AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

RADIOACTIVE WASTE STORAGE ISSUES

A Research Project Presented to the
Faculty of Colorado Christian University

in partial fulfillment of the requirements
for the Bachelor's degree

by
Daniel E. Kunz

prepared for
Professor: Judy Lavell
Colorado Christian University
School of Innovative Studies
Class# MHR-86
August 15, 1994

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

MASTER

Certification Page

This is to certify that the Research Project prepared

By Daniel E. Kunz

Entitled Radioactive Waste Storage Issues

Has been accepted by the Faculty of Colorado Christian University

Signed:

Project Professor _____ Date _____

Director _____ Date _____

This Research Project is not to be regarded as confidential, and its use as a sample in future classes is not restricted.

ABSTRACT

In the United States we generate greater than 500 million tons of toxic waste per year which pose a threat to human health and the environment. Some of the most toxic of these wastes are those that are radioactively contaminated. This thesis explores the need for permanent disposal facilities to isolate radioactive waste materials that are being stored temporarily, and therefore potentially unsafely, at generating facilities. Because of current controversies involving the interstate transfer of toxic waste, more states are restricting the flow of wastes into their borders with the resultant outcome of requiring the management (storage and disposal) of wastes generated solely within a state's boundary to remain there.

The purpose of this project is to study nuclear waste storage issues and public perceptions of this important matter. Temporary storage at generating facilities is a cause for safety concerns and underscores the need for the opening of permanent disposal sites. Political controversies and public concern are forcing states to look within their own borders to find solutions to this difficult problem. Permanent disposal or retrievable storage for radioactive waste may become a necessity in the near future in Colorado. Suitable areas that could support a nuclear storage/disposal site need to be explored to make certain the health, safety and environment of our citizens now, and that of future generations, will be protected.

TABLE OF CONTENTS

Title Page	
Certification Page.....	i
Abstract.....	ii
Table of Contents.....	iii-iv
CHAPTER ONE--PROBLEM AREA.....	1-8
Purpose of the Study.....	2
Problem Statement.....	3-4
Hypotheses.....	5
Definition of Terms.....	6-7
Summary.....	8
CHAPTER TWO--PRECEDENCE IN RESEARCH.....	9-24
Literature Review.....	10-22
Relevance to Current Study.....	23-24
CHAPTER THREE--RESEARCH DESIGN.....	25-34
Hypotheses.....	26
General Methodology.....	27
Specific Procedures.....	28-29
Research Population/Sample.....	30
Data Collection.....	31
Treatment of Data.....	32-34
CHAPTER FOUR--FINDINGS.....	35-44
Problem Statement.....	36-37
General Results.....	38-39
Hypotheses.....	40

TABLE OF CONTENTS

Results.....	41-43
Spreadsheet.....	44
Charts.....	45
Summary.....	46
CHAPTER FIVE--CONCLUSIONS.....	47-51
Conclusions.....	48-49
Conclusions Based on Findings.....	48
Alternative Explanations of Findings.....	48-49
Limitations of the Study.....	49
Implications.....	50
Implications for Professional Practice or Decision Making.....	50
Implications for Future Research.....	50
Recommendations.....	51
Recommendations for Policy Development.....	51
Recommendations for Professional Practice.....	51
REFERENCES.....	52-54
APPENDIX A--COVER LETTER.....	56
APPENDIX B--QUESTIONNAIRE.....	57-62
APPENDIX C--LEARNING OUTCOMES AT CCU.....	63-65
Concrete Experiences.....	64
Generalizations.....	64
Skills Acquired.....	65
Personal Reflections.....	65

CHAPTER ONE--PROBLEM AREA

Purpose of the Study

The purpose of this project is to study nuclear waste storage issues and public perceptions of this important matter. Delayed openings of any planned or completed permanent disposal facilities has impacted most radioactive waste generating facilities, forcing them to store the wastes at their sites much longer than anticipated. Temporary storage at generating facilities is a cause for public safety concerns and underscores the need for the opening of permanent disposal sites. Controversies over whether enough study and testing has been completed to insure isolation of the wastes and provide for public protection has created a debate over permanent disposal or the alternative of monitored retrievable storage (MRS). Monitored retrievable storage allows for retrieving of the wastes at any point in time or transfer in the future to disposal sites, if proven safe. Public distrust of such disposal sites has impacted their opening or removed the sites from consideration of further study. Gaining public trust by involving citizens in any planning activity surrounding radioactive waste disposal is paramount to solving this important issue. Political concerns are forcing states to look within their own borders to find solutions to this difficult problem. Permanent disposal or retrievable radioactive waste storage in Colorado may become a necessity in the near future. What areas are suitable for supporting these endeavors need to be explored to make certain the health, safety and environment of our citizens now, and that of future generations, will be protected.

Problem Statement

In the United States we generate greater than 500 million tons of toxic waste per year that poses a threat to human health and the environment. Some of the most toxic of these wastes are those that are radioactively contaminated. This thesis explores the need for permanent disposal facilities to isolate radioactive waste materials that are being stored temporarily, and therefore potentially unsafely, at generating facilities.

Because of current controversies involving the interstate transfer of toxic waste, more states are restricting the flow of wastes into their borders with the resultant outcome of requiring the management (storage and disposal) of wastes generated solely within a state's boundary to remain there.

Public opinion also plays a major role in the acceptance or rejection of any radioactive waste disposal/storage site. Educating the public about nuclear waste storage issues is a necessary element to gaining their confidence and thus obtaining an operating permit for any site.

The scope of this project involves the radioactive waste storage issues mentioned above. Many companies in Colorado utilizing radioactive materials and components (or that used them in the past) are generating (or have generated) radioactive wastes that are being stored temporarily because no permanent disposal sites are available. These facilities have

had to store radioactive wastes much longer than anticipated or planned and in some cases have exceeded their permitted capacity. The safety and security of these wastes are in question due to the manner and location in which they are stored. As mentioned above, many politically motivated and controversial issues are forcing us to look within our own borders to find solutions to these complex and difficult disposal/storage problems.

Furthermore, permanent disposal or monitored retrievable storage for radioactive waste may become a necessity in the near future in Colorado. Areas that are suitable for supporting a nuclear disposal/storage site need to be explored to safely and effectively isolate these wastes to protect human health and the environment.

Prevailing attitudes of *not in my back yard* have continued to fester and future public information campaigns, coupled with appropriate technology demonstrations, will be necessary to restore public confidence in this issue and prove beyond a reasonable doubt the ability of these facilities to safely and securely isolate these wastes to protect human health and the environment and eliminate the current concerns for radioactive wastes stored temporarily at generating facilities.

Hypotheses

- H1: Many companies in Colorado utilizing radioactive materials and components, or that used them in the past, are generating radioactive wastes that are being stored temporarily because no permanent disposal sites are available.
- H2: The safety and security of these wastes are in question due to the manner and location in which they are stored.
- H3: Many controversial issues are forcing states to look within their own borders to find solutions to this complex and difficult disposal problem.
- H4: Public opinion plays an important role in the future protection of human health and the longevity of our environment.

Definition of Terms

Contamination	the presence of unwanted radioactive or non-radioactive (e.g., chemicals) matter
Decontamination	the reduction or removal of contaminating radioactive material from a structure, area, object or person
Decay	the spontaneous radioactive transformation of one nuclide into a different nuclide; every decay process has a definite half life
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
Half Life	the time in which half the atoms in a radioactive substance disintegrate; varies from millionths of a second to billions of years
Monitored Retrievable Storage (MRS)	secured and protected storage concept proposed for medium to high-level radioactive waste that allows for retrieval for transfer to other MRS sites if needed or ultimate disposal if proven safe in the future

NRC	Nuclear Regulatory Commission
Radiation	particulates or waves from atomic or nuclear processes
Radioactive	exhibiting radioactivity or pertaining to radioactivity
Radioactive contamination	deposition of radioactive material in any place where it is not contained or wanted
Repository	a permanent disposal facility for high-level or transuranic waste and spent reactor fuel
Siting	the process of locating a waste disposal facility
Transuranic waste	waste material contaminated with U-235, certain isotopes of plutonium and nuclides with an atomic number greater than 92 (uranium)
WIPP	Waste Isolation Pilot Plant--a DOE facility designated for nuclear waste and located in southern New Mexico in deep salt beds

Summary

The purpose of this project is to study nuclear waste storage issues and public perceptions of this important matter. Temporary storage at generating facilities is a cause for safety concerns and underscores the need for the opening of permanent disposal sites. Political controversies and public concern are forcing states to look within their own borders to find solutions to this difficult problem. Permanent disposal or retrievable storage for radioactive waste may become a necessity in the near future in Colorado. Suitable areas that could support a nuclear storage/disposal site need to be explored to make certain the health, safety and environment of our citizens now, and that of future generations, will be protected.

CHAPTER TWO--PRECEDENCE IN RESEARCH

Literature Review, Article #1

Hal Winslow (1992). Using the Dumpster as the Gauge for Waste Identification and Management. Journal of Environmental Regulation/Autumn 1992, Volume 2, Number 1. 1-6.

Thesis: This article focuses on the following thesis: What kind of wastes can be placed into the trash dumpster and how to avoid environmental liability by closely screening all wastes destined for the dumpster.

Methodology: Environmental regulations have become very comprehensive over the past decades. The regulations for environmental management contain very severe penalties and fines for violations with the goal to protect human health and the environment. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), also known as the Superfund Law, can require owners/operators to pay the costs of cleaning up any contaminated site where their waste has been disposed. CERCLA laws are designed and written very broadly to catch violators and make them liable for the cleanup. In order for companies to avoid this kind of liability, they must develop proactive programs to be sure they are meeting the intent and the letter of the law. Managing wastes within the framework of this comprehensive regulatory scheme has become very time consuming and costly. Developing programs to ensure compliance with the regulations is a top priority for every company.

One method of complying is to look closely at all waste destined for the dumpster (landfill) to be sure that it does not contain any regulated constituents. Waste that contains regulated constituents must be treated to meet disposal standards and/or be disposed of in a hazardous waste disposal facility. Because both of the above options have very high costs associated with them, companies must make the right decisions to remain competitive in the marketplace and avoid liability due to improper waste disposal determinations.

Conclusions: Between World War II and about 1980, commercial disposal led to widespread contamination of sanitary landfills, which are now being identified for cleanup. Another law now regulates the operation of sanitary landfills. The Resource Conservation and Recovery Act (RCRA) requires managing all hazardous waste properly. In addition to managing hazardous waste, new standards for landfill design, operation and monitoring requirements for contamination were proposed and promulgated in September 1991. These new standards require landfills to have a permit to operate. There are many new requirements an operator must meet to operate a landfill. These new standards have caused landfill operators to develop their own waste acceptance criteria. The facility waste acceptance requirements can be more restrictive than the RCRA requirements often to satisfy the conditions of the operators' insurance companies. All of these regulations and requirements are to achieve increased protection of human health and the environment. Companies must develop successful compliance strategies to avoid liability and

comply with the regulations. By making proper waste determinations prior to disposal, companies can avoid costly liabilities and fines now and in the future.

Strengths and Weaknesses: Managing waste at the source (i.e., the dumpster) is one method of ensuring compliance with all of the environmental regulations. But because of the increasing costs and liabilities associated with proper waste management, many companies are looking at the processes that create waste and are attempting to reduce or eliminate the waste and thus the need to manage it.

Waste minimization is one of the best methods of avoiding environmental liability today. Implementing simple improvements in work practices and housekeeping to reduce or eliminate waste production can have substantial cost savings and offer reduced environmental liability. Substituting non-hazardous for hazardous products can eliminate hazardous waste generation. Recycling and treatment of any remaining waste streams can also reduce or eliminate them.

Significance: Successful business practices today include not only managing wastes at the point of generation but employing every method possible to avoid generating the waste in the first place. Successful waste minimization programs can eliminate or reduce waste production and result in substantial cost savings and reduced environmental liabilities.

Literature Review, Article #2

Paul Aamodt (1993). The Mixed Waste Maze: A Guide for Working through Duplicate Regulations and Conflicting Jurisdictions. Federal Facilities Environmental Journal/Summer 1993. 139-149.

Thesis: This article focuses on the problems associated with mixed waste (radioactive and hazardous) and regulatory conflicts created by two federal agencies that each have jurisdiction for managing and regulating this class of waste. The U.S. Environmental Protection Agency (EPA) has historically had regulatory authority for managing hazardous waste. The U.S. Department of Energy (DOE) has had the authority for regulating radioactive waste. The conflict arises when these wastes are created together or combined with each other; then both agencies have jurisdiction.

Methodology: The EPA's approach relies heavily on detailed waste characterization, thorough sampling, analysis, prescribed treatment standards and specified treatment methods, and long-term isolation, including pit liners, leachate collection/treatment and groundwater monitoring requirements. These methods place less emphasis on the total system (facility and geology) and more on sampling, analysis and treatment. These are all very costly and generally involve more risk to the workers, especially to mixed or radioactive waste workers.

The DOE's approach is based on the principle of "as low as reasonably achievable" (ALARA) for treatment, packaging, storage and disposal. It uses activity levels, radiation emission characteristics, dose rates, decay rates, thermal output and physical form (must be dry for disposal) as bases on which to prescribe appropriate handling and storage/disposal requirements. It also relies heavily on the natural physical conditions of a site to ensure that radioactive waste is contained and isolated (especially from groundwater and other natural pathways to the biosphere) for the design life of a disposal facility. This philosophy assumes institutional control for a minimum of 100 years and isolation for a minimum of 200 years for low level (radioactive) wastes (LLW).

Conclusions: Both the EPA and the DOE have regulatory authority for the classes of wastes that they are charged with managing. When problems arise over issues involving overlapping authority (as is the case of mixed wastes) and when the application of both regulatory regimes proves conflicting in specific instances, then, per agreement the EPA yields to the DOE requirements. The EPA and the DOE regulations are more similar than they are dissimilar. Careful review is necessary to ensure protection of human health and the environment any time a conflict arises within the regulatory framework. Attention to the health and safety of those workers handling such wastes is paramount in determining the right course of action.

Strengths and Weaknesses: Anyone working within the complex universe of environmental regulation knows how frustrating multiple

regulations can be. The important issue here is to constantly involve all regulators having jurisdiction in multiple jurisdictional disputes when worker health and safety or increased potential for environmental release become evident due to the nature of the waste form and the conflicting regulations. Working toward a favorable solution frequently involves negotiations with both agencies. Many times requesting a variance is required to resolve the dispute. These efforts can be very time consuming and costly, often resulting in project and cost overruns.

Significance: When working with mixed waste issues that involve duplicate regulations and conflicting jurisdictions it is necessary to plan for the additional time and projected costs necessary to provide for additional reviews and negotiations with the regulators involved. Careful planning early on can yield cost savings by involving the regulatory agencies at the onset and eliminate potential project overruns. This planning strategy can sometimes be the key to successful conflict resolution.

Literature Review, Article #3

Robert H. Gray (1993). Applying Total Quality Environmental Management to Hanford's Public Outreach and Involvement Efforts. Federal Facilities Environmental Journal/Summer 1993. 231-243.

Thesis: The US Department of Energy's (DOE) Hanford Nuclear Site in western Washington State has applied Total Quality Environmental Management (TQEM) to its public outreach and involvement efforts in a successful program that encourages public involvement via multi-media information exchanges.

Methodology: If quality is defined as that which meets the customers' expectations, then public outreach and involvement are key aspects of total quality environmental management, especially when the public (i.e., the taxpayer) ultimately pays the bill. When citizens fund activities designed to protect public health and the environment, they are the customers and, thus, the ultimate judge of a product's quality. This realization involves a complete paradigm shift, which is currently under way at the DOE's Hanford Site. Hanford has been involved with nuclear weapons production since 1944. More recently the site's mission has changed from production to environmental cleanup and restoration. A model program for environmental monitoring was instituted by Hanford. The program involves monitoring stations located in concerned neighboring communities and is operated by the public. This unique program offers citizens the chance to be involved with environmental

monitoring in their community. The stations are accessible by anyone who resides in the communities. In addition, citizens (usually local high school science teachers and an alternate) were trained to operate the equipment. Citizens can also learn about the sampling equipment and talk with individuals involved with Hanford's environmental surveillance program. Participation of the public in environmental surveillance activities serves to strengthen ties and enhance understanding of environmental issues associated with Hanford's operations.

Conclusions: The communications initiative for the DOE's environmental programs at Hanford is a vital aspect of TQEM and shows promise as a public outreach model for other programs. Their initial success has been derived from their courage to try ideas and approaches that have historically been rejected by most scientists and from involving scientists who are willing to explain technical information to the public, the ultimate customer, in nontechnical language. Scientists are being trained in public communications and media relations and encouraged to participate in public interactions. Their communications agenda is to keep it simple, regardless of whether they are talking to general or scientific audiences. In today's multidisciplinary setting, even technical specialists have trouble communicating across scientific disciplines. The use of library networks should not be overlooked in public outreach efforts. These efforts will no doubt increase awareness by the public, local and state officials, and off-site scientists, and promote a better understanding of environmental management and other initiatives at Hanford by making the public an integral part of the process.

Strengths and Weaknesses: Hanford's public outreach program is being duplicated at other major environmental cleanup sites throughout the country. By involving citizens in decisions that affect their future, cooperative efforts are being forged that will no doubt pave the way for more public interest in environmental endeavors. Projects meeting with this kind of success are necessary to cleanup the legacy of the Cold War. Increased costs associated with programs such as this will no doubt pay off in the public acceptance of environmental cleanup projects. In addition, lower cost will be encountered with less time spent suggesting unpopular or unacceptable cleanup strategies with these cooperative programs. On the other hand, unpopular cleanup strategies may gain approval and public acceptance as their merits are demonstrated to be superior or more cost effective.

Significance: By providing the public with knowledgeable facts about complex and often controversial issues, inviting them to listen, ask questions and provide comments on all aspects of environmental cleanup projects (such as this example at Hanford) they become more willing to be involved in decision making as it affects their communities.

Literature Review, Article #4

Todd Peterson (1993). Public Consultation in the Evaluation of Innovative Technology for Environmental Cleanup. Federal Facilities Environmental Journal/Winter 1993-94. 493-502.

Thesis: The DOE is managing a national effort to develop and demonstrate promising new technologies in order to expedite cleanup efforts at DOE sites across the country including the Hanford Site in Washington State. An integral part of this process involves consultation with individuals and groups concerned and/or knowledgeable about the cleanup of contamination at DOE sites. The purpose of this consultation is to involve stakeholders from the outset so that the technologies developed are both technically effective and publicly acceptable. Hanford has undertaken a wide-ranging program of public consultation. What distinguishes this approach from others is the thorough involvement of stakeholders in the consideration of complex technical issues and the responsiveness of the approach to stakeholders' insights. Stakeholders can see the results of their involvement at distinct points during the process of technology evaluation and development. This article describes this innovative approach to public consultation.

Methodology: What distinguishes acceptable innovative technologies from unacceptable ones is the degree to which stakeholders are involved in the technical evaluation. Successful stakeholder analysis contributes directly to designing appropriate demonstrations that collect data on

issues of concern to the public. This approach goes beyond acknowledging the public's right to be involved to making the stakeholders' contributions essential to the completeness of the proposed technologies' technical evaluation. In an effort to inform and learn from the public about innovative environmental cleanup technologies, Hanford developed an interactive computer program called ProTech. ProTech is a tool to facilitate the involvement of stakeholders in the development process so that their interests and concerns can be addressed by the technology developers before a technology is demonstrated. The program allows the user to compare an innovative cleanup technology to the baseline technology currently in use. All of the information ProTech offers comes from technology profiles written by technology developers in response to the criteria that the stakeholders help define. Public opposition is often the reason a new technology is not deployed. It is therefore critical that stakeholders' issues and concerns be considered in parallel with technical issues. Identifying public concerns early in the process of technology development allows these issues to be addressed and solved before they become problems. A great deal of intellectual and emotional energy can be contributed by people to solve these problems if only they are asked to help and are given the opportunity.

Conclusions: Now that the mission of DOE sites across the country has turned from weapons production to environmental cleanup, innovative technologies for environmental remediation are urgently needed. The ultimate goal of public involvement in the cleanup strategies is to expedite deployment of innovative technologies. Time and resources are

too limited to be invested in methods of remediation that will never see the light of day because they have not been rigorously evaluated or because, in the end, they face withering public opposition. For example, for all its technical merits, incineration as a disposal method for solid and hazardous waste faces an uncertain future because of the intense public opposition it inspires. And just as important, extensive public consultation improves the quality of technology and the quality of its evaluation. Hanford's scientists' hope is that this approach to public involvement will serve as a model for consultation with stakeholders concerned about the cleanup of other DOE sites around the country.

Strengths and Weaknesses: Involving public stakeholders in programs such as this requires dedication and substantial up front investments of both time and money. Even though the costs are high in the beginning, the overall cost savings realized are the successful implementation of the project or use of the innovative technology. Many times in the past, projects were rejected because of public opposition to things they did not understand. Past efforts in time and money that were lost in rejected projects because of the lack of public involvement tell the real story.

Significance: As demonstrated in this article, the importance of stakeholder involvement in environmental cleanup technologies cannot be taken lightly. The successes experienced by this program at Hanford clearly indicate that public involvement not only is necessary to gain acceptance of new technologies, but also makes their implementation

possible. This concept has far reaching applications when imported to other issues involving public mistrust of government agencies or their contractors involved with either implementation of innovative technologies or other controversial matters regarding environmental cleanups.

Relevance to Current Study

Robert H. Gray (1993) stressed the importance of involving the public early on in environmental decision making. The current study involves similar issues. A well informed public is thought to increase the chances for success of opening any radioactive waste facility. This research focuses on public opinion and involvement as being necessary ingredients to gaining acceptance of and successfully siting and opening needed storage facilities to provide for secure radioactive waste disposal.

Paul Aamodt (1993) indicated that there are situations that pose problems with overlapping regulatory jurisdictions, both having authority for managing radioactive and hazardous mixed wastes. When working with mixed waste issues that involve duplicate regulations and conflicting jurisdictions it is necessary to plan for the additional time and increase of projected costs to provide for additional reviews and negotiations with the regulators involved. Careful planning early on can yield cost savings by involving the regulatory agencies at the onset and eliminate potential project overruns. This planning strategy can sometimes be the key to successful conflict resolution. This research involves mixed wastes that are regulated by multiple regulatory disciplines. Aamoldt's research is specific and focuses on conflict with overlapping regulations.

Todd Peterson (1993) stressed the importance of stakeholder and public involvement at the DOE's Hanford site. This research focus involves public involvement of waste issues in Colorado and has impact nationwide.

As demonstrated in this article, the importance of stakeholder involvement in environmental cleanup technologies cannot be taken lightly. The successes experienced by this program at Hanford clearly indicate that public involvement not only is necessary to gain acceptance of new technologies, but also makes their implementation possible. This concept has far reaching applications when imported to other issues involving public mistrust of government agencies or their contractors involved with either implementation of innovative technologies or other controversial matters regarding environmental cleanups.

Hal Winslow (1992) indicated the importance of waste minimization as applied to garbage. Successful business practices today include not only managing wastes at the point of generation but employing every method possible to avoid generating the waste in the first place. Successful waste minimization programs can eliminate or reduce waste production and result in substantial cost savings and reduced environmental liabilities. This research also focuses on the principles of waste minimization as it applies to radioactive waste generation.

CHAPTER THREE--RESEARCH DESIGN

Hypotheses

- H1: Many companies in Colorado utilizing radioactive materials and components, or that used them in the past, are generating radioactive wastes that are being stored temporarily because no permanent disposal sites are available.
- H2: The safety and security of these wastes are in question due to the manner and location in which they are stored.
- H3: Many controversial issues are forcing states to look within their own borders to find solutions to this complex and difficult disposal problem.
- H4: Public opinion plays an important role in the future protection of human health and the longevity of our environment.

General Methodology

The current research project utilized the opinion polling methodology. This method was selected to permit the research project to objectively analyze current public attitudes about radioactive waste storage issues affecting local communities. The research design was intended to capture and reflect public opinions affecting the protection of human health and the environment.

Questionnaires were submitted to a wide cross-section of community residents to obtain a representative sample of public opinion. To control for bias, respondents had only a certain number of options to select for their answers. Survey questionnaires contained a total of twenty questions. A total of four hypotheses were assigned five questions each in which to provide the required source of data. Correlations were calculated from the survey results which determined whether the hypotheses were supported or not.

A primary goal of this project was to determine what types of public information campaigns might be necessary to ensure public involvement in important environmental decisions affecting communities where radioactive wastes are generated or stored.

Specific Procedures

The researcher developed the survey that was utilized to gather the data. This survey was developed in cooperation with a university professor to control for bias and ensure the statements were directly linked to the hypotheses. The statements were not tested individually or collectively for statistical reliability. The survey consisted of twenty statements with groups of five statements assigned to each of four hypotheses. The survey contained a cover letter explaining that the research was being conducted as a requirement for the researcher's undergraduate thesis project to complete a baccalaureate degree at a local university. The cover letter did not give details of the study as a bias control measure so the respondents were less likely to be led to answer the survey questions according to the researcher's beliefs.

Each of the twenty questions related to different aspects of radioactive waste storage issues that impact the public in local communities. Some of the questions were of a technical nature as a control to afford the ability to measure each respondent's knowledge of technical issues affecting radioactive waste storage. Past and present public information exchanges have occurred frequently through a variety of media in attempts to educate the public about radioactive waste issues affecting their communities.

Each question was measured with a five point scale to control for bias and to offer the greatest degree of uniformity for collection of the

data. The following five point scale was utilized to obtain data input from each question: 1=strongly agree, 2=agree, 3=unsure, 4=disagree and 5=strongly disagree. In each case the prospective respondent answered the question by selecting only one of the five categories that represented their opinion.

The surveys were distributed to a wide cross-section of residents in Jefferson County, Colorado starting on February 28, 1994. Most surveys were completed within thirty minutes by the respondents. Surveys were issued to students at a local university, employees from several local industries (not involved with radioactive waste generation) and several public service organizations (including local government employees).

The survey was designed to measure the extent of public knowledge in order to demonstrate the need for more effective information exchanges and education campaigns designed to ensure citizens from communities affected by environmental issues are afforded every opportunity to be involved in the decision making process. Often solutions to these waste storage issues involve complex technologies that must be communicated to the lay person in both terms and demonstration projects that they can understand to ensure a level playing field for a better informed public. It is this researcher's belief that important issues involving radioactive waste storage and disposal will not be solved until the public is made a part of the decision making process.

Research Population/Sample

Data was gathered by distributing fifty questionnaires to the target population. Fifty of the questionnaires were utilized to sample a broad spectrum of citizens in Jefferson County, Colorado, including students at a local university, employees from several local industries (not involved with radioactive waste generation) and several public service organizations (including local government employees).

Participants varied in age from 18 to 60 years of age. All participants resided in Front Range Counties most within the greater metropolitan Denver area. Most of the participants resided and worked in Jefferson County, Colorado.

Data Collection

Data was gathered by distributing questionnaires to the target population that were selected to represent the general public (non-technically knowledgeable of the subject matter).

Fifty questionnaires were utilized to sample a broad spectrum of citizens in Jefferson County, Colorado including students at a local university, employees from several local industries (not involved with radioactive waste generation) and several public service organizations (including local government employees).

Questions were to be answered on a five point scale to reduce introduction of error or bias. The significance level was set at 75% more and 25% or less where applicable. A spreadsheet was created to display the results using Microsoft's Excel software. This software program has broad applications to support both database and spreadsheet development in addition to charting capabilities to display and interpret the data.

Treatment of Data

The significance level for the current study was set at 75% or more, 25% or less when required. All the hypotheses required the same set of significance levels in order to measure the correlations. Each hypothesis was measured by a five point scale, where 1=strongly agree, 2=agree, 3=unsure, 4=disagree, and 5=strongly disagree.

Hypothesis one: Many companies in Colorado utilizing radioactive materials and components, or that used them in the past, are generating radioactive wastes that are being stored temporarily because no permanent disposal sites are available. Respondents that agreed are knowledgeable of radioactive waste generation and storage issues in their communities. Respondents that disagreed or were unsure demonstrate the need for more public information campaigns to educate and involve community residents in solutions to solve environmental problems.

Hypothesis two: The safety and security of these wastes are in question due to the manner and location in which they are stored. Respondents that agreed are knowledgeable of radioactive waste generation and storage issues in their communities. Respondents that disagreed or are unsure demonstrate the need for more public information campaigns to educate and involve community residents in solutions to solve environmental problems.

Hypothesis three: Many controversial issues are forcing states to look within their own borders to find solutions to this complex and difficult disposal problem. Respondents that agreed are knowledgeable of radioactive waste generation and storage issues in their communities. Respondents that disagreed or are unsure demonstrate the need for more public information campaigns to educate and involve community residents in solutions to solve environmental problems.

Hypothesis four: Public opinion plays an important role in the future protection of human health and the longevity of our environment. Respondents that agreed are knowledgeable of radioactive waste generation and storage issues in their communities. Respondents that disagreed or are unsure demonstrate the need for more public information campaigns to educate and involve community residents in solutions to solve environmental problems.

An overall analysis was completed for all the hypotheses by totaling the responses for each question in a spreadsheet and charting the results utilizing Microsoft's Excel software program. See pages 44 and 45 for the spreadsheet and charts.

Groups of five questions each were assigned to each hypothesis sequentially (Q1-Q5=H1, Q6-Q10=H2, etc.) in the survey with a total of twenty questions being assigned for all four hypotheses.

The five point scale was further subdivided into three categories. Rankings of both 1 and 2 were assigned to the "agree category". Rankings of 3 were assigned to the "unsure category" which was utilized separately as a control measure. Rankings of 4 and 5 were assigned to the "disagree category". In addition, the "unsure category" was considered when rating the overall need for more public information campaigns due to lack of public knowledge toward the issue.

CHAPTER FOUR--FINDINGS

Problem Statement

In the United States we generate greater than 500 million tons of toxic waste per year that poses a threat to human health and the environment. Some of the most toxic of these wastes are those that are radioactively contaminated. This thesis explores the need for permanent disposal facilities to isolate radioactive waste materials that are being stored temporarily, and therefore potentially unsafely, at generating facilities.

Because of current controversies involving the interstate transfer of toxic waste, more states are restricting the flow of wastes into their borders with the resultant outcome of requiring the management (storage and disposal) of wastes generated solely within a state's boundary to remain there.

Public opinion also plays a major role in the acceptance or rejection of any radioactive waste disposal/storage site. Educating the public about nuclear waste storage issues is a necessary element to gaining their confidence and thus obtaining an operating permit for any site.

The scope of this project involves the radioactive waste storage issues mentioned above. Many companies in Colorado utilizing radioactive materials and components (or that used them in the past) are generating (or have generated) radioactive wastes that are being stored temporarily because no permanent disposal sites are available. These facilities have

had to store radioactive wastes much longer than anticipated or planned and in some cases have exceeded their permitted capacity. The safety and security of these wastes are in question due to the manner and location in which they are stored. As mentioned above, many politically motivated and controversial issues are forcing us to look within our own borders to find solutions to these complex and difficult disposal/storage problems.

Furthermore, permanent disposal or monitored retrievable storage for radioactive waste may become a necessity in the near future in Colorado. Areas that are suitable for supporting a nuclear disposal/storage site need to be explored to safely and effectively isolate these wastes to protect human health and the environment.

Prevailing attitudes of *not in my back yard* have continued to fester and future public information campaigns, coupled with appropriate technology demonstrations, will be necessary to restore public confidence in this issue and prove beyond a reasonable doubt the ability of these facilities to safely and securely isolate these wastes to protect human health and the environment and eliminate the current concerns for radioactive wastes stored temporarily at generating facilities.

General Results

It was anticipated that 50 surveys would be distributed to the students at Colorado Christian University. The Colorado Christian University held classes at night, Monday through Thursday from 6 P.M. to 10 P.M. The surveys were distributed prior to the scheduled start of class for three of the Tuesday evening class groups. All students were adults and were working toward the completion of their bachelor degree programs. The majority of the students worked full time during the day while continuing their pursuit of completing a degree program.

The surveys were distributed commencing the week of February 14 and ending April 11, 1994. Due to some absences only 42 of the original 50 were distributed. Of the 42 distributed only 40 were returned completed. The other two were not returned at all. Therefore the total number of surveys used to calculate the results was 40. Of the 40 surveys completed it was unknown how many were completed by males and how many were completed by females. Neither gender nor age information was requested of the survey participants. The researcher did not feel the need to compile demographic, sex or age information for any aspect of the research project.

Class instructors and prospective participants were notified prior to distribution of the surveys to ensure that each participant would be given ample time to complete the surveys so as not to disrupt normal class-time activities.

It was estimated that on the average the survey took approximately 10 minutes to complete. After all surveys were distributed and completed the researcher returned to the classes and collected the surveys.

The researcher offered to share the results of the survey with any participant or faculty member who provided a self-addressed, stamped envelope. At the time of this writing (over four weeks after the last of the surveys was collected) no self-addressed envelopes had been received.

Explanations were given that the results were to be used for the researcher's course requirements only. The researcher was completing a college course which required a research project. The participants were assured that the results of their individual survey would be kept confidential and that the completed research project would be bound and a copy retained by the University, accessible by faculty, staff and students. The bound and completed research project was (completed to satisfy the requirements for a bachelor's degree) not to be sold, formally published, or used in any way that would violate the privacy of the participants or the University. The completed paper was to become the property of the University and was to reside in the school's library. If the participants did not want to complete the survey based on the above information, they could decline. Two participants declined to participate in the study by not returning the survey.

Hypotheses

- H1: Many companies in Colorado utilizing radioactive materials and components, or that used them in the past, are generating radioactive wastes that are being stored temporarily because no permanent disposal sites are available.
- H2: The safety and security of these wastes are in question due to the manner and location in which they are stored.
- H3: Many controversial issues are forcing states to look within their own borders to find solutions to this complex and difficult disposal problem.
- H4: Public opinion plays an important role in the future protection of human health and the longevity of our environment.

Results

Questions 1 through 5 were assigned by research design and directly related to Hypothesis H1 which stated:

Many companies in Colorado utilizing radioactive materials and components, or that used them in the past, are generating radioactive wastes that are being stored temporarily because no permanent disposal sites are available.

H1 was supported by the results, although a large percentage of respondents answered unsure (A3) to the supporting questions. The researcher believes that the high percentage of respondents answering unsure (23%-38%) to these questions indicates:

- Future public education campaigns are necessary to educate the public on concerns that affect their communities.
- The technical nature of this subject matter is difficult for the lay person to understand and better efforts to make the subject matter more easily understood are necessary to allow greater public involvement.

Questions 6 through 10 were assigned by research design and directly related to Hypothesis H2 which stated:

The safety and security of these wastes are in question due to the manner and location in which they are stored.

H2 was supported by the results, with a large percentage of respondents answering strongly agree (A1) to the supporting questions.

Questions 11 through 15 were assigned by research design and directly related to Hypothesis H3 which stated:

Many controversial issues are forcing states to look within their own borders to find solutions to this complex and difficult disposal problem.

H3 was supported by the results, also with a large percentage of respondents answering strongly agree (A1) to the supporting questions.

Questions 16 through 20 were assigned by research design and directly related to Hypothesis H4 which stated:

Public opinion plays an important role in the future protection of human health and the longevity of our environment.

H4 was supported by the results, although a large percentage of respondents answered unsure (A3) to the supporting questions. The researcher believes that the high percentage of respondents answering unsure (5%-75%) to these questions indicates:

- The questions may have been too technical in nature thus interfering with the respondents' ability to answer the questions.
- Agencies and industries responsible for radioactive waste management need to develop strategies to involve the public more in issues that affect their communities.

RADIOACTIVE WASTE STORAGE QUESTIONNAIRE RESULTS/SPREADSHEET

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
2	R1	3	3	4	2	2	2	3	3	1	3	2	3	2	2	3	3	3	3	3	2
3	R2	3	2	4	2	2	2	1	1	1	3	1	1	1	3	3	4	3	3	3	1
4	R3	No Data					No Data					No Data					No Data				
5	R4	2	4	5	2	2	2	1	1	3	2	1	2	1	2	3	4	3	3	3	1
6	R5	3	2	3	3	3	2	1	2	3	3	3	4	3	3	3	3	3	3	3	1
7	R6	2	2	4	4	4	2	1	2	2	2	1	2	2	2	2	4	4	3	3	2
8	R7	2	2	5	4	2	3	1	2	2	3	4	4	2	2	3	3	3	3	4	1
9	R8	2	3	4	2	3	2	3	1	1	2	2	2	2	2	3	3	1	4	1	1
10	R9	No Data					No Data					No Data					No Data				
11	R10	3	3	3	3	2	2	1	2	2	3	2	2	2	2	3	3	3	3	3	1
12	R11	3	2	3	2	4	2	2	3	1	3	2	2	1	3	2	3	5	3	3	2
13	R12	5	2	3	2	2	2	2	2	2	4	3	2	2	3	3	3	3	3	2	2
14	R13	3	3	2	3	2	2	2	3	3	3	3	4	2	2	3	3	3	3	3	2
15	R14	3	3	3	3	3	3	1	1	1	3	1	5	1	1	3	3	3	3	3	1
16	R15	3	2	2	4	2	2	1	2	1	2	1	1	1	2	3	3	3	3	3	1
17	R16	1	2	1	5	1	1	3	2	4	2	1	1	1	2	1	4	5	1	4	4
18	R17	3	3	3	3	3	3	2	2	2	3	4	3	3	2	3	3	3	3	3	2
19	R18	2	2	3	1	2	3	1	2	1	2	2	1	1	2	5	2	1	3	2	2
20	R19	2	2	4	3	2	3	1	2	2	2	2	3	4	3	2	2	4	2	2	1
21	R20	1	1	3	4	3	1	1	1	1	3	1	1	1	4	1	1	1	1	1	1
22	R21	1	5	2	3	1	2	2	3	3	2	2	4	3	1	1	4	4	1	5	4
23	R22	2	1	4	1	1	2	1	1	2	2	1	1	2	2	2	1	4	4	4	1
24	R23	2	3	2	4	3	2	1	2	1	2	1	1	1	1	5	2	5	1	1	1
25	R24	3	3	4	3	3	3	1	3	2	3	2	3	1	2	3	3	3	3	3	2
26	R25	3	3	4	3	3	2	1	2	2	3	2	4	4	2	3	3	3	3	2	3
27	R26	3	3	3	3	3	3	2	2	4	2	2	2	2	2	2	3	4	3	3	2
28	R27	1	1	3	2	2	2	2	1	1	3	2	2	2	3	4	2	1	3	3	2
29	R28	2	2	3	2	3	1	1	1	1	1	1	1	1	2	3	3	3	3	3	1
30	R29	2	4	4	2	2	2	1	4	2	3	2	2	2	1	2	3	4	3	3	2
31	R30	1	2	3	2	2	1	1	1	1	2	2	2	2	2	2	2	3	1	2	1
32	R31	2	2	5	2	1	2	1	2	1	1	1	1	1	2	1	2	4	2	2	1
33	R32	1	1	3	3	2	2	1	1	1	3	2	2	3	3	3	3	3	3	3	2
34	R33	3	2	2	3	2	3	1	1	3	4	1	1	2	2	3	3	2	3	2	2
35	R34	2	2	3	2	2	1	1	3	2	2	2	3	4	2	3	2	3	3	2	4
36	R35	2	2	4	2	3	2	1	1	1	4	1	1	1	1	4	2	2	3	2	2
37	R36	2	2	4	3	2	3	2	3	2	3	2	2	2	2	4	2	2	3	2	2
38	R37	2	1	5	2	1	1	1	1	1	2	2	3	3	3	5	2	5	3	3	2
39	R38	1	4	4	3	2	2	1	1	1	2	1	2	1	2	4	2	3	3	3	1
40	R39	2	2	4	3	3	2	1	1	1	2	1	2	3	3	3	3	3	3	3	3
41	R40	2	1	5	2	2	1	1	1	2	3	2	2	1	3	3	3	3	3	3	2
42	R41	1	1	5	1	1	1	1	1	1	1	1	3	1	1	3	3	3	5	3	1
43	R42	4	1	4	2	2	2	2	2	2	3	2	2	2	2	2	2	4	3	2	2
44	Total Number of Responses for Each Question																				
45	A1	8	8	1	3	6	8	28	17	19	3	16	11	16	6	4	2	4	5	3	17
46	A2	17	18	5	16	20	23	9	15	14	16	19	16	15	23	8	12	3	2	11	18
47	A3	13	10	14	15	12	9	3	7	5	18	3	7	6	10	21	21	21	30	22	2
48	A4	1	3	14	5	2	0	0	1	2	3	2	5	3	1	4	5	8	2	3	3
49	A5	1	1	6	1	0	0	0	0	0	0	0	1	0	0	3	0	4	1	1	0
50		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
51	SUM	2.25	2.28	3.48	2.63	2.25	2.03	1.38	1.8	1.75	2.53	1.78	2.23	1.9	2.15	2.85	2.73	3.13	2.8	2.7	1.78
52	Percent of Responses for Each Question																				
53	Yes	63%	65%	15%	48%	65%	78%	93%	80%	83%	48%	88%	68%	78%	73%	30%	35%	18%	18%	35%	88%
54	Unsure	33%	25%	35%	38%	30%	23%	8%	18%	13%	45%	8%	18%	15%	25%	53%	53%	53%	75%	55%	5%
55	No	5%	10%	50%	15%	5%	0%	0%	3%	5%	8%	5%	15%	8%	3%	18%	13%	30%	8%	10%	8%

RADIOACTIVE WASTE STORAGE QUESTIONNAIRE RESULTS/CHARTS

Hypothesis #1

Hypothesis #2

Hypothesis #3

Hypothesis #4

Summary

All results were entered into a Microsoft Excel spreadsheet. A macro program was developed to total the answers for each question, and totalled the number of answers for each of the five possibilities, entering the total for each question at the bottom of the data column. Possible answers consisted of the five point scale utilized. A1 represented strongly agree. A2 represented agree. A3 represented unsure. A4 represented disagree. A5 represented strongly disagree.

Although all four hypotheses were supported by the results, two of them (H1 & H4) received large percentages of unsure (A3) answers. An additional objective considered by the researcher was to evaluate the number of questions in which the respondents checked the unsure category and decide if further study was warranted to ascertain whether participants felt the questions were too difficult to answer. This phenomena led the researcher to believe that the participants' apparent lack of knowledge on issues that affect their communities needs to be corrected through concentrated efforts to educate and make the public more aware of radioactive waste storage issues and to involve the public in decision-making.

CHAPTER FIVE--CONCLUSIONS

Conclusions

Conclusions Based on Findings

The cleanup of contaminated sites and the siting, construction and operation of the facilities for the disposal of radioactive waste may have many significant effects on communities, public and worker health, the environment, and the local, regional and national economies. Similarly, the delay or failure to provide safe and permanent disposal sites may adversely affect the communities in which the waste is now held in temporary storage--in facilities that were never intended for such long-term storage. Therefore, it is important not only that citizens become active in deciding how things will be done, but also that they contribute to the process of making things happen, addressing significant problems, rather than delaying action indefinitely. Deciding when action is called for is sometimes the most difficult decision. Those who have faith in the democratic process believe that the public will help ensure that the right decisions will be made about how and when to act.

Alternative Explanations of Findings

Some citizens will follow a decision and implementation process diligently during all its phases. Others will become involved only at major decision points or when a potential decision affects them directly. In any case, citizens can play their important roles well only if they have accurate, understandable and timely information, sufficient time and technical support, and an opportunity to be heard. Citizens can work to ensure that the responsible agencies will provide these tools, and must

prepare to use them wisely. By getting involved, individuals can help shape the ground rules--key management plans, strategies and regulations--and thus help ensure effective and equitable policies in the future.

Limitations of the Study

This study was conducted by surveying a relatively small group of students at a local university. To be meaningful it should be expanded and conducted on a fairly widespread scale throughout both the areas that already have similar issues affecting their communities and, for comparison, those areas that have not been affected by such issues. It would be helpful to compare this study to two relatively isolated control groups--a study of those that live in an area or country unaffected by these issues directly and another study of those that are actively involved with these issues in their communities. An assessment could then be made as to the difference in public perception of the issues and a judgement could be assumed as to the amount of information provided to the public versus the amount of knowledge demonstrated by the participants involved in this study.

Implications

Implications for Professional Practice or Decision Making

Without a doubt, all agencies involved with the regulation of radioactive waste and all who have responsibilities for the management of facilities that process or generate these wastes should develop comprehensive public information campaigns that would continue to involve the public in important decisions that ultimately affect their communities.

Agencies and facilities have a responsibility to educate and involve all their stakeholders in all levels of decision-making. These issues involve environmental ethics and need to be addressed to ensure that only the best areas and alternatives will be explored to dispose of radioactive wastes.

Implications for Future Research

Better and smarter ways need to be explored to provide for the safest methods possible to effectively isolate these wastes. There are many promising technologies that need to be tested and piloted. We need to keep searching for new ways of dealing with this perpetual problem, given the long half lives of many radioactive isotopes.

Recommendations

Recommendations for Policy Development

The DOE and other federal, state and local agencies need to adopt policies to ensure that public involvement will be required at all levels of decision-making affecting nuclear waste storage issues.

In addition, program development for federally funded public information outreach programs needs to be accelerated to provide for greater public understanding of the radioactive waste issues affecting the communities involved.

Recommendations for Professional Practice

Multidisciplinary approaches should be the preferred method and utilized wherever possible to allow for better information exchanges given the complex nature of these issues. Good science concepts need to be demonstrated to all stakeholders to allow the lay person a chance to participate in the decision process on a level playing field.

Our government has the responsibility to provide information to the public on these important topics and ensure that all sides and alternatives are presented in depth. All costs associated with providing the required information should be placed upon the facilities that generate radioactive waste in the form of a waste tax.

REFERENCES

References Cited

- Aamodt, P. (1993) . The mixed waste maze: a guide for working through duplicate regulations and conflicting jurisdictions Federal Facilities Compliance Journal.
- Gray, R. H. (1993) . Applying total quality environmental management to hanford's public outreach and involvement efforts Federal Facilities Compliance Journal.
- Peterson, T. (1993) . Public consultation in the evaluation of innovative technology for environmental cleanup Federal Facilities Compliance Journal.
- Winslow, H. (1992) . Using the dumpster as the gauge for waste identification and management Journal of Environmental Regulation.

Additional References Utilized

- Colorado Department of Health. (1993) . Colorado hazardous waste regulations 6-CCR-1007-3. Denver, Colorado: Author.
- Conservation Foundation. (1987) . State of the environment, a view toward the nineties . Washington D.C.: Author.
- Freeman, H. M. (1989) . Standard handbook of hazardous waste treatment and disposal. New York: McGraw-Hill.
- Government Institutes Inc. (1993) . RCRA hazardous wastes handbook. (10th ed.) . Rockville, Maryland: Author.
- Higgins, T. (1990) . Hazardous waste minimization handbook. Chelsea, Michigan: Lewis Publishers.
- Keller, E. A. (1988) . Environmental geology. Merrill Publishing Co.
- McCoy and Associates. (1993) . RCRA Regulations and keyword index. Denver, Colorado: Author.
- Tower-Borner. (1993) . Hazmat world. Chicago, Illinois: Tower-Borner Publishing Co.
- U. S. Govt. Printing Office. (1993) . Code of federal regulations, CFR-10. Washington, D.C.: Author.
- U. S. Govt. Printing Office. (1993) . Code of federal regulations, CFR-40. Washington, D.C.: Author.
- Wentz, C. A. (1989) . Hazardous waste management. New York: McGraw-Hill Publishing Co.
- Worobec, M. D. & Ordway, G. (1989) . Toxic substances controls guide. Washington, D.C.: BNA Books.

APPENDIX A--COVER LETTER

I am a student at a local university. As part of my graduation requirements, I have to complete a research project. You are asked to participate in the study. The current research involves radioactive waste storage issues.

Please answer all questions on the following five pages and return.

Note: Questions are printed on both sides to save paper.

All data gathered for the project is held in strict confidence. Your name and other identification are not requested. The results of this project will not be sold, formally published or utilized for any commercial profit. However, the completed project will be bound and placed in the university's library. Other people will have access to it to read or use as a reference text for other research.

If you would like a copy of the results of the study, please leave a self addressed stamped envelope with the completed survey you return. Results will be mailed to you as soon as the project is completed. The anticipated completion date is September 15, 1994.

APPENDIX B--QUESTIONNAIRE

1. Radioactive wastes are accumulating where they are generated because proposed permanent waste disposal sites are not yet open, mainly due to political concerns.

-- strongly agree
-- agree
-- unsure
-- disagree
-- strongly disagree

2. Radioactive wastes are accumulating where they are generated because of doubts over proposed technologies to safely store them.

-- strongly agree
-- agree
-- unsure
-- disagree
-- strongly disagree

3. Radioactive disposal sites have been designed and built to the highest standards possible and are ready to receive wastes.

-- strongly agree
-- agree
-- unsure
-- disagree
-- strongly disagree

4. Technologies have not been tested thoroughly enough to prove their ability to permanently isolate radioactive waste from the environment.

-- strongly agree
-- agree
-- unsure
-- disagree
-- strongly disagree

5. Valid public concern has delayed the opening of radioactive disposal facilities.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

6. The safety of these wastes is in question due to the manner and locations in which they are temporarily stored.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

7. Radioactive waste must be isolated effectively and permanently to prevent damage to human health and the environment.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

8. Radioactive wastes must be afforded the highest levels of priority, technology and funding available to safely isolate them.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

9. Wherever possible the generation of radioactive waste must be minimized or eliminated.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

10. Environmental activists (proclaiming, *not in my backyard*) are compromising the opening of permanent waste disposal facilities already constructed and impacting the increased interim and temporary storage at radioactive waste generating facilities. This is causing states to look for suitable storage locations within their borders jeopardizing public safety and the environment in those states with unsuitable areas for disposal.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

11. A public information campaign should be launched to educate the public on nuclear waste issues and associated problems.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

12. A better informed public will help solve nuclear waste storage problems.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

13. A well informed public can be an asset during public hearings for radioactive waste disposal sites.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

14. Public opposition to a nuclear waste disposal site can exert enough pressure during the public review process to eliminate it from consideration as a dump.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

15. Colorado has some areas that could be considered for permanent or retrievable radioactive waste storage.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

16. Should nuclear waste disposal sites being considered be canceled in the planning stage and monitored retrievable storage be implemented while current or future technologies are proven and tested over longer periods of time.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

17. No areas are suitable for permanent radioactive waste disposal in Colorado.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

18. The Waste Isolation Pilot Plant (WIPP) in New Mexico is suitable for permanent storage and should accept radioactive wastes from anywhere in the U.S.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

19. More testing is required to ensure radioactive wastes will be isolated permanently at WIPP prior to its opening.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

20. The agencies charged with regulating radioactive waste should continue in their quest to find the best possible areas in the world to permanently isolate these wastes.

- strongly agree
- agree
- unsure
- disagree
- strongly disagree

APPENDIX C--LEARNING OUTCOMES AT CCU

Concrete Experiences

I have learned that research is a continuing process. There is always new information coming to light that can be compared to past studies. The new information either supports the previous research by validating the previous study or it invalidates the previous study by disproving a previously formulated and accepted hypothesis based on new information. The researchers job is never done, and they must constantly be looking for new information and at comparative studies to learn all they can about their research topic. This for many is a life long endeavor.

Generalizations

I have discovered that research is a science unto itself. To compete in this world arena of study and have your work accepted by others, you must follow very specific rules that allow your work to be unbiased and reproducible. Good research is research that can be repeated over and over yielding the same result even by independent verification.

Skills Acquired

My ability to use an analytical approach in my thinking has been enhanced by the research project. I find that I almost instinctively start to subdivide projects into more manageable pieces and look for common denominators to categorize the sub-parts. This refinement in my thinking has allowed me to tackle large projects with greater skill and confidence and carry them out to their fullest completion.

Personal Reflections

This academic program has met and exceeded my expectations of its outcome. It has provided me with the requisite skills necessary to carry on and succeed in the business world today. It has also prepared me for completion of a masters program that I have been involved with for the past several years. I believe that I will be able to complete and deliver my masters capstone thesis project with a higher level of assurance.

**DATE
FILMED**

10/19/94

END