



# ***Heavy-Duty Gaseous Fuel Application***



*National Alternative Fuels  
Training Consortium*

*Headquartered at*

 **West Virginia University®**





## *Heavy-Duty Gaseous Fuels Applications*

### **Notes**





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### **Notes**





## Foreword

### Heavy-Duty Gaseous Fuels Applications

#### Notes

Energy consumption is increasing at a dramatic rate everywhere in the world. The extent of this consumption is directly proportional to a society's economic and industrial development. It is a well-established fact that petroleum is one of the most widely-used fuel resources in the world today. As more and more countries prosper, we will see accelerating depletion of traditional energy sources used for transportation.

Energy independence is becoming a crucial factor affecting homeland security, in the U.S. and in other developed countries. An adequate and reliable fuel supply is a critical component of any strategic plan for economic development and national security. In every nation, the choice of fuel has assumed serious economic and environmental consequences, in the forms of budget deficits caused by oil imports and ecological degradation caused by pollution.

Air pollution in some metropolitan areas has reached alarming levels. In response to this pollution, environmental concerns have contributed to the improvement of fuel quality. Over the past decade, the possibility of substituting cleaner-burning alternatives for gasoline and diesel has drawn the attention of the automobile industry, as well as of federal, state, and local governments. Even though it is well known that alternative fuels create less pollution and help states and metropolitan areas to meet stringent environmental requirements, gasoline and diesel remain the most common transportation fuels in the U.S. Additionally, alternative fuels have marked benefits beyond air quality: new fuels in the marketplace offer consumers new choices and can decrease the country's dependence on imported oil.

Alternative fuel vehicles are becoming more readily available to consumers and fleets. Their widespread use in the near future is not only feasible, but necessary. To enable the transition to alternative fuels, technologies must be refined so that vehicles can achieve optimum performance and emissions characteristics. New infrastructures must be developed and supported.

Heavy-duty engines consume the most fuel, cover the longest distances, and serve the largest populations. A typical locomotive burns 2,000 to 3,000 gallons of fuel per day. Large fleets, such as that of the U.S. Postal Service, must pay thousands of dollars more for every one-cent increase in the price of gasoline.

Using less-expensive alternative fuels—including compressed natural gas, liquefied natural gas, and propane—has the potential to significantly reduce an operation's transportation costs. Using less-polluting fuels will also help meet EPA emissions requirements and contribute to a cleaner environment, as well as help to lessen our dependence on foreign oil imports.

These are compelling reasons to create a pool of properly-trained technicians to service these vehicles. The primary goal of this course is to meet this need.

The National Alternative Fuels Training Consortium, working in cooperation with the United States Environmental Protection Agency, is pleased to provide this course on Heavy-Duty Gaseous Fuel Applications.

*Al Ebron*

Executive Director,  
National Alternative Fuels Training Consortium  
West Virginia University



**National Alternative Fuels Training Consortium**





# Acknowledgements

## Heavy-Duty Gaseous Fuels Applications

### Notes

The *Heavy Duty Gaseous Fuel Applications* Course was developed by the National Alternative Fuels Training Consortium (NAFTC), headquartered at West Virginia University in Morgantown, West Virginia, under a Cooperative Agreement with the United States Environmental Protection Agency. Many individuals and organizations in academia, government, and industry participated in this process.

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- Wentworth Institute of Technology, Boston, MA.
- College of Human Resources and Education, Department of Technology Education, West Virginia University, Morgantown, WV.
- Extension Service, Department of Communications, West Virginia University, Morgantown, WV.
- Various Industry, Trade, and Fleet organizations.

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Project management was provided by Al Ebron, *Executive Director*, Bill Davis, *Program Manager*, and Tom Hudson, *Curriculum Developer* of the NAFTC, West Virginia University, Morgantown, WV.





## Course Description

### Heavy-Duty Gaseous Fuels Applications

#### Notes

The number of heavy-duty vehicles powered by alternative fuels is growing every year. Mandates such as the federal Energy Policy Act and the California Federal Pilot Program require most large fleets to include alternative fuel vehicles (AFVs) in ever-growing numbers.

All of this means that the demand for AFV technicians is increasing dramatically. The AFV technician needs to know everything that is currently applicable to heavy-duty vehicles, along with new technology to deal with the gaseous fuel system, engine, electronics, and exhaust.

For an experienced diesel technician, the greatest challenges when working with AFVs include the concepts of working with fuels such as natural gas and propane, emission-control equipment, electronic ignition, and safety.

Each chapter of the **Technician's Manual** contains text, illustrations, explanatory figures and tables, chapter review questions, and job aids, along with classroom and/or shop activities.

Each corresponding chapter of the **Instructor's Manual** contains everything in the Technician's Manual, as well as a detailed daily agenda, teaching suggestions, group discussion topics, chapter review questions with answers, PowerPoint slides, and animated presentations.

The National Alternative Fuels Training Consortium (NAFTC) is pleased to offer this new course, Heavy-Duty Gaseous Fuel Applications, which meets the needs of the technician, the employer, the fleet operator, and the training institution.

## COURSE OBJECTIVES

Upon successful completion of this course, the technician will be able to

- Explain the sources and processing of hydrocarbon gaseous fuels.
- Discuss the impact of dependence on foreign oil on the U.S. economy.
- Describe the sources and effects of environmental pollution.
- List the major alternative fuels currently or soon to be in use, and compare the benefits and drawbacks of each.
- Use the concepts of pressure, density, and volume in describing, measuring, and handling gaseous fuels.
- State the chemical and physical properties of methane, propane, and hydrogen.
- List the primary emissions from automotive and transportation uses, and identify the sources and remedies for each.
- Describe the four-stroke Otto and diesel cycles, and explain how combustion is different with a gaseous fuel.
- Explain lean-burn technology and calculate the correct air-fuel ratio to achieve best power, lowest emissions, and greatest fuel economy.
- Describe the components of a natural gas fuel system and explain how each operates.
- Explain the operation of the Electronic Control Module (ECM) and the components that connect to it.
- Describe the operation of the ignition system and its components.
- List personal and shop safety procedures, and describe the appropriate responses to common emergencies such as fire, gas leakage, and collision.
- List the major policies and regulations pertaining to the installation, operation, and inspection of gaseous fuel vehicles.



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## Course Outline

*Heavy-Duty Gaseous Fuels Applications*

### Notes

Chapter	Topics
1	<b>Origin and Nature of Gaseous Fuels</b> Uses and sources of hydrocarbon gaseous fuels; the impact of imported fuels on the economy; environmental implications; drilling and processing of natural gas.
2	<b>Alternative Fuel Vehicles</b> Overview of several alternative fuels: ethanol, methanol, compressed natural gas (CNG), liquefied natural gas (LNG), propane (LPG), hydrogen, electricity (and hybrids), and fuel cells.
3	<b>Pressure, Temperature, and Density</b> Basic science of working with gases; hands-on practice using various instruments to take precise measurements.
4	<b>Properties of Gaseous Fuels</b> Chemical and physical properties of methane (CNG/LNG) and propane (LPG); overview of emissions.
5	<b>Combustion and Engine Design</b> Four-stroke Otto cycle; Diesel engines; air-fuel mixtures; emissions; lean-burn technology; compression ratio; timing; combustion chamber components (valves, cylinders, pistons, rings); and useful formulas.
6	<b>Fuel-System Components</b> CNG distribution and on-board storage systems; pressure-relief devices; filtration; pressure regulators; air-fuel mixers; and fuel injection options.
7	<b>Electronic Control Systems</b> Electronic control module (ECM) system: sensors, monitors, and actuators.
8	<b>Ignition Requirements and Controls</b> Magnetism and electricity; energy, voltage and current; ignition coil fundamentals; Ohm's Law; condensers and capacitors; inductance; secondary ignition; and spark plugs.
9	<b>Safety, Maintenance, and Inspection of NGVs</b> The natural gas safety record; personal and shop safety procedures; emergency and fire procedures; installation; and CNG cylinder inspection.
10	<b>Alternative Fuel Vehicle Standards</b> The Clean Air Act of 1963 and its amendments; the Energy Policy Act of 1982; the California Air Resources Board; DOT regulations; the National Fire Protection Agency; and safety regulation agencies.
plus	<b>Glossary of Terms</b>

This course is five days in length and includes hands-on workshop activities in a heavy-duty vehicle lab.

For information about class schedules, pricing, locations, and registration, please contact the National Alternative Fuels Training Consortium at 304 293-7882 or go online to <http://www.naftc.wvu.edu> for further details.





## DISCLAIMER

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**Notes**

The information contained in this manual was obtained from sources believed to be reliable and is based on technical information and experience currently available. However, the National Alternative Fuels Training Consortium (NAFTC)—a program of West Virginia University—and its members, jointly or severally, make no guarantee of the results and assume no liability or responsibility in connection with the information or suggestions herein contained. Moreover, it should not be assumed that every acceptable or necessary commodity grade, test, safety procedure, method, precaution, equipment, or device is contained within, nor that abnormal or unusual conditions or circumstances may not warrant or suggest further requirements or additional procedures.

This document is subject to periodic review and users are cautioned to obtain the latest version of the manual. Comments and suggestions are invited from all users for consideration by the NAFTC in connection with such review. Please send all comments to the NAFTC, attention Executive Director.

It is important that individuals using this information as an aid to perform maintenance and repair on Natural Gas Vehicles (NGVs) read and follow all other applicable reference material and industry standards. The guidance and information in this manual are not meant to replace vehicle or equipment manufacturer guidelines and are not intended to supersede other information provided by manufacturers, safety officials or other applicable standards and recommended practices.

This document does not take the place of and should not be confused with federal, state, provincial, or municipal specifications or regulations, insurance requirements, or safety codes.



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## Course Agenda

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DAY	AGENDA
1	Introduction to the Course Chapter 1 Chapter 2 Chapter 3
2	Chapter 4 Chapter 5
3	Chapter 6
4	Chapter 7 Chapter 8 (to bottom of page 8-14)
5	Chapter 8 (page 8-14 to end) Chapter 9 Chapter 10 Course Evaluation Presentation of Completion Certificates

Specific agendas for each chapter appear in this Instructor's Manual in the introductory material for the chapter.

This course is designed to take five eight-hour days to complete.

Instructional time is **6.5 hours per day**, which allows for a 15-minute break in the morning and afternoon, and one hour for lunch each day.





## Instructor Feedback Form

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**Notes**

**INSTRUCTOR:** Please use this form to notify the NAFTC of any corrections, suggestions, or other observations that you feel may contribute to improving the quality, flow, or learning experience from this course. Please make as many copies of this page as necessary.

Instructor Name: \_\_\_\_\_

Telephone Number: \_\_\_\_\_

(This is needed in case we require further clarification.)

Chapter: \_\_\_\_\_

Page: \_\_\_\_\_

*Please check one of the following:*

☐ **Text**

☐ **Activity**

☐ **Note Box**

☐ **Figure**

☐ **Discussion Question**

☐ **Instructor's Note**

☐ **Table**

☐ **Review Question**

☐ **Other**

*Problem, Concern, or Comment:*

*Suggested Solution, Correction, or Improvement:*

Continue on the back of this sheet if necessary.

Please mail or fax this form to the following:

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