ESTABLISHING A WASTE MINIMIZATION PROGRAM AT YOUR FACILITY

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for planning, implementing, and managing the research, development and demonstration of programs to provide an authoritative, defensible engineering basis in support of the policies, programs, and regulations of the EPA with respect to drinking water, wastewater, pesticides, toxic substances, solid and hazardous wastes, and Superfund-related activities. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

The EPA encourages generators of hazardous and non-hazardous waste to carry out assessments in their facilities to identify opportunities for waste minimization. This paper was prepared by the EPA's Risk Reduction Engineering Laboratory to describe six elements which should be considered when establishing a waste minimization program for a facility. These non-binding guidelines, as suggested by the Agency, have applications across a wide range of industries and manufacturing processes and can assist a waste generator in meeting regulatory requirements.

Introduction

There is underway today in manufacturing facilities in the United States and other industrial countries, a clear movement toward "waste minimization" as a means for reducing environmental problems caused by the generation, treatment, and disposal of hazardous wastes. In many respects this is only a continuation of efforts by industry to increase product yields and profits by reducing wastes. However, as it has become increasingly clear that there is a limit as to what can be achieved through "end-of-the-pipe" approaches to solving problems, waste minimization has become increasingly popular.

This paper offers several suggestions for implementing an effective waste minimization program. Included is a review of the EPA's recently issued guidance for establishing a waste minimization program.

Background

With the passage of the Hazardous and Solid Waste Amendments (HSWA) of 1984, the U.S. Congress established a national policy declaring the importance of reducing or eliminating the generation of hazardous waste. This policy statement is:

> The Congress hereby declares it to be a national policy of the United States that wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated should be treated, stored, or disposed of so as to minimize present and future threat to human health and the environment.

In this declaration, Congress established a clear priority for reducing or eliminating the generation of hazardous wastes (a concept referred to as waste minimization) over managing wastes that were "nevertheless" generated.

EPA believes that hazardous waste minimization means the reduction, to the extent feasible, of hazardous waste that is generated prior to treatment, storage or disposal of the waste. It is defined as any source reduction or recycling activity that results in either: (1) reduction of total volume of hazardous waste; (2) reduction of toxicity of hazardous waste; or (3) both, as long as that reduction is consistent with the general goal of minimizing present and future threats to human health and the environment.[1]

The transfer of hazardous constituents from one environmental medium to another does not constitute waste minimization. Neither would concentration conducted solely for reducing volume unless, for example, concentration of the waste allowed for recovery of useful constituents prior to treatment and disposal. Likewise, dilution as a means of toxicity reduction would not be considered waste minimization, unless later recycling steps were involved.[1]

In a related action, the EPA published in the Federal Register on January 26, 1989, a proposed policy statement on source reduction and recycling. This policy commits the Agency to a preventive strategy to reduce or eliminate the generation of environmentally-harmful pollutants which may be released to the air, land, surface water or ground water. It further proposed to incorporate this preventive strategy into EPA's overall mission to protect human health and the environment by making source reduction a priority for every aspect of Agency decision-making and planning, with environmentally-sound recycling as a second priority over treatment and disposal.[2] The Agency's encouragement of waste minimization is an example of the pollution prevention policy for RCRA hazardous wastes.

Current Federal Regulatory Requirements for Waste Minimization Programs

Besides establishing the national policy, Congress also enacted several provisions in HSWA for implementing hazardous waste minimization. These include a generator certification on hazardous waste manifests and permits for treatment, storage, or disposal of hazardous waste. These certifications (effective September 1, 1985) require generators to certify two conditions: (1) the generator of the hazardous waste has a program in place to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable; and (2) the proposed method of treatment, storage or disposal is that practicable method currently available to the generator which minimizes the present and future threat to human health and the environment.[1]

In addition, Congress also added a new provision in 1984 that requires hazardous waste generators to identify in their biennial reports to EPA (or the State): (1) The efforts undertaken during the year to reduce the volume and toxicity of waste generated; and (2) the changes in volume and toxicity actually achieved in comparison with previous years, to the extent such information is available prior to 1984.[1]

Waste Minimization Approaches and Techniques

Waste minimization is inevitably site and plant-specific, but a number of generic approaches and techniques have been used successfully across the country to reduce many kinds of industrial wastes.

Generally, waste minimization techniques can be grouped into four major categories: inventory management and improved operations, modification of equipment, production process changes, and recycling and reuse. Such techniques can have applications across a range of industries and manufacturing processes, and can apply to non-hazardous as well as hazardous waste.

Many of these techniques involve source reduction -- the preferred option on EPA's hierarchy of waste management. Others deal with on and off-site recycling. In practice, waste minimization opportunities are limited only by the ingenuity of the generator. In the end, a company looking carefully at bottom-line returns may conclude that the most feasible strategy would be a combination of source reduction and recycling approaches.[6]

The approaches discussed and illustrated in Figure 1 provide waste minimization examples for generic and specific processes.

Figure 1. Waste Minimization Approaches and Techniques

Inventory Management & Improved Operations

- Inventory and trace all raw materials.
- Purchase fewer toxic and more nontoxic production materials.
- Implement employee training and management feedback.
- Improve material receiving, storage, and handling practices.

Modification of Equipment

- Install equipment that produces minimal or no waste.
- Modify equipment to enhance recovery or recycling options.
- Redesign equipment or production lines to produce less waste.
- Improve operating efficiency of equipment.
- Maintain strict preventive maintenance program.

Production Process Changes

- Substitute nonhazardous for hazardous raw materials.
- Segregate wastes by type for recovery.
- Eliminate sources of leaks and spills.
- Separate hazardous from nonhazardous wastes.
- Redesign or reformulate end products to less hazardous.
- Optimize reactions and raw material use.

Recycling and Reuse

- Install closed-loop systems.
- Recycle onsite for reuse.
- Recycle offsite for reuse.
- Exchange wastes.

Source: EPA/530-SW-87-026

Elements of a Waste Minimization Program

So, what is a "waste minimization program?" Understandably, the Agency has been asked this many times since the September 1985 date, after which generators were to have certified that they had one in place.

The generator has a wide latitude in structuring his or her program. Also, since Congress indicated in its accompanying report to HSWA that "economically practicable" is to be determined by the generator and is not subject to subsequent evaluation by the EPA, the generator has even more latitude in defining a program. The EPA has, in a June 12, 1989 Federal Register Notice, issued some non-binding guidelines as to what the elements of an effective waste minimization program might include. These elements are:

- TOP MANAGEMENT SUPPORT
- CHARACTERIZATION OF WASTE GENERATION
- PERIODIC WASTE MINIMIZATION ASSESSMENTS
- A COST ALLOCATION SYSTEM
- ENCOURAGE TECHNOLOGY TRANSFER
- PROGRAM EVALUATION (1)

Top Management Support

The first step in developing a program is to establish a clear corporate policy. The full commitment from management of time, personnel and financing is extremely important. Lack of this commitment is often one of the most formidable obstacles to waste minimization. The chances for obtaining this commitment are often enhanced by outlining the potential incentives for waste minimization as shown in Table 1.

TABLE 1. WASTE MINIMIZATION INCENTIVES

Economics

- Landfill disposal cost increases.
- Costly alternative treatment technologies.
- Savings in raw material and manufacturing costs.

Regulations

- Certification of a WM program on the hazardous waste manifest.
- Biennial WM program reporting.
- Land disposal restrictions and bans.
- Increasing permitting requirements for waste handling and treatment.

Liability

- Potential reduction in generator liability for environmental problems at both onsite and offsite treatment, storage, and disposal facilities.
- Potential reduction in liability for worker safety.

Public Image and Environmental Concern

- Improved image in the community and from employees.
- Concern for improving the environment.

Source: Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003)

An appreciation of the necessity for top management support is summed up very well by G. J. Hollod:

> "Lack of senior management support will doom a waste minimization program from the start. Many managers in addition to the standard business functions have become occupied with other priorities in the environmental area like land bans, right-to-know and occupational health considerations. Waste minimization is competing with other environmental priorities but management must be convinced that waste minimization is a program that deserves priority and should be part of the "daily diet" for the line organization and not just another environmental headache left to the site's environmental coordinator."[10]

-- **Make waste minimization a company policy.**

The objectives of a waste reduction program are best conveyed to a business's employees through a formal policy statement or management directive. A business's upper management is responsible for establishing a formal commitment throughout all levels of the business. An environmental policy statement or the business's operating guidelines might include the following points:

- Environmental protection is a production line responsibility and an important measure of employee performance. In addition, every employee is responsible for environmental protection in the same manner(s) he is for safety;

- Reducing or eliminating the generation of waste has been and continues to be a prime consideration in research, process design, and plant operations, and is viewed by management like safety, yield, and loss prevention; and

- Reuse and recycling of materials has been and will continue to be given first consideration prior to classification and disposal as a hazardous waste.[11]

As an example of such a policy the 3M Company of St. Paul, Minnesota, has a part of its official environmental policy that the company will "prevent pollution at the source wherever and whenever possible." It might be noted that this company also has as part of its policy to "develop products that will have a minimum effect on the environment." While this is somewhat outside the goals of a typical waste minimization program, it is clearly within the goals of an overall pollution prevention program, and should certainly be considered by any company producing products that will ultimately end up in the wastestream.

-- **Set specific goals for reducing the volume or toxicity of waste streams.**

Quantitation helps. Some examples of waste minimization goals are:

- The U.S. Department of Defense is committed to reducing its hazardous waste disposal rates by 50 percent by 1992.[3]

- The Dupont Company has stated that its wastes will be reduced by 35 percent by 1990 compared to 1982 values.[4]

- As a benchmark for evaluation of waste minimization goals, a report on waste reduction issued by the Congressional Office of Technology Assessment in 1986 states that "substantially more waste reduction is feasible and more will become feasible. Setting a national voluntary waste reduction goal of perhaps 10 percent annually for 5 years would be useful."[5]

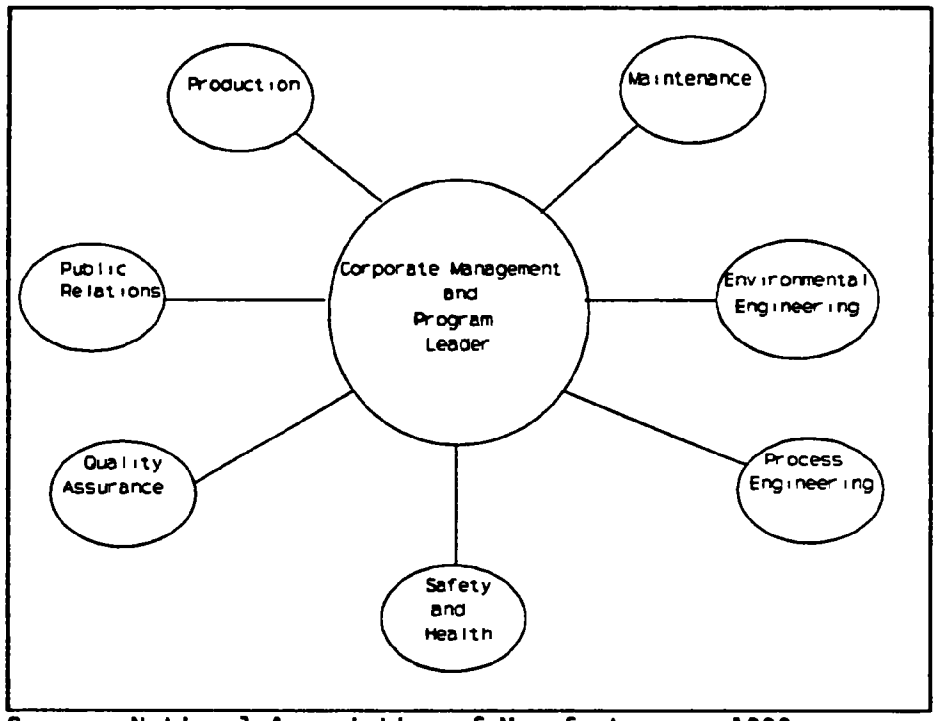
-- **Commit to implementing recommendations identified through assessments, evaluations or other means.**

A sure way to undermine a program is to not follow up on recommendations developed by a committed group of employees. Although it may be unreasonable to expect facility management to make wholesale commitments to accept recommendations, it is not unreasonable to expect management to commit to giving a high priority to considering such recommendations and then doing it.

-- **Designate a waste minimization coordinator and select a team at each facility to ensure effective implementation of the program.**

For a small facility with only a few waste streams, one person such as a plant manager, plant engineer, or environmental engineer may be responsible for the entire waste minimization program. For larger, highly integrated facilities with many different processes and emission sources, a team or task force might be established. As shown in Figure 2, team members should represent major departments that are involved in waste generation and management and different areas of expertise. A team may include members from production, facilities/maintenance, environmental engineering, process engineering, safety and health, and quality assurance departments. Your appointed minimization "champion" should lead the effort and coordinate all involved departments. Outside consultants and/or corporate staff should also be considered, depending on the company's nature, the facility's complexity, and available in-house skills.[7]

Figure 2. Suggested Waste Minimization Team Organization



Source: National Association of Manufacturers, 1989.

A summary of functions that might be assigned to the waste minimization team are shown in Table 2.

TABLE 2. FUNCTIONS OF A WASTE MINIMIZATION COORDINATION TEAM

- Define Objectives
- Review with Site Management
- Communicate to site
- Buy-in from generators
- Representation from areas
- Ongoing awareness and training
- Provide Resources
- Catalyze
- Coordinate
- Accounting System
- Upgrade projects
- Schedule reviews
- Conduct audits
- Summarize site progress
- Recognize

Source: Hazardous Waste Minimization (McGraw Hill, 1989)

-- Publicize success stories. - - Reward employees that identify cost-effective waste minimization opportunities; train employees on aspects of waste minimization that relate to their job.

Employees often cause the generation of waste and they can contribute to the overall success of the waste reduction program. Just as incentives are used to boost employee productivity, management should provide incentives for the development of useful waste reduction ideas. To utilize this important resource, many businesses give their employees incentives such as:

- Recognition awards for outstanding waste reduction projects and individuals, as well as for resource and energy conservation projects; and

- Bonuses or financial awards for innovative approaches to waste reduction.

Public recognition helps to inform the public of actions taken by the business to reduce and control hazardous waste. Recognition programs can be varied to accommodate each business, their level of involvement, and local attitudes. For instance, public recognition such as an award or certificate may be welcomed by many businesses. Other businesses, however, maintain a "low profile" as a matter of policy. In such cases, a letter from the Board may be preferred. The effectiveness of this program could be increased by combining it with other awards, such as an employee-of-the-month program, or a percentage of the cash savings realized by the suggestion. Regardless of the form of the incentives, employees should realize part of the benefits of their waste reduction ideas and efforts. In some businesses, meeting the waste reduction goals is used as a measure for evaluating the job performance of managers and employees.[11]

The Dow Chemical Company incorporates these elements into its widely recognized and very successful Waste Reduction Always Pays Program; through utilizing company newsletters to publicize waste reduction success stories, and through recognition for teams of employees that propose changes that lead to decreased waste generation. The company also strives to incorporate the principles of waste reduction into all of its training activities.

Characterization of Waste Generation

Maintain a waste accounting system to track the types, amounts and hazardous constituents of wastes and the dates they are generated. It has been our observation, and we might add the observation of many others active in encouraging waste minimization, that most generators do not really know what is in their wastestream, or what possibilities might exist for reducing the volume or toxicity of the streams through relatively simple means. Information about waste streams can come from a variety of sources. Some information on waste quantities is readily available from the completed hazardous waste manifests, which include the description and quantity of hazardous waste shipped to a Treatment Storage and Disposal Facility. The total amount of hazardous waste shipped during a one-year period, for example, is a convenient means of measuring waste generation and waste reduction efforts. However, manifests often lack such information as chemical analysis

of the waste, specific source of the waste, and the time period during which the waste was generated. Also, manifests do not cover wastewater effluent, air emissions, or nonhazardous solid wastes. Potential sources of information on waste streams are shown in Table 3.

TABLE 3. SOURCES OF WASTE GENERATORS INFORMATION

- hazardous waste manifests
- biennial hazardous waste generator reports
- SARA Title III Section 313 environmental release reports
- environmental audit reports
- permits (RCRA Part B, National Pollution Discharge Elimination System (NPDES< etc.)
- lab reports/characterization data
- chemical inventory and usage records
- NPDES monitoring reports
- Material Safety Data Sheets (MSDSs)
- internal waste tracking system records
- production records

Source: National Association of Manufacturers, 1989

A useful form for conducting waste stream characterization is shown in Figure 3. This is from the EPA Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003).

In addition to providing a means for measuring the effectiveness of your program, there are currently three reasons why it is very important to track your progress in this area.

- First, HSWA requires that generators report on the progress of their waste minimization program with the biennial generator report.
- Also, EPA can make a minimization program and associated reporting a condition of a RCRA permit.
- Finally, SARA Title III reporting allows for minimization to be addressed, and although this is currently voluntary it may become mandatory.[7]

The tracking function or recordkeeping at a minimum should record and identify the generator or "owner" of the waste reduction method being used to reduce that particular waste stream. Table 4 shows a typical printout from a computer tracking program that has been used by the DuPont Company.[10]

One reporting function that would be of particular interest to any program is the tracking of the most successful or most often used waste minimization technique. Table 5 lists the validation codes for the typical waste minimization techniques that are used at DuPont. This information can be used by business managers and technical managers to inform manufacturing facilities in different locations of the country to what might be the most successful waste minimization technique to apply.[10]

FIGURE 3 Form for Conducting Waste Minimization Characterization.

Firm _____	Waste Minimization Assessment	Prepared By _____
Site _____	Proc. Unit/Oper _____	Checked By _____
Date _____	Proj No _____	Sheet 1 of 1 Page __ of __

WORKSHEET

WASTE STREAM SUMMARY

Attribute		Description[1]					
		Stream No. ___		Stream No. ___		Stream No. ___	
Waste ID/Name:							
Source/Origin							
Component/or Property of Concern							
Annual Generation Rate (units_____)							
Overall							
Component(s) of Concern							
Cost of Disposal							
Unit Cost ($ per: _____)							
Overall (per year)							
Method of Management[2]							
Priority Rating Criteria[3]	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		Σ(R x W)		Σ(R x W)		Σ(R x W)	
Priority Rank							

Notes: 1. Stream numbers, if applicable, should correspond to those used on process flow diagrams.

2. For example, sanitary landfill, hazardous waste landfill, onsite recycle, incineration, combustion with heat recovery, distillation, dewatering, etc.

3. Rate each stream in each category on a scale from 0 (none) to 10 (high).

Table 4

Typical Column Headers in Computer Printouts

Production Area	Waste Description	Hazardous Classification	Quantity Generated M lb/yr	Management Disposal Costs $M/yr	Minimization Method
V1023	Organic Acid	Flammable	2	5.5	Recycle
NR126	Polymers	Caustic	50	25	Sale
GA462	Spent Catalyst	Acidic	10	42	Reuse
ME621	Lab Solvent	Ignitable	0.5	1	Fuel
BU215	Acid Catalyst	Corrosive	40	16	Administrative Control

Source: Hazardous Waste Minimization (McGraw Hill, 1989)

TABLE 5. VALIDATION CODES FOR TYPICAL WASTE MINIMIZATION TECHNIQUES

10 :	Process Change
11 :	Modify Operating Procedure
12 :	Advanced Process Control
13 :	Substituted Chemicals
14 :	Use Higher Quality Materials
20 :	Recycle
21 :	Direct Use in the Process
22 :	Direct Use in Another Process
23:	Regeneration for Reuse
24 :	Use as a Fuel
25 :	Sale
30 :	Improve Waste Treatment
31 :	Waste Filtration
32 :	Waste Decantation
33 :	On-Line Treatment
40 :	Administrative Controls
41 :	Minimizing Washdown
42 :	Reduce Cleaning Frequency
43 :	Longer Turnaround Time
44 :	Improved Spill Control
45 :	Separate Hazardous from Nonhazardous
46 :	Discontinue Manufacture

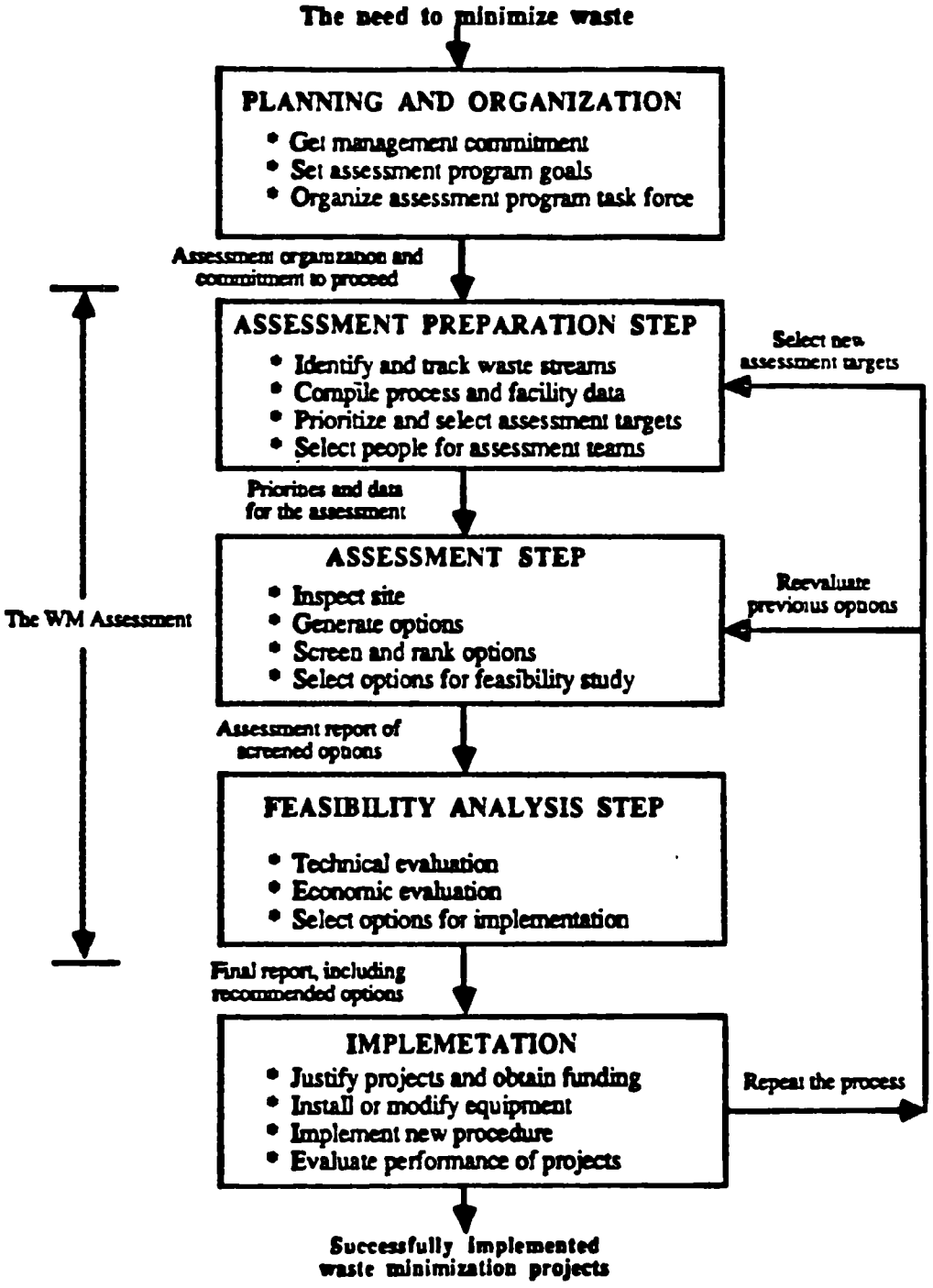
Source: Hazardous Waste Minimization (McGraw Hill 1989)

Periodic Waste Minimization Assessment

An important element in a waste minimization program is to perform periodic waste minimization assessments, sometimes referred to as "waste reduction audit." Conducted by an in-house assessment team or with an independent outside expert, a waste minimization assessment is simply a structured review of potential opportunities to reduce or recycle waste. Its focus can be broad or narrow. Most find that it is usually more effective to select a few waste streams or processes for intensive assessment rather than to attempt to cover all waste streams and processes at once.

The USEPA has published a manual for conducting waste minimization assessments. This manual entitled Waste Minimization Opportunity Assessment Manual (EPA/625/7-88/003) is available free from the Waste Minimization Branch, USEPA, 26 W. Martin Luther King Dr., Cincinnati, OH 45268. The procedure recommended by the EPA is outlined in Figure 4.[9]

Figure 4: THE WASTE MINIMIZATION ASSESSMENT PROCEDURE



Waste minimization opportunity assessments are an extremely good way to focus attention on potential improvements. The reader is encouraged to obtain a copy of the EPA manual.

A Cost Allocation System

Departments and managers should be charged "fully-loaded" waste management costs for the wastes they generate. In addition to the actual disposal fee for a wastestream of interest, the generator should also consider other cost elements such as:

- Generator Fees/Taxes
- Transportation
- Onsite Storage and Handling
- Pre-disposal Treatment
- Permitting, Reports and Recordkeeping
- Emergency Preparedness and Site Cleanup Contingency
- Pollution Liability Insurance
- Raw Materials
- Operating and Maintenance Costs

Encourage Technology Transfer

Seek or exchange technical information on waste minimization from other parts of your company, from other firms, trade associations, State and university technical assistance programs or professional consultants. Many techniques have been evaluated and documented that may be useful in your facility.

To facilitate the transfer of technical information EPA was mandated by the Congress to establish a national clearinghouse to provide easily accessible and reliable information on waste minimization/pollution prevention. The clearinghouse is to contain both technical information on how to identify and implement pollution prevention opportunities, and general information conveying the message that, "We, as a society, must begin to integrate pollution prevention into the way we design, build, buy and consume."

EPA's Pollution Prevention Information Clearinghouse (PPIC), which is supported by the Agency's Pollution Prevention Office as well as OR&D, has been created to fulfill this mandate. PPIC (pronounced pea-pick) is being pilot-tested by some 300-400 users this year and will be in full operation, accessible to all, in 1990. PPIC collects and disseminates technical and other information on pollution prevention through a telephone hotline and an electronic information exchange network. Indexed bibliographies and abstracts of reports, publications and case studies on pollution prevention will be available. PPIC will also include a calendar of pertinent conferences and seminars, information on federal and State activities and legislation, information on pollution prevention abroad, a directory of waste exchanges and lists of knowledgeable contacts within State organizations, trade associations and the EPA. Copies of various reports will be made available by the clearinghouse either by electronic transfer or through the National Technical Information Service (NTIS) or other sources.

Program Evaluation

Conduct a periodic review of program effectiveness. Use these reviews to provide feedback and identify potential areas for improvement.

Conclusion

We feel that waste minimization provides opportunities to deal more efficiently and effectively with wastes that are hazardous to human health and the environment. The program outlined in this paper is one way a company might pursue establishing a waste minimization program. They reflect the results of agency analyses conducted over the last several years and extensive interaction with private and public sector waste minimization program managers. However, it is recognized that programs must be tailored to fit various companies. We would leave you with a request, that since nothing happens until somebody does something, do something and incorporate a program that fits your facility.

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