

Hazardous Materials

Title:	Hazardous Materials
Lesson Purpose:	To provide the participant with the skills necessary to identify a hazardous materials incident, implement proper notification, and identify immediate threats to themselves and others through the use of the U.S. Department of Transportation (DOT) <i>Emergency Response Guidebook</i> (ERG).
Training Objectives:	At the end of this block of instruction, the participant will be able to achieve the following objectives in accordance with the information presented during the instructional period: 1. Define “hazardous materials” and the risks associated with them during a hazardous materials incident. 2. Describe the duties of an awareness-level first responder at the scene of a hazardous materials incident. 3. List methods used to recognize the presence of a hazardous material, to include the identification of the possible material or substance based on readily available clues. 4. Demonstrate the ability to use the DOT <i>Emergency Response Guidebook</i> in identifying a hazardous material and appropriate first responder actions, to include notifying additional resources. 5. Explain what WISER is and how to use it as a resource when at the scene of a suspected hazardous materials incident. 6. Identify the occurrence of a natural gas leak and what protective measures to take to assure life safety until the leak can be mitigated.
Hours:	Two (2)
Instructional Method:	Lecture Discussion Demonstration Practical Exercise
Materials Required:	Lesson Plan Pen/Pencil/Paper
Training Aids:	LCD Projector/Computer

Screen
Flip Chart/Easel
Markers
2016 Emergency Response Guidebook
Handout
PowerPoint Slides

References:

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NFPA 472 and 473, Hazardous Materials/Weapons of Mass Destruction Response Handbook. Quincy, MA: National Fire Protection Association, [2013].

"NTSB: Defective Joint, Lack of Supporting Soil Caused East Harlem Gas Main Leak That Killed Eight, Destroyed Two Buildings." National Transportation Safety Board, June 2015. [On-line]. Available at: <https://www.nts.gov/news/press-releases/Pages/PR20150609.aspx> [December 2017].

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"Regulations (Standards – 29 CFR): 1910.120." Washington, DC: United States Department of Labor, Occupational Safety and Health Administration, 2012. [On-line]. Available at: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9765 [April 2017].

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Prepared By:	Chris Anderson Deputy Director of Operations North Carolina Justice Academy-West Campus
Date Prepared:	May 2012
Reviewed By:	Chris Anderson Deputy Director of Operations North Carolina Justice Academy-West Campus
Date Reviewed:	June 2014
Revised By:	Chris Anderson Deputy Director of Operations North Carolina Justice Academy-West Campus
Date Revised:	May 2016
Revised By:	Gary Dudley Training Manager

Hazardous Materials

North Carolina Justice Academy

Date Revised: May 2017

Revised By: Gary Dudley
Training Manager
North Carolina Justice Academy

Date Revised: December 2018

Hazardous Materials

Title: Hazardous Materials – **Instructor Notes**

1. This in-service lesson plan must be presented by an instructor currently certified by the North Carolina Criminal Justice Education and Training Standards Commission as a Specialized Explosives and Hazardous Materials Instructor.
2. A test is provided which meets the mandatory testing requirements. Consult your Commission's 2018 Frequently Asked Questions for further guidance.
3. To document the fulfillment of the requirement of Title 29 Code of Federal Regulations 1910.120(q)(8)(ii) each student's test should be maintained in the Agency's training files.

Hazardous Materials

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I. Introduction

NOTE: Show slide, “Hazardous Materials.” Greet class, introduce yourself, and provide a brief background.

A. Opening Statement

NOTE: Show slide, “Hazardous Locations.”

Hazardous materials can be found all around us. They are stored under our sinks, in our closets, and in our storage buildings. We pass by them in larger quantities on the highways, railways and industries. Most of the time, there isn't an issue with their presence. This can change quickly when there is a traffic accident, spill or illegal activity. In most incidents, law enforcement officers are the first on the scene. In the worst case scenarios, first responders can be injured or killed, such as in the unfortunate situation on February 5, 2017 in Augusta, Georgia. Sergeant Greg Meagher with the Richmond County (GA) Sheriff's Office and several other deputies attempted to rescue an unconscious woman inside a sperm bank. After Meagher was overcome by fumes, he was rescued by firefighters and died at the hospital. The other three deputies were treated for their exposure to what was determined to be leaking liquid nitrogen.¹

The fact is, most people are near hazardous materials on a daily basis, whether we realize it or not. The goal is to raise your awareness of hazardous materials in your everyday surroundings and enhance the way you think of hazardous materials, while providing the knowledge necessary to protect yourself and others through proper early identification and notification of resources.

B. Training Objectives

NOTE: Show slides, “Training Objectives.”

C. Reasons

NOTE: Show slide, “Save Lives, Protect Property.”

As emergency personnel, we work to protect and serve the public. We must also work to protect ourselves during hazardous materials incidents. Emergency personnel must be aware of the presence of hazards and their potential threats, in order to make the appropriate response to insure the safety for themselves, other emergency personnel, and the public.

II. Body

Hazardous Materials

A. Hazardous Materials Defined

The Occupational Safety and Health Administration (OSHA) establish regulations for employing organizations and define responder levels. These are codified in 29 CFR 1910.120. Many different organizations define hazardous materials. The following are the definitions of hazardous materials as defined by OSHA and the U.S. Department of Transportation (DOT).

1. OSHA

NOTE: Show slide, “Occupational Safety & Health Administration.”

“Hazardous substance means any substance designated or listed under (A) through (D) of this definition, exposure to which results or may result in adverse effects on the health or safety of employees:

[A] Any substance defined under section 103(14) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (42 U.S.C. 9601).

[B] Any biologic agent and other disease causing agent which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations in such persons or their offspring.

[C] Any substance listed by the U.S. Department of Transportation as hazardous materials under 49 CFR 172.101 and appendices; and

[D] Hazardous waste as herein defined.

Hazardous waste means —

[A] A waste or combination of wastes as defined in 40 CFR 261.3, or

[B] Those substances defined as hazardous wastes in 49 CFR 171.8.”²

2. Department of Transportation

NOTE: Show slide, “Department of Transportation.”

Hazardous Materials

“A hazardous material is defined as any substance or material that could adversely affect the safety of the public, handlers or carriers during transportation.

NOTE: Show slide, “DOT Hazard Classes.”

There are nine classes of hazardous materials identified by DOT.”³

Hazard Class 1: Explosives	1.1 mass explosion hazard 1.2 projectile hazard 1.3 minor blast/projectile/fire 1.4 minor blast 1.5 insensitive explosives 1.6 very insensitive explosives
Hazard Class 2: Compressed Gases	2.1 flammable gases 2.2 non-flammable compressed 2.3 poisonous
Hazard Class 3: Flammable Liquids	Flammable (flash point below 141°) Combustible (flash point 141°-200°)
Hazard Class 4: Flammable Solids	4.1 flammable solids 4.2 spontaneously combustible 4.3 dangerous when wet
Hazard Class 5: Oxidizers and Organic Peroxides	5.1 Oxidizer 5.2 Organic Peroxide
Hazard Class 6: Toxic Materials	6.1 Material that is poisonous 6.2 Infectious Agents
Hazard Class 7: Radioactive Material	Radioactive I Radioactive II Radioactive III
Hazard Class 8: Corrosive Substances	Destruction of the human skin Corrode steel at a rate of 0.25 inches per year
Hazard Class 9: Miscellaneous	A material that presents a hazard during shipment but does not meet the definition of the other classes

3. More specifically, “a hazardous material is any substance or material that possesses an unreasonable risk to health and safety of persons and/or the environment if it is not properly controlled during handling, storage, manufacture, processing, packaging, use, disposal, or transportation.”⁴

B. Awareness-level Responsibilities of First Responders

NOTE: Show slide, “Awareness-level Responsibilities.”

First responders such as law enforcement officers are classified as awareness-level personnel according to OSHA’s Hazardous Waste Operations and Emergency Response (HAZWOPER) standard 29 CFR 1910.120. “First responders at the awareness level shall have sufficient training or have had sufficient experience to objectively demonstrate competency in the following areas:

1. An understanding of what hazardous substances are, and the risks associated with them in an incident.
2. An understanding of the potential outcomes associated with an emergency created when hazardous substances are present.
3. The ability to recognize the presence of hazardous substances in an emergency.
4. The ability to identify the hazardous substances, if possible.
5. An understanding of the role of the first responder awareness individual in the employer’s emergency response plan including site security and control and the U.S. Department of Transportation’s Emergency Response Guidebook.
6. The ability to realize the need for additional resources, and to make appropriate notifications to the communication center.”⁵

C. Recognition and Identification

Regardless of how OSHA or DOT define hazardous materials and whether the substance fits specifically in the box as defined, hazardous materials exist in all environments and pose a substantial risk to emergency personnel, citizens, and property. Emergency personnel must be vigilant in their every activity throughout their shift. For the officer responding to the call, the citizen who called 911, the telecommunicator who has just answered the call, or the detention officer who has custody, care, and control, being aware of key clues may have lifesaving effects.

1. Initial tactics

NOTE: Show slide, “Initial Tactics.”

- a) Before an emergency, become familiar with the *Emergency Response Guidebook* (ERG). In the United States, according to the requirements of the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA, 29 CFR 1910.120), and regulations issued by the U.S. Environmental Protection Agency (EPA, 40 CFR Part 311), first responders must be trained regarding the use of this guidebook.
 - b) Resist rushing in.
 - c) Approach incident from upwind.
 - d) Stay clear of all spills, vapors, fumes, smoke and suspicious sources.
2. Recognition

NOTE: Show slide, "Recognition Tips."

By no means can we list every clue which may help you recognize the presence of a hazardous material. It is critical that emergency personnel be keenly aware of the totality of the circumstances that have brought them to this point. Take in all the information available. Suggestions below represent only a few of the many clues:

- a) Odd smells, colored smoke, plume visible, hissing noises from pressure leaks, visible vapor clouds, odd or unusual taste in your mouth, the feel of burning or greasiness on the skin. Be aware of indicators from your senses of hearing, sight, smell, taste, and touch. The indicators listed above may provide clues but also may indicate a situation that could be immediately dangerous to life and health. Take immediate precautions to protect yourself.
- b) Be aware of individuals who are on the ground at the scene and observe the surroundings for other clues. This may be a hazardous materials incident mistaken as a heart attack, abandoned vehicle, or someone passed out in the yard.
- c) Location of the building such as an industrial sight, manufacturer, or shipping terminal may be an indicator. However be aware! Just because it is a house or car does not mean you are clear of hazardous materials.
- d) Container shapes and construction, reinforcement rings, emergency relief valves, etc.

- e) Commercial placards, fixed site placards, labels, container markings
- f) Shipping papers, Safety Data Sheets (SDS)
- g) Presence of unlabeled containers, empty containers, unexplained items around bodies or located in the vicinity of persons exhibiting symptoms of exposure such as coughing, choking, tears, blistering of skin, redness of skin, or other unusual behavior/symptoms

3. Identification

Once the incident has been recognized as a possible hazardous material involved incident, it is critical to gather as much information as possible about the incident to include the identification of the possible material or substance based on readily available clues.

- a) The first concern is the protection of life and safety of emergency personnel and the general public.
- b) Utilize information on packaging if visible, such as labels
- c) Utilize information from placards, shipping papers, SDS
- d) Look for physical symptoms experienced by victims
- e) Use the *Emergency Response Guidebook* (ERG)

D. The *Emergency Response Guidebook*

NOTE: Show slide, “Emergency Response Guidebook.”

NOTE: Have students examine their ERG. Point out the different sections that can be identified by observing the different colors indicated on the edge of the book. This allows the student to reference the book quickly during an emergency.

1. Instructions

“The white pages at the beginning of the ERG include instructions on how to use the book, where to call for emergency assistance, an overview of the hazard classification system, and an explanation of placards and other warning systems.”⁶

2. Numerical index

“The yellow-bordered pages near the beginning of the ERG are a numerically sequenced listing of 4-digit hazardous material identification numbers, followed by a three-digit emergency response guide number and the name of the material. The guide numbers refer to orange bordered pages near the end of the book, which spell out the hazards encountered in the event of a transportation related release and the immediate emergency response procedures.”⁷

NOTE: Explain to the student the proper procedure for using the numerical index and the relationship it has with the alphabetical index (which is cross indexed between United Nations (UN) and North America (NA) numbers).

3. Alphabetical index

“The blue-bordered pages are similar to the yellow-bordered pages, but are alphabetically sequenced by the name of the hazardous material.”⁸

NOTE: Explain to the student the proper procedure for using the alphabetical index and the relationship it has to the numerical index. Explain the importance of the bold print and coloring code.

4. Response guides

“The orange-bordered pages are the emergency response guides, which include the potential hazards to health, risk of fire or explosion, and emergency response procedures.”⁹

NOTE: Explain the use of the emergency response guides as it relates to the potential hazards and emergency action. Use Guide 111 as a generic guide to walk them through an example of a spill.

5. Isolation and evacuation tables

“The green-bordered pages identify initial isolation and protective action distances. In previous editions of the ERG, certain materials for which the DOT had identified isolation and protective action distances were highlighted in yellow in the yellow bordered pages and in blue in the blue bordered pages. This indicated that the emergency responder should refer to Table 1-- Initial Isolation and Protective Action Distances. Now, all entries that require immediate reference to Table 1 are highlighted in green. Table 1 is located in green-bordered pages at the end of the book.”¹⁰

NOTE: Explain to the student the difference between isolation and evacuation as it relates to the size of the spill and the need for downwind evacuation.

6. Final pages

“White pages near the end of the ERG include information on personal protective equipment, fire & spill control, criminal/terrorist use of hazardous materials, and a glossary. Finally, the inside of the back cover includes key emergency response numbers for use in the US, Canada, Mexico, Argentina, Brazil, and Colombia.”¹¹

7. “CHEMTREC serves as a round-the-clock resource for obtaining immediate critical response information for incidents involving hazardous materials and dangerous goods. CHEMTREC is linked to the largest network of chemical and hazardous material experts in the world, including chemical and response specialists, public emergency services, and private contractors.”¹² They can be reached at 1-800-424-9300.
8. Using the ERG¹³

NOTE: Show slide, “Using the Guidebook.” Show students the steps outlined below that are in the front of the ERG. Cover the steps in order; step one through step three.

a) Step one

Identify the material by finding one of the following:

- (1) The 4-digit ID number on a placard, orange panel, or shipping document
- (2) The name of the material on a shipping document, placard, or package
- (3) If an ID number or the name of the material cannot be found, find the corresponding placard in front of the ERG and use the referenced response guide number.
- (4) If there is no identifying information and the material is believed to be hazardous, use ERG Guide #111. If an explosive is suspected, but no name or UN number is present, use ERG Guide #112.

b) Step two

- (1) Find the appropriate 3-digit guide number in either:
 - (a) The ID Number Index – the yellow-bordered pages in the ERG
 - (b) The Name of Material Index – the blue-bordered pages in the ERG

- (2) If the guide number is supplemented with the letter “P,” it indicates that the material may undergo violent polymerization if subjected to heat or contamination.
- (3) If the index entry is highlighted and there is no fire, find the ID number and name of the material in the table of initial isolation and protective action distances (the green-bordered pages). If necessary, begin protective actions immediately (see sections on “Protective Actions”).

c) Step three

Turn to the numbered ERG (orange-bordered pages) and read carefully and completely (both pages).

NOTE: Distribute handout, “ERG Usage Practice” and allow students to practice the use of the ERG. Review the answers for the practice handout.

E. Wireless Information System for Emergency Responders (WISER)

NOTE: Show slide, “WISER.”

“WISER, an acronym for the Wireless Information System for Emergency Responders, is a resource first responders use to figure out how to deal with hazardous material incidents like accidents involving tanker trucks or chemical plants. When first responders arrive at situations involving hazardous materials, they have to quickly assess the situations in order to protect people and the environment. To do this, they rely on information from several sources, as well as common sense and environmental factors like wind direction.”¹⁴

“WISER gathers chemical, biological and radiological information from a lot of sources including the National Library of Medicine’s Hazardous Substances Data Bank, known as the HSDB, CHEMM, and REMM resources, as well as the Department of Transportation’s Emergency Response Guidebook 2016, and the WMD Response Guidebook.”¹⁵

WISER aggregates the information into a useful application for Apple and Android devices as well as desktop computers and online at WebWISER.nlm.nih.gov. It then couples the information from those trusted resources with useful tools like an interactive protective distance map and comprehensive decision support which provides first responders with the resources and knowledge to save lives and minimize the impact on the environment and physical property.”¹⁶ “WISER provides a wide range of information on hazardous substances, including substance identification

support, physical characteristics, and human health information, and containment and suppression advice.”¹⁷

F. Natural Gas Leaks

NOTE: Show slide, “Natural Gas Leaks.”

1. What is natural gas?

“Natural gas occurs deep beneath the earth's surface. Natural gas consists mainly of methane, a compound with one carbon atom and four hydrogen atoms. Natural gas also contains small amounts of hydrocarbon gas liquid and non-hydrocarbon gases.”¹⁸ It is used to generate electric power, as well as being used for multiple applications in industrial, residential, commercial, and the transportation sectors.

2. Causes of gas leaks

a) Construction and digging

“Gas leaks can come unexpected at the worst of times, and can end up causing some serious damage not only to the underlying pipe system, but it also threatens safety and well-being of persons in the area. For this reason, it's vitally important to take evasive action whenever early signs of a gas line leak are detected. A gas line leak comes with a number of negative possibilities, such as the chance of there being a fire, an explosion, or rising levels of dangerous carbon monoxide.”¹⁹

“An underground utility line is damaged once every six minutes nationwide because someone decided to dig without first calling 811.”²⁰ In 2016, 5,115 natural gas lines were damaged.²¹

b) Improper installation

“The National Transportation Safety Board found that a natural gas explosion that destroyed two five-story buildings in the East Harlem section of New York City was caused both by a defective pipe joint that allowed gas to leak from a gas main into the building, and an earlier breach in a sewer line that caused the gas main to sag and overstress the defective joint. The explosion on March 12, 2014, killed eight, injured 50 and displaced more than 100 families. Among the findings by the Board was that the surfaces of the service tee and the gas main were not adequately prepared before the tee was fusion-welded to the gas main in 2011 by a contractor to Consolidated Edison

Company of New York, Inc., resulting in a defective fusion joint.”²²

c) Mechanical malfunctions

“Underneath [homes] lies a maze of a crisscrossing pipes that bring gas into the pipe connectors of appliances. This piping system can become faulty and erode with time. Sometimes the pipes will wear out and just disconnect, and sometimes they can be disconnected by something like surrounding tree roots. Poor piping is extremely common with older homes, and can allow gas to seep into the home.”²³

Appliances that use “natural gas or propane to generate heat, include water heaters, stoves, dryers, and fireplaces. With time, the seals that hold and connect the piping of these appliances can wear out and corrode. The corrosion of these seals and pipes can easily cause gas leaks...”²⁴

d) Accidental

An example of an accident involving gas was the ConAgra Slim Jim factory explosion in Garner, North Carolina. “Three workers were crushed to death when a large section of the building collapsed. The explosion critically burned four others and sent a total of 71 people to the hospital including three firefighters who were exposed to toxic anhydrous ammonia from the plant’s refrigeration system. Approximately 18,000 pounds of ammonia were released to the environment and 100,000 square feet of the plant were damaged. Due to the severity of the structural collapse, there was the potential for numerous additional deaths or serious injuries.”²⁵

The accident occurred as the result of workers attempting to purge a new gas line by using natural gas to directly displace the air. “Code officials and other parties told the CSB that they believe this practice to be common.”²⁶ This led to a build-up of gas in the structure that exploded.

e) Intentional

Gas leaks can be intentional. In one tragic case, a patrolman in Joplin, Missouri died from injuries sustained one month earlier when a suicidal person “had disconnected the natural gas line from his stove and turned the valve on to its highest setting. The house filled with gas while the man was outside. After the officers chased the man into the home, one of the officers fired a Taser at the man. The spark from the Taser may have caused the

gas to ignite, resulting in the explosion. The suspect the officers were attempted to arrest was taken into custody.”²⁷

3. Hazards associated with gas leaks²⁸

a) Fire

Natural gas may ignite rather than explode if it contacts an ignition source as it escapes during a leak. The fire will continue to burn until the leak is shut off. The best strategy for a natural gas fire is to let it burn. “Contact the local utility and wait for them to arrive. Meanwhile, evacuate the area and protect exposures.”²⁹ “Burning natural gas should not normally be extinguished, since this would change the situation from a visible to invisible hazard with explosive potential. Fires should be controlled by stopping the flow.”³⁰

b) Explosion

“Natural gas has a flammable range of five to 15 percent in air...”³¹ “If released under ground, it is known to travel hundreds of feet following natural fishers and voids around pipes. Following the path of least resistance it will present in the most unlikely locations.”³² It can accumulate in a space until a mixture with the right concentration contacts an ignition source. The resulting explosion can be devastating, as in the ConAgra incident.

4. Law enforcement response

NOTE: Show slide, “Law Enforcement Response” and tell students the following procedures can apply to propane leaks as well.

- a) Check wind direction and stay upwind.
- b) Deny access to the area and evacuate all people in the affected area based on fire department recommendations or refer to Guide 115 in the Emergency Response Guidebook.
- c) Detour traffic
- d) Locate potential witnesses that may give insight if illegal activity was the cause.

III. Conclusion

A. Summary

NOTE: Show slides, “Training Objectives.”

Hazardous materials is a term that elicits fear in many because a lack of knowledge and facts. We have defined hazardous materials based on OSHA, DOT, and a generally accepted definition. We discussed what a hazardous materials incident is, identified several tactics, clues, and how to properly utilize the *Emergency Response Guidebook* to implement protective measures. Next, we discussed what WISER is and how it can be used as a resource to the first responder at the scene of a suspected hazardous materials incident. Finally, we discussed the hazards associated with responding to calls involving natural gas leaks and protective measures to implement to mitigate these types of situations.

B. Questions

NOTE: Show slide, “Questions.”

C. Closing Statement

In today’s society, it is imperative that emergency responders be aware of the dangers that exist when confronting the unknown. Proper identification of clues and indicators of a hazardous material presence is critical in the performance of duties. It is likely that emergency responders will encounter hazardous materials in a non-traditional location; it may be a home, a car, or an unmarked container in a trash can. No matter where the material or substance may be, responders must be able to respond appropriately, request additional resources, and protect life and property. Hazardous materials are a fact of life in today’s world. Be prepared and be safe!

NOTE: Administer the required test.

NOTES

¹ “ODMP Remembers Sergeant Greg Meagher” (Fairfax, Virginia: Officer Down Memorial Page, 2017) [On-line] Available at: <http://www.odmp.org/officer/23112-sergeant-gregory-michael-meagher> [February 2017].

² “Regulations (Standards – 29 CFR): 1910.120” (Washington, DC: United States Department of Labor, Occupational Safety and Health Administration, 2012) [On-line] Available at: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9765 [April 2017].

³ “Hazardous Materials Definition” (Boston, MA: Northeastern University Office of Environmental Health and Safety, 2017) [On-line] Available at: <http://www.northeastern.edu/ehs/ehs-programs/research-material-shipping/hazardous-material-definition/> [April 2017].

⁴ International Fire Service Training Association, *Hazardous Materials for First Responders*, 4th edition. (Oklahoma State University: Fire Protection Publications, 2010), 697.

⁵ “1910.120 - Hazardous waste operations and emergency response” (Washington, DC: Occupational Safety and Health Administration, 2017) [On-line] Available at: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9765 [May 2017].

⁶ “What do the Color Coded Pages in the Emergency Response Guidebook Indicate?” (Washington, DC: Environmental Resource Center, 2008) [On-line] Available at: <http://www.ercweb.com/resources/viewreg.aspx?id=7271> [January 2017].

⁷ Ibid.

⁸ Ibid.

⁹ Ibid.

¹⁰ Ibid.

¹¹ Ibid.

¹² “CHEMTREC” (Falls Church, VA: CHEMTREC, 2017) [On-line] Available at: <http://www.chemtrec.com/> [April 2017].

¹³ 2016 *Emergency Response Guidebook* (Washington, DC: United States Department of Transportation, [2016]), 1.

¹⁴ “Welcome to WISER.” (Washington, DC: United States Department of Health and Human Services, National Library of Medicine, 2017) [On-line] Available at: <https://wiser.nlm.nih.gov/index.html> [November 2017].

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ Ibid.

¹⁸ “Natural Gas Explained.” (Washington, DC: United States Department of Energy, U.S. Energy Information Administration, 2017) [On-line] Available at: https://www.eia.gov/energyexplained/index.cfm?page=natural_gas_home [November 2017].

¹⁹ “What Causes Gas Line Leaks?” (Taylor, Texas: S & D Plumbing, January 2013) [On-line] Available at: <https://www.sanddplumbing.com/blog/2013/january/what-causes-gas-line-leaks/> [December 2017].

²⁰ “Call Before You Dig!” (Alexandria VA: Common Ground Alliance, 2017) [On-line] Available at: <http://call811.com/> [December 2017].

²¹ “2016 DIRT Report Interactive Analysis.” (Alexandria VA: Common Ground Alliance, 2017) [On-line] Available at: <http://commongroundalliance.com/dirt-2016-interactive-report> [December 2017].

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