pump stalled against pressure, turn the pressure control valve stem clockwise until 325 to 350 psi (2 240 to 2 413 kPa) is attained on the manifold pressure gauge (3).
5. Tighten the locknut to lock the stem in position.

Note: The flow control valve (5) is factory adjusted to 2.5 GPM (9.5 L/min.). ***Do not change this setting.***

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INJECTORS (SL-1 Series "H")

Injector Specifications

- Each lube injector services only one grease point. In case of pump malfunction, each injector is equipped with a covered grease fitting to allow the use of external lubricating equipment.
- Injector output is adjustable:
  Maximum output = 0.08 in^3 (1.31 cc).
  Minimum output = 0.008 in^3 (0.13 cc).
- Operating Pressure:
  Minimum - 1850 psi (12 755 kPa)
  Maximum - 3500 psi (24 133 kPa)
  Recommended - 2500 psi (17 238 kPa)
  Maximum Vent Pressure - (Recharge)
  600 psi (4 137 kPa)

Injector Adjustment

The injectors may be adjusted to supply from 0.008 in^3 to 0.08 in^3 (0.13 cc to 1.31 cc) of lubricant per injection cycle. The injector piston travel distance determines the amount of lubricant supplied. This travel is in turn controlled by an adjusting screw in the top of the injector housing.

Turn the adjusting screw (1, Figure 3-7) counterclockwise to increase lubricant amount delivered and clockwise to decrease the lubricant amount.

When the injector is not pressurized, maximum injector delivery volume is attained by turning the adjusting screw (1) fully counterclockwise until the indicating pin (8) just touches the adjusting screw. At the maximum delivery point, about 0.38 inch (9.7 mm) adjusting screw threads should be showing. Decrease the delivered lubricant amount by turning the adjusting screw clockwise to limit injector piston travel. If only half the lubricant is needed, turn the adjusting screw to the point where about 0.19 inch (4.8 mm) threads are showing. The injector will be set at minimum delivery point with about 0.009 inch (0.22 mm) thread showing.

NOTE: The above information concerns adjustment of injector delivery volume. The timer adjustment should also be changed, if overall lubricant delivery is too little or too much. Injector output should NOT be adjusted to less than one-fourth capacity.

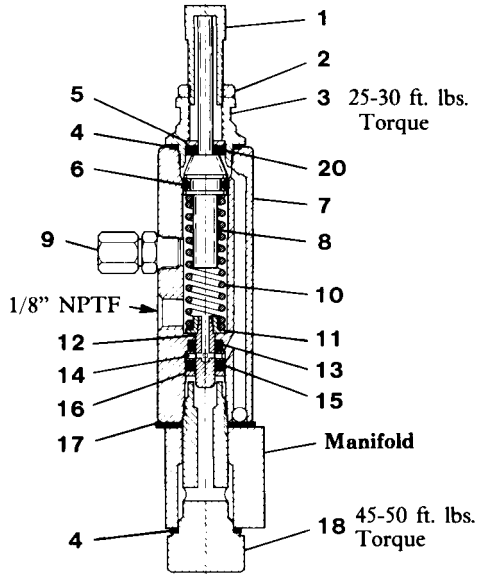


FIGURE 3-7. TYPE SL-1 INJECTOR

1. Adjusting Screw	11. Spring Seat
2. Locknut	12. Plunger
3. Piston Stop Plug	13. Viton Packing
4. Gasket	14. Inlet Disc
5. Washer	15. Viton Packing
6. Viton O-Ring	16. Washer
7. Injector Body Assy.	17. Gasket
8. Piston Assembly	18. Adapter Bolt
9. Fitting Assembly	19. Adapter
10. Plunger Spring	20. Viton Packing

NOTE: The Piston Assembly (8) has a visible indicator pin at the top of the assembly to verify the injector operation.

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SYSTEM CHECKOUT

To check system operation (not including timer), proceed as follows:

1. Turn keyswitch "ON" and start the engine.
2. Actuate the manual override (6, Figure 3-1) on the end of the solenoid valve.
3. The pump should operate and the system should build grease pressure.
4. When the pump stalls, release the manual override knob and motor should turn off. The vent valve should open to vent grease pressure from the injector bank feeder lines.

24 VDC TIMER CHECK

To check the timer operation without waiting for the normal timer setting, proceed as follows:

1. Remove timer dust cover.

NOTE: The timer incorporates a liquid and dust tight cover which must be in place and secured at all times during truck operation.

2. Adjust timer selector (3, Figure 3-8) to 5 minute interval setting.
3. The timer should cycle in five minutes if the truck is operating.

NOTE: If the timer check is being made on a cold start, the first cycle will be approximately double the nominal setting. All subsequent cycles should be within the selected time tolerance.

4. Voltage checks at the timer should be accomplished if the above checks do not identify the problem.
   a. Insure timer ground connection is clean and tight.
   b. Using a Volt-Ohm meter, read the voltage between positive and negative posts on the solid state timer with the truck keyswitch "ON".
   Normal reading should be 18-26 VDC, depending upon whether or not the engine is running.

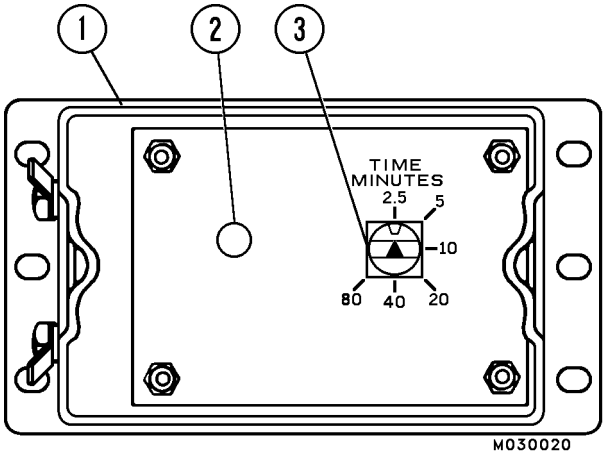


FIGURE 3-8. TIMER (TOP COVER REMOVED)

1. Timer Enclosure
2. Red LED (Light Emitting Diode)
3. Timer Selector

Lubrication Cycle Timer Adjustment

The timer is factory set for a nominal 2.5 minute (off time) interval. Dwell time is approximately 1 minute, 15 seconds. A longer interval (off time) is obtained by turning the Selector knob (3, Figure 3-8) to the desired position.

NOTE: Set timer by turning the Selector knob (3) to the 2.5 minute setting point. Then, turn the Selector clockwise, one detent at a time, to the desired setting, or until the maximum limit of eighty minutes is reached.

The timer is a sealed unit, do not attempt disassembly.

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PUMP REBUILD

⚠WARNING

Be certain to bleed steering accumulators to relieve hydraulic pressure and to relieve pump outlet grease pressure before removing any hoses or fittings.

Disassembly

1. Remove the four socket head screws (33, Figure 3-9) and separate the manifold (37) from the hydraulic motor (42).
2. Remove pipe plug (45) and drain the crankcase oil from pump housing (46).
3. Remove the six screws (29) and remove the housing cover (30) and cover gasket (31).
4. Remove retaining ring (57) and pull the shovel plug (56) from the housing tube (55).
5. Remove two socket head screws (44) and separate hydraulic motor (42) from the pump housing (46).
6. Remove two outlet pin nuts (50) from pump housing.
7. Remove the pump subassembly (1 through 28) from the pump housing. Pushing the subassembly up with a 0.75 in. (19 mm) diameter wooden or plastic rod against the check seat housing (28) is helpful.
8. Remove the housing tube (55) from the pump housing by inserting a 0.75 in. (19 mm) diameter rod through the inlet holes at the bottom of the housing tube and unscrewing it.
9. Remove the bronze bearing (51), O-ring (52), backup washer (53), and O-ring (54) from the housing tube.
10. Remove the crankrod assembly (1 through 8) from the pump by unscrewing the button head screws (12) and then pulling out the wrist pin bushings (13).
11. Remove the check seat housing (28) from the reciprocating tube (21).

Note: There is a 3/8 in. allen head socket in the throat of the check seat housing to facilitate removal.

12. Unscrew the wrist pin anchor (14) from the reciprocating tube (21) and pull the plunger assembly (9 through 20) from the tube.
13. Using a 0.50 in. (13 mm) diameter wooden or plastic rod, push the cup seal (22) and the pump cylinder (24) from the reciprocating tube.
14. Remove the pump plunger (20) from the plunger link rod (17). (A spanner wrench, which uses the holes in the pump plunger, is required.)
15. Unscrew the plunger link rod (17) from the plunger tube (11) and slide off the cup seal (16) backup washer (15) and wrist pin anchor (14).
16. Unscrew the plunger tube (11) from the outlet pin (9).
17. To dismantle the crankrod assembly (1 through 8), remove flat head screws (1) and the inner and outer weights (2 & 3).
18. Remove the small retaining rings (6) and press the crank eccentric (7) out of the ball bearing (8). Be sure to support the ball bearing on the inner race.

Cleaning and Inspection

1. Discard all seals and gaskets. Repair kits are available containing all the necessary seals and gaskets for reassembly. Refer to the appropriate truck parts book.
2. Clean and inspect the following parts. Replace if excessive wear is evident:

- Ball bearing (8)
- Crank eccentric (7)
- Crankrod (5)
- Wrist pin bushings (13)
- Plunger tube (11)
- Pump plunger & upper check parts (20, 19 & 18)
- Pump cylinder (24)
- Check seat housing/lower check ball (28, 26)
- Upper bronze bushing (51)
- Housing tube (55)
- Shovel plug (56)
- Reciprocating tube (21)

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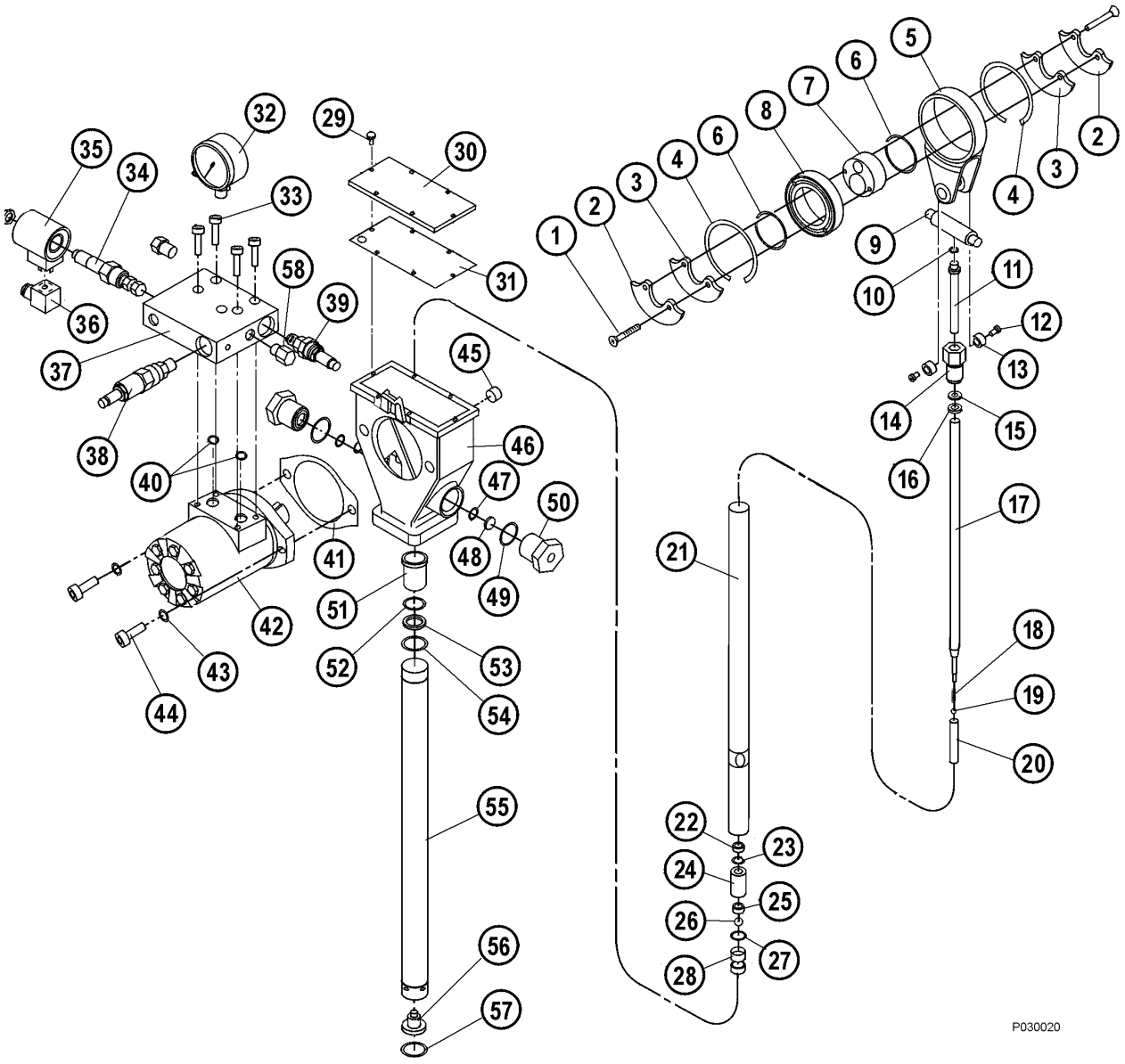


FIGURE 3-9. LUBE PUMP ASSEMBLY

1. Screw
2. Outer Weight
3. Inner Weight
4. Retaining Ring
5. Crankrod
6. Retaining Ring
7. Eccentric Crank
8. Ball Bearing
9. Outlet Pin
10. O-Ring
11. Plunger Tube
12. Screw
13. Wrist Pin Bushing
14. Wrist Pin Anchor
15. Backup Washer
16. Cup Seal
17. Plunger Rod
18. Spring
19. Steel Ball
20. Plunger
21. Reciprocating Tube
22. Cup Seal
23. O-Ring
24. Cylinder
25. Ball Cage
26. Steel Ball
27. O-Ring
28. Check Seat
29. Screw
30. Housing Cover
31. Cover Gasket
32. Gauge
33. Screw
34. Valve Cartridge
35. Solenoid Valve
36. Connector
37. Manifold
38. Press. Reducing Valve
39. Flow Control Valve
40. O-Ring
41. Gasket
42. Hydraulic Motor
43. Washer
44. Screw
45. Pipe Plug
46. Pump Housing
47. Backup Ring
48. O-Ring
49. O-Ring
50. Nut
51. Bronze Bearing
52. O-Ring
53. Backup Washer
54. O-Ring
55. Housing Tube
56. Shovel Plug
57. Retaining Ring
58. Orifice Fitting

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Assembly

Note: Use Loctite® 242 (or equivalent) thread locker on all torqued, threaded connections. Use extreme care to prevent thread locker from flowing into adjacent areas such as clearance fits and ball check. Allow a minimum of 30 minutes cure time before operating pump.

1. Support ball bearing (8, Figure 3-9) inner race and press eccentric (7) into bore. Install small retaining rings (6).
2. Assemble crankrod assembly parts; large retaining rings (4), inner weights (3), outer weights (2) and install flat head screws (1). Tighten to **100 - 110 in. lbs. (11.3 - 12.4 N.m)** torque.
3. Using a new O-ring (10), install plunger tube (11) on outlet pin (9). Tighten to **100 - 110 in. lbs. (11.3 - 12.4 N.m)** torque.
4. Assemble the wrist pin anchor (14), backup washer (15), cup seal (16) and plunger link rod (17) onto plunger tube (11). Tighten to **100 - 110 in. lbs. (11.3 - 12.4 N.m)** torque.
5. Assemble spring (18), ball (19), and plunger (20) on plunger link rod (17). Tighten plunger to **100 - 110 in. lbs. (11.3 - 12.4 N.m)** torque.
6. Install reciprocating tube (21) onto wrist pin anchor (14). Tighten to **20 - 25 ft. lbs. (27.1 - 33.9 N.m)** torque.
7. Install cup seal (22), O-ring (23), cylinder (24), ball cage (25), ball (26), O-ring (27) and check seat (28) into reciprocating tube (21). Tighten check seat housing to **20 - 25 ft. lbs. (27.1 - 33.9 N.m)** torque.
8. Assemble crank rod assembly, to pump with bushings (13) and button head screws (12). Tighten screws to **100 - 110 in. lbs. (11.3 - 12.4 N.m)** torque.
9. Place pump subassembly (parts 1 through 28) into pump housing (46).
10. Install new O-ring (54), backup washer (53) and O-ring (52) and bronze bushing (51) into housing tube (55).
11. Install housing tube assembly onto pump housing (46). Be certain reciprocating tube (21) is inserted through both bushings. Using a 0.75 in. (19 mm) diameter rod through the inlet holes at bottom of tube, tighten to **20 - 25 ft. lbs. (27.1 - 33.9 N.m)** torque.
12. Install shovel plug (56) and retainer (57).
13. Install new backup rings (47), O-rings (48 & 49), and outlet pin nuts (50). Tighten to **30 - 35 ft. lbs. (40.7 - 47.5 N.m)** torque.
14. Install gasket (41) and motor (42) on pump housing (46). Install washers (43) and socket head screws (44).
15. Install shovel plug (56) in housing tube (55). Install retaining ring (57).
16. Install gasket (31), cover (30) and six self-tapping screws (29), on pump housing.
17. Using new O-rings (40), install manifold (37) on motor (42). Install socket head screws (33).
18. With the pump assembly in its normal operating position, add SAE 10W-30 motor oil to pump housing until oil is level with bottom of pipe plug (45) hole. Install pipe plug.

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SYSTEM TROUBLESHOOTING CHART

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

POSSIBLE CAUSES	*SUGGESTED CORRECTIVE ACTION*
TROUBLE: Pump Does Not Operate	
Lube system not grounded.	Correct grounding connections to pump assembly and truck chassis.
Electrical power loss.	Locate cause of power loss and repair. 24 VDC power required. Be sure keyswitch is "ON".
Timer malfunction.	Replace timer assembly
Solenoid valve malfunctioning.	Replace the solenoid valve assembly
Relay malfunctioning	Replace relay
Motor or pump malfunction.	Replace motor and/or pump assembly
	NOTE: On initial start-up of the lube system, the timing capacitor will not contain a charge, therefore the first timing cycle will be about double in length compared to the normal interval. Subsequent timer cycles should be as specified.
TROUBLE: Pump Will Not Prime	
Low lubricant supply.	Dirt in reservoir, pump inlet clogged, filter clogged.
TROUBLE: Pump Will Not Build Pressure	
Air trapped in lubricant supply line.	Prime system to remove trapped air.
Lubricant supply line leaking.	Check lines and connections to repair leakage.
Vent valve leaking.	Clean or replace vent valve.
Pump worn or scored.	Repair or replace pump assembly.
TROUBLE: Injector Indicator Stem Does Not Operate	
NOTE: Normally, during operation, the injector indicator stem will move into the body of the injector when pressure builds properly. When the system vents (pressure release) the indicator stem will again move out into the adjusting yoke.	
Malfunctioning injector - usually indicated by the pump building pressure and then venting.	Replace individual injector assembly.
All injectors inoperative - pump build up not sufficient to cycle injectors.	Service and/or replace pump assembly.

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POSSIBLE CAUSES	*SUGGESTED CORRECTIVE ACTION*
TROUBLE: Pressure Gauge Does Not Register Pressure	
No system pressure to the pump motor.	Check hydraulic hose from steering system.
No 24 VDC signal at pump solenoid.	Determine problem in 24 VDC electric system.
Pressure reducing valve set too low.	Refer to "Pressure Control Valve Adjustment".
24V Relay may be defective.	Replace relay.
TROUBLE: Pump Pressure Builds Very Slowly Or Not At All	
No signal at 24V relay.	Check Timer.
Pressure switch may be defective	Replace pressure switch.
Pressure reducing valve may be set too low.	Refer to "Pressure Control Valve Adjustment".
Grease viscosity may be too high for temperature at which pump is operating.	Replace grease with a lower viscosity lubricant.
Pump inlet check or outlet check may have foreign matter trapped causing leakage.	Remove, inspect and clean, if necessary.Inspect sealing surfaces between checks. Replace if rough or pitted.
Lubricant supply line leaks or is broken.	Repair lubricant supply line
Insufficient hydraulic oil supply.	Check oil pressure and flow to motor.
TROUBLE: 24VDC Timer Not Operating	
Timer BAT (-) connection is not on grounded member.	Connect to good ground.
Timer BAT (+) connection not on circuit continuously connected to BAT (+) terminal during operation of vehicle.	Establish direct connection between Timer BAT (+) connection and 24 V BAT (+) terminal.
Loose wire connections at any of the timer terminals.	Secure wire connections.
TROUBLE: Timer Stays Timed Out	
Commutation failure in timer caused by damaged component.	Replace Timer.
Output relay contacts welded shut caused by extended short to ground.	Replace Timer
Solenoid valve connected to LUBE SW terminal of timer instead of terminal marked SOL.	Correct wiring hook-up.

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POSSIBLE CAUSES	*SUGGESTED CORRECTIVE ACTION*
TROUBLE: Timer Turns On At Intervals Two (2) To Ten (10) Times More Often Than Set Time Interval	
Electrical noise is being introduced into the power supply to the timer overcoming suppressor capacitor causing uncontrolled turn-on of its output relay.	***IMPORTANT: In some instances, electrical noise may be generated into vehicle electrical system which may cause timer to turn on at random intervals, independent of timer setting.*** ***If this occurs, a 250 to 1,000 MFD capacitor rated 150 to 350 VDC should be added across BAT (+) and BAT (-) terminals to suppress this noise and improve timer performance.***
TROUBLE: Timer Turns On At Intervals Faster Than Allowable Tolerances Of Settings	
Timer out of adjustment or damaged component.	Refer to "Timer Adjustment" and re-adjust timer or replace timer.

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Preventative Maintenance Procedures

The following maintenance procedures should be used to insure proper system operation.

Daily Lubrication System Inspection

1. Check grease reservoir level.

   Inspect grease level height after each shift of operation. Grease usage should be consistent from day-to-day operations.

   - ❑ Lack of lubricant usage would indicate an inoperative system. Excessive usage would indicate a broken supply line.

2. Check filter bypass indicator when filling reservoir. Replace element if bypassing.
3. Check all grease feed line hoses from the SL-1 Injectors to the lubrication points.
   a. Repair or replace all damaged feed line hoses.
   b. Make sure that all air is purged and all new feed line hoses are filled with grease before sending the truck back into service.
4. Inspect key lubrication points for a bead of lubricant around seal. If a lubrication point appears dry, troubleshoot and repair problem.

250 Hour Inspection

1. Check all grease feed line hoses from the SL-1 Injectors to the lubrication points (see, Figure 3-2).
   a. Repair or replace all worn / broken feed line hoses.
   b. Make sure that all air is purged and all new feed line hoses are filled with grease before sending the truck back into service.
2. Check all grease supply line hoses from the pump to the SL-1 injectors.
   a. Repair or replace all worn / broken supply lines.
   b. Make sure that all air is purged and all new supply line hoses are filled with grease before sending the truck back into service.
3. Check grease reservoir level.
   a. Fill reservoir if low.
   b. Check reservoir for contaminants. Clean, if required.
   c. Check that all filler plugs, covers and breather vents on the reservoir are intact and free of contaminants.
4. Inspect all bearing points for a bead of lubricant around the bearing seal.

   It is good practice to manually lube each bearing point at the grease fitting provided on each Injector. This will indicate if there are any frozen or plugged bearings, and will help flush the bearings of contaminants.
5. System Checkout
   a. Remove all SL-1 injector cover caps to allow visual inspection of the injector cycle indicator pins during system operation.
   b. Start truck engine.
   c. Lift the passenger seat and connect a jumper wire between "SOL" and "LUBE SW" on the lube cycle timer or activate test switch if installed. The hydraulic grease pump should operate.
   d. Keep the system activated until the pump stalls out or the pressure switch closes.
   e. With the pump in the stalled-out mode, check each SL-1 injector assembly. The cycle indicator pin should be retracted inside the injector body.
   f. Once all of the SL-1 injectors have been inspected under pressure remove the jumper wire between the "SOL" terminal and "LUBE SW" terminal on the timer assembly or open test switch. The pump should shut off and the pressure in the system should drop to zero, venting back to the grease reservoir.
   g. With the system vented, check all of the SL-1 injector indicator pins; all of the pins should be visible. Replace or repair injectors, if defective.
   h. Reinstall all injector cover caps.
   i. Check timer operation.

Note: With engine running, lube system should activate within 5 minutes. The system should build 2000 to 2500 psi within 25-40 seconds.

   j. If the system is working properly, the machine is ready for operation.
   k. If the system is malfunctioning, refer to the troubleshooting chart.

1000 Hour Inspection

1. Check pump housing oil level.

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NOTES:

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MOTORIZED WHEEL MAINTENANCE SCHEDULE

AXLE BOX

MOTORIZED WHEEL MAINTENANCE SCHEDULE	772	**776/791**	**787**	**788**
WORK TO BE DONE (See Note 1)	HOURS	HOURS	HOURS	HOURS
1. Check oil level and dipstick (or oil-fill cap) gasket.	Daily	Daily	Weekly	Weekly
2. Add 0.5 ounce grease to each dirt seal grease fitting. (Note4)	Daily	Daily	—	—
3. Add 1.0 ounce grease to each dirt seal grease fitting.	250	250	—	—
4. Clean sun pinion cover magnetic plugs.	250	250	250	250
5. Clean or replace gearcase filters.	250	250	250	250
6. Check vent pipes for obstruction.	250	250	250	250
7. Check current shunts for tightness and discoloration.	250	250	250	250
8. Check cable connections for tightness and discoloration.	250	250	250	250
9. Check axle box for door seal.	250	250	250	250
10. Inspect for oil and grease leaks.	250	250	250	250
11. Take oil sample (see Note 2).	250	250	250	250
12. Clean axle box door seal.	250	250	250	250
13. Change oil (see Note 3).	500	500	1500	1500
14. Clean sump magnetic plugs.	500	500	1500	1500
15. Check drive ring internal spline wear.	500	500	2500	2500
16. Remove and inspect the sun pinion. a. Check gear condition (visually) b. Check spline wear (visually) c. Check oil baffle and snap rings for damage d. Check for sufficient clearance from cover	500	500	2500	2500
17. Check end play of gears.	1000	1000	2500	2500

NOTE 1: The numbers in the columns under each motor type represent operating hours, except as specified.

NOTE 2: Oil samples on Motorized Wheels with less than 1000 hours should be taken twice as often as recommended in the Maintenance Schedule.

NOTE 3: On GE787 and GE788 Motorized Wheels, change the oil after the FIRST 500 hours; thereafter, at the indicated 1500 hour interval, 1500 hours is maximum. More frequent oil change may be required, depending on individual mine conditions.

NOTE: 4. Motorized Wheels produced after March, 1988 are equipped with a new dirt seal and do not have grease fittings.

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MOTORIZED WHEEL MAINTENANCE SCHEDULE

ARMATURE AREA

MOTORIZED WHEEL MAINTENANCE SCHEDULE	772	**776/791**	**787**	**788**
WORK TO BE DONE (See Note 1)	HOURS	HOURS	HOURS	HOURS
1. Brush length, condition, freedom of movement.	500	500	500	500
2. Brushholder condition, clearance, brush tension.	500	500	500	500
3. Commutator condition, film, etc.	500	500	500	500
4. All connections for tightness.	500	500	500	500
5. Clean Teflon** band.	500	500	500	500
6. Check coil insulation (visually).	500	500	500	500
7. Check hydraulic line connections for leakage Clean any fluid found in the frame.	500	500	500	500
8. Blow out brushholder and commutator area.	500	500	500	500

AT TIRE CHANGE — FOR ALL MOTORIZED WHEELS

1. Remove dirt and grease build-up from dirt seal area.				
2. Inspect dirt seal grease fittings. (If Equipped)				
3. Check wear of torque tube wear band (GE772, GE776 Only).				
4. Visually inspect for broken grease lines, damage to hub caps, etc.				
5. Check condition of grease line guards (if used).				
6. Check tightness of exposed bolts.				
7. Retorque brake adapter bolts on models equipped with disc brakes.				

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MOTORIZED WHEEL MAINTENANCE SCHEDULE

GENERATOR/ALTERNATOR

CONTROL MAINTENANCE SCHEDULE	P.M. HOURS	
WORK TO BE DONE	250	500
Brush length, condition, free moving.	X	X
Brushholder condition, spacing tension.	X	X
Commutator/slip ring condition, film, etc.	X	X
Clean string/Teflon band.	X	X
Check all connections; tightness, burning, etc.	X	X
Blow out commutator.	X	X

GRID BLOWER MOTOR

CONTROL MAINTENANCE SCHEDULE	P.M. HOURS	
WORK TO BE DONE	250	500
Brush length, condition, free moving.		X
Brushholder condition, spacing tension.		X
Commutator condition, film, etc.		X
Clean string/Teflon band.		X
Check all connections; tightness, burning, etc.		X
Check cables for abrasion and burning		X
Blow out commutator area with clean dry air, 70 psi (482 KPa) maximum.		X

CONTROL EQUIPMENT CHECKS

CONTROL MAINTENANCE SCHEDULE	P.M. HOURS	
WORK TO BE DONE	250	500
Vacuum the control cabinet.	X	X
Check all electrical connections for tightness.	X	X
Check current shunts for tightness, discoloration.	X	X
Check insulators, terminal strips, springs, etc. for breaks or cracks.	X	X
Check reverser contactors, interlocks and relays for top wear, burning, tip break, overtravel, tip pressure and frayed, broken or discolored shunts.	X	X
Check magnet valves for leaks.	X	X
Check condition of arc chutes.	X	X
Check door seal and latch.	X	X

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MOTORIZED WHEEL MAINTENANCE SCHEDULE

AUXILIARY EQUIPMENT AND AIR VENTILATION SYSTEM

CONTROL MAINTENANCE SCHEDULE	P.M. HOURS
WORK TO BE DONE	
Inspect retarding grids; check for damaged parts, foreign objects.	1000
Check rectifier panel air passages.	1000
Check all connections; tightness, damaged clamps.	1000
Clean blower inlet filter or screen, make sure it is free from obstructions and foreign objects; lubricate pillow blocks.	1000
Check flexible air ducts for damage; measure static air pressure (axle box).	250

VEHICLE OPERATION TESTS

WORK TO BE DONE	P.M. HOURS
Check battery voltage. Adjust as required.	1000
Check speedometer calibrations.	1000
Check all speed events calibrations.	1000
Test ground relay operation.	1000
ENGINE CHECKS *	
Check tach calibration, adjust as required.	1000
Check low idle; Retarding RPM; Top End RPM; Adjust as required.	1000
Check for proper operation of blower loss warning device.	1000
Check high idle and throttle cut-off solenoid operation.	1000
Measure motor field retarding current noting generator/armature voltage. Adjust as required.	1000
Check horsepower vs. RPM in road test or statically.	1000
Check operation of grid blower in road test.	1000
Measure retarding motor armature current as a function of speed. Adjust as required in road test or statically.	1000

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NOTES

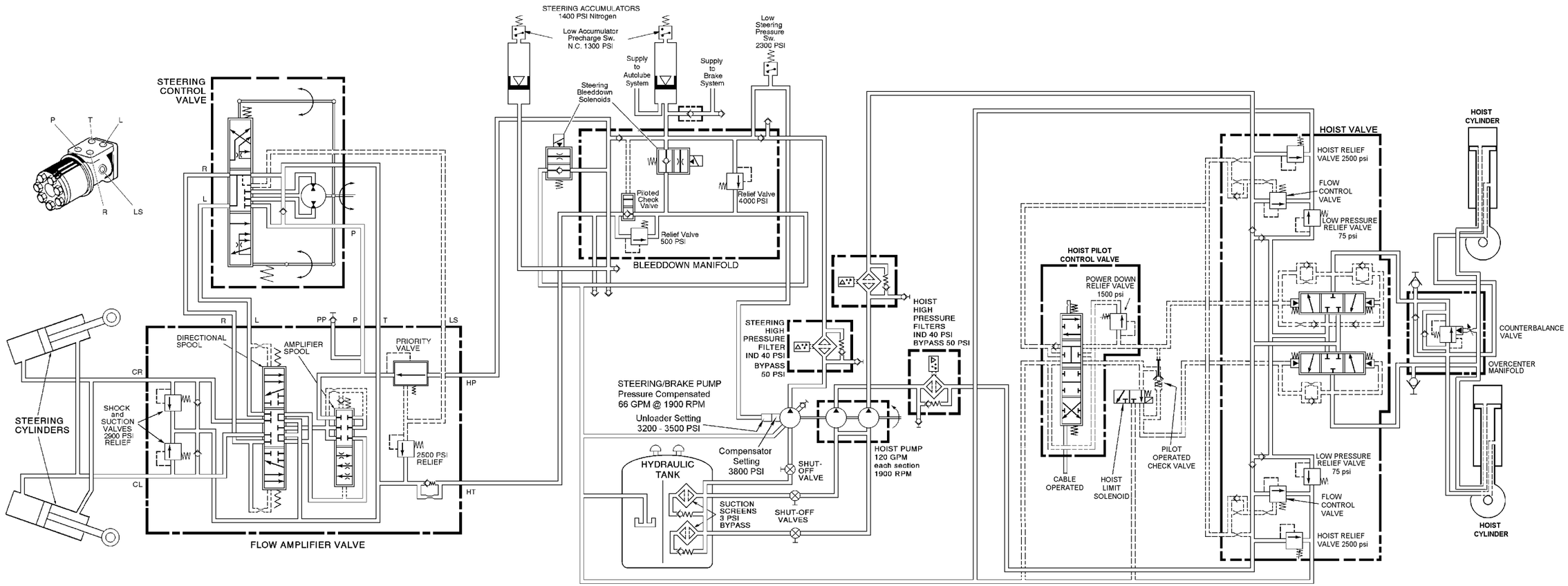
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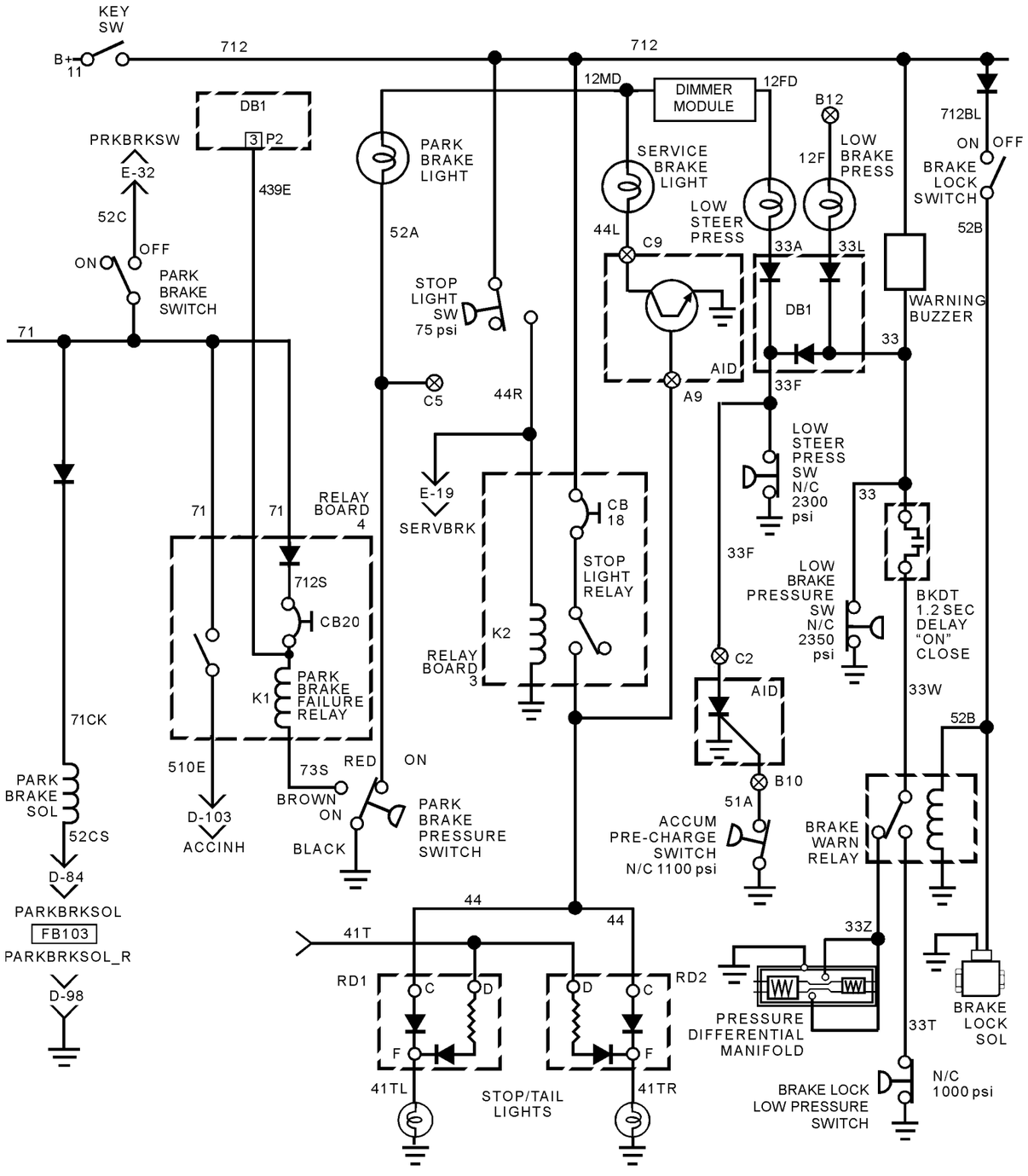
HYDRAULIC SCHEMATIC

Effective with A30650 & Up

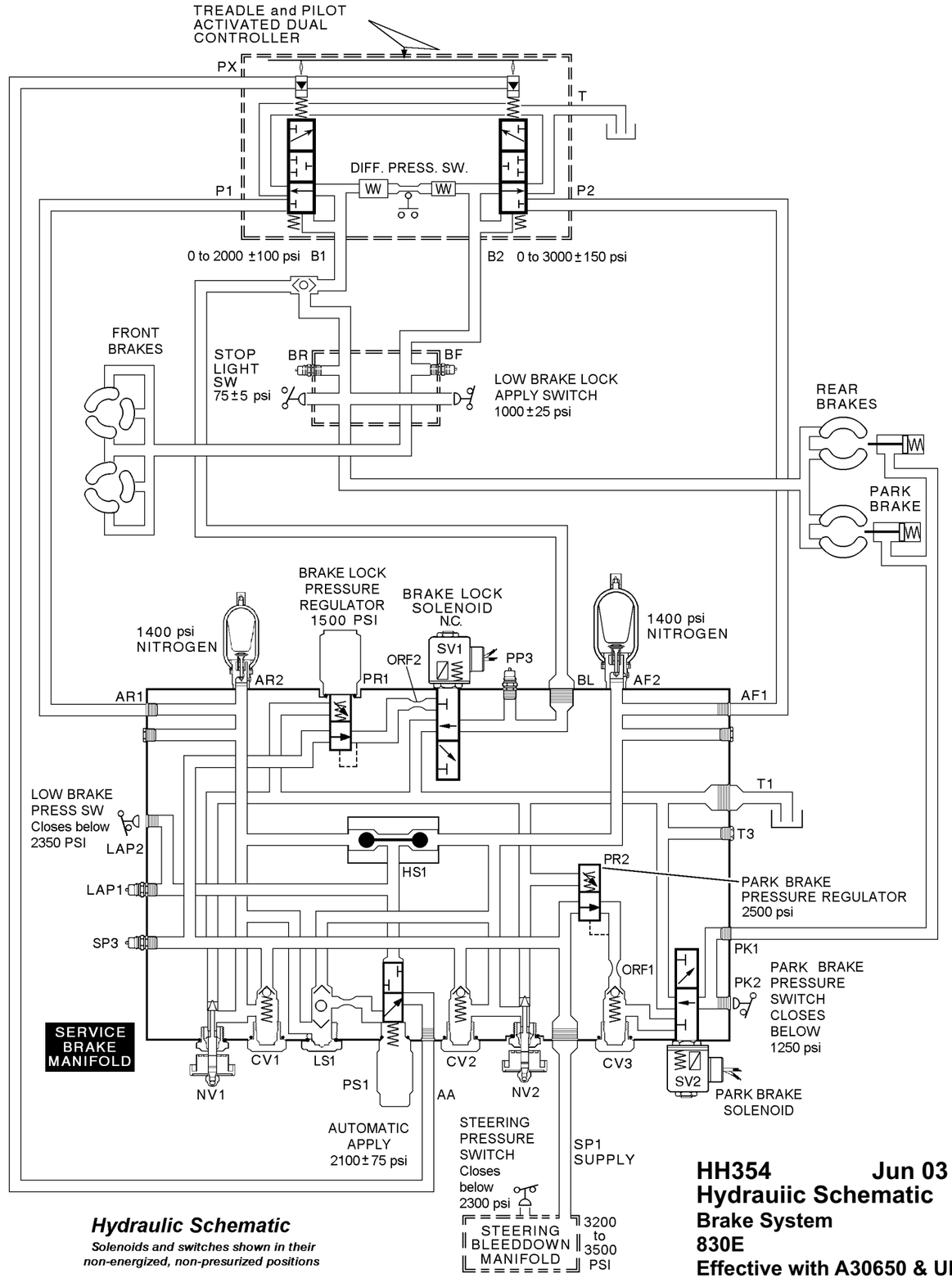


steering control — *hydraulic supply* — *hoist control*

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Electrical Schematic

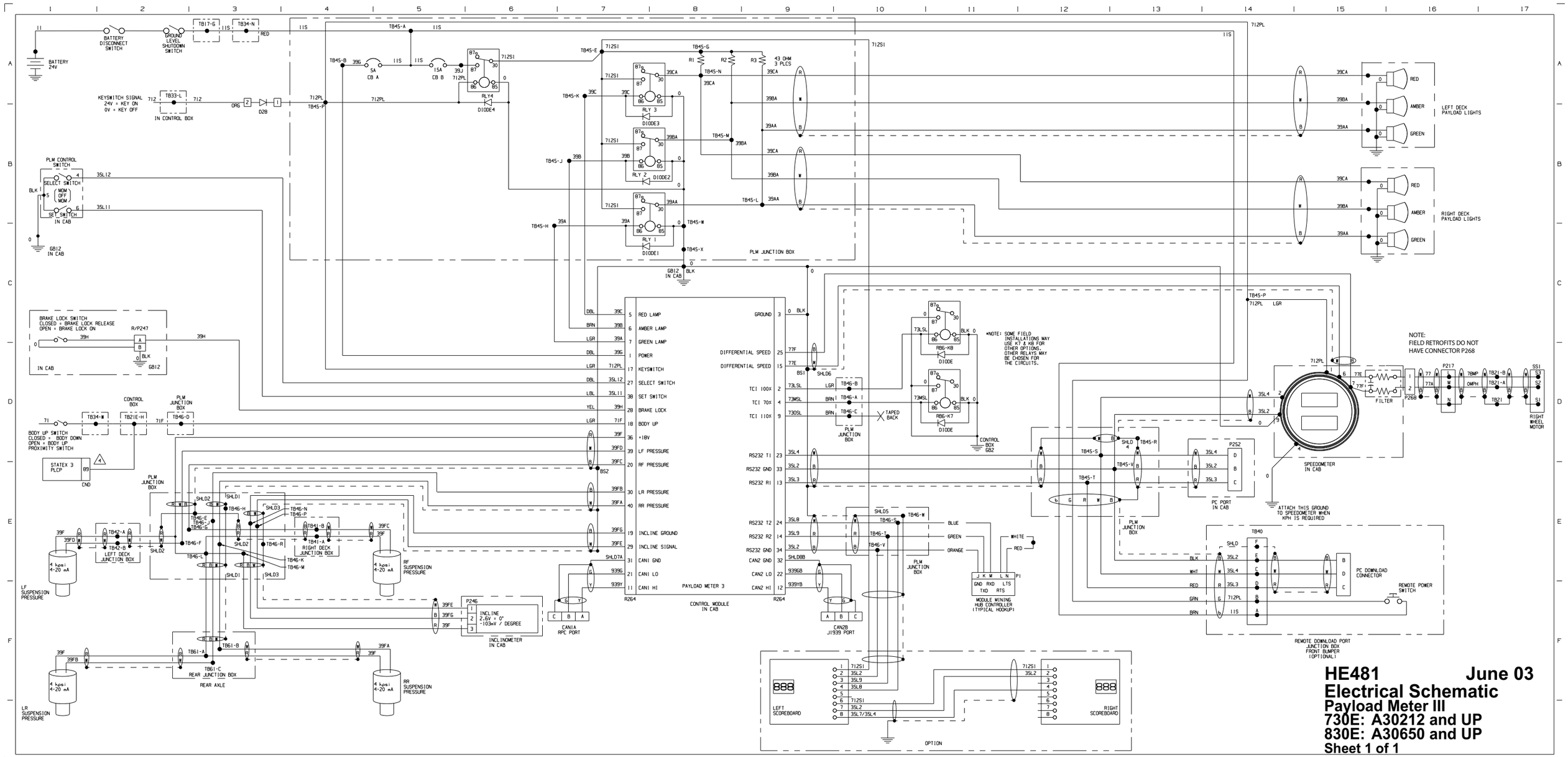


Hydraulic Schematic

Solenoids and switches shown in their non-energized, non-presurized positions

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Hydrauiic Schematic
Brake System
830E
Effective with A30650 & UP

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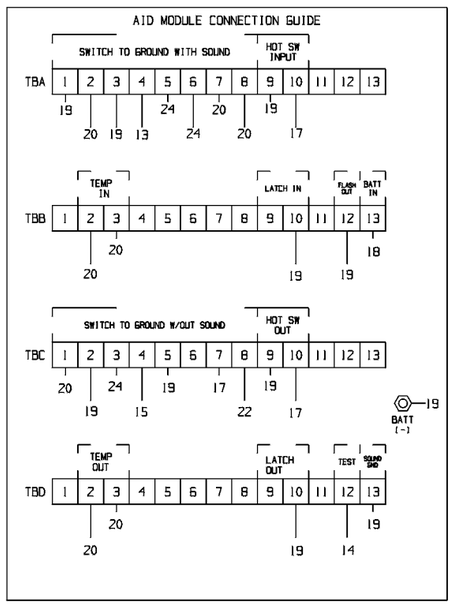
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SYMBOLS USED IN SCHEMATICS

- TERMINAL POINT IN REAR AXLE BOX
- TERMINAL POINT IN CONTROL CABINET
- TERMINAL POINT IN CONTROL CABINET JUNCTION BOX
- TERMINAL IN INSTRUMENT PANEL AREA
- TERMINAL POINT IN LADDER JUNCTION BOX
- TERMINAL POINT IN AUX. RETARDING COMPARTMENT
- TERMINAL POINT IN HOT START JUNCTION BOX
- TERMINAL POINT IN FRONT FRAME RAIL JUNCTION BOX
- KNIFE DISCONNECT
- GROUND WITHIN G.E. COMPONENT PACKAGE
- FACTORY WIRING
- VENDOR SUPPLIED WIRING
- CONNECTOR - R FOR RECEPTICAL SIDE, P FOR PLUG SIDE (R P)
- SHIELDED WIRE
- SHIELDED TWISTED WIRE
- SWITCH
- PUSHBUTTON SWITCH - NORMALLY CLOSED
- CIRCUIT BREAKER
- VARISTER
- DIODE
- SOLENOID
- CONNECTION POINT
- OPERATING COIL (Z,Y-X) — CONTACT LOCATION INFORMATION; ZONE LOCATION; SHEET NUMBER
- CONTACT - NORMALLY OPEN (Z,Y-X) — OPERATIN COIL LOCATION INFORMATION --TYPICAL FOR BOTH NORMALLY OPEN AND NORMALLY CLOSED CONTACTS--; ZONE LOCATION; SHEET NUMBER
- CONTACT - NORMALLY CLOSED
- C FORM CONTACT - NORMALLY OPEN CONTACT & NORMALLY CLOSED CONTACT COMMON ON ONE SIDE
- PRESSURE SWITCH - PRESSURE TO OPEN
- PRESSURE SWITCH - PRESSURE TO CLOSE
- FLUID LEVEL SWITCH - LOW FLUID LEVEL TO CLOSE
- FLUID LEVEL SWITCH - LOW FLUID LEVEL TO OPEN
- PRESSURE OPERATED VARIABLE RESISTOR
- FLUID OPERATED VARIABLE RESISTOR
- TEMPERATURE SWITCH - INCREASE TEMPERATURE TO OPEN
- TEMPERATURE SWITCH - DECREASE TEMPERATURE TO OPEN
- TEMPERATURE OPERATED VARIABLE RESISTOR
- LIMIT SWITCH - CAM TO CLOSE
- LIMIT SWITCH - CAM TO OPEN
- RESISTOR
- ADJUSTABLE RESISTOR
- SOLID STATE AMPLIFER (INPUT - FOR NON INVERTED OUTPUT) (INPUT - FOR INVERTED OUTPUT)
- MOTOR (M)

AID MODULE CONNECTION GUIDE



SELECTOR SWITCH CHART				
CONTACT NO	FRWD	NEUT	REV	SHEET NUMBER
1			X	
2			X	
3		X		25, B-4
4	X	X		
5	X			17, A-2
6		X		
7	X			
8			X	17, A-2

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WIRE NUMBERS AND SHEET LOCATIONS

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0AM	10
0AMB	6
0AOV	6,7,8
0AFA	9
0ATA	9
0LEV	18
0M1A	9
0M2R	9
0M2V	6,7,8
0MFA	9
0MTA	9
0S1	10
0S2	10
0S3	10
0S4	10
0S5	10
0TA	9
0TM	9
1	25
10V	17,18
11	5,9,16,21,24,25
11A	5,11,21
11B	5,25
11B1	5,14,25
11B1A	5,25
11B2	14
11B4	5,14
11B5	14
11B6	5,14
11B7	14
11CL	5,21
11D	5,21
11DL	5,21
11DR	5,21
11F	5,21
11H	21
11HL	5,21
11HR	5,21
11HS	21
11L	5,21
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11R	13
11RB	21
11PL	25
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11T	5,21
11TD	13
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11Z	5,21
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12FD2	20
12FD3	20
12FD4	20
12FD5	19
12GE	14
12H	5,20
12M	5,12,13,18,21,24
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12MD6	19
12MD7	24
12T	21
18D09	10
18S1	10
18S2	10
18S3	10
18S4	10
18S5	10
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21A	25
21C	25
21PB	5,25
21PS	25
21PSW	25
21PT	25
21S	5,25
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23F	5,24
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23LI	13
24FC	24
28E	14
2DDA	10
2DDB	10
2DDC	10
2DDD	10
2DDE	10
2DDF	10
2DDG	10
2DDH	10
2DDL	10
2DDM	10
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2DP5	10
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33L	19
33RR	17
33RS	17
33T	19
33Z	19
34L	20
34LL	20
34T	20
34TL	20
35L2	23
35L8	23
35L9	23
36	21
38	19
39G	14
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41L	21
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48B	21
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67M	14
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72PP	16
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72RR	15
72S	9
72T	9
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73E	16
73J	16
73L	16
73LL	17
73LS	17
73R	15
73S	19
73V	11
73VR	11
73Y	9
73Z	9
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74AF	6,7,8
74B	9
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74D	6,7,8,9
74E	9
74F	9
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74H	16
74HS	15
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76S	16
76SS	15
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76TS	15
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76WS	15
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76XS	15
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79VS	20
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7JI6	6,7,8
7JI7	6,7,8
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90CAR	22
90CBD	22
90CBG	22
90CBR	22
90DR	24
90DT	24
900	24
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SP8	13
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SPR2	12
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SPR21	13
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SPR23	13
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SPR32	13
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SPR63	12
TAI	6
TA2	6
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T2	6,7,8
T3	6,7,8

ABBREVIATIONS

A	- AMPERE
ACCL	- ACCELERATOR
ACCUMR	- ACCUMULATOR
AID	- ALARM INDICATING DEVICE
A/C	- AIR CONDITIONER
ALT	- ALTERNATOR
ANNUN	- ANNUNCIATOR
AUX	- AUXILIARY
BAT	- BATTERY
BL	- BLEED
BLWR	- BLOWER
BK	- BRAKE
BKR	- BREAKER
BUZ	- BUZZER
CKT/BKR	- CIRCUIT BREAKER
CK	- CHECK
CKT	- CIRCUIT
CLEAR	- CLEARANCE
CLR	- COOLER
CNTRL	- CONTROL
COMP	- COMPARTMENT
CONNR	- CONNECTOR
DET	- DETECTOR
DIAGN	- DIAGNOSTIC
DIFF	- DIFFERENTIAL
DIG	- DIGITAL
DN	- DOWN
DYN	- DYNAMIC
ECM	- ENGINE CONTROL MONITOR
ELECL	- ELECTRICAL
EMER	- EMERGENCY
ENG	- ENGINE
EQ	- EQUALIZER
EXC	- EXCITER
EXTRNL	- EXTERNAL
FIL	- FILTER
FRWD	- FORWARD
GA	- GAUGE
GEN	- GENERATOR
GRND	- GROUND
HSNG	- HOUSING
HTR	- HEATER
HYD	- HYDRAULIC
INDCTG	- INDICATING
INLCK	- INTERLOCK
JCT	- JUNCTION
L.H.	- LEFT HAND
LEV	- LEVEL
LK	- LEAK
LOCAT	- LOCATION
LT	- LIGHT
MTR	- MOTOR
MAN	- MANUAL
MFA	- MOTOR FIELD "A"
MFB	- MOTOR FIELD "B"
MODL	- MODULE
MON	- MONITOR
MTD	- MOUNTED
NO	- NUMBER
PLG	- PLUG
PNL	- PANEL
POS	- POSITION
PRESS	- PRESSURE
PROP	- PROPULSION
RECPCL	- RECEPTACLE
RAD	- RADIATOR
RD	- ROAD
RES	- RESITOR
RETD	- RETARD
REV	- REVERSE
R.H.	- RIGHT HAND
REL	- RELAY
SEC	- SECOND, SECONDARY
SLCTR	- SELECTOR
SNDR	- SENDER
SIG	- SIGNAL
SOLEN	- SOLENOID
SERV	- SERVICE
SS1	- SPEED SENSOR 1
SS2	- SPEED SENSOR 2
STRG	- STEERING
SW	- SWITCH
SYS	- SYSTEM
TACH	- TACHOMETER
TB	- TERMINAL BOARD
TEMP	- TEMPERATURE
THERMO	- THERMOSTAT
THROT	- THROTTLE
TRANSF	- TRANSFORMER
VLV	- VALVE
WRNG	- WARNING
WT	- WEIGHT

XS1402 MAR03

ELECTRIC SCHEMATIC

CIRCUIT NUMBER LOCATOR

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DEVICE NAMES AND SHEET NUMBER LOCATIONS

A/C & HEATER

A/C COMPRESSOR	20
A/C CONDENSER	20
A/C RECEIVER DRYER	20
BLOWER MOTOR	20

ALARMS

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12 VOLT BUSS	14

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CIGAR LIGHTER 12VDC	14

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CB14, 15A	5,21
CB15, 15A	5,21
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CB17, 15A	5,17
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CB19, 15A	7,17
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CB21, 15A	5,21
CB22, 5A	5,24
CB23, 15A	5,21
CB24, 15A	5,21
CB25, 15A	5,21
CB26, 15A	5,21
CB27, 15A	5,21
CB30, 15A	5,21
CB31, 15A	5,20
CB32, 15A	5,18
CB33, 15A	5,19
CB34, 10A	5,17
CB35, 10A	5,11
CB36, 10A	5,14
CB37, 10A	5,20
CB38, 5A	5,14
CB39, 5A	5,14
CB40A,5A	5,14
CB40B,10A	5,14
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COMPONENT LOCATOR
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DEVICE NAMES AND SHEET NUMBER LOCATIONS

RESISTORS

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R4, 2.0K	24
R5, 3.3K	18
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R7, 4.7K	22
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MFSE, MOTOR FIELD STATIC EXCITER	9

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5 - MINUTE IDLE TIMER	13
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TRANSDUCTOR

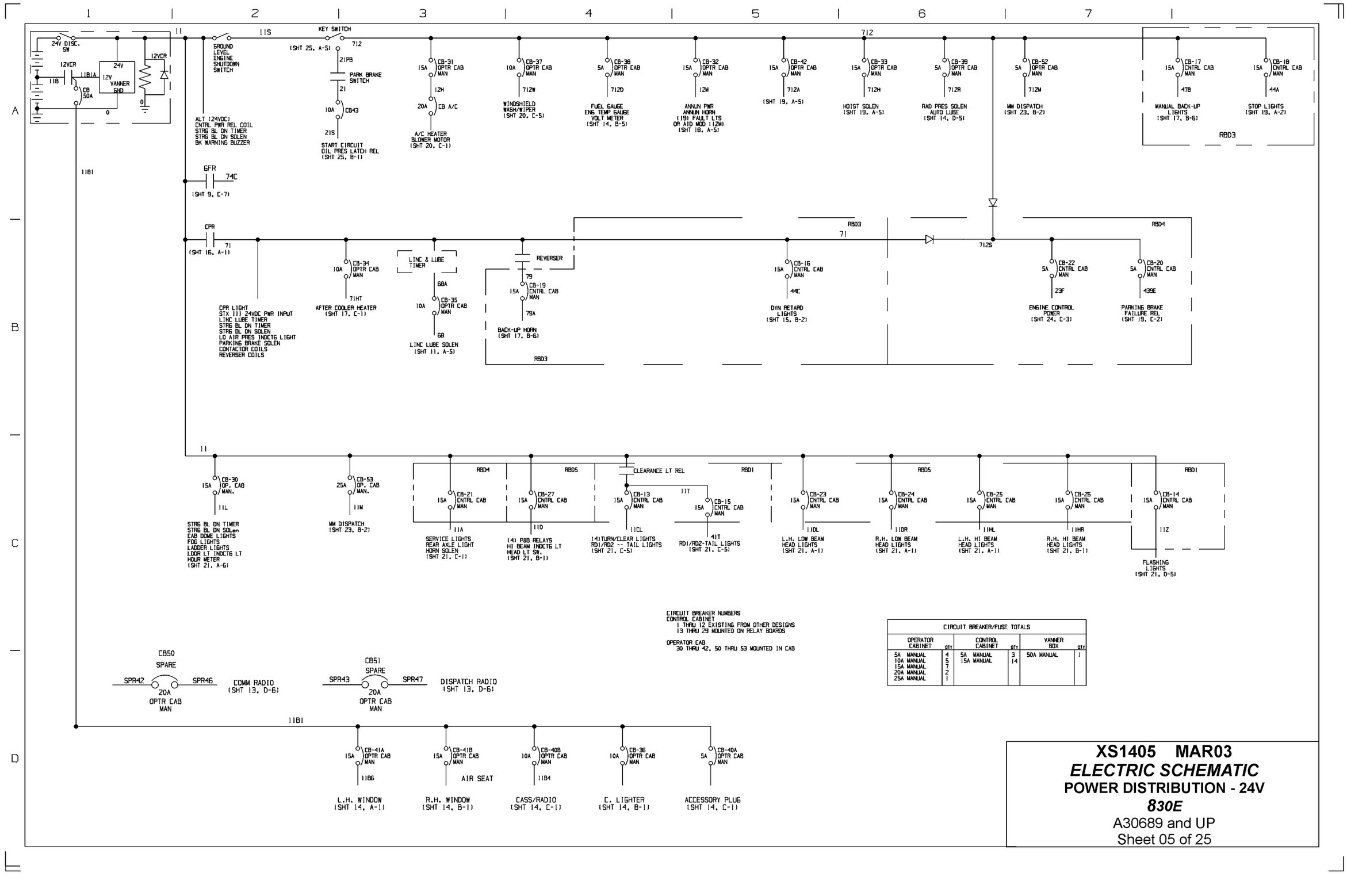
FDT, FAILED DIODE TRANSDUCTOR	9

TRANSFORMER

ST1, SYNCHRONIZATION TRANSFORMER #1	9
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CIRCUIT BREAKER NUMBERS
CONTROL CABINET
1 THRU 12 EXISTING FROM OTHER DESIGNS
13 THRU 29 MOUNTED ON RELAY BOARDS

OPERATOR CAB
30 THRU 42, 50 THRU 53 MOUNTED IN CAB

CIRCUIT BREAKER/FUSE TOTALS					
OPERATOR CABINET	QTY	CONTROL CABINET	QTY	VANNER BOX	QTY
5A MANUAL	4	5A MANUAL	3	50A MANUAL	1
10A MANUAL	5	15A MANUAL	14		
15A MANUAL	7				
20A MANUAL	2				
25A MANUAL	1				

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POWER DISTRIBUTION - 24V
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NOTE: SEE SHEET 15 FOR FEEDBACK SIGNAL CONTACTS. SEE SHEET 16 FOR CONTACTOR COILS.

WHEEL MOTOR 1

WHEEL MOTOR 2

STATEX 3

NOTE: SEE SHEET 15 FOR THE CONTACTOR SIGNAL FEEDBACK CONTACTS. SEE SHEET 16 FOR THE CONTACTOR COILS.

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PWR 18 ELEM. 3 STEP RETARDING

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NOTE: SEE SHEET 15 FOR FEEDBACK SIGNAL CONTACTS. SEE SHEET 16 FOR CONTACTOR COILS.

WHEEL MOTOR 1

WHEEL MOTOR 2

STATEX 3

NOTE: SEE SHEET 15 FOR THE CONTACTOR SIGNAL FEEDBACK CONTACTS.
SEE SHEET 16 FOR THE CONTACTOR COILS.

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PWR 18 ELEM. 7 STEP RETARDING

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NOTE: SEE SHEET 15 FOR FEEDBACK SIGNAL CONTACTS. SEE SHEET 16 FOR CONTACTOR COILS.

WHEEL MOTOR 1

WHEEL MOTOR 2

STATEX 3

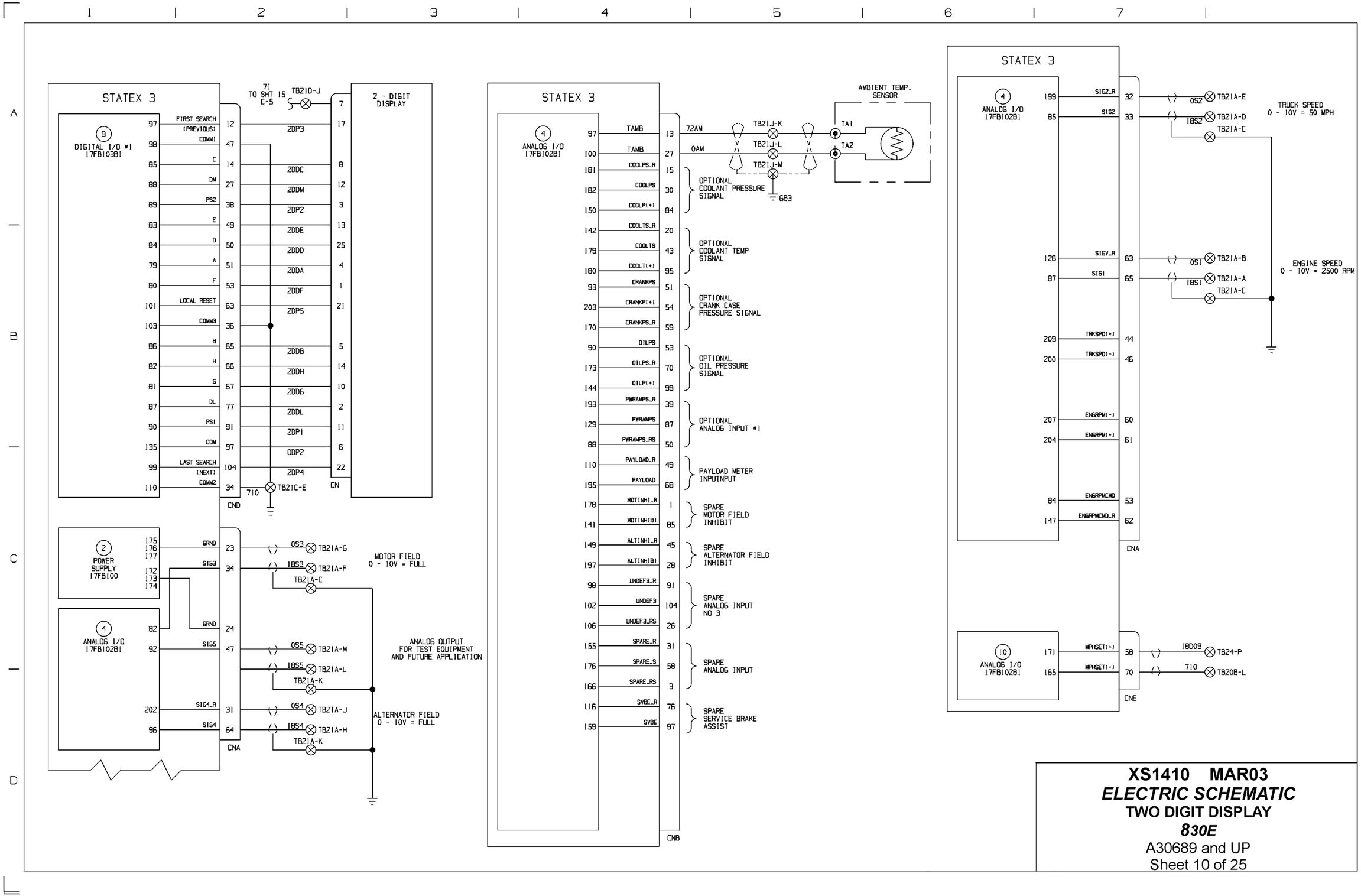
NOTE: SEE SHEET 15 FOR THE CONTACTOR SIGNAL FEEDBACK CONTACTS. SEE SHEET 16 FOR THE CONTACTOR COILS.

XS1408 MAR03
ELECTRIC SCHEMATIC
PWR 20 ELEM. 7 STEP RETARDING
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ELECTRIC SCHEMATIC
DRIVE SYSTEM CONTROL CIRCUITS
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ELECTRIC SCHEMATIC
TWO DIGIT DISPLAY
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STATEX 3

9 DIGITAL I/O #1 17FB103B1

91 SPAREIN4 — 26 — SPARE DIGITAL INPUT NO 4 (CRANKCASE PRESSURE SW)
92 COMM6 — 48

155 SPARE OUT 3(+) — 9
156
140 SPARE OUT 3(-) — 10
141 — SPARE DIGITAL DRIVER NO 3

152 SPARE OUT 2(+) — 22
153
143 SPARE OUT 2(-) — 99
144 — SPARE DIGITAL DRIVER NO 2

94 SPARE IN 5 — 37 — SPARE DIGITAL DRIVER NO 5 CONTROL INPUT
93 COMM 7 — 76

158 SPARE OUT 4(+) — 85
159
137 SPARE OUT 4(-) — 23
138 — SPARE DIGITAL DRIVER NO 4

125 SPARE IN 6 — 86 — SPARE DIGITAL DRIVER NO 6 CONTROL INPUT
126 SPARE IN 3 — 101 — SPARE DIGITAL DRIVER NO 3 CONTROL INPUT
122 SPARE IN 2 — 102 — SPARE DIGITAL DRIVER NO 2 CONTROL INPUT

CND

209 SPARE OUT 1 — 10
210
200 SPARE OUT 1_R — 11
201 — LOW SIDE DRIVER FOR BLOW BUZZER

186 OS(+) — 91 — TB21F-A — R/P217 D — 73V
185 OS(-) — 77 — TB21C-6 — 710 — GB3

195 SPARE OUT 5(+) — 53
175 SPARE OUT 5(-) — 14 — SPARE DIGITAL DRIVER NO 5

CNE

TB11-F — 71 — GB13 — LINCOLN LUBE TIMER (IGN., SOL., (-)) — 68A — R/P223 2 — CB35 10A — 68 — R/P223 1 — R/P227 2 — R/P218 k — TB35-L

TB16A-G — F — 712H — R/P511 C — 712A — LUBE TEST SWITCH — 68
712H SHT 19 A-7 — 712H

TB35-L — 68 — TB16A-H F — R/P511 B — 68 — 2500 PSI PRESS. SWITCH — 68SR

TB16A-E F — R/P511 B — 68T — LUBE PUMP SOLENOID (+ −) — 0 — TB16A-D F

TB32-K — 68T — RB6-1 — 68 — TB32-L — 68SR — GB2
68SR

TB16A-F F — R/P511 D — 68SR

604K TIME DELAY MODULE

RB6-4 — 68 — 68D — 1 3 — 68TL — RB6-6 — 712H
68 — 68P — TB32-J

68LLPI — RB6-6 — 68LLPI

RB6-2 — 0 — 0 — 68TL — 68TL

GB2

68P — TB15-A

REAR AXLE PRESS. SWITCH — 68P — 0

2000 PSI

12FD SHT. 12 ZONE D-6 — 12FD — RFD8 — L. LUBE LOW PRESS. — 68LLP — R/P201 14 — R/P213 14 — R/P218 r — 68LLP — TB32-H — LLDI

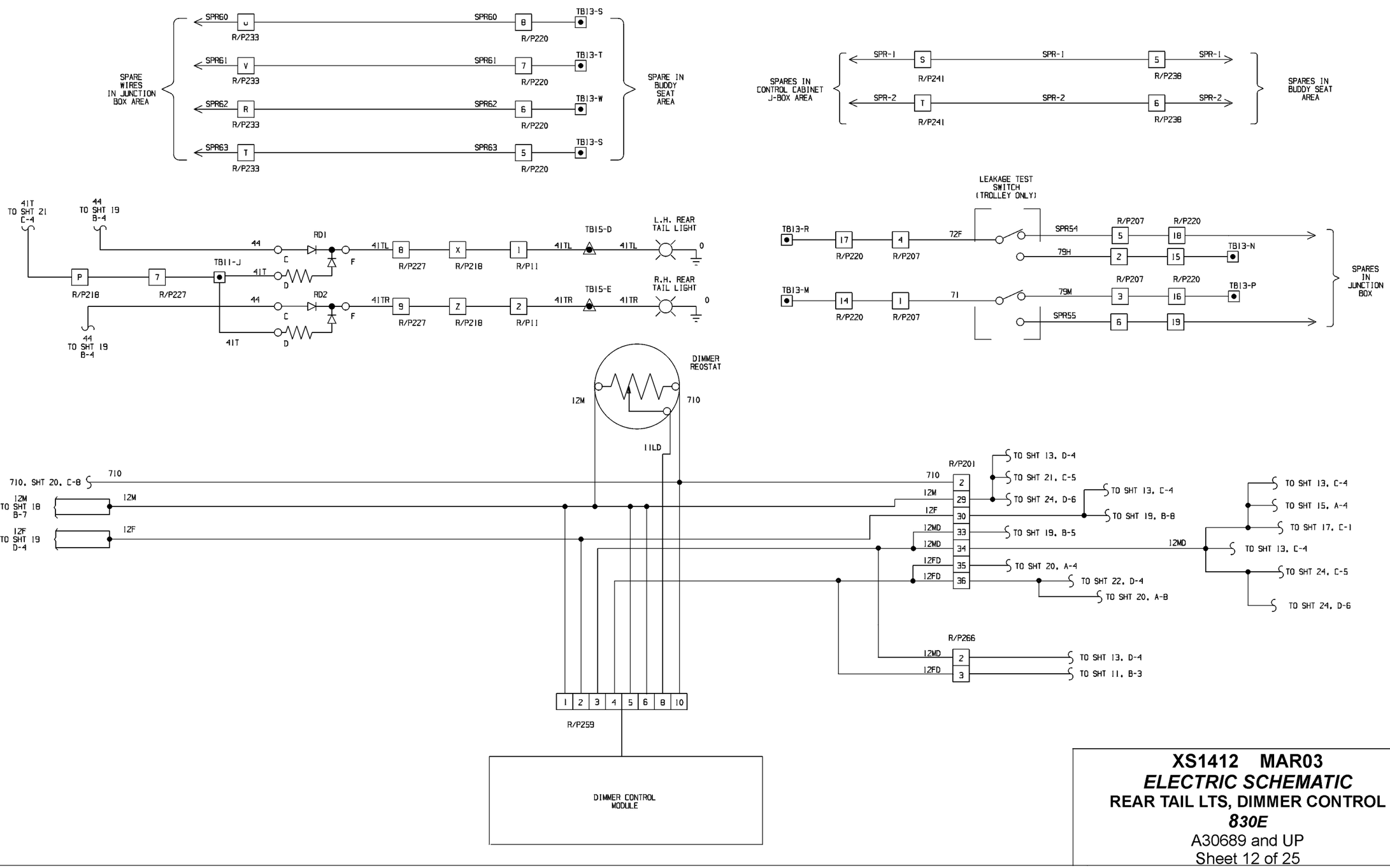
68LLP — R/P220 1 — DI1 — 33H — TB11-W — 33H SHT. 13 ZONE C-1

OVERSPEED RELAY — 73V — 11A — R/P209 85 — 11A — TO SHEET 21, D-3
73VR — 87 — R/P209 — 73VR — 11A — 30 — R/P209

OVERSPEED LIGHT (CAB MOUNTED) — 0

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G.E. DIG. INPUTS, LUBE CENTER TEST
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XS1412 MAR03

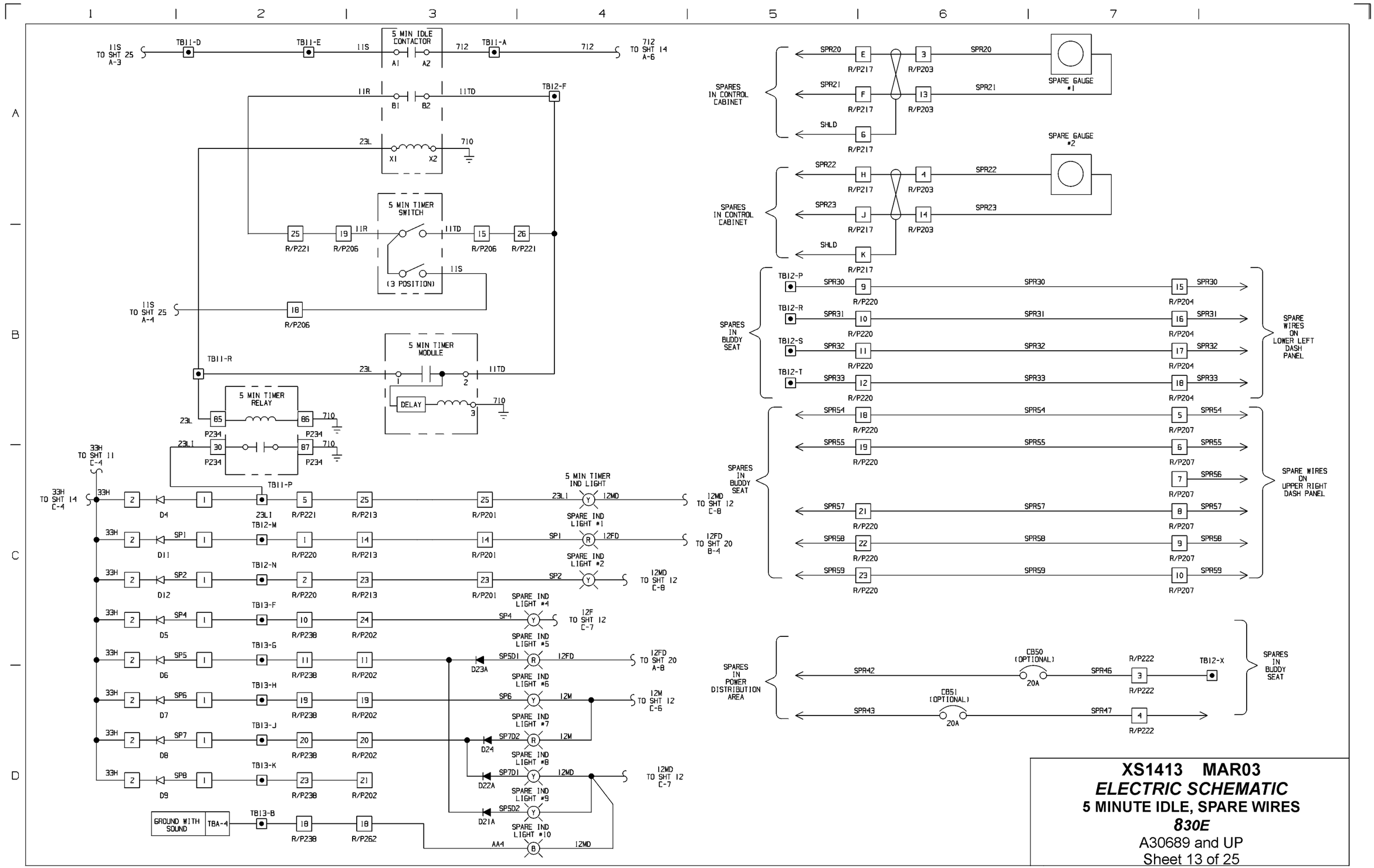
ELECTRIC SCHEMATIC

REAR TAIL LTS, DIMMER CONTROL

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ELECTRIC SCHEMATIC

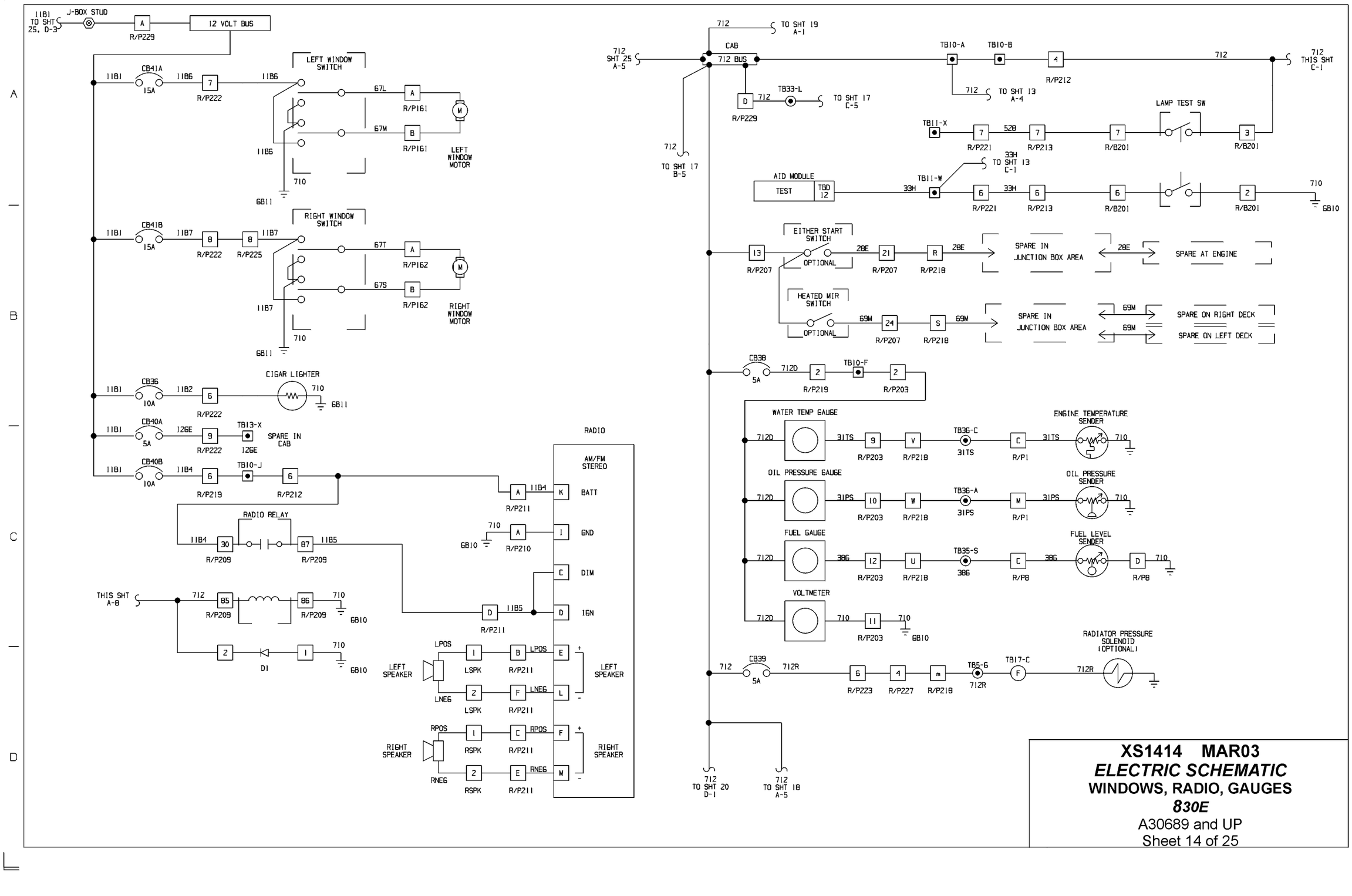
5 MINUTE IDLE, SPARE WIRES

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ELECTRIC SCHEMATIC

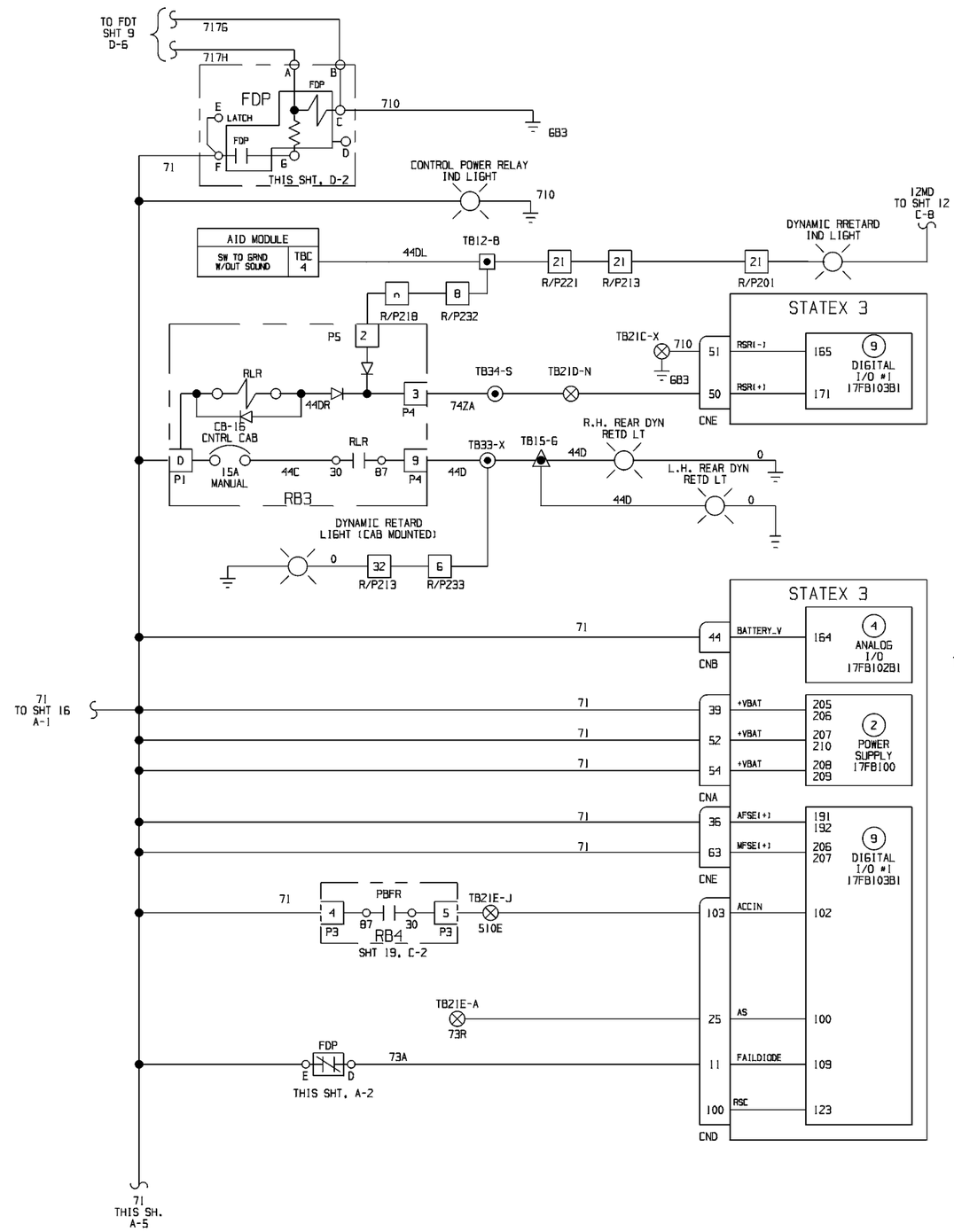
WINDOWS, RADIO, GAUGES

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XS1415 MAR03

ELECTRIC SCHEMATIC

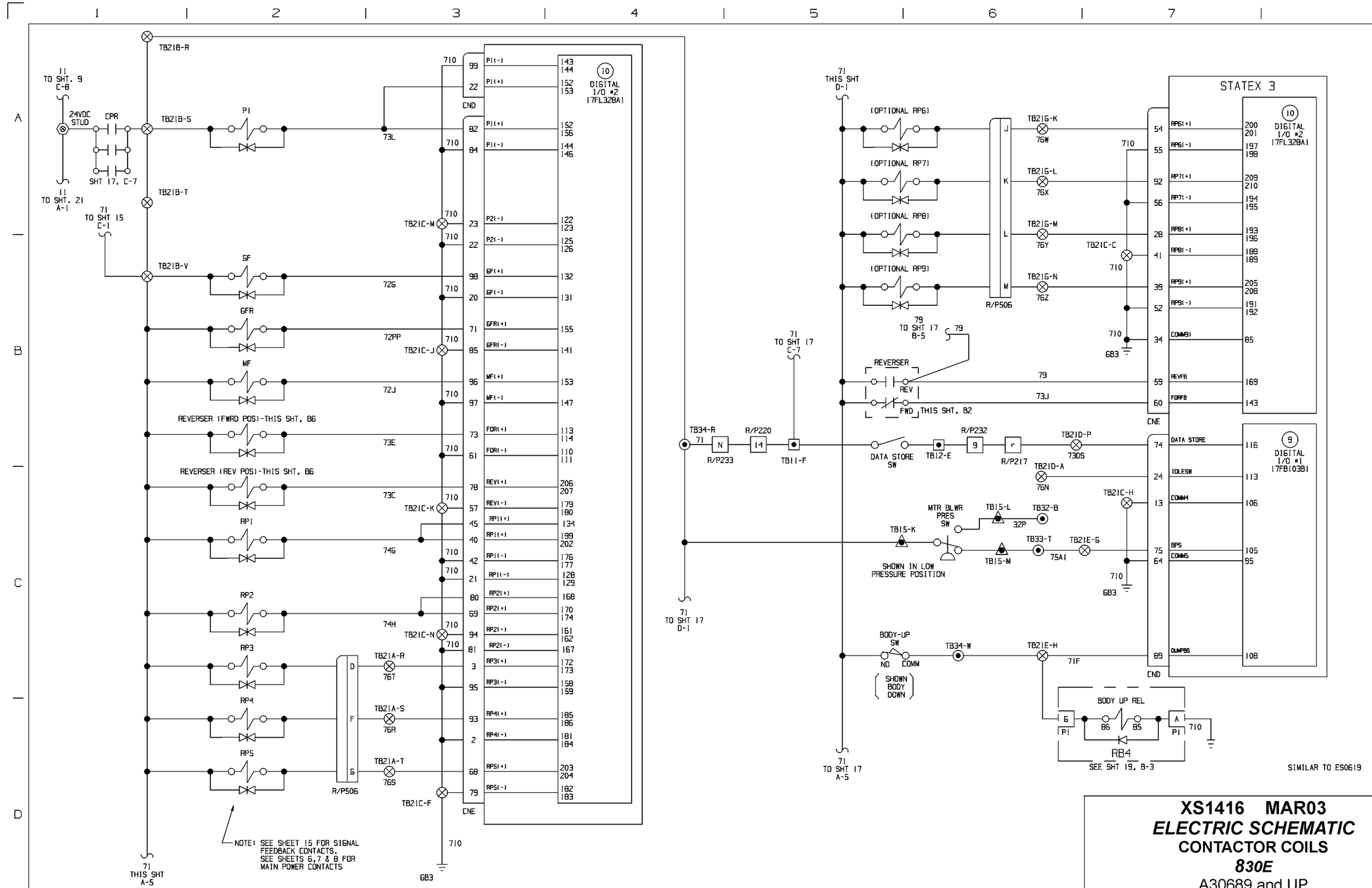
CONTACTOR FEEDBACK

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ELECTRIC SCHEMATIC

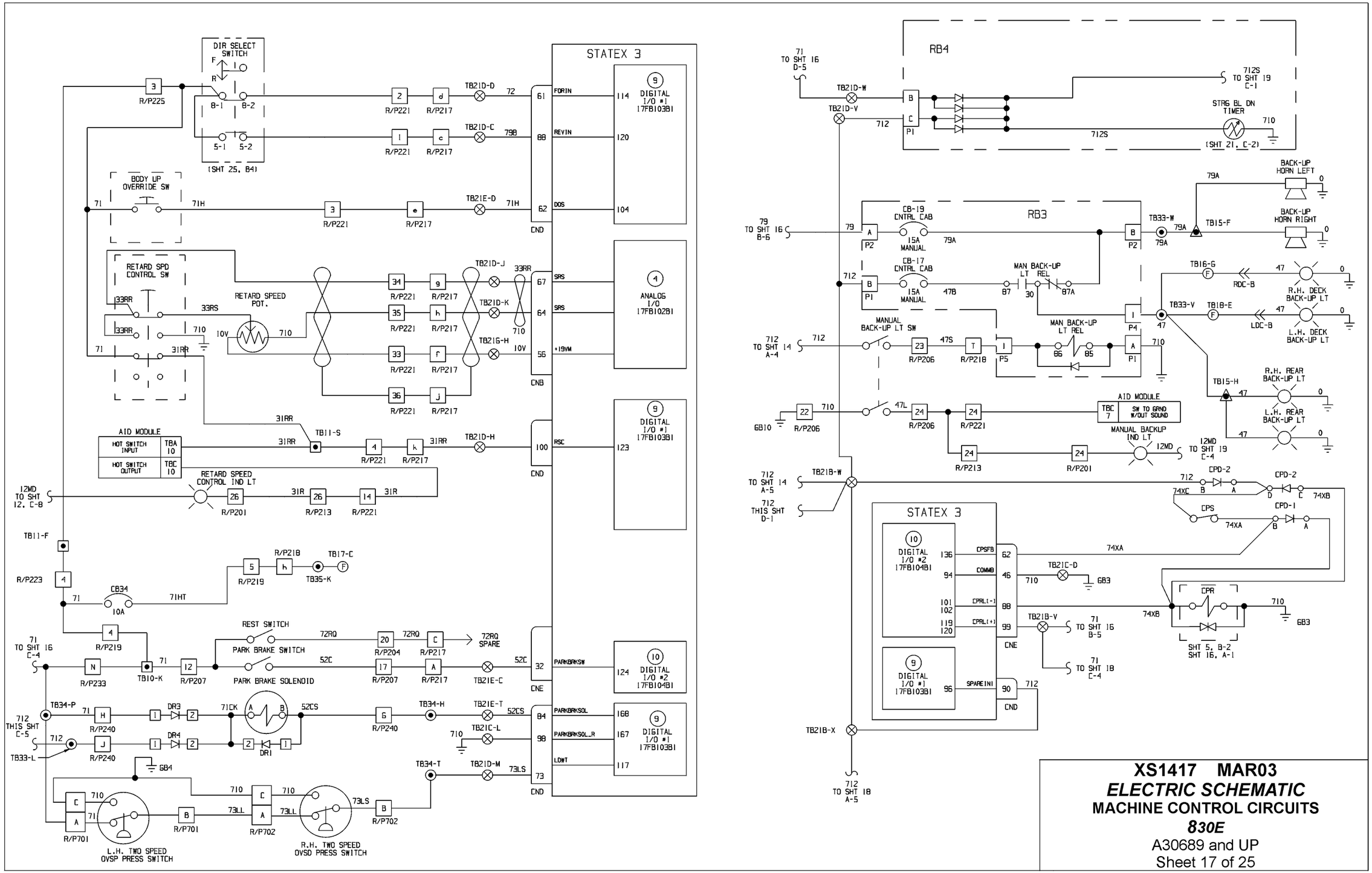
CONTACTOR COILS

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ELECTRIC SCHEMATIC

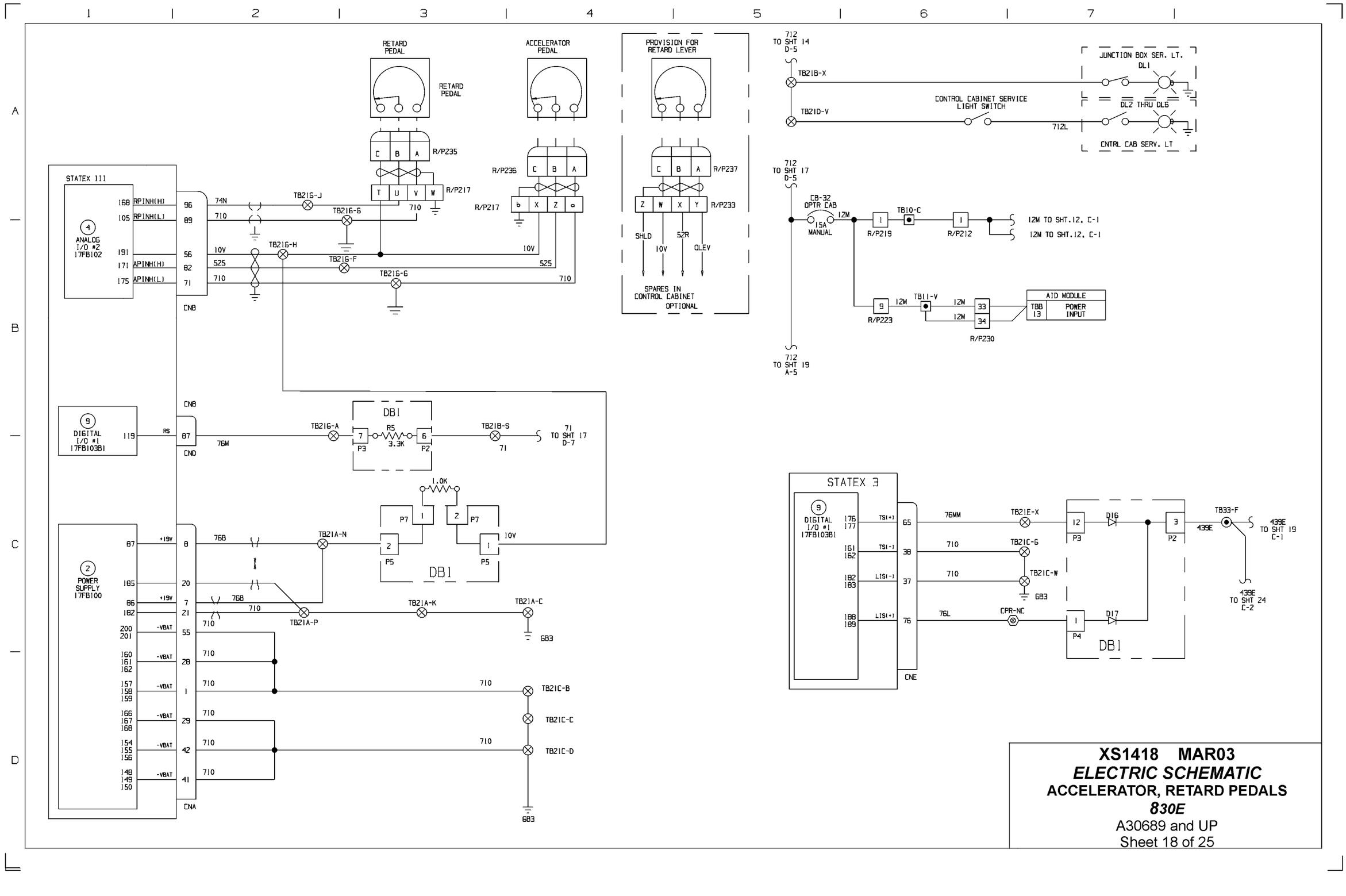
MACHINE CONTROL CIRCUITS

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XS1418 MAR03

ELECTRIC SCHEMATIC

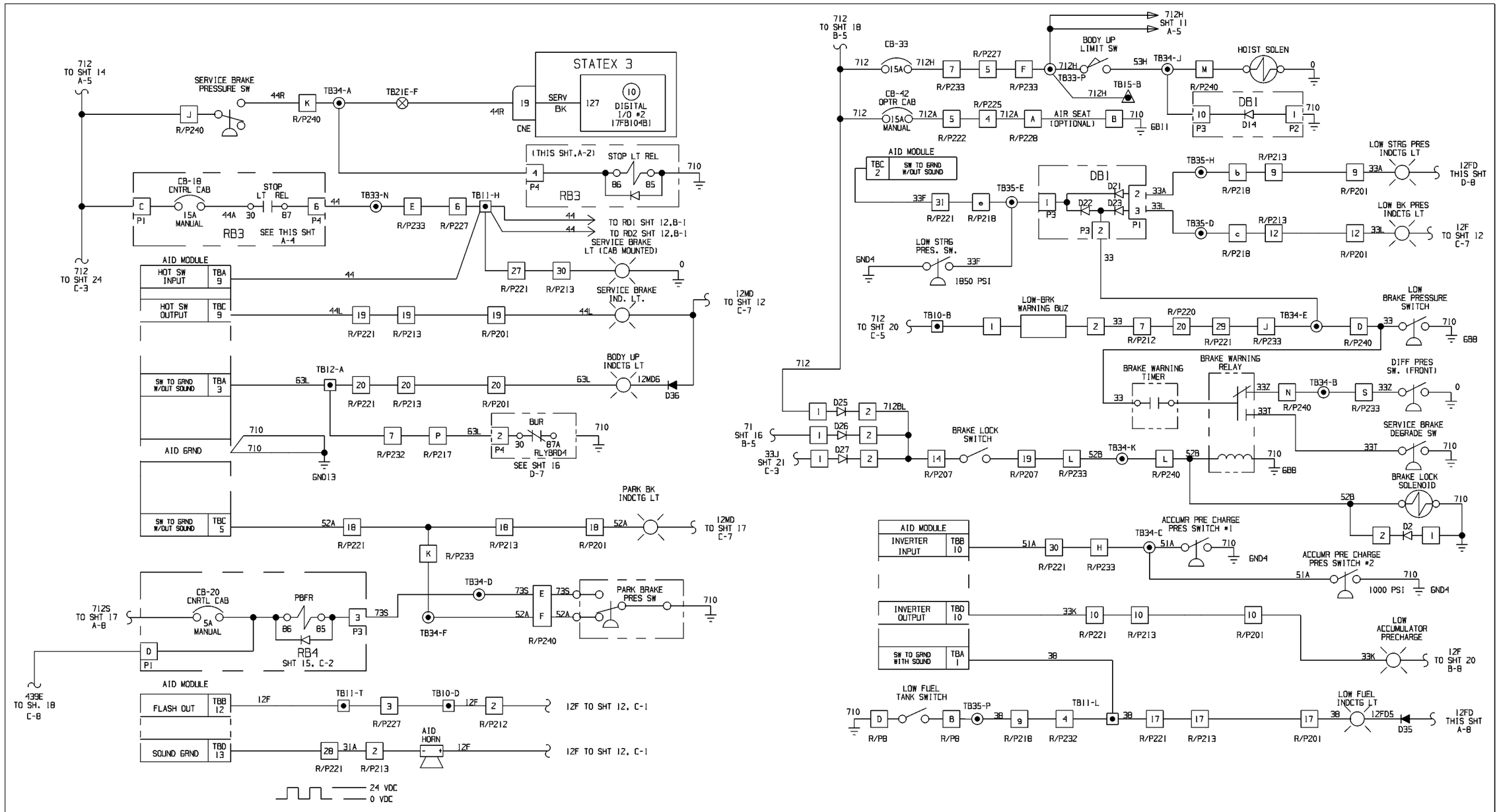
ACCELERATOR, RETARD PEDALS

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ELECTRIC SCHEMATIC

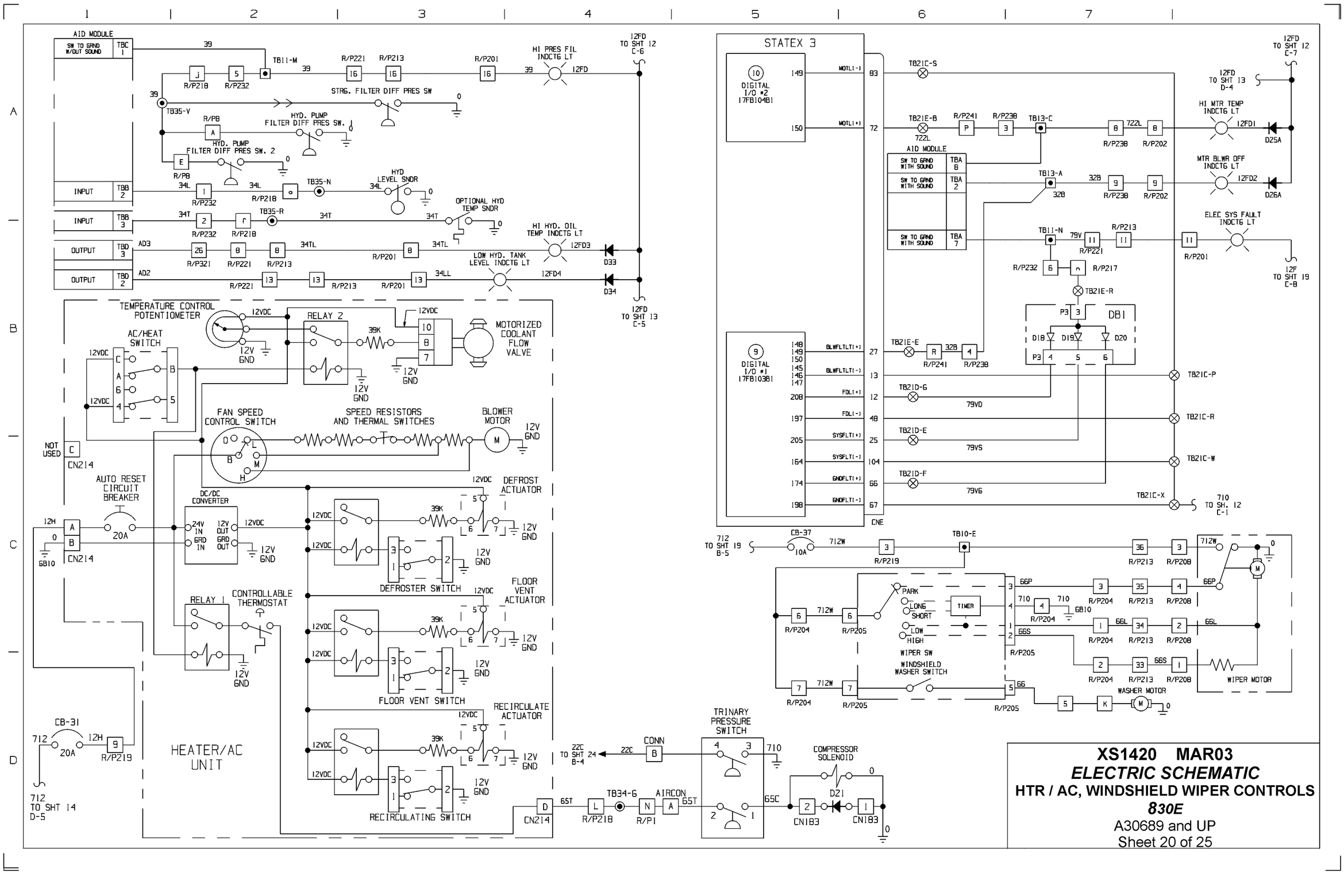
HYDRAULIC CONTROLS, ALARMS

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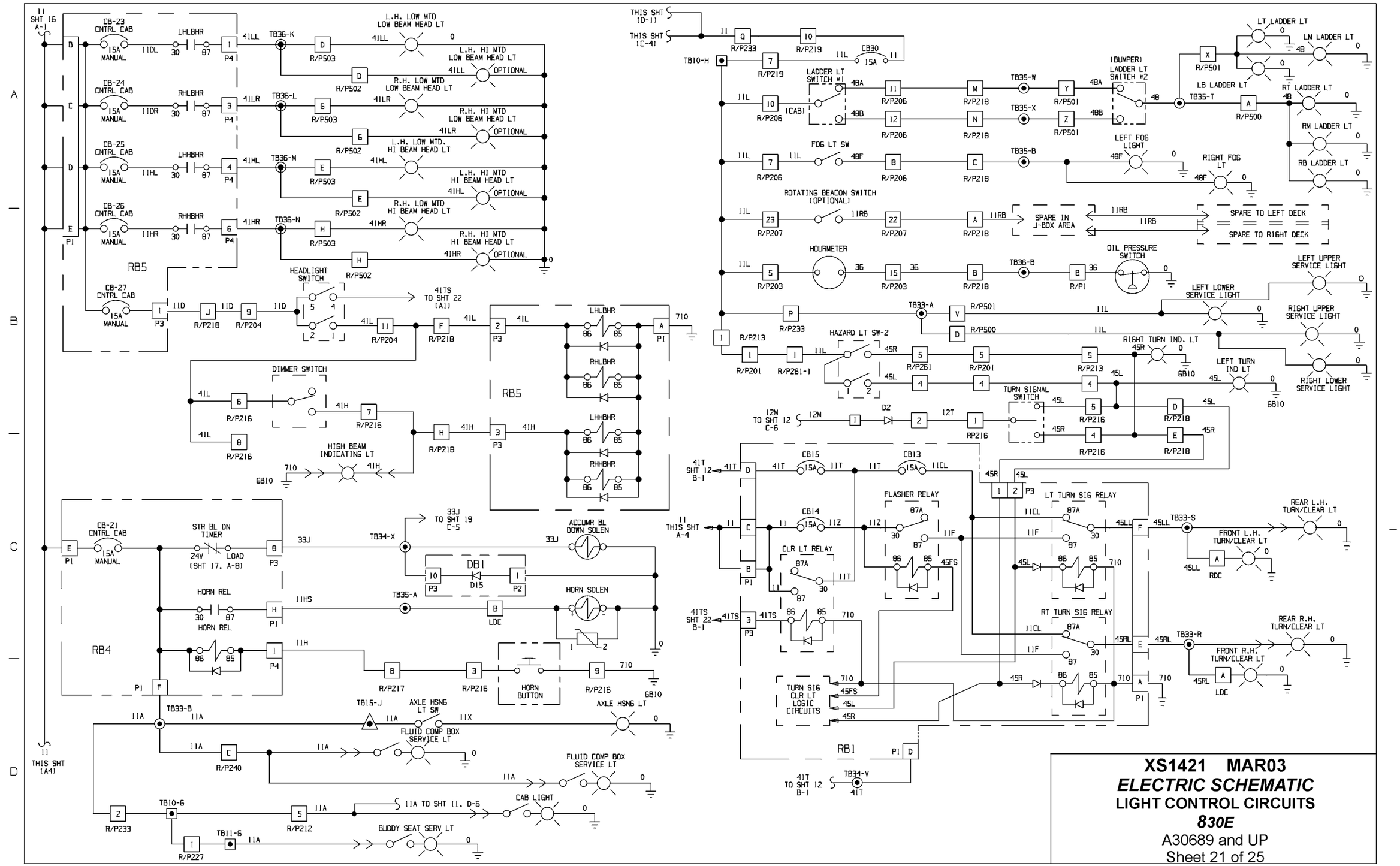
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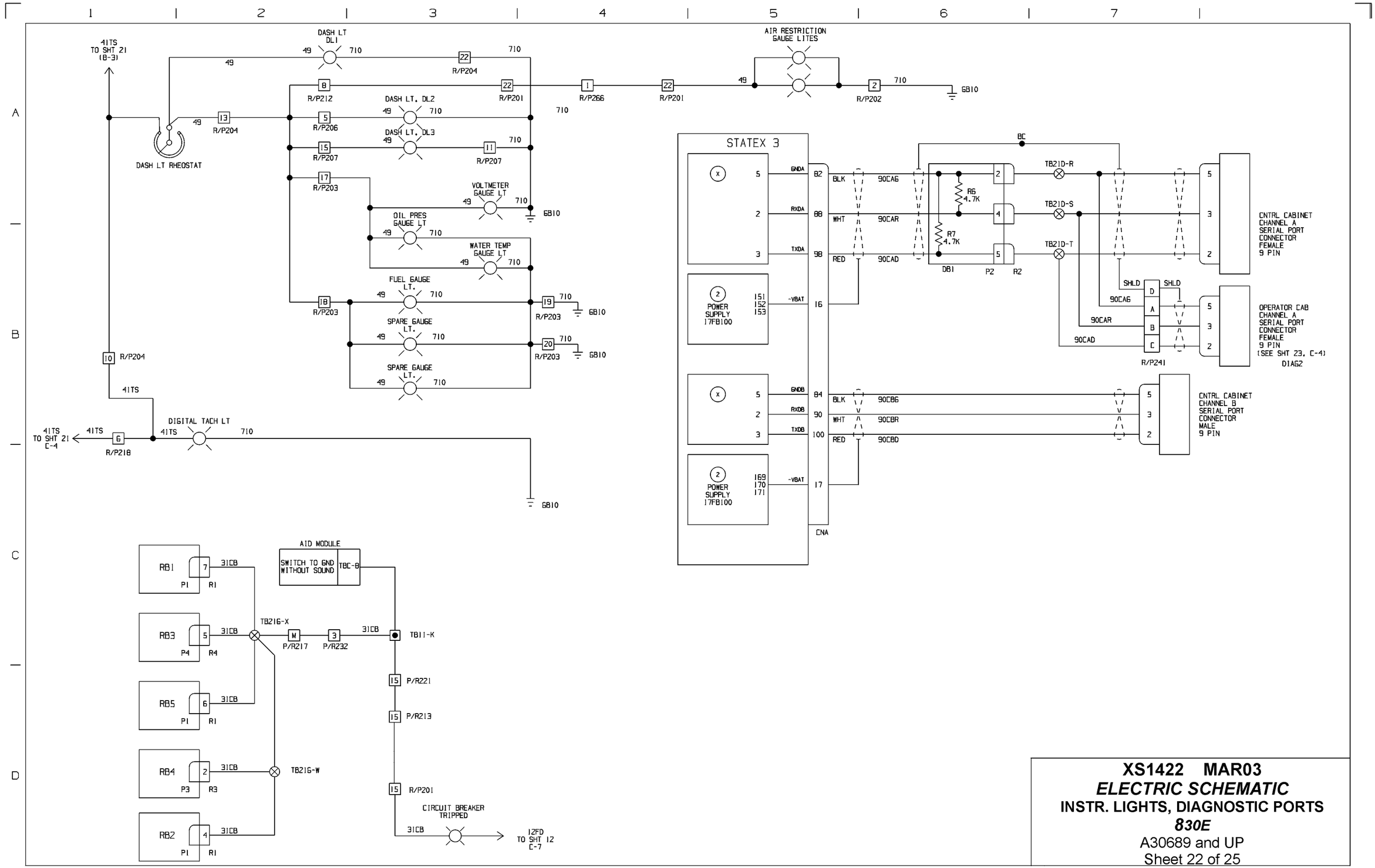
LIGHT CONTROL CIRCUITS

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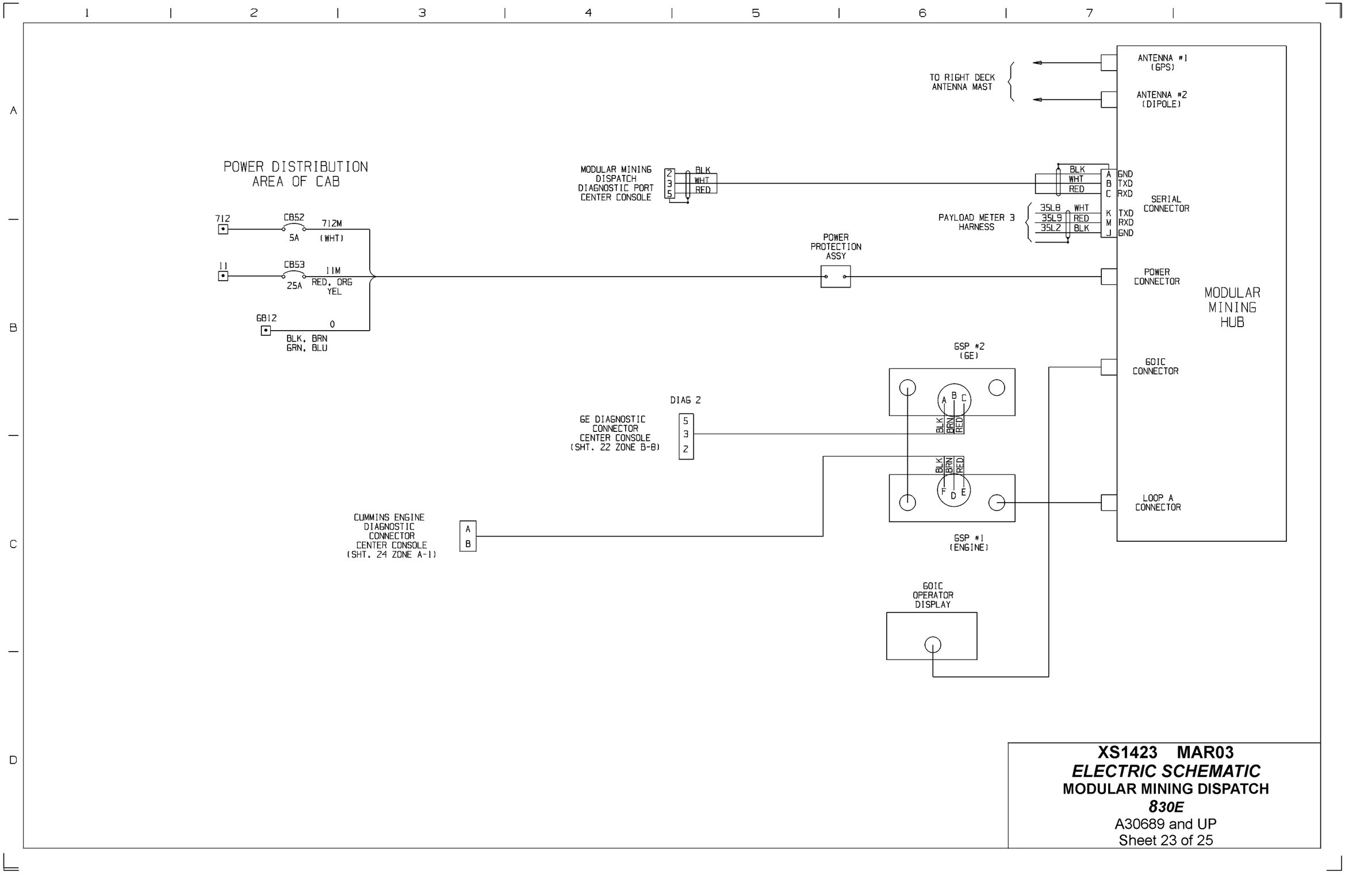
ELECTRIC SCHEMATIC

INSTR. LIGHTS, DIAGNOSTIC PORTS

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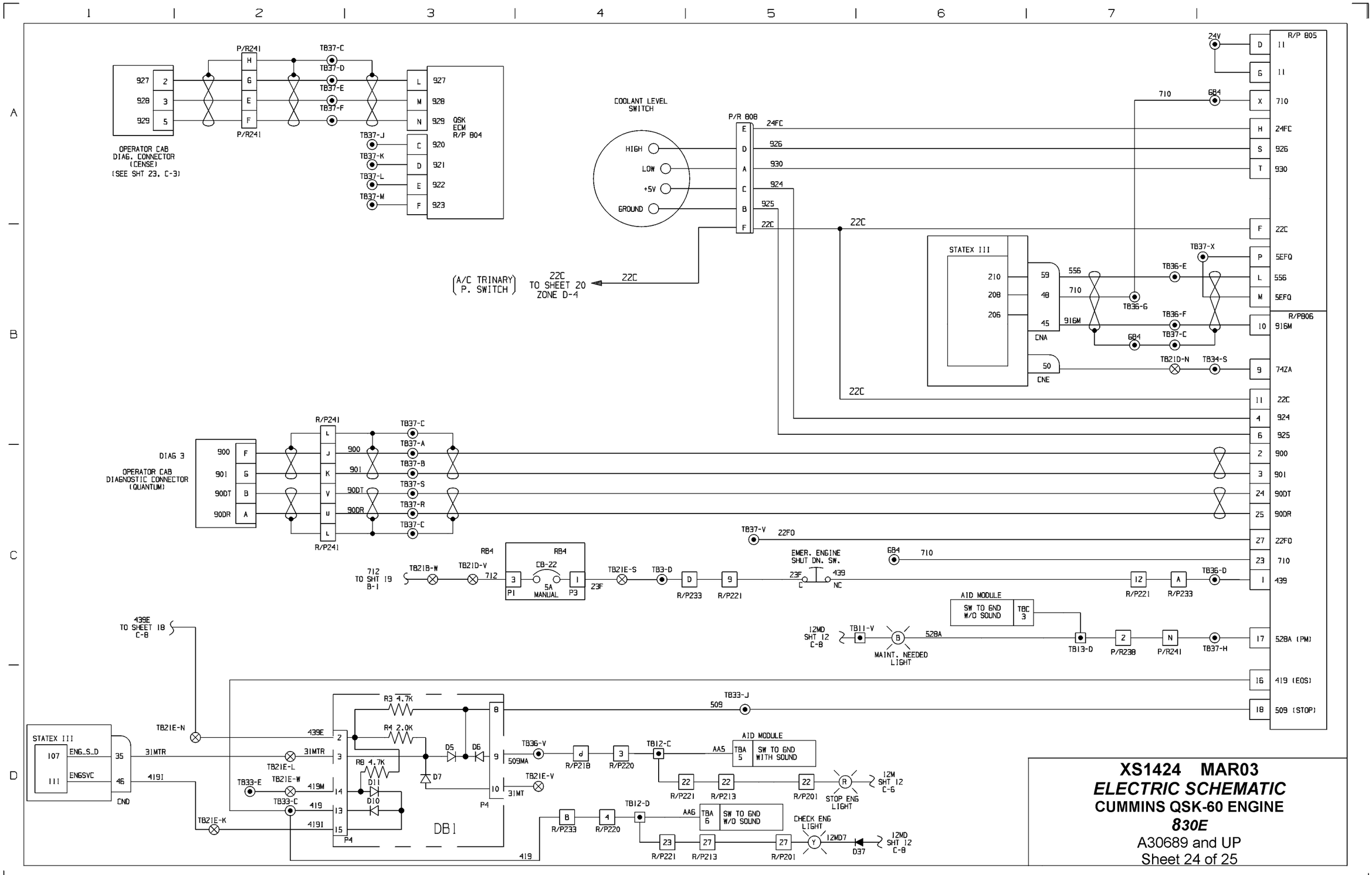
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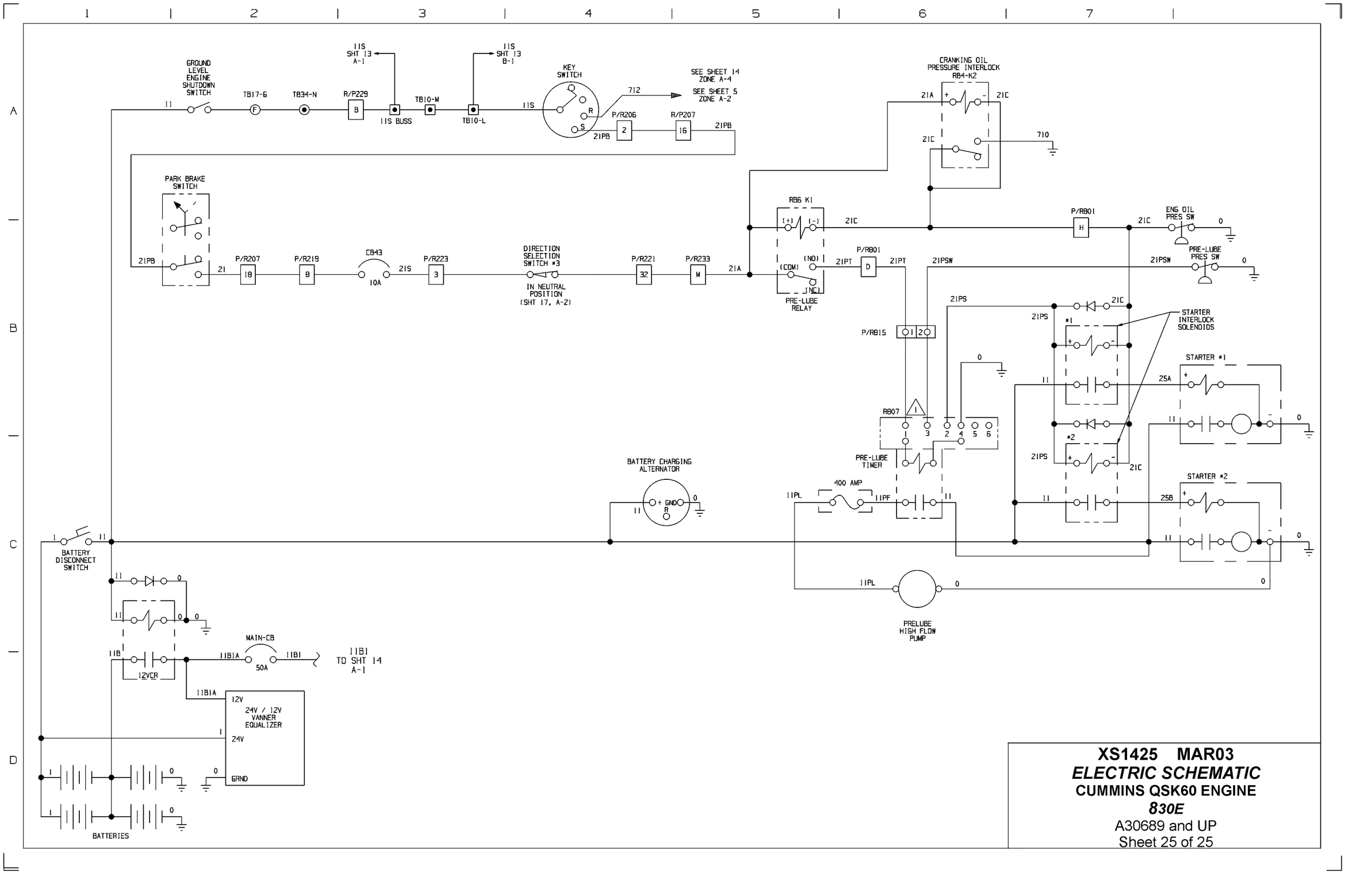
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MODULAR MINING DISPATCH
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ELECTRIC SCHEMATIC

CUMMINS QSK60 ENGINE

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