Pollution Control

Pollution control is the **process of reducing or eliminating the release of pollutants into the environment** . It is regulated by various environmental agencies which establish pollutant discharge limits for air, water, and land.

Air pollution control strategies can be divided into two categories, the control of **particulate** emissions and the control of gaseous emissions. There are many kinds of equipment which can be used to reduce particulate emissions. Physical separation of the particulates from the air using settling chambers, **cyclone** collectors, impingers, wet **scrubbers** , electrostatic precipitators, and **filtration** devices, are all processes that are typically employed

Gaseous emissions are controlled by similar devices and typically can be used in conjunction with particulate control options. Such devices include scrubbers, **adsorption** systems, condensers, flares, and incinerators.

Water pollution control methods can be subdivided into physical, chemical, and biological treatment systems. Most treatment systems use combinations of any of these three technologies. Additionally, **water conservation** is a beneficial means to reduce the volume of **wastewater** generated.

Solid pollution control methods which are typically used include landfilling, **composting** , and incineration. Sanitary landfills are operated by spreading the **solid waste** in compact layers which are separated by a thin layer of **soil** . Aerobic and anaerobic microorganisms help to break down the biodegradable substances in the **landfill** and produce carbon dioxide and **methane** gas which is typically venter to the surface. Landfills also generate a strong wastewater called leachate which must be collected and treated to avoid **groundwater** contamination.

Principles for pollution control

The following principles are used to help control pollution.

Polluter pays principle

The polluter pays principle says that whoever is responsible for pollution should pay for the damage caused. It is about economic accountability. Any organisation or individual is responsible for handling and taking care of the waste they produce and should be accountable for any damage that it causes. Imagine a factory that produces many types of wastes that potentially damage the air, water and soil. The polluter pays principle encourages the factory to treat the waste before it is released. If any damage to the environment is caused by the factory waste, then the factory is liable to compensate for the loss of life, damage to health and damage to property and the environment.

Precautionary principle

For any activity, there should be an obligation not to cause harm, even if you are not sure of the outcome. For example, if a factory owner wants to discharge wastewater into a river, they should not be allowed to do so if the possible effects of the wastes are not known. The precautionary principle means you do not release any waste into the environment even if you are not certain that damage will result. It means to be cautious rather than take risks about unknown consequences.

Pollution prevention

Pollution prevention (P2) is the reduction or elimination of wastes and pollutants at their sources. For all the pollution that is avoided in the first place, there is that much less pollution to manage, treat, dispose of, or clean up.

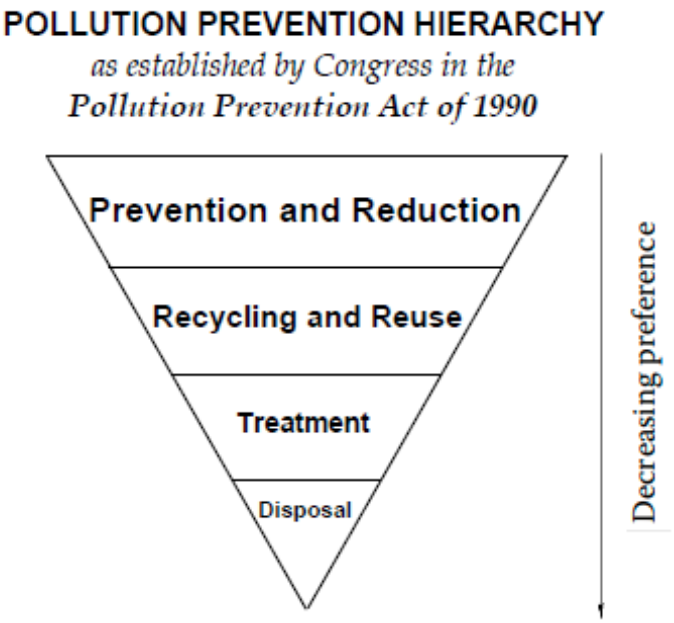
P2 can encompass activities such as:

- redesigning products to cause less waste or pollution during manufacture, use, or disposal
- altering production processes to minimize the use of toxic chemicals
- implementing better housekeeping practices to minimize leaks and fugitive releases from manufacturing processes
- taking steps to reduce energy consumption

The EPA's Pollution Prevention Act of 1990 has established pollution prevention as a national policy declaring "waste should be prevented or reduced at the source wherever feasible,

EPA's policy does not consider recycling or treatment as actual pollution prevention methods, these methods **present an opportunity** to reduce the amount of waste that might otherwise be discharged into the environment. Clearly, the definition of pollution prevention and its synonyms (e.g., waste minimization) must be understood to fully appreciate and apply these techniques

The EPA's policy establishes the following hierarchy of waste management:



Waste minimization generally considers all of the methods in the EPA hierarchy (except for disposal) appropriate to reduce the volume or quantity of waste requiring disposal (e.g., source reduction).

1. Source reduction as applied in the Pollution Prevention Act, however, is "any practice which reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

   Source reduction includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control.

2. Recycling (reuse, reclamation) refers to the use or reuse of materials that would otherwise be disposed of or treated as a waste product. Wastes that cannot be directly reused may often be recovered on-site through methods such as distillation. When on-site recovery or reuse is not feasible due to quality specifications or the inability to perform recovery on-site, off-site recovery at a permitted commercial recovery facility is often a possibility. Such management techniques are considered secondary to source reduction and should only be used when pollution cannot be prevented.

3. The treatment of waste is the third element of the hierarchy and should be utilized only in the absence of feasible source reduction or recycling opportunities. Waste treatment involves the use of chemical, biological, or physical processes to reduce or eliminate

waste material. The incineration of wastes is included in this category and is considered "preferable to other treatment methods (i.e., chemical, biological, and physical) because incineration can permanently destroy the hazardous components in waste materials" [3]. Of course, many of these pollution prevention elements are used by industry in combination to achieve the greatest waste reduction. Residual wastes that cannot be prevented or otherwise managed are then disposed of only as a last resort

4. Disposal has been included in the hierarchy because it is recognized that residual wastes will exist; the EPA's so-called ultimate disposal options in the past included landfilling, land farming, ocean dumping, and deep-well injection. However, the term "ultimate disposal" is a misnomer, but is included here because of its earlier adaptation by the EPA.

The hierarchy's categories are prioritized so as to promote the examination of each individual alternative prior to the investigation of subsequent options (i.e., the most preferable alternative should be thoroughly evaluated before consideration is given to a less accepted option.) Practices that decrease, avoid, or eliminate the generation of waste are considered source reduction and can include the implementation of procedures as simple and economical as good housekeeping

POLLUTION PREVENTION ASSESSMENT PROCEDURES

The first step in establishing a pollution prevention program is the obtainment of management commitment. Management commitment is necessary given the inherent need for project structure and control. Management will determine the amount of funding allotted for the program as well as specific program goals. The data collected during the actual evaluation is then used to develop options for reducing the types and amounts of waste generated. Figure 30.2 depicts a systematic approach that can be used during the procedure. After a particular waste stream or area of concern is identified, feasibility studies are performed involving both economic and technical considerations. Finally, preferred alternatives are implemented. The four phases of the assessment (i.e., planning and organization, assessment, feasibility, and implementation) are introduced in the following subsections. Sources of additional information as well as information on industrial programs are also provided in this section.

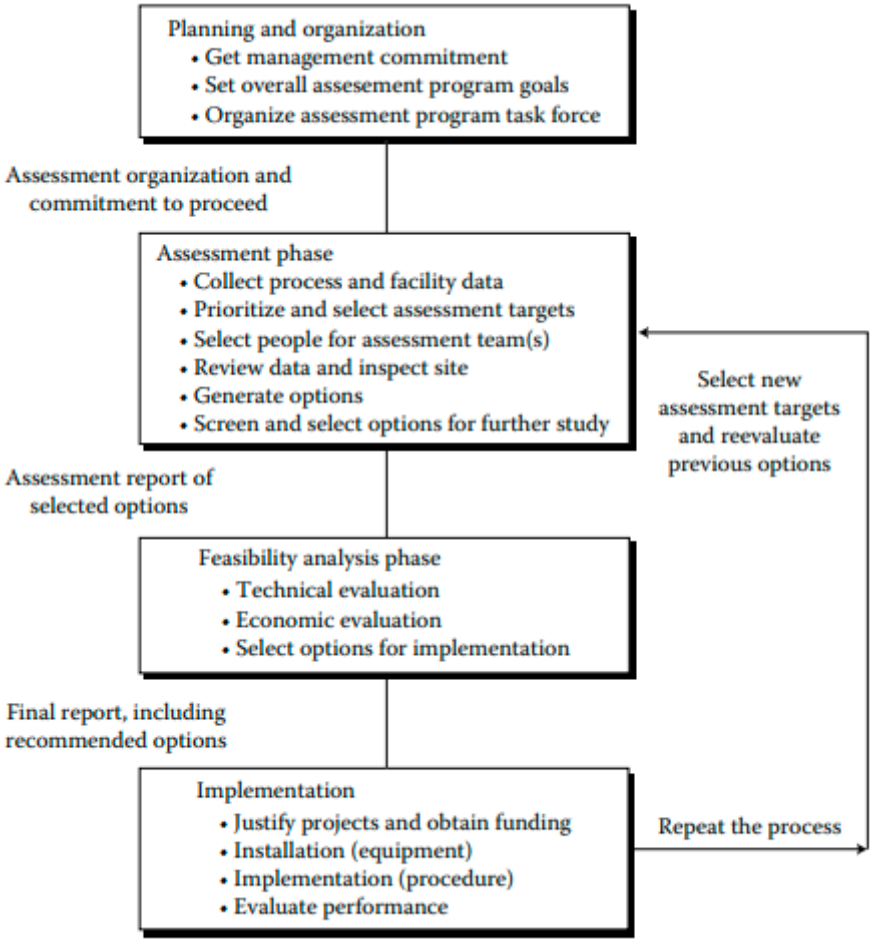
PLANNING AND ORGANIZATION

The purpose of this phase is to obtain management commitment, define and develop program goals, and to assemble a project team.

Proper planning and organization are crucial to the successful performance of the pollution prevention assessment.

Both managers and facility staff play important roles in the assessment procedure by providing the necessary commitment and familiarity with the facility, its process(es), and current waste management operations.

The benefits of the program, including economic advantages, liability reduction, regulatory compliance, and improved public image, often lead to management support.
Once management has made a commitment to the program and goals have been set, a program task force is established.
The selection of a team leader will be dependent upon many factors including his or her ability to effectively interface with both the assessment team and management staff.



Pollution prevention assessment procedures

The task force must be capable of identifying pollution reduction alternatives, as well as be cognizant of inherent obstacles to the process. Barriers frequently arise from the anxiety associated with the belief that the program will negatively affect product quality or result in production losses. According to an EPA survey, 30% of industry comments responded that they were concerned that product quality would decline if waste minimization techniques were implemented [6]. Thus, the assessment team, and the team leader in particular, must be prepared to react to these and other concerns [3].

ASSESSMENT PHASE

The assessment phase aims to collect data required to identify and analyze pollution prevention opportunities.
Assessment of the facility's waste reduction needs includes the examination of hazardous waste streams, process operations, and the identification of techniques that often promise the reduction of waste generation.
Information is also derived from observations made during a facility walk-through, interviews with employees (e.g., operators, line workers), and review of site or regulatory records.
The American Society of Testing and Materials (ASTM) suggests the following information sources be reviewed, as available [7].
1. Product design criteria.
2. Process flow diagrams for all solid waste, wastewater, and air emissions sources.
3. Site maps showing the location of all pertinent units (e.g., pollution control devices, points of discharge).
4. Environmental documentation, including: Material Safety Data Sheets (MSDS), military specifi cation data, permits (e.g., NPDES, POTW, RCRA), SARA Title III reports, waste manifests, and any pending permits or application information.
5. Economic data, including: cost of raw material management; cost of air, wastewater, and hazardous waste treatment; waste management operating and maintenance costs; and, waste disposal costs.
6. Managerial information: environmental policies and procedures; prioritization of waste management concerns; automated or computerized waste management systems; inventory and distribution procedures; maintenance scheduling practices; planned modifications or revisions to existing operations that would impact waste generation activities; and, the basis of source reduction decisions and policies.

The use of process flow diagrams and material balances are worthwhile methods to "quantify losses or emissions, and provide essential data to estimate the size and cost of additional equipment, data to evaluate economic performance, and a baseline for tracking the progress of minimization efforts". Material balances should be applied to individual waste streams or processes, and then utilized to construct an overall balance for the facility. Details on these calculations are available in the literature.

The data collected is then used to prioritize waste streams and operations for assessment. Each waste stream is assigned a priority based on corporate pollution prevention goals and objectives. Once waste origins are identified and ranked, potential methods to reduce the waste stream are evaluated. The identification of alternatives is generally based on discussions with the facility staff, review of technical literature, and contacts with suppliers, trade organizations, and regulatory agencies.
Alternatives identified during this phase of the assessment are evaluated using screening procedures so as to reduce the number of alternatives requiring further exploration during the feasibility analysis phase. The criteria used during this screening procedure include: cost-effectiveness; implementation time; economic, compliance, safety, and liability concerns; waste reduction potential; and, whether the technology is proven [3,6]. Options which meet established criteria are then examined further during the feasibility analysis.

FEASIBILITY ANALYSIS Preferred alternative selection is performed by an evaluation of technical and economic considerations.
The technical evaluation determines whether a given option will work as planned. Some typical considerations follow:
1. Safety concerns
2. Product quality impacts or production delays during implementation
3. Labor and/or training requirements
4. Creation of new environmental concerns
5. Waste reduction potential
6. Utility and budget requirements
7. Space and compatibility concerns If an option proves to be technically ineffective or inappropriate, it is deleted from the list of potential alternatives.
Either following or concurrent with the technical evaluation, an economic study is performed weighing standard measures of profitability such as payback period, investment returns, and net present value. Many of these costs (or more appropriately, cost savings) may be substantial yet are difficult to quantify [4].

IMPLEMENTATION The findings of the overall assessment are used to demonstrate the technical and economic worthiness of program implementation. Once appropriate funding is obtained, the program is implemented, not unlike any other project requiring new procedures or equipment. When preferred waste pollution prevention techniques are identified, they are implemented, and should become part of the facility's day-to-day management and operation. Subsequent to the program's execution, its performance should be evaluated in order to demonstrate effectiveness, generate data to further refine and augment waste reduction procedures, and maintain management support. It should be noted that waste reduction, energy conservation, and safety issues are interrelated and often complementary to each other. For example, the reduction in the amount of energy a facility consumes results in reduced emissions associated with the generation of power. Energy expenditures associated with the treatment and transport of waste are similarly reduced when the amount of waste generated is lessened; at the same time worker safety is elevated due to reduced exposure to hazardous materials.

BARRIERS TO POLLUTION PREVENTION

This section will briefly outline barriers that may need to be confronted or considered during the evaluation of a pollution prevention program. There are numerous reasons why more businesses are not reducing the wastes they generate. The following "dirty dozen" are common disincentives:

1. Technical limitations.

Given the complexity of present manufacturing processes, waste streams exist that cannot be reduced with current technology. The need for continued research and development is evident.

2. Lack of information.

In some instances, the information needed to make a pollution prevention decision may be confidential or is difficult to obtain. In addition, many decision makers are simply unaware of the potential opportunities available regarding information to aid in the implementation of a pollution prevention program.

3. Consumer preference obstacles.

Consumer preference strongly affects the manner in which a product is produced, packaged, and marketed. If the implementation of a pollution prevention program results in the increase in the cost of a product, or decreased convenience or availability, consumers might be reluctant to use it.

4. Concern over product quality decline.

The use of a less hazardous material in a product's manufacturing process may result in decreased life, durability, or competitiveness.

5. Economic concerns.

Many companies are unaware of the economic advantages associated with pollution prevention. Legitimate concerns may include decreased profit margins or the lack of funds required for the initial capital investment.

6. Resistance to change.

The unwillingness of many businesses to change is rooted in their reluctance to try technologies that may be unproven, or based on a combination of the barriers discussed in this section.

7. Regulatory barriers.

Existing regulations that have created incentives for the control and containment of wastes, are at the same time discouraging the exploration of pollution prevention alternatives. Moreover, since regulatory enforcement is often intermittent, current legislation can weaken waste reduction incentives.

8. Lack of markets.

The implementation of pollution prevention processes and the production of environmentally friendly products will be of no avail if markets do not exist for such goods. As an example, the recycling of newspaper in the United States has resulted in an overabundance of waste paper without markets prepared to take advantage of this "raw" material.

9. Management apathy.

Many managers capable of making decisions to begin pollution prevention activities, do not realize the potential benefits of pollution prevention and may therefore take on an attitude of passiveness.

10. Institutional barriers.

In an organization without a strong infrastructure to support pollution prevention plans, waste reduction programs will be difficult to implement. Similarly, if there is no mechanism in place to hold individuals accountable for their actions, the successful implementation of a pollution prevention program will be limited.

11. Lack of awareness of pollution prevention advantages.

As mentioned in economic concerns, decision makers may be uninformed of the benefits associated with pollution reduction.

12. Concern over the dissemination of confidential product information.

If a pollution prevention assessment reveals confidential data pertinent to a company's product, fear may exist that the organization will lose a competitive edge with other businesses in the industry

POLLUTION PREVENTION ADVANTAGES

Various means exist to encourage pollution prevention through regulatory measures, economic incentives, and technical assistance programs. Since the benefits of pollution prevention undoubtedly surpass prevention barriers, a baker's dozen incentives is presented below:

1. Economic benefits.

The most obvious economic benefits associated with pollution prevention are the savings that result from the elimination of waste storage, treatment, handling, transport, and disposal. Additionally, less tangible economic benefits are realized in terms of decreased liability, regulatory compliance costs (e.g., permits), legal and insurance costs, and improved process effi ciency. Pollution prevention almost always pays for itself, particularly when the time investment required to comply with regulatory standards is considered. Several of these economic benefi ts are discussed separately below.

2. Regulatory compliance.

Quite simply, when wastes are not generated, compliance issues are not a concern. Waste management costs associated with recordkeeping, reporting, and laboratory analysis are reduced or eliminated. Pollution prevention's proactive approach to waste management will better prepare industry for the future regulation of many hazardous substances and wastes that are currently unregulated. Regulations have, and will continue to be, a moving target.

3. Liability reduction.

Facilities are responsible for their wastes from "cradle-to-grave." By eliminating or reducing waste generation, future liabilities can also be decreased. Additionally, the need for expensive pollution liability insurance requirements may be abated.

4. Enhanced public image.

Consumers are interested in purchasing goods that are safer for the environment and this demand, depending on how they respond, can mean success or failure for many companies. Business should therefore be sensitive to consumer demands and use pollution prevention efforts to their utmost advantage by producing goods that are environmentally friendly.

5. Federal and state grants.

Federal and State grant programs have been developed to strengthen pollution prevention programs initiated by states and private entities. The EPA's Pollution Prevention By and For Small Business Grant Program awards grants to small businesses to assist their development and demonstration of new pollution prevention technologies.

6.Market incentives.

Public demand for environmentally preferred products has generated a market for recycled goods and related products; products can be designed with these environmental characteristics in mind, offering a competitive advantage. In addition, many private and public

agencies are beginning to stimulate the market for recycled goods by writing contracts and specifications that call for the use of recycled materials.

7. Reduced waste treatment costs.

As discussed in "economic benefits," the increasing costs of traditional end-of-pipe waste management practices are avoided or reduced through the implementation of pollution prevention programs.

8. Potential tax incentives.

As an effort to promote pollution prevention, taxes may eventually need to be levied to encourage waste generators to consider reduction programs. Conversely, tax breaks to corporations that utilize pollution prevention methods could similarly be developed to foster pollution prevention.

9. Decreased worker exposure.

By reducing or eliminating chemical exposures, businesses benefit by lessening the potential for chronic workplace exposure, and serious accidents and emergencies. The burden of medical monitoring programs, personal exposure monitoring, and potential damage claims are also reduced.

10. Decreased energy consumption.

As mentioned previously, energy conservation strategies are often interrelated and complementary to each other. Energy expenditures associated with the treatment and transport of waste are reduced when the amount of waste generated is lessened, while at the same time the pollution associated with energy consumed by these activities is abated.

11. Increased operating efficiencies.

A potential beneficial side effect of pollution prevention activities is a concurrent increase in operating efficiency. Through a pollution prevention assessment, the assessment team can identify sources of waste that results in hazardous waste generation and loss in process performance. The implementation of a waste reduction program will often rectify such problems through modernization, innovation, and the implementation of good operating practices.

12. Competitive advantages.

By taking advantage of the many benefits associated with pollution prevention, businesses can gain a competitive edge.

1**3. Reduced negative environmental impacts**.

Through an evaluation of pollution prevention alternatives which consider a total systems approach, consideration is given to the negative impact of environmental damage to natural resources and species that occur during raw material procurement and waste disposal. The performance of pollution prevention endeavors will therefore result in enhanced environmental protection.

The development of new markets by means of regulatory and economic incentives will further assist the effective implementation of waste reduction. Various combinations of 352 Introduction to Environmental Management the pollution prevention barriers provided earlier have appeared on numerous occasions in the literature, and in many different forms. However, there is one other concern that both industry and the taxpayer should be aware of. EPA Administrators have repeatedly claimed that pollution prevention is the organization's top

priority. “Nothing could be further from the truth.” Despite near unlimited resources, the EPA has contributed little to furthering the pollution prevention effort.

Reference

Introduction to Environmental Management by Mary K. Theodore Louis Theodore