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# ENVIRONMENTAL RESEARCH BRIEF

## Waste Minimization Assessment for a Manufacturer of Parts for Truck Engines

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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. In an effort to assist these manufacturers 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 That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992).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 Tennessee performed an assessment at a plant that manufactures turbochargers, fan drives, and vibration dampers for truck engines. Metal castings are machined and cleaned; degreased, coated and/or painted, if required; and assembled, inspected, packaged, and shipped. The team's report, detailing findings and recommendations, indicated that the plant could achieve significant cost savings by replacing its solvent-based painting system with an electrostatic powder coating system, thereby reducing paint overspray.

This Research Brief was developed by the principal investigators and EPA's Risk Reduction Engineering 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 Tennessee'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 waste minimization 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 waste minimization.

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.

### Methodology of Assessments

The waste minimization assessments require several site visits to each client served. In general, the WMACs follow the proce-

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dures 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

The plant manufactures turbochargers, fan drives, and vibration dampers for truck engines. It operates approximately 6,000 hr/yr to produce more than 600,000 units annually.

### *Manufacturing Process*

The major raw materials used by the plant are iron, aluminum, magnesium, and steel castings. Manufactured parts purchased by the plant include bearings, finger sleeves, bands, studs, and rubber strips.

For the production of turbochargers, steel castings undergo a vapor degreasing operation and friction welding. In parallel operations, the steel, aluminum, and iron castings are turned, drilled, tapped, and sent through an alkaline cleaner. The finished parts are assembled into complete turbocharger units, packaged, and shipped.

In the fan drive production line, aluminum, magnesium, iron, and steel castings are turned, drilled, and tapped, resulting in rotors, shafts, and bearing housings. Rotors are sandblasted, vapor degreased, spray-coated with a wear-resistant formulation, and heated in a curing oven. The shafts and bearing housings, after an alkaline cleaning, are assembled with the finished rotors. The finished product is packaged and shipped.

To produce dampers, iron castings are first turned, drilled, and tapped. The parts are cleaned and conveyed through a secondary phosphate etchant. After heating, the parts are primed, coated with rubber, heated again, cleaned, painted, and cleaned again. Finished parts are assembled, packaged, and shipped.

An abbreviated process flow diagram for this plant is shown in Figure 1.

### *Existing Waste Management Practices*

This plant already has implemented the following techniques to manage and minimize its wastes:

- Onsite solvent recovery units are used to distill spent degreasing solvent for reuse.
- Several waste streams, including an anti-rust treatment and cleaning chemicals, have been eliminated from the production process.
- A heat pump evaporator has been purchased for drying of wastewater sludge.
- Waste cardboard is baled and sold to a recycler.
- Waste metals are compacted into blocks and sold as scrap.

## Waste Minimization 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 waste minimization that the WMAC team recommended for the plant. The minimization opportunity, the type of waste, the possible waste reduction and associated savings, and the implementation cost along with the simple payback 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 financial savings of the minimization opportunities result from the need for less raw material and from reduced present and future costs associated with waste management. 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 the savings achievable when implementing each waste minimization opportunity independently 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, two additional measures were considered. These measures were not analyzed completely because of insufficient data, implementation difficulty, or a projected lengthy payback. Since one or more of these approaches to waste reduction may, however, increase in attractiveness with changing conditions in the plant, they were brought to the plant's attention for future consideration.

- Reduce the frequency of leaks and spills of hydraulic oil.
- Dispose of spent coolant through a method other than the onsite wastewater treatment plant.

This research brief summarizes a part of the work done under Cooperative Agreement No. CR-914903 by the University City Science Center under the sponsorship of the U.S. Environmental Protection Agency. The EPA Project Officer was **Emma Lou George**.

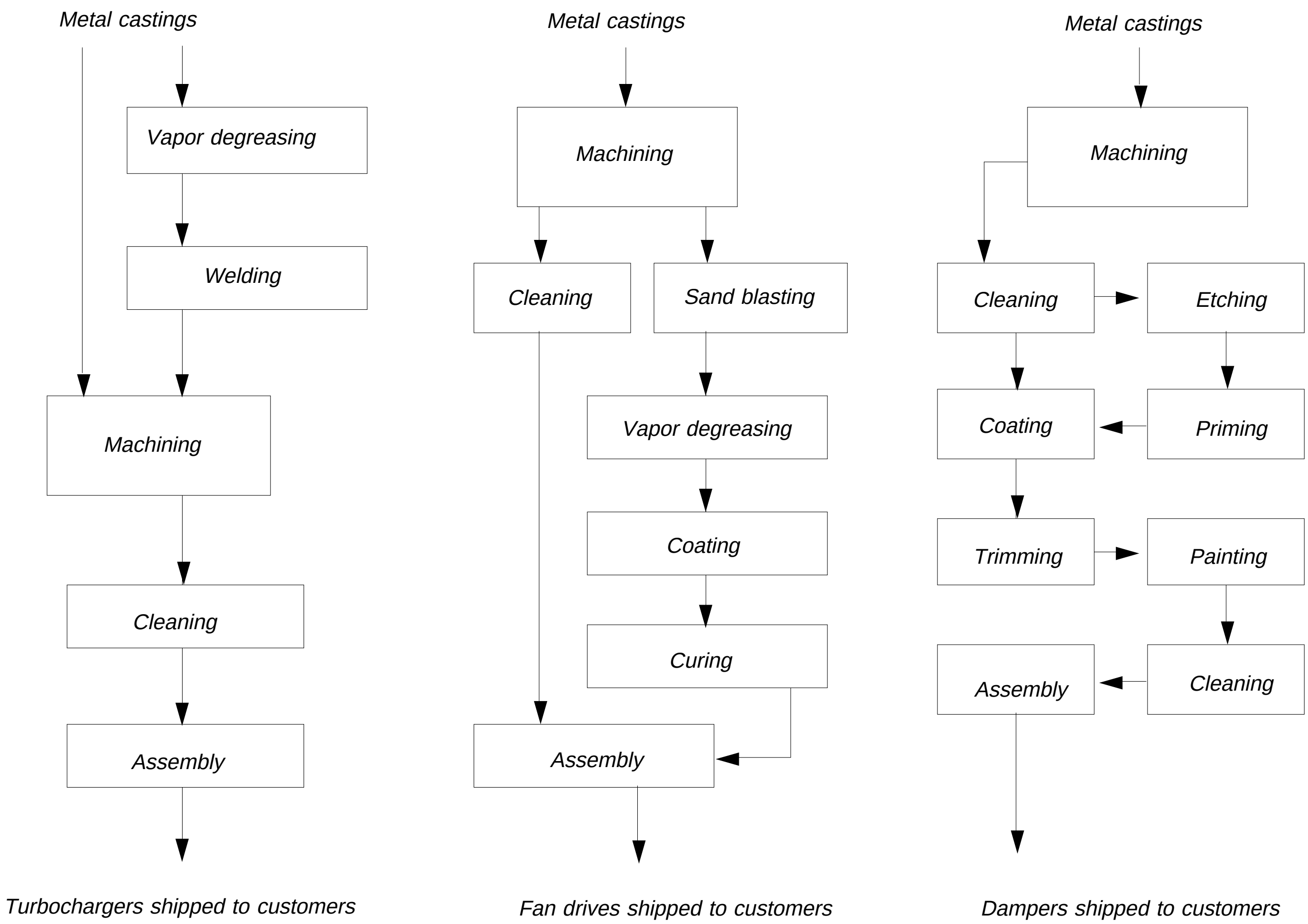


***Figure 1.*** *Abbreviated process flow diagram for truck engine parts manufacture.*

**Table 1.** *Summary of Current Waste Generation*

| Waste Generated | Source of Waste | Waste Management Method | Annual Quantity Generated (lb) | Annual Waste Management Cost[1] |
|---|---|---|---|---|
| Rejected metal castings | Inspection of raw materials | Returned to supplier | 102,800 | $0 |
| Metal chips | Machining operations | Compacted into blocks; sold to recycler | 398,772 | -15,450 |
| Wastewater (contains coolant, alkaline cleaner, iron phosphate cleaner) | Machining operations, cleaning operations, etching | Treated in onsite wastewater treatment plant; sewered | 3,046,080 | 118,820 |
| Evaporated perchloroethylene | Vapor degreasing | Evaporates to plant air | 12,580 | 4,780 |
| Perchloroethylene still bottoms | Onsite recovery unit | Shipped offsite as hazardous waste | 740 | 1,380 |
| Spent hydraulic oil | Machining operations | Shipped offsite as hazardous waste | 23,080 | 1,660 |
| Metal grindings and spent grinding wheels | Grinding of parts | Shipped to landfill | 12,000 | 1,610 |
| Steam-washer sludge | Cleaning of production equipment | Shipped offsite as hazardous waste | 6,000 | 16,450 |
| Spent powder abrasive | Sandblasting | Shipped to landfill | 8,000 | 810 |
| Evaporated “Genesolv” | Vapor degreasing | Evaporates to plant air | 13,400 | 22,520 |
| “Genesolv” still bottoms | Onsite recovery | Shipped offsite as hazardous waste | 590 | 2,170 |
| Unusable Teflon™ dust | Overspray from coating operation | Shipped to landfill | 880 | 2,180 |
| Evaporated mineral spirits | Parts cleaning | Evaporates to plant air | 1,470 | 560 |
| Spent mineral spirits | Parts cleaning | Shipped offsite as hazardous waste | 4,400 | 5,130 |
| Residual primer mixture | Painting | Shipped offsite as hazardous waste | 6,600 | 16,450 |
| Residual adhesive | Overspray from adhesive application | Shipped offsite as hazardous waste | 550 | 1,660 |
| Evaporated toluene | Primer application | Evaporates to plant air | 13,725 | 0 |
| Evaporated methyl ethyl ketone | Adhesive application | Evaporates to plant air | 1,100 | 0 |
| Paint overspray | Painting | Shipped offsite as hazardous waste | 1,000 | 7,530 |
| Paint containers | Painting | Sold to reclaimer | 1,440 | 1,310 |
| Paint filters | Paint spray booths | Shipped offsite as hazardous waste | 30 | 2,980 |
| Evaporated thinner | Painting | Evaporates to plant air | 7,130 | 0 |
| Cardboard | Disassembly of returned parts | Baled; sold to recycler | 24,000 | 1,390 |
| Filters | Wastewater treatment plant | Shipped to landfill | 180 | 6,080 |
| Waste oil | Wastewater treatment plant | Shipped offsite as hazardous waste | 27,950 | 2,020 |

[1]Includes waste treatment, disposal, and handling costs and applicable raw material costs.

***Table 2.*** *Summary of Recommended Waste Minimization Opportunities*

| | | Annual Waste Reduction | | | | |
|---|---|---|---|---|---|---|
| *Minimization Opportunity* | *Waste Reduced* | *Quantity (lb)* | *Percent* | *Net Annual Savings* | *Implementation Cost* | *Simple Payback (yr)* |
| *Reuse treated water from the onsite wastewater treatment facility for mopping and equipment washdown. Discharged water should be monitored for zinc and if the permitted threshold for that constituent is exceeded, the water should be treated accordingly.* | *Wastewater* | *431,600* | *14* | *$2,340* | *$10,900* | *4.7* |
| *Install an electrostatic powder paint coating system to replace the solvent-based spray paint booths used currently.* | *Residual primer mixture*<br>*Paint overspray*<br>*Paint containers*<br>*Paint filters* | *6,600*<br>*1,000*<br>*1,440*<br>*30* | *100*<br>*100*<br>*100*<br>*100* | *59,030* | *46,260* | *0.8* |
| *Install a small distillation unit for the onsite recovery and reuse of spent mineral spirits. A small quantity of still bottoms will be generated and shipped offsite if this opportunity is implemented.* | *Spent mineral spirits* | *4,400* | *100* | *4,430* | *13,320* | *3.0* |
| *Fabricate and utilize conveniently re-movable, lightweight corrosion-resistant plastic covers for the vapor degreasers to reduce evapor-ative losses.* | *Evaporated Genesolv*<br>*Evaporated perchloroethylene* | *6,664*<br>*6,290* | *50*<br>*50* | *13,650* | *440* | *0.1* |

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