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EPA ENVIRONMENTAL RESEARCH BRIEF

Waste Reduction Activities and Options for a State Department of Transportation Maintenance Facility

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Abstract

The U.S. Environmental Protection Agency (EPA) funded a project with the New Jersey Department of Environmental Protection and Energy (NJDEPE) to assist in conducting waste minimization assessments at 30 small- to medium-sized businesses in New Jersey. One of the sites selected was a State Department of Transportation (DOT) maintenance facility. The assessment process was coordinated by a team of technical staff from the New Jersey Institute of Technology (NJIT) with experience in process operations, basic chemical experience, and knowledge of environmental concerns and needs. A site visit was made in 1990 during which several opportunities for waste minimization were identified. These opportunities include antifreeze reconditioning and reuse, capture and reuse of chlorofluorocarbons (CFC's) from vehicle air conditioning systems, and modified spray-painting techniques. Implementation of the identified waste minimization opportunities was not part of the program. Percent waste reduction, net annual savings, implementation costs, and payback periods were estimated.

This Research Brief was developed by the Principal Investigators and EPA's Risk Reduction Engineering Laboratory in Cincinnati, OH, to announce key findings of this completed assessment.

Introduction

The environmental issues facing industry today have expanded considerably beyond traditional concerns. Wastewater, air emissions, potential soil and groundwater contamination, solid waste disposal, and employee health and safety have become increasingly important concerns. The management and disposal of hazardous substances, including both process-related wastes and residues from waste treatment, receive significant attention because of regulation and economics.

As environmental issues have become more complex, the strategies for waste management and control have become more systematic and integrated. The positive role of waste minimization and pollution prevention within industrial operations at each stage of product life is recognized throughout the world. An ideal goal is to manufacture products while generating the least amount of waste possible.

The Hazardous Waste Advisement Program (HWAP) of the Division of Hazardous Waste Management, NJDEPE, is pursuing the goals of waste minimization awareness and program implementation in the state. HWAP, with the help of an EPA grant from the Risk Reduction Engineering Laboratory, conducted an Assessment of Reduction and Recycling Opportunities for Hazardous Waste (ARROW) project. ARROW was designed to assess waste minimization potential across a broad range of New Jersey industries. The project targeted 30 sites to perform waste minimization assessments following the approach outlined in EPA's *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003). Under contract to NJDEPE, the Hazardous Substance Management Research Center at NJIT assisted in conducting the assessments. This research brief presents an assessment of a State Department of Transportation maintenance facility (1 of the 30 assessments performed) and provides recommendations for waste minimization options resulting from the assessment.

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Methodology of Assessments

The assessment process was coordinated by a team of technical staff from NJIT with experience in process operations, basic chemistry, and environmental concerns and needs. Because the EPA waste minimization manual is designed to be primarily applied by the in-house staff of the facility, the degree of involvement of the NJIT team varied according to the ease with which the facility staff could apply the manual. In some cases, NJIT's role was to provide advice. In others, NJIT conducted essentially the entire evaluation.

The goal of the project was to encourage participation in the assessment process by management and staff at the facility. To do this, the participants were encouraged to proceed through the organizational steps outlined in the manual. These steps can be summarized as follows:

- Obtaining corporate commitment to a waste minimization initiative
- Organizing a task force or similar group to carry out the assessment
- Developing a policy statement regarding waste minimization for issuance by corporate management
- Establishing tentative waste reduction goals to be achieved by the program
- Identifying waste-generating sites and processes
- Conducting a detailed site inspection
- Developing a list of options which may lead to the waste reduction goal
- Formally analyzing the feasibility of the various options
- Measuring the effectiveness of the options and continuing the assessment.

Not every facility was able to follow these steps as presented. In each case, however, the identification of waste-generating sites and processes, detailed site inspections, and development of options were carried out. Frequently, it was necessary for a high degree of involvement by NJIT to accomplish these steps. Two common reasons for needing outside participation were a shortage of technical staff within the company and a need to develop an agenda for technical action before corporate commitment and policy statements could be obtained.

It was not a goal of the ARROW project to participate in the feasibility analysis or implementation steps. However, NJIT offered to provide advice for feasibility analysis if requested.

In each case, the NJIT team made several site visits to the facility. Initially, visits were made to explain the EPA manual and to encourage the facility through the organizational stages. If delays and complications developed, the team offered assistance in the technical review, inspections, and option development.

Transportation Maintenance

The major activity at the facility is the maintenance of vehicles used by the Department, including automobiles and trucks, and to a more limited extent, large machinery used by the Department such as mowers. Other activities that are carried out at the facility include wood shop, metal shop, and collection and reuse or disposal of no longer useful materials. Because of the diversity of the activities at the facility, it is difficult to develop a unified schematic plan of material flow and waste generation. Therefore, each operating area was examined individually for the purpose of identifying waste reduction opportunities.

The management of the facility has already taken solid constructive action to strengthen waste management practices and to institute waste reduction policies. For example, used oil and tires are forwarded to a vendor for recycling. There is a strong effort to identify and begin to use materials with reduced levels of toxicity in the facility's operations. Moreover, it is clear from discussions with the management and personnel at the facility that there is a commitment to the concept of pollution prevention and to putting it to work in their operations.

Waste Reduction Opportunities

Oil

From 12 maintenance facilities in the DOT system, approximately 14,000 gal of used oil are produced each year. More than half of that amount is generated at three facilities. The study facility during fiscal year 1989 generated approximately 2700 gal of used oil. As indicated previously, the facility practices recycling as the preferred management technique for waste oil.

The oil handling procedure at present is to collect used oil in small drums near work stations and to periodically, or as needed, transfer the contents to a larger storage tank. When that larger tank is filled a contracted recycler removes the contents and takes it offsite.

While this handling approach is reasonably routine and in keeping with industry practices, three challenging concerns were identified which, if addressed, have potential for improving the overall effectiveness of this waste reduction initiative. The recycler occasionally observes that the storage tank contains oil/water mixtures. The presence of such mixtures will, in the best case, reduce the value of the used oil or, in the worst case, cause the recycler to reject the entire contents. Such rejection results in a substantial quantity of waste that would have to be treated as a hazardous waste. It is important, therefore, to determine the source of the water and to modify procedures to reduce the chances of introducing water into the oil.

The cause of the water entering the oil has not been investigated, therefore, it is not known precisely what happens at this facility. There are three possible sources of water that could lead to this situation. Water may be mixing with the oil while it is in the vehicle. This would probably be a rare situation. When encountered, it is recommended that the drained oil be maintained separately from the bulk of the oil awaiting pickup for recycling. Such separation would minimize the volume of the mixture, protecting the value of the larger quantity of used oil and minimizing the quantity of material that may need special handling. Alternatively, water may be entering the oil during the time it is kept in the smaller receiving containers near the work stations. This would imply that water is being added to the containers. If the addition is being done by employees for the sake of convenience, it is recommended that a two-fold initiative be undertaken to inform the technical staff of the importance of keeping water from the oil and to assure that there are convenient and appropriate alternative disposal routes for aqueous wastes. There is also a possibility that water enters the collection containers as a result of precipitation leaking in while the containers are exposed to the elements while awaiting transfer to the large collection tank. In this event, it would be important to assure that appropriate covers are available for each of the small collection containers and that the covers are used effectively and regularly.

The third possibility is that the large collection tank itself is used in such a way that water can occasionally enter. Possibilities that could be checked include accidental addition of waste streams other than used oil, precipitation entering the tank because of leaking covers or seals, and other leaks in the body of the tank itself. Because the appearance of the oil/water mixture is sporadic, it seems most likely that the cause is one of occasional leaks from an improperly closed cover or an accidental addition by a staff member.

The second concern deals with the relationship between the generator and the contractor who has the responsibility to pick up the collected waste oil and to take it offsite for processing. To assure the smooth and effective operation of the recycling process, it is important that the large collection tank be emptied before it is completely full. This not only demonstrates to the staff of the facility that the recycling process is working but continues to provide capacity for the used oil generated from ongoing vehicle maintenance activities. When the large tank is not emptied regularly, an unintentional, but strong, message is sent to the staff that the management of the facility does not consider oil recycling to be a particularly important activity and interest and compliance on the part of the staff will fall off. Because of difficulties within the purchasing process in bidding and contracting for the services of an oil recycling vendor, and not because of disinterest by management, the large tank is not always regularly emptied. It is recommended that this process be reexamined from the perspective of making it more responsive to the time needs of the capacity of the tank and to the incentives for encouraging responsible waste reduction actions on the part of the staff.

The third area of concern is that of oil spills. Certainly, any spilled oil which cannot be recovered in an appropriate physical condition cannot be recycled. Currently oil spills are managed with an adsorbent material such as "Speedy-dry*," which is sprinkled over the spill, swept up, and treated appropriately. There are three major sources for such spills: 1) inability to collect all of the used oil draining from a vehicle being serviced, 2) oil dripping from engine parts, and 3) leaks and spills occurring during oil transfer. The source of most of the spills could not be identified within the limited timeframe of conducting the assessment. Observation or record keeping of spill causes should aid in pinpointing possible corrective actions. For example, if spills occur during drainage, it may be desirable to use a larger catch basin to facilitate lining it up with the drain on the engine. It may be advantageous to encourage the use of metal or plastic pans to receive oily engine parts and disposable parts such as oil filters to assure that any oil which leaks from them can be recovered and added to the recycling stream. In general, most identifiable spills occur during the transfer of materials from one container to another or in the process of moving materials from one place to another. To promote spill prevention, therefore, it is important to minimize such transfers. Where it is necessary to transfer used oil from one container to another, it is desirable to use a drip pan or spill collector to retain any spillage and allow it to be returned to the recycling stream. When it is necessary to move containers, the moving process should use closed containers to prevent liquid loss and should minimize the chances of the containers tipping or falling.

A longer-term option leading to reduction in oil usage could be explored. It is certain that if the time between oil changes could be lengthened, then less used oil would be generated. Lengthening the time between oil changes, however, is a difficult unilateral move by those responsible for vehicle maintenance. There are potential complications with engine warranty conditions; motor oil manufacturers may need to change their formulations and product use recommendations. The issue may be an important one to raise and may have more impact if operators of large vehicle fleets or associations of such large users bring it to the attention of the appropriate manufacturers and encourage them to respond.

Antifreeze

Engine antifreeze is typically a solution of ethylene glycol in water and also contains certain additives to inhibit corrosion. Current practice is to drain the cooling system periodically and to replace the antifreeze solution with fresh liquid, discarding the old. Records available at the facility demonstrate that over the period 1985 through 1989, an average of 5100 gal/yr of antifreeze was purchased for use throughout the network of maintenance facilities. Usually, about 40% of all such purchases are used at the facility studied. Therefore, we can assume that about 2000 gal/yr of commercial antifreeze is used there. Of course, the volume of the waste stream would be larger because the coolant in the engine is a water solution, often about a 1:1 mixture.

There could be a significant impact on the quantity of waste generated from the facility by initiating a program leading to reuse or recycling of the antifreeze solution that is drained from vehicle engines. There are commercial systems available that will prepare drained antifreeze solution for reuse by filtration, pH adjustment, and additive addition, if necessary. In addition, more glycol can be added if necessary to maintain a low freezing point.

In theory, such reconditioning and reuse could continue indefinitely. Purchase and use of virgin ethylene glycol should decrease significantly. This reuse approach should result in savings from avoided replacement costs and from avoided disposal costs. It is recommended that use of such a system be considered.

Freon and Other Chlorofluorocarbons (CFC's)

Freon and other CFC's are present at the facility because of their use in vehicle air conditioning systems. They have been recognized as significant contributing factors in the depletion of ozone in the upper atmosphere. International accords have been signed leading to controls on the production and use of these materials. The primary effect of the accord will be to limit severely the production of the CFC's that will have the secondary effect of raising the price of the materials. Therefore, in addition to the major importance of preventing the release of the CFC's for environmental reasons, there will be a significant economic incentive to encourage recovery and reuse of these materials.

* Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Based upon purchase data, the use of CFC's at the facility is about 140 lb/yr. As is typical for the vehicle maintenance industry, there are two substantial pathways for the loss of the material to the atmosphere. The first is loss through leaks that develop in the air conditioning systems in the vehicles. Frequently, the vehicles are presented for servicing with the complaint that the air conditioning system is not working, usually because a large proportion of the CFC charge has leaked out. The second pathway results from what has been in the past an industry-wide repair procedure of recharging the system with fresh CFC, locating the leak, discharging the CFC to the atmosphere, repairing the leak, and recharging the system with fresh CFC. Occasionally, it has been necessary to repeat the procedure when the system had more than one leak.

Two options can be proposed to address these procedures. Loss prevention through leak prevention appears to have potential for reduction in the use of CFC. This would require development of a regularly scheduled preventative maintenance inspection of all vehicle air conditioning systems to guard against the development of major leaks. Second, during the repair stage, rather than venting CFC to the atmosphere, it would be preferred to use a commercial CFC capture and reuse device. Such devices are capable of connection to the vehicle system for recovery of the CFC and have the ability to purify the material to quality standards that qualify it for reuse.

Paint

The painting operations at the facility have a relatively small volume of throughput because the staff is responsible not only for coating application but for surface preparation as well. The relatively small quantity of wastes from the surface preparation activities is largely handled as solid waste. Any wastes such as paint strippers containing solvents that may be hazardous are treated appropriately. The larger quantity of wastes comes from the painting operation itself. A wide variety of objects are painted during the year requiring that several varieties of coatings be kept on hand. Nevertheless, the painting operation has also made constructive steps in the direction of pollution prevention by shifting away from solvent-based coatings to water-based materials. Current stocks of coatings include 85 gal of water-based paints and 215 gal of solvent-based paints.

The movement away from solvent-based coatings will become easier as manufacturers broaden the availability of water-based coatings with necessary performance characteristics. Reduction in the use of solvent-based coatings can be expected to reduce the quantity of solvent released to the atmosphere and reduce the volume of solvent used for equipment cleaning.

Because much of the painting is done using spray techniques, there is value in considering options that have potential to reduce the quantity of waste generated as a result of overspraying. While it was not possible to determine the amount of coating lost at this facility due to overspraying, in some studies, losses of up to 50% of the coating used have been found. Some options that have potential to reduce overspray include use of electrostatic spray systems, use of air-assisted airless spray guns in place of air spray guns, and reduced air pressure in the coating system.

Tires

There is an active program for recycling used tires. The study facility serves as a collection point for used tires from throughout the system. A contractor periodically picks up the collected tires and takes them offsite for recycling. About 95% of the tires are obtained from the vehicles of the Department, the other 5% are found abandoned along the roadside.

It is assumed that the recycling contractor removes any recappable tires from the collection before beginning any destructive recycling process. Typically, tires from large vehicles have more value after recapping than do automobile tires because of lack of commercial demand for the latter. The accumulated tires at the facility represent a very broad range of types and sizes because of the diversity of vehicles which the organization uses. Moreover, because of the frequency with which the vehicles drive near curbs in carrying out their activities, there is an increased amount of sidewall wear as compared with tread wear that would be observed in a more typical on-the-road vehicle. This increased level of sidewall wear would be expected to reduce the potential for recapping, which depends upon a satisfactory sidewall integrity.

A potential waste reduction option would be to increase the useful life of the tire in service on the vehicle. In those situations where tires eventually must be replaced because of sidewall wear, a modified tire rotation procedure of actually turning the tire around to equalize wear on both sides of the tire may extend the life. Obviously, this needs to be done in such a way that safety issues are not compromised. Additional emphasis in training programs concerning the importance of avoiding contact with curbs may also have a beneficial effect.

Drums and Containers

As part of a concerted waste management initiative for the facility, a drum-crushing apparatus has been acquired. It is proposed to use the device to reduce the volume of waste from this source as well as other departments in the organization. While the use of such a device has potential for making this waste stream more manageable, it cannot be considered a waste minimization option. It is a volume reduction activity. Furthermore, it has potential for additional complexities. Clearly, staff will have to be trained in the proper operation of the equipment as well as in proper sorting and separation of drum types that will facilitate the reuse of the materials of construction of the crushed drums.

In addition, it will be important to develop procedures to àssure that any residues of hazardous materials have been removed from the containers before crushing. This will require some training to assure employee identification of any containers that may have held hazardous materials. In some situations, the containers may require triple rinsing to assure removal of the contents. Ideally, such rinsing should be done at the operating facility where the container is emptied. Moreover, the rinses may have to be handled as a hazardous waste and in any event will require appropriate environmental management.

A better approach would be to look at two other options for drum management that may reduce the number of waste drums. One approach would be to consider the reuse of the containers either within the facility or through a drum salvage company. A second option would be to require the purchase of materials in returnable containers that are sent back to the manufacturer for refilling when empty. Many suppliers are now offering this shipping arrangement.

Other Waste

The facility serves as a collection point for other types of scrap such as damaged traffic control devices including aluminum poles. Similar types of wastes can come from the metal shop at the facility. It is expected that periodically a contractor will remove these materials from the site for recycling. There appears to be an operational problem here, however, again related to the contracting procedures. Lengthy delays have been encountered in identifying and contracting with an appropriate recycling outlet. These delays can result in the accumulation of more material at the facility than can be appropriately housed. When storage capacity is exceeded, a powerful psychological disincentive to waste minimization is sent to the staff, by raising questions about the level of commitment of management to the concept. It is recommended that contracting procedures be reviewed to overcome this complication.

Training and Employee Incentives

An ultimate goal of an organizational waste reduction/pollution prevention program is to institutionalize it, that is, to make the idea of waste reduction a part of the everyday thinking and actions of each employee. A key aspect of this has been found to be a training program for every employee. The training could include discussions and illustrations of the corporate commitment to waste reduction, the types of waste currently generated at the facility and the areas within the facility where they are generated, the methods of storage, treatment, and disposal required for these wastes, the costs of treatment and disposal, and some examples of waste reduction success stories at the facility or at other corporate sites. Such training could be incorporated into the general employee safety training programs at the facility.

Some discussion of the importance of each employee to the continuing waste reduction effort is also valuable. Companies such as DuPont, Monsanto, Dow Chemical, and 3M have found that the development of an incentive and recognition program for waste reduction ideas developed and submitted by employees has been very successful. Obviously, the employees who carry out the activities are the ones most directly responsible for generating waste. They typically have the best ideas for reducing the amount of waste created. The companies named above, among others, reward such ideas monetarily or provide other recognition in newsletters or posters. A similar program at this facility might have value.

Because a waste reduction program is not a one-time activity, continuous employee training and awareness raising is important. Regular monitoring and reporting of waste reduction results can facilitate the on-going effectiveness of the program with employees.

Conclusion

The waste reduction opportunity assessment process has confirmed that the facility has already initiated several positive actions leading to waste reduction/pollution prevention. Several options have been identified that could result in additional reductions in waste generation in the areas of used oil, antifreeze solution, CFC's, and coatings. Some administrative complexities in the area of contracting with recycling facilities have also been identified.

It is recommended that the feasibility of these options be investigated by the facility. It is further recommended that employee training programs be broadened to include more material on the importance of pollution prevention actions within the facility.

Summary of Waste Minimization Opportunities

Table 1 presents the type of waste currently generated by the plant, the sources of waste, the quantity of waste, and the annual treatment and disposal costs (where known and available).

Table 2 presents the opportunities for waste minimization identified during the assessment. The types of waste, the minimization opportunities, and possible waste reductions are presented in the table. When available or estimable, the associated savings, implementation costs, and payback times are usually determined. However, because the feasibility analysis was to be carried out by the staff of the facility, that information was not readily available for this assessment.

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Table 1. *Summary of Generated Wastes*

Waste Generated	*Source of Waste*	*Annual Quantity Generated*	*Annual Costs*
Waste oil	*Motor vehicle engines*	*2700 gal*	*($54 profit)*
Antifreeze solution	*Motor vehicle engine cooling systems*	*4000 gal*	*$7,300*
Chlorofluorocarbons	*Motor vehicle air conditioning systems*	*130 lb*	*No management cost*
Paint Solvents	*Spray painting operation*	*300 gal*	*No management cost*

Table 2. *Summary of Waste Minimization Options Identified*

Waste Generated	Minimization Opportunity	Annual Waste Reduction		Net Annual Savings	Implementation Cost	Payback Years*
		Quantity	Percent			
Waste Oil	Fluid analysis to stretch out oil changes. Control water content of used oil.	675 gal	25	$ 2,690**	$ 5,000	2.0
Antifreeze Solution	Initiate use of reconditioning and reuse technology.	4000 gal	100	7,300	12,000	1.7
Chlorofluorocarbons	Initiate use of capture and reuse technology.	130 lb	100	1,300	5,000	3.8
Paint Solvents	Continue change to water based coatings. Use new hardware to minimize over spray.	100 gal	33	600	1,300	2.1

*Savings result from reduced raw material and treatment and disposal costs when implementing each minimization opportunity independently.
** After the initial fluids analysis cost, there will be continuing costs for more analyses and improved record keeping.

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