



OPERATOR'S HANDBOOK

Mack® Natural Gas
(LEU / MRU)

Mack® Natural Gas

21607699

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Printed in U.S.A.

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(LEU / MRU)



21607699
September 2010

Foreword

The information in this manual applies to vehicles built January 2010 and later. Please keep this manual in the vehicle at all times.

This Handbook only applies to LEU and MRU models equipped with natural gas engines. For models equipped with diesel engines, please refer to Mack Terra Pro Series Operator's Handbook.

Note: Illustrations in this manual are used for reference only and may differ slightly from the actual vehicle. However, key components addressed in this document are represented as accurately as possible.

The National Highway Traffic Safety Administration (NHTSA) and MACK Trucks, Inc. should be informed immediately if you believe that the vehicle has a defect that could cause a crash, injury or death.

Contact NHTSA by calling the Auto Safety Hotline at 1 (888) 327-4236, by writing to NHTSA, U.S. Department of Transportation, Washington, DC 20590, by TTY at 1 (800) 424-9153, or visit their website at www.nhtsa.dot.gov.

Mack Trucks, Inc.
Greensboro, NC USA

Order number: PV776-21607699

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TO THE OWNER

About This Handbook

This handbook is referred to as the Cummins-Wesport ISL-G™ Natural Gas Engine Handbook. It covers all Natural Gas Engine models. Keep this handbook with the vehicle at all times to ensure that each owner and/or operator will have access to all pertinent information relating to the operation and handling of this vehicle.

This supplement was prepared to provide the driver with all relevant information concerning the natural gas engine, its characteristics and its potential hazards if not maintained properly. Please read it thoroughly; pay particular attention to advisory labels that have been included to draw attention to important issues of operator safety and overall performance.

Information and illustrations in this handbook are based on the latest production usage at the time of printing and are subject to change without prior notice.

Refer to your vehicle's Operator's Handbook for additional vehicle information.

2 Safety Information

Important Safety Information for All Operators of Natural Gas Vehicles

 **DANGER**

Do not operate, occupy or refuel an LNG/CNG vehicle if you are unsure of your qualifications for operating, refueling or recognizing and responding to potentially dangerous emergency situations that could arise related to LNG/CNG vehicles and equipment.

Although formal certification is not currently required - from an operational, safety and liability perspective - it may be desirable for personnel handling LNG/CNG equipment to carry a written certificate attesting to such training. It is the responsibility of the owner and operator of any LNG/CNG facility or equipment to have proper safety training before operating LNG/CNG equipment. Information concerning proper LNG/CNG safety training is available through the manufacturer of LNG/CNG vehicles and equipment. If you are unsure about your qualifications for operating, refueling or recognizing and responding to potentially dangerous emergency situations that could arise related to the operating of an LNG/CNG vehicle, contact your immediate supervisor or call MACK OneCall™ Customer Support System at 1-800-866-1177.

The scope of this handbook is not to cover all situations related to LNG/CNG safety. Effective safety training programs are required at all LNG/CNG vehicle facilities to ensure the safety of personnel, protect property and maintain facility performance requirements. Familiarizing all personnel with basic LNG/CNG information will allow them to make well-informed safety judgments. A safety program at the facility should include:

- 1 Scheduled equipment inspections
- 2 Operational safety procedures
- 3 Personnel training and certification
- 4 Emergency response procedures and periodic practice drills
- 5 Emergency response community interaction

Although this handbook contains safety information that may be used in conjunction with a safety training program, it is not to be viewed as a safety-training manual. The safety information contained in this manual is for reference and recall of information already covered in an ongoing safety program. Only safety training and periodic practice drills can adequately train operators and local emergency personnel (such as fire departments, medical emergency units and police departments) for safely handling potentially dangerous situations in the community proximate to LNG/CNG facilities and LNG/CNG vehicle operation.



DANGER

It is recommended that personnel never enter a vapor cloud. If the vapor ignites, they could be severely burned. Inhaling the vapor can cause breathing problems or asphyxiation.

4 Safety Information

Properties of LNG:

Liquefied Natural Gas/Methane (LNG) is a colorless, odorless gas or liquid. At ambient temperatures, the product is a gas, but at cryogenic (super-cooled) temperatures it is a liquid or heavy gas that may travel along the ground, rise as it warms and vaporizes, and become trapped under any closed-in space.

Properties of CNG:

Compressed Natural Gas/Methane (CNG) is a colorless, odorless (sulfur) gas. It is compressed at 2400 to 3600 pounds per square inch and stored/used in specially designed cylinders.

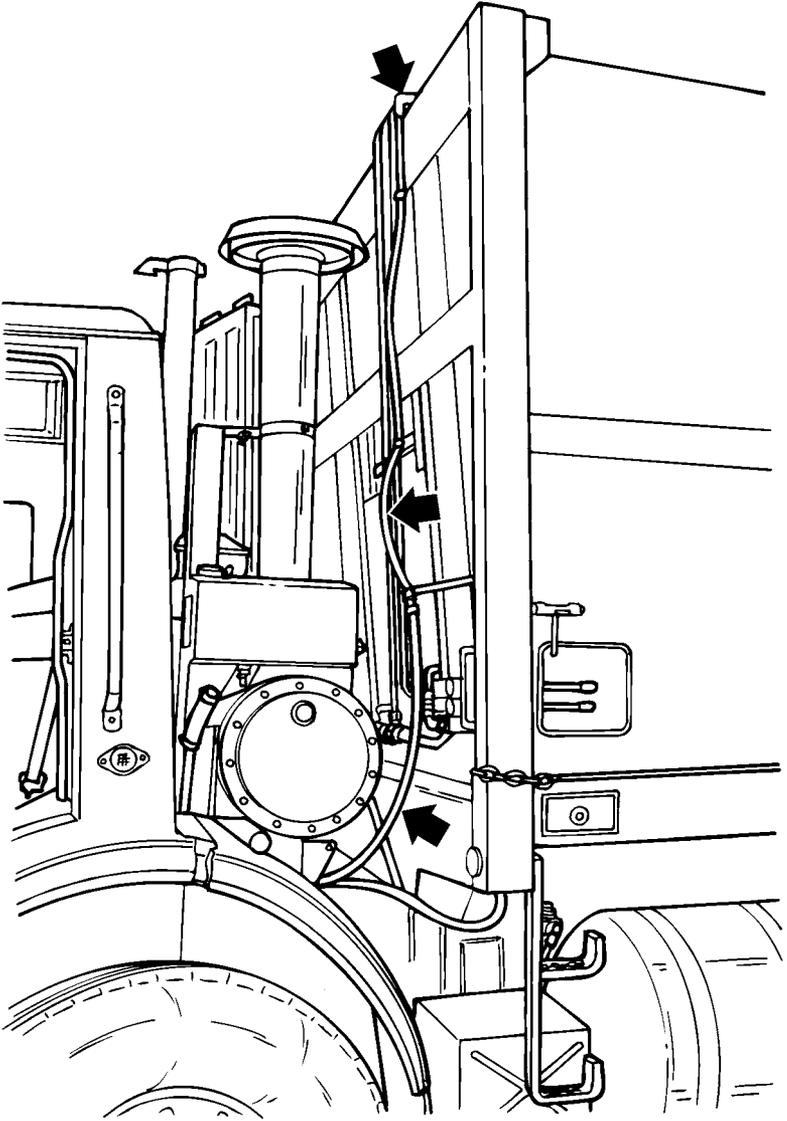
Normal Methane Venting

The methane fuel tanks automatically vent to release pressure when the vehicle is parked for some time. During venting a hissing sound may be heard. The frequency and duration of this venting will vary depending on tank pressure and ambient temperature. It will continue to vent until the truck is operated again, thereby dropping the pressure, or until the tank(s) is empty.

Primary LNG Tank Vent Piping

From the factory, the vent piping from the primary LNG tank vents is attached to the intake stack by disposable plastic straps. The piping should be removed from the intake stack and plumbed up and over the body by the body installers as shown in the following illustration. For more information, see the section titled "LNG Tank Pressure Vents" in the *OPERATION* section of this manual.

 CAUTION
It is important to keep the primary pressure vent free of blockage due to ice, snow or debris.



6 Safety Information

Methane Leaks

During the daily walk around, inspect the outside of the LNG fuel tank for frost. Frosted LNG tank(s), other than at the shroud area*, indicates that the inner tank is leaking into the outer tank. The appearance of a vapor cloud accompanied by a hissing noise may also indicate a methane leak. A leak requires service on the tank(s) before the vehicle can be operated.

*Rear fuel tank door and plumbing fixtures.



WARNING

Do not operate a vehicle which has a methane leak.

Rapid Pressure Rise

There are three main causes of rapid pressure rise on LNG systems; overfilling, fuel system leaks or malfunctions and loss of vacuum. A properly functioning, properly filled LNG fuel system should build less than 15 psig/ day. Any system building more than 40 psig/ day needs troubleshooting to find the cause.

Vacuum Loss

Total vacuum loss is an unusual event for an LNG tank (resulting in frosting the entire shell), however the vacuum will slowly decay with time as gasses diffuse out of the tank materials. This will show up over time as a more rapid pressure rise time, eventually exceeding 40 psig/ day. Once the vacuum has decayed to this point, the tank will need to be re-evacuated by a competent maintenance facility.

METHANE DETECTOR/ALARM SYSTEM

Note: The following information applies to equipment located on the vehicle only. Separate methane detector/alarm systems should be installed in facilities that frequently house natural gas vehicles. In addition, hand-held methane detector/alarm devices should be used when working on natural gas vehicles with non-functioning or disconnected methane detector/alarm systems and where no auxiliary methane detector/alarm system is installed.

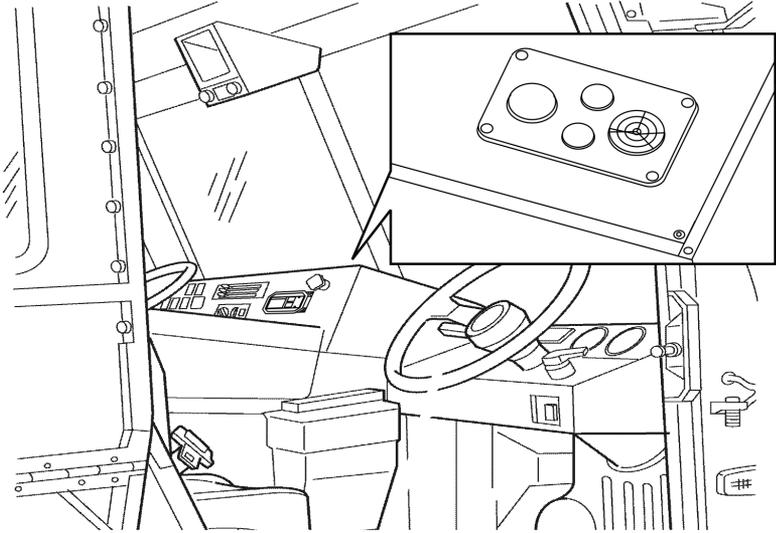
Note: Consult your local fire code and/or fire inspector to make sure that adequate detection and prevention measures are in place.

The methane vapor detection system utilizes two sensors to identify methane vapors; one located in the cab compartment and one located in the engine compartment of the vehicle. The system operates with both a visual and an audible alarm to warn the operator of potential danger. The alarms are triggered at trace levels (20% LEL [Lower Explosive Limit]) and at significant levels (50% LEL) of vapor concentration. The system and sensor operation is constantly monitored. An internal relay controls two indicator lamps (1 green and 1 red) that can be seen through the windshield. The green lamp will go out and the red lamp will illuminate 15 seconds after a significant level of methane has been detected. The methane detector also has a passto-test button that can be used to test the indicator lamps and the audible alarm.

8 Safety Information

Before Entering the Vehicle

Green and red methane detector remote indicator lamps are easily viewed through the windshield and should always be checked before entering the vehicle. (See illustration.)



W0059509

**DANGER**

WHEN APPROACHING THE CAB TO ENTER: Do not open the vehicle doors if the RED LAMP IS ON! Do not open the vehicle doors if the ALARM IS SOUNDING! Do not open the vehicle doors if the GREEN LAMP is NOT ON! If the indicator lamp is red, if the alarm is sounding or if the green lamp is NOT ON, it is unsafe to open the vehicle doors because even static electricity can ignite concentrated methane fumes in an enclosed area. Immediately implement the following procedure:* Remove all personnel from the area. Turn off electrical circuits and sources of ignition in the immediate area. Manually turn off the Fuel Shut-Off Valve on each fuel tank to prevent further gas leakage. Wait until the gas has dissipated and the alarm situation has cleared. It is now safe to open the vehicle doors and windows to vent the vehicle. Do not operate the vehicle until the source of the leak has been repaired.

Note: When the battery is disconnected, the methane detector/alarm system will not operate so the green lights will not be on. The methane detector/alarm system is powered by the battery and is active at all times unless the battery is disconnected or the fuse is blown.

Hand-held methane detector/alarm devices should be used when working on natural gas vehicles with a nonfunctional or disconnected methane detector/alarm system and where no auxiliary methane detector/ alarm system is installed.

10 Safety Information

DANGER

In the event of an alarm while operating the vehicle, immediately open the cab windows, safely stop the vehicle, shut down the engine and turn off the ignition. Exit the cab and leave the doors and windows open to vent the vehicle. Manually turn off the Fuel Shut-Off Valve on each fuel tank to prevent further gas leakage. Wait until the gas has dissipated and the alarm situation has cleared. Do not operate the vehicle until the source of the leak has been repaired.

CAUTION

AMGaDS III Plus is a propane, CNG (Compressed Natural Gas) and LNG (Liquid Natural Gas) detector only. However, because the sensors detect all hydrocarbon vapors, an alarm may be triggered by the use of chemicals such as cleaners, paint, polish, lacquer, etc. Do not expose sensors to liquids or chemicals unnecessarily. When using such substances, keep the vehicle well ventilated and do not allow direct contact with the sensors. For cleaning and maintenance of the Gas Detection System, refer to the AMGaDS III Plus Owner's Manual supplied with the vehicle.

Note: For additional information, refer to and in the INSTRUMENTS AND CONTROLS section of this handbook.

Potential Hazard Associates with LNG/CNG:

Skin/Eyes

LNG is stored at cryogenic temperatures (low-temperature state, starts at or below -240 °F (about -150 °C) and CNG is stored in specially designed tanks under extremely high pressure. Therefore, properly insulated safety gloves and eye protection such as goggles or a face shield should be worn when working with or around LNG/CNG as when refueling. If super-cooled liquid or gas comes into contact with the skin or eyes, see a physician immediately.



WARNING

COVER EYES AND EXPOSED SKIN. Accidental contact of the eyes or skin with LNG may cause a freezing injury similar to a burn. Protect the eyes and cover the skin whenever the possibility of contact with super-cold metals, liquids or gas exists.

12 Safety Information

Inhalation

LNG/CNG is not toxic, but can cause **asphyxiation** in concentration or in enclosed areas because it reduces the oxygen available for breathing. For this reason, methane detectors are located in the engine compartment and inside the cab. These detectors will trigger an alarm inside the cab if methane concentration goes above a safe level. These detectors are always active whether the vehicle is on or off, as long as the battery is connected and the fuse is in place and not blown. If overcome by vapor, remove the individual from exposure and call a physician immediately. If breathing is irregular or has stopped, start resuscitation (if trained in CPR) and administer oxygen if available.

DANGER

KEEP THE EQUIPMENT AREA WELL VENTILATED. Although LNG/CNG is non-toxic, it can cause asphyxiation in a confined area without ventilation. Any atmosphere that does not contain enough oxygen for breathing can cause dizziness, unconsciousness, or even death. LNG, being colorless, odorless and tasteless, cannot be detected by human senses. Even though CNG is sulfurized, the smell may go unnoticed on some vehicles, such as a refuse truck. Without adequate ventilation, natural gas will displace the oxygen and give no warning that a non-life supporting atmosphere is present. Store LNG/CNG in a well ventilated area.

If vehicles equipped with an LNG engine must be parked or worked on indoors for short periods of time, piping from the primary LNG tank vent pipe to the outside of the building should be provided. See "Primary LNG Tank Vent Piping" at the end of the SAFETY section. De-fueling or removal of the LNG tank(s) is recommended for vehicles stored indoors for long periods of time.

Separate methane detector/alarm systems should be installed in facilities that frequently house LNG/CNG vehicles, consult local codes and ordinances to ensure compliance. In addition, handheld methane detector/alarm devices should be used when working on LNG/CNG vehicles with non-functioning or disconnected methane detector/alarm system and where no auxiliary methane detector/alarm system is installed.

Note: Due to the cryogenic state of LNG fuel, it cannot be odorized, therefore, it will not smell like CNG or pipeline gas in a home.

Flammability

Since LNG is extremely flammable, the tank(s) should be grounded when fueling, to avoid creating sparks from static electricity. Keep any source of ignition, such as a lit cigarette, far away from LNG/CNG tanks and fueling areas.



WARNING

KEEP AWAY FROM FLAME OR SPARK.

Natural gas is flammable. Smoking, open flames, and general purpose electrical equipment shall be prohibited where natural gas is stored or handled.

Pressure

The LNG/CNG fuel systems are pressurized systems. Therefore, automatic and manual safety vents, relief valves and shutoff points are installed throughout the system to prevent excess pressure from building.



WARNING

REMOVE PRESSURE. Always empty the LNG/CNG fuel tank(s) and remove any pressure on the system prior to removing parts or components of the tank for repair.

Releases or Spills

During a release or spill, shut off and eliminate all ignition sources. If desired, stop the source of the release or spill. Keep people away. Minimize breathing vapors. Absolutely avoid skin contact. Ventilate confined spaces. No disposal method is necessary, nor should it be attempted, because extremely rapid evaporation of the natural gas will take place. If a spill is in danger of igniting, use a water spray (do not use solid streams of water) to direct gas-air mixtures away from ignition sources

If a spill has ignited, use water to keep fire-exposed containers and equipment cool and to protect personnel who may have to stop the source of the leak. If it is desirable to extinguish the fire, use dry chemical, carbon dioxide or halogenated extinguishing agents.

14 Safety Information

SPECIFIC SAFETY INFORMATION REGARDING THE INSTRUMENTS AND CONTROLS, THE OPERATION, AND THE MAINTENANCE OF THE CHASSIS WILL BE COVERED IN YOUR OPERATOR'S HANDBOOK.

Cab Entry/Exit

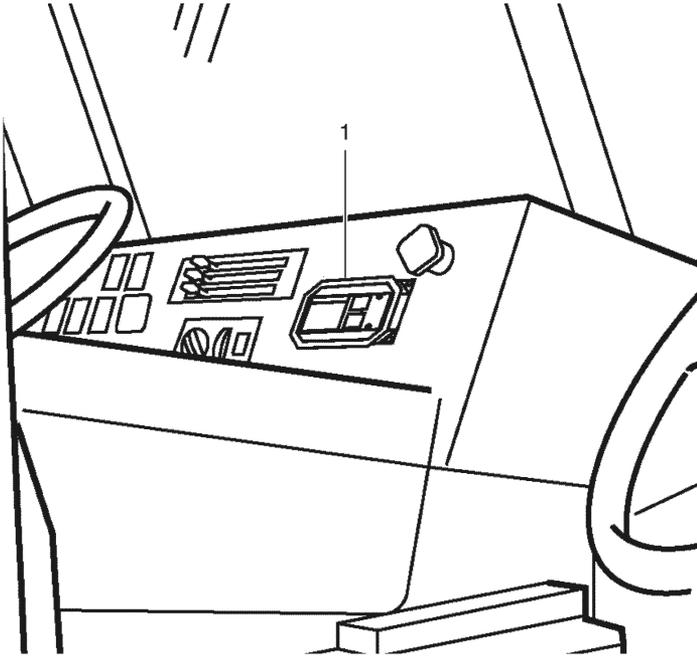
As described in your Operator's Handbook, follow the Three-Limb Contact Rule to enter and exit your vehicle.

DANGER

Before opening either vehicle door, always look through the driver side window at the methane alarm box located on instrument panel (MRU and LEU). Do NOT open the door if a red alarm light is on or if you hear the audible alarm sounding. Do NOT open the door if the green light is not ON.

CAB INTERIOR

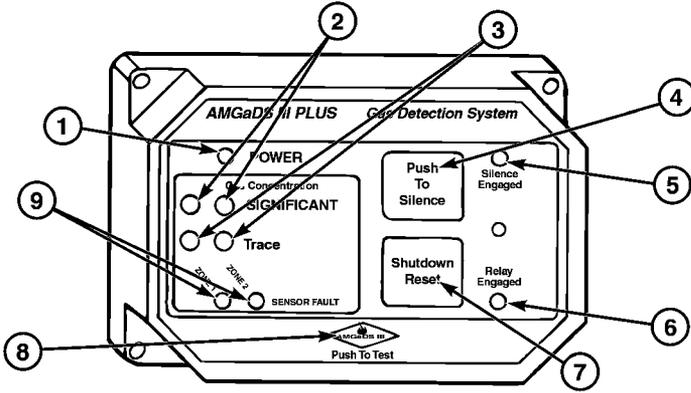
Below you will see how the methane detector/alarm system is arranged on a typical LEU instrument panel: (The exact layout may differ from your truck, but the gas detection system will look the same.)



W0059510

1. **Gas Detection System** — See below for detailed display information

16 INSTRUMENTS AND CONTROLS



C0032252

1. Power On Indicator (Green)	6. Relay On/Off Indicator
2. Significant Alarm Indicators (Red)	7. Relay Reset Button
3. Trace Sensor Alarm Indicators (Amber)	8. System Test Button
4. Audible Alarm Silence Button	9. Sensor Fault Indicators
5. Alarm Silenced Indicator	

- 1 **Power On Indicator (Green)** — This green LED should always be on. No power on/off switch is provided for this unit as it should be on at all times.

Note: When the battery is disconnected, the methane detector/alarm system will not operate so the green light will not be on. The methane detector/alarm system is powered by the battery and is active at all times unless the battery is disconnected or the fuse is blown. Hand-held methane detector/alarm devices should be used when working on natural gas vehicles with a non-functioning or disconnected methane detector/alarm system and where no auxiliary methane detector/alarm system is installed.



DANGER

WHEN APPROACHING THE CAB TO ENTER:

Do not open the vehicle doors if the RED LAMP IS ON! Do not open the vehicle doors if the ALARM IS SOUNDING! Do not open the vehicle doors if the GREEN LAMP is NOT ON!

If the indicator lamp is RED, if the alarm is sounding or if the green lamp is NOT ON, it is unsafe to open the vehicle doors because even static electricity can ignite concentrated methane fumes in an enclosed area. Immediately implement the following procedure:*

Remove all personnel from the area.

Turn off electrical circuits and sources of ignition in the immediate area.

Manually turn off the Fuel Shut- Off Valve on each fuel tank to prevent further gas leakage . Wait until the gas has dissipated and the alarm situation has cleared. It is now safe to open the vehicle doors and windows to vent the vehicle.

Do not operate the vehicle until the source of the leak has been repaired.

* Depending on local ordinances or company policy, it may be recommended that emergency personnel be contacted to implement these procedures



DANGER

the event of an alarm while operating the vehicle, immediately open the cab windows, safely stop the vehicle, shut down the engine and turn off the ignition. Exit the cab and leave the doors and windows open to vent the vehicle. Manually turn off the Fuel Shut-Off Valve on each fuel tank to prevent further gas leakage. Wait until the gas has dissipated and the alarm situation has cleared. Do not operate the vehicle until the source of the leak has been repaired.

- 2 **Significant Sensor Alarm Indicators (Red)** — Illumination of the red LED for "Zone 1" (cab compartment) or "Zone 2" (engine compartment) indicates the system has detected gas fumes in concentrations above 50% of the Lower Explosive Limit (LEL) and an audible horn will sound.

18 INSTRUMENTS AND CONTROLS

3. **Trace Sensor Alarm Indicators (Amber)** — Illumination of the amber LED for "Zone 1" (cab compartment) or "Zone 2" (engine compartment) indicates the system has detected a gas concentration above 20% of the LEL. This is a cautionary situation. Corrective measures should be taken as soon as possible — including opening the vehicle windows and returning the vehicle for service — to identify and correct the source of the methane leak.
4. **Audible Alarm Silence Button** — Press to silence the audible alarm.
5. **Alarm Silenced Indicator** — Illuminates to indicate the audible alarm has been silenced.
6. **Relay On/Off Indicator** — If there is a SIGNIFICANT alarm detected for 15 seconds, the "Relay Engaged" LED will go on. The remote windshield-visible green lamp will go out and the remote windshield-visible red lamp will illuminate.
7. **Relay (Shutdown) Reset Button** — Only after the methane gas has cleared and the alarms are off, may the internal relay be reset by pressing the "Shutdown Reset" button. After pressing the Shutdown Reset button, the "Relay Engaged" LED goes off.
8. **System Test Button** — Pressing the button will cause the system to perform a self-test of all electrical and sensor functions and simulate an alarm condition. The system returns to normal when the test button is released.
9. **Sensor Fault Indicators** — If either Sensor Fault light remains illuminated or illuminates intermittently, a disconnected or faulty sensor is indicated in the corresponding zone. Zone 1 indicates the cab compartment sensor and Zone 2 indicates the engine compartment sensor. Do not operate the vehicle until a qualified person corrects this condition.

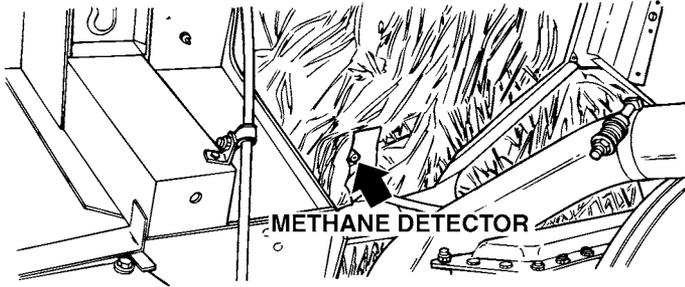


CAUTION

AMGaDS III Plus is a propane, CNG (Compressed Natural Gas) and LNG (Liquid Natural Gas) detector only. However, because the sensors detect all hydrocarbon vapors, an alarm may be triggered by the use of chemicals such as cleaners, paint, polish, lacquer, etc. Do not expose sensors to liquids or chemicals unnecessarily. When using such substances, keep the vehicle well ventilated and do not allow direct contact with the sensors. For cleaning and maintenance of the Gas Detection System, refer to the AMGaDS III Plus Owner's Manual supplied with the vehicle.

Methane Detector/Alarm System

In addition to the methane detector located in the cab, there is another methane detector located in the "doghouse" under the cab as shown in the following illustration.



C0032253

The methane alarm/detection system runs off the battery and is active at all times unless the battery is disconnected.

DANGER

If the battery is disconnected, the methane detector/alarm system will not operate.

DANGER

In the event the methane alarm red light comes on and the alarm sounds, the cab windows should immediately be opened, the vehicle should be safely stopped and turned off, and personnel should exit the cab. Follow safety precautions in the SAFETY section of this manual.

Frosted LNG tank(s), other than around the area of the rear fuel tank door and plumbing fixtures, indicates that the inner tank is leaking into the outer tank. The appearance of a vapor cloud accompanied by a hissing noise may also indicate a methane leak. A leaking condition requires service on the tank(s) before the vehicle can be operated.

WARNING

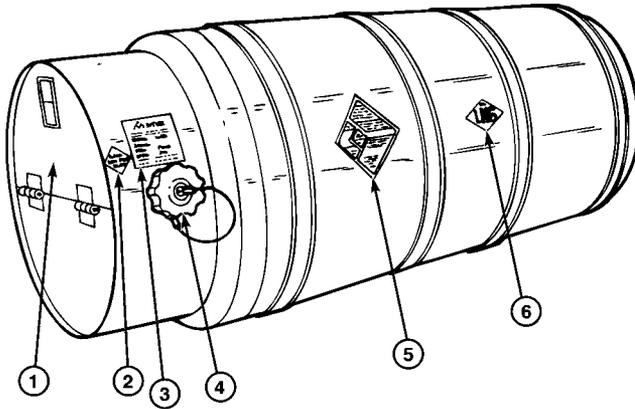
Do NOT operate a vehicle which has a methane leak.

20 OPERATION

LIQUID NATURAL GAS SYSTEM

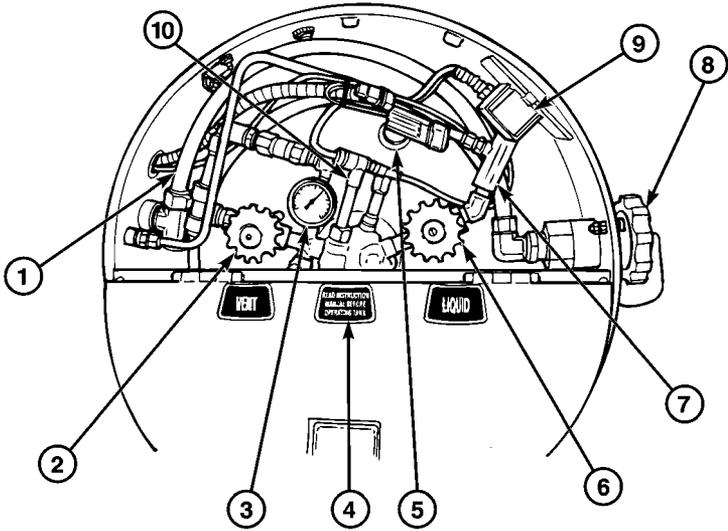
LNG Tank

There are one or two LNG tanks. They are mounted on one or both sides of the truck with the plumbing components accessible inside the rear of each tank. The LNG fuel tank is, for simplicity of explanation, designed like a vacuum (Thermos™) bottle which can withstand pressures up to 230 psi, or whatever maximum pressure is posted on the manufacturer's label (see illustration).



C0032254

1. Rear of Tank (Shroud) with Door Closed	4. Fuel Tank Fill Fitting
2. Maximum-Pressure Label in Pounds per Square Inch (psi)	5. Tank Safety Label
3. Manufacturer's Label	6. Liquefied Natural Gas Symbol



C0032255

1. Fill Connection to Second Fuel Tank	6. Fuel Shut-Off Valve
2. Manual Vent	7. Excess Flow Valve
3. Fuel Tank Pressure Gauge	8. Fuel Tank Fill Fitting
4. Tank Manufacturer's Manual (Inside Bottom half of Tank Door)	9. Fuel Gauge Sending Unit
5. Evacuation Plug (Do Not Remove)	10. Fuel Tank Level Probe

22 OPERATION

- 1 **Fill Connection to Second Fuel Tank** — When fueling, LNG will enter the second vessel through this connecting pipe.
- 2 **Manual Vent** — This valve is clearly marked with OPEN and CLOSE directional arrows. It is normally kept closed, but may be opened to bleed the tank or in certain fueling situations which are described in the section "LNG Fueling."
Note: There is normally no need to manually vent the tank. The vessel is protected from over-pressurization by several automatic safety relief valves.
- 3 **Fuel Tank Pressure Gauge** — Each tank has a separate pressure gauge. The normal operating pressure of the tanks is approximately 120 psi or higher. Normal procedure is to refuel on a daily basis or each time the vehicle is taken into active service.
- 4 **Tank Manufacturer's Manual** — Located inside the bottom half of the tank door. As the label indicates, this manual should be read entirely before operating the tank.
- 5 **Evacuation Plug (Do Not Remove)** — The LNG fuel tank is equipped with an outer jacket evacuation plug that will pop open if there is a loss of vacuum. The loss of the evacuation plug indicates an inner vessel leak. The evacuation plug is protected from the environment and tampering by a plastic cap. Do not remove the plastic cap or evacuation plug.
- 6 **Fuel Shut-Off Valve** — This valve is clearly marked with OPEN and CLOSE directional arrows. During normal operation, the valve should remain fully open to allow fuel to reach the engine. Close this valve to shut off fuel to the engine.
Note: If there is more than one tank, both tank valves must be turned off to shut off fuel to the engine.
- 7 **Excessive Flow Valve** — Restricts excess fuel flow in the event of a fuel line breakage.
- 8 **Fuel Tank Fill Fitting** — Filling the LNG vehicle fuel tanks is done through a single hose connected to the fill fitting. Instructions on filling the fuel tanks are under the section "LNG Fueling."
- 9 **Fuel Gauge Sending Unit** — Receives signals from the tank probe and converts them into values compatible with the fuel gauge. The sending unit is sealed and non-adjustable.
- 10 **Fuel Tank Level Probe** — Senses the fuel level in the tank.

During the daily walk around inspection, if you see any signs of a methane leaks as previously mentioned in the *SAFETY* section of this handbook, open the tank door. If the Evacuation Plug has popped out, the tank must be serviced before operating.

LNG Tank Pressure Relief Valves

Periodically pressure will be harmlessly released through the primary relief valve as the fuel heats up and expands due to ambient outside temperature. Liquid LNG in the tanks can be as low as -260°F (-177°C). Because small amounts of LNG are converted into large amounts of natural gas, pressures may rapidly increase if a means of relief is not provided.

The primary and secondary pressure vents are located inside the fuel tank door. The primary vent is connected to piping which should be attached to the body of the truck facing toward the rear of the vehicle, away from the passenger compartment. Only the primary relief valve is piped away. The secondary relief valve should be left with the factory installed plastic cap in place. Refer to the tank manufacturer's manual for more details.

From the factory, the vent piping from the primary LNG tank vent is attached to the intake stack by disposable plastic straps. The piping should be removed from the intake stack and plumbed up and over the body by the body installers as shown in the illustration at the end of the SAFETY section in this handbook.



CAUTION

It is important to keep the primary pressure vent free of blockage due to ice, snow or debris.

LNG Fueling

Normal procedure is to refuel the tanks on a daily basis or each time the vehicle is taken into active service. The normal operating pressure in each tank is approximately 120 psi or higher. If the pressure is low, say 90 psi, the vehicle is probably low on fuel. As a result, it will be low in power and may eventually run out of fuel.

Note: Complete and safe instructions on LNG fueling should be obtained from the tank manufacturer's manual and from the assistance of personnel who are experienced in LNG fueling.



WARNING

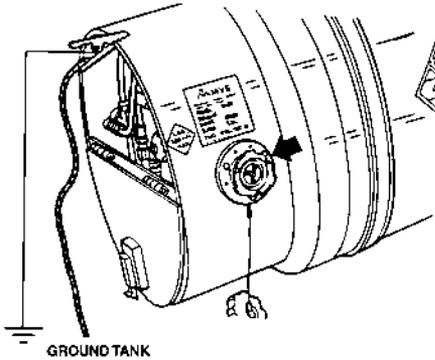
COVER EYES AND EXPOSED SKIN. Accidental contact with the eyes or skin may cause a freezing injury similar to a burn. Protect the eyes and cover the skin whenever possible contact with supercooled metals, liquids or gases exists.

24 OPERATION

DANGER

KEEP THE EQUIPMENT AREA WELL VENTILATED. Although LNG/CNG is non-toxic, it can cause asphyxiation in a confined area without ventilation. Any atmosphere that does not contain enough oxygen for breathing can cause dizziness, unconsciousness, or even death. LNG, being colorless, odorless and tasteless, cannot be detected by human senses. Without adequate ventilation, natural gas will displace the oxygen and give no warning that a non-life supporting atmosphere is present. Store LNG in a well ventilated area.

Ground Tank and Open Fuel Tank Fill Fitting

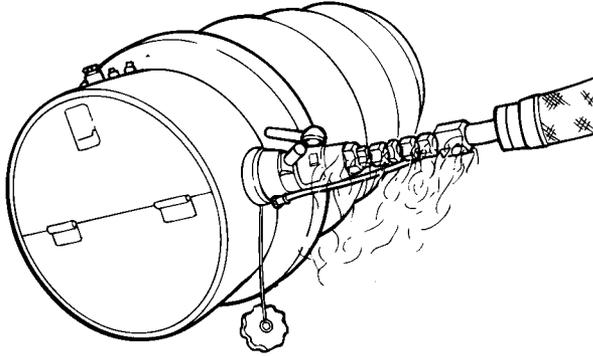


C0032256

DANGER

KEEP AWAY FROM FLAME OR SPARK. Natural gas is flammable. Before fueling, connect the fuel tank to the ground cable at the fueling station. Smoking, open flames, and general purpose electrical equipment shall be prohibited where liquefied natural gas is stored or handled.

Connect Fill Hose



C0032257

DANGER

Fueling stations and fueling situations differ. Do not fill an LNG tank without first going through the procedures with the assistance of experienced personnel.

Normal Filling

Filling the inner vessel of the LNG vehicle fuel tank is done through a single hose. When the fill hose is connected to the fuel tank fill fitting, LNG is supplied at a pressure higher than the vehicle tank pressure. The fill is automatically terminated when the pressure reaches a preset value at the fueling station. Remove the filling hose from the fitting.

Warm Tank Filling

The LNG vehicle fuel tank is considered to have a warm inner vessel either prior to initial filling of the tank, or after the tank has been out of service for more than two weeks. The recommended procedure for a warm tank fill is to fill the vehicle tank with approximately 95 liters (25 gallons) of LNG and allow it to build pressure. This will begin to cool the inner vessel and build enough pressure to allow a leak test to be performed. The pressure may now be manually vented down and a normal fueling sequence may be done.

COMPRESSED NATURAL GAS SYSTEM

CNG Fueling

Refer to **Fuel System Installer** for fueling/defueling requirements.



WARNING

COVER EYES AND EXPOSED SKIN. Accidental contact with the eyes or skin may cause a freezing injury similar to a burn. Protect the eyes and cover the skin whenever possible contact with supercooled metals or gases exists.



DANGER

KEEP AWAY FROM FLAME OR SPARK. Natural gas is flammable. Before fueling, connect the fuel tank to the ground cable at the fueling station. Smoking, open flames, and general purpose electrical equipment shall be prohibited where compressed natural gas is stored or handled.



DANGER

KEEP THE EQUIPMENT AREA WELL VENTILATED. Although CNG is non-toxic, it can cause asphyxiation in a confined area without ventilation. Any atmosphere that does not contain enough oxygen for breathing can cause dizziness, unconsciousness, or even death. Even though CNG is odorized, under certain circumstances, in a refuse vehicle for example, it may not be detected by human senses. Without adequate ventilation, natural gas will displace the oxygen and give no warning that a non-life supporting atmosphere is present. Store CNG in a well ventilated area.



DANGER

Fueling stations and fueling situations differ. Do not fill a CNG tank without first going through the procedures with the assistance of experienced personnel.



DANGER

Failure or improper selection or improper use of this product can cause death, personal injury and property damage, including, but not limited to electrocution, fluid injection or loss of limb caused by high pressure leak, dangerously whipping hose, fire explosion or contact with suddenly moving or falling objects.

MAINTENANCE INTRODUCTION

This handbook contains maintenance information specific to the Natural Gas Vehicle and Engine. For recommended lubrication change intervals and procedures for gear oils (transmission, rear axle carrier[s], front drive axle carrier, transfer case and flywheel PTO) or other maintenance schedules or procedures not included in this portion of the handbook, refer to the *Maintenance and Lubrication Manual (21394653)* or your vehicle model's Operator Handbook.

DAILY LNG/CNG FUEL SYSTEM CHECKS

Check for Methane Leaks or Loss of Vacuum

The LNG and CNG fuel systems are pressurized systems. Any damage to the fuel delivery system may result in leaks. All the tubing carrying liquid or gas fuel from the fuel tanks to the vaporizer are stainless steel. The tubing from the vaporizer throughout the remainder of the fuel delivery system is specialized high pressure tubing. Any damage to this system should be repaired as soon as possible.

During the daily walk around, check for any leaks or damage to the fuel system. The appearance of a vapor cloud accompanied by a hissing noise may indicate a methane leak. Inspect the outside of the fuel tank for frost (LNG only). A frosted tank indicates that the inner tank is leaking into the outer tank or there has been a loss of vacuum. Open the tank door; if the Evacuation Plug has popped out, the tank must be serviced. A leaking condition requires service before the vehicle is operated.



WARNING

Do not operate a vehicle which has a methane leak.

Note: Some frosting and sweating is normal around the plumbing fittings in the shrouded end of the tank.

28 MAINTENANCE AND LUBRICATION

Primary LNG Tank Vent Piping

From the factory, the vent piping from the primary LNG tank vents is attached to the intake stack by disposable plastic straps. The piping should be removed from the intake stack and plumbed up and over the body by the body installers.



CAUTION

It is important to keep the primary pressure vent free of blockage due to ice, snow or debris.



CAUTION

If LNG vehicles must be parked or worked on indoors for short periods of time, piping from the primary LNG tank vent pipe to the outside of the building should be provided. De-fueling or removal of the LNG/CNG tanks is recommended for vehicles stored indoors for long periods of time.

BEFORE PERFORMING MAINTENANCE ON THE LNG OR CNG TANKS OR FUEL SYSTEM

Note: Separate methane detector/alarm systems should be installed in facilities that frequently house LNG/CNG vehicles. In addition, hand-held methane detector/ alarm devices should be used when working on LNG/ CNG vehicles with a non-functioning or disconnected methane detector/alarm system and where no auxiliary methane detector/alarm system is installed.



CAUTION

Before performing any maintenance on the LNG/CNG tank system, refer to the tank manufacturer's operation manual.



WARNING

REMOVE PRESSURE. Before working on the LNG/ CNG fuel system, close the fuel valves on each tank and relieve the pressure in the fuel line by opening the drain on the fuel filter or by running the engine until it stops. The LNG/CNG fuel systems are pressurized systems. LNG will boil and cause pressure to build in the system. Do NOT allow LNG to become trapped in piping, as between two closed valves. It will vaporize and rapidly increase pressure, bursting the pipe.

Removing Pressure Before Working on the Engine Fuel System

Before servicing the LNG/CNG engine fuel system, remove pressure from the fuel lines by turning the valves on each tank to the OFF position. This will stop more fuel from entering the lines to the engine. Allow the engine to run until it "dies."

30 MAINTENANCE AND LUBRICATION

Removing Pressure Before Working on the Tanks

If the fuel lines between the tanks or the tanks themselves must be worked on, the system must be totally "bled" of fuel, including the tanks. With a minimum amount of fuel in the tanks, open the manual vent valves on the tanks until the tank pressure gauges read zero.

Note: If possible, try to service the tanks after the vehicle has used most of its on-board fuel.



WARNING

Never bleed the tanks in an enclosed area. Be sure there are no sources of ignition in the area.

Moving a Vehicle Using Auxiliary Fuel

When LNG tanks are not fueled or have been removed, the vehicle may be moved by connecting an auxiliary CNG (compressed natural gas) tank to the connection located on the left side frame rail behind the front inside of the fuel tank on the driver side.

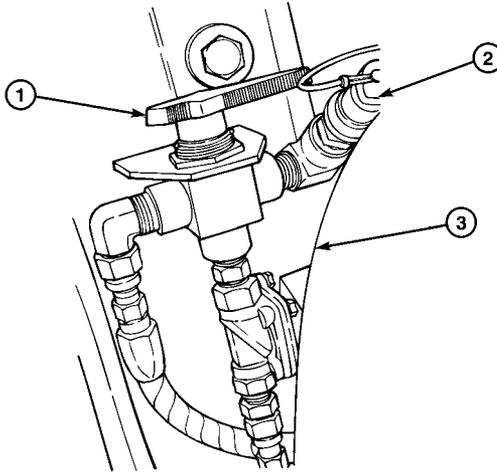


CAUTION

Use a CNG tank with its own pressure regulator. Pressure must not exceed 120 psig at auxiliary tank connection valve (see illustration).

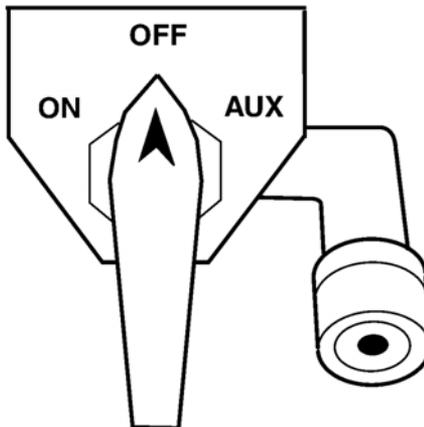
Turn the three-way valve to **AUX** to operate the vehicle from an auxiliary tank.

Turn the valve to **ON** to operate from the main tank(s) and, be sure to turn the valve to **OFF** when parking the vehicle.



C0032260

1. Three-Way Fuel Valve	3. Front Edge of Fuel Tank, Driver Side
2. Auxiliary Tank Connection Valve - 120 psig maximum	



C0032261

32 MAINTENANCE AND LUBRICATION

ENGINE MAINTENANCE

Air Filter

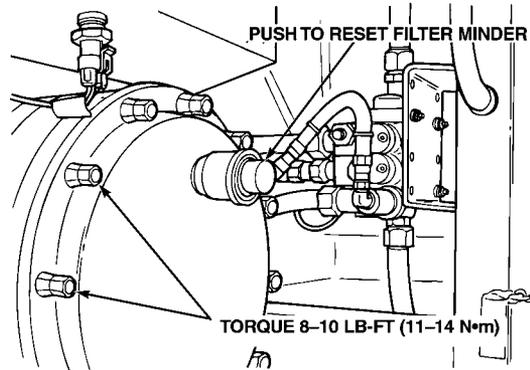
Check the Filter Minder Gauge daily. The Filter Minder Gauge is typically mounted directly on the air cleaner canister behind the cab (MRU and LEU) as shown in the illustration following. Change the filter when the gauge shows 300 mm (12 in) of water or the restriction gauge red signal locks in full view. Regardless of the gauge reading, change the element at least once yearly.

Note: As damage or holes in the filter medium will give an inaccurate restriction reading, change the element at least once yearly to prevent dust, dirt and other harmful contaminants from entering the engine.



CAUTION

Do not attempt to clean the air filter element with compressed air as this could damage the filter medium and possibly result in severe engine damage.



C0032262

To properly install a new filter element:

- 1 Wipe the air cleaner housing clean.
- 2 Loosen the cover retaining nuts and remove the filter element.
- 3 Inspect sealing areas for "dirt tracks" which would indicate that dust has leaked past the seal. If dirt tracks are found, the cause must be determined and corrected.
- 4 Thoroughly clean the inside of the air cleaner canister with a damp cloth or vacuum cleaner.
- 5 Inspect the inside of the canister for rust. If rust is present:
 - Remove the air cleaner canister from the chassis.
 - Remove all loose rust with a wire brush or coarse Scotch Brite® pad.
 - Thoroughly wash the area with PPG DX-440®, or equivalent wax and grease remover.
 - Etch and prepare with PPG Metal Prep 79 (DX-579®), or equivalent.
 - Rinse with water and dry thoroughly.
 - Treat the area with undiluted Galvaprep SG DX-520®, or equivalent.
 - Rinse with water and dry thoroughly.
 - Paint with PPG DP 40/401®, or equivalent.
 - Reinstall the air cleaner canister on the chassis.
- 6 Inspect the sealing areas of the housing for damage. Repair or replace as necessary.
- 7 Use MACK Trucks, Inc., approved replacement elements and gaskets. Make sure the new elements and gaskets are not damaged. Be sure to use new gaskets each time the element is changed.
- 8 Reinstall the cover and torque the retaining nuts evenly at 11 N.m (8-10 lb-ft).
- 9 Reset the Filter Minder by pushing in the button.

34 MAINTENANCE AND LUBRICATION

Air Inlet System Ducts, Hoses and Clamps

Every 45 days or 150 hours, whichever occurs first, inspect all ducts and hoses for signs of leakage or chafing. Replace hose and repair or replace ducts with holes. Tighten clamps.

Chassis-Mounted Charge Air Cooling (CMCAC)

Vehicles equipped with CMCAC require the following preventive maintenance:

- **Daily** — Remove all insects, leaves and other foreign debris from the frontal area by using a firm bristle brush and soapy water.



CAUTION

Do not use a caustic solution to clean CMCAC.

- **Every 45 days of usage or 150 hours*** — Check all air ducting and gasket connections. Proper hose clamp torquing procedure is to tighten hose clamp nuts until spring is fully compressed 3.9 to 4.5 N.m (35–40 lb-in).
- **Every 180 days of usage or 600 hours*** — Check for cracks. Check the mounting brackets for security and condition. Torque the mounts to 41 N.m (30 lb-ft). Check core fins for external damage, debris or salt corrosion. Use a firm, bristled brush to removed salt corrosion. Use air pressure to clean core blockage due to debris.

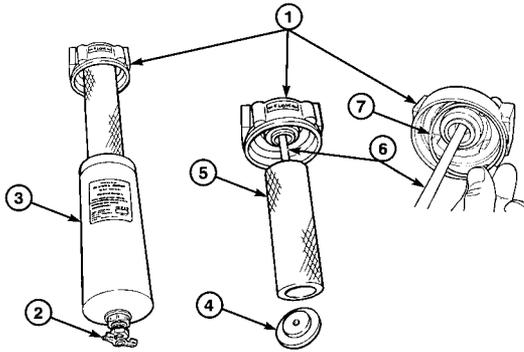
* Whichever occurs first.

Fuel System



WARNING

Before servicing the LNG/CNG engine fuel system, remove pressure from the fuel lines by turning the valves on each tank to the OFF position. This will stop more fuel from entering the lines to the engine. Allow the engine to run until it "dies."



C0032264

1. Engine-Mounted Filter Adapter (For clarity, the filter assembly is shown removed from the engine.)	5. Filter Element
2. Filter Drain	6. Threaded Filter Rod
3. Filter Canister	7. O-Ring
4. Filter Retainer	

36 MAINTENANCE AND LUBRICATION

- After all fuel has been removed from the fuel system, open the filter canister drain [2] at the bottom of the filter unit. Allow any accumulated water and any remaining fuel to drain.
- Rotate the filter canister [3] counterclockwise to release it from the mounted filter adapter [1].
- Remove the retainer [4] from the bottom of the threaded rod [6] that holds the filter element. Pull straight down on the filter element to remove it from the rod.
- Replace the canister bowl O-ring [7] if there are any signs of damage or deterioration. Clean any filter debris from the adapter, canister and retainer.
- Lubricate the O-ring very lightly with clean engine oil and reinstall it in the adapter groove. Install the new filter element onto the rod and hand-tighten the retainer onto the rod to hold the filter in place.
- Reinstall and hand-tighten the canister over the filter element.
- Close the filter drain.
- Open the valves on each tank to allow fuel to re-enter the system.
- Start the engine and check for leaks.

Note: A vapor cloud or hissing sound near the filter indicates a leak.



CAUTION

Use of anything other than genuine MACK/Cummins filters may cause damage and void the engine warranty.

COOLING SYSTEM

The cooling system plays an important role in overall engine performance by keeping the engine within the normal operating temperature range - hot enough for efficient combustion, and cool enough to prevent engine damage from overheating. Good preventive maintenance practices, along with monitoring cooling system performance, go a long way in preventing engine damage that could result from cooling system problems. The maintenance items and tests outlined in this section should be performed at the intervals specified to ensure optimum performance from the cooling system.

Radiator Pressure Cap

At every C and D inspection, check the condition of the radiator cap gasket. Also, pressure test the cap using a suitable cooling system and radiator cap tester. A 16-psi pressure cap is currently used on all MACK Trucks, Inc., model chassis.

Thermostat

Check thermostat operation, particularly during cold weather, to make sure the thermostat closes fully, does not allow any leakage and does not open too soon. Also, the thermostat seal should be checked for leakage. Coolant leaking past the thermostat can cause overcooling and may result in insufficient cab heat.

38 MAINTENANCE AND LUBRICATION

FEDERAL EMISSION REQUIREMENTS

This section covers the requirement of the United States Clean Air Act which states:

"The manufacturer shall furnish with each new motor vehicle or motor vehicle engine such written instructions for the maintenance and use of the vehicle or engine by the ultimate purchaser as may be reasonable and necessary to assure the proper functioning of emission control devices and systems."

This section also covers the requirements of the emissions regulations promulgated under the Motor Vehicle Safety Act in Canada.

Tampering with Gaseous Emission Control Systems Prohibited

The Federal Clean Air Act prohibits the removal or rendering inoperative of any device or element of design installed on or in a motor vehicle or motor vehicle engine in compliance with Federal Emission Regulations by:

- 1 Any person prior to its sale and delivery to the ultimate purchaser, or
- 2 Any manufacturer or distributor after its sale and delivery to the ultimate purchaser, or
- 3 Any person engaged in the business of repairing, servicing, selling, leasing, or trading motor vehicles or motor vehicle engines following its sale and delivery to the ultimate purchaser, or
- 4 Any person who operates a fleet of motor vehicles following its sale and delivery to the ultimate purchaser.

40 Federal Emissions

Gaseous Emission Control Systems Warranty

(Supplement to Standard Vehicle Warranty)

MACK Trucks, Inc. warrants to the original and each subsequent purchaser of a MACK Trucks, Inc., motor vehicle or Cummins-Wesport ISL_G engine that such vehicle or engine is designed, built and equipped so as to conform at the time of sale with all such United States and Canada Federal emissions regulations applicable at the time of manufacture, and that it is free from defects in materials and workmanship which would cause it to fail to meet such regulations within a period of five years after delivery of such vehicle or engine to the original purchaser or, subject to the exclusions set forth below for components not manufactured by MACK Trucks, Inc., before such vehicle or the vehicle in which such engine has been installed, has been operated 480 000 km (300,000 miles) or 10,800 hours of engine operation, whichever first occurs.

Equipment such as turbochargers, injection equipment, and charge air coolers not manufactured by MACK Trucks, Inc. are excluded from the above warranty, but are covered by the applicable warranty of the respective manufacturer in effect at the time of delivery; provided, however, that in no case will any such component be warranted for less than five years after delivery of the vehicle or engine to the original purchaser or 160 000 km (100,000 miles) of operation of such vehicle or of the vehicle in which such engine has been installed, or 3,000 hours of engine operation, whichever first occurs.

The manufacturer's obligation under this warranty is limited to the repair or replacement, as herein provided, at its option of any part or parts of the emission control system of such vehicle or engine found to the Manufacturer's satisfaction to be defective upon examination by it, provided that such part or parts shall be returned to the Manufacturer's factory or to its nearest authorized Distributor or Subsidiary.

GASEOUS EMISSIONS CONTROL SYSTEM WARRANTY FEDERAL EMISSION REQUIREMENTS

The following engine components are covered by the supplemental emissions control system warranty policy as required by the Federal emissions regulations.

Items Not Covered by the Emission Control Systems Warranty

- Malfunctions caused by misuse, improper adjustments, modification, alteration, tampering, disconnection, improper or inadequate maintenance.
- Damage resulting from accident, acts of nature or other events beyond the control of MACK Trucks, Inc.
- Inconvenience, loss of use of the vehicle, or commercial loss.
- Any vehicle on which the odometer has been changed so that mileage cannot be readily determined.

The repair or replacement of defective parts under this warranty will be made without charge for parts and, if made at the manufacturer's factory, Subsidiary, or authorized Distributor's place of business, without charge for labor.

THIS WARRANTY IS MADE EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND OF ANY OTHER OBLIGATION ON THE PART OF THE MANUFACTURER, INCLUDING, WITHOUT LIMITATION OF THE FOREGOING, CONSEQUENTIAL AND INCIDENTAL DAMAGE.

42 Federal Emissions

Emission Control Systems Warranty — California

The California Air Resources Board and Mack Trucks, Inc. are pleased to explain the California emission control system warranty on your new motor vehicle engine. In California, new motor vehicle engines must be designed, built and equipped to meet the State's stringent anti-smog standards. Mack Trucks, Inc. must warrant the emission control system on your engine for the period of time listed below; provided there has been no abuse, neglect, or improper maintenance of your engine.

Your emission control system may include parts such as the fuel control system, turbocharger assembly, electronic control module and other emission-related assemblies.

Where a warrantable condition exists, Mack Trucks, Inc. will repair your engine at no cost to you including diagnosis, parts, and labor.

Manufacturer's Warranty Coverage

If an emission-related part of your engine is defective, the part will be repaired or replaced by Mack Trucks, Inc. This is your emission control system DEFECTS WARRANTY.

Owner's Warranty Responsibilities

As the motor vehicle engine owner, you are responsible for the performance of the required maintenance listed in this manual. Mack Trucks, Inc. recommends that you retain all receipts covering maintenance of your vehicle, but MACK Trucks, Inc. cannot deny warranty solely for the lack of receipts or for your failure to ensure the performance of all scheduled maintenance listed in other manuals which were supplied with your vehicle(s).

You are responsible for presenting your motor vehicle engine to a MACK Trucks, Inc. dealer as soon as a problem exists. The warranty repairs should be completed in a reasonable amount of time, not to exceed 30 days.

As the motor vehicle engine owner, you should also be aware that Mack Trucks, Inc. may deny you warranty coverage if your vehicle or a part has failed due to abuse, neglect, improper maintenance, or unapproved modifications.

If you have any questions regarding your warranty rights and responsibilities, you should contact the Mack Trucks, Inc. Warranty Department at P.O. Box 1801, Allentown, PA 18105, or the California Air Resources Board at 9480 Telstar Avenue, El Monte, California 91731.

(Supplement to Standard Vehicle Warranty)

(Applicable only to vehicles and/or engines certified for sale and registered in the State of California)

Mack Trucks, Inc. warrants to the original and each subsequent purchaser of a MACK Trucks Inc. motor vehicle or Cummins-Wesport ISL_G engine that such vehicle or engine is designed, built and equipped so as to conform at the time of sale with all State of California emissions standards applicable at the time of manufacture, and that it is free from defects in materials and workmanship which would cause it to fail to meet such standards within a period of five years after delivery of such vehicle or engine to the original purchaser, or subject to the exclusions set forth below for components not manufactured by MACK Trucks, Inc., before such vehicle or the vehicle in which such engine has been installed, has been operated 480 000 km (300,000 miles) or 10,800 hours of engine operation, whichever first occurs.

Equipment such as turbochargers, injection equipment, and charge air coolers not manufactured by MACK Trucks, Inc. are excluded from the above warranty, but are covered by the applicable warranty of the respective manufacturer in effect at the time of delivery; provided, however, that in no case will any such component be warranted for less than five years after delivery of the vehicle or engine to the original purchaser or 160 000 km (100,000 miles) of operation of such vehicle or of the vehicle in which such engine has been installed, or 3,000 hours of engine operation, whichever first occurs.

MACK Trucks, Inc.'s obligation under this warranty is limited to the repair or replacement, as herein provided, at its option of any part or parts of the emissions control system of such vehicle or engine found to the Manufacturer's satisfaction to be defective upon examination by it, provided that such part or parts shall be returned to the Manufacturer's factory or to its nearest authorized dealer.

This warranty shall not apply to any defects which arise solely as a result of accident or owner abuse or lack of required maintenance.

The repair or replacement of defective parts under this warranty will be made without charge for parts and, if made at MACK Trucks, Inc.'s factory or authorized dealer's place of business, or authorized repair facility, without charge for diagnosis or labor.

THIS WARRANTY IS MADE EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND OF ANY OTHER OBLIGATION OR LIABILITY ON THE PART OF MACK TRUCKS, INC. INCLUDING, WITHOUT LIMITATION OF THE FOREGOING, CONSEQUENTIAL AND INCIDENTAL DAMAGES SUCH AS INCONVENIENCE, LOSS OF USE OF THE VEHICLE, COMMERCIAL LOSS, ETC.

44 Federal Emissions

EMISSIONS CONTROL SYSTEM WARRANTY — CALIFORNIA

Procedures for Handling Emissions Control System Warranty

The following engine components are covered by the supplemental emissions control system warranty policy as required by the California Code of Regulations.

1 Repairs by MACK Trucks, Inc. Dealers, Sub-Dealers and Service Dealers

Repairs covered by the California Emission Control Systems Warranty will be performed by an authorized MACK Trucks, Inc. repair facility at his place of business with no charge for parts and labor (including diagnosis), using MACK Trucks, Inc. parts for any part of the emission control systems covered by this warranty and found defective.

2 In an Emergency

In an emergency, where an authorized MACK Trucks, Inc. facility is not available, repairs may be performed at any available service establishment, or by the owner, using any replacement part, within the limitations of paragraphs 4 and 5 in this section. An emergency condition exists under this section if, after 30 days, repairs have not been completed or parts are not yet available. MACK Trucks, Inc. will reimburse the owner for such repairs that are covered under this warranty, including diagnosis, not to exceed MACK Trucks, Inc. suggested retail price for parts replaced and labor charges based on MACK Trucks, Inc. recommended time allowance and geographically appropriate hourly labor rate. Replaced parts and paid invoices must be presented at a MACK Trucks, Inc. facility as a condition of reimbursement for emergency repairs performed elsewhere.

3 Repairs by Non-MACK Trucks, Inc. Facilities

Owners may elect to have maintenance, replacement, or repair of emission control systems performed by any repair facility, and may elect to use parts other than MACK Trucks, Inc. parts without invalidating the warranty on other components, but the cost of such service or parts will not be covered by MACK Trucks, Inc. under its warranty.

4 Use of Non-MACK Trucks, Inc. Parts

Use of replacement parts which are not the equivalent of MACK Trucks, Inc. parts may impair the effectiveness of emission control systems. If other than MACK Trucks, Inc. parts are used, the owner should obtain assurances that such parts are warranted by their manufacturer to be the equivalent of MACK parts in performance and durability. MACK Trucks, Inc. assumes no liability under this warranty with respect to parts other than MACK Trucks, Inc. parts; however, the use of non-MACK Trucks, Inc. parts does not invalidate the warranty on other components unless non-MACK Trucks, Inc. parts cause damage to warranted parts.

5 Maintenance and Maintenance Records

The vehicle owner is responsible for the performance of all required maintenance specified in this handbook. MACK Trucks, Inc. will not deny a warranty claim solely because there is no record of maintenance; however, MACK Trucks, Inc. may deny a warranty claim if failure to perform required maintenance results in the failure of a warranted part. Receipts or other records covering the performance

of scheduled maintenance should be retained to answer questions that may arise concerning maintenance. Maintenance records should be transferred to subsequent owners if the vehicle is sold.

6 Items Not Covered by the Emission Control Systems Warranty

- Malfunctions caused by misuse, improper adjustments, modification, alteration, tampering, disconnection, improper or inadequate maintenance.
- Damage resulting from accident, acts of nature or other events beyond the control of MACK Trucks, Inc..
- Inconvenience, loss of use of the vehicle, or commercial loss.
- Any vehicle on which the odometer has been changed so that mileage cannot be readily determined.



CAUTION

In the event that damage results from unauthorized adjustments as evidenced by settings other than as specified, or broken fastener seals, the cost of repairing such damage **WILL NOT BE COVERED** under warranty.



CAUTION

Any unauthorized adjustments can cause severe damage to the engine. In the event that damage results from unauthorized adjustments, as evidenced by settings other than specified, or broken fastener seals, the cost of repairing such damage **WILL NOT BE COVERED**.

7 Customer Assistance

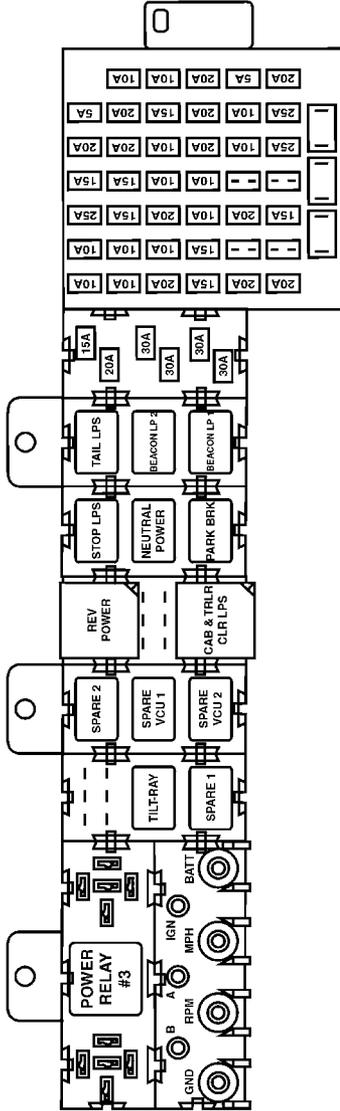
MACK Trucks, Inc. wishes to ensure that the California Emission Control System Warranty is properly administered. In the event that owners do not receive the warranty service to which they believe they are entitled under the California Emission Control Systems Warranty, they should contact the nearest MACK Trucks, Inc. Regional Office for assistance. The address and telephone number for each Regional Office is in the MACK Trucks, Inc. Directory of Sales, Parts and Service Centers. Owners in need of additional assistance or information concerning the California Emission Control Systems Warranty may also contact:

**Mack Trucks, Inc.
Warranty Activities
P.O. Box 26259
Greensboro, NC 27402-6115**

Circuit Breaker and Relay Panel

LEU Series with CNG Engine

**LE ELECTRICAL EQUIPMENT PANEL
(LOCATED BEHIND DRIVER'S SIDE KICK PANEL)**



(SEE DETAIL OF
FUSE POSITIONS
ON NEXT PAGE)

48 ELECTRICAL

LEU Series with CNG Engine

Cab Circuit Protection

#1 — 5A	#2 — 20A	#3 — 15A	#4 — 25A
Rear Hazard Lamps	Headlamps (Type I Breaker)	Marker Lamps, Cab ID Lamps, Park & Tail Lamps	Directional Lamps, Flasher
#5 — 10A	#6 — 10A	#7 — 15A	#8 — 20A
Park Brake, Emergency Stop Lamps	Dome Lamps	Ignition Switch	Cigar Lighter, Horn
#9 - 20A	#10 - 15A	#11 - 20A	#12 - 10A
CB Posts	Communication Connector	Spare	Park Brake Apply Solenoid
#13 - 10A	#14 - 10A	#15 - 5A	#16 - 10A
Anti-Lock Brake System	Anti-Lock Brake System	Spare	Body Buzzer
#17 - 10A	#18 - 5A	#19 - 15A	#20 - 15A
Kysor Control	Anti-Lock Brake System	Gauges, Indicator Lamp	Woodward Engine ECU
#21 - 20A	#22 - 20A	#23 - 10A	#24 - 10A
LH Wiper Motor	RH Wiper Motor	Wiper Control, Washer Motor	Master LH-RH Switch
#25 - 30A	#26 - 15A	#27 - 10A	#28 - 15A
Heater	Plow Up-Down Solenoids	Rear Hopper Lamps	Allison HD Interface Circuits
#29 - 10A	#30 -	#31 -	#32 - 15A
Hydraulic Pump Protection Circuit	No Circuit	No Circuit	Rear Flood Lamp
#33 - 20A	#34 -	#35 - 20A	#36 -
Stop Lamps	No Circuit	Clearance Lamps	No Circuit

Cab Circuit Protection			
#37 - 20A	#38 -	#39 - 20A	#40 - 15A
Tail Lamps	No Circuit	Body, Ignition Power	Reserve Fuel Tank
#41 - 15A	#42 - 20A	#43 -	#44 - 20A
Hydraulic Pump Solenoid	Reverse Lamps, Back Up Alarm	No Circuit	Air Dryer, Drain Valve
#45 -	#46 - 15A	#47 - 20A	#48 - 10A
Spare	Synchro Start	Spare	Allison HD Control Unit

50 ELECTRICAL

LEU Series with LNG Engine

Cab Circuit Protection			
#1 - 15A	#2 - 20A	#3 - 15A	#4 - 20A
Lighter, Horn	CB Post	Radio, Ignition	Directional Signal Lamps
#5 - 20A	#6 - 20A	#7 - 20A	#8 - 10A
Stop, Park Lamps	Headlamp DRL (Type I Breaker)	Marker Lamps	Dome Lamps
#9 - 20A	#10 - 20A	#11 - 10A	#12 - 10A
Clearance Lamp	Battery Power Feed	Spare	Spare Power, Indicator Lamps
#13 - 15A	#14 - 10A	#15 - 15A	#16 - 20A
Gauge Panel	Kysor Warning	Mirror Heat	Air Dryer
#17 - 20A	#18 - 10A	#19 - 30A	#20 - 20A
Ignition Power Feed	Engine Brake	Heater	RH Wiper
#21 - 20A	#22 - 10A	#23 - 10A	#24 - 15A
LH Wiper	LH/RH Control	Muncie PTO	Mirror Motor
#25 - 15A	#26 -	#27 - 5A	#28 - 15A
CNG Engine Interface	No Circuit	ABS, Ignition Power	Automatic Transmission
#29 - 20A	#30 - 15A	#31 - 10A	#32 -
Power, Indicator Lamps	J1708 Diagnostic Connection	Spare, Ignition	No Circuit
#33 -	#34 - 30A	#35 -	#36 -
No Circuit	Neutral/Reverse Power	No Circuit	No Circuit

Cab Circuit Protection			
#37 - 15A	#38 -	#39 -	#40 -
2-Way Radio	No Circuit	D-Full, ABS, Battery	No Circuit
#41 -	#42 -	#43 -	#44 - 15A
No Circuit	No Circuit	No Circuit	D-Basic, ABS, Battery
#45 -	#46 - 20A	#47 -	#48 - 10A
No Circuit	Beacon Lamps	No Circuit	Automatic Transmission ECU

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MRU Series

TRAILER ABS RELAY		TILT RAY RELAY	
CB-38 20 AMP	CB-5 10 AMP	CB-15 15 AMP	CB-42 15 AMP
CB-44 20 AMP	CB-17 10 AMP	CB-28 15 AMP	OPEN
CB-18 15 AMP	CB-41 10 AMP	OPEN	CB-19 10 AMP
CB-43 20 AMP	CB-18 15 AMP	CB-41 10 AMP	CB-19 10 AMP

CB-20 20 AMP	CB-26 10 AMP	CB-45 30 AMP	OPEN	OPEN	OPEN	OPEN	CB-25 30 AMP
CB-39 20 AMP	CB-6 10 AMP	OPEN	OPEN	OPEN	OPEN	OPEN	CB-30 OPEN
CB-33 20 AMP	CB-7 10 AMP	CB-32 15 AMP	OPEN	OPEN	OPEN	OPEN	CB-24 10 AMP
CB-23 20 AMP	OPEN CB-16	OPEN CB-47	OPEN	OPEN	OPEN	OPEN	CB-31 10 AMP
			SPARE CB-4	SPARE CB-12	SPARE CB-2	SPARE CB-2	CB-2 20 AMP

DRL DAYTIME RUNNING LIGHTS	FLASHER
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CAB & TRAILER CLEARANCE LPS MINI RELAY	REVERSE POWER MINI RELAY	REV/PWR/NEUTRAL CLR LPS CAB & TRAILER 30 AMP
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SPARE RELAY #1	BEACON LAMP RELAY W/REV. W/PTO TRIGGER	SPARE RELAY #5
SPARE RELAY #2	BEACON LAMP RELAY W/PTO TRIGGER	NEUTRAL POWER RELAY

TRLR LPS RELAY	ENGINE BRAKE DISABLE RELAY	TRLR STOP LPS RELAY
CB POST RELAY	HORN RELAY	EMERGENCY STOP LPS RELAY

KYSOR SHUTDOWN INTERLOCK		ACCESSORY RELAY	
CB-9 20 AMP	CB-13 15 AMP	CB-10 15 AMP	CB-11 15 AMP
CB-37 20 AMP	CB-14 10 AMP	ABS CB-27 5 AMP	CB-3 15 AMP
CB-46 20 AMP	CB-29 15 AMP	CB-1 5 AMP	CB-8 20 AMP
ABS CB-13 15, 20 AMP	CB-14 10 AMP	CB-1 5 AMP	CB-3 15 AMP

Cab Circuit Protection			
#1 - 5A	#2 - 20A	#3 - 15A	#4 - 25A
Accessory Relay	Headlamps	Marker Lams, ID Lamps	Directional Signal Flasher
#5 - 10A	#6 - 10A	#7 - 10A	#8 - 20A
Stop Lamps	Dome Lamps	Ignition Switch	Horn, Cigar Lighter
#9 - 20A	#10 - 15A	#11 - 15A	#12 -
CB, Radio	Communication Connection	Battery Stud	Spare
#13 - 10, 15, 20A	#14 - 10A	#15 - 15A	#16 -
ABS	ABS	Spare	Open
#17 - 10A	#18 - 15A	#19 - 10A	#20 - 20A
Kysor Shutdown	NG Woodward ECU	Gauges	Mirror Heat
#21 - 20A	#22 - 20A	#23 - 20A	#24 - 10A
LH Wiper	RH Wiper	Battery Box, Ignition Stud	Spare
#25 - 30A	#26 - 10A	#27 - 5A	#28 - 15A
Heater, A/C	Spare	ABS	HD Automatic Transmission
#29 - 15A	#30 -	#31 - 10A	#32 - 15A
Ignition Stud	Open	Automatic Transmission	Spare
#33 - 20A	#34 - 30A	#35 - 30A	#37 - 20A
Trailer Stop Lamps	Reverse/Neutral Power	Cab & Trailer Clearance Lamps	Trailer Tail Lamps
#38 - 20A	#39 - 20A	#40 -	#41 - 10A
Battery Stud	Trailer ABS Power	Open	PTO, Fan Clutch
#42 - 15A	#43 - 20A	#44 - 20A	#45 - 30A
Back-Up Lamps	Battery Box, Ignition Stud	Air Dryer	Fuel Heater
#46 - 20A	#47 -		
Strobe	Open		

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- 1 **F1-5A** — MPH Sensor, Transmission Modulator Relay, Fuel Gauge, Power Stud, Electronic Malfunction Indicator, Powers Fuse 8
- 2 **F2-15A** — Cam Sensor, Relay #1
- 3 **F3-35A** — Manifold Absolute Pressure, Natural Gas Temperature, Engine Coolant Temperature, Pre-Turbine Pressure, NGTP/TK Temperature Return, Exhaust Back Pressure, Relay #2
- 4 **F4-15A** — UEGO Connection Oxygen Sensor, Low Pressure Lockoff Solenoid, High Pressure Lockoff Solenoid
- 5 **F5-15A** — Governor, Wastegate
- 6 **F6-10A** — Ignition Module
- 7 **F7-3A** — Methane Warning Detector
- 8 **F8-1A** — Powered by Fuse 1, Fuel Tank Sending Unit (LNG Only)

