Maintenance Manual

TAYLOR

THDC / THDCP - 954 / 955 / 974

IMPORTANT!
Read contents carefully prior to operation.

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⚠ WARNING

DEATH OR SERIOUS INJURY MAY RESULT FROM IMPROPER OPERATION OF THIS MACHINE

- OPERATOR **MUST** BE TRAINED AND KNOWLEDGEABLE OF THE OPERATOR'S GUIDE, SAFETY MANUAL, AND OSHA STANDARD SECTION 29 CFR 1910.178 FOR POWERED INDUSTRIAL TRUCKS.
- CAPACITY IS WITH MAST IN **VERTICAL** POSITION AND LOAD RETRACTED.
- CAPACITY **GREATLY** DECREASES WITH TILTING, HIGH LOAD LIFTING, ACCELERATION, BRAKING, SHARP TURNING, **HIGH WIND VELOCITY,** AND POOR YARD CONDITIONS.
- TILT (MAST AND LOAD OUT) **ONLY** WHEN LOAD IS OVER A STACK.
- VISIBILITY MAY BE IMPAIRED BY STRUCTURAL DESIGN. (**ALWAYS** LOOK IN DIRECTION OF TRAVEL; DO NOT RELY ON MIRRORS.)
- **DO NOT** OPERATE WITH BYSTANDERS PRESENT.
- **ALWAYS** TRAVEL WITH LOAD IN LOWEST POSSIBLE POSITION THAT ALLOWS GOOD VISIBILITY.
- **ALWAYS** WEAR SEAT BELT WHILE MACHINE IS IN OPERATION.
- **DO NOT** ATTEMPT TO JUMP FROM MACHINE IN EVENT OF TIP OVER. REMAIN SEATED WITH SEAT BELT FASTENED.

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CAUTION

Observe The Following Precautions For Maximum Safety Of Machine Operation

1. Only trained and responsible operators shall be permitted to handle loads with this truck.
2. Operate the truck from the operator's seat only. Do not allow riders.
3. Test hydraulic controls for proper response before using the machine.
4. Know your load. Do not attempt to lift or transport loads in excess of rated capacity.
5. When the load obstructs the view, operate the truck in the reverse range.
6. Do not stand or work under an elevated load.
7. Transport the load low and tilted back.
8. Avoid sudden stops with a load.
9. Center the load to evenly distribute the weight.
10. Back down a ramp in excess of 10 percent when loaded.
11. Do not move the truck until the air system reaches recommended pressure. Air pressure is required for the service brakes.
12. Have defects repaired immediately. Do not operate a truck with damaged or defective systems.
13. When leaving truck, lifting mechanism shall be fully lowered, controls shall be neutralized, power shut off, parking brake set, and key removed. Block wheels if on incline.

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LIMITED WARRANTY

Products manufactured by Taylor Machine Works, Inc. ("Taylor") and sold are warranted by Taylor to be free from defects in material and workmanship, under normal use and service, when Taylor products are operated at or below rated capacity* in accordance with operating instructions.

This warranty is limited to repair or replacement, (as Taylor may elect, and at an establishment authorized by Taylor) of such parts as shall appear to Taylor upon inspection to have been defective in material or workmanship.

This warranty period shall begin on the delivery date of the product to the Purchaser and end on the earlier of twelve (12) months or two thousand (2000) hours. During the first six (6) months or one thousand (1000) hours, Taylor will provide genuine Taylor parts, labor, and travel time to replace or repair any part furnished by Taylor and found to be defective in material and workmanship. If a defect in material and workmanship is found during the first six (6) months and/or one thousand (1000) hours whichever occurs first of the warranty period, Taylor will replace lubricating oil, filters, antifreeze, and other service items made unusable by the defect. In the second six (6) months and/or second one thousand (1000) hours after the delivery date of the truck, Taylor will approve parts only. Only genuine Taylor parts provided by Taylor's Sudden Service, Inc. will be used during the warranty period.

THE FOLLOWING ITEMS ARE NOT COVERED BY THIS WARRANTY:

1. Normal maintenance services and parts or supplies used therein including, without limitation, engine tune-up, wheel alignment, brake and linkage adjustment, lubrication services, tightening and adjusting such as bolts, screws, hoses, fittings, etc., replacement of fuses, bulbs, filters, tune-up parts, fluids and brake and clutch linings, glass; shop supplies such as rags, oil dry, hand soaps, degreasers, cleaning solutions including brake clean, etc.; and adjustments which are a part of the required or recommended predelivery inspection and periodic inspections in accordance with Operator's Manual. Electrical components including wiring will be excluded after the first six (6) months or one thousand (1000) hours whichever occurs first.
2. Normal deterioration of appearance due to use and exposure; or conditions resulting from misuse, negligence, or accident.
3. Any product on which any of the required or recommended periodic inspections or services have not been made.
4. Any parts or accessories, installed on the product which were not manufactured or installed by Taylor whether or not such parts or accessories were selected, recommended or installed by Taylor (including without limitation, engines, tires, batteries, air conditioners, air dryers, etc.). Such parts or accessories shall be covered by the warranties given by the manufacturers thereof and any claim thereof shall be made to such manufacturers.
5. Loss of time, inconvenience, loss of equipment use, other consequential damages or other matters not specifically included.

Taylor parts and assemblies which are furnished and installed under this warranty are themselves within the coverage of the machine warranty and are covered only for the duration of the original machine warranty period.

NOTE: All International warranty parts shipments are F.O.B. point of debarkation, duties, tariffs, or local taxes excluded.

This warranty is expressly in lieu of any other warranties, expressed or implied, including any warranty of merchantability or fitness for a particular purpose.

Replacement parts are warranted for ninety (90) days to be free from defects in material or workmanship. Parts only, no labor.

Taylor Machine Works, Inc. does not authorize any person to create (for Taylor) any other obligation or liability in connection with Taylor products.

*For example, a machine rated capacity at any stipulated load center is the rated lift capacity at less than load center. That is, a machine rated at 20,000 pounds at 24-inch load center connotes 20,000 pounds is the maximum lift capacity even though the load center may be less than 24-inches. Subjecting Taylor products to conditions or loads exceeding those stipulated is justification for immediate cancellation of warranty for products involved.

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This manual is to be used as a guide for lubrication and maintenance as well as general equipment care. A separate section is provided to discuss each major component or system. This method of presenting the maintenance instructions enables Taylor Machine Works, Inc. to assemble a maintenance manual with explicit instructions on the exact equipment installed on the machine.

No single rule in the booklet can be followed to the exclusion of others. Each rule must be considered in light of the other rules, the knowledge and training of the man (operator), the limitations of the machine, and the workplace environment.

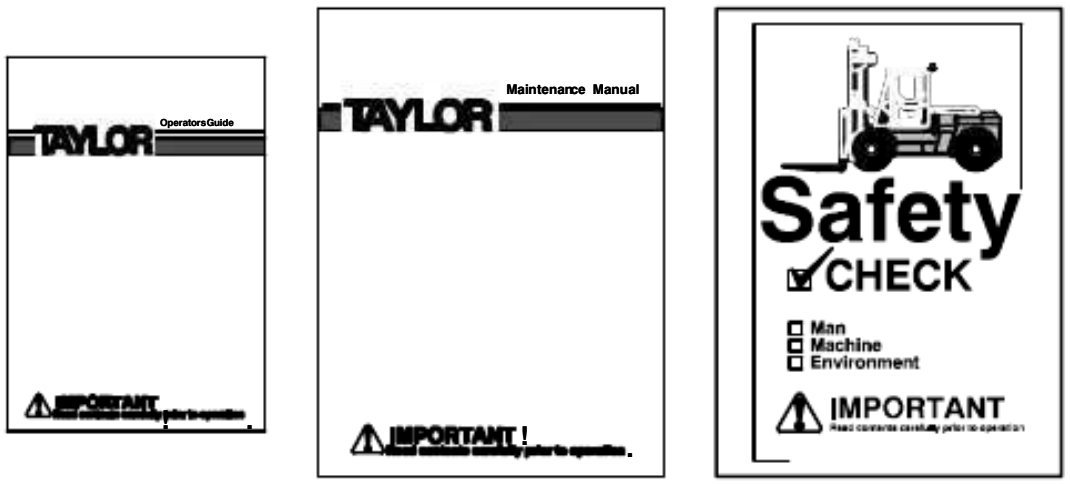
Warnings and cautions are included to reduce the probability of personal injury, when performing maintenance procedures which if improperly performed could be potentially hazardous. Failure to comply with these warnings and cautions can result in serious injury and possible death.

All circumstances and conditions under which service will be performed cannot be anticipated. Do not perform any service if you are unsure that it can be done safely. Contact your Taylor Dealer or Taylor Machine Works, Inc. if you have questions about the proper service techniques.

WARNING: Operating this powered industrial truck when it is in need of repair can result in death or serious injury to the operator or other personnel or cause severe property damage.

Machine checks must be performed daily:

1. before the machine is placed in service,
2. by qualified, trained, and skilled personnel who have proper tools and knowledge, and
3. in accordance with the Operator's Guide, Maintenance Manual and Safety Check booklet.



Regularly Scheduled maintenance, lubrication, and safety inspections will help ensure a safe and productive work life for the machine and the operator(s).

WARNING: Do not operate the truck if it is in need of repair. Remove the ignition key and attach a "Lock-out" tag.

WARNING: Do not attempt to perform maintenance procedures unless you have been thoroughly trained and you have the proper tools.

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WARNING: Use only genuine Taylor replacement parts. Lesser quality parts may fail, resulting in property damage, personal injury or death.

Maintenance and / or service personnel who find it necessary to operate this machine, even for a short period of time, must fully understand all operational literature including:

- OSHA operating rules found in 29 CFR 1910.178; Appendix A in Safety Check
- ANSI B56.1 rules for operating a powered industrial truck; Appendix B in Safety Check
- The Operator's Guide for the machine
- The manufacturer's Safety Booklet
- The manufacturer's Safety Video
- The manufacturer's Service Bulletins
- The content and meaning of all machine decals

WARNING: Know how to avoid slip and fall accidents such as those described in the Slip and Fall Accidents Section of Safety Check.

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Safety First

Important Safety Instructions

Observe these rules. They are recognized as practices that reduce the risk of injury to yourself and others, or damage to the container handling truck or load.

This manual contains maintenance and service procedures for filling, lubricating, removing, repairing, and installing various components comprising a container handling truck. Because of the size and weight of the container handling truck, and high pressures in some of the components and systems, improperly performing service on the truck can be dangerous.

Warnings and cautions are included to reduce the probability of personal injury, when performing maintenance procedures which if improperly performed could be potentially hazardous. Failure to comply with these warnings and cautions can result in serious injury and possible death.

No single rule in the booklet can be followed to the exclusion of others. Each rule must be considered in light of the other rules, the knowledge and training of the man (operator / maintenance), the limitations of the machine, and the workplace environment.

Report all mechanical problems to mechanics and supervisors.

Proper Training:

Taylor Machine Works, Inc. publishes Safety Check, TMW-072 a booklet citing some safety precautions to observe during lift truck operation.

One copy is shipped with each lift truck; additional copies are available at a nominal fee from the authorized Taylor dealer from which the equipment was initially purchased.

Minimum Required Personnel Safety Equipment

1. Hard Hat
2. Safety Shoes
3. Safety Glasses
4. Heavy Gloves
5. Hearing Protection
6. Reflective Clothing

Failure to follow the safety precautions outlined in this manual can create a dangerous situation.

Some of the common ways this can occur are as follows:

1. Use of hoisting devices not capable of supporting the weight of the component being lifted.
2. Improper attachment of slings to heavy components being hoisted.
3. Use of inadequate or rotten timbers for support or improper alignment of supporting material.
4. Failure to securely block the wheels, when disconnecting or removing components that hold the container handling truck stationary under normal conditions.
5. Failure to read and understand the safety precautions in this manual.

WARNING: Know how to avoid accidents such as those described in the Maintenance / Service Accidents Section of Safety Check: Some Maintenance / Servicing Accidents Listed below:

1. Improperly refueling the truck.
2. Improperly checking for hydraulic leaks or diesel fuel leaks.
3. Improperly checking the engine cooling system.
4. Improperly checking battery fluid levels or “jump” starting engines.
5. Putting air in a multi-piece tire and rim assembly without proper tools and training.
6. Attempting to service a multi-piece tire and rim assembly without proper tools and training.
7. Using an improperly suited chain while performing maintenance.
8. Using the container handling truck hydraulic system as a substitute for a fixed stand.
9. Relying on jacks or hoists to support heavy loads.
10. Operating a truck that is damaged or in need of repair.
11. Climbing on the mast of a forklift, on the top of the cab, or other high places on the container handling truck.
12. Operating a container handling truck which has been modified without the manufacturer’s approval. This includes the attachment, counterweight, tires, etc.

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13. Lifting people with a forklift not properly equipped for elevating personnel.
14. Improperly using chains.
15. Improperly blocking and supporting mast, carriage, or attachment before repairing truck.

Maintenance / Service Personnel:

1. Keep the truck clean, free of oil, grease and fuel.
2. Steam clean / wash the truck prior to performing maintenance. Wear anti-slip footwear when performing maintenance procedures.
3. Use OSHA approved ladders and other proper cleaning accessories to access hard to reach maintenance places.
4. Keep gratings free of ice, dirt and gravel.
5. Regularly inspect and replace anti-slip mastic on the vehicle as needed.
6. Ensure all safety decals are in place on the vehicle.

WARNING: Remove all rings, watches, chains, other jewelry, and all loose clothing before working around moving parts!

WARNING: Do not operate the vehicle or attempt to perform maintenance on the vehicle while under the influence of alcohol, drugs, or any other medications or substances that slow reflexes, alter safe judgement, or cause drowsiness.

WARNING: Never park the container handling truck on an incline. Always park the container handling truck on a level surface; otherwise, the lift truck could possibly roll resulting in possible injury to personnel or damage to the truck or other property.

WARNING: Maintenance and service personnel should never operate this lift truck unless they are thoroughly familiar with Safety Check, TMW-072 and the Operator's Guide for this lift truck.

WARNING: Electrical, mechanical, and hydraulic safety devices have been installed on this container handling truck to help protect against personal injury and / or damage to equipment. Under no circumstances should any attempt be made to disconnect or in any way render any of these devices inoperable. If you discover that any safety device is malfunctioning, Do Not operate the truck; notify appropriate maintenance personnel immediately.

WARNING: Use only genuine Taylor replacement parts. Lesser quality parts may fail, resulting in property damage, personal injury or death.

WARNING: Keep all hydraulic components in good repair.

WARNING: Relieve pressure on the hydraulic system before repairing or adjusting or disconnecting.

WARNING: Wear proper hand and eye protection when searching for leaks. Use wood or cardboard instead of hands.

WARNING: Under no circumstances, without prior written approval from Taylor Machine Works, Inc. Engineering Department, should the container handling truck be modified, i.e. adding of additional counterweights. As per OSHA 29 CFR1910.178 (a) (4).

Container Handling Truck Lock-out / Tag-out:

The engine should be locked-out / tagged-out to prevent it from being inadvertently started before performing maintenance or repairs. The battery should be locked-out / tagged-out to prevent accidental activation of the starter and possible starting the engine. Refer to **Lock-Out / Tag-Out Procedure** in the back of this section for the procedures to be followed to perform lock-out / tag-out.

WARNING: Turn the engine off and remove the ignition key before entering the tire pivot area to prevent death or serious injury from pivoting tires.

WARNING: Deflate tires before removing (the tires). Always remove the valve core and

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exhaust all air from a single tire and both tires of a dual assembly prior to removing any rim components or wheel components such as nuts and rim clamps. Run a piece of wire through the valve stem to make sure the valve stem is not damaged or plugged and all air is exhausted.

WARNING: Serious falls and injuries can result from improper mounting or dismounting of the container handling truck.

Mounting and Dismounting:

1. Face the container handling truck when getting on or off the truck.
2. One hand and two feet or two hands and one foot must be in contact with the truck at all times (3 point contact).
3. Use handrails and other grab points.

WARNING: Do not start the engine if the ignition switch, or engine control panel has been locked-out / tagged-out by maintenance personnel. Doing so can result in personal injury and / or damage to the equipment. If in doubt, contact the maintenance supervisor.

WARNING: If maintenance requires running the engine indoors, ensure the room has adequate flow-through ventilation!

WARNING: Never operate the container handling truck without proper instruction. Ignorance of operational characteristics and limitations can lead to equipment damage, personal injury, or death.

WARNING: Do not operate the container handling truck without the seat belt properly and securely fastened.

WARNING: Operating instructions, warnings, and caution labels are placed on the container handling truck to alert personnel to dangers and to advise personnel of proper operating procedures (of the lift truck). Do not remove or obscure any warning, caution, danger, or instructional sign or label.

Traveling:
Start, stop, change direction and travel smoothly. Slow down while turning.

Obstructions And Clearances:
Watch end clearances and overhead obstructions.

WARNING: Do not release the parking brake or attempt to move the container handling truck if the air pressure gauge indicates that the air pressure is below 100 psi.

WARNING: Make sure all ground personnel know the rules and responsibilities set by your employer. Make sure they know what you are going to do and be sure they are clear of the area before you move the container handling truck.

WARNING: Cameras are not substitutes for looking in the direction of and keeping a clear view of the path of travel. Never use them as substitutes, *Always* look in the path of travel.

WARNING: Total reliance on electrical aids can be dangerous. The responsibility for safe operation of the container handling truck shall remain with the operator who shall ensure that all warning and instructions provided are fully understood and observed.

WARNING: Do not operate the container handling truck until both forward and reverse travel paths are clear. Do not operate the truck with bystanders present.

WARNING: Do not move the container handling truck until the surrounding area has been checked and is clear of personnel and obstructions.

WARNING: Always look in the direction of travel and keep a clear view of the path of travel; slow down and sound the horn at cross aisles and other locations where vision may be obscured.

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WARNING: This equipment is not electrically insulated. Contact with electricity can cause severe injury or death. Electrocution can occur without direct contact. Do not operate this container handling truck in areas with energized power lines or a power supply. Check local, state and federal safety codes for proper clearance. Use a groundman to ensure that there is proper clearance.

WARNING: Do not allow anyone on the container handling truck during operation.

WARNING: Do not move the container handling truck onto a surface or area that has not been approved for container handling truck operation. The container handling truck is heavy and could possibly break through an insufficient surface and cause damage to the truck or injury to personnel.

WARNING: Do not operate the container handling truck over potholes and debris. Clear the yard of obstructions.

WARNING: Avoid sudden starts and stops.

WARNING: Serious falls or injuries can result from riding on the container handling truck! Do not ride on the container handling truck.

Handling Loads:

WARNING: If any abnormal operating condition occurs while operating the container handling truck, move the truck to a safe parking area, if possible; when safe to do so, shut down the truck and notify the appropriate maintenance personnel.

WARNING: Do not allow anyone near the container handling truck - certainly not walking or standing under or beside the container or lifting mechanism.

WARNING: Stacks of containers or materials can cause "blind spots" for the operator. It is essential, for safe operation, that the ground crew stay clear of "blind spots" and stay within sight of the operator at all times. Do not allow anyone to walk in the travel aisleways.

WARNING: Do not move or lift container until all four twistlocks are fully locked (green container light illuminated). The container could fall from the attachment causing death or serious injury to ground personnel or physical damage to the container, container handling truck or other yard equipment.

WARNING: Do not lift a loaded container that exceeds the rated capacity of the container handling truck. Failure to do so, may result in death, personal injury or damage to the container handling truck.

WARNING: Do not handle unstable loaded containers.

If the load shifts in the container, stop the truck immediately, lower the container and adjust the side shift until load weight is centered and properly held. If the load shift is too great for adjustment with side shift, lower the container and rearrange the load before attempting to move the container.

WARNING: Never move containers over personnel or vehicles.

WARNING: Do not back away from a rack or stack without complete release of the container. Failure to do so, may result in death or serious bodily injury and property damage caused by dropping a container on the truck, a bystander or on the ground.

WARNING: Position the container before traveling to eliminate interference with visibility in the direction of travel.

WARNING: Use care when traveling with or without a container.

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WARNING: Never leave the container handling truck with a container suspended. The load could inadvertently lower and cause serious injury or death.

WARNING: Be exact in load placement. Make sure the load will not tilt, fall or slide out of position when released. Personal injury or equipment damage can result from unstable placement of loads.

WARNING: Do not unlatch a container until you, the operator, have determined that it is safe to do so. Never unlatch a container that is not positioned securely; the container could shift or fall.

WARNING: Do not back away from a rack or stack with a container until it is clear of the container below it. Failure to do so, may result in death or serious bodily injury and property damage caused by dropping a container on the truck, a bystander or on the ground.

Battery Safety:

WARNING: Lighted smoking materials, flames, arcs, or sparks may result in battery explosion.

1. Keep all metal tools away from battery terminals.
2. Batteries contain sulfuric acid which will burn skin on contact; wear rubber gloves and eye protection when working with batteries.
3. Flush eyes or wash skin with water and seek medical attention immediately in case of contact.
4. When jump starting:
   a. Do not lean over the battery while making connection.
   b. First, connect the positive (+) terminal of the booster battery to the positive (+) terminal of the discharged battery.
   c. Then, connect the negative (-) terminal of the booster battery to the engine or body ground (-). Never Cross Polarity of Terminals.
   d. Disconnect cables in exact reverse order.

Lock-Out / Tag-Out Procedure

Purpose. This procedure establishes the minimum requirements for lock-out / tag-out of energy sources that could cause injury to personnel. All employees shall comply with the procedure.

Responsibility. The responsibility for seeing that this procedure is followed is binding upon all employees. All employees shall be instructed in the safety significance of the lock-out / tag-out procedure by (designated individual). Each new or transferred affected employee shall be instructed by (designated individuals) in the purpose and use of the lock-out / tag-out procedure.

Preparation for Lock-Out / Tag-Out. Employees authorized to perform lockout / tagout shall be certain as to which switch, valve, or other energy isolating devices apply to the equipment being locked out / tagged out. More than one energy source (electrical, mechanical, or others) may be involved. Any questionable identification of sources shall be cleared by the employees with their supervisors. Before lock-out /tag-out commences, job authorization should be obtained.

Sequence of Lock-Out / Tag-Out Procedure

1. Notify all affected employees that a lock-out / tag-out is required and the reason therefor.
2. If the equipment is operating, shut it down by the normal stopping procedure.
3. Operate the switch, valve, or other energy isolating device so that the energy source(s) (electrical, mechanical, hydraulic, etc.) is disconnected or isolated from the equipment. Stored energy, such as that in capacitors, springs, elevated crane members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc. must also be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding-down, etc.
4. Lock-out / tag-out the energy isolating devices with an assigned individual lock / tag.
5. After ensuring that no personnel are exposed and as a check on having disconnected the energy sources, operate the push button or other normal operating controls to make certain the equipment will not operate.

CAUTION: Return operating controls to neutral after the test.

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6. The equipment is now locked out / tagged out.

Restoring Equipment to Service

1. When the job is complete and equipment is ready for testing or normal service, check the equipment area to see that no one is exposed.

2. When equipment is all clear, remove all locks / tags. The energy isolating devices may be operated to restore energy to equipment.

Procedure Involving More Than One Person.
In the preceding steps, if more than one individual is required to lock-out / tag-out equipment, each shall place his own personal lock / tag on the energy isolating device(s). One designated individual of a work crew or a supervisor, with the knowledge of the crew, may lock-out / tag-out equipment for the whole crew. In such cases, it shall be the responsibility of the individual to carry out all steps of the lock-out / tag-out procedure and inform the crew when it is safe to work on the equipment. Additionally, the designated individual shall not remove a crew lock / tag until it has been verified that all individuals are clear.

Rules for Using Lock-Out / Tag-Out Procedure.
All equipment shall be locked out / tagged out to protect against accidental or inadvertent operation when such operation could cause injury to personnel. Do not attempt to operate any switch, valve, or other energy isolating device bearing a lock / tag.

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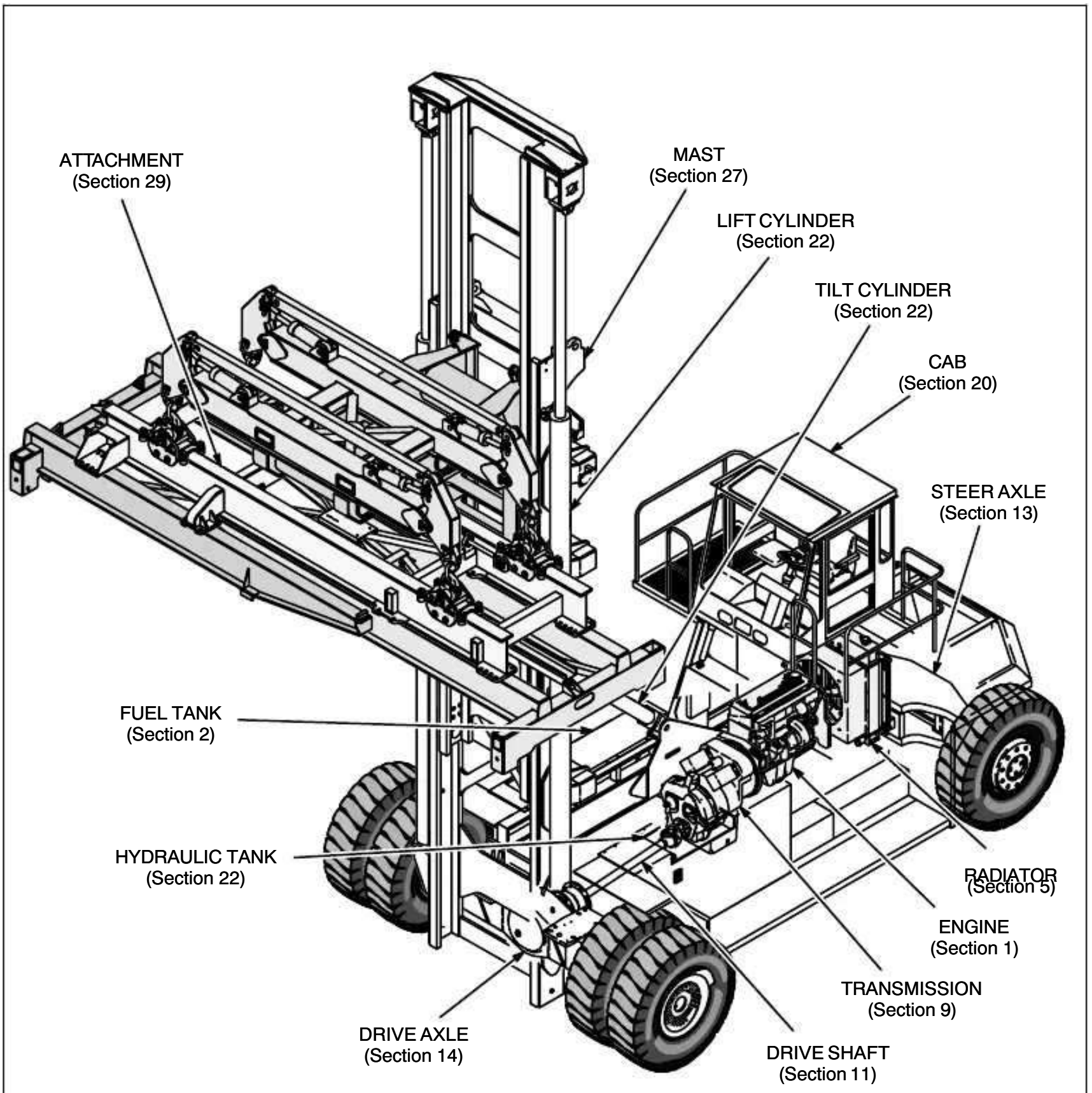
Major Components Locations



NOTE: All circuit drawings illustrate the components in de-energized states. Circuit drawings and illustrations are drawn in the position of the operator facing forward, looking toward the mast assembly.

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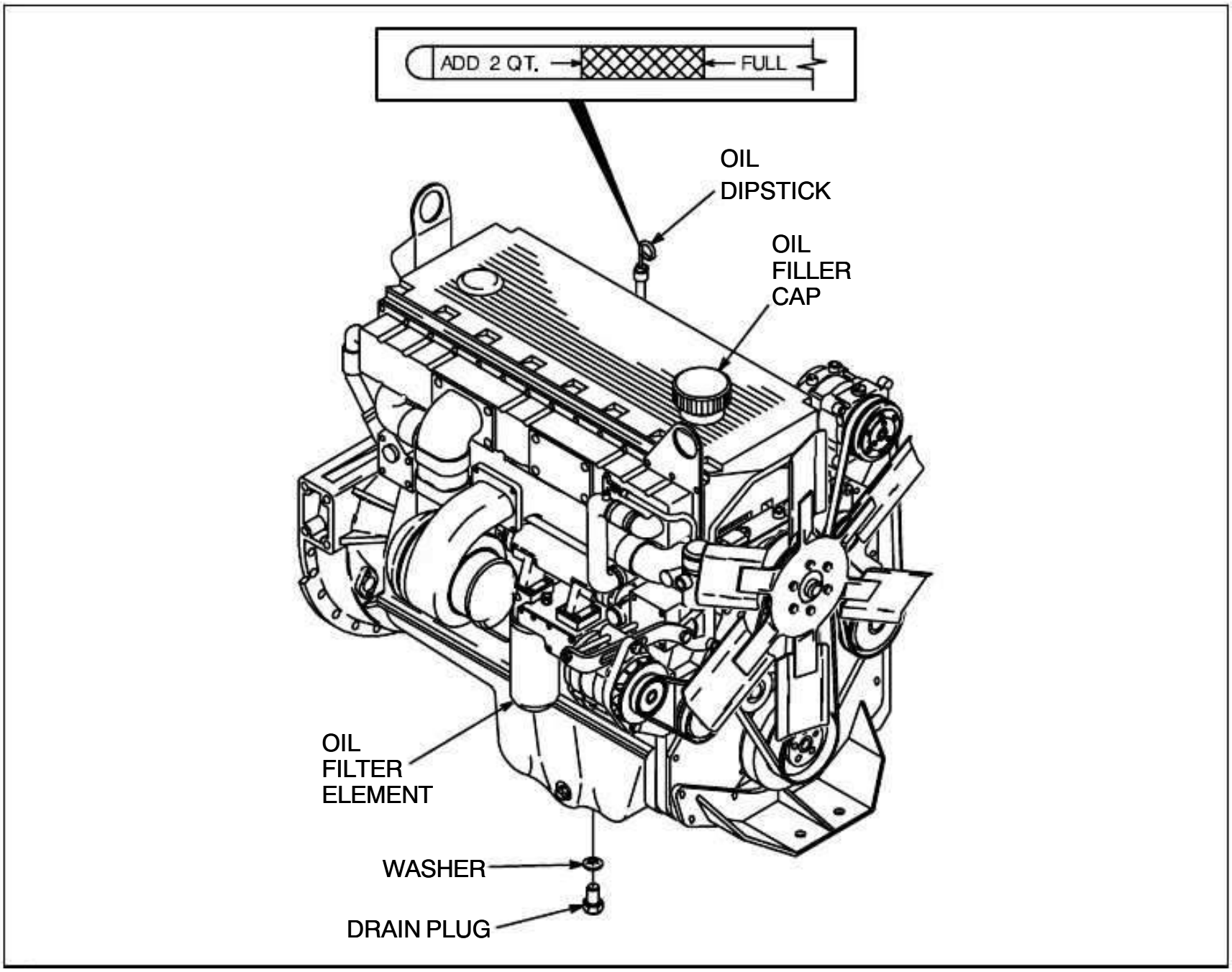

Illustration 1-1. Cummins QSM11-C330 Engine Service Points

Introduction. This engine is pressure lubricated, generating 330 horsepower at 2100 governed rpm and delivering 1170 ft-lbs of peak torque at 1400 rpm. Oil pressure is supplied by a gear-type lubricating oil pump and controlled by a pressure regulator. The filter bypass valve ensures that a supply of oil, in the event the filter becomes plugged, is present. One full flow oil filter is incorporated in the lubricating system to provide maximum cleansing and filtration of the engine lubricating oil. If additional engine information is needed, refer to the engine operation and maintenance manual supplied with the truck.

Checking the Lubricating Oil (Illustration 1-1). The engine lubricating oil should be checked daily on the oil dipstick to ensure the engine has the proper amount of oil for operation.

Changing the Oil and Filter Element (Illustration 1-1)**.** The engine lubricating oil should be changed monthly or every 250 hours, whichever comes first. The oil filter should be replaced each time the engine oil is changed. Refer to the **Fuel and Lubricant Specifications** chart in the back of this manual for the proper grade of oil to use.

WARNINGS:

- **Park machine on a level surface, apply parking brake, block wheels and Lock Out & Tag Out while servicing machine.**

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- **Avoid touching exhaust components while changing the oil for severe burns could occur.**
- **Some state and federal agencies in the United States have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion and prolonged contact with used engine oil.**

⚠ **CAUTIONS:**

- **Dispose of oil and filter in accordance with federal and local regulations.**
- **Do not use a strap wrench to tighten the oil filter. Mechanical over-tightening may distort the threads or damage the filter gasket.**
- **Never operate the engine with the oil level below the ADD mark or above the FULL mark on the oil dipstick.**
- **Do not use excessive amounts of starting fluid when starting the engine. The use of too much starting fluid will cause engine damage.**

1. Operate the engine until the water temperature reaches 140°F and then shut off the engine.
2. Place a suitable container under the drain plug of the oil pan. Remove the drain plug and washer to drain the oil. Replace washer if damaged.
3. When the oil has completely drained, reinstall the washer and drain plug. Apply a torque of 65 ft-lbs of torque to tighten the drain plug.
4. Unscrew the spin-off type oil filter (see Illustration 1-1). It should be possible to unscrew the oil filter by hand; however, a band type filter wrench may be used if necessary. Discard the used oil filter.
5. Clean the area on the filter base that will contact the gasket on the new oil filter.
6. Fill the new filter with clean engine oil before installation.
7. Apply a light film of engine oil on the gasket of the new filter. Screw the new filter onto the filter base until the gasket comes in contact with the filter base and then tighten filter 1/2 to 3/4 turn by hand only.
8. Remove the oil fill cap and fill crankcase with oil to the FULL mark on the oil dipstick (see Illustration 1-1).
9. Start the engine and allow to idle. Visually check the drain plug and oil filter for leaks.
10. Shut down the engine and wait approximately 5 minutes for the oil to drain back into the oil pan. When the engine has cooled, recheck the oil level and add oil as necessary to bring the oil level to the FULL mark on the oil dipstick.

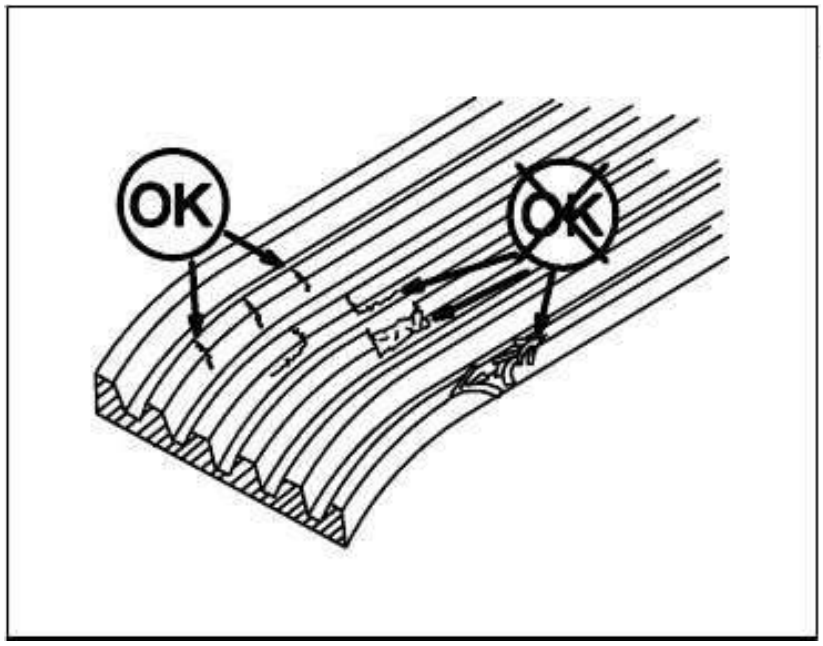

Illustration 1-2. Drive Belt Inspection

Drive Belts (Illustration 1-2)**.** Visually inspect the drive belts daily. Check the belt for intersecting cracks. Transverse cracks (across the belt width) are acceptable. Longitudinal cracks (direction of belt length) that intersect with transverse cracks are not acceptable. Replace the belt if belt is frayed or has pieces of material missing. Adjust drive belts that have a glazed or shiny surface which indicates belt slippage. Correctly installed and tensioned belts will show even pulley and belt wear. After installation of a new belt, check the tension and adjust if necessary.

Belt damage can be caused by:

- Incorrect tension
- Incorrect size or length
- Pulley misalignment
- Incorrect installation
- Severe operating environment
- Oil or grease on the belts

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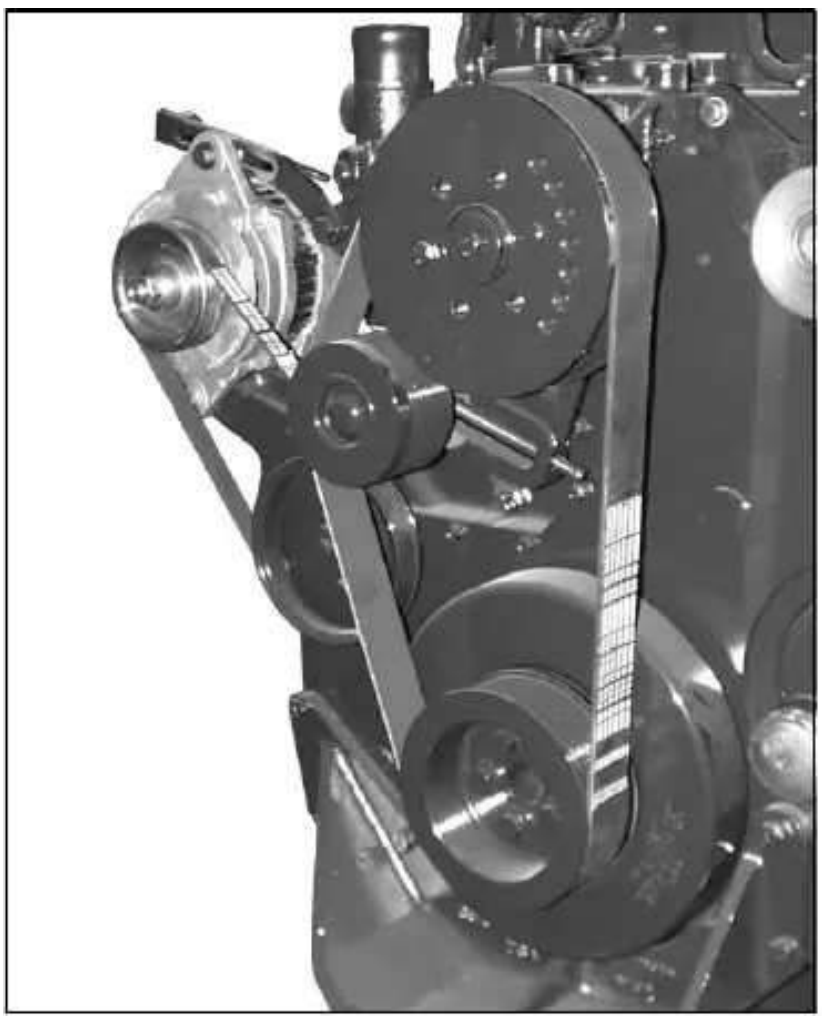

Illustration 1-3. Fan Drive Belt

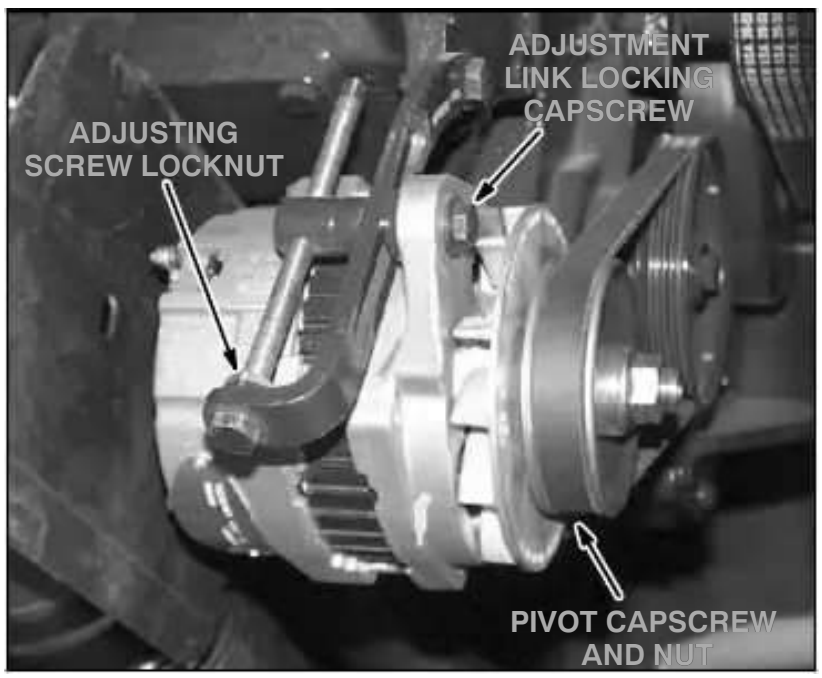

Illustration 1-4. Alternator Drive Belt

Fan Drive Belt Tension (Illustration 1-3)**.** The tension of the fan drive belt should be 200 - 240 ft-lbs (890 - 1070 N·m) for a used belt and 300 ft-lbs (1330 N·m) for a new belt. A belt is considered used if it has been in operation for 10 minutes or longer. If the used belt tension is less than the minimum tension value, tighten the belt to the maximum tension value. To obtain the proper belt tension value, use an appropriate belt tension gauge. Perform the following procedures to adjust the tension of the belt.

⚠ **CAUTION: Do not adjust belt tension to the maximum value with the adjusting screw. Belt tension can increase when the locknut is tightened and cause reduced belt and bearing life.**

1. Loosen the idler pulley shaft locknut.
2. Adjust the belt to the correct tension by turning the adjusting screw clockwise until the proper belt tension is obtained (see **Caution** above).
3. Tighten the idler pulley shaft locknut to a torque value of 140 ft-lbs (190 N·m).
4. Check the belt tension again to make sure the belt is adjusted to the correct value.

Alternator Drive Belt Tension (Illustration 1-4)**.** The tension of the alternator drive belt should be 60 - 120 ft-lbs (270 - 530 N·m) for a used belt and 150 ft-lbs (670 N·m) for a new belt. A belt is considered used if it has been in operation for 10 minutes or longer. If the used belt tension is less than the minimum tension value, tighten the belt to the maximum tension value. To obtain the proper belt tension value, use an appropriate belt tension gauge. Perform the following procedures to adjust the tension of the belt:

1. Loosen the adjusting screw locknut.
2. Loosen the adjustment link locking capscrew.
3. Loosen the pivot capscrew and nut.
4. Adjust the belt to the correct tension by turning the adjusting screw clockwise until the proper belt tension is obtained.
5. Tighten the adjusting screw locknut against the retainer.
6. Tighten the adjustment link locking capscrew to a torque value of 60 ft-lbs (80 N·m).
7. Tighten the pivot capscrew and nut to a torque value of 35 ft-lbs (47 N·m).

Engine Cleaning. The engine must be steam cleaned every 6 months or 1500 hours, whichever

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comes first. If steam is not available, use a solvent to wash the engine. When cleaning the engine, protect all electrical components, openings and wiring from the full force of the cleaner spray nozzle.

WARNING: When using a steam cleaner, wear protective clothing and safety glasses or a face shield. Hot steam will cause serious personal injury.

Checking Engine Mounting Bolts. The engine mounting bolts should be checked for the appropriate torque every 6 months or 1500 hours, whichever comes first. The torque value of the engine mounting bolts is 380 ft-lbs. Inspect the rubber mounts for deterioration and age hardening. Replace any broken or lost bolts and damaged rubber mounts.

Cummins QSM11-C330 Engine General Information

Oil Pressure (normal)	28 - 35 psi
Oil Capacity (includes filter change)	39.2 quarts
High RPMs (no load)	2250 rpm
Low RPMs	750 rpm

NOTES:

- *Setting high rpms under no load conditions to 2250 rpm ensures that the engine will have 2100 rpms under a loaded condition.*

- *Some special applications may use engine speed settings that are different from the standards shown. The proper settings are permanently stamped on a metal tag affixed to the engine.*

Calibration Of Electronic Accelerator Pedal To ECM Of Engine. The Cummins QSM11 engine uses an electronic accelerator to control engine speed. Each time the accelerator pedal is changed, disconnected and the ignition switch is turned on, or ECM (Electronic Control Module) is changed out, the accelerator pedal must be calibrated to the ECM. Calibration procedures are as follows:

1. Apply the parking brake, place the shifter in neutral, and turn the ignition switch to the Ignition position (first click).
2. Cycle the accelerator pedal through its full range of travel three times.
3. Turn the ignition switch to the Off position for 30 seconds.

Diagnostic Lights (Illustration 1-5)**.** The diagnostic lights, located on the right side of the dash, are used to alert the operator of engine related problems. At initial power up, all 3 lights will be illuminated for 2 seconds. After 2 seconds, the red light will turn off. After 2.5 seconds, the yellow light will turn off. After 3 seconds from power up, the blue light will turn off. Each light's function is listed as follows:

1. **Blue Light.** This light will begin to flash at approximately 230 hours, indicating routine maintenance is forthcoming. This light illuminates at approximately 250 hours when routine maintenance is required. To reset this light, perform the following procedures to reset the blue light:
   a. Toggle the diagnostic switch (located inside the dash on the right side) to the ON position.
   b. Turn the ignition key to its accessory position (first click).
   c. Allow all the diagnostic lights to complete the flash sequences prior to starting procedure 4.
   d. Fully depress the accelerator pedal and hold for more than 3 seconds.
   e. Fully depress the accelerator pedal twice (each time less than 1 second).
   f. Fully depress the accelerator pedal and hold for more than 3 seconds.

NOTE: *Procedures d. through f. must be completed within 30 seconds.*

   g. The blue light will flash three quick flashes signifying that the ECM has responded to the reset command.
   h. Toggle the diagnostic switch to the OFF position.
   i. Turn the ignition switch to the OFF position. Allow the ignition switch to remain off for a minimum of 30 seconds before turn-

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ing the ignition switch back on to confirm that the blue light has been reset.

2. **Yellow Light** (System Fault)**.** This light illuminates during a non-fatal system error. The engine can still be run, but the fault should be corrected as soon as possible.

NOTE: *In the diagnostic mode, the yellow light will flash after the red light completes the three-digit fault code.*

3. **Red Light** (Engine Shutting Down)**.** This light illuminates when the engine needs to be shut off before permanent damage occurs to the engine. Should the red light illuminate while operating, the fault can be engine disabling after approximately 32 seconds. Should the engine shut down due to the severity of the fault, it can be restarted and will run for approximately 32 seconds. The engine will run for approximately 32 seconds each time it is restarted. There are no limits on the number of times the engine may be restarted.

NOTES:

- *The engine should be shut off as soon as it can be shut off safely. The engine should* ***not*** *be run until the fault is corrected.*
- *This light is also used to flash out the fault code number in the diagnostic mode.*

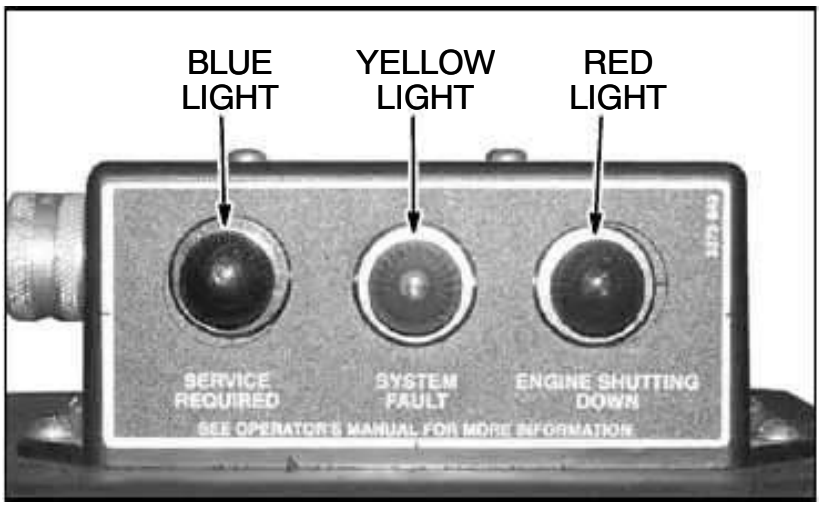

Illustration 1-5. Diagnostic Lights

Diagnostic Fault Codes (Illustration 1-5)**.** If the **red light** (Engine Shutting Down) or **yellow light** (System Fault) light comes on when the engine is running, it means a fault code has been recorded. The light will remain on as long as the fault exists. The severity of the fault will determine the light that will come on. Only active fault codes can be viewed by use of the diagnostic lights. To view inactive fault codes, a laptop computer equipped with Cummins Insite software is required.

To view active fault codes, perform the following:

1. Turn off the engine.
2. Toggle the diagnostic switch (located inside the dash on the right side) to the ON position.
3. Turn the ignition key to its accessory position (first click). If no active fault codes are recorded, the yellow light (System Fault) and red light (Engine Shutting Down) will illuminate and stay on. If active fault codes are recorded, the yellow light and red light will illuminate momentarily, and then the red light will begin to flash the three-digit code of the recorded fault(s).
4. The fault code will flash in the following sequence:
   a. First, the yellow light will flash beginning the sequence. There will be a short 1 or 2 second pause after which the red light will flash the first, second, and third digits of the recorded fault code. There will be a 1 or 2 second pause between each number of the code. When all three digits of the fault code have flashed, the yellow light will illuminate again and repeat the sequence until the fault is cleared or the Diagnostic switch is toggled to the OFF position.

   Example:
   Fault Code 432
   4 flashes, pause
   3 flashes, pause
   2 flashes

   b. If multiple fault codes have been stored, the first fault code must be cleared before the second fault code can be displayed.

Fault Code Information. All fault codes identified in bold print on the preceding fault code information chart deal with engine and transmission protection systems external to the Cummins QSM11 engine. Fault code #151 can be caused by both engine and external components. Contact Taylor Machine Works Sudden Service Department for additional assistance if needed.

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QSM11 Fault Code Information

Fault Code - Light	Failure Description	Failure Results
111 - Red	Error internal to the ECM related to memory hardware failures or internal ECM voltage supply circuits.	The engine will not start.
115 - Red	No engine speed signal detected at both engine position sensor circuits.	The engine will die and will not start.
121 - Yellow	No engine speed signal detected from one of the engine position sensor circuits.	None on performance.
122 - Yellow	High voltage detected on the intake manifold pressure circuit.	Derate in power output of the engine.
123 - Yellow	Low voltage detected on the intake manifold pressure circuit.	Derate in power output of the engine.
131 - Red	High voltage detected at the throttle position signal circuit.	Severe derate (power and speed). Limp home power only.
132 - Red	Low voltage detected at the throttle position signal circuit.	Severe derate (power and speed). Limp home power only.
133 - Red	High voltage detected at the remote throttle position signal circuit.	None on performance if remote throttle is not used.
134 - Red	Low voltage detected at the remote throttle position signal circuit.	None on performance if remote throttle is not used.
135 - Yellow	High voltage detected at the oil pressure circuit.	No engine protection for oil pressure.
141 - Yellow	Low voltage detected at the oil pressure circuit.	No engine protection for oil pressure.
143 - Yellow	Oil pressure signal indicates oil pressure is below the low oil pressure engine protection limit.	Progressive power and speed derate with increasing time after alert. Engine will shut down 30 seconds after red light starts flashing.
144 - Yellow	High voltage detected at the coolant temperature circuit.	Possible white smoke. Fan will stay on if controlled by the electronic control module (ECM). No engine protection for coolant temperature.
145 - Yellow	Low voltage detected at the coolant temperature circuit.	Possible white smoke. Fan will stay on if controlled by the electronic control module (ECM). No engine protection for coolant temperature.
147 - Red	A frequency of less than 100 Hz was detected at the frequency throttle signal pin of the actuator harness connector at the ECM.	Calibration dependent power and speed derate.
148 - Red	A frequency of more than 100 Hz was detected at the frequency throttle signal pin of the actuator harness connector at the ECM.	Calibration dependent power and speed derate.
151 - Red	Coolant temperature signal indicates coolant temperature is above 104°C (220°F).	Progressive power derate with increasing time after alert. Engine will shut down 30 seconds after red light starts flashing.
153 - Yellow	High voltage detected at the intake manifold temperature circuit.	Possible white smoke. Fan will stay on if controlled by the electronic control module (ECM). No engine protection for coolant temperature.
154 - Yellow	Low voltage detected at the intake manifold temperature circuit.	Possible white smoke. Fan will stay on if controlled by the electronic control module (ECM). No engine protection for coolant temperature.

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Fault Code - Light	Failure Description	Failure Results
155 - Red	Intake manifold temperature signal indicates temperature is above 87.8°C (190°F).	Progressive power derate with increasing time after alert. If Engine Protection Shutdown feature is enabled, engine will shut down 30 seconds after red light starts flashing.
187 - Yellow	Low voltage detected on the ECM voltage supply line to some sensors (VSEN2 supply).	The engine will run derated. No engine protection for oil pressure and coolant level.
211 - None	Additional OEM or Vehicle diagnostic codes have been logged. Check other ECM's for diagnostic codes.	None on engine performance.
212 - Yellow	High voltage detected at the oil temperature circuit.	No engine protection for oil temperature.
213 - Yellow	Low voltage detected at the oil temperature circuit.	No engine protection for oil temperature.
214 - Red	Oil temperature signal indicates oil temperature is above 123.9°C (255°F).	Progressive power derate with increasing time after alert. If Engine Protection Shutdown feature is enabled, engine will shut down 30 seconds after red light starts flashing.
219 - Blue	Low oil level was detected in the Centinel™ makeup oil tank.	None on performance. Centinel™ is deactivated.
221 - Yellow	High voltage detected at the ambient air pressure circuit.	Derate in power output of the engine.
222 - Yellow	Low voltage detected at the ambient air pressure circuit.	Derate in power output of the engine.
223 - Yellow	Incorrect voltage detected at the Centinel™ actuator circuit by the ECM.	None on performance. Centinel™ is deactivated.
227 - Yellow	High voltage detected on the ECM voltage supply line to some sensors (VSEN2 supply).	The engine will run derated. No engine protection for oil pressure and coolant level.
234 - Red	Engine speed signal indicates engine speed is greater than 2730 rpm.	Fuel shutoff valve closes until engine speed falls to 2184 rpm.
235 - Red	Coolant level signal indicates coolant level is below the normal range.	Engine will shut down 30 seconds after red light starts flashing. Add coolant as required.
237 - Yellow	Duty cycle of the throttle input signal to the primary or secondary engine for multiple unit synchronization is less than 3% or more than 97%.	All engines (primary and secondary) are shut down with increasing time after alert if hard-coupled. Only secondary engines are shut down with increasing time after alert if soft-coupled.
241 - Yellow	The ECM lost the vehicle speed signal.	Engine speed limited to Maximum Engine Speed without Vehicle Speed Sensor parameter value Cruise Control, Gear-Down Protection and Road Speed Governor will not work (automotive only).
242 - Yellow	Invalid or inappropriate vehicle speed signal detected. Signal indicates an intermittent connection or VSS tampering.	Engine speed limited to Maximum Engine Speed without Vehicle Speed Sensor parameter value Cruise Control, Gear-Down Protection and Road Speed Governor will not work (automotive only).
245 - Yellow	Less than 6 VDC detected at fan clutch circuit when on. Indicates an excessive current draw from the ECM or faulty ECM output circuit.	Then fan may stay on at all times.
254 - Red	Less than 6 VDC detected at FSO circuit when on. Indicates an excessive current draw from the ECM or a faulty ECM output circuit.	The ECM turns off the FSO supply voltage. The engine will shut down.

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Fault Code - Light	Failure Description	Failure Results
255 - Yellow	Externally supplied voltage detected going to the fuel shutoff solenoid supply circuit.	None on performance. Fuel shutoff valve stays open.
285 - Yellow	The ECM expected information from a multiplexed device but did not receive it soon enough or did not receive it at all.	At least one multiplexed device will not operate properly.
286 - Yellow	The ECM expected information from a multiplexed device but only received a portion of the necessary information.	At least one multiplexed device will not operate properly.
287 - Red	The OEM vehicle electronic control unit (VECU) detected a fault with its throttle pedal.	The engine will only idle.
288 - Red	The OEM vehicle electronic control unit (VECU) detected a fault with its remote throttle.	The engine will not respond to the remote throttle.
293 - Yellow	High voltage detected at the OEM temperature sensor signal pin of the 31-pin OEM connector.	No engine protection for OEM temperature.
294 - Yellow	Low voltage detected at the OEM temperature sensor signal pin of the 31-pin OEM connector.	No engine protection for OEM temperature.
295 - Yellow	An error in the ambient air pressure sensor signal was detected by the ECM.	The engine is derated to no air setting.
297 - Yellow	High voltage detected at the OEM pressure sensor signal pin of the 31-pin OEM connector.	No engine protection for OEM pressure.
298 - Yellow	Transmission's temperature exceeds 245°F.	Engine will shut down 30 seconds after the red light begins flashing.
299 - Yellow	Engine shutdown by device other than keyswitch before proper engine cool down resulting in filtered load factor above maximum shutdown threshold.	No action taken by the ECM.
311 - Yellow	Current detected at No. 1 injector when the voltage is turned off.	Current to the injector is shut off.
312 - Yellow	Current detected at No. 5 injector when the voltage is turned off.	Current to the injector is shut off.
313 - Yellow	Current detected at No. 3 injector when the voltage is turned off.	Current to the injector is shut off.
314 - Yellow	Current detected at No. 6 injector when the voltage is turned off.	Current to the injector is shut off.
315 - Yellow	Current detected at No. 2 injector when the voltage is turned off.	Current to the injector is shut off.
319 - Blue	Real time clock lost power.	None on performance. Data in the ECM will not have accurate time and date information.
321 - Yellow	Current detected at No. 4 injector when the voltage is turned on.	Current to the injector is shut off.
322 - Yellow	No current detected at No. 1 injector when the voltage is turned on.	Current to the injector is shut off.
323 - Yellow	No current detected at No. 5 injector when the voltage is turned on.	Current to the injector is shut off.
324 - Yellow	No current detected at No. 3 injector when the voltage is turned on.	Current to the injector is shut off.

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Fault Code - Light	Failure Description	Failure Results
325 - Yellow	No current detected at No. 6 injector when the voltage is turned on.	Current to the injector is shut off.
331 - Yellow	No current detected at No. 2 injector when the voltage is turned on.	Current to the injector is shut off.
332 - Yellow	No current detected at No. 4 injector when the voltage is turned on.	Current to the injector is shut off.
341 - Yellow	Severe loss of data from the ECM.	Possible no noticeable performance effects OR engine dying OR hard starting. Fault information, trip information, and maintenance monitor data may be inaccurate.
343 - Yellow	Internal ECM error.	Possible none on performance or severe derate.
349 - Yellow	A frequency greater than calibrated threshold was detected at the tailshaft governor signal of the 31-pin OEM connector.	Calibration dependent power and speed derate.
352 - Yellow	Low voltage detected on the ECM voltage supply line to some sensors (VSEN1 supply).	The engine is derated to no air setting.
386 - Yellow	High voltage detected on the ECM voltage supply line to some sensors (VSEN1 supply).	The engine is derated to no air setting.
387 - Yellow	High voltage detected on the ECM voltage supply line to the throttle(s) (VTP supply).	The engine will only idle.
415 - Red	Oil pressure signal indicates oil pressure is below the very low oil pressure engine protection limit.	Progressive power derate with increasing time from alert. Engine will shut down 30 seconds after red light starts flashing.
418 - Blue	Water has been detected in the fuel filter.	Possible white smoke, loss of power, or hard starting.
419 - Yellow	An error in the intake manifold pressure sensor signal was detected by the ECM.	The engine is derated to no air setting.
422 - Yellow	Voltage detected simultaneously on both the coolant level high and low signal circuits OR no voltage detected on both circuits.	Engine will shut down 30 seconds after red light starts flashing. Disconnected or loose plug at coolant sensor, defective coolant sensor, or loose or broken wire between sensor and ECM.
426 - None	Communication between the ECM and the J1939 data link has been lost.	None on performance. J1939 devices may not operate.
428 - Yellow	High voltage detected at water-in-fuel sensor.	None on performance.
429 - Yellow	Low voltage detected at water-in-fuel sensor.	None on performance.
431 - Yellow	Voltage detected simultaneously on both the idle validation off-idle and on-idle circuits.	None on performance.
432 - Red	Voltage detected at idle validation on-idle circuit when voltage at throttle position circuit indicates the pedal is not at idle OR voltage detected at idle validation off-idle circuit when voltage at throttle position circuit indicates the pedal is at idle.	The engine will only idle.
433 - Yellow	Voltage signal at intake manifold pressure circuit indicates high intake manifold pressure but other engine characteristics indicate intake manifold pressure must be low.	Derate to no air setting.

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Fault Code - Light	Failure Description	Failure Results
434 - Yellow	Supply voltage to the ECM fell below 6.2 VDC for a fraction of a second OR the ECM was not allowed to power down correctly (retain battery voltage for 30 seconds after key off).	Possible no noticeable performance effects OR possibility of engine dying OR hard staring. Fault information, trip information, and maintenance monitor data may be inaccurate.
435 - Yellow	An error in the oil pressure sensor signal was detected by the ECM.	None on performance. No engine protection for oil pressure.
441 - Yellow	Battery voltage is below the normal operating level.	Possible no noticeable performance effects OR possibility of rough idle.
442 - Yellow	Battery voltage is above the normal operating level.	None on performance.
443 - Yellow	Low voltage detected on the ECM voltage supply line to the throttle(s) (VTP supply).	The engine will only idle.
489 - Yellow	Auxiliary speed frequency on input pin indicated that the frequency is below a calibration dependent threshold.	The engine will only idle.
527 - Yellow	Less than 17.0 VDC detected at the dual output A signal pin of the 31-pin OEM connector.	No action taken by the ECM.
528 - Yellow	Less than 17.0 VDC detected at the dual output B signal pin of the 31-pin OEM connector.	No action taken by the ECM.
529 - Yellow	Less than 17.0 VDC detected at the dual output B signal pin at the ECM.	No action taken by the ECM.
551 - Yellow	No voltage detected simultaneously on both the idle validation off-idle and on-idle circuits.	The engine will only idle.
581 - Yellow	High voltage detected at the fuel inlet restriction sensor signal pin.	Fuel inlet restriction monitor deactivated.
582 - Yellow	Low voltage detected at the fuel inlet restriction sensor signal pin.	Fuel inlet restriction monitor deactivated.
583 - Yellow	Restriction has been detected at the fuel pump inlet.	Fuel inlet restriction monitor warning is set.
596 - Yellow	High battery voltage detected by the battery voltage monitor feature.	Yellow light will be illuminated until high battery voltage condition is corrected.
597 - Yellow	ICON™ has restarted the engine 3 times within 3 hours due to low battery voltage (automotive only) OR low battery voltage detected by the battery voltage monitor feature.	Yellow light will be illuminated until low battery voltage condition is corrected. The ECM may increase idle speed and deactivate idle decrement switch. Idle speedup is enabled. The engine will run continuously if ICON™ is active (automotive only).
598 - Red	Very low battery voltage detected by the battery voltage monitor feature.	Red light will be illuminated until very low battery voltage condition is corrected.
611 - None	Engine shutdown by operator before proper engine cool down resulting in filtered load factor above maximum shutdown threshold.	No action taken by the ECM.
951 - None	A power imbalance between cylinders was detected by the ECM.	The engine may have rough idle or misfire.

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Engine Troubleshooting (Cummins QSM11-C330) (Illustration 1-6)

The following chart includes some of the problems that an operator may encounter during the service life of a Cummins diesel engine. Always check the easiest and obvious things first, such as the master disconnect switch, the neutral start switch, an empty fuel tank, closed fuel shut off, dead battery or corroded terminals. Study the problem thoroughly before starting to work on the engine. Ask yourself the following questions.

1. What were the warning signs preceding the trouble?
2. Has the engine been subjected to recent repair or maintenance?
3. Has a similar trouble occurred before?
4. If the engine still runs, is it safe to continue operation of the engine in an effort to diagnose the trouble?

Check the items most easily and inexpensively corrected before proceeding to the more difficult, time consuming and expensive items. After a malfunction has been corrected, locate and correct the cause of the trouble to prevent recurrence of the same trouble.

Problem	Cause	Correction
1. Air compressor air pressure rises slowly	1. Intake air restriction to air compressor is excessive. 2. Air system leaks. 3. Carbon buildup excessive in the air discharge line.	1. Remove restriction. 2. Check for air compressor gasket, hoses, and fitting leaks. Check for safety pressure valve leaks. Rating must be 135 psi. 3. Check valve or cylinder head for carbon buildup and remove. 4. Contact a Cummins Authorized Repair Facility.
2. Air compressor cycles frequently	1. Air system leaks. 2. Carbon buildup is excessive in the air discharge line, check valve, or cylinder head. 3. Air compressor pumping time is excessive.	1. Block the truck's wheels. Inspect the air system for leaks with the parking brakes applied and released. Check for leaks from the air compressor gaskets and the air system hoses, fittings, and valves. 2. Check for air discharge line, check valve, and cylinder head for carbon buildup. Replace the air compressor discharge line if required. 3. Replace the desiccant cartridge in the air dryer (if equipped). Check the air compressor duty cycle. 4. Contact a Cummins Authorized Repair Facility.
3. Air compressor noise is excessive *continued*	1. Carbon buildup excessive in the air discharge line.	1. Refer to Correction 3. of Problem 1. of this troubleshooting chart.

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Problem	Cause	Correction
3. Air compressor noise is excessive (Continued)	2. Ice buildup in the air system components.	2. Inspect air discharge line and elbow fittings for ice. Remove ice. 3. Contact a Cummins Authorized Repair Facility.
4. Air compressor pumping excess lubricating oil into the air system	1. Air compressor pumping time excessive. 2. Carbon buildup excessive in the air discharge line.	1. Check air compressor duty cycle. 2. Refer to Correction 3. of Problem 1. of this troubleshooting chart. 3. Contact a Cummins Authorized Repair Facility.
5. Air compressor will not maintain adequate air pressure (not pumping continuously)	1. Air system leaks.	1. Refer to Correction 2. of Problem 1. of this troubleshooting chart. 2. Contact a Cummins Authorized Repair Facility.
6. Air compressor will not stop pumping	1. Air system leaks. 2. Defective air governor.	1. Refer to Correction 2. of Problem 1. of this troubleshooting chart. 2. Replace air governor. 3. Contact a Cummins Authorized Repair Facility.
7. Alternator not charging or insufficiently charging	1. Alternator belt is loose. 2. Battery cable or connection is loose, broken or corroded (excessive resistance). 3. Batteries failed. 4. Alternator pulley is loose on shaft.	1. Check belt tension. 2. Check battery cables and connections. 3. Check battery conditions. 4. Tighten pulley. 5. Contact a Cummins Authorized Repair Facility.
8. Coolant loss - External	1. Coolant level is high. 2. Radiator cap is incorrect or defective. 3. External engine leak. 4. Radiator or cab heater is leaking.	1. Check coolant level. 2. Replace with correct radiator cap (15 psi). 3. Visually inspect the engine and components for seal or gasket leaks and repair. 4. Visually inspect the radiator, heater, hoses and connections for leaks and repair.

continued

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Problem	Cause	Correction
8. Coolant loss - External (Continued)	5. Engine is overheating.	5. Refer to Problems 9. and 10. of this troubleshooting chart. 6. Contact a Cummins Authorized Repair Facility.
9. Coolant temperature above normal (gradual overheat)	1. Coolant level is low. 2. Charge air cooler fins, radiator fins, or air conditioner condenser fins are damaged or obstructed with debris, insects, dirt, etc. 3. Radiator hoses are collapsed, restricted or leaking. 4. Fan drive belt or water pump belt is loose. 5. Incorrect oil level. 6. Cooling fan shroud is damaged. 7. Radiator cap is incorrect or defective. 8. Overconcentration of antifreeze and / or supplemental coolant additives. 9. Defective water pump. 10. Defective thermostat.	1. Inspect the engine and cooling system for external leaks. Repair as required. Add coolant as required. 2. Inspect the charge air cooler, air conditioner condenser, and radiator fins. Clean or repair as required. 3. Inspect and repair radiator hoses. 4. Check belt tension and tighten if necessary. 5. Add or drain engine oil as required. 6. Inspect shroud; repair or replace. 7. Replace with correct radiator cap (15 psi). 8. Use the correct antifreeze concentration (refer to the engine operation and maintenance manual). 9. Replace water pump. 10. Replace thermostat. 11. Contact a Cummins Authorized Repair Facility.
10. Coolant temperature above normal (sudden overheat) *continued*	1. Electronic fault codes are active. 2. **Coolant temperature sensor malfunction.** 3. Coolant level is low. 4. Radiator hoses are collapsed, restricted, or leaking. 5. Fan drive belt is broken. 6. Charge air cooler fins, radiator fins, or air conditioner condenser fins are damaged or obstructed with debris, insects, dirt, etc. 7. Radiator cap is incorrect or defective.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. **Check / clean sensor and coolant passage.** 3. Inspect for external leaks on engine and radiator, and make repairs. 4. Inspect and repair radiator hoses. 5. Replace drive belt. 6. Inspect the charge air cooler, air conditioner condenser, and radiator fins. Clean or repair as required. 7. Replace with correct radiator cap (15 psi).

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Problem	Cause	Correction
10. Coolant temperature above normal (sudden overheat) (Continued)	8. Defective water pump. 9. Defective thermostat.	8. Replace water pump. 9. Replace thermostat. 10. Contact a Cummins Authorized Repair Facility.
11. Coolant temperature below normal	1. Electronic fault codes are active. 2. **Coolant temperature sensor malfunction.** 3. **Engine operating at low ambient temperature.** 4. Temperature gauge malfunction. 5. Thermostat is incorrect or malfunctioning.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. **Check / clean sensor and coolant passage.** 3. 4. Test the gauge and replace if necessary. 5. Check thermostat and replace if necessary. 6. Contact a Cummins Authorized Repair Facility.
12. Engine acceleration or response is poor	1. Electronic fault codes are active. 2. **Engine operating at low ambient temperature.** 3. Air intake system or exhaust system leaks. 4. Fuel grade is not correct or fuel quality is poor.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. 3. Check for loose or damaged piping connections, and missing pipe plugs. Check the turbocharger and exhaust manifold mounting (Refer to the Cummins Engine Operation and Maintenance Manual. 4. Operate the engine from a tank of high-quality fuel (refer to the **Fuel and Lubricant Specifications** in the **Appendices**). 5. Contact a Cummins Authorized Repair Facility.
13. Engine decelerates slowly	1. Electronic fault codes are active. 2. Accelerator pedal is sticking.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Check for a sticking accelerator pedal. 3. Contact a Cummins Authorized Repair Facility.

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Problem	Cause	Correction
14. Engine difficult to start or will not start (no smoke from exhaust)	1. Electronic fault codes are active.	1. Refer to the **QSM11 Fault Code Information** chart in this section.
	2. Low fuel tank level.	2. Add fuel.
	3. Exhaust system is leaking hot air into engine compartment.	3. Check the exhaust plumbing for leaks or broken components.
	4. Fuel shutoff valve closed.	4. Repair fuel shutdown solenoid.
	5. Battery voltage supply to the electronic control system is low, interrupted, or open.	5. Check the battery connections. Check the fuses and the unswitched battery supply circuit.
	6. Fuel filter(s) are plugged.	6. Replace fuel filter(s).
	7. Fuel connection is loose on suction side of fuel pump.	7. Tighten all fuel fittings and connections from fuel tank to fuel pump.
	8. Starting motor rotation is incorrect.	8. Check direction of crankshaft rotation. Replace starting motor if necessary.
	9. Engine cranking speed too slow.	9. Check engine cranking rpm. Refer to Problem 26. of this troubleshooting chart.
	10. Loose wire on master disconnect switch.	10. Isolate and tighten wire.
		11. Contact a Cummins Authorized Repair Facility.
15. Engine difficult to start or will not start (exhaust smoke present)	1. Electronic fault codes are active.	1. Refer to the **QSM11 Fault Code Information** chart in this section.
	2. Batteries have drained or are defective.	2. Recharge or replace batteries.
	3. Fuel shutoff valve(s) is closed (electronically controlled injection).	3. Check the fuel shutoff valve and circuit.
	4. Fuse(s) malfunctioning.	4. Replace the fuse(s) in the OEM interface harness.
	5. Fuel filter(s) are plugged.	5. Replace fuel filter(s).
	6. Intake air or exhaust system is restricted.	6. Check intake air and exhaust systems for restrictions. Remove restrictions.
	7. Fuel grade is not correct or fuel quality is poor.	7. Operate the engine from a tank of high-quality fuel (refer to the **Fuel and Lubricant Specifications** in the **Appendices**).
	8. Engine cranking speed too slow.	8. Check engine cranking rpm. Refer to Problem 26. of this troubleshooting chart.
	9. Hydraulic pump is dead-headed.	9. De-energize hydraulic circuit.

continued

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Problem	Cause	Correction
15. Engine difficult to start or will not start (exhaust smoke present) (Continued)	10. Starting aid needed for cold weather or not working properly.	10. Check / repair or replace cold starting aid if necessary. 11. Contact a Cummins Authorized Repair Facility.
16. Engine noise excessive	1. Oil supply insufficient or oil pressure is low. 2. Lubricating oil is thin or diluted. 3. Coolant temperature is above normal. 4. Loose motor mount. 5. Fan belt is malfunctioning. a. Fan belt is too loose or too tight. b. Fan belt is not in alignment. 6. Damaged vibration damper. 7. Drive shaft is not in phase.	1. Check oil level. Refer to Problem 36. of this troubleshooting chart. 2. Refer to the **Fuel and Lubricant Specifications** in the **Appendices** for the proper type of oil to use. Refer to Problem 34. of this troubleshooting chart. 3. Refer to Problem 10. of this troubleshooting chart. 4. Inspect and tighten motor mounts. 5. a. Check the tension and adjust if needed. b. Check pulley alignment and adjust is necessary. 6. Check vibration damper and replace if required. 7. Reposition drive shaft. 8. Contact a Cummins Authorized Repair Facility.
17. Engine noise excessive (combustion knocks)	1. Poor fuel quality. 2. **Engine operating at low ambient temperature.**	1. Verify by operating from a temporary tank with good fuel. Clean and flush the fuel supply tanks, and use the proper fuel (refer to the **Fuel and Lubricant Specifications** in the **Appendices**). 2. 3. Contact a Cummins Authorized Repair Facility.
18. Engine power output low *continued*	1. Electronic fault codes are active. 2. Fuel suction line or fuel filter is restricted.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Replace fuel filter or check fuel line for restriction and replace if necessary.

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Problem	Cause	Correction
18. Engine power output low (Continued)	3. Oil level is too high.	3. Check oil dipstick and oil pan capacity. Adjust to the proper oil level.
	4. Intake or exhaust system is restricted.	4. Check intake and exhaust systems for restrictions. Remove restrictions.
	5. Air intake or exhaust leak.	5. Check for loose or damaged piping connections or missing pipe plugs. Check turbocharger and exhaust manifold mounting.
	6. Air in fuel.	6. Check for air in the fuel, and tighten fuel connections and filter.
	7. Fuel drain line restriction.	7. Check the fuel lines for restriction. Clear or replace the fuel lines.
	8. Fuel grade is not correct or fuel quality is poor.	8. Refer to Correction 1. of Problem 17. of this troubleshooting chart.
	9. Engine operating above recommended altitudes	9. Engine power decreases at 10,000 feet above sea level. 10. Contact a Cummins Authorized Repair Facility.
19. Engine runs rough at idle	1. **Engine operating at low ambient temperatures.**	1. Refer to the Cummins Engine Operation and Maintenance Manual.
	2. Electronic fault codes are active.	2. Refer to the **QSM11 Fault Code Information** chart in this section.
	3. Engine mounts are worn or damaged.	3. Visually check engine mounts and replace if necessary.
	4. Engine idle speed is set too low (electronically controlled fuel systems).	4. **Verify the correct idle speed setting.**
	5. Air in the fuel.	5. Check for air in the fuel, and tighten fuel connections and filter.
	6. Fuel grade is not correct or fuel quality is poor.	6. Refer to Correction 1. of Problem 17. of this troubleshooting chart.
	7. Overhead adjustments are incorrect.	7. Measure and adjust the overhead settings. Refer to the Cummins Engine Operation and Maintenance Manual. 8. Contact a Cummins Authorized Repair Facility.
20. Engine runs rough or misfires *continued*	1. Condition occurs only at idle.	1. Refer to Problem 19. of this troubleshooting chart.

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Problem	Cause	Correction
20. Engine runs rough or misfires (Continued)	2. Engine operating in low ambient temperatures. 3. Electronic fault codes are active. 4. Fuel leak. 5. Fuel grade is not correct or fuel quality is poor. 6. Air in the fuel. 7. Fuel filter(s) are plugged. 8. Overhead adjustments are incorrect. 9. Engine mounts are worn or damaged.	2. Refer to the Cummins Engine Operation and Maintenance Manual. 3. Refer to the **QSM11 Fault Code Information** chart in this section. 4. Check the fuel lines, fuel connections, and the fuel filters for leaks. 5. Refer to Correction 1. of Problem 17. of this troubleshooting chart. 6. Check for air in the fuel and tighten fuel connections and filter. 7. Replace fuel filter(s). 8. Measure and adjust the overhead settings. Refer to the Cummins Engine Operation and Maintenance Manual. 9. Visually check engine mounts and replace if necessary. 10. Contact a Cummins Authorized Repair Facility.
21. Engine shuts off unexpectedly or dies during deceleration	1. Electronic fault codes are active. 2. Battery voltage supply to the electronic control module (ECM) has been lost. 3. Engine will not restart. 4. Fuel inlet restriction or air in the fuel. 5. Low battery voltage. 6. Loose wire on master disconnect switch. 7. Fuel cutoff valve is closed. 8. Fuel grade is not correct or fuel quality is poor.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Check the battery connections. Check the fuses and the unswitched battery supply circuit. 3. Refer to Problems 14. and 15. of this troubleshooting chart. 4. Check fuel tank, fuel filter, fuel lines, connections and fuel cooling plate. 5. Check battery power supply circuits. 6. Isolate and tighten wire connection. 7. Check for loose wires and power to the fuel cutoff valve solenoid. 8. Refer to Correction 1. of Problem 17. of this troubleshooting chart. 9. Contact a Cummins Authorized Repair Facility.

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Problem	Cause	Correction
22. Engine speed surges at low idle or high idle	1. Electronic fault codes are active. 2. Low fuel level in the tank.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Fill fuel tank with fuel. 3. Contact a Cummins Authorized Repair Facility.
23. Engine speed surges under load or in operating range	1. Electronic fault codes are active. 2. Low fuel level in the tank.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Fill fuel tank with fuel. 3. Contact a Cummins Authorized Repair Facility.
24. Engine starts, but will not keep running	1. Electronic fault codes are active. 2. Low fuel level in tank. 3. Load on hydraulic pump. 4. Air in the fuel system. 5. Fuel filter plugged or fuel waxing due to cold weather. 6. Fuel inlet restriction. 7. Fuel grade is not correct or fuel quality is poor. 8. Intake or exhaust system is restricted. 9. Loose wire on master disconnect switch. 10. Engine protection circuit is active. 11. Fuel cutoff valve is closed.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Fill fuel tank with fuel. 3. Isolate and remove restriction from hydraulic circuit. 4. Check for air in fuel, tighten fuel connections and tighten fuel filter. 5. Replace fuel filter. Weather conditions can require fuel heater. 6. Inspect fuel line for restriction and replace if necessary. 7. Refer to Correction 1. of Problem 17. of this troubleshooting chart. 8. Check intake and exhaust for restriction and remove restriction. 9. Isolate and tighten wire connection. 10. Refer to the **Engine Protection System Troubleshooting** chart. 11. Check for loose wires and power to the fuel cutoff valve solenoid. 12. Contact a Cummins Authorized Repair Facility.
25. Engine vibration excessive *continued*	1. Electronic fault codes are active. 2. Engine is misfiring. 3. Engine idle speed is too low. 4. Fan is loose, damaged or unbalanced.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Refer to Problem 20. of this troubleshooting chart. 3. Adjust idle speed. 4. Check fan. Tighten, replace or adjust.

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Problem	Cause	Correction
25. Engine vibration excessive (Continued)	5. Engine belt driven accessories malfunctioning: fan hub, alternator, Freon compressor or air compressor. 6. Engine mounts are worn or damaged. 7. Damaged vibration damper.	5. Check for interference. Loosen belt, if applicable, to isolate component from vibration. 6. Visually check engine mounts and replace if necessary. 7. Check vibration damper and replace if required. 8. Contact a Cummins Authorized Repair Facility.
26. Engine will not crank or cranks slowly (OEM electrical)	1. Master disconnect switch is turned off. 2. Load on hydraulic pump. 3. Battery connections are broken, loose or corroded. 4. Low battery charge. 5. Battery rating is too low or battery is defective. 6. Shifter is not in the neutral position. 7. Circuit breaker (CB2, CB7 or CB10; Illustration **6-16**) is tripped or defective. 8. Circuit breaker (CB1) is defective. 9. Defective truck power solenoid (L1). 10. Defective neutral start relay (K1). 11. Defective starter solenoid (L2). 12. Defective starter. 13. Defective ignition switch (S1). 14. Defective fuel cutoff valve (L4). 15. Loose or broken wires, pins, or plugs between any of the components in Causes 1. thru 14.	1. Turn master disconnect switch on. 2. Isolate and remove restriction from hydraulic circuit. 3. Check for damage. Replace, tighten or clean. 4. Check electrolyte level and specific gravity. Recharge or replace batteries. 5. Replace with correct rated battery. 6. Place shifter in the neutral position. 7. Reset or replace circuit breaker (CB2, CB7 or CB10). 8. Replace circuit breaker (CB1). 9. Replace truck power solenoid (L1). 10. Replace neutral start relay (K1). 11. Replace starter solenoid (L2). 12. Replace or repair starter. 13. Refer to Component 4. of the **Component Troubleshooting** chart in **Section 6.** 14. Refer to **Fuel Solenoid Valve** found in **Section 2** for proper fuel cutoff valve operation. 15. Isolate and repair.

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Problem	Cause	Correction
27. Engine will not reach rated speed (rpm)	1. Electronic fault codes are active. 2. Engine power output is low. 3. Fuel grade is not correct or fuel quality is poor. 4. Fuel suction line is restricted. 5. Overhead adjustments are incorrect.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Refer to Problem 18. of this troubleshooting chart. 3. Refer to Correction 1. of Problem 17. of this troubleshooting chart. 4. Check fuel inlet for restriction. 5. Measure and adjust the overhead settings. Refer to the Cummins Engine Operation and Maintenance Manual. 6. Contact a Cummins Authorized repair facility.
28. Engine will not shut off	1. Ignition switch circuit is malfunctioning. 2. Engine is running on fumes drawn into air intake.	1. Check ignition key switch circuit. **NOTE:** Should an electrical malfunction prevent engine shutdown, turn the master disconnect switch off. 2. Locate and isolate the source of fumes.
29. Fuel consumption excessive	1. Oil level is too high. 2. Intake air restriction is excessive. 3. Fuel leaks.	1. Check oil dipstick and oil pan capacity. Adjust to the proper oil level. 2. Visually inspect air filter and restriction indicator. Replace air filter if necessary. 3. Visually check fuel system and supply for leaks. 4. Contact a Cummins Authorized Repair Facility.
30. Fuel in coolant	1. Bulk coolant supply contaminated.	1. Check coolant supply. Drain coolant and replace with non-contaminated coolant. Replace coolant filter. 2. Contact a Cummins Authorized Repair Facility.

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Problem	Cause	Correction
31. Fuel in the lubricating oil	1. Bulk oil supply is contaminated. 2. Engine idle time is excessive.	1. Check oil supply. Drain oil and replace with non-contaminated oil and replace filters. 2. Low oil and coolant temperatures can be caused by long periods of engine idling (time greater than 10 minutes). Shut off the engine rather than idle for long periods of time. 3. Contact a Cummins Authorized Repair Facility.
32. Intake manifold air temperature above specification	1. Truck speed too low for adequate cooling at high engine load. 2. Cooling fan shroud is damaged. 3. Fan drive belt is broken. 4. Charge air cooler fins, radiator fins, and Freon condenser fins are damaged or obstructed with debris, insects, dirt, etc. (external)	1. Reduce engine load. 2. Repair or replace shroud. 3. Check the fan drive belt and replace belt if necessary. 4. Inspect charge air cooler, radiator, and Freon condenser. Clean fins if necessary. 5. Contact a Cummins Authorized Repair Facility.
33. Lubricating oil consumption excessive	1. Verify oil consumption rate. 2. External oil leaks. 3. Oil does not meet specifications. 4. Crankcase ventilation system is plugged.	1. Check oil added versus hours. 2. Tighten capscrews, pipe plugs and fittings as needed. Replace gaskets if necessary. 3. Change oil and replace with the proper oil (refer to **Fuel and Lubricant Specifications** in the **Appendices**). 4. Check and clean crankcase breather and vent tube. 5. Contact a Cummins Authorized Repair Facility.
34. Lubricating oil contaminated *continued*	1. Identify contamination. 2. Bulk oil supply is contaminated. 3. Oil sludge is excessive.	1. Perform an oil analysis to determine the contaminants. 2. Check oil supply. Drain oil and replace with non-contaminated oil and replace filters. 3. Refer to Problem 37. of this troubleshooting chart.

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Problem	Cause	Correction
34. Lubricating oil contaminated (Continued)	4. Fuel in the oil.	4. Refer to Problem 31. of this troubleshooting chart. 5. Contact a Cummins Authorized Repair Facility.
35. Lubricating oil pressure (high)	1. Oil pressure switch, gauge or sensor is malfunctioning. 2. Engine coolant temperature is too low. 3. Oil does not meet specifications.	1. Verify that the oil pressure switch, gauge and sensor is functioning properly. 2. Refer to Problem 11. of this troubleshooting chart. 3. Change the oil with the proper type of oil (refer to the **Fuel and Lubricant Specifications** in the **Appendices**). 4. Contact a Cummins Authorized Repair Facility.
36. Lubricating oil pressure (low)	1. Electronic fault codes are active. 2. Incorrect oil level. 3. External oil leaks. 4. Oil pressure switch, gauge or sensor is malfunctioning. 5. Oil does not meet specifications. 6. Oil contaminated with coolant or fuel. 7. Oil filter(s) are plugged.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Add or drain engine oil. 3. Visually inspect for oil leaks. Tighten the capscrews, pipe plugs, and fittings. Replace gaskets if necessary. 4. Refer to Correction 1. of Problem 35. of this troubleshooting chart. 5. Change oil and filters. Refer to **Fuel and Lubricant Specifications** in the **Appendices** for the proper type of oil to be used. 6. Refer to Problem 34. of this troubleshooting chart. 7. Change oil and replace oil filter(s). 8. Contact a Cummins Authorized Repair Facility.
37. Lubricating oil sludge in the engine crankcase excessive	1. Bulk oil supply is contaminated. 2. Oil does not meet specifications.	1. Refer to Correction 2. of Problem 34. of this troubleshooting chart. 2. Change the oil with the proper type of oil (refer to the **Fuel and Lubricant Specifications** in the **Appendices**).

continued

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Problem	Cause	Correction
37. Lubricating oil sludge in the engine crankcase excessive (Continued)	3. Oil drain interval is excessive. 4. Fuel grade is not correct or fuel quality is poor. 5. Crankcase ventilation system is plugged.	3. Change oil and filter(s) at the appropriate intervals (refer to the **Preventive Maintenance** chart in the **Appendices**). 4. Refer to Correction 1. of Problem 17. of this troubleshooting chart. 5. Check and clean crankcase breather and vent tube. 6. Contact a Cummins Authorized Repair Facility.
38. Lubricating oil temperature above specification	1. Incorrect oil level. 2. Engine coolant temperature is above normal. 3. Oil pressure switch, gauge or sensor is malfunctioning.	1. Add or drain engine oil. 2. Refer to Problem 10. of this troubleshooting chart. 3. Refer to Correction 1. of Problem 35. of this troubleshooting chart. 4. Contact a Cummins Authorized Repair Facility.
39. Lubricating or transmission oil in the coolant	1. Bulk coolant supply contaminated.	1. Check coolant supply. Drain coolant, flush cooling system and replace with non-contaminated coolant. Replace coolant filter. 2. Contact a Cummins Authorized Repair Facility.
40. Excessive black smoke	1. Turbocharger wheel clearance is out of specification. 2. Air intake or exhaust leaks. 3. Fuel grade is not correct or fuel quality is poor. 4. Fuel drain line restriction.	1. Check the radial bearing clearance and axial clearance. Inspect the turbocharger. Repair or replace the turbocharger if necessary. 2. Check for loose or damaged piping connections or missing pipe plugs. Check turbocharger and exhaust manifold mounting. 3. Refer to Correction 1. of Problem 17. of this troubleshooting chart. 4. Check the fuel lines for restriction. Clear or replace the fuel lines. 5. Contact a Cummins Authorized Repair Facility.

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Problem	Cause	Correction
41. Excessive white smoke	1. Electronic fault codes are active. 2. Engine block heater malfunctioning (if equipped). 3. Coolant temperature is too low. 4. Engine is cold. 5. Fuel grade is incorrect or fuel quality poor. 6. Overhead adjustments are incorrect.	1. Refer to the **QSM11 Fault Code Information** chart in this section. 2. Check electrical source and wiring to cylinder block heater. Replace block heater if necessary. 3. Refer to Problem 11. of this troubleshooting chart. 4. Allow engine to warm to operating temperature. 5. Refer to Correction 1. of Problem 17. of this troubleshooting chart. 6. Measure and adjust the overhead settings. Refer to the Cummins Engine Operation and Maintenance Manual. 7. Contact a Cummins Authorized Repair Facility.
42. Intake manifold pressure (Boost) is below normal	1. Air intake or exhaust leaks. 2. Air compressor connection is loose or damaged.	1. Check for loose or damaged piping connections or missing pipe plugs. Check turbocharger and exhaust manifold mounting. 2. Check the connection between the manifold and the air compressor. Repair or replace if necessary. 3. Contact a Cummins Authorized Repair Facility.
43. Turbocharger leaks engine oil or fuel	1. Operating for extended periods under light or no load conditions. 2. Engine oil or fuel entering turbocharger. 3. Turbocharger drain line is restricted.	1. Refer to the Cummins Engine Operation and Maintenance Manual. 2. Remove intake and exhaust piping, and check for oil or fuel. 3. Remove the turbocharger drain line and check for restriction. Clean or replace the drain line. 4. Contact a Cummins Authorized Repair Facility.

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Cummins QSM11-C330 Diesel Engine

Engine Operating Conditions		2100 rpm	
Lubrication System		**English**	**Metric**
Lubricating oil pressure (min. / max. at rated speed) . . . . . psi (kPa)		15 - 35	103 - 241
Minimum for safe operation (at idle) . . . . . psi (kPa)		10	69
*Lubrication oil temperature maximum . . . . . °F (°C)		275	135
Oil pan capacity High / Low . . . . . qt (L)		36 / 28	34 / 26.5
Total engine oil capacity with filters . . . . . qt (L)		39.2	37
Air System			
Air inlet restriction, full load maximum	Dirty air cleaner . . . . . in H_2O (mm H_2O)	25	635
	Clean air cleaner . . . . in H_2O (mm H_2O)	15	381
Exhaust back pressure maximum full load . . . . . in Hg (mm Hg)		3.0	76
Max. allowable air temp. rise over ambient at turbo compressor inlet . °F (°C)		30	16
Fuel System			
Maximum fuel inlet restriction	Dirty fuel filter . . . . . in Hg (mm Hg)	8	203
	Clean fuel filter . . . . . in Hg (mm Hg)	4	102
Maximum fuel drain restriction less check valves . . . . . in Hg (mm Hg)		2.5	63
Maximum fuel flow (on supply side of fuel pump) . . . . . lb/hr (kg/hr)		540	245
Cooling System			
Coolant flow	Normal temp. . . . . °F (°C)	190	88
	Full load speed . . . . . gal/min (L/sec)	62	3.9
Engine coolant capacity . . . . . qt (L)		13.6	12.9
Min. pressure cap . . . . . psi (kPa)		7	48
Max. pressure cap . . . . . psi (kPa)		15	103
Max. top tank temperature . . . . . °F (°C)		212	100
Min. top tank temperature . . . . . °F (°C)		160	71
Thermostats	Start to open . . . . . °F (°C)	180	82
	Fully open . . . . . °F (°C)	200	93

*The lubricating oil temperature range is based on the temperature measurement in the oil gallery. When measuring the oil temperature in the pan, it will normally be approximately 10°F higher than the oil gallery temperature.

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Illustration 1-6. Cummins QSM11-C330 Engine Electrical Wiring ANSI Circuit

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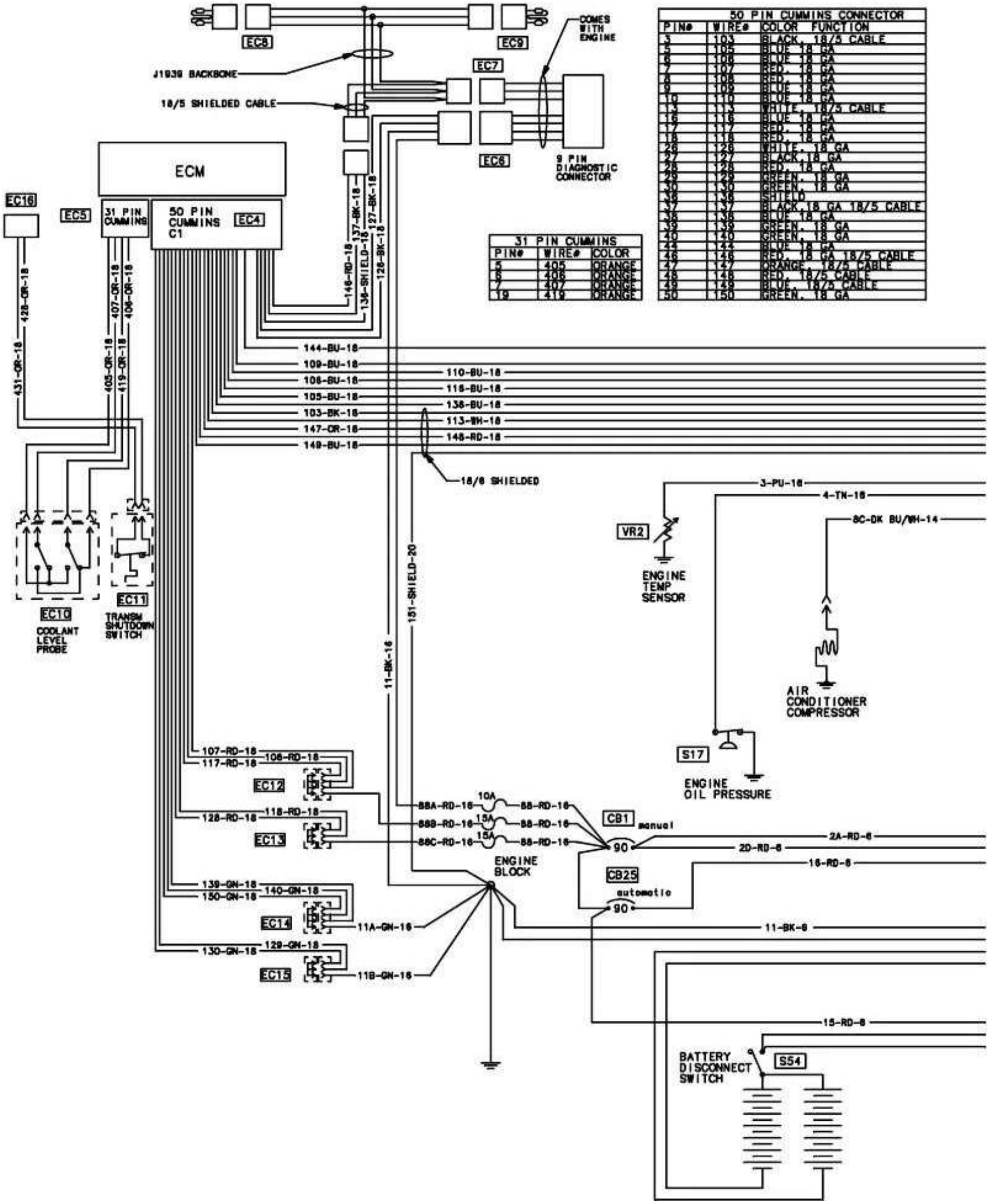

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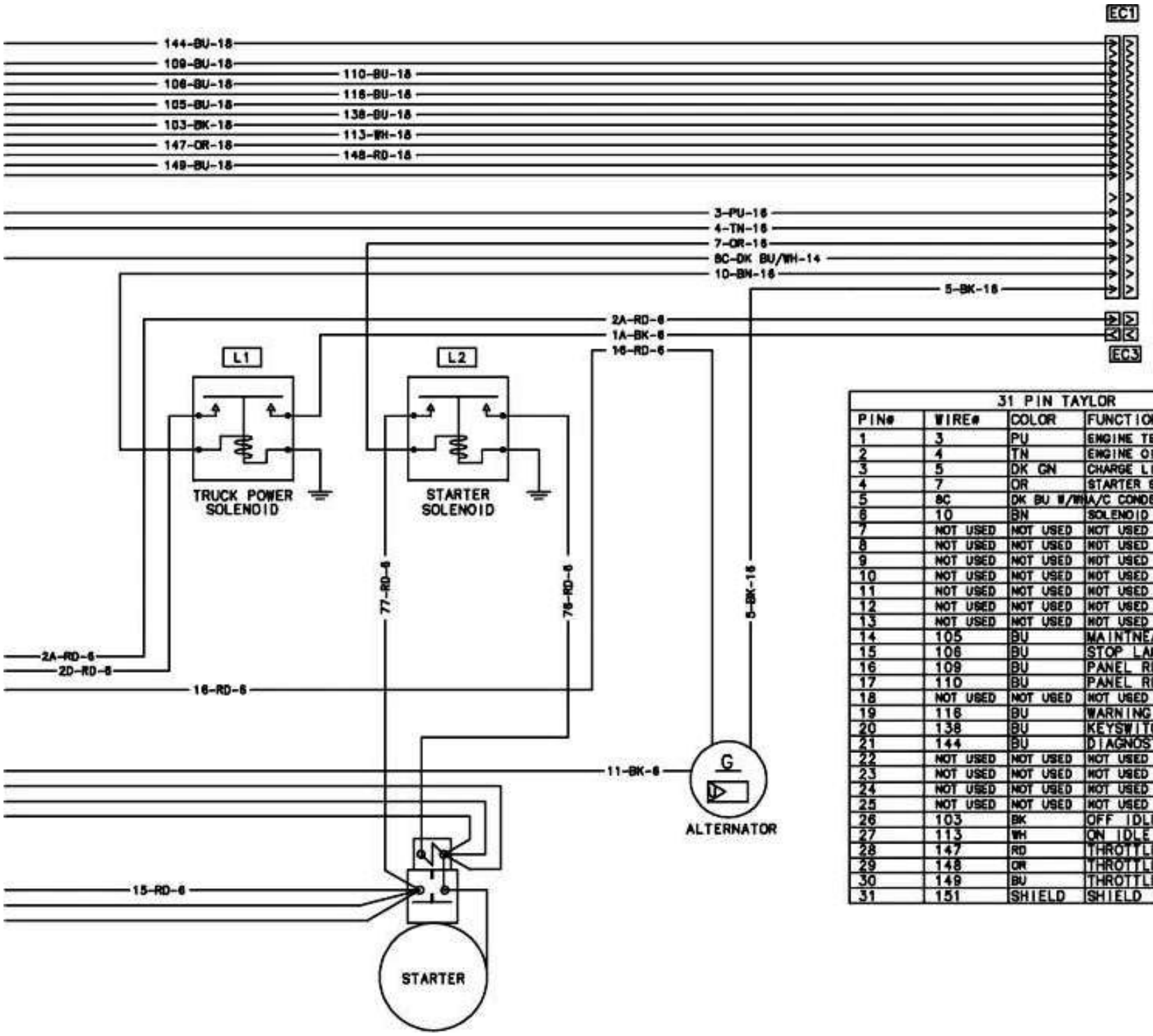

31 PIN TAYLOR			
PIN#	WIRE#	COLOR	FUNCTION
1	3	PU	ENGINE TEMP
2	4	TN	ENGINE OIL PRESSURE
3	5	DK GN	CHARGE LIGHT
4	7	OR	STARTER SOLENOID
5	8C	DK BU W/WH	A/C CONDENSOR
6	10	BN	SOLENOID CONTROL
7	NOT USED	NOT USED	NOT USED
8	NOT USED	NOT USED	NOT USED
9	NOT USED	NOT USED	NOT USED
10	NOT USED	NOT USED	NOT USED
11	NOT USED	NOT USED	NOT USED
12	NOT USED	NOT USED	NOT USED
13	NOT USED	NOT USED	NOT USED
14	105	BU	MAINTNEANCE LAMP
15	106	BU	STOP LAMP
16	109	BU	PANEL RETURN
17	110	BU	PANEL RETURN
18	NOT USED	NOT USED	NOT USED
19	116	BU	WARNING LAMP
20	138	BU	KEYSWITCH ON
21	144	BU	DIAGNOSTIC ENABLE
22	NOT USED	NOT USED	NOT USED
23	NOT USED	NOT USED	NOT USED
24	NOT USED	NOT USED	NOT USED
25	NOT USED	NOT USED	NOT USED
26	103	BK	OFF IDLE SWITCH
27	113	WH	ON IDLE SWITCH
28	147	RD	THROTTLE POSITION
29	148	OR	THROTTLE SUPPLY (+)
30	149	BU	THROTTLE RETURN (-)
31	151	SHIELD	SHIELD

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PLACE THE FOLLOWING ILLUSTRATIONS IN FOLDER ENVELOPES:

Illustration 1-7 - CUMMINS QSM11 ECM CIRCUIT

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Fuel System

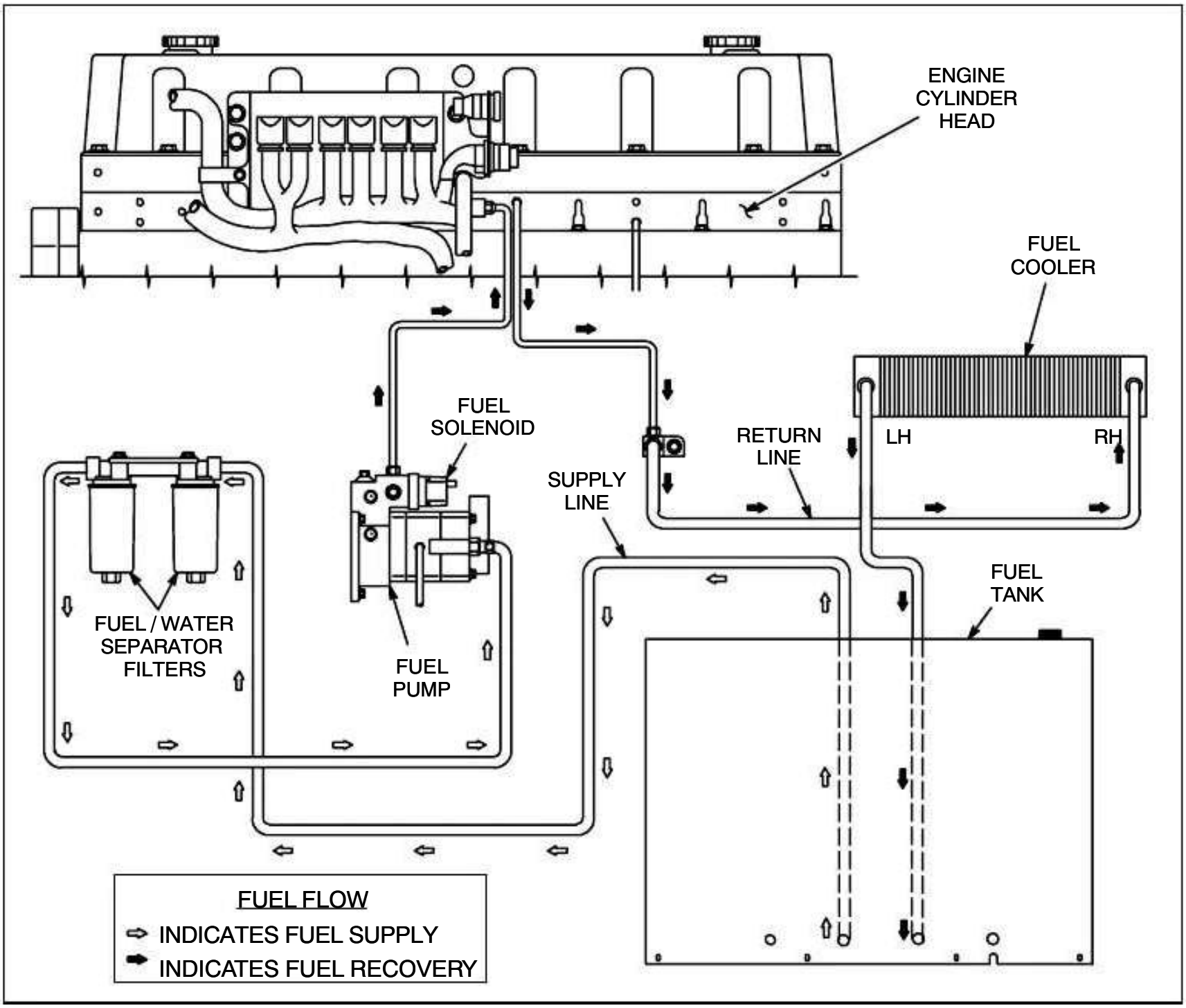

Illustration 2-1. Fuel System

Introduction. Fuel is drawn from the tank through the fuel / water separator filters by the fuel pump. From here, the fuel is sent to the fuel injectors. Unused fuel is returned through the fuel cooler and into the fuel tank.

Major Components (Illustration 2-1)**.** The fuel system consists of a fuel tank, two fuel / water separator filters, fuel pump, fuel solenoid valve, fuel cooler, fuel injectors and fuel lines.

Fuel Solenoid Valve (Illustration 2-1). The fuel solenoid valve, located on the fuel pump itself, controls the on / off flow of fuel to the fuel injectors. The fuel solenoid valve is normally closed and requires a 12 VDC signal to energize the coil, shifting the spool to the open state. This allows the fuel to flow to the injector pump.

Adding Fuel (Illustration 2-3)**.** When adding diesel fuel to the fuel tank, make sure the fuel strainer is in the filler neck and free of debris. Adding fuel with the strainer removed could lead to debris entering the fuel tank, resulting in poor engine performance.

Fuel Cooler (Illustration 2-1)**.** The fuel cooler, located inside the radiator shroud, is forced-air

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cooled. Fuel is circulated through its tubes and the engine fan circulates air across the cooler and through the fins, cooling the fuel before it returns to the fuel tank.

Changing the Fuel / Water Separator Filters (Illustration 2-2). With the engine shut down, perform the following procedures to replace the fuel / water separator filters. They should be changed every 250 hours or more often if conditions warrant.

CAUTIONS:

- **Dispose of used fuel / water separator filters and drained fuel in accordance to federal and local regulations.**
- **Mechanical tightening of the fuel / water separator filter may result in seal and / or cartridge damage. Tighten the fuel / water separator filter by hand only.**

1. Provide a suitable container to catch drained fuel and use a strap wrench to remove the fuel / water separator filters from the filter base.
2. Clean the area around the filter heads.
3. Remove the fuel filter thread adapter sealing rings.
4. Clean the gasket surface of the fuel filter head with a lint free cloth.
5. Install the new thread adapter sealing rings on the fuel filter head.
6. Fill new filters with clean fuel and lubricate the filter seals with clean oil.
7. Install filters and tighten them 1/2 turn after the seals contact the filter head surface.

General Information

Fuel Capacity	240 Gallons

Draining The Fuel / Water Separator Filters (Illustration 2-2). The fuel / water separator filters should be drained daily to remove water and sediments from the fuel. Perform the following procedures to drain the water from the fuel / water separator filters.

CAUTIONS:

- **Dispose of drained fuel in accordance to federal and local regulations.**
- **Do not overtighten the drain valve. Overtightening may cause thread damage.**

1. Provide a suitable container to catch drained water and open the drain valve approximately 1-1/2 to 2 turns until draining occurs. Drain each fuel / water separator filter of water until clear fuel is visible.
2. Once the water has drained, turn the valve clockwise to close the drain valve.

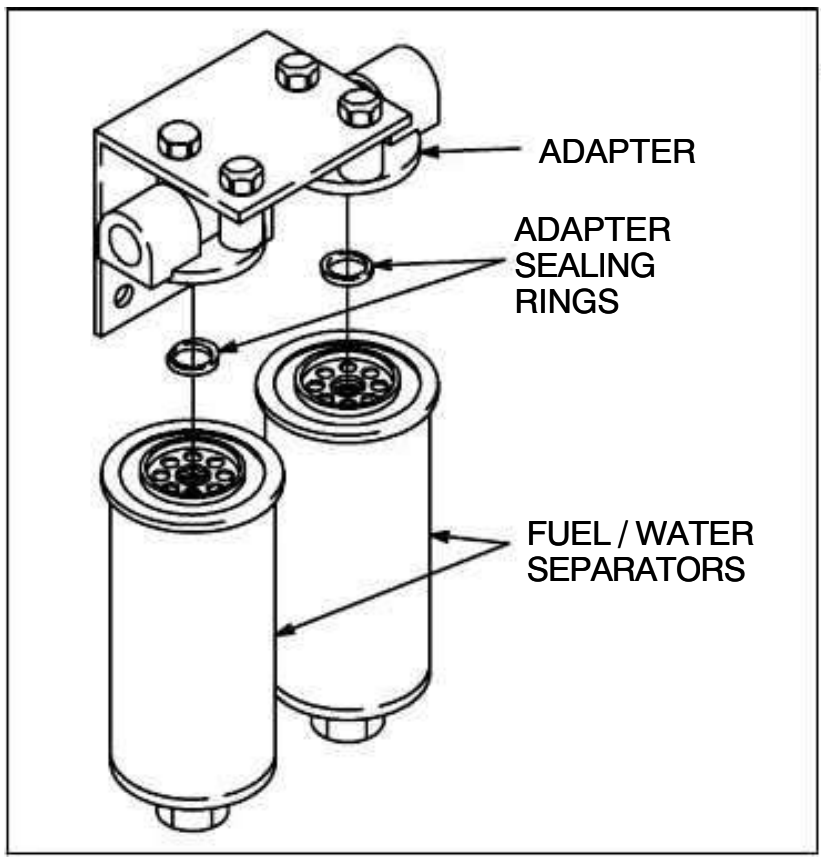

Illustration 2-2. Fuel / Water Separator Filters

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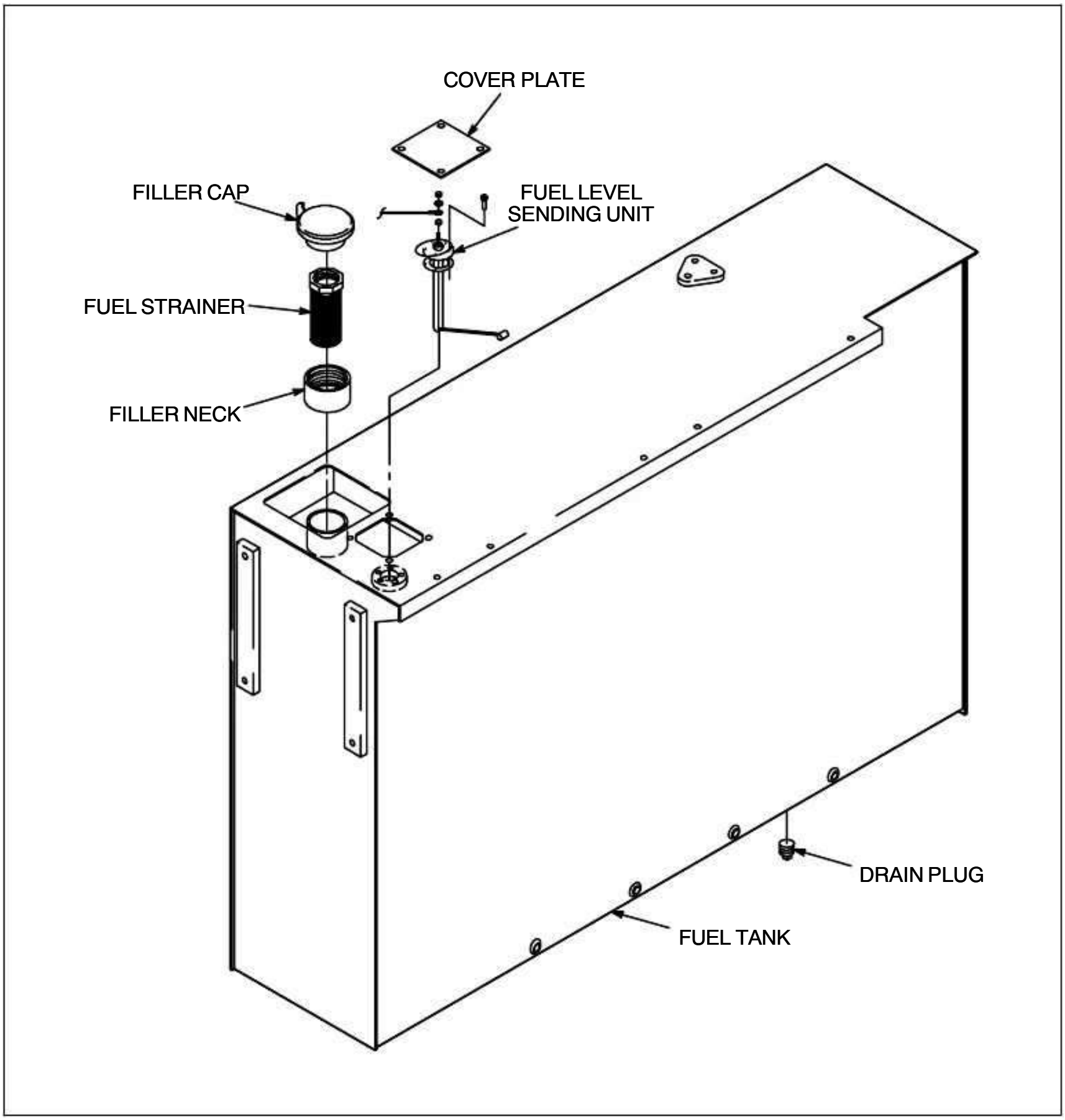

Illustration 2-3. Fuel Tank

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Air Intake System

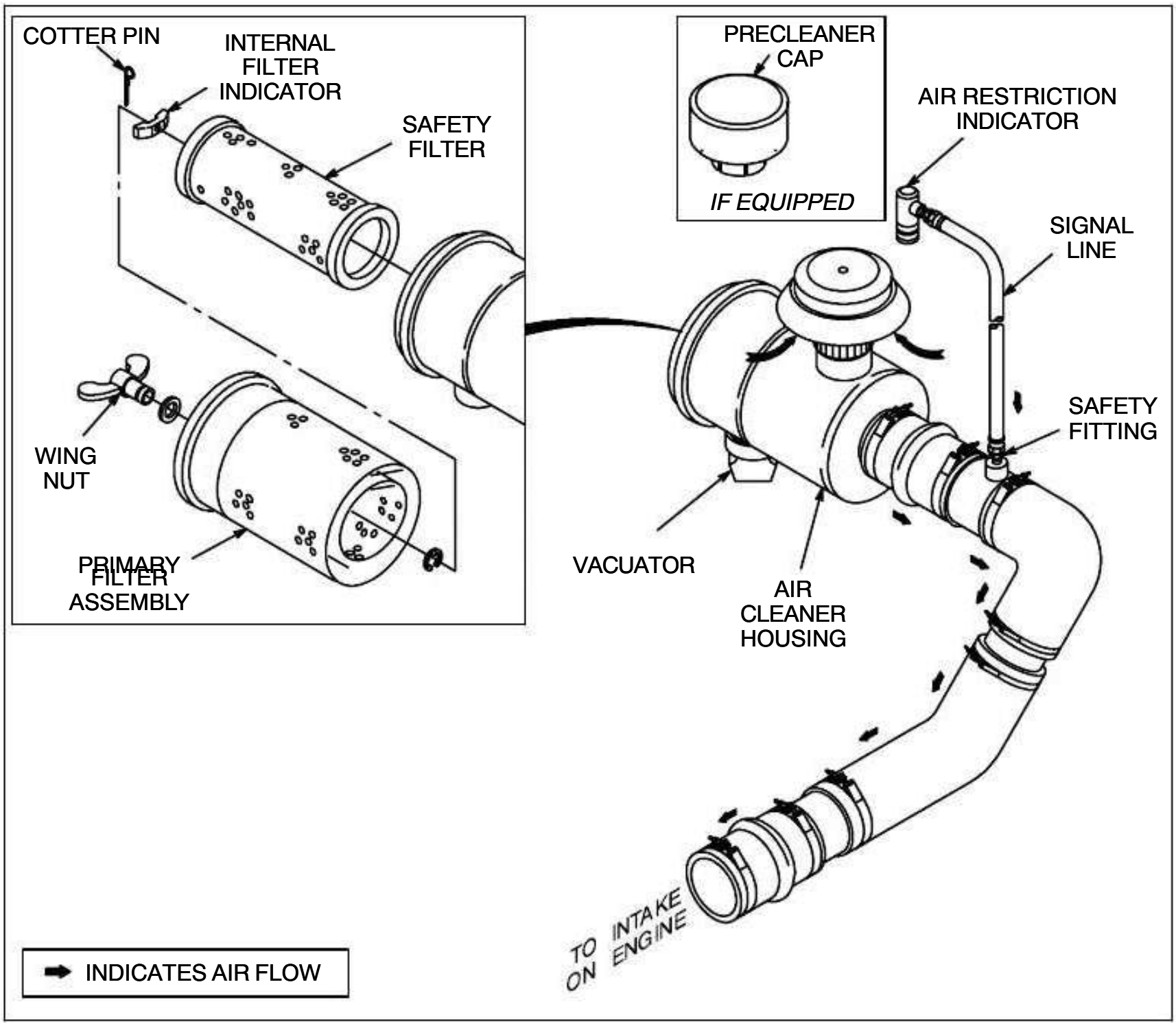

Illustration 3-1. Air Intake System Components

Introduction. The air cleaner is designed to be serviced efficiently and quickly. Intake air enters the air cleaner through the cap or optional precleaner. When the air reaches the filter body, a helical ramp imparts a high-speed circular motion to the intake air. This action separates up to 85% of the dust from the air by centrifugal action. The dust is then forced out the vacuator. The air then passes through the primary and safety elements, where it is cleaned, before entering the engine.

Major Components (Illustration 3-1)**.** The air cleaner consists of the primary filter element, internal filter indicator, safety element, air cleaner housing, cap (or optional precleaner), vacuator and an air restriction indicator.

Servicing (Illustration 3-1)**.** If the equipment is being operated under extremely dusty conditions, the vacuator should be checked every day to be certain it is not clogged. Perform the following procedures to service the filter element and air

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cleaner components. Overservicing of the filter elements is not recommended. Filter element efficiency increases with initial operation.

CAUTIONS:

- **Normally the primary filter element should be changed after 1500 hours of operation or when the air restriction indicator shows red. In dusty conditions, the primary filter element may have to be changed more often.**
- **Replace the safety element when the internal filter indicator turns red, yearly or every 3000 hours, whichever comes first.**
- **Do Not use ether type fuels to help start the engine for this may damage the engine.**

1. When the air restriction indicator indicates element servicing is required, remove the wing nut and cover assembly, then remove the primary filter assembly. In high humidity situations, the air restriction indicator may indicate a restricted condition due to moisture in the filter element. When the element dries out, restriction levels drop back to normal. The indicator will now have to be reset (refer to procedure 9. to reset the indicator).
2. Check the internal filter indicator to determine if the safety element also requires servicing.
3. If the internal filter indicator indicates a green dot in its center (Illustration 3-2), the safety element is good, continue to procedure 6.
4. If the internal filter indicator indicates red, the safety filter element must be replaced.

   Remove internal filter indicator, old safety filter and replace with a new safety filter element.
5. Reset the internal filter indicator by applying suction to window and re-install indicator.
6. Remove all dust and foreign particles from the air cleaner components, and clean the inside of the air cleaner housing with a damp cloth.

CAUTION: Do not use flammable liquids to clean the inside of the air cleaner housing. Only use a cloth dampened with water.

7. Replace the primary filter element with a new filter element. Remove clip from the used primary filter element to release the wing nut and washer.
8. Re-install wing nut, washer and clip on replacement primary filter element. Re-install and secure the primary filter assembly in the air cleaner housing.
9. Push the reset button on the top of the air restriction indicator.
10. Inspect air intake system for leaks.
11. Inspect rubber elbow, joints and clamps for wear, damage and looseness.
12. Inspect the vacuator cup joint for sealing.

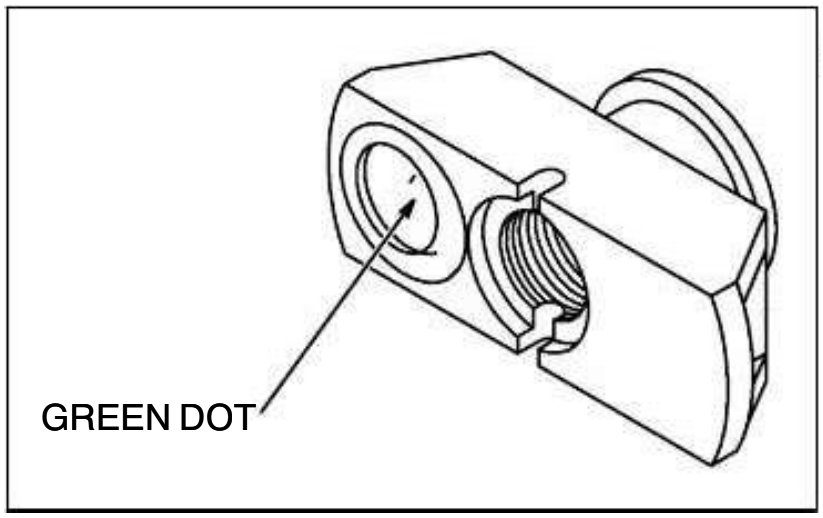

Illustration 3-2. Internal Filter Indicator

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Air Intake System Troubleshooting

Problem	Cause	Correction
1. Short element life (primary filter element)	1. Improper assembly when prior element was replaced. 2. Damaged or missing vacuator. 3. Damaged seal on the cover. 4. Damaged air cleaner body. 5. Loose system connections. 6. Loose wing nut on cover. 7. Excessively dusty environment. 8. Incorrect element used. 9. Seal on dust cover is not sealing.	1. Properly install. 2. Replace vacuator. 3. Replace seal on the cover. 4. Replace air cleaner body. 5. Tighten system connections. 6. Tighten wing nut. 7. Replace element as needed. 8. Replace with proper element. 9. Ensure that no foreign object is between seal and metal mating surface.
2. Short element life (safety element)	1. Bypassing primary filter element. a. Seal of primary filter element is not sealing. b. Damaged primary element. c. Loose primary filter element wing nut.	1. a. Replace element. b. Replace primary filter element. c. Tighten wing nut.
3. Airborne contaminants entering the engine	1. Damaged element(s). 2. Damaged seals or sealing surfaces. 3. Damaged or loose connections between air cleaner body and engine. 4. Incorrect element used.	1. Replace element(s). 2. Replace damaged components. 3. Replace or repair connections. 4. Replace with proper element.
4. Air restriction indicator indicates green condition and primary filter element is clogged	1. Restriction in air hose between the air restriction indicator and the safety fitting. 2. Air leak in air hose between the air restriction indicator and the safety fitting. 3. Damaged air restriction indicator. 4. Damaged safety fitting. 5. Loose system connections.	1. Remove restriction. 2. Repair or replace air hose. 3. Replace air restriction indicator. 4. Replace safety fitting. 5. Tighten connections.

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Exhaust System

Introduction. The exhaust system is responsible for venting exhaust gases, generated by the engine, to the atmosphere. It also provides noise suppression.

WARNINGS:

- **Do not service exhaust system until exhaust system is cool. Failure to do so may result in severe burns.**
- **Keep all flammable materials away from exhaust components.**
- **Avoid breathing toxic exhaust fumes.**
- **All internal combustion engines produce carbon monoxide, which can become concentrated in enclosed areas. Exposure to carbon monoxide can result in serious injuries or health hazards, including death. Properly ventilate work areas, vent exhaust fumes, and keep shop clean and dry.**

  (A) Initial symptoms of carbon monoxide poisoning include headaches, dizziness, and nausea. The smell of lift truck exhaust means carbon monoxide is present.

  (B) If you experience initial symptoms, shut off the lift truck engine, notify your employer, and obtain medical attention.

- **Never rely on a control device to reduce carbon monoxide output. Carbon monoxide levels can change depending on maintenance. Make sure carbon monoxide level testing is included in regular maintenance procedures and that ventilation is used as the primary control for emissions.**

Maintenance. There is minimal maintenance required on the standard exhaust system.

1. Check for leaks at all pipe connections.
2. Check for holes in the muffler and exhaust piping.
3. Keep guard clean and in place.
4. Keep exhaust system free of debris.

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Cooling System

Introduction. The cooling system cools the engine. Refer to **Section 9A** for transmission cooling and **Section 15C** for the wet disc brakes cooling system to find more detailed cooling information on these particular systems.

Major Components (Illustration 5-5)**.** The engine cooling system consists of coolant, radiator / charge air cooler, piping connecting the radiator to the engine and a water pump to circulate the coolant. A coolant filter, remote mounted, is used to filter and condition the coolant.

Operation (Illustration 5-5)**.** When the engine is started, the water pump draws coolant from the radiator into the engine block. The coolant is circulated through the engine and the coolant filter until it reaches a temperature of approximately 180°F, at which point the thermostat will start to open. This will allow coolant flow back into the top of the radiator core. Air trapped in the coolant will travel to the top of the deairation space by means of the deaeration line and an internal deaeration stand tube. Coolant is made available from the deaeration tank to displace the removed air by way of the make-up line.

Coolant. The cooling system of this equipment is protected to -34°F (-36°C) and 228°F (108.9°C). The solution is a 50 - 50 mixture of ethylene glycol base antifreeze to water solution. Use soft water in the coolant mixture. It is recommended that 50% solution be maintained year round.

A proper coolant / SCA (Supplemental Coolant Additive) additive concentration must be maintained to prevent liner pitting, corrosion and scale deposits in the cooling system. Refer to the Cummins QSM11 Engine Operation and Maintenance Manual for coolant additive concentration. The coolant additive concentration level may be tested with a coolant test kit, Taylor part number 1006-175.

⚠ **CAUTION: Insufficient concentration of the coolant additives will result in liner pitting and engine failure.**

Coolant Filter (Illustration 5-1)**.** The coolant filter is used in the cooling system to control the water acidity, soften the water to reduce scale formation, filter out suspended materials and add a corrosion inhibiting chemical to the coolant which provides a protective film on the water passages.

⚠ **CAUTION: Coolant containing anti-leak additives must not be used with the coolant filter because it will clog the element.**

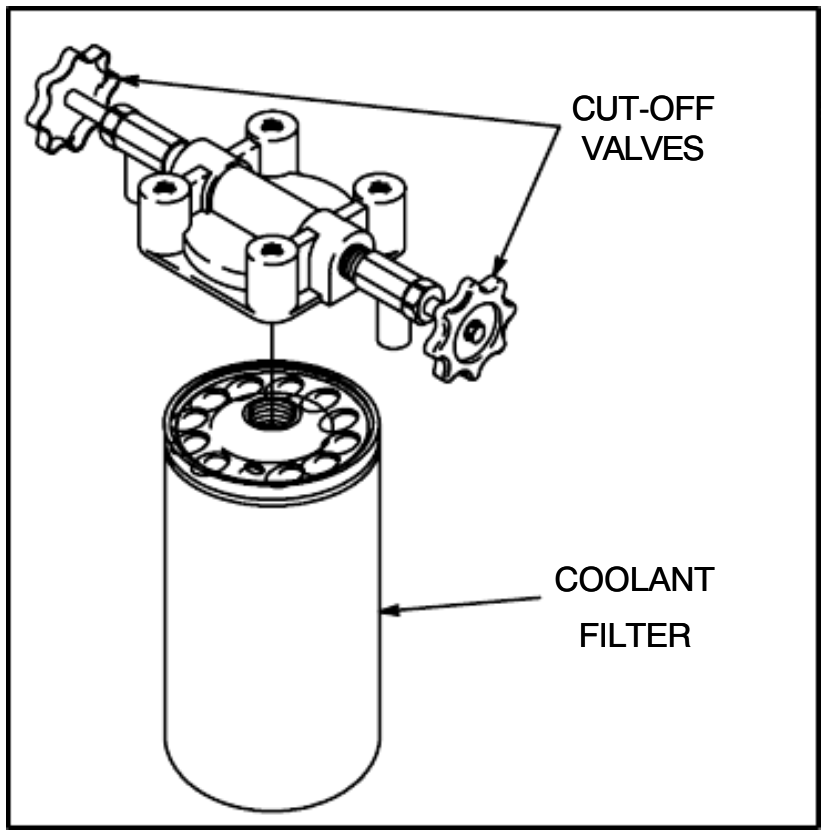

Illustration 5-1. Coolant Filter

Radiator / Charge Air Cooler (Illustration 5-4)**.** The radiator is comprised of a deaeration tank, core, and a charge air cooler. The deaeration tank functions as a coolant storage tank. When adding coolant to the system, coolant should be added to the deaeration tank. Access to the deaeration tank is supplied through a 7 psi radiator cap located on the left side of the radiator, above the radiator sight glasses. The radiator coolant level is to be maintained by the coolant sight glasses below the 7 psi radiator cap.

The radiator is force-air-cooled. Access to the core is supplied through a 15 psi radiator cap located on the right side of the radiator. When the cooling system has been completely drained, the 15 psi radiator cap neck will allow a quicker, more efficient method of refilling the cooling system.

Charge Air Cooler (Illustration 5-4)**.** The QSM11 engine is equipped with a trubocharger. The turbocharger is driven by the exhaust from the engine. The exhaust turbine of the turbocharger is coupled to the intake turbine. The exhaust turbine drives the intake turbine. The intake turbine com-

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presses the intake air. The act of compressing the intake air generates heat and causes the air molecules to expand. To increase combustion efficiency, a charge air cooler is integrated into the radiator. The charge air cooler is an air to air cooler. By reducing the temperature of the intake air before it enters the piston chamber, the air becomes denser (the air molcules get smaller). The denser the air, the more oxygen that will be present in the piston chamber during combustion. The more oxygen in the chamber, the hotter the combustion cycle becomes. This results in a more complete burning of the fuel, emitting fewer pollutants. This increase in combustion efficiency also creates lower engine operating temperatures, which pro-long the life of the engine and it's components.

Checking The Coolant Level (Illustration 5-2)**.** The coolant level should be checked daily with the engine cool. The coolant level is full when the coolant is visible at the center of the upper coolant sight glass on the radiator. If the coolant level is visible at the lower coolant sight glass, add coolant until the coolant level is visible at the center of the upper coolant sight glass on the radiator.

Cooling Requirements. The following requirements must be followed for trouble-free operation of the cooling system.

1. Always use a properly corrosion inhibited coolant.
2. Maintain prescribed inhibitor strength.
3. Use low silicate antifreeze with an ethylene glycol base.
4. Always follow the manufacturer's recommendations on inhibitor usage and handling. Refer to the engine operation and maintenance manual for coolant requirements.
5. Do Not use soluble oil!
6. Sealer type antifreeze should Not be used.

Changing the Coolant Filter. Refer to the engine operation and maintenance manual for the coolant filter change interval. Perform the following procedures to replace the coolant filter.

WARNING: Shut down the engine and allow the engine to cool before changing the coolant filter.

CAUTIONS:

- **Dispose of coolant filter in accordance with federal and local regulations.**
- **Do not use a strap wrench to tighten the coolant filter. Mechanical over-tightening may distort the threads or damage the filter gasket.**

1. Close both cut-off valves (Illustration 5-1).
2. Remove the coolant filter. It may be possible to unscrew the coolant filter by hand; however, a band type filter wrench may be used if necessary.
3. Clean the gasket surface of the filter base.
4. Apply a light film of lubricating oil to the gasket sealing surface of the new coolant filter.
5. Screw the new coolant filter onto the filter base until the gasket comes in contact with the filter base and then tighten filter 1/2 to 3/4 turn by hand only.
6. Open the cut-off valves.
7. Start up engine and check for leaks at the coolant filter base.

Draining / Flushing The Cooling System. The cooling system should be drained and flushed every 2 years or 6000 hours, whichever comes first. The cooling system is drained by opening the drain cock on the bottom of the radiator. Removal of the 15 psi radiator cap will allow air to enter the cooling passages, decreasing drain time and ensuring that the coolant drains completely from the system. Leave the drain cock open until all coolant has been allowed to drain from the system.

WARNINGS:

- **Shut down the engine and allow the engine to cool before opening the radiator cap and the drain cock to drain the cooling system.**
- **Coolant should only be added to the cooling system when the engine has been shut down and allowed to cool. Failure to do so may result in personal injury from heated coolant spray.**
- **Dispose of coolant in accordance with federal and local regulations.**

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CAUTION: When freezing weather is expected, any cooling system not adequately protected by antifreeze should be drained.

Filling The Cooling System. Before starting the engine, close the drain cock of the radiator and fill the cooling system. Remove the 15 psi radiator cap and fill the core of the radiator. Remove the 7 psi cap and fill the deaeration tank to the upper sight glass. Start the engine to remove air from the coolant. Recheck the coolant level at the sight glasses and add coolant as required to obtain the proper level.

WARNING: Coolant should only be added to the cooling system when the engine has been shut down and allowed to cool. Failure to do so may result in personal injury from heated coolant spray.

CAUTION: The 15 psi radiator cap is a sealing cap. Be sure it is installed securely after the coolant has been added.

Coolant Temperature. When the engine warms up, the indicator for the coolant temperature gauge should be in the green temperature area (180°F - 210°F). The thermostat will start to open at approximately 180°F and fully open when the coolant temperature reaches approximately 201°F.

General Information

Coolant Capacity	17 Gallons

Inspection. Components of the cooling system should be checked periodically to keep the engine operating at peak efficiency. The radiator should be inspected externally for excessive dirt or oil buildup. The radiator should be cleaned externally as conditions warrant. The cooling system hoses should be inspected and any hose that is abnormally hard or soft should be replaced immediately. Check the hose clamps to make sure they are tight. All external leaks should be corrected as soon as detected. The shroud should be tight against the radiator core to prevent recirculation of air which may lower cooling efficiency. Check the fan belts for proper tension.

Drive Belt Tension. The proper tension should be maintained on all drive belts. Refer to **Drive Belt Tension** in **Section 1** for the proper tension values.

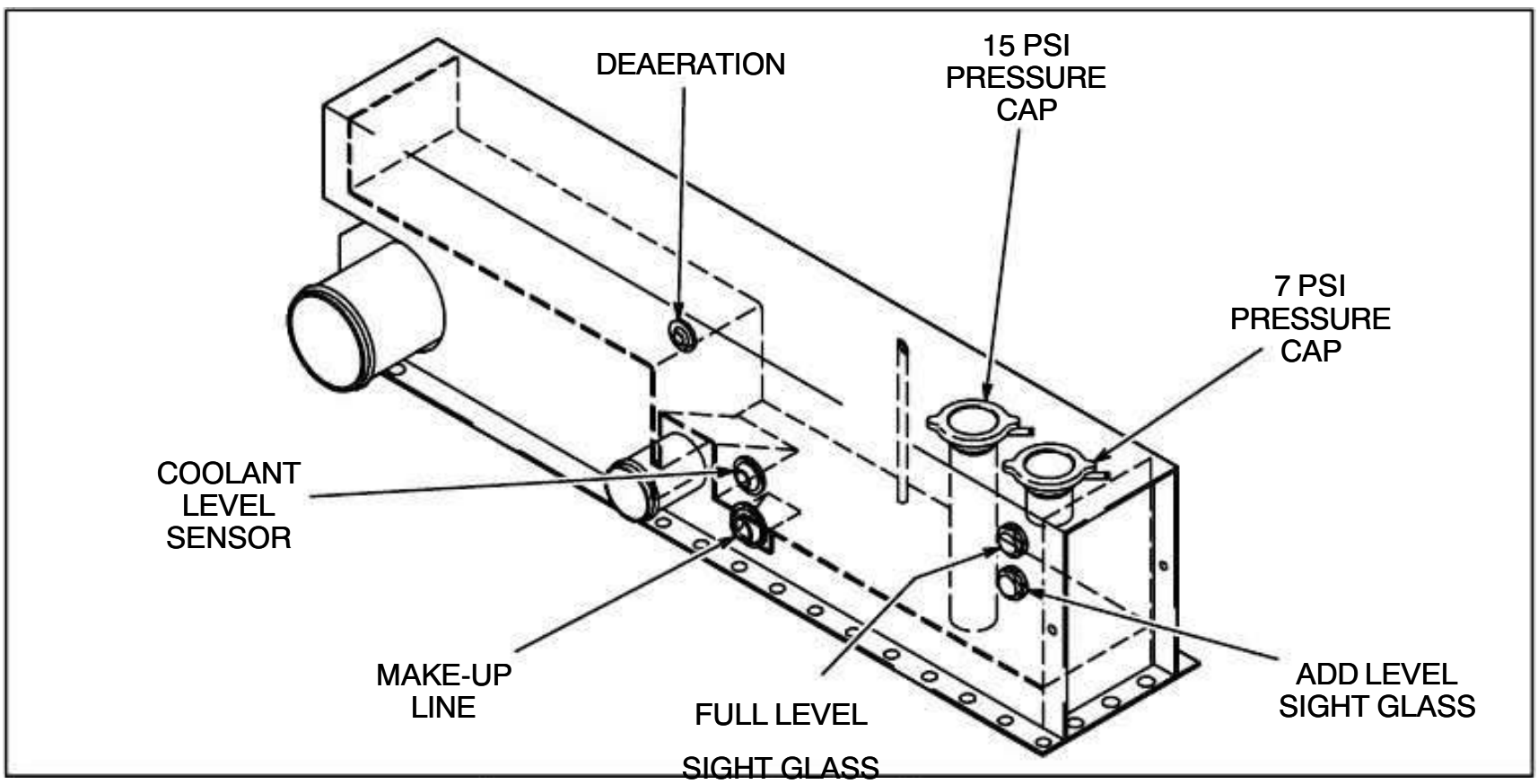

Illustration 5-2. Checking The Coolant Level

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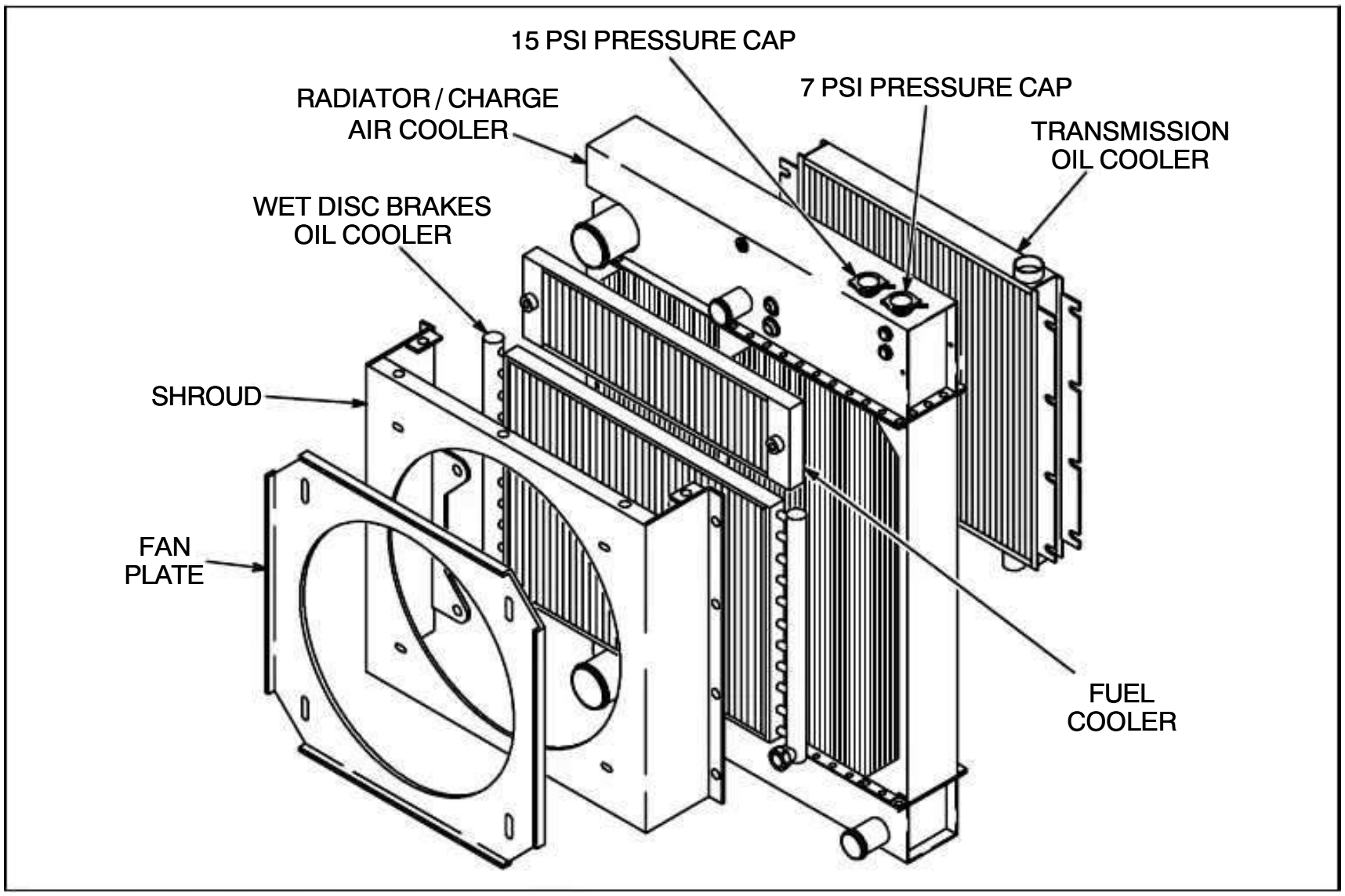

Illustration 5-3. Cooling Components Identification

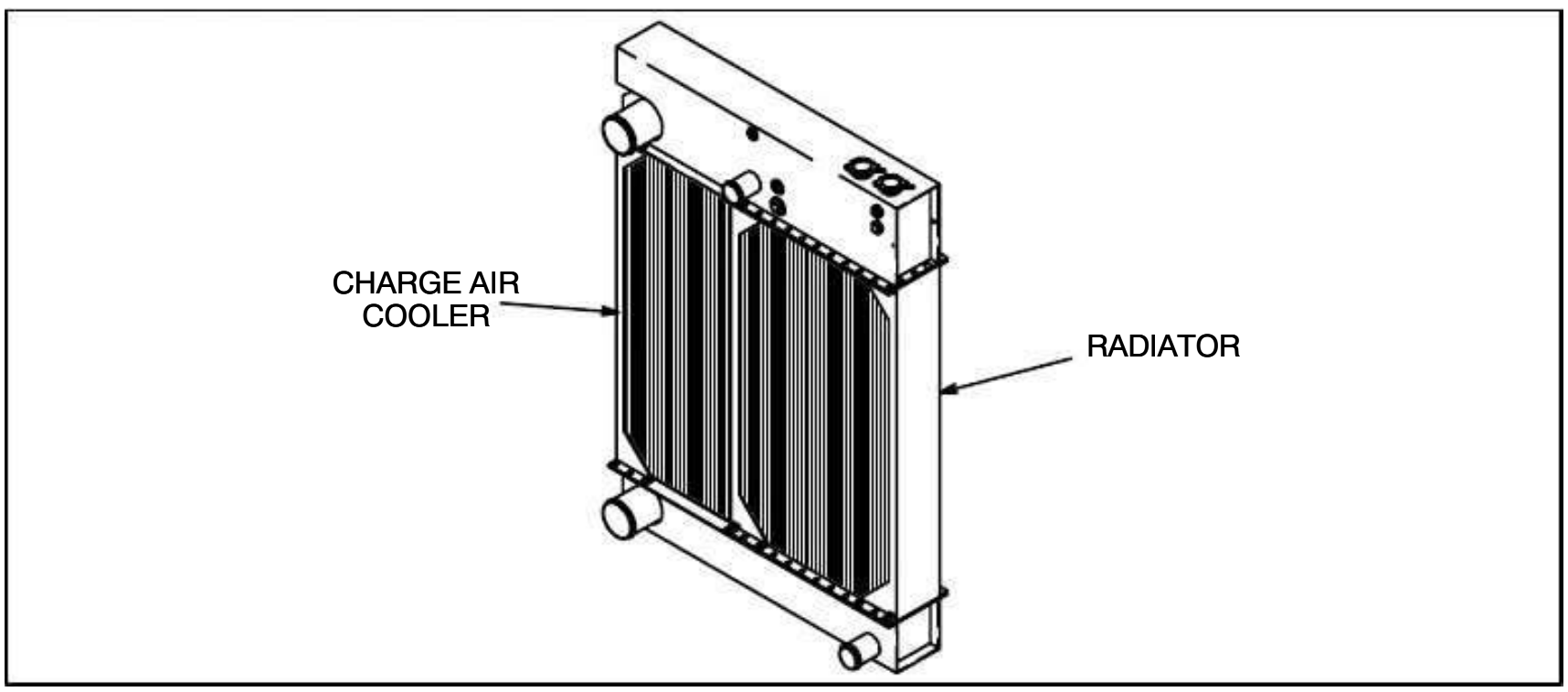

Illustration 5-4. Radiator / Charge Air Cooler

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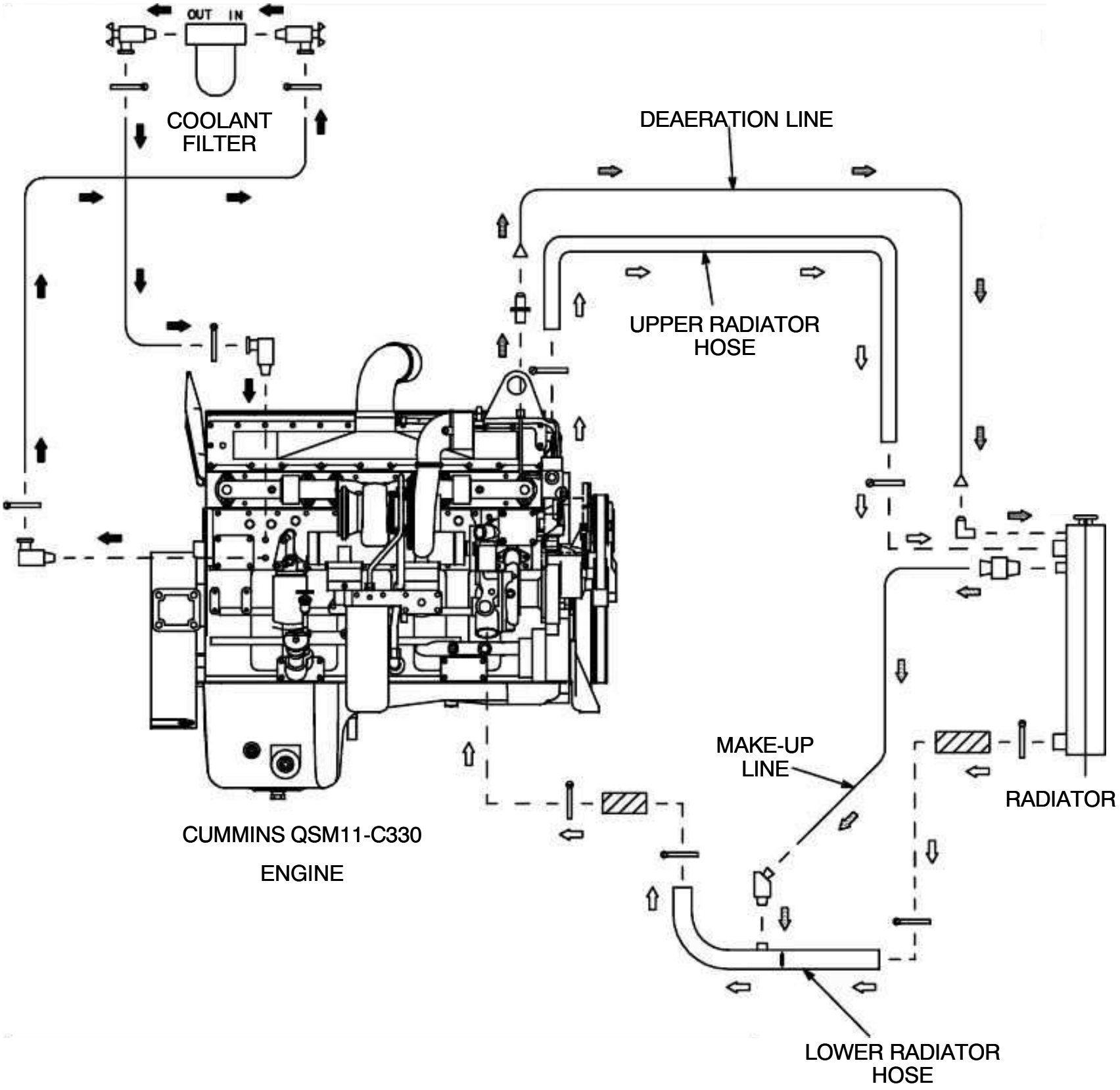
Illustration 5-5. Cooling System Circuit



COOLANT FLOW
- ⇨ MAIN FLOW, THERMOSTAT OPEN
- ⇨ DEAERATION REMOVES UNWANTED AIR FROM COOLING CIRCUIT
- ➡ COOLANT FILTER FLOW
- ⇨ MAKE UP FLOW

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Introduction. This machine incorporates a 12-volt DC electrical system. Optional equipment selected by the customer will determine the electrical equipment to be installed in addition to the standard electrical system.

Major Components. The 12 volt DC electrical system consists of two batteries, battery charging alternator, voltage regulator, starter switch, starter and starter solenoid. The remainder of the electrical system consists of lights and / or gauges, switches, circuit breakers and accessory circuits. The above items are included as standard equipment in the electrical system. Refer to Illustrations 6-1 through 6-16 for location of components and wiring diagrams.

Batteries. This machine is equipped with two industrial type, long life batteries. The batteries are perishable and require servicing on a regular basis. Batteries that are properly cared for can be expected to give long trouble-free service. Perform the following procedures to maintain the batteries in a serviceable condition.

WARNINGS:

- **Under no circumstances allow any sparks or open flames around batteries. No smoking. Batteries produce a highly flammable gas which could lead to battery explosion if ignited.**
- **Never check the battery by placing a metal object across the battery posts.**

CAUTION: Overfilling cells of the battery can cause poor performance or early failure.

1. The battery's electrolyte level should be checked monthly or every 250 hours, whichever comes first. Add distilled water if necessary to bring the electrolyte level to 3/8 inch above the separator plates. Do not overfill.
2. Keep the top of the battery, terminals and cable clamps clean. When necessary, wash them with a solution of baking soda and water, and rinse with clean water.

CAUTION: Do not allow the soda and water solution to enter the battery cells.

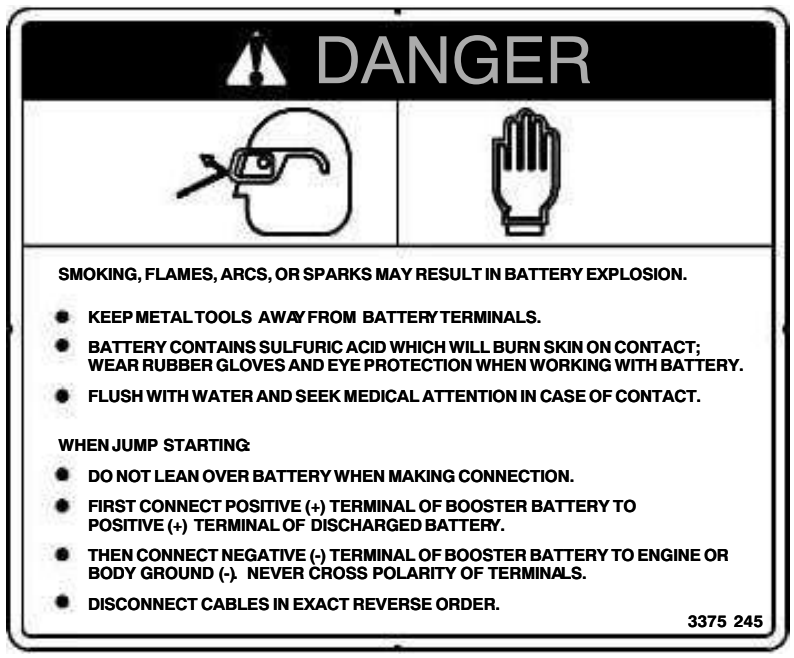
3. Inspect the cables, clamps and hold down bracket regularly. Replace any damaged parts. Clean and re-apply a light coating of grease to the terminals and cable clamps when necessary.

NOTE: *A number of devices and applications are available on the commercial market to deter corrosion on battery terminal connections.*

4. Check the electrical system if the battery becomes discharged repeatedly.
5. If the battery indicator illuminates, the alternator or alternator circuit is defective.

NOTE: *If the truck is to be inoperative or idle for more than 30 days, remove the battery. The battery should be stored in a cool, dry place. The electrolyte level should be checked regularly and the battery kept fully charged.*

Booster Battery Connection Procedure. Accidentally reversing the battery connections must be avoided. If a booster battery is to be used, first connect the positive (+) terminal of booster battery to the positive (+) terminal of discharged battery and then connect the negative (-) terminal of booster battery to engine or body ground (-) (Refer to the decal below). Never cross polarity of the battery terminals. Disconnect cables in the exact reverse order from above.



Alternator. The standard alternator for the Cummins QSM11-C330 engine is a 100 amp alternator. It should be expected to give long, trouble-free service; however, the diodes and transistors in the alternator circuit are very sensitive and can be easily destroyed. The following precautions

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should be observed when working on or around the alternator.

Avoid grounding the output wires or the field wires between the alternator and the regulator. Never run an alternator on an open circuit.

Grounding an alternator's output wires or terminals, which are always hot regardless of whether or not the engine is running or accidentally reversing of the battery polarity, will destroy the diodes. Grounding the field circuit will also result in the destruction of the diodes. Some voltage regulators provide protection against some of these circumstances; however, it is recommended that extreme caution be used.

Never disconnect the battery while the alternator is in operation. Disconnecting the battery will result in damage to the diodes, caused by the momentary high voltage and current induced by the instantaneous collapse of the magnetic field surrounding the field windings.

CAUTION: Accidentally reversing the battery polarity will destroy the diodes of the alternator circuit.

NOTE: *It is normal for the alternator light to stay on when the engine is started. Once the engine is accelerated, the light should go out.*

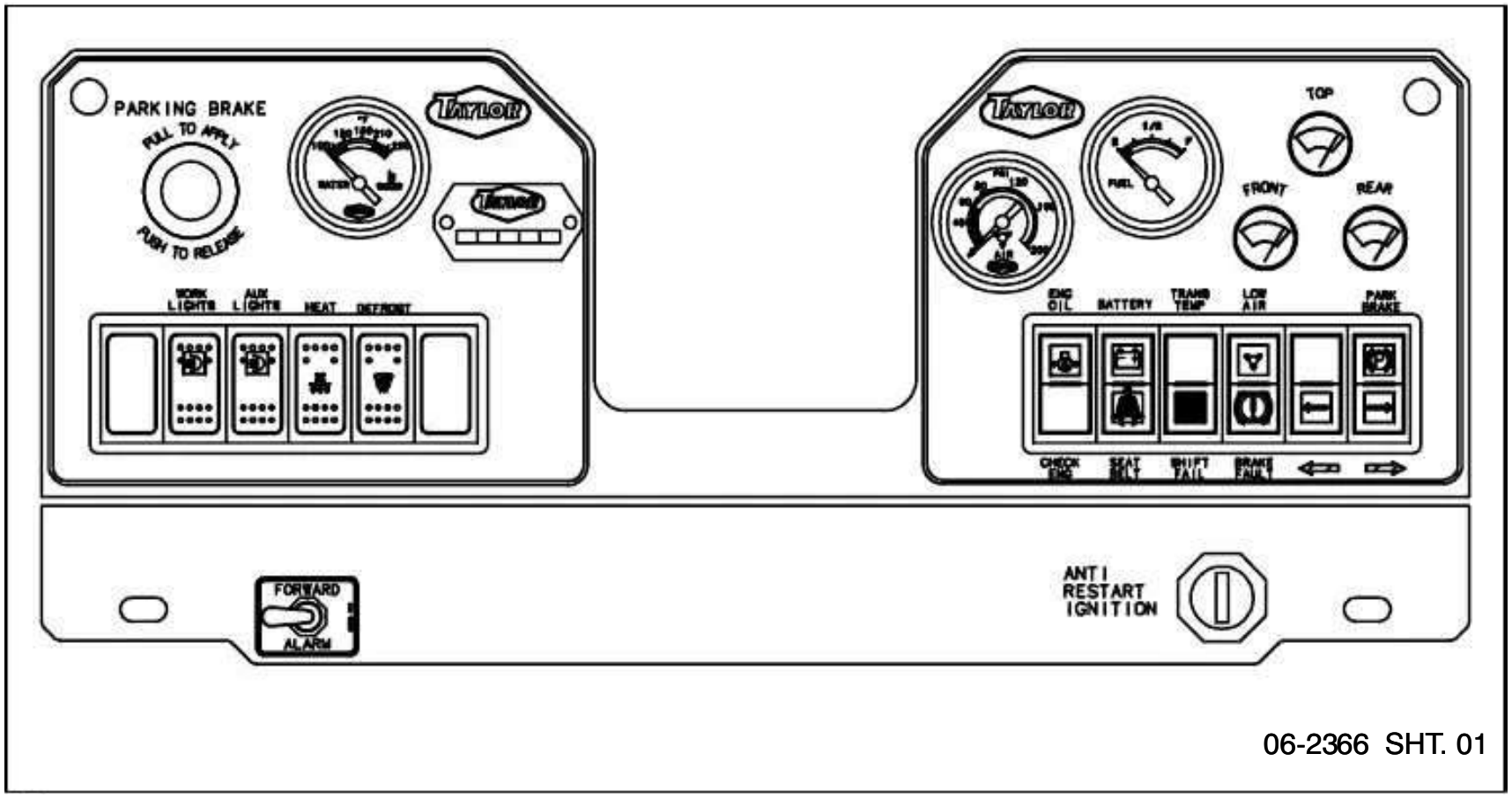

Illustration 6-1. Dash Panel

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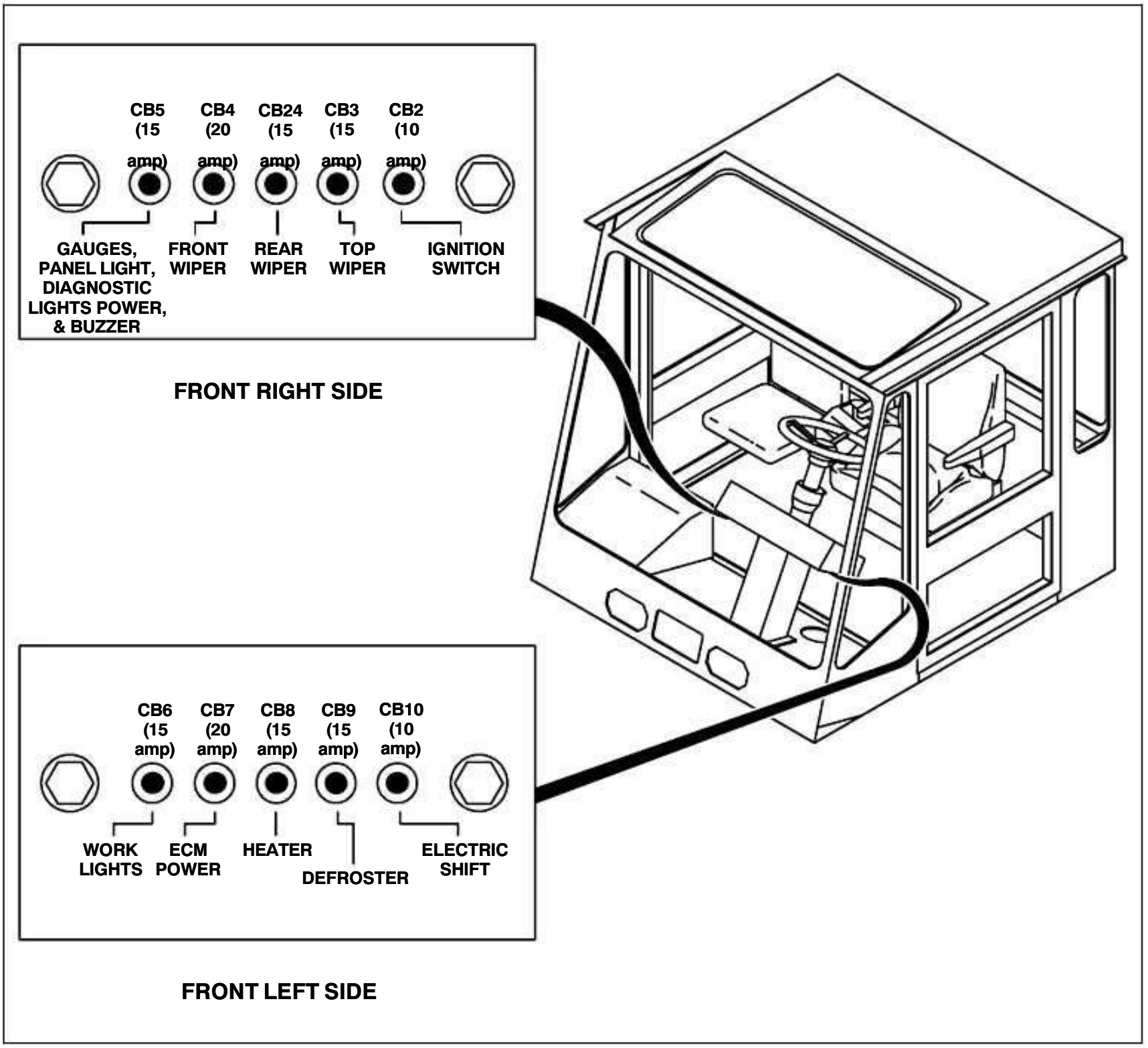

Illustration 6-2. Dash Circuit Breakers

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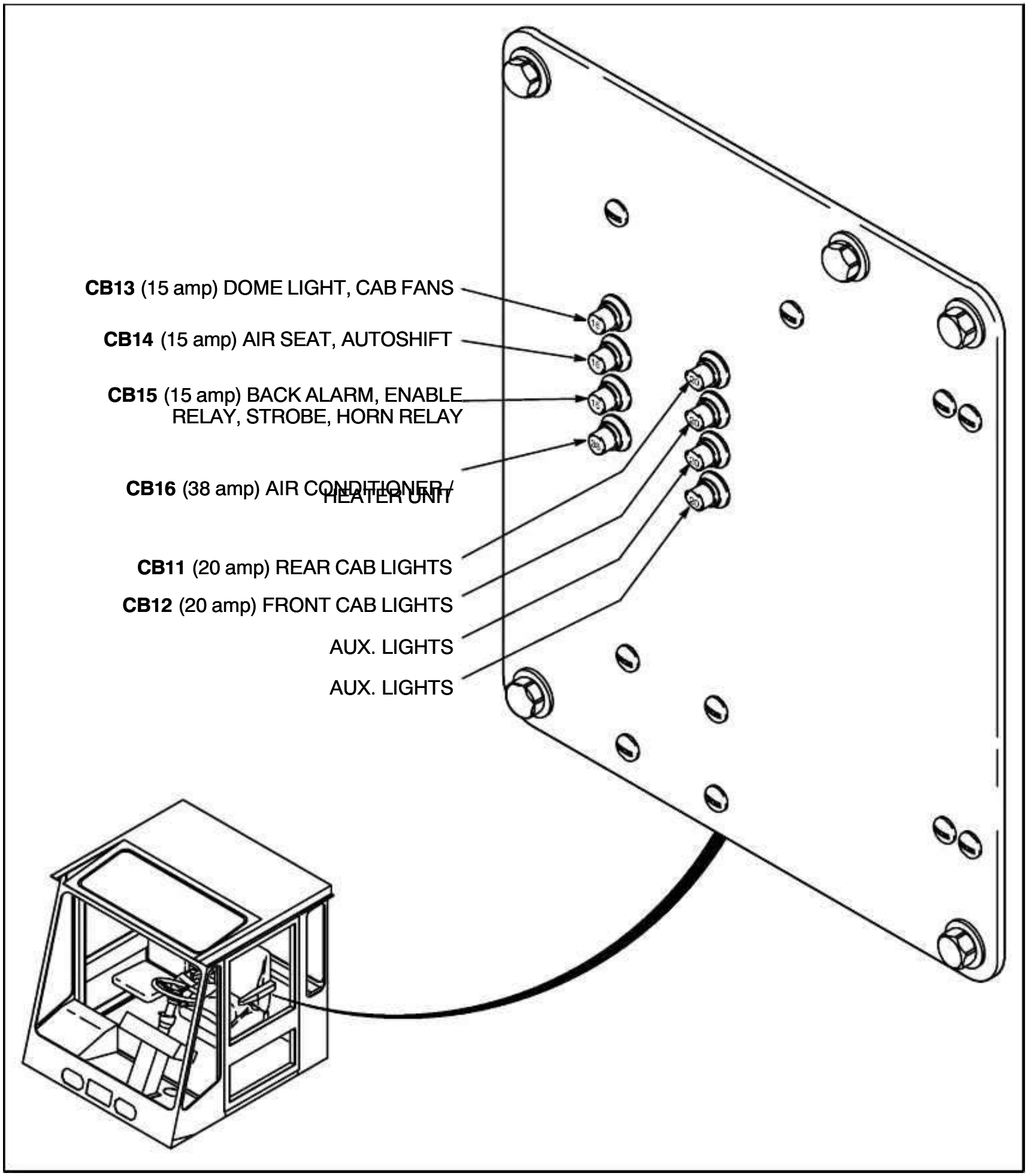

Illustration 6-3. Cab Rear Panel Circuit Breakers

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Component Troubleshooting

Alternator. The alternator provides 13.8 - 14.4 VDC at 100 amps of power for the electrical system and trickle charges the battery when the engine is being operated. When the alternator is started, it will output 6 VDC to a relay (K3), energizing the relay and taking away the ground from the Battery light (DS3, Illustration 6-16) on the instrument panel.

The most effective way to troubleshoot an alternator is with an ammeter on the output of the alternator. Another good check is with a voltmeter across the battery. With the engine operating at a moderate speed, the voltmeter reading should never exceed 15.5 VDC. If reading exceeds 15.5 VDC, the alternator is defective and requires replacing. Should the alternator output drop below 12 VDC, the alternator is defective and requires replacing.

Perform the following procedures below for abnormal charging system operation.

1. Insure that the undercharged condition (below 12 VDC) has not been caused by accessories having been left on for extended periods of time.
2. Check the drive belt for proper tension (refer to **Alternator Drive Belt Tension** in **Section 1**).
3. Ensure that battery is good and capable of holding a charge.
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the alternator and connections at the battery.
5. With the ignition switch on and all wiring harness leads connected, connect a voltmeter from:
   a. alternator “BAT” terminal to ground
   b. alternator #1 terminal to ground
   c. alternator #2 terminal to ground

   An infinity reading indicates an open circuit between the voltmeter connection and battery. Repair if required.
6. With all accessories turned off, connect a voltmeter across the battery. Operate engine at moderate speed. If voltage is 15.5 VDC or higher, replace the alternator.

Circuit Breakers. Circuit breakers are employed in the electrical system and act similar to fuses, protecting the electrical circuits and valuable components from overloads which could damage them. Perform the following troubleshooting procedures to troubleshoot a circuit breaker.

1. Turn the ignition key to the “Ignition” position.
2. If the circuit breaker is tripped, reset the circuit breaker.
3. If the circuit breaker immediately retrips, remove all wires from the output side (load side) of the circuit breaker.
4. Reset the circuit breaker. If the circuit breaker retrips, the circuit breaker is bad and must be replaced.
5. If the circuit breaker maintains a set state, one of the output circuits is shorted. Reconnect the wires one by one to the output side (load side) until the circuit breaker trips. Troubleshoot the circuit of the wire, that tripped the circuit breaker, for a short.
6. Isolate and remove the short from the circuit.

Automatic 90 amp Circuit Breaker (Illustration 1-5)**.** The automatic circuit breaker (CB1) is located on the right side of engine. It will automatically reset itself if it trips. If the circuit breaker cannot maintain a set state, perform the following troubleshooting procedures to troubleshoot the automatic circuit breaker.

1. Turn the ignition key to the Off position.
2. Remove all wires from the output side (load side) of the circuit breaker.
3. Turn the ignition key to the “Ignition” position. If the circuit breaker retrips, the circuit breaker is bad and must be replaced.
4. If the circuit breaker maintains a set state, one of the output circuits is shorted. Reconnect the wires one by one to the output side (load side) until the circuit breaker trips. Troubleshoot the circuit of the wire, that tripped the circuit breaker, for a short.
5. Isolate and remove the short from the circuit.

Single-Pole, Single-Throw 30 amp Relays (Illustration 6-4)**.** A relay is nothing more than an electrically controlled switch. Relays are always shown on electrical circuits in a de-energized state. The internal switch, common at pin 30,

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toggles between pins 87A (when de-energized) and 87 (when energized). Pins 86 and 85 of the relay will energize the coil of the relay. Pin 85, in all cases, is always the ground side and pin 86, in all cases, is always the hot side. Either signal can be sent to the relay to energize it. Ensure that pin 85 is properly grounded, when required, and that 12 VDC is present at pin 86 when it is required.

When the relay is de-energized, the internal switch connects pins 30 and 87A completing the circuit of the two pins. When the relay is energized, the coil shifts the switch, connecting pins 30 and 87 completing the circuit of the two pins.

The most effective way to troubleshoot the relay is with an ohmmeter. This can be accomplished by removing the female spade connectors from pins 30, 87, and 87A. In a de-energized state, ensure that pins 30 and 87A have continuity between them. With an ohmmeter, check the resistance between pins 30 and 87a. The ohmmeter should indicate a reading of 0 - 40 ohms. Energize the relay and check the resistance between pins 30 and 87. The ohmmeter should indicate a reading of 0 - 40 ohms. If these two checks are good, the relay is good. If one of these checks fails and 12 VDC required at pin 86 was or was not present, or ground signal at pin 85 was or was not present, dependant on the desired state of relay (energized or de-energized), the relay is bad and must be replaced.

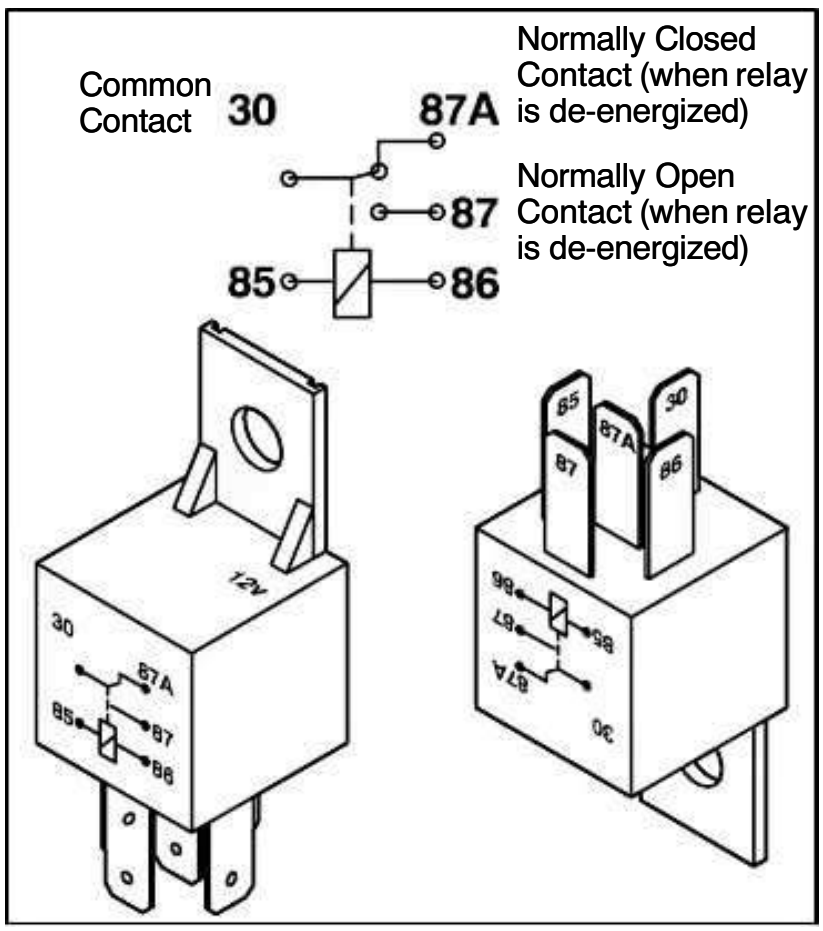

Illustration 6-4. SP, ST 30 amp Relay

Single-Pole, Single-Throw 10 amp Relays with L.E.D.s (Illustration 6-5). A relay is nothing more than an electrically controlled switch. Relays are always shown on electrical circuits in a de-energized state. The positive side of the relay coil is pin 14 while the negative side of the coil is pin 13. Either signal, 12 VDC or ground (or both), can be sent to the relay coil to energize the relay.

When the relay is de-energized, the internal switch connects pins 9 and 1 completing the circuit of the two pins. When the relay is energized, the coil shifts the switch, connecting pins 9 and 5 completing the circuit of the two pins.

When the L.E.D. is illuminated, the coil of the relay is energized. This does not indicate that the contact points of the internal switches are functioning properly. Do not rely on the L.E.D. to give the full operational status of the relay.

The most effective way to troubleshoot this type relay is with an ohmmeter. This can be accomplished by removing the wires at relay socket terminals 9, 5, and 1. In a de-energized state, ensure that terminals 9 and 1 have continuity between them. With an ohmmeter, check the resistance between terminals 9 and 1. The ohmmeter should indicate a reading of 0 - 40 ohms. Energize the relay and check the resistance between terminals 9 and 5. The ohmmeter should indicate a reading of 0 - 40 ohms. If these two checks are good, the relay is good. If one of these checks fails and 12 VDC required at terminal 14 was or was not present, or ground signal at terminal 13 was or was not present, dependant on the desired state of relay (energized or de-energized), the relay is bad and must be replaced.

Double-Pole, Double-Throw 10 amp Relays with L.E.D.s (Illustration 6-6). A relay is nothing more than an electrically controlled switch. Relays are always shown on electrical circuits in a de-energized state. The positive side of the relay coil is pin 14 while the negative side of the coil is pin 13. Either signal, 12 VDC or ground (or both), can be sent to the relay coil to energize the relay.

When the relay is de-energized, the internal switch connects pins (9 and 1) and pins (12 and 4) completing the circuit of both sets of pins.

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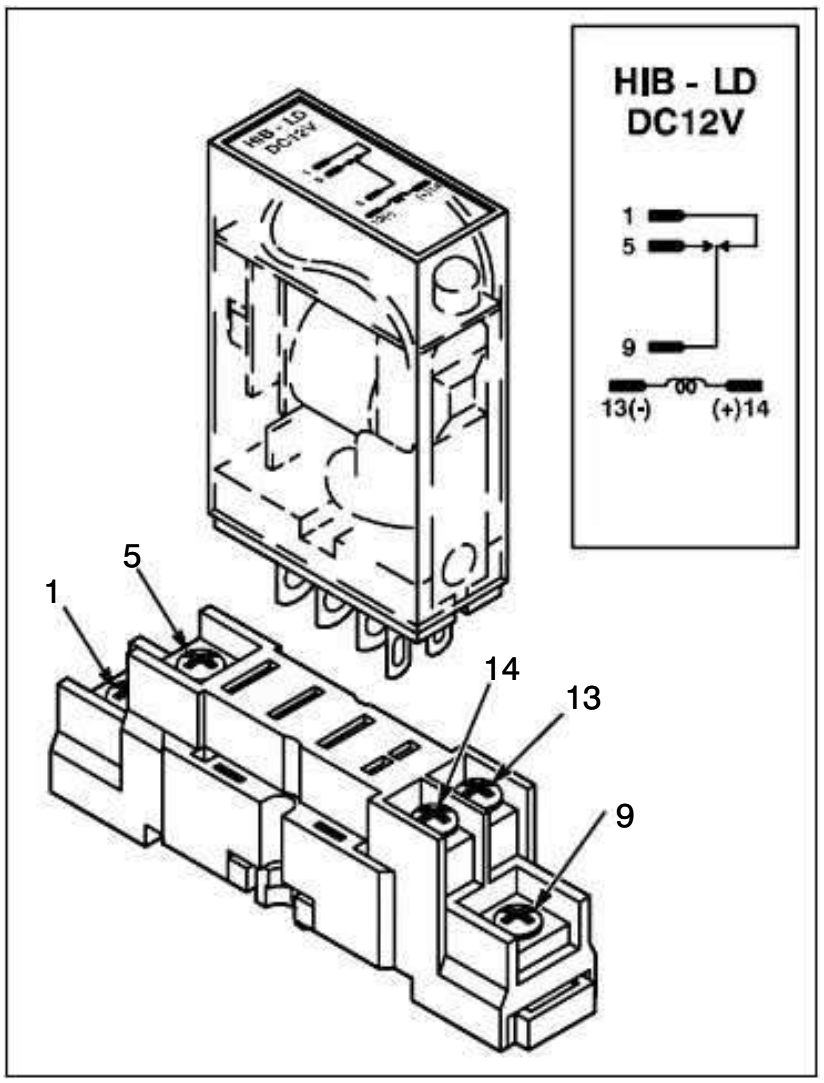

Illustration 6-5. SP, ST 10 amp Relay

When the relay is energized, the coil shifts the switch, connecting pins (9 and 5) and pins (12 and 8) completing the circuit of both sets of pins.

When the L.E.D. is illuminated, the coil of the relay is energized. This does not indicate that the contact points of the internal switches are functioning properly. Do not rely on the L.E.D. to give the full operational status of the relay.

The most effective way to troubleshoot this type relay is with an ohmmeter. This can be accomplished by removing the wires at relay socket terminals (12, 8, and 4) and terminals (9, 5, and 1). In a de-energized state, ensure that terminals (9 and 1) and terminals (12 and 4) have continuity between them. With an ohmmeter, check the resistance between terminals (9 and 1) and terminals (12 and 4). The ohmmeter should indicate a reading of 0 - 40 ohms. Energize the relay and check the resistance between terminals (9 and 5) and terminals (12 and 8). The ohmmeter should indicate a reading of 0 - 40 ohms. If these two checks are good, the relay is good. If one of these checks fails and 12 VDC required at terminal 14 was or was not present, or ground signal at terminal 13 was or was not present, dependant on the desired state of relay (energized or de-energized), the relay is bad and must be replaced.

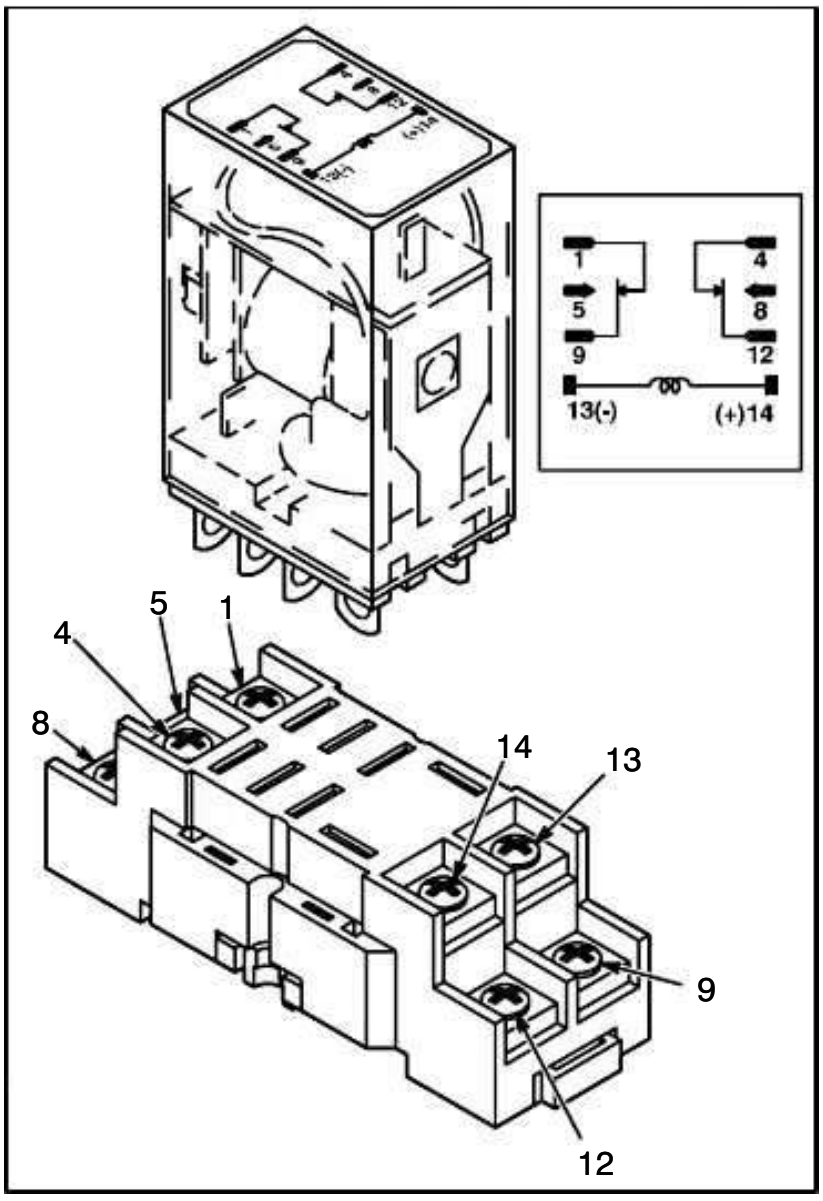

Illustration 6-6. DP, DT 10 amp Relay

Double-Pole, Double-Throw 15 amp Relays (Illustration 6-7). A relay is nothing more than an electrically controlled switch. Relays are always shown on electrical circuits in a de-energized state. The positive side of the relay coil is pin 14 while the negative side of the coil is pin 13. Either signal, 12 VDC or ground (or both), can be sent to the relay coil to energize the relay.

When the relay is de-energized, the internal switch connects pins (9 and 1) and pins (12 and

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4) completing the circuit of both sets of pins. When the relay is energized, the coil shifts the switch, connecting pins (9 and 5) and pins (12 and 8) completing the circuit of both sets of pins.

The most effective way to troubleshoot this type relay is with an ohmmeter. This can be accomplished by removing the wires at relay socket terminals (12, 8, and 4) and terminals (9, 5, and 1). In a de-energized state, ensure that terminals (9 and 1) and terminals (12 and 4) have continuity between them. With an ohmmeter, check the resistance between terminals (9 and 1) and terminals (12 and 4). The ohmmeter should indicate a reading of 0 - 40 ohms. Energize the relay and check the resistance between terminals (9 and 5) and terminals (12 and 8). The ohmmeter should indicate a reading of 0 - 40 ohms. If these two checks are good, the relay is good. If one of these checks fails and 12 VDC required at terminal 14 was or was not present, or ground signal at terminal 13 was or was not present, dependant on the desired state of relay (energized or de-energized), the relay is bad and must be replaced.

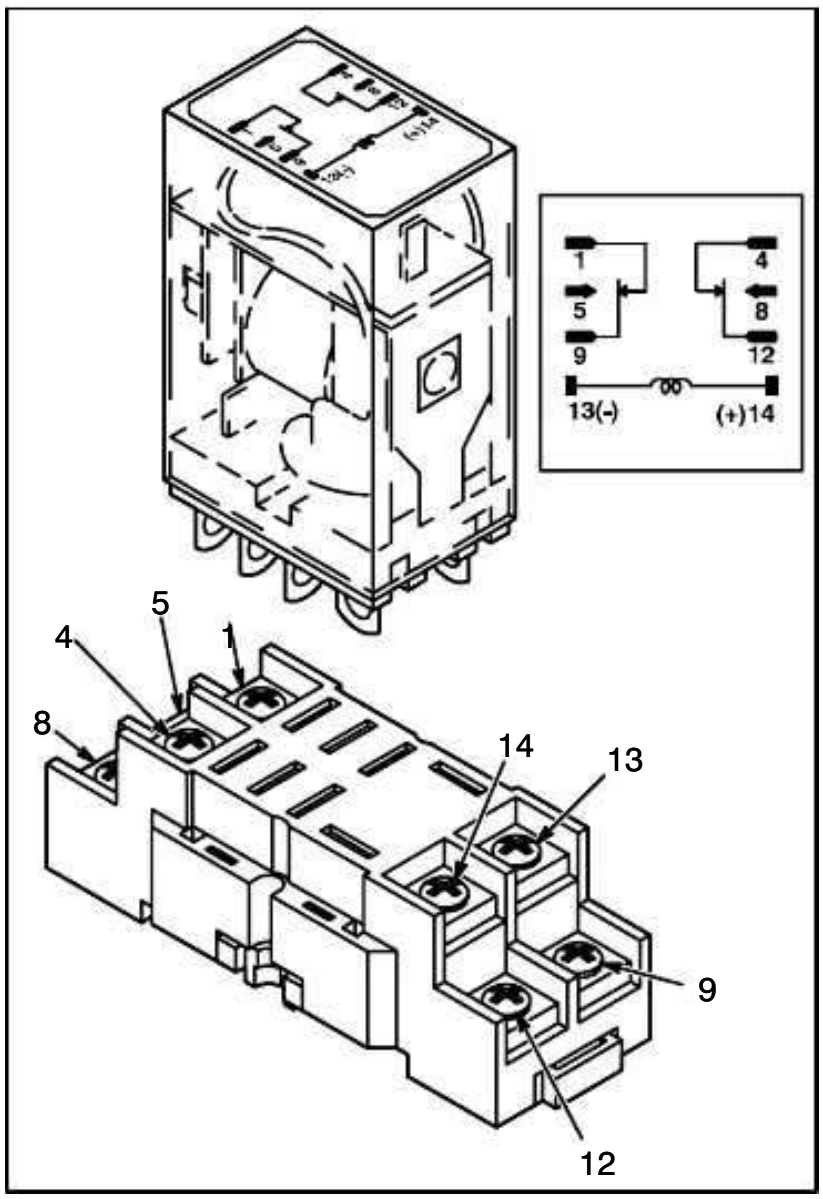

Illustration 6-7. DP, DT 15 amp Relay

Double-Pole, Double-Throw Latching Relays (Illustration 6-8). A relay is nothing more than an electrically controlled switch. This type of relay is shown in a reset state. A latching relay has a power saving feature. It does not require the relay coil to be energized at all times to maintain the set state. The positive side of the relay coil is pin 14 while the negative side of the coil is pin 13 for the set state of the relay. The internal red flag of the relay will be visible in the small window, located at the top of relay's cover, indicating a set state. In a set state, pins (10 and 5) and pins (6 and 8) of the relay will be closed and continuity exists between each set of pins. In a reset state, the positive side of the relay coil is pin 12 while the negative side of the coil is pin 9. In a reset state, pins (10 and 1) and pins (6 and 4) of the relay will be closed and continuity exists between each set of pins. The internal red flag of the relay will not be visible in the small window in the top of the relay's cover, indicating a reset state. A constant 12 VDC signal is not required to set or reset the latching relay. A momentary 12 VDC signal is required at either the set or reset coil, depending on the desired state of the relay, to set or reset the relay.

The most effective way to troubleshoot this type relay is with an ohmmeter. This can be accomplished by removing the wires at relay socket terminals (10, 1, and 5) and (6, 8, and 4). Set the relay by applying 12 VDC to pin 14. In a set state (the internal red flag is visible in the window), ensure that terminals (10 and 5) and (6 and 8) have continuity between them. With an ohmmeter, check the resistance between terminals (10 and 5) and then terminals (6 and 8). The ohmmeter should indicate a reading of 0 - 40 ohms. Reset the relay by applying 12 VDC to pin 12 (the internal red flag should not be visible in the window). Check the resistance between terminals (6 and 4) and then terminals (10 and 1). The ohmmeter should indicate a reading of 0 - 40 ohms. If these four checks are good, the relay is good. If one of these checks fails and 12 VDC required at terminals (14 or 12) was or was not present and ground signal at terminals (13 or 9) was present, dependant on the desired state of relay (set or reset), the relay is bad and must be replaced.

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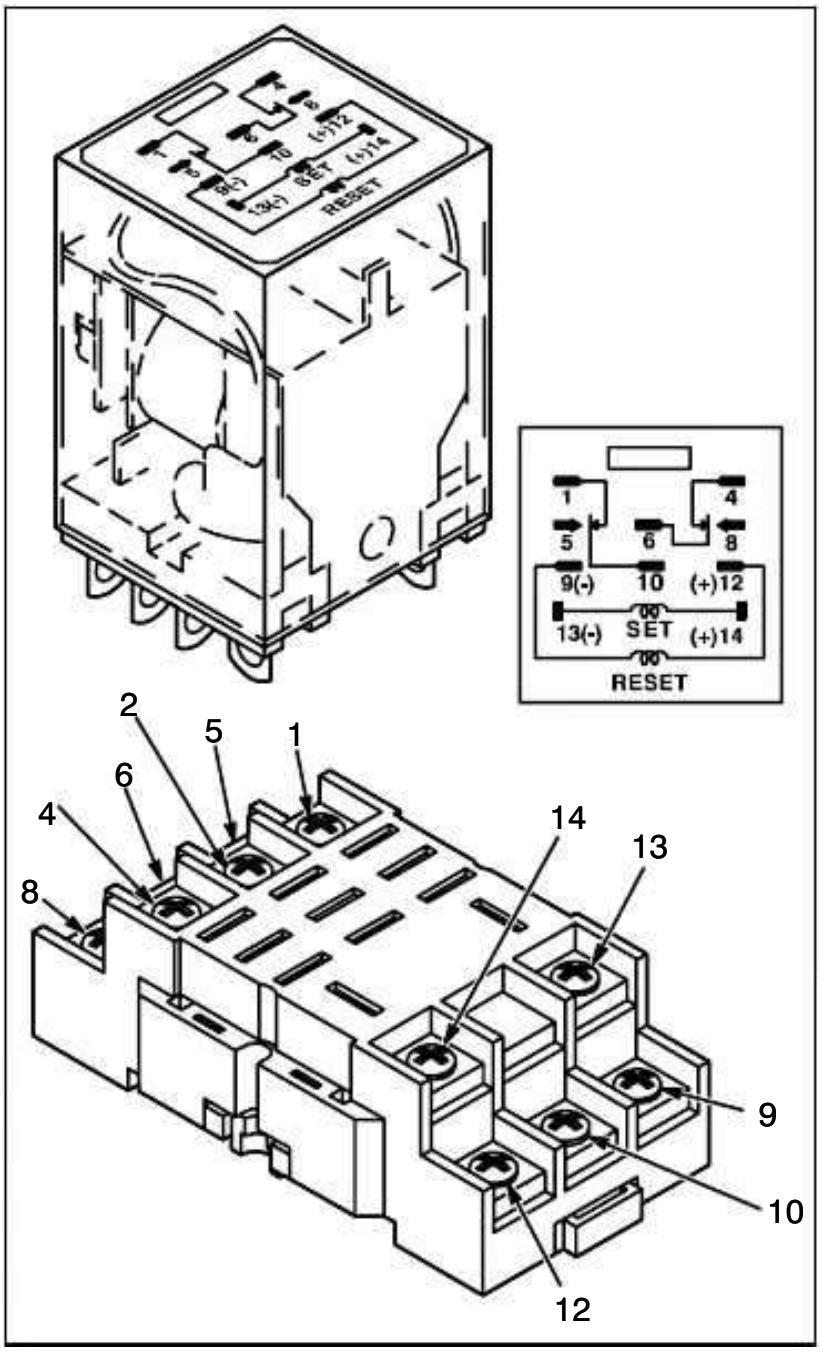

Illustration 6-8. DP, DT Latching Relay

30mm Proximity Switches (Illustration 6-9)**.** The proximity switches employed on Taylor equipment are state-of-the-art switching devices. The red wire of the proximity switch powers the proximity switch itself and also powers the red L.E.D. on the cable side of the proximity switch. The black wire is the ground side of the proximity switch while the white wire is the common post of the internal switch. The blue wire is the normal closed post of the internal switch and the orange wire is the normally open post of the internal switch.

The proximity switch will be energized when the proximity switch senses its target. Once this happens, the red L.E.D. will illuminate and the internal switch will switch, closing the circuit of the white and orange wires. The white and orange wires will have continuity between them only as long as the proximity switch senses its target. The maximum targeting distance is approximately 3/8".

The most effective way to troubleshoot the proximity switch is with an ohmmeter. This can be accomplished by disconnecting the weatherpack connector (located approximately 3 foot from the proximity switch), jumpering the red wires at each end and jumpering the black wires at each end. Target the proximity switch (the red L.E.D. should illuminate) and check the continuity of the white and orange wires located on the proximity switch side of the weatherpack. The ohmmeter should indicate a reading of 0 - 40 ohms. Remove the target from the proximity switch and with an ohmmeter, check the continuity between the white and orange wires. The ohmmeter should now read infinity If these two checks are good, the proximity switch is good. If one of these checks fails, the proximity switch is bad and must be replaced. Do not rely on the red L.E.D. as a sole indicator that the internal switch did, in fact, close. Always check the continuity between the white and orange wires as described above.

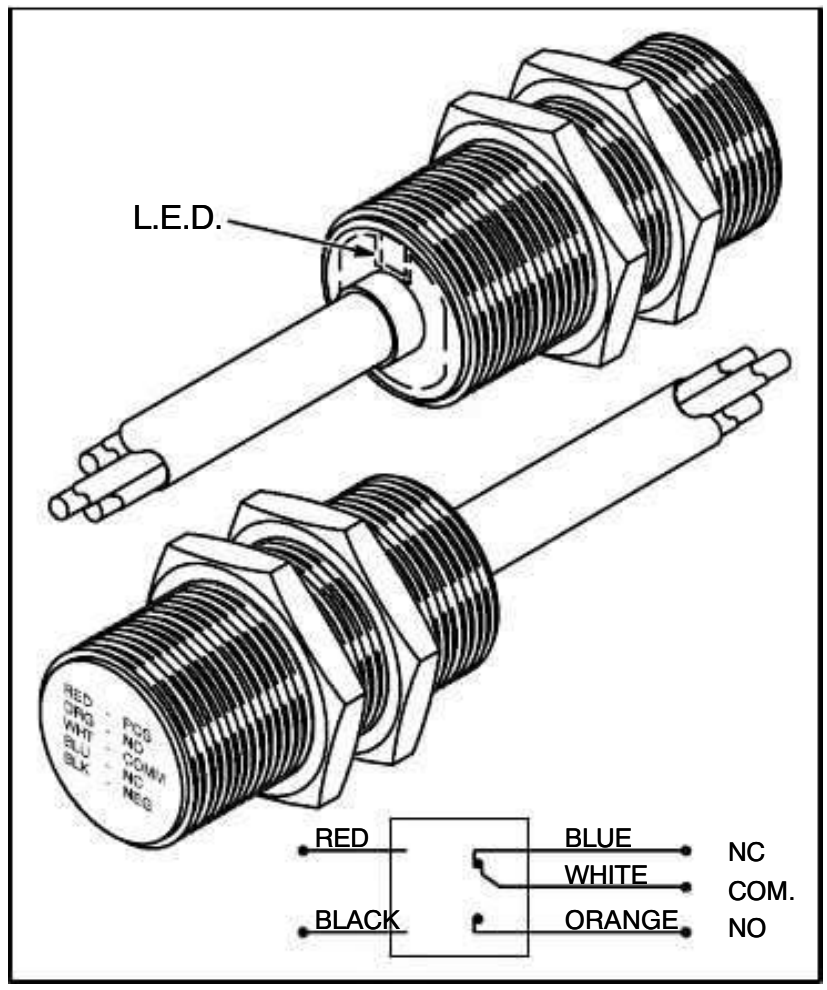

Illustration 6-9. Proximity Switch

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Single-Pole, Single-Throw, Maintain Contact Switches. A switch is designed with the purpose of controlling an electrical circuit by completing or opening the circuit. With an ohmmeter, check the resistance between the contact points of the switch. With the switch closed (completing the circuit), the ohmmeter reading should indicate 0 - 40 ohms. With the switch open (opening the circuit), the ohmmeter reading should be infinity. If the above checks are good, the switch is good. If any of the above checks fail, the switch is bad and must be replaced.

Single-Pole, Double-Throw, Momentary Rocker Switches. This type of switch operates on the principle that the circuit is closed only when the switch is held in the closed state. Once the switch is released, the circuit will open. This switch is checked like an On-Off switch with the exception that the switch must be held closed to complete resistance checks.

Solenoids. A solenoid is an electrical component. When electricity is applied to the coil, the solenoid will form an electromagnet. The magnetic field will pull or push an armature into the coil (based on application). The armature can be connected to a switch in electrical circuits to turn the switch on or off. An armature can also be used to open or close valves.

Solenoids employed as electrical switches can be troubleshot with an ohmmeter. Remove the two wires from the two larger posts of the solenoid. Energize the solenoid. With an ohmmeter, check the resistance between the two larger posts. The ohmmeter should indicate between 0 - 40 ohms nominally.

Solenoids employed as hydraulic switches are used to open and close spools of valves. The simplest way to prove the solenoid coil good is to energize the solenoid and then, with a metal object, touch the nut that secures the coil to the cartridge. The magnetic field generated when the coil becomes an electromagnet will be significant enough to pull the metal object to the nut (some solenoids employ a metal nut encased in plastic and will require removal in order to detect the magnetic field). This will prove the coil good; however, the armature may be stuck. If the hydraulic circuit is still defective at this point, remove the coil and cartridge. Now energize the coil, the armature inside the cartridge should shift. If the armature inside the cartridge did not shift and the coil is magnetized, replace the cartridge.

Exercise care not to reverse polarity because some solenoids employ internal diodes which can be destroyed when the polarity is reversed. The solenoids employed on the transmission control valve contain diodes. The black wire of the coil connects to the ground side of the circuit while the red wire goes to the positive side of the circuit.

Diodes (Illustration 6-10)**.** Diodes are one-way conductors that provide isolation. Current flow through a diode is from anode to cathode. They are easily proven good by using an ohmmeter. When using the ohmmeter, place the leads of the ohmmeter on the opposite ends of the diode. Observe the ohmmeter reading. Then reverse the ohmmeter leads on the ends of the diode. Observe the ohmmeter reading. The ohmmeter readings should indicate a higher ohm resistance in one direction opposed to the other direction because the current generated by the ohmmeter is sufficient enough to forward-bias the diode.

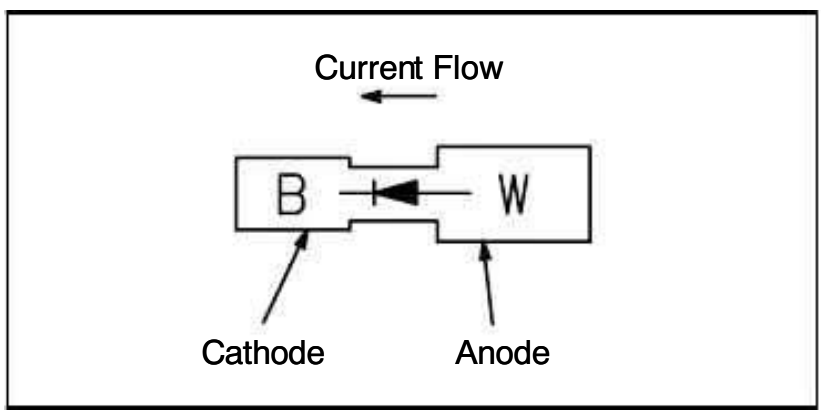

Illustration 6-10. Diode

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Refer to Illustration 6-16 for component reference

Component	Problem	Correction
1. Battery	1. Low voltage.	1. a. Low electrolyte level. Check electrolyte level in battery, fill with distilled water as required, and recharge battery. b. Alternator output is bad. Refer to the Alternator troubleshooting section below. c. Loose, broken, or corroded wires. Repair or replace wires. d. Ensure that low voltage condition has not been caused by accessories having been left on for extended periods of time.
2. Alternator	1. Low output voltage (voltage is below 12 VDC).	1. a. Ensure drive belts are tight. b. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the alternator and connections at the battery. c. Defective alternator. Replace alternator.
	2. High output voltage (voltage exceeds 15.5 VDC).	2. Defective alternator. Replace alternator.
3. Battery Disconnect Switch	1. When key switch is in the ON position, contact points of switch do not close.	1. Remove wires from the switch, turn the switch on. With an ohmmeter, check the resistance across the contact points. The ohmmeter reading should indicate 0 - 40 ohms.
	2. When key switch is in the OFF position, contact points of switch do not open.	2. Remove wires from the switch, turn the switch off. With an ohmmeter, check the resistance across contact points. The ohmmeter reading should indicate infinity.

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Component	Problem	Correction
4. Ignition Switch	1. Ignition switch (S1) does not close (accessory position).	1. On the back of the ignition switch (S1), at the B terminal, check for 12 VDC from circuit breaker (CB2). Ensure that the battery disconnect switch (S54, Illustration 1-6) is in the On position. If 12 VDC is not present, ensure that circuit breaker (CB2) is set. Ensure that Deutsch connector (EC1) is not loose or that pin 6 or 11 is backed out of this connector. Ensure that all battery cables are connected to the terminals of the batteries. Ensure that the batteries are charged. Ensure that circuit breaker (CB1) can maintain a set state. If 12 VDC is present at the B terminal, turn the key to the ignition position, at the I terminal, you should see 12 VDC; if not, remove the wire from the I terminal and recheck voltage. If 12 VDC is now present, there is a short between the ignition switch (S1) and the truck power solenoid (L1); isolate and repair short. If 12 VDC is not present and 12 VDC was present at the B terminal, replace the ignition switch (S1).
	2. Ignition switch (S1) does not close (start position).	2. The truck is equipped with an anti-restart ignition switch (S1). Should the truck fail to start on the first attempt, the key must be turned fully off to reset the ignition switch, allowing the B (Battery) and S (Start) contacts to close when the ignition switch is turned to the Start position. This is a momentary position that should only make contact when the key is fully turned. On the back of the ignition switch (S1), ensure that 12 VDC is present at the B terminal. If 12 VDC is not present, ensure that circuit breaker (CB2) is set. Ensure that Deutsch connector (EC1) is not loose or that pin 7 is backed out of this connector. Ensure that all battery cables are

continued

(continued)

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Component	Problem	Correction
4. Ignition Switch (Continued)		(Continued) connected to the terminals of the batteries. Ensure that the batteries are charged. Ensure that circuit breaker (CB1) can maintain a set state. If 12 VDC is present, turn the ignition switch (S1) to the Start position. Check the S terminal of the ignition switch for 12 VDC. If not present, remove the wire from the S terminal; turn the ignition switch to the Start position and check for 12 VDC at the S terminal. If 12 VDC is present, the ignition switch is good.
5. Wires	1. Wire has lost continuity.	1. Isolate the wire from the circuit (ohm out the wire). Ohms will vary according to the length of the wire. Expect to see low ohms if wire is good.

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Electrical System Troubleshooting

Some of the components described in this section are optional equipment.

Eng Oil light (DS1, Illustration 6-16)**.** The engine oil light will illuminate when engine oil pressure switch (S17, Illustration 1-6) has closed. The engine oil pressure switch will close between 7 - 10 psi on falling engine oil pressure.

Battery light (DS3, Illustration 6-16)**.** When the battery light illuminates, it lets the operator know that there is a problem with the alternator. Refer to the **Component Troubleshooting** of the **Alternator** found earlier in this section.

Seat Belt light (DS4, Illustration 6-16)**.** The seat belt light (DS4) will only illuminate when the key is in the ignition position and the seat belt is unfastened. With the seat belt fastened, the seat belt switch (S18) will send a ground through wire #38, energizing the seat belt relay (K2) and breaking the contact between pins #30 and #87A of relay (K2), removing the ground from the seat belt light (DS4).

Shift Fail light (DS6, Illustration 6-16, if equipped with APC 70)**.** The shift fail light (DS6) is controlled by the APC 70 and will illuminate only when the operator has attempted an improper shifting procedure. The only purpose of this light is to let the operator know that he or she is outside of the operating parameters.

Low Air light (DS7, Illustration 6-16)**.** The low air light (DS7) will illuminate when the air pressure falls below 75 psi. The low air pressure switch (S13), a normally closed switch, will close when the air pressure drops below 75 psi, sending ground through wire #31 (Illustration 6-16) completing the circuit to the low air light (DS7). In addition to the low air light being illuminated, an audible alarm will be heard from the low air / shut down buzzer (LS5). When the air pressure drops to 60 psi, the parking brake valve will pop out, applying the parking brake, closing the parking brake switch (S11). As a result, this will energize the brake saver relays (K23 and K31, Illustration 9C-2), taking away the 12 VDC signal from the forward and reverse solenoids of the control valve that is located on the transmission. This inhibits the operator from driving through the brakes. The air pressure gauge in the instrument panel will assist in determining if the low air switch (S13) is defective, if a short exists on wire #31, or if a low air pressure problem exists. If the air pressure gauge indicates above 75 psi, remove wire #31 from the low air pressure switch (S13). If the low air light (DS7) does not go out, wire #31 is shorted out.

Brake Fault light (DS8, Illustration 6-16) (if equipped)**.** There are three signals in parallel capable of illuminating the brake fault light (DS8).

It is imperative that the technician understand how these switches work to isolate the source of the failure. The simplest way to troubleshoot is to remove the signal wire #32 from the switches (S23, S24, and S27), one switch at a time. Start the engine and see if the brake fault light (DS8) is illuminated. By removing the signal wire #32 from the switch (S23, S24, or S27), the switch will be eliminated from the circuit. Once the defective circuit has been removed, the brake fault light (DS8) will not illuminate. Next, the technician must determine if the switch is bad or if the circuit, the switch (S23, S24, or S27) is monitoring, is at fault.

Troubleshoot the switches (S23, S24, and S27) as follows:

1. The power cluster overstroke indicator switch (S27) is located on the end cover between the shell assembly and the tube cylinder of the power cluster. The overstroke indicator switch is a normally open switch. A visual inspection of the switch will confirm overstroke condition. The brass colored indicator rod will be protruding from the end cover approximately 3/4” to 1”. The indicator rod must be physically reseated. The most common cause of the brake fault light (DS8) illuminating is when an overstroke condition has occurred.
2. The brake coolant temperature switch (S24, Illustration 6-16) is located in the brake cooling valve. The brake coolant temperature switch is a normally open switch that will close at 190°F. The simplest way to check this switch is to turn the truck off and allow the truck to cool. With an ohmmeter, measure the resistance between the posts on the switch and the chassis ground. The ohmmeter reading should indicate infinity (open circuit). If the ohmmeter reading indicates a short, then the brake coolant temperature switch (S24) must be replaced. Care must be taken to insure that a good chassis ground is obtained.
3. The brake coolant pressure switch (S23, Illustration 6-16) is located in the brake man-

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ifold valve. The brake coolant pressure switch is a normally closed switch that will open at 10 psi. The purpose of this switch is to monitor for a low pressure problem in the brake cooling circuit. When the pressure drops below 10 psi, the switch will then close completing the electrical circuit to the brake fault light (DS8). It must now be determined if the switch (S23) is defective or if a low pressure problem exists in the brake cooling circuit. There is a pressure test coupling (pressure check) located on the brake cooling manifold at port A. Plug a pressure gauge into the test port and with the engine running, observe the gauge reading. The maximum pressure observed should be no more than 600 psi (the pressure will be between 0 and 600 psi). Remember it takes 10 psi to open the switch. If the pressure indicated is above 10 psi, the brake coolant pressure switch (S23) is defective and must be replaced.

If all three of the switches, described above, have been proven to be good and the brake fault light is still illuminated, there is a short on the signal wire #32. Isolate and remove the short.

Front Wiper Circuit (Illustration 6-16)**.** The front wiper circuit is comprised of a circuit breaker (CB4), wiper switch (S7) and wiper motor (B1). 12 VDC power is supplied from circuit breaker (CB4) to the B (Battery) posts of the wiper switch (S7). There are 6 posts on the back of the wiper switch (S7). The P (Park) post of the wiper switch is used for parking the wiper motor (B1). When the wiper switch is turned off, 12 VDC will be present at the P post. When the wiper switch is turned on, 12 VDC will be present at the L (Low) or H (High) post of the wiper switch (depending on desired speed). 12 VDC will be present at the W (Washer) post of the wiper switch (S7) when the wiper switch is depressed. Five wires are used on the wiper motor (B1). The black wire of the wiper motor is used for ground. The blue wire of the wiper motor (B1) is is used for high speed. The yellow wire of the wiper motor (B1) has a constant 12 VDC supply to it at all times while the key is at the accessory position. The red wire of the wiper motor (B1) is used for low speed. In this application, 12 VDC will be applied to the red wire when the wiper switch (S7) is in the Low position. The green wire of the wiper motor (B1) is used to drive the wiper motor to the Park position when the wiper switch (S7) is turned off. There will be 12 VDC present on the green wire when the wiper switch (S7) is in the Park position.

Top and Rear Wiper Circuits (Illustration 6-16)**.** The top and rear wiper circuits are comprised of a circuit breakers (CB3 and CB24), wiper switches (S8 and S9) and wiper motors (B8 and B9). 12 VDC power is supplied from circuit breaker (CB3) to the B (Battery) post of the wiper switch (S8) while 12 VDC power is supplied from circuit breaker (CB24) to the B (Battery) post of the wiper switch (S9). There are 5 posts on the back of the wiper switches (S8 and S9). The P (Park) post of the wiper switches are used for parking the wiper motor (B9 and B8). When the wiper switches are turned off, 12 VDC will be present at the P post. When the wiper switches are turned on, 12 VDC will be present at the L (Low) post or H (High) post of the wiper switches, contingent on the speed selected. 12 VDC will be present at the W (Washer) post of the wiper switches (S8 or S9) when the wiper switch is depressed. With the wiper switch (S8 or S9) turned off, 12 VDC is applied at the P terminal of the wiper motor (B9 or B8) to drive the wiper motor to the Park position. With the wiper switch (S8 or S9) in the Low position, 12 VDC is applied to the L terminal of the wiper motor (B9 or B8) for low speed. With the wiper switch (S8 or S9) in the high speed position, 12 VDC is applied to the H terminal of the wiper motor (B9 or B8) for high speed. The wiper motors (B9 and B8) utilize chassis ground.

Defroster Fan Motors (B2 and B4, Illustration 6-16)**.** The front defroster (B2) and the rear defroster (B4) fan motors are controlled by defroster switch (S6). Defroster switch (S6) is powered by circuit breaker (CB9). There is a diode between circuit breaker (CB9) and defroster switch (S6). Its purpose is to prevent an induced voltage generated by the defroster fan motors (B2 and B4), which could prolong engine shut down, after the ignition switch (S1) is turned to the Off position. With the defroster switch (S6) in the Low position, 12 VDC will be present on wire #40A for the front defroster motor (B2) or on wire #40 for the rear defroster motor (B4). With the defroster switch (S6) in the High position, 12 VDC will be present on wire #41A for the front defroster motor (B2) or wire #41 for the rear defroster motor (B4). Both defroster motors (B2 and B4) utilize chassis ground.

Heater Fan Motor (B5, Illustration 6-16)**.** The heater fan motor (B5) is controlled by heater

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switch (S5). Heater switch (S5) is powered by circuit breaker (CB8). There is a diode between circuit breaker (CB8) and heater switch (S5). Its purpose is to prevent an induced voltage generated by the heater fan motor (B5), which could prolong engine shut down, after the ignition switch (S1) is turned to the Off position. With the heater switch (S5) in the Low / High position, 12 VDC will be present on wire #43 to the heater fan motor (B5) for low speed operation. With the heater switch (S5) in the High position, 12 VDC will be present on wire #44 to the heater fan motor (B5) for high speed operation. The heater fan motor (B5) is connected to the chassis ground by wire #11. The heater fan motor (B5) will circulate air through a heater coil (which is heated by the engine coolant) and into the cab.

Air Conditioner / Heater Unit (B7, Illustration 6-16). The air conditioner / heater unit (B7) is powered by circuit breaker (CB16). Two power wires #72 are sent from the circuit breaker (CB16) to the air conditioner / heater unit (B7). This is required to deliver the sufficient amperage to the air conditioner / heater. All controls to the air conditioner / heater unit (B7) are internal to the air conditioner / heater unit (refer to **Section 20A** for additional information on the air conditioner / heater unit).

Forward Alarm (LS4, Illustrations 6-16, 9C-2, and 29-30). The forward alarm circuit is designed to emit an audible alarm when the shifter is in the forward position and the forward alarm circuit has been activated. The forward alarm circuit is controlled by two switches, the forward alarm key switch (S14) and the forward alarm toggle switch (S10). The forward alarm mode key switch (S14) is an on and off switch. When the forward alarm mode key switch (S14) is in the Automatic Position, the contacts of the switch are closed. When the forward alarm mode key switch (S14) is off (Operator Controlled Mode), the contacts of the switch are open. With the forward alarm mode key switch (S14) turned to the Automatic Position, the forward alarm (LS4) will always be energized, sounding an audible alarm any time the shifter is placed in the forward position. With the forward alarm override switch (S14) turned to the Operator Controlled position, the forward alarm toggle switch (S10) can activate the forward alarm circuit when the shifter is in the forward position. This allows the operator to determine when or when not to use the forward alarm circuit. With the shifter in the forward position, 12 VDC is sent on wire #306 to pin 14 of forward relay (K17). Ground to energize K17 is supplied by either S10 or S14. 12 VDC is supplied by circuit breaker (CB19) at all times to pin 9 (common pin) of K17. When K17 energizes, the 12 VDC at pin 9 will pass out pin 5 to LS4 (forward alarm unit), energizing it.

Refer to Illustration 6-16 for component reference

WARNING: See the information in the Operator's Guide and Safety Check concerning selecting the appropriate mode of operation.

Reverse Alarm (LS3, Illustration 6-16). The reverse alarm circuit is designed to emit an audible alarm when the shifter is in the reverse position. The reverse alarm circuit is controlled by the shifter. With the shifter in the reverse position, relay (K18) is energized. Circuit breaker (CB15) will supply 12 VDC to pin #30 of relay (K18). When relay (K18) energizes, the 12 VDC present at pin #30 will pass out pin #87 through wire #39, energizing the reverse alarm (LS3). Any time 12 VDC is present on wire #319 at relay (K18), pin #86, the reverse alarm (LS3) should be energized.

Problem	Cause	Correction
1. Eng Oil light (DS1) is illuminated.	1. Engine oil pressure is below 7 - 10 psi.	1. Refer to Problem 36. in the **Engine Troubleshooting** chart in **Section 1**.
	2. Defective engine oil pressure switch (S17).	2. Replace engine oil pressure switch (S17).
	3. There is a short on wire #4.	3. Isolate and repair short.

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Problem	Cause	Correction
2. Battery light (DS3) is illuminated.	1. Charge indicator relay (K3) is defective. 2. Defective alternator. 3. There is a short on wire #34. 4. Wire #5 is open or shorted.	1. Replace charge indicator relay (K3). Refer to **Alternator** of the **Component Troubleshooting**. 2. Replace alternator. 3. Isolate and repair wire. 4. Isolate and repair wire.
3. Seat Belt light (DS4) is illuminated.	1. Seat belt is unfastened.	1. Fasten seat belt.
4. Seat Belt light (DS4) is illuminated with the seat belt fastened.	1. Seat belt relay (K2) is defective. 2. Wire #35 from Seat Belt light (DS4) to seat belt relay (K2) has a short on it. 3. Wire #38 or #35 from the enable relay (K20) is open. 4. Defective seat belt switch (S18).	1. Refer to the **Component Troubleshooting** found earlier in this section. 2. Isolate and repair short. 3. Isolate and repair. 4. Replace seat belt.
5. Shift Fail light (DS6) is illuminated. *(if equipped with APC-70)*	1. Shift request is outside of shifting parameters.	1. Operate truck correctly (refer to the Operator's Guide for proper shifting operations).
6. Low Air light (DS7) is illuminated and buzzer (LS5) is energized.	1. Air pressure is below 75 psi. 2. Wire #31 is shorted between the low air pressure switch (S13) and Low Air light (DS7).	1. Locate and repair leak (check all fittings, hoses, seals, air tank, service brake valve, de-clutch valve and brake actuators). 2. Isolate and repair short. A good indication of this problem will be the air pressure gauge on the instrument panel shows good air pressure.

continued

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Problem	Cause	Correction
9. Low Air light (DS7) is illuminated and buzzer (LS5) is energized. (Continued)	3. Defective low air pressure switch (S13).	3. Allow truck to build air pressure, shut down engine, and with an ohmmeter read across each terminal of the low air pressure switch (S13) to chassis ground. Ohmmeter readings on one terminal should be 0 - 40 ohms while the other terminal's ohmmeter reading should be infinity. If the air pressure gauge, located on the instrument panel, shows good air pressure and the ohmmeter readings are not as described above, replace low air pressure switch (S13).
7. Brake Fault light (DS6) is illuminated	1. Overstroke indicator switch (S27) is overstroked.	1. Visually inspect the overstroke indicator switch (S27). If an overstroked condition has occurred, a brass colored indicator rod will be protruding from the end cover of the power cluster approximately 3/4" to 1". To reset, push the indicator rod back into the end cover.
	2. Brake coolant pressure switch (S23) is defective.	2. Refer to the **Electrical System Troubleshooting** of the **Brake Fault light** found earlier in this section.
	3. Brake coolant pressure is below 10 psi. a. Leak in brake cooling circuit. b. Defective pressure relief valve in port 3 of the brake manifold valve.	3. a. Isolate leak and repair. b. Replace the 175 psi pressure relief valve in the brake manifold valve at port 3.
	4. Brake coolant temperature switch (S24) is defective.	4. Refer to the **Electrical System Troubleshooting** of the **Brake Fault light** found earlier in this section.
	5. Brake coolant temperature exceeds 190°F.	5. Refer to Problem 1. in the **Wet Disc Brakes Cooling System Troubleshooting** chart in **Section 15C**.
	6. There is a short on wire #32.	6. Isolate and repair

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Problem	Cause	Correction
8. Left turn lamp (DS9) will not illuminate when the turn signal is activated for a left turn *(if equipped)*	1. The left turn lamp (internal to DS9) is burned out. 2. Circuit breaker is tripped (this will affect DS11 as well). 3. Defective flasher (this will affect DS11 as well). 4. Defective turn switch (left side). The turn switch is mounted on the steering column. 5. Loose or broken wire.	1. Replace left turn lamp bulb. 2. Reset circuit breaker. 3. Replace flasher. 4. Replace turn switch. 5. Check all connections or repair wire.
9. Park Brake light (DS10) is illuminated	1. Parking brake is applied. 2. Park brake switch (S11) is defective. 3. Air pressure is below 60 psi.	1. Release parking brake. 2. Replace park brake switch (S11). 3. Refer to Problem 3. in the **Brake Control System Troubleshooting** chart in **Section 15**.
10. Right turn lamp (DS11) will not illuminate when the turn signal is activated for a right turn *(if equipped)*	1. The right turn lamp (internal to DS11) is burned out. 2. Circuit breaker is tripped (this will affect DS9 as well). 3. Defective flasher (this will affect DS9 as well). 4. Defective turn switch (right side). The turn switch is mounted on the steering column. 5. Loose or broken wire.	1. Replace right turn lamp bulb. 2. Reset circuit breaker. 3. Replace flasher. 4. Replace turn switch. 5. Check all connections and repair wire if necessary.

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Illustration 6-11. Truck Layout Wiring Diagram

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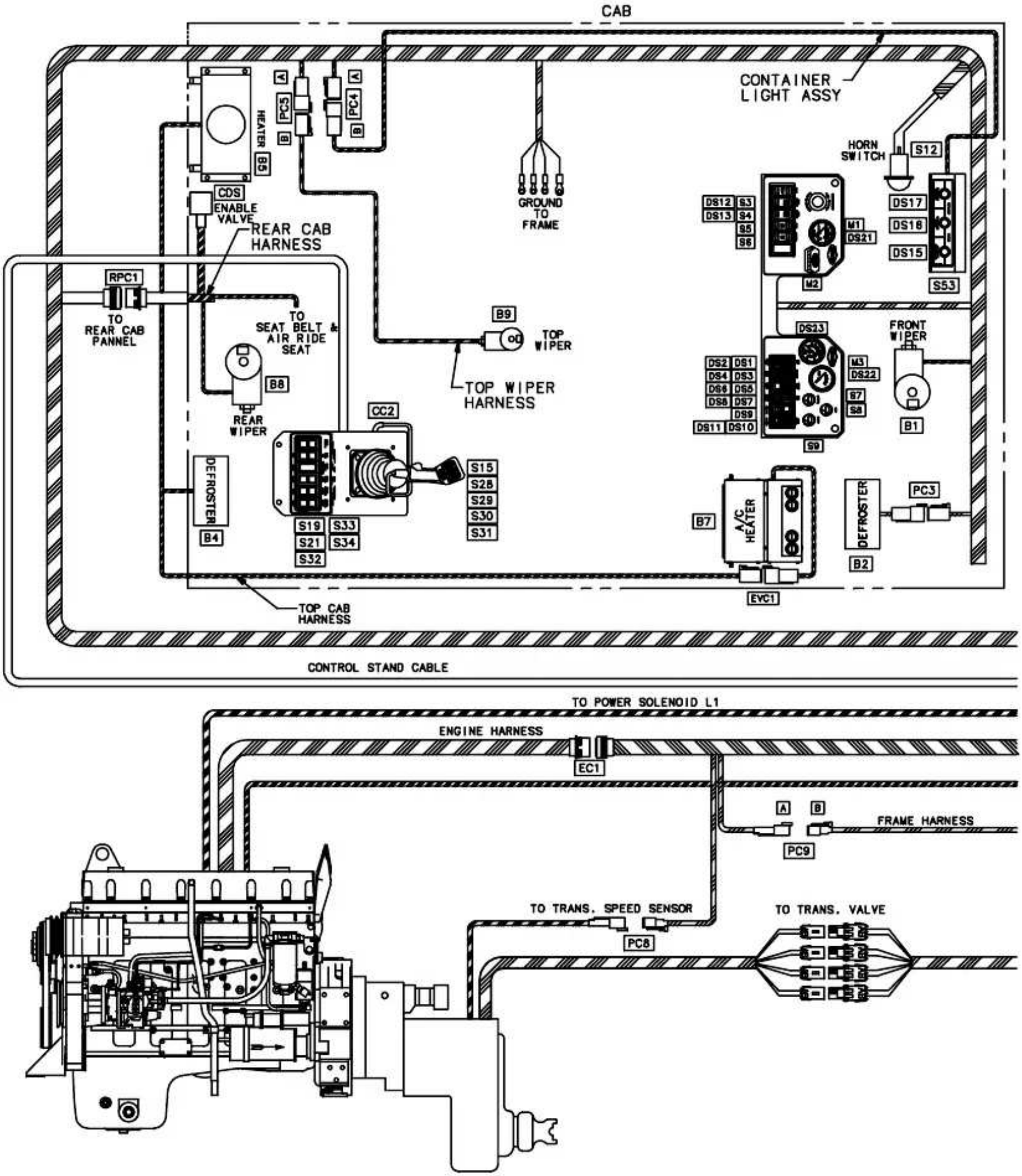

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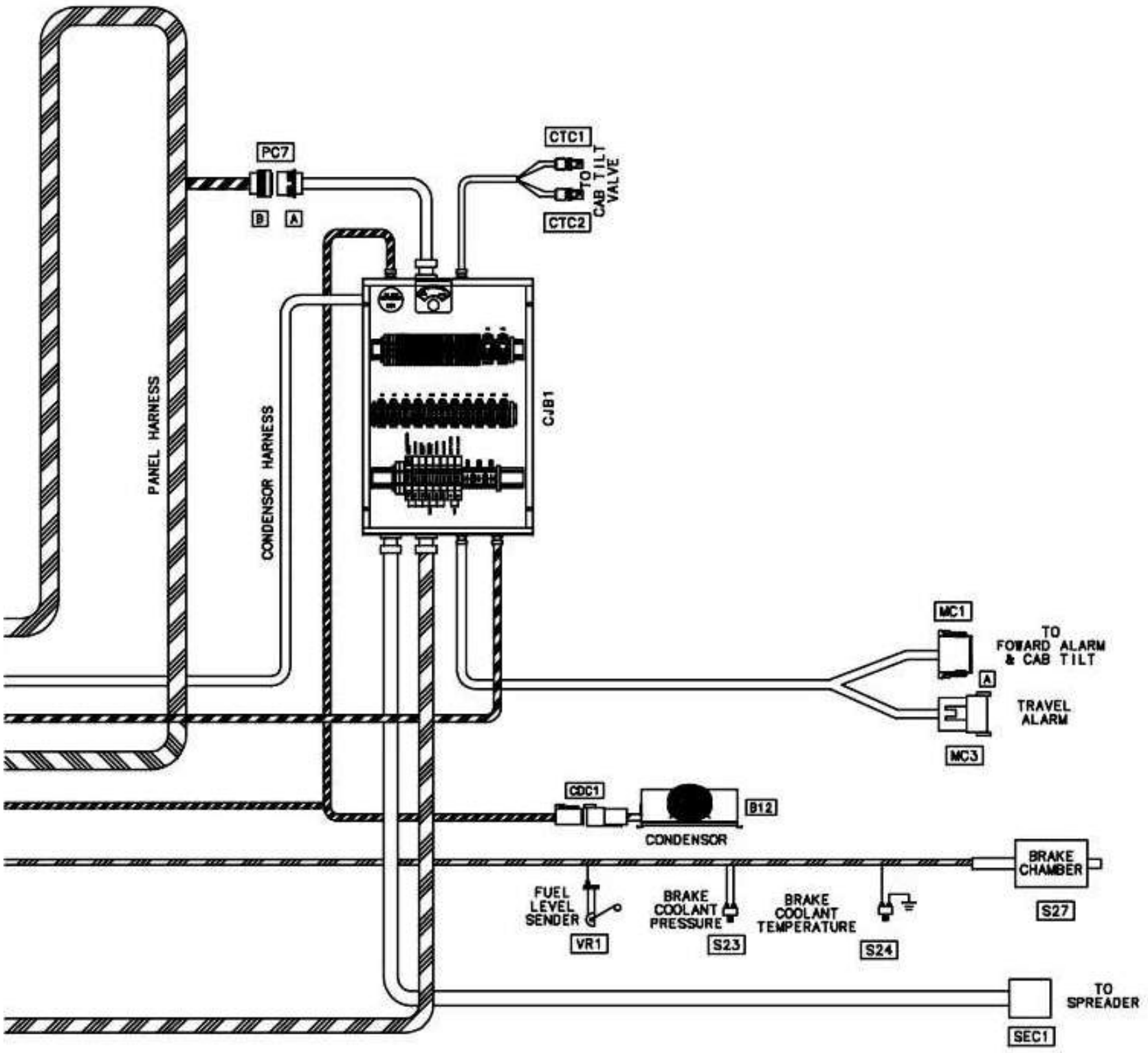

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Illustration 6-12. Truck Control ANSI Diagram

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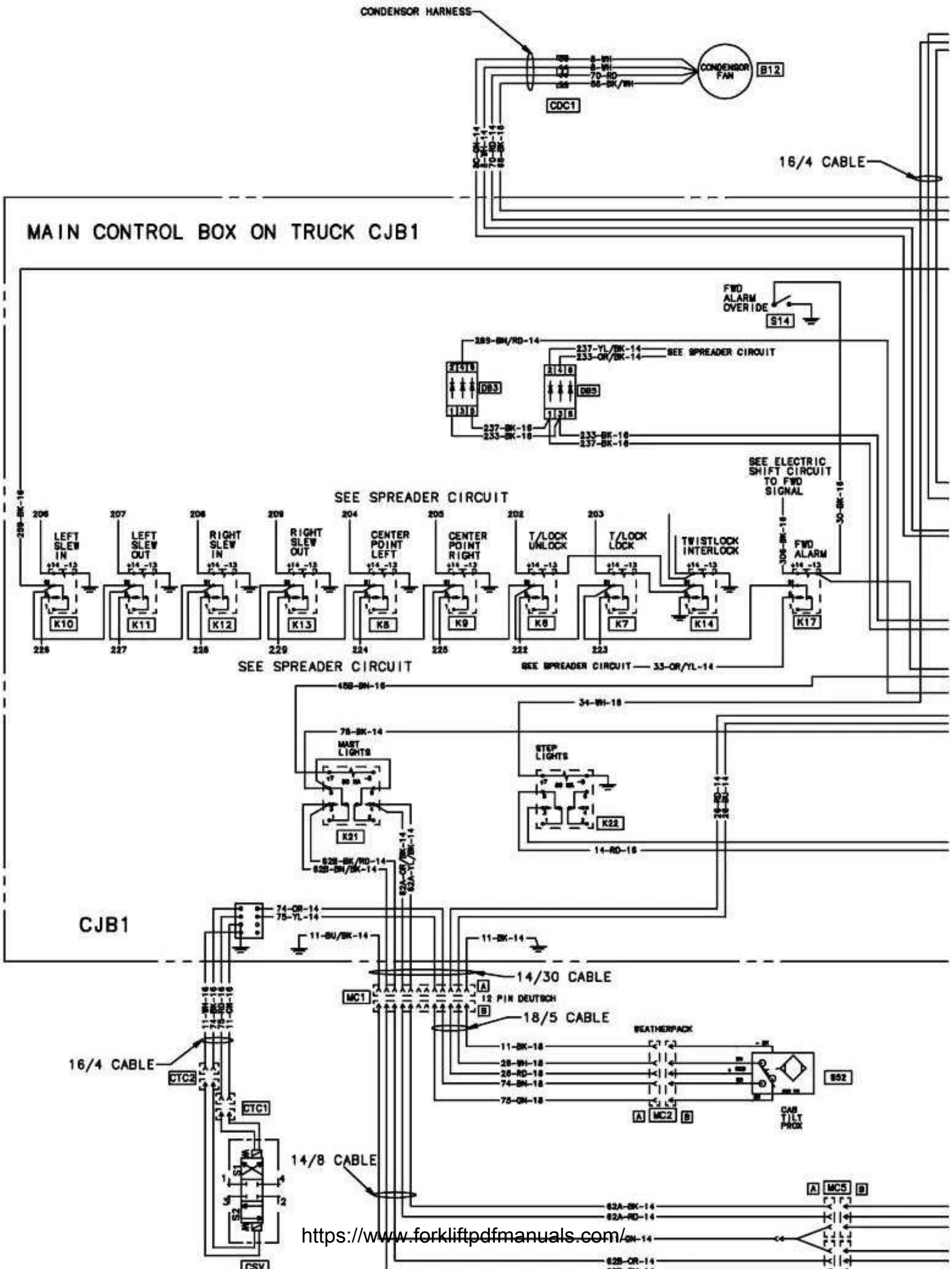

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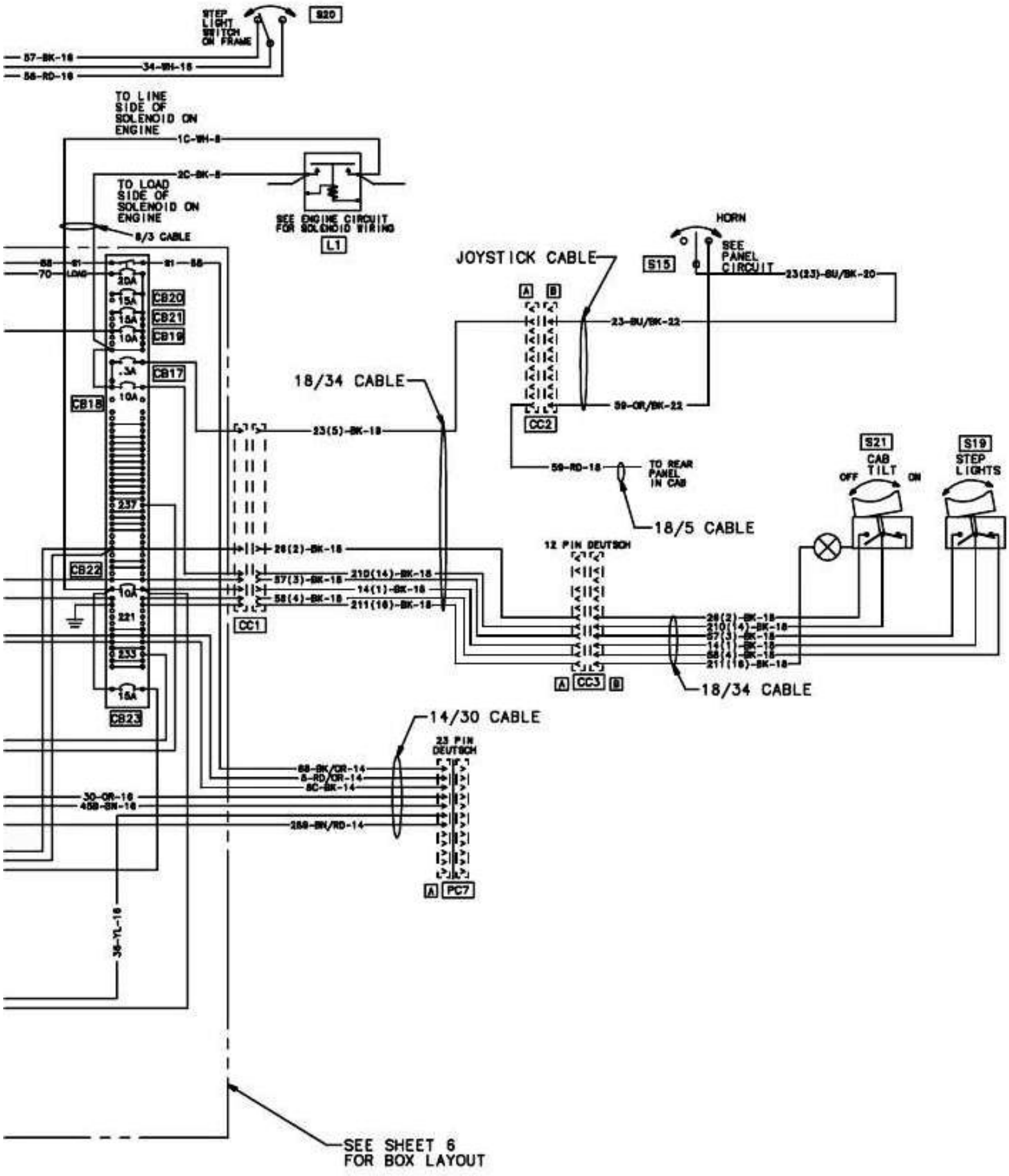

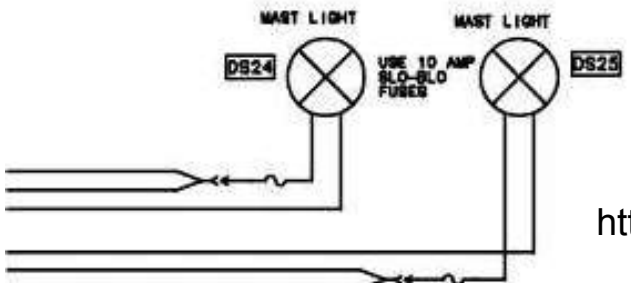

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Illustration 6-13. Main Control Junction Box

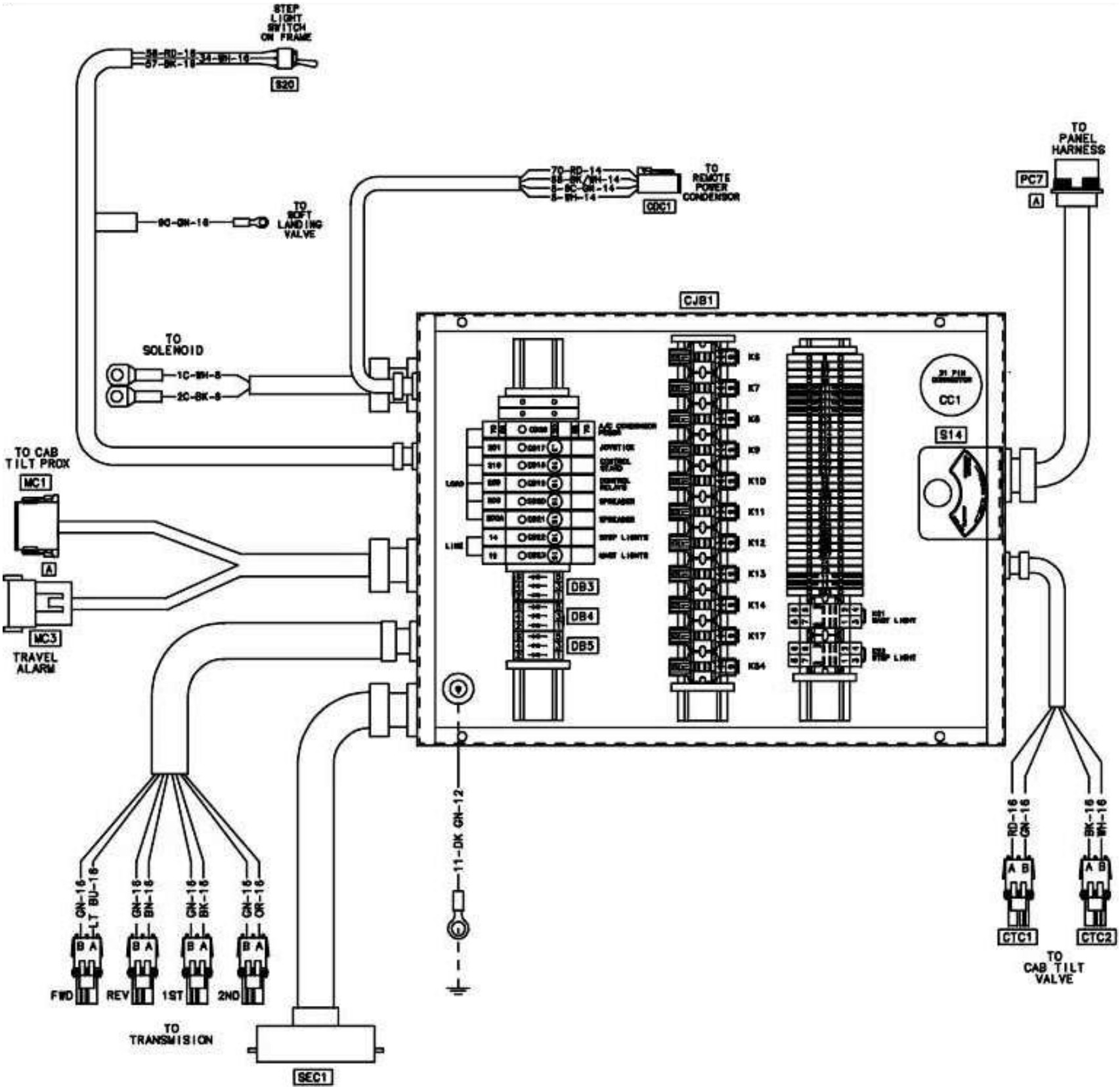

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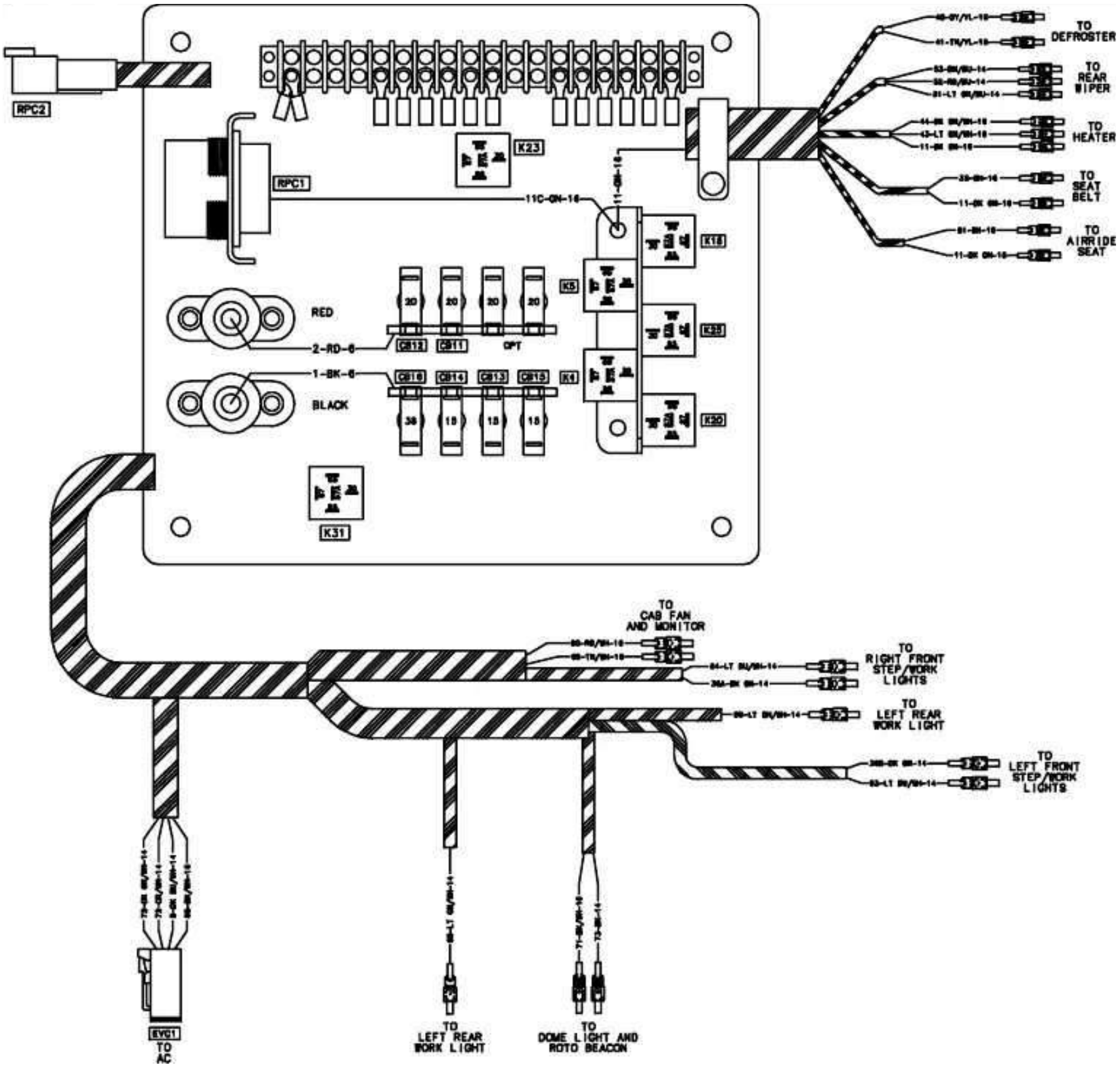
Illustration 6-14. Cab Rear Panel Harness



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PLACE THE FOLLOWING ILLUSTRATIONS IN FOLDER ENVELOPES:

Illustration 6-15 - 06 2366 SHT. 10 (Truck Control ANSI)

Illustration 6-16 - 06 2366 SHT. 9 (ANSI)

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