COLORADO POLLUTION PREVENTION CASE STUDIES

for

CHEMICAL MANUFACTURING

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Preface

The case studies in this compendium were researched and written by Ms. Joni Canterbury, a graduate student intern of the Colorado Department of Public Health and Environment (CDPHE) Pollution Prevention Program. The project was sponsored by the Colorado Pollution Prevention Advisory Board (PPAB), and was supervised by Neil Kolwey of the CDPHE P2 Program, with input from Parry Burnap, the CDPHE P2 Program Manager.

We would like to thank the companies in these case studies for taking the time to help us document their pollution prevention successes and their willingness to share their information with other businesses.

Disclaimer. The names of specific products and vendors, included in the case studies, is for information purposes only, and does not imply any type of endorsement by CDPHE.

P2 Case Studies for Chemical Manufacturing

Pollution Prevention Case Study

Chemicals and Allied Products: Solvent Management Policy to Reduce Solvent Wastes/Emissions

Company	**Geneva Pharmaceuticals, Inc.** 2655 W. Midway Blvd. Broomfield, CO 80038-0446
Person to Contact	Gary Long, Manager Safety & Environment Telephone: (303) 438-4233
Product or Service	Pharmaceuticals
Number of Employees	850
Waste Stream Targeted	**Solvent waste, emissions**
Original System	**No formalized, written solvent management policy.**
New System (with P2 Modification)	**Formalized**, written **Solvent Management Policy**. Summary of policy: 1. Develop products which do not require the use of solvents or which minimize solvent use. 2. When solvents are required, use solvents that are as "friendly" as possible to human health and the environment, and recycle as much as possible. The policy lists solvent use criteria and acceptable solvents for use. (For example, for alcohols, order of priority is to use ethanol first (least toxic), then IPA, and methanol as a last resort.) 3. Minimize use of solvents in analysis or testing of new products. 4. Track solvent usage, wastes/emissions, and associated costs, with tools such as the Corporate Safety, Energy, and Environmental Protection (SEEP) report.
Cost Savings	not quantified
Major Benefits	**Emissions of methylene chloride were eliminated (over 2 tons/yr).** **30% overall reduction in use of toxic alcohol blends.** (use of pure methanol blends in new products have decreased to about 5%). **Positive Business Image.** Eliminated the 5,000 gallon methanol storage tank (they now use 55 gallon drums instead) by increased substitution of ethanol. Improved worker health and safety, liability reduction. Reduced potential for hazardous material spills.
Obstacles	Time and costs associated with solvent substitutions, R & D, equipment modifications. Process/procedure/material changes are more difficult to implement in an FDA-regulated facility.

Company	**Geneva Pharmaceuticals, Inc.** 2655 W. Midway Blvd. Broomfield, CO 80038-0446
Time Since Implementation	3.5 years.
Source/Supplier	None
Main Reason Implemented	Improve worker health and safety, reduce liability concerns and associated costs.
Key to Success in Making this P2 Modification	Management support/commitment to pollution prevention. It is important to include P2 and other safety & environmental concerns in employee performance objectives.

Pollution Prevention Case Study

Chemicals and Allied Products: Continuous Improvement Process Suggestion System

Company	**Fel-Pro Chemical Products L.P.** 6120 E. 58th Avenue Commerce City, CO 80022
Person to Contact	Catherine Griffith, Regulatory Affairs Manager Telephone: (303) 289-5651
Product or Service	Manufacturer of sealants, adhesives, lubricants, and epoxies for industrial applications.
Number of Employees	50
Waste Stream Targeted	**All wastes.**
Original System	**Management Hierarchy.** Team problem solving was not a part of the company policy. There was no formal quality improvement program, and generally no follow-up on employee suggestions. As a result,employee ideas disappeared.
New System **(with P2 Modification)**	To encourage recommendations on improving operations, waste elimination, and safety, Fel-Pro developed a **Continuous Improvement Process (CIP)** suggestion system to reward employees for good ideas. After an idea is submitted, a review committee from the employee's area evaluates the suggestion to make sure it meets the suggestion system guidelines. (Suggestions must support the company's goals of quality, timeliness, innovation, waste elimination, and safety). If it does, it is then forwarded to the appropriate operation area for evaluation and response within 10 working days. If the idea can be implemented, the employee receives an award. The first time a Fel-Pro associate submits an idea that is implemented, they receive a CIP suggestion system special award. With each additional idea implemented, an associated receives a lunch/merchandise ticket. For every five ideas implemented, an associate receives $150. In addition, the employee receives a CIP button with the number of suggestions implemented printed on the button. The best CIPs of the year are recognized and receive an award of $1,000.00. In addition managers and supervisors establish yearly goals to increase efficiencies, eliminate waste, and improve safety within their respective departments.
Cost Savings Initial Equipment Costs Operating/Material Cost Savings	The CIP approach has generated real savings within the organization. For example, a suggestion to install a waste compactor generated an **annual savings of $16,000.00**. Fel-Pro also achieved a **$35,000.00 savings** by deciding to label cans as they used them, thus requiring significantly less inventory. Suggestions have also led to shorter product production runs, which provided more timely deliveries and less waste.
Major Benefits	**CIP approach has generated real savings within the organization at a low cost.** **By recognizing employee suggestions, CIP helps improve morale and productivity.** Suggestions have improved production levels within the manufacturing process and packaging operations and reduced waste. The CIP serves as a way to alert associates to identify potential problems which helps prevent pollution and reduce waste.
Obstacles	None
Time Since Implementation of P2 Modification	3 years.

Company	**Fel-Pro Chemical Products L.P.** 6120 E. 58th Avenue Commerce City, CO 80022
Source/Supplier	None
Main Reason Implemented P2 Modification	Improve operations, eliminate waste, reduce worker health and safety concerns.
Key to Success in Making this P2 Modification	Employee recognition.

1/26/96

Pollution Prevention Case Study

Chemicals and Allied Products: Solvent Management Team Formed to Reduce Solvent Wastes/Emissions

Company	**Hauser Chemical Research, Inc.** 5555 Airport Boulevard Boulder, CO 80301
Person to Contact	Steve Perich, Environmental Affairs Manager Telephone: (303) 443-4662
Product or Service	Natural Source Pharmaceutical and Food Ingredient Manufacturer
Number of Employees	150
Waste Stream Targeted	**Solvent wastes, emissions**
Original System	**No Formal Solvent Management Team**. Problem solving started with management and trickled down to employees. Individuals looked at the **specific problem** and not the entire process to minimize waste and reduce solvent emissions. A large quantity of methylene chloride was used as a solvent in the product purification processes. Methylene chloride (dichloromethane) is considered a volatile organic compound (VOC) and hazardous air pollutant (HAP) and must be disposed of as hazardous waste.
New System (with P2 Modification)	**Formal Solvent Management Team**. Problem solving started from the bench (key people in the processes) and scaled up to management. A team of employees reviews the **entire process** to minimize waste and reduce solvent emissions. A waste minimization team was formed; solvent wastes/emissions were targeted for reduction (primarily methylene chloride) and several changes implemented: 1. Methylene chloride degrades seals in the process totes. Maintenance was performed on all totes, leaks welded, and seals replaced. 2. Use of dedicated containers for specific processes to reduce the need for solvent cleaning. 3. Reviewed and improved sampling procedures to reduce solvent waste. 4. Improved operating procedures and employee training to reduced solvent emissions/waste. 5. Improved vapor recovery and recycling systems.
Cost Savings	not quantified

Company	**Hauser Chemical Research, Inc.** 5555 Airport Boulevard Boulder, CO 80301
Major Benefits	**Reduced solvent emissions from 23.7 tons/year in 1992 to 3.7 tons/year in 1995.** **Reduced methylene chloride hazardous waste from 293 tons/year in 1992 to 59 tons/year in 1995.** **Recycled 10 million pounds of methylene chloride in 1995.** **Recycled 275,000 pounds of isobutyl alcohol in 1995** (other solvents not quantified). Improved business image.
Obstacles	Research and development and testing of new methods/solvent substitutions requires time and money.
Time Since Implementation	3.5 years.
Source/Supplier	None
Main Reason Implemented	Improve worker health and safety and reduce associated liability concerns. Reduce hazardous waste costs and liabilities.
Key to Success in Making this P2 Modification	Team work in developing new methods/ideas on pollution prevention. Management support/commitment to pollution prevention.

Pollution Prevention Case Study

Chemicals and Allied Products: Switch to a Less Hazardous Solvent

Company	**BIRKO Corp.** 9152 Yosemite Street Henderson, CO 80640
Person to Contact	Terry McAninch, Director R & D Telephone: (303) 289-1090
Product or Service	Produce Industrial Detergents for the Meat Packing Industry
Number of Employees	24
Waste Stream Targeted	**Solvent waste, emissions**
Original System	**Orthodichlorobenzene (ODCB) and Naphthalene-based solvents were used in a detergent product** as wetting agents, for penetration of brine, and bacteriostatic characteristics. ODCBs (chlorinated organics) and napthalene-based solvents contain volatile organic compounds (VOCs) and hazardous air pollutants (HAPs).
New System (with P2 Modification)	**Replaced solvent-based additives in the detergent blend with plant-extracted Essential Oils.** This substitution eliminates the use of hazardous solvents in the detergent blend.
Cost Savings Initial Equipment Costs Material Cost savings	There are no cost savings associated with this improvement. None. Raw material costs increased ~20%; however product prices were increased ~25% to offset these costs.
Major Benefits	**Reduced use of ODCB by ~66,000 lb/year and naphthalene-based solvents by 8,300 lb/year.** **Customers are willing to pay more for a safer product.** Reduced health and safety concerns, liability reduction. Positive Business Image. Reduced potential for hazardous spills, leaks.
Obstacles	Costs more to make the new detergent blend, but these costs can be passed on to the customer. R & D to find less hazardous chemical additives takes time and money.
Time Since Implementation	1.5 years.
Main Reason Implemented	Reduce liability concerns and associated costs. Business philosophy - it is important to provide a safer product for the customer and employees.

Company	**BIRKO Corp.** 9152 Yosemite Street Henderson, CO 80640
Key to Success in Making this P2 Modification	Recognition that P2 must be addressed at the Research & Development phase, considering the entire life cycle of the product.

Pollution Prevention Case Study

Chemicals and Allied Products: Solvent Miser Recycle/Reuse of Solvents in Liquid Chromatography

Company	**Geneva Pharmaceuticals, Inc.** 2655 W. Midway Blvd. Broomfield, CO 80038-0446
Person to Contact	Gary Long, Manager Safety & Environment Telephone: (303) 438-4233
Product or Service	Pharmaceuticals
Number of Employees	850
Waste Stream Targeted	**Solvent waste, emissions**
Original System	Samples are taken during different cycles of the manufacturing processes and analyzed by liquid chromatography (HPLC) to determine product purity, stability, concentration, etc. **Solvents used in the separation process are discarded with the sample material.** This process generates a lot of hazardous waste.
New System (with P2 Modification)	**Analtech Solvent Miser** is a two-way valve attached to the HPLC system to transfer contaminated solvent from the separation process to a hazardous waste container. Uncontaminated solvent material is routed back to the HPLC reservoir for reuse, reducing the amount solvent disposed of as hazardous waste.
Cost Savings Initial Equipment Costs Material Cost Savings Waste Disposal Cost Savings Total Cost Savings Payback Period	 1 Solvent Miser Unit costs ~$1,800. Geneva purchased 55 units at a cost of ~$99,000. 1 Solvent Miser unit handles ~65 liters of pure solvent in 3 months; ~50% of this becomes waste. Therefore, ~32 liters is recycled/reused per quarter or 128 liters/year. Analytical grade methanol costs ~$4.00/liter, for a total **material cost saving of ~$28,200/year for 55 units.** Hazardous waste disposal costs ~$300/55 gal. Geneva disposes of ~14 drums/2 months from the analytical laboratories at a cost of ~$25,200.00/year. The Solvent Misers allow a **50% savings on hazardous waste disposal or ~$12,600/year** (not including hazardous waste materials handling/profile costs). **~$41,000/yr** **Payback is about 2.4 years.**

Company	**Geneva Pharmaceuticals, Inc.** 2655 W. Midway Blvd. Broomfield, CO 80038-0446
Major Benefits	**Material cost savings of $28,000/year.** **Hazardous Waste Disposal Cost Savings of $12,600/year.** **Reduced hazardous waste liability.** **Positive Business Image.**
Obstacles	Time and costs associated with equipment modifications, recycling/reuse.
Time Since Implementation	3.5 years.
Source/Supplier	
Main Reason Implemented	Reduce hazardous waste disposal costs and associated liabilities.
Key to Success in Making this P2 Modification	Management support/commitment to pollution prevention.

2/6/96

Pollution Prevention Case Study

Chemicals and Allied Products: Switch to a Water-Based Release Coating.

Company	**Central Products Company** 1095 South Fourth Avenue Brighton, CO 80601
Person to Contact	Randy Putnam, Environ. Engineer Telephone: (303) 654-0500
Product or Service	Pressure Sensitive Tapes
Number of Employees	260
Waste Stream Targeted	**Solvent waste, emissions**
Original System	A **solvent-based** synthetic rubber/resin **release coating** is melted, blended, and applied to one side of the hot melt film and chilled. The release coating allows the tape to peel easily. The release coating contains toluene which is a volatile organic compound (VOC) and hazardous air pollutant (HAP) and may be hazardous to human health and the environment.
New System (with P2 Modification)	A **nonhazardous water-based release coating** replaced the solvent-based coating in the manufacture of hot melt tape. This substitution eliminates the use of toluene in the release coating.
Cost Savings Initial Equipment Costs Material Cost Savins	 None required; however, water-based release dries much slower than solvent-based and may require purchase of drying equipment (can be expensive) to maintain a similar rate of production. The cost of water-based release is about the same as the solvent-based release coating.
Major Benefits	**Reduced total toluene emissions by 10%.** **Positive Business Image.** Improved worker health and safety, liability reduction.
Obstacles	Water-based release coatings are more difficult to dry.
Time Since Implementation	1 year.
Source/Supplier	For information, contact Randy Putnam.
Main Reason Implemented	Reduce hazardous solvent usage, emissions. Customer demand for less hazardous release coating.

Company	**Central Products Company** 1095 South Fourth Avenue Brighton, CO 80601
Key to Success in Making this P2 Modification	Management support/commitment to pollution prevention.

2/14/96

Pollution Prevention Case Study

Chemicals and Allied Products: Switch to Less Hazardous Cleaning Agents

Company	**Fel-Pro Chemical Products L.P.** 6120 E. 58th Avenue Commerce City, CO 80022
Person to Contact	Catherine Griffith, Regulatory Affairs Manager Telephone: (303) 289-5651
Product or Service	Manufacturer of sealants, adhesives, lubricants, and epoxies for industrial applications.
Number of Employees	50
Waste Stream Targeted	**VOC, HAP emissions**
Original System	**Methylene Chloride** was used in the plant as a cleaning solvent for cleaning mixing tanks and equipment used in the formulation processes. Methylene chloride is considered a Hazardous Air Pollutant (HAP), and wastes/residues must be disposed of as hazardous waste.
New System **(with P2 modification)**	**Thermaclean (095-0057) Graf Compound** is used to replace methylene chloride for cleaning mixing tanks and process equipment. Thermaclean contains primarily Ethyl 3-ethoxyproprionate and N-methyl-2-pyrrolidone (NMP) which are not considered hazardous chemicals at this time.
Cost Savings Initial Equipment Costs Operating/Material Cost Savings	None **Saved ~$4,000/year in material costs** and **$5,000/year in hazardous waste disposal and other environmental costs** (such as reduced compliance costs, savings in safety equipment).
Major Benefits	**Cost savings of ~$9,000/year** **Reduced HAP emissions.** **Reduced hazardous waste generation and associated liabilities.** Improved worker health and safety.
Obstacles	Thermaclean dries more slowly. Finding an effective substitute takes time and money.
Time Since Implementation	2 years.
Source/Supplier	Cook Composites and Polymers Company 919 E. 14th Avenue North Kansas City, MO 64116

Company	**Fel-Pro Chemical Products L.P.** 6120 E. 58th Avenue Commerce City, CO 80022
Main Reason Implemented	Reduce worker health and safety concerns.
Key to Success in Making this P2 Modification	Management support/commitment to P2 and worker safety.

1/26/96

Pollution Prevention Case Study

Chemicals and Allied Products: Recycle Water, Recapture Product from Wastwater Stream

Company	**Sand Creek Chemical L.P.** 4150 East 60th Commerce City, CO 80020
Person to Contact	Mark Ebson Telephone: (303) 286-7233
Product or Service	Methanol Production
Number of Employees	24
Waste Stream Targeted	**Wastewater**
Original System	Natural gas and steam are used in the methanol manufacturing process. A mixture of 85% methanol/15% water is produced and distilled. **Wastewater from the process is sent to the POTW (some of the water may contain methanol).** Methanol is considered a hazardous air pollutant (HAP) and a listed SARA 313 toxic chemical.
New System (with P2 Modification)	**20% of the water from the methanol manufacturing process is reused and pumped back into the steam system.** Wastewater is sent to a 20,000 gallon holding tank where it is sampled daily for methanol content before being discharged to the POTW. Methanol-contaminated wastewater is reprocessed and methanol removed before final discharge to the POTW.
Cost Savings Initial Equipment Costs Operating Cost Savings	 (2) 20,000 gallon storage tanks cost $50,000 installed (one is a backup storage tank). 20% of the water is reused in the process or ~2,000 gallons/day are saved @ ~$3.00/1,000 gallons or ~$2,200/year. Methanol is saved in the monitoring process, but has not been quantified. (This savings does not include the savings from POTW surcharges and discharge fines of greater than $1,000/year).
Major Benefits	**20% of the process water is recycled/reused in the process, saving over $2,000/year.** **Reduced discharges of methanol to the POTW and reduced compliance problems and liabilities.** **Positive Business Image.**
Obstacles	Capitol costs associated with reclaiming methanol.

Company	**Sand Creek Chemical L.P.** 4150 East 60th Commerce City, CO 80020
Time Since Implementation	1 year.
Main Reason Implemented	Reduce liability and associated costs.
Key to Success in Making this P2 Modification	Management commitment to P2/reducing discharges.

2/2/96

Pollution Prevention Case Study

Chemicals and Allied Products: Equipment Modification to Increase Solvent Recovery and Decrease Solvent Emissions.

Company	**Central Products Company** 1095 South Fourth Avenue Brighton, CO 80601
Person to Contact	Randy Putnam, Environ. Engineer Telephone: (303) 654-0500
Product or Service	Pressure Sensitive Tapes
Number of Employees	260
Waste Stream Targeted	**Solvent waste, emissions**
Original System	Activated carbon beds are a solid sorbent used for capture of organic vapors (VOCs and HAPs) used in the manufacturing processes. The carbon beds were designed with a layer of hardware cloth (expanded metal mesh) layered with gravel and a 10 ton carbon bed. A diffuser spreads the air and distributes the solvent vapors onto the carbon beds. This design allowed channeling (air/solvent escaped through holes in the bed) and decreased the carbon bed efficiency. A steam regeneration system and distillation column are used for solvent recovery from the carbon beds, allowing reuse of the solvent in the manufacturing processes.
New System (with P2 Modification)	The carbon beds are now designed with a titanium fine mesh screen under a 12-13 ton carbon bed (increased carbon bed capacity, larger surface area and higher adsorption capacity) replacing the gravel layer. This design gives more depth, helps prevent channeling, and improves the recovery efficiency of the carbon beds by almost 10%. The same solvent recovery system is used. Forced ventilation drying decreases the cycle time and allows recovery of the solvent with little or no HAPs generation.
Cost Savings Initial Equipment Costs Operating Costs Savings	 not quantified. **~$39,000/year is saved in material costs (recovered solvent).**

Company	**Central Products Company** 1095 South Fourth Avenue Brighton, CO 80601
Major Benefits	**Increased HAPs recovery efficiency by 10% (capture efficiency is now 99%).** **This process change was a primary factor in overall reductions in HAPs emissions by ~90 tons/year, during a period when production rates doubled.** **Material Cost savings of ~$39,000/year (increased solvent recovery).** **Positive Business Image.**
Obstacles	Relatively large capital costs.
Time Since Implementation	6 years.
Source/Supplier	None
Main Reason Implemented	Increase solvent recovery and reduce HAPs emissions and associated costs.
Key to Success in Making this P2 Modification	Management support/commitment to pollution prevention.

2/14/96

Pollution Prevention Case Study

Chemicals and Allied Products: Waste Segregation System to Increase Recycling

Company	**Central Products Company** 1095 South Fourth Avenue Brighton, CO 80601
Person to Contact	Randy Putnam, Environ. Engineer Telephone:(303) 654-0500
Product or Service	Manufacture Pressure Sensitive Tapes.
Number of Employees	260
Waste Stream Targeted	**All Wastes Generated from the Manufacturing Processes**
Original System	Wastes generated from the manufacturing processes were contained in 55-gallon drums, labeled, and **disposed of as hazardous and/or nonhazardous waste.**
New System (with P2 Modification)	**Wastes generated from the manufacturing processes which can be recycled/reused are placed into separate, color-coded 55-gallon drums.** For example, yellow drums contain natural rubber adhesive wastes which are recycled/reused in the process. Yellow/red drums contain release coating which can be recycled/reused in the process. This system reduces the amount of waste disposed of as hazardous waste.
Cost Savings Initial Equipment Costs Operating/Material Cost Savings Waste Disposal Cost Savings	 None. **~30,000 lb/yr of release coating are recycled/reused at a material cost savings of $5,500/year. ~300,000 lb/yr of adhesive waste are recycled/reused at a material cost savings of ~$130,000/year.** Labor and other operating costs are about the same under the new system. Under the new system, hazardous waste disposal is reduced by 8 drums/month, for a **waste disposal cost reduction of ~$14,500/year.**
Major Benefits	**Reduced material costs by ~$135,000/year.** **Reduced waste disposal costs by $14,500/year.** **Reduced hazardous waste liability.** **Positive Business Image.**
Obstacles	None.
Time Since Implementation	6 years.
Source/Supplier	None. Material supply drums are painted in-house and reused.

Company	**Central Products Company** 1095 South Fourth Avenue Brighton, CO 80601
Main Reason Implemented	Reduce waste generation and associated costs and liabilities.
Key to Success in Making this P2 Modification	Management support/commitment to pollution prevention.

2/14/96

Pollution Prevention Case Study

Chemicals and Allied Products: Recycle Waste Streams Back into the Processes.

Company	**KWAL-HOWELLS Paint and Wall covering** 3900 Joliet Street Denver, CO 80239-0119
Person to Contact	Christine Les Camela, Tech. Director Telephone: (303) 371-5600
Product or Service	Architectural Paints
Number of Employees	70
Waste Stream Targeted	**Spent Solvent and Water used to rinse out mixing tanks.**
Original System	Mixing tanks (200 - 6,000 gal) used in the paint manufacturing process are rinsed between batches with water or a solvent blend (e.g., mineral spirits/alcohol blend or mineral spirits/xylene blend - depends upon the type of batch). 92% of the products are water-based and can be cleaned with water. The spent water or solvent blend from the cleaning process was disposed of as hazardous waste or nonhazardous waste.
New System (with P2 Modification)	Spent water from the cleaning process is pumped from the mixing tank into a storage tank and reused for cleaning a similar batch. The solvent blend is recovered from distillation and then reused for cleaning a similar batch. For a 3,000 gallon batch, ~200 gallons of solvent or water is reused which saves water and solvent and reduces hazardous waste disposal costs. Spent solvent blends or water are disposed of as hazardous and nonhazardous waste.
Cost Savings Initial Equipment Costs Material Cost Savings Waste Disposal Cost Savings Total Cost Savings	 None. Storage tanks, pumps, piping was already in place. **~5,000 gal/year is saved in the purchase of the raw material solvent blends. Saves ~115,000 gallons/year of water.** **Recycle/reuse of the solvent blend and water in the processes saves a substantial amount per year in waste disposal costs.** **Over $200,000/year in total savings.**
Major Benefits	**Total cost savings of over $200,000/yr.** **Substantial savings in hazardous waste disposal costs and associated liabilities.** **Savings in raw material costs.** Positive Business Image.

Company	**KWAL-HOWELLS Paint and Wall covering** 3900 Joliet Street Denver, CO 80239-0119
Obstacles	Production time is increased because it takes extra time to recycle/reuse the water or solvent.
Time Since Implementation	10 years.
Source/Supplier	None.
Main Reason Implemented	Reduce generation of water and solvent waste and associated costs and liabilities.
Key to Success in Making this P2 Modification	Must schedule paint batches properly for the most efficient use/reuse of the spent water/solvents.

2/23/96