HAZARDOUS WASTE MINIMIZATION

OR

"THE STRATEGY OF THE CORK?"

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Throughout the years of rapidly developing environmental awareness a type of pollution control culture has developed In 1985, the administrator of the EPA, Lee M. Thomas, summed up this phenomenon:[1]

> The current statutory structure arises from a general environmental strategy that has been accepted - consciously or not - by nearly everyone who has worked for environmental protection in this country. Let's call it the strategy of the cork.

It has been hoped, that by putting a regulatory cork at the point of release for every pollutant you can eventually stop the flow and protect the environment. As a practical matter, a certain amount of "pollution" escapes because some of the corks are loose. But it has been assumed that as technology develops the corks can be pressed in tighter. Of course, like the legendary dutch boy with his finger in the dike, the so-called pollution tends to pop out in other unexpected places. The solution has been to develop new and better corks and the cycle repeats itself.

In recent years the number of people in the public and private sector have begun to realize the wisdom of the adage, "An ounce of prevention is worth a pound of cure." Indeed, in the environmental arena, an ounce of prevention may be worth several thousand pounds of cure. Consequently, there is a rapidly developing focus on hazardous waste minimization and/or source reduction. The idea is that if the generation of a particular hazardous waste can be reduced or eliminated, the environment will be protected and the risks and liabilities associated with the transportation, treatment, and disposal of hazardous wastes will also be minimized.

EMERGENCE OF HAZARDOUS WASTE MINIMIZATION

The public emergence of the hazardous waste minimization concept began with a position statement published by the USEPA in the Federal Register on August 18, 1976.[2] At that time, the EPA established, "priority pathways" to waste management, which later became referred to as a, "waste management hierarchy." Later on, the hierarchy became the basis for developing national policy. However it was nearly ten years before hazardous waste minimization began to find its way into the legal and regulatory structure.

The Hazardous and Solid Waste Amendments of 1984 (HSWA)[3] established a new policy concerning the generation of hazardous waste and identified certain waste minimization requirements. These new provisions amended the Resource Conservation and Recovery Act of 1976 (RCRA). Additional, albeit optional requirements were established in Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) entitled, "Emergency Planning and Community Right-to-Know Act of 1986."

THE LAW

According to Section 1003 of RCRA, the "Objectives and National Policy" has become:

> The Congress hereby declares it to be the 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 the present and future threat to human health and the environment.

These objectives were expanded in a later paragraph which requires the protection of health and the environment by:

> ... minimizing the generation of hazardous waste and the land disposal of hazardous waste by encouraging process substitution, materials recovery, properly conducted recycling and reuse, and treatment ...

At that time, the Congress officially established a public policy which focuses on the primacy of source reduction or elimination of hazardous waste. It is only after source issues have been addressed that the focus turns to the proper treatment, storage and disposal of hazardous wastes.

In order to encourage waste minimization Congress specifically required certain reporting procedures. Generators were required to report on "... efforts undertaken ... to reduce the volume and toxicity of waste generated" as well as "... the changes in volume and toxicity of the waste actually achieved," during the reporting period. In addition, generators were required to sign a waste minimization certification statement on each manifest that accompanied a shipment of hazardous waste and comply with a new specific condition in hazardous waste permits which required certification, no less often than annually that, "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 ... 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 environment." In addition, the EPA was required to conduct a study to evaluate the desireability of a regulatory approach to minimize the generation of hazardous waste including recommendations for legislative changes which the Administrator determines are appropriate. The report was due to Congress by October 1, 1986.

THE REGULATIONS

By July 15, 1985, the USEPA had published final rules addressing hazardous waste minimization.[4]

The Uniform Hazardous Waste Manifest

On each manifest that accompanies a shipment of hazardous waste the generator must sign a certification statement which reads:

> ... Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the [practical] method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment.

The certification statement was later amended to include the word "practical."

The Biennial Report

Generators who treat, store, or dispose of hazardous waste either onsite or offsite must submit a biennial report by March 1 of each even numbered year. However, only those generators who ship offsite are required to report waste minimization activities. Specifically, they are required by the USEPA to include in their report:

> ... a description of the efforts undertaken during the year to reduce the volume and toxicity of waste generated ... [and] ... a description of the changes in volume and toxicity of waste actually achieved during the year in comparison to previous years to the extent such information is available for years prior to 1984.

Florida rules are more stringent that federal regulations, requiring annual reporting of hazardous waste management. Accordingly, Florida generators must annually report their efforts to reduce the volume and toxicity of wastes generated as well as a description of the changes in volume and toxicity of wastes actually achieved during the preceding calendar year. The FDER, "Generator Annual Hazardous Waste Report" forms, found in FAC 17-30.401(3), are currently being transferred to 17-30.900(3).

The Hazardous Waste Permit

Any generator who treats, stores or disposes of hazardous waste onsite must comply with a new permit condition which requires him to certify:

> ... no less often than annually, that the permittee has a program in place to reduce the volume and toxicity of hazardous waste that he generates to the degree determined by the permittee to be economically practicable; and the proposed methods of treatment, storage or disposal is that practicable method currently available to the permittee which minimizes the present and future threat to human health and the environment.

These three certifications, i.e., the Uniform Hazardous Waste Manifest, the biennial report (annual in Florida), and hazardous waste permit condition have been used to encourage generators to "voluntarily" reduce the generation of hazardous waste and to properly manage the hazardous waste that cannot be practically eliminated. Although the system has been especially designed to reduce the amount of hazardous waste that must be disposed in landfills, it also implies the reduction of hazardous substance releases to other media.

SARA III - Optional Waste Minimization Reporting

Section 313 under SARA Title III requires that all releases of toxic chemicals to air, water or land exceeding established thresholds must be reported. Although not specifically required by the law, regulations for "optional" reporting of hazardous waste minimization activities were included as part of EPA Form R in the final rules published in the Federal Register on February 16, 1988.[5] The optional hazardous waste minimization reporting is attached to a three year sunset provision.

Various industry groups objected to the provisions because they were not required by the Law, adding that substantial cost would be incurred to gather the so-called optional information. They feared that generators electing not to complete that portion of Form R because of cost or trade secret considerations would be viewed negatively by the agency or various public interest groups.

CONTRASTING VIEWS OF USEPA AND OTA

It has become clear that the USEPA and the Congressional Office of Technology Assessment have adopted significantly differing views regarding the priorities of hazardous waste management. In a report entitled, "Serious Reduction of Hazardous Waste," the OTA focused on waste reduction as the only true measureable way to reach the goal of minimizing the wastes generated which must subsequently be transported, treated, stored, and disposed. OTA specifically defined waste reduction as:

> In-plant practices that reduce, avoid, or eliminate the generation of hazardous waste so as to reduce risks to health and environment. Actions taken away from the waste generating activity, including waste recycling or treatment of wastes after they are generated, are not considered waste reduction. Also, an action that merely concentrates the hazardous content of a waste to reduce waste volume or dilutes it to reduce degree of hazard is not considered waste reduction.[6]

The USEPA on the other hand published their, "Report to Congress" the following month entitled, "Minimization of Hazardous Waste." In that report the USEPA indicated that waste minimization:

> "means the reduction, to the extent feasible, of hazardous waste that is generated or subsequently treated, stored, or disposed of. It includes any source reduction or recycling activity undertaken by a generator that results in either (1) the reduction of total volume or quantity of hazardous waste, or (2) the reduction of toxicity of hazardous waste, or both, so long as the reduction is consistent with the goal of minimizing present and future threats to human health and the environment.[7]

It is clear that the OTA definition of waste reduction allows for the inclusion of only certain types of onsite recycling activities which are an integral part of the process. On the other hand, the USEPA has defined waste minimization in a manner consistent with their own recent regulatory history, i.e, which may include various onsite or offsite recycling activities or certain types of treatment activities which reduce the volume or toxicity of hazardous waste. In the Report to Congress, the EPA did attempt to define, "source reduction" but allowed that source reduction measures, "can include some types of treatment processes ..."

Since waste reduction/minimization programs are essentially voluntary, the most affected industries have adopted the best elements of both approaches. For example, the Dow Chemical USA, Waste Reduction Always Pays, (WRAP) program[8] identifies a priority list of waste management techniques including,

- o source reduction,
- o recycling/reuse,
- o resource recovery, and
- o volume reduction.

According to Dow, waste reduction includes source reduction and internal recycling practices which may include material substitution, process operating changes, administrative changes, and/or equipment changes. Waste minimization is broadly defined in the WRAP program to include all of the above waste reduction techniques, offsite recycling, and certain waste treatment or resource recovery practices.

Similarly, J.S. Hunter and D.M. Benforado, 3M Company, have embraced a, "Life Cycle Approach To Effective Waste Minimization."[9] They have likened the life cycle model for waste minimization to a model of communicable disease control. It is well known that communicable diseases can be managed by controlling the source, the mode of transmission, or the susceptability of the receptor. Although a disease can be managed by controlling any one of three elements, it is well known that the best approach is to attack all three elements simultaneously. For the waste minimization model, the similar components are the source, waste handling procedures, and land disposal. Similarly, the optimum approach to hazardous waste management is to control all three elements in the process. Messrs. Hunter and Benforado go on to define the "life cycle" in terms of the birth, life, and final disposal of a given quantity of hazardous waste. They subsequently demonstrate how the amount of hazardous material finally reaching a land disposal facility can be reduced first by prevention, then sequentially by reclaim/recycle onsite, reclaim/recycle offsite, and treatment to reduce volume and toxicity. Indeed, it is the combination of approaches that provides maximum timely protection of the environment and is also cost effective.

Nevertheless, while the USEPA and OTA grapple with legal/regulatory issues, the affected industries are proceeding to address hazardous materials minimization at each step along the way.

Meanwhile, the EPA has recommended that, "generators should continue to determine which waste minimization techniques are economically practicable and that EPA should not specify requirements for waste minimization."[7] Although the EPA has endorsed the voluntary approach to minimization they do have an obligation to report back to Congress by December 1990, regarding the progress that has been demonstrated since the HSWA amendments of 1984. In the interim, the EPA has adopted a three point strategy for waste minimization including:

- information gathering,
- a core waste minimization program, and
- an evaluation of longer term options which may include performance standards and other mandatory requirements.

Although OTA has endorsed continued voluntary efforts, they have also recommended, "a new highly visible waste reduction program." The OTA approach would establish a grants program to fund certain private sector waste reduction efforts, expand federal reporting and planning requirements for industry, establish requirements for financial reports, provide an Office of Waste Reduction in EPA, provide for regulatory concessions for compliance, and establish and empower State Waste Reduction Boards. The regulatory concessions to waste generators could include longer periods for environmental permits or deferred permits while waste reduction projects are in progress, special designation that would give a facility priority attention when requesting agency action, specific exemptions, variances or delistings offset by the benefits of waste reduction activities, exemption from regulation for firms with RCRA hazardous waste treatment facilities for certain in-plant recycling or recovery operations and longer time periods for the storage of wastes without a RCRA permit.

Although the EPA and OTA have both endorsed nonregulatory approaches for addressing hazardous substance issues, the OTA approach is clearly more aggressive in the short term.

APPROACHES TO WASTE MINIMIZATION

In order to effectively address waste reduction/minimization issues it is important to understand what constitutes a hazardous waste or a hazardous substance. In the report, OTA has provided a list of, "statutory definitions of hazardous waste terms, reproduced here as Figure 1. Since that time, numerous other laws and regulations have established a myriad of other lists of chemicals and other related definitions:

- The Safe Drinking Water Act addresses, "maximum contaminant levels," of substances in drinking water.

- The OSHA Hazard Communication Standard identifies a hazardous chemical as, "any chemical which is a physical hazard or a health hazard." Subsequently, highly technical definitions are provided for, "physical hazard," and, "health hazard."

- Various sections of SARA Title III provide for a list of extremely hazardous substances, cross-reference CERCLA hazardous substances, further cross-reference OSHA hazardous chemicals, and define a special list of Section 313 toxic chemicals.

- Of course, the Federal Insecticide, Fungicide, and Rodentcide Act addresses the controlled use of substances which are toxic by definition.

OTA chooses to side step the limitations and the complexities of the many legal and regulatory definitions by providing a very broad definition of their own which says that:

> Hazardous waste refers to all nonproduct hazardous outputs from an industrial operation into all environmental media, even though they may be within permitted or licensed limits.

Indeed, industry is continuously looking for new ways to reduce, eliminate, or safely manage chemicals whether they are raw materials, processed chemicals, or ultimately become hazardous wastes. New techniques are constantly being developed to protect the environment, employees and to limit the clear liabilities resulting from a host of environmental laws and regulations and even greater liabilities which can be associated with toxic tort issues.

A hierarchy of specific waste minimization techniques has been prepared by the USEPA (Figure 2). Note that changes can be incorporated at any stage of an industrial process. Nonhazardous raw materials can be used. By-products can be recycled either onsite or offsite with or without being subjected to a reclaim process to recover or regenerate the useable product. The process itself can be modified to alter the variables, improve controls or equipment, conserve energy or water, improve materials handling to avoid spills or leaks, improve inventory control, waste stream segregation and scheduling. Finally, the end product can be altered such that the process or the end use becomes less hazardous. Despite all of these efforts there will continue to be some hazardous waste which will be generated. It is only the residual hazardous wastes which then must be treated to reduce the volume or toxicity and ultimately find its way to final disposal via incineration or landfill.

WHY SHOULD INDUSTRY MINIMIZE WASTE?

The EPA has provided a matrix representation of incentives and disincentives for various waste minimization techniques (Figure 3). Waste minimization reduces the burgeoning cost of waste management. Lynn L. Berguson, Esq., reported recently that according to the congressional budget office, "the annual cost to industry of hazardous waste management was between 4.2 and 5.8 billion dollars in 1983 and will be between 8.4 and 11.2 billion in 1990."[10] In addition, efforts towards hazardous waste minimization may reduce or eliminate the requirements for existing permits. Over the long

term, permitting costs may be reduced as well as the costs associated with corrective actions resulting from any kind of hazardous material spill. Further incentives for minimizing hazardous wastes include avoidance of the liabilities established by each major regulatory program and also a reduction in exposure to toxic tort liability, i.e., the liability that results from exposure of citizens or adjacent landowners to substances from a manufacturing facility. It is indeed a sobering thought to many manufacturers that they can be in compliance with all of the environmental laws and regulations and yet still be vulnerable to toxic tort liability resulting from the alleged exposure of others nearby to substances from the facility.

Although environmental impairment liability (EIL) insurance is slowly becoming available after a hiatus of several years, the inability to get it continues to be an incentive for hazardous waste minimization. The public perception of widely publicized hazardous waste horrors has also provided a strong incentive for waste minimization. Traditionally this has been a particularly strong incentive for those manufacturers producing consumer goods; however, in recent years the sensitivity to public perception has moved "upstream" to the original suppliers of goods and services.

On the other side of the coin, there are a number of disincentives to waste minimization including economic disincentives. There are also technical barriers related to employee attitudes, batch processes, lack of information, technical limits on the process and quality concerns related to the end product. Additional regulatory barriers include the cost of revising other environmental permits, the possibility of having to obtain a hazardous waste permit and the perceived stigma associated with managing hazardous waste.

Despite the number of barriers the overall balance tilts in favor of hazardous waste minimization. This view was best summed up by J. Howard Todd of Dupont, addressing a symposium of technical professionals saying:

> Reduced waste will inevitably lead to lower cost for products, and thus, a higher standard of living for all Americans ... It will not be the law, per se, that will fuel waste minimization efforts but rather basic economics of good waste management.[11]

He later added:

> The challenge to reduce the amount of waste generated is directed by the society in which we operate and by our stockholders ... Stockholders benefit through reduced production costs and a reduction of future liabilities. These increase both short and long term profits.

Clearly, it is in the best interest of everyone in both the public and private sectors to work toward practical, cost effective hazardous waste minimization.

INDUSTRIAL WASTE MINIMIZATION PROGRAM

The best approach for minimizing the hazardous waste generated at any manufacturing facility is to establish a company wide industrial waste minimization program. The question isn't really whether or not such a program is needed. It is clear, that any firm exposed to environmental regulations needs a waste minimization program. The programs vary only in cost and intensity. Of course, a larger more complex facility will have a more formal waste minimization program. A small quantity generator may have a less formal program which may require relatively little time and effort. Nevertheless, the hazardous waste issues should be addressed.

A company-wide hazardous waste minimization program must not only have senior management support but also involve all of the employees. The program will be most effective when it is developed using a consensus approach which involves all employees in planning and implementation. It is no longer solely the responsibility of those in the environmental department but must include employees in the operating, engineering, and even the purchasing and accounting departments. It is equally important to motivate by setting goals and providing special incentives to those individuals in departments reaching the goals. The program may include posters, advertisements, and special training.

As new techniques and procedures are developed it is important to transfer this information throughout other plants in the company and perhaps throughout the industry.

Seek technical assistance from outside sources. Generally in-house employees are more familiar with the details of a process but are sometimes, "unable to see the forest for the trees." Consultants can offer a broader perspective and also provide speciality services related to hazardous waste minimization efforts.

It is important to revisit traditional accounting procedures, introducing changes as required, so that the short and long term costs of managing wastes are charge to the profit centers responsible for the processes that generate the wastes. The same profit centers should also be charged with the liabilities associated with hazardous waste management. Anticipated liabilities are difficult to estimate but are nevertheless a very important aspect of evaluating any waste minimization project.

One of the most important parts of a facility's waste minimization program is to conduct a hazardous waste minimization audit. Our experience is that a two-tiered approach is generally the most cost effective.[12] The first tier is a broad based investigation of all the hazardous waste streams at a facility. The second tier focuses on a much more detailed investigation of the few hazardous waste streams considered most likely to yield beneficial results. The first tier of the hazardous waste minimization audit normally includes five phases which are:

- previsit preparations,
- onsite information gathering,
- information on individual waste streams,
- identification of options for minimizing specific wastes, and
- prioritization of the options.

The primary previsit preparations involve careful selection of the audit team, which may include consultants, in-house employees, or a combination of both. It is important that all key disciplines be represented on the team and also that the team members have a strong working knowledge of the applicable federal, state, and local environmental regulations.

The onsite information gathering phase should be conducted from a carefully prepared checklist to assure that all of the appropriate information is gathered. Carefully selected personnel will be interviewed using a prepared questionnaire to assure that the information gathered will be uniform. At this stage every hazardous waste generation stream will be inventoried. Each stream will be characterized in terms of applicable chemical and physical analyses, an estimate of the rate of production and identification of the reason(s) why the waste is hazardous, i.e., ignitable, corrosive, listed, etc. Additional information will be gathered regarding a description of the process which generates the hazardous waste. It is also important to document the present method of treatment, storage and disposal along with associated costs. Further inquiries will be conducted into past or present minimization efforts and associated costs.

After all of the important information has been gathered it will be evaluated in terms of identifying specific minimization options. These options generally include process change, recycle/reuse, materials substitution, segregation, delisting, and treatment. It is clear that the best method cannot be determined until all the options are identified and evaluated.

Industry is replete with examples of waste minimization techniques. Solvent based inks are being replaced with water based inks. Solvent recovery systems are being used to recapture solvents previously lost or incinerated. Heavy metals are being recovered from wastewater streams. Processes are being reworked to reduce or eliminate the use of toxic raw materials. There are virtually no limits to the creativity of engineers and scientists in this area.

When the options for waste minimization have been identified and costed they can be prioritized. The prioritization criteria generally falls into seven categories:

1. Calculation of total life cycle costs of each option as compared to the current cost of waste generation and management - It is important to estimate the cost for future offsite treatment and disposal of hazardous wastes and also the cost of future liabilities even though they may be difficult to estimate.
2. The degree of complexity and difficulty involved in implementation
3. The likelihood that implementation will require research, testing, or additional resources
4. The time required for implementation
5. Associated regulatory pressures such as the land disposal ban
6. Acceptance by facility personnel
7. Customer preferences with respect to altered products

When these criteria have been evaluated the various waste minimization options can be ranked. Either a weighted numerical system can be used or the team members can use a qualitative ranking system based on good engineering judgement.

At the conclusion of the first tier of the hazardous waste minimization audit a few streams will likely emerge as candidates for a much more detailed tier two audit. The second tier audit will generally focus on those streams having the largest volume or the greatest toxicity of some combination of both. Since disposal of these materials will be more costly than the other streams, it may be appropriate to undertake a more detailed engineering study to determine the optimum approaches to waste minimization.

In April 1988 the USEPA published guidance for waste minimization assessments, which generally describe the tier one investigations as a planning, organization and assessment phase, used to gather vital information and screen various options for further study.[13] The tier two investigation are described in the EPA document as a feasibility analysis phase. The guidance document includes an assortment of forms which can be used to assess opportunities for hazardous waste minimization.

Consistent with any management endeavor it is important to monitor the progress toward minimization of hazardous waste. This can be accomplished only by gathering sufficient information to correctly evaluate the improvements or reductions in the generation of hazardous waste. The calculations must identify the costs and savings as well as any waste which may have been shifted from one environmental medium to another. The follow-up must also identify any unanticipated cost or inconveniences which may have developed. Finally, due to variations in annual production levels, it is important to reduce the mass of data to a ratio of each pound of waste generated per pound of chemical product. A true picture of actual waste reduction can only be achieved by comparing annual waste generation totals on a unit production basis rather than a time (annual) basis.

OUTLOOK FOR THE FUTURE

It is clear that the, "strategy of the cork" will no longer be accepted by the public and the regulatory agencies as the only approach to protecting the environment. The traditional approach has been effective but also has certain limitations. From a generator's perspective it is like trying to hit a "moving target." There will be developed progressively more stringent requirements for land disposal; hazardous waste treatment and disposal costs will steadily increase as the available capacities of treatment and disposal facilities are consumed.[14] Although more facilities will be sited and built, any prudent manufacturer must take advantage of every practical opportunity to minimize generation of hazardous waste.

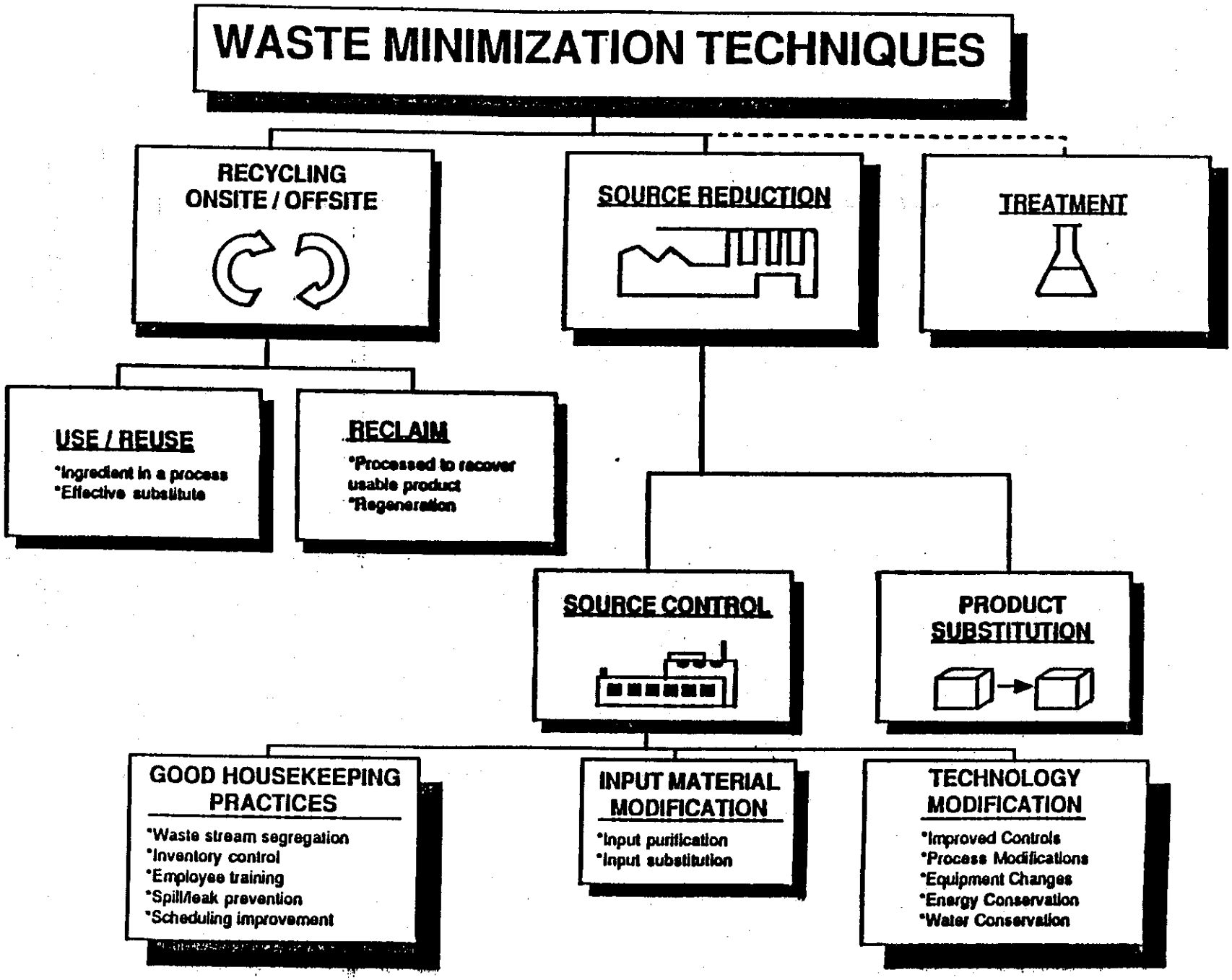
At present there are several new bills before Congress designed to accelerate these activities. HR 2800 has already moved through the House Energy and Commerce Committee on its way to the floor. The most recent draft focuses on a recent waste reduction as a cross media effort, not restricted to just solid and hazardous waste. A controversy has developed over provisions requiring that the optional reporting under section 313 of SARA Title III become mandatory. The only exemption would be for manufacturing facilities producing only a single product whereby such detailed reporting would in effect disclose a proprietary process. The bill's fate is still uncertain because key legislators prefer to consider waste minimization issues as part of a reauthorization of RCRA which is likely to be pushed back until next year. Finally, the EPA Science Advisory Board has recommended a new risk reduction strategy that focuses on preventive actions rather than "end of the pipe" regulations. The trends are clear. It is up to all of us to participate in a way in which will achieve common objectives.

FIGURE 1 —Statutory Definitions of Hazardous Waste Terms

Terms by program	Statutory definition	Notes
Clean Water:		
Conventional pollutants ...	... including but not limited to pollutants classified as biological oxygen demanding, suspended solids, fecal coliform, and pH. [Section 304(a)(4)]	List appears in 40 CRF 401.16; with oil and grease added
Toxic pollutants	... those pollutants, or combinations of pollutants, including disease-causing agents, which after discharge ... will, on the basis of information available to the Administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in ... organisms or their offspring. [Section 502(13)]	
	Table 1 of Committee Print 95-30 of the Committee on Public Works and Transportation of the House of Representatives ... to be published by Administrator... Revisions to list must take into account toxicity of pollutant, persistence, degradability, usual or potential presence of affected organisms in any waters and their importance, and nature and extent of effect on organisms. [Section 307(a)(1)]	List of 65 substances appears in 40 CRF 401.15 Commonly referred to as "priority" pollutants
Hazardous substances	... such elements and compounds which, when discharged in any quantity into or upon the navigable waters of the United States ... present an imminent and substantial danger to the public health and welfare, including, but not limited to fish, ... [Section 311(b)(2)(A)]	A list of hazardous substances as identified by the regulatory system appears in 40 CFR 116.4
Clean Air:		
Air pollutants	... emissions which, in his [the Administrator's] judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare ... [Section 108(a)(1)(A)]	Often referred to as "criteria" pollutants because of the air quality criteria document that must be issued prior to regulation
Hazardous air pollutants...	An air pollutant to which no ambient air quality standard is applicable and which in the judgment of the Administrator may cause, or contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness [Section 112(a)(1)]	Commonly referred to as "toxic" air pollutants
RCRA:		
Hazardous waste	... any solid waste, or combination, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (A) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. [Section 1004(5)]	List of reportable quantities of hazardous substances is in 40 CFR 261
CERCLA:		
Hazardous substances	... (A) any substances designated ... [by] Section 31(b)(2)(A) of the Federal Water Pollution Control Act, (B) any element, compound, mixture, solution, or substance designated pursuant to section 102 of this Act, (C) any hazardous waste ... [regulated under] Section 3001 of Solid Waste Disposal Act ... (D) any toxic pollutant listed under Section 307(a) of Federal Water Pollution Control Act, (E) any hazardous air pollutant listed under Section 112 of the Clean Air Act, and (F) any imminently hazardous chemical substance or mixture ... [listed under] Section 7 of TSCA. [Section 101(14)]	List of reportable quantities of hazardous substances is in 40 CFR 302
TSCA:		
Chemical substances and mixtures	... any organic or inorganic substance of a particular molecular density ... (not excluded by subparagraph B) [Section 3(2)(A)]	To regulate, must make a finding of "unreasonable risk of injury to health or the environment"

SOURCE: Compiled by the Office of Technology Assessment, 1986, from environmental statutes and 40 CFR.

FIGURE 2


WASTE MINIMIZATION TECHNIQUES
RECYCLING ONSITE / OFFSITE
SOURCE REDUCTION
TREATMENT
USE / REUSE
*Ingredient in a process
*Effective substitute
RECLAIM
*Processed to recover usable product
*Regeneration
SOURCE CONTROL
PRODUCT SUBSTITUTION
GOOD HOUSEKEEPING PRACTICES
*Waste stream segregation
*Inventory control
*Employee training
*Spill/leak prevention
*Scheduling improvement
INPUT MATERIAL MODIFICATION
*Input purification
*Input substitution
TECHNOLOGY MODIFICATION
*Improved Controls
*Process Modifications
*Equipment Changes
*Energy Conservation
*Water Conservation

	Source Reduction	Offsite Recycling	Onsite Recycling
INCENTIVES			
Increased Cost of Waste Management	•	•	•
Difficulties in siting new HW management facilities	•		•
Permitting Burdens and Corrective Action Requirements	•	•	•
Financial Liability of HW Generators	•		•
Shortages of Liability Insurance	•		•
Public Perception	•	•	•
DISINCENTIVES			
Economic Barriers –Lack of Capital	•		•
–Financial Liability		•	
Technical Barriers –Attitudes toward unfamiliar methods	•	•	•
–Batch Processes			•
–Lack of Information	•	•	•
–Technical Limits of Process	•		
–Technical Quality Concerns	•		
Regulatory Barriers –Need to Obtain TSD Permit	•	•	•
–Perceived Stigma of Man'g Haz. Waste		•	•
–Revisions to Other Env. Permits	•	•	•

FIGURE 3 INCENTIVES AND DISINCENTIVES FOR VARIOUS WASTE MINIMIZATION TECHNIQUES

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