3-16-2006

Development of an Evaluation Methodology for hazardous Waste Training Programs

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DEVELOPMENT OF AN EVALUATION METHODOLOGY FOR HAZARDOUS WASTE TRAINING PROGRAMS

THESIS

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AFIT/GEM/ENV/06M-03

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THESIS

Presented to the Faculty

Department of Systems and Engineering Management

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Engineering Management

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March 2006

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Abstract

The purpose of this research was to develop a methodology to measure hazardous waste training programs. The Air Force Material Command (AFMC) hazardous waste training program was used to conduct this research. To measure the effectiveness of AFMC's hazardous waste training program, the research attempted to answer four research questions. These questions addressed correlations between hazardous waste training programs and ECAMP findings, the understanding personnel have of hazardous waste principles and concepts, the effectiveness of hazardous waste training courses, and how personnel feel about the hazardous waste training they are receiving. In addition, the research consisted of a web-based survey to test the knowledge of AFMC personnel, and measure their attitudes, in the hazardous waste program.

The results indicate that there are significant differences in hazardous waste knowledge of personnel in AFMC. Several demographic populations have a higher and lower understanding of basic hazardous waste principles and concepts. Furthermore, several hazardous waste training courses can be attributed to greater and lesser understanding of hazardous waste principles and concepts. Overall, these results suggest what is and is not working in the hazardous waste training program of AFMC.

Acknowledgments

I would like thank my mom and dad for their continued support throughout each chapter of my Air Force career. Without their continued guidance and encouragement through this and each of my endeavors, I would not have been as successful as I have been.

I am also very appreciative of the support and guidance my thesis committee has given me. I would like to thank Dr. Al Thal, my advisor, for his encouragement and professional assistance throughout every step of the research, his direction was instrumental. Major Samuel Wright's expertise was invaluable and I thank him for answering my many questions. Thank you to Mr. Ed Hess for his advice early on in the thesis process support, his recommendations were very influential.

I would also like to thank Mr. Tony Negri and Ms. Connie Strobbe for their assistance in generating the survey, their support is truly appreciated. Lastly, I would like to thank my sponsor Dave Fort for taking his valuable time to educate me about hazardous waste and working with me throughout the research process.

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DEVELOPMENT OF AN EVALUATION METHODOLOGY

FOR HAZARDOUS WASTE TRAINING PROGRAMS

1. Introduction

Hazardous materials are important to many industrial processes; therefore, their use is ubiquitous in the United States (U.S.). For example, gasoline is a hazardous material whose daily use in the U.S. is extensive; it is also essential to the transportation and manufacturing industries, and our quality of life. However, the widespread use of hazardous materials generates a correspondingly large amount of hazardous waste. In fact, the United States Environmental Protection Agency (EPA) reported that the U.S. generated 30 million tons of hazardous waste in calendar year 2003 (USEPAb, 2005:1-1). Since it poses a threat to the environment and public health, it is important that companies and their employees manage hazardous waste in an appropriate manner. This begins with a training program that meets or exceeds the requirements set forth by federal, state, and local regulations.

1.1. Background

1.1.1. Legal Requirements

The Resource, Conservation, and Recovery Act (RCRA) of 1976 and its amendments establish national policy addressing the generation of hazardous waste in the United States. Many other legislative actions also contributed to controlling hazardous waste, to include the National Environmental Policy Act (NEPA) of 1970 and the

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Congress passed RCRA and other acts in response to an EPA estimate which stated that in the 1970s "only 10 percent of hazardous waste was managed in an environmentally safe manner" (USEPA, 2003:III-1). Failure to abide by regulations set forth by RCRA and other environmental laws allows the EPA to take various enforcement actions, ranging in severity from notice of violation (NOV) to criminal and civil actions with possible financial penalties. Since the EPA delegates its enforcement duties, it is the states who are responsible for issuing appropriate enforcement actions. However, the EPA holds parallel authority with each state to enforce RCRA. Federal facilities were immune from these enforcement actions until Congress passed the Federal Facility Compliance Act (FFCA) in 1992. Consequently, government agencies and their facilities are subject to RCRA guidelines and associated EPA enforcement actions, including fines and other penalties.

1.1.2. Air Force Compliance

To perform its mission, the Air Force relies heavily on the use of hazardous materials. As the main agency responsible for sustaining Air Force aircraft, the Air Force Materiel Command's (AFMC) industrial infrastructure is a major generator of hazardous waste with over 6,000 tons generated in Fiscal Year (FY) 2004 (AFMC/A7CVQ, 2005:1). The Air Force periodically receives enforcement actions from federal and state levels for not maintaining full compliance with the requirements stated in RCRA, state laws, and hazardous waste permits. Typically, these violations come in the form of NOVs from state environmental agencies. AFMC alone received four such violations in 2005. A recent violation in August 2005 at Robins Air Force Base (AFB), Georgia, cited the base for “failure to perform a hazardous waste determination,…failure to label a container with the words ‘Hazardous Waste’,… failure to keep containers closed except when waste is being added or removed…, and failure to notify of a release which could impact human health or the environment,” (Georgia Department of Natural Resources, 2005:1) among other violations. Inappropriate handling of hazardous waste, as cited at Robins AFB, can put the health of humans and the environment in danger and ultimately affect the ability of the command to perform its mission. While other factors may be at play, one assumes that many of these problems result from deficiencies in education and awareness levels of supervisors and personnel working with hazardous waste.

To guard against violations like those received at Robins AFB, the Air Force uses the Environmental Compliance Assessment and Management Program (ECAMP) “to assist Air Force installations and organizations in complying with all applicable pollution control standards” (AFI 32-7045, 1998:3). ECAMP inspections are conducted annually at major and minor installations with environmental permits. Ultimately, these inspections identify and address problem areas for installations and help the Air Force to stay within compliance.

1.1.3. Air Force Training

Every year, AFMC is responsible for providing hazardous waste training to 6,000 people. In addition to the command’s tremendous training requirement, hazardous waste training programs must accommodate varying levels of expertise and diverse career fields. To comply with RCRA, state laws, and permit guidelines, as well as Air Force and command policies, each base must operate a training program (AFI 32-7042, 1994:3). Such training programs ensure the education and awareness levels of personnel who handle hazardous waste are sufficient to maintain compliance and mitigate negative effects on the mission.

In 1996, a study was performed by Argonne National Laboratory on the quality and effectiveness of AFMC's hazardous waste training program (Kopla:1). This study discovered numerous positive and negative findings of training programs at 14 installations. These findings included the affect each of the following had on training: class size and focus, culture and attitude of an organization, and training program alignment with the Hazardous Waste Management Plan. In addition, this report found that training program evaluations were not conducted at any installations.

1.1.5. Evaluating Training Programs

To meet and maintain standards, organizations must operate effective training programs. This can be difficult for most organizations because of diverse training requirements, staffing shortages, and funding and resource limitations. Additionally, organizations should evaluate these programs frequently to ensure the effectiveness of the training. In discussing training evaluation models, Basarab (1992:2) defines evaluation as "a systematic process by which pertinent data are collected and converted into information for measuring the effects of training, helping in decision making, documenting results to be used in program improvement, and providing a method for deterring the quality of training." Although various evaluation models exist, the most widely used one is Kirkpatrick's 1959 model in which the effectiveness of training programs is measured in four-levels: reaction, learning, behavior, and results (1998:19). Additionally, Phillips (1996) extended Kirkpatrick's model to include the use of return of investment to evaluate training programs. Applying the evaluation models of Kirkpatrick and Phillips will help measure the effectiveness of Air Force training programs. Not applying the evaluation models will potentially lead to ineffective training programs and wasted resources.

1.2. Problem Statement and Research Questions

The Air Force and its components, which includes AFMC, have a comprehensive hazardous waste program that seeks to comply with federal, state, and local hazardous waste laws and regulations. The effectiveness of AFMC's hazardous waste program depends greatly on the ability to properly train personnel working with hazardous waste. Yet, many Air Force bases continue to receive multiple administrative actions such as NOVs for failure to follow hazardous waste policies. Furthermore, annual ECAMP inspections continually identify program violations, many presumably caused by training deficiencies. Therefore, the objective of this research is to determine the effectiveness of the hazardous waste training program within AFMC, which other Air Force agencies can use to extrapolate the success of their programs. This objective will be analyzed and assessed by researching the following questions:

1. Is there a correlation between characteristics of the hazardous waste training provided and the number of ECAMP findings received?
2. Do personnel working with hazardous waste understand the principles and concepts of handling hazardous waste appropriately?
3. Is current training effective at instilling hazardous waste knowledge? Which hazardous waste training is most effective? Which needs improvement?
4. How do personnel feel about the hazardous waste training they receive?

1.3. Methodology

This research will be accomplished using a multi-step approach. First, the researcher will use linear regression to analyze hazardous waste training in AFMC over the past 5 years. The goal of this step is to examine the relationships between a dependent variable and several independent variables. The dependent variable will be derived from the number of hazardous waste ECAMP findings at each base and knowledge scores from a survey. The independent variables will include characteristics of the base hazardous waste programs and the amount and types of hazardous waste training conducted. This analysis will result in a correlation between the hazardous waste training data and subsequent violations.

Second, the research will survey a sample of AFMC personnel working with hazardous waste at the command's 11 installations. The purpose of this survey is to gain insight into the effectiveness of the base hazardous waste training programs. The survey will consist of three sections. The first section will measure knowledge of hazardous waste principles with 25 multiple choice and true and false questions. The second section will ask for opinions about hazardous waste use and training in the Air Force with eight attitudinal questions. The third section will gather demographic data. The research will analyze results from these surveys by comparing knowledge scores of respondents based on individual demographic fields using analysis of variance (ANOVA). Additionally, data obtained from the survey will be incorporated into the multivariate regression described above and analyzed to detect correlation with ECAMP findings.

1.4. Relevance

Appropriate handling and disposal of hazardous waste is essential in mitigating potential incidents that may harm humans or the environment, and/or result in penalties, which ultimately affects the ability of the Air Force to perform its mission. Though active and seemingly effective, the Air Force's hazardous waste program is not foolproof, as evidenced by annual ECAMP findings and occasional NOVs at Air Force installations. Leaders need to evaluate hazardous waste training programs in response to these findings and violations seemingly caused by training deficiencies. Applying principles of previously unused training evaluation methods will help increase the effectiveness of hazardous waste training courses and potentially result in a decrease in hazardous waste violations. The results of this research can be applied across the Air Force to improve hazardous waste training programs. Although this research focuses on one major command within the Air Force, the methodology has broad applicability and should be useful to non-Air Force organizations in both the public and private sectors.

1.5. Thesis Overview

The remainder of this thesis contains four chapters: literature review, methodology, results, and conclusion. Chapter 2 presents background information on hazardous waste, hazardous waste law, associated Air Force regulations and training requirements, and applicable training evaluation methods. Chapter 3 explains the methodology used to analyze hazardous waste training throughout AFMC. Chapter 4 discusses the results of the analysis. Chapter 5 summarizes the research and results, identifies limitations of the research, and provides recommendations for future research.

2. Literature Review

This chapter examines applicable literature concerning hazardous waste in the United States (U.S.) and the Air Force. After briefly discussing the history of hazardous waste, an overview of environmental laws that regulate hazardous waste is provided. Environmental guidance issued by the White House and Department of Defense (DoD) are also reviewed. Within the DoD, emphasis is placed on the description of Air Force hazardous waste operations. Finally, the importance of effective training programs and the need to evaluate those programs are discussed.

2.1. Background

The purpose of this section is to provide an historical overview of hazardous waste generation in the U.S. It begins by linking the increase in hazardous waste generation with industrialization growth. This includes references to past disposal practices and their subsequent impact. The amount and type of hazardous waste currently generated in the U.S. is also discussed. The section concludes by briefly providing information regarding present-day hazardous waste generation in the Air Force Materiel Command (AFMC).

2.1.1. Past Hazardous Waste Generation

The United States' generation of hazardous waste mirrored its progress as a world economic leader. This problem began during the industrial revolution in the late 19th century and continued through the heavy manufacturing years of World War II (USEPA, 2003:I-1). A large amount of new chemicals were created for military use during World War II, including insecticides, plastics, synthetic rubber, and nylon. This development continued through the century with over 70,000 new chemicals being created since the 1940s (Girdner, 2002:4). The increased use of these chemicals and other waste resulted in a 500-fold increase in the generation of hazardous waste, from 500,000 metric tons in 1941 to 279 million metric tons in 1995 (USEPA, 2003:I-1). While these chemicals enabled new manufacturing processes and products, mismanagement of their ensuing wastes caused health problems to humans and damage to the environment.

Before the creation of the Environmental Protection Agency (EPA) and specific laws and regulations addressing hazardous waste and their management, industries and the general public were not overly concerned with the appropriate care of waste. In fact, “take it out back and dump it” was a common and generally accepted way to dispose of waste. Waste was often dumped directly on the ground or into ditches, drainage wells, and trash dumps. Additionally, many industrial manufacturers simply stored hazardous waste in 55-gallon drums that were often leaky and piled on top of each other in open fields or buried in the ground (Blackman, 1996:13). Although these practices have since been outlawed, the impact of these practices is still being addressed.

Numerous examples exist of the dangerous conditions created by the improper management of hazardous waste; however, some of the most publicized cases are listed in Table 1. One example is the case of the Love Canal in Niagara Falls, New York. A chemical company used an old canal to dispose of 22,000 tons of chemicals in 1952. After filling-in the landfill, the city of Niagara Falls purchased the land from the company to build schools and homes. However, after numerous complaints of strange odors and substances in yards and the development of an unusually large amount of health problems, the area was evacuated in 1978. After numerous tests, it was concluded that leaking hazardous waste from the landfill had increased the risk of cancer and caused reproductive problems and genetic damage for residents in the area (Blackman, 1996:2). Love Canal is just one example of mismanaged hazardous waste that has unfortunately affected the health of humans and the environment.

Table 1. **Publicized Hazardous Waste Cases**

Case	Details
Love Canal, 1978 (Niagara Falls, New York)	Hazardous substances from a landfill leaked and seeped into homes and a school, causing birth defects and other health problems.
Valley of the Drums, 1979 (Bullitt County, Kentucky)	Drums from an abandoned 23-acre site leaked hazardous chemicals into Wilson Creek, a tributary of the Ohio River.
Times Beach, 1983 (Missouri)	Dixon-contaminated oil was sprayed on roads for dust control.
Aberdeen Proving Grounds, 1989 (Maryland)	Three managers at the U.S. Army facility were convicted for illegally handling, storing, and disposing of hazardous waste

Other publicized cases include Valley of the Drums, Times Beach, and Aberdeen Proving Grounds. In 1979, the "Valley of the Drums" was known as one of the country's worst abandoned hazardous waste sites. Over a 10-year period, approximately 1500 drums containing hazardous chemicals such as benzene and toluene were placed on a 23-acre site in Bullitt County, Kentucky. These drums deteriorated and leaked into Wilson Creek, a tributary of the Ohio River (USEPA, 1981). For Times Beach, Missouri, the EPA relocated residents and businesses in 1983 at a cost of $30 million due to contaminated soil cause by spraying roads with dioxin-contaminated oil for dust control (USEPA, 1988). In the last case, government officials indicted three high-level managers in 1989 at Aberdeen Proving Grounds, a U.S. Army facility known for developing chemical weapons, for illegally handling, storing, and disposing of hazardous waste. Illegal actions included the following violations: leaving flammable and cancer-causing substances in the open; keeping chemicals that become lethal if mixed in the same room; misplacing, not labeling, and poorly containing drums of hazardous waste; and not cleaning up leaking drums (Texas A&M, 2006).

2.1.2. *Current Hazardous Waste Generation*

Though regulated better, Americans still generate tremendous amounts of hazardous waste today. According to the EPA's National Biennial Resource Conservation and Recovery Act (RCRA) Hazardous Waste Report, over 30 million tons of hazardous waste was generated from over 17,000 generators in 2003 (USEPA, 2005b:1-1). Note, the amount of hazardous waste generated in 2003 should not be compared to data before 1997 because the EPA changed its reporting requirements and no longer reports wastewater data in their Biennial reports (USEPA, 1997:4). Table 2 lists the top 20 types of hazardous waste generated; as the table indicates, most of the waste results from various manufacturing processes.

Table 2. Categories of Hazardous Waste Generated (USEPA, 2005b: 1-7)

Rank	Description	Tons Generated
1	Basic Chemical Manufacturing	13,968,303
2	Petroleum and Coal Products Manufacturing	3,915,137
3	Waste Treatment and Disposal	1,878,827
4	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	1,855,158
5	Iron and Steel Mills and Ferroalloy Manufacturing	1,295,959
6	Semiconductor and Other Electronic Component Manufacturing	1,019,500
7	Nonferrous Metal (except Aluminum) Production and Processing	806,651
8	Coating, Engraving, Heat Treating, and Allied Activities	876,191
9	Other Chemical Product and Preparation Manufacturing	566,627
10	Remediation and Other Waste Management Services	469,394
11	Pharmaceutical and Medicine Manufacturing	397,228
12	Steel Product Manufacturing from Purchased Steel	219,881
13	Motor Vehicle Parts Manufacturing	208,735
14	Other Miscellaneous Manufacturing	178,746
15	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	164,338
16	Paint, Coating, and Adhesive Manufacturing	142,346
17	Glass and Glass Product Manufacturing	137,538
18	Other Fabricated Metal Product Manufacturing	129,889
19	Plastics Products Manufacturing	125,363
20	Sawmills and Wood Preservation	111,977

2.1.3. Department of Defense and Air Force Hazardous Waste Generation

The Air Force, too, generates a large amount of hazardous waste. Table 3 lists the amount of hazardous waste each command generated from Calendar Years (CY) 2000 through 2004. During this period, the Air Force generated approximately 9800 tons per year. AFMC is by far the Air Force's largest generator, accounting for more than 50% of the hazardous waste in the Air Force every year. AFMC generated an average of 5000 tons of waste per year over the past five years (AFMC/A7CVQ, 2005); Table 4 lists the amount of waste for each installation in AFMC. The generators and types of waste they generated vary at each installation. For example, generators at Wright-Patterson AFB include the Air Force Research Laboratory, aircraft maintenance units from the 445th Airlift Wing, civil engineering, and vehicle maintenance (Selby, 2006). Additionally, the types of hazardous waste generated at Wright-Patterson AFB include a variety of chemicals such as sodium hydroxide and hydrochloric acid, gas filters and paint-related products, and solids containing JP8 jet fuel (Selby, 2006).

Table 3. Air Force Hazardous Waste Generation (in tons) (AF/A7CVQ, 2006)

Command	**CY00**	**CY01**	**CY02**	**CY03**	**CY04**
ACC	732	541	676	421	485
AETC	194	241	347	331	203
AFMC	5252	5108	4772	5877	6246
AFRC	80	79	74	68	103
AFRPA	NA	89	34	6	0
AFSOC	7	12	12	18	75
AFSPC	287	284	300	277	615
AMC	1122	1185	459	553	840
ANG	1093	436	623	438	604
PACAF	298	444	395	449	667
USAFE	1005	936	1494	1469	726
Air Force Total	10095	9379	9201	9920	10567

Table 4. AFMC Hazardous Waste Generation (in tons) (AMFC/A7CVQ, 2005)

Base	FY01	FY02	FY03	FY04	FY05
Arnold	18	41	23	30	11
Brooks	11	12	7	9	6
Edwards	337	921	738	756	1693
Eglin	56	32	150	35	46
Hanscom	99	40	20	69	15
Hill	1254	860	868	1686	888
Kirtland	168	48	54	42	32
Robins	964	916	1151	1361	943
Rome	15	4	1	2	1
Tinker	1908	1672	1801	2162	824
Wright-Patterson	48	56	185	227	29
AFMC Total	4877	4604	4998	6378	4488

2.2. Environmental Laws

This section outlines the laws relating to the generation and management of hazardous waste, enforcement provisions, and training requirements. Laws relating to the generation and management of hazardous waste include RCRA, the Hazardous and Solid Waste Amendments (HSWA), the Federal Facility Compliance Act (FFCA), the Land Disposal Program Flexibility Act (LDPFA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Hazardous Materials Transportation Act (HMTA), the Occupational Safety and Health (OSH) Act, and others. The discussion regarding enforcement covers administrative, civil, and criminal action. Finally, some of the primary training requirements are discussed. Before discussing these laws, it should be noted that each law refers to all subsequent amendments, regulations, and EPA policy and guidance. Regulations refer to the rules developed by the EPA to implement the laws. These rules are incorporated into the Code of Federal Regulations (CFR). Guidance documents are issued by the EPA to explain how to implement requirements, and policy statements typically outline how operating procedures should be conducted (USEPA, 2003:I-4).

2.2.1. Generation and Management

2.2.1.1. Resource Conservation and Recovery Act

In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA) as an amendment to the Solid Waste Disposal Act (SWDA) of 1965. In response to the increasing amount of municipal and industrial waste generated in the U.S., Congress "remodeled the nation's solid waste management system and laid out basic framework of the current hazardous waste management program" (USEPA, 2003:I-3). RCRA was written to achieve three goals: "protection of human health and the environment, reduction of waste and conservation of energy and natural resources, and reduction or elimination of the generation of hazardous waste as expeditiously as possible" (USEPA, 2000:2). To meet its goals, RCRA established three major programs: Subtitle C, Hazardous Waste Program; Subtitle D, Solid Waste Program; and Subtitle I, Underground Storage Tank Program. Other subtitles of RCRA can be seen in Table 4.

Table 5. RCRA Subtitles (USEPA, 2003:I-3)

Subtitle	Provisions
A	General Provisions
B	Office of Solid Waste
C	Hazardous Waste Management
D	State or Regional Solid Waste Plans
E	Duties of the Secretary of Commerce in Resource and Recovery
F	Federal Responsibilities
G	Miscellaneous Provisions
H	Research, Development, Demonstration, and Information
I	Regulation of Underground Storage Tanks
J	Standards for the Tracking and Management of Medical Waste

Of the three major programs established by RCRA, Subtitle C is the most relevant to the current research. It specifically addresses hazardous waste and establishes a program with a simple objective: "to ensure that hazardous waste is handled in a manner that protects human health and the environment" (USEPA, 2003:I-5). Subtitle C accomplishes this objective through comprehensive regulations addressing hazardous waste from cradle-to-grave, including the generation, transportation, and treatment, storage, and disposal of hazardous waste (USEPA, 2003:I-4). Figure 1 details the 11 areas that Subtitle C covers.

Hazardous Waste Identification
Hazardous Waste Recycling and Universal Wastes
Hazardous Waste Generators
Hazardous Waste Transporters
Treatment, Storage, and Disposal Facilities
Land Disposal Restrictions
Combustion
Permitting
Corrective Action
Enforcement
State Authorization

Figure 1. Subtitle C: Hazardous Waste Program (USEPA, 2003:III-2)

Since its passage, Congress has amended RCRA three times. The first amendment was the HSWA of 1984, which expanded and strengthened the nation's hazardous waste policies. Specifically, it added land disposal restrictions, implemented additional requirements for small quantity generators, and raised maximum critical penalties (USEPA, 2006a). The FFCA of 1992 was the second amendment; it added the authority to enforce RCRA at federal facilities. Prior to 1992, federal facilities were immune to civil fines and penalties; this act enabled the EPA to issue enforcement actions against federal agencies as they did other entities (USEPA, 2003:III-133). The final amendment was the LDPFA of 1996, which enabled RCRA "to provide regulatory flexibility for the land disposal of certain wastes" (USEPA, 2003:I-3). Additionally, the LDPFA required the EPA to perform a study on certain waste to determine potential risks to human health and the environment (USEPA, 2006b).

Regulations emanating from RCRA define hazardous waste as "a waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment" (USEPA, 2003:III-3). Additionally, RCRA regulations (40 CFR 261 and 262) specify that a waste is hazardous if its meets any of the following conditions:

1) exhibits any of the characteristics of a hazardous waste
2) has been named as a hazardous waste and listed as such in the regulations
3) is a mixture containing listed hazardous waste and a nonhazardous solid waste
4) is a waste derived-from the treatment, storage, or disposal of a listed hazardous waste (Blackman, 2001:41)

As determined by the EPA, the four characteristics that make a waste hazardous are ignitability, corrosivity, reactivity, and toxicity. Ignitability identifies waste that can catch fire, corrosivity identifies waste that is acidic, reactivity identifies waste that can readily explode or react to toxic gases or fumes, and toxicity identifies waste likely to leach high concentrations into groundwater (USEPA, 2003:III-22).

Additionally, the EPA maintains various lists of chemicals that qualify as hazardous waste; these are the F list, K list, P list, and U list. The F list, known as "waste from nonspecific sources," includes chemicals from common industrial and manufacturing processes. Examples of F list wastes are spent solvents, electroplating wastes, and petroleum refinery wastewater treatment sludges. The K list, known as "waste from specific sources," includes waste from specific industries like wood preservation, organic chemicals manufacturing, and pesticides manufacturing. The P and U list are pure or commercial grade formulations of specific unused chemicals that are referred to as "discarded commercial chemical products" (USEPA, 2003:III-18). The P list includes chemicals that are acutely toxic and the U list includes chemicals that are toxic, but also include other characteristics such as ignitability or reactivity (USEPA, 2003:III-18). Examples of P and U list wastes include chloroform, sulfuric and hydrochloric acids, and pesticides such as DDT (Blackman, 1996:44). The EPA also created a "contained-in" policy which states that any media used to contain a hazardous waste should be managed as if it were a hazardous waste itself. Examples include construction materials such as bricks or concrete, industrial equipment such as pumps or tanks, and personal protective equipment (USEPA, 2003:III-26).

2.2.1.2. Comprehensive Environmental Response, Compensation, and Liability Act

In 1980, Congress passed the CERCLA in response to a rise in abandoned hazardous waste dumps that were leaking, including the Love Canal incident. CERCLA addressed areas that RCRA did not address, abandoned and inactive hazardous waste sites. Commonly referred to as Superfund, CERCLA "provides federal funding for response and site remediation where responsible parties cannot be identified or are unwilling or unable to accomplish the necessary cleanup" (Blackman, 2001:24). The act initiated a five-year, $1.6 billion dollar program to perform site remediation (UESPA, 2003;VI-10).

Congress amended CERCLA with the Superfund Amendments and Reauthorization Act (SARA) of 1986. SARA extended the 5-year program of CERCLA and increased funding to $8.5 billion. SARA also created new standards and schedules for site cleanup and a program to increase public participation in the clean-up process. In addition, Title III of SARA, also known as the Emergency Planning and Community Right-to-Know Act, "imposed an emergency planning regime upon states and communities and required community right-to-know and toxic release reporting" (Blackman, 2001:24).

2.2.1.3. Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act (HMTA), passed in 1975, requires the regulation "of marking, labeling, and packaging of hazardous materials for transportation and thereby includes the transportation aspects of hazardous waste management" (Blackman, 2001:24). Marking requirements include proper addresses, a Department of Transportation shipping name, and identification numbers. Labeling requirements consist of an appropriate diamond-shaped label that corresponds to the specific material or waste. Packaging should be "compatible with the hazardous material and adequate considering the level of risk presented by the material" (DOE, 2006). Congress amended the HMTA by the Hazardous Materials Transportation Uniform Security Act of 1990 to bring packaging standards in line with international standards. Transporters of hazardous waste must follow regulations developed by the HMTA in 49 CFR, Parts 171-179 and by Subtitle C of RCRA in 40 CFR, Part 263 (USEPA, 2003:III-49).

2.2.1.4. Occupational Safety and Health Act

In 1970, Congress passed the OSH Act and created the Occupational Health and Safety Administration (OHSA). The act aimed "to assure safe and healthful working conditions for working men and women by authorizing enforcement of standards developed under that Act" (OSHA, 2006). The act states under 29 CFR 1910.120(b)(1)(i) that:

> Employers shall develop and implement a written safety and health program for their employees involved in hazardous waste operations. The program shall be designed to identify, evaluate, and control safety and health hazards, and provide for emergency response for hazardous waste operations (OSHA, 2006).

Furthermore, OSHA developed the Hazard Communication (HAZCOM) Standard and the Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard to protect employees from the dangers of hazardous waste. The HAZCOM program demands employers communicate the hazards of chemicals employees work with through the use of container labeling, material safety data sheets, and training (OSHA, 2006). The HAZWOPER program protects employees who engage in specific hazardous waste operations, including cleanup, emergency response, and treatment, storage, and disposal facilities operations (USEPA, 2003:VI-6).

2.2.1.5. Other Environmental Laws

There are many other statutes that work alongside the ones mentioned above to protect the nation from the harmful effects of hazardous waste. For instance, the Clean Air Act (CAA); Clean Water Act (CWA); Marine Protection, Research, and Sanctuaries Act (MPRSA); and Safe Drinking Water Act (SDWA) are "media- specific statutes that limit and monitor the amount of waste introduced into the air, waterways, oceans, and drinking water" (USEPA, 2003:VI-3). The CAA requires RCRA hazardous waste combustion facilities to have CAA permits. It also requires air emissions from incinerators and treatment, storage, and disposal facilities (TSDF) to comply with appropriate CAA standards (USEPA, 2003, VI-3). The CWA also requires discharges from RCRA facilities to meet the standards of its National Pollutant Discharge Elimination System (NPDES) permit program. Additionally, sludges from CWA wastewater treatment plants must meet RCRA standards if hazardous (USEPA, 2003:VI-5). The MPRSA prevents waste from being dumped in the ocean without a permit, and the SDWA prohibits the underground injection of hazardous waste that does not meet treatment standards (USEPA, 2003:VI-4).

Two other key laws are the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and Toxic Substances Control Act (TSCA). These statutes "limit the production, rather than the release, of chemical substances and products that may contribute to the nation's waste" (USEPA, 2003:VI-3). FIFRA controls the amount of pesticides produced, including how they are manufactured and sold, which helps reduce the amount of waste covered by RCRA. Similarly, TSCA controls "the manufacture and sale of certain chemical substances" (USEPA, 2003:VI-7) and the disposal of various chemical substances, which reduces the amount of waste covered by RCRA.

2.2.2. Enforcement of Hazardous Waste Regulations

The goals of the RCRA enforcement program are "to ensure that the regulatory and statutory provisions of RCRA are met, and to compel necessary action to correct violations" (USEPA, 2003:III-127). Federal and state environmental officials primarily use periodic facility inspections to enforce RCRA. Officials have three options if they find a facility out of compliance during inspections: administrative action, civil action, or criminal action.

Administrative actions can be both formal and informal. Informal actions are used for minor problems and are usually resolved quickly. They are often referred to as a notice of violation or notice of noncompliance. Formal actions are used for more serious problems and demand facility managers take certain actions. Formal actions often follow a failed response to an informal action and can include financial penalties and revoked permits (USEPA, 2003:129).

A civil action is a formal lawsuit filed against an entity that failed to comply with hazardous waste regulations or contributed to a release of hazardous waste. Civil actions are usually used after repeated administrative actions or significant violations. Using civil actions, the EPA has the authority to force an entity to comply with RCRA regulations and assess financial penalties (USEPA, 2003:131).

Lastly, the law authorizes the EPA to use criminal action against people who seriously violate RCRA regulations. Criminal actions can lead to fines up to $1 million and imprisonment of 15 years (USEPA, 2003:III-132). Examples of criminal actions include knowingly transporting hazardous waste to a nonpermitted facility, transporting waste without a manifest, and treating or disposing of waste that places a person in danger (Blackman, 1996:203).

2.2.3. Training Requirements

RCRA requires personnel working in a hazardous waste facility to attend annual training as stated in 40 CFR 264.16 and 265.16 (2005): "facility personnel must successfully complete a program of classroom instruction or on-the-job training that teaches them to perform their duties in a way that ensures the facility's compliance". Owners and operators of hazardous waste facilities must include a description of their training program in their permit application. Owner/operators must train employees within 6 months of employment and provide annual refresher training. As a minimum, awareness training must include hazardous waste emergency procedures, equipment, and systems. Training requirements increase with specific job responsibilities. RCRA regulations also require owner/operators keep detailed employee training records to include job titles, employee names, job description, and the type and amount of training provided (40 CFR 265.16, 2005).

OSHA has additional training requirements for hazardous waste personnel, some of which overlap RCRA requirements. OSHA's HAZCOM Program "requires training in the physical and health hazards of chemicals in the work area" to include protective measures such as personal protective equipment and descriptions of labeling systems and material safety data sheets (29 CFR 1910.1200, 2005). OSHA's HAZWOPER Program requires basic awareness training for personnel who may be exposed to a hazardous substance. The law requires further training for personnel with job responsibilities such as clean-up or emergency response operations (29 CFR 1910.120, 2005).

2.3. Other Government Guidance

While Congress develops environmental laws and regulations, the executive branch ensures federal agencies comply with those regulations. Therefore, this section includes environmental guidance from the White House and DoD, which affect Air Force operations.

2.3.1. Executive Order 13148, Greening the Government Through Leadership in Environmental Management

The White House (2000) released Executive Order (EO) 13148 to readdress the continued importance of environmental issues within our country. This document calls for federal agencies to place a renewed focus on "Leadership in Environmental Management," specifically attending to such areas as environmental management, environmental compliance, pollution prevention, the use of toxic chemicals and ozone-depleting substances, and landscaping. EO 13148 directs federal agencies to train appropriate employees, including senior level managers, to increase their awareness of the environmental requirements listed. The heads of federal agencies are responsible for ensuring this guidance is integrated into all aspects of their agencies.

2.3.2. DOD Environmental Goals and Objectives

Complementing the policy set in EO 13148, the DoD has four primary environmental objectives:

1) to comply with the law,
2) to support military readiness by ensuring continued access to the air, land, and water needed for training and testing,
3) to improve the quality of life for military personnel and their families by protecting them from environmental health hazards and maintaining quality military facilities, and
4) to contribute to weapon system effectiveness by promoting improved performance, ease of maintenance, and lower (life-cycle) costs (Environmental Web University, 2005).

It is important that the head of DoD agencies recall these objectives when executing their organization's environmental responsibilities, including the training for these responsibilities. With regard to the Air Force, employees must complete specific environmental tasks in order for the Air Force to comply with federal, state, and local laws, and meet the DoD objectives stated above (Environmental Web University, 2005).

2.4. Hazardous Waste Operations in the Air Force

This section gives an overview of hazardous waste operations in the Air Force. It begins by describing the policy addressing hazardous waste generation at each base. This section then explains the Air Force Environmental Compliance Assessment and Management Program (ECAMP). It also outlines the hazardous waste process used in the Air Force and discusses specific training requirements. This chapter concludes with an overview of a study performed on AFMC's hazardous waste program in 1996.

2.4.1. Air Force Hazardous Waste Policy

Air Force Instruction (AFI) 32-7042; Civil Engineering, Solid and Hazardous Waste Compliance (12 May 1994); serves as the primary hazardous waste policy for the Air Force. The purpose of this instruction is to ensure the Air Force complies with federal, state, and local solid and hazardous waste standards. Chapter 2 of the AFI addresses hazardous waste specifically and states "hazardous waste generators (installations) must have a hazardous waste management program (HWMP) to comply with federal, state, and local regulations and this instruction" (DAF, 1994a:3). The HWMP at each installation should address the following areas: a hazardous waste management plan, training, characterization, turn-in and disposal, inspections, permits and record keeping, and host-tenant support (DAF, 1994a:3). In addition, each major command is responsible for issuing additional guidance. For example, AFMC specific guidance includes AFMC Standard Operation Procedures for Hazardous Waste Management (7 Dec 1994), and AFMC Supplement 1 to AFI 32-7042 (18 May 1995).

2.4.2. ECAMP

The ECAMP program is "designed to ensure compliance with federal, state, and local environmental laws and regulations … through the use of comprehensive environmental compliance assessments and management action plans" (DAF, 1998:1). The program is subject to guidelines from AFI 32-7045; Civil Engineering, Environmental Compliance Assessment and Management Program (1 July 1998). This instruction requires Air Force installations to conduct internal inspections annually and external inspections once every three years (DAF, 1998:3). Internal inspections are conducted by installations with in-house personnel, while external inspections are conducted by the command with personnel from the command or other bases. Inspections can include Air Force personnel only, or a mix of Air Force and contractor personnel (DAF, 1998:7). During an ECAMP inspection, a team will conduct a site assessment to determine compliance of the installation in a variety of environmental disciplines. Each identified deficiency is written up as a finding for which the installation must develop a corrective action. Findings can be categorized into one of 20 categories, seen in Table 6. Each finding category includes multiple types of findings. For example, the hazardous waste management category includes 15 types of findings, seen in Table 7.

Table 6. ECAMP Finding ID Categories (DAF, 1998:15)

Air Emissions	POL Management
Cultural Resource Management	Pollution Prevention
Hazardous Materials Management	Solid Waste Management
Installation Restoration Program	Storage Tank Management
Natural Resources Management	PCBs
National Environmental Policy Act	Asbestos
Hazardous Waste Management	Radon Mitigation
Environmental Noise	Lead-Based Paint Management
Program Management	Wastewater Management
Pesticides Management	Water Quality Management

Table 7. Hazardous Waste Management Finding ID Codes (DAF, 1998:17)

Actual Code	Finding ID Code
HW1	Satellite Accumulation Point Deficiency
HW 2	90-day or 180-day Accumulation Point
HW 3	TSD Facility Deficiency
HW 4	Lack of Characterization
HW 5	Transportation/Manifest Deficiency (except LDR)
HW 6	Unpermitted/Improper Disposal
HW 7	Unpermitted/Treatment
HW 8	Inadequate Waste Minimization
HW 9	Program Planning Deficiency
HW 10	Waste Analysis Characterization Planning Deficiency
HW 11	Facility-Wide Records Deficiency
HW 12	AFI/Procedural Records Deficiency
HW 13	Training Deficiency
HW 14	Land Disposal Restriction (LDR) Deficiency
HW 15	Other

2.4.3. Hazardous Waste Process

The installation's hazardous waste process is dependent on specific operations, particularly the amount and type of hazardous waste generated. The process for each installation is described in their HWMP. Each HWMP should include location of hazardous waste facilities, responsibilities of personnel working with hazardous waste, a waste analysis plan, and hazardous waste management procedures. The processes at installations tend to be similar. When installations generate waste, they store it at an Initial Accumulation Point (IAP). From the IAP, the waste might be transferred to a 90 or 180-day accumulation point or sent to a Treatment, Storage, and Disposal Facility (TSDF). In most cases, waste will eventually be taken off base by contractors for final disposal.

2.4.4. Environmental Education and Training in the Air Force

Air Force and command policies state that installations must meet minimum training requirements stated by federal and state laws. The Air Force Center of Environmental Excellence (AFCEE) works with the environmental divisions at Air Force Headquarters and major commands to develop environmental education and training (EET) requirements. The Air Force satisfies these requirements through a variety of instructional tools, some of which are created and controlled through AFCEE. Air Force employees generally complete training at base-level or through the Air Force Institute of Technology and Web University.

According to AFI 32-7042, hazardous waste training must include the nine topics listed in Figure 2. Each base should address how they will meet these training requirements in their HWMP. For example, the Wright-Patterson AFB HWMP has a chapter on training that, among other things, discusses the types of training required for different personnel (88 ABW/EMC, 1999:6-1). In general, formats of base-level training include classroom training, on-the-job training, and computer-based training.

Introduction to the Resource Conservation and Recovery Act
Identification of Hazardous Waste
Accumulation Point Management
Container Use, Marking, and Labeling, and On-base Transportation
Waste Turn-in Procedures
Manifesting and Transportation of Hazardous Waste
Spill Prevention and Emergency Response
Waste Reduction
Personnel Safety and Health and Fire Safety

Figure 2. Hazardous Waste Training Areas (DAF, 1994:4)

The Air Force Institute of Technology Civil Engineering and Services School (AFIT/CE) and Environmental Web University are the Air Force's primary providers of EET outside of base-level. AFIT/CE develops and delivers environmental education through in-residence and distance learning courses, including the Hazardous Waste Management course and Unit Environmental Coordinator course. AFIT/CE also provides funding for personnel to attend hazardous waste courses taught by a third party. Environmental Web University, run by AFCEE, is an electronically based school that contains a multitude of Web training classes and is an excellent source for introductory and advanced environmental topics. Environmental Web University offers a Hazardous Waste Management Training course.

2.4.5. Previous Study of AFMC Hazardous Waste Program

Argonne National Laboratory (Kopla, 1996:1) performed a study of AFMC hazardous waste training programs and summarized their findings in a 1996 report. Their analysis focused specifically on training programs at installations. They used seven major performance objectives to evaluate the hazardous waste training programs:

organizational structure, culture and attitude, environmental training programs, internal communication, staffing and resources, program review and evaluation, environmental program documentation (Kolpa, 1996:3). Argonne National Laboratory used these areas to guide questionnaires and interviews during visits to 14 installations. Overall, the study concluded that there were critical elements found in successful training programs, to include: strong command support, a minimal level of formality in training, integration with other environment, health, and safety training programs, commitment by management for resources to adequately train workers, and good communication mechanisms that encourage feedback (Kolpa, 1996:10).

This report specifically mentioned several positive and negative findings that affected AFMC hazardous waste training programs (Kolpa, 1996). The following attributes are examples of these findings. First, positive culture and attitude positively affected hazardous waste training. Also, well-developed training programs, directly supporting the HWMPs, were more effective then generic programs. Furthermore, smaller class sizes composed of students with similar job responsibilities, though less efficient, were considered more effective than larger classes taught to a diverse group. Lastly, while the report states that evaluating training is necessary, this report found that installations did not formally evaluate their training programs.

2.5. Training Program Evaluation

This section discusses training program evaluation. It begins with a description of a 10-step plan to implement an effective training program. It then explains each level of a four-level training program evaluation model developed by Kirkpatrick in 1959. This section also describes an addition to Kirkpatrick's model by Phillips (1996) regarding return on investment.

2.5.1. Effective Training Program Steps

It is essential to evaluate a training program to determine the overall effectiveness of the program. Kirkpatrick (1998) lists a 10-step process for planning and implementing a training program, with evaluation as the last step:

1. Determining needs
2. Setting objectives
3. Determining subject content
4. Selecting participants
5. Determining the best schedule
6. Selecting appropriate facilities
7. Selecting appropriate teachers
8. Selecting and preparing audiovisual aids
9. Coordinating the program
10. Evaluating the program

While evaluation of a training program is important, every planning and implementation step must be considered in establishing an effective training program. Failure to consider the entire process will result in poor evaluations and a wasted effort. Therefore, a strong emphasis on planning and implementation will more likely lead toward positive results for the evaluation step of the program.

2.5.2. Training Program Evaluation

The evaluation of training programs has three purposes: to improve future programs, to determine whether a program should be continued or dropped, and to justify existence of the training department (Kirkpatrick, 1998:18). Simply put, evaluation of training programs determines whether training is worthwhile and beneficial to an organization. Not evaluating training can easily lead to ineffective training programs and wasted resources. Hence, it is extremely important that environmental training is evaluated to determine its overall effectiveness. Kirkpatrick's (1998) four-level evaluation model is considered the leading training evaluation model in the field. His four levels measure training in the following areas: reaction, learning, behavior, and results. Each level uses different data and provides evaluators with specific information on their training program. A summary of each level is provided in Table 8. Understanding the evaluation levels and their outputs can help in obtaining useful information in the environmental training evaluation process.

Table 8. Kirkpatrick Four-level Training Evaluation Model (1998)

Level	Measures	Measurement Techniques
Reaction	How participant liked training	End of course survey or reaction sheet
Learning	Change in knowledge, attitude, and/or skill	Pretest and posttest
Behavior	Change in behavior	Interviews and questionnaires before and after training
Results	On-the-job results	Statistics from job performance

2.5.2.1. Level 1: Reaction

The reaction level of Kirkpatrick's model (1998:25) often referred to as customer satisfaction, measures whether participants liked the training. Evaluation at the reaction level is usually performed through a survey or questionnaire administered at the end of a course. Based on the results, management can determine whether a program is valuable and make necessary changes. Because of its relative simplicity, 77 percent of organizations use reaction measures to evaluate their training programs (Wexley, 2002:128). Although beneficial, the reaction level fails to measure the amount of learning garnered.

2.5.2.2. Level 2: Learning

"Learning can be defined as the extent to which participants change attitudes, improve knowledge, and/or increase skill as a result of attending the program" (Kirkpatrick, 1998:20). Training programs can be developed to measure one or all of these areas. Kirkpatrick (1998:40) suggests the following guidelines for evaluating learning:

1. Use a control group, if practical.
2. Evaluate knowledge, skills, and/or attitudes before and after the program.
3. Use a paper-and-pencil test to measure knowledge and attitudes.
4. Use a performance test to measure skills.
5. Get a 100 percent response.
6. Use the results of the evaluation to take appropriate action.

Evaluating participants at the learning level is essential in determining whether participants increased their knowledge, skills, or attitude as a result of the training they received. This evaluation also gives the trainer an idea of whether the material in the program was effective. However, only 36 percent of organizations use learning evaluations to evaluate their training programs (Wexley, 2002:128).

2.5.2.3. Level 3: Behavior

Behavior is Kirkpatrick's (1998:48) third training evaluation measure. This level "measures how well participant's training skills or behaviors from the training program have been transferred to the job" (Basarab, 1992:11). Behavior differs from learning in that it measures whether a participant has incorporated the new knowledge gained from training into their job duties. The behavior level can be measured through interviews or questionnaires of the participants or their supervisors, both before and after the training.

Positive outcomes from behavior evaluations often lead to an increase at Kirkpatrick's next evaluation level, results. However, only 15 percent of organizations use these evaluations for the behavior level due to time and cost constraints to obtain additional information (Wexley, 2002:128).

2.5.2.4. Level 4: Results

The results level measures the change in outcome caused by participants who attended the training program. Results can "include increased production, improved quality, decreased costs, reduced frequency and or severity of accidents, increased sales, reduced turnover, and higher profits" (Kirkpatrick, 1998:23). Though this level measures a change in results for an organization, it does not measure the costs of the training itself. Even with good results, high costs of the training program might outweigh the potential benefit. Only eight percent of organizations tend to use result evaluations (Wexley, 2002:128).

2.5.2.5. Return on Investment

Return on investment (ROI) is an extension to Kirkpatrick's original four-level model of evaluation. In this level, "measurement compares the program's monetary benefits with its costs" (Phillips, 2001:24). ROI is usually used in the form of a percentage or benefit-cost ratio. While ROI can be extremely useful, it is important to obtain results from the other four levels first to gain a multifaceted understanding of training benefits and because the levels build on each other. Ignoring the first four levels can lead to confusion on whether ROI can be attributed to the training. There are many barriers to ROI, including costs, time, skills of training staff, fear, and discipline and planning concerns. However, benefits of ROI are increased senior management support, confidence of clients, an improved training process, and a results-focused approach (Phillips, 2001:34-38). Managers throughout industry increasingly use ROI as an evaluation tool because it shows cost-related results, which enables them and trainers to make informed decisions.

3. Methodology

This chapter describes the methodology used in this research. It discusses the data collection method of web-based surveys, specifically explaining the survey development process, including survey creation, testing, and distribution. This chapter also explains the statistical tools, such as linear regression and analysis of variance (ANOVA), used to analyze the data.

3.1. Data Collection

To answer the research questions, two types of data are necessary. The first research question requires the following data from each base: characteristics of their hazardous waste training program and Environmental Compliance Assessment and Management Program (ECAMP) findings. The other three research questions require data about the personnel in each hazardous waste training program, including: knowledge of hazardous waste principles, perception of hazardous waste, and demographic information. The method used to collect this data is described in the next two paragraphs.

To collect the first set of data, the Air Force Automated Civil Engineer System (ACES) program and a data call were used. Data obtained from ACES originated from the Environmental Hazardous Waste Module. The module provided characteristics of the hazardous waste program at Air Force Materiel Command (AFMC) installations. These characteristics include permit information, generator type, number of waste streams generated, and number of Recourse Conservation and Recovery Act (RCRA) hazardous waste containers processed. Additionally, a data call sent to AFMC installations provided the number of internal ECAMP findings from Fiscal Year 2001 to 2005. Lastly, the AFMC environmental office provided external ECAMP findings. Appendix A includes a list of all external ECAMP findings in AFMC by base.

The second set of data was collected using a web-based survey. Surveys are considered effective and efficient tools to gather information on attitudes, behaviors, needs, and demographics (Alreck, 2004:3). Web-based surveys are extremely flexible compared to other forms of surveys because they allow large populations to participate, ease survey development, and simplify analysis (Alreck, 2004). The survey used in this research gathered three types of hazardous waste data from personnel in AFMC: knowledge of hazardous waste concepts, perceptions of hazardous waste, and demographic information. The next section will discuss how the survey was developed, tested, and distributed.

3.2. Survey

This section begins with a description of how the survey was developed. It also explains how the survey was pilot tested, including the use of an index of discrimination test. The section concludes by describing the survey population and discussing how the survey was distributed. The complete survey can be seen in Appendix B.

3.2.1. Survey Development

The survey used in this research consisted of three sections. The first section was a knowledge-based test of individuals' hazardous waste knowledge. The second section measured individual perceptions of hazardous waste, and the third section asked for demographic information. Each section is discussed in more detail in the following paragraphs.

The first section consisted of 25 knowledge-based items, either multiple choice or true and false questions. The intent of this section was to assess the working knowledge of AFMC personnel, focusing on areas of hazardous waste principles, regulations, and policies. Faculty members from the Air Force Institute of Technology's Civil Engineer and Services School worked with the AFMC Hazardous Waste Manager to develop the questions. These individuals were asked to design questions regarding common hazardous waste principles. Additionally, they were asked to focus some questions on typical hazardous waste problem areas using hypothetical scenarios. The questions ranged from basic conceptual ideas to specific policy questions. After development, the questions were pilot tested and reviewed, as discussed in the survey testing section below.

The second portion of the survey measured individual perceptions toward hazardous waste in the Air Force. The purpose of this section was to gauge how personnel feel about their hazardous waste knowledge and ability, as well as their opinions about the hazardous waste program at their base and in the Air Force in general. This was accomplished by asking respondents to state their agreement with eight statements using a 5-point Likert scale, ranging from strongly disagree to strongly agree. The first question asked respondents to judge how well they think they have done on the survey. Additionally, the survey asked respondents whether they feel they have an appropriate level of knowledge regarding hazardous waste concepts and regulations, and if they can effectively apply this knowledge. Other questions asked respondents whether they have been given the appropriate training and tools to perform their jobs successfully. The last set of questions asked respondents whether the Air Force and their respective installations are doing a good job of promoting proper care of hazardous waste.

The third section obtains demographic information about each respondent. This information will be used to statistically compare average knowledge scores from respondents and their perception towards hazardous waste using analysis methods discussed later in this chapter. These questions asked about the respondent's base of assignment, job duration, unit identifier, hazardous waste handling experience, and managerial experience. The section also gathered data on the hazardous waste activities the respondents participated in and the associated frequency of those activities. The respondents also answered questions on hazardous waste training courses they have attended, including the timeframe in which they attended the training and the amount of knowledge they gained from the course. Lastly, the section gathered information on the respondent's highest educational level and employment status, including grade and occupational series.

3.2.2. Survey Testing

A pilot test for this survey was conducted with nine hazardous waste personnel at Wright-Patterson AFB. The purpose of this test was two-fold. The first purpose of the test was to assess the survey's format and clarity by examining how well respondents answered questions. Based on a review of the respondent's test answers, small structural changes were made to clarify several questions. The second purpose of the pilot test was to measure the validity of each knowledge question in section one of the survey. This included a thorough review from a content perspective of the 25 questions with the question designers.

In this review, the statistical parameter index of discrimination was used. Index of discrimination helps identify how each question differentiates between those who scored high on the survey versus those who scored low. One determines the index of discrimination by taking the difference between the proportion in the upper 50th percentile that answer the question correctly and the proportion in the lower 50th percentile that answer the question correctly. The equation for index of discrimination is as follows (Crocker, 1986:314):

$$D = p_u - p_l$$

where D is the index of discrimination, p_u is the proportion in the upper 50th percentile that answer the question correctly, and p_l is the proportion in the lower 50th percentile that answer the question correctly. Values of index of discrimination range between -1.00 and 1.00 (Crocker, 1986:314).

Ebel (1965) states the functionality of the question based on the ratio suggests whether the question should be revised or kept as is (Crocker, 1986:313). Ebel (1965) offered the following guidelines for interpretation:

1. If $D \geq 0.40$, the item is functioning quite satisfactorily.
2. If $0.30 \leq D \leq 0.39$, little or no revision is required.
3. If $0.20 \leq D \leq 0.29$, the item is marginal and needs revision.
4. If $D \leq 0.19$, the item should be eliminated or completely revised.

Using these guidelines, the index of discrimination results from each question were thoroughly discussed and reviewed.

This question-by-question review also considered two other factors: the number of answers used by respondents for each question; and questions left unanswered or included multiple answers. These factors, along with the index of discrimination scores, were discussed with the question designers. Of the 25 knowledge questions reviewed, 14 questions had an index of discrimination of less than or equal to 0.19. These questions were thoroughly reviewed; however, not all questions were revised due to the small sample size for this pilot test. If the question designers considered the question to be poorly constructed, it was revised.

In addition to a pilot test, it was necessary to test whether the survey was accessible throughout AFMC. To perform this test, the web-based survey was sent to 20 non-hazardous waste personnel at Air Force bases throughout the world. This test validated the survey would work properly and acted as a final operational test before survey release.

3.2.3. Survey Distribution

This survey was intended for all personnel in AFMC who work with hazardous waste or supervise personnel who work with hazardous waste, approximately 6000 personnel. The survey was distributed through the hazardous waste management hierarchy at each base, including the base hazardous waste manager and unit environmental coordinator(s). Hazardous waste managers are responsible for an installation's hazardous waste program. To assist the hazardous waste managers, unit environmental coordinators (UECs) manage hazardous waste operations in their unit.

AFIT hosted the survey on one of its Internet servers, and a link to the survey was sent via e-mail to the 11 AFMC hazardous waste managers. These individuals then forwarded the e-mail to their unit environmental coordinators who, in turn, forwarded the email to personnel who work with hazardous waste in their unit, and their supervisors.

The survey was open for 15 days, at which time data was downloaded from the database for analysis.

3.3. Analysis

This section explains the statistical tools used to analyze the data. First, it explains the theory of multiple regression and ANOVA. It then explains how these tests were applied to the data. Finally, the section discusses how the data regarding perceptions was analyzed.

3.3.1. Linear Regression

Regression is used to measure the relationship and significance between an independent variable and a dependent variable (Alreck, 2004:329). Linear regression is used to measure the relationship and significance between linear independent variables and a dependent variable (McClave, 2005:768). A form of multiple regression called stepwise regression was used to analyze the collected data. Stepwise regression can be conducted with any statistical software package and produces a model containing the independent variables that are considered significant to the dependent variable. The following equation represents the result of a sample model (McClave, 2005:854):

$$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3$$

where $E(y)$ represents the dependent variable; β_0 is the y-intercept; β_1, β_2, and β_3 represent the respective contributions of the independent variables; and x_1, x_2, and x_3 are the independent variables (McClave, 2005:854).

In this research, stepwise regression was used to build a model to detect a relationship between the dependent variable, hazardous waste ECAMP findings, and the independent variables listed in Table 9. Using a significance level of 0.05, the final model included the independent variables that influence ECAMP findings the greatest. Based on this model, a conclusion was made on which variables had a positive and negative affect on ECAMP findings.

Table 9. Regression Independent Variables

Independent Variables	Categories or Measure By
Base Type	Typical, Depot, Research & Development
Geographically Separated Properties	Number of Properties
Generator Type	Large Quantity Generator, Small Quantity Generator, Conditionally Exempt Small Quantity Generator
Permit Type	Central Storage Facility (CSF), Transportable Treatment Unit (TTU)
Hazardous Waste Generated	Amount in Tons (average past 5 years)
Initial and Secondary Accumulation Sites	Number of Sites
90, 180, 270 Accumulation Points	Number of Points
Waste Streams Generated	Number of Streams
RCRA Containers Processed	Number of Containers
Base Population Working with Hazardous Waste	Number of People
Course Attended	HW Initial, HW Annual, HW Awareness, Computer Based, On-the-job Training, AFIT Courses, Web University, etc.*

*A complete list of courses and descriptions of courses can be seen in Appendix C

3.3.2. ANOVA

ANOVA is a method used to measure the statistical significance of the differences between two or more means (Alreck, 2004:314). ANOVA tests conclude that the means are all equal or that one or more means is different. Pairwise comparisons expand a single ANOVA test to multiple ANOVA tests between each mean and generate a final ranking of means (McClave, 2005:583). This analysis used the Bonferroni method of pairwise comparisons. The Bonferroni method can be used with any statistical package and allows comparisons of means with unequal sample sizes (McClave, 2005:584).

ANOVA was used in this analysis to detect differences in the mean of knowledge scores in several demographic categories. For example, an ANOVA test compared the mean of knowledge scores from each base to detect if a difference in those scores was statistically significant. Table 10 lists the subsections for which ANOVA tests were performed and the means that were compared in each subsection. Using a 0.05 significance level, the Bonferroni method of pairwise comparisons was used to further delineate differences between means.

Table 10. Subsections to Compare Means of Knowledge Scores

Demographic Subsections	Comparing Means Of
Base	Arnold, Brooks, Edwards, Eglin, Hanscom, Hill, Kirtland, Robins, Rome, Tinker, Wright-Patterson
Time in Unit & Position, Time at Base, Time Working with Hazardous Waste	Time (in Years)
Primary Workplace	Generator, Initial Accumulation Point, 90 or 180-day Accumulation Point, Treatment, Storage, and Disposal Facility (TSDF), Unit Environmental Coordinator
Workplace Manager	Yes or No
Hazardous Waste Handling Frequency	Almost Everyday, Often, Occasionally, Rarely, Never
Hazardous Waste Handling Activity	Container Selection, Waste Stream Profiling, Characterization Sampling, Marking and Labeling, Collection Site Inspections, Packaging and Shipping, Waste Recycling, Empty Container Management, Consolidation, Bulking, and Lab Packing
Course Attended	HW Initial, HW Annual, HW Awareness, Computer Based, On-the-job Training, AFIT Courses, Web University, etc.*
Education Level	GED, High School, Some College, Associate's Degree, Bachelor Degree, Graduate Degree, Doctorate Degree
Employment Status, Grade, & Occupational Series	Military, Civilian, Contractor

*A complete list of courses and descriptions of courses can be seen in Appendix C

3.3.3. Attitudinal Data

Analysis of the attitudinal data will be conducted to determine the perceptions personnel have towards hazardous waste. Analysis was performed using the answers from the eight questions in the second section of the survey. To perform this analysis, the average score was tabulated for each question. This analysis was also conducted using ANOVA to detect differences in perception at each base throughout the command.

4. Results and Discussion

This chapter provides the results of this research effort. It begins with a review of the descriptive statistics used to summarize the survey responses. The results from analyzing the survey data using multiple linear regression and analysis of variance (ANOVA) techniques are presented next. Finally, the results from the attitudinal questions are reported and reviewed.

4.1. Descriptive Statistics

This section provides the descriptive statistics of the survey responses. This includes a summary of the survey response rate throughout the command and a review of the statistics from the knowledge-based questions used in the survey.

4.1.1. Response Rates

Table 11 summarizes the response rate information. Out of 6211 personnel in the Air Force Materiel Command (AFMC) hazardous waste program, 544 usable responses were received for a final usable response rate of 8.8%. Of the 568 responses received in the database, 24 were identified as unusable because they were duplicates, had numerous unanswered questions, or did not have a base identified.

Table 11. Survey Participation Results

Number of Hazardous Waste Personnel in AFMC	6211
Total Responses	568
Unusable Responses	24
Total Number of Usable Responses	544
Final Usable Response Rate	8.8%

The response rate of 8.8% was low and rather disappointing. Although a number of factors may have contributed to this, the most obvious is the manner in which the survey was distributed. As discussed in Chapter 3, a link to the web-based survey was e-mailed to the hazardous waste manager at each base with instructions to forward the link to the unit environmental coordinators (UECs) in each organization at their respective bases. The UECs were then asked to forward the link to individuals in their respective organizations. Although the hazardous waste manager for the Air Force Materiel Command (AFMC) was confident in this method of distribution, it did not prove to be very successful. There was no way to verify that the survey was actually forwarded in a timely manner. Therefore, it is possible that not all of the 6,211 personnel who are involved in the AFMC hazardous waste program were notified of the survey.

Table 12 gives a breakdown of the number of usable responses at each base and the associated response rate. This table shows that the response rate varied significantly across the command. Arnold had the highest response rate at 66.7% and Robins had the lowest response rate at 2%. Figure 3 provides a visual representation of the number of responses received at each base.

Table 12. Response Rate by Base

Base	HW Personnel	# of Usable Responses	Response Rate
Arnold	18	12	66.7%
Brooks	57	22	38.6%
Edwards	217	48	22.1%
Eglin	348	70	20.1%
Hanscom	102	15	14.7%
Hill	1125	67	5.96%
Kirtland	600	30	5.0%
Robins	2326	47	2.0%
Rome	12	3	25.0%
Tinker	1200	200	16.7%
Wright-Patterson	206	30	14.6%
Total	**6211**	**544**	**8.8%**

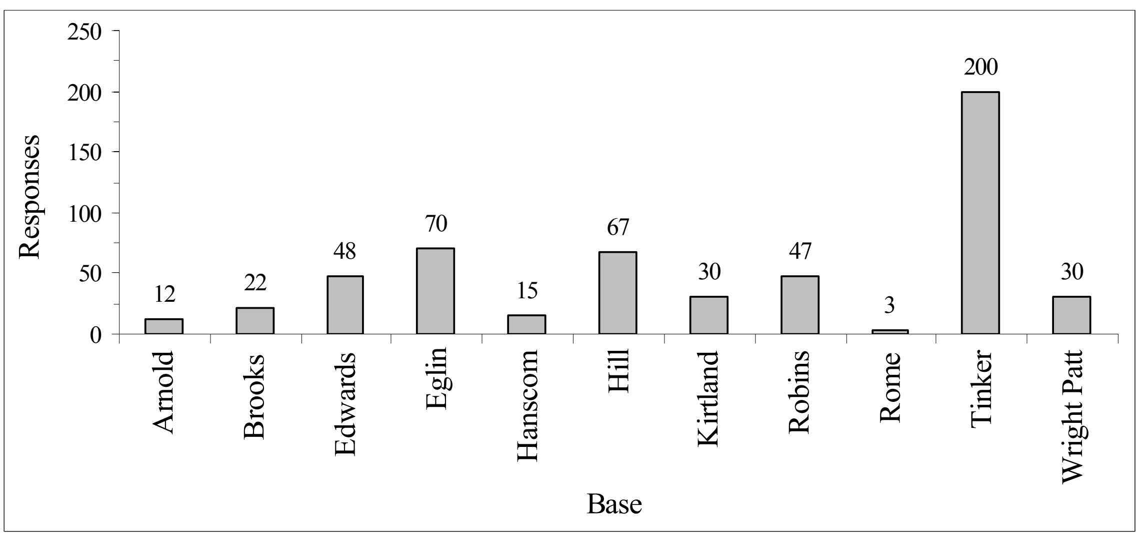

Figure 3. Number of Responses by Base

4.1.2. Knowledge Scores

The mean score from the 25-question knowledge section of the survey was 15.61, with scores ranging from 2 to 25 correct answers. The standard deviation was 3.16. A histogram of the scores is shown in Figure 4. This histogram shows that the knowledge scores are approximately normally distributed (i.e., mound shaped and symmetric about the mean). Three additional tests also demonstrate that we would fail to reject the hypothesis that the data is normally distributed. First, the percentage of data that falls within one, two, and three standard deviations of the mean is 68%, 94%, and 100%, respectively, which is very close to the expected values of 68%, 95%, and 100% for an approximately normal distribution. Second, the interquartile range (IQR = 5) divided by the standard deviation is 1.58, which is close to 1.3, indicating an approximately normal distribution. Third, the normal probability plot in Appendix D shows that the data falls approximately on a straight line, indicating approximately normal distribution. In addition to normality, it is important to note that there was one outlier in the distribution of knowledge scores. This outlier, a knowledge score of 2, falls more than three standard deviations away from the mean and can be seen in Figure 4. This outlier was kept in the data set.

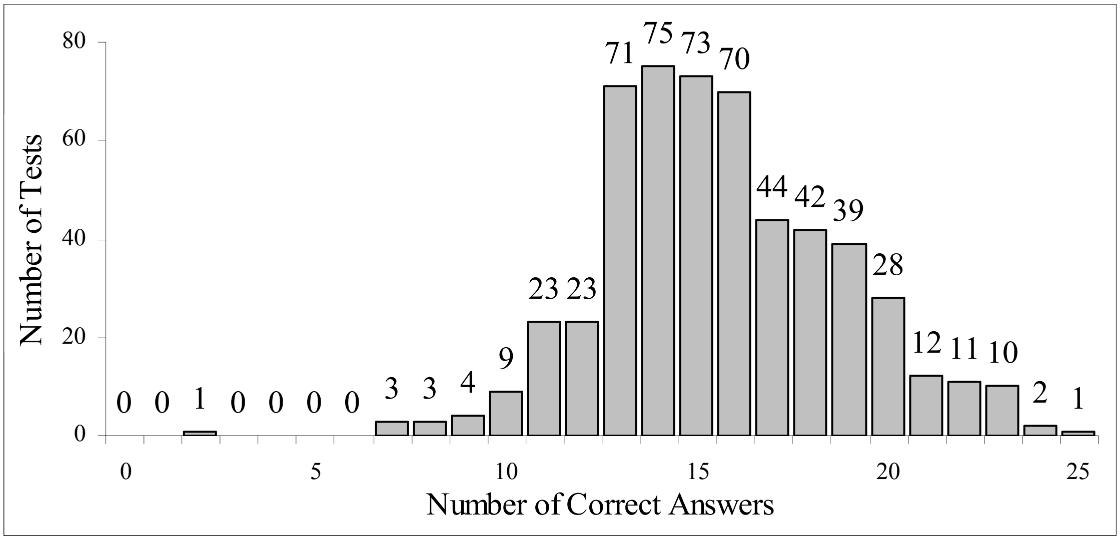

Figure 4. Total Score Distribution

Table 13 shows the mean knowledge score and standard deviation of mean knowledge scores from each base. Rome and Arnold had the highest scores, 21.33 and 18.33, respectively, while Tinker's score of 14.06 was the lowest. Figure 5 is a box plot that depicts the range of scores from each base. The top and bottom of each box represents the 75th and 25th percentiles of knowledge scores for each base. The overall mean knowledge score is represented by the horizontal line across the entire figure. Note that the only boxes to fall completely above the overall mean knowledge score are Eglin and Rome and the only box to fall completely below the mean knowledge score is Tinker. Further comparison of mean knowledge scores will be discussed later in this chapter. In addition, scores that are considered outliers for their base are denoted on the box plot as dots that are above or below the highest and lowest horizontal line. Hanscom, Robins, and Tinker had one or more outliers at their base.

Table 13. Mean Knowledge Score and Standard Deviation by Base

Base	Number of Scores	Mean Score	Standard Deviation
Arnold	12	18.33	3.82
Brooks	22	16.05	2.72
Edwards	48	16.06	3.31
Eglin	70	17.24	2.53
Hanscom	15	16.47	3.29
Hill	67	16.42	3.29
Kirtland	30	18.80	3.23
Robins	47	15.94	3.74
Rome	3	21.33	0.58
Tinker	200	14.06	2.43
Wright-Patterson	30	16.53	2.70
AFMC	544	15.61	3.16

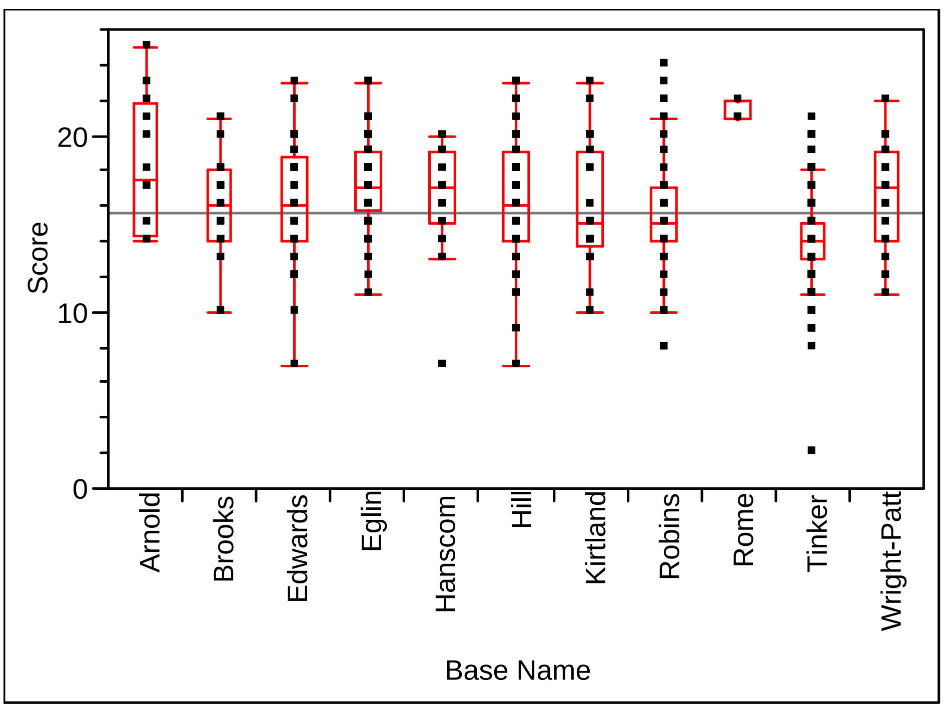

Figure 5. Range of Scores by Base

Appendix E shows the statistics for individual questions. These statistics include the percentage of correct and incorrect answers for each question, and the percentage that each possible response within a question was used. Of the 25 questions, 7 questions (2, 5, 7, 9, 10, 16, 17, 19, and 24) were answered correctly by at least 90% of the personnel and 9 questions (11, 12, 18, 20, 21, 22, and 25) were answered correctly by less than 50% of the personnel.

4.2. Linear Regression

Stepwise regression was used to compare the independent variables listed in Table 8 of Chapter 3 against the Environmental Compliance Assessment and Management Program (ECAMP) findings, the dependent variable. Table 14 summarizes the ECAMP findings across the command from Fiscal Years (FY) 2001 to 2005. The table includes both external and internal ECAMPs. Since every base did not have an ECAMP every year, the number used for the dependent variable was the mean number of findings per ECAMP over the past 5 years. Stepwise regression was also used to compare the independent variables with another dependent variable, the mean knowledge scores from each base listed in Table 13.

Table 14. ECAMP Findings by Base

Base	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Mean per ECAMP
Arnold	NA	4	4	3	5	4
Brooks	NA	NA	NA	4	NA	4
Edwards	NA	35	55	NA	35	42
Eglin	26	21	NA	18	18	21
Hanscom	9	6	2	5	7	6
Hill	16	20	15	6	10	13
Kirtland	56	33	43	76	11	26
Robins	17	37	18	22	35	26
Rome	NA	NA	4	NA	NA	4
Tinker	23	21	23	16	16	20
Wright-Patterson	25	22	13	15	14	18

(Note: Years in which a base did not have an ECAMP are denoted by NA)

Initially, four stepwise regression models were created. The first two stepwise regression models were created for the first dependent variable, ECAMP findings. The first ECAMP findings model factored in dependent variables based on the percentage of people who have taken a training course. The second ECAMP findings model factored in dependent variables based on the percentage of people who have taken a training course within the past two years. The last two stepwise regression models were created for the second dependent variable, mean knowledge scores. The first mean knowledge score model factored in dependent variables based on the percentage of people who have taken a training course while the second mean knowledge score model factored in dependent variables based on the percentage of the people who have taken a training course within the past two years. The four models used a y-intercept of 0 and a significance factor of 0.05.

The outputs from each of these four models were considered unusable because of high interaction. When creating the models, the R^2 value increased with the addition of every parameter, indicating the model accurately predicted the dependent variable. However, as each parameter was added to the model, there were considerable changes in the coefficient and significance value of previous parameters already in the model. These changes often changed the apparent relationship of a parameter with the independent variable. This phenomenon implies that the parameters were highly correlated with each other. Due to this, these models were not used and were not reported.

Due to the complex interactions causing inexplicable correlations between independent variables, new models were created. These models avoided interaction problems associated from the previous four models. A separate model was created for each independent variable, thereby enabling one-on-one analysis of each independent variable with each dependent variable. This resulted in 42 new models for each dependent variable; Appendix F lists the independent variables used in each model. Of the 84 total models, half compared the independent variables to ECAMP findings and half compared the independent variables to mean knowledge scores. These models used a significance factor of 0.05.

From the 84 models, Table 15 and Table 16 list the parameters having the lowest p-value (less than 0.05), implying highest significance and thus having the highest correlation, with their respective dependent variable (Appendix G shows the results of all 84 models). These tables show 19 parameters with a p-value less than 0.05, sorted in order of their p-value from lowest to highest. All parameters had an R^2 value of 0.396 or greater.

Parameters that have a negative correlation with ECAMP findings or positive correlation with mean knowledge scores are considered to be positive outcomes from a hazardous waste program and are denoted by a plus sign in the result column of each table. Parameters that have a positive correlation with ECAMP findings or a negative correlation with mean knowledge scores are considered to be negative outcomes from a hazardous waste program and are denoted by a minus sign in the result column of each table. It should be noted that all parameters considered to have a significant relationship with ECAMP findings had a negative correlation with a hazardous waste program.

Table 15. Parameters with Highest Correlation to ECAMP Findings

Parameter	R-Squared Value	Coefficient Estimate	Significant Probability	Result
On-the-job*	0.618	85.53	0.0040	-
WENV 521*	0.603	182.82	0.0050	-
On-the-job	0.54	80.18	0.0100	-
AFIT-funded*	0.538	240.66	0.0100	-
Initial*	0.492	58.53	0.0160	-
Awareness*	0.472	58.74	0.0200	-
TTU Permit	0.415	18.31	0.0320	-
Awareness	0.396	47.10	0.0380	-

(Note: Parameters representing data within the past 2 years is denoted with an asterisk)

Table 16. Parameters with Highest Correlation to Knowledge Scores

Parameter	R-Squared Value	Coefficient Estimate	Significant Probability	Result
DOT	0.875	10.30	0.0000	+
Other, Base*	0.806	9.34	0.0000	+
Other, Base	0.801	6.21	0.0000	+
DOT*	0.719	17.80	0.0010	+
Awareness	0.687	-7.96	0.0020	-
Properties	0.572	0.90	0.0070	+
Initial	0.56	-7.91	0.0080	-
On-the-job	0.55	-10.38	0.0090	-
Awareness*	0.545	-8.09	0.0100	-
Annual	0.532	-5.41	0.0110	-
Annual*	0.427	-4.96	0.0290	-

(Note: Parameters representing data within the past 2 years is denoted with an asterisk)

Table 17 summarizes the positive and negative results from Table 15 and Table 16 by grouping parameters. This table is divided into two sections, one for training course parameters and one for base hazardous waste program characteristics. The positive (+) and negative (–) columns in Table 17 signify the number of models for which each parameter had a significant positive or negative relationship with a dependent variable. Note that each of the 10 parameters listed had a strictly positive or negative relationship, and not a mixture.

Training course parameters that have a positive result on a hazardous waste program are the DOT (Department of Transportation) training course and other base-level training. Hazardous waste program characteristic parameters that have a positive result on a hazardous waste program are number of properties on a base and having a TTU (Transportable Treatment Unit) permit.

Training course parameters that have a negative result on a hazardous waste program are awareness training, on-the-job training, annual training, initial training, the Air Force Institute of Technology (AFIT) WENV 521 course, and other AFIT-funded training. Note that awareness training was considered a negative result for each of the 4 models in which it was tested and on-the-job training was considered a negative result in 3 of the 4 models in which it was tested. No hazardous waste program characteristic parameters had a negative result on a hazardous waste program.

Table 17. Summary of Significant Parameters

Parameter	+	-	Overall
Training Courses			
DOT	2	0	+2
Other-Base Level	2	0	+2
WENV 521	0	1	-1
AFIT-funded	0	1	-1
Initial	0	2	-2
Annual	0	2	-2
On-the-job	0	3	-3
Awareness	0	4	-4
Base Characteristics			
Properties	1	0	+1
TTU Permit	0	1	-1

(Note: The + and – columns signify the number of models each parameter had a significant positive or negative relationship with a dependent variable)

4.3. ANOVA

ANOVA tests were performed to compare the mean knowledge scores of groups based on the demographic information listed in Table 10 of Chapter 3. To conduct ANOVA tests, three conditions are required. The first condition requires random samples of the population. This condition is satisfied because the survey responses, and their associated knowledge scores, were random. The second condition requires an approximately normal distribution. As discussed in section 4.1., the sample population is approximately normal. Further, base-by-base normality tests of knowledge scores also show that the sample is approximately normally distributed. Lastly, the third condition requires that the population variances are equal. Based on an 8.8% response rate, it is impossible to determine whether this condition is satisfied. However, visual inspection concludes that the population variances are approximately equal. Therefore, these ANOVA test will assume that population variances are equal.

In addition to the standard ANOVA test between two means, the Bonferroni method of pairwise comparisons was used to test group means against each other. The Bonferroni method was used because it allows unequal sample sizes. Using a 0.05 p-value for all ANOVA tests, this section summarizes the results of these tests.

4.3.1. No Significant Differences

ANOVA tests concluded there was no significant difference in mean knowledge scores between groups based on each of the three areas: time personnel have worked in their current position, personnel who are managers, and the frequency personnel handle hazardous waste. Therefore, no discriminatory conclusions can be made from these tests. Appendix H shows the results from the tests that showed no significant differences.

4.3.2. Base

Table 18 shows the ANOVA results for the mean knowledge scores of personnel at each AFMC installation. The mean knowledge scores of personnel at Arnold, Eglin, Hill, and Rome were each considered significantly higher than the mean of all other AFMC personnel. The mean knowledge score of personnel at Tinker was considered significantly lower than the mean of all other personnel; this is examined in more detail in Section 4.5. Figure 6 graphically depicts the difference of means using 95% confidence intervals.

Table 18. ANOVA by Base

Base	Mean	Number	Sig
Arnold			
At Base	18.33	12	0.0025*
Not At Base	15.55	532	
Brooks			
At Base	16.05	22	0.5104
Not At Base	15.59	522	
Edwards			
At Base	16.06	48	0.2999
Not At Base	15.57	496	
Eglin			
At Base	17.24	70	<0.0001*
Not At Base	15.37	474	
Hanscom			
At Base	16.47	15	0.2879
Not At Base	15.59	529	
Hill			
At Base	16.42	67	0.0254*
Not At Base	15.50	477	
Kirtland			
At Base	15.80	30	0.7357
Not At Base	15.60	514	
Robins			
At Base	15.94	47	0.4603
Not At Base	15.58	497	
Rome			
At Base	21.33	3	0.0016*
Not At Base	15.58	541	
Tinker			
At Base	14.05	200	<0.0001*
Not At Base	16.51	344	
Wright-Patterson			
At Base	16.53	30	0.1000
Not At Base	15.56	514	

(Note: Significant differences are denoted with an asterisk)

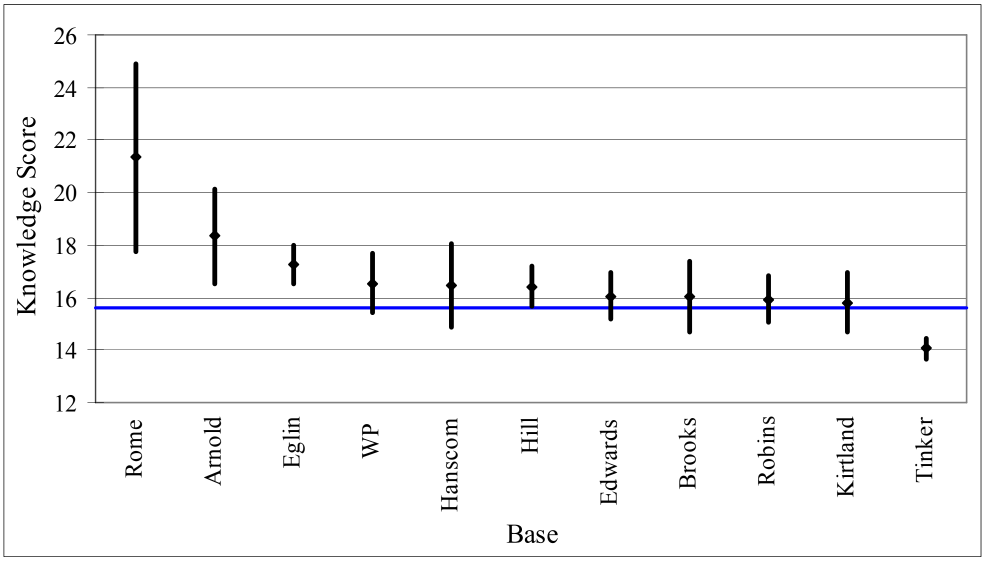

Figure 6. 95% Confidence Intervals of Mean Knowledge Scores by Base

Fifty-five pairwise comparison tests between the mean knowledge score of each base were also performed. Table 19 shows only the significant results from these tests. These comparisons show that significant differences exist between the mean knowledge score at Tinker and the mean at seven other bases. In each instance, the mean knowledge score at Tinker was considered lower than the mean at the other bases. Given these results, the scores for Tinker were examined in more detail and are discussed in Section 4.5. No other significant differences between means of other bases existed.

Table 19. ANOVA Pairwise Comparison by Base

Base with Highest Mean Score	Base with Lowest Mean Score	Sig
Arnold (18.33)	Tinker (14.06)	0.000
Edwards (16.06)	Tinker (14.06)	0.001
Eglin (17.24)	Tinker (14.06)	0.000
Hill (16.42)	Tinker (14.06)	0.000
Robins (15.93)	Tinker (14.06)	0.004
Rome (21.33)	Tinker (14.06)	0.001
Wright-Patterson (16.53)	Tinker (14.06)	0.001

(Note: Mean score for each base is in parentheses)

4.3.3. Time Working with Hazardous Waste

Table 20 shows the ANOVA results for the mean knowledge scores based on the amount of time personnel have worked with hazardous waste. The mean knowledge score for personnel who had between 10 and 20 years of experience working with hazardous waste was significantly higher than the mean of all other personnel. The mean knowledge score for personnel who had less than 10 years experience working with hazardous waste was significantly lower than the mean for all other personnel.

Six pairwise comparison tests of mean knowledge scores between each category were also performed. The only significant pairwise comparison shows that the mean knowledge score of personnel who had between 10 and 20 years of experience working with hazardous waste was significantly higher ($p = 0.0000$) than the mean knowledge score of personnel who had less than 10 years experience.

Table 20. ANOVA by Time Working with Hazardous Waste

Time Working with Hazardous Waste	Mean	Number	Sig
Less than 10 years			
Less than 10	15.27	310	0.0042*
All others	16.06	234	
Between 10 and 20 years			
Between 10 and 20	16.56	141	<0.0001*
All others	15.28	403	
Between 20 and 30 years			
Between 20 and 30	15.38	74	0.4978
All others	15.65	470	
30 or more years			
30 or more years	14.95	19	0.3527
All others	15.64	525	

(Note: Significant differences are denoted with an asterisk)

4.3.4. Time Working in Unit

Table 21 shows the ANOVA results for mean knowledge scores based on the amount of time personnel have worked in their current unit. The mean knowledge score for personnel who had between 10 and 20 years experience in their current unit was significantly higher than the mean of all other personnel. Additionally, six pairwise comparison tests of mean knowledge scores between each category were also performed. The only significant pairwise comparison shows that the mean knowledge score of personnel who had between 10 and 20 years of experience in their current unit was significantly higher ($p = 0.0025$) than the mean knowledge score of personnel who had between 20 and 30 years of experience.

Table 21. ANOVA by Time Working in Unit

Time Working in Unit	Mean	Number	Sig
Less than 10 years			
Less than 10	15.53	380	0.3935
All others	15.70	164	
Between 10 and 20 years			
Between 10 and 20	16.42	100	0.0045*
All others	15.43	444	
Between 20 and 30 years			
Between 20 and 30	14.86	51	0.0761
All others	15.69	493	
30 or more years			
30 or more years	14.54	13	0.2164
All others	15.64	531	

(Note: Significant differences are denoted with an asterisk)

4.3.5. Time Working at Base

Table 22 shows the ANOVA results for mean knowledge scores based on the amount of time personnel have worked at their current base. The mean knowledge score for personnel who had between 10 and 20 years experience at their current base was significantly higher than the mean of all other personnel. The mean knowledge score for personnel who had less than 10 years experience at their current base was significantly lower than the mean of all other personnel. Furthermore, six pairwise comparison tests of mean knowledge scores between each category were also performed. Pairwise comparison shows that the mean knowledge score of personnel who had between 10 and 20 years of experience at their current base was significantly higher (p = 0.000, 0.002, and 0.023, respectively) than the means of the following categories: personnel who had less than 10 years experience, between 20 and 30 years experience, and 30 or more years experience.

Table 22. ANOVA by Time Working at Base

Time Working at Base	Mean	Number	Sig
Less than 10 years			
Less than 10	15.30	281	0.0175*
All others	15.94	263	
Between 10 and 20 years			
Between 10 and 20	16.92	100	<0.0001*
All others	15.32	444	
Between 20 and 30 years			
Between 20 and 30	15.42	136	0.4161
All others	15.67	408	
30 or more years			
30 or more years	14.96	27	0.2756
All others	15.64	517	

(Note: Significant differences are denoted with an asterisk)

4.3.6. Primary Workplace

Table 23 shows the ANOVA results for mean knowledge scores of personnel based on their primary workplace. The mean knowledge score of personnel whose workplace was a TSDF or personnel who work as a UEC was significantly higher than the mean of all other personnel. The mean knowledge score of personnel whose workplace is a hazardous waste generator or initial accumulation point (IAP) was significantly lower than the mean of all other personnel.

Twenty-one pairwise comparison tests of mean knowledge scores between each primary workplace were performed. Table 24 shows the significant results of the pairwise comparison tests between each workplace. The comparisons show that the mean knowledge score of personnel whose workplace was a TSDF was significantly higher than the mean of personnel whose workplace is a hazardous waste generator, an IAP, a 180-day accumulation point (AP), or workplaces not listed. Similarly, the mean knowledge score of personnel who work as a UEC was also significantly higher than the mean of personnel in the same four categories (hazardous waste generator, an IAP, a 180-day AP, or workplaces not listed).

Table 23. ANOVA by Primary Workplace

Primary Workplace	Mean	Number	Sig
Generator			
Generator	15.05	112	0.0364*
Other Workplaces	15.75	432	
Initial Accumulation Point			
IAP	15.14	147	0.0332*
Other Workplaces	15.79	397	
90-day Accumulation Point			
90-day AP	16.12	16	0.5092
Other Workplaces	15.60	528	
180-day Accumulation Point			
180-day AP	13.00	5	0.0636
Other Workplaces	15.63	539	
Treatment, Storage, and Disposal Facility			
TSDF	18.27	11	0.0047*
Other Workplaces	15.56	533	
Unit Environmental Coordinator			
UEC	17.81	67	<0.0001*
Other Workplaces	15.30	477	
Workplaces Not Listed Above			
Unlisted Workplaces	15.40	186	0.2591
Other Workplaces	15.72	358	

(Note: Significant differences are denoted with an asterisk)

Table 24. ANOVA Pairwise Comparison, by Primary Workplace

Workplace with Highest Mean Score	Workplace with Lowest Mean Score	Sig
TSDF (18.27)	Generator (15.05)	0.017
TSDF (18.27)	IAP (15.14)	0.020
TSDF (18.27)	180-day AP (13.00)	0.027
TSDF (18.27)	Other (15.40)	0.048
UEC (17.81)	Generator (15.05)	0.000
UEC (17.81)	IAP (15.14)	0.000
UEC (17.81)	180-day AP (13.00)	0.014
UEC (17.81)	Other (15.40)	0.000

(Note: Mean score for each workplace is in parentheses)

4.3.7. Handling Characteristics

Table 25 shows the ANOVA results for the mean knowledge scores of personnel based on the type of hazardous waste activities in which they participated. The mean knowledge score of personnel who participated in hazardous waste activity six or more days a month was significantly higher than the mean for personnel who participated in the activity less than 6 days a month. In addition, thirty-six pairwise comparison tests of mean knowledge scores between each hazardous waste activity were performed. However, there were no significant differences between hazardous waste activities.

4.3.8. Training Course

Several ANOVA tests were performed on training courses, including comparison of courses command-wide and by base, comparison by the number of courses taken, and comparison by the knowledge gained from a course. This section includes results for all training course related tests. Also, note that a list of other base-level and professional continuing education courses that personnel have taken is included in Appendix I.

Table 25. ANOVA by Hazardous Waste Activity

Hazardous Waste Activity	Mean	Number	Sig
Container Selection			
6 or more days a month	16.06	158	0.0349*
Less than 6 days a month	15.43	386	
Waste Stream Profiling			
6 or more days a month	16.97	124	<0.0001*
Less than 6 days a month	15.21	420	
Characterization Sampling			
6 or more days a month	17.53	57	<0.0001*
Less than 6 days a month	15.39	487	
Marking and Labeling			
6 or more days a month	16.16	192	0.0029*
Less than 6 days a month	15.31	352	
Collection Site Inspections			
6 or more days a month	16.40	307	<0.0001*
Less than 6 days a month	14.59	237	
Packaging and Shipping			
6 or more days a month	16.26	107	0.0173*
Less than 6 days a month	15.45	437	
Waste Recycling			
6 or more days a month	16.64	161	<0.0001*
Less than 6 days a month	15.18	383	
Empty Container Management			
6 or more days a month	16.16	167	0.0067*
Less than 6 days a month	15.37	377	
Consolidation, Bulking, and Lab Packing			
6 or more days a month	16.81	54	0.0031*
Less than 6 days a month	15.48	490	

(Note: Significant differences are denoted with an asterisk)

4.3.8.1. Training Course, Comparison of Courses Command-wide

Table 26 shows the ANOVA results for the mean knowledge scores of personnel in the command who have attended a particular training course. The mean knowledge score of personnel who attended initial training, computer-based training, on-the-job training, other base-level training, AFIT's WENV 220 course, other AFIT-funded training, Hazardous Waste Operations and Emergency Response (HAZWOPER) training, or DOT training was significantly higher than the mean of personnel who did not attend the training. There were no training courses where the mean knowledge score of personnel who took the course was significantly lower than the mean of personnel who did not attend the course. Figure 7 graphically depicts the 95% confidence intervals of the mean knowledge score for each training course.

Table 27 shows the ANOVA results for the mean knowledge scores of personnel in the command who have attended a particular training course in the past two years. The mean knowledge score of personnel who, within the past two years, attended computer-based training or other base-level training was significantly higher than the mean of personnel who did not attend the training in the past two years. The mean knowledge score of personnel who, within the past two years, attended initial training, awareness training, or AFIT's WENV 521 course was significantly lower than the mean of personnel who did not attend the training in the past two years. Figure 8 graphically depicts the 95% confidence intervals of the mean knowledge score for each training course based on attendance within the past two years. Pairwise comparison tests were conducted between the mean knowledge scores of personnel who have taken a particular course at each base. For example, the mean knowledge score of personnel who completed initial training at Arnold was compared to the mean knowledge score of personnel who completed initial training at every other base. These comparisons did not include Rome due to a small number of responses. Table 28 shows only the significant results of these pairwise comparison tests. Note there were no significant differences between mean knowledge scores of personnel who took other base-level training courses at each base.

The comparisons show that the mean knowledge score of personnel who took initial training at Brooks, Edwards, Eglin, Hill, Robins, and Wright-Patterson were all higher than the mean knowledge score of personnel who took initial training at Tinker. The mean knowledge score of personnel who took annual training at Edwards, Eglin, Hill, Robins, and Wright-Patterson were all higher than the mean knowledge score of personnel who took annual training at Tinker. The mean knowledge score of personnel who took awareness training at Arnold, Brooks, Eglin, and Hill were all higher than the mean knowledge score of personnel who took awareness training at Tinker. The mean knowledge score of personnel who took computer training at Eglin and Robins were higher than the mean knowledge score of personnel who took computer training at Tinker. Lastly, the mean knowledge score of personnel who took on-the-job training at Edwards, Eglin, and Hill were all higher than the mean knowledge score of personnel who took on-the-job training at Tinker. Note that personnel at Tinker had the lower mean knowledge score for all pairwise comparisons. Given these results, the scores for Tinker were examined in more detail and are discussed in Section 4.5.

Table 26. ANOVA by Course

Attendance	Mean	Number	Sig
HW Initial (On-Base Classroom)			
Attended	15.83	446	0.0006*
Have Not Attended	14.62	98	
HW Annual (On-Base Classroom)			
Attended	15.78	388	0.0542
Have Not Attended	15.20	156	
HW Awareness (On-Base Classroom)			
Attended	15.52	324	0.4606
Have Not Attended	15.73	220	
Computer based: CD/DVD			
Attended	16.20	183	0.0018*
Have Not Attended	15.31	361	
On-the-job training			
Attended	15.85	357	0.0127*
Have Not Attended	15.14	187	
Other Base-level Training			
Attended	16.86	473	0.0003*
Have Not Attended	15.42	71	
WENV 521			
Attended	15.66	88	0.8745
Have Not Attended	15.60	456	
WENV 220			
Attended	16.57	97	0.0010*
Have Not Attended	15.40	447	
WESS 010			
Attended	15.17	40	0.3662
Have Not Attended	15.65	504	
AFIT-funded			
Attended	16.80	55	0.0032*
Have Not Attended	15.47	489	
Web University			
Attended	15.50	58	0.7790
Have Not Attended	15.62	486	
HAZWOPER			
Attended	17.08	151	<0.0001*
Have Not Attended	15.04	393	
DOT			
Attended	17.38	78	<0.0001*
Have Not Attended	15.31	466	
Other PCE			
Attended	16.29	38	0.1700
Have Not Attended	15.56	506	

(Note: Significant differences are denoted with an asterisk)

Table 27. ANOVA by Course (Past 2 Years)

Attendance Past 2 Years	Mean	Number	Sig
HW Initial (On-Base Classroom)			
Attended	14.99	331	0.0002*
Have Not Attended	16.01	213	
HW Annual (On-Base Classroom)			
Attended	15.66	359	0.6088
Have Not Attended	15.51	185	
HW Awareness (On-Base Classroom)			
Attended	15.19	266	0.0022*
Have Not Attended	16.01	278	
Computer based: CD/DVD			
Attended	16.23	154	0.0041*
Have Not Attended	15.37	390	
On-the-job training			
Attended	15.77	290	0.1831
Have Not Attended	15.41	254	
Other Base-level Training			
Attended	16.47	64	0.0206*
Have Not Attended	15.50	480	
WENV 521			
Attended	14.54	59	0.0059*
Have Not Attended	15.74	485	
WENV 220			
Attended	15.35	54	0.5273
Have Not Attended	15.64	490	
WESS 010			
Attended	14.75	28	0.1395
Have Not Attended	15.66	516	
AFIT-funded			
Attended	15.81	37	0.6899
Have Not Attended	15.81	507	
Web University			
Attended	15.13	46	0.2825
Have Not Attended	15.65	498	
HAZWOPER			
Attended	16.00	66	0.2859
Have Not Attended	15.56	478	
DOT			
Attended	16.41	37	0.1132
Have Not Attended	15.55	507	
Other PCE			
Attended	15.22	23	0.3703
Have Not Attended	15.63	521	

(Note: Significant differences are denoted with an asterisk)

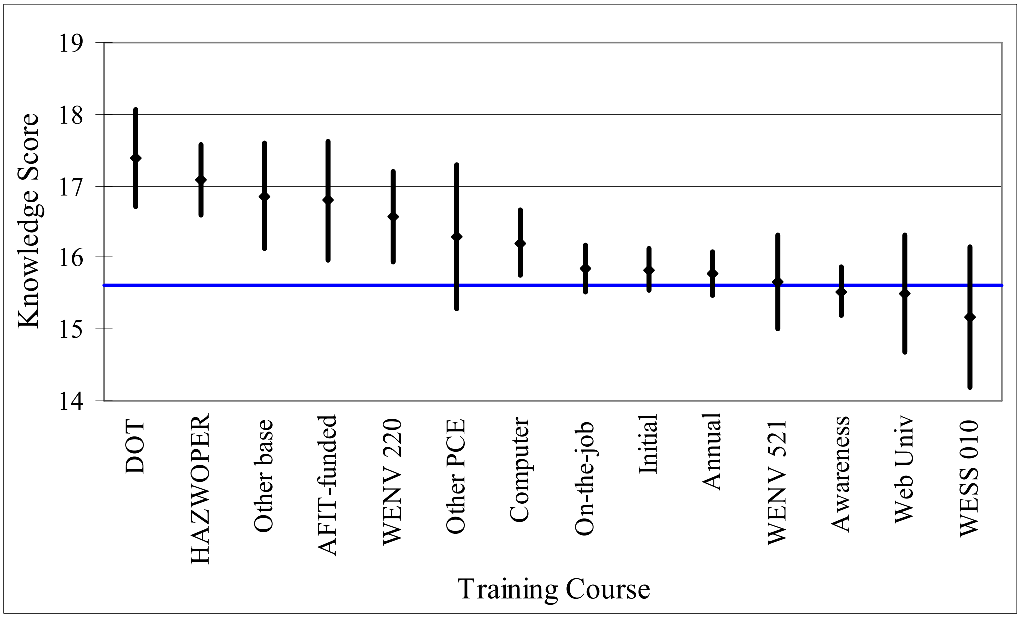

Figure 7. 95% Confidence Intervals for Mean Knowledge Scores by Training Course

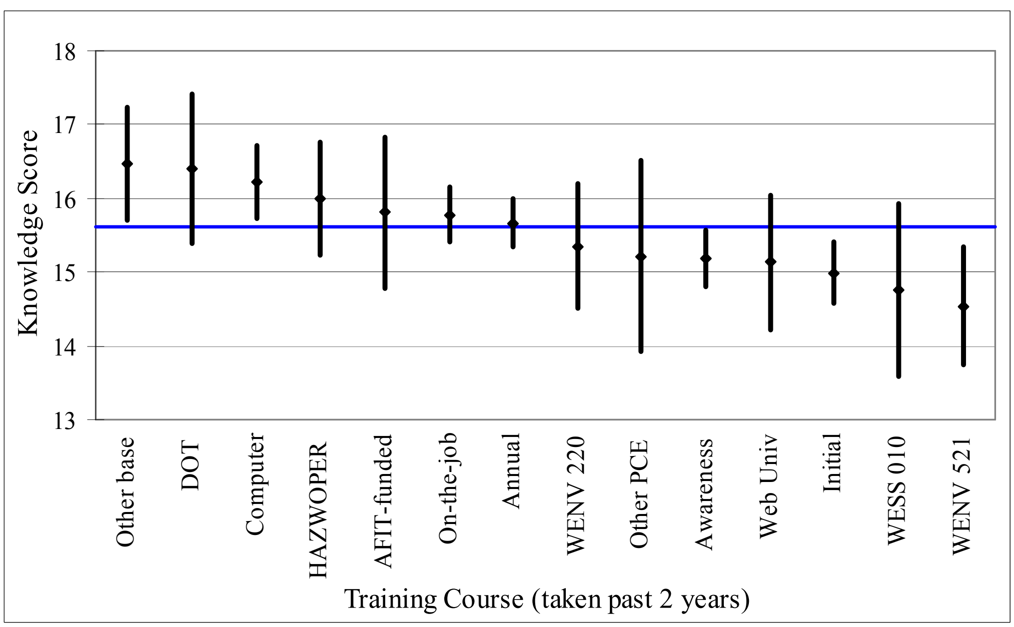

Figure 8. 95% Confidence Intervals for Mean Knowledge Scores by Training Course (Past 2 Years)

Table 28. ANOVA Pairwise Comparison by Course

Base with Highest Mean Score	Base with Lowest Mean Score	Sig
Initial Training		
Brooks (16.87)	Tinker (14.34)	0.039
Edwards (16.35)	Tinker (14.34)	0.002
Eglin (17.25)	Tinker (14.34)	0.000
Hill (16.65)	Tinker (14.34)	0.000
Robins (16.61)	Tinker (14.34)	0.001
Wright-Patterson (16.37)	Tinker (14.34)	0.023
Annual Training		
Edwards (16.46)	Tinker (14.26)	0.000
Eglin (17.73)	Tinker (14.26)	0.000
Hill (16.76)	Tinker (14.26)	0.000
Robins (16.20)	Tinker (14.26)	0.022
Wright-Patterson (16.24)	Tinker (14.26)	0.043
Awareness Training		
Arnold (18.17)	Tinker (14.19)	0.028
Brooks (17.27)	Tinker (14.19)	0.020
Eglin (17.58)	Tinker (14.19)	0.000
Hill (16.14)	Tinker (14.19)	0.009
Computer Training		
Eglin (17.14)	Tinker (14.63)	0.005
Robins (17.43)	Tinker (14.63)	0.009
On-the-job Training		
Edwards (16.29)	Tinker (14.40)	0.028
Eglin (17.43)	Tinker (14.40)	0.000
Hill (16.71)	Tinker (14.40)	0.000

(Note: Mean score for each base training is in parentheses)

4.3.8.2. Training Course, Comparison of Courses by Base

Table 29 shows the ANOVA results for the mean knowledge scores of personnel that have taken a training course at a base compared to those who have not taken the training course at a base. For example, the mean knowledge score of personnel who took initial training at Brooks was compared to the mean of personnel at Brooks who did not take initial training. Of the courses that had a significant difference, Wright-Patterson awareness training was the only course in which personnel who took the course had a significantly lower mean than personnel who did not take the course. In each of the remaining courses, those who took a course had a significantly higher mean than those who did not take the course. Those courses are initial and awareness training at Brooks, annual training at Edwards, annual and other-base level training at Eglin, initial training at Hill, initial and computer-based training at Robins, and initial, annual, computer-based, on-the-job, and other base-level training at Tinker.

4.3.8.3. Training Course, Number of Courses Taken

Table 30 shows the ANOVA results for the mean knowledge scores of personnel based on the number of training courses they have taken. The mean knowledge score of personnel who have taken 4 to 6 training courses, or 7 to 9 training courses, was significantly higher than personnel who have not taken the same number of training courses. The mean knowledge score of personnel who have taken 3 or less training courses was significantly lower than the knowledge score of personnel who have taken 4 or more training courses. Pairwise comparison tests were not conducted on these categories.

Table 29. ANOVA by Training Course at Each Base

Attendance	Mean	Number	Sig
Brooks Initial Training			
Have Attended	16.87	15	0.0343*
Have Not Attended	14.29	7	
Brooks Awareness Training			
Have Attended	17.27	11	0.0302*
Have Not Attended	14.82	11	
Edwards Annual Training			
Have Attended	16.46	41	0.0409*
Have Not Attended	13.71	7	
Eglin Annual Training			
Have Attended	17.73	44	0.0365*
Have Not Attended	16.42	26	
Eglin Other Base-Level Training			
Have Attended	19.27	11	0.0031*
Have Not Attended	16.86	59	
Hill Initial Training			
Have Attended	16.65	63	0.0205*
Have Not Attended	12.75	4	
Robins Initial Training			
Have Attended	16.61	36	0.0234*
Have Not Attended	13.73	11	
Robins Computer-Based Training			
Have Attended	17.43	23	0.0058*
Have Not Attended	14.50	24	
Tinker Initial Training			
Have Attended	14.34	158	0.0014*
Have Not Attended	13.00	42	
Tinker Annual Training			
Have Attended	14.26	148	0.0401*
Have Not Attended	13.46	52	
Tinker Computer Based Training			
Have Attended	14.63	56	0.00380*
Have Not Attended	13.83	144	
Tinker On-the-job Training			
Have Attended	14.40	122	0.0112*
Have Not Attended	13.51	78	
Tinker Other Base-Level Training			
Have Attended	15.40	20	0.0087*
Have Not Attended	13.91	180	
Wright-Patterson Awareness Training			
Have Attended	15.53	15	0.0402*
Have Not Attended	17.53	15	

(Note: Significant differences are denoted with an asterisk)

Table 30. ANOVA by Number of Training Courses Taken

Attendance	Mean	Number	Sig
Have Taken 3 or Less Courses			
0-3 Courses	14.80	202	<0.0001*
All Others	16.09	342	
Have Taken 4-6 Courses			
4-6 Courses	15.93	254	0.0296*
All Others	15.33	290	
Have Taken 7-9 Courses			
7-9 Courses	17.08	62	<0.0001*
All Others	15.42	482	
Have Taken 10 or More Courses			
10+ Courses	15.35	26	0.6629
All Others	15.62	518	

(Note: Significant differences are denoted with an asterisk)

4.3.8.4. Training Course, Knowledge Gained

Table 31 shows the amount of knowledge that personnel thought they received from a course, which could be scored in 4 categories: none, very little, some, and a lot. Overall, the average score was 3.13, which meant that personnel thought they received at least some knowledge from each course. Personnel thought they received the most knowledge from (scores of 3.32, 3.32, and 3.39, respectively). Personnel thought they received the least knowledge from AFIT's WENV 521 course and WENV 010 course (2.97 and 2.80, respectively). Furthermore, the 4 courses with the highest percent (42% and higher) of responses for gaining 'a lot' of knowledge were DOT training, other base-level training, HAZWOPER training, and other professional continuing education training. Lastly, DOT training was the only course with more responses for 'a lot' of knowledge gained than 'some' knowledge gained. These statistics suggest that personnel feel they obtain more knowledge from certain courses.

Table 31. Knowledge Gained by Course

Course	Knowledge Responses	None (1)	Very Little (2)	Some (3)	A lot (4)	Average Score
Initial	402	5	43	239	115	3.15
Annual	343	3	35	211	94	3.15
Awareness	281	5	25	191	60	3.09
Computer-based	161	4	19	98	40	3.08
On-the-job	317	2	15	186	114	3.30
Other Base-level	57	2	3	27	25	3.32
WENV 521	70	5	6	45	14	2.97
WENV 220	75	2	4	49	20	3.16
WENV 010	27	3	1	21	2	2.80
AFIT-funded	38	2	2	22	12	3.16
Web University	40	2	2	24	12	3.15
HAZWOPER	113	3	6	56	48	3.32
DOT	57	4	7	20	26	3.19
Other PCE	31	1	0	16	14	3.39

4.3.9. Employment Status

Table 32 shows the ANOVA results for the mean knowledge scores of personnel based on employment status. The mean knowledge score for contractors was significantly higher than the mean of non-contractors. The mean knowledge score for military personnel was significantly lower than the mean of non-military personnel. Also, pairwise comparison tests show that the mean knowledge score of contractors was significantly higher than the mean of military personnel and civilian personnel (0.004 and 0.043, respectively).

Table 32. ANOVA by Employment Status

Employment Status	Mean	Number	Sig
Military			
Military	14.86	73	0.0299*
Civilians and Contractors	15.73	471	
Civilians			
Civilians	15.56	372	0.5794
Military and Contractors	15.72	172	
Contractors			
Contractors	16.53	93	0.0018*
Military and Civilians	15.41	451	

(Note: Significant differences are denoted with an asterisk)

4.3.10. Rank and Grade

Eleven groups were formed for the various ranks and grades of personnel. Table 33 shows the ANOVA results for the mean knowledge scores of personnel based on their rank or grade group. Additionally, Appendix J shows ungrouped comparisons of mean knowledge scores for all rank and grades. Pairwise comparison tests were not performed for each group.

The mean knowledge score for the group of personnel with a grade of GS-11 through GS-15 was significantly higher than the mean of personnel of all other groups of ranks and grades. The mean knowledge score for groups of personnel with a grade of GS-2 through GS-6, WG-5 through WG-10, WG-11 through WG-15, and WS-11 through WS-16 was significantly lower than the mean of personnel of all other groups of ranks and grades.

Table 33. ANOVA by Rank and Grade

Rank or Grade Group	Mean	Number	Sig
E-4 through E-5			
E-4 through E-5	14.58	31	0.0618
All Others	15.67	513	
E-6 through E-9			
E-6 through E-9	15.45	38	0.7422
All Others	15.62	506	
O-1 through O-4			
O-1 through O-4	14.00	9	0.1235
All Others	15.64	535	
GS-2 through GS-6			
GS-2 through GS-6	11.14	7	0.0002*
All Others	15.67	537	
GS-7 through GS-10			
GS-7 through GS-10	16.09	32	0.3731
All Others	15.58	512	
GS-11 through GS-15			
GS-11 through GS-15	17.69	113	<0.0001*
All Others	15.07	431	
WG-5 through WG-10			
WG-5 through WG-10	14.24	115	<0.0001*
All Others	15.98	429	
WG-11 through WG-15			
WG-11 through WG-15	13.97	39	0.0008*
All Others	15.74	505	
WL-9 through WL-11			
WL-9 through WL-11	14.00	6	0.2100
All Others	15.63	538	
WS-6 through WS-10			
WS-6 through WS-10	14.92	13	0.4282
All Others	15.63	531	
WS-11 through WS-16			
WS-11 through WS-16	14.00	16	0.0386*
All Others	15.66	528	

(Note: Significant differences are denoted with an asterisk)

4.3.11. Air Force Specialty Code and Occupational Series

Table 34 shows ANOVA results for mean knowledge scores of personnel for Air Force Specialty Code (AFSC) and occupational series classifications. This table only includes the AFSC's and occupational series' whose mean knowledge score was significantly different from all other means. Appendix K shows the mean knowledge score for all AFSCs and occupational series. Pairwise comparison tests were not performed for each AFSC and occupational series.

The mean knowledge score for personnel with an occupational series of miscellaneous occupations, engineering & architecture, and physical sciences was significantly higher than the mean of personnel of all other AFSCs and occupational series. The mean knowledge score for personnel with an AFSC of fuels or occupational series of investigators, metal work, fluid systems maintenance, engine overhaul, or aircraft overhaul was significantly lower than the mean of personnel of all other AFSCs and occupational series.

Table 34. ANOVA by AFSC and Occupational Series

AFSC or Occupational Series	Mean	Number	Sig
0000-0099 Miscellaneous Occupations			
Miscellaneous Occupations	19.03	30	<0.0001*
All Others	15.41	514	
0800-0899 Engineering & Architecture			
Engineering & Architecture	17.91	34	<0.0001*
All Others	15.46	510	
1300-1399 Physical Sciences			
Physical Sciences	17.81	26	0.0003*
All Others	15.50	518	
1800-1899 Investigators			
Investigators	8.50	2	0.0014*
All Others	15.64	542	
3800-3899 Metal Work			
Metal Work	12.56	16	<0.0001*
All Others	15.70	528	
8200-8299 Fluid Systems Maintenance			
Fluid Systems Maintenance	13.80	15	0.0244*
All Others	15.66	529	
8600-8699 Engine Overhaul			
Engine Overhaul	14.00	26	0.0077*
All Others	15.69	518	
8800-8899 Aircraft Overhaul			
Aircraft Overhaul	12.86	7	0.0203*
All Others	15.65	537	
2F Fuels			
Fuels	8.00	1	0.0159*
All Others	15.62	543	

(Note: Significant differences are denoted with an asterisk)

4.3.12. Education Level

Table 35 and Table 36 show the ANOVA results for the mean knowledge scores of personnel based on education level. Table 35 compares mean knowledge scores of personnel based on education level with all personnel of other education levels. Table 36 compares mean knowledge scores of personnel those who have reached a certain education level with those who have not.

The mean knowledge score for personnel whose highest education level is a bachelor's or graduate degree was significantly higher than the mean of personnel whose highest education level is not that degree. The mean knowledge score for personnel whose highest education level is a high school diploma was significantly lower than the mean of personnel whose highest education level is not a high school diploma.

Additionally, the mean knowledge score for personnel whose highest education level is at least a high school degree is significantly higher than the mean of personnel whose highest level of education is lower. The same can be said for the mean knowledge score for personnel whose education level is at least some college, is at least an associate's degree, or is at least a bachelor's degree.

Table 35. ANOVA by Education Level

Education Level	Mean	Number	Sig
GED			
GED	15.16	12	0.6236
All Others	15.62	532	
High School			
High School	13.70	98	<0.0001*
All Others	16.03	446	
Some College			
Some College	15.39	206	<0.2015
All Others	15.74	338	
Associate's Degree			
Associate's Degree	15.80	74	<0.5846
All Others	15.58	470	
Bachelor's Degree			
Bachelor's Degree	16.89	100	<0.0001*
All Others	15.32	444	
Graduate Degree			
Graduate Degree	17.90	39	<0.0001*
All Others	15.43	505	
Doctorate Degree			
Doctorate Degree	17.18	11	0.0959
All Others	15.58	533	

(Note: Significant differences are denoted with an asterisk)

Table 36. ANOVA by Education Level (Having at least a certain degree)

Education Level	Mean	Number	Sig
High School			
No High School	14.69	16	0.2364
At least High School	15.64	528	
Some College			
No college	13.83	114	<0.0001*
At least some college or more	16.08	430	
Associate's Degree			
No Associate's Degree	14.83	224	<0.0001*
At least Associate's Degree	16.72	320	
Bachelor's Degree			
No Bachelor Degree	15.02	394	<0.0001*
At least Bachelor's Degree	17.17	150	
Master's Degree			
No Master's Degree	15.40	494	<0.0001*
At least Master's Degree	17.74	50	
Doctorate Degree			
No Doctorate Degree	15.58	533	0.0959
Doctorate Degree	17.18	11	

(Note: Significant differences are denoted with an asterisk)

Twenty-one pairwise comparison tests between the mean knowledge score of each base were also performed. Table 37 shows only the significant results of pairwise comparison tests between each education level. The comparisons show that the mean knowledge score of personnel whose highest education level is a bachelor's degree was significantly higher than the mean of personnel whose highest education level is some college. Also, the comparisons show that the mean knowledge score of personnel whose highest education level is a master's degree was significantly higher than the mean of personnel whose highest education level is some college or an associate's degree. Lastly, the comparisons show that the mean knowledge score of personnel whose highest education level is a high school diploma was significantly lower than the mean of personnel whose highest education level is some college or any college degree.

Table 37. ANOVA Pairwise Comparison by Education Level

Education Level with Highest Mean Score	Education Level with Lowest Mean Score	Sig
Some College (15.39)	High School (13.69)	0.000
Associate's Degree (15.80)	High School (13.69)	0.000
Bachelor's Degree (16.89)	High School (13.69)	0.000
Bachelor's Degree (16.89)	Some College (15.39)	0.001
Master's Degree (17.90)	High School (13.69)	0.000
Master's Degree (17.90)	Some College (15.39)	0.000
Master's Degree (17.90)	Associate's Degree (15.80)	0.009
Doctorate Degree (17.18)	High School (13.69)	0.006

(Note: Mean score for each education level is in parentheses)

ANOVA results based on education level show that having a higher education level signifies greater knowledge of hazardous waste principles and concepts. Note that those with only a high school degree had a significantly lower mean knowledge score than 5 of the 6 other education levels and those with only some college had a significantly lower mean knowledge score than 2 of the 6 other education levels.

4.4. Attitudinal Questions

This section includes results for the attitudinal section of the survey. Table 38 shows the average score by question and the number of answers for each Likert-scale answer. The mean scores for each question ranges from 3.6 for question 1 to 4.2 for questions 5, 6, and 7. These results indicate, with all scores near 4.0 (agree), that the personnel in AFMC who work with hazardous waste understand basic concepts and can apply them, receive adequate training, know where to go for help with hazardous waste issues, and can effectively mitigate hazardous waste problems. Additionally, these results indicate that the Air Force and each base in AFMC do a good job of promoting proper care of hazardous waste.

Table 38. Attitudinal Statistics by Question

Question	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Mean Score	Standard Deviation
1	18	46	3	235	30	3.6	0.85
2	11	28	4	338	63	3.9	0.80
3	23	55	5	261	61	3.7	0.97
4	18	30	6	308	67	3.9	0.88
5	14	14	7	271	204	4.2	0.87
6	14	19	8	267	170	4.2	0.91
7	11	13	9	296	141	4.2	0.83
8	13	28	10	295	102	4.0	0.88

(Note: The questions are in section 2 of the survey in Appendix B)

ANOVA tests were performed to compare the mean score for each question by base, with the results being shown in Table 39. The mean scores range from 3.1 to 4.7. Means with a significant difference are indicated by an asterisk in the table. Note that normality tests conducted for each question concluded that the data is approximately normal. Furthermore, it has been assumed that the population variances are equal for these ANOVA tests. Only the questions with significant difference are discussed in the following sections.

Table 39. Attitudinal Statistics by Question and Base

Question	Arnold	Brooks	Edwards	Eglin	Hanscom	Hill	Kirtland	Robins	Rome	Tinker	Wright-Patterson	Total
1	3.3	3.5	3.5	3.5	3.5	3.4	3.5	3.4	3.7	3.3*	3.6	3.6
2	4.0	3.8	3.9	3.9	4.1	3.9	3.9	3.7	4.0	3.6*	3.9	3.9
3	3.4	3.8	3.9*	3.8*	3.9	3.6	3.7	3.1*	4.3	3.3*	3.8	3.7
4	3.5	3.8	3.8	4.0*	3.8	3.7	3.9	3.6	3.7	3.5*	3.8	3.9
5	4.4	4.4	4.4*	4.3	4.3	4.4*	4.3	4.2	4.7	3.9*	4.3	4.2
6	4.6*	4.3	4.2	4.2	4.2	4.3*	4.1	3.9	4.3	3.7*	4.1	4.2
7	4.2	4.1	4.1	4.2*	3.9	4.1	3.9	3.9	4.3	3.8*	4.1	4.2
8	4.0	4.0	4.0	4.1*	4.1	3.9	4.0	3.9	3.7	3.5*	3.9	4.0

(Note: Scores that are considered significantly different are denoted with an asterisk)

Arnold. The mean score for question 6 was significantly higher ($p = 0.0321$) than the mean score of all others for that question. Therefore, personnel at Arnold had a higher confidence that their base was doing a good job promoting proper care of hazardous waste compared to all other personnel.

Edwards. The mean scores for questions 3 and 5 were each significantly higher ($p = 0.0045$ and 0.0261) than the mean score of all others for those respective questions. Therefore, personnel at Edwards had a higher confidence that they are receiving adequate training and that they know where to go for help with hazardous waste issues compared to all other personnel.

Eglin. The mean scores for questions 3, 4, 7, and 8 were each significantly higher ($p = 0.0059$, 0.0009, 0.0128, and 0.0062) than the mean score of all others for those respective questions. Therefore, personnel at Eglin had a higher confidence that they are receiving adequate training; that they can effectively apply hazardous waste concepts, rules, and regulations to real world problems; that the Air Force does a good job at promoting proper care of hazardous waste; and that they have enough guidance to effectively mitigate hazardous waste problems compared to all other personnel.

Hill. The mean scores for questions 5 and 6 were each significantly higher (p = 0.0421 and 0.0038) than the mean score of all others for those respective questions. Therefore, personnel at Hill had a higher confidence that they know where to go for help with hazardous waste issues and that their base does a good job at promoting proper care of hazardous waste compared to all other personnel.

Robins. The mean score for question 3 was significantly lower ($p = 0.0059$) than the mean score of all others for that question. Therefore, personnel at Robins had a lower confidence that they are receiving adequate training compared to all other personnel.

Tinker. The mean score was significantly lower for all 8 questions. Therefore, personnel at Tinker had a lower confidence that they answered questions from section 1 of the survey correctly; that they understood basic hazardous waste concepts, rules, and regulations; that they are receiving adequate training; that they can effectively apply hazardous waste concepts, rules, and regulations to real world problems; that they know where to go for help with hazardous waste issues; that their base does a good job at promoting proper care of hazardous waste; that the Air Force does a good job at promoting proper care of hazardous waste; and that they have enough guidance to effectively mitigate hazardous waste problems compared to all other personnel. Given these results, the scores for Tinker were examined in more detail and are discussed in Section 4.5.

4.5. Additional Analysis

Results from the previous sections indicate significantly lower scores from personnel at Tinker. First, ANOVA results showed that the mean knowledge score of personnel at Tinker was considered significantly lower than the mean knowledge score of all other personnel. In addition, pairwise comparison tests show the mean knowledge score of personnel at Tinker was considered significantly lower than the mean knowledge score of personnel at seven other bases (Arnold, Edwards, Eglin, Hill, Robins, Rome, and Wright-Patterson). Also, other pairwise comparison tests show the mean knowledge score of personnel who took specific base-level courses at Tinker were considered significantly lower than the mean knowledge score of personnel who took that same course at other bases (6 other bases for initial training, 5 other bases for annual training, 4 other bases for awareness training, 2 other bases for computer-based training, and 3 other bases for on-the-job training). Lastly, personnel at Tinker scored significantly lower on all 8 attitudinal questions.

Due to these results, further research was conducted to determine if there were differences in the composition of survey respondents at Tinker versus the rest of the command. The composition of respondents at Tinker was 5 percent military, 84 percent civilians, and 10 percent contractors. The composition of all respondents not at Tinker was 18 percent military, 59 percent civilians, and 21 percent contractors. This shows that Tinker had a greater percentage of civilians participating in the survey than the rest of command.

Further research was also conducted to determine if there were differences in the grade levels of civilians from Tinker participating in the survey versus the rest of the population. Results show that 39 percent of Tinker's respondents were civilians in the grade of WG-5 through WG-10, compared to 11 percent of the respondents not at Tinker. Results also show that 15 percent of Tinker's respondents were civilians in the grade of GS-11 through GS-15, compared to 24 percent of those not at Tinker. This shows that Tinker had a greater percentage of respondents in the grade of WG-5 through WG-10 and a smaller percentage of civilians in the grade of GS-11 through GS-15. As discussed earlier, civilians in the grade of WG-5 through WG-10 had significantly lower mean knowledge scores than all other personnel and civilians in the grade of GS-11 through GS-15 had significantly higher mean knowledge scores than all other personnel. This partially explains the low mean knowledge scores at Tinker.

ANOVA tests were conducted between the mean knowledge scores of personnel at Tinker with personnel not at Tinker in grades WG-5 through WG-10 and GS-11 through GS-15. The results show that the mean knowledge score of personnel in grades WG-5 through WG-10 at Tinker was significantly lower (<0.0001) than personnel in grades WG-5 through WG-10 not at Tinker. Additionally, the mean knowledge score of personnel in grades GS-11 through GS-15 at Tinker was significantly lower (0.0046) than personnel in grades GS-11 through GS-15 not at Tinker. This shows that even though Tinker has a different composition of personnel than the rest of the command, including more personnel with grades of WG-5 through WG-10 and fewer personnel with grades GS-11 through GS-15, personnel at Tinker in those grades still have significantly lower scores than the rest of the command. With that said, this additional research shows that the low results from Tinker are not caused by the difference in composition of Tinker's personnel compared to the rest of the command.

4.6. Additional Comments

Survey respondents were given the opportunity to include comments about their opinions of hazardous training in the Air Force. Appendix L contains a list of the comments received. Each comment includes the respondent's base and employment status. These comments ranged from recommendations for hazardous waste training to remarks about the good things the Air Force is already doing.

5. Conclusions

The objective of this study was to develop an evaluation methodology for hazardous waste training programs. The hazardous waste training program in Air Force Materiel Command (AFMC) was used to conduct this study. Four research questions were asked to direct this research. These questions will be reviewed one by one to explain the effectiveness of the hazardous waste training program in AFMC. This chapter also explains limitations of this research and concludes with recommendations for future research.

5.1. Research Questions

5.1.1. Is there a correlation between characteristics of the hazardous waste training provided and the number of External Compliance Assessment and Management Program (ECAMP) findings received?

There were significant correlations between ECAMP findings and training courses taken. Training courses that correlated with increased ECAMP findings were initial training, awareness training, on-the-job training, the Air Force Institute of Technology's WENV 521 course, and other AFIT-funded training. The only non-training related characteristic that correlated with increased ECAMP findings was having a TTU (Transportable Treatment Unit) permit. No training courses or non-training course related characteristics correlated with reduced ECAMP findings. The training courses that are correlated with increased ECAMP findings have a negative outcome on a base hazardous waste training program.

5.1.2. Do personnel working with hazardous waste understand the principles and concepts of handling hazardous waste appropriately?

The level to which personnel understand the principles and concepts of handling hazardous waste varies greatly across the command. There are some principles for which the vast majority of personnel have a good understanding, i.e., seven questions that were answered correctly by at least 90% of personnel. However, there are some principles for which the vast majority of personnel do not have a good understanding, i.e., nine questions that were answered incorrectly by more than 50% of personnel.

There are many personnel demographics within the AFMC hazardous waste program that had a better than average understanding of hazardous waste principles and concepts. Personnel from Arnold, Eglin, Hill, and Rome had a better than average understanding of hazardous waste principles and concepts. Personnel with between 10 and 20 years of experience working with hazardous waste, working in their unit, and working at their current base had a better than average understanding of hazardous waste principles and concepts. Personnel who work in a Treatment, Storage, and Disposal Facility (TSDF) or personnel who work as a Unit Environmental Coordinator (UEC) had a better than average understanding of hazardous waste principles and concepts. Personnel who participate in a specific hazardous waste activity 6 or more days a month had a better than average understanding of hazardous waste principles and concepts. Personnel that work as a contractor; are in the grade of GS-11 through GS-15; or have an occupational series of miscellaneous occupations, engineering & architecture, or physical science; had a better than average understanding of hazardous waste principles and concepts. Lastly, personnel with a bachelor or master's degree had a better than average understanding of hazardous waste principles and concepts.

There are many personnel demographics that had a lesser than average understanding of hazardous waste principles and concepts. Personnel from Tinker demonstrated a lower than average understanding of hazardous waste principles and concepts. Personnel with less than 10 years of experience working with hazardous waste had a lower than average understanding of hazardous waste principles and concepts. Personnel whose workplace is a hazardous waste generator or initial accumulation point (IAP) had a lower than average understanding of hazardous waste principles and concepts. Personnel that are military; are in the grade of GS-2 through GS-6, WG-5 through 15, and WS-11 through WS-16; or have an AFSC or occupational series of investigators, metal work, fluid systems maintenance, engine overhaul, aircraft overhaul, or fuels; had a lower than average understanding of hazardous waste principles and concepts. Lastly, personnel with a high school diploma had a lower than average understanding of hazardous waste principles and concepts.

5.1.3. Is current training effective at instilling hazardous waste knowledge? Which hazardous waste training is more effective? Which needs improvement?

The effectiveness of training varies by base and course. Some courses are more effective than others. Given the results from the ANOVA and regression tests, the most effective courses were other base-level training, Department of Transportation (DOT) training, computer-based training, AFIT's WENV 220 course, and Hazardous Waste Operations and Emergency Response Training (HAZWOPER) training. The least effective courses were awareness training, initial training, annual training, on-the-job training, and the past 2 years of AFIT's WENV 521 course. Furthermore, specific courses at each base can be considered the most and least effective at that base.

5.1.4. How do personnel feel about hazardous waste training they receive?

The overall consensus is that personnel in AFMC feel that they have received adequate training. Over 59% of personnel (322 of 544 responses) believe they have received adequate training. However, 16.2% of personnel (88 of the 544 responses) believe they are not receiving adequate hazardous waste training. Personnel at Robins and Tinker had the lowest confidence that they were receiving adequate training and personnel at Edwards and Eglin had the highest. Outside of training, in general, personnel in AFMC believe they are able to effectively apply hazardous waste concepts and believe the Air Force and each base promote proper care of hazardous waste.

5.2. Summary

The results show that there are certain training courses that have positive and negative effects on a hazardous waste training program. Overall though, these results indicate that the more training courses personnel take, the more likely they will have a better understanding of hazardous waste principles. Particular courses stood out as well, both positively and negatively. These courses should be reviewed to find out what is and is not working. These findings should then be shared across the command to improve the entire program.

Though the general AFMC population in the hazardous waste program is knowledgeable of hazardous waste principles, there are certain groups of personnel that are lagging behind. To improve on this, it is recommended to determine if these subsections of personnel are being offered the necessary training. Also, it might be necessary to determine why these personnel have lower scores and perhaps adjust training courses to cater to their needs, ensuring they are learning the appropriate principles and concepts. Furthermore, attention should be given to the particular principles with which a majority of personnel are unfamiliar.

5.3. Limitations

There were several limitations to this study. First, the process used to distribute the survey allowed for several levels of the hazardous waste hierarchy to use discretion on whether they should send the survey out or not. It is very possible that many people in the AFMC hazardous waste program were not given the opportunity to complete the survey. Along those same lines, there is no concrete evidence that the population who took the survey was representative of the actual population. For example, Robins has the largest hazardous waste training program in AFMC with over 2000 personnel; however, they had a very small response rate (2.0%). Fortunately, an overall response of 544 personnel (8.8%) was sufficient, allowing for significant conclusions.

Another limitation could be found in the ECAMP data. While an external or internal ECAMP is required by every base, 5 of the 11 bases did not have annual ECAMPs over the past 5 years and 2 of those bases only had 1 ECAMP in the past 5 years. Additionally, several categories of base hazardous waste characteristics are from Fiscal Year 2001; more recent data would have been ideal.

5.4. Future Research

There are several opportunities for future research with this topic. First, this study can be expanded to test knowledge of personnel before and after attending a training course. This would allow researchers to determine the effectiveness of a particular course and help assess whether a course meets certain hazardous waste training objectives.

The 3rd and 4th level of Kirkpatrick's (1998) four-level evaluation model can also be better applied to a hazardous waste training program. The 3rd level measures change in the behavior of an individual and the 4th level measures on-the-job results such as increased production of an individual. This research would be better suited as a base-level study and could identify the specific courses at a base that are most effective in improving behavior and results.

The application of return of investment to the evaluation methodology for hazardous waste training programs is another idea for future research. This study did not consider the financial aspects of the training conducted. Incorporating return of investment to hazardous waste training programs will identify the training programs that are the most and least cost effective. Return on investment can also address the hazardous waste training program as a whole, and not just training.

This methodology can also be applied to other disciplines within the Air Force, environmental and non-environmental. For example, the effectiveness of environmental training programs such as pollution prevention or water quality could benefit from this methodology. Also, non-environmental areas such as contracting or aircraft maintenance could benefit from this methodology.

Appendix A. External ECAMP Findings, Fiscal Year 2001-2005

Arnold Air Force Base (AFB)

Date	Rating	Title	Finding ID Code
08-Apr-02	Minor	Hazardous Waste Drums Lack Hazard Class Labels -- Basewide	HW12
09-Apr-02	Major	No Precious Metal Recovery Records -- Bldg 430	HW1
09-Apr-02	Minor	Site-Specific Spill Plans -- Bldgs 464, 673, 768, and 1412	HW9
10-Apr-02	Major	Hazardous Waste Tanks Not Labeled -- SWMUs #s 1, 8, and 10	HW2
28-Feb-05	Minor	IAP Managers Not Trained -- Bldg 1103	HW13
01-Mar-05	Major	Universal Waste Time Limit Demonstration -- Bldg 1456	HW3
02-Mar-05	Major	More than 55 Gallons of Hazardous Waste at IAP -- Bldg 1601	HW1
02-Mar-05	Major	Inappropriate Storage/Disposal of Hazardous Waste -- Bldg 251	HW6
03-Mar-05	Major	Inadequate Precious Metal Recovery Records -- Bldg 430	HW1

Brooks AFB

Date	Rating	Title	Finding ID Code
27-Jul-04	Major	Improper Signage at Generator Sites -- Basewide	HW1
27-Jul-04	Major	Hazardous Waste Spill Not Cleaned Up -- Bldg 140, IAP #7	HW1
27-Jul-04	Minor	Improperly Maintained IAP -- Bldg 140	HW1
27-Jul-04	Minor	Hazardous Waste Not Labeled as Hazardous Waste -- Bldg 140	HW1

Edwards AFB

Date	Rating	Title	Finding ID Code
11-Mar-03	Major	Improper Management of ACCS -- Bldg 2110	HW1
11-Mar-03	Major	No Initial Date Marked on HW Container -- Bldg 8451	HW1
11-Mar-03	Major	Accumulation Point Manager Training Expired -- 412 MX/MXFO	HW13
11-Mar-03	Major	Inappropriate Storage of Reactive, Flammable, Caustic Wastes -- Bldg 6001	HW6
11-Mar-03	Minor	Drum of Ignitable Waste Not Grounded -- Bldg 164	HW15
11-Mar-03	Minor	No DTSC Approval for CSF Staging Area -- Bldg 4916	HW2
12-Mar-03	Major	Unlabeled Hazardous Waste Containers	HW1
12-Mar-03	Major	ACCS Managers Not Trained	HW13
12-Mar-03	Minor	Hazardous Waste Stored Outside of Designated IAP	HW1
13-Mar-03	Major	Unlabeled Hazardous Waste Containers -- Bldg 1874	HW1
13-Mar-03	Major	Open, Unlabeled Hazardous Waste -- Bldg 1405	HW1
13-Mar-03	Major	No Inspections of PIRA EOD Unit	HW15
13-Mar-03	Minor	Contingency Plan Outdated -- Bldg 4916	HW9
11-Mar-03	Major	Improper Management of ACCS -- Bldg 2110	HW1
11-Mar-03	Major	No Initial Date Marked on HW Container -- Bldg 8451	HW1

Eglin AFB

Date	Rating	Title	Finding ID Code
25-Jan-04	Minor	More Than 55 Gallons of Waste in IAPs -- Basewide	HW1
26-Jan-04	Major	Universal Waste Bulbs Not Packaged or Dated -- Basewide	HW15
26-Jan-04	Major	Hazardous Waste Release -- Bldg 520	HW15
27-Jan-04	Major	Open Hazardous Waste Container -- Bldg 650	HW1
27-Jan-04	Major	Open Hazardous Waste Container -- Bldg 8642	HW1
27-Jan-04	Major	Improper Open Burn Unit Management	HW15
27-Jan-04	Major	Uncharacterized Hazardous Waste -- Bldg 780	HW4
27-Jan-04	Major	Improper Disposal of Hazardous Waste -- in front of Bldg 3074 and Wash Rack	HW6
27-Jan-04	Minor	Incompatible Hazardous Waste Storage -- Bldg 127	HW1
27-Jan-04	Minor	Incomplete Weekly Inspections Documents -- Bldg 1343	HW12
27-Jan-04	Minor	No RCRA Annual Training -- Bldg 8633	HW13
28-Jan-04	Major	Improperly Managed IAP -- Bldgs 707, 2587	HW1
28-Jan-04	Major	Uncharacterized Waste Streams -- Bldg 1757	HW1
28-Jan-04	Minor	Incomplete Weekly Inspections -- Bldg 2825	HW1
28-Jan-04	Minor	Incompatible Hazardous Waste Storage -- Bldg 422	HW6
29-Jan-04	Major	Uncharacterized Waste -- Warehouse 8	HW4
29-Jan-04	Major	Improper Waste Labeling and Profiling -- Bldg 592	HW4
29-Jan-04	Minor	Improperly Managed IAP -- Bldg 2803	HW1

Hanscom AFB

Date	Rating	Title	Finding ID Code
10-Jun-02	Major	Improper Storage of Universal Waste -- Bldg 1716	HW15
11-Jun-02	Major	Open Five-gallon Hazardous Waste Container (Bldg 1105-B -- IAP #160)	Not Listed
11-Jun-02	Major	Open Hazardous Waste Container -- Bldg 1722	HW1
11-Jun-02	Major	Unsecure IAP -- Bldg 1720	HW1
11-Jun-02	Minor	Failure to Obtain Hazardous Waste Disposal Waiver -- Bldg 1825	HW9
12-Jun-02	Minor	Missing IAP Weekly Inspections	HW1
13-Jun-05	Major	Missing 90-day Accumulation Site Inspection Records -- Bldg 1302	HW2
13-Jun-05	Major	Improper Storage of Universal Waste -- Bldg 1302	HW1
14-Jun-05	Major	Missing Inspection Records -- Bldg 1900	HW1
14-Jun-05	Major	Open Hazardous Waste Container -- Bldg 1722	HW1
14-Jun-05	Major	Improper Storage of Universal Waste -- Bldg 1639	HW1
16-Jun-05	Major	Inadequate Hazardous Waste Marking -- Bldg 1065	HW3
16-Jun-05	Minor	Failure to Obtain Hazardous Non-DRMO Waste Disposal Approval -- Bldg 1825	HW9

Hill AFB

Date	Rating	Title	Finding ID Code
05-Jun-01	Major	Residual Material Not Characterized -- TTU Site 1	HW6
05-Jun-01	Major	Emergency Permit Conditions Not Met -- MSA	HW9
05-Jun-01	Minor	Incomplete Container Log -- 40011	HW12
06-Jun-01	Major	LDR Certificates Not Maintained -- 40020	HW14
11-Jun-01	Major	Deficient Biennial Reports -- Bldg 5	HW11
11-Jun-01	Major	Improper Disposal of Fluorescent Light Bulbs -- Bldg 1102	HW6
12-Jun-01	Major	Contingency Plan/Spill Plan Not Accessible to Workers -- Bldg 507	HW13
12-Jun-01	Major	Lack of Spill Cleanup Supplies -- Bldg 514	HW2
13-Jun-01	Major	Deficient Weekly Inspections/Checklists	HW2
13-Jun-01	Major	Open Hazardous Waste Container -- Industrial Wastewater Treatrnent Plant	HW2
13-Jun-01	Minor	Improper Tracking of HazWaste -- Bldg 206	Not Listed
14-Jun-01	Major	Improper Disposal	HW15
14-Jun-01	Major	Uncharacterized Waste -- Bldg 1701	HW4
14-Jun-01	Major	Open, Unlabeled Container of Hazardous Waste -- Bldg 820	HW4
14-Jun-01	Minor	Drum Exceeds HWMP Time Limit for ACCS	HW2
16-Jun-01	Minor	Inconsistent Recordkeeping at IAP sites	HW2
04-May-04	Minor	Hazard Class Labels Not Affixed to Hazardous Waste Containers	HW12
04-May-04	Minor	No Annual Review of Hazardous Waste Management Plan	HW9
05-May-04	Major	Open Hazardous Waste Containers -- IWTP	HW6
11-May-04	Major	Missing RCRA Permit Submittals -- Bldg 40020	HW15
11-May-04	Major	Incomplete TTU Operation Log -- Bldg 40020	HW15
11-May-04	Minor	Improper Labeling of Used Lead Solder -- Bldgs 10008 and 40085	HW9

Kirtland AFB

Date	Rating	Title	Finding ID Code
12-Aug-02	Major	Light Bulb Containers Unmarked -- Bldg 20666	HW1
12-Aug-02	Major	Improper Disposal of Hazardous Waste -- Dumpster Southeast of Paint Shop (Bldg 20681)	HW4
12-Aug-02	Minor	Incomplete Daily/Weekly Accumulation Checklist	HW12
13-Aug-02	Major	Open Container -- IAP 204	HW1
13-Aug-02	Major	Incomplete Biennial Report -- Bldg 20685	HW11
13-Aug-02	Major	Outdated RCRA Training, Transit Alert -- Bldg 333	HW13
13-Aug-02	Major	Missing RCRA Training Certificate -- Tire Shop	HW13
13-Aug-02	Major	Outdated RCRA Training -- Aero Club	HW13
13-Aug-02	Major	Outdated RCRA Training -- Bldg 1060	HW13
13-Aug-02	Major	Outdated RCRA Training -- IAPs 192 and 200	HW13
13-Aug-02	Major	No Annual Training Exercise -- Bldg 1024	HW3
13-Aug-02	Major	Mischaracterized Wastes in IAPs -- Bldgs 617, 761	HW4
13-Aug-02	Major	Uncharacterized Waste Disposed of on Roadside -- near Storm Water Point 6, Outfall E	HW6
13-Aug-02	Major	Uncharacterized Waste in Dumpster at Bldg 1068	HW6
13-Aug-02	Major	Uncharacterized Waste in Dumpsters next to Bldg 1043N	HW6
13-Aug-02	Minor	Missing IAP Sign/Placard, and Daily/Weekly Inspections -- Bldg 333	HW1
13-Aug-02	Minor	Incomplete Daily/Weekly Accumulation Checklist -- Bldg 737	HW12
13-Aug-02	Minor	No Weekly Inspections -- IAP 200, 203	HW12
13-Aug-02	Minor	Incomplete Daily/Weekly Inspection Checklist -- Bldg 1047	HW12
13-Aug-02	Minor	Incomplete Daily/Weekly Inspection Checklist -- Bldg 1061	HW12
13-Aug-02	Minor	Incomplete IAP Documentation -- Tire Shop	HW12
13-Aug-02	Minor	Incomplete Weekly/Daily Checklists	HW12

Kirtland AFB (Continued)

Date	Rating	Title	Finding ID Code
13-Aug-02	Minor	No Annual Review of HWMP -- Bldg 20685	HW9
14-Aug-02	Major	HazWaste Labeled	HW1
14-Aug-02	Major	Mislabeled, Non-DOT Container of Hazardous Waste -- Bldg 291	HW1
14-Aug-02	Major	Outdated RCRA Training -- IAP #42	HW13
14-Aug-02	Major	Outdated RCRA Training -- IAP #120	HW13
14-Aug-02	Major	Outdated RCRA training -- IAP #117	HW13
14-Aug-02	Major	No 2002 Annual Report for EOD Sampling -- Bldg 20685	HW3
14-Aug-02	Major	Uncharacterized Waste Enamel Paints Disposed of to Trash -- Bldg 472	HW4
14-Aug-02	Major	Unmarked/Unknown Waste -- Bldg 20411	HW4
14-Aug-02	Major	Unknown/Unmarked Waste -- Bldg 737	HW4
15-Aug-02	Major	Over 55 Gallons of Hazardous Waste at IAP 224 -- Bldg 1006	HW1
11-Jul-05	Major	Manifest/LDR Inconsistencies -- Bldg 1048	HW2
11-Jul-05	Major	Inadequate 90-day Accumulation Point -- DRMO Yard	HW1
11-Jul-05	Minor	Inadequate IAP -- Bldg 20602	HW14
11-Jul-05	Minor	Training Incomplete -- Basewide	HW1
12-Jul-05	Major	Improperly Labeled Hazardous Waste Container (Bldg 1010)	HW1
12-Jul-05	Major	Over 55 gallons of Hazardous Waste at IAP-30	HW1
12-Jul-05	Minor	Inconsistent Labeling of Waste in IAP 202	HW14
12-Jul-05	Minor	Containers Retained for More than Two Years at Some IAPs	HW1
14-Jul-05	Major	No Biennial Report for OB/OD Activities	HW12
14-Jul-05	Major	Improper Disposal of Uncharacterized Waste -- Bldg 20375	HW4
14-Jul-05	Major	Missing Inspections for OB/OD Facilities	HW15

Robins AFB

Date	Rating	Title	Finding ID Code
07-Apr-03	Minor	HWMP Not Reviewed Annually -- Bldg 359	HW9
08-Apr-03	Major	Unlabeled Container of Mercury-Containing Lamps -- Bldg 359	HW1
08-Apr-03	Major	Unlabeled Container of Mercury Lamps -- Pole Bldg	HW1
08-Apr-03	Major	Open Container of Hazardous Waste -- Bldg 304, Paint Shop IAP 30401I	HW1
08-Apr-03	Major	Open Hazardous Waste Drum -- Golf Course	HW1
08-Apr-03	Major	Expired RCRA Training -- Bldg 359	HW13
08-Apr-03	Major	Deficient RCRA Training -- Bldg 272	HW13
08-Apr-03	Minor	No Spill Plan Posted -- outside 90-day ACCS #14	HW12
09-Apr-03	Major	Missing Hazardous Waste Label -- Bldg 148	HW1
09-Apr-03	Major	HAZWASTE Container Not under Control of the Operator -- Bldg 148	HW1
09-Apr-03	Major	Expired RCRA Training for Several ACCS Managers -- WR-ALC/MANP	HW13
10-Apr-03	Major	Improper Characterization and Labeling of Hazardous Waste Drum -- Bldg 169	HW4
10-Apr-03	Major	Improper Labeling/Dating and Storage of Hazardous Waste -- Bldg 169	HW14
10-Apr-03	Major	Open IAP Hazardous Waste Container -- Bldg 640	HW15
10-Apr-03	Major	Expired RCRA Training -- WR-ALC/MANHE	HW13
10-Apr-03	Major	Failure to Perform Weekly Inspections -- ACCS #17, Bldg 670	HW13
10-Apr-03	Minor	Primary ACCS Manager Not Appointed -- WR-ALC/MAIE	HW13
11-Apr-03	Minor	Deficient RCRA Training -- WR-ALC/MANRC	HW13

Rome AFB

Date	Rating	Title	Finding ID Code
09-Jun-03	Major	Open Drum of Waste Diesel Fuel -- Bldg 101	HW1
09-Jun-03	Major	Unlabeled Universal Waste Lamps Containers -- Bldg 101	HW1
11-Jun-03	Major	Unlabeled, Unknown Waste Container outside Bldg 277	HW4
11-Jun-03	Major	Improper Universal Waste Management -- Stockbridge Research Site	HW1

Tinker AFB

Date	Rating	Title	Finding ID Code
26-Mar-01	Major	Incomplete and Inaccurate EPA 1998-1999 Biennial Reports	HW15
26-Mar-01	Major	Improper Disposal of Aerosol Container - Bldg. 1	HW6
27-Mar-01	Major	Open, Unlabeled Hazardous Waste Containers - Bldg. 3001, LP0013, Q109	HW1
27-Mar-01	Major	Open Containers of Hazardous Waste - Bldg. 3125	HW1
27-Mar-01	Major	IAP Improperly Managed - Bldg. 229	HW1
27-Mar-01	Major	Uncontained Hazardous Waste Outside Container - B62516	HW1
27-Mar-01	Major	Mislabeled Hazardous Waste Container - Bldg. 2101, IAP E-13	HW1
27-Mar-01	Major	Open Containers	HW1
27-Mar-01	Major	Inadequate Hazardous Waste Training	HW13
27-Mar-01	Major	Improper disposal of Uncharacterized Hazardous Waste - Outfall 005	HW4
27-Mar-01	Major	Hazardous Waste Disposal Plan Requires Update	HW9
27-Mar-01	Minor	Weekly Inspections Not Performed - Bldg. 3001, I-63	HW1
27-Mar-01	Minor	Improperly Labeled Hazardous Waste	HW1
28-Mar-01	Major	Hazardous Waste Drums Not Under Control of the Operator	HW1
28-Mar-01	Major	Open Containers of Hazardous Waste - Bldg. 3001, post Y-26	HW1
28-Mar-01	Major	Incorrect/Incomplete Hazardous Waste Manifests	HW14

Tinker AFB (Continued)

Date	Rating	Title	Finding ID Code
29-Mar-01	Major	IAPs Exceed 55-gal Volume Limit	HW1
29-Mar-01	Major	Damaged Hazardous Waste Container - Bldg. 809	HW2
29-Mar-01	Major	No Corrosive Spill Control Equipment - Bldg. 809, Bay 205	HW2
29-Mar-01	Major	No Operating Two-Way Communication - Bldgs. 3728, 3770	HW3
29-Mar-01	Major	Unpermitted Treatment of Fluorescent Light Tubes - Bldg. 808	HW7
29-Mar-01	Minor	TAFB Hazardous Waste Management Instruction Outdated	HW12
29-Mar-01	Minor	No Hazard Class Labels - Bldg. 809, Bay 204	HW2
29-Mar-04	Major	Deficiencies in 2003 Biennial Report -- Bldg 808	HW3
29-Mar-04	Minor	Deficiencies in Manifests -- Bldg 808	HW14
30-Mar-04	Major	Mislabeled Hazardous Waste Containers at Hazardous Waste Management Facility	HW2
30-Mar-04	Major	Open and Mislabeled Hazardous Waste Containers -- Bldg 1130	HW1
30-Mar-04	Major	Illegible HAZWASTE Drum Label -- MANMMT Wash Rack	HW1
30-Mar-04	Major	Open Hazardous Waste Drum -- Jet Propulsion Paint Shop	HW1
30-Mar-04	Minor	Hazardous Waste Training for TECOM Personnel Lacking	HW13
31-Mar-04	Major	Open Container (Rings Not Secured) -- Bldg 289	HW1
31-Mar-04	Major	Two Open Containers -- Bldg 255	HW1
31-Mar-04	Major	Illegible Hazardous Waste Drum Label -- Bldg 414	HW1
31-Mar-04	Major	Unlabeled Hazardous Waste Containers -- Bldg 810	HW3
31-Mar-04	Major	Outdated Contingency Plan -- Bldg 808	HW3
31-Mar-04	Minor	No Annual Review of HWMP (OC-ALC-TAFB Instruction 32-7004)	HW12
31-Mar-04	Minor	Outdated Annual Hazardous Waste Training -- Bldg 6002	HW1
31-Mar-04	Minor	Training Documentation Not Available -- Bldg 255	HW1
01-Apr-04	Major	Open Hazardous Waste Containers -- Bldg 2135	HW2

Wright Patterson AFB

Date	Rating	Title	Finding ID Code
27-Apr-03	Major	Stillbottoms Discarded to Dumpster -- Bldg 34024	HW4
28-Apr-03	Major	Abandoned Drum of Recovered JP4 -- near Bldg 30029	HW4
28-Apr-03	Major	Abandoned Airplane Crash Components -- near Bldg 30093	HW4
28-Apr-03	Major	Emergency Treatment of Hazardous Waste Not Reflected in Annual Report -- Bldg 30089	HW7
28-Apr-03	Minor	Installation HWMP Not Approved by EPC -- Bldg 30089	HW9
28-Apr-03	Minor	Update Personnel List for Manifest Signatures -- Bldg 30089	HW5
29-Apr-03	Major	Propane Tank in Dumpster -- Boy Scout Camp	HW6
30-Apr-03	Major	Unlabeled Universal Waste -- Bldg 10867	HW1
30-Apr-03	Major	Abandoned Waste -- Bldg 30256	HW6
01-May-03	Major	Unlabeled Universal Waste -- Bldg 30022	HW1
01-May-03	Major	Open Container of Waste -- Auto Hobby Shop	HW1
01-May-03	Major	TSDF Deficiencies -- Bldg 20479	HW3
01-May-03	Major	Improper Disposal of Hazardous Waste -- Bldg 30901	HW6

Appendix B. Hazardous Waste Knowledge Survey

A SURVEY TO ASSESS HAZARDOUS WASTE KNOWLEDGE OF AFMC PERSONNEL

Conducted by:

AIR FORCE INSTITUTE OF TECHNOLOGY

AIR UNIVERSITY (AETC)

DEPARTMENT OF THE AIR FORCE

For

Air Force Materiel Command

HAZARDOUS WASTE KNOWLEDGE SURVEY

Privacy Notice

In accordance with AFI 37-132, Paragraph 3.2, the following information is provided as required by the Privacy Act of 1974:

Authority: 10 U.S.C. 8012, Secretary of the Air Force; powers and duties; delegation by; implemented by AFI 36-2601, Air Force Personnel Survey Program.

Purpose: The purpose of this study is to measure the effectiveness of hazardous waste training programs in Air Force Materiel Command. The survey will assess the knowledge level of personnel working with hazardous waste.

Anonymity: ALL ANSWERS ARE STRICTLY ANONYMOUS. We would greatly appreciate you completing this survey. No one outside the research team will see your questionnaire. No identification will be tied to individual responses. We ask for demographic information to aid with result interpretation and to make comparisons between large population groups.

Routine Use: The research team will use the survey results for academic research, which subsequently, will be published in aggregate form within a final report. The team will provide a report to the Air Force Materiel Command Hazardous Waste Manager. No individual data will be revealed and only members of the Air Force Institute of Technology research team will be permitted access to the data. If you would like to receive a summary of the results of this survey, use the contact information provided below.

Participation: Participation is VOLUNTARY. No adverse action will be taken against any member who does not participate in the survey or any member who does not complete any part of the survey. The estimated time to complete this survey is 20 minutes.

Suspense: Please complete the survey **NLT Friday, 10 February 2005**.

Contact Information: If you have any questions or comments about the survey, contact Capt Ryan Crowley using the information below.

Ryan A. Crowley, Capt, USAF
AFIT/ENV/GEM06M
BLDG 640 Box 4422
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765
Email: ryan.crowley@afit.edu

Section 1: Hazardous Waste Knowledge Questions
Instructions: This portion of the survey is to assess your knowledge of hazardous waste rules and principles. Select the correct answer for each question below. Please do not use any resources.

1. The Resource Conservation and Recovery Act (RCRA) is the primary federal law governing hazardous waste management activities on Air Force installations.

A. True
B. False

2. The principal enforcement authority for hazardous waste regulations on an Air Force installation is the _______________.

A. State environmental regulatory agency
B. Local county or city administrative agency
C. United States Environmental Protection Agency
D. Parent major command environmental function
E. None of the above

3. A particular item or substance is determined to be a waste under which of the following conditions:

A. The item no longer possesses the necessary "new" characteristics
B. The item is maintained for future use
C. The item has been inadvertently released or contaminated
D. Both A and C
E. All of the above

4. The general categories of regulated hazardous wastes include all of the following except:

A. Characteristic wastes
B. Waste mixtures
C. Listed wastes
D. Hazardous wastes designated for other uses
E. Waste residues

5. A non-empty aerosol container about to be discarded is considered what type of characteristic waste?

A. Ignitable waste
B. Toxic waste
C. Listed waste
D. Reactive waste
E. Non-hazardous solid waste

6. At an initial (satellite) accumulation point, the waste volume cannot exceed _____ at any time.

A. 15 gallons of hazardous waste
B. 30 gallons of hazardous waste; 1 quart of acute hazardous waste
C. 55 gallons of hazardous waste; 1 quart of acute hazardous waste
D. 75 gallons of hazardous waste; 1 gallon of acute hazardous waste
E. There is no volume limit for an initial (satellite) accumulation point

7. The accumulation "start date" of a 55-gallon container placed into use in an initial (satellite) accumulation point within an industrial work center is the date on which:

A. the waste is first placed into the container
B. the container is placed into the work center, but not used
C. the container reaches its "working" capacity
D. the container was obtained through the supply system
E. the container begins its transfer to an accumulation site

8. To comply with regulatory provisions regarding container management, containers within accumulation <u>sites</u> must be inspected how often?

A. Daily
B. Weekly
C. Every 30 days
D. At the discretion of the installation
E. No inspection frequency is specified

9. In 1995, the USEPA established an alternative waste management program for certain high-volume, low-risk hazardous wastes. These "universal wastes" include which of the following?

A. Used batteries, thermostats (containing mercury), and lamps (light bulbs)
B. Used batteries, cancelled pesticides being recalled, and PCBs
C. Used batteries, lamps (light bulbs), and low-level radioactive waste
D. Used batteries, lead-based paint chips, and lamps (light bulbs)
E. Used batteries, lamps (light bulbs), used oil, and paint residue

10. Starting with the date the item is declared a waste, the storage time limit for a universal waste item is _________.

A. 30 days
B. 6 months
C. unlimited
D. state-specific
E. 1 year

11. Hazardous waste shipments from an Air Force installation must be accompanied by a Uniform Hazardous Waste Manifest regardless of the volume or number of containers of waste being shipped.

A. True
B. False

12. Placing multiple wastes from different waste streams into a single container within an initial (satellite) accumulation point is an acceptable and common practice on an Air Force installation.

A. True
B. False

13. In accordance with Air Force policy, a Hazardous Waste Management Plan is ___________ at each Air Force installation.

A. recommended
B. required
C. required, if directed by the major command,
D. developed by each waste-generating organization
E. none of the above

14. A waste liquid having a flashpoint of less than 140 ^{o}F is classified as an Ignitable characteristic waste.

A. True
B. False

15. Which organization/office/group is responsible for preparing and modifying hazardous waste permits and acting as the installation liaison with respect to regulatory authorities?

A. Bioenvironmental Engineer
B. Judge Advocate General
C. Base Civil Engineer/Environmental Office
D. Defense Reutilization and Marketing Office
E. Environmental Protection Committee

16. Hazardous wastes from non-specific sources, including spent solvents, plating wastes, and metal-treating wastes, are best described or categorized as ______________.

A. U-listed wastes
B. F-listed wastes
C. characteristic wastes
D. hazardous waste mixtures
E. none of the above

17. Discarded unused commercial chemical products, off-spec products, and container residues which are considered acutely hazardous are referred to as _____________.

A. P-listed wastes
B. K-listed wastes
C. universal wastes
D. toxicity characteristic wastes
E. wastes which may be hazardous depending on the concentration of constituents

18. Within an industrial work center, containers holding hazardous wastes may be left open for extended periods as long as the containers are closed at the end of the shift or duty day.

A. True
B. False

19. Typical hazardous waste violations found on an Air Force installation include:

A. Failure to maintain adequate inspection records
B. Improperly-labeled containers
C. Physically maintaining inspection records at the initial accumulation point or the accumulation site.
D. Both A and B
E. All of the above

20. A waste-generating organization or unit must notify the installation hazardous waste program manager any time ___________.

A. a new hazardous waste stream is created
B. an existing hazardous waste stream is modified
C. an existing hazardous waste stream is terminated permanently
D. both A and C
E. all of the above

21. An empty hazardous waste container can always be thrown in the trash.

A. True
B. False

22. A waste is determined to be hazardous when it is listed by generating process or chemical name or because it exhibits one or more of the hazardous waste characteristics.

A. True
B. False

23. The length of time allowed by law for collecting and staging hazardous waste in containers depends solely on the amount of waste requiring staging.

A. True
B. False

24. In the event of a hazardous waste spill, the first priority is to contain the spill to mitigate the threat of environmental damage.

A. True
B. False

25. As a general rule, you should never fill a hazardous waste container completely.

A. True
B. False

Section 2: Attitudinal Questions
Instructions: Using the following scale, indicate your level of agreement with the following statements:

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

1. I think I answered most of the previous hazardous waste questions correctly.

2. I understand basic hazardous waste concepts, rules, and regulations.

3. I have received adequate hazardous waste training.

4. I can effectively apply hazardous waste concepts, rules, and regulations to real world problems.

5. I know where to go for help with hazardous waste issues related to my job.

6. I think my base does a good job promoting proper care of hazardous waste.

7. I think the Air Force does a good job promoting proper care of hazardous waste.

8. I have enough guidance to effectively mitigate hazardous waste problems.

Section 3: Demographic Questions

1. To which base are you assigned?

A. Arnold
B. Brooks
C. Edwards
D. Eglin
E. Hanscom
F. Hill
G. Kirtland
H. Robins
I. Rome
J. Tinker
K. Wright-Patterson

2. How long have you been in your current unit? (Fill in box for years, months)

3. How long have you been in your current duty position? (Fill in box for years, months)

4. How long have you been at your current base? (Fill in box for years, months)

5. How long have you worked with hazardous waste? (Fill in box for years, months)

6. Where is your primary workplace? (*Provide one answer only; Primary workplace can be defined as the location that you spend most of your duty hours at)*

A. Generator
B. Initial Accumulation Point (IAP)
C. 90 day Accumulation Point
D. 180 day Accumulation Point
E. Treatment, Storage, and Disposal Facility (TSDF)
F. Unit Environmental Coordinator (UEC)
G. Other: ______________________

7. Are you a manager (primary/alternate) in your primary workplace?

A. Yes
B. No

8. How often do you handle hazardous waste?

A. Almost everyday (15 or more days a month)
B. Often (6-14 days a month)
C. Occasionally (2-5 days a month)
D. Rarely (1 or less days a month)
E. Never

9. In the table below, please indicate how often you participate in the specified hazardous waste activities? For frequency, please use the following definitions.

Almost everyday: an average of 15 or more days a month
Often: an average of 6-14 days a month
Occasionally: an average of 2-5 days a month
Rarely: an average of 1 day or less a month
Never

HW Activity	Frequency				
	Almost everyday	Often	Occasionally	Rarely	Never
Container Selection	O	O	O	O	O
Waste Stream Profiling	O	O	O	O	O
Characterization Sampling	O	O	O	O	O
Marking and Labeling	O	O	O	O	O
Collection Site Inspections	O	O	O	O	O
Packaging and Shipping	O	O	O	O	O
Waste Recycling	O	O	O	O	O
Empty Container Management	O	O	O	O	O
Consolidation, Bulking, and Lab Packing	O	O	O	O	O

10. In the table below please indicate the last time you attended the specified training (see columns under "Attendance") and please indicate the amount of hazardous waste knowledge you recall learning from the specified training (see columns under "Knowledge").

Course	Attendance							Knowledge			
	Last 3 months	4 to 6 months	7 to 9 months	10 to 12 months	12 to 24 months	24 months or more	Have not taken	None	Very little	Some	A lot
Base- Level Training											
HW Initial (On-Base Classroom)	O	O	O	O	O	O	O	O	O	O	O
HW Annual Refresher (On-Base Classroom)	O	O	O	O	O	O	O	O	O	O	O
HW Awareness (On-Base Classroom)	O	O	O	O	O	O	O	O	O	O	O
Computer based: CD/DVD	O	O	O	O	O	O	O	O	O	O	O
Computer based: Internet (other than AFIT or Web University)	O	O	O	O	O	O	O	O	O	O	O
On-the-job training	O	O	O	O	O	O	O	O	O	O	O
Other (Fill-in) ____________________	O	O	O	O	O	O	O	O	O	O	O
Professional Continuing Education											
AFIT, WENV 521, HW Management Course (Satellite)	O	O	O	O	O	O	O	O	O	O	O
AFIT, WENV 220, Unit Environmental Course (Satellite)	O	O	O	O	O	O	O	O	O	O	O
AFIT, WESS 010, HW Accumulation Seminar (Web-enabled)	O	O	O	O	O	O	O	O	O	O	O
AFIT-funded HW course/conference	O	O	O	O	O	O	O	O	O	O	O
Web University, HW Management Training Course	O	O	O	O	O	O	O	O	O	O	O
HAZWOPER 40 Hour Course	O	O	O	O	O	O	O	O	O	O	O
DOT 40 Hour Certification	O	O	O	O	O	O	O	O	O	O	O
Other (Fill-in) ____________________	O	O	O	O	O	O	O	O	O	O	O

11. What best describes your employment status?

    A. Military
    B. Civilian
    C. Contractor

12. What is your grade?
    Military (drop box with list; E-1 through E-9, O-1 through O-10)
    Civilian-General Service (drop box with list; GS-1 through GS-15)
    Civilian-Wage Grade (drop box with list; WG-1 through WG-15)
    Contractor
    Other (fill-in)

13. What is your AFSC (military) or occupational series (civilian) group?
    Military-Enlisted (drop box with list)
    Military-Officer (drop box with list)
    Civilian-GS (drop box with list)
    Civilian-Wage (drop box with list)
    Other (fill-in): ___________________________

14. What is your highest level of education completed?

    A. GED
    B. High School
    C. Some College
    D. Associate's Degree
    E. Bachelor's Degree
    F. Graduate Degree
    G. Doctorate Degree

Thank you for participating in this survey. If you have any thoughts or comments about hazardous waste training in the Air Force, please provide them below:

____
____
____

If you would like to receive a summary of survey results, please use the contact information provided below.

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Appendix C. Training Course List

Base Level Training Courses:
Hazardous Waste Initial Training (on-base classroom): required within the first 6 months of working with hazardous waste

Hazardous Waste Annual Training (on-base classroom): required annually for personnel who work with hazardous waste

Hazardous Waste Awareness Training (on-base classroom): required for supervisors of personnel who work with hazardous waste, also required for personnel who work around hazardous waste, but not with hazardous waste

Computer Based (CD/DVD) Training: any CD or DVD hazardous waste training

On-the-job Training: any on-the-job hazardous waste training

Other Base-level Training: any base-level hazardous waste training not included above

Professional Continuing Education Courses:
WENV 521: Air Force Institute of Technology (AFIT) Hazardous Waste Management Course, currently taught via satellite, 1-week long

WENV 220: AFIT Unit Environmental Coordinator Course, currently taught via satellite, 1-week of five half days

WESS 010: Hazardous Waste Accumulation Seminar, currently taught via the internet, 3 hours

AFIT-funded: any other AFIT-funded courses or conferences

Web University: USAF Hazardous Waste Management Training Course, three levels of training through the internet, sponsored by the Air Force Center of Environmental Excellence

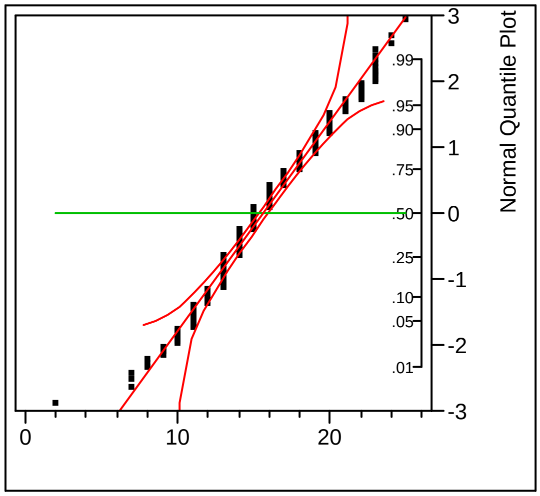
Hazardous Waste Operations and Emergency Response (HAZWOPER) Training: Any 40-hour HAZWOPER course

Department of Transportation (DOT) Training: any 40-hour DOT hazardous waste certification course

Other Professional Continuing Education Training: any professional continuing education hazardous waste courses not listed above

Appendix D. Normal Probability Plot

Normal Probability Plot for Knowledge Scores



(Note: This plot shows that the knowledge scores are approximately normal)

Appendix E. Statistics on Individual Questions

Question	Correct Answer	% Answered									
		Correct	Incorrect	T	F	A	B	C	D	E	Blank
1	T	85	15	85*	14	0	0	0	0	0	0
2	A	31	69	0	0	31*	3	49	11	6	0
3	D	69	31	0	0	7	1	12	69*	11	0
4	D	54	46	0	0	11	9	8	54*	18	1
5	D	14	86	0	0	53	6	14	14*	12	1
6	C	77	23	0	0	2	3	77*	2	15	0
7	C	17	83	0	0	46	13	17*	9	16	0
8	B	58	42	0	0	31	58*	7	2	2	0
9	A	39	61	0	0	39*	2	5	10	44	0
10	E	28	72	0	0	26	21	13	12	28*	1
11	T	96	4	96*	3	0	0	0	0	0	0
12	F	93	7	6	93*	0	0	0	0	0	1
13	B	88	12	0	0	2	88*	3	6	1	0
14	T	78	22	78*	22	0	0	0	0	0	0
15	C	55	45	0	0	23	6	55*	2	14	1
16	B	24	76	0	0	12	24*	21	34	8	1
17	A	34	66	0	0	34*	12	11	22	19	2
18	F	96	4	4	96*	0	0	0	0	0	0
19	D	43	57	0	0	1	2	1	43*	54	0
20	E	90	10	0	0	2	1	0	7	90*	0
21	F	96	4	4	96*	0	0	0	0	0	0
22	T	97	3	97*	3	0	0	0	0	0	0
23	F	76	24	24	76*	0	0	0	0	0	0
24	F	28	72	72	28*	0	0	0	0	0	0
25	T	96	4	96*	4	0	0	0	0	0	0

(Note: The correct answers are denoted with an asterisk)

Appendix F. Independent Variables for Regression Models

Hazardous waste program characteristic variables:

1) Type of base
2) Geographically separated properties
3) Large Quantity Generator
4) Small Quantity Generator
5) Conditionally Exempt Small Quantity Generator
6) Central Storage Facility Permit
7) Transportable Treatment Unit Permit
8) Amount of hazardous waste generated
9) Number of initial and secondary accumulation sites
10) Number of 90, 180, 270, accumulation points
11) Number of initial and secondary accumulation sites, 90, 180, and 270 accumulation points
12) Number of waste streams generated
13) Number of RCRA (Resource Conservation and Recovery Act) containers processed
14) Base population working with hazardous waste

Training course variables (each course has two associated variables: percentage of people who have ever taken a course, percentage of people who have taken a course within the past 2 years):

1) Initial training
2) Annual training
3) Awareness training
4) Computer-based training
5) On-the-job training
6) Other base-level training
7) WENV 521 course
8) WENV 220 course
9) WESS 010 course
10) AFIT-funded training
11) Web University training
12) HAZWOPER training
13) DOT training
14) Other professional continuing education training

Appendix G. Results from Regression Models

(Note: Courses are in order of R-Squared Value)

Parameter	Dependent Variable	R-Squared Value	Coefficient Estimate	Significant Probability	Result
DOT	KS	0.875	10.30	0.0000	+
Other, Base (2)	KS	0.806	9.34	0.0000	+
Other, Base	KS	0.801	6.21	0.0000	+
DOT (2)	KS	0.719	17.80	0.0010	+
Awareness	ECAMP	0.687	-7.96	0.0020	-
On-the-job (2)	ECAMP	0.618	85.53	0.0040	-
WENV 521 (2)	ECAMP	0.603	182.82	0.0050	-
Properties	KS	0.572	0.90	0.0070	+
Initial	KS	0.56	-7.91	0.0080	-
On-the-job	KS	0.55	-10.38	0.0090	-
Awareness (2)	KS	0.545	-8.09	0.0100	-
On-the-job	ECAMP	0.54	80.18	0.0100	-
AFIT-funded (2)	ECAMP	0.538	240.66	0.0100	-
Annual	KS	0.532	-5.41	0.0110	-
Initial (-2)	ECAMP	0.492	58.53	0.0160	-
Awareness (2)	ECAMP	0.472	58.74	0.0200	-
Annual (2)	KS	0.427	-4.96	0.0290	-
TTU Permit	ECAMP	0.415	18.31	0.0320	-
Awareness	ECAMP	0.396	47.10	0.0380	-
WENV 521 (2)	KS	0.353	-17.95	0.0540	-
CESQG	KS	0.328	2.60	0.0660	+
Amount	KS	0.328	-0.002	0.0650	-
Other, PCE	KS	0.318	10.75	0.0710	+
AFIT-funded	ECAMP	0.302	126.67	0.0800	-
Initial (2)	KS	0.299	-5.846	0.082	-
WESS 010	KS	0.278	-18.731	0.095	-
Base Type	KS	0.273	-1.239	0.099	-
LQG	KS	0.273	-2.373	0.099	-
SQG	KS	0.273	2.373	0.099	+
Containers	KS	0.268	0	0.103	+
WESS 010 (2)	ECAMP	0.263	185.782	0.107	-
Web Univ (2)	KS	0.248	-12.343	0.119	-
Other, PCE (2)	ECAMP	0.244	167.452	0.123	-
LQG	ECAMP	0.242	17.424	0.124	-
SQG	ECAMP	0.242	-17.424	0.124	+
All Sites	KS	0.238	-0.003	0.128	-
WENV 521	KS	0.23	11.179	0.135	+
IAP/SAP Sites	KS	0.228	-0.003	0.138	-
Population	KS	0.21	-0.001	0.157	-

Parameter	Dependent Variable	R-Squared Value	Coefficient Estimate	Significant Probability	Result
Web Univ	KS	0.201	-10.342	0.167	-
Streams	KS	0.197	-0.003	0.172	-
Other, PCE (2)	KS	0.194	-19.131	0.176	-
WESS 010 (2)	KS	0.189	-20.211	0.181	-
WENV 220 (2)	KS	0.186	-8.95	0.186	-
HAZWOPER (2)	KS	0.186	-6.988	0.185	-
Base Type	ECAMP	0.166	7.533	0.214	-
Initial	ECAMP	0.162	33.185	0.219	-
Other, Base (2)	ECAMP	0.161	-32.551	0.221	+
On-the-job (2)	KS	0.16	-5.852	0.223	-
WENV 220 (2)	ECAMP	0.152	63.155	0.236	-
AFIT-funded (2)	KS	0.129	-15.103	0.279	-
HAZWOPER (2)	ECAMP	0.121	43.85	0.295	-
Computer (2)	KS	0.121	-3.872	0.294	-
Other, Base	ECAMP	0.12	-18.713	0.298	+
AFIT-funded	KS	0.12	-10.253	0.296	-
Computer (2)	ECAMP	0.111	28.846	0.317	-
CESQG	ECAMP	0.109	-11.68	0.322	+
CSF Permit	KS	0.108	-1.155	0.325	-
DOT	ECAMP	0.107	-28.131	0.325	+
WENV 220	KS	0.104	-3.532	0.333	-
WESS 010	ECAMP	0.103	89.049	0.335	-
Population	ECAMP	0.1	0.006	0.344	-
Amount	ECAMP	0.095	0.007	0.355	-
Streams	ECAMP	0.092	0.014	0.364	-
Annual	ECAMP	0.089	17.243	0.373	-
WENV 220	ECAMP	0.085	24.908	0.384	-
All Sites	ECAMP	0.08	0.013	0.399	-
IAP/SAP Sites	ECAMP	0.074	0.013	0.418	-
Properties	ECAMP	0.069	-2.455	0.434	+
HAZWOPER	KS	0.069	2.929	0.434	+
DOT (2)	ECAMP	0.065	-41.689	0.45	+
Annual (2)	ECAMP	0.048	12.951	0.518	-
CSF Permit	ECAMP	0.03	4.742	0.612	-
TTU Permit	KS	0.025	-0.577	0.642	-
WENV 521	ECAMP	0.017	23.774	0.701	-
Containers	ECAMP	0.016	0.001	0.707	-
Computer	ECAMP	0.015	11.929	0.723	-
AP Sites	ECAMP	0.013	0.056	0.739	-
AP Sites	KS	0.013	-0.007	0.743	-
Computer	KS	0.009	1.167	0.787	+
Web Univ (2)	ECAMP	0.004	11.976	0.856	-

Parameter	Dependent Variable	R-Squared Value	Coefficient Estimate	Significant Probability	Result
HAZWOPER	ECAMP	0.003	-4.519	0.879	+
Web Univ	ECAMP	0.001	-6.828	0.912	+
Other, PCE	ECAMP	0	0.708	0.989	-

Appendix H. Results from Insignificant ANOVA Test

ANOVA by Time Working in Current Position

Time Working in Current Position	Mean	Number	Sig
Less than 10 years			
Less than 10	15.66	447	0.3918
All others	15.36	97	
Between 10 and 20 years			
Between 10 and 20	15.67	61	0.8714
All others	15.60	483	
Between 20 and 30 years			
Between 20 and 30	15.00	32	0.2608
All others	15.65	512	
30 or more years			
30 or more years	13.50	4	0.1806
All others	15.62	540	

ANOVA by Manager

Attendance	Mean	Number	Sig
Manager			
Manager	15.71	305	0.3846
Not a Manager	15.48	239	

ANOVA by Hazardous Waste Handling Frequency

Hazardous Waste Handling Frequency	Mean	Number	Sig
Almost Everyday (15 or more days a month)			
Almost Everyday	15.59	190	0.8414
All Others	15.65	354	
Often (6-14 days a month)			
Often	15.84	61	0.5545
All Others	15.58	483	
Occasionally (2-5 days a month)			
Occasionally	15.35	91	0.3930
All Others	15.66	453	
Rarely (1 day or less a month)			
Rarely	15.34	137	0.2404
All Others	15.70	407	
Never			
Never	16.23	65	0.0918
All Others	15.53	479	

Appendix I. List of Other Types of Training

Other Base-Level Training

Base	Course and Comments
Arnold	Lion Technology Advanced HW Course
Arnold	Off-base classroom
Arnold	Offsite training
Brooks	Computer Based: website
Brooks	HW Annual Refresher off-base
Brooks	Civilian safety training service
Edwards	DOT Multi-Modal HM Shipping
Edwards	FRO
Edwards	TITLE 22
Eglin	AFITS HW courses
Eglin	Articles, Written Studies
Eglin	Computer Based: online
Eglin	Explosive related training
Eglin	FDEP/EPA/Industry HW Workshop
Eglin	Instructor base level
Eglin	McCoy's seminar
Eglin	UEC
Eglin	Used oil transporter
Hanscom	HW training for MASS Generators (MANIFESTS)
Hanscom	HW Training for Mass. Generators (HW Manifests)
Hill	Recommended courses that the Air Force has provided
Hill	McCoy RCRA
Hill	McCoy's RCRA Seminar
Kirtland	Commercial Based Advanced HW Training
Kirtland	McCoy
Kirtland	McCoy class
Rome	Contractor course
Rome	Contractor provided course-off-site
Rome	RCRA Yearly Training - Contractor
Tinker	AF Environmental Symposium
Tinker	CHMM training
Tinker	Continual Training
Tinker	Hazmat reg. & reporting requirements
Tinker	HW Working Group meetings
Tinker	I attended McCoy's RCRA course 2 years ago.
Tinker	Section Safety Briefing
Tinker	Unit Environmental Coordinator HW training
Wright Patterson	Chemistry for Non-Chemists
Wright Patterson	Initial HW was an off-Base class
Wright Patterson	Previous job experience

Other Professional Continuing Education

Base	Course and Comments
Brooks	DOT Less than 40 Hours
Brooks	RCRA Annual Refresher (off-site)
Edwards	40 HR Site Supervisor
Edwards	California Title 22 refresher
Edwards	Confined Space Training
Edwards	First Responder Operators
Edwards	FRO HAZWOPER
Eglin	ECAMP
Eglin	WESS 090, WENV222, ISO 14000, ALMC-HA 40 hr HazMaterial, & HazWaste training
Hill	AAFES Hazardous class
Hill	AFCEE web based classes
Hill	annual training
Hill	Conferences and seminars yearly
Hill	McCoy RCRA Seminar
Hill	RCRA seminar/ McCoy's and assoc.
Hill	Working group
Kirtland	AF Env. Training Symposium, ECAMP AFIT Course, HMMP AFIT Course, Chemistry for Non-chemist
Kirtland	On Station/TDY AFIT Courses for HW Mgmt
Robins	HAZMAT Level III, DOT Basic
Robins	HMMP course WENV 222
Robins	site assessments, EH&S audits, RCRA, WENE020
Rome	DOT Recertification - 3 Year - Contractor
Tinker	CBT
Tinker	I have an MA Degree in HW Env. Science
Tinker	Numerous HW courses while working for the Navy prior to the Air Force
Tinker	Hazwoper before I started at Tinker at Gordon Cooper Vo-tech
Tinker	Training done on base in group
Wright Patterson	Cargo-Pak 1-day Transportation of Nitrocellulose-based Films course
Wright Patterson	DOT 8 HR. SATELLITE REFRESHER
Wright Patterson	Ecamp
Wright Patterson	Hazwoper refresher

Appendix J. ANOVA, by Rank and Grade

Rank, Military

Attendance	Mean	Number	Sig
E-4			
E-4	13.75	12	0.0392*
All Others	15.65	532	
E-5			
E-5	15.11	19	0.4790
All Others	15.63	525	
E-6			
E-6	15.57	21	0.9543
All Others	15.62	523	
E-7			
E-7	15.19	16	0.5877
All Others	15.62	528	
E-9			
E-9	17.00	1	0.6604
All Others	15.61	543	
O-1			
O-1	15.50	2	0.9606
All Others	15.61	542	
O-2			
O-2	12.75	4	0.0694
All Others	15.63	540	
O-3			
O-3	14.00	2	0.4711
All Others	15.62	542	
O-4			
O-4	16.00	1	0.9020
All Others	15.61	543	

(Note: Significant differences are denoted with an asterisk)

Grade, Civilians

Attendance	Mean	Number	Sig
GS-2			
GS-2	7.00	1	0.0063*
All Others	15.63	543	
GS-3			
GS-3	9.00	1	0.0363*
All Others	15.62	543	
GS-5			
GS-5	11.33	3	0.0187*
All Others	15.63	541	
GS-6			
GS-6	14.00	2	0.4711
All Others	15.62	542	
GS-7			
GS-7	17.14	7	0.1971
All Others	15.59	537	
GS-8			
GS-8	15.00	1	0.8470
All Others	15.61	543	
GS-9			
GS-9	15.70	20	0.8973
All Others	15.61	524	
GS-10			
GS-10	16.50	4	0.5727
All Others	15.60	540	
GS-11			
GS-11	17.59	44	<0.0001*
All Others	15.44	500	
GS-12			
GS-12	17.77	514	0.0001*
All Others	15.48	30	
GS-13			
GS-13	17.94	18	0.0014*
All Others	15.53	526	
GS-14			
GS-14	17.10	10	0.1328
All Others	15.58	534	
GS-15			
GS-15	18.00	11	0.0112*
All Others	15.56	533	

(Note: Significant differences are denoted with an asterisk)

Grade, Civilians (continued)

Attendance	Mean	Number	Sig
WG-5			
WG-5	13.00	1	0.4092
All Others	15.62	543	
WG-6			
WG-6	14.57	14	0.2133
All Others	15.64	530	
WG-7			
WG-7	14.38	16	0.1128
All Others	15.65	528	
WG-8			
WG-8	14.27	11	0.1566
All Others	15.64	533	
WG-9			
WG-9	14.24	29	0.0164*
All Others	15.69	515	
WG-10			
WG-10	14.11	44	0.0010*
All Others	15.74	500	
WG-11			
WG-11	13.70	10	0.0537
All Others	15.65	534	
WG-12			
WG-12	14.89	9	0.4906
All Others	15.62	535	
WG-13			
WG-13	13.00	5	0.0636
All Others	15.63	539	
WG-14			
WG-14	14.20	5	0.3168
All Others	15.62	539	
WG-15			
WG-15	13.80	10	0.0676
All Others	15.64	534	

(Note: Significant differences are denoted with an asterisk)

Grade, Civilians (continued)

Attendance	Mean	Number	Sig
WS-6			
WS-6	18.50	2	0.1957
All Others	15.60	542	
WS-7			
WS-7	14.50	2	0.6193
All Others	15.61	542	
WS-8			
WS-8	14.00	2	0.4711
All Others	15.62	542	
WS-9			
WS-9	14.29	7	0.2650
All Others	15.63	537	
WS-10			
WS-10	13.75	8	0.0937
All Others	15.64	536	
WS-11			
WS-11	13.75	4	0.2380
All Others	15.62	540	
WS-12			
WS-12	14.00	2	0.4711
All Others	15.62	542	
WS-14			
WS-14	16.00	1	0.9020
All Others	15.61	543	
WS-16			
WS-16	15.00	1	0.8470
All Others	15.62	543	
WL-9			
WL-9	14.00	2	0.4711
All Others	15.62	542	
WL-10			
WS-10	14.00	2	0.4711
All Others	15.62	542	
WL-11			
WS-11	14.00	2	0.4711
All Others	15.62	542	

Appendix K. ANOVA, AFSC and Occupational Series

AFSC's (Enlisted)

Attendance	Mean	Number	Sig
1T Aircrew Protection			
Aircrew Protection	14.33	3	0.4836
All Others	15.62	541	
2A Manned Aerospace Maintenance			
Manned Aerospace Maintenance	15.41	32	0.7071
All Others	15.62	512	
2E Communications-Electronics Systems			
Communications-Electronics Systems	18.00	2	0.2847
All Others	15.60	542	
2F Fuels			
Fuels	8.00	1	0.0159*
All Others	15.62	543	
2T Transportation & Vehicle Maintenance			
Transportation & Vehicle Maintenance	15.00	3	0.7378
All Others	15.61	541	
2W Munitions & Weapons			
Munitions & Weapons	13.80	5	0.1987
All Others	15.63	539	
3E Civil Engineering			
Civil Engineering	14.00	5	0.2530
All Others	15.63	539	
3F Security Forces			
Security Forces	14.20	5	0.3168
All Others	15.62	539	
3S Mission Support			
Mission Support	18.00	1	0.4499
All Others	15.61	543	
4A-V Medical			
Medical	14.00	2	0.4711
All Others	15.62	542	
4X Medical			
Medical	14.00	1	0.6107
All Others	15.61	543	
4Y Dental			
Dental	17.00	2	0.5340
All Others	15.61	542	
8 Special Duty Identifiers			
Special Duty Identifiers	14.00	1	0.6107
All Others	15.61	543	

(Note: Significant differences are denoted with an asterisk)

AFSC's (Officer)

Attendance	Mean	Number	Sig
16 Operations Support			
Operations Support	15.61	1	0.9020
All Others	16.00	543	
21 Logistics			
Logistics	14.00	1	0.6107
All Others	15.61	543	
31 Security Forces			
Security Forces	18.00	1	0.4499
All Others	15.69	543	
32 Civil Engineering			
Civil Engineering	13.00	1	0.4092
All Others	15.62	543	
61 Scientific Research			
Scientific Research	14.00	1	0.6107
All Others	15.61	543	
62 Developmental Engineering			
Developmental Engineering	12.00	2	0.1058
All Others	15.62	542	

GS Occupational Series

Attendance	Mean	Number	Sig
0000-0099 Miscellaneous Occupations			
Miscellaneous Occupations	19.03	30	<0.0001*
All Others	15.41	514	
0300-0399 General Administration, Computer, Etc			
General Administration	15.00	9	0.5598
All Others	15.62	535	
0400-0499 Biological Sciences			
Biological Sciences	16.55	11	0.3222
All Others	15.59	533	
0600-0699 Medical, Hospital, Dental, & Public Health			
Medical	16.33	3	0.6916
All Others	15.61	541	
0800-0899 Engineering & Architecture			
Engineering & Architecture	17.91	34	<0.0001*
All Others	15.46	510	
1000-1099 Information & Arts			
Information & Arts	14.50	2	0.6193
All Others	15.61	542	
1100-1199 Business & Industry			
Business & Industry	16.33	6	0.5738
All Others	15.60	538	
1300-1399 Physical Sciences			
Physical Sciences	17.81	518	0.0003*
All Others	15.50	26	
1400-1499 Library & Archivists			
Library & Archivists	20.00	1	0.1649
All Others	15.60	543	
1500-1599 Mathematicians & Statisticians			
Mathematicians & Statisticians	17.00	1	0.6604
All Others	15.61	543	
1600-1699 Equipment, Facilities & Services			
Equipment, Facilities & Services	16.00	1	0.9020
All Others	15.61	543	
1700-1799 Education & Training			
Education & Training	15.61	7	0.7431
All Others	16.00	537	
1800-1899 Investigators			
Investigators	8.50	2	0.0014*
All Others	15.64	542	

(Note: Significant differences are denoted with an asterisk)

GS Occupational Series (continued)

Attendance	Mean	Number	Sig
1900-1999 Quality Assurance, Inspection & Grading			
Quality Assurance, Inspection & Grading	15.00	5	0.6650
All Others	15.62	539	
2000-2099 Supply			
Supply	14.50	6	0.3876
All Others	15.62	538	
2100-2199 Transportation			
Transportation	11.50	2	0.0655
All Others	15.63	542	
2200 Information Technology			
Information Technology	13.00	1	0.4092
All Others	15.62	543	

WG Occupational Series

Attendance	Mean	Number	Sig
2600-2699 Electronic Equipment Installation and Maintenance			
Electronic Equipment Installation and Maintenance	16.33	9	0.4896
All Others	15.60	535	
2800-2899 Electrical Installation and Maintenance			
Electrical Installation and Maintenance	14.67	3	0.6047
All Others	15.62	541	
3100-3199 Fabric and Leather Work			
Fabric and Leather Work	11.00	1	0.1446
All Others	15.62	543	
3400-3499 Machine Tool Work			
Machine Tool Work	13.00	5	0.0636
All Others	15.63	539	
3500-3599 General Service and Support Work			
General Services and Support Work	13.50	6	0.1003
All Others	15.63	538	
3600-3699 Structural and Finishing Work			
Structural and Finishing Work	16.00	1	0.9020
All Others	15.61	543	
3700-3799 Metal Processing			
Metal Processing	14.18	17	0.0574
All Others	15.66	527	
3800-3899 Metal Work			
Metal Work	12.56	16	<0.0001*
All Others	15.70	528	
4100-4199 Painting and Paper			
Painting and Paper	14.67	6	0.4628
All Others	15.62	538	
4200-4299 Plumbing and Pipefitting			
Plumbing and Pipefitting	16.50	2	0.6905
All Others	15.61	542	
4300-4399 Pliable Materials Work			
Pliable Materials Work	14.00	4	0.3071
All Others	15.62	540	
4600-4699 Wood Work			
Wood Work	13.00	3	0.1518
All Others	15.62	541	
4700-4799 General Maintenance and Operations Work			
General Maintenance and Operations Work	14.67	12	0.2963
All Others	15.63	532	

(Note: Significant differences are denoted with an asterisk)

WG Occupational Series (continued)

Attendance	Mean	Number	Sig
4800-4899 General Equipment Maintenance			
General Equipment Maintenance	15.80	5	0.8929
All Others	15.61	539	
5000-5099 Plant and Animal Work			
Plant and Animal Work	14.00	2	0.4711
All Others	15.62	542	
5200-5299 Miscellaneous Occupations			
Miscellaneous Occupations	15.00	1	0.8470
All Others	15.61	543	
5300-5399 Industrial Equipment Maintenance			
Industrial Equipment Maintenance	14.25	8	0.2206
All Others	15.63	536	
5400-5499 Industrial Equipment Operating			
Industrial Equipment Operating	16.50	2	0.6905
All Others	15.61	542	
5700-5799 Transportation/Mobile Equipment Operation			
Transportation/Mobile Equipment Operation	19.00	1	0.2837
All Others	15.60	543	
5800-5899 Transportation/Mobile Equipment Maintenance			
Transportation/Mobile Equipment Maintenance	18.00	1	0.4499
All Others	15.61	543	
6900-6999 Warehousing and Stock Handling			
Warehousing and Stock Handling	15.05	22	0.3929
All Others	15.63	522	
7000-7099 Packing and Processing			
Packing and Processing	15.00	3	0.7378
All Others	15.61	541	
8200-8299 Fluid Systems Maintenance			
Fluid Systems Maintenance	13.88	15	0.0244*
All Others	15.66	529	
8600-8699 Engine Overhaul			
Engine Overhaul	14.00	26	0.0077*
All Others	15.69	518	
8800-8899 Aircraft Overhaul			
Aircraft Overhaul	12.85	7	0.0203*
All Others	15.65	537	

(Note: Significant differences are denoted with an asterisk)

Appendix L: Comments from Survey

Brooks (Employment Status, Comments)

Civilian	Hazardous Waste training should be made available by satellite or a person can choose to take the training in person. Not everyone learns by viewing training on the satellite link, some people require more direction or explanation.
Military	My unit is a small quantity generator; we have little to no waste, yet I'm subjected to training requirements as if we were a large quantity generator. The HW program for the AF is suiting for a flightline, but not for the research lab, yet my lab is treated like a flightline! Flightline policies hinder mission productivity and efficiency in the research setting without providing any additional safety or protection we could get from more streamlined sensible programs like those used in industry and at Universities all over the USA. The AFI which was written for HW for laboratories simply states that "labs are subject to the base" in regards to policies for managing a lab, it does not say labs should be subject to the same universal policies for a flightline, the AFI eludes to the fact the base could create guidance for the lab environment, yet Brooks fails to do this. I know the AF loves uniformity, but programs like this one need to acknowledge that not everyone fits into the same generic box in order to increase mission support.

Edwards

Contractor	I have received quality training from knowledgeable instructors while working on the base.
Contractor	Make flow charts and then post them for review.
Civilian	We need to get our certificates for the training received. They take up to 3 months and as a supervisor I must maintain the employee profiles. Presently they have a great problem getting the certs to us.

Eglin

Civilian	Although I have attended many classes and refresher courses during my career, the area I work in has a very limited amount of activity with waste streams. We have so very little to dispose of, i.e. lead solder waste...it would take years just to accumulate 2-5 lbs. Classes do not equate to experience, but, we keep trying.
Contractor	I believe that AFIT should waiver all cost for classes for contractors if seats are available after registration is closed. This would allow for greater dissimilation of information about waste management and benefit the base programs.
Civilian	I think the Air Force hazardous waste training at Eglin is very available and far above the norm. It's the attitude of the individual as how far he will succeed in the Environmental field.

Hanscom

Military	Many of the questions in the survey do not apply to my duty section. The answers I provided may skew the results of the survey i.e., I only work with very small amounts of materials classified as hazardous waste (lead foil, scrap dental amalgam, spent amalgam capsules, and silver recovered from an x-ray film processor). Several of the question referenced industrial work locations; when compared to an AF dental clinic is an "apples to oranges comparison"
Contractor	We handle very small quantities of hazardous waste. Our on-site safety and hazmat/waste people are key resources.

Hill

Civilian	I work in an explosives area, we get explosive safety but not a lot of waste disposal or bio-environmental training -
Contractor	The new refresher course allowed the formation of groups to discuss each others sites. This is a waste because each site area is individual to its own needs. Its info that we didn't need nor did it increase our knowledge of how to handle our sites properly. The instructor was not at all trained in hazardous and could not answer the questions and problems between site managers and their supervisors. The instructor was needed to give advice on our situations not use slides, cross talk between students, lesson plans with general training to refresh our memory of daily responsibilities we have. We needed help and training not a person who follows a lesson plan with practical experience. How about some training from state instructors or knowledgeable people of the problems here at Hill we can help with from our own sites.

Kirtland

Military	Honestly, much of anything I've ever had to do with HAZMAT could have been given to me as a simple flow chart cheat sheet with the numbers I needed to call/fax and the forms I needed to fill out. We could cut the AF training budget immensely with no loss of performance (actually improving it) if requirements like HAZ-Waste etc. were neatly summarized like this. But teaching me and refreshing me over and over again on "check the box" requirements (that I promise I will forget once the test is over) is costing the tax payers millions of dollars every year, if not more.
Military	I am a monitor for a IAP in a "2A" avionics. We have 3 waste stream for a complete 5 shop avionics section which are very simple and very low in volume. The training I have received is sufficient
Civilian	The training material at our facility is outdated. There are new procedures in place that have not been added to the training materials but are taught in class. Our environmental flight is short staffed in the hazardous waste section.

Robins

Military	I believe that hazardous waste training is very important, but it is not taken very seriously. I believe there needs to be more emphasis on hands on training annually.
Civilian	I feel that sufficient training is available at Robins.
Civilian	More training!

Tinker

Civilian	Good job with the survey. I feel we need more class on the small a amount of chemicals that are on the floor that we all deal with in our shop areas. It seems to me that most of the class are for large amounts that we do not deal with here.
Civilian	I just want to thank the Air Force for the opportunity to be involved with the hazardous waste program. I have learned a lot about the way the system works. I have never been written up for any violations in my shop, I contribute in my shop, I contribute that to the training I receive annually. Thanks.
Military	I really enjoy benchmarking and cross-tell with other units/bases. I feel more comprehensive and standardized AF wide training is needed. Consideration of an Environmental or Haz Material/Waste AFSC may also be worth exploring.
Civilian	I think that we need more hands on training geared towards our specific locations. I feel that we also need haz-woper and hazwoper refreshers every year provided by tinker if we are going to be haz-mat monitors in our areas. Reason I feel this is if I could be fined for a violation then I want adequate training and proper review.
Civilian	I would like to have more training. "ASAP" It is hard when this job is dumped on you and you are training to get up to speed without much help.
Civilian	I would like to have the opportunity to further my education in HazMat training I like what I do but I am not always confident that I am fully aware of all the rules and regulations Thanks
Civilian	It seems to me most of the training is to broad based and should be more specific to the job a person does.
Civilian	More emphasis is needed on proper training including classroom sessions on a regular basis such as annually and practical application for those areas who regularly are associated with hazardous waste.
Military	More in-depth training would have been very helpful since there are so many different governing sources and some conflicts between them. UEC for my unit is not very helpful I have spent at least 3 months of emails and phone calls to get expired materials turned in and letters updated. Any questions I have now get referred to the UEC at Cannon AFB because I know I can count on her to reply and won't be told to "look it up and let me know what you find out". UECs are supposed to be the experts in hazardous waste and ours has not helped at all.
Civilian	The hazardous waste rules at tinker are ok. But they can change without notice.
Civilian	The HW training offered by the base (Base Training)is poor. The training does not teach our monitors how to manage their HW sites.

Wright-Patterson

Civilian	I definitely don't have a need to use HW info on a regular basis. I do know where to look up the answers to every question posed on the survey, but I followed the instructions and did not use any references. It might be interesting to see how people do on the survey if they can check references. My responses should not carry much weight given that I focus on health concerns (PPE, eyewashes, MSDSs) not environmental compliance to do my job. If needed, I would consult the appropriate AFIs and 40 CFR to check waste tables, etc.
Civilian	I know it would be complicated and probably expensive, but I wish that a hazwaste/hazmat course could be designed specific to an organization. This course could follow a generalized class, so that the general knowledge could be expertly applied to the situation of a specific organization and its employees and their needs. I think people would get more out of that and be more engaged if they could see it applied directly to their own situation.
Civilian	Since I am rarely involved in day-to-day activities, I rely on our Unit Environmental Coordinator for advice and help with any questions.
Civilian	The first part of this "survey" is not a survey, but rather a test of what we may(not) have learned in classes. If you want to test that, do it in the classes. AF HW training is totally inadequate. Rather than focus on the things a person truly needs to know to perform their job as, for instance, a UEC, the training focuses on the "rah-rah environment" and the historical background of the environmental requirements, EIAP, the overall USAF environmental program, etc. Only about 30% (if that) of the ENV220 class was of any direct use in my UEC duties. I left that class thinking, "So what do I actually DO as a UEC?" The HM Materials Management portion was much more useful. But presented as it is, mixed in with many hours of mind-deadening background, it's presentation is a bit rushed, and lost in the overall class. I expected to learn what I was responsible for actually doing, and how to do it (HMMS and procurement, how to dispose of HW, POCs for my base, what to do in case of a spill, etc.) and then how the other things (regulations, ECAMPS) influence or tie-into my job. There is absolutely NO training on the base HMMS system. As everyone who uses it knows, it leaves a lot to be desired and is not particularly simple to operate. I realize that different bases use different systems, but that is no excuse to offer no training for the system users. I suspect that the real problems with USAF HM/W training is that rather than go to the trouble and expense of having base/area specific training that would truly benefit personnel and the environment, virtually all efforts are being spent on developing "one-size-fits-all" training that can be broadcast AF-wide and can be used to check off regulatory training requirements.

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Vita

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REPORT DOCUMENTATION PAGE	*Form Approved* OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
23-03-2006	Master's Thesis	Aug 2004-Mar 2006

4. TITLE AND SUBTITLE
Development of an Evaluation Methodology for Hazardous Waste Training Programs

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Crowley, Ryan, A., Capt, USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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2950 Hobson Way
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8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GEM/ENV/06M-03

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The purpose of this research was to develop a methodology to measure hazardous waste training programs. The Air Force Material Command (AFMC) hazardous waste training program was used to conduct this research. To measure the effectiveness of AFMC's hazardous waste training program, the research attempted to answer four research questions. These questions addressed correlations between hazardous waste training programs and ECAMP findings, the understanding personnel have of hazardous waste principles and concepts, the effectiveness of hazardous waste training courses, and how personnel feel about the hazardous waste training they are receiving. In addition, the research consisted of a web-based survey to test the knowledge of AFMC personnel, and measure their attitudes, in the hazardous waste program. The results indicate that there are significant differences in hazardous waste knowledge of personnel in AFMC. Several demographic populations have a higher and lower understanding of basic hazardous waste principles and concepts. Furthermore, several hazardous waste training courses can be attributed to greater and lesser understanding of hazardous waste principles and concepts. Overall, these results suggest what is and is not working in the hazardous waste training program of AFMC.

15. SUBJECT TERMS
hazardous wastes, training, training management, environmental management

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
U	U	U	UU	164	Alfred E. Thal Jr., AFIT/ENV
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