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Standard Guide for Development and Implementation of a Pollution Prevention Program[1]

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1. Scope

1.1 This guide covers guidance on a logical progression of tasks and procedures to be followed in a pollution prevention program to reduce or eliminate the generation of waste, the loss of natural resources, and process emissions through source reduction, reuse, recycling, and reclamation.

1.2 *Summary*—The basic components of a pollution prevention program should include the following seven activities:

1.2.1 Develop an organizational commitment to pollution prevention (see Section 4).

1.2.2 Establish goals, objectives, and an implementation schedule (see Section 5).

1.2.3 Generate baseline information (see Section 6).

1.2.4 Develop a resource, emissions, and waste measurement and tracking system (see Section 7).

1.2.5 Analyze pollution prevention opportunities (see Section 8).

1.2.6 Prioritize pollution prevention opportunities (see Section 9).

1.2.7 Implement and maintain the progress of a pollution prevention program (see Section 10).

1.3 *Organization of Text*—This guide is organized based on the activities previously enumerated. Each section of the guide describes the manner in which the specified activity may be conducted to implement a program of pollution prevention at a facility.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Terminology

2.1 ~~*Descriptions*~~*Definitions of Terms Specific to This Standard:*

2.1.1 *by-product*—material, other than principal product, that is generated as a consequence of a process and that has productive use.

2.1.2 *capital budget*—a statement of the firm's planned financial expenditures, generally based on estimates of future sales, costs, production, and research and development (R&D) needs and the availability of capital.

2.1.3 *cost accounting system*—the internal procedure used to track and allocate production costs and revenues to a product or process.

2.1.4 *cost allocation*—a process within an internal cost accounting system of assigning costs and revenues to cost and profit centers for the purposes of product pricing, cost tracking, and performance evaluation.

2.1.5 *fugitives*—emissions or releases that leave a system or process without containment or capture.

2.1.6 *full-cost accounting*—a method of managerial accounting that accounts for both the direct and indirect costs of an item. Full-cost accounting uses historical data to assign all costs to a process, product, or product line, most often for the purposes of pricing.

2.1.7 *materials*—physical substances that are used, applied, produced, formed, or processed.

2.1.8 *media*—any or all specific physical components of the environment, such as air, water (surface water and ground water), and soil.

2.1.9 *minimization*—the process of determining and achieving the optimal amount of resources necessary to perform a particular function. In addition, minimization is the process of determining and achieving the least practicable harmful effects of a particular function or activity.

2.1.10 *performance measurements*—a means by which a system or process can be evaluated for effectiveness or efficiency, or

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both. It must have a quantitative and consistent basis for evaluating the effectiveness or efficiency, or both, of a particular function or activity.

2.1.11 *point source*—the discrete—a single, stationary location of emissions or releases that leave a system or process through a duct, pipe, or other containment device. fixed facility from which pollutants are discharged; any single identifiable source of pollution.

2.1.12 *pollutant*—any substance that directly or indirectly creates an adverse human health or environmental effect when introduced into any environmental media.

2.1.13 *pollution*—the introduction of a pollutant into the environment.

2.1.14 *pollution control*—a control device, mechanism, or system that is used to reduce the quantity or toxicity of a pollutant, or both, before it is introduced into the environment, or to reduce the probability of release of a pollutant to the environment.

2.1.15 *pollution prevention*—the act of reducing or eliminating the use, release, or generation of a pollutant or potential pollutant through source reduction, recycling, reuse, reclamation, or modification of operating practices.[2]

2.1.16 *pollution prevention program*—a comprehensive management, planning, capital budgeting, and monitoring program to promote and support the development and implementation of pollution prevention throughout an organization or at a specific facility. Such a program should have a statement of policy and goals; plan for measuring performance; and specified time frames for implementation, measurement of progress, and reevaluation.

2.1.17 *process*—a method, or collection of methods, or series of progressive and interdependent steps for generating a product or performing a service.

2.1.18 *product*—the intended output of a process or a facility operation, other than a waste.

2.1.19 *reclaim*—a procedure of either regenerating or processing a material, either used or unused, to recover or make a usable product.

2.1.20 *recycle*—the act of using—to recover or reprocess materials for use in the output form of a process as an ingredient to produce a product raw materials in the same, similar, manufacture of new products other than fuel for producing heat or related process from which that output was generated. power by combustion.

2.1.21 *release*—any spilling, leaking, pumping, pouring, emitting, discharging, injecting, escaping, leaching, dumping, or disposing any material or pollutant into the environment.

2.1.22 *resource*—a material that has a recoverable value.

2.1.23 *reuse*—the act of using the output of—to use a process as an ingredient to produce a product material, product, or component in a process other its original form more than the same, similar, once, diverting or related process removing it from which that output was generated originally. the waste stream.

2.1.24 *source reduction*—any activity that eliminates or decreases wastes by avoiding their creation, typically by materials substitution, process design, or product redesign.

2.1.25 *total cost assessment (TCA)*—a comprehensive financial analysis of the life cycle costs and savings of a pollution prevention project. A TCA approach includes the following:

(*1*) Internal allocation of environmental costs to product lines or processes through full-cost accounting;

(*2*) Inclusion in a project financial analysis of direct and indirect costs and short- and long-term costs, liability costs, and less tangible benefits of an investment;

(*3*) Evaluation of project costs and savings over a long time period (for example, 10 to 15 years); and

(*4*) Use measures of profitability that capture the long-term profitability of the project (for example, net present value and internal rate of return).

2.1.26 *total quality management (TQM)*—a management philosophy involving continuous process improvement activities involving all personnel in an organization in an integrated effort toward improving performance at every level.

2.1.27 *treatment*—any mechanism used for reducing the quantity or toxicity of a waste after its generation in a process.

2.1.28 *waste*—any output from a process or facility operation that is not used, reused, reclaimed, or recycled productively, and that is placed directly into the environment or treated through pollution control.

2.1.29 *waste minimization*—to eliminate or decrease, to the maximum extent practicable, the generation of waste by any method of source reduction, reuse, reclamation, or recycling.

2.1.30 *waste reduction*—to decrease or eliminate the generation of waste by any method of source reduction, reuse, reclamation, or recycle.

3. Significance and Use

3.1 This guide for development and implementation of a pollution prevention program is applicable to any organization or facility that releases materials to any of the three environmental media (such as the air, (air, water, or land) and that wishes to reduce those releases, without using treatment or transferring them to one of the other two media primarily for the purpose of disposal. Incentives for applying this standard of practice include concern for the environment, conservation of natural resources,

[2] It should be noted that ASTM's definition of "pollution prevention" is different from some definitions used by the Environmental Protection Agency. See, for example, 58 Fed. Reg. 6478 (Jan. 29, 1993, Council on Environmental Quality), and 58 Fed. Reg. 41,981 (Aug. 6, 1993, Executive Order).

economic considerations, and current and future regulatory compliance. Effective pollution prevention can also increase the efficiency of operations and use of resources, employee morale, and profitability while reducing liability.

3.2 A successful pollution prevention program can save money by reducing waste management costs and raw material purchases, reduce potential emissions and disposal liabilities, protect public health and worker health and safety, and protect the environment. It will also position an organization to compete domestically and internationally through both long-term cost reductions and participation in green marketing opportunities.

4. Development of an Organizational Commitment to Pollution Prevention

4.1 *Introduction*—The purpose of this activity is to develop an organizational commitment to the pollution prevention process; establish program goals; assign strategic and tactical responsibilities; and identify and procure requisite financial, material, and human resources necessary for successful pollution prevention.

4.1.1 The inclusion of a policy statement on pollution prevention in an organization's overall environmental policy, or as an independent policy, is necessary to convey, to all employees, customers, suppliers, shareholders, and the public, the organization's commitment to pollution prevention.

4.1.2 The statement should express clearly the reasons that a pollution prevention program is being implemented, how it will be accomplished, and who will be involved. The policy should be relevant to the organization's activities, products, and services and the associated environmental effects. The policy statement can be general in nature, allowing for the specific pollution prevention methods to be developed by organization employees. For example, the policy statement might be stated simply as follows:

4.1.3 It is this organization's policy for all employees to reduce or eliminate the use of toxic materials, to reduce the volume and toxicity of all waste generated, and to recycle, reuse, or reclaim materials whenever possible.

4.1.4 Alternatively, the policy statement may cover specific components of the pollution prevention program.

4.1.5 Commitment throughout an organization is necessary in order to motivate employees and to encourage cooperation and participation in achieving overall success in the program. The appointment of a team, including members from all business units in an organization, to assist in the development of this policy can enhance the overall success of the program. Approval of the policy by the board of directors of a corporation and the executive officer lends credibility to the policy and demonstrates commitment at the highest level of the organization.

4.1.6 Organizational commitment is the key to success of the pollution prevention process. Without sufficient commitment, planning, and organization, any changes recommended by the following activities may not be implemented properly, and the goals of the pollution prevention program may not be attained fully.

4.1.7 *Procedure*—Suggested components for the development of a pollution prevention commitment include the following:

4.1.8 Develop a philosophical and resource commitment to the process among key members of the organization.

4.1.9 Determine long- and short-range strategies.

4.1.10 Define and obtain infrastructure, human, and financial resources.

4.1.10.1 Infrastructure includes the necessary office space and information management systems.

4.1.10.2 Human resources include a structure for implementing a pollution prevention program, such as pollution prevention teams or committees.

4.1.10.3 Financial resources include a budget and funds for pollution prevention program startup, human resources, and process changes or raw material substitutions.

4.1.11 Organize and mobilize the process.

4.2 *Organization Structure and Responsibilities*—Development of an organizational structure and responsibilities that emphasize and support the importance of a pollution prevention program are paramount to the success of a program. This could include appointment of a pollution prevention manager, as well as production area or group managers who could work together in order to meet the goals of the pollution prevention program.

4.2.1 *Integration*—Pollution prevention must become part of the everyday work ethic. The following activities should be performed to establish an organizational structure that promotes pollution prevention:

4.2.1.1 Define the organization of the program and individual responsibilities.

4.2.1.2 Assign a lead responsibility with authority.

4.2.1.3 Define the program responsibilities across all parts of the organization.

4.2.2 *Responsibilities*—Once the program organization is defined, specific job responsibilities can be defined for the program lead, as well as all others involved throughout the organization. The defined responsibilities should include accountability both internally and externally. Program responsibilities should be as consistent as possible with other policies and commitments in order to provide a solid foundation for the pollution prevention program.

4.2.3 *Level of Effort*—There should be an ongoing commitment to allocate human resources commensurate with the scope of the program. Human resources should be adjusted by number and skill as demanded by the program objectives.

5. Establishment of Goals, Objectives, and Implementation Schedule

5.1 *Introduction*—When implementing a pollution prevention program, it is important to establish goals, objectives, and schedules that are consistent with the organization's policy statement and organizational structure.

5.2 *Development of General Goals*:

5.2.1 It is important that the goals of the pollution prevention program reflect the management style and operation of the organization. An organization that operates by total quality management (TQM) may focus on goals that allow and encourage participation by all employees, whereas an organization that is more traditionally managed may focus on specific pollution prevention projects identified by management.

5.2.2 Since each organization's culture, management structure, and operational procedures can differ dramatically, this activity may be accomplished in a variety of ways. For example, pollution prevention goals may be qualitative and strive to meet "a significant reduction" in waste generation. A company that is TQM based may direct its goals toward continuous improvement or zero discharges. However, a company that focuses on yearly productivity goals may focus on a specific waste reduction goal, such as "90 % waste reduction."

5.2.3 It is important that the organization's overall goals be incorporated within each department's goals in order to allow the opportunity to develop an acceptable and achievable program directed toward its specific processes. An effective program will find its way into all aspects of the operations of an organization, including marketing, product design, procurement, materials control, production, and environmental affairs.

5.2.4 Goals can cover a number of areas, such as costs, waste quantities generated, waste disposed of, or waste toxicity. At minimum, the pollution prevention program should incorporate the goal of reducing the generation of all wastes and the release of pollutants. The following are other examples of program goals:

5.2.5 Reduce risks to human health and the environment.

5.2.6 Reduce the costs of waste management, including costs of potential long-term liability.

5.2.7 Improve worker health and safety.

5.2.8 Enhance the reliability of service and productivity when reducing wastes.

5.2.9 Eliminate the land disposal of hazardous wastes.

5.2.10 Reduce or eliminate hazardous waste generation from specific plant sources.

5.3 *Development of Specific Objectives*:

5.3.1 In addition to general goals, a pollution prevention program should incorporate specific objectives in order to make progress toward the goals. The objectives should cover a variety of areas such as risk, costs, safety, and reliability. Some examples of objectives include the following:

5.3.2 Seek a specific significant (such as percent) reduction in the generation of hazardous and industrial wastes over a specific time period.

5.3.3 Demonstrate a continuous reduction in the rate of waste generation per unit of output.

5.3.4 Save sufficient resources through pollution prevention programs to offset half the costs of environmental management.

5.3.5 Replace oil-based paints with water-based paints.

5.4 *Measurement of Objectives*—The pollution prevention program objectives should be sufficiently quantitative to allow measurement of the program's success. Quantifiable objectives provide a clear and understandable guide to the program expectations. At a minimum, measurements should identify:

5.4.1 A baseline,

5.4.2 Percentage of improvement relative to the baseline, and

5.4.3 Units of measurement.

5.5 *Implementation Schedule*:

5.5.1 A schedule should be an integral part of the goals and objectives and should be used as a feedback mechanism for determining whether they have been met. The goals, objectives, and implementation schedule should be sufficiently flexible to encourage employee involvement in implementation of the pollution prevention program.

5.5.2 The initial development of the pollution prevention program should include specific time frames for all aspects of implementation of the program. This includes employee awareness and participation, completion of baseline measurements, and submission of the first and subsequent reports.

5.5.3 The implementation schedule should include a periodic evaluation of the program goals and objectives. Changes in technology, process input material supplies, and environmental regulations may mandate adjustments to the goals.

6. Generation of Baseline Information

6.1 *Introduction*—The objective of this step ~~of the pollution prevention process~~ is to ~~identify~~ assess the baseline facility or process ~~information that will serve as the means for identifying~~ to identify pollution prevention opportunities and to measure the ~~basis for demonstrating the success, progress, and accomplishments~~ progress or success of the program. A baseline assessment should be made of a facility's current processes and operations, including the process limitations and the materials use, products, by-products, and wastes of each process and operation. The development of baseline information is important to providing adequate information to highlight pollution prevention options and frame them in a proper perspective.

6.2 *Impact of Organizational Structure*—The amount and complexity of the data that are required is highly dependent on the organization's management and decision-making structure. In an organization in which individuals at all levels of the organization are empowered to take appropriate actions in order to reduce or eliminate waste, an individual, within his or her level of authority, would take action on waste reduction based on a goal of continuous reduction of waste and his or her professional knowledge and

evaluation of the available data. The baseline under this structure may tend to be more general rather than an extensive, highly detailed, and centrally located database.

6.3 *Examples*—The following is a list of possible information sources that may be used to develop the baseline information. The list is not all inclusive, and it is not necessary to use all of the information sources in every case.

6.3.1 *Design Information*:
6.3.1.1 Process flow diagrams and schematics.
6.3.1.2 Material balances for production and pollution control processes.
6.3.1.3 Operating manuals and process descriptions.
6.3.1.4 Standard batch sheets.
6.3.1.5 Quality control manuals.
6.3.1.6 Equipment lists, specifications, and data sheets.
6.3.1.7 Piping and instrument diagrams.
6.3.1.8 Site plans, including equipment layouts.
6.3.2 *Environmental Records*:
6.3.2.1 Permits and permit applications.
6.3.2.2 Periodic hazardous waste generation reports.
6.3.2.3 Waste manifests.
6.3.2.4 Air emission inventories, including fugitives.
6.3.2.5 Emergency planning and community right-to-know act (EPCRA) submittals.
6.3.2.6 National pollutant discharge elimination system (NPDES) discharge monitoring reports.
6.3.2.7 Previous environmental assessments.
6.3.2.8 Spill and release reports.
6.3.2.9 Media reports.
6.3.3 *Raw Material and Production Data*:
6.3.3.1 Material safety data sheets.
6.3.3.2 Product data (quantities and specifications).
6.3.3.3 Product and raw material inventory records.
6.3.3.4 Purchasing records.
6.3.3.5 Operator procedures and data logs.
6.3.3.6 Production schedules.
6.3.4 *Economic Information*:
6.3.4.1 *Direct Costs or Benefits*:
(*1*) Changes in product revenues;
(*2*) Capital expenditures (buildings, equipment, utility connections, equipment installation, and project engineering);
(*3*) Operation and maintenance expenses and revenues (raw materials and supplies, labor (maintenance and operations), waste disposal, utilities (for example, water, sewer, electricity, and fuels), and revenue from recovered materials); and
(*4*) Environmental impairment and liability insurance premium.
6.3.4.2 *Indirect Costs or Benefits*:
(*1*) Compliance costs (permitting, reporting, tracking, monitoring, manifesting, training, waste handling, record keeping, labeling, testing, emergency preparedness, and medical surveillance);
(*2*) Waste storage;
(*3*) Operation of on-site pollution control equipment;
(*4*) Replacement of non-product output;
(*5*) Marginal change in costs due to the reduced use or generation of hazardous materials; and
(*6*) Legal fees.
6.3.4.3 *Liability Costs*:
(*1*) Penalties and fines;
(*2*) Damage to property and casualty loss;
(*3*) Legal fees; and
(*4*) Insurance premiums.
6.3.5 *Less Tangible Benefits*:
6.3.5.1 Revenue from enhanced product quality.
6.3.5.2 Revenue from an increased market share of green products.
6.3.5.3 Reduced worker compensation claims and absenteeism costs from improved employee health.
6.3.5.4 Increased productivity from improved employee relations.
6.3.5.5 Reduced staff time in dealing with community concerns.

7. Development of Resource, Emissions, and Waste Measurement and Tracking System

7.1 *Introduction*—The resource, emissions, and waste measurement and tracking system will be used to set pollution prevention

goals and objectives, quantify and document progress in reducing wastes, prepare progress reports, and identify and solve problems. An important aspect of the program is the development and maintenance of accurate records on existing resource use and waste generation. However, it is recognized that estimates may be appropriate for developing a new pollution prevention program.

7.2 *Measurement and Tracking*—The measurement and tracking of resource use and waste generation must be specific to the individual organization or facility. There are several specific attributes, as follow, that are necessary for any system to be effective.

7.2.1 *The system must be accurate*. Any system for measuring resource use and waste generation must be accurate and reproducible. The ability to demonstrate progress in pollution prevention will be impeded seriously if it is an arbitrary or estimated value.

7.2.2 *It must fit the organization's goals and objectives*. The goals and objectives that have been established must follow through to the measurement and tracking methodology. The measurement system must be capable of measuring all wastes if the goal is to reduce all wastes. The measurement system must include all costs if the objective is to reduce disposal costs.

7.2.3 *The system should be simple*. In order to ensure the buy-in of all employees, the measurement system must be simple and user friendly. When possible, the use of data already generated for production or accounting purposes is preferred. A system that would require extensive additional measurement or record keeping by facility personnel is less likely to succeed than a simple system.

7.2.4 *The system should be integrated with the corporate culture and operational methods*. If an organization is focused heavily on TQM, the measurement system should fit into a TQM system. A TQM system may include all wastes since TQM involves all employees working toward a common goal. On the other hand, a company that does not use TQM, but instead establishes short-range goals, could focus on specific waste streams and consequently adapt its measurement system to that method of operation.

7.2.5 *The system should be flexible*. The measurement system should allow flexibility in reporting. It should be easy to correct or update. Furthermore, the capacity to normalize data should be assessed.

7.2.6 *The system should be continuous*. Once the measurement and tracking system is in place, it should be monitored and modified as required to ensure the continuous accuracy and value of the information.

7.3 *Measurement Methods*—A variety of approaches customized to suit each process should be considered. Measurement methods are listed as follows:

7.4 *Measurement Techniques*:

7.4.1 Material balance.

7.4.2 Materials accounting.

7.4.2.1 Process specific.

7.4.2.2 Facility wide.

7.4.3 Hybrid.

8. Analysis of Pollution Prevention Opportunities

8.1 *Introduction*—The purpose of the opportunity analysis (OA) activity in the pollution prevention program is to develop data with which to prioritize and identify the various pollution prevention opportunities available. The success of the overall pollution prevention process frequently hinges on the success of the first projects undertaken. Success can be defined in many ways: volumetric reductions, avoided liabilities, cost savings, improved communications, etc., according to the organization and its demeanor. Whatever the prevailing factors, pollution prevention priorities should be established according to the financial, physical, and human resources available to the process. It is therefore critical to match opportunities with available resources in order to determine a hierarchy of activities. This prioritization does not ensure, but certainly improves, the probability for success of the pollution prevention program. An example of a checklist for a pollution prevention OA is given in Appendix X2.

8.2 *Source Reduction*—This section of the guide provides direction for identifying opportunities for pollution prevention as a part of the program strategy.

8.2.1 *Inventory Management*:

8.2.1.1 Purchasing practices.

8.2.1.2 Just-in-time manufacturing.

8.2.2 *Product Redesign*—Material substitution.

8.2.3 *Modification of Production Processes*—Equipment modifications.

8.2.4 *Reduction of Waste Volume*—Segregation.

8.3 *Recycling*:

8.3.1 Internal recycling.

~~8.3.2 Recovery of waste.~~

~~8.3.3 External~~

8.3.2 External recycling.

8.4 *Reuse/Reclamation*.

8.5 *Operating Practices*.

8.6 *Product Stewardship*:

8.6.1 Product packaging.
8.6.2 Product recyclable.
8.6.3 Product take back/remanufacturing.

9. Prioritization of Pollution Prevention Opportunities

9.1 *Introduction*:

9.1.1 A priority setting system for pollution prevention opportunities should be developed based on the management structure of the organization or facility. The part of the organization or level of management charged with identifying and implementing pollution prevention opportunities will determine the degree of formality required for setting priorities in the organization's pollution prevention program.

9.1.2 For example, within a TQM-oriented organization, each employee would prioritize the opportunities available within his or her level of authority. However, some opportunities that are beyond the expenditure authority of the individuals at a specific facility may be subject to prioritization at a higher level of management. The organization or facility should evaluate the overall impact of proposed opportunities within specific activities.

9.1.3 Within an organizational structure that requires a formal priority setting system prior to program implementation, it will be possible to identify pollution prevention opportunities following the collection of ~~all~~ necessary facility and process information. Once the opportunities have been identified, each must be examined carefully to decide which can be implemented. Flexibility is required in setting priorities.

9.2 *Feasibility Analysis*:

9.2.1 *Technical Feasibility Analysis*—The first step is to determine the technical and economic feasibility of each pollution prevention opportunity. The outcome of the these analyses is the decision whether a specific opportunity will work in the proposed application and a summary of the economic impact. The following factors should be considered in the technical feasibility analysis:

9.2.1.1 *Inventory Management Option*:
(*1*) Affected departments,
(*2*) Impact on production,
(*3*) Training or procedural changes, and
(*4*) Ease of implementing.

9.2.1.2 *Modification of Production Processes Option*:
(*1*) Affected products and production processes,
(*2*) Affected departments,
(*3*) Availability of materials,
(*4*) Availability of equipment,
(*5*) Testing or scale-up requirements,
(*6*) Impact on production,
(*7*) Impact on product quality,
(*8*) Safety considerations,
(*9*) Additional storage or handling requirements,
(*10*) Additional laboratory and analytical requirements,
(*11*) Training or procedural changes,
(*12*) Material testing and quality control requirements, and
(*13*) Ease of implementation.

9.2.1.3 *Waste Reduction and Recycling Option*:
(*1*) Affected departments,
(*2*) Impact on production,
(*3*) Training or procedural changes,
(*4*) Ease of implementation, and
(*5*) Safety considerations.

9.2.1.4 *Waste Recovery, Reuse, and Reclamation Option*:
(*1*) Affected departments,
(*2*) Availability of equipment,
(*3*) Testing or scale-up requirements,
(*4*) Impact on product quality,
(*5*) Additional storage or handling requirements,
(*6*) Additional laboratory and analytical requirements,
(*7*) Training or procedural changes,
(*8*) Ease of implementation, and
(*9*) Safety considerations.

9.2.2 *Economic Feasibility Analysis*—In the economic feasibility analysis, an estimate of the total costs and benefits expected from each option is obtained, based on an evaluation of the following inputs:

9.2.2.1 *Direct Costs or Benefits*:

(*1*) Changes in product revenues;

(*2*) Capital expenditures (buildings, equipment, utility connections, equipment installation, and project engineering);

(*3*) Operation and maintenance expenses and revenues (raw materials and supplies, labor (maintenance and operations), waste disposal, utilities (for example, water, sewer, electricity, and fuels), revenue from recovered materials); and

(*4*) Environmental impairment and liability insurance premium.

9.2.2.2 *Indirect Costs or Benefits*:

(*1*) Compliance costs (permitting, reporting, tracking, monitoring, manifesting, training, waste handling, record keeping, labeling, testing, emergency preparedness, and medical surveillance);

(*2*) Waste storage;

(*3*) Operation of on-site pollution control equipment;

(*4*) Replacement of non-product output;

(*5*) Marginal change in costs due to the reduced use or generation of hazardous materials; and

(*6*) Legal fees.

9.2.2.3 *Liability Costs*:

(*1*) Penalties and fines;

(*2*) Damage to property and casualty loss;

(*3*) Legal fees; and

(*4*) Insurance premiums.

9.2.2.4 *Intangibles*:

(*1*) Revenue from enhanced product quality;

(*2*) Revenue from an increased market share of green products;

(*3*) Worker compensation claim and absenteeism costs from improved employee health;

(*4*) Productivity from improved employee relations; and

(*5*) Staff time in dealing with community concerns.

9.3 *Prioritization*:

9.3.1 Upon completion of the technical and economic feasibility analyses, other factors should be considered in order to make the final decisions in setting priorities. These include the ability of the organization to maintain compliance with environmental regulations, overall environmental protection benefits to employees and the community, and overall reduction of the environmental and safety risks of the facility.

9.3.2 Any prioritization method selected is a dynamic process. As the capital and operating costs of individual opportunities change, it may become necessary to reevaluate the opportunities. See Appendix X3 for an example of a method of prioritizing pollution prevention opportunities. As new information becomes available on different opportunities, some may become technically feasible while others become economically impractical.

9.3.3 An effective priority-setting system should do the following:

9.3.3.1 Evaluate the performance of potential projects in terms of goals and objectives such as the following:

(*1*) Total cost savings, such as process savings, treatment and disposal cost savings, and avoidance of estimated future liability. (Savings estimates must be consistent with facility level tracking data and must include estimates of uncertainty.)

(*2*) Waste elimination, such as volume reduction and reduction in waste toxicity. (Estimates must once again be consistent with facility level tracking data.)

(*3*) Response to directives (for example, Montreal Protocol on Substances that Deplete the Ozone Layer or the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal) to curtail the use of specific chemicals.

(*4*) Response to public and national concerns, such as facility-specific environmental issues, nationwide phase-outs of specific products, and the protection of endangered species.

9.3.3.2 Incorporate feedback on actual plant performance over time in order to adjust annual goals on the basis of objective data in the tracking system.

9.3.3.3 Become more refined over time as better data become available and the program focuses on the more difficult pollution prevention projects.

9.3.3.4 Remain dynamic as new information is obtained.

10. Implementation and Maintenance of Progress of a Pollution Prevention Program

10.1 *Introduction*—After pollution prevention opportunities have been prioritized, it is appropriate to begin to implement and maintain the pollution prevention program. A large part of this step involves developing awareness, training, and motivating the participants. These aspects of the program become increasingly important as the program matures.

10.2 *Publication and Promotion of Pollution Prevention Program*:

10.2.1 *Communications*—It is important for an organization to develop and maintain a continuous process of internal communications addressing the development and milestones of the pollution prevention program. The first step will require the development of an internal communications plan that identifies the goals, objectives, and methods of internal communications.

10.2.2 *Objectives*—Some of the objectives that may be identified include the following:

10.2.2.1 Promote a corporate culture that embraces pollution prevention,

10.2.2.2 Introduce awareness of pollution prevention to all employees,

10.2.2.3 Obtain a commitment to pollution prevention at all management levels,

10.2.2.4 Bring concepts of pollution prevention into daily tasks associated with facility operation and maintenance,

10.2.2.5 Encourage employees to extend pollution prevention concepts into their homes and communities,

10.2.2.6 Commit to an ongoing organizational dialogue on pollution prevention, and

10.2.2.7 Encourage a team approach.

10.2.3 *Tools*:

10.2.3.1 A variety of tools may be used for internal communications. Newsletters or stories can be used as educational tools or for selling the success of the program. The newsletter can initially be used to report the organization's pollution prevention goals. When the program is underway, it can then be used to report on progress toward achieving those goals. Employees may be encouraged to use the newsletter as a forum for suggestions. Furthermore, successful pollution prevention efforts can be spotlighted to motivate employees toward continued success. Organizations may choose to distribute a brochure periodically that identifies the pollution prevention goals for the upcoming year.

10.2.3.2 The communications may also include an employee suggestion box for ideas relating to pollution prevention. A system for understanding the suggestions, as well as monitoring and acting on the employee suggestions, should be developed.

10.2.3.3 Finally, a free-standing or mounted display may be produced that provides a continuous report on that status toward achieving the program goals. The display may also be used to recognize individual, departmental, or team pollution prevention efforts periodically.

10.2.3.4 The following are examples of activities that can be used for publicizing and promoting a pollution prevention program:

(*1*) Conducting open houses and facility tours;

(*2*) Establishing a pollution prevention speakers' bureau;

(*3*) Preparing educational materials;

(*4*) Encouraging the formation of community advisory panels;

(*5*) Sponsorship of community activities and pollution prevention workshops;

(*6*) Providing monetary awards and financial support to employees and community members for pollution prevention activities;

(*7*) Promoting media communications; and

(*8*) Communicating with customers, vendors, and suppliers.

10.2.4 *Reports*—An effective communications program should flow up and down. Periodic reports to upper management that identify program successes and failures are essential. Of equal importance would be senior management's appraisal of the program to the rank-and-file. The latter reports could provide employees with much needed encouragement, even in the face of some failures, to continue their commitment. The organization may choose to distribute a brochure annually that identifies the pollution prevention goals for the upcoming year. Employees may be able to display this in the work areas.

10.3 *Integration of Pollution Prevention Concepts into Ongoing Training Programs*:

10.3.1 *Introduction*:

10.3.1.1 Training is an essential component of a corporate pollution prevention program. A high level of commitment to training is a prerequisite for a viable program. The degree and level of sophistication of training afforded may be tailored to employees or functions, or both, in an organization. However, at a minimum, all employees should receive training that articulates the philosophy of the program and the particular activities that can be taken by the employees involved.

10.3.1.2 Internal training is a critical means for the organization to stress its dedication to, and the importance of, the pollution prevention program. Adding an introduction to the pollution prevention program at new employee orientation programs will emphasize the importance of the programs. In addition, adding elements of the pollution prevention program to the routine training programs will also emphasize the importance of the program to the employees.

10.3.2 *Resources*:

10.3.2.1 Employees must be provided with training in order to be able to plan, develop, implement, and maintain a pollution prevention program. It is therefore important that organizations allocate adequate time and resources for training programs.

10.3.2.2 A training plan developed early in the process should identify the training objectives, scope of training, and audience. The complexity of the training program will be determined by the number of tasks to be covered, as well as the different audiences to be involved. It may be appropriate to develop the training program in modules in order to allow maximum flexibility. For example, employees evaluating and setting priorities for pollution prevention opportunities may benefit more from training in life-cycle costing, while employees operating a production process may benefit more from training in specific pollution prevention option implementation.

10.3.3 *Delivery*—Training might involve discussions in group meetings or may require the delivery of a detailed training course. In addition to serving as reference materials, training manuals help to minimize the most common causes of lack of consistency in performance, namely, a lack of accountability and poor understanding of the requirements.

10.4 *Personnel or Group Awards and Incentive Programs*:

10.4.1 *Introduction*—The development of individual or group incentive programs may also be useful for training employees in

the importance of the pollution prevention program and their role in such a program. This may include monthly recognition awards for achieving certain levels of performance or an annual award for overall performance.

10.4.2 *Recognition*:

10.4.2.1 Recognition and incentive programs that acknowledge the successful efforts of employees can be significant motivators. Programs should be structured to identify the types of activities that deserve recognition. For example, an organization may recognize activities that are keyed to measurable goals or linked to the accomplishment of these goals.

10.4.2.2 While the incentives may take the form of special recognition or monetary awards, it is also important to recognize the potential for overall improvement in the quality of the work environment due to pollution prevention efforts.

10.5 *Quality Assurance and Quality-Control Procedures*:

10.5.1 *Introduction*:

10.5.1.1 The development and implementation of quality assurance and quality control (QA/QC) procedures may be useful for determining the baseline levels of operations and establishing performance goals, while accomplishing quality goals. Whenever possible, it is important that the pollution prevention QA/QC program be integrated with the organization's other QA/QC programs.

10.5.1.2 The development and implementation of QA/QC procedures can be critical to the effectiveness and success of the pollution prevention program. Commitment to quality builds a pollution prevention program that encourages continuous improvement.

10.5.2 *Process*—A quality improvement process generally includes the following activities:

10.5.2.1 Measurement of existing conditions using quantifiable parameters.

10.5.2.2 Identification of improvement opportunities, that is, specific projects.

10.5.2.3 Establishment of agreed upon goals.

10.5.2.4 Development of a detailed plan for improvement for each project.

10.5.2.5 Identification and implementation of training requirements.

10.5.2.6 Measurement, monitoring, and documentation of results of the plan.

10.5.2.7 Evaluation of results, analysis of failures, and communication of the lessons learned.

10.5.2.8 Go to Step 1 (see 10.5.2.1) and repeat.

10.6 *Contingency Plan*—The development of a contingency plan will allow the organization to cope with unforeseen factors that may impact the development and implementation of the organization's pollution prevention program positively or negatively. Contingency planning should be built into every component of the pollution prevention program. Environmental and safety factors or equipment deficiencies, or both, caused by factors beyond those recognized as part of prudent planning and operating practices, could hinder pollution prevention efforts. This planning should establish an effective means of anticipating, assessing, and responding, in an appropriate and coordinated manner, to a long- or short-term deficiency. Contingency planning may range from developing an organizational plan to creating a public relations program.

10.7 *Public Relations Program*:

10.7.1 *Introduction*—Developing a sound and responsive public relations program will provide the basis for enhancing an organization's credibility within its community. To some extent, the pollution prevention public relations program can dovetail with the organization's risk communication efforts to address the public's concerns about health, safety, environmental protection, and public policy. The public relations program must have clearly defined objectives and must identify specific action plans for communicating with all targeted sectors of the public, including the local community, the public and private sector organizations, and the media.

10.7.2 *Objectives*—The objectives of the public relations program may include the following:

10.7.2.1 Projecting a positive public image.

10.7.2.2 Establishing good relationships within the community.

10.7.2.3 Establishing and maintaining an ongoing dialogue with the public.

10.7.2.4 Communicating responsible pollution prevention practices as good corporate citizens.

10.7.2.5 Creating a continuum of daily practices promoting pollution prevention as a framework for daily life within the community.

10.7.2.6 Promoting and coordinating efforts with local public and private sector organizations.

10.7.3 *Action Plans*—Action plans must be tailored specifically to the targeted audience, reflecting its perspective, level of technical knowledge, and concerns. The following activities can be used for meeting the selected objectives:

10.7.3.1 Conducting open houses and facility tours.

10.7.3.2 Establishing a speakers' bureau.

10.7.3.3 Preparing educational materials.

10.7.3.4 Encouraging the formation of community advisory panels.

10.7.3.5 Sponsorship of community activities and pollution prevention workshops.

10.7.3.6 Providing monetary awards and financial support to community members' pollution prevention efforts.

10.7.3.7 Promoting media communications.

10.8 *Review of Program*—A periodic review of the program should be performed as a method of evaluating the past and

ensuring the future effectiveness of the pollution prevention program. This should include review of the following:

10.8.1 Initial program goals and baseline information.

10.8.2 Results of program activities.

10.8.3 Program priorities.

10.8.4 Implementation of contingencies.

10.9 The best methods for evaluating the success of the pollution program will depend on the goals and objectives of the program. In cases in which economic criteria are important, it might be appropriate to use a method of economic evaluation.

10.10 The review should be announced and supported by senior management, facilitated by the pollution prevention task force members, and implemented by members of the general work force. Review should be performed frequently enough that it provides the organization and program with information necessary to function in the most efficient and effective manner, normally every one to three years.

10.11 Failures, as well as successes, should be communicated throughout the organization, in objective terms. Individuals deserving credit should be recognized formally. Unsuccessful efforts should be evaluated for their cause and corrective actions taken and communicated.

APPENDIXES

(Nonmandatory Information)

X1. SUGGESTED ADDITIONAL PUBLICATIONS

Achievements in Source Reduction and Recycling for Ten Industries in the United States, U.S. Environmental Protection Agency, EPA/600/2-91/052, 1991.

Approaches to Source Reduction: Practical Guidelines from Existing Policies and Programs, Environmental Defense Fund, 1986.

Campbell, John M., Jr., "Market-Based Incentives for Pollution Prevention Projects," presented at the *Hazardous Materials Management Conference & Exhibition International*, Atlantic City, NJ, June 1988.

Cebon, Peter B., "Organizational Behavior as a Key Element in Waste Management Decision Making," presented at the *Second International Conference on Pollution Prevention*, Washington, DC, July 1990.

Crumpler, P., *Pollution Prevention By Design*, Chemical Engineering, Vol 104, No. 10, 1997, pp. 102-110.

Cunningham, V., et al., *ECAS-Environmental Cost Analysis System*, Van Nostrand Reinhold, New York, NY, 1986.

Dharmavaram, Seshasayi, J. Mount, Brian, and Donahue, Bernard A., "Automated Economic Analysis Model for Hazardous Waste Minimization," *Journal of Air and Waste Management Association*, Vol 40, No. 7, July 1990, pp. 1004–1011.

Economic Implications of Waste Reduction, Recycling, Treatment and Disposal of Hazardous Wastes, The Fourth Biennial Report, California Department of Health Services, Toxic Substances Control Division, Alternative Technology Section, Sacramento, CA, 1988.

Economic Incentives: Options for Environmental Protection, Report of the U.S. EPA Economic Incentives Task Force, Office of Policy, Planning, and Evaluation, U.S. Environmental Protection Agency, 1991.

Financial Analysis of Waste Management Alternatives, General Electric Company, Corporate Environmental Programs, 1987.

Freeman, H. M., *Industrial Pollution Prevention Handbook*, EPA Risk Reduction Engineering Laboratory, Cincinnati, OH, 1995.

Fromm, Carl H., and Butler, David, "Practical Guidelines for Estimating the Profitability of Waste Minimization Measures," Jacobs Engineering Group, Inc., Pasadena, CA.

Gulledge, William P., "Developing a Pollution Liability Insurance Underwriting Model: Managing for the Potential Exposure from Toxic Releases," *The Environmental Professsional*, Vol 11, 1989, pp. 447–453.

Karem, Joseph, Verderese, James, and Bailey, Paul, "How Full Cost Accounting Can Drive the Economic Viability of a Pollution Prevention Project," presented at the *Hazardous Materials Management Conference & Exhibit/International*, Atlantic City, NJ, June 1990.

Lunt, R. R., and Bowen, R. C., "Realizing the Promise of Pollution Prevention," *Pollution Prevention Review*, Vol 6, No. 3, 1996, pp. 23-31.

MacLean, Richard W., "Financial Analysis of Waste Minimization Options—Considerations in Developing a Corporate Program," presented at the *1987 Waste Minimization Workshop*, Chemical Manufacturer's Association, Washington, DC, Nov. 11–13, 1987.

Marchetti, J. A., Poston, B., McPherson, E., and Webb, J. R., "Overcoming the Barriers to Pollution Prevention," *Pollution Prevention Review*, Vol 6, No. 1, 1995-1996, pp. 41-50.

Pollution Prevention Benefits Manual: Vol 1: The Manual, Phase II, U.S. Environmental Protection Agency, 1989.

Ramey, D., Sanders, D. A., and Veenstra, J., "Pollution Prevention Self-Assessment: A Sensible Approach for Small Businesses," *Pollution Prevention Review*, Vol 9, No. 3, 1999, pp. 81-92.

Report on Barriers to Pollution Prevention, Minnesota Office of Waste Management, 1991.
Wigglesworth, David, *Profiting From Waste Reduction in Your Small Business*, Alaska Health Project, Anchorage, AK, 1988.

X2. EXAMPLE OF A POLLUTION PREVENTION OPPORTUNITY ANALYSIS CHECKLIST

X2.1 *Documentation Review*—The following data sources may be accessed (if applicable and available) in order to understand facility operations thoroughly and in order to begin identifying source reduction opportunities:

X2.1.1 *Product Design Criteria*.

X2.1.2 *Process Flow Diagrams for all Solid Waste, Wastewater, and Air Emissions Production Sources*—Ideally, these diagrams will include, or be accompanied by, the following:

X2.1.2.1 Flow data.

X2.1.2.2 Waste concentration or physical and chemical characterization data, or both; raw material input data.

X2.1.2.3 Typical production rates for end products.

X2.1.2.4 Points of waste generation.

X2.1.2.5 Continuous versus batch nature of process.

X2.1.2.6 Wastewater and hazardous waste treatment facilities.

X2.1.2.7 Air pollution control devices.

X2.1.2.8 Machinery lubricating systems.

X2.1.2.9 Hydraulic oil circulating systems.

X2.1.3 *Site Maps, Showing the Locations of All Pertinent Units and Process Flow Diagrams as Described Above*—Information including the following:

X2.1.3.1 Cooling towers.

X2.1.3.2 Cooling water users.

X2.1.3.3 Wastewater treatment systems.

X2.1.3.4 Air pollution control devices.

X2.1.3.5 Points of discharge to the sewer system.

X2.1.3.6 Land treatment or disposal units, or both.

X2.1.3.7 Bulk raw and waste material storage components, systems, and facilities.

X2.1.4 *Additional Documentation*—Information such as follows:

X2.1.4.1 Material safety data sheets (MSDS) for all raw materials and process equipment cleaning chemicals.

X2.1.4.2 Any MILSPECs (military specifications), FDA, or other customer specifications that would preclude or hamper the process modifications (for example, if cyanide zinc plating were required by customer specifications).

X2.1.4.3 Publicly owned treatment works (POTW) permits, a national pollutant discharge elimination system (NPDES) permit, and any reports of ~~exceedence of~~ exceeding those permits.

X2.1.4.4 Resource conservation and recovery act (RCRA) permits and relevant requirements.

X2.1.4.5 Hazardous waste manifests and annual and biennial reports.

X2.1.4.6 SARA Title III reports of chemical usage, discharge, and waste minimization for the latest years.

X2.1.4.7 State and local air, waste, solid, and hazardous waste permits and applications.

X2.1.5 *Economic Data*—Information such as follows:

X2.1.5.1 Cost of raw materials management, including material cost, storage, and health and safety programs.

X2.1.5.2 Cost of air, wastewater, and hazardous waste treatment chemicals.

X2.1.5.3 Waste management operating and maintenance costs, including labor, transportation, sewer use fees, and solid and hazardous waste disposal costs.

X2.1.6 *Managerial Information*—Information including the following may be reviewed:

X2.1.6.1 Environmental policies and procedures at all relevant levels, including organization charts.

X2.1.6.2 Prioritization of waste management concerns (such as whether any environmental issues take precedence over other issues).

X2.1.6.3 Automated waste tracking system databases or other relevant computerized waste management systems.

X2.1.6.4 Inventory and distribution procedures including procurement policies and routine and non-routine maintenance scheduling practices.

X2.1.6.5 The basis of source reduction decisions and policies (for example, economics, environmental and safety liability concerns, capital costs, potential operational benefits, and ease of implementation).

X2.1.6.6 Any planned modifications or revisions to existing operations that would impact waste generation activities.

X2.2 *Facility Tour*:

X2.2.1 *Overview*—A tour of the facility should be scheduled after review of all documentation. Department managers should be available to describe and discuss their area of the facility as it relates to pollution prevention. In addition to production

department managers, maintenance, purchasing, R&D, and engineering management information systems (MIS) managers should be contacted as appropriate.

X2.2.2 *Purpose of Plant Tour*—The purpose of the plant tour is to verify the information contained in the documentation and to gain a better understanding of the points of view of each of the individuals involved. These personnel typically have unique insights into potential projects that may not be identified from the documentation. (For example, a production department manager may be aware that they already have plans to make the required source reductions or perhaps discontinue the production process.)

X2.2.3 *Identification of Materials*—The material needs to be defined clearly before going to the marketplace. Each component material needs to be identified by type, origin, supply manufacturer, each number, and trade name. The basic parameters of the material should be identified (such as viscosity of the liquid, durometer of the rubber, hardness of the metal, weight of the paper, flow rate of the plastic, etc.).

X2.2.3.1 *Sources of Information*:

(*1*) Vendor product data.

(*2*) Material safety data sheets (MSDS).

(*3*) Waste stream profile sheet.

(*4*) Purchase specifications.

(*5*) Modifications during processing (chemical reactions and mechanical modifications and additive introduced).

X2.2.3.2 *Quantification*—To determine the volume and weight generated on a time basis, both the steady-state and periodic state of generation must be reviewed. For purposes of reuse and reclamation, a sufficient quantity must be available to justify the expense of qualification for use.

X2.2.3.3 *Marketing Plan Development*—After it is understood that the material is to be reused and reclaimed, a market analysis must be completed. The following sources should be reviewed.

(*1*) Survey of existing literature.

(*2*) Discussion with brokers, dealers, and recyclers.

(*3*) Discussion with internal technical personnel.

(*4*) Discussion with universities and consultants.

X2.2.3.4 *Implementation*—Sample both internal and external users and recyclers.

X2.2.3.5 *Other Considerations*:

(*1*) Transportation to accumulation point (method of transportation, who will pay transportation charges, whether the material is hazardous, and whether special handling is required).

(*2*) Accumulation (who will develop the accumulation system; where the accumulation system will be located; whether the accumulation point will have to be volume reduced, for either confidential reasons or freight savings; and who will pay the accumulation costs).

(*3*) Transportation to the recycling location (what the method of transportation is, who will pay the transportation charges, whether the material is hazardous, and whether special handling is required).

(*4*) Company(s) to reuse and reclaim the material (whether the reclaimer credit is worthy (Has a credit check been done?), whether the material is hazardous (Has the facility been inspected?), ownership of the facility, and contractual arrangements).

X3. EXAMPLE OF A METHOD OF EVALUATION OF POLLUTION PREVENTION OPPORTUNITIES

X3.1 *Summary*—Each waste stream or operation is assigned a priority rank using a weighted sum method based on a ranking criteria, the relative weight of each criteria, and the rating of the waste stream or operation for each criteria.

X3.2 *Procedure*:

X3.2.1 *Ranking Criteria*—Establish the ranking criteria on the basis of corporate or facility pollution prevention policies and objectives, or both. Typical criteria, or factors used in establishing the criteria, may include the following:

X3.2.1.1 Compliance with current regulations.

X3.2.1.2 Compliance with future regulations.

X3.2.1.3 Total cost of materials management, including waste management, and including all labor costs.

X3.2.1.4 Potential environmental and safety liability.

X3.2.1.5 Quantity of waste.

X3.2.1.6 Hazardous properties of input materials or wastes.

X3.2.1.7 Ease of implementation potential for the pollution prevention method.

X3.2.1.8 Potential operational benefits.

X3.2.1.9 Pollution prevention budget.

X3.2.2 *Weight Criteria*—Establish the relative weight of each ranking criteria, and assign a numerical value to each criteria that reflects its importance (for example, 1 through 10).

X3.2.3 *Rating Scale*—Establish a rating scale (for example, 1 through 10) to be applied uniformly to each criteria.

X3.2.4 *Ratings*—Assign a rating to each waste stream for each criteria, calculate the product of each rating and the criteria weight, and sum the products to determine the waste stream priority rating score.

X3.2.5 *Order*—Rank order each waste stream or operation based on the priority rating score.

X3.3 *Report*—Brief descriptions of each waste stream operation should be prepared and listed in accordance with rank order from the most important to least important.