A STRATEGY FOR COMBINING THE POLLUTION PREVENTION OPPORTUNITY ASSESSMENT WITH THE ENVIRONMENTAL COMPLIANCE ASSESSMENT AND MANAGEMENT PROGRAM

THESIS

Stacy E. Gent, GS-12

AFIT/GEE/ENV/93S-08

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

Accession For	
NTIS GRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

AFIT/GEE/ENV/93S-08

A STRATEGY FOR COMBINING THE POLLUTION PREVENTION OPPORTUNITY ASSESSMENT WITH THE ENVIRONMENTAL COMPLIANCE ASSESSMENT AND MANAGEMENT PROGRRAM

THESIS

Presented to the Faculty of the School of Engineering

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Masters of Science in

Engineering and Environmental Management

Stacy E. Gent, B.S.

GS-12, Department of the Air Force Civilian

September 1993

Approved for public release; distribution unlimited

Acknowledgments

The preparation of this thesis required the support and assistance of many people. Starting with a special thanks to Capt James Todd and Ms Christine Steagall of the Environmental Flight at Shaw AFB for all their moral support and insights, not only during the thesis preparation, but throughout my AFIT career, as well. Beyond these two people, I owe a real debt of gratitude to Ms Jean-Marie Jacobs at Headquarters Air Combat Command and Capt Nathan Macias at the School of Civil Engineering for providing data and background information necessary for the completion of this study. An extra special thank you goes to my thesis committee, Capt James Aldrich and Ms Kim Campbell for their patience, suggestions, and most importantly, for helping me develop and broaden my critical thinking skills. Finally, not to be forgotten, is Ms Sherry Rydzewski, for all her administrative help. Every one of these people was instrumental in the successful completion of this document, and a great big thank you is extended to them.

Stacy Ellen Gent

Table of Content

List of Figures

List of Tables

AFIT/GEE/ENV/93S-08

Abstract

This research develops a method to allow an installation environmental function to satisfy the assessment requirements of both the Air Force Pollution Prevention and Environmental Compliance Assessment and Management programs with the implementation of one assessment process. The model developed is designed to achieve the goals of both programs while increasing the efficiency of implementation.

The resulting assessment model formulated within this research is applied on a theoretical level to yield preliminary results. These results indicate that the combination of the Pollution Prevention Opportunity Assessment and the environmental compliance assessment required by the Environmental Compliance Assessment and Management Program is a viable initiative. These results also indicate that by combining both assessments, greater efficiency, as measured by cost, time, and interruptions, can be achieved.

Although the model developed in this research is designed for application to Air Force programs, it could also support requirements of the other military services.

A STRATEGY FOR COMBINING THE POLLUTION PREVENTION OPPORTUNITY ASSESSMENT WITH THE ENVIRONMENTAL COMPLIANCE ASSESSMENT AND MANAGEMENT PROGRAM

I. Introduction

General Issue

Historically, Congress has passed a wide range of laws to protect the environment from the effects of population and industrial growth. These laws have established end-of-pipe solutions to protect air, water, soil, and groundwater, and provided waste management criteria for these media. Recently, however, a trend has emerged that transfers the emphasis of legal requirements away from end-of-pipe waste treatment to prevention of pollution at the source (Alm, 1991:1023). With the passage of the 1990 *Pollution Prevention Act*, Congress declared its intent to realize existing opportunities for reducing and preventing pollution at the source. Toward the realization of these opportunities, federal environmental agencies have turned to pollution prevention as a method of achieving environmental compliance and reducing generated wastes (42 USC, 1990:583). Although the awareness of source reduction as a solution has evolved over time, it is a cornerstone for the creation of most new Environmental Protection Agency (EPA) programs.

As early as the 1970's, an increase in pollutant generation and associated compliance problems, such as air pollution and waste disposal, were recognized. Initial attempts to control this increased pollution were based upon strategies addressing waste once it was generated (i.e. end-of-pipe strategies). These strategies included the installation of scrubbers on industrial smoke stacks to purify air emissions, and the recycling and treatment of liquid waste once it was generated. As waste disposal concerns have grown, the nation has recognized that coping with waste once it is generated is not an answer to the pollution problem. Today, the focus is upon preventing pollution before it is generated. This change is not only driven by a desire to clean up the environment, but also by financial concerns as government budgets are being reduced in the 1990's and costs to control pollution are increasing as technology advances. As budget reductions occur, all government agencies will be faced with a need to streamline their programs and reduce their program implemetation and compliance costs.

A recognition has recently emerged that federal commitments for the environment exceed available resources (Hanash, 1991:243). Although federal budgets are being cut, Congress is continually developing additional environmental regulations. This development is occurring despite the fact that estimates for the Department of Defense environmental clean-up exceeded 24 billion dollars in 1992 (Hanson, 1992:15). Subsequent to concerns over funding and a recent Congressional order for the Air Force to cut an estimated 2.8 billion dollars from its 1994 budget, all organizations within the Air Force must find more efficient ways of performing their assigned tasks (Hutcheson, 1993:4A). These cuts will eventually affect all programs within the Air Force. Although environmental compliance budgets have not felt the budget reduction impact to date, it is logical to assume that they will be affected as deeper financial cuts are implemented.

This thesis proposes one method to meet environmental compliance and pollution management requirements, while reducing the budgetary requirements of the installation environmental function. The proposal is a strategy for combining the assessments required by the Pollution Prevention Program and the Environmental Compliance Assessment and Management Program (ECAMP). This study is primarily descriptive; examining federal laws, Air Force regulations and programs, and EPA guidance. First, federal laws applicable to pollution prevention and environmental compliance will be examined, then Air Force programs developed in response to these laws, industry practices, and EPA policy will be examined and discussed. Next, based upon this examination, and information gained from publications on assessment techniques, a strategy to combine the Pollution Prevention Opportunity Assessment and the ECAMP assessment will be proposed. This strategy will provide for the performance of a single assessment to satisfy environmental compliance requirements of both programs, while at the same time satisfying their information requirements.

Specific literature to be reviewed includes, but is not limited to, articles and publications on the Resource Conservation and Recovery Act, the Pollution Prevention Act, industry environmental auditing philosophy and techniques, and the Air Force Environmental Compliance Assessment and Management Program. Next, an outline of the Air Force Pollution Prevention Program, concentrating on the Opportunity Assessment, and the ECAMP assessment will be provided. A review of two basic approaches for structuring environmental assessments will also be provided and finally, a strategy for combining the two assessments will be proposed and recommendations for further study will be provided. The study will conclude with recommendations on further projects to promote this combined assessment approach.

Problem Statement

This research will investigate combining the Pollution Prevention Opportunity Assessment with the ECAMP assessment.

In support of this strategy, a method to integrate the two assessments will be proposed.

Research Objectives

Three specific objectives will be satisfied by this research:

1. Establish that the requirements of the Pollution Prevention Opportunity Assessment and ECAMP assessment are similar;

2. Propose a model for the combination of the Pollution Prevention Opportunity Assessment and the ECAMP assessment; and

3. Provide a theoretical application of the proposed model.

II. Background

The Air Force Environmental Compliance Assessment and Management Program (ECAMP) and the Pollution Prevention (PP) program were both developed in response to the advent of federal laws concerning waste management and reduction. Both programs evaluate an installations environmental operations utilizing an assessment procedure designed to enhance environmental compliance while at the same time obtaining the necessary information required to satisfy federal environmental laws. The Air Force assessment programs for environmental compliance and pollution prevention are currently administered as two stand-alone assessment programs. This portion of the review will discuss the laws and policies that relate to each program, Environmental Protection Agency (EPA) policy, methods used by industry to comply with the laws, and the Air Force programs, PP and ECAMP, developed to comply with each law and/or policy. This information will serve as a basis for developing a strategy for combining the two assessments required by PP and ECAMP.

Waste Minimization

Waste minimization refers to the reduction in volume or toxicity of a waste prior to its discharge or disposal

(Vajda, 1992:36). The concept of waste minimization is an idea that is neither unique or new. The term "waste minimization" was first used in the 1972 Clean Air Act to address the reduction of air pollutants released to the en ironment. Subsequently, the term has become closely associated with hazardous waste and the *Resource Conservation and Recovery Act* (RCRA).

In 1976, Congress enacted RCRA to establish a hazardous waste management system and to encourage the conservation and recovery of materials and energy (42 USC, 1984:5577). In 1984, Congress reauthorized RCRA and turned the spotlight on the concept of conservation and recovery through waste minimization (42 USC, 1984:5605). The intent of RCRA, and specifically the 1984 amendments, is to "convey a clear and unambiguous message" that advanced treatment, recycling, incineration, and other hazardous waste control technologies should be used wherever feasible to reduce the amount of hazardous waste disposed (42 USC, 1984:5615).

The 1984 RCRA amendments also introduced waste minimization requirements. For the first time, companies were required to demonstrate they had processes in place to minimize the amount of wastes generated. These amendments required that hazardous waste manifests, used to track the transport of hazardous waste, include a certification indicating the waste generator had a minimization program (Megna, 1992:7). Furthermore, these amendments required generators to prepare and submit annual reports to EPA outlining waste minimization initiatives and amounts of waste reduction achieved.

Although waste minimization is mentioned in laws other than RCRA, since 1976 the term has been primarily associated with the minimization of waste streams, especially those that are hazardous (Megna, 1992:7). Waste minimization is usually accomplished by reducing the quantity or toxicity of waste generated or by recycling waste. In the 1990's, the concept of waste minimization has expanded and evolved into the Pollution Prevention Act.

Pollution Prevention Act

In 1990, Congress passed the *Pollution Prevention Act*, in response to the growing recognition that many unrealized opportunities exist for industry to reduce or prevent pollution at the source. Congress, with the passage of this act, acknowledged that opportunities for waste reduction at the source are lost as a result of existing federal regulations. These existing regulations increase the cost of, or prevent entirely, the implementation of source reduction opportunities. Thus, the passage of this law switched the regulatory focus from treatment and disposal to source reduction (42 USC, 1990:584). Source reduction, as defined within the Pollution Prevention Act, is any practice which:

1. reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released to the environment prior to recycling, treatment or disposal; and

2. reduces the hazards to public health and the environment associated with the release of such substances, pollutants or contaminants (42 USC, 1990:584).

This act was passed as a catalyst to shift the focus of waste generators and regulatory agencies from waste treatment and disposal to reduction and/or prevention at the source. Pollution prevention ideally involves modifying or completely changing production processes to use fewer toxic and hazardous materials and to use these materials more efficiently to produce less waste (Mooney, 1992:38).

The *Pollution Prevention Act* also establishes a preferred disposal hierarchy for wastes. This hierarchy outlines the official United States policy on pollution reduction. This hierarchy, represented in Figure 1, sets the following goals:

- reduce or prevent pollution at the source;
- recycle waste that cannot be prevented;
- treat waste that cannot be prevented or recycled; and
- dispose of waste when no other alternative exists.

This act also requires the Environmental Protection Agency (EPA) to establish a strategy to promote source reduction. The prescribed approach for this strategy is multi-media, focusing on integrated pollution reduction alternatives (42 USC, 1990:585). As a result of this

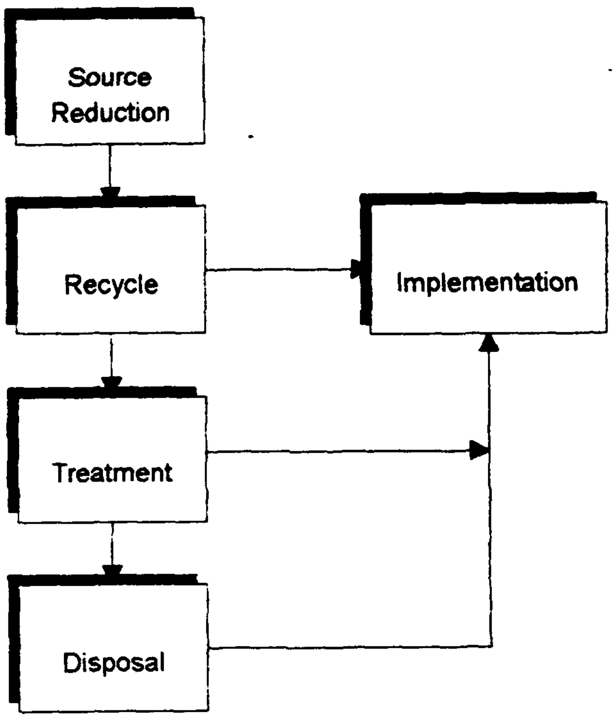


Figure 1: Pollution Prevention Hierarchy shown in the order of preferred waste disposition as stated in the Pollution Prevention Act of 1990.

tasking, EPA is responsible for establishing a clearinghouse of source reduction information, available to every company and federal organization.

Although the Act places a burden on EPA, it also tasks industry with a reporting requirement. A primary provision of the *Pollution Prevention Act* requires all companies to file annual reports detailing the amount of chemicals entering a waste stream and all source reduction practices a company has implemented to reduce pollutant generation (42 USC, 1990:587-588). The detailed information needed to satisfy this reporting requirement acted as a catalyst for the development of a pollution prevention assessment. This information requirement imposes a heavy burden on anyone generating any type or quantity of pollutant. In order to provide the necessary information for annual reports, the following steps have been identified as necessary:

- conduct a baseline audit and annual assessment;
- ensure that costs and benefits of pollution prevention can be tracked; and
- document all pollution prevention activities. (Mooney, 1992:40)

Additionally, a successful pollution prevention program must examine all operational areas and break them down into functional areas (Woodman, 1992:27). Consequently, the *Pollution Prevention Act* requires companies to describe and quantify their efforts to reduce waste (Ember, 1991:12).

The Act itself, in fact, requires reporting of very specific information on an annual basis. This information requirement is outlined in Table 1.

TABLE 1

REPORTING REQUIREMENTS OF THE
POLLUTION PREVENTION ACT

CHEMICAL INFORMATION	PROCESS INFORMATION
- quantity of chemical entering any waste stream	- recycling process used
- quantity of chemical recycled	- source reduction practices used
- percentage change of recycled material from the previous year	- a description of recycling processes and source reduction practices planned for the following two years
- estimate of the above information for the following two years	- a ratio of production in the reporting year to production in the previous year
- amount of chemical that is treated during the reporting year	- a description of techniques used to identify source reduction opportunities
- amount of chemical released to the environment during the reporting year	

TABLE 1: Information required to be submitted in the annual Pollution Prevention report to EPA (42 USC, 1990:587-588).

The data within this report provides an accounting of a company's pollution prevention efforts and provides the basis for an EPA report to Congress. Because of the extent of information required, and the specificity of the information required, conducting annual assessments of pollution producing processes has become necessary.

Environmental Compliance Assessment and Management Program

Unlike the Pollution Prevention Program, the Environmental Compliance Assessment and Management Program (ECAMP) was not developed to comply with any federal law(s). Instead, this program is designed to comply with the mandates of an Executive Order issued in October 1978. This order was intended to compel federal agencies to come into compliance with all environmental related laws (Bertino, 1990:45). This Executive Order, numbered 12088, required all federal facilities to cooperate with the EPA and provide for compliance with their regulations.

Subsequent to the issuance of this order, EPA issued a formal agency-wide policy statement encouraging all federal facilities to adopt environmental auditing practices (Bertino, 1990:45). This policy came about because of an increase in regulatory requirements. These requirements, combined with enforcement activities by EPA and States, policy statements, Executive Orders, and criminal liability of federal employees for violations, necessitated the implementation of some compliance oriented program. Additionally, despite the implementation by the Air Force of the first compliance assessments in 1984, a rise in the number of environmental violations at federal facilities was occurring (Macias, personal interview, 1993).

In 1986, the first formal ECAMP manual was published by the Air Force. This manual was quickly followed by an official policy, issued in May 1986 (Ahern, briefing slides). Subsequent to this initial manual, revisions were issued in 1989 and 1992. Today's ECAMP process has evolved from these early documents into a comprehensive assessment program covering all environmental laws.

Environmental Protection Agency (EPA) Suggested Assessment Methods

Within the federal EPA, pollution prevention has become the operative strategy for the 1990's (Ember, 1991:7). In support of this strategy, recent literature notes that EPA is avidly working to incorporate pollution prevention concepts into its regulations (Firestone, 1991:79). To promote the incorporation of these concepts, EPA established a separate pollution prevention office, emphasizing the importance of pollution prevention as a national strategy. The creation of this office demonstrates EPA's commitment to waste reduction at the source. The following remark by a deputy EPA Administrator, F. Henry Mahicht, II, characterizes this agencies commitment:

> ...the road we will take to get there [integrated

> environmental policy] will be marked by a commitment to pollution prevention and waste minimization. (Ludwiszewski, 1991:13).

Pollution prevention and environmental compliance have become integrally linked at the EPA with the promotion of pollution prevention as the solution of choice for environmental problems (Nichols, 1991:54). The focus at EPA has shifted to the prevention of waste generation as a method of achieving regulatory compliance. Waste reduction through prevention is accomplished by encouraging compliance agreements seeking permanent source reduction opportunities (Ludwiszewski, 1991:14). Although EPA cannot force pollution prevention, the agency does have the authority to include pollution prevention conditions in a Consent Order when resolving enforcement actions (Ludwiszewski, 1991:13). The agency is thus using enforcement, pollution prevention, and environmental auditing as behavior modification techniques to promote the reduction of hazardous pollutants (Firestone,1991:79). As the use of these techniques increases, so will the environmental awareness of the United States and the trend toward the integration of pollution prevention into operational processes by waste generating activities.

A primary benefit of pollution prevention is that it offers the unique advantage of harmonizing environmental protection with economic efficiency in an endeavor to obtain environmental compliance (Nichols, 1991:55). As a result, companies that previously have not focused on pollution reduction are quickly converting. This is occurring as EPA changes its focus to risk prevention rather than trying to control risk once it has been created (Nichols, 1991:54). A commitment to pollution prevention not only benefits the regulators, but translates into efficiency, financial gains, and an opportunity to prevent future compliance problems (Ludwiszewski, 1991:13).

Industry Assessment Methods

The Pollution Prevention Act, combined with other existing environmental laws, has resulted in a need to develop new management mechanisms for achieving environmental compliance (Wilson and Billings, 1991:73). Conducting assessments of a company's operations is the primary mechanism adopted by industry to achieve environmental compliance. Conducting one assessment that satisfies compliance by source reduction has long been accomplished by industry. Industry began using this strategy to promote compliance with the waste minimization requirements contained in the *Resource Conservation and Recovery Act*. This section will provide evidence that demonstrates the use of source reduction as a waste minimization activity by industry. While source reduction is a new regulatory requirement, it has been a goal of industry as a means to reduce expenses for many years.

Historically, industry has accomplished the goal of obtaining environmental compliance through source reduction under the banner of environmental auditing. This environmental auditing, however, has been directed toward the achievement of production efficiency. Many private sector companies realize that pollution prevention translates into increased compliance, lower production cost, and increased efficiency. Environmental auditing to ensure process efficiency is advocated by private sector industries, as is pollution prevention. Although it may be argued by some readers that industry performs these assessments as a method to reduce regulatory fines, it must be remembered that only those facilities possessing a permit for environmental activities are subject to routine regulatory inspection. Since not all facilities are inspected routinely, such as occurs on Air Force installations, it is likely that the reduction of expenses associated with the manufacturing or production process is the primary driver behind industry environmental compliance audits. Subsequently, the following review discusses industry theories and practices regarding these two programs without reference to reduction in compliance findings at facilities.

Pollution Prevention. Many cases of pollution prevention opportunities being implemented as a result of compliance auditing can be found within the literature.

Primarily, pollution abatement through source reduction has been initiated within industry as a method to better achieve compliance with federal environmental programs by reducing the need to comply. In fact, as early as the 1980's, industry recognized that pollution prevention projects reduce expenses, while at the same time improving environmental compliance. Savings are achieved by conserving raw materials, energy, and water resources and by reducing the associated liability (Vendinello, 1992:28). One industry, the Dye industry, has even identified two steps necessary to promote successful pollution prevention programs. These steps are:

> 1) preparation of a guidance manual to aid workers in identifying opportunities for source reduction and process modifications; and
>
> 2) preparation of a baseline survey of current pollution prevention practices within a company. (Woodman, 1992:27).

Implementation of these practices has allowed this industry to obtain an industry-wide reduction of pollution. This reduction is attributed to the increased awareness of workers of the consequences of pollutant generation and the establishment of procedures within the guidance manual for workers to follow in suggesting process modifications to reduce pollutant generation.

The 3M Company has also recognized the benefits of pollution prevention. In 1975, 3M began a program to encourage pollution and energy reduction activities. This program, entitled "Pollution Prevention Pays," has saved an estimated 530+ million dollars to date (Ember, 1991:12). In 1986, Dow Chemical followed suit and began a voluntary program of pollution (waste) reduction as a method to achieve greater production efficiency. The stated goal of Dow's program is to reduce environmental releases in a cost effective manner (Ember, 1991:12). The first year implementation savings for 1990 waste reduction projects are estimated at over 18 million dollars (Ember, 1991:12).

These companies provide an example of how industry has reduced production expenses by implementing Pollution Prevention. Additionally, these companies provide evidence of the private sector's awareness that the road to environmental compliance lies in the direction of reducing pollution generation. In reducing their pollutant generation, industry reduces their environmental compliance burden. Because of this philosophy that wastes that are eliminated negate compliance responsibilities, pollution prevention is considered integral to achieving environmental compliance within industry. The concept of source reduction has long been addressed as an industry goal of environmental auditing and achieving process efficiency.

Environmental Compliance. The private sector has long recognized the value of reducing pollution through compliance assessments as a method of achieving environmental compliance. Indeed, many articles detailing industry environmental auditing practices identify the ability to assess activities for pollution reduction opportunities as a key element of environmental auditing practices (Hill, 1991:34). According to Anne-Marie Warris, in her article "Making the Case for Environmental Assessments", the European Community is developing a method to combine compliance assessments with raw material balances and management systems; two key elements of pollution prevention auditing. This approach will provide the Europeans with a comprehensive approach to environmental compliance by pollution reduction, and will make them commensurate with United States industries.

Many companies use environmental compliance auditing. One example is DuPont; a company that has been auditing since the 1970's (McGuinness, 1992:72). The objective of the DuPont audit is to assess and improve the company's environmental performance. This improvement can occur through many different avenues; source reduction and process modification are two examples. Success for DuPont's program was defined as a reduction of generated wastes requiring disposal and/or a reduction in costs to comply with environmental laws. Because of their success in reducing waste generation and costs associated with environmental compliance, this company is cited industry-wide as an example of successful environmental auditing. There is one key point to note about the DuPont audit. According to this company, an auditor must have an understanding of management systems and controls (McGuinness, 1992:75). This translates into a knowledge of the processes the company uses to produce its products, a key element within pollution prevention.

Allied-Signal is another company with a well established environmental auditing program. As a result of a pesticide leak in 1975, Allied Chemical, the predecessor of Allied-Signal, established a comprehensive environmental auditing program (Harris, 1991:36). The Allied-Signal program is considered by management to be a comprehensive tool with which to view the overall management of its plants. The company's goal is to verify conformance with the corporate's health, safety, and environmental policy; the first step of which is compliance with the applicable federal and state regulations (Harris, 1991:37). The auditing program at Allied-Signal has grown so extensively that the company now has its own auditing division. This division provides oversight to 240 plants worldwide (Harris, 1991:36). Reports prepared subsequent to the audit are provided to each area President along with an action plan for the correction of any deficiencies. This action plan can include such minor fixes as employee training or major fixes such as process modifications.

The notion of environmental auditing as an approach to identifying waste reduction opportunities, and thus pollution prevention opportunities, seems to be a recurring theme throughout industry. Most private sector industries undertake voluntary self-monitoring programs such as environmental auditing. Pojasek and Cali confirm this observation that industry typically uses compliance auditing procedures to assess waste reduction opportunities, in addition to determining compliance status (Pojasek and Cali, 1991:225).

The realization by industry that source reduction is more desirable than waste management and pollution control, has led to their establishment of guidelines for environmental auditing. These guidelines include a requirement that environmental assessments not only review environmental compliance, but also produce a report containing recommendations to minimize the environmental impact of operations (Warris, 1991:13). Audits should also measure the impact of an organizations operations on the environment and investigate opportunities for improvement (Maxwell, 1990:70). The efficiency of management systems and production processes should also be evaluated. This evaluation is directed toward determining methods to reduce pollution, and thus compliance problems. Finally, environmental auditing should also provide a basis for minimizing liability of a company and developing cost-saving measures (Hill, 1991:33).

Air Force Assessment Methods

Pollution Prevention Program. The Air Force pollution prevention (PP) program has been designed to identify opportunities for complying with the national policy of prevention or reduction of pollution at the source. Reduction or elimination of hazardous substances and waste, and reduction of environmental discharges to air, land, surface water, and groundwater comprise the plan for accomplishing these objectives (AFPD 19-4, 1992:1). In support of this plan, the Air Force has developed a PP assessment program, outlined in the *U. S. Air Force Installation Pollution Prevention Program Manual, 1992* and Air Force Instruction 19-40, *Instruction for the Pollution Prevention Program.*

The Air Force program requires a survey of all installation waste generating activities and each waste stream, and the development of a Pollution Prevention management plan (AFI 19-40, 1992:4). The survey, called an "Opportunity Assessment", involves a systematic environmental assessment and process review. The objective of this assessment and process review is to identify methods to reduce or eliminate wastes (USAF Pollution Prevention Manual, 1992:3-1). Implementation of this assessment is designed to facilitate reductions in waste generation, compliance problems, costs, and associated environmental liabilities.

The Air Force PP program is a multi-faceted approach to environmental problem solving and regulatory compliance (USAF Pollution Prevention Manual, 1992:1-4). The official program goal is the reduction of the use and disposal of hazardous and toxic materials at Air Force installations by minimizing the amount of material used at the source, recycling wastes, and increasing worker awareness of material and waste handling practices (USAF Pollution Prevention Manual, 1992:1-1). The PP Opportunity Assessment is the Air Force's proposed method of identifying opportunities for implementing these ideals and achieving the program goal. The PP Opportunity Assessment is a four step process consisting of:

1. planning and organization;
2. site assessment;
3. feasibility analysis; and
4. implementation.

The implementation strategy for the PP program is outlined within the *Air Force Installation Pollution Prevention Manual*. The planning and organization phase and the feasibility analysis phase are the most complex stages of the program. A flow diagram of each of these stages is provided at Figures 2 and 3. The Opportunity Assessment involves assembling a multidisciplinary assessment team whose primary responsibility is conducting the on-site assessment. This assessment is performed as a systematic

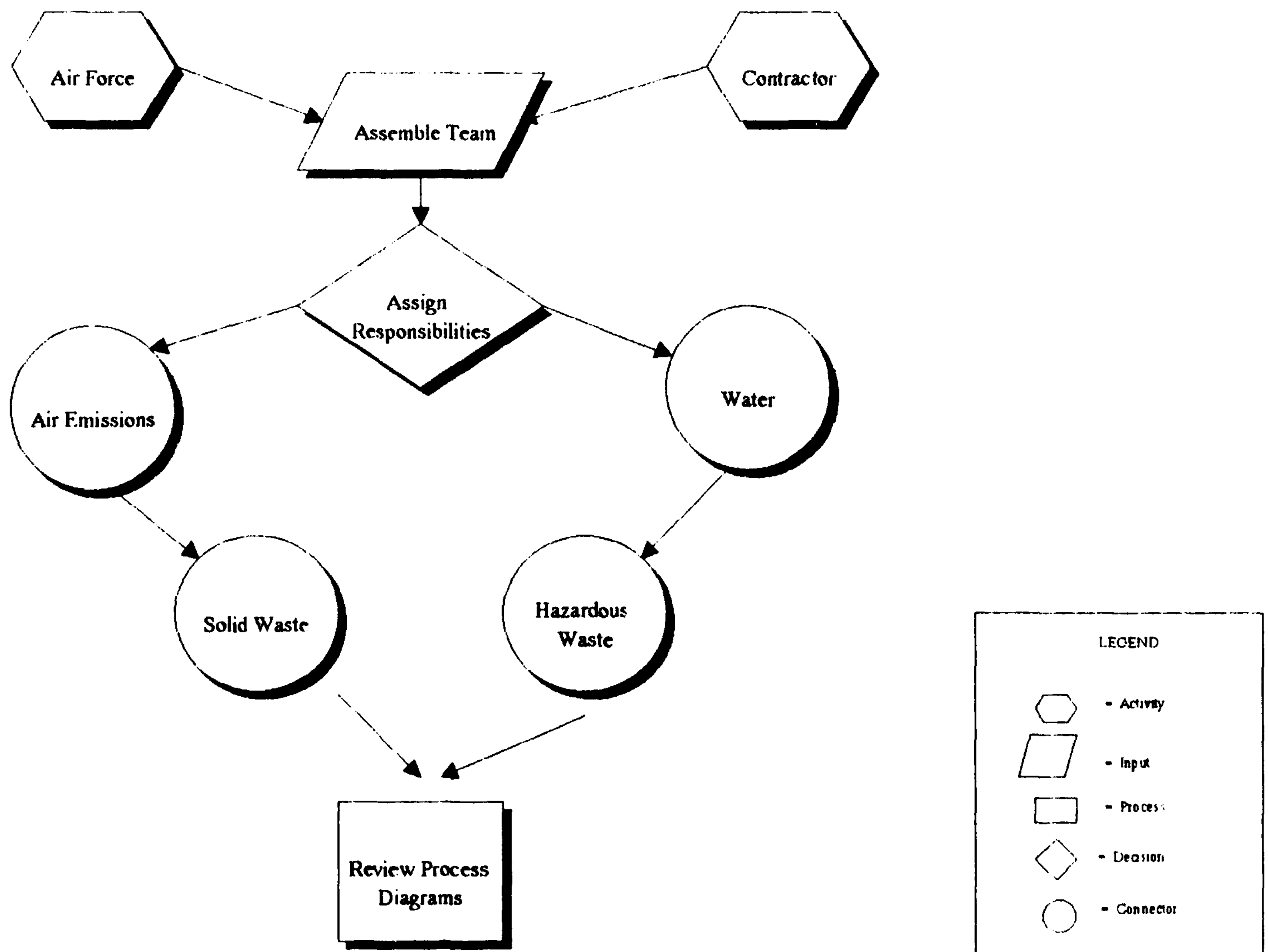


Figure 2: Flow Chart of the Steps Involved in the Planning and Organization Phase of the Opportunity Assessment. An explanation of the Legend is in Appendix A.

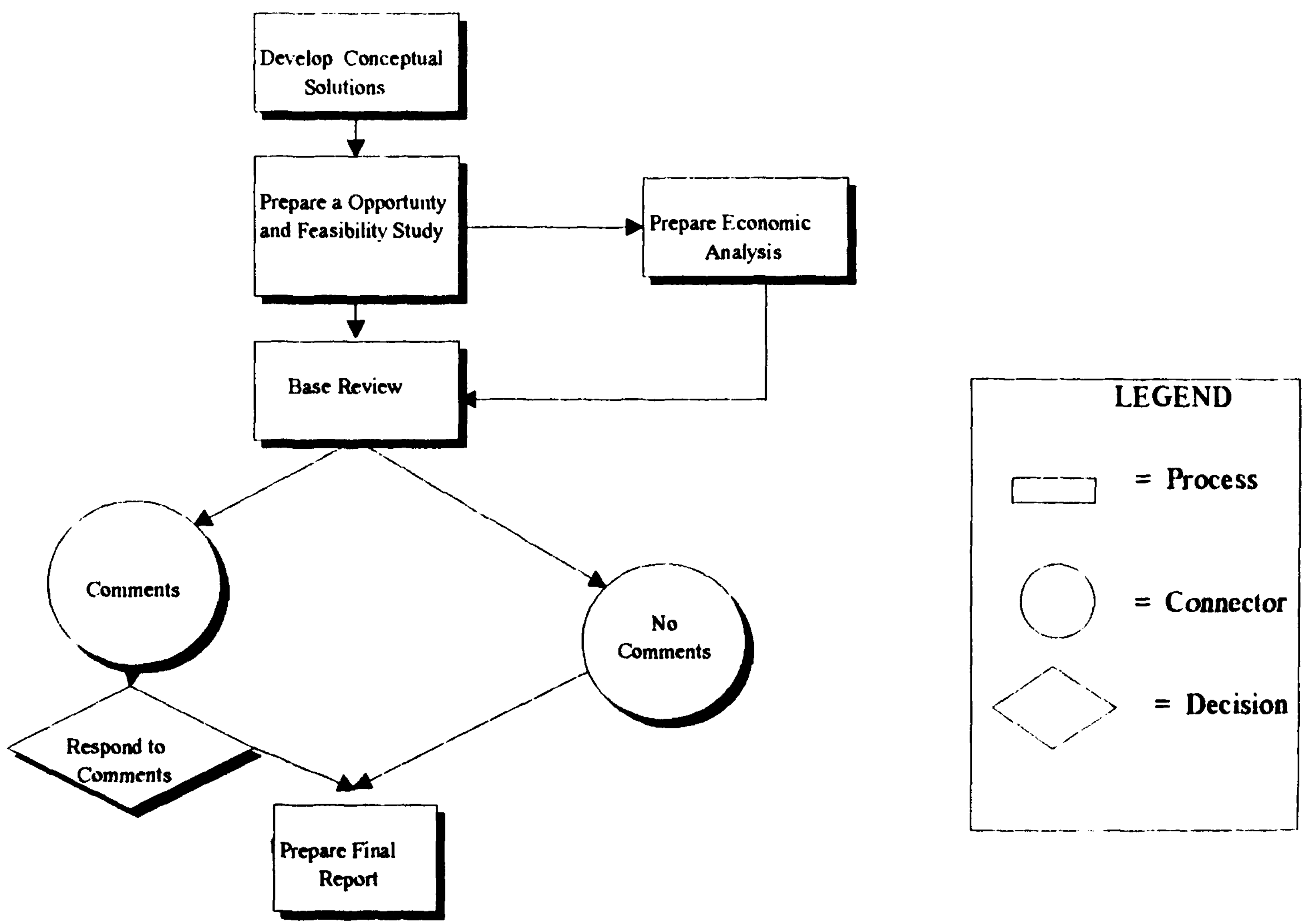


Figure 3: Flow Chart of the Steps Involved in the Feasibility Analysis Phase of the Opportunity Assessment. An explanation of the Legend is in Appendix A.

environmental assessment and review procedure intended to identify base waste streams, amounts of waste produced, and classify the wastes by hazard (USAF Pollution Prevention Manual, 1992:3-1, 3-2). The assessment also involves cataloging and presenting findings, and making recommendations to the base Environmental Protection Committee on process changes to reduce pollution (USAF Pollution Prevention Manual, 1992:2-3).

A site assessment of installation facilities is conducted as the second step Opportunity Assessment. This assessment provides the assessment team with more detailed information on waste generating processes and investigates the methods that generate the waste to identify areas where in-process losses can be reduced (USAF Pollution Prevention Manual, 1992:3-4). Opportunity Assessments are conducted at each Air Force base annually to update process and waste generation information and identify further pollution reduction opportunities. This site survey is an integral portion of the Air Force pollution prevention process since all required data to meet the Environmental Protection Agency reporting requirements is obtained at this time.

Environmental Compliance Assessment and Management Program. The Air Force conducts its environmental assessment program under the title of the Environmental Compliance Assessment and Management Program (ECAMP). The ECAMP assessment is a comprehensive self-evaluation to monitor compliance with environmental laws and regulations (AFR 19-16,1990:1). The ECAMP assessment is a tool to aid the Air Force in improving its environmental management in the United States (AFR 19-16, 1990:3). Thus, the primary objective underlying the ECAMP assessment is the identification of areas where an installation is out of compliance with state or federal regulations. The ECAMP, as designed, does not seek to minimize the amounts of waste generated, but to identify areas of environmental non-compliance at a given installation. The underlying intent of the ECAMP assessment is to identify and correct non-compliance areas prior to a regulatory inspection.

ECAMP assessments are performed on an annual basis, as required by Air Force regulation 19-16, *Environmental Compliance Assessment and Management Program*. The intent of the ECAMP assessment is achieved through the performance of a systematic, documented, periodic, and objective evaluation of an installations operations. This evaluation will determine the environmental compliance status of the installation. The Air Force ECAMP is performed as a three phase process. These phases are:

1. Pre-evaluation;
2. Site evaluation; and
3. Post evaluation (ECAMP Manual, 1991:1-4).

The ECAMP pre-evaluation phase consists of the completion of a questionnaire detailing information on base waste disposal practices and generating processes (ECAMP

Manual, 1991;1-4, 1-12 to 1-24). A copy of this questionnaire can be found in Appendix B. The completed questionnaire is then used by the assessment team to obtain a basic understanding of installation activities. This questionnaire is the primary tool available to familiarize the assessment team with a base prior to their arrival for the site evaluation. The pre-evaluation phase is presented in a flow-diagram at Figure 4.

The "site evaluation" phase involves assembling a multidisciplinary evaluation team to visit all areas of the installation that handle, store, generate, and/or dispose of waste. All liquid, solid, and gaseous wastes and the processes that generate them are reviewed during the site evaluation. Additionally, all operational areas are evaluated for compliance with federal and state environmental regulations. Record searches, interviews, and site surveys are also performed as part of this evaluation. The information collected provides a basis for making recommendations to the installation on process/procedure modification to achieve environmental compliance (ECAMP Manual, 1991:1-5). Recommendations on process/procedure modification(s) are made during post evaluation activities.

Post-evaluation activities include an out-brief, the preparation of a report of findings, and a plan of corrective actions. The out-brief is a presentation provided to the installation Environmental Protection

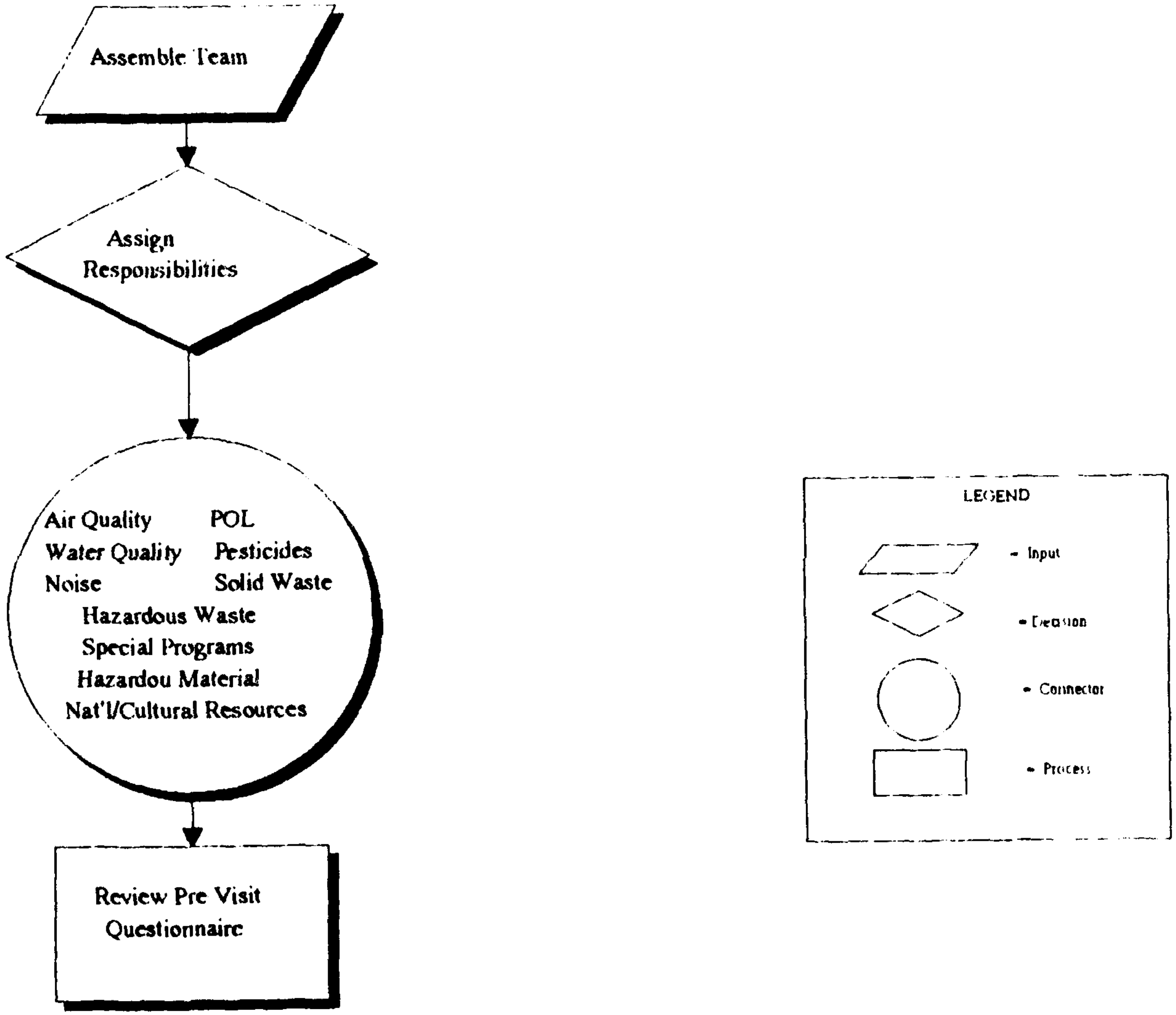


Figure 4: Flow Chart of the Steps Involved in the Pre-Evaluation Phase of the ECAMP. An explanation of the Legend is in Appendix A

Committee summarizing any non-compliance situations found on the installation and recommending changes to correct these violations. Recommendations on modifying procedures to reduce waste generation and/or improve operating procedures can also be made at this time.

After the out-brief, and after the evaluation team has left the installation, a report of findings and a plan of corrective actions are prepared. The report of findings details all non-compliance situations noted by the assessment team and provides a basis for the installation to begin planning corrective actions. After the installation is provided the report of findings, they then are responsible for preparing a corrective actions plan in response. This plan outlines what actions the installation will undertake to correct all non-compliance issues. The ECAMP process is an on-going and dynamic process that continues until all compliance issues are resolved and no new issues can be identified. This process is presented in a flow-diagram at Figure 5.

In examining the ECAMP process and comparing its steps to the pollution prevention process, it becomes obvious that these programs are executed in similar manners. In fact, both assessments involve many of the same processes. Table 2 provides a comparison of each assessment. Both programs require assembling a multidisciplinary team, conducting a site survey, and visiting all waste generating activities.

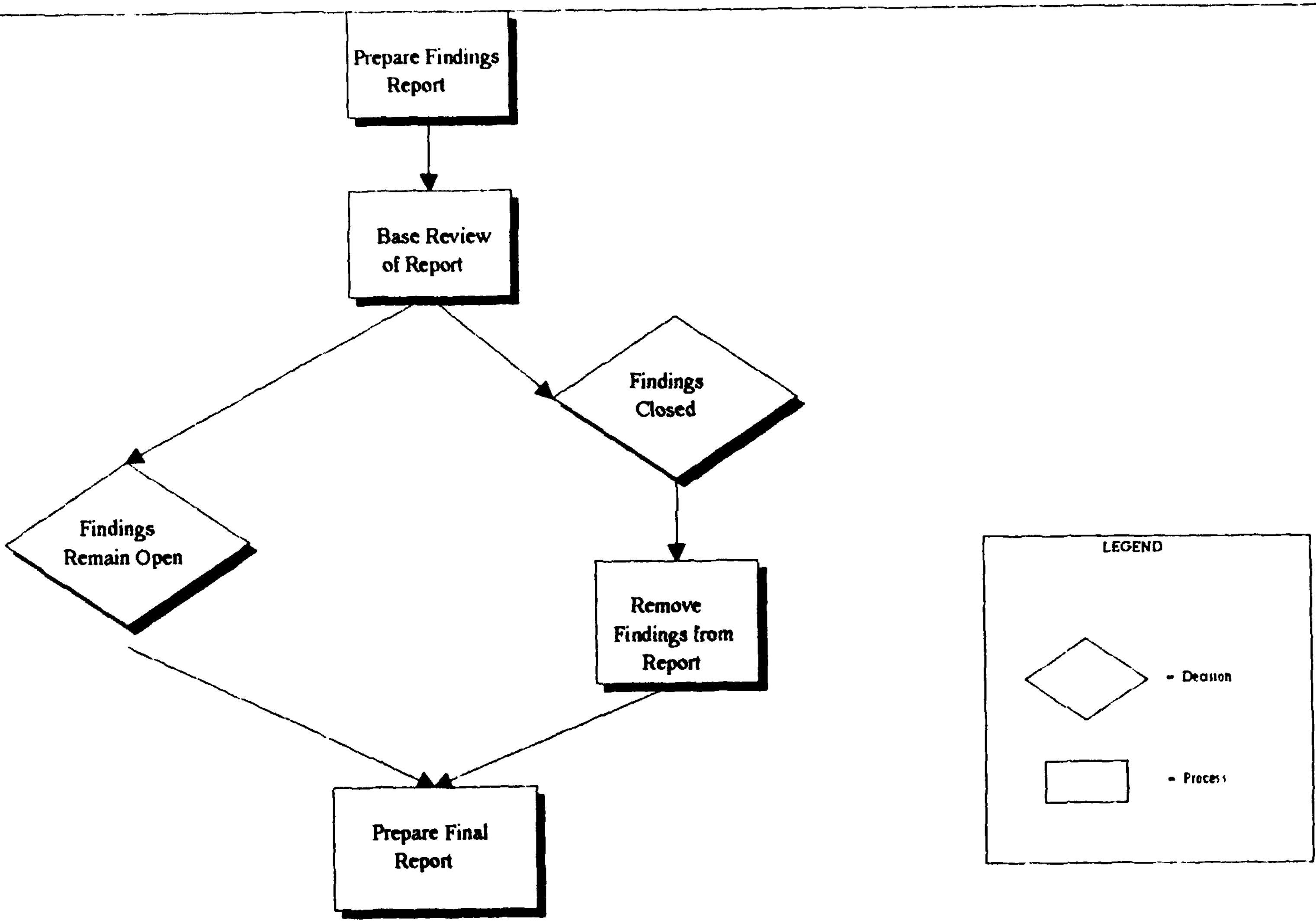


Figure 5: Flow Chart of the Steps Involved in the Post Evaluation Phase of the ECAMP. An explanation of the Legend is in Appendix A

Finally, both the ECAMP and PP program assessments involve briefing the Environmental Protection Committee and making recommendations on ways to improve base environmental practices. The audit approach proposed by this study relies upon the basic similarities in structure of the programs in formulating a strategy to combine the assessments.

TABLE 2

COMPARISON OF ASSESSMENTS

<table>
<tr><th>OPPORTUNITY ASSESSMENT</th><th>ECAMP</th></tr>
<tr><td colspan="2">Multidisciplinary Team</td></tr>
<tr><td colspan="2">Review of Process</td></tr>
<tr><td colspan="2">Site Visit</td></tr>
<tr><td>Evaluation by Industrial Process</td><td>Evaluation by Environmental Media</td></tr>
<tr><td>Report on Pollution Reduction Opportunities and Economic Evaluation</td><td>Report on Non-compliance Findings</td></tr>
<tr><td colspan="2">Base Review and Comment on Report</td></tr>
<tr><td colspan="2">Final Report Provided to the Environmental Protection Committee</td></tr>
</table>

TABLE 2: A comparison of Pollution Prevention Opportunity Assessment requirements with Environmental Compliance Assessment and Management Program requirements.

III. Proposed Assessment Approach

Environmental auditing procedures are typically structured around one of two approaches. This Chapter will introduce these two environmental audit approaches and provide the basis for the proposed assessment approach developed within this thesis. The two approaches discussed are the prescriptive and descriptive assessment approaches. This discussion will include identification of the implementation styles of each approach, the benefits and drawbacks of each approach, and culminate with a proposed assessment strategy that combines both assessments. This strategy is intended to combine the Pollution Prevention Opportunity Assessment with the Environmental Compliance Assessment and Management Program only, not to combine the entire program goals.

Basic Assessment Approaches

Two basic audit approaches are used when performing various types of environmental audits: the prescriptive approach and the descriptive approach. The prescriptive approach is typically used for compliance auditing while the descriptive approach is commonly used for pollution reduction or waste minimization auditing.

Prescriptive Approach. As previously mentioned, the prescriptive approach is primarily used in environmental compliance auditing. This approach involves the collection and organization of data using questionnaires, work sheets, and checklists as assessment tools (Pojasek and Cali, 1991:227). Typically, these tools consist of an outline of applicable environmental regulations and provide questions to ask and conditions to look for to locate potential compliance problems. An example of one of these checklists/questionnaires currently used by the Air Force in its Environmental Compliance Assessment and Management Program is in Appendix C.

There are several advantages to the prescriptive audit approach; the first is the standardized system of the approach (Pojasek and Cali, 1991:229). This standardized system allows the checklist/questionnaire to be used at any facility, thus saving the assessment team up-front preparation time. Additionally, standardized documents mean that the auditors themselves do not require specialized knowledge or training relating to environmental regulations. The auditors must only possess the ability to read and understand how to use the assessment tools. This advantage allows assessments to be performed with minimal effort, environmental training, and prior preparation.

These same advantages are what were considered by the

Environmental Protection Agency (EPA) when it adopted this approach for the *Waste Minimization Opportunity Assessment Manual.* This approach has become the most widely recognized and accepted environmental assessment technique since its adoption by EPA (Pojasek and Cali, 1991:226).

Although these checklists/questionnaires provide the benefit of standardization and simplicity, they do have disadvantages. The generic nature of these documents means that they are not always applicable to the process being audited. For example, Appendix C item SW.8.1 requires all on base landfills to be licensed or permitted. However, an installation may not have an on-base landfill, or even more compelling, the State in which the installation is located may not require permits or licenses for the installation's specific type of landfill. Thus, the standard at SW.8.1 may not be applicable to all installations. Because the entire standardized document may not be applicable, misidentification of compliance problems can occur (Pojasek and Cali, 1991:229). For example, the auditors, not realizing that a permit/license is not required in that State, may cite the lack of a landfill permit as a compliance violation. This misidentification of compliance problems ultimately may cost a facility substantial amounts of time and resources. Again, using the previous example, an installation, because it is written up for not having a permit/license, may expend the time and resources to have a permit application completed for a landfill only to find out later that no such permit/license is required by the State where it is located. The generic nature of the checklist combined with the limited environmental training required, may lead to a compounding of inefficiency in the assessment process.

Another disadvantage of this approach is the assessor gains no understanding of the interrelationships among processes and thus does not see the a "big picture." An example where this instance has occurred is at Shaw AFB in South Carolina. On a 1991 ECAMP inspection, the hazardous waste auditor cited the base as out of compliance because a waste storage tank was not permitted to hold hazardous waste. A review of the process involved with the tank revealed that the system for treating the waste, placing it in the tank, and ultimately disposing of it was a closed-loop system. Because the system was closed loop, that waste was treated to render it non-hazardous once it was in the tank, and the tank waste was eventually discharged to the base permitted Wastewater Treatment Facility, the requirement for a permit was not applicable. However, because the auditor was only familiar with the fact that the tank was a site where waste was stored and treated, she assumed that a permit was required. This example indicates not only how a familiarity with the process is beneficial, but also where a knowledge of the environmental regulations may prevent misidentification of non-compliance problems. As is indicated by this example, this disadvantage may, in fact, cause compliance problems to be misunderstood. In contrast, this disadvantage may also cause valid problems to be overlooked, or ignored. Thus, an understanding of the process being evaluated is key to the proper identification of the environmental regulations that apply to the process. For the facility being audited, this could cause needless work in review and verification of audit findings or, as in the landfill examples above, needless work to come into a compliance that is not even required.

Descriptive Approach. The descriptive approach to environmental assessments is just as a widely used as the prescriptive approach, but less publicized. This approach focuses on describing pollution producing processes and their associated wastes (Pojasek and Cali, 1991:225). The goal of the descriptive approach is the identification of all potential pollution-generating processes and any associated material loss, either to a waste stream or to the environment, so that appropriate pollution reduction measures can be taken.

The descriptive approach consists of two basic components: a flow diagram and a materials accounting

(Pojasek and Cali, 1991:230). The flow diagram is used to represent the steps involved in a process, identify the materials used and determine their fate. The fate of materials can be described as (a) complete use in process, (b) disposal as hazardous waste, (c) evaporation in process, and/or (d) loss to minor leaks and spills in process. Individual process information is prepared prior to the assessment. The actual on-site assessment exists to confirm the flow-diagram, determine material fate, and prepare a material accounting. The audit, as performed within industry, is designed to highlight areas of suspected non-compliance and areas where pollution reduction opportunities may exist (Pojasek and Cali, 1991:232).

There are several advantages to using the descriptive approach. One of these advantages is that information gathering is focused on the process. This focus allows the assessor to obtain an understanding of the process and identify where other laws may apply or where material losses occur accordingly. The waste tank example previously discussed can be used to illustrate this point. Had the auditor understood the entire process, i.e. the fate of the waste from generation to ultimate disposal, he might have consulted someone with knowledge of wastewater treatment requirements, or investigated the environmental regulations to determine if the process was properly permitted. The flow diagram, because it summarizes the relevant process information in a small space, makes the process information easily reviewable and manageable (Pojasek and Cali, 1991:233). These tools permit the auditor to spend his time actually observing the process, formulating ideas, and identifying problems instead of having to spend time familiarizing himself with the process. Additionally, this approach provides documentation on a facilities operations for use in future audits and process evaluations. This documentation consists of the flow diagrams and the material balances. Finally, this type approach can be used for any type manufacturing or industrial operation that can be flow-diagrammed, and can be executed in any sequence (Pojasek and Cali, 1991:234). This approach allows flexibility in the assessment process, and permits the auditor to use professional judgement in a constructive manner. Again, both the landfill example and the waste tank example from the previous section can be used to illustrate how professional judgement may be used. In both instances, the auditor would have had the leeway to question the process and the applicability of the regulations had the entire process been understood and without the standardized, black and white, checklist/questionnaire.

One disadvantage does exist with the descriptive approach to auditing. Because professional judgement is necessary, this approach is technically demanding; requiring personnel who are familiar with each process in order to produce the initial flow-diagrams. Also, some environmental training and process knowledge on the part of assessment personnel is desirable. However, once the initial documentation and training are performed, future assessments become less demanding.

Air Force Approach

Currently, the Air Force uses different approached to administering the ECAMP and Pollution Prevention Opportunity Assessments different approaches. The ECAMP assessment is based upon the prescriptive approach while the Pollution Prevention Opportunity Assessment utilizes the descriptive approach.

The execution of the Air Force ECAMP program relies upon a standardized manual containing checklists for all environmental areas. These checklists outline the laws relating to hazardous waste, stormwater, drinking water, natural resources, historic preservation, solid waste, waste minimization, and other areas of concern. Not only do the checklists outline Federal environmental laws, but they also outline environmental requirements of Air Force regulations and Executive Orders. The checklists in this manual are used when performing an Air Force ECAMP.

The Pollution Prevention Opportunity Assessment, on the other hand, is based upon a descriptive assessment approach. During the baseline survey, a flow-diagram of each process is prepared, and any material losses and waste generated documented. These flow-diagrams then become an integral part of the annual Opportunity Assessment. During the Opportunity Assessment, flow-diagrams from the initial baseline survey are verified and any process changes and/or new emissions are documented. The process information obtained is then used to formulate methods to reduce pollution associated with each process and waste stream.

It is the contention of this research that the two assessment approaches can be combined to form a hybrid assessment that accomplishes the goals of both the Pollution Prevention Program and the Environmental Compliance Assessment and Management Program. This combined assessment will increase the efficiency of the two programs and provide assessors and workers with a more complete understanding of a process from material input to waste generation, including environmental compliance concerns. Efficiency, for the purpose of this research, is determined as follows:

1. when a reduction in the number of interruptions an industrial shop experiences during a given assessment is achieved;
2. when a reduction in the amount of time required to perform the on-site portion of the assessment is realized; and/or
3. when the cost to perform the assessment is reduced.

These measures will be discussed further in Chapter 4 where they will be used to analyze the viability of the proposed assessment approach.

The viability of combining these approaches has been demonstrated by industry. The identification of source reduction opportunities during environmental audits, which has historically been performed by industry, is simply a combination of what the Air Force operates as two distinct programs. Implementation of a combined audit approach within the Air Force is possible, as will be shown in the proposed assessment approach.

Proposed Assessment Strategy

This section provides a description of a combined assessment approach for the Pollution Prevention program and ECAMP. The descriptive and prescriptive assessment approaches described previously provide the basis for the proposed Combined Assessment (CA) strategy. A flow-diagram of the proposed process is provided at Figure 6.

The CA is a three stage process, much like the ECAMP. The three stages are:

1. Pre-evaluation activities;
2. Site survey; and
3. Post evaluation activities.

However, while ECAMP is based upon evaluation of a facility by protocol (or individual environmental media), the CA

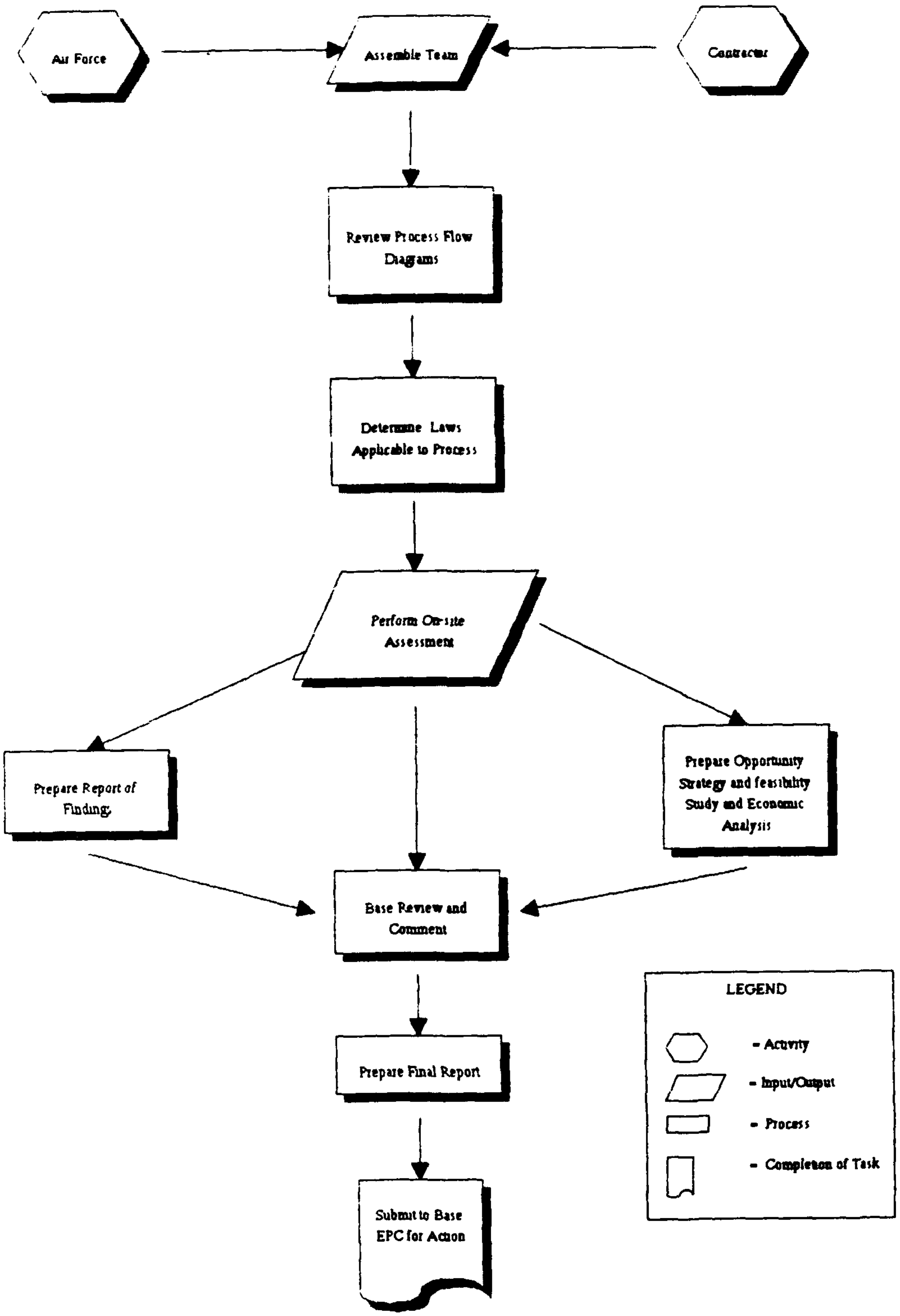


Figure 6: Flow Chart of the Combined Assessment Approach

process is based upon evaluation by process. This evaluation by process allows each shop or process to be evaluated for all information at one time. The CA blends the two assessment approaches to enhance the information gathering process of both programs. The following description of the CA, by stage, provides a basis for conducting a CA.

Pre-evaluation Activities. The pre-evaluation activities for the CA consist of obtaining flow-diagrams and material accountings from the baseline pollution prevention survey, reviewing these documents, and assigning team member responsibilities for the on-site portion of the assessment. The information within these documents provides the basis for the CA pre-site evaluation process. Flow diagrams provide the information on base processes usually provided to the ECAMP team on the pre-evaluation questionnaire while the material balances provide insight on how materials are being disposed, used up, and/or lost in process. This information provides an indication of areas of concern on which to concentrate compliance efforts. Within these two documents, all information required to determine applicable environmental laws for a process can be located, as well as information required to evaluate pollution prevention opportunities. Thus, the pre-evaluation background information requirement for both ECAMP and Pollution

Prevention is satisfied within these two documents.

By using the process diagrams and materials accounting from the pollution prevention baseline survey, the CA can ensure the compliance laws appropriate to a process are identified. No longer is the preparation of a questionnaire to determine what processes occur and what environmental laws apply to an installation required before an assessment is performed. Instead, the CA team simply obtains a copy of the most current process flow diagrams and materials accounting for the installation being evaluated. These documents, combined with the knowledge of applicable compliance laws and/or a review of these laws, provide the necessary information to determine what permits are likely to be required, what wastes are generated, and what environmental laws are applicable to a process. Review of these diagrams also familiarizes assessment team members with base processes and consequently allows them to ask more meaningful and appropriate questions during the site survey phase. More appropriate questions not only provide the assessors with more useful information, but also allows for a more thorough understanding of a process and associated compliance issues. After the flow-diagrams and material accountings are reviewed and the applicable compliance laws are identified, the CA team is ready to perform the site survey.

Site Survey. The on-site portion of the CA is designed to verify, and modify if necessary, the flow-diagram and material accounting information. Additionally, processes are evaluated for compliance with applicable environmental laws and regulations. The primary change from pollution prevention and ECAMP procedures required by the CA site survey, is a change in the philosophy behind the assessment. Instead of assessing compliance issues by protocol, or law, compliance is assessed by process, and each process is evaluated for environmental compliance at the same time it is being reviewed for pollution reduction opportunities. This approach allows a more complete compliance assessment, while providing the assessor with a better understanding of the "big picture" of an installations environmental activities. This "big picture" view provides for more accurate and thorough compliance evaluations while providing a better understanding of the production process involved, how waste streams originate from the process, and legal requirements imposed on the process that may affect pollutant reduction activities.

The site survey portion of the CA is the most critical phase. This is the time when all information is gathered on which decisions are based. These decisions involve how pollutants will be reduced and how compliance will be achieved, where necessary. The importance of this phase of the assessment relevant to the other phases makes it imperative that installation personnel have an understanding of the CA process.

Because of the need for personnel to understand the CA process, an initial in-brief is provided to the installation Environmental Protection Committee (EPC) prior to performing this portion of the assessment. This in-brief consists of an overview of the CA philosophy and a description of planned assessment team activities while on the installation. In addition the this initial briefing, an informal briefing should be conducted at the end of each working day to outline to installation staff any compliance findings and/or pollution reduction opportunities that may be readily apparent. Another topic that should be discussed during the daily briefings is any process modifications that may have occurred since the previous CA. Finally, an out-brief should be provided to the EPC when all site survey activities are completed. This briefing should outline all compliance and pollution reduction findings and a rough draft of these initial findings provided to the installation. One important factor to remember when evaluating for compliance and pollution reduction opportunities is that any solutions formulated should not sacrifice pollutant reduction for compliance, and vice versa. This factor is especially important during the post evaluation phase when formal documentation is prepared.

Post Evaluation Activities. Post-evaluation activities do not differ substantially from the Pollution Prevention Program or the Environmental Compliance Assessment and Management Program post evaluation activities. Both programs involve preparing reports after completion of the on-site survey. These reports contain information on compliance findings and areas where pollution reduction opportunities can be implemented to promote environmental compliance through pollution reduction. These activities do not change materially under the CA approach; a combined report of environmental compliance findings, opportunities for pollutant reduction, and an economic analysis of suggested pollution reduction opportunities will be prepared and provided to the installation. This combined report can be completed in separate sections, or may be completed as a whole. A draft of the report should be provided to the installation for comments prior to the preparation of a final report. After comments or changes received from the installation are incorporated, a final report is provided to the installation EPC for action.

The final report provided to the EPC should consist of at least the following information:

- process evaluated and location by building number;
- the date and time (if appropriate) the process was evaluated;
- a detailed description of the process, to include a

flow diagram;
- a detailed description of compliance problems noticed;
- a listing of amounts and types of pollutants generated by a process and the method by which they are generated; and
- suggestions for reducing pollutants that promote environmental compliance.

An information package will be developed on each process during the first application of the CA. This package will also be provided to the installation and will form the basis for subsequent evaluations; much like the baseline survey in Pollution Prevention provides all the subsequent data for the annual Opportunity Assessment. This is one of the primary benefits of this strategy; the ability to use the previous years data to facilitate the current years assessment activities. In addition, once the initial assessment package is developed, the lead time required to prepare for subsequent evaluations will be reduced.

As with all assessment methods, this strategy also has its drawbacks. Drawbacks include the culture change required by the change in assessment philosophy, the amount of technical knowledge required by assessors, and the amount of initial (one time only) preparation time to assemble the initial compliance/reduction package.

The philosophy change required will perhaps be the most difficult change to achieve. The CA requires a departure from the accepted method of administering programs within the Air Force. Typically, the Air Force establishes a program to satisfy a specific requirement, such as the Pollution Prevention Program to satisfy the requirements of the Pollution Prevention Act. However, by changing to this method of reduction/compliance assessing, the Air Force will be satisfying multiple requirements while at the same time taking a proactive approach to environmental compliance. This approach promotes compliance while reducing pollutants generated in a complementary manner.

The training and preparation time required for the CA are two disadvantages that will lessen as the approach becomes more widely used. Initially, assessors and installation personnel will require training on process evaluation, flow diagramming, and environmental compliance laws. Once personnel are familiar with the CA approach, the need for training and preparation time will be reduced.

As was demonstrated in Chapter II, the trend within the EPA is toward integrated environmental management. By following this approach, the Air Force will be also be able to manage its environmental programs in an integrated manner, and gain a better understanding of its processes and the interrelationship with compliance issues that affect them. This increased understanding and awareness will aid in better environmental management throughout the Air Force.

IV. Theoretical Application of the Combined Assessment Model

Before the Combined Assessment model can be applied theoretically, an understanding of the definition of "efficiency" is required. The following quote, from the textbook *Accounting and Control for Governmental and Other Nonbusiness Organizations*, provides the basis for the definition of "efficiency" to be used for this evaluation.

> The concept of efficiency is linked to the use of organizational resources. When fewer organizational resources are used to accomplish the same results or when additional results are attained using the same resources, then a program or set of activities are said to be more efficient.

Efficiency, as used within this application, is a function of cost, time, and interruptions in work performance. Efficiency will be considered to be achieved whenever one of the following three criteria are satisfied:

1. a reduction in the number of interruptions (i) experienced by a shop or activity during a single on-site portion of an assessment (i.e. $i_{CA} < i_E + i_{OA}$)

2. a reduction in the amount of time (t) required to complete the on-site portion of a required assessment (i.e. $t_{CA} < t_E + t_{OA}$); and/or

3. a reduction in the cost (c) to perform the required assessment activities (i.e. $c_{CA} < c_E + c_{OA}$).

For the purpose of the first criteria, a reduction in the number of interruptions, it will be assumed that any time an auditor visits a shop, an interruption has occurred. This assumption can be justified by realizing that any time someone unfamiliar enters a shop, it poses a distraction for workers. This distraction in itself is enough to slow the work process from its normal rate and thus, qualify as an "interruption."

With the metric for this chapter defined, a theoretical analysis of the Combined Assessment can be performed. This analysis will address the activities of the assessment team from the point of team assembly through the preparation of the final report. Some steps in the process, such as the "Base Review and Comments" on reports and the submittal of the final reports to the Environmental Protection Committee for action, will not be discussed because they require no activity on the part of the assessment team. Also, the base review and comment portion of the assessment is a process solely dictated by the base and does not have a bearing on the performance of assessment activities by the team.

Theoretical Application

Assemble Team. In assembling the team for an Air Force ECAMP assessment, the activity responsible for team assembly must consider the background of potential team members. Ideally, the team members will be acquainted with several of the laws relating to the protocols, but should be familiar with at least one protocol, the one they are assigned to evaluate. This familiarity is preferred because it allows the assessor to understand the laws rlating to the areas of the installation they will view and allows the number of disruptions experienced by the installation environmental function to be minimized. As an example, if an ECAMP assessor is responsible for the Hazardous Material protocol, but is not familiar with hazardous materials, the assessor may constantly be questioning the environmental function on whether a given substance is hazardous and subject to the protocol. These constant questions could then lead to a large number of work disruptions for the installation environmental function. Thus, it is desirable that the assessor have a general knowledge of the laws applicable to the protocol they are assigned to evaluate.

The same type considerations apply to the selection of team members for the Pollution Prevention Opportunity Assessment, with the inclusion of one other qualification. This additional qualification is a basic knowledge of industrial activities undertaken at an Air Force installation of the type to be evaluated. This additional knowledge is necessary to allow the accurate verification of the process flow-diagramming being evaluated. The environmental knowledge required for the Opportunity Assessment is necessary so that the assessor understands the potential fate of the inputs to the process, such a chemicals and equipment, and to accurately diagram their fate with respect to the process. For example, when diagramming an aircraft painting operation, the assessor not only needs to understand the steps in the process and adequately reflect them on the flow-diagram, but must also understand that the chemical used in the process, such as is the case with methyl ethyl ketone, may volatilize while in use and create a material loss to the air. This chemical loss in process must also be reflected on the flow-diagram. Thus, for the Opportunity Assessment, a general knowledge of how chemicals may interact with the environment is required.

When assembling a team for the Combined Assessment, the same requirements exist for these team members as the Opportunity Assessment team members. Team members for the Combined Assessment should possess a basic knowledge of environmental regulations and understand the principles of flow-diagramming a process. The combined knowledge of these two topics will ensure that the assessor understands how to review the flow-diagram and identify the environmental regulations that may apply to the process.

Thus, in the case of assembling a team for the ECAMP, Opportunity Assessment, or Combined Assessment, the same steps are ultimately involved. These steps are (a) identification of necessary expertise, (b) notification to the team members of their selection, and (c) assignment of responsibilities (either a protocol or a process).

Because the required steps are virtually the same, it is logical to assume that the time required to perform these steps, regardless of the type of assessment, are equal. Thus, for this step of the process, $t_{CA} < t_E + t_{OA}$. The next step in the Combined Assessment process is the review of the process flow-diagrams.

Review Process Flow Diagrams. When performing the ECAMP assessment, there is no requirement to review process flow-diagrams. However, there is a requirement to review the pre-visit questionnaire (see Appendix B). In evaluating this step in relation to the Combined Assessment process, the completion and review of the pre-visit questionnaire will be considered. The pre-visit questionnaire is a detailed questionnaire concerning the environmental operations at an installation. This questionnaire is completed by the installation and forwarded to the assessment team for review prior to the on-site evaluation. While the completion of this questionnaire by the installation may be very time consuming, its review by the assessment team is relatively simple.

In the case of the Opportunity Assessment, the review of the process diagrams is also relatively simple. This step involves obtaining the flow-diagrams from the Baseline Survey, or previous years Opportunity Assessment, and becoming familiar with the processes each assessor will be evaluating.

Finally, the Combined Assessment also has a review step. This step is the review of the process flow-diagrams from the previous Combined Assessment. In reviewing the flow-diagrams, a review of identified environmental regulations applicable apply to the process should also be made. This review is to verify that all applicable environmental regulations for the process have been identified. This preliminary review offers the assessor the opportunity to minimize the amount of time spent on regulatory requirement identification when performing the site survey. These pre-assessment activities are important because they provide the basic information necessary to apply the combined assessment approach.

When comparing all three assessment review processes, the ECAMP review consists of two basic steps, (a) the preparation of the pre-visit questionnaire by the installation and (b) the actual review of the questionnaire by the assessment team. Likewise, the Opportunity Assessment review involves the following two steps, (a) the acquisition of the flow-diagrams from the previous assessment, and (b) the review of the flow-diagrams to become familiar with the process to be evaluated. Finally, the Combined Assessment review process is also a two step process. These steps are (a) the acquisition of the previous assessments' flow-diagrams and environmental law identification, and (b) the review of the flow-diagrams, etc. Thus, when comparing all three assessments to determine if the definition of efficiency has been met, the Combined Assessment is at least as efficient as the other two assessments when performed separately, since all three processes include two steps. However, when considering that the Combined Assessment replaces the need for two assessments with a single assessment, time can, in fact, be saved by the performance of the Combined Assessment. This can best be exemplified by noting that by adding the number of steps of the ECAMP to the Opportunity Assessment, a total of four steps are necessary for completion of this portion of the process. However, only two steps are necessary for the Combined Assessment. Because the number of steps involved in this portion of the Combined Assessment are fewer, it is logical that the time required to complete this portion of the assessment is less. Thus, it can be stated that $t_{CA} < t_E + t_{OA}$. Since the time involved in completing this portion of the Combined Assessment is less than the other two, it is also logical to assume that the cost involved is also less. Consequently, $c_{CA} < c_E + c_{OA}$.

Determine Applicable Laws. When performing the ECAMP assessment, there is no requirement to identify the applicable laws prior to the assessment, however, this is normally performed during the review of the pre-visit questionnaire. For the purpose of this section, it will be assumed that the time involved in this process is negligible, since the pre-visit questionnaire was previously discussed. Thus $t_E = 0$. Since no time is involved in this stage of the process, it is safe to assume that no cost is incurred in the performance of this step, thus $c_E = 0$.

The determination of applicable laws is a step that is also not considered a part of the Opportunity Assessment. Since this step is not part of this assessment, it is logical to state that there is no time involved in completing this portion of the assessment for the pollution prevention program. The lack of this step in the Opportunity Assessment process can be represented by the equation $t_{OA} = 0$, and consequently $c_{OA} = 0$.

Finally, when comparing this stage for the ECAMP, Opportunity Assessment, and Combined Assessment, it is clear that the Combined Assessment is less efficient. This lack of efficiency is credited to the inclusion of a step in the implementation process of the Combined Assessment that does not exist in the other two assessments. Because this step exists in the Combined Assessment process and not in the other two, the time and cost incurred for this stage of the process is obviously greater. Thus, for this stage $t_{CA} > t_E + t_{OA,}$ and subsequently the Combined Assessment process is less efficient, and possible more costly, at this stage of the assessment process.

Perform The On-Site Assessment. In the performance of the on-site portion of the ECAMP assessment, each team member is assigned at least one protocol to evaluate. As part of the evaluation, the assessor calls upon each activity on the installation that might be affected by their assigned protocol to determine the activities compliance. The compliance evaluations performed as part of the ECAMP are carried out with the goal of determining the activities compliance with applicable environmental requirements. As is indicated in Chapter II, Figure 4, ten protocols exist within the ECAMP. Assuming all ten protocols apply to a given process, the approximate maximum number of interruptions (i) to be expected at that process is ten. This is assuming that the activity is called upon only one time per protocol per ECAMP.

In contrast, the Opportunity Assessment evaluates each activity, or shop, by process. The evaluations performed at the shops during the Opportunity Assessment are for the purpose of reviewing and modifying the flow-diagram, if necessary, and to evaluate for the presence of pollution reduction opportunities. This concept of evaluating the activity by process translates into a number of interruptions (i) equal to the number of processes present at a single activity. Assuming an optimal scenario, only one process is present, per shop, then only one interruption will occur per shop, per assessment.

Finally, when reviewing a theoretical application of the Combined Assessment, as designed, each process at an activity, or shop, is evaluated not only for flow-diagram modification and pollution reduction opportunity, but also for environmental compliance. The Combined Assessment evaluates for these factors at the time of initial visit to a shop. Because these items are evaluated for during the initial visit to the shop, the number of interruptions (i) for a specified shop can be determined to be equivalent to the number of processes present at the location. Assuming a best case scenario, as in the above discussion on the Opportunity Assessment, each shop is assumed to support one process. This translates to one interruption per shop per assessment.

Comparing the three assessment to determine the efficiency, based upon the number of interruptions (i), reveals that the Combined Assessment approach is equivalent in efficiency to the Opportunity Assessment, but more efficient than the ECAMP. However, when considering that these two assessments are performed separately, and the Combined Assessment satisfies the goals of the two separate assessment with the performance of one assessment, the number of interruptions (i) for the ECAMP and Opportunity Assessment can be added together for comparison to the Combined Assessment. Thus, it is evident that $i_{CA} < i_E + i_{OA}$. This can also be argued by assuming a best case scenario of only one interruption per ECAMP assessment and one interruption per Opportunity Assessment. Because the Combined Assessment is designed to satisfy the goals of both the ECAMP and the Opportunity Assessment within the context of one assessment, the Combined Assessment would still be more efficient since it replaces a minimum of two interruption per year with one interruption per year. Thus, the Combined Assessment satisfies the first criteria for determining efficiency.

Another aspect of the criteria for determining efficiency is the cost of performing the assessment. With regard to the on-site portion of the assessments, it must be noted that the ECAMP and Opportunity Assessment are conducted independently of each other. Regardless of the total cost of the ECAMP and Opportunity Assessment, an acknowledgement that each assessment involves a "mobilization" cost must be made. Mobilization cost is defined as the cost incurred to transport the team members to and from the installation being evaluated. Because the ECAMP and Opportunity Assessment are performed independently, these costs are incurred at two separate times in a given year. In the case of the Combined Assessment, one team performs the function of both the ECAMP and Opportunity Assessment teams, consequently, the mobilization costs are only incurred once in a given year. Thus, it can be surmised that the cost to perform the on-site portion of the Combined Assessment is less than the cost to perform the on-site portions of the ECAMP and

Opportunity Assessments together. This can be represented by the following equation: $c_{CA} < c_E + c_{OA}$, indicating that the cost of the on-site portion of the Combined Assessment is less than the same portion of the other two assessments combined. Finally, since the requirement to mobilize an assessment team is reduced to once per year, and because shop interruptions are reduced, the case can be made that the combined assessment also reduces the time involved with the on-site portion of the assessment.

Prepare Report of Findings. Within the ECAMP assessment, the Report of Findings is prepared after the completion of the on-site portion of the assessment. The time involved with the preparation of this document is solely dependant upon the number of findings noted at the installation. Thus, if the number of findings at an installation can be reduced, the length of time required to complete this report can also be reduced. The key, then, to the amount of unnecessary time spent in the preparation of this report for an ECAMP assessment, is in the number of non-compliance situations erroneously identified. Consequently, if these erroneous situations can be reduced or eliminated, the efficiency of the preparation of this document will be increased because fewer non-compliance situation identified in error will be reported.

In the case of the Opportunity Assessment however, the preparation of this report is not required. Consequently, the time and cost involved in the preparation of this report for this assessment are zero. Thus, $t_{OA} = 0$.

In preparing the Report of Findings for the Combined Assessment, the uncertainties involved are the same as those for the same report prepared for the ECAMP assessment. The amount of time that is taken to prepare the report is dependant upon the number of findings. However, it is the contention of the Combined Assessment approach that the number of non-compliance issues noted on an assessment in error will decrease with the implementation of the Combined Assessment. This contention is made based upon the assumption that the better the assessor understands a process, how the process interacts with the operation of the installation, and how the implementation of environmental laws interact with the process, the fewer the number of non-compliance items that will be noted erroneously. Thus, because this approach will decrease the number of erroneous findings placed in a report, it is logical to assume that less time will be required to complete the Report of Findings. Consequently, $t_{CA} < t_E + t_{OA}$, where $t_{OA} = 0$. Thus, the Combined Assessment approach is more efficient than the other two approaches added together at this stage of the assessment process.

<u>Prepare Opportunity and Feasibility Study and Economic Analysis</u>. The Opportunity and Feasibility Study and Economic Analysis are documents that are not prepared as

part of the ECAMP process. Thus, for this assessment, the time and cost associated with the preparation of these documents are zero ($t_E = 0$, $c_E = 0$).

The Opportunity Assessment, on the other hand, does require the preparation of these reports. The Opportunity and Feasibility Study outlines the pollution prevention opportunities that exist at the installation and provides an estimate of the feasibility of their implementation. The Economic Analysis is another part of this stage. This portion of the document provides an analysis of the economic factor involved with implementing the pollution prevention opportunities identified in the Opportunity and Feasibility Study. The contents of these documents within the context of the Combined Assessment are essentially the same as within the Opportunity Assessment documents.

Because the contents of the documents required for the Opportunity Assessment and the Combined Assessment are basically the same, it is rational to assume that the time and cost involved in the preparation of these documents are essentially the same for either assessment. Thus, $t_{CA} = t_E + t_{OA}$, where $t_E = 0$. The same assumption is appropriate for the cost involved with document preparation. If the time involved in document preparation is fundamentally the same, and the time involved reflects the cost of document preparation, then the cost of document preparation for the Combined Assessment equals the total cost of the preparation of this same document for the Opportunity Assessment and the ECAMP assessment combined ($c_{CA} = c_{OA}$).

Prepare Final Report. The final stage of the assessment process for the assembled teams is the preparation of the final report. For all three assessment processes, this stage consists of the same steps. These steps are (a) the consideration of any comments made by the installation on the Draft documents, and (b) the incorporation of any changes requested by the installation. Because the steps involved in all three assessments at this stage are virtually the same, it can be assumed that the time involved for the preparation of the final reports is equivalent. Consequently, $t_{CA} = t_E = t_{OA}$. Thus, no efficiency is gained, or lost, at this stage of the Combined Assessment process.

Summary

This theoretical evaluation of the Combined Assessment provides a preliminary indication that this approach is more efficient than the Opportunity Assessment and ECAMP performed separately. This increase in efficiency is with regard to time, cost, and work interruptions. In evaluating the Combined Assessment approach theoretically, the proposed model is found to be more efficient in four different stages with regard to the efficiency criteria. These four stages are:

- Assemble Team;
- Review Process Flow Diagrams;
- Perform On-site Assessment; and
- Prepare Report of Findings.

The CA, however, is only less efficient in one stage, "Determination of Applicable Laws." These preliminary results suggest an overall increase in efficiency when the CA is performed in lieu of the Pollution Prevention Opportunity Assessment and the Environmental Compliance Assessment and Management Program (ECAMP) assessment.

Although this model implies that the Combined Assessment model is theoretically more efficient, it does not take into account compliance items contained within the ECAMP that are not related to a process. Examples of items not accounted for by the model are the evaluation of polychlorinated biphenyl electrical equipment and the Installation Restoration Program. These compliance areas are located within the *Special Programs* protocol within the ECAMP assessment manual. These areas can, however, easily be integrated into the Combined Assessment model by assigning an assessor to evaluate them as they historically have been under ECAMP. Instead of evaluating these compliance areas as processes, they will continue to be evaluated by a checklist approach, such as is done with the ECAMP.

V. Conclusion and Recommendations

The Air Force has recognized the benefit of environmental auditing as a tool for achieving greater compliance. In fact, the Air Force made a major commitment to the environment in 1992, when it set a goal to become the leader of the military services in environmental compliance (Hanson, 1992:15). In addition to environmental compliance, pollution prevention has recently been established as an Air Force program to achieve reductions in cost and liability. Because improved compliance is inherent in the reduction of pollution, the two programs, ECAMP and PP, ultimately achieve a common goal. This goal is the attainment of environmental compliance at all installations while reducing the costs associated with compliance and installation operation. At present, this goal is accomplished by separate programs. However, these programs lend themselves well to integration, as has been demonstrated by this research.

Conclusion

This research developed and analyzed a model for combining the Pollution Prevention Opportunity Assessment and the Environmental Compliance Assessment and Management Program (ECAMP). Within the introduction to this research, three specific objectives were outlined for accomplishment. These objectives will be discussed in the following paragraphs.

Objective one established that the Pollution Prevention Opportunity Assessment and the ECAMP criteria are similar. In establishing this objective, federal laws and Executive Orders establishing the requirements for the two programs were reviewed, as were the Environmental Protection Agency suggested assessment methods and industry assessment methods, and Air Force programs developed to implement these laws and orders.

In satisfying Objective two, the proposal of a model for the combination of the two assessments, a review of typical environmental audit structures was reviewed. This review, along with the proposed model, is presented in Chapter III.

Finally, objective three, the theoretical application of the proposed model, was presented in Chapter IV. This application evaluated the models performance with relation to the efficiency of the Combined Assessment. Efficiency was defined in Chapters III and IV as a reduction in time, cost, and interruptions associated with the assessment implementation. Table 3 below presents the results of the theoretical application of the Combined Assessment approach.

TABLE 3

RESULTS OF THEORETICAL ANALYSIS
OF THE COMBINED ASSESSMENT

Activity	Cost	Time	Interruptions
Assemble Team	N/A	+	N/A
Review Process Flow Diagrams	+	+	N/A
Determine Applicable Laws	-	-	N/A
Perform On-Site Assessment	+	+	+
Prepare Report of Findings	N/A	+	N/A
Prepare Opportunity & Feasibility Study and Economic Analysis	0	0	N/A
Prepare Final Report	N/A	0	N/A

N/A = not applicable "-" = less efficient
"+" = more efficient "0" = no difference in efficiency

TABLE 3: Overview of efficiency of the Combined Assessment Approach compared to ECAMP plus the Opportunity Assessment.

When reviewing the results reflected in this table, it becomes evident that on a theoretical level, the Combined Assessment is more efficient with regard to the time involved in performing the assessment in three of the steps evaluated. Additionally, the on-site portion of the

Combined Assessment is more efficient the combined ECAMP and Opportunity Assessments. Finally, as is evidenced by the table, the Combined Assessment is just as efficient in six instances with regard to cost, time and interruptions, as the ECAMP and Opportunity Assessments together. Overall, based upon the theoretical evaluation, the Combined Assessment approach does provide greater efficiency than the current method of performing the ECAMP and Opportunity Assessments separately.

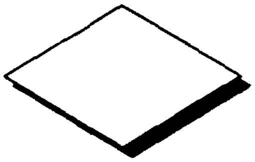
Recommendations

This study outlines a theoretical combined assessment approach and analysis. However, field validation of this approach must still be accomplished. It is recommended that this field validation be accomplished as part of an Engineering and Environmental Management thesis. The application of this assessment approach should first be attempted either at a small installation or within a limited area of a larger installation. Although this combined approach is outlined as a stand alone assessment, the ideas contained within it may also be applied within the context of a pollution prevention assessment.

Additionally, though this research is geared toward Air Force programs, all branches of the military service are required to comply with the laws and Executive Order discussed. Because all services must comply with the same requirements, the information contained within this thesis is not limited to an Air Force application.

APPENDIX A

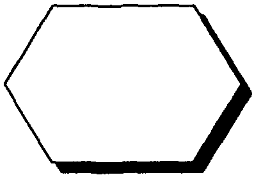
Explanation of Legend for
Figures 2,3,4, and 5



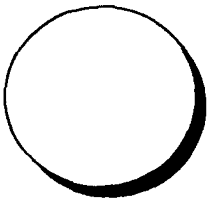
= Decision; this symbol represents that a decision has been made or must be made at this stage of the process

= Process; this symbol represents that some office or paperwork type process is occurring

= Input or Output; this symbol represents that some input is required for this process and/or some output, such as a report, is generated.



= Activity ; this symbol signifies that some entity is undertaking an action.



= Connector; this symbol connects the preceeding process with the proceeding process

PREVISIT ENVIRONMENTAL MANAGEMENT QUESTIONNAIRE

This questionnaire will provide background information necessary to plan and conduct an environmental compliance assessment.

Name of Installation:____________________________________

	YES	NO	N/A
II. Air Emissions			
1. Does installation operate a fuel burner?	_	_	_
a. Central steam plant?	_	_	_
b. Hot water?	_	_	_
c. Approximate size of fuel burner _______			
2. Are any hazardous or toxic air pollutants present in the installation's air emissions (e.g., Beryllium, mercury, and vinyl chloride)?	_	_	_
3. Is the installation subject to any of the following air emission standards:			
a. Particulates?	_	_	_
b. NO_x?	_	_	_
c. Sulfur dioxide?	_	_	_
d. Volatile organic compounds?	_	_	_
e. Carbon monoxide?	_	_	_
f. Toxic air pollutants?	_	_	_

If yes, please specify:

____

	YES	NO	N/A
4. Does the installation operate any incinerators? (i.e., for classified documents, medical waste, solid waste, etc.)	___	___	___
a. How many _____			
b. Attach list of locations.			
5. Does the installation engage in:			
a. Open burning?	___	___	___
b. Fire fighter training?	___	___	___
6. Does the installation use any solvent degreasers?	___	___	___
7. Does the installation have a dry cleaning facility?	___	___	___
8. Does the installation have a:			
a. Spray painting operation?	___	___	___
b. Surface coating operation?	___	___	___
c. Attach list of locations if answered yes to either.			
9. Have installation emissions resulted in complaints from the public due to:			
a. Odors?	___	___	___
b. Fugitive dusts?	___	___	___
c. Other? ____________________	___	___	___
10. Does the installation use air pollution control equipment?	___	___	___
If yes, please explain:			
______________________________			
______________________________			
11. Does installation operate a motor vehicle station?	___	___	___
12. Does the installation dispense fuel to motor vehicles?	___	___	___

	YES	NO	N/A
13. Please list number of fuel storage areas and the fuel type.			

Fuel type	Quantity	Fuel type	Quantity
___	___	___	___
___	___	___	___

	YES	NO	N/A
14. Does the installation have active aircraft operations?	___	___	___
15. Does the installation have active aircraft maintenance operations?	___	___	___
16. Does the installation have aerospace ground equipment (AGE) operations?	___	___	___

17. Please list any additional shop activities that generate any form of air pollution:

____

____

III. Hazardous Materials Management

	YES	NO	N/A
1. Does the installation store any flammable materials?	___	___	___
2. Does the installation transport any hazardous materials off-installation?	___	___	___
3. Does the installation have a procedure to ensure the proper labeling, packaging and spill response for hazardous materials?	___	___	___
4. Does the installation store:			
a. Acids?	___	___	___
b. Caustics?	___	___	___
c. Flammables?	___	___	___
d. Combustibles?	___	___	___
e. Compressed gases?	___	___	___
f. Oxidizers?	___	___	___

	YES	NO	N/A
IV. Hazardous Waste Management			
1. Does the installation produce any wastes classified as:			
a. Ignitable?	___	___	___
b. Corrosive?	___	___	___
c. Reactive?	___	___	___
d. Toxic?	___	___	___
2. Does the installation treat, store or dispose of hazardous wastes on site?	___	___	___
If so, please specify waste type and treatment method: ______________________________			
3. Does the installation accept wastes from other installations for treatment, storage or disposal?	___	___	___
4. Does the installation engage in the transportation of hazardous wastes:			
a. on base?	___	___	___
b. off base?	___	___	___
c. central transport (transportation squadron)?	___	___	___
d. individual unit transport?	___	___	___
5. Does the installation have a hazardous waste management (contingency) plan?	___	___	___
6. Does the installation utilize other locations for the treatment, storage or disposal of hazardous waste?	___	___	___

Please specify:

____

____

	YES	NO	N/A
7. Does the installation use any non-hazardous solid waste (including used oil) as a supplemental fuel source?	___	___	___
8. Does the installation have a contractor dispose of its hazardous waste?	___	___	___

Which office monitors this contract?

____

V. Natural and Cultural Resources Management

	YES	NO	N/A
1. Does the installation have an area designated as a natural resource, including "highly protected" and "more generally protected"?	___	___	___
2. Does the installation have a plan for managing its natural resources?	___	___	___
3. Does the installation have an area which is designated as any of the following (If so, please have maps indicating locations available for team on arrival):			
a. Cultural resource?	___	___	___
b. Archeological resource?	___	___	___
c. Historic structure?	___	___	___
4. Are there any areas on the installation which have any of the following (If so, please have maps indicating locations available for team on arrival):			
a. Wetlands?	___	___	___
b. Flood Plains?	___	___	___

VI. Noise Management (ENVIRONMENTAL)

	YES	NO	N/A
1. Does the installation have an active runway?	___	___	___
2. Does the installation have any operations or maneuvers that produce environmental noise (i.e., target ranges, skeet range, helicopter pad)?	___	___	___

	YES	NO	N/A
VII. Pesticide Management			
1. Does the installation use pesticides in regulated quantities?	___	___	___
2. Are pesticide wastes disposed of at the installation?	___	___	___
3. Are pesticides stored on the installation? Please list locations: ______________ ______________ ______________	___	___	___
4. Are medical records kept for individuals involved in the management of pesticides?	___	___	___
5. Where are pesticides used at the installation? ______________ ______________			
VIII. POL			
Fuels and Lubricants			
1. Does the installation have a motor pool?	___	___	___
a. How many?__________			
b. Locations (if more than one)			
2. Does the installation store oil in large volumes?	___	___	___
3. Does the installation have a spill prevention and response plan?	___	___	___
4. Does the installation's spill plan include provisions pertaining to hazardous substances or hazardous wastes?	___	___	___
5. Does the installation conduct spill response training?	___	___	___

	YES	NO	N/A
3. Does installation dispose of PCBs or PCB items at the base?	___	___	___

Asbestos

4. Does the installation have primary or secondary schools?	___	___	___
5. Has the installation conducted a complete base-wide asbestos facility survey?	___	___	___
6. Does the installation have a written Asbestos Management Plan?	___	___	___
7. Does the installation have a written Asbestos Operating Plan?	___	___	___
8. Has the installation undergone any asbestos removal projects in the past?	___	___	___
9. Is there any asbestos on the installation that has been removed and is awaiting disposal at this time?	___	___	___
10. Will the installation have any demolition, remodeling or renovation projects underway at the time of the ECAMP assessment?	___	___	___

Please identify those projects and buildings:

____

____

____

____

11. Does the installation maintain training records for asbestos workers?	___	___	___

Location of records

____

Radon Gas

12. Is the installation located in a geographic area where radon gas is found?	___	___	___

	YES	NO	N/A
5. Does the installation dispose of ash residues or sludge:			
a. on base?	___	___	___
b. off base?	___	___	___
6. Is the installation monitored for:			
a. Leachate?	___	___	___
b. Groundwater?	___	___	___
7. Does the installation currently dispose of, or has it been used for the disposal of asbestos?	___	___	___
8. Does the installation generate pathological wastes?	___	___	___
8. Does the installation dispose of pathological wastes on base by incineration?	___	___	___

X. Special Programs

PCBs

1. Are PCB (polychlorinated biphenyl) or PCB-contaminated oils in use or stored in the installation:			
a. Transformers?	___	___	___
b. Capacitors?	___	___	___
c. Electromagnets?	___	___	___
d. Hydraulic systems?	___	___	___
e. Other? ______________________	___	___	___
2. Are there any PCB items in storage for disposal?	___	___	___

PCB concentration (if known)

____

	YES	NO	N/A
5. Does the installation have any USTs used to store hazardous substances?	___	___	___

If yes, where are they located, how many are there, what size are they, and what hazardous product do they contain?

____

____

6. Does the installation have any underground tanks out of service? If yes, provide locations.	___	___	___

IX. Solid Waste Management

1. Does the installation have a solid waste management facility on site?	___	___	___
2. Does the installation have a:			
a. Resource Recovery facility (DRMO) on the installation?	___	___	___
b. Resource Recovery facility (DRMO) off the installation?	___	___	___
c. Landfill?	___	___	___
d. Solid waste incinerator?	___	___	___
e. Solid waste recycling program?	___	___	___
3. Does the installation have any "unofficial" landfill sites that are no longer in use?	___	___	___
4. Is waste transported off-installation for disposal:			
a. in landfills?	___	___	___
b. in incinerators?	___	___	___
c. other (specify):____________	___	___	___

	YES	NO	N/A
6. Does the installation use "fuel bladders" during field exercises?	___	___	___
7. Does the installation have any oil/water separators? (Please have a map available for the team showing locations.)	___	___	___

Underground Storage Tanks (USTs)

1. Does the installation have an aircraft fuel storage yard?	___	___	___

If yes, how many USTs are in the aircraft fuel storage yard and what size are they?

____

____

2. Does the installation have a ground vehicle fuel storage yard?	___	___	___

If yes, how many USTs are in the ground vehicle fuel storage yard and what size are they?

____

____

3. Does the installation have an AAFES-run or other type of gas station located on the base?	___	___	___

If yes, how many USTs are located at the gas station and what size are they?

____

____

4. Does the base have any other USTs used to store petroleum products?	___	___	___

If yes, where are they located, how many are there and what size are they?

____

____

	YES	NO	N/A
8. Are monitoring samples analyzed by:			
a. Installation personnel?	___	___	___
b. Off-site contractor?	___	___	___
9. Does the installation have a separate storm water runoff system	___	___	___
10. Does the installation have vehicle washracks (or other designated vehicle wash areas)?	___	___	___

XII. General Information

	YES	NO	N/A
1. Does the installation contain water protection areas?	___	___	___
2. Is the installation suspected of contributing to a groundwater contamination problem?	___	___	___

XIII. Records/Files to be Compiled

Briefly state the installation mission, size, scope of operations, and activities. Include approximate base population, housing units, industrial operations, aerospace systems supported land area, and other significant factors:

____

____

____

Signature of individual completing this form:______________________

Date completed:______________________

	YES	NO	N/A
XI. Water Quality			
Drinking Water			
1. Does installation operate a public water system?	__	__	__
2. Does any portion of the installation's drinking water supply come from on-site wells or surface water sources?	__	__	__
3. Does the installation monitor on-site drinking water sources?	__	__	__
Waste Water Discharge			
4. Does the installation have any discharges of the following:			
a. Storm water runoff from operational/storage area?	__	__	__
b. Storm water runoff from undeveloped area?	__	__	__
c. Dredge and fill solids drainage water?	__	__	__
d. Waste water treatment installation effluent?	__	__	__
e. Process waste water?	__	__	__
f. Heat/Power production cooling water?	__	__	__
g. Other?______________________________	__	__	__
5. Does the installation discharge into a Publicly Owned Treatment Works (POTW)?	__	__	__

If yes, please specify types of discharge
(i.e., process waste water, sanitary waste water, etc.)

____

____

	YES	NO	N/A
6. Does the installation make use of an on-site waste water treatment system prior to effluent discharge?	__	__	__
7. Does the installation conduct any effluent monitoring?	__	__	__

	YES	NO	N/A
13. Does the installation monitor for radon gas?	___	___	___

Installation Restoration Process (IRP)

14. Does the installation currently have any designated IRP sites?	___	___	___
15. If IRP sites are present, does the installation maintain documentation of all interim and final remedial actions/decisions in the IRP process.	___	___	___
a. Location of documents			
16. For installations with IRP sites, determine if the installation maintains the Administrative Record which details the physical situation at the installation.	___	___	___
a. Is the location of the Record normally frequented or found by the public.	___	___	___

Environmental Impact Analysis Plan (EIAP)

17. Does the Base Civil Engineering Office perform Environmental Planning functions?	___	___	___
Do they maintain copies of AF Form 813, Request for Environmental Analysis?	___	___	___
18. Does the Environmental Protection Committee review, and approve, or disapprove environmental documents during the EIAP?	___	___	___

A-106

19. Does the installation include all environmental projects listed in the CECORS in the A-106 report?	___	___	___
20. Does the installation maintain a copy of the previous year's A-106 Pollution Abatement Plan?	___	___	___
a. Location of documents			

ENVIRONMENTAL COMPLIANCE REQUIREMENTS

ENVIRONMENTAL COMPLIANCE ASSESSMENT AND MANAGEMENT PROGRAM (ECAMP)

COMPLIANCE CATEGORY: **SOLID WASTE**

REGULATOR REQUIREMENTS AND INSTRUCTIONS TO EVALUATOR

SECTION A–ALL INSTALLATIONS

SW.1. Determine actions or changes since previous review on solid waste management.

SW.1.1. Obtain a copy of previous review report and determine if noncompliance issues were resolved. (1)(2)

SW.2. The installation should maintain a current file of applicable Federal, DoD, U.S. Air Force, and state/local regulations (AFR 19-1).

SW.2.1. Examine file of Federal, state, and local solid waste management regulations.

SW.2.2. Determine if copies of the following regulations are current and available at the installation: (1)

- 7 CFR 330,
- 40 CFR 240-241, 243-246,
- 40 CFR 260 - 271,
- 40 CFR 61.22,
- 49 CFR 172-177,
- DoD Directive 4165.60,
- AFR 19-1,
- AF Pamphlet 19-5,
- AF Pamphlet 91-8,
- AFM 88-11, and
- AFM 91-11.

(NOTE: A consolidated listing of approved test methods should also be maintained at the installation *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* EPA Publication SW-846, Document #PB87-120-291.)

SW.3. The Air Force encourages its installations to have active resource recovery and recycling programs as outlined in AFR 215-8 and DoD 4165.60 (GMP).

SW.3.1. Determine if the installation has an active resource recovery and recycling program.

CONTACT/LOCATION CODES

(1) Base Environmental Manager (EM); (2) Base Civil Engineering (BCE); (3) Base Bioenvironmental Engineering (BEE).

SOLID WASTE

REGULATOR REQUIREMENTS AND INSTRUCTIONS TO EVALUATOR

SW.3.2. Are current market surveys for recycled products available, and are they used to make program decisions.

SW.4. If the installation generates 10 or more tons of waste corrugated containers monthly, a program shall be established to segregate and separately collect for the purpose of recycling (DoD 4165.60).

SW.4.1. Determine if the installation generates 10 or more tons of corrugated waste containers.

SW.4.2. If so, determine if an active program exists to segregate and separately collect the containers.

SW.5. If the installation has more than 500 families residing on it, an active program shall be established for the separation of used newspapers at the source of residential generation, in conjunction with separate collections, for the purpose of recycling (DoD 4165.60).

SW.5.1. Determine if 500 (or more) families reside on the installation.

SW.5.2. If so, determine if an active newspaper recycling program exists.

SW.6. If any installation office building has over 100 workers, the paper generated shall be separated at the source of generation and collected for the purpose of recycling (DoD 4165.60).

SW.6.1. Determine if the installation currently has a recycling program for paper generated in office buildings.

SW.7. Air Force installations are required to participate in any Federal, state, or local recycling programs and to reduce the volume of solid waste materials at the source whenever practical (DoD 4165.60; AFP 91-8; and 40 CFR 243-244).

SW.7.1. Conduct interviews to verify that recycling programs are complying with applicable Federal, state, or local requirements. (1)(2)

CONTACT/LOCATION CODES

(1) Base Environmental Manager (EM); (2) Base Civil Engineering (BCE); (3) Base Bioenvironmental Engineering (BEE).

COMPLIANCE CATEGORY:

SOLID WASTE

REGULATOR REQUIREMENTS AND INSTRUCTIONS TO EVALUATOR

SECTION B—WASTE DISPOSAL: ON-BASE LANDFILLS

SW.8. On-base landfills should be licensed or permitted (state/local regulations should be consulted).

SW.8.1. Verify that all on-base landfills are licensed or permitted. (1)

SW.8.2. Examine permit for operating conditions or requirements.

SW.9. On-base landfills should be inspected quarterly to verify that permit conditions are being met, unless permit terms and conditions require more frequent inspections (GMP).

SW.9.1. Determine through interview and records review that on-base landfills have been inspected quarterly.(1)

SW.9.2. Verify that any noted variances from permit conditions have been corrected. (1)(2)

SW.9.3. Inspect on-base landfills to verify that permit conditions are currently being met. (1)(2)

SW.9.4. Observe trucks unloading waste to see if hazardous wastes are being improperly disposed of at the landfills.

SW.9.5. Verify that solid waste is not being disposed of improperly at demolition sites, borrow pits, etc.

SW.9.6. Verify that the landfill is secure during nonoperating hours to prevent unauthorized dumping.

SW.10. The closure of on-base landfills may require the filing of a closure plan. This plan often will specify monitoring and inspection procedures (state/local regulations should be consulted).

(NOTE: Some states do not regulate demolition debris fills.)

SW.10.1. Determine if closure plans for base landfills are required by state or local regulations. Verify that required closure plans have been developed. (1)(2)(3)

SW.10.2. Verify that required monitoring activities and inspections have been performed. (1)(3)

CONTACT/LOCATION CODES

(1) Base Environmental Manager (EM); (2) Base Civil Engineering (BCE); (3) Base Bioenvironmental Engineering (BEE).

SOLID WASTE

REGULATOR REQUIREMENTS AND INSTRUCTIONS TO EVALUATOR

SW.10.3. Inspect monitoring data and determine if results required remediation actions. (3)

SW.10.4. Verify that any required remediation has been instituted. (1) (2)

SECTION C–WASTE DISPOSAL: OFF-BASE LANDFILLS

SW.11. Solid waste which is disposed off-base must be disposed of only at licensed or permitted facilities (DoD Directive 4165.60; AFR 19-1, applicable state/local regulations).

SW.11.1. Verify through interview and records search that off-base landfills receiving installation wastes are licensed or permitted. (1) (2)

SW.12. As a good management practice, off-base landfills should be inspected quarterly to verify that permit conditions are being met.

(NOTE: Some MAJCOMs require these quarterly inspections.)

SW.12.1. Determine through interviews and records review that off-base landfills have been inspected quarterly. (1)

SW.12.2. Verify that any noted variances from permit conditions have been called to the attention of the landfill operators and that appropriate steps to protect the interests of the base have been taken. (1)

SW.13. Solid wastes should be disposed of at regional facilities wherever practical (AFR 19-1; DoD Directive 4165.60).

SW.13.1. Interview BCE to verify that proper efforts have been made to use regional waste disposal facilities. (1) (2)

CONTACT/LOCATION CODES

(1) Base Environmental Manager (EM); (2) Base Civil Engineering (BCE); (3) Base Bioenvironmental Engineering (BEE).

COMPLIANCE CATEGORY:

SOLID WASTE

REGULATOR REQUIREMENTS AND INSTRUCTIONS TO EVALUATOR

SECTION D–SOLID WASTE RECEPTACLES

SW.14. Solid waste receptacles must comply with design and operations specifications (state/local regulations should be consulted).

SW.14.1. Inspect receptacle locations for evidence of improper disposal practices or maintenance: (1)

- wastes should be totally contained within receptacle;
- receptacles must be vermin-proof and waterproof;
- waste receptacles should have functioning lids;
- only minimal odors should be present.

SW.15. As a good management practice, on-base industrial shop waste receptacles should be inspected quarterly to verify that hazardous wastes are not being deposited.

SW.15.1. Interview and examine records to verify that receptacles were inspected. (1)

SW.15.2. Verify that corrective actions were taken where indicated. (1)

SW.15.3. Inspect a sample of solid waste receptacles at shops for presence of hazardous waste.

SW.16. Base personnel should be periodically informed about materials that are prohibited from disposal in solid waste receptacles (Good Management Practices).

SW.16.1. Determine if a program exists at the installation to keep personnel informed about proper waste disposal practices. (2)

SECTION E–ASH RESIDUE/SLUDGE DISPOSAL

SW.17. Ash residues and sludge from air pollution control devices at coal-fired base heating plant operations and sludge from wastewater treatment plants should be analyzed for hazardous properties before sale or disposal (40 CFR 260 (Appendix I); applicable state/local regulations; GMP).

CONTACT/LOCATION CODES

(1) Base Environmental Manager (EM); (2) Base Civil Engineering (BCE); (3) Base Bioenvironmental Engineering (BEE).

COMPLIANCE CATEGORY:

SOLID WASTE

REGULATOR REQUIREMENTS AND INSTRUCTIONS TO EVALUATOR

SW.17.1. Determine if installation generates ash residues or sludges.

SW.17.2. If ash residues or sludges are handled as a solid waste, verify that any testing requirements for hazardous properties have been conducted. (1) (3)

SW.17.3. Verify that any such special handling or testing procedures have been conducted. (1)(3)

SW.17.4. Determine if waste water treatment sludge requires a permit. If so, verify that permit conditions are being followed. (1)(3)

SECTION F–REFUSE FROM OUTSIDE THE U.S.

SW.18. Garbage from outside the United States which is on or unloaded from vessels or aircraft arriving in the United States and certain territories and possessions is subject to certain inspection and disposal requirements to prevent dissemination of pests and diseases (7 CFR 330.400).

SW.18.1. Determine if garbage is on or unloaded from vessels or aircraft arriving in the places listed below: (1)(3)

- the United States from any place outside the United States;
- the continental United States from Hawaii or any territory or possession;
- any territory or possession from any other territory or possession or Hawaii;
- Hawaii from any territory or possession.

SW.18.2. Inspect arriving vessels and aircraft. Observe that: (1)(3)

- garbage is contained in tight leak-proof covered receptacles inside guardrails on vessels;
- garbage is removed in tight, leak-proof covered containers under direction of USDA inspector to an approved facility for incineration, sterilization, or grinding into an approved sewage system, or
- garbage is removed for other handling and under supervision approved by the USDA.

SW.18.3. Determine if installation has received approval of facility or sewage system used for disposal from Administrator, Animal and Plant Health Inspection Service, USDA. (1)

CONTACT/LOCATION CODES

(1) Base Environmental Manager (EM); (2) Base Civil Engineering (BCE); (3) Base Bioenvironmental Engineering (BEE).

ENVIRONMENTAL COMPLIANCE REQUIREMENTS

ENVIRONMENTAL COMPLIANCE ASSESSMENT AND MANAGEMENT PROGRAM (ECAMP)

COMPLIANCE CATEGORY:

SOLID WASTE

REGULATOR REQUIREMENTS AND INSTRUCTIONS TO EVALUATOR

SECTION G--MEDICAL/ PATHOLOGICAL WASTES

SW.19. Most solid waste landfills are prohibited from accepting medical/pathological wastes (state/local regulations should be consulted).

(NOTE: Installations located in states that participate in the Federal medical waste program should consult the Federal regulations.)

(NOTE: Installations in Connecticut, New Jersey, New York, Puerto Rico, and Rhode Island, the states participating in the Federal medical waste demonstration program [effective through June 22, 1991], should consult 40 CFR 259.)

SW.19.1. Determine quantities and types of medical/pathological wastes generated on the installation. (1)(3)

SW.19.2. Interview to verify that medical/pathological wastes are being disposed of in accordance with state regulations. (1) (3)

SW.19.3. Inspect solid waste receptacles at base hospital for medical/pathological wastes. (1)

SW.20. Incinerators which handle medical/pathological or other organic wastes must maintain a temperature of 1500°F for a minimum of 0.3 seconds retention time (appropriate state limitation).

SW.20.1. Check controls of pathological incinerator to see if temperature is monitored. If it is, check to see if criteria (1500°F for a minimum of 0.3 seconds) is achieved (or appropriate state limitation). (1)(3)

SW.21. Both pathological and classified material incinerators should be secured to prevent unauthorized use.

SW.21.1. Check the incinerators for fenced in areas or locks on doors and control cabinets. (3)

CONTACT/LOCATION CODES

(1) Base Environmental Manager (EM); (2) Base Civil Engineering (BCE); (3) Base Bioenvironmental Engineering (BEE).

Bibliography

Alm, Alvin L. "A Two-Year Retrospective," *Environmental Science and Technology,* 25: 1023 (June 1991).

Department of the Air Force. *U.S. Air Force Installation Pollution Prevention Manual*, Washington: HQ USAF, January 1992.

Department of the Air Force. *Environmental Compliance Assessment and Management Program.* AFR 19-16. Washington: HQ USAF, 24 August 1990.

Department of the Air Force. *Instruction for the Pollution Prevention Program.* AFI 19-40. Washington: HQ USAF, 1 September 1992.

Department of the Air Force. *Pollution Prevention.* AFPD 19-4. Washington: HQ USAF, 30 November 1992.

Ember, Lois R. "Strategies for Reducing Pollution At the Source Are Gaining Ground," *Chemical and Engineering News,* 69: 7-16 (July 1991).

Firestone, Nancy. "EPA's Pollution Prevention Strategy," *Water Environmental and Technology,* 3: 79 (June 1991).

Hanash, Rami S. "Environmental Compliance Within the Confines of the Federal Budget Process," *Federal Facilities Environmental Journal,* 2: 243-251 (Summer 1991).

Hanson, David J. "Industry Documents 20 Years of Environmental Improvement," *Chemical Engineering News,* 68: 15-17 (June 18, 1990).

Hanson, David J. "Defense Pollution Reduction Efforts Paying Off," *Chemical Engineering News,* 70: 15 (September 21, 1992).

Herbert, Leo. Larry N. Killough, and Alan Walter Steiss. *Accounting and Control for Governmental and Other Nonbusiness Organizations.* New York: McGraw-Hill Book Company.

Hill, Darryl C. "Hazardous Waste Audits: They May Save You," *Professional Safety,* 36: 33-37 (June 1991).

Hutcheson, Ron. "Air Force Budget-Cutters Offer to Sacrifice F-16," *Dayton Daily News*, pp. 4A (February 9, 1993).

Ludwiszewski, Raymond B. "Pollution Prevention Plays Enforcement Role," *Pollution Engineering*, 23: 13-15 (October 1991).

McGuinness, Barbara J. "DuPont's Environmental Audit Program," *Environmental Management Review*, pp. 71-79, (Fourth Quarter 1992).

Mooney, Gregory A. "Pollution Prevention: Shrinking the Waste Stream," *Pollution Engineering*, 24: 36-41 (March 1, 1992).

Nichols, Alan B. "EPA Makes Pollution Prevention A Top Priority," *Water Management and Technology*, 3: 54-59 (October 1991).

Pojasek, Robert B., and Lawrence J. Cali. "Contrasting Approaches to Pollution Prevention Auditing," *Pollution Prevention Review*, pp. 225-235 (Summer 1991).

United States Congress. *Pollution Prevention Act of 1990*. Public Law 101-508, 42 united States Code, Chapter 133. Washington: GPO, 1990.

Vendinello, Lynn. "EPA Targets Pollution Prevention," *Pollution Engineering*, 24: 27-29 (May 1, 1992).

Warris, Anne-Marie. "Making the Case For Environmental Audits," *Process Engineering*, 72: 11-13 (Spring 1991).

Wilson, J. Fraser, and Randy Billings. "Designing and Implementing Effective Environmental Management," *CIM Bulletin*, 84: 73-74 (August 1991).

Woodman, Jocelyn. "Pollution Prevention for Dye Manufacturers, " *Pollution Engineering*, 24: 27-19 (March 1, 1992).

Vita

Ms Stacy Ellen Gent was born 21 September 1963 in West Palm Beach, Florida and graduated from Northeast High School in Oakland Park, Florida in 1981. In the fall of 1981, Ms Gent matriculated at Furman University in Greenville, South Carolina. In 1983, Ms Gent transferred to Florida Atlantic University in Boca Raton, Florida where she graduated in 1985. Ms Gent holds a Bachelor of Science degree in Geology (Multidisciplinary). In 1986 Ms Gent was hired by the State of Florida, Department of Natural Resources and in 1987 transferred to the Department of Environmental Regulation. While employed by the latter agency, Ms Gent provided oversight on environmental compliance/restoration activities for various facilities handling hazardous, industrial, and/or solid waste. In 1988, Ms Gent began her affiliation with the Air Force as a Tactical Air Command contracted technical representative. In this capacity, Ms Gent provided technical assistance to the Hazardous Waste, Polychlorinated Biphenyl, and Installation Restoration Management programs at Homestead AFB. In May 1989, Ms Gent was hired by Shaw AFB, where she established a hazardous waste management program and in 1991 was promoted to Environmental Compliance Manager/Resource Advisor for the base environmental function. In May 1992, Ms Gent entered the Air Force Institute of Technology, School of Engineering, masters degree program in Engineering and Environmental Management.

Permanent Address: 5711 NE 20 Terrace
Ft Lauderdale, Florida 33308

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
September 1993

3. REPORT TYPE AND DATES COVERED
Master's Thesis

4. TITLE AND SUBTITLE
A STRATEGY FOR COMBINING THE POLLUTION PREVENTION OPPORTUNITY ASSESSMENT WITH THE ENVIRONMENTAL COMPLIANCE ASSESSMENT AND MANAGEMENT PROGRAM

5. FUNDING NUMBERS

6. AUTHOR(S)
Stacy E. Gent, GS-12

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology
WPAFB OH 45433-6583

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GEE/ENV/93S-08

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release;
distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This research develops a method to allow an installation environmental function to satisfy the assessment requirements of both the Air Force Pollution Prevention and the Environmental Compliance Assessment and Management Program with the implementation of one assessment process. The model developed is designed to achieve the goals of both programs while increasing the efficiency of implementation.

The resulting assessment model formulated within this research is applied on a theoretical level to yield preliminary results. These results indicate that the combination of the Pollution Prevention Opportunity Assessment and the environmental compliance assessment required by the Environmental Compliance Assessment and Management Program is a viable initiative. These results also indicate that by combining both assessments, greater efficiency, as measured by cost, time, and interruptions, can be achieved.

14. SUBJECT TERMS
Pollution Prevention, Environmental Compliance, Auditing, Pollution, ECAMP

15. NUMBER OF PAGES
96

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR