Designing and Delivering a 40-hour Compliant HAZWOPER Course That Included Technical Content

McKell W Sanderson

A project submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Science

Gustavios P. Williams, Chair
M. Brett Borup
A. Woodruff Miller

Department of Civil and Environmental Engineering

Brigham Young University

ABSTRACT

Designing and Delivering a 40-hour Compliant
HAZWOPER Course That Included Technical Content

McKell W Sanderson
Department of Civil and Environmental Engineering, BYU
Master of Science

For my project, I developed a 40-hour HAZWOPER course that includes technical content to offer to graduate students. The goal of this effort was to expose students to the HAZWOPER curriculum, and cover those topics in depth sufficient for a graduate level course. This course was designed to teach the student 'why' the procedures, rules, and regulations were established, not just 'what' those are. I designed a curriculum, studied concepts of "active learning," and reviewed content to ensure it met the requirements of a HAZWOPER course. The course was primarily aimed at CE EN students, but over the two semesters I taught it, it included several students from other disciplines as well, such as Chemical Engineering, and Public Health.

The course was divided into 3 sections. The first section covered the background information that would be needed in order to understand and complete a HAZWOPER course. These included concepts from chemistry, thermodynamics, physics, organic chemistry, toxicology, radiation (energy), bio-accumulation, transportation of pollutants, and risk assessment. This section also includes a summary of milestone events or environmental tragedies that occurred in the past and why these laws were needed. The second section of the class covered the required regulations and standards for working on a hazardous waste site. These included sections on: confined spaces, fall protection, soil mechanics/excavation, exposure assessments, personal protective equipment, electrical safety (including lock-out tag-out), Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response Compensation and Liability Act (CERCLA/Superfund), Toxic Substances Control Act (TSCA), as well as the HAZWOPER standard. The third section of the course covered elements of emergency response, as well as hands on practical portions. These emergency response topics included, Incident Command System (ICS) training, Emergency Response Guidebook, identifying unknown chemical/hazards, field testing, site security, site set-up, and a practical exercise. The practical exercise involved students donning personal protective equipment (level A suits, and self-contained breathing apparatuses) and assuming roles in an incident command structure. Students were allowed to make decisions, and control the process from start to finish.

Students were assigned reading from the LaGrega text "Hazardous Waste Management" (2nd edition) as well as homework problems. Additionally, several "table top" exercises were performed throughout the semester to ensure understanding. Assessments were completed in the form of a mid-term exam, as well as a final exam.

The course allowed students to obtain a 40-hour HAZWOPER certificate upon successful completion of the course.

Keywords: 40-hour, HAZWOPER, course, OSHA, EPA, emergency response

ACKNOWLEDGEMENTS

I would like to acknowledge Risk Management, for employing me and working with me through the process of obtaining this Master's Degree. I would also like to thank Dr. Williams, Dr. Borup, and Dr. Miller, for serving as my committee and helping ensure my success in the program. I would also like to thank my wife, Janeene, for her constant unwavering support, I couldn't have done this without your help.

TABLE OF CONTENTS

LIST OF FIGURES

1 INTRODUCTION

One of the major concerns with employers in the Environmental Health and Safety field about hiring new graduates is the lack of applicable certifications. There are several certifications that are relevant to the profession, but very few undergraduates achieve any during their time as students. One of the primary reason for this lack of certifications is the manner in which they are presented to professionals in the field.

Many of the Occupational Safety and Health Administration (OSHA) courses are taught at remote locations, for 3-5 days at a time. This structure excludes college students, who typically have different class schedules for each day of the week. A second factor limiting participation in these courses from college students is cost. A typical 3-day course costs around $600, while 5-day courses cost $1000. These two factors could easily be overcome in the University setting. In addition, these courses are designed for workers, rather than technical employees, so they stress ‘what to do’ and ‘how to do it’ rather than ‘why’ things are done. While this training is very applicable, it does not prepare students for unexpected or new scenarios.

First, college students don’t have 40 hours a week for a class. They do however, have 3-5 hours per week per class. This, over the course of 14 weeks covers the 40-hour requirement for courses such as HAZWOPER. Second, the cost can be greatly reduced for college students, because it can be rolled into the tuition costs. In addition, students taking the course while in college will get the training as well as University credit. This can be a win-win situation for the

student. And last, the course is designed to provide students with the technical foundations of the procedures, rules, and processes better preparing them for technical and supervisory roles.

One of the more familiar requirements is the hazardous waste operations and emergency response (HAZWOPER) standard. This OSHA standard requires workers involved in uncontrolled hazardous waste sites, superfund sites, or emergency responders to undergo specific training. The HAZWOPER standard is becoming more and more a "basic" safety standard and more and more companies require their contractors to be trained to this standard prior to bidding on work. Because of this, I created a 40-hour HAZWOPER course to be taught as a college course. The benefits of this course are several, including: students will leave school being 40-hour trained, they will receive hands-on experience with equipment, the topics are applicable to Civil Engineering (as well as other) students, and they will have a preliminary understanding of why the various rules and regulations are in place, not just what these rules and regulations are.

The final benefit to consider, is the members of the class. If you enroll in a typical 40-hour HAZWOPER course, the only requirement for taking the class is a high-school diploma or GED equivalent. This severely limits the speed and depth that can be covered in a 40-hour HAZWOPER course. By offering this course to seniors, and graduate level students, the opportunity to address these topics in detail and depth is opened. This allows for a better experience for the students, as well as the understanding that is sought after in the traditional class.

The HAZWOPER standard, mandates 40 hours of initial off-site-training, and dictates several environmental, health and safety topics that must be covered. Generally, the topics are:

- Safety and health hazards on hazardous waste clean-up sites

- Control techniques for managing those hazards effectively
- Monitoring procedures to effectively characterize exposure levels
- What makes an effective employer safety and health program
- What a site safety plan is, and what it should include
- Hands on training, including experience with personal protective equipment
- Contents of the OSHA standard relevant to the employee's duties, functions, and responsibilities
- Other applicable regulations that govern work on a hazardous waste site
- Elements of the emergency response plan, and how to handle emergency incidents

These topics are important for anyone working around hazards to understand. In addition, because of the additional time that is spent in a college course (beyond 40 hours utilizing homework, exams, reports, etc.) more depth can be covered with these topics than would be typical for a 40-hour HAZWOPER course.

In addition to helping students stand out to potential employers, the reason for developing this course is that it directly impacts my place of employment. I am the Environmental Manager for Brigham Young University, and part of our laboratory management plan requires that we train our "trained professionals" to the HAZWOPER standard. We have accomplished this in the past by sending students away for a week for off-site training at the University of Utah. It is expensive, time consuming, and inconvenient. It doesn't work well for my student employees, nor does it work well for my operation. Being able to create a program that could taught to student employees over the course of a semester was a huge advantage for us. However, because we had a system in place to send them to the University of Utah, it was not a high priority.

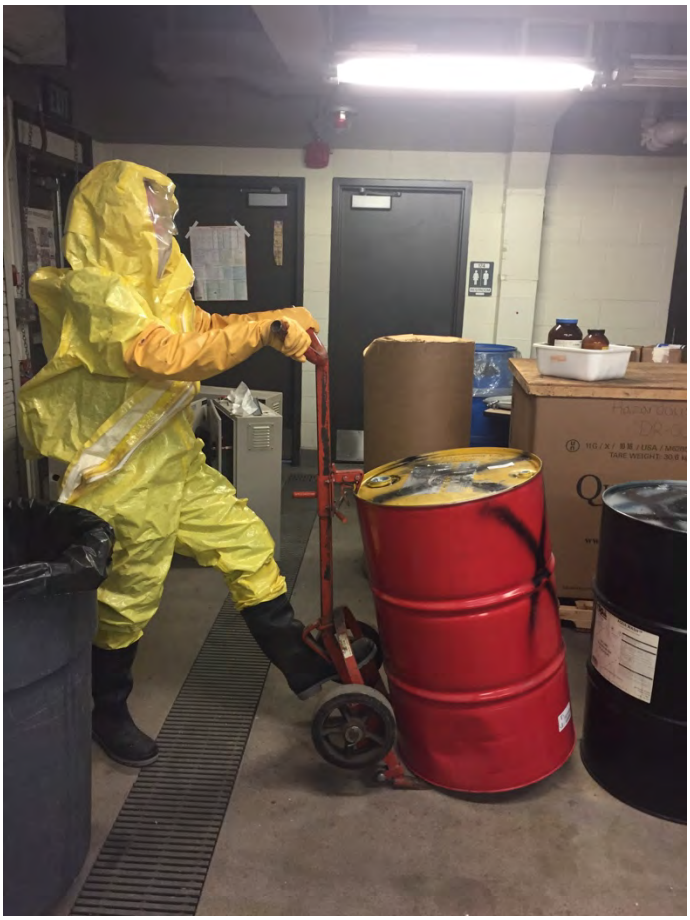

Figure 1: Student demonstrating "active learning" through exercise in class

As a manager, I am responsible for the safety and training of my employees. Creating a HAZWOPER course that I designed would allow me to build a course that focused on what I thought was most important and added the most value. In addition to focusing on value added items, it allowed Brigham Young University, to certify students to the HAZWOPER standard without the need to send them off-site for 40-hours. This also provided with the experience and background to understand the more in-depth requirements of such a course and integrate these elements into the standard curriculum.

2 COURSE SECTIONS

I developed and taught the HAZWOPER course in three major sections. These sections include: Technical Material, Regulatory Material, and Emergency Response Materials.

2.1 Technical Material

Although HAZWOPER is traditionally aimed at high-school graduates, it covers a remarkably complex area of science. The skills required to determine the hazards associated with hazardous materials cover many disciplines, including: chemistry, physics, thermodynamics, engineering, radiation, toxicology, infectious pathologies, risk assessment, transport phenomena, remediation techniques, and more. I designed the first section of the course to cover these multiple disciplines to the extent that is required to learn hazardous materials. This section also includes the historical tragedies that occurred because of mismanagement, or lack of understanding of the dangers posed by hazardous materials.

I selected the first topic to show the need for a HAZWOPER course, and why it could benefit students to take a course on it. It focuses on a case study, from the early 2000's involving a professor from John's Hopkins University. The professor hoarded chemicals in his home, and after he passed away, his niece went into the home to prepare it for sale. She found thousands of bottles of expired chemicals, and called the local health department to deal with the mess. The

health department called the State division of Environmental Quality, who called the University, the FBI, and the Department of Homeland Security. The lecture asks "what would you do if this was your neighbor? How would you safely manage this site?" It goes on to explain the federal agencies that govern hazardous materials, and the requirements for working with them.

The second topic focuses on historical events that led to the creation of the various laws governing hazardous materials. It is meant to illustrate several things, including: why laws are important, how mismanaging hazardous materials can have devastating consequences, and how hazardous materials are around us every day of our lives. Major environmental events are discussed: Rachel Carson's Silent Spring, Times Beach, Love Canal, Valley of the Drums, Woburn Massachusetts, Chernobyl, Bhopal, and Fukushima to name a few.

The third topic discussed, is properties of hazardous materials. This covers a very large array of topics and may take several class periods to complete. It begins by explaining that the Occupational Safety and Health Administration (OSHA) divides hazards into two types: physical hazards, and health hazards. Then the topic proceeds by discussing a brief review of organic chemistry. The organic chemistry review is to familiarize the student with nomenclature, and functional groups. It also serves to help students begin to predict how molecules or chemicals will react. Following the organic chemistry review, the topic moves on to physical properties. This covers properties that can affect how a material interacts with humans or the environment. These include: boiling point, flash point, flammability ranges (explosive limits), solubility, octanol-water partition coefficients, auto-ignition temperature, pyrophoric materials, oxidation-reduction reactions, Henry's law, Raoult's law, corrosivity, specific gravity, density, vapor pressure, volatility, and more.

The fourth topic covered, is toxicology. This builds upon the material from topic three, but introduces how those properties can affect the human body. It introduces the concept of dose-response curves, threshold doses, exposure routes, target organs, mechanisms of action, xenobiotics, metabolic transformation, distribution in the body, excretion routes, water solubility vs lipid solubility, systemic poisons, toxicants, toxins, poisons, venom, depressants, stimulants, chemical synergy, chemical potentiation, chemical antagonism, and body burdens. Exposure limits, such as threshold limit values, time weighted averages, and immediately dangerous to life and health atmospheres are introduced as well. Lethal doses, Lethal concentrations, clinical endpoints, mutagens, teratogens, carcinogens, and more. This topic may also take multiple class periods to cover. It finishes up with a short discussion about radio-toxicity.

The fifth topic presented is radiation. This topic builds off the radio-toxicity discussion and introduces radiation types, isotopes, common radioactive elements, half-life, inverse square law, the law of conservation of mass/energy, safety procedures, linear no-threshold model, ALARA, shielding requirements, control principles, and exposure consequences. The last half of the topic focuses on radiations effect on the body, and then finishes with a discussion about background radiation sources that affect us all every day.

The final topic of section one is risk assessment. This topic explains in detail the steps to performing both quantitative and qualitative risk assessments. The discussion begins with a definition of risk, and moves to the purpose of a risk assessment. It compares the idea of a risk assessment with exposure assessments. It next discusses the steps to performing a risk assessment (from a toxicological stand point). A case study on PCB's in a landfill is presented to discuss the point further and allow students to apply what has been discussed. Next is risk characterization, and explanations for useful metrics to know what is acceptable and what is not

(such as reference dose, and cancer risk ranges). The concept of safety factors is introduced (as it applies for animal to human extrapolations and then from person to person extrapolations). Then quantifying risk is next presented. Simple qualitative methods are presented first (how bad? how much? how likely?) followed by more quantitative methods. The quantitative methods involve several different approaches, but ultimately utilize statistical models to generate risk-contour maps. Once risk assessments have been explained, the discussion moves to controlling risk and then specific methods such as failure modes effect analysis, hazard and operability studies, fault tree analysis etc. It continues with "practical risk assessment" steps to reiterate the necessity of performing and recording risk assessments and maintaining records of decisions based on these assessments. Ultimately the idea is to find a level of risk that is tolerable.

2.2 Regulation and Standards Overview

The second section of the course covers the required regulations and standards. HAZWOPER dictates that applicable standards must be covered for hazardous waste sites. Broadly, this has been interpreted to mean that EPA and OSHA regulations that may affect operations on a hazardous waste site must be covered. This section is divided into EPA regulations, and OSHA standards.

2.2.1 EPA Regulations

The EPA regulations that govern hazardous materials, particularly hazardous waste, are extremely complex. While there are not many topics here, these are challenging to teach, because they are not intuitive. They are very complex, written by reference, and conflict with themselves.

The first topic covered in this section is the largest. It is RCRA. RCRA is split up into three parts for ease. The first part covers RCRA basics. It outlines the history of the RCRA regulations, and then explains the regulation's structure. The module proceeds to explain the definition of a solid waste, and the relation between solid and hazardous wastes. It utilizes four questions that are commonly taught in the industry to classify a hazardous waste. It is designed to empower students to be able to classify waste as hazardous or not. Upon answering the four questions, students should be able to indicate what materials are hazardous, and assign the proper waste codes to the materials. The second module focuses on the requirements for land disposal restrictions, and underlying hazardous constituents. The third module covers generator status, and temporary storage areas that are legal for hazardous waste. It covers the requirements for these as enforced by the federal EPA. These topics require several hours to explain properly. In industry, RCRA courses typically require 40-hours alone to gain proficiency. In HAZWOPER, this topic is required to be covered as it will dictate the operations at the hazardous waste site in terms of ultimate disposal.

The second topic covered in the EPA section is TSCA, CERCLA, SARA. The module briefly shows the increase in environmental laws over the past 100 years, then explains TSCA. TSCA is defined, and major impacts are introduced. CERCLA is next presented, and Superfund is explained. CERCLA is deconstructed as a simple law that has one requirement "anyone who knows of a release of a hazardous substance above a reportable quantity must notify the EPA" and that grants two powers to the federal government. The ability to designate sites for clean-up, and the ability to recover any and all costs associated with the clean-up. Because of these two powers, CERCLA is presented in a legal context of strict, as well as joint and several, liabilities. The powers also allow for CERCLA to be retroactive. The discussion then revisits Love Canal,

for its historical impact on the Superfund program, and moves to SARA. SARA is the Superfund Amendments and Reauthorization Act. SARA re-authorized the Superfund tax, but most importantly added the Emergency Planning Community Right to Know Act (EPCRA). EPCRA is explained at the close of the module.

2.2.2 OSHA Standards

The OSHA standards that are required under the HAZWOPER standard are numerous. This section of the course, meets the requirements for "training courses" in each of the standards that are presented. The requirements for these topics, under the OSHA standards, are each topic must be addressed for a minimum of one hour. They cannot be completed any faster than that and count toward OSHA certification.

The first topic in this module presented is the HAZWOPER overview. This topic outlines the provisions required under the HAZWOPER standard, and explains the purpose of the standard. It defines the scope, applicability, and the intent. It presents the concept of a safety and health program (which will be a collection of all the programs/procedures required for the site). It discusses briefly site characterizations, site analysis, monitoring, risk identification, training requirements, medical surveillance programs, hazard control, PPE levels, entry procedures, high risk employees monitoring, handling of drums and containers, decontamination procedures, defines uncontrolled hazardous waste sites, defines treatment storage and disposal facilities, defines emergency response, introduces emergency response plans, and finishes with emergency response employee types that must be on hand.

The next topic presented is OSHA's electrical standard. This standard is often combined with the lock-out tag-out (LOTO) standard to save time. They are split as separate modules but

both can be covered simultaneously to save time if required. These are the only standards that can "overlap" and still meet the one hour requirement. The electrical standard covers the applicability of the standard, the general requirements for electrical installations, types of conductors, safety related work practices near electricity, and hazard identification with electricity and common deficiencies.

The third topic is lock-out tag-out. This standard covers the LOTO applicability and requirements. It begins with a focus on controlling hazardous energies, not just electricity. Hazardous energies can include mechanical, electrical, thermal, gravitational (potential), kinetic, chemical, hydraulic, and more. The LOTO explains types of acceptable LOTO devices, and controls that must be implemented when hazardous energies are present. There is a lot of overlap with the electrical standard.

The fourth topic is fall protection. Fall protection module begins with the consequences of failing to use proper fall protection, identifying work area fall hazards, OSHA regulations for fall protection (both general industry and construction standards), introduces fall protection systems, describes proper use of fall arrest equipment, calculating free-fall distances and required clearances, describes fall protection technical rescue plans, care and maintenance of personal fall protection equipment, inspecting fall protection equipment, and finishes with a required practical. The practical requires students to "suit-up" in a fall arrest harness, and clip the self-retracting lifeline into the D-ring. The hands-on portion for the student is required under the OSHA standard, and must be completed if certificates are to be issued.

The fifth topic covered is confined spaces. The confined space module covers both initial and refresher training requirements under the OSHA standard. It defines a confined space, utilizing various definitions (OSHA, ANSI, API, NIOSH, etc.). Then it leads to the discussion of

permit required, vs non-permit required confined spaces. Identification of confined spaces is the next portion of the module, followed by evaluation of confined spaces. Hazard assessment for confined spaces, including atmospheric, electrical, mechanical, and inwardly converging walls are next discussed. This proceeds to entry requirements, and duties for entry team members. These include entrants, attendants, supervisors, rescue services, and bystanders. Air monitoring equipment and requirements are covered, then non-entry rescues. It finishes with specific confined space training requirements.

Figure 2: Student demonstrating use of escape breathing apparatus

The sixth topic covered is respiratory protection. The objectives outlined in this topic are to understand and analyze OSHA standards for respiratory protection, understand the purpose and use of respirators, identify and select appropriate respirators for the hazards, and understand the

requirements for respiratory protection. It explains types of respirators (air purifying vs. atmosphere supplying) and the limitations of each type. Hazardous atmospheres are covered and the appropriate selection for hazardous atmospheres are discussed. Fit testing requirements are covered, and maintenance schedules are introduced to finish the module.

The seventh topic is personal protective equipment (PPE). PPE begins with a description on what it is, and what it is used for. It focuses on selecting the appropriate PPE for the hazards that are present. Protection factors for respiratory protection are discussed, and limitations are re-discussed. Types of PPE are next introduced, everything from steel toed shoes to hard hats. Next PPE ensembles are introduced. This introduces the concept of "levels" into PPE. The various levels are introduced and explanation is given for when to use each one. Modifications to levels are also introduced to show students that these are not "hard and fast" rules. The topic finishes with a discussion about when to upgrade or downgrade levels of PPE.

The eighth and final topic is excavation and trenching. This portion of the class is typically focused on regulations only, but because it is a civil engineering course, extra time is spent on soil classification, soil testing, and protective systems for trenches/excavations. Collapse forces, and soil weight is introduced to illustrate the hazards associated with excavations and several excavation related tragedies are discussed. Trenching hazards, and unsafe hazards commonly found on sites are discussed. Causes of excavation failings (cave-ins) are discussed from an OSHA standpoint, then general requirements are introduced. Specific hazards, such as: surface encumbrances, underground utility installations, access/egress, hazardous atmospheres, fall protection, exposure to vehicle traffic, water accumulations, stability of adjacent structures, and exposure to falling loads are addressed per the standard. There is overlap with confined space standard that is briefly discussed as well. The concept of a competent person is introduced for

excavations, and the associated responsibilities and duties are laid out. Safety systems, such as trench boxes are next discussed, along with applicable regulations. Shielding, sloping, shoring trenching are all defined and explained. The topic then moves to the engineering aspects of soil classification, and soil categories. Specific hazards, such as soil fissuring, and water are discussed. Soil strength measures, (unconfined compressive strength) is explained briefly, because it is the base for the OSHA classification method. Visual tests, manual tests, field sediments tests, ribbon test, penciling, are all introduced, as well as shear vane, pocket penetrometer, and thumb penetration tests are explained to help classify soil types. The soil discussion continues with discussion on layered geological strata, and how to classify "layers." Visual danger signs are discussed, and the discussion finishes with a brief overview of soil mechanics (including OSHA sloping benching and shoring requirements).

2.3 Emergency Response and Site Control

The final section of the course is the emergency response and site control. This section is the practical portion for the course. There are several topics covered, in both portions of the section. I designed and taught this using a lot of hands on exercises and active learning.

2.3.1 Site Control

The site control portion of the course covers a variety of topics. However, it is focused on determining the hazards, and setting up a site that minimizes danger to the responders, and surrounding community. Setting up a work flow for the site is also addressed.

First, it begins with site assessment. Site assessment and characterization begins with a discussion on site investigation. Concepts of phase 1 and phase 2 environmental site assessments are introduced. A discussion on locating contamination, and preparing methods for abatement follows. Three-dimensional site characterization, is provided as a method for mapping contaminants and contaminant transport. Remediation techniques are introduced next, like in-situ chemical oxidation (ISCO), and oxidation potential is discussed for several common oxidizers. Monitoring requirements (temperature, movement) are set forth as well. Specific chemical case studies are presented to discuss the various aspects above. Sampling plans, and site specific health and safety plans are discussed at length. Several best management practices for quality assurance, quality control, and chain of custody are discussed (regarding sampling of site). This section concludes with a quality assurance project plan, that covers the sampling portions of site assessment.

The second topic in this section is specific to site set-up. This topic is mandatory per the HAZWOPER standard. It discusses the concept of exclusion zones, contamination reduction zone (CRZ), and support zone. It also relates the everyday terms of hot, warm, and cold zones respectively. Operations for each zone are discussed, and the OSHA buddy system is introduced as mandatory for entrance into the exclusion zones.

Site Security is the third topic covered here. Primarily the standard focuses on administrative controls, such as plans and procedures for site security. However, in recent years, a focus has again returned to engineering controls that keep unqualified persons out of the exclusion zones (such as fences). Site security requires the use of a site-specific plan, and the elements that a compliant plan must contain.

Site control concludes with site security. Other traditional site security topics have been melded with emergency response.

2.3.2 Emergency Response

The emergency response section begins with a brief discussion on the Incident Command System (ICS), and the roles associated within a standard response team. It then shifts gears, and moves towards emergency response guidebook usage, HAZCAT (hazard categorization), spill response, and roles of responders.

The first topic in the emergency response section is the introduction to the incident command system. The introduction outlines the basic history of the ICS system, the roles of the command staff, and the incidents that it can be utilized for. The benefits and key features of the ICS are presented. The focus then shifts to ICS-NIMS (National Incident Management System) and presents a general overview for Senior Officials. This set-up is utilized for the students as well, because it helps illustrate how an event can fit into the larger scheme of a company or organization. It builds on the incident management teams, and how those are utilized in the event of an emergency.

The second topic in the emergency response section is utilizing the Emergency Response Guidebook. The lecture for this topic is a class based table-top exercise. Several scenarios are presented to the students, who have to complete worksheets outlining the procedures for dealing with a hazardous materials spill. The activities involve identifying the substance spilled, identifying immediate hazards, establishing evacuation perimeters and protective distances, and clean-up procedures.

The third topic in emergency response is dealing with unknowns. Again, this lecture is not a PowerPoint, but rather a table top exercise, with some laboratory components. Students are introduced to several tools to help identify unknown chemical compounds. The tools range from a traditional HAZCAT kit, to apps for their phones. Students are taught the process of using a HAZCAT kit, but the procedure is not done at this point in the class. A mock spill is generated, and the students are provided PPE appropriate for the exercise, and proceed to learn to clean-up a hazardous material spill. Reporting requirements for the spill are covered next.

The fourth and final lecture for this section is the practical portion of the course. Students are randomly assigned a role in the ICS, and then given a scenario. The Chemicals Management Building is staged for the drill. Students read the scenario, and utilize PPE to go in and perform reconnaissance on the spill, then report to their incident commander. Plans are drawn up, and implemented. Students again don PPE and take samples, test the samples, and identify the compound, then perform the clean-up. A short report is required from each student at the completion of the exercise.

3 ASSESSMENTS

I developed the HAZWOPER course as a University Course for graduate students. As such, it requires assessments to determine the level of understanding and learning that has occurred. I created several homework assignments, assigned readings, in-class exercises, two exams, and a short report that are required as part of the course. These assignments, exams, and reports are not part of a standard HAZWOPR course.

I selected homework problems from the required text, Hazardous Waste Management, by LaGrega (2nd Edition). I primarily assigned homework from chapters 1-5, and chapters 14-15. The goal is to prepare students for the exams, and to encourage them to seek help with the concepts that they are not understanding. Readings are assigned from the same chapters, and expected to be completed before class on the discussed topics. These chapters cover most of the technical concepts associated with hazardous waste operations.

I designed the in-class exercises, to offer a guided approach to topics that are not well covered in the text. They are primarily accomplished utilizing worksheets, but could be implemented in several different ways. Worksheets were used to establish uniformity through these early versions of the course.

The two exams consist of a mid-term and a final. Both exams are comprehensive, and both exams are take-home. The exams are challenging if the student is not prepared, but very manageable for one who is. The exams consist of short answer problems, and require assumptions to be made by the student. Assumptions must be justified, and credit is based upon the justification given, as well as for the correct answer. Several of the exam questions are open to interpretation, and therefore justifying assumptions is a crucial element of solving the problems correctly.

I required the students to write a short report that is a written de-brief of the practical exercise. It is limited to two pages in length, but must address the role that each student had, problems they encountered, and how they would have proceeded differently knowing the outcome. It is encouraged for students to identify roles that they feel they would excel at, as well as roles that they would need to improve prior to being assigned.

The assessments are not meant to be busy work, but rather to help students prepare for the final, (which they must pass with an 80% in order to earn their certificate). The typical HAZWOPER final exam is a multiple-choice exam. That is not consistent with graduate level course work that I have encountered, and so the open-ended problem format is adapted and utilized for certification in the course as well.

4 EXPERIENCE

The HAZWOPER course was successfully offered in Fall 2016 under the label CEEN 594R Section 1. There were seven students enrolled in the course.

The course went well, students performed well in both the practical assessment and on the exams. The average score on the final exam was 91/100. The average on the midterm was 92/100. The practical portion of the course was also completed very well (with the average being a 94 on the write-up). The lowest issued grade was a B.

Students reported total time spent on the class. It varied for different students, the low was 52 hours and the high was over 70. The class was designed to require about 65 hours of total effort, with 42 hours of class time, and about half of that again spent on homework, reading, and exams. The engineering students completed the course in 52 and 56 hours respectively, while the public health students spent longer, (61-70+) hours.

In delivering the course the first semester, there were several points that needed to be changed. I re-evaluated some of the topics, and the manner in which they were delivered, and decided to re-teach the course in Winter of 2017. The changes made to the course structure and topics, are covered in this report.

The other major difference between Fall 2016 and Winter 2017 was the schedule for the class. In Fall it was taught bi-weekly, for 1.5 hours a session. In Winter, it is being taught weekly as an evening class for 3 hours. This schedule is more fitting for the topics, and the expected lengths required for them.

APPENDIX A. EXAMPLE ASSESSMENTS

The information provided in Appendix A is to give an example of some of the assessments that were utilized in the HAZWOPER course. There is an example of homework problems, the two exams, and one of the table top exercises.

APPENDIX B. LECTURE SLIDES

Appendix B contains a PDF of the lecture slides submitted in “handout” form. They are presented 6 per page.