Guidelines

004
April 2012

Reduce Aerosol Can Use and Waste

Background/Rationale:

Many businesses and organizations have facility or automobile maintenance departments that make extensive use of products typically packaged in aerosol cans, such as paints or a variety of cleaning products. Any business seeking to make operations more sustainable should consider using refillable spray bottles or cans to reduce or eliminate the use of aerosol cans. Using these devices will likely result in reduced costs, as products purchased in bulk and applied with the spray bottles are roughly half the cost of those in aerosol cans. In addition, the empty cans may be considered hazardous waste depending on their contents and whether or not they have been emptied and punctured, thus disposal costs are incurred and some reporting may be required. Even as non-hazardous solid or universal waste, empty cans increase waste disposal volume and costs and labor costs associated with properly processing the empty cans. Because the propellants commonly used in aerosol cans (e.g., CO_2, propane, and butane) are greenhouse gases (GHGs), reducing their use will, in turn, help reduce greenhouse gas (GHG) emissions and any adverse environmental impact associated with excess emissions.

The material contained in these guidelines is intended for use by persons who have a basic level of technical training/competence and familiarity with source reduction concepts and strategies.

Step 1: Assess the Current Situation/Define the Scope of the Situation

1.a. Collect and analyze information about current operations, including but not limited to:

- identify key sources of information (see Appendix 1, Example 1)
  - the environmental cause champion
  - maintenance, facility, and/or shop supervisor(s)
  - purchasing or accounts payable personnel
  - key suppliers/vendors
- collect pertinent documents and information (see Appendix 1, all examples)
  - policies/procedures related to use of aerosol cans:
    - formal/informal guidelines/expectations regarding use/disposal
  - purchasing and disposal invoices to determine annual number, volume of contents and cost of aerosol cans used by type/size of can
- keep track of, document and distinguish between key assumptions, known or reported data, and information which is calculated (see Appendix 1, all examples)
- conduct use and cost analyses by observing, interviewing staff, reviewing existing information and developing supplemental data (see Appendix 1, Example 1)
  - identify specific aerosol application(s) or purpose for product use (e.g., air brake cleaner)
  - determine annual number of cans used by type/size

- determine annual volume of product(s) used (e.g., paint, brake cleaner, etc.) and unit cost
- identify waste category for empty used cans (solid, hazardous, universal) and any related costs associated with disposal (e.g., labor/time, fees, reporting, etc.) (see Appendix 1, Example 2)
- determine annual volume of waste generated (e.g., drums, number of cans, weight of cans, etc.)

- conduct life cycle assessment using reference material cited below to determine global warming potential impact of greenhouse gas emissions associated with product use, waste reduction and/or costs saved (see Appendix 3)

1.b. Conduct necessary research and calculations using the following references:

The following references are use to help identify full costs of using aerosol cans and the costs/benefits of switching to refillable spray bottles:

- Aerosol Can Waste, Nebraska Department of Environmental Quality Environmental Guidance Document, 05-181, December 2005, available online at: http://www.deq.state.ne.us/ (type the document number into the search for PDF)
- *Refillable Spray Bottles*, US EPA Department of Toxic Substances Control, Best Environment Practices for Auto Repair and Fleet Maintenance, November 2001, available online at: http://www.epa.gov/region09/waste/p2/autofleet/spray.pdf

The following reference(s) are used to calculate life cycle impact on greenhouse gas emissions for the wastes to be reduced as well as for the net impact of implementing alternative practices:

- *Economic Input-Output Life Cycle Assessment (EIO-LCA)*, US 2002 Industry Benchmark model, Green Design Institute, Carnegie Mellon University, 2012, available online at: http://www.eiolca.net
- *Waste Reduction Model (WARM),* U.S. Environmental Protection Agency (EPA), available online at: http://epa.gov/climatechange/wycd/waste/calculators/Warm_home.html

Step 2: Identify Feasible P2 Opportunities

2.1. In General:

- analyze the purposes for the use of the products and the characteristics needed that result in the choice of aerosol cans being used
- research types of refillable containers (spray bottles/can) and include relevant vendor information (the vendor information included in these guidelines is for example only)
- keep track of, document and distinguish between key assumptions, known or reported data, and information which is calculated
- include a thorough cost analysis, comparing suggested modifications with current practices, and use a chart to compare current to proposed costs
    - be specific on the "unit" for application, i.e. which uses or applications to modify
    - calculate amount/cost of annual product used and determine feasibility of using bulk product vs. aerosol can product
    - calculate capital costs for switching to refillable spray containers: supplies and labor
    - calculate possible maintenance costs for refillable spray containers
    - calculate pay back periods for return on investment
- watch for hidden costs: expected life of spray bottles/nozzles, training of employees in new product delivery system and waste management, other installation considerations
- identify how to monitor/measure impact, e.g. monitor savings, follow up survey to determine user satisfaction

2.2. Selected strategies to consider, including techniques and calculations to perform:

- improve management of existing aerosol cans (see Appendix 2, Example 1)
    - explain the benefits of reducing hazardous waste and related regulatory burden
    - provide cost comparison of current practice to suggested alternative
    - suggest a vendor and provide background information on vendor
    - emphasize cost savings and reduction in hazardous waste
- replace aerosol cans with refillable spray containers and bulk product (see Appendix 2, Example 2)
    - provide a range of options to encourage change in current practices
    - emphasize cost savings, ease of implementation and adaptability of devices
    - provide detailed calculations and summarize costs/savings in table
    - suggest a vendor and provide background information on vendor
    - calculate payback period
- calculate life cycle impact on greenhouse gas emissions compared to current processes (see Appendix 3 for examples)

Step 3: Identify Barriers to and Benefits of Implementation for Each Opportunity

After analyzing the extent of use of aerosol cans and how they are managed onsite, and identifying feasible opportunities for realizing savings, you will want to make as strong a business case as possible for making changes to include the use of refillable containers and/or making improvements in managing existing can waste.

Based on experiences over the past 15 years, the P3 program has found that simple projects with thorough documentation and short pay back periods or projects with compelling cost and environmental savings or suggestions for the use of newer and improved technology have a greater likelihood of being implemented. For example, suggestions for using the latest model of easy to use spray bottles in lieu of aerosol cans is now more likely to be implemented than in the past, with cumbersome equipment required. Using spray bottles for some applications is typically easily and quickly accomplished and can be expanded to additional areas as savings are proven and employees adjust to the change.

On the other hand, suggestions for which a cost/benefit analysis has not been fully documented or potential vendors have not been identified are unlikely to be implemented. Interestingly, even though the savings may be well documented, this opportunity involves changing employee behavior and perception of efficiency and effectiveness, therefore may not be implemented due to the employee concerns. Employers are typically sensitive to employees' perceptions.

Specific to reducing or eliminating the use of aerosol cans, benefits are decreased solid or hazardous waste, decreased maintenance time/costs related to processing used cans and reporting hazardous waste, and increased employee awareness of environmental stewardship. Perceived barriers include capital costs, implementation logistics, and employee concerns regarding efficiency/effectiveness of alternative containers/products. See Appendix 2 for examples of implemented P2 suggestions from the Nebraska intern program. These are annotated to make it clear what information is needed to perform these calculations for a different facility and to explain why some suggestions were implemented and others were not.

Common Barriers:

Beliefs & Attitudes

- resistance to change—employees set in ways and enjoy convenience of having aerosol cans conveniently available for tasks as needed
- other/higher strategic priorities—the company may have other issues is sees as more important to address in the short run
- misinformation or lack of understanding about how use of products using aerosol propellants affect the environment

Costs and Investments

- cost of purchasing refillable containers
  - if spray bottles/cans are likely to be damaged due to dropping or use in tight spaces, the expected life of the reusable container is low and the economics are poor

- time/costs for re-training employees in proper use of refillable containers

Technical Issues: What to Do and How

- amount of different/conflicting vendor information about refillable containers can overwhelm
- concern re: managing logistics and employee responses to process changes
- concern re: quality of product/effectiveness of new application method

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Common Direct and Indirect Benefits:

Company Image

- employees may appreciate a healthier/safer working environment
- demonstrates social responsibility and best management practices; improves/develops a positive public image, sets an example/sets pace for the industry

Cost Savings

- reduces costs and improves efficiency:
  - raw materials
  - waste management and disposal of cans
  - time and labor involved in disposing of cans
- reduces regulatory burden and time/money spent on compliance paperwork
- increases revenue from recycling if option to simply puncture cans is chosen

Education

- educates employees and general public in efficiency and responsibility when information is posted about the change and why it was made

Environmental Impact

- reduces impact on the environment:
  - reduces amount of harmful wastes generated/expelled
  - conserves/preserves/provides clean environment/quality of life for future generations

Step 4: Make the Business Case for Change

4.1. Develop a written report for submission to decision makers.

- include a thorough waste assessment with process descriptions, flow charts and material balance representations.
- outline specific P2 Opportunities/Suggestions with the following information:
  - recommended action
  - brief summary of current operations
  - cost of implementing recommendation: don't forget to consider labor costs and savings in your economic analyses.
  - summary of benefits:
    - potential cost savings ($)
    - waste reduction(s)
    - simple payback
    - indirect benefits: safety, risk/liability reduction, GHG reductions, etc.
- always identify how to monitor/measure impact for future analysis
- incentives to change: conclude the report with a summary of the benefits to be realized from implementing the recommendations made. Stress environmental stewardship. Call for action!
  - see Appendix 2 for examples of similar projects which have been implemented.
  - you may want to reference previous successes in similar businesses as a selling point.

4.2. Make an oral presentation to summarize your findings and call to action:

- focus on pertinent details of waste assessment and P2 opportunities
- make it interesting yet include sufficient technical detail to be convincing and make the business case for change—include a picture of the product/change in action
- develop a final "impact" slide with table of metrics—call for action/change
- allow time for question/answer period

4.3. Advocate for change based on metrics/facts and environmental ethic:

- use informal interactions to establish trust in your abilities and to build a foundation for change
- use written report and formal presentation to communicate your findings and provide the formal information/rationale for implementing recommendations
- emphasize sustainability (triple bottom line) and preserving resources for future generations—energy conservation and the relationship to greenhouse gas emissions is particularly important for compressed air system operations

4.4. Report potential Greenhouse Gas (GHG) emission reductions as an important indirect benefit:

- include in written report and oral presentation
- include explanation of why GHG emissions are relevant/of concern to all businesses
- calculate potential carbon dioxide equivalent (CO_2e) emission reductions for each recommendation
- include an appendix in written report documenting calculations
  - see Appendix 3 for details and an example of calculations for aerosol can options

See Appendix 4 for additional tips for making the business case for change.

Appendix 1
Example Waste Assessments for Aerosol Cans

Note: *Several examples of waste assessments related to aerosol can use and waste are included below. Each of these addresses one or more of the steps needed to accomplish a thorough assessment. In these examples, we have attempted to clarify for the reader what information is known or reported, what is logically assumed, and what has been calculated. This is embodied within the example narrative for easy reference. In an actual report, many of these details would likely be in attached appendices so as not to interrupt the flow of the report.*

Example #1: Assessment of Aerosol Can Use and Cost: Based on Purchasing Data

(adapted from report by Amanda Schlender, 2009)

As part of the assessment for hazardous waste reduction, the P3 intern worked with the Health, Safety, & Environmental (HS&E) leader at the plant to analyze aerosol can usage to determine if there was potential for source reduction or recycling.

Aerosol cans are used primarily in the packing and maintenance areas. Most of the cans used in the packing area are for a heavy-duty silicone lubricant used on the packaging line conveyors to prevent product bags from sticking to them. The maintenance area uses over 20 different types of lubricants. Review of the purchasing record identified the specific types and quantities of products the plant purchased in aerosol cans. The plant also generates some spray paint aerosols (less than 5 per year) used for touch-up work and small projects. Spent or broken aerosols are collected in 55 gallon drums, located in the packing area, the maintenance area, and one other location in the plant, and then placed in a RCRA-approved hazardous waste storage trailer to be picked up as-needed by Safety-Kleen. Three full drums are collected each year. A diagram of the aerosol can use is shown in Figure 1 below.

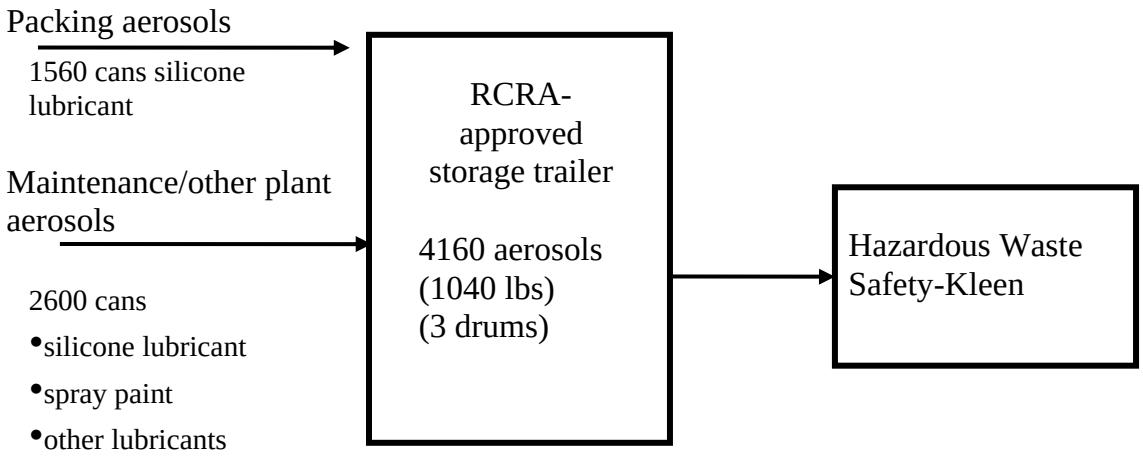


Figure 1. Aerosol Can Use

Each year, the plant disposes of the 3 drums of hazardous waste containing 4160 aerosol cans (1040 lbs). In addition the facility purchasing indicates roughly 163 gallons of the heavy duty

silicone lubricant is used each week in the packing area, costing **over $12,000** for that product alone each year. If it is assumed that the same unit cost is applied to all products used in aerosol cans, the plant spends **$32,115/year on aerosols**. Detailed calculations are shown below. (Note to reader: For a comprehensive assessment the quantity used and cost of each individual product should be determined.)

Calculations for Heavy Duty Silicone Use in Packing Area

Known Values
12 cans per case
$7.72 per can
2.5 cases/30 cans per week=1560 cans used per year
368 g product per can
0.93 g/mL density (from the MSDS)
390 lbs for 1 drum of Hazardous Waste containing Heavy Duty Silicone aerosol cans (per Safety Kleen invoices)

Calculations
Weight of a single empty can:
12 cans per case X 2.5 cases/wk X 52 wks = 1560 cans/yr
390 lbs/1560 cans = 0.25 lb per empty can

Product Volume:
368 g per can X 1560 cans/.93 g mL density = 617.20 L per year X .26417 = 163 gal per year

Product Cost:
1560 cans/year X $7.72/can = $12,043/year

Extrapolating to all aerosol can product use:
4160 cans/year X $7.72/can = $32,115/year

Example #2: Assessment of Aerosol Can Waste and Cost: Based on Collection Drum Logs
(adapted from report by Ann Francis, 2006)

The company maintains hundreds of pieces of electrical equipment and a large vehicle fleet. The focus of this assessment is use of aerosol products at one location and the waste these cans generate. The products used most frequently are paints, lubricants, and solvents. Aerosol cans are convenient and easy to use but they cause a significant disposal problem for any company that generates them. Aerosol cans are usually classified as hazardous waste, either because of the products they once contained (*listed* hazardous waste) or more likely because of the reactivity of the compressed air and propellant inside the can (*characteristic* hazardous waste). The ultimate goal of this project is to ensure that the company manages all aerosol cans in an environmentally, economically, and regulatory friendly manner.

Currently the facility being assessed is a Conditionally Exempt Small Quantity Generator (CESQG), i.e., it generates 220 pounds or less hazardous waste per month and no more than 43 pounds per day. CESQGs are exempt from most management requirements and it is greatly advantageous to stay that way. Some areas where it is especially beneficial for a company to be conditionally exempt include: bookkeeping, audits, satellite collection time, and emergency prevention and response. Because it is conditionally exempt, the facility is permitted to dispose of their hazardous waste in a municipal solid waste (MSW) landfill, as opposed to paying the high cost of hazardous waste disposal. This is an easy method of disposal; however, the aerosol cans consume a significant portion of the facility's allotted hazardous waste totals per month. This is not the best pollution prevention choice and does expose the company to the liability of exceeding the monthly hazardous waste limit and incurring more onerous reporting requirements.

It is estimated that two 55 gallon collection drums are filled per month with aerosol cans. Based on observation, each drum can hold an average of 100 cans (based on hand counting of two drums), and each can weighs an average of 0.25 lb. **Annually, the facility is assumed to generate as many as 2,400 aerosol cans, weighing 600 lbs and filling 24 of the 55 gallon drums**. Disposing of the cans could cost the company $200 per 55 gallon drum or as much as $4,800 each year.

Calculations for Aerosol Can Waste

Known Values

2 drums/month aerosol can waste collected
100 waste aerosol cans/drum
0.25 lbs per empty can
$200/drum waste disposal costs including transportation

Calculations

Waste Quantity and Weight:
2 drums/month X 12 months/year = 24 drums/year
100 cans/drum X 24 drums/year = 2,400 cans/yr X 0.25/lbs per can=600 lbs

Waste Disposal Cost:
$200/drum X 24 drums/year = $4,800/year

Appendix 2
Examples of P2 Opportunities for Aerosol Cans

Note: *Several examples opportunities for reducing aerosol can use and waste are included below. Each of these addresses a different way to improve practices and achieve direct and/or indirect savings and each uses different techniques for encouraging implementation. In these examples, calculations are embodied within the narrative for easy reference, although in an actual report, these would likely be in appendices at the end so as not to interrupt the flow of the report.*

Example #1: Improve management of aerosol cans: puncturing and use of bulk product
(adapted from report by Ann Francis, 2006)

Example 1.a: Puncture aerosol cans prior to disposal: Empty aerosol cans can be considered a hazardous waste due to the remaining compressed air and propellant's property of reactivity. A relatively easy way to avoid this is by puncturing the empty aerosol cans using a commercially available can puncturing device that releases pressure, collects hazardous residue and is safe for employees to use.

An Aerosol Can Puncturing System attaches to the two inch bunghole on a drum. The used aerosol can is placed in the device and a lever triggers a pin that punctures the dome of the can. The propellant is then released along with any leftover product. The product drains into the drum and a carbon filter attached to the small bunghole filters hazardous vapors from the contents of the cans.

Automatic Puncturing Systems that require little manual effort are available, but they are more expensive and require electricity. A manual system is easy to operate; an entire 55-gallon drum full of cans can be punctured in under an hour. Diagrams of a typical aerosol can puncturers and example vendor information are included below.

The company would still pay for the disposal of the waste accumulated in the drum (at $100/drum), rather than disposing of the entire waste aerosol can as hazardous waste at a cost of $200/drum or $4,800/year. According to waste disposal experts, it takes the residue from approximately 4,000 cans to fill a 55 gallon drum. The drum can then be disposed of in compliance with RCRA regulation for $100.00. If all aerosol cans were punctured **approximately 700 lb of hazardous waste annually would be eliminated and $4550/year saved**. Table 1 below shows the cost comparison of disposing of un-punctured and punctured aerosol cans.

Table 1. Cost Comparison of Puncturing and not Puncturing Cans

Disposal Method	# cans used/yr	# drums used/yr	Disposal cost/drum	Lbs/yr Haz Waste Generated	Disposal Cost/yr Haz Waste	Initial Cost Can Puncturer	Total Cost
Not Punctured	2400	24	$200/drum	960 lb/yr	$4800/yr	$0	$5000/yr
Punctured	2400	0.5	$100/drum	200 lb/yr	$50/yr	$400	$450/yr

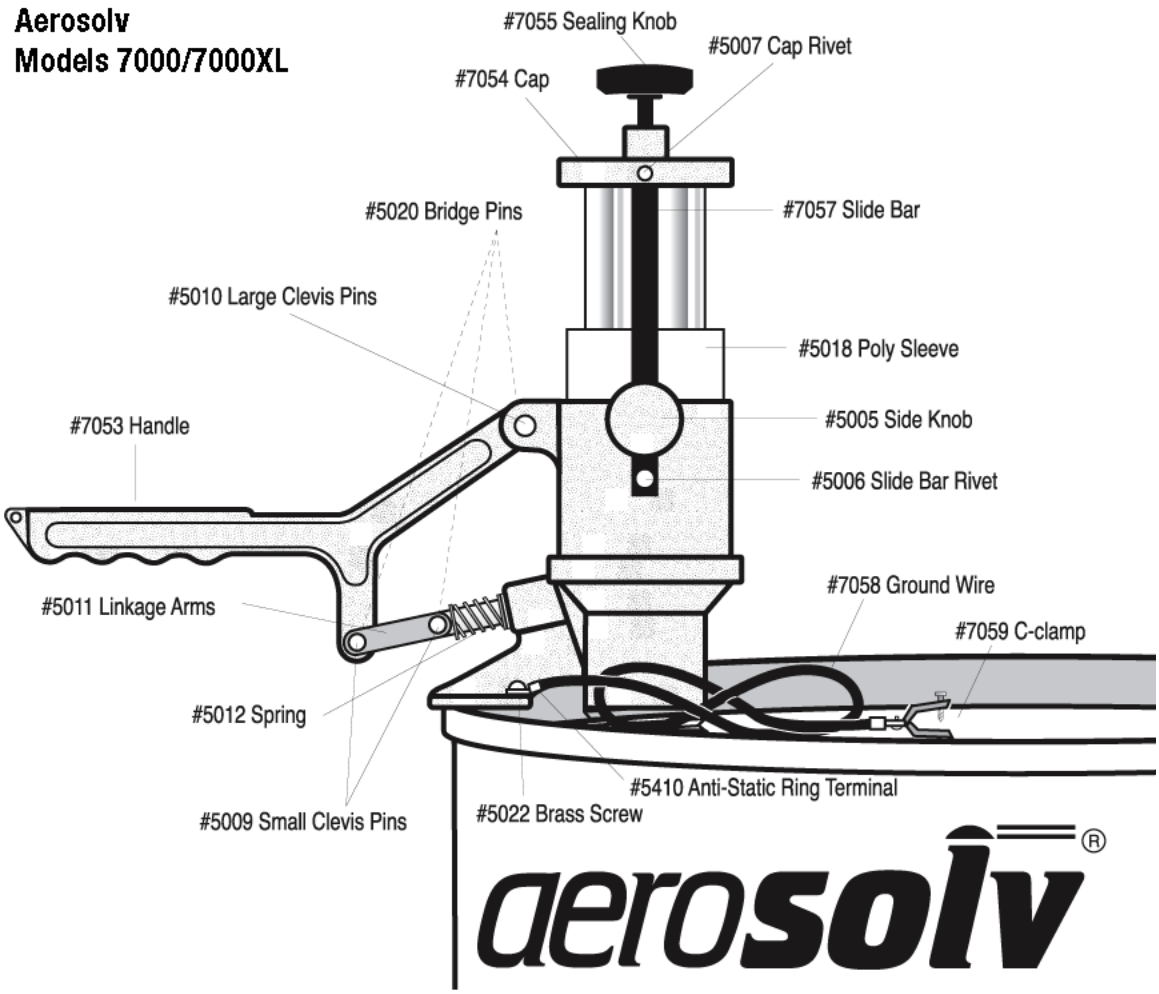
The payback period for disposing of punctured instead of un-punctured cans is one month, using the following formula:

Payback period (in years) = I/(C-N)

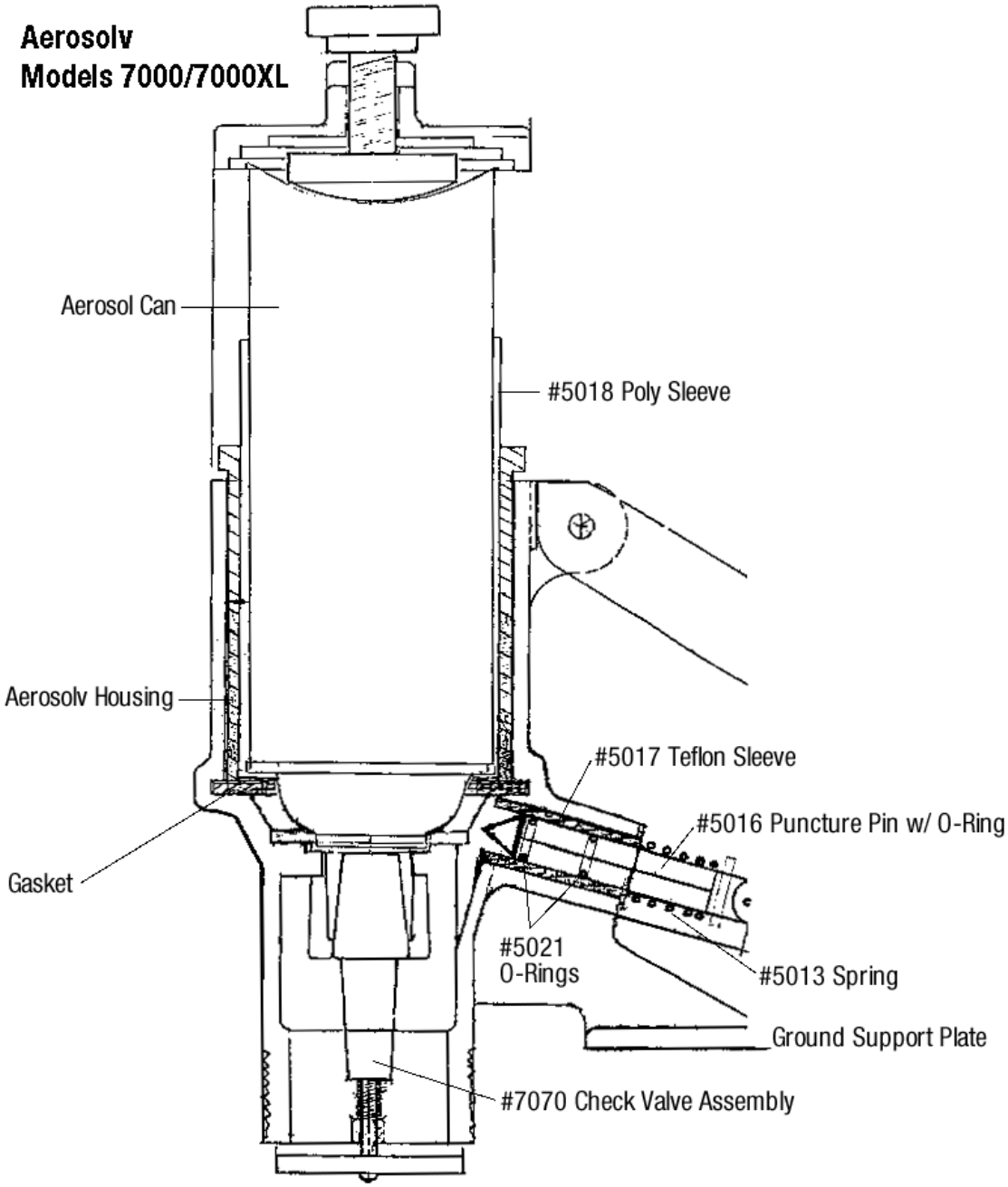
I = initial investment, start up costs (in dollars)
C = annual cost of current practice (in dollars/year)
N = annual cost of new practice (in dollars/year)

$400/ ($4800/year-$50/year) = 0.084 years =1.01 months

Aerosol Can Puncturer Schematic I



Aerosol Can Puncturer Schematic II



Example Aerosol Can Puncturer

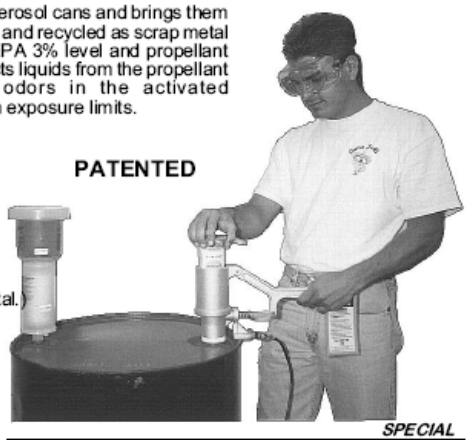
Vendor

SPRAY CAN RECYCLING SYSTEM

PUNCTURES - RECLAIMS - ALLOWS YOU TO RECYCLE AEROSOL CANS AND CONTENTS SAFELY

MADE IN THE U.S.A.

PPE AEROSOLV® Aerosol can recycling system safely punctures aerosol cans and brings them equal to atmospheric pressure. This allows your cans to be collected and recycled as scrap metal rather than as regulated hazardous waste. Residuals are below EPA 3% level and propellant gases are filtered. The specially designed filter coalesces and collects liquids from the propellant gases while reducing VOC emissions and eliminating odors in the activated carbon chamber. Emissions are 75% lower than OSHA short term exposure limits.



PATENTED

- SPECIFICATIONS & FEATURES -

- Used and approved by many state and federal agencies.
- Punctures aerosol cans safely.
- Accepts cans up to jumbo 24 oz.
- Can be used with any standard 20-30 or 55 Gal. drum
- Aerosol can is a non-regulated container after its punctured. (OSWER Directive 9432.01 (80) and may be recycled as scrap metal.)
- Reduces hazardous waste.
- No permits required.
- Approx. 4200 cans can be punctured per 55 gal. drum.
- Pays for itself after puncturing 100 cans.
- Collects residual contents directly into drum.
- Liquid in drum can be reused or sent to a waste handler.
- Puncturing unit threads directly into 2" drum bung.
- Filter threads directly on 3/4" drum bung.
- Filter processes 1200 spent aerosols.
- Portable, weighs 5 pounds.
- No power source required, hand operated.
- Made of aircraft aluminum, no maintenance.
- All moving parts are 308 Stainless Steel.
- Puncture pin is carbide tipped and o-ring sealed to prevent leakage. Grease packing lubricates puncture pin chamber with each use.
- Carbide tipped puncture pin will withstand repeated, long term use, showing no visible wear after puncturing 10,000 aerosol cans.
- By bringing the propellant to atmospheric pressure, AEROSOLV® achieves compliance with:
  40 CFR 261.7(b)(1)
  40 CFR 261.7(b)(1)(B)(2)
  40 CFR 261.23(a)(6)

SPECIAL

PART NO.	DESCRIPTION	PRICE
5000	Aerosolv Recycling System Includes: puncturing unit, 2 stage filter, ground wire & goggles	*$298.00* ~~$345.00~~
6163	Spare Combination Filter Includes: Coalescing Filter and Carbon Cartridge	99.00
6363	Carbon Cartridge (pkg of 2)	115.00
6100	Coalescing Filter only	45.00
6325	Drum Vent Adaptor	3.00
5353	6 ft. Anti-Static Ground Wire with connectors	35.00
5111	Viton Gasket	8.00
5112	Viton + Gylon Gaskets, 1 each (Gylon for harsh chemicals)	14.00
5165	Maintenance Kit Kit includes: 1 carbide tipped puncture pin with o-rings, 1 viton gasket, 1 spring, 3 bridge pins, and 1 tube of grease	74.00
VHS5000	Informational VHS Tape	3.00

-SAFETY FEATURES -

- Allows puncturing of aerosol cans without worker contact. The aerosol can is secured in the AEROSOLV housing. With a press of the handle, the puncture pin moves through a fluid-tight chamber and pierces the can sideways, locking the can in place in its holder.
- AEROSOLV leaves no sharp edges or crushed metal. The only effect on the can is a small, smooth-edged hole.
- Residual contents are safely collected in a drum.
- AEROSOLV Combination Filter coalesces VOC's for collection in filter reservoir.
- Anti-Static Wire enhances operational safety; required under several Federal and Local codes.
- AEROSOLV is designed to prohibit unsafe usage; will not accept propane bottles or aerosol cans inserted "right side up."

Patented: U.S.A. Patent Pending: Canada, Japan, Taiwan, U.K. & Europe

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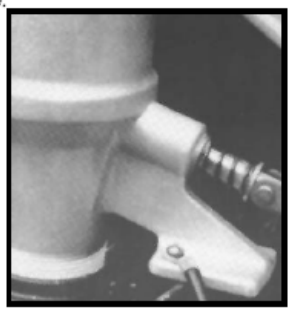
SPRAY CAN RECYCLING SYSTEM

AEROSOLV® UNIT INSTALLATION

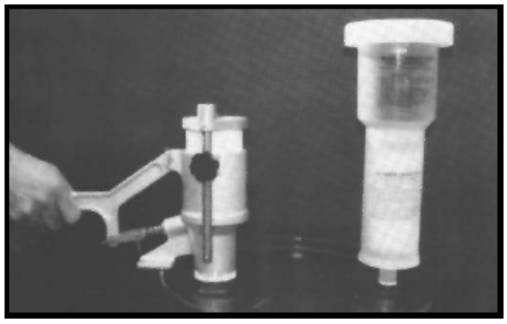
Prior to operating AEROSOLV unit, install Combination Filter and Anti-Static Wire.



- Thread AEROSOLV into 2" bung, Rotate clockwise until ground support plate firmly engages drum rim.

See lower right side of photo

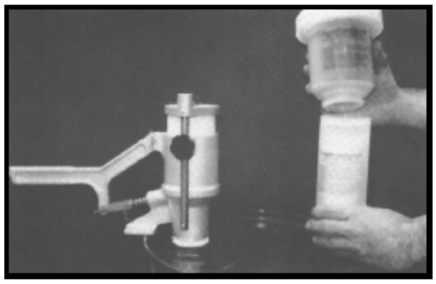
- Insert aerosol can, NOZZLE END DOWN, into AEROSOLV housing sleeve so that shoulder of can rests on the gasket. Gasket prevents residual contents from leaking back around can being punctured. *Be sure to remove cap from aerosol can prior to insertion.*
- Lower sliding top plate and firmly engage it against bottom of can. TIGHTEN lock knob.



- Push handle down firmly and release. Wait 20 seconds before removing punctured aerosol can to allow residual liquids to drain into drum. **When puncturing full and half-full cans, best results are obtained by "pumping" the handle several times when puncturing, to moderate evacuation pressure.**
- After removing punctured can, lower sliding top to seal collection drum or leave the last punctured can locked in place.

AEROSOLV® FILTER INSTALLATION

- The unique AEROSOLV Combination Filter comprises a coalescing lower portion, which removes airborne organic compounds, and an Activated Carbon upper portion, which absorbs odor. The coalescing portion combines submicrometer aerosol particulate into droplets which are gravitationally drained into the filter reservoir.
- Rain Hood on filter provides protection from elements for outdoor use.
- Thread directly into 3/4" bung of drum.
- Replace Activated Carbon Cartridge every 45-60 days. Remove spent Activated Carbon Cartridge by turning counter- clockwise while holding in place the Coalescing Cartridge.



- Replace Coalescing Cartridge every 6 months. To replace, simply order a Combination Filter, which includes the Coalescing Cartridge and the Activated Carbon Cartridge.

★OPTIONAL USE ACTIVATED CARBON DRUM VENT

The Activated Carbon Cartridge can be converted for usage as a Drum Vent on a storage drum, eliminating pressure build-up, adsorbing VOC's and facilitating free-pour into and from drum.

- Install Drum Vent Adaptor onto bottom of Activated Carbon Cartridge by turning clockwise.
- Mount Drum Vent onto 3/4" bung of a storage drum.

Note: Drum Vent is not for use during puncturing with AEROSOLV. Drum Vent is for use on storage drums only.

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Example 1.b: Eliminate the use of aerosol cans wherever possible and replace with bulk product

Another pollution prevention recommendation is to eliminate aerosol can use totally eliminating the potential for hazardous waste. The best way to do this is to replace commonly used aerosol products with bulk products. The bulk product can be applied with one of two basic types of refillable spray bottles; a plastic bottle that applies product with a hand pump (cost: about $5.00) or a metal bottle that uses compressed air to apply product. The metal bottle more closely resembles an aerosol can, but is usually more expensive. Depending on the vendor, metal spray bottles can cost anywhere from $10-$60 but may be preferred by mechanics over plastic hand pump bottles. See examples of refillable containers below.

The best candidate for product replacement is brake cleaner. Based on a review of purchasing records, the company purchases an average of 800 13-oz. cans of brake cleaner (81.25 gallons) each year at a unit cost of $15.00/gallon. The total annual cost for brake cleaner is currently $1,217. Bulk brake cleaner is available for $6.00/gallon (staff from ArroChem Incorporated quoted a price of $329 for a 55-gallon drum of brake cleaner). Table 2 below shows a cost comparison of the current brake cleaning method with aerosol cans to the alternate method of refillable spray bottles.

Table 2. Cost Analysis of Brake Cleaner Methods

Method	# gal used/yr	Cost per gallon	Annual cost product	Cost of refillable spray bottles	Refilling or replacing time	Annual cost of disposal	TOTAL COST
Aerosol cans, un-punctured disposal	81.25	$15	$1219	$0	3 minutes	$1600	$2819
Refillable spray bottle, bulk product	81.25	$ 6	$486	$55 (4 bottles)	3 minutes	$0	$ 541

Total saving possible by replacing aerosol cans with a refillable spray bottle is $2,278. Total annual hazardous waste reduction is 200 pounds (assuming .025/lb per can for 800 cans/year).

Examples of Refillable Container & Bulk Product Vendors

Refillable Can Sprayer

Milwaukee Manufacturing Company Inc.
Web Site: www.sureshotsprayer.com
Phone: 800-558-7035
Email: sureshot@sureshotsprayer.com

- 2-3 16oz Atomizer Sprayer (Model B)
  - Anywhere from $25 to $35 online (each)
- Hypodermic nozzle extender 3"/Repair Kit
  - Needle $1, Kit $10 online

Refillable Spray Bottles

Mc-Master Carr
Web Site: http://www.mcmaster.com/#spray-bottles/=22br9
Phone: 732-329-3200
Email: atlsales@mcmaster.com

- 4 24oz Plastic Bottle Sprayers ($7.99) #4372T28
- 4 Replacement Heads ($6.31) #4372T39

Bulk Product

Zep Manufacturing Company
Web Site: http://www.zepmfg.com/products/products.aspx
Phone: 877-428-9937

- Zep I.D. CLEAN – liquid
  - Heavy Duty degreaser and parts cleaning solvent
  - Zep I.D. Clean liquid is a heavy duty degreaser and parts cleaning solvent. It is slow-evaporating, thereby extending contact time. I.D. Clean liquid is also VOC-compliant in all air districts. Zep I.D. Clean is a member of the Zep GreenLink line of Environmentally Preferred Products (EPP).
  - 20 Gallon Drum ($375-$400) # 464649
  - 5 Gallon Pail ($98.39) # 464639

CRC Industries Inc.
Web Site: http://www.crcindustries.com
Phone: 800-272-8963
Email: custserv.crc@crcindustries.com

- 05052 -- Brakleen® Non-Chlorinated Brake Parts Cleaner - 50 State Formula, 5 Gal
  - Brake linings, brake parts, clutches, wheel cylinders, springs, CV joints, drums, disc brake parts & calipers
  - 5 Gallon Pail
- Many other products available!

Example 1.c: Update aerosol product inventory

An additional pollution prevention recommendation for aerosol can management is to conduct regular inventories of all aerosol products.

The first step to successfully managing a waste stream is determining exactly what and how much product is used and waste generated. The company already uses a web-based program to catalog their inventory. The system allows employees to access a list of items at a facility, and view the material safety data sheet (MSDS) for each chemical. All aerosol products utilized can be located with a simple search for product name or product manufacturer. The online database also can create a detailed, accurate waste stream of all aerosol products. This process is only efficient, however, when inventories are up-to-date. Accurate inventories can help control purchasing and help ensure that products are only ordered when needed.

Implementation Status: Implemented (adapted from reports by Chris New, 2008)

The company implemented some of the recommendations and has applied the suggestions to additional facilities it operates. See Table 3 below for a summary of the status of the recommendations made.

Table 3. Status of P2 Recommendations

P2 Recommendation	Potential Benefit Identified	Status	Actual Benefit
Puncture all spent aerosol cans prior to disposal	Reduce 600 lb/yr hazardous waste Save $4,550/yr	Implemented	As calculated + 200 lb/yr steel recycled
Replace aerosol brake cleaner with bulk brake cleaner	Reduce 200 lb/yr hazardous waste	Not Implemented	N/A
Conduct regular inventories of all aerosol products	Increase safety and health, document waste streams	Implemented	As stated

Key Barriers and Benefits: Potential waste and savings were well documented and inspired the implementation of the recommendations at additional facilities operated by the company. Implementing the recommendations was straightforward and simple. The implementation cost was minimal. The payback period was short. Some employee resistance to change may have played a part in the delay in implementation of the use of bulk product with refillable containers in lieu of aerosol cans. The facility will save on operating costs and related environmental impact on an ongoing basis.

Example #2: Replace aerosol cans with refillable spray containers and bulk product: large facility comparison to "No Action" option (adapted from report by Amanda Schlender, 2009)

Note that the P3 intern outlined a range of options for the client, but ultimately recommended one course of action (Option 4) as detailed below. Detailed cost calculations for each option follow.

Option 1: Take no action
The plant could continue to dispose of aerosol cans as hazardous waste. If this practice is continued, they will spend over $4,500 per year in disposal costs. This method also generates a large amount of hazardous waste and creates a large environmental footprint for the plant. Option 1 is not a recommended course of action.

Option 2: Purchase one aerosol can puncturing system
The plant could purchase an aerosol can puncturing system and reduce operating costs by **over $4,000 per year**. The system costs approximately $700 and maintenance is approximately $500/year. However, the plant will reduce hazardous waste and associated disposal costs by about $4,000/year, and gain some revenue from recycling the steel from punctured cans.

Option 3: Prevent the generation of aerosol cans waste with reusable spray bottles/bulk product
The plant should replace the use of aerosol cans with reusable spray bottles filled with bulk product for the heavy duty silicone lubricant used in the packing area, which generates the most waste. A local vendor provided information about an alternative product called JAX Dry-Glide Food Grade Silicone. This product is cheaper and is available in bulk (one or 5 gallon pails, and 55 gallon drums).

The plant could use the equivalent of three 55 gallon drums of the JAX product each year to replace aerosol can usage in the packing area, resulting in **operating costs savings of over $10,000/year.** Minimal costs incurred from replacing/disposing of broken spray bottles are neglected in the cost analysis of this opportunity. It should be noted that trigger bottle spray may cause some issues regarding application when compared to traditional aerosol sprays. Also, this introduces new chemical management (storage, documentation, etc.) needed for the JAX product being purchased in bulk.

Option 4: The recommended course of action is a combination of Option 2 (puncturing system) and Option 3 (reusable spray bottles/bulk product) that is hereafter called Option 4. The plant should switch the heavy duty silicone lubricant aerosol product to the JAX bulk product, and should purchase a can puncturing system for any other aerosols that are generated. Cost savings for Option 4 is **$12,700** annually. This option would also provide hazardous waste reduction of **1040 lb**, and overall waste reduction of **390 lb**. Detailed cost calculations are provided below. The upfront cost, operating cost, cost savings and payback period for each of the four options is provided in Table 1 below.

Table 1. Estimated Annual Cost Savings and Payback Periods for Options

Option	Annual Operating Cost	Upfront Cost	Annual Cost Savings	Payback Period
1	$16,630	-	-	-
2	$12,580	$709	$ 4,050	2.1 months
3	$ 6,270	$ 68	$10,360	2.5 days
4: 2&3	**$3,938**	**$777**	**$12,700**	**23 days**

Additional benefits for the plant include:

- Reduced disposal of hazardous waste
- Improved company image
- Reduced environmental impact
- Enhanced feeling of environmental responsibility

A detailed table of cost calculations follows.

Cost Calculations for Options 1-4

Option 1: No Action						
Heavy Duty Silicone Lubricant				Annual Cost of Aerosols		
1560	cans/yr	368	g per can	Purchase		$ 12,043
$7.72	cost per can	0.93	g/mL (density)	Disposal		$ 4,588
$12,043	cost/yr	617.29	L /yr	Total		$ 16,631
		162.96	gal /yr			

Option 2: Purchasing Aerosol Puncturing System						
Puncturing System Cost		Maintenance Items	Cost	Life	Amt/yr	Cost/yr
$699	Can puncturing system	Carbon cartride (2/box)	$165	3 months	1	$165
$10	Freight	Filter (incl cartridge)	$147	6 months	2	$294
$709	Total Upfront Cost	Maintenance kit	$79		1	$79
		Gaskets	$8.25			
Decrease in Operating Costs		Total Annual Maintenance Costs				$538
No disposal	$ (4,588)					
Annual Maint	$ 538					
Decrease	$ (4,050)					

Payback Period		Years	Months	Days
Upfront Cost	$709	0.18	2.10	64
$ saved/yr	$ 4,050			

Option 3: Switching to Reusable Containers & Alternative Lubricant							
Upfront; Reusable Containers		Alternative Lubricant		Current Operating Costs of Aerosols			
				Total		Heavy Duty Lube	
$ 5.65	per trigger bottle	55	gal/drum	$ 4,588	disposal/yr	$ 1,721	dispose/yr
12	bottles per case	2.96	drums/yr	$ 16,631	cost/yr	$ 13,764	cost/yr
$ 68	cost per case	$ 1,149.25	cost/drum				
		$ 3,405	cost/yr				

Decrease in Operating Costs		Payback Period*		Years	Months	Days
Heavy Duty Lube Cost/yr	$ (13,764)	Upfront Cost	$68	0.00	0.06	2
Alternate Lube/yr	$ 3,405	$ saved/yr	$ 13,764			
Decrease	$ (10,359)					

*payback calculated using heavy duty lube total cost/yr

Option 4: (Options 2 & 3 Combined) Puncture System + Reusable Containers & Alternative Lube			
	Option 2	Option 4	Total
Upfront Costs	$ 709	$ 68	$ 777
Operating Costs	$ 538	$ 3,405	$ 3,943

Decrease in Operating Costs		Payback Period		Years	Months	Days
Current Costs	$ (16,631)	Upfront Cost	$777	0.06	0.73	22
Options 2 &4 Costs	$ 3,943	$ saved/yr	$ 12,688			
Decrease	$ (12,688)					

Implementation Status: Implemented (adapted from reports by Amanda Schlender, 2009 and a reassessment report by Meghan Ray, 2010)

The P3 intern worked closely with the plant to implement Option 4, including purchasing and setting up an aerosol can puncturing system, testing the bulk silicone product with the plant technicians, and purchasing the bulk silicone for permanent use. In addition, necessary measures for spill containment, fire protection, and maintenance were put into place. The plant decided to purchase the bulk product in easier to manage 5 gallon pails rather than 55 gallon drums. During the first year after the original recommendation, the plant began phasing out the aerosol cans that were not completely necessary. Since implementation, there has been no hazardous waste generated because of aerosol cans. The recommendation initially cost $700 to implement, with a cost savings of **$5,000 per year.** It has also reduced the amount of hazardous waste due to aerosol cans by **1000 pounds per year.**

Key Barriers and Benefits: Potential waste and savings were well documented. Implementing the recommendation was straightforward and simple. The implementation cost was minimal. The payback period was short. The facility will save on operating costs and related environmental impact on an ongoing basis.

Appendix 3
Greenhouse Gas Reductions Explanation and Calculations

Relevance of Greenhouse Gas Emission Estimates
This issue is an increasingly important one for business decision makers as it relates to regulations, stakeholder interests and day-to-day business operations and energy use.

There are several important dimensions of analysis for any pollution prevention opportunity. One is certainly direct environmental impact (e.g. reductions in solid or hazardous waste, water use, air pollution, or energy use). Another important dimension is cost. Yet another is the intangible (not quantifiable) impact, such as reduced liability, increased worker safety/satisfaction, or improved corporate image. A final important dimension is indirectly estimating the impact on greenhouse gas (GHG) emissions that can be achieved by implementing any given pollution prevention opportunity.

GHGs include a number of different gases such as carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons and water vapor. These gases contribute to the "greenhouse effect" in the Earth's atmosphere. While GHGs make the planet warm enough to be habitable, an excessive amount of these gases is believed to be building up in the atmosphere and causing the average global temperature to rise, leading to climate change and instability. A significant spike in GHG concentrations in the atmosphere has occurred since the industrial revolution, pointing to the man-made nature of this change. This is why a new emphasis, and discussion of possible regulations, has been placed on reducing GHG emissions in all parts of our society, including government, business and industry.

The most widely recognized unit for measuring GHG emissions is carbon dioxide equivalent (CO2e). Each of the GHGs has a different capacity to heat the earth's atmosphere, called its global warming potential (GWP). Carbon dioxide (CO2) has a GWP of 1, so in order to standardize reporting, when GHG emissions are calculated, they are reported as equivalent to a given volume of CO2.

Reductions in GHG emissions can be estimated using a variety of calculation tools and computer models. The direct environmental/cost benefits estimated or realized are used as quantified input for these calculations, therefore the resulting GHG emission reduction estimates are considered indirect benefits. Some commonly used tools are listed below:

--Nationally recognized conversion factors from the U.S. Department of Energy and the American Water Works Association are used to estimate GHG emissions for electricity, natural gas, and water use. For example, kilowatt-hours (kWh) of electricity used can be converted to GHG emissions using a factor of 1.404 pounds CO2 e per kWh.

--Another tool to determine GHG emissions related to solid waste, is the EPA's WAste Reduction Model (WARM). This online calculator uses a life-cycle approach to determine the change in GHG emissions caused by alternative end-of-life waste management decisions or disposal methods for a number of different kinds of wastes. For example, using the weight of a solid waste diverted from a landfill and recycled, an approximate reduction in GHG can be

calculated. WARM is periodically updated and new material types are added by the EPA as new information from climate change research becomes available.

--Another model used to estimate GHG reductions is the Economic Input Output Life Cycle Assessment (EIO-LCA) developed by researchers at Carnegie Mellon University. This model provides a useful approximation of GHG reductions through the full life-cycle production of a material or chemical, based on the cost savings from reductions in use. For example, if a business reduces its lubricating oil purchases by $50,000, the EIO-LCA estimates the GHG emissions to produce that oil through the mining, extracting, refining, packaging and delivery (to list a few) steps in the process of getting that oil to the end user.

--Recycled Content (ReCon) Tool: EPA created the ReCon Tool to help companies and individuals estimate life-cycle greenhouse gas (GHG) emissions and energy impacts from purchasing and/or manufacturing materials with varying degrees of post-consumer recycled content.

When using one of these models to estimate GHG emission reductions for a client, always provide an explanation of which model was used, why, what assumptions were applied, and the importance of reducing GHG emissions as a business and global sustainability strategy. An example of an appendix documenting GHG emissions reductions related to the reduction in use of aerosol cans is shown below.

Example Greenhouse Gas Calculations for Use of Aerosol Cans

Two alternative sources used to calculate GHG emission reductions: similar results

Recommendation – Eliminate use of aerosol cans: 1560 cans/390 lbs solid waste diverted from landfill

- Assumptions
  - aerosol cans punctured/drained, disposed of as solid waste
  - -3.18 MTCO2E per short ton (based on EPA WARM calculator conversion factors)
  - assume "National Average" for landfill characteristics and default setting applied for landfill transportation distance
  - 1560 cans X 0.25 lbs/can = 390 lbs/2000 lbs = .195 tons source reduction
- Calculation
  - .195 tons metal cans X -3.18 MTCO2E = **0.62 MTCO2E reduced**
- Source
  - Environmental Protection Agency (EPA) Waste Reduction Model (WARM), http://epa.gov/climatechange/wycd/waste/calculators/Warm_home.html, March 2012

Recommendation – Eliminate use of aerosol cans: 1560 cans/$12,600 annual savings

- Assumptions
  - annual savings result from eliminating aerosol can use to apply lubricant
  - EIO-LCA model applied to calculate GHG reduction
    - Model: US National Producer Price Model (2002)
    - Sector: Metal Can Container Production
    - $12,600 annual savings
- Calculation
  - Based on EIO-LCA model, $12,000 of savings in metal can use results in .705 tons CO2E reduction
  - .705 tons (US) = **.64 MTCO2E reduced**

- Source: Carnegie Mellon University Green Design Institute. (2012) Economic Input-Output Life Cycle Assessment (EIO-LCA) US 2002 (428) model [Internet], Available from: <http://www.eiolca.net/> [Accessed 12 Apr, 2012]

Appendix 4
Tips for Making the Business Case for Change

Tip # 1: Writing an Executive Summary

An executive summary is a brief overview of a report designed to give readers a quick preview of its contents. Its purpose is to consolidate the principal points of a document in one place. After reading the summary, your audience should understand the main points you are making and your evidence for those points without having to read every part of your report in full. It is called an executive summary because the audience is usually someone who makes funding, personnel, or policy decisions and needs information quickly and efficiently in order to make decisions and respond appropriately.

Guidelines:

An executive summary should communicate independently of the report. It should stand on its own as a complete document.

It should explain why you wrote the report, emphasize your conclusions or recommendations, and include only the essential or most significant information to support those conclusions.

Use subtitles, bullets, tables, selective bolding or other types of organizational structure to add clarity to your summary

It should be concise—about 10% of the length of the full report.

It should be organized according to the sequence of information presented in the full report. Don't introduce any new information that is not in your report.

To help with organizing the executive summary, after you have written the full report, find key words; words that enumerate (first, next, finally); words that express causation (therefore, consequently); words that signal essentials (basically, central, leading, principal, major); and contrast (however, similarly, less likely).

Read the completed summary with fresh eyes. Check spelling, grammar, punctuation, details, and content. Ask someone else to read it.

Tip #2: Technical Writing Tips

Use these tips as a **checklist** as you prepare your report.

- **Proof reading.** Write your report, let it sit, then proof read it for grammar, jargon, clarity, multiple meanings, and technical correctness before submittal. Re-read the report from the recipient's point of view. Reading the report aloud may help.
- **Figures and tables.** Refer to each figure and table in the text prior to inserting it. Always place the figure or table in the report soon after you have referred to it. Include a title and number for all figures and tables, capitalizing the title when referring to a specific table or figure, e.g., "All of the wastes generated by the shop are listed in Table 1
- **Transitions.** Provide brief transition sentences between sections of the report and before a bulleted list to explain what the list consists of and how it is organized.
- **Parallel construction.** Use parallel construction in all numbered or bulleted lists. For example, all items should be a complete sentence or none should be; or all items might begin with an active verb, e.g., "use," "change," "remove" or a noun, like this list.
- **Format.** A general format/outline has been suggested, although this may need to be modified to address a client's requests. Generally you should:
  - Move from generalities to specifics, in each section and across the report as a whole.
  - Use page numbers.
  - Keep section headings with the narrative that follows at page breaks.
  - Rarely split a table across two pages.
- **Abbreviations.** On first use, spell the term out completely, followed by the abbreviation in parentheses. For example, "Volatile Organic Compounds (VOCs) are another waste that could be minimized." Subsequently, just the abbreviation is sufficient unless it is used at the beginning of a sentence. Never start a sentence with an abbreviation or a numeral.
- **Professional tone.**
  - Avoid slang, informal terminology (inexpensive vs. cheap), or imprecise (there, that, it) language.
  - Be careful how you word suggestions. Avoid making recommendations outside of your area and level of expertise in source reduction and waste minimization.
  - Use tact and be positive in your conclusions. Remember a reader likes to be complimented, but can see through phoniness.
  - Be careful to confirm your information if you state it as a fact; or cite your source, e.g., "According to Mr. Jones, Plant Engineer, . ." or state that the information is a potential based on xyz assumptions.
- **Common errors.**
  - i.e. vs. e.g.: i.e. means "that is" or "in other words," and e.g. means "for example."
  - compliment vs. complement: a compliment is a nice comment, and a complement is a part of a whole
  - how many vs. how much: how many can be counted, and how much is uncountable, e.g., how many bottles of water vs. how much water.
  - policies vs. procedures vs. practices: policies are formal written positions or statements about some issue; procedures are written directives aimed at accomplishing a task or complying with a policy; practices are typically informal steps people take, which may or may not follow written policies and procedures

Tip #3: General Recommendations

General recommendations are made to help a company establish the culture and infrastructure needed to establish and sustain a commitment to source reduction and sustainability. Examples of commonly made general recommendations include:

1. A pollution prevention policy statement should be generated and periodically updated by management to formally reflect management's commitment to incorporating pollution prevention in the company's operations. Some examples of formal policy statements follow:

> *This company is committed to continued excellence, leadership, and stewardship in protecting the environment. Environmental policy is a primary management responsibility, as well as the responsibility of every employee.*
>
> *The corporate objective is to reduce waste and achieve minimal adverse impact on the air, water, and land through excellence in environmental control.*
>
> *Minimizing or eliminating the generation of hazardous waste is a prime consideration in process design and plant operations and is viewed by management as having a priority as high as safety, yield, and loss prevention.*

2. To further implement the corporate pollution prevention policy, one or more "cause champions" should be selected to lead the pollution prevention program and overcome the resistance present when changes are made to existing operations. These "cause champions" may include a project manager, an environmental coordinator, or anyone else dedicated to implementing the pollution prevention ideal and company policy. These individuals must be given authority by management to carry out the policy.

3. Input from employees should be considered, encouraged, and valued. Since the employees must deal with the waste, they may have insight into how a specific pollution prevention opportunity may be implemented. Many companies offer incentives to employees who suggest innovations to minimize or reduce waste generation.

4. Goals should be established to help implement and track the progress of the corporate pollution prevention policy. Specific, quantitative goals should be set that are acceptable to those willing to work to achieve them, flexible to changing requirements, and achievable with a practical level of effort. To document the progress of the pollution prevention goals, a waste accounting system should be used.