Waste Minimization in the Auto Repair Sector

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A three-year research project to investigate waste minimization and pollution prevention opportunities in the state of Nebraska is being conducted by members of the civil engineering faculty at the University of Nebraska. This article discusses the research team's waste assessment for the automotive sector in the state. These facilities produce sizable quantities of solid and liquid waste, some of which are hazardous, although operators of these facilities are often unfamiliar with appropriate disposal and reuse technologies. Nevertheless, there are many incentives motivating these businesses to improve their waste management practices, including the rising costs of landfilling, increasing legal liability associated with the disposal of hazardous wastes, and potential regulatory controls applied to small-quantity generators of hazardous waste.

ALTHOUGH POLLUTION (solid, liquid, and airborne) created by small industrial and commercial entities is not as aggressively managed or regulated as it is for larger industrial facilities, these small-scale polluters generate a substantial amount of hazardous and nonhazardous waste. Most of these facilities fall within this conditionally exempt category.[1]

The Department of Civil Engineering at the University of Nebraska at Lincoln has been involved in research, funded by the U.S. Environmental Protection Agency (EPA) to study the waste management practices of some of these smaller establishments and pollution prevention opportunities in the state of Nebraska. This article presents the results of a review of the segment of this study that focused on waste minimization options in the automobile repair industry.[2]

Automobile repair facilities not only produce sizable quantities of solid and liquid waste, but some of the waste streams also are hazardous. These facilities generally fall under the conditionally exempt or small-quantity generator category where operators often may not be familiar with appropriate disposal and reuse technologies. Nevertheless, there are many incentives for these businesses, particularly those producing hazardous waste, to conduct waste assessments and implement waste minimization programs. The cost of landfill and other disposal options continue to increase, making waste minimization more attractive financially. Second, implementing waste minimization programs may be a regulatory necessity, even for small-quantity generators of hazardous wastes. Third, potential liability associated with exposure to and improper disposal of the hazardous wastes can be decreased if the actual amounts and/or toxicity of those wastes produced are decreased.

As is the case with all waste minimization programs, the goal of

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Table 1. Mechanical Repair Operations

Facility	Vehicles Serviced per Year	Mechanics	Maintenance Bays
A	4,961	5	5
B	9,600	11	28
C	13,590	11	26

this study was to assist auto repair facilities in decreasing the volume and toxicity of their waste streams. This was accomplished by examining options for process modification, feedstock or materials substitution, recycling, equipment upgrading, and better housekeeping. The study also identified wastes that potentially could be considered hazardous. A sampling and waste characterization program was carried out to contribute to a better understanding of the nature of solid wastes produced by the automobile repair sector. For the purposes of this study, automobile repair facilities were divided into two distinct subcategories: (1) mechanical repair and (2) automobile body repair and painting.

Procedures and Methods

The University of Nebraska study was conducted in three parts: pre-assessment, assessment, and post-assessment. During the pre-assessment phase a comprehensive literature review was conducted, with reports reported elsewhere.[3] Several automobile repair facilities were invited to participate in the study; an effort was made to include participants of different sizes and with varying levels of sophistication in waste management and handling procedures. As a final step in the pre-assessment phase, an initial meeting and tour of each participating facility was conducted. This tour helped the assessors characterize the facilities, which included identifying all waste streams produced at these facilities.

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The initial visit was followed by the actual assessment. At this time, the services provided, number of employees, number of vehicles serviced per year, raw materials purchased, types and quantities of wastes generated, equipment used, and current waste disposal practices were recorded for each facility. This information was used when possible to construct materials balances for the assessed facilities. In addition, representative solid waste samples were collected and sorted to determine their recyclable and nonrecyclable content.

During the post-assessment phase, opportunities to implement waste minimization practices were identified and evaluated. This evaluation included the determination of payback periods for pro-

Table 2. Material Usage in Mechanical Repair

Item	*Average use per 1,000 Vehicles*
Parts cleaning solvent	3.6 gallons
Carburetor cleaner	0.6 gallons
Antifreeze	109.0 gallons
Engine oil	491.0 gallons
Power steering fluid	14.9 gallons
Transmission fluid	82.0 gallons
Radiator flush	2.3 gallons
Freon	45.0 gallons
De-greaser	4.4 gallons
Brake fluid	0.8 gallons
Absorbent	591.0 pounds
Batteries	1.7 units
Oil filters	519.0 units

posed purchases of new equipment. For study and reporting purposes, the analyses of the mechanical repair and the body repair and painting areas were separated.

Mechanical Repair Operations

Each of the three participating auto repair facilities was characterized by the number of vehicles serviced per year, the number of mechanics, and the number of maintenance bays. This information is presented in **Table 1**.

The services provided at these facilities included preventive maintenance, transmission maintenance, deep engine repair, brake service, front-end alignment, tune-up, electrical repair, and lubrication. Equipment used at the facilities included sixteen- or thirty-gallon solvent sinks at all three, a high temperature detergent parts washer at Facility B, and freon recycling systems and brake cleaning systems at Facilities A and B.

Material Usage and Waste Production

Raw materials quantified during this part of the assessment program are listed in **Table 2** on a per-thousand-automobile basis.

Waste disposal practices for the materials used in mechanical repair and observed during the study are discussed below. Spent solvent and carburetor cleaner were collected and recycled by a nationally-based recycling firm. Petroleum-based products such as used engine oil, transmission fluid, and brake fluid were stored and picked up by a regional recycling vendor. The liquids were either used as a fuel for energy recovery or refined and reused. Spent antifreeze and spent radiator flush were discharged to the municipal sewer system. Absorbent was used an average of three times at Facility B, then landfilled. Used oil filters at all three facilities were also landfilled. Aerosol degreasers were allowed to evaporate during use. Freon was captured and recycled on-site at Facility C. Finally, old batteries were stored for collection by a local battery recycler.

Existing Waste Prevention and Minimization Practices

All three facilities pursued some form of waste minimization. For example, virgin engine oil, transmission fluid, and lubricant grease were stored in large tanks; the lubricants were transported to mechanics' stations through overhead pneumatic systems at Facilities B and C. The dispensers were equipped with gauges so that exact amounts of fluid could be dispensed. Closed-tip nozzles were used to minimize losses from dripping.

Parts cleaning was performed in solvent sinks. Once the solvent was contaminated, it was collected and recycled. Some solvent was lost as dragout on parts or to direct evaporation.Solvent losses at Facilities A, B, and C were estimated at 22 percent, 28 percent, and 28 percent, respectively.

The average cost of the freon recycling units was estimated at $3,200. Assuming an interest rate of 8 percent, annual proceeds from the sale of recycled freon would have to be $801 to achieve a payback period of five years on the equipment.

As mandated by EPA, freon recycling at facilities servicing more than one hundred automobiles a year was required as of January 1, 1992. Facility C began collecting and reusing freon in the summer of 1990. During that time, eighty pounds were recycled and sold back to customers at $3.00 a pound. The average cost of the freon recycling units was estimated at $3,200. Assuming an interest rate of 8 percent, annual proceeds from the sale of recycled freon would have to be $801 to achieve a payback period of five years on the equipment.

Facility B operated a parts cleaner that used a biodegradable detergent to augment its solvent sinks. The advantage of using this type of unit is reduced dependence on organic solvents and other losses to the environment from the use of these hazardous materials.

Waste Minimization Opportunities

Spent antifreeze is not yet classified as a hazardous waste by the state of Nebraska. However, some states, including California, have classified antifreeze as hazardous because of its toxicity if ingested. In California, spent antifreeze reportedly is collected, distilled, and

Table 3. Spent Antifreeze Production and Resale Potential

Facility	*Spent Antifreeze (gallons/year)*	*Estimated Resale Value ($)*
A	360	1,800
B	1,200	6,000
C	1,626	8,130

augmented with additives before resale for as much as $5.00 per gallon.[4]

Collection of spent antifreeze recently has become available as a service in Nebraska. At the time of the study, the recycling firm was instituting a program in which it would pick up the antifreeze free of charge and reportedly redistill and resell it. This service gives auto repair facilities an alternative to the current practice of disposing antifreeze into municipal wastewater collection systems. **Table 3** lists the estimated quantities of spent antifreeze produced at the three facilities along with its estimated resale value. (The cost of spent antifreeze reclamation was not included in this estimate.)

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Approximately 2,800, 4,000, and 5,000 gallons of spent petroleum-based products (mostly spent engine oil) were collected in 1990 from Facilities A, B, and C, respectively. Although this practice does result in the reuse of the recovered material, there is also the potential for on-site use of the waste oil as heating fuel during the winter. If used in an EPA-approved waste oil heater, the waste oil has a heating value of sixty cents a gallon when compared to the cost of natural gas (at prevailing midwestern natural gas prices as of June 1991). A heating cost analysis for all three facilities was performed using one popular waste oil furnace with an installed cost of $9,995. At an assumed annual interest rate of 8 percent and including appropriate operation and maintenance costs, payback periods of 8.8, 4.7, and 4.3 years were estimated for Facilities A, B, and C, respectively. The shorter payback period for Facility C resulted from the fact that it produced more waste oil than the other two.[5]

Another high-potential area for waste reduction pollution prevention was the handling of used oil filters discarded in a trash receptacle. For example, gravity draining of a medium-sized oil filter can result in the recovery of about ten ounces of oil.[6] When the filters are discarded directly to the refuse container, this residual oil ends up in the landfill. This oil is known to contain varying concentrations of lead, cadmium, chromium, arsenic, and barium, all of which are listed hazardous constituents.[7]

Oil filters also can be crushed, a process that can recover an additional 6.5 ounces of used oil. Assuming all the filters at the three facilities were gravity drained and crushed, a total of 368 gallons of oil could be recovered at Facility A, 453 gallons at Facility B, and 1,023 gallons at Facility C. This oil could then be used in the waste oil heaters or reclaimed at a recycling facility. Most importantly, it would not go to the landfill. It should be noted that many states, including Nebraska, have already banned, or are in the process of banning, oil filters from their landfills because of the waste oil hazard.

Facilities B and C did not use brake cleaning equipment. Instead, they used an aerosol solvent brake cleaner. Facility C estimated its usage of this cleaner at 9.2 gallons per month. This practice not only results in solvent loss to the environment, but also can result in the release of asbestos from the brake shoes and pads. The purchase and use of enclosed brake cleaning systems was strongly recommended.

Facility B used one high-temperature detergent-based parts washer in place of a solvent-based washer. This was an example of materials substitution where water and detergent were used in place of potentially toxic solvents. After use, the water and oil were allowed to separate. The water was discharged to the sewer and the skimmed oil was stored for recycling. In these systems, care must be taken to avoid the release of oil with the water discharged to the sewer.

Several other potentially hazardous materials were used at all three facilities. These included choke and carburetor aerosol cleaners, aluminum brighteners, and a compound used to remove a coating applied to automobiles for protection during shipping. Less hazardous substitutes for these materials need to be found, or in the case of the protective covering, the practice could be discontinued.

Solid waste stream assessment

As indicated earlier, automobile repair facilities produce large volumes and weights of solid waste. To determine the makeup and potential to reduce this waste stream, representative samples of solid waste were collected from the three facilities, sorted, and weighed. Although not all the solid waste was collected, there was sufficient data to allow the assessment team to estimate the total waste generation and its components at all three facilities. These estimates are shown in **Table 4**. All noncontaminated metals, cardboard, paper, and plastics were assumed to be recyclable. The most voluminous component of the solid waste stream was cardboard used in the shipment of automobile parts.

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The weights given in Table 4 show that the percentage of recyclable material was estimated at 66 percent (Facility A), 58 percent (Facility B), and 77 percent (Facility C) of total waste production. If these three facilities recycled these materials, approximately 89,000 pounds of waste could be diverted away from the landfill every year.

Body Repair and Painting Operations

Two of the three participants in the study also operated body repair and painting facilities. These facilities are described in

Table 4. Solid Waste Generation Rates

	Projected weight (pounds/year)			
Facility	Metal	Cardboard and Paper	Plastic	Non-Recyclable
A	11,050	5,200	3,900	9,750
B	14,880	5,925	7,970	22,000
C	28,314	6,800	5,400	12,300

Table 5 by the number of vehicles serviced and the number of mechanics and painters employed. Operations at these facilities consisted mainly of repairing or replacing body parts damaged in accidents or parts with rust-through that also needed painting.

Material usage and waste production

The raw materials quantified during the assessment are listed in **Table 6** on a per-thousand-automobile basis. Waste products produced during operations in the body shop included filler dust, paint-contaminated waste thinner, and unused paint. Because of the hazardous nature of wastes from painting operations, these materials were being managed or recycled in some manner.

Established waste minimization practices

During this study, Facility B reused both waste thinner and waste paint sludge on-site. This was made possible by a recent purchase of an in-house waste thinner recycling machine. The device distilled contaminated high-grade thinner which, in turn, was used as low-grade thinner, primarily for equipment cleaning and occasionally during primer applications. According to another study of waste streams in automotive paint shops, at least five gallons of spent thinner can be redistilled into 4.5 gallons of low-grade thinner leaving

Table 5. Body Repair and Painting Operations

Facility	***Vehicles Serviced per Year***	***Mechanics***	***Maintenance Bays***
A	800	2	3
B	1,200	2	3

Table 6. Materials Usage in Body Repair and Painting Operations

Item	*Average Use per 1000 Vehicles (gal.)*
Fiberglass resin	0.6
Filler	60.0
High-grade thinner	30.0
Low-grade thinner	187.5
Lacquer thinner	110.0
Urethane paint	27.0
Urethane catalyst	5.4
Surface primer	110.0
Retarder	27.0
Rubbing compound	6.7
Wax	1.7

.5 gallons of paint sludge.[8] Filler sandings can be mixed with the paint sludge and used as a protective undercoating on automobiles. The use of the recycling system at this facility eliminated the need to purchase low-grade thinner, at a savings of $180 in direct material expenses and an additional $150 in off-site recycling costs per year.

During this study, Facility C recycled spent high-grade thinner through a local company that sent it away for reprocessing, where it was distilled and upgraded with additives such as 2-butanol and resold as high-grade thinner.

As far as the painting process is concerned, Facility B previously used only quart-sized paint sprayers. Use of these sprayers often left large amounts of paint in the containers at the end of a job. Recently, Facility B purchased smaller containers (e.g., seven- and twenty-ounce sizes); a practice that minimizes the amount of contaminated thinner and unused paint produced. In some cases, if owners were not particular about the color, unused paint was stored and mixed together to paint older automobiles. This eliminated the need to discard most of the paint waste.

Finally, at Facility B, the high-grade thinner was stored in fifteengallon containers. These containers were equipped with spigots, which minimized losses during transfer and allowed the painters to withdraw only the required amount.

Because of the hazardous nature of the wastes produced during the painting of automobiles, it seems likely that most facilities will be required to implement some form of waste management and waste minimization.

Waste minimization opportunities

Facility B appeared to be taking all necessary measures to minimize its waste. Facility C, however, would have benefited from the purchase of an on-site thinner distillation apparatus and smaller paint spray containers. Because of the hazardous nature of the wastes produced during the painting of automobiles, it seems likely that most facilities will be required to implement some form of waste management and waste minimization. In addition to using smaller paint sprayers and redistilling used thinner, paint shops should consider using low-volume, high-pressure sprayers to minimize overspray, and paint booths with filters to minimize the releases of paint particles to the atmosphere.

Solid waste stream assessment

Analysis of samples of solid waste produced in the body repair and painting operations at Facilities B and C indicated that most of the solid waste discarded was not reusable on-site or recyclable. Solid waste from the painting and body repair facilities was made up of paint-contaminated tape and paper, empty paint cans, cardboard, scrap metals, and plastics. Most of these materials also were contaminated with filler dust. Many of the plastic and metal parts were sharp or difficult to separate from each other. The only items being recycled were bumpers that were sent to a local company for restoration and reuse. If the cardboard, metal, and recyclable plastics remained uncontaminated, they could be recycled along with materials produced in the mechanical repair facilities.

Conclusions

Although the automobile repair sector is not yet required by law to implement waste prevention and minimization measures, these establishments could benefit greatly if such practices were universally adopted. This study revealed that these facilities produce large quantities of waste, some of which are hazardous. In particular, organic solvents are used to clean dirty parts and as part of the painting and subsequent cleanup process. In addition, automotive oil waste is produced in large quantities during engine repair and routine oil and filter changes.

Automobile repair and painting facilities need to reclaim and reuse waste liquids either on-site or through recycling vendors to minimize the release of potentially hazardous materials to the environment. Waste oil can be burned in specifically-designed EPA-approved waste oil heaters, reducing the heating costs at these facilities. Solvents can be redistilled and reused on-site for parts cleaning. Some of the liquid waste, such as antifreeze, which typically is discharged to municipal sewer systems, may come under stricter control in the future.

Substantial amounts of cardboard, plastic, and scrap metal also are produced at automobile service and repair facilities. Efforts should be made to identify local recycling vendors to pick up these materials and thus divert them away from landfills.

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As can be seen from the results of this study, the key to developing a waste minimization program is to identify and isolate the types and quantities of waste being produced. This principle applies to all categories of industries and businesses. Many establishments deal with solvents and paint wastes, and all generate solid waste in the form of paper, cardboard, and so on. The same waste minimization practices proposed here could be applied in many other cases.

Support for establishing in-house waste minimization programs is often available through such mechanisms as technical information clearinghouses and government-assisted waste assessments. Nebraska is currently establishing a recycling information clearinghouse and waste exchange in the Department of Environmental Quality under the Pollution Prevention Project. The availability of private recycling services also is increasing, which takes the burden of direct reuse or disposal off the generator. By using these and other resources, and implementing material substitutes and process changes, most businesses should be able to dramatically reduce their waste output. ◆

Notes

1. See *Pollution Prevention Review*, Summer 1992, pp. 287-96 and 311-30.

2. Another article from this project, prepared by faculty at the University of Nebraska, discusses solid waste management techniques at several grocery stores in the state. Dahab, M.F., H.C. Johnson, and D.R. Andersen, "Case Study: Solid Waste Management: A Study of Grocery Stores in Nebraska," *Pollution Prevention Review*, Vol. 2, No. 1 (1992), pp. 85-93.

3. Gouger, T., "Waste Minimization Opportunities for the Vehicle Repair Industry," Master of Science Thesis, Department of Civil Engineering, University of Nebraska-Lincoln (Dec. 1991).

4. Romic Chemical Company, Personal Communication with Mr. Snyder (Jan. 1991).

5. See Gouger (cited in note 3).

6. Konefes, J.L., and J.A. Olson, "Motor Vehicle Oil Filter Recycling Demonstration Project," Iowa Waste Reduction Center, University of Northern Iowa (1990).

7. See Konefes and Olson (cited in note 6).

8. Stearns, Conrad, and Schmidt Engineers, "Waste Audit Study: Automotive Paint Shops," prepared for the California Department of Health Services, File No. 18626 (Jan. 1987).