

# EMERGENCY RESPONSE TO NATURAL GAS VEHICLES



**INSTRUCTOR'S GUIDE**  
**JANUARY, 2003**



# INSTRUCTORS GUIDE

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## Emergency Response to Natural Gas Vehicles

### INTRODUCTION

The “Emergency Response to Natural Gas Vehicles” is a training program that has been years in the making. This program follows-up the first alternative fuels class “Emergency Response to Electric Vehicles” produced by the California Energy Commission and the California Air Resources Board along with funding and information from utility companies and the automotive industry. Likewise, a great number of people have been instrumental in putting this program together for the emergency response community so that you have all the information you need to respond to natural gas vehicles safely and effectively.

This program is designed as an 8-hour class. It can be customized to accommodate one or two-hour crew training, or you can use this curriculum in conjunction with other alternative fuel or vehicle technology curriculum like auto extrication. The opened-ended design of the course materials purposely allows the instructor a great deal of flexibility and course delivery options.

### LESSON PLANS

These lesson plans are to be used as a guide for trainers and instructors. To make this class as effective as possible it is important that the instructor review all course material before teaching the class. It is up to each individual instructor to line-up several natural gas vehicles for display and/or a refueling station to pre-plan and walk-through. These resources can be found in a variety of fleet operations such as, your local transit, school district, utility company, parcel and postal delivery companies, or through your city, county, or state government fleet operations.

The lesson plans were developed to State Fire Training standards. No test was developed for this program. Instructor’s who wish to test student knowledge, and their own training effectiveness, are encouraged to develop test questions of their own. To help, there are a number of review questions at the end of each lesson plan.

### MULTIMEDIA PRESENTATION

The multimedia presentation was developed in a program called “Astound.” You do not need the software or license to run this program. It is suggested that you transfer by clicking and dragging the presentation file from the CD-ROM to a file on your hard drive. While the program will run from the CD, it runs even better off of your hard drive.

The presentation and your lesson plans are set-up to allow you to customize the delivery of this program into short subject courses for one or two-hour crew training or as an eight-hour stand-alone class. To enable this function, a menu slide was added for your convenience to navigate specific subject areas. When you get to the end of the lesson the slide will automatically advance back to the menu slide.

To advance the slides click on the left mouse button. You can also use your left and right arrow keys to advance or go back to a previous slide. To go to another section of the program click and hold your right

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## Emergency Response to Natural Gas Vehicles

mouse button and release. A small window displaying all of the slides will appear. To exit this program at any time simply hit the escape key on your computer.

There are several unique pens available on your presentation. To change pen color and function use the following key code:

- F2 Black Pen— handy for circling or to use to check bulleted items.
- F3 Red Pen—handy for slides with a dark background to highlight certain information.
- F4 Yellow Highlighter—used like a regular highlighter and not obscure the text.
- F5 Pink Highlighter—provides you an option with the yellow highlighter.

To make the pens work, click and hold you left mouse button, and while its held down move the mouse across the slide. Experiment and practice with these pens to customize the delivery of your presentation.

## STUDENT MANUAL

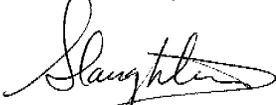
This class was designed from the student manual. Instructors can print the student manual from the CD/ROM and make any number of copies to accommodate your class size. The manual is in color if you choose to use a color printer or color copier. The material will just as easily print in black and white. The student manual allows your class to take their material with them to use for review at their leisure.

## VIDEO

The video tape that accompanies this training program can be shown all at once to reinforce the lesson plans or it can be shown as short segments that coincide with each lesson.

As we begin to see more and more alternative fueled vehicles on the road, and specifically natural gas vehicles this program will be as relevant today as it will be in the future. All fuels have advantages and disadvantages for emergency responders. With the right information you should be able to deal with each fuel type safely. This class, though a serious subject, was designed to be as fun for you to deliver as it will be for your class to watch and listen to. Good Luck!

All The Best,



Rodney Slaughter, President  
Dragonfly Communications Network  
[www.dragonflynet.com](http://www.dragonflynet.com)

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Emergency Response to Natural Gas Vehicles

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## Emergency Response to Natural Gas Vehicles

### Lesson Plan 1 INTRODUCTION

**TOPIC:** PROGRAM INFORMATION AND INTRODUCTION

**LEVEL:** I

**TIME:** 30 MINUTES

**BEHAVIORIAL OBJECTIVE:**

**Condition:** Complete evaluation with 70% accuracy

**Behavior:** The student will . . .

1. Cite why natural gas is a popular alternative fuel.
2. Determine how natural gas vehicles will impact emergency response.

**Standard:** According to the referenced text

**REFERENCES:** Slaughter, Rodney “Emergency Response to Natural Gas Vehicles,” California State University, Chico Instructional Media Center, November 2002.

**MATERIALS NEEDED:** PC projector, projection screen, VCR, multimedia slide show on CD-ROM, speakers.

**PREPARATION:** Vehicle manufacturers have been experimenting for years on a wide range of alternative fuels to help improve air quality and to reduce our reliance on foreign oil. This program explores one of those alternative vehicle fuels types, natural gas, and how this emerging technology will impact your emergency response.

Natural gas is the fuel we trust today to heat our homes and cook our food. But natural gas also has a proven safety record as a vehicle fuel. Unlike gasoline, natural gas is nontoxic, non-corrosive and contains almost no smog-forming hydrocarbons. With its high ignition temperature and narrow explosive range, natural gas is much less likely to ignite than gasoline.

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PRESENTATION	APPLICATION
<p><b>I. Program Background</b></p> <p><b>A. Title</b> “Emergency Response to Natural Gas Vehicles”</p> <p><b>B. Program Funding Provided By:</b></p> <ol style="list-style-type: none"><li>1. California Office of Traffic Safety</li><li>2. California Energy Commission</li><li>3. California Natural Gas Vehicle Coalition</li></ol> <p><b>C. Program Produced By:</b></p> <ol style="list-style-type: none"><li>1. The Instructional Media Center California State University, Chico</li><li>2. Rodney Slaughter, President Dragonfly Communications Network</li></ol> <p><b>II. Program Goal</b></p> <p>The goal of this program is to provide the emergency responder with important information about natural gas vehicles so that they can make informed decisions at the scene of a natural gas vehicle emergency</p> <p>This background information should be correlated with your own department’s Standard Operating Guidelines for incident management, scene safety, auto extrication and rescue</p>	<p>Title Slide</p> <p>Program Funding Slide</p> <p>Program Production Slide</p> <p>Program Goal Slide</p>



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PRESENTATION	APPLICATION
<p>B. Natural Gas Vehicles (NGV's) offer solutions to the pressing problems of air pollution, ocean and ground water contamination and global oil supply uncertainty</p> <p>C. NGV's meet low emission standards well ahead of state-mandated phase-in schedules</p> <p>D. The use of natural gas reduces our dependence on foreign oil – vast reserves available in the continental U.S.</p> <p>E. NGV's are powered by a proven clean and reliable domestic fuel that is available through a rapidly expanding retail infrastructure, with over 80,000 miles of distribution pipeline within California alone, natural gas is already available in most communities</p> <p>F. The number of compressed natural gas (CNG) fueling stations has grown in California from a mere handful in 1990 to several hundred today</p> <p>G. Across the country there are over 1,300 fueling stations with more stations being built each week</p> <p>H. There are over 109,000 NGVs on U.S. roads and over one and a half million worldwide. Approximately 1,000 new vehicles are now being sold annually— typically to government and fleet vehicle operators</p> <p>I. Over 40 different manufacturers today are producing light duty, medium duty and heavy duty vehicles and engines</p>	<p>OHQ: Why Natural Gas?</p> <p>Intro-2 Why NGV's</p> <p>Intro-3 California Fuel Map</p> <p>Intro-4 U.S. Map</p> <p>Intro-5 NGV Advantages</p>

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PRESENTATION	APPLICATION
<p>J. CNG driving cost and range is comparable to gasoline vehicles with approximately 25 to 30 miles per gallon</p>	
<p>K. Natural gas can cost less than other fuels and burns cleaner, reducing routine maintenance costs</p>	
<p>L. Fleets that have switched to NGV's are finding their overall operating costs competitive with, if not lower than, conventional vehicles; making NGV's popular fleet vehicles</p>	Intro-6 NGV Advantages
<p>M. Natural gas is lighter than air which means that it doesn't pool on the ground like gasoline, diesel or propane fuel vapors</p>	
<p>N. The fuel storage cylinders are stronger than gasoline tanks and have been tested to withstand crash tests, bonfire tests, and gun-shot tests</p>	
<p>O. There are two unique fuel storage techniques for natural gas vehicles, "Compressed Natural Gas" and "Liquefied Petroleum Gas"</p>	Intro-7 NGV Advantages
<p>P. Each term is abbreviated as CNG (compressed natural gas) and LNG (liquefied natural gas). While a safe and reliable fuel, these fuel storage techniques warrant safety precautions and awareness for emergency response personnel</p>	
<p>Q. While natural gas vehicles may be safe they will operate in an environment that, in California alone, had 511,248 traffic collisions in the year 2000</p>	Intro-8 Impact on Emergency Services

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## Emergency Response to Natural Gas Vehicles

<b>PRESENTATION</b>	<b>APPLICATION</b>
<p>R. Of these, 3,331 were fatal and 198,348 injury-related according to the State Wide Integrated Traffic Records System (SWITRS 2000 report)</p> <p>S. With more and more natural gas vehicles entering the highways, the potential for natural gas vehicle emergencies will grow</p>	<p>Return to Main Menu Slide</p>

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## **SUMMARY:**

As you can see there are multiple reasons why natural gas is being considered as the alternative fuel of choice for many auto-makers in the country. The question remains, however- how will this technology affect your emergency response to vehicle incidents and fires?

## **EVALUATION:**

1. Why should consumers consider natural gas over conventional fuel systems?  
Answer: protect the environment, lower fuel and maintenance costs, reduce reliance on foreign oil
2. Will natural gas vehicles alter emergency response?  
Answer: As NGV's become more prevalent, emergency responders will have to determine fuel types of the vehicle before committing to a plan of action

## **ASSIGNMENT:**

Read the introduction of the text including the origin and history of natural gas.

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Emergency Response to Natural Gas Vehicles

## Lesson Plan 2 NATURAL GAS VEHICLES

**TOPIC:** VEHICLE IDENTIFICATION

**LEVEL:** I

**TIME:** 1.5 - Hours

**BEHAVIORIAL OBJECTIVE:**

**Condition:** Complete evaluation with 70% accuracy

**Behavior:** The student will . . .

1. Identify the differences and similarities between natural gas vehicles and other fuel types
2. Perform vehicle shutdown procedures

**Standard:** According to the referenced text

**REFERENCES:** Slaughter, Rodney "Emergency Response to Natural Gas Vehicles," California State University, Chico Instructional Media Center, November 2002.

**MATERIALS NEEDED:** PC projector, projection screen, VCR, multimedia slide show on CD-ROM, speakers

**PREPARATION:** Today, we can expect to encounter a wide range of vehicle types that use natural gas as their primary and secondary fuel source: passenger vehicles, mass transit vehicles, refuse disposal vehicles, and freight vehicles.

In this section we will review what types of vehicles are using natural gas and how you can potentially identify them. We will also review the standard operating systems and shutdown procedures for natural gas vehicles.

# INSTRUCTORS GUIDE

PRESENTATION	APPLICATION
<p><b>I. Objective</b></p> <ul style="list-style-type: none"> <li>A. Identify the differences and similarities between natural gas vehicles and other vehicle fuel types</li> <li>B. Perform vehicle shut-down procedures</li> </ul> <p><b>II. Natural Gas Vehicle Types</b></p> <ul style="list-style-type: none"> <li>A. Light duty vehicles include: Ford F150, GMC Sierra, and Chevy Silverado pick-up trucks; Chevy Cavalier, Ford Crown Victoria, and Honda Civic; along with a variety of service vans and trucks</li> <li>B. Medium and heavy duty vehicles include: refuse haulers, street sweepers, Blue Bird school buses, transit buses, transit shuttles, trolleys, Isuzu service vans, and large vans and trucks by manufacturers like Freightliner, and Mack</li> <li>C. Natural gas vehicle manufacturers include: Daimler Chrysler, Ford, General Motors, Isuzu, Honda, Toyota, Blue Bird, Mack, and Freightliner</li> <li>D. Natural gas engine makers include: Caterpillar, Cummins, Detroit Diesel, and John Deere Power Systems</li> <li>E. Many of these vehicle types may contain both gasoline tanks and natural gas cylinders that can be easily switched</li> <li>F. In either case, bi-fuel or all natural gas—the emergency responder must first identify the vehicles fuel system before committing to a specific fire or rescue operation</li> </ul>	<p>From Menu click on “Vehicle Identification”</p> <p>Vehicle ID-1</p> <p>Vehicle ID-2</p>

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PRESENTATION	APPLICATION
<p data-bbox="131 520 509 552"><b>III. Vehicle Identification</b></p> <p data-bbox="220 594 1019 699">A. Many of these vehicles are modified from the same make and model (gasoline or diesel) vehicles that you see on the road everyday.</p> <p data-bbox="220 741 1084 846">B. When a natural gas vehicles is delivered to the customer, they come equipped with a distinctive diamond shaped insignia with CNG or LNG printed in the middle</p> <p data-bbox="220 1213 1003 1287">C. Decals are typically located on the rear or side/rear of the vehicle and on exposed cylinders</p> <p data-bbox="220 1329 1094 1465">D. Emergency response personnel should recognize that there is no guarantee the customer will keep the insignia on the vehicle or if the insignia will be as easily identified after a vehicle collision or fire</p> <p data-bbox="220 1507 1068 1612">E. The natural gas industry approved symbol was designed to aid emergency response personnel by identifying the type of fuel being used</p> <p data-bbox="220 1654 1068 1759">F. As with any vehicle emergency, it is important for the emergency responder to identify the potential hazards for each and every response</p>	<p data-bbox="1125 447 1292 478">Vehicle ID-3</p> <p data-bbox="1125 846 1479 1035"><b>OHQ:</b> How would you distinguish natural gas vehicles involved in an incident with their standard fuel counterparts?</p> <p data-bbox="1125 1108 1292 1140">Vehicle ID-4</p>



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PRESENTATION	APPLICATION
<p>3. On LNG vehicles the fuel will flow through a heat exchanger to warm and expand the gas vapor before it flows to the engine compartment</p> <p>C. There is no case where the stainless steel fuel lines transverse The posts, roof or passenger compartment of the vehicle</p> <p>D Realizing that high pressure fuel lines are present-- care should be exercised in extrication emergencies that the fuel lines are not inadvertently severed</p>	<p>Vehicle ID-8</p> <p>Vehicle ID-9</p>
<p><b>V. Vehicle Shut-Down</b></p> <p>A. To shut down a natural gas vehicle you turn the ignition key to the off position which will simultaneously turn-off the engine and stop the flow of fuel from the cylinder</p> <p>B. To insure that a CNG or LNG cylinder is no longer flowing fuel, or to stop a fuel leak, locate the container shut-off valve under the vehicle chassis or close to fuel container</p> <p>C. The shut-off valve requires a quarter turn on most vehicles to shut-off the flow of fuel from the container</p> <p>D. The location of the fuel shut-off valve can vary from make and model of the vehicle, typically near the container itself</p>	<p>Return to Main Menu Slide</p> <p>Activity Sheet-1 Vehicle Display</p>

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## **SUMMARY:**

Natural gas vehicles use the same internal combustion engine technology that we are all comfortable and familiar with. The same ignition process and shutdown procedures are used in both types of vehicles. The only difference is the type of fuel that is used to propel these vehicles down the highways and streets of our communities. But how safe is this natural gas over diesel or gasoline fuels? That is what we will discuss in the next section.

## **EVALUATION:**

1. What should you look for when approaching a vehicle emergency?  
Answer: Look for emblems and decals that identify the fuel type. Emergency response personnel can no longer afford to assume that all vehicles are fueled with gasoline or diesel.
2. How would you shutdown a natural gas vehicle?  
Answer: Like any other vehicle, you would turn the ignition key to the off position.
3. If you detect a leak in the natural gas fuel system, how can you isolate the fuel?  
Answer: Locate the fuel shutoff valve at the cylinder or tank.

## **ASSIGNMENT:**

Read and review the introduction and natural gas vehicle section of the text.

## **INSTRUCTORS NOTE:**

For the student exercise, locate a variety of natural gas vehicles and have them available to your students. Vehicle fleets are the best source such as, school buses, transit buses and vans, state, county, and city motor pool, as well as utility companies and U.S. Postal Service or United Parcel Service. The wider the range of vehicles available equates to a more effective exercise for your students.

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Emergency Response to Natural Gas Vehicles

## STUDENT ACTIVITY SHEET #1

From the vehicles that your instructor has on display identify the following:

### Vehicle I

Make and Model \_\_\_\_\_  
Fuel Storage Location \_\_\_\_\_  
Fuel Shut-off Valve Location \_\_\_\_\_  
Pressure Release Device Vent Location \_\_\_\_\_  
Engine Compartment Fuel Line Location \_\_\_\_\_  
Cut-in Areas for Extrication \_\_\_\_\_  
Unusual Hazards \_\_\_\_\_

### Vehicle II

Make and Model \_\_\_\_\_  
Fuel Storage Location \_\_\_\_\_  
Fuel Shut-off Valve Location \_\_\_\_\_  
Pressure Release Device Vent Location \_\_\_\_\_  
Engine Compartment Fuel Line Location \_\_\_\_\_  
Cut-in Areas for Extrication \_\_\_\_\_  
Unusual Hazards \_\_\_\_\_

### Vehicle III

Make and Model \_\_\_\_\_  
Fuel Storage Location \_\_\_\_\_  
Fuel Shut-off Valve Location \_\_\_\_\_  
Pressure Release Device Vent Location \_\_\_\_\_  
Engine Compartment Fuel Line Location \_\_\_\_\_  
Cut-in Areas for Extrication \_\_\_\_\_  
Unusual Hazards \_\_\_\_\_

### Vehicle IV

Make and Model \_\_\_\_\_  
Fuel Storage Location \_\_\_\_\_  
Fuel Shut-off Valve Location \_\_\_\_\_  
Pressure Release Device Vent Location \_\_\_\_\_  
Engine Compartment Fuel Line Location \_\_\_\_\_  
Cut-in Areas for Extrication \_\_\_\_\_  
Unusual Hazards \_\_\_\_\_

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Emergency Response to Natural Gas Vehicles

## Lesson Plan 3 PROPERTIES OF CNG AND LNG

<b><u>TOPIC:</u></b>	PROPERTIES OF CNG AND LNG
<b><u>LEVEL:</u></b>	I
<b><u>TIME:</u></b>	1-HOUR
<b><u>BEHAVIORIAL OBJECTIVE:</u></b>	
<b>Condition:</b>	Complete evaluation with 70% accuracy
<b>Behavior:</b>	The student will . . . <ol style="list-style-type: none"><li>1. Cite the properties of natural gas</li><li>2. Assess the danger in a natural gas fuel leak</li><li>3. Develop mitigation measures for a natural gas leak</li></ol>
<b>Standard:</b>	According to the referenced text
<b><u>REFERENCES:</u></b>	Slaughter, Rodney "Emergency Response to Natural Gas Vehicles," California State University, Chico Instructional Media Center, November 2002.
<b><u>MATERIALS NEEDED:</u></b>	PC projector, projection screen, VCR, multimedia slide show on CD-ROM.
<b><u>PREPARATION:</u></b>	Natural gas is stored and transported in two distinct methods; compressed or liquefied. Compressed natural gas (CNG) is typically used on light and medium duty vehicles, while liquefied natural gas (LNG) can be found on medium to heavy duty vehicles. Each fuel option has advantages for the vehicle operator and pose slightly different procedures for emergency responders.

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PRESENTATION	APPLICATION
<p><b>I. OBJECTIVE</b></p> <ul style="list-style-type: none"><li>A. Cite the properties of natural gas</li><li>B. Assess the danger in a natural gas fuel leak</li><li>C. Develop mitigation measures for a natural gas leak</li></ul> <p><b>II. CHARACTERISTICS OF COMPRESSED NATURAL GAS</b></p> <ul style="list-style-type: none"><li>A. Natural gas is compressed so that it can be used as a practical and portable fuel supply<ul style="list-style-type: none"><li>1. Compressed natural gas (CNG) is comprised mostly of methane with 5 to 20 percent of other vapors like, ethane, propane and butane</li><li>2. A methane molecule is comprised of 4 hydrogen and one carbon atom and is considered a “simple” hydrocarbon (CH<sub>4</sub>)</li><li>3. Comparatively, gasoline and diesel are considered “complicated” hydrocarbons</li></ul></li><li>B. Natural gas is lighter than air and naturally colorless and odorless<ul style="list-style-type: none"><li>1. To aid in detection of gas leaks producers add an odorant, Mercaptan, which smells like sulfur or rotten eggs</li><li>2. This smell can be detected before the gas reaches its lower Flammability Limits</li></ul></li></ul>	<p>From the Menu slide click on “Properties of CNG &amp; LNG”</p> <p>CNG&amp;LNG-1</p> <p>CNG&amp;LNG-2</p>

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PRESENTATION	APPLICATION
<p>C. Natural gas is non-toxic and presents no exposure hazard</p> <ol style="list-style-type: none"><li>1. However natural gas can displace the atmosphere and can pose an asphyxiation hazard in enclosed spaces</li><li>2. Fortunately, natural gas can be ventilated to the outside and dispersed into the atmosphere</li></ol> <p>D. CNG is stored under high pressure. The storage container is thicker than other types of fuel tanks</p> <ol style="list-style-type: none"><li>1. If a high-pressure fuel system component fails, gas can be suddenly and forcefully released</li><li>2. CNG systems are commonly pressurized up to 3600 psi, almost 30 times the pressure in an air-brake system, and similar to the pressure of your self-contained breathing apparatus</li></ol> <p>E. Natural gas is lighter than air and will rise if released into the Atmosphere</p> <ol style="list-style-type: none"><li>1. Vapors from gasoline, diesel, methanol, or propane, are heavier than air and tend to settle in low lying areas</li><li>2. The buoyancy of natural gas provides emergency responders with the option of allowing the gas, or a gas fueled fire, to release itself to the atmosphere without harm to the environment</li></ol>	<p>CNG&amp;LNG-3</p>





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PRESENTATION	APPLICATION
<p>H. Gas when cooled becomes a liquid</p> <ol style="list-style-type: none"><li>1. Steam for example, turns to water at 212 degrees (F)</li><li>2. Methane on the other hand turns to liquid at -258 (F)</li><li>3. This is equivalent to compressing natural gas to 9300 psi.</li></ol> <p>I. The advantages of storing natural gas as a liquid include:</p> <ol style="list-style-type: none"><li>1. Lowering the percentage of impurities. Which in turn provides a consistent and controlled mixture of gas to air in the engine</li><li>2. Lower storage pressure. LNG tanks are stored at 230 psi, rather than 3,600 psi used for compressed natural gas</li><li>3. Greater storage density. One cubic foot of LNG has more than 700 cubic feet of gas, in other words a vehicle can carry about 2-3 times as much LNG as CNG</li></ol> <p>F. LNG is stored in double walled, stainless steel container, much like a thermos</p> <ol style="list-style-type: none"><li>1. It is possible to store at least three times as much natural gas in the same volume of space as compressed gas</li></ol>	<p>CNG&amp;LNG-9</p> <p>CNG&amp;LNG-10</p> <p>CNG&amp;LNG-11</p>

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PRESENTATION	APPLICATION
<p>2. Should a failure occur in both walls of a LNG tank, and liquefied natural gas flows out, it will pool as a liquid and form a vapor cloud that will dissipate into the atmosphere</p> <p>3. Propane on the other hand is heavier than air and the vapor cloud will stay low to the ground without a breeze to help it dissipate</p>	CNG&LNG-12
<p>G. BLEVE's or other catastrophic failures have never been reported for an LNG storage tank</p> <p>H. Because of the physical differences between LNG and liquefied petroleum gas (Propane or LPG), along with the differences in storage techniques, BLEVEs (boiling liquid expanding vapor explosion) are less of a concern for LNG storage cylinders</p>	CNG&LNG-13
<p>I. Water should not be sprayed on a liquefied natural gas spill</p> <p>J. Water will warm the liquefied gas rapidly, causing a faster release of vapor</p> <p>K. The cryogenic liquid should not be allowed to flow into storm or sewer drains, but instead contained with a berm of dirt or sand</p>	CNG&LNG-14
	Return to Main Menu

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## **SUMMARY:**

In this section you learned that natural gas, while flammable, is as safe as the gasoline or diesel fuels that you are all accustomed to working around every day. The next section we will talk about fuel storage and fuel transfer techniques along with refueling stations.

## **EVALUATION:**

1. At a natural gas vehicle emergency, what characteristics of natural gas should you be familiar with?  
Answer: Natural gas, lighter than air, non-toxic, flammable range 5-15%, little energy is needed to ignite it.
2. Which part of a CNG vehicle poses the greatest danger and why?  
Answer: CNG cylinder and high-pressure fittings, these are pressurized to 3600 psi.
3. Would the smell of rotten eggs be a good indication of an LNG fuel leak?  
Answer: No, mercaptan is not added to LNG.
4. What would be the greatest danger of working around LNG?  
Answer: LNG is a cryogenic liquid that could cause severe burns and frostbite.

## **ASSIGNMENT:**

Read the Characteristic of CNG and LNG section of the text.

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Emergency Response to Natural Gas Vehicles

## Lesson Plan 4 NGV REFUELING

**TOPIC:** CYLINDERS – TANKS - REFUELING

**LEVEL:** I

**TIME:** 2-Hour

**BEHAVIORIAL OBJECTIVE:**

**Condition:** Complete evaluation with 70% accuracy

**Behavior:** The student will . . .

1. Recognize cylinder safety and deficiencies.
2. Pre-plan NGV refueling centers.
3. Identify fuel shut-off valves and locations

**Standard:** According to the referenced text

**REFERENCES:** Slaughter, Rodney “Emergency Response to Natural Gas Vehicles,” California State University, Chico Instructional Media Center, November 2002.

**MATERIALS NEEDED:** PC projector, projection screen, VCR, multimedia slide show on CD-ROM, speakers

**PREPARATION:** Emergency response scenarios for NGV’s could also include fuel leaks and/or fires at NGV re-fueling and maintenance centers. This section will help you identify fuel shut-off valves and their location in the event of an emergency.

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PRESENTATION	APPLICATION
<p><b>I. Objectives</b></p> <ul style="list-style-type: none"><li>A. Recognize cylinder and tank safety features and deficiencies</li><li>B. Pre-plan NGV refueling centers</li><li>C. Identify fuel shut-off valves and locations</li></ul> <p><b>II. CNG Fuel Cylinders</b></p> <p>A. CNG Cylinders</p> <ul style="list-style-type: none"><li>1. CNG cylinders and SCBA are similar in design and construction</li><li>2. CNG cylinders contain pressurized natural gas</li><li>3. The high-pressure gas exerts forces on the walls of the cylinders</li><li>4. To withstand these forces, cylinders are made of thick-walled, high strength materials such as steel, aluminum, or composites</li><li>5. Cylinders are made to withstand much higher pressures than the normal service pressure</li></ul>	<p>From Main Menu click on Cylinders-Tanks-Refueling</p> <p>Refueling-1</p>

# INSTRUCTORS GUIDE

<b>PRESENTATION</b>	<b>APPLICATION</b>
<p>6. A cylinder rated for service at 3,600 psi is designed to withstand pressures in excess of 8,100 psi.</p> <p>7. Cylinders should never be pressurized above their maximum fill pressure (generally, 1.25 times the service pressure)</p> <p>8. The typical CNG cylinder has a cylinder-shaped sidewall section with hemispherical domes on the ends</p> <p>9. The cylinder ends typically contain a metal port that can be used for inserting a valve, end plug, or other part</p> <p>10. The expected life span of a cylinder is 15-20 years</p> <p>11. The four types of CNG cylinders include:</p> <p style="padding-left: 40px;">Type 1: An all metal cylinder made of steel or aluminum</p> <p style="padding-left: 40px;">Type 2: A cylinder with a metal liner made of steel or Aluminum and a hoop-wrapped overwrap</p> <p style="padding-left: 40px;">Type 3: A cylinder with a thin metal liner and fully wound Fiber overwrap</p> <p style="padding-left: 40px;">Type 4: A cylinder with a plastic liner and a fully wound Fiber overwrap</p> <p>12. In composite-wrapped cylinders, the composite fibers play a key role in resisting the high gas pressure forces pushing against the cylinder liner wall</p> <p>13. As gas pressure increases, it produces tension on the fibers and causes them to stretch slightly</p>	<p>Refueling-2</p>

# INSTRUCTORS GUIDE

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<b>PRESENTATION</b>	<b>APPLICATION</b>
<p>14. Fibers can easily handle normal gas pressure</p> <p>15. However, going beyond the maximum fill pressure may put too much stress on the fibers leading to fiber breakage and possible cylinder failure</p> <p>16. Type 1 cylinders are the most widely used, and typically are made of low-alloy steel, due to steel's low cost and durability</p> <p>17. All-aluminum cylinders are also used to store CNG</p> <p>18. A 2400 psi cylinder in a pickup truck in LaPorte, IN did explode in 2000 due to over pressurization, no injuries were reported, failures have occurred in Italy, Canada, and Argentina due to fires or manufacturing problems</p> <p>19. Type 2 cylinders consist of a metal liner and composite wrap</p> <p>20. The cylinder is also commonly called hooped-wrapped because the composite wrap is wound only around the cylinder sidewall, in the manner of barrel hoops</p> <p>21. These cylinders are designed so that the liner, without the wrap, can contain the maximum fill pressure (1.25 times the service pressure)</p> <p>22. There have been two reported failures of the Type 2 cylinders in the U.S. both were aluminum</p> <p>23. Type 2 designs and were mainly due to gross degradation of the composite wrap combined with over-pressurization of the cylinder</p> <p>24. Type 3 cylinders consist of a metal liner wrapped with composite fiber, kevlar, carbon, or fiberglass over the entire sidewall and domes ends</p>	

# INSTRUCTORS GUIDE

PRESENTATION	APPLICATION
<p>25. In these cylinders, the majority of the containment strength is provided by the wrap, and the primary purpose of the liner is to contain the gas</p> <p>26. These types of cylinders have a long service record as SCBA for firefighters, and have been used in CNG vehicle service since 1971</p> <p>27. There have been four reported failures of Type 3 fiberglass wrapped cylinders in the U.S. Stress, corrosion, or cracking of the glass fibers is known or suspected as the primary cause</p> <p>28. Type 4 cylinders consist of a plastic liner wrapped with composite over the entire sidewall and dome ends</p> <p>29. In these cylinders, all of the gas pressure load is carried by the composite fibers</p> <p>30. The plastic liner is used solely as a gas barrier</p> <p>31. These cylinders have been used in CNG vehicle service since 1991</p> <p>32. There has been one catastrophic failure of a Type 4 cylinder, probably due to impact damage</p> <p>33. There have also been cases of leaking Type 4 cylinders due to cracked plastic liners</p> <p><b>B. Cylinder Sensitivity</b></p> <p>1. Despite rare and isolated failure incidents, the natural gas cylinders overall have had a remarkable safety record</p> <p>2. The success of natural gas cylinder safety is a result of rigorous safety standards and tests</p>	<p>Refueling-3</p>



# INSTRUCTORS GUIDE

<b>PRESENTATION</b>	<b>APPLICATION</b>
<p>4. The FMVSS and DOT/NHTSA tests include pressure cycle, burst, and bonfire</p> <p>5. For the fire service, the National Fire Protection Association NFPA 52<sup>2</sup> “Compressed Natural Gas CNG Vehicular Fuel Systems Code,” along with FMVSS 303 (Fuel System Integrity of Compressed Natural Gas Vehicles) , ensure that pressurized CNG fuel tanks are shielded from damage by road hazards and mounted to minimize damage from a collision.</p> <p>6. Fuel tanks cannot be mounted in front of or behind the vehicles axles</p> <p>7. The tanks must be securely fastened to the frame of the vehicle and shielded from direct heat generated by the vehicle exhaust system</p> <p>8. Pressure relief device (PRD) must be vented to the outside of the vehicle</p> <p>9. The pressure relief device (PRD) releases gas when the cylinder is exposed to a fire, to insure that the cylinder will not explode, it can also release pressure when the tank pressure increases beyond its rated capacity</p> <p>10. The vent tube can be located at the rear or the side (rear) of the vehicle, depending on manufacturer</p> <p>11. It is important for emergency response personnel to identify the location of the relief valve vent before they begin any operation around the vehicle</p>	<p>Refueling-6</p> <p>Refueling-7</p>

# INSTRUCTORS GUIDE

PRESENTATION	APPLICATION
<p><b>III. Vehicle Refueling</b></p> <p>A. Natural gas is delivered to the refueling site through an intricate network of transmission and distribution pipelines that crisscross the country</p> <ol style="list-style-type: none"><li>1. Typically, distribution or feeder lines deliver product to site at or below 60 psi</li><li>2. Pressure in the transmission pipeline runs 60 psi or greater</li></ol> <p>B. Natural gas is then run through several stages before it is delivered to the customer</p> <ol style="list-style-type: none"><li>1. From the feeder line the gas is sent through a dryer to remove moisture</li><li>2. Then through a filter to remove particulate matter</li></ol> <p>3. Natural gas is then compressed to 3,600 psi and stored in above ground storage tanks</p> <p>4. The storage tanks can hold 10,000 cubic feet or 300 gallons of product</p> <p>C. The refueling customer typically has a plastic card that unlocks and provides access to the natural gas dispenser</p> <ol style="list-style-type: none"><li>1. The customer then attaches the hose to the vehicle and begins the refueling operation</li><li>2. Once fuel has been transferred the dispenser automatically stops the flow of fuel</li></ol>	<p>Refueling-8</p> <p>Refueling-9</p> <p>Refueling-10</p>

# INSTRUCTORS GUIDE

PRESENTATION	APPLICATION
<p>D. The NFPA Standards for natural gas fuel systems include:</p> <ol style="list-style-type: none"><li>1. NFPA 52, “Compressed Natural Gas (CNG) Vehicular Fuel Systems Code”</li><li>2. Each of these standards specifies that refueling stations have manual and automatic shut-off valves</li></ol> <p>E. There are number of methods to shut off the flow of natural gas:</p> <ol style="list-style-type: none"><li>1. A manual shut-off switch is located at the main CNG dispensing location<ol style="list-style-type: none"><li>a. Customers are trained to shut down the dispenser if they feel a problem or hazard exists</li><li>b. If the dispenser detects a problem it too will automatically shut down</li></ol></li><li>2. Breakaway protection is provided in the event of a vehicle pulling away from the refueling station while the fueling hose is still connected to the vehicle<ol style="list-style-type: none"><li>a. The breakaway device stops the flow of natural gas to the dispenser</li></ol></li><li>3. A manual emergency shut-down switch is remotely located from the dispenser<ol style="list-style-type: none"><li>a. The location is clearly marked with a red sign and white lettering</li></ol></li></ol>	<p>Refueling-11</p>

# INSTRUCTORS GUIDE

<b>PRESENTATION</b>	<b>APPLICATION</b>
<ul style="list-style-type: none"><li>b. The emergency switch will stop the flow of fuel to the dispenser</li><li>4. For emergency response personnel, a curbside shut-off valve is also provided<ul style="list-style-type: none"><li>a. The emergency shut-off valve will turn off the gas supply to the dispenser</li><li>b. It is important that emergency response personnel identify and locate the curbside valve before responding to an emergency at the facility</li></ul></li><li>5. Another emergency shut-off switch is located on the compressor control panel for use by company maintenance staff<ul style="list-style-type: none"><li>a. Typically a trained gas company employee would use this switch and any of the valves located in the compressor and storage area while performing maintenance</li><li>b. The switch shuts down power and the flow of gas to the compressor</li></ul></li><li>6. When pre-planning a natural gas fueling station, be sure to review the gas company's EPA Mandated MSDS sheets and emergency action plan</li><li>7. These documents specify the locations of the main electrical power as well as emergency shutoff valves and switches</li><li>8. Preplans of the fueling facility should include:<ul style="list-style-type: none"><li>a. the location of fuel storage areas and compressors</li><li>b. along with manual shutdown switch</li><li>c. curbside shutdown valve</li></ul></li></ul>	<p>Refueling-12</p>

# INSTRUCTORS GUIDE

PRESENTATION	APPLICATION
<p>d. and emergency shut-off valves and switches</p> <p>e. proximity to other property and exposures</p> <p>9. Emergency response to refueling stations must include the use of full Structural firefighting protective clothing and SCBA's</p> <p>10. You can protect and extinguish a fire involving a vehicle or threatening exposures using water and foam</p> <p>11. If the venting CNG is on fire and it doesn't threaten lives or exposures you can let the fire continue to burn until a gas company employee arrives to assist</p> <p>12. With LNG facility fires you would also allow the fuel to burn off</p> <p>13. You should not put water on a LNG fuel leak</p> <p>14. If the area around above ground fueling containers are involved in a fire, and if there is no liquefied natural gas carefully approach the tanks and use water to cool the tanks and/or to protect surrounding exposures</p> <p>N. CNG Residential Refueling</p> <p>1. Though not yet common, several companies are marketing compressors that take the natural gas piped to a residential site and compress it to refuel a CNG vehicle</p> <p>2. The residential fueling facility (RFF) is an assembly used for compression and delivery of natural gas into vehicles</p>	<p>Refueling-13</p>

# INSTRUCTORS GUIDE

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<b>PRESENTATION</b>	<b>APPLICATION</b>
<ol style="list-style-type: none"><li>3. The RFF includes all associated equipment such as hoses and couplings</li><li>4. Similar to commercial refueling stations, RFF systems have manual and automatic safeguards that shut off both the flow of fuel and electrical power as mandated by NFPA 52</li><li>5. All related equipment for an RFF is designed to minimize the possibility of physical damage and vandalism</li><li>6. The systems can be allowed either indoors or outdoors, but outdoor installation is preferable</li><li>7. With indoor installations, a gas detector set to alarm at one fifth the flammable limit is required, and the compression unit must be located to allow venting to the outdoors</li><li>8. The ability for homeowners to fuel their vehicles in their private garages suggests that emergency responders should be prepared to deal with natural gas emergencies not only on the highway but at commercial refueling stations and in residential setting</li><li>9. To find out if you have residential refueling in your jurisdiction, contact the local building department and ask for any codes or ordinances that allow such devices</li><li>10. Also, inquire about recently issued permits and the location of residences that have installed RFF systems</li></ol>	

# INSTRUCTORS GUIDE

PRESENTATION	APPLICATION
<p><b>IV. LNG Cylinders and Refueling</b></p> <p>A. NFPA 57, “Liquefied Natural Gas (LNG) Vehicular Fuel Systems Code”</p> <p>C. Tanker trucks deliver LNG to refueling centers</p> <p>D. A tanker can hold up to 10,000 gallons of LNG</p> <p>E. It is estimated that 200,000 gallons are trucked into California every day</p> <p>F. The delivery truck transfer LNG to an on-site storage tank or to another vehicle for mobile refueling</p> <p>G. Refueling operators wear rubber aprons, work boots, leather welding gloves, safety glasses, and face shield to protect themselves from the cryogenic liquid</p> <p>H. Fuel is then transferred from the storage tank to the vehicle through a dispenser</p> <p>I. Emergency shut-off switch is located at the dispenser and another within 50 feet</p>	<p>Refueling-14</p> <p>Refueling-15 Photograph of LNG tanker delivering product to a pit fire on the South Rim of the Grand Canyon</p> <p>Refueling-16</p> <p>Refueling 17</p> <p>Refueling-18</p>

# INSTRUCTORS GUIDE

PRESENTATION	APPLICATION
<p>J. Cryogenic LNG cylinders have two nested tanks that form a thermos-like insulating vessel to keep the liquid from reaching its boiling point at the designed storage pressure</p> <p>K. The space between the inner and outer tank is vacuum sealed to provide thermal insulation</p> <p>L. Ice frost or ice crystals on the outside of the cylinder indicate an inner or outer tank failure</p> <p>M. Ice crystals or frost around the valve stem are normal</p> <p><b>V. Natural Gas Cylinder Location</b></p> <p>A. Natural gas cylinders may be found in the rear, trunk, pick-up bed, as side tanks, or on top of the vehicle</p> <p>B. In passenger vehicles and small trucks, the CNG cylinders are typically found in the rear of the vehicle</p> <p>C. Large heavy-duty vehicles may replace their sidesaddle diesel tanks with LNG cylinders, while buses may have cylinders in the side compartments or on top of the vehicle</p>	<p>Refueling-19</p> <p>Refueling-20</p> <p>Refueling-21</p> <p>Refueling-22</p> <p>Return to Main Menu</p> <p>Activity Sheet-2 Facility Walk-Through</p>

# INSTRUCTORS GUIDE

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## **SUMMARY:**

This session gives you insight in to the overall operation and safety features of the fuel storage cylinders along with the natural gas refueling centers. With what you now know of natural gas vehicles it's time to extrapolate this information in to an emergency response plan. That will be the subject of our next lesson.

## **EVALUATION:**

1. What is the maximum pressure on a CNG cylinder?  
Answer: 3600 psi.
2. Which is stronger a CNG cylinder or a gasoline tank?  
Answer: CNG cylinder.
3. How many emergency shut-offs are there at a CNG refueling center?  
Answer: Five: dispenser, breakaway, emergency, curbside, and compressor.
4. How does the liquefied natural gas get to the refueling station?  
Answer: Tanker truck.
5. What does ice or frost on the outside of an LNG tank indicate?  
Answer: Failure in the inner or outer lining of the tank.
6. What is the minimum level of protection for emergency personnel working around LNG?  
Answer: Full protective clothing, boots, gloves, turnouts, helmet and SCBA.

## **ASSIGNMENT:**

Read the Refueling section of your text.

# INSTRUCTORS GUIDE

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Emergency Response to Natural Gas Vehicles

## STUDENT ACTIVITY SHEET #1

### **Pre-Fire Plan a Refueling Facility**

From your walk through of a local natural gas refueling station use a separate piece of paper to outline a pre-fire plan that your department can use for any potential emergencies at the facility. Be sure to include, emergency vehicle access, emergency shut-off switches and valves, exposure hazards, utility shut-off, and emergency contacts and phone numbers.

### **Pre-Fire Plan a Maintenance Facility**

Conduct a walk through of an NGV maintenance facility and note the maintenance operations with an eye toward potential sources of ignition.

### **Pre-Fire Plan a Refueling Facility**

Based on the information you collected from the class and your facility walk through develop a standard operating guideline (SOG) for your departments response to a vehicle emergency at a refueling station in the space provided below or the back of this sheet.

# INSTRUCTORS GUIDE

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## Emergency Response to Natural Gas Vehicles

### Lesson Plan 5 Emergency Response

<b><u>TOPIC:</u></b>	Emergency Response to NGV Vehicles
<b><u>LEVEL:</u></b>	I
<b><u>TIME:</u></b>	1.5-Hours
<b><u>BEHAVIORIAL OBJECTIVE:</u></b>	
<b>Condition:</b>	Complete evaluation with 70% accuracy
<b>Behavior:</b>	The student will . . . <ol style="list-style-type: none"><li>1. Recall specific safety guidelines for natural gas emergencies</li><li>2. Develop a standard operating guidelines for your department</li><li>3. Make informed decisions at the scene of an NGV emergency</li></ol>
<b>Standard:</b>	According to the referenced text
<b><u>REFERENCES:</u></b>	Slaughter, Rodney "Emergency Response to Natural Gas Vehicles," California State University, Chico Instructional Media Center, November 2002.
<b><u>MATERIALS NEEDED:</u></b>	PC projector, projection screen, VCR, multimedia slide show on CD-ROM, speakers
<b><u>PREPARATION:</u></b>	As a flammable gas, CNG leaks and fires can occur during fueling, maintenance, repair or as a result of traffic collisions. Open flames will cause CNG to ignite, which disallows smoking, welding, grinding or any other open flame operations around CNG facilities or vehicles. CNG can also be ignited by sparks from electrical equipment, static electricity, and contact with hot surfaces. CNG fires can be fought using foam or water. However, water should not be used when fighting LNG fires. One recommended strategy when dealing with NGV emergencies is to allow the gas vapors to dissipate into the atmosphere, or to burn off all the fuel when no lives or exposures are threatened.

# INSTRUCTORS GUIDE

## Emergency Response to Natural Gas Vehicles

PRESENTATION	APPLICATION
<p><b>I. Objectives</b></p> <ul style="list-style-type: none"> <li>A. Recall specific safety guidelines for natural gas emergencies</li> <li>B. Develop Standard Operating Guidelines for your department</li> <li>C. Make informed decisions at the scene of an NGV emergency</li> </ul> <p><b>II. Emergency Response Guidelines:</b></p> <ul style="list-style-type: none"> <li>A. Emergency response personnel are required to wear full Structural firefighting clothing as well as SCBA</li> <li>B. Deploy a charged hose or hand line when approaching a vehicle emergency</li> <li>C. Avoid cutting into or around fuel lines or tank storage areas of the vehicle</li> <li>D. Isolate the fuel by turning the manual shut-off valve</li> </ul> <p><b>III. CNG Hazards to Personnel</b></p> <ul style="list-style-type: none"> <li>A. A leak from the high-pressure side of a CNG fuel system could Produce a high-velocity cold gas jet</li> </ul>	<p>From the Main Menu click on Emergency Response</p> <p>Response-OBJ</p> <p>Show Video “<b>Emergency Response To Natural Gas Vehicles</b>”</p> <p>Response-1</p> <p>Response-2</p>



# INSTRUCTORS GUIDE

PRESENTATION	APPLICATION
<p><b>IV. CNG Emergency Response</b></p> <ul style="list-style-type: none"> <li>A. Isolate potential sources of ignition from coming into contact with the fuel leak</li> <li>B. Turn off the gas at the source</li> <li>C. If the vapor plume is on fire, protect surrounding exposures and allow the gas to burn off</li> <li>D. Use foam and/or water to extinguish an interior vehicle fire</li> <li>E. If gas vents from the pressure release device allow the gas to burn itself out</li> <li>F. Protect exposures with water and/or foam</li> <li>G. CNG is almost always odorized, you should be able to detect a leak before the gas reaches its flammable limits</li> <li>H. LNG is generally not odorized, use a gas detector to identify a leak</li> <li>I. You cannot rely on the characteristic smell to detect an LNG leak</li> </ul>	<p>Response-5</p> <p>Response-6</p> <p>Response-7</p> <p>Response-8</p>

# INSTRUCTORS GUIDE

PRESENTATION	APPLICATION
<p>J. LNG hazards to emergency personnel</p> <ol style="list-style-type: none"> <li>1. LNG is a cryogenic liquid that can cause first degree burns when in contact with skin</li> <li>2. LNG reacts violently when water is applied, the reaction warms the liquid to boiling creating more gas vapor</li> <li>3. Adding water to an LNG liquid fire will intensify the fire</li> </ol>	<p>Response-9</p>
<p><b>V. LNG Emergency Response</b></p>	<p>Response-10</p>
<p>A. It is best to allow the LNG fuel spill to vaporize and disperse into the atmosphere</p>	<p>Response-11</p>
<p>B. Large spills would require evacuating the area within a 1,000 Foot perimeter</p>	<p>Response-12</p>
<p>C. Use hose streams to direct the vapor cloud away from buildings and other potential sources of ignition</p>	<p>Response-13</p>
<p>D. Fire Control- Use dry powder or purple K to extinguish an LNG fire</p>	
<p>E. Use high expansion foam on liquid fire to reduce the intensity of the fire</p>	

# INSTRUCTORS GUIDE

## Emergency Response to Natural Gas Vehicles

PRESENTATION	APPLICATION
<p>F. When ever possible isolate the LNG fuel leak from the source</p> <p>G. Use dirt or sand to build a berm around an LNG fuel leak</p> <p>H. Make every attempt to keep the liquid gas from flowing into storm and sewer drains or from entering enclosed spaces</p>	<p>Response-14</p>
<p>I. Emergency Medical</p> <ol style="list-style-type: none"> <li>1. LNG will cause first degree burns and frostbite if not treated immediately</li> <li>2. If a person has LNG on their clothes be sure to defrost the material first with water before trying to remove the clothing</li> <li>3. Additional skin damage could result if the frozen clothing is removed before defrosting</li> </ol>	<p>Response-15</p>
<p>J. Emergencies involving NGV's can occur in vehicles collisions, during refueling operations, or as a result of maintenance</p>	<p>Response-16</p>
<p>K. Your response maybe dictated by your departments Standard Operating Guidelines and your own experience</p> <p>L. How will the information you learned today alter your response in the future?</p>	<p>Response-17</p> <p>Instructors Note: Using the emergency scenario's in the student manual discuss with your class how you would handle a NGV emergency</p>

# INSTRUCTORS GUIDE

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## Emergency Response to Natural Gas Vehicles

### **SUMMARY:**

By understanding the characteristics of natural gas and NGV technology, you can extrapolate ways to respond to a variety of vehicle emergencies. The technical knowledge you have gained from reading this document should be integrated with your department's standard operating procedures for incident command, scene management, and extrication or rescue.

Once again, in every NGV event, emergency response personnel should wear complete protective gear including: turn-out jacket and pants, boots, gloves, helmet, and SCBA. Charged hose lines and fog patterns should be used on initial approach.

While no one can predict the nature of vehicle emergencies in the future, you now have the essential information you need to make informed decisions at the scene of natural gas vehicle emergency.

### **EVALUATION:**

1. What are the dangers of a CNG leak?  
Answer: Potential asphyxiation in confined spaces, explosions when it reaches its flammability limits, and fire or explosion.
2. What is the appropriate level of personnel protection when working around NGV's?  
Answer: Full protective clothing and SCBA.
3. What would you use to put out a CNG fire?  
Answer: Water and/or foam.
4. How much water should be used on an LNG spill or fire?  
Answer: None. Water warms the liquid gas, vaporizing it faster and potentially intensifies the fire.
5. How can you control the vapor cloud of an LNG fuel leak?  
Answer: Use hose streams in a narrow fog pattern to direct the vapor away from buildings and other potential sources of ignition.

### **ASSIGNMENT:**

Read the emergency response section of your text.