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ENVIRONMENTAL RESEARCH BRIEF

Pollution Prevention Assessment for a Manufacturer of Automotive Lighting Equipment and Accessories

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Abstract

The U.S. Environmental Protection Agency (EPA) has funded a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to do so. Waste Minimization Assessment Centers (WMACs) were established at selected universities and procedures were adapted from the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992). The WMAC team at the University of Louisville performed an assessment at a plant that manufactures automotive lighting equipment and accessories. Plastic, metal, glass, and composite-component products are assembled by the plant. Raw materials include coils of metal, paint, solvents, oils, coolants, light bulbs, glass and mirrors, plastic resins, wiring, and wire terminals. Plant operations include plastic injection molding, metal pressing and punching, painting, and assembly. The team's report, detailing findings and recommendations, indicated that a significant amount of waste is generated through the stripping of paint hooks and parts and that the greatest cost savings could be achieved by installing a plastic media blasting paint stripper.

This Research Brief was developed by the principal investigators and EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

Introduction

The amount of waste generated by industrial plants has become an increasingly costly problem for manufacturers and an additional stress on the environment. One solution to the problem of waste generation is to reduce or eliminate the waste at its source.

University City Science Center (Philadelphia, PA) has begun a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the in-house expertise to do so. Under agreement with EPA's Risk Reduction Engineering Laboratory, the Science Center has established three WMACs. This assessment was done by engineering faculty and students at the University of Louisville's WMAC. The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize waste generation.

The pollution prevention opportunity assessments are done for small and medium-size manufacturers at no out-of-pocket cost to the client. To qualify for the assessment, each client must fall within Standard Industrial Classification Code 20-39, have gross annual sales not exceeding $75 million, employ no more than 500 persons, and lack in-house expertise in pollution prevention.

The potential benefits of the pilot project include minimization of the amount of waste generated by manufacturers and reduction of waste treatment and disposal costs for participating plants. In addition, the project provides valuable experience for graduate and undergraduate students who participate in the program, and a cleaner environment without more regulations and higher costs for manufacturers.

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Methodology of Assessments

The pollution prevention opportunity assessments require several site visits to each client served. In general, the WMACs follow the procedures outlined in the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). The WMAC staff locate the sources of waste in the plant and identify the current disposal or treatment methods and their associated costs. They then identify and analyze a variety of ways to reduce or eliminate the waste. Specific measures to achieve that goal are recommended and the essential supporting technological and economic information is developed. Finally, a confidential report that details the WMAC's findings and recommendations (including cost savings, implementation costs, and payback times) is prepared for each client.

Plant Background

This plant produces automotive products, including lamps, mirrors, flashers and switches, wiring systems, and emergency warning equipment.

Manufacturing Process

Numerous plastic, metal, glass, and composite-component products are assembled by the plant. Operations include plastic injection molding, metal pressing and punching, painting, and assembly. Raw materials used by the plant include coils of metal, paint, solvents, oils, coolants, light bulbs, glass and mirrors, plastic resins, wiring, and wire terminals. The various production operations used by the plant are described in the following sections.

Metal Working Operations

In the metal working area, several single-station and two multi-station metal presses perform blanking, drawing, bending, punching, or breaking of metal sheets or tubing. A small amount of tapping of pressed and cast metals is also done. Drawing oils, cutting lubricant, and rust-proofing compounds may be applied automatically or manually prior to metal working. As a result of the necessary lubrication, parts must be washed before they are painted, used in assembly, or packaged and sold.

Wire Harness Fabrication

Wiring is cut to appropriate lengths and the plastic insulation surrounding the wires is stripped off at each end of the wiring prior to terminating or molding. Workers attach terminals to the wires for assembly. In the shuttle molding process, some of the wires are bundled together and the terminals are placed in a mold into which PVC is injected. A junction block that provides sealed, plug-in connection ports for other wires is thus formed.

Plastic Injection Molding

Various thermoplastics, including nylons, acrylics, polycarbonates, polypropylenes, and acrylic-butadiene-styrene, are processed according to customer specifications. Plastic pellets are transferred pneumatically from storage boxes to heated driers above the injection-molding presses. The pellets are melted in a screw injection molder and injected into the mold. Sprues and runners from the finished parts are reground and returned to the hopper above the press, when possible.

Metal Painting

Several different solvent-based paints are used for painting metal parts. In general, the painting campaigns for metal parts last between a half-hour and several days.

Metal parts that are to be painted are first placed on an overhead conveying system that carries them through a six-stage pretreatment system to remove oils from metal working and to undergo surface preparation by chemical treatment. The six stages are an aqueous alkaline cleaner, a rinse, an iron phosphate-phosphoric acid chemical conversion coating for rust prevention and paint adhesion enhancement, another rinse, a chromating seal, and a final rinse.

After the six-stage treatment, the parts pass through a compressed air blow-off and air-knife, and then enter a drying oven. The parts are allowed to cool and then are sent to the first paint booth and then through a second booth where the other side is painted. The majority of the paint overspray in these two booths is collected in a waterfall. The parts are allowed to air dry for a short time and then enter a hand-spray touch-up booth.

The painted metal parts then go through the direct-fired oven, are allowed to air cool, and are removed from the hangers. Parts are placed in boxes and stored for later use in assembly operations. Some painted parts are put in final packaging for shipment from the warehouse.

Plastic Painting

The plastic parts painting operation consists of five separate paint lines which are usually cleaned out daily.

Solvent-based acrylics, lacquers, and two-component urethanes and epoxies are used in plastic painting. Preparation of plastic parts for painting is not needed because the parts are clean when received for painting.

Assembly

A variety of assembly operations, including fastening, crimping, terminating, boring, drilling, reaming, and stapling, are performed in the assembly lines for a variety of products. Assembly operations may be automated or manual.

In a typical assembly operation, parts are unpacked from various storage containers and placed on a conveyor belt. Smaller parts are attached to the main housing as the part moves down the line. Assembly may consist of attaching a wire harness or other subassembly to the main housing. Bonding is done using various techniques such as hot melting, sonic welding, hot-knife welding, and mechanical bonding. Lamps are soldered to wires or conductors. Brazing is used for bonding terminals to a lamp in a specific product assembly line. Next, the assembly is tested by plugging it into an electric outlet prior to final bonding and sealing. The part then undergoes final bonding with glue, is sealed with grease, and is submerged in water for testing. In the mirror assembly operations, glass is placed inside a painted rubber ring and is crimped using a press or glued into housings.

An abbreviated process flow diagram depicting the manufacture of automotive lighting equipment is shown in Figure 1.

Existing Waste Management Practices

This plant already has taken the following steps to manage and minimize its wastes:

- Some waste cardboard is baled and recycled.
- Scrap metal and plastic are collected and sold.
- A portion of the rejected plastic parts is reused.
- Shipping containers and packaging is reused, when possible.
- Unwanted pallets and skids are given away to a shelter workhouse for rebuilding.

Plant personnel are currently evaluating the following options for managing and minimizing plant wastes:

- Alternatives to caustic and methylene chloride paint stripping, such as plastic media blasting are being considered.
- The plant is considering participating in a local pallet and packaging waste exchange.
- A central chiller is to be installed to replace portable chillers that tend to generate waste oil emulsions from ethylene glycol losses from connection and disconnection.
- The purchase of a softwood denailing/chipping machine is being considered to provide materials from waste pallets which may be useful elsewhere.
- The use of a laundry service for the cleaning and subsequent reuse of rags is being considered.

Pollution Prevention Opportunities

The type of waste currently generated by the plant, the source of the waste, the waste management method, the quantity of the waste, and the annual waste management cost for each waste stream identified are given in Table 1.

Table 2 shows the opportunities for pollution prevention that the WMAC team recommended for the plant. The opportunity, the type of waste, the possible waste reduction and associated savings, and the implementation cost along with the payback

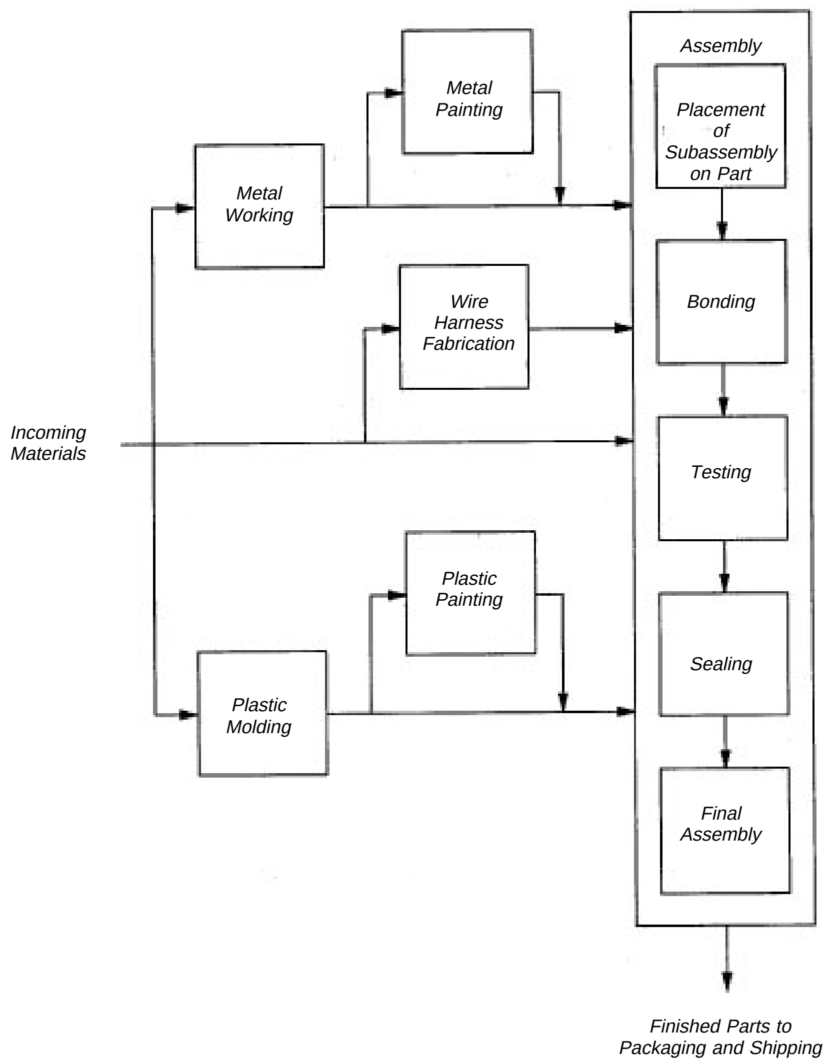

Figure 1. *Abbreviated process flow diagram for manufacture of automotive lighting equipment.*

time are given in the table. The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. All values should be considered in that context.

It should be noted that the economic savings of the opportunity, in most cases, results from the reduction in raw material and costs associated with waste treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each opportunity reflect that pollution prevention opportunity only and do not reflect duplication of savings that would result when the opportunities are implemented in a package.

Additional Recommendations

In addition to the opportunities recommended and analyzed by the WMAC team, several additional measures were considered. These measures were not analyzed completely because of insufficient data, minimal savings, implementation difficulty, or a projected lengthy payback. Since one or more of these approaches to pollution prevention may, however, increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

- Recover solvent from the cleaning of paint lines and guns instead of spraying it into the water curtains and emitting it to the atmosphere. Reuse the solvent if it is sufficiently clean or dispose of the waste through the waste fuels program. This opportunity would lead to reduced discharges to the POTW and reduced fugitive emissions, stack emissions, and worker exposure.
- Instead of landfilling waste pallets, grind the waste into wood chips and mulch in cooperation with the local recycling roundtable.
- Use dedicated dispensers for oil changeouts and dedicated buckets for leaks from oil drums in the metal working area instead of using unsegregated waste oil drums and buckets.
- Reuse packaging in cooperation with customers and suppliers to reduce the amount of packaging waste generated.
- Minimize the number of waste paint drums that must be disposed of by purchasing paint in 330-gallon returnable totes.
- Reduce evaporative losses from metal part painting pretreatment tanks by keeping lids closed.
- Use permanent washable filters in the paint booths instead of disposable filters.
- Replace the current painting system for metal parts with one that would generate less solvent-containing waste and fewer air emissions. (The plant is in the process of implementing this change.) Consider replacing the painting system for plastic parts also.
- Investigate further opportunities for waste recycling.
- Replace hot caustic and methylene chloride with a nonhazardous solvent for stripping.

This research brief summarizes a part of the work done under Cooperative Agreement No. CR-814903 by the University City Science Center under the sponsorship of the U. S. Environmental Protection Agency. The EPA Project Officer was **Emma Lou George**.

Table 1. *Summary of Current Waste Generation*

Waste Generated	Source of Waste	Waste Management Method	Annual Quantity Generated (lb/yr)	Annual Waste Management Cost*
Scrap metal	Metal working operations, rejected parts and customer returns, other operations	Segregated; sold to scrap dealer	732,000	$-27,330
Brazing waste	Brazing/soldering operations in assembly area	Shipped offsite to be fixed in concrete; landfilled	2,000	1,750
Brazing gloves	Brazing/soldering operations in assembly area	Incinerated offsite	400	1,000
Packaging waste (wooden pallets and skids)	Incoming shipments of raw materials	Given away for refurbishing	52,500	0
Packaging waste (cardboard, wooden pallets, fiber drums, paper spools, pails)	Incoming shipments of raw materials	Landfilled offsite	2,344,500	24,570
Packaging waste (drums)	Incoming shipments of raw materials	Shipped offsite to be crushed for scrap	3,000	2,250
Packaging waste (drums)	Incoming shipments of raw materials	Returned to supplier	7,000	0
Waste absorbents	Collection of liquid leaks in plant	Shipped offsite to fuels program	50,200	42,350
Aqueous wastes	Leaks from equipment, centrifugal separator, metal plating, chromating	Shipped offsite as hazardous waste to disposal facility	61,870	8,670
Aqueous wastes	Metal parts painting pretreatment, paint booth water curtain	Drained to POTW	251,400	20
Oil wastes	Oil changeouts, dispensing losses, drips, leaks	Shipped offsite to fuels program	4,500	780
Oil wastes	Skimming of paint pretreatment wash tank and stainless steel wash tank	Drained to POTW	6,230	10
Oil wastes	Hydraulic oil leaks from turbines, compressors, and hydraulic presses	Shipped offsite as hazardous waste to disposal facility	6,610	1,250
Oily rags	Cleaning	Landfilled offsite	5,200	70
Plastic waste (contaminated and rejected composite parts)	Bonding operations	Ground; sold to recycler	20,000	-600 (net revenue rec'd)
Plastic waste	Customer returns	Ground; sold to recycler or landfilled offsite	11,500	not available
Plastic waste (insulation, cable scrap, foam)	Stripping and terminating operations, wire harness operations, injection molding, and assembly	Landfilled offsite	13,420	730
Solvent waste	Paint line and paint gun cleaning, paint equipment and fixture cleaning, paint stripping	Shipped offsite to be used as fuel	35,640	11,210
Evaporated solvent	Fugitive and stack emissions	Evaporates to atmosphere	17,010	0
Solvent waste	Paint stripping and parts washing	Shipped offsite for recovery	18,720	20,800
Paint waste (obsolete paint, overspray, plastic sheet, paint solids, filters)	Metal and plastics paint spray booths	Shipped offsite to be used as fuel	57,270	37,650
Paint waste (water/paint)	Plastics paint spray booth	Incinerated offsite	11,690	14,500

Table 1. *(continued)*

Waste Generated	Source of Waste	Waste Management Method	Annual Quantity Generated (lb/yr)	Annual Waste Management Cost*
Paint waste (paint overstocks)	Plastics parts painting	Returned to supplier for reworking	1,000	$2,250
Paint waste (stripper solids)	Metal parts painting	Shipped offsite as hazardous waste to disposal facility	2,200	1,000
Grease	Assembly operations	Landfilled offsite	1,440	20
Ink waste	Label printing	Shipped offsite to be used as fuel	375	60
Miscellaneous solid waste	Various operations	Landfilled offsite	722,180	18,780

*Includes waste disposal costs.
It is estimated that an additional $119,000/yr is spent on waste management costs such as labor, administration, and record keeping.

Table 2. *Summary of Recommended Pollution Prevention Opportunities*

Pollution Prevention Opportunity	Waste Stream Reduced	Annual Waste Reduction Quantity (lb/yr)	Annual Waste Reduction Per Cent	Net Annual Savings	Implementation Cost	Simple Payback (yr)
Replace the hot caustic and methylene chloride strippers used for stripping paint hooks and painted parts with a plastic media blasting paint stripper. Implementation of this opportunity will lead to the generation of a nonhazardous waste stream of paint chips and spent plastic media.	Solvent waste shipped offsite for recovery Solvent waste shipped offsite to be used as fuel Evaporated solvent Paint waste (stripper solids)	1,320 6,000 40 2,200	7 10 0.2 100	$48,850	$10,800	0.2
Replace existing VMF naphtha parts washers with environmentally preferred solvent washers. Purchase three new parts washers to replace the three washers leased by the plant. Replace the VMF naphtha in all five washers with the preferred solvent.	Solvent waste shipped offsite for recovery	17,400	93	14,050	4,150	0.3
Replace the existing VMF naphtha parts washing service with one that uses petroleum naphtha. The recommended service offers a program in which spent mineral spirits are used directly in asphalt manufacturing.	Solvent waste shipped offsite for recovery	17,400	93	11,510	0	0
Use wringable reusable absorbents and a manual wringer in the metal working and injection molding areas for pick-up of oil from spills.	Waste absorbents	10,040	20	21,260	6,270	0.3

Table 2. *(continued)*

Pollution Prevention Opportunity	Waste Stream Reduced	Annual Waste Reduction Quantity (lb/yr)	Annual Waste Reduction Per Cent	Net Annual Savings	Implementation Cost	Simple Payback (yr)
Contract with a new waste collection service that recovers recyclables from the trash. The generation of solid waste at the plant site will not be reduced, but the quantity of waste landfilled will be reduced.	*Solid waste*	*0*	—-	*$2,040*	*$170*	*0.1*
Purchase and install cardboard balers to permit baling of the scrap cardboard from the plant. Cardboard recovered from the solid waste can be sold as scrap. Implementation of this opportunity will not reduce the generation of solid waste at the plant site, but it will reduce the quantity of waste landfilled.	*Packaging waste (cardboard)*	*0*	—-	*18,060*	*14,600*	*0.8*
Improve the segregation of scrap metal that is sold to the scrap metal dealer in order to increase the revenue the plant receives. Implementation of this opportunity will not lead to reduced waste generation at the plant.	*Scrap metal*	*0*	—-	*4,710*	*6,450*	*1.4*
Sell all pallets which cannot be reused by the plant to a pallet broker/rebuilder. Implementation of this opportunity will reduce the amount of pallets being landfilled.	*Packaging waste (wooden pallets)*	*0*	—-	*1,750*	*0*	*0*
Place the waste material from the gaskets used in the assembly area on a waste exchange. Implementation of this opportunity will reduce the quantity of solid waste landfilled.	*Plastic waste (foam)*	*0*	—-	*690*	*0*	*0*
Use paint pigs in the tank containing recirculated water from the lacquer line to absorb the paint overspray. The saturated pigs can be disposed of through a fuels program and the water can continue to be incinerated, but less frequently.	*Paint waste (water/paint)*	*4,470*	*38*	*6,890*	*0*	*0*

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