**Instructor Guide**

Principles of Natural Gas - Hazards of Natural Gas and Prevention of Accidental Ignition Gas Migration

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Overview and Goals

Natural gas which is a mixture of several gases and largely made up of methane, is a clean burning, safe and efficient energy source when handled correctly.

In this unit of work the instructor will:

* Highlight the concepts introduced in the online course.
* Demonstrate how to use the relevant tools and reference guides, applicable to the content and activities.
* Guide the participants through hands-on activities to work safely with natural gas, as a qualified operator would on the job.

Upon completion of this unit of work, participants will be able to:

* Identify the chemical composition, physical characteristics, and properties of natural gas.
* Explain the flammability range of natural gas–Lower Explosive Limit (LEL) and Upper Explosive Limit (UEL).
* Prepare pipes to eliminate natural gas ignition.
* Capture gas samples.
* Identify and be able to explain and or demonstrate how to manage leaks and abnormal operating conditions (AOCs).
* Discuss actions necessary to confront the potential dangers in response to natural gas leaks.

***Note:*** *Specific step-by-step details and the outcomes of the demonstrations and participant activities will be determined by the materials and tools used at the training facility.*

Preparation – Facilitation Guidelines

Ensure the participants have completed:

* ASME Gas 01e-TNG – Hazards of Natural Gas and Prevention of Accidental Ignition, including the pre-test and 20 question course assessment.

Conduct this training in a classroom setting, with a simulated lab environment using the local materials and tools for illustration, demonstration, and the hands-on workshop activities.

During the class introduction:

* Encourage discussion through demonstrations and activities.
* Discuss the importance of participation.
* Explain that participants may work with a partner or in small groups to complete the activities. After each activity, the participants will be encouraged to present their findings for further discussion to the workshop.

Use a flipchart to capture key lessons learned from the group discussions, or to identify questions that will be answered in upcoming units of work or that require further research and discussion.

Reinforce the importance of damage prevention programs and the best practices and guidelines of the Compressed Gas Association (CGA), the Occupational Safety and Health Administration (OSHA), and the Federal Government.

Review the following regulations as tasks are introduced, demonstrated, and practiced.

* §192.615 Emergency plans.
* §192.625 Odorization of gas.
* §192.751 Prevention of accidental ignition.

Materials

Provide the following to each participant:

* A copy of the Appendix and the Activity Worksheets.
* Access to the Internet, as needed, for OSHA, federal, and industry resources/references supporting course related discussions, demonstrations, and hands-on activities.
* Access to manufacturers’ instructions as needed.

Provide the following materials and tools used locally for the lab demonstrations and hands-on practice:

* Plastic pipe
* Metal pipe
* Alligator clip
* Insulation materials
* Soapy detergent
* Welding gun/welding material-for demonstration only
* Combustible gas indictor (CGI) -for demonstration only
* Mercaptan-for demonstration only

***Note:*** *These items, and any other materials used for demonstrations and participant activities, will be determined by the materials and tools used at the training facility.*

Schedule

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| **Time**  | **Topics for Discussion, Demonstrations, and Activities**  |
| **30 minutes**  | **Introduction** * Review how natural gas is formed, extracted, and refined.
* Review how natural gas is used.
* Emphasize that controlled combustion of natural gas is used to create energy, which is managed by:
	+ Controlling gas pressure
	+ Controlling the gas-air mixture
	+ Venting the equipment properly
* List the potential dangers and hazards of natural gas.
	+ Point out, and offer examples that explain:
		- How fires or explosions occur.
		- How incomplete combustion can result in carbon monoxide poison.
		- Symptoms of carbon monoxide poisoning.
		- How natural gas can cause asphyxiation.
* Reinforce that all natural gas local, state, and federal safety guidelines must be followed.
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| **60 minutes**  | **Topic: Natural Gas Properties** * Point out that natural gas, once extracted from the earth:
* Is processed for purity and some of the chemical elements, such as hydrocarbons like propane and butane are removed for separate uses.
* Can be stored.
* Review the following:
* Chemical composition of natural gas.
	+ Processed natural gas contains 85% to 90% of methane and 10% to 15% of other gases such as ethane, propane, and butane.
* Flammability range: 4.5%-14.5%
	+ Ignition temperature between 1100 and 1200 degrees Fahrenheit
	+ Vapor density of approximately .60
* Characteristics.
	+ Colorless, odorless, non-toxic, non-poisonous, lighter than air, and combustible.
	+ Mercaptan, an odorant, is added before distribution to assist in leak detection.
 |
| **60 minutes** | **Topic: Flammability*** Explain that natural gas will only ignite when specific gas-to-air ratios are present.
* The flammability range is 4.5% to 14.5% gas in air.
	+ The Lower Explosive Limit (LEL) must take up to 4.5% of the atmosphere to burn.
	+ The Upper Explosive Limit (UEL), if greater than 14.5% of the atmosphere will not burn.

***Note:*** *If the training lab has meters for field use; show the participants how to use a methane meter. Specific steps will be determined by the materials, tools, and manufacturers’ instructions used at the training facility.* |
| **Time**  | **Topics for Discussion, Demonstrations, and Activities**  |
| **30 minutes** | **Demonstration: Static Electricity*** Review and reinforce.
* Static electricity is a potential source of ignition in a natural gas atmosphere.
* Demonstrate the conditions which cause static electricity: friction, accumulations, etc. using materials available in the training lab.
* Explain:
* The importance of grounding the tools to prevent any source of ignition.
* Demonstrate how to coat a plastic pipe to remove electrical charges.

***Note:*** *If there are any specific local practices used on the job, for example, setting an alligator clip, show the participants, and allow them to practice the task using the materials, tools, and manufacturers’ instructions used at the training facility.* |
| **90 minutes** | **Demonstration: Preparing Pipes** * Demonstrate, wearing the appropriate personal protection equipment (PPE):
* How to prepare plastic pipes before cutting to prevent an electrical charge.
* How to prepare metal pipes before cutting to prevent an electrical charge.
* How to insulate pipes.
* How to weld a pipe (demonstration only with certified operator).
	+ Point out that if welding is necessary, qualified personnel must test the atmosphere for the presence of natural gas, using CGI equipment.
* Instruct participants to complete **Activity Worksheet #1.**
 |
| **60 minutes** | **Demonstration: Gas Leaks*** Discuss how to detect natural gas leaks.
* Provide real-world examples and encourage discussion on how operators on the job made the assessments.
* Emphasize the importance of using one’s natural senses**.**
	+ **Smell-** Explain that mercaptan contains sulfur and how it is added to natural gas to detect leaks.
	+ **Look**-Explain that natural gas leaks often cause bubbling water, blowing dirt or dead plants, or on a larger scale, sink holes and/or exposed pipe.
	+ **Listen-**Explain that natural gas leaks often cause a hissing sound near a natural gas line or meter.
* Demonstrate using local materials and tools in a controlled environment that will show how:
	+ Mercaptan is used to indicate a gas leak.
	+ A gas leak is isolated by using a gas leak solution such as a soapy liquid.
	+ Air pushing through a pipe can create a hissing sound, similar to what you will hear with a gas leak.
* Demonstrate how to use a gas flow meter to measure the amount of natural gas passing through a given point at any point in time or over a period of time (type used, e.g.; mechanical, thermal, based on materials and tools used locally).
* Discuss how to secure a leak site.
* Point out the importance of eliminating ignition sources.
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| **Time**  | **Topics for Discussion, Demonstrations, and Activities**  |
| **30 minutes** | **Demonstration and Practice: Assess a Gas Leak** * Demonstrate how to sample the air and analyze gas concentration with a combustible gas indictor (CGI).
* Reinforce the information provided by the industry, manufacturer and online course work on how to use a CGI.
	+ *Most CGIs will sound an alarm when gas levels are at 10% LEL.*
* Explain that the results are evaluated by a lab.
* Provide hands-on time for the participants to use the CGI.
 |
| **120 minutes** | **Topic: Detecting and Managing Abnormal Operating Conditions (AOCs)** * Review and reinforce how to evaluate and respond to abnormal operation conditions.
* Discuss the importance of calling 8-1-1 or the One-Call Center.
* Emphasize online course topics and instruction.
* Provide real-world examples and stories.
* Show, if available, videos which illustrate the importance of natural gas safety.

(*Typically videos are available from state natural gas organizations; if none are available, participants can access a wide variety of YouTube videos for illustration. For example,Case* Study: [Lafayette Indiana Natural Gas Pipeline Explosion](http://www.youtube.com/watch?v=y1TibjFOToM))* Instruct the participants to complete **Activity Worksheets #2-#7.**
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Boot Camp Activities

Working with a partner or partners, answer the following questions and complete the tasks, according to the materials, equipment, and manufacturers’ instructions used.

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| Activity Worksheet #1 - Prepare Pipes |
| Task | Using the materials and tools available, prepare pipes to prevent an electrical charge.* Plastic
* Metal

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| Tools used  |  |
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| Steps-actions  |  |
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| References/Guidelines including:* Industry sources
* Online course materials
* CFR

Indicate, if applicable, measures that appear to be a potential problem and or an abnormal operating condition (AOC). |   |
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| General discussion questions or notes |  |
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Working with a partner or partners, determine what you must do to ensure the safety of the public and personnel in the following situations.

Be thorough in your discussion and discuss all the answers in each group to ensure everyone is aware of the options that need to be evaluated and actions necessary to safely manage each situation.

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| Activity Worksheet #2 - On the Job Scenario |
| Scenario | At the local veterinarian’s office a nurse began smelling an odd odor. The nurse has been trained for emergencies and calls the gas company as soon as she smelled the odd odor. The gas company advises the nurse to evacuate the building and that a crew will immediately be dispatched to the office. As a crew member, with the information available, what do you do:* Once dispatched?
* Upon arrival?
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| Tools used  |  |
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| References/Guidelines including:* Industry sources
* Online course materials
* CFR

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| Activity Worksheet #3 - On the Job Scenario |
| Scenario | A woman calls gas company and says her gas dryer smells funny. A crew is immediately dispatched. How is this abnormal operating condition assessed?If it is determined that the line to the gas dryer is leaking, what actions are taken to:* The surrounding area?
* The pipe?
* The property?

Why would you ask the home owner if she and or any other member of the household was feeling any flu-like symptoms? |
| Tools used  |  |
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| Steps-actions  |  |
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| References/Guidelines including:* Industry sources
* Online course materials
* CFR

Indicate, if applicable, measures that appear to be a potential problem and or an abnormal operating condition (AOC). |   |
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| Activity Worksheet #4 - On the Job Scenario |
| Scenario | At a construction site a gas tank was ignited. Emergency crews were immediately dispatched. What actions were taken? Why?  |
| Tools used  |  |
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| Steps-actions  |  |
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| References/Guidelines including:* Industry sources
* Online course materials
* CFR

Indicate, if applicable, measures that appear to be a potential problem and or an abnormal operating condition (AOC). |   |
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| Activity Worksheet #5 - On the Job Scenario |
| Scenario | A beauty salon operator, whose shop is in a strip shopping center calls and says she smells an odd odor outside the back door of her shop.* What advice is given while the crew is being dispatched?
* What actions are taken upon arrival?
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| Tools used  |  |
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| Steps-actions  |  |
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| References/Guidelines including:* Industry sources
* Online course materials
* CFR

Indicate, if applicable, measures that appear to be a potential problem and or an abnormal operating condition (AOC). |   |
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| Activity Worksheet #6 - On the Job Scenario |
| Scenario | An old home was being excavated and the plumber heard an odd hissing sound under the basement crawl space. He inspected the area and could not find any leaking pipes.The plumber called the gas company for help and an operator was dispatched to assess the severity and location of the leak. What tools did the gas company employee use? Why?  |
| Tools used  |  |
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| Steps-actions  |  |
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| References/Guidelines including:* Industry sources
* Online course materials
* CFR

Indicate, if applicable, measures that appear to be a potential problem and or an abnormal operating condition (AOC). |   |
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| Activity Worksheet #7 - On the Job Scenario |
| Scenario | A kitchen fire started when the gas stove top ignited unexpectedly. Once the open flames were put out the property was inspected. The insurance company paid the claim, however the cause of the fire was not a defective stove top. It was determined to be a faulty electrical switch. How and why could this determination be made? |
| Tools used  |  |
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| Steps-actions  |  |
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| References/Guidelines including:* Industry sources
* Online course materials
* CFR

Indicate, if applicable, measures that appear to be a potential problem and or an abnormal operating condition (AOC). |   |
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Appendix 1- References and Resources

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| **References and Resources** | **URL** |
| Background of Natural Gas | From NaturalGas.org website:<http://www.naturalgas.org/overview/background.asp>  |
| A table outlining the typical chemical composition of natural gas. | From the Union Gas website:<http://www.uniongas.com/aboutus/aboutng/composition.asp> |
| A job aid on Material Safety Data Sheets, including hazardous ingredients, physical data, fire and explosion hazard, reactivity, preventative measures and equipment.  | From the Union Gas website:<http://www.uniongas.com/safety/msdsenglish.pdf> |
| Typical Sulfur Compounds Contained in Natural Gas | From the California Gas Transmission website.<http://www.pge.com/pipeline/operations/sulfur/sulfur_info.shtml> |
| Material Safety Data Sheet | From the Piedmont Natural Gas website:<http://www.piedmontng.com/files/pdfs/safety/materialsafetydatasheet_090809.pdf> <http://www.piedmontng.com/files/pdfs/safety/MaterialSafetyDataSheet_92404.pdf> |
| Testing mercaptan  | [http://www.astm.org/Standards/D1988.htm 1](http://www.astm.org/Standards/D1988.htm%201)<http://www.atsdr.cdc.gov/mhmi/mmg139.pdf> |
| §192.615 Emergency plans.*Note*: Often each state will specify guidelines, for example, the state of Florida:<http://www.floridapsc.com/utilities/electricgas/naturalgassafety/PHMSA_Part_192_Emergency%20Response_Plans.pdf>  | <http://www.gpo.gov/fdsys/granule/CFR-2011-title49-vol3/CFR-2011-title49-vol3-sec192-615/content-detail.html>  |
| §192.625 Odorization of gas.  | <http://www.gpo.gov/fdsys/pkg/CFR-2012-title49-vol3/pdf/CFR-2012-title49-vol3-sec192-625.pdf>  |
| §192.751 Prevention of accidental ignition. | <http://www.gpo.gov/fdsys/pkg/CFR-2012-title49-vol3/pdf/CFR-2012-title49-vol3-sec192-751.pdf>  |
| OSHAOSHA Glossary of Terms  | <http://www.osha.gov/><http://www.osha.gov/SLTC/etools/oilandgas/glossary_of_terms/glossary_of_terms_a.html>  |
| **Videos:*** LNG Natural Gas Industry Tutorial
* Case Study: Lafayette Indiana Natural Gas Pipeline Explosion
* BP Texas City Explosion
 | <http://www.youtube.com/watch?v=uztD_gAfNzA><http://www.youtube.com/watch?v=y1TibjFOToM><http://www.youtube.com/watch?v=VCcN4SQkb9A>  |

1 ASTM D1988, "Coal Standards and Gas Standards," ASTM International, West Conshohocken, PA, 2003, 10.1520/D1988-06R11, [www.astm.org](http://www.astm.org).