



Division of Hazardous Waste Management

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# Pollution Prevention Assessment Procedures Manual

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# Section 1

## 1.0 Introduction

This manual provides Ohio EPA Division of Hazardous Waste Management (DHWM) inspectors and pollution prevention (P2) specialists with guidance on how they should conduct P2 assessments. Throughout this manual, we will refer to inspectors and P2 specialists who conduct assessments as assessors. The manual describes the steps that assessors should use when conducting a P2 assessment and the standard steps that they must complete for all assessments.

### 1.1 Who Does P2 Assessments?

P2 assessments are done by inspectors and/or the P2 specialist. The P2 assessment may be conducted with assistance from OCAPP.

### 1.2 What is a P2 Assessment?

A P2 assessment is a pre-arranged on-site evaluation of a company's manufacturing processes, conducted by an assessor. The assessor conducts the assessment at the request of the company usually as a follow up to a CEI. During a P2 assessment, the assessor focuses on one or more selected industrial processes of the company in greater detail than during the typical CEI. The purpose of the assessment is to identify and evaluate opportunities to reduce or eliminate waste, including, but not limited to, hazardous waste, solid waste, air emissions and wastewater. In addition to doing the assessment, the assessor will communicate his/her findings verbally and in writing to the company in a way that will encourage the company to implement the strategy or procedures that the assessor uncovers during the assessment.

The degree of complexity of a P2 assessment will depend on:

1. The range of P2 opportunities that may be present;
2. The company's willingness to have its processes evaluated; and
3. The assessor's knowledge and understanding of P2 concepts.

The outputs of the P2 assessment include the following:

1. A cover letter that clearly states that the P2 assessment recommendations made within the P2 report are non-regulatory and includes an example P2 Assessment Report Cover Letter ([see Attachment I](#));
2. A written report containing recommendations for P2 opportunities;
3. An outline of economic and environmental benefits of implementing recommended P2 opportunities;
4. Relevant case studies, fact sheets, vendor information, and other supporting documentation; and
5. Other information as requested by the company or deemed significant by the assessor.

The P2 assessor must complete and mail the assessment report within 60 days from the last day of the P2 assessment visit. Thirty days after the report has been mailed, Central Office will send out a brief customer satisfaction survey ([see Attachment II](#)) following standard survey techniques. Within five days of receiving the completed survey, Central Office will give the P2 assessor a copy of the survey.

### **1.3 Ways to Identify Candidates**

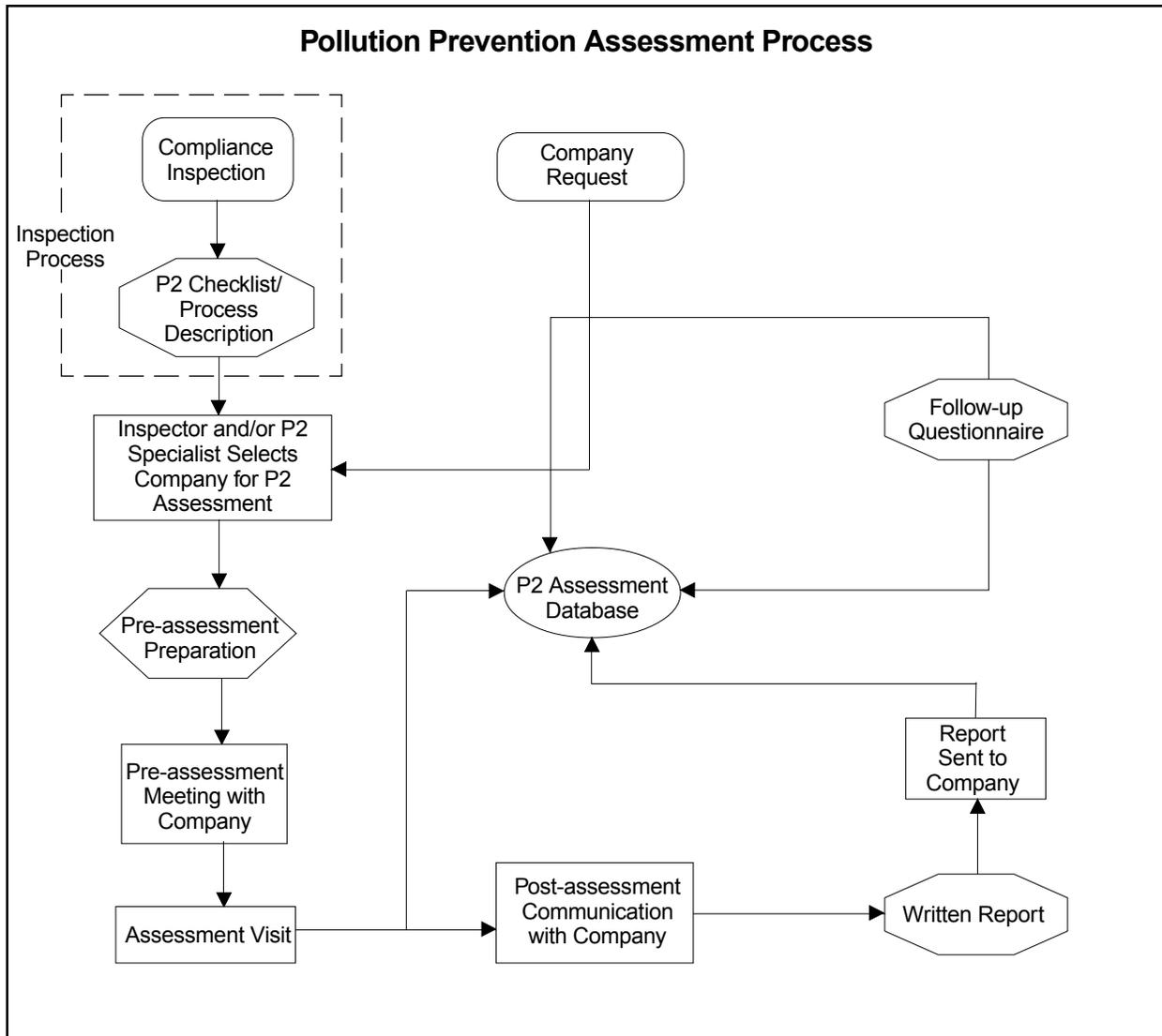
Assessors will determine candidates for a P2 assessment based on a set of criteria, usually after the inspector has conducted a compliance inspection. In the event that the assessors receive a request from a company for a P2 assessment, they should determine if the company is eligible by using the following criteria. For these companies that have not been identified via a compliance inspection, the assessor must send them a copy of the Compliance Policy.

Each District should feel free to use any or all of the following criteria in order to determine who to assess. Companies will normally be assessed on a first come first served basis. Factors may affect assessment scheduling including DHWM priorities, special initiatives, and availability of supporting staff. The assessor may want to consider the following criteria in determining who to provide an assessment to:

- The company is willing to have an assessment done. (We do not have any legal authority to do an assessment at a company that does not agree to it.)
- The assessor(s) has the skills and knowledge to successfully assess the company. If the assessor(s) lacks these skills and knowledge, then an outside source (namely the Office of Pollution Prevention) may be asked to help;
- The company has good environmental standing (or are taking appropriate steps to address environmental problems); and
- The company has a willing representative, time and other resources to devote to an assessment.
- The company has been cited with violations and it is apparent that P2 opportunities exist that would assist the facility in returning to compliance. (Please also refer to the enforcement referral guidance for a discussion on when you can delay an enforcement referral in exchange for implementation of a P2 project.)

## 1.4 P2 Assessment Flow Diagram

The following is a process flow diagram of the P2 assessment process:



## Section 2

### 2.0 Pre-Assessment Preparation

The purpose of the pre-assessment preparation is to equip the assessor with the resources and information necessary prior to conducting an assessment. Once a P2 candidate has been identified, which will usually follow a compliance inspection, the assessor(s) will need to become familiar with the *P2 Assessment Procedures Manual*. Prior to conducting a pre-assessment meeting with the company, and the P2 Assessment, the assessor should review the following items so that P2 opportunities may be recognized:

- Determine the P2 information required for the assessment such as relevant case studies and fact sheets. Assessors are encouraged to familiarize themselves with this information whenever possible. These documents will help to identify P2 strategies, emerging trends, or problems particular to an industry sector. Copies of fact sheets, case studies, vendor information, and technical information of specific industries have been provided to each district office and are located at the district P2 library. Industry-specific fact sheets should be taken along on the assessment;
- The Office of Compliance Assistance and Pollution Prevention (OCAPP) maintains case studies, fact sheets, and industry specific process information, and shares that information with DHWM on a regular basis. Assessors may discuss specific site activity with OCAPP, either prior to or following an assessment. OCAPP may be aware of emerging trends, new technologies, or common problems;
- Review industry-specific information;
- Review the file information including the recent compliance inspection reports;
- Review the hazardous waste notification form;
- Review proposed or issued Part A/Part B Permits;
- File review may include DERR, DSW, and DAPC. Assessors should review applications for proposed and issued NPDES and DAPC permits;
- Review Annual TRI Report (available on the DAPC web site at [www.epa.ohio.gov/dapc/tri/reptsdb.aspx](http://www.epa.ohio.gov/dapc/tri/reptsdb.aspx));
- Search the Internet for the company's web site to get an overview of the business operations and hot buttons; and
- Review the Annual Report.

**Please note that the annual report is a very valuable source of information that can provide information on the waste minimization activities already implemented.**

Ohio Administrative Code (OAC) rule 3745-52-41 requires the generator to describe efforts made to reduce the quantity or toxicity of their wastes. Form IC contains a comment box for this purpose as well as Yes/No indicators of source reduction, recycling, and opportunity assessment. A historical review of the site's reports can show trends in generation quantities and management methods that will provide a perspective that is helpful in understanding the generator's operations. Descriptive codes such as SIC, Source, Origin, and Form are listed for each waste and are useful in selecting P2 reference materials targeted specifically to the company's processes and reduction of the wastes generated. A shipper is required to list a code describing the management method used by the receiving facility, which can also provide enlightenment on the waste characteristics. In conjunction with the other information available from the Annual Report, this may suggest alternative methods for the waste's management.

Some examples of how the Annual Report data can be used are:

- The Source Code is for electroplating. A P2 manual for that process can be given to the generator.
- The generator listed numerous wastes with a Source Code indicating off-spec or out-of-date materials. Inventory control should be emphasized during the assessment.
- The generator's biggest waste streams were residuals from waste treatment processes. Are there any new technologies available that would reduce the residuals? Can a change in the process reduce the amount of waste that requires treatment?
- Review the historical data and look for changes and trends. Have they shown a reduction in quantities or listed waste minimization activities?

The annual report can be obtained from Central Office, Data Management Section.

## 2.1 Developing Site-Specific Questions

Prior to the P2 assessment, the assessor should have a clear idea of the additional questions that need to be posed to the facility representatives to clarify any information discrepancies noted during the pre-assessment preparation. The assessor can ask questions to clarify sources of significant waste streams, reasons for using materials, or methods of operation which lead to generation of waste and the availability of alternate raw materials. Examples of specific questions which an assessor may ask are found in Section 3 of this manual in the pre-assessment meeting discussion.

## Section 3

### P2 Assessment Site Visit

#### 3.0 Pre-Assessment Meeting with the Company via Telephone

Prior to conducting the P2 assessment, the assessor(s) should have a phone conference with the facility representative(s). The purpose of the phone call is two-fold:

1. For the assessor to gain a greater understanding of the company's operations and processes; and
2. For the assessor and the company to clarify expectations about the P2 assessment and its outcome.

Some issues for the assessor to address during the conference:

- Discuss Compliance Policy and confidentiality issues;
- Ask what safety equipment is necessary;
- Ask about P2/waste minimization program(s) in place;
- Ask if the company has implemented any waste reduction or recycling techniques;
- Ask if the company has a P2/waste minimization coordinator;
- Ask about the materials used in the facility's processes (type and quantity);
- Ask about all waste streams, which media they affect, and how much is generated in each;
- Ask about the different processes and operations performed at the facility;
- Ask about the production; obtain a rough estimate of production-line volume per month;
- Ask about any "headache" processes and waste streams; and
- Ask other questions you feel necessary to fill in the gaps in the information already obtained.

The information gathered during the conference call should be evaluated by the assessor(s). The assessor(s) may then develop more questions as a result of the call. Prior to the P2 assessment, the assessor(s) should have an idea of the additional questions that he/she needs to pose to the facility representatives to clarify any information discrepancies noted during the pre-assessment preparation and pre-meeting. These types of questions can be written in the field notebook to pose to the facility representatives during the P2 assessment.

#### What to Take on an Assessment

The following is a list of materials which may be taken on an assessment:

- Applicable checklists (from U.S. EPA Industry-Specific P2 Files);
- P2 Fact Sheets/Waste Minimization Forms;
- P2 plans from other facilities with similar processes;
- Camera and film;

- Required safety equipment;
- Field notebook;
- EPA identification and business cards;
- P2 report template or example report (so the company can see an example); and
- Other (whatever you feel necessary).

### 3.1 Opening Meeting

Once the assessor(s) has arrived at the facility, a opening meeting should be conducted with the company personnel who will be assisting during the P2 assessment. This meeting, prior to examining records or the walk-through of the facility, should be conducted to discuss the following:

- Purpose and expectations;
- P2 Assessment process;
- P2 Assessment site visit;
- P2 Report;
- 30-day report follow-up;
- One year follow-up;
- Review the proposed agenda and identification of any schedule constraints;
- Identify company personnel that the assessor(s) may want to interview;
- A general overview of how primary plant processes function (draw a diagram);
- An overview of the raw materials entering each process operation;
- An overview of all wastes generated from company operations;
- An overview of disposal practices; and
- Other questions as a result of the pre-meeting conference call.

**The assessor(s) must remind the facility representative(s) what will happen if Ohio EPA finds violations (see Attachment III):**

#### **Confidentiality**

The assessor(s) must discuss confidentiality issues as described in OAC rule 3745-50-30 (see Attachment IV). The assessor(s) should inform the company representative not to give them any documents that are confidential unless they are marked as such.

#### **Disclaimer**

The assessor(s) must make clear that the P2 recommendations are NOT compliance instructions. The assessor(s) should remind the company to make their own decisions concerning any recommendation(s) made during the assessment which should only be implemented at the company's discretion. The general rule to follow is to discuss the benefits of P2, such as saving money and reducing regulatory burden. The assessor must avoid endorsing specific name-brand products.

## 3.2 Walk-Through

During the course of the P2 assessment, the assessor(s) should examine the facility's operating procedures, materials usage and technology. Changes to operating procedures, substitution of materials, and utilization of more efficient technology can improve the facility's operating efficiency, and reduce raw material usage and waste generation. The assessor(s) may observe the following opportunities:

### • Operation and Maintenance Improvements

There are various types of O&M improvements which can reduce the generation of wastes, including improvements in: (a) inventory control to reduce waste resulting from overstocking or out-of-stock materials; (b) preventive maintenance to reduce leaks or spills; and (c) general housekeeping and materials management.

### • Technology Changes

These changes range from fairly minor adjustments in the design and efficiency of operations to the implementation of technological changes to, or substitutions for, existing processes or equipment which significantly changes a facility's operations. They may be quickly adopted and inexpensive, or involve major capital outlays for innovative production technologies.

### • Product Change

Product changes include changes made to the composition of the end product, or the development of alternative but functionally similar end products, by the manufacturer to reduce waste resulting from the manufacture, use, or ultimate disposal of the product. The products are designed to cause less environmental impact and/or to increase product life.

### • Activity-Based Costing

Activity-based costing is an indirect activity that leads to P2. Accounting for all costs associated with environmental compliance such as taxes, insurance, reporting, waste disposal, utilities, training, permits, etc...provides a true picture of the cost of compliance with environmental regulations. An added benefit of activity-based accounting is that the progress of waste minimization can be measured in dollars and therefore be used to justify P2 alternatives.

### • Recycling Opportunities

Examine opportunities to recycle waste. Where possible, look for in-process opportunities to recycle and reuse materials. Out-of-process recycling on-site may also allow re-capture and reuse of materials which can serve as feedstock in place of new raw material inputs. Finally, opportunities for recycling off-site may often be preferable to disposal of materials which could either be directly reused in a less sensitive process elsewhere, or reconstituted and reused. Waste exchanges and brokers provide opportunities to identify potential markets for materials which are wastes at one facility, but usable raw materials at another.

During the course of the P2 assessment, the assessor(s) should record all observations and interviews with company staff via field notebook, or camera.

## 3.3 Closing Meeting

Upon completion of the P2 assessment, the assessor(s) must hold an exit meeting with the company to discuss the results of the assessment, obtain additional information, identify major opportunities, brainstorm ideas, and develop additional questions. At this time the assessors should discuss the schedule for a follow-up call, reports, and the follow-up pollution prevention customer satisfaction survey.

## Section 4

### 4.0 Preparation of P2 Assessment Report

Following the P2 assessment, the assessor prepares a draft report of P2 recommendations based on observations and information gathered during the assessment. The assessor may collaborate closely with the Office of Compliance Assistance and Pollution Prevention (OCAPP) or the P2 specialist when developing the report. In addition, technical information compiled by the assessor as a follow up to the P2 assessment can be included. The P2 specialist and/or environmental supervisor may review the draft report for consistency and accuracy prior to finalization and mailing of the document under the signature of the assessor. The document is mailed within 60 days of the date the P2 assessment was conducted.

The P2 assessment report will contain one or more of the following:

- a. A cover letter that clearly states that the recommendations made within the P2 report are non-regulatory and includes a standard disclaimer;
- b. A written report containing recommendations for P2 opportunities;
- c. An outline of economic and environmental benefits of implementing recommended P2 opportunities;
- d. Relevant case studies, fact sheets, vendor information, and other supporting documentation;  
and
- e. Other information as requested by the company or deemed significant by the Assessor.

[A P2 assessment report template and a sample of a P2 assessment report is included in Attachments V and VI.](#)

# Attachments

## Example P2 Assessment Report Cover Letter

Attachment I

June 11, 1998

Joe Smith  
Company A  
100 Main Street  
Columbus, Ohio 43216

Dear Mr. Smith:

Please find enclosed a copy of the Pollution Prevention Assessment Report for Company A. The assessment report identifies potential pollution prevention opportunities. Ohio EPA's Division of Hazardous Waste Management (DHWM) is committed to providing continuing assistance to Company A regarding these and other pollution prevention opportunities. Since the recommendations made in the report are not regulatory requirements your implementation of any of the recommendations is purely voluntary.

DHWM thanks you and your staff for the time and effort in participating in the assessment program. DHWM looks forward to discussing this report with you. If you have any questions or need assistance, please feel free to contact me by e-mail at [XXX.xxxx@epa.state.oh.us](mailto:XXX.xxxx@epa.state.oh.us) or phone at (XXX) XXX-XXXX.

Sincerely,

XXXX XXXXX  
Division of Hazardous Waste Management

Enclosure

cc: Linda Neumann, CO



Attachment II

**Pollution Prevention  
Assessment Services**

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A Survey of Customer Satisfaction

This survey is to evaluate Ohio hazardous waste generator's satisfaction with Ohio EPA's Pollution Prevention Assessment Services

Return this questionnaire to:  
Ohio EPA  
Division of Hazardous Waste Management  
Lazarus Government Center  
P.O. Box 1049  
Columbus, OH 43216-1049

**Thank you for your time and cooperation**

Ohio Environmental Protection Agency (Ohio EPA), Division of Hazardous Waste Management recently started offering pollution prevention assessment services to Ohio's hazardous waste generators.

Your company was one of the first to receive Ohio EPA's new pollution prevention assessment services. We are asking all of the companies that received a pollution prevention assessment to fill out the enclosed questionnaire.

### Section 1: Ohio EPA Services

For the following sections, circle the letter(s) that best describe your experiences using the following:

- SD— Strongly Disagree
- D—Disagree
- N—Neither Disagree or Agree
- A—Agree
- SA—Strongly Agree
- NA—Not Applicable

#### Level of Agreement (circle your response)

- |   | SD | D | N | A | SA | NA |
|---|----|---|---|---|----|----|
| 1. The report was easy for me to understand.                                |    |   |   |   |    |    |
| 2. The report will be useful to me.   |    |   |   |   |    |    |
| 3. I was satisfied with how timely I received the report.                   |    |   |   |   |    |    |
| 4. Ohio EPA employee understood my company's processes.                     |    |   |   |   |    |    |
| 5. Ohio EPA employee understood my company's particular problems and needs. |    |   |   |   |    |    |
| 6. Overall, I was satisfied with Ohio EPA's services.                       |    |   |   |   |    |    |

### Section 2: Outcomes

#### Level of Agreement (circle your response)

- |   | SD | D | N | A | SA | NA |
|---|----|---|---|---|----|----|
| 7. I would recommend Ohio EPA's pollution prevention services to other companies.   |    |   |   |   |    |    |
| 8. I might carry out at least one of the recommendations in Ohio EPA's pollution prevention report.                             |    |   |   |   |    |    |
| 9. I might not carry out any of the pollution prevention recommendations in the report because I am too busy.                   |    |   |   |   |    |    |
| 10. I might not carry out any of the recommendations in Ohio EPA's pollution prevention report because we don't have the money. |    |   |   |   |    |    |
| 11. I might not carry out any of the recommendations in Ohio EPA's pollution prevention report because I don't understand them. |    |   |   |   |    |    |

### Section 3: Suggestions

Please use the space below and on the reverse side to give suggestions to help Ohio EPA improve the quality or value of its pollution prevention assessment services.

## **Pollution Prevention Assessments for Hazardous Waste Generators**

### **What will happen if Ohio EPA finds violations?**

I am looking forward to helping you identify pollution prevention opportunities at your company during a pollution prevention assessment. I am sure you have many questions about the process and what to expect. We developed this information sheet to help you understand what will happen if I find violations during the assessment. Although I am explaining what will happen if I find violations during a pollution prevention assessment, finding violations is not the real purpose of a pollution prevention assessment.

Ideally, someone from Ohio EPA recently inspected your company for compliance with the hazardous waste rules. If we identified violations, I hope your company is well on its way to compliance. During the pollution prevention assessment I might find violations or compliance issues. I will respond formally to those violations if they meet either of the following criteria:

- they pose substantial and imminent danger to human health or the environment; or
- they constitute criminal conduct.

If they are hazardous waste violations, I will also formally respond if they were previously identified by Ohio EPA through routine inspections or citizens' complaints and are chronic in nature. For hazardous waste violations, a formal response will initially be a letter. For violations of other environmental rules, like air or water pollution a formal response will be to notify the appropriate Ohio EPA representative.

If I see violations during the assessment that do not meet the above criteria, I will point those out to you as a courtesy, but I will not formally cite them in a notice of violation or notify any other Ohio EPA representative; however, I still expect you to promptly abate those violations.

Although I am explaining what will happen if I find violations during a pollution prevention assessment, finding violations is not the real purpose of a pollution prevention assessment. Therefore, please do not use your participation in or completion of pollution prevention activities as a warranty or certification that there are no violations at your facility or that your company is in compliance.

*This document was prepared by the Ohio EPA, Division of Hazardous Waste Management, October 1999.*

## 3745-50-30 Trade Secrets-Request for Confidentiality

Attachment IV

(A) Any record, report or other information obtained under the hazardous waste rules or Chapter 3734. of the Revised Code shall not be available to the public upon a showing satisfactory to Ohio EPA that all or part of such record, report or other information (other than discharge or emission data) would divulge methods or processes entitled to protection as trade secrets of such person, in which instance, Ohio EPA shall consider such record, report or other information or part thereof confidential and administer such record, report or other information pursuant to this rule.

(B) A request for confidentiality shall be submitted to Ohio EPA simultaneously with submission of the specific record, report or other information, and such request shall be accompanied by sufficient supporting documentation. Failure to make such timely request shall constitute a waiver of the right to prevent public disclosure.

(C) A decision as to the confidentiality request shall be made by Ohio EPA within 45 days of receipt of a request filed in accordance with rule 3745-49-031 of the Administrative Code. Until such decision is made, the record, report, or other information or part thereof, shall be confidential. The person requesting confidentiality shall be notified by mail of the decision.

(D) Any record, report or other information determined to be confidential may be disclosed, without such person's consent:

- (1) To officers, employees, or authorized representatives of the state or federal agency;
- (2) In any judicial proceeding; and
- (3) In any hearing conducted by Ohio EPA or the board.

(E) As used in this rule, "trade secrets" may include but are not limited to, any formula, plan, pattern, process, tool, mechanism, compound, procedure, production data or compilation of information which is not patented, which is known only to certain individuals within a commercial concern who are using it to fabricate, produce, or compound an article, trade or service having commercial value, and which gives its user an opportunity to obtain a business advantage over competitors who do not know or use it.

**Effective:** 12/30/89

**Certification:** \_\_\_\_\_

**Date:** \_\_\_\_\_

Promulgated under: RC Chapter 119  
Rule amplifies: RC Section 3734.12  
Statutory authority: RC Section 3734.12  
119.032 review dates: 8/30/00  
Prior effective dates: 4/15/81, 5/22/81 (Emer.), 8/26/81 (Emer.), 12/2/81

This rule is promulgated so that Ohio may administer a hazardous waste program as required by Section 6926 of the Resource Conservation and Recovery Act (42 U.S.C. Section 6901 et seq.) and federal regulations promulgated thereunder (40 C.F.R. Part 271).

## Introduction

(COMPANY NAME/  
ADDRESS)

Ohio EPA, Division of Hazardous Waste Management (DHWM) conducted a Pollution Prevention Assessment for (COMPANY NAME). The purpose of the assessment was to review the company's operations and identify pollution prevention opportunities.

This report contains the results of DHWM's assessment activities. Included in this report is information on:

- specific pollution prevention opportunities
- vendors
- case studies
- fact sheets and guidance materials
- resources and references

A site visit by DHWM staff members (SPECIFY) was conducted on (DATE). The (SPECIFY COMPANY) representative for the assessment was (SPECIFY STAFF).

## Company Description

**BRIEF DESCRIPTION OF COMPANY OPERATIONS INCLUDING PRODUCT AND/OR SERVICE. SIZE OF FACILITY. NUMBER OF EMPLOYEES. SIC CODES.**

## Opportunity Findings

This report is offered for educational and informational purposes only.

Further evaluation is required to determine technical, economic and regulatory impact regarding these findings.

The mention of any company names, products or services does not constitute endorsement or recommendation for use by DHWM or Ohio EPA.

Specific pollution prevention opportunities identified by DHWM during the assessment are presented below, including the following areas:

**1. LIST SPECIFIC P2 OPPORTUNITY (INCLUDE ESTIMATED ECONOMIC AND/OR ENVIRONMENTAL BENEFITS)**

- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

### 1. LIST P2 OPPORTUNITY

### Observations

**INCLUDE BASIC OBSERVATIONS REGARDING SPECIFIC PROCESS/OPERATION. INCLUDE DESCRIPTION OF EXISTING CONDITIONS.**

**Economic and  
Environmental Benefits**

**Analysis**

**OUTLINE ESTIMATED ECONOMIC AND ENVIRONMENTAL BENEFITS RELATED TO P2 OPPORTUNITY. INCLUDE SUPPORTING DATA AND ASSUMPTIONS.**

**Recommendation 1.1 -**

The following recommendations may help (**COMPANY NAME**) implement this P2 opportunity.

**LIST SPECIFIC  
RECOMMENDATION**

**IDENTIFY SPECIFIC P2 RECOMMENDATION(S) TO IMPLEMENT THE P2 OPPORTUNITY. CONSIDER MATERIAL SUBSTITUTIONS, IMPROVED OPERATING PRACTICES, PROCESS OR TECHNOLOGY CHANGES, PRODUCT REDESIGN, IN-PROCESS OR OFF-SITE RECYCLING.**

**INCLUDE POTENTIAL IMPLEMENTATION ISSUES.**

*Note: The remainder of the P2 Assessment Report would follow this format.*

**SUPPORT EACH RECOMMENDATION WITH RESOURCES SUCH AS CASE STUDIES, VENDOR INFORMATION, GUIDANCE DOCUMENTS, ASSISTANCE PROVIDERS.**

**References**  

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**SPECIFY**

**Attachments**  

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**SPECIFY**

Ohio EPA's Office of Compliance Assistance and Pollution Prevention (OCAPP) conducted a pollution prevention (P2) assessment for ABC Company (ABC). The purpose of the assessment was to review the company's operations and identify P2 opportunities.

## Introduction

**ABC Company**  
123 Main Street  
Anytown, OH

This report contains the results of OCAPP's assessment activities. Included in this report is information on:

- Specific P2 Opportunities
- Vendor Information
- Case Studies
- Fact Sheets and Guidance Materials
- Resources and References

The site visit was conducted on June 9, 1998.

## Company Description

ABC produces epoxy, UV curable, and anaerobic adhesives for various applications, including automotive and electronic components. ABC also has a production area that coats fasteners with a locking agent for automotive applications. ABC employs approximately 70 people, 25 of which are plant personnel. The Standard Industrial Classification (SIC) Code for this facility is 2891-Adhesives and Sealants.

## Opportunity Findings

- This report is offered for educations and informational purposes.
- Further evaluation is required to determine technical, economic and regulatory impact regarding these findings.
- The mention of any company names, products or service does not constitute endorsement or recommendation for use by OCAPP or Ohio EPA.

Specific P2 opportunities identified by OCAPP during the assessment are presented below, including the following areas:

### **1. Extending the life of Aqueous Cleaning Solutions**

*Extending the life of aqueous cleaners by 33 percent will result in a **potential reduction of 900 gallons of wastewater per year and save over \$5,900 in cleaning costs annually.***

### **2. Extending the Life of Cleaning Solvent**

*Extending the life of cleaning solvent by 50 percent will result in a **potential reduction of over 16,000 pounds per year of hazardous waste and save \$24,150 in cleaning costs annually.***

### **3. Reducing Epoxy Waste Generation**

*Recycling waste epoxy through a waste exchange **may help avoid disposal fees of \$335 a drum.***

### **4. Reducing Solid Waste including Wood Waste and Steel Drums**

Recycling steel drums through a reconditioner will **reduce non-hazardous wastes disposal by an estimated 15,480 pounds per year.**

**5. Financial Assistance Resources Including the State of Ohio Pollution Prevention Loan Program. *Low interest loans up to \$350,000 are available from Ohio's P2 Loan Program to help ABC finance P2 improvements including those identified in this assessment.***

## **1. Extend Life of Aqueous Cleaning Solutions**

### ***Observations***

ABC uses two aqueous (water-based) cleaning lines. A top loading parts washer is used for microencapsulated (MEC) adhesive removal from parts, tools, and equipment. This parts washer is equipped with a cartridge filter for soil and particulate removal. Tap water is used for mixing the water-based cleaning formulation.

A second cleaning line using a pass-through parts washer is used for oil removal and cleaning of parts (fasteners) prior to MEC coating. This parts washer is equipped with an oil skimmer for oil removal and a large filter for soil and particulate removal. The same water-based cleaning solution used for the top loading parts washer (used with tap water) is also used in this washer.

A waste management company (contractor) currently services both parts washing systems. Servicing includes maintaining parts washer equipment, replenishing the water-based cleaning solution, collecting and off-site disposal of spent water-based cleaning solution.

## **Economic and Environmental Benefits**

### ***Analysis***

Extending the life of the aqueous cleaning solutions will reduce costs associated with use and disposal of cleaning solutions. Based on OCAPP's analysis of ABC's current situation, the life of aqueous cleaning solutions may be able to be extended by 33 percent (or a third) or more. ABC may want to establish a higher goal resulting in increased economic and environmental benefits. To demonstrate the significance of this opportunity, the following environmental and economic benefits have been estimated:

### ***Assumptions***

- Current disposal volume of spent cleaning solution is 3,000 gallons annually (a little more than four drums a month).
- Current service cost is \$18,000 annually. Cost includes purchase of new solution, disposal of spent solution, and equipment maintenance.
- Extend the life of cleaning solution by 33 percent (or 33 percent reduction in spent cleaning solution).

### **Environmental Benefit - Waste Reduction Savings from Reducing Spent Cleaning Solution Disposal by 33 percent**

$(3,000 \text{ gallons/year})(.33 \text{ reduction}) = 990 \text{ gallons annual cleaning solution disposal reduction savings}$

### **Economic Benefit - Service Cost Savings from Extending Life of Cleaning Solution by 33 percent**

$(\$18,000/\text{year service cost})(.33 \text{ reduction}) = \$5,940 \text{ annual service cost savings}$

Several factors have not been accounted for in this analysis. For example, the analysis assumes a reduction in cleaning solution use and disposal will result in reduced service costs. ABC may need to revise the current cleaning contract with their service provider to reflect these savings.

OCAPP encourages ABC to more closely evaluate the economics of extending the life of aqueous cleaning solutions. The enclosed OCAPP fact sheet, *Financial Analysis of Pollution Prevention Projects*, provides information on how to more comprehensively consider all the costs and savings of P2 projects. DHWM is available to assist ABC in further evaluating the estimated costs and savings presented above.

The following **recommendations** will help ABC extend the life of aqueous cleaning solutions.

#### ***Recommendation 1.1 - Change cleaning solution on a "criteria-basis" rather than on a "calendar-basis."***

Companies can reduce raw material costs, waste generation, and disposal costs by changing from a calendar-basis disposal schedule (i.e. disposing cleaning solutions once every two weeks) to a criteria-basis schedule.

Criteria-basis schedules identify important parameters that can be measured which indicate when cleaning solutions need to be replaced. Parameters that can be easily measured include: cleaner concentration and/or pH, and temperature. Other parameters may include dissolved solids, and oil and grease.

Criteria-basis schedules optimize the life of cleaning solutions. Changing cleaning solutions "once a week" or "because they look dirty" will result in increased raw material costs, waste generation, and disposal costs. ABC is encouraged to work closely with their current cleaning solution service provider to ensure cleaning solutions are replaced on a "criteria-basis" rather than "calendar-basis."

Specific criteria should be determined and a testing schedule established for the cleaning solutions. Keeping a daily log will allow close monitoring of criteria for trends or changes indicating the need for replacement.

***Recommendation 1.2 -  
Consider partial bath  
replacements***

The life of cleaning solutions can be extended by partial “recharging” or “replenishing” with new cleaning solution. Instead of replacing the entire bath with new cleaning solution, consider adding only a portion to the bath.

The volume of new cleaning solution to be added will vary and should be based on an analysis of the current cleaning criteria and operating history.

Eventually the entire bath will need to be replaced due to build-up of contaminants and other undesirable conditions (bacteria growth).

***Recommendation 1.3 -  
Consider using deionized  
water instead of tap water.***

Deionized water can be used to extend the life of cleaning solutions. The higher the mineral content of the tap water used for making up the cleaning solution, the increased likelihood that stability problems will occur sooner in the cleaning solutions. The stability problems are caused from the build-up of dissolved solids from the tap water. The build-up of dissolved solids may cause changes in the cleaning solution reducing the effectiveness and life of cleaning solutions.

ABC is encouraged to work with their current cleaning solution service provider to analyze the quality of make-up water. This analysis may lead to a recommendation for use of deionized water.

***Recommendation 1.4 -  
Evaluation on-site  
equipment to extend the  
life of cleaning solutions.***

Recycling technologies can be used to significantly extend the life of aqueous cleaning solutions. These technologies include membrane filtration (including microfiltration and ultrafiltration). Vendors of membrane filtration systems provide assistance in the application and selection of recycling equipment for parts washing wastewater. Vendor assistance may include feasibility testing and equipment leasing. ABC is encouraged to contact several vendors for a comparison of features and costs.

***Resources including  
Vendor Contacts***

Enclosed are two documents that provide additional information on equipment for aqueous cleaning bath recovery:

- Extending the Life of Aqueous Cleaning Solution, Ohio EPA, Office of Pollution Prevention, 1995.
- Closed Loop Aqueous Cleaning  
The Massachusetts Toxics Use Reduction Institute, 1995.

Information provided by these resource documents include technical and economic data, case studies, and vendor (equipment) contacts.

## 2. Extend the Life of Cleaning Solvents

### Economic and Environmental Benefits

#### **Observations**

ABC applies a microencapsulated adhesive (MEC) to various fasteners. For some of the fasteners, MEC is applied only where the customer requires it. But for the remaining fasteners, the excess MEC must be removed from the end of the fastener, per customer requirements. The MEC is removed using a solvent cleaning system. The solvent is a blend of toluene and trichloroethylene (TCE). The ends of the fasteners are placed in a small tank of solvent equipped with ultrasonics. There are four solvent cleaning systems/machines. During normal production each machine will use five gallons of solvent a day, which is disposed of as a hazardous waste.

#### **Analysis**

Eliminating the use of the solvent or extending the life of the solvent will reduce costs associated with the use and disposal of the solvent. Based on OCAPP's analysis of ABC's current solvent cleaning practices, cleaning solvent life may be able to be increased by 50 percent or more. ABC may establish a higher goal resulting in increased economic and environmental benefits. To demonstrate the significance of this waste reduction opportunity, the following environmental and economic benefits have been estimated based on increased cleaning solvent life by 50 percent.

#### **Assumptions**

- Current solvent raw material cost is based on \$400/55-gallon drum (or \$7.27/gallon). Solvent usage is 3,220 gallons/year.

$$(3,220 \text{ gallons/per year})(\$7.27/\text{gallon}) = \$23,409/\text{year}$$

- Current disposal cost is based on \$425/55-gallon drum (or \$7.73/gallon). Assuming no loss of solvent, the 3,220 gallons of purchased solvent requires disposal as a hazardous waste.

$$(3,220 \text{ gallons per year})(\$7.73/\text{gallon}) = \$24,891/\text{year}$$

- Extend the life of the cleaning solvent by 50 percent.

#### **Environmental Benefit - Waste Reduction Savings from Spent Cleaning Solution Disposal by 50 percent**

$$(3,220 \text{ gallons/year})(.50 \text{ reduction}) = 1,610 \text{ gallons (or 16,201 pounds) annual hazardous waste reduction savings}$$

Depending on ABC's total hazardous waste generation, this reduction could result in lowering the company's hazardous waste generation category from a large quantity generator (LQG) to a small quantity generator (SQG). A change in generator category from LQG to SQG will significantly reduce ABC's regulatory compliance requirements and associated costs.

ABC would be **exempted** from several regulatory requirements if their category is lowered from LQG to SQG. **Exempted requirements** would include:

- Completion and submission of Annual Hazardous Waste Report.
- Preparation and maintenance of a Written Detailed Contingency Plan.
- Development of Written Waste Minimization Plan.
- Preparation and maintenance of training programs including initial and annual refresher for employees involved in hazardous waste management.

### **Economic Benefit - Raw Material and Disposal Cost Savings from Extending the Life of the Cleaning Solvent by 50 percent**

(Raw Material Costs + Disposal Costs)(.50 reduction)= Cost Savings  
(\$23,409/year + \$24,891/year)(.50) = \$24,150 annual cleaning solvent cost savings.

Several factors were not considered in this evaluation. For example, equipment operation costs or labor cost/savings were not considered. The previously mentioned OCAPP fact sheet, *Financial Analysis of Pollution Prevention Projects*, provides information on how to more comprehensively consider all the costs and savings of P2 projects. DHWM is available to assist ABC in further evaluating the estimated costs and savings presented above.

The following **recommendations** are aimed at eliminating the solvent cleaning process or extending the life of the cleaning solvent.

#### ***Recommendation 2.1 - Change the MEC application method to apply MEC only where customers require.***

For some parts, ABC applies MEC only where the customer requires it. This application method eliminates the need for cleaning. Evaluate and implementing this application method for all parts, ABC could realize significant cost, labor, and productivity savings. **Cleaning cost savings (raw materials and disposal) alone could be more than \$48,000 a year.**

Other savings could include costs associated with MEC that is currently removed, labor used to solvent clean the fasteners and environmental costs (including reducing the company's status from a LQG to a SQG). In addition, eliminating the solvent cleaning process may decrease production time, resulting in shorter turnaround times for customer orders.

***Recommendation 2.2 -  
Establish solvent quality  
requirements.***

ABC currently uses visual inspection to determine if parts are cleaned to an acceptable level. ABC is encouraged to equate their cleanliness requirements for parts to a cleaning solvent quality level. Establishing solvent quality requirements will help ensure that solvent life is maximized, and that “good” cleaning solvent will not be prematurely disposed.

Establishing an appropriate solvent quality level will also help ABC more accurately design a solvent recycling system that produces acceptable solvent quality. Often, companies want or require a higher quality solvent than needed, but is not justifiable to meet its cleanliness requirements.

When solvent no longer cleans parts in MEC production effectively, it should be considered for reuse in “gross cleaning” or “less critical cleaning” applications such as maintenance parts washers.

***Recommendation 2.3 -  
Extend the life of the  
cleaning solvent using  
simple physical separation  
and/or filtration equipment.***

Depending on the characteristics of MEC and the cleaning solvent mixture, ABC may be able use simple physical separation methods to extend cleaning solvent life. This is a low cost option with no or little capital costs. For example, gravity settling is often used to extend the life of the cleaning solvent by allowing “heavier particles” to settle to the bottom of a container over time. “Cleaner” solvent can then be removed from the top of the container by decanting and reused. Typically, settling time could range from 24-48 hours. Similarly, for particles that float, a hand screener can be used for particle removal to further extend solvent life.

Another option to extend the life of the cleaning solvent, which ABC is currently evaluating, is a solvent filtering system. ABC is currently evaluating a dual cartridge 50 micron filter (steel mesh) to extend solvent life. This system appears to be a fairly standard application that should significantly extend cleaning solvent life.

Vendors of the filtering systems and filter elements are good sources of information for this application. OCAPP recommends several units and setups be evaluated to determine the most cost effective system. In addition, spent filter elements must be closely evaluated prior to disposal to determine if they are a hazardous waste.

The following list of filter vendors is being provided to assist ABC in evaluating vendors of filtration equipment.

**Vendor Information**  
**Solvent Filtration Systems**

Rosedale Products, Inc.  
3730 W. Liberty Road  
Ann Arbor, MI 48103  
800-821-5373  
[www.rosedale-products.com](http://www.rosedale-products.com)

Engineered Filter Systems  
P.O. Box 1049  
Latham, NY 12110  
518-786-6253

Great Lakes Filters  
5151 Loraine  
Detroit, MI 48208  
800-521-8565  
[www.greatlakesfilters.com](http://www.greatlakesfilters.com)

Refilco  
North American Filtration Corporation  
200 Westshore Boulevard  
Newark, NY 14513  
315-331-7000

Towner Filtration  
P.O. Box 432  
Twinsburg, OH 44087  
800-286-9637  
<http://towner-filtration.com/>

Zep Manufacturing Company  
10126 Transportation Way  
Cincinnati, OH 45246  
513-870-0330  
<http://zepmfg.com>

Other technologies are available to recycle solvents. These include centrifugation and distillation. Initial investigation by OCAPP indicated that cost and technical issues may limit the application of these technologies for ABC's current cleaning situation. If ABC is interested in further evaluating these technologies, OCAPP is available to provide addition assistance.

**Recommendation 2.4 -  
Continue to evaluate  
changing adhesive  
formulations.**

ABC is working with several customers to identify acceptable water-based adhesives for several product lines to replace current solvent based MEC formulations. OCAPP encourages ABC to continue to pursue this P2 opportunity. Cleaning the fasteners of water-based adhesive could eliminate the need for solvent cleaning. Eliminating the need for solvent cleaning will provide several benefits as previously discussed under Recommendation 2.1.

**Recommendation 2.5 -  
Evaluate alternative  
(replacement) cleaners.**

Alternative cleaners to TCE and toluene may be available to meet ABC's cleaning needs. Replacing TCE and toluene with alternative cleaners may reduce ABC's regulatory compliance requirements and related costs. TCE and toluene are currently on several regulatory program lists including:

- Air Contaminants (Occupational and Safety Health Act)
- Hazardous Air Pollutants (Clean Air Act)
- Hazardous Constituents (RCRA Hazardous Waste)
- Hazardous Substances (Superfund)
- Maximum Contaminant Levels (Safe Drinking Water Act)
- Priority Pollutants (Clean Water Act)
- Toxic Release Inventory (TRI) Chemicals

These programs have established regulations and requirements affecting the use of TCE and toluene. In addition to reducing regulatory burden, alternative cleaners may be available to help ABC reduce cleaning costs.

OCAPP is available to provide ABC assistance in the identification and evaluation of alternative cleaners. This could include identifying potential replacements and providing vendor contacts for assistance in selecting alternative cleaners.

### **3. Reduce Epoxy Waste**

**Observations**

ABC generates non-hazardous waste from the epoxy production area. Waste epoxy can result from off-specification material, over or under production batch sizes, and products which have expired shelf-life.

**Analysis**

Actual epoxy waste generation volumes were not collected during the assessment. **Disposal costs for waste epoxy is estimated at approximately \$335 a drum.** ABC has improved inventory control practices to minimize products that exceed shelf-life. In addition, ABC is working to address off-spec material and over or under production batch sizes.

The following **recommendations** will also help ABC reduce epoxy waste.

**Recommendation 3.1 -  
Evaluate the recertification  
of expired product.**

ABC is encouraged to actively pursue the recertification of expired epoxy. ABC should make it a priority to establish agreements and requirements with customers to allow recertification of expired product.

Recertification could also be extended to off-specification material that can be reworked, or over or under sized batches that become waste.

**Recommendation 3.2 -  
Consider using waste  
exchange programs for  
the waste epoxy.**

Waste exchanges are specialized services that promote and expedite the recycling of wastes by providing a network for linking wastes with those who may recycle them.

Ohio recently established the Ohio Materials Exchange (OMEx). This new state-wide materials exchange program will help companies identify potential users for unwanted materials. Available/Wanted materials can be classified into one of twenty-five categories. OMEx publishes a bi-monthly catalog of available/wanted materials. The fact sheet, *Ohio's Material Exchange - A Statewide Reuse and Recycling Directory*, has been enclosed for more information. Information on OMEx, including the most recent material available/material wanted postings, is available on OCAPP's web site [www.epa.ohio.gov/ocapp/Recycle.aspx](http://www.epa.ohio.gov/ocapp/Recycle.aspx).

Also enclosed is contact information for other resources and organizations providing recycling or waste exchange services. Some of these companies provide active searches for locating reuse opportunities for unwanted materials and wastes. This information is also available on OCAPP's web site. [www.epa.ohio.gov/ocapp/Recycle.aspx](http://www.epa.ohio.gov/ocapp/Recycle.aspx).

**4. Reduce Solid Waste  
Wood Waste Including Used  
Pallets**

**Observation**

ABC disposes of some wood wastes as non-hazardous waste (trash). During the site visit, a significant portion of a trash dumpster examined contained wood-related waste (pallets, crates).

**Analysis**

Data to analyze environmental and economic benefits from wood waste recycling was not collected as part of the assessment. However, this data can be easily acquired or estimated.

Implementation costs for wood waste recycling are expected to be minimum.

***Recommendation 4.1 -  
Recycle wood waste.***

Recycling wood waste is an easily implemented opportunity that will reduce disposal volume and costs. ABC can also consider partnering with other companies in their industrial park to work on an agreement with a local wood waste recycler. To assist ABC with recycling wood waste, OCAPP identified the following local wood pallet and wood waste recycling operations:

Butler County

Williams Pallet Company  
9154 Port Union Road  
West Chester, OH 45069  
513-874-4014

Hamilton County

Alvis Landscape & Golf Course Materials  
9570 State Route 128  
Harrison, OH 45030  
513-353-3333

Davis & Sons  
3662 Brotherton Road  
Cincinnati, OH 45209  
513-533-4990

National Pallet Company  
10725 Evendale Drive  
Cincinnati, OH  
513-771-4800

Ohio Valley Goodwill Industries  
10600 Springfield Pike  
Cincinnati, OH 45215  
513-771-4800

Young Pallet  
809 Evans Street  
Cincinnati, OH 45204  
513-471-5765

Warren County

Spartan Supply Co., Inc.  
942 Old State Route 122  
Lebanon, OH 45036  
513-932-6954

## Steel Drum Recycling

### **Observation**

ABC currently disposes of empty steel drums as non-hazardous solid waste. A drum crusher is used to reduce disposal volume. ABC has not investigated off-site recycling opportunities (including reconditioning) for the used steel drums.

### **Analysis**

ABC estimated as many as 30 used 55-gallon steel drums are disposed monthly (360 drums annually) as non-hazardous solid waste. An empty steel drum weighs approximately 43 pounds. The **environmental benefit** of recycling the steel drums could result in an estimated **reduction in solid waste generation by 360 drums or by 15,480 pounds annually.**

Data was not collected during the assessment to estimate disposal cost savings. This could be easily estimated by determining a unit cost of non-hazardous waste disposal (i.e., \$50/ton) and multiplying by the annual weight of steel drums disposed (15,480 pounds or about 8 tons). For this example, the disposal cost savings would be:

$(\$50/\text{ton non-hazardous waste disposal cost})(8 \text{ tons per year steel drums generated}) = \$400 \text{ annual savings.}$

Some companies have also included liability costs (disposal of empty drums in a landfill) as a motivating factor to recycle or recondition used steel drums.

OCAPP contacted one steel drum reconditioner to estimate associated costs with steel drum recycling. Steel drum reconditioners will strip, paint, and resell good-quality, heavy-gauge empty steel drums. Typically for large numbers of steel drums (more than 100), a reconditioner may spot a trailer at the company for drums at no cost and pick-up the trailer at no cost. For a smaller number of drums, the company must arrange for transportation to the reconditioner. In either case, recyclable steel drums are accepted at no charge to the company.

### **Recommendation 4.2 - Recycle steel drums.**

Recycling the steel drums is a low cost opportunity to reduce disposal volume and costs. ABC can also consider partnering with other companies in their industrial part to work on an agreement with a local steel drum recycler or reconditioner.

To facilitate using a steel drum reconditioner, ABC should ask chemical suppliers to ship materials in reconditionable, heavy-gauge steel drums.

To assist ABC with recycling steel drums through a reconditioner, OCAPP identified the following local used steel drum reconditioners.

## Vendor Information

### ***Steel Drum Reconditioners***

#### Hamilton County

The Queen City Barrel Company  
1937 South Street  
Cincinnati, OH 45204  
513-921-8811

#### Montgomery County

Dayton Industrial Drum, Inc.  
1880 Radio Road  
Dayton, OH 45431-1099  
800-253-1997  
513-253-8933

ABC may also be able to recycle used steel drums through a local scrap metal recycler, providing no hazardous residues remain in the container.

Other recommendations to reduce steel drum waste would include working with chemical suppliers to allow empty containers to be returned for reuse.

For more information on steel drum recycling, see the enclosed fact sheet, *Waste Reduction and Recycling Tips for Empty Containers*, prepared by the Minnesota Technical Assistance Program (MnTAP).

## **Financial Assistance Resources Including the State of Ohio Pollution Prevention Program**

Several resources are available to help ABC with financing the purchase and installation of P2 equipment. The State of Ohio has developed the Pollution Prevention Loan Program. This program provides low interest loans (at 2/3 prime rate) for the construction and/or purchase of equipment to complete P2 activities at small to medium sized (less than 500 employees) facilities. Loan amounts range from \$25,000 to \$350,000 per facility and up to 75 percent of the project cost. The Pollution Prevention Loan Program is coordinated by the Ohio Department of Development and Ohio EPA.

Eligible projects must demonstrate one or more of the following: minimization, reduction or elimination in the generation of pollution or wastes; increased energy efficiency and/or water conservation; and/or improved process economics. Projects involving the opportunities identified in this report, including purchasing equipment to extend the life of aqueous cleaners and cleaning solvents, would be eligible for the loan program.

Enclosed is more information on the loan program. For additional assistance contact:

Bill Narotski  
Ohio EPA/Office of Pollution Prevention  
P.O. Box 1049  
Columbus, Ohio 43216-1049  
614-728-1264  
bill.narotski@epa.state.oh.us

## **Additional Resources for Financial Assistance**

A listing of additional resources for project financing is also enclosed with this report. ABC can evaluate these financial resources to help support the implementation of P2 projects. These resources include loans, grants, and tax incentives for P2 equipment. Included with each listing is a brief description of the resource and contact information for additional assistance.

This information is also available electronically from OCAPP's web site ([www.epa.ohio.gov/ocapp/funding.aspx](http://www.epa.ohio.gov/ocapp/funding.aspx))

## **References**

Financial Analysis of Pollution Prevention Projects. Ohio EPA, Office of Pollution Prevention. 1995.

## **Attachments**

Extending the Life of Aqueous Cleaning Solutions. Ohio EPA, Office of Pollution Prevention. 1995.

## **None cited**

Closed Loop Aqueous Cleaning.  
The Massachusetts Toxics Use Reduction Institute.

Ohio Materials Exchange (OMEx). Association of Ohio Recyclers. 1997

Ohio Contacts for Industrial Waste Recycling. Ohio EPA, Office of Pollution Prevention. 1998

Waste Exchanges. Ohio EPA, Office of Pollution Prevention. 1998

Waste Reduction and Recycling Tips for Empty Containers. Minnesota Technical Assistance Program (MnTAP), University of Minnesota. 1997

Pollution Prevention Loan Program Instruction Packet. Ohio EPA, Office of Pollution Prevention. 1997

State of Ohio Project Financing Resources. Ohio EPA, Office of Pollution Prevention. 1997